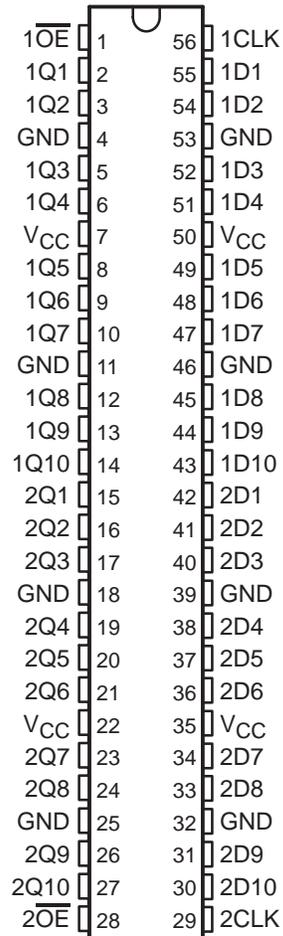


SN54ABT16821, SN74ABT16821 20-BIT BUS-INTERFACE FLIP-FLOPS WITH 3-STATE OUTPUTS

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- **Members of the Texas Instruments Widebus™ Family**
- **State-of-the-Art EPIC-IIB™ BiCMOS Design Significantly Reduces Power Dissipation**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)**
- **Typical V_{OLP} (Output Ground Bounce) < 1 V at $V_{CC} = 5 V, T_A = 25^\circ C$**
- **Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise**
- **Flow-Through Architecture Optimizes PCB Layout**
- **High-Drive Outputs ($-32\text{-mA } I_{OH}, 64\text{-mA } I_{OL}$)**
- **Package Options Include Plastic Thin Shrink Small-Outline (DGG), 300-mil Shrink Small-Outline (DL) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings**

SN54ABT16821 . . . WD PACKAGE
SN74ABT16821 . . . DGG OR DL PACKAGE
(TOP VIEW)



description

These 20-bit flip-flops feature 3-state outputs designed specifically for driving highly capacitive or relatively low-impedance loads. They are particularly suitable for implementing wider buffer registers, I/O ports, bidirectional bus drivers with parity, and working registers.

The 'ABT16821 can be used as two 10-bit flip-flops or one 20-bit flip-flop. The 20 flip-flops are edge-triggered D-type flip-flops. On the positive transition of the clock (CLK) input, the device provides true data at the Q outputs.

A buffered output-enable (\overline{OE}) input can be used to place the ten outputs in either a normal logic state (high or low logic level) or a high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and increased drive provide the capability to drive bus lines without need for interface or pullup components.

\overline{OE} does not affect the internal operation of the flip-flops. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

To ensure the high-impedance state during power up or power down, \overline{OE} should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

The SN54ABT16821 is characterized for operation over the full military temperature range of $-55^\circ C$ to $125^\circ C$. The SN74ABT16821 is characterized for operation from $-40^\circ C$ to $85^\circ C$.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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 **TEXAS
INSTRUMENTS**

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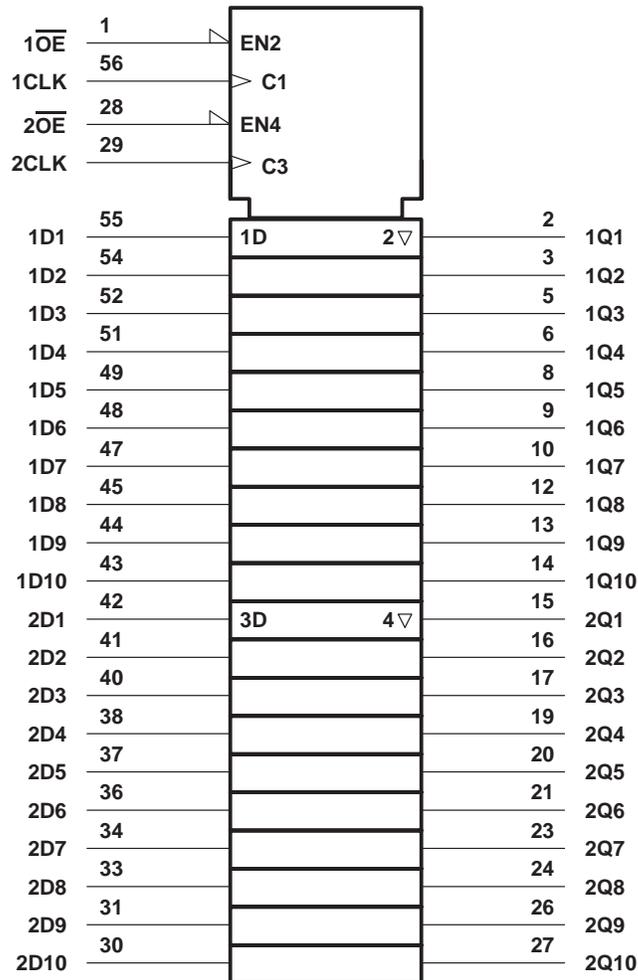
SN54ABT16821, SN74ABT16821 20-BIT BUS-INTERFACE FLIP-FLOPS WITH 3-STATE OUTPUTS

