



# DS90UB927Q-Q1 具有双向控制通道的 5MHz 至 85MHz 24 位彩色 FPD-Link III 串行器

## 1 特性

- 双向控制通道接口，可连接到 I<sup>2</sup>C 兼容串行控制总线
- 低电磁干扰 (EMI) FPD-Link 视频输入
- 支持高清 (720p) 数字视频格式
- 支持 5MHz 至 85MHz 像素时钟 (PCLK)
- 支持 RGB888 + VS、HS、DE 和 I<sup>2</sup>S 音频
- 多达 4 个针对环绕立体声应用的 I<sup>2</sup>S 数字音频输入
- 4 条具有 2 个专用引脚的双向通用输入输出 (GPIO) 通道
- 通过 1.8V 或 3.3V 兼容 LVCMOS I/O 接口实现 3.3V 单电源运行
- 长达 10 米的交流耦合屏蔽双绞线 (STP) 互连
- 具有嵌入式时钟的直流均衡和扰频数据
- 支持中继器应用
- 内部模式生成
- 低功率模式最大限度地减少了功率耗散
- 汽车应用级产品：符合 AEC-Q100 2 级要求
- >8kV 的人体模型 (HBM) 和 ISO 10605 静电放电 (ESD) 额定值
- 向后兼容模式

## 2 应用范围

- 汽车导航显示屏
- 后座娱乐系统
- 汽车驾驶员辅助系统
- 车载百万像素级摄像机系统

## 3 说明

DS90UB927Q-Q1 串行器与 DS90UB928Q-Q1 或 DS90UB926Q-Q1 解串器配套使用，可提供完整的数字接口以实现汽车显示屏和图像传感应用中视频、音频和控制数据的高速并行传输。

该芯片组非常适合高清 (HD) 格式的车载视频显示系统以及具有百万像素级分辨率的车载视觉系统。

DS90UB927Q-Q1 整合了嵌入式双向控制通道和低延迟 GPIO 控制。该器件将 FPD-Link 视频接口转换为单对高速串行化接口。FPD-Link III 串行总线方案支持通过单个差分链路实现高速正向通道数据传输和低速反向通道通信的全双工控制。通过单个差分对整合音频、视频和控制数据可减小互连线尺寸和重量，同时还消除了偏差问题并简化了系统设计。

DS90UB927Q-Q1 串行器嵌入了时钟，并将信号电平位移至高速低压差分信号。多达 24 个 RGB 数据位连同 3 个视频控制信号和多达 4 个 I<sup>2</sup>S 数据输入一起被串行化。

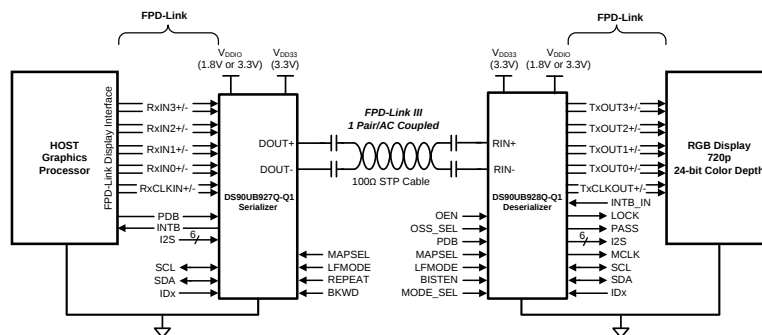
凭借 FPD-Link 数据接口，该器件可轻松连接数据源，同时还能减小 EMI 和总线宽度。通过使用低压差分信号、数据扰频和随机生成以及直流均衡功能可最大程度减少高速 FPD-Link III 总线上的 EMI。

### 器件信息<sup>(1)</sup>

| 器件型号          | 封装        | 封装尺寸 (标称值)      |
|---------------|-----------|-----------------|
| DS90UB927Q-Q1 | WQFN (40) | 6.00mm x 6.00mm |

(1) 如需了解所有可用封装，请见数据表末尾的可订购产品附录。

### 应用图



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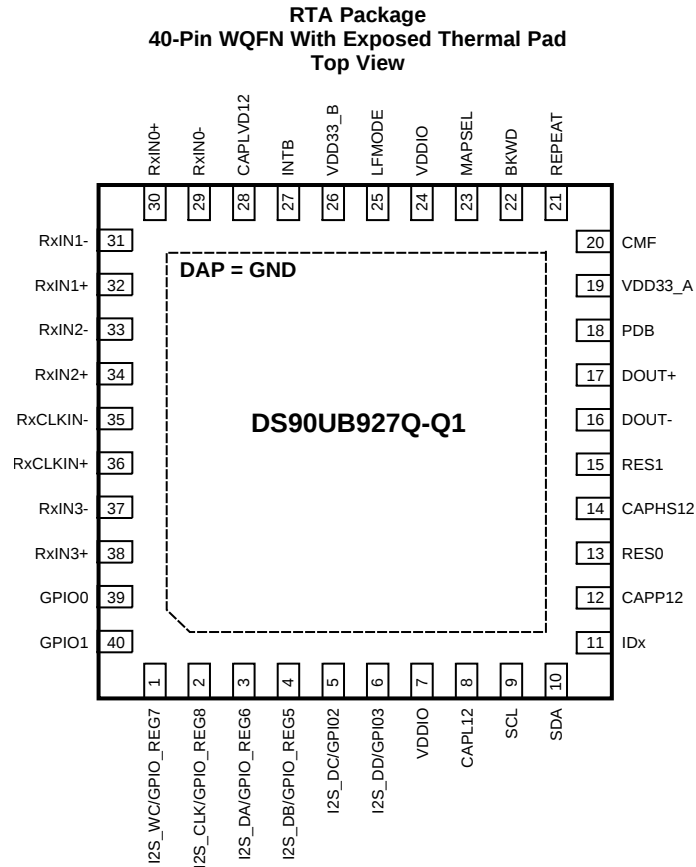
## 4 修订历史记录

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

| Changes from Revision C (October 2012) to Revision D                                    | Page |
|-----------------------------------------------------------------------------------------|------|
| • 已添加 ESD 额定值表, 特性描述部分, 器件功能模式, 应用和实施部分, 电源相关建议部分, 布局部分, 器件和文档支持部分以及机械、封装和可订购信息部分 ..... | 1    |

| Changes from Revision B (June 2012) to Revision C          | Page |
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| • Changed layout of National data sheet to ti format ..... | 49   |

## 5 Pin Configuration and Functions



### Pin Functions

| PIN                                  |                   | I/O                           | DESCRIPTION                                                                                                                                                                          |
|--------------------------------------|-------------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                 | NO.               |                               |                                                                                                                                                                                      |
| FPD-LINK INPUT INTERFACE             |                   |                               |                                                                                                                                                                                      |
| RxCLKIN-                             | 35                | I, LVDS                       | Inverting LVDS Clock Input<br>The pair requires external 100-Ω differential termination for standard LVDS levels                                                                     |
| RxCLKIN+                             | 36                | I, LVDS                       | True LVDS Clock Input<br>The pair requires external 100-Ω differential termination for standard LVDS levels                                                                          |
| RxIN[3:0]-                           | 37, 33,<br>31, 29 | I, LVDS                       | Inverting LVDS Data Inputs<br>Each pair requires external 100-Ω differential termination for standard LVDS levels                                                                    |
| RxIN[3:0]+                           | 38, 34,<br>32, 30 | I, LVDS                       | True LVDS Data Inputs<br>Each pair requires external 100-Ω differential termination for standard LVDS levels                                                                         |
| LVC MOS PARALLEL INTERFACE           |                   |                               |                                                                                                                                                                                      |
| BKWD                                 | 22                | I, LVC MOS<br>with pulldown   | Backward Compatible Mode Select<br>BKWD = 0, interfacing to DS90UH926/8Q-Q1 (Default)<br>BKWD = 1, interfacing to DS90UR906/8Q-Q1, DS90UR916Q<br>Requires a 10-kΩ pullup if set HIGH |
| GPIO[1:0]                            | 40, 39            | I/O, LVC MOS<br>with pulldown | General Purpose I/O<br>See <a href="#">Table 1</a>                                                                                                                                   |
| I2S_DA<br>I2S_DB<br>I2S_DC<br>I2S_DD | 3<br>4<br>5<br>6  | I, LVC MOS<br>with pulldown   | Digital Audio Interface I <sup>2</sup> S Data Inputs<br>Shared with GPIO_REG6, GPIO_REG5, GPIO2, GPIO3                                                                               |
| I2S_WC<br>I2S_CLK                    | 1<br>2            | I, LVC MOS<br>with pulldown   | Digital Audio Interface I <sup>2</sup> S Word Clock and I <sup>2</sup> S Bit Clock Inputs<br>Shared with GPIO_REG7 and GPIO_REG8 ( <a href="#">Table 3</a> )                         |

**Pin Functions (continued)**

| PIN                                  |            | I/O                       | DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------|------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| NAME                                 | NO.        |                           |                                                                                                                                                                                                                                                                                                                                                                                                             |
| LFMODE                               | 25         | I, LVCMOS with pulldown   | Low Frequency Mode Select<br>LFMODE = 0, 15 MHz ≤ RxCLKIN ≤ 85 MHz (Default)<br>LFMODE = 1, 5 MHz ≤ RxCLKIN < 15 MHz<br>Requires a 10-kΩ pullup if set HIGH                                                                                                                                                                                                                                                 |
| MAPSEL                               | 23         | I, LVCMOS with pulldown   | FPD-Link Input Map Select<br>MAPSEL = 0, LSBs on RxIN3± (Default)<br>MAPSEL = 1, MSBs on RxIN3±<br>See <a href="#">Figure 19</a> and <a href="#">Figure 20</a><br>Requires a 10-kΩ pullup if set HIGH                                                                                                                                                                                                       |
| REPEAT                               | 21         | I, LVCMOS with pulldown   | Repeater Mode Select<br>REPEAT = 0, Repeater Mode disabled (Default)<br>REPEAT = 1, Repeater Mode enabled<br>Requires a 10-kΩ pullup if set HIGH                                                                                                                                                                                                                                                            |
| <b>OPTIONAL PARALLEL INTERFACE</b>   |            |                           |                                                                                                                                                                                                                                                                                                                                                                                                             |
| GPIO[3:2]                            | 6, 5       | I/O, LVCMOS with pulldown | General Purpose I/O<br>Shared with I2S_DD and I2S_DC (See <a href="#">Table 1</a> )                                                                                                                                                                                                                                                                                                                         |
| GPIO_REG [8:5]                       | 2, 1, 3, 4 | I/O, LVCMOS with pulldown | Register-Only General Purpose I/O<br>Shared with I2S_CLK, I2S_WC, I2S_DA, I2S_DB (See <a href="#">Table 2</a> )                                                                                                                                                                                                                                                                                             |
| <b>CONTROL AND CONFIGURATION</b>     |            |                           |                                                                                                                                                                                                                                                                                                                                                                                                             |
| IDx                                  | 11         | I, Analog                 | I <sup>2</sup> C Address Select<br>External pullup to V <sub>DD33</sub> is required under all conditions. <b>DO NOT FLOAT.</b><br>Connect to external pullup to V <sub>DD33</sub> and pulldown to GND to create a voltage divider.<br>See <a href="#">Figure 25</a> and <a href="#">Table 4</a>                                                                                                             |
| PDB                                  | 18         | I, LVCMOS with pulldown   | Power-down Mode Input Pin<br>Must be driven or pulled up to V <sub>DD33</sub> . Refer to <a href="#">Power Supply Recommendations</a> .<br>PDB = H, device is enabled (normal operation)<br>PDB = L, device is powered down.<br>When the device is in the powered down state, the Driver Outputs are both HIGH, the PLL is shutdown, and I <sub>DD</sub> is minimized. Control Registers are <b>RESET</b> . |
| SCL                                  | 9          | I/O, LVCMOS Open Drain    | I <sup>2</sup> C Clock Input / Output Interface<br>Must have an external pullup to V <sub>DD33</sub> . <b>DO NOT FLOAT.</b><br>Recommended pullup: 4.7 kΩ.                                                                                                                                                                                                                                                  |
| SDA                                  | 10         | I/O, LVCMOS Open Drain    | I <sup>2</sup> C Data Input / Output Interface<br>Must have an external pullup to V <sub>DD33</sub> . <b>DO NOT FLOAT.</b><br>Recommended pullup: 4.7 kΩ.                                                                                                                                                                                                                                                   |
| <b>STATUS</b>                        |            |                           |                                                                                                                                                                                                                                                                                                                                                                                                             |
| INTB                                 | 27         | O, LVCMOS Open Drain      | Interrupt<br>INTB = H, normal<br>INTB = L, Interrupt request<br>Recommended pullup: 4.7 kΩ to V <sub>DDIO</sub> . <b>DO NOT FLOAT.</b>                                                                                                                                                                                                                                                                      |
| <b>FPD-LINK III SERIAL INTERFACE</b> |            |                           |                                                                                                                                                                                                                                                                                                                                                                                                             |
| CMF                                  | 20         | Analog                    | Common Mode Filter.<br>Connect 0.1 μF to GND (required)                                                                                                                                                                                                                                                                                                                                                     |
| DOUT-                                | 16         | I/O, LVDS                 | Inverting Output<br>The output must be AC-coupled with a 0.1-μF capacitor.                                                                                                                                                                                                                                                                                                                                  |
| DOUT+                                | 17         | I/O, LVDS                 | True Output<br>The output must be AC-coupled with a 0.1-μF capacitor.                                                                                                                                                                                                                                                                                                                                       |

### Pin Functions (continued)

| PIN                             |                | I/O    | DESCRIPTION                                                                                                                   |
|---------------------------------|----------------|--------|-------------------------------------------------------------------------------------------------------------------------------|
| NAME                            | NO.            |        |                                                                                                                               |
| POWER <sup>(1)</sup> AND GROUND |                |        |                                                                                                                               |
| GND                             | DAP            | Ground | Large metal contact at the bottom center of the device package <b>Connect to the ground plane (GND) with at least 9 vias.</b> |
| VDD33_A<br>VDD33_B              | 19<br>26       | Power  | Power to on-chip regulator <b>3.0 V - 3.6 V</b> . Each pin requires a 4.7-μF capacitor to GND                                 |
| VDDIO                           | 7, 24          | Power  | LVCMOS I/O Power <b>1.8 V ±5% OR 3.0 V - 3.6 V</b> . Each pin requires 4.7-μF capacitor to GND                                |
| REGULATOR CAPACITOR             |                |        |                                                                                                                               |
| CAPL12                          | 8              | CAP    | Decoupling capacitor connection for on-chip regulator<br>Requires two 4.7-μF decoupling capacitors to GND                     |
| CAPP12<br>CAPHS12<br>CAPLVD12   | 12<br>14<br>28 | CAP    | Decoupling capacitor connection for on-chip regulator<br>Each requires a 4.7-μF decoupling capacitor to GND.                  |
| OTHER                           |                |        |                                                                                                                               |
| RES[1:0]                        | 15, 13         | GND    | Reserved<br>Connect to GND.                                                                                                   |

(1) The  $V_{DD}$  ( $V_{DD33}$  and  $V_{DDIO}$ ) supply ramp should be faster than 1.5 ms with a monotonic rise.

## 6 Specifications

### 6.1 Absolute Maximum Ratings<sup>(1)(2)(3)</sup>

|                                | MIN  | MAX              | UNIT |
|--------------------------------|------|------------------|------|
| Supply Voltage – $V_{DD33}$    | –0.3 | 4.0              | V    |
| Supply Voltage – $V_{DDIO}$    | –0.3 | 4.0              | V    |
| LVCMOS I/O Voltage             | –0.3 | $V_{DDIO} + 0.3$ | V    |
| Serializer Output Voltage      | –0.3 | 2.75             | V    |
| Junction Temperature           |      | 150              | °C   |
| Storage Temperature, $T_{stg}$ | –65  | 150              | °C   |

- (1) For soldering specifications: see product folder at [www.ti.com](http://www.ti.com) and [SNOA549](#).  
(2) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.  
(3) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.

### 6.2 ESD Ratings

|                                     |                                                                                                                                                | VALUE  | UNIT |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------|------|
| $V_{(ESD)}$ Electrostatic discharge | Human body model (HBM), per AEC Q100-002 <sup>(1)</sup>                                                                                        | ±8000  | V    |
|                                     | Charged device model (CDM), per AEC Q100-011                                                                                                   | ±1250  |      |
|                                     | Machine model (MM)                                                                                                                             | ±250   |      |
|                                     | (IEC 61000-4-2, powered-up only)<br>$R_D = 330 \Omega$ , $C_S = 150 \text{ pF}$                                                                | ±15000 |      |
|                                     | Air Discharge<br>(Pin 16 and 17)                                                                                                               | ±15000 |      |
|                                     | Contact Discharge<br>(Pin 16 and 17)                                                                                                           | ±8000  |      |
|                                     | (ISO 10605)<br>$R_D = 330 \Omega$ , $C_S = 150 \text{ pF}/330 \text{ pF}$<br>$R_D = 2 \text{ k}\Omega$ , $C_S = 150 \text{ pF}/330 \text{ pF}$ | ±15000 |      |
|                                     | Air Discharge<br>(Pin 16 and 17)                                                                                                               | ±15000 |      |
|                                     | Contact Discharge<br>(Pin 16 and 17)                                                                                                           | ±8000  |      |

(1) AEC Q100-002 indicates HBM stressing is done in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 6.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

|                                                     |                                               | MIN  | NOM | MAX  | UNIT              |
|-----------------------------------------------------|-----------------------------------------------|------|-----|------|-------------------|
| Supply Voltage ( $V_{DD33}$ )                       |                                               | 3.0  | 3.3 | 3.6  | V                 |
| LVCMOS Supply Voltage ( $V_{DDIO}$ ) <sup>(1)</sup> | Connect $V_{DDIO}$ to 3.3 V and use 3.3-V IOs | 3.0  | 3.3 | 3.6  | V                 |
|                                                     | Connect $V_{DDIO}$ to 1.8 V and use 1.8-V IOs | 1.71 | 1.8 | 1.89 |                   |
| Operating Free Air Temperature ( $T_A$ )            |                                               | –40  | +25 | +105 | °C                |
| PCLK Frequency                                      |                                               | 5    |     | 85   | MHz               |
| Supply Noise <sup>(2)</sup>                         |                                               |      |     | 100  | mV <sub>p-p</sub> |

 (1)  $V_{DDIO} < V_{DD33} + 0.3$  V

 (2) Supply noise testing was done with minimum capacitors on the PCB. A sinusoidal signal is AC coupled to the  $V_{DD33}$  and  $V_{DDIO}$  supplies with amplitude = 100 mV<sub>p-p</sub> measured at the device  $V_{DD33}$  and  $V_{DDIO}$  pins. Bit error rate testing of input to the Ser and output of the Des with 10 meter cable shows no error when the noise frequency on the Ser is less than 50 MHz. The Des on the other hand shows no error when the noise frequency is less than 50 MHz.

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                              | DS90UB927Q-Q1 | UNIT |
|-------------------------------|----------------------------------------------|---------------|------|
|                               |                                              | RTA (WQFN)    |      |
|                               |                                              | 40 PINS       |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 29.0          | °C/W |
| $R_{\theta JC(top)}$          | Junction-to-case (top) thermal resistance    | 14.4          |      |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 5.1           |      |
| $\Psi_{JT}$                   | Junction-to-top characterization parameter   | 0.2           |      |
| $\Psi_{JB}$                   | Junction-to-board characterization parameter | 5.1           |      |
| $R_{\theta JC(bot)}$          | Junction-to-case (bottom) thermal resistance | 1.4           |      |

 (1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, [SPRA953](#).

## 6.5 DC Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified.<sup>(1)(2)(3)</sup>

| PARAMETER         | TEST CONDITIONS              | PIN / FREQ                                                                             | MIN                      | NOM | MAX                        | UNIT |
|-------------------|------------------------------|----------------------------------------------------------------------------------------|--------------------------|-----|----------------------------|------|
| <b>LVCMOS I/O</b> |                              |                                                                                        |                          |     |                            |      |
| V <sub>IH</sub>   | High Level Input Voltage     | PDB                                                                                    | 2.0                      |     | V <sub>DDIO</sub>          | V    |
| V <sub>IL</sub>   | Low Level Input Voltage      |                                                                                        | GND                      |     | 0.8                        | V    |
| I <sub>IN</sub>   | Input Current                |                                                                                        | -15                      | ±1  | +15                        | μA   |
| V <sub>IH</sub>   | High Level Input Voltage     | GPIO[1:0]<br>I2S_CLK<br>I2S_WC<br>I2S_D[A,B,C,D]<br>LFMODE<br>MAPSEL<br>BKWD<br>REPEAT | 2.0                      |     | V <sub>DDIO</sub>          | V    |
|                   |                              |                                                                                        | 0.65*V <sub>DDIO</sub>   |     | V <sub>DDIO</sub>          | V    |
| V <sub>IL</sub>   | Low Level Input Voltage      |                                                                                        | GND                      |     | 0.8                        | V    |
|                   |                              |                                                                                        | GND                      |     | 0.35*<br>V <sub>DDIO</sub> | V    |
| I <sub>IN</sub>   | Input Current                |                                                                                        | -15                      | ±1  | +15                        | μA   |
|                   |                              |                                                                                        | -15                      | ±1  | +15                        | μA   |
| V <sub>OH</sub>   | High Level Output Voltage    | GPIO[3:0],<br>GPO_REG[8:5]                                                             | 2.4                      |     | V <sub>DDIO</sub>          | V    |
|                   |                              |                                                                                        | V <sub>DDIO</sub> - 0.45 |     | V <sub>DDIO</sub>          | V    |
| V <sub>OL</sub>   | Low Level Output Voltage     |                                                                                        | GND                      |     | 0.4                        | V    |
|                   |                              |                                                                                        | GND                      |     | 0.45                       | V    |
| I <sub>OS</sub>   | Output Short Circuit Current |                                                                                        |                          | -55 |                            | mA   |
| I <sub>OZ</sub>   | Tri-state Output Current     |                                                                                        | -15                      |     | +15                        | μA   |

- (1) The *Electrical Characteristics* tables list verified specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics* conditions and/or notes. Typical specifications are estimations only and are not verified.
- (2) Typical values represent most likely parametric norms at V<sub>DD33</sub> = 3.3 V, V<sub>DDIO</sub> = 1.8 V or 3.3 V, T<sub>A</sub> = 25°C, and at the *Recommended Operating Conditions* at the time of product characterization and are not verified.
- (3) Current into device pins is defined as positive. Current out of a device pin is defined as negative. Voltages are referenced to ground except V<sub>OD</sub> and ΔV<sub>OD</sub>, which are differential voltages. Supply noise testing was done with minimum capacitors on the PCB. A sinusoidal signal is AC coupled to the supply pins with amplitude = 100 mVp-p measured at the device V<sub>DD33</sub> and V<sub>DDIO</sub> pins. Bit error rate testing of input to the serializer and output of the deserializer with 10 meter cable shows no error when the noise frequency is less than 50 MHz.
- (4) PDB is specified to 3.3 V LVCMOS only and must be driven or pulled up to V<sub>DD33</sub> or to V<sub>DDIO</sub> ≥ 3.0 V

**DS90UB927Q-Q1**

ZHCSDA3D – JUNE 2012 – REVISED JANUARY 2015

[www.ti.com.cn](http://www.ti.com.cn)
**DC Electrical Characteristics (continued)**

