



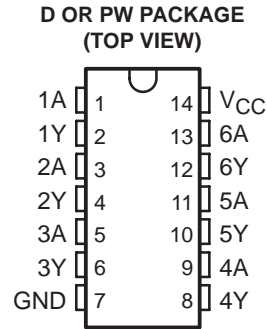
**THE DATASHEET OF  
SN74AHC14QPWRG4Q1**



# SN74AHC14Q-Q1 HEX SCHMITT-TRIGGER INVERTER

SGDS016A – FEBRUARY 2002 – REVISED APRIL 2008

- Qualified for Automotive Applications
- EPIC™ (Enhanced-Performance Implanted CMOS) Process
- Operating Range 2-V to 5.5-V  $V_{CC}$
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model ( $C = 200$  pF,  $R = 0$ )



## description

The SN74AHC14Q contains six independent inverters. This device performs the Boolean function  $Y = \bar{A}$ .

Each circuit functions as an independent inverter, but because of the Schmitt action, the inverters have different input threshold levels for positive-going ( $V_{T+}$ ) and negative-going ( $V_{T-}$ ) signals.

## ORDERING INFORMATION†

| $T_A$          | PACKAGE‡   |               | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|------------|---------------|-----------------------|------------------|
|                | SOIC – D   | Tape and reel |                       |                  |
| –40°C to 125°C | SOIC – D   | Tape and reel | SN74AHC14QDRQ1        | AHC14Q           |
|                | TSSOP – PW | Tape and reel | SN74AHC14QPWRQ1       | HA14Q            |

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at <http://www.ti.com>.

‡ Package drawings, thermal data, and symbolization are available at <http://www.ti.com/packaging>.

## FUNCTION TABLE (each inverter)

| INPUT<br>A | OUTPUT<br>Y |
|------------|-------------|
| H          | L           |
| L          | H           |



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 **TEXAS  
INSTRUMENTS**

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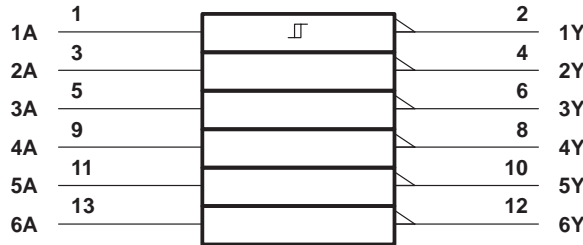
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# SN74AHC14Q-Q1

## HEX SCHMITT-TRIGGER INVERTER

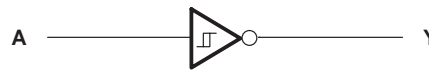
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### logic symbol†



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

### 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              |
| Output voltage range, $V_O$ (see Note 1)                         | .....      | -0.5 V to $V_{CC} + 0.5$ V |
| Input clamp current, $I_{IK}$ ( $V_I < 0$ )                      | .....      | -20 mA                     |
| Output clamp current, $I_{OK}$ ( $V_O < 0$ or $V_O > V_{CC}$ )   | .....      | ±20 mA                     |
| Continuous output current, $I_O$ ( $V_O = 0$ to $V_{CC}$ )       | .....      | ±25 mA                     |
| Continuous current through $V_{CC}$ or GND                       | .....      | ±50 mA                     |
| Package thermal impedance, $\theta_{JA}$ (see Note 2): D package | .....      | 86°C/W                     |
|  | PW package | 113°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 voltage ratings may be exceeded if the input and output current ratings are observed.  
 2. The package thermal impedance is calculated in accordance with JESD 51-7.

### recommended operating conditions (see Note 3)

|          |                                | MIN                      | MAX      | UNIT |    |
|----------|--------------------------------|--------------------------|----------|------|----|
| $V_{CC}$ | Supply voltage                 | 2                        | 5.5      | V    |    |
| $V_I$    | Input voltage                  | 0                        | 5.5      | V    |    |
| $V_O$    | Output voltage                 | 0                        | $V_{CC}$ | V    |    |
| $I_{OH}$ | High-level output current      | $V_{CC} = 2$ V           |          | -50  | μA |
|          |                                | $V_{CC} = 3.3$ V ± 0.3 V |          | -4   | mA |
|          |                                | $V_{CC} = 5$ V ± 0.5 V   |          | -8   |    |
| $I_{OL}$ | Low-level output current       | $V_{CC} = 2$ V           |          | 50   | μA |
|          |                                | $V_{CC} = 3.3$ V ± 0.3 V |          | 4    | mA |
|          |                                | $V_{CC} = 5$ V ± 0.5 V   |          | 8    |    |
| $T_A$    | Operating free-air temperature | -40                      | 125      | °C   |    |

NOTE 3: All unused inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.