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FUNCTION TABLE
(each flip-flop)

| INPUTS | | | OUTPUT |
|-----------------|-----|---|--------|
| \overline{OE} | CLK | D | Q |
| L | ↑ | H | H |
| L | ↑ | L | L |
| L | L | X | Q_0 |
| H | X | X | Z |

logic symbol†

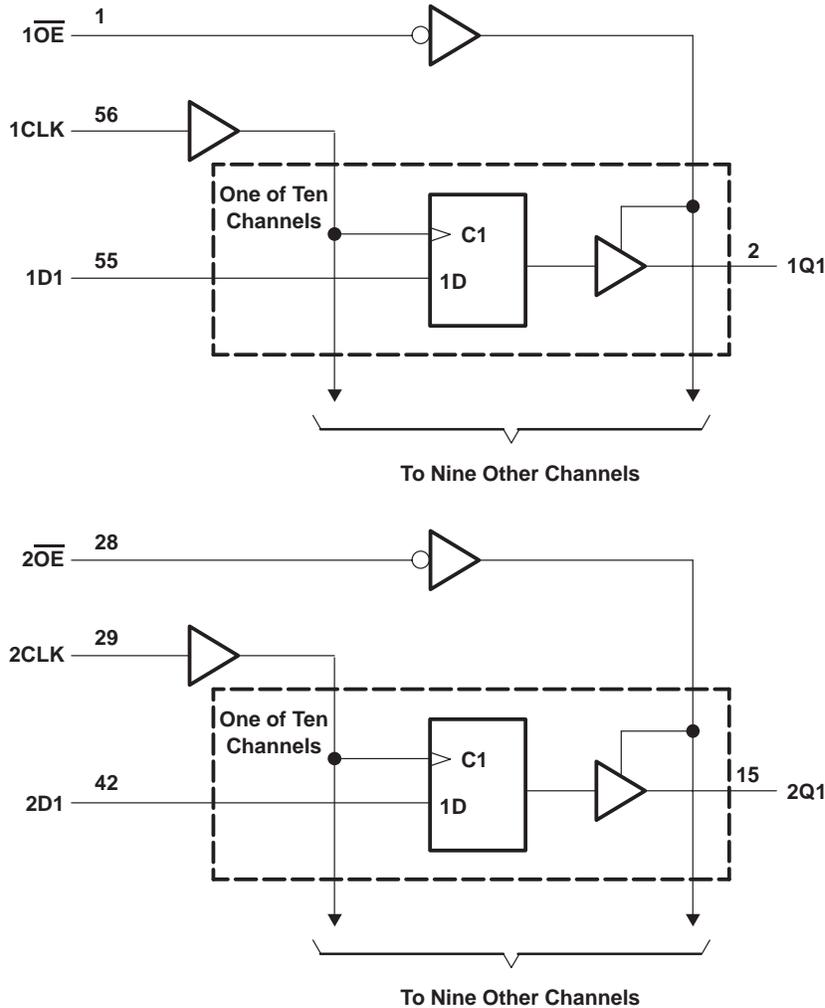


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

SN54ABT16821, SN74ABT16821
20-BIT BUS-INTERFACE FLIP-FLOPS
WITH 3-STATE OUTPUTS

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logic diagram (positive logic)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)[†]

| | |
|---|-----------------|
| Supply voltage range, V_{CC} | -0.5 V to 7 V |
| Input voltage range, V_I (see Note 1) | -0.5 V to 7 V |
| Voltage range applied to any output in the high or power-off state, V_O | -0.5 V to 5.5 V |
| Current into any output in the low state, I_O : SN54ABT16821 | 96 mA |
| SN74ABT16821 | 128 mA |
| Input clamp current, I_{IK} ($V_I < 0$) | -18 mA |
| Output clamp current, I_{OK} ($V_O < 0$) | -50 mA |
| Package thermal impedance, θ_{JA} (see Note 2): DGG package | 81°C/W |
| DL package | 74°C/W |
| Storage temperature range, T_{stg} | -65°C to 150°C |

[†] Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. The package thermal impedance is calculated in accordance with EIA/JEDEC Std JESD51.



