

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

- High Slew Rate . . . 10.5 V/ $\mu$ s Typ
- High-Gain Bandwidth . . . 5.1 MHz Typ
- Supply Voltage Range 2.5 V to 5.5 V
- Rail-to-Rail Output
- 360  $\mu$ V Input Offset Voltage
- Low Distortion Driving 600- $\Omega$   
0.005% THD+N
- 1 mA Supply Current (Per Channel)
- 17 nV/ $\sqrt{\text{Hz}}$  Input Noise Voltage
- 2 pA Input Bias Current
- Characterized From  $T_A = -55^\circ\text{C}$  to  $125^\circ\text{C}$
- Available in MSOP and SOT-23 Packages
- Micropower Shutdown Mode . . .  $I_{DD} < 1 \mu\text{A}$
- Available in Q-Temp Automotive  
High Reliability Automotive Applications  
Configuration Control / Print Support  
Qualification to Automotive Standards

### description

The TLV277x CMOS operational amplifier family combines high slew rate and bandwidth, rail-to-rail output swing, high output drive, and excellent dc precision. The device provides 10.5 V/ $\mu$ s of slew rate and 5.1 MHz of bandwidth while only consuming 1 mA of supply current per channel. This ac performance is much higher than current competitive CMOS amplifiers. The rail-to-rail output swing and high output drive make these devices a good choice for driving the analog input or reference of analog-to-digital converters. These devices also have low distortion while driving a 600- $\Omega$  load for use in telecom systems.

These amplifiers have a 360- $\mu$ V input offset voltage, a 17 nV/ $\sqrt{\text{Hz}}$  input noise voltage, and a 2-pA input bias current for measurement, medical, and industrial applications. The TLV277x family is also specified across an extended temperature range ( $-40^\circ\text{C}$  to  $125^\circ\text{C}$ ), making it useful for automotive systems, and the military temperature range ( $-55^\circ\text{C}$  to  $125^\circ\text{C}$ ), for military systems.

These devices operate from a 2.5-V to 5.5-V single supply voltage and are characterized at 2.7 V and 5 V. The single-supply operation and low power consumption make these devices a good solution for portable applications. The following table lists the packages available.

FAMILY PACKAGE TABLE

| DEVICE  | NUMBER OF CHANNELS | PACKAGE TYPES |      |      |        |       |      |      |      | SHUTDOWN | UNIVERSAL EVM BOARD                             |
|---------|--------------------|---------------|------|------|--------|-------|------|------|------|----------|-------------------------------------------------|
|         |                    | PDIP          | CDIP | SOIC | SOT-23 | TSSOP | MSOP | LCCC | CPAK |          |                                                 |
| TLV2770 | 1                  | 8             | —    | 8    | —      | —     | 8    | —    | —    | Yes      | Refer to the EVM Selection Guide (Lit# SLOU060) |
| TLV2771 | 1                  | —             | —    | 8    | 5      | —     | —    | —    | —    | —        |                                                 |
| TLV2772 | 2                  | 8             | 8    | 8    | —      | 8     | 8    | 20   | 10   | —        |                                                 |
| TLV2773 | 2                  | 14            | —    | 14   | —      | —     | 10   | —    | —    | Yes      |                                                 |
| TLV2774 | 4                  | 14            | —    | 14   | —      | 14    | —    | —    | —    | —        |                                                 |
| TLV2775 | 4                  | 16            | —    | 16   | —      | 16    | —    | —    | —    | Yes      |                                                 |

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

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

This document contains information on products in more than one phase of development. The status of each device is indicated on the page(s) specifying its electrical characteristics.

  
**TEXAS  
INSTRUMENTS**  
WWW.TI.COM

Copyright © 1998–2004, Texas Instruments Incorporated  
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TLV2770 and TLV2771 AVAILABLE OPTIONS

| T <sub>A</sub> | V <sub>IO</sub> max AT 25°C (mV) | PACKAGED DEVICES         |                  |                   |                 |
|----------------|----------------------------------|--------------------------|------------------|-------------------|-----------------|
|                |                                  | SMALL OUTLINE (D)        | SOT-23 (DBV)     | MSOP (DGK)        | PLASTIC DIP (P) |
| 0°C to 70°C    | 2.5                              | TLV2770CD<br>TLV2771CD   | —<br>TLV2771CDBV | TLV2770CDGK†<br>— | TLV2770CP<br>—  |
| –40°C to 125°C | 2.5                              | TLV2770ID<br>TLV2771ID   | —<br>TLV2771IDBV | TLV2770IDGK†<br>— | TLV2770IP<br>—  |
|                | 1.6                              | TLV2770AID<br>TLV2771AID | —<br>—           | —<br>—            | TLV2770AIP<br>— |

† This device is in the Product Preview stage of development. Please contact your local TI sales office for availability.

