WINSOURCE ELECTRONICS

# THE DATASHEET OF

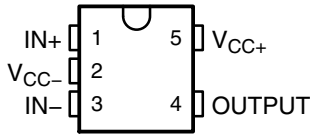
# LPV358ID

# LPV321 SINGLE, LPV358 DUAL, LPV324 QUAD GENERAL-PURPOSE, LOW-VOLTAGE, LOW-POWER, RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

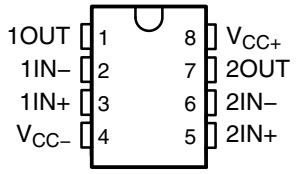
SLOS433I – FEBRUARY 2004 – REVISED MARCH 2005

- **2.7-V and 5-V Performance**
- **–40°C to 125°C Specification at 5 V**
- **No Crossover Distortion**
- **Gain Bandwith of 152 kHz**
- **Low Supply Current**
  - **LPV321 . . . 9 μA**
  - **LPV358 . . . 15 μA**
  - **LPV324 . . . 28 μA**
- **Rail-to-Rail Output Swing at 100-kΩ Load**
  - **$V_{CC+}$ – 3.5 mV**
  - **$V_{CC-}$ + 90 mV**
- **$V_{ICR}$ . . . –0.2 V to $V_{CC+}$ – 0.8 V**
- **Stable With Capacitive Load of 1000 pF**
- **Applications**
  - **Active Filters**
  - **General-Purpose, Low-Voltage Applications**
  - **Low-Power and/or Portable Applications**
- **Latch-Up Performance Exceeds 100 mA per JESD 78, Class II**
- **ESD Protection Exceeds JESD 22**
  - **2000-V Human-Body Model (A114-A)**
  - **200-V Machine Model (A115-A)**
  - **1000-V Charged-Device Model (C101)**

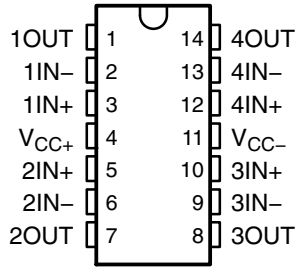
**LPV321 . . . DBV OR DCK PACKAGE**
**(TOP VIEW)**




**LPV358 . . . D, DDU, OR DGK PACKAGE**
**(TOP VIEW)**




**LPV324 . . . D OR PW PACKAGE**
**(TOP VIEW)**




## description/ordering information

The LPV321/358/324 devices are low-power (9 μA per channel at 5 V) versions of the LMV321/358/324 operational amplifiers. These are additions to the LMV321/358/324 family of commodity operational amplifiers.

The LPV321/358/324 devices are the most cost-effective solutions for applications where low voltage, low-power operation, space saving, and low price are needed. These devices have rail-to-rail output-swing capability, and the input common-mode voltage range includes ground. They all exhibit excellent speed-power ratios, achieving 152 kHz of bandwidth, with a supply current of only 9 μA typical.

The LPV321, LPV358, and LPV324 are characterized for operation from –40°C to 85°C. The LPV321I, LPV358I, and LPV324I are characterized for operation from –40°C to 125°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.

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.

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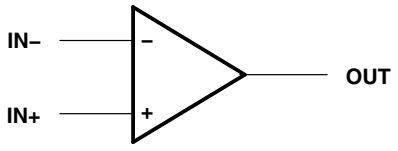
## description/ordering information (continued)

**ORDERING INFORMATION**

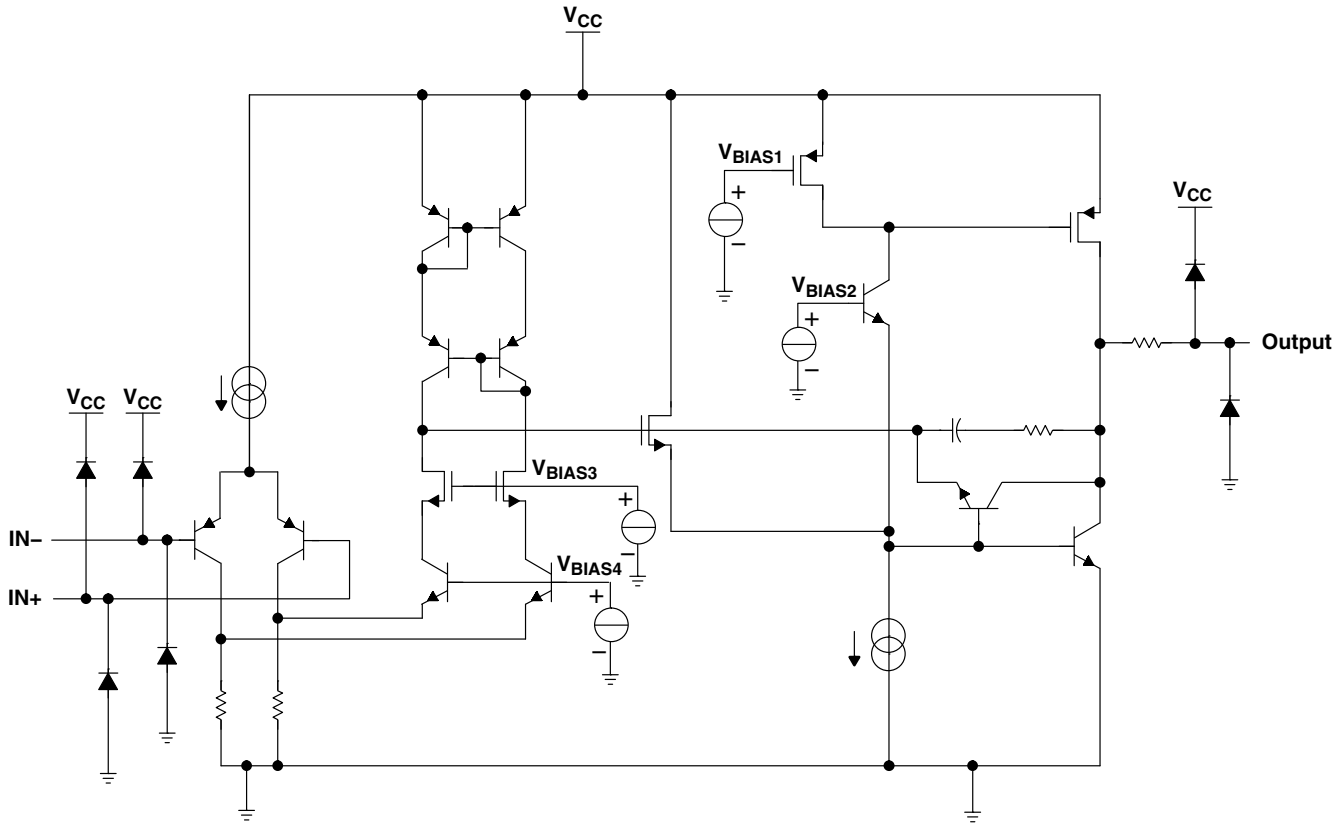
| $T_A$ | PACKAGE† | | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|---|
| –40°C to 85°C | Single | SOT23-5 (DBV) | Reel of 3000 | LPV321DBVR | 5C7_ |
| | | | Reel of 250 | LPV321DBVT | PREVIEW |
| | | SC-70 (DCK) | Reel of 3000 | LPV321DCKR | 52_ |
| | | | Reel of 250 | LPV321DCKT | PREVIEW |
| | Dual | SOIC-8 (D) | Tube of 75 | LPV358D | PV358 |
| | | | Reel of 2500 | LPV358DR | |
| | | VSSOP-8 (DDU) | Reel of 3000 | LPV358DDUR | 5A56 |
| | | VSSOP-8 (DGK) | Reel of 2500 | LPV358DGKR | 546 |
| | | | Reel of 250 | LPV358DGKT | PREVIEW |
| | Quad | SOIC-14 (D) | Tube of 50 | LPV324D | LPV324 |
| | | | Reel of 2500 | LPV324DR | |
| | | TSSOP-14 (PW) | Tube of 90 | LPV324PW | PV324 |
| | | | Reel of 2000 | LPV324PWR | |
| –40°C to 125°C | Single | SOT23-5 (DBV) | Reel of 3000 | LPV321IDBVR | 5C1_ |
| | | | Reel of 250 | LPV321IDBVT | PREVIEW |
| | | SC-70 (DCK) | Reel of 3000 | LPV321IDCKR | 53_ |
| | | | Reel of 250 | LPV321IDCKT | PREVIEW |
| | Dual | SOIC-8 (D) | Tube of 75 | LPV358ID | PV358I |
| | | | Reel of 2500 | LPV358IDR | |
| | | VSSOP-8 (DDU) | Reel of 3000 | LPV358IDDUR | 5AE6 |
| | | VSSOP-8 (DGK) | Reel of 2500 | LPV358IDGKR | 556 |
| | | | Reel of 250 | LPV358IDGKT | PREVIEW |
| | Quad | SOIC-14 (D) | Tube of 50 | LPV324ID | LPV324I |
| | | | Reel of 2500 | LPV324IDR | |
| | | TSSOP-14 (PW) | Tube of 90 | LPV324IPW | PV324I |
| | | | Reel of 2000 | LPV324IPWR | |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.
‡ DBV/DCK: The actual top-side marking has one additional character that designates the assembly/test site.

## symbol (each amplifier)



### LPV324 simplified schematic




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

| | | |
|---|---|---|
| Supply voltage, $V_{CC+} - V_{CC-}$ (see Note 1) | | 5.5 V |
| Differential input voltage, $V_{ID}$ (see Note 2) | | $\pm V_{CC}$ |
| Input voltage range, $V_I$ (either input) | | $V_{CC-}$ to $V_{CC+} - 1$ V |
| Package thermal impedance, $\theta_{JA}$ (see Notes 3 and 4): | 5-pin DBV package | 206°C/W |
| | 5-pin DCK package | 252°C/W |
| | 8-pin D package | 97°C/W |
| | 8-pin DDU package | TBD°C/W |
| | 8-pin DGK package | 172°C/W |
| | 14-pin D package | 86°C/W |
| | 14-pin PW package | 113°C/W |
| Maximum junction temperature, $T_J$ | | 150°C |
| 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. 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. 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 $P_D = (T_J(max) - T_A)/\theta_{JA}$. Selecting the maximum of 150°C can affect reliability.
4. The package thermal impedance is calculated in accordance with JESD 51-7.

