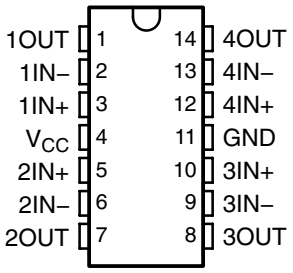
- **Qualified for Automotive Applications**
- **ESD Protection <500 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0); 1500 V Using Charged Device Model**
- **ESD Human Body Model >2 kV Machine Model >200 V and Charge Device Model = 2 kV For K-Suffix Devices.**
- **Low Supply-Current Drain Independent of Supply Voltage . . . 0.8 mA Typ**
- **Low Input Bias and Offset Parameters:**
  - **Input Offset Voltage . . . 3 mV Typ**
  - **Input Offset Current . . . 2 nA Typ**
  - **Input Bias Current . . . 20 nA Typ**
- **Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground**
- **Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage:**
  - **Non-V devices . . . 26 V**
  - **V-Suffix devices . . . 32 V**
- **Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ**
- **Internal Frequency Compensation**

**D OR PW PACKAGE**
**(TOP VIEW)**




## description/ordering information

This device consists of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies is possible when the difference between the two supplies is 3 V to 26 V (3 V to 32 V for V-suffixed devices), and $V_{CC}$ is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational-amplifier circuits that now can be more easily implemented in single-supply-voltage systems. For example, the LM2902 can be operated directly from the standard 5-V supply that is used in digital systems and easily provides the required interface electronics without requiring additional ±15-V supplies.

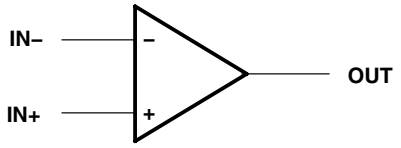
**ORDERING INFORMATION†**

| $T_A$ | $V_{IO}$ max AT 25°C | MAX $V_{CC}$ | PACKAGE‡ | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|---|---|
| –40°C to 125°C | 7 mV | 26 V | SOIC (D) | Reel of 2500 | LM2902QDRQ1 | 2902Q1 |
| | | | TSSOP (PW) | Reel of 2000 | LM2902QPWRQ1 | 2902Q1 |
| | 7 mV | 32 V | SOIC (D) | Reel of 2500 | LM2902KVQDRQ1 | 2902KVQ |
| | | | TSSOP (PW) | Reel of 2000 | LM2902KVQPWRQ1 | 2902KVQ |
| | 2 mV | 32 V | SOIC (D) | Reel of 2500 | LM2902KAVQDRQ1 | 2902KAQ |
| | | | TSSOP (PW) | Reel of 2000 | LM2902KAVQPWRQ1 | 2902KAQ |

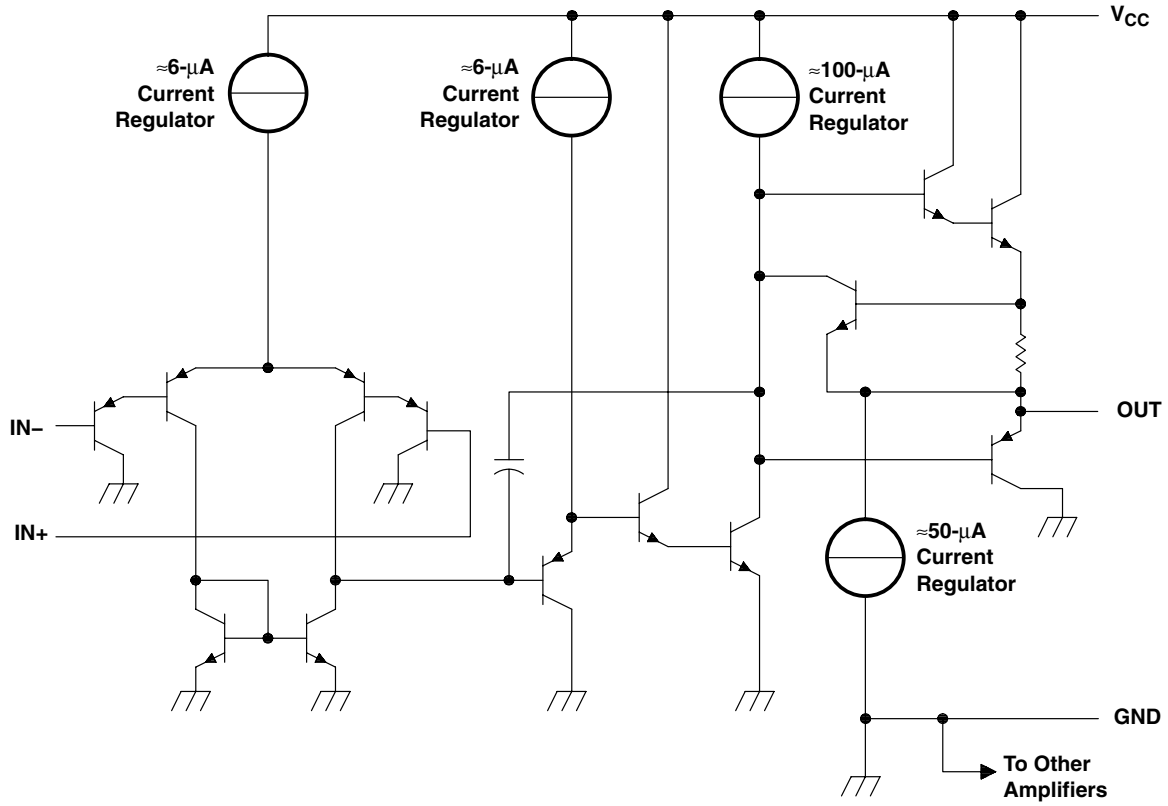
† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at http://www.ti.com.

