

# DM385 and DM388 DaVinci™ Digital Media Processor

Check for Samples: [DM385](#), [DM388](#)

## 1 High-Performance System-on-Chip (SoC)

### 1.1 Features

- **High-Performance DaVinci Digital Media Processors**
  - Up to 1000-MHz ARM® Cortex™-A8 RISC Processor
  - Up to 2000 ARM Cortex-A8 MIPS
- **ARM Cortex-A8 Core**
  - ARMv7 Architecture
    - In-Order, Dual-Issue, Superscalar Processor Core
    - NEON™ Multimedia Architecture
    - Supports Integer and Floating Point
    - Jazelle® RCT Execution Environment
- **ARM Cortex-A8 Memory Architecture**
  - 32KB of Instruction and Data Caches
  - 256KB of L2 Cache with ECC
  - 64KB of RAM, 48KB of Boot ROM
- **256KB of On-Chip Memory Controller (OCMC) RAM**
- **Imaging Subsystem (ISS)**
  - **Camera Sensor Connection**
    - Parallel Connection for Raw (up to 16-Bit) and BT.656/BT.1120 (8- or 16-Bit)
    - CSI2 Serial Connection
  - **Image Sensor Interface (ISIF) for Handling Image and Video Data From the Camera Sensor**
  - **Image Pipe Interface (IPIPEIF) for Image and Video Data Connection Between Camera Sensor, ISIF, IPIPE, and DRAM**
  - **Image Pipe (IPIPE) for Real-Time Image and Video Processing**
  - **Resizer**
    - Resizing Image and Video From 1/16x to 8x
    - Generating Two Different Resizing Outputs Concurrently
    - Hardware 3A Engine (H3A) for Generating Key Statistics for 3A (AE, AWB, and AF) Control
- **Face Detect (FD) Engine**
  - **Hardware Face Detection for up to 35 Faces Per Frame**
- **Programmable High-Definition Video Image Coprocessing (HDVICP v2) Engine**
  - Encode, Decode, Transcode Operations
  - H.264 BP/MP/HP, MPEG-2, VC-1, MPEG-4 SP/ASP, JPEG/MJPEG
  - Fourth-Generation Motion-Compensated Noise Filter (DM388 Only)
- **Media Controller**
  - Controls the HDVPSS, HDVICP2, and ISS
- **Endianness**
  - ARM Instructions and Data – Little Endian
- **HD Video Processing Subsystem (HDVPSS)**
  - **Two 165-MHz HD Video Capture Inputs**
    - One 16- or 24-Bit Input, Splittable Into Dual 8-Bit SD Capture Ports
    - One 8-, 16-, or 24-Bit HD Input and 8-Bit SD Input Capture Port
  - **Two 165-MHz HD Video Display Outputs**
    - One 16-, 24-, or 30-Bit and One 16- or 24-Bit Output
  - **Component HD Analog Output**
  - **Composite Analog Output**
  - **Digital HDMI 1.3 Transmitter with Integrated PHY**
  - **Advanced Video Processing Features Such as Scan, Format, and Rate Conversion**
  - **Three Graphics Layers and Compositors**
- **32-Bit DDR2, DDR3, and DDR3L SDRAM Interface**
  - Supports up to 400 MHz for DDR2, 533 MHz for DDR3, and 533 MHz for DDR3L
  - Up to Two x 16 Devices, 2GB of Total Address Space
  - **Dynamic Memory Manager (DMM)**
    - Programmable Multi-Zone Memory Mapping
    - Enables Efficient 2D Block Accesses
    - Supports Tiled Objects in 0°, 90°, 180°, or 270° Orientation and Mirroring



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- **General-Purpose Memory Controller (GPMC)**
  - 8- or 16-Bit Multiplexed Address and Data Bus
  - 512MB of Total Address Space Divided Among up to 8 Chip Selects
  - Glueless Interface to NOR Flash, NAND Flash (BCH/Hamming Error Code Detection), SRAM and Pseudo-SRAM
  - Error Locator Module (ELM) Outside of GPMC to Provide up to 16-Bit or 512-Byte Hardware ECC for NAND
  - Flexible Asynchronous Protocol Control for Interface to FPGA, CPLD, ASICs, and More
- **Enhanced Direct Memory Access (EDMA) Controller**
  - Four Transfer Controllers
  - 64 Independent DMA Channels
  - 8 QDMA Channels
- **Ethernet Switch with Dual 10-, 100-, or 1000-Mbps External Interfaces (EMAC Software)**
  - IEEE 802.3 Compliant (3.3-V I/O Only)
  - MII/RMII/GMII/RGMII Media Independent Interfaces
  - Management Data I/O (MDIO) Module
  - Reset Isolation
  - IEEE 1588 Time-Stamping and Industrial Ethernet Protocols
- **Dual USB 2.0 Ports with Integrated PHYs**
  - USB2.0 High- and Full-Speed Clients
  - USB2.0 High-, Full-, and Low-Speed Hosts
  - Supports End Points 0-15
- **One PCI Express 2.0 Port with Integrated PHY**
  - Supported on
    - All DM385 Devices
    - DM388 Devices with PCIe Enabled
  - Single Port with 1 Lane at 5.0 GT/s
  - Configurable as Root Complex or Endpoint
- **Eight 32-Bit General-Purpose Timers (Timer1–8)**
- **One System Watchdog Timer (WDT0)**
- **Three Configurable UART/IrDA/CIR Modules**
  - UART0 with Modem Control Signals
  - Supports up to 3.6864 Mbps
  - SIR, MIR, FIR (4.0 MBAUD), and CIR
- **Four Serial Peripheral Interfaces (SPIs) (up to 48 MHz)**
  - Each with Four Chip Selects
- **Three MMC/SD/SDIO Serial Interfaces (up to 48 MHz)**
  - Supporting up to 1-, 4-, or 8-Bit Modes
- **Four Inter-Integrated Circuit (I<sup>2</sup>C Bus™) Ports**
- **Two Multichannel Audio Serial Ports (McASP)**
  - Six Serializer Transmit and Receive Ports
  - Two Serializer Transmit and Receive Ports
  - DIT-Capable For S/PDIF (All Ports)
- **Four Audio Tracking Logic (ATL) Modules**
- **Real-Time Clock (RTC)**
  - One-Time or Periodic Interrupt Generation
- **Up to 125 General-Purpose I/O (GPIO) Pins**
- **One Spin Lock Module with up to 128 Hardware Semaphores**
- **One Mailbox Module with 12 Mailboxes**
- **On-Chip ARM ROM Bootloader (RBL)**
- **Power, Reset, and Clock Management**
  - SmartReflex™ Technology (Level 2b)
  - Multiple Independent Core Power Domains
  - Multiple Independent Core Voltage Domains
  - Support for Multiple Operating Points per Voltage Domain
  - Clock Enable and Disable Control for Subsystems and Peripherals
- **32KB of Embedded Trace Buffer™ (ETB™) and 5-pin Trace Interface for Debug**
- **IEEE 1149.1 (JTAG) Compatible**
- **609-Pin Pb-Free BGA Package (AAR Suffix), 0.8-mm Effective Pitch with Via Channel Technology to Reduce PCB Cost (0.5-mm Ball Spacing)**
- **45-nm CMOS Technology**
- **1.8- and 3.3-V Dual Voltage Buffers for General I/O**

## **1.2 Applications**

- **IP Netcam**
- **Video IP Phones**
- **Embedded USB Encoding Cameras**
- **All Camera Applications**
- **HD Video Conferencing - Skype™ Endpoints**
- **Digital Signage**
- **Media Players and Adapters**
- **Mobile Medical Imaging**
- **Network Projectors**
- **Home Audio and Video Equipment**
- **Embedded Vision**
- **Portable Medical Imaging and Diagnostics and Patient Monitoring**
- **Remote Media Display**
- **Thin Clients**
- **Camcorders**
- **Digital Scanner**
- **Video Doorbells**
- **Digital Photo Frames**
- **Intrusion Control Panels with Video**
- **Access Control Panels with Video**

### 1.3 Description

DM385 and DM388 DaVinci Digital Media Processors are a highly integrated, cost-effective, low-power, programmable platform that leverages TI's DaVinci processor technology to meet the processing needs of HD Video Conferencing - Skype endpoints, IP Netcam, Digital Signage, Media Players and Adapters, Mobile Medical Imaging, Network Projectors, Home Audio and Video Equipment, and similar devices in SD, HD, and 4K x 2K resolutions. The Programmable High-Definition Video Image Processor of the device supports 1080p60 of real time H.264BP/MP/HP video encode or decode. The included best-in-class H.264 encoder provides high-quality video encode for the lowest possible bit rate under all conditions, reducing valuable storage space to a minimum. In addition, the device also supports other video codecs such as MJPEG, MPEG-2, and MPEG-4. The device provides a full set of video preprocessing and postprocessing functions to ensure the best video quality. The low power consumption and high performance of the device makes it particularly suitable for portable and automotive applications. The DM388 is uniquely capable of running the Fourth-Generation Motion-Compensated Noise Filtering technology of TI.

The device enables original-equipment manufacturers (OEMs) and original-design manufacturers (ODMs) to quickly bring to market devices featuring robust operating systems support, rich user interfaces, and high processing performance through the maximum flexibility of a fully integrated mixed processor solution. The device also combines programmable video and audio processing with a highly integrated peripheral set.

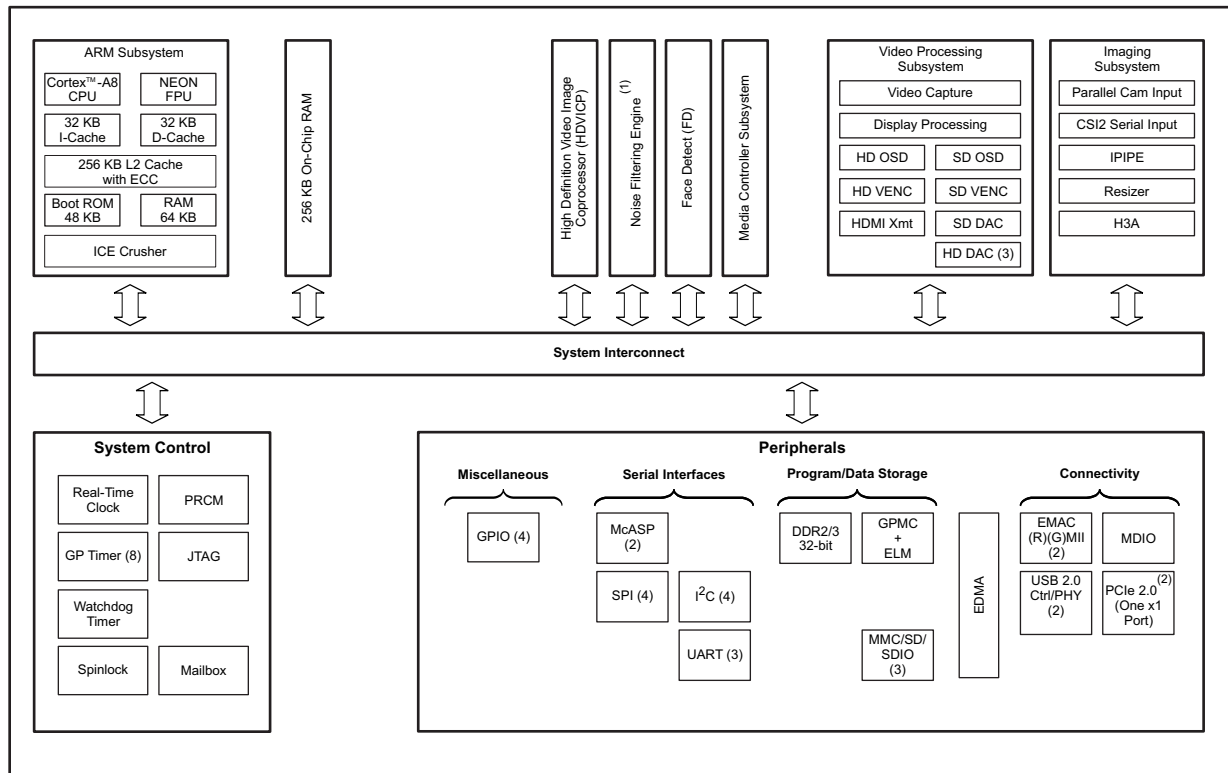
The device processors include a high-definition video and imaging coprocessor 2 (HDVICP2), to off-load many video and imaging processing tasks for common video and imaging algorithms. Programmability is provided by an ARM Cortex-A8 RISC CPU with NEON extension and high-definition video and imaging coprocessors. The ARM lets developers separate control functions from A/V algorithms programmed on coprocessors, thus reducing the complexity of the system software. The ARM Cortex-A8 32-bit RISC processor with NEON floating-point extension includes: 32KB of instruction cache; 32KB of data cache; 256KB of L2 cache with ECC; 48KB of boot ROM; and 64KB of RAM.

The rich peripheral set provides the ability to control external peripheral devices and communicate with external processors. For details on each peripheral, see the related sections in this document and the associated peripheral reference guides. The peripheral set includes: HD Video Processing Subsystem; Dual-Port Gigabit Ethernet MACs (10/100/1000 Mbps) (Ethernet Switch) with MII/RMII/GMII/RGMII and MDIO interface supporting IEEE 1588 Time-Stamping, and Industrial Ethernet Protocols; two USB ports with integrated 2.0 PHY; PCIe x1 GEN2-Compliant interface; two serializer McASP audio serial ports (with DIT mode); three UARTs with IrDA and CIR support; four SPI serial interfaces; a CSI2 serial connection; three MMC/SD/SDIO serial interfaces; four I<sup>2</sup>C master and slave interfaces; a parallel camera interface (CAM); up to 125 general-purpose I/Os (GPIOs); eight 32-bit general-purpose timers; system watchdog timer; DDR2/DDR3/DDR3L SDRAM interface; flexible 8- or 16-bit asynchronous memory interface; a Spin Lock; and Mailbox.

Additionally, TI provides a complete set of development tools for the ARM which include C compilers and a Microsoft® Windows® debugger interface for visibility into source code execution.

## 1.4 Functional Block Diagram

Figure 1-1 shows the functional block diagram of the device.



- (1) Noise Filtering Engine is available only on DM388.
- (2) PCIe is supported on all DM385 devices and also on DM388 devices with PCIe enabled.

**Figure 1-1. Functional Block Diagram**

|           |                                                                                                                               |                            |  |  |  |
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## Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

This revision history highlights the technical changes made to the document in the current revision.

### Revision History

| SEE                                    | ADDITIONS/MODIFICATIONS/DELETIONS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Global                                 | Added notes specifying PCIe support on all DM385 devices and also on DM388 devices with PCIe enabled to: <ul style="list-style-type: none"> <li>• <a href="#">Section 1.1</a>, <i>Features</i></li> <li>• <a href="#">Figure 1-1</a>, <i>Functional Block Diagram</i></li> <li>• <a href="#">Section 3.3.15</a>, <i>PCI Express (PCIe) Terminal Functions</i></li> <li>• <a href="#">Table 4-10</a>, <i>Pins Used in PCIe Bootmode</i></li> <li>• <a href="#">Section 8.16</a>, <i>Peripheral Component Interconnect Express (PCIe)</i></li> <li>• <a href="#">Figure 9-1</a>, <i>Device Nomenclature</i></li> </ul> |
|                                        | Added support for 4K x 2K resolution: <ul style="list-style-type: none"> <li>• <a href="#">Section 1.3</a>, <i>Description</i></li> <li>• <a href="#">Section 2.6</a>, <i>HDVICP2 Overview</i></li> <li>• <a href="#">Section 8.12</a>, <i>Imaging Subsystem (ISS)</i></li> </ul>                                                                                                                                                                                                                                                                                                                                    |
|                                        | Added notes specifying OPP100 is supported only on DM388 commercial temperature devices to: <ul style="list-style-type: none"> <li>• <a href="#">Section 6.2</a>, <i>Recommended Operating Conditions</i></li> <li>• <a href="#">Section 6.3</a>, <i>Reliability Data</i></li> <li>• <a href="#">Section 7.2.2.1</a>, <i>Dynamic Voltage Frequency Scaling</i></li> <li>• <a href="#">Table 7-3</a>, <i>Device Operating Points (OPPs)</i></li> <li>• <a href="#">Table 7-4</a>, <i>Supported OPP Combinations</i></li> </ul>                                                                                        |
| Power, Reset, Clocking, and Interrupts | Changed OPP100 speed from 500 to 600 MHz for ARM Cortex-A8 in <a href="#">Table 7-3</a> , <i>Device Operating Points (OPPs)</i> .                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|                                        | Removed requirement that the maximum voltage difference between CVDD and any other CVDD_x voltage domain must be < 150 mV. <ul style="list-style-type: none"> <li>• <a href="#">Table 7-4</a>, <i>Supported OPP Combinations</i></li> </ul>                                                                                                                                                                                                                                                                                                                                                                          |

## 2 Device Overview

### 2.1 Device Comparison

Table 2-1 shows a comparison between devices, highlighting the differences.

**Table 2-1. Device Comparison**

| FEATURE                | DEVICE |       |
|------------------------|--------|-------|
|                        | DM385  | DM388 |
| Noise Filtering Engine | NO     | YES   |

### 2.2 Device Characteristics

Table 2-2 provides an overview of the DM385 and DM388 DaVinci™ Digital Media Processors,, which includes significant features of the device, including the capacity of on-chip RAM, peripherals, and the package type with pin count.

**Table 2-2. Characteristics of the Processor**

| HARDWARE FEATURES |                                                                          | DM385/DM388                                                                                                                                                                                                                                                                                                                                          |
|-------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Peripherals       | HD Video Processing Subsystem (HDVPSS)                                   | 1 16-/24-bit HD Capture Port <b>or</b><br>2 8-bit SD Capture Ports<br><b>and</b><br>1 8/16/24-bit HD Input Port<br><b>and</b><br>1 8-bit SD Input Port<br><b>and</b><br>1 16-/24-/30-bit HD Display Port<br>or 1 HDMI 1.3 Transmitter<br><b>and</b><br>1 16-/24-bit HD Display Port<br><b>and</b><br>1 SD Video DAC<br><b>and</b><br>3 HD Video DACs |
|                   | Imaging Subsystem (ISS)                                                  | 1 Parallel Camera Input for Raw (up to 16-bit)<br>and BT.656/BT.1120 (8/16-bit)<br>and 1 CSI2 Serial Input                                                                                                                                                                                                                                           |
|                   | DDR2/3 Memory Controller                                                 | 16-/32-bit Bus Width                                                                                                                                                                                                                                                                                                                                 |
|                   | GPMC + ELM                                                               | Asynchronous (8-/16-bit bus width)<br>RAM, NOR, NAND                                                                                                                                                                                                                                                                                                 |
|                   | EDMA                                                                     | 64 Independent Channels<br>8 QDMA Channels                                                                                                                                                                                                                                                                                                           |
|                   | 10/100/1000 Ethernet MAC Switch with Management Data Input/Output (MDIO) | 1 (with 2 MII/RMII/GMII/RGMII)                                                                                                                                                                                                                                                                                                                       |
|                   | USB 2.0                                                                  | 2 (Supports High- and Full-Speed as a Device and High-, Full-, and Low-Speed as a Host)                                                                                                                                                                                                                                                              |
|                   | PCI Express 2.0                                                          | 1 Port (5.0 GT/s lane)                                                                                                                                                                                                                                                                                                                               |
|                   | Timers                                                                   | 8 (32-bit General purpose)<br><b>and</b><br>1 (System Watchdog)                                                                                                                                                                                                                                                                                      |
|                   | UART                                                                     | 3 (with SIR, MIR, FIR, CIR support and RTS/CTS flow control)<br>(UART0 Supports Modem Interface)                                                                                                                                                                                                                                                     |
| SPI               |                                                                          | 4 (Each supporting up to 4 slave devices)                                                                                                                                                                                                                                                                                                            |

Not all peripherals pins are available at the same time (for more details, see the Device Configurations section).



**Table 2-2. Characteristics of the Processor (continued)**

| HARDWARE FEATURES  |                                                                         |                                          | DM385/DM388                                                                                             |
|--------------------|-------------------------------------------------------------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------|
|                    | MMC/SD/SDIO                                                             |                                          | 1 (1-bit or 4-bit or 8-bit modes)<br><b>and</b><br>1 (8-bit mode) <b>or</b><br>2 (1-bit or 4-bit modes) |
|                    | I2C                                                                     |                                          | 4 Master or Slave                                                                                       |
|                    | Media Controller                                                        |                                          | Controls HDVPSS, HDVICP2, and ISS                                                                       |
|                    | McASP                                                                   |                                          | 2 (6/2 Serializers, each with Transmit/Receive and DIT capability)                                      |
|                    | RTC                                                                     |                                          | 1                                                                                                       |
|                    | GPIO                                                                    |                                          | Up to 125 pins                                                                                          |
|                    | Spinlock Module                                                         |                                          | 1 (up to 128 H/W Semaphores)                                                                            |
|                    | Mailbox Module                                                          |                                          | 1 (with 12 Mailboxes)                                                                                   |
| On-Chip Memory     | Size (Bytes)                                                            |                                          | 640KB RAM, 48KB ROM                                                                                     |
|                    | Organization                                                            |                                          | <b>ARM</b><br>32KB I-cache<br>32KB D-cache<br>256KB L2 Cache with ECC<br>64KB RAM<br>48KB Boot ROM      |
|                    |                                                                         |                                          | <b>ADDITIONAL SHARED MEMORY</b><br>256KB On-chip RAM                                                    |
| JTAG BSDL ID       | DEVICE_ID Register (address location: 0x4814 0600)                      |                                          | see <a href="#">Section 8.5.3.1</a> , JTAG ID (JTAGID) Register Description                             |
| CPU Frequency      | MHz                                                                     |                                          | ARM® Cortex™-A8 up to 1000 MHz                                                                          |
| Cycle Time         | ns                                                                      |                                          | ARM® Cortex™ -A8 1.0 ns                                                                                 |
| Voltage            | Core Logic (V)                                                          | DEEP SLEEP, OPP100, OPP120, Turbo, Nitro | 0.83 V – 1.35 V                                                                                         |
|                    | I/O (V)                                                                 |                                          | 1.35 V, 1.5 V, 1.8 V, 3.3 V                                                                             |
| Package            | 16 x 16 mm                                                              |                                          | 609-Pin BGA (AAR) [with Via Channel™ Technology]                                                        |
| Process Technology | µm                                                                      |                                          | 0.045 µm                                                                                                |
| Product Status     | Product Preview (PP), Advance Information (AI), or Production Data (PD) |                                          | PD                                                                                                      |

## 2.3 Device Compatibility

## 2.4 ARM® Cortex™-A8 Microprocessor Unit (Processor) Subsystem Overview

The ARM® Cortex™-A8 Subsystem is designed to allow the ARM Cortex-A8 master control of the device. In general, the ARM Cortex-A8 is responsible for configuration and control of the various subsystems, peripherals, and external memories.

The ARM Cortex-A8 Subsystem includes the following features:

- ARM Cortex-A8 RISC processor:
  - ARMv7 ISA plus Thumb2™, JazelleX™, and Media Extensions
  - NEON™ Floating-Point Unit
  - Enhanced Memory Management Unit (MMU)
  - Little Endian
  - 32KB L1 Instruction Cache
  - 32KB L1 Data Cache
  - 256KB L2 Cache with Error Correction Code (ECC)
- CoreSight Embedded Trace Module (ETM)
- ARM Cortex-A8 Interrupt Controller (AINTC)
- Embedded PLL Controller (PLL\_ARM)
- 64KB Internal RAM
- 48KB Internal Public ROM

Figure 2-1 shows the ARM Cortex-A8 Subsystem for the device.

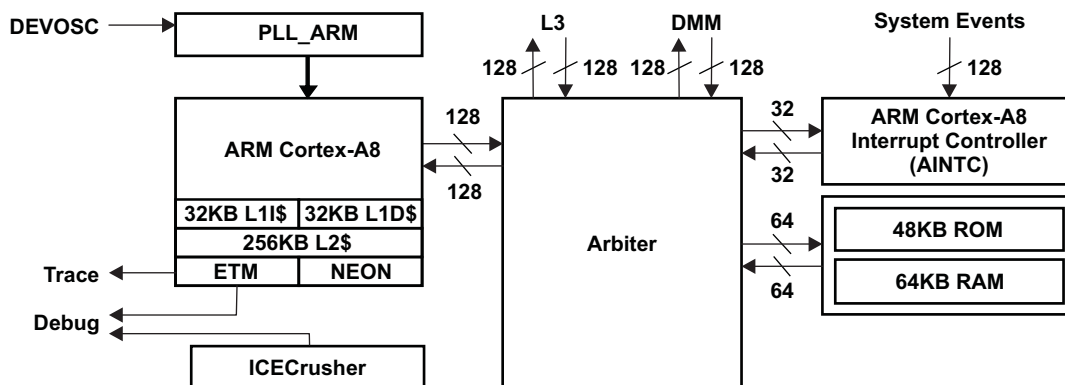


Figure 2-1. ARM Cortex-A8 Subsystem

### 2.4.1 ARM Cortex-A8 RISC Processor

The ARM Cortex-A8 processor is a member of ARM Cortex family of general-purpose microprocessors. This processor is targeted at multi-tasking applications where full memory management, high performance, low die size, and low power are all important. The ARM Cortex-A8 processor supports the ARM debug architecture and includes logic to assist in both hardware and software debug. The ARM Cortex-A8 processor has a Harvard architecture and provides a complete high-performance subsystem, including:

- ARM Cortex-A8 Integer Core
- Superscalar ARMv7 Instruction Set
- Thumb-2 Instruction Set
- Jazelle RCT Acceleration
- CP14 Debug Coprocessor

- CP15 System Control Coprocessor
- NEON 64-/128-bit Hybrid SIMD Engine for Multimedia
- Enhanced VFPv3 Floating-Point Coprocessor
- Enhanced Memory Management Unit (MMU)
- Separate Level-1 Instruction and Data Caches
- Integrated Level-2 Cache with ECC Support
- 128-bit Interconnect with Level 3 Fast (L3) System Memories and Peripherals
- Embedded Trace Module (ETM).

### **2.4.2 Embedded Trace Module (ETM)**

To support real-time trace, the ARM Cortex-A8 processor provides an interface to enable connection of an embedded trace module (ETM). The ETM consists of two parts:

- The Trace port which provides real-time trace capability for the ARM Cortex-A8.
- Triggering facilities that provide trigger resources, which include address and data comparators, counter, and sequencers.

The ARM Cortex-A8 trace port is not pinned out and is, instead, only connected to the system-level Embedded Trace Buffer (ETB). The ETB has a 32KB buffer memory. ETB enabled debug tools are required to read/interpret the captured trace data.

### **2.4.3 ARM Cortex-A8 Interrupt Controller (AINTC)**

The ARM Cortex-A8 subsystem contains an interrupt controller (AINTC) that prioritizes all service requests from the system peripherals and generates either IRQ or FIQ to the ARM Cortex-A8 processor.

### **2.4.4 ARM Cortex-A8 PLL (PLL\_ARM)**

The ARM Cortex-A8 subsystem contains an embedded PLL Controller (PLL\_ARM) for generating the subsystem's clocks from the device Clock input.

### **2.4.5 ARM Processor Interconnect**

The ARM Cortex-A8 processor is connected through the arbiter to the L3 interconnect port. The L3 interconnect port is 128-bits wide and provides access to the other device modules.

## 2.5 Media Controller Overview

The Media Controller has the responsibility of managing the HDVPSS, HDVICP2, and ISS modules.

## 2.6 HDVICP2 Overview

The HDVICP2 is a Video Encoder/Decoder hardware accelerator supporting a range of encode, decode, and transcode operations for most major video codec standards. The main video Codec standards supported in hardware are MPEG1/2/4 ASP/SP, H.264 BL/MP/HP, VC-1 SP/MP/AP, RV9/10, AVS-1.0, and ON2 VP6.2/VP7.

Supports up to 4K x 2K @ 15fps, 12Mpixels @ 10fps, 20Mpixels @ 6fps, and so on.

The HDVICP2 hardware accelerator is composed of the following elements:

- Motion estimation acceleration engine
- Loop filter acceleration engine
- Sequencer, including its memories and an interrupt controller
- Intra-prediction estimation engine
- Calculation engine
- Motion compensation engine
- Entropy coder/decoder
- Video Direct Memory Access (DMA)
- Synchronization boxes
- Shared L2 controller
- Local interconnect

## 2.7 Face Detect (FD) Overview

The device Face Detection (FD) module performs face detection and tracking within a picture stored in memory. This module is typically used for video encoding, face-based priority auto-focusing, or red-eye removal. The FD module supports QVGA resolution inputs stored in DRR memory in 8-bit Luma format. In addition, it uses 51.25KB of DDR for its working memory.

The FD module supports the following features:

- Input image:
  - QVGA Input Image Size (H x V = 320 x 240)
  - 8-bit Gray Scale Data (0x00 = Black and 0xFF = White)

- Detection Capabilities:
  - Face Inclination of  $\pm 45^\circ$
  - Face Direction:
    - Up/Down:  $\pm 30^\circ$
    - Left/Right:  $\pm 60^\circ$
  - Supported Detection Directions:
    - $0^\circ$  Faces are Vertical
    - $+90^\circ$  Faces are Rotated Right by  $90^\circ$
    - $-90^\circ$  Faces are Rotated Left by  $90^\circ$
    - Supported Minimum Face Sizes of 20, 25, 32 or 40 Pixels
  - Supported Detection Start Positions:
    - X = 0 to 160
    - Y = 0 to 120
  - Supported Detection Area Sizes:
    - X = 160 to 320
    - Y = 120 to 240
  - Provides Size, Position, Angle, and Confidence Level for Each Face

## 2.8 Spinlock Module Overview

The Spinlock module provides hardware assistance for synchronizing the processes running on multiple processors in the device:

- ARM Cortex-A8 processor
- Media Controller

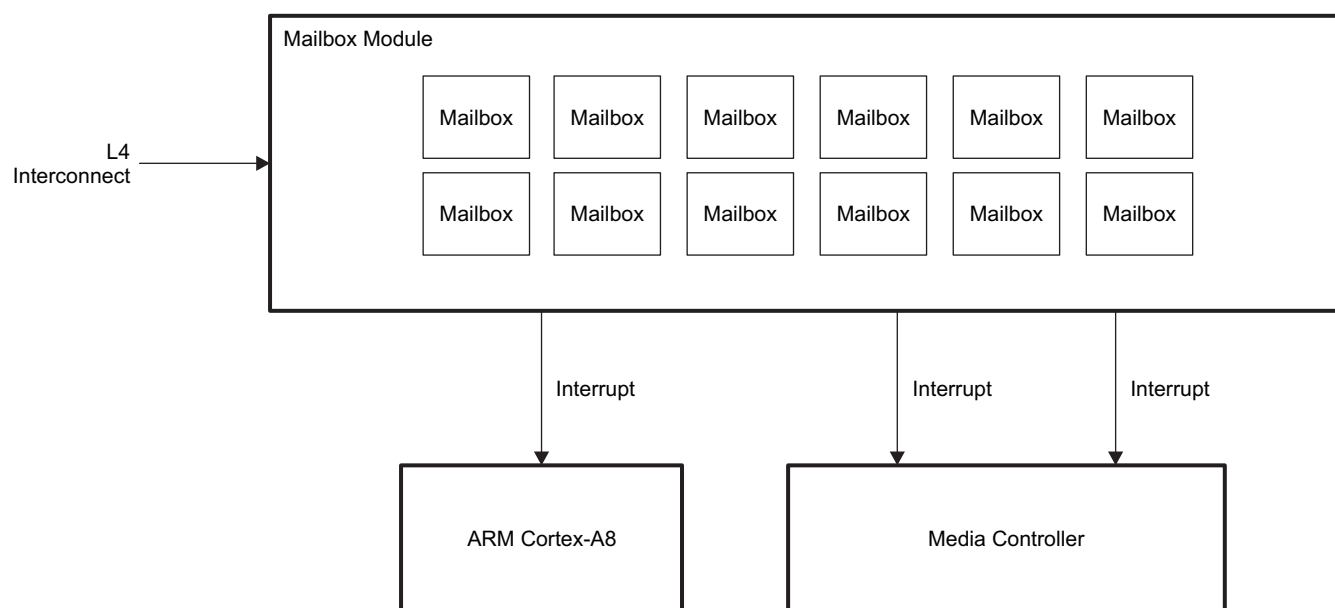
The Spinlock module implements 128 spinlocks (or hardware semaphores) that provide an efficient way to perform a lock operation of a device resource using a single read-access, avoiding the need for a read-modify-write bus transfer of which the programmable cores are not capable.

## 2.9 Mailbox Module Overview

The device Mailbox module facilitates communication between the ARM Cortex-A8 and the Media Controller. It consists of twelve mailboxes, each supporting a 1-way communication between two of the above processors. The sender sends information to the receiver by writing a message to the mailbox registers. Interrupt signaling is used to notify the receiver that a message has been queued or to notify the sender about an overflow situation.

The Mailbox module supports the following features (see [Figure 2-2](#)):

- 12 mailboxes
- Flexible mailbox-to-processor assignment scheme
- Four-message FIFO depth for each message queue
- 32-bit message width
- Message reception and queue-not-full notification using interrupts
- Three interrupts (one to ARM Cortex-A8 and two to Media Controller)



**Figure 2-2. Mailbox Module Block Diagram**

## 2.10 Memory Map Summary

The device has multiple on-chip memories associated with its processor and subsystems. To help simplify software development a unified memory map is used where possible to maintain a consistent view of device resources across all bus masters.

### 2.10.1 L3 Memory Map

Table 2-3 shows the L3 memory map for all system masters (including Cortex-A8).

For more details on the interconnect topology and connectivity across the L3 and L4 interconnects, see [Section 5](#).

**Table 2-3. L3 Memory Map**

| START ADDRESS<br>(HEX) | END ADDRESS<br>(HEX) | SIZE       | DESCRIPTION                                                       |
|------------------------|----------------------|------------|-------------------------------------------------------------------|
| 0x0000_0000            | 0x00FF_FFFF          | 16MB       | Reserved (BOOTROM)                                                |
| 0x1000_0000            | 0x1FFF_FFFF          | 496MB      | General Purpose Memory Controller (GPMC)<br>External Memory Space |
| 0x2000_0000            | 0x2FFF_FFFF          | 256MB      | PCIe                                                              |
| 0x3000_0000            | 0x3FFF_FFFF          | 256MB      | Reserved                                                          |
| 0x4000_0000            | 0x4001_FFFF          | 128KB      | Reserved                                                          |
| 0x4002_0000            | 0x4002_BFFF          | 48KB       | ARM Cortex-A8 ROM<br>(Accessible by ARM Cortex-A8 <i>only</i> )   |
| 0x4002_C000            | 0x402E_FFFF          | 2832KB     | Reserved                                                          |
| 0x402F_0000            | 0x402F_03FF          | 1KB        | Reserved                                                          |
| 0x402F_0400            | 0x402F_FFFF          | 64KB - 1KB | ARM Cortex-A8 RAM<br>(Accessible by ARM Cortex-A8 <i>only</i> )   |
| 0x4030_0000            | 0x4033_FFFF          | 256KB      | OCMC SRAM                                                         |
| 0x4034_0000            | 0x407F_FFFF          | 4864KB     | Reserved                                                          |
| 0x4080_0000            | 0x4083_FFFF          | 256KB      | Reserved                                                          |
| 0x4084_0000            | 0x40DF_FFFF          | 5888KB     | Reserved                                                          |
| 0x40E0_0000            | 0x40E0_7FFF          | 32KB       | Reserved                                                          |
| 0x40E0_8000            | 0x40EF_FFFF          | 992KB      | Reserved                                                          |
| 0x40F0_0000            | 0x40F0_7FFF          | 32KB       | Reserved                                                          |
| 0x40F0_8000            | 0x40FF_FFFF          | 992KB      | Reserved                                                          |
| 0x4100_0000            | 0x41FF_FFFF          | 16MB       | Reserved                                                          |
| 0x4200_0000            | 0x43FF_FFFF          | 32MB       | Reserved                                                          |
| 0x4400_0000            | 0x443F_FFFF          | 4MB        | L3 Fast configuration registers                                   |
| 0x4440_0000            | 0x447F_FFFF          | 4MB        | L3 Mid configuration registers                                    |
| 0x4480_0000            | 0x44BF_FFFF          | 4MB        | L3 Slow configuration registers                                   |
| 0x44C0_0000            | 0x45FF_FFFF          | 20MB       | Reserved                                                          |
| 0x4600_0000            | 0x463F_FFFF          | 4MB        | McASP0 Data Peripheral Registers                                  |
| 0x4640_0000            | 0x467F_FFFF          | 4MB        | McASP1 Data Peripheral Registers                                  |
| 0x4680_0000            | 0x46BF_FFFF          | 4MB        | Reserved                                                          |
| 0x46C0_0000            | 0x46FF_FFFF          | 4MB        | HDMI                                                              |
| 0x4700_0000            | 0x473F_FFFF          | 4MB        | Reserved                                                          |
| 0x4740_0000            | 0x477F_FFFF          | 4MB        | USB                                                               |
| 0x4780_0000            | 0x4780_FFFF          | 64KB       | Reserved                                                          |
| 0x4781_0000            | 0x4781_1FFF          | 8KB        | MMC/SD/SDIO2 Peripheral Registers                                 |
| 0x4781_2000            | 0x47BF_FFFF          | 4MB - 72KB | Reserved                                                          |
| 0x47C0_0000            | 0x47FF_FFFF          | 4MB        | Reserved                                                          |
| 0x47C0_0000            | 0x47C0_BFFF          | 48KB       | Reserved                                                          |

**Table 2-3. L3 Memory Map (continued)**

| START ADDRESS<br>(HEX) | END ADDRESS<br>(HEX) | SIZE   | DESCRIPTION                                                                                  |
|------------------------|----------------------|--------|----------------------------------------------------------------------------------------------|
| 0x47C0_C000            | 0x47C0_C3FF          | 1KB    | Reserved                                                                                     |
| 0x47C0_C400            | 0x47C0_C7FF          | 1KB    | DDR PHY Registers                                                                            |
| 0x47C0_C800            | 0x47C0_CBFF          | 1KB    | Reserved                                                                                     |
| 0x47C0_CC00            | 0x47C0_CFFF          | 1KB    | Reserved                                                                                     |
| 0x47C0_D000            | 0x47FF_FFFF          | 4052KB | Reserved                                                                                     |
| 0x4800_0000            | 0x48FF_FFFF          | 16MB   | L4 Slow Peripheral Domain<br>(see <a href="#">Table 2-5</a> )                                |
| 0x4900_0000            | 0x490F_FFFF          | 1MB    | EDMA TPCC Registers                                                                          |
| 0x4910_0000            | 0x497F_FFFF          | 7MB    | Reserved                                                                                     |
| 0x4980_0000            | 0x498F_FFFF          | 1MB    | EDMA TPTC0 Registers                                                                         |
| 0x4990_0000            | 0x499F_FFFF          | 1MB    | EDMA TPTC1 Registers                                                                         |
| 0x49A0_0000            | 0x49AF_FFFF          | 1MB    | EDMA TPTC2 Registers                                                                         |
| 0x49B0_0000            | 0x49BF_FFFF          | 1MB    | EDMA TPTC3 Registers                                                                         |
| 0x49C0_0000            | 0x49FF_FFFF          | 4MB    | Reserved                                                                                     |
| 0x4A00_0000            | 0x4AFF_FFFF          | 16MB   | L4 Fast Peripheral Domain<br>(see <a href="#">Table 2-4</a> )                                |
| 0x4B00_0000            | 0x4BFF_FFFF          | 16MB   | Emulation Subsystem                                                                          |
| 0x4C00_0000            | 0x4CFF_FFFF          | 16MB   | DDR Registers                                                                                |
| 0x4D00_0000            | 0x4DFF_FFFF          | 16MB   | Reserved                                                                                     |
| 0x4E00_0000            | 0x4FFF_FFFF          | 32MB   | DDR DMM Registers                                                                            |
| 0x5000_0000            | 0x50FF_FFFF          | 16MB   | GPMC Registers                                                                               |
| 0x5100_0000            | 0x51FF_FFFF          | 16MB   | PCIE Registers                                                                               |
| 0x5200_0000            | 0x54FF_FFFF          | 48MB   | Reserved                                                                                     |
| 0x5500_0000            | 0x55FF_FFFF          | 16MB   | Media Controller                                                                             |
| 0x5600_0000            | 0x56FF_FFFF          | 16MB   | Reserved                                                                                     |
| 0x5700_0000            | 0x57FF_FFFF          | 16MB   | Reserved                                                                                     |
| 0x5800_0000            | 0x58FF_FFFF          | 16MB   | HDVICP2 Configuration                                                                        |
| 0x5900_0000            | 0x59FF_FFFF          | 16MB   | HDVICP2 SL2                                                                                  |
| 0x5A00_0000            | 0x5BFF_FFFF          | 32MB   | Reserved                                                                                     |
| 0x5C00_0000            | 0x5DFF_FFFF          | 32MB   | ISS                                                                                          |
| 0x5E00_0000            | 0x5FFF_FFFF          | 32MB   | Reserved                                                                                     |
| 0x6000_0000            | 0x7FFF_FFFF          | 512MB  | DDR DMM Tiler Window (see <a href="#">Table 2-6</a> )                                        |
| 0x8000_0000            | 0xFFFF_FFFF          | 2GB    | DDR                                                                                          |
| 0x1 0000 0000          | 0x1 FFFF FFFF        | 4GB    | DDR DMM Tiler Extended Address Map<br>(ISS and HDVPSS only) [see <a href="#">Table 2-6</a> ] |



## 2.10.2 L4 Memory Map

The L4 Fast Peripheral Domain and L4 Slow Peripheral Domain regions of the memory maps above are broken out into [Table 2-4](#) and [Table 2-5](#).

For more details on the interconnect topology and connectivity across the L3 and L4 interconnects, see , *System Interconnect*.

### 2.10.2.1 L4 Fast Peripheral Memory Map

**Table 2-4. L4 Fast Peripheral Memory Map**

| Cortex-A8 and L3 Masters |                   | SIZE    | DEVICE NAME                                     |
|--------------------------|-------------------|---------|-------------------------------------------------|
| START ADDRESS (HEX)      | END ADDRESS (HEX) |         |                                                 |
| 0x4A00_0000              | 0x4A00_07FF       | 2KB     | L4 Fast Configuration - Address/Protection (AP) |
| 0x4A00_0800              | 0x4A00_0FFF       | 2KB     | L4 Fast Configuration - Link Agent (LA)         |
| 0x4A00_1000              | 0x4A00_13FF       | 1KB     | L4 Fast Configuration - Initiator Port (IP0)    |
| 0x4A00_1400              | 0x4A00_17FF       | 1KB     | L4 Fast Configuration - Initiator Port (IP1)    |
| 0x4A00_1800              | 0x4A00_1FFF       | 2KB     | Reserved                                        |
| 0x4A00_2000              | 0x4A07_FFFF       | 504KB   | Reserved                                        |
| 0x4A08_0000              | 0x4A09_FFFF       | 128KB   | Reserved                                        |
| 0x4A0A_0000              | 0x4A0A_0FFF       | 4KB     | Reserved                                        |
| 0x4A0A_E000              | 0x4A0F_FFFF       | 380KB   | Reserved                                        |
| 0x4A10_0000              | 0x4A10_7FFF       | 32KB    | EMAC SW Peripheral Registers                    |
| 0x4A10_8000              | 0x4A10_8FFF       | 4KB     | EMAC SW Interconnect Registers                  |
| 0x4A14_0000              | 0x4A14_FFFF       | 64KB    | Reserved                                        |
| 0x4A15_0000              | 0x4A15_0FFF       | 4KB     | Reserved                                        |
| 0x4A15_1000              | 0x4A17_FFFF       | 188KB   | Reserved                                        |
| 0x4A18_0000              | 0x4A1A_1FFF       | 136KB   | Reserved                                        |
| 0x4A1A_2000              | 0x4A1A_3FFF       | 8KB     | Reserved                                        |
| 0x4A1A_4000              | 0x4A1A_4FFF       | 4KB     | Reserved                                        |
| 0x4A1A_5000              | 0x4A1A_5FFF       | 4KB     | Reserved                                        |
| 0x4A1A_6000              | 0x4A1A_6FFF       | 4KB     | Reserved                                        |
| 0x4A1A_7000              | 0x4A1A_7FFF       | 4KB     | Reserved                                        |
| 0x4A1A_8000              | 0x4A1A_9FFF       | 8KB     | Reserved                                        |
| 0x4A1A_A000              | 0x4A1A_AFFF       | 4KB     | Reserved                                        |
| 0x4A1A_B000              | 0x4A1A_BFFF       | 4KB     | Reserved                                        |
| 0x4A1A_C000              | 0x4A1A_CFFF       | 4KB     | Reserved                                        |
| 0x4A1A_D000              | 0x4A1A_DFFF       | 4KB     | Reserved                                        |
| 0x4A1A_E000              | 0x4A1A_FFFF       | 8KB     | Reserved                                        |
| 0x4A1B_0000              | 0x4A1B_0FFF       | 4KB     | Reserved                                        |
| 0x4A1B_1000              | 0x4A1B_1FFF       | 4KB     | Reserved                                        |
| 0x4A1B_2000              | 0x4A1B_2FFF       | 4KB     | Reserved                                        |
| 0x4A1B_3000              | 0x4A1B_5FFF       | 12KB    | Reserved                                        |
| 0x4A1B_6000              | 0x4A1B_6FFF       | 4KB     | Reserved                                        |
| 0x4A1B_4000              | 0x4AFF_FFFF       | 14632KB | Reserved                                        |

## 2.10.2.2 L4 Slow Peripheral Memory Map

**Table 2-5. L4 Slow Peripheral Memory Map**

| Cortex-A8 and L3 Masters |                   | SIZE | DEVICE NAME                                     |
|--------------------------|-------------------|------|-------------------------------------------------|
| START ADDRESS (HEX)      | END ADDRESS (HEX) |      |                                                 |
| 0x4800_0000              | 0x4800_07FF       | 2KB  | L4 Slow Configuration – Address/Protection (AP) |
| 0x4800_0800              | 0x4800_0FFF       | 2KB  | L4 Slow Configuration – Link Agent (LA)         |
| 0x4800_1000              | 0x4800_13FF       | 1KB  | L4 Slow Configuration – Initiator Port (IP0)    |
| 0x4800_1400              | 0x4800_17FF       | 1KB  | L4 Slow Configuration – Initiator Port (IP1)    |
| 0x4800_1800              | 0x4800_1FFF       | 2KB  | Reserved                                        |
| 0x4800_2000              | 0x4800_7FFF       | 24KB | Reserved                                        |
| 0x4800_8000              | 0x4800_8FFF       | 32KB | Reserved                                        |
| 0x4801_0000              | 0x4801_0FFF       | 4KB  | Reserved                                        |
| 0x4801_1000              | 0x4801_1FFF       | 4KB  | Reserved                                        |
| 0x4801_2000              | 0x4801_FFFF       | 56KB | Reserved                                        |
| 0x4802_0000              | 0x4802_0FFF       | 4KB  | UART0 Peripheral Registers                      |
| 0x4802_1000              | 0x4802_1FFF       | 4KB  | UART0 Interconnect Registers                    |
| 0x4802_2000              | 0x4802_2FFF       | 4KB  | UART1 Peripheral Registers                      |
| 0x4802_3000              | 0x4802_3FFF       | 4KB  | UART1 Interconnect Registers                    |
| 0x4802_4000              | 0x4802_4FFF       | 4KB  | UART2 Peripheral Registers                      |
| 0x4802_5000              | 0x4802_5FFF       | 4KB  | UART2 Interconnect Registers                    |
| 0x4802_6000              | 0x4802_7FFF       | 8KB  | Reserved                                        |
| 0x4802_8000              | 0x4802_8FFF       | 4KB  | I2C0 Peripheral Registers                       |
| 0x4802_9000              | 0x4802_9FFF       | 4KB  | I2C0 Interconnect Registers                     |
| 0x4802_A000              | 0x4802_AFFF       | 4KB  | I2C1 Peripheral Registers                       |
| 0x4802_B000              | 0x4802_BFFF       | 4KB  | I2C1 Interconnect Registers                     |
| 0x4802_C000              | 0x4802_DFFF       | 8KB  | Reserved                                        |
| 0x4802_E000              | 0x4802_EFFF       | 4KB  | TIMER1 Peripheral Registers                     |
| 0x4802_F000              | 0x4802_FFFF       | 4KB  | TIMER1 Interconnect Registers                   |
| 0x4803_0000              | 0x4803_0FFF       | 4KB  | SPI0 Peripheral Registers                       |
| 0x4803_1000              | 0x4803_1FFF       | 4KB  | SPI0 Interconnect Registers                     |
| 0x4803_2000              | 0x4803_2FFF       | 4KB  | GPIO0 Peripheral Registers                      |
| 0x4803_3000              | 0x4803_3FFF       | 4KB  | GPIO0 Interconnect Registers                    |
| 0x4803_4000              | 0x4803_7FFF       | 16KB | Reserved                                        |
| 0x4803_8000              | 0x4803_9FFF       | 8KB  | McASP0 CFG Peripheral Registers                 |
| 0x4803_A000              | 0x4803_AFFF       | 4KB  | McASP0 CFG Interconnect Registers               |
| 0x4803_B000              | 0x4803_BFFF       | 4KB  | Reserved                                        |
| 0x4803_C000              | 0x4803_DFFF       | 8KB  | McASP1 CFG Peripheral Registers                 |
| 0x4803_E000              | 0x4803_EFFF       | 4KB  | McASP1 CFG Interconnect Registers               |
| 0x4803_F000              | 0x4803_FFFF       | 4KB  | Reserved                                        |
| 0x4804_0000              | 0x4804_0FFF       | 4KB  | TIMER2 Peripheral Registers                     |
| 0x4804_1000              | 0x4804_1FFF       | 4KB  | TIMER2 Interconnect Registers                   |
| 0x4804_2000              | 0x4804_2FFF       | 4KB  | TIMER3 Peripheral Registers                     |
| 0x4804_3000              | 0x4804_3FFF       | 4KB  | TIMER3 Interconnect Registers                   |
| 0x4804_4000              | 0x4804_4FFF       | 4KB  | TIMER4 Peripheral Registers                     |
| 0x4804_5000              | 0x4804_5FFF       | 4KB  | TIMER4 Interconnect Registers                   |
| 0x4804_6000              | 0x4804_6FFF       | 4KB  | TIMER5 Peripheral Registers                     |
| 0x4804_7000              | 0x4804_7FFF       | 4KB  | TIMER5 Interconnect Registers                   |

**Table 2-5. L4 Slow Peripheral Memory Map (continued)**

| Cortex-A8 and L3 Masters |                   | SIZE  | DEVICE NAME                           |
|--------------------------|-------------------|-------|---------------------------------------|
| START ADDRESS (HEX)      | END ADDRESS (HEX) |       |                                       |
| 0x4804_8000              | 0x4804_8FFF       | 4KB   | TIMER6 Peripheral Registers           |
| 0x4804_9000              | 0x4804_9FFF       | 4KB   | TIMER6 Interconnect Registers         |
| 0x4804_A000              | 0x4804_AFFF       | 4KB   | TIMER7 Peripheral Registers           |
| 0x4804_B000              | 0x4804_BFFF       | 4KB   | TIMER7 Interconnect Registers         |
| 0x4804_C000              | 0x4804_CFFF       | 4KB   | GPIO1 Peripheral Registers            |
| 0x4804_D000              | 0x4804_DFFF       | 4KB   | GPIO1 Interconnect Registers          |
| 0x4804_E000              | 0x4804_FFFF       | 8KB   | Reserved                              |
| 0x4805_0000              | 0x4805_1FFF       | 8KB   | Reserved                              |
| 0x4805_2000              | 0x4805_2FFF       | 4KB   | Reserved                              |
| 0x4805_3000              | 0x4805_FFFF       | 52KB  | Reserved                              |
| 0x4806_0000              | 0x4806_FFFF       | 64KB  | MMC/SD/SDIO0 Peripheral Registers     |
| 0x4807_0000              | 0x4807_0FFF       | 4KB   | MMC/SD/SDIO0 Interconnect Registers   |
| 0x4807_1000              | 0x4807_FFFF       | 60KB  | Reserved                              |
| 0x4808_0000              | 0x4808_FFFF       | 64KB  | ELM Peripheral Registers              |
| 0x4809_0000              | 0x4809_0FFF       | 4KB   | ELM Interconnect Registers            |
| 0x4809_1000              | 0x4809_FFFF       | 60KB  | Reserved                              |
| 0x480A_0000              | 0x480A_FFFF       | 64KB  | Reserved                              |
| 0x480B_0000              | 0x480B_0FFF       | 4KB   | Reserved                              |
| 0x480B_1000              | 0x480B_FFFF       | 60KB  | Reserved                              |
| 0x480C_0000              | 0x480C_0FFF       | 4KB   | RTC Peripheral Registers              |
| 0x480C_1000              | 0x480C_1FFF       | 4KB   | RTC Interconnect Registers            |
| 0x480C_2000              | 0x480C_3FFF       | 8KB   | Reserved                              |
| 0x480C_4000              | 0x480C_7FFF       | 16KB  | Reserved                              |
| 0x480C_8000              | 0x480C_8FFF       | 4KB   | Mailbox Peripheral Registers          |
| 0x480C_9000              | 0x480C_9FFF       | 4KB   | Mailbox Interconnect Registers        |
| 0x480C_A000              | 0x480C_AFFF       | 4KB   | Spinlock Peripheral Registers         |
| 0x480C_B000              | 0x480C_BFFF       | 4KB   | Spinlock Interconnect Registers       |
| 0x480C_C000              | 0x480F_FFFF       | 208KB | Reserved                              |
| 0x4810_0000              | 0x4811_FFFF       | 128KB | HDVPSS Peripheral Registers           |
| 0x4812_0000              | 0x4812_0FFF       | 4KB   | HDVPSS Interconnect Registers         |
| 0x4812_1000              | 0x4812_1FFF       | 4KB   | Reserved                              |
| 0x4812_2000              | 0x4812_2FFF       | 4KB   | HDMI Peripheral Registers             |
| 0x4812_3000              | 0x4812_3FFF       | 4KB   | HDMI Interconnect Registers           |
| 0x4812_4000              | 0x4813_FFFF       | 112KB | Reserved                              |
| 0x4814_0000              | 0x4815_FFFF       | 128KB | Control Module Peripheral Registers   |
| 0x4816_0000              | 0x4816_0FFF       | 4KB   | Control Module Interconnect Registers |
| 0x4816_1000              | 0x4817_FFFF       | 124KB | Reserved                              |
| 0x4818_0000              | 0x4818_2FFF       | 12KB  | PRCM Peripheral Registers             |
| 0x4818_3000              | 0x4818_3FFF       | 4KB   | PRCM Interconnect Registers           |
| 0x4818_4000              | 0x4818_7FFF       | 16KB  | Reserved                              |
| 0x4818_8000              | 0x4818_8FFF       | 4KB   | SmartReflex0 Peripheral Registers     |
| 0x4818_9000              | 0x4818_9FFF       | 4KB   | SmartReflex0 Interconnect Registers   |
| 0x4818_A000              | 0x4818_AFFF       | 4KB   | SmartReflex1 Peripheral Registers     |
| 0x4818_B000              | 0x4818_BFFF       | 4KB   | SmartReflex1 Interconnect Registers   |
| 0x4818_C000              | 0x4818_CFFF       | 4KB   | OCP Watchpoint Peripheral Registers   |
| 0x4818_D000              | 0x4818_DFFF       | 4KB   | OCP Watchpoint Interconnect Registers |

**Table 2-5. L4 Slow Peripheral Memory Map (continued)**

| Cortex-A8 and L3 Masters |                   | SIZE  | DEVICE NAME                         |
|--------------------------|-------------------|-------|-------------------------------------|
| START ADDRESS (HEX)      | END ADDRESS (HEX) |       |                                     |
| 0x4818_E000              | 0x4818_EFFF       | 4KB   | Reserved                            |
| 0x4818_F000              | 0x4818_FFFF       | 4KB   | Reserved                            |
| 0x4819_0000              | 0x4819_3FFF       | 16KB  | Reserved                            |
| 0x4819_4000              | 0x4819_BFFF       | 32KB  | Reserved                            |
| 0x4819_C000              | 0x481F_FFFF       | 400KB | Reserved                            |
| 0x4819_C000              | 0x4819_CFFF       | 4KB   | I2C2 Peripheral Registers           |
| 0x4819_D000              | 0x4819_DFFF       | 4KB   | I2C2 Interconnect Registers         |
| 0x4819_E000              | 0x4819_EFFF       | 4KB   | I2C3 Peripheral Registers           |
| 0x4819_F000              | 0x4819_FFFF       | 4KB   | I2C3 Interconnect Registers         |
| 0x481A_0000              | 0x481A_0FFF       | 4KB   | SPI1 Peripheral Registers           |
| 0x481A_1000              | 0x481A_1FFF       | 4KB   | SPI1 Interconnect Registers         |
| 0x481A_2000              | 0x481A_2FFF       | 4KB   | SPI2 Peripheral Registers           |
| 0x481A_3000              | 0x481A_3FFF       | 4KB   | SPI2 Interconnect Registers         |
| 0x481A_4000              | 0x481A_4FFF       | 4KB   | SPI3 Peripheral Registers           |
| 0x481A_5000              | 0x481A_5FFF       | 4KB   | SPI3 Interconnect Registers         |
| 0x481A_6000              | 0x481A_6FFF       | 4KB   | Reserved                            |
| 0x481A_7000              | 0x481A_7FFF       | 4KB   | Reserved                            |
| 0x481A_8000              | 0x481A_8FFF       | 4KB   | Reserved                            |
| 0x481A_9000              | 0x481A_9FFF       | 4KB   | Reserved                            |
| 0x481A_A000              | 0x481A_AFFF       | 4KB   | Reserved                            |
| 0x481A_B000              | 0x481A_BFFF       | 4KB   | Reserved                            |
| 0x481A_C000              | 0x481A_CFFF       | 4KB   | GPIO2 Peripheral Registers          |
| 0x481A_D000              | 0x481A_DFFF       | 4KB   | GPIO2 Interconnect Registers        |
| 0x481A_E000              | 0x481A_EFFF       | 4KB   | GPIO3 Peripheral Registers          |
| 0x481A_F000              | 0x481A_FFFF       | 4KB   | GPIO3 Interconnect Registers        |
| 0x481B_0000              | 0x481B_FFFF       | 64KB  | Reserved                            |
| 0x481C_0000              | 0x481C_0FFF       | 4KB   | Reserved                            |
| 0x481C_1000              | 0x481C_1FFF       | 4KB   | TIMER8 Peripheral Registers         |
| 0x481C_2000              | 0x481C_2FFF       | 4KB   | TIMER8 Interconnect Registers       |
| 0x481C_3000              | 0x481C_3FFF       | 4KB   | SYNCTIMER32K Peripheral Registers   |
| 0x481C_4000              | 0x481C_4FFF       | 4KB   | SYNCTIMER32K Interconnect Registers |
| 0x481C_5000              | 0x481C_5FFF       | 4KB   | PLLSS Peripheral Registers          |
| 0x481C_6000              | 0x481C_6FFF       | 4KB   | PLLSS Interconnect Registers        |
| 0x481C_7000              | 0x481C_7FFF       | 4KB   | WDT0 Peripheral Registers           |
| 0x481C_8000              | 0x481C_8FFF       | 4KB   | WDT0 Interconnect Registers         |
| 0x481C_9000              | 0x481C_9FFF       | 8KB   | Reserved                            |
| 0x481C_A000              | 0x481C_BFFF       | 8KB   | Reserved                            |
| 0x481C_C000              | 0x481C_DFFF       | 8KB   | Reserved                            |
| 0x481C_E000              | 0x481C_FFFF       | 8KB   | Reserved                            |
| 0x481D_0000              | 0x481D_1FFF       | 8KB   | Reserved                            |
| 0x481D_2000              | 0x481D_3FFF       | 8KB   | Reserved                            |
| 0x481D_4000              | 0x481D_5FFF       | 8KB   | Reserved                            |
| 0x481D_6000              | 0x481D_6FFF       | 4KB   | Reserved                            |
| 0x481D_7000              | 0x481D_7FFF       | 4KB   | Reserved                            |
| 0x481D_8000              | 0x481E_7FFF       | 64KB  | MMC/SD/SDIO1 Peripheral Registers   |
| 0x481E_8000              | 0x481E_8FFF       | 4KB   | MMC/SD/SDIO1 Interconnect Registers |

**Table 2-5. L4 Slow Peripheral Memory Map (continued)**

| Cortex-A8 and L3 Masters |                   | SIZE  | DEVICE NAME                          |
|--------------------------|-------------------|-------|--------------------------------------|
| START ADDRESS (HEX)      | END ADDRESS (HEX) |       |                                      |
| 0x481E_9000              | 0x481F_FFFF       | 52KB  | Reserved                             |
| 0x4820_0000              | 0x4820_0FFF       | 4KB   | Interrupt controller <sup>(1)</sup>  |
| 0x4820_1000              | 0x4823_FFFF       | 252KB | Reserved <sup>(1)</sup>              |
| 0x4824_0000              | 0x4824_0FFF       | 4KB   | MPUSS config register <sup>(1)</sup> |
| 0x4824_1000              | 0x4827_FFFF       | 252KB | Reserved <sup>(1)</sup>              |
| 0x4828_0000              | 0x4828_0FFF       | 4KB   | SSM <sup>(1)</sup>                   |
| 0x4828_1000              | 0x482F_FFFF       | 508KB | Reserved <sup>(1)</sup>              |
| 0x4830_0000              | 0x48FF_FFFF       | 13MB  | Reserved                             |

(1) These regions decoded internally by the Cortex™-A8 Subsystem and are not physically part of the L4 Slow. They are included here only for reference when considering the Cortex™-A8 Memory Map. For Masters other than the Cortex-A8 these regions are reserved.

### 2.10.3 DDR DMM TILER Extended Addressing Map

The Tiler includes an additional 4-GBytes of addressing range, enabled by a 33rd address bit, to access the frame buffer in rotated and mirrored views. shows the details of the Tiler Extended Address Mapping. This entirety of this additional range is only accessible to the HDVPSS and ISS subsystems. However, other masters can access any one single view through the 512-MB Tiler region in the base 4GByte address memory map.

**Table 2-6. DDR DMM TILER Extended Address Mapping**

| BLOCK NAME   | START ADDRESS (HEX) | END ADDRESS (HEX) | SIZE  | DESCRIPTION                     |
|--------------|---------------------|-------------------|-------|---------------------------------|
| Tiler View 0 | 0x1 0000_0000       | 0x1 1FFF_FFFF     | 512MB | Natural 0° View                 |
| Tiler View 1 | 0x1 2000_0000       | 0x1 3FFF_FFFF     | 512MB | 0° with Vertical Mirror View    |
| Tiler View 2 | 0x1 4000_0000       | 0x1 5FFF_FFFF     | 512MB | 0° with Horizontal Mirror View  |
| Tiler View 3 | 0x1 6000_0000       | 0x1 7FFF_FFFF     | 512MB | 180° View                       |
| Tiler View 4 | 0x1 8000_0000       | 0x1 9FFF_FFFF     | 512MB | 90° with Vertical Mirror View   |
| Tiler View 5 | 0x1 A000_0000       | 0x1 BFFF_FFFF     | 512MB | 270° View                       |
| Tiler View 6 | 0x1 C000_0000       | 0x1 DFFF_FFFF     | 512MB | 90° View                        |
| Tiler View 7 | 0x1 E000_0000       | 0x1 FFFF_FFFF     | 512MB | 90° with Horizontal Mirror View |

## 3 Device Pins

### 3.1 Pin Maps

The following tables show the top view of the package pin assignments in eight pin maps.

**Table 3-1. AAR Ball Map [Section Top\_Left - Top View]**

|    | A                 | B                  | C                  | D                 | E                   | F                 |
|----|-------------------|--------------------|--------------------|-------------------|---------------------|-------------------|
| 31 | VSS               | VOUT[0]_R_CR[9]    |                    | UART0_RTS         | UART0_DCD           |                   |
| 30 | VOUT[0]_R_CR[8]   | VOUT[0]_R_CR[7]    | VOUT[0]_R_CR[6]    | UART0_CTS         | UART0_DTR           | DEVOSC_MXI        |
| 29 | VOUT[0]_R_CR[5]   | VOUT[0]_R_CR[4]    |                    |                   | UART0_DSR           |                   |
| 28 |                   | VOUT[0]_R_CR[3]    | VOUT[0]_R_CR[2]    |                   | UART0_TXD           |                   |
| 27 | VOUT[0]_G_Y_YC[9] | VOUT[0]_G_Y_YC[8]  |                    |                   |                     |                   |
| 26 | VOUT[0]_G_Y_YC[6] | VOUT[0]_G_Y_YC[5]  | VOUT[0]_G_Y_YC[3]  |                   | VOUT[0]_G_Y_YC[4]   |                   |
| 25 |                   | VOUT[0]_G_Y_YC[7]  | VOUT[0]_G_Y_YC[2]  | VSS               | VSS                 | VSS               |
| 24 | USB1_ID           | USB1_VBUSIN        | VOUT[0]_B_CB_C[9]  | VOUT[0]_B_CB_C[8] | VOUT[0]_B_CB_C[7]   | VOUT[0]_B_CB_C[2] |
| 23 | USB1_DP           | USB1_DM            |                    |                   |                     |                   |
| 22 |                   | USB0_VBUSIN        |                    |                   |                     |                   |
| 21 | USB0_DP           | USB0_DM            | USB1_CE            | VOUT[0]_B_CB_C[3] | VSS                 | VOUT[0]_HSYNC     |
| 20 | USB0_ID           | USB0_CE            | VOUT[0]_AVID       | VSSA_USB          | VOUT[0]_VSYNC       | VSS               |
| 19 |                   | EMU1               |                    |                   |                     |                   |
| 18 | EMU0              | VIN[0]A_D[0]       |                    |                   |                     |                   |
| 17 | VIN[0]A_D[1]      | VIN[0]A_D[2]       | VIN[0]A_D[3]       | VIN[0]A_D[4]      | DVDD                | VIN[0]A_D[5]      |
| 16 |                   | VIN[0]A_D[8]_BD[0] | VIN[0]A_D[9]_BD[1] | DVDD              | VIN[0]A_D[10]_BD[2] | DVDD              |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |

**Table 3-2. AAR Ball Map [Section Top\_Left\_Middle - Top View]**

|    | G             | H                   | J                   | K              | L               | M               |
|----|---------------|---------------------|---------------------|----------------|-----------------|-----------------|
| 31 | DEVOSC_MXO    | SERDES_CLKN         |                     | PCIE_TXN0      | PCIE_TXP0       |                 |
| 30 | VSSA_DEVOSC   | SERDES_CLKP         | PCIE_RXN0           | PCIE_RXP0      | RSV27           | RSV28           |
| 29 | SPI[0]_SCS[0] | RSV40               | SPI[1]_SCS[0]       |                |                 | SPI[1]_SCLK     |
| 28 | SPI[0]_SCS[1] | RSV3                | SPI[0]_D[0]         |                |                 | RSV54           |
| 27 | VSS           | RSV1                | SPI[0]_D[1]         |                |                 | SPI[1]_D[1]     |
| 26 | VSS           | VSS                 | UART0_RXD           |                |                 | VDDA_PCIE_1P8   |
| 25 | VSS           | RSV39               | RSV0                |                |                 | VDDA_1P8        |
| 24 | VSS           | RSV2                | VOUT[0]_B_CB_C[6]   |                |                 | LDOCAP_SERDESKL |
| 23 | VSS           | VOUT[0]_B_CB_C[5]   | VOUT[0]_B_CB_C[4]   | USB0_DRVVBUS   |                 |                 |
| 22 |               |                     |                     | VOUT[0]_CLK    | UART2_RXD       |                 |
| 21 |               |                     |                     |                |                 | UART2_TXD       |
| 20 | VSS           | VIN[0]A_D[7]        |                     | LDOCAP_ARMRAM  | VIN[0]A_D[6]    | VDDA_USB_3P3    |
| 19 |               |                     | LDOCAP_ARM          | VDDA_USB0_1P8  | VDDA_ARMPLL_1P8 | VDDA_USB_3P3    |
| 18 |               |                     |                     |                | CVDD_ARM        |                 |
| 17 | RSV4          | VIN[0]A_D[11]_BD[3] | VDDA_USB1_1P8       | CVDD_ARM       | CVDD_ARM        | CVDD_ARM        |
| 16 | RSV5          | VIN[0]A_D[13]_BD[5] | VIN[0]A_D[12]_BD[4] | VDDA_HDDAC_1P1 | VSS             | VSS             |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |



**Table 3-3. AAR Ball Map [Section Top\_Middle\_Middle - Top View]**

|    | N           | P             | R     | T                 | U               | V           |
|----|-------------|---------------|-------|-------------------|-----------------|-------------|
| 31 | RSV30       | RSV31         |       | TMS               | AUXOSC_MXO      |             |
| 30 | RSV29       | RSV43         | RSV32 | RSV33             | VSSA_AUXOSC     | AUXOSC_MXI  |
| 29 | RTCK        |               |       | TCLK              | SD1_DAT[2]_SDRW |             |
| 28 | TDI         |               |       | DVDD              | DEVOSC_WAKE     |             |
| 27 | RSV55       |               |       | I2C[0]_SCL        | DVDD            |             |
| 26 | UART0_RIN   |               |       | DVDD              | TDO             |             |
| 25 | VDDA_1P8    |               |       | DVDD_SD           | DVDD_SD         |             |
| 24 | SPI[0]_SCLK |               |       | I2C[0]_SDA        | TRST            |             |
| 23 | SPI[1]_D[0] | VDDA_1P8      |       | VDDA_HDVICPLL_1P8 | VSS             |             |
| 22 | VDDA_1P8    |               |       | LDOCAP_RAM1       |                 |             |
| 21 |             | VDDS_OSC0_1P8 | VSS   | VSS               | CVDD_HDVICP     | CVDD_HDVICP |
| 20 | VSSA_USB    | VDDS_OSC1_1P8 | VSS   | VSS               | CVDD_HDVICP     | CVDD_HDVICP |
| 19 | VSSA_USB    |               |       | VSS               |                 |             |
| 18 |             | VSS           | VSS   | CVDD              | VSS             | VSS         |
| 17 | VSS         | CVDD          | CVDD  | CVDD              | CVDD            | CVDD        |
| 16 | VSS         |               |       | VSS               |                 |             |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |

**Table 3-4. AAR Ball Map [Section Top\_Right\_Middle - Top View]**

|    | W             | Y                | AA               | AB           | AC            | AD            |
|----|---------------|------------------|------------------|--------------|---------------|---------------|
| 31 | SD1_DAT[0]    | SD0_DAT[2]_SDRW  |                  | SD0_DAT[6]   | MCA[0]_AXR[3] |               |
| 30 | SD1_CLK       | SD0_DAT[3]       | SD1_DAT[1]_SDIRQ | SD0_CLK      | SD0_DAT[7]    | MCA[0]_ACLKR  |
| 29 |               | SD1_CMD          | SD0_CMD          |              |               | MCA[1]_ACLKR  |
| 28 |               | VSS              | SD0_DAT[0]       |              |               | MCA[0]_ACLKX  |
| 27 |               | SD1_DAT[3]       | VSS              |              |               | MCA[0]_AXR[5] |
| 26 |               | VSS              | SD0_DAT[1]_SDIRQ |              |               | MCA[0]_AXR[4] |
| 25 |               | VSS              |                  |              | VSS           | VSS           |
| 24 |               | LDOCAP_HDVICPRAM |                  |              | MCA[1]_AFSR   | VSS           |
| 23 | LDOCAP_HDVICP |                  |                  |              | MCA[1]_ACLKX  | DDR[0]_A[10]  |
| 22 | CVDD_HDVICP   | MCA[1]_AXR[0]    |                  | MCA[1]_AFSX  | DDR[0]_A[1]   |               |
| 21 |               | MCA[1]_AXR[1]    |                  | DDR[0]_CS[0] |               |               |
| 20 | CVDD          | CVDD             | DDR[0]_RST       |              |               | DDR[0]_CKE    |
| 19 | CVDD          | CVDD             | VDDA_DDRPLL_1P8  |              | DDR[0]_D[29]  | DDR[0]_D[28]  |
| 18 |               |                  | VSS              | DVDD_DDR[0]  | DVDD_DDR[0]   |               |
| 17 | VSS           | VSS              | VSS              | DVDD_DDR[0]  | DVDD_DDR[0]   |               |
| 16 | VSS           | VSS              | VSS              |              | DDR[0]_D[23]  | DDR[0]_D[22]  |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |

**Table 3-5. AAR Ball Map [Section Top\_Right - Top View]**

|    | AE            | AF            | AG           | AH                        | AJ                                  | AK                                | AL                            |
|----|---------------|---------------|--------------|---------------------------|-------------------------------------|-----------------------------------|-------------------------------|
| 31 | MCA[0]_AXR[1] | AUD_CLKIN0    |              | $\overline{\text{NMI}}$   | CLKIN32                             |                                   | VSS                           |
| 30 | MCA[0]_AXR[2] | MCA[0]_AFSR   | AUD_CLKIN2   | $\overline{\text{POR}}$   | $\overline{\text{RSTOUT\_WD\_OUT}}$ | DDR[0]_A[6]                       | DDR[0]_VTP                    |
| 29 | MCA[0]_AFSX   | MCA[0]_AXR[0] |              | $\overline{\text{RESET}}$ |                                     | DDR[0]_A[9]                       | DDR[0]_A[8]                   |
| 28 | VSS           |               |              |                           |                                     | DDR[0]_A[4]                       |                               |
| 27 | VSS           | AUD_CLKIN1    |              | DDR[0]_A[5]               | DDR[0]_A[3]                         | $\overline{\text{DDR[0]_CLK}}$    | DDR[0]_CLK                    |
| 26 | VSS           |               |              |                           |                                     | DDR[0]_BA[0]                      | $\overline{\text{DDR[0]_WE}}$ |
| 25 | VSS           | VSS           | VSS          | DDR[0]_BA[2]              | $\overline{\text{DDR[0]_RAS}}$      | $\overline{\text{DDR[0]_CAS}}$    |                               |
| 24 | VSS           | VSS           | VSS          | RSV34                     | RSV35                               | DDR[0]_A[11]                      | DDR[0]_A[0]                   |
| 23 | VSS           | DDR[0]_BA[1]  | DDR[0]_A[7]  | DDR[0]_A[12]              | DDR[0]_A[2]                         | DDR[0]_A[13]                      | DDR[0]_A[14]                  |
| 22 |               |               |              |                           |                                     | DDR[0]_A[15]                      |                               |
| 21 |               |               |              |                           |                                     | RSV42                             | DDR[0]_ODT[0]                 |
| 20 | VSS           | VSS           | DDR[0]_D[31] | VSS                       | DDR[0]_D[30]                        | $\overline{\text{DDR[0]_DQS[3]}}$ | DDR[0]_DQS[3]                 |
| 19 | VSS           | DDR[0]_D[27]  | VSS          | DDR[0]_D[26]              | DDR[0]_D[25]                        | DDR[0]_D[24]                      |                               |
| 18 |               |               |              |                           |                                     | DDR[0]_DQM[3]                     | VREFSSTL_DDR[0]               |
| 17 |               |               |              |                           |                                     | $\overline{\text{DDR[0]_DQS[2]}}$ | DDR[0]_DQS[2]                 |
| 16 | DVDD_DDR[0]   | DVDD_DDR[0]   | DDR[0]_D[21] | DVDD_DDR[0]               | DDR[0]_D[20]                        | DDR[0]_D[19]                      |                               |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |

**Table 3-6. AAR Ball Map [Section Bottom\_Left - Top View]**

|    | A                 | B                 | C               | D                 | E             | F                   |
|----|-------------------|-------------------|-----------------|-------------------|---------------|---------------------|
| 15 | HDMI_CLKP         | HDMI_CLKN         |                 |                   |               |                     |
| 14 | HDMI_DN0          | HDMI_DP0          |                 |                   |               |                     |
| 13 |                   | HDMI_DN1          | VIN[0]A_VSYNC   | VIN[0]A_HSYNC     | DVDD_C        | VIN[0]A_D[14]_BD[6] |
| 12 | HDMI_DN2          | HDMI_DP1          | VIN[0]A_DE      | DVDD_C            | VIN[0]A_D[17] | DVDD_C              |
| 11 | HDMI_DP2          | TV_RSET           |                 |                   |               |                     |
| 10 |                   | TV_VFB0           |                 |                   |               |                     |
| 9  | HDDAC_A           | TV_OUT0           | VIN[0]A_CLK     | HDDAC_VSYNC       | HDDAC_HSYNC   | VIN[0]A_D[20]       |
| 8  | HDDAC_B           | HDDAC_C           | VSSA_VDAC       | VSS               | VSS           | VSS                 |
| 7  |                   | HDDAC_VREF        | VIN[0]A_D[21]   | VIN[0]A_D[19]     | VSS           | VSS                 |
| 6  | VIN[0]A_D[22]     | HDDAC_IREF        |                 |                   |               |                     |
| 5  | VIN[0]A_D[23]     | VIN[0]A_DE        | VIN[0]B_DE      | VOUT[1]_B_CB_C[1] |               | VOUT[1]_VSYNC       |
| 4  |                   | VIN[0]A_FLD       |                 |                   |               |                     |
| 3  | VIN[0]B_FLD       | VOUT[0]_FLD       |                 | VOUT[1]_CLK       |               | VOUT[1]_B_CB_C[4]   |
| 2  | VOUT[1]_G_Y_YC[1] | VOUT[1]_G_Y_YC[0] | VOUT[1]_R_CR[0] | I2C[1]_SCL        | VOUT[1]_HSYNC | VOUT[1]_B_CB_C[3]   |
| 1  | VSS               |                   | VOUT[1]_R_CR[1] | I2C[1]_SDA        |               | VOUT[1]_AVID        |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |

**Table 3-7. AAR Ball Map [Section Bottom\_Left\_Middle - Top View]**

|    | G                 | H                   | J                 | K                 | L                 | M                 |
|----|-------------------|---------------------|-------------------|-------------------|-------------------|-------------------|
| 15 |                   |                     |                   |                   | VDDA_HDDACREF_1P8 |                   |
| 14 |                   |                     | VDDA_VDAC_1P8     | VDDA_HDMI_1P8     | VDDA_HDDAC_1P8    | CVDD_ARM          |
| 13 | DVDD_C            | VIN[0]A_D[15]_BD[7] | VIN[0]A_FLD       |                   | VDDA_VIDPLL_1P8   | CVDD_ARM          |
| 12 | DVDD_C            | VIN[0]B_CLK         |                   |                   | VOUT[1]_R_CR[6]   |                   |
| 11 |                   |                     |                   | VIN[0]A_D[16]     |                   | VOUT[1]_R_CR[5]   |
| 10 |                   |                     | VOUT[1]_FLD       | VIN[0]A_D[18]     |                   | VOUT[1]_R_CR[7]   |
| 9  | VSSA_HDMI         | VOUT[1]_B_CB_C[0]   | VOUT[1]_G_Y_YC[7] |                   |                   |                   |
| 8  | VSS               | VSSA_HDMI           | VOUT[1]_G_Y_YC[4] |                   |                   | VOUT[1]_B_CB_C[2] |
| 7  | VSS               | VSS                 | VSS               |                   |                   | DVDD              |
| 6  | VSS               | VOUT[1]_G_Y_YC[3]   |                   |                   | VOUT[1]_R_CR[2]   | DVDD              |
| 5  | VSS               | VOUT[1]_B_CB_C[9]   |                   |                   | DVDD              | GPMC_A[19]        |
| 4  | VSS               | VOUT[1]_G_Y_YC[6]   |                   |                   | VOUT[1]_R_CR[3]   | DVDD              |
| 3  | VOUT[1]_B_CB_C[8] | VOUT[1]_B_CB_C[7]   |                   |                   | VOUT[1]_G_Y_YC[8] | GPMC_A[18]        |
| 2  | VOUT[1]_B_CB_C[6] | VOUT[1]_R_CR[4]     | VOUT[1]_R_CR[8]   | VOUT[1]_R_CR[9]   | VOUT[1]_G_Y_YC[2] | GPMC_A[17]        |
| 1  | VOUT[1]_B_CB_C[5] |                     | VOUT[1]_G_Y_YC[5] | VOUT[1]_G_Y_YC[9] |                   | GPMC_A[16]        |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |

**Table 3-8. AAR Ball Map [Section Bottom\_Middle\_Middle - Top View]**

|    | N          | P          | R          | T         | U           | V                 |
|----|------------|------------|------------|-----------|-------------|-------------------|
| 15 |            | CVDD       | CVDD       | VSS       | CVDD        | CVDD              |
| 14 | VSS        | VSS        | VSS        | VSS       | VSS         | VSSA_CSI2         |
| 13 | VSS        |            |            | CVDD      |             |                   |
| 12 |            | VSS        | VSS        | VSS       | CVDD        | CVDD              |
| 11 | DVDD       | VSS        | VSS        | VSS       | CVDD        | CVDD              |
| 10 | DVDD       |            |            | VDDA_1P8  |             |                   |
| 9  | GPMC_A[20] |            | VDDA_1P8   | VDDA_1P8  | LDOCAP_RAM0 | VDDA_AUDIOPLL_1P8 |
| 8  |            |            | GPMC_A[23] | GPMC_D[9] |             |                   |
| 7  |            |            | DVDD_GPMC  | DVDD_GPMC |             |                   |
| 6  |            |            | GPMC_D[10] | DVDD_GPMC |             |                   |
| 5  |            |            | DVDD_GPMC  | GPMC_D[5] |             |                   |
| 4  |            |            | GPMC_D[11] | DVDD_GPMC |             |                   |
| 3  |            |            | GPMC_D[12] | GPMC_D[6] |             |                   |
| 2  | GPMC_A[22] | GPMC_D[15] | GPMC_D[13] | GPMC_D[7] | GPMC_D[3]   | CSI2_DY[4]        |
| 1  | GPMC_A[21] |            | GPMC_D[14] | GPMC_D[8] |             | CSI2_DX[4]        |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |

**Table 3-9. AAR Ball Map [Section Bottom\_Right\_Middle - Top View]**

|    | W             | Y              | AA           | AB           | AC               | AD           |
|----|---------------|----------------|--------------|--------------|------------------|--------------|
| 15 |               |                | VSS          | DVDD_DDR[0]  | DVDD_DDR[0]      | DDR[0]_D[18] |
| 14 | CVDD          | CVDD           | VSS          | DVDD_DDR[0]  |                  |              |
| 13 | CVDD          | CVDD           | VSS          |              | DDR[0]_D[13]     |              |
| 12 |               |                | GPMC_CS[1]   | DDR[0]_D[11] |                  | DDR[0]_D[10] |
| 11 | VDDA_L3L4_1P8 | GPMC_BE[1]     |              |              |                  |              |
| 10 | VDDA_CSI2_1P8 |                | GPMC_ADV_ALE | LDOCAP_RAM2  |                  |              |
| 9  | GPMC_D[4]     |                |              | GPMC_CLK     | GPMC_CS[0]       | DDR[0]_D[5]  |
| 8  | GPMC_WAIT[0]  | GPMC_OE_RE     |              |              | SD2_DAT[2]_SDRW  | RSV41        |
| 7  | DVDD_RGMII    | DVDD_RGMII     |              |              | VSSA_CSI2        | VSS          |
| 6  | GPMC_D[0]     | DVDD_RGMII     |              |              | SD2_SCLK         | VSS          |
| 5  | DVDD_RGMII    | GPMC_WE        |              |              | SD2_DAT[1]_SDIRQ | VSS          |
| 4  | GPMC_D[1]     | DVDD_RGMII     |              |              | SD2_DAT[0]       | VSS          |
| 3  | GPMC_D[2]     | GPMC_BE[0]_CLE |              |              | GPMC_CS[2]       | VSS          |
| 2  | CSI2_DX[3]    | CSI2_DY[2]     | CSI2_DX[2]   | CSI2_DX[0]   | CSI2_DY[0]       | SD2_DAT[4]   |
| 1  | CSI2_DY[3]    |                | CSI2_DX[1]   | CSI2_DY[1]   |                  | SD2_DAT[3]   |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |

**Table 3-10. AAR Ball Map [Section Bottom\_Right - Top View]**

|    | AE                                   | AF                                 | AG                                   | AH                                   | AJ                                   | AK                                   | AL                                   |
|----|--------------------------------------|------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|
| 15 | DVDD_DDR[0]                          | DDR[0]_D[17]                       | DVDD_DDR[0]                          | DDR[0]_D[16]                         | DDR[0]_DQM[2]                        | DDR[0]_DQS[1]                        | DDR[0]_DQS[1]                        |
| 14 |                                      |                                    |                                      |                                      |                                      | DDR[0]_D[15]                         | DDR[0]_D[14]                         |
| 13 |                                      |                                    |                                      |                                      |                                      | DDR[0]_D[12]                         |                                      |
| 12 | VSS                                  | VSS                                | DDR[0]_D[9]                          | VSS                                  | DDR[0]_D[8]                          | DDR[0]_DQM[1]                        | DDR[0]_D[7]                          |
| 11 |                                      | DDR[0]_D[6]                        | VSS                                  | DDR[0]_D[4]                          | DDR[0]_D[3]                          | DDR[0]_DQS[0]                        | DDR[0]_DQS[0]                        |
| 10 |                                      |                                    |                                      |                                      |                                      | DDR[0]_D[2]                          |                                      |
| 9  | VSS                                  |                                    |                                      |                                      |                                      | DDR[0]_D[1]                          | DDR[0]_D[0]                          |
| 8  | VSS                                  | EMAC[0]_MTXEN/<br>EMAC[1]_RGRXD[2] | EMAC[0]_MTXD[7]/<br>EMAC[1]_RGTXD[3] | EMAC[0]_MTXD[6]/<br>EMAC[1]_RGRXD[0] | EMAC[0]_MTXD[5]/<br>EMAC[1]_RGTXC    | EMAC[0]_MTXD[4]/<br>EMAC[1]_RGTXD[2] | DDR[0]_DQM[0]                        |
| 7  | VSS                                  | VSS                                | VSS                                  | VSS                                  | EMAC[0]_MTXD[1]/<br>EMAC[1]_RGTXD[1] | EMAC[0]_MTXD[2]/<br>EMAC[1]_RGTXCTL  |                                      |
| 6  | VSS                                  |                                    | GPMC_CS[4]                           |                                      | EMAC[0]_MRXDV/<br>EMAC[1]_RGRXD[1]   | EMAC[0]_MTXD[0]/<br>EMAC[1]_RGRXD[3] | EMAC[0]_GMTCLK/<br>EMAC[1]_RGRXC     |
| 5  | VSS                                  |                                    |                                      |                                      |                                      | EMAC[0]_MRXD[7]/<br>EMAC[0]_RGTXD[1] | EMAC[0]_MRXD[6]/<br>EMAC[0]_RGTXD[2] |
| 4  | EMAC[0]_MTXD[3]/<br>EMAC[1]_RGTXD[0] |                                    | EMAC[0]_MTCLK/<br>EMAC[0]_RGRXC      |                                      | EMAC[0]_MRXD[5]/<br>EMAC[0]_RGTXD[3] | EMAC[0]_MRXD[4]/<br>EMAC[0]_RGRXD[3] |                                      |
| 3  | SD2_DAT[7]                           |                                    | MDIO                                 |                                      |                                      | EMAC[0]_MRXD[3]/<br>EMAC[1]_RGRXCTL  | EMAC[0]_MRXD[2]/<br>EMAC[0]_RGRXD[1] |
| 2  | SD2_DAT[6]                           | GPMC_CS[3]                         | MDCLK                                | EMAC[0]_MCRS/<br>EMAC[0]_RGRXD[2]    | EMAC[0]_MRXER/<br>EMAC[0]_RGTXCTL    | EMAC[0]_MRXD[0]/<br>EMAC[0]_RGTXD[0] | EMAC[0]_MRXD[1]/<br>EMAC[0]_RGRXD[0] |
| 1  | SD2_DAT[5]                           |                                    | EMAC_RMREFCLK                        | EMAC[0]_MCOL/<br>EMAC[0]_RGRXCTL     |                                      | EMAC[0]_MRCLK/<br>EMAC[0]_RGTXC      | VSS                                  |

**Ball Map Position**

|   |   |   |   |    |
|---|---|---|---|----|
| 1 | 2 | 3 | 4 | 5  |
| 6 | 7 | 8 | 9 | 10 |



## 3.2 Pin Assignments

The following table provides a summary of the device signal ball assignments and characteristics.

1. **BALL NUMBER:** Package ball number(s) associated with each signal(s).
2. **BALL NAME:** The name of the package ball or terminal.  
**Note:** The table does not take into account subsystem terminal multiplexing options.
3. **SIGNAL NAME:** The signal name for that ball in the mode being used.
4. **PINCNTL REGISTER NAME AND ADDRESS:** The name and address of the register that controls the pin's internal pull-up/down resistors and multiplexing options.
5. **PINCNTL DEFAULT VALUE:** The default value of the PINCNTL after reset.
6. **MODE:** The setting of the MUXMODE[10:0] bits in the associated PINCNTL register that selects this multiplexed signal option.
7. **TYPE:** Signal direction
  - I = Input
  - O = Output
  - I/O = Input/Output
  - D = Open drain
  - DS = Differential
  - A = Analog
  - PWR = Power
  - GND = Ground
8. **DSIS:** The deselected input state (DSIS) indicates the state driven on the peripheral input (logic "0", logic "1", or "PIN" level) when the peripheral pin function is not selected by any of the PINCNTLx registers.
  - 0: Logic 0 driven on the peripheral's input signal port.
  - 1: Logic 1 driven on the peripheral's input signal port.
  - PIN: The value on the pin is driven to the peripheral's input signal port.
9. **BALL RESET STATE:** The state of the ball during device reset.
  - 0: The buffer drives  $V_{OL}$  (pulldown/pullup resistor not activated)  
0(PD): The buffer drives  $V_{OL}$  with an active pulldown resistor
  - 1: The buffer drives  $V_{OH}$  (pulldown/pullup resistor not activated)  
1(PU): The buffer drives  $V_{OH}$  with an active pullup resistor
  - Z: High-impedance.
  - L: High-impedance with an active pulldown resistor
  - H : High-impedance with an active pullup resistor
10. **BALL RESET REL. STATE:** The state of the ball following the device coming out of reset.
  - 0: The buffer drives  $V_{OL}$  (pulldown/pullup resistor not activated)  
0(PD): The buffer drives  $V_{OL}$  with an active pulldown resistor
  - 1: The buffer drives  $V_{OH}$  (pulldown/pullup resistor not activated)  
1(PU): The buffer drives  $V_{OH}$  with an active pullup resistor
  - Z: High-impedance.
  - L: High-impedance with an active pulldown resistor
  - H : High-impedance with an active pullup resistor
11. **POWER:** The voltage supply that powers the terminal's I/O buffers.
12. **HYS:** Indicates if the input buffer is with hysteresis.
13. **BUFFER TYPE:** Drive strength of the associated output buffer.

Table 3-11. Ball Characteristics (AAR Package)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS [4] | PINCNTL DEFAULT VALUE [5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]    | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|-----------------|---------------------------------------|---------------------------|----------|----------|----------|----------------------|----------------------------|---------------|----------|------------------|
| AF31            | AUD_CLKIN0    | AUD_CLKIN0      | PINCNTL14 / 0x4814 0834               | 0x000C 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD          |          |                  |
|                 |               | MCA[0]_AHCLKX   |                                       |                           | 0x04     | I/O      | PIN      |                      |                            |               |          |                  |
|                 |               | ATL_CLKOUT1     |                                       |                           | 0x10     | O        | PIN      |                      |                            |               |          |                  |
|                 |               | ATL_CLKOUT0     |                                       |                           | 0x20     | O        | PIN      |                      |                            |               |          |                  |
|                 |               | USB1_DRVVBUS    |                                       |                           | 0x80     | O        | PIN      |                      |                            |               |          |                  |
| AF27            | AUD_CLKIN1    | AUD_CLKIN1      | PINCNTL15 / 0x4814 0838               | 0x000C 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD          |          |                  |
|                 |               | MCA[1]_AHCLKX   |                                       |                           | 0x04     | I/O      | PIN      |                      |                            |               |          |                  |
|                 |               | ATL_CLKOUT2     |                                       |                           | 0x10     | O        | PIN      |                      |                            |               |          |                  |
|                 |               | EDMA_EVT3       |                                       |                           | 0x20     | I        | PIN      |                      |                            |               |          |                  |
|                 |               | TIM2_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |               |          |                  |
|                 |               | GP0[8]          |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| AG30            | AUD_CLKIN2    | AUD_CLKIN2      | PINCNTL16 / 0x4814 083C               | 0x000C 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD          |          |                  |
|                 |               | ATL_CLKOUT3     |                                       |                           | 0x10     | O        | PIN      |                      |                            |               |          |                  |
|                 |               | EDMA_EVT2       |                                       |                           | 0x20     | I        | PIN      |                      |                            |               |          |                  |
|                 |               | TIM3_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |               |          |                  |
|                 |               | GP0[9]          |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| V30             | AUXOSC_MXI    | AUXOSC_MXI      | NA / NA                               | NA                        | 0x01     | I        | NA       | NA                   | NA                         | VDDS_OSC1_1P8 |          |                  |
| U31             | AUXOSC_MXO    | AUXOSC_MXO      | NA / NA                               | NA                        | 0x01     | O        | NA       | NA                   | NA                         | VDDS_OSC1_1P8 |          |                  |
| AJ31            | CLKIN32       | CLKIN32         | PINCNTL259 / 0x4814 0C08              | 0x0004 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD          |          |                  |
|                 |               | CLKOUT0         |                                       |                           | 0x04     | O        | PIN      |                      |                            |               |          |                  |
|                 |               | TIM3_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |               |          |                  |
|                 |               | GP3[31]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| AB2             | CSI2_DX[0]    | CSI2_DX[0]      | NA / NA                               | NA                        | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |
| AA1             | CSI2_DX[1]    | CSI2_DX[1]      | NA / NA                               | NA                        | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |
| AA2             | CSI2_DX[2]    | CSI2_DX[2]      | NA / NA                               | NA                        | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |
| W2              | CSI2_DX[3]    | CSI2_DX[3]      | NA / NA                               | NA                        | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |
| V1              | CSI2_DX[4]    | CSI2_DX[4]      | NA / NA                               | NA                        | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |
| AC2             | CSI2_DY[0]    | CSI2_DY[0]      | NA / NA                               | NA                        | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |
| AB1             | CSI2_DY[1]    | CSI2_DY[1]      | NA / NA                               | NA                        | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |
| Y2              | CSI2_DY[2]    | CSI2_DY[2]      | NA / NA                               | NA                        | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1]                                                                                                   | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]    | HYS [12] | BUFFER TYPE [13] |
|-------------------------------------------------------------------------------------------------------------------|---------------|-----------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|---------------|----------|------------------|
| W1                                                                                                                | CSI2_DY[3]    | CSI2_DY[3]      | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |
| V2                                                                                                                | CSI2_DY[4]    | CSI2_DY[4]      | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_CSI2_1P8 |          |                  |
| P15, P17, R15, R17, T13, T17, T18, U11, U12, U15, U17, V11, V12, V15, V17, W13, W14, W19, W20, Y13, Y14, Y19, Y20 | CVDD          | CVDD            | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA            |          |                  |
| K17, L17, L18, M13, M14, M17                                                                                      | CVDD_ARM      | CVDD_ARM        | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA            |          |                  |
| U20, U21, V20, V21, W22                                                                                           | CVDD_HDVICP   | CVDD_HDVICP     | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA            |          |                  |
| AL24                                                                                                              | DDR[0]_A[0]   | DDR[0]_A[0]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AC22                                                                                                              | DDR[0]_A[1]   | DDR[0]_A[1]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AJ23                                                                                                              | DDR[0]_A[2]   | DDR[0]_A[2]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AJ27                                                                                                              | DDR[0]_A[3]   | DDR[0]_A[3]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AK28                                                                                                              | DDR[0]_A[4]   | DDR[0]_A[4]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AH27                                                                                                              | DDR[0]_A[5]   | DDR[0]_A[5]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AK30                                                                                                              | DDR[0]_A[6]   | DDR[0]_A[6]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AG23                                                                                                              | DDR[0]_A[7]   | DDR[0]_A[7]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AL29                                                                                                              | DDR[0]_A[8]   | DDR[0]_A[8]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AK29                                                                                                              | DDR[0]_A[9]   | DDR[0]_A[9]     | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AD23                                                                                                              | DDR[0]_A[10]  | DDR[0]_A[10]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AK24                                                                                                              | DDR[0]_A[11]  | DDR[0]_A[11]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AH23                                                                                                              | DDR[0]_A[12]  | DDR[0]_A[12]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AK23                                                                                                              | DDR[0]_A[13]  | DDR[0]_A[13]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AL23                                                                                                              | DDR[0]_A[14]  | DDR[0]_A[14]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AK22                                                                                                              | DDR[0]_A[15]  | DDR[0]_A[15]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]  | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|-----------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|-------------|----------|------------------|
| AK26            | DDR[0]_BA[0]  | DDR[0]_BA[0]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AF23            | DDR[0]_BA[1]  | DDR[0]_BA[1]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AH25            | DDR[0]_BA[2]  | DDR[0]_BA[2]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AK25            | DDR[0]_CAS    | DDR[0]_CAS      | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AD20            | DDR[0]_CKE    | DDR[0]_CKE      | NA / NA                              | NA                       | 0x01     | O        | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AL27            | DDR[0]_CLK    | DDR[0]_CLK      | NA / NA                              | NA                       | 0x01     | O        | NA       | L                    | 0                          | DVDD_DDR[0] |          |                  |
| AK27            | DDR[0]_CLK    | DDR[0]_CLK      | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AB21            | DDR[0]_CS[0]  | DDR[0]_CS[0]    | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AL9             | DDR[0]_D[0]   | DDR[0]_D[0]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AK9             | DDR[0]_D[1]   | DDR[0]_D[1]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AK10            | DDR[0]_D[2]   | DDR[0]_D[2]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AJ11            | DDR[0]_D[3]   | DDR[0]_D[3]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AH11            | DDR[0]_D[4]   | DDR[0]_D[4]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AD9             | DDR[0]_D[5]   | DDR[0]_D[5]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AF11            | DDR[0]_D[6]   | DDR[0]_D[6]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AL12            | DDR[0]_D[7]   | DDR[0]_D[7]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AJ12            | DDR[0]_D[8]   | DDR[0]_D[8]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AG12            | DDR[0]_D[9]   | DDR[0]_D[9]     | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AD12            | DDR[0]_D[10]  | DDR[0]_D[10]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AB12            | DDR[0]_D[11]  | DDR[0]_D[11]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AK13            | DDR[0]_D[12]  | DDR[0]_D[12]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AC13            | DDR[0]_D[13]  | DDR[0]_D[13]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AL14            | DDR[0]_D[14]  | DDR[0]_D[14]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]  | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|-----------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|-------------|----------|------------------|
| AK14            | DDR[0]_D[15]  | DDR[0]_D[15]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AH15            | DDR[0]_D[16]  | DDR[0]_D[16]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AF15            | DDR[0]_D[17]  | DDR[0]_D[17]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AD15            | DDR[0]_D[18]  | DDR[0]_D[18]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AK16            | DDR[0]_D[19]  | DDR[0]_D[19]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AJ16            | DDR[0]_D[20]  | DDR[0]_D[20]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AG16            | DDR[0]_D[21]  | DDR[0]_D[21]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AD16            | DDR[0]_D[22]  | DDR[0]_D[22]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AC16            | DDR[0]_D[23]  | DDR[0]_D[23]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AK19            | DDR[0]_D[24]  | DDR[0]_D[24]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AJ19            | DDR[0]_D[25]  | DDR[0]_D[25]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AH19            | DDR[0]_D[26]  | DDR[0]_D[26]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AF19            | DDR[0]_D[27]  | DDR[0]_D[27]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AD19            | DDR[0]_D[28]  | DDR[0]_D[28]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AC19            | DDR[0]_D[29]  | DDR[0]_D[29]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AJ20            | DDR[0]_D[30]  | DDR[0]_D[30]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AG20            | DDR[0]_D[31]  | DDR[0]_D[31]    | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | L                          | DVDD_DDR[0] |          |                  |
| AL8             | DDR[0]_DQM[0] | DDR[0]_DQM[0]   | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AK12            | DDR[0]_DQM[1] | DDR[0]_DQM[1]   | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AJ15            | DDR[0]_DQM[2] | DDR[0]_DQM[2]   | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AK18            | DDR[0]_DQM[3] | DDR[0]_DQM[3]   | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |
| AL11            | DDR[0]_DQS[0] | DDR[0]_DQS[0]   | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | 0                          | DVDD_DDR[0] |          |                  |
| AK11            | DDR[0]_DQS[0] | DDR[0]_DQS[0]   | NA / NA                              | NA                       | 0x01     | I/O      | NA       | H                    | 1                          | DVDD_DDR[0] |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1]                                                        | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]    | HYS [12] | BUFFER TYPE [13] |
|------------------------------------------------------------------------|---------------|-----------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|---------------|----------|------------------|
| AK15                                                                   | DDR[0]_DQS[1] | DDR[0]_DQS[1]   | NA / NA                              | NA                       | 0x01     | I/O      | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AL15                                                                   | DDR[0]_DQS[1] | DDR[0]_DQS[1]   | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | 0                          | DVDD_DDR[0]   |          |                  |
| AL17                                                                   | DDR[0]_DQS[2] | DDR[0]_DQS[2]   | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | 0                          | DVDD_DDR[0]   |          |                  |
| AK17                                                                   | DDR[0]_DQS[2] | DDR[0]_DQS[2]   | NA / NA                              | NA                       | 0x01     | I/O      | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AK20                                                                   | DDR[0]_DQS[3] | DDR[0]_DQS[3]   | NA / NA                              | NA                       | 0x01     | I/O      | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AL20                                                                   | DDR[0]_DQS[3] | DDR[0]_DQS[3]   | NA / NA                              | NA                       | 0x01     | I/O      | NA       | L                    | 0                          | DVDD_DDR[0]   |          |                  |
| AL21                                                                   | DDR[0]_ODT[0] | DDR[0]_ODT[0]   | NA / NA                              | NA                       | 0x01     | O        | NA       | L                    | 0                          | DVDD_DDR[0]   |          |                  |
| AJ25                                                                   | DDR[0]_RAS    | DDR[0]_RAS      | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| AA20                                                                   | DDR[0]_RST    | DDR[0]_RST      | NA / NA                              | NA                       | 0x01     | O        | NA       | L                    | 0                          | DVDD_DDR[0]   |          |                  |
| AL30                                                                   | DDR[0]_VTP    | DDR[0]_VTP      | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | DVDD_DDR[0]   |          |                  |
| AL26                                                                   | DDR[0]_WE     | DDR[0]_WE       | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | 1                          | DVDD_DDR[0]   |          |                  |
| F30                                                                    | DEVOSC_MXI    | DEV_CLKIN       | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDS_OSC0_1P8 |          |                  |
|                                                                        |               | DEVOSC_MXI      | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         |               |          |                  |
| G31                                                                    | DEVOSC_MXO    | DEVOSC_MXO      | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDS_OSC0_1P8 |          |                  |
| U28                                                                    | DEVOSC_WAKE   | DEVOSC_WAKE     | PINCNTL7 / 0x4814 0818               | 0x000E 0000              | 0x01     | I        | 1        | H                    | H                          | DVDD_SD       |          |                  |
|                                                                        |               | SPI[1]_SCS[1]   |                                      |                          | 0x02     | I/O      | 1        |                      |                            |               |          |                  |
|                                                                        |               | TIM5_IO         |                                      |                          | 0x40     | I/O      | PIN      |                      |                            |               |          |                  |
|                                                                        |               | GP1[7]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| D16, E17, F16, L5, M4, M6, M7, N10, N11, T26, T28, U27                 | DVDD          | DVDD            | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA            |          |                  |
| D12, E13, F12, G12, G13                                                | DVDD_C        | DVDD_C          | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA            |          |                  |
| AB14, AB15, AB17, AB18, AC15, AC17, AC18, AE15, AE16, AF16, AG15, AH16 | DVDD_DDR[0]   | DVDD_DDR[0]     | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA            |          |                  |
| R5, R7, T4, T6, T7                                                     | DVDD_GPMC     | DVDD_GPMC       | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA            |          |                  |
| W5, W7, Y4, Y6, Y7                                                     | DVDD_RGMII    | DVDD_RGMII      | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA            |          |                  |
| T25, U25                                                               | DVDD_SD       | DVDD_SD         | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]                        | SIGNAL NAME [3]                      | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| AL6             | EMAC[0]_GMTCLK/<br>EMAC[1]_RGRXC     | EMAC[0]_GMTCLK/<br>EMAC[1]_RGRXC     | PINCNTL249 /<br>0x4814 0BE0          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | GPMC_A[6]                            |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | SPI[2]_D[1]                          |                                      |                          | 0x20     | I/O      | PIN      |                      |                            |            |          |                  |
| AH1             | EMAC[0]_MCOL/<br>EMAC[0]_RGRXCTL     | EMAC[0]_MCOL/<br>EMAC[0]_RGRXCTL     | PINCNTL236 /<br>0x4814 0BAC          | 0x000C 0000              | 0x01     | I        | 0        | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | VIN[1]B_D[1]                         |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | EMAC[0]_RMRXD[0]                     |                                      |                          | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GP3[24]                              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AH2             | EMAC[0]_MCRS/<br>EMAC[0]_RGRXD[2]    | EMAC[0]_MCRS/<br>EMAC[0]_RGRXD[2]    | PINCNTL237 /<br>0x4814 0BB0          | 0x000C 0000              | 0x01     | I        | 0        | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | VIN[1]B_D[2]                         |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | EMAC[0]_RMRXD[1]                     |                                      |                          | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GP3[25]                              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AK1             | EMAC[0]_MRCLK/<br>EMAC[0]_RGTXC      | EMAC[0]_MRCLK/<br>EMAC[0]_RGTXC      | PINCNTL239 /<br>0x4814 0BB8          | 0x000C 0000              | 0x01     | I/O      | 0        | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | VIN[1]B_D[4]                         |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | EMAC[0]_RMCSDV                       |                                      |                          | 0x04     | I        | 0        |                      |                            |            |          |                  |
|                 |                                      | SPI[3]_SCS[2]                        |                                      |                          | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                                      | GP3[27]                              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AJ6             | EMAC[0]_MRXDV/<br>EMAC[1]_RGRXD[1]   | EMAC[0]_MRXDV/<br>EMAC[1]_RGRXD[1]   | PINCNTL248 /<br>0x4814 0BDC          | 0x0004 0000              | 0x01     | I/O      | 0        | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | GPMC_A[5]                            |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | SPI[2]_SCLK                          |                                      |                          | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
| AK2             | EMAC[0]_MRXD[0]/<br>EMAC[0]_RGTXD[0] | EMAC[0]_MRXD[0]/<br>EMAC[0]_RGTXD[0] | PINCNTL240 /<br>0x4814 0BBC          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | VIN[1]B_D[5]                         |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | EMAC[0]_RMTXD[0]                     |                                      |                          | 0x04     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GP3[28]                              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AL2             | EMAC[0]_MRXD[1]/<br>EMAC[0]_RGRXD[0] | EMAC[0]_MRXD[1]/<br>EMAC[0]_RGRXD[0] | PINCNTL241 /<br>0x4814 0BC0          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | VIN[1]B_D[6]                         |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | EMAC[0]_RMTXD[1]                     |                                      |                          | 0x04     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GP3[29]                              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AL3             | EMAC[0]_MRXD[2]/<br>EMAC[0]_RGRXD[1] | EMAC[0]_MRXD[2]/<br>EMAC[0]_RGRXD[1] | PINCNTL242 /<br>0x4814 0BC4          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | VIN[1]B_D[7]                         |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | EMAC[0]_RMTXEN                       |                                      |                          | 0x04     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GP3[30]                              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]                        | SIGNAL NAME [3]                      | PINCNTL REGISTER NAME AND ADDRESS [4] | PINCNTL DEFAULT VALUE [5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|--------------------------------------|--------------------------------------|---------------------------------------|---------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| AK3             | EMAC[0]_MRXD[3]/<br>EMAC[1]_RGRXCTL  | EMAC[0]_MRXD[3]/<br>EMAC[1]_RGRXCTL  | PINCNTL243 /<br>0x4814 0BC8           | 0x0004 0000               | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | GPMC_A[27]                           |                                       |                           | 0x04     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GPMC_A[26]                           |                                       |                           | 0x08     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GPMC_A[0]                            |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
| AK4             | EMAC[0]_MRXD[4]/<br>EMAC[0]_RGRXD[3] | EMAC[0]_MRXD[4]/<br>EMAC[0]_RGRXD[3] | PINCNTL244 /<br>0x4814 0BCC           | 0x0004 0000               | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | GPMC_A[1]                            |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
| AJ4             | EMAC[0]_MRXD[5]/<br>EMAC[0]_RGTXD[3] | EMAC[0]_MRXD[5]/<br>EMAC[0]_RGTXD[3] | PINCNTL245 /<br>0x4814 0BD0           | 0x0004 0000               | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | GPMC_A[2]                            |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
| AL5             | EMAC[0]_MRXD[6]/<br>EMAC[0]_RGTXD[2] | EMAC[0]_MRXD[6]/<br>EMAC[0]_RGTXD[2] | PINCNTL246 /<br>0x4814 0BD4           | 0x0004 0000               | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | GPMC_A[3]                            |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
| AK5             | EMAC[0]_MRXD[7]/<br>EMAC[0]_RGTXD[1] | EMAC[0]_MRXD[7]/<br>EMAC[0]_RGTXD[1] | PINCNTL247 /<br>0x4814 0BD8           | 0x0004 0000               | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | GPMC_A[4]                            |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | SPI[2]_SCS[3]                        |                                       |                           | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
| AJ2             | EMAC[0]_MRXER/<br>EMAC[0]_RGTXCTL    | EMAC[0]_MRXER/<br>EMAC[0]_RGTXCTL    | PINCNTL238 /<br>0x4814 0BB4           | 0x000C 0000               | 0x01     | I/O      | 0        | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | VIN[1]B_D[3]                         |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | EMAC[0]_RMRXER                       |                                       |                           | 0x04     | I        | 0        |                      |                            |            |          |                  |
|                 |                                      | GP3[26]                              |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AG4             | EMAC[0]_MTCLK/<br>EMAC[0]_RGRXC      | EMAC[0]_MTCLK/<br>EMAC[0]_RGRXC      | PINCNTL235 /<br>0x4814 0BA8           | 0x000C 0000               | 0x01     | I/O      | 0        | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | VIN[1]B_D[0]                         |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | SPI[3]_SCS[3]                        |                                       |                           | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                                      | I2C[2]_SDA                           |                                       |                           | 0x40     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                                      | GP3[23]                              |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AK6             | EMAC[0]_MTXD[0]/<br>EMAC[1]_RGRXD[3] | EMAC[0]_MTXD[0]/<br>EMAC[1]_RGRXD[3] | PINCNTL250 /<br>0x4814 0BE4           | 0x0004 0000               | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | GPMC_A[7]                            |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | SPI[2]_D[0]                          |                                       |                           | 0x20     | I/O      | PIN      |                      |                            |            |          |                  |
| AJ7             | EMAC[0]_MTXD[1]/<br>EMAC[1]_RGTXD[1] | EMAC[0]_MTXD[1]/<br>EMAC[1]_RGTXD[1] | PINCNTL251 /<br>0x4814 0BE8           | 0x0004 0000               | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | GPMC_A[8]                            |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
| AK7             | EMAC[0]_MTXD[2]/<br>EMAC[1]_RGTXCTL  | EMAC[0]_MTXD[2]/<br>EMAC[1]_RGTXCTL  | PINCNTL252 /<br>0x4814 0BEC           | 0x0004 0000               | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | EMAC[1]_RMRXD[0]                     |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GPMC_A[9]                            |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |



Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]                        | SIGNAL NAME [3]                      | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| AE4             | EMAC[0]_MTXD[3]/<br>EMAC[1]_RGTXD[0] | EMAC[0]_MTXD[3]/<br>EMAC[1]_RGTXD[0] | PINCNTL253 /<br>0x4814 0BF0          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | EMAC[1]_RMRXD[1]                     |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GPMC_A[10]                           |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
| AK8             | EMAC[0]_MTXD[4]/<br>EMAC[1]_RGTXD[2] | EMAC[0]_MTXD[4]/<br>EMAC[1]_RGTXD[2] | PINCNTL254 /<br>0x4814 0BF4          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | EMAC[1]_RMRXER                       |                                      |                          | 0x02     | I        | 0        |                      |                            |            |          |                  |
|                 |                                      | GPMC_A[11]                           |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
| AJ8             | EMAC[0]_MTXD[5]/<br>EMAC[1]_RGTXC    | EMAC[0]_MTXD[5]/<br>EMAC[1]_RGTXC    | PINCNTL255 /<br>0x4814 0BF8          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | EMAC[1]_RMCSDV                       |                                      |                          | 0x02     | I        | 0        |                      |                            |            |          |                  |
|                 |                                      | GPMC_A[12]                           |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | UART1_RXD                            |                                      |                          | 0x20     | I        | 1        |                      |                            |            |          |                  |
| AH8             | EMAC[0]_MTXD[6]/<br>EMAC[1]_RGRXD[0] | EMAC[0]_MTXD[6]/<br>EMAC[1]_RGRXD[0] | PINCNTL256 /<br>0x4814 0BFC          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | EMAC[1]_RMTXD[0]                     |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GPMC_A[13]                           |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | UART1_TXD                            |                                      |                          | 0x20     | O        | PIN      |                      |                            |            |          |                  |
| AG8             | EMAC[0]_MTXD[7]/<br>EMAC[1]_RGTXD[3] | EMAC[0]_MTXD[7]/<br>EMAC[1]_RGTXD[3] | PINCNTL257 /<br>0x4814 0C00          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | EMAC[1]_RMTXD[1]                     |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GPMC_A[14]                           |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | UART1_CTS                            |                                      |                          | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
| AF8             | EMAC[0]_MTXEN/<br>EMAC[1]_RGRXD[2]   | EMAC[0]_MTXEN/<br>EMAC[1]_RGRXD[2]   | PINCNTL258 /<br>0x4814 0C04          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | EMAC[1]_RMTXEN                       |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | GPMC_A[15]                           |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                                      | UART1_RTS                            |                                      |                          | 0x20     | O        | PIN      |                      |                            |            |          |                  |
| AG1             | EMAC_RMREFCLK                        | EMAC_RMREFCLK                        | PINCNTL232 /<br>0x4814 0B9C          | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD_RGMII |          |                  |
|                 |                                      | TIM2_IO                              |                                      |                          | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                                      | GP1[10]                              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| A18             | EMU0                                 | EMU0                                 | NA /<br>NA                           | NA                       | 0x01     | I/O      | NA       | H                    | H                          | DVDD       |          |                  |
| B19             | EMU1                                 | EMU1                                 | NA /<br>NA                           | NA                       | 0x01     | I/O      | NA       | H                    | H                          | DVDD       |          |                  |
| M1              | GPMC_A[16]                           | GPMC_A[16]                           | PINCNTL105 /<br>0x4814 09A0          | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD_GPMC  |          |                  |
|                 |                                      | GP2[5]                               |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| M2              | GPMC_A[17]                           | GPMC_A[17]                           | PINCNTL106 /<br>0x4814 09A4          | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD_GPMC  |          |                  |
|                 |                                      | GP2[6]                               |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]  | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS [4] | PINCNTL DEFAULT VALUE [5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|----------------|-----------------|---------------------------------------|---------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| M3              | GPMC_A[18]     | GPMC_A[18]      | PINCNTL107 / 0x4814 09A8              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD_GPMC  |          |                  |
|                 |                | TIM2_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                | GP1[13]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| M5              | GPMC_A[19]     | GPMC_A[19]      | PINCNTL108 / 0x4814 09AC              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD_GPMC  |          |                  |
|                 |                | TIM3_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                | GP1[14]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| N9              | GPMC_A[20]     | GPMC_A[20]      | PINCNTL109 / 0x4814 09B0              | 0x0006 0000               | 0x01     | O        | PIN      | H                    | H                          | DVDD_GPMC  |          |                  |
|                 |                | SPI[2]_SCS[1]   |                                       |                           | 0x04     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                | GP1[15]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| N1              | GPMC_A[21]     | GPMC_A[21]      | PINCNTL110 / 0x4814 09B4              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD_GPMC  |          |                  |
|                 |                | SPI[2]_D[0]     |                                       |                           | 0x04     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                | GP1[16]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| N2              | GPMC_A[22]     | GPMC_A[22]      | PINCNTL111 / 0x4814 09B8              | 0x0006 0000               | 0x01     | O        | PIN      | H                    | H                          | DVDD_GPMC  |          |                  |
|                 |                | SPI[2]_D[1]     |                                       |                           | 0x04     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                | HDMI_CEC        |                                       |                           | 0x10     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                | TIM4_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                | GP1[17]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| R8              | GPMC_A[23]     | GPMC_A[23]      | PINCNTL112 / 0x4814 09BC              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD_GPMC  |          |                  |
|                 |                | SPI[2]_SCLK     |                                       |                           | 0x04     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                | HDMI_HPDET      |                                       |                           | 0x10     | I        | 0        |                      |                            |            |          |                  |
|                 |                | TIM5_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                | GP1[18]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AA10            | GPMC_ADV_ALE   | GPMC_ADV_ALE    | PINCNTL128 / 0x4814 09FC              | 0x0006 0000               | 0x01     | O        | PIN      | H                    | H                          | DVDD_GPMC  |          |                  |
|                 |                | GPMC_CS[6]      |                                       |                           | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                | TIM5_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                | GP1[28]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| Y11             | GPMC_BE[1]     | GPMC_BE[1]      | PINCNTL132 / 0x4814 0A0C              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD_GPMC  |          |                  |
|                 |                | GPMC_A[24]      |                                       |                           | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                | EDMA_EVT1       |                                       |                           | 0x20     | I        | PIN      |                      |                            |            |          |                  |
|                 |                | TIM7_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                | GP1[30]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| Y3              | GPMC_BE[0]_CLE | GPMC_BE[0]_CLE  | PINCNTL131 / 0x4814 0A08              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD_GPMC  |          |                  |
|                 |                | GPMC_A[25]      |                                       |                           | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                | EDMA_EVT2       |                                       |                           | 0x20     | I        | PIN      |                      |                            |            |          |                  |
|                 |                | TIM6_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                | GP1[29]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|-----------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| AB9             | GPMC_CLK      | GPMC_CLK        | PINCNTL127 / 0x4814 09F8             | 0x0006 0000              | 0x01     | O        | 0        | H                    | H                          | DVDD_GPMC  |          |                  |
|                 |               | GPMC_CS[5]      |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |               | GPMC_WAIT[1]    |                                      |                          | 0x08     | I        | 1        |                      |                            |            |          |                  |
|                 |               | CLKOUT1         |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |               | EDMA_EVT3       |                                      |                          | 0x20     | I        | PIN      |                      |                            |            |          |                  |
|                 |               | TIM4_IO         |                                      |                          | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |               | GP1[27]         |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AC9             | GPMC_CS[0]    | GPMC_CS[0]      | PINCNTL122 / 0x4814 09E4             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_GPMC  |          |                  |
|                 |               | GP1[23]         |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AA12            | GPMC_CS[1]    | GPMC_CS[1]      | PINCNTL123 / 0x4814 09E8             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_GPMC  |          |                  |
|                 |               | GPMC_A[25]      |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |               | GP1[24]         |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AC3             | GPMC_CS[2]    | GPMC_CS[2]      | PINCNTL124 / 0x4814 09EC             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_RGMII |          |                  |
|                 |               | GPMC_A[24]      |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |               | GP1[25]         |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AF2             | GPMC_CS[3]    | GPMC_CS[3]      | PINCNTL125 / 0x4814 09F0             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_RGMII |          |                  |
|                 |               | VIN[1]B_CLK     |                                      |                          | 0x02     | I        | 0        |                      |                            |            |          |                  |
|                 |               | SPI[2]_SCS[0]   |                                      |                          | 0x04     | I/O      | 1        |                      |                            |            |          |                  |
|                 |               | GP1[26]         |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AG6             | GPMC_CS[4]    | GPMC_CS[4]      | PINCNTL126 / 0x4814 09F4             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_RGMII |          |                  |
|                 |               | SD2_CMD         |                                      |                          | 0x02     | O        | 1        |                      |                            |            |          |                  |
|                 |               | GP1[8]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| W6              | GPMC_D[0]     | GPMC_D[0]       | PINCNTL89 / 0x4814 0960              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC  |          |                  |
|                 |               | BTMODE[0]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |            |          |                  |
| W4              | GPMC_D[1]     | GPMC_D[1]       | PINCNTL90 / 0x4814 0964              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC  |          |                  |
|                 |               | BTMODE[1]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |            |          |                  |
| W3              | GPMC_D[2]     | GPMC_D[2]       | PINCNTL91 / 0x4814 0968              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC  |          |                  |
|                 |               | BTMODE[2]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |            |          |                  |
| U2              | GPMC_D[3]     | GPMC_D[3]       | PINCNTL92 / 0x4814 096C              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC  |          |                  |
|                 |               | BTMODE[3]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |            |          |                  |
| W9              | GPMC_D[4]     | GPMC_D[4]       | PINCNTL93 / 0x4814 0970              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC  |          |                  |
|                 |               | BTMODE[4]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |            |          |                  |
| T5              | GPMC_D[5]     | GPMC_D[5]       | PINCNTL94 / 0x4814 0974              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC  |          |                  |
|                 |               | BTMODE[5]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |            |          |                  |
| T3              | GPMC_D[6]     | GPMC_D[6]       | PINCNTL95 / 0x4814 0978              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC  |          |                  |
|                 |               | BTMODE[6]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |            |          |                  |
| T2              | GPMC_D[7]     | GPMC_D[7]       | PINCNTL96 / 0x4814 097C              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC  |          |                  |
|                 |               | BTMODE[7]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]    | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|-----------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|---------------|----------|------------------|
| T1              | GPMC_D[8]     | GPMC_D[8]       | PINCNTL97 / 0x4814 0980              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC     |          |                  |
|                 |               | BTMODE[8]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |               |          |                  |
| T8              | GPMC_D[9]     | GPMC_D[9]       | PINCNTL98 / 0x4814 0984              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC     |          |                  |
|                 |               | BTMODE[9]       |                                      |                          | 0x80     | I        | PIN      |                      |                            |               |          |                  |
| R6              | GPMC_D[10]    | GPMC_D[10]      | PINCNTL99 / 0x4814 0988              | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC     |          |                  |
|                 |               | BTMODE[10]      |                                      |                          | 0x80     | I        | PIN      |                      |                            |               |          |                  |
| R4              | GPMC_D[11]    | GPMC_D[11]      | PINCNTL100 / 0x4814 098C             | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC     |          |                  |
|                 |               | BTMODE[11]      |                                      |                          | 0x80     | I        | PIN      |                      |                            |               |          |                  |
| R3              | GPMC_D[12]    | GPMC_D[12]      | PINCNTL101 / 0x4814 0990             | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC     |          |                  |
|                 |               | BTMODE[12]      |                                      |                          | 0x80     | I        | PIN      |                      |                            |               |          |                  |
| R2              | GPMC_D[13]    | GPMC_D[13]      | PINCNTL102 / 0x4814 0994             | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC     |          |                  |
|                 |               | BTMODE[13]      |                                      |                          | 0x80     | I        | PIN      |                      |                            |               |          |                  |
| R1              | GPMC_D[14]    | GPMC_D[14]      | PINCNTL103 / 0x4814 0998             | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC     |          |                  |
|                 |               | BTMODE[14]      |                                      |                          | 0x80     | I        | PIN      |                      |                            |               |          |                  |
| P2              | GPMC_D[15]    | GPMC_D[15]      | PINCNTL104 / 0x4814 099C             | 0x0005 0000              | 0x01     | I/O      | PIN      | Z                    | Z                          | DVDD_GPMC     |          |                  |
|                 |               | BTMODE[15]      |                                      |                          | 0x80     | I        | PIN      |                      |                            |               |          |                  |
| Y8              | GPMC_OE_RE    | GPMC_OE_RE      | PINCNTL129 / 0x4814 0A00             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_GPMC     |          |                  |
| W8              | GPMC_WAIT[0]  | GPMC_WAIT[0]    | PINCNTL133 / 0x4814 0A10             | 0x0006 0000              | 0x01     | I        | 1        | H                    | H                          | DVDD_GPMC     |          |                  |
|                 |               | GPMC_A[26]      |                                      |                          | 0x02     | O        | PIN      |                      |                            |               |          |                  |
|                 |               | EDMA_EVT0       |                                      |                          | 0x20     | I        | PIN      |                      |                            |               |          |                  |
|                 |               | GP1[31]         |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| Y5              | GPMC_WE       | GPMC_WE         | PINCNTL130 / 0x4814 0A04             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_GPMC     |          |                  |
| A9              | HDDAC_A       | HDDAC_A         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_VDAC_1P8 |          |                  |
| A8              | HDDAC_B       | HDDAC_B         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_VDAC_1P8 |          |                  |
| B8              | HDDAC_C       | HDDAC_C         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_VDAC_1P8 |          |                  |
| E9              | HDDAC_HSYNC   | HDDAC_HSYNC     | NA / NA                              | NA                       | 0x01     | O        | NA       | L                    | L                          | DVDD          |          |                  |
| B6              | HDDAC_IREF    | HDDAC_IREF      | NA / NA                              | NA                       | 0x01     | I/O      | NA       | NA                   | NA                         | VDDA_VDAC_1P8 |          |                  |
| B7              | HDDAC_VREF    | HDDAC_VREF      | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_VDAC_1P8 |          |                  |
| D9              | HDDAC_VSYNC   | HDDAC_VSYNC     | NA / NA                              | NA                       | 0x01     | O        | NA       | L                    | L                          | DVDD          |          |                  |
| B15             | HDMI_CLKN     | HDMI_CLKN       | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_HDMI_1P8 |          |                  |
| A15             | HDMI_CLKP     | HDMI_CLKP       | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_HDMI_1P8 |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]    | SIGNAL NAME [3]  | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]    | HYS [12] | BUFFER TYPE [13] |
|-----------------|------------------|------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|---------------|----------|------------------|
| A14             | HDMI_DN0         | HDMI_DN0         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_HDMI_1P8 |          |                  |
| B13             | HDMI_DN1         | HDMI_DN1         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_HDMI_1P8 |          |                  |
| A12             | HDMI_DN2         | HDMI_DN2         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_HDMI_1P8 |          |                  |
| B14             | HDMI_DP0         | HDMI_DP0         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_HDMI_1P8 |          |                  |
| B12             | HDMI_DP1         | HDMI_DP1         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_HDMI_1P8 |          |                  |
| A11             | HDMI_DP2         | HDMI_DP2         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_HDMI_1P8 |          |                  |
| T27             | I2C[0]_SCL       | I2C[0]_SCL       | PINCNTL263 / 0x4814 0C18             | 0x000C 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
| T24             | I2C[0]_SDA       | I2C[0]_SDA       | PINCNTL264 / 0x4814 0C1C             | 0x000C 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
| D2              | I2C[1]_SCL       | I2C[1]_SCL       | PINCNTL78 / 0x4814 0934              | 0x000E 0000              | 0x01     | I/O      | 1        | H                    | H                          | DVDD          |          |                  |
|                 |                  | HDMI_SCL         |                                      |                          | 0x02     | I/O      | 1        |                      |                            |               |          |                  |
| D1              | I2C[1]_SDA       | I2C[1]_SDA       | PINCNTL79 / 0x4814 0938              | 0x000E 0000              | 0x01     | I/O      | 1        | H                    | H                          | DVDD          |          |                  |
|                 |                  | HDMI_SDA         |                                      |                          | 0x02     | I/O      | 1        |                      |                            |               |          |                  |
| J19             | LDOCAP_ARM       | LDOCAP_ARM       | NA / NA                              | NA                       | NA       | A        | NA       | NA                   | NA                         | NA            |          |                  |
| K20             | LDOCAP_ARMRAM    | LDOCAP_ARMRAM    | NA / NA                              | NA                       | NA       | A        | NA       | NA                   | NA                         | NA            |          |                  |
| W23             | LDOCAP_HDVICP    | LDOCAP_HDVICP    | NA / NA                              | NA                       | NA       | A        | NA       | NA                   | NA                         | NA            |          |                  |
| Y24             | LDOCAP_HDVICPRAM | LDOCAP_HDVICPRAM | NA / NA                              | NA                       | NA       | A        | NA       | NA                   | NA                         | NA            |          |                  |
| U9              | LDOCAP_RAM0      | LDOCAP_RAM0      | NA / NA                              | NA                       | NA       | A        | NA       | NA                   | NA                         | NA            |          |                  |
| T22             | LDOCAP_RAM1      | LDOCAP_RAM1      | NA / NA                              | NA                       | NA       | A        | NA       | NA                   | NA                         | NA            |          |                  |
| AB10            | LDOCAP_RAM2      | LDOCAP_RAM2      | NA / NA                              | NA                       | NA       | A        | NA       | NA                   | NA                         | NA            |          |                  |
| M24             | LDOCAP_SERDESCLK | LDOCAP_SERDESCLK | NA / NA                              | NA                       | NA       | A        | NA       | NA                   | NA                         | NA            |          |                  |
| AD30            | MCA[0]_ACLKR     | MCA[0]_ACLKR     | PINCNTL19 / 0x4814 0848              | 0x0004 0000              | 0x01     | I/O      | 0        | L                    | L                          | DVDD          |          |                  |
| AD28            | MCA[0]_ACLKX     | MCA[0]_ACLKX     | PINCNTL17 / 0x4814 0840              | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD          |          |                  |
| AF30            | MCA[0]_AFSR      | MCA[0]_AFSR      | PINCNTL20 / 0x4814 084C              | 0x000C 0000              | 0x01     | I/O      | 0        | L                    | L                          | DVDD          |          |                  |
| AE29            | MCA[0]_AFSX      | MCA[0]_AFSX      | PINCNTL18 / 0x4814 0844              | 0x000C 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD          |          |                  |
| AF29            | MCA[0]_AXR[0]    | MCA[0]_AXR[0]    | PINCNTL21 / 0x4814 0850              | 0x000C 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD          |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]    | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|-----------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|---------------|----------|------------------|
| AE31            | MCA[0]_AXR[1] | MCA[0]_AXR[1]   | PINCNTL22 / 0x4814 0854              | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
|                 |               | I2C[3]_SCL      |                                      |                          | 0x20     | I/O      | 1        |                      |                            |               |          |                  |
| AE30            | MCA[0]_AXR[2] | MCA[0]_AXR[2]   | PINCNTL23 / 0x4814 0858              | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
|                 |               | I2C[3]_SDA      |                                      |                          | 0x20     | I/O      | 1        |                      |                            |               |          |                  |
| AC31            | MCA[0]_AXR[3] | MCA[0]_AXR[3]   | PINCNTL24 / 0x4814 085C              | 0x000C 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD          |          |                  |
| AD26            | MCA[0]_AXR[4] | MCA[0]_AXR[4]   | PINCNTL25 / 0x4814 0860              | 0x000C 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD          |          |                  |
| AD27            | MCA[0]_AXR[5] | MCA[0]_AXR[5]   | PINCNTL26 / 0x4814 0864              | 0x000C 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD          |          |                  |
| AD29            | MCA[1]_ACLKR  | MCA[1]_ACLKR    | PINCNTL33 / 0x4814 0880              | 0x0004 0000              | 0x01     | I/O      | 0        | L                    | L                          | DVDD          |          |                  |
| AC23            | MCA[1]_ACLKX  | MCA[1]_ACLKX    | PINCNTL31 / 0x4814 0878              | 0x0004 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD          |          |                  |
| AC24            | MCA[1]_AFSR   | MCA[1]_AFSR     | PINCNTL34 / 0x4814 0884              | 0x000C 0000              | 0x01     | I/O      | 0        | L                    | L                          | DVDD          |          |                  |
| AB22            | MCA[1]_AFSX   | MCA[1]_AFSX     | PINCNTL32 / 0x4814 087C              | 0x000C 0000              | 0x01     | I/O      | PIN      | L                    | L                          | DVDD          |          |                  |
| Y22             | MCA[1]_AXR[0] | MCA[1]_AXR[0]   | PINCNTL35 / 0x4814 0888              | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
|                 |               | SD0_DAT[4]      |                                      |                          | 0x02     | I/O      | PIN      |                      |                            |               |          |                  |
| Y21             | MCA[1]_AXR[1] | MCA[1]_AXR[1]   | PINCNTL36 / 0x4814 088C              | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
|                 |               | SD0_DAT[5]      |                                      |                          | 0x02     | I/O      | PIN      |                      |                            |               |          |                  |
| AG2             | MDCLK         | MDCLK           | PINCNTL233 / 0x4814 0BA0             | 0x000E 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_RGMII    |          |                  |
|                 |               | GP1[11]         |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| AG3             | MDIO          | MDIO            | PINCNTL234 / 0x4814 0BA4             | 0x000E 0000              | 0x01     | I/O      | 1        | H                    | H                          | DVDD_RGMII    |          |                  |
|                 |               | GP1[12]         |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| AH31            | NMI           | NMI             | PINCNTL261 / 0x4814 0C10             | 0x000E 0000              | 0x01     | I        | PIN      | H                    | H                          | DVDD          |          |                  |
| J30             | PCIE_RXN0     | PCIE_RXN0       | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_PCIE_1P8 |          |                  |
| K30             | PCIE_RXP0     | PCIE_RXP0       | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_PCIE_1P8 |          |                  |
| K31             | PCIE_TXN0     | PCIE_TXN0       | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_PCIE_1P8 |          |                  |
| L31             | PCIE_TXP0     | PCIE_TXP0       | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_PCIE_1P8 |          |                  |
| AH30            | POR           | POR             | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | DVDD          |          |                  |
| AH29            | RESET         | RESET           | PINCNTL260 / 0x4814 0C0C             | 0x000E 0000              | 0x01     | I        | PIN      | H                    | H                          | DVDD          |          |                  |
| AJ30            | RSTOUT_WD_OUT | RSTOUT_WD_OUT   | PINCNTL262 / 0x4814 0C14             | 0x0005 0001              | 0x01     | O        | PIN      | L                    | Z                          | DVDD          |          |                  |
| J25             | RSV0          | RSV0            |                                      |                          | NA       | NA       | NA       | NA                   | NA                         | NA            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|-----------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| H27             | RSV1          | RSV1            | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| H24             | RSV2          | RSV2            | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| L30             | RSV27         | RSV27           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| M30             | RSV28         | RSV28           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| N30             | RSV29         | RSV29           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| H28             | RSV3          | RSV3            | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| N31             | RSV30         | RSV30           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| P31             | RSV31         | RSV31           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| R30             | RSV32         | RSV32           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| T30             | RSV33         | RSV33           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| AH24            | RSV34         | RSV34           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| AJ24            | RSV35         | RSV35           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| H25             | RSV39         | RSV39           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| G17             | RSV4          | RSV4            | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA         |          |                  |
| H29             | RSV40         | RSV40           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| AD8             | RSV41         | RSV41           |                                      |                          | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| AK21            | RSV42         | RSV42           | NA / NA                              | NA                       | 0x01     | O        | NA       | L                    | 0                          | NA         |          |                  |
| P30             | RSV43         | RSV43           | NA / NA                              | NA                       | NA       | NA       | NA       | NA                   | NA                         | NA         |          |                  |
| G16             | RSV5          | RSV5            | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA         |          |                  |
| M28             | RSV54         | RSV54           | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA         |          |                  |
| N27             | RSV55         | RSV55           | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA         |          |                  |
| N29             | RTCK          | RTCK            | NA / NA                              | NA                       | 0x01     | O        | NA       | H                    | Z                          | DVDD       |          |                  |
| AB30            | SD0_CLK       | SD0_CLK         | PINCNTL8 / 0x4814 081C<br>GP0[1]     | 0x0006 0000              | 0x01     | O        | 1        | H                    | H                          | DVDD_SD    |          |                  |
|                 |               |                 |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]    | SIGNAL NAME [3]  | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|------------------|------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| AA29            | SD0_CMD          | SD0_CMD          | PINCNTL9 / 0x4814 0820               | 0x000E 0000              | 0x01     | O        | 1        | H                    | H                          | DVDD_SD    |          |                  |
|                 |                  | SD1_CMD          |                                      |                          | 0x02     | O        | 1        |                      |                            |            |          |                  |
|                 |                  | GP0[2]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AA28            | SD0_DAT[0]       | SD0_DAT[0]       | PINCNTL10 / 0x4814 0824              | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
|                 |                  | SD1_DAT[4]       |                                      |                          | 0x02     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                  | GP0[3]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| Y30             | SD0_DAT[3]       | SD0_DAT[3]       | PINCNTL13 / 0x4814 0830              | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
|                 |                  | SD1_DAT[7]       |                                      |                          | 0x02     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                  | GP0[6]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AB31            | SD0_DAT[6]       | SD0_DAT[6]       | PINCNTL41 / 0x4814 08A0              | 0x000E 0000              | 0x02     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
|                 |                  | GP0[12]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AC30            | SD0_DAT[7]       | SD0_DAT[7]       | PINCNTL42 / 0x4814 08A4              | 0x000E 0000              | 0x02     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
|                 |                  | GP0[13]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AA26            | SD0_DAT[1]_SDIRQ | SD0_DAT[1]_SDIRQ | PINCNTL11 / 0x4814 0828              | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
|                 |                  | SD1_DAT[5]       |                                      |                          | 0x02     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                  | GP0[4]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| Y31             | SD0_DAT[2]_SDRW  | SD0_DAT[2]_SDRW  | PINCNTL12 / 0x4814 082C              | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
|                 |                  | SD1_DAT[6]       |                                      |                          | 0x02     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                  | GP0[5]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| W30             | SD1_CLK          | SD1_CLK          | PINCNTL1 / 0x4814 0800               | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_SD    |          |                  |
| Y29             | SD1_CMD          | SD1_CMD          | PINCNTL2 / 0x4814 0804               | 0x000E 0000              | 0x01     | O        | 1        | H                    | H                          | DVDD_SD    |          |                  |
|                 |                  | GP0[0]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| W31             | SD1_DAT[0]       | SD1_DAT[0]       | PINCNTL3 / 0x4814 0808               | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
| Y27             | SD1_DAT[3]       | SD1_DAT[3]       | PINCNTL6 / 0x4814 0814               | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
| AA30            | SD1_DAT[1]_SDIRQ | SD1_DAT[1]_SDIRQ | PINCNTL4 / 0x4814 080C               | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
| U29             | SD1_DAT[2]_SDRW  | SD1_DAT[2]_SDRW  | PINCNTL5 / 0x4814 0810               | 0x000E 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_SD    |          |                  |
| AC4             | SD2_DAT[0]       | SD2_DAT[0]       | PINCNTL120 / 0x4814 09DC             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_RGMII |          |                  |
|                 |                  | GPMC_A[4]        |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                  | GP1[14]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| AD1             | SD2_DAT[3]       | SD2_DAT[3]       | PINCNTL117 / 0x4814 09D0             | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_RGMII |          |                  |
|                 |                  | GPMC_A[1]        |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                  | GP2[5]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |



Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]    | SIGNAL NAME [3]  | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]     | HYS [12] | BUFFER TYPE [13] |
|-----------------|------------------|------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|----------------|----------|------------------|
| AD2             | SD2_DAT[4]       | SD2_DAT[4]       | PINCNTL116 / 0x4814 09CC             | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_RGMII     |          |                  |
|                 |                  | GPMC_A[27]       |                                      |                          | 0x02     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | GPMC_A[23]       |                                      |                          | 0x04     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | GPMC_CS[7]       |                                      |                          | 0x08     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | EDMA_EVT0        |                                      |                          | 0x20     | I        | PIN      |                      |                            |                |          |                  |
|                 |                  | TIM7_IO          |                                      |                          | 0x40     | I/O      | PIN      |                      |                            |                |          |                  |
|                 |                  | GP1[22]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |                |          |                  |
| AE1             | SD2_DAT[5]       | SD2_DAT[5]       | PINCNTL115 / 0x4814 09C8             | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_RGMII     |          |                  |
|                 |                  | GPMC_A[26]       |                                      |                          | 0x02     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | GPMC_A[22]       |                                      |                          | 0x04     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | TIM6_IO          |                                      |                          | 0x40     | I/O      | PIN      |                      |                            |                |          |                  |
|                 |                  | GP1[21]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |                |          |                  |
| AE2             | SD2_DAT[6]       | SD2_DAT[6]       | PINCNTL114 / 0x4814 09C4             | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_RGMII     |          |                  |
|                 |                  | GPMC_A[25]       |                                      |                          | 0x02     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | GPMC_A[21]       |                                      |                          | 0x04     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | UART2_TXD        |                                      |                          | 0x20     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | GP1[20]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |                |          |                  |
| AE3             | SD2_DAT[7]       | SD2_DAT[7]       | PINCNTL113 / 0x4814 09C0             | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_RGMII     |          |                  |
|                 |                  | GPMC_A[24]       |                                      |                          | 0x02     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | GPMC_A[20]       |                                      |                          | 0x04     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | UART2_RXD        |                                      |                          | 0x20     | I        | 1        |                      |                            |                |          |                  |
|                 |                  | GP1[19]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |                |          |                  |
| AC5             | SD2_DAT[1]_SDIRQ | SD2_DAT[1]_SDIRQ | PINCNTL119 / 0x4814 09D8             | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_RGMII     |          |                  |
|                 |                  | GPMC_A[3]        |                                      |                          | 0x02     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | GP1[13]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |                |          |                  |
| AC8             | SD2_DAT[2]_SDRW  | SD2_DAT[2]_SDRW  | PINCNTL118 / 0x4814 09D4             | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD_RGMII     |          |                  |
|                 |                  | GPMC_A[2]        |                                      |                          | 0x02     | O        | PIN      |                      |                            |                |          |                  |
|                 |                  | GP2[6]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |                |          |                  |
| AC6             | SD2_SCLK         | SD2_SCLK         | PINCNTL121 / 0x4814 09E0             | 0x0006 0000              | 0x01     | I/O      | 1        | H                    | H                          | DVDD_RGMII     |          |                  |
|                 |                  | GP1[15]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |                |          |                  |
| H31             | SERDES_CLKN      | SERDES_CLKN      | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_SATA0_1P8 |          |                  |
| H30             | SERDES_CLKP      | SERDES_CLKP      | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_SATA0_1P8 |          |                  |
| J28             | SPI[0]_D[0]      | SPI[0]_D[0]      | PINCNTL84 / 0x4814 094C              | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD           |          |                  |
| J27             | SPI[0]_D[1]      | SPI[0]_D[1]      | PINCNTL83 / 0x4814 0948              | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD           |          |                  |
| N24             | SPI[0]_SCLK      | SPI[0]_SCLK      | PINCNTL82 / 0x4814 0944              | 0x0006 0000              | 0x01     | I/O      | PIN      | H                    | H                          | DVDD           |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS [4] | PINCNTL DEFAULT VALUE [5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]    | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|-----------------|---------------------------------------|---------------------------|----------|----------|----------|----------------------|----------------------------|---------------|----------|------------------|
| G29             | SPI[0]_SCS[0] | SPI[0]_SCS[0]   | PINCNTL81 / 0x4814 0940               | 0x0006 0000               | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
| G28             | SPI[0]_SCS[1] | SPI[0]_SCS[1]   | PINCNTL80 / 0x4814 093C               | 0x0006 0000               | 0x01     | I/O      | 1        | H                    | H                          | DVDD          |          |                  |
|                 |               | SD1_SDCD        |                                       |                           | 0x02     | I        | 1        |                      |                            |               |          |                  |
|                 |               | EDMA_EVT1       |                                       |                           | 0x20     | I        | PIN      |                      |                            |               |          |                  |
|                 |               | TIM4_IO         |                                       |                           | 0x40     | I/O      | PIN      |                      |                            |               |          |                  |
|                 |               | GP1[6]          |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| N23             | SPI[1]_D[0]   | SPI[1]_D[0]     | PINCNTL88 / 0x4814 095C               | 0x0006 0000               | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
|                 |               | GP1[26]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| M27             | SPI[1]_D[1]   | SPI[1]_D[1]     | PINCNTL87 / 0x4814 0958               | 0x0006 0000               | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
|                 |               | GP1[18]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| M29             | SPI[1]_SCLK   | SPI[1]_SCLK     | PINCNTL86 / 0x4814 0954               | 0x0006 0000               | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
|                 |               | GP1[17]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| J29             | SPI[1]_SCS[0] | SPI[1]_SCS[0]   | PINCNTL85 / 0x4814 0950               | 0x0006 0000               | 0x01     | I/O      | PIN      | H                    | H                          | DVDD          |          |                  |
|                 |               | GP1[16]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |
| T29             | TCLK          | TCLK            | NA / NA                               | NA                        | 0x01     | I        | NA       | H                    | H                          | DVDD          |          |                  |
| N28             | TDI           | TDI             | NA / NA                               | NA                        | 0x01     | I        | NA       | H                    | H                          | DVDD          |          |                  |
| U26             | TDO           | TDO             | NA / NA                               | NA                        | 0x01     | O        | NA       | H                    | H                          | DVDD          |          |                  |
| T31             | TMS           | TMS             | NA / NA                               | NA                        | 0x01     | I        | NA       | H                    | H                          | DVDD          |          |                  |
| U24             | TRST          | TRST            | NA / NA                               | NA                        | 0x01     | I        | NA       | L                    | L                          | DVDD          |          |                  |
| B9              | TV_OUT0       | TV_OUT0         | NA / NA                               | NA                        | 0x01     | O        | NA       | NA                   | NA                         | VDDA_VDAC_1P8 |          |                  |
| B11             | TV_RSET       | TV_RSET         | NA / NA                               | NA                        | 0x01     | A        | NA       | NA                   | NA                         | VDDA_VDAC_1P8 |          |                  |
| B10             | TV_VFB0       | TV_VFB0         | NA / NA                               | NA                        | 0x01     | O        | NA       | NA                   | NA                         | VDDA_VDAC_1P8 |          |                  |
| D30             | UART0_CTS     | UART0_CTS       | PINCNTL72 / 0x4814 091C               | 0x000E 0000               | 0x01     | I/O      | 1        | H                    | H                          | DVDD          |          |                  |
|                 |               | SPI[1]_SCS[3]   |                                       |                           | 0x10     | I/O      | 1        |                      |                            |               |          |                  |
|                 |               | SD0_SDCD        |                                       |                           | 0x40     | I        | 1        |                      |                            |               |          |                  |
| E31             | UART0_DCD     | UART0_DCD       | PINCNTL74 / 0x4814 0924               | 0x000E 0000               | 0x01     | I        | 1        | H                    | H                          | DVDD          |          |                  |
|                 |               | SPI[0]_SCS[3]   |                                       |                           | 0x10     | I/O      | 1        |                      |                            |               |          |                  |
|                 |               | I2C[2]_SCL      |                                       |                           | 0x20     | I/O      | 1        |                      |                            |               |          |                  |
|                 |               | SD1_POW         |                                       |                           | 0x40     | O        | PIN      |                      |                            |               |          |                  |
|                 |               | GP1[2]          |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |               |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]   | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|-----------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|--------------|----------|------------------|
| E29             | UART0_DSR     | UART0_DSR       | PINCNTL75 / 0x4814 0928              | 0x000E 0000              | 0x01     | I        | 1        | H                    | H                          | DVDD         |          |                  |
|                 |               | SP[0]_SCS[2]    |                                      |                          | 0x10     | I/O      | 1        |                      |                            |              |          |                  |
|                 |               | I2C[2]_SDA      |                                      |                          | 0x20     | I/O      | 1        |                      |                            |              |          |                  |
|                 |               | SD1_SDWP        |                                      |                          | 0x40     | I        | 0        |                      |                            |              |          |                  |
|                 |               | GP1[3]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |              |          |                  |
| E30             | UART0_DTR     | UART0_DTR       | PINCNTL76 / 0x4814 092C              | 0x000E 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD         |          |                  |
|                 |               | UART1_TXD       |                                      |                          | 0x04     | O        | PIN      |                      |                            |              |          |                  |
|                 |               | GP1[4]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |              |          |                  |
| N26             | UART0_RIN     | UART0_RIN       | PINCNTL77 / 0x4814 0930              | 0x000E 0000              | 0x01     | I        | 1        | H                    | H                          | DVDD         |          |                  |
|                 |               | UART1_RXD       |                                      |                          | 0x04     | I        | 1        |                      |                            |              |          |                  |
|                 |               | GP1[5]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |              |          |                  |
| D31             | UART0_RTS     | UART0_RTS       | PINCNTL73 / 0x4814 0920              | 0x000E 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD         |          |                  |
|                 |               | SP[1]_SCS[2]    |                                      |                          | 0x10     | I/O      | 1        |                      |                            |              |          |                  |
|                 |               | SD2_SDCD        |                                      |                          | 0x40     | I        | 1        |                      |                            |              |          |                  |
| J26             | UART0_RXD     | UART0_RXD       | PINCNTL70 / 0x4814 0914              | 0x000E 0000              | 0x01     | I        | PIN      | H                    | H                          | DVDD         |          |                  |
| E28             | UART0_TXD     | UART0_TXD       | PINCNTL71 / 0x4814 0918              | 0x000E 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD         |          |                  |
| L22             | UART2_RXD     | UART2_RXD       | PINCNTL69 / 0x4814 0910              | 0x000E 0000              | 0x02     | I        | 1        | H                    | H                          | DVDD         |          |                  |
|                 |               | I2C[3]_SCL      |                                      |                          | 0x20     | I/O      | 1        |                      |                            |              |          |                  |
|                 |               | GP1[1]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |              |          |                  |
| M21             | UART2_TXD     | UART2_TXD       | PINCNTL68 / 0x4814 090C              | 0x000E 0000              | 0x02     | O        | PIN      | H                    | H                          | DVDD         |          |                  |
|                 |               | I2C[3]_SDA      |                                      |                          | 0x20     | I/O      | 1        |                      |                            |              |          |                  |
|                 |               | GP1[0]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |              |          |                  |
| B20             | USB0_CE       | USB0_CE         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |
| B21             | USB0_DM       | USB0_DM         | NA / NA                              | NA                       | 0x01     | I/O      | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |
| A21             | USB0_DP       | USB0_DP         | NA / NA                              | NA                       | 0x01     | I/O      | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |
| K23             | USB0_DRVVBUS  | USB0_DRVVBUS    | PINCNTL270 / 0x4814 0C34             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD         |          |                  |
|                 |               | GP0[7]          |                                      |                          | 0x02     | I/O      | PIN      |                      |                            |              |          |                  |
| A20             | USB0_ID       | USB0_ID         | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |
| B22             | USB0_VBUSIN   | USB0_VBUSIN     | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |
| C21             | USB1_CE       | USB1_CE         | NA / NA                              | NA                       | 0x01     | O        | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |
| B23             | USB1_DM       | USB1_DM         | NA / NA                              | NA                       | 0x01     | I/O      | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1]                 | BALL NAME [2]     | SIGNAL NAME [3]       | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]   | HYS [12] | BUFFER TYPE [13] |
|---------------------------------|-------------------|-----------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|--------------|----------|------------------|
| A23                             | USB1_DP           | USB1_DP               | NA / NA                              | NA                       | 0x01     | I/O      | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |
| A24                             | USB1_ID           | USB1_ID               | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |
| B24                             | USB1_VBUSIN       | USB1_VBUSIN           | NA / NA                              | NA                       | 0x01     | I        | NA       | NA                   | NA                         | VDDA_USB_3P3 |          |                  |
| M25, N22, N25, P23, R9, T10, T9 | VDDA_1P8          | VDDA_1P8              | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| L19                             | VDDA_ARMPLL_1P8   | VDDA_ARMPLL_1P8       | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| V9                              | VDDA_AUDIOPLL_1P8 | VDDA_AUDIOPLL_1P8     | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| W10                             | VDDA_CSI2_1P8     | VDDA_CSI2_1P8         | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| AA19                            | VDDA_DDRPLL_1P8   | VDDA_DDRPLL_1P8       | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| L15                             | VDDA_HDDACREF_1P8 | VDDA_HDDACREF_1P8     | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| K16                             | VDDA_HDDAC_1P1    | VDDA_HDDAC_1P1        | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| L14                             | VDDA_HDDAC_1P8    | VDDA_HDDAC_1P8        | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| K14                             | VDDA_HDMI_1P8     | VDDA_HDMI_1P8         | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| T23                             | VDDA_HDVICPLL_1P8 | VDDA_HDVICPLL_1P8     | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| W11                             | VDDA_L3L4_1P8     | VDDA_L3L4PLL_1P8      | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| M26                             | VDDA_PCIE_1P8     | VDDA_PCIE_1P8         | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| K19                             | VDDA_USB0_1P8     | VDDA_USB0_1P8         | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| J17                             | VDDA_USB1_1P8     | VDDA_USB1_1P8         | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| M19, M20                        | VDDA_USB_3P3      | VDDA_USB_3P3          | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| J14                             | VDDA_VDAC_1P8     | VDDA_VDAC_1P8         | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| L13                             | VDDA_VIDPLL_1P8   | VDDA_VIDPLL_1P8       | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| P21                             | VDDS_OSC0_1P8     | VDDS_OSC0_1P8         | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| P20                             | VDDS_OSC1_1P8     | VDDS_OSC1_1P8         | NA / NA                              | NA                       | NA       | PWR      | NA       | NA                   | NA                         | NA           |          |                  |
| C9                              | VIN[0]A_CLK       | VIN[0]A_CLK<br>GP2[2] | PINCNTL137 /<br>0x4814 0A20          | 0x000C 0000              | 0x01     | I        | 0        | L                    | L                          | DVDD         |          |                  |
|                                 |                   |                       |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |              |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2] | SIGNAL NAME [3]  | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------|------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| B18             | VIN[0]A_D[0]  | VIN[0]A_D[0]     | PINCNTL140 / 0x4814 0A2C             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |               | GP1[11]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| A17             | VIN[0]A_D[1]  | VIN[0]A_D[1]     | PINCNTL141 / 0x4814 0A30             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |               | GP1[12]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| B17             | VIN[0]A_D[2]  | VIN[0]A_D[2]     | PINCNTL142 / 0x4814 0A34             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |               | GP2[7]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C17             | VIN[0]A_D[3]  | VIN[0]A_D[3]     | PINCNTL143 / 0x4814 0A38             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |               | GP2[8]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| D17             | VIN[0]A_D[4]  | VIN[0]A_D[4]     | PINCNTL144 / 0x4814 0A3C             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |               | GP2[9]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| F17             | VIN[0]A_D[5]  | VIN[0]A_D[5]     | PINCNTL145 / 0x4814 0A40             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |               | GP2[10]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| L20             | VIN[0]A_D[6]  | VIN[0]A_D[6]     | PINCNTL146 / 0x4814 0A44             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |               | GP2[11]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| H20             | VIN[0]A_D[7]  | VIN[0]A_D[7]     | PINCNTL147 / 0x4814 0A48             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |               | GP2[12]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| K11             | VIN[0]A_D[16] | VIN[0]A_D[16]    | PINCNTL156 / 0x4814 0A6C             | 0x000E 0000              | 0x01     | I        | PIN      | H                    | H                          | DVDD_C     |          |                  |
|                 |               | CAM_D[8]         |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |               | I2C[2]_SCL       |                                      |                          | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |               | GP0[10]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| E12             | VIN[0]A_D[17] | VIN[0]A_D[17]    | PINCNTL157 / 0x4814 0A70             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |               | CAM_D[9]         |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |               | EMAC[1]_RMRXER   |                                      |                          | 0x08     | I        | 0        |                      |                            |            |          |                  |
|                 |               | GP0[11]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| K10             | VIN[0]A_D[18] | VIN[0]A_D[18]    | PINCNTL158 / 0x4814 0A74             | 0x000E 0000              | 0x01     | I        | PIN      | H                    | H                          | DVDD_C     |          |                  |
|                 |               | CAM_D[10]        |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |               | EMAC[1]_RMRXD[1] |                                      |                          | 0x08     | I        | PIN      |                      |                            |            |          |                  |
|                 |               | I2C[3]_SCL       |                                      |                          | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |               | GP0[12]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| D7              | VIN[0]A_D[19] | VIN[0]A_D[19]    | PINCNTL159 / 0x4814 0A78             | 0x000E 0000              | 0x01     | I        | PIN      | H                    | H                          | DVDD_C     |          |                  |
|                 |               | CAM_D[11]        |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |               | EMAC[1]_RMRXD[0] |                                      |                          | 0x08     | I        | PIN      |                      |                            |            |          |                  |
|                 |               | I2C[3]_SDA       |                                      |                          | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |               | GP0[13]          |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]       | SIGNAL NAME [3]     | PINCNTL REGISTER NAME AND ADDRESS [4] | PINCNTL DEFAULT VALUE [5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------------|---------------------|---------------------------------------|---------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| F9              | VIN[0]A_D[20]       | VIN[0]A_D[20]       | PINCNTL160 / 0x4814 0A7C              | 0x000C 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                     | CAM_D[12]           |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                     | EMAC[1]_RMCSDV      |                                       |                           | 0x08     | I        | 0        |                      |                            |            |          |                  |
|                 |                     | SPI[3]_SCS[0]       |                                       |                           | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                     | GP0[14]             |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C7              | VIN[0]A_D[21]       | VIN[0]A_D[21]       | PINCNTL161 / 0x4814 0A80              | 0x0004 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                     | CAM_D[13]           |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                     | EMAC[1]_RMTXD[0]    |                                       |                           | 0x08     | O        | PIN      |                      |                            |            |          |                  |
|                 |                     | SPI[3]_SCLK         |                                       |                           | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                     | GP0[15]             |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| A6              | VIN[0]A_D[22]       | VIN[0]A_D[22]       | PINCNTL162 / 0x4814 0A84              | 0x0004 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                     | CAM_D[14]           |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                     | EMAC[1]_RMTXD[1]    |                                       |                           | 0x08     | O        | PIN      |                      |                            |            |          |                  |
|                 |                     | SPI[3]_D[1]         |                                       |                           | 0x20     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                     | GP0[16]             |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| A5              | VIN[0]A_D[23]       | VIN[0]A_D[23]       | PINCNTL163 / 0x4814 0A88              | 0x0004 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                     | CAM_D[15]           |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                     | EMAC[1]_RMTXEN      |                                       |                           | 0x08     | O        | PIN      |                      |                            |            |          |                  |
|                 |                     | SPI[3]_D[0]         |                                       |                           | 0x20     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                     | GP0[17]             |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C12             | VIN[0]A_DE          | VIN[0]A_DE          | PINCNTL135 / 0x4814 0A18              | 0x000E 0000               | 0x01     | I        | 0        | H                    | H                          | DVDD       |          |                  |
|                 |                     | VIN[0]B_HSYNC       |                                       |                           | 0x10     | I        | 0        |                      |                            |            |          |                  |
|                 |                     | I2C[2]_SDA          |                                       |                           | 0x40     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                     | GP2[0]              |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| B5              | VIN[0]A_DE          | VIN[0]A_DE          | PINCNTL164 / 0x4814 0A8C              | 0x0006 0000               | 0x01     | I        | 0        | H                    | H                          | DVDD_C     |          |                  |
|                 |                     | CAM_D[7]            |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                     | GP0[18]             |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| E16             | VIN[0]A_D[10]_BD[2] | VIN[0]A_D[10]_BD[2] | PINCNTL150 / 0x4814 0A54              | 0x000C 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | GP2[15]             |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| H17             | VIN[0]A_D[11]_BD[3] | VIN[0]A_D[11]_BD[3] | PINCNTL151 / 0x4814 0A58              | 0x000C 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | CAM_WE              |                                       |                           | 0x20     | I        | 0        |                      |                            |            |          |                  |
|                 |                     | GP2[16]             |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| J16             | VIN[0]A_D[12]_BD[4] | VIN[0]A_D[12]_BD[4] | PINCNTL152 / 0x4814 0A5C              | 0x0004 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | CLKOUT1             |                                       |                           | 0x20     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                     | GP2[17]             |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| H16             | VIN[0]A_D[13]_BD[5] | VIN[0]A_D[13]_BD[5] | PINCNTL153 / 0x4814 0A60              | 0x000C 0000               | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | CAM_RESET           |                                       |                           | 0x20     | I/O      | 0        |                      |                            |            |          |                  |
|                 |                     | GP2[18]             |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]       | SIGNAL NAME [3]     | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|---------------------|---------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| F13             | VIN[0]A_D[14]_BD[6] | VIN[0]A_D[14]_BD[6] | PINCNTL154 / 0x4814 0A64             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | CAM_STROBE          |                                      |                          | 0x20     | O        | PIN      |                      |                            |            |          |                  |
|                 |                     | GP2[19]             |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| H13             | VIN[0]A_D[15]_BD[7] | VIN[0]A_D[15]_BD[7] | PINCNTL155 / 0x4814 0A68             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | CAM_SHUTTER         |                                      |                          | 0x20     | O        | PIN      |                      |                            |            |          |                  |
|                 |                     | GP2[20]             |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| B16             | VIN[0]A_D[8]_BD[0]  | VIN[0]A_D[8]_BD[0]  | PINCNTL148 / 0x4814 0A4C             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | GP2[13]             |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C16             | VIN[0]A_D[9]_BD[1]  | VIN[0]A_D[9]_BD[1]  | PINCNTL149 / 0x4814 0A50             | 0x000C 0000              | 0x01     | I        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | GP2[14]             |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| J13             | VIN[0]A_FLD         | VIN[0]A_FLD         | PINCNTL136 / 0x4814 0A1C             | 0x000E 0000              | 0x01     | I        | 0        | H                    | H                          | DVDD       |          |                  |
|                 |                     | VIN[0]B_VSYNC       |                                      |                          | 0x10     | I        | 0        |                      |                            |            |          |                  |
|                 |                     | I2C[2]_SCL          |                                      |                          | 0x40     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                     | GP2[1]              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| B4              | VIN[0]A_FLD         | VIN[0]A_FLD         | PINCNTL166 / 0x4814 0A94             | 0x0006 0000              | 0x01     | I        | 0        | H                    | H                          | DVDD_C     |          |                  |
|                 |                     | CAM_D[5]            |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                     | GP0[20]             |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| D13             | VIN[0]A_HSYNC       | VIN[0]A_HSYNC       | PINCNTL138 / 0x4814 0A24             | 0x000E 0000              | 0x01     | I        | 0        | H                    | H                          | DVDD       |          |                  |
|                 |                     | GP2[3]              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C13             | VIN[0]A_VSYNC       | VIN[0]A_VSYNC       | PINCNTL139 / 0x4814 0A28             | 0x000E 0000              | 0x01     | I        | 0        | H                    | H                          | DVDD       |          |                  |
|                 |                     | GP2[4]              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| H12             | VIN[0]B_CLK         | VIN[0]B_CLK         | PINCNTL134 / 0x4814 0A14             | 0x0004 0000              | 0x01     | I        | 0        | L                    | L                          | DVDD       |          |                  |
|                 |                     | CLKOUT0             |                                      |                          | 0x20     | O        | PIN      |                      |                            |            |          |                  |
|                 |                     | GP1[9]              |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C5              | VIN[0]B_DE          | VIN[0]B_DE          | PINCNTL165 / 0x4814 0A90             | 0x0006 0000              | 0x01     | I        | 0        | H                    | H                          | DVDD_C     |          |                  |
|                 |                     | CAM_D[6]            |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                     | GP0[19]             |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| A3              | VIN[0]B_FLD         | VIN[0]B_FLD         | PINCNTL167 / 0x4814 0A98             | 0x0006 0000              | 0x01     | I        | 0        | H                    | H                          | DVDD_C     |          |                  |
|                 |                     | CAM_D[4]            |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                     | GP0[21]             |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C20             | VOUT[0]_AVID        | VOUT[0]_AVID        | PINCNTL179 / 0x4814 0AC8             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | VOUT[0]_FLD         |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                     | SPI[3]_SCLK         |                                      |                          | 0x10     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                     | TIM7_IO             |                                      |                          | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                     | GP2[21]             |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| F24             | VOUT[0]_B_CB_C[2]   | VOUT[0]_B_CB_C[2]   | PINCNTL180 / 0x4814 0ACC             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                     | EMU2                |                                      |                          | 0x02     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                     | GP2[22]             |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]     | SIGNAL NAME [3]   | PINCNTL REGISTER NAME AND ADDRESS [4] | PINCNTL DEFAULT VALUE [5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|-------------------|-------------------|---------------------------------------|---------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| D21             | VOUT[0]_B_CB_C[3] | VOUT[0]_B_CB_C[3] | PINCNTL181 / 0x4814 0AD0              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | GP2[23]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| J23             | VOUT[0]_B_CB_C[4] | VOUT[0]_B_CB_C[4] | PINCNTL182 / 0x4814 0AD4              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| H23             | VOUT[0]_B_CB_C[5] | VOUT[0]_B_CB_C[5] | PINCNTL183 / 0x4814 0AD8              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| J24             | VOUT[0]_B_CB_C[6] | VOUT[0]_B_CB_C[6] | PINCNTL184 / 0x4814 0ADC              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| E24             | VOUT[0]_B_CB_C[7] | VOUT[0]_B_CB_C[7] | PINCNTL185 / 0x4814 0AE0              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| D24             | VOUT[0]_B_CB_C[8] | VOUT[0]_B_CB_C[8] | PINCNTL186 / 0x4814 0AE4              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| C24             | VOUT[0]_B_CB_C[9] | VOUT[0]_B_CB_C[9] | PINCNTL187 / 0x4814 0AE8              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| K22             | VOUT[0]_CLK       | VOUT[0]_CLK       | PINCNTL176 / 0x4814 0ABC              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| B3              | VOUT[0]_FLD       | VOUT[0]_FLD       | PINCNTL175 / 0x4814 0AB8              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                   | CAM_PCLK          |                                       |                           | 0x02     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | GPMC_A[12]        |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | UART2_RTS         |                                       |                           | 0x20     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP2[02]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C25             | VOUT[0]_G_Y_YC[2] | VOUT[0]_G_Y_YC[2] | PINCNTL188 / 0x4814 0AEC              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMU3              |                                       |                           | 0x02     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | GP2[24]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C26             | VOUT[0]_G_Y_YC[3] | VOUT[0]_G_Y_YC[3] | PINCNTL189 / 0x4814 0AF0              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | GP2[25]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| E26             | VOUT[0]_G_Y_YC[4] | VOUT[0]_G_Y_YC[4] | PINCNTL190 / 0x4814 0AF4              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| B26             | VOUT[0]_G_Y_YC[5] | VOUT[0]_G_Y_YC[5] | PINCNTL191 / 0x4814 0AF8              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| A26             | VOUT[0]_G_Y_YC[6] | VOUT[0]_G_Y_YC[6] | PINCNTL192 / 0x4814 0AFC              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| B25             | VOUT[0]_G_Y_YC[7] | VOUT[0]_G_Y_YC[7] | PINCNTL193 / 0x4814 0B00              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| B27             | VOUT[0]_G_Y_YC[8] | VOUT[0]_G_Y_YC[8] | PINCNTL194 / 0x4814 0B04              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| A27             | VOUT[0]_G_Y_YC[9] | VOUT[0]_G_Y_YC[9] | PINCNTL195 / 0x4814 0B08              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| F21             | VOUT[0]_HSYNC     | VOUT[0]_HSYNC     | PINCNTL177 / 0x4814 0AC0              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| C28             | VOUT[0]_R_CR[2]   | VOUT[0]_R_CR[2]   | PINCNTL196 / 0x4814 0B0C              | 0x000C 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMU4              |                                       |                           | 0x02     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | GP2[26]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |



Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]     | SIGNAL NAME [3]   | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|-------------------|-------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| B28             | VOUT[0]_R_CR[3]   | VOUT[0]_R_CR[3]   | PINCNTL197 / 0x4814 0B10             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | GP2[27]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| B29             | VOUT[0]_R_CR[4]   | VOUT[0]_R_CR[4]   | PINCNTL198 / 0x4814 0B14             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| A29             | VOUT[0]_R_CR[5]   | VOUT[0]_R_CR[5]   | PINCNTL199 / 0x4814 0B18             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| C30             | VOUT[0]_R_CR[6]   | VOUT[0]_R_CR[6]   | PINCNTL200 / 0x4814 0B1C             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| B30             | VOUT[0]_R_CR[7]   | VOUT[0]_R_CR[7]   | PINCNTL201 / 0x4814 0B20             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| A30             | VOUT[0]_R_CR[8]   | VOUT[0]_R_CR[8]   | PINCNTL202 / 0x4814 0B24             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| B31             | VOUT[0]_R_CR[9]   | VOUT[0]_R_CR[9]   | PINCNTL203 / 0x4814 0B28             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| E20             | VOUT[0]_VSYNC     | VOUT[0]_VSYNC     | PINCNTL178 / 0x4814 0AC4             | 0x000C 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
| F1              | VOUT[1]_AVID      | VOUT[1]_AVID      | PINCNTL207 / 0x4814 0B38             | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXER     |                                      |                          | 0x02     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_CLK       |                                      |                          | 0x04     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | TIM6_IO           |                                      |                          | 0x40     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                   | GP2[31]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| H9              | VOUT[1]_B_CB_C[0] | VOUT[1]_B_CB_C[0] | PINCNTL173 / 0x4814 0AB0             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_C     |          |                  |
|                 |                   | CAM_VS            |                                      |                          | 0x02     | I/O      | 0        |                      |                            |            |          |                  |
|                 |                   | GPMC_A[10]        |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | UART2_TXD         |                                      |                          | 0x20     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP0[27]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| D5              | VOUT[1]_B_CB_C[1] | VOUT[1]_B_CB_C[1] | PINCNTL172 / 0x4814 0AAC             | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                   | CAM_HS            |                                      |                          | 0x02     | I/O      | 0        |                      |                            |            |          |                  |
|                 |                   | GPMC_A[9]         |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | UART2_RXD         |                                      |                          | 0x20     | I        | 1        |                      |                            |            |          |                  |
|                 |                   | GP0[26]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| M8              | VOUT[1]_B_CB_C[2] | VOUT[1]_B_CB_C[2] | PINCNTL231 / 0x4814 0B98             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD       |          |                  |
|                 |                   | GPMC_A[0]         |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[7]      |                                      |                          | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | HDMI_CEC          |                                      |                          | 0x10     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | SPI[2]_D[0]       |                                      |                          | 0x20     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[30]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]     | SIGNAL NAME [3]   | PINCNTL REGISTER NAME AND ADDRESS [4] | PINCNTL DEFAULT VALUE [5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|-------------------|-------------------|---------------------------------------|---------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| F2              | VOUT[1]_B_CB_C[3] | VOUT[1]_B_CB_C[3] | PINCNTL208 / 0x4814 0B3C              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRCLK     |                                       |                           | 0x02     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[0]      |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[0]            |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| F3              | VOUT[1]_B_CB_C[4] | VOUT[1]_B_CB_C[4] | PINCNTL209 / 0x4814 0B40              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXD[0]   |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[1]      |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[1]            |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| G1              | VOUT[1]_B_CB_C[5] | VOUT[1]_B_CB_C[5] | PINCNTL210 / 0x4814 0B44              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXD[1]   |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[2]      |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[2]            |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| G2              | VOUT[1]_B_CB_C[6] | VOUT[1]_B_CB_C[6] | PINCNTL211 / 0x4814 0B48              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXD[2]   |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[3]      |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[3]            |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| H3              | VOUT[1]_B_CB_C[7] | VOUT[1]_B_CB_C[7] | PINCNTL212 / 0x4814 0B4C              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXD[3]   |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[4]      |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[4]            |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| G3              | VOUT[1]_B_CB_C[8] | VOUT[1]_B_CB_C[8] | PINCNTL213 / 0x4814 0B50              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXD[4]   |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[5]      |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | I2C[3]_SCL        |                                       |                           | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
| H5              | VOUT[1]_B_CB_C[9] | VOUT[1]_B_CB_C[9] | PINCNTL214 / 0x4814 0B54              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXD[5]   |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[6]      |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | I2C[3]_SDA        |                                       |                           | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
| D3              | VOUT[1]_CLK       | VOUT[1]_CLK       | PINCNTL204 / 0x4814 0B2C              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MTCLK     |                                       |                           | 0x02     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_HSYNC     |                                       |                           | 0x04     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | GP2[28]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]     | SIGNAL NAME [3]   | PINCNTL REGISTER NAME AND ADDRESS[4] | PINCNTL DEFAULT VALUE[5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|-------------------|-------------------|--------------------------------------|--------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| J10             | VOUT[1]_FLD       | VOUT[1]_FLD       | PINCNTL174 / 0x4814 0AB4             | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                   | CAM_FLD           |                                      |                          | 0x02     | I/O      | 0        |                      |                            |            |          |                  |
|                 |                   | CAM_WE            |                                      |                          | 0x04     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | GPMC_A[11]        |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | UART2_CTS         |                                      |                          | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | GP0[28]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| B2              | VOUT[1]_G_Y_YC[0] | VOUT[1]_G_Y_YC[0] | PINCNTL169 / 0x4814 0AA0             | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                   | CAM_D[2]          |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GPMC_A[6]         |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP0[23]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| A2              | VOUT[1]_G_Y_YC[1] | VOUT[1]_G_Y_YC[1] | PINCNTL168 / 0x4814 0A9C             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD_C     |          |                  |
|                 |                   | CAM_D[3]          |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GPMC_A[5]         |                                      |                          | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP0[22]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| L2              | VOUT[1]_G_Y_YC[2] | VOUT[1]_G_Y_YC[2] | PINCNTL228 / 0x4814 0B8C             | 0x0006 0000              | 0x01     | O        | PIN      | H                    | H                          | DVDD       |          |                  |
|                 |                   | GPMC_A[13]        |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[21]     |                                      |                          | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | HDMI_SCL          |                                      |                          | 0x10     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | SPI[2]_SCS[2]     |                                      |                          | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | I2C[2]_SCL        |                                      |                          | 0x40     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | GP3[20]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                   |                   |                                      |                          |          |          |          |                      |                            |            |          |                  |
| H6              | VOUT[1]_G_Y_YC[3] | VOUT[1]_G_Y_YC[3] | PINCNTL215 / 0x4814 0B58             | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXD[6]   |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[8]      |                                      |                          | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[7]            |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| J8              | VOUT[1]_G_Y_YC[4] | VOUT[1]_G_Y_YC[4] | PINCNTL216 / 0x4814 0B5C             | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXD[7]   |                                      |                          | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[9]      |                                      |                          | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[8]            |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| J1              | VOUT[1]_G_Y_YC[5] | VOUT[1]_G_Y_YC[5] | PINCNTL217 / 0x4814 0B60             | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MRXDV     |                                      |                          | 0x02     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[10]     |                                      |                          | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[9]            |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| H4              | VOUT[1]_G_Y_YC[6] | VOUT[1]_G_Y_YC[6] | PINCNTL218 / 0x4814 0B64             | 0x0004 0000              | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_GMTCLK    |                                      |                          | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[11]     |                                      |                          | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[10]           |                                      |                          | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]     | SIGNAL NAME [3]   | PINCNTL REGISTER NAME AND ADDRESS [4] | PINCNTL DEFAULT VALUE [5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11] | HYS [12] | BUFFER TYPE [13] |
|-----------------|-------------------|-------------------|---------------------------------------|---------------------------|----------|----------|----------|----------------------|----------------------------|------------|----------|------------------|
| J9              | VOUT[1]_G_Y_YC[7] | VOUT[1]_G_Y_YC[7] | PINCNTL219 / 0x4814 0B68              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MTXD[0]   |                                       |                           | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[12]     |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[11]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| L3              | VOUT[1]_G_Y_YC[8] | VOUT[1]_G_Y_YC[8] | PINCNTL220 / 0x4814 0B6C              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MTXD[1]   |                                       |                           | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[13]     |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[12]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| K1              | VOUT[1]_G_Y_YC[9] | VOUT[1]_G_Y_YC[9] | PINCNTL221 / 0x4814 0B70              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MTXD[2]   |                                       |                           | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[14]     |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[13]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| E2              | VOUT[1]_HSYNC     | VOUT[1]_HSYNC     | PINCNTL205 / 0x4814 0B30              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | EMAC[1]_MCOL      |                                       |                           | 0x02     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_VSYNC     |                                       |                           | 0x04     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | SPI[3]_D[1]       |                                       |                           | 0x10     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                   | GP2[29]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C2              | VOUT[1]_R_CR[0]   | VOUT[1]_R_CR[0]   | PINCNTL171 / 0x4814 0AA8              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                   | CAM_D[0]          |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GPMC_A[8]         |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP0[25]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| C1              | VOUT[1]_R_CR[1]   | VOUT[1]_R_CR[1]   | PINCNTL170 / 0x4814 0AA4              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD_C     |          |                  |
|                 |                   | CAM_D[1]          |                                       |                           | 0x02     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | GPMC_A[7]         |                                       |                           | 0x10     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | GP0[24]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| L6              | VOUT[1]_R_CR[2]   | VOUT[1]_R_CR[2]   | PINCNTL230 / 0x4814 0B94              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD       |          |                  |
|                 |                   | GPMC_A[15]        |                                       |                           | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[23]     |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | HDMI_HPDET        |                                       |                           | 0x10     | I        | 0        |                      |                            |            |          |                  |
|                 |                   | SPI[2]_D[1]       |                                       |                           | 0x20     | I/O      | PIN      |                      |                            |            |          |                  |
|                 |                   | GP3[22]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |
| L4              | VOUT[1]_R_CR[3]   | VOUT[1]_R_CR[3]   | PINCNTL229 / 0x4814 0B90              | 0x0006 0000               | 0x01     | O        | PIN      | H                    | H                          | DVDD       |          |                  |
|                 |                   | GPMC_A[14]        |                                       |                           | 0x02     | O        | PIN      |                      |                            |            |          |                  |
|                 |                   | VIN[1]A_D[22]     |                                       |                           | 0x04     | I        | PIN      |                      |                            |            |          |                  |
|                 |                   | HDMI_SDA          |                                       |                           | 0x10     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | SPI[2]_SCLK       |                                       |                           | 0x20     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | I2C[2]_SDA        |                                       |                           | 0x40     | I/O      | 1        |                      |                            |            |          |                  |
|                 |                   | GP3[21]           |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |            |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1] | BALL NAME [2]   | SIGNAL NAME [3] | PINCNTL REGISTER NAME AND ADDRESS [4] | PINCNTL DEFAULT VALUE [5] | MODE [6] | TYPE [7] | DSIS [8] | BALL RESET STATE [9] | BALL RESET REL. STATE [10] | POWER [11]  | HYS [12] | BUFFER TYPE [13] |
|-----------------|-----------------|-----------------|---------------------------------------|---------------------------|----------|----------|----------|----------------------|----------------------------|-------------|----------|------------------|
| H2              | VOUT[1]_R_CR[4] | VOUT[1]_R_CR[4] | PINCNTL222 / 0x4814 0B74              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD        |          |                  |
|                 |                 | EMAC[1]_MTXD[3] |                                       |                           | 0x02     | O        | PIN      |                      |                            |             |          |                  |
|                 |                 | VIN[1]A_D[15]   |                                       |                           | 0x04     | I        | PIN      |                      |                            |             |          |                  |
|                 |                 | SPI[3]_SCS[1]   |                                       |                           | 0x20     | I/O      | 1        |                      |                            |             |          |                  |
|                 |                 | GP3[14]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |             |          |                  |
| M11             | VOUT[1]_R_CR[5] | VOUT[1]_R_CR[5] | PINCNTL223 / 0x4814 0B78              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD        |          |                  |
|                 |                 | EMAC[1]_MTXD[4] |                                       |                           | 0x02     | O        | PIN      |                      |                            |             |          |                  |
|                 |                 | VIN[1]A_D[16]   |                                       |                           | 0x04     | I        | PIN      |                      |                            |             |          |                  |
|                 |                 | SPI[3]_SCLK     |                                       |                           | 0x20     | I/O      | 1        |                      |                            |             |          |                  |
|                 |                 | GP3[15]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |             |          |                  |
| L12             | VOUT[1]_R_CR[6] | VOUT[1]_R_CR[6] | PINCNTL224 / 0x4814 0B7C              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD        |          |                  |
|                 |                 | EMAC[1]_MTXD[5] |                                       |                           | 0x02     | O        | PIN      |                      |                            |             |          |                  |
|                 |                 | VIN[1]A_D[17]   |                                       |                           | 0x04     | I        | PIN      |                      |                            |             |          |                  |
|                 |                 | SPI[3]_D[1]     |                                       |                           | 0x20     | I/O      | PIN      |                      |                            |             |          |                  |
|                 |                 | GP3[16]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |             |          |                  |
| M10             | VOUT[1]_R_CR[7] | VOUT[1]_R_CR[7] | PINCNTL225 / 0x4814 0B80              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD        |          |                  |
|                 |                 | EMAC[1]_MTXD[6] |                                       |                           | 0x02     | O        | PIN      |                      |                            |             |          |                  |
|                 |                 | VIN[1]A_D[18]   |                                       |                           | 0x04     | I        | PIN      |                      |                            |             |          |                  |
|                 |                 | SPI[3]_D[0]     |                                       |                           | 0x20     | I/O      | PIN      |                      |                            |             |          |                  |
|                 |                 | GP3[17]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |             |          |                  |
| J2              | VOUT[1]_R_CR[8] | VOUT[1]_R_CR[8] | PINCNTL226 / 0x4814 0B84              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD        |          |                  |
|                 |                 | EMAC[1]_MTXD[7] |                                       |                           | 0x02     | O        | PIN      |                      |                            |             |          |                  |
|                 |                 | VIN[1]A_D[19]   |                                       |                           | 0x04     | I        | PIN      |                      |                            |             |          |                  |
|                 |                 | GP3[18]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |             |          |                  |
| K2              | VOUT[1]_R_CR[9] | VOUT[1]_R_CR[9] | PINCNTL227 / 0x4814 0B88              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD        |          |                  |
|                 |                 | EMAC[1]_MTXEN   |                                       |                           | 0x02     | O        | PIN      |                      |                            |             |          |                  |
|                 |                 | VIN[1]A_D[20]   |                                       |                           | 0x04     | I        | PIN      |                      |                            |             |          |                  |
|                 |                 | GP3[19]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |             |          |                  |
| F5              | VOUT[1]_VSYNC   | VOUT[1]_VSYNC   | PINCNTL206 / 0x4814 0B34              | 0x0004 0000               | 0x01     | O        | PIN      | L                    | L                          | DVDD        |          |                  |
|                 |                 | EMAC[1]_MCRS    |                                       |                           | 0x02     | I        | 0        |                      |                            |             |          |                  |
|                 |                 | VIN[1]A_FLD     |                                       |                           | 0x04     | I        | 0        |                      |                            |             |          |                  |
|                 |                 | VIN[1]A_DE      |                                       |                           | 0x08     | I        | 0        |                      |                            |             |          |                  |
|                 |                 | SPI[3]_D[0]     |                                       |                           | 0x10     | I/O      | PIN      |                      |                            |             |          |                  |
|                 |                 | GP2[30]         |                                       |                           | 0x80     | I/O      | PIN      |                      |                            |             |          |                  |
| AL18            | VREFSSTL_DDR[0] | VREFSSTL_DDR[0] | NA / NA                               | NA                        | NA       | PWR      | NA       | NA                   | NA                         | DVDD_DDR[0] |          |                  |

Table 3-11. Ball Characteristics (AAR Package) (continued)

| BALL NUMBER [1]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | BALL NAME [2] | SIGNAL NAME [3] | PINCNTL<br>REGISTER NAME<br>AND ADDRESS[4] | PINCNTL<br>DEFAULT<br>VALUE[5] | MODE<br>[6] | TYPE [7] | DSIS [8] | BALL<br>RESET<br>STATE [9] | BALL<br>RESET<br>REL.<br>STATE [10] | POWER [11] | HYS [12] | BUFFER<br>TYPE [13] |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------|--------------------------------------------|--------------------------------|-------------|----------|----------|----------------------------|-------------------------------------|------------|----------|---------------------|
| A1, A31, AA13,<br>AA14, AA15, AA16,<br>AA17, AA18, AA27,<br>AC25, AD24, AD25,<br>AD3, AD4, AD5,<br>AD6, AD7, AE12,<br>AE19, AE20, AE23,<br>AE24, AE25, AE26,<br>AE27, AE28, AE5,<br>AE6, AE7, AE8,<br>AE9, AF12, AF20,<br>AF24, AF25, AF7,<br>AG11, AG19,<br>AG24, AG25, AG7,<br>AH12, AH20, AH7,<br>AL1, AL31, D25,<br>D8, E21, E25, E7,<br>E8, F20, F25, F7,<br>F8, G20, G23, G24,<br>G25, G26, G27,<br>G4, G5, G6, G7,<br>G8, H26, H7, J7,<br>L16, M16, N13,<br>N14, N16, N17,<br>P11, P12, P14,<br>P18, R11, R12,<br>R14, R18, R20,<br>R21, T11, T12,<br>T14, T15, T16, T19,<br>T20, T21, U14,<br>U18, U23, V18,<br>W16, W17, Y16,<br>Y17, Y25, Y26, Y28 | VSS           | VSS             | NA /<br>NA                                 | NA                             | NA          | GND      | NA       | NA                         | NA                                  | NA         |          |                     |
| U30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | VSSA_AUXOSC   | VSSA_AUXOSC     | NA /<br>NA                                 | NA                             | NA          | GND      | NA       | NA                         | NA                                  | NA         |          |                     |
| AC7, V14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | VSSA_CSI2     | VSSA_CSI2       | NA /<br>NA                                 | NA                             | NA          | GND      | NA       | NA                         | NA                                  | NA         |          |                     |
| G30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | VSSA_DEVOSC   | VSSA_DEVOSC     | NA /<br>NA                                 | NA                             | NA          | GND      | NA       | NA                         | NA                                  | NA         |          |                     |
| G9, H8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | VSSA_HDMI     | VSSA_HDMI       | NA /<br>NA                                 | NA                             | NA          | GND      | NA       | NA                         | NA                                  | NA         |          |                     |
| D20, N19, N20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | VSSA_USB      | VSSA_USB        | NA /<br>NA                                 | NA                             | NA          | GND      | NA       | NA                         | NA                                  | NA         |          |                     |
| C8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | VSSA_VDAC     | VSSA_VDAC       | NA /<br>NA                                 | NA                             | NA          | GND      | NA       | NA                         | NA                                  | NA         |          |                     |

### 3.3 Terminal Functions

The terminal functions tables identify the external signal names, the associated pin (ball) numbers along with the mechanical package designator, the pin type, whether the pin has any internal pullup or pulldown resistors, and a functional pin description. For more detailed information on device configurations, peripheral selection, and multiplexed/shared pin see *Device Configurations* section.

- (1) **SIGNAL NAME:** The signal name
- (2) **DESCRIPTION:** Description of the signal
- (3) **TYPE:** Ball type for this specific function:
  - I = Input
  - O = Output
  - I/O = Input/Output
  - D = Open drain
  - DS = Differential
  - A = Analog
- (4) **BALL:** Package ball location

#### 3.3.1 Audio Tracking Logic (ATL)

**Table 3-12. ATL Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                     | TYPE [3] | AAR BALL [4] |
|-----------------|-------------------------------------|----------|--------------|
| ATL_CLKOUT0     | Audio Tracking Logic Clock 0 Output | O        | AF31         |
| ATL_CLKOUT1     | Audio Tracking Logic Clock 1 Output | O        | AF31         |
| ATL_CLKOUT2     | Audio Tracking Logic Clock 2 Output | O        | AF27         |
| ATL_CLKOUT3     | Audio Tracking Logic Clock 3 Output | O        | AG30         |

### 3.3.2 Boot Configuration

**Table 3-13. Boot Configuration Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | TYPE [3] | AAR BALL [4] |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| BTMODE[0]       | Boot Mode Selection 0. ARM Cortex-A8 Boot Mode Configuration Bits. This pin is multiplexed between ARM Cortex-A8 boot mode and the General-Purpose Memory Controller (GPMC) peripheral functions. At reset, the boot mode inputs BTMODE[4:0] are sampled to determine the ARM boot configuration. For more details on the types of boot modes supported, see Section 4.2, Boot Modes, of this document, along with the ROM Code Memory and Peripheral Booting chapter of the device Technical Reference Manual. After reset, this pin functions as GPMC multiplexed data/address pin 0 (GPMC_D[0]). | I        | W6           |
| BTMODE[1]       | Boot Mode Selection 1. ARM Cortex-A8 Boot Mode Configuration Bits. This pin is multiplexed between ARM Cortex-A8 boot mode and the General-Purpose Memory Controller (GPMC) peripheral functions. At reset, the boot mode inputs BTMODE[4:0] are sampled to determine the ARM boot configuration. For more details on the types of boot modes supported, see Section 4.2, Boot Modes, of this document, along with the ROM Code Memory and Peripheral Booting chapter of the device Technical Reference Manual. After reset, this pin functions as GPMC multiplexed data/address pin 1 (GPMC_D[1]). | I        | W4           |
| BTMODE[2]       | Boot Mode Selection 2. ARM Cortex-A8 Boot Mode Configuration Bits. This pin is multiplexed between ARM Cortex-A8 boot mode and the General-Purpose Memory Controller (GPMC) peripheral functions. At reset, the boot mode inputs BTMODE[4:0] are sampled to determine the ARM boot configuration. For more details on the types of boot modes supported, see Section 4.2, Boot Modes, of this document, along with the ROM Code Memory and Peripheral Booting chapter of the device Technical Reference Manual. After reset, this pin functions as GPMC multiplexed data/address pin 2 (GPMC_D[2]). | I        | W3           |
| BTMODE[3]       | Boot Mode Selection 3. ARM Cortex-A8 Boot Mode Configuration Bits. This pin is multiplexed between ARM Cortex-A8 boot mode and the General-Purpose Memory Controller (GPMC) peripheral functions. At reset, the boot mode inputs BTMODE[4:0] are sampled to determine the ARM boot configuration. For more details on the types of boot modes supported, see Section 4.2, Boot Modes, of this document, along with the ROM Code Memory and Peripheral Booting chapter of the device Technical Reference Manual. After reset, this pin functions as GPMC multiplexed data/address pin 3 (GPMC_D[3]). | I        | U2           |
| BTMODE[4]       | Boot Mode Selection 4. ARM Cortex-A8 Boot Mode Configuration Bits. This pin is multiplexed between ARM Cortex-A8 boot mode and the General-Purpose Memory Controller (GPMC) peripheral functions. At reset, the boot mode inputs BTMODE[4:0] are sampled to determine the ARM boot configuration. For more details on the types of boot modes supported, see Section 4.2, Boot Modes, of this document, along with the ROM Code Memory and Peripheral Booting chapter of the device Technical Reference Manual. After reset, this pin functions as GPMC multiplexed data/address pin 4 (GPMC_D[4]). | I        | W9           |
| BTMODE[5]       | Boot Mode Selection 5. Reserved Boot Pin. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. For proper device operation at reset, this pin should be externally pulled low. After reset, this pin functions as GPMC multiplexed data/address pin 5 (GPMC_D[5]).                                                                                                                                                                                                                                                            | I        | T5           |



**Table 3-13. Boot Configuration Terminal Functions (continued)**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| BTMODE[6]       | Boot Mode Selection 6. Reserved Boot Pin. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. For proper device operation at reset, this pin should be externally pulled low. After reset, this pin functions as GPMC multiplexed data/address pin 6 (GPMC_D[6]).                                                                                                                                                                                                                                                                                                                                                             | I        | T3           |
| BTMODE[7]       | Boot Mode Selection 7. RGMII Internal Delay Selection. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. At reset, BTMODE[7] is sampled to determine the RGMII Internal Delay Selection: <ul style="list-style-type: none"> <li>0 = Internal Delay Enabled</li> <li>1 = Internal Delay Disabled</li> </ul> After reset, this pin functions as GPMC multiplexed data/address pin 7 (GPMC_D[7]).                                                                                                                                                                                                                              | I        | T2           |
| BTMODE[8]       | Boot Mode Selection 8. Ethernet PHY Configuration. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. At reset, when EMAC bootmode is selected (see Table 4-1), BTMODE[9:8] pins are sampled to determine the function of the Ethernet PHY Mode selection: <ul style="list-style-type: none"> <li>00 = MII (GMII)</li> <li>01 = RMII</li> <li>10 = RGMII</li> <li>11 = Reserved</li> </ul> For more detailed information on the EMAC PHY boot modes and the EMAC pin functions selected, see Section 4.2.6, Ethernet PHY Mode Selection. After reset, this pin functions as GPMC multiplexed data/address pin 8 (GPMC_D[8]). | I        | T1           |
| BTMODE[9]       | Boot Mode Selection 9. Ethernet PHY Configuration. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. At reset, when EMAC bootmode is selected (see Table 4-1), BTMODE[9:8] pins are sampled to determine the function of the Ethernet PHY Mode selection: <ul style="list-style-type: none"> <li>00 = MII (GMII)</li> <li>01 = RMII</li> <li>10 = RGMII</li> <li>11 = Reserved</li> </ul> For more detailed information on the EMAC PHY boot modes and the EMAC pin functions selected, see Section 4.2.6, Ethernet PHY Mode Selection. After reset, this pin functions as GPMC multiplexed data/address pin 9 (GPMC_D[9]). | I        | T8           |
| BTMODE[10]      | Boot Mode Selection 10. XIP (NOR) on GPMC Configuration. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. At reset, when the XIP (MUX0), XIP (MUX1), XIP w/ WAIT (MUX0) or XIP w/ WAIT (MUX1) bootmode is selected (see Table 4-1), BTMODE[10] is sampled to select between GPMC pin muxing options A or B shown in Table 4-2, XIP (on GPMC) Boot Options [Muxed or Non-Muxed]. <ul style="list-style-type: none"> <li>0 = GPMC Option A</li> <li>1 = GPMC Option B</li> </ul> After reset, this pin functions as GPMC multiplexed data/address pin 10 (GPMC_D[10]).                                                       | I        | R6           |

**Table 3-13. Boot Configuration Terminal Functions (continued)**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| BTMODE[11]      | <p>Boot Mode Selection 11. <math>\overline{\text{RSTOUT\_WD\_OUT}}</math> Configuration. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. At reset, BTMODE[11] is sampled to determine the function of the <math>\overline{\text{RSTOUT\_WD\_OUT}}</math> pin:</p> <ul style="list-style-type: none"> <li>0 = <math>\overline{\text{RSTOUT}}</math> is asserted when a Watchdog Timer reset, <math>\overline{\text{POR}}</math>, <math>\overline{\text{RESET}}</math>, or Emulation/Software-Global Cold/Warm reset occurs</li> <li>1 = <math>\overline{\text{RSTOUT\_WD\_OUT}}</math> is asserted only when a Watchdog Timer reset occurs</li> </ul> <p>After reset, this pin functions as GPMC multiplexed data/address pin 11 (GPMC_D[11]).</p> | I        | R4           |
| BTMODE[12]      | <p>Boot Mode Selection 12. GPMC CS0 default Data Bus Width input. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. At reset, BTMODE[12] is sampled to determine the GPMC CS0 bus width:</p> <ul style="list-style-type: none"> <li>0 = 8-bit data bus</li> <li>1 = 16-bit data bus</li> </ul> <p>After reset, this pin functions as GPMC multiplexed data/address pin 12 (GPMC_D[12]).</p>                                                                                                                                                                                                                                                                                                                                                         | I        | R3           |
| BTMODE[13]      | <p>Boot Mode Selection 13. GPMC CS0 default Address/Data multiplexing mode input. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. At reset, BTMODE[14:13] are sampled to determine the GPMC CS0 Address/Data multiplexing:</p> <ul style="list-style-type: none"> <li>00 = Not muxed</li> <li>01 = A/A/D muxed</li> <li>10 = A/D muxed</li> <li>11 = Reserved</li> </ul> <p>After reset, this pin functions as GPMC multiplexed data/address pin 13 (GPMC_D[13]).</p>                                                                                                                                                                                                                                                                             | I        | R2           |
| BTMODE[14]      | <p>Boot Mode Selection 14. GPMC CS0 default Address/Data multiplexing mode input. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. At reset, BTMODE[14:13] are sampled to determine the GPMC CS0 Address/Data multiplexing:</p> <ul style="list-style-type: none"> <li>00 = Not muxed</li> <li>01 = A/A/D muxed</li> <li>10 = A/D muxed</li> <li>11 = Reserved</li> </ul> <p>After reset, this pin functions as GPMC multiplexed data/address pin 14 (GPMC_D[14]).</p>                                                                                                                                                                                                                                                                             | I        | R1           |
| BTMODE[15]      | <p>Boot Mode Selection 15. GPMC CS0 default GPMC_Wait enable input. This pin is multiplexed between ARM Cortex-A8 boot mode and General-Purpose Memory Controller (GPMC) peripheral functions. At reset, BTMODE[15] is sampled to determine the GPMC CS0 Wait enable:</p> <ul style="list-style-type: none"> <li>0 = Wait disabled</li> <li>1 = Wait enabled</li> </ul> <p>After reset, this pin functions as GPMC multiplexed data/address pin 15 (GPMC_D[15]).</p>                                                                                                                                                                                                                                                                                                                                                         | I        | P2           |

### 3.3.3 CSI2 Interface (I/F) Signals

**Table 3-14. CSI2 I/F Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                       | TYPE [3] | AAR BALL [4] |
|-----------------|-------------------------------------------------------------------------------------------------------|----------|--------------|
| CSI2_DX[0]      | CSI2 Camera lane 0 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | AB2          |
| CSI2_DX[1]      | CSI2 Camera lane 1 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | AA1          |
| CSI2_DX[2]      | CSI2 Camera lane 2 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | AA2          |
| CSI2_DX[3]      | CSI2 Camera lane 3 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | W2           |
| CSI2_DX[4]      | CSI2 Camera lane 4 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | V1           |
| CSI2_DY[0]      | CSI2 Camera lane 0 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | AC2          |
| CSI2_DY[1]      | CSI2 Camera lane 1 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | AB1          |
| CSI2_DY[2]      | CSI2 Camera lane 2 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | Y2           |
| CSI2_DY[3]      | CSI2 Camera lane 3 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | W1           |
| CSI2_DY[4]      | CSI2 Camera lane 4 differential pair input. When CSI2 is not used these pins can be left unconnected. | I        | V2           |

### 3.3.4 Camera Interface (I/F)

**Table 3-15. Camera I/F Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                               | TYPE [3] | AAR BALL [4] |
|-----------------|-----------------------------------------------|----------|--------------|
| CAM_D[0]        | Camera data input                             | I        | C2           |
| CAM_D[1]        | Camera data input                             | I        | C1           |
| CAM_D[2]        | Camera data input                             | I        | B2           |
| CAM_D[3]        | Camera data input                             | I        | A2           |
| CAM_D[4]        | Camera data input                             | I        | A3           |
| CAM_D[5]        | Camera data input                             | I        | B4           |
| CAM_D[6]        | Camera data input                             | I        | C5           |
| CAM_D[7]        | Camera data input                             | I        | B5           |
| CAM_D[8]        | Camera data input                             | I        | K11          |
| CAM_D[9]        | Camera data input                             | I        | E12          |
| CAM_D[10]       | Camera data input                             | I        | K10          |
| CAM_D[11]       | Camera data input                             | I        | D7           |
| CAM_D[12]       | Camera data input                             | I        | F9           |
| CAM_D[13]       | Camera data input                             | I        | C7           |
| CAM_D[14]       | Camera data input                             | I        | A6           |
| CAM_D[15]       | Camera data input                             | I        | A5           |
| CAM_FLD         | Camera Field Identification input             | I/O      | J10          |
| CAM_HS          | Camera Horizontal Synchronization             | I/O      | D5           |
| CAM_PCLK        | Camera Pixel Clock                            | I        | B3           |
| CAM_RESET       | Camera Reset. Used for Strobe Synchronization | I/O      | H16          |
| CAM_SHUTTER     | Camera Mechanical Shutter Control Signal      | O        | H13          |
| CAM_STROBE      | Camera Flash Strobe Control Signal            | O        | F13          |
| CAM_VS          | Camera Vertical Synchronization               | I/O      | H9           |
| CAM_WE          | Camera Write Enable                           | I        | H17, J10     |

### 3.3.5 DDR2/DDR3/DDR3L Memory Controller

**Table 3-16. DDR2/DDR3/DDR3L Memory Controller 0 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                     | TYPE [3] | AAR BALL [4] |
|-----------------|-------------------------------------|----------|--------------|
| DDR[0]_A[0]     | DDR[0] Address Bus                  | O        | AL24         |
| DDR[0]_A[1]     | DDR[0] Address Bus                  | O        | AC22         |
| DDR[0]_A[2]     | DDR[0] Address Bus                  | O        | AJ23         |
| DDR[0]_A[3]     | DDR[0] Address Bus                  | O        | AJ27         |
| DDR[0]_A[4]     | DDR[0] Address Bus                  | O        | AK28         |
| DDR[0]_A[5]     | DDR[0] Address Bus                  | O        | AH27         |
| DDR[0]_A[6]     | DDR[0] Address Bus                  | O        | AK30         |
| DDR[0]_A[7]     | DDR[0] Address Bus                  | O        | AG23         |
| DDR[0]_A[8]     | DDR[0] Address Bus                  | O        | AL29         |
| DDR[0]_A[9]     | DDR[0] Address Bus                  | O        | AK29         |
| DDR[0]_A[10]    | DDR[0] Address Bus                  | O        | AD23         |
| DDR[0]_A[11]    | DDR[0] Address Bus                  | O        | AK24         |
| DDR[0]_A[12]    | DDR[0] Address Bus                  | O        | AH23         |
| DDR[0]_A[13]    | DDR[0] Address Bus                  | O        | AK23         |
| DDR[0]_A[14]    | DDR[0] Address Bus                  | O        | AL23         |
| DDR[0]_A[15]    | DDR[0] Address Bus                  | O        | AK22         |
| DDR[0]_BA[0]    | DDR[0] Bank Address outputs         | O        | AK26         |
| DDR[0]_BA[1]    | DDR[0] Bank Address outputs         | O        | AF23         |
| DDR[0]_BA[2]    | DDR[0] Bank Address outputs         | O        | AH25         |
| DDR[0]_CAS      | DDR[0] Column Address Strobe output | O        | AK25         |
| DDR[0]_CKE      | DDR[0] Clock Enable                 | O        | AD20         |
| DDR[0]_CLK      | DDR[0] Negative Clock               | O        | AK27         |
| DDR[0]_CLK      | DDR[0] Clock                        | O        | AL27         |
| DDR[0]_CS[0]    | DDR[0] Chip Select                  | O        | AB21         |
| DDR[0]_D[0]     | DDR[0] Data Bus                     | I/O      | AL9          |
| DDR[0]_D[1]     | DDR[0] Data Bus                     | I/O      | AK9          |
| DDR[0]_D[2]     | DDR[0] Data Bus                     | I/O      | AK10         |
| DDR[0]_D[3]     | DDR[0] Data Bus                     | I/O      | AJ11         |
| DDR[0]_D[4]     | DDR[0] Data Bus                     | I/O      | AH11         |
| DDR[0]_D[5]     | DDR[0] Data Bus                     | I/O      | AD9          |
| DDR[0]_D[6]     | DDR[0] Data Bus                     | I/O      | AF11         |
| DDR[0]_D[7]     | DDR[0] Data Bus                     | I/O      | AL12         |
| DDR[0]_D[8]     | DDR[0] Data Bus                     | I/O      | AJ12         |
| DDR[0]_D[9]     | DDR[0] Data Bus                     | I/O      | AG12         |
| DDR[0]_D[10]    | DDR[0] Data Bus                     | I/O      | AD12         |
| DDR[0]_D[11]    | DDR[0] Data Bus                     | I/O      | AB12         |
| DDR[0]_D[12]    | DDR[0] Data Bus                     | I/O      | AK13         |
| DDR[0]_D[13]    | DDR[0] Data Bus                     | I/O      | AC13         |
| DDR[0]_D[14]    | DDR[0] Data Bus                     | I/O      | AL14         |
| DDR[0]_D[15]    | DDR[0] Data Bus                     | I/O      | AK14         |
| DDR[0]_D[16]    | DDR[0] Data Bus                     | I/O      | AH15         |
| DDR[0]_D[17]    | DDR[0] Data Bus                     | I/O      | AF15         |
| DDR[0]_D[18]    | DDR[0] Data Bus                     | I/O      | AD15         |
| DDR[0]_D[19]    | DDR[0] Data Bus                     | I/O      | AK16         |
| DDR[0]_D[20]    | DDR[0] Data Bus                     | I/O      | AJ16         |

**Table 3-16. DDR2/DDR3/DDR3L Memory Controller 0 Terminal Functions (continued)**

| <b>SIGNAL NAME [1]</b>            | <b>DESCRIPTION [2]</b>                                            | <b>TYPE [3]</b> | <b>AAR BALL [4]</b> |
|-----------------------------------|-------------------------------------------------------------------|-----------------|---------------------|
| DDR[0]_D[21]                      | DDR[0] Data Bus                                                   | I/O             | AG16                |
| DDR[0]_D[22]                      | DDR[0] Data Bus                                                   | I/O             | AD16                |
| DDR[0]_D[23]                      | DDR[0] Data Bus                                                   | I/O             | AC16                |
| DDR[0]_D[24]                      | DDR[0] Data Bus                                                   | I/O             | AK19                |
| DDR[0]_D[25]                      | DDR[0] Data Bus                                                   | I/O             | AJ19                |
| DDR[0]_D[26]                      | DDR[0] Data Bus                                                   | I/O             | AH19                |
| DDR[0]_D[27]                      | DDR[0] Data Bus                                                   | I/O             | AF19                |
| DDR[0]_D[28]                      | DDR[0] Data Bus                                                   | I/O             | AD19                |
| DDR[0]_D[29]                      | DDR[0] Data Bus                                                   | I/O             | AC19                |
| DDR[0]_D[30]                      | DDR[0] Data Bus                                                   | I/O             | AJ20                |
| DDR[0]_D[31]                      | DDR[0] Data Bus                                                   | I/O             | AG20                |
| DDR[0]_DQM[0]                     | Data Mask for lower byte data bus DDR[0]_D[7:0]                   | O               | AL8                 |
| DDR[0]_DQM[1]                     | Data Mask for DDR[0]_D[15:8]                                      | O               | AK12                |
| DDR[0]_DQM[2]                     | Data Mask for DDR[0]_D[23:16]                                     | O               | AJ15                |
| DDR[0]_DQM[3]                     | Data Mask for upper byte data bus DDR[0]_D[31:24]                 | O               | AK18                |
| DDR[0]_DQS[0]                     | Data Strobe for lower byte data bus DDR[0]_D[7:0]                 | I/O             | AL11                |
| $\overline{\text{DDR[0]_DQS[0]}}$ | Complimentary data strobe for lower byte data bus DDR[0]_D[7:0]   | I/O             | AK11                |
| $\overline{\text{DDR[0]_DQS[1]}}$ | Complimentary data strobe for DDR[0]_D[15:8]                      | I/O             | AK15                |
| DDR[0]_DQS[1]                     | Data Strobe for DDR[0]_D[15:8]                                    | I/O             | AL15                |
| DDR[0]_DQS[2]                     | Data Strobe for DDR[0]_D[23:16]                                   | I/O             | AL17                |
| $\overline{\text{DDR[0]_DQS[2]}}$ | Complimentary data strobe for DDR[0]_D[23:16]                     | I/O             | AK17                |
| $\overline{\text{DDR[0]_DQS[3]}}$ | Complimentary data strobe for upper byte data bus DDR[0]_D[31:24] | I/O             | AK20                |
| DDR[0]_DQS[3]                     | Data Strobe for upper byte data bus DDR[0]_D[31:24]               | I/O             | AL20                |
| DDR[0]_ODT[0]                     | DDR[0] On-Die Termination for Chip Select 0                       | O               | AL21                |
| $\overline{\text{DDR[0]_RAS}}$    | DDR[0] Row Address Strobe output                                  | O               | AJ25                |
| DDR[0]_RST                        | DDR[0] Reset output                                               | O               | AA20                |
| DDR[0]_VTP                        | DDR VTP Compensation Resistor Connection                          | I               | AL30                |
| $\overline{\text{DDR[0]_WE}}$     | DDR[0] Write Enable                                               | O               | AL26                |

### 3.3.6 EDMA

**Table 3-17. EDMA Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]       | TYPE [3] | AAR BALL [4] |
|-----------------|-----------------------|----------|--------------|
| EDMA_EVT0       | External EDMA Event 0 | I        | AD2, W8      |
| EDMA_EVT1       | External EDMA Event 1 | I        | G28, Y11     |
| EDMA_EVT2       | External EDMA Event 2 | I        | AG30, Y3     |
| EDMA_EVT3       | External EDMA Event 3 | I        | AB9, AF27    |

### 3.3.7 EMAC [(R)(G)MII Modes] and MDIO

#### 3.3.7.1 EMAC

**Table 3-18. EMAC Terminal Functions [(R)(G)MII]**

| SIGNAL NAME [1]                  | DESCRIPTION [2]                                               | TYPE [3] | AAR BALL [4] |
|----------------------------------|---------------------------------------------------------------|----------|--------------|
| EMAC[0]_GMTCLK/EMAC[1]_RGRXC     | GMII Source Asynchronous Transmit Clock / RGMII Receive Clock | I/O      | AL6          |
| EMAC[0]_MCOL/EMAC[0]_RGRXCTL     | [G]MII Collision Detect (Sense) input / RGMII Receive Control | I        | AH1          |
| EMAC[0]_MCRS/EMAC[0]_RGRXD[2]    | [G]MII Carrier Sense input / RGMII Receive Data               | I        | AH2          |
| EMAC[0]_MRCLK/EMAC[0]_RGTXC      | [G]MII Receive Clock / RGMII Transmit Clock                   | I/O      | AK1          |
| EMAC[0]_MRXDV/EMAC[1]_RGRXD[1]   | [G]MII Receive Data Valid input / RGMII Receive Data          | I/O      | AJ6          |
| EMAC[0]_MRXD[0]/EMAC[0]_RGTXD[0] | [G]MII Receive Data / RGMII Transmit Data                     | I/O      | AK2          |
| EMAC[0]_MRXD[1]/EMAC[0]_RGRXD[0] | [G]MII Receive Data / RGMII Receive Data                      | I/O      | AL2          |
| EMAC[0]_MRXD[2]/EMAC[0]_RGRXD[1] | [G]MII Receive Data / RGMII Receive Data                      | I/O      | AL3          |
| EMAC[0]_MRXD[3]/EMAC[1]_RGRXCTL  | [G]MII Receive Data / RGMII Receive Control                   | I/O      | AK3          |
| EMAC[0]_MRXD[4]/EMAC[0]_RGRXD[3] | [G]MII Receive Data / RGMII Receive Data                      | I/O      | AK4          |
| EMAC[0]_MRXD[5]/EMAC[0]_RGTXD[3] | [G]MII Receive Data / RGMII Transmit Data                     | I/O      | AJ4          |
| EMAC[0]_MRXD[6]/EMAC[0]_RGTXD[2] | [G]MII Receive Data / RGMII Transmit Data                     | I/O      | AL5          |
| EMAC[0]_MRXD[7]/EMAC[0]_RGTXD[1] | [G]MII Receive Data / RGMII Transmit Data                     | I/O      | AK5          |
| EMAC[0]_MRXER/EMAC[0]_RGTXCTL    | [G]MII Receive Data Error input / RGMII Transmit Enable       | I/O      | AJ2          |
| EMAC[0]_MTCLK/EMAC[0]_RGRXC      | [G]MII Transmit Clock input / RGMII Receive Clock             | I/O      | AG4          |
| EMAC[0]_MTXD[0]/EMAC[1]_RGRXD[3] | [G]MII Transmit Data / RGMII Receive Data                     | I/O      | AK6          |
| EMAC[0]_MTXD[1]/EMAC[1]_RGTXD[1] | [G]MII Transmit Data / RGMII Transmit Data                    | I/O      | AJ7          |
| EMAC[0]_MTXD[2]/EMAC[1]_RGTXCTL  | [G]MII Transmit Data / RGMII Transmit Enable                  | I/O      | AK7          |
| EMAC[0]_MTXD[3]/EMAC[1]_RGTXD[0] | [G]MII Transmit Data / RGMII Transmit Data                    | I/O      | AE4          |
| EMAC[0]_MTXD[4]/EMAC[1]_RGTXD[2] | [G]MII Transmit Data / RGMII Transmit Data                    | I/O      | AK8          |
| EMAC[0]_MTXD[5]/EMAC[1]_RGTXC    | [G]MII Transmit Data / RGMII Transmit Clock                   | I/O      | AJ8          |
| EMAC[0]_MTXD[6]/EMAC[1]_RGRXD[0] | [G]MII Transmit Data / RGMII Receive Data                     | I/O      | AH8          |
| EMAC[0]_MTXD[7]/EMAC[1]_RGTXD[3] | [G]MII Transmit Data / RGMII Transmit Data                    | I/O      | AG8          |
| EMAC[0]_MTXEN/EMAC[1]_RGRXD[2]   | [G]MII Transmit Data Enable output / RGMII Receive Data       | I/O      | AF8          |
| EMAC[0]_RMCSDV                   | RMII Carrier Sense input                                      | I        | AK1          |
| EMAC[0]_RMRXD[0]                 | RMII Receive Data                                             | I        | AH1          |
| EMAC[0]_RMRXD[1]                 | RMII Receive Data                                             | I        | AH2          |
| EMAC[0]_RMRXER                   | RMII Receive Data Error input                                 | I        | AJ2          |
| EMAC[0]_RMTXD[0]                 | RMII Transmit Data                                            | O        | AK2          |
| EMAC[0]_RMTXD[1]                 | RMII Transmit Data                                            | O        | AL2          |
| EMAC[0]_RMTXEN                   | RMII Transmit Data Enable output                              | O        | AL3          |
| EMAC[1]_GMTCLK                   | GMII Source Asynchronous Transmit Clock                       | O        | H4           |
| EMAC[1]_MCOL                     | [G]MII Collision Detect (Sense) input                         | I        | E2           |
| EMAC[1]_MCRS                     | [G]MII Carrier Sense input                                    | I        | F5           |
| EMAC[1]_MRCLK                    | [G]MII Receive Clock                                          | I        | F2           |
| EMAC[1]_MRXD[0]                  | [G]MII Receive Data                                           | I        | F3           |
| EMAC[1]_MRXD[1]                  | [G]MII Receive Data                                           | I        | G1           |
| EMAC[1]_MRXD[2]                  | [G]MII Receive Data                                           | I        | G2           |
| EMAC[1]_MRXD[3]                  | [G]MII Receive Data                                           | I        | H3           |
| EMAC[1]_MRXD[4]                  | [G]MII Receive Data                                           | I        | G3           |
| EMAC[1]_MRXD[5]                  | [G]MII Receive Data                                           | I        | H5           |
| EMAC[1]_MRXD[6]                  | [G]MII Receive Data                                           | I        | H6           |



**Table 3-18. EMAC Terminal Functions [(R)(G)MII] (continued)**

| SIGNAL NAME [1]  | DESCRIPTION [2]                    | TYPE [3] | AAR BALL [4] |
|------------------|------------------------------------|----------|--------------|
| EMAC[1]_MRXD[7]  | [G]MII Receive Data                | I        | J8           |
| EMAC[1]_MRXDV    | [G]MII Receive Data Valid input    | I        | J1           |
| EMAC[1]_MRXER    | [G]MII Receive Data Error input    | I        | F1           |
| EMAC[1]_MTCLK    | [G]MII Transmit Clock input        | I        | D3           |
| EMAC[1]_MTXD[0]  | [G]MII Transmit Data               | O        | J9           |
| EMAC[1]_MTXD[1]  | [G]MII Transmit Data               | O        | L3           |
| EMAC[1]_MTXD[2]  | [G]MII Transmit Data               | O        | K1           |
| EMAC[1]_MTXD[3]  | [G]MII Transmit Data               | O        | H2           |
| EMAC[1]_MTXD[4]  | [G]MII Transmit Data               | O        | M11          |
| EMAC[1]_MTXD[5]  | [G]MII Transmit Data               | O        | L12          |
| EMAC[1]_MTXD[6]  | [G]MII Transmit Data               | O        | M10          |
| EMAC[1]_MTXD[7]  | [G]MII Transmit Data               | O        | J2           |
| EMAC[1]_MTXEN    | [G]MII Transmit Data Enable output | O        | K2           |
| EMAC[1]_RMCSDV   | RMII Carrier Sense input           | I        | AJ8, F9      |
| EMAC[1]_RMRXD[0] | RMII Receive Data                  | I        | AK7, D7      |
| EMAC[1]_RMRXD[1] | RMII Receive Data                  | I        | AE4, K10     |
| EMAC[1]_RMRXER   | RMII Receive Data Error input      | I        | AK8, E12     |
| EMAC[1]_RMTXD[0] | RMII Transmit Data                 | O        | AH8, C7      |
| EMAC[1]_RMTXD[1] | RMII Transmit Data                 | O        | A6, AG8      |
| EMAC[1]_RMTXEN   | RMII Transmit Data Enable output   | O        | A5, AF8      |
| EMAC_RMREFCLK    | RMII Reference Clock               | I/O      | AG1          |

### 3.3.7.2 MDIO

**Table 3-19. MDIO Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                     | TYPE [3] | AAR BALL [4] |
|-----------------|-------------------------------------|----------|--------------|
| MDCLK           | Management Data Serial Clock output | O        | AG2          |
| MDIO            | Management Data I/O                 | I/O      | AG3          |

### 3.3.8 GPMC

**Table 3-20. GPMC Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                              | TYPE [3] | AAR BALL [4]  |
|-----------------|--------------------------------------------------------------|----------|---------------|
| GPMC_A[0]       | GPMC Address 0                                               | O        | AK3, M8       |
| GPMC_A[1]       | GPMC Address 1                                               | O        | AD1, AK4      |
| GPMC_A[2]       | GPMC Address 2                                               | O        | AC8, AJ4      |
| GPMC_A[3]       | GPMC Address 3                                               | O        | AC5, AL5      |
| GPMC_A[4]       | GPMC Address 4                                               | O        | AC4, AK5      |
| GPMC_A[5]       | GPMC Address 5                                               | O        | A2, AJ6       |
| GPMC_A[6]       | GPMC Address 6                                               | O        | AL6, B2       |
| GPMC_A[7]       | GPMC Address 7                                               | O        | AK6, C1       |
| GPMC_A[8]       | GPMC Address 8                                               | O        | AJ7, C2       |
| GPMC_A[9]       | GPMC Address 9                                               | O        | AK7, D5       |
| GPMC_A[10]      | GPMC Address 10                                              | O        | AE4, H9       |
| GPMC_A[11]      | GPMC Address 11                                              | O        | AK8, J10      |
| GPMC_A[12]      | GPMC Address 12                                              | O        | AJ8, B3       |
| GPMC_A[13]      | GPMC Address 13                                              | O        | AH8, L2       |
| GPMC_A[14]      | GPMC Address 14                                              | O        | AG8, L4       |
| GPMC_A[15]      | GPMC Address 15                                              | O        | AF8, L6       |
| GPMC_A[16]      | GPMC Address 16                                              | O        | M1            |
| GPMC_A[17]      | GPMC Address 17                                              | O        | M2            |
| GPMC_A[18]      | GPMC Address 18                                              | O        | M3            |
| GPMC_A[19]      | GPMC Address 19                                              | O        | M5            |
| GPMC_A[20]      | GPMC Address 20                                              | O        | AE3, N9       |
| GPMC_A[21]      | GPMC Address 21                                              | O        | AE2, N1       |
| GPMC_A[22]      | GPMC Address 22                                              | O        | AE1, N2       |
| GPMC_A[23]      | GPMC Address 23                                              | O        | AD2, R8       |
| GPMC_A[24]      | GPMC Address 24                                              | O        | AC3, AE3, Y11 |
| GPMC_A[25]      | GPMC Address 25                                              | O        | AA12, AE2, Y3 |
| GPMC_A[26]      | GPMC Address 26                                              | O        | AE1, AK3, W8  |
| GPMC_A[27]      | GPMC Address 27                                              | O        | AD2, AK3      |
| GPMC_ADV_ALE    | GPMC Address Valid output or Address Latch Enable output     | O        | AA10          |
| GPMC_BE[1]      | GPMC Upper Byte Enable output                                | O        | Y11           |
| GPMC_BE[0]_CLE  | GPMC Lower Byte Enable output or Command Latch Enable output | O        | Y3            |
| GPMC_CLK        | GPMC Clock output                                            | O        | AB9           |
| GPMC_CS[0]      | GPMC Chip Select 0                                           | O        | AC9           |
| GPMC_CS[1]      | GPMC Chip Select 1                                           | O        | AA12          |
| GPMC_CS[2]      | GPMC Chip Select 2                                           | O        | AC3           |
| GPMC_CS[3]      | GPMC Chip Select 3                                           | O        | AF2           |
| GPMC_CS[4]      | GPMC Chip Select 4                                           | O        | AG6           |
| GPMC_CS[5]      | GPMC Chip Select 5                                           | O        | AB9           |
| GPMC_CS[6]      | GPMC Chip Select 6                                           | O        | AA10          |
| GPMC_CS[7]      | GPMC Chip Select 7                                           | O        | AD2           |
| GPMC_D[0]       | GPMC Multiplexed Data/Address I/O                            | I/O      | W6            |
| GPMC_D[1]       | GPMC Multiplexed Data/Address I/O                            | I/O      | W4            |
| GPMC_D[2]       | GPMC Multiplexed Data/Address I/O                            | I/O      | W3            |
| GPMC_D[3]       | GPMC Multiplexed Data/Address I/O                            | I/O      | U2            |