## recommended operating conditions

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply voltage | | 2.7 | 5 | V |
| $T_A$ | Operating free-air temperature | LPV3xx | –40 | 85 | °C |
| | | LPV3xxI | –40 | 125 | |

## ESD protection

| TEST CONDITIONS | TYP | UNIT |
|---|---|---|
| Human-Body Model | 2 | kV |
| Machine model | 200 | V |
| Charged-Device Model | 1 | kV |

## 2.7-V electrical characteristics

**$T_A$ = 25°C, $V_{CC+}$ = 2.7 V, $V_{CC-}$ = 0 V, $V_{IC}$ = 1 V, $V_O$ = $V_{CC+}$/2, and $R_L$ > 1 MΩ (unless otherwise noted)**

| PARAMETER | | TEST CONDITIONS | | MIN | TYP† | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input offset voltage | | | | 1.2 | 7 | mV |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage | | | | 4 | | μV/°C |
| $I_{IB}$ | Input bias current | | | | 1.7 | 50 | nA |
| $I_{IO}$ | Input offset current | | | | 0.6 | 40 | nA |
| CMRR | Common-mode rejection ratio | 0 ≤ $V_{IC}$ ≤ 1.7 V | | 50 | 70 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio | 2.7 V ≤ $V_{CC+}$ ≤ 5 V, $V_{IC}$ = 1 V, $V_O$ = 1 V | | 50 | 65 | | dB |
| $V_{ICR}$ | Common-mode input voltage range | CMRR ≥ 50 dB | | 0 to 1.7 | –0.2 to 1.9 | | V |
| $V_O$ | Output swing | $R_L$ = 100 kΩ to 1.35 V | High level | $V_{CC+}$ – 0.100 | $V_{CC+}$ – 0.003 | | V |
| | | | Low level | | 0.080 | 0.180 | |
| $I_{CC}$ | Supply current | LPV321 | | | 4 | 8 | μA |
| | | LPV358 (both amplifiers) | | | 8 | 16 | |
| | | LPV324 (all four amplifiers) | | | 16 | 24 | |
| SR | Slew rate‡ | | | | 0.1 | | V/μs |
| GBW | Gain bandwidth product | $C_L$ = 22 pF (see Note 5) | | | 205 | | kHz |
| $\Phi_m$ | Phase margin | $C_L$ = 22 pF (see Note 5) | | | 71 | | deg |
| | Gain margin | $C_L$ = 22 pF (see Note 5) | | | 11 | | dB |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz | | | 178 | | nV/√Hz |
| $I_n$ | Equivalent input noise current | f = 1 kHz | | | 0.5 | | pA/√Hz |

† All typical values are at $V_{CC}$ = 2.7 V, $T_A$ = 25°C.
‡ Number specified is the slower of the positive and negative slew rates.
NOTE 5: Closed-loop gain = 18 dB, $V_{IC}$ = $V_{CC+}$/2

## 5-V electrical characteristics

**$T_A$ = 25°C, $V_{CC+}$ = 5 V, $V_{CC-}$ = 0 V, $V_{IC}$ = 2 V, $V_O$ = $V_{CC+}$/2, and $R_L$ > 1 MΩ (unless otherwise noted)**

| PARAMETER | | TEST CONDITIONS | | $T_A$ | MIN | TYP† | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_{IO}$ | Input offset voltage | | | 25°C | | 1.5 | 7 | mV |
| | | | | –40°C to 85°C | | | 10 | |
| | | | | –40°C to 125°C | | | 11 | |
| $\alpha_{VIO}$ | Average temperature coefficient of input offset voltage | | | 25°C | | 4 | | µV/°C |
| $I_{IB}$ | Input bias current | | | 25°C | | 2 | 50 | nA |
| | | | | –40°C to 85°C | | | 60 | |
| | | | | –40°C to 125°C | | | 65 | |
| CMRR | Common-mode rejection ratio | 0 ≤ $V_{IC}$ ≤ 4 V | | 25°C | 50 | 71 | | dB |
| $k_{SVR}$ | Supply-voltage rejection ratio | 2.7 V ≤ $V_{CC+}$ ≤ 5 V, $V_{IC}$ = 1 V, $V_O$ = 1 V | | 25°C | 50 | 65 | | dB |
| $V_{ICR}$ | Common-mode input voltage range | CMRR ≥ 50 dB | | 25°C | 0 to 4 | –0.2 to 4.2 | | V |
| $I_{IO}$ | Input offset current | | | 25°C | | 0.6 | 40 | nA |
| | | | | –40°C to 85°C | | | 50 | |
| | | | | –40°C to 125°C | | | 55 | |
| $V_O$ | Output swing | $R_L$ = 100 kΩ to 2.5 V | High level | 25°C | $V_{CC+}$ – 0.100 | $V_{CC+}$ – 0.0035 | | V |
| | | | | –40°C to 85°C | $V_{CC+}$ – 0.200 | | | |
| | | | | –40°C to 125°C | $V_{CC+}$ – 0.225 | | | |
| | | | Low level | 25°C | | 0.090 | 0.180 | |
| | | | | –40°C to 85°C | | | 0.220 | |
| | | | | –40°C to 125°C | | | 0.240 | |
| $I_{OS}$ | Output short-circuit current | Sourcing, $V_O$ = 0 V | | 25°C | 2 | 17 | | mA |
| | | Sinking, $V_O$ = 5 V | | | 20 | 72 | | |
| $I_{CC}$ | Supply current | LPV321 | | 25°C | | 9 | 12 | µA |
| | | | | –40°C to 85°C | | | 15 | |
| | | | | –40°C to 125°C | | | 40 | |
| | | LPV358 (both amplifiers) | | 25°C | | 15 | 20 | |
| | | | | –40°C to 85°C | | | 24 | |
| | | | | –40°C to 125°C | | | 80 | |
| | | LPV324 (all four amplifiers) | | 25°C | | 28 | 42 | |
| | | | | –40°C to 85°C | | | 46 | |
| | | | | –40°C to 125°C | | | 125 | |
| $A_V$‡ | Large-signal voltage gain | $R_L$ = 100 kΩ | | 25°C | 15 | 100 | | V/mV |
| | | | | –40°C to 85°C | 10 | | | |
| | | | | –40°C to 125°C | 10 | | | |
| SR§ | Slew rate | | | 25°C | | 0.1 | | V/µs |

† All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.
‡ $R_L$ is connected to $V_{CC-}$. The output voltage is 0.5 V ≤ $V_O$ ≤ 4.5 V.
§ Number specified is the slower of the positive and negative slew rates. Connected as a voltage follower with 3-V step input.

### 5-V electrical characteristics
### $T_A$ = 25°C, $V_{CC+}$ = 5 V, $V_{CC-}$ = 0 V, $V_{IC}$ = 2 V, $V_O$ = $V_{CC+}$/2, and $R_L$ > 1 MΩ (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | $T_A$ | MIN | TYP† | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| GBW | Gain bandwidth product | $C_L$ = 22 pF (see Note 5) | 25°C | | 237 | | kHz |
| $\Phi_m$ | Phase margin | $C_L$ = 22 pF (see Note 5) | 25°C | | 74 | | deg |
| | Gain margin | $C_L$ = 22 pF (see Note 5) | 25°C | | 12 | | dB |
| $V_n$ | Equivalent input noise voltage | f = 1 kHz | 25°C | | 146 | | nV/√Hz |
| $I_n$ | Equivalent input noise current | f = 1 kHz | 25°C | | 0.3 | | pA/√Hz |

† All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.
NOTE 5: Closed-loop gain = 18 dB, $V_{IC}$ = $V_{CC+}$/2

