

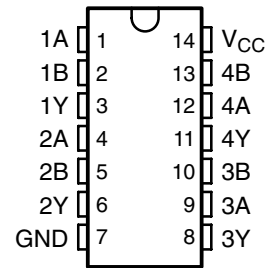
SN74HC86-Q1

QUADRUPLE 2-INPUT EXCLUSIVE-OR GATE

SCLS587C – JUNE 2004 – REVISED APRIL 2008

- Qualified for Automotive Applications
- Wide Operating Voltage Range of 2 V to 6 V
- Outputs Can Drive Up To 10 LSTTL Loads
- Low Power Consumption, 20- μ A Max I_{CC}
- ± 4 -mA Output Drive at 5 V
- Low Input Current of 1 μ A Max
- True Logic

D OR PW PACKAGE
(TOP VIEW)



description/ordering information

This device contains four independent 2-input exclusive-OR gates. They perform the Boolean function $Y = A \oplus B$ or $Y = \overline{A}B + A\overline{B}$ in positive logic.

A common application is as a true/complement element. If one of the inputs is low, the other input is reproduced in true form at the output. If one of the inputs is high, the signal on the other input is reproduced inverted at the output.

ORDERING INFORMATION[†]

| T_A | PACKAGE [‡] | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|----------------------|--------------|-----------------------|------------------|
| -40°C to 85°C | SOIC – D | Reel of 2500 | SN74HC86IDRQ1 | HC86I |
| | TSSOP – PW | Reel of 2000 | SN74HC86IPWRQ1 | HC86I |
| -40°C to 125°C | SOIC – D | Reel of 2500 | SN74HC86QDRQ1 | HC86Q |
| | TSSOP – PW | Reel of 2000 | SN74HC86QPWRQ1 | HC86Q |

[†] 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 gate)

| INPUTS | | OUTPUT Y |
|--------|---|-------------|
| A | B | |
| L | L | L |
| L | H | H |
| H | L | H |
| H | H | L |



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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS
INSTRUMENTS**

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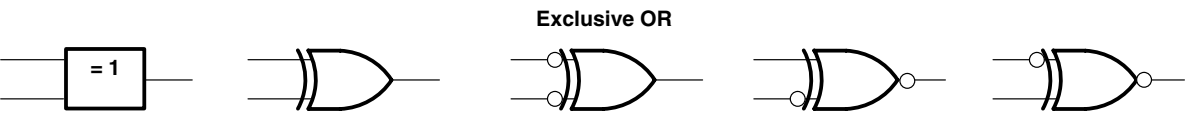
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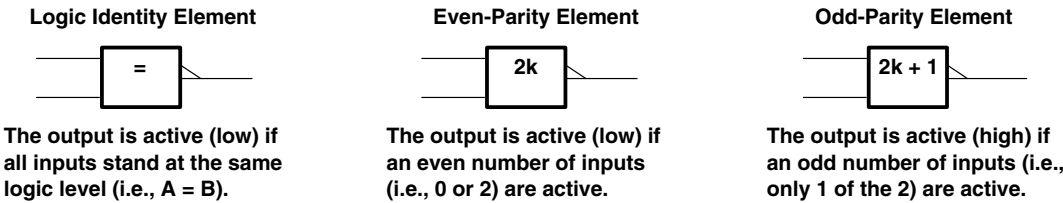
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exclusive-OR logic

An exclusive-OR gate has many applications, some of which can be represented better by alternative logic symbols.



These are five equivalent exclusive-OR symbols valid for an 'HC86 gate in positive logic; negation may be shown at any two ports.



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

| | |
|--|----------------|
| Supply voltage range, V _{CC} | –0.5 V to 7 V |
| Input clamp current, I _{IK} (V _I < 0 or V _I > V _{CC}) (see Note 1) | ±20 mA |
| Output clamp current, I _{OK} (V _O < 0 or V _O > V _{CC}) (see Note 1) | ±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, θ _{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.