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

### symbol (each amplifier)




### schematic (each amplifier)




| COMPONENT COUNT (TOTAL DEVICE) | |
|---|---|
| Epi-FET | 1 |
| Transistors | 95 |
| Diodes | 4 |
| Resistors | 11 |
| Capacitors | 4 |

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

| | | LM2902-Q1 | LM2902KV-Q1 | UNIT |
|---|---|---|---|---|
| Supply voltage, $V_{CC}$ (see Note 1) | | 26 | 32 | V |
| Differential input voltage, $V_{ID}$ (see Note 2) | | ±26 | ±32 | V |
| Input voltage, $V_I$ (either input) | | –0.3 to 26 | –0.3 to 32 | V |
| Duration of output short circuit (one amplifier) to ground at (or below) $T_A$ = 25°C, $V_{CC}$ ≤ 15 V (see Note 3) | | Unlimited | Unlimited | |
| Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5) | D package (0 LFPM) | 101 | 101 | °C/W |
| | PW package | 113 | 113 | |
| Operating virtual junction temperature, $T_J$ | | 142 | 142 | °C |
| Storage temperature range, $T_{stg}$ | | –65 to 150 | –65 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. All voltage values, except differential voltages and $V_{CC}$ specified for the measurement of $I_{OS}$, are with respect to the network GND.
2. Differential voltages are at IN+ with respect to IN–.
3. Short circuits from outputs to $V_{CC}$ can cause excessive heating and eventual destruction.
4. Maximum power dissipation is a function of $T_J(max)$, $\theta_{JA}$, and $T_A$. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Operating at the absolute maximum $T_J$ of 142°C can affect reliability.
5. The package thermal impedance is calculated in accordance with JESD 51-7.

## electrical characteristics at specified free-air temperature, $V_{CC}$ = 5 V (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS† | $T_A$‡ | LM2902-Q1 | | | UNIT |
|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP§ | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{CC}$ = 5 V to 26 V, $V_{IC} = V_{ICR}$min, $V_O$ = 1.4 V | 25°C | | 3 | 7 | mV |
| | | | Full range | | | 10 | |
| $I_{IO}$ | Input offset current | $V_O$ = 1.4 V | 25°C | | 2 | 50 | nA |
| | | | Full range | | | 300 | |
| $I_{IB}$ | Input bias current | $V_O$ = 1.4 V | 25°C | | –20 | –250 | nA |
| | | | Full range | | | –500 | |
| $V_{ICR}$ | Common-mode input voltage range | $V_{CC}$ = 5 V to 26 V | 25°C | 0 to $V_{CC}$ – 1.5 | | | V |
| | | | Full range | 0 to $V_{CC}$ – 2 | | | |
| $V_{OH}$ | High-level output voltage | $R_L$ = 10 kΩ | 25°C | $V_{CC}$ – 1.5 | | | V |
| | | $V_{CC}$ = 26 V, $R_L$ = 2 kΩ | Full range | 22 | | | |
| | | $V_{CC}$ = 26 V, $R_L$ ≥ 10 kΩ | Full range | 23 | 24 | | |
| $V_{OL}$ | Low-level output voltage | $R_L$ ≤ 10 kΩ | Full range | | 5 | 20 | mV |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{CC}$ = 15 V, $V_O$ = 1 V to 11 V, $R_L$ ≥ 2 kΩ | 25°C | | 100 | | V/mV |
| | | | Full range | 15 | | | |
| CMRR | Common-mode rejection ratio | $V_{IC} = V_{ICR}$min | 25°C | 50 | 80 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$) | | 25°C | 50 | 100 | | dB |
| $V_{O1}/V_{O2}$ | Crosstalk attenuation | f = 1 kHz to 20 kHz | 25°C | | 120 | | dB |
| $I_O$ | Output current | $V_{CC}$ = 15 V, $V_{ID}$ = 1 V, $V_O$ = 0 | 25°C | –20 | –30 | –60 | mA |
| | | | Full range | –10 | | | |
| | | $V_{CC}$ = 15 V, $V_{ID}$ = –1 V, $V_O$ = 15 V | 25°C | 10 | 20 | | |
| | | | Full range | 5 | | | |
| | | $V_{ID}$ = –1 V, $V_O$ = 200 mV | 25°C | | 30 | | μA |
| $I_{OS}$ | Short-circuit output current | $V_{CC}$ at 5 V, $V_O$ = 0, GND at –5 V | 25°C | | ±40 | ±60 | mA |
| $I_{CC}$ | Supply current (four amplifiers) | $V_O$ = 2.5 V, No load | Full range | | 0.7 | 1.2 | mA |
| | | $V_{CC}$ = 26 V, $V_O$ = 0.5 $V_{CC}$, No load | Full range | | 1.4 | 3 | |