SN54ABT16821, SN74ABT16821 20-BIT BUS-INTERFACE FLIP-FLOPS WITH 3-STATE OUTPUTS

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recommended operating conditions (see Note 3)

| | | SN54ABT16821 | | SN74ABT16821 | | UNIT |
|---------------------|------------------------------------|-----------------|----------|--------------|----------|------|
| | | MIN | MAX | MIN | MAX | |
| V_{CC} | Supply voltage | 4.5 | 5.5 | 4.5 | 5.5 | V |
| V_{IH} | High-level input voltage | 2 | | 2 | | V |
| V_{IL} | Low-level input voltage | | 0.8 | | 0.8 | V |
| V_I | Input voltage | 0 | V_{CC} | 0 | V_{CC} | V |
| I_{OH} | High-level output current | | -24 | | -32 | mA |
| I_{OL} | Low-level output current | | 48 | | 64 | mA |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | Outputs enabled | | 10 | 10 | ns/V |
| T_A | Operating free-air temperature | -55 | 125 | -40 | 85 | °C |

NOTE 3: Unused inputs must be held high or low to prevent them from floating.

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

| PARAMETER | TEST CONDITIONS | $T_A = 25^\circ\text{C}$ | | | SN54ABT16821 | | SN74ABT16821 | | UNIT |
|-------------------|--|--------------------------|------|-----------|--------------|---------|--------------|-----------|---------------|
| | | MIN | TYP† | MAX | MIN | MAX | MIN | MAX | |
| V_{IK} | $V_{CC} = 4.5\text{ V}$, $I_I = -18\text{ mA}$ | | | -1.2 | -1.2 | | | -1.2 | V |
| V_{OH} | $V_{CC} = 4.5\text{ V}$, $I_{OH} = -3\text{ mA}$ | 2.5 | | | 2.5 | | | 2.5 | V |
| | $V_{CC} = 5\text{ V}$, $I_{OH} = -3\text{ mA}$ | 3 | | | 3 | | | 3 | |
| | $V_{CC} = 4.5\text{ V}$ | $I_{OH} = -24\text{ mA}$ | 2 | | | 2 | | | |
| | | | | | | | | 2 | |
| V_{OL} | $V_{CC} = 4.5\text{ V}$ | $I_{OL} = 48\text{ mA}$ | | | 0.55 | | | 0.55 | V |
| | | $I_{OL} = 64\text{ mA}$ | | | 0.55* | | | 0.55 | |
| V_{hys} | | | 100 | | | | | | mV |
| I_I | $V_{CC} = 5.5\text{ V}$, $V_I = V_{CC}$ or GND | | | ± 1 | | ± 1 | | ± 1 | μA |
| I_{OZH} | $V_{CC} = 5.5\text{ V}$, $V_O = 2.7\text{ V}$ | | | 50 | | 50 | | 50 | μA |
| I_{OZL} | $V_{CC} = 5.5\text{ V}$, $V_O = 0.5\text{ V}$ | | | -50 | | -50 | | -50 | μA |
| I_{off} | $V_{CC} = 0$, V_I or $V_O \leq 4.5\text{ V}$ | | | ± 100 | | | | ± 100 | μA |
| I_{CEX} | $V_{CC} = 5.5\text{ V}$, $V_O = 5.5\text{ V}$ Outputs high | | | 50 | | 50 | | 50 | μA |
| $I_{O\ddagger}$ | $V_{CC} = 5.5\text{ V}$, $V_O = 2.5\text{ V}$ | -50 | -100 | -200 | -50 | -200 | -50 | -200 | mA |
| I_{CC} | $V_{CC} = 5.5\text{ V}$, $I_O = 0$, $V_I = V_{CC}$ or GND | Outputs high | | | 500 | | | 500 | μA |
| | | Outputs low | | | 89 | | | 89 | mA |
| | | Outputs disabled | | | 500 | | | 500 | μA |
| $\Delta I_{CC}\S$ | $V_{CC} = 5.5\text{ V}$, One input at 3.4 V, Other inputs at V_{CC} or GND | | | 1.5 | | 1.5 | | 1.5 | mA |
| C_i | $V_I = 2.5\text{ V}$ or 0.5 V | | | 3.5 | | | | | pF |
| C_o | $V_O = 2.5\text{ V}$ or 0.5 V | | | 7.5 | | | | | pF |

* On products compliant to MIL-PRF-38535, this parameter does not apply.

† All typical values are at $V_{CC} = 5\text{ V}$.

‡ Not more than one output should be tested at a time, and the duration of the test should not exceed one second.

§ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

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WITH 3-STATE OUTPUTS

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timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 1)

| | | V _{CC} = 5 V, T _A = 25°C | | SN54ABT16821 | | SN74ABT16821 | | UNIT |
|--------------------|---------------------------------|---|-----|--------------|-----|--------------|-----|------|
| | | MIN | MAX | MIN | MAX | MIN | MAX | |
| f _{clock} | Clock frequency | 0 | 150 | 0 | 150 | 0 | 150 | MHz |
| t _w | Pulse duration, CLK high or low | 3.3 | | 3.3 | | 3.3 | | ns |
| t _{su} | Setup time, data before CLK↑ | 1.8 | | 1.8 | | 1.8 | | ns |
| t _h | Hold time, data after CLK↑ | 1.3 | | 1.3 | | 1.3 | | ns |