 Over recommended operating supply and temperature ranges unless otherwise specified.<sup>(1)(2)(3)</sup>

| PARAMETER               |                                                            | TEST CONDITIONS                            |                            | PIN / FREQ | MIN | NOM                                      | MAX  | UNIT              |     |
|-------------------------|------------------------------------------------------------|--------------------------------------------|----------------------------|------------|-----|------------------------------------------|------|-------------------|-----|
| FPD-LINK LVDS RECEIVER  |                                                            |                                            |                            |            |     |                                          |      |                   |     |
| V <sub>TH</sub>         | Threshold High Voltage                                     | V <sub>CM</sub> = 1.2 V                    | RxCLKIN±<br>RxIN[3:0]±     |            |     |                                          | +100 | mV                |     |
| V <sub>TL</sub>         | Threshold Low Voltage                                      |                                            |                            |            |     |                                          | −100 | mV                |     |
| V <sub>ID</sub>         | Differential Input Voltage Swing                           |                                            |                            |            |     | 200                                      |      | 600               | mV  |
| V <sub>CM</sub>         | Common Mode Voltage                                        |                                            |                            |            |     | 0                                        | 1.2  | 2.4               | V   |
| I <sub>IN</sub>         | Input Current                                              |                                            |                            |            |     |                                          | −10  |                   | +10 |
| FPD-LINK III CML DRIVER |                                                            |                                            |                            |            |     |                                          |      |                   |     |
| V <sub>ODp-p</sub>      | Differential Output Voltage (DOUT+) – (DOUT-)              | R <sub>L</sub> = 100 Ω (Figure 1)          | DOUT±                      |            | 800 | 1000                                     | 1200 | mV <sub>p-p</sub> |     |
| ΔV <sub>OD</sub>        | Output Voltage Unbalance                                   |                                            |                            |            |     | 1                                        |      | 50                | mV  |
| V <sub>OS</sub>         | Offset Voltage – Single-ended                              | R <sub>L</sub> = 100 Ω (Figure 1)          |                            |            |     | 2.5-0.25*<br>V <sub>ODp-p</sub><br>(TYP) |      |                   | V   |
| ΔV <sub>OS</sub>        | Offset Voltage Unbalance Single-ended                      |                                            |                            |            |     | 1                                        |      | 50                | mV  |
| I <sub>OS</sub>         | Output Short Circuit Current                               | DOUT+/- = 0 V, PDB = L or H <sup>(5)</sup> |                            |            |     |                                          | −30  |                   | mA  |
| R <sub>T</sub>          | Internal Termination Resistance - Differential             |                                            |                            |            |     | 80                                       | 100  | 120               | Ω   |
| SUPPLY CURRENT          |                                                            |                                            |                            |            |     |                                          |      |                   |     |
| I <sub>DD1</sub>        | Supply Current<br>R <sub>L</sub> = 100 Ω,<br>PCLK = 85 MHz | Checkerboard Pattern (Figure 8)            | V <sub>DD33</sub> = 3.6 V  |            |     | 135                                      | 160  | mA                |     |
| I <sub>DDIO1</sub>      |                                                            |                                            | V <sub>DDIO</sub> = 3.6 V  |            |     | 100                                      | 500  | μA                |     |
|                         |                                                            |                                            | V <sub>DDIO</sub> = 1.89 V |            |     | 200                                      | 600  | μA                |     |
| I <sub>DD2</sub>        |                                                            | Random Pattern<br>PRBS7                    | V <sub>DD33</sub> = 3.6 V  |            |     | 133                                      |      | mA                |     |
| I <sub>DDIO2</sub>      |                                                            |                                            | V <sub>DDIO</sub> = 3.6 V  |            |     | 100                                      |      | μA                |     |
|                         |                                                            |                                            | V <sub>DDIO</sub> = 1.89 V |            |     | 100                                      |      | μA                |     |
| I <sub>DDS</sub>        | Supply Current – Remote Auto Power Down                    | reg_0x01[7]=1, Back channel Idle           | V <sub>DD33</sub> = 3.6 V  |            |     | 1.2                                      | 2.4  | mA                |     |
| I <sub>DDIOS</sub>      |                                                            |                                            | V <sub>DDIO</sub> = 3.6 V  |            |     | 4                                        | 30   | μA                |     |
|                         |                                                            |                                            | V <sub>DDIO</sub> = 1.89 V |            |     | 5                                        | 30   | μA                |     |
| I <sub>DDZ</sub>        | Supply Current – Power Down                                | PDB = 0 V, All other LVCMOS inputs = 0 V   | V <sub>DD33</sub> = 3.6 V  |            |     | 1                                        | 2.2  | mA                |     |
| I <sub>DDIOZ</sub>      |                                                            |                                            | V <sub>DDIO</sub> = 3.6 V  |            |     | 8                                        | 20   | μA                |     |
|                         |                                                            |                                            | V <sub>DDIO</sub> = 1.89 V |            |     | 4                                        | 20   | μA                |     |

 (5) I<sub>OS</sub> is not specified for an indefinite period of time. Do not hold in short circuit for more than 500 ms or part damage may result

## 6.6 AC Electrical Characteristics

over operating free-air temperature range (unless otherwise noted)<sup>(1)(2)(3)</sup>

| PARAMETER                                           |                                                                                               | TEST CONDITIONS                                            | PIN / FREQ                        | MIN            | TYP  | MAX  | UNIT             |
|-----------------------------------------------------|-----------------------------------------------------------------------------------------------|------------------------------------------------------------|-----------------------------------|----------------|------|------|------------------|
| FPD-LINK LVDS INPUT                                 |                                                                                               |                                                            |                                   |                |      |      |                  |
| t <sub>RSP</sub>                                    | Receiver Strobe Position                                                                      | See <a href="#">Figure 4</a>                               | RxCLKIN±, RXIN[3:0]±              | 0.25           | 0.5  | 0.75 | UI               |
| AC ELECTRICAL CHARACTERISTICS - FPD-LINK III CML IO |                                                                                               |                                                            |                                   |                |      |      |                  |
| t <sub>LHT</sub>                                    | CML Output Low-to-High Transition Time                                                        | See <a href="#">Figure 3</a>                               | DOUT+, DOUT-                      | 100            | 140  |      | ps               |
| t <sub>HLT</sub>                                    | CML Output High-to-Low Transition Time                                                        |                                                            |                                   | 100            | 140  |      | ps               |
| t <sub>PLD</sub>                                    | Serializer PLL Lock Time                                                                      | See <a href="#">Figure 5</a> <sup>(4)</sup>                | PCLK = 5MHz to 85MHz              |                |      | 5    | ms               |
| t <sub>SD</sub>                                     | Delay — Latency                                                                               | See <a href="#">Figure 6</a>                               |                                   | 146*T          |      |      | ns               |
| t <sub>TJIT</sub>                                   | Output Total Jitter, Bit Error Rate ≤1E-9 <a href="#">Figure 7</a> <sup>(5)(6)(7)(8)(9)</sup> | Checkerboard Pattern PCLK=5 MHz, <a href="#">Figure 8</a>  | RxCLKIN±                          | 0.17           | 0.2  |      | UI               |
|                                                     |                                                                                               | Checkerboard Pattern PCLK=85 MHz, <a href="#">Figure 8</a> |                                   | 0.26           | 0.29 |      | UI               |
| t <sub>IJIT</sub>                                   | Input Jitter Tolerance, Bit Error Rate ≤1E-9 <sup>(6)(10)</sup>                               | f/40 < Jitter Freq < f/20, DES = DS90UB926Q-Q1             | RxCLKIN±, f = 78 MHz              | 0.6            |      |      | UI               |
|                                                     |                                                                                               | f/40 < Jitter Freq < f/20, DES = DS90UB928Q-Q1             |                                   | 0.5            |      |      | UI               |
| AC ELECTRICAL CHARACTERISTICS - I2S RECEIVER        |                                                                                               |                                                            |                                   |                |      |      |                  |
| T <sub>I2S</sub>                                    | I <sup>2</sup> S Clock Period <sup>(5)(11)</sup>                                              | RxCLKIN± f=5 MHz to 85 MHz                                 | I2S_CLK, PCLK = 5 MHz to 85 MHz   | >4/PCLK or >77 |      |      | ns               |
| T <sub>HC</sub>                                     | I <sup>2</sup> S Clock High Time <sup>(11)</sup>                                              |                                                            | I2S_CLK                           | 0.35           |      |      | T <sub>I2S</sub> |
| T <sub>LC</sub>                                     | I <sup>2</sup> S Clock Low Time <sup>(11)</sup>                                               |                                                            | I2S_CLK                           | 0.35           |      |      | T <sub>I2S</sub> |
| t <sub>sr</sub>                                     | I <sup>2</sup> S Set-up Time                                                                  |                                                            | I2S_WC I2S_D[A,B,C,D]             | 0.2            |      |      | T <sub>I2S</sub> |
| t <sub>htr</sub>                                    | I <sup>2</sup> S Hold Time                                                                    |                                                            | I2S_WC I2S_D[A,B,C,D]             | 0.2            |      |      | T <sub>I2S</sub> |
| AC ELECTRICAL CHARACTERISTICS - OTHER I/O           |                                                                                               |                                                            |                                   |                |      |      |                  |
| t <sub>GPIO,FC</sub>                                | GPIO Pulse Width, Forward Channel                                                             |                                                            | GPIO[3:0], PCLK = 5 MHz to 85 MHz | >2/PCLK        |      |      | s                |
| t <sub>GPIO,BC</sub>                                | GPIO Pulse Width, Back Channel                                                                |                                                            | GPIO[3:0]                         | 20             |      |      | μs               |

- (1) The *Electrical Characteristics* tables list verified specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics* conditions and/or notes. Typical specifications are estimations only and are not verified.
- (2) Typical values represent most likely parametric norms at  $V_{DD33} = 3.3$  V,  $V_{DDIO} = 1.8$  V or 3.3 V,  $T_A = 25^\circ\text{C}$ , and at the *Recommended Operating Conditions* at the time of product characterization and are not verified.
- (3) Current into device pins is defined as positive. Current out of a device pin is defined as negative. Voltages are referenced to ground except  $V_{OD}$  and  $\Delta V_{OD}$ , which are differential voltages. Supply noise testing was done with minimum capacitors on the PCB. A sinusoidal signal is AC coupled to the supply pins with amplitude = 100 mVp-p measured at the device  $V_{DD33}$  and  $V_{DDIO}$  pins. Bit error rate testing of input to the serializer and output of the deserializer with 10 meter cable shows no error when the noise frequency is less than 50 MHz.
- (4)  $t_{PLD}$  is the time required by the device to obtain lock when exiting power-down state with an active PCLK.
- (5) Specification is verified by design and is not tested in production
- (6) Specification is verified by characterization and is not tested in production
- (7) UI – Unit Interval is equivalent to one ideal serialized bit width. The UI scales with PCLK frequency.
- (8) Output jitter specs are dependent upon the input clock jitter at the SER
- (9)  $t_{TJIT}$  (@BER of 1E-9) specifies the allowable jitter on RxCLKIN $\pm$ .
- (10) Jitter Frequency is specified in conjunction with DS90UB928Q-Q1 PLL bandwidth.
- (11) I<sup>2</sup>S specifications for  $t_{LC}$  and  $t_{HC}$  pulses must each be greater than 2 PCLK periods to verify sampling and supersedes the  $0.35 \cdot T_{I2S\_CLK}$  requirement.  $t_{LC}$  and  $t_{HC}$  must be longer than the greater of either  $0.35 \cdot T_{I2S\_CLK}$  or  $2 \cdot \text{PCLK}$

## AC Electrical Characteristics (continued)

over operating free-air temperature range (unless otherwise noted)<sup>(1)(2)(3)</sup>

| PARAMETER                                           | TEST CONDITIONS                                                       | PIN / FREQ | MIN | TYP | MAX | UNIT |
|-----------------------------------------------------|-----------------------------------------------------------------------|------------|-----|-----|-----|------|
| <b>DC AND AC SERIAL CONTROL BUS CHARACTERISTICS</b> |                                                                       |            |     |     |     |      |
| $t_R$ SDA RiseTime – READ                           | SDA, RPU = 10 k $\Omega$ , Cb $\leq$ 400 pF, <a href="#">Figure 9</a> |            |     | 430 |     | ns   |
| $t_F$ SDA Fall Time – READ                          |                                                                       |            |     | 20  |     | ns   |

## 6.7 Electrical Characteristics: DC and AC Serial Control Bus

Over 3.3-V supply and temperature ranges unless otherwise specified.<sup>(1)(2)(3)</sup>

| PARAMETER                        | TEST CONDITIONS                     | MIN             | TYP | MAX             | UNIT    |
|----------------------------------|-------------------------------------|-----------------|-----|-----------------|---------|
| $V_{IH}$ Input High Level        | SDA and SCL                         | 0.7* $V_{DDIO}$ |     | $V_{DD33}$      | V       |
| $V_{IL}$ Input Low Level Voltage | SDA and SCL                         | GND             |     | 0.3* $V_{DD33}$ | V       |
| $V_{HY}$ Input Hysteresis        |                                     |                 | >50 |                 | mV      |
| $V_{OL}$                         | SDA or SCL, IOL = 1.25 mA           | 0               |     | 0.36            | V       |
| $I_{in}$                         | SDA or SCL, Vin = $V_{DDIO}$ or GND | -10             |     | +10             | $\mu$ A |
| $C_{in}$ Input Capacitance       | SDA or SCL                          |                 | <5  |                 | pF      |

- (1) The *Electrical Characteristics* tables list verified specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics* conditions and/or notes. Typical specifications are estimations only and are not verified.
- (2) Typical values represent most likely parametric norms at  $V_{DD33}$  = 3.3 V,  $V_{DDIO}$  = 1.8 V or 3.3 V,  $T_A$  = 25°C, and at the *Recommended Operating Conditions* at the time of product characterization and are not verified.
- (3) Current into device pins is defined as positive. Current out of a device pin is defined as negative. Voltages are referenced to ground except  $V_{OD}$  and  $\Delta V_{OD}$ , which are differential voltages. Supply noise testing was done with minimum capacitors on the PCB. A sinusoidal signal is AC coupled to the supply pins with amplitude = 100 mVp-p measured at the device  $V_{DD33}$  and  $V_{DDIO}$  pins. Bit error rate testing of input to the serializer and output of the deserializer with 10 meter cable shows no error when the noise frequency is less than 50 MHz.

## 6.8 Timing Requirements for the Serial Control Bus

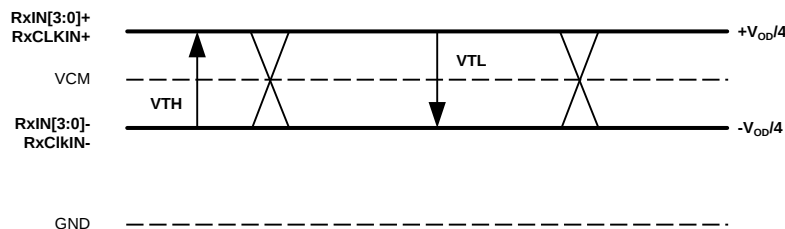
Over 3.3-V supply and temperature ranges unless otherwise specified. <sup>(1)(2)(3)</sup>

|              |                                                                  |               | MIN | NOM | MAX  | UNIT    |
|--------------|------------------------------------------------------------------|---------------|-----|-----|------|---------|
| $f_{SCL}$    | SCL Clock Frequency                                              | Standard Mode | 0   |     | 100  | kHz     |
|              |                                                                  | Fast Mode     | 0   |     | 400  |         |
| $t_{LOW}$    | SCL Low Period                                                   | Standard Mode | 4.7 |     |      | $\mu$ s |
|              |                                                                  | Fast Mode     | 1.3 |     |      |         |
| $t_{HIGH}$   | SCL High Period                                                  | Standard Mode | 4.0 |     |      | $\mu$ s |
|              |                                                                  | Fast Mode     | 0.6 |     |      |         |
| $t_{HD;STA}$ | Hold time for a start or a repeated start condition (Figure 9)   | Standard Mode | 4.0 |     |      | $\mu$ s |
|              |                                                                  | Fast Mode     | 0.6 |     |      |         |
| $t_{SU;STA}$ | Set Up time for a start or a repeated start condition (Figure 9) | Standard Mode | 4.7 |     |      | $\mu$ s |
|              |                                                                  | Fast Mode     | 0.6 |     |      |         |
| $t_{HD;DAT}$ | Data Hold Time (Figure 9)                                        | Standard Mode | 0   |     | 3.45 | $\mu$ s |
|              |                                                                  | Fast Mode     | 0   |     | 0.9  |         |
| $t_{SU;DAT}$ | Data Set Up Time (Figure 9)                                      | Standard Mode | 250 |     |      | ns      |
|              |                                                                  | Fast Mode     | 100 |     |      |         |
| $t_{SU;STO}$ | Set Up Time for STOP Condition (Figure 9)                        | Standard Mode | 4.0 |     |      | $\mu$ s |
|              |                                                                  | Fast Mode     | 0.6 |     |      |         |
| $t_{BUF}$    | Bus Free Time Between STOP and START (Figure 9)                  | Standard Mode | 4.7 |     |      | $\mu$ s |
|              |                                                                  | Fast Mode     | 1.3 |     |      |         |
| $t_r$        | SCL & SDA Rise Time, (Figure 9)                                  | Standard Mode |     |     | 1000 | ns      |
|              |                                                                  | Fast Mode     |     |     | 300  |         |
| $t_f$        | SCL & SDA Fall Time, (Figure 9)                                  | Standard Mode |     |     | 300  | ns      |
|              |                                                                  | Fast mode     |     |     | 300  |         |

- (1) The *Electrical Characteristics* tables list verified specifications under the listed *Recommended Operating Conditions* except as otherwise modified or specified by the *Electrical Characteristics* conditions and/or notes. Typical specifications are estimations only and are not verified.
- (2) Typical values represent most likely parametric norms at  $V_{DD33} = 3.3$  V,  $V_{DDIO} = 1.8$  V or 3.3 V,  $T_A = 25^\circ\text{C}$ , and at the *Recommended Operating Conditions* at the time of product characterization and are not verified.
- (3) Current into device pins is defined as positive. Current out of a device pin is defined as negative. Voltages are referenced to ground except  $V_{OD}$  and  $\Delta V_{OD}$ , which are differential voltages. Supply noise testing was done with minimum capacitors on the PCB. A sinusoidal signal is AC coupled to the supply pins with amplitude = 100 mVp-p measured at the device  $V_{DD33}$  and  $V_{DDIO}$  pins. Bit error rate testing of input to the serializer and output of the deserializer with 10 meter cable shows no error when the noise frequency is less than 50 MHz.

## 6.9 Timing Requirements - DC and AC Serial Control Bus Characteristics

|              |                                | MIN | TYP | MAX | UNIT |
|--------------|--------------------------------|-----|-----|-----|------|
| $t_{SU;DAT}$ | Set Up Time – READ (Figure 9)  |     | 560 |     | ns   |
| $t_{HD;DAT}$ | Hold Up Time – READ (Figure 9) |     | 615 |     | ns   |
| $t_{SP}$     | Input Filter                   |     | 50  |     | ns   |



**Figure 1. FPD-Link DC  $V_{TH}/V_{TL}$  Definition**

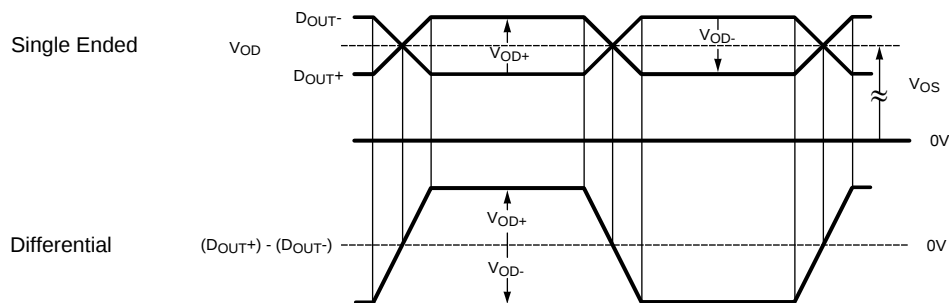
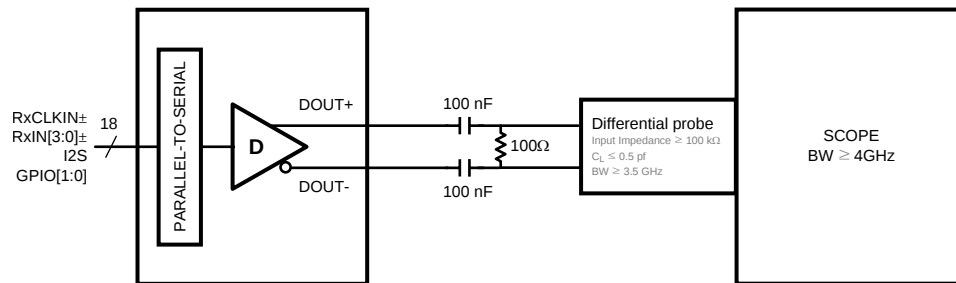


Figure 2. Serializer  $V_{OD}$  DC Output



Figure 3. Output Transition Times

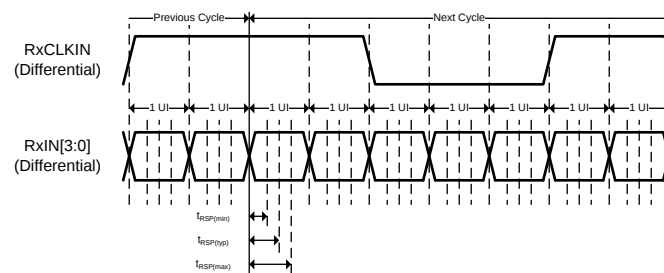
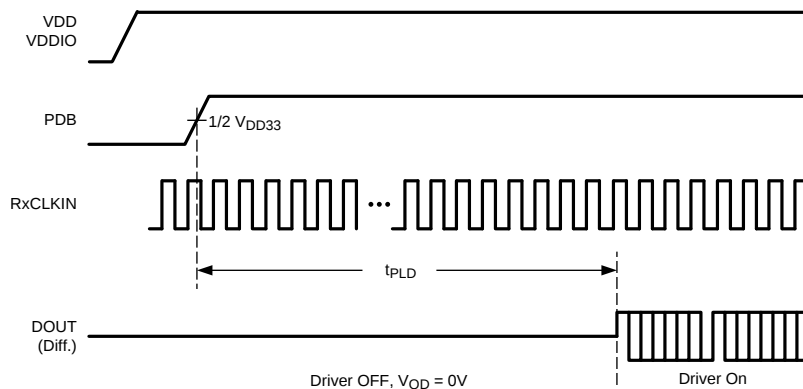
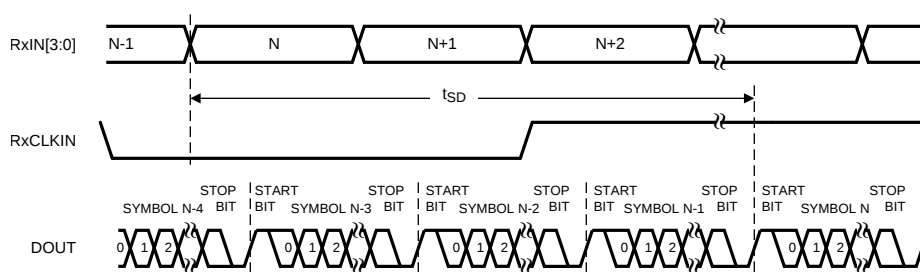


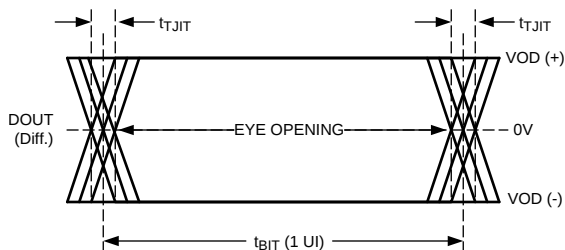
Figure 4. FPD-Link Input Strobe Position



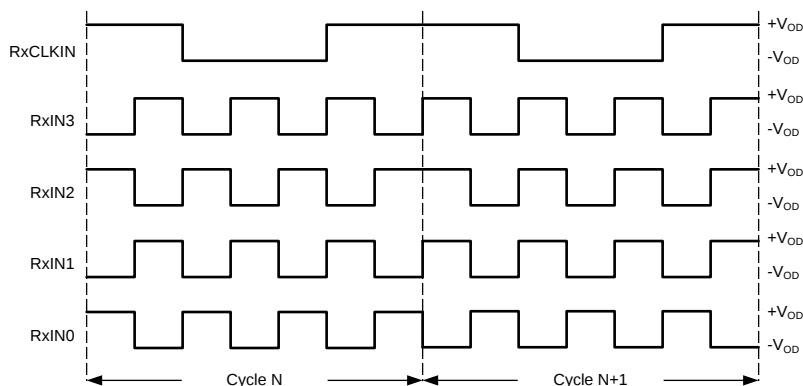
**Figure 5. Serializer Lock Time**



**Figure 6. Latency Delay**



**Figure 7. CML Serializer Output Jitter**



**Figure 8. Checkerboard Data Pattern**

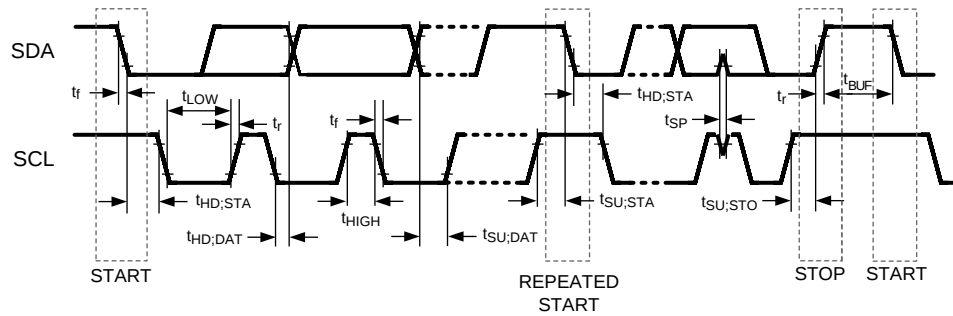


Figure 9. Serial Control Bus Timing Diagram

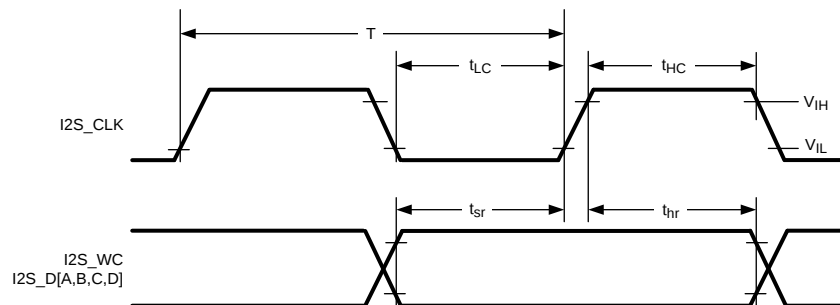


Figure 10. I²S Timing Diagram

## 6.10 Typical Characteristics

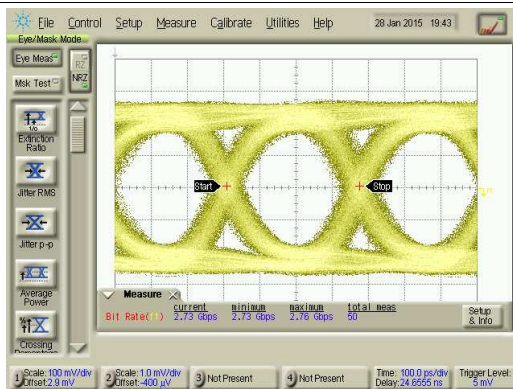


Figure 11. Serializer Eye with 78 MHz Input Clock

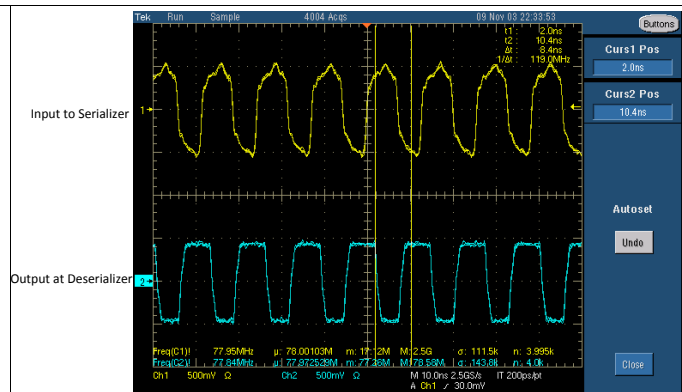


Figure 12. 78-MHz Clock at Serializer and Deserializer

## 7 Detailed Description

### 7.1 Overview

The DS90UB927Q-Q1 converts a FPD-Link interface (4 LVDS data channels + 1 LVDS Clock) to a FPD-Link III interface. This device transmits a 35-bit symbol over a single serial pair operating at up to a 2.975-Gbps line rate. The serial stream contains an embedded clock, video control signals, RGB video data, and audio data. The payload is DC-balanced to enhance signal quality and support AC coupling.