**Table 3-20. GPMC Terminal Functions (continued)**

| SIGNAL NAME [1]                  | DESCRIPTION [2]                   | TYPE [3] | AAR BALL [4]        |
|----------------------------------|-----------------------------------|----------|---------------------|
| GPMC_D[4]                        | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">W9</a>  |
| GPMC_D[5]                        | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">T5</a>  |
| GPMC_D[6]                        | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">T3</a>  |
| GPMC_D[7]                        | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">T2</a>  |
| GPMC_D[8]                        | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">T1</a>  |
| GPMC_D[9]                        | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">T8</a>  |
| GPMC_D[10]                       | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">R6</a>  |
| GPMC_D[11]                       | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">R4</a>  |
| GPMC_D[12]                       | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">R3</a>  |
| GPMC_D[13]                       | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">R2</a>  |
| GPMC_D[14]                       | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">R1</a>  |
| GPMC_D[15]                       | GPMC Multiplexed Data/Address I/O | I/O      | <a href="#">P2</a>  |
| $\overline{\text{GPMC\_OE\_RE}}$ | GPMC Output Enable output         | O        | <a href="#">Y8</a>  |
| GPMC_WAIT[0]                     | GPMC Wait input 0                 | I        | <a href="#">W8</a>  |
| GPMC_WAIT[1]                     | GPMC Wait input 1                 | I        | <a href="#">AB9</a> |
| $\overline{\text{GPMC\_WE}}$     | GPMC Write Enable output          | O        | <a href="#">Y5</a>  |

### 3.3.9 General-Purpose Input/Outputs (GPIOs)

#### 3.3.9.1 GP0

**Table 3-21. GP0 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                      | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------|----------|--------------|
| GP0[0]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | Y29          |
| GP0[1]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AB30         |
| GP0[2]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AA29         |
| GP0[3]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AA28         |
| GP0[4]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AA26         |
| GP0[5]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | Y31          |
| GP0[6]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | Y30          |
| GP0[7]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | K23          |
| GP0[8]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AF27         |
| GP0[9]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AG30         |
| GP0[10]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | K11          |
| GP0[11]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | E12          |
| GP0[12]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AB31, K10    |
| GP0[13]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AC30, D7     |
| GP0[14]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | F9           |
| GP0[15]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C7           |
| GP0[16]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | A6           |
| GP0[17]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | A5           |
| GP0[18]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | B5           |
| GP0[19]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C5           |
| GP0[20]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | B4           |
| GP0[21]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | A3           |
| GP0[22]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | A2           |
| GP0[23]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | B2           |
| GP0[24]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C1           |
| GP0[25]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C2           |
| GP0[26]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | D5           |
| GP0[27]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H9           |
| GP0[28]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | J10          |

#### 3.3.9.2 GP1

**Table 3-22. GP1 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                      | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------|----------|--------------|
| GP1[0]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | M21          |
| GP1[1]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | L22          |
| GP1[2]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | E31          |
| GP1[3]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | E29          |
| GP1[4]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | E30          |
| GP1[5]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | N26          |
| GP1[6]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | G28          |
| GP1[7]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | U28          |
| GP1[8]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AG6          |
| GP1[9]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H12          |

**Table 3-22. GP1 Terminal Functions (continued)**

| SIGNAL NAME [1] | DESCRIPTION [2]                                      | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------|----------|--------------|
| GP1[10]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AG1          |
| GP1[11]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AG2, B18     |
| GP1[12]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | A17, AG3     |
| GP1[13]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AC5, M3      |
| GP1[14]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AC4, M5      |
| GP1[15]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AC6, N9      |
| GP1[16]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | J29, N1      |
| GP1[17]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | M29, N2      |
| GP1[18]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | M27, R8      |
| GP1[19]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AE3          |
| GP1[20]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AE2          |
| GP1[21]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AE1          |
| GP1[22]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AD2          |
| GP1[23]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AC9          |
| GP1[24]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AA12         |
| GP1[25]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AC3          |
| GP1[26]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AF2, N23     |
| GP1[27]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AB9          |
| GP1[28]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AA10         |
| GP1[29]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | Y3           |
| GP1[30]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | Y11          |
| GP1[31]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | W8           |

### 3.3.9.3 GP2

**Table 3-23. GP2 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                      | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------|----------|--------------|
| GP2[0]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C12          |
| GP2[1]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | J13          |
| GP2[2]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C9           |
| GP2[02]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | B3           |
| GP2[3]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | D13          |
| GP2[4]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C13          |
| GP2[5]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AD1, M1      |
| GP2[6]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AC8, M2      |
| GP2[7]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | B17          |
| GP2[8]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C17          |
| GP2[9]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | D17          |
| GP2[10]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | F17          |
| GP2[11]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | L20          |
| GP2[12]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H20          |
| GP2[13]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | B16          |
| GP2[14]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C16          |
| GP2[15]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | E16          |
| GP2[16]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H17          |
| GP2[17]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | J16          |
| GP2[18]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H16          |

**Table 3-23. GP2 Terminal Functions (continued)**

| SIGNAL NAME [1] | DESCRIPTION [2]                                      | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------|----------|--------------|
| GP2[19]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | F13          |
| GP2[20]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H13          |
| GP2[21]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C20          |
| GP2[22]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | F24          |
| GP2[23]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | D21          |
| GP2[24]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C25          |
| GP2[25]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C26          |
| GP2[26]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | C28          |
| GP2[27]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | B28          |
| GP2[28]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | D3           |
| GP2[29]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | E2           |
| GP2[30]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | F5           |
| GP2[31]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | F1           |

**3.3.9.4 GP3****Table 3-24. GP3 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                      | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------|----------|--------------|
| GP3[0]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | F2           |
| GP3[1]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | F3           |
| GP3[2]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | G1           |
| GP3[3]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | G2           |
| GP3[4]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H3           |
| GP3[5]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | G3           |
| GP3[6]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H5           |
| GP3[7]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H6           |
| GP3[8]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | J8           |
| GP3[9]          | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | J1           |
| GP3[10]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H4           |
| GP3[11]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | J9           |
| GP3[12]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | L3           |
| GP3[13]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | K1           |
| GP3[14]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | H2           |
| GP3[15]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | M11          |
| GP3[16]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | L12          |
| GP3[17]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | M10          |
| GP3[18]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | J2           |
| GP3[19]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | K2           |
| GP3[20]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | L2           |
| GP3[21]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | L4           |
| GP3[22]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | L6           |
| GP3[23]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AG4          |
| GP3[24]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AH1          |
| GP3[25]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AH2          |
| GP3[26]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AJ2          |
| GP3[27]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AK1          |
| GP3[28]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | AK2          |

**Table 3-24. GP3 Terminal Functions (continued)**

| SIGNAL NAME [1] | DESCRIPTION [2]                                      | TYPE [3] | AAR BALL [4]            |
|-----------------|------------------------------------------------------|----------|-------------------------|
| GP3[29]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | <a href="#">AL2</a>     |
| GP3[30]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | <a href="#">AL3, M8</a> |
| GP3[31]         | Interrupt-Capable General-Purpose Input/Output (I/O) | I/O      | <a href="#">AJ31</a>    |

### 3.3.10 Ground Pins (VSS)

**Table 3-25. Ground Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                        | TYPE [3] | AAR BALL [4]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| VSS             | Ground (GND)                                                                                                                           | GND      | A1, A31, AA13, AA14, AA15, AA16, AA17, AA18, AA27, AC25, AD24, AD25, AD3, AD4, AD5, AD6, AD7, AE12, AE19, AE20, AE23, AE24, AE25, AE26, AE27, AE28, AE5, AE6, AE7, AE8, AE9, AF12, AF20, AF24, AF25, AF7, AG11, AG19, AG24, AG25, AG7, AH12, AH20, AH7, AL1, AL31, D25, D8, E21, E25, E7, E8, F20, F25, F7, F8, G20, G23, G24, G25, G26, G27, G4, G5, G6, G7, G8, H26, H7, J7, L16, M16, N13, N14, N16, N17, P11, P12, P14, P18, R11, R12, R14, R18, R20, R21, T11, T12, T14, T15, T16, T19, T20, T21, U14, U18, U23, V18, W16, W17, Y16, Y17, Y25, Y26, Y28 |
| VSSA_AUXOSC     | Supply Ground for Auxiliary Oscillator. If internal oscillator is bypassed, this pin should be connected to ground.                    | GND      | U30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| VSSA_CSI2       | Analog GND for CSI2. Connect to ground even if the CSI2 is not being used.                                                             | GND      | AC7, V14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| VSSA_DEVOSC     | Supply Ground for DEV Oscillator. If the internal oscillator is bypassed, this pin should be connected to ground.                      | GND      | G30                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| VSSA_HDMI       | Analog GND for HDMI. For proper device operation, this pin must always be connected to ground, even if HDMI is not being used.         | GND      | G9, H8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| VSSA_USB        | Analog GND for USB0 and USB1. For proper device operation, this pin must always be connected to ground, even if USB is not being used. | GND      | D20, N19, N20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| VSSA_VDAC       | Analog GND for VDAC. For proper device operation, this pin must always be connected to ground, even if VDAC is not being used.         | GND      | C8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |



### 3.3.11 HDMI

**Table 3-26. HDMI Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                             | TYPE [3] | AAR BALL [4] |
|-----------------|---------------------------------------------------------------------------------------------|----------|--------------|
| HDMI_CEC        | HDMI Consumer Electronics Control I/O                                                       | I/O      | M8, N2       |
| HDMI_CLKN       | HDMI Clock Output. When the HDMI PHY is powered down, this pin should be left unconnected.  | O        | B15          |
| HDMI_CLKP       | HDMI Clock Output. When the HDMI PHY is powered down, this pin should be left unconnected.  | O        | A15          |
| HDMI_DN0        | HDMI Data 0 output. When the HDMI PHY is powered down, this pin should be left unconnected. | O        | A14          |
| HDMI_DN1        | HDMI Data 1 output. When the HDMI PHY is powered down, this pin should be left unconnected. | O        | B13          |
| HDMI_DN2        | HDMI Data 2 output. When the HDMI PHY is powered down, this pin should be left unconnected. | O        | A12          |
| HDMI_DP0        | HDMI Data 0 output. When the HDMI PHY is powered down, this pin should be left unconnected. | O        | B14          |
| HDMI_DP1        | HDMI Data 1 output. When the HDMI PHY is powered down, this pin should be left unconnected. | O        | B12          |
| HDMI_DP2        | HDMI Data 2 output. When the HDMI PHY is powered down, this pin should be left unconnected. | O        | A11          |
| HDMI_HPDET      | HDMI Hot Plug Detect Input                                                                  | I        | L6, R8       |
| HDMI_SCL        | HDMI I2C Serial Clock Output                                                                | I/O      | D2, L2       |
| HDMI_SDA        | HDMI I2C Serial Data I/O                                                                    | I/O      | D1, L4       |

### 3.3.12 I2C

**Table 3-27. I2C Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                              | TYPE [3] | AAR BALL [4]       |
|-----------------|--------------------------------------------------------------------------------------------------------------|----------|--------------------|
| I2C[0]_SCL      | I2C[0] Clock I/O. For proper device operation, this pin must be pulled up via external resistor.             | I/O      | T27                |
| I2C[0]_SDA      | I2C[0] Data I/O. For proper device operation, this pin must be pulled up via external resistor.              | I/O      | T24                |
| I2C[1]_SCL      | I2C[1] Clock I/O. For proper device operation in I2C mode, this pin must be pulled up via external resistor. | I/O      | D2                 |
| I2C[1]_SDA      | I2C[1] Data I/O. For proper device operation in I2C mode, this pin must be pulled up via external resistor.  | I/O      | D1                 |
| I2C[2]_SCL      | I2C[2] Clock I/O. For proper device operation in I2C mode, this pin must be pulled up via external resistor. | I/O      | E31, J13, K11, L2  |
| I2C[2]_SDA      | I2C[2] Data I/O. For proper device operation in I2C mode, this pin must be pulled up via external resistor.  | I/O      | AG4, C12, E29, L4  |
| I2C[3]_SCL      | I2C[3] Clock I/O. For proper device operation in I2C mode, this pin must be pulled up via external resistor. | I/O      | AE31, G3, K10, L22 |
| I2C[3]_SDA      | I2C[3] Data I/O. For proper device operation in I2C mode, this pin must be pulled up via external resistor.  | I/O      | AE30, D7, H5, M21  |

### 3.3.13 McASP

#### 3.3.13.1 McASP0

**Table 3-28. McASP0 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                 | TYPE [3] | AAR BALL [4] |
|-----------------|-------------------------------------------------|----------|--------------|
| MCA[0]_ACLKR    | McASP0 Receive Bit Clock I/O                    | I/O      | AD30         |
| MCA[0]_ACLKX    | McASP0 Transmit Bit Clock I/O                   | I/O      | AD28         |
| MCA[0]_AFSR     | McASP0 Receive Frame Sync I/O                   | I/O      | AF30         |
| MCA[0]_AFSX     | McASP0 Transmit Frame Sync I/O                  | I/O      | AE29         |
| MCA[0]_AHCLKX   | McASP0 Transmit High-Frequency Master Clock I/O | I/O      | AF31         |
| MCA[0]_AXR[0]   | McASP0 Transmit/Receive Data I/O                | I/O      | AF29         |
| MCA[0]_AXR[1]   | McASP0 Transmit/Receive Data I/O                | I/O      | AE31         |
| MCA[0]_AXR[2]   | McASP0 Transmit/Receive Data I/O                | I/O      | AE30         |
| MCA[0]_AXR[3]   | McASP0 Transmit/Receive Data I/O                | I/O      | AC31         |
| MCA[0]_AXR[4]   | McASP0 Transmit/Receive Data I/O                | I/O      | AD26         |
| MCA[0]_AXR[5]   | McASP0 Transmit/Receive Data I/O                | I/O      | AD27         |

#### 3.3.13.2 McASP1

**Table 3-29. McASP1 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                 | TYPE [3] | AAR BALL [4] |
|-----------------|-------------------------------------------------|----------|--------------|
| MCA[1]_ACLKR    | McASP1 Receive Bit Clock I/O                    | I/O      | AD29         |
| MCA[1]_ACLKX    | McASP1 Transmit Bit Clock I/O                   | I/O      | AC23         |
| MCA[1]_AFSR     | McASP1 Receive Frame Sync I/O                   | I/O      | AC24         |
| MCA[1]_AFSX     | McASP1 Transmit Frame Sync I/O                  | I/O      | AB22         |
| MCA[1]_AHCLKX   | McASP1 Transmit High-Frequency Master Clock I/O | I/O      | AF27         |
| MCA[1]_AXR[0]   | McASP1 Transmit/Receive Data I/O                | I/O      | Y22          |
| MCA[1]_AXR[1]   | McASP1 Transmit/Receive Data I/O                | I/O      | Y21          |

### 3.3.14 Oscillator/PLL, Audio Reference Clocks, and Clock Generator

#### 3.3.14.1 Audio Reference Clocks

**Table 3-30. Audio Reference Clocks Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                               | TYPE [3] | AAR BALL [4] |
|-----------------|-----------------------------------------------|----------|--------------|
| AUD_CLKIN0      | Audio Reference Clock 0 for Audio Peripherals | I        | AF31         |
| AUD_CLKIN1      | Audio Reference Clock 1 for Audio Peripherals | I        | AF27         |
| AUD_CLKIN2      | Audio Reference Clock 2 for Audio Peripherals | I        | AG30         |

#### 3.3.14.2 CLOCK GENERATOR

**Table 3-31. Clock Generator Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                         | TYPE [3] | AAR BALL [4] |
|-----------------|-------------------------------------------------------------------------|----------|--------------|
| CLKOUT0         | Device Clock output 0. Can be used as a system clock for other devices. | O        | AJ31, H12    |
| CLKOUT1         | Device Clock output 1. Can be used as a system clock for other devices. | O        | AB9, J16     |

#### 3.3.14.3 OSCILLATOR/PLL

**Table 3-32. Oscillator/PLL Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                                                                                                                                        | TYPE [3] | AAR BALL [4] |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| AUXOSC_MXI      | Auxiliary Crystal input [Optional Audio/Video Reference Crystal Input]. Crystal connection to internal oscillator for auxiliary clock. Functions as AUX_CLKIN clock input when an external oscillator is used. If neither a crystal or external clock is used, this pin should be connected to ground. | I        | V30          |
| AUXOSC_MXO      | Auxiliary Crystal output [Optional Audio/Video Reference Crystal Output]. When auxiliary oscillator is BYPASSED, leave this pin unconnected.                                                                                                                                                           | O        | U31          |
| CLKIN32         | RTC Clock input. Optional 32.768 KHz clock for RTC reference.                                                                                                                                                                                                                                          | I        | AJ31         |
| DEVOSC_MXI      | Device Crystal input. Crystal connection to internal oscillator for system clock. Functions as DEV_CLKIN clock input when an external oscillator is used.                                                                                                                                              | I        | F30          |
| DEVOSC_MXO      | Device Crystal output. Crystal connection to internal oscillator for system clock. When device oscillator is BYPASSED, leave this pin unconnected.                                                                                                                                                     | O        | G31          |
| DEVOSC_WAKE     | Oscillator Wake-up input                                                                                                                                                                                                                                                                               | I        | U28          |
| DEV_CLKIN       | Clock input when an external oscillator is used                                                                                                                                                                                                                                                        | I        | F30          |

### 3.3.15 PCI Express (PCIe)

**Table 3-33. PCI Express (PCIe) Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                          | TYPE [3] | AAR BALL [4] |
|-----------------|----------------------------------------------------------------------------------------------------------|----------|--------------|
| PCIE_RXN0       | PCIE Receive Data Lane 0. When the PCIe SERDES are powered down, these pins should be left unconnected.  | I        | J30          |
| PCIE_RXP0       | PCIE Receive Data Lane 0. When the PCIe SERDES are powered down, these pins should be left unconnected.  | I        | K30          |
| PCIE_TXN0       | PCIE Transmit Data Lane 0. When the PCIe SERDES are powered down, these pins should be left unconnected. | O        | K31          |
| PCIE_TXP0       | PCIE Transmit Data Lane 0. When the PCIe SERDES are powered down, these pins should be left unconnected. | O        | L31          |
| SERDES_CLKN     | PCIE Serdes Reference Clock Inputs. When PCIe is not used these pins can be left unconnected.            | I        | H31          |
| SERDES_CLKP     | PCIE Serdes Reference Clock Inputs. When PCIe is not used these pins can be left unconnected.            | I        | H30          |

#### NOTE

PCIe is supported on all DM385 devices and also on DM388 devices with PCIe enabled. For DM388 devices with PCIe disabled, the pins in [Table 3-33](#) should be left unconnected.

### 3.3.16 Reserved Pins

**Table 3-34. Reserved Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                         | TYPE [3] | AAR BALL [4] |
|-----------------|-----------------------------------------------------------------------------------------|----------|--------------|
| RSV0            | Reserved. Leave unconnected, do not connect to power or ground.                         |          | J25          |
| RSV1            | Reserved. Leave unconnected, do not connect to power or ground.                         |          | H27          |
| RSV2            | Reserved. Leave unconnected, do not connect to power or ground.                         |          | H24          |
| RSV27           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | L30          |
| RSV28           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | M30          |
| RSV29           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | N30          |
| RSV3            | Reserved. Leave unconnected, do not connect to power or ground.                         |          | H28          |
| RSV30           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | N31          |
| RSV31           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | P31          |
| RSV32           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | R30          |
| RSV33           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | T30          |
| RSV34           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | AH24         |
| RSV35           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | AJ24         |
| RSV39           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | H25          |
| RSV4            | Reserved. Leave unconnected, do not connect to power or ground.                         | PWR      | G17          |
| RSV40           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | H29          |
| RSV41           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | AD8          |
| RSV42           | Reserved. Leave unconnected, do not connect to power or ground.                         | O        | AK21         |
| RSV43           | Reserved. Leave unconnected, do not connect to power or ground.                         |          | P30          |
| RSV5            | Reserved. Leave unconnected, do not connect to power or ground.                         | PWR      | G16          |
| RSV54           | For proper device operation, this pin must always be connected to a 1.8-V Power Supply. | PWR      | M28          |
| RSV55           | For proper device operation, this pin must always be connected to a 1.8-V Power Supply. | PWR      | N27          |

### 3.3.17 Reset, Interrupts, and JTAG Interface

#### 3.3.17.1 Interrupts

**Table 3-35. Interrupts Terminal Functions**

| SIGNAL NAME [1]         | DESCRIPTION [2]              | TYPE [3] | AAR BALL [4] |
|-------------------------|------------------------------|----------|--------------|
| $\overline{\text{NMI}}$ | Non-Maskable Interrupt input | I        | AH31         |

#### 3.3.17.2 JTAG

**Table 3-36. JTAG Terminal Functions**

| SIGNAL NAME [1]          | DESCRIPTION [2]                                                                                                                                               | TYPE [3] | AAR BALL [4] |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| EMU0                     | Emulator pin 0                                                                                                                                                | I/O      | A18          |
| EMU1                     | Emulator pin 1                                                                                                                                                | I/O      | B19          |
| EMU2                     | Emulator pin 2                                                                                                                                                | I/O      | F24          |
| EMU3                     | Emulator pin 3                                                                                                                                                | I/O      | C25          |
| EMU4                     | Emulator pin 4                                                                                                                                                | I/O      | C28          |
| RTCK                     | JTAG return clock output. The internal pullup (IPU) is enabled for this pin when the device is in reset and the IPU is disabled (DIS) when reset is released. | O        | N29          |
| TCLK                     | JTAG test clock input                                                                                                                                         | I        | T29          |
| TDI                      | JTAG test data input                                                                                                                                          | I        | N28          |
| TDO                      | JTAG test port data output                                                                                                                                    | O        | U26          |
| TMS                      | JTAG test port mode select input. For proper operation, do not oppose the IPU on this pin.                                                                    | I        | T31          |
| $\overline{\text{TRST}}$ | JTAG test port reset input                                                                                                                                    | I        | U24          |

#### 3.3.17.3 Reset

**Table 3-37. Reset Terminal Functions**

| SIGNAL NAME [1]                     | DESCRIPTION [2]                                                                                    | TYPE [3] | AAR BALL [4] |
|-------------------------------------|----------------------------------------------------------------------------------------------------|----------|--------------|
| $\overline{\text{POR}}$             | Power-On Reset input                                                                               | I        | AH30         |
| $\overline{\text{RESET}}$           | Device Reset input                                                                                 | I        | AH29         |
| $\overline{\text{RSTOUT\_WD\_OUT}}$ | Reset output (RSTOUT) or watchdog out (WD_OUT). If this pin is unused, it can be left unconnected. | O        | AJ30         |

### 3.3.18 SD Signals (MMC/SD/SDIO)

#### 3.3.18.1 SD0

**Table 3-38. SD0 Terminal Functions**

| SIGNAL NAME [1]  | DESCRIPTION [2]                                                                                         | TYPE [3] | AAR BALL [4] |
|------------------|---------------------------------------------------------------------------------------------------------|----------|--------------|
| SD0_CLK          | SD0 Clock output                                                                                        | O        | AB30         |
| SD0_CMD          | SD0 Command output                                                                                      | O        | AA29         |
| SD0_DAT[0]       | SD0 Data0 I/O. Functions as data bit 0 for 4-/8-bit SD mode and single data bit for 1-bit SD mode.      | I/O      | AA28         |
| SD0_DAT[3]       | SD0 Data3 I/O. Functions as data bit 3 for 4-/8-bit SD mode.                                            | I/O      | Y30          |
| SD0_DAT[4]       | SD0 Data4 I/O. Functions as data bit 4 for 8-bit SD mode.                                               | I/O      | Y22          |
| SD0_DAT[5]       | SD0 Data5 I/O. Functions as data bit 5 for 8-bit SD mode.                                               | I/O      | Y21          |
| SD0_DAT[6]       | SD0 Data6 I/O. Functions as data bit 6 for 8-bit SD mode.                                               | I/O      | AB31         |
| SD0_DAT[7]       | SD0 Data7 I/O. Functions as data bit 7 for 8-bit SD mode.                                               | I/O      | AC30         |
| SD0_DAT[1]_SDIRQ | SD0 Data1 I/O. Functions as data bit 1 for 4-/8-bit SD mode and as an IRQ input for 1-bit SD mode.      | I/O      | AA26         |
| SD0_DAT[2]_SDRW  | SD0 Data2 I/O. Functions as data bit 2 for 4-/8-bit SD mode and as a Read Wait input for 1-bit SD mode. | I/O      | Y31          |
| SD0_SDCD         | SD0 Card Detect input                                                                                   | I        | D30          |

#### 3.3.18.2 SD1

**Table 3-39. SD1 Terminal Functions**

| SIGNAL NAME [1]  | DESCRIPTION [2]                                                                                         | TYPE [3] | AAR BALL [4] |
|------------------|---------------------------------------------------------------------------------------------------------|----------|--------------|
| SD1_CLK          | SD1 Clock output                                                                                        | O        | W30          |
| SD1_CMD          | SD1 Command output                                                                                      | O        | AA29, Y29    |
| SD1_DAT[0]       | SD1 Data0 I/O. Functions as data bit 0 for 4-/8-bit SD mode and single data bit for 1-bit SD mode.      | I/O      | W31          |
| SD1_DAT[3]       | SD1 Data3 I/O. Functions as data bit 3 for 4-/8-bit SD mode.                                            | I/O      | Y27          |
| SD1_DAT[4]       | SD1 Data4 I/O. Functions as data bit 4 for 8-bit SD mode.                                               | I/O      | AA28         |
| SD1_DAT[5]       | SD1 Data5 I/O. Functions as data bit 5 for 8-bit SD mode.                                               | I/O      | AA26         |
| SD1_DAT[6]       | SD1 Data6 I/O. Functions as data bit 6 for 8-bit SD mode.                                               | I/O      | Y31          |
| SD1_DAT[7]       | SD1 Data7 I/O. Functions as data bit 7 for 8-bit SD mode.                                               | I/O      | Y30          |
| SD1_DAT[1]_SDIRQ | SD1 Data1 I/O. Functions as data bit 1 for 4-/8-bit SD mode and as an IRQ input for 1-bit SD mode.      | I/O      | AA30         |
| SD1_DAT[2]_SDRW  | SD1 Data2 I/O. Functions as data bit 2 for 4-/8-bit SD mode and as a Read Wait input for 1-bit SD mode. | I/O      | U29          |
| SD1_POW          | SD1 Card Power Enable output                                                                            | O        | E31          |
| SD1_SDCD         | SD1 Card Detect input                                                                                   | I        | G28          |
| SD1_SDWP         | SD1 Card Write Protect input                                                                            | I        | E29          |



### 3.3.18.3 SD2

**Table 3-40. SD2Terminal Functions**

| SIGNAL NAME [1]  | DESCRIPTION [2]                                                                                         | TYPE [3] | AAR BALL [4] |
|------------------|---------------------------------------------------------------------------------------------------------|----------|--------------|
| SD2_CMD          | SD2 Command output                                                                                      | O        | AG6          |
| SD2_DAT[0]       | SD2 Data0 I/O. Functions as data bit 0 for 4-/8-bit SD mode and single data bit for 1-bit SD mode.      | O        | AC4          |
| SD2_DAT[3]       | SD2 Data3 I/O. Functions as data bit 3 for 4-/8-bit SD mode.                                            | I/O      | AD1          |
| SD2_DAT[4]       | SD2 Data4 I/O. Functions as data bit 4 for 8-bit SD mode.                                               | I/O      | AD2          |
| SD2_DAT[5]       | SD2 Data5 I/O. Functions as data bit 5 for 8-bit SD mode.                                               | I/O      | AE1          |
| SD2_DAT[6]       | SD2 Data6 I/O. Functions as data bit 6 for 8-bit SD mode.                                               | I/O      | AE2          |
| SD2_DAT[7]       | SD2 Data7 I/O. Functions as data bit 7 for 8-bit SD mode.                                               | I/O      | AE3          |
| SD2_DAT[1]_SDIRQ | SD2 Data1 I/O. Functions as data bit 1 for 4-/8-bit SD mode and as an IRQ input for 1-bit SD mode.      | I/O      | AC5          |
| SD2_DAT[2]_SDRW  | SD2 Data2 I/O. Functions as data bit 2 for 4-/8-bit SD mode and as a Read Wait input for 1-bit SD mode. | I/O      | AC8          |
| SD2_SCLK         | SD2 Clock output                                                                                        | I/O      | AC6          |
| SD2_SDCD         | SD2 Card Detect input                                                                                   | I        | D31          |

### 3.3.19 SPI

#### 3.3.19.1 SPI 0

**Table 3-41. SPI 0 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                         | TYPE [3] | AAR BALL [4] |
|-----------------|---------------------------------------------------------|----------|--------------|
| SPI[0]_D[0]     | SPI Data I/O. Can be configured as either MISO or MOSI. | I/O      | J28          |
| SPI[0]_D[1]     | SPI Data I/O. Can be configured as either MISO or MOSI. | I/O      | J27          |
| SPI[0]_SCLK     | SPI Clock I/O                                           | I/O      | N24          |
| SPI[0]_SCS[0]   | SPI Chip Select I/O                                     | I/O      | G29          |
| SPI[0]_SCS[1]   | SPI Chip Select I/O                                     | I/O      | G28          |
| SPI[0]_SCS[2]   | SPI Chip Select I/O                                     | I/O      | E29          |
| SPI[0]_SCS[3]   | SPI Chip Select I/O                                     | I/O      | E31          |

#### 3.3.19.2 SPI 1

**Table 3-42. SPI 1 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                         | TYPE [3] | AAR BALL [4] |
|-----------------|---------------------------------------------------------|----------|--------------|
| SPI[1]_D[0]     | SPI Data I/O. Can be configured as either MISO or MOSI. | I/O      | N23          |
| SPI[1]_D[1]     | SPI Data I/O. Can be configured as either MISO or MOSI. | I/O      | M27          |
| SPI[1]_SCLK     | SPI Clock I/O                                           | I/O      | M29          |
| SPI[1]_SCS[0]   | SPI Chip Select I/O                                     | I/O      | J29          |
| SPI[1]_SCS[1]   | SPI Chip Select I/O                                     | I/O      | U28          |
| SPI[1]_SCS[2]   | SPI Chip Select I/O                                     | I/O      | D31          |
| SPI[1]_SCS[3]   | SPI Chip Select I/O                                     | I/O      | D30          |

#### 3.3.19.3 SPI 2

**Table 3-43. SPI 2 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                         | TYPE [3] | AAR BALL [4] |
|-----------------|---------------------------------------------------------|----------|--------------|
| SPI[2]_D[0]     | SPI Data I/O. Can be configured as either MISO or MOSI. | I/O      | AK6, M8, N1  |
| SPI[2]_D[1]     | SPI Data I/O. Can be configured as either MISO or MOSI. | I/O      | AL6, L6, N2  |
| SPI[2]_SCLK     | SPI Clock I/O                                           | I/O      | AJ6, L4, R8  |
| SPI[2]_SCS[0]   | SPI Chip Select I/O                                     | I/O      | AF2          |
| SPI[2]_SCS[1]   | SPI Chip Select I/O                                     | I/O      | N9           |
| SPI[2]_SCS[2]   | SPI Chip Select I/O                                     | I/O      | L2           |
| SPI[2]_SCS[3]   | SPI Chip Select I/O                                     | I/O      | AK5          |

#### 3.3.19.4 SPI 3

**Table 3-44. SPI 3 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                         | TYPE [3] | AAR BALL [4] |
|-----------------|---------------------------------------------------------|----------|--------------|
| SPI[3]_D[0]     | SPI Data I/O. Can be configured as either MISO or MOSI. | I/O      | A5, F5, M10  |
| SPI[3]_D[1]     | SPI Data I/O. Can be configured as either MISO or MOSI. | I/O      | A6, E2, L12  |

**Table 3-44. SPI 3 Terminal Functions (continued)**

| SIGNAL NAME [1] | DESCRIPTION [2]     | TYPE [3] | AAR BALL [4]                 |
|-----------------|---------------------|----------|------------------------------|
| SPI[3]_SCLK     | SPI Clock I/O       | I/O      | <a href="#">C20, C7, M11</a> |
| SPI[3]_SCS[0]   | SPI Chip Select I/O | I/O      | <a href="#">F9</a>           |
| SPI[3]_SCS[1]   | SPI Chip Select I/O | I/O      | <a href="#">H2</a>           |
| SPI[3]_SCS[2]   | SPI Chip Select I/O | I/O      | <a href="#">AK1</a>          |
| SPI[3]_SCS[3]   | SPI Chip Select I/O | I/O      | <a href="#">AG4</a>          |

### 3.3.20 Supply Voltages

**Table 3-45. Supply Voltages Terminal Functions**

| SIGNAL NAME [1]   | DESCRIPTION [2]                                                                                                                                                                | TYPE [3] | AAR BALL [4]                                                                                                      |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-------------------------------------------------------------------------------------------------------------------|
| CVDD              | Variable Voltage Supply for the CORE_L Core Logic Voltage Domain                                                                                                               | PWR      | P15, P17, R15, R17, T13, T17, T18, U11, U12, U15, U17, V11, V12, V15, V17, W13, W14, W19, W20, Y13, Y14, Y19, Y20 |
| CVDD_ARM          | Variable Voltage Supply for the ARM_L Core Logic Voltage Domain. For actual voltage supply ranges, see Recommended Operating Conditions.                                       | PWR      | K17, L17, L18, M13, M14, M17                                                                                      |
| CVDD_HDVICP       | Variable Voltage Supply for the HDVICP_L Core Logic Voltage Domain. For actual voltage supply ranges, see Recommended Operating Conditions.                                    | PWR      | U20, U21, V20, V21, W22                                                                                           |
| DVDD              | 3.3 V/1.8 V Power Supply for General I/Os                                                                                                                                      | PWR      | D16, E17, F16, L5, M4, M6, M7, N10, N11, T26, T28, U27                                                            |
| DVDD_C            | 3.3 V/1.8 V Power Supply for Camera I/F I/Os. For proper device operation, this pin must always be connected to a DVDD Power Supply, even if the Camera I/F is not being used. | PWR      | D12, E13, F12, G12, G13                                                                                           |
| DVDD_DDR[0]       | 1.35 V/1.5 V/1.8 V Power Supply for DDR[0] I/Os                                                                                                                                | PWR      | AB14, AB15, AB17, AB18, AC15, AC17, AC18, AE15, AE16, AF16, AG15, AH16                                            |
| DVDD_GPMC         | 3.3 V/1.8 V Power Supply for GPMC I/Os. For proper device operation, this pin must always be connected to a DVDD Power Supply, even if the GPMC is not being used.             | PWR      | R5, R7, T4, T6, T7                                                                                                |
| DVDD_RGMII        | 3.3 V/1.8 V Power Supply for RGMII I/Os. For proper device operation, this pin must always be connected to a DVDD Power Supply, even if the RGMII is not being used.           | PWR      | W5, W7, Y4, Y6, Y7                                                                                                |
| DVDD_SD           | 3.3 V/1.8 V Power Supply for MMC/SD/SDIO I/Os. For proper device operation, this pin must always be connected to a DVDD Power Supply, even if the interface is not being used. | PWR      | T25, U25                                                                                                          |
| LDOCAP_ARM        | ARM Cortex-A8 VBB LDO output. This pin must always be connected via a 1-uF capacitor to VSS.                                                                                   | A        | J19                                                                                                               |
| LDOCAP_ARMRAM     | ARM Cortex-A8 RAM LDO output. This pin must always be connected via a 1-uF capacitor to VSS.                                                                                   | A        | K20                                                                                                               |
| LDOCAP_HDVICP     | HDVICP2 VBB LDO output. This pin must always be connected via a 1-uF capacitor to VSS.                                                                                         | A        | W23                                                                                                               |
| LDOCAP_HDVICPRAM  | HDVICP2 RAM LDO output. This pin must always be connected via a 1-uF capacitor to VSS.                                                                                         | A        | Y24                                                                                                               |
| LDOCAP_RAM0       | CORE RAM0 LDO output. This pin must always be connected via a 1-uF capacitor to VSS.                                                                                           | A        | U9                                                                                                                |
| LDOCAP_RAM1       | CORE RAM1 LDO output. This pin must always be connected via a 1-uF capacitor to VSS.                                                                                           | A        | T22                                                                                                               |
| LDOCAP_RAM2       | CORE RAM2 LDO output. This pin must always be connected via a 1-uF capacitor to VSS.                                                                                           | A        | AB10                                                                                                              |
| LDOCAP_SERDESCLK  | SERDES_CLKP/N Pins LDO output. This pin must always be connected via a 1-uF capacitor to VSS.                                                                                  | A        | M24                                                                                                               |
| VDDA_1P8          | 1.8 V Power Supply for on-chip LDOs and I/O biasing                                                                                                                            | PWR      | M25, N22, N25, P23, R9, T10, T9                                                                                   |
| VDDA_ARMPLL_1P8   | 1.8 V Analog Power Supply for PLL_ARM                                                                                                                                          | PWR      | L19                                                                                                               |
| VDDA_AUDIOPLL_1P8 | 1.8 V Analog Power Supply for PLL_AUDIO and PLL_HDVPSS. For proper device operation, this pin must always be connected to a 1.8-V Power Supply.                                | PWR      | V9                                                                                                                |

**Table 3-45. Supply Voltages Terminal Functions (continued)**

| SIGNAL NAME [1]   | DESCRIPTION [2]                                                                                                                                                                                                                                                               | TYPE [3] | AAR BALL [4] |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| VDDA_CSI2_1P8     | 1.8 V Analog Power Supply for CSI2. For proper device operation, this pin must always be connected to a 1.8-V Power Supply, even if the CSI2 is not being used.                                                                                                               | PWR      | W10          |
| VDDA_DDRPLL_1P8   | 1.8 V Analog Power Supply for PLL_DDR                                                                                                                                                                                                                                         | PWR      | AA19         |
| VDDA_HDDACREF_1P8 | 1.8 V Reference Power Supply for HDDAC. For proper device operation, this pin must always be connected to a 1.8-V Power Supply, even if the HDDAC is not being used.                                                                                                          | PWR      | L15          |
| VDDA_HDDAC_1P1    | 1.1 V Power Supply for HD-DAC Digital Logic. For proper device operation, this pin must always be connected to a 1.1-V Power Supply, or if the HD-DAC is not being used it can be connected to a power supply in the range of 0.9–1.35 V (same level as other core voltages). | PWR      | K16          |
| VDDA_HDDAC_1P8    | 1.8 V Power Supply for HDDAC Analog Circuit. For proper device operation, this pin must always be connected to a 1.8-V Power Supply, even if the HDDAC is not being used.                                                                                                     | PWR      | L14          |
| VDDA_HDMI_1P8     | 1.8 V Analog Power Supply for HDMI. For proper device operation, this pin must always be connected to a 1.8-V Power Supply, even if the HDMI is not being used.                                                                                                               | PWR      | K14          |
| VDDA_HDVICPLL_1P8 | 1.8 V Analog Power Supply for PLL_HDVICP. For proper device operation, this pin must always be connected to a 1.8-V Power Supply, even if the HDVICP2 is not being used.                                                                                                      | PWR      | T23          |
| VDDA_L3L4PLL_1P8  | 1.8 V Analog Power Supply for PLL_L3L4                                                                                                                                                                                                                                        | PWR      | W11          |
| VDDA_PCIE_1P8     | 1.8 V Analog Power Supply for PCIe. For proper device operation, this pin must always be connected to a 1.8-V Power Supply, even if the PCIe is not being used.                                                                                                               | PWR      | M26          |
| VDDA_USB0_1P8     | 1.8 V Analog Power Supply for USB0. For proper device operation, this pin must always be connected to a 1.8-V Power Supply, even if the USB0 is not being used.                                                                                                               | PWR      | K19          |
| VDDA_USB1_1P8     | 1.8 V Analog Power Supply for USB1. For proper device operation, this pin must always be connected to a 1.8-V Power Supply, even if the USB1 is not being used.                                                                                                               | PWR      | J17          |
| VDDA_USB_3P3      | 3.3 V Analog Power Supply for USB0 and USB1. For proper device operation, this pin must always be connected to a 3.3-V Power Supply, even if USB0 and USB1 are not being used.                                                                                                | PWR      | M19, M20     |
| VDDA_VDAC_1P8     | 1.8 V Reference Power Supply for VDAC. For proper device operation, this pin must always be connected to a 1.8-V Power Supply, even if the VDAC is not being used.                                                                                                            | PWR      | J14          |
| VDDA_VIDPLL_1P8   | 1.8 V Analog Power Supply for PLL_VIDEO0 and PLL_VIDEO1. For proper device operation, this pin must always be connected to a 1.8-V Power Supply.                                                                                                                              | PWR      | L13          |
| VDDS_OSC0_1P8     | Oscillator0 IO secondary supply and LJCBO LDO supply                                                                                                                                                                                                                          | PWR      | P21          |
| VDDS_OSC1_1P8     | Oscillator1 IO secondary power supply                                                                                                                                                                                                                                         | PWR      | P20          |
| VREFSSTL_DDR[0]   | Reference Power Supply DDR[0]                                                                                                                                                                                                                                                 | PWR      | AL18         |

### 3.3.21 Timer

**Table 3-46. Timer Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                           | TYPE [3] | AAR BALL [4]   |
|-----------------|-------------------------------------------|----------|----------------|
| TIM2_IO         | Timer 2 capture event input or PWM output | I/O      | AF27, AG1, M3  |
| TIM3_IO         | Timer 3 capture event input or PWM output | I/O      | AG30, AJ31, M5 |
| TIM4_IO         | Timer 4 capture event input or PWM output | I/O      | AB9, G28, N2   |
| TIM5_IO         | Timer 5 capture event input or PWM output | I/O      | AA10, R8, U28  |
| TIM6_IO         | Timer 6 capture event input or PWM output | I/O      | AE1, F1, Y3    |
| TIM7_IO         | Timer 7 capture event input or PWM output | I/O      | AD2, C20, Y11  |

### 3.3.22 UART

#### 3.3.22.1 UART0

**Table 3-47. UART0 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                           | TYPE [3] | AAR BALL [4] |
|-----------------|---------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| UART0_CTS       | UART0 Clear to Send Input. Functions as SD transceiver control output in IrDA and CIR modes.                              | I/O      | D30          |
| UART0_DCD       | UART0 Data Carrier Detect Input                                                                                           | I        | E31          |
| UART0_DSR       | UART0 Data Set Ready Input                                                                                                | I        | E29          |
| UART0_DTR       | UART0 Data Terminal Ready Output                                                                                          | O        | E30          |
| UART0_RIN       | UART0 Ring Indicator Input                                                                                                | I        | N26          |
| UART0_RTS       | UART0 Request to Send Output. Indicates module is ready to receive data. Functions as transmit data output in IrDA modes. | O        | D31          |
| UART0_RXD       | UART0 Receive Data Input. Functions as IrDA receive input in IrDA modes and CIR receive input in CIR mode.                | I        | J26          |
| UART0_TXD       | UART0 Transmit Data Output. Functions as CIR transmit output in CIR mode.                                                 | O        | E28          |

#### 3.3.22.2 UART1

**Table 3-48. UART1 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                 | TYPE [3] | AAR BALL [4] |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| UART1_CTS       | UART1 Clear to Send Input. Functions as SD transceiver control output in IrDA and CIR modes.                                    | I/O      | AG8          |
| UART1_RTS       | UART1 Request to Send Output. Indicates module is ready to receive data. Functions as transmit data output in IrDA modes.       | O        | AF8          |
| UART1_RXD       | UART1 Receive Data Input. Functions as IrDA receive input in IrDA modes and CIR receive input in CIR mode. (N26:MUX0, AJ8:MUX1) | I        | AJ8, N26     |
| UART1_TXD       | UART1 Transmit Data Output. Functions as CIR transmit output in CIR mode. (E30:MUX0, AH8:MUX1)                                  | O        | AH8, E30     |

#### 3.3.22.3 UART2

**Table 3-49. UART2 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                          | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| UART2_CTS       | UART2 Clear to Send Input. Functions as SD transceiver control output in IrDA and CIR modes.                                             | I/O      | J10          |
| UART2_RTS       | UART2 Request to Send Output. Indicates module is ready to receive data. Functions as transmit data output in IrDA modes.                | O        | B3           |
| UART2_RXD       | UART2 Receive Data Input. Functions as IrDA receive input in IrDA modes and CIR receive input in CIR mode. (D5:MUX0, L22:MUX1, AE3:MUX3) | I        | AE3, D5, L22 |
| UART2_TXD       | UART2 Transmit Data Output. Functions as CIR transmit output in CIR mode. (H9:MUX0, M21:MUX1, AE2:MUX3)                                  | O        | AE2, H9, M21 |

### 3.3.23 USB

#### 3.3.23.1 USB0

**Table 3-50. USB0 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                                                                                                                        | TYPE [3] | AAR BALL [4] |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| USB0_CE         | USB0 charger enable. When the USB0 PHY is powered down, this pin should be left unconnected.                                                                                                                                                                                           | O        | B20          |
| USB0_DM         | USB0 bidirectional data differential signal pair [plus/minus]. When the USB0 PHY is powered down, this pin should be left unconnected.                                                                                                                                                 | I/O      | B21          |
| USB0_DP         | USB0 bidirectional data differential signal pair [plus/minus]. When the USB0 PHY is powered down, this pin should be left unconnected.                                                                                                                                                 | I/O      | A21          |
| USB0_DRVVBUS    | USB0 Controller VBUS Control output. When this pin is used as USB0_DRVVBUS and the USB0 Controller is operating as a Host, this signal is used by the USB0 Controller to enable the external VBUS charge pump. When the USB0 PHY is powered down, this pin should be left unconnected. | O        | K23          |
| USB0_ID         | USB0 identification input. When the USB0 PHY is powered down, this pin should be left unconnected.                                                                                                                                                                                     | I        | A20          |
| USB0_VBUSIN     | 5-V USB0 VBUS comparator input. This analog input pin senses the level of the USB VBUS voltage and should connect directly to the USB VBUS voltage. When the USB0 PHY is powered down, this pin should be left unconnected.                                                            | I        | B22          |

#### 3.3.23.2 USB1

**Table 3-51. USB1 Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                                                                                                                        | TYPE [3] | AAR BALL [4] |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| USB1_CE         | USB1 charger enable. When the USB1 PHY is powered down, this pin should be left unconnected.                                                                                                                                                                                           | O        | C21          |
| USB1_DM         | USB1 bidirectional data differential signal pair [plus/minus]. When the USB1 PHY is powered down, this pin should be left unconnected.                                                                                                                                                 | I/O      | B23          |
| USB1_DP         | USB1 bidirectional data differential signal pair [plus/minus]. When the USB1 PHY is powered down, this pin should be left unconnected.                                                                                                                                                 | I/O      | A23          |
| USB1_DRVVBUS    | USB1 Controller VBUS Control output. When this pin is used as USB1_DRVVBUS and the USB1 Controller is operating as a Host, this signal is used by the USB1 Controller to enable the external VBUS charge pump. When the USB1 PHY is powered down, this pin should be left unconnected. | O        | AF31         |
| USB1_ID         | USB1 identification input. When the USB1 PHY is powered down, this pin should be left unconnected.                                                                                                                                                                                     | I        | A24          |
| USB1_VBUSIN     | 5-V USB1 VBUS comparator input. This analog input pin senses the level of the USB VBUS voltage and should connect directly to the USB VBUS voltage. When the USB1 PHY is powered down, this pin should be left unconnected.                                                            | I        | B24          |



### 3.3.24 Video Input (Digital)

#### 3.3.24.1 Video Input 0 (Digital)

**Table 3-52. Video Input 0 (Digital) Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                   | TYPE [3] | AAR BALL [4] |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| VIN[0]A_CLK     | Video Input 0 Port A Clock input. Input clock for 8-bit, 16-bit, or 24-bit Port A video capture.                                                                                  | I        | C9           |
| VIN[0]A_D[0]    | Video Input 0 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B data inputs. | I        | B18          |
| VIN[0]A_D[1]    | Video Input 0 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B data inputs. | I        | A17          |
| VIN[0]A_D[2]    | Video Input 0 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B data inputs. | I        | B17          |
| VIN[0]A_D[3]    | Video Input 0 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B data inputs. | I        | C17          |
| VIN[0]A_D[4]    | Video Input 0 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B data inputs. | I        | D17          |
| VIN[0]A_D[5]    | Video Input 0 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B data inputs. | I        | F17          |
| VIN[0]A_D[6]    | Video Input 0 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B data inputs. | I        | L20          |
| VIN[0]A_D[7]    | Video Input 0 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B data inputs. | I        | H20          |
| VIN[0]A_D[16]   | Video Input 0 Data inputs. For RGB capture, D[23:16] are R data inputs.                                                                                                           | I        | K11          |
| VIN[0]A_D[17]   | Video Input 0 Data inputs. For RGB capture, D[23:16] are R data inputs.                                                                                                           | I        | E12          |
| VIN[0]A_D[18]   | Video Input 0 Data inputs. For RGB capture, D[23:16] are R data inputs.                                                                                                           | I        | K10          |
| VIN[0]A_D[19]   | Video Input 0 Data inputs. For RGB capture, D[23:16] are R data inputs.                                                                                                           | I        | D7           |
| VIN[0]A_D[20]   | Video Input 0 Data inputs. For RGB capture, D[23:16] are R data inputs.                                                                                                           | I        | F9           |
| VIN[0]A_D[21]   | Video Input 0 Data inputs. For RGB capture, D[23:16] are R data inputs.                                                                                                           | I        | C7           |
| VIN[0]A_D[22]   | Video Input 0 Data inputs. For RGB capture, D[23:16] are R data inputs.                                                                                                           | I        | A6           |
| VIN[0]A_D[23]   | Video Input 0 Data inputs. For RGB capture, D[23:16] are R data inputs.                                                                                                           | I        | A5           |
| VIN[0]A_DE      | Video Input 0 Port A Data Enable input. Discrete data valid signal for Port A RGB capture mode or YCbCr capture without embedded syncs (BT.601 modes).                            | I        | B5, C12      |

**Table 3-52. Video Input 0 (Digital) Terminal Functions (continued)**

| <b>SIGNAL NAME [1]</b> | <b>DESCRIPTION [2]</b>                                                                                                                                                                                      | <b>TYPE [3]</b> | <b>AAR BALL [4]</b> |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------|
| VIN[0]A_D[10]_BD[2]    | Video Input 0 Data inputs. For 16-bit capture, D[15:8] are Y Port A inputs. For 8-bit capture, D[15:8] are Port B YCbCr data inputs. For RGB capture, D[15:8] are G data inputs.                            | I               | E16                 |
| VIN[0]A_D[11]_BD[3]    | Video Input 0 Data inputs. For 16-bit capture, D[15:8] are Y Port A inputs. For 8-bit capture, D[15:8] are Port B YCbCr data inputs. For RGB capture, D[15:8] are G data inputs.                            | I               | H17                 |
| VIN[0]A_D[12]_BD[4]    | Video Input 0 Data inputs. For 16-bit capture, D[15:8] are Y Port A inputs. For 8-bit capture, D[15:8] are Port B YCbCr data inputs. For RGB capture, D[15:8] are G data inputs.                            | I               | J16                 |
| VIN[0]A_D[13]_BD[5]    | Video Input 0 Data inputs. For 16-bit capture, D[15:8] are Y Port A inputs. For 8-bit capture, D[15:8] are Port B YCbCr data inputs. For RGB capture, D[15:8] are G data inputs.                            | I               | H16                 |
| VIN[0]A_D[14]_BD[6]    | Video Input 0 Data inputs. For 16-bit capture, D[15:8] are Y Port A inputs. For 8-bit capture, D[15:8] are Port B YCbCr data inputs. For RGB capture, D[15:8] are G data inputs.                            | I               | F13                 |
| VIN[0]A_D[15]_BD[7]    | Video Input 0 Data inputs. For 16-bit capture, D[15:8] are Y Port A inputs. For 8-bit capture, D[15:8] are Port B YCbCr data inputs. For RGB capture, D[15:8] are G data inputs.                            | I               | H13                 |
| VIN[0]A_D[8]_BD[0]     | Video Input 0 Data inputs. For 16-bit capture, D[15:8] are Y Port A inputs. For 8-bit capture, D[15:8] are Port B YCbCr data inputs. For RGB capture, D[15:8] are G data inputs.                            | I               | B16                 |
| VIN[0]A_D[9]_BD[1]     | Video Input 0 Data inputs. For 16-bit capture, D[15:8] are Y Port A inputs. For 8-bit capture, D[15:8] are Port B YCbCr data inputs. For RGB capture, D[15:8] are G data inputs.                            | I               | C16                 |
| VIN[0]A_FLD            | Video Input 0 Port A Field ID input. Discrete field identification signal for Port A RGB capture mode or YCbCr capture without embedded syncs (BT.601 modes).                                               | I               | B4, J13             |
| VIN[0]A_HSYNC          | Video Input 0 Port A Horizontal Sync0 input. Discrete horizontal synchronization signal for Port A RGB capture mode or YCbCr capture without embedded syncs (BT.601 modes).                                 | I               | D13                 |
| VIN[0]A_VSYNC          | Video Input 0 Port A Vertical Sync0 input. Discrete vertical synchronization signal for Port A RGB capture mode or YCbCr capture without embedded syncs (BT.601 modes).                                     | I               | C13                 |
| VIN[0]B_CLK            | Video Input 0 Port B Clock input. Input clock for 8-bit Port B video capture. This signal is not used in 16-bit and 24-bit capture modes.                                                                   | I               | H12                 |
| VIN[0]B_DE             | Video Input 0 Port B Data Enable input. Discrete data valid signal for Port B RGB capture mode or YCbCr capture without embedded syncs (BT.601 modes).                                                      | I               | C5                  |
| VIN[0]B_FLD            | Video Input 0 Port B Field ID input. Discrete field identification signal for Port B 8-bit YCbCr capture without embedded syncs (BT.601 modes). Not used in RGB or 16-bit YCbCr capture modes.              | I               | A3                  |
| VIN[0]B_HSYNC          | Video Input 0 Port B Horizontal Sync input. Discrete horizontal synchronization signal for Port B 8-bit YCbCr capture without embedded syncs (BT.601 modes). Not used in RGB or 16-bit YCbCr capture modes. | I               | C12                 |
| VIN[0]B_VSYNC          | Video Input 0 Port B Vertical Sync1 input. Discrete vertical synchronization signal for Port B 8-bit YCbCr capture without embedded syncs (BT.601 modes). Not used in RGB or 16-bit YCbCr capture modes.    | I               | J13                 |

### 3.3.24.2 Video Input 1 (Digital)

**Table 3-53. Video Input 1 (Digital) Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                          | TYPE [3] | AAR BALL [4] |
|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| VIN[1]A_CLK     | Video Input 1 Port A Clock input. Input clock for 8-bit, 16-bit, or 24-bit Port A video capture. Input data is sampled on the CLK0 edge.                                                 | I        | F1           |
| VIN[1]A_D[0]    | Video Input 1 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B Port A data inputs. | I        | F2           |
| VIN[1]A_D[1]    | Video Input 1 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B Port A data inputs. | I        | F3           |
| VIN[1]A_D[2]    | Video Input 1 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B Port A data inputs. | I        | G1           |
| VIN[1]A_D[3]    | Video Input 1 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B Port A data inputs. | I        | G2           |
| VIN[1]A_D[4]    | Video Input 1 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B Port A data inputs. | I        | H3           |
| VIN[1]A_D[5]    | Video Input 1 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B Port A data inputs. | I        | G3           |
| VIN[1]A_D[6]    | Video Input 1 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B Port A data inputs. | I        | H5           |
| VIN[1]A_D[7]    | Video Input 1 Data inputs. For 16-bit capture, D[7:0] are Cb/Cr Port A inputs. For 8-bit capture, D[7:0] are Port A YCbCr data inputs. For RGB capture, D[7:0] are B Port A data inputs. | I        | M8           |
| VIN[1]A_D[8]    | Video Input 1 Data inputs. For 16-bit capture, [15:8] are Y Port A inputs. For RGB capture, D[15:8] are G Port A data inputs.                                                            | I        | H6           |
| VIN[1]A_D[9]    | Video Input 1 Data inputs. For 16-bit capture, [15:8] are Y Port A inputs. For RGB capture, D[15:8] are G Port A data inputs.                                                            | I        | J8           |
| VIN[1]A_D[10]   | Video Input 1 Data inputs. For 16-bit capture, [15:8] are Y Port A inputs. For RGB capture, D[15:8] are G Port A data inputs.                                                            | I        | J1           |
| VIN[1]A_D[11]   | Video Input 1 Data inputs. For 16-bit capture, [15:8] are Y Port A inputs. For RGB capture, D[15:8] are G Port A data inputs.                                                            | I        | H4           |
| VIN[1]A_D[12]   | Video Input 1 Data inputs. For 16-bit capture, [15:8] are Y Port A inputs. For RGB capture, D[15:8] are G Port A data inputs.                                                            | I        | J9           |
| VIN[1]A_D[13]   | Video Input 1 Data inputs. For 16-bit capture, [15:8] are Y Port A inputs. For RGB capture, D[15:8] are G Port A data inputs.                                                            | I        | L3           |
| VIN[1]A_D[14]   | Video Input 1 Data inputs. For 16-bit capture, [15:8] are Y Port A inputs. For RGB capture, D[15:8] are G Port A data inputs.                                                            | I        | K1           |
| VIN[1]A_D[15]   | Video Input 1 Data inputs. For 16-bit capture, [15:8] are Y Port A inputs. For RGB capture, D[15:8] are G Port A data inputs.                                                            | I        | H2           |

**Table 3-53. Video Input 1 (Digital) Terminal Functions (continued)**

| <b>SIGNAL NAME [1]</b> | <b>DESCRIPTION [2]</b>                                                                                                                                                            | <b>TYPE [3]</b> | <b>AAR BALL [4]</b> |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------|
| VIN[1]A_D[16]          | Video Input 1 Data inputs. For RGB capture, D[23:16] are R Port A data inputs.                                                                                                    | I               | M11                 |
| VIN[1]A_D[17]          | Video Input 1 Data inputs. For RGB capture, D[23:16] are R Port A data inputs.                                                                                                    | I               | L12                 |
| VIN[1]A_D[18]          | Video Input 1 Data inputs. For RGB capture, D[23:16] are R Port A data inputs.                                                                                                    | I               | M10                 |
| VIN[1]A_D[19]          | Video Input 1 Data inputs. For RGB capture, D[23:16] are R Port A data inputs.                                                                                                    | I               | J2                  |
| VIN[1]A_D[20]          | Video Input 1 Data inputs. For RGB capture, D[23:16] are R Port A data inputs.                                                                                                    | I               | K2                  |
| VIN[1]A_D[21]          | Video Input 1 Data inputs. For RGB capture, D[23:16] are R Port A data inputs.                                                                                                    | I               | L2                  |
| VIN[1]A_D[22]          | Video Input 1 Data inputs. For RGB capture, D[23:16] are R Port A data inputs.                                                                                                    | I               | L4                  |
| VIN[1]A_D[23]          | Video Input 1 Data inputs. For RGB capture, D[23:16] are R Port A data inputs.                                                                                                    | I               | L6                  |
| VIN[1]A_DE             | Video Input 1 Port A Data Enable input. Discrete data valid signal for Port A YCbCr capture modes without embedded syncs (BT.601 modes).                                          | I               | F5                  |
| VIN[1]A_FLD            | Video Input 1 Port A Field ID input. Discrete field identification signal for Port A YCbCr capture modes without embedded syncs (BT.601 modes).                                   | I               | F5                  |
| VIN[1]A_HSYNC          | Video Input 1 Port A Horizontal Sync input. Discrete horizontal synchronization signal for Port A YCbCr capture modes without embedded syncs (BT.601 modes).                      | I               | D3                  |
| VIN[1]A_VSYNC          | Video Input 1 Port A Vertical Sync input. Discrete vertical synchronization signal for Port A YCbCr capture modes without embedded syncs (BT.601 modes).                          | I               | E2                  |
| VIN[1]B_CLK            | Video Input 1 Port B Clock input. Input clock for 8-bit Port B video capture. Input data is sampled on the CLK1 edge. This signal is not used in 16-bit and 24-bit capture modes. | I               | AF2                 |
| VIN[1]B_D[0]           | Video Input Port B Data inputs. For 8-bit capture, B_D[7:0] are Port B YCbCr data inputs.                                                                                         | I               | AG4                 |
| VIN[1]B_D[1]           | Video Input Port B Data inputs. For 8-bit capture, B_D[7:0] are Port B YCbCr data inputs.                                                                                         | I               | AH1                 |
| VIN[1]B_D[2]           | Video Input Port B Data inputs. For 8-bit capture, B_D[7:0] are Port B YCbCr data inputs.                                                                                         | I               | AH2                 |
| VIN[1]B_D[3]           | Video Input Port B Data inputs. For 8-bit capture, B_D[7:0] are Port B YCbCr data inputs.                                                                                         | I               | AJ2                 |
| VIN[1]B_D[4]           | Video Input Port B Data inputs. For 8-bit capture, B_D[7:0] are Port B YCbCr data inputs.                                                                                         | I               | AK1                 |
| VIN[1]B_D[5]           | Video Input Port B Data inputs. For 8-bit capture, B_D[7:0] are Port B YCbCr data inputs.                                                                                         | I               | AK2                 |
| VIN[1]B_D[6]           | Video Input Port B Data inputs. For 8-bit capture, B_D[7:0] are Port B YCbCr data inputs.                                                                                         | I               | AL2                 |
| VIN[1]B_D[7]           | Video Input Port B Data inputs. For 8-bit capture, B_D[7:0] are Port B YCbCr data inputs.                                                                                         | I               | AL3                 |

### 3.3.25 Video Output (Analog, TV)

**Table 3-54. Video Output (Analog, TV) Terminal Functions**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | TYPE [3] | AAR BALL [4] |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| HDDAC_A         | Analog HD Video DAC (G/Y). This pin should be connected to ground through a 165-ohm resistor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                | O        | A9           |
| HDDAC_B         | Analog HD Video DAC (B/Pb). This pin should be connected to ground through a 165-ohm resistor.                                                                                                                                                                                                                                                                                                                                                                                                                                                               | O        | A8           |
| HDDAC_C         | Analog HD Video DAC (R/Pr). This pin should be connected to ground through a 165-ohm resistor.                                                                                                                                                                                                                                                                                                                                                                                                                                                               | O        | B8           |
| HDDAC_HSYNC     | Analog HD Video DAC Discrete HSYNC Output                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | O        | E9           |
| HDDAC_IREF      | Video DAC reference current. When the video DACs are used, this pin should be connected to ground through a 2.67K-ohm resistor. When the video DACs are powered down, this pin should be left unconnected.                                                                                                                                                                                                                                                                                                                                                   | I/O      | B6           |
| HDDAC_VREF      | Video DAC reference voltage. When the video DACs are powered down, this pin should be left unconnected.                                                                                                                                                                                                                                                                                                                                                                                                                                                      | I        | B7           |
| HDDAC_VSYNC     | Analog HD Video DAC Discrete VSYNC Output                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | O        | D9           |
| TV_OUT0         | Composite Amplifier Output. In <b>Normal mode</b> (internal amplifier used), this pin drives the 75-Ohm TV load. An external resistor (Rout) should be connected between this pin and the TV_VFB0 pin and be placed as close to the pins as possible. The nominal value of Rout is 2700 Ohm. In <b>TVOUT Bypass mode</b> (internal amplifier not used), this pin is not used. When this pin is not used or the TV output is powered-down, this pin should be left unconnected.                                                                               | O        | B9           |
| TV_RSET         | TV Input Reference Current Setting. An external resistor (Rset) should be connected between this pin and VSSA_VDAC to set the reference current of the video DAC. The value of the resistor depends on the mode of operation. In <b>Normal mode</b> (internal amplifier used), the nominal value for Rset is 4700 Ohm. In <b>TVOUT Bypass mode</b> (internal amplifier not used), the nominal value for Rset is 10000 Ohm. When the TV output is not used, this pin should be connected to ground (VSS).                                                     | A        | B11          |
| TV_VFB0         | Composite Feedback. In <b>Normal mode</b> (internal amplifier used), this pin acts as the buffer feedback node. An external resistor (Rout) should be connected between this pin and the TV_OUT0 pin. In <b>TVOUT Bypass mode</b> (internal amplifier not used), this pin acts as the direct Video DAC output and should be connected to ground through a load resistor (Rload) and to an external video amplifier. The nominal value of Rload is 1500 Ohm. When this pin is not used or the TV output is powered-down, this pin should be left unconnected. | O        | B10          |

### 3.3.26 Video Output (Digital)

#### 3.3.26.1 Video Output 0 (Digital)

**Table 3-55. Video Output 0 (Digital) Terminal Functions**

| SIGNAL NAME [1]   | DESCRIPTION [2]                                                                                                                                                                                                                                                                 | TYPE [3] | AAR BALL [4] |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| VOUT[0]_AVID      | Video Output Active Video output. This is the discrete active video indicator output. This signal is not used for embedded sync modes.                                                                                                                                          | O        | C20          |
| VOUT[0]_B_CB_C[2] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.               | O        | F24          |
| VOUT[0]_B_CB_C[3] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.               | O        | D21          |
| VOUT[0]_B_CB_C[4] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.               | O        | J23          |
| VOUT[0]_B_CB_C[5] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.               | O        | H23          |
| VOUT[0]_B_CB_C[6] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.               | O        | J24          |
| VOUT[0]_B_CB_C[7] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.               | O        | E24          |
| VOUT[0]_B_CB_C[8] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.               | O        | D24          |
| VOUT[0]_B_CB_C[9] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.               | O        | C24          |
| VOUT[0]_CLK       | Video Output Clock output                                                                                                                                                                                                                                                       | O        | K22          |
| VOUT[0]_FLD       | Video Output Field ID output. This is the discrete field identification output. This signal is not used for embedded sync modes.                                                                                                                                                | O        | B3, C20      |
| VOUT[0]_G_Y_YC[2] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O        | C25          |

**Table 3-55. Video Output 0 (Digital) Terminal Functions (continued)**

| SIGNAL NAME [1]   | DESCRIPTION [2]                                                                                                                                                                                                                                                                 | TYPE [3] | AAR BALL [4] |
|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| VOUT[0]_G_Y_YC[3] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O        | C26          |
| VOUT[0]_G_Y_YC[4] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O        | E26          |
| VOUT[0]_G_Y_YC[5] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O        | B26          |
| VOUT[0]_G_Y_YC[6] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O        | A26          |
| VOUT[0]_G_Y_YC[7] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O        | B25          |
| VOUT[0]_G_Y_YC[8] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O        | B27          |
| VOUT[0]_G_Y_YC[9] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O        | A27          |
| VOUT[0]_HSYNC     | Video Output Horizontal Sync output. This is the discrete horizontal synchronization output. This signal is not used for embedded sync modes.                                                                                                                                   | O        | F21          |
| VOUT[0]_R_CR[2]   | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O        | C28          |
| VOUT[0]_R_CR[3]   | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O        | B28          |
| VOUT[0]_R_CR[4]   | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O        | B29          |
| VOUT[0]_R_CR[5]   | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O        | A29          |



**Table 3-55. Video Output 0 (Digital) Terminal Functions (continued)**

| SIGNAL NAME [1] | DESCRIPTION [2]                                                                                                                                                                                               | TYPE [3] | AAR BALL [4] |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| VOUT[0]_R_CR[6] | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused. | O        | C30          |
| VOUT[0]_R_CR[7] | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused. | O        | B30          |
| VOUT[0]_R_CR[8] | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused. | O        | A30          |
| VOUT[0]_R_CR[9] | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused. | O        | B31          |
| VOUT[0]_VSYNC   | Video Output Vertical Sync output. This is the discrete vertical synchronization output. This signal is not used for embedded sync modes.                                                                     | O        | E20          |

**3.3.26.2 Video Output 1 (Digital)****Table 3-56. Video Output 1 (Digital) Terminal Functions**

| SIGNAL NAME [1]   | DESCRIPTION [2]                                                                                                                                                                                                                                                                                                                                                            | TYPE [3] | AAR BALL [4] |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| VOUT[1]_AVID      | Video Output Active Video output. This is the discrete active video indicator output. This signal is not used for embedded sync modes.                                                                                                                                                                                                                                     | O        | F1           |
| VOUT[1]_B_CB_C[0] | Video Output Data. These signals represent the 2 LSBs of B/Cb/C video data for 10-bit, 20-bit, and 30-bit video modes (VOUT[1] only). For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused. These signals are not used in 16/24-bit modes. | O        | H9           |
| VOUT[1]_B_CB_C[1] | Video Output Data. These signals represent the 2 LSBs of B/Cb/C video data for 10-bit, 20-bit, and 30-bit video modes (VOUT[1] only). For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused. These signals are not used in 16/24-bit modes. | O        | D5           |
| VOUT[1]_B_CB_C[2] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.                                                                                                          | O        | M8           |
| VOUT[1]_B_CB_C[3] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.                                                                                                          | O        | F2           |
| VOUT[1]_B_CB_C[4] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.                                                                                                          | O        | F3           |
| VOUT[1]_B_CB_C[5] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.                                                                                                          | O        | G1           |



**Table 3-56. Video Output 1 (Digital) Terminal Functions (continued)**

| SIGNAL NAME [1]   | DESCRIPTION [2]                                                                                                                                                                                                                                                                                                                                                                            | TYPE [3] | AAR BALL [4] |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------|
| VOUT[1]_B_CB_C[6] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.                                                                                                                          | O        | G2           |
| VOUT[1]_B_CB_C[7] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.                                                                                                                          | O        | H3           |
| VOUT[1]_B_CB_C[8] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.                                                                                                                          | O        | G3           |
| VOUT[1]_B_CB_C[9] | Video Output Data. These signals represent the 8 MSBs of B/Cb/C video data. For RGB mode they are blue data bits, for YUV444 mode they are Cb (Chroma) data bits, for Y/C mode they are multiplexed Cb/Cr (Chroma) data bits and for BT.656 mode they are unused.                                                                                                                          | O        | H5           |
| VOUT[1]_CLK       | Video Output Clock output                                                                                                                                                                                                                                                                                                                                                                  | O        | D3           |
| VOUT[1]_FLD       | Video Output Field ID output. This is the discrete field identification output. This signal is not used for embedded sync modes.                                                                                                                                                                                                                                                           | O        | J10          |
| VOUT[1]_G_Y_YC[0] | Video Output Data. These signals represent the 2 LSBs of G/Y/YC video data for 10-bit, 20-bit, and 30-bit video modes (VOUT[1] only). For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. These signals are not used in 8/16/24-bit modes. | O        | B2           |
| VOUT[1]_G_Y_YC[1] | Video Output Data. These signals represent the 2 LSBs of G/Y/YC video data for 10-bit, 20-bit, and 30-bit video modes (VOUT[1] only). For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. These signals are not used in 8/16/24-bit modes. | O        | A2           |
| VOUT[1]_G_Y_YC[2] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits.                                                                                                            | O        | L2           |
| VOUT[1]_G_Y_YC[3] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits.                                                                                                            | O        | H6           |
| VOUT[1]_G_Y_YC[4] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits.                                                                                                            | O        | J8           |
| VOUT[1]_G_Y_YC[5] | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits.                                                                                                            | O        | J1           |

**Table 3-56. Video Output 1 (Digital) Terminal Functions (continued)**

| <b>SIGNAL NAME [1]</b> | <b>DESCRIPTION [2]</b>                                                                                                                                                                                                                                                          | <b>TYPE [3]</b> | <b>AAR BALL [4]</b> |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------|
| VOUT[1]_G_Y_YC[6]      | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O               | H4                  |
| VOUT[1]_G_Y_YC[7]      | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O               | J9                  |
| VOUT[1]_G_Y_YC[8]      | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O               | L3                  |
| VOUT[1]_G_Y_YC[9]      | Video Output Data. These signals represent the 8 MSBs of G/Y/YC video data. For RGB mode they are green data bits, for YUV444 mode they are Y data bits, for Y/C mode they are Y (Luma) data bits and for BT.656 mode they are multiplexed Y/Cb/Cr (Luma and Chroma) data bits. | O               | K1                  |
| VOUT[1]_HSYNC          | Video Output Horizontal Sync output. This is the discrete horizontal synchronization output. This signal is not used for embedded sync modes.                                                                                                                                   | O               | E2                  |
| VOUT[1]_R_CR[0]        | Video Output Data. These signals represent the 2 LSBs of R/Cr video data for 30-bit video modes. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused. These signals are not used in 24-bit mode. | O               | C2                  |
| VOUT[1]_R_CR[1]        | Video Output Data. These signals represent the 2 LSBs of R/Cr video data for 30-bit video modes. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused. These signals are not used in 24-bit mode. | O               | C1                  |
| VOUT[1]_R_CR[2]        | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O               | L6                  |
| VOUT[1]_R_CR[3]        | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O               | L4                  |
| VOUT[1]_R_CR[4]        | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O               | H2                  |
| VOUT[1]_R_CR[5]        | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O               | M11                 |
| VOUT[1]_R_CR[6]        | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O               | L12                 |
| VOUT[1]_R_CR[7]        | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused.                                                                   | O               | M10                 |

**Table 3-56. Video Output 1 (Digital) Terminal Functions (continued)**

| <b>SIGNAL NAME [1]</b> | <b>DESCRIPTION [2]</b>                                                                                                                                                                                        | <b>TYPE [3]</b> | <b>AAR BALL [4]</b> |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|---------------------|
| VOUT[1]_R_CR[8]        | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused. | O               | J2                  |
| VOUT[1]_R_CR[9]        | Video Output Data. These signals represent the 8 MSBs of R/Cr video data. For RGB mode they are red data bits, for YUV444 mode they are Cr (Chroma) data bits, for Y/C mode and BT.656 modes they are unused. | O               | K2                  |
| VOUT[1]_VSYNC          | Video Output Vertical Sync output. This is the discrete vertical synchronization output. This signal is not used for embedded sync modes.                                                                     | O               | F5                  |

## 4 Device Configurations

### 4.1 Control Module Registers

### 4.2 Boot Modes

The state of the device after boot is determined by sampling the input states of the BTMODE[15:0] pins when device reset ( $\overline{\text{POR}}$  or  $\overline{\text{RESET}}$ ) is de-asserted. The sampled values are latched into the CONTROL\_STATUS register, which is part of the Control Module. The BTMODE[15:11] values determine the following system boot settings:

- $\overline{\text{RSTOUT\_WD\_OUT}}$  Control
- GPMC CS0 Default Data Bus Width, Wait Enable, and Address/Data Multiplexing

For additional details on BTMODE[15:11] pin functions, see [Table 3-13, Boot Configuration Terminal Functions](#).

The BTMODE[4:0] values determine the boot mode order according to [Table 4-1, Boot Mode Order](#). The 1st boot mode listed for each BTMODE[4:0] configuration is executed as the primary boot mode. If the primary boot mode fails, the 2nd, 3rd, and 4th boot modes are executed in that order until a successful boot is completed.

The BTMODE[6:5] pins are RESERVED and should be pulled down as indicated in [Table 3-13, Boot Configuration Terminal Functions](#).

When the EMAC bootmode is selected (see [Table 4-1](#)), the sampled value from BTMODE[9:8] pins are used to determine the Ethernet PHY Mode selection (see [Table 4-7](#)) and the BTMODE[7] pin is used for RGMII Internal Delay selection (see [Table 4-8](#)).

When the XIP (MUX0), XIP (MUX1), XIP w/ WAIT (MUX0) or XIP w/ WAIT (MUX1) bootmode is selected (see [Table 4-1](#)), the sampled value from BTMODE[10] pin is used to select between GPMC pin muxing options shown in [Table 4-2, XIP \(on GPMC\) Boot Options \[Muxed or Non-Muxed\]](#).

For more detailed information on booting the device, including which pins are used for each boot mode, see the *ROM Code Memory and Peripheral Booting* chapter in the device-specific Technical Reference Manual.

**Table 4-1. Boot Mode Order**

| BTMODE[4:0] | 1st                                 | 2nd                                 | 3rd                          | 4th                          |
|-------------|-------------------------------------|-------------------------------------|------------------------------|------------------------------|
| 00000       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 00001       | UART                                | XIP w/WAIT (MUX0) <sup>(1)(2)</sup> | MMC                          | SPI                          |
| 00010       | UART                                | SPI                                 | NAND                         | NANDI2C                      |
| 00011       | UART                                | SPI                                 | XIP (MUX0) <sup>(1)(2)</sup> | MMC                          |
| 00100       | EMAC <sup>(3)</sup>                 | SPI                                 | NAND                         | NANDI2C                      |
| 00101       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 00110       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 00111       | EMAC <sup>(3)</sup>                 | MMC                                 | SPI                          | XIP (MUX1) <sup>(1)(2)</sup> |
| 01000       | PCIE_32 <sup>(4)</sup>              | RESERVED                            | RESERVED                     | RESERVED                     |
| 01001       | PCIE_64 <sup>(4)</sup>              | RESERVED                            | RESERVED                     | RESERVED                     |
| 01010       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 01011       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 01100       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 01101       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 01110       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 01111       | Fast XIP (MUX0) <sup>(1)</sup>      | UART                                | EMAC <sup>(3)</sup>          | PCIE_64 <sup>(4)</sup>       |
| 10000       | XIP (MUX1) <sup>(1)(2)</sup>        | UART                                | EMAC <sup>(3)</sup>          | MMC                          |
| 10001       | XIP w/WAIT (MUX1) <sup>(1)(2)</sup> | UART                                | EMAC <sup>(3)</sup>          | MMC                          |
| 10010       | NAND                                | NANDI2C                             | SPI                          | UART                         |
| 10011       | NAND                                | NANDI2C                             | MMC                          | UART                         |
| 10100       | NAND                                | NANDI2C                             | SPI                          | EMAC <sup>(3)</sup>          |
| 10101       | NANDI2C                             | MMC                                 | EMAC <sup>(3)</sup>          | UART                         |
| 10110       | SPI                                 | MMC                                 | UART                         | EMAC <sup>(3)</sup>          |
| 10111       | MMC                                 | SPI                                 | UART                         | EMAC <sup>(3)</sup>          |
| 11000       | SPI                                 | MMC                                 | PCIE_32 <sup>(4)</sup>       | RESERVED                     |
| 11001       | SPI                                 | MMC                                 | PCIE_64 <sup>(4)</sup>       | RESERVED                     |
| 11010       | XIP (MUX0) <sup>(1)(2)</sup>        | UART                                | SPI                          | MMC                          |
| 11011       | XIP w/WAIT (MUX0) <sup>(1)(2)</sup> | UART                                | SPI                          | MMC                          |
| 11100       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 11101       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 11110       | RESERVED                            | RESERVED                            | RESERVED                     | RESERVED                     |
| 11111       | Fast XIP (MUX0) <sup>(1)</sup>      | EMAC <sup>(3)</sup>                 | UART                         | PCIE_32 <sup>(4)</sup>       |

- (1) GPMC CS0 eXecute In Place (XIP) boot for NOR/OneNAND/ROM. MUX0/1 refers to the multiplexing option for the GPMC\_A[12:0] pins. For more detailed information on booting the device, including which pins are used for each boot mode, see the *ROM Code Memory and Peripheral Booting* chapter in the device-specific Technical Reference Manual.
- (2) When the XIP (MUX0), XIP (MUX1), XIP w/ WAIT (MUX0) or XIP w/ WAIT (MUX1) bootmode is selected, the sampled value from BTMODE[10] pin is used to select between GPMC pin configuration options shown in [Table 4-2](#), *XIP (on GPMC) Boot Options*.
- (3) When the EMAC bootmode is selected, the sampled value from BTMODE[9:8] pins are used to determine the Ethernet PHY Mode Selection (see [Table 4-7](#)).
- (4) When the PCIe bootmode is selected (PCIE\_32 or PCIE\_64), the sampled value from BTMODE[15:12] pins are used to determine the addressing options. For more detailed information on the PCIe addressing options, see the *ROM Code Memory and Peripheral Booting* chapter in the device-specific Technical Reference Manual.

#### 4.2.1 XIP (NOR) Boot Options

[Table 4-2](#) shows the XIP (NOR) boot mode GPMC pin configuration options (Option A: BTMODE[10] = 0 and Option B: BTMODE[10] = 1). For Option B, the pull state on select pins is reconfigured to IPD and remains IPD after boot until the user software reconfigures it. In [Table 4-2](#), GPMC\_A[1:12] are configured only for Non-Muxed NOR flash. In the case of Muxed NOR Flash, GPMC\_D[15:0] act as both address and data lines so configuration of GPMC\_A[1:12] in XIP\_Mux0 mode and XIP\_Mux1 mode doesn't apply for a Muxed NOR flash and those pins are not configured by Boot ROM.

Table 4-2. XIP (on GPMC) Boot Options

| SIGNAL NAME                         | PIN NO.                                                        | OTHER CONDITIONS                         | CONTROLLED I/O FUNCTION DURING XIP (NOR) BOOT |            |                           |                    |
|-------------------------------------|----------------------------------------------------------------|------------------------------------------|-----------------------------------------------|------------|---------------------------|--------------------|
|                                     |                                                                |                                          | BTMODE[10] = 0 [OPTION A]                     |            | BTMODE[10] = 1 [OPTION B] |                    |
|                                     |                                                                |                                          | PIN FUNCTION                                  | PULL STATE | PIN FUNCTION              | PULL STATE         |
| GPMC_CS[0]/*                        | AC9                                                            |                                          | GPMC_CS[0]                                    | IPU        | GPMC_CS[0]                | IPU                |
| GPMC_ADV_ALE/*                      | AA10                                                           | BTMODE[14:13] = 01b or 10b (Mux)         | GPMC_ADV_ALE                                  | IPU        | GPMC_ADV_ALE              | IPU                |
|                                     |                                                                | BTMODE[14:13] = 00b (Non-Mux)            |                                               |            | Default                   |                    |
| GPMC_OE_RE                          | Y8                                                             |                                          | GPMC_OE_RE                                    | IPU        | GPMC_OE_RE                | IPU                |
| GPMC_BE[0]_CLE/GPMC_A[25]/*         | Y3                                                             |                                          | GPMC_BE[0]_CLE                                | IPD        | Default                   | IPD                |
| GPMC_BE[1]/GPMC_A[24]/*             | Y11                                                            |                                          | Default                                       | IPD        | Default                   | IPD                |
| GPMC_WE                             | Y5                                                             |                                          | GPMC_WE                                       | IPU        | GPMC_WE                   | IPU                |
| GPMC_WAIT[0]/GPMC_A[26]/*           | W8                                                             | BTMODE[15] = 1b (WAIT Used/Enabled)      | GPMC_WAIT[0]                                  | IPU        | GPMC_WAIT[0]              | IPU                |
|                                     |                                                                | BTMODE[15] = 0b (WAIT Not Used/Disabled) |                                               |            | Default                   | IPD <sup>(1)</sup> |
| GPMC_CLK/*                          | AB9                                                            |                                          | GPMC_CLK                                      | IPU        | Default                   | IPU                |
| GPMC_D[15:0]/*                      | P2, R1, R2, R3, R4, R6, T8, T1, T2, T3, T5, W9, U2, W3, W4, W6 |                                          | GPMC_D[15:0]                                  | Off        | GPMC_D[15:0]              | Off                |
| */GPMC_A[27]/GPMC_A[26]/GPMC_A[0]/* | AK3                                                            | BTMODE[12] = 0b (8-bit Mode)             | GPMC_A[0]                                     | IPD        | GPMC_A[0]                 | IPD                |
|                                     |                                                                | BTMODE[12] = 1b (16-bit Mode)            |                                               |            | Default                   |                    |
| */GPMC_A[1:12]/*                    | AK4, AJ4, AL5, AK5, AJ6, AL6, AK6, AJ7, AK7, AE4, AK8, AJ8     | XIP_MUX0 Mode                            | GPMC_A[1:12]                                  | IPD        | GPMC_A[1:12]              | IPD                |
|                                     |                                                                | XIP_MUX1 Mode                            | Default                                       | IPD        | Default                   | IPD                |
| */GPMC_A[1:12]/* (M1)               | AD1, AC8, AC5, AC4, A2, B2, C1, C2, D5, H9, J10, B3            | XIP_MUX0 Mode                            | Default                                       | Default    | Default                   | Default            |
|                                     |                                                                | XIP_MUX1 Mode                            | GPMC_A[1:12]                                  | Default    | GPMC_A[1:12]              | Default            |
| */GPMC_A[13:15]/* (M0)              | AH8, AG8, AF8                                                  |                                          | Default                                       | IPD        | Default                   | IPD                |
| */GPMC_A[0]/* (M1)                  | M8                                                             | BTMODE[12] = 0b (8-bit Mode)             | Default                                       | IPU        | Default                   | IPU                |
|                                     |                                                                | BTMODE[12] = 1b (16-bit Mode)            |                                               |            |                           |                    |
| */GPMC_A[13]/* (M1)                 | L2                                                             | BTMODE[14:13] = 01b or 10b (Mux)         | Default                                       | IPU        | Default                   | IPU                |
|                                     |                                                                | BTMODE[14:13] = 00b (Non-Mux)            |                                               |            |                           | IPD <sup>(1)</sup> |
| */GPMC_A[14]/* (M1)                 | L4                                                             | BTMODE[14:13] = 01b or 10b (Mux)         | Default                                       | IPU        | Default                   | IPU                |
|                                     |                                                                | BTMODE[14:13] = 00b (Non-Mux)            |                                               |            |                           | IPD <sup>(1)</sup> |
| */GPMC_A[15]/* (M1)                 | L6                                                             |                                          | Default                                       | IPD        | Default                   | IPD                |
| GPMC_A[16:19]/*                     | M1, M2, M3, M5                                                 |                                          | Default                                       | IPD        | Default                   | IPD                |
| GPMC_A[20] (M0)                     | N9                                                             |                                          | Default                                       | IPU        | Default                   | IPD <sup>(1)</sup> |
| GPMC_A[21] (M0)                     | N1                                                             |                                          | Default                                       | IPD        | Default                   | IPD                |
| GPMC_A[22] (M0)                     | N2                                                             |                                          | Default                                       | IPU        | Default                   | IPD <sup>(1)</sup> |
| GPMC_A[23] (M0)                     | R8                                                             |                                          | Default                                       | IPD        | Default                   | IPD                |

(1) After initial power-up the internal pullup (IPU) will be at its default configuration of IPU. During the boot ROM execution, the pull state is reconfigured to IPD and it remains IPD after boot until the user software reconfigures it.

Table 4-2. XIP (on GPMC) Boot Options (continued)

| SIGNAL NAME               | PIN NO. | OTHER CONDITIONS | CONTROLLED I/O FUNCTION DURING XIP (NOR) BOOT |            |                           |                    |
|---------------------------|---------|------------------|-----------------------------------------------|------------|---------------------------|--------------------|
|                           |         |                  | BTMODE[10] = 0 [OPTION A]                     |            | BTMODE[10] = 1 [OPTION B] |                    |
|                           |         |                  | PIN FUNCTION                                  | PULL STATE | PIN FUNCTION              | PULL STATE         |
| */GPMC_A[24]/GPMC_A[20]/* | AE3     |                  | Default                                       | IPU        | Default                   | IPD <sup>(1)</sup> |
| */GPMC_A[25]/GPMC_A[21]/* | AE2     |                  | Default                                       | IPU        | Default                   | IPD <sup>(1)</sup> |
| */GPMC_A[26]/GPMC_A[22]/* | AE1     |                  | Default                                       | IPU        | Default                   | IPD <sup>(1)</sup> |
| */GPMC_A[27]/GPMC_A[23]/* | AD2     |                  | Default                                       | IPU        | Default                   | IPU                |
| GPMC_A[24] (M1)           | AC3     |                  | Default                                       | IPU        | Default                   | IPU                |
| GPMC_A[25] (M1)           | AA12    |                  | Default                                       | IPU        | Default                   | IPU                |

## 4.2.2 NAND Flash Boot

Table 4-3 lists the device pins that are configured by the ROM for the NAND Flash boot mode.

NOTE: Table 4-3 lists the configuration of the GPMC\_CLK pin (pin mux and pull state) in NAND bootmodes.

The NAND flash memory is not XIP and requires shadowing before the code can be executed.

**Table 4-3. Pins Used in NAND FLASH Bootmode**

| SIGNAL NAME                                              | PIN NO.                                                        | TYPE | OTHER CONDITIONS                                                                                                                             |
|----------------------------------------------------------|----------------------------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------|
| $\overline{\text{GPMC\_CS}}[0]/*$                        | AC9                                                            | O    | BTMODE[12] = 0b (8-bit Mode)<br>BTMODE[12] = 1b (16-bit Mode)<br>BTMODE[14:13] = 00b (GPMC CS0 not muxed)<br>BTMODE[15] = 0b (wait disabled) |
| $\text{GPMC\_ADV\_ALE}/*$                                | AA10                                                           | O    |                                                                                                                                              |
| $\overline{\text{GPMC\_OE\_RE}}$                         | Y8                                                             | O    |                                                                                                                                              |
| $\text{GPMC\_BE}}[0]_{\text{CLE}}/\text{GPMC\_A}}[25]/*$ | Y3                                                             | O    |                                                                                                                                              |
| $\text{GPMC\_BE}}[1]/\text{GPMC\_A}}[24]/*$              | Y11                                                            | O    |                                                                                                                                              |
| $\overline{\text{GPMC\_WE}}$                             | Y5                                                             | O    |                                                                                                                                              |
| $\text{GPMC\_WAIT}}[0]/\text{GPMC\_A}}[26]/*^{(1)}$      | W8                                                             | I    |                                                                                                                                              |
| $\text{GPMC\_CLK}/*$                                     | AB9                                                            | I/O  |                                                                                                                                              |
| $\text{GPMC\_D}}[15:0]/*$                                | P2, R1, R2, R3, R4, R6, T8, T1, T2, T3, T5, W9, U2, W3, W4, W6 | I/O  |                                                                                                                                              |

(1) GPMC\_CLK/\* is not configured in BTMODE[10] = 1 [OPTION B]

## 4.2.3 NAND I2C Boot (I2C EEPROM)

Table 4-4 lists the device pins that are configured by the ROM for the NAND I2C boot mode.

**Table 4-4. Pins Used in NAND I2C Bootmode**

| SIGNAL NAME | PIN NO. | TYPE |
|-------------|---------|------|
| I2C[0]_SCL  | T27     | I/O  |
| I2C[0]_SDA  | T24     | I/O  |

## 4.2.4 MMC/SD Cards Boot

Table 4-5 lists the device pins that are configured by the ROM for the MMC/SD boot mode.

**Table 4-5. Pins Used in MMC/SD Bootmode**

| SIGNAL NAME                           | PIN NO. | TYPE |
|---------------------------------------|---------|------|
| SD1_CLK                               | W30     | I/O  |
| SD1_CMD/GP0[0] [MUX0]                 | Y29     | I/O  |
| SD1_DAT[0]                            | W31     | I/O  |
| SD1_DAT[1]_SDIR $\overline{\text{Q}}$ | AA30    | I/O  |
| SD_DAT[2]_SDRW $\overline{\text{W}}$  | U29     | I/O  |
| SD1_DAT[3]                            | Y27     | I/O  |



## 4.2.5 SPI Boot

Table 4-6 lists the device pins that are configured by the ROM for the SPI boot mode.

**Table 4-6. Pins Used in SPI Bootmode**

| SIGNAL NAME        | PIN NO. | TYPE |
|--------------------|---------|------|
| SPI[0]_SCS[0]      | G29     | I/O  |
| SPI[0]_D[0] (MISO) | J28     | I/O  |
| SPI[0]_D[1] (MOSI) | J27     | I/O  |
| SPI[0]_SCLK        | N24     | I/O  |

## 4.2.6 Ethernet PHY Mode Selection

When the EMAC bootmode is selected, via the BTMODE[4:0] pins (see Table 4-1), Table 4-7 shows the sampled value of BTMODE[9:8] pins and the Ethernet PHY Mode selection.

Table 4-9 shows the signal names (pin functions) and the associated pin numbers selected in each particular EMAC mode.

**Table 4-7. EMAC PHY Mode Selection**

| BTMODE[9:8] | ETHERNET PHY MODE SELECTION |
|-------------|-----------------------------|
| 00b         | MII/GMII                    |
| 01b         | RMII                        |
| 10b         | RGMII                       |
| 11b         | RESERVED                    |

**Table 4-8. RGMII Internal Delay Selection**

| BTMODE[7] | RGMII INTERNAL DELAY SELECTION |
|-----------|--------------------------------|
| 0b        | Internal Delay Enabled         |
| 1b        | Internal Delay Disabled        |

**Table 4-9. Pins Used in EMAC[0] MII/GMII, RGMII, and RMII Boot Modes**

| PIN NO. | SIGNAL NAMES    |      |                  |      |                  |             |
|---------|-----------------|------|------------------|------|------------------|-------------|
|         | MII/GMII        | TYPE | RGMII            | TYPE | RMII             | TYPE        |
| AG1     | DEFAULT         |      | DEFAULT          |      | EMAC_RMREFCLK    | Output only |
| AH1     | EMAC[0]_MCOL    | I    | EMAC[0]_RGRXCTL  | I    | EMAC[0]_RMRXD[0] | I           |
| AH2     | EMAC[0]_MCRS    | I    | EMAC[0]_RGRXD[2] | I    | EMAC[0]_RMRXD[1] | I           |
| AL6     | EMAC[0]_GMTCLK  | O    | DEFAULT          |      | DEFAULT          |             |
| AK1     | EMAC[0]_MRCLK   | I    | EMAC[0]_RGTXC    | O    | EMAC[0]_RMCSDV   | I           |
| AK2     | EMAC[0]_MRXD[0] | I    | EMAC[0]_RGTXD[0] | O    | EMAC[0]_RMTXD[0] | O           |
| AL2     | EMAC[0]_MRXD[1] | I    | EMAC[0]_RGRXD[0] | I    | EMAC[0]_RMTXD[1] | O           |
| AL3     | EMAC[0]_MRXD[2] | I    | EMAC[0]_RGRXD[1] | I    | EMAC[0]_RMTXEN   | O           |
| AK3     | EMAC[0]_MRXD[3] | I    | DEFAULT          |      | DEFAULT          |             |
| AK4     | EMAC[0]_MRXD[4] | I    | EMAC[0]_RGRXD[3] | I    | DEFAULT          |             |
| AJ4     | EMAC[0]_MRXD[5] | I    | EMAC[0]_RGTXD[3] | O    | DEFAULT          |             |
| AL5     | EMAC[0]_MRXD[6] | I    | EMAC[0]_RGTXD[2] | O    | DEFAULT          |             |

**Table 4-9. Pins Used in EMAC[0] MII/GMII, RGMII, and RMII Boot Modes (continued)**

| PIN NO. | SIGNAL NAMES    |      |                  |      |                |      |
|---------|-----------------|------|------------------|------|----------------|------|
|         | MI/GMII         | TYPE | RGMII            | TYPE | RMII           | TYPE |
| AK5     | EMAC[0]_MRXD[7] | I    | EMAC[0]_RGTXD[1] | O    | DEFAULT        |      |
| AJ6     | EMAC[0]_MRXDV   | I    | DEFAULT          |      | DEFAULT        |      |
| AJ2     | EMAC[0]_MRXER   | I    | EMAC[0]_RGTXCTL  | O    | EMAC[0]_RMRXER | I    |
| AG4     | EMAC[0]_MTCLK   | I    | EMAC[0]_RGRXC    | I    | DEFAULT        |      |
| AK6     | EMAC[0]_MTXD[0] | O    | DEFAULT          |      | DEFAULT        |      |
| AJ7     | EMAC[0]_MTXD[1] | O    | DEFAULT          |      | DEFAULT        |      |
| AK7     | EMAC[0]_MTXD[2] | O    | DEFAULT          |      | DEFAULT        |      |
| AE4     | EMAC[0]_MTXD[3] | O    | DEFAULT          |      | DEFAULT        |      |
| AK8     | EMAC[0]_MTXD[4] | O    | DEFAULT          |      | DEFAULT        |      |
| AJ8     | EMAC[0]_MTXD[5] | O    | DEFAULT          |      | DEFAULT        |      |
| AH8     | EMAC[0]_MTXD[6] | O    | DEFAULT          |      | DEFAULT        |      |
| AG8     | EMAC[0]_MTXD[7] | O    | DEFAULT          |      | DEFAULT        |      |
| AF8     | EMAC[0]_MTXEN   | O    | DEFAULT          |      | DEFAULT        |      |
| AG2     | MDCLK           | O    | MDCLK            | O    | MDCLK          | O    |
| AG3     | MDIO            | I/O  | MDIO             | I/O  | MDIO           | I/O  |

#### 4.2.7 PCIe Bootmode (PCIE\_32 and PCIE\_64)

Table 4-10 lists the device pins that are configured by the ROM for the PCIe boot mode.

**Table 4-10. Pins Used in PCIe Bootmode<sup>(1)</sup>**

| SIGNAL NAME | PIN NO. | TYPE |
|-------------|---------|------|
| PCIE_TXP0   | L31     | O    |
| PCIE_TXN0   | K31     | O    |
| PCIE_RXP0   | K30     | I    |
| PCIE_RXN0   | J30     | I    |
| SERDES_CLKP | H30     | I    |
| SERDES_CLKN | H31     | I    |

(1) PCIe bootmode is supported on all DM385 devices and also on DM388 devices with PCIe enabled. PCIe bootmode is not supported on DM388 devices with PCIe disabled.

#### 4.2.8 UART Bootmode

Table 4-11 lists the device pins that are configured by the ROM for the UART boot mode.

**Table 4-11. Pins Used in UART Bootmode**

| SIGNAL NAME | PIN NO. | TYPE |
|-------------|---------|------|
| UART0_RXD   | J26     | I    |
| UART0_TXD   | E28     | O    |

### 4.3 Pin Multiplexing Control

Device level pin multiplexing is controlled on a pin-by-pin basis by the MUXMODE bits of the PINCNTL1 – PINCNTL270 registers in the Control Module.

Pin multiplexing selects which one of several peripheral pin functions controls the pin's I/O buffer output data values. [Table 4-12](#) shows the peripheral pin functions associated with each MUXMODE setting for all multiplexed pins. The default pin multiplexing control for almost every pin is to select MUXMODE = 0x0, in which case the pin's I/O buffer is 3-stated.

In most cases, the input from each pin is routed to all of the peripherals that share the pin, regardless of the MUXMODE setting. However, in some cases a constant "0" or "1" value is routed to the associated peripheral when its peripheral function is not selected to control any output pin. For more details on the De-Selected Input State (DSIS), see the columns of each Terminal Functions table ([Section 3.3, Terminal Functions](#)).

Some peripheral pin functions can be routed to more than one device pin. These types of peripheral pin functions are called Multimuxed and may have different Switching Characteristics and Timing Requirements for each device pin option.

For more detailed information on the Pin Control 1 through Pin Control 270 (PINCNTLx) registers breakout, see [Figure 4-1](#) and [Table 4-12](#).

**Figure 4-1. PINCNTL1 – PINCNTL270 (PINCNTLx) Registers Breakout**

|               |    |                 |    |     |     |                 |         |
|---------------|----|-----------------|----|-----|-----|-----------------|---------|
| 31            | 24 | 23              | 20 | 19  | 18  | 17              | 16      |
| RESERVED      |    | RESERVED        |    | RSV | RSV | PLLTYP<br>PESEL | PLLUDEN |
| R - 0000 0000 |    | R - 0000        |    | R/W |     |                 |         |
| 15            | 8  | 7               | 0  |     |     |                 |         |
| RESERVED      |    | MUXMODE[7:0]    |    |     |     |                 |         |
| R - 0000 0000 |    | R/W - 0000 0000 |    |     |     |                 |         |

LEGEND: R/W = Read/Write; R = Read only; -n = value after reset

**Table 4-12. PINCNTL1 – PINCNTL270 (PINCNTLx) Registers Bit Descriptions**

| Bit   | Field        | Description                                                                                                                  | Comments                                                                                                                                                                                  |
|-------|--------------|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:20 | RESERVED     | Reserved. Read only, writes have no effect.                                                                                  | For PINCNTLx register reset value examples, see <a href="#">Table 4-13, PINCNTLx Register Reset Value Examples</a> .<br><br>For the full register reset values of all PINCNTLx registers. |
| 19    | RSV          | Reserved. This bit <b>must</b> always be written with the reset (default) value.                                             |                                                                                                                                                                                           |
| 18    | RSV          | Reserved. This field <b>must</b> always be written as "1".                                                                   |                                                                                                                                                                                           |
| 17    | PLLTYPSEL    | Pullup/Pulldown Type Selection bit<br>0 = Pulldown (PD) selected<br>1 = Pullup (PU) selected                                 |                                                                                                                                                                                           |
| 16    | PLLUDEN      | Pullup/Pulldown Enable bit<br>0 = PU/PD enabled<br>1 = PU/PD disabled                                                        |                                                                                                                                                                                           |
| 15:8  | RESERVED     | Reserved. Read only, writes have no effect.                                                                                  |                                                                                                                                                                                           |
| 7:0   | MUXMODE[7:0] | MUXMODE Selection bits<br>These bits select the multiplexed mode pin function settings. Values other than those are illegal. |                                                                                                                                                                                           |

**Table 4-13. PINCNTLx Register Reset Value Examples**

| HEX<br>ADDRESS<br>RANGE | PINCNTLx<br>REGISTER<br>NAME | Bits 31:24 | Bits 23:20 | Bit 19   | Bit 18   | Bit 17     | Bit 16  | Bits 15:8 | Bits 7:0     | REGISTER<br>RESET<br>VALUE |
|-------------------------|------------------------------|------------|------------|----------|----------|------------|---------|-----------|--------------|----------------------------|
|                         |                              | RESERVED   | RESERVED   | RESERVED | RXACTIVE | PLLTYPESEL | PLLUDEN | RESERVED  | MUXMODE[7:0] |                            |
| 0x4814 0800             | PINCNTL1                     | 00h        | 0h         | 0        | 1        | 1          | 0       | 00h       | 00h          | 0x0006 0000                |
| 0x4814 0804             | PINCNTL2                     | 00h        | 0h         | 1        | 1        | 1          | 0       | 00h       | 00h          | 0x000E 0000                |
| 0x4814 0808             | PINCNTL3                     | 00h        | 0h         | 1        | 1        | 1          | 0       | 00h       | 00h          | 0x000E 0000                |
| ...                     |                              |            |            |          |          |            |         |           |              |                            |
| 0x4814 0C34             | PINCNTL270                   | 00h        | 0h         | 1        | 1        | 0          | 0       | 00h       | 00h          | 0x000C 0000                |

## 4.4 Handling Unused Pins

When device signal pins are unused in the system, they can be left unconnected unless otherwise noted in the Terminal Functions tables (see [Section 3.3](#)). For unused input pins, the internal pull resistor should be enabled, or an external pull resistor should be used, to prevent floating inputs. All supply pins must always be connected to the correct voltage, even when their associated signal pins are unused.

## 4.5 DeBugging Considerations

### 4.5.1 Pullup/Pulldown Resistors

Proper board design should ensure that input pins to the device always be at a valid logic level and not floating. This may be achieved via pullup/pulldown resistors. The device features internal pullup (IPU) and internal pulldown (IPD) resistors on most pins to eliminate the need, unless otherwise noted, for external pullup/pulldown resistors.

An external pullup/pulldown resistor needs to be used in the following situations:

- *Boot Configuration Pins:* If the pin is both routed out and 3-stated (not driven), an external pullup/pulldown resistor is **strongly recommended**, even if the IPU/IPD matches the desired value/state.
- *Other Input Pins:* If the IPU/IPD *does not* match the desired value/state, use an external pullup/pulldown resistor to pull the signal to the opposite rail.

For the boot configuration pins (listed in [Section 3.3](#), *Boot Configuration Terminal Functions*), if they are both routed out and 3-stated (not driven), it is **strongly recommended** that an external pullup/pulldown resistor be implemented. Although, internal pullup/pulldown resistors exist on these pins and they may match the desired configuration value, providing external connectivity can help ensure that valid logic levels are latched on these device boot configuration pins. In addition, applying external pullup/pulldown resistors on the boot and configuration pins adds convenience to the user in debugging and flexibility in switching operating modes.

Tips for choosing an external pullup/pulldown resistor:

- Consider the total amount of current that may pass through the pullup or pulldown resistor. Make sure to include the leakage currents of all the devices connected to the net, as well as any internal pullup or pulldown resistors.
- Decide a target value for the net. For a pulldown resistor, this should be below the lowest  $V_{IL}$  level of all inputs connected to the net. For a pullup resistor, this should be above the highest  $V_{IH}$  level of all inputs on the net. A reasonable choice would be to target the  $V_{OL}$  or  $V_{OH}$  levels for the logic family of the limiting device; which, by definition, have margin to the  $V_{IL}$  and  $V_{IH}$  levels.
- Select a pullup/pulldown resistor with the largest possible value; but, which can still ensure that the net will reach the target pulled value when maximum current from all devices on the net is flowing through the resistor. The current to be considered includes leakage current plus, any other internal and external pullup/pulldown resistors on the net.
- For bidirectional nets, there is an additional consideration which sets a lower limit on the resistance value of the external resistor. Verify that the resistance is small enough that the weakest output buffer can drive the net to the opposite logic level (including margin).
- Remember to include tolerances when selecting the resistor value.
- For pullup resistors, also remember to include tolerances on the  $DV_{DD}$  rail.

For most systems, a 1-k $\Omega$  resistor can be used to oppose the IPU/IPD while meeting the above criteria. Users should confirm this resistor value is correct for their specific application.

For most systems, a 20-k $\Omega$  resistor can be used to compliment the IPU/IPD on the boot and configuration pins while meeting the above criteria. Users should confirm this resistor value is correct for their specific application.

For most systems, a 20-k $\Omega$  resistor can also be used as an external PU/PD on the pins that have IPU/IPDs disabled and require an external PU/PD resistor while still meeting the above criteria. Users should confirm this resistor value is correct for their specific application.

For more detailed information on input current ( $I_i$ ), and the low-/high-level input voltages ( $V_{IL}$  and  $V_{IH}$ ) for the device, see [Section 6.4](#), *Electrical Characteristics Over Recommended Ranges of Supply Voltage and Operating Temperature*.

For the internal pullup/pulldown resistors for all device pins, see the peripheral/system-specific terminal functions table.

## 5 System Interconnect

The device's various processors, subsystems, and peripherals are interconnected through a switch fabric architecture. The switch fabric is composed of an L3 and L4 interconnect, a switched central resource (SCR), and multiple bridges (for an overview, see [Figure 5-1](#)). Not all Initiators in the switch fabric are connected to all Target peripherals. The supported initiator and target connections are designated by a "X" in [Table 5-1, Target/Initiator Connectivity](#).