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, C_L = 50 pF (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | V _{CC} = 5 V, T _A = 25°C | | | SN54ABT16821 | | SN74ABT16821 | | UNIT |
|------------------|-----------------|----------------|---|-----|-----|--------------|-----|--------------|-----|------|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| f _{max} | | | 150 | | | 150 | | 150 | | MHz |
| t _{PLH} | CLK | Q | 1.3 | 3.7 | 5.1 | 1.3 | 6.7 | 1.3 | 6.1 | ns |
| t _{PHL} | | | 1.6 | 3.9 | 5.1 | 1.6 | 5.8 | 1.6 | 5.4 | |
| t _{PZH} | \overline{OE} | Q | 1.1 | 3.2 | 4.7 | 1.1 | 5.8 | 1.1 | 5.7 | ns |
| t _{PZL} | | | 1.6 | 3.8 | 5 | 1.6 | 5.7 | 1.6 | 5.6 | |
| t _{PHZ} | \overline{OE} | Q | 2 | 4.5 | 5.7 | 2 | 6.6 | 2 | 6.5 | ns |
| t _{PLZ} | | | 1.8 | 4.1 | 5.8 | 1.8 | 8.4 | 1.8 | 7.1 | |

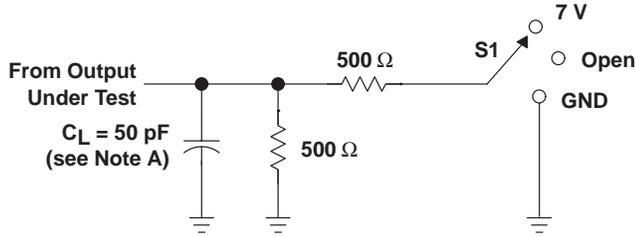
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SN54ABT16821, SN74ABT16821
20-BIT BUS-INTERFACE FLIP-FLOPS
WITH 3-STATE OUTPUTS

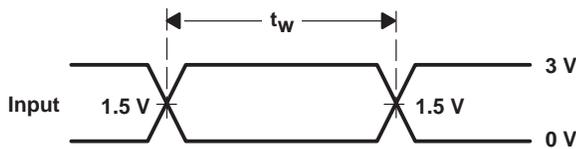
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PARAMETER MEASUREMENT INFORMATION

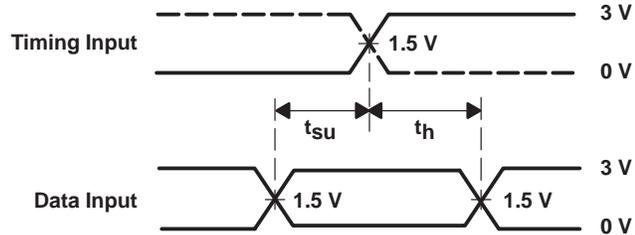


| TEST | S1 |
|-------------------|------|
| t_{PLH}/t_{PHL} | Open |
| t_{PLZ}/t_{PZL} | 7 V |
| t_{PHZ}/t_{PZH} | Open |

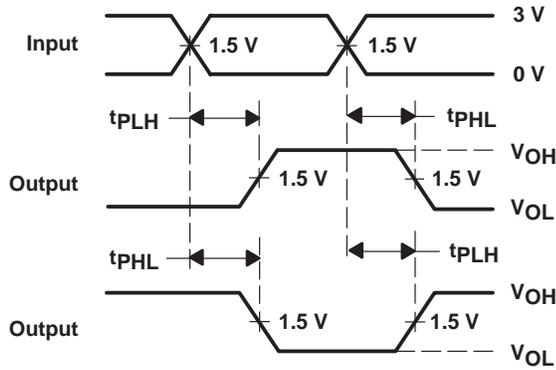
LOAD CIRCUIT



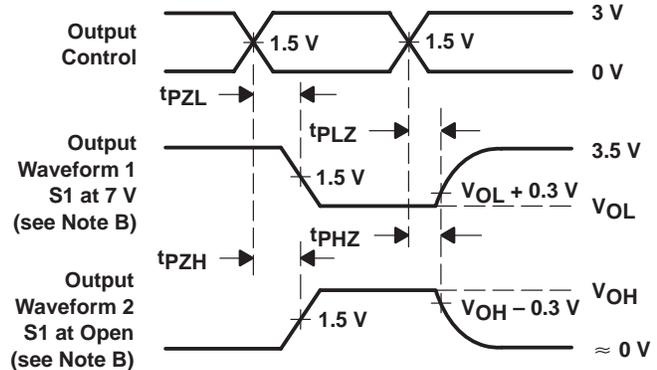
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

- NOTES: A. C_L includes probe and jig capacitance.
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 C. All input pulses are supplied by generators having the following characteristics: $PRR \leq 10$ MHz, $Z_O = 50 \Omega$, $t_r \leq 2.5$ ns, $t_f \leq 2.5$ ns.
 D. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|-------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| SN74ABT16821DGGR | ACTIVE | TSSOP | DGG | 56 | 2000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ABT16821 | Samples |
| SN74ABT16821DL | ACTIVE | SSOP | DL | 56 | 20 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ABT16821 | Samples |
| SN74ABT16821DLR | ACTIVE | SSOP | DL | 56 | 1000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ABT16821 | Samples |
| SN74ABT16821DLRG4 | ACTIVE | SSOP | DL | 56 | 1000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 85 | ABT16821 | Samples |

(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.