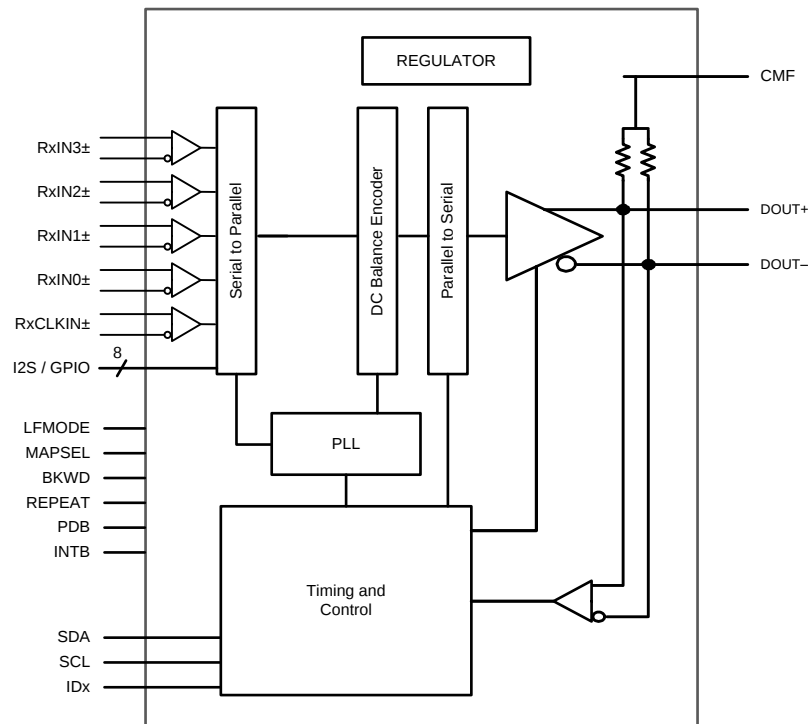
The DS90UB927Q-Q1 serializer is intended for use with a DS90UB928Q-Q1 or DS90UB926Q-Q1 deserializer, but is also backward compatible with DS90UR906Q, DS90UR908Q, DS90UR910Q, and DS90UR916Q FPD-Link II deserializers.

The DS90UB927Q-Q1 serializer and DS90UB928Q-Q1 or DS90UB926Q-Q1 deserializer incorporate an I<sup>2</sup>C compatible interface. The I<sup>2</sup>C compatible interface allows programming of serializer or deserializer devices from a local host controller. In addition, the devices incorporate a bidirectional control channel (BCC) that allows communication between serializer/deserializer as well as remote I<sup>2</sup>C slave devices.

The bidirectional control channel (BCC) is implemented via embedded signaling in the high-speed forward channel (serializer to deserializer) combined with lower speed signaling in the reverse channel (deserializer to serializer). Through this interface, the BCC provides a mechanism to bridge I<sup>2</sup>C transactions across the serial link from one I<sup>2</sup>C bus to another. The implementation allows for arbitration with other I<sup>2</sup>C compatible masters at either side of the serial link.

There are two operating modes available on DS90UB927Q-Q1: display mode and camera mode. In display mode, I<sup>2</sup>C transactions originate from the host controller attached to the serializer and target either the deserializer or an I<sup>2</sup>C slave attached to the deserializer. Transactions are detected by the I<sup>2</sup>C slave in the deserializer and forwarded to the I<sup>2</sup>C master in the serializer. Similarly, in camera mode, I<sup>2</sup>C transactions originate from a controller attached to the deserializer and target either the serializer or an I<sup>2</sup>C slave attached to the serializer. Transactions are detected by the I<sup>2</sup>C slave in the deserializer and forwarded to the I<sup>2</sup>C master in the serializer.

### 7.2 Functional Block Diagram



## 7.3 Feature Description

### 7.3.1 High-Speed Forward Channel Data Transfer

The High Speed Forward Channel is composed of a 35-bit frame containing RGB data, sync signals, I<sup>2</sup>C, and I<sup>2</sup>S audio transmitted from Serializer to Deserializer. Figure 13 illustrates the serial stream generated per PCLK cycle into RxCLKIN±. This data payload is optimized for signal transmission over an AC coupled link. Data is randomized, DC-balanced and scrambled.



**Figure 13. FPD-Link III Serial Stream**

The device supports pixel clock ranges of 5 MHz to 15 MHz (LFMODE=1) and 15 MHz to 85 MHz (LFMODE=0). This corresponds to an application payload rate range of 155 Mbps to 2.635 Gbps, with an actual line rate range of 525 Mbps to 2.975 Gbps.

### 7.3.2 Low-Speed Back Channel Data Transfer

The Low-Speed Back Channel of the DS90UB927Q-Q1 provides bidirectional communication between the display and host processor. Data is transferred simultaneously over the same physical link as the high-speed forward channel data. The back channel transports I<sup>2</sup>C, CRC, and 4 bits of standard GPIO information with a 10-Mbps line rate.

### 7.3.3 Common Mode Filter Pin (CMF)

The serializer provides access to the center tap of the internal CML termination. A 0.1-μF capacitor must be connected from this pin to GND for additional common-mode filtering of the differential pair (Figure 29). This increases noise rejection capability in high-noise environments.

### 7.3.4 Video Control Signals

The video control signal bits embedded in the high-speed FPD-Link LVDS are subject to certain limitations relative to the video pixel clock period (PCLK). By default, the DS90UB927Q-Q1 applies a minimum pulse width filter on these signals to help eliminate spurious transitions.

Normal Mode Control Signals (VS, HS, DE) have the following restrictions:

- Horizontal Sync (HS): The video control signal pulse width must be 3 PCLKs or longer when the Control Signal Filter (register bit 0x03[4]) is enabled (default). Disabling the Control Signal Filter removes this restriction (minimum is 1 PCLK). See Table 5. HS can have at most two transitions per 130 PCLKs.
- Vertical Sync (VS): The video control signal pulse is limited to 1 transition per 130 PCLKs. Thus, the minimum pulse width is 130 PCLKs.
- Data Enable Input (DE): The video control signal pulse width must be 3 PCLKs or longer when the Control Signal Filter (register bit 0x03[4]) is enabled (default). Disabling the Control Signal Filter removes this restriction (minimum is 1 PCLK). See Table 5. DE can have at most two transitions per 130 PCLKs.

### 7.3.5 EMI Reduction Features

#### 7.3.5.1 LVCMOS V<sub>DDIO</sub> Option

The 1.8-V or 3.3-V LVCMOS inputs and outputs are powered from separate VDDIO supply pins to offer compatibility with external system interface signals. Note: When configuring the VDDIO power supplies, all the single-ended control input pins for device need to scale together with the same operating VDDIO levels. If VDDIO is selected to operate in the 3.0 V to 3.6 V range, VDDIO must be operated within 300 mV of VDD33.

### 7.3.6 Built-In Self Test (BIST)

An optional At-Speed Built-In Self Test (BIST) feature supports testing of the high speed serial link and the low-speed back channel without external data connections. This is useful in the prototype stage, equipment production, in-system test, and system diagnostics.

## Feature Description (continued)

### 7.3.6.1 BIST Configuration and Status

The BIST mode is enabled at the deserializer by pin (BISTEN) or BIST configuration register. The test may select either an external PCLK or the 33-MHz internal Oscillator clock (OSC) frequency. In the absence of PCLK, the user can select the internal OSC frequency at the deserializer through the BISTC pin or BIST configuration register.

When BIST is activated at the deserializer, a BIST enable signal is sent to the serializer through the Back Channel. The serializer outputs a test pattern and drives the link at speed. The deserializer detects the test pattern and monitors it for errors. The deserializer PASS output pin toggles to flag each frame received containing one or more errors. The serializer also tracks errors indicated by the CRC fields in each back channel frame.

The BIST status can be monitored real time on the deserializer PASS pin, with each detected error resulting in a half pixel clock period toggled LOW. After BIST is deactivated, the result of the last test is held on the PASS output until reset (new BIST or Power Down). A high on PASS indicates NO ERRORS were detected. A Low on PASS indicates one or more errors were detected. The duration of the test is controlled by the pulse width applied to the deserializer BISTEN pin. LOCK is valid throughout the entire duration of BIST.

See [Figure 14](#) for the BIST mode flow diagram.

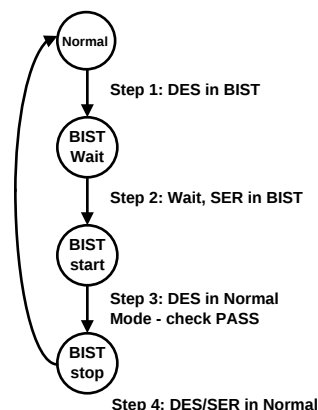
### 7.3.6.2 Sample BIST Sequence

**Step 1:** For the DS90UB927Q-Q1 paired with a FPD-Link III Deserializer, BIST Mode is enabled via the BISTEN pin of Deserializer. The desired clock source is selected through the deserializer BISTC pin.

**Step 2:** The DS90UB927Q-Q1 serializer is awakened through the back channel if it is not already on. An all-zeros pattern is balanced, scrambled, randomized, and sent through the FPD-Link III interface to the deserializer. Once the serializer and the deserializer are in BIST mode and the deserializer acquires Lock, the PASS pin of the deserializer goes high and BIST starts checking the data stream. If an error in the payload (1 to 35) is detected, the PASS pin will switch low for one half of the clock period. During the BIST, the PASS output can be monitored and counted to determine the payload error rate.

**Step 3:** To Stop the BIST mode, the deserializer BISTEN pin is set Low. The deserializer stops checking the data. The final test result is held on the PASS pin. If the test ran error free, the PASS output will remain HIGH. If there one or more errors were detected, the PASS output will output constant LOW. The PASS output state is held until a new BIST is run, the device is RESET, or the device is powered down. BIST duration is user-controlled and may be of any length.

The link returns to normal operation after the deserializer BISTEN pin is low. [Figure 15](#) shows the waveform diagram of a typical BIST for two cases. Case 1 is error free, and Case 2 shows one with multiple errors. In most cases it is difficult to generate errors due to the robustness of the link (differential data transmission, and so forth), thus they may be introduced by greatly extending the cable length, faulting the interconnect medium, or reducing signal condition enhancements (Rx Equalization).



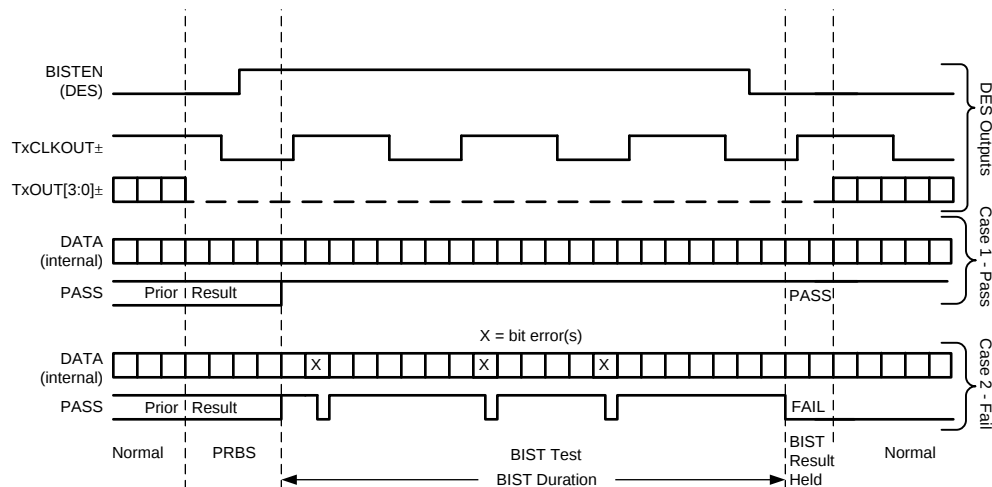
**Figure 14. BIST Mode Flow Diagram**

## Feature Description (continued)

### 7.3.7 Forward Channel and Back Channel Error Checking

While in BIST mode, the serializer stops sampling the FPD-Link input pins and switches over to an internal all zeroes pattern. The internal all-zeroes pattern goes through scrambler, DC-balancing, and so forth, and is transmitted over the serial link to the deserializer. The deserializer, on locking to the serial stream, compares the recovered serial stream with all-zeroes and records any errors in status registers. Errors are also dynamically reported on the PASS pin of the deserializer.

The back-channel data is checked for CRC errors once the serializer locks onto the back-channel serial stream, as indicated by link detect status (register bit 0x0C[0] - [Table 5](#)). CRC errors are recorded in an 8-bit register in the serializer. The register is cleared when the serializer enters BIST mode. As soon as the serializer enters BIST mode, the functional mode CRC register starts recording any back channel CRC errors. The BIST mode CRC error register is active in BIST mode only and keeps a record of the last BIST run until cleared or the serializer enters BIST mode again.



**Figure 15. BIST Waveforms**

### 7.3.8 Internal Pattern Generation

The DS90UB927Q-Q1 serializer provides an internal pattern generation feature. It allows basic testing and debugging of an integrated panel. The test patterns are simple and repetitive and allow for a quick visual verification of panel operation. As long as the device is not in power down mode, the test pattern will be displayed even if no input is applied. If no clock is received, the test pattern can be configured to use a programmed oscillator frequency. For detailed information, refer to Application Note AN-2198.

#### 7.3.8.1 Pattern Options

The DS90UB927Q-Q1 serializer pattern generator is capable of generating 17 default patterns for use in basic testing and debugging of panels. Each can be inverted using register bits ([Table 5](#)), shown below:

1. White/Black (default/inverted)
2. Black/White
3. Red/Cyan
4. Green/Magenta
5. Blue/Yellow
6. Horizontally Scaled Black to White/White to Black
7. Horizontally Scaled Black to Red/Cyan to White
8. Horizontally Scaled Black to Green/Magenta to White
9. Horizontally Scaled Black to Blue/Yellow to White
10. Vertically Scaled Black to White/White to Black

## Feature Description (continued)

11. Vertically Scaled Black to Red/Cyan to White
12. Vertically Scaled Black to Green/Magenta to White
13. Vertically Scaled Black to Blue/Yellow to White
14. Custom Color (or its inversion) configured in PGRS
15. Black-White/White-Black Checkerboard (or custom checkerboard color, configured in PGCTL)
16. YCBB/RBCY VCOM pattern, orientation is configurable from PGCTL
17. Color Bars (White, Yellow, Cyan, Green, Magenta, Red, Blue, Black) – Note: not included in the auto-scrolling feature

Additionally, the Pattern Generator incorporates one user-configurable full-screen 24-bit color, which is controlled by the PGRS, PGGS, and PGBS registers. This is pattern #14. One of the pattern options is statically selected in the PGCTL register when Auto-Scrolling is disabled. The PGTSC and PGTSO1-8 registers control the pattern selection and order when Auto-Scrolling is enabled.

### 7.3.8.2 Color Modes

By default, the Pattern Generator operates in 24-bit color mode, where all bits of the Red, Green, and Blue outputs are enabled. 18-bit color mode can be activated from the configuration registers (Table 5). In 18-bit mode, the 6 most significant bits (bits 7-2) of the Red, Green, and Blue outputs are enabled; the 2 least significant bits will be 0.

### 7.3.8.3 Video Timing Modes

The Pattern Generator has two video timing modes – external and internal. In external timing mode, the Pattern Generator detects the video frame timing present on the DE and VS inputs. If Vertical Sync signaling is not present on VS, the Pattern Generator determines Vertical Blank by detecting when the number of inactive pixel clocks (DE = 0) exceeds twice the detected active line length. In internal timing mode, the Pattern Generator uses custom video timing as configured in the control registers. The internal timing generation may also be driven by an external clock. By default, external timing mode is enabled. Internal timing or Internal timing with External Clock are enabled by the control registers (Table 5).

### 7.3.8.4 External Timing

In external timing mode, the Pattern Generator passes the incoming DE, HS, and VS signals unmodified to the video control outputs after a two pixel clock delay. It extracts the active frame dimensions from the incoming signals in order to properly scale the brightness patterns. If the incoming video stream does not use the VS signal, the Pattern Generator determines the Vertical Blank time by detecting a long period of pixel clocks without DE asserted.

### 7.3.8.5 Pattern Inversion

The Pattern Generator also incorporates a global inversion control, located in the PGCFG register, which causes the output pattern to be bitwise-inverted. For example, the full screen Red pattern becomes full-screen cyan, and the Vertically Scaled Black to Green pattern becomes Vertically Scaled White to Magenta.

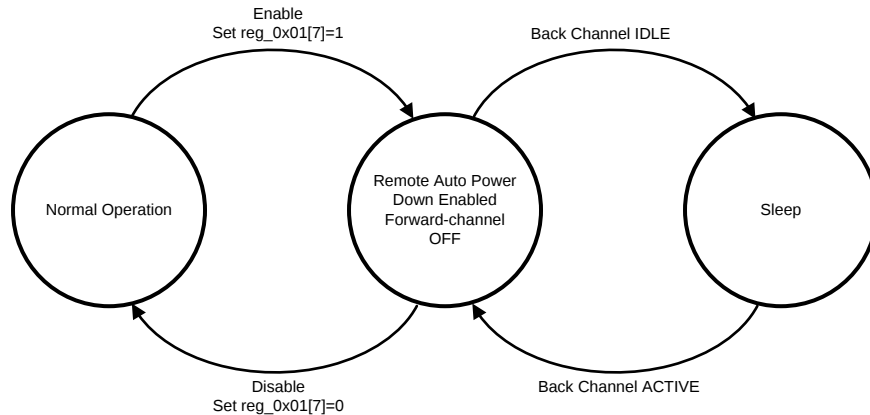
### 7.3.8.6 Auto Scrolling

The Pattern Generator supports an Auto-Scrolling mode, in which the output pattern cycles through a list of enabled pattern types. A sequence of up to 16 patterns may be defined in the registers. The patterns may appear in any order in the sequence and may also appear more than once.

## Feature Description (continued)

### 7.3.9 Remote Auto Power-Down Mode

The DS90UB927Q-Q1 serializer features a Remote Auto Power Down mode. This feature is enabled and disabled through the register bit 0x01[7] (Table 5). When the back channel is not detected, either due to an idle or powered-down deserializer, the serializer enters remote auto power down mode. Power dissipation of the serializer is significantly reduced in this mode. The serializer automatically attempts to resume normal operation upon detection of an active back channel from the deserializer. To complete the wake-up process and reactivate forward channel operation, the remote power-down feature must be disabled by either a local I<sup>2</sup>C host, or by an auto-ACK I<sup>2</sup>C transaction from a remote I<sup>2</sup>C host located at the deserializer. The Remote Auto Power Down Sleep/Wake cycle is shown below in Figure 16:



**Figure 16. Remote Auto Power Down Sleep/Wake Cycle**

To resume normal operation, the Remote Auto Power Down feature must be disabled in the device control register. This may be accomplished from a local I<sup>2</sup>C controller by writing reg\_0x01[7]=0 (Table 5). To disable from a remote I<sup>2</sup>C controller located at the deserializer, perform the following procedure to complete the wake-up process:

1. Power up remote deserializer (back channel must be active)
2. Enable I<sup>2</sup>C PASS-THROUGH ALL by setting deserializer register reg\_0x05[7]=1
3. Enable I<sup>2</sup>C AUTO ACK by setting deserializer register reg\_0x03[2]=1
4. Disable Remote Auto Power Down by setting serializer register reg\_0x01[7]=0
5. Disable I<sup>2</sup>C AUTO ACK by setting deserializer register reg\_0x03[2]=0
6. Disable I<sup>2</sup>C PASS-THROUGH ALL by setting deserializer register reg\_0x05[7]=0

### 7.3.10 Input RxCLKIN Loss Detect

The serializer can be programmed to enter a low power SLEEP state when the input clock (PCLK) is lost. A clock loss condition is detected when PCLK drops below approximately 1 MHz. When a PCLK is detected again, the serializer will then lock to the incoming RxCLKIN±. Note – when RxCLKIN± is lost, the optional Serial Bus Control Registers values are still retained. See (Table 5) for more information.

### 7.3.11 Serial Link Fault Detect

The DS90UB927Q-Q1 can detect fault conditions in the FPD-Link III interconnect. If a fault condition occurs, the Link Detect Status is 0 (cable is not detected) on bit 0 of address 0x0C (Table 5). The DS90UB927Q-Q1 will detect any of the following conditions:

1. Cable open
2. "+" to "-" short
3. "+" to GND short
4. "-" to GND short
5. "+" to battery short

## Feature Description (continued)

6. "-" to battery short
7. Cable is linked incorrectly (DOUT+/DOUT- connections reversed)

Note: The device will detect any of the above conditions, but does not report specifically which one has occurred.

### 7.3.12 Interrupt Pin (INTB)

1. On the DS90UB927Q-Q1 serializer, set register reg\_0xC6[5] = 1 and 0xC6[0] = 1 (Table 5) to configure the interrupt.
2. On the serializer, read from ISR register 0xC7 to arm the interrupt for the first time.
3. When INTB\_IN on the deserializer (DS90UB926Q-Q1 or DS90UB928Q-Q1) is set LOW, the INTB pin on the serializer also pulls low, indicating an interrupt condition.
4. The external controller detects INTB = LOW and reads the ISR register (Table 5) to determine the interrupt source. Reading this register also clears and resets the interrupt.