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.
‡ Full range is –40°C to 125°C.
§ All typical values are at $T_A$ = 25°C.

## electrical characteristics at specified free-air temperature, $V_{CC}$ = 5 V (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS† | | $T_A$‡ | LM2902KV-Q1 | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | TYP§ | MAX | |
| $V_{IO}$ | Input offset voltage | $V_{CC}$ = 5 V to 32 V, $V_{IC} = V_{ICR}$min, $V_O$ = 1.4 V | Non-A devices | 25°C | | 3 | 7 | mV |
| | | | | Full range | | | 10 | |
| | | | A-suffix devices | 25°C | | 1 | 2 | |
| | | | | Full range | | | 4 | |
| $\Delta V_{IO}/\Delta T$ | Temperature drift | $R_S$ = 0 Ω | | Full range | | 7 | | µV/°C |
| $I_{IO}$ | Input offset current | $V_O$ = 1.4 V | | 25°C | | 2 | 50 | nA |
| | | | | Full range | | | 150 | |
| $\Delta I_{IO}/\Delta T$ | Temperature drift | | | Full range | | 10 | | pA/°C |
| $I_{IB}$ | Input bias current | $V_O$ = 1.4 V | | 25°C | | –20 | –250 | nA |
| | | | | Full range | | | –500 | |
| $V_{ICR}$ | Common-mode input voltage range | $V_{CC}$ = 5 V to 32 V | | 25°C | 0 to $V_{CC}$ – 1.5 | | | V |
| | | | | Full range | 0 to $V_{CC}$ – 2 | | | |
| $V_{OH}$ | High-level output voltage | $R_L$ = 10 kΩ | | 25°C | $V_{CC}$ – 1.5 | | | V |
| | | $V_{CC}$ = 32 V, | $R_L$ = 2 kΩ | Full range | 26 | | | |
| | | $V_{CC}$ = 32 V, | $R_L \geq$ 10 kΩ | Full range | 27 | | | |
| $V_{OL}$ | Low-level output voltage | $R_L \leq$ 10 kΩ | | Full range | | 5 | 20 | mV |
| $A_{VD}$ | Large-signal differential voltage amplification | $V_{CC}$ = 15 V, $V_O$ = 1 V to 11 V, $R_L \geq$ 2 kΩ | | 25°C | 25 | 100 | | V/mV |
| | | | | Full range | 15 | | | |
| | Amplifier-to-amplifier coupling¶ | f = 1 kHz to 20 kHz, input referred | | 25°C | | 120 | | dB |
| CMRR | Common-mode rejection ratio | $V_{IC} = V_{ICR}$min | | 25°C | 60 | 80 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$) | | | 25°C | 60 | 100 | | dB |
| $V_{O1}/V_{O2}$ | Crosstalk attenuation | f = 1 kHz to 20 kHz | | 25°C | | 120 | | dB |
| $I_O$ | Output current | $V_{CC}$ = 15 $V_O$ = 0 | $V_{ID}$ = 1 V, | 25°C | –20 | –30 | –60 | mA |
| | | | | Full range | –10 | | | |
| | | $V_{CC}$ = 15 $V_O$ = 15 V | $V_{ID}$ = –1 V, | 25°C | 10 | 20 | | |
| | | | | Full range | 5 | | | |
| | | $V_{ID}$ = –1 V, | $V_O$ = 200 mV | 25°C | 12 | 40 | | µA |
| $I_{OS}$ | Short-circuit output current | $V_{CC}$ at 5 V, GND at –5 V | $V_O$ = 0, | 25°C | | ±40 | ±60 | mA |
| $I_{CC}$ | Supply current (four amplifiers) | $V_O$ = 2.5 V, | No load | Full range | | 0.7 | 1.2 | mA |
| | | $V_{CC}$ = 32 V $V_O$ = 0.5 $V_{CC}$, | No load | Full range | | 1.4 | 3 | |