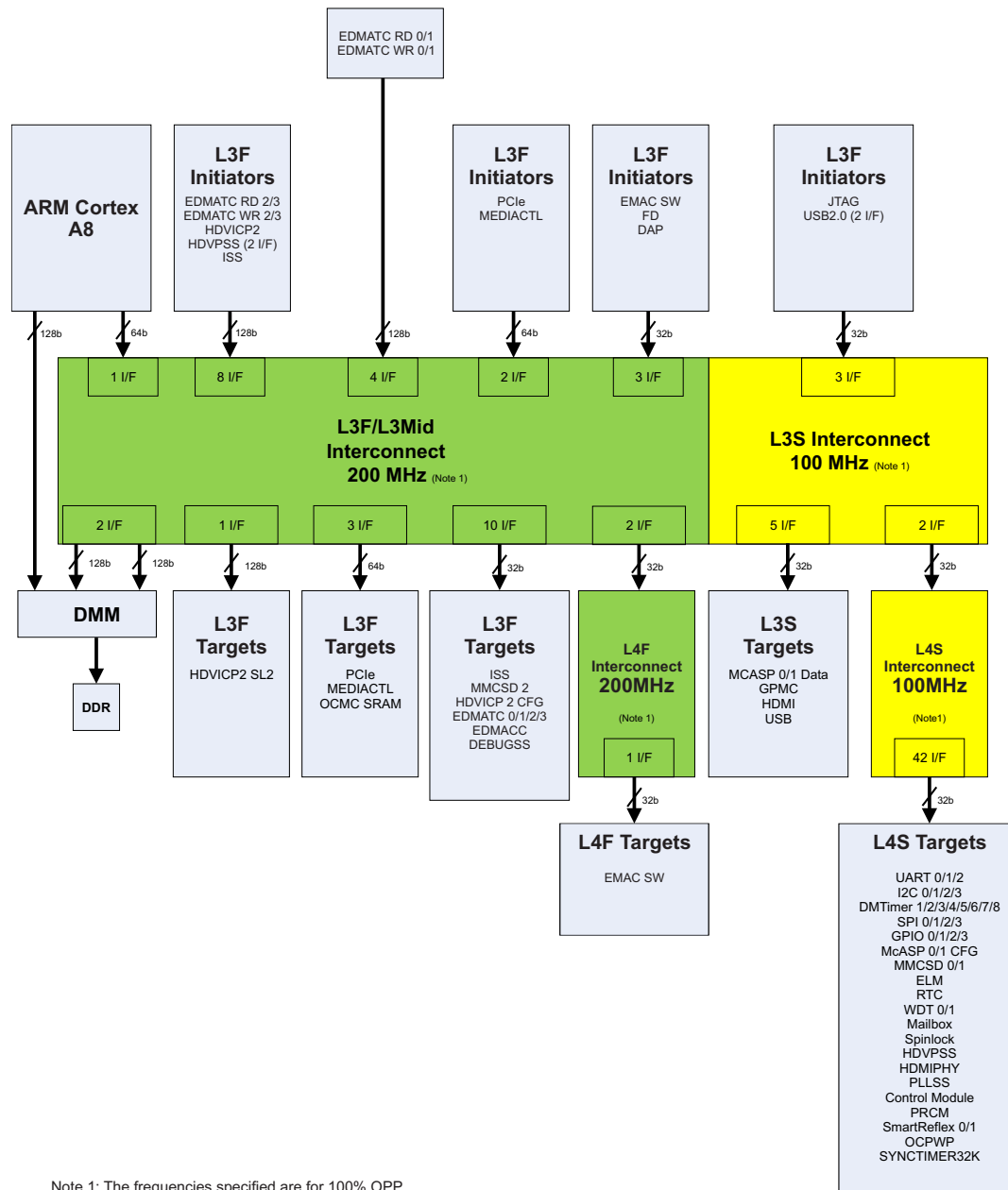


Figure 5-1. System Interconnect

**Table 5-1. L3 Master/Slave Connectivity**

| MASTERS                 | SLAVES               |                      |               |             |             |                  |      |                 |           |                   |                     |                     |                      |                      |              |                    |           |          |            |            |     |
|-------------------------|----------------------|----------------------|---------------|-------------|-------------|------------------|------|-----------------|-----------|-------------------|---------------------|---------------------|----------------------|----------------------|--------------|--------------------|-----------|----------|------------|------------|-----|
|                         | EDMA DMM Tiler/Lisa0 | EDMA DMM Tiler/Lisa1 | EDMA DMM ELLA | HDVICP2 SL2 | HDVICP2 Hst | Media Controller | GPMC | PCIe Gen2 Slave | McASP 0/1 | HDMI 1.3 Tx Audio | L4 HS Periph Port 0 | L4 HS Periph Port 1 | L4 Std Periph Port 0 | L4 Std Periph Port 1 | L3 Registers | EDMA TPTC0 - 3 CFG | EDMA TPCC | OCMC RAM | USB2.0 CFG | Imaging SS | SD2 |
| ARM M1 (128-bit)        |                      |                      | X             |             |             |                  |      |                 |           |                   |                     |                     |                      |                      |              |                    |           |          |            |            |     |
| ARM M2 (64-bit)         |                      | X                    |               | X           | X           | X                | X    | X               | X         | X                 | X                   |                     | X                    |                      | X            | X                  | X         | X        | X          | X          | X   |
| HDVICP2 VDMA            | X                    |                      |               |             |             |                  |      |                 |           |                   |                     |                     |                      |                      |              |                    |           | X        |            |            |     |
| HDVPSS Mstr0            | X                    |                      |               | X           |             |                  |      |                 |           |                   |                     |                     |                      |                      |              |                    |           | X        |            |            |     |
| HDVPSS Mstr1            |                      | X                    |               | X           |             |                  |      |                 |           |                   |                     |                     |                      |                      |              |                    |           | X        |            |            |     |
| EMAC SW                 | X                    |                      |               | X           |             |                  |      |                 |           |                   |                     |                     |                      |                      |              |                    |           | X        |            |            |     |
| USB2.0 DMA              | X                    |                      |               | X           |             |                  |      |                 |           |                   |                     |                     |                      |                      |              |                    |           |          |            |            |     |
| USB2.0 Queue Mgr        | X                    |                      |               | X           |             |                  | X    |                 |           |                   |                     |                     |                      |                      |              |                    |           | X        |            |            |     |
| PCIe Gen2               | X                    |                      |               | X           | X           | X                | X    |                 | X         | X                 |                     | X                   |                      | X                    |              | X                  | X         | X        | X          | X          | X   |
| Media Controller        | X                    |                      |               | X           | X           |                  | X    | X               | X         | X                 | X                   |                     | X                    |                      |              | X                  | X         | X        | X          |            | X   |
| DeBug Access Port (DAP) | X                    |                      |               | X           | X           | X                | X    | X               | X         | X                 |                     | X                   |                      | X                    | X            | X                  | X         | X        | X          |            |     |
| EDMA TPTC0 RD           | X                    |                      |               | X           | X           | X                | X    | X               | X         | X                 |                     | X                   |                      | X                    |              |                    | X         | X        | X          | X          | X   |
| EDMA TPTC0 WR           |                      | X                    |               | X           | X           | X                | X    | X               | X         | X                 |                     | X                   |                      | X                    |              |                    | X         | X        | X          | X          | X   |
| EDMA TPTC1 RD           |                      | X                    |               | X           | X           | X                | X    | X               | X         | X                 | X                   |                     | X                    |                      |              |                    | X         | X        | X          | X          | X   |
| EDMA TPTC1 WR           | X                    |                      |               | X           | X           | X                | X    | X               | X         | X                 | X                   |                     | X                    |                      |              |                    | X         | X        | X          | X          | X   |
| EDMA TPTC2 RD           |                      | X                    |               | X           | X           | X                | X    | X               | X         | X                 |                     | X                   |                      | X                    |              |                    | X         | X        | X          | X          | X   |
| EDMA TPTC2 WR           | X                    |                      |               | X           | X           | X                | X    | X               | X         | X                 |                     | X                   |                      | X                    |              |                    | X         | X        | X          | X          | X   |
| EDMA TPTC3 RD           | X                    |                      |               | X           | X           | X                | X    | X               | X         | X                 | X                   |                     | X                    |                      |              |                    | X         | X        | X          | X          | X   |
| EDMA TPTC3 WR           |                      | X                    |               | X           | X           | X                | X    | X               | X         | X                 | X                   |                     | X                    |                      |              |                    | X         | X        | X          | X          | X   |
| ISS                     |                      | X                    |               |             |             |                  |      |                 |           |                   |                     |                     |                      |                      |              |                    |           | X        |            |            |     |



The L4 interconnect is a non-blocking peripheral interconnect that provides low-latency access to a large number of low-bandwidth, physically-dispersed target cores. The L4 can handle incoming traffic from up to four initiators and can distribute those communication requests to and collect related responses from up to 63 targets.

The device provides two interfaces with L3 interconnect for high-speed and standard peripherals.

**Table 5-2. L4 Peripheral Connectivity<sup>(1)</sup>**

| L4 PERIPHERALS                      | MASTERS                   |            |            |            |            |       |
|-------------------------------------|---------------------------|------------|------------|------------|------------|-------|
|                                     | ARM Cortex-A8 M2 (64-bit) | EDMA TPTC0 | EDMA TPTC1 | EDMA TPTC2 | EDMA TPTC3 | PCIe  |
| <b>L4 Fast Peripherals Port 0/1</b> |                           |            |            |            |            |       |
| EMAC SW                             | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| <b>L4 Slow Peripherals Port 0/1</b> |                           |            |            |            |            |       |
| I2C0                                | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| I2C1                                | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| I2C2                                | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| I2C3                                | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| SPI0                                | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| SPI1                                | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| SPI2                                | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| SPI3                                | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| UART0                               | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| UART1                               | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| UART2                               | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| Timer1                              | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| Timer2                              | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| Timer3                              | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| Timer4                              | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| Timer5                              | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| Timer6                              | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| Timer7                              | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| Timer8                              | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| GPIO0                               | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| GPIO1                               | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| MMC/SD0/SDIO                        | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| MMC/SD1/SDIO                        | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| MMC/SD2/SDIO                        | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| WDT0                                | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| RTC                                 | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| SmartReflex0                        | Port0                     |            |            |            |            |       |
| SmartReflex1                        | Port0                     |            |            |            |            |       |
| Mailbox                             | Port0                     |            |            |            |            |       |
| Spinlock                            | Port0                     |            |            |            |            |       |
| HDVPSS                              | Port0                     | Port1      | Port0      | Port1      | Port0      | Port1 |
| PLLSS                               | Port0                     |            |            |            |            | Port1 |
| Control/Top Regs (Control Module)   | Port0                     |            |            |            |            | Port1 |
| PRCM                                | Port0                     |            |            |            |            | Port1 |
| ELM                                 | Port0                     |            |            |            |            | Port1 |

(1) X, Port0, Port1 = Connection exists.

**Table 5-2. L4 Peripheral Connectivity<sup>(1)</sup> (continued)**

| L4 PERIPHERALS | MASTERS                      |            |            |            |            |       |
|----------------|------------------------------|------------|------------|------------|------------|-------|
|                | ARM Cortex-A8<br>M2 (64-bit) | EDMA TPTC0 | EDMA TPTC1 | EDMA TPTC2 | EDMA TPTC3 | PCIe  |
| HDMIPHY        | Port0                        |            |            |            |            | Port1 |
| OCPWP          | Port0                        |            |            |            |            | Port0 |
| McASP0 CFG     | Port0                        | Port1      | Port0      | Port1      | Port0      | Port1 |
| McASP1 CFG     | Port0                        | Port1      | Port0      | Port1      | Port0      | Port1 |
| SYNCTIMER32K   | Port0                        | Port1      | Port0      | Port1      | Port0      | Port1 |

## 6 Device Operating Conditions

### 6.1 Absolute Maximum Ratings <sup>(1)(2)</sup>

|                                                                             |                                                                                                                                                                                                                                                                                                           |                                                       |
|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------|
| Supply voltage ranges (Steady State):                                       | Core (CVDD, CVDD_ARM, CVDD_HDVICP)                                                                                                                                                                                                                                                                        | -0.3 V to 1.5 V                                       |
|                                                                             | HD-DAC Digital Logic, 1.1V (VDDA_HDDAC_1P1)                                                                                                                                                                                                                                                               | -0.5 V to 1.5 V                                       |
|                                                                             | I/O, 1.8 V (DVDD_DDR[0], VDDA_1P8, VDDA_ARMPLL_1P8, VDDA_VIDPLL_1P8, VDDA_AUDIOPLL_1P8, VDDA_DDRPLL_1P8, VDDA_L3L4PLL_1P8, VDDA_PCIE_1P8, VDDA_HDMI_1P8, VDDA_USB0_1P8, VDDA_USB1_1P8, VDDA_VDAC_1P8, VDDA_CSI2_1P8, VDDA_HDDACREF_1P8, VDDA_HDDAC_1P8, VDDA_HDVICPPLL_1P8, VDDA_OSC0_1P8, VDDA_OSC1_1P8) | -0.3 V to 2.1 V                                       |
|                                                                             | I/O 3.3 V (DVDD, DVDD_GPMC, DVDD_RGMII, DVDD_SD, DVDD_C)                                                                                                                                                                                                                                                  | -0.3 V to 4.0 V                                       |
|                                                                             | DDR Reference Voltage (VREFSSTL_DDR[0])                                                                                                                                                                                                                                                                   | -0.3 V to 1.1 V                                       |
|                                                                             |                                                                                                                                                                                                                                                                                                           |                                                       |
| Input and Output voltage ranges:                                            | V I/O, 1.35-V pins (Steady State)                                                                                                                                                                                                                                                                         | -0.3 V to DVDD_DDR[0] + 0.3 V                         |
|                                                                             | V I/O, 1.35-V pins (Transient Overshoot/Undershoot)                                                                                                                                                                                                                                                       | 30% of DVDD_DDR[0] for up to 30% of the signal period |
|                                                                             | V I/O, 1.5-V pins (Steady State)                                                                                                                                                                                                                                                                          | -0.3 V to DVDD_DDR[0] + 0.3 V                         |
|                                                                             | V I/O, 1.5-V pins (Transient Overshoot/Undershoot)                                                                                                                                                                                                                                                        | 30% of DVDD_DDR[0] for up to 30% of the signal period |
|                                                                             | V I/O, 1.8-V pins (Steady State)                                                                                                                                                                                                                                                                          | -0.3 V to DVDD + 0.3 V<br>-0.3 V to DVDD_x + 0.3 V    |
|                                                                             | V I/O, 1.8-V pins (Transient Overshoot/Undershoot)                                                                                                                                                                                                                                                        | 25% of DVDDx for up to 30% of the signal period       |
|                                                                             | V I/O, 3.3-V pins (Steady State)                                                                                                                                                                                                                                                                          | -0.3 V to DVDD + 0.3 V<br>-0.3 V to DVDD_x + 0.3 V    |
|                                                                             | V I/O, 3.3-V pins (Transient Overshoot/Undershoot)                                                                                                                                                                                                                                                        | 25% of DVDDx for up to 30% of the signal period       |
| Operating junction temperature range, T <sub>J</sub> :                      | Commercial Temperature (default)                                                                                                                                                                                                                                                                          | 0°C to 95°C                                           |
|                                                                             | Extended temperature                                                                                                                                                                                                                                                                                      | -40°C to 95°C                                         |
| Storage temperature range, T <sub>stg</sub> :                               |                                                                                                                                                                                                                                                                                                           | -55°C to 150°C                                        |
| Component-Level Electrostatic Discharge (ESD) Stress Voltage <sup>(3)</sup> | ESD-HBM (Human Body Model) <sup>(4)</sup>                                                                                                                                                                                                                                                                 | ±1000 V                                               |
|                                                                             | ESD-CDM (Charged-Device Model) <sup>(5)</sup>                                                                                                                                                                                                                                                             | ±250 V                                                |
| Latch-up Performance <sup>(6)</sup>                                         | Class II (105°C)                                                                                                                                                                                                                                                                                          | 50 mA                                                 |

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltage values are with respect to their associated VSS or VSSA\_x.
- (3) Electrostatic discharge (ESD) to measure device sensitivity or immunity to damage caused by electrostatic discharges into the device.
- (4) Level listed is the passing level per ANSI/ESDA/JEDEC JS-001. JEDEC document JEP155 states that 500 V HBM allows safe manufacturing with a standard ESD control process, and manufacturing with less than 500 V HBM is possible if necessary precautions are taken. Pins listed as 1000 V may actually have higher performance.
- (5) Level listed is the passing level per EIA-JEDEC JESD22-C101E. JEDEC document JEP157 states that 250 V CDM allows safe manufacturing with a standard ESD control process, and manufacturing with less than 250 V CDM is possible if necessary precautions are taken. Pins listed as 250 V may actually have higher performance.
- (6) Based on JEDEC JESD78D [IC Latch-Up Test].

## 6.2 Recommended Operating Conditions

| PARAMETER                            |                                                                                                                                                                                                                                                                                                                                                                                                                     |                         | MIN                   | NOM                   | MAX  | UNIT |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-----------------------|-----------------------|------|------|
| CVDD                                 | Supply voltage, Core (Scalable)<br>DVFS only, No AVS                                                                                                                                                                                                                                                                                                                                                                | OPP_Nitro               | 1.28                  | 1.35                  | 1.42 | V    |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | OPP_Turbo               | 1.28                  | 1.35                  | 1.42 |      |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 120% OPP                | 1.14                  | 1.20                  | 1.26 |      |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 100% OPP <sup>(1)</sup> | 1.05                  | 1.10                  | 1.16 |      |
| CVDD_ARM                             | Supply voltage, Core ARM<br>(Scalable)                                                                                                                                                                                                                                                                                                                                                                              | OPP_Nitro               | 1.28                  | 1.35                  | 1.42 | V    |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | OPP_Turbo               | 1.28                  | 1.35                  | 1.42 |      |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 120% OPP                | 1.14                  | 1.20                  | 1.26 |      |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 100% OPP <sup>(1)</sup> | 1.05                  | 1.10                  | 1.16 |      |
| CVDD_HDVICP                          | Supply voltage, Core, HDVICP2<br>(Scalable)                                                                                                                                                                                                                                                                                                                                                                         | OPP_Nitro               | 1.28                  | 1.35                  | 1.42 | V    |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | OPP_Turbo               | 1.28                  | 1.35                  | 1.42 |      |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 120% OPP                | 1.14                  | 1.20                  | 1.26 |      |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 100% OPP <sup>(1)</sup> | 1.05                  | 1.10                  | 1.16 |      |
| DVDD                                 | Supply voltage, I/O, standard<br>pins <sup>(2)</sup>                                                                                                                                                                                                                                                                                                                                                                | 3.3 V                   | 3.14                  | 3.3                   | 3.47 | V    |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.8 V                   | 1.71                  | 1.8                   | 1.89 |      |
| DVDD_GPMC                            | Supply voltage, I/O, GPMC pin<br>group                                                                                                                                                                                                                                                                                                                                                                              | 3.3 V                   | 3.14                  | 3.3                   | 3.47 | V    |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.8 V                   | 1.71                  | 1.8                   | 1.89 |      |
| DVDD_RGMII                           | Supply voltage, I/O, RGMII pin<br>group                                                                                                                                                                                                                                                                                                                                                                             | 3.3 V                   | 3.14                  | 3.3                   | 3.47 | V    |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.8 V                   | 1.71                  | 1.8                   | 1.89 |      |
| DVDD_SD                              | Supply voltage, I/O, SD pin<br>group                                                                                                                                                                                                                                                                                                                                                                                | 3.3 V                   | 3.14                  | 3.3                   | 3.47 | V    |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.8 V                   | 1.71                  | 1.8                   | 1.89 |      |
| DVDD_C                               | Supply voltage, I/O, C pin group                                                                                                                                                                                                                                                                                                                                                                                    | 3.3 V                   | 3.14                  | 3.3                   | 3.47 | V    |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | 1.8 V                   | 1.71                  | 1.8                   | 1.89 |      |
| DVDD_DDR[0]                          | Supply voltage, I/O, DDR[0]                                                                                                                                                                                                                                                                                                                                                                                         | DDR2                    | 1.71                  | 1.8                   | 1.89 | V    |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | DDR3                    | 1.43                  | 1.5                   | 1.58 |      |
|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                     | DDR3L                   | 1.28                  | 1.35                  | 1.42 |      |
| VDDA_USB_3P3                         | Supply voltage, I/O, Analog, USB 3.3 V                                                                                                                                                                                                                                                                                                                                                                              |                         | 3.14                  | 3.3                   | 3.47 | V    |
| VDDA_1P8<br>VDDA_x_1P8<br>VDDS_x_1P8 | Supply Voltage, I/O, Analog, (VDDA_1P8,<br>VDDA_ARMPLL_1P8, VDDA_VIDPLL_1P8,<br>VDDA_AUDIOPLL_1P8, VDDA_DDRPLL_1P8,<br>VDDA_L3L4PLL_1P8, VDDA_PCIE_1P8,<br>VDDA_HDMI_1P8, VDDA_USB0_1P8, VDDA_USB1_1P8,<br>VDDA_VDAC_1P8, VDDA_CSI2_1P8,<br>VDDA_HDDACREF_1P8, VDDA_HDDAC_1P8,<br>VDDA_HDVICPPLL_1P8, VDDS_OSC0_1P8,<br>VDDS_OSC1_1P8)<br><b>Note:</b> HDMI, USB0/1, and VDAC relative to their<br>respective VSSA. |                         | 1.71                  | 1.8                   | 1.89 | V    |
| VDDA_HDDAC_1P1                       | Supply voltage, I/O, Analog, HD-DAC 1.1 V                                                                                                                                                                                                                                                                                                                                                                           |                         | 1.05                  | 1.1                   | 1.15 | V    |
| VSS                                  | Supply Ground (VSS, VSSA_HDMI, VSSA_USB,<br>VSSA_VDAC, VSSA_DEVOSC <sup>(3)</sup> , VSSA_AUXOSC <sup>(3)</sup> )                                                                                                                                                                                                                                                                                                    |                         |                       | 0                     |      | V    |
| V <sub>REFSSTL_DDR[0]</sub>          | IO Reference Voltage, (VREFSSTL_DDR[0])                                                                                                                                                                                                                                                                                                                                                                             | 0.49 *<br>DVDD_DDR[0]   | 0.50 *<br>DVDD_DDR[0] | 0.51 *<br>DVDD_DDR[0] |      | V    |
| USBx_VBUSIN                          | USBx VBUS Comparator Input                                                                                                                                                                                                                                                                                                                                                                                          |                         | 4.75                  | 5                     | 5.25 | V    |

(1) OPP100 is currently supported only on DM388 commercial temperature devices.

(2) LVCMOS pins are all I/O pins powered by DVDD, DVDD\_GPMC, DVDD\_RGMII, DVDD\_SD, DVDD\_C supplies except for I2C[0] and I2C[1] pins.

(3) When using the internal Oscillators, the oscillator grounds (VSSA\_DEVOSC, VSSA\_AUXOSC) must be kept separate from other grounds and connected directly to the crystal load capacitor ground.

**Recommended Operating Conditions (continued)**

| PARAMETER       |                                                                                                                                      |                                        | MIN                                    | NOM                                    | MAX       | UNIT |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------------------------------------|----------------------------------------|-----------|------|
| V <sub>IH</sub> | High-level input voltage, LVCMOS (JTAG[TCK] pins), 3.3 V <sup>(2)</sup>                                                              |                                        | 2                                      |                                        |           | V    |
|                 | High-level input voltage, JTAG[TCK], 3.3 V                                                                                           |                                        | 2.15                                   |                                        |           | V    |
|                 | High-level input voltage, JTAG[TCK], 1.8 V                                                                                           |                                        | 1.45                                   |                                        |           | V    |
|                 | High-level input voltage, I2C (I2C[0] and I2C[1])                                                                                    |                                        | 0.7DVDD                                |                                        |           | V    |
|                 | High-level input voltage, LVCMOS <sup>(2)</sup> , 1.8 V                                                                              |                                        | 0.65DVDDx                              |                                        |           | V    |
|                 | High-level input voltage, DDR[0] signals in DDR2 mode                                                                                |                                        | V <sub>REFSSTL_DDR[x]</sub><br>+ 0.125 |                                        |           | V    |
|                 | High-level input voltage, DDR[0] signals in DDR3 mode                                                                                |                                        | V <sub>REFSSTL_DDR[x]</sub><br>+ 0.1   |                                        |           | V    |
|                 | High-level input voltage, DDR[0] signals in DDR3L mode                                                                               |                                        | V <sub>REFSSTL_DDR[x]</sub><br>+ 0.09  |                                        |           | V    |
| V <sub>IL</sub> | Low-level input voltage, LVCMOS <sup>(2)</sup> , 3.3 V                                                                               |                                        |                                        |                                        | 0.8       | V    |
|                 | Low-level input voltage, JTAG[TCK]                                                                                                   |                                        |                                        |                                        | 0.45      | V    |
|                 | Low-level input voltage, I2C (I2C[0] and I2C[1])                                                                                     |                                        |                                        |                                        | 0.3DVDDx  | V    |
|                 | Low-level input voltage, LVCMOS <sup>(2)</sup> , 1.8 V                                                                               |                                        |                                        |                                        | 0.35DVDDx | V    |
|                 | Low-level input voltage, DDR[0] signals in DDR2 mode                                                                                 |                                        |                                        | V <sub>REFSSTL_DDR[x]</sub><br>- 0.125 |           | V    |
|                 | Low-level input voltage, DDR[0] signals in DDR3 mode                                                                                 |                                        |                                        | V <sub>REFSSTL_DDR[x]</sub><br>- 0.1   |           | V    |
|                 | Low-level input voltage, DDR[0] signals in DDR3L mode                                                                                |                                        |                                        | V <sub>REFSSTL_DDR[x]</sub><br>- 0.09  |           | V    |
| I <sub>OH</sub> | High-level output current                                                                                                            | 6 mA I/O buffers                       |                                        |                                        | -6        | mA   |
|                 |                                                                                                                                      | DDR[0] buffer @ 50-Ω impedance setting |                                        |                                        | -8        | mA   |
| I <sub>OL</sub> | Low-level output current                                                                                                             | 6 mA I/O buffers                       |                                        |                                        | 6         | mA   |
|                 |                                                                                                                                      | DDR[0] buffer @ 50-Ω impedance setting |                                        |                                        | 8         | mA   |
| V <sub>ID</sub> | Differential input voltage (SERDES_CLKN/P), [AC coupled]                                                                             |                                        | 0.250                                  |                                        | 2.0       | V    |
| t <sub>t</sub>  | Transition time, 10% - 90%, All inputs (unless otherwise specified in the <i>Electrical Data/Timing</i> sections of each peripheral) |                                        |                                        | 0.25P or 10 <sup>(4)</sup>             |           | ns   |
| T <sub>J</sub>  | Operating junction temperature range <sup>(5)</sup>                                                                                  | Commercial Temperature (default)       | 0                                      |                                        | 95        | °C   |
|                 |                                                                                                                                      | Extended temperature                   | -40                                    |                                        | 95        | °C   |

(4) Whichever is smaller. P = the period of the applied signal. Maintaining transition times as fast as possible is recommended to improve noise immunity on input signals.

(5) For more detailed information on estimating junction temps within systems, see the *IC Package Thermal Metrics* Application Report (Literature Number: [SPRA953](#)).

### 6.3 Reliability Data<sup>(1)</sup>

The information in this table is provided solely for convenience and does not extend or modify the warranty provided under TI's standard terms and conditions for TI semiconductor products.

| Operating Condition   | CVDD <sup>(2)</sup> | CVDD_ARM <sup>(2)</sup> | CVDD_HDVICP <sup>(2)</sup> | Commercial Junction Temp. (T <sub>J</sub> ) | Lifetime (POH) <sup>(3)</sup> |
|-----------------------|---------------------|-------------------------|----------------------------|---------------------------------------------|-------------------------------|
| Nitro                 | 1.35 V ± 5%         | 1.35 V ± 5%             | 1.35 V ± 5%                | 95°C                                        | 55K                           |
| Turbo                 | 1.35 V ± 5%         | 1.35 V ± 5%             | 1.35 V ± 5%                | 95°C                                        | 59K                           |
| OPP120                | 1.20 V ± 5%         | 1.20 V ± 5%             | 1.20 V ± 5%                | 95°C                                        | 100K                          |
| OPP100 <sup>(4)</sup> | 1.10 V ± 5%         | 1.10 V ± 5%             | 1.10 V ± 5%                | 95°C                                        | 100K                          |

- (1) Logic functions and parameter values are not ensured out of the range specified in the recommended operating conditions. The above notations cannot be deemed a warranty or deemed to extend or modify the warranty under TI's standard terms and conditions for TI semiconductor products.
- (2) Voltage specification at the device package pin.
- (3) Power-on-hours (POH) represent device operation under the specified nominal conditions continuously for the duration of the calculated lifetime. If actual application results in a system that operates at conditions less than the limits, the resulting POH may increase.
- (4) OPP100 is currently supported only on DM388 commercial temperature devices.

## 6.4 Electrical Characteristics Over Recommended Ranges of Supply Voltage and Operating Temperature (Unless Otherwise Noted)

| PARAMETER                           |                                                              | TEST CONDITIONS <sup>(1)</sup>             | MIN  | TYP               | MAX | UNIT |
|-------------------------------------|--------------------------------------------------------------|--------------------------------------------|------|-------------------|-----|------|
| V <sub>OH</sub>                     | Low/Full speed: USBx_DM and USBx_DP                          |                                            | 2.8  | VDDA_USB_3P_3     |     | V    |
|                                     | High speed: USBx_DM and USBx_DP                              |                                            | 360  |                   | 440 | mV   |
|                                     | High-level output voltage, LVCMOS <sup>(2)</sup> (3.3-V I/O) | 3.3 V, DVDDx = MIN, I <sub>OH</sub> = MAX  | 2.4  |                   |     | V    |
|                                     | High-level output voltage, LVCMOS <sup>(2)</sup> (1.8-V I/O) | 1.8 V, DVDDx = MIN, I <sub>OH</sub> = MAX  | 1.26 |                   |     | V    |
|                                     | High-level output voltage, DDR[0] signals in DDR2 mode       | 1.8 V, I <sub>OL</sub> = 6mA, 50 ohm load  |      | DVDD_DDR[0] - 0.4 |     | V    |
|                                     | High-level output voltage, DDR[0] signals in DDR3 mode       | 1.5 V, I <sub>OL</sub> = 6mA, 50 ohm load  |      | DVDD_DDR[0] - 0.4 |     | V    |
|                                     | High-level output voltage, DDR[0] signals in DDR3L mode      | 1.35 V, I <sub>OL</sub> = 6mA, 50 ohm load |      | DVDD_DDR[0] - 0.4 |     | V    |
| V <sub>OL</sub>                     | Low/Full speed: USBx_DM and USBx_DP                          |                                            | 0.0  |                   | 0.3 | V    |
|                                     | High speed: USBx_DM and USBx_DP                              |                                            | -10  |                   | 10  | mV   |
|                                     | Low-level output voltage, LVCMOS <sup>(2)</sup> (3.3-V I/O)  | 3.3 V, DVDDx = MAX, I <sub>OL</sub> = MAX  |      |                   | 0.4 | V    |
|                                     | Low-level output voltage, LVCMOS <sup>(2)</sup> (1.8-V I/O)  | 1.8 V, DVDDx = MAX, I <sub>OL</sub> = MAX  |      |                   | 0.4 | V    |
|                                     | Low-level output voltage, I2C (I2C[0], I2C[1])               | 1.8/3.3 V, I <sub>OL</sub> = 4mA           |      |                   | 0.4 | V    |
|                                     | Low-level output voltage, DDR[0] signals in DDR2 mode        | 1.8 V, I <sub>OL</sub> = 6mA, 50 ohm load  |      |                   | 0.4 | V    |
|                                     | Low-level output voltage, DDR[0] signals in DDR3 mode        | 1.5 V, I <sub>OL</sub> = 6mA, 50 ohm load  |      |                   | 0.4 | V    |
|                                     | Low-level output voltage, DDR[0] signals in DDR3L mode       | 1.35 V, I <sub>OL</sub> = 6mA, 50 ohm load |      |                   | 0.4 | V    |
| LDOs (applies to all LDOCAP_x pins) |                                                              |                                            |      |                   | 1.5 | V    |

(1) For test conditions shown as MIN, MAX, or TYP, use the appropriate value specified in the recommended operating conditions table.

(2) LVCMOS pins are all I/O pins powered by DVDD, DVDD\_GPMC, DVDD\_RGMII, DVDD\_SD, DVDD\_C supplies except for I2C[0] and I2C[1] pins.

**Electrical Characteristics Over Recommended Ranges of Supply Voltage and Operating Temperature  
(Unless Otherwise Noted) (continued)**

| PARAMETER      |                                                   | TEST CONDITIONS <sup>(1)</sup>                            | MIN  | TYP  | MAX  | UNIT    |
|----------------|---------------------------------------------------|-----------------------------------------------------------|------|------|------|---------|
| $I_I^{(3)}$    | Input current, LVCMOS <sup>(2)</sup> , 3.3 V mode | $0 < V_I < DVDDx$ , 3.3 V pull disabled                   | -20  |      | 20   | $\mu A$ |
|                |                                                   | $0 < V_I < DVDDx$ , 3.3 V pulldown enabled <sup>(4)</sup> | 20   | 100  | 300  | $\mu A$ |
|                |                                                   | $0 < V_I < DVDDx$ , 3.3 V pullup enabled <sup>(4)</sup>   | -20  | -100 | -300 | $\mu A$ |
|                | Input current, LVCMOS <sup>(2)</sup> , 1.8 V mode | $0 < V_I < DVDDx$ , 1.8 V pull disabled                   | -5   |      | 5    | $\mu A$ |
|                |                                                   | $0 < V_I < DVDDx$ , 1.8 V pulldown enabled <sup>(4)</sup> | 50   | 100  | 200  | $\mu A$ |
|                |                                                   | $0 < V_I < DVDDx$ , 1.8 V pullup enabled <sup>(4)</sup>   | -50  | -100 | -200 | $\mu A$ |
|                | Input current, I2C (I2C[0], I2C[1])               | 3.3 V mode                                                | -20  |      | 20   | $\mu A$ |
|                |                                                   | 1.8 V mode                                                | -5   |      | 5    | $\mu A$ |
| $I_{OZ}^{(5)}$ | I/O Off-state output current                      | 3.3 V mode, pull enabled                                  | -300 |      | 300  | $\mu A$ |
|                |                                                   | 3.3 V mode, pull disabled                                 | -20  |      | 20   | $\mu A$ |
|                |                                                   | 1.8 V mode, pull enabled                                  | -200 |      | 200  | $\mu A$ |
|                |                                                   | 1.8 V mode, pull disabled                                 | -5   |      | 5    | $\mu A$ |
| $C_I$          | Input capacitance LVCMOS <sup>(2)</sup>           |                                                           |      |      | 12   | pF      |
| $C_O$          | Output capacitance LVCMOS <sup>(2)</sup>          |                                                           |      |      | 12   | pF      |

(3)  $I_I$  applies to input-only pins and bi-directional pins. For input-only pins,  $I_I$  indicates the input leakage current. For bi-directional pins,  $I_I$  indicates the input leakage current and off-state (Hi-Z) output leakage current.

(4) Applies only to pins with an internal pullup (IPU) or pulldown (IPD) resistor.

(5)  $I_{OZ}$  applies to output-only pins, indicating off-state (Hi-Z) output leakage current.



## 7 Power, Reset, Clocking, and Interrupts

### 7.1 Power, Reset and Clock Management (PRCM) Module

The PRCM module is the centralized management module for the power, reset, and clock control signals of the device. It interfaces with all the components on the device for power, clock, and reset management through power-control signals. It integrates enhanced features to allow the device to adapt energy consumption dynamically, according to changing application and performance requirements. The innovative hardware architecture allows a substantial reduction in leakage current.

The PRCM module is composed of two main entities:

- Power reset manager (PRM): Handles the power, reset, wake-up management, and system clock source control (oscillator)
- Clock manager (CM): Handles the clock generation, distribution, and management.

For more details on the PRCM, see the *Power, Reset, and Clock Management (PRCM) Module* chapter in the device-specific Technical Reference Manual.

### 7.2 Power

#### 7.2.1 Voltage and Power Domains

Every Module within the device belongs to a Core Logic Voltage Domain, Memory Voltage Domain, and a Power Domain (see [Table 7-1](#)).

**Table 7-1. Voltage and Power Domains**

| CORE LOGIC VOLTAGE DOMAIN | MEMORY VOLTAGE DOMAIN | POWER DOMAIN | MODULE(S)                                                                                                                                                                                                                                                                                                   |
|---------------------------|-----------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ARM_L                     | ARM_M                 | ALWAYS ON    | ARM Cortex-A8 Subsystem, SmartReflex Sensor 0                                                                                                                                                                                                                                                               |
| CORE_L                    | CORE_M                |              | ATL, HDMI, DMM, EDMA, ELM, DDR, EMAC Switch, GPIO Banks 0/1/2/3, GPMC, I2C0/1/2/3, IPC, MCASP0/1, OCMC SRAM, PCIE, PRCM, RTC, SD/MMC0/1/2, SPI01/2/3, Timer1/2/3/4/5/6/7/8, UART0/1/2, USB0/1, WDT0, System Interconnect, JTAG, Media Controller, ISS, SmartReflex Control Module 0/1, SmartReflex Sensor 1 |
|                           |                       |              | ISP, CSI2 PHY LOGIC                                                                                                                                                                                                                                                                                         |
|                           |                       |              | HDVPSS, SD-DAC, HD-DAC                                                                                                                                                                                                                                                                                      |
| HDVICP_L                  | HDVICP_M              | HDVICP       | HDVICP2, SmartReflex Sensor 2                                                                                                                                                                                                                                                                               |

##### 7.2.1.1 Core Logic Voltage Domains

The device contains three Core Logic Voltage Domains. These domains define groups of Modules that share the same supply voltage for their core logic. Each Core Logic Voltage Domain is powered by a dedicated supply voltage rail that can be independently scaled using SmartReflex technology to trade off power versus performance. [Table 7-2](#) shows the mapping between the Core Logic Voltage Domains and their associated supply pins.

**Table 7-2. Core Logic Voltage Domains and Supply Pin Associations**

| CORE LOGIC<br>VOLTAGE DOMAIN | SUPPLY PIN NAME |
|------------------------------|-----------------|
| ARM_L                        | CVDD_ARM        |
| CORE_L                       | CVDD            |
| HDVICP_L                     | CVDD_HDVICP     |

**Note:** A regulated supply voltage **must** be supplied to each Core Logic Voltage Domain at all times, regardless of the Core Logic Power Domain states.

### 7.2.1.2 Power Domains

The device contains four Power Domains which supply power to both the Core Logic and SRAM within their associated modules. Each Power Domain, except for the ALWAYS ON domain, has an internal power switch that can completely remove power from that domain. All power switches are turned "OFF" by default after reset, and software can individually turn them "ON/OFF" via Control Module registers.

*Note:* All Modules within a Power Domain are unavailable when the domain is powered "OFF". For instructions on powering "ON/OFF" the Power domains, see the *Power, Reset, and Clock Management (PRCM) Module* chapter of the device-specific *Technical Reference Manual*.

### 7.2.2 SmartReflex™ [Currently Not Supported]

The device contains SmartReflex modules that help to minimize power consumption on the Core Logic Voltage Domains by using external variable-voltage power supplies. Based on the device process, temperature, and desired performance, the SmartReflex modules advise the host processor to raise or lower the supply voltage to each domain for minimal power consumption.

The communication link between the host processor and the external regulators is a system-level decision and can be accomplished using GPIOs, I2C, SPI, or other methods. The following sections briefly describe the two major techniques employed by SmartReflex: Dynamic Voltage Frequency Scaling (DVFS) and Adaptive Voltage Scaling (AVS).

#### 7.2.2.1 Dynamic Voltage Frequency Scaling (DVFS) [Currently Supports Only Discrete OPPs]

Each device Core Logic Voltage Domain can be run independently at one of several Operating Performance Points (OPPs). An OPP for a specific Core Logic Voltage Domain is defined by: (1) maximum frequencies of operation for Modules within the Domain and (2) an associated supply voltage range. Trading off power versus performance, OPPs with lower maximum frequencies also have lower voltage ranges for power savings.

The OPP for a domain can be changed in real-time without requiring a reset. This feature is called Dynamic Voltage Frequency Scaling (DVFS) [Table 7-3](#) contains a list of voltage ranges and maximum module frequencies for the OPPs of each Core Logic Voltage Domain.

#### NOTE

Not all devices support all OPP frequencies.

OPP100 is currently supported only on DM388 commercial temperature devices.

**Table 7-3. Device Operating Points (OPPs)**

| OPP                                | CORE LOGIC VOLTAGE DOMAINS |         |              |           |                   |                   |                          |
|------------------------------------|----------------------------|---------|--------------|-----------|-------------------|-------------------|--------------------------|
|                                    | ARM                        | HDVICP2 | CORE         |           |                   |                   |                          |
|                                    | Cortex A8 (MHz)            | HDVICP2 | HDVPSS (MHz) | ISS (MHz) | Media Ctlr. (MHz) | L3/L4, Core (MHz) | DDR (MHz) <sup>(1)</sup> |
| 100%(1.1 V) (AAR0x) <sup>(2)</sup> | 600                        | 220     | 200          | 400       | 200               | 200               | 400                      |
| 120% (1.2 V) (AAR0x)               | 720                        | 290     | 200          | 400       | 200               | 200               | 400                      |
| Turbo (1.35 V) (AAR1x)             | 970                        | 410     | 240          | 480       | 240               | 240               | 533                      |
| Nitro (1.35 V) (AAR2x)             | 1000                       | 450     | 260          | 560       | 280               | 240               | 533                      |

(1) All DDR access **must** be suspended prior to changing the DDR frequency of operation.

(2) OPP100 is currently supported only on DM388 commercial temperature devices.

Although the OPP for each Core Logic Voltage Domain is independently selectable, not all combinations of OPPs are supported. [Table 7-4](#) marks the supported ARM OPPs for a given CORE OPP.

**Table 7-4. Supported OPP Combinations<sup>(1)</sup>**

| CORE                  | ARM   |       |        |                       | HDVICP2 |       |        |                       |
|-----------------------|-------|-------|--------|-----------------------|---------|-------|--------|-----------------------|
|                       | Nitro | Turbo | OPP120 | OPP100 <sup>(2)</sup> | Nitro   | Turbo | OPP120 | OPP100 <sup>(2)</sup> |
| Nitro                 | X     |       |        |                       | X       |       |        |                       |
| Turbo                 |       | X     |        |                       |         | X     |        |                       |
| OPP120                |       |       | X      | X                     |         |       | X      | X                     |
| OPP100 <sup>(2)</sup> |       |       |        | X                     |         |       |        | X                     |

(1) "X" denotes supported combinations.

(2) OPP100 is currently only supported on DM388 commercial temperature devices.

### 7.2.2.2 Adaptive Voltage Scaling [Currently Not Supported]

As mentioned in [Section 7.2.2.1, Dynamic Voltage Frequency Scaling \(DVFS\)](#) above, every OPP has an associated voltage range. Based on the silicon process, temperature, and chosen OPP, the SmartReflex modules guide software in adjusting the Core Logic Voltage Domain supply voltage (CVDD) within these ranges. This technique is called Adaptive Voltage Scaling (AVS). AVS occurs continuously and in real-time, helping to minimize power consumption in response to changing operating conditions.

### 7.2.3 Memory Power Management

In order to reduce SRAM leakage, many SRAM blocks can be switched from ACTIVE mode to SHUTDOWN mode. When SRAM is put in SHUTDOWN mode, the voltage supplied to it is automatically removed and all data in that SRAM is lost.

All SRAM located in a switchable power domain (all domains except ALWAYS\_ON) automatically enters SHUTDOWN mode whenever its associated power domain goes into the "OFF" state. The SRAM returns to the ACTIVE state when the corresponding Power Domain returns to the "ON" state.

In addition, the following SRAM within the ALWAYS\_ON Power Domain can also be independently put into SHUTDOWN by programming the x\_MEM\_PWRDN registers in the Control Module:

- Media Controller SRAM
- OCMC SRAM

### 7.2.4 SERDES\_CLKP/N LDO

The SERDES\_CLKP/N input buffers are powered by an internal LDO which is programmed through the REFCLK\_LJCB LDO\_CTRL register in the Control Module.

### 7.2.5 Dual Voltage I/Os

The device supports dual voltages on some of its I/Os. These I/Os are partitioned into the following groups, and each group has its own dedicated supply pins: DVDD, DVDD\_GPMC, DVDD\_C, and DVDD\_SD. The supply voltage for each group can be independently powered with either 1.8 V or 3.3 V.

For the mapping between pins and power groups, see [Section 3.3](#), *Terminal Functions* of the datasheet.

In addition, the I/O voltage on the DDR interface is independently selectable between 1.35 V, 1.5 V or 1.8 V to support various DDR device types.

### 7.2.6 I/O Power-Down Modes

On the device, there are power-down modes available for the following PHYs:

- Video DACs
- DDR
- USB
- HDMI
- CSI2
- PCIE

When a PHY controller is in a power domain that is to be turned "OFF", software must configure the corresponding PHY into power-down mode, prior to putting the power domain in the "OFF" state.

## 7.2.7 Standby and Deep Sleep Modes

The device supports Low-Power Standby and Deep-Sleep Modes as described below.

**Standby Mode** is defined as a state in which:

- All switchable power domains are in "OFF" state
- The ARM Cortex-A8 is executing an IDLE loop at its lowest frequency of operation
- All functional blocks not needed for a given application are clock gated

**Deep Sleep Mode** is defined to be the same as Standby Mode, with the addition of gating the crystal oscillator to further eliminate all active power. The device core voltages can be reduced for optimal power savings.

For detailed instructions on entering and exiting from Standby and Deep Sleep Modes, see the *Power, Reset, and Clock Management (PRCM) Module* chapter in the device-specific Technical Reference Manual.

## 7.2.8 Supply Sequencing

The device power supplies are organized into five Supply Sequencing Groups:

1. CVDD Core Logic supply (CVDD)
2. All CVDD\_x supplies (CVDD\_ARM and CVDD\_HDVICP)
3. All 1.35-/1.5-/1.8-V DVDD\_DDR[0] Supplies (1.35 V for DDR3L, 1.5 V for DDR3, 1.8 V for DDR2)
4. All 1.8-V Supplies (DVDD\_x, VDDA\_x\_1P8, VDDA\_1P8)
5. All 3.3-V Supplies (DVDD, DVDD\_x, DVDD\_C, VDDA\_x\_3P3)

To ensure proper device operation, a specific power-up and power-down sequence must be followed. Some TI power-supply devices include features that facilitate these power sequencing requirements — for example, TI's TPS659113 integrated PMIC. For more information on TI power supplies and their features, visit [www.ti.com/processorpower](http://www.ti.com/processorpower).

### 7.2.8.1 Power-Up Sequence

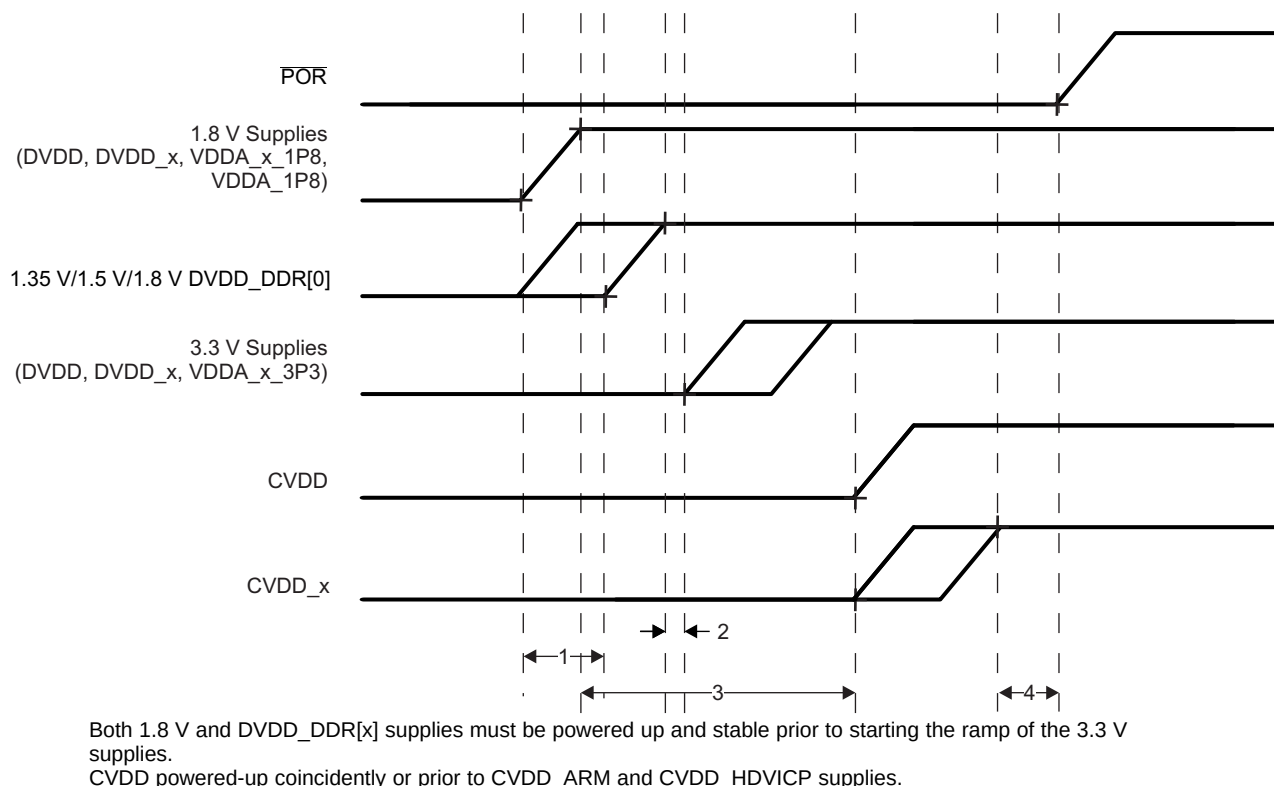
For proper device operation, the following power-up sequence in [Table 7-5](#) and [Figure 7-1](#) **must** be followed.

**Table 7-5. Power-Up Sequence Ramping Values**

| NO. | DESCRIPTION                                                          | MIN              | MAX | UNIT          |
|-----|----------------------------------------------------------------------|------------------|-----|---------------|
| 1   | 1.8 V supplies to 1.35-/1.5-/1.8-V DVDD_DDR[x] supplies              | 0 <sup>(1)</sup> |     | ms            |
| 2   | DVDD_DDR supplies stable to 3.3 V supplies ramp start                | 0 <sup>(2)</sup> |     | ms            |
| 3   | 1.8 V supplies stable to CVDD, CVDD_x variable supplies ramp start   | 0 <sup>(1)</sup> |     | ms            |
| 4   | All supplies valid to power-on-reset ( $\overline{\text{POR}}$ high) | 4 096            |     | Master Clocks |

(1) The 1.8 V supplies **must** be  $\geq$  1.35-/1.5-/1.8-V DVDD\_DDR[x] and CVDD, CVDD\_x variable supplies.

(2) Both 1.8 V and DVDD\_DDR[x] supplies must be powered up and stable prior to starting the ramp of the 3.3 V supplies.

**Figure 7-1. Power-Up Sequence****7.2.8.2 Power-Down Sequence**

For proper device operation, the following power-down sequence in [Table 7-6](#), [Figure 7-2](#), [Figure 7-3](#), and [Figure 7-4](#) **must** be followed.

**Table 7-6. Power-Down Sequence Ramping Values**

| NO. | DESCRIPTION                                             | MIN | MAX | UNIT |
|-----|---------------------------------------------------------|-----|-----|------|
| 5   | CVDD, CVDD_x variable supplies to 1.8 V supplies        | 0   |     | ms   |
| 6   | 1.35-/1.5-/1.8-V DVDD_DDR[x] supplies to 1.8 V supplies | 0   |     | ms   |
| 7   | 3.3 V supplies to 1.8 V supplies                        | (1) | (1) | ms   |
| 8   | CVDD_x supplies to CVDD supply                          | (2) | (2) | ms   |

(1) The 3.3 V supplies **must** never be more than 2 V above the 1.8 V supplies (see [Figure 7-3](#)).

(2) The CVDD supply must be powered down coincidentally or after CVDD\_ARM and CVDD\_HDVICP supplies (see [Figure 7-4](#)).

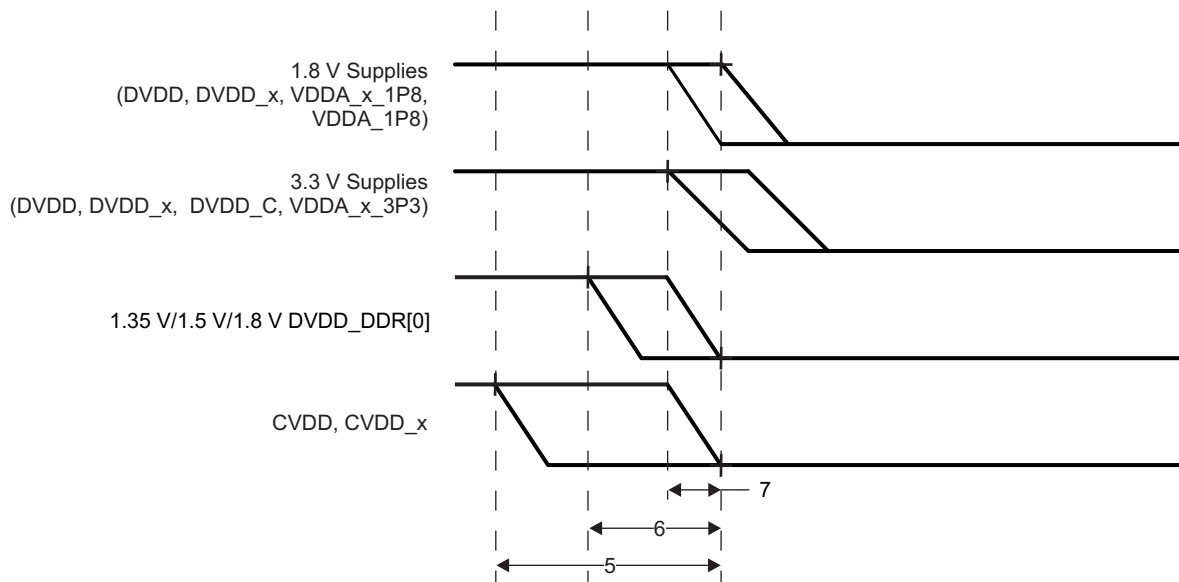


Figure 7-2. Power-Down Sequence

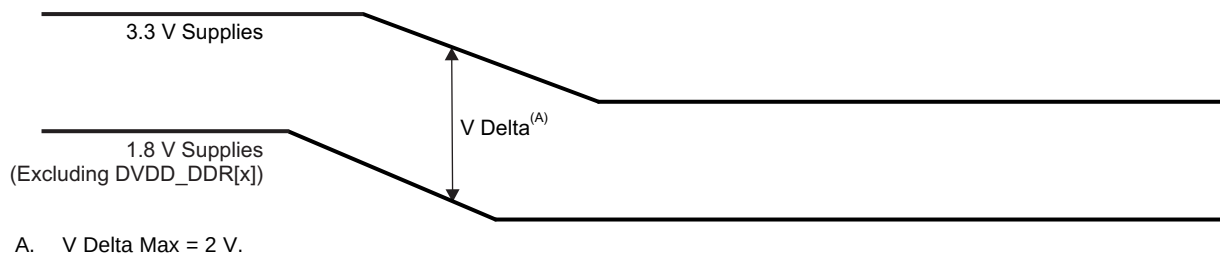


Figure 7-3. 3.3 V Supplies Falling After 1.8 V Supplies Delta

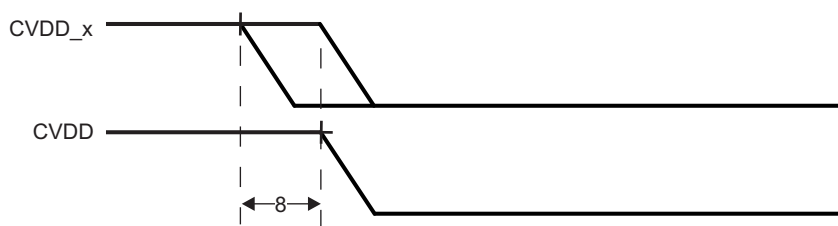


Figure 7-4. CVDD and CVDD\_x Power-Down Sequence

## 7.2.9 Power-Supply Decoupling

### 7.2.9.1 Analog and PLL

PLL and Analog supplies benefit from filters or ferrite beads to keep the noise from causing problems. The minimum recommendation is a ferrite bead along with at least one capacitor on the device side of the bead. An additional recommendation is to add one capacitor just before the bead to form a Pi filter. The filter needs to be as close as possible to the device pin, with the device side capacitor being the most important component to be close to the device pin. PLL pins close together can be combined on the same supply, but analog pins should all have their own filters. PLL pins farther away from each other may need their own filtered supply.

### 7.2.9.2 Digital

Recommended capacitors for power supply decoupling are all 0.1uF in the smallest body size that can be used. Capacitors are more effective in the smallest physical size to limit lead inductance. For example, 0201 sized capacitors are better than 0402 sized capacitors, and so on. TI recommends using capacitors no larger than 0402. Place at least one capacitor for every two power pins. For those power pins that have only one pin, a capacitor is still required. Place one bulk (10 uF or larger) capacitor for every 10 or so power pins as closely as possible to the chip. These larger caps do not need to be under the chip footprint.

Pay special attention not to put so much capacitance on the supply that it slows the start-up voltage ramp enough to change the power sequencing order. Also be sure to verify that the main chip reset is low until after all supplies are at their correct voltage and stable.

DDR peripheral related supply capacitor numbers are provided in [Section 8.13](#), *DDR2/DDR3/DDR3L Memory Controller*.



## 7.3 Reset

### 7.3.1 System-Level Reset Sources

The device has several types of system-level resets. [Table 7-7](#) lists these reset types, along with the reset initiator, and the effects of each reset on the device.

**Table 7-7. System-Level Reset Types**

| TYPE                       | INITIATOR                     | RESETS ALL MODULES, EXCLUDING EMAC SWITCH, EMULATION, PLL AND CLOCK CONFIG | RESETS EMAC SWITCH      | RESETS EMULATION | PLL AND CLOCK CONFIG | LATCHES BOOT PINS | ASSERTS RSTOUT_WD_OUT PIN  |
|----------------------------|-------------------------------|----------------------------------------------------------------------------|-------------------------|------------------|----------------------|-------------------|----------------------------|
| Power-on Reset (POR)       | $\overline{\text{POR}}$ pin   | Yes                                                                        | Yes                     | Yes              | Yes                  | Yes               | Optional <sup>(1)(2)</sup> |
| External Warm Reset        | $\overline{\text{RESET}}$ pin | Yes                                                                        | Optional <sup>(3)</sup> | No               | No                   | Yes               | Optional <sup>(1)(2)</sup> |
| Emulation Warm Reset       | On-Chip Emulation Logic       | Yes                                                                        | Optional <sup>(3)</sup> | No               | No                   | No                | Optional <sup>(1)</sup>    |
| Watchdog Reset             | Watchdog Timer                | Yes                                                                        | Optional <sup>(3)</sup> | No               | No                   | No                | Yes                        |
| Software Global Cold Reset | Software                      | Yes                                                                        | Optional <sup>(3)</sup> | Yes              | Yes                  | No                | Optional <sup>(1)</sup>    |
| Software Global Warm Reset | Software                      | Yes                                                                        | Optional <sup>(3)</sup> | No               | No                   | No                | Optional <sup>(1)</sup>    |
| Test Reset                 | $\overline{\text{TRST}}$ pin  | No                                                                         | No                      | Yes              | No                   | No                | No                         |

- (1)  $\overline{\text{RSTOUT\_WD\_OUT}}$  pin asserted only if BTMODE[11] was latched as "0" when coming out of reset.
- (2) While POR and/or  $\overline{\text{RESET}}$  is asserted, the  $\overline{\text{RSTOUT\_WD\_OUT}}$  pin is 3-stated and the internal pull resistor is disabled; therefore, an external pullup/pulldown can be used to set the state of this pin (high/low) while POR and/or  $\overline{\text{RESET}}$  is asserted. For more detailed information on external PUs/PDs, see [Section 4.5.1, Pullup/Pulldown Resistors](#).
- (3) EMAC Switch is NOT reset when the ISO\_CONTROL bit in the RESET\_ISO Control Module register is set to "1".

### 7.3.2 Power-on Reset ( $\overline{\text{POR}}$ pin)

Power-on Reset (POR) is initiated by the  $\overline{\text{POR}}$  pin and is used to reset the entire chip, including the Test and Emulation logic, and the EMAC Switch.  $\overline{\text{POR}}$  is also referred to as a cold reset since it is required to be asserted when the device goes through a power-up cycle. However, a device power-up cycle is not required to initiate a Power-on Reset.

The following sequence **must** be followed during a Power-on Reset:

1. Wait for the power supplies to reach normal operating conditions while keeping the  $\overline{\text{POR}}$  pin asserted.
2. Wait for the input clock sources DEV\_CLKIN, AUX\_CLKIN, and SERDES\_CLKN/P to be stable (if used by the system) while keeping the  $\overline{\text{POR}}$  pin asserted (low).
3. Once the power supplies and the input clock sources are stable, the  $\overline{\text{POR}}$  pin must remain asserted (low) [see [Section 7.3.18, Reset Electrical Data/Timing](#)]. Within the low period of the  $\overline{\text{POR}}$  pin, the following happens:
  - (a) All pins except Emulation pins enter a Hi-Z mode and the associated pulls, if applicable, will be enabled.
  - (b) The PRCM asserts reset to all modules within the device.
  - (c) The PRCM begins propagating these clocks to the chip with the PLLs in BYPASS mode.
4. The  $\overline{\text{POR}}$  pin may now be de-asserted (driven high). When the  $\overline{\text{POR}}$  pin is de-asserted (high):
  - (a) The BTMODE[15:0] pins are latched.
  - (b) Reset to the ARM Cortex-A8 and Modules without a local processor is de-asserted.
  - (c)  $\overline{\text{RSTOUT\_WD\_OUT}}$  is briefly asserted if BTMODE[11] was latched as "0".
  - (d) The clock, reset, and power-down state of each peripheral is determined by the default settings of the PRCM.
  - (e) The ARM Cortex-A8 begins executing from the Boot ROM.

### 7.3.3 External Warm Reset ( $\overline{\text{RESET}}$ pin)

An external warm reset is activated by driving the  $\overline{\text{RESET}}$  pin active-low. This resets everything in the device, except for the Test and Emulation logic, and the EMAC Switch (optional). An emulator session stays alive during warm reset.

The following sequence **must** be followed during a warm reset:

1. Power supplies and input clock sources should already be stable.
2. The  $\overline{\text{RESET}}$  pin must be asserted (low)[see [Section 7.3.18, Reset Electrical Data/Timing](#)]. Within the low period of the  $\overline{\text{RESET}}$  pin, the following happens:
  - (a) All pins, except Test and Emulation pins, enter a Hi-Z mode and the associated pulls, if applicable, will be enabled.
  - (b) The PRCM asserts reset to all modules within the device, except for the Test and Emulation logic, EMAC Switch (optional), PLL, and Clock configuration.
3. The  $\overline{\text{RESET}}$  pin may now be de-asserted (driven high). When the  $\overline{\text{RESET}}$  pin is de-asserted (high):
  - (a) The BTMODE[15:0] pins are latched.
  - (b) Reset to the ARM Cortex-A8 and modules without a local processor is de-asserted, with the exception of Test and Emulation logic, EMAC Switch (optional), PLL, and Clock configuration.
  - (c) RSTOUT\_WD\_OUT is asserted [see [Section 7.3.18, Reset Electrical Data/Timing](#)], if BTMODE[11] was latched as "0".
  - (d) The clock, reset, and power-down state of each peripheral is determined by the default settings of the PRCM.
  - (e) The ARM Cortex-A8 begins executing from the Boot ROM.

### 7.3.4 Emulation Warm Reset

An Emulation Warm Reset is activated by the on-chip Emulation Module. It has the same effect and requirements as an External Warm Reset ( $\overline{\text{RESET}}$ ), with the following exceptions:

- BTMODE[15:0] pins are not re-latched
- $\overline{\text{RSTOUT\_WD\_OUT}}$  is not 3-stated and is actively driven based on the value previously latched on the BTMODE[11] pin.

The emulator initiates an Emulation Warm Reset via the ICEPICK module. To invoke the Emulation Warm Reset via the ICEPICK module, the user can perform the following from the Code Composer Studio™ IDE menu: Target -> Reset -> System Reset.

### 7.3.5 Watchdog Reset

A Watchdog Reset is initiated when the Watchdog Timer counter reaches zero. It has the same effect and requirements as an External Warm Reset ( $\overline{\text{RESET}}$  pin), with the following exceptions:

- BTMODE[15:0] pins are not re-latched
- $\overline{\text{RSTOUT\_WD\_OUT}}$  is not 3-stated and is actively driven based on the value previously latched on the BTMODE[11] pin.

In addition, a Watchdog Reset always results in  $\overline{\text{RSTOUT\_WD\_OUT}}$  being asserted, regardless of whether the BTMODE[11] pin was latched as "0" or "1".

### 7.3.6 Software Global Cold Reset

A Software Global Cold Reset is initiated under software control. It has the same effect and requirements as a POR Reset, with the following exceptions:

- BTMODE[15:0] pins are not re-latched and EMAC Switch (optional) is not reset
- $\overline{\text{RSTOUT\_WD\_OUT}}$  is not 3-stated and is actively driven based on the value previously latched on the BTMODE[11] pin.

Software initiates a Software Global Cold Reset by writing a "1" to the RST\_GLOBAL\_COLD\_SW bit in the PRM\_RSTCTRL register in the PRCM.

For more detailed information on the PRM\_RSTCTRL register, see the PRCM Registers section of the *Power, Reset, and Clock Management (PRCM) Module* chapter in the device-specific Technical Reference Manual.

### 7.3.7 Software Global Warm Reset

A Software Global Warm Reset is initiated under software control. It has the same effect and requirements as a External Warm Reset ( $\overline{\text{RESET}}$  pin), with the following exceptions:

- BTMODE[15:0] pins are not re-latched
- $\overline{\text{RSTOUT\_WD\_OUT}}$  is not 3-stated and is actively driven based on the value previously latched on the BTMODE[11] pin.

Software initiates a Software Global Warm Reset by writing a "1" to the RST\_GLOBAL\_WARM\_SW bit in the PRM\_RSTCTRL register in the PRCM.

For more detailed information on the PRM\_RSTCTRL register, see the PRCM Registers section of the *Power, Reset, and Clock Management (PRCM) Module* chapter in the device-specific Technical Reference Manual.

### 7.3.8 Test Reset ( $\overline{\text{TRST}}$ pin)

A Test Reset is activated by the emulator asserting the  $\overline{\text{TRST}}$  pin. The only effect a Test Reset has is to reset the Test and Emulation Logic.

### 7.3.9 Local Reset

The Local Reset for various Modules within the device is controlled by programming the PRCM and/or the Peripheral Module's internal registers. Only the associated Module is reset when a Local Reset is asserted, leaving the rest of the device unaffected.

For more details on Peripheral Local Resets, see the Reset Management section of the *Power, Reset, and Clock Management (PRCM) Module* chapter in the device-specific Technical Reference Manual.

### 7.3.10 Reset Priority

If any of the above reset sources occur simultaneously, the device only processes the highest-priority reset request. The reset request priorities, from high-to-low, are as follows:

1. Power-on Reset ( $\overline{\text{POR}}$ )
2. Test Reset ( $\overline{\text{TRST}}$ )
3. External Warm Reset ( $\overline{\text{RESET}}$  pin)
4. Emulation Warm Resets
5. Watchdog Reset
6. Software Global Cold/Warm Resets

### 7.3.11 Reset Status Register

The Reset Status Register (PRM\_RSTST) contains information about the last reset that occurred in the system. For more information on this register, see the *Power, Reset, and Clock Management (PRCM) Module* chapter in the device-specific Technical Reference Manual.

### 7.3.12 PCIE Reset Isolation

The device supports reset isolation for the PCI Express (PCIE) module. This means that the PCI Express Subsystem can be reset without resetting the rest of the device.

When the device is a PCI Express Root Complex (RC), the PCIE Subsystem can be reset by software through the PRCM. Software should ensure that there are no ongoing PCIE transactions before asserting this reset by first taking the PCIE Subsystem into the IDLE state. After bringing the PCIE Subsystem out of reset, bus enumeration should be performed again and should treat all Endpoints (EP) as if they had just been connected.

When the device is a PCI Express Endpoint (EP), the PCIE Subsystem will generate an interrupt when an in-band reset is received. Software should process this interrupt by putting the PCIE Subsystem in the IDLE state and then asserting the PCIE local reset through the PRCM.

All device level resets mentioned in the previous sections, except Test Reset, will also reset the PCIE Subsystem. Therefore, the PCIE peripheral should issue a Hot Reset to all downstream devices and re-enumerate the bus upon coming out of reset.

For more detailed information on reset isolation procedures, see the PCIe Reset Isolation section of the *Power, Reset, and Clock Management (PRCM) Module* chapter in the device-specific Technical Reference Manual.

### 7.3.13 EMAC Switch Reset Isolation

The device supports reset isolation for the Ethernet Switch (EMAC Switch) only when clock sourced from SERDES. The other clocking source options do not provide RESET Isolation. This allows the device to undergo all resets listed in [Section 7.3.1, System-Level Reset Sources](#), with the exception of  $\overline{\text{POR}}$  Reset, without disrupting the Ethernet Switch or the traffic being routed through the switch during the reset condition. The following reset types can optionally provide an EMAC Switch reset isolation by setting the ISO\_CONTROL bit in the RESET\_ISO Control Module register to a "1":

- External Warm Reset
- Emulation Warm Reset
- Watchdog Reset
- Software Global Cold Reset
- Software Global Warm Reset

When one of above resets occurs and the Ethernet Switch (EMAC Switch) is programmed to be isolated:

- The switch function of the EMAC Switch and the PLL embedded in the SERDES Module (which provides the reference clocks to the EMAC Switch) will not be reset.
- Several Control Module registers are not reset. For more details, see the description of the RESET\_ISO register in the *Control Module* chapter of the device-specific Technical Reference Manual.
- The pin multiplexing of some of the EMAC Switch pins is unaffected. For more details, see the description of the RESET\_ISO register in the *Control Module* chapter in the device-specific Technical Reference Manual.

The EMAC Switch is always reset when:

- One of the above resets occurs and the Ethernet Switch is programmed to be "not isolated"
- A  $\overline{\text{POR}}$  Reset occurs

### 7.3.14 $\overline{\text{RSTOUT\_WD\_OUT}}$ Pin

The  $\overline{\text{RSTOUT\_WD\_OUT}}$  pin reflects device reset status and is de-asserted (high) when the device is out reset. This output will always be asserted when a Watchdog Timer reset (Watchdog Reset) occurs. In addition, this output is always 3-stated and the internal pull resistor is disabled on this pin while  $\overline{\text{POR}}$  and/or  $\overline{\text{RESET}}$  is asserted; therefore, an external pullup/pulldown can be used to set the state of this pin (high/low) while  $\overline{\text{POR}}$  and/or  $\overline{\text{RESET}}$  is asserted. For more detailed information on external PUs/PDs, see [Section 4.5.1, Pullup/Pulldown Resistors](#).

If the BTMODE[11] pin is latched as a "0" at the rising edge of  $\overline{\text{POR}}$  or  $\overline{\text{RESET}}$ , then  $\overline{\text{RSTOUT\_WD\_OUT}}$  is also asserted when any of the below resets occur:

- Power-On Reset (asserted after the BTMODE[11] pin is latched)
- External Warm Reset (asserted after the BTMODE[11] pin is latched)
- Emulation Warm Reset
- Software Global Cold/Warm Reset

The  $\overline{\text{RSTOUT\_WD\_OUT}}$  pin remains asserted until the PRCM releases the host ARM Cortex-A8 processor for reset.

### 7.3.15 Effect of Reset on Emulation & Trace

The device Emulation & Trace Logic will only be reset by the following sources:

- Power-On Reset
- Software Global Cold Reset
- Test Reset

Other than these three reset types, none of the other resets will affect the Emulation and Trace Logic. However, the multiplexing of the EMU[4:2] pins is reset by all system reset types except Test Reset.

### 7.3.16 Reset During Power Domain Switching

Each Power Domain has a dedicated Warm Reset and Cold Reset. Warm Reset for a Power Domain is asserted under either of the following two conditions:

1. An External Warm Reset, Emulation Warm Reset, or Software Global Warm Reset occurs
2. When that Power Domain switches from the "ON" state to the "OFF" state

Cold Reset for a Power Domain is asserted under either of the following two conditions:

1. Power-On Reset or Software Global Cold Reset occurs
2. When that Power Domain switches from the "OFF" state to the "ON" state

### 7.3.17 Pin Behaviors at Reset

When any reset, other than Test Reset, (all described in [Section 7.3.1, System-Level Reset Sources](#)) is asserted, all device I/O pins are reset into a Hi-Z state except for:

- Emulation Pins. These pins are only put into a Hi-Z state when Test Reset ( $\overline{\text{TRST}}$ ) is asserted.
- EMAC Switch Pins. These pins are always put into a Hi-Z state during Power-On Reset. However, some EMAC Switch pins will **not** be put into a Hi-Z state during the other reset modes when the ISO\_CONTROL bit in the RESET\_ISO register of the Control Module is programmed as a "1". For more details, see the description of the RESET\_ISO register in the *Control Module* chapter in the device-specific Technical Reference Manual.
- $\overline{\text{RSTOUT\_WD\_OUT}}$  Pin during any reset types except for  $\overline{\text{POR}}$  and  $\overline{\text{RESET}}$ . For more detailed information on  $\overline{\text{RSTOUT\_WD\_OUT}}$  pin behavior, see [Section 7.3.14,  \$\overline{\text{RSTOUT\\_WD\\_OUT}}\$  Pin](#).
- DDR[0] Address/Control Pins (CLK,  $\overline{\text{CLK}}$ , CKE,  $\overline{\text{WE}}$ ,  $\overline{\text{CS}}[0]$ , RAS,  $\overline{\text{CAS}}$ ,  $\overline{\text{ODT}}[0]$ , RST, BA[2:0], A[15:0]). These pins are 3-stated during reset. However, these pins are then driven to the same value as their internal pull resistor reset value when reset is released.

In addition, the PINCNTL registers, which control pin multiplexing, enabling the IPU/IPDs, and enabling the receiver, are reset to their default state. Again, enabling the EMAC Switch reset isolation prevents some PINCNTL registers from being reset.

For details on EMAC Switch reset isolation, see the descriptions of the RESET\_ISO register and the PINCNTL registers in the *Control Module* chapter in the device-specific Technical Reference Manual.

Internal pull-up/down (IPU/IPD) resistors are enabled during and immediately after reset as described in [Section 3.3, Terminal Functions](#) of this document.

**NOTE**

The reset pin state is after all the power supplies are ramped up and stable. The state is not not ensured during power-up sequencing.

Upon coming out of reset, the ARM Cortex-A8 starts executing code from the internal Boot ROM. The Boot ROM code modifies the PINCNTLx registers to configure the associated pins for the chosen primary and backup Bootmodes.

**7.3.18 Reset Electrical Data/Timing****NOTE**

For supported OPP frequencies, see [Table 7-3, Device Operating Points \(OPPs\)](#).

**Table 7-8. Timing Requirements for Reset (see [Figure 7-5](#) and [Figure 7-6](#))**

| NO. |                 |                                                                                             |                    | OPP100            |                    | UNIT |
|-----|-----------------|---------------------------------------------------------------------------------------------|--------------------|-------------------|--------------------|------|
|     |                 |                                                                                             |                    | MIN               | MAX                |      |
| 1   | $t_{w(RESSET)}$ | Pulse duration, $\overline{POR}$ low or $\overline{RESET}$ low                              |                    |                   | 12P <sup>(1)</sup> | ns   |
| 2   | $t_{su(BOOT)}$  | Setup time, BTMODE[15:0] pins valid before $\overline{POR}$ high or $\overline{RESET}$ high | $\overline{POR}$   | 2P <sup>(2)</sup> |                    | ns   |
|     |                 |                                                                                             | $\overline{RESET}$ | 2P <sup>(2)</sup> |                    | ns   |
| 3   | $t_h(BOOT)$     | Hold time, BTMODE[15:0] pins valid after $\overline{POR}$ high or $\overline{RESET}$ high   |                    |                   | 0                  | ns   |

(1) The device clock source **must** be stable and at a valid frequency prior to meeting the  $t_{w(RESSET)}$  requirement.

(2) P = 1/(DEV Clock) frequency in ns.

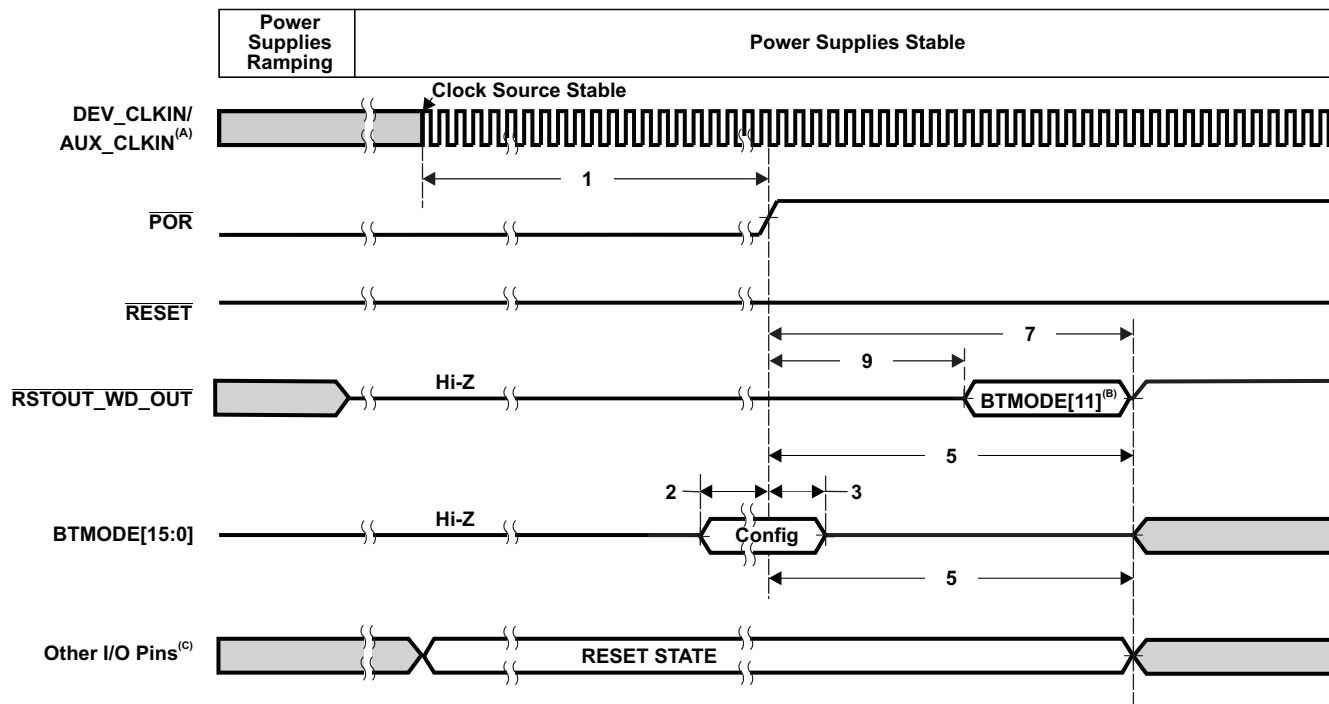
**Table 7-9. Switching Characteristics Over Recommended Operating Conditions During Reset (see [Figure 7-6](#))**

| NO. | PARAMETER                     |                                                                                                                                                |                                                                  | OPP100 |                              | UNIT |
|-----|-------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|--------|------------------------------|------|
|     |                               |                                                                                                                                                |                                                                  | MIN    | MAX                          |      |
| 4   | t <sub>d</sub> (RSTL-IORST)   | Delay time, $\overline{\text{RESET}}$ low or $\overline{\text{POR}}$ low to all I/Os entering their reset state                                |                                                                  |        | 14                           | ns   |
| 5   | t <sub>d</sub> (RSTH-IOFUNC)  | Delay time, $\overline{\text{RESET}}$ high or $\overline{\text{POR}}$ high to all I/Os exiting their reset state                               |                                                                  |        | 14                           | ns   |
| 6   | t <sub>d</sub> (RSTH-RSTOUTH) | Delay time, $\overline{\text{RESET}}$ high to $\overline{\text{RSTOUT\_WD\_OUT}}$ high <sup>(1)(2)</sup>                                       | $\overline{\text{RESET}}$ assertion t <sub>w</sub> (RESET) ≥ 30P | 0      | 2P                           | ns   |
|     |                               |                                                                                                                                                | $\overline{\text{RESET}}$ assertion t <sub>w</sub> (RESET) < 30P | 0      | 32P - t <sub>w</sub> (RESET) | ns   |
| 7   | t <sub>d</sub> (PORH-RSTOUTH) | Delay time, $\overline{\text{POR}}$ high to $\overline{\text{RSTOUT\_WD\_OUT}}$ high <sup>(1)(2)</sup>                                         |                                                                  | 0      | 12500P                       | ns   |
| 8   | t <sub>d</sub> (RSTL-RSTOUTZ) | Delay time, $\overline{\text{RESET}}$ low to $\overline{\text{RSTOUT\_WD\_OUT}}$ Hi-Z <sup>(1)(2)</sup>                                        |                                                                  | 0      | 2P                           | ns   |
| 9   | t <sub>d</sub> (PORH-RSTOUTL) | Delay time, value <sup>(1)(2)</sup> , $\overline{\text{POR}}$ high to $\overline{\text{RSTOUT\_WD\_OUT}}$ driven based on latched BTMODE[11]   |                                                                  | 0      | 2P                           | ns   |
| 10  | t <sub>d</sub> (RSTH-RSTOUTD) | Delay time, value <sup>(1)(2)</sup> , $\overline{\text{RESET}}$ high to $\overline{\text{RSTOUT\_WD\_OUT}}$ driven based on latched BTMODE[11] |                                                                  | 0      | 2P                           | ns   |

(1) For more detailed information on  $\overline{RSTOUT\_WD\_OUT}$  pin behavior, see [Section 7.3.14,  \$\overline{RSTOUT\\_WD\\_OUT}\$  Pin](#).

(2) P = 1/(DEV Clock) frequency in ns.

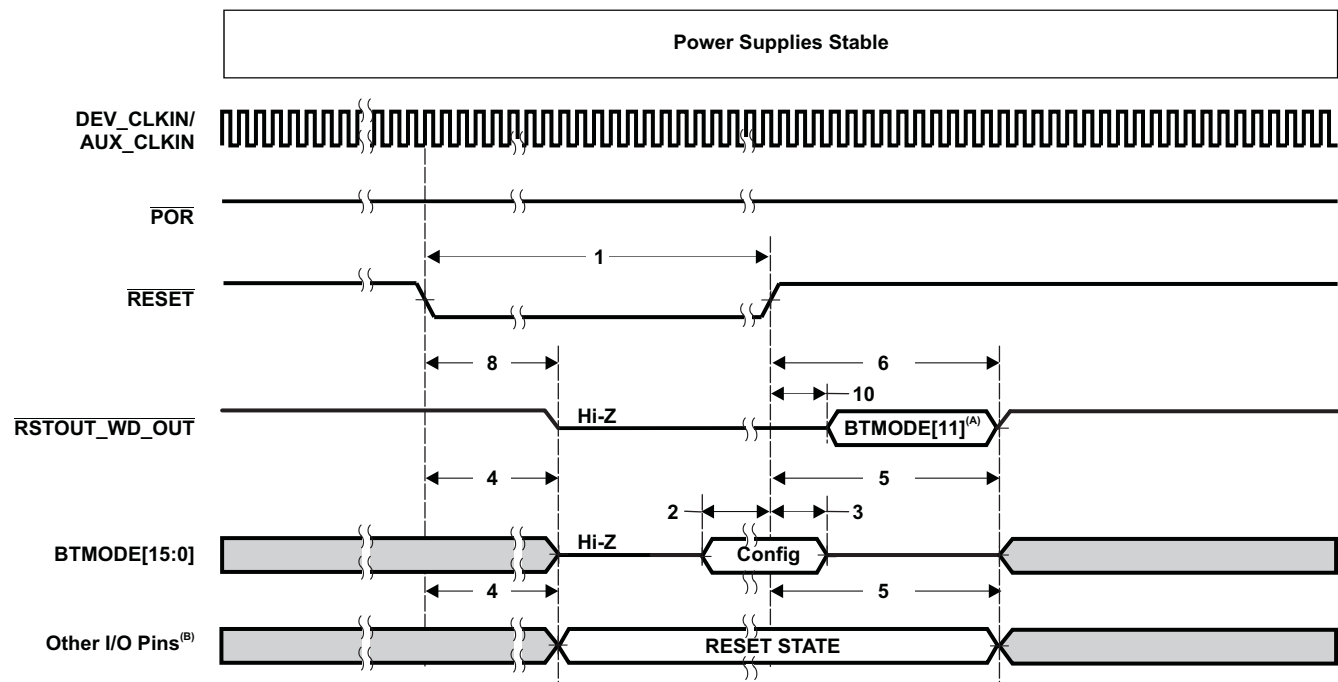
Figure 7-5 shows the Power-Up Timing. Figure 7-6 shows the Warm Reset ( $\overline{\text{RESET}}$ ) Timing. Max Reset Timing is identical to Warm Reset Timing, except the BTMODE[15:0] pins are *not* re-latched.



- A. Power supplies and DEV\_CLKIN/AUX\_CLKIN must be stable before the start of  $t_{w(\text{RESET})}$ .
- B.  $\overline{\text{RSTOUT\_WD\_OUT}}$  only asserted if BTMODE[11] was latched as a "0" when coming out of reset.
- C. For more detailed information on the RESET STATE of each pin, see Section 7.3.17, *Pin Behaviors at Reset*. Also see , *Terminal Functions* for the IPU/IPD settings during reset.

Figure 7-5. Power-Up Timing





- A.  $\overline{\text{RSTOUT\_WD\_OUT}}$  only asserted if BTMODE[11] was latched as a "0" when coming out of reset.
- B. For more detailed information on the RESET STATE of each pin, see [Section 7.3.17, Pin Behaviors at Reset](#). Also see , *Terminal Functions* for the IPU/IPD settings during reset.

**Figure 7-6. Warm Reset ( $\overline{\text{RESET}}$ ) Timing**



## 7.4 Clocking

The device clocks are generated from several reference clocks that are fed to on-chip PLLs and dividers (both inside and outside of the PRCM Module). [Figure 7-7](#) shows a high-level overview of the device system clocking structure (Note: to reduce complexity, not all clocking connections are shown). For detailed information on the device clocks, see the Clock Generation and Management section of the *Power, Reset, and Clock Management (PRCM) Module* chapter in the device-specific Technical Reference Manual.

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### NOTE

For supported OPP frequencies, see [Table 7-3](#), *Device Operating Points (OPPs)*.

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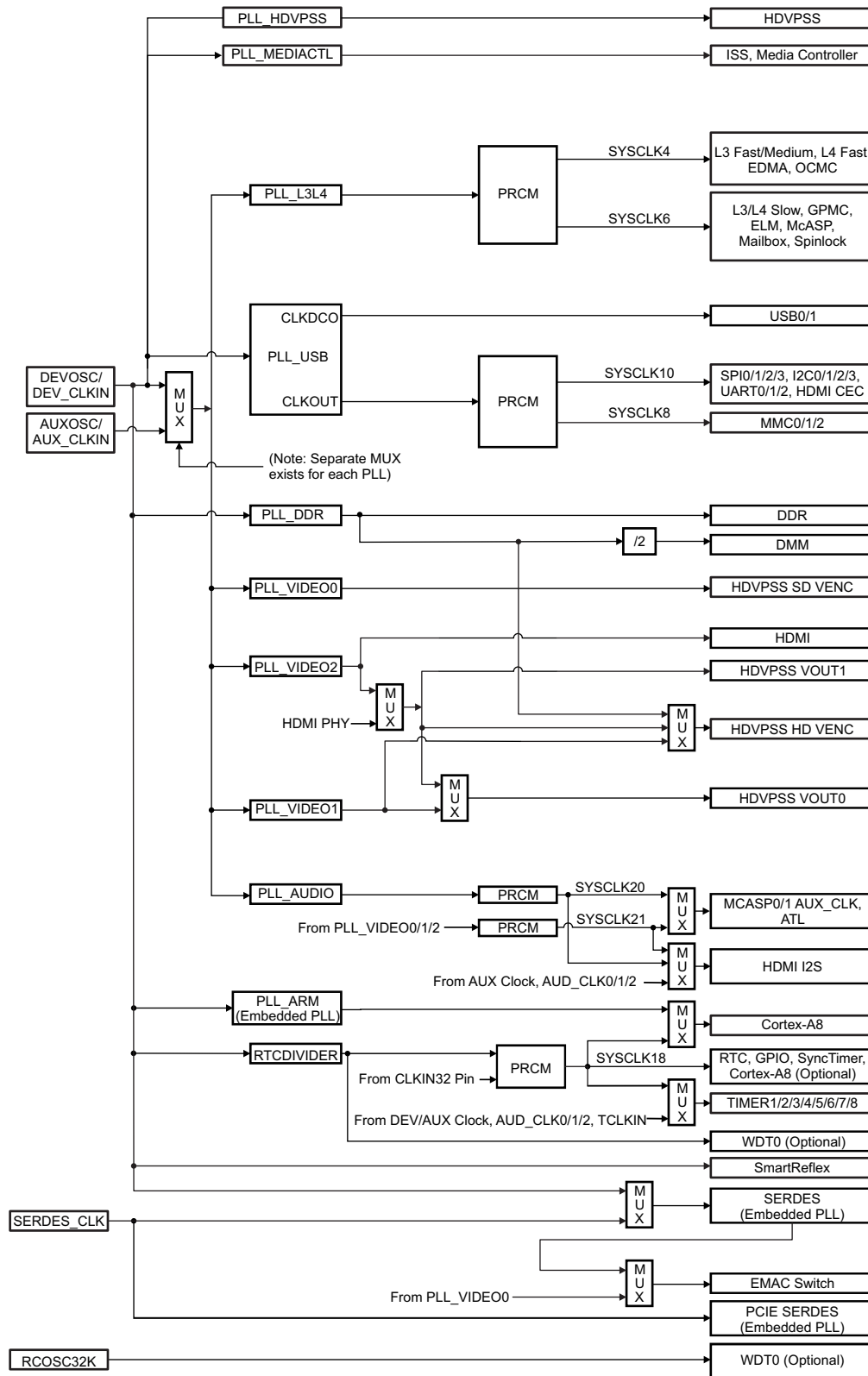


Figure 7-7. System Clocking Overview

### 7.4.1 Device (DEV) and Auxiliary (AUX) Clock Inputs

The device provides two clock inputs, Device (DEVOSC\_MXI/DEV\_CLKIN) and Auxiliary (AUXOSC\_MXI/AUX\_CLKIN). The Device (DEV) clock is used to generate the majority of the internal reference clocks, while the Auxiliary (AUX) clock can optionally be used as a source for the Audio and/or Video PLLs.

The DEV and AUX clocks can be sourced in two ways:

1. Using an external crystal in conjunction with the internal oscillator or
2. Using an external 1.8-V LVCMOS-compatible clock input

**Note:** The external crystals used with the internal oscillators **must** operate in fundamental parallel resonant mode **only**. There is no overtone support.

The DEV Clock should in most cases be 20 MHz. However, it can optionally range anywhere from 20 - 30 MHz if the following are true:

- A precise 32768-Hz clock is not needed for Real-Time Clock functionality
- If the boot mode is FAST XIP

The AUX Clock is optional and can range from 20-30 MHz. It can be used to source the Audio and/or Video PLLs when a very precise audio or video frequency is required.

#### 7.4.1.1 Using the Internal Oscillators

When the internal oscillators are used to generate the DEV and AUX clocks, external crystals are required to be connected across the DEVOSC or AUXOSC oscillator MXI and MXO pins, along with two load capacitors (see Figure 7-8 and Figure 7-9). The external crystal load capacitors should also be connected to the associated oscillator ground pin (VSSA\_DEVOSC or VSSA\_AUXOSC). The capacitors should **not** be connected to board ground (VSS).

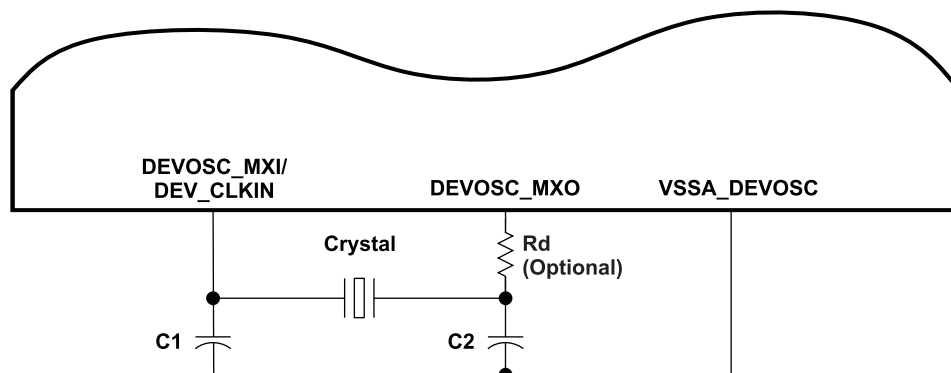
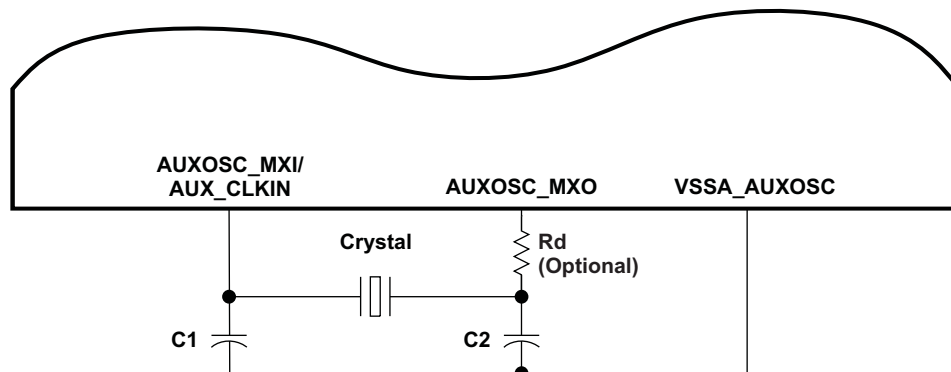


Figure 7-8. Device Oscillator

**Figure 7-9. Auxiliary Oscillator**

The load capacitors, C1 and C2 in the above pictures, should be chosen such that the below equation is satisfied. CL in the equation is the load specified by the crystal manufacturer. All discrete components used to implement the oscillator circuit should be placed as close as possible to the associated oscillator MXI, MXO, and VSS pins.

$$C_L = \frac{C_1 C_2}{C_1 + C_2} + C_{\text{shunt}}$$

**Table 7-10. Input Requirements for Crystal Circuit on the Device Oscillator (DEVOSC)**

| PARAMETER |                                                                     | MIN | TYP              | MAX | UNIT |
|-----------|---------------------------------------------------------------------|-----|------------------|-----|------|
|           | Start-up time (from power up until oscillating at stable frequency) |     |                  | 4   | ms   |
|           | Crystal Oscillation frequency <sup>(1)</sup>                        | 20  | 20               | 30  | MHz  |
|           | Parallel Load Capacitance (C1 and C2)                               | 12  |                  | 24  | pF   |
|           | Crystal ESR                                                         |     |                  | 50  | Ω    |
|           | Crystal Shunt Capacitance (Cshunt)                                  |     | 5                |     | pF   |
|           | Crystal Oscillation Mode                                            |     | Fundamental Only |     | n/a  |
|           | Crystal Frequency stability                                         |     |                  | ±50 | ppm  |

(1) 20-MHz DEV clock is required for all bootmodes other than Fast XIP. For more detailed information on boot modes, see the *ROM Code Memory and Peripheral Booting* chapter in the device-specific Technical Reference Manual.

**Table 7-11. Input Requirements for Crystal Circuit on the Auxiliary Oscillator (AUXOSC)**

| PARAMETER |                                                                     | MIN | TYP              | MAX | UNIT |
|-----------|---------------------------------------------------------------------|-----|------------------|-----|------|
|           | Start-up time (from power up until oscillating at stable frequency) |     |                  | 4   | ms   |
|           | Crystal Oscillation frequency                                       | 20  |                  | 30  | MHz  |
|           | Parallel Load Capacitance (C1 and C2)                               | 12  |                  | 24  | pF   |
|           | Crystal ESR                                                         |     |                  | 50  | Ω    |
|           | Crystal Shunt Capacitance (Cshunt)                                  |     | 5                |     | pF   |
|           | Crystal Oscillation Mode                                            |     | Fundamental Only |     | n/a  |
|           | Crystal Frequency stability <sup>(1)</sup>                          |     |                  | ±50 | ppm  |

(1) Applies only when sourcing the HDMI or HDVPSS DAC clocks from the AUXOSC

#### 7.4.1.2 Using a 1.8V LVCMOS-Compatible Clock Input

A 1.8-V LVCMOS-Compatible Clock Input can be used instead of the internal oscillators as the DEV and AUX clock inputs to the system. The external connections to support this are shown in [Figure 7-10](#) and [Figure 7-11](#). The DEV\_CLKIN and AUX\_CLKIN pins are connected to the 1.8-V LVCMOS-Compatible clock sources. The DEV\_MXO and AUX\_MXO pins are left unconnected. The VSSA\_DEVOSC and VSSA\_AUXOSC pins are connected to board ground (VSS).

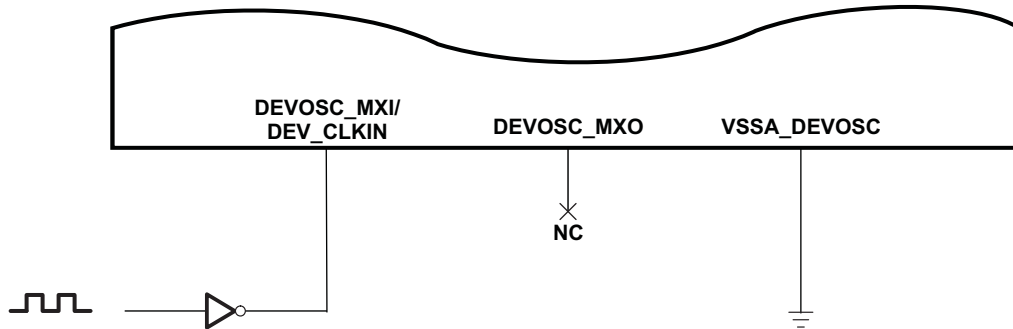


Figure 7-10. 1.8-V LVCMOS-Compatible Clock Input (DEV\_OSC)

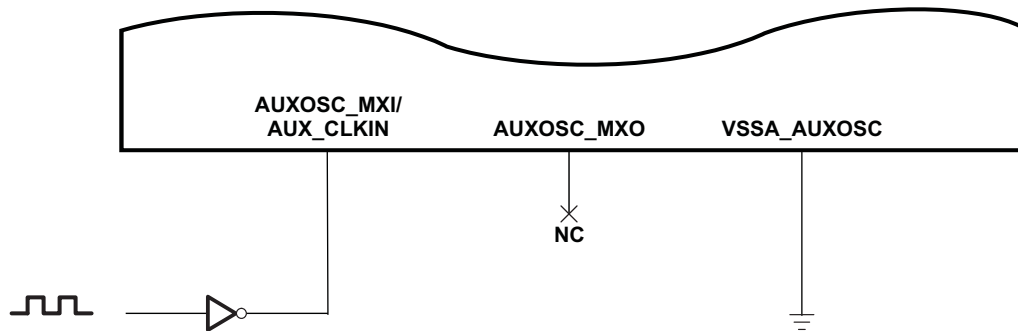


Figure 7-11. 1.8-V LVCMOS-Compatible Clock Input (AUX\_OSC)

The clock source **must** meet the DEVOSC\_MXI/DEV\_CLKIN timing requirements shown in [Table 7-14, Timing Requirements for DEVOSC\\_MXI/DEV\\_CLKIN](#).

The clock source must meet the AUXOSC\_MXI/AUX\_CLKIN timing requirements shown in [Table 7-15, Timing Requirements for AUXOSC\\_MXI/AUX\\_CLKIN](#).

## 7.4.2 SERDES\_CLKN/P Input Clock

A high-quality, low-jitter differential clock source is required for the PCIE PHY. The clock is required to be AC coupled to the device's SERDES\_CLKP and SERDES\_CLKN pins according to the specifications in [Table 7-12](#). Both the clock source and the coupling capacitors should be placed physically as close to the processor as possible. In addition, make sure to follow any PCB routing and termination recommendations that the clock source manufacturer recommends.

Table 7-12. SERDES\_CLKN/P AC Coupling Capacitors Recommendations

| PARAMETER |                                                                    | MIN  | TYP  | MAX  | UNIT |
|-----------|--------------------------------------------------------------------|------|------|------|------|
|           | SERDES_CLKN/P AC coupling capacitor value                          | 0.25 | 0.27 | 4.0  | nF   |
|           | SERDES_CLKN/P AC coupling capacitor package size <sup>(1)(2)</sup> |      | 0402 | 0603 | EIA  |

(1) L x W, 10 Mil units, that is, a 0402 is a 40 x 20 Mil surface mount capacitor.

(2) The physical size of the capacitor should be as small as practical. Use the same size on both lines in each pair placed side-by-side.

The value of this capacitor depends on several factors including differential input clock swing. For a 100MHz differential clock with an approximate 1V voltage swing, the recommended typical value for the SerDes Clock AC Coupling Capacitors is 270pF.

Deviating from this recommendation can result in the reduction of clock signal amplitude or lowering the noise rejection characteristics.

The differential clock source is required to meet the REFCLK AC Specifications outlined in the *PCI EXPRESS CARD ELECTROMECHANICAL SPECIFICATION, REV. 2.0*, at the input to the AC coupling capacitors.

In addition, LVDS clock sources that are compliant to the above specification, but with the following exceptions, are also acceptable:

**Table 7-13. Acceptable Exceptions to the REFCLK AC Specifications for LVDS Clock Sources**

| PARAMETER       |                                       | MIN   | MAX  | UNIT |
|-----------------|---------------------------------------|-------|------|------|
| V <sub>IH</sub> | Differential High-Level Input Voltage | 125   | 1000 | mV   |
| V <sub>IL</sub> | Differential Low-Level Input Voltage  | -1000 | -125 | mV   |

### 7.4.3 CLKIN32 Input Clock

An external 32768-Hz clock input can optionally be provided at the CLKIN32 pin to serve as a reference clock in place of the RTCDIVIDER clock for the following Modules:

- RTC
- GPIO0/1/2/3
- TIMER1/2/3/4/5/6/7
- ARM Cortex-A8
- SYNCTIMER

The CLKIN32 source must meet the timing requirements shown in [Table 7-16](#).

### 7.4.4 Output Clocks Select Logic

The device includes two selectable general-purpose clock outputs (CLKOUT0 and CLKOUT1). The source for these output clocks is controlled by the CLKOUT\_MUX register in the Control Module (see [Figure 7-12](#)).

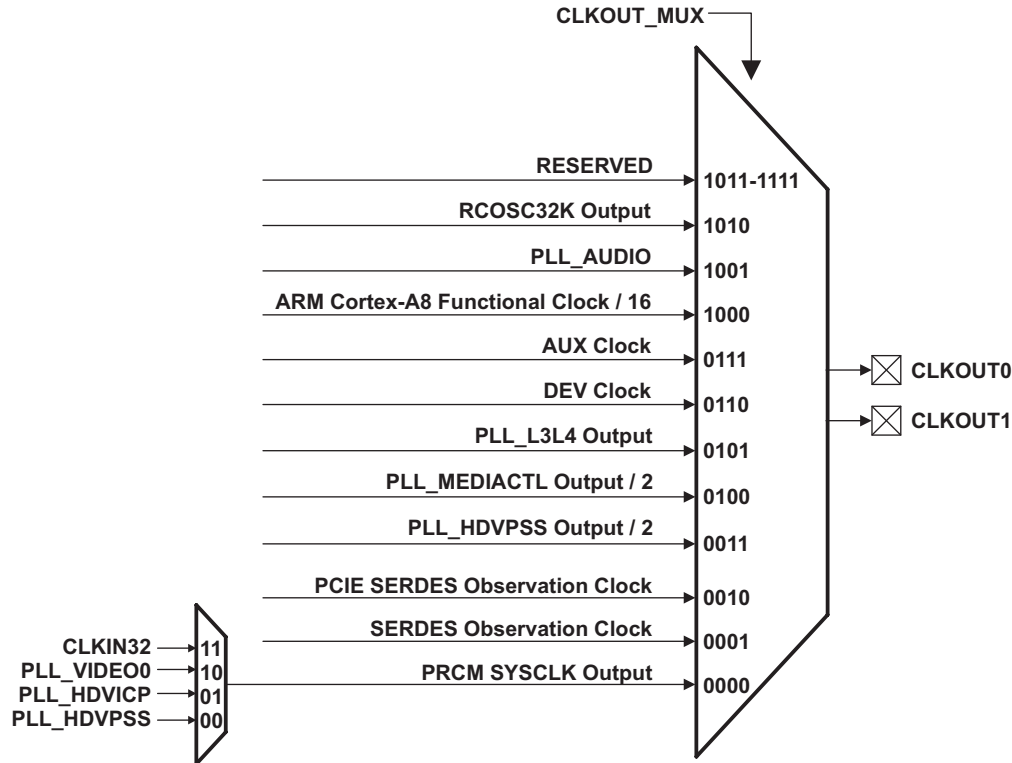


Figure 7-12. CLKOUTx Source Selection Logic

For detailed information on the CLKOUTx switching characteristics, see [Table 7-17](#).

#### 7.4.5 Input/Output Clocks Electrical Data/Timing

**Note:** If an external clock oscillator is used, a single clean power supply should be used to power both the device and the external clock oscillator circuit.

Table 7-14. Timing Requirements for DEVOSC\_MXI/DEV\_CLKIN<sup>(1)</sup> <sup>(2)</sup> <sup>(3)</sup>(see [Figure 7-13](#))

| NO. |                                                          | OPP100 |     |       | UNIT |
|-----|----------------------------------------------------------|--------|-----|-------|------|
|     |                                                          | MIN    | NOM | MAX   |      |
| 1   | $t_{c(DMXI)}$ Cycle time, DEVOSC_MXI/DEV_CLKIN           | 33.33  | 50  | 50    | ns   |
| 2   | $t_{w(DMXIH)}$ Pulse duration, DEVOSC_MXI/DEV_CLKIN high | 0.45C  |     | 0.55C | ns   |
| 3   | $t_{w(DMXIL)}$ Pulse duration, DEVOSC_MXI/DEV_CLKIN low  | 0.45C  |     | 0.55C | ns   |
| 4   | $t_{t(DMXI)}$ Transition time, DEVOSC_MXI/DEV_CLKIN      |        |     | 7     | ns   |
| 5   | $t_{j(DMXI)}$ Period jitter, DEVOSC_MXI/DEV_CLKIN        |        |     | 0.02C | ns   |
|     | Frequency Stability                                      |        |     | ±50   | ppm  |

- (1) The DEVOSC\_MXI/DEV\_CLKIN frequency and PLL settings should be chosen such that the resulting SYSClks and Module Clocks are within the specific ranges shown in the [Section 7.4.7](#), SYSClks and [Section 7.4.8](#), Module Clocks.
- (2) The reference points for the rise and fall transitions are measured at  $V_{IL}$  MAX and  $V_{IH}$  MIN.
- (3) C = DEV\_CLKIN cycle time in ns. For example, when DEVOSC\_MXI/DEV\_CLKIN frequency is 20 MHz, use C = 50 ns.

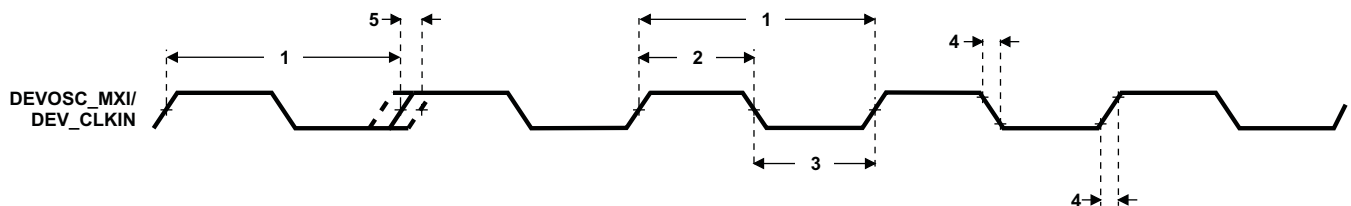


Figure 7-13. DEV\_MXI/DEV\_CLKIN Timing

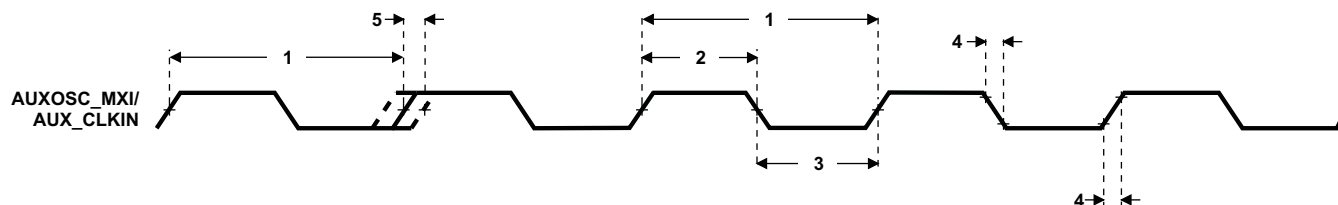
**Table 7-15. Timing Requirements for AUX\_MXI/AUX\_CLKIN <sup>(1)</sup> <sup>(2)</sup> (see Figure 7-14)**

| NO. |                                                                | OPP100 |     |       | UNIT |
|-----|----------------------------------------------------------------|--------|-----|-------|------|
|     |                                                                | MIN    | NOM | MAX   |      |
| 1   | $t_{c(AMXI)}$ Cycle time, AUXOSC_MXI/AUX_CLKIN                 | 33.3   | 50  | 50    | ns   |
| 2   | $t_{w(AMXIH)}$ Pulse duration, AUXOSC_MXI/AUX_CLKIN high       | 0.45C  |     | 0.55C | ns   |
| 3   | $t_{w(AMXIL)}$ Pulse duration, AUXOSC_MXI/AUX_CLKIN low        | 0.45C  |     | 0.55C | ns   |
| 4   | $t_t(AMXI)$ Transition time, AUXOSC_MXI/AUX_CLKIN              |        |     | 7     | ns   |
| 5   | $t_{j(AMXI)}$ Period jitter, AUXOSC_MXI/AUX_CLKIN              |        |     | 0.02C | ns   |
| 6   | $S_f$ Frequency stability, AUXOSC_MXI/AUX_CLKIN <sup>(3)</sup> |        |     | ± 50  | ppm  |

(1) The reference points for the rise and fall transitions are measured at  $V_{IL}$  MAX and  $V_{IH}$  MIN.

(2) C = AUX\_CLKIN cycle time in ns. For example, when AUXOSC\_MXI/AUX\_CLKIN frequency is 20 MHz, use C = 50 ns.

(3) Applies only when sourcing the HDMI or HDVPSS DAC clocks from the AUXOSC.