### 7.3.13 General-Purpose I/O

#### 7.3.13.1 GPIO[3:0]

In normal operation, GPIO[3:0] may be used as general purpose I/Os in either forward channel (inputs) or back channel (outputs) applications. GPIO modes may be configured from the registers (Table 5). GPIO[1:0] are dedicated pins and GPIO[3:2] are shared with I2S\_DC and I2S\_DD respectively. Note: if the DS90UB927Q-Q1 is paired with a DS90UB926Q-Q1 deserializer, the devices must be configured into 18-bit mode to allow usage of GPIO pins on the DS90UB927 serializer. To enable 18-bit mode, set serializer register reg\_0x12[2] = 1. 18-bit mode will be auto-loaded into the deserializer from the serializer. See Table 1 for GPIO enable and configuration.

**Table 1. GPIO Enable and Configuration**

| DESCRIPTION | DEVICE          | FORWARD CHANNEL | BACK CHANNEL |
|-------------|-----------------|-----------------|--------------|
| GPIO3       | DS90UB927Q-Q1   | 0x0F = 0x03     | 0x0F = 0x05  |
|             | DS90UB926/8Q-Q1 | 0x1F = 0x05     | 0x1F = 0x03  |
| GPIO2       | DS90UB927Q-Q1   | 0x0E = 0x30     | 0x0E = 0x50  |
|             | DS90UB926/8Q-Q1 | 0x1E = 0x50     | 0x1E = 0x30  |
| GPIO1       | DS90UB927Q-Q1   | 0x0E = 0x03     | 0x0E = 0x05  |
|             | DS90UB926/8Q-Q1 | 0x1E = 0x05     | 0x1E = 0x03  |
| GPIO0       | DS90UB927Q-Q1   | 0x0D = 0x03     | 0x0D = 0x05  |
|             | DS90UB926/8Q-Q1 | 0x1D = 0x05     | 0x1D = 0x03  |

The input value present on GPIO[3:0] may also be read from register, or configured to local output mode (Table 5).

#### 7.3.13.2 GPIO[8:5]

GPIO\_REG[8:5] are register-only GPIOs and may be programmed as outputs or read as inputs through local register bits only. Where applicable, these bits are shared with I<sup>2</sup>S pins and will override I<sup>2</sup>S input if enabled into REG\_GPIO mode. See Table 2 for GPIO enable and configuration.

Note: Local GPIO value may be configured and read either through local register access, or remote register access through the Low-Speed Bidirectional Control Channel. Configuration and state of these pins are not transported from serializer to deserializer as is the case for GPIO[3:0].

**Table 2. GPIO\_REG and GPIO Local Enable and Configuration**

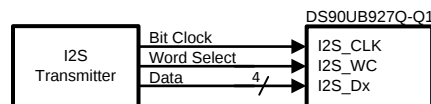
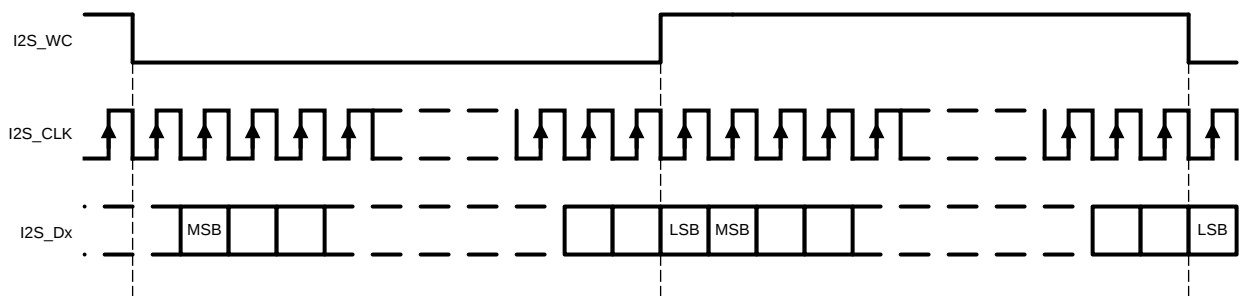
| DESCRIPTION | REGISTER CONFIGURATION | FUNCTION             |
|-------------|------------------------|----------------------|
| GPIO_REG8   | 0x11 = 0x01            | Output, L            |
|             | 0x11 = 0x09            | Output, H            |
|             | 0x11 = 0x03            | Input, Read: 0x1D[0] |

**Table 2. GPIO\_REG and GPIO Local Enable and Configuration (continued)**

| DESCRIPTION | REGISTER CONFIGURATION | FUNCTION             |
|-------------|------------------------|----------------------|
| GPIO_REG7   | 0x10 = 0x01            | Output, L            |
|             | 0x10 = 0x09            | Output, H            |
|             | 0x10 = 0x03            | Input, Read: 0x1C[7] |
| GPIO_REG6   | 0x10 = 0x01            | Output, L            |
|             | 0x10 = 0x09            | Output, H            |
|             | 0x10 = 0x03            | Input, Read: 0x1C[6] |
| GPIO_REG5   | 0x0F = 0x01            | Output, L            |
|             | 0x0F = 0x09            | Output, H            |
|             | 0x0F = 0x03            | Input, Read: 0x1C[5] |
| GPIO3       | 0x0F = 0x01            | Output, L            |
|             | 0x0F = 0x09            | Output, H            |
|             | 0x0F = 0x03            | Input, Read: 0x1C[3] |
| GPIO2       | 0x0E = 0x01            | Output, L            |
|             | 0x0E = 0x09            | Output, H            |
|             | 0x0E = 0x03            | Input, Read: 0x1C[2] |
| GPIO1       | 0x0E = 0x01            | Output, L            |
|             | 0x0E = 0x09            | Output, H            |
|             | 0x0E = 0x03            | Input, Read: 0x1C[1] |
| GPIO0       | 0x0D = 0x01            | Output, L            |
|             | 0x0D = 0x09            | Output, H            |
|             | 0x0D = 0x03            | Input, Read: 0x1C[0] |

### 7.3.14 I<sup>2</sup>S Audio Interface

The DS90UB927Q-Q1 serializer features six I<sup>2</sup>S input pins that, when paired with a DS90UB928Q-Q1 deserializer, supports surround sound audio applications. The bit clock (I2S\_CLK) supports frequencies between 1 MHz and <PCLK/2 (or <13 MHz). Four I<sup>2</sup>S data inputs transport two channels of I<sup>2</sup>S-formatted digital audio each, with each channel delineated by the word select (I2C\_WC) input. I<sup>2</sup>S audio transport is not available in Backwards Compatibility Mode (BKWD = 1).


**Figure 17. I<sup>2</sup>S Connection Diagram**

**Figure 18. I<sup>2</sup>S Frame Timing Diagram**

When paired with a DS90UB926Q-Q1, the DS90UB927Q-Q1 I<sup>2</sup>S interface supports a single I<sup>2</sup>S data input through I2S\_DA (24-bit video mode), or two I<sup>2</sup>S data inputs through I2S\_DA and I2S\_DB (18-bit video mode).

[Table 3](#) covers several common I<sup>2</sup>S sample rates:

**Table 3. Audio Interface Frequencies**

| Sample Rate (kHz) | I <sup>2</sup> S Data Word Size (bits) | I2S CLK (MHz) |
|-------------------|----------------------------------------|---------------|
| 32                | 16                                     | 1.024         |
| 44.1              | 16                                     | 1.411         |
| 48                | 16                                     | 1.536         |
| 96                | 16                                     | 3.072         |
| 192               | 16                                     | 6.144         |
| 32                | 24                                     | 1.536         |
| 44.1              | 24                                     | 2.117         |
| 48                | 24                                     | 2.304         |
| 96                | 24                                     | 4.608         |
| 192               | 24                                     | 9.216         |
| 32                | 32                                     | 2.048         |
| 44.1              | 32                                     | 2.822         |
| 48                | 32                                     | 3.072         |
| 96                | 32                                     | 6.144         |
| 192               | 32                                     | 12.288        |

#### 7.3.14.1 I<sup>2</sup>S Transport Modes

By default, audio is packetized and transmitted during video blanking periods in dedicated Data Island Transport frames. Data Island frames may be disabled from control registers if Forward Channel Frame Transport of I<sup>2</sup>S data is desired. In this mode, only I2S\_DA is transmitted to the DS90UB928Q-Q1 deserializer. If connected to a DS90UB926Q-Q1 deserializer, I2S\_DA and I2S\_DB are transmitted. Surround Sound Mode, which transmits all four I<sup>2</sup>S data inputs (I2S\_D[A..D]), may only be operated in Data Island Transport mode. This mode is only available when connected to a DS90UB928Q-Q1 deserializer.

#### 7.3.14.2 I<sup>2</sup>S Repeater

I<sup>2</sup>S audio may be fanned-out and propagated in the repeater application. By default, data is propagated via Data Island Transport on the FPD-Link interface during the video blanking periods. If frame transport is desired, then the I<sup>2</sup>S pins should be connected from the deserializer to all serializers. Activating surround sound at the top-level deserializer automatically configures downstream DS90UB927Q-Q1 serializers and DS90UB928Q-Q1 deserializers for surround sound transport utilizing Data Island Transport. If 4-channel operation utilizing I2S\_DA and I2S\_DB only is desired, this mode must be explicitly set in each serializer and deserializer control register throughout the repeater tree (Table 5).

A DS90UB927Q-Q1 serializer configured in repeater mode may also regenerate I<sup>2</sup>S audio from its I<sup>2</sup>S input pins in lieu of Data Island frames. See the Repeater Connection Diagram (Figure 23) and the I<sup>2</sup>C Control Registers (Table 5) for additional details.

#### 7.3.15 Additional Features

Additional pattern generator features can be accessed through the Pattern Generator Indirect Register Map. It consists of the Pattern Generator Indirect Address (PGIA reg\_0x66 — Table 5) and the Pattern Generator Indirect Data (PGID reg\_0x67 — Table 5). See TI application Note AN-2198.

### 7.4 Device Functional Modes

#### 7.4.1 Power Down (PDB)

The Serializer has a PDB input pin to ENABLE or POWER DOWN the device. This pin may be controlled by an external device, or through V<sub>DDIO</sub>, where V<sub>DDIO</sub> = 3.0 V to 3.6 V or V<sub>DD33</sub>. To save power, disable the link when the display is not needed (PDB = LOW). Ensure that this pin is not driven HIGH before V<sub>DD33</sub> and V<sub>DDIO</sub> have reached final levels. When PDB is driven low, ensure that the pin is driven to 0 V for at least 1.5 ms before releasing or driving high. In the case where PDB is pulled up to V<sub>DDIO</sub> = 3.0 V to 3.6 V or V<sub>DD33</sub> directly, a 10-kΩ pullup resistor and a >10-μF capacitor to ground are required (See Figure 29).

## Device Functional Modes (continued)

Toggling PDB low will POWER DOWN the device and RESET all control registers to default. During this time, PDB must be held low for a minimum period of time. See [AC Electrical Characteristics](#) for more information.

### 7.4.2 Backward Compatible Mode

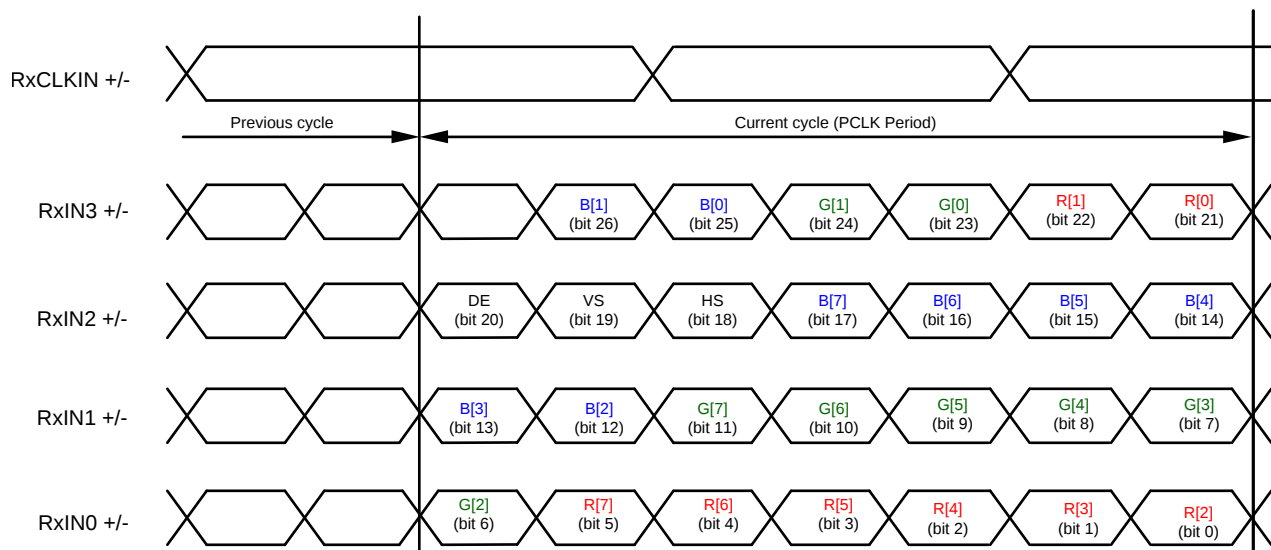
The DS90UB927Q-Q1 is also backward compatible to DS90UR906Q, DS90UR908Q FPD, and DS90UR916Q FPD-Link II deserializers for PCLK frequencies ranging from 5MHz to 65MHz. It is also backward compatible with the DS90UR910Q for PCLK frequencies ranging from 5 MHz to 75 MHz. The serializer transmits 28-bits of data over a single serial FPD-Link II pair operating at a payload rate of 120 Mbps to 1.8 Gbps, corresponding to a line rate of 140 Mbps to 2.1 Gbps. The Backward Compatibility configuration can be selected through the BKWD pin or programmed through the configuration register ([Table 5](#)). The bidirectional control channel, bidirectional GPIOs, I<sup>2</sup>S, and interrupt (INTB) are not active in this mode. However, local I<sup>2</sup>C access to the serializer is still available. Note: PCLK frequency range in this mode is 15 MHz to 75 MHz for LFMODE=0 and 5 MHz to <15 MHz for LFMODE=1.

### 7.4.3 Low Frequency Optimization (LFMODE)

The LFMODE is set via register ([Table 5](#)) or LFMODE Pin. This mode optimizes device operation for lower input data clock ranges supported by the serializer. If LFMODE is Low (LFMODE = 0, default), the RxCLKIN± frequency is between 15 MHz and 85 MHz. If LFMODE is High (LFMODE = 1), the RxCLKIN± frequency is between 5 MHz and <15 MHz. Note: when the device LFMODE is changed, a PDB reset is required. When LFMODE is high (LFMODE=1), the line rate relative to the input data rate is multiplied by four. Thus, for the operating range of 5MHz to <15MHz, the line rate is 700Mbps to <2.1Gbps with an effective data payload of 175Mbps to 525Mbps. Note: for Backwards Compatibility Mode (BKWD=1), the line rate relative to the input data rate remains the same.

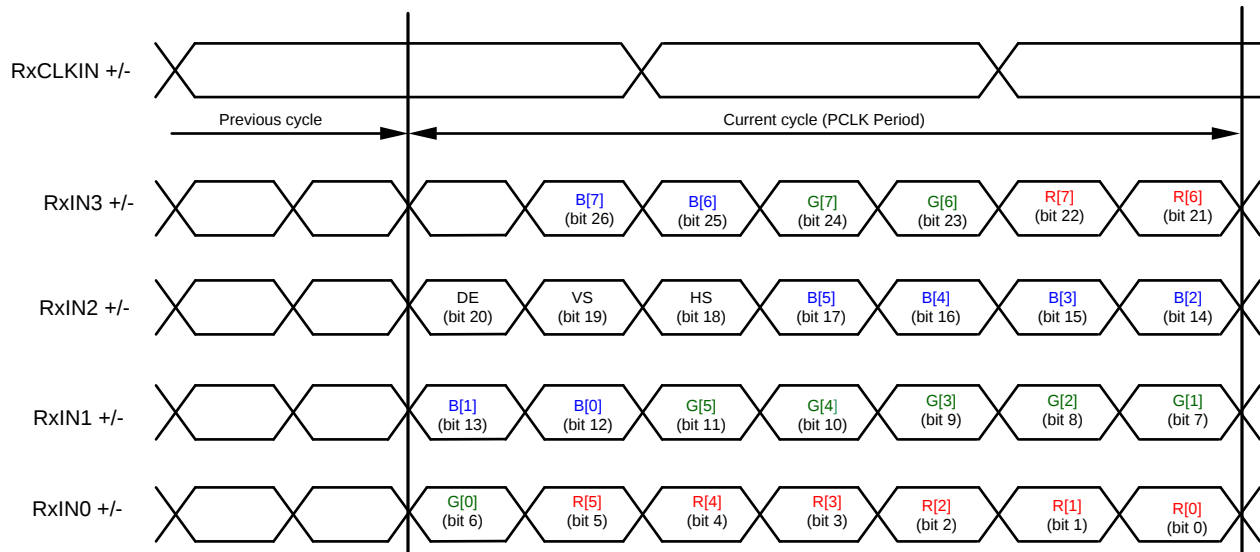
### 7.4.4 FPD-Link Input Frame and Color Bit Mapping Select

The DS90UB927Q-Q1 can be configured to accept 24-bit color (8-bit RGB) with 2 different mapping schemes: LSBs on RxIN[3]±, shown in [Figure 19](#), or MSBs on RxIN[3], shown in [Figure 20](#). Each frame corresponds to a single-pixel clock (PCLK) cycle. The LVDS clock input to RxCLKIN± follows a 4:3 duty cycle scheme, with each 28-bit pixel frame starting with two LVDS bit clock periods high, three low, and ending with two high. The mapping scheme is controlled by MAPSEL pin or by Register ([Table 5](#)).



**Figure 19. FPD-Link Mapping: LSBs on RxIN3 (MAPSEL=L)**

## Device Functional Modes (continued)



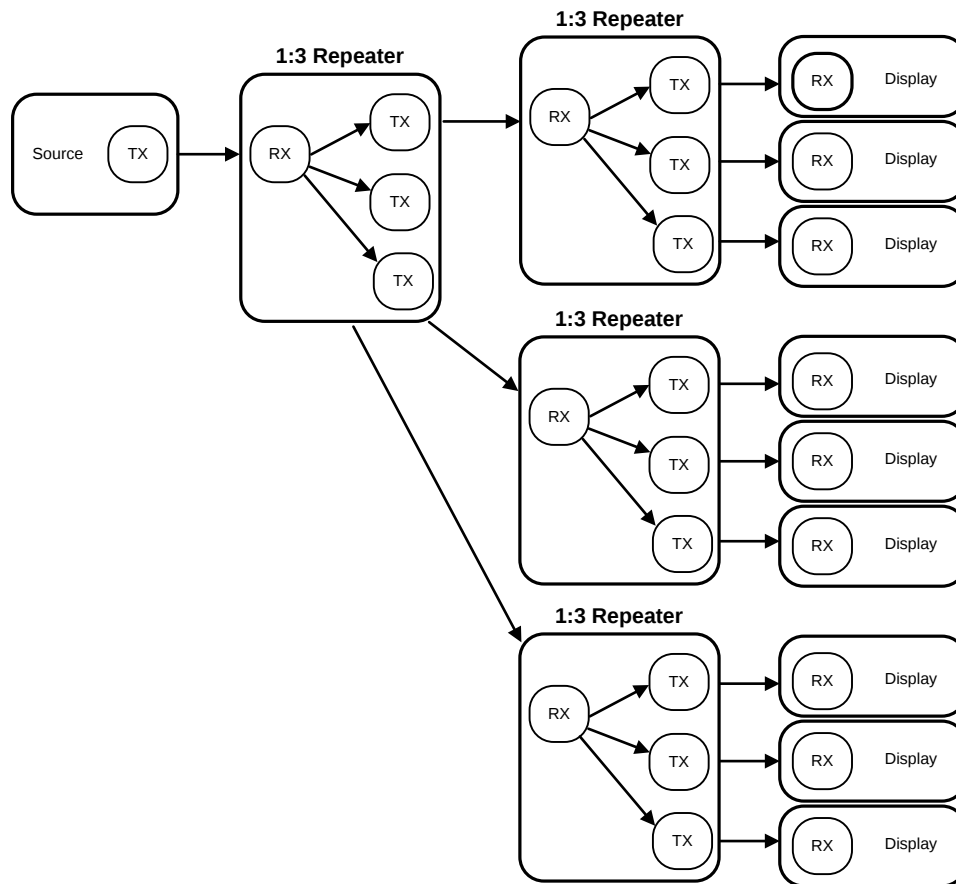
**Figure 20. FPD-Link Mapping: MSBs on RxIN3 (MAPSEL=H)**

### 7.4.5 Repeater

The supported Repeater application provides a mechanism to extend transmission over multiple links to multiple display devices.

#### 7.4.5.1 Repeater Configuration

In the repeater application, this document refers to the DS90UB927Q-Q1 as the Transmitter (TX), and refers to the DS90UB928Q-Q1 as the Receiver (RX). [Figure 21](#) shows the maximum configuration supported for Repeater implementations using the DS90UB925/7Q-Q1 (TX), and DS90UB926/8Q-Q1 (RX). Two levels of Repeaters are supported with a maximum of three Transmitters per Receiver. To ensure parallel video interface compatibility, repeater nodes should feature either the DS90UB926Q-Q1/DS90UB925Q (RX/TX) chipset or the DS90UB927Q-Q1/DS90UB928Q-Q1 (TX/RX) chipset.

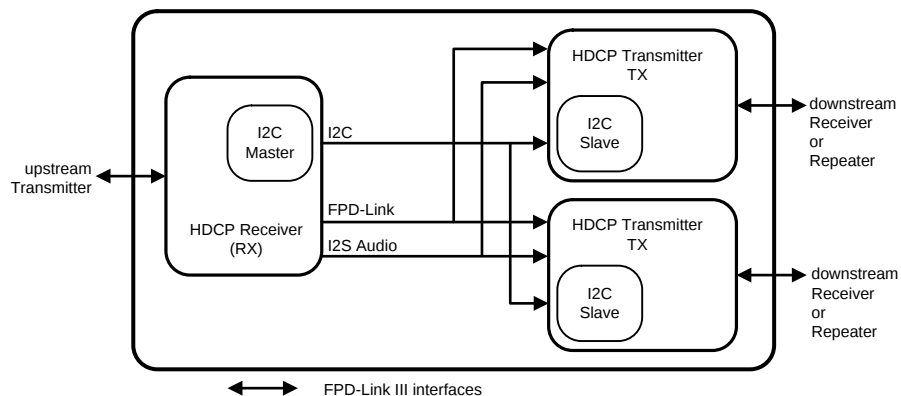
**Device Functional Modes (continued)**

**Figure 21. Maximum Repeater Application**

In a repeater application, the I<sup>2</sup>C interface at each TX and RX may be configured to transparently pass I<sup>2</sup>C communications upstream or downstream to any I<sup>2</sup>C device within the system. This includes a mechanism for assigning alternate IDs (Slave Aliases) to downstream devices in the case of duplicate addresses.

At each repeater node, the FPD-Link interface fans out to up to three serializer devices, providing video, audio, and control signals and, optionally, packetized audio data (transported during video blanking intervals). Alternatively, the I<sup>2</sup>S audio interface may be used to transport digital audio data between receiver and transmitters in place of packetized audio. All audio and video data is transmitted at the output of the receiver and is received by the transmitter.

If video data is output to a local display, White Balancing and Hi-FRC dithering functions should not be used as they will block encrypted I<sup>2</sup>S audio.