† All characteristics are measured under open-loop conditions, with zero common-mode input voltage, unless otherwise specified.
‡ Full range is –40°C to 125°C.
§ All typical values are at $T_A$ = 25°C.
¶ Due to proximity of external components, ensure that coupling is not originating via stray capacitance between these external parts. Typically, this can be detected, as this type of coupling increases at higher frequencies.

## operating conditions, $V_{CC}$ = ±15 V, $T_A$ = 25°C

| PARAMETER | | TEST CONDITIONS | TYP | UNIT |
|---|---|---|---|---|
| SR | Slew rate at unity gain | $R_L$ = 1 MΩ, $C_L$ = 30 pF, $V_I$ = ±10 V (see Figure 1) | 0.5 | V/μs |
| $B_1$ | Unity-gain bandwidth | $R_L$ = 1 MΩ, $C_L$ = 20 pF (see Figure 1) | 1.2 | MHz |
| $V_n$ | Equivalent input noise voltage | $R_S$ = 100 Ω, $V_I$ = 0 V, f = 1 kHz (see Figure 2) | 35 | nV/√Hz |

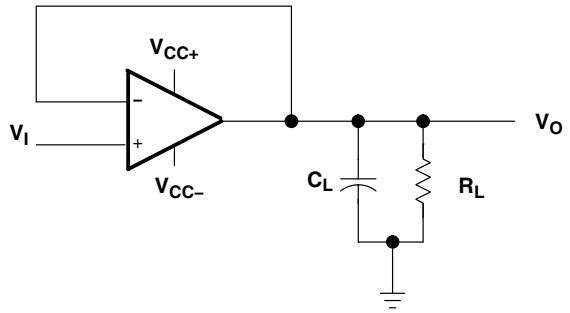



**Figure 1. Unity-Gain Amplifier**

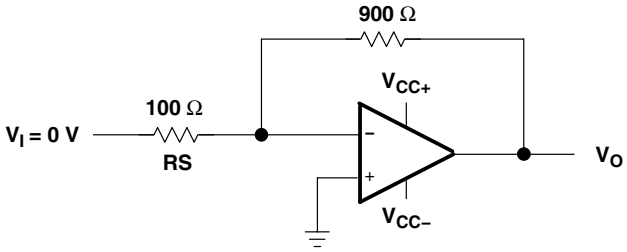



**Figure 2. Noise-Test Circuit**

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LM2902KAVQDRQ1 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902KAQ | Samples |
| LM2902KAVQPWRG4Q1 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902KAQ | Samples |
| LM2902KAVQPWRQ1 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902KAQ | Samples |
| LM2902KVQDRQ1 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902KVQ | Samples |
| LM2902KVQPWRG4Q1 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902KVQ | Samples |
| LM2902KVQPWRQ1 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902KVQ | Samples |
| LM2902QDRG4Q1 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902Q1 | Samples |
| LM2902QDRQ1 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902Q1 | Samples |
| LM2902QPWRG4Q1 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902Q1 | Samples |
| LM2902QPWRQ1 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 2902Q1 | 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.
**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.



**OTHER QUALIFIED VERSIONS OF LM2902-Q1 :**

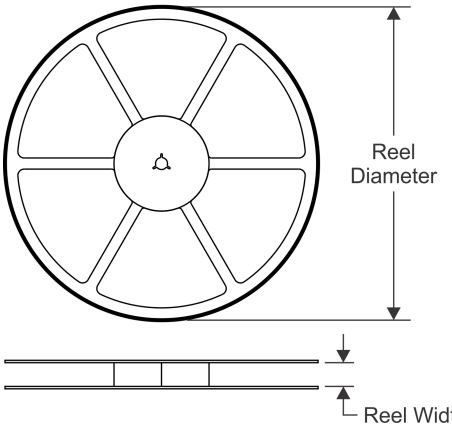
- Catalog: LM2902
- Enhanced Product: LM2902-EP