**Figure 7-14. AUX\_MXI/AUX\_CLKIN Timing**

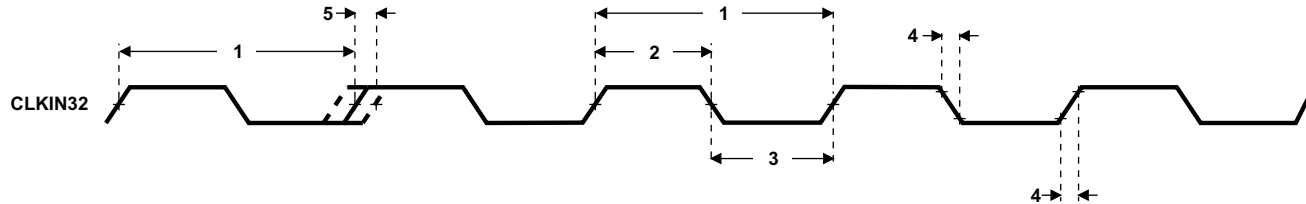


**Table 7-16. Timing Requirements for CLKIN32 <sup>(1)(2)</sup> (see Figure 7-15)**

| NO. |                   |                              | OPP100  |     |     | UNIT |
|-----|-------------------|------------------------------|---------|-----|-----|------|
|     |                   |                              | MIN     | NOM | MAX |      |
| 1   | $t_{c(CLKIN32)}$  | Cycle time, CLKIN32          | 1/32768 |     |     | s    |
| 2   | $t_{w(CLKIN32H)}$ | Pulse duration, CLKIN32 high | 0.45C   |     |     | ns   |
| 3   | $t_{w(CLKIN32L)}$ | Pulse duration, CLKIN32 low  | 0.45C   |     |     | ns   |
| 4   | $t_t(CLKIN32)$    | Transition time, CLKIN32     | 7       |     |     | ns   |
| 5   | $t_j(CLKIN32)$    | Period jitter, CLKIN32       | 0.02C   |     |     | ns   |

(1) The reference points for the rise and fall transitions are measured at  $V_{IL}$  MAX and  $V_{IH}$  MIN.

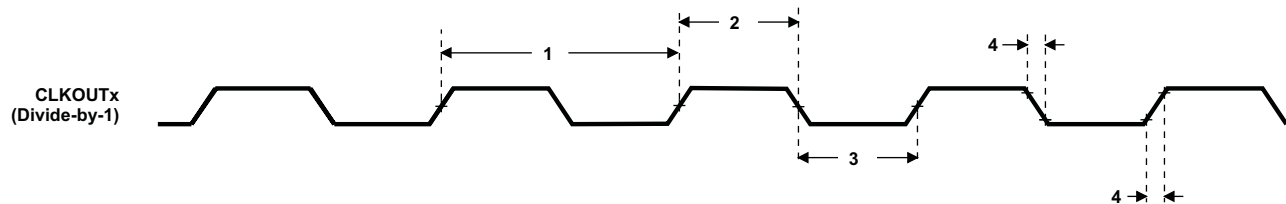
(2) C = CLKIN32 cycle time in ns. For example, when CLKIN32 frequency is 32768 Hz, use C = 1/32768 s.


**Figure 7-15. CLKIN32 Timing**
**Table 7-17. Switching Characteristics Over Recommended Operating Conditions for CLKOUTx (CLKOUT0 and CLKOUT1) <sup>(1)(2)</sup> (see Figure 7-16)**

| NO. | PARAMETER         |                              | OPP100 |       | UNIT |
|-----|-------------------|------------------------------|--------|-------|------|
|     |                   |                              | MIN    | MAX   |      |
| 1   | $t_{c(CLKOUTx)}$  | Cycle time, CLKOUTx          | 5      |       | ns   |
| 2   | $t_{w(CLKOUTxH)}$ | Pulse duration, CLKOUTx high | 0.45P  | 0.55P | ns   |
| 3   | $t_{w(CLKOUTxL)}$ | Pulse duration, CLKOUTx low  | 0.45P  | 0.55P | ns   |
| 4   | $t_t(CLKOUTx)$    | Transition time, CLKOUTx     | 0.05P  |       | ns   |

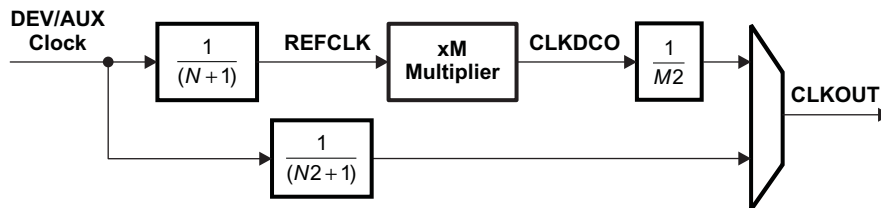
(1) The reference points for the rise and fall transitions are measured at  $V_{OL}$  MAX and  $V_{OH}$  MIN.

(2) P = 1/CLKOUTx clock frequency in nanoseconds (ns). For example, when CLKOUTx frequency is 200 MHz, use P = 5 ns.

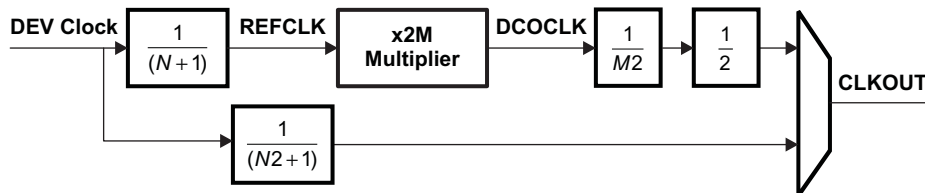

**Figure 7-16. CLKOUTx Timing**

### 7.4.6 PLLs

The device contains 10 top-level PLLs, and embedded PLLs (within the ARM Cortex-A8, PCIE, and CSI) that provide clocks to different parts of the system. [Figure 7-17](#) and [Figure 7-18](#) show simplified block diagrams of the Top-Level PLL and PLL\_ARM. In addition, see the System Clocking Overview ([Figure 7-7](#)) for a high-level view of the device clock architecture including the PLL reference clock sources and connections.



**Figure 7-17. Top-Level PLL Simplified Block Diagram**



**Figure 7-18. PLL\_ARM Simplified Block Diagram**

The reference clock for most of the PLLs comes from the DEV input clock, with select PLLs also having the option to use the AUX input clock as a reference. Also, each PLL supports a Bypass mode in which the reference clock can be directly passed to the PLL CLKOUT through a divider. All device PLL's will come-up in Bypass mode after reset.

For details on programming the device PLLs, see the *Control Module* chapter in the device-specific Technical Reference Manual.

#### 7.4.6.1 PLL Power Supply Filtering

The device PLLs are supplied externally via the VDDA\_xPLL\_1P8 power-supply pins (where "x" represents ARM, VID0, VID1, AUDIO, DDR, and/or L3). External filtering must be added on the PLL supply pins to ensure that the requirements in [Table 7-18](#) are met.

**Table 7-18. PLL Power Supply Requirements**

| PARAMETER                           | MIN | MAX | UNIT   |
|-------------------------------------|-----|-----|--------|
| Dynamic noise at VDDA_xPLL_1P8 pins |     | 50  | mV p-p |

#### 7.4.6.2 PLL Multipliers and Dividers

The Top-Level and PLL\_ARM PLLs support the internal multiplier and divider values shown in [Table 7-19](#), *Top-Level PLL Multiplier and Divider Limits* and [Table 7-20](#), *PLL\_ARM Multiplier and Divider Limits*. The PLLs must be programmed to conform to the various REFCLK, CLKDCO, DCOCLK, and CLKOUT limits described in [Section 7.4.6.3, PLL Frequency Limits](#).

**Table 7-19. Top-Level PLL Multiplier and Divider Limits**

| PARAMETER     | MIN | MAX |
|---------------|-----|-----|
| N Pre-Divider | 0   | 255 |

**Table 7-19. Top-Level PLL Multiplier and Divider Limits (continued)**

| PARAMETER          | MIN | MAX                 |
|--------------------|-----|---------------------|
| PLL Multiplier (M) | 2   | 4095 <sup>(1)</sup> |
| M2 Post Divider    | 1   | 127                 |
| N2 Bypass Divider  | 0   | 15                  |

(1) The PLL Multiplier supports fractional values (up to 18-bits of fraction) except when the PLL Multiplier is > 4093.

**Table 7-20. PLL\_ARM Multiplier and Divider Limits**

| PARAMETER                         | MIN | MAX                 |
|-----------------------------------|-----|---------------------|
| N Pre-Divider                     | 0   | 127                 |
| PLL Multiplier (M) <sup>(1)</sup> | 2   | 2047 <sup>(2)</sup> |
| M2 Post Divider                   | 1   | 31                  |
| N2 Bypass Divider                 | 0   | 15                  |

(1) This parameter describes the limits on the programmable multiplier value M. The multiplication factor for the PLL\_ARM is equal to 2 \* M (also see [Figure 7-18](#)).

(2) The PLL Multiplier supports fractional values (up to 18-bits of fraction) except when the PLL Multiplier is < 20 OR > 2045.

### 7.4.6.3 PLL Frequency Limits

Each PLL supports a minimum and maximum operating frequency for its REFCLK, CLKDCO, and CLKOUT values. The PLLs must be configured not to exceed any of the constraints placed on these values shown in [Table 7-21](#) through [Table 7-23](#). Care must be taken to stay within these limits when selecting external clock input frequencies, internal divider values, and PLL multiply ratios. In addition, limits shown in these tables may be further restricted by the clock frequency limitations of the device modules using these clocks. For more detailed information on the SYSCLK and Module Clock frequency limits, see [Section 7.4.7](#), SYSCLKs and [Section 7.4.8](#), Module Clocks.

**Table 7-21. Top-Level PLL Frequency Ranges (ALL OPPs)**

| CLOCK                       | MIN                            | MAX                            | UNIT |
|-----------------------------|--------------------------------|--------------------------------|------|
| REFCLK                      | 0.5                            | 2.5                            | MHz  |
| CLKDCO (HS1) <sup>(1)</sup> | 1000                           | 2000                           | MHz  |
| CLKDCO (HS2) <sup>(2)</sup> | 500                            | 1000                           | MHz  |
| CLKOUT                      | see <a href="#">Table 7-23</a> | see <a href="#">Table 7-23</a> | MHz  |

(1) The PLL has two modes of operation: HS1 and HS2. The mode of operation should be set, according to the desired CLKDCO frequency, by programming the SELFREQDCO field of the ADPLLJx\_CLKCTRL registers in the Control Module.

(2) CLKDCO of the PLL\_USB is used undivided by the USB modules; therefore, CLKDCO for the PLL\_USB PLL must be programmed to 960 MHz for proper operation.

**Table 7-22. ARM Cortex-A8 Embedded PLL (PLL\_ARM) Frequency Ranges (ALL OPPs)**

| CLOCK  | MIN                            | MAX                            | UNIT |
|--------|--------------------------------|--------------------------------|------|
| REFCLK | 0.032                          | 52                             | MHz  |
| DCOCLK | 20                             | 2000                           | MHz  |
| CLKOUT | see <a href="#">Table 7-23</a> | see <a href="#">Table 7-23</a> | MHz  |

**Table 7-23. PLL CLKOUT Frequency Ranges**

| PLL        | OPP100 |     | UNIT |
|------------|--------|-----|------|
|            | MIN    | MAX |      |
| PLL_ARM    | 10     | 600 | MHz  |
| PLL_HDVICP | 10     | 266 | MHz  |
| PLL_L3L4   | 10     | 200 | MHz  |

**Table 7-23. PLL CLKOUT Frequency Ranges (continued)**

| PLL          | OPP100            |     | UNIT |
|--------------|-------------------|-----|------|
|              | MIN               | MAX |      |
| PLL_DDR      | 10                | 400 | MHz  |
| PLL_HDVPSS   | 10                | 200 | MHz  |
| PLL_AUDIO    | 10                | 200 | MHz  |
| PLL_MEDIACLK | 10                | 400 | MHz  |
| PLL_USB      | 10 <sup>(1)</sup> | 960 | MHz  |
| PLL_VIDEO0   | 10                | 200 | MHz  |
| PLL_VIDEO1   | 10                | 200 | MHz  |
| PLL_VIDEO2   | 10                | 200 | MHz  |

(1) When the USB is used, PLL\_USB **must** be fixed at 960 MHz.

#### 7.4.6.4 PLL Register Description(s)

The PLL Control Registers reside in the Control Module and are listed in [Section 4.1, Control Module](#) of this datasheet.

#### 7.4.7 SYSCLKs

In some cases, the system clock inputs and PLL outputs are sent to the PRCM Module for division and multiplexing before being routed to the various device Modules. These clock outputs from the PRCM Module are called SYSCLKs. [Table 7-24](#) lists the device SYSCLKs along with their maximum supported clock frequencies. In addition, limits shown in these tables may be further restricted by the clock frequency limitations of the device modules using these clocks. For more details on Module Clock frequency limits, see [Section 7.4.8 Module Clocks](#).

#### NOTE

For supported OPP frequencies, see [Table 7-3, Device Operating Points \(OPPs\)](#).

**Table 7-24. Maximum SYSCLK Clock Frequencies**

| SYSCLK   | MAX CLOCK FREQUENCY<br>OPP100 (MHz) |
|----------|-------------------------------------|
| SYSCLK1  | RSV                                 |
| SYSCLK2  | RSV                                 |
| SYSCLK3  | 266                                 |
| SYSCLK4  | 220                                 |
| SYSCLK5  | RSV                                 |
| SYSCLK6  | 110                                 |
| SYSCLK7  | RSV                                 |
| SYSCLK8  | 192                                 |
| SYSCLK9  | RSV                                 |
| SYSCLK10 | 48                                  |
| SYSCLK11 | RSV                                 |
| SYSCLK12 | RSV                                 |
| SYSCLK13 | RSV                                 |
| SYSCLK14 | 27                                  |
| SYSCLK15 | RSV                                 |
| SYSCLK16 | 27                                  |
| SYSCLK17 | RSV                                 |

**Table 7-24. Maximum SYSCLK Clock Frequencies (continued)**

| SYSCLK   | MAX CLOCK FREQUENCY<br>OPP100 (MHz) |
|----------|-------------------------------------|
| SYSCLK18 | 0.032768                            |
| SYSCLK19 | 192                                 |
| SYSCLK20 | 192                                 |
| SYSCLK21 | 192                                 |
| SYSCLK22 | RSV                                 |
| SYSCLK23 | RSV                                 |

### 7.4.8 Module Clocks

Device Modules either receive their clock directly from an external clock input, directly from a PLL, or from a PRCM SYSCLK output. [Table 7-25](#) lists the clock source options for each Module on this device, along with the maximum frequency that Module can accept. To ensure proper Module functionality, the device PLLs and dividers **must** be programmed not to exceed the maximum frequencies listed in this table.

**Table 7-25. Maximum Module Clock Frequencies**

| MODULE                     | CLOCK SOURCE(S)                                   | MAX FREQUENCY<br>OPP100 (MHz) |
|----------------------------|---------------------------------------------------|-------------------------------|
| Cortex-A8                  | PLL_ARM<br>SYSCLK18                               | 600                           |
| DDR0                       | PLL_DDR                                           | 400                           |
| DMM                        | PLL_DDR/2                                         | 200                           |
| EDMA                       | SYSCLK4                                           | 220                           |
| EMAC Switch (GMII)         | SERDES<br>PLL_VIDEO0                              | Fixed 125                     |
| EMAC Switch (RGMII)        | PLL_VIDEO0<br>SERDES                              | Fixed 250                     |
| EMAC Switch (RMII and MII) | SERDES<br>PLL_VIDEO0<br>EMAC_RMREFCLK Pin         | Fixed 50                      |
| Face Detect                | SYSCLK4                                           | 220                           |
| GPIO                       | SYSCLK6                                           | 110                           |
| GPIO Debounce              | SYSCLK18                                          | Fixed 0.032768                |
| GPMC                       | SYSCLK6                                           | 110                           |
| HDMI                       | PLL_VIDEO2                                        | 186                           |
| HDMI CEC                   | SYSCLK10                                          | Fixed 48                      |
| HDMI I2S                   | SYSCLK20<br>SYSCLK21<br>AUD_CLK0/1/2<br>AUX Clock | 50                            |
| HDVICP2                    | SYSCLK3                                           | 266                           |
| HDVPSS                     | PLL_HDVPSS                                        | 200                           |
| HDVPSS VOUT1               | PLL_VIDEO2<br>HDMI PHY                            | 186                           |
| HDVPSS VOUT0               | PLL_VIDEO1<br>PLL_VIDEO2                          | 165                           |
| HDVPSS SD VENC             | PLL_VIDEO0                                        | Fixed 54                      |
| HDVPSS HD VENC             | PLL_VIDEO0<br>PLL_VIDEO1<br>HDMI                  | Fixed 148.5                   |
| I2C0/1/2/3                 | SYSCLK10                                          | 48                            |
| ISS                        | PLL_MEDIACLK                                      | 400                           |
| L3 Fast                    | SYSCLK4                                           | 220                           |

**Table 7-25. Maximum Module Clock Frequencies (continued)**

| MODULE               | CLOCK SOURCE(S)                                              | MAX FREQUENCY<br>OPP100 (MHz) |
|----------------------|--------------------------------------------------------------|-------------------------------|
| L3 Medium            | SYSCLK4                                                      | 220                           |
| L3 Slow              | SYSCLK6                                                      | 110                           |
| L4 Fast              | SYSCLK4                                                      | 220                           |
| L4 Slow              | SYSCLK6                                                      | 110                           |
| Mailbox              | SYSCLK6                                                      | 110                           |
| McASP                | SYSCLK6                                                      | 110                           |
| McASP0/1 AUX_CLK     | SYSCLK20<br>SYSCLK21                                         | 192                           |
| Media Controller     | PLL_MEDIACLK                                                 | 400                           |
| MMCSD0/1/2           | SYSCLK8                                                      | 192                           |
| OCMC RAM             | SYSCLK4                                                      | 220                           |
| PCIe SERDES          | SERDES_CLKx Pins                                             | 100                           |
| SERDES               | DEV Clock<br>SERDES_CLKx Pins                                | 20 or 100                     |
| SmartReflex          | DEV Clock                                                    | 30                            |
| SPI0/1/2/3           | SYSCLK10                                                     | 48                            |
| Spinlock             | SYSCLK6                                                      | 110                           |
| Sync Timer           | SYSCLK18                                                     | Fixed 0.032768                |
| TIMER1/2/3/4/5/6/7/8 | SYSCLK18<br>DEV Clock<br>AUX Clock<br>AUD_CLK0/1/2<br>TCLKIN | 30                            |
| UART0/1/2            | SYSCLK10                                                     | 48                            |
| USB                  | PLL_USB CLKDCO                                               | Fixed 960                     |
| WDT0                 | RTCDIVIDER<br>RCOSC32K                                       | Fixed 0.032768                |

## 7.5 Interrupts

The device has a large number of interrupts to service the needs of its many peripherals and subsystems. The ARM Cortex-A8 and Media Controller are capable of servicing these interrupts. The following sections list the device interrupt mapping and multiplexing schemes.

### 7.5.1 ARM Cortex-A8 Interrupts

The ARM Cortex-A8 Interrupt Controller (AINTC) is responsible for prioritizing all service requests from the System peripherals and generating either IRQs or FIQs to the Cortex-A8. The AINTC has the capability to handle up to 128 requests, and the priority of the interrupt inputs are programmable. [Table 7-26](#) lists the interrupt sources for the AINTC.

For more details on ARM Cortex-A8 interrupt control, see the Interrupt Controller section of the *Chip Level Resources* chapter in the device-specific Technical Reference Manual.

**Table 7-26. ARM Cortex-A8 Interrupt Controller (AINTC) Interrupt Sources**

| Cortex-A8<br>INTERRUPT NUMBER | ACRONYM     | SOURCE                       |
|-------------------------------|-------------|------------------------------|
| 0                             | EMUINT      | Cortex-A8 Emulation          |
| 1                             | COMMTX      | Cortex-A8 Emulation          |
| 2                             | COMMRX      | Cortex-A8 Emulation          |
| 3                             | BENCH       | Cortex-A8 Emulation          |
| 4                             | ELM_IRQ     | ELM                          |
| 5                             | –           | Reserved                     |
| 6                             | –           | Reserved                     |
| 7                             | NMI         | NMI In Pin                   |
| 8                             | –           | Reserved                     |
| 9                             | L3DEBUG     | L3 Interconnect              |
| 10                            | L3APPINT    | L3 Interconnect              |
| 11                            | TINT8       | TIMER8                       |
| 12                            | EDMACOMPINT | EDMA CC Completion           |
| 13                            | EDMAMPERR   | EDMA Memory Protection Error |
| 14                            | EDMAERRINT  | EDMA CC Error                |
| 15                            | WDTINT0     | Watchdog Timer 0             |
| 16                            | –           | Reserved                     |
| 17                            | USBSSINT    | USB Subsystem                |
| 18                            | USBINT0     | USB0                         |
| 19                            | USBINT1     | USB1                         |
| 20-27                         | –           | Reserved                     |
| 28                            | SDINT1      | MMC/SD1                      |
| 29                            | SDINT2      | MMC/SD2                      |
| 30                            | I2CINT2     | I2C2                         |
| 31                            | I2CINT3     | I2C3                         |
| 32                            | GPIOINT2A   | GPIO2 A                      |
| 33                            | GPIOINT2B   | GPIO2 B                      |
| 34                            | USBWAKEUP   | USB Subsystem Wakeup         |
| 35                            | PCIeWAKEUP  | PCIe Wakeup                  |
| 36                            | DSSINT      | HDVPSS                       |
| 37                            | –           | Reserved                     |
| 38                            | HDMIINT     | HDMI                         |
| 39                            | ISS_IRQ_5   | ISS                          |

**Table 7-26. ARM Cortex-A8 Interrupt Controller (AINTC) Interrupt Sources (continued)**

| Cortex-A8<br>INTERRUPT NUMBER | ACRONYM       | SOURCE                      |
|-------------------------------|---------------|-----------------------------|
| 40                            | 3PGSWRXTHR0   | EMAC Switch RX Threshold    |
| 41                            | 3PGSWRXINT0   | EMAC Switch Receive         |
| 42                            | 3PGSWTXINT0   | EMAC Switch Transmit        |
| 43                            | 3PGSWMISC0    | EMAC Switch Miscellaneous   |
| 44-47                         | –             | Reserved                    |
| 48                            | PCIINT0       | PCIE                        |
| 49                            | PCIINT1       | PCIE                        |
| 50                            | PCIINT2       | PCIE                        |
| 51                            | PCIINT3       | PCIE                        |
| 52-61                         | –             | Reserved                    |
| 62                            | GPIOINT3A     | GPIO3                       |
| 63                            | GPIOINT3B     | GPIO3                       |
| 64                            | SDINT0        | MMC/SD0                     |
| 65                            | SPIINT0       | SPI0                        |
| 66                            | -             | Reserved                    |
| 67                            | TINT1         | TIMER1                      |
| 68                            | TINT2         | TIMER2                      |
| 69                            | TINT3         | TIMER3                      |
| 70                            | I2CINT0       | I2C0                        |
| 71                            | I2CINT1       | I2C1                        |
| 72                            | UARTINT0      | UART0                       |
| 73                            | UARTINT1      | UART1                       |
| 74                            | UARTINT2      | UART2                       |
| 75                            | RTCINT        | RTC                         |
| 76                            | RTCALARMINT   | RTC Alarm                   |
| 77                            | MBINT         | Mailbox                     |
| 78                            | –             | Reserved                    |
| 79                            | PLLINT        | PLL Recalculation Interrupt |
| 80                            | MCATXINT0     | McASP0 Transmit             |
| 81                            | MCARXINT0     | McASP0 Receive              |
| 82                            | MCATXINT1     | McASP1 Transmit             |
| 83                            | MCARXINT1     | McASP1 Receive              |
| 84                            | –             | Reserved                    |
| 85                            | –             | Reserved                    |
| 86                            | –             | Reserved                    |
| 87                            | –             | Reserved                    |
| 88                            | –             | Reserved                    |
| 89                            | –             | Reserved                    |
| 90                            | SMRFLX_HDVICP | SmartReflex HDVICP Domain   |
| 91                            | –             | Reserved                    |
| 92                            | TINT4         | TIMER4                      |
| 93                            | TINT5         | TIMER5                      |
| 94                            | TINT6         | TIMER6                      |
| 95                            | TINT7         | TIMER7                      |
| 96                            | GPIOINT0A     | GPIO0                       |
| 97                            | GPIOINT0B     | GPIO0                       |
| 98                            | GPIOINT1A     | GPIO1                       |

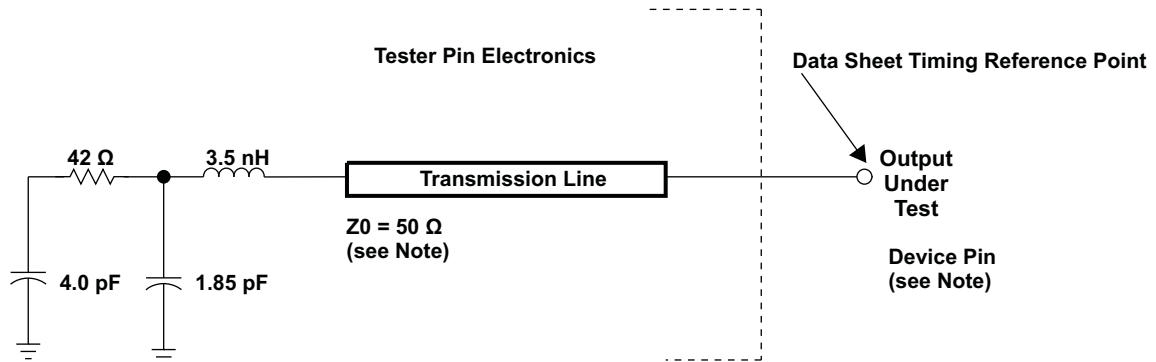


**Table 7-26. ARM Cortex-A8 Interrupt Controller (AINTC) Interrupt Sources (continued)**

| Cortex-A8<br>INTERRUPT NUMBER | ACRONYM         | SOURCE                  |
|-------------------------------|-----------------|-------------------------|
| 99                            | GPIOINT1B       | GPIO1                   |
| 100                           | GPMCINT         | GPMC                    |
| 101                           | DDRERR          | DDR                     |
| 102                           | –               | Reserved                |
| 103                           | HDVICPCONT1SYNC | HDVICP2                 |
| 104                           | HDVICPCONT2SYNC | HDVICP2                 |
| 105                           | –               | Reserved                |
| 106                           | –               | Reserved                |
| 107                           | IVA0MBOXINT     | HDVICP2 Mailbox         |
| 108                           | –               | Reserved                |
| 109                           | –               | Reserved                |
| 110                           | –               | Reserved                |
| 111                           | –               | Reserved                |
| 112                           | TCERRINT0       | EDMA TC 0 Error         |
| 113                           | TCERRINT1       | EDMA TC 1 Error         |
| 114                           | TCERRINT2       | EDMA TC 2 Error         |
| 115                           | TCERRINT3       | EDMA TC 3 Error         |
| 116-119                       | –               | Reserved                |
| 120                           | SMRFLX_ARM      | SmartReflex ARM Domain  |
| 121                           | SMRFLX_CORE     | SmartReflex CORE Domain |
| 122                           | –               | Reserved                |
| 123                           | MCMUUINT        | Media Controller        |
| 124                           | DMMINT          | DMM                     |
| 125                           | SPIINT1         | SPI1                    |
| 126                           | SPIINT2         | SPI2                    |
| 127                           | SPIINT3         | SPI3                    |

## 8 Peripheral Information and Timings

### 8.1 Parameter Information



NOTE: The data sheet provides timing at the device pin. For output timing analysis, the tester pin electronics and its transmission line effects must be taken into account. A transmission line with a delay of 2 ns can be used to produce the desired transmission line effect. The transmission line is intended as a load only. It is not necessary to add or subtract the transmission line delay (2 ns) from the data sheet timings.

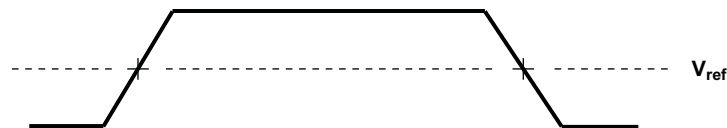
Input requirements in this data sheet are tested with an input slew rate of < 4 Volts per nanosecond (4 V/ns) at the device pin.

**Figure 8-1. Test Load Circuit for AC Timing Measurements**

The load capacitance value stated is only for characterization and measurement of AC timing signals. This load capacitance value does not indicate the maximum load the device is capable of driving.

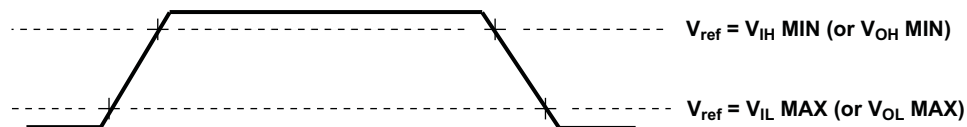
#### 8.1.1 1.8-V and 3.3-V Signal Transition Levels

All input and output timing parameters are referenced to  $V_{ref}$  for both "0" and "1" logic levels. For 3.3-V I/O,  $V_{ref} = 1.5$  V. For 1.8-V I/O,  $V_{ref} = 0.9$  V.



**Figure 8-2. Input and Output Voltage Reference Levels for AC Timing Measurements**

All rise and fall transition timing parameters are referenced to  $V_{IL}$  MAX and  $V_{IH}$  MIN for input clocks,  $V_{OL}$  MAX and  $V_{OH}$  MIN for output clocks.



**Figure 8-3. Rise and Fall Transition Time Voltage Reference Levels**

#### 8.1.2 3.3-V Signal Transition Rates

All timings are tested with an input edge rate of 4 volts per nanosecond (4 V/ns).

### 8.1.3 Timing Parameters and Board Routing Analysis

The timing parameter values specified in this data manual do *not* include delays by board routings. As a good board design practice, such delays must *always* be taken into account. Timing values may be adjusted by increasing/decreasing such delays. TI recommends utilizing the available I/O buffer information specification (IBIS) models to analyze the timing characteristics correctly. If needed, external logic hardware such as buffers may be used to compensate any timing differences.

## 8.2 Recommended Clock and Control Signal Transition Behavior

All clocks and control signals **must** transition between  $V_{IH}$  and  $V_{IL}$  (or between  $V_{IL}$  and  $V_{IH}$ ) in a monotonic manner.

---

#### NOTE

For supported OPP frequencies, see [Table 7-3](#), *Device Operating Points (OPPs)*.

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**8.3 Audio Tracking Logic (ATL)**

**8.3.1 Overview**

The device contains four ATL modules that can be used for asynchronous sample rate conversion of audio. The ATL calculates the error between two time bases, such as audio syncs, and optionally generates an averaged clock using cycle stealing via software.

For more detailed information on the ATL peripheral, see the Audio Tracking Logic (ATL) chapter of the device-specific Technical Reference Manual.

**8.3.2 ATL Peripheral Registers**

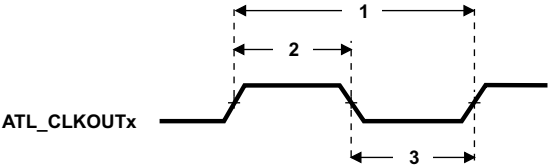
This ATL peripheral registers are described in the device-specific Technical Reference Manual (TRM). Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

**8.3.3 ATL Electrical Data/Timing**

**Table 8-1. Switching Characteristics Over Recommended Operating Conditions for ATL\_CLKOUTx**

| NO. | PARAMETER           |                                  | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|---------------------|----------------------------------|-------------------------------|-----|------|
|     |                     |                                  | MIN                           | MAX |      |
| 1   | $t_{c(ATLCLKOUT)}$  | Cycle time, ATL_CLKOUTx          | 20                            |     | ns   |
| 2   | $t_{w(ATLCLKOUTL)}$ | Pulse Duration, ATL_CLKOUTx low  | $0.45 \cdot P - M^{(1)}$      |     | ns   |
| 3   | $t_{w(ATLCLKOUTH)}$ | Pulse Duration, ATL_CLKOUTx high | $0.45 \cdot P - M^{(1)}$      |     | ns   |

(1) P = ATL\_CLKOUTx period.  
M = internal ATL PCLK period.



**Figure 8-4. ATL\_CLKOUTx Timing**

## 8.4 EDMA

The EDMA controller handles all data transfers between memories and the device slave peripherals on the device. These data transfers include cache servicing, non-cacheable memory accesses, user-programmed data transfers, and host accesses.

### 8.4.1 EDMA Channel Synchronization Events

The EDMA channel controller supports up to 64 channels which service peripherals and memory. Each EDMA channel is mapped to a default EDMA synchronization event as shown in [Table 8-2](#). In addition, each EDMA channel can alternatively be mapped to one of the 31 multiplexed EDMA synchronization events shown in [Table 8-3](#). The EVT\_MUX\_x registers in the Control Module are used to select between the default event and the multiplexed events for each channel.

For more detailed information on the EDMA module and how EDMA events are enabled, captured, processed, linked, chained, cleared, and more, see the *Enhanced Direct Memory Access Controller* chapter in the device-specific Technical Reference Manual.

**Table 8-2. EDMA Default Synchronization Events**

| EVENT NUMBER | DEFAULT EVENT NAME | DEFAULT EVENT DESCRIPTION |
|--------------|--------------------|---------------------------|
| 0-1          | –                  | Reserved                  |
| 2            | SDTXEVT1           | SD1 Transmit              |
| 3            | SDRXEVT1           | SD1 Receive               |
| 4-7          | –                  | Reserved                  |
| 8            | AXEVT0             | McASP0 Transmit           |
| 9            | AREVT0             | McASP0 Receive            |
| 10           | AXEVT1             | McASP1 Transmit           |
| 11           | AREVT1             | McASP1 Receive            |
| 12           | –                  | Reserved                  |
| 13           | –                  | Reserved                  |
| 14           | –                  | Reserved                  |
| 15           | –                  | Reserved                  |
| 16           | SPI0XEVT0          | SPI0 Transmit 0           |
| 17           | SPI0REVT0          | SPI0 Receive 0            |
| 18           | SPI0XEVT1          | SPI0 Transmit 1           |
| 19           | SPI0REVT1          | SPI0 Receive 1            |
| 20           | SPI0XEVT2          | SPI0 Transmit 2           |
| 21           | SPI0REVT2          | SPI0 Receive 2            |
| 22           | SPI0XEVT3          | SPI0 Transmit 3           |
| 23           | SPI0REVT3          | SPI0 Receive 3            |
| 24           | SDTXEVT0           | SD0 Transmit              |
| 25           | SDRXEVT0           | SD0 Receive               |
| 26           | UTXEVT0            | UART0 Transmit            |
| 27           | URXEVT0            | UART0 Receive             |
| 28           | UTXEVT1            | UART1 Transmit            |
| 29           | URXEVT1            | UART1 Receive             |
| 30           | UTXEVT2            | UART2 Transmit            |
| 31           | URXEVT2            | UART2 Receive             |
| 32-35        | –                  | Reserved                  |
| 36           | ISS_DMA_REQ1       | ISS Event 1               |
| 37           | ISS_DMA_REQ2       | ISS Event 2               |
| 38           | ISS_DMA_REQ3       | ISS Event 3               |

**Table 8-2. EDMA Default Synchronization Events (continued)**

| EVENT<br>NUMBER | DEFAULT<br>EVENT NAME | DEFAULT EVENT DESCRIPTION |
|-----------------|-----------------------|---------------------------|
| 39              | ISS_DMA_REQ4          | ISS Event 4               |
| 40              | –                     | Reserved                  |
| 41              | –                     | Reserved                  |
| 42              | SPI1XEVT0             | SPI1 Transmit 0           |
| 43              | SPI1REVT0             | SPI1 Receive 0            |
| 44              | SPI1XEVT1             | SPI1 Transmit 1           |
| 45              | SPI1REVT1             | SPI1 Receive 1            |
| 46              | –                     | Reserved                  |
| 47              | –                     | Reserved                  |
| 48              | TINT4                 | TIMER4                    |
| 49              | TINT5                 | TIMER5                    |
| 50              | TINT6                 | TIMER6                    |
| 51              | TINT7                 | TIMER7                    |
| 52              | GPMCEVT               | GPMC                      |
| 53              | HDMIEVT               | HDMI                      |
| 54              | –                     | Reserved                  |
| 55              | –                     | Reserved                  |
| 56              | –                     | Reserved                  |
| 57              | –                     | Reserved                  |
| 58              | I2CTXEVT0             | I2C0 Transmit             |
| 59              | I2CRXEVT0             | I2C0 Receive              |
| 60              | I2CTXEVT1             | I2C1 Transmit             |
| 61              | I2CRXEVT1             | I2C1 Receive              |
| 62              | –                     | Reserved                  |
| 63              | –                     | Reserved                  |

**Table 8-3. EDMA Multiplexed Synchronization Events**

| EVT_MUX_x<br>VALUE | MULTIPLEXED<br>EVENT NAME | MULTIPLEXED EVENT DESCRIPTION |
|--------------------|---------------------------|-------------------------------|
| 0                  | –                         | Default Event                 |
| 1                  | SDTXEVT2                  | SD2 Transmit                  |
| 2                  | SDRXEVT2                  | SD2 Receive                   |
| 3                  | I2CTXEVT2                 | I2C2 Transmit                 |
| 4                  | I2CRXEVT2                 | I2C2 Receive                  |
| 5                  | I2CTXEVT3                 | I2C3 Transmit                 |
| 6                  | I2CRXEVT3                 | I2C3 Receive                  |
| 7                  | –                         | Reserved                      |
| 8                  | –                         | Reserved                      |
| 9                  | –                         | Reserved                      |
| 10                 | –                         | Reserved                      |
| 11                 | –                         | Reserved                      |
| 12                 | –                         | Reserved                      |
| 13                 | –                         | Reserved                      |
| 14                 | –                         | Reserved                      |
| 15                 | –                         | Reserved                      |
| 16                 | SPI2XEVT0                 | SPI2 Transmit 0               |
| 17                 | SPI2REVT0                 | SPI2 Receive 0                |

**Table 8-3. EDMA Multiplexed Synchronization Events (continued)**

| EVT_MUX_x<br>VALUE | MULTIPLEXED<br>EVENT NAME | MULTIPLEXED EVENT DESCRIPTION |
|--------------------|---------------------------|-------------------------------|
| 18                 | SPI2XEVT1                 | SPI2 Transmit 1               |
| 19                 | SPI2REVT1                 | SPI2 Receive 1                |
| 20                 | SPI3XEVT0                 | SPI3 Transmit 0               |
| 21                 | SPI3REVT0                 | SPI3 Receive 0                |
| 22                 | –                         | Reserved                      |
| 23                 | TINT1                     | TIMER1                        |
| 24                 | TINT2                     | TIMER2                        |
| 25                 | TINT3                     | TIMER3                        |
| 26                 | –                         | Reserved                      |
| 27                 | –                         | Reserved                      |
| 28                 | EDMAEVT0                  | EDMA_EVT0 Pin                 |
| 29                 | EDMAEVT1                  | EDMA_EVT1 Pin                 |
| 30                 | EDMAEVT2                  | EDMA_EVT2 Pin                 |
| 31                 | EDMAEVT3                  | EDMA_EVT3 Pin                 |

### 8.4.2 EDMA Peripheral Register Description

The EDMA peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

## 8.5 Emulation Features and Capability

### 8.5.1 Advanced Event Triggering (AET)

The device supports Advanced Event Triggering (AET). This capability can be used to debug complex problems as well as understand performance characteristics of user applications. AET provides the following capabilities:

- **Hardware Program Breakpoints:** specify addresses or address ranges that can generate events such as halting the processor or triggering the trace capture.
- **Data Watchpoints:** specify data variable addresses, address ranges, or data values that can generate events such as halting the processor or triggering the trace capture.
- **Counters:** count the occurrence of an event or cycles for performance monitoring.
- **State Sequencing:** allows combinations of hardware program breakpoints and data watchpoints to precisely generate events for complex sequences.

For more information on AET, see the following documents:

- *Using Advanced Event Triggering to Find and Fix Intermittent Real-Time Bugs* application report (Literature Number: [SPRA753](#)).
- *Using Advanced Event Triggering to Debug Real-Time Problems in High Speed Embedded Microprocessor Systems* application report (Literature Number: [SPRA387](#)).

### 8.5.2 Trace

The device supports Trace at the Cortex™-A8 and System levels. Trace is a debug technology that provides a detailed, historical account of application code execution, timing, and data accesses. Trace collects, compresses, and exports debug information for analysis. The debug information can be exported to the Embedded Trace Buffer (ETB), or to the 5-pin Trace Interface (system trace only). Trace works in real-time and does not impact the execution of the system.

For more information on board design guidelines for Trace Advanced Emulation, see the *Emulation and Trace Headers Technical Reference Manual* (Literature Number: [SPRU655](#)).

### 8.5.3 IEEE 1149.1 JTAG

The JTAG (IEEE Standard 1149.1-1990 Standard-Test-Access Port and Boundary Scan Architecture) interface is used for BSDL testing and emulation of the device. The  $\overline{\text{TRST}}$  pin only needs to be released when it is necessary to use a JTAG controller to debug the device or exercise the device's boundary scan functionality. For maximum reliability, the device includes an internal pulldown (IPD) on the  $\overline{\text{TRST}}$  pin to ensure that  $\overline{\text{TRST}}$  is always asserted upon power up and the device's internal emulation logic is always properly initialized. JTAG controllers from Texas Instruments actively drive  $\overline{\text{TRST}}$  high. However, some third-party JTAG controllers may not drive  $\overline{\text{TRST}}$  high but expect the use of a pullup resistor on  $\overline{\text{TRST}}$ . When using this type of JTAG controller, assert  $\overline{\text{TRST}}$  to initialize the device after powerup and externally drive  $\overline{\text{TRST}}$  high before attempting any emulation or boundary-scan operations.

The main JTAG features include:

- 32KB embedded trace buffer (ETB)
- 5-pin system trace interface for debug
- Supports Advanced Event Triggering (AET)
- All processors can be emulated via JTAG ports
- All functions on EMU pins of the device:
  - EMU[1:0] - cross-triggering, boot mode (WIR), STM trace
  - EMU[4:2] - STM trace only (single direction)



### 8.5.3.1 JTAG ID (JTAGID) Register Description

**Table 8-4. JTAG ID Register<sup>(1)</sup>**

| HEX ADDRESS | ACRONYM | REGISTER NAME                               |
|-------------|---------|---------------------------------------------|
| 0x4814 0600 | JTAGID  | JTAG Identification Register <sup>(2)</sup> |

(1) IEEE Standard 1149.1-1990 Standard-Test-Access Port and Boundary Scan Architecture.

(2) Read-only. Provides the device 32-bit JTAG ID.

The JTAG ID register is a read-only register that identifies to the customer the JTAG/device ID. For this device, the JTAG ID register resides at address location 0x4814 0600. For the actual register bit names and their associated bit field descriptions, see [Figure 8-5](#) and [Table 8-5](#).

|                 |    |                       |  |  |  |  |  |  |  |    |    |                       |  |  |  |  |   |     |
|-----------------|----|-----------------------|--|--|--|--|--|--|--|----|----|-----------------------|--|--|--|--|---|-----|
| 31              | 28 | 27                    |  |  |  |  |  |  |  | 12 | 11 |                       |  |  |  |  | 1 | 0   |
| VARIANT (4-bit) |    | PART NUMBER (16-bit)  |  |  |  |  |  |  |  |    |    | MANUFACTURER (11-bit) |  |  |  |  |   | LSB |
| R-xxxx          |    | R-1011 1001 0110 1011 |  |  |  |  |  |  |  |    |    | R-0000 0010 111       |  |  |  |  |   | R-1 |

LEGEND: R/W = Read/Write; R = Read only; -n = value after reset

**Figure 8-5. JTAG ID Register Description - Device Register Value: 0x0B8F 202F**
**Table 8-5. JTAG ID Register Selection Bit Descriptions**

| Bit   | Field        | Description                                                                                                                                                                                                                                                           |
|-------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 31:28 | VARIANT      | Variant (4-bit) value. Device value: xxxx. This value reflects the device silicon revision [For example, 0x0 (0000) for initial silicon (1.0)]. For more detailed information on the current device silicon revision, see the device-specific <i>Silicon Errata</i> . |
| 27:12 | PART NUMBER  | Part Number (16-bit) value. Device value: 0xB96B (1011 1001 0110 1011)                                                                                                                                                                                                |
| 11:1  | MANUFACTURER | Manufacturer (11-bit) value. Device value: 0x017 (0000 0010 111)                                                                                                                                                                                                      |
| 0     | LSB          | LSB. This bit is read as a "1" for this device.                                                                                                                                                                                                                       |

### 8.5.3.2 JTAG Electrical Data/Timing

**Table 8-6. Timing Requirements for IEEE 1149.1 JTAG**

(see [Figure 8-6](#))

| NO. |                   |                                                                  | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|-------------------|------------------------------------------------------------------|-------------------------------|-----|------|
|     |                   |                                                                  | MIN                           | MAX |      |
| 1   | $t_{c(TCK)}$      | Cycle time, TCK                                                  | 59                            |     | ns   |
| 1a  | $t_{w(TCKH)}$     | Pulse duration, TCK high (40% of $t_c$ )                         | 23.6                          |     | ns   |
| 1b  | $t_{w(TCKL)}$     | Pulse duration, TCK low (40% of $t_c$ )                          | 23.6                          |     | ns   |
| 3   | $t_{su(TDI-TCK)}$ | Input setup time, TDI valid to TCK high (20% of ( $t_c * 0.5$ )) | 5.9                           |     | ns   |
| 3   | $t_{su(TMS-TCK)}$ | Input setup time, TMS valid to TCK high (20% of ( $t_c * 0.5$ )) | 5.9                           |     | ns   |
| 4   | $t_h(TCK-TDI)$    | Input hold time, TDI valid from TCK high                         | 29.5                          |     | ns   |
|     | $t_h(TCK-TMS)$    | Input hold time, TMS valid from TCK high                         | 29.5                          |     | ns   |

**Table 8-7. Switching Characteristics Over Recommended Operating Conditions for IEEE 1149.1 JTAG**

(see [Figure 8-6](#))

| NO. | PARAMETER        | OPP100/OPP120/<br>Turbo/Nitro    |                         | UNIT |
|-----|------------------|----------------------------------|-------------------------|------|
|     |                  | MIN                              | MAX                     |      |
| 2   | $t_d(TCKL-TDOV)$ | Delay time, TCK low to TDO valid | 0 23.575 <sup>(1)</sup> | ns   |

(1)  $(0.5 * t_c) - 2$

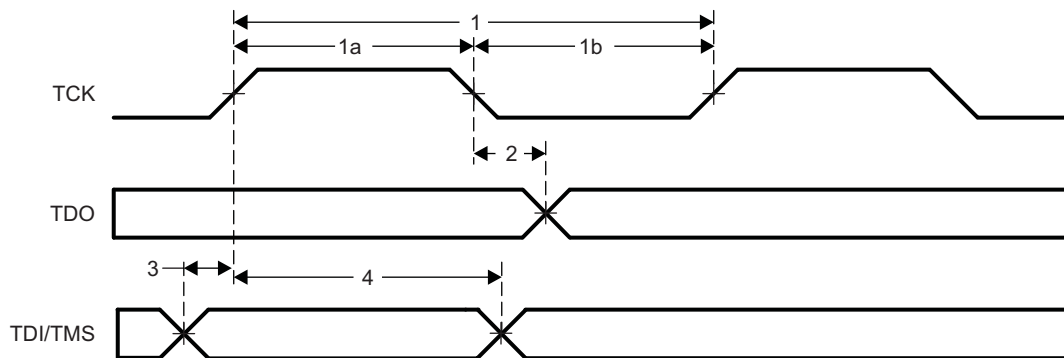


Figure 8-6. JTAG Timing

Table 8-8. Timing Requirements for IEEE 1149.1 JTAG With RTCK

(see [Figure 8-6](#))

| NO. |                   |                                                                  | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|-------------------|------------------------------------------------------------------|-------------------------------|-----|------|
|     |                   |                                                                  | MIN                           | MAX |      |
| 1   | $t_{c(TCK)}$      | Cycle time, TCK                                                  | 59                            |     | ns   |
| 1a  | $t_{w(TCKH)}$     | Pulse duration, TCK high (40% of $t_c$ )                         | 23.6                          |     | ns   |
| 1b  | $t_{w(TCKL)}$     | Pulse duration, TCK low (40% of $t_c$ )                          | 23.6                          |     | ns   |
| 3   | $t_{su(TDI-TCK)}$ | Input setup time, TDI valid to TCK high (20% of ( $t_c * 0.5$ )) | 5.9                           |     | ns   |
| 3   | $t_{su(TMS-TCK)}$ | Input setup time, TMS valid to TCK high (20% of ( $t_c * 0.5$ )) | 5.9                           |     | ns   |
| 4   | $t_h(TCK-TDI)$    | Input hold time, TDI valid from TCK high                         | 29.5                          |     | ns   |
|     | $t_h(TCK-TMS)$    | Input hold time, TMS valid from TCK high                         | 29.5                          |     | ns   |

Table 8-9. Switching Characteristics Over Recommended Operating Conditions for IEEE 1149.1 JTAG With RTCK

(see [Figure 8-7](#))

| NO. | PARAMETER       |                                                                                                                                                                                              | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-----|------|
|     |                 |                                                                                                                                                                                              | MIN                           | MAX |      |
| 5   | $t_d(TCK-RTCK)$ | Delay time, TCK to RTCK with no selected subpaths (that is, ICEPick is the only tap selected - when the ARM is in the scan chain, the delay time is a function of the ARM functional clock.) | 0                             | 24  | ns   |
| 6   | $t_c(RTCK)$     | Cycle time, RTCK                                                                                                                                                                             | 59                            |     | ns   |
| 7   | $t_w(RTCKH)$    | Pulse duration, RTCK high (40% of $t_c$ )                                                                                                                                                    | 23.6                          |     | ns   |
| 8   | $t_w(RTCKL)$    | Pulse duration, RTCK low (40% of $t_c$ )                                                                                                                                                     | 23.6                          |     | ns   |

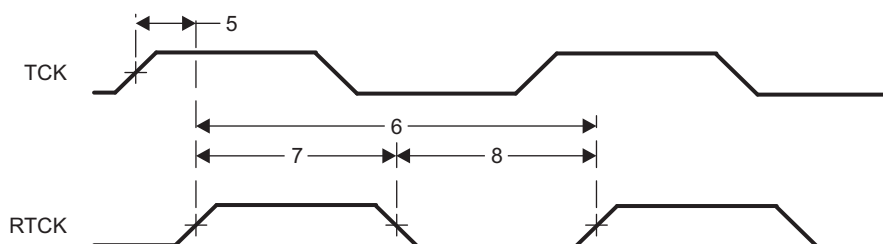


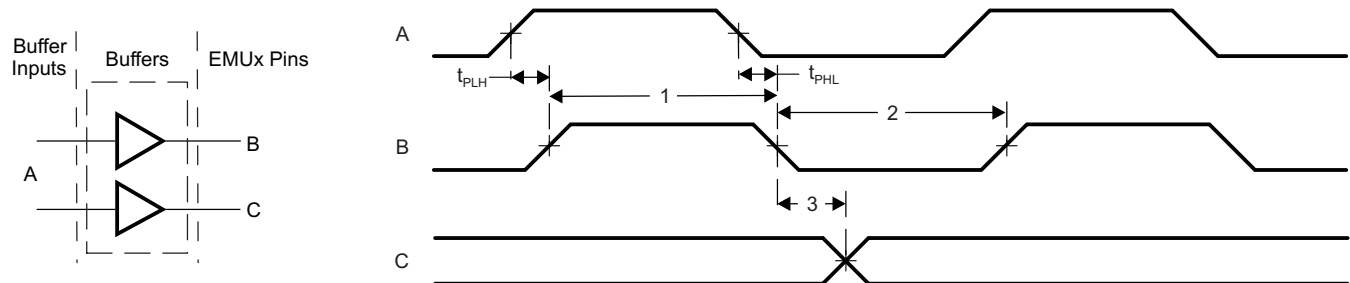
Figure 8-7. JTAG With RTCK Timing

**Table 8-10. Switching Characteristics Over Recommended Operating Conditions for STM Trace**

(see [Figure 8-8](#))

| NO. | PARAMETER         |                                                                                                                        | OPP100/OPP120/<br>Turbo/Nitro |                    | UNIT |
|-----|-------------------|------------------------------------------------------------------------------------------------------------------------|-------------------------------|--------------------|------|
|     |                   |                                                                                                                        | MIN                           | MAX                |      |
| 1   | $t_{w(EMUH50)}$   | Pulse duration, EMUx high detected at 50% $V_{OH}$ with 60/40 duty cycle                                               | 4 <sup>(1)</sup>              |                    | ns   |
|     | $t_{w(EMUH90)}$   | Pulse duration, EMUx high detected at 90% $V_{OH}$                                                                     | 3.5                           |                    | ns   |
| 2   | $t_{w(EMUL50)}$   | Pulse duration, EMUx low detected at 50% $V_{OH}$ with 60/40 duty cycle                                                | 4 <sup>(1)</sup>              |                    | ns   |
|     | $t_{w(EMUL10)}$   | Pulse duration, EMUx low detected at 10% $V_{OH}$                                                                      | 3.5                           |                    | ns   |
| 3   | $t_{sko(EMU)}$    | Output skew time, time delay difference between EMUx pins configured as trace.                                         | -0.5                          | 0.5                | ns   |
|     | $t_{skp(EMU)}$    | Pulse skew, magnitude of difference between high-to-low ( $t_{PHL}$ ) and low-to-high ( $t_{PLH}$ ) propagation delays |                               | 0.6 <sup>(1)</sup> | ns   |
|     | $t_{sldp_o(EMU)}$ | Output slew rate EMUx                                                                                                  | 3.3                           |                    | V/ns |

(1) This parameter applies to the maximum trace export frequency operating in a 40/60 duty cycle.



**Figure 8-8. STM Trace Timing**

## 8.6 Ethernet MAC Switch (EMAC SW)

The EMAC SW controls the flow of packet data between the device and two external Ethernet PHYs, with hardware flow control and quality-of-service (QoS) support. The EMAC SW contains a 3-port gigabit switch, where one port is internally connected and the other two ports are brought out externally. Each of the external EMAC ports supports 10Base-T (10 Mbps/second [Mbps]), and 100BaseTX (100 Mbps), in either half- or full-duplex mode, and 1000BaseT (1000 Mbps) in full-duplex mode.

The EMAC SW controls the flow of packet data from the device to the external PHYs. The EMAC0/1 ports on the device support four interface modes: Media Independent Interface (MII), Gigabit Media Independent Interface (GMII), Reduced Media Independent Interface (RMII) and Reduced Gigabit Media Independent Interface (RGMII). In addition, a single MDIO interface is pinned out to control the PHY configuration and status monitoring. Multiple external PHYs can be controlled by the MDIO interface.

The EMAC SW module conforms to the IEEE 802.3-2002 standard, describing the “Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer” specifications. The IEEE 802.3 standard has also been adopted by ISO/IEC and re-designated as ISO/IEC 8802-3:2000(E). Deviating from this standard, the EMAC SW module does not use the Transmit Coding Error signal MTXER. Instead of driving the error pin when an underflow condition occurs on a transmitted frame, the EMAC SW will intentionally generate an incorrect checksum by inverting the frame CRC, so that the transmitted frame will be detected as an error by the network. In addition, the EMAC SW I/Os operate at 3.3 V and are not compatible with 2.5-V I/O signaling. Therefore, only Ethernet PHYs with 3.3-V I/O interface should be used.

In networking systems, packet transmission and reception are critical tasks. The communications port programming interface (CPPI) protocol maximizes the efficiency of interaction between the host software and communications modules. The CPPI block contains 2048 words of 32-bit buffer descriptor memory that holds up to 512 buffer descriptors.

Ethernet port mirroring is not supported internally on this device. This function is supported by using an external Ethernet repeater.

For more detailed information on the EMAC SW module, see the *3PSW Ethernet Subsystem* chapter in the device-specific Technical Reference Manual.

### 8.6.1 EMAC Peripheral Register Descriptions

The EMAC peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

## 8.6.2 EMAC Electrical Data/Timing

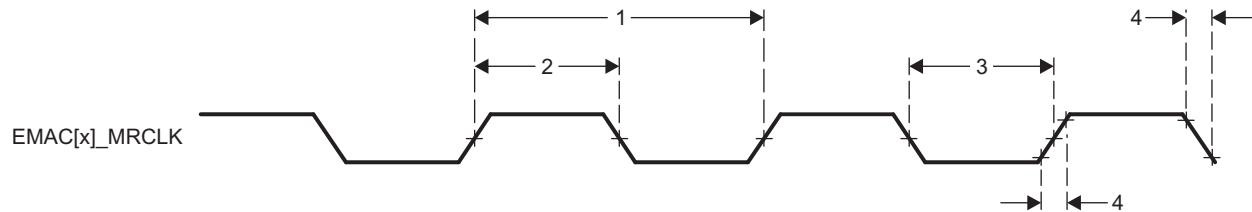
### 8.6.2.1 EMAC MII and GMII Electrical Data/Timing

GMII mode is not supported for OPP50.

**Table 8-11. Timing Requirements for EMAC[x]\_MRCLK - [G]MII Operation**

(see [Figure 8-9](#))

| NO. |                 |                                       | OPP100/OPP120/Turbo/Nitro         |     |          |     |         |     | UNIT |
|-----|-----------------|---------------------------------------|-----------------------------------|-----|----------|-----|---------|-----|------|
|     |                 |                                       | 1000 Mbps (1 Gbps)<br>(GMII Only) |     | 100 Mbps |     | 10 Mbps |     |      |
|     |                 |                                       | MIN                               | MAX | MIN      | MAX | MIN     | MAX |      |
| 1   | $t_{c(MRCLK)}$  | Cycle time, EMAC[x]_MRCLK             | 8                                 |     | 40       |     | 400     |     | ns   |
| 2   | $t_{w(MRCLKH)}$ | Pulse duration,<br>EMAC[x]_MRCLK high | 2.8                               |     | 14       |     | 140     |     | ns   |
| 3   | $t_{w(MRCLKL)}$ | Pulse duration,<br>EMAC[x]_MRCLK low  | 2.8                               |     | 14       |     | 140     |     | ns   |
| 4   | $t_t(MRCLK)$    | Transition time,<br>EMAC[x]_MRCLK     |                                   | 1   |          | 3   |         | 3   | ns   |

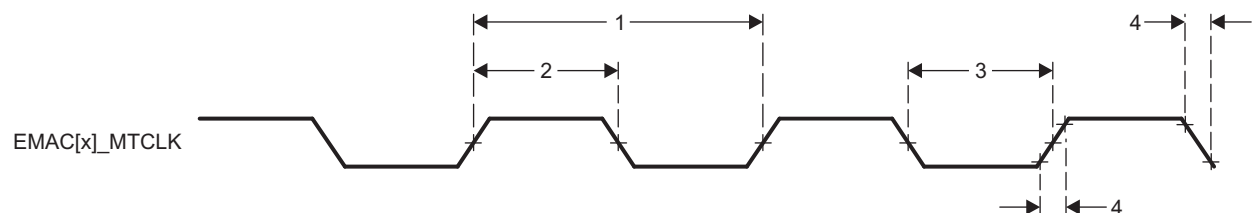


**Figure 8-9. EMAC[x]\_MRCLK Timing (EMAC Receive) - [G]MII Operation**

**Table 8-12. Timing Requirements for EMAC[x]\_MTCLK - [G]MII Operation**

(see [Figure 8-14](#))

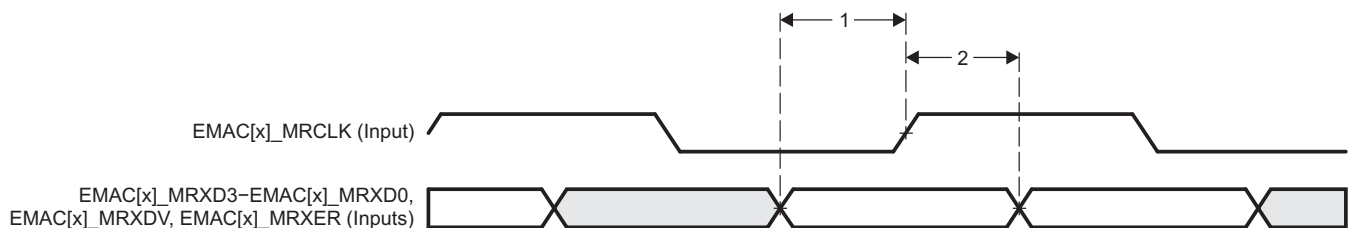
| NO. |                 |                                    | OPP100/OPP120/Turbo/Nitro         |     |          |     |         |     | UNIT |
|-----|-----------------|------------------------------------|-----------------------------------|-----|----------|-----|---------|-----|------|
|     |                 |                                    | 1000 Mbps (1 Gbps)<br>(GMII Only) |     | 100 Mbps |     | 10 Mbps |     |      |
|     |                 |                                    | MIN                               | MAX | MIN      | MAX | MIN     | MAX |      |
| 1   | $t_{c(MTCLK)}$  | Cycle time, EMAC[x]_MTCLK          | 8                                 |     | 40       |     | 400     |     | ns   |
| 2   | $t_{w(MTCLKH)}$ | Pulse duration, EMAC[x]_MTCLK high | 2.8                               |     | 14       |     | 140     |     | ns   |
| 3   | $t_{w(MTCLKL)}$ | Pulse duration, EMAC[x]_MTCLK low  | 2.8                               |     | 14       |     | 140     |     | ns   |
| 4   | $t_{t(MTCLK)}$  | Transition time, EMAC[x]_MTCLK     | 1                                 |     | 3        |     | 3       |     | ns   |



**Figure 8-10. EMAC[x]\_MTCLK Timing (EMAC Transmit) - [G]MII Operation**

**Table 8-13. Timing Requirements for EMAC [G]MII Receive 10/100/1000 Mbit/s**(see [Figure 8-11](#))

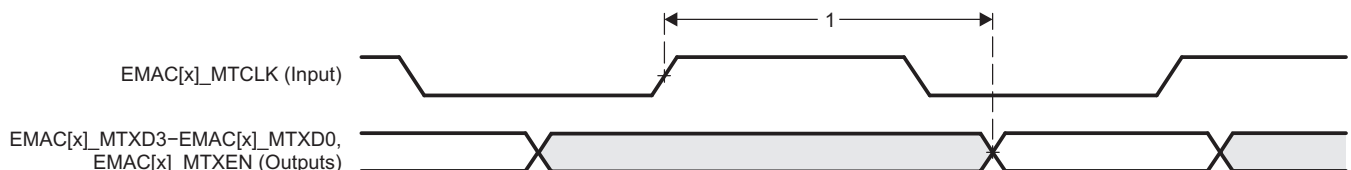
| NO. |                               |                                                                   | OPP100/OPP120/Turbo/Nitro |     |             |     | UNIT |
|-----|-------------------------------|-------------------------------------------------------------------|---------------------------|-----|-------------|-----|------|
|     |                               |                                                                   | 1000 Mbps (1 Gbps)        |     | 100/10 Mbps |     |      |
|     |                               |                                                                   | MIN                       | MAX | MIN         | MAX |      |
| 1   | t <sub>SU</sub> (MRXD-MRCLK)  | Setup time, receive selected signals valid before EMAC[1:0]_MRCLK | 3.14                      |     | 8           |     | ns   |
|     | t <sub>SU</sub> (MRXDV-MRCLK) |                                                                   |                           |     |             |     |      |
|     | t <sub>SU</sub> (MRXER-MRCLK) |                                                                   |                           |     |             |     |      |
| 2   | t <sub>H</sub> (MRCLK-MRXD)   | Hold time, receive selected signals valid after EMAC[1:0]_MRCLK   | 1.09                      |     | 8           |     | ns   |
|     | t <sub>H</sub> (MRCLK-MRXDV)  |                                                                   |                           |     |             |     |      |
|     | t <sub>H</sub> (MRCLK-MRXER)  |                                                                   |                           |     |             |     |      |

**Figure 8-11. EMAC Receive Interface Timing [G]MII Operation****Table 8-14. Switching Characteristics Over Recommended Operating Conditions for EMAC [G]MII Transmit 10/100 Mbits/s**(see [Figure 8-12](#))

| NO. | PARAMETER                    |                                                              | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|------------------------------|--------------------------------------------------------------|-------------------------------|-----|------|
|     |                              |                                                              | 100/10 Mbps                   |     |      |
|     |                              |                                                              | MIN                           | MAX |      |
| 1   | t <sub>d</sub> (MTXCLK-MTXD) | Delay time, EMAC[x]_MTCLK to transmit selected signals valid | 0                             | 25  | ns   |
|     | t <sub>d</sub> (MTCLK-MTXEN) |                                                              |                               |     |      |

**Table 8-15. Switching Characteristics Over Recommended Operating Conditions for EMAC [G]MII Transmit 1000 Mbits/s**(see [Figure 8-12](#))

| NO. | PARAMETER                     |                                                               | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|-------------------------------|---------------------------------------------------------------|-------------------------------|-----|------|
|     |                               |                                                               | 1000 Mbps (1 Gbps)            |     |      |
|     |                               |                                                               | MIN                           | MAX |      |
| 1   | t <sub>d</sub> (GMTCLK-MTXD)  | Delay time, EMAC[x]_GMTCLK to transmit selected signals valid | 0.5                           | 5   | ns   |
|     | t <sub>d</sub> (GMTCLK-MTXEN) |                                                               |                               |     |      |

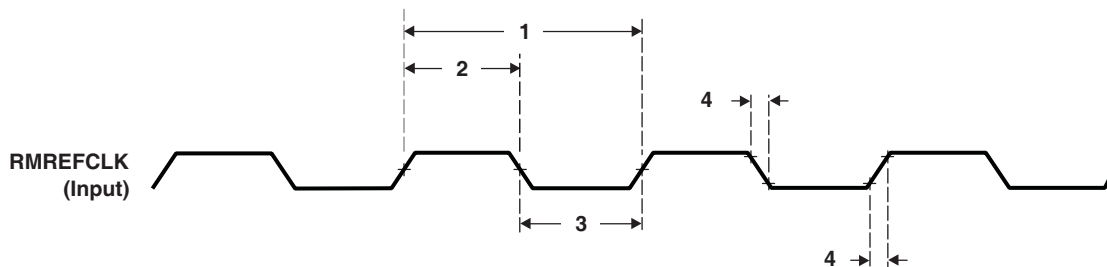
**Figure 8-12. EMAC Transmit Interface Timing [G]MII Operation**

### 8.6.2.2 EMAC RMII Electrical Data/Timing

**Table 8-16. Timing Requirements for EMAC[x]\_RMREFCLK - RMII Operation**

(see [Figure 8-13](#))

| NO. |                    |                                       | OPP100/OPP120/Turbo/Nitro |        | UNIT |
|-----|--------------------|---------------------------------------|---------------------------|--------|------|
|     |                    |                                       | MIN                       | MAX    |      |
| 1   | $t_{c(RMREFCLK)}$  | Cycle time, EMAC[x]_RMREFCLK          | 19.999                    | 20.001 | ns   |
| 2   | $t_{w(RMREFCLKH)}$ | Pulse duration, EMAC[x]_RMREFCLK high | 7                         | 13     | ns   |
| 3   | $t_{w(RMREFCLKL)}$ | Pulse duration, EMAC[x]_RMREFCLK low  | 7                         | 13     | ns   |
| 4   | $t_t(RMREFCLK)$    | Transition time, EMAC[x]_RMREFCLK     |                           | 3      | ns   |

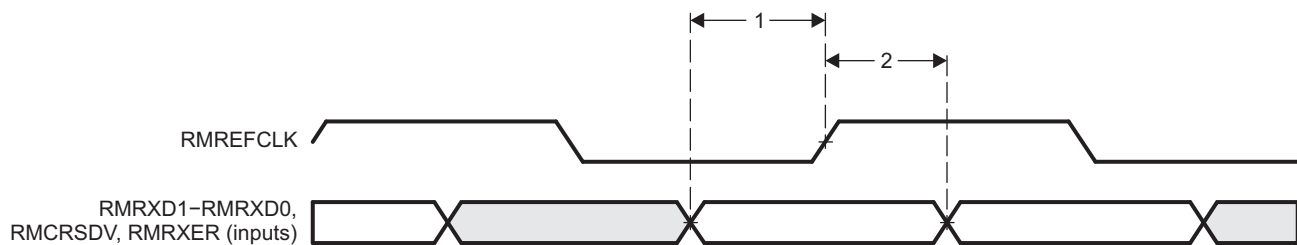


**Figure 8-13. RMREFCLK Timing RMII Operation**

**Table 8-17. Timing Requirements for EMAC RMII Receive**

(see [Figure 8-13](#))

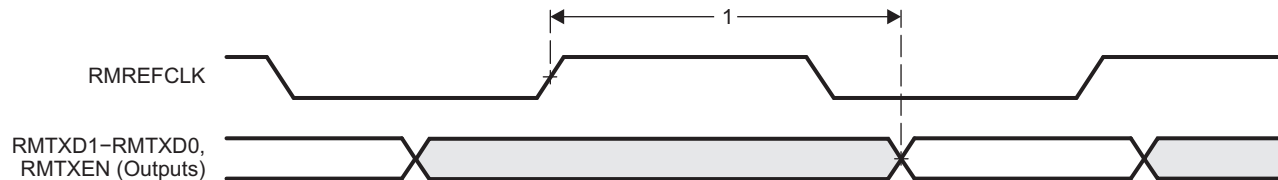
| NO. |                           |                                                                    | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|---------------------------|--------------------------------------------------------------------|-------------------------------|-----|------|
|     |                           |                                                                    | MIN                           | MAX |      |
| 1   | $t_{su(RMRXD-RMREFCLK)}$  | Setup time, receive selected signals valid before EMAC[x]_RMREFCLK | 4                             |     | ns   |
|     | $t_{su(RMCSDV-RMREFCLK)}$ |                                                                    |                               |     |      |
|     | $t_{su(RMRXER-RMREFCLK)}$ |                                                                    |                               |     |      |
| 2   | $t_h(RMREFCLK-RMRXD)$     | Hold time, receive selected signals valid after EMAC[x]_RMREFCLK   | 2                             |     | ns   |
|     | $t_h(RMREFCLK-RMCSDV)$    |                                                                    |                               |     |      |
|     | $t_h(RMREFCLK-RMRXER)$    |                                                                    |                               |     |      |



**Figure 8-14. EMAC Receive Interface Timing RMII Operation**

**Table 8-18. Switching Characteristics Over Recommended Operating Conditions for EMAC RMII Transmit 10/100 Mbits/s**
(see [Figure 8-15](#))

| NO. | PARAMETER                 |                                                             | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|---------------------------|-------------------------------------------------------------|-------------------------------|-----|------|
|     |                           |                                                             | MIN                           | MAX |      |
| 1   | $t_{d(RMREFCLK-RMTXD)}$   | Delay time, EMAC[x]_RMREFCLK high to EMAC[x]_RMTXD[x] valid | 2.4                           | 13  | ns   |
| 2   | $t_{dd(RMREFCLK-RMTXEN)}$ | Delay time, EMAC[x]_RMREFCLK high to EMAC[x]_RMTXEN valid   | 2.4                           | 13  |      |


**Figure 8-15. EMAC Transmit Interface Timing RMII Operation**

### 8.6.2.3 EMAC RGMII Electrical Data/Timing

RGMII mode is not supported for OPP50.

**Table 8-19. Timing Requirements for EMAC[x]\_RGRXC - RGMII Operation**
(see [Figure 8-16](#))

| NO. |                 |                                    | OPP100/OPP120/Turbo/Nitro |                      | UNIT                 |    |
|-----|-----------------|------------------------------------|---------------------------|----------------------|----------------------|----|
|     |                 |                                    | MIN                       | MAX                  |                      |    |
| 1   | $t_{c(RGRXC)}$  | Cycle time, EMAC[x]_RGRXC          | 10 Mbps                   | 360                  | 440                  | ns |
|     |                 |                                    | 100 Mbps                  | 36                   | 44                   |    |
|     |                 |                                    | 1000 Mbps                 | 7.2                  | 8.8                  |    |
| 2   | $t_{w(RGRXCH)}$ | Pulse duration, EMAC[x]_RGRXC high | 10 Mbps                   | 0.40* $t_{c(RGRXC)}$ | 0.60* $t_{c(RGRXC)}$ | ns |
|     |                 |                                    | 100 Mbps                  | 0.40* $t_{c(RGRXC)}$ | 0.60* $t_{c(RGRXC)}$ |    |
|     |                 |                                    | 1000 Mbps                 | 0.45* $t_{c(RGRXC)}$ | 0.55* $t_{c(RGRXC)}$ |    |
| 3   | $t_{w(RGRXCL)}$ | Pulse duration, EMAC[x]_RGRXC low  | 10 Mbps                   | 0.40* $t_{c(RGRXC)}$ | 0.60* $t_{c(RGRXC)}$ | ns |
|     |                 |                                    | 100 Mbps                  | 0.40* $t_{c(RGRXC)}$ | 0.60* $t_{c(RGRXC)}$ |    |
|     |                 |                                    | 1000 Mbps                 | 0.45* $t_{c(RGRXC)}$ | 0.55* $t_{c(RGRXC)}$ |    |
| 4   | $t_{t(RGRXC)}$  | Transition time, EMAC[x]_RGRXC     | 10 Mbps                   | 0.75                 |                      | ns |
|     |                 |                                    | 100 Mbps                  | 0.75                 |                      |    |
|     |                 |                                    | 1000 Mbps                 | 0.75                 |                      |    |

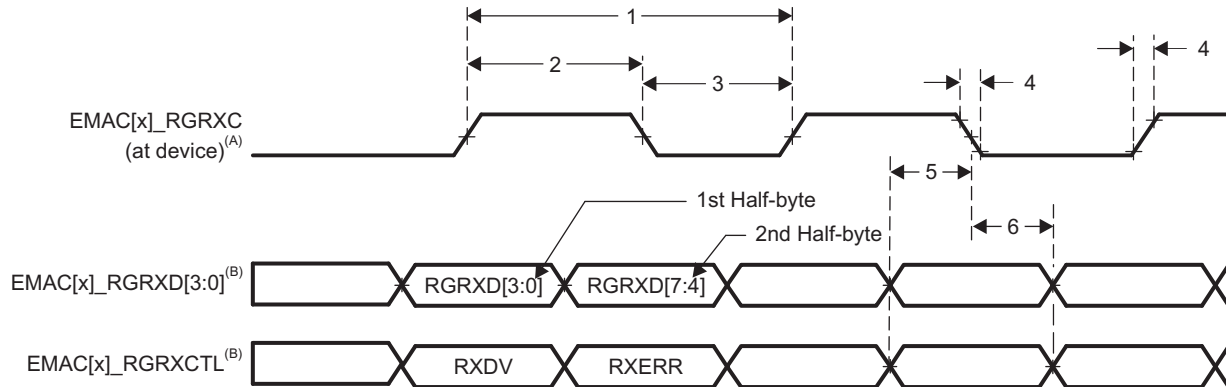


**Table 8-20. Timing Requirements for EMAC RGMII Input Receive for 10/100/1000 Mbps<sup>(1)</sup>**

(see Figure 8-16)

| NO. |                        |                                                                                      |                        | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|------------------------|--------------------------------------------------------------------------------------|------------------------|-------------------------------|-----|------|
|     |                        |                                                                                      |                        | MIN                           | MAX |      |
| 5   | $t_{su}(RGRXD-RGRXCH)$ | Setup time, receive selected signals valid before EMAC[x]_RGRXC (at device) high/low | Internal delay enabled | 1.0                           |     | ns   |
| 6   | $t_h(RGRXCH-RGRXD)$    | Hold time, receive selected signals valid after EMAC[x]_RGRXC (at device) high/low   | Internal delay enabled | 1.0                           |     | ns   |

(1) For RGMII, receive selected signals include: EMAC[x]\_RGRXD[3:0] and EMAC[x]\_RGRXCTL.



- A. EMAC[x]\_RGRXC must be externally delayed relative to the data and control pins. The internal delay can be enabled or disabled via the EMAC RGMII<sub>IN</sub>\_ID\_MODE register.
- B. Data and control information is received using both edges of the clocks. EMAC[x]\_RGRXD[3:0] carries data bits 3-0 on the rising edge of EMAC[x]\_RGRXC and data bits 7-4 on the falling edge of EMAC[x]\_RGRXC. Similarly, EMAC[x]\_RGRXCTL carries RXDV on rising edge of EMAC[x]\_RGRXC and RXERR on falling edge of EMAC[x]\_RGRXC.

**Figure 8-16. EMAC Receive Interface Timing [RGMII Operation]**

**Table 8-21. Switching Characteristics Over Recommended Operating Conditions for RGTXC - RGMII Operation for 10/100/1000 Mbit/s**

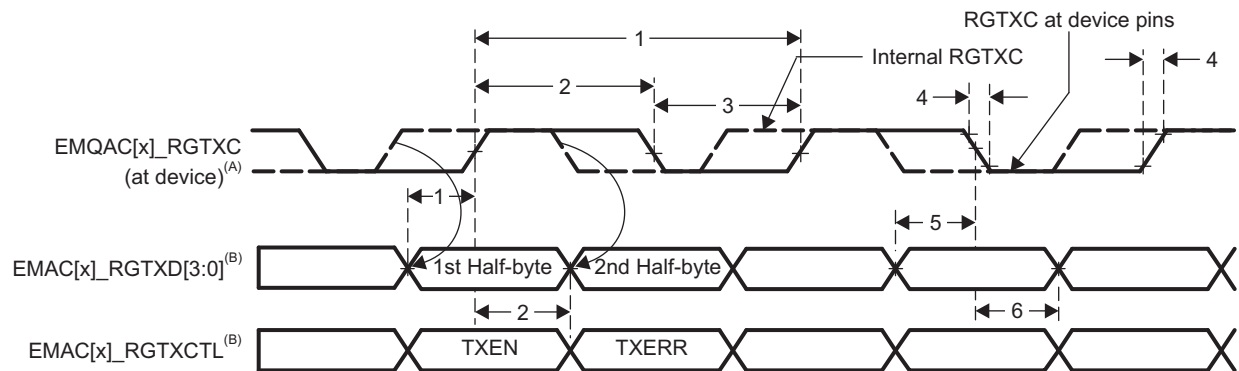
(see Figure 8-17)

| NO. |                 |                                    | OPP100/OPP120/<br>Turbo/Nitro |                           | UNIT                      |    |
|-----|-----------------|------------------------------------|-------------------------------|---------------------------|---------------------------|----|
|     |                 |                                    | MIN                           | MAX                       |                           |    |
| 1   | $t_{c(RGTXC)}$  | Cycle time, EMAC[x]_RGTXC          | 10 Mbps                       | 360                       | 440                       | ns |
|     |                 |                                    | 100 Mbps                      | 36                        | 44                        |    |
|     |                 |                                    | 1000 Mbps                     | 7.2                       | 8.8                       |    |
| 2   | $t_{w(RGTXCH)}$ | Pulse duration, EMAC[x]_RGTXC high | 10 Mbps                       | $0.40 \cdot t_{c(RGTXC)}$ | $0.60 \cdot t_{c(RGTXC)}$ | ns |
|     |                 |                                    | 100 Mbps                      | $0.40 \cdot t_{c(RGTXC)}$ | $0.60 \cdot t_{c(RGTXC)}$ |    |
|     |                 |                                    | 1000 Mbps                     | $0.45 \cdot t_{c(RGTXC)}$ | $0.55 \cdot t_{c(RGTXC)}$ |    |
| 3   | $t_{w(RGTXCL)}$ | Pulse duration, EMAC[x]_RGTXC low  | 10 Mbps                       | $0.40 \cdot t_{c(RGTXC)}$ | $0.60 \cdot t_{c(RGTXC)}$ | ns |
|     |                 |                                    | 100 Mbps                      | $0.40 \cdot t_{c(RGTXC)}$ | $0.60 \cdot t_{c(RGTXC)}$ |    |
|     |                 |                                    | 1000 Mbps                     | $0.45 \cdot t_{c(RGTXC)}$ | $0.55 \cdot t_{c(RGTXC)}$ |    |
| 4   | $t_l(RGTXC)$    | Transition time, EMAC[x]_RGTXC     | 10 Mbps                       |                           | 0.75                      | ns |
|     |                 |                                    | 100 Mbps                      |                           | 0.75                      |    |
|     |                 |                                    | 1000 Mbps                     |                           | 0.75                      |    |

**Table 8-22. Switching Characteristics Over Recommended Operating Conditions for EMAC RGMII Transmit<sup>(1)</sup>**
(see [Figure 8-17](#))

| NO. | PARAMETER             |                                                                                       | OPP100/OPP120<br>/ Turbo/Nitro |     | UNIT |
|-----|-----------------------|---------------------------------------------------------------------------------------|--------------------------------|-----|------|
|     |                       |                                                                                       | MIN                            | MAX |      |
| 5   | $t_{su}(RGTXD-RGTXC)$ | Setup time, transmit selected signals valid before EMAC[x]_RGTXC (at device) high/low | Internal delay enabled         |     | ns   |
| 6   | $t_h(RGTXC-RGTXD)$    | Hold time, transmit selected signals valid after EMAC[x]_RGTXC (at device) high/low   | Internal delay enabled         |     | ns   |

(1) For RGMII, transmit selected signals include: EMAC[x]\_RGTXD[3:0] and EMAC[x]\_RGTXCTL.



- A. RGTXC is delayed internally before being driven to the EMAC[x]\_RGTXC pin. The internal delay can be enabled or disabled via the EMAC RGMII<sub>n</sub>\_ID\_MODE register.
- B. Data and control information is transmitted using both edges of the clocks. EMAC[x]\_RGTXD[3:0] carries data bits 3-0 on the rising edge of EMAC[x]\_RGTXC and data bits 7-4 on the falling edge of EMAC[x]\_RGTXC. Similarly, EMAC[x]\_RGTXCTL carries TXEN on rising edge of EMAC[x]\_RGTXC and TXERR on falling edge of EMAC[x]\_RGTXC.

**Figure 8-17. EMAC Transmit Interface Timing [RGMII Operation]**

### 8.6.3 Management Data Input/Output (MDIO)

The Management Data Input/Output (MDIO) module continuously polls all 32 MDIO addresses in order to enumerate all PHY devices in the system.

The MDIO module implements the 802.3 serial management interface to interrogate and control Ethernet PHYs using a shared two-wire bus. Host software uses the MDIO module to configure the auto-negotiation parameters of each PHY attached to the EMAC SW, retrieve the negotiation results, and configure required parameters in the EMAC SW module for correct operation. The module is designed to allow almost transparent operation of the MDIO interface, with very little maintenance from the core processor. A single MDIO interface is pinned out to control the PHY configuration and status monitoring. Multiple external PHYs can be controlled by the MDIO interface.

For more detailed information on the MDIO peripheral, see the *3PSW Ethernet Subsystem* chapter in the device-specific Technical Reference Manual.

#### 8.6.3.1 MDIO Peripheral Register Descriptions

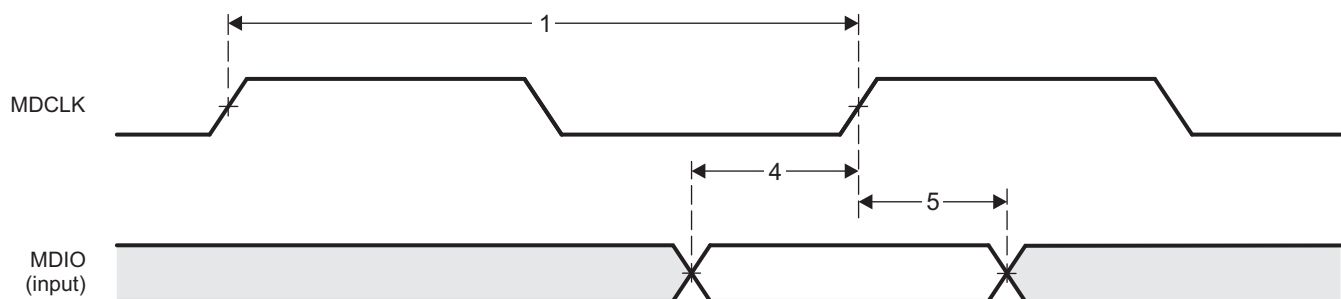
The MDIO peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

#### 8.6.3.2 MDIO Electrical Data/Timing

**Table 8-23. Timing Requirements for MDIO Input**

(see [Figure 8-18](#))

| NO. |                       |                                                     | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|-----------------------|-----------------------------------------------------|-------------------------------|-----|------|
|     |                       |                                                     | MIN                           | MAX |      |
| 1   | $t_{c(MDCLK)}$        | Cycle time, MDCLK                                   | 400                           |     | ns   |
|     | $t_{w(MDCLK)}$        | Pulse duration, MDCLK high or low                   | 180                           |     | ns   |
| 4   | $t_{su(MDIO-MDCLKH)}$ | Setup time, MDIO data input valid before MDCLK high | 15                            |     | ns   |
| 5   | $t_{h(MDCLKH-MDIO)}$  | Hold time, MDIO data input valid after MDCLK high   | 10                            |     | ns   |

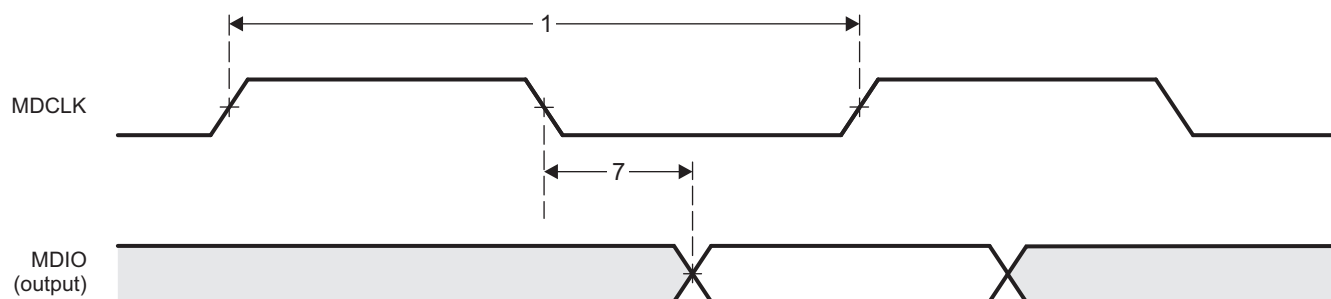


**Figure 8-18. MDIO Input Timing**

**Table 8-24. Switching Characteristics Over Recommended Operating Conditions for MDIO Output**

(see [Figure 8-19](#))

| NO. | PARAMETER            | OPP100/OPP120/<br>Turbo/Nitro                   |     | UNIT   |
|-----|----------------------|-------------------------------------------------|-----|--------|
|     |                      | MIN                                             | MAX |        |
| 7   | $t_{d(MDCLKL-MDIO)}$ | Delay time, MDCLK low to MDIO data output valid |     | 100 ns |

**Figure 8-19. MDIO Output Timing**

## 8.7 General-Purpose Input/Output (GPIO)

The GPIO peripheral provides general-purpose pins that can be configured as either inputs or outputs. When configured as an output, a write to an internal register controls the state driven on the output pin. When configured as an input, the state of the input is detectable by reading the state of an internal register. In addition, the GPIO peripheral can produce CPU interrupts in different interrupt generation modes. The GPIO peripheral provides generic connections to external devices.

The device contains four GPIO modules and each GPIO module consists of up to 32 identical channels.

The device GPIO peripheral supports the following:

- Up to 125 1.8-V/3.3-V GPIO pins, GP0[0:28], GP1[0:31], GP2[0:31], and GP3[0:31] (the exact number available varies as a function of the device configuration). Each channel can be configured to be used in the following applications:
  - Data input/output
  - Keyboard interface with a de-bouncing cell
  - Synchronous interrupt generation (in active mode) upon the detection of external events (signal transitions and/or signal levels).
- Synchronous interrupt requests from each channel are processed by four identical interrupt generation sub-modules to be used independently by the ARM or Media Controller. Interrupts can be triggered by rising and/or falling edge, specified for each interrupt-capable GPIO signal.
- Shared registers can be accessed through "Set & Clear" protocol. Software writes 1 to corresponding bit positions to set or to clear GPIO signals. This allows multiple software processes to toggle GPIO output signals without critical section protection (disable interrupts, program GPIO, re-enable interrupts, to prevent context switching to another process during GPIO programming).
- Separate input/output registers.
- Output register in addition to set/clear so that, if preferred by software, some GPIO output signals can be toggled by direct write to the output registers.
- Output register, when read, reflects output drive status. This, in addition to the input register reflecting pin status and open-drain I/O cell, allows wired logic to be implemented.

For more detailed information on GPIOs, see the *General-Purpose I/O (GPIO) Interface* chapter in the device-specific Technical Reference Manual.

### 8.7.1 GPIO Peripheral Register Descriptions

The GPIO peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

## 8.7.2 GPIO Electrical Data/Timing

**Table 8-25. Timing Requirements for GPIO Inputs**

(see [Figure 8-20](#))

| NO. |               |                                      | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|---------------|--------------------------------------|-------------------------------|-----|------|
|     |               |                                      | MIN                           | MAX |      |
| 1   | $t_{w(GPIH)}$ | Pulse duration, GPx[31:0] input high | 12P <sup>(1)</sup>            |     | ns   |
| 2   | $t_{w(GPIL)}$ | Pulse duration, GPx[31:0] input low  | 12P <sup>(1)</sup>            |     | ns   |

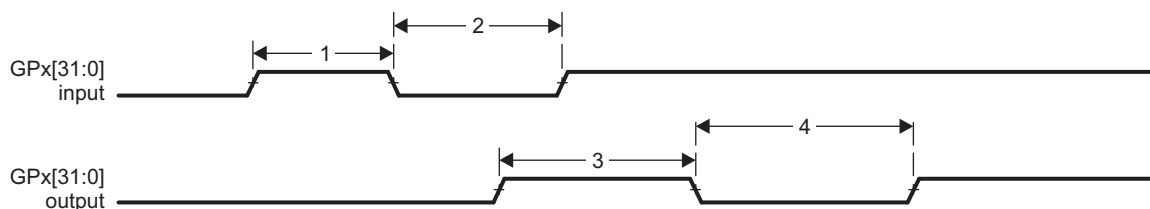
(1) P = Module clock.

**Table 8-26. Switching Characteristics Over Recommended Operating Conditions for GPIO Outputs**

(see [Figure 8-20](#))

| NO. | PARAMETER     |                                       | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|---------------|---------------------------------------|-------------------------------|-----|------|
|     |               |                                       | MIN                           | MAX |      |
| 3   | $t_{w(GPOH)}$ | Pulse duration, GPx[31:0] output high | 36P-8 <sup>(1)</sup>          |     | ns   |
| 4   | $t_{w(GPOL)}$ | Pulse duration, GPx[31:0] output low  | 36P-8 <sup>(1)</sup>          |     | ns   |

(1) P = Module clock.



**Figure 8-20. GPIO Port Timing**

## 8.8 General-Purpose Memory Controller (GPMC) and Error Location Module (ELM)

The GPMC is a device memory controller used to provide a glueless interface to external memory devices such as NOR Flash, NAND Flash (with BCH and Hamming Error Code Detection for 8-bit or 16-bit NAND Flash), SRAM, and Pseudo-SRAM. It includes flexible asynchronous protocol control for interface to SRAM-like memories and custom logic (FPGA, CPLD, ASICs, etc.).

Other supported features include:

- 8-/16-bit wide multiplexed address/data bus
- 512 MBytes maximum addressing capability divided among up to eight chip selects
- Non-multiplexed address/data mode
- Pre-fetch and write posting engine associated with system DMA to get full performance from NAND device with minimum impact on NOR/SRAM concurrent access.

The device also contains an Error Locator Module (ELM) which is used to extract error addresses from syndrome polynomials generated using a BCH algorithm. Each of these polynomials gives a status of the read operations for a 512 bytes block from a NAND flash and its associated BCH parity bits, plus optionally spare area information. The ELM has the following features:

- 4-bit, 8-bit and 16-bit per 512byte block error location based on BCH algorithms
- Eight simultaneous processing contexts
- Page-based and continuous modes
- Interrupt generation on error location process completion
  - When the full page has been processed in page mode
  - For each syndrome polynomial in continuous mode

### 8.8.1 GPMC and ELM Peripherals Register Descriptions

The GPMC and ELM peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

## 8.8.2 GPMC Electrical Data/Timing

### 8.8.2.1 GPMC and NOR Flash Interface Synchronous Mode Timing (Non-Multiplexed and Multiplexed Modes)

**Table 8-27. Timing Requirements for GPMC and NOR Flash Interface - Synchronous Mode**

(see Figure 8-21, Figure 8-22, Figure 8-23 for Non-Multiplexed Modes)

(see Figure 8-24, Figure 8-25, Figure 8-26 for Multiplexed Modes)

| NO. |                      |                                                          | OPP100/OPP120/Turbo/Nitro |     | UNIT |
|-----|----------------------|----------------------------------------------------------|---------------------------|-----|------|
|     |                      |                                                          | MIN                       | MAX |      |
| 13  | $t_{su}(DV-CLKH)$    | Setup time, read GPMC_D[15:0] valid before GPMC_CLK high | 3.2                       |     | ns   |
| 14  | $t_h(CLKH-DV)$       | Hold time, read GPMC_D[15:0] valid after GPMC_CLK high   | 2.5                       |     | ns   |
| 22  | $t_{su}(WAITV-CLKH)$ | Setup time, GPMC_WAIT[x] valid before GPMC_CLK high      | 3.2                       |     | ns   |
| 23  | $t_h(CLKH-WAITV)$    | Hold time, GPMC_WAIT[x] valid after GPMC_CLK high        | 2.5                       |     | ns   |

**Table 8-28. Switching Characteristics Over Recommended Operating Conditions for GPMC and NOR Flash Interface - Synchronous Mode**

(see Figure 8-21, Figure 8-22, Figure 8-23 for Non-Multiplexed Modes)

(see Figure 8-24, Figure 8-25, Figure 8-26 for Multiplexed Modes)

| NO. | PARAMETER         |                                                                                  | OPP100/OPP120/Turbo/Nitro |                        | UNIT |
|-----|-------------------|----------------------------------------------------------------------------------|---------------------------|------------------------|------|
|     |                   |                                                                                  | MIN                       | MAX                    |      |
| 1   | $t_c(CLK)$        | Cycle time, output clock GPMC_CLK period                                         | 16 <sup>(1)</sup>         |                        | ns   |
| 2   | $t_w(CLKH)$       | Pulse duration, output clock GPMC_CLK high                                       | 0.5P <sup>(2)</sup>       |                        | ns   |
|     | $t_w(CLKL)$       | Pulse duration, output clock GPMC_CLK low                                        | 0.5P <sup>(2)</sup>       |                        |      |
| 3   | $t_d(CLKH-nCSV)$  | Delay time, GPMC_CLK rising edge to $\overline{GPMC\_CS[x]}$ transition          | F - 2.2 <sup>(3)</sup>    | F + 4.5 <sup>(3)</sup> | ns   |
| 4   | $t_d(CLKH-nCSIV)$ | Delay time, GPMC_CLK rising edge to $\overline{GPMC\_CS[x]}$ invalid             | E - 2.2 <sup>(4)</sup>    | E + 4.5 <sup>(4)</sup> | ns   |
| 5   | $t_d(ADDV-CLK)$   | Delay time, GPMC_A[27:0] address bus valid to GPMC_CLK first edge                | B - 4.5 <sup>(5)</sup>    | B + 2.3 <sup>(5)</sup> | ns   |
| 6   | $t_d(CLKH-ADDIV)$ | Delay time, GPMC_CLK rising edge to GPMC_A[27:0] GPMC address bus invalid        | -2.3                      |                        | ns   |
| 7   | $t_d(nBEV-CLK)$   | Delay time, GPMC_BE0_CLE, $\overline{GPMC\_BE1}$ valid to GPMC_CLK first edge    | B - 1.9 <sup>(5)</sup>    | B + 2.3 <sup>(5)</sup> | ns   |
| 8   | $t_d(CLKH-nBEIV)$ | Delay time, GPMC_CLK rising edge to GPMC_BE0_CLE, $\overline{GPMC\_BE1}$ invalid | D - 2.3 <sup>(6)</sup>    | D + 1.9 <sup>(6)</sup> | ns   |

(1) Sync mode = 62.5 MHz; Async mode = 125 MHz.

(2) P = GPMC\_CLK period.

(3) For nCS falling edge (CS activated):

- For GpmcFCLKDivider = 0:

$$F = 0.5 * CSEExtraDelay * GPMC\_FCLK$$

- For GpmcFCLKDivider = 1:

$$F = 0.5 * CSEExtraDelay * GPMC\_FCLK \text{ if (ClkActivationTime and CSOnTime are odd) or (ClkActivationTime and CSOnTime are even)}$$

$$F = (1 + 0.5 * CSEExtraDelay) * GPMC\_FCLK \text{ otherwise}$$

- For GpmcFCLKDivider = 2:

$$F = 0.5 * CSEExtraDelay * GPMC\_FCLK \text{ if ((CSOnTime - ClkActivationTime) is a multiple of 3)}$$

$$F = (1 + 0.5 * CSEExtraDelay) * GPMC\_FCLK \text{ if ((CSOnTime - ClkActivationTime - 1) is a multiple of 3)}$$

$$F = (2 + 0.5 * CSEExtraDelay) * GPMC\_FCLK \text{ if ((CSOnTime - ClkActivationTime - 2) is a multiple of 3)}$$

(4) For single read: E = (CSRdOffTime - AccessTime) \* (TimeParaGranularity + 1) \* GPMC\_FCLK

For burst read: E = (CSRdOffTime - AccessTime) \* (TimeParaGranularity + 1) \* GPMC\_FCLK

For burst write: E = (CSWrOffTime - AccessTime) \* (TimeParaGranularity + 1) \* GPMC\_FCLK

(5) B = ClkActivationTime \* GPMC\_FCLK

(6) For single read: D = (RdCycleTime - AccessTime) \* (TimeParaGranularity + 1) \* GPMC\_FCLK

For burst read: D = (RdCycleTime - AccessTime) \* (TimeParaGranularity + 1) \* GPMC\_FCLK

For burst write: D = (WrCycleTime - AccessTime) \* (TimeParaGranularity + 1) \* GPMC\_FCLK



**Table 8-28. Switching Characteristics Over Recommended Operating Conditions for GPMC and NOR Flash Interface - Synchronous Mode (continued)**

(see Figure 8-21, Figure 8-22, Figure 8-23 for Non-Multiplexed Modes)

(see Figure 8-24, Figure 8-25, Figure 8-26 for Multiplexed Modes)

| NO. | PARAMETER                                                                      | OPP100/OPP120/Turbo/Nitro |                        | UNIT |
|-----|--------------------------------------------------------------------------------|---------------------------|------------------------|------|
|     |                                                                                | MIN                       | MAX                    |      |
| 9   | $t_{d(CLKH-nADV)}$ Delay time, GPMC_CLK rising edge to GPMC_ADV_ALE transition | G - 2.3 <sup>(7)</sup>    | G + 4.5 <sup>(7)</sup> | ns   |
| 10  | $t_{d(CLKH-nADVIV)}$ Delay time, GPMC_CLK rising edge to GPMC_ADV_ALE invalid  | D - 2.3 <sup>(6)</sup>    | D + 4.5 <sup>(6)</sup> | ns   |
| 11  | $t_{d(CLKH-nOE)}$ Delay time, GPMC_CLK rising edge to GPMC_OE_RE transition    | H - 2.3 <sup>(8)</sup>    | H + 3.5 <sup>(8)</sup> | ns   |
| 12  | $t_{d(CLKH-nOEIV)}$ Delay time, GPMC_CLK rising edge to GPMC_OE_RE invalid     | E - 2.3 <sup>(4)</sup>    | E + 3.5 <sup>(4)</sup> | ns   |

(7) For ADV falling edge (ADV activated):

- Case GpmcFCLKDivider = 0:  
 $G = 0.5 * ADVExtraDelay * GPMC\_FCLK$
- Case GpmcFCLKDivider = 1:  
 $G = 0.5 * ADVExtraDelay * GPMC\_FCLK$  if (ClkActivationTime and ADVOnTime are odd) or (ClkActivationTime and ADVOnTime are even)  
 $G = (1 + 0.5 * ADVExtraDelay) * GPMC\_FCLK$  otherwise
- Case GpmcFCLKDivider = 2:  
 $G = 0.5 * ADVExtraDelay * GPMC\_FCLK$  if ((ADVOnTime – ClkActivationTime) is a multiple of 3)  
 $G = (1 + 0.5 * ADVExtraDelay) * GPMC\_FCLK$  if ((ADVOnTime – ClkActivationTime – 1) is a multiple of 3)  
 $G = (2 + 0.5 * ADVExtraDelay) * GPMC\_FCLK$  if ((ADVOnTime – ClkActivationTime – 2) is a multiple of 3)

For ADV rising edge (ADV deactivated) in Reading mode:

- Case GpmcFCLKDivider = 0:  
 $G = 0.5 * ADVExtraDelay * GPMC\_FCLK$
- Case GpmcFCLKDivider = 1:  
 $G = 0.5 * ADVExtraDelay * GPMC\_FCLK$  if (ClkActivationTime and ADVRdOffTime are odd) or (ClkActivationTime and ADVRdOffTime are even)  
 $G = (1 + 0.5 * ADVExtraDelay) * GPMC\_FCLK$  otherwise
- Case GpmcFCLKDivider = 2:  
 $G = 0.5 * ADVExtraDelay * GPMC\_FCLK$  if ((ADVRdOffTime – ClkActivationTime) is a multiple of 3)  
 $G = (1 + 0.5 * ADVExtraDelay) * GPMC\_FCLK$  if ((ADVRdOffTime – ClkActivationTime – 1) is a multiple of 3)  
 $G = (2 + 0.5 * ADVExtraDelay) * GPMC\_FCLK$  if ((ADVRdOffTime – ClkActivationTime – 2) is a multiple of 3)

For ADV rising edge (ADV deactivated) in Writing mode:

- Case GpmcFCLKDivider = 0:  
 $G = 0.5 * ADVExtraDelay * GPMC\_FCLK$
- Case GpmcFCLKDivider = 1:  
 $G = 0.5 * ADVExtraDelay * GPMC\_FCLK$  if (ClkActivationTime and ADVWrOffTime are odd) or (ClkActivationTime and ADVWrOffTime are even)  
 $G = (1 + 0.5 * ADVExtraDelay) * GPMC\_FCLK$  otherwise
- Case GpmcFCLKDivider = 2:  
 $G = 0.5 * ADVExtraDelay * GPMC\_FCLK$  if ((ADVWrOffTime – ClkActivationTime) is a multiple of 3)  
 $G = (1 + 0.5 * ADVExtraDelay) * GPMC\_FCLK$  if ((ADVWrOffTime – ClkActivationTime – 1) is a multiple of 3)  
 $G = (2 + 0.5 * ADVExtraDelay) * GPMC\_FCLK$  if ((ADVWrOffTime – ClkActivationTime – 2) is a multiple of 3)

(8) For OE falling edge (OE activated) / IO DIR rising edge (IN direction) :

- Case GpmcFCLKDivider = 0:  
 $H = 0.5 * OEExtraDelay * GPMC\_FCLK$
- Case GpmcFCLKDivider = 1:  
 $H = 0.5 * OEExtraDelay * GPMC\_FCLK$  if (ClkActivationTime and OEOnTime are odd) or (ClkActivationTime and OEOnTime are even)  
 $H = (1 + 0.5 * OEExtraDelay) * GPMC\_FCLK$  otherwise
- Case GpmcFCLKDivider = 2:  
 $H = 0.5 * OEExtraDelay * GPMC\_FCLK$  if ((OEOnTime – ClkActivationTime) is a multiple of 3)  
 $H = (1 + 0.5 * OEExtraDelay) * GPMC\_FCLK$  if ((OEOnTime – ClkActivationTime – 1) is a multiple of 3)  
 $H = (2 + 0.5 * OEExtraDelay) * GPMC\_FCLK$  if ((OEOnTime – ClkActivationTime – 2) is a multiple of 3)

For OE rising edge (OE deactivated):

- Case GpmcFCLKDivider = 0:  
 $H = 0.5 * OEExtraDelay * GPMC\_FCLK$
- Case GpmcFCLKDivider = 1:  
 $H = 0.5 * OEExtraDelay * GPMC\_FCLK$  if (ClkActivationTime and OEOffTime are odd) or (ClkActivationTime and OEOffTime are even)  
 $H = (1 + 0.5 * OEExtraDelay) * GPMC\_FCLK$  otherwise
- Case GpmcFCLKDivider = 2:  
 $H = 0.5 * OEExtraDelay * GPMC\_FCLK$  if ((OEOffTime – ClkActivationTime) is a multiple of 3)  
 $H = (1 + 0.5 * OEExtraDelay) * GPMC\_FCLK$  if ((OEOffTime – ClkActivationTime – 1) is a multiple of 3)  
 $H = (2 + 0.5 * OEExtraDelay) * GPMC\_FCLK$  if ((OEOffTime – ClkActivationTime – 2) is a multiple of 3)

**Table 8-28. Switching Characteristics Over Recommended Operating Conditions for GPMC and NOR Flash Interface - Synchronous Mode (continued)**

(see Figure 8-21, Figure 8-22, Figure 8-23 for Non-Multiplexed Modes)

(see Figure 8-24, Figure 8-25, Figure 8-26 for Multiplexed Modes)

| NO. | PARAMETER                                                                                             | OPP100/OPP120/Turb<br>o/Nitro |                         | UNIT |
|-----|-------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------|------|
|     |                                                                                                       | MIN                           | MAX                     |      |
| 15  | $t_{d(CLKH-nWE)}$ Delay time, GPMC_CLK rising edge to $\overline{GPMC\_WE}$ transition                | I - 2.3 <sup>(9)</sup>        | I + 4.5 <sup>(9)</sup>  | ns   |
| 16  | $t_{d(CLKH-Data)}$ Delay time, GPMC_CLK rising edge to GPMC_D[15:0] data bus transition               | J - 2.3 <sup>(10)</sup>       | J + 1.9 <sup>(10)</sup> | ns   |
| 18  | $t_{d(CLKH-nBE)}$ Delay time, GPMC_CLK rising edge to GPMC_BE0_CLE, $\overline{GPMC\_BE1}$ transition | J - 2.3 <sup>(10)</sup>       | J + 1.9 <sup>(10)</sup> | ns   |
| 19  | $t_{w(nCSV)}$ Pulse duration, $\overline{GPMC\_CS[x]}$ low                                            | A <sup>(11)</sup>             |                         | ns   |
| 20  | $t_{w(nBEV)}$ Pulse duration, GPMC_BE0_CLE, $\overline{GPMC\_BE1}$ low                                | C <sup>(12)</sup>             |                         | ns   |
| 21  | $t_{w(nADV)}$ Pulse duration, GPMC_ADV_ALE low                                                        | K <sup>(13)</sup>             |                         | ns   |

(9) For WE falling edge (WE activated):

- Case GpmcFCLKDivider = 0:  
 $I = 0.5 * WEExtraDelay * GPMC\_FCLK$
- Case GpmcFCLKDivider = 1:  
 $I = 0.5 * WEExtraDelay * GPMC\_FCLK$  if (ClkActivationTime and WEOnTime are odd) or (ClkActivationTime and WEOnTime are even)  
 $I = (1 + 0.5 * WEExtraDelay) * GPMC\_FCLK$  otherwise
- Case GpmcFCLKDivider = 2:  
 $I = 0.5 * WEExtraDelay * GPMC\_FCLK$  if ((WEOnTime - ClkActivationTime) is a multiple of 3)  
 $I = (1 + 0.5 * WEExtraDelay) * GPMC\_FCLK$  if ((WEOnTime - ClkActivationTime - 1) is a multiple of 3)  
 $I = (2 + 0.5 * WEExtraDelay) * GPMC\_FCLK$  if ((WEOnTime - ClkActivationTime - 2) is a multiple of 3)

For WE rising edge (WE deactivated):

- Case GpmcFCLKDivider = 0:  
 $I = 0.5 * WEExtraDelay * GPMC\_FCLK$
- Case GpmcFCLKDivider = 1:  
 $I = 0.5 * WEExtraDelay * GPMC\_FCLK$  if (ClkActivationTime and WEOffTime are odd) or (ClkActivationTime and WEOffTime are even)  
 $I = (1 + 0.5 * WEExtraDelay) * GPMC\_FCLK$  otherwise
- Case GpmcFCLKDivider = 2:  
 $I = 0.5 * WEExtraDelay * GPMC\_FCLK$  if ((WEOffTime - ClkActivationTime) is a multiple of 3)  
 $I = (1 + 0.5 * WEExtraDelay) * GPMC\_FCLK$  if ((WEOffTime - ClkActivationTime - 1) is a multiple of 3)  
 $I = (2 + 0.5 * WEExtraDelay) * GPMC\_FCLK$  if ((WEOffTime - ClkActivationTime - 2) is a multiple of 3)

(10) J = GPMC\_FCLK period.