## Device Functional Modes (continued)

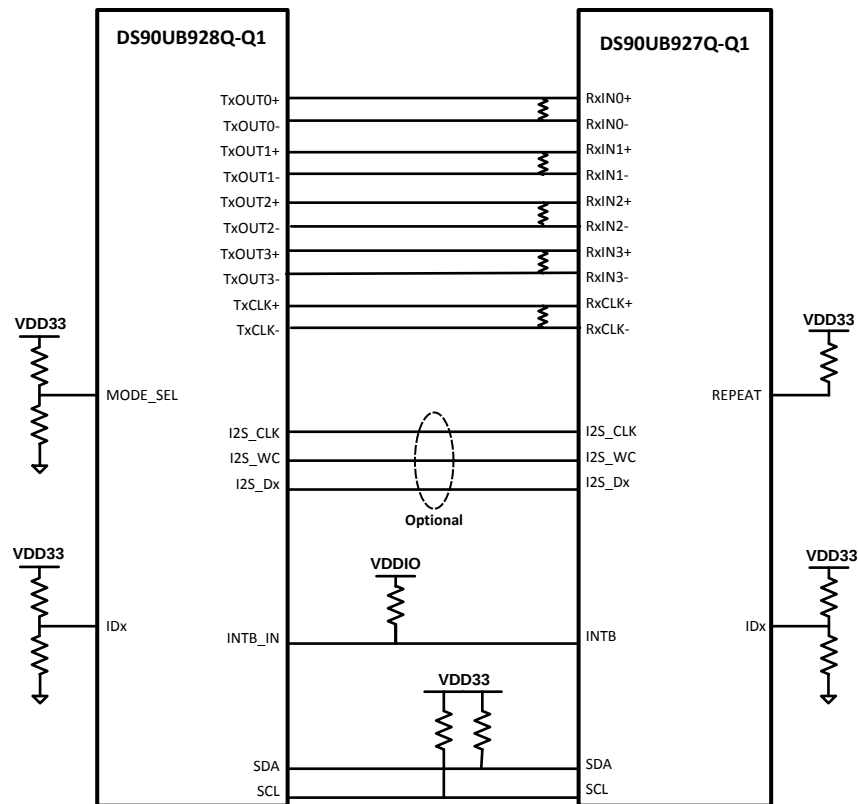


**Figure 22. 1:2 Repeater Configuration**

### 7.4.5.2 Repeater Connections

The Repeater requires the following connections between the Receiver and Transmitter [Figure 23](#).

1. Video Data – Connect all FPD-Link data and clock pairs
2. I<sup>2</sup>C – Connect SCL and SDA signals. Both signals should be pulled up to  $V_{DD33}$  or  $V_{DDIO} = 3.0\text{ V}$  to  $3.6\text{ V}$  with  $4.7\text{-k}\Omega$  resistors.
3. Audio (optional) – Connect I2S\_CLK, I2S\_WC, and I2S\_Dx signals.
4. IDx pin – Each Transmitter and Receiver must have a unique I<sup>2</sup>C address.
5. REPEAT pin — All Transmitters and Receivers must be set into Repeater Mode.
6. Interrupt pin – Connect DS90UB928Q-Q1 INTB\_IN pin to DS90UB927Q-Q1 INTB pin. The signal must be pulled up to  $V_{DDIO}$ .

**Device Functional Modes (continued)**

**Figure 23. Repeater Connection Diagram**
**7.4.5.2.1 Repeater Fan-Out Electrical Requirements**

Repeater applications requiring fan-out from one DS90UB928Q-Q1 deserializer to up to three DS90UB927Q-Q1 serializers requires special considerations for routing and termination of the FPD-Link differential traces. [Figure 24](#) details the requirements that must be met for each signal pair:

## Device Functional Modes (continued)

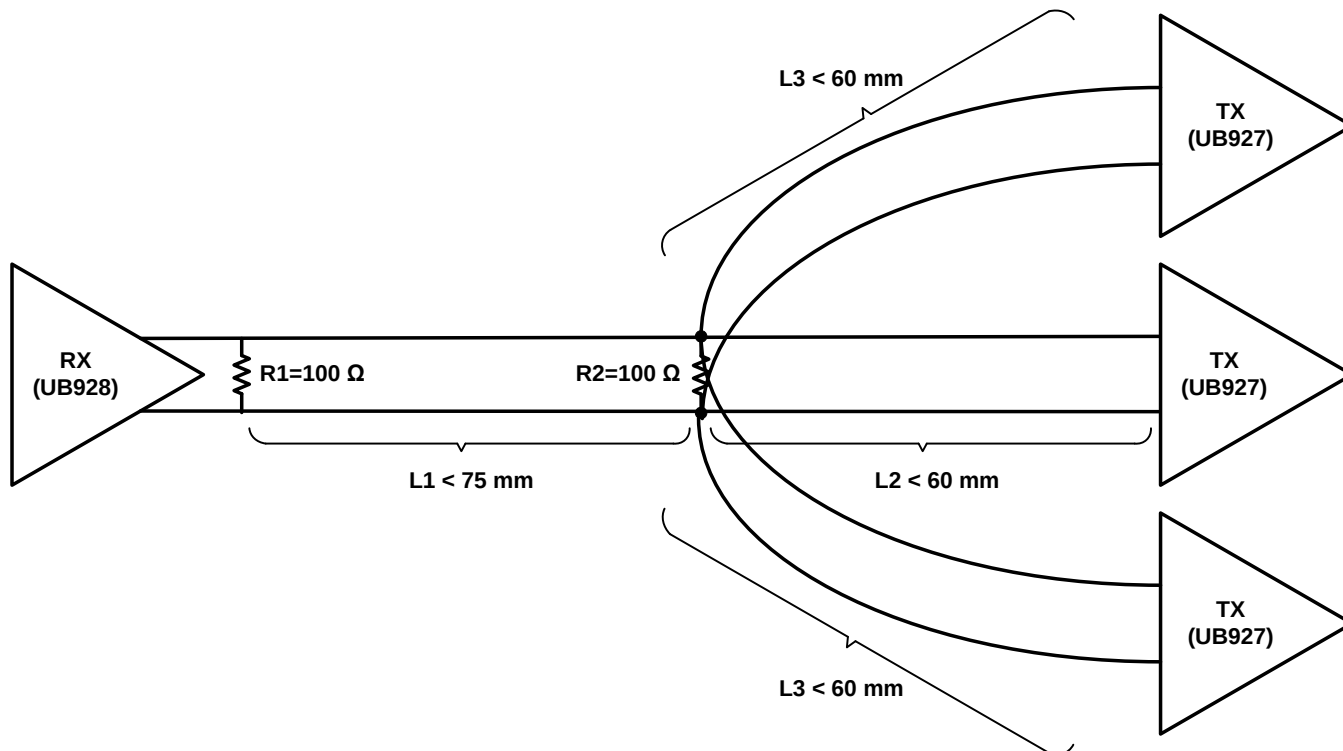


Figure 24. FPD-Link Fan-Out Electrical Requirements

## 7.5 Programming

### 7.5.1 Serial Control Bus

The DS90UB927Q-Q1 may also be configured by the use of an I<sup>2</sup>C compatible serial control bus. Multiple devices may share the serial control bus (up to 10 device addresses supported). The device address is set via a resistor divider (R1 and R2 — see Figure 25 below) connected to the IDx pin.

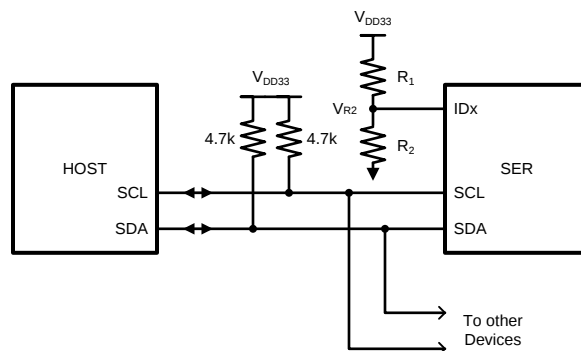


Figure 25. Serial Control Bus Connection

The serial control bus consists of two signals, SCL and SDA. SCL is a Serial Bus Clock Input. SDA is the Serial Bus Data Input / Output signal. Both SCL and SDA signals require an external pullup resistor to V<sub>DD33</sub> or V<sub>DDIO</sub> = 3.0 V to 3.6 V. For most applications, a 4.7-kΩ pullup resistor to V<sub>DD33</sub> is recommended. However, the pullup resistor value may be adjusted for capacitive loading and data rate requirements. The signals are either pulled High, or driven Low.

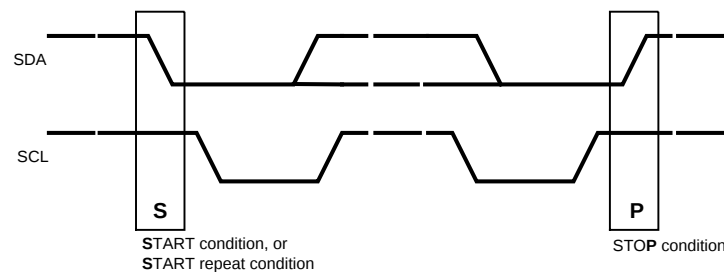
## Programming (continued)

The IDx pin configures the control interface to one of 10 possible device addresses. A pullup resistor and a pulldown resistor may be used to set the appropriate voltage ratio between the IDx input pin ( $V_{R2}$ ) and  $V_{DD33}$ , each ratio corresponding to a specific device address. See [Table 5](#) below.

**Table 4. Serial Control Bus Addresses for IDx**

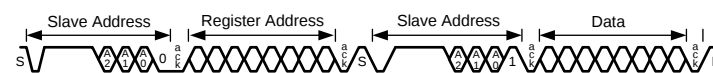
| NO. | Ideal Ratio $V_{R2} / V_{DD33}$ | Ideal $V_{R2}$ (V) | Suggested Resistor R1 k $\Omega$ (1% tol) | Suggested Resistor R2 k $\Omega$ (1% tol) | Address 7'b | Address 8'b |
|-----|---------------------------------|--------------------|-------------------------------------------|-------------------------------------------|-------------|-------------|
| 1   | 0                               | 0                  | Open                                      | 40.2 or >10                               | 0x0C        | 0x18        |
| 2   | 0.306                           | 1.011              | 221                                       | 97.6                                      | 0x13        | 0x26        |
| 3   | 0.350                           | 1.154              | 210                                       | 113                                       | 0x14        | 0x28        |
| 4   | 0.393                           | 1.298              | 196                                       | 127                                       | 0x15        | 0x2A        |
| 5   | 0.440                           | 1.452              | 182                                       | 143                                       | 0x16        | 0x2C        |
| 6   | 0.483                           | 1.594              | 169                                       | 158                                       | 0x17        | 0x2E        |
| 7   | 0.529                           | 1.745              | 147                                       | 165                                       | 0x18        | 0x30        |
| 8   | 0.572                           | 1.887              | 143                                       | 191                                       | 0x19        | 0x32        |
| 9   | 0.618                           | 2.040              | 121                                       | 196                                       | 0x1A        | 0x34        |
| 10  | 0.768                           | 2.535              | 90.9                                      | 301                                       | 0x1B        | 0x36        |

The Serial Bus protocol is controlled by START, START-Repeated, and STOP phases. A START occurs when SCL transitions Low while SDA is High. A STOP occurs when SDA transitions High while SCL is also HIGH. See [Figure 26](#).



**Figure 26. START and STOP Conditions**

To communicate with a remote device, the host controller (master) sends the slave address and listens for a response from the slave. This response is referred to as an acknowledge bit (ACK). If a slave on the bus is addressed correctly, it Acknowledges (ACKs) the master by driving the SDA bus low. If the address doesn't match a device's slave address, it Not-acknowledges (NACKs) the master by letting SDA be pulled High. ACKs also occur on the bus when data is being transmitted. When the master is writing data, the slave ACKs after every data byte is successfully received. When the master is reading data, the master ACKs after every data byte is received to let the slave know it wants to receive another data byte. When the master wants to stop reading, it NACKs after the last data byte and creates a stop condition on the bus. All communication on the bus begins with either a Start condition or a Repeated Start condition. All communication on the bus ends with a Stop condition. A READ is shown in [Figure 27](#) and a WRITE is shown in [Figure 28](#).



**Figure 27. Serial Control Bus — READ**



**Figure 28. Serial Control Bus — WRITE**

The I<sup>2</sup>C Master located at the DS90UB927Q-Q1 serializer must support I<sup>2</sup>C clock stretching. For more information on I<sup>2</sup>C interface requirements and throughput considerations, refer to TI Application Note [SNLA131](#).

## 7.6 Register Maps

**Table 5. Serial Control Bus Registers**

| ADD (dec) | ADD (hex) | Register Name              | Bit | Type | Default (hex) | Function                                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------|-----------|----------------------------|-----|------|---------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0         | 0x00      | I <sup>2</sup> C Device ID | 7:1 | RW   | IDx           | Device ID                                      | 7-bit address of Serializer<br>Note: Read-only unless bit 0 is set                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|           |           |                            | 0   | RW   |               | ID Setting                                     | I <sup>2</sup> C ID Setting<br>0: Device ID is from IDx pin<br>1: Register I <sup>2</sup> C Device ID overrides IDx pin                                                                                                                                                                                                                                                                                                                                                                                                            |
| 1         | 0x01      | Reset                      | 7   | RW   | 0x00          | Remote Auto Power Down                         | Remote Auto Power Down<br>0: Do not power down when no Bidirectional Control Channel link is detected (default)<br>1: Enable power down when no Bidirectional Control Channel link is detected                                                                                                                                                                                                                                                                                                                                     |
|           |           |                            | 6:2 |      |               |                                                | <b>Reserved.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|           |           |                            | 1   | RW   |               | Digital RESET1                                 | Reset the entire digital block including registers<br>This bit is self-clearing.<br>0: Normal operation (default)<br>1: Reset                                                                                                                                                                                                                                                                                                                                                                                                      |
|           |           |                            | 0   | RW   |               | Digital RESET0                                 | Reset the entire digital block except registers<br>This bit is self-clearing<br>0: Normal operation (default)<br>1: Reset                                                                                                                                                                                                                                                                                                                                                                                                          |
| 3         | 0x03      | General Configuration      | 7   | RW   | 0xD2          | Back channel CRC Checker Enable                | Back Channel Check Enable<br>0: Disable<br>1: Enable (default)                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|           |           |                            | 6   |      |               |                                                | <b>Reserved.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|           |           |                            | 5   | RW   |               | I <sup>2</sup> C Remote Write Auto Acknowledge | Automatically Acknowledge I <sup>2</sup> C Remote Write When enabled, I <sup>2</sup> C writes to the Deserializer (or any remote I <sup>2</sup> C Slave, if I <sup>2</sup> C PASS ALL is enabled) are immediately acknowledged without waiting for the Deserializer to acknowledge the write. This allows higher throughput on the I <sup>2</sup> C bus. Note: this mode will prevent any NACK or read/write error indication from a remote device from reaching the I <sup>2</sup> C master.<br>0: Disable (default)<br>1: Enable |
|           |           |                            | 4   | RW   |               | Filter Enable                                  | HS, VS, DE two clock filter When enabled, pulses less than two full PCLK cycles on the DE, HS, and VS inputs will be rejected<br>0: Filtering disable<br>1: Filtering enable (default)                                                                                                                                                                                                                                                                                                                                             |
|           |           |                            | 3   | RW   |               | I <sup>2</sup> C Pass-through                  | I <sup>2</sup> C Pass-Through Mode<br>Read/Write transactions matching any entry in the DeviceAlias registers will be passed through to the remote deserializer I <sup>2</sup> C interface.<br>0: Pass-Through Disabled (default)<br>1: Pass-Through Enabled                                                                                                                                                                                                                                                                       |
| 3         | 0x03      | General Configuration      | 2   |      | 0xD2          |                                                | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|           |           |                            | 1   | RW   |               | PCLK Auto                                      | Switch over to internal OSC in the absence of PCLK<br>0: Disable auto-switch<br>1: Enable auto-switch (default)                                                                                                                                                                                                                                                                                                                                                                                                                    |
|           |           |                            | 0   | RW   |               | TRFB                                           | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

**Register Maps (continued)**
**Table 5. Serial Control Bus Registers (continued)**

| ADD (dec) | ADD (hex) | Register Name            | Bit | Type | Default (hex) | Function                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----------|-----------|--------------------------|-----|------|---------------|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 4         | 0x04      | Mode Select              | 7   | RW   | 0x80          | Failsafe State                     | Input Failsafe State<br>0: Failsafe to High<br>1: Failsafe to Low (default)                                                                                                                                                                                                                                                                                                                                                                                                       |
|           |           |                          | 6   |      |               |                                    | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|           |           |                          | 5   | RW   |               | CRC Error Reset                    | Clear back channel CRC Error Counters<br>This bit is NOT self-clearing<br>0: Normal Operation (default)<br>1: Clear Counters                                                                                                                                                                                                                                                                                                                                                      |
|           |           |                          | 4   | RW   |               | DE Gate RGB                        | DE Gates RGB Data<br>0: Pass RGB data independent of DE in Backward Compatibility mode and non-HDCP operation (default)<br>1: Gate RGB data with DE in Backward Compatibility Mode and with non-HDCP deserializers                                                                                                                                                                                                                                                                |
|           |           |                          | 3   | RW   |               | BKWD Mode Override                 | Backward Compatible mode set by BKWD pin or register<br>0: BC mode is set by BKWD pin (default)<br>1: BC mode is set by register bit                                                                                                                                                                                                                                                                                                                                              |
|           |           |                          | 2   | RW   |               | BKWD                               | Backward compatibility mode, device to pair with DS90UR906Q, DS90UR908Q, or DS90UR916Q<br>0: Normal device (default)<br>1: Compatible with 906/908/916                                                                                                                                                                                                                                                                                                                            |
|           |           |                          | 1   | RW   |               | LFMODE Override                    | Frequency mode set by LFMODE pin or register<br>0: Frequency mode is set by LFMODE pin (default)<br>1: Frequency mode is set by register bit                                                                                                                                                                                                                                                                                                                                      |
|           |           |                          | 0   | RW   |               | LFMODE                             | Frequency mode select<br>0: High frequency mode (15 MHz ≤ RxCLKIN ≤ 85 MHz) (default)<br>1: Low frequency mode (5 MHz ≤ RxCLKIN < 15 MHz)                                                                                                                                                                                                                                                                                                                                         |
| 5         | 0x05      | I <sup>2</sup> C Control | 7:5 |      | 0x00          |                                    | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|           |           |                          | 4:3 | RW   |               | SDA Output Delay                   | SDA output delay<br>Configures output delay on the SDA output. Setting this value will increase output delay in units of 40ns.<br>Nominal output delay values for SCL to SDA are:<br>00: 240ns (default)<br>01: 280ns<br>10: 320ns<br>11: 360ns                                                                                                                                                                                                                                   |
|           |           |                          | 2   | RW   |               | Local Write Disable                | Disable Remote Writes to Local Registers Setting this bit to a 1 will prevent remote writes to local device registers from across the control channel. This prevents writes to the Serializer registers from an I <sup>2</sup> C master attached to the Deserializer. Setting this bit does not affect remote access to I <sup>2</sup> C slaves at the Serializer.<br>0: Enable (default)<br>1: Disable                                                                           |
| 5         | 0x05      | I <sup>2</sup> C Control | 1   | RW   | 0x00          | I <sup>2</sup> C Bus Timer Speedup | Speed up I <sup>2</sup> C Bus Watchdog Timer<br>0: Watchdog Timer expires after approximately 1 s (default)<br>1: Watchdog Timer expires after approximately 50 μs                                                                                                                                                                                                                                                                                                                |
|           |           |                          | 0   | RW   |               | I <sup>2</sup> C Bus timer Disable | Disable I <sup>2</sup> C Bus Watchdog Timer When the I <sup>2</sup> C Watchdog Timer may be used to detect when the I <sup>2</sup> C bus is free or hung up following an invalid termination of a transaction. If SDA is high and no signaling occurs for approximately 1 s, the I <sup>2</sup> C bus will be assumed to be free. If SDA is low and no signaling occurs, the device will attempt to clear the bus by driving 9 clocks on SCL<br>0: Enable (default)<br>1: Disable |

## Register Maps (continued)

**Table 5. Serial Control Bus Registers (continued)**

| ADD (dec) | ADD (hex) | Register Name  | Bit | Type | Default (hex) | Function                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------|-----------|----------------|-----|------|---------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 6         | 0x06      | DES ID         | 7:1 | RW   | 0x00          | DES Device ID           | 7-bit Deserializer Device ID Configures the I <sup>2</sup> C Slave ID of the remote Deserializer. A value of 0 in this field disables I <sup>2</sup> C access to the remote Deserializer. This field is automatically configured by the Bidirectional Control Channel once RX Lock has been detected. Software may overwrite this value, but should also assert the FREEZE DEVICE ID bit to prevent overwriting by the Bidirectional Control Channel. |
|           |           |                | 0   |      |               |                         | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 7         | 0x07      | Slave ID 0     | 7:1 | RW   | 0x00          | Slave Device ID 0       | 7-bit Remote Slave Device ID 0 Configures the physical I <sup>2</sup> C address of the remote I <sup>2</sup> C Slave device attached to the remote Deserializer. If an I <sup>2</sup> C transaction is addressed to the Slave Device Alias ID 0, the transaction will be remapped to this address before passing the transaction across the Bidirectional Control Channel to the Deserializer.                                                        |
|           |           |                | 0   |      |               |                         | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 8         | 0x08      | Slave Alias 0  | 7:1 | RW   | 0x00          | Slave Device Alias ID 0 | 7-bit Remote Slave Device Alias ID 0 Configures the decoder for detecting transactions designated for an I <sup>2</sup> C Slave device attached to the remote Deserializer. The transaction will be remapped to the address specified in the Slave ID 0 register. A value of 0 in this field disables access to the remote I <sup>2</sup> C Slave.                                                                                                    |
|           |           |                | 0   |      |               |                         | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 10        | 0x0A      | CRC Errors     | 7:0 | R    | 0x00          | CRC Error LSB           | Number of Back Channel CRC errors – 8 least significant bits. Cleared by 0x04[5]                                                                                                                                                                                                                                                                                                                                                                      |
| 11        | 0x0B      |                | 7:0 | R    | 0x00          | CRC Error MSB           | Number of Back Channel CRC errors – 8 most significant bits. Cleared by 0x04[5]                                                                                                                                                                                                                                                                                                                                                                       |
| 12        | 0x0C      | General Status | 7:4 |      | 0x00          |                         | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|           |           |                | 3   | R    |               | BIST CRC Error          | Back Channel CRC error during BIST communication with Deserializer. This bit is cleared upon loss of link, restart of BIST, or assertion of CRC ERROR RESET in register 0x04. 0: No CRC errors detected during BIST (default) 1: CRC Errors detected during BIST                                                                                                                                                                                      |
|           |           |                | 2   | R    |               | PCLK Detect             | Pixel Clock Status<br>0: Valid PCLK not detected (default)<br>1: Valid PCLK detected                                                                                                                                                                                                                                                                                                                                                                  |
|           |           |                | 1   | R    |               | DES Error               | CRC error during BIST communication with Deserializer. This bit is cleared upon loss of link or assertion of 0x04[5] 0: No CRC errors detected (default) 1: CRC errors detected                                                                                                                                                                                                                                                                       |
|           |           |                | 0   | R    |               | LINK Detect             | LINK Detect Status<br>0: Cable link not detected (default)<br>1: Cable link detected                                                                                                                                                                                                                                                                                                                                                                  |

**Register Maps (continued)**
**Table 5. Serial Control Bus Registers (continued)**

| ADD (dec) | ADD (hex) | Register Name                 | Bit | Type | Default (hex) | Function            | Description                                                                                                                                                                                                                   |
|-----------|-----------|-------------------------------|-----|------|---------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13        | 0x0D      | GPIO0 Configuration           | 7:4 | R    | 0x20          | Revision ID         | Revision ID:<br>0010: Production Device                                                                                                                                                                                       |
|           |           |                               | 3   | RW   |               | GPIO0 Output Value  | Local GPIO Output Value This value is output on the GPIO pin when the GPIO function is enabled, the local GPIO direction is Output, and remote GPIO control is disabled.<br>0: Output LOW (default)<br>1: Output HIGH         |
|           |           |                               | 2   | RW   |               | GPIO0 Remote Enable | Remote GPIO Control<br>0: Disable GPIO control from remote Deserializer (default)<br>1: Enable GPIO control from remote Deserializer. The GPIO pin will be an output, and the value is received from the remote Deserializer. |
|           |           |                               | 1   | RW   |               | GPIO0 Direction     | Local GPIO Direction<br>0: Output (default)<br>1: Input                                                                                                                                                                       |
|           |           |                               | 0   | RW   |               | GPIO0 Enable        | GPIO Function Enable<br>0: Enable normal operation (default)<br>1: Enable GPIO operation                                                                                                                                      |
| 14        | 0x0E      | GPIO1 and GPIO2 Configuration | 7   | RW   | 0x00          | GPIO2 Output Value  | Local GPIO Output Value This value is output on the GPIO pin when the GPIO function is enabled, the local GPIO direction is Output, and remote GPIO control is disabled.<br>0: Output LOW (default)<br>1: Output HIGH         |
|           |           |                               | 6   | RW   |               | GPIO2 Remote Enable | Remote GPIO Control<br>0: Disable GPIO control from remote Deserializer (default)<br>1: Enable GPIO control from remote Deserializer. The GPIO pin will be an output, and the value is received from the remote Deserializer. |
|           |           |                               | 5   | RW   |               | GPIO2 Direction     | Local GPIO Direction<br>0: Output (default)<br>1: Input                                                                                                                                                                       |
|           |           |                               | 4   | RW   |               | GPIO2 Enable        | GPIO Function Enable<br>0: Enable normal operation (default)<br>1: Enable GPIO operation                                                                                                                                      |
|           |           |                               | 3   | RW   |               | GPIO1 Output Value  | Local GPIO Output Value This value is output on the GPIO pin when the GPIO function is enabled, the local GPIO direction is Output, and remote GPIO control is disabled.<br>0: Output LOW (default)<br>1: Output HIGH         |
|           |           |                               | 2   | RW   |               | GPIO1 Remote Enable | Remote GPIO Control<br>0: Disable GPIO control from remote Deserializer (default)<br>1: Enable GPIO control from remote Deserializer. The GPIO pin will be an output, and the value is received from the remote Deserializer. |
|           |           |                               | 1   | RW   |               | GPIO1 Direction     | Local GPIO Direction<br>1: Input<br>0: Output                                                                                                                                                                                 |
|           |           |                               | 0   | RW   |               | GPIO1 Enable        | GPIO function enable<br>1: Enable GPIO operation<br>0: Enable normal operation                                                                                                                                                |