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

| PARAMETER   | TEST CONDITIONS   | V <sub>CC</sub> | T <sub>A</sub> = 25°C |     |           | MIN  | MAX     | UNIT    |
|---|---|-----------------|-----------------------|-----|-----------|------|---------|---------|
|   |   |                 | MIN                   | TYP | MAX       |      |         |         |
| V <sub>T+</sub><br>Positive-going<br>input threshold voltage    |   | 3 V             | 1.2                   |     | 2.2       | 1.2  | 2.2     | V       |
|   |   | 4.5 V           | 1.75                  |     | 3.15      | 1.75 | 3.15    |         |
|   |   | 5.5 V           | 2.15                  |     | 3.85      | 2.15 | 3.85    |         |
| V <sub>T-</sub><br>Negative-going<br>input threshold voltage    |   | 3 V             | 0.9                   |     | 1.9       | 0.9  | 1.9     | V       |
|   |   | 4.5 V           | 1.35                  |     | 2.75      | 1.35 | 2.75    |         |
|   |   | 5.5 V           | 1.65                  |     | 3.35      | 1.65 | 3.35    |         |
| $\Delta V_T$<br>Hysteresis (V <sub>T+</sub> - V <sub>T-</sub> ) |   | 3 V             | 0.3                   |     | 1.2       | 0.3  | 1.2     | V       |
|   |   | 4.5 V           | 0.4                   |     | 1.4       | 0.4  | 1.4     |         |
|   |   | 5.5 V           | 0.5                   |     | 1.6       | 0.5  | 1.6     |         |
| V <sub>OH</sub>   | I <sub>OH</sub> = -50 $\mu$ A                               | 2 V             | 1.9                   | 2   |           | 1.9  |         | V       |
|   |   | 3 V             | 2.9                   | 3   |           | 2.9  |         |         |
|   |   | 4.5 V           | 4.4                   | 4.5 |           | 4.4  |         |         |
|   | I <sub>OH</sub> = -4 mA                                     | 3 V             |                       |     | 2.58      |      | 2.48    |         |
|   | I <sub>OH</sub> = -8 mA                                     | 4.5 V           |                       |     | 3.94      |      | 3.8     |         |
| V <sub>OL</sub>   | I <sub>OL</sub> = 50 $\mu$ A                                | 2 V             |                       |     | 0.1       |      | 0.1     | V       |
|   |   | 3 V             |                       |     | 0.1       |      | 0.1     |         |
|   |   | 4.5 V           |                       |     | 0.1       |      | 0.1     |         |
|   | I <sub>OL</sub> = 4 mA                                      | 3 V             |                       |     | 0.36      |      | 0.5     |         |
|   | I <sub>OL</sub> = 8 mA                                      | 4.5 V           |                       |     | 0.36      |      | 0.5     |         |
| I <sub>I</sub>  | V <sub>I</sub> = 5.5 V or GND                               | 0 V to 5.5 V    |                       |     | $\pm 0.1$ |      | $\pm 1$ | $\mu$ A |
| I <sub>CC</sub>   | V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0 | 5.5 V           |                       |     | 2         |      | 20      | $\mu$ A |
| C <sub>i</sub>  | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 5 V             |                       | 2   | 10        |      |         | pF      |

switching characteristics over recommended operating free-air temperature range,  
V<sub>CC</sub> = 3.3 V  $\pm$  0.3 V (unless otherwise noted) (see Figure 1)