NOTE: Qualified Version Definitions:

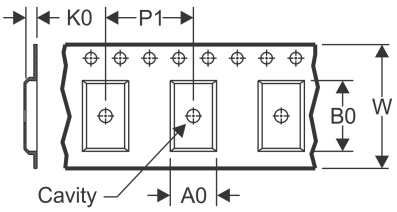
- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**

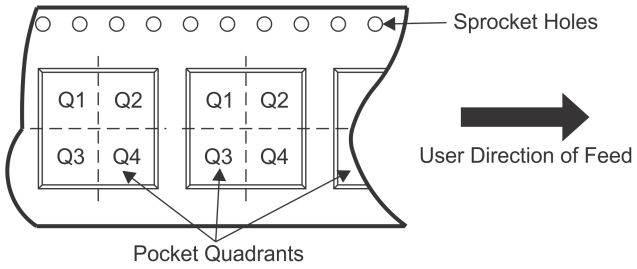



**TAPE DIMENSIONS**




| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

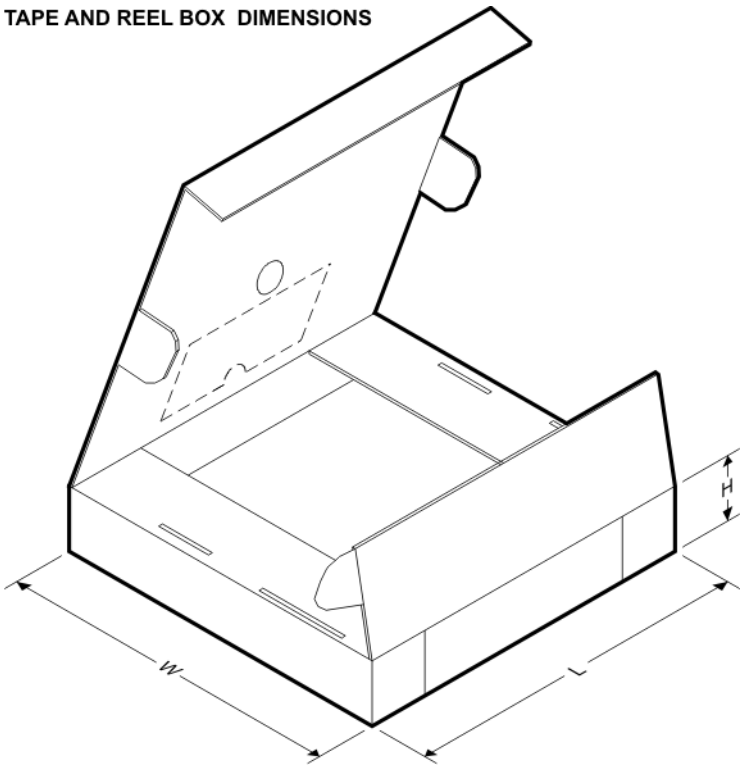
**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**




*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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LM2902KAVQPWRG4Q1 | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2902KAVQPWRQ1 | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2902KVQPWRG4Q1 | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2902KVQPWRQ1 | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2902QPWRG4Q1 | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LM2902QPWRQ1 | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

