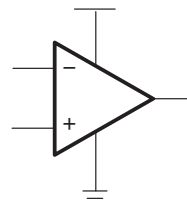


# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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- Supply Current . . . 23  $\mu$ A/Channel
- Gain-Bandwidth Product . . . 220 kHz
- Output Drive Capability . . .  $\pm 10$  mA
- Input Offset Voltage . . . 20  $\mu$ V (typ)
- $V_{DD}$  Range . . . 2.7 V to 6 V
- Power Supply Rejection Ratio . . . 106 dB
- Ultralow-Power Shutdown Mode  
 $I_{DD}$  . . . 16 nA/ch
- Rail-To-Rail Input/Output (RRIO)
- Ultrasmall Packaging
  - 5 or 6 Pin SOT-23 (TLV2450/1)
  - 8 or 10 Pin MSOP (TLV2452/3)

Operational Amplifier



## description

The TLV245x is a family of rail-to-rail input/output operational amplifiers that sets a new performance point for supply current and ac performance. These devices consume a mere 23  $\mu$ A/channel while offering 220 kHz of gain-bandwidth product, much higher than competitive devices with similar supply current levels. Along with increased ac performance, the amplifier provides high output drive capability, solving a major shortcoming of older micropower rail-to-rail input/output operational amplifiers. The TLV245x can swing to within 250 mV of each supply rail while driving a 2.5-mA load. Both the inputs and outputs swing rail-to-rail for increased dynamic range in low-voltage applications. This performance makes the TLV245x family ideal for portable medical equipment, patient monitoring systems, and data acquisition circuits.

FAMILY PACKAGE TABLE

| DEVICE  | NUMBER OF CHANNELS | PACKAGE TYPES |      |        |       |      | SHUTDOWN | UNIVERSAL EVM BOARD                             |
|---------|--------------------|---------------|------|--------|-------|------|----------|-------------------------------------------------|
|         |                    | PDIP          | SOIC | SOT-23 | TSSOP | MSOP |          |                                                 |
| TLV2450 | 1                  | 8             | 8    | 6      | —     | —    | Yes      | Refer to the EVM Selection Guide (Lit# SLOU060) |
| TLV2451 | 1                  | 8             | 8    | 5      | —     | —    | —        |                                                 |
| TLV2452 | 2                  | 8             | 8    | —      | —     | 8    | —        |                                                 |
| TLV2453 | 2                  | 14            | 14   | —      | —     | 10   | Yes      |                                                 |
| TLV2454 | 4                  | 14            | 14   | —      | 14    | —    | —        |                                                 |
| TLV2455 | 4                  | 16            | 16   | —      | 16    | —    | Yes      |                                                 |

A SELECTION OF SINGLE-SUPPLY OPERATIONAL AMPLIFIER PRODUCTS<sup>†</sup>

| DEVICE  | $V_{DD}$ (V) | BW (MHz) | SLEW RATE (V/ $\mu$ s) | $I_{DD}$ (per channel) ( $\mu$ A) | RAIL-TO-RAIL |
|---------|--------------|----------|------------------------|-----------------------------------|--------------|
| TLV245X | 2.7 – 6.0    | 0.22     | 0.11                   | 23                                | I/O          |
| TLV247X | 2.7 – 6.0    | 2.8      | 1.5                    | 600                               | I/O          |
| TLV246X | 2.7 – 6.0    | 6.4      | 1.6                    | 550                               | I/O          |
| TLV277X | 2.5 – 6.0    | 5.1      | 10.5                   | 1000                              | O            |

<sup>†</sup> All specifications measured at 5 V.



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

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# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## description (continued)

Three members of the family (TLV2450/3/5) offer a shutdown terminal for conserving battery life in portable applications. During shutdown, the outputs are placed in a high-impedance state and the amplifier consumes only 16 nA/channel. The family is fully specified at 3 V and 5 V across an expanded industrial temperature range ( $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ ). The singles and duals are available in the SOT23 and MSOP packages, while the quads are available in TSSOP. The TLV2450 offers an amplifier with shutdown functionality all in a 6-pin SOT23 package, making it perfect for high density circuits.

TLV2450 and TLV2451 AVAILABLE OPTIONS

| T <sub>A</sub>                                 | PACKAGED DEVICES                  |                            |              |                          |
|------------------------------------------------|-----------------------------------|----------------------------|--------------|--------------------------|
|                                                | SMALL OUTLINE<br>(D) <sup>†</sup> | SOT-23                     |              | PLASTIC DIP<br>(P)       |
|                                                |                                   | (DBV)                      | SYMBOL       |                          |
| 0°C to 70°C                                    | TLV2450CD<br>TLV2451CD            | TLV2450CDBV<br>TLV2451CDBV | VAQC<br>VARC | TLV2450CP<br>TLV2451CP   |
| $-40^{\circ}\text{C}$ to $125^{\circ}\text{C}$ | TLV2450ID<br>TLV2451ID            | TLV2450IDBV<br>TLV2451IDBV | VAQI<br>VARI | TLV2450IP<br>TLV2451IP   |
|                                                | TLV2450AID<br>TLV2451AID          | —<br>—                     | —<br>—       | TLV2450AIP<br>TLV2451AIP |

<sup>†</sup> This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TLV2450CDR).

TLV2452 and TLV2453 AVAILABLE OPTIONS

| T <sub>A</sub>                                 | PACKAGED DEVICES                  |                    |                     |                    |                     |                    |                    |
|------------------------------------------------|-----------------------------------|--------------------|---------------------|--------------------|---------------------|--------------------|--------------------|
|                                                | SMALL OUTLINE<br>(D) <sup>†</sup> | MSOP               |                     |                    |                     | PLASTIC DIP<br>(N) | PLASTIC DIP<br>(P) |
|                                                |                                   | (DGK) <sup>†</sup> | SYMBOL <sup>‡</sup> | (DGS) <sup>†</sup> | SYMBOL <sup>‡</sup> |                    |                    |
| 0°C to 70°C                                    | TLV2452CD<br>TLV2453CD            | TLV2452CDGK<br>—   | xxTIABI<br>—        | —<br>TLV2453CDGS   | —<br>xxTIABK        | —<br>TLV2453CN     | TLV2452CP<br>—     |
| $-40^{\circ}\text{C}$ to $125^{\circ}\text{C}$ | TLV2452ID<br>TLV2453ID            | TLV2452IDGK<br>—   | xxTIABJ<br>—        | —<br>TLV2453IDGS   | —<br>xxTIABL        | —<br>TLV2453IN     | TLV2452IP<br>—     |
|                                                | TLV2452AID<br>TLV2453AID          | —<br>—             | —<br>—              | —<br>—             | —<br>—              | —<br>TLV2453AIN    | TLV2452AIP<br>—    |

<sup>†</sup> This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TLV2452CDR).

<sup>‡</sup> xx represents the device date code.

TLV2454 and TLV2455 AVAILABLE OPTIONS

| T <sub>A</sub>                                 | PACKAGED DEVICES                  |                          |                            |
|------------------------------------------------|-----------------------------------|--------------------------|----------------------------|
|                                                | SMALL OUTLINE<br>(D) <sup>†</sup> | PLASTIC DIP<br>(N)       | TSSOP<br>(PW) <sup>†</sup> |
| 0°C to 70°C                                    | TLV2454CD<br>TLV2455CD            | TLV2454CN<br>TLV2455CN   | TLV2454CPW<br>TLV2455CPW   |
| $-40^{\circ}\text{C}$ to $125^{\circ}\text{C}$ | TLV2454ID<br>TLV2455ID            | TLV2454IN<br>TLV2455IN   | TLV2454IPW<br>TLV2455IPW   |
|                                                | TLV2454AID<br>TLV2455AID          | TLV2454AIN<br>TLV2455AIN | TLV2454AIPW<br>TLV2455AIPW |

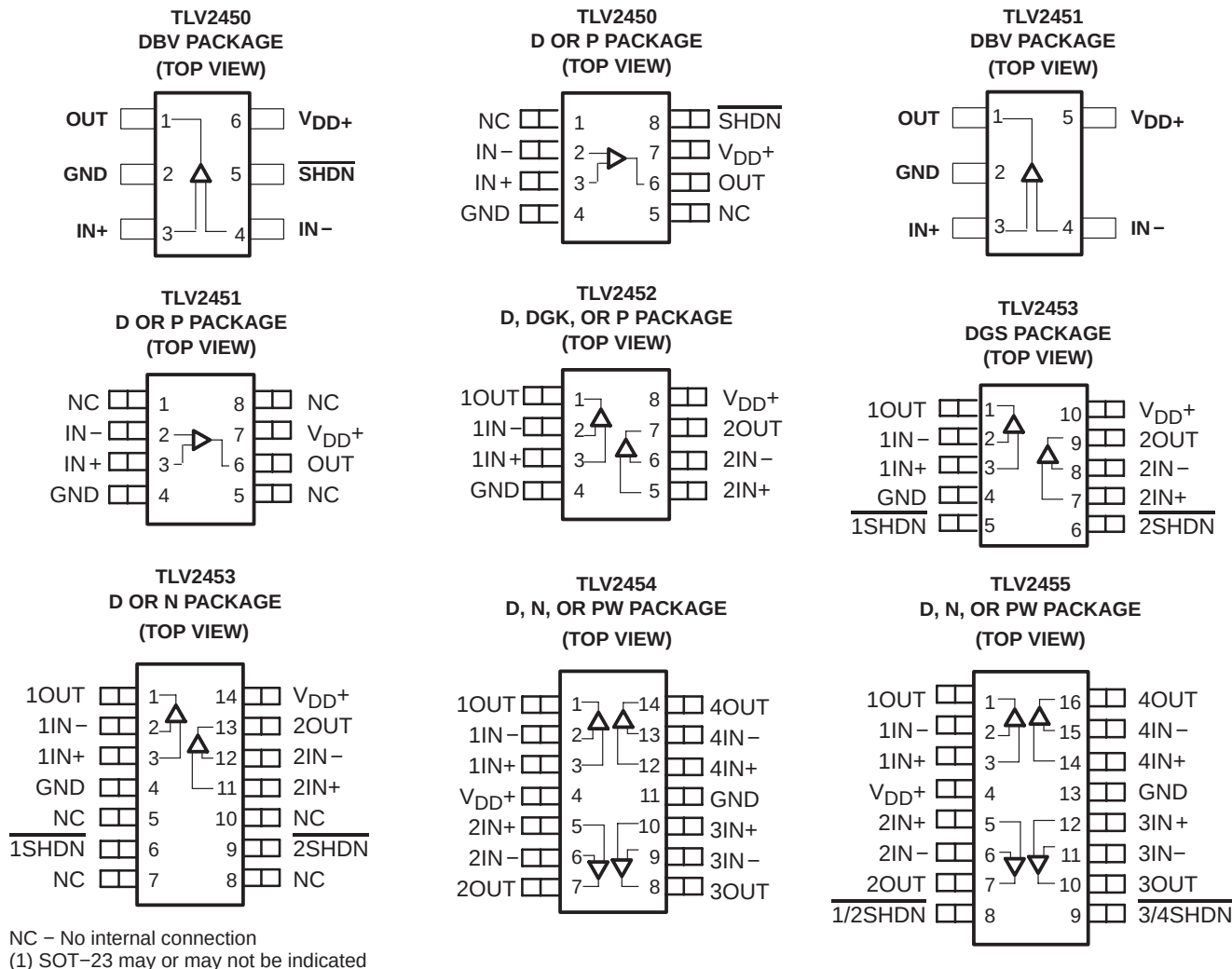
<sup>†</sup> This package is available taped and reeled. To order this packaging option, add an R suffix to the part number (e.g., TLV2454CDR).

**NOTE:** For the most current package and ordering information, see the Package Option Addendum located at the end of this data sheet, or refer to our web site at [www.ti.com](http://www.ti.com).

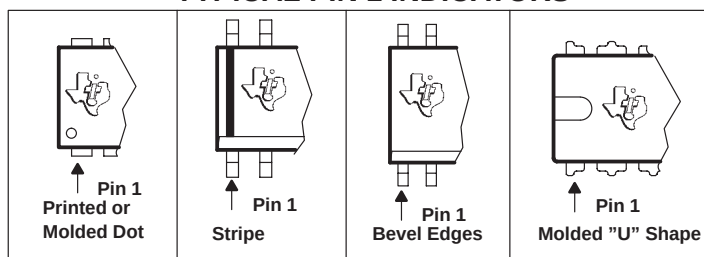
# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## TLV245x PACKAGE PINOUTS<sup>(1)</sup>



## TYPICAL PIN 1 INDICATORS



# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

### OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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

|                                                              |                              |
|--------------------------------------------------------------|------------------------------|
| Supply voltage, $V_{DD}$ (see Note 1)                        | 7 V                          |
| Differential input voltage, $V_{ID}$                         | $\pm V_{DD}$                 |
| Continuous total power dissipation                           | See Dissipation Rating Table |
| Operating free-air temperature range, $T_A$ : C suffix       | 0°C to 70°C                  |
| I suffix                                                     | –40°C to 125°C               |
| Maximum junction temperature, $T_J$                          | 150°C                        |
| Storage temperature range, $T_{stg}$                         | –65°C to 150°C               |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 260°C                        |

<sup>†</sup> 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.

**NOTE:** All voltage values, except differential voltages, are with respect to GND.

DISSIPATION RATING TABLE

| PACKAGE    | $\theta_{JC}$<br>(°C/W) | $\theta_{JA}$<br>(°C/W) | $T_A \leq 25^\circ\text{C}$<br>POWER RATING |
|------------|-------------------------|-------------------------|---------------------------------------------|
| D (8)      | 38.3                    | 176                     | 710 mW                                      |
| D (14)     | 26.9                    | 122.3                   | 1022 mW                                     |
| D (16)     | 25.7                    | 114.7                   | 1090 mW                                     |
| DBV (5)    | 55                      | 324.1                   | 385 mW                                      |
| DBV (6)    | 55                      | 294.3                   | 425 mW                                      |
| DGK (8)    | 54.2                    | 259.9                   | 481 mW                                      |
| DGS (10)   | 54.1                    | 257.7                   | 485 mW                                      |
| N (14, 16) | 32                      | 78                      | 1600 mW                                     |
| P (8)      | 41                      | 104                     | 1200 mW                                     |
| PW (14)    | 29.3                    | 173.6                   | 720 mW                                      |
| PW (16)    | 28.7                    | 161.4                   | 774 mW                                      |

#### recommended operating conditions

|                                            |               | MIN           | MAX      | UNIT |
|--------------------------------------------|---------------|---------------|----------|------|
| Supply voltage, $V_{DD}$                   | Single supply | 2.7           | 6        | V    |
|                                            | Split supply  | $\pm 1.35$    | $\pm 3$  |      |
| Common-mode input voltage range, $V_{ICR}$ |               | 0             | $V_{DD}$ | V    |
| Operating free-air temperature, $T_A$      | C-suffix      | 0             | 70       | °C   |
|                                            | I-suffix      | –40           | 125      |      |
| Shutdown on/off voltage level <sup>‡</sup> | $V_{IH}$      |               | 2        | V    |
|                                            | $V_{IL}$      | $V_{DD} = 5V$ | 0.8      |      |
|                                            |               | $V_{DD} = 3V$ | 0.5      | V    |

<sup>‡</sup> Relative to voltage on the GND terminal of the device.



**TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA**  
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**electrical characteristics at specified free-air temperature,  $V_{DD} = 3$  V (unless otherwise noted)**

| PARAMETER             |                                                                           | TEST CONDITIONS |                                                                                                      | T <sub>A</sub> <sup>†</sup>           | MIN             | TYP  | MAX  | UNIT  |    |
|-----------------------|---------------------------------------------------------------------------|-----------------|------------------------------------------------------------------------------------------------------|---------------------------------------|-----------------|------|------|-------|----|
| V <sub>IO</sub>       | Input offset voltage                                                      | TLV245x         | V <sub>DD</sub> = ±1.5 V<br>V <sub>IC</sub> = 0,<br><br>V <sub>O</sub> = 0,<br>R <sub>S</sub> = 50 Ω | 25°C                                  | 300             |      | 1500 | μV    |    |
|                       |                                                                           | Full range      |                                                                                                      | 2000                                  |                 |      |      |       |    |
|                       | TLV245xA                                                                  | 25°C            |                                                                                                      | 300                                   |                 | 1000 |      |       |    |
|                       | Full range                                                                | 1300            |                                                                                                      |                                       |                 |      |      |       |    |
| α <sub>VIO</sub>      | Temperature coefficient of input offset voltage                           |                 |                                                                                                      |                                       |                 | 0.3  |      | μV/°C |    |
| I <sub>IO</sub>       | Input offset current                                                      |                 |                                                                                                      |                                       | 25°C            | 0.3  |      | 4.5   | nA |
|                       |                                                                           |                 |                                                                                                      | Full range                            | 5.5             |      |      |       |    |
| I <sub>IB</sub>       | Input bias current                                                        |                 |                                                                                                      |                                       | 25°C            | 0.9  |      | 5     | nA |
|                       |                                                                           |                 | Full range                                                                                           | 7                                     |                 |      |      |       |    |
| V <sub>OH</sub>       | High-level output voltage                                                 |                 | V <sub>IC</sub> = 1.5 V,<br><br>I <sub>OH</sub> = −500 μA                                            | 25°C                                  | 2.85            | 2.95 |      | V     |    |
|                       |                                                                           |                 |                                                                                                      | Full range                            | 2.83            |      |      |       |    |
| V <sub>OL</sub>       | Low-level output voltage                                                  |                 | V <sub>IC</sub> = 1.5 V,<br><br>I <sub>OL</sub> = 500 μA                                             | 25°C                                  | 0.09            |      | 0.16 | V     |    |
|                       |                                                                           |                 |                                                                                                      | Full range                            | 0.2             |      |      |       |    |
| I <sub>OS</sub>       | Short-circuit output current                                              |                 | Sourcing                                                                                             | 25°C                                  | 4               | 12   |      | mA    |    |
|                       |                                                                           |                 |                                                                                                      | Full range                            | 3               |      |      |       |    |
|                       |                                                                           |                 | Sinking                                                                                              | 25°C                                  | 2               | 7    |      |       |    |
|                       |                                                                           |                 |                                                                                                      | Full range                            | 1               |      |      |       |    |
| I <sub>O</sub>        | Output current                                                            |                 | V <sub>O</sub> = 0.5 V from rail                                                                     | 25°C                                  | ±4              |      | mA   |       |    |
| A <sub>VD</sub>       | Large-signal differential voltage amplification                           |                 | V <sub>O(PP)</sub> = 1 V,<br><br>R <sub>L</sub> = 10 kΩ                                              | 25°C                                  | 96              | 110  |      | dB    |    |
|                       |                                                                           |                 |                                                                                                      | Full range                            | 91              |      |      |       |    |
| r <sub>i(d)</sub>     | Differential input resistance                                             |                 |                                                                                                      | 25°C                                  | 10 <sup>9</sup> |      | Ω    |       |    |
| C <sub>IC</sub>       | Common-mode input capacitance                                             |                 | f = 10 kHz                                                                                           | 25°C                                  | 4.5             |      | pF   |       |    |
| z <sub>0</sub>        | Closed-loop output impedance                                              |                 | f = 10 kHz,<br><br>A <sub>V</sub> = 10                                                               | 25°C                                  | 80              |      | Ω    |       |    |
| CMRR                  | Common-mode rejection ratio                                               |                 | V <sub>IC</sub> = 0 to 3 V,<br>R <sub>S</sub> = 50 Ω                                                 | 25°C                                  | 70              | 80   |      | dB    |    |
|                       |                                                                           |                 |                                                                                                      | TLV245xC                              | Full range      | 66   |      | dB    |    |
| k <sub>SVR</sub>      | Supply voltage rejection ratio (ΔV <sub>DD</sub> /ΔV <sub>IO</sub> )      |                 | V <sub>DD</sub> = 2.7 V to 6 V,<br>No load                                                           | V <sub>IC</sub> = V <sub>DD</sub> /2, | 25°C            | 76   | 89   |       | dB |
|                       |                                                                           |                 |                                                                                                      |                                       | Full range      | 74   |      |       |    |
|                       |                                                                           |                 | V <sub>DD</sub> = 3 V to 5 V,<br>No load                                                             | V <sub>IC</sub> = V <sub>DD</sub> /2, | 25°C            | 88   | 106  |       |    |
|                       |                                                                           |                 |                                                                                                      |                                       | Full range      | 84   |      |       |    |
| I <sub>DD</sub>       | Supply current (per channel)                                              |                 | V <sub>O</sub> = 1.5 V, No load                                                                      |                                       | 25°C            | 23   |      | 35    | μA |
|                       |                                                                           |                 |                                                                                                      | TLV245xC                              | Full range      | 40   |      |       |    |
|                       |                                                                           |                 |                                                                                                      | TLV245xI                              | Full range      | 45   |      |       |    |
| I <sub>DD(SHDN)</sub> | Supply current in shutdown mode (TLV2450, TLV2453, TLV2455) (per channel) |                 | $\overline{\text{SHDN}}$ = −V <sub>DD</sub>                                                          |                                       | 25°C            | 12   |      | 65    | nA |
|                       |                                                                           |                 |                                                                                                      | TLV245xC                              | Full range      | 70   |      |       |    |
|                       |                                                                           |                 |                                                                                                      | TLV245xI                              | Full range      | 80   |      |       |    |

$^\dagger$  Full range is 0°C to 70°C for C suffix and –40°C to 125°C for I suffix.



**TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA**  
**FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT**  
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operating characteristics at specified free-air temperature,  $V_{DD} = 3\text{ V}$  (unless otherwise noted)

| PARAMETER   |                                      | TEST CONDITIONS                                                                                             | $T_A^\dagger$                   | MIN  | TYP   | MAX | UNIT                   |
|-------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------------------|------|-------|-----|------------------------|
| SR          | Slew rate at unity gain              | $V_{O(PP)} = 0.8\text{ V}$ ,<br>$R_L = 10\text{ k}\Omega$                                                   | $C_L = 150\text{ pF}$ ,<br>25°C | 0.05 | 0.11  |     | V/ $\mu$ s             |
|             |                                      |                                                                                                             | Full range                      | 0.02 |       |     |                        |
| $V_n$       | Equivalent input noise voltage       | $f = 100\text{ Hz}$                                                                                         | 25°C                            |      | 49    |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                      | $f = 1\text{ kHz}$                                                                                          | 25°C                            |      | 51    |     |                        |
| $I_n$       | Equivalent input noise current       | $f = 1\text{ kHz}$                                                                                          | 25°C                            |      | 3.5   |     | pA/ $\sqrt{\text{Hz}}$ |
| THD + N     | Total harmonic distortion plus noise | $V_{O(PP)} = 1.5\text{ V}$ ,<br>$R_L = 10\text{ k}\Omega$ ,<br>$f = 1\text{ kHz}$                           | $A_V = 1$                       |      | 0.04% |     |                        |
|             |                                      |                                                                                                             | $A_V = 10$                      |      | 0.3%  |     |                        |
|             |                                      |                                                                                                             | $A_V = 100$                     |      | 1.5%  |     |                        |
| $t_{(on)}$  | Amplifier turnon time                | $A_V = 5$ ,<br>$R_L = \text{OPEN}$ ,<br>Measured at 50% point                                               | 25°C                            |      | 59    |     | $\mu$ s                |
| $t_{(off)}$ | Amplifier turnoff time               |                                                                                                             | 25°C                            |      | 836   |     | ns                     |
|             | Gain-bandwidth product               | $f = 10\text{ kHz}$ ,<br>$R_L = 10\text{ k}\Omega$                                                          | 25°C                            |      | 200   |     | kHz                    |
| $t_s$       | Settling time                        | $V(\text{STEP})_{PP} = 2\text{ V}$ ,<br>$A_V = -1$ ,<br>$C_L = 10\text{ pF}$ ,<br>$R_L = 10\text{ k}\Omega$ | 0.1%                            |      | 26    |     | $\mu$ s                |
|             |                                      |                                                                                                             | 0.01%                           |      | 31    |     |                        |
|             |                                      | $V(\text{STEP})_{PP} = 2\text{ V}$ ,<br>$A_V = -1$ ,<br>$C_L = 56\text{ pF}$ ,<br>$R_L = 10\text{ k}\Omega$ | 0.1%                            |      | 26    |     |                        |
|             |                                      |                                                                                                             | 0.01%                           |      | 31    |     |                        |
| $\phi_m$    | Phase margin                         | $R_L = 10\text{ k}\Omega$ ,<br>$C_L = 1000\text{ pF}$                                                       | 25°C                            |      | 56°   |     |                        |
|             | Gain margin                          | $R_L = 10\text{ k}\Omega$ ,<br>$C_L = 1000\text{ pF}$                                                       | 25°C                            |      | 7     |     | dB                     |

$^\dagger$  Full range is 0°C to 70°C for C suffix and -40°C to 125°C for I suffix.

**TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA**  
**FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT**  
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**electrical characteristics at specified free-air temperature,  $V_{DD} = 5$  V (unless otherwise noted)**

| PARAMETER             |                                                                              | TEST CONDITIONS                                      |                                                                                                      | T <sub>A</sub> <sup>†</sup> | MIN             | TYP  | MAX  | UNIT |       |
|-----------------------|------------------------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------|-----------------|------|------|------|-------|
| V <sub>IO</sub>       | Input offset voltage                                                         | TLV245x                                              | V <sub>DD</sub> = ±2.5 V<br>V <sub>IC</sub> = 0,<br><br>V <sub>O</sub> = 0,<br>R <sub>S</sub> = 50 Ω | 25°C                        | 300             |      | 1500 | μV   |       |
|                       |                                                                              |                                                      |                                                                                                      | Full range                  | 2000            |      |      |      |       |
|                       |                                                                              |                                                      |                                                                                                      | TLV245xA                    | 25°C            | 300  |      |      | 1000  |
|                       |                                                                              |                                                      |                                                                                                      |                             | Full range      | 1300 |      |      |       |
| α <sub>VIO</sub>      | Temperature coefficient of input offset voltage                              |                                                      |                                                                                                      |                             |                 | 0.3  |      |      | μV/°C |
| I <sub>IO</sub>       | Input offset current                                                         |                                                      |                                                                                                      |                             | 25°C            | 0.3  |      | 4.5  | nA    |
|                       |                                                                              |                                                      |                                                                                                      |                             | Full range      | 5.5  |      |      |       |
| I <sub>IB</sub>       | Input bias current                                                           |                                                      |                                                                                                      |                             | 25°C            | 0.5  |      | 5    | nA    |
|                       |                                                                              |                                                      |                                                                                                      | Full range                  | 7               |      |      |      |       |
| V <sub>OH</sub>       | High-level output voltage                                                    | V <sub>IC</sub> = 2.5 V,                             | I <sub>OH</sub> = -500 μA                                                                            | 25°C                        | 4.87            | 4.97 |      | V    |       |
|                       |                                                                              |                                                      |                                                                                                      | Full range                  | 4.85            |      |      |      |       |
| V <sub>OL</sub>       | Low-level output voltage                                                     | V <sub>IC</sub> = 2.5 V,                             | I <sub>OL</sub> = 500 μA                                                                             | 25°C                        | 0.07            |      | 0.15 | V    |       |
|                       |                                                                              |                                                      |                                                                                                      | Full range                  | 0.16            |      |      |      |       |
| I <sub>OS</sub>       | Short-circuit output current                                                 | Sourcing                                             |                                                                                                      | 25°C                        | 20              | 32   |      | mA   |       |
|                       |                                                                              |                                                      |                                                                                                      | Full range                  | 18              |      |      |      |       |
|                       |                                                                              | Sinking                                              |                                                                                                      | 25°C                        | 12              | 18   |      |      |       |
|                       |                                                                              |                                                      |                                                                                                      | Full range                  | 10              |      |      |      |       |
| I <sub>O</sub>        | Output current                                                               | V <sub>O</sub> = 0.5 V from rail                     |                                                                                                      | 25°C                        | ±10             |      | mA   |      |       |
| A <sub>VD</sub>       | Large-signal differential voltage amplification                              | V <sub>O(PP)</sub> = 3 V,                            | R <sub>L</sub> = 10 kΩ                                                                               | 25°C                        | 96              | 103  |      | dB   |       |
|                       |                                                                              |                                                      |                                                                                                      | Full range                  | 91              |      |      |      |       |
| r <sub>i(d)</sub>     | Differential input resistance                                                |                                                      |                                                                                                      | 25°C                        | 10 <sup>9</sup> |      | Ω    |      |       |
| C <sub>IC</sub>       | Common-mode input capacitance                                                | f = 10 kHz                                           |                                                                                                      | 25°C                        | 4.5             |      | pF   |      |       |
| z <sub>O</sub>        | Closed-loop output impedance                                                 | f = 10 kHz,                                          | A <sub>V</sub> = 10                                                                                  | 25°C                        | 45              |      | Ω    |      |       |
| CMRR                  | Common-mode rejection ratio                                                  | V <sub>IC</sub> = 0 to 5 V,<br>R <sub>S</sub> = 50 Ω |                                                                                                      | 25°C                        | 70              | 80   |      | dB   |       |
|                       |                                                                              |                                                      | TLV245xC                                                                                             | Full range                  | 68              |      |      |      |       |
| k <sub>SVR</sub>      | Supply voltage rejection ratio<br>(ΔV <sub>DD</sub> /ΔV <sub>IO</sub> )      | V <sub>DD</sub> = 2.7 V to 6 V,<br>No load           | V <sub>IC</sub> = V <sub>DD</sub> /2,                                                                | 25°C                        | 76              | 89   |      | dB   |       |
|                       |                                                                              |                                                      |                                                                                                      | Full range                  | 74              |      |      |      |       |
|                       |                                                                              | V <sub>DD</sub> = 3 V to 5 V,<br>No load             | V <sub>IC</sub> = V <sub>DD</sub> /2,                                                                | 25°C                        | 88              | 106  |      |      |       |
|                       |                                                                              |                                                      |                                                                                                      | Full range                  | 84              |      |      |      |       |
| I <sub>DD</sub>       | Supply current (per channel)                                                 | V <sub>O</sub> = 2.5 V, No load                      |                                                                                                      | 25°C                        | 23              |      | 42   | μA   |       |
|                       |                                                                              |                                                      | TLV245xC                                                                                             | Full range                  | 44              |      |      |      |       |
|                       |                                                                              |                                                      | TLV245xI                                                                                             | Full range                  | 46              |      |      |      |       |
| I <sub>DD(SHDN)</sub> | Supply current in shutdown mode<br>(TLV2450, TLV2453, TLV2455) (per channel) | $\overline{\text{SHDN}}$ = -V <sub>DD</sub>          |                                                                                                      | 25°C                        | 16              |      | 70   | nA   |       |
|                       |                                                                              |                                                      | TLV245xC                                                                                             | Full range                  | 70              |      |      |      |       |
|                       |                                                                              |                                                      | TLV245xI                                                                                             | Full range                  | 80              |      |      |      |       |

$^\dagger$  Full range is 0°C to 70°C for C suffix and –40°C to 125°C for I suffix.



**TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA**  
**FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT**  
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operating characteristics at specified free-air temperature,  $V_{DD} = 5$  V (unless otherwise noted)

| PARAMETER              |                                      | TEST CONDITIONS                                                                                           |                          | T <sub>A</sub> <sup>†</sup> | MIN  | TYP   | MAX | UNIT   |
|------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------------|-----------------------------|------|-------|-----|--------|
| SR                     | Slew rate at unity gain              | V <sub>O(PP)</sub> = 2 V,<br>R <sub>L</sub> = 10 kΩ                                                       |                          | 25°C                        | 0.05 | 0.11  |     | V/μs   |
|                        |                                      |                                                                                                           |                          | Full range                  | 0.02 |       |     |        |
| V <sub>n</sub>         | Equivalent input noise voltage       | f = 100 Hz                                                                                                |                          | 25°C                        |      | 49    |     | nV/√Hz |
|                        |                                      | f = 1 kHz                                                                                                 |                          | 25°C                        |      | 52    |     |        |
| I <sub>n</sub>         | Equivalent input noise current       | f = 1 kHz                                                                                                 |                          | 25°C                        |      | 3.5   |     | pA/√Hz |
| THD + N                | Total harmonic distortion plus noise | V <sub>O(PP)</sub> = 3 V,<br>R <sub>L</sub> = 10 kΩ,<br>f = 1 kHz                                         | A <sub>V</sub> = 1       | 25°C                        |      | 0.02% |     |        |
|                        |                                      |                                                                                                           | A <sub>V</sub> = 10      |                             |      | 0.18% |     |        |
|                        |                                      |                                                                                                           | A <sub>V</sub> = 100     |                             |      | 0.9%  |     |        |
| t <sub>(on)</sub>      | Amplifier turnon time                | A <sub>V</sub> = 5, R <sub>L</sub> = OPEN,                                                                |                          | 25°C                        |      | 59    |     | μs     |
| t <sub>(off)</sub>     | Amplifier turnoff time               | Measured at 50% point                                                                                     |                          | 25°C                        |      | 836   |     | ns     |
| Gain-bandwidth product |                                      | f = 10 kHz,                                                                                               | R <sub>L</sub> = 10 kΩ   | 25°C                        |      | 220   |     | kHz    |
| t <sub>s</sub>         | Settling time                        | V(STEP) <sub>PP</sub> = 2 V,<br>A <sub>V</sub> = -1,<br>C <sub>L</sub> = 10 pF,<br>R <sub>L</sub> = 10 kΩ | 0.1%                     | 25°C                        |      | 24    |     | μs     |
|                        |                                      |                                                                                                           | 0.01%                    |                             |      | 30    |     |        |
|                        |                                      | V(STEP) <sub>PP</sub> = 2 V,<br>A <sub>V</sub> = -1,<br>C <sub>L</sub> = 56 pF,<br>R <sub>L</sub> = 10 kΩ | 0.1%                     |                             |      | 25    |     |        |
|                        |                                      |                                                                                                           | 0.01%                    |                             |      | 30    |     |        |
| φ <sub>m</sub>         | Phase margin                         | R <sub>L</sub> = 10 kΩ,                                                                                   | C <sub>L</sub> = 1000 pF | 25°C                        |      | 56°   |     |        |
| Gain margin            |                                      | R <sub>L</sub> = 10 kΩ,                                                                                   | C <sub>L</sub> = 1000 pF | 25°C                        |      | 7     |     | dB     |

$^\dagger$  Full range is 0°C to 70°C for C suffix and -40°C to 125°C for I suffix.



**TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA**  
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**TYPICAL CHARACTERISTICS**

**Table of Graphs**

|             |                                      |                                                         | <b>FIGURE</b> |
|-------------|--------------------------------------|---------------------------------------------------------|---------------|
| $V_{IO}$    | Input offset voltage                 | vs Common-mode input voltage                            | 1, 2          |
| $I_{IO}$    | Input offset current                 | vs Common-mode input voltage<br>vs Free-air temperature | 3, 4<br>7, 8  |
| $I_{IB}$    | Input bias current                   | vs Common-mode input voltage<br>vs Free-air temperature | 5, 6<br>7, 8  |
| $A_{VD}$    | Differential voltage amplification   | vs Frequency                                            | 9, 10         |
|             | Phase                                | vs Frequency                                            | 9, 10         |
| $V_{OL}$    | Low-level output voltage             | vs Low-level output current                             | 11, 13        |
| $V_{OH}$    | High-level output voltage            | vs High-level output current                            | 12, 14        |
| $Z_o$       | Output impedance                     | vs Frequency                                            | 15, 16        |
| CMRR        | Common-mode rejection ratio          | vs Frequency                                            | 17            |
| PSRR        | Power supply rejection ratio         | vs Frequency                                            | 18            |
| $I_{DD}$    | Supply current                       | vs Supply voltage                                       | 19            |
| $I_{DD}$    | Supply current                       | vs Free-air temperature                                 | 20            |
| $V_n$       | Equivalent input noise voltage       | vs Frequency                                            | 21            |
| THD + N     | Total harmonic distortion plus noise | vs Frequency                                            | 22, 23        |
| $\phi_m$    | Phase margin                         | vs Load capacitance                                     | 24            |
|             | Gain-bandwidth product               | vs Supply voltage                                       | 25            |
| SR          | Slew rate                            | vs Supply voltage<br>vs Free-air temperature            | 26<br>27      |
| $V_{O(PP)}$ | Maximum peak-to-peak output voltage  | vs Frequency                                            | 28            |
|             | Crosstalk                            | vs Frequency                                            | 29, 30        |
|             | Small-signal follower pulse response | vs Time                                                 | 31, 33        |
|             | Large-signal follower pulse response | vs Time                                                 | 32, 34        |
|             | Shutdown on supply current           | vs Time                                                 | 35            |
|             | Shutdown off supply current          | vs Time                                                 | 36            |
|             | Shutdown supply current              | vs Free-air temperature                                 | 37            |
|             | Shutdown supply current              | vs Time                                                 | 38 – 41       |
|             | Shutdown pulse                       | vs Time                                                 | 38 – 41       |
|             | Shutdown off pulse response          | vs Time                                                 | 42, 43        |
|             | Shutdown on pulse response           | vs Time                                                 | 44, 45        |
|             | Shutdown reverse isolation           | vs Frequency                                            | 46            |
|             | Shutdown forward isolation           | vs Frequency                                            | 47            |



# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

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#### TYPICAL CHARACTERISTICS

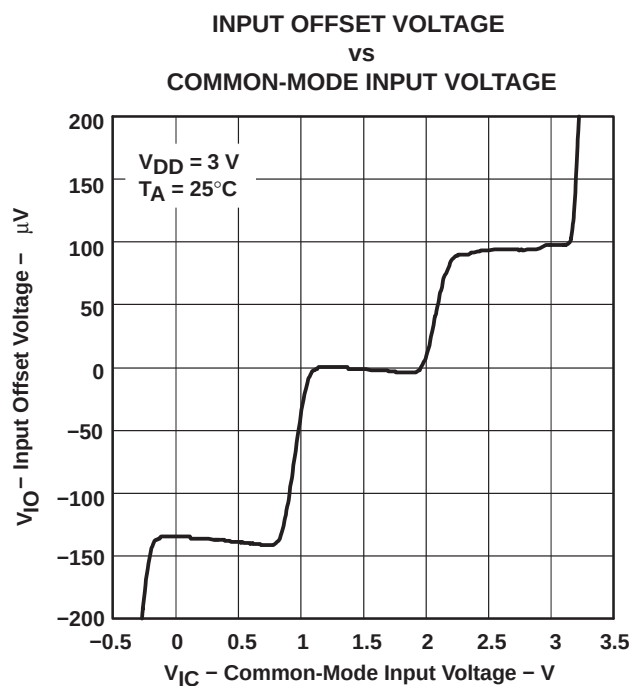


Figure 1

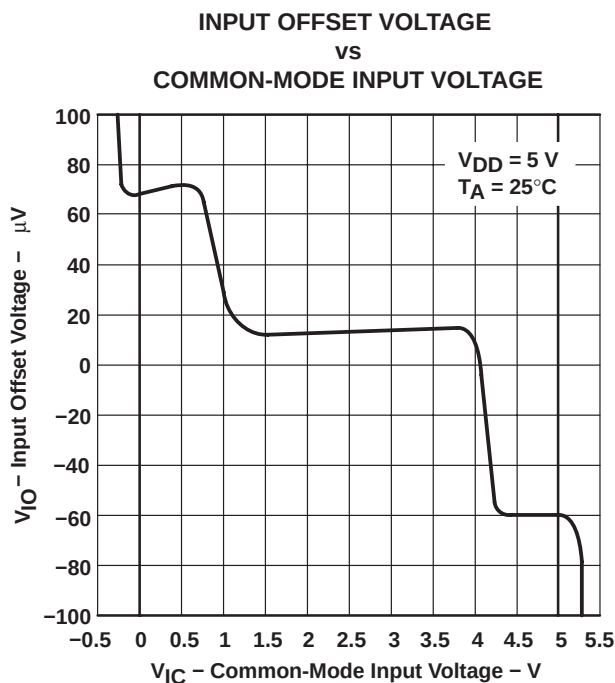


Figure 2

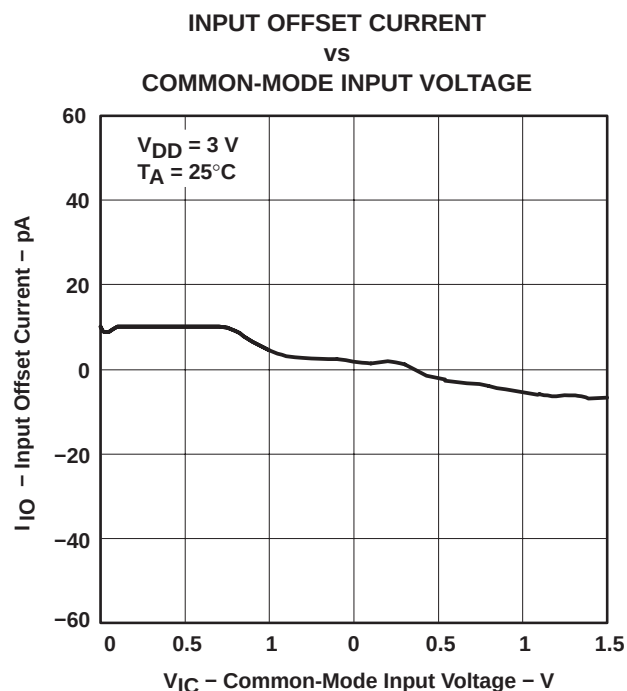


Figure 3

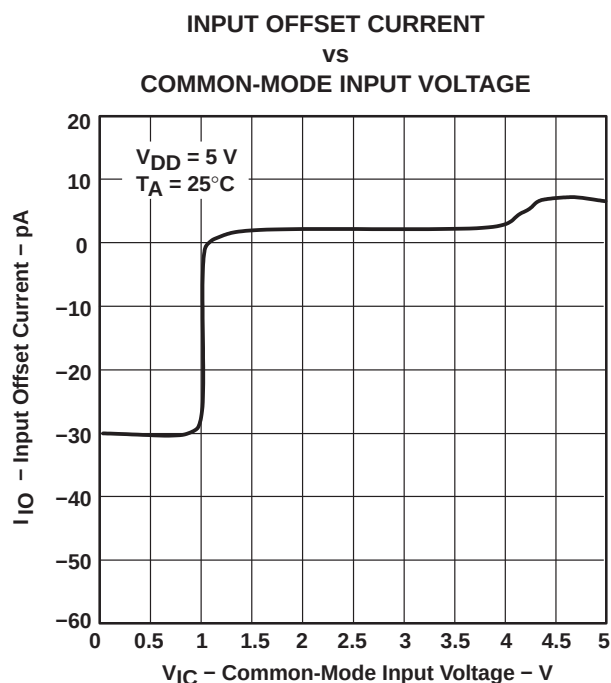


Figure 4

TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA  
FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT  
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TYPICAL CHARACTERISTICS

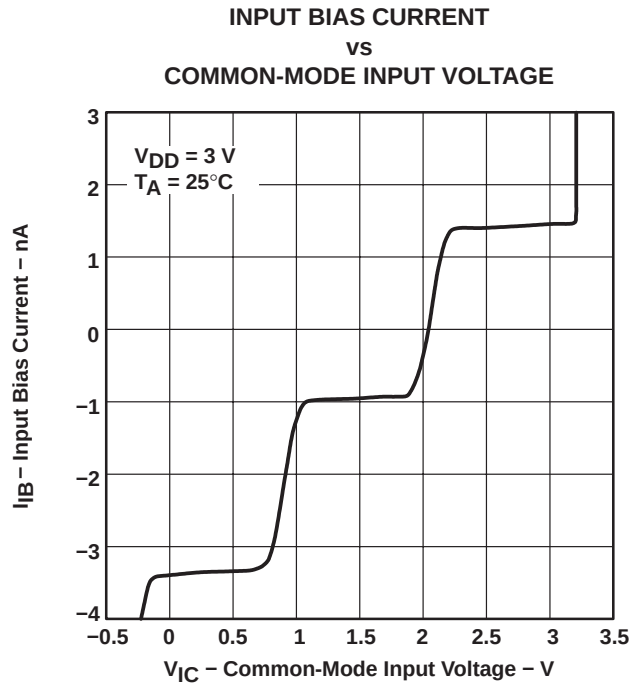


Figure 5

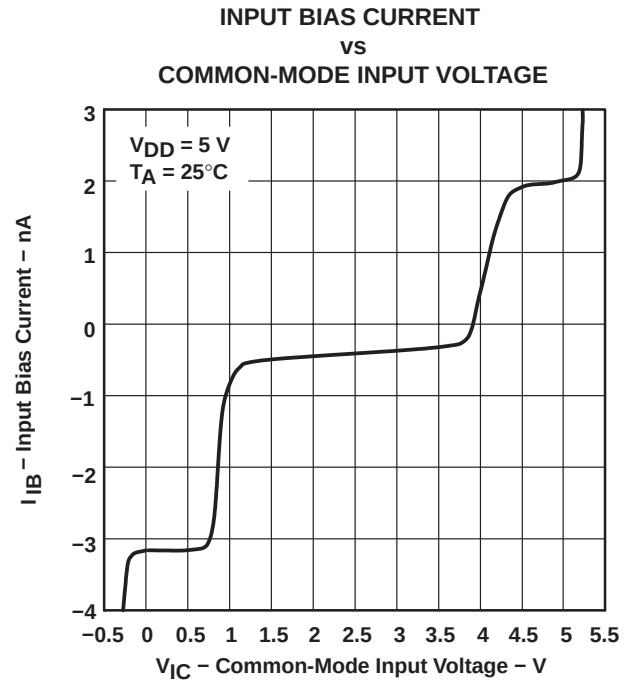


Figure 6

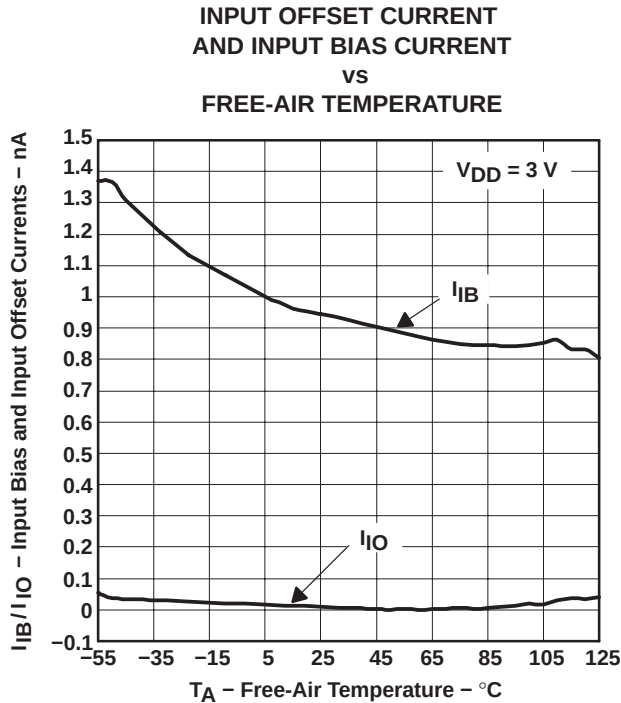


Figure 7

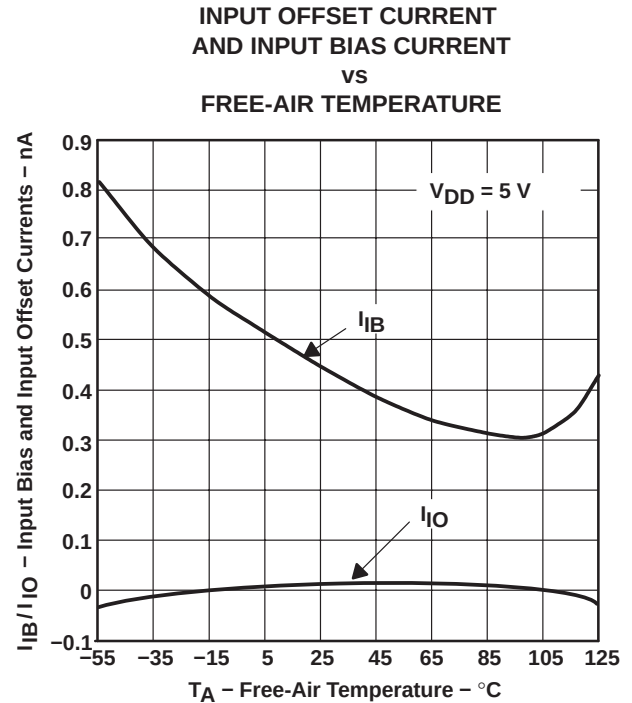


Figure 8

# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

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#### TYPICAL CHARACTERISTICS

##### DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE vs FREQUENCY

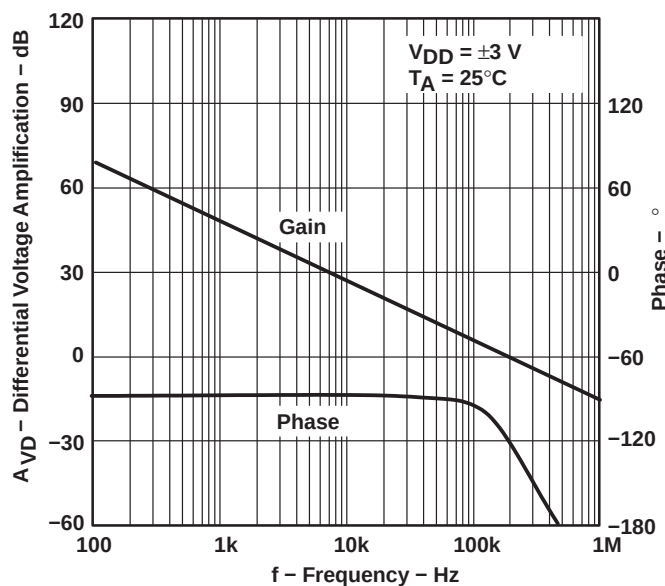


Figure 9

##### DIFFERENTIAL VOLTAGE AMPLIFICATION AND PHASE vs FREQUENCY

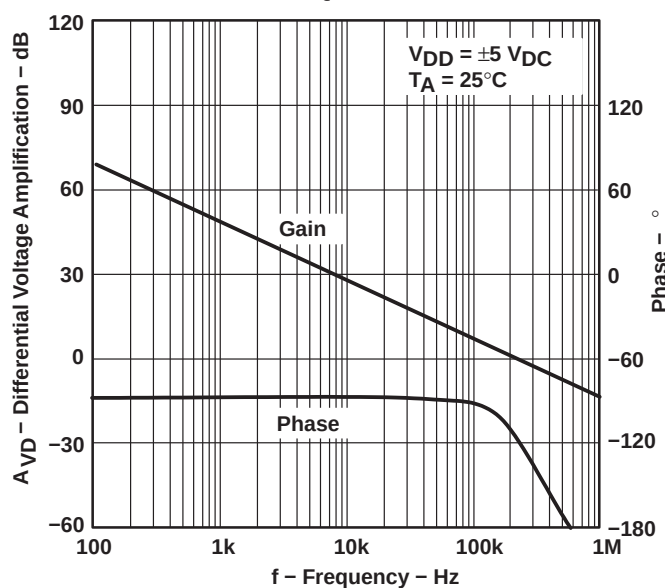


Figure 10

**TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA**  
**FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

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**TYPICAL CHARACTERISTICS**

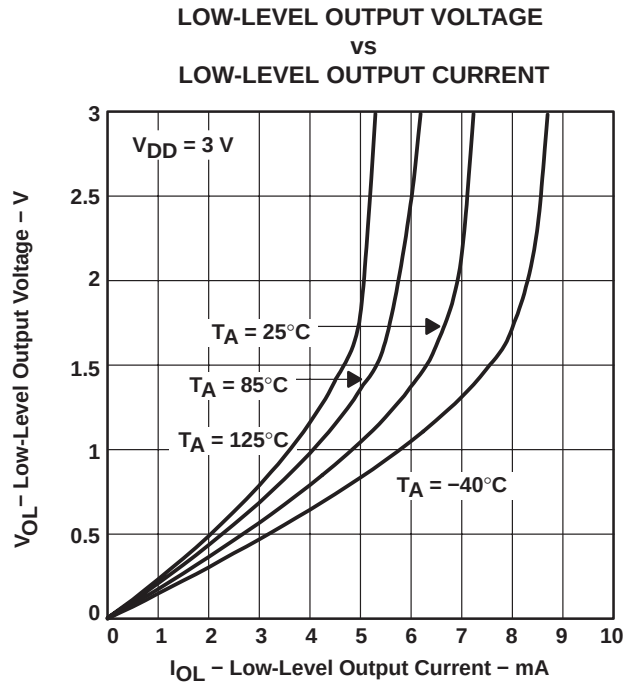


Figure 11

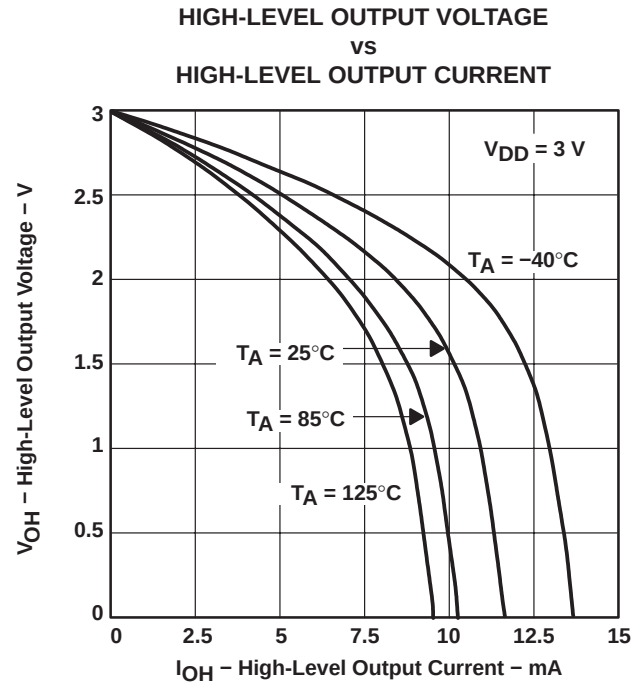


Figure 12

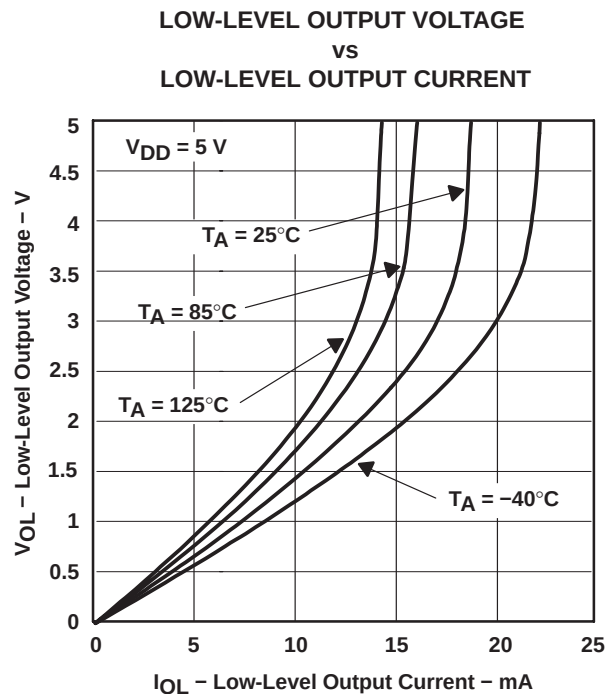


Figure 13

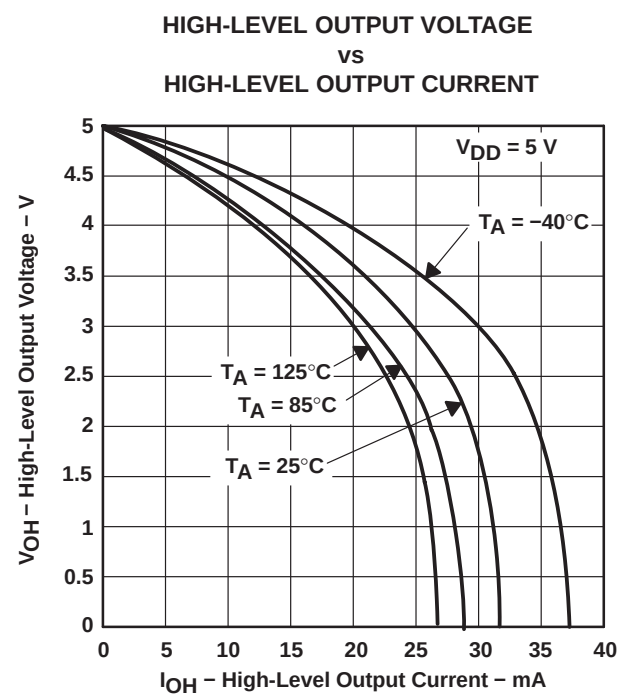


Figure 14

# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

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#### TYPICAL CHARACTERISTICS

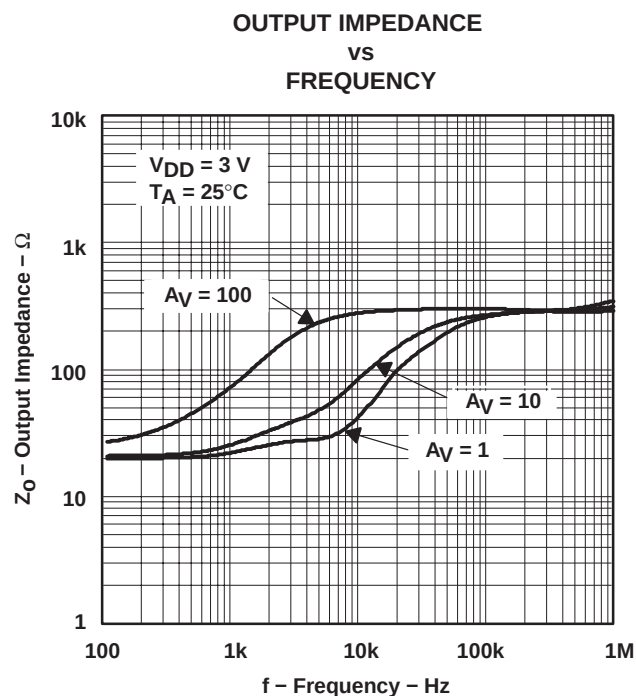


Figure 15

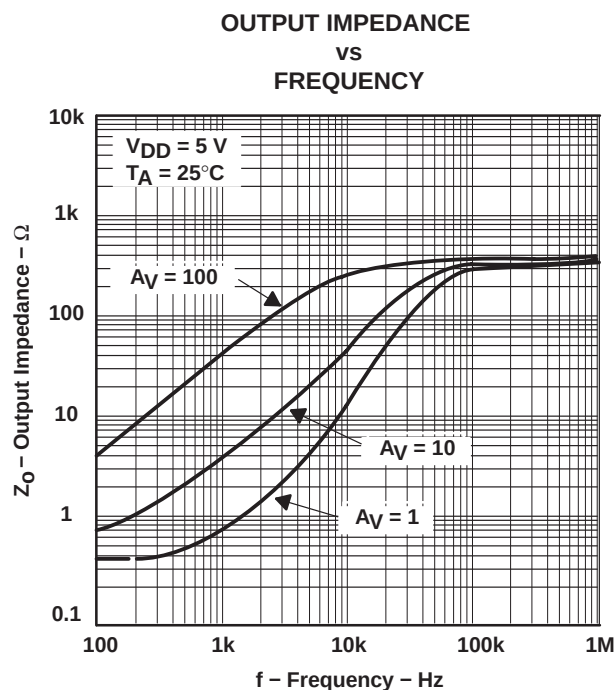


Figure 16

#### COMMON-MODE REJECTION RATIO vs FREQUENCY

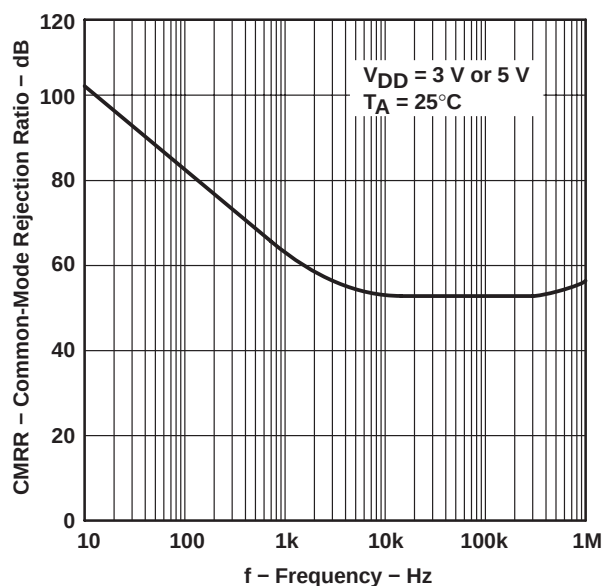


Figure 17

TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA  
FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT  
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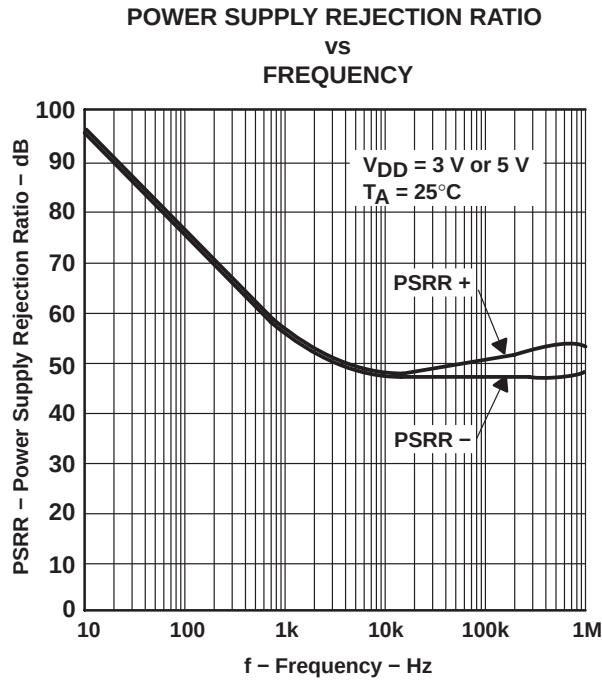


Figure 18

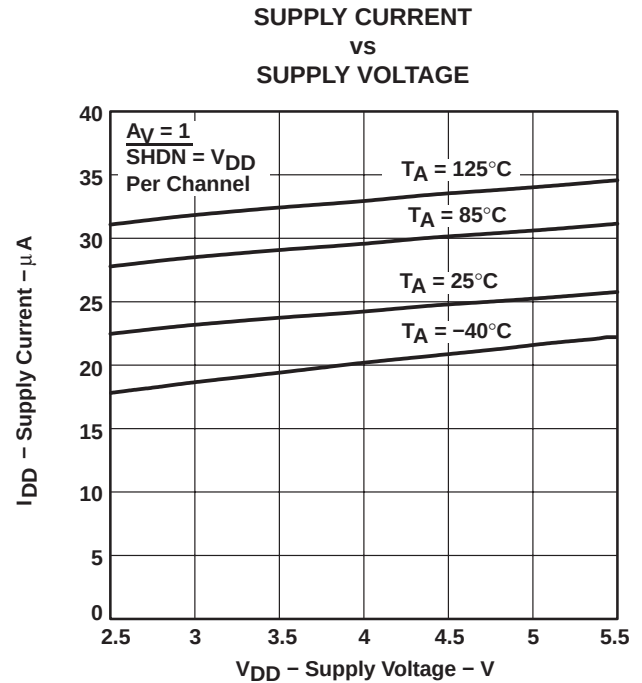


Figure 19

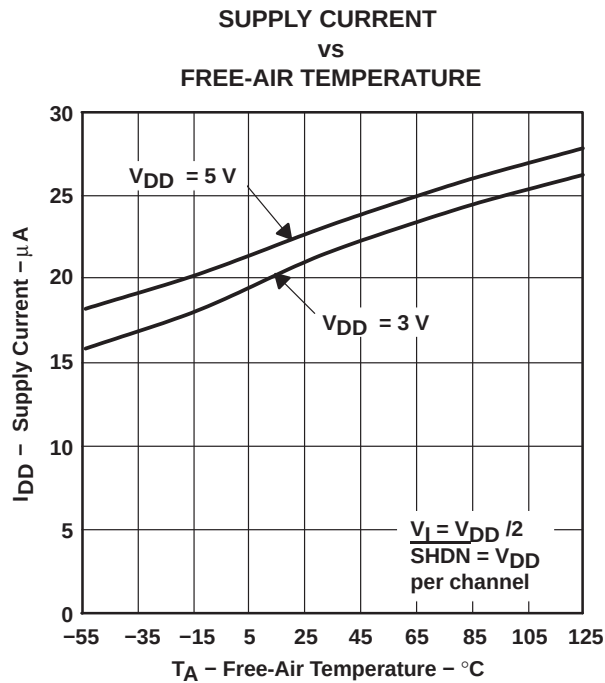


Figure 20

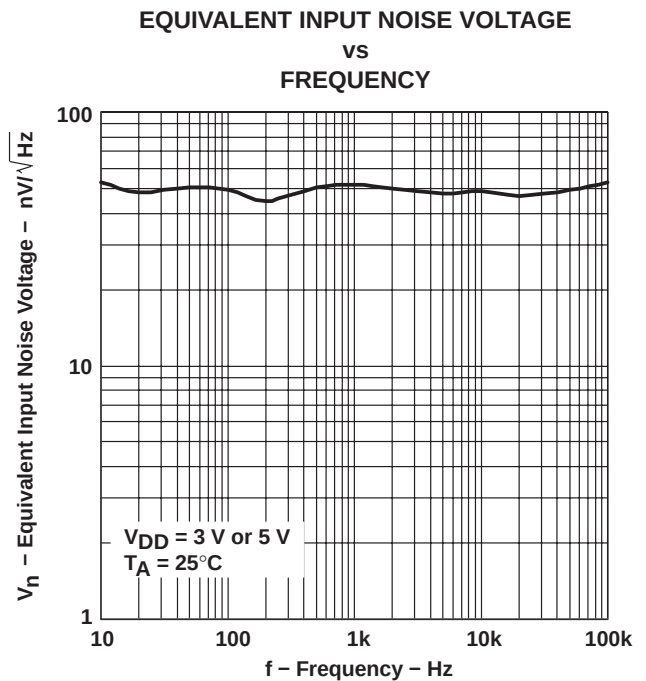


Figure 21

# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

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#### TYPICAL CHARACTERISTICS

TOTAL HARMONIC DISTORTION PLUS NOISE  
VS  
FREQUENCY

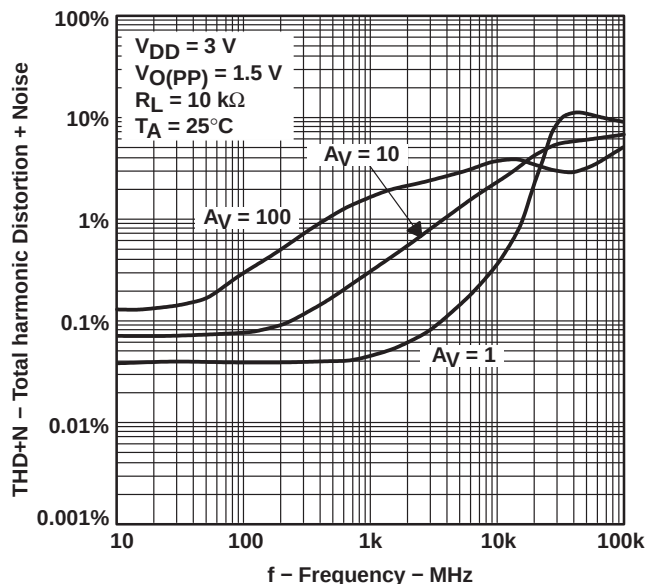


Figure 22

TOTAL HARMONIC DISTORTION PLUS NOISE  
VS  
FREQUENCY

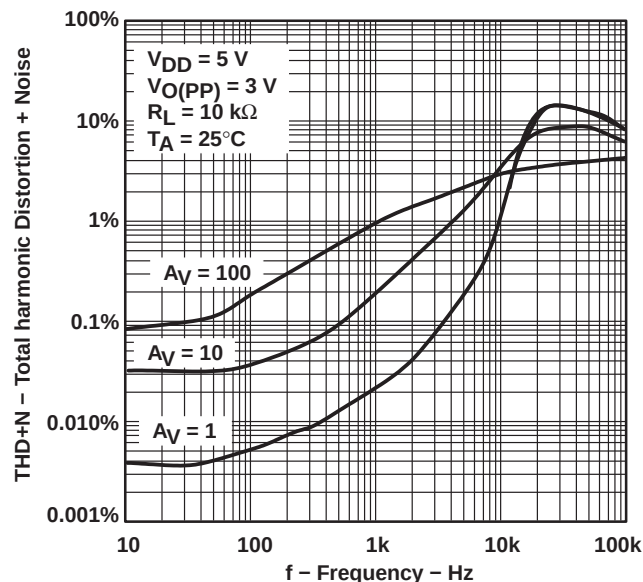


Figure 23

PHASE MARGIN  
VS  
LOAD CAPACITANCE

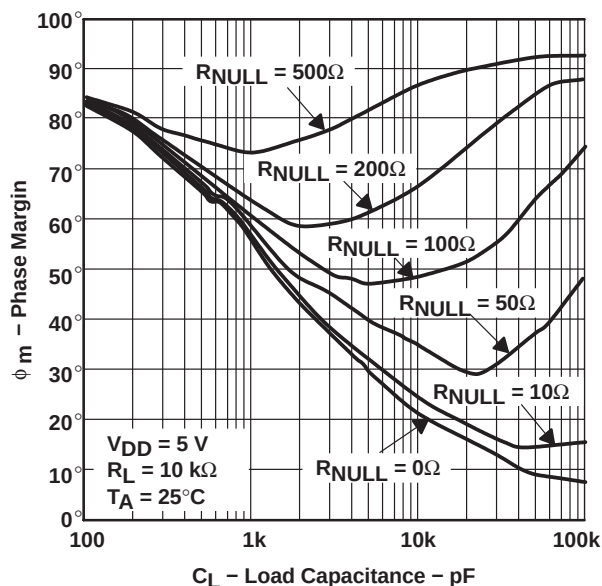


Figure 24

GAIN-BANDWIDTH PRODUCT  
VS  
SUPPLY VOLTAGE

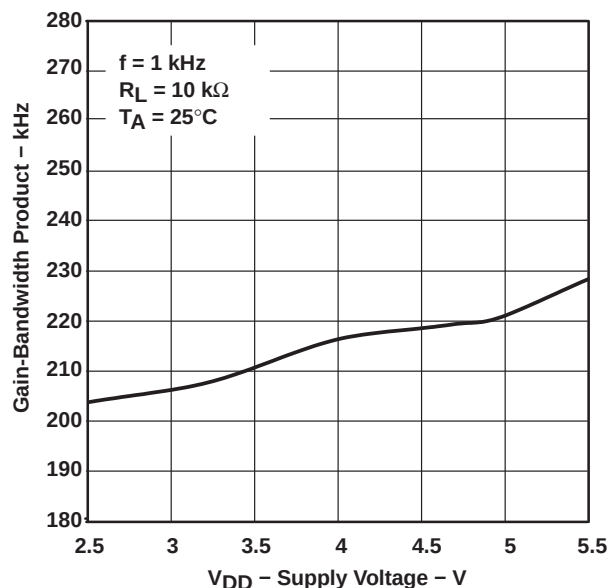


Figure 25



TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA  
FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT  
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TYPICAL CHARACTERISTICS

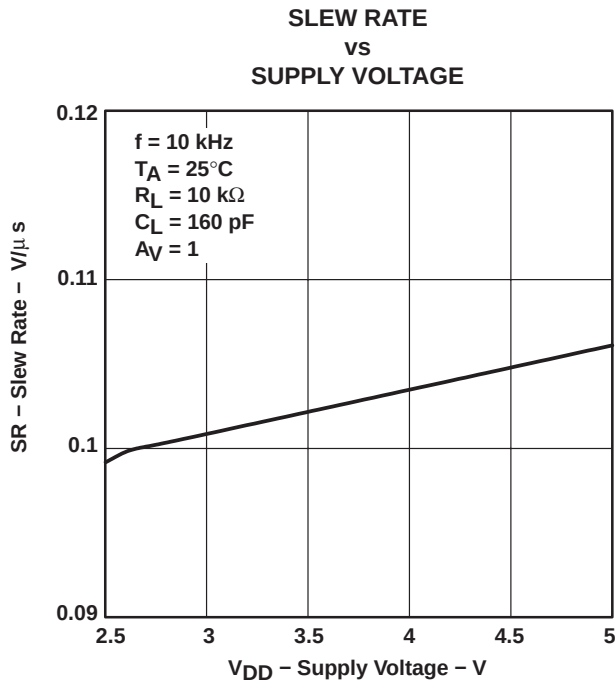


Figure 26

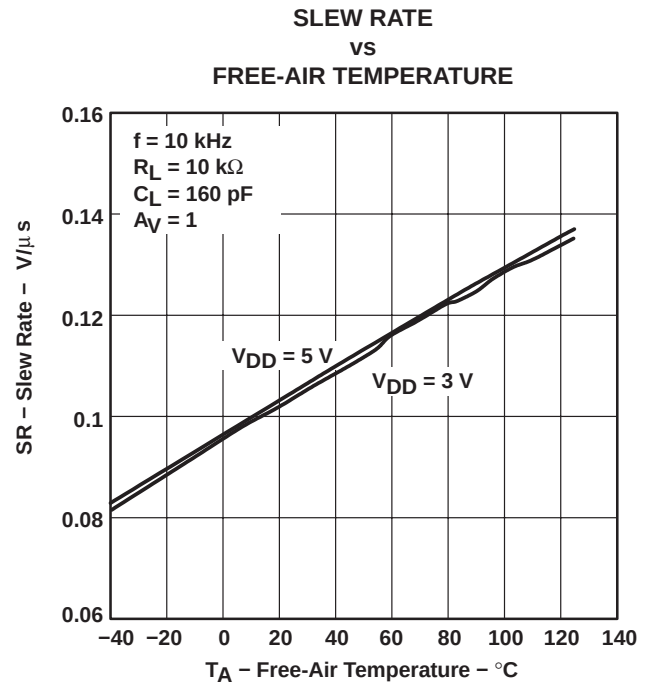


Figure 27

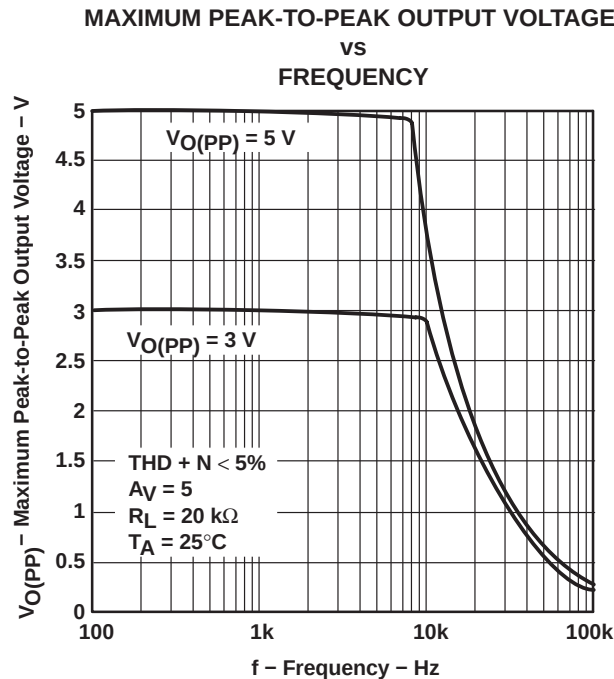


Figure 28

# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

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#### TYPICAL CHARACTERISTICS