OBSELETE: 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.

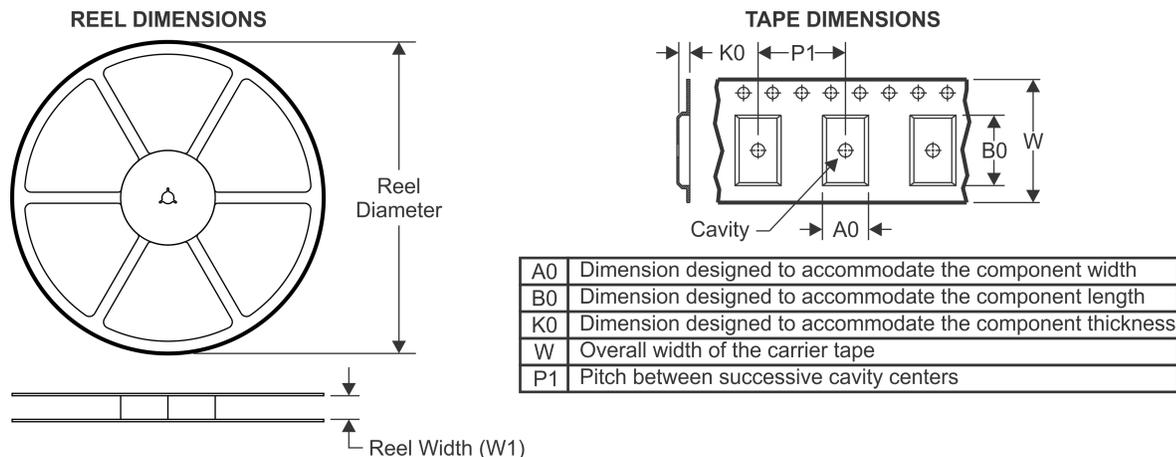
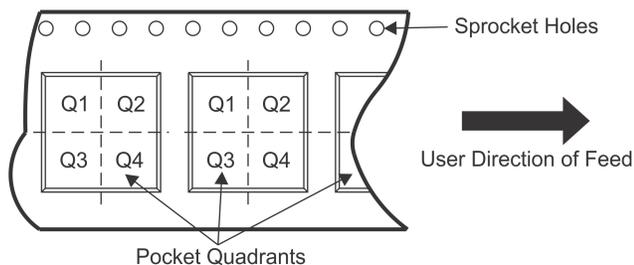
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(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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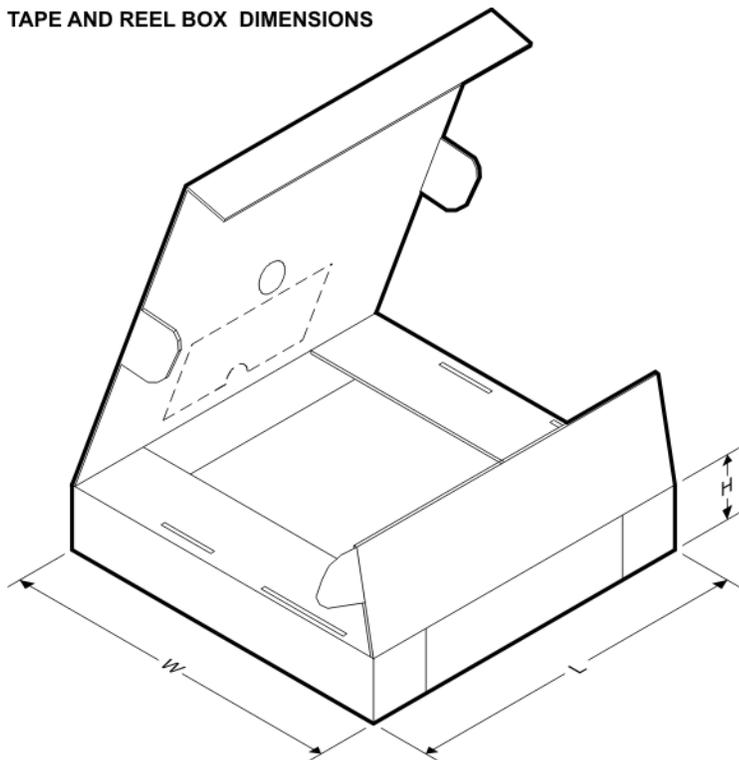
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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