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QUADRUPLE 2-INPUT EXCLUSIVE-OR GATE

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recommended operating conditions (see Note 3)

| | | MIN | NOM | MAX | UNIT |
|---------------------|---------------------------------|-------------------------|------|----------|------|
| V_{CC} | Supply voltage | 2 | 5 | 6 | V |
| V_{IH} | High-level input voltage | $V_{CC} = 2\text{ V}$ | 1.5 | | V |
| | | $V_{CC} = 4.5\text{ V}$ | 3.15 | | |
| | | $V_{CC} = 6\text{ V}$ | 4.2 | | |
| V_{IL} | Low-level input voltage | $V_{CC} = 2\text{ V}$ | | 0.5 | V |
| | | $V_{CC} = 4.5\text{ V}$ | | 1.35 | |
| | | $V_{CC} = 6\text{ V}$ | | 1.8 | |
| V_I | Input voltage | 0 | | V_{CC} | V |
| V_O | Output voltage | 0 | | V_{CC} | V |
| $\Delta t/\Delta v$ | Input transition rise/fall time | $V_{CC} = 2\text{ V}$ | | 1000 | ns |
| | | $V_{CC} = 4.5\text{ V}$ | | 500 | |
| | | $V_{CC} = 6\text{ V}$ | | 400 | |
| 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.

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

| PARAMETER | TEST CONDITIONS | V_{CC} | $T_A = -40^\circ\text{C}$ TO 125°C | | $T_A = -40^\circ\text{C}$ TO 85°C | | UNIT |
|-----------|--------------------------------|-----------------------------------|---|------------|--|-----|---------------|
| | | | MIN | MAX | MIN | MAX | |
| V_{OH} | $V_I = V_{IH}$ or V_{IL} | $I_{OH} = -20\text{ }\mu\text{A}$ | 2 V | 1.9 | 1.9 | | V |
| | | | 4.5 V | 4.4 | 4.4 | | |
| | | | 6 V | 5.9 | 5.9 | | |
| | | $I_{OH} = -4\text{ mA}$ | 4.5 V | 3.7 | 3.84 | | |
| | | $I_{OH} = -5.2\text{ mA}$ | 6 V | 5.2 | 5.34 | | |
| V_{OL} | $V_I = V_{IH}$ or V_{IL} | $I_{OL} = 20\text{ }\mu\text{A}$ | 2 V | 0.1 | 0.1 | | V |
| | | | 4.5 V | 0.1 | 0.1 | | |
| | | | 6 V | 0.1 | 0.1 | | |
| | | $I_{OL} = 4\text{ mA}$ | 4.5 V | 0.4 | 0.33 | | |
| | | $I_{OL} = 5.2\text{ mA}$ | 6 V | 0.4 | 0.33 | | |
| I_I | $V_I = V_{CC}$ or 0 | 6 V | | ± 1000 | ± 1000 | | nA |
| I_{CC} | $V_I = V_{CC}$ or 0, $I_O = 0$ | 6 V | | 40 | 20 | | μA |
| C_i | | 2 V to 6 V | | 10 | 10 | | pF |