## Register Maps (continued)

**Table 5. Serial Control Bus Registers (continued)**

| ADD (dec) | ADD (hex) | Register Name                         | Bit | Type | Default (hex) | Function                | Description                                                                                                                                                                                                                   |
|-----------|-----------|---------------------------------------|-----|------|---------------|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 15        | 0x0F      | GPIO3 Configuration                   | 7:4 |      | 0x00          |                         | <b>Reserved</b>                                                                                                                                                                                                               |
|           |           |                                       | 3   | RW   |               | GPIO3 Output Value      | Local GPIO Output Value This value is output on the GPIO pin when the GPIO function is enabled, the local GPIO direction is Output, and remote GPIO control is disabled.<br>0: Output LOW (default)<br>1: Output HIGH         |
|           |           |                                       | 2   | RW   |               | GPIO3 Remote Enable     | Remote GPIO Control<br>0: Disable GPIO control from remote Deserializer (default)<br>1: Enable GPIO control from remote Deserializer. The GPIO pin will be an output, and the value is received from the remote Deserializer. |
|           |           |                                       | 1   | RW   |               | GPIO3 Direction         | Local GPIO Direction<br>0: Output (default)<br>1: Input                                                                                                                                                                       |
|           |           |                                       | 0   | RW   |               | GPIO3 Enable            | GPIO Function Enable<br>0: Enable normal operation (default)<br>1: Enable GPIO operation                                                                                                                                      |
| 16        | 0x10      | GPIO_REG5 and GPIO_REG6 Configuration | 7   | RW   | 0x00          | GPIO_RE G6 Output Value | Local GPIO Output Value This value is output on the GPIO pin when the GPIO function is enabled, and the local GPIO direction is Output.<br>0: Output LOW (default)<br>1: Output HIGH                                          |
|           |           |                                       | 6   |      |               |                         | <b>Reserved</b>                                                                                                                                                                                                               |
|           |           |                                       | 5   | RW   |               | GPIO_RE G6 Direction    | Local GPIO Direction<br>0: Output (default)<br>1: Input                                                                                                                                                                       |
|           |           |                                       | 4   | RW   |               | GPIO_RE G6 Enable       | GPIO Function Enable<br>0: Enable normal operation (default)<br>1: Enable GPIO operation                                                                                                                                      |
|           |           |                                       | 3   | RW   |               | GPIO_RE G5 Output Value | Local GPIO Output Value This value is output on the GPIO pin when the GPIO function is enabled, and the local GPIO direction is Output.<br>0: Output LOW (default)<br>1: Output HIGH                                          |
|           |           |                                       | 2   |      |               |                         | <b>Reserved</b>                                                                                                                                                                                                               |
|           |           |                                       | 1   | RW   |               | GPIO_RE G5 Direction    | GPIO Function Enable<br>0: Enable normal operation (default)<br>1: Enable GPIO operation                                                                                                                                      |
|           |           |                                       | 0   | RW   |               | GPIO_RE G5 Enable       | GPIO Function Enable<br>0: Enable normal operation (default)<br>1: Enable GPIO operation                                                                                                                                      |
|           |           |                                       |     |      |               |                         |                                                                                                                                                                                                                               |

**Register Maps (continued)**
**Table 5. Serial Control Bus Registers (continued)**

| ADD<br>(dec) | ADD<br>(hex) | Register Name                                  | Bit | Type | Default<br>(hex) | Function                                            | Description                                                                                                                                                                                                       |
|--------------|--------------|------------------------------------------------|-----|------|------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 17           | 0x11         | GPIO_REG7<br>and<br>GPIO_REG8<br>Configuration | 7   | RW   | 0x00             | GPIO_RE<br>G8 Output<br>Value                       | Local GPIO Output Value This value is output on the GPIO pin when the GPIO function is enabled, and the local GPIO direction is Output.<br>0: Output LOW (default)<br>1: Output HIGH                              |
|              |              |                                                | 6   |      |                  |                                                     | <b>Reserved</b>                                                                                                                                                                                                   |
|              |              |                                                | 5   | RW   |                  | GPIO_RE<br>G8<br>Direction                          | Local GPIO Direction<br>0: Output (default)<br>1: Input                                                                                                                                                           |
|              |              |                                                | 4   | RW   |                  | GPIO_RE<br>G8 Enable                                | GPIO Function Enable<br>0: Enable normal operation (default)<br>1: Enable GPIO operation                                                                                                                          |
|              |              |                                                | 3   | RW   |                  | GPIO_RE<br>G7 Output<br>Value                       | Local GPIO Output Value This value is output on the GPIO pin when the GPIO function is enabled, and the local GPIO direction is Output.<br>0: Output LOW (default)<br>1: Output HIGH                              |
|              |              |                                                | 2   |      |                  |                                                     | <b>Reserved</b>                                                                                                                                                                                                   |
|              |              |                                                | 1   | RW   |                  | GPIO_RE<br>G7<br>Direction                          | Local GPIO Direction<br>0: Output (default)<br>1: Input                                                                                                                                                           |
|              |              |                                                | 0   | RW   |                  | GPO_REG<br>7 Enable                                 | GPIO Function Enable<br>0: Enable normal operation (default)<br>1: Enable GPIO operation                                                                                                                          |
| 18           | 0x12         | Data Path<br>Control                           | 7:6 |      | 0x00             |                                                     | <b>Reserved</b>                                                                                                                                                                                                   |
|              |              |                                                | 5   | RW   |                  | DE Polarity                                         | This bit indicates the polarity of the DE (Data Enable) signal.<br>0: DE is positive (active high, idle low) (default)<br>1: DE is inverted (active low, idle high)                                               |
|              |              |                                                | 4   | RW   |                  | I <sup>2</sup> S<br>Repeater<br>Regen               | Regenerate I <sup>2</sup> S Data From Repeater I <sup>2</sup> S Pins<br>0: Repeater pass through I <sup>2</sup> S from video pins (default)<br>1: Repeater regenerate I <sup>2</sup> S from I <sup>2</sup> S pins |
|              |              |                                                | 3   | RW   |                  | I <sup>2</sup> S<br>Channel B<br>Enable<br>Override | I <sup>2</sup> S Channel B Override<br>0: Set I <sup>2</sup> S Channel B Disabled (default)<br>1: Set I <sup>2</sup> S Channel B Enable from reg_12[0]                                                            |
|              |              |                                                | 2   | RW   |                  | 18-bit<br>Video<br>Select                           | Video Color Depth Mode<br>0: Select 24-bit video mode (default)<br>1: Select 18-bit video mode                                                                                                                    |
|              |              |                                                | 1   | RW   |                  | I <sup>2</sup> S<br>Transport<br>Select             | Select I <sup>2</sup> S Transport Mode<br>0: Enable I <sup>2</sup> S Data Island Transport (default)<br>1: Enable I <sup>2</sup> S Data Forward Channel Frame Transport                                           |
|              |              |                                                | 0   | RW   |                  | I <sup>2</sup> S<br>Channel B<br>Enable             | I <sup>2</sup> S Channel B Enable<br>0: I <sup>2</sup> S Channel B disabled (default)<br>1: Enable I <sup>2</sup> S Channel B                                                                                     |

## Register Maps (continued)

**Table 5. Serial Control Bus Registers (continued)**

| ADD (dec) | ADD (hex) | Register Name            | Bit | Type | Default (hex) | Function                      | Description                                                                                                                                                                                                                                                                                                                                                                                |
|-----------|-----------|--------------------------|-----|------|---------------|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19        | 0x13      | General Purpose Control  | 7   | R    | 0x10          | MAPSEL Mode                   | Returns Map Select Mode (MAPSEL) pin status                                                                                                                                                                                                                                                                                                                                                |
|           |           |                          | 6   | RW   |               | MAPSEL Override               | FPD-Link Map Select (MAPSEL) set by input pin or register<br>0: Map Select is set by input pin (default)<br>1: Map Select is set by register bit 0x13[5]                                                                                                                                                                                                                                   |
|           |           |                          | 5   | RW   |               | MAPSEL Value                  | FPD-Link Map Select (MAPSEL) value when 0x13[6] is set<br>0: LSBs on RxIN3± (default)<br>1: MSBs on RxIN3±                                                                                                                                                                                                                                                                                 |
|           |           |                          | 4   |      |               |                               | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                            |
|           |           |                          | 3   | R    |               | LFMODE Status                 | Low Frequency Mode (LFMODE) pin status<br>0: 15 ≤ RxCLKIN ≤ 85MHz (default)<br>1: 5 ≤ RxCLKIN < 15MHz                                                                                                                                                                                                                                                                                      |
|           |           |                          | 2   | R    |               | REPEAT Status                 | Repeater Mode (REPEAT) pin Status<br>0: Non-repeater (default)<br>1: Repeater                                                                                                                                                                                                                                                                                                              |
|           |           |                          | 1   | R    |               | BKWD Status                   | Backward Compatible Mode (BKWD) Status<br>0: Compatible to DS90UB926/8Q-Q1 (default)<br>1: Backward compatible to DS90UR906/8Q-Q1                                                                                                                                                                                                                                                          |
|           |           |                          | 0   | R    |               | I <sup>2</sup> S_DB Status    | I <sup>2</sup> S Channel B Mode (I <sup>2</sup> S_DB) Status<br>0: I <sup>2</sup> S_DB inactive (default)<br>1: I <sup>2</sup> S_DB active                                                                                                                                                                                                                                                 |
| 20        | 0x14      | BIST Control             | 7:3 |      | 0x00          |                               | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                            |
|           |           |                          | 2:1 | RW   |               | OSC Clock Source              | Internal OSC clock select for Functional Mode or BIST.<br>Functional Mode when PCLK is not present and 0x03[1]=1.<br>00: 33 MHz Oscillator (default)<br>01: 33 MHz Oscillator<br>Clock Source in BIST mode<br>00: External Pixel Clock (default)<br>01: 33 MHz Oscillator<br>Note: In LFMODE=1, the internal oscillator is 12.5MHz                                                         |
|           |           |                          | 0   | R    |               | BIST Enable                   | BIST Control<br>0: Disabled (default)<br>1: Enabled                                                                                                                                                                                                                                                                                                                                        |
| 22        | 0x16      | BCC Watchdog Control     | 7:1 | RW   | 0xFE          | Timer Value                   | The watchdog timer allows termination of a control channel transaction if it fails to complete within a programmed amount of time. This field sets the Bidirectional Control Channel Watchdog Timeout value in units of 2 milliseconds. This field should not be set to 0.                                                                                                                 |
|           |           |                          | 0   | RW   |               | Timer Control                 | Disable BCC Watchdog Timer<br>0: Enable BCC Watchdog Timer operation (default)<br>1: Disable BCC Watchdog Timer operation                                                                                                                                                                                                                                                                  |
| 23        | 0x17      | I <sup>2</sup> C Control | 7   | RW   | 0x1E          | I <sup>2</sup> C Pass All     | Pass All<br>0: Enable Forward Control Channel pass-through only of I <sup>2</sup> C accesses to I <sup>2</sup> C Slave IDs matching either the remote Deserializer Slave ID or the remote Slave ID. (default)<br>1: Enable Forward Control Channel pass-through of all I <sup>2</sup> C accesses to I <sup>2</sup> C Slave IDs that do not match the Serializer I <sup>2</sup> C Slave ID. |
|           |           |                          | 6:4 | RW   |               | SDA Hold Time                 | Internal SDA Hold Time<br>Configures the amount of internal hold time provided for the SDA input relative to the SCL input. Units are 40 nanoseconds.                                                                                                                                                                                                                                      |
|           |           |                          | 3:0 | RW   |               | I <sup>2</sup> C Filter Depth | Configures the maximum width of glitch pulses on the SCL and SDA inputs that will be rejected. Units are 5 nanoseconds.                                                                                                                                                                                                                                                                    |

**Register Maps (continued)**
**Table 5. Serial Control Bus Registers (continued)**

| ADD (dec) | ADD (hex) | Register Name       | Bit | Type | Default (hex) | Function                           | Description                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------|-----------|---------------------|-----|------|---------------|------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 24        | 0x18      | SCL High Time       | 7:0 | RW   | 0xA1          | SCL HIGH Time                      | I <sup>2</sup> C Master SCL High Time<br>This field configures the high pulse width of the SCL output when the Serializer is the Master on the local I <sup>2</sup> C bus. Units are 40 ns for the nominal oscillator clock frequency.                                                                                                                                                                                          |
| 25        | 0x19      | SCL Low Time        | 7:0 | RW   | 0xA5          | SCL LOW Time                       | I <sup>2</sup> C SCL Low Time<br>This field configures the low pulse width of the SCL output when the Serializer is the Master on the local I <sup>2</sup> C bus. This value is also used as the SDA setup time by the I <sup>2</sup> C Slave for providing data prior to releasing SCL during accesses over the Bidirectional Control Channel. Units are 40 ns for the nominal oscillator clock frequency.                     |
| 26        | 0x1A      | Data Path Control 2 | 7   | RW   | 0x00          | Block I <sup>2</sup> S Auto Config | Block automatic I <sup>2</sup> S mode configuration (repeater only)<br>0: I <sup>2</sup> S mode (2-channel, 4-channel, or surround) is detected from the in-band audio signaling<br>1: Disable automatic detection of I <sup>2</sup> S mode                                                                                                                                                                                     |
|           |           |                     | 6:1 |      |               |                                    | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |
|           |           |                     | 0   | RW   |               | I <sup>2</sup> S Surround          | Enable 5.1- or 7.1-channel I <sup>2</sup> S audio transport<br>0: 2-channel or 4-channel I <sup>2</sup> S audio is enabled as configured in register 0x12 bits 3 and 0 (default)<br>1: 5.1- or 7.1-channel audio is enabled<br>Note that I <sup>2</sup> S Data Island Transport is the only option for surround audio. Also note that in a repeater, this bit may be overridden by the in-band I <sup>2</sup> S mode detection. |
| 27        | 0x1B      | BIST BC Error Count | 7:0 | R    | 0x00          | BIST BC Error                      | BIST Back Channel CRC Error Counter<br>This register stores the back-channel CRC error count during BIST Mode (saturates at 255 errors). Clears when a new BIST is initiated or by 0x04[5]                                                                                                                                                                                                                                      |
| 28        | 0x1C      | GPIO Pin Status 1   | 7   | R    | 0x00          | GPIO_RE G7 Pin Status              | GPIO_REG7 Input Pin Status<br>Status valid only if set to GPI (input) mode                                                                                                                                                                                                                                                                                                                                                      |
|           |           |                     | 6   | R    |               | GPIO_RE G6 Pin Status              | GPIO_REG6 Input Pin Status<br>Status valid only if set to GPI (input) mode                                                                                                                                                                                                                                                                                                                                                      |
|           |           |                     | 5   | R    |               | GPIO_RE G5 Pin Status              | GPIO_REG5 Input Pin Status<br>Status valid only if set to GPI (input) mode                                                                                                                                                                                                                                                                                                                                                      |
|           |           |                     | 4   |      |               |                                    | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |
|           |           |                     | 3   | R    |               | GPIO3 Pin Status                   | GPIO3 Input Pin Status<br>Status valid only if set to GPI (input) mode                                                                                                                                                                                                                                                                                                                                                          |
|           |           |                     | 2   | R    |               | GPIO2 Pin Status                   | GPIO2 Input Pin Status<br>Status valid only if set to GPI (input) mode                                                                                                                                                                                                                                                                                                                                                          |
|           |           |                     | 1   | R    |               | GPIO1 Pin Status                   | GPIO1 Input Pin Status<br>Status valid only if set to GPI (input) mode                                                                                                                                                                                                                                                                                                                                                          |
|           |           |                     | 0   | R    |               | GPIO0 Pin Status                   | GPIO0 Input Pin Status<br>Status valid only if set to GPI (input) mode                                                                                                                                                                                                                                                                                                                                                          |
| 29        | 0x1D      | GPIO Pin Status 2   | 7:1 |      | 0x00          |                                    | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |
|           |           |                     | 0   | R    |               | GPIO_RE G8 Pin Status              | GPIO_REG8 Input Pin Status<br>Status valid only if set to GPI (input) mode                                                                                                                                                                                                                                                                                                                                                      |
| 30        | 0x1F      | Frequency Counter   | 7:0 | RW   | 0x00          | Frequency Counter                  | Frequency Counter Control<br>Write: Measure number of pixel clock periods in written interval (40ns units)<br>Read: Return number of pixel clock periods counted                                                                                                                                                                                                                                                                |

## Register Maps (continued)

**Table 5. Serial Control Bus Registers (continued)**

| ADD (dec) | ADD (hex) | Register Name             | Bit | Type | Default (hex) | Function                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------|-----------|---------------------------|-----|------|---------------|--------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 32        | 0x20      | Deserializer Capabilities | 7   | RW   | 0x00          | Freeze DES CAP           | Freeze Deserializer Capabilities<br>Prevent auto-loading of the Deserializer Capabilities by the Bidirectional Control Channel. The Capabilities will be frozen at the values written in registers 0x20 and 0x21.<br>0: Normal operation (default)<br>1: Freeze                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|           |           |                           | 6:2 |      |               |                          | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|           |           |                           | 1   | RW   |               | HD Audio                 | Deserializer supports 24-bit video concurrently with HD audio<br>This field is automatically configured by the Bidirectional Control Channel once RX Lock has been detected. Software may overwrite this value, but must also set the FREEZE DES CAP bit to prevent overwriting by the Bidirectional Control Channel.<br>0: Normal operation (default)<br>1: Freeze                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|           |           |                           | 0   | RW   |               | FC GPIO                  | Deserializer supports GPIO in the Forward Channel Frame<br>This field is automatically configured by the Bidirectional Control Channel once RX Lock has been detected. Software may overwrite this value, but must also set the FREEZE DES CAP bit to prevent overwriting by the Bidirectional Control Channel.<br>0: Normal operation (default)<br>1: Freeze                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 100       | 0x64      | Pattern Generator Control | 7:4 | RW   | 0x10          | Pattern Generator Select | Fixed Pattern Select<br>Selects the pattern to output when in Fixed Pattern Mode. Scaled patterns are evenly distributed across the horizontal or vertical active regions. This field is ignored when Auto-Scrolling Mode is enabled.<br>xxxx: normal/inverted<br>0000: Checkerboard<br>0001: White/Black (default)<br>0010: Black/White<br>0011: Red/Cyan<br>0100: Green/Magenta<br>0101: Blue/Yellow<br>0110: Horizontal Black-White/White-Black<br>0111: Horizontal Black-Red/White-Cyan<br>1000: Horizontal Black-Green/White-Magenta<br>1001: Horizontal Black-Blue/White-Yellow<br>1010: Vertical Black-White/White—Black<br>1011: Vertically Scaled Black to Red/White to Cyan<br>1100: Vertical Black-Green/White-Magenta<br>1101: Vertical Black-Blue/White-Yellow<br>1110: Custom color (or its inversion) configured in PGRS, PGGS, PGS registers<br>1111: VCOM<br>See TI App Note AN-2198. |
|           |           |                           | 3   |      |               |                          | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|           |           |                           | 2   | RW   |               | Color Bars Pattern       | Enable Color Bars<br>0: Color Bars disabled (default)<br>1: Color Bars enabled<br>Overrides the selection from reg_0x64[7:4]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|           |           |                           | 1   | RW   |               | VCOM Pattern Reverse     | Reverse order of color bands in VCOM pattern<br>0: Color sequence from top left is (YCBR) (default)<br>1: Color sequence from top left is (RBCY)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|           |           |                           | 0   | RW   |               | Pattern Generator Enable | Pattern Generator Enable<br>0: Disable Pattern Generator (default)<br>1: Enable Pattern Generator                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

**Register Maps (continued)**
**Table 5. Serial Control Bus Registers (continued)**

| ADD<br>(dec) | ADD<br>(hex) | Register Name                         | Bit | Type | Default<br>(hex) | Function            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------|--------------|---------------------------------------|-----|------|------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 101          | 0x65         | Pattern<br>Generator<br>Configuration | 7   |      | 0x00             |                     | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|              |              |                                       | 6   | RW   |                  | Checkerboard Scale  | Scale Checkered Patterns:<br>0: Normal operation (each square is 1x1 pixel) (default)<br>1: Scale checkered patterns (VCOM and checkerboard) by 8 (each square is 8x8 pixels)<br>Setting this bit gives better visibility of the checkered patterns.                                                                                                                                                                                                              |
|              |              |                                       | 5   | RW   |                  | Custom Checkerboard | Use Custom Checkerboard Color<br>0: Use white and black in the Checkerboard pattern (default)<br>1: Use the Custom Color and black in the Checkerboard pattern                                                                                                                                                                                                                                                                                                    |
|              |              |                                       | 4   | RW   |                  | PG 18-bit Mode      | 18-bit Mode Select:<br>0: Enable 24-bit pattern generation. Scaled patterns use 256 levels of brightness. (default)<br>1: Enable 18-bit color pattern generation. Scaled patterns will have 64 levels of brightness and the R, G, and B outputs use the six most significant color bits.                                                                                                                                                                          |
|              |              |                                       | 3   | RW   |                  | External Clock      | Select External Clock Source:<br>0: Selects the internal divided clock when using internal timing (default)<br>1: Selects the external pixel clock when using internal timing. This bit has no effect in external timing mode (PATGEN_TSEL = 0).                                                                                                                                                                                                                  |
|              |              |                                       | 2   | RW   |                  | Timing Select       | Timing Select Control:<br>0: the Pattern Generator uses external video timing from the pixel clock, Data Enable, Horizontal Sync, and Vertical Sync signals. (default)<br>1: The Pattern Generator creates its own video timing as configured in the Pattern Generator Total Frame Size, Active Frame Size, Horizontal Sync Width, Vertical Sync Width, Horizontal Back Porch, Vertical Back Porch, and Sync Configuration registers.<br>See TI App Note AN-2198. |
|              |              |                                       | 1   | RW   |                  | Color Invert        | Enable Inverted Color Patterns:<br>0: Do not invert the color output. (default)<br>1: Invert the color output.<br>See TI App Note AN-2198.                                                                                                                                                                                                                                                                                                                        |
|              |              |                                       | 0   | RW   |                  | Auto Scroll         | Auto Scroll Enable:<br>0: The Pattern Generator retains the current pattern. (default)<br>1: The Pattern Generator will automatically move to the next enabled pattern after the number of frames specified in the Pattern Generator Frame Time (PGFT) register.<br>See TI App Note AN-2198.                                                                                                                                                                      |
| 102          | 0x66         | PGIA                                  | 7:0 | RW   | 0x00             | PG Indirect Address | This 8-bit field sets the indirect address for accesses to indirectly-mapped registers. It should be written prior to reading or writing the Pattern Generator Indirect Data register.<br>See TI App Note AN-2198                                                                                                                                                                                                                                                 |
| 103          | 0x67         | PGID                                  | 7:0 | RW   | 0x00             | PG Indirect Data    | When writing to indirect registers, this register contains the data to be written. When reading from indirect registers, this register contains the read back value.<br>See TI App Note AN-2198                                                                                                                                                                                                                                                                   |
| 112          | 0x70         | Slave ID[1]                           | 7:1 | RW   | 0x00             | Slave ID 1          | 7-bit Remote Slave Device ID 1<br>Configures the physical I <sup>2</sup> C address of the remote I <sup>2</sup> C Slave device attached to the remote Deserializer. If an I <sup>2</sup> C transaction is addressed to the Slave Alias ID1, the transaction will be remapped to this address before passing the transaction across the Bidirectional Control Channel to the Deserializer.                                                                         |
|              |              |                                       | 0   |      |                  |                     | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