| PARAMETER        | FROM<br>(INPUT) | TO<br>(OUTPUT) | LOAD<br>CAPACITANCE    | T <sub>A</sub> = 25°C |      |      | MIN | MAX  | UNIT |
|------------------|-----------------|----------------|------------------------|-----------------------|------|------|-----|------|------|
|                  |                 |                |                        | MIN                   | TYP  | MAX  |     |      |      |
| t <sub>PLH</sub> | A               | Y              | C <sub>L</sub> = 15 pF |                       | 8.3  | 12.8 | 1   | 15   | ns   |
| t <sub>PHL</sub> |                 |                |                        |                       | 8.3  | 12.8 | 1   | 15   |      |
| t <sub>PLH</sub> | A               | Y              | C <sub>L</sub> = 50 pF |                       | 10.8 | 16.3 | 1   | 18.5 | ns   |
| t <sub>PHL</sub> |                 |                |                        |                       | 10.8 | 16.3 | 1   | 18.5 |      |

switching characteristics over recommended operating free-air temperature range,  
V<sub>CC</sub> = 5 V  $\pm$  0.5 V (unless otherwise noted) (see Figure 1)

| PARAMETER        | FROM<br>(INPUT) | TO<br>(OUTPUT) | LOAD<br>CAPACITANCE    | T <sub>A</sub> = 25°C |     |      | MIN | MAX | UNIT |
|------------------|-----------------|----------------|------------------------|-----------------------|-----|------|-----|-----|------|
|                  |                 |                |                        | MIN                   | TYP | MAX  |     |     |      |
| t <sub>PLH</sub> | A               | Y              | C <sub>L</sub> = 15 pF |                       | 5.5 | 8.6  | 1   | 10  | ns   |
| t <sub>PHL</sub> |                 |                |                        |                       | 5.5 | 8.6  | 1   | 10  |      |
| t <sub>PLH</sub> | A               | Y              | C <sub>L</sub> = 50 pF |                       | 7   | 10.6 | 1   | 12  | ns   |
| t <sub>PHL</sub> |                 |                |                        |                       | 7   | 10.6 | 1   | 12  |      |



# SN74AHC14Q-Q1

## HEX SCHMITT-TRIGGER INVERTER

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noise characteristics,  $V_{CC} = 5\text{ V}$ ,  $C_L = 50\text{ pF}$ ,  $T_A = 25^\circ\text{C}$  (see Note 4)