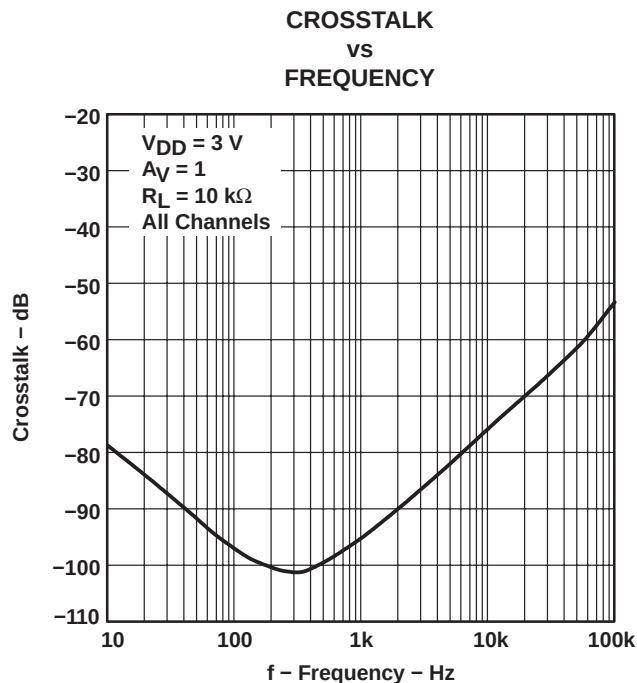


Figure 29

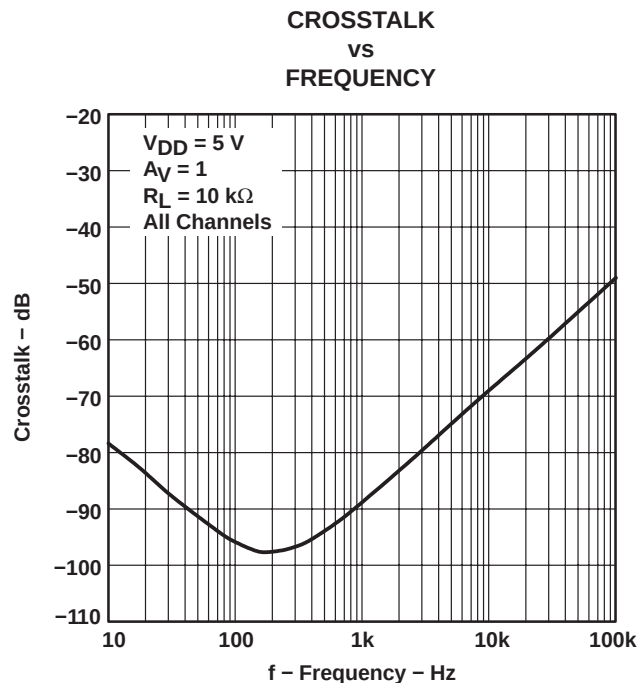


Figure 30

#### SMALL-SIGNAL FOLLOWER PULSE RESPONSE

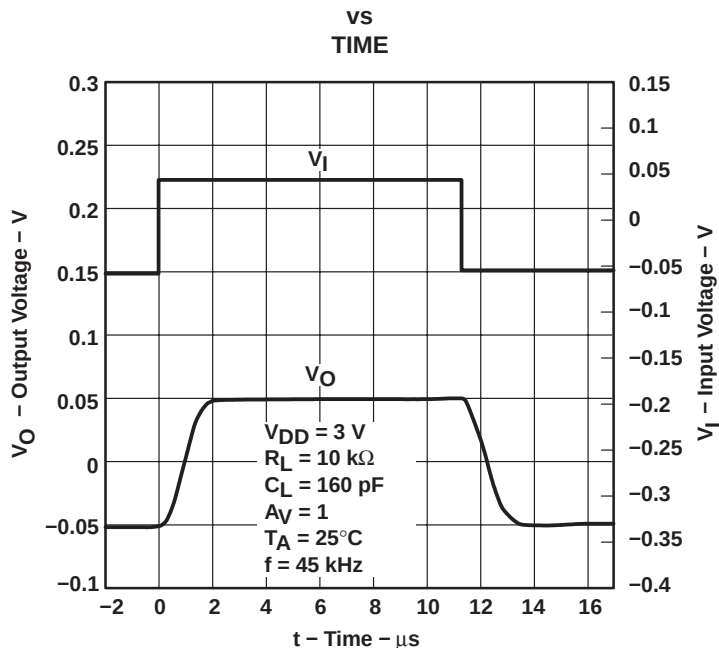


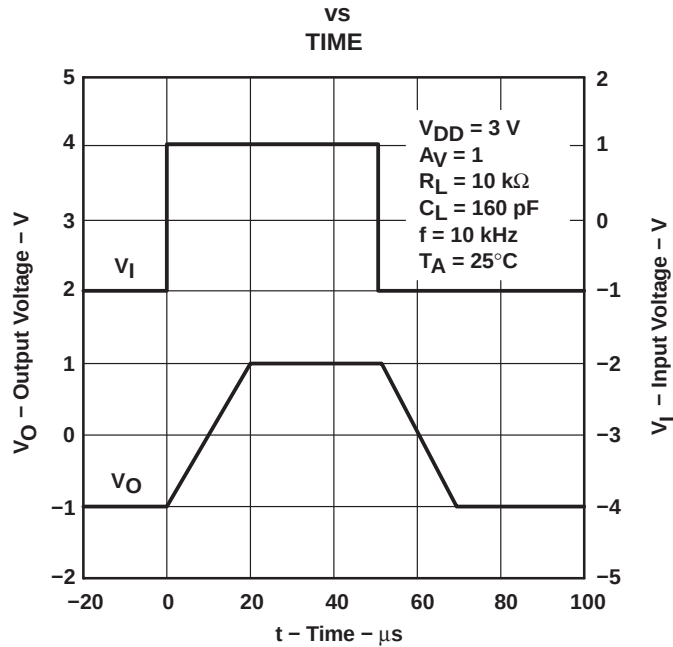
Figure 31

**TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA**  
**FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT**  
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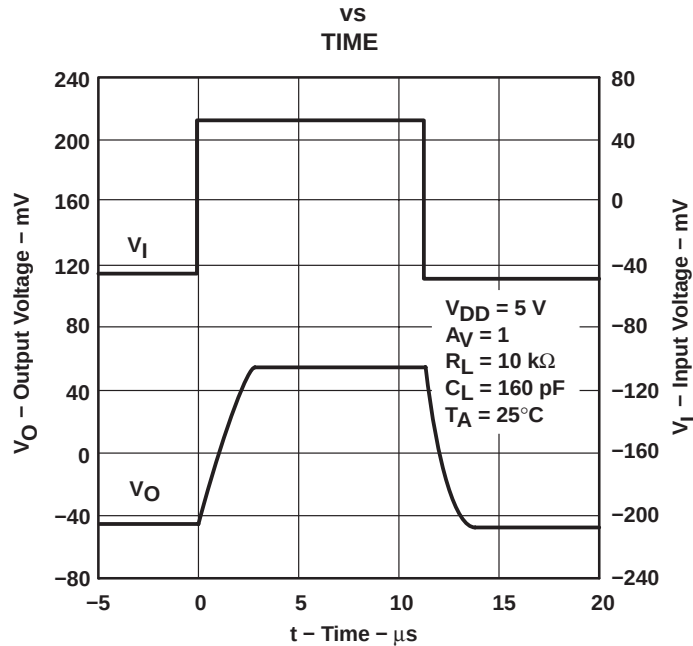
**TYPICAL CHARACTERISTICS**

**LARGE-SIGNAL FOLLOWER PULSE RESPONSE**



**Figure 32**

**SMALL-SIGNAL FOLLOWER PULSE RESPONSE**



**Figure 33**



# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

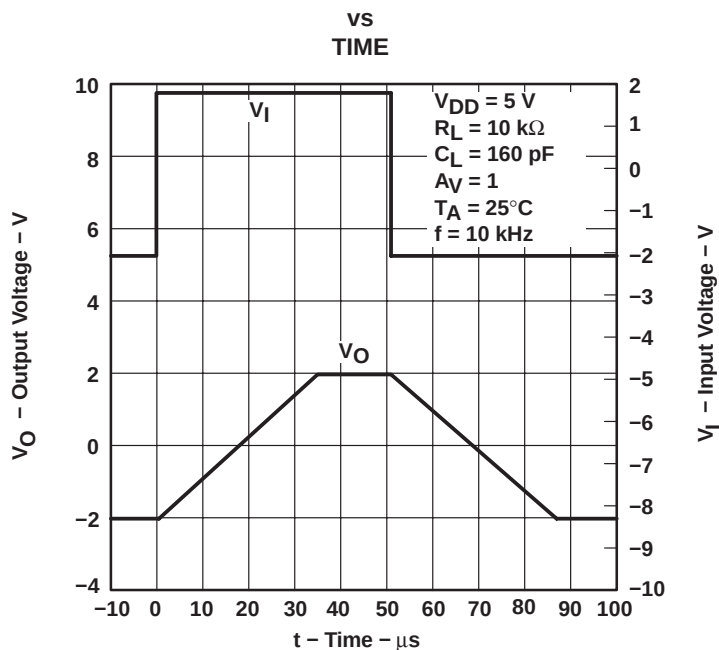
## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

### OPERATIONAL AMPLIFIERS WITH SHUTDOWN

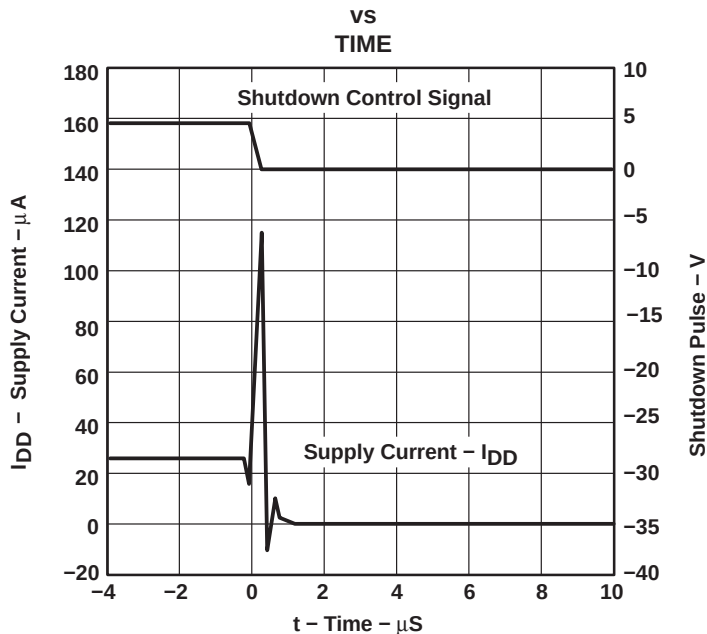
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#### TYPICAL CHARACTERISTICS

##### LARGE-SIGNAL FOLLOWER PULSE RESPONSE



##### SHUTDOWN ON SUPPLY CURRENT



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TYPICAL CHARACTERISTICS

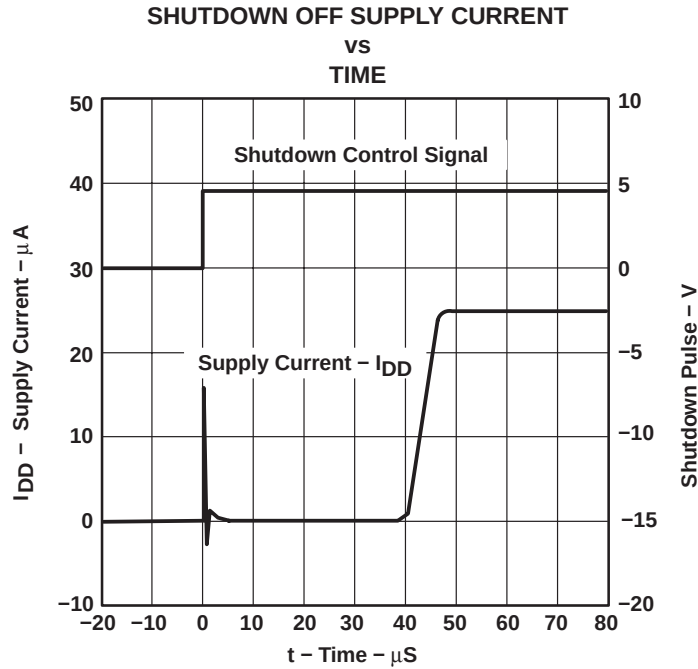


Figure 36

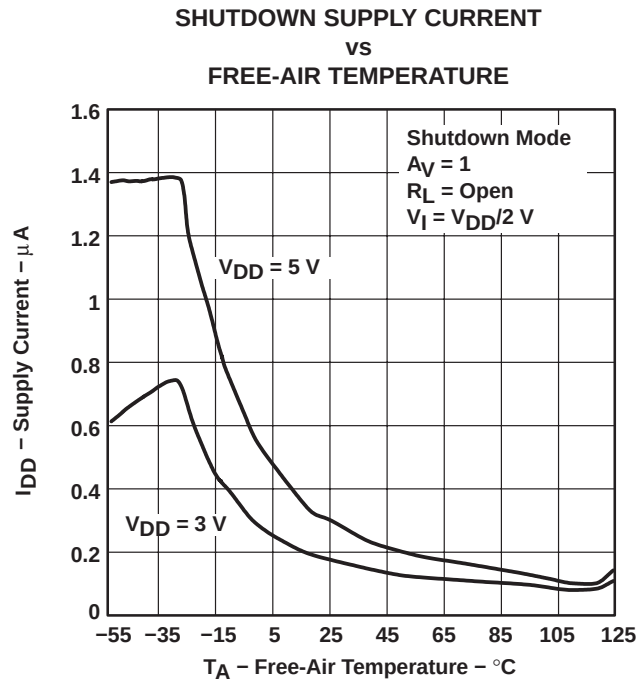


Figure 37



# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

### OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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#### TYPICAL CHARACTERISTICS

##### SHUTDOWN SUPPLY CURRENT AND SHUTDOWN PULSE VS TIME

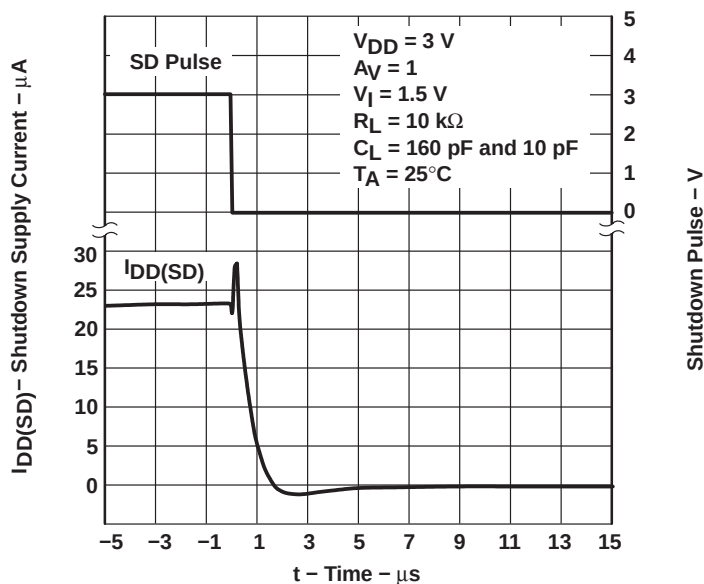


Figure 38

##### SHUTDOWN SUPPLY CURRENT AND SHUTDOWN PULSE VS TIME

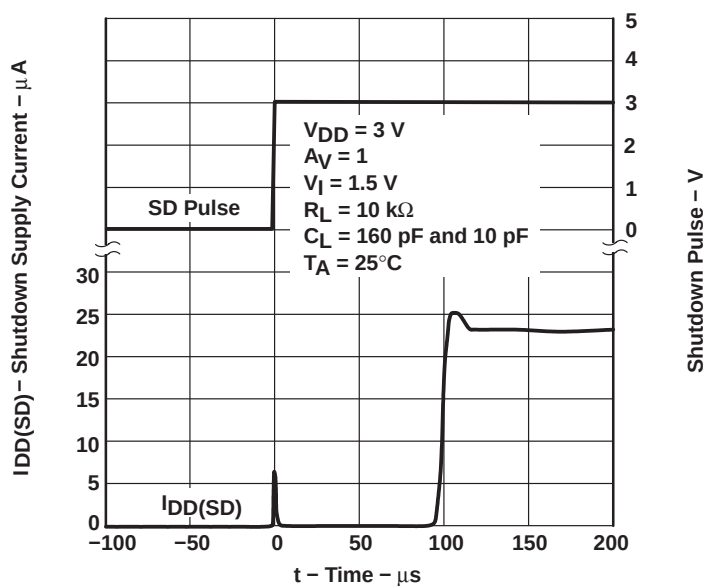


Figure 39

TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA  
FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT  
OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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TYPICAL CHARACTERISTICS

SHUTDOWN SUPPLY CURRENT AND SHUTDOWN PULSE  
vs  
TIME

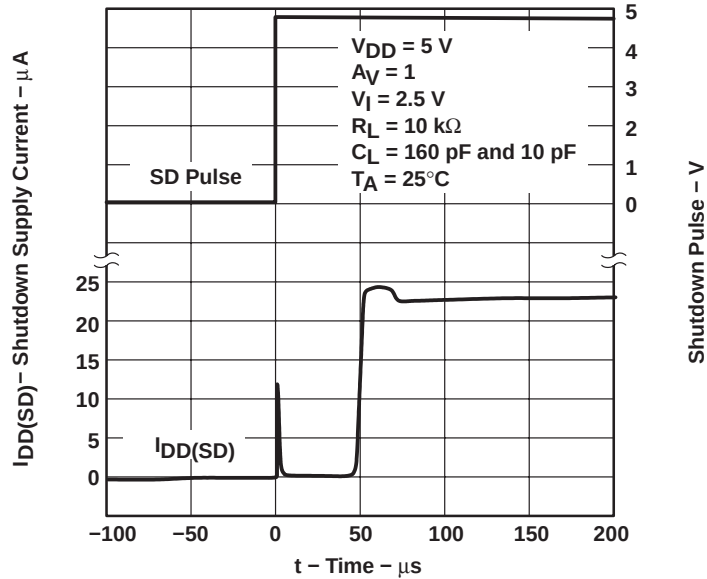


Figure 40

SHUTDOWN SUPPLY CURRENT AND SHUTDOWN PULSE  
vs  
TIME

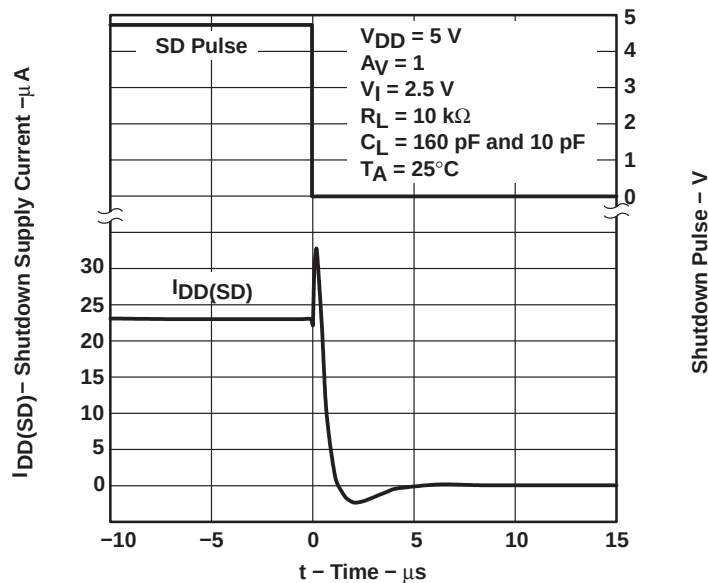


Figure 41



# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

### OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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#### TYPICAL CHARACTERISTICS

SHUTDOWN OFF PULSE RESPONSE

VS  
TIME

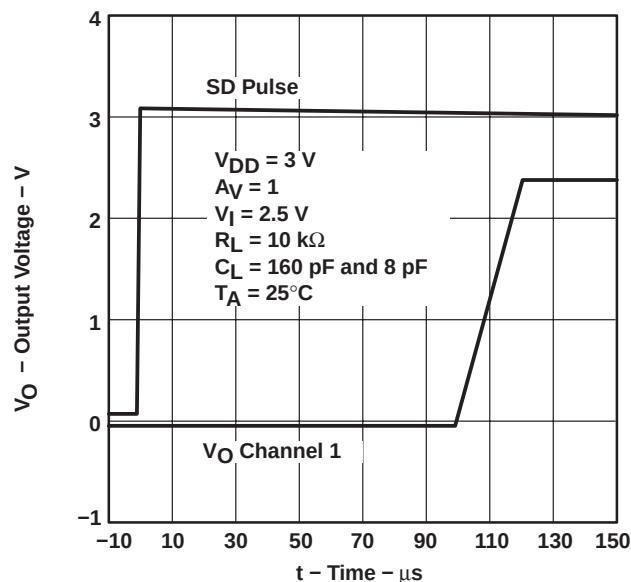


Figure 42

SHUTDOWN OFF PULSE RESPONSE

VS  
TIME

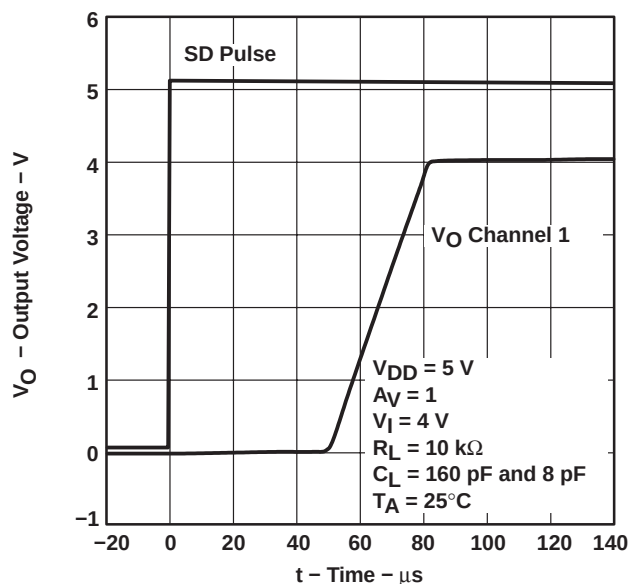


Figure 43

SHUTDOWN ON PULSE RESPONSE

VS  
TIME

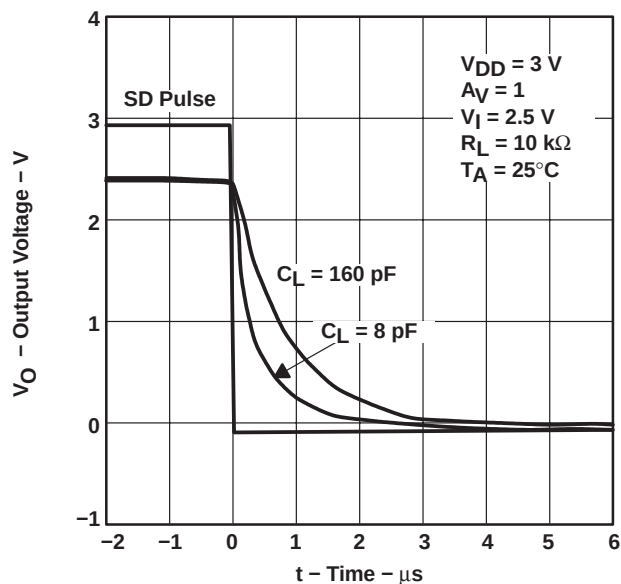


Figure 44

SHUTDOWN ON PULSE RESPONSE

VS  
TIME

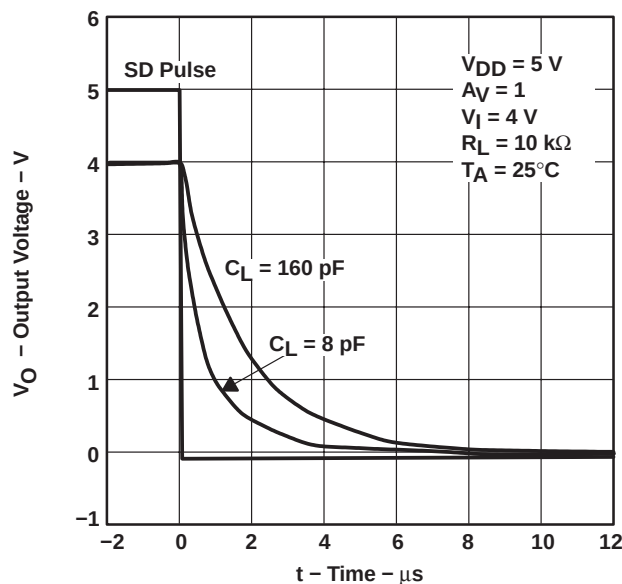


Figure 45



# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## TYPICAL CHARACTERISTICS

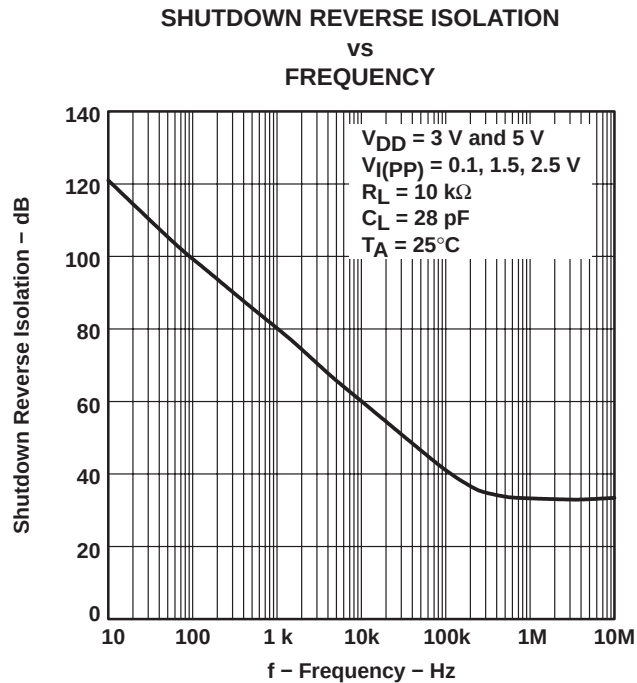


Figure 46

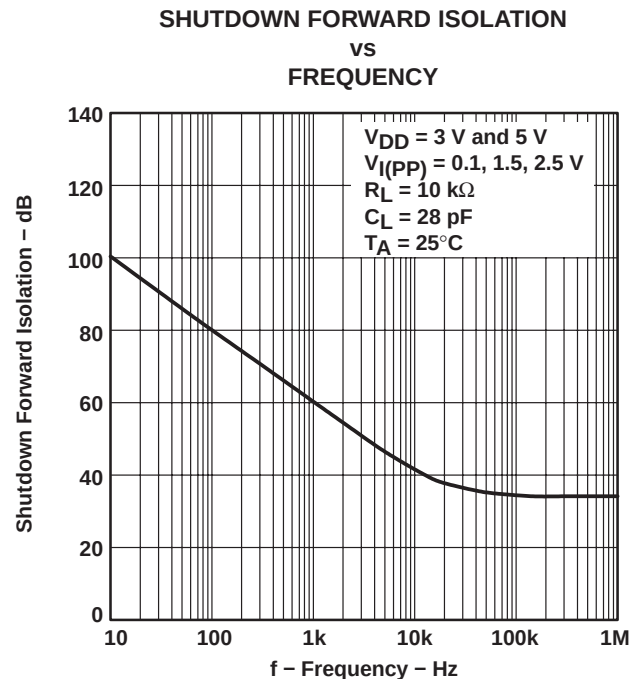


Figure 47

## PARAMETER MEASUREMENT INFORMATION

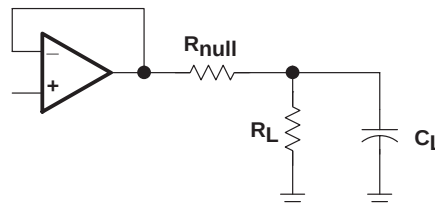


Figure 48

# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

### OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## APPLICATION INFORMATION

### shutdown function

Three members of the TLV245x family (TLV2450/3/5) have a shutdown terminal for conserving battery life in portable applications. When the shutdown terminal is pulled to the voltage level on the GND terminal of the device, the supply current is reduced to 16 nA/channel, the amplifier is disabled, and the outputs are placed in a high impedance mode. To enable the amplifier, the shutdown terminal must be pulled high. The shutdown terminal should never be left floating. The shutdown terminal threshold is always referenced to the GND terminal of the device. Therefore, when operating the device with split supply voltages (e.g.  $\pm 2.5$  V), the shutdown terminal needs to be pulled to  $V_{DD-}$  (not system ground) to disable the operational amplifier.