**SUPPLY CURRENT vs SUPPLY VOLTAGE (LPV324 – All Channels)**

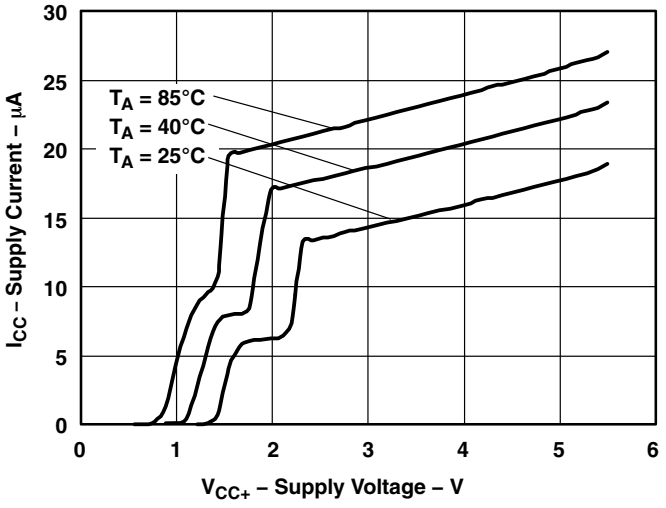



**Figure 1**

**INPUT BIAS CURRENT vs TEMPERATURE**

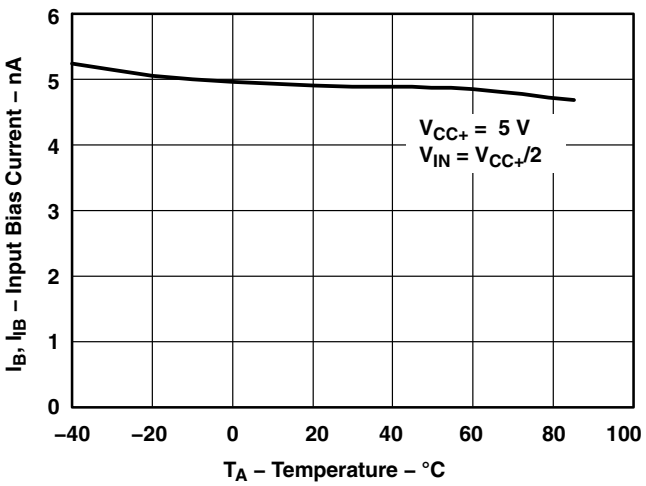



**Figure 2**

**SOURCING CURRENT vs OUTPUT VOLTAGE**

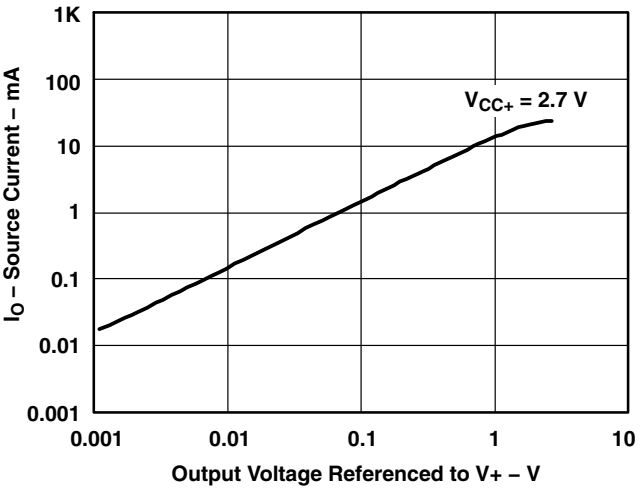



**Figure 3**

**SOURCING CURRENT vs OUTPUT VOLTAGE**

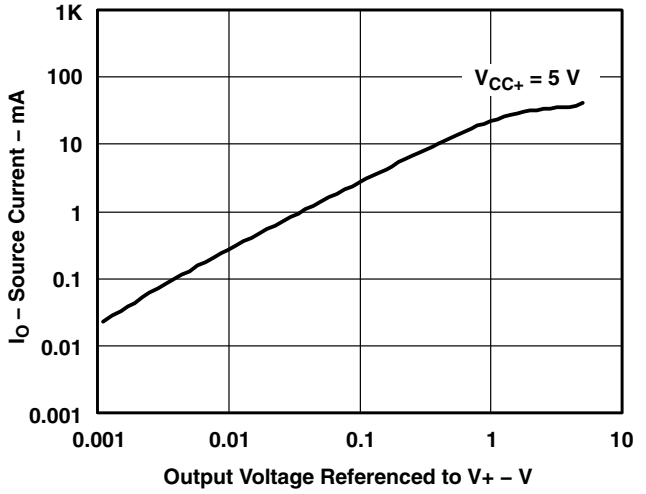



**Figure 4**

**SINKING CURRENT vs OUTPUT VOLTAGE**

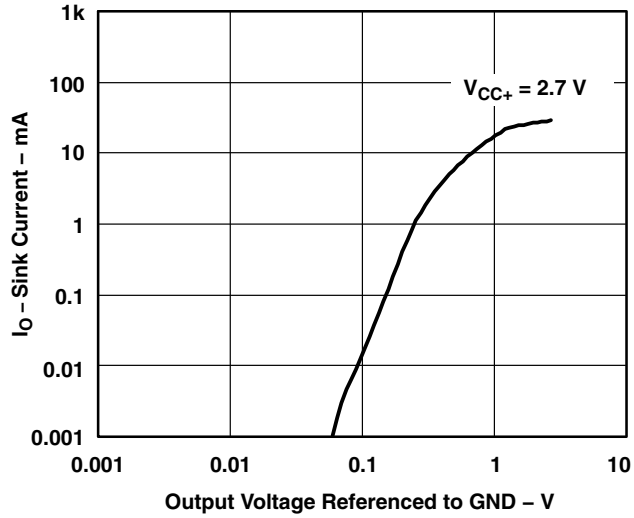



**Figure 5**

**SINKING CURRENT vs OUTPUT VOLTAGE**

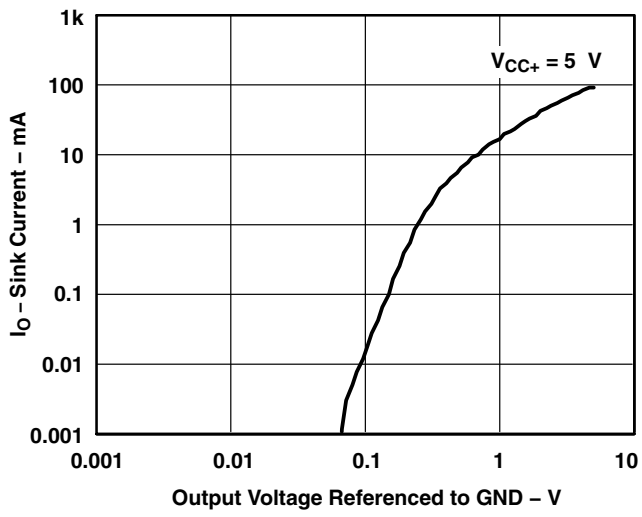



**Figure 6**

**OUTPUT VOLTAGE SWING vs SUPPLY VOLTAGE**

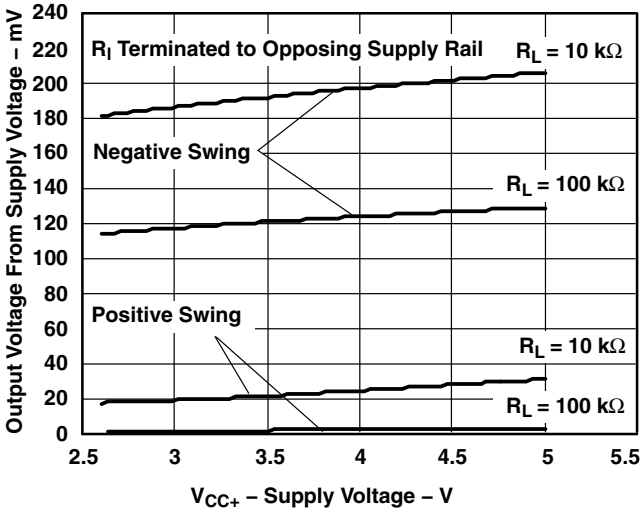



**Figure 7**

**INPUT VOLTAGE NOISE vs FREQUENCY**

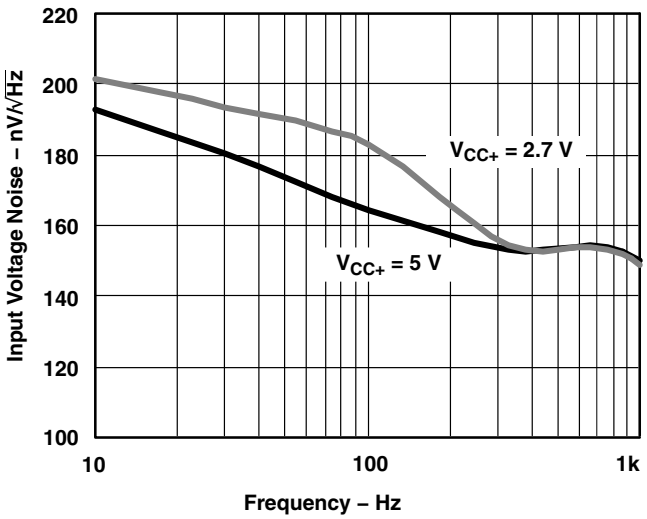



**Figure 8**

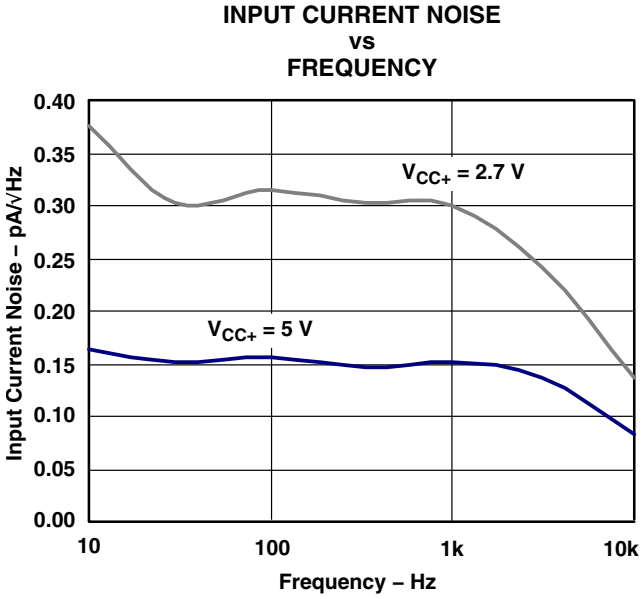



Figure 9

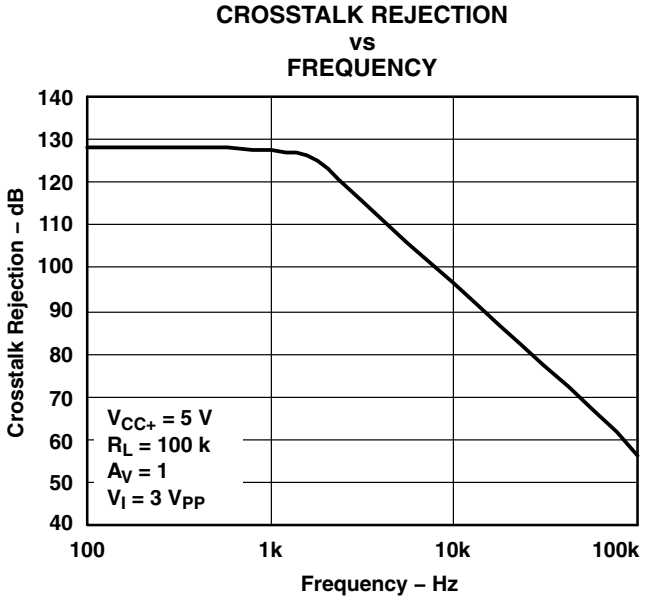



Figure 10

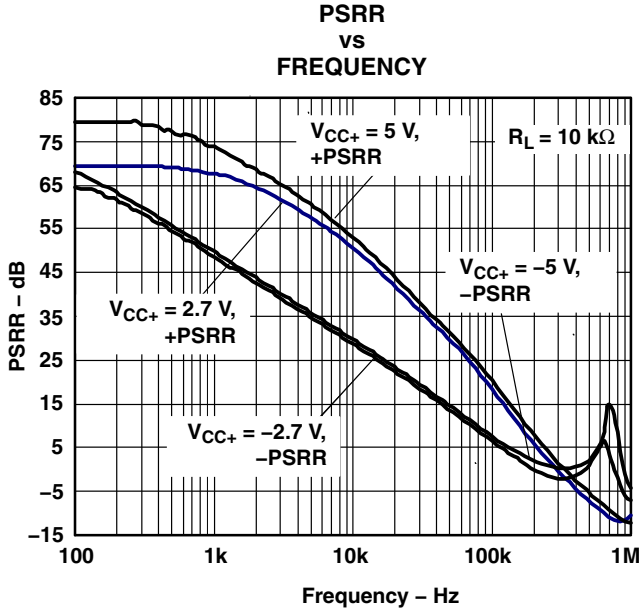



Figure 11

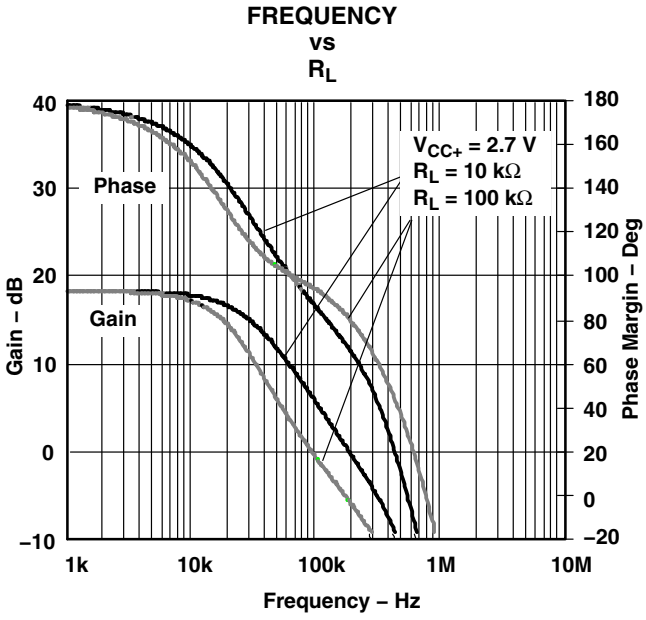



Figure 12

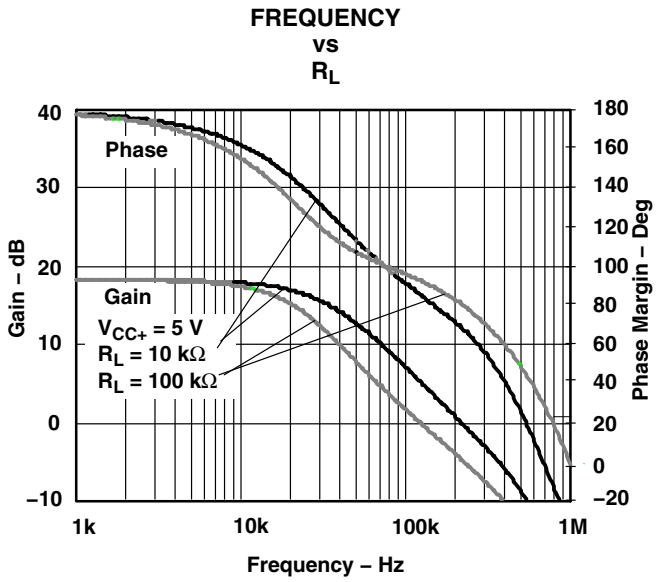



Figure 13

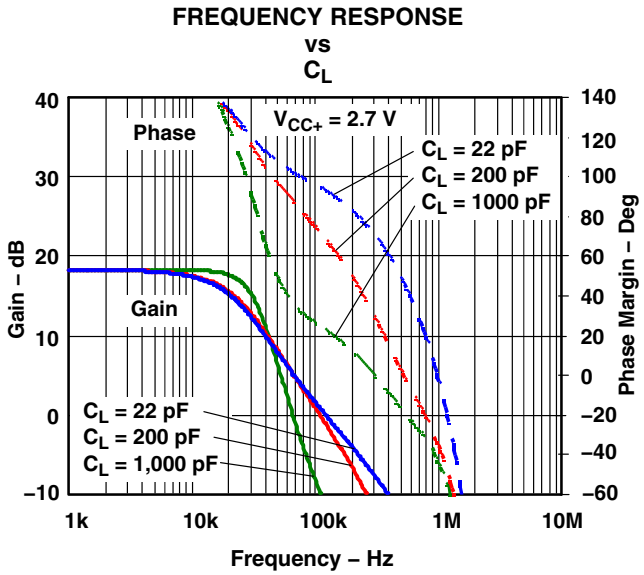



Figure 14

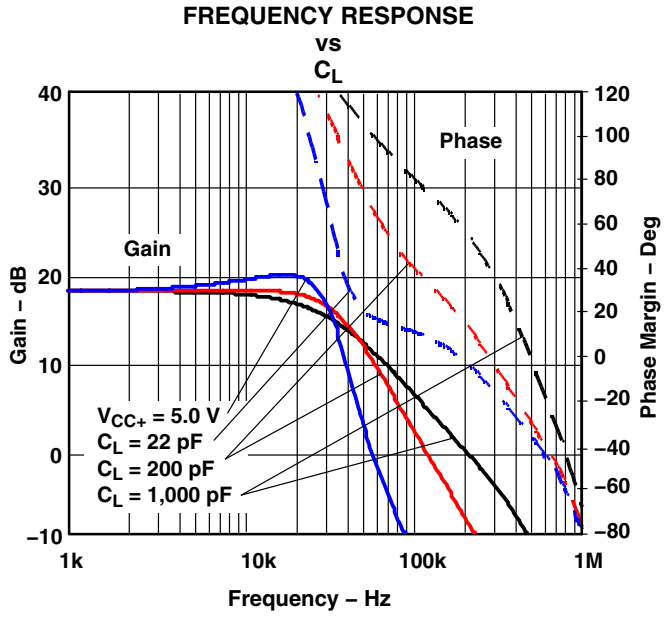



Figure 15

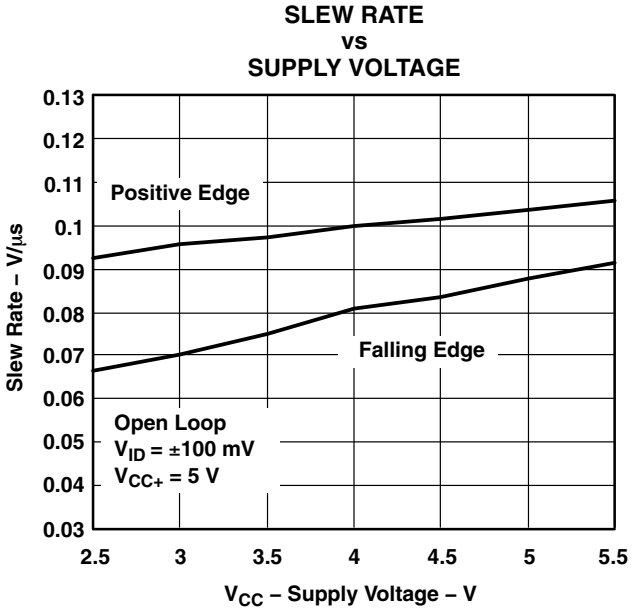



Figure 16

NONINVERTING LARGE-SIGNAL PULSE RESPONSE

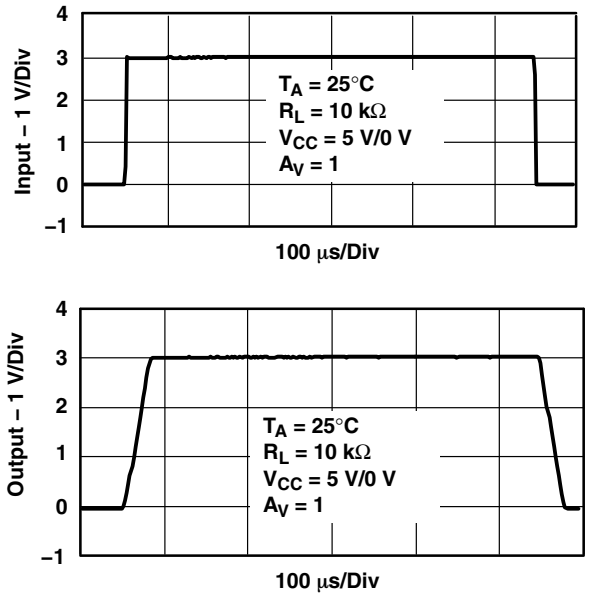



Figure 17

NONINVERTING SMALL-SIGNAL PULSE RESPONSE

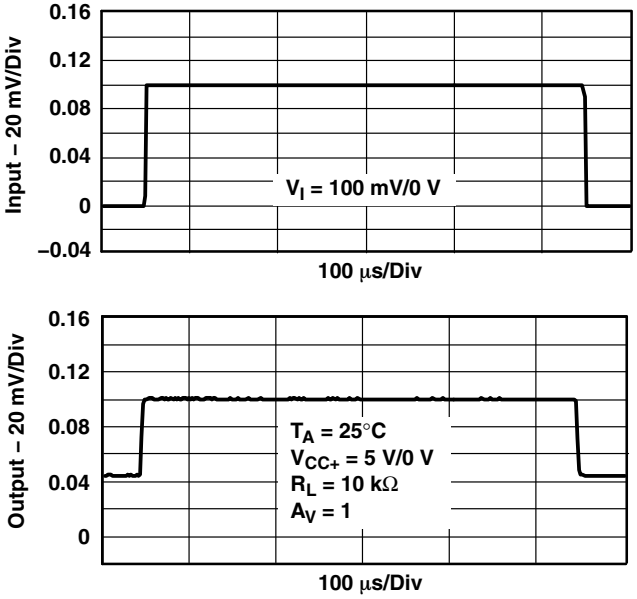



Figure 18

INVERTING LARGE-SIGNAL PULSE RESPONSE

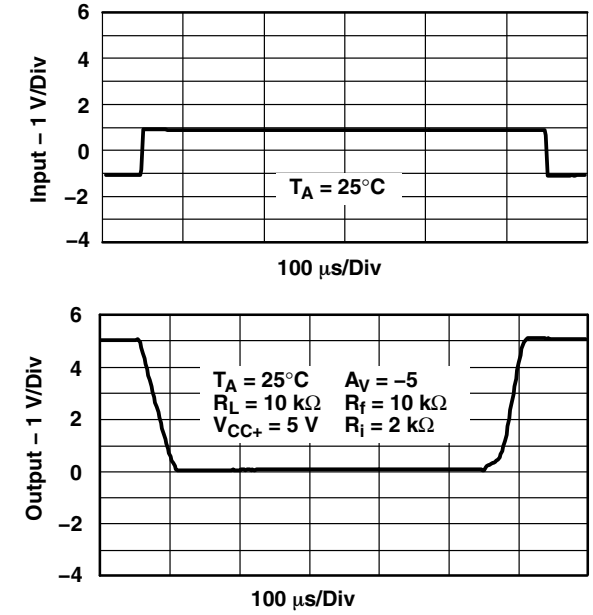



Figure 19

INVERTING SMALL-SIGNAL PULSE RESPONSE

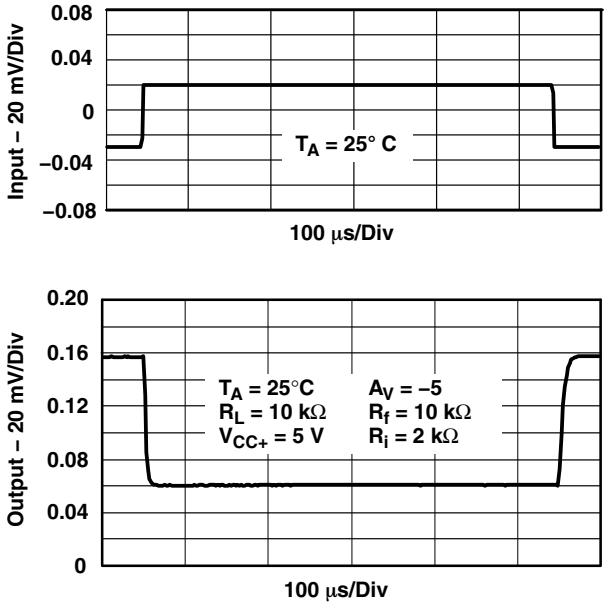



Figure 20

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/ Ball Finish | MSL Peak Temp (3) | Samples (Requires Login) |
|---|---|---|---|---|---|---|---|---|---|
| LPV321DBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321DBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321DBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321DCKR | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321DCKRE4 | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321DCKRG4 | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321IDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321IDBVRE4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321IDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321IDCKR | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321IDCKRE4 | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV321IDCKRG4 | ACTIVE | SC70 | DCK | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324D | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324DE4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324DG4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324DR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324DRE4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/ Ball Finish | MSL Peak Temp (3) | Samples (Requires Login) |
|---|---|---|---|---|---|---|---|---|---|