### TLV2772 and TLV2773 AVAILABLE OPTIONS

| T <sub>A</sub> | V <sub>IO</sub> max AT 25°C (mV) | PACKAGED DEVICES         |                  |                  |                 |                 |
|----------------|----------------------------------|--------------------------|------------------|------------------|-----------------|-----------------|
|                |                                  | SMALL OUTLINE (D)        | MSOP (DGK)       | MSOP (DGS)       | PLASTIC DIP (N) | PLASTIC DIP (P) |
| 0°C to 70°C    | 2.5                              | TLV2772CD<br>TLV2773CD   | TLV2772CDGK<br>— | —<br>TLV2773CDGS | —<br>TLV2773CN  | TLV2772CP<br>—  |
| –40°C to 125°C | 2.5                              | TLV2772ID<br>TLV2773ID   | TLV2772IDGK<br>— | —<br>TLV2773IDGS | —<br>TLV2773IN  | TLV2772IP<br>—  |
|                | 1.6                              | TLV2772AID<br>TLV2773AID | —<br>—           | —<br>—           | —<br>TLV2773AIN | TLV2772AIP<br>— |

### TLV2774 and TLV2775 AVAILABLE OPTIONS

| T <sub>A</sub> | V <sub>IO</sub> max AT 25°C (mV) | PACKAGED DEVICES         |                 |                 |                            |
|----------------|----------------------------------|--------------------------|-----------------|-----------------|----------------------------|
|                |                                  | SMALL OUTLINE (D)        | PLASTIC DIP (N) | PLASTIC DIP (P) | TSSOP (PW)                 |
| 0°C to 70°C    | 2.7                              | TLV2774CD<br>TLV2775CD   | —<br>TLV2775CN  | TLV2774CP<br>—  | TLV2774CPW<br>TLV2775CPW   |
| –40°C to 125°C | 2.7                              | TLV2774ID<br>TLV2775ID   | —<br>TLV2775IN  | TLV2774IP<br>—  | TLV2774IPW<br>TLV2775IPW   |
|                | 2.1                              | TLV2774AID<br>TLV2775AID | —<br>TLV2775AIN | TLV2774AIP<br>— | TLV2774AIPW<br>TLV2775AIPW |

### TLV2772M/Q AND TLV2772AM/Q AVAILABLE OPTIONS

| T <sub>A</sub> | V <sub>IO</sub> max AT 25°C (mV) | PACKAGED DEVICES  |                   |                  |                      |              |
|----------------|----------------------------------|-------------------|-------------------|------------------|----------------------|--------------|
|                |                                  | SMALL OUTLINE (D) | CHIP CARRIER (FK) | CERAMIC DIP (JG) | CERAMIC FLATPACK (U) | TSSOP (PW)   |
| –40°C to 125°C | 2.5                              | TLV2772QD‡        | —                 | —                | —                    | TLV2772QPW‡  |
|                | 1.6                              | TLV2772AQD‡       | —                 | —                | —                    | TLV2772AQPW‡ |
| –55°C to 125°C | 2.5                              | TLV2772MD         | TLV2772MFK        | TLV2772MJG       | TLV2772MU            | —            |
|                | 1.6                              | TLV2772AMD        | TLV2772AMFK       | TLV2772AMJG      | TLV2772AMU           | —            |