## Register Maps (continued)

**Table 5. Serial Control Bus Registers (continued)**

| ADD (dec) | ADD (hex) | Register Name  | Bit | Type | Default (hex) | Function         | Description                                                                                                                                                                                                                                                                                                                                                                               |
|-----------|-----------|----------------|-----|------|---------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 113       | 0x71      | Slave ID[2]    | 7:1 | RW   | 0x00          | Slave ID 2       | 7-bit Remote Slave Device ID 2<br>Configures the physical I <sup>2</sup> C address of the remote I <sup>2</sup> C Slave device attached to the remote Deserializer. If an I <sup>2</sup> C transaction is addressed to the Slave Alias ID2, the transaction will be remapped to this address before passing the transaction across the Bidirectional Control Channel to the Deserializer. |
|           |           |                | 0   |      |               |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                           |
| 114       | 0x72      | Slave ID[3]    | 7:1 | RW   | 0x00          | Slave ID 3       | 7-bit Remote Slave Device ID 3<br>Configures the physical I <sup>2</sup> C address of the remote I <sup>2</sup> C Slave device attached to the remote Deserializer. If an I <sup>2</sup> C transaction is addressed to the Slave Alias ID3, the transaction will be remapped to this address before passing the transaction across the Bidirectional Control Channel to the Deserializer. |
|           |           |                | 0   |      |               |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                           |
| 115       | 0x73      | Slave ID[4]    | 7:1 | RW   | 0x00          | Slave ID 4       | 7-bit Remote Slave Device ID 4<br>Configures the physical I <sup>2</sup> C address of the remote I <sup>2</sup> C Slave device attached to the remote Deserializer. If an I <sup>2</sup> C transaction is addressed to the Slave Alias ID4, the transaction will be remapped to this address before passing the transaction across the Bidirectional Control Channel to the Deserializer. |
|           |           |                | 0   |      |               |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                           |
| 116       | 0x74      | Slave ID[5]    | 7:1 | RW   | 0x00          | Slave ID 5       | 7-bit Remote Slave Device ID 5<br>Configures the physical I <sup>2</sup> C address of the remote I <sup>2</sup> C Slave device attached to the remote Deserializer. If an I <sup>2</sup> C transaction is addressed to the Slave Alias ID5, the transaction will be remapped to this address before passing the transaction across the Bidirectional Control Channel to the Deserializer. |
|           |           |                | 0   |      |               |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                           |
| 117       | 0x75      | Slave ID[6]    | 7:1 | RW   | 0x00          | Slave ID 6       | 7-bit Remote Slave Device ID 6<br>Configures the physical I <sup>2</sup> C address of the remote I <sup>2</sup> C Slave device attached to the remote Deserializer. If an I <sup>2</sup> C transaction is addressed to the Slave Alias ID6, the transaction will be remapped to this address before passing the transaction across the Bidirectional Control Channel to the Deserializer. |
|           |           |                | 0   |      |               |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                           |
| 118       | 0x76      | Slave ID[7]    | 7:1 | RW   | 0x00          | Slave ID 7       | 7-bit Remote Slave Device ID 7<br>Configures the physical I <sup>2</sup> C address of the remote I <sup>2</sup> C Slave device attached to the remote Deserializer. If an I <sup>2</sup> C transaction is addressed to the Slave Alias ID7, the transaction will be remapped to this address before passing the transaction across the Bidirectional Control Channel to the Deserializer. |
|           |           |                | 0   |      |               |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                           |
| 119       | 0x77      | Slave Alias[1] | 7:1 | RW   | 0x00          | Slave Alias ID 1 | 7-bit Remote Slave Device Alias ID 1<br>Configures the decoder for detecting transactions designated for an I <sup>2</sup> C Slave device attached to the remote Deserializer. The transaction will be remapped to the address specified in the Slave ID1 register. A value of 0 in this field disables access to the remote I <sup>2</sup> C Slave.                                      |
|           |           |                | 0   |      |               |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                                                           |

**Register Maps (continued)**
**Table 5. Serial Control Bus Registers (continued)**

| ADD<br>(dec) | ADD<br>(hex) | Register Name  | Bit | Type | Default<br>(hex) | Function         | Description                                                                                                                                                                                                                                                                                                                                          |
|--------------|--------------|----------------|-----|------|------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 120          | 0x78         | Slave Alias[2] | 7:1 | RW   | 0x00             | Slave Alias ID 2 | 7-bit Remote Slave Device Alias ID 2<br>Configures the decoder for detecting transactions designated for an I <sup>2</sup> C Slave device attached to the remote Deserializer. The transaction will be remapped to the address specified in the Slave ID2 register. A value of 0 in this field disables access to the remote I <sup>2</sup> C Slave. |
|              |              |                | 0   |      |                  |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
| 121          | 0x79         | Slave Alias[3] | 7:1 | RW   | 0x00             | Slave Alias ID 3 | 7-bit Remote Slave Device Alias ID 3<br>Configures the decoder for detecting transactions designated for an I <sup>2</sup> C Slave device attached to the remote Deserializer. The transaction will be remapped to the address specified in the Slave ID3 register. A value of 0 in this field disables access to the remote I <sup>2</sup> C Slave. |
|              |              |                | 0   |      |                  |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
| 122          | 0x7A         | Slave Alias[4] | 7:1 | RW   | 0x00             | Slave Alias ID 4 | 7-bit Remote Slave Device Alias ID 4<br>Configures the decoder for detecting transactions designated for an I <sup>2</sup> C Slave device attached to the remote Deserializer. The transaction will be remapped to the address specified in the Slave ID4 register. A value of 0 in this field disables access to the remote I <sup>2</sup> C Slave. |
|              |              |                | 0   |      |                  |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
| 123          | 0x7B         | Slave Alias[5] | 7:1 | RW   | 0x00             | Slave Alias ID 5 | 7-bit Remote Slave Device Alias ID 5<br>Configures the decoder for detecting transactions designated for an I <sup>2</sup> C Slave device attached to the remote Deserializer. The transaction will be remapped to the address specified in the Slave ID5 register. A value of 0 in this field disables access to the remote I <sup>2</sup> C Slave. |
|              |              |                | 0   |      |                  |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
| 124          | 0x7C         | Slave Alias[6] | 7:1 | RW   | 0x00             | Slave Alias ID 6 | 7-bit Remote Slave Device Alias ID 6<br>Configures the decoder for detecting transactions designated for an I <sup>2</sup> C Slave device attached to the remote Deserializer. The transaction will be remapped to the address specified in the Slave ID6 register. A value of 0 in this field disables access to the remote I <sup>2</sup> C Slave. |
|              |              |                | 0   |      |                  |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
| 125          | 0x7D         | Slave Alias[7] | 7:1 | RW   | 0x00             | Slave Alias ID 7 | 7-bit Remote Slave Device Alias ID 7<br>Configures the decoder for detecting transactions designated for an I <sup>2</sup> C Slave device attached to the remote Deserializer. The transaction will be remapped to the address specified in the Slave ID7 register. A value of 0 in this field disables access to the remote I <sup>2</sup> C Slave. |
|              |              |                | 0   |      |                  |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
| 198          | 0xC6         | ICR            | 7:6 |      | 0x00             |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
|              |              |                | 5   | RW   |                  | IS_RX_INT        | Interrupt on Receiver interrupt<br>Enables interrupt on indication from the Receiver. Allows propagation of interrupts from downstream devices                                                                                                                                                                                                       |
|              |              |                | 4:1 |      |                  |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
| 199          | 0xC7         | ISR            | 7:6 |      | 0x00             |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
|              |              |                | 5   | R    |                  | IS RX INT        | Interrupt on Receiver interrupt<br>Receiver has indicated an interrupt request from downstream device                                                                                                                                                                                                                                                |
|              |              |                | 4:1 |      |                  |                  | <b>Reserved</b>                                                                                                                                                                                                                                                                                                                                      |
|              |              |                | 0   | R    |                  | INT Enable       | Global Interrupt Enable<br>Set if any enabled interrupt is indicated                                                                                                                                                                                                                                                                                 |

## Register Maps (continued)

**Table 5. Serial Control Bus Registers (continued)**

| ADD (dec) | ADD (hex) | Register Name | Bit | Type | Default (hex) | Function | Description                 |
|-----------|-----------|---------------|-----|------|---------------|----------|-----------------------------|
| 240       | 0xF0      | TX ID         | 7:0 | R    | 0x5F          | ID0      | First byte ID code, '_'     |
| 241       | 0xF1      |               | 7:0 | R    | 0x55          | ID1      | Second byte of ID code, 'U' |
| 242       | 0xF2      |               | 7:0 | R    | 0x42          | ID2      | Third byte of ID code, 'B'  |
| 243       | 0xF3      |               | 7:0 | R    | 0x39          | ID3      | Forth byte of ID code: '9'  |
| 244       | 0xF4      |               | 7:0 | R    | 0x32          | ID4      | Fifth byte of ID code: "2"  |
| 245       | 0xF5      |               | 7:0 | R    | 0x37          | ID5      | Sixth byte of ID code: "7"  |

## 8 Application and Implementation

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### NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

---

### 8.1 Application Information

The DS90UB927Q-Q1, in conjunction with the DS90UB928Q-Q1 or DS90UB926Q-Q1, is intended for interface between a host (graphics processor) and a display, supporting 24-bit color depth (RGB888) and high definition (720p) digital video format. It can receive an 8-bit RGB stream with a pixel clock rate up to 85 MHz together with three control bits (VS, HS and DE) and four I<sup>2</sup>S audio streams.

### 8.2 Typical Application

[Figure 29](#) shows a typical application of the DS90UB927Q-Q1 serializer for an 85-MHz 24-bit Color Display Application. The 5 LVDS input pairs require external 100 $\Omega$  terminations. The CML outputs must have an external 0.1- $\mu$ F AC coupling capacitor on the high speed serial lines. The serializer has internal CML termination on its high speed outputs.

Bypass capacitors should be placed near the power supply pins. At a minimum, four (4) 4.7- $\mu$ F capacitors should be used for local device bypassing. Ferrite beads are placed on the two sets of supply pins (VDD33 and VDDIO) for effective noise suppression. The interface to the graphics source is LVDS. The VDDIO pins may be connected to 3.3 V or 1.8 V. A capacitor and resistor are placed on the PDB pin to delay the enabling of the device until power is stable.

## Typical Application (continued)

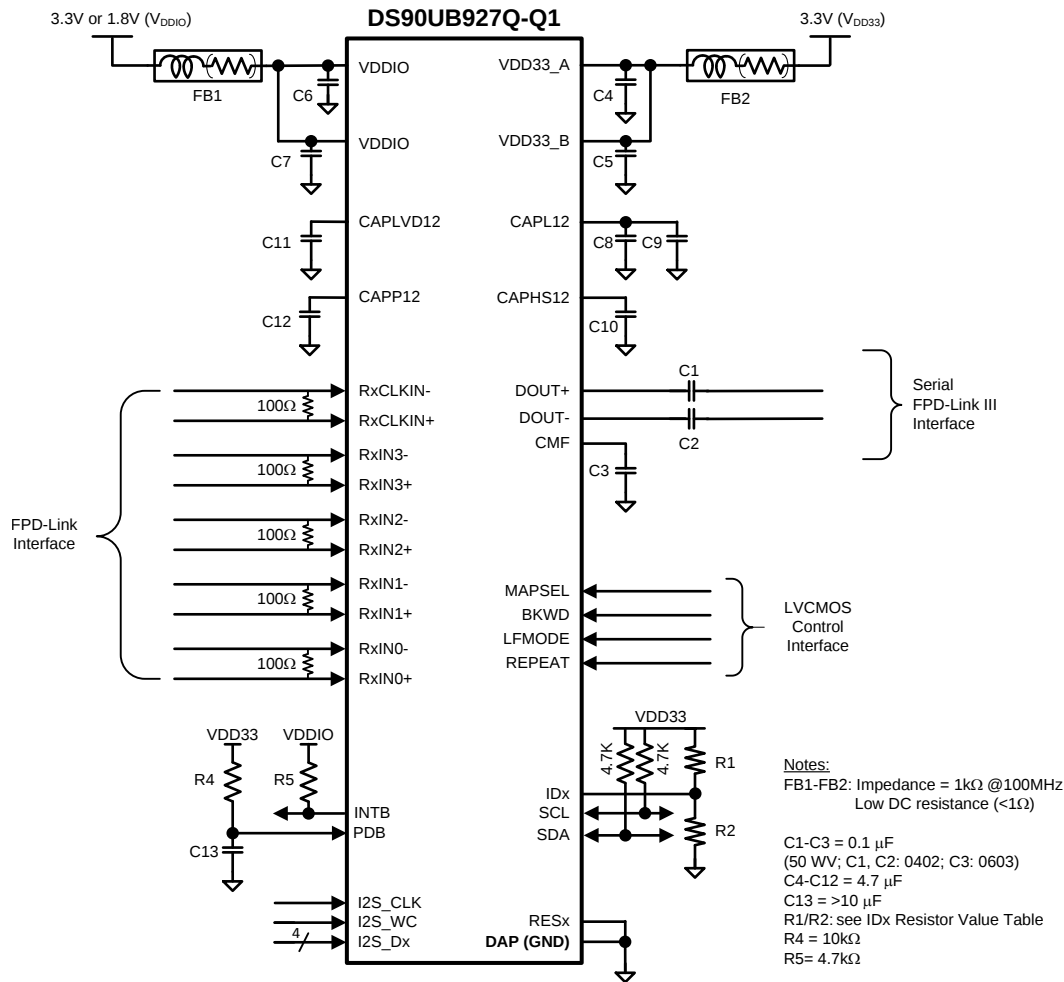


Figure 29. Color Display Typical Connection Diagram

### 8.2.1 Design Requirements

For the typical design application, use the following as input parameters.

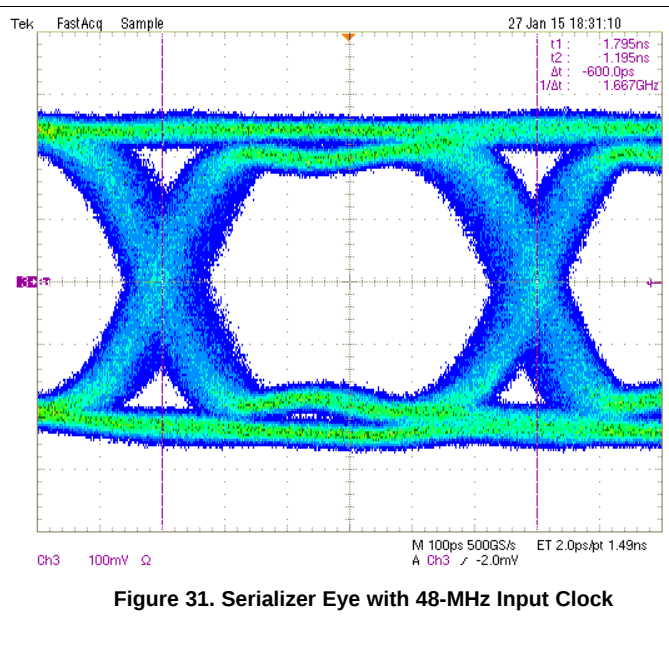
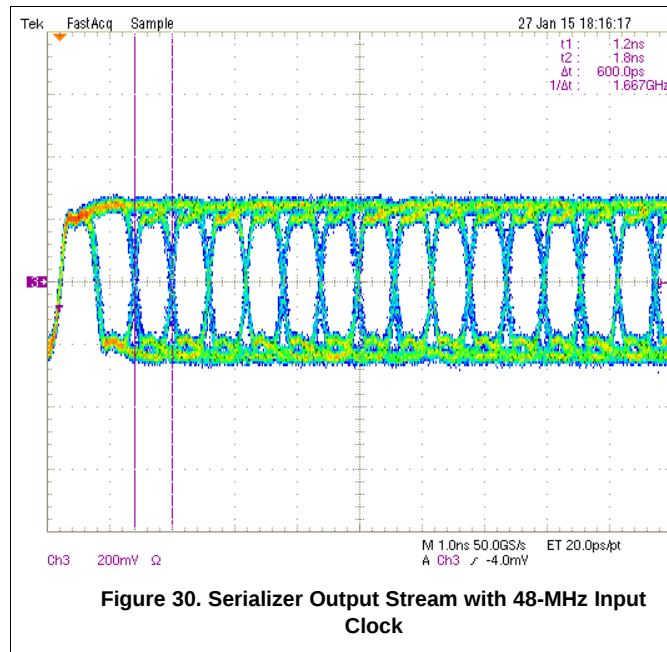
Table 6. Design Parameters

| DESIGN PARAMETER                | EXAMPLE VALUE  |
|---------------------------------|----------------|
| VDDIO                           | 1.8 V or 3.3 V |
| VDD33                           | 3.3 V          |
| AC Coupling Capacitor for DOUT± | 100 nF         |
| PCLK Frequency                  | 85 MHz         |

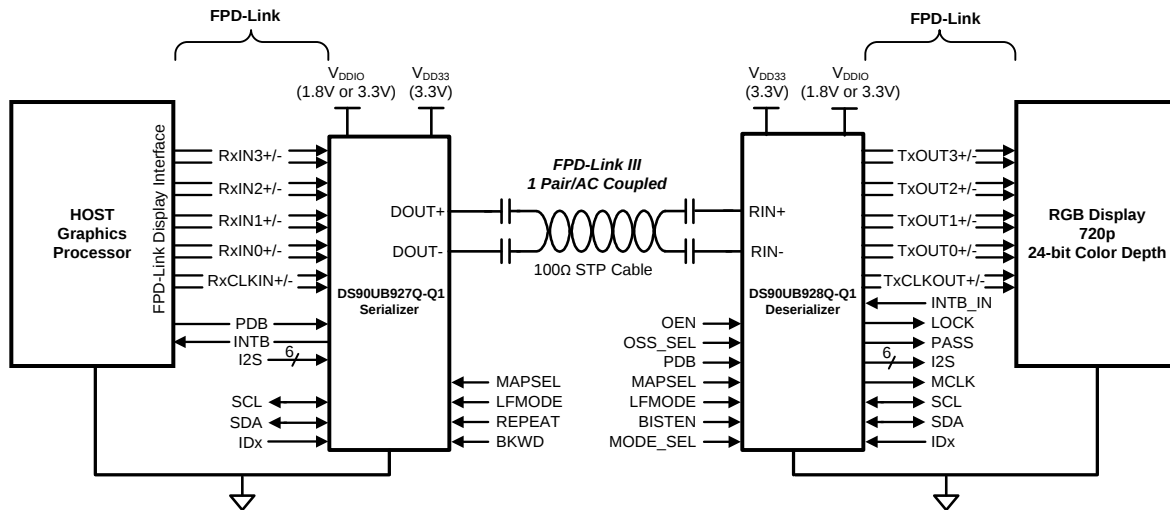
### 8.2.2 Detailed Design Procedure

Figure 29 shows a typical application of the DS90UB927Q-Q1 serializer for an 85-MHz 24-bit Color Display Application. The CML outputs must have an external 0.1-μF AC coupling capacitor on the high speed serial lines. Bypass capacitors are placed near the power supply pins. At a minimum, six 4.7-μF capacitors and two additional 1-μF capacitors should be used for local device bypassing. Ferrite beads are placed on the two VDDs (VDD33 and VDDIO) for effective noise suppression. An RC delay is placed on the PDB signal to delay the enabling of the device until power is stable.

## 8.2.3 Application Curves



## 8.3 System Examples



**Figure 32. Color Display Application Diagram**

## System Examples (continued)

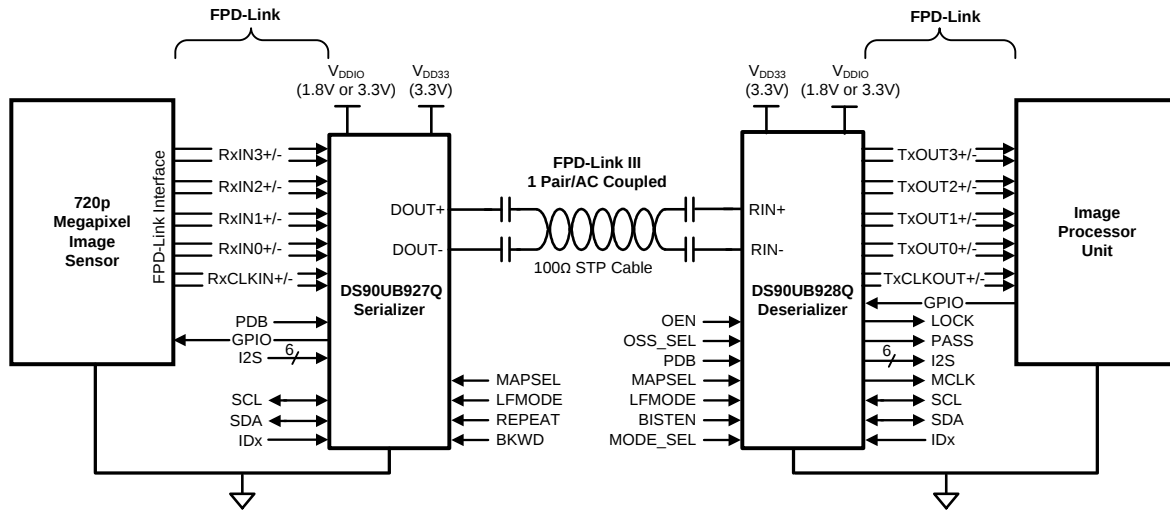


Figure 33. Megapixel Camera Application Diagram

## 9 Power Supply Recommendations

This section describes the power-up requirements and PDB pin. The power supply ramp ( $V_{DD33}$  and  $V_{DDIO}$ ) should be faster than 1.5 ms with a monotonic rise. A large capacitor on the PDB pin is needed to ensure PDB arrives after all the supply pins have settled to the recommended operating voltage. When PDB pin is pulled up to  $V_{DD33}$ , a 10-k $\Omega$  pullup and a >10- $\mu$ F capacitor to GND are required to delay the PDB input signal rise. All inputs must not be driven until both  $V_{DD33}$  and  $V_{DDIO}$  has reached steady state. Pins VDD33\_A and VDD33\_B should both be externally connected, bypassed, and driven to the same potential (they are not internally connected).

## 10 Layout

### 10.1 Layout Guidelines

Circuit board layout and stack-up for the LVDS serializer and deserializer devices should be designed to provide low-noise power to the device. Good layout practice will also separate high frequency or high-level inputs and outputs to minimize unwanted stray noise, feedback and interference. Power system performance may be greatly improved by using thin dielectrics (2 to 4 mil) for power / ground sandwiches. This arrangement utilizes the plane capacitance for the PCB power system and has low-inductance, which has proven effectiveness especially at high frequencies, and makes the value and placement of external bypass capacitors less critical. External bypass capacitors should include both RF ceramic and tantalum electrolytic types. RF capacitors may use values in the range of 0.01  $\mu$ F to 10  $\mu$ F. Tantalum capacitors may be in the 2.2  $\mu$ F to 10  $\mu$ F range. The voltage rating of the tantalum capacitors should be at least 5X the power supply voltage being used.

MLCC surface mount capacitors are recommended due to their smaller parasitic properties. When using multiple capacitors per supply pin, locate the smaller value closer to the pin. A large bulk capacitor is recommended at the point of power entry. This is typically in the 50  $\mu$ F to 100  $\mu$ F range and will smooth low frequency switching noise. It is recommended to connect power and ground pins directly to the power and ground planes with bypass capacitors connected to the plane with via on both ends of the capacitor. Connecting power or ground pins to an external bypass capacitor will increase the inductance of the path. A small body size X7R chip capacitor, such as 0603 or 0805, is recommended for external bypass. A small body sized capacitor has less inductance. The user must pay attention to the resonance frequency of these external bypass capacitors, usually in the range of 20 MHz to 30 MHz. To provide effective bypassing, multiple capacitors are often used to achieve low impedance between the supply rails over the frequency of interest. At high frequency, it is also a common practice to use two vias from power and ground pins to the planes, reducing the impedance at high frequency.

Some devices provide separate power and ground pins for different portions of the circuit. This is done to isolate switching noise effects between different sections of the circuit. Separate planes on the PCB are typically not required. Pin Description tables typically provide guidance on which circuit blocks are connected to which power pin pairs. In some cases, an external filter may be used to provide clean power to sensitive circuits such as PLLs. For DS90UB927Q-Q1, only one common ground plane is required to connect all device related ground pins.