The amplifier's output with a shutdown pulse is shown in Figures 42, 43, 44, and 45. The amplifier is powered with a single 5-V supply and configured as a noninverting configuration with a gain of 5. The amplifier turnon and turnoff times are measured from the 50% point of the shutdown pulse to the 50% point of the output waveform. The times for the single, dual, and quad are listed in the data tables.

Figures 46 and 47 show the amplifier's forward and reverse isolation in shutdown. The operational amplifier is powered by  $\pm 1.35$ -V supplies and configured as a voltage follower ( $A_V = 1$ ). The isolation performance is plotted across frequency using 0.1- $V_{PP}$ , 1.5- $V_{PP}$ , and 2.5- $V_{PP}$  input signals. During normal operation, the amplifier would not be able to handle a 2.5- $V_{PP}$  input signal with a supply voltage of  $\pm 1.35$  V since it exceeds the common-mode input voltage range ( $V_{ICR}$ ). However, this curve illustrates that the amplifier remains in shutdown even under a worst case scenario.

### driving a capacitive load

When the amplifier is configured in this manner, capacitive loading directly on the output will decrease the device's phase margin leading to high frequency ringing or oscillations. Therefore, for capacitive loads of greater than 10 pF, it is recommended that a resistor be placed in series ( $R_{NULL}$ ) with the output of the amplifier, as shown in Figure 49. A minimum value of 20  $\Omega$  should work well for most applications.

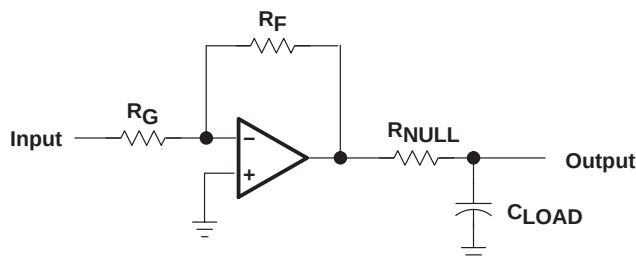


Figure 49. Driving a Capacitive Load

## APPLICATION INFORMATION

### offset voltage

The output offset voltage, ( $V_{OO}$ ) is the sum of the input offset voltage ( $V_{IO}$ ) and both input bias currents ( $I_{IB}$ ) times the corresponding gains. The following schematic and formula can be used to calculate the output offset voltage:

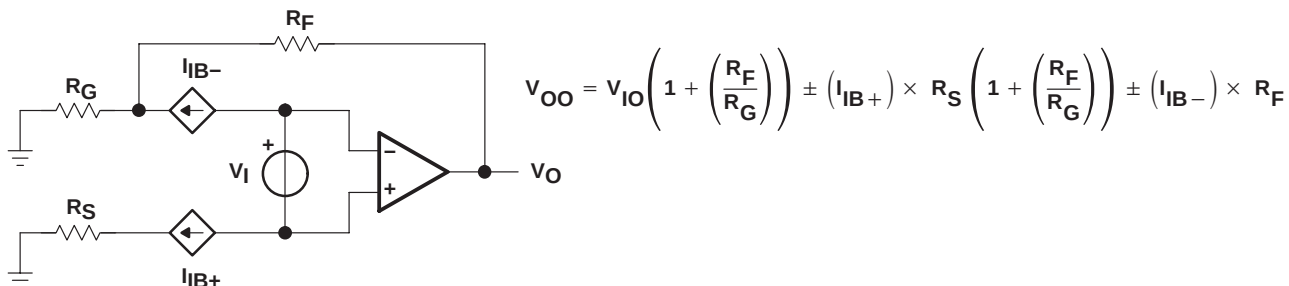


Figure 50. Output Offset Voltage Model

### general configurations

When receiving low-level signals, limiting the bandwidth of the incoming signals into the system is often required. The simplest way to accomplish this is to place an RC filter at the noninverting terminal of the amplifier (see Figure 51).

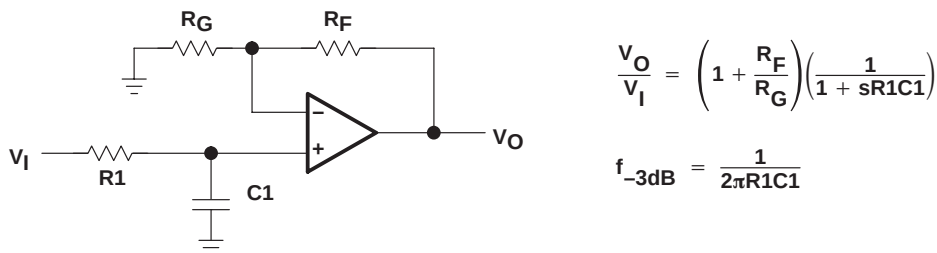


Figure 51. Single-Pole Low-Pass Filter

If even more attenuation is needed, a multiple pole filter is required. The Sallen-Key filter can be used for this task. For best results, the amplifier should have a bandwidth that is 8 to 10 times the filter frequency bandwidth. Failure to do this can result in phase shift of the amplifier.

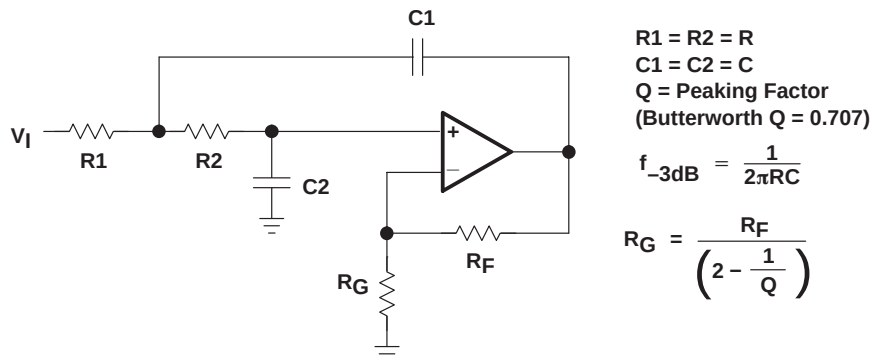


Figure 52. 2-Pole Low-Pass Sallen-Key Filter

# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## APPLICATION INFORMATION

### general power dissipation considerations

For a given  $\theta_{JA}$ , the maximum power dissipation is shown in Figure 53 and is calculated by the following formula:

$$P_D = \left( \frac{T_{MAX} - T_A}{\theta_{JA}} \right)$$

Where:

$P_D$  = Maximum power dissipation of TLV245x IC (watts)

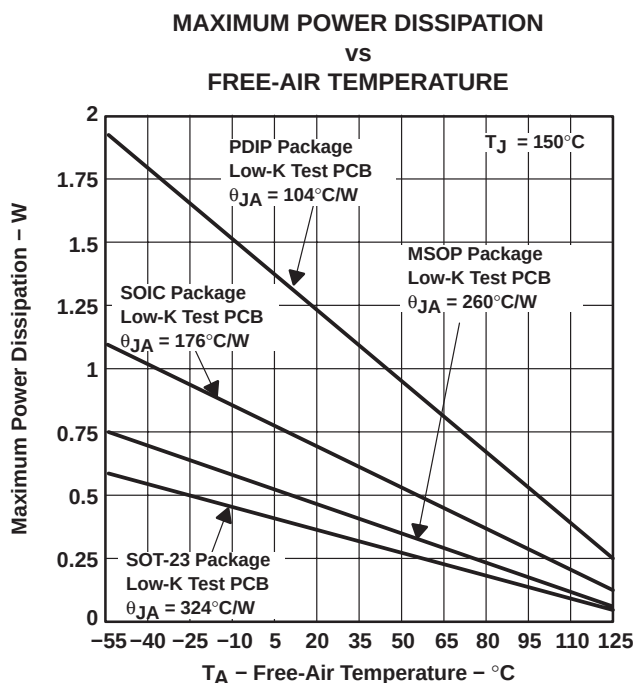
$T_{MAX}$  = Absolute maximum junction temperature (150°C)

$T_A$  = Free-ambient air temperature (°C)

$\theta_{JA} = \theta_{JC} + \theta_{CA}$

$\theta_{JC}$  = Thermal coefficient from junction to case

$\theta_{CA}$  = Thermal coefficient from case to ambient air (°C/W)



NOTE A: Results are with no air flow and using JEDEC Standard Low-K test PCB.

**Figure 53. Maximum Power Dissipation vs Free-Air Temperature**

# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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## APPLICATION INFORMATION

### macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 1) and subcircuit in Figure 54 are generated using the TLV245x typical electrical and operating characteristics at  $T_A = 25^\circ\text{C}$ . Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification
- Unity-gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

NOTE 1: G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, "Macromodeling of Integrated Circuit Operational Amplifiers," *IEEE Journal of Solid-State Circuits*, SC-9, 353 (1974).

*PSpice* and *Parts* are trademarks of MicroSim Corporation.



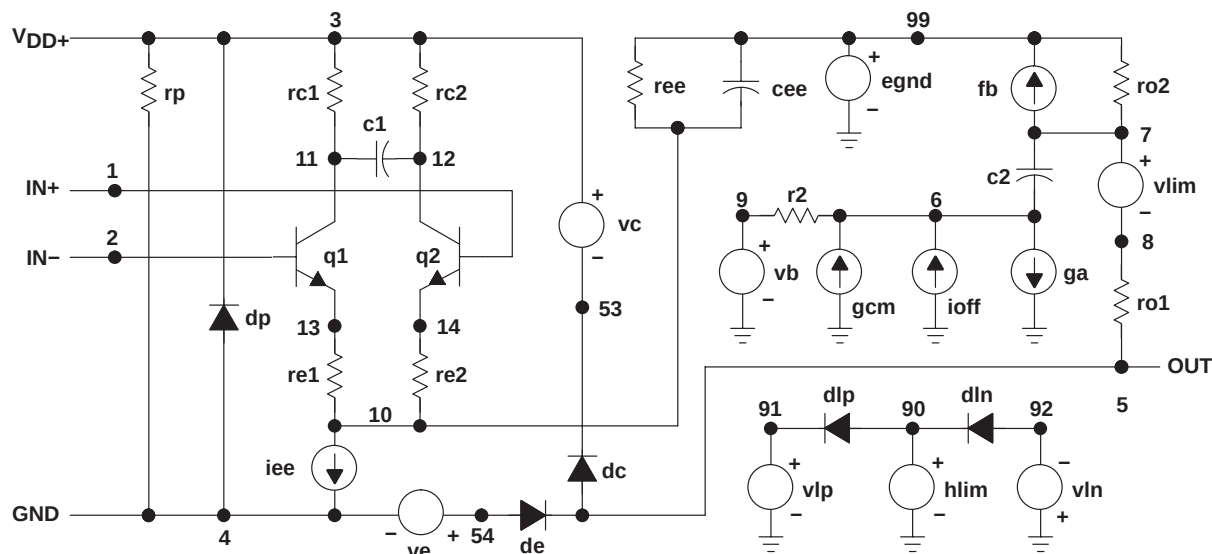
# TLV2450, TLV2451, TLV2452, TLV2453, TLV2454, TLV2455, TLV245xA

## FAMILY OF 23- $\mu$ A 220-kHz RAIL-TO-RAIL INPUT/OUTPUT

### OPERATIONAL AMPLIFIERS WITH SHUTDOWN

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#### APPLICATION INFORMATION



\* AMP\_TLV2450-X operational amplifier "macromodel" subcircuit  
 \* created using Parts release 8.0 on 10/12/98 at 11:06  
 \* Parts is a MicroSim product.

\* connections:

noninverting input  
 |  
 inverting input  
 |  
 positive power supply  
 |  
 negative power supply  
 |  
 output

.subckt AMP\_TLV2450-X 1 2 3 4 5

\*

|                                  |    |    |                             |
|----------------------------------|----|----|-----------------------------|
| C1                               | 11 | 12 | 354.48E-15                  |
| C2                               | 6  | 7  | 7.5000E-12                  |
| CEE                              | 10 | 99 | 42.237E-15                  |
| DC                               | 5  | 53 | dy                          |
| DE                               | 54 | 5  | dy                          |
| DLP                              | 90 | 91 | dx                          |
| DLN                              | 92 | 90 | dx                          |
| DP                               | 4  | 3  | dx                          |
| EGND                             | 99 | 0  | poly(2) (3,0) (4,0) 0 .5 .5 |
| FB                               | 7  | 99 | poly(5) vb vc ve vlp vln 0  |
| + 207.31E6 -1E3 1E3 210E6 -210E6 |    |    |                             |
| GA                               | 6  | 0  | 11 12 15.254E-6             |
| GCM                              | 0  | 6  | 10 99 48.237E-12            |

|                                           |    |    |          |           |
|-------------------------------------------|----|----|----------|-----------|
| IEE                                       | 10 | 4  | dc       | 938.61E-9 |
| HLIM                                      | 90 | 0  | vlim     | 1K        |
| Q1                                        | 11 | 2  | 13       | qx1       |
| Q2                                        | 12 | 1  | 14       | qx2       |
| R2                                        | 6  | 9  | 100.00E3 |           |
| RC1                                       | 3  | 11 | 65.557E3 |           |
| RC2                                       | 3  | 12 | 65.557E3 |           |
| RE1                                       | 13 | 10 | 10.367E3 |           |
| RE2                                       | 14 | 10 | 10.367E3 |           |
| REE                                       | 10 | 99 | 213.08E6 |           |
| RO1                                       | 8  | 5  | 10       |           |
| RO2                                       | 7  | 99 | 10       |           |
| RP                                        | 3  | 4  | 147.06   |           |
| VB                                        | 9  | 0  | dc       | 0         |
| VC                                        | 3  | 53 | dc       | .82       |
| VE                                        | 54 | 4  | dc       | .82       |
| VLIM                                      | 7  | 8  | dc       | 0         |
| VLP                                       | 91 | 0  | dc       | 38        |
| VLN                                       | 0  | 92 | dc       | 38        |
| .model dx D(Is=800.00E-18)                |    |    |          |           |
| .model dy D(Is=800.00E-18 Rs=1m Cjo=10p)  |    |    |          |           |
| .model qx1 NPN(Is=800.00E-18 Bf=843.08)   |    |    |          |           |
| .model qx2 NPN(Is=800.0000E-18 Bf=843.08) |    |    |          |           |
| .ends                                     |    |    |          |           |

Figure 54. Boyle Macromodel and Subcircuit

**PACKAGING INFORMATION**

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TLV2450AID       | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2450AI                   | <a href="#">Samples</a> |
| TLV2450AIDG4     | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2450AI                   | <a href="#">Samples</a> |
| TLV2450AIDR      | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2450AI                   | <a href="#">Samples</a> |
| TLV2450AIDRG4    | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2450AI                   | <a href="#">Samples</a> |
| TLV2450AIP       | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2450AI                | <a href="#">Samples</a> |
| TLV2450AIPe4     | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2450AI                | <a href="#">Samples</a> |
| TLV2450CD        | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2450C                    | <a href="#">Samples</a> |
| TLV2450CDBVR     | ACTIVE        | SOT-23       | DBV                | 6    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | VAQC                     | <a href="#">Samples</a> |
| TLV2450CDBVRG4   | ACTIVE        | SOT-23       | DBV                | 6    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | VAQC                     | <a href="#">Samples</a> |
| TLV2450CDBVT     | ACTIVE        | SOT-23       | DBV                | 6    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | VAQC                     | <a href="#">Samples</a> |
| TLV2450CDBVTG4   | ACTIVE        | SOT-23       | DBV                | 6    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | VAQC                     | <a href="#">Samples</a> |
| TLV2450CDG4      | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2450C                    | <a href="#">Samples</a> |
| TLV2450CP        | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | 0 to 70      | TLV2450C                 | <a href="#">Samples</a> |
| TLV2450CPE4      | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | 0 to 70      | TLV2450C                 | <a href="#">Samples</a> |
| TLV2450ID        | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2450I                    | <a href="#">Samples</a> |
| TLV2450IDBVR     | ACTIVE        | SOT-23       | DBV                | 6    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | VAQI                     | <a href="#">Samples</a> |
| TLV2450IDBVRG4   | ACTIVE        | SOT-23       | DBV                | 6    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | VAQI                     | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TLV2450IDBVT     | ACTIVE        | SOT-23       | DBV                | 6    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | VAQI                     | <a href="#">Samples</a> |
| TLV2450IDBVTG4   | ACTIVE        | SOT-23       | DBV                | 6    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | VAQI                     | <a href="#">Samples</a> |
| TLV2450IDG4      | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2450I                    | <a href="#">Samples</a> |
| TLV2451AID       | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2451AI                   | <a href="#">Samples</a> |
| TLV2451AIDG4     | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2451AI                   | <a href="#">Samples</a> |
| TLV2451AIDR      | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2451AI                   | <a href="#">Samples</a> |
| TLV2451AIDRG4    | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2451AI                   | <a href="#">Samples</a> |
| TLV2451AIP       | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2451AI                | <a href="#">Samples</a> |
| TLV2451AIPe4     | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2451AI                | <a href="#">Samples</a> |
| TLV2451CD        | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2451C                    | <a href="#">Samples</a> |
| TLV2451CDBVR     | ACTIVE        | SOT-23       | DBV                | 5    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | VARC                     | <a href="#">Samples</a> |
| TLV2451CDBVRG4   | ACTIVE        | SOT-23       | DBV                | 5    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | VARC                     | <a href="#">Samples</a> |
| TLV2451CDBVT     | ACTIVE        | SOT-23       | DBV                | 5    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | VARC                     | <a href="#">Samples</a> |
| TLV2451CDBVTG4   | ACTIVE        | SOT-23       | DBV                | 5    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | VARC                     | <a href="#">Samples</a> |
| TLV2451CDG4      | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2451C                    | <a href="#">Samples</a> |
| TLV2451CDR       | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2451C                    | <a href="#">Samples</a> |
| TLV2451CDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2451C                    | <a href="#">Samples</a> |
| TLV2451CP        | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | 0 to 70      | TLV2451C                 | <a href="#">Samples</a> |



| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TLV2451CPE4      | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | 0 to 70      | TLV2451C                 | <a href="#">Samples</a> |
| TLV2451ID        | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2451I                    | <a href="#">Samples</a> |
| TLV2451IDBVR     | ACTIVE        | SOT-23       | DBV                | 5    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | VARI                     | <a href="#">Samples</a> |
| TLV2451IDBVRG4   | ACTIVE        | SOT-23       | DBV                | 5    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | VARI                     | <a href="#">Samples</a> |
| TLV2451IDBVT     | ACTIVE        | SOT-23       | DBV                | 5    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | VARI                     | <a href="#">Samples</a> |
| TLV2451IDBVTG4   | ACTIVE        | SOT-23       | DBV                | 5    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | VARI                     | <a href="#">Samples</a> |
| TLV2451IDG4      | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2451I                    | <a href="#">Samples</a> |
| TLV2451IDR       | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2451I                    | <a href="#">Samples</a> |
| TLV2451IDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2451I                    | <a href="#">Samples</a> |
| TLV2451IP        | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2451I                 | <a href="#">Samples</a> |
| TLV2451IPE4      | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2451I                 | <a href="#">Samples</a> |
| TLV2452AID       | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2452AI                   | <a href="#">Samples</a> |
| TLV2452AIDG4     | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2452AI                   | <a href="#">Samples</a> |
| TLV2452AIDR      | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2452AI                   | <a href="#">Samples</a> |
| TLV2452AIDRG4    | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2452AI                   | <a href="#">Samples</a> |
| TLV2452AIP       | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2452AI                | <a href="#">Samples</a> |
| TLV2452AIPE4     | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2452AI                | <a href="#">Samples</a> |
| TLV2452CD        | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2452C                    | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TLV2452CDG4      | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2452C                    | <a href="#">Samples</a> |
| TLV2452CDGK      | ACTIVE        | VSSOP        | DGK                | 8    | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | ABI                      | <a href="#">Samples</a> |
| TLV2452CDGKG4    | ACTIVE        | VSSOP        | DGK                | 8    | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | ABI                      | <a href="#">Samples</a> |
| TLV2452CDGKR     | ACTIVE        | VSSOP        | DGK                | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | ABI                      | <a href="#">Samples</a> |
| TLV2452CDGKRG4   | ACTIVE        | VSSOP        | DGK                | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | ABI                      | <a href="#">Samples</a> |
| TLV2452CDR       | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2452C                    | <a href="#">Samples</a> |
| TLV2452CDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2452C                    | <a href="#">Samples</a> |
| TLV2452ID        | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2452I                    | <a href="#">Samples</a> |
| TLV2452IDG4      | ACTIVE        | SOIC         | D                  | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2452I                    | <a href="#">Samples</a> |
| TLV2452IDGK      | ACTIVE        | VSSOP        | DGK                | 8    | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | ABJ                      | <a href="#">Samples</a> |
| TLV2452IDGKG4    | ACTIVE        | VSSOP        | DGK                | 8    | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | ABJ                      | <a href="#">Samples</a> |
| TLV2452IDGKR     | ACTIVE        | VSSOP        | DGK                | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | ABJ                      | <a href="#">Samples</a> |
| TLV2452IDGKRG4   | ACTIVE        | VSSOP        | DGK                | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | ABJ                      | <a href="#">Samples</a> |
| TLV2452IDR       | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2452I                    | <a href="#">Samples</a> |
| TLV2452IDRG4     | ACTIVE        | SOIC         | D                  | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2452I                    | <a href="#">Samples</a> |
| TLV2452IP        | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2452IP                | <a href="#">Samples</a> |
| TLV2452IPE4      | ACTIVE        | PDIP         | P                  | 8    | 50          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2452IP                | <a href="#">Samples</a> |
| TLV2453AIN       | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2453AIN               | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TLV2453AINE4     | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2453AIN               | <a href="#">Samples</a> |
| TLV2453CD        | ACTIVE        | SOIC         | D                  | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TLV2453C                 | <a href="#">Samples</a> |
| TLV2453CDG4      | ACTIVE        | SOIC         | D                  | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TLV2453C                 | <a href="#">Samples</a> |
| TLV2453CDGS      | ACTIVE        | VSSOP        | DGS                | 10   | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | ABK                      | <a href="#">Samples</a> |
| TLV2453CDGSG4    | ACTIVE        | VSSOP        | DGS                | 10   | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | ABK                      | <a href="#">Samples</a> |
| TLV2453CDGSR     | ACTIVE        | VSSOP        | DGS                | 10   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | ABK                      | <a href="#">Samples</a> |
| TLV2453CDGSRG4   | ACTIVE        | VSSOP        | DGS                | 10   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | ABK                      | <a href="#">Samples</a> |
| TLV2453CDR       | ACTIVE        | SOIC         | D                  | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TLV2453C                 | <a href="#">Samples</a> |
| TLV2453CDRG4     | ACTIVE        | SOIC         | D                  | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TLV2453C                 | <a href="#">Samples</a> |
| TLV2453IDGS      | ACTIVE        | VSSOP        | DGS                | 10   | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | ABL                      | <a href="#">Samples</a> |
| TLV2453IDGSG4    | ACTIVE        | VSSOP        | DGS                | 10   | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | ABL                      | <a href="#">Samples</a> |
| TLV2453IDGSR     | ACTIVE        | VSSOP        | DGS                | 10   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | ABL                      | <a href="#">Samples</a> |
| TLV2453IDGSRG4   | ACTIVE        | VSSOP        | DGS                | 10   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | ABL                      | <a href="#">Samples</a> |
| TLV2453IN        | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2453IN                | <a href="#">Samples</a> |
| TLV2453INE4      | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2453IN                | <a href="#">Samples</a> |
| TLV2454AID       | ACTIVE        | SOIC         | D                  | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2454AI                   | <a href="#">Samples</a> |
| TLV2454AIDG4     | ACTIVE        | SOIC         | D                  | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2454AI                   | <a href="#">Samples</a> |
| TLV2454AIDR      | ACTIVE        | SOIC         | D                  | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2454AI                   | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TLV2454AIDRG4    | ACTIVE        | SOIC         | D                  | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2454AI                   | <a href="#">Samples</a> |
| TLV2454AIN       | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2454AI                | <a href="#">Samples</a> |
| TLV2454AINE4     | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2454AI                | <a href="#">Samples</a> |
| TLV2454AIPW      | ACTIVE        | TSSOP        | PW                 | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   |              | TY2454A                  | <a href="#">Samples</a> |
| TLV2454AIPWG4    | ACTIVE        | TSSOP        | PW                 | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   |              | TY2454A                  | <a href="#">Samples</a> |
| TLV2454AIPWR     | ACTIVE        | TSSOP        | PW                 | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2454A                  | <a href="#">Samples</a> |
| TLV2454AIPWRG4   | ACTIVE        | TSSOP        | PW                 | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2454A                  | <a href="#">Samples</a> |
| TLV2454CD        | ACTIVE        | SOIC         | D                  | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2454C                    | <a href="#">Samples</a> |
| TLV2454CDG4      | ACTIVE        | SOIC         | D                  | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | 2454C                    | <a href="#">Samples</a> |
| TLV2454CN        | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | 0 to 70      | TLV2454C                 | <a href="#">Samples</a> |
| TLV2454CNE4      | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | 0 to 70      | TLV2454C                 | <a href="#">Samples</a> |
| TLV2454CPW       | ACTIVE        | TSSOP        | PW                 | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TV2454                   | <a href="#">Samples</a> |
| TLV2454CPWG4     | ACTIVE        | TSSOP        | PW                 | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TV2454                   | <a href="#">Samples</a> |
| TLV2454CPWR      | ACTIVE        | TSSOP        | PW                 | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TV2454                   | <a href="#">Samples</a> |
| TLV2454CPWRG4    | ACTIVE        | TSSOP        | PW                 | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TV2454                   | <a href="#">Samples</a> |
| TLV2454ID        | ACTIVE        | SOIC         | D                  | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2454I                    | <a href="#">Samples</a> |
| TLV2454IDG4      | ACTIVE        | SOIC         | D                  | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2454I                    | <a href="#">Samples</a> |
| TLV2454IDR       | ACTIVE        | SOIC         | D                  | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2454I                    | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TLV2454IDRG4     | ACTIVE        | SOIC         | D                  | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | 2454I                    | <a href="#">Samples</a> |
| TLV2454IN        | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2454I                 | <a href="#">Samples</a> |
| TLV2454INE4      | ACTIVE        | PDIP         | N                  | 14   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2454I                 | <a href="#">Samples</a> |
| TLV2454IPW       | ACTIVE        | TSSOP        | PW                 | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2454                   | <a href="#">Samples</a> |
| TLV2454IPWG4     | ACTIVE        | TSSOP        | PW                 | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2454                   | <a href="#">Samples</a> |
| TLV2454IPWR      | ACTIVE        | TSSOP        | PW                 | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2454                   | <a href="#">Samples</a> |
| TLV2454IPWRG4    | ACTIVE        | TSSOP        | PW                 | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2454                   | <a href="#">Samples</a> |
| TLV2455AID       | ACTIVE        | SOIC         | D                  | 16   | 40          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TLV2455AI                | <a href="#">Samples</a> |
| TLV2455AIDG4     | ACTIVE        | SOIC         | D                  | 16   | 40          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TLV2455AI                | <a href="#">Samples</a> |
| TLV2455AIDR      | ACTIVE        | SOIC         | D                  | 16   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TLV2455AI                | <a href="#">Samples</a> |
| TLV2455AIDRG4    | ACTIVE        | SOIC         | D                  | 16   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TLV2455AI                | <a href="#">Samples</a> |
| TLV2455AIN       | ACTIVE        | PDIP         | N                  | 16   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2455AI                | <a href="#">Samples</a> |
| TLV2455AINE4     | ACTIVE        | PDIP         | N                  | 16   | 25          | Pb-Free<br>(RoHS)          | CU NIPDAU        | N / A for Pkg Type   | -40 to 125   | TLV2455AI                | <a href="#">Samples</a> |
| TLV2455AIPW      | ACTIVE        | TSSOP        | PW                 | 16   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2455A                  | <a href="#">Samples</a> |
| TLV2455AIPWG4    | ACTIVE        | TSSOP        | PW                 | 16   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2455A                  | <a href="#">Samples</a> |
| TLV2455AIPWR     | ACTIVE        | TSSOP        | PW                 | 16   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2455A                  | <a href="#">Samples</a> |
| TLV2455AIPWRG4   | ACTIVE        | TSSOP        | PW                 | 16   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2455A                  | <a href="#">Samples</a> |
| TLV2455CD        | ACTIVE        | SOIC         | D                  | 16   | 40          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TLV2455C                 | <a href="#">Samples</a> |