| LPV324DRG4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324ID | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IDE4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IDG4 | ACTIVE | SOIC | D | 14 | 50 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IDR | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IDRE4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IDRG4 | ACTIVE | SOIC | D | 14 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IPW | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IPWE4 | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IPWG4 | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IPWR | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IPWRE4 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324IPWRG4 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324PW | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324PWE4 | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324PWG4 | ACTIVE | TSSOP | PW | 14 | 90 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324PWR | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV324PWRE4 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/ Ball Finish | MSL Peak Temp (3) | Samples (Requires Login) |
|---|---|---|---|---|---|---|---|---|---|
| LPV324PWRG4 | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358D | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DDUR | ACTIVE | VSSOP | DDU | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DDURE4 | ACTIVE | VSSOP | DDU | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DDURG4 | ACTIVE | VSSOP | DDU | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DGKR | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DGKRG4 | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358DRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358ID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358IDDUR | ACTIVE | VSSOP | DDU | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358IDDURE4 | ACTIVE | VSSOP | DDU | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358IDDURG4 | ACTIVE | VSSOP | DDU | 8 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358IDE4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358IDG4 | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/ Ball Finish | MSL Peak Temp (3) | Samples (Requires Login) |
|---|---|---|---|---|---|---|---|---|---|
| LPV358IDGKR | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358IDGKRG4 | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358IDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358IDRE4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| LPV358IDRG4 | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |

(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.

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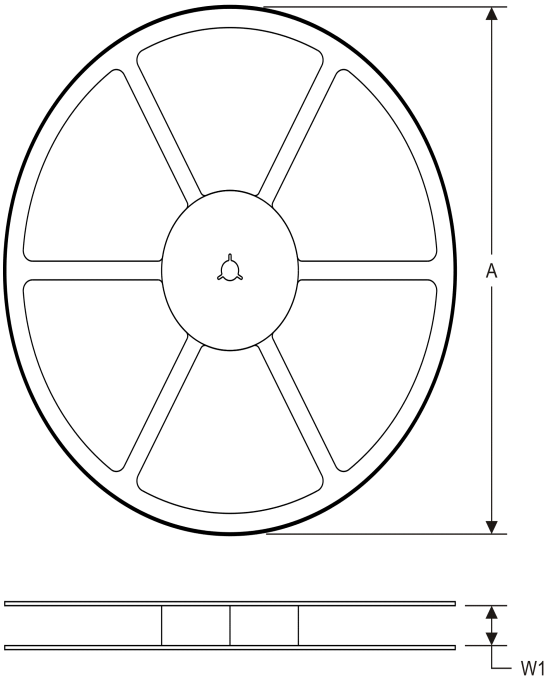
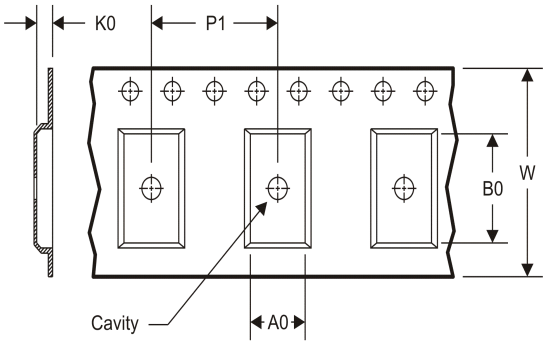
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**