‡ Available in tape and reel

# **TLV277x, TLV277xA** **FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

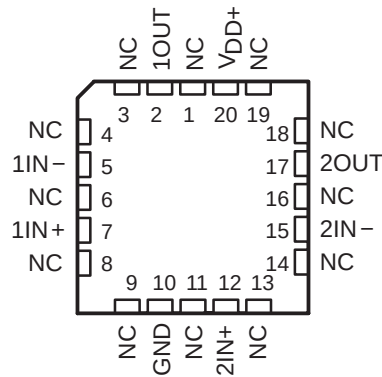
## **PACKAGE SYMBOLS**

| PACKAGE TYPE | PINS   | PART NUMBER | SYMBOL <sup>†</sup> |
|--------------|--------|-------------|---------------------|
| SOT23        | 5 Pin  | TLV2771CDBV | VAMC                |
|              |        | TLV2771IDBV | VAMI                |
| MSOP         | 8 Pin  | TLV2770CDGK | xxTIABO             |
|              |        | TLV2770IDGK | xxTIABP             |
|              |        | TLV2772CDGK | xxTIAAF             |
|              |        | TLV2772IDGK | xxTIAAG             |
|              | 10 Pin | TLV2773CDGS | xxTIABQ             |
|              |        | TLV2773IDGS | xxTIABR             |