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package Qty | Eco Plan<br>(2)            | Lead/Ball Finish | MSL Peak Temp<br>(3) | Op Temp (°C) | Top-Side Markings<br>(4) | Samples                 |
|------------------|---------------|--------------|--------------------|------|-------------|----------------------------|------------------|----------------------|--------------|--------------------------|-------------------------|
| TLV2455CDG4      | ACTIVE        | SOIC         | D                  | 16   | 40          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TLV2455C                 | <a href="#">Samples</a> |
| TLV2455CN        | OBSOLETE      | PDIP         | N                  | 16   |             | TBD                        | Call TI          | Call TI              | 0 to 70      | TLV2455C                 |                         |
| TLV2455CNE4      | ACTIVE        | PDIP         | N                  | 16   |             | TBD                        | Call TI          | Call TI              | 0 to 70      |                          | <a href="#">Samples</a> |
| TLV2455CPW       | ACTIVE        | TSSOP        | PW                 | 16   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TV2455                   | <a href="#">Samples</a> |
| TLV2455CPWG4     | ACTIVE        | TSSOP        | PW                 | 16   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | 0 to 70      | TV2455                   | <a href="#">Samples</a> |
| TLV2455ID        | ACTIVE        | SOIC         | D                  | 16   | 40          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TLV2455I                 | <a href="#">Samples</a> |
| TLV2455IDG4      | ACTIVE        | SOIC         | D                  | 16   | 40          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TLV2455I                 | <a href="#">Samples</a> |
| TLV2455IDR       | ACTIVE        | SOIC         | D                  | 16   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TLV2455I                 | <a href="#">Samples</a> |
| TLV2455IDRG4     | ACTIVE        | SOIC         | D                  | 16   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TLV2455I                 | <a href="#">Samples</a> |
| TLV2455IPW       | ACTIVE        | TSSOP        | PW                 | 16   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2455                   | <a href="#">Samples</a> |
| TLV2455IPWG4     | ACTIVE        | TSSOP        | PW                 | 16   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU        | Level-1-260C-UNLIM   | -40 to 125   | TY2455                   | <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.

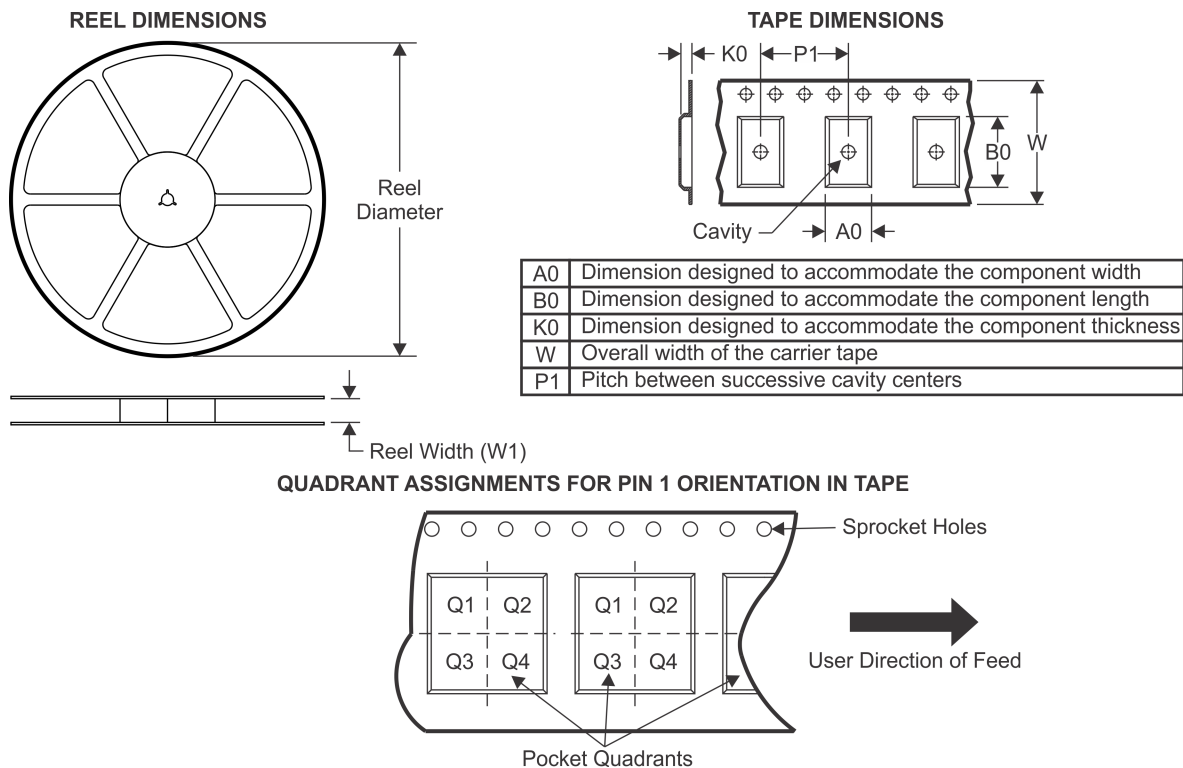
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

<sup>(4)</sup> Only one of markings shown within the brackets will appear on the physical device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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**


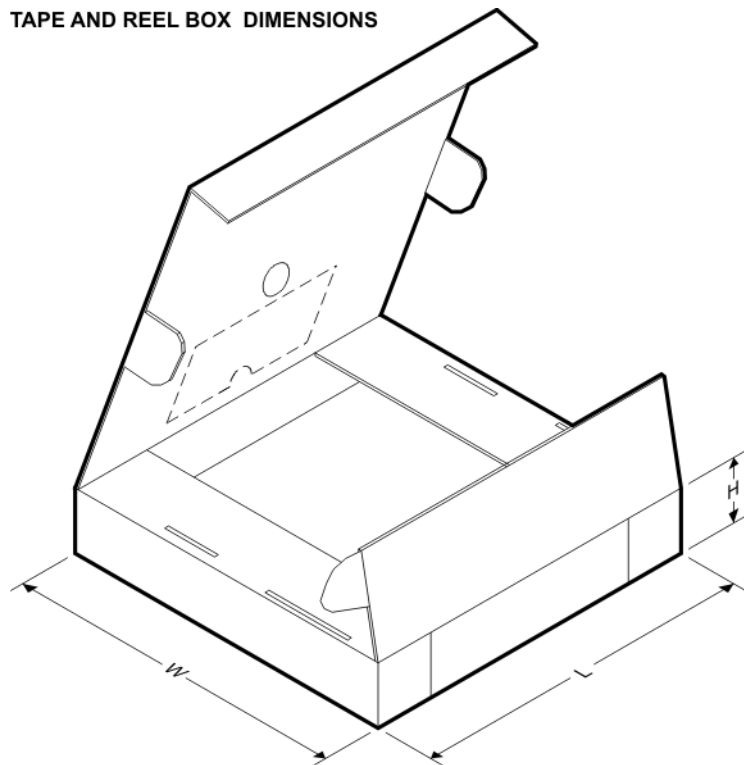
\*All dimensions are nominal

| 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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLV2450AIDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2450CDBVR | SOT-23       | DBV             | 6    | 3000 | 180.0              | 9.0                | 3.15    | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV2450CDBVT | SOT-23       | DBV             | 6    | 250  | 180.0              | 9.0                | 3.15    | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV2450IDBVR | SOT-23       | DBV             | 6    | 3000 | 180.0              | 9.0                | 3.15    | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV2450IDBVT | SOT-23       | DBV             | 6    | 250  | 180.0              | 9.0                | 3.15    | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV2451AIDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2451CDBVR | SOT-23       | DBV             | 5    | 3000 | 180.0              | 9.0                | 3.15    | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV2451CDBVT | SOT-23       | DBV             | 5    | 250  | 180.0              | 9.0                | 3.15    | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV2451CDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2451CDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2451IDBVR | SOT-23       | DBV             | 5    | 3000 | 180.0              | 9.0                | 3.15    | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV2451IDBVT | SOT-23       | DBV             | 5    | 250  | 180.0              | 9.0                | 3.15    | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV2451IDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2452AIDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2452AIDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2452CDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2452CDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2452CDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |



| 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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLV2452CDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2452IDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2452IDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2452IDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2452IDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2453CDGSR | VSSOP        | DGS             | 10   | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2453CDR   | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLV2453IDGSR | VSSOP        | DGS             | 10   | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2454AIDR  | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLV2454AIPWR | TSSOP        | PW              | 14   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TLV2454CPWR  | TSSOP        | PW              | 14   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TLV2454IDR   | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLV2454IPWR  | TSSOP        | PW              | 14   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TLV2455AIDR  | SOIC         | D               | 16   | 2500 | 330.0              | 16.4               | 6.5     | 10.3    | 2.1     | 8.0     | 16.0   | Q1            |
| TLV2455AIPWR | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TLV2455IDR   | SOIC         | D               | 16   | 2500 | 330.0              | 16.4               | 6.5     | 10.3    | 2.1     | 8.0     | 16.0   | Q1            |

## TAPE AND REEL BOX DIMENSIONS



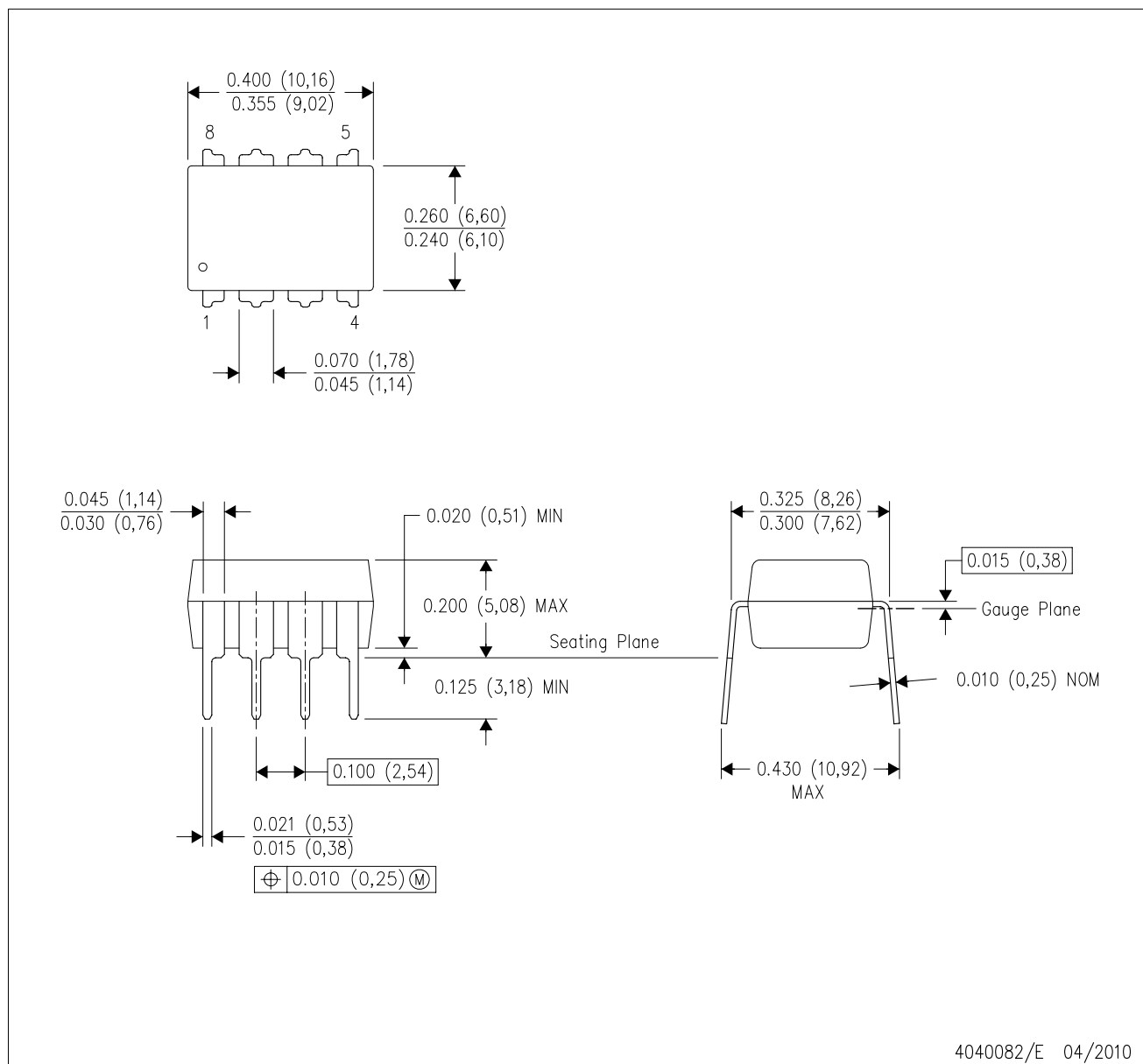
\*All dimensions are nominal

| Device      | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLV2450AIDR | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLV2450CDBVR | SOT-23       | DBV             | 6    | 3000 | 182.0       | 182.0      | 20.0        |
| TLV2450CDBVT | SOT-23       | DBV             | 6    | 250  | 182.0       | 182.0      | 20.0        |
| TLV2450IDBVR | SOT-23       | DBV             | 6    | 3000 | 182.0       | 182.0      | 20.0        |
| TLV2450IDBVT | SOT-23       | DBV             | 6    | 250  | 182.0       | 182.0      | 20.0        |
| TLV2451AIDR  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2451CDBVR | SOT-23       | DBV             | 5    | 3000 | 182.0       | 182.0      | 20.0        |
| TLV2451CDBVT | SOT-23       | DBV             | 5    | 250  | 182.0       | 182.0      | 20.0        |
| TLV2451CDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2451CDR   | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| TLV2451IDBVR | SOT-23       | DBV             | 5    | 3000 | 182.0       | 182.0      | 20.0        |
| TLV2451IDBVT | SOT-23       | DBV             | 5    | 250  | 182.0       | 182.0      | 20.0        |
| TLV2451IDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2452AIDR  | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| TLV2452AIDR  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2452CDGKR | VSSOP        | DGK             | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| TLV2452CDGKR | VSSOP        | DGK             | 8    | 2500 | 358.0       | 335.0      | 35.0        |
| TLV2452CDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2452CDR   | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| TLV2452IDGKR | VSSOP        | DGK             | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| TLV2452IDGKR | VSSOP        | DGK             | 8    | 2500 | 358.0       | 335.0      | 35.0        |
| TLV2452IDR   | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| TLV2452IDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2453CDGSR | VSSOP        | DGS             | 10   | 2500 | 358.0       | 335.0      | 35.0        |
| TLV2453CDR   | SOIC         | D               | 14   | 2500 | 367.0       | 367.0      | 38.0        |
| TLV2453IDGSR | VSSOP        | DGS             | 10   | 2500 | 358.0       | 335.0      | 35.0        |
| TLV2454AIDR  | SOIC         | D               | 14   | 2500 | 367.0       | 367.0      | 38.0        |
| TLV2454AIPWR | TSSOP        | PW              | 14   | 2000 | 367.0       | 367.0      | 35.0        |
| TLV2454CPWR  | TSSOP        | PW              | 14   | 2000 | 367.0       | 367.0      | 35.0        |
| TLV2454IDR   | SOIC         | D               | 14   | 2500 | 367.0       | 367.0      | 38.0        |
| TLV2454IPWR  | TSSOP        | PW              | 14   | 2000 | 367.0       | 367.0      | 35.0        |
| TLV2455AIDR  | SOIC         | D               | 16   | 2500 | 367.0       | 367.0      | 38.0        |
| TLV2455AIPWR | TSSOP        | PW              | 16   | 2000 | 367.0       | 367.0      | 35.0        |
| TLV2455IDR   | SOIC         | D               | 16   | 2500 | 367.0       | 367.0      | 38.0        |

P (R-PDIP-T8)

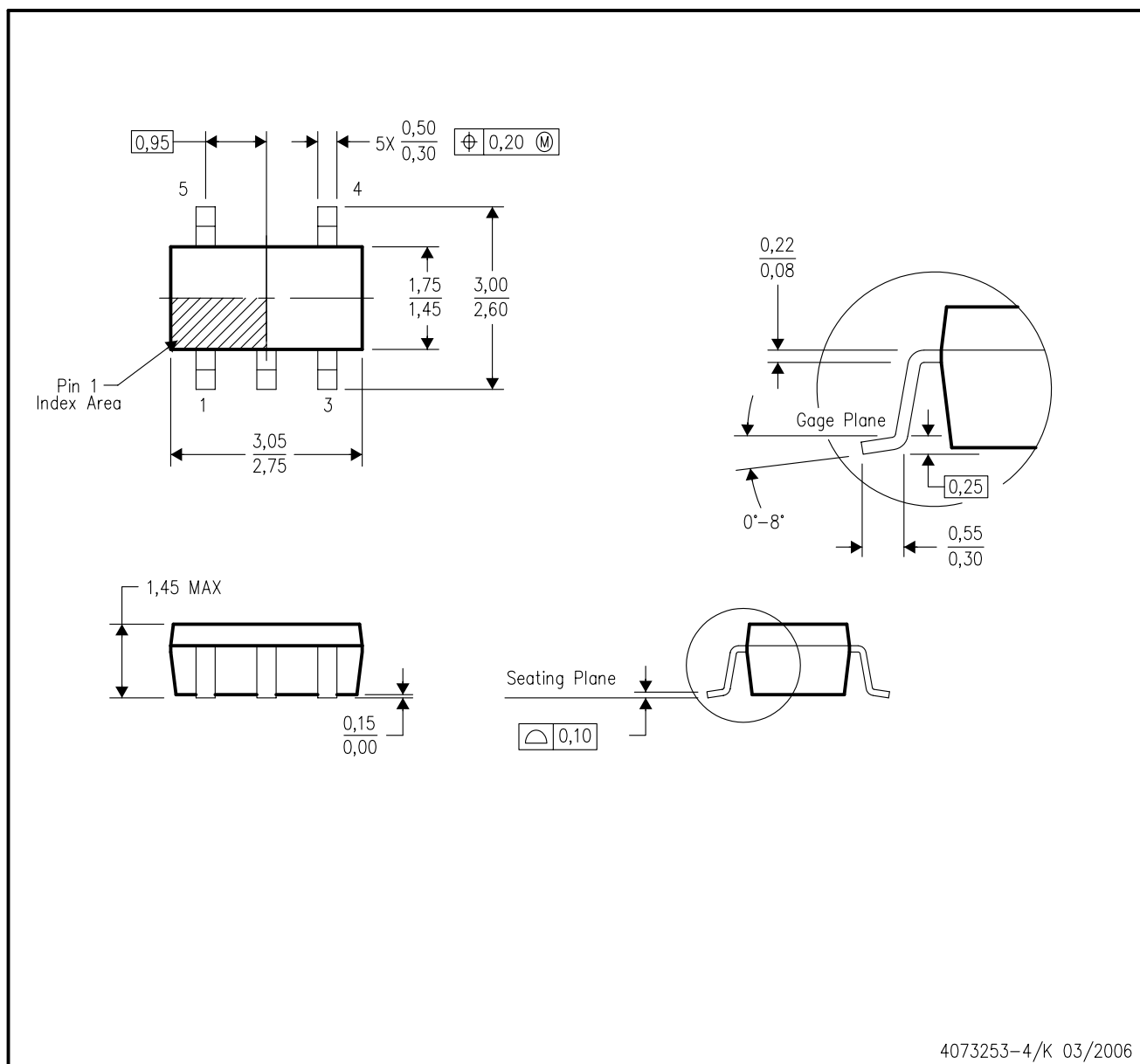
PLASTIC DUAL-IN-LINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