**TAPE DIMENSIONS**



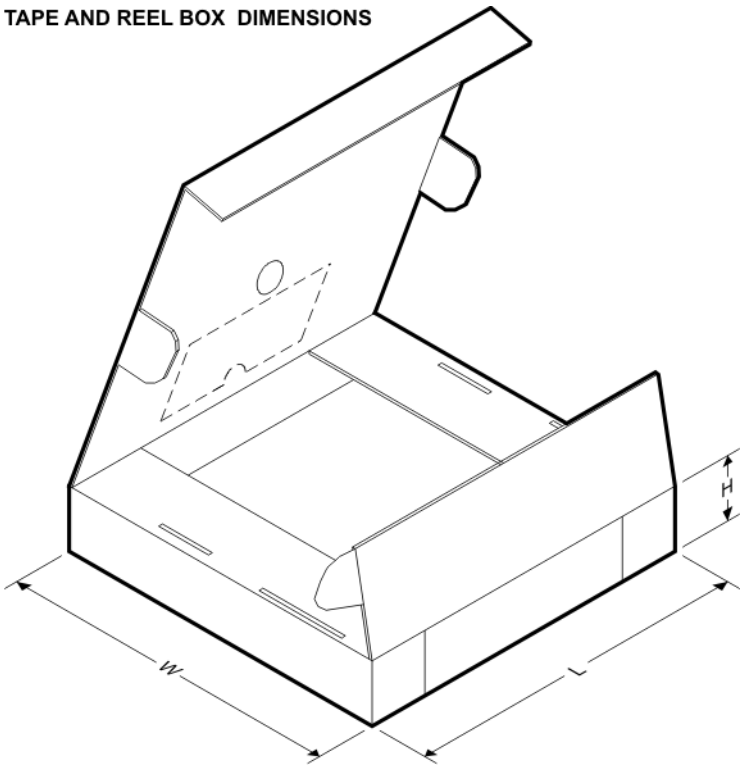

| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LPV321DBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| LPV321DCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LPV321DCKR | SC70 | DCK | 5 | 3000 | 178.0 | 9.0 | 2.4 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LPV321IDBVR | SOT-23 | DBV | 5 | 3000 | 178.0 | 9.0 | 3.23 | 3.17 | 1.37 | 4.0 | 8.0 | Q3 |
| LPV321IDCKR | SC70 | DCK | 5 | 3000 | 178.0 | 9.0 | 2.4 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LPV321IDCKR | SC70 | DCK | 5 | 3000 | 179.0 | 8.4 | 2.2 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| LPV324DR | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |
| LPV324IDR | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |
| LPV324IPWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LPV324PWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| LPV358DDUR | VSSOP | DDU | 8 | 3000 | 180.0 | 8.4 | 2.25 | 3.35 | 1.05 | 4.0 | 8.0 | Q3 |
| LPV358DGKR | MSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| LPV358DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| LPV358IDDUR | VSSOP | DDU | 8 | 3000 | 180.0 | 8.4 | 2.25 | 3.35 | 1.05 | 4.0 | 8.0 | Q3 |
| LPV358IDGKR | MSOP | DGK | 8 | 2500 | 330.0 | 12.4 | 5.3 | 3.4 | 1.4 | 8.0 | 12.0 | Q1 |
| LPV358IDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |

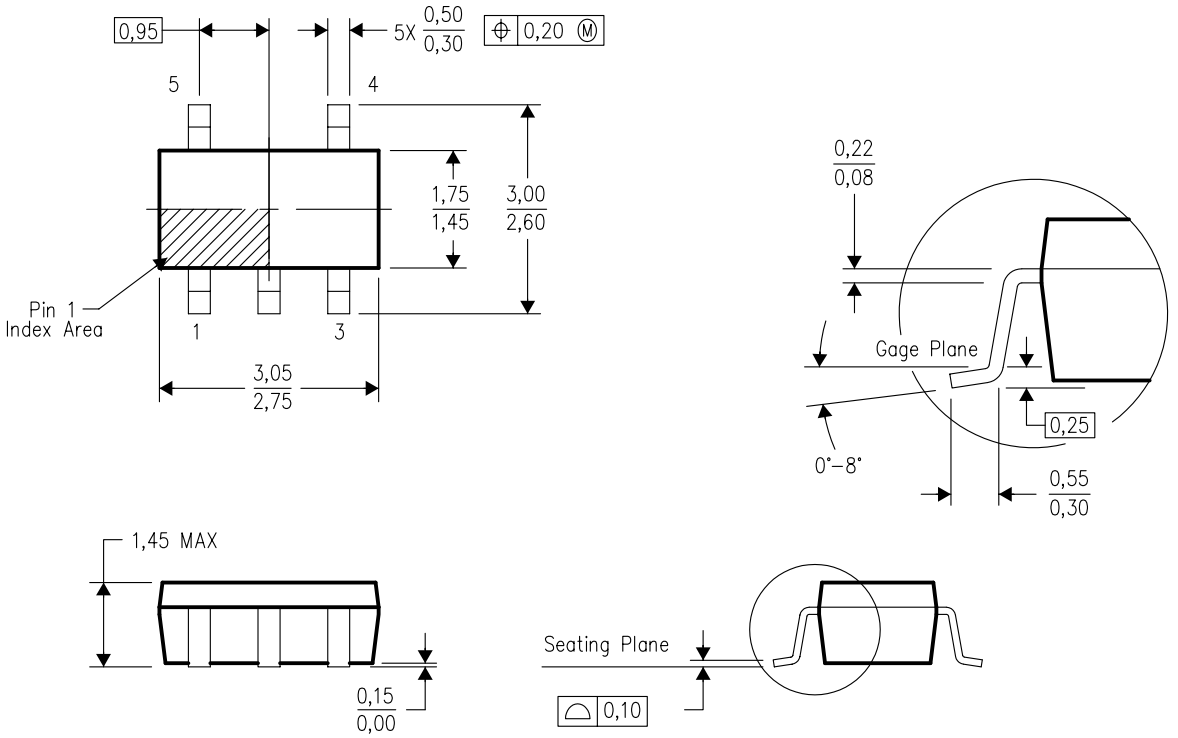
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| LPV321DBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| LPV321DCKR | SC70 | DCK | 5 | 3000 | 203.0 | 203.0 | 35.0 |
| LPV321DCKR | SC70 | DCK | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| LPV321IDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| LPV321IDCKR | SC70 | DCK | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| LPV321IDCKR | SC70 | DCK | 5 | 3000 | 203.0 | 203.0 | 35.0 |
| LPV324DR | SOIC | D | 14 | 2500 | 346.0 | 346.0 | 33.0 |
| LPV324IDR | SOIC | D | 14 | 2500 | 346.0 | 346.0 | 33.0 |
| LPV324IPWR | TSSOP | PW | 14 | 2000 | 346.0 | 346.0 | 29.0 |
| LPV324PWR | TSSOP | PW | 14 | 2000 | 346.0 | 346.0 | 29.0 |
| LPV358DDUR | VSSOP | DDU | 8 | 3000 | 202.0 | 201.0 | 28.0 |
| LPV358DGKR | MSOP | DGK | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| LPV358DR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| LPV358IDDUR | VSSOP | DDU | 8 | 3000 | 202.0 | 201.0 | 28.0 |
| LPV358IDGKR | MSOP | DGK | 8 | 2500 | 358.0 | 335.0 | 35.0 |
| LPV358IDR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |

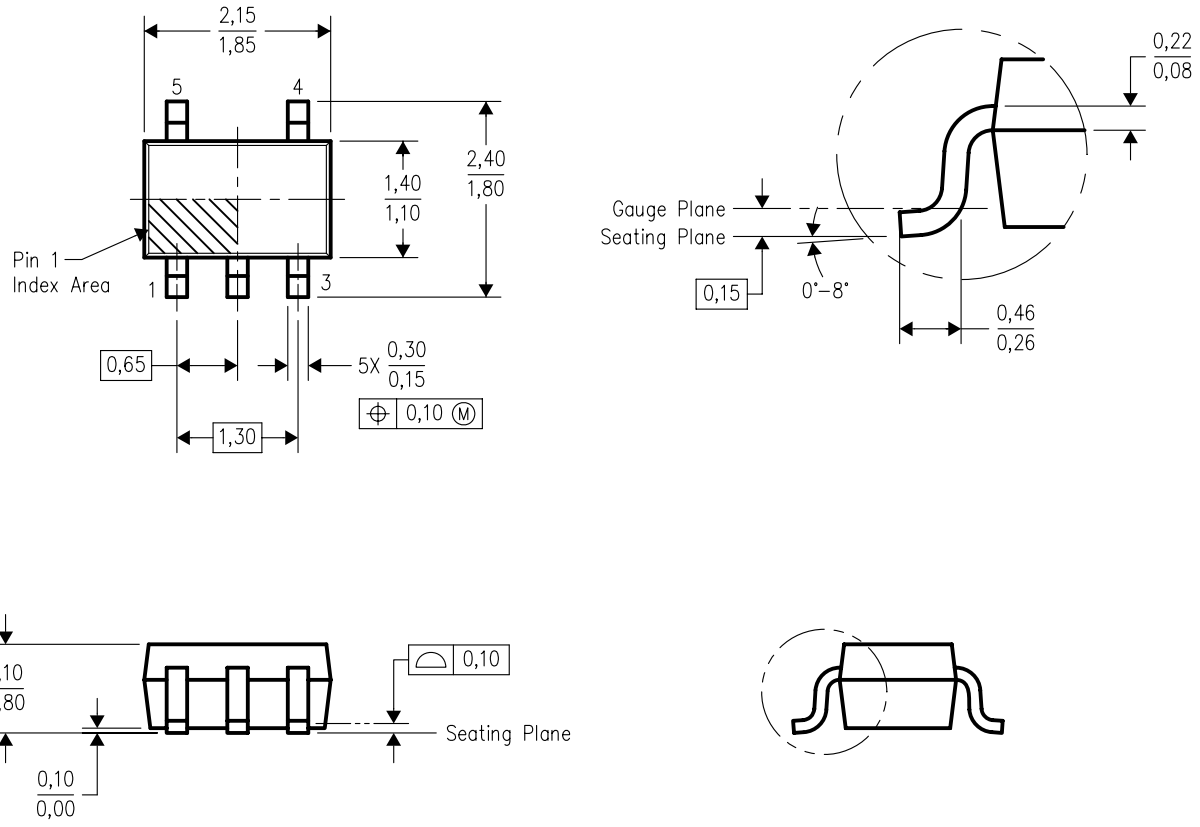
## DBV (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE




4073253–4/K 03/2006

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–178 Variation AA.