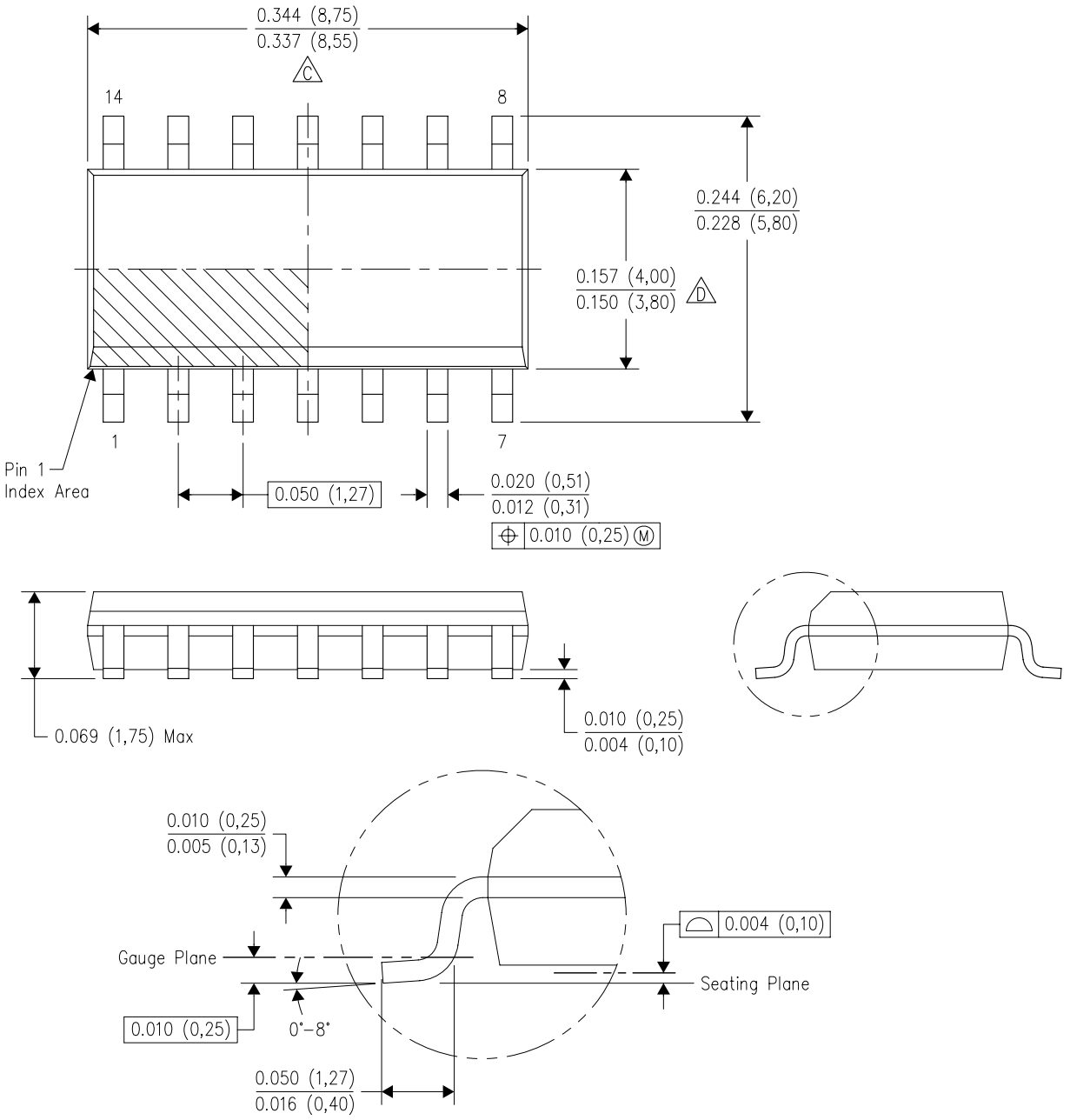
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| LM2902KAVQPWRG4Q1 | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2902KAVQPWRQ1 | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2902KVQPWRG4Q1 | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2902KVQPWRQ1 | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2902QPWRG4Q1 | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |
| LM2902QPWRQ1 | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |

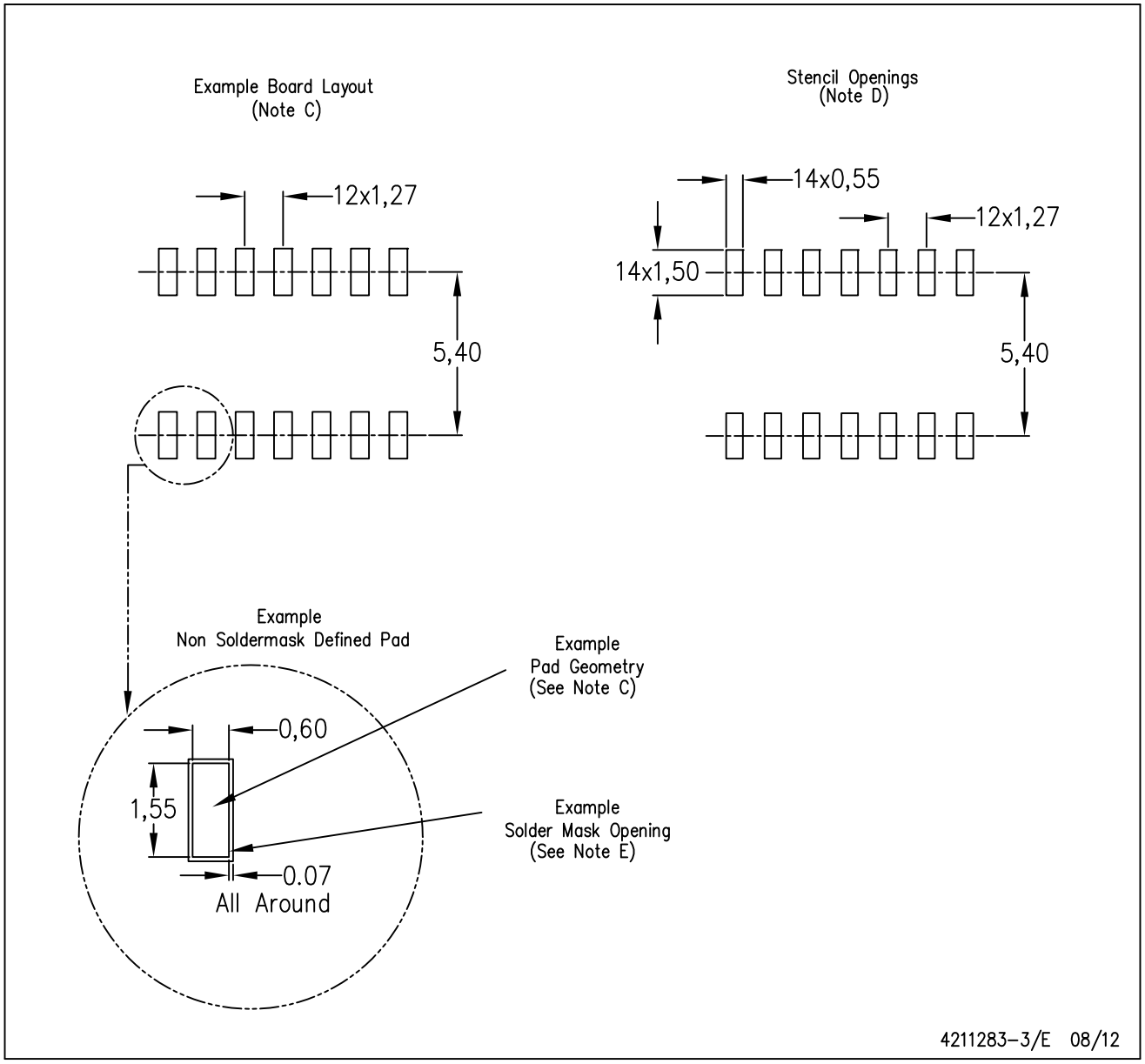
D (R–PDSO–G14) PLASTIC SMALL OUTLINE




4040047–5/M 06/11

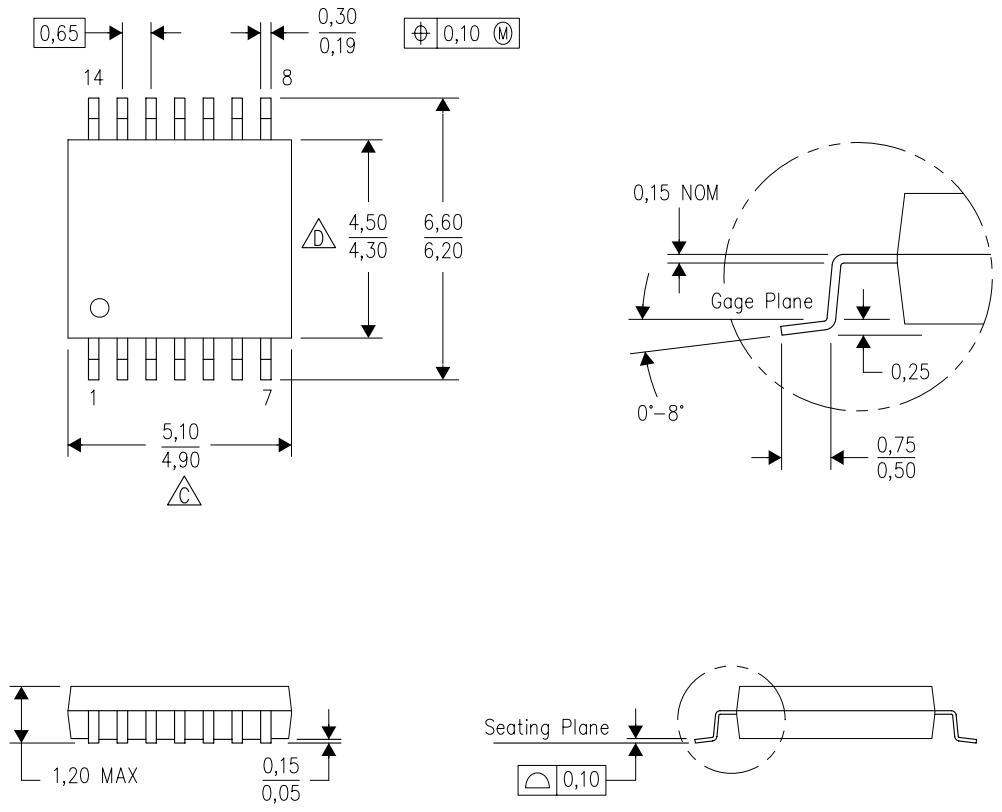
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead 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.