(11) For single read:  $A = (CSRdOffTime - CSOnTime) * (TimeParaGranularity + 1) * GPMC\_FCLK$  period

For burst read:  $A = (CSRdOffTime - CSOnTime + (n - 1) * PageBurstAccessTime) * (TimeParaGranularity + 1) * GPMC\_FCLK$  period [n = page burst access number]

For burst write:  $A = (CSWrOffTime - CSOnTime + (n - 1) * PageBurstAccessTime) * (TimeParaGranularity + 1) * GPMC\_FCLK$  period [n = page burst access number]

(12) For single read:  $C = RdCycleTime * (TimeParaGranularity + 1) * GPMC\_FCLK$

For burst read:  $C = (RdCycleTime + (n - 1) * PageBurstAccessTime) * (TimeParaGranularity + 1) * GPMC\_FCLK$  [n = page burst access number]

For Burst write:  $C = (WrCycleTime + (n - 1) * PageBurstAccessTime) * (TimeParaGranularity + 1) * GPMC\_FCLK$  [n = page burst access number]

(13) For read:  $K = (ADVRdOffTime - ADVOnTime) * (TimeParaGranularity + 1) * GPMC\_FCLK$

For write:  $K = (ADVWrOffTime - ADVOnTime) * (TimeParaGranularity + 1) * GPMC\_FCLK$

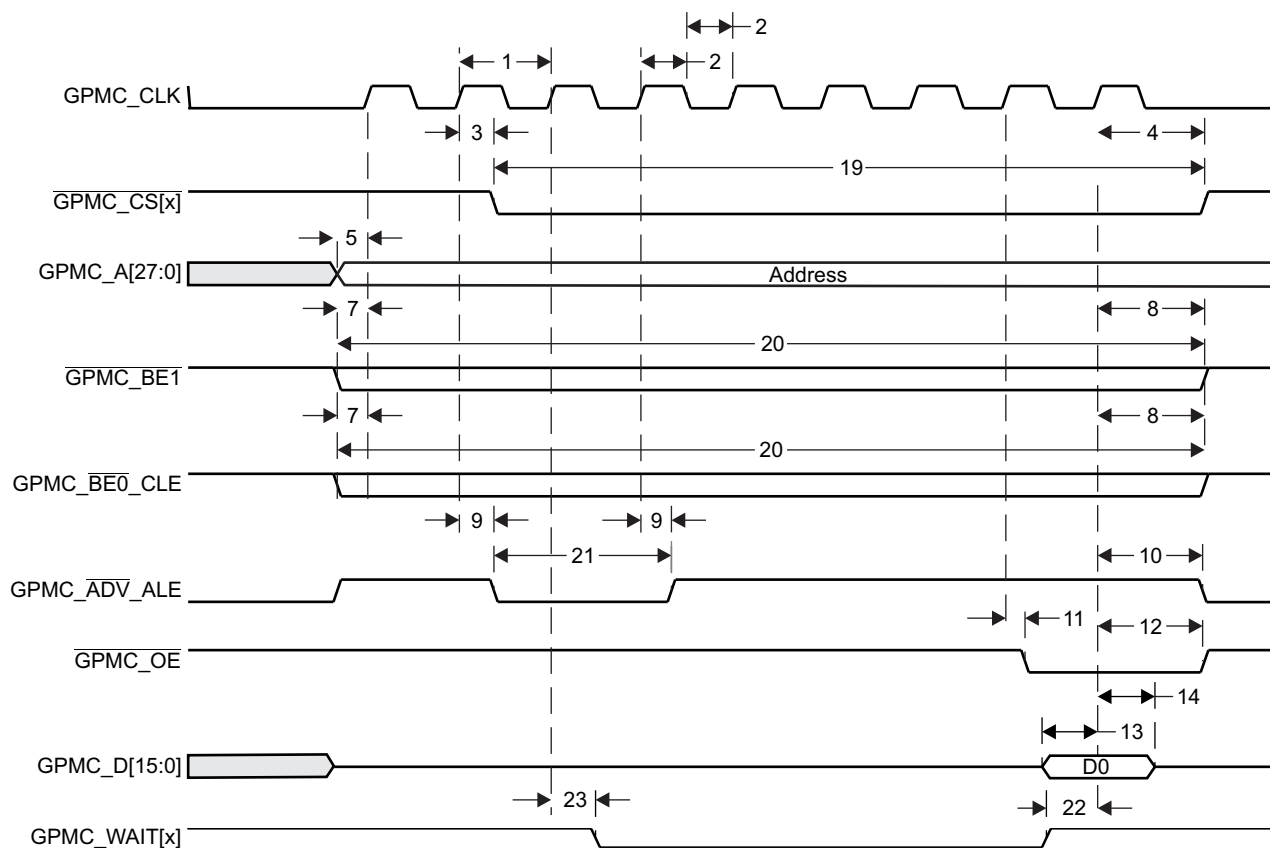


Figure 8-21. GPMC Non-Multiplexed NOR Flash - Synchronous Single Read (GPMCFCLKDIVIDER = 0)

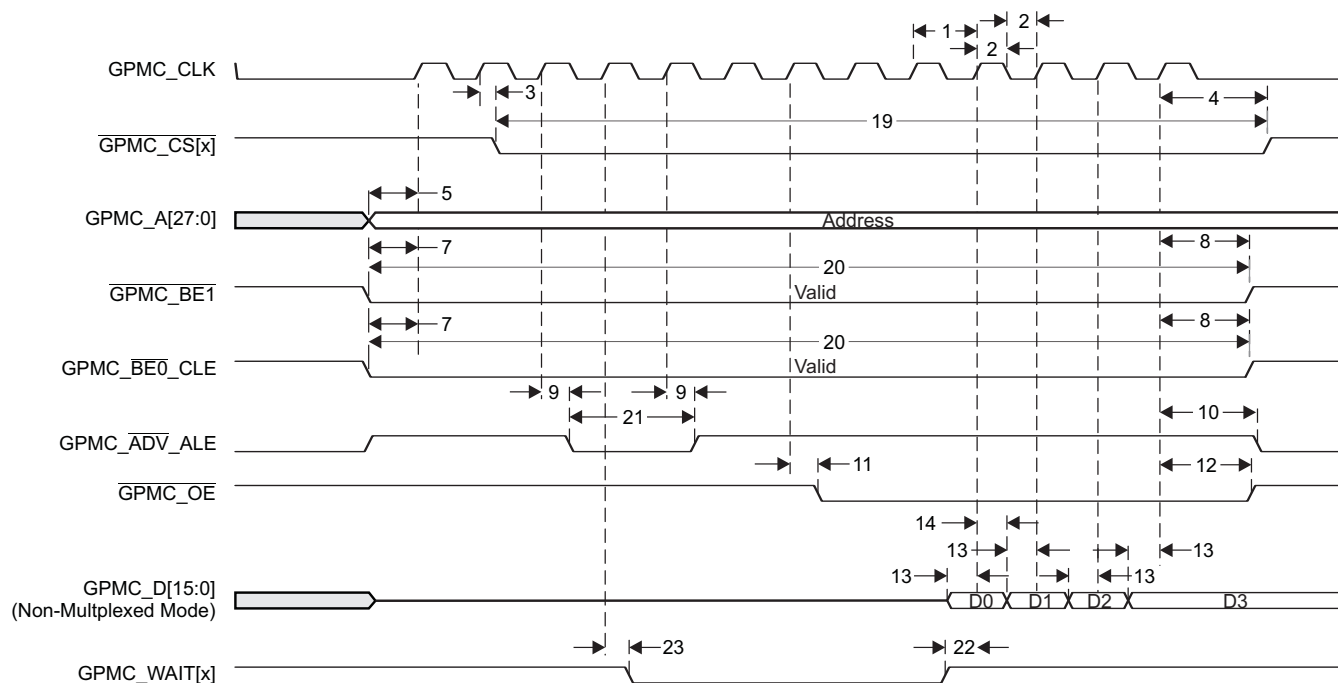
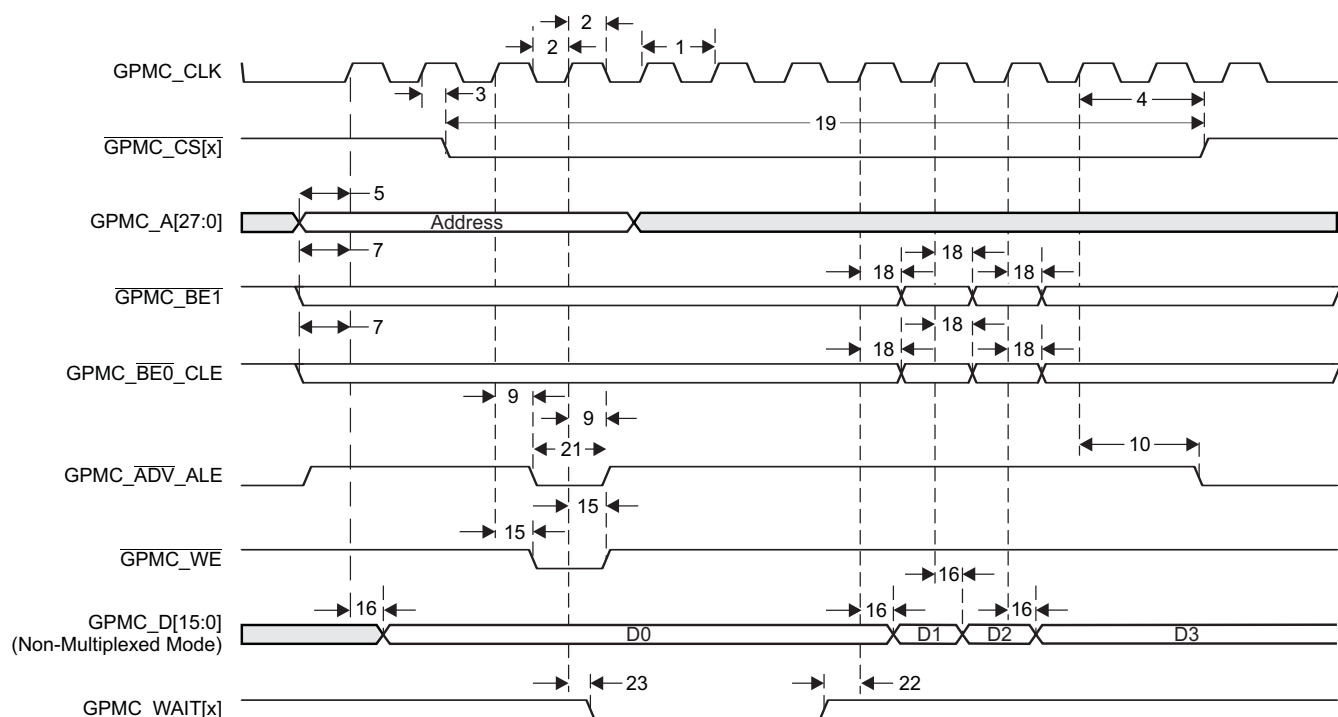
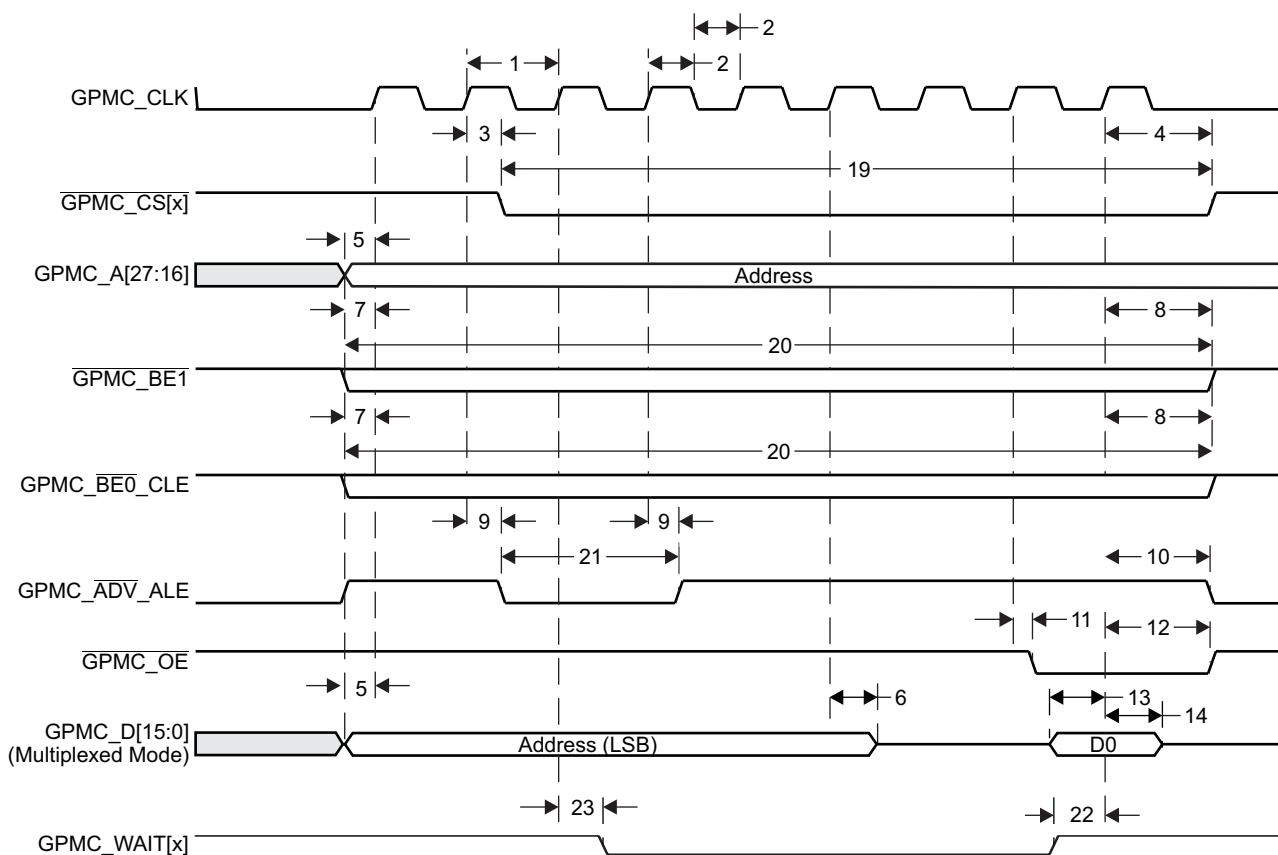


Figure 8-22. GPMC Non-Multiplexed NOR Flash - 14x16-bit Synchronous Burst Read (GPMCFCLKDIVIDER = 0)



**Figure 8-23. GPMC Non-Multiplexed NOR Flash - Synchronous Burst Write (GPMCFCLKDIVIDER = 0)**



**Figure 8-24. GPMC Multiplexed NOR Flash - Synchronous Single Read (GPMCFCLKDIVIDER = 0)**

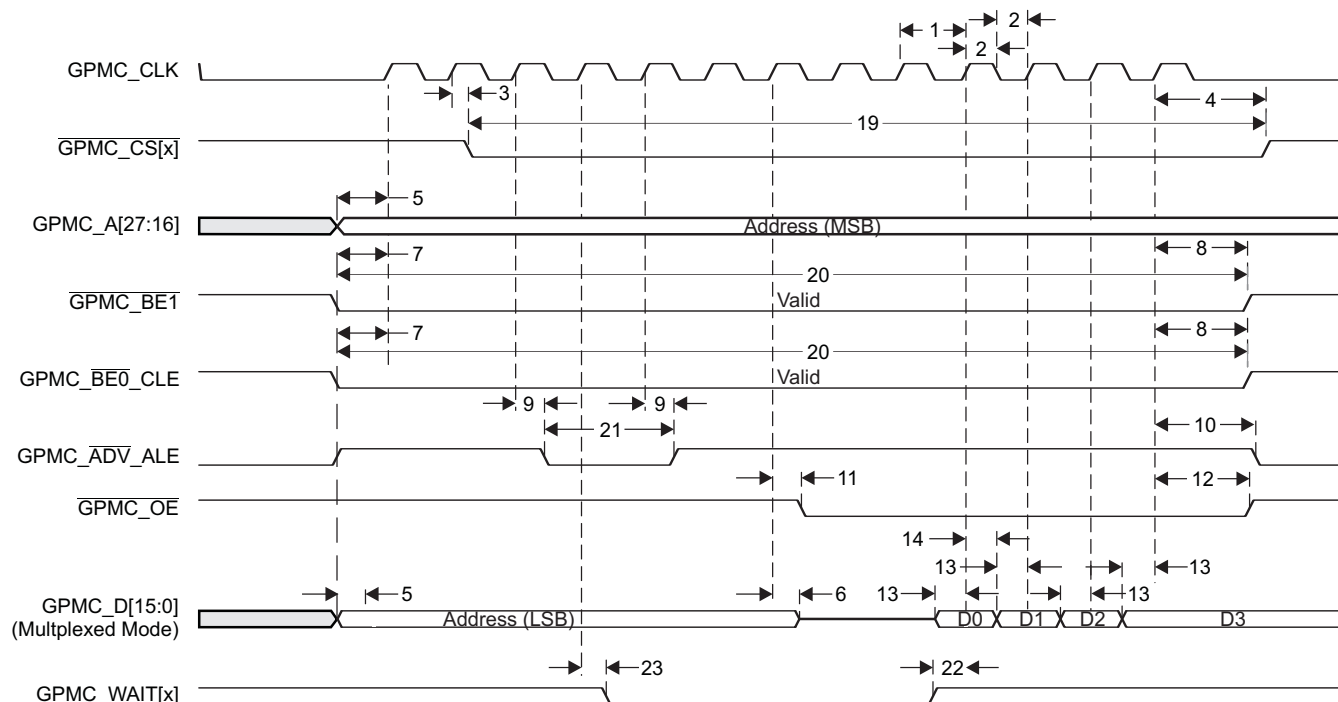


Figure 8-25. GPMC Multiplexed NOR Flash - 14x16-bit Synchronous Burst Read (GPMCFCLKDIVIDER = 0)

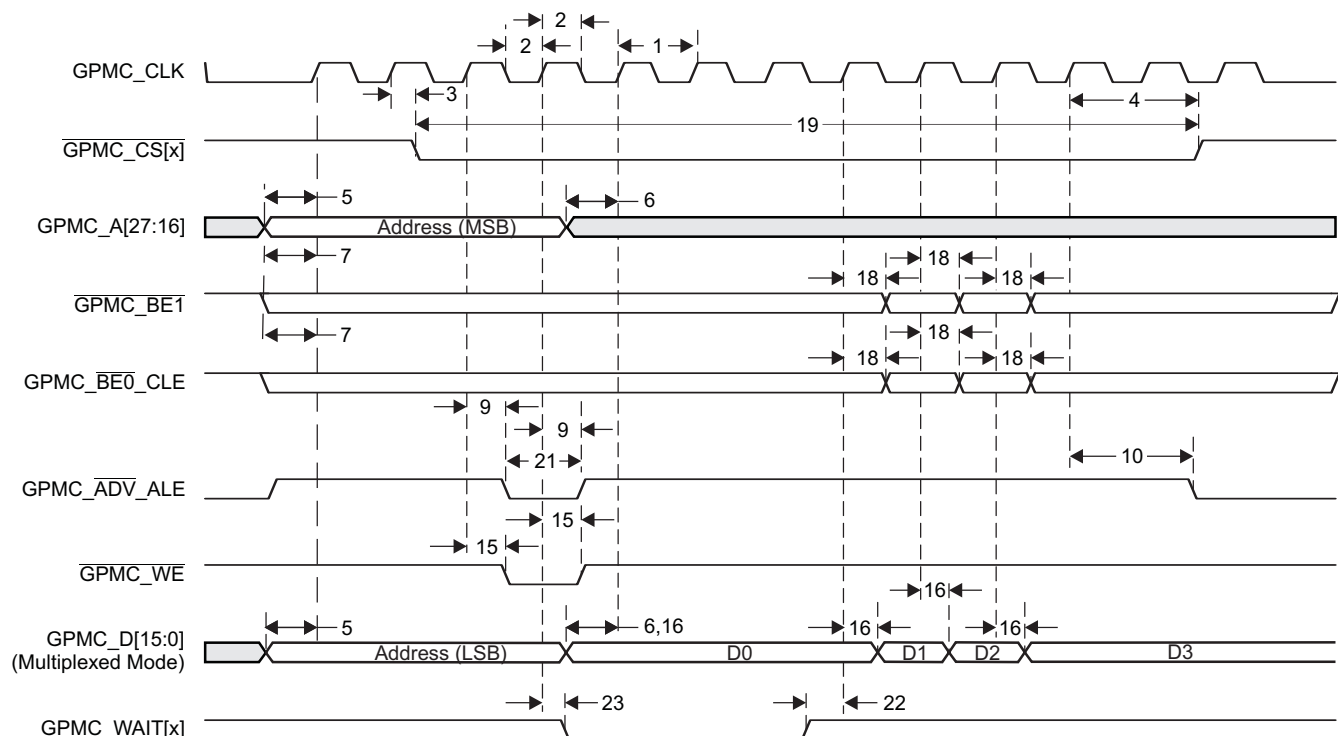


Figure 8-26. GPMC Non-Multiplexed NOR Flash - Synchronous Burst Write (GPMCFCLKDIVIDER = 0)

### 8.8.2.2 GPMC and NOR Flash Interface Asynchronous Mode Timing (Non-Multiplexed and Multiplexed Modes)

**Table 8-29. Timing Requirements for GPMC and NOR Flash Interface - Asynchronous Mode**

(see Figure 8-27, Figure 8-28 for Non-Multiplexed Mode)

(see Figure 8-29, Figure 8-31 for Multiplexed Mode)

| NO. |                        |                                                                  | OPP100/OPP120/Turbo/Nitro |                  | UNIT   |
|-----|------------------------|------------------------------------------------------------------|---------------------------|------------------|--------|
|     |                        |                                                                  | MIN                       | MAX              |        |
| 6   | $t_{acc}(DAT)$         | Data maximum access time (GPMC_FCLK cycles)                      |                           | H <sup>(1)</sup> | cycles |
| 21  | $t_{acc1-pgmode}(DAT)$ | Page mode successive data maximum access time (GPMC_FCLK cycles) |                           | P <sup>(2)</sup> | cycles |
| 22  | $t_{acc2-pgmode}(DAT)$ | Page mode first data maximum access time (GPMC_FCLK cycles)      |                           | H <sup>(1)</sup> | cycles |

(1)  $H = \text{AccessTime} * (\text{TimeParaGranularity} + 1)$ (2)  $P = \text{PageBurstAccessTime} * (\text{TimeParaGranularity} + 1)$ .**Table 8-30. Switching Characteristics Over Recommended Operating Conditions for GPMC and NOR Flash Interface - Asynchronous Mode**

(see Figure 8-27, Figure 8-28, Figure 8-29, Figure 8-30 for Non-Multiplexed Modes)

(see Figure 8-31, Figure 8-32 for Multiplexed Modes)

| NO. | PARAMETER           | OPP100/OPP120/Turbo/Nitro |                         | UNIT |
|-----|---------------------|---------------------------|-------------------------|------|
|     |                     | MIN                       | MAX                     |      |
| 1   | $t_{w(nBEV)}$       |                           | N <sup>(1)</sup>        | ns   |
| 2   | $t_{w(nCSV)}$       |                           | A <sup>(2)</sup>        | ns   |
| 4   | $t_{d(nCSV-nADV)}$  | B - 0.2 <sup>(3)</sup>    | B + 2.0 <sup>(3)</sup>  | ns   |
| 5   | $t_{d(nCSV-nOEIV)}$ | C - 0.2 <sup>(4)</sup>    | C + 2.0 <sup>(4)</sup>  | ns   |
| 10  | $t_{d(AV-nCSV)}$    | J - 0.2 <sup>(5)</sup>    | J + 2.0 <sup>(5)</sup>  | ns   |
| 11  | $t_{d(nBEV-nCSV)}$  | J - 0.2 <sup>(5)</sup>    | J + 2.0 <sup>(5)</sup>  | ns   |
| 13  | $t_{d(nCSV-nADV)}$  | K - 0.2 <sup>(6)</sup>    | K + 2.0 <sup>(6)</sup>  | ns   |
| 14  | $t_{d(nCSV-nOEIV)}$ | L - 0.2 <sup>(7)</sup>    | L + 2.0 <sup>(7)</sup>  | ns   |
| 17  | $t_{w(AIV)}$        | G <sup>(8)</sup>          |                         | ns   |
| 19  | $t_{d(nCSV-nOEIV)}$ | I - 0.2 <sup>(9)</sup>    | I + 2.0 <sup>(9)</sup>  | ns   |
| 21  | $t_{w(AV)}$         | D <sup>(10)</sup>         |                         | ns   |
| 26  | $t_{d(nCSV-nWEV)}$  | E - 0.2 <sup>(11)</sup>   | E + 2.0 <sup>(11)</sup> | ns   |

(1) For single read:  $N = \text{RdCycleTime} * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$ For single write:  $N = \text{WrCycleTime} * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$ For burst read:  $N = (\text{RdCycleTime} + (n - 1) * \text{PageBurstAccessTime}) * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$ For burst write:  $N = (\text{WrCycleTime} + (n - 1) * \text{PageBurstAccessTime}) * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$ (2) For single read:  $A = (\text{CSRdOffTime} - \text{CSOnTime}) * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$ For single write:  $A = (\text{CSWrOffTime} - \text{CSOnTime}) * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$ For burst read:  $A = (\text{CSRdOffTime} - \text{CSOnTime} + (n - 1) * \text{PageBurstAccessTime}) * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$ For burst write:  $A = (\text{CSWrOffTime} - \text{CSOnTime} + (n - 1) * \text{PageBurstAccessTime}) * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$ (3)  $B = nCS \text{ Max Delay} + nADV \text{ Min Delay}$ For reading:  $B = ((\text{ADVrdOffTime} - \text{CSOnTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{ADVExtraDelay} - \text{CSEExtraDelay})) * \text{GPMC\_FCLK}$ For writing:  $B = ((\text{ADVwrOffTime} - \text{CSOnTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{ADVExtraDelay} - \text{CSEExtraDelay})) * \text{GPMC\_FCLK}$ (4)  $C = nCS \text{ Max Delay} + nOE \text{ Min Delay}$  $C = ((\text{OEOffTime} - \text{CSOnTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{OEExtraDelay} - \text{CSEExtraDelay})) * \text{GPMC\_FCLK}$ (5)  $J = nCS \text{ Max Delay} + nCS \text{ Min Delay}$  $J = (\text{CSOnTime} * (\text{TimeParaGranularity} + 1) + 0.5 * \text{CSEExtraDelay}) * \text{GPMC\_FCLK}$ (6)  $K = nCS \text{ Max Delay} + nADV \text{ Min Delay}$  $K = ((\text{ADVOnTime} - \text{CSOnTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{ADVExtraDelay} - \text{CSEExtraDelay})) * \text{GPMC\_FCLK}$ (7)  $L = nCS \text{ Max Delay} + nOE \text{ Min Delay}$  $L = ((\text{OEOnTime} - \text{CSOnTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{OEExtraDelay} - \text{CSEExtraDelay})) * \text{GPMC\_FCLK}$ (8)  $G = \text{Cycle2CycleDelay} * \text{GPMC\_FCLK}$ (9)  $I = nCS \text{ Max Delay} + nOE \text{ Min Delay}$  $I = ((\text{OEOffTime} + (n - 1) * \text{PageBurstAccessTime} - \text{CSOnTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{OEExtraDelay} - \text{CSEExtraDelay})) * \text{GPMC\_FCLK}$ (10)  $D = \text{PageBurstAccessTime} * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$ (11)  $E = nCS \text{ Max Delay} + nWE \text{ Min Delay}$  $E = ((\text{WEOnTime} - \text{CSOnTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{WEExtraDelay} - \text{CSEExtraDelay})) * \text{GPMC\_FCLK}$

**Table 8-30. Switching Characteristics Over Recommended Operating Conditions for GPMC and NOR Flash Interface - Asynchronous Mode (continued)**

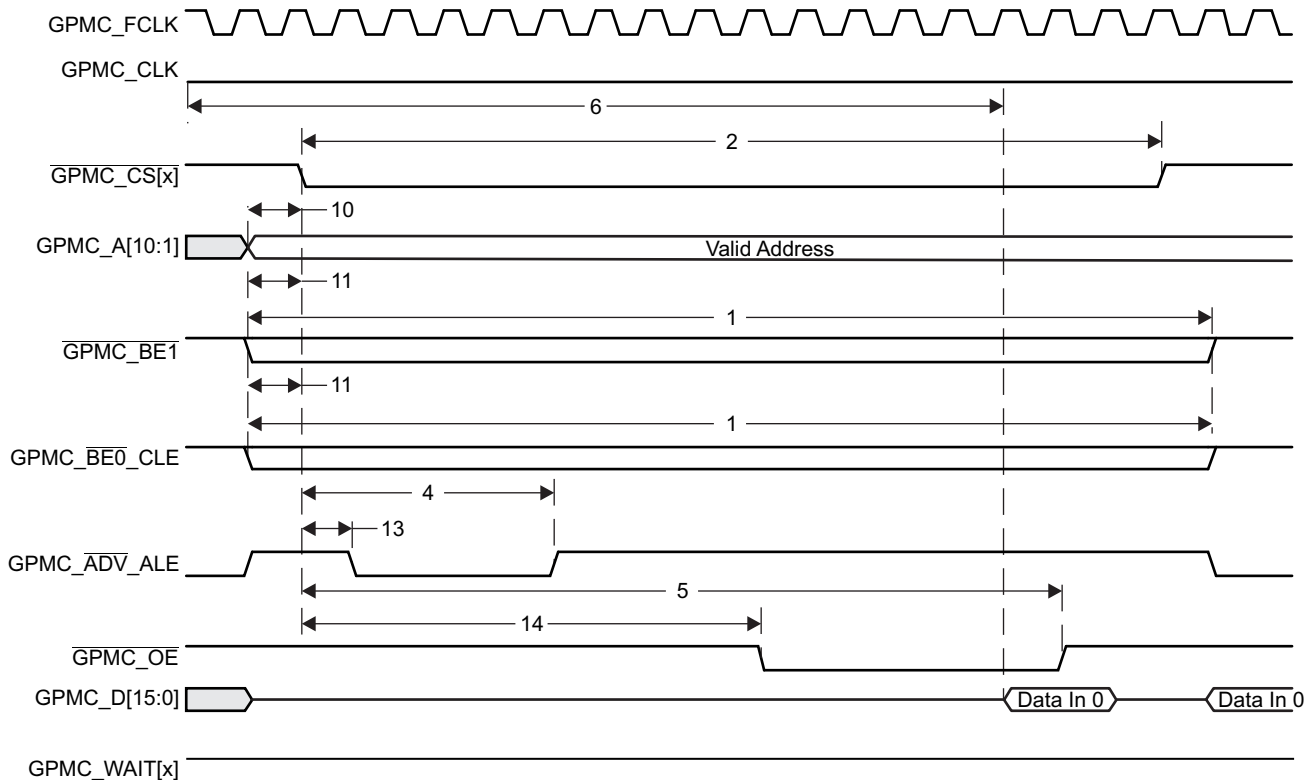
(see Figure 8-27, Figure 8-28, Figure 8-29, Figure 8-30 for Non-Multiplexed Modes)

(see Figure 8-31, Figure 8-32 for Multiplexed Modes)

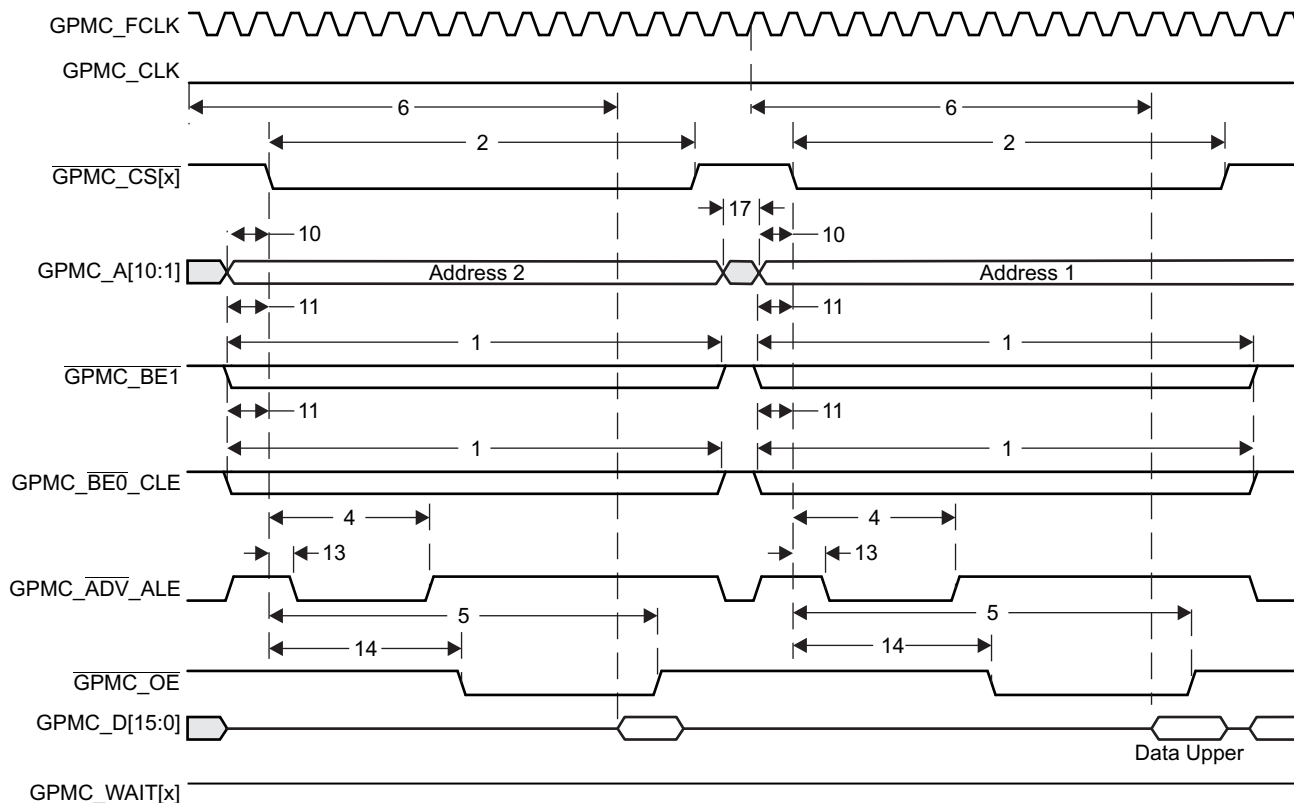
| NO | PARAMETER                                                                                                                    | OPP100/OPP120/Turbo/Nitro |                  | UNIT |
|----|------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------------|------|
|    |                                                                                                                              | MIN                       | MAX              |      |
| 28 | $t_{d(nCSV-nWEIV)}$ Delay time, $\overline{\text{GPMC\_CS}}[x]$ valid to $\overline{\text{GPMC\_WE}}$ invalid                | $F - 0.2^{(12)}$          | $F + 2.0^{(12)}$ | ns   |
| 29 | $t_{d(nWEV-DV)}$ Delay time, $\text{GPMC\_WE}$ valid to $\text{GPMC\_D}[15:0]$ data bus valid                                |                           | 2.0              | ns   |
| 30 | $t_{d(DV-nCSV)}$ Delay time, $\text{GPMC\_D}[15:0]$ data bus valid to $\overline{\text{GPMC\_CS}}[x]$ valid                  | $J - 0.2^{(5)}$           | $J + 2.0^{(5)}$  | ns   |
| 37 | $t_{d(ADV-AIV)}$ Delay time, $\overline{\text{GPMC\_ADV\_ALE}}$ valid to $\text{GPMC\_D}[15:0]$ address invalid              |                           | 2.0              | ns   |
| 38 | $t_{d(nOEV-AIV)}$ Delay time, $\overline{\text{GPMC\_OE\_RE}}$ valid to $\text{GPMC\_D}[15:0]$ address/data busses phase end |                           | 2.0              | ns   |
| 39 | $t_{d(AIV-ADV)}$ Delay time, $\text{GPMC\_D}[15:0]$ address valid to $\overline{\text{GPMC\_ADV\_ALE}}$ invalid              |                           | 2.0              | ns   |

(12) =  $F - nCS \text{ Max Delay} + nWE \text{ Min Delay}$

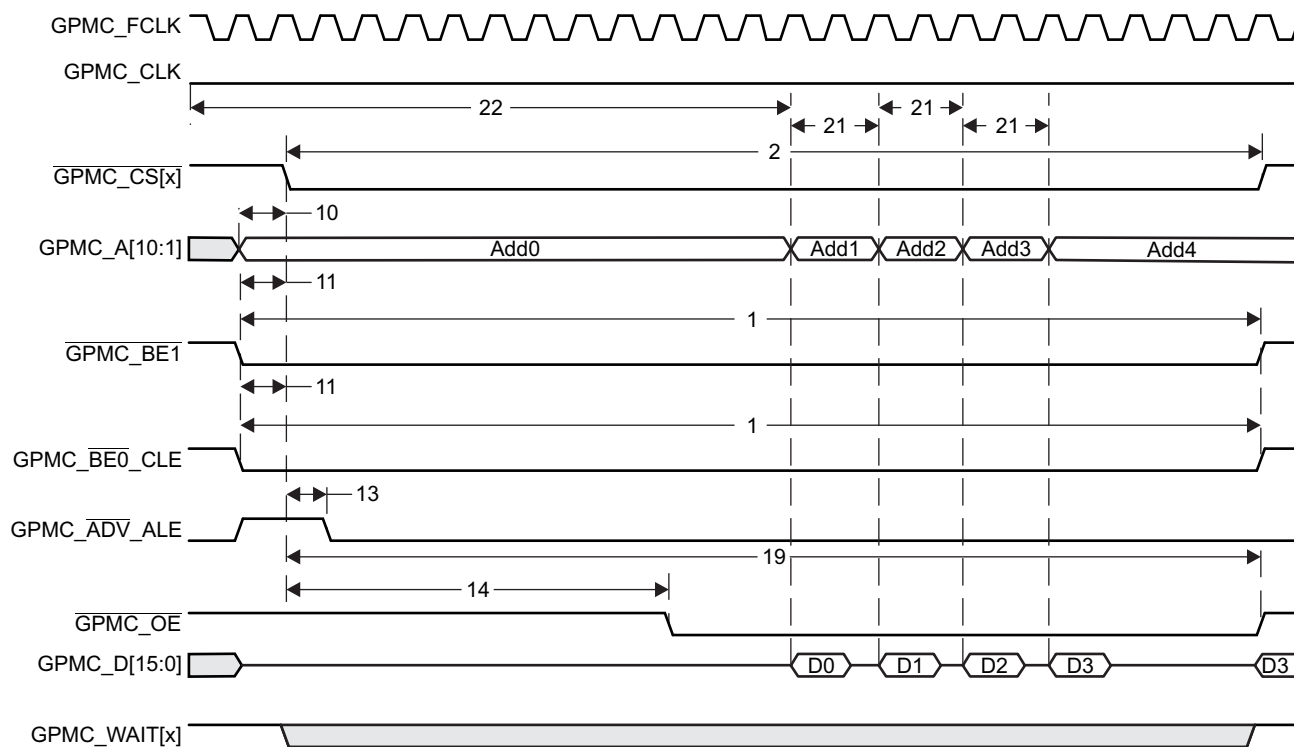
$F = ((WEOffTime - CSOnTime) * (TimeParaGranularity + 1) + 0.5 * (WEExtraDelay - CSEExtraDelay)) * \text{GPMC\_FCLK}$



**Figure 8-27. GPMC/Non-Multiplexed NOR Flash - Asynchronous Read - Single Word Timing**

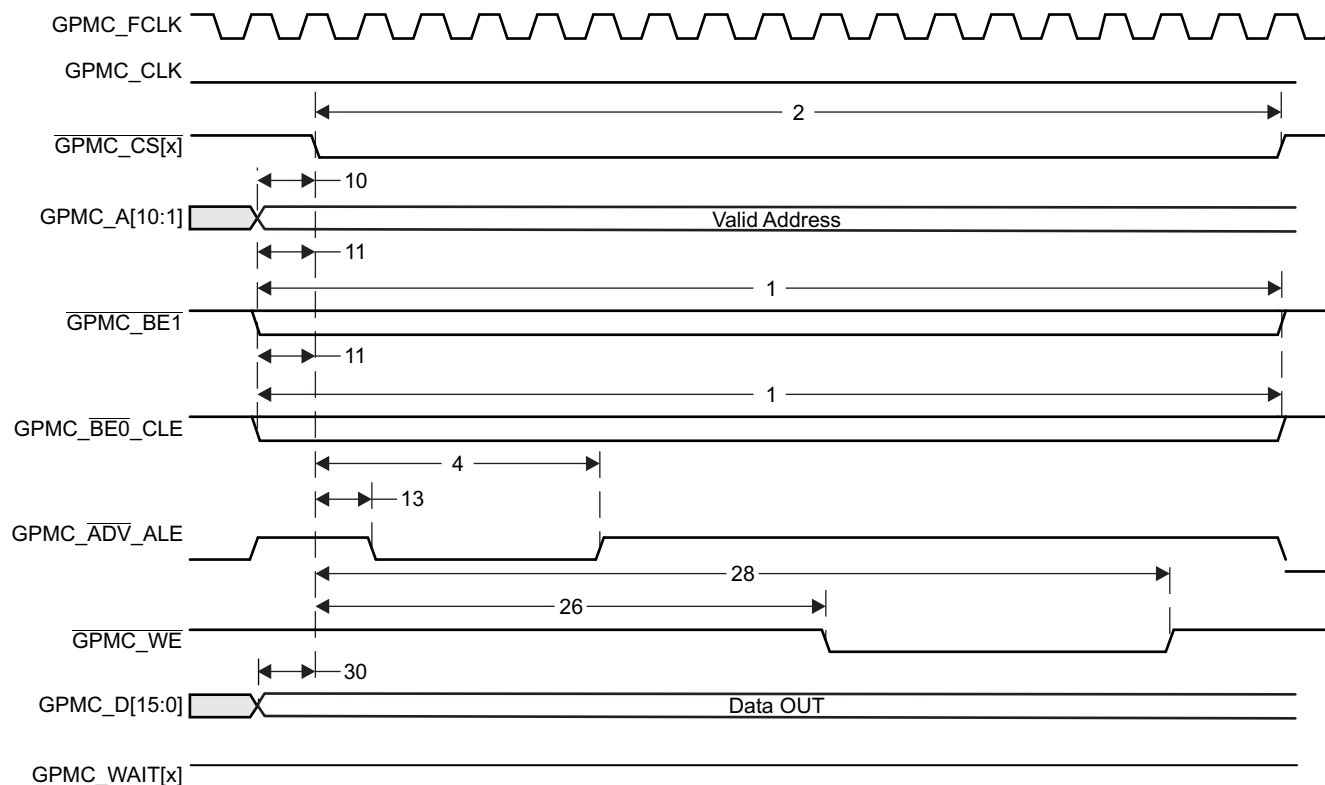


**Figure 8-28. GPMC/Non-Multiplexed NOR Flash - Asynchronous Read - 32-Bit Access Timing**

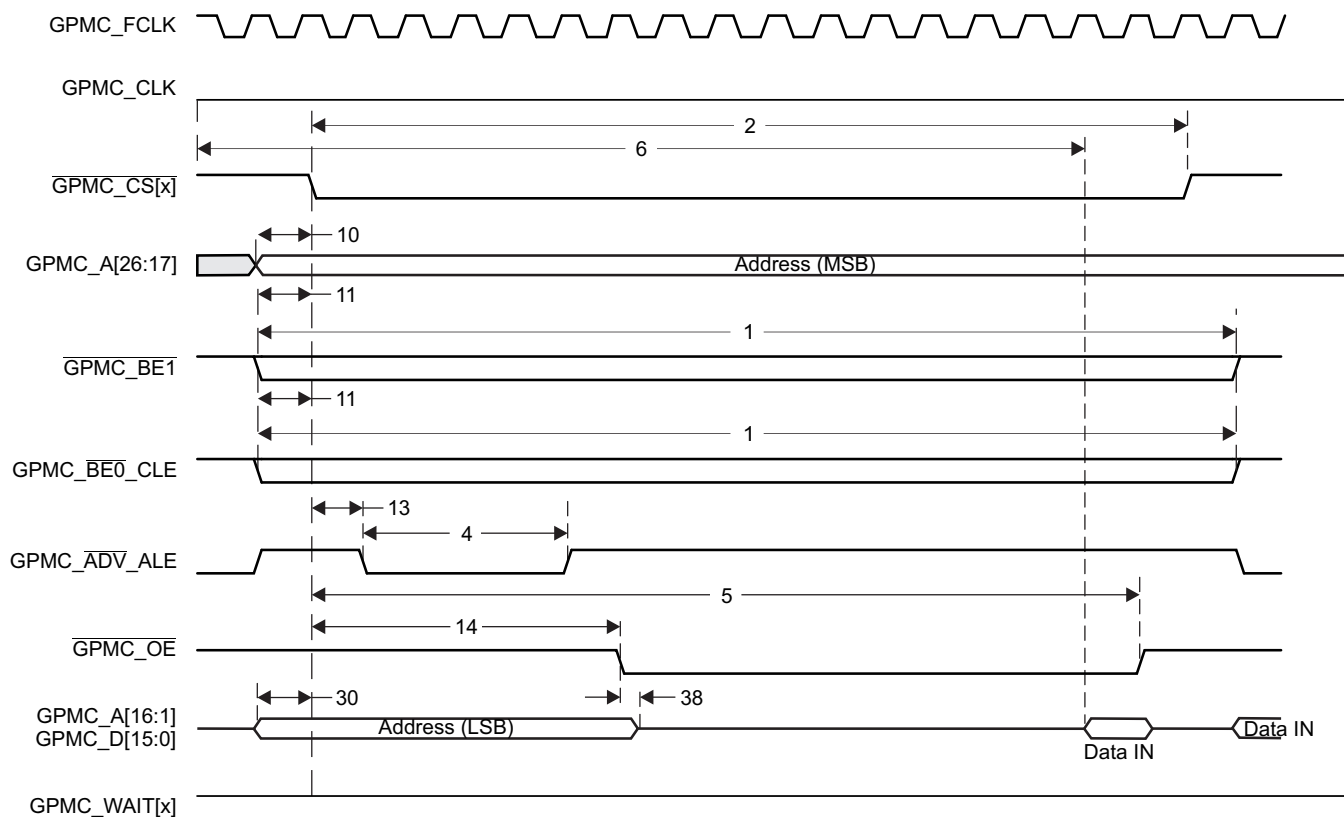


**Figure 8-29. GPMC/Non-Multiplexed Only NOR Flash - Asynchronous Read - Page Mode 4x16-Bit Timing**

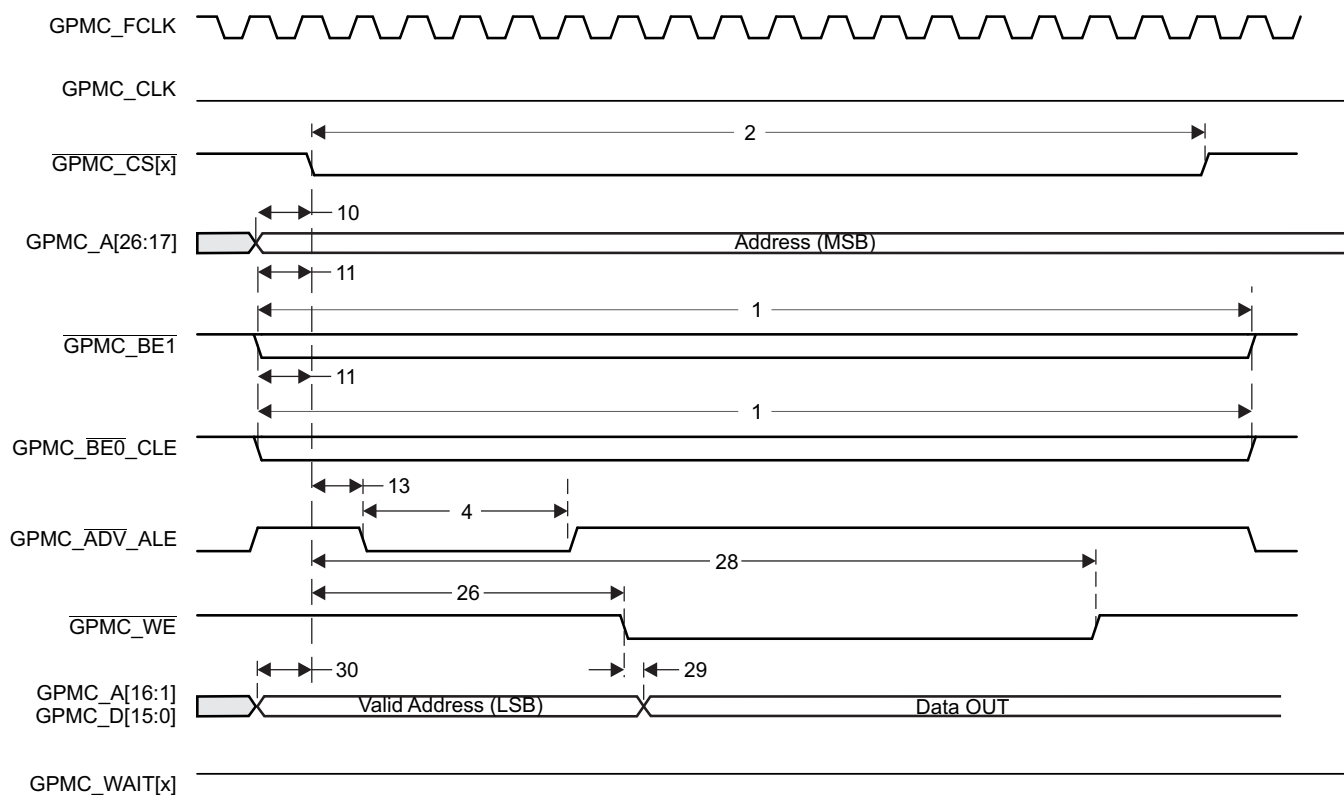




**Figure 8-30. GPMC/Non-Multiplexed NOR Flash - Asynchronous Write - Single Word Timing**



**Figure 8-31. GPMC/Multiplexed NOR Flash - Asynchronous Read - Single Word Timing**



**Figure 8-32. GPMC/Multiplexed NOR Flash - Asynchronous Write - Single Word Timing**

### 8.8.2.3 GPMC/NAND Flash and ELM Interface Timing

**Table 8-31. Timing Requirements for GPMC/NAND Flash Interface**

(see [Figure 8-35](#))

| NO. |                                                            | OPP100/OPP120/Turbo/Nitro |                  | UNIT   |
|-----|------------------------------------------------------------|---------------------------|------------------|--------|
|     |                                                            | MIN                       | MAX              |        |
| 13  | $t_{acc(DAT)}$ Data maximum access time (GPMC_FCLK cycles) |                           | J <sup>(1)</sup> | cycles |

(1)  $J = \text{AccessTime} * (\text{TimeParaGranularity} + 1)$ 
**Table 8-32. Switching Characteristics Over Recommended Operating Conditions for GPMC/NAND Flash Interface**

(see [Figure 8-33](#), [Figure 8-34](#), [Figure 8-35](#), [Figure 8-36](#))

| NO. | PARAMETER                                                                                                           | OPP100/OPP120/Turbo/Nitro |                         | UNIT |
|-----|---------------------------------------------------------------------------------------------------------------------|---------------------------|-------------------------|------|
|     |                                                                                                                     | MIN                       | MAX                     |      |
| 1   | $t_{w(nWEV)}$ Pulse duration, $\overline{\text{GPMC\_WE}}$ valid time                                               |                           | A <sup>(1)</sup>        | ns   |
| 2   | $t_{d(nCSV-nWEV)}$ Delay time, $\overline{\text{GPMC\_CS[X]}}$ valid to $\overline{\text{GPMC\_WE}}$ valid          | B - 0.2 <sup>(2)</sup>    | B + 2.0 <sup>(2)</sup>  | ns   |
| 3   | $t_{d(CLEH-nWEV)}$ Delay time, GPMC_BE0_CLE high to $\overline{\text{GPMC\_WE}}$ valid                              | C - 0.2 <sup>(3)</sup>    | C + 2.0 <sup>(3)</sup>  | ns   |
| 4   | $t_{d(nWEV-DV)}$ Delay time, GPMC_D[15:0] valid to $\overline{\text{GPMC\_WE}}$ valid                               | D - 0.2 <sup>(4)</sup>    | D + 2.0 <sup>(4)</sup>  | ns   |
| 5   | $t_{d(nWEIV-DIV)}$ Delay time, $\overline{\text{GPMC\_WE}}$ invalid to GPMC_AD[15:0] invalid                        | E - 0.2 <sup>(5)</sup>    | E + 2.0 <sup>(5)</sup>  | ns   |
| 6   | $t_{d(nWEIV-CLEIV)}$ Delay time, $\overline{\text{GPMC\_WE}}$ invalid to GPMC_BE0_CLE invalid                       | F - 0.2 <sup>(6)</sup>    | F + 2.0 <sup>(6)</sup>  | ns   |
| 7   | $t_{d(nWEIV-nCSV)}$ Delay time, $\overline{\text{GPMC\_WE}}$ invalid to $\overline{\text{GPMC\_CS[X]}}$ invalid     | G - 0.2 <sup>(7)</sup>    | G + 2.0 <sup>(7)</sup>  | ns   |
| 8   | $t_{d(ALEH-nWEV)}$ Delay time, GPMC_ADV_ALE High to $\overline{\text{GPMC\_WE}}$ valid                              | C - 0.2 <sup>(3)</sup>    | C + 2.0 <sup>(3)</sup>  | ns   |
| 9   | $t_{d(nWEIV-ALEIV)}$ Delay time, $\overline{\text{GPMC\_WE}}$ invalid to GPMC_ADV_ALE invalid                       | F - 0.2 <sup>(6)</sup>    | F + 2.0 <sup>(6)</sup>  | ns   |
| 10  | $t_{c(nWE)}$ Cycle time, write cycle time                                                                           |                           | H <sup>(8)</sup>        | ns   |
| 11  | $t_{d(nCSV-nOEIV)}$ Delay time, $\overline{\text{GPMC\_CS[X]}}$ valid to $\overline{\text{GPMC\_OE\_RE}}$ valid     | I - 0.2 <sup>(9)</sup>    | I + 2.0 <sup>(9)</sup>  | ns   |
| 12  | $t_{w(nOEIV)}$ Pulse duration, $\overline{\text{GPMC\_OE\_RE}}$ valid time                                          |                           | K <sup>(10)</sup>       | ns   |
| 13  | $t_{c(nOE)}$ Cycle time, read cycle time                                                                            |                           | L <sup>(11)</sup>       | ns   |
| 14  | $t_{d(nOEIV-nCSV)}$ Delay time, $\overline{\text{GPMC\_OE\_RE}}$ invalid to $\overline{\text{GPMC\_CS[X]}}$ invalid | M - 0.2 <sup>(12)</sup>   | M + 2.0 <sup>(12)</sup> | ns   |

- (1)  $A = (\text{WEOffTime} - \text{WEOnTime}) * (\text{TimeParaGranularity} + 1) * \text{GPMC\_FCLK}$   
(2)  $B = \text{nWE Min Delay} - \text{nCS Max Delay}$   
 $B = ((\text{WEOnTime} - \text{CSONTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{WEEExtraDelay} - \text{CSEExtraDelay})) * \text{GPMC\_FCLK}$   
(3)  $C = \text{nWE Min Delay} - \text{CLE Max Delay}$   
 $C = ((\text{WEOnTime} - \text{ADVOnTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{WEEExtraDelay} - \text{ADVExtraDelay})) * \text{GPMC\_FCLK}$   
(4)  $D = \text{nWE Min Delay} - \text{Data Max Delay}$   
 $D = (\text{WEOnTime} * (\text{TimeParaGranularity} + 1) + 0.5 * \text{WEEExtraDelay}) * \text{GPMC\_FCLK}$   
(5)  $E = \text{Data Min Delay} - \text{nWE Max Delay}$   
 $E = ((\text{WrCycleTime} - \text{WEOffTime}) * (\text{TimeParaGranularity} + 1) - 0.5 * \text{WEEExtraDelay}) * \text{GPMC\_FCLK}$   
(6)  $F = \text{CLE Min Delay} - \text{nWE Max Delay}$   
 $F = ((\text{ADVWrOffTime} - \text{WEOffTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{ADVExtraDelay} - \text{WEEExtraDelay})) * \text{GPMC\_FCLK}$   
(7)  $G = \text{nCS Min Delay} - \text{nWE Max Delay}$   
 $G = ((\text{CSWrOffTime} - \text{WEOffTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{CSEExtraDelay} - \text{WEEExtraDelay})) * \text{GPMC\_FCLK}$   
(8)  $H = \text{WrCycleTime} * (1 + \text{TimeParaGranularity}) * \text{GPMC\_FCLK}$   
(9)  $I = \text{nOE Min Delay} - \text{nCS Max Delay}$   
 $I = ((\text{OEOnTime} - \text{CSONTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{OEEExtraDelay} - \text{CSEExtraDelay})) * \text{GPMC\_FCLK}$   
(10)  $K = (\text{OEOffTime} - \text{OEOnTime}) * (1 + \text{TimeParaGranularity}) * \text{GPMC\_FCLK}$   
(11)  $L = \text{RdCycleTime} * (1 + \text{TimeParaGranularity}) * \text{GPMC\_FCLK}$   
(12)  $M = \text{nCS Min Delay} - \text{nOE Max Delay}$   
 $M = ((\text{CSRdOffTime} - \text{OEOffTime}) * (\text{TimeParaGranularity} + 1) + 0.5 * (\text{CSEExtraDelay} - \text{OEEExtraDelay})) * \text{GPMC\_FCLK}$

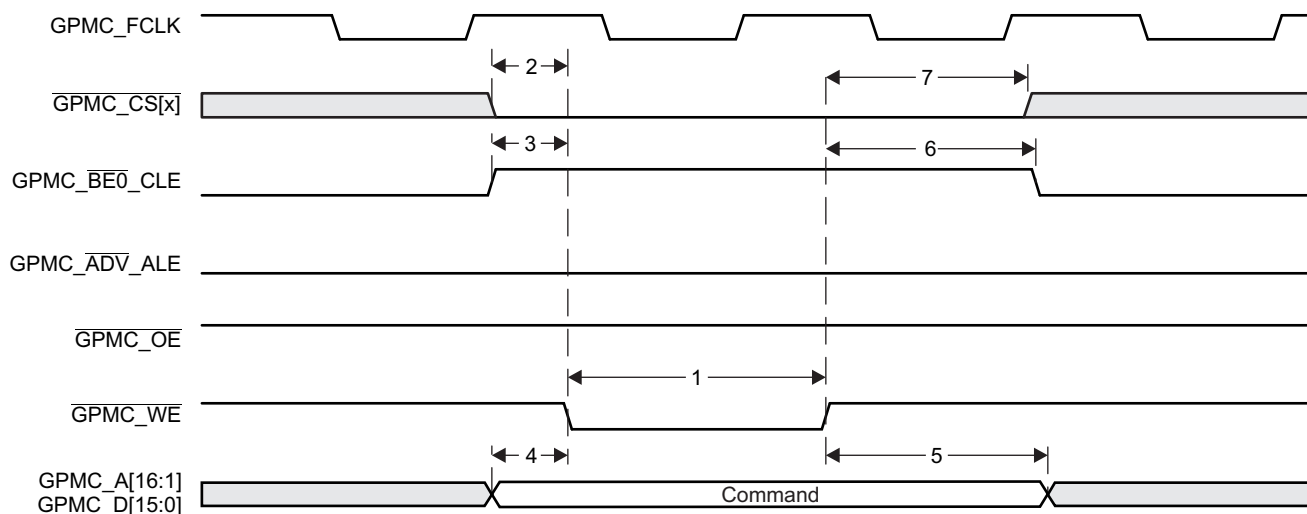


Figure 8-33. GPMC/NAND Flash - Command Latch Cycle Timing

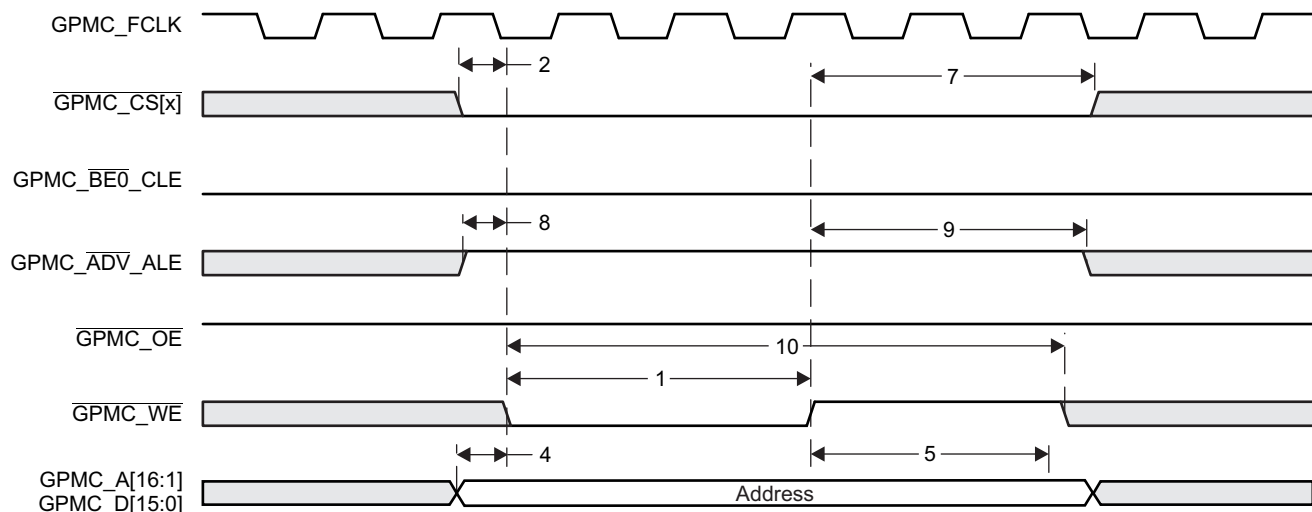


Figure 8-34. GPMC/NAND Flash - Address Latch Cycle Timing

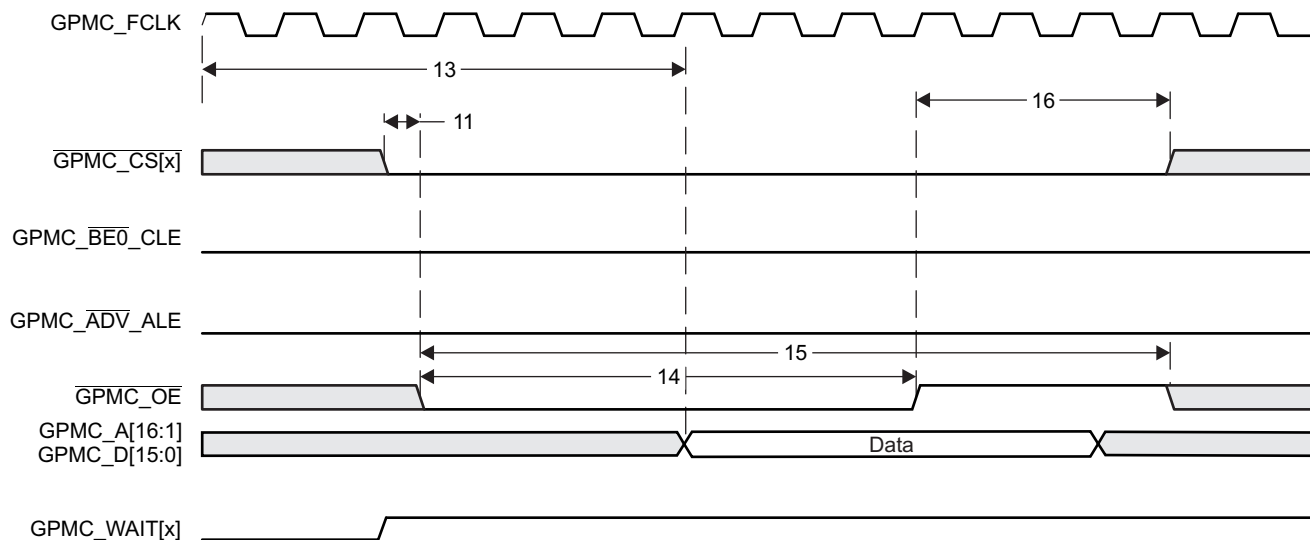


Figure 8-35. GPMC/NAND Flash - Data Read Cycle Timing

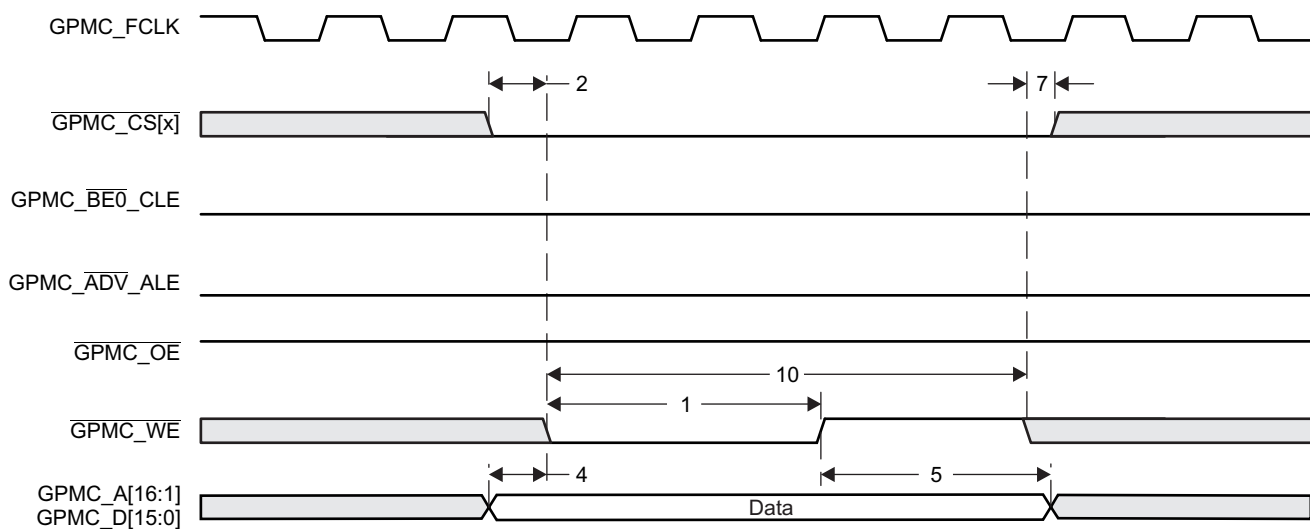


Figure 8-36. GPMC/NAND Flash - Data Write Cycle Timing

## 8.9 High-Definition Multimedia Interface (HDMI)

The device includes an HDMI 1.3a-compliant transmitter for digital video and audio data to display devices. The HDMI interface consists of a digital HDMI transmitter core with TMDS encoder, a core wrapper with interface logic and control registers, and a transmit PHY, with the following features:

- Hot-plug detection
- Consumer electronics control (CEC) messages
- DVI 1.0 compliant (only RGB pixel format)
- CEA 861-D and VESA DMT formats
- Supports up to 165-MHz pixel clock
  - 1920 x 1080p @75 Hz with 8-bit/component color depth
  - 1600 x 1200 @60 Hz with 8-bit/component color depth
- Support for deep-color mode:
  - 10-bit/component color depth up to 1080p @60 Hz (Max pixel clock = 148.5 MHz)
  - 12-bit/component color depth up to 720p/1080i @60 Hz (Max pixel clock = 123.75 MHz)
- TMDS clock to the HDMI-PHY is up to 185.625 MHz
- Maximum supported pixel clock:
  - 165 MHz for 8-bit color depth
  - 148.5 MHz for 10-bit color depth
  - 123.75 MHz for 12-bit color depth
- Uncompressed multichannel (up to eight channels) audio (L-PCM) support
- Master I2C interface for display data channel (DDC) connection
- Options available to support HDCP encryption engine for transmitting protected audio and video (for information, contact your local TI sales representative).

For more details on the HDMI, see the *High-Definition Multimedia Interface (HDMI)* chapter in the device-specific Technical Reference Manual.

### 8.9.1 HDMI Design Guidelines

This section provides PCB design and layout guidelines for the HDMI interface. The design rules constrain PCB trace length, PCB trace skew, signal integrity, cross-talk, and signal timing. Simulation and system design work has been done to ensure the HDMI interface requirements are met.

#### 8.9.1.1 HDMI Interface Schematic

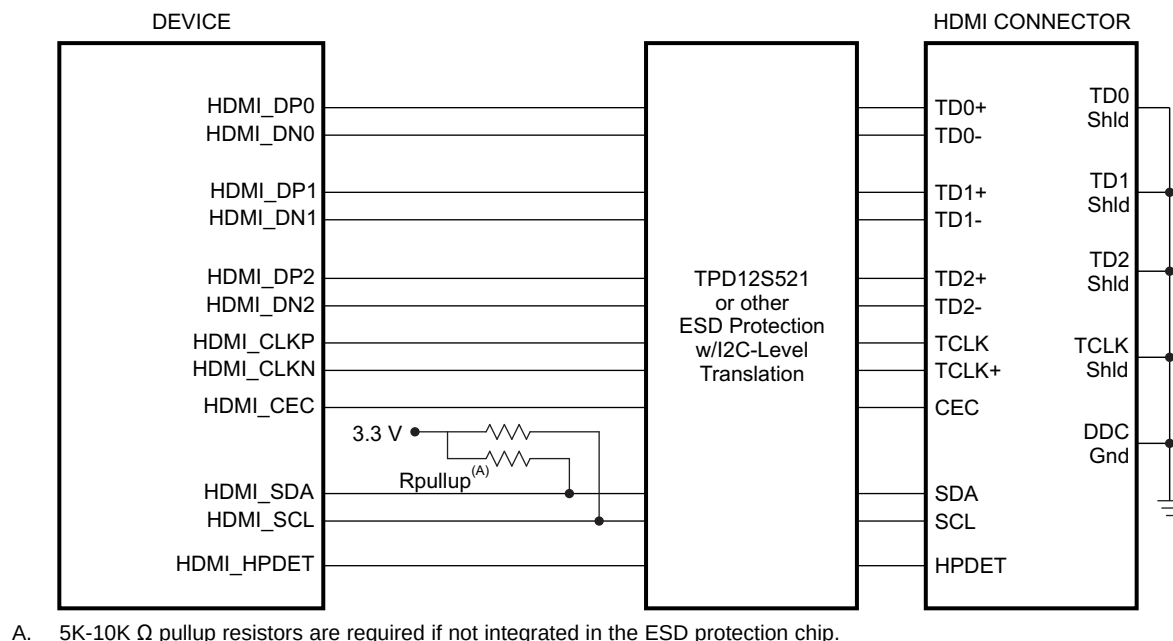
The HDMI bus is separated into three main sections:

1. Transition Minimized Differential Signaling (TMDS) high-speed digital video interface
2. Display Data Channel (I2C bus for configuration and status exchange between two devices)
3. Consumer Electronics Control (optional) for remote control of connected devices.

The DDC and CEC are low-speed interfaces, so nothing special is required for PCB layout of these signals. Their connection is shown in [Figure 8-37](#), *HDMI Interface High-Level Schematic*.

The TMDS channels are high-speed differential pairs and, therefore, require the most care in layout. Specifications for TMDS layout are below.

[Figure 8-37](#) shows the HDMI interface schematic. The specific pin numbers can be obtained from , *HDMI Terminal Functions*.



**Figure 8-37. HDMI Interface High-Level Schematic**

### 8.9.1.2 TMDS Routing

The TMDS signals are high-speed differential pairs. Care must be taken in the PCB layout of these signals to ensure good signal integrity.

The TMDS differential signal traces must be routed to achieve 100  $\Omega$  ( $\pm 10\%$ ) differential impedance and 60  $\Omega$  ( $\pm 10\%$ ) single-ended impedance. Single-ended impedance control is required because differential signals are extremely difficult to closely couple on PCBs and, therefore, single-ended impedance becomes important.

These impedances are impacted by trace width, trace spacing, distance to reference planes, and dielectric material. Verify with a PCB design tool that the trace geometry for both data signal pairs results in as close to 60  $\Omega$  impedance traces as possible. For best accuracy, work with your PCB fabricator to ensure this impedance is met.

In general, closely coupled differential signal traces are not an advantage on PCBs. When differential signals are closely coupled, tight spacing and width control is necessary. Very small width and spacing variations affect impedance dramatically, so tight impedance control can be more problematic to maintain in production.

Loosely coupled PCB differential signals make impedance control much easier. Wider traces and spacing make obstacle avoidance easier, and trace width variations do not affect impedance as much; therefore, it is easier to maintain an accurate impedance over the length of the signal. The wider traces also show reduced skin effect and, therefore, often result in better signal integrity.

Table 8-33 shows the routing specifications for the TMDS signals.

**Table 8-33. TMDS Routing Specifications**

| PARAMETER                              | MIN | TYP | MAX  | UNIT     |
|----------------------------------------|-----|-----|------|----------|
| Processor-to-HDMI header trace length  |     |     | 7000 | Mils     |
| Number of stubs allowed on TMDS traces |     |     | 0    | Stubs    |
| TX/RX pair differential impedance      | 90  | 100 | 110  | $\Omega$ |
| TX/RX single ended impedance           | 54  | 60  | 66   | $\Omega$ |

**Table 8-33. TMDS Routing Specifications (continued)**

| PARAMETER                                         | MIN                 | TYP | MAX | UNIT                |
|---------------------------------------------------|---------------------|-----|-----|---------------------|
| Number of vias on each TMDS trace                 |                     |     | 2   | Vias <sup>(1)</sup> |
| TMDS differential pair to any other trace spacing | 2*DS <sup>(2)</sup> |     |     |                     |

(1) Vias must be used in pairs with their distance minimized.

(2) DS = differential spacing of the HDMI traces.

### 8.9.1.3 DDC Signals

As shown in [Figure 8-37](#), *HDMI Interface High-Level Schematic*, the DDC connects just like a standard I2C bus. As such, resistor pullups must be used to pull up the open drain buffer signals unless they are integrated into the ESD protection chip used. If used, these pullup resistors should be connected to a 3.3-V supply.

### 8.9.1.4 HDMI ESD Protection Device (Required)

Interfaces that connect to a cable such as HDMI generally require more ESD protection than can be built into the processor's outputs. Therefore, this HDMI interface requires the use of an ESD protection chip to provide adequate ESD protection and to translate I2C voltage levels from the 3.3 V supplied by the device to the 5 volts required by the HDMI specification.

When selecting an ESD protection chip, choose the lowest capacitance ESD protection available to minimize signal degradation. In no case should the ESD protection circuit capacitance be more than 5 pF.

TI manufactures devices that provide ESD protection for HDMI signals such as the TPD12S521. For more information see the [www.ti.com](http://www.ti.com) website.

### 8.9.1.5 PCB Stackup Specifications

[Table 8-34](#) shows the stackup and feature sizes required for HDMI.

**Table 8-34. HDMI PCB Stackup Specifications**

| PARAMETER                                                               | MIN | TYP | MAX | UNIT   |
|-------------------------------------------------------------------------|-----|-----|-----|--------|
| PCB routing/plane layers                                                | 4   | 6   | -   | Layers |
| Signal routing layers                                                   | 2   | 3   | -   | Layers |
| Number of ground plane cuts allowed within HDMI routing region          | -   | -   | 0   | Cuts   |
| Number of layers between HDMI routing region and reference ground plane | -   | -   | 0   | Layers |
| PCB trace width                                                         | -   | 4   | -   | Mils   |
| PCB BGA escape via pad size                                             | -   | 20  | -   | Mils   |
| PCB BGA escape via hole size                                            | -   | 10  | -   | Mils   |
| Processor device BGA pad size <sup>(1)(2)</sup>                         |     | 0.4 |     | mm     |

(1) Non-solder mask defined pad.

(2) Per IPC-7351A BGA pad size guideline.

### 8.9.1.6 Grounding

Each TMDS channel has its own shield pin which should be grounded to provide a return current path for the TMDS signal.



## 8.10 High-Definition Video Processing Subsystem (HDVPSS)

The device High-Definition Video Processing Subsystem (HDVPSS) provides a video input interface for external imaging peripherals (for example, image sensors, video decoders, and more) and a video output interface for display devices, such as analog SDTV and HDTV displays, digital HDTV displays, digital LCD panels, and more. It includes HD and SD video encoders and an HDMI transmitter interface.

The device HDVPSS features include:

- Two display processing pipelines with de-interlacing, scaling, alpha blending, chroma keying, color space conversion, flicker filtering, and pixel format conversion.
- HD/SD compositor features for PIP support.
- Format conversions (up to 1080p 60 Hz) include scan format conversion, scan rate conversion, aspect-ratio conversion, and frame size conversion.
- Supports additional video processing capabilities by using the subsystem's memory-to-memory feature.
- Two parallel video processing pipelines support HD (up to 1080p60) and SD (NTSC/PAL) simultaneous outputs.
  - HD analog component output with OSD and embedded timing codes (BT.1120)
    - 3-channel HD-DAC with 10-bit resolution.
    - External HSYNC and VSYNC signals.
  - SD analog output with OSD with embedded timing codes (BT.656)
    - Composite output
    - 1-channel SD-DAC with 10-bit resolution
    - Options available to support MacroVision and CGMS-A (contact local TI Sales rep for information).
  - Digital HDMI 1.3a-compliant transmitter (for details, see [Section 8.9, High-Definition Multimedia Interface \(HDMI\)](#)).
  - One digital video output supporting up to 30-bits @ 165 MHz
  - One digital video output supporting up to 24-bits @ 165 MHz
  - Supports clock inversion for VOUT[0] and VOUT[1] clock signals.
- Two independently configurable external video input capture ports (up to 165 MHz).
  - 16/24-bit HD digital video input or dual clock independent 8-bit SD inputs on each capture port.
  - 8/16/24-bit digital video input
  - 8-bit digital video input
  - Embedded sync and external sync modes are supported for all input configurations (VIN1 Port B supports embedded sync only).
  - De-multiplexing of both pixel-to-pixel and line-to-line multiplexed streams, effectively supporting up to 16 simultaneous SD inputs with a glueless interface to an external multiplexer such as the TVP5158.
  - Additional features include: programmable color space conversion, scaler and chroma downsampler, ancillary VANC/VBI data capture (decoded by software).
- Graphics features:
  - Three independently-generated graphics layers.
  - Each supports full-screen resolution graphics in HD, SD or both.
  - Up/down scaler optimized for graphics.
  - Global and pixel-level alpha blending supported.

For more detailed information on specific features and registers, see the *High Definition Video Processing Subsystem* chapter in the device-specific Technical Reference Manual.

### 8.10.1 HDVPSS Electrical Data/Timing

**Table 8-35. Timing Requirements for HDVPSS Input**

(see [Figure 8-38](#) and [Figure 8-39](#))

| NO.         |                             |                                                           | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-------------|-----------------------------|-----------------------------------------------------------|-------------------------------|-----|------|
|             |                             |                                                           | MIN                           | MAX |      |
| VIN[x]A_CLK |                             |                                                           |                               |     |      |
| 1           | t <sub>c</sub> (CLK)        | Cycle time, VIN[x]A_CLK                                   | 6.06 <sup>(1)</sup>           |     | ns   |
| 2           | t <sub>w</sub> (CLKH)       | Pulse duration, VIN[x]A_CLK high (45% of t <sub>c</sub> ) | 2.73                          |     | ns   |
| 3           | t <sub>w</sub> (CLKH)       | Pulse duration, VIN[x]A_CLK low (45% of t <sub>c</sub> )  | 2.73                          |     | ns   |
| 7           | t <sub>t</sub> (CLK)        | Transition time, VIN[x]A_CLK (10%-90%)                    | 2.64                          |     | ns   |
| 4           | t <sub>su</sub> (DE-CLK)    | Input setup time, control valid to VIN[x]A_CLK high/low   | 3.11                          |     | ns   |
|             | t <sub>su</sub> (VSYNC-CLK) |                                                           |                               |     |      |
|             | t <sub>su</sub> (FLD-CLK)   |                                                           |                               |     |      |
|             | t <sub>su</sub> (HSYNC-CLK) |                                                           |                               |     |      |
|             | t <sub>su</sub> (D-CLK)     | Input setup time, data valid to VIN[x]A_CLK high/low      | 3.11                          |     |      |
| 5           | t <sub>h</sub> (CLK-DE)     | Input hold time, control valid from VIN[x]A_CLK high/low  | -0.5                          |     | ns   |
|             | t <sub>h</sub> (CLK-VSYNC)  |                                                           |                               |     |      |
|             | t <sub>h</sub> (CLK-FLD)    |                                                           |                               |     |      |
|             | t <sub>h</sub> (CLK-HSYNC)  |                                                           |                               |     |      |
|             | t <sub>h</sub> (CLK-D)      | Input hold time, data valid from VIN[x]A_CLK high/low     | -0.5                          |     |      |
| VIN[x]B_CLK |                             |                                                           |                               |     |      |
| 1           | t <sub>c</sub> (CLK)        | Cycle time, VIN[x]B_CLK                                   | 6.06 <sup>(1)</sup>           |     | ns   |
| 2           | t <sub>w</sub> (CLKH)       | Pulse duration, VIN[x]B_CLK high (45% of t <sub>c</sub> ) | 2.73                          |     | ns   |
| 3           | t <sub>w</sub> (CLKH)       | Pulse duration, VIN[x]B_CLK low (45% of t <sub>c</sub> )  | 2.73                          |     | ns   |
| 7           | t <sub>t</sub> (CLK)        | Transition time, VIN[x]B_CLK (10%-90%)                    | 2.64                          |     | ns   |
| 4           | t <sub>su</sub> (DE-CLK)    | Input setup time, control valid to VIN[x]B_CLK high/low   | 3.11                          |     | ns   |
|             | t <sub>su</sub> (VSYNC-CLK) |                                                           |                               |     |      |
|             | t <sub>su</sub> (FLD-CLK)   |                                                           |                               |     |      |
|             | t <sub>su</sub> (HSYNC-CLK) |                                                           |                               |     |      |
|             | t <sub>su</sub> (D-CLK)     | Input setup time, data valid to VIN[x]B_CLK high/low      | 3.11                          |     |      |
| 5           | t <sub>h</sub> (CLK-DE)     | Input hold time, control valid from VIN[x]B_CLK high/low  | -0.5                          |     | ns   |
|             | t <sub>h</sub> (CLK-VSYNC)  |                                                           |                               |     |      |
|             | t <sub>h</sub> (CLK-FLD)    |                                                           |                               |     |      |
|             | t <sub>h</sub> (CLK-HSYNC)  |                                                           |                               |     |      |
|             | t <sub>h</sub> (CLK-D)      | Input hold time, data valid from VIN[x]B_CLK high/low     | -0.5                          |     |      |

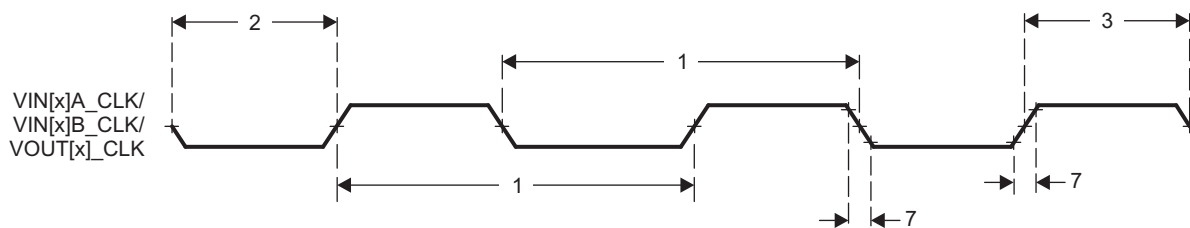
(1) For maximum frequency of 165 MHz.

**Table 8-36. Switching Characteristics Over Recommended Operating Conditions for HDVPSS Output**

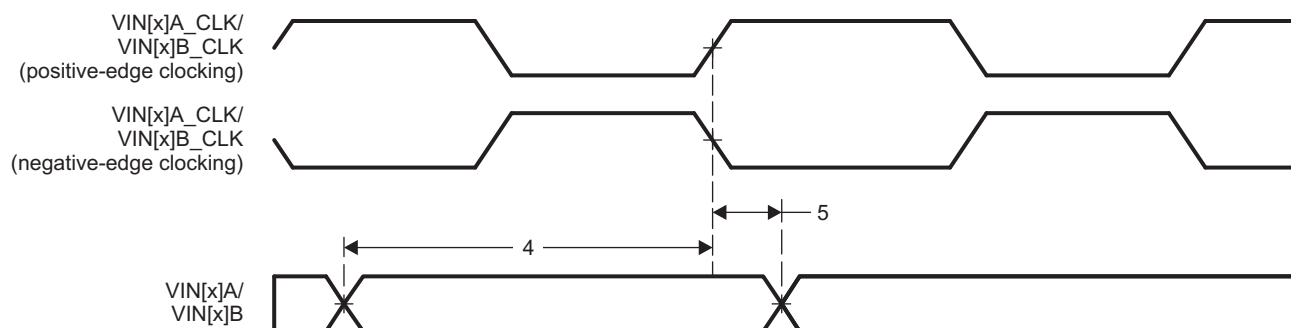
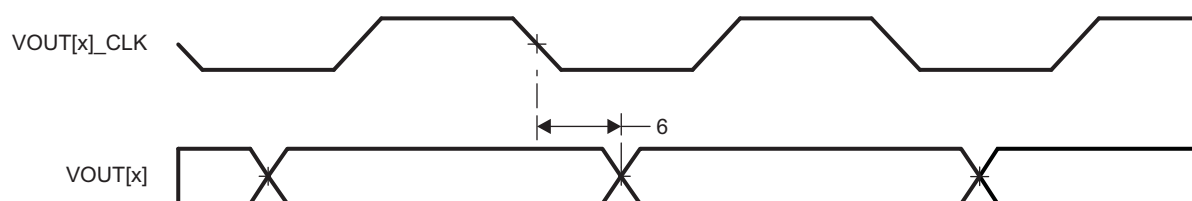
(see [Figure 8-38](#) and [Figure 8-40](#))

| NO. | PARAMETER        |                                                                             | OPP100/OPP120/Turbo/<br>Nitro |      | UNIT |
|-----|------------------|-----------------------------------------------------------------------------|-------------------------------|------|------|
|     |                  |                                                                             | MIN                           | MAX  |      |
| 1   | $t_{c(CLK)}$     | Cycle time, VOUT[x]_CLK                                                     | 6.06 <sup>(1)</sup>           |      | ns   |
| 2   | $t_{w(CLKH)}$    | Pulse duration, VOUT[x]_CLK high (45% of $t_c$ )                            | 2.73                          |      | ns   |
| 3   | $t_{w(CLKL)}$    | Pulse duration, VOUT[x]_CLK low (45% of $t_c$ )                             | 2.73                          |      | ns   |
| 7   | $t_t(CLK)$       | Transition time, VOUT[x]_CLK (10%-90%)                                      |                               | 2.64 | ns   |
| 6   | $t_d(CLK-AVID)$  | Delay time, VOUT[x]_CLK low (falling) to control valid, positive clock edge | 1.64                          | 4.18 | ns   |
|     | $t_d(CLK-FLD)$   |                                                                             |                               |      |      |
|     | $t_d(CLK-VSYNC)$ |                                                                             |                               |      |      |
|     | $t_d(CLK-HSYNC)$ |                                                                             |                               |      |      |
|     | $t_d(CLK-RCR)$   | Delay time, VOUT[0]_CLK low (falling) to data valid, positive clock edge    | 1.64                          | 4.18 | ns   |
|     | $t_d(CLK-GYYC)$  |                                                                             |                               |      |      |
|     | $t_d(CLK-BCBC)$  |                                                                             |                               |      |      |
|     | $t_d(CLK-YYC)$   | Delay time, VOUT[1]_CLK low (falling) to data valid, positive clock edge    | 1.64                          | 4.18 | ns   |
|     | $t_d(CLK-C)$     |                                                                             |                               |      |      |
|     | $t_d(CLK-AVID)$  | Delay time, VOUT[x]_CLK low (falling) to control valid, negative clock edge | -1.64                         | 4.18 | ns   |
|     | $t_d(CLK-FLD)$   |                                                                             |                               |      |      |
|     | $t_d(CLK-VSYNC)$ |                                                                             |                               |      |      |
|     | $t_d(CLK-HSYNC)$ |                                                                             |                               |      |      |
|     | $t_d(CLK-RCR)$   | Delay time, VOUT[0]_CLK low (falling) to data valid, negative clock edge    | -1.64                         | 4.18 | ns   |
|     | $t_d(CLK-GYYC)$  |                                                                             |                               |      |      |
|     | $t_d(CLK-BCBC)$  |                                                                             |                               |      |      |
|     | $t_d(CLK-YYC)$   | Delay time, VOUT[1]_CLK low (falling) to data valid, negative clock edge    | -1.64                         | 4.18 | ns   |
|     | $t_d(CLK-C)$     |                                                                             |                               |      |      |

(1) For maximum frequency of 165 MHz.



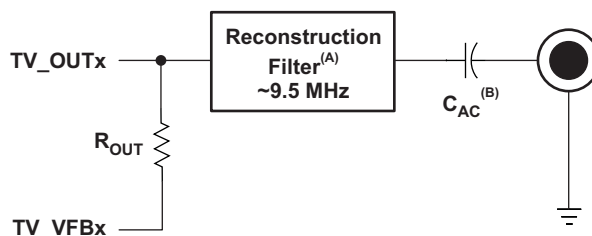
**Figure 8-38. HDVPSS Clock Timing**

**Figure 8-39. HDVPSS Input Timing****Figure 8-40. HDVPSS Output Timing**

### 8.10.2 Video SD-DAC Guidelines and Electrical Data/Timing

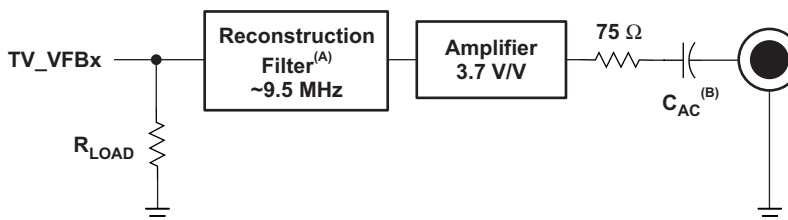
The device's analog video SD-DAC output can be operated in one of two modes: Normal mode and TVOUT Bypass mode. In Normal mode, the device's internal video amplifier is used. In TVOUT Bypass mode, the internal video amplifier is bypassed and an external amplifier is required.

Figure 8-41 shows a typical circuit that permits connecting the analog video output from the device to standard 75-Ω impedance video systems in Normal mode. Figure 8-42 shows a typical circuit that permits connecting the analog video output from the device to standard 75-Ω impedance video systems in TVOUT Bypass mode.



- A. Reconstruction Filter (optional)
- B. AC coupling capacitor (optional)

Figure 8-41. TV Output (Normal Mode)



- A. Reconstruction Filter (optional). Note: An amplifier with an integrated reconstruction filter can alternatively be used instead of a discrete reconstruction filter.
- B. AC coupling capacitor (optional)

Figure 8-42. TV Output (TVOUT Bypass Mode)

During board design, the onboard traces and parasitics must be matched for the channel. The video SD-DAC output pin (TV\_OUT0/TV\_VFB0) are very high-frequency analog signals and must be routed with extreme care. As a result, the paths of these signals must be as short as possible, and as isolated as possible from other interfering signals. In TVOUT Bypass mode, the load resistor and amplifier/buffer should be placed as close as possible to the TV\_VFB0 pin. Other layout guidelines include:

- Take special care to bypass the VDDA\_VDAC\_1P8 power supply pin with a capacitor. For more information, see Section 7.2.9, Power-Supply Decoupling.
- In **TVOUT Bypass mode**, place the  $R_{LOAD}$  resistor as close as possible to the Reconstruction Filter and Amplifier. In addition, place the 75-Ω resistor as close as possible (< 0.5 ") to the Amplifier/buffer output pin. To maintain a high-quality video signal, the onboard traces after the 75-Ω resistor should have a characteristic impedance of 75 Ω ( $\pm 20\%$ ).
- In **Normal mode**, TV\_VFB0 is the most sensitive pin in the TV out system. The  $R_{OUT}$  resistor should be placed as close as possible to the device pin. To maintain a high-quality video signal, the onboard traces leading to the TV\_OUT0 pin should have a characteristic impedance of 75 Ω ( $\pm 20\%$ ) starting from the closest possible place to the device pin output.
- Minimize input trace lengths to the device to reduce parasitic capacitance.
- Include solid ground return paths.

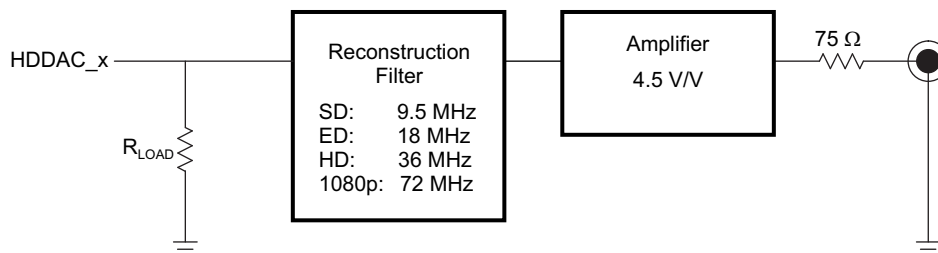
For additional Video SD-DAC Design guidelines, see the *High Definition Video Processing Subsystem* chapter in the device-specific Technical Reference Manual.

**Table 8-37. Static and Dynamic SD-DAC Specifications**

| VDAC STATIC SPECIFICATIONS                                     |                                                        |                                      |       |       |          |
|----------------------------------------------------------------|--------------------------------------------------------|--------------------------------------|-------|-------|----------|
| PARAMETER                                                      | TEST CONDITIONS                                        | MIN                                  | TYP   | MAX   | UNIT     |
| Reference Current Setting Resistor ( $R_{SET}$ )               | Normal Mode                                            | 4653                                 | 4700  | 4747  | $\Omega$ |
|                                                                | TVOUT Bypass Mode                                      | 9900                                 | 10000 | 10100 | $\Omega$ |
| Output resistor between TV_OUT0 and TV_VFB0 pins ( $R_{OUT}$ ) | Normal Mode                                            | 2673                                 | 2700  | 2727  | $\Omega$ |
|                                                                | TVOUT Bypass Mode                                      | N/A                                  |       |       |          |
| Load Resistor ( $R_{LOAD}$ )                                   | Normal Mode                                            | 75- $\Omega$ Inside the Display      |       |       |          |
|                                                                | TVOUT Bypass Mode                                      | 1485                                 | 1500  | 1515  | $\Omega$ |
| AC-Coupling Capacitor (Optional) [ $C_{AC}$ ]                  | Normal Mode                                            | 220                                  |       |       | $\mu F$  |
|                                                                | TVOUT Bypass Mode                                      | See External Amplifier Specification |       |       |          |
| Total Capacitance from TV_OUT0 to VSSA_VDAC_1P8                | Normal Mode                                            |                                      |       | 300   | pF       |
|                                                                | TVOUT Bypass Mode                                      | N/A                                  |       |       |          |
| Resolution                                                     |                                                        |                                      | 10    |       | Bits     |
| Integral Non-Linearity (INL), Best Fit                         | Normal Mode                                            | -4                                   |       | 4     | LSB      |
|                                                                | TVOUT Bypass Mode                                      | -1                                   |       | 1     | LSB      |
| Differential Non-Linearity (DNL)                               | Normal Mode                                            | -2.5                                 |       | 2.5   | LSB      |
|                                                                | TVOUT Bypass Mode                                      | -1                                   |       | 1     | LSB      |
| Full-Scale Output Voltage                                      | Normal Mode ( $R_{LOAD} = 75 \Omega$ )                 |                                      | 1.3   |       | V        |
|                                                                | TVOUT Bypass Mode ( $R_{LOAD} = 1.5 k\Omega$ )         |                                      | 0.7   |       | V        |
| Full-Scale Output Current                                      | Normal Mode                                            | N/A                                  |       |       |          |
|                                                                | TVOUT Bypass Mode                                      |                                      | 470   |       | $\mu A$  |
| Gain Error                                                     | Normal Mode (Composite) and TVOUT Bypass Mode          | -10                                  |       | 10    | %FS      |
| Output Impedance                                               | Looking into TV_OUT0 nodes                             |                                      | 75    |       | $\Omega$ |
| VDAC DYNAMIC SPECIFICATIONS                                    |                                                        |                                      |       |       |          |
| PARAMETER                                                      | TEST CONDITIONS                                        | MIN                                  | TYP   | MAX   | UNIT     |
| Output Update Rate ( $F_{CLK}$ )                               |                                                        |                                      | 54    | 60    | MHz      |
| Signal Bandwidth                                               | 3 dB                                                   |                                      | 6     |       | MHz      |
| Spurious-Free Dynamic Range (SFDR) within bandwidth            | $F_{CLK} = 54 \text{ MHz}$ , $F_{OUT} = 1 \text{ MHz}$ |                                      | 50    |       | dBc      |
| Signal-to-Noise Ratio (SNR)                                    | $F_{CLK} = 54 \text{ MHz}$ , $F_{OUT} = 1 \text{ MHz}$ |                                      | 54    |       | dB       |
| Power Supply Rejection (PSR)                                   | Normal Mode, 100 mVpp @ 6 MHz on VDDA_VDAC_1P8         |                                      | 6     |       | dB       |
|                                                                | TVOUT Bypass Mode, 100 mVpp @ 6 MHz on VDDA_VDAC_1P8   |                                      | 20    |       |          |

### 8.10.3 Video HD-DAC Guidelines and Electrical Data/Timing

The device's analog video HD-DAC outputs are designed to drive a 165- $\Omega$  load. An external video buffer/amplifier is required to provide additional gain (4.5V/V) and to drive the actual video outputs. 75- $\Omega$  back termination resistors should be connected in series with the video buffer output pins. For component video applications, a reconstruction filter should precede the video buffer. One solution is to use a video buffer/amplifier with integrated reconstruction filter, such as the Texas Instruments THS7360, which provides a complete solution for the typical output circuit, shown in Figure 8-43.



**Figure 8-43. Typical Output Circuits for Analog Video from DACs**

During board design, the onboard traces and parasitics must be matched for the channel. The video HD-DAC output pins (HDDAC\_x) are very high-frequency analog signals and must be routed with extreme care. As a result, the path of this signal must be as short as possible, and as isolated as possible from other interfering signals. Other schematic and layout guidelines include:

- The correct external video gain (4.5V/V) must always be provided (even when not using the recommended video buffer). The recommended video buffer is the THS7360.
- The load resistor (R<sub>LOAD</sub>) should be placed as close as possible (< 0.5 in.) to the THS7360 video buffer input pins.
- The 75- $\Omega$  series resistors should be placed as close as possible (< 0.5 in.) to the THS7360 video buffer output pins.
- The trace lengths within a video format group should match as close as possible (for example, for component video outputs, the Y, Pb, and Pr trace lengths should match each other).
- The characteristic impedance of the HD-DAC output signal traces should match the HD-DAC load value (165 $\Omega$ ) as close as possible ( $\pm 10\%$ ). The minimum trace width may limit how closely these impedances can be matched.
- The characteristic impedance of the video buffer output signal traces should match the back termination value (75  $\Omega$ ) as close as possible ( $\pm 10\%$ ). The minimum trace width may limit how closely these impedances can be matched.
- To provide adequate frequency response on the VGA/YPbPr output, recommend the following:
  - The length of the signal traces from the HD-DAC output pins to the THS7360 video buffer input pins should be minimized (< 1 in.) to reduce parasitic capacitance (~2 pF per inch).
  - Ensure the THS7360 reconstruction filter is properly programmed for each output format.
  - Enable 2x up-sampling for 720p/1080i component video outputs.
- To minimize noise on the VGA/YPbPr output, recommend the following:
  - The HD-DAC power supply pins (VDDA\_REF\_1P8V, VDDA\_HD\_1P8V) should be connected to a low-noise 1.8-V analog supply. Use a dedicated voltage regulator for best noise performance.
  - The THS7360 power supply pin should be connected to a low-noise 3.3-V analog supply. Use a dedicated voltage regulator for best noise performance.
  - Special care should be taken to provide adequate power supply decoupling on all analog supply pins (for example, ferrite bead and bypass capacitor).
  - Provide a ground guard adjacent to analog video signal traces to minimize noise coupling.
  - Provide a low impedance path to ground for the shield of the VGA/YPbPr output connector.
  - Include solid ground return paths.

- To provide adequate ESD protection on the VGA/YPbPr output, recommend the following:
  - Provide ESD protection on all output signals (that is, Video, Syncs and DDC I/F).
  - Minimize the distance from the ESD protection device to the VGA/YPbPr output connector.
  - Mount all ESD protection devices on the PCB level next to the ground plane to provide the lowest possible impedance path to ground.
  - Provide a low impedance path to ground for the shield of the VGA/YPbPr output connector.
- For VGA outputs, recommend the following:
  - 3.3 V to 5 V level shifters should be used for the H/V Sync signals.
  - 3.3 V to 5 V bi-directional level shifters should be used for the DDC signals. This is typically implemented using two N-channel enhancement MOSFETs.
  - Recommend using the TPD7S019 ESD protection device with integrated level shifters for the H/V Sync and DDC signals.
  - The source impedance of the H/V Sync outputs should be 50  $\Omega$ .
  - The characteristic impedance of the H/V Sync output signal traces should be 50  $\Omega$ .
  - The THS7360 reconstruction filter should be bypassed to provide maximum bandwidth.
  - The 5-V supply output should be current limited (for example, using a series resistor or resettable fuse).

For additional video HD-DAC design guidelines, see the *High Definition Video Processing Subsystem* chapter in the device-specific Technical Reference Manual.

**Table 8-38. HD-DAC Recommended Operating Conditions**

|                                                                 | MIN | NOM  | MAX | UNIT       |
|-----------------------------------------------------------------|-----|------|-----|------------|
| Output Load Capacitance ( $C_{LOAD}$ ) <sup>(1)</sup>           |     |      | 5   | pF         |
| Output Load Resistors ( $R_{LOAD}$ )                            | –1% | 165  | +1% | $\Omega$   |
| Full-Scale Current Adjust Resistor ( $R_{HDDAC\_IREF}$ )        | –1% | 2.67 | +1% | k $\Omega$ |
| Optional External Voltage Reference (HDDAC_VREF) <sup>(2)</sup> | –5% | 467  | +5% | mV         |
| Required External Amplification (THS7360)                       | –3% | 4.5  | +3% | V/V        |

(1) The output load capacitance includes the signal trace parasitic capacitance and the video buffer input capacitance.

(2) An external voltage reference is not required since an internal bandgap reference is provided.

**Table 8-39. HD-DAC Specifications**

| PARAMETER                              | CONDITIONS                                       | MIN  | TYP | MAX  | UNIT |
|----------------------------------------|--------------------------------------------------|------|-----|------|------|
| Resolution                             |                                                  |      | 10  |      | Bits |
| DC Accuracy                            |                                                  |      |     |      |      |
| Integral Non-Linearity (INL), best fit |                                                  |      |     | 2.5  | LSB  |
| Differential Non-Linearity (DNL)       |                                                  |      |     | 1.0  | LSB  |
| Analog Output                          |                                                  |      |     |      |      |
| Full-Scale Output Current (IFS)        | DAC input = 1023                                 |      | 3   |      | mA   |
| Full-Scale Output Voltage (VFS)        | DAC input = 1023                                 | –15% | 494 | +15% | mV   |
| Zero Scale Offset Error (ZSET)         |                                                  |      | 0.5 |      | LSB  |
| Channel matching                       |                                                  |      |     | 2    | %    |
| Dynamic Specifications                 |                                                  |      |     |      |      |
| Maximum Output Update Rate (FCLK)      |                                                  | 150  |     |      | MHz  |
| Spurious - Free Dynamic Range (SFDR)   | FCLK = 74.25 MHz,<br>30-MHz full-scale sine wave |      | 70  |      | dB   |
|                                        | FCLK = 148.5 MHz,<br>30-MHz full-scale sine wave |      | 60  |      | dB   |



## 8.11 Inter-Integrated Circuit (I2C)

The device includes four inter-integrated circuit (I2C) modules which provide an interface to other devices compliant with Philips Semiconductors Inter-IC bus (I2C-bus™) specification version 2.1. External components attached to this 2-wire serial bus can transmit/receive 8-bit data to/from the device through the I2C module. The I2C port *does not* support CBUS compatible devices.

The I2C port supports the following features:

- Compatible with Philips I2C Specification Revision 2.1 (January 2000)
- Standard and fast modes from 10 - 400 Kbps (no fail-safe I/O buffers)
- Noise filter to remove noise 50 ns or less
- Seven- and ten-bit device addressing modes
- Multimaster transmitter/slave receiver mode
- Multimaster receiver/slave transmitter mode
- Combined master transmit/receive and receive/transmit modes
- Two DMA channels, one interrupt line
- Built-in FIFO (32 byte) for buffered read or write.

For more detailed information on the I2C peripheral, see the *Inter-Integrated Circuit (I2C) Controller Module* chapter in the device-specific Technical Reference Manual.

### 8.11.1 I2C Peripheral Register Descriptions

The I2C peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

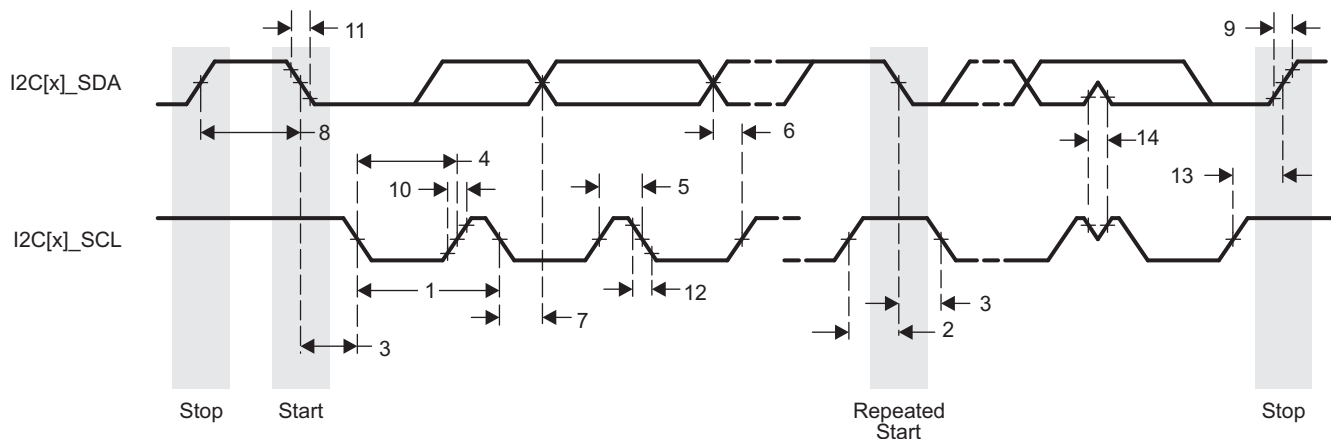
### 8.11.2 I2C Electrical Data/Timing

**Table 8-40. Timing Requirements for I2C Input Timings<sup>(1)</sup>**

(see [Figure 8-44](#))

| NO. |                               |                                                                               | OPP100/OPP120/Turbo/Nitro |                     |                                       |                    | UNIT    |
|-----|-------------------------------|-------------------------------------------------------------------------------|---------------------------|---------------------|---------------------------------------|--------------------|---------|
|     |                               |                                                                               | STANDARD MODE             |                     | FAST MODE                             |                    |         |
|     |                               |                                                                               | MIN                       | MAX                 | MIN                                   | MAX                |         |
| 1   | $t_{c(SCL)}$                  | Cycle time, SCL                                                               | 10                        |                     | 2.5                                   |                    | $\mu$ s |
| 2   | $t_{su(SCLH-SDAL)}$           | Setup time, SCL high before SDA low (for a repeated START condition)          | 4.7                       |                     | 0.6                                   |                    | $\mu$ s |
| 3   | $t_{h(SDAL-SCLL)}$            | Hold time, SCL low after SDA low (for a START and a repeated START condition) | 4                         |                     | 0.6                                   |                    | $\mu$ s |
| 4   | $t_{w(SCLL)}$                 | Pulse duration, SCL low                                                       | 4.7                       |                     | 1.3                                   |                    | $\mu$ s |
| 5   | $t_{w(SCLH)}$                 | Pulse duration, SCL high                                                      | 4                         |                     | 0.6                                   |                    | $\mu$ s |
| 6   | $t_{su(SDAV-SCLH)}$           | Setup time, SDA valid before SCL high                                         | 250                       |                     | 100 <sup>(2)</sup>                    |                    | ns      |
| 7   | $t_{h(SCLL-SDAV)}$            | Hold time, SDA valid after SCL low                                            | 0 <sup>(3)</sup>          | 3.45 <sup>(4)</sup> | 0 <sup>(3)</sup>                      | 0.9 <sup>(4)</sup> | $\mu$ s |
| 8   | $t_{w(SDAH)}$                 | Pulse duration, SDA high between STOP and START conditions                    | 4.7                       |                     | 1.3                                   |                    | $\mu$ s |
| 9   | $t_r(SDA)$                    | Rise time, SDA                                                                | 1000                      |                     | 20 + 0.1C <sub>b</sub> <sup>(5)</sup> | 300                | ns      |
| 10  | $t_r(SCL)$                    | Rise time, SCL                                                                | 1000                      |                     | 20 + 0.1C <sub>b</sub> <sup>(5)</sup> | 300                | ns      |
| 11  | $t_f(SDA)$                    | Fall time, SDA                                                                | 300                       |                     | 20 + 0.1C <sub>b</sub> <sup>(5)</sup> | 300                | ns      |
| 12  | $t_f(SCL)$                    | Fall time, SCL                                                                | 300                       |                     | 20 + 0.1C <sub>b</sub> <sup>(5)</sup> | 300                | ns      |
| 13  | $t_{su(SCLH-SDAH)}$           | Setup time, SCL high before SDA high (for STOP condition)                     | 4                         |                     | 0.6                                   |                    | $\mu$ s |
| 14  | $t_w(SP)$                     | Pulse duration, spike (must be suppressed)                                    |                           |                     | 0                                     | 50                 | ns      |
| 15  | C <sub>b</sub> <sup>(5)</sup> | Capacitive load for each bus line                                             | 400                       |                     |                                       | 400                | pF      |

- (1) The I2C pins SDA and SCL do not feature fail-safe I/O buffers. These pins could potentially draw current when the device is powered down.
- (2) A Fast-mode I<sup>2</sup>C-bus™ device can be used in a Standard-mode I<sup>2</sup>C-bus system, but the requirement  $t_{su(SDA-SCLH)} \geq 250$  ns must then be met. This will automatically be the case if the device does not stretch the LOW period of the SCL signal. If such a device does stretch the LOW period of the SCL signal, it must output the next data bit to the SDA line  $t_r + t_{su(SDA-SCLH)} = 1000 + 250 = 1250$  ns (according to the Standard-mode I<sup>2</sup>C-Bus Specification) before the SCL line is released.
- (3) A device must internally provide a hold time of at least 300 ns for the SDA signal (referred to the  $V_{IHmin}$  of the SCL signal) to bridge the undefined region of the falling edge of SCL.
- (4) The maximum  $t_{h(SDA-SCLL)}$  has only to be met if the device does not stretch the low period [ $t_{w(SCLL)}$ ] of the SCL signal.
- (5)  $C_b$  = total capacitance of one bus line in pF. If mixed with HS-mode devices, faster fall-times are allowed.