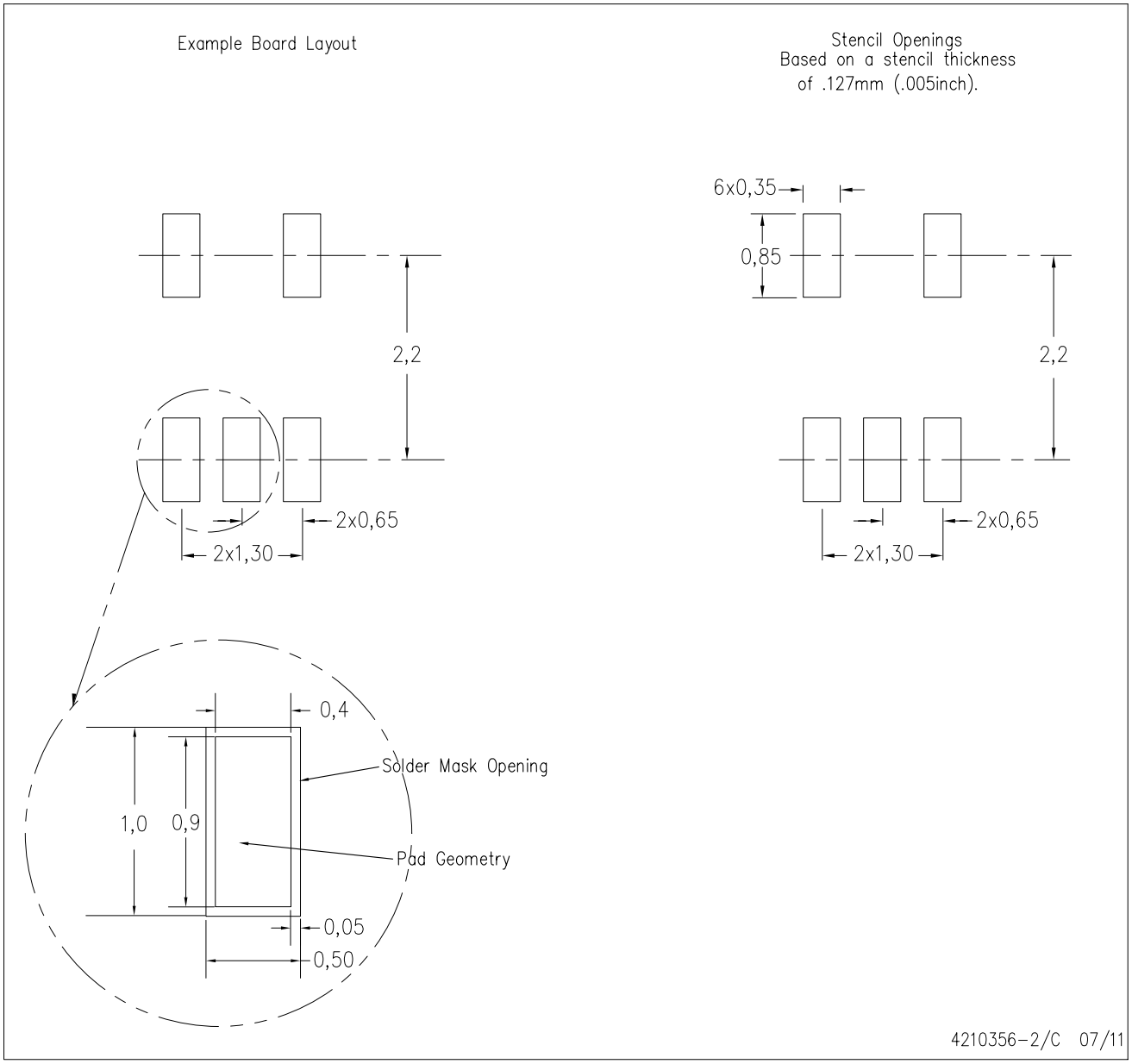
## DCK (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE




4093553–3/G 01/2007

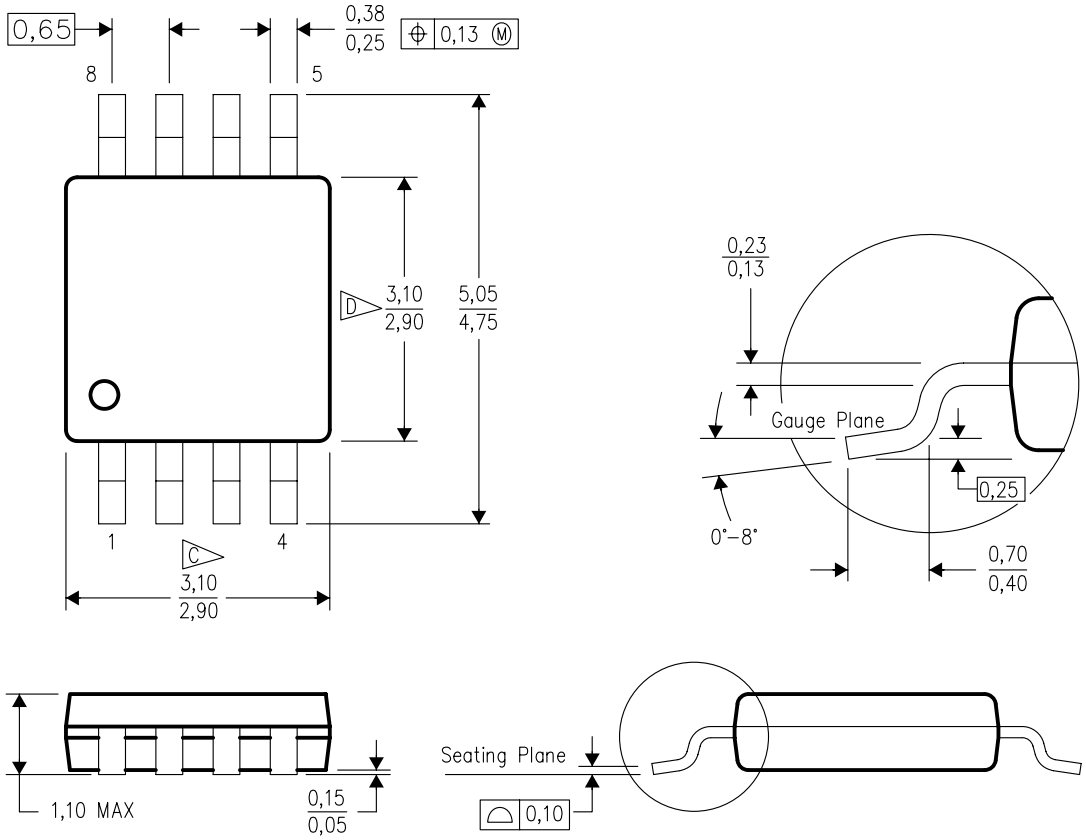
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–203 variation AA.

DCK (R–PDSO–G5) PLASTIC SMALL OUTLINE




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

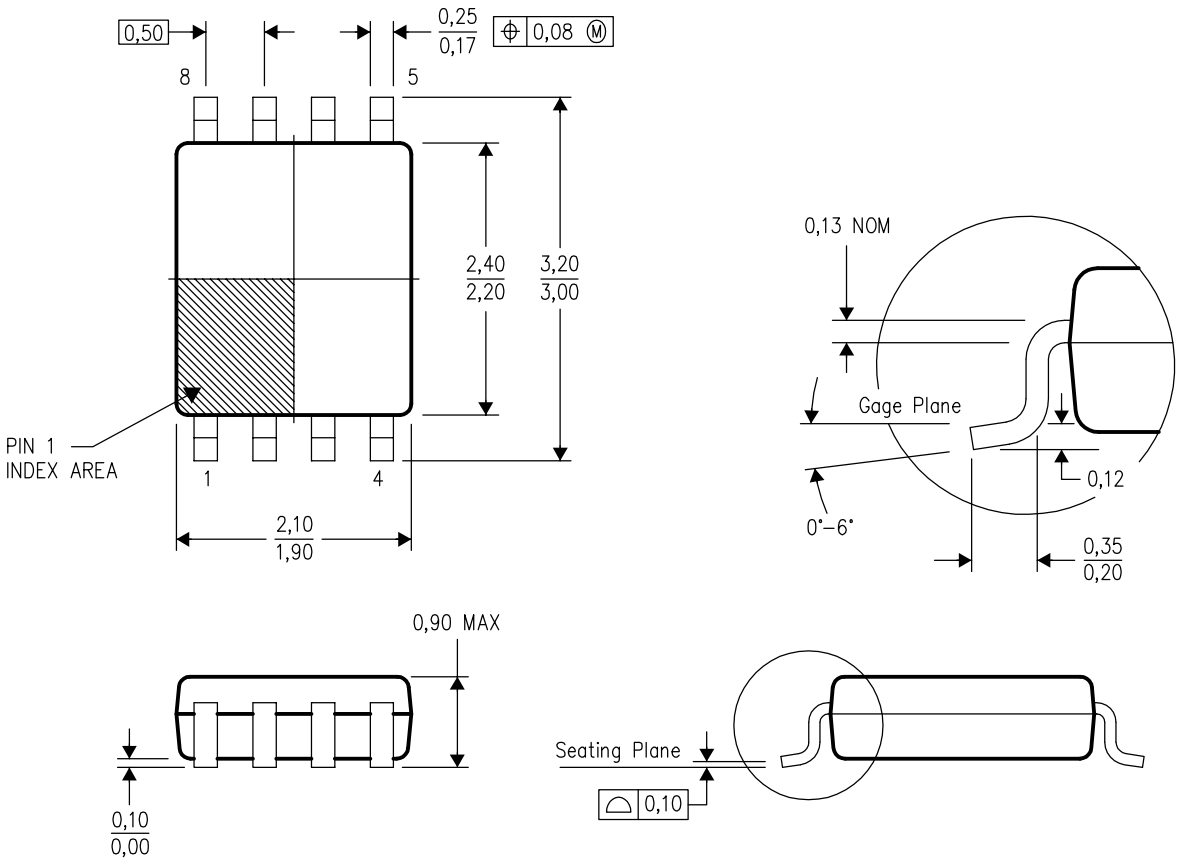
DGK (S–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE




4073329/E 05/06

NOTES:
A. All linear dimensions are in 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 0.15 per end.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0.50 per side.
E. Falls within JEDEC MO–187 variation AA, except interlead flash.