Use at least a four layer board with a power and ground plane. Locate LVCMOS signals away from the LVDS lines to prevent coupling from the LVCMOS lines to the LVDS lines. Closely coupled differential lines of 100 $\Omega$  are typically recommended for LVDS interconnect. The closely coupled lines help to ensure that coupled noise will appear as common mode and thus is rejected by the receivers. The tightly coupled lines will also radiate less.

At least 9 thermal vias are necessary from the device center DAP to the ground plane. They connect the device ground to the PCB ground plane, as well as conduct heat from the exposed pad of the package to the PCB ground plane. More information on the WQFN style package, including PCB design and manufacturing requirements, is provided in TI Application Note: *AN-1187 Leadless Leadframe Package (LLP)* ([SNOA401](#)).

## Layout Guidelines (continued)

### 10.1.1 CML Interconnect Guidelines

See [SNLA008](#) and [SNLA035](#) for full details.

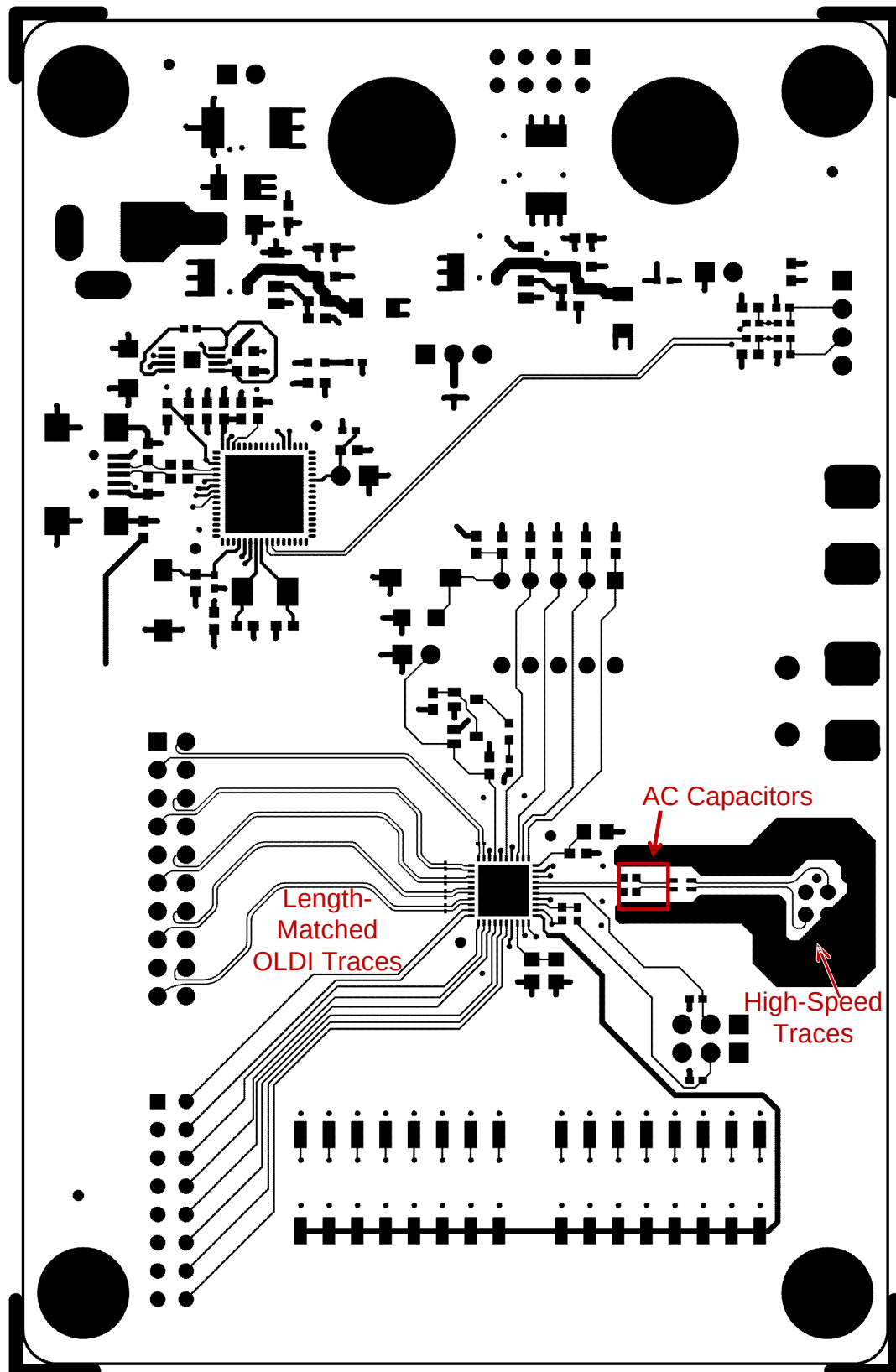
- Use 100- $\Omega$  coupled differential pairs
- Use the S/2S/3S rule in spacings
  - S = space between the pair
  - 2S = space between pairs
  - 3S = space to LVCMOS signal
- Minimize the number of Vias
- Use differential connectors when operating above 500 Mbps line speed
- Maintain balance of the traces
- Minimize skew within the pair
- Terminate as close to the TX outputs and RX inputs as possible.

Additional general guidance can be found in the *LVDS Owner's Manual* - available at: [SNLA187](#)

### 10.2 Layout Example

[Figure 34](#) PCB layout example is derived from the layout design of the DS90UB927Q-Q1 Evaluation Board. The graphic and layout description are used to determine both proper routing and proper solder techniques when designing the Serializer board.

**Layout Example (continued)**



**Figure 34. DS90UB927Q-Q1 Serializer Example Layout**

## 11 器件和文档支持

### 11.1 文档支持

#### 11.1.1 相关文档

相关文档如下：

- [AN-2198](#) 《探讨 720p 的内部测试图案生成特性》，[SNLA132](#)
- 《通过具有双向控制通道的 FPD-Link III 进行 I2C 通信》，[SNLA131](#)
- [AN-1187](#) 《无引线框架封装 (LLP)》，[SNOA401](#)
- [AN-1108](#) 《通道链路 PCB 和互连设计指南》，[SNLA008](#)
- [AN-905](#) 《传输线路 RAPIDESIGNER 操作和应用指南》，[SNLA035](#)
- 《LVDS 所有者手册》，[SNLA187](#)
- 《QFN/SON PCB 连接》，[SLUA271](#)

### 11.2 商标

All trademarks are the property of their respective owners.

### 11.3 静电放电警告



这些装置包含有限的内置 ESD 保护。存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

### 11.4 术语表

[SLYZ022](#) — TI 术语表。

这份术语表列出并解释术语、首字母缩略词和定义。

## 12 机械封装和可订购信息

以下页中包括机械封装和可订购信息。 这些信息是针对指定器件可提供的最新数据。 这些数据会在无通知且不对本文档进行修订的情况下发生改变。 欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

## 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                 |
|--------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| DS90UB927QSQ/NOPB  | ACTIVE        | WQFN         | RTA                | 40   | 1000           | RoHS & Green    | SN                                   | Level-3-260C-168 HR  | -40 to 105   | UB927QSQ                | <a href="#">Samples</a> |
| DS90UB927QSQE/NOPB | ACTIVE        | WQFN         | RTA                | 40   | 250            | RoHS & Green    | SN                                   | Level-3-260C-168 HR  | -40 to 105   | UB927QSQ                | <a href="#">Samples</a> |
| DS90UB927QSQX/NOPB | ACTIVE        | WQFN         | RTA                | 40   | 2500           | RoHS & Green    | SN                                   | Level-3-260C-168 HR  | -40 to 105   | UB927QSQ                | <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.

(2) **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 <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) 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.

(6) 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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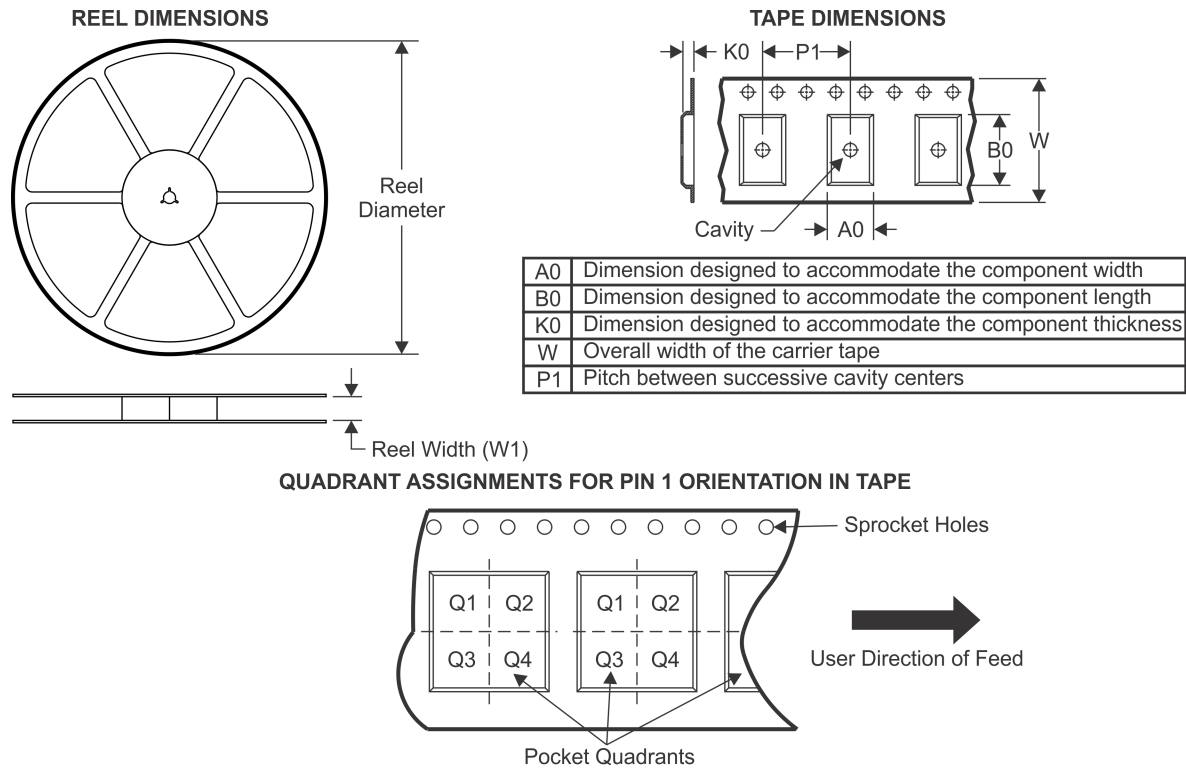
www.ti.com

## PACKAGE OPTION ADDENDUM

10-Dec-2020

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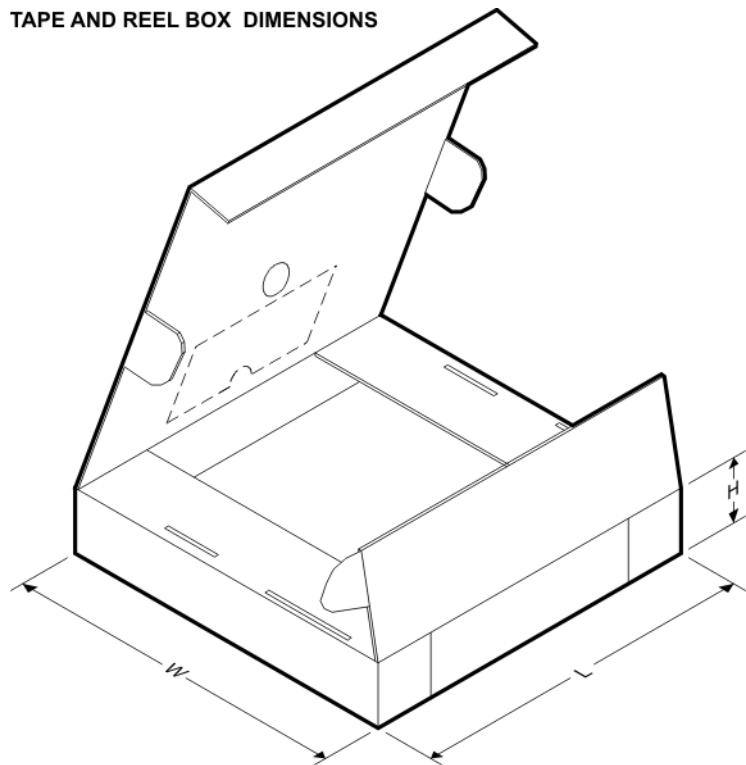
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device             | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DS90UB927QSQ/NOPB  | WQFN         | RTA             | 40   | 1000 | 330.0              | 16.4               | 6.3     | 6.3     | 1.5     | 12.0    | 16.0   | Q1            |
| DS90UB927QSQE/NOPB | WQFN         | RTA             | 40   | 250  | 178.0              | 16.4               | 6.3     | 6.3     | 1.5     | 12.0    | 16.0   | Q1            |
| DS90UB927QSQX/NOPB | WQFN         | RTA             | 40   | 2500 | 330.0              | 16.4               | 6.3     | 6.3     | 1.5     | 12.0    | 16.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

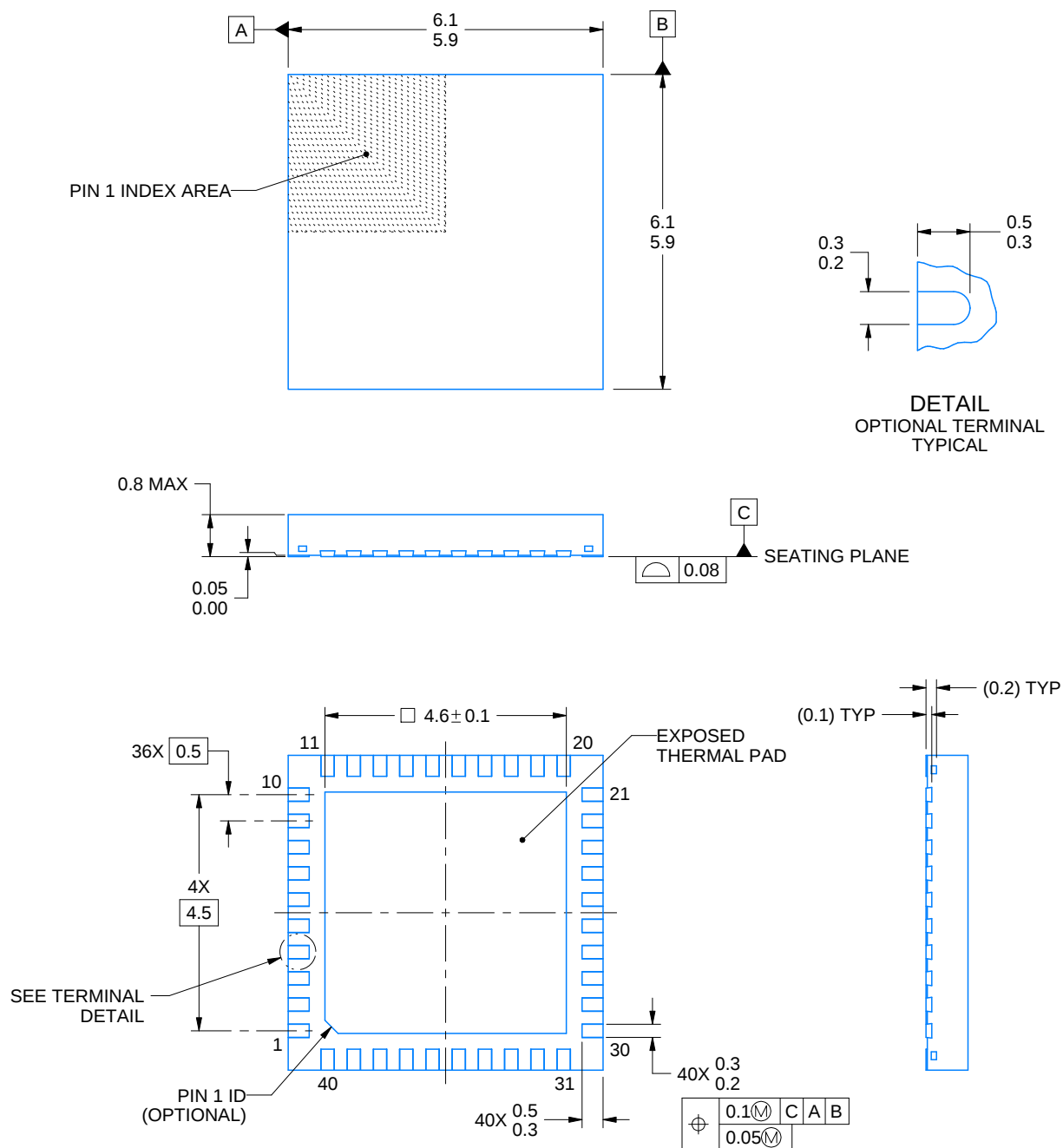
| Device             | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DS90UB927QSQ/NOPB  | WQFN         | RTA             | 40   | 1000 | 853.0       | 449.0      | 35.0        |
| DS90UB927QSQE/NOPB | WQFN         | RTA             | 40   | 250  | 208.0       | 191.0      | 35.0        |
| DS90UB927QSQX/NOPB | WQFN         | RTA             | 40   | 2500 | 853.0       | 449.0      | 35.0        |



## PACKAGE OUTLINE

**WQFN - 0.8 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



4214989/B 02/2017

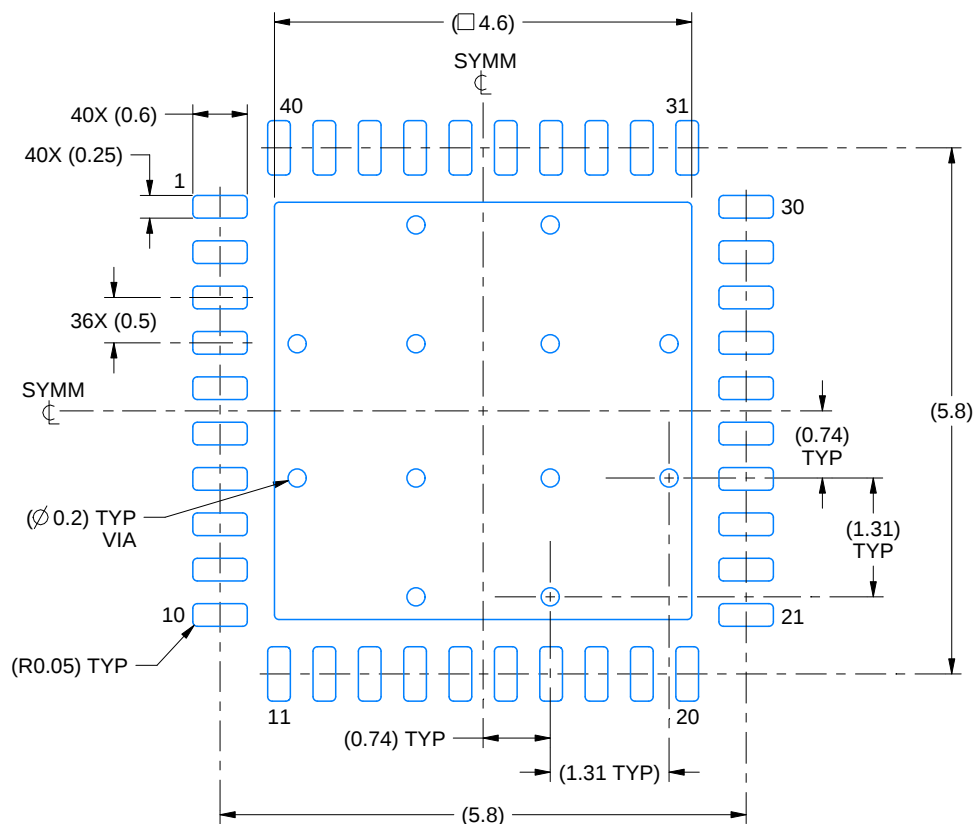
NOTES:

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. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

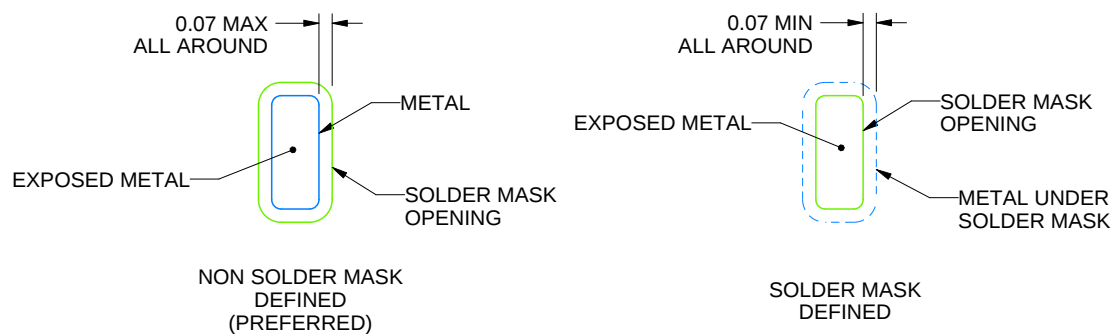
**RTA0040A**

**WQFN - 0.8 mm max height**

PLASTIC QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:12X



## SOLDER MASK DETAILS

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NOTES: (continued)

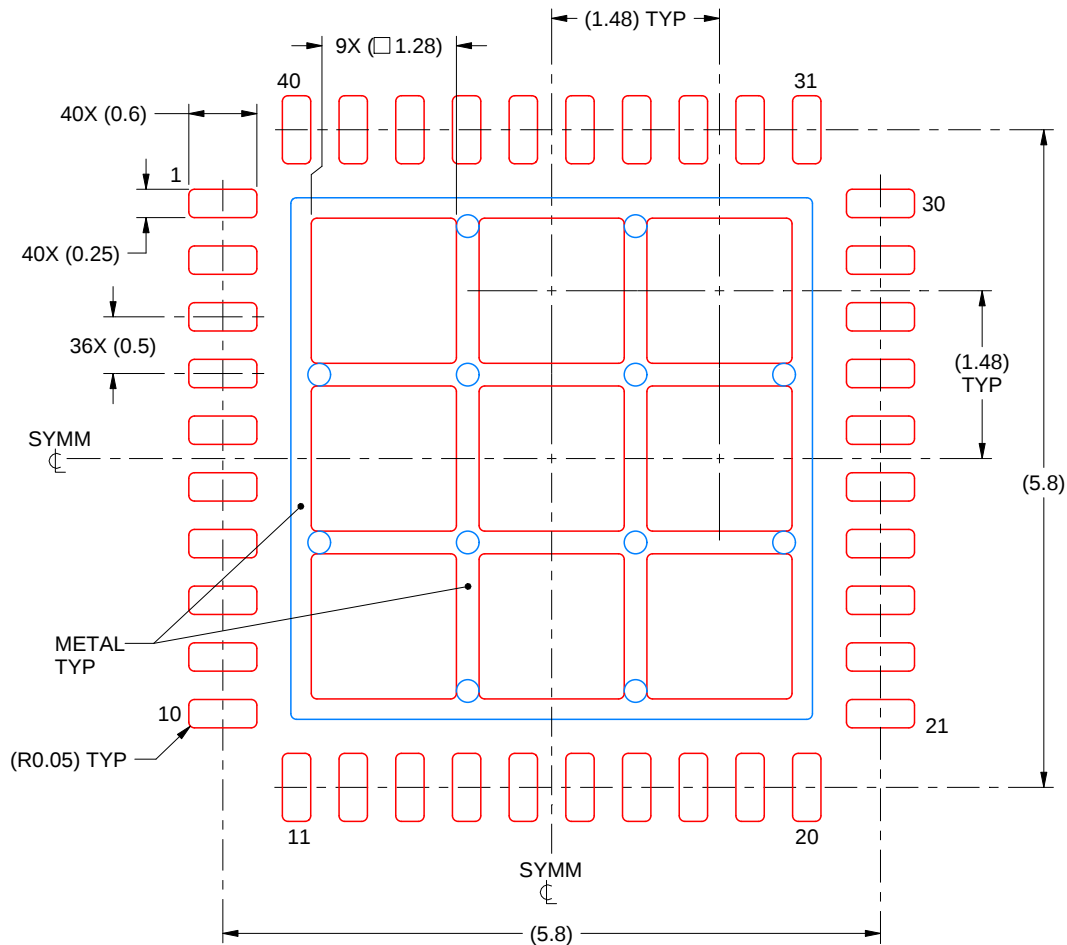
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

RTA0040A

WQFN - 0.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



**SOLDER PASTE EXAMPLE**  
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD  
70% PRINTED SOLDER COVERAGE BY AREA  
SCALE:15X

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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