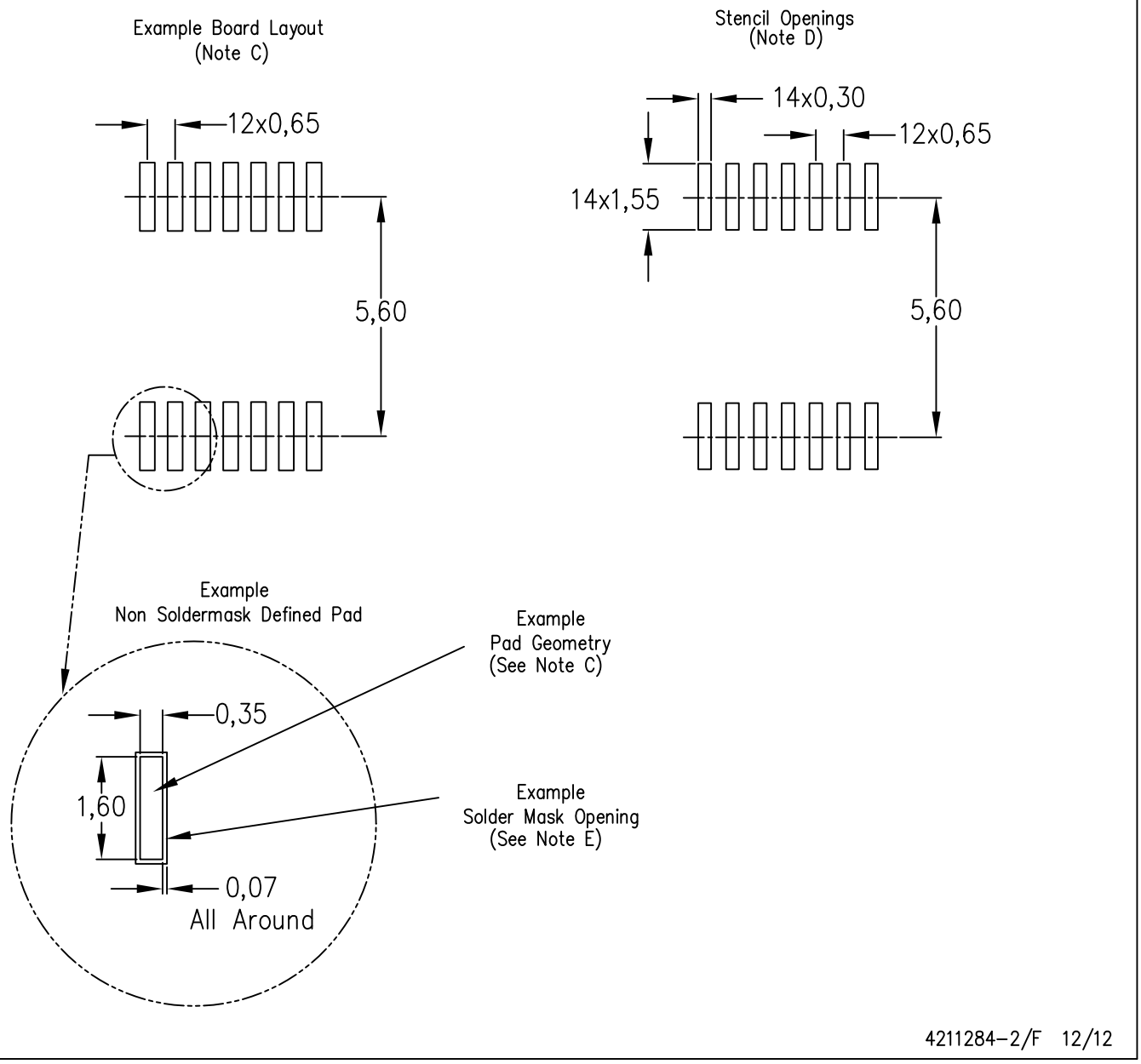
PW (R–PDSO–G14) PLASTIC SMALL OUTLINE




4040064–3/G 02/11

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

PW (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.

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