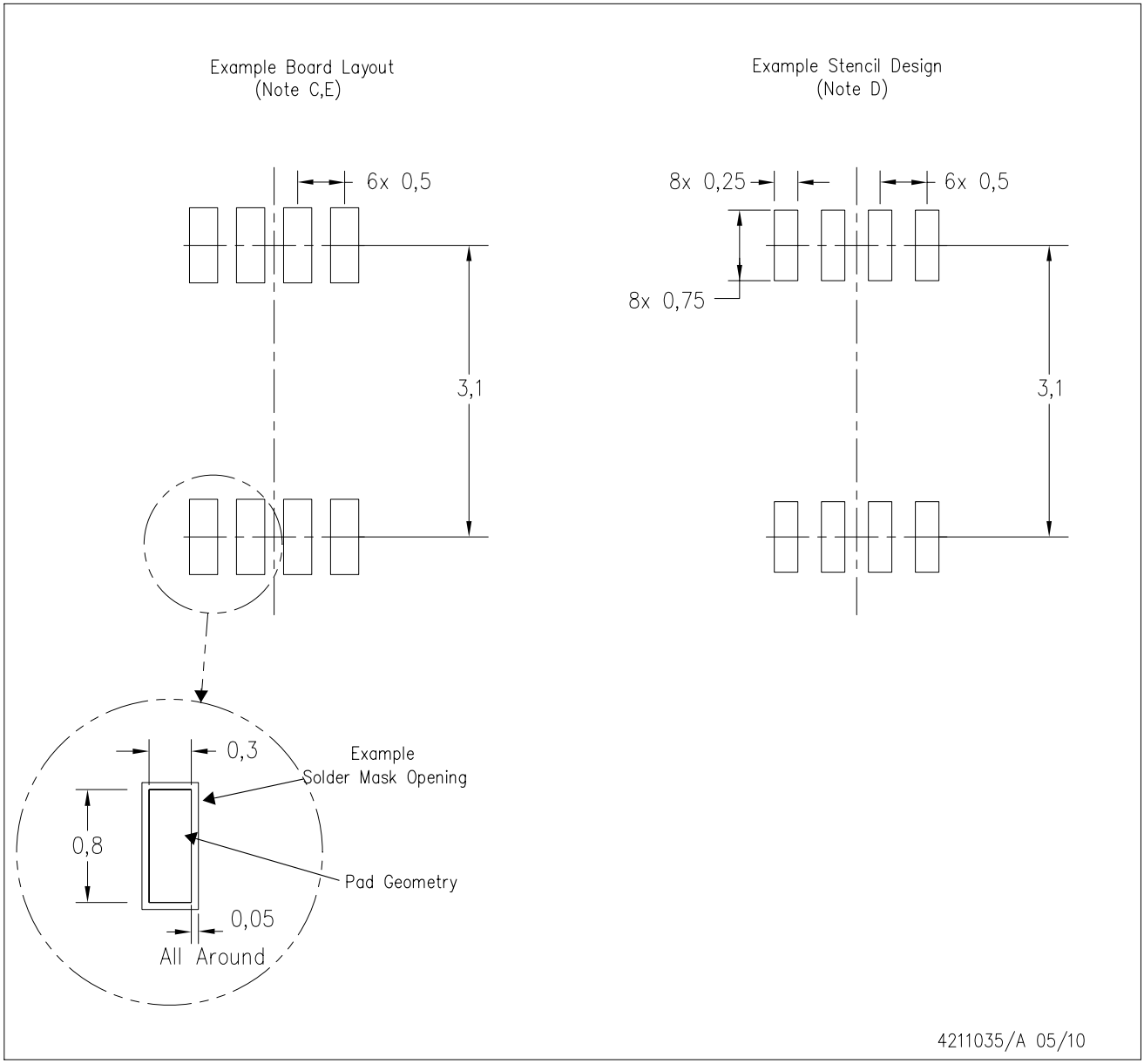
## DDU (R–PDSO–G8) PLASTIC SMALL–OUTLINE PACKAGE




4205140/A 05/03

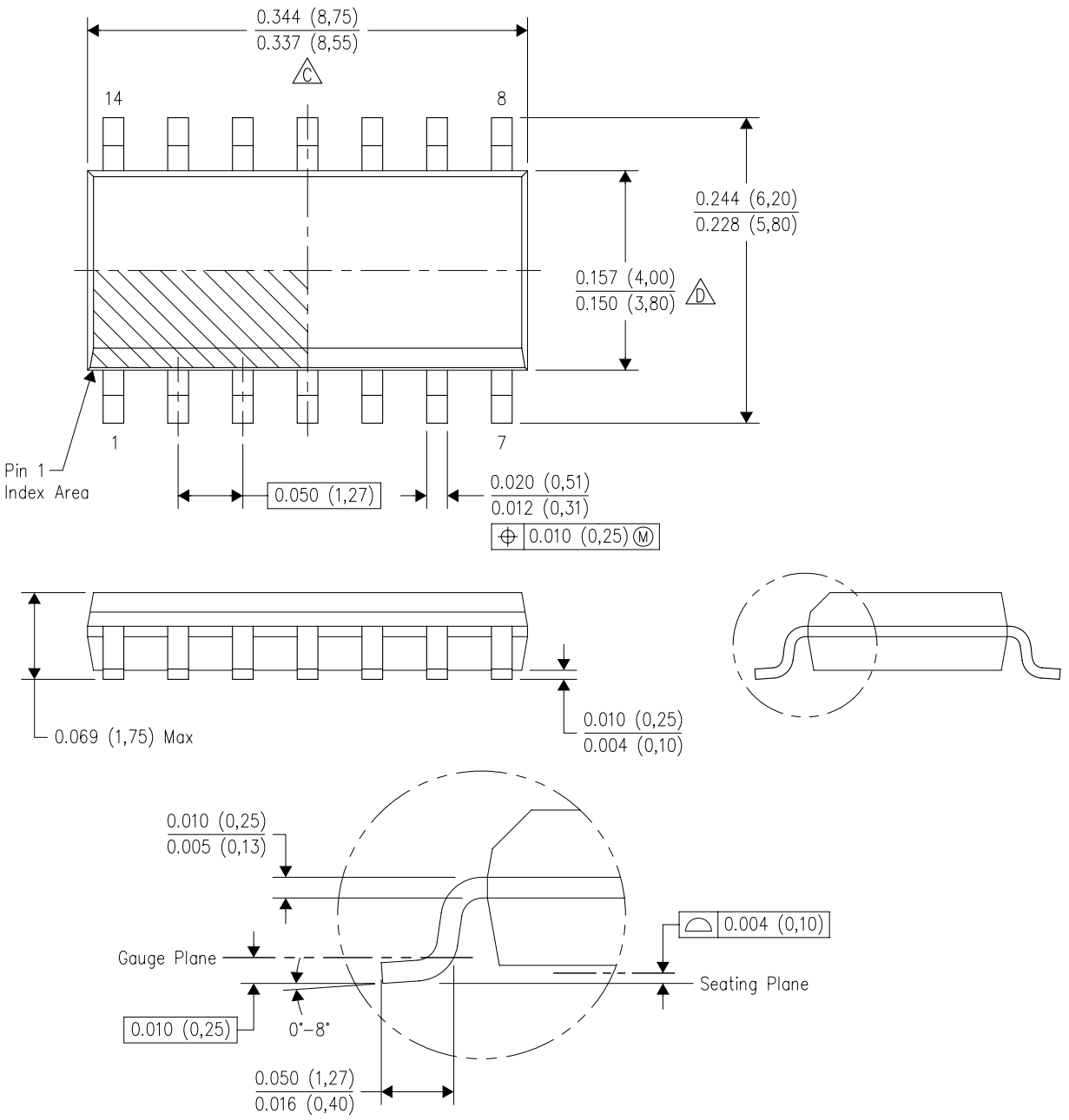
NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC MO–187 variation CA.

DDU (S–PDSO–G8) PLASTIC SMALL OUTLINE PACKAGE (DIE UP)



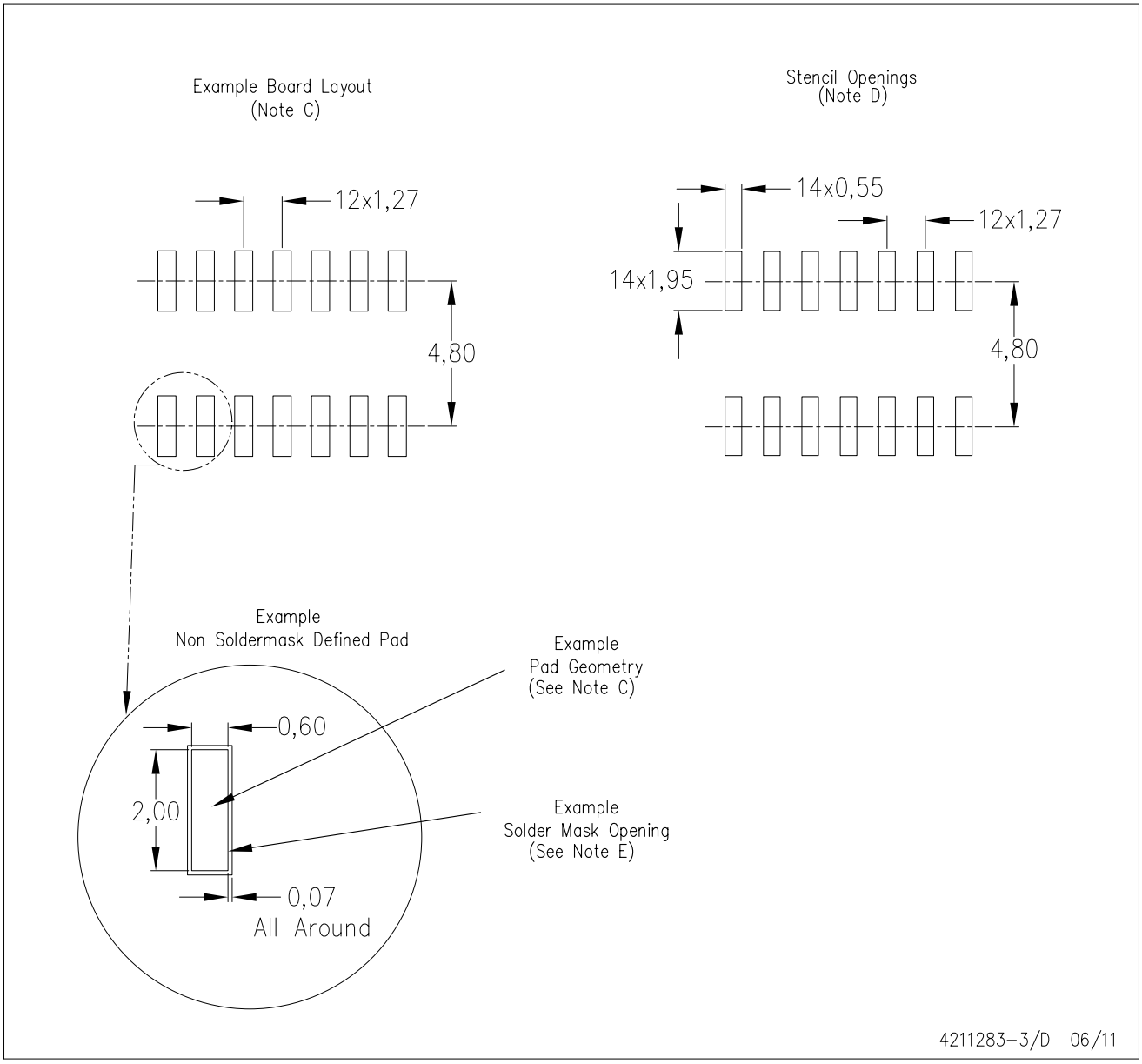

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact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

D (R–PDSO–G14) PLASTIC SMALL OUTLINE



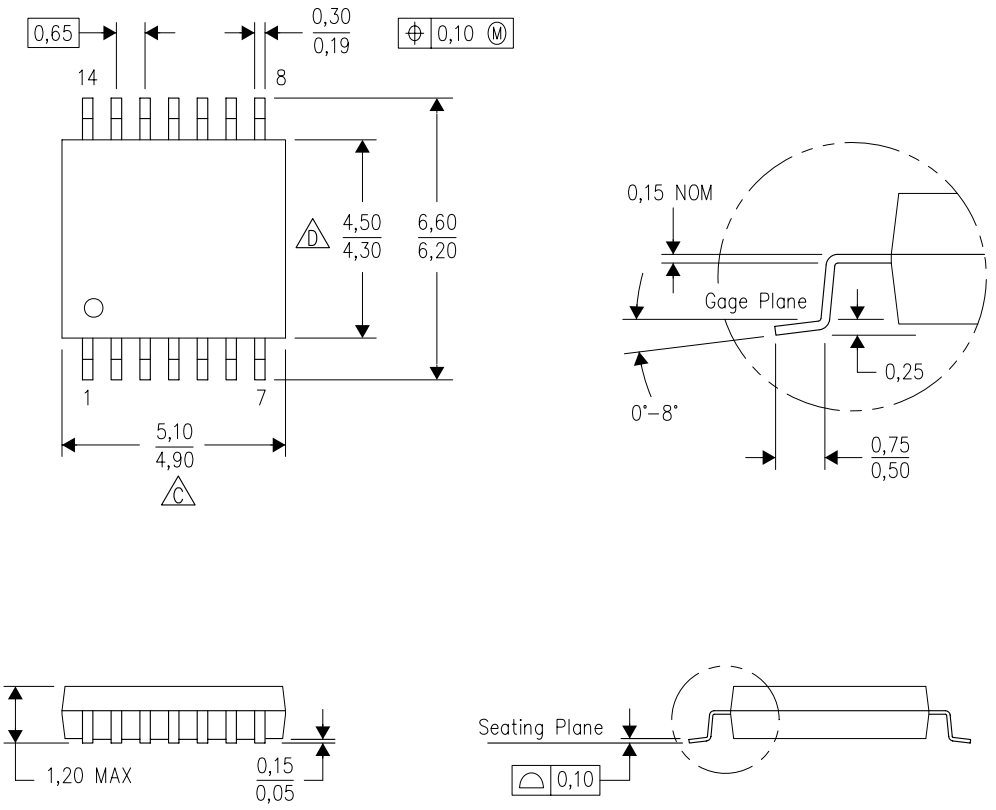

NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
D. Body width does not include interlead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