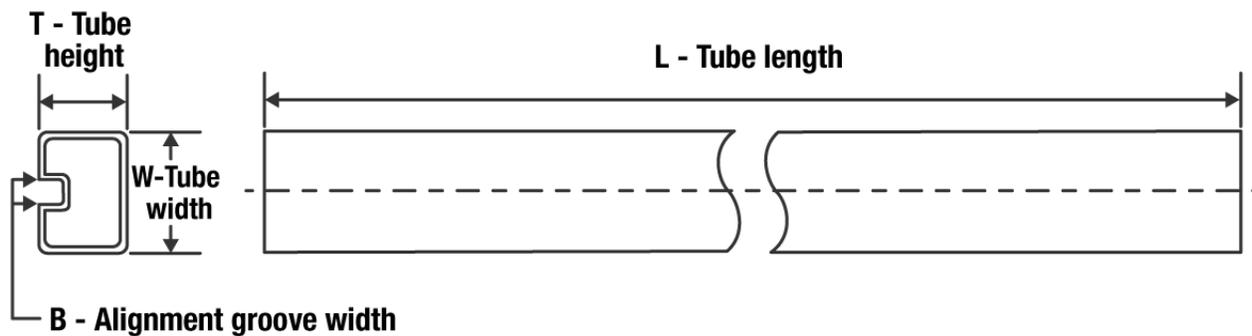
*All dimensions are nominal

| 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 |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74ABT16821DGGR | TSSOP | DGG | 56 | 2000 | 330.0 | 24.4 | 8.6 | 15.6 | 1.8 | 12.0 | 24.0 | Q1 |
| SN74ABT16821DLR | SSOP | DL | 56 | 1000 | 330.0 | 32.4 | 11.35 | 18.67 | 3.1 | 16.0 | 32.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74ABT16821DGGR | TSSOP | DGG | 56 | 2000 | 367.0 | 367.0 | 45.0 |
| SN74ABT16821DLR | SSOP | DL | 56 | 1000 | 367.0 | 367.0 | 55.0 |

TUBE


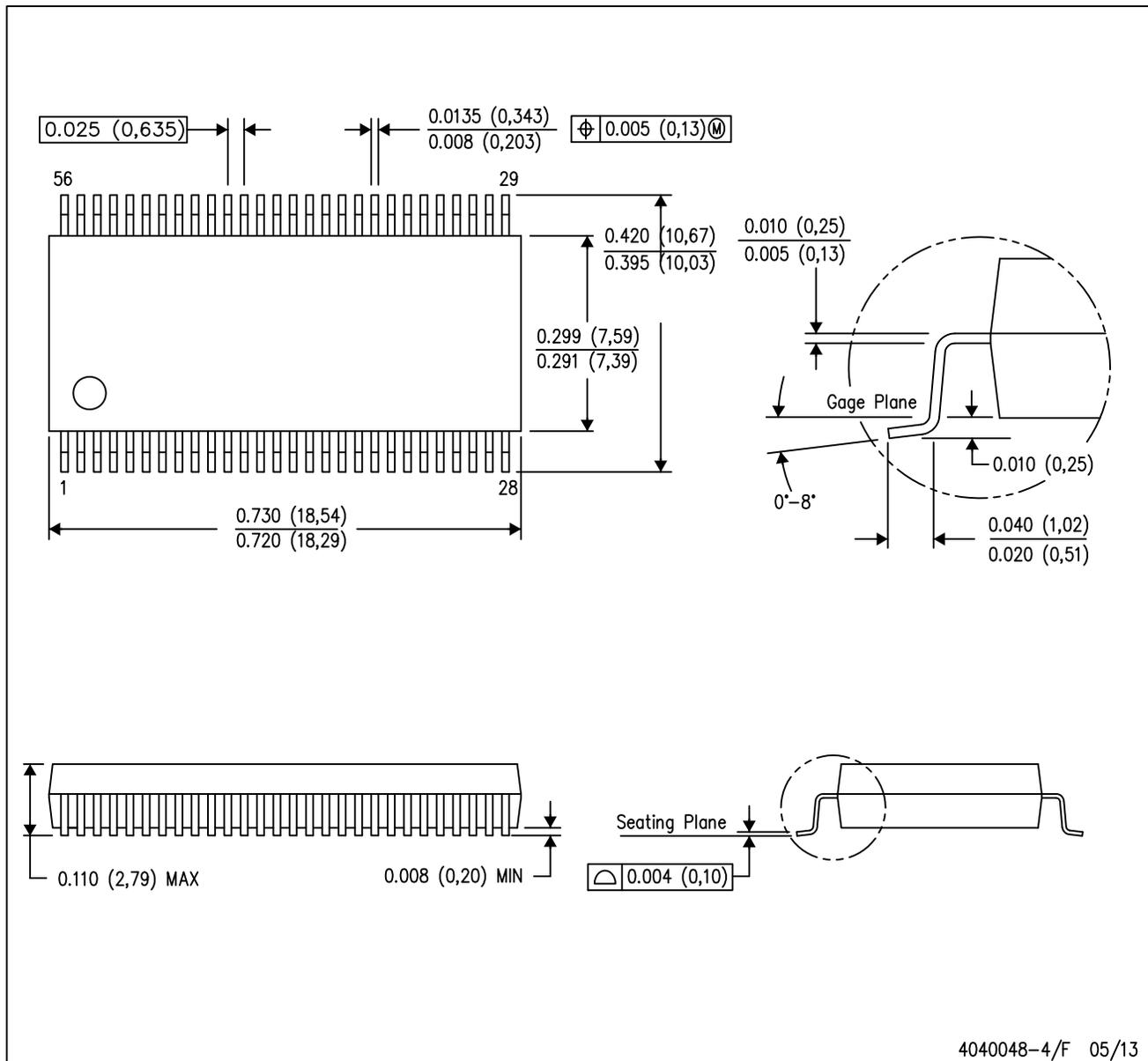
*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|----------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| SN74ABT16821DL | DL | SSOP | 56 | 20 | 473.7 | 14.24 | 5110 | 7.87 |