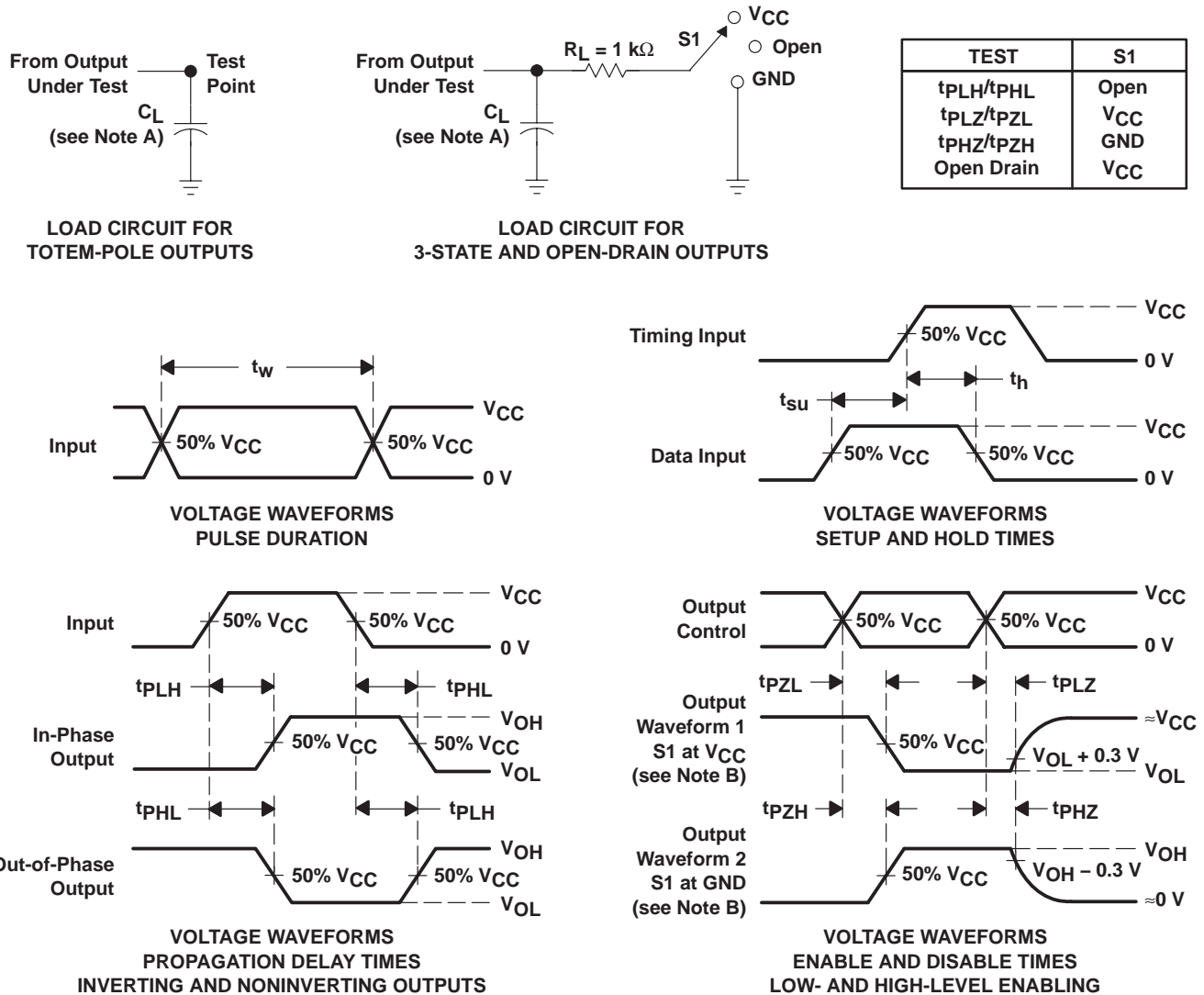
| PARAMETER  | MIN | TYP  | MAX | UNIT |
|--|-----|------|-----|------|
| $V_{OL(P)}$ Quiet output, maximum dynamic $V_{OL}$ |     | 0.8  |     | V    |
| $V_{OL(V)}$ Quiet output, minimum dynamic $V_{OL}$ |     | -0.4 |     | V    |
| $V_{OH(V)}$ Quiet output, minimum dynamic $V_{OH}$ |     | 4.6  |     | V    |
| $V_{IH(D)}$ High-level dynamic input voltage       | 3.5 |      |     | V    |
| $V_{IL(D)}$ Low-level dynamic input voltage        |     |      | 1.5 | V    |

NOTE 4: Characteristics are for surface-mount packages only.

operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER                              | TEST CONDITIONS             | TYP | UNIT |
|--|-----------------------------|-----|------|
| $C_{pd}$ Power dissipation capacitance | No load, $f = 1\text{ MHz}$ | 9   | pF   |

PARAMETER MEASUREMENT INFORMATION



- NOTES: A. C<sub>L</sub> 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 ≤ 1 MHz, Z<sub>O</sub> = 50 Ω, t<sub>r</sub> ≤ 3 ns, t<sub>f</sub> ≤ 3 ns.  
 D. The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

**PACKAGING INFORMATION**

| Orderable Device  | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|-------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| SN74AHC14QDRQ1    | ACTIVE        | SOIC         | D               | 14   | 2500        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | AHC14Q                  | <a href="#">Samples</a> |
| SN74AHC14QPWRG4Q1 | ACTIVE        | TSSOP        | PW              | 14   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | HA14Q                   | <a href="#">Samples</a> |
| SN74AHC14QPWRQ1   | ACTIVE        | TSSOP        | PW              | 14   | 2000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | HA14Q                   | <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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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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 |
|-------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74AHC14QPWRG4Q1 | TSSOP        | PW              | 14   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| SN74AHC14QPWRQ1   | TSSOP        | PW              | 14   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |

TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device            | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74AHC14QPWRG4Q1 | TSSOP        | PW              | 14   | 2000 | 367.0       | 367.0      | 35.0        |
| SN74AHC14QPWRQ1   | TSSOP        | PW              | 14   | 2000 | 367.0       | 367.0      | 35.0        |

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  - $\triangle D$  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AB.

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



PW (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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