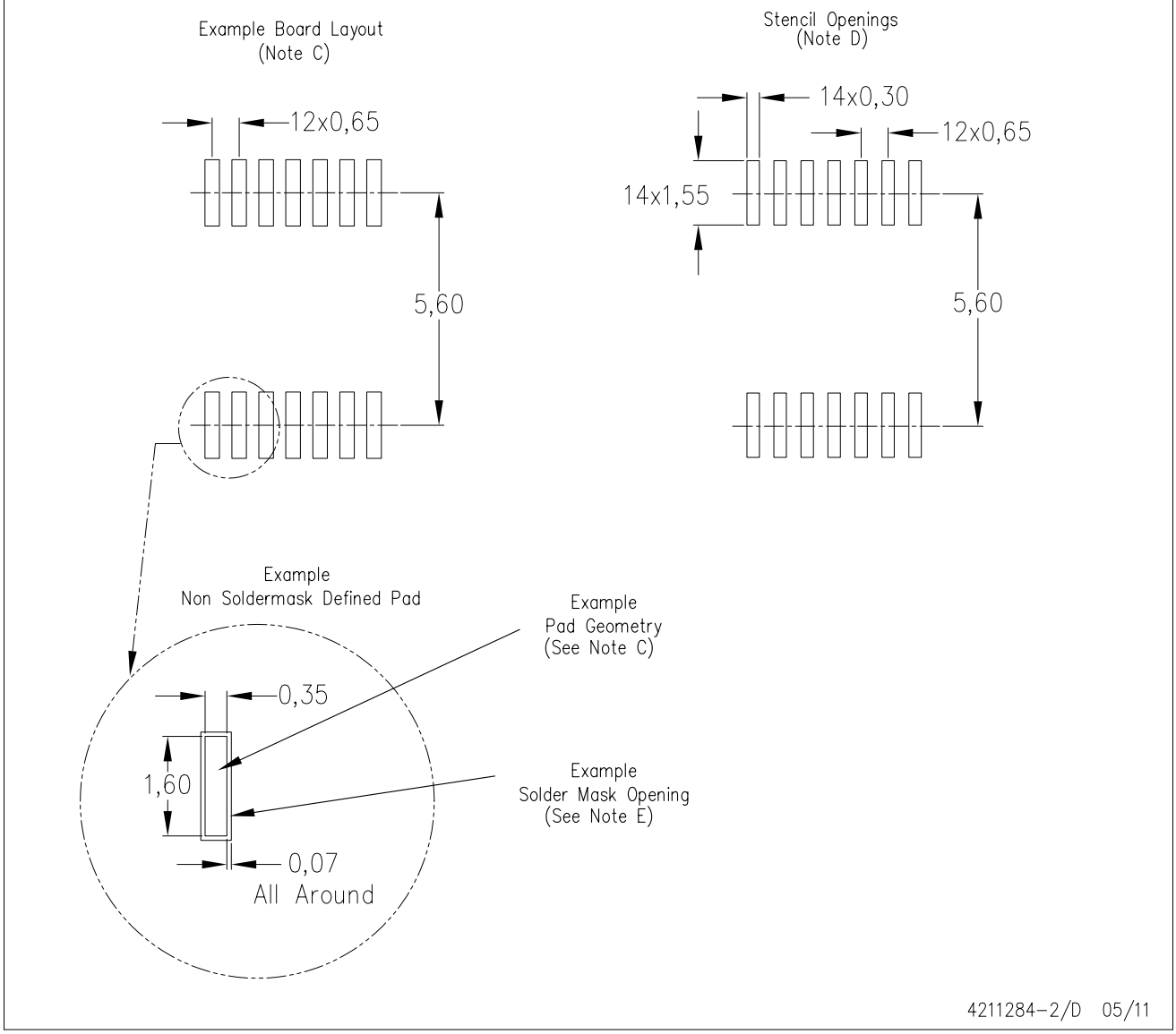
PW (R–PDSO–G14) PLASTIC SMALL OUTLINE




4040064–3/G 02/11

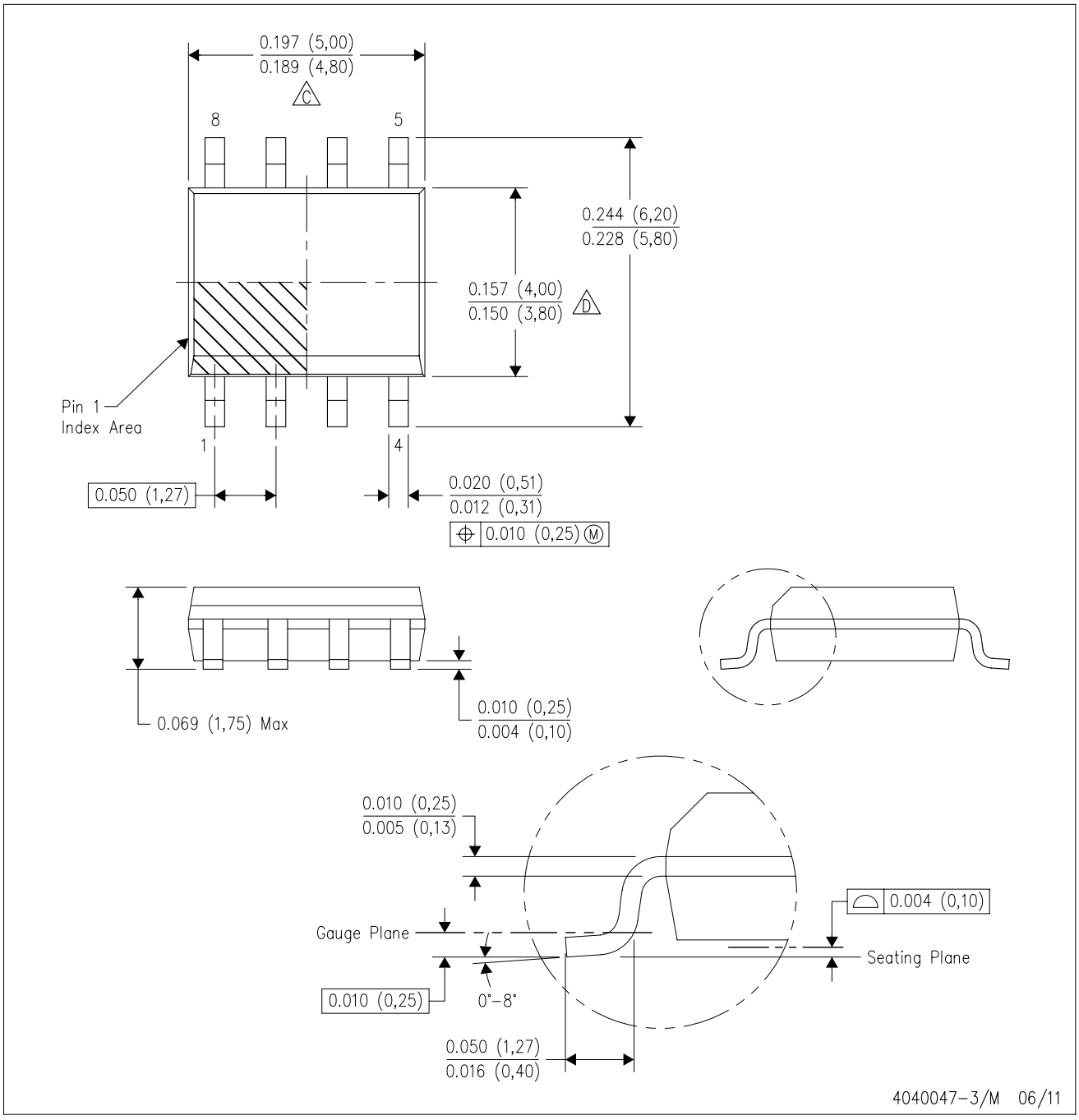
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D.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



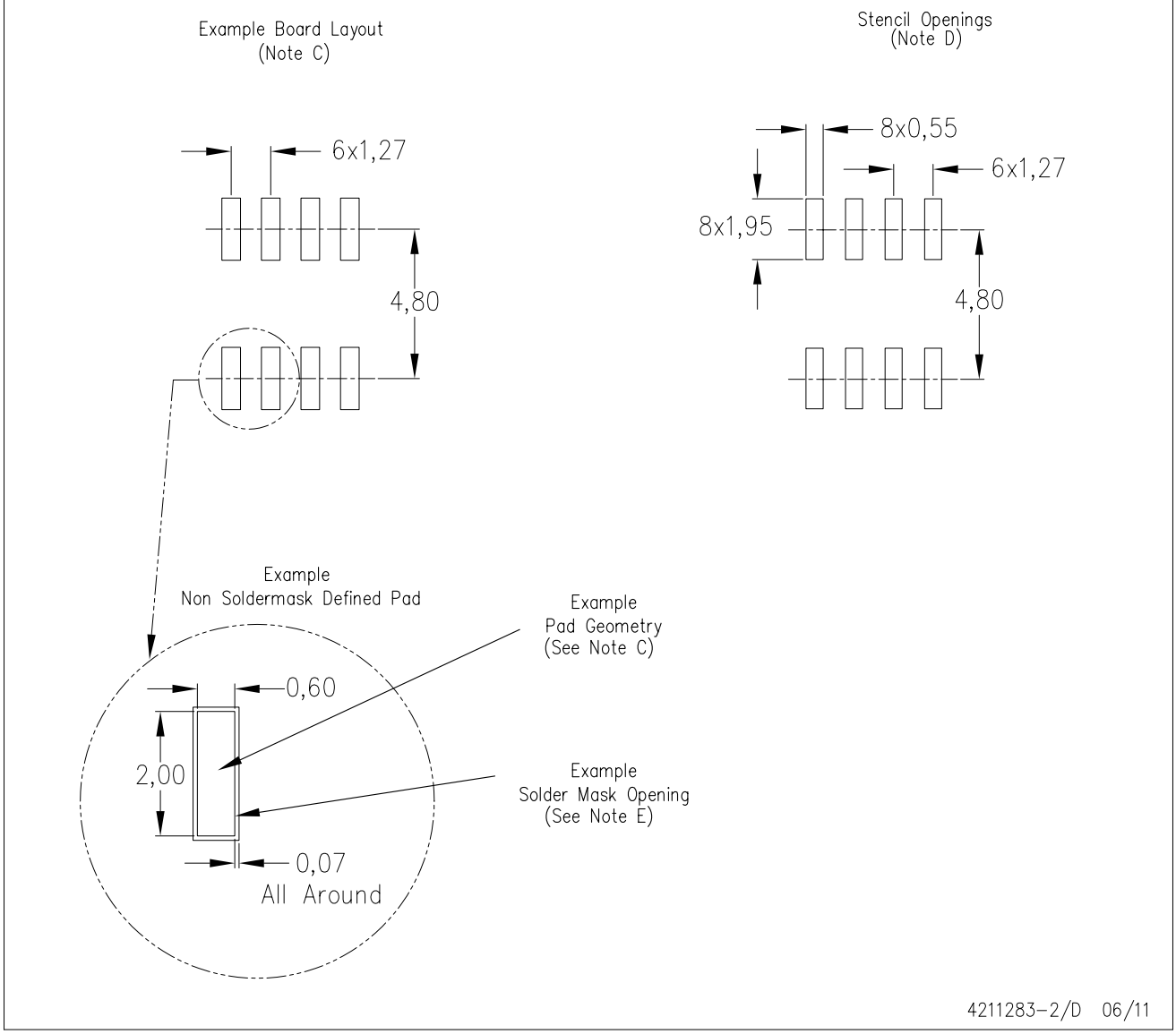

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact 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.

D (R–PDSO–G8) PLASTIC SMALL OUTLINE




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 AA.

D (R–PDSO–G8) 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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