MECHANICAL DATA

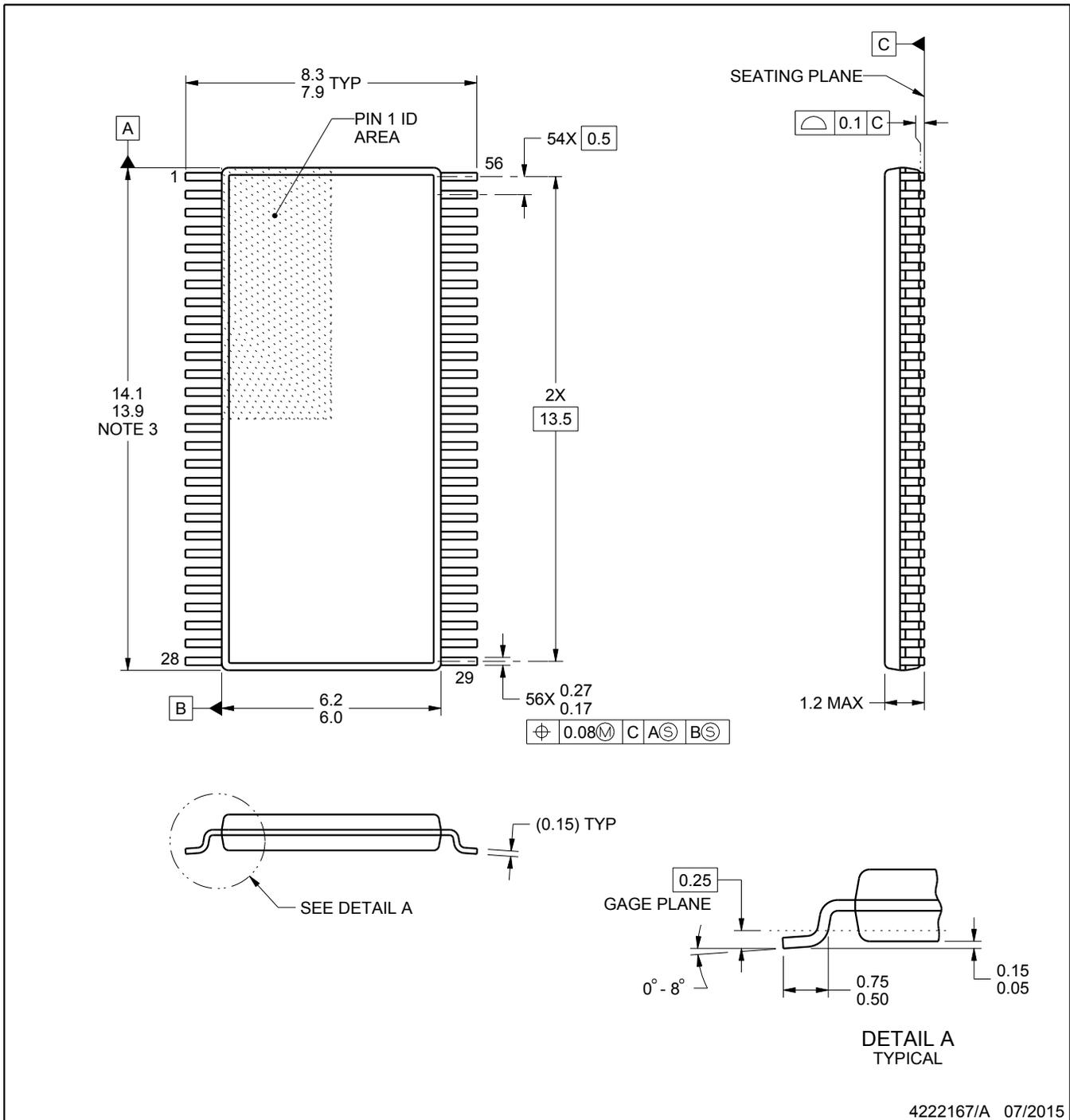
DL (R-PDSO-G56)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - Falls within JEDEC MO-118

PowerPAD is a trademark of Texas Instruments.