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

## **TLV277x PACKAGE PINOUT**

### **TLV2772M AND TLV2772AM FK PACKAGE (TOP VIEW)**



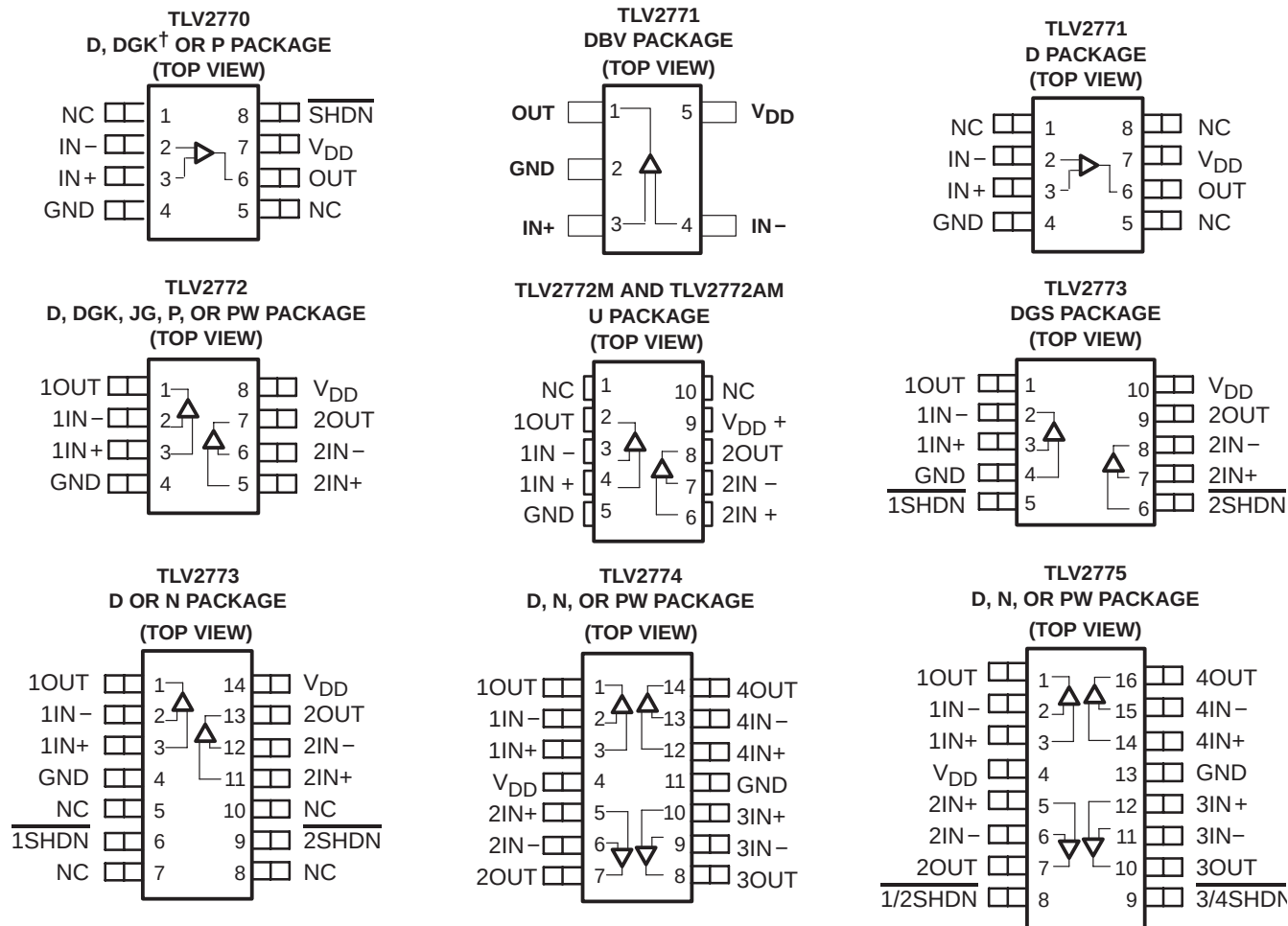
NC – No internal connection

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

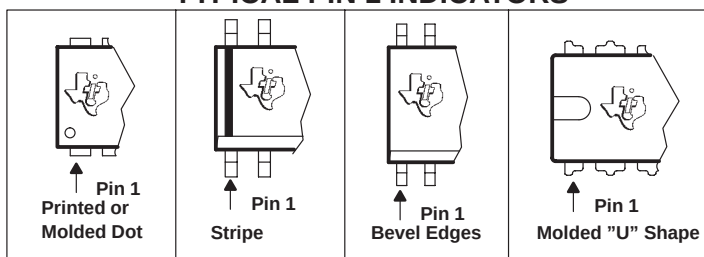
### TLV277x PACKAGE PINOUTS<sup>(1)</sup>



<sup>†</sup> This device is in the Product Preview stage of development. Please contact your local TI sales office for availability.

(1) SOT-23 may or may not be indicated

### TYPICAL PIN 1 INDICATORS



# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### 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, $V_{ID}$ (see Note 2)                 | $\pm V_{DD}$                 |
| Input voltage range, $V_I$ (any input, see Note 1)                | -0.3 V to $V_{DD}$           |
| Input current, $I_I$ (any input)                                  | $\pm 4$ mA                   |
| Output current, $I_O$                                             | $\pm 50$ mA                  |
| Total current into $V_{DD+}$                                      | $\pm 50$ mA                  |
| Total current out of GND                                          | $\pm 50$ mA                  |
| Duration of short-circuit current (at or below) 25°C (see Note 3) | unlimited                    |
| 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               |
| Q suffix                                                          | -40°C to 125°C               |
| M suffix                                                          | -55°C to 125°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.

- NOTES:
1. All voltage values, except differential voltages, are with respect to GND.
  2. Differential voltages are at the noninverting input with respect to the inverting input. Excessive current flows when input is brought below GND - 0.3 V.
  3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

DISSIPATION RATING TABLE

| PACKAGE | $T_A \leq 25^\circ\text{C}$<br>POWER RATING | DERATING FACTOR<br>ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$<br>POWER RATING | $T_A = 85^\circ\text{C}$<br>POWER RATING | $T_A = 125^\circ\text{C}$<br>POWER RATING |
|---------|---------------------------------------------|---------------------------------------------------|------------------------------------------|------------------------------------------|-------------------------------------------|
| D       | 725 mW                                      | 5.8 mW/°C                                         | 464 mW                                   | 377 mW                                   | 145 mW                                    |
| DBV     | 437 mW                                      | 3.5 mW/°C                                         | 280 mW                                   | 227 mW                                   | 87 mW                                     |
| DGK     | 424 mW                                      | 3.4 mW/°C                                         | 271 mW                                   | 220 mW                                   | 85 mW                                     |
| DGS     | 424 mW                                      | 3.4 mW/°C                                         | 271 mW                                   | 220 mW                                   | 85 mW                                     |
| FK      | 1375 mW                                     | 11.0 mW/°C                                        | 672 mW                                   | 546 mW                                   | 210 mW                                    |
| JG      | 1050 mW                                     | 8.4 mW/°C                                         | 880 mW                                   | 714 mW                                   | 275 mW                                    |
| N       | 1150 mW                                     | 9.2 mW/°C                                         | 736 mW                                   | 598 mW                                   | 230 mW                                    |
| P       | 1000 mW                                     | 8.0 mW/°C                                         | 640 mW                                   | 520 mW                                   | 200 mW                                    |
| PW      | 700 mW                                      | 5.6 mW/°C                                         | 448 mW                                   | 364 mW                                   | 140 mW                                    |
| U       | 675 mW                                      | 5.4 mW/°C                                         | 432 mW                                   | 350 mW                                   | 135 mW                                    |