## DBV (R-PDSO-G5)

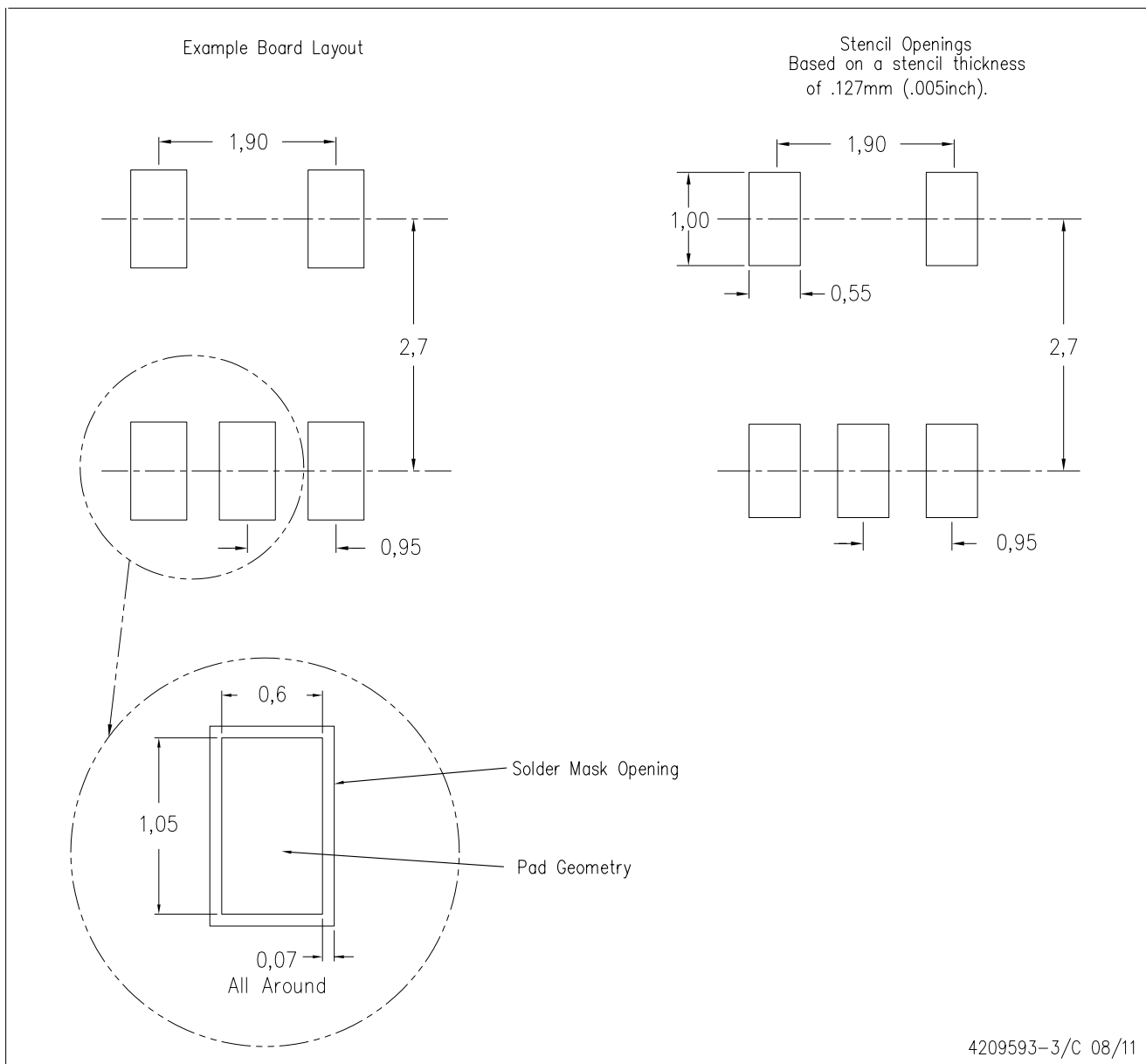
## PLASTIC SMALL-OUTLINE PACKAGE



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

DBV (R-PDSO-G5)

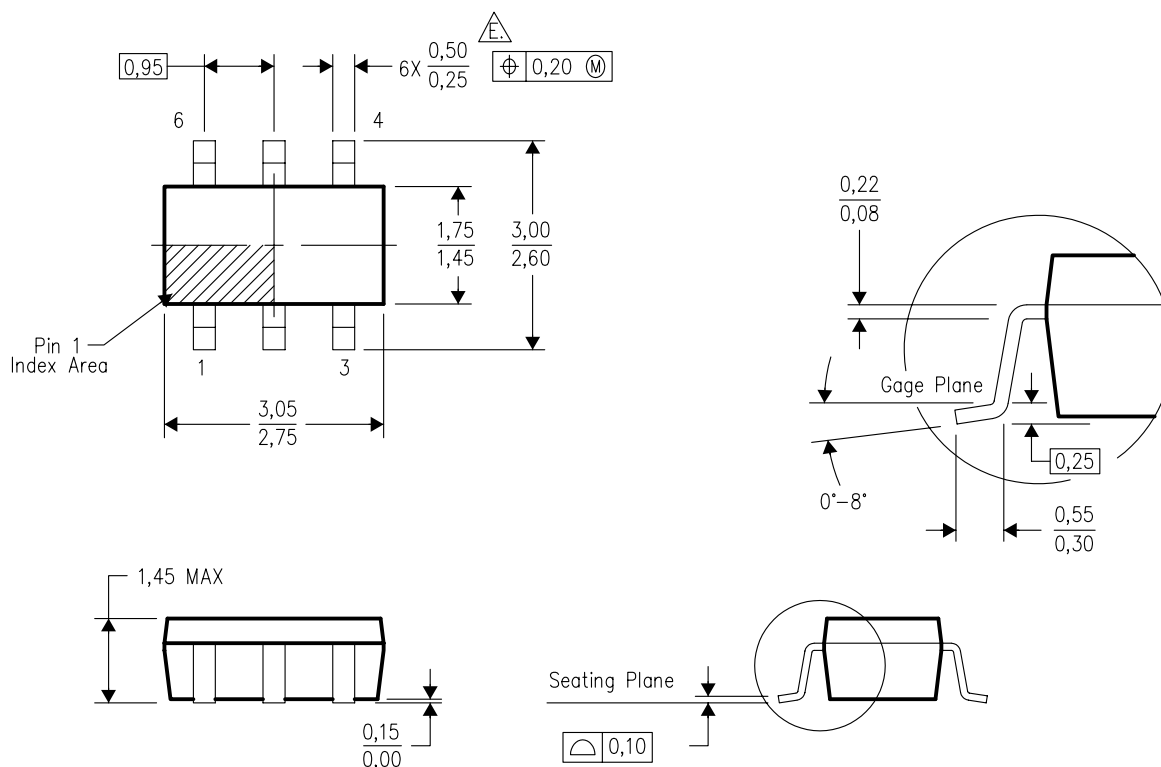
PLASTIC SMALL OUTLINE



- 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.

## DBV (R-PDSO-G6)

## PLASTIC SMALL-OUTLINE PACKAGE

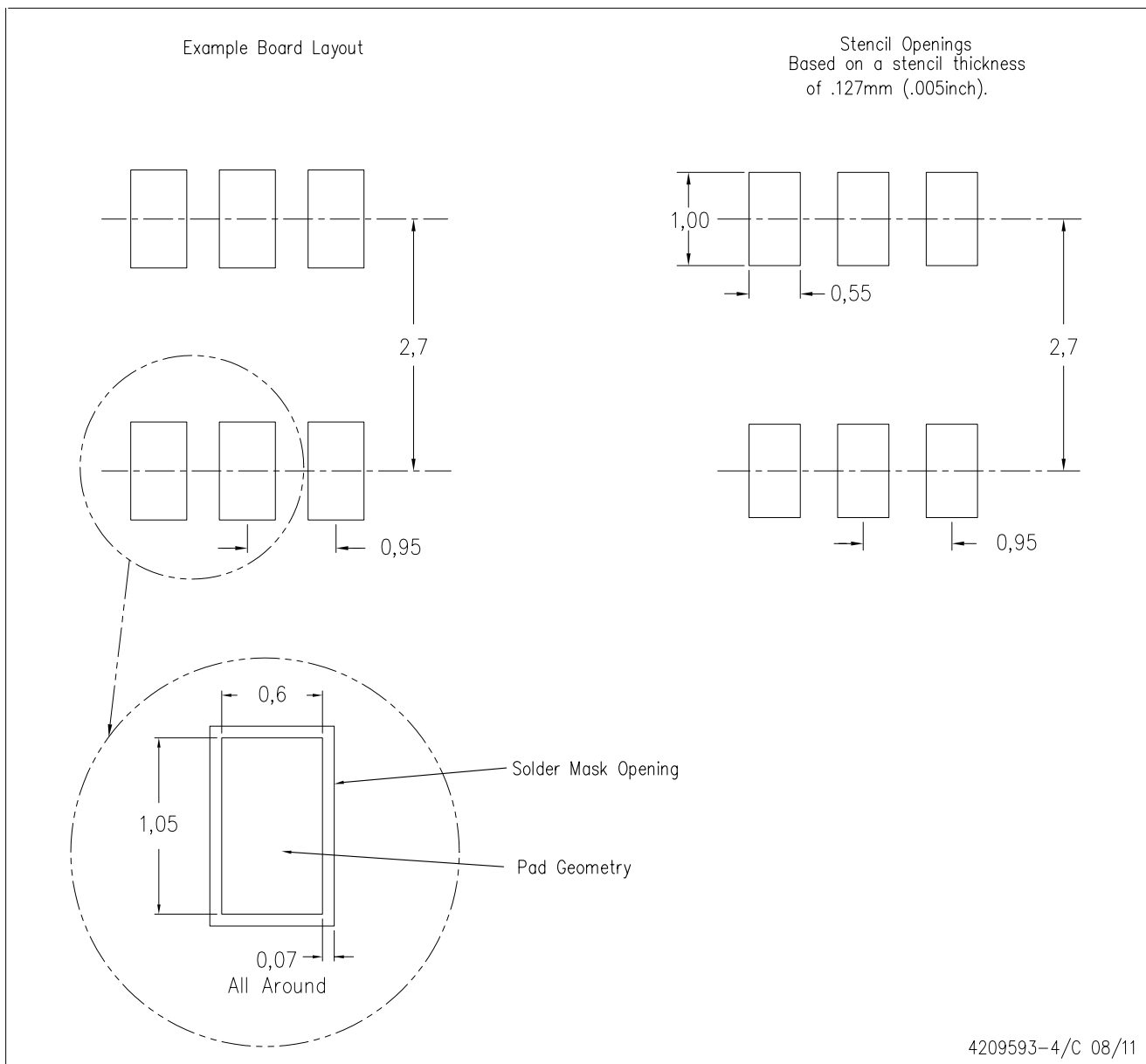


4073253-5/K 03/2006

- 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. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
- $\triangle$  Falls within JEDEC MO-178 Variation AB, except minimum lead width.

DBV (R-PDSO-G6)

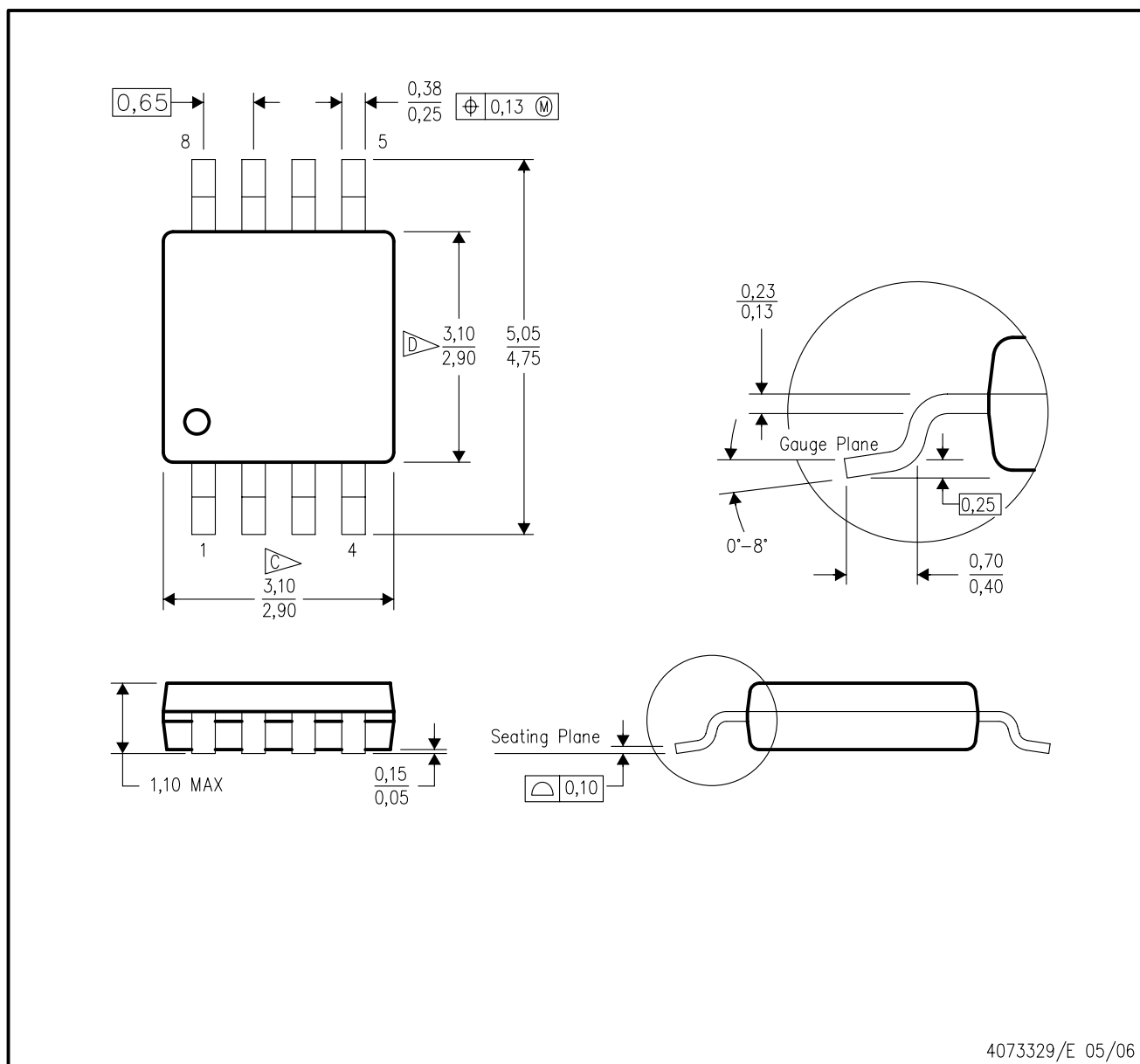
PLASTIC SMALL OUTLINE



- 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



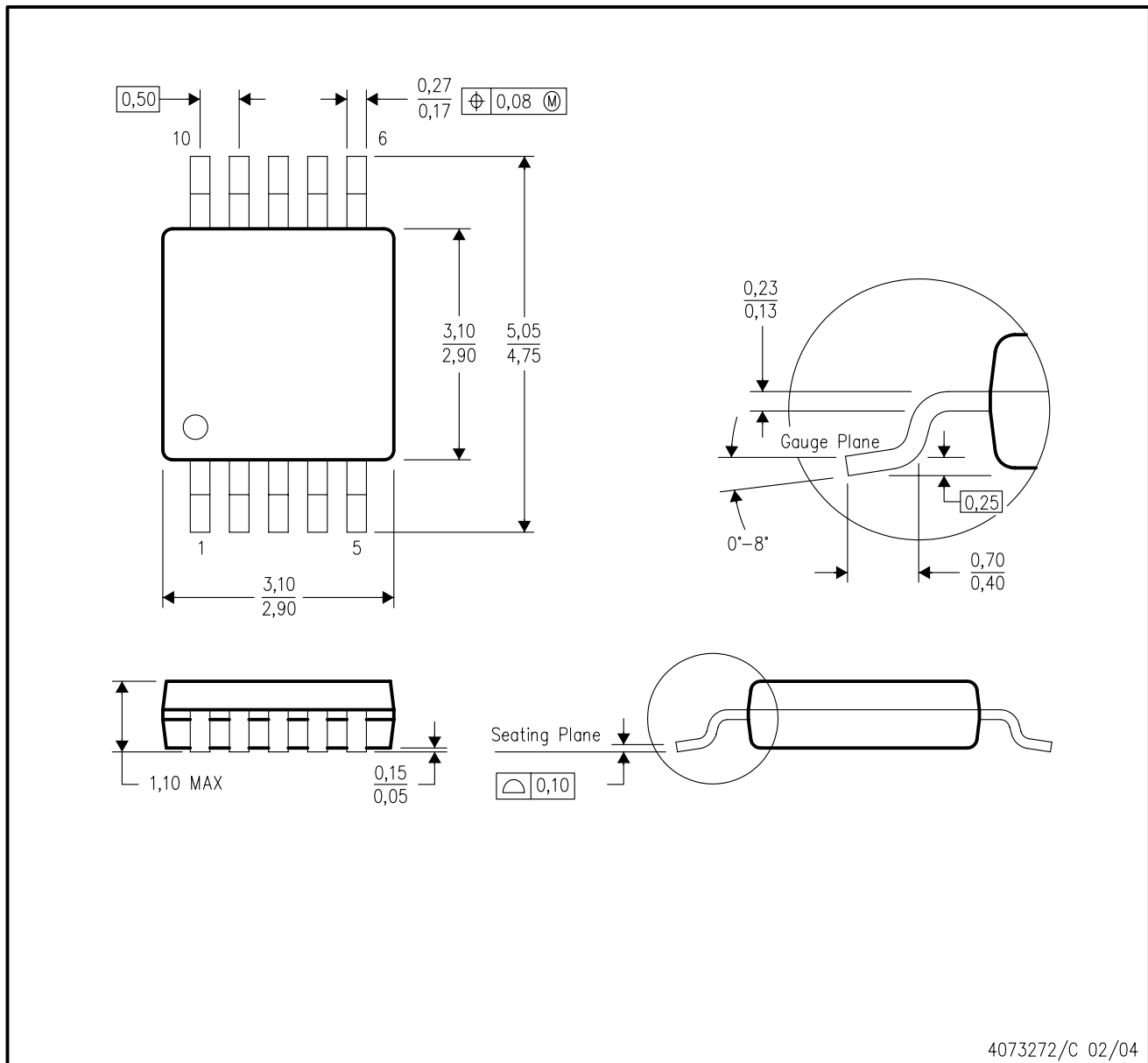
## NOTES:

- 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.



## DGS (S-PDSO-G10)

## PLASTIC SMALL-OUTLINE PACKAGE

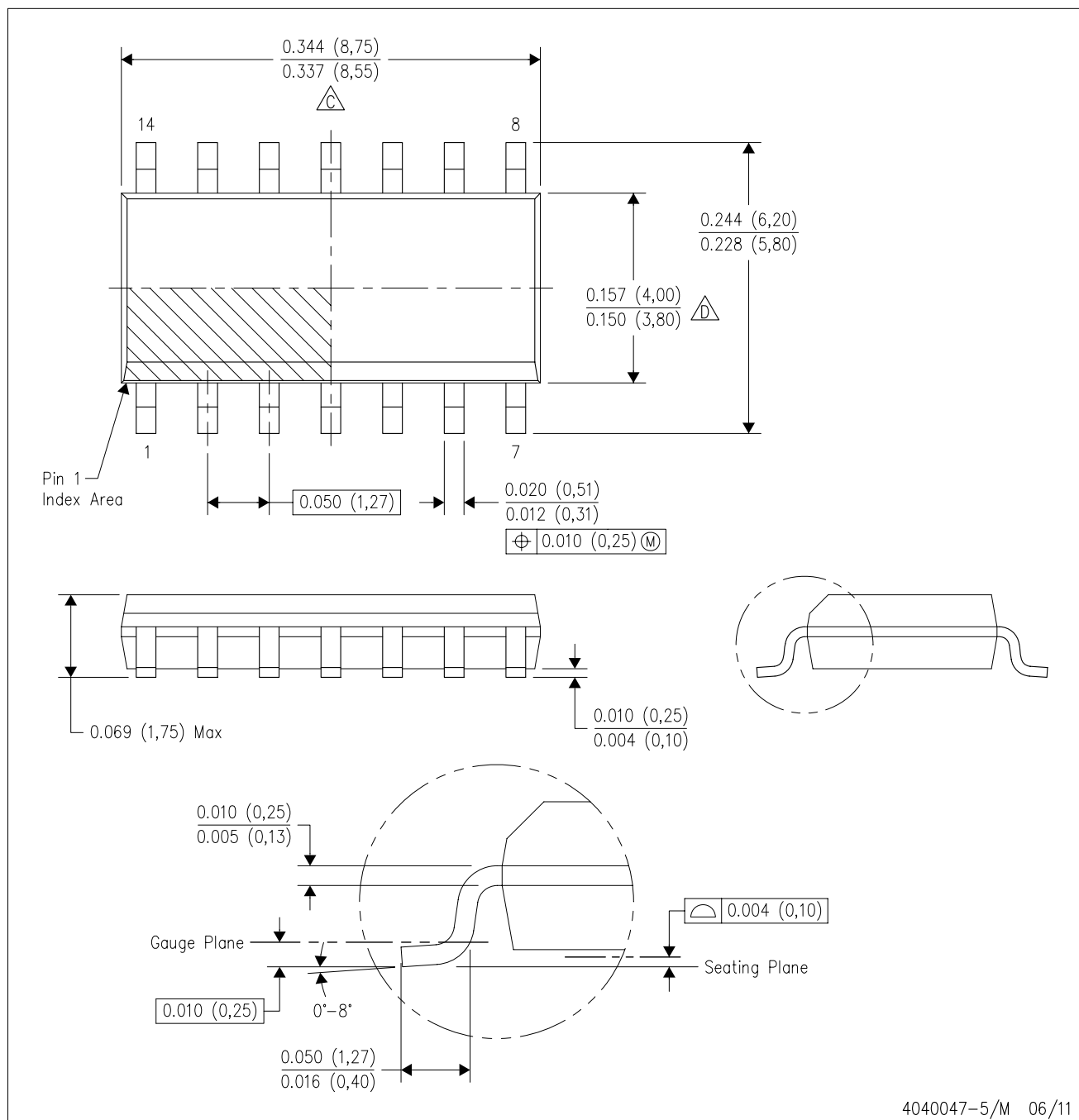


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- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion.
  - Falls within JEDEC MO-187 variation BA.

D (R-PDSO-G14)

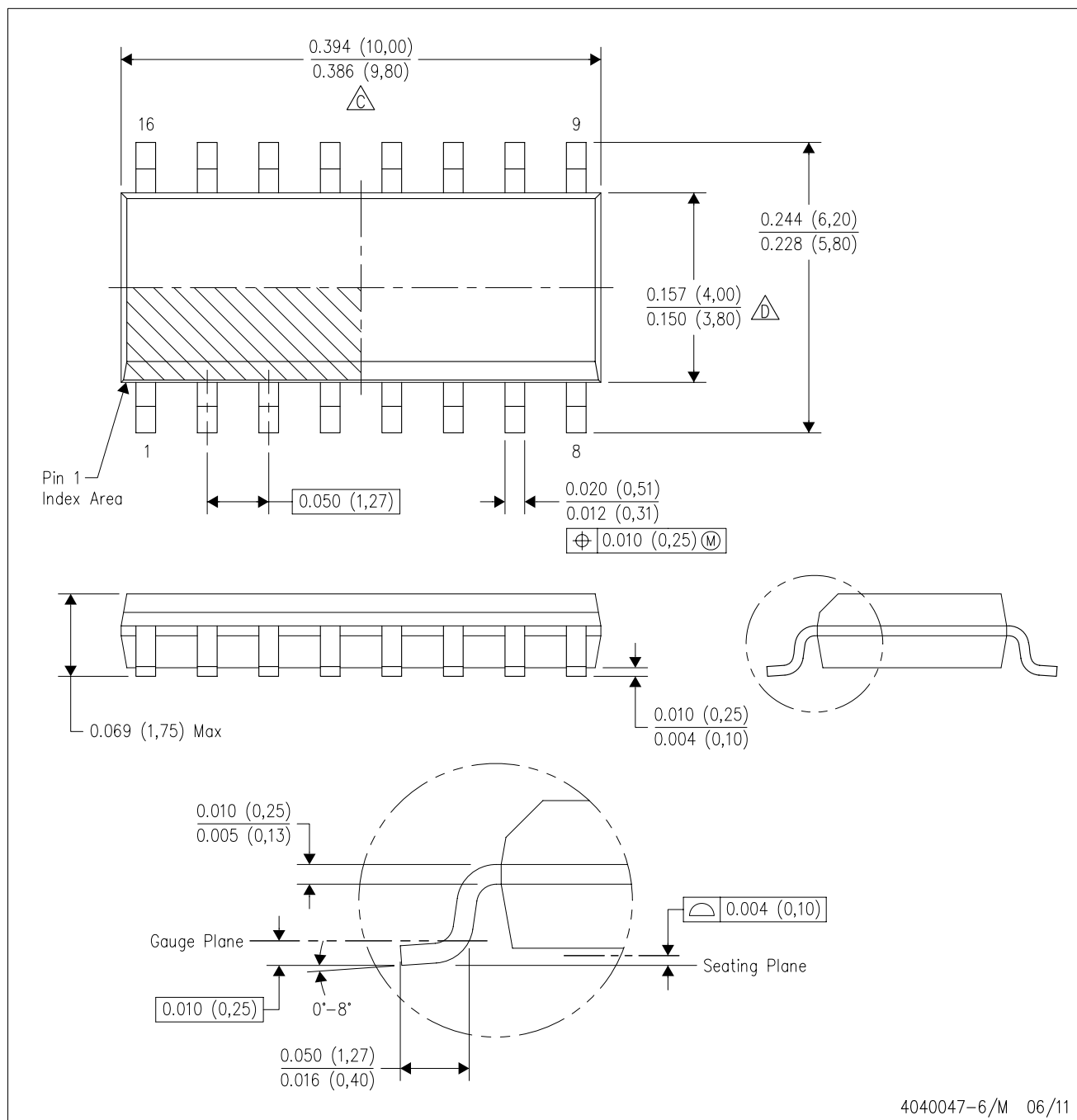
PLASTIC SMALL OUTLINE



4040047-5/M 06/11

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE

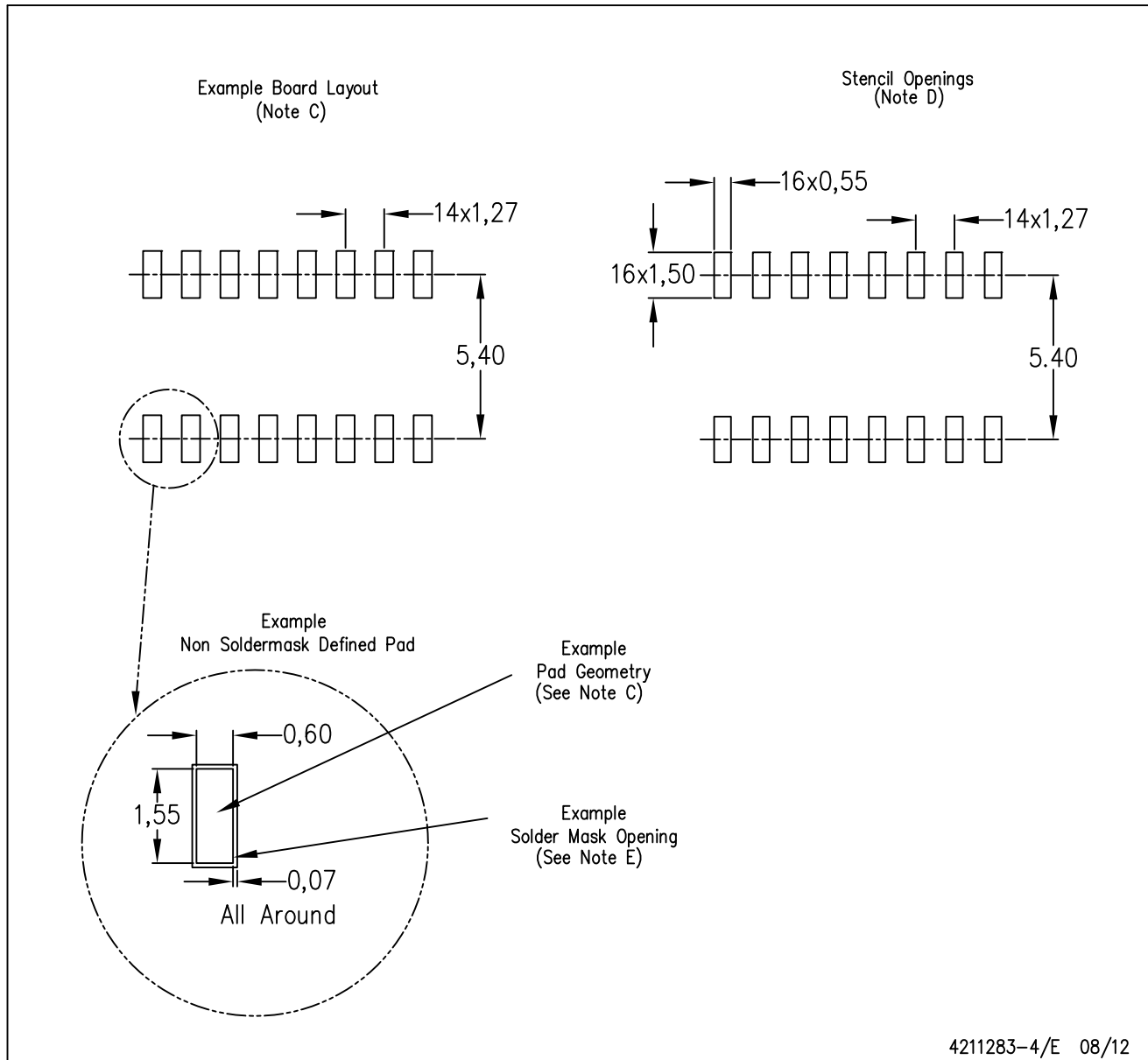


4040047-6/M 06/11

- 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 AC.