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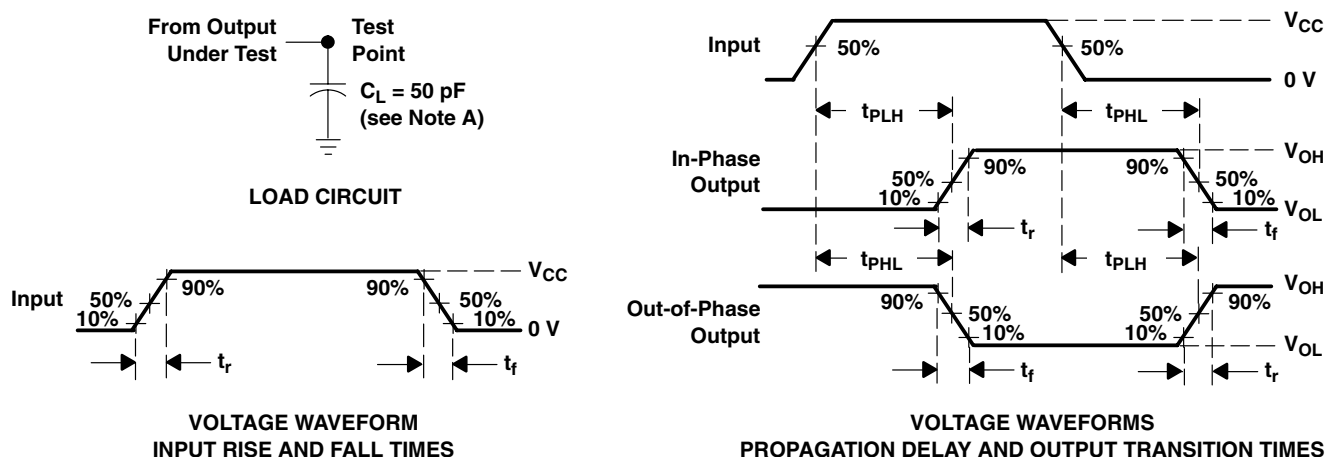
switching characteristics over recommended operating free-air temperature range, $C_L = 50$ pF (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | V_{CC} | $T_A = -40^\circ\text{C}$ TO 125°C | | $T_A = -40^\circ\text{C}$ TO 85°C | | UNIT |
|-----------|--------------|-------------|----------|--|-----|---|-----|------|
| | | | | MIN | MAX | MIN | MAX | |
| t_{pd} | A or B | Y | 2 V | | 150 | | 125 | ns |
| | | | 4.5 V | | 30 | | 25 | |
| | | | 6 V | | 25 | | 21 | |
| t_t | | Y | 2 V | | 110 | | 95 | ns |
| | | | 4.5 V | | 22 | | 19 | |
| | | | 6 V | | 19 | | 16 | |

operating characteristics, $T_A = 25^\circ\text{C}$

| PARAMETER | | TEST CONDITIONS | TYP | UNIT |
|-----------|--|-----------------|-----|------|
| C_{pd} | Power dissipation capacitance per gate | No load | 35 | pF |

PARAMETER MEASUREMENT INFORMATION



- NOTES:
- C_L includes probe and test-fixture capacitance.
 - Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1$ MHz, $Z_O = 50 \Omega$, $t_r = 6$ ns, $t_f = 6$ ns.
 - The outputs are measured one at a time, with one input transition per measurement.
 - t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish | MSL Peak Temp (3) | Op Temp (°C) | Top-Side Markings (4) | Samples |
|------------------|---------------|--------------|--------------------|------|----------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| SN74HC86IDRG4Q1 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | HC86I | Samples |
| SN74HC86IDRQ1 | OBSOLETE | SOIC | D | 14 | | TBD | Call TI | Call TI | -40 to 85 | HC86I | |
| SN74HC86IPWRG4Q1 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 85 | HC86I | Samples |
| SN74HC86IPWRQ1 | OBSOLETE | TSSOP | PW | 14 | | TBD | Call TI | Call TI | -40 to 85 | HC86I | |
| SN74HC86QDRG4Q1 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | HC86Q | Samples |
| SN74HC86QDRQ1 | OBSOLETE | SOIC | D | 14 | | TBD | Call TI | Call TI | -40 to 125 | HC86Q | |
| SN74HC86QPWRG4Q1 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | HC86Q | Samples |
| SN74HC86QPWRQ1 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | -40 to 125 | HC86Q | 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) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

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OTHER QUALIFIED VERSIONS OF SN74HC86-Q1 :

- Catalog: [SN74HC86](#)
- Military: [SN54HC86](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

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 |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74HC86IPWRG4Q1 | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| SN74HC86QPWRG4Q1 | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| SN74HC86QPWRQ1 | 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) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74HC86IPWRG4Q1 | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |
| SN74HC86QPWRG4Q1 | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |
| SN74HC86QPWRQ1 | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