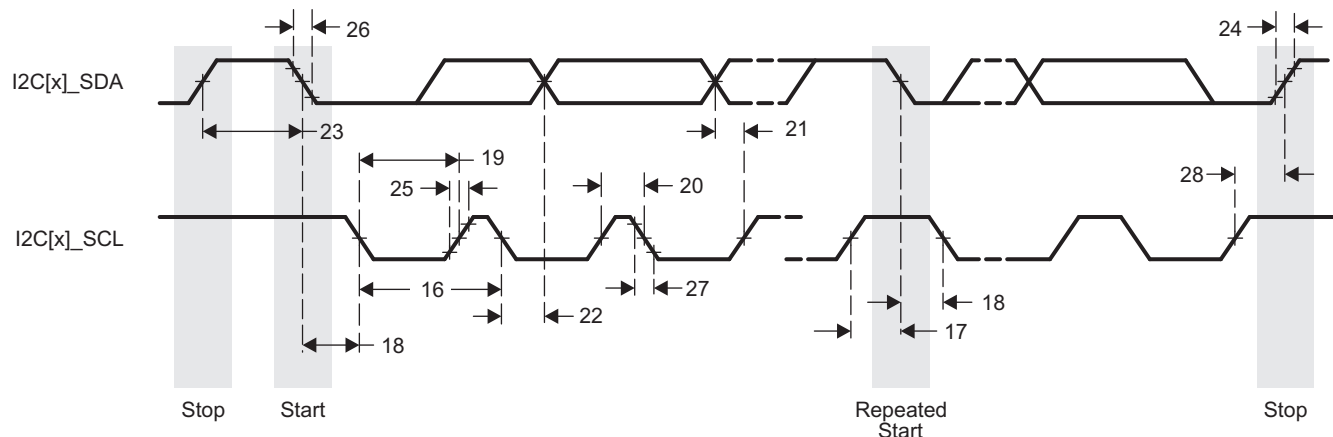


**Figure 8-44. I2C Receive Timing**

**Table 8-41. Switching Characteristics Over Recommended Operating Conditions for I2C Output Timings**  
(see Figure 8-45)

| NO. | PARAMETER                   |                                                                               | OPP100/OPP120/Turbo/Nitro |      |                           |     | UNIT |
|-----|-----------------------------|-------------------------------------------------------------------------------|---------------------------|------|---------------------------|-----|------|
|     |                             |                                                                               | STANDARD MODE             |      | FAST MODE                 |     |      |
|     |                             |                                                                               | MIN                       | MAX  | MIN                       | MAX |      |
| 16  | t <sub>c</sub> (SCL)        | Cycle time, SCL                                                               | 10                        |      | 2.5                       |     | μs   |
| 17  | t <sub>su</sub> (SCLH-SDAL) | Setup time, SCL high before SDA low (for a repeated START condition)          | 4.7                       |      | 0.6                       |     | μs   |
| 18  | t <sub>h</sub> (SDAL-SCLL)  | Hold time, SCL low after SDA low (for a START and a repeated START condition) | 4                         |      | 0.6                       |     | μs   |
| 19  | t <sub>w</sub> (SCLL)       | Pulse duration, SCL low                                                       | 4.7                       |      | 1.3                       |     | μs   |
| 20  | t <sub>w</sub> (SCLH)       | Pulse duration, SCL high                                                      | 4                         |      | 0.6                       |     | μs   |
| 21  | t <sub>su</sub> (SDAV-SCLH) | Setup time, SDA valid before SCL high                                         | 250                       |      | 100                       |     | ns   |
| 22  | t <sub>h</sub> (SCLL-SDAV)  | Hold time, SDA valid after SCL low (for I2C bus devices)                      | 0                         | 3.45 | 0                         | 0.9 | μs   |
| 23  | t <sub>w</sub> (SDAH)       | Pulse duration, SDA high between STOP and START conditions                    | 4.7                       |      | 1.3                       |     | μs   |
| 24  | t <sub>r</sub> (SDA)        | Rise time, SDA                                                                | 1000                      |      | 20 + 0.1C <sub>b(1)</sub> | 300 | ns   |
| 25  | t <sub>r</sub> (SCL)        | Rise time, SCL                                                                | 1000                      |      | 20 + 0.1C <sub>b(1)</sub> | 300 | ns   |
| 26  | t <sub>f</sub> (SDA)        | Fall time, SDA                                                                | 300                       |      | 20 + 0.1C <sub>b(1)</sub> | 300 | ns   |
| 27  | t <sub>f</sub> (SCL)        | Fall time, SCL                                                                | 300                       |      | 20 + 0.1C <sub>b(1)</sub> | 300 | ns   |
| 28  | t <sub>su</sub> (SCLH-SDAH) | Setup time, SCL high before SDA high (for STOP condition)                     | 4                         |      | 0.6                       |     | μs   |
| 29  | C <sub>p</sub>              | Capacitance for each I2C pin                                                  | 10                        |      | 10                        |     | pF   |

(1)  $C_b$  = total capacitance of one bus line in pF. If mixed with HS-mode devices, faster fall-times are allowed.



**Figure 8-45. I2C Transmit Timing**

## 8.12 Imaging Subsystem (ISS)

The device Imaging Subsystem captures and processes pixel data from external image and video inputs. The inputs can be connected to the Image Processing block through the Parallel Camera Interface (CAM). In addition, a Timing control module provides flash strobe and mechanical shutter interfaces. The features of each component of the ISS are described below.

- Parallel Camera (CAM) interface features:
  - Input format
    - Bayer pattern Raw (up to 16bit) or YCbCr 422 (8-bit or 16-bit) data.
    - ITU-R BT.656/1120 standard format
  - Generates HD/VD timing signals and field ID to an external timing generator, or can synchronize to the external timing generator.
  - Support for progressive and interlaced sensors (hardware support for up to 2 fields and firmware supports for higher number of fields, typically 3-, 4-, and 5-field sensors).
- CSI2 Serial Connection features:
  - Supports up to 1Gb/s data-rate per lane for 1, 2, and 3 Data-lane configurations, and up to 824Mbps per lane for a 4 Data-lane configuration
  - Supports sensor capture up to 4K x 2K 10-bit Bayer @ 30fps
  - Supports up to four data configurable links in addition to the clock signaling
  - Data merger for 2-, 3-, or 4-data lane configurations
  - 1-D and 2-D addressing mode
  - Supports all primary and secondary MIPI-defined formats (RGB, RAW, YUV, and more)
  - DPCM decompression
  - Image cropping and A-Law/DPCM compression
- Image Sensor Interface (ISIF) features:
  - Support for up to 32K pixels (image size) in both the horizontal and vertical direction
  - Color space conversion for non-Bayer pattern Raw data
  - Digital black clamping with Horizontal/Vertical offset drift compensation
  - Vertical Line defect correction based on a lookup table
  - Color-dependent gain control and black level offset control
  - Ability to control output to the DDR2/DDR3/DDR3L via an external write enable signal
  - Down sampling via programmable culling patterns
  - A-law/DPCM compression
  - Generating 16-, 12- or 8-bit output to memory
- Two independent Resizers
  - Providing two different sizes of outputs simultaneously on one input
  - Maximum line width is 5376 and 2336, respectively
  - YUV422 to YUV420 conversion
  - Data output format: RGB565, ARGB888, YUV422 co sited and YUV4:2:0 planar
  - Resizer Ratio: x1/4096 ~ x20
  - Input from memory
- Timing control module features:
  - STROBE signal for flash pre-strobe and flash strobe
  - SHUTTER signal for mechanical shutter control
  - Global reset control

For more detailed information on the ISS, see the ISS Overview section, the ISS Interfaces section, and the ISS ISP section of the device-specific Technical Reference Manual.

### 8.12.1 ISS Peripheral Register Description

The ISS peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

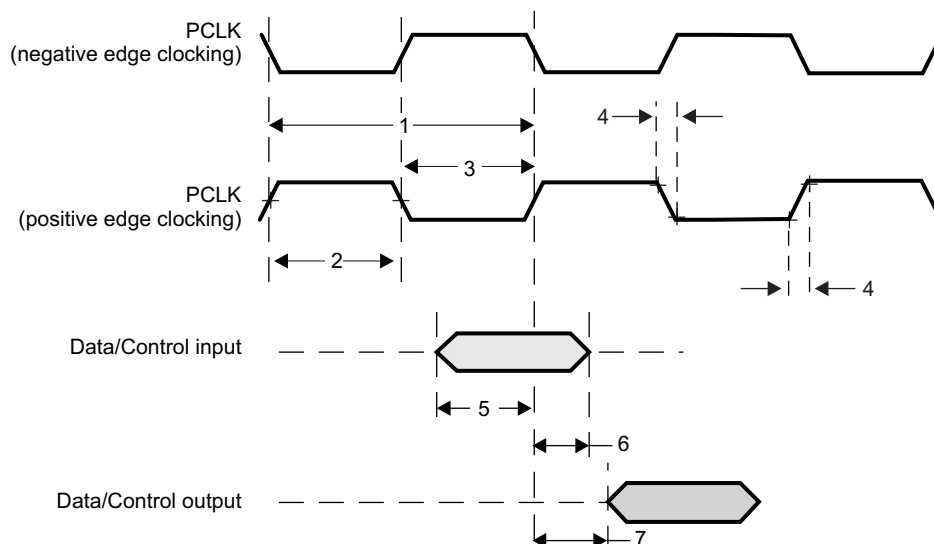
### 8.12.2 ISSCAM Electrical Data/Timing

**Table 8-42. Timing Requirements for ISSCAM (see [Figure 8-46](#))**

| N<br>O. |                     |                                                           |                                             | OPP100/OPP120/Turbo/Nitro |      |      | UNIT |
|---------|---------------------|-----------------------------------------------------------|---------------------------------------------|---------------------------|------|------|------|
|         |                     |                                                           |                                             | MIN                       | NOM  | MAX  |      |
| 1       | $t_{c(PCLK)}$       | Cycle time, PCLK                                          |                                             |                           | 6.17 |      | ns   |
| 2       | $t_{w(PCLKH)}$      | Pulse duration, PCLK high                                 |                                             |                           | 2.78 |      | ns   |
| 3       | $t_{w(PCLKL)}$      | Pulse duration, PCLK low                                  |                                             |                           | 2.78 |      | ns   |
| 4       | $t_l(PCLK)$         | Transition time, PCLK                                     |                                             |                           |      | 2.64 | ns   |
| 5       | $t_{su}(DATA-PCLK)$ | Input setup time, Data/Control valid before PCLK high/low |                                             |                           | 3.11 |      | ns   |
|         | $t_{su}(DE-PCLK)$   |                                                           |                                             |                           | 3.11 |      | ns   |
|         | $t_{su}(VS-PCLK)$   |                                                           |                                             |                           | 3.11 |      | ns   |
|         | $t_{su}(HS-PCLK)$   |                                                           |                                             |                           | 3.11 |      | ns   |
|         | $t_{su}(FLD-PCLK)$  |                                                           |                                             |                           | 3.11 |      | ns   |
| 6       | $t_h(PCLK-DATA)$    | Input hold time, Data valid after PCLK high/low           | $\leq 148.5$ MHz clock rate                 | -0.5                      |      |      | ns   |
|         |                     |                                                           | $> 148.5$ MHz and $\leq 162$ MHz clock rate | 0.0                       |      |      | ns   |
|         | $t_h(PCLK-DE)$      | Input hold time, Control valid after PCLK high/low        |                                             | -0.5                      |      |      | ns   |
|         | $t_h(PCLK-VS)$      |                                                           |                                             | -0.5                      |      |      | ns   |
|         | $t_h(PCLK-HS)$      |                                                           |                                             | -0.5                      |      |      | ns   |
|         | $t_h(PCLK-FLD)$     |                                                           |                                             | -0.5                      |      |      | ns   |

**Table 8-43. Switching Characteristics Over Recommended Operating Conditions for ISSCAM (see Figure 8-46)**

| NO. | PARAMETER                                                                         | OPP100/OPP120/Turbo/Nitro |       | UNIT |
|-----|-----------------------------------------------------------------------------------|---------------------------|-------|------|
|     |                                                                                   | MIN                       | MAX   |      |
| 15  | $t_{d(PCLK-FLD)}$ Delay time, PCLK rising/falling clock edge to Control valid     | 1.64                      | 14.68 | ns   |
| 16  | $t_{d(PCLK-VS)}$ Delay time, PCLK rising/falling clock edge to Control valid      | 1.64                      | 14.68 | ns   |
| 17  | $t_{d(PCLK-HS)}$ Delay time, PCLK rising/falling clock edge to Control valid      | 1.64                      | 14.68 | ns   |
| 18  | $t_{d(PCLK-STROBE)}$ Delay time, PCLK rising/falling clock edge to Control valid  | 1.64                      | 14.68 | ns   |
| 19  | $t_{d(PCLK-SHUTTER)}$ Delay time, PCLK rising/falling clock edge to Control valid | 1.64                      | 14.68 | ns   |


**Figure 8-46. ISSCAM Timings**

### 8.12.3 CSI2 PCB Layout Specifications

The following PCB guidelines for CSI2 working at 1 Gbps (up to 3 data lanes), 824 Mbps (up to 4 data lanes), and 800 Mbps (up to 4 data lanes) are based on a three-step design and validation methodology.

For the design of the PCB differential lines, PCB designers need to keep in mind the requirements of [Step 1](#) and [Step 2](#): the characteristic impedance must be 50  $\Omega$ , the total length must be smaller than 100 mm, and the length mismatch requirements must be satisfied.

After the PCB design is finished, the S-parameters of the PCB differential lines will be extracted with a 3D Maxwell Equation Solver, such as High-Frequency Structure Simulator (HFSS) or equivalent, and compared to the frequency-domain specification as outlined in Step 3 of the design methodology. If the PCB lines satisfy the frequency-domain specification, the design is done. Otherwise, the design needs to be improved.

#### 8.12.3.1 Step 1: General Guidelines

The general guidelines for the PCB differential lines of CSI2 are given as:

- Single-ended  $Z_0 = 50 \Omega$
- Total conductor length on the board < 100 mm

In this step, the general rule of thumb for the space  $S = 2 \times W$  is not designated. Although the  $S = 2 \times W$  rule is a good rule of thumb, it is not always the best solution. The electrical performance will be checked with the frequency-domain specification in [Step 3](#). Even if the design does not follow the  $S = 2 \times W$  rule, the differential lines are okay if the lines satisfy the frequency-domain specification in Step 3.

### 8.12.3.2 Step 2: Length Mismatch Guidelines

#### 8.12.3.2.1 CSI2 at 1.0 Gbps

The guidelines of the length mismatch for CSI2 at 1.0 Gbps are presented in [Table 8-44](#). The intralane length mismatch must be less than 0.5 mm, and the interlane length mismatch must be less than 1.5 mm.

**Table 8-44. Length Mismatch Guidelines for CSI2 at 1.0 Gbps**

| PARAMETER                     | TYPICAL VALUE | UNIT |
|-------------------------------|---------------|------|
| Operating speed               | 1000          | Mbps |
| UI (bit time)                 | 1000          | ps   |
| Intralane skew (UI / 300)     | 3             | ps   |
| Length between N and P traces | 0.5           | mm   |
| Interlane skew (UI / 100)     | 10            | ps   |
| Length between pairs          | 1.5           | mm   |

#### 8.12.3.2.2 CSI2 at 824 Mbps

The guidelines of the length mismatch for CSI2 at 824 Mbps are presented in [Table 8-45](#). The intralane length mismatch must be less than 0.6 mm, and the interlane length mismatch must be less than 1.8 mm.

**Table 8-45. Length Mismatch Guidelines for CSI2 at 824 Mbps**

| PARAMETER                     | TYPICAL VALUE | UNIT |
|-------------------------------|---------------|------|
| Operating speed               | 824           | Mbps |
| UI (bit time)                 | 1213          | ps   |
| Intralane skew (UI / 300)     | 4             | ps   |
| Length between N and P traces | 0.6           | mm   |
| Interlane skew (UI / 100)     | 12            | ps   |
| Length between pairs          | 1.8           | mm   |

#### 8.12.3.2.3 CSI2 at 800 Mbps

The guidelines of the length mismatch for CSI2 at 800 Mbps are presented in [Table 8-46](#). The intralane length mismatch must be less than 0.6 mm, and the interlane length mismatch must be less than 1.8 mm.

**Table 8-46. Length Mismatch Guidelines for CSI2 at 800 Mbps**

| PARAMETER                     | TYPICAL VALUE | UNIT |
|-------------------------------|---------------|------|
| Operating speed               | 800           | Mbps |
| UI (bit time)                 | 1250          | ps   |
| Intralane skew (UI / 300)     | 4             | ps   |
| Length between N and P traces | 0.6           | mm   |
| Interlane skew (UI / 100)     | 12            | ps   |
| Length between pairs          | 1.8           | mm   |

### 8.12.3.3 Step 3: Frequency-Domain Specification Guidelines

The PCB differential lines should be drawn in order to satisfy the Step 1 and Step 2 requirements. However, although the PCB designer may draw the lines carefully, the lines can have poor electrical performance due to many reasons.

Vertical connections such as vias and non-uniform line connections can degrade the electrical performance of the differential lines. The ground design around the lines can also affect the electrical performance. To ensure that the differential lines are well designed, the frequency-domain behavior must be compared to the frequency-domain specification.

#### 1. Intralane frequency-domain specification

- Differential-mode characteristics
  - Sdd12, Sdd11/Sdd22
- Common-mode characteristics
  - Scc11/Scc22
- Mode-conversion characteristics
  - Scd11, Scd12, Scd21, Scd22, Sdc11, Sdc12, Sdc21, Sdc22

#### 2. Interlane frequency-domain specification

- Differential-mode characteristics
  - Sdd11/Sdd22
- Common-mode characteristics
  - Scc11/Scc22



### 8.13 DDR2/DDR3/DDR3L Memory Controller

The device has a dedicated interface to DDR3L, DDR3 and DDR2 SDRAM. It supports DDR2, DDR3 and DDR3L SDRAM devices with the following features:

- 16-bit or 32-bit data path to external SDRAM memory
- Memory device capacity: 64Mb, 128Mb, 256Mb, 512Mb, 1Gb, 2Gb, and 4Gb devices
- One interface with associated DDR2/DDR3/DDR3L PHY

For details on the DDR2, DDR3 and DDR3L Memory Controller, see the *DDR2/DDR3/DDR3L Memory Controller* chapter in the device-specific Technical Reference Manual.

### 8.13.1 DDR2/3/3L Memory Controller Register Descriptions

The DDR2/3/3L peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

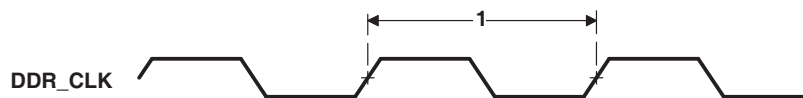
### 8.13.2 DDR2 Routing Specifications

#### 8.13.2.1 Board Designs

TI only supports board designs that follow the guidelines outlined in this document. The switching characteristics and the timing diagram for the DDR2 memory controller are shown in [Table 8-47](#) and [Figure 8-47](#).

**Table 8-47. Switching Characteristics Over Recommended Operating Conditions for DDR2 Memory Controller**

| NO. | PARAMETER                             | -1G |     | UNIT |
|-----|---------------------------------------|-----|-----|------|
|     |                                       | MIN | MAX |      |
| 1   | $t_{c(DDR\_CLK)}$ Cycle time, DDR_CLK | 2.5 | 8   | ns   |



**Figure 8-47. DDR2 Memory Controller Clock Timing**

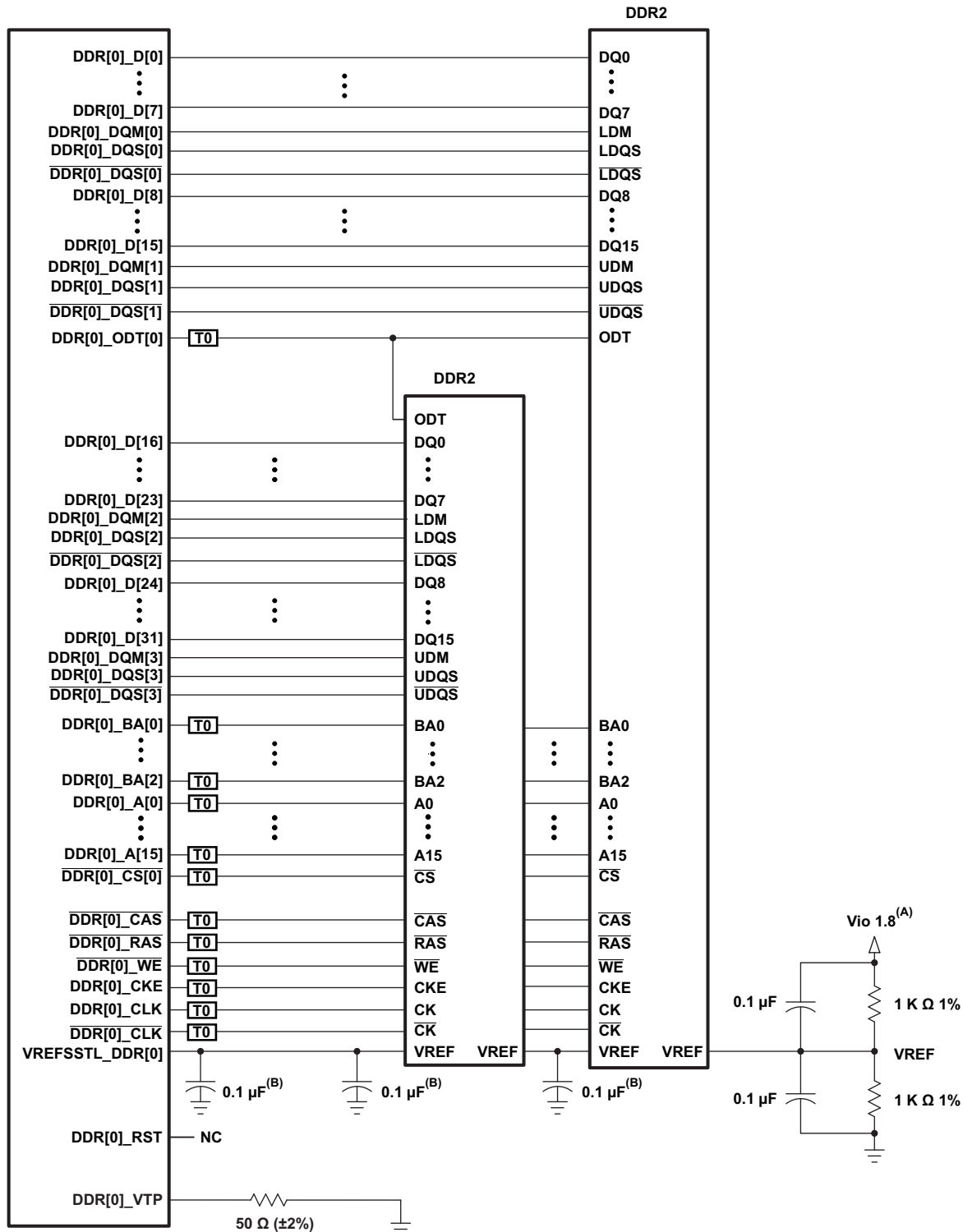
#### 8.13.2.2 DDR2 Interface

This section provides the timing specification for the DDR2 interface as a PCB design and manufacturing specification. The design rules constrain PCB trace length, PCB trace skew, signal integrity, cross-talk, and signal timing. These rules, when followed, result in a reliable DDR2 memory system without the need for a complex timing closure process. For more information regarding the guidelines for using this DDR2 specification, see the *Understanding TI's PCB Routing Rule-Based DDR Timing Specification* Application Report (Literature Number: [SPRAAV0](#)).

##### 8.13.2.2.1 DDR2 Interface Schematic

[Figure 8-48](#) shows the DDR2 interface schematic for a x32 DDR2 memory system. In [Figure 8-49](#) the x16 DDR2 system schematic is identical except that the high-word DDR2 device is deleted.

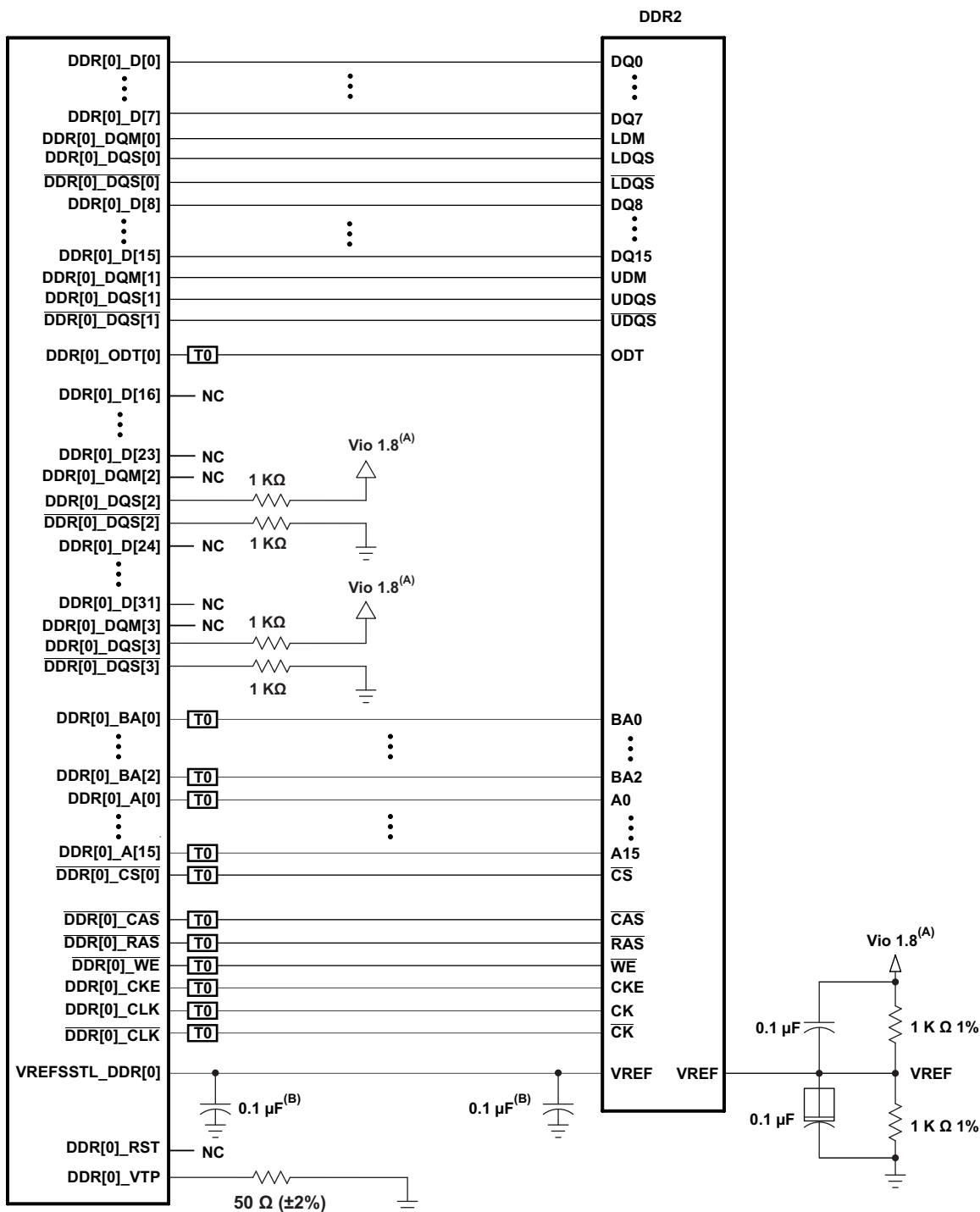
When not using a DDR2 interface, the proper method of handling the unused pins is to tie off the DQS pins by pulling the non-inverted DQS pin to the DVDD\_DDR[0] supply via a 1k-Ω resistor and pulling the inverted DQS pin to ground via a 1k-Ω resistor. This needs to be done for each byte not used. Also, include the 50-Ω pulldown for DDR[0]\_VTP. The DVDD\_DDR[0] and VREFSSTL\_DDR[0] power supply pins must be connected to their respective power supplies even if DDR[0] is not used. All other DDR interface pins can be left unconnected. Note that the supported modes for use of the DDR EMIF are 32-bits wide, 16-bits wide, or not used.



**T0** Termination is required. See terminator comments.

- A. Vio1.8 is the power supply for the DDR2 memories and the device DDR2 interface.
- B. One of these capacitors can be eliminated if the divider and its capacitors are placed near a VREF pin.

**Figure 8-48. 32-Bit DDR2 High-Level Schematic**



**T0** Termination is required. See terminator comments.

- A. Vio1.8 is the power supply for the DDR2 memories and the device DDR2 interface.
- B. One of these capacitors can be eliminated if the divider and its capacitors are placed near a VREF pin.

**Figure 8-49. 16-Bit DDR2 High-Level Schematic**

### 8.13.2.2.2 Compatible DDR2 Devices

Table 8-48 shows the parameters of the DDR2 devices that are compatible with this interface. Generally, the DDR2 interface is compatible with x16 DDR2-800 speed grade DDR2 devices.

**Table 8-48. Compatible DDR2 Devices (Per Interface)**

| NO. | PARAMETER                              | MIN      | MAX | UNIT    |
|-----|----------------------------------------|----------|-----|---------|
| 1   | DDR2 device speed grade <sup>(1)</sup> | DDR2-800 |     |         |
| 2   | DDR2 device bit width                  | x16      | x16 | Bits    |
| 3   | DDR2 device count <sup>(2)</sup>       | 1        | 2   | Devices |
| 4   | DDR2 device ball count <sup>(3)</sup>  | 84       | 92  | Balls   |

(1) Higher DDR2 speed grades are supported due to inherent DDR2 backwards compatibility.

(2) One DDR2 device is used for a 16-bit DDR2 memory system. Two DDR2 devices are used for a 32-bit DDR2 memory system.

(3) The 92-ball devices are retained for legacy support. New designs will migrate to 84-ball DDR2 devices. Electrically, the 92- and 84-ball DDR2 devices are the same.

### 8.13.2.2.3 PCB Stackup

The minimum stackup required for routing the device is a six-layer stackup as shown in Table 8-49. Additional layers may be added to the PCB stackup to accommodate other circuitry or to reduce the size of the PCB footprint.

**Table 8-49. Minimum PCB Stackup**

| LAYER | TYPE   | DESCRIPTION                    |
|-------|--------|--------------------------------|
| 1     | Signal | Top routing mostly horizontal  |
| 2     | Plane  | Ground                         |
| 3     | Plane  | Power                          |
| 4     | Signal | Internal routing               |
| 5     | Plane  | Ground                         |
| 6     | Signal | Bottom routing mostly vertical |

Complete stackup specifications are provided in [Table 8-50](#).

**Table 8-50. PCB Stackup Specifications**

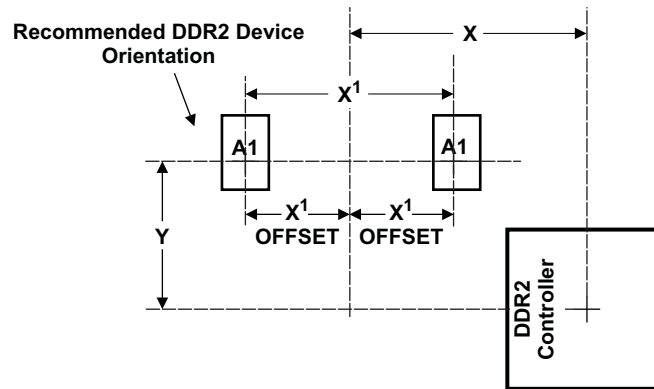
| NO. | PARAMETER                                                              | MIN | TYP | MAX | UNIT |
|-----|------------------------------------------------------------------------|-----|-----|-----|------|
| 1   | PCB routing/plane layers                                               | 6   |     |     |      |
| 2   | Signal routing layers                                                  | 3   |     |     |      |
| 3   | Full ground layers under DDR2 routing region                           | 2   |     |     |      |
| 4   | Number of ground plane cuts allowed within DDR routing region          |     |     | 0   |      |
| 5   | Number of ground reference planes required for each DDR2 routing layer | 1   |     |     |      |
| 6   | Number of layers between DDR2 routing layer and reference ground plane |     |     | 0   |      |
| 7   | PCB feature spacing                                                    |     | 4   |     | Mils |
| 8   | PCB trace width, w                                                     |     | 4   |     | Mils |
| 9   | PCB BGA escape via pad size <sup>(1)</sup>                             |     | 18  | 20  | Mils |
| 10  | PCB BGA escape via hole size <sup>(1)</sup>                            |     | 10  |     | Mils |
| 11  | Processor BGA pad size                                                 |     | 0.4 |     | mm   |
| 13  | Single-ended impedance, Z <sub>0</sub>                                 | 50  |     | 75  | Ω    |
| 14  | Impedance control <sup>(2)</sup>                                       | Z-5 | Z   | Z+5 | Ω    |

(1) A 20/10 via may be used if enough power routing resources are available. An 18/10 via allows for more flexible power routing to the processor.

(2) Z is the nominal singled-ended impedance selected for the PCB specified by item 13.

#### 8.13.2.2.4 Placement

Figure 8-50 shows the required placement for the processor as well as the DDR2 devices. The dimensions for this figure are defined in Table 8-51. The placement does not restrict the side of the PCB on which the devices are mounted. The ultimate purpose of the placement is to limit the maximum trace lengths and allow for proper routing space. For a 16-bit DDR memory system, the high-word DDR2 device is omitted from the placement.



**Figure 8-50. Device and DDR2 Device Placement**

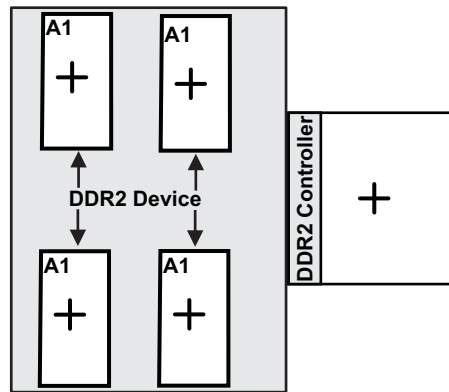
**Table 8-51. Placement Specifications**

| NO. | PARAMETER                                                            | MIN | MAX  | UNIT |
|-----|----------------------------------------------------------------------|-----|------|------|
| 1   | $X + Y^{(1)(2)}$                                                     |     | 1660 | Mils |
| 2   | $X'^{(1)(2)}$                                                        |     | 1280 | Mils |
| 3   | $X' \text{ Offset}^{(1)(2)(3)}$                                      |     | 650  | Mils |
| 4   | DDR2 keepout region <sup>(4)</sup>                                   |     |      |      |
| 5   | Clearance from non-DDR2 signal to DDR2 keepout region <sup>(5)</sup> | 4   |      | w    |

- (1) For dimension definitions, see Figure 8-48.
- (2) Measurements from center of processor to center of DDR2 device.
- (3) For 16-bit memory systems, it is recommended that  $X'$  offset be as small as possible.
- (4) DDR2 keepout region to encompass entire DDR2 routing area.
- (5) Non-DDR2 signals allowed within DDR2 keepout region provided they are separated from DDR2 routing layers by a ground plane.

### 8.13.2.2.5 DDR2 Keepout Region

The region of the PCB used for the DDR2 circuitry must be isolated from other signals. The DDR2 keepout region is defined for this purpose and is shown in [Figure 8-51](#). The size of this region varies with the placement and DDR routing. Additional clearances required for the keepout region are shown in [Table 8-51](#).



**Figure 8-51. DDR2 Keepout Region**

#### NOTE

The region shown in should encompass all the DDR2 circuitry and varies depending on placement. Non-DDR2 signals should not be routed on the DDR signal layers within the DDR2 keepout region. Non-DDR2 signals may be routed in the region, provided they are routed on layers separated from DDR2 signal layers by a ground layer. No breaks should be allowed in the reference ground layers in this region. In addition, the 1.8-V power plane should cover the entire keepout region. Routes for the DDR interface must be separated by at least 4x; the more separation, the better.

### 8.13.2.2.6 Bulk Bypass Capacitors

Bulk bypass capacitors are required for moderate speed bypassing of the DDR2 and other circuitry. [Table 8-52](#) contains the minimum numbers and capacitance required for the bulk bypass capacitors. Note that this table only covers the bypass needs of the DDR2 interfaces and DDR2 device. Additional bulk bypass capacitance may be needed for other circuitry.

**Table 8-52. Bulk Bypass Capacitors**

| No. | Parameter                                         | Min | Max | Unit    |
|-----|---------------------------------------------------|-----|-----|---------|
| 1   | DVDD18 bulk bypass capacitor count <sup>(1)</sup> | 3   |     | Devices |
| 2   | DVDD18 bulk bypass total capacitance              | 30  |     | μF      |
| 3   | DDR bulk bypass capacitor count <sup>(1)</sup>    | 1   |     | Devices |
| 4   | DDR bulk bypass total capacitance <sup>(1)</sup>  | 10  |     | μF      |

(1) These devices should be placed near the device they are bypassing, but preference should be given to the placement of the high-speed (HS) bypass capacitors.

### 8.13.2.2.7 High-Speed Bypass Capacitors

High-speed (HS) bypass capacitors are critical for proper DDR2 interface operation. It is particularly important to minimize the parasitic series inductance of the HS bypass capacitors, processor/DDR power, and processor/DDR ground connections. [Table 8-53](#) contains the specification for the HS bypass capacitors as well as for the power connections on the PCB. Due to the number of required bypass capacitors, it is recommended that the bypass capacitors are placed before routing the board.



**Table 8-53. High-Speed Bypass Capacitors**

| NO. | PARAMETER                                                             | MIN | MAX  | UNIT    |
|-----|-----------------------------------------------------------------------|-----|------|---------|
| 1   | HS bypass capacitor package size <sup>(1)</sup>                       |     | 0402 | 10 Mils |
| 2   | Distance from HS bypass capacitor to device being bypassed            |     | 250  | Mils    |
| 3   | Number of connection vias for each HS bypass capacitor <sup>(2)</sup> | 2   |      | Vias    |
| 4   | Trace length from bypass capacitor contact to connection via          | 1   | 30   | Mils    |
| 5   | Number of connection vias for each processor power/ground ball        | 1   |      | Vias    |
| 6   | Trace length from processor power/ground ball to connection via       |     | 35   | Mils    |
| 7   | Number of connection vias for each DDR2 device power/ground ball      | 1   |      | Vias    |
| 8   | Trace length from DDR2 device power/ground ball to connection via     |     | 35   | Mils    |
| 9   | DVDD18 HS bypass capacitor count <sup>(3)</sup>                       | 20  |      | Devices |
| 10  | DVDD18 HS bypass capacitor total capacitance                          | 1.2 |      | μF      |
| 11  | DDR device HS bypass capacitor count <sup>(4)(5)</sup>                | 8   |      | Devices |
| 12  | DDR device HS bypass capacitor total capacitance <sup>(5)</sup>       | 0.4 |      | μF      |

(1) LxW, 10-mil units, that is, a 0402 is a 40x20-mil surface-mount capacitor.

(2) An additional HS bypass capacitor can share the connection vias only if it is mounted on the opposite side of the board.

(3) These devices should be placed as close as possible to the device being bypassed.

(4) These devices should be placed as close as possible to the device being bypassed.

(5) Per DDR device.

### 8.13.2.2.8 Net Classes

Table 8-54 lists the clock net classes for the DDR2 interface. Table 8-55 lists the signal net classes, and associated clock net classes, for the signals in the DDR2 interface. These net classes are used for the termination and routing rules that follow.

**Table 8-54. Clock Net Class Definitions**

| CLOCK NET CLASS     | PROCESSOR PIN NAMES         |
|---------------------|-----------------------------|
| CK                  | DDR[0]_CLK/DDR[0]_CLK       |
| DQS0                | DDR[0]_DQS[0]/DDR[0]_DQS[0] |
| DQS1                | DDR[0]_DQS[1]/DDR[0]_DQS[1] |
| DQS2 <sup>(1)</sup> | DDR[0]_DQS[2]/DDR[0]_DQS[2] |
| DQS3 <sup>(1)</sup> | DDR[0]_DQS[3]/DDR[0]_DQS[3] |

(1) Only used on 32-bit wide DDR2 memory systems.

**Table 8-55. Signal Net Class Definitions**

| CLOCK NET CLASS    | ASSOCIATED CLOCK NET CLASS | PROCESSOR PIN NAMES                                                                                        |
|--------------------|----------------------------|------------------------------------------------------------------------------------------------------------|
| ADDR_CTRL          | CK                         | DDR[0]_BA[2:0], DDR[0]_A[15:0], DDR[0]_CS[x], DDR[0]_CAS, DDR[0]_RAS, DDR[0]_WE, DDR[0]_CKE, DDR[0]_ODT[0] |
| DQ0                | DQS0                       | DDR[0]_D[7:0], DDR[0]_DQM[0]                                                                               |
| DQ1                | DQS1                       | DDR[0]_D[15:8], DDR[0]_DQM[1]                                                                              |
| DQ2 <sup>(1)</sup> | DQS2                       | DDR[0]_D[23:16], DDR[0]_DQM[2]                                                                             |
| DQ3 <sup>(1)</sup> | DQS3                       | DDR[0]_D[31:24], DDR[0]_DQM[3]                                                                             |

(1) Only used on 32-bit wide DDR2 memory systems.

### 8.13.2.2.9 DDR2 Signal Termination

Signal terminators are required in CK and ADDR\_CTRL net classes. Serial terminators may be used on data lines to reduce EMI risk; however, serial terminations are the only type permitted. ODT's are integrated on the data byte net classes. They should be enabled to ensure signal integrity. Table 8-56 shows the specifications for the series terminators.

**Table 8-56. DDR2 Signal Terminations**

| NO. | PARAMETER                                                 | MIN | TYP | MAX | UNIT     |
|-----|-----------------------------------------------------------|-----|-----|-----|----------|
| 1   | CK net class <sup>(1)(2)</sup>                            | 0   |     | 10  | $\Omega$ |
| 2   | ADDR_CTRL net class <sup>(1) (2)(3)(4)</sup>              | 0   | 22  | Zo  | $\Omega$ |
| 3   | Data byte net classes (DQS0-DQS3, DQ0-DQ3) <sup>(5)</sup> | 0   |     | Zo  | $\Omega$ |

(1) Only series termination is permitted, parallel or SST specifically disallowed on board.

(2) Only required for EMI reduction.

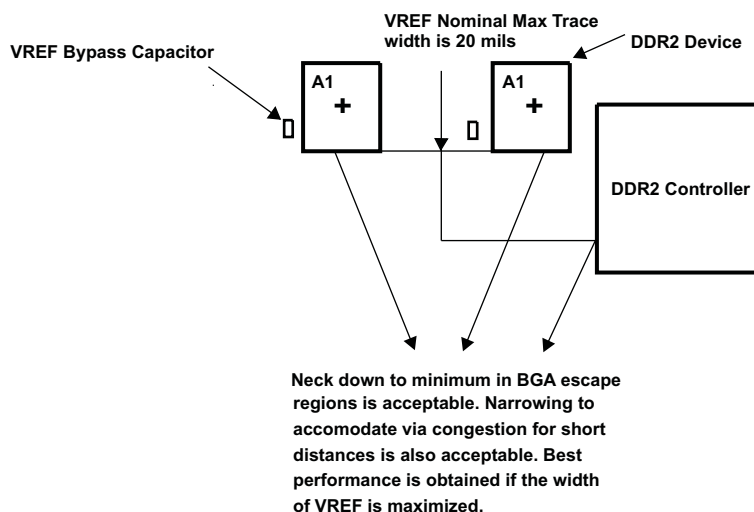
(3) Terminator values larger than typical only recommended to address EMI issues.

(4) Termination value should be uniform across net class.

(5) No external terminations allowed for data byte net classes. ODT is to be used.

### 8.13.2.2.10 VREFSSTL\_DDR Routing

VREFSSTL\_DDR is used as a reference by the input buffers of the DDR2 memories as well as the processor. VREF is intended to be half the DDR2 power supply voltage and should be created using a resistive divider as shown in Figure 8-49. Other methods of creating VREF are not recommended. Figure 8-52 shows the layout guidelines for VREF.

**Figure 8-52. VREF Routing and Topology**

### 8.13.2.3 DDR2 CK and ADDR\_CTRL Routing

Figure 8-53 shows the topology of the routing for the CK and ADDR\_CTRL net classes. The route is a balanced  $T$  as it is intended that the length of segments B and C be equal. In addition, the length of A ( $A' + A''$ ) should be maximized.

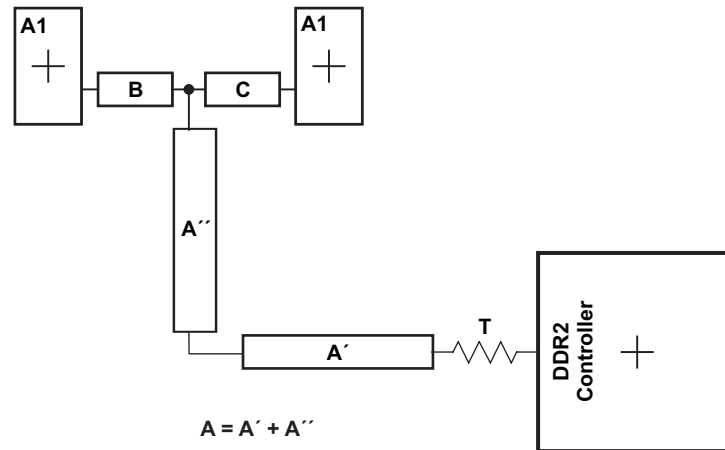


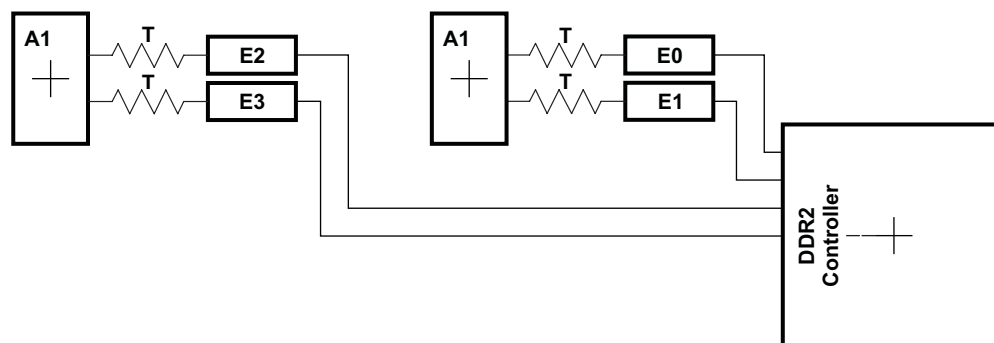
Figure 8-53. CK and ADDR\_CTRL Routing and Topology

Table 8-57. CK and ADDR\_CTRL Routing Specification <sup>(1)</sup>

| NO. | PARAMETER                                                                  | MIN      | TYP   | MAX      | UNIT |
|-----|----------------------------------------------------------------------------|----------|-------|----------|------|
| 1   | Center-to-center CK-CK spacing                                             |          |       | 2w       |      |
| 2   | CK/CK skew <sup>(1)</sup>                                                  |          |       | 25       | Mils |
| 3   | CK A-to-B/A-to-C skew length mismatch <sup>(2)</sup>                       |          |       | 25       | Mils |
| 4   | CK B-to-C skew length mismatch                                             |          |       | 25       | Mils |
| 5   | Center-to-center CK to other DDR2 trace spacing <sup>(3)</sup>             | 4w       |       |          |      |
| 6   | CK/ADDR_CTRL nominal trace length <sup>(4)</sup>                           | CACLM-50 | CACLM | CACLM+50 | Mils |
| 7   | ADDR_CTRL-to-CK skew length mismatch                                       |          |       | 100      | Mils |
| 8   | ADDR_CTRL-to-ADDR_CTRL skew length mismatch                                |          |       | 100      | Mils |
| 9   | Center-to-center ADDR_CTRL to other DDR2 trace spacing <sup>(3)</sup>      | 4w       |       |          |      |
| 10  | Center-to-center ADDR_CTRL to other ADDR_CTRL trace spacing <sup>(3)</sup> | 3w       |       |          |      |
| 11  | ADDR_CTRL A-to-B/A-to-C skew length mismatch <sup>(2)</sup>                |          |       | 100      | Mils |
| 12  | ADDR_CTRL B-to-C skew length mismatch                                      |          |       | 100      | Mils |

- (1) The length of segment  $A = A' + A''$  as shown in Figure 8-53.
- (2) Series terminator, if used, should be located closest to the device.
- (3) Center-to-center spacing is allowed to fall to minimum (2w) for up to 500 mils of routed length to accommodate BGA escape and routing congestion.
- (4) CACLM is the longest Manhattan distance of the CK and ADDR\_CTRL net classes.

Figure 8-54 shows the topology and routing for the DQS and DQ net classes; the routes are point to point. Skew matching across bytes is not needed nor recommended.



**Figure 8-54. DQS and DQ Routing and Topology**

**Table 8-58. DQS and DQ Routing Specification**

| NO. | PARAMETER                                                          | MIN     | TYP  | MAX     | UNIT |
|-----|--------------------------------------------------------------------|---------|------|---------|------|
| 1   | Center-to-center DQS-DQSn spacing in E0 E1 E2 E3                   |         |      | 2w      |      |
| 2   | DQS-DQSn skew in E0 E1 E2 E3                                       |         |      | 25      | Mils |
| 3   | Center-to-center DQS to other DDR2 trace spacing <sup>(1)</sup>    | 4w      |      |         |      |
| 4   | DQS/DQ nominal trace length <sup>(2)(3)(4)</sup>                   | DQLM-50 | DQLM | DQLM+50 | Mils |
| 5   | DQ-to-DQS skew length mismatch <sup>(2)(3)(4)</sup>                |         |      | 100     | Mils |
| 6   | DQ-to-DQ skew length mismatch <sup>(2)(3)(4)</sup>                 |         |      | 100     | Mils |
| 7   | DQ-to-DQ/DQS via count mismatch <sup>(2)(3)(4)</sup>               |         |      | 1       | Vias |
| 8   | Center-to-center DQ to other DDR2 trace spacing <sup>(1)(5)</sup>  | 4w      |      |         |      |
| 9   | Center-to-center DQ to other DQ trace spacing <sup>(1)(6)(7)</sup> | 3w      |      |         |      |
| 10  | DQ/DQS E skew length mismatch <sup>(2)(3)(4)</sup>                 |         |      | 100     | Mils |

- (1) Center-to-center spacing is allowed to fall to minimum (2w) for up to 500 mils of routed length to accommodate BGA escape and routing congestion.
- (2) A 16-bit DDR memory system has two sets of data net classes; one for data byte 0, and one for data byte 1, each with an associated DQS (2 DQSs) per DDR EMIF used.
- (3) A 32-bit DDR memory system has four sets of data net classes; one each for data bytes 0 through 3, and each associated with a DQS (4 DQSs) per DDR EMIF used.
- (4) There is no need, and it is not recommended, to skew match across data bytes; that is, from DQS0 and data byte 0 to DQS1 and data byte 1.
- (5) DQs from other DQS domains are considered *other DDR2 trace*.
- (6) DQs from other data bytes are considered *other DDR2 trace*.
- (7) DQLM is the longest Manhattan distance of each of the DQS and DQ net classes.

### 8.13.3 DDR3/DDR3L Routing Specifications

#### 8.13.3.1 Board Designs

TI only supports board designs utilizing DDR3/DDR3L memory that follow the guidelines in this document. The switching characteristics and timing diagram for the DDR3/DDR3L memory controller are shown in [Table 8-59](#) and [Figure 8-55](#). For the remainder of this section, DDR3 refers to both DDR3 and DDR3L.

**Table 8-59. Switching Characteristics Over Recommended Operating Conditions for DDR3 Memory Controller**

| NO. | PARAMETER                             | -1G   |                    | UNIT |
|-----|---------------------------------------|-------|--------------------|------|
|     |                                       | MIN   | MAX                |      |
| 1   | $t_{c(DDR\_CLK)}$ Cycle time, DDR_CLK | 1.876 | 3.3 <sup>(1)</sup> | ns   |

- (1) This is the absolute maximum the clock period can be. Actual maximum clock period may be limited by DDR3 speed grade and operating frequency (see the *DDR2/3 Memory Controller* chapter in the device-specific Technical Reference Manual).



**Figure 8-55. DDR3 Memory Controller Clock Timing**

#### 8.13.3.1.1 DDR3 versus DDR2

This specification only covers device PCB designs that utilize DDR3 memory. Designs using DDR2 memory should use the PCB design specifications for DDR2 memory in [Section 8.13.2](#). While similar, the two memory systems have different requirements. It is currently not possible to design one PCB that covers both DDR2 and DDR3.

#### 8.13.3.2 DDR3 Device Combinations

Since there are several possible combinations of device counts and single- or dual-side mounting, [Table 8-60](#) summarizes the supported device configurations.

**Table 8-60. Supported DDR3 Device Combinations**

| NUMBER OF DDR3 DEVICES | DDR3 DEVICE WIDTH (BITS) | MIRRORED?        | DDR3 EMIF WIDTH (BITS) |
|------------------------|--------------------------|------------------|------------------------|
| 1                      | 16                       | N                | 16                     |
| 2                      | 8                        | Y <sup>(1)</sup> | 16                     |
| 2                      | 16                       | N                | 32                     |
| 2                      | 16                       | Y <sup>(1)</sup> | 32                     |
| 4                      | 8                        | N                | 32                     |
| 4                      | 8                        | Y <sup>(2)</sup> | 32                     |

(1) Two DDR3 devices are mirrored when one device is placed on the top of the board and the second device is placed on the bottom of the board.

(2) This is two mirrored pairs of DDR3 devices.

### 8.13.3.3 DDR3 Interface Schematic

#### 8.13.3.3.1 32-Bit DDR3 Interface

The DDR3 interface schematic varies, depending upon the width of the DDR3 devices used and the width of the bus used (16 or 32 bits). General connectivity is straightforward and very similar. 16-bit DDR devices look like two 8-bit devices. [Figure 8-56](#) and [Figure 8-57](#) show the schematic connections for 32-bit interfaces using x16 devices.

#### 8.13.3.3.2 16-Bit DDR3 Interface

Note that the 16-bit wide interface schematic is practically identical to the 32-bit interface (see [Figure 8-56](#) and [Figure 8-57](#)); only the high-word DDR memories are removed and the unused DQS inputs are tied off. The processor `DDR[0]_DQS[2]` and `DDR[0]_DQS[3]` pins should be pulled to the DDR supply via 1-k $\Omega$  resistors. Similarly, the `DDR[0]_DQS[2]` and `DDR[0]_DQS[3]` pins should be pulled to ground via 1-k $\Omega$  resistors.

When not using a DDR interface, the proper method of handling the unused pins is to tie off the `DDR[0]_DQS[n]` pins to the corresponding `DVDD_DDR[0]` supply via a 1-k $\Omega$  resistor and pulling the `DDR[0]_DQS[n]` pins to ground via a 1k- $\Omega$  resistor. This needs to be done for each byte not used. Although these signals have internal pullups and pulldowns, external pullups and pulldowns provide additional protection against external electrical noise causing activity on the signals.

Also, include the 50- $\Omega$  pulldown for `DDR[0]_VTP`. The `DVDD_DDR[0]` and `VREFSSTL_DDR[0]` power supply pins must be connected to their respective power supplies even if `DDR[0]` is not used. All other DDR interface pins can be left unconnected. Note that the supported modes for use of the DDR EMIF are 32 bits wide, 16 bits wide, or not used.

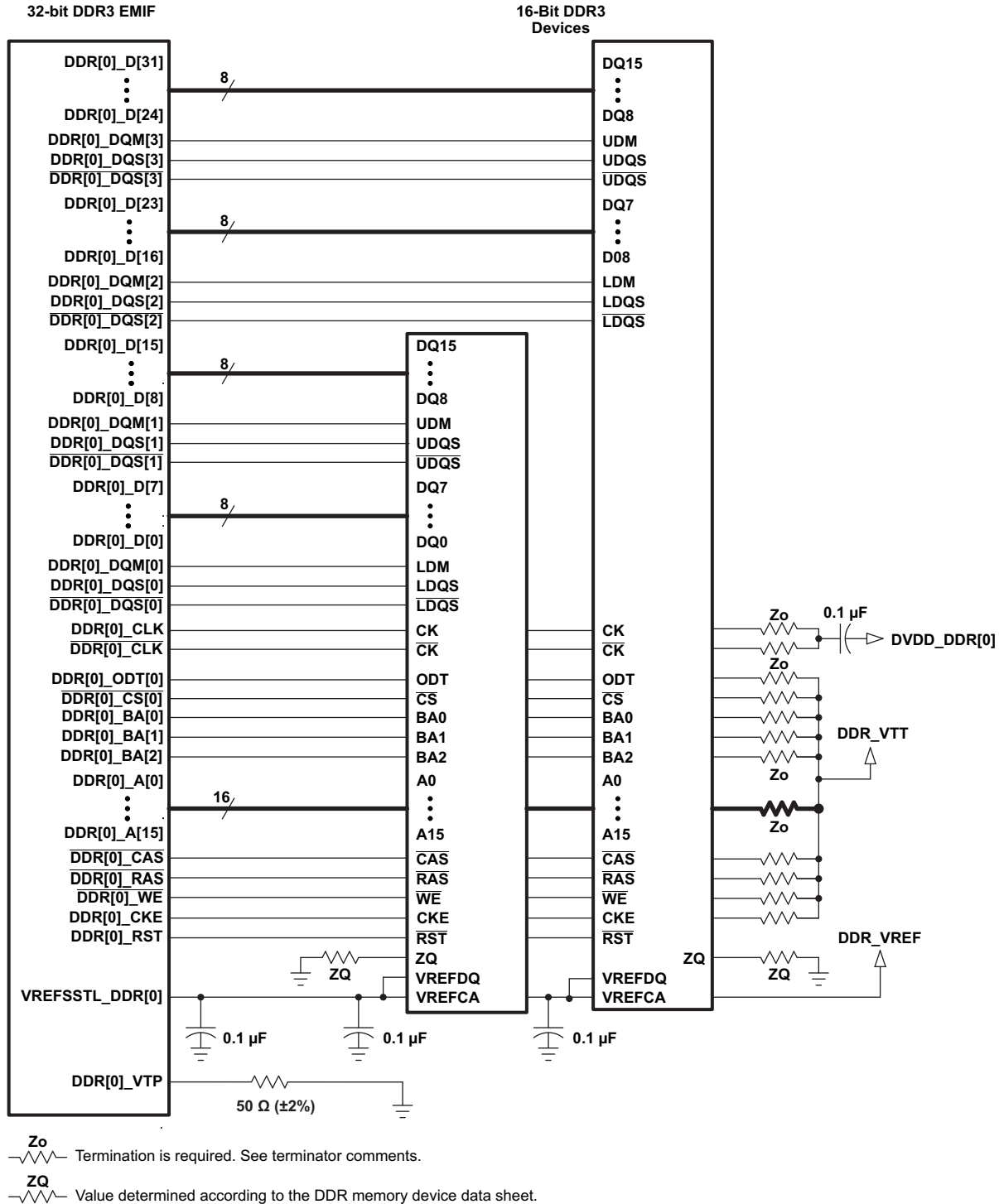


Figure 8-56. 32-Bit, One-Bank DDR3 Interface Schematic Using Two 16-Bit DDR3 Devices





### 8.13.3.4 Compatible DDR3 Devices

Table 8-61 shows the parameters of the DDR3 devices that are compatible with this interface. Generally, the interface is compatible with DDR3 devices in the x8 or x16 widths.

**Table 8-61. Compatible DDR3 Devices (Per Interface)**

| NO. | PARAMETER                                                         | MIN       | MAX            | UNIT    |
|-----|-------------------------------------------------------------------|-----------|----------------|---------|
| 1   | DDR3 device speed grade: $\leq$ 400 MHz clock rate <sup>(1)</sup> | DDR3-800  | <sup>(2)</sup> |         |
| 2   | DDR3 device speed grade: $>$ 400 MHz clock rate <sup>(1)</sup>    | DDR3-1600 | <sup>(2)</sup> |         |
| 3   | DDR3 device bit width                                             | x8        | x16            | Bits    |
| 4   | DDR3 device count <sup>(3)</sup>                                  | 2         | 4              | Devices |

(1) DDR3 speed grade depends on desired clock rate. Data rate is 2x the clock rate. For DDR3-800, the clock rate is 400 MHz.

(2) DDR3 devices with higher speed grades are supported; however, max clock rate will still be limited to 533 MHz as stated in Table 8-59 *Switching Characteristics Over Recommended Operating Conditions for DDR3 Memory Controller*.

(3) For valid DDR3 device configurations and device counts, see Section 8.13.3.3, Figure 8-56, and Figure 8-57.

### 8.13.3.5 PCB Stackup

The minimum stackup for routing the DDR3 interface is a four-layer stack up as shown in Table 8-62. Additional layers may be added to the PCB stackup to accommodate other circuitry, enhance SI/EMI performance, or to reduce the size of the PCB footprint. A six-layer stackup is shown in Table 8-63. Complete stackup specifications are provided in Table 8-64.

**Table 8-62. Minimum PCB Stackup**

| LAYER | TYPE   | DESCRIPTION                      |
|-------|--------|----------------------------------|
| 1     | Signal | Top routing mostly vertical      |
| 2     | Plane  | Split power plane                |
| 3     | Plane  | Full ground plane                |
| 4     | Signal | Bottom routing mostly horizontal |

**Table 8-63. Six-Layer PCB Stackup Suggestion**

| LAYER | TYPE   | DESCRIPTION                           |
|-------|--------|---------------------------------------|
| 1     | Signal | Top routing mostly vertical           |
| 2     | Plane  | Ground                                |
| 3     | Plane  | Split power plane                     |
| 4     | Plane  | Split power plane or Internal routing |
| 5     | Plane  | Ground                                |
| 6     | Signal | Bottom routing mostly horizontal      |

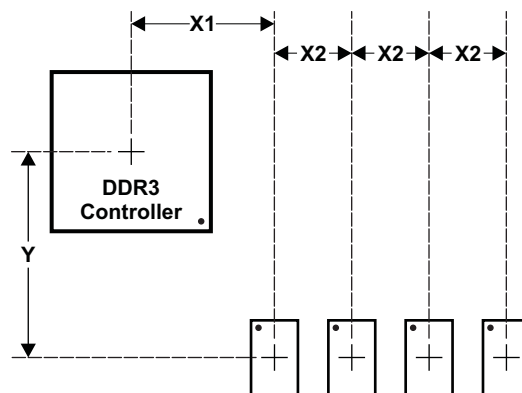
**Table 8-64. PCB Stackup Specifications**

| NO. | PARAMETER                                                                             | MIN | TYP | MAX | UNIT     |
|-----|---------------------------------------------------------------------------------------|-----|-----|-----|----------|
| 1   | PCB routing/plane layers                                                              | 4   | 6   |     |          |
| 2   | Signal routing layers                                                                 | 2   |     |     |          |
| 3   | Full ground reference layers under DDR3 routing region <sup>(1)</sup>                 | 1   |     |     |          |
| 4   | Full 1.35-V/1.5-V power reference layers under the DDR3 routing region <sup>(1)</sup> | 1   |     |     |          |
| 5   | Number of reference plane cuts allowed within DDR routing region <sup>(2)</sup>       |     |     | 0   |          |
| 6   | Number of layers between DDR3 routing layer and reference plane <sup>(3)</sup>        |     |     | 0   |          |
| 7   | PCB feature spacing                                                                   |     | 4   |     | Mils     |
| 8   | PCB trace width, w                                                                    |     | 4   |     | Mils     |
| 9   | PCB BGA escape via pad size <sup>(4)</sup>                                            |     | 18  | 20  | Mils     |
| 10  | PCB BGA escape via hole size                                                          |     | 10  |     | Mils     |
| 11  | Processor BGA pad size                                                                |     | 0.4 |     | mm       |
| 13  | Single-ended impedance, $Z_0$                                                         | 50  |     | 75  | $\Omega$ |
| 14  | Impedance control <sup>(5)</sup>                                                      | Z-5 | Z   | Z+5 | $\Omega$ |

- (1) Ground reference layers are preferred over power reference layers. Be sure to include bypass caps to accommodate reference layer return current as the trace routes switch routing layers.
- (2) No traces should cross reference plane cuts within the DDR routing region. High-speed signal traces crossing reference plane cuts create large return current paths which can lead to excessive crosstalk and EMI radiation.
- (3) Reference planes are to be directly adjacent to the signal plane to minimize the size of the return current loop.
- (4) An 18-mil pad assumes Via Channel is the most economical BGA escape. A 20-mil pad may be used if additional layers are available for power routing. An 18-mil pad is required for minimum layer count escape.
- (5) Z is the nominal single-ended impedance selected for the PCB specified by item 13.

### 8.13.3.6 Placement

Figure 8-58 shows the required placement for the processor as well as the DDR3 devices. The dimensions for this figure are defined in Table 8-65. The placement does not restrict the side of the PCB on which the devices are mounted. The ultimate purpose of the placement is to limit the maximum trace lengths and allow for proper routing space. For a 16-bit DDR memory system, the high-word DDR3 devices are omitted from the placement.

**Figure 8-58. Placement Specifications**

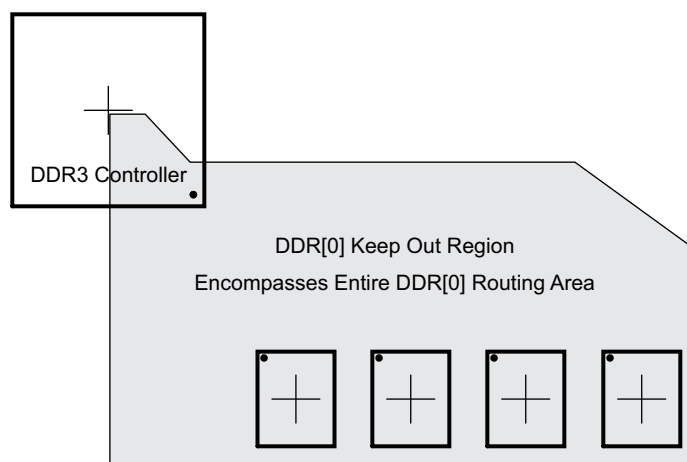
**Table 8-65. Placement Specifications**

| NO. | PARAMETER                                                               | MIN | MAX  | UNIT |
|-----|-------------------------------------------------------------------------|-----|------|------|
| 1   | X1 <sup>(1)(2)(3)</sup>                                                 |     | 1000 | Mils |
| 2   | X2 <sup>(1)(2)</sup>                                                    |     | 600  | Mils |
| 3   | Y Offset <sup>(1)(2)(3)</sup>                                           |     | 1500 | Mils |
| 4   | DDR3 keepout region                                                     |     |      |      |
| 5   | Clearance from non-DDR3 signal to DDR3 keepout region <sup>(4)(5)</sup> | 4   |      | w    |

- (1) For dimension definitions, see [Figure 8-58](#).  
(2) Measurements from center of processor to center of DDR3 device.  
(3) Minimizing X1 and Y improves timing margins.  
(4) w is defined as the signal trace width.  
(5) Non-DDR3 signals allowed within DDR3 keepout region provided they are separated from DDR3 routing layers by a ground plane.

### 8.13.3.7 DDR3 Keepout Region

The region of the PCB used for DDR3 circuitry must be isolated from other signals. The DDR3 keepout region is defined for this purpose and is shown in [Figure 8-59](#). The size of this region varies with the placement and DDR routing. Additional clearances required for the keepout region are shown in [Table 8-65](#). Non-DDR3 signals should not be routed on the DDR signal layers within the DDR3 keepout region. Non-DDR3 signals may be routed in the region, provided they are routed on layers separated from the DDR signal layers by a ground layer. No breaks should be allowed in the reference ground layers in this region. In addition, the 1.35-V/1.5-V DDR3L/DDR3 power plane should cover the entire keepout region. Also note that the DDR3 controller's signals should be separated from each other by the specification in item 5 (see [Table 8-65](#) for item 5 specification).



**Figure 8-59. DDR3 Keepout Region**

### 8.13.3.8 Bulk Bypass Capacitors

Bulk bypass capacitors are required for moderate speed bypassing of the DDR3 and other circuitry. [Table 8-66](#) contains the minimum numbers and capacitance required for the bulk bypass capacitors. Note that this table only covers the bypass needs of the DDR3 controller and DDR3 devices. Additional bulk bypass capacitance may be needed for other circuitry.

**Table 8-66. Bulk Bypass Capacitors**

| NO. | PARAMETER                                              | MIN | MAX | UNIT    |
|-----|--------------------------------------------------------|-----|-----|---------|
| 1   | DVDD_DDR[0] bulk bypass capacitor count <sup>(1)</sup> | 6   |     | Devices |
| 2   | DVDD_DDR[0] bulk bypass total capacitance              | 140 |     | μF      |

(1) These devices should be placed near the devices they are bypassing, but preference should be given to the placement of the high-speed (HS) bypass capacitors and DDR3 signal routing.

### 8.13.3.9 High-Speed Bypass Capacitors

High-speed (HS) bypass capacitors are critical for proper DDR3 interface operation. It is particularly important to minimize the parasitic series inductance of the HS bypass capacitors, processor/DDR power, and processor/DDR ground connections. [Table 8-67](#) contains the specification for the HS bypass capacitors as well as for the power connections on the PCB. Generally speaking, it is good to:

1. Fit as many HS bypass capacitors as possible. Due to the number of required bypass capacitors, it is recommended that the bypass capacitors are placed before routing the board.
2. Minimize the distance from the bypass cap to the pins/balls being bypassed.
3. Use the smallest physical sized capacitors possible with the highest capacitance readily available.
4. Connect the bypass capacitor pads to their vias using the widest traces possible and using the largest hole size via possible.
5. Minimize via sharing. Note the limits on via sharing shown in [Table 8-67](#).

**Table 8-67. High-Speed Bypass Capacitors**

| NO. | PARAMETER                                                                           | MIN  | TYP | MAX | UNIT    |
|-----|-------------------------------------------------------------------------------------|------|-----|-----|---------|
| 1   | HS bypass capacitor package size <sup>(1)</sup>                                     |      | 201 | 402 | 10 Mils |
| 2   | Distance, HS bypass capacitor to processor being bypassed <sup>(2)(3)(4)</sup>      |      |     | 400 | Mils    |
| 3   | Processor DVDD_DDR[0] HS bypass capacitor count                                     | 35   |     |     | Devices |
| 4   | Processor DVDD_DDR[0] HS bypass capacitor total capacitance                         | 2.5  |     |     | μF      |
| 5   | Number of connection vias for each device power/ground ball <sup>(5)</sup>          |      |     |     | Vias    |
| 6   | Trace length from device power/ground ball to connection via <sup>(2)</sup>         |      | 35  | 70  | Mils    |
| 7   | Distance, HS bypass capacitor to DDR device being bypassed <sup>(6)</sup>           |      |     | 150 | Mils    |
| 8   | DDR3 device HS bypass capacitor count <sup>(7)</sup>                                | 12   |     |     | Devices |
| 9   | DDR3 device HS bypass capacitor total capacitance <sup>(7)</sup>                    | 0.85 |     |     | μF      |
| 10  | Number of connection vias for each HS capacitor <sup>(8)(9)</sup>                   | 2    |     |     | Vias    |
| 11  | Trace length from bypass capacitor connect to connection via <sup>(2)(9)</sup>      |      | 35  | 100 | Mils    |
| 12  | Number of connection vias for each DDR3 device power/ground ball <sup>(10)</sup>    | 1    |     |     | Vias    |
| 13  | Trace length from DDR3 device power/ground ball to connection via <sup>(2)(8)</sup> |      | 35  | 60  | Mils    |

(1) LxW, 10-mil units, that is, a 0402 is a 40x20-mil surface-mount capacitor.

(2) Closer/shorter is better.

(3) Measured from the nearest processor power/ground ball to the center of the capacitor package.

(4) Three of these capacitors should be located underneath the processor, between the cluster of DVDD\_DDR[0] balls and ground balls, between the DDR interfaces on the package.

(5) See the Via Channel™ escape for the processor package.

(6) Measured from the DDR3 device power/ground ball to the center of the capacitor package.

(7) Per DDR3 device.

(8) An additional HS bypass capacitor can share the connection vias only if it is mounted on the opposite side of the board. No sharing of vias is permitted on the same side of the board.

(9) An HS bypass capacitor may share a via with a DDR device mounted on the same side of the PCB. A wide trace should be used for the connection and the length from the capacitor pad to the DDR device pad should be less than 150 mils.

(10) Up to a total of two pairs of DDR power/ground balls may share a via.

### 8.13.3.9.1 Return Current Bypass Capacitors

Use additional bypass capacitors if the return current reference plane changes due to DDR3 signals hopping from one signal layer to another. The bypass capacitor here provides a path for the return current to hop planes along with the signal. As many of these return current bypass capacitors should be used as possible. Since these are returns for signal current, the signal via size may be used for these capacitors.

### 8.13.3.10 Net Classes

Table 8-68 lists the clock net classes for the DDR3 interface. Table 8-69 lists the signal net classes, and associated clock net classes, for signals in the DDR3 interface. These net classes are used for the termination and routing rules that follow.

**Table 8-68. Clock Net Class Definitions**

| CLOCK NET CLASS     | PROCESSOR PIN NAMES         |
|---------------------|-----------------------------|
| CK                  | DDR[0]_CLK/DDR[0]_CLK       |
| DQS0                | DDR[0]_DQS[0]/DDR[0]_DQS[0] |
| DQS1                | DDR[0]_DQS[1]/DDR[0]_DQS[1] |
| DQS2 <sup>(1)</sup> | DDR[0]_DQS[2]/DDR[0]_DQS[2] |
| DQS3 <sup>(1)</sup> | DDR[0]_DQS[3]/DDR[0]_DQS[3] |

(1) Only used on 32-bit wide DDR3 memory systems.

**Table 8-69. Signal Net Class Definitions**

| CLOCK NET CLASS    | ASSOCIATED CLOCK NET CLASS | PROCESSOR PIN NAMES                                                                                        |
|--------------------|----------------------------|------------------------------------------------------------------------------------------------------------|
| ADDR_CTRL          | CK                         | DDR[0]_BA[2:0], DDR[0]_A[15:0], DDR[0]_CS[x], DDR[0]_CAS, DDR[0]_RAS, DDR[0]_WE, DDR[0]_CKE, DDR[0]_ODT[0] |
| DQ0                | DQS0                       | DDR[0]_D[7:0], DDR[0]_DQM[0]                                                                               |
| DQ1                | DQS1                       | DDR[0]_D[15:8], DDR[0]_DQM[1]                                                                              |
| DQ2 <sup>(1)</sup> | DQS2                       | DDR[0]_D[23:16], DDR[0]_DQM[2]                                                                             |
| DQ3 <sup>(1)</sup> | DQS3                       | DDR[0]_D[31:24], DDR[0]_DQM[3]                                                                             |

(1) Only used on 32-bit wide DDR3 memory systems.

### 8.13.3.11 DDR3 Signal Termination

Signal terminators are required for the CK and ADDR\_CTRL net classes. The data lines are terminated by ODT and, thus, the PCB traces should be unterminated. Detailed termination specifications are covered in the routing rules in the following sections.

### 8.13.3.12 VREFSSTL\_DDR Routing

VREFSSTL\_DDR (VREF) is used as a reference by the input buffers of the DDR3 memories as well as the processor. VREF is intended to be half the DDR3 power supply voltage and is typically generated with the DDR3 1.35-V/1.5-V and VTT power supply. It should be routed as a nominal 20-mil wide trace with 0.1 µF bypass capacitors near each device connection. Narrowing of VREF is allowed to accommodate routing congestion.

### 8.13.3.13 VTT

Like VREF, the nominal value of the VTT supply is half the DDR3 supply voltage. Unlike VREF, VTT is expected to source and sink current, specifically the termination current for the ADDR\_CTRL net class Thevenin terminators. VTT is needed at the end of the address bus and it should be routed as a power sub-plane. VTT should be bypassed near the terminator resistors.

### 8.13.3.14 CK and ADDR\_CTRL Topologies and Routing Definition

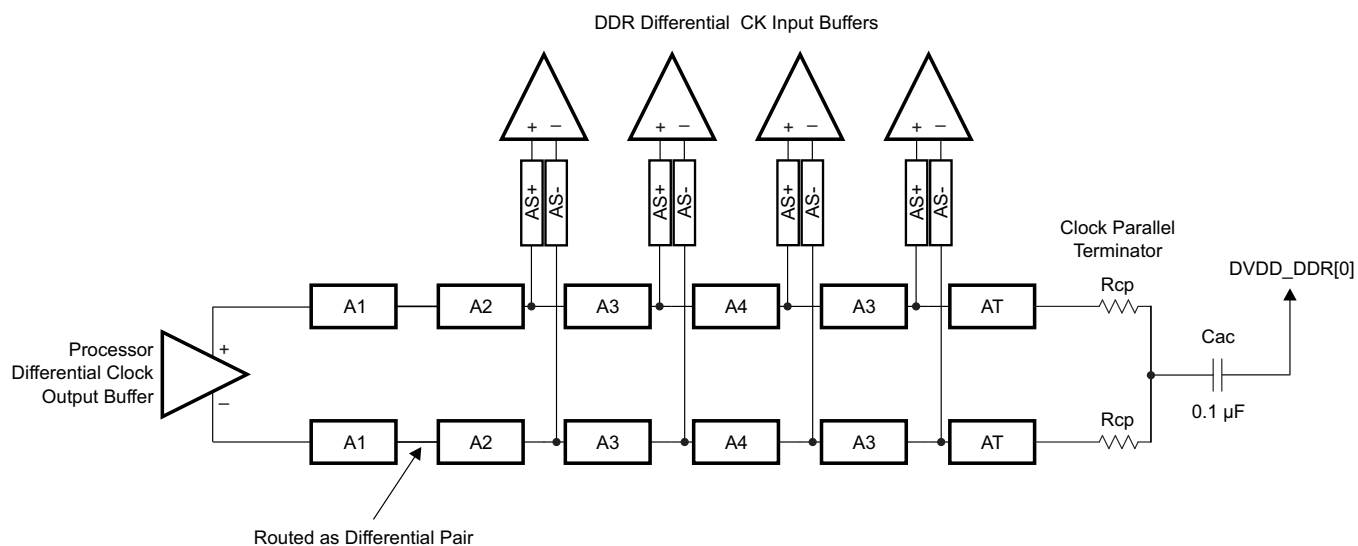
The CK and ADDR\_CTRL net classes are routed similarly and are length matched to minimize skew between them. CK is a bit more complicated because it runs at a higher transition rate and is differential. The following subsections show the topology and routing for various DDR3 configurations for CK and ADDR\_CTRL. The figures in the following subsections define the terms for the routing specification detailed in [Table 8-70](#).

#### 8.13.3.14.1 Four DDR3 Devices

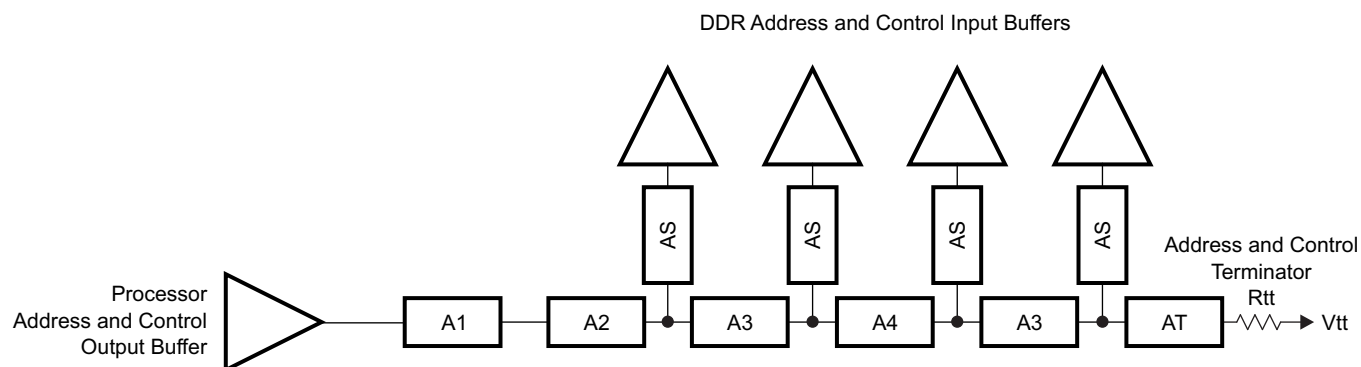
Four DDR3 devices are supported on the DDR EMIF consisting of four x8 DDR3 devices arranged as one bank (CS). These four devices may be mounted on a single side of the PCB, or may be mirrored in two pairs to save board space at a cost of increased routing complexity and parts on the backside of the PCB.

##### 8.13.3.14.1.1 CK and ADDR\_CTRL Topologies, Four DDR3 Devices

[Figure 8-60](#) shows the topology of the CK net classes and [Figure 8-61](#) shows the topology for the corresponding ADDR\_CTRL net classes.



**Figure 8-60. CK Topology for Four x8 DDR3 Devices**



**Figure 8-61. ADDR\_CTRL Topology for Four x8 DDR3 Devices**

##### 8.13.3.14.1.2 CK and ADDR\_CTRL Routing, Four DDR3 Devices

[Figure 8-62](#) shows the CK routing for four DDR3 devices placed on the same side of the PCB. [Figure 8-63](#) shows the corresponding ADDR\_CTRL routing.

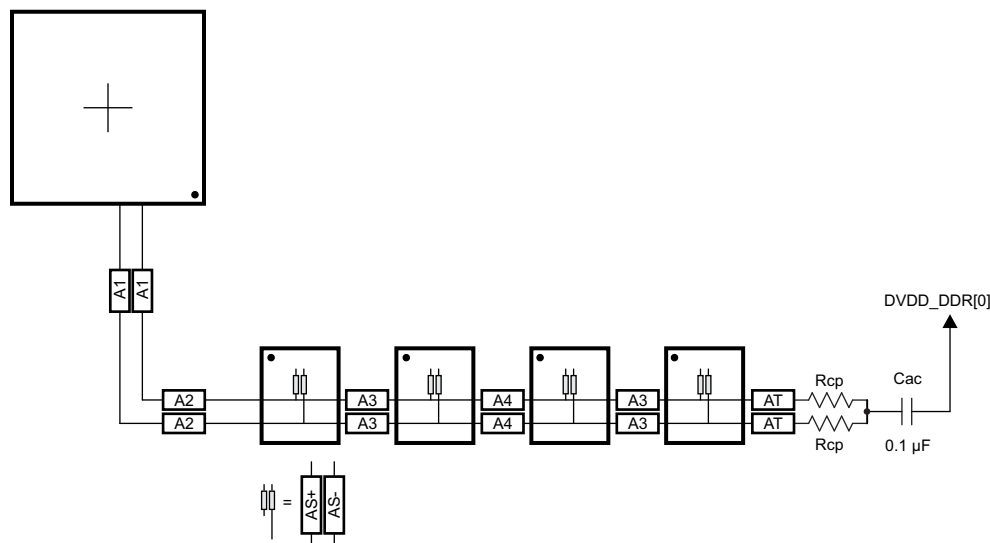


Figure 8-62. CK Routing for Four Single-Side DDR3 Devices

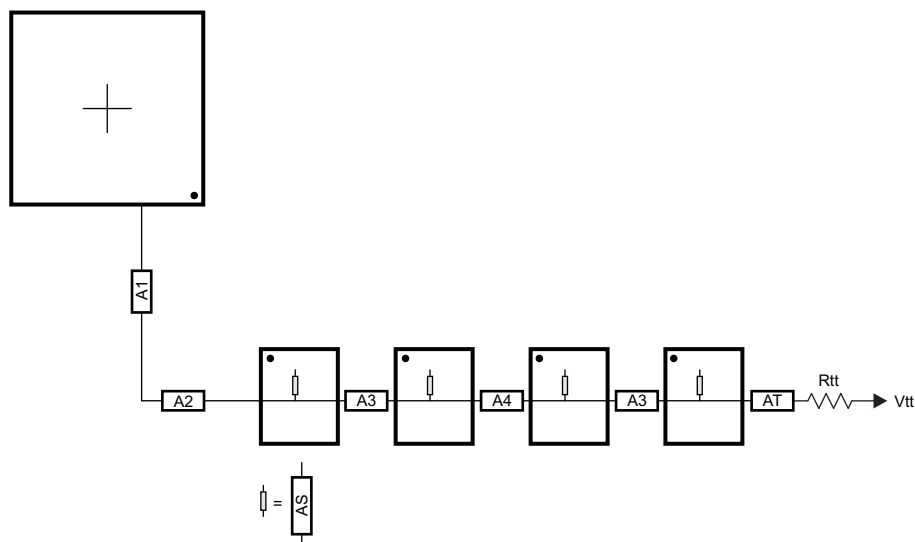


Figure 8-63. ADDR\_CTRL Routing for Four Single-Side DDR3 Devices

To save PCB space, the four DDR3 memories may be mounted as two mirrored pairs at a cost of increased routing and assembly complexity. [Figure 8-64](#) and [Figure 8-65](#) show the routing for CK and ADDR\_CTRL, respectively, for four DDR3 devices mirrored in a two-pair configuration.

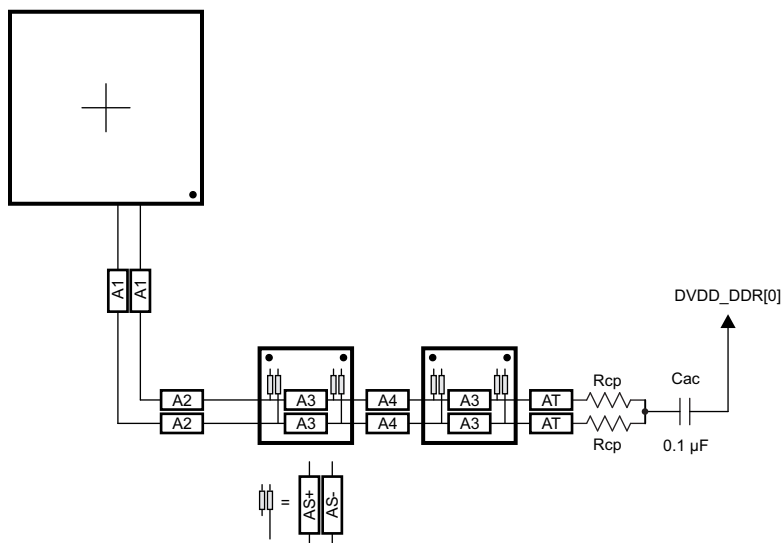


Figure 8-64. CK Routing for Four Mirrored DDR3 Devices

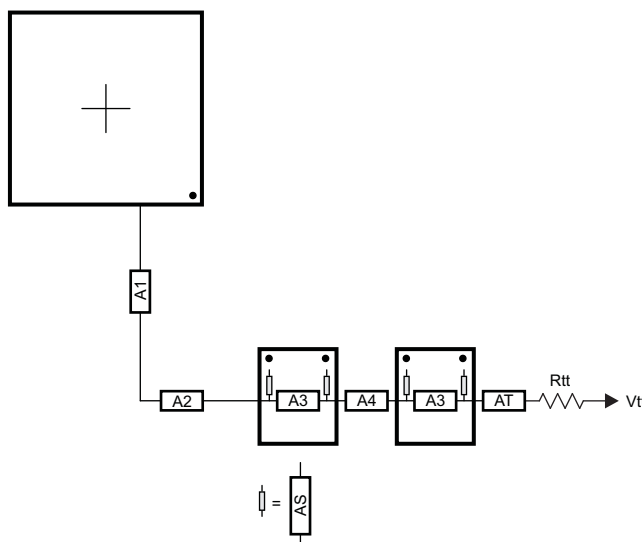


Figure 8-65. ADDR\_CTRL Routing for Four Mirrored DDR3 Devices

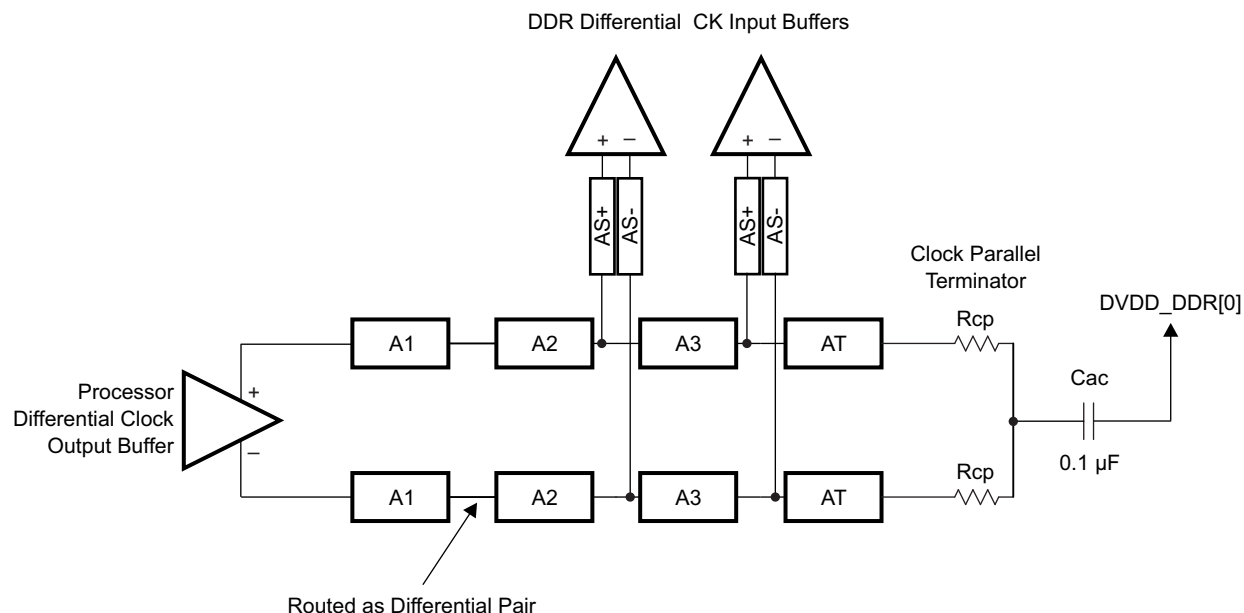
#### 8.13.3.14.2 Two DDR3 Devices

Two DDR3 devices are supported on the DDR EMIF consisting of two x8 DDR3 devices arranged as one bank (CS), 16 bits wide, or two x16 DDR3 devices arranged as one bank (CS), 32 bits wide. These two devices may be mounted on a single side of the PCB, or may be mirrored in a pair to save board space at a cost of increased routing complexity and parts on the backside of the PCB.

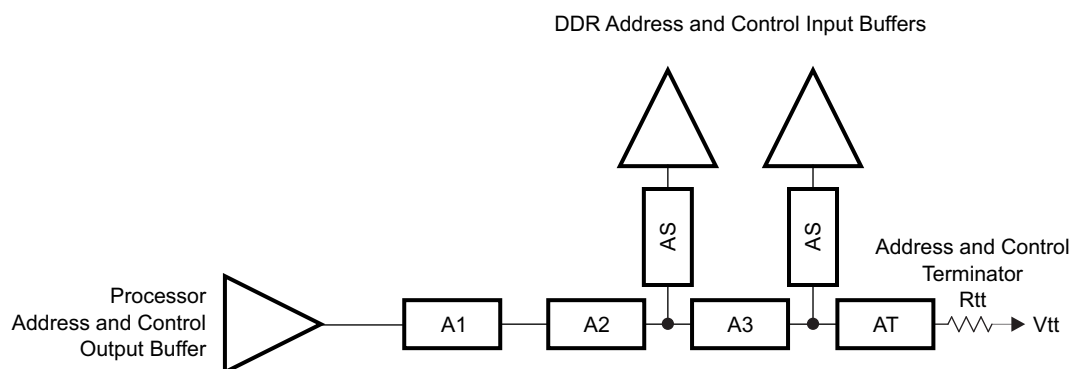
##### 8.13.3.14.2.1 CK and ADDR\_CTRL Topologies, Two DDR3 Devices

Figure 8-66 shows the topology of the CK net classes and Figure 8-67 shows the topology for the corresponding ADDR\_CTRL net classes.





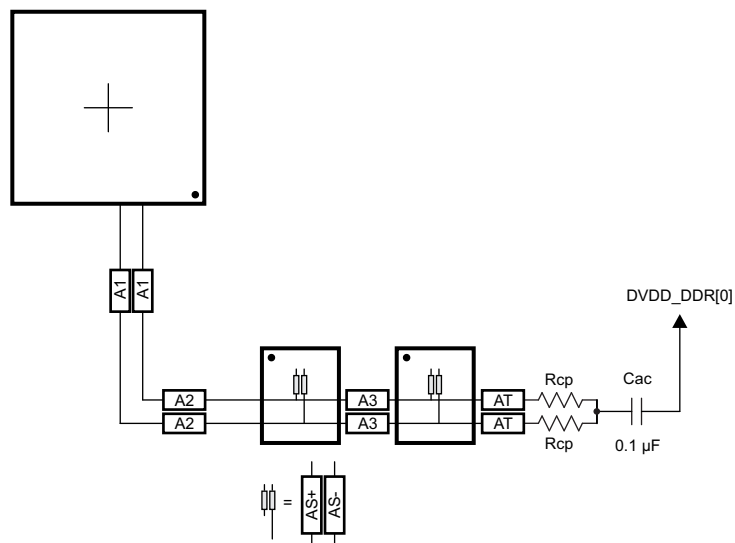
**Figure 8-66. CK Topology for Two DDR3 Devices**



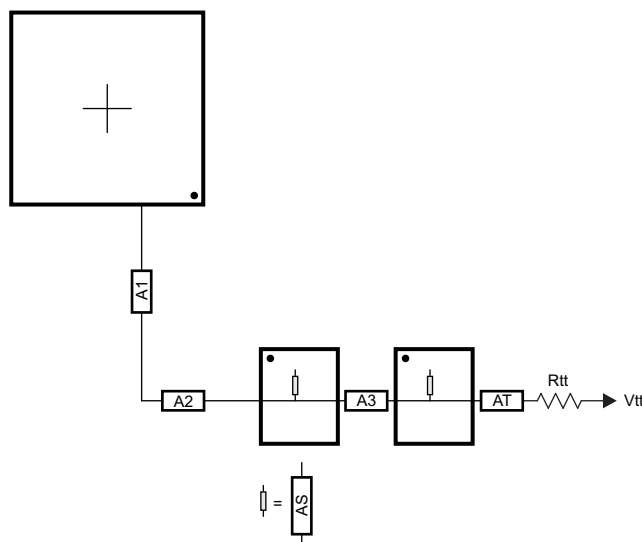
**Figure 8-67. ADDR\_CTRL Topology for Two DDR3 Devices**

#### 8.13.3.14.2.2 CK and ADDR\_CTRL Routing, Two DDR3 Devices

Figure 8-68 shows the CK routing for two DDR3 devices placed on the same side of the PCB. Figure 8-69 shows the corresponding ADDR\_CTRL routing.



**Figure 8-68. CK Routing for Two Single-Side DDR3 Devices**



**Figure 8-69. ADDR\_CTRL Routing for Two Single-Side DDR3 Devices**

To save PCB space, the two DDR3 memories may be mounted as a mirrored pair at a cost of increased routing and assembly complexity. [Figure 8-70](#) and [Figure 8-71](#) show the routing for CK and ADDR\_CTRL, respectively, for two DDR3 devices mirrored in a single-pair configuration.

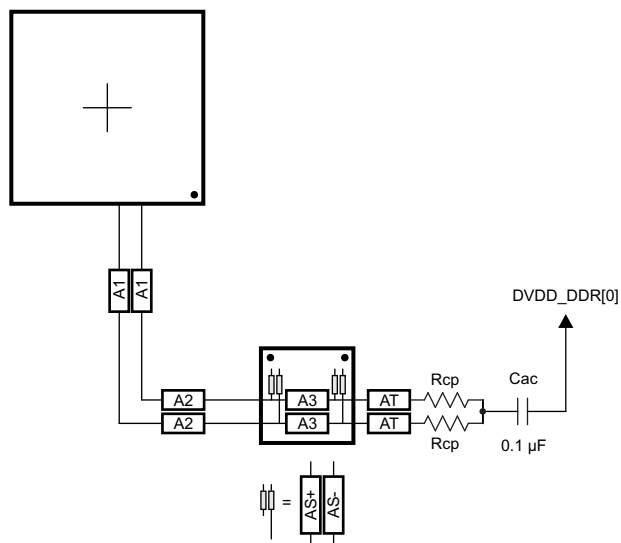


Figure 8-70. CK Routing for Two Mirrored DDR3 Devices

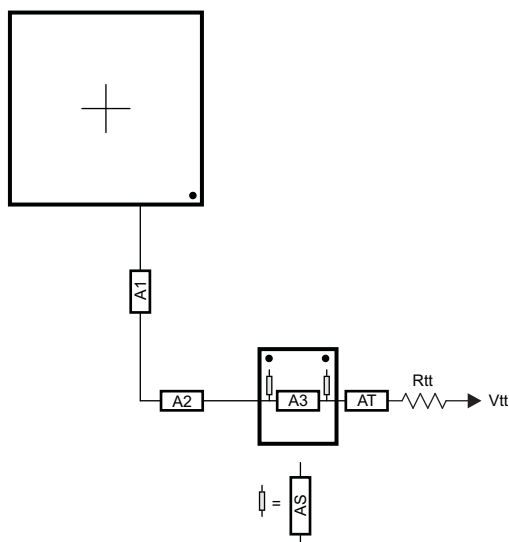


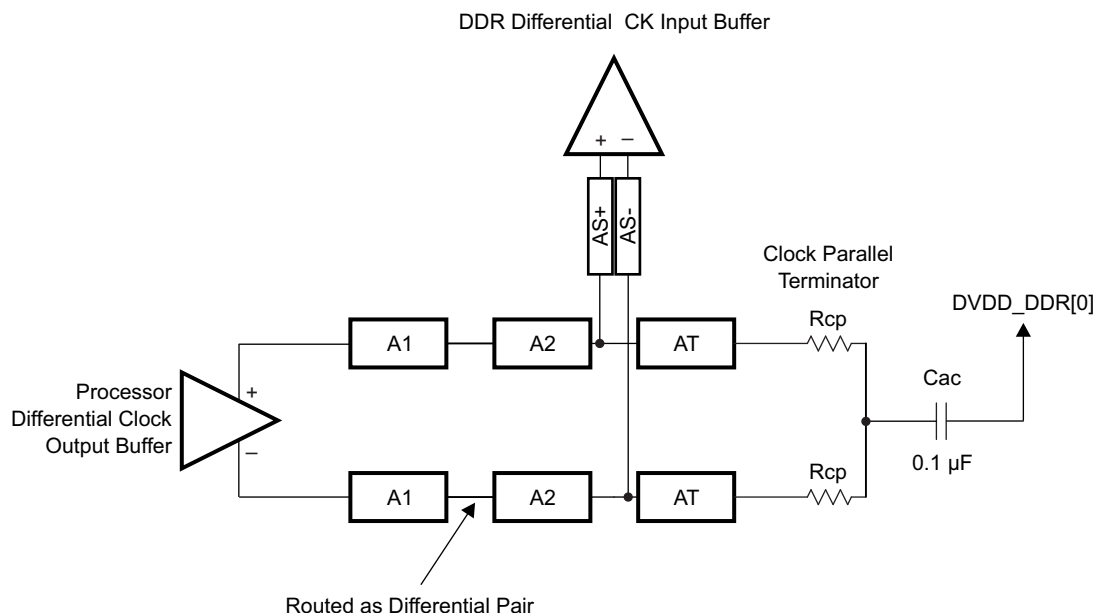
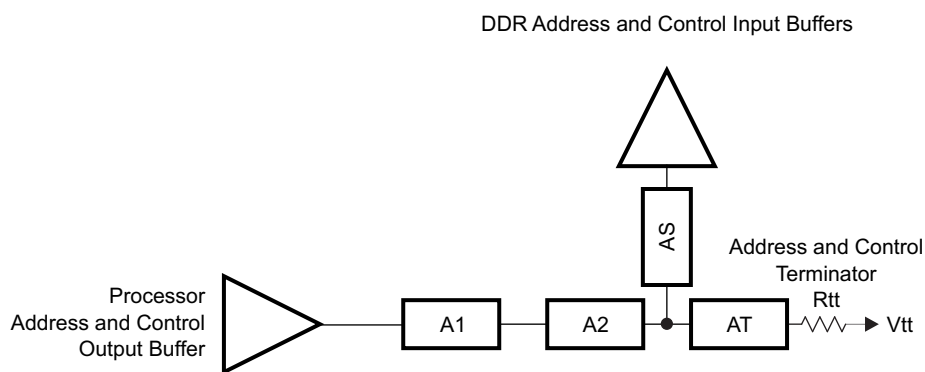
Figure 8-71. ADDR\_CTRL Routing for Two Mirrored DDR3 Devices

#### 8.13.3.14.3 One DDR3 Device

A single DDR3 device is supported on the DDR EMIF consisting of one x16 DDR3 device arranged as one bank (CS), 16 bits wide.

##### 8.13.3.14.3.1 CK and ADDR\_CTRL Topologies, One DDR3 Device

Figure 8-72 shows the topology of the CK net classes and Figure 8-73 shows the topology for the corresponding ADDR\_CTRL net classes.

**Figure 8-72. CK Topology for One DDR3 Device****Figure 8-73. ADDR\_CTRL Topology for One DDR3 Device**

#### 8.13.3.14.3.2 CK and ADDR/CTRL Routing, One DDR3 Device

Figure 8-74 shows the CK routing for one DDR3 device placed on the same side of the PCB. Figure 8-75 shows the corresponding ADDR\_CTRL routing.

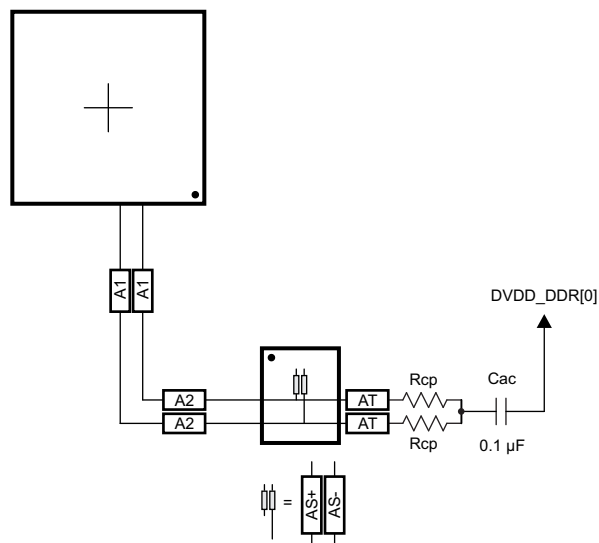


Figure 8-74. CK Routing for One DDR3 Device

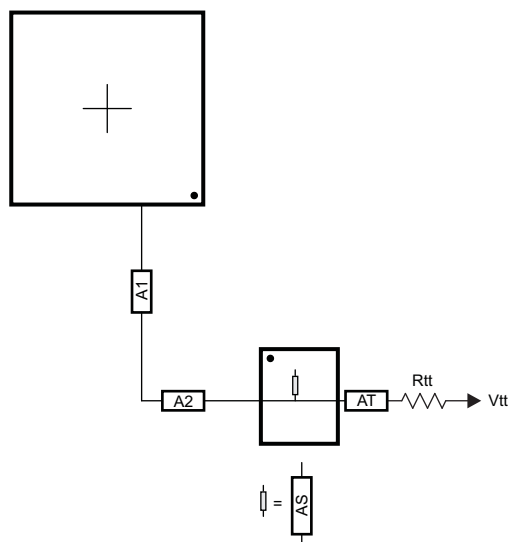


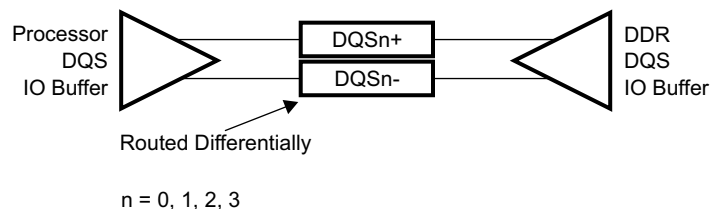
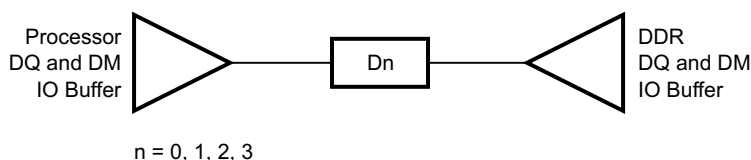
Figure 8-75. ADDR\_CTRL Routing for One DDR3 Device

#### 8.13.3.15 Data Topologies and Routing Definition

No matter the number of DDR3 devices used, the data line topology is always point to point, so its definition is simple.

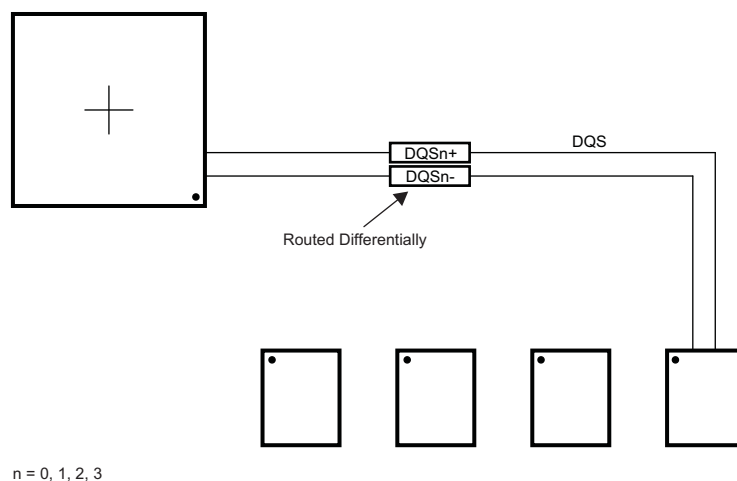
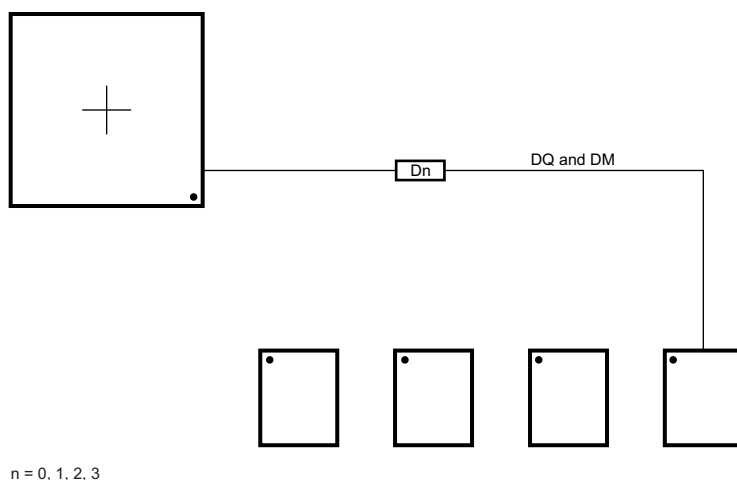
##### 8.13.3.15.1 DQS and DQ/DM Topologies, Any Number of Allowed DDR3 Devices

DQS lines are point-to-point differential, and DQ/DM lines are point-to-point singled ended. [Figure 8-76](#) and [Figure 8-77](#) show these topologies.

**Figure 8-76. DQS Topology****Figure 8-77. DQ/DM Topology**

### 8.13.3.15.2 DQS and DQ/DM Routing, Any Number of Allowed DDR3 Devices

Figure 8-78 and Figure 8-79 show the DQS and DQ/DM routing.

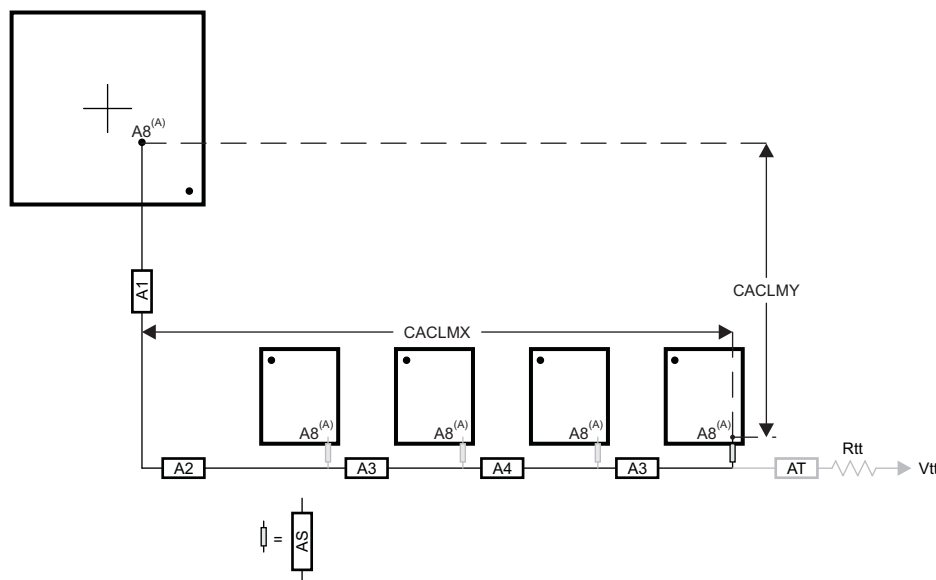
**Figure 8-78. DQS Routing With Any Number of Allowed DDR3 Devices****Figure 8-79. DQ/DM Routing With Any Number of Allowed DDR3 Devices**

### 8.13.3.16 Routing Specification

#### 8.13.3.16.1 CK and ADDR\_CTRL Routing Specification

Skew within the CK and ADDR\_CTRL net classes directly reduces setup and hold margin and, thus, this skew must be controlled. The only way to practically match lengths on a PCB is to lengthen the shorter traces up to the length of the longest net in the net class and its associated clock. A metric to establish this maximum length is Manhattan distance. The Manhattan distance between two points on a PCB is the length between the points when connecting them only with horizontal or vertical segments. A reasonable trace route length is to within a percentage of its Manhattan distance. CACLM is defined as Clock Address Control Longest Manhattan distance.

Given the clock and address pin locations on the processor and the DDR3 memories, the maximum possible Manhattan distance can be determined given the placement. Figure 8-80 and Figure 8-81 show this distance for four loads and two loads, respectively. It is from this distance that the specifications on the lengths of the transmission lines for the address bus are determined. CACLM is determined similarly for other address bus configurations; that is, it is based on the longest net of the CK/ADDR\_CTRL net class. For CK and ADDR\_CTRL routing, these specifications are contained in Table 8-70.