D (R-PDSO-G16)

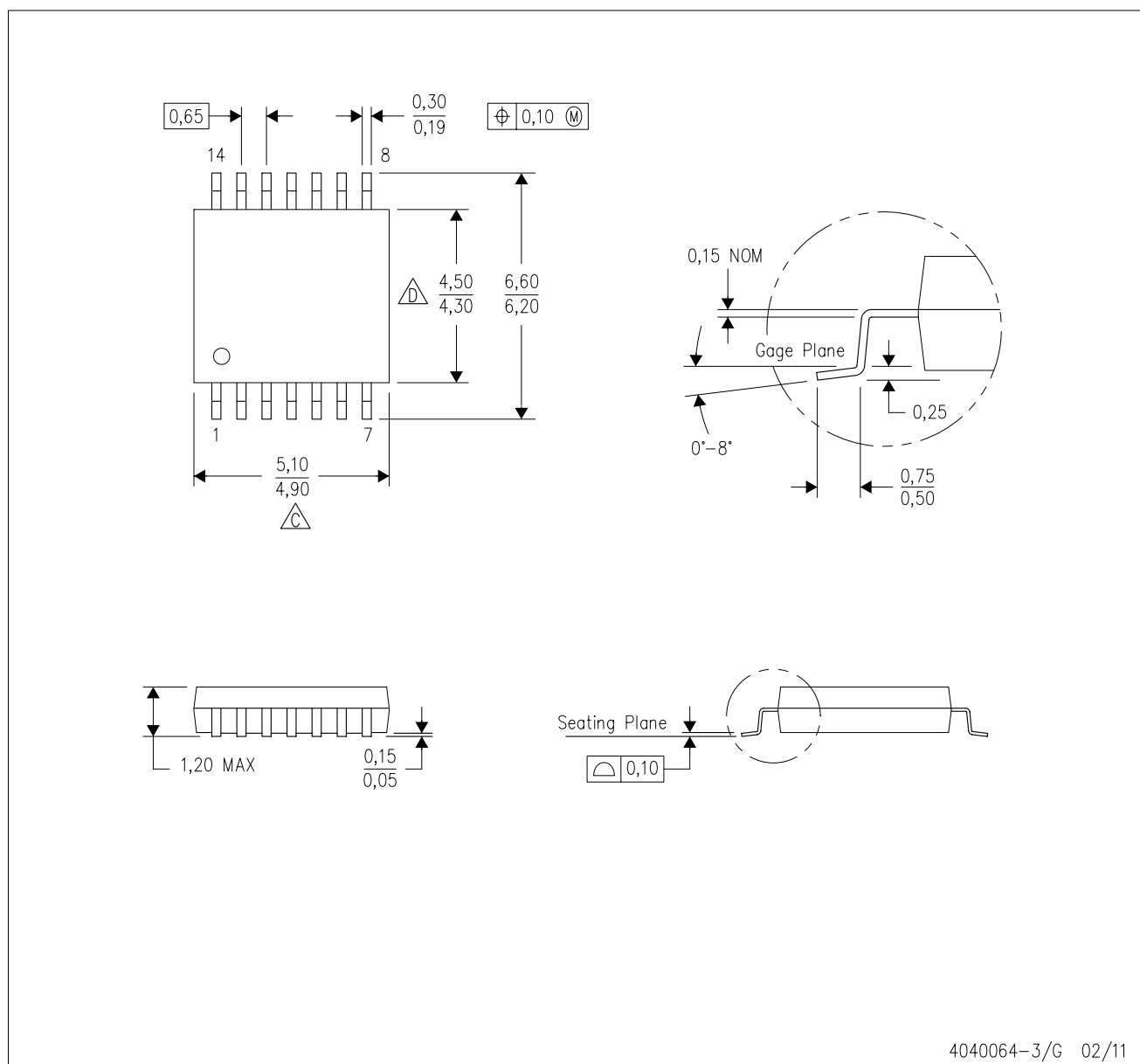
PLASTIC SMALL OUTLINE



- 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

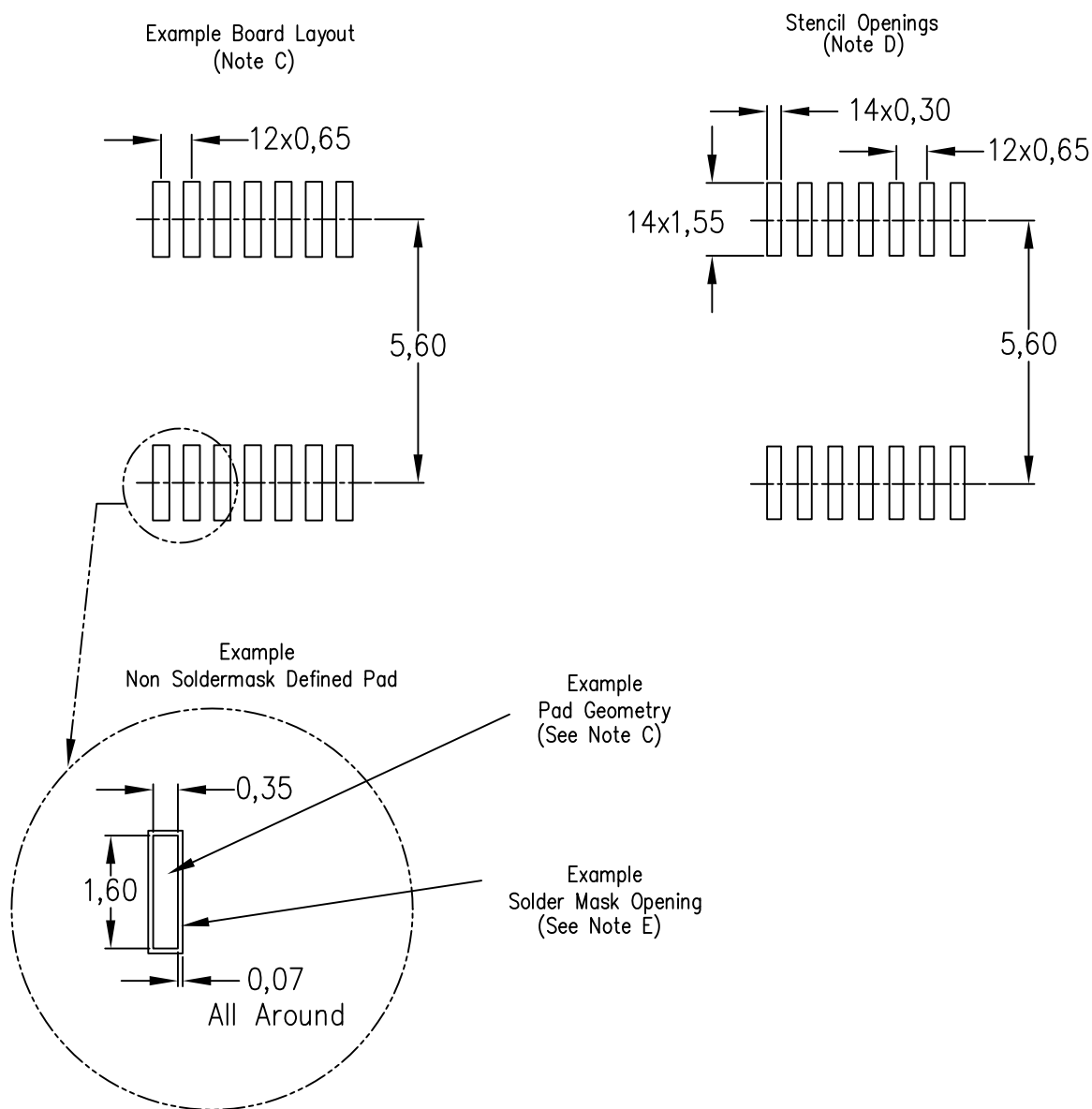


4040064-3/G 02/11

- 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



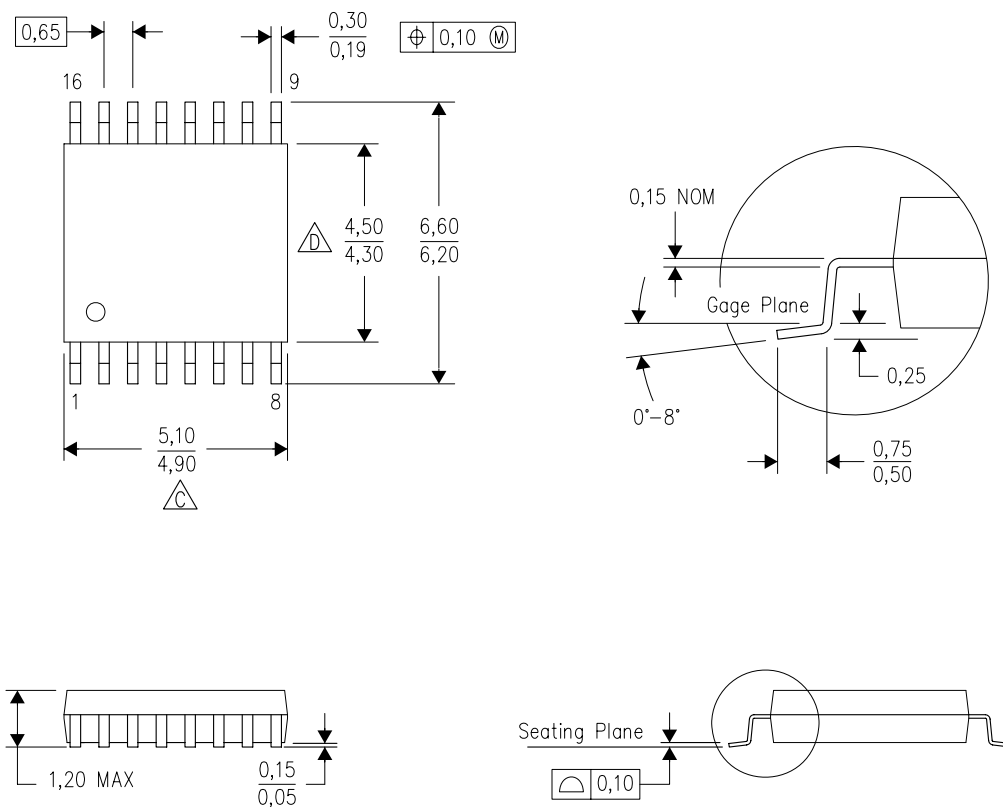
4211284-2/F 12/12

- 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.

## MECHANICAL DATA

PW (R-PDSO-G16)

# PLASTIC SMALL OUTLINE



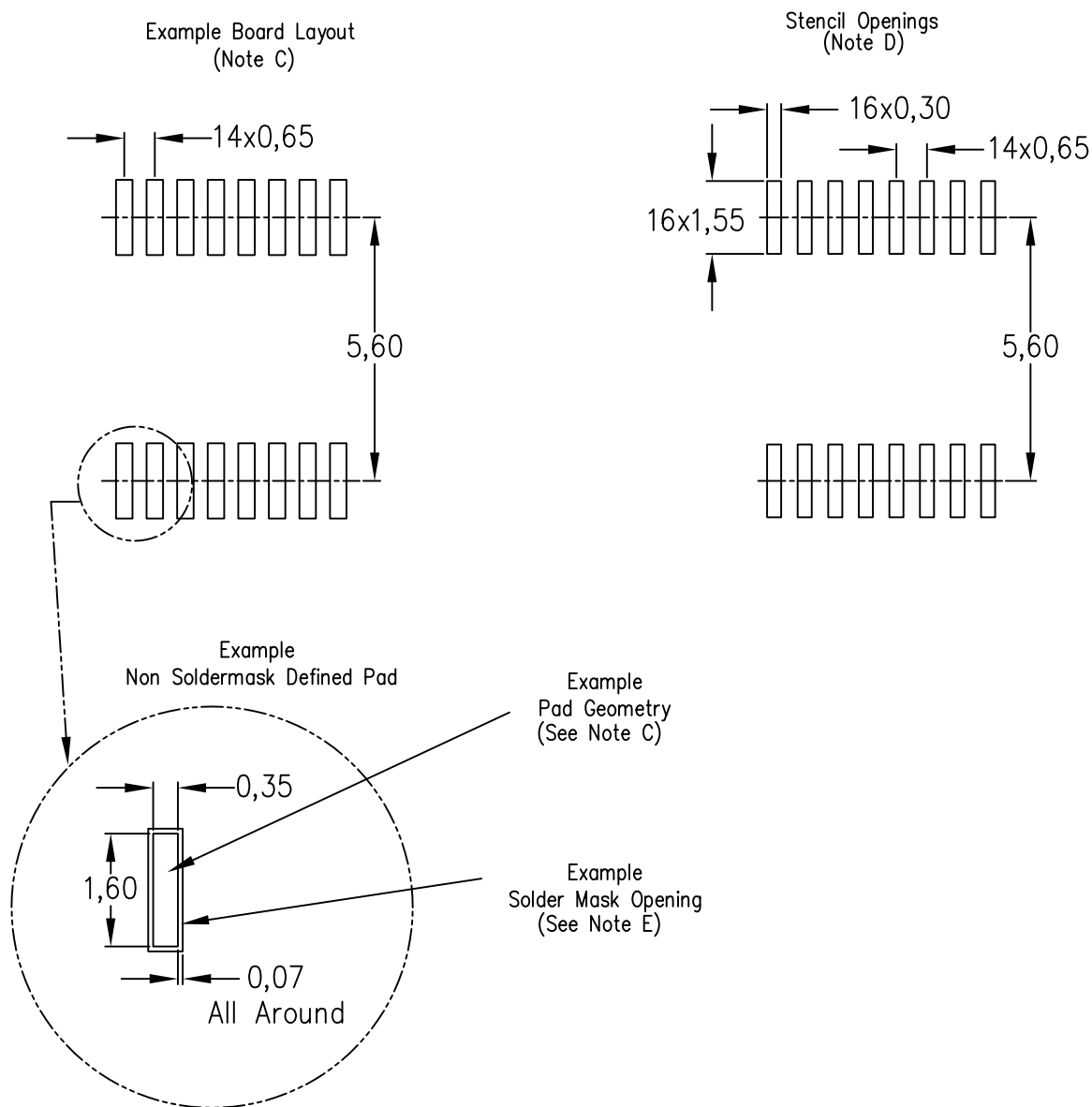
4040064-4/G 02/11

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-G16)

PLASTIC SMALL OUTLINE



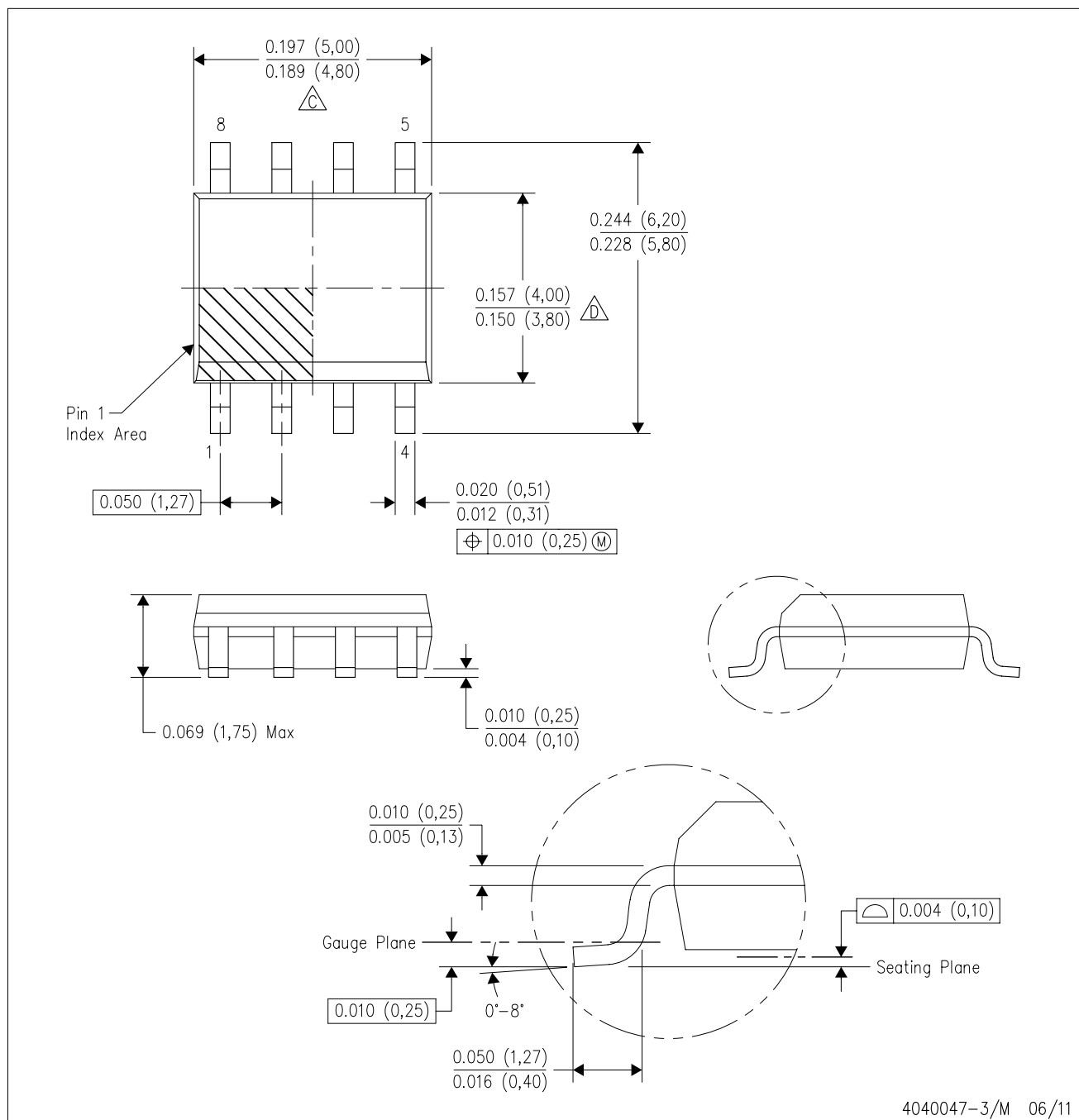
4211284-3/F 12/12

- 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.



D (R-PDSO-G8)

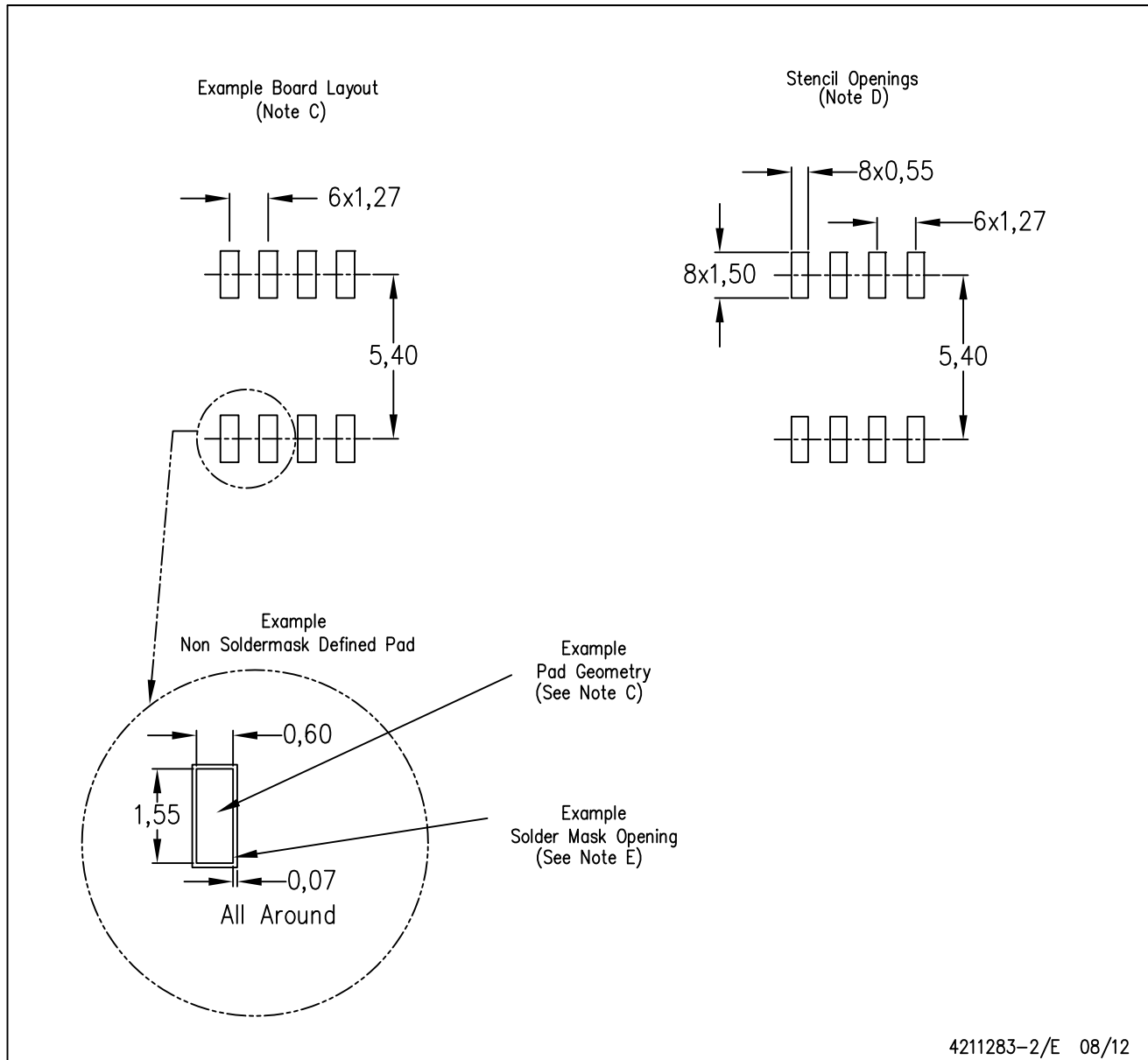
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  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 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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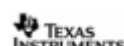
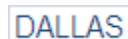
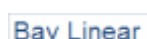
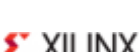
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