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NOTES:

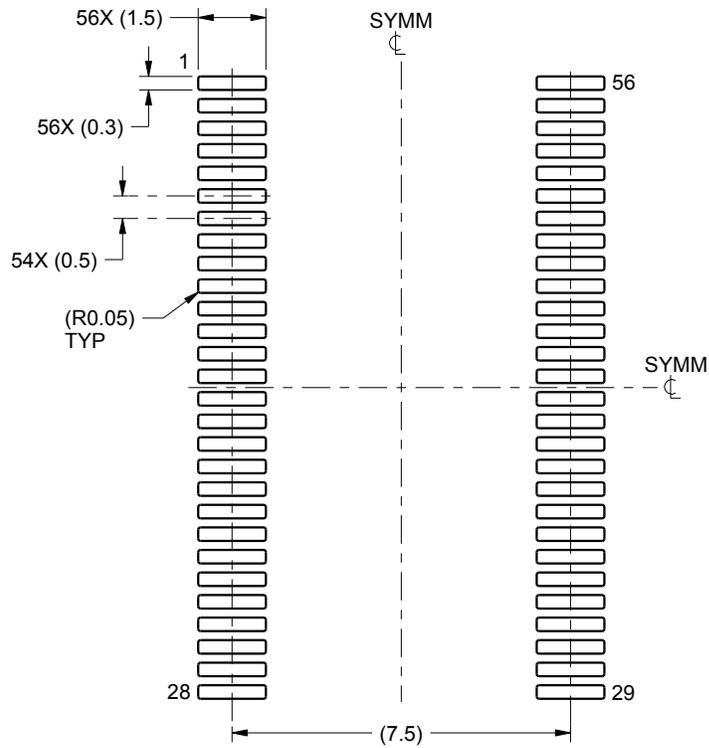
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

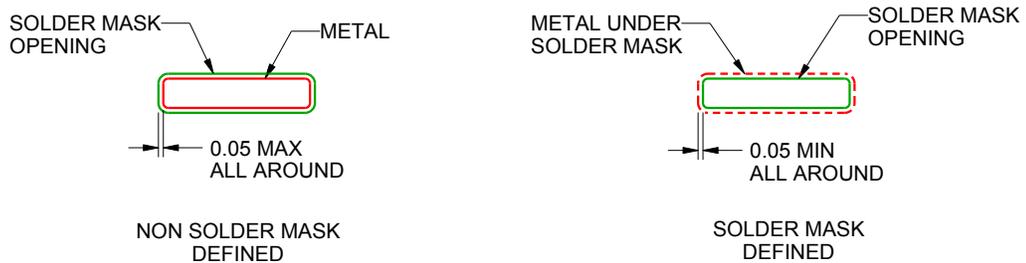
DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

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NOTES: (continued)

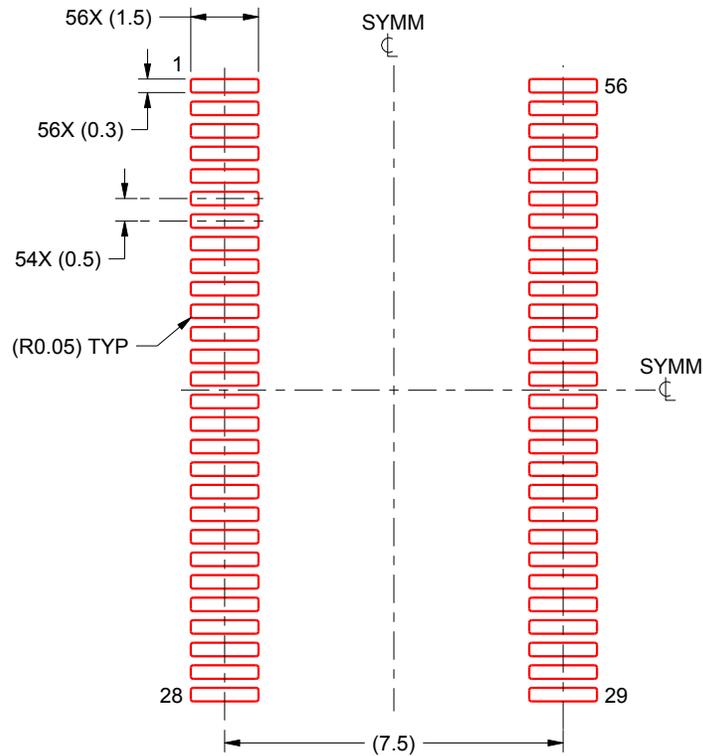
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

4222167/A 07/2015

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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