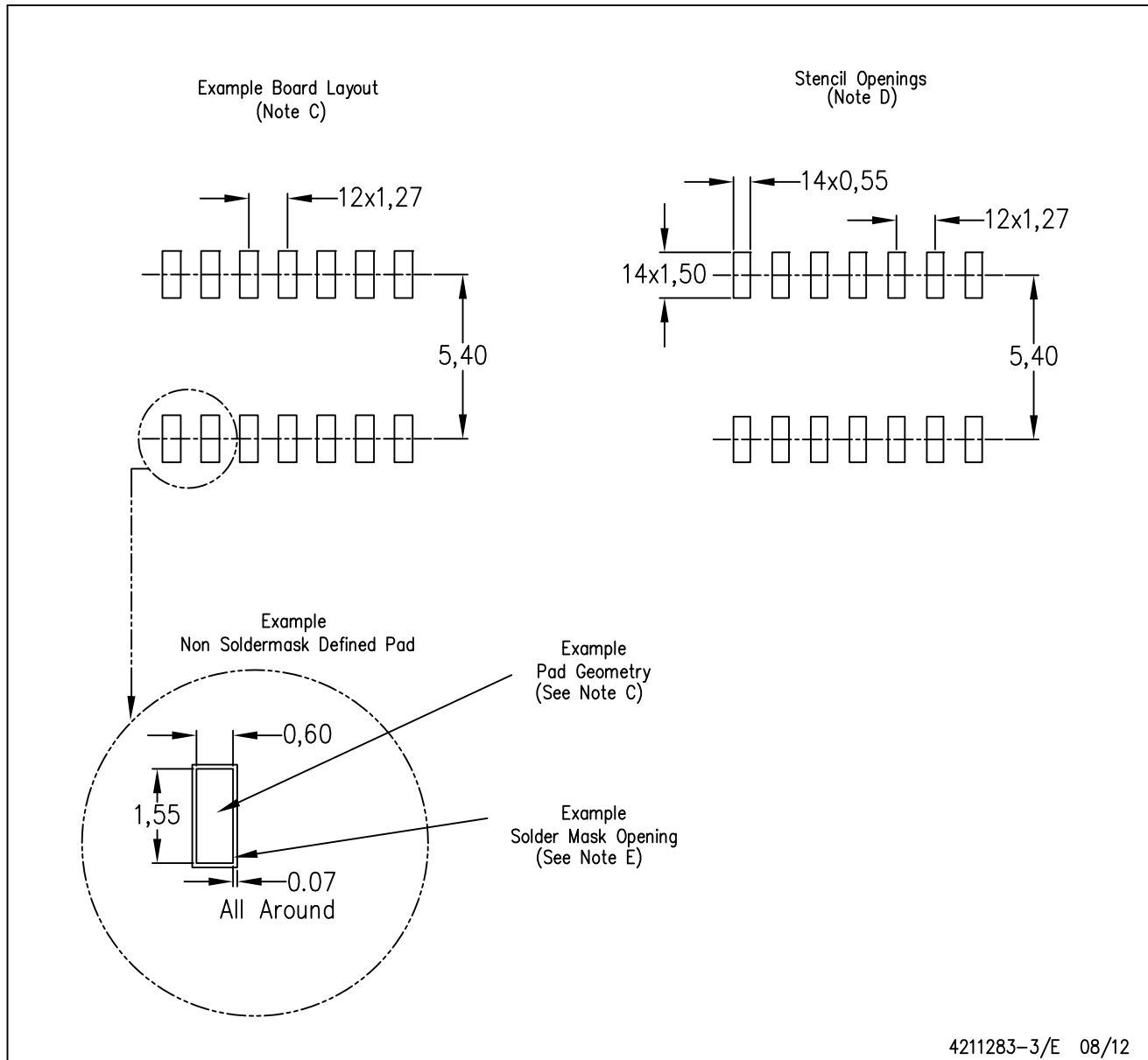
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NOTES:

- 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



- 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



4211284-2/F 12/12

- 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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