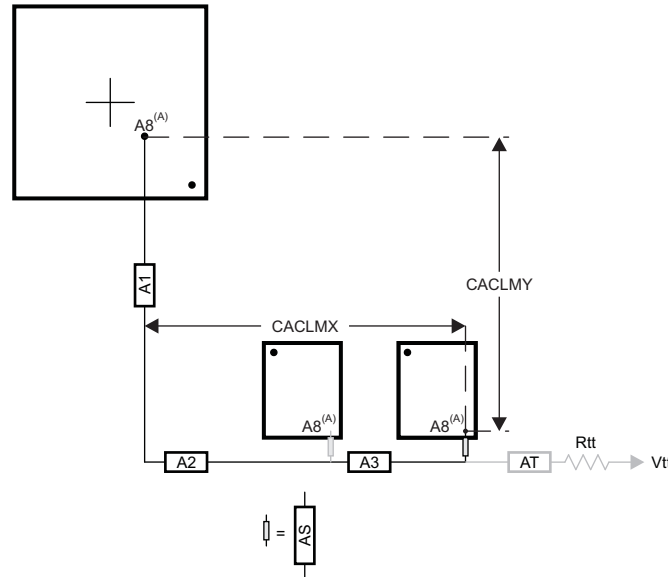
- A. It is very likely that the longest CK/ADDR\_CTRL Manhattan distance will be for Address Input 8 (A8) on the DDR3 memories. CACLM is based on the longest Manhattan distance due to the device placement. Verify the net class that satisfies this criteria and use as the baseline for CK/ADDR\_CTRL skew matching and length control.

The length of shorter CK/ADDR\_CTRL stubs as well as the length of the terminator stub are not included in this length calculation. Non-included lengths are grayed out in the figure.

Assuming A8 is the longest, CALM = CACLMY + CACLMX + 300 mils.

The extra 300 mils allows for routing down lower than the DDR3 memories and returning up to reach A8.

**Figure 8-80. CACLM for Four Address Loads on One Side of PCB**



- A. It is very likely that the longest CK/ADDR\_CTRL Manhattan distance will be for Address Input 8 (A8) on the DDR3 memories. CACLM is based on the longest Manhattan distance due to the device placement. Verify the net class that satisfies this criteria and use as the baseline for CK/ADDR\_CTRL skew matching and length control.

The length of shorter CK/ADDR\_CTRL stubs as well as the length of the terminator stub are not included in this length calculation. Non-included lengths are grayed out in the figure.

Assuming A8 is the longest, CALM = CACLMY + CACLMX + 300 mils.

The extra 300 mils allows for routing down lower than the DDR3 memories and returning up to reach A8.

**Figure 8-81. CACLM for Two Address Loads on One Side of PCB**

**Table 8-70. CK and ADDR\_CTRL Routing Specification<sup>(1)(2)</sup>**

| NO. | PARAMETER                                        | MIN      | TYP   | MAX      | UNIT |
|-----|--------------------------------------------------|----------|-------|----------|------|
| 1   | A1+A2 length                                     |          |       | 2500     | mils |
| 2   | A1+A2 skew                                       |          |       | 25       | mils |
| 3   | A3 length                                        |          |       | 660      | mils |
| 4   | A3 skew <sup>(3)</sup>                           |          |       | 25       | mils |
| 5   | A3 skew <sup>(4)</sup>                           |          |       | 125      | mils |
| 6   | A4 length                                        |          |       | 660      | mils |
| 7   | A4 skew                                          |          |       | 25       | mils |
| 8   | AS length                                        |          |       | 100      | mils |
| 9   | AS skew                                          |          |       | 100      | mils |
| 10  | AS+/AS- length                                   |          |       | 70       | mils |
| 11  | AS+/AS- skew                                     |          |       | 5        | mils |
| 12  | AT length <sup>(5)</sup>                         |          | 500   |          | mils |
| 13  | AT skew <sup>(6)</sup>                           |          | 100   |          | mils |
| 14  | AT skew <sup>(7)</sup>                           |          |       | 5        | mils |
| 15  | CK/ADDR_CTRL nominal trace length <sup>(8)</sup> | CACLM-50 | CACLM | CACLM+50 | mils |

(1) The use of vias should be minimized.

(2) Additional bypass capacitors are required when using the DVDD\_DDR[0] plane as the reference plane to allow the return current to jump between the DVDD\_DDR[0] plane and the ground plane when the net class switches layers at a via.

(3) Non-mirrored configuration (all DDR3 memories on same side of PCB).

(4) Mirrored configuration (one DDR3 device on top of the board and one DDR3 device on the bottom).

(5) While this length can be increased for convenience, its length should be minimized.

(6) ADDR\_CTRL net class only (not CK net class). Minimizing this skew is recommended, but not required.

(7) CK net class only.

(8) CACLM is the longest Manhattan distance of the CK and ADDR\_CTRL net classes + 300 mils. For definition, see [Section 8.13.3.16.1](#), [Figure 8-80](#), and [Figure 8-81](#).



**Table 8-70. CK and ADDR\_CTRL Routing Specification<sup>(1)(2)</sup> (continued)**

| NO. | PARAMETER                                                                  | MIN  | TYP | MAX  | UNIT |
|-----|----------------------------------------------------------------------------|------|-----|------|------|
| 16  | Center-to-center CK to other DDR3 trace spacing <sup>(9)</sup>             | 4w   |     |      |      |
| 17  | Center-to-center ADDR_CTRL to other DDR3 trace spacing <sup>(9)(10)</sup>  | 4w   |     |      |      |
| 18  | Center-to-center ADDR_CTRL to other ADDR_CTRL trace spacing <sup>(9)</sup> | 3w   |     |      |      |
| 19  | CK center-to-center spacing <sup>(11)</sup>                                |      |     |      |      |
| 20  | CK spacing to other net <sup>(9)</sup>                                     | 4w   |     |      |      |
| 21  | Rcp <sup>(12)</sup>                                                        | Zo-1 | Zo  | Zo+  | Ω    |
| 22  | Rtt <sup>(12)(13)</sup>                                                    | Zo-5 | Zo  | Zo+5 | Ω    |

(9) Center-to-center spacing is allowed to fall to minimum (2w) for up to 1250 mils of routed length.

(10) The ADDR\_CTRL net class of the other DDR EMIF is considered *other DDR3 trace spacing*.

(11) CK spacing set to ensure proper differential impedance.

(12) Source termination (series resistor at driver) is specifically not allowed.

(13) Termination values should be uniform across the net class.

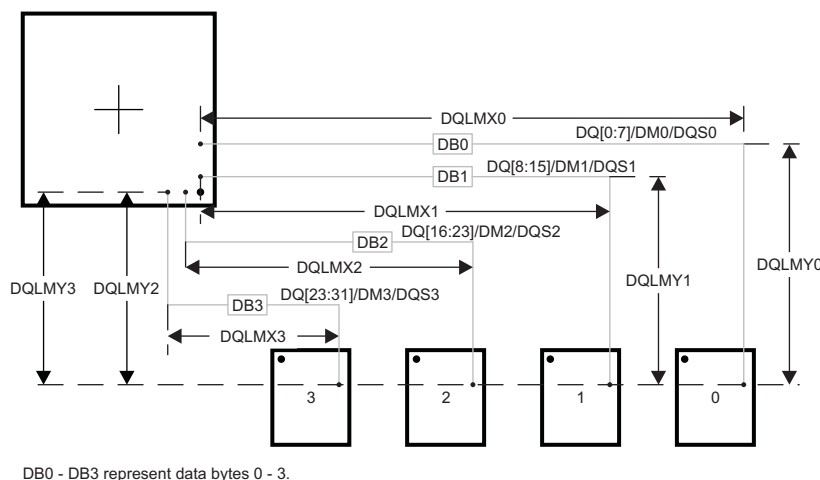
### 8.13.3.16.2 DQS and DQ Routing Specification

Skew within the DQS and DQ/DM net classes directly reduces setup and hold margin and thus this skew must be controlled. The only way to practically match lengths on a PCB is to lengthen the shorter traces up to the length of the longest net in the net class and its associated clock. As with CK and ADDR\_CTRL, a reasonable trace route length is to within a percentage of its Manhattan distance. DQLMn is defined as DQ Longest Manhattan distance n, where n is the byte number. For a 32-bit interface, there are four DQLMs, DQLM0-DQLM3. Likewise, for a 16-bit interface, there are two DQLMs, DQLM0-DQLM1.

#### NOTE

It is not required, nor is it recommended, to match the lengths across all bytes. Length matching is only required within each byte.

Given the DQS and DQ/DM pin locations on the processor and the DDR3 memories, the maximum possible Manhattan distance can be determined given the placement. Figure 8-82 shows this distance for four loads. It is from this distance that the specifications on the lengths of the transmission lines for the data bus are determined. For DQS and DQ/DM routing, these specifications are contained in Table 8-71.



DB0 - DB3 represent data bytes 0 - 3.

There are four DQLMs, one for each byte (32-bit interface). Each DQLM is the longest Manhattan distance of the byte; therefore:

$$DQLM0 = DQLMX0 + DQLMY0$$

$$DQLM1 = DQLMX1 + DQLMY1$$

$$DQLM2 = DQLMX2 + DQLMY2$$

$$DQLM3 = DQLMX3 + DQLMY3$$

**Figure 8-82. DQLM for Any Number of Allowed DDR3 Devices**

**Table 8-71. Data Routing Specification<sup>(1)</sup>**

| NO. | PARAMETER                                                           | MIN | TYP | MAX   | UNIT |
|-----|---------------------------------------------------------------------|-----|-----|-------|------|
| 1   | DB0 nominal length <sup>(2)(3)</sup>                                |     |     | DQLM0 | mils |
| 2   | DB1 nominal length <sup>(2)(4)</sup>                                |     |     | DQLM1 | mils |
| 3   | DB2 nominal length <sup>(2)(5)</sup>                                |     |     | DQLM2 | mils |
| 4   | DB3 nominal length <sup>(2)(6)</sup>                                |     |     | DQLM3 | mils |
| 5   | DBn skew <sup>(7)</sup>                                             |     |     | 25    | mils |
| 6   | DQSn+ to DQSn- skew                                                 |     |     | 5     | mils |
| 7   | DQSn to DBn skew <sup>(7)(8)</sup>                                  |     |     | 25    | mils |
| 8   | Center-to-center DBn to other DDR3 trace spacing <sup>(9)(10)</sup> | 4w  |     |       |      |
| 9   | Center-to-center DBn to other DBn trace spacing <sup>(9)(11)</sup>  | 3w  |     |       |      |
| 10  | DQSn center-to-center spacing <sup>(12)</sup>                       |     |     |       |      |
| 11  | DQSn center-to-center spacing to other net <sup>(9)</sup>           | 4w  |     |       |      |

(1) External termination disallowed. Data termination should use built-in ODT functionality.

(2) DQLMn is the longest Manhattan distance of a byte. r definition, see [Section 8.13.3.16.2](#) and [Figure 8-82](#).

(3) DQLM0 is the longest Manhattan length for the net classes of Byte 0.

(4) DQLM1 is the longest Manhattan length for the net classes of Byte 1.

(5) DQLM2 is the longest Manhattan length for the net classes of Byte 2.

(6) DQLM3 is the longest Manhattan length for the net classes of Byte 3.

(7) Length matching is only done within a byte. Length matching across bytes is neither required nor recommended.

(8) Each DQS pair is length matched to its associated byte.

(9) Center-to-center spacing is allowed to fall to minimum (2w) for up to 1250 mils of routed length.

(10) Other DDR3 trace spacing means other DDR3 net classes not within the byte.

(11) This applies to spacing within the net classes of a byte.

(12) DQS pair spacing is set to ensure proper differential impedance.

## 8.14 Multichannel Audio Serial Port (McASP)

The multichannel audio serial port (McASP) functions as a general-purpose audio serial port optimized for the needs of multichannel audio applications. The McASP is useful for time-division multiplexed (TDM) stream, Inter-Integrated Sound (I2S) protocols, and inter-component digital audio interface transmission (DIT).

### 8.14.1 McASP Device-Specific Information

The device includes two multichannel audio serial port (McASP) interface peripherals (McASP0 and McASP1). The McASP module consists of a transmit and receive section. These sections can operate completely independently with different data formats, separate master clocks, bit clocks, and frame syncs or, alternatively, the transmit and receive sections may be synchronized. The McASP module also includes shift registers that may be configured to operate as either transmit data or receive data.

The transmit section of the McASP can transmit data in either a time-division-multiplexed (TDM) synchronous serial format or in a digital audio interface (DIT) format where the bit stream is encoded for S/PDIF, AES-3, IEC-60958, CP-430 transmission. The receive section of the McASP peripheral supports the TDM synchronous serial format.

The McASP module can support one transmit data format (either a TDM format or DIT format) and one receive format at a time. All transmit shift registers use the same format and all receive shift registers use the same format; however, the transmit and receive formats need not be the same. Both the transmit and receive sections of the McASP also support burst mode, which is useful for non-audio data (for example, passing control information between two devices).

The McASP peripheral has additional capability for flexible clock generation and error detection/handling, as well as error management.

The device McASP0 module has up to 6 serial data pins, while McASP1 has 2 serial data pins. The McASP FIFO size is 256 bytes and two DMA and two interrupt requests are supported. Buffers are used transparently to better manage DMA, which can be leveraged to manage data flow more efficiently.

For more detailed information on and the functionality of the McASP peripheral, see the *Multichannel Audio Serial Port (McASP)* chapter in the device-specific Technical Reference Manual.

### 8.14.2 McASP0 and McASP1 Peripheral Registers Descriptions

The McASP0 and McASP1 peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

### 8.14.3 McASP (McASP[1:0]) Electrical Data/Timing

**Table 8-72. Timing Requirements for McASP<sup>(1)</sup>**

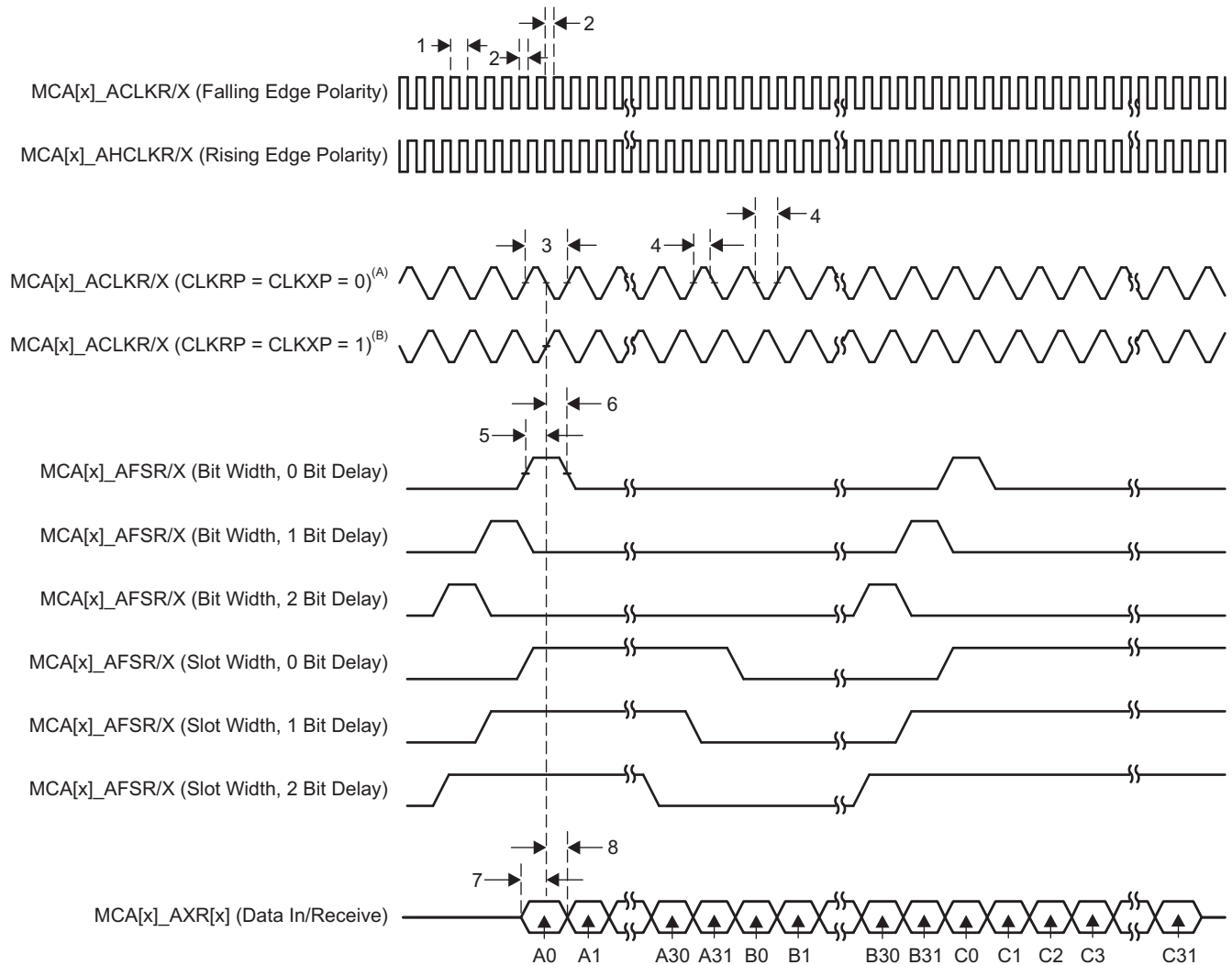
(see [Figure 8-83](#))

| NO. |                        |                                                                | OPP100/OPP120/<br>Turbo/Nitro |      | UNIT |
|-----|------------------------|----------------------------------------------------------------|-------------------------------|------|------|
|     |                        |                                                                | MIN                           | MAX  |      |
| 1   | $t_{c(AHCLKRX)}$       | Cycle time, MCA[x]_AHCLKR/X                                    | 20                            |      | ns   |
| 2   | $t_{w(AHCLKRX)}$       | Pulse duration, MCA[x]_AHCLKR/X high or low                    | 0.5P -<br>2.5 <sup>(2)</sup>  |      | ns   |
| 3   | $t_{c(ACLKRX)}$        | Cycle time, MCA[x]_ACLKR/X                                     | 20                            |      | ns   |
| 4   | $t_{w(ACLKRX)}$        | Pulse duration, MCA[x]_ACLKR/X high or low                     | 0.5R -<br>2.5 <sup>(3)</sup>  |      | ns   |
| 5   | $t_{su(AFSRX-ACLKRX)}$ | Setup time, MCA[x]_AFSR/X input valid before<br>MCA[X]_ACLKR/X | ACLKR/X int                   | 10.5 | ns   |
|     |                        |                                                                | ACLKR/X ext in                | 4    |      |
|     |                        |                                                                | ACLKR/X ext out               | 4    |      |
| 6   | $t_{h(ACLKRX-AFSRX)}$  | Hold time, MCA[x]_AFSR/X input valid after<br>MCA[X]_ACLKR/X   | ACLKR/X int                   | -1   | ns   |
|     |                        |                                                                | ACLKR/X ext in                | 1    |      |
|     |                        |                                                                | ACLKR/X ext out               | 1    |      |
| 7   | $t_{su(AXR-ACLKRX)}$   | Setup time, MCA[x]_AXR input valid before<br>MCA[X]_ACLKR/X    | ACLKR/X int                   | 10.5 | ns   |
|     |                        |                                                                | ACLKR/X ext in                | 4    |      |
|     |                        |                                                                | ACLKR/X ext out               | 4    |      |
| 8   | $t_{h(ACLKRX-AXR)}$    | Hold time, MCA[x]_AXR input valid after<br>MCA[X]_ACLKR/X      | ACLKR/X int                   | -1   | ns   |
|     |                        |                                                                | ACLKR/X ext in                | 1    |      |
|     |                        |                                                                | ACLKR/X ext out               | 1    |      |

- (1) ACLKR internal: ACLKRCTL.CLKRM=1, PDIR.ACLKR = 1  
 ACLKR external input: ACLKRCTL.CLKRM=0, PDIR.ACLKR=0  
 ACLKR external output: ACLKRCTL.CLKRM=0, PDIR.ACLKR=1  
 ACLKX internal: ACLKXCTL.CLKXM=1, PDIR.ACLKX = 1  
 ACLKX external input: ACLKXCTL.CLKXM=0, PDIR.ACLKX=0  
 ACLKX external output: ACLKXCTL.CLKXM=0, PDIR.ACLKX=1

(2) P = MCA[x]\_AHCLKR/X period in nano seconds (ns).

(3) R = MCA[x]\_ACLKR/X period in ns.



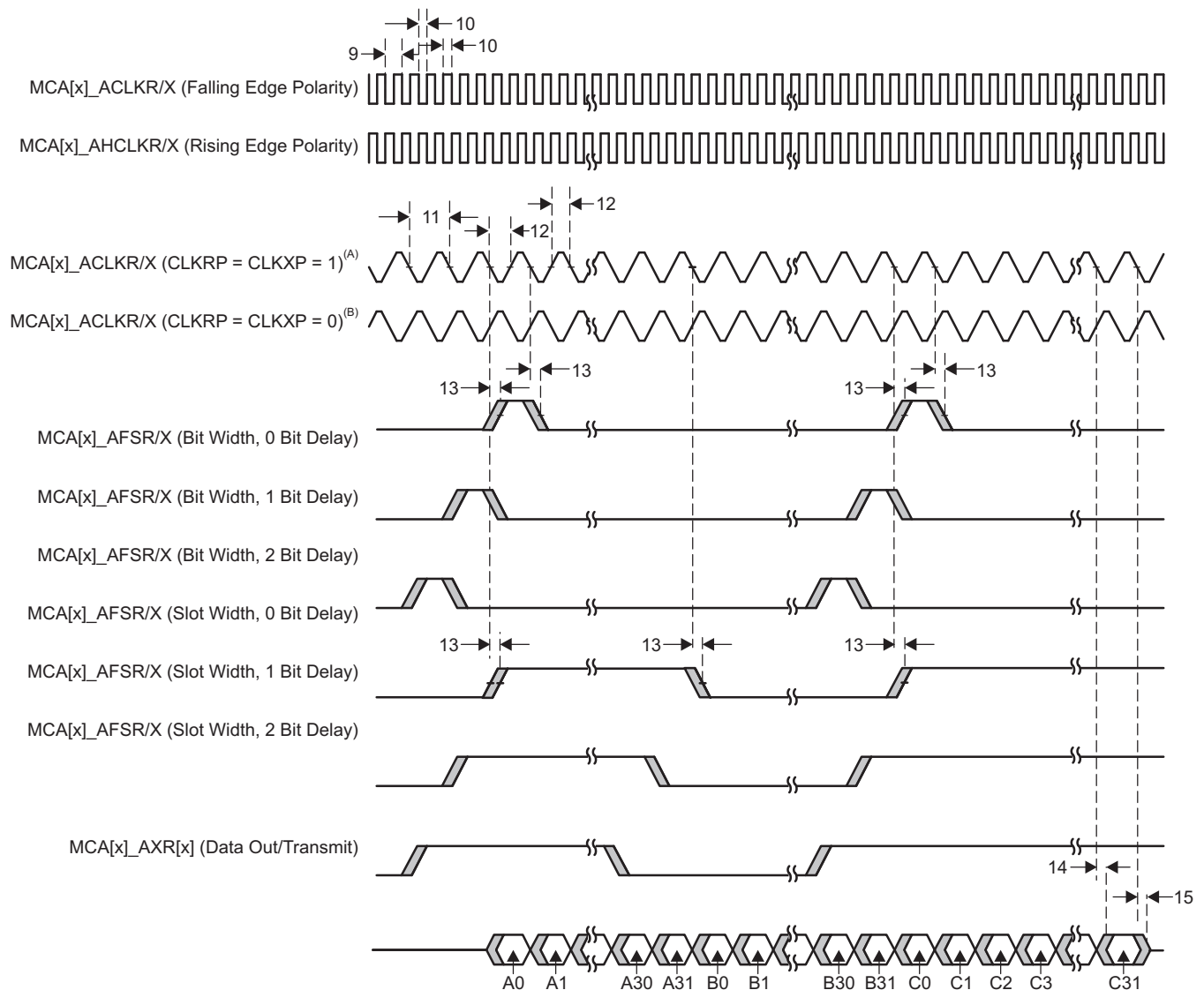
- A. For CLKRP = CLKXP = 0, the McASP transmitter is configured for rising edge (to shift data out) and the McASP receiver is configured for falling edge (to shift data in).
- B. For CLKRP = CLKXP = 1, the McASP transmitter is configured for falling edge (to shift data out) and the McASP receiver is configured for rising edge (to shift data in).

### Figure 8-83. McASP Input Timing

**Table 8-73. Switching Characteristics Over Recommended Operating Conditions for McASP<sup>(1)</sup>**(see [Figure 8-84](#))

| NO. | PARAMETER             |                                                                                                |                 | OPP100/OPP120/<br>Turbo/Nitro |      | UNIT |
|-----|-----------------------|------------------------------------------------------------------------------------------------|-----------------|-------------------------------|------|------|
|     |                       |                                                                                                |                 | MIN                           | MAX  |      |
| 9   | $t_{c(AHCLKRX)}$      | Cycle time, MCA[X]_AHCLKR/X                                                                    |                 | 20 <sup>(2)</sup>             |      | ns   |
| 10  | $t_{w(AHCLKRX)}$      | Pulse duration, MCA[X]_AHCLKR/X high or low                                                    |                 | 0.5P -<br>2.5 <sup>(3)</sup>  |      | ns   |
| 11  | $t_{c(ACLKRX)}$       | Cycle time, MCA[X]_ACLKR/X                                                                     |                 | 20                            |      | ns   |
| 12  | $t_{w(ACLKRX)}$       | Pulse duration, MCA[X]_ACLKR/X high or low                                                     |                 | 0.5P -<br>2.5 <sup>(3)</sup>  |      | ns   |
| 13  | $t_{d(ACLKRX-AFSRX)}$ | Delay time, MCA[X]_ACLKR/X transmit edge to MCA[X]_AFSR/X output valid                         | ACLKR/X int     | -2                            | 5    | ns   |
|     |                       |                                                                                                | ACLKR/X ext in  | 1                             | 11.5 |      |
|     |                       | Delay time, MCA[X]_ACLKR/X transmit edge to MCA[X]_AFSR/X output valid with Pad Loopback       | ACLKR/X ext out | 1                             | 11.5 |      |
| 14  | $t_{d(ACLKX-AXR)}$    | Delay time, MCA[X]_ACLKX transmit edge to MCA[X]_AXR output valid                              | ACLKX int       | -2                            | 5    | ns   |
|     |                       |                                                                                                | ACLKX ext in    | 1                             | 11.5 |      |
|     |                       | Delay time, MCA[X]_ACLKX transmit edge to MCA[X]_AXR output valid with Pad Loopback            | ACLKX ext out   | 1                             | 11.5 |      |
| 15  | $t_{dis(ACLKX-AXR)}$  | Disable time, MCA[X]_ACLKX transmit edge to MCA[X]_AXR output high impedance                   | ACLKX int       | -2                            | 5    | ns   |
|     |                       |                                                                                                | ACLKX ext in    | 1                             | 11.5 |      |
|     |                       | Disable time, MCA[X]_ACLKX transmit edge to MCA[X]_AXR output high impedance with Pad Loopback | ACLKX ext out   | 1                             | 11.5 |      |

- (1) ACLKR internal: ACLKRCTL.CLKRM=1, PDIR.ACLKR = 1  
 ACLKR external input: ACLKRCTL.CLKRM=0, PDIR.ACLKR=0  
 ACLKR external output: ACLKRCTL.CLKRM=0, PDIR.ACLKR=1  
 ACLKX internal: ACLKXCTL.CLKXM=1, PDIR.ACLKX = 1  
 ACLKX external input: ACLKXCTL.CLKXM=0, PDIR.ACLKX=0  
 ACLKX external output: ACLKXCTL.CLKXM=0, PDIR.ACLKX=1
- (2) 50 MHz
- (3) P = AHCLKR/X period.



- A. For CLKRP = CLKXP = 1, the McASP transmitter is configured for falling edge (to shift data out) and the McASP receiver is configured for rising edge (to shift data in).
- B. For CLKRP = CLKXP = 0, the McASP transmitter is configured for rising edge (to shift data out) and the McASP receiver is configured for falling edge (to shift data in).

**Figure 8-84. McASP Output Timing**

## 8.15 MultiMedia Card/Secure Digital/Secure Digital Input Output (MMC/SD/SDIO)

The device includes 3 MMC/SD/SDIO Controllers which are compliant with MMC V4.3, Secure Digital Part 1 Physical Layer Specification V2.00 and Secure Digital Input Output (SDIO) V2.00 specifications.

The device MMC/SD/SDIO Controller has the following features:

- MultiMedia card (MMC)
- Secure Digital (SD) memory card
- MMC/SD protocol support
- SDIO protocol support
- Programmable clock frequency
- 1024 byte read/write FIFO to lower system overhead
- Slave EDMA transfer capability
- SD High capacity support
- SDXC card support
  - Supports only SDHC clock rates
  - Booting from SDXC cards is not supported

### 8.15.1 MMC/SD/SDIO Peripheral Register Descriptions

The MMC/SD/SDIO peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

### 8.15.2 MMC/SD/SDIO Electrical Data/Timing

**Table 8-74. Timing Requirements for MMC/SD/SDIO**

(see [Figure 8-86](#), [Figure 8-88](#))

| NO. |                     |                                                           | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|---------------------|-----------------------------------------------------------|-------------------------------|-----|------|
|     |                     |                                                           | ALL MODES                     |     |      |
|     |                     |                                                           | MIN                           | MAX |      |
| 1   | $t_{su}(CMDV-CLKH)$ | Setup time, SD_CMD valid before SD_CLK rising clock edge  | 4.1                           |     | ns   |
| 2   | $t_h(CLKH-CMDV)$    | Hold time, SD_CMD valid after SD_CLK rising clock edge    | 1.9                           |     | ns   |
| 3   | $t_{su}(DATV-CLKH)$ | Setup time, SD_DATx valid before SD_CLK rising clock edge | 4.1                           |     | ns   |
| 4   | $t_h(CLKH-DATV)$    | Hold time, SD_DATx valid after SD_CLK rising clock edge   | 1.9                           |     | ns   |

**Table 8-75. Switching Characteristics Over Recommended Operating Conditions for MMC/SD/SDIO**

(see [Figure 8-85](#) through [Figure 8-88](#))

| NO. | PARAMETER               |                                       | OPP100/OPP120/<br>Turbo/Nitro |     |                         |     | UNIT |
|-----|-------------------------|---------------------------------------|-------------------------------|-----|-------------------------|-----|------|
|     |                         |                                       | MODES                         |     |                         |     |      |
|     |                         |                                       | 3.3 V STD<br>1.8 V SDR12      |     | 3.3 V HS<br>1.8 V SDR25 |     |      |
|     |                         |                                       | MIN                           | MAX | MIN                     | MAX |      |
| 7   | f <sub>op</sub> (CLK)   | Operating frequency, SD_CLK           | 24                            |     | 48                      |     | MHz  |
|     | t <sub>c</sub> (CLK)    | Operating period: SD_CLK              | 41.7                          |     | 20.8                    |     | ns   |
| 8   | f <sub>op</sub> (CLKID) | Identification mode frequency, SD_CLK | 400                           |     | 400                     |     | kHz  |
|     | t <sub>c</sub> (CLKID)  | Identification mode period: SD_CLK    | 2500.0                        |     | 2500.0                  |     | ns   |
| 9   | t <sub>w</sub> (CLKL)   | Pulse duration, SD_CLK low            | 0.5*P <sup>(1)</sup>          |     | 0.5*P <sup>(1)</sup>    |     | ns   |
| 10  | t <sub>w</sub> (CLKH)   | Pulse duration, SD_CLK high           | 0.5*P <sup>(1)</sup>          |     | 0.5*P <sup>(1)</sup>    |     | ns   |

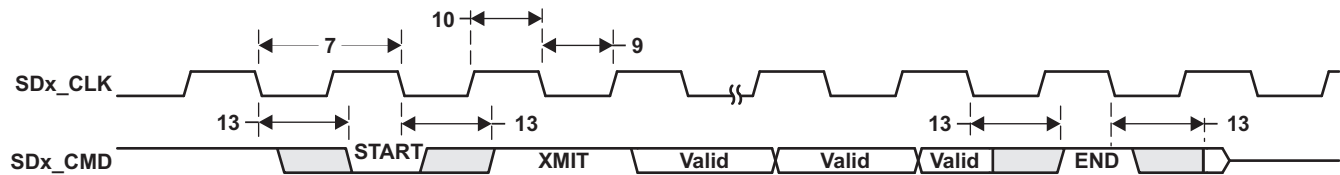
(1) P = SD\_CLK period.



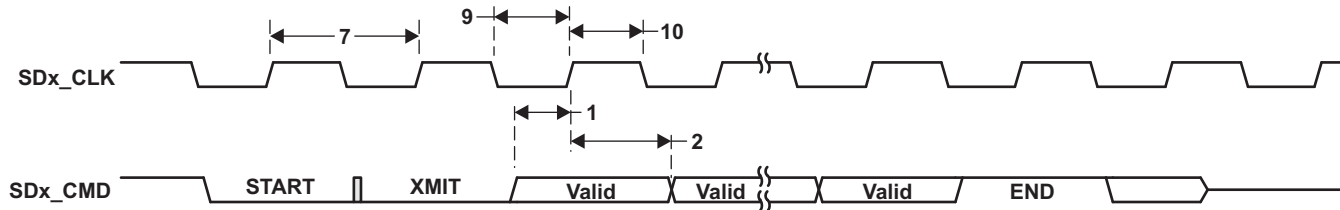
**Table 8-75. Switching Characteristics Over Recommended Operating Conditions for MMC/SD/SDIO (continued)**

(see [Figure 8-85](#) through [Figure 8-88](#))

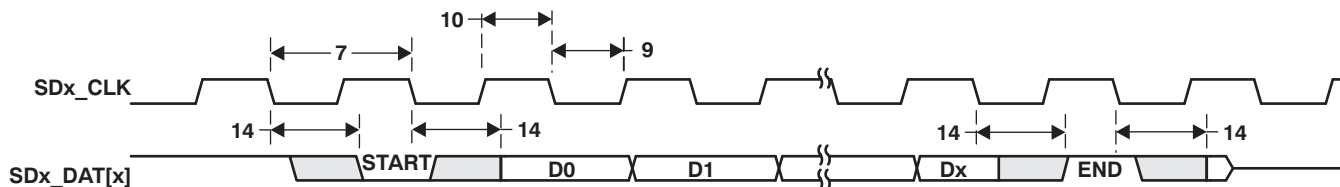
| NO. | PARAMETER                |                                                            | OPP100/OPP120/<br>Turbo/Nitro |     |                         |     | UNIT |
|-----|--------------------------|------------------------------------------------------------|-------------------------------|-----|-------------------------|-----|------|
|     |                          |                                                            | MODES                         |     |                         |     |      |
|     |                          |                                                            | 3.3 V STD<br>1.8 V SDR12      |     | 3.3 V HS<br>1.8 V SDR25 |     |      |
|     |                          |                                                            | MIN                           | MAX | MIN                     | MAX |      |
| 11  | t <sub>r(CLK)</sub>      | Rise time, All Signals (10% to 90%)                        | 2.2                           |     | 2.2                     |     | ns   |
| 12  | t <sub>f(CLK)</sub>      | Fall time, All Signals (10% to 90%)                        | 2.2                           |     | 2.2                     |     | ns   |
| 13  | t <sub>d(CLKL-CMD)</sub> | Delay time, SD_CLK rising clock edge to SD_CMD transition  | -4                            | 4   | 2.3                     | 14  | ns   |
| 14  | t <sub>d(CLKL-DAT)</sub> | Delay time, SD_CLK rising clock edge to SD_DATx transition | -4                            | 4   | 2.3                     | 14  | ns   |



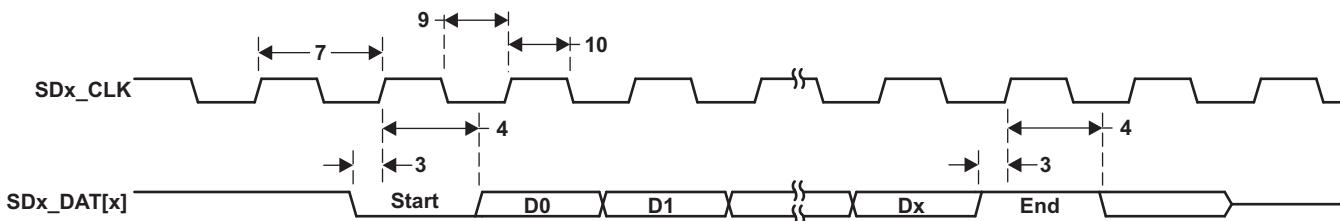
**Figure 8-85. MMC/SD/SDIO Host Command Timing**



**Figure 8-86. MMC/SD/SDIO Card Response Timing**



**Figure 8-87. MMC/SD/SDIO Host Write Timing**



**Figure 8-88. MMC/SD/SDIO Host Read and Card CRC Status Timing**

## 8.16 Peripheral Component Interconnect Express (PCIe)

The device supports connections to PCIe-compliant devices via the integrated PCIe master/slave bus interface. The PCIe module is comprised of a dual-mode PCIe core and a SerDes PHY. The device implements a single one-lane PCIe 2.0 (5.0 GT/s) Endpoint/Root Complex port.

The device PCIe supports the following features:

- Supports Gen1/Gen2 in x1 or x2 mode
- One port with one 5 GT/s lane
- Single virtual channel (VC), single traffic class (TC)
- Single function in end-point mode
- Automatic width and speed negotiation and lane reversal
- Max payload: 128 byte outbound, 256 byte inbound
- Automatic credit management
- ECRC generation and checking
- Configurable BAR filtering
- Supports PCIe messages
- Legacy interrupt reception (RC) and generation (EP)
- MSI generation and reception
- PCI device power management, except D3 cold with vaux
- Active state power management state L0 and L1.

For more detailed information on the PCIe port peripheral module, see the *PCI Express (PCIe) Module* chapter in the device-specific Technical Reference Manual.

The PCIe peripheral on the device conforms to the PCI Express Base 2.0 Specification.

**Note:** PCIe is supported on all DM385 devices and also on DM388 devices with PCIe enabled.

### 8.16.1 PCIe Peripheral Register Descriptions

The PCIe peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

### 8.16.2 PCIe Electrical Data/Timing

Texas Instruments (TI) has performed the simulation and system characterization to ensure that the PCIe peripheral meets all AC timing specifications as required by the PCI Express Base 2.0 Specification. Therefore, the AC timing specifications are not reproduced here. For more information on the AC timing specifications, see Sections 4.3.3.5 and 4.3.4.4 of the PCI Express Base 2.0 Specification.

### 8.16.3 PCIe Design and Layout Guidelines

#### 8.16.3.1 Clock Source

A standard 100-MHz PCIe differential clock source must be used for PCIe operation (for more details, see [Section 7.4.2, SERDES CLKN/P Input Clock](#)).

#### 8.16.3.2 PCIe Connections and Interface Compliance

The PCIe interface on the device is compliant with the PCI Express Base 2.0 Specification. Refer to the PCIe specifications for all connections that are described in it. For coupling capacitor selection, see [Section 8.16.3.2.1, Coupling Capacitors](#).

The use of PCIe-compatible bridges and switches is allowed for interfacing with more than one other processor or PCIe device.

### 8.16.3.2.1 Coupling Capacitors

AC coupling capacitors are required on the transmit data pair. [Table 8-76](#) shows the requirements for these capacitors.

**Table 8-76. AC Coupling Capacitors Requirements**

| PARAMETER                                              | MIN | TYP  | MAX  | UNIT               |
|--------------------------------------------------------|-----|------|------|--------------------|
| PCIe AC coupling capacitor value                       | 75  |      | 200  | nF                 |
| PCIe AC coupling capacitor package size <sup>(1)</sup> |     | 0402 | 0603 | EIA <sup>(2)</sup> |

(1) The physical size of the capacitor should be as small as practical. Use the same size on both lines in each pair, placed side by side.

(2) EIA LxW units; that is, a 0402 is a 40x20 mil (thousandths of an inch) surface-mount capacitor.

### 8.16.3.2.2 Polarity Inversion

The PCIe specification requires polarity inversion support. This means, for layout purposes, polarity is unimportant since each signal can change its polarity on-die inside the chip. This means polarity within a lane is unimportant for layout.

### 8.16.3.3 Non-Standard PCIe Connections

The following sections contain suggestions for any PCIe connection that is **not** described in the official PCIe specification, such as an on-board device-to-device connection, or device-to-other PCIe-compliant processor connection.

#### 8.16.3.3.1 PCB Stackup Specifications

[Table 8-77](#) shows the stackup and feature sizes required for these types of PCIe connections.

**Table 8-77. PCIe PCB Stackup Specifications**

| PARAMETER                                                                     | MIN | TYP | MAX | UNIT   |
|-------------------------------------------------------------------------------|-----|-----|-----|--------|
| PCB Routing/Plane Layers                                                      | 4   | 6   | -   | Layers |
| Signal Routing Layers                                                         | 2   | 3   | -   | Layers |
| Number of ground plane cuts allowed within PCIe routing region                | -   | -   | 0   | Cuts   |
| Number of layers between PCIe routing area and reference plane <sup>(1)</sup> | -   | -   | 0   | Layers |
| PCB Routing clearance                                                         | -   | 4   | -   | Mils   |
| PCB Trace width <sup>(2)</sup>                                                | -   | 4   | -   | Mils   |
| PCB BGA escape via pad size                                                   | -   | 20  | -   | Mils   |
| PCB BGA escape via hole size                                                  | -   | 10  | -   | Mils   |
| Processor BGA pad size <sup>(3)(4)</sup>                                      |     | 0.4 |     | mm     |

(1) A reference plane may be a ground plane or the power plane referencing the PCIe signals.

(2) In breakout area.

(3) Non-solder mask defined pad.

(4) Per IPC-7351A BGA pad size guideline.

#### 8.16.3.3.2 Routing Specifications

The PCIe data signal traces must be routed to achieve 100  $\Omega$  ( $\pm 20\%$ ) differential impedance and 60  $\Omega$  ( $\pm 15\%$ ) single-ended impedance. The single-ended impedance is required because differential signals are extremely difficult to closely couple on PCBs and, therefore, single-ended impedance becomes important. These requirements are the same as those recommended in the *PCIe Motherboard Checklist 1.0* document, available from PCI-SIG.

These impedances are impacted by trace width, trace spacing, distance between signals and referencing planes, and dielectric material. Verify with a PCB design tool that the trace geometry for both data signal pairs result in as close to 100  $\Omega$  differential impedance and 60  $\Omega$  single-ended impedance as possible. For best accuracy, work with your PCB fabricator to ensure this impedance is met.

In general, closely coupled differential signal traces are not an advantage on PCBs. When differential signals are closely coupled, tight spacing and width control is necessary. Very small width and spacing variations affect impedance dramatically, so tight impedance control can be more problematic to maintain in production.

Loosely coupled PCB differential signals make impedance control much easier. Wider traces and spacing make obstacle avoidance easier, and trace width variations do not affect impedance as much; therefore, it is easier to maintain an accurate impedance over the length of the signal. The wider traces also show reduced skin effect and, therefore, often result in better signal integrity.

Table 8-78 shows the routing specifications for the PCIe data signals.

**Table 8-78. PCIe Routing Specifications**

| PARAMETER                                             | MIN                 | TYP | MAX               | UNIT                |
|-------------------------------------------------------|---------------------|-----|-------------------|---------------------|
| PCIe signal trace length                              |                     |     | 10 <sup>(1)</sup> | Inches              |
| Differential pair trace matching                      |                     |     | 10 <sup>(2)</sup> | Mils                |
| Number of stubs allowed on PCIe traces <sup>(3)</sup> |                     |     | 0                 | Stubs               |
| TX/RX pair differential impedance                     | 80                  | 100 | 120               | Ω                   |
| TX/RX single ended impedance                          | 51                  | 60  | 69                | Ω                   |
| Pad size of vias on PCIe trace                        |                     |     | 25 <sup>(4)</sup> | Mils                |
| Hole size of vias on PCIe trace                       |                     |     | 14                | Mils                |
| Number of vias on each PCIe trace                     |                     |     | 3                 | Vias <sup>(5)</sup> |
| PCIe differential pair to any other trace spacing     | 2*DS <sup>(6)</sup> |     |                   |                     |

(1) Beyond this, signal integrity may suffer.

(2) For example, RXP0 within 10 Mils of RXN0.

(3) In-line pads may be used for probing.

(4) 35-Mil antipad max recommended.

(5) Vias must be used in pairs with their distance minimized.

(6) DS = differential spacing of the PCIe traces.

## 8.17 Serial Peripheral Interface (SPI)

The SPI is a high-speed synchronous serial input/output port that allows a serial bit stream of programmed length (4 to 32 bits) to be shifted into and out of the device at a programmed bit-transfer rate. The SPI is normally used for communication between the device and external peripherals. Typical applications include an interface-to-external I/O or peripheral expansion via devices such as shift registers, display drivers, SPI EEPROMs, and Analog-to-Digital Converters (ADCs).

The SPI supports the following features:

- Master/Slave operation
- Four chip selects for interfacing/control to up to four SPI Slave devices and connection to a single external Master
- 32-bit shift register
- Buffered receive/transmit data register per channel (1 word deep), FIFO size is 64 bytes
- Programmable SPI configuration per channel (clock definition, enable polarity and word width)
- Supports one interrupt request and two DMA requests per channel.

For more detailed information on the SPI, see the *Multichannel Serial Port Interface (McSPI)* chapter in the device-specific Technical Reference Manual.

### 8.17.1 SPI Peripheral Register Descriptions

The SPI peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

### 8.17.2 SPI Electrical Data/Timing

**Table 8-79. Timing Requirements for SPI - Master Mode**

 (see [Figure 8-89](#) and [Figure 8-90](#))

| NO.                                                                                                                                      |                               |                                                                                          |                             | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|------------------------------------------------------------------------------------------|-----------------------------|-------------------------------|-----|------|
|                                                                                                                                          |                               |                                                                                          |                             | MIN                           | MAX |      |
| MASTER: SPI0, SPI1, SPI2 (M0) and SPI3 (M0)1 LOAD AT A MAXIMUM OF 5 pF                                                                   |                               |                                                                                          |                             |                               |     |      |
| 1                                                                                                                                        | t <sub>c</sub> (SPICLK)       | Cycle time, SPI_CLK <sup>(1)(2)</sup>                                                    |                             | 20.8 <sup>(3)</sup>           |     | ns   |
| 2                                                                                                                                        | t <sub>w</sub> (SPICLKL)      | Pulse duration, SPI_CLK low <sup>(1)</sup>                                               |                             | 0.5*P - 1 <sup>(4)</sup>      |     | ns   |
| 3                                                                                                                                        | t <sub>w</sub> (SPICLKH)      | Pulse duration, SPI_CLK high <sup>(1)</sup>                                              |                             | 0.5*P - 1 <sup>(4)</sup>      |     | ns   |
| 4                                                                                                                                        | t <sub>su</sub> (MISO-SPICLK) | Setup time, SPI_D[x] valid before SPI_CLK active edge <sup>(1)</sup>                     | SPI0, SPI1                  | 2.29                          |     | ns   |
|                                                                                                                                          |                               |                                                                                          | SPI2, SPI3                  | 4                             |     |      |
| 5                                                                                                                                        | t <sub>h</sub> (SPICLK-MISO)  | Hold time, SPI_D[x] valid after SPI_CLK active edge <sup>(1)</sup>                       |                             | 2.67                          |     | ns   |
| 6                                                                                                                                        | t <sub>d</sub> (SPICLK-MOSI)  | Delay time, SPI_CLK active edge to SPI_D[x] transition <sup>(1)</sup>                    |                             | 3.57                          |     | ns   |
| 7                                                                                                                                        | t <sub>d</sub> (SCS-MOSI)     | Delay time, SPI_SCS[x] active edge to SPI_D[x] transition                                |                             | 3.57                          |     | ns   |
| 8                                                                                                                                        | t <sub>d</sub> (SCS-SPICLK)   | Delay time, $\overline{\text{SPI\_SCS[x]}}$ active to SPI_CLK first edge <sup>(1)</sup>  | MASTER_PH A0 <sup>(5)</sup> | B-4.2 <sup>(6)</sup>          |     | ns   |
|                                                                                                                                          |                               |                                                                                          | MASTER_PH A1 <sup>(5)</sup> | A-4.2 <sup>(7)</sup>          |     | ns   |
| 9                                                                                                                                        | t <sub>d</sub> (SPICLK-SCS)   | Delay time, SPI_CLK last edge to $\overline{\text{SPI\_SCS[x]}}$ inactive <sup>(1)</sup> | MASTER_PH A0 <sup>(5)</sup> | A-4.2 <sup>(7)</sup>          |     | ns   |
|                                                                                                                                          |                               |                                                                                          | MASTER_PH A1 <sup>(5)</sup> | B-4.2 <sup>(6)</sup>          |     | ns   |
| MASTER: SPI0, SPI1, SPI2 (M0) and SPI3 (M0) LOAD AT MAX 25pF<br>MASTER: SPI2 (M1, M2, M3) and SPI3 (M1, M2, M3) 1 to 4 LOAD AT 5 to 25pF |                               |                                                                                          |                             |                               |     |      |
| 1                                                                                                                                        | t <sub>c</sub> (SPICLK)       | Cycle time, SPI_CLK <sup>(1)(2)</sup>                                                    |                             | 41.7 <sup>(8)</sup>           |     | ns   |
| 2                                                                                                                                        | t <sub>w</sub> (SPICLKL)      | Pulse duration, SPI_CLK low <sup>(1)</sup>                                               |                             | 0.5*P - 2 <sup>(4)</sup>      |     | ns   |
| 3                                                                                                                                        | t <sub>w</sub> (SPICLKH)      | Pulse duration, SPI_CLK high <sup>(1)</sup>                                              |                             | 0.5*P - 2 <sup>(4)</sup>      |     | ns   |
| 4                                                                                                                                        | t <sub>su</sub> (MISO-SPICLK) | Setup time, SPI_D[x] valid before SPI_CLK active edge <sup>(1)</sup>                     | SPI0, SPI1                  | 4                             |     | ns   |
|                                                                                                                                          |                               |                                                                                          | SPI2, SPI3                  | 6                             |     |      |
| 5                                                                                                                                        | t <sub>h</sub> (SPICLK-MISO)  | Hold time, SPI_D[x] valid after SPI_CLK active edge <sup>(1)</sup>                       |                             | 3.8                           |     | ns   |
| 6                                                                                                                                        | t <sub>d</sub> (SPICLK-MOSI)  | Delay time, SPI_CLK active edge to SPI_D[x] transition <sup>(1)</sup>                    |                             | -5.5      5.5                 |     | ns   |
| 7                                                                                                                                        | t <sub>d</sub> (SCS-MOSI)     | Delay time, $\overline{\text{SPI\_SCS[x]}}$ active edge to SPI_D[x] transition           |                             | 5.5                           |     | ns   |
| 8                                                                                                                                        | t <sub>d</sub> (SCS-SPICLK)   | Delay time, $\overline{\text{SPI\_SCS[x]}}$ active to SPI_CLK first edge <sup>(1)</sup>  | MASTER_PH A0 <sup>(5)</sup> | B-3.5 <sup>(6)</sup>          |     | ns   |
|                                                                                                                                          |                               |                                                                                          | MASTER_PH A1 <sup>(5)</sup> | A-3.5 <sup>(7)</sup>          |     | ns   |
| 9                                                                                                                                        | t <sub>d</sub> (SPICLK-SCS)   | Delay time, SPI_CLK last edge to $\overline{\text{SPI\_SCS[x]}}$ inactive <sup>(1)</sup> | MASTER_PH A0 <sup>(5)</sup> | A-3.5 <sup>(7)</sup>          |     | ns   |
|                                                                                                                                          |                               |                                                                                          | MASTER_PH A1 <sup>(5)</sup> | B-3.5 <sup>(6)</sup>          |     | ns   |

- (1) This timing applies to all configurations regardless of SPI\_CLK polarity and which clock edges are used to drive output data and capture input data.
- (2) Related to the SPI\_CLK maximum frequency.
- (3) Maximum frequency = 48 MHz
- (4) P = SPICLK period.
- (5) SPI\_CLK phase is programmable with the PHA bit of the SPI\_CH(i)CONF register.
- (6) B =  $(TCS + 0.5) \cdot TSPICKREF \cdot F_{ratio}$ , where TCS is a bit field of the SPI\_CH(i)CONF register and  $F_{ratio} = \text{Even} \geq 2$ .
- (7) When P = 20.8 ns, A =  $(TCS + 1) \cdot TSPICKREF$ , where TCS is a bit field of the SPI\_CH(i)CONF register. When P > 20.8 ns, A =  $(TCS + 0.5) \cdot F_{ratio} \cdot TSPICKREF$ , where TCS is a bit field of the SPI\_CH(i)CONF register.
- (8) Maximum frequency = 24 MHz

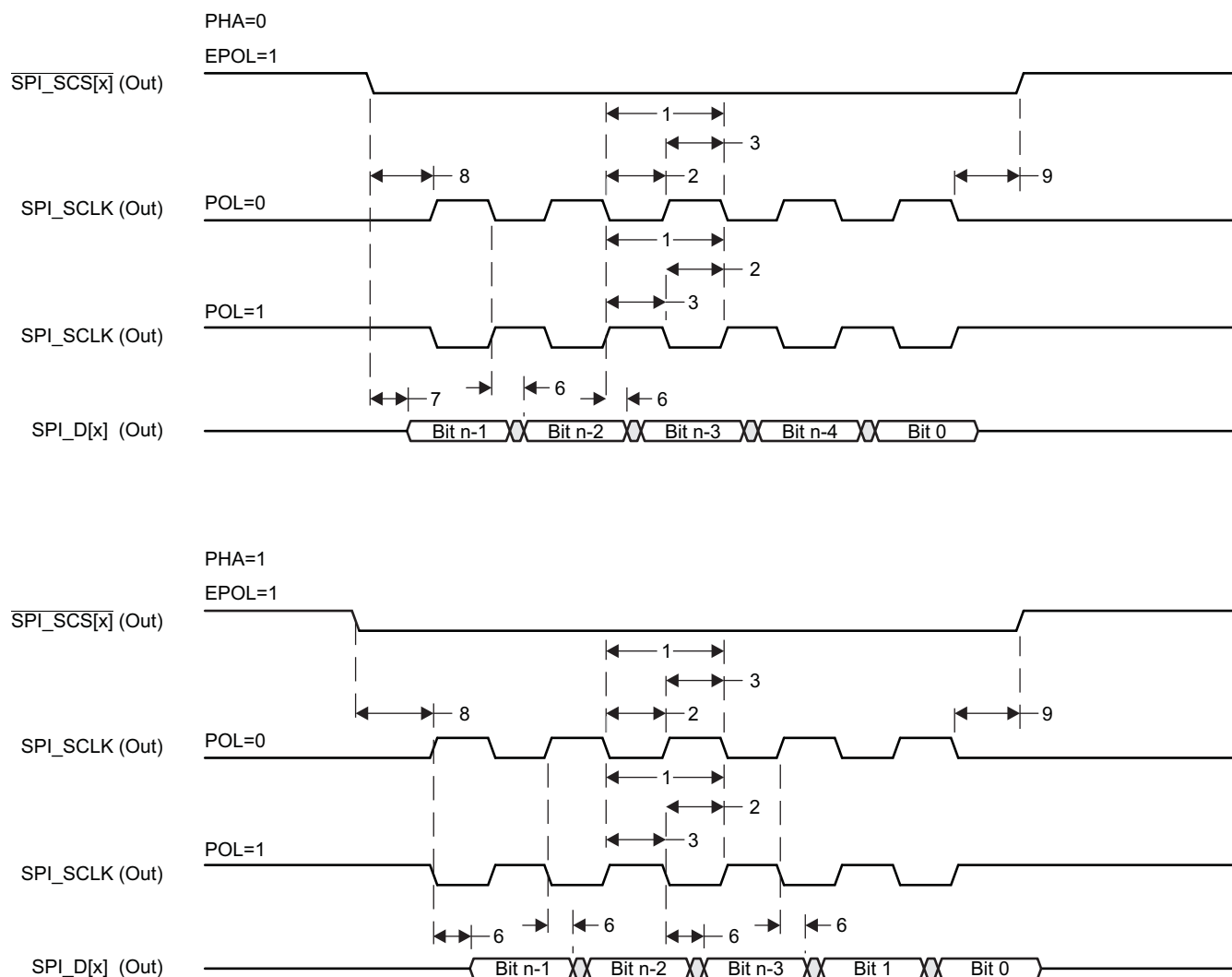
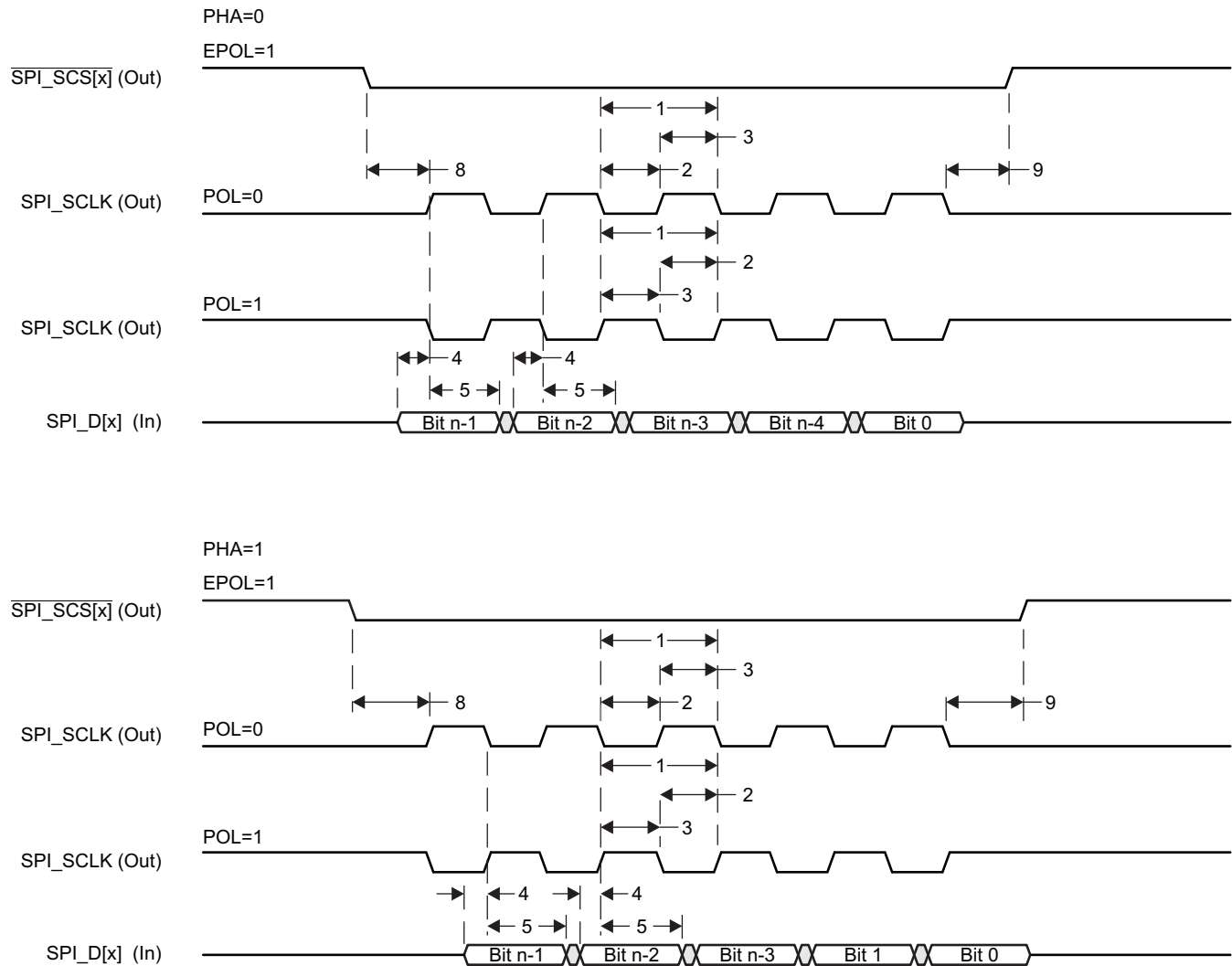


Figure 8-89. SPI Master Mode Transmit Timing

**Figure 8-90. SPI Master Mode Receive Timing****Table 8-80. Timing Requirements for SPI - Slave Mode**(see [Figure 8-91](#) and [Figure 8-92](#))

| NO. |                       |                                                                                        | OPP100/OPP120/Turbo/Nitr<br>o    |      | UNIT |
|-----|-----------------------|----------------------------------------------------------------------------------------|----------------------------------|------|------|
|     |                       |                                                                                        | MIN                              | MAX  |      |
| 1   | $t_{c(SPICLK)}$       | Cycle time, SPI_CLK <sup>(1)(2)</sup>                                                  | 62.5 <sup>(3)</sup>              |      | ns   |
| 2   | $t_{w(SPICLKl)}$      | Pulse duration, SPI_CLK low <sup>(1)</sup>                                             | $0.5 \cdot P - 3$ <sup>(4)</sup> |      | ns   |
| 3   | $t_{w(SPICLKlH)}$     | Pulse duration, SPI_CLK high <sup>(1)</sup>                                            | $0.5 \cdot P - 3$ <sup>(4)</sup> |      | ns   |
| 4   | $t_{su(MOSI-SPICLK)}$ | Setup time, SPI_D[x] valid before SPI_CLK active edge <sup>(1)</sup>                   | 12.92                            |      | ns   |
| 5   | $t_{h(SPICLK-MOSI)}$  | Hold time, SPI_D[x] valid after SPI_CLK active edge <sup>(1)</sup>                     | 12.92                            |      | ns   |
| 6   | $t_d(SPICLK-MISO)$    | Delay time, SPI_CLK active edge to SPI_D[x] transition <sup>(1)</sup>                  | -4.00                            | 17.1 | ns   |
| 7   | $t_d(SCS-MISO)$       | Delay time, $\overline{SPI\_SCS[x]}$ active edge to SPI_D[x] transition <sup>(5)</sup> |                                  | 17.1 | ns   |

(1) This timing applies to all configurations regardless of SPI\_CLK polarity and which clock edges are used to drive output data and capture input data.

(2) Related to the input maximum frequency supported by the SPI module.

(3) Maximum frequency = 16 MHz

(4) P = SPICLK period.

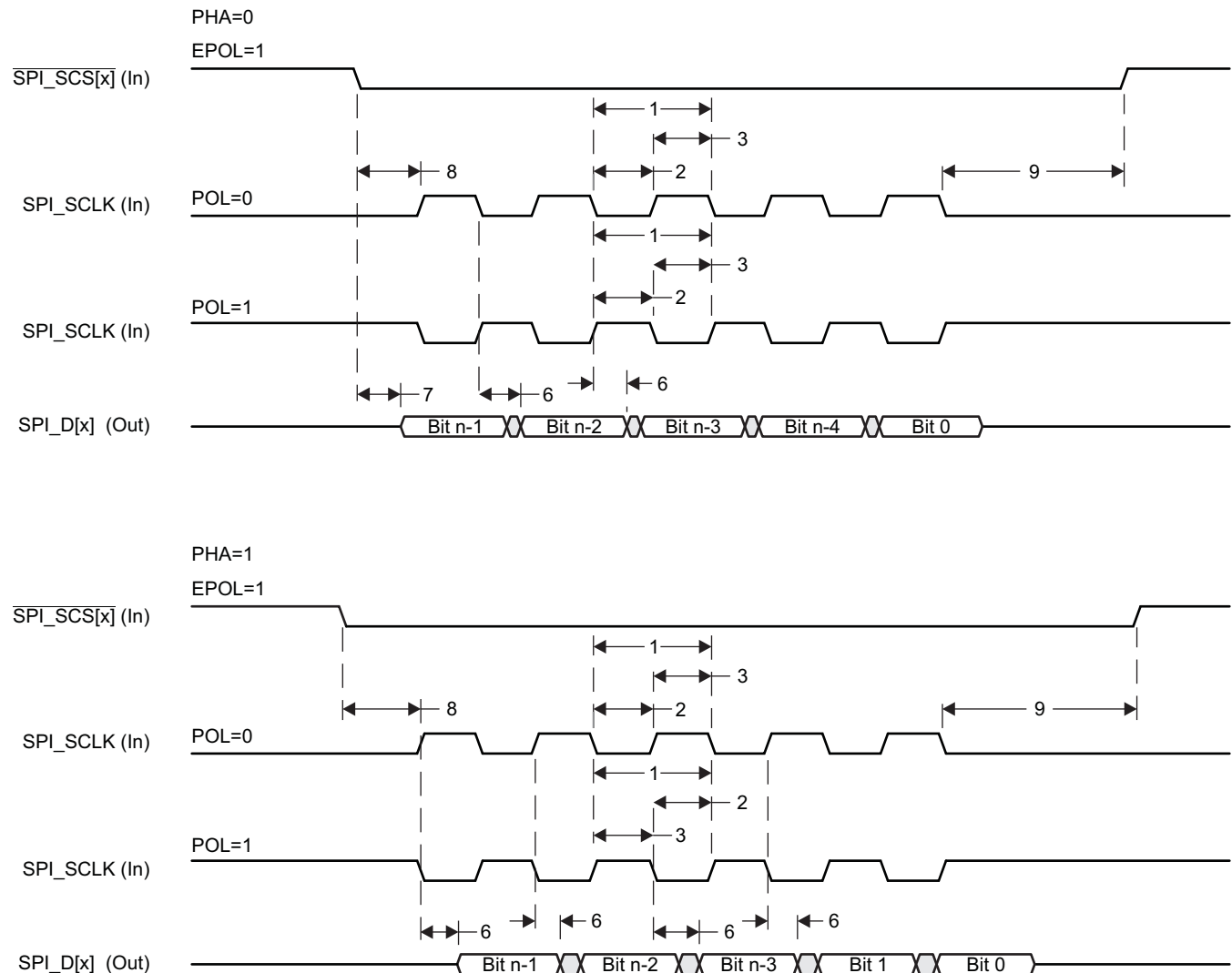
(5) PHA = 0; SPI\_CLK phase is programmable with the PHA bit of the SPI\_CH(i)CONF register.



**Table 8-80. Timing Requirements for SPI - Slave Mode (continued)**

(see [Figure 8-91](#) and [Figure 8-92](#))

| NO. |                      |                                                                                     | OPP100/OPP120/Turbo/Nitro |     | UNIT |
|-----|----------------------|-------------------------------------------------------------------------------------|---------------------------|-----|------|
|     |                      |                                                                                     | MIN                       | MAX |      |
| 8   | $t_{su}(SCS-SPICLK)$ | Setup time, $\overline{SPI\_SCS}[x]$ valid before SPI_CLK first edge <sup>(1)</sup> | 12.92                     |     | ns   |
| 9   | $t_h(SPICLK-SCS)$    | Hold time, $\overline{SPI\_SCS}[x]$ valid after SPI_CLK last edge <sup>(1)</sup>    | 12.92                     |     | ns   |



**Figure 8-91. SPI Slave Mode Transmit Timing**

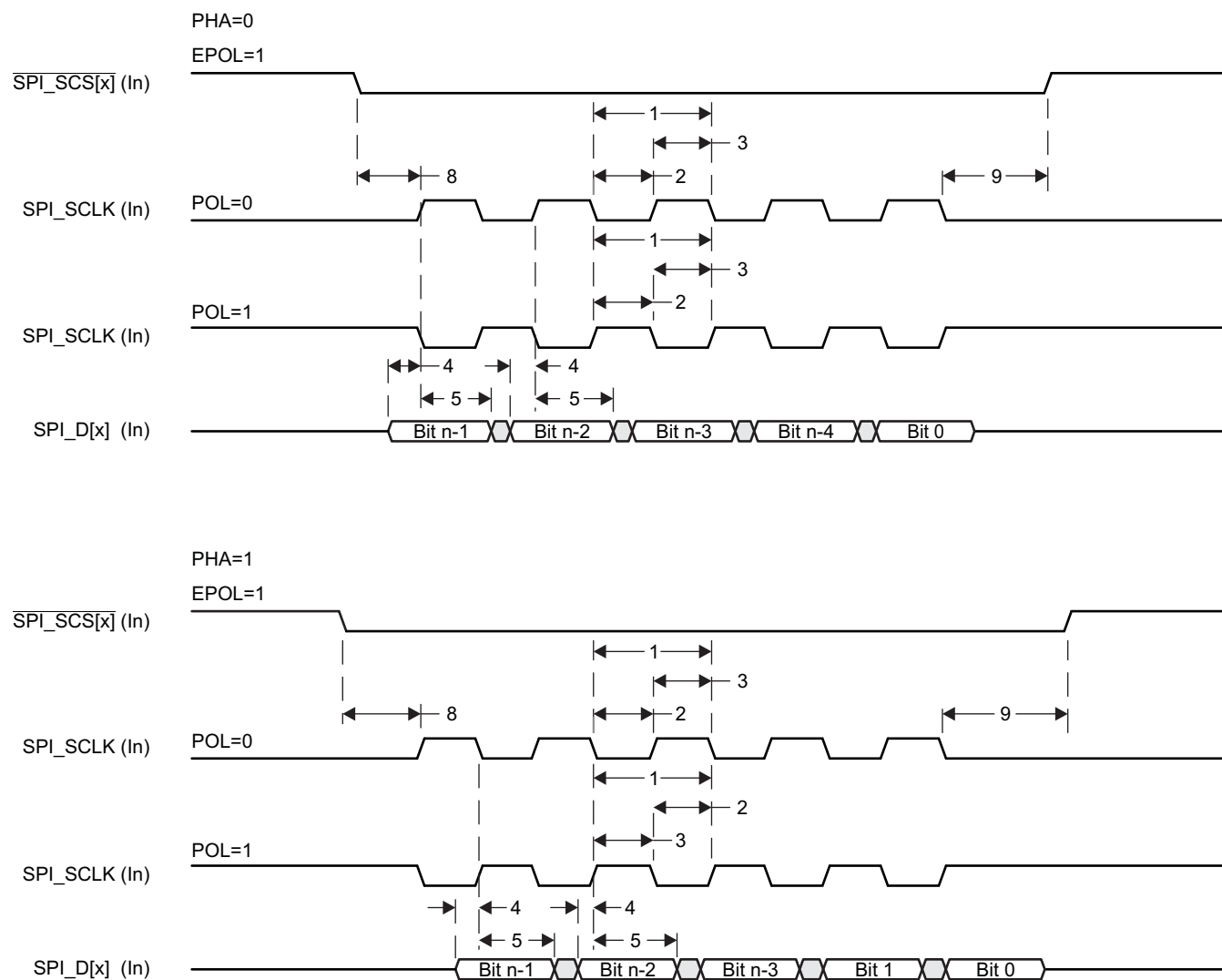


Figure 8-92. SPI Slave Mode Receive Timing

## 8.18 Timers

The device has eight 32-bit general-purpose (GP) timers (TIMER8 - TIMER1) that have the following features:

- TIMER8, TIMER1 are for software use and do not have an external connection
- Dedicated input trigger for capture mode and dedicated output trigger/pulse width modulation (PWM) signal
- Interrupts generated on overflow, compare, and capture
- Free-running 32-bit upward counter
- Supported modes:
  - Compare and capture modes
  - Auto-reload mode
  - Start-stop mode
- TIMER[8:1] functional clock is sourced from either the DEVOSC, AUXOSC, AUD\_CLK2/1/0, TCLKIN, or SYSClk18 27 MHz as selected by the timer clock multiplexers.
- On-the-fly read/write register (while counting)
- Generates interrupts to the ARM and Media Controller.

The device has one system watchdog timer that have the following features:

- Free-running 32-bit upward counter
- On-the-fly read/write register (while counting)
- Reset upon occurrence of a timer overflow condition
- The system watchdog timer has two possible clock sources:
  - RCOSC32K oscillator
  - RTCDIVIDER
- The watchdog timer is used to provide a recovery mechanism for the device in the event of a fault condition, such as a non-exiting code loop.

For more detailed information on the GP and Watchdog Timers, see the *Timers* and *Watchdog Timer* chapters in the device-specific Technical Reference Manual.

### 8.18.1 Timer Peripheral Register Descriptions

The Timer peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

### 8.18.2 Timer Electrical/Data Timing

**Table 8-81. Timing Requirements for Timer**

(see [Figure 8-93](#))

| NO. |                |                      | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|----------------|----------------------|-------------------------------|-----|------|
|     |                |                      | MIN                           | MAX |      |
| 1   | $t_{W(EVTIH)}$ | Pulse duration, high | 4P <sup>(1)</sup>             |     | ns   |
| 2   | $t_{W(EVTIL)}$ | Pulse duration, low  | 4P <sup>(1)</sup>             |     | ns   |

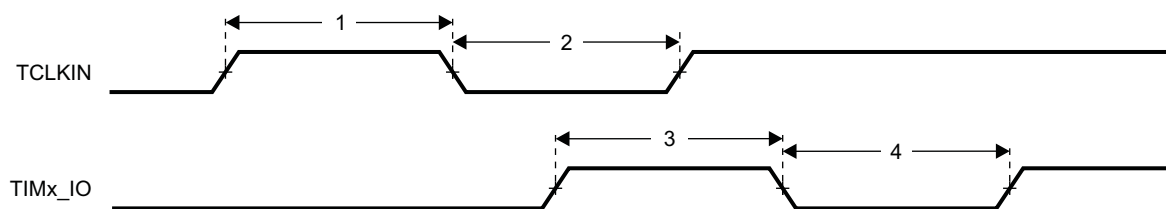
(1) P = module clock.

**Table 8-82. Switching Characteristics Over Recommended Operating Conditions for Timer**

(see [Figure 8-93](#))

| NO. | PARAMETER      |                      | OPP100/OPP120/<br>Turbo/Nitro |     | UNIT |
|-----|----------------|----------------------|-------------------------------|-----|------|
|     |                |                      | MIN                           | MAX |      |
| 3   | $t_{W(EVTOH)}$ | Pulse duration, high | 4P-3 <sup>(1)</sup>           |     | ns   |
| 4   | $t_{W(EVTOL)}$ | Pulse duration, low  | 4P-3 <sup>(1)</sup>           |     | ns   |

(1) P = module clock.



**Figure 8-93. Timer Timing**

## 8.19 Universal Asynchronous Receiver/Transmitter (UART)

The UART performs serial-to-parallel conversions on data received from a peripheral device and parallel-to-serial conversion on data received from the CPU. The device provides up to three UART peripheral interfaces, depending on the selected pin multiplexing.

Each UART has the following features:

- Selectable UART/IrDA (SIR/MIR)/CIR modes
- Dual 64-entry FIFOs for received and transmitted data payload
- Programmable and selectable transmit and receive FIFO trigger levels for DMA and interrupt generation
- Baud-rate generation based upon programmable divisors N (N=1...16384)
- Two DMA requests and one interrupt request to the system
- Can connect to any RS-232 compliant device.

UART functions include:

- Baud-rate up to 3.6 Mbit/s on UART0, UART1, and UART2
- Programmable serial interfaces characteristics
  - 5, 6, 7, or 8-bit characters
  - Even, odd, or no parity-bit generation and detection
  - 1, 1.5, or 2 stop-bit generation
  - Flow control: hardware (RTS/CTS) or software (XON/XOFF)
- Additional modem control functions (UART0\_DTR, UART0\_DSR, UART0\_DCD, and UART0\_RIN) for UART0 only; UART1 and UART2 do not support full-flow control signaling.

IR-IrDA functions include:

- Support of IrDA 1.4 slow infrared (SIR, baud-rate up to 115.2 Kbits/s), medium infrared (MIR, baud-rate up to 1.152 Mbits/s) and fast infrared (FIR baud-rate up to 4.0 Mbits/s) communications
- Supports framing error, cyclic redundancy check (CRC) error, illegal symbol (FIR), and abort pattern (SIR, MIR) detection
- 8-entry status FIFO (with selectable trigger levels) available to monitor frame length and frame errors.

IR-CIR functions include:

- Consumer infrared (CIR) remote control mode with programmable data encoding
- Free data format (supports any remote control private standards)
- Selectable bit rate and configurable carrier frequency.

For more detailed information on the UART peripheral, see the *UART/IrDA/CIR Module* chapter in the device-specific Technical Reference Manual.

### 8.19.1 UART Peripheral Register Descriptions

The UART peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

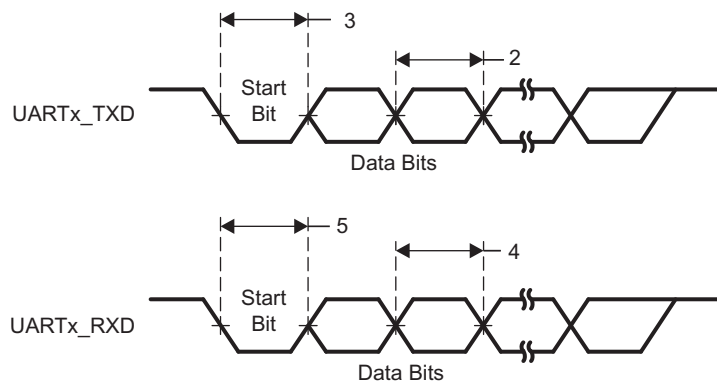
## 8.19.2 UART Electrical/Data Timing

**Table 8-83. Timing Requirements for UART**
(see [Figure 8-94](#))

| NO. |                 |                                                         | OPP100/OPP120/<br>Turbo/Nitro |               | UNIT |
|-----|-----------------|---------------------------------------------------------|-------------------------------|---------------|------|
|     |                 |                                                         | MIN                           | MAX           |      |
| 4   | $t_{w(RX)}$     | Pulse width, receive data bit, 15/30/100pF high or low  | $0.96U^{(1)}$                 | $1.05U^{(1)}$ | ns   |
| 5   | $t_{w(CTS)}$    | Pulse width, receive start bit, 15/30/100pF high or low | $0.96U^{(1)}$                 | $1.05U^{(1)}$ | ns   |
|     | $t_{d(RTS-TX)}$ | Delay time, transmit start bit to transmit data         | $P^{(2)}$                     |               | ns   |
|     | $t_{d(CTS-TX)}$ | Delay time, receive start bit to transmit data          | $P^{(2)}$                     |               | ns   |

(1)  $U$  = UART baud time =  $1/\text{programmed baud rate}$ (2)  $P$  = Clock period of the reference clock (FCLK, usually 48 MHz).
**Table 8-84. Switching Characteristics Over Recommended Operating Conditions for UART**
(see [Figure 8-94](#))

| NO. | PARAMETER           |                                                           | OPP100/OPP120/<br>Turbo/Nitro |               | UNIT |
|-----|---------------------|-----------------------------------------------------------|-------------------------------|---------------|------|
|     |                     |                                                           | MIN                           | MAX           |      |
|     | $f_{(\text{baud})}$ | Maximum programmable baud rate                            | 15 pF                         | 5             | MHz  |
|     |                     |                                                           | 30 pF                         | 0.23          |      |
|     |                     |                                                           | 100 pF                        | 0.115         |      |
| 2   | $t_{w(TX)}$         | Pulse width, transmit data bit, 15/30/100 pF high or low  | $U - 2^{(1)}$                 | $U + 2^{(1)}$ | ns   |
| 3   | $t_{w(RTS)}$        | Pulse width, transmit start bit, 15/30/100 pF high or low | $U - 2^{(1)}$                 | $U + 2^{(1)}$ | ns   |

(1)  $U$  = UART baud time =  $1/\text{programmed baud rate}$ 
**Figure 8-94. UART Timing**

## 8.20 Universal Serial Bus (USB2.0)

The device includes two USB2.0 modules which support the *Universal Serial Bus Specification Revision 2.0*. The following are some of the major USB features that are supported:

- USB 2.0 peripheral at high speed (HS: 480 Mbps) and full speed (FS: 12 Mbps)
- USB 2.0 host at HS, FS, and low speed (LS: 1.5 Mbps)
- Each endpoint (other than endpoint 0, control only) can support all transfer modes (control, bulk, interrupt, and isochronous)
- Supports high-bandwidth ISO mode
- Supports 15 Transmit (TX) and 15 Receive (RX) endpoints including endpoint 0
- FIFO RAM
  - 32K endpoint
  - Programmable size
- Includes two integrated PHYs
- RNDIS-like mode for terminating RNDIS-type protocols without using short-packet termination for support of MSC applications.
- USB Dual Role Device: Host Negotiation Protocol (HNP)

The USB2.0 peripherals do not support the following features:

- On-chip charge pump (VBUS Power must be generated external to the device.)
- RNDIS mode acceleration for USB sizes that are not multiples of 64 bytes
- Endpoint max USB packet sizes that do not conform to the USB 2.0 spec (for FS/LS: 8, 16, 32, 64, – and 1023 are defined; for HS: 64, 128, 512, and 1024 are defined)
- USB OTG extension: Session Request Protocol (SRP)

For more detailed information on the USB2.0 peripheral, see the *Universal Serial Bus (USB)* chapter in the device-specific Technical Reference Manual.

### 8.20.1 USB2.0 Peripheral Register Descriptions

The USB peripheral registers are described in the device-specific Technical Reference Manual. Each register is documented as an offset from a base address for the peripheral. The base addresses for all of the peripherals are in the device memory map (see [Section 2.10](#)).

## 8.20.2 USB2.0 Electrical Data/Timing

**Table 8-85. Switching Characteristics Over Recommended Operating Conditions for USB2.0**

(see [Figure 8-95](#))

| NO. | PARAMETER                 |                                                               | OPP100/OPP120/<br>Turbo/Nitro |      |                       |      |                        |      | UNIT |
|-----|---------------------------|---------------------------------------------------------------|-------------------------------|------|-----------------------|------|------------------------|------|------|
|     |                           |                                                               | LOW SPEED<br>1.5 Mbps         |      | FULL SPEED<br>12 Mbps |      | HIGH SPEED<br>480 Mbps |      |      |
|     |                           |                                                               | MIN                           | MAX  | MIN                   | MAX  | MIN                    | MAX  |      |
| 1   | t <sub>r(D)</sub>         | Rise time, USBx_DP and USBx_DM signals <sup>(1)</sup>         | 75                            | 300  | 4                     | 20   | 0.5                    |      | ns   |
| 2   | t <sub>f(D)</sub>         | Fall time, USBx_DP and USBx_DM signals <sup>(1)</sup>         | 75                            | 300  | 4                     | 20   | 0.5                    |      | ns   |
| 3   | t <sub>rfM</sub>          | Rise/Fall time, matching <sup>(2)</sup>                       | 80                            | 125  | 90                    | 111  | –                      | –    | %    |
| 4   | V <sub>CRS</sub>          | Output signal cross-over voltage <sup>(1)</sup>               | 1.3                           | 2    | 1.3                   | 2    | –                      | –    | V    |
| 5   | t <sub>jr(source)NT</sub> | Source (Host) Driver jitter, next transition                  |                               | 2    |                       | 2    |                        | (3)  | ns   |
|     | t <sub>jr(FUNC)NT</sub>   | Function Driver jitter, next transition                       |                               | 25   |                       | 2    |                        | (3)  | ns   |
| 6   | t <sub>jr(source)PT</sub> | Source (Host) Driver jitter, paired transition <sup>(4)</sup> |                               | 1    |                       | 1    |                        | (3)  | ns   |
|     | t <sub>jr(FUNC)PT</sub>   | Function Driver jitter, paired transition                     |                               | 10   |                       | 1    |                        | (3)  | ns   |
| 7   | t <sub>w(EOPT)</sub>      | Pulse duration, EOP transmitter                               | 1250                          | 1500 | 160                   | 175  | –                      | –    | ns   |
| 8   | t <sub>w(EOPR)</sub>      | Pulse duration, EOP receiver <sup>(5)</sup>                   | 670                           |      | 82                    |      | –                      |      | ns   |
| 9   | t <sub>(DRATE)</sub>      | Data Rate                                                     |                               | 1.5  |                       | 12   |                        | 480  | Mb/s |
| 10  | Z <sub>DRV</sub>          | Driver Output Resistance                                      | –                             | –    | 28                    | 49.5 | 40.5                   | 49.5 | Ω    |
| 11  | Z <sub>INP</sub>          | Receiver Input Impedance                                      | 300                           |      | 300                   | –    | –                      | –    | kΩ   |

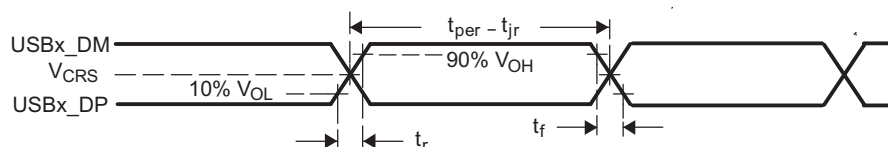
(1) Low Speed:  $C_L = 200$  pF, Full Speed:  $C_L = 50$  pF, High Speed:  $C_L = 50$  pF

(2)  $t_{RFM} = (t_r/t_f) \times 100$ . [Excluding the first transaction from the Idle state.]

(3) For more detailed information, see the Universal Serial Bus Specification Revision 2.0, Chapter 7, *Electrical*.

(4)  $t_{jr} = t_{px(1)} - t_{px(0)}$

(5) Must accept as valid EOP.



**Figure 8-95. USB2.0 Integrated Transceiver Interface Timing**

For more detailed information on USB2.0 board design, routing, and layout guidelines, see the *USB 2.0 Board Design and Layout Guidelines* Application Report (Literature Number: [SPRAAR7](#)).



## 9 Device and Documentation Support

### 9.1 Device Support

#### 9.1.1 Development Support

TI offers an extensive line of development tools, including tools to evaluate the performance of the processors, generate code, develop algorithm implementations, and fully integrate and debug software and hardware modules. The tool's support documentation is electronically available within the Code Composer Studio™ Integrated Development Environment (IDE).

The following products support development of DM385 processor applications:

**Software Development Tools:** Code Composer Studio™ Integrated Development Environment (IDE): including Editor C/C++/Assembly Code Generation, and Debug plus additional development tools Scalable, Real-Time Foundation Software ( Device/BIOS™), which provides the basic run-time target software needed to support any DM385 processor application.

**Reference Design Kits:** Production ready reference kits including hardware collaterals and software, for a faster time-to-market.

**Hardware Development Tools:** Extended Development System ( XDS™) Emulator

For a complete listing of development-support tools for the DM385 processor platform, visit the Texas Instruments website at [www.ti.com](http://www.ti.com). For information on pricing and availability, contact the nearest TI field sales office or authorized distributor.

### 9.1.2 Device and Development Support-Tool Nomenclature

To designate the stages in the product development cycle, TI assigns prefixes to the part numbers of all MPUs and support tools. Each device has one of three prefixes: X, P, or null (no prefix). Texas Instruments recommends two of three possible prefix designators for its support tools: TMDX and TMDS. These prefixes represent evolutionary stages of product development from engineering prototypes (TMDX) through fully qualified production devices/tools (TMDS).

Device development evolutionary flow:

- |             |                                                                                                                                                        |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>X</b>    | Pre-production device that is not necessarily representative of the final device's electrical specifications and may not use production assembly flow. |
| <b>P</b>    | Prototype device that is not necessarily the final silicon die and may not necessarily meet final electrical specifications.                           |
| <b>null</b> | Production version of the silicon die that is fully qualified.                                                                                         |

Support tool development evolutionary flow:

- |             |                                                                                                          |
|-------------|----------------------------------------------------------------------------------------------------------|
| <b>TMDX</b> | Development-support product that has not yet completed Texas Instruments internal qualification testing. |
| <b>TMDS</b> | Fully-qualified development-support product.                                                             |

X and P devices and TMDX development-support tools are shipped against the following disclaimer:

"Developmental product is intended for internal evaluation purposes."

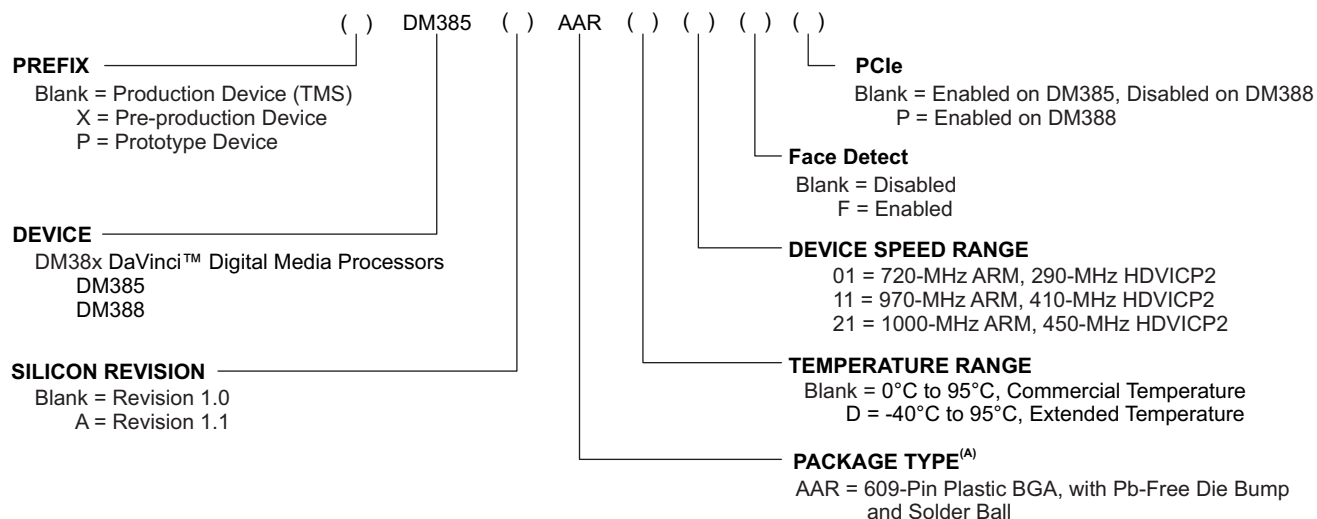
Production devices and TMDS development-support tools have been characterized fully, and the quality and reliability of the device have been demonstrated fully. TI's standard warranty applies.

Predictions show that prototype devices (X or P) have a greater failure rate than the standard production devices. Texas Instruments recommends that these devices not be used in any production system because their expected end-use failure rate still is undefined. Only qualified production devices are to be used.

### 9.1.3 Device Nomenclature

TI device nomenclature also includes a suffix with the device family name. This suffix indicates the package type (for example, AAR), the temperature range (for example, blank is the default commercial temperature range), and the device speed range (for example, 01 is the 720 MHz ARM device). [Figure 9-1](#) provides a legend for reading the complete device name for any DM385 device.

For device part numbers and further ordering information of DM385 devices in the AAR package type, see the TI website ([www.ti.com](http://www.ti.com)) or contact your TI sales representative.



**Figure 9-1. Device Nomenclature**

## 9.2 Documentation Support

Contact your TI sales representative for support documents.

For additional peripheral information, see the latest version of the *DM38x DaVinci™ Digital Media Processor Technical Reference Manual* (Literature Number: SPRUHG1).

## 9.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

**[TI E2E Community](#)** *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

**[TI Embedded Processors Wiki](#)** *Texas Instruments Embedded Processors Wiki*. Established to help developers get started with Embedded Processors from Texas Instruments and to foster innovation and growth of general knowledge about the hardware and software surrounding these devices.

## 10 Mechanical

Table 10-1 shows the thermal resistance characteristics for the PBGA–AAR mechanical package.

The device package has been specially engineered with a new technology called Via Channel™, allowing 0.8 mm PCB design rules to be employed. This allows larger than normal PCB via and trace sizes and reduced PCB signal layers to be used in a PCB design with this 0.5 mm pitch package, and will substantially reduce PCB costs. It also allows PCB routing in only two signal layers (four layers total deleted) due to the increased layer efficiency of the Via Channel™ BGA technology.

### 10.1 Thermal Data for the AAR

**Table 10-1. Thermal Resistance Characteristics (PBGA Package) [AAR]**

|                            |                                         | Air Flow (m/s) <sup>(1)</sup> | °C/W <sup>(2)</sup> |
|----------------------------|-----------------------------------------|-------------------------------|---------------------|
| $\Theta_{JA/JMA}$          | Junction-to-air/ Junction-to-moving air | still air                     | 17.79               |
|                            |                                         | 1.0 m/s                       | 13.36               |
|                            |                                         | 2.0 m/s                       | 12.54               |
|                            |                                         | 3.0 m/s                       | 12.04               |
| $\Psi_{JT}$                | Junction-to-package top                 | still air                     | 0.08                |
|                            |                                         | 1.0 m/s                       | 0.16                |
|                            |                                         | 2.0 m/s                       | 0.20                |
|                            |                                         | 3.0 m/s                       | 0.23                |
| $\Psi_{JB}$                | Junction-to-board                       | still air                     | 4.90                |
|                            |                                         | 1.0 m/s                       | 4.81                |
|                            |                                         | 2.0 m/s                       | 4.78                |
|                            |                                         | 3.0 m/s                       | 4.76                |
| $\Theta_{JB}$              | Junction-to-board                       |                               | 4.86                |
| $\Theta_{JC}$ (1SOP board) | Junction-to-case                        |                               | 3.84                |

(1) m/s = meters per second.

(2) These measurements were conducted in a JEDEC defined 2S2P system (with the exception of the Theta JC [ $\Theta_{JC}$ ] measurement, which was conducted in a JEDEC defined 1S0P system) and will change based on environment as well as application. For more information, see these EIA/JEDEC standards:

- JESD51-2, *Integrated Circuits Thermal Test Method Environment Conditions - Natural Convection (Still Air)*.
- JESD51-3, *Low Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*.
- JESD51-7, *High Effective Thermal Conductivity Test Board for Leaded Surface Mount Packages*.
- JESD51-9, *Test Boards for Area Array Surface Mount Packages*.

### 10.2 Packaging Information

The following packaging information and addendum reflect the most current data available for the designated device(s). This data is subject to change without notice and without revision of this document.

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| DM385AAAR01      | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM385AAAR01             | <a href="#">Samples</a> |
| DM385AAAR01F     | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM385AAAR01F            | <a href="#">Samples</a> |
| DM385AAAR11      | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM385AAAR11             | <a href="#">Samples</a> |
| DM385AAAR11F     | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM385AAAR11F            | <a href="#">Samples</a> |
| DM385AAAR21      | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM385AAAR21             | <a href="#">Samples</a> |
| DM385AAAR21F     | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM385AAAR21F            | <a href="#">Samples</a> |
| DM385AAARD21F    | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | -40 to 95    | DM385AAARD21F           | <a href="#">Samples</a> |
| DM388AAAR11      | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM388AAAR11             | <a href="#">Samples</a> |
| DM388AAAR11F     | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM388AAAR11F            | <a href="#">Samples</a> |
| DM388AAAR21      | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM388AAAR21             | <a href="#">Samples</a> |
| DM388AAAR21F     | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | 0 to 95      | DM388AAAR21F            | <a href="#">Samples</a> |
| DM388AAARD11     | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | -40 to 95    | DM388AAARD11            | <a href="#">Samples</a> |
| DM388AAARD11F    | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | -40 to 90    | DM388AAARD11F           | <a href="#">Samples</a> |
| DM388AAARD11FP   | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  |              | DM388AAARD11FP          | <a href="#">Samples</a> |
| DM388AAARD21     | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | -40 to 95    | DM388AAARD21            | <a href="#">Samples</a> |
| DM388AAARD21F    | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  | -40 to 95    | DM388AAARD21F           | <a href="#">Samples</a> |
| DM388AAARD21FP   | ACTIVE        | FCBGA        | AAR                | 609  | 90             | RoHS & Green    | Call TI                              | Level-3-260C-168 HR  |              | DM388AAARD21FP          | <a href="#">Samples</a> |

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm threshold requirement.

<sup>(3)</sup> MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

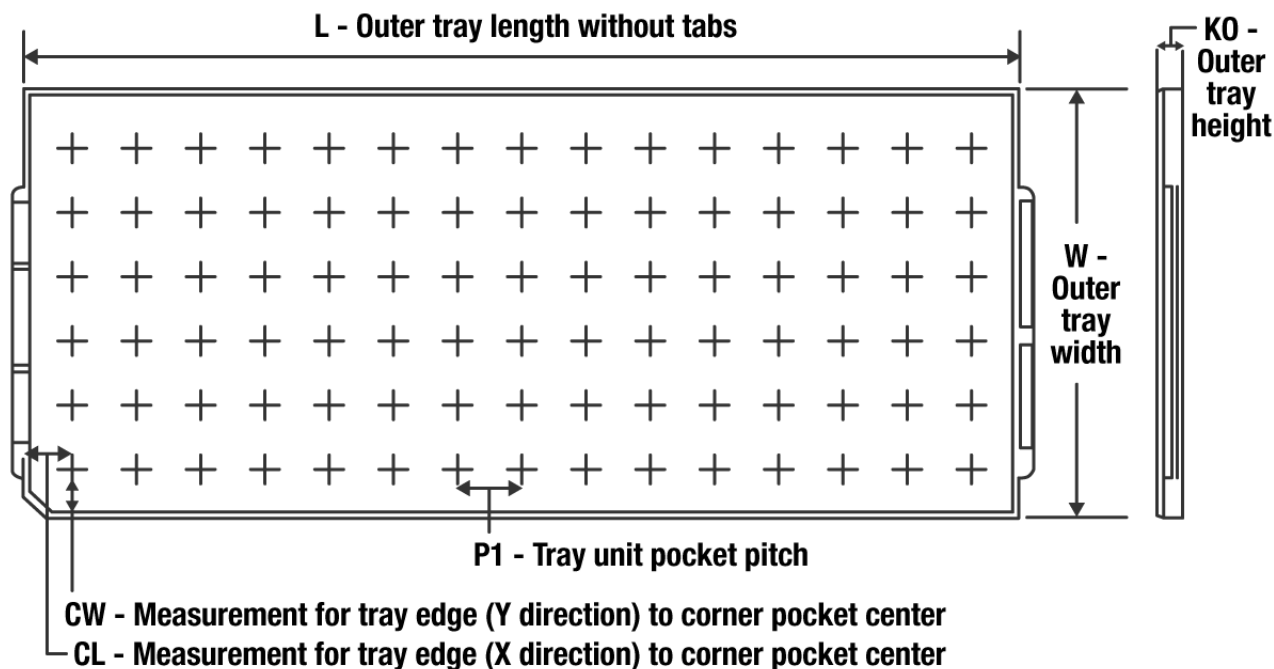
<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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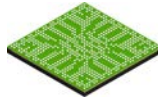
## TRAY



Chamfer on Tray corner indicates Pin 1 orientation of packed units.

\*All dimensions are nominal

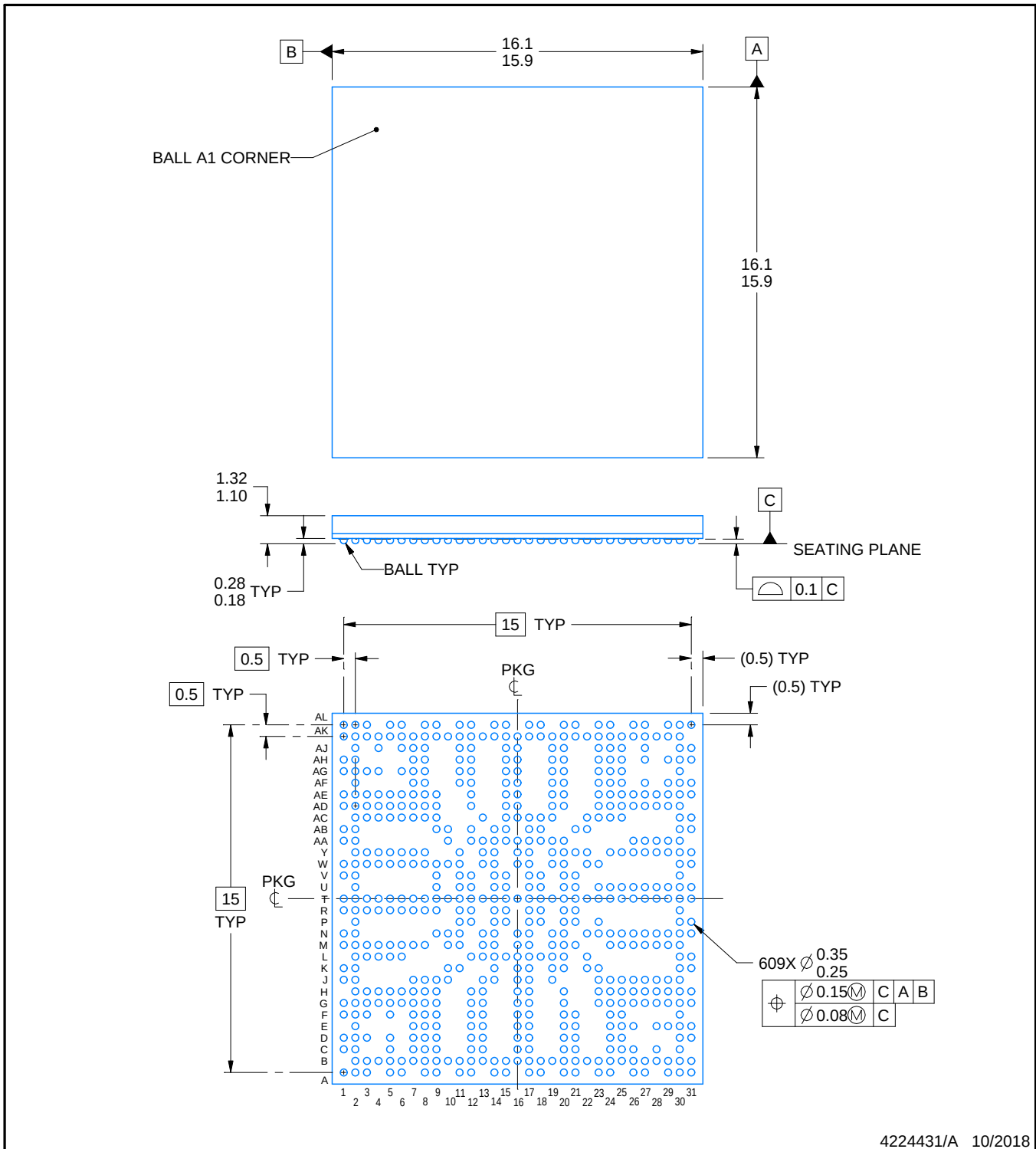
| Device         | Package Name | Package Type | Pins | SPQ | Unit array matrix | Max temperature (°C) | L (mm) | W (mm) | K0 (µm) | P1 (mm) | CL (mm) | CW (mm) |
|----------------|--------------|--------------|------|-----|-------------------|----------------------|--------|--------|---------|---------|---------|---------|
| DM385AAAR01    | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM385AAAR01F   | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM385AAAR11    | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM385AAAR11F   | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM385AAAR21    | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM385AAAR21F   | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM385AAARD21F  | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAAR11    | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAAR11F   | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAAR21    | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAAR21F   | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAARD11   | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAARD11F  | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAARD11FP | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAARD21   | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAARD21F  | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |
| DM388AAARD21FP | AAR          | FCCSP        | 609  | 90  | 6 X 15            | 150                  | 315    | 135.9  | 7620    | 20      | 17.5    | 15.45   |



**AAR0609A**

# **PACKAGE OUTLINE** **FCBGA - 1.32 mm max height**

BALL GRID ARRAY



## NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Pb-free solder ball design.

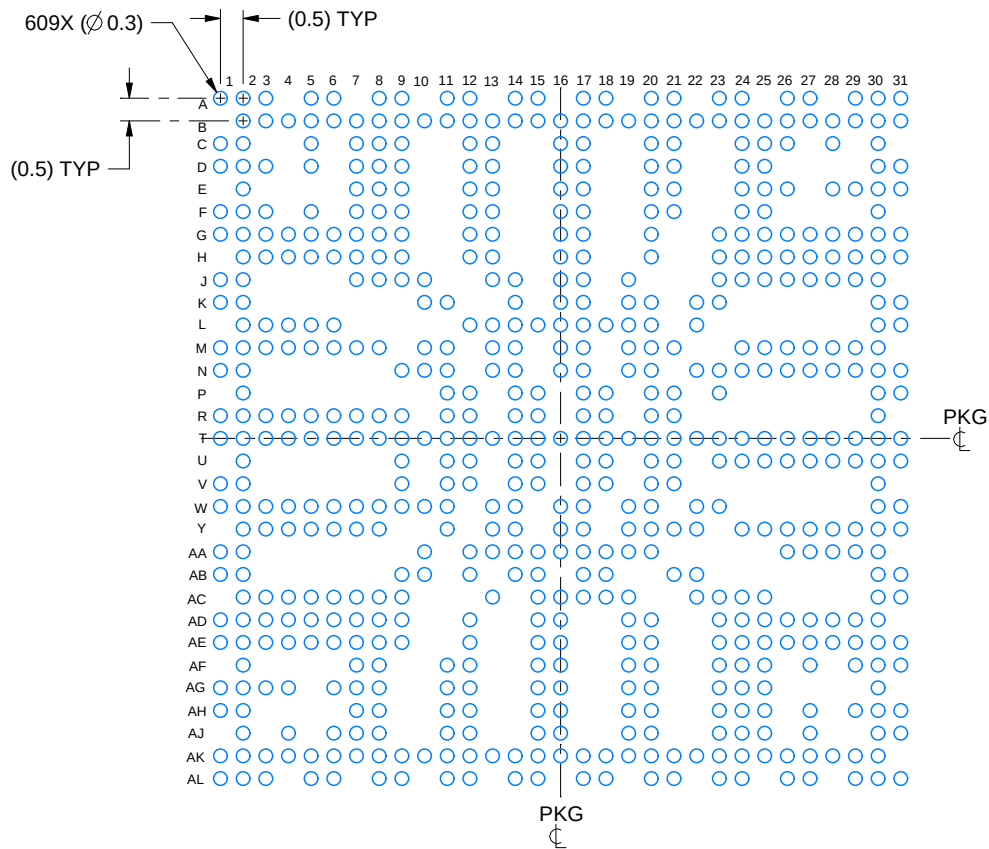


# EXAMPLE BOARD LAYOUT

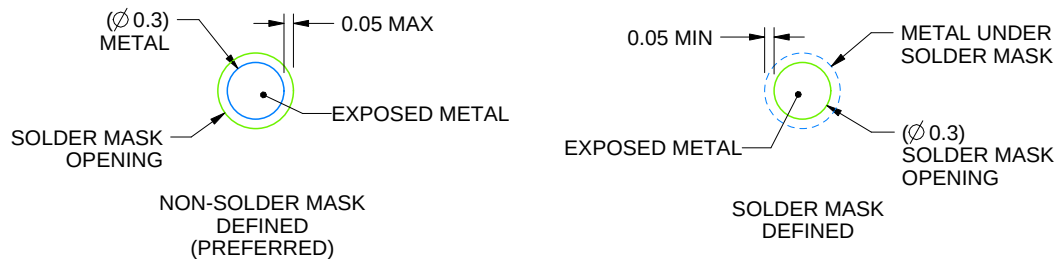
AAR0609A

FCBGA - 1.32 mm max height

BALL GRID ARRAY



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:6X



SOLDER MASK DETAILS  
NOT TO SCALE

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NOTES: (continued)

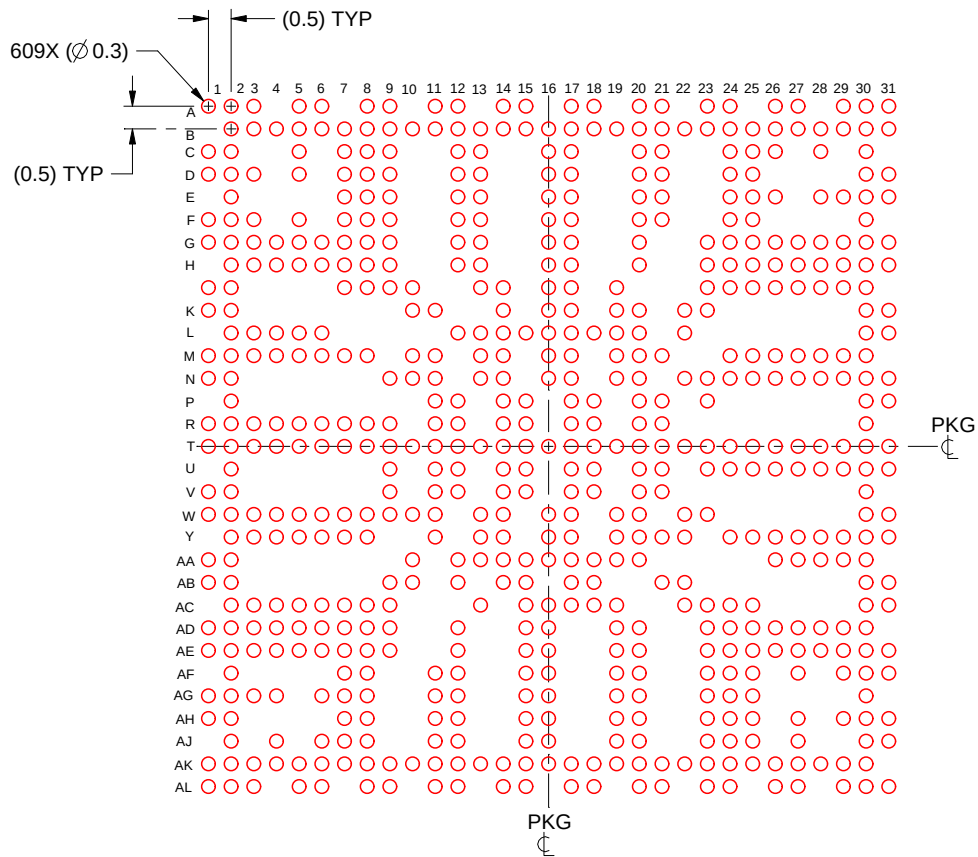
5. Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. For more information, see Texas Instruments literature number SPRU811 ([www.ti.com/lit/spru811](http://www.ti.com/lit/spru811)).

# EXAMPLE STENCIL DESIGN

AAR0609A

FCBGA - 1.32 mm max height

BALL GRID ARRAY



SOLDER PASTE EXAMPLE  
 BASED ON 0.1 mm THICK STENCIL  
 SCALE:6X

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

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