### recommended operating conditions

|                                       | C SUFFIX |                 | I SUFFIX |                 | Q SUFFIX |                 | M SUFFIX |                 | UNIT |
|---------------------------------------|----------|-----------------|----------|-----------------|----------|-----------------|----------|-----------------|------|
|                                       | MIN      | MAX             | MIN      | MAX             | MIN      | MAX             | MIN      | MAX             |      |
| Supply voltage, $V_{DD}$              | 2.5      | 6               | 2.5      | 6               | 2.5      | 6               | 2.5      | 6               | V    |
| Input voltage range, $V_I$            | GND      | $V_{DD+} - 1.3$ | GND      | $V_{DD+} - 1.3$ | GND      | $V_{DD+} - 1.3$ | GND      | $V_{DD+} - 1.3$ | V    |
| Common-mode input voltage, $V_{IC}$   | GND      | $V_{DD+} - 1.3$ | GND      | $V_{DD+} - 1.3$ | GND      | $V_{DD+} - 1.3$ | GND      | $V_{DD+} - 1.3$ | V    |
| Operating free-air temperature, $T_A$ | 0        | 70              | -40      | 125             | -40      | 125             | -55      | 125             | °C   |

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

electrical characteristics at specified free-air temperature,  $V_{DD} = 2.7$  V (unless otherwise noted)

| PARAMETER      |                                                                    | TEST CONDITIONS                                   | $T_A^\dagger$                        | TLV277xC   |                  |     | UNIT             |
|----------------|--------------------------------------------------------------------|---------------------------------------------------|--------------------------------------|------------|------------------|-----|------------------|
|                |                                                                    |                                                   |                                      | MIN        | TYP              | MAX |                  |
| $V_{IO}$       | Input offset voltage                                               | $V_{IC} = 0$ ,<br>$R_S = 50\ \Omega$ ,<br>No load | $V_O = 0$ ,<br>$V_{DD} = \pm 1.35$ V | 25°C       | 0.48             | 2.5 | mV               |
|                |                                                                    |                                                   |                                      | Full range | 0.53             | 2.7 |                  |
|                |                                                                    |                                                   |                                      | 25°C       | 0.8              | 2.7 |                  |
|                |                                                                    |                                                   |                                      | Full range | 0.86             | 2.9 |                  |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage                    |                                                   | 25°C to 125°C                        |            | 2                |     | $\mu V/^\circ C$ |
| $I_{IO}$       | Input offset current                                               | $V_{IC} = 0$ ,<br>$R_S = 50\ \Omega$              | $V_O = 0$ ,<br>$V_{DD} = \pm 1.35$ V | 25°C       | 1                | 60  | pA               |
|                |                                                                    |                                                   |                                      | Full range | 2                | 100 |                  |
| $I_{IB}$       | Input bias current                                                 |                                                   |                                      | 25°C       | 2                | 60  | pA               |
|                |                                                                    |                                                   |                                      | Full range | 6                | 100 |                  |
| $V_{OH}$       | High-level output voltage                                          | $I_{OH} = -0.675$ mA                              |                                      | 25°C       | 2.6              |     | V                |
|                |                                                                    |                                                   |                                      | Full range | 2.5              |     |                  |
|                |                                                                    | $I_{OH} = -2.2$ mA                                |                                      | 25°C       | 2.4              |     |                  |
|                |                                                                    |                                                   |                                      | Full range | 2.1              |     |                  |
| $V_{OL}$       | Low-level output voltage                                           | $V_{IC} = 1.35$ V, $I_{OL} = 0.675$ mA            |                                      | 25°C       | 0.1              |     | V                |
|                |                                                                    |                                                   |                                      | Full range | 0.2              |     |                  |
|                |                                                                    | $V_{IC} = 1.35$ V, $I_{OL} = 2.2$ mA              |                                      | 25°C       | 0.21             |     |                  |
|                |                                                                    |                                                   |                                      | Full range | 0.6              |     |                  |
| $A_{VD}$       | Large-signal differential voltage amplification                    | $V_{IC} = 1.35$ V,<br>$V_O = 0.6$ V to 2.1 V      | $R_L = 10$ k $\Omega$ ,              | 25°C       | 20               | 380 | V/mV             |
|                |                                                                    |                                                   |                                      | Full range | 13               |     |                  |
| $r_{i(d)}$     | Differential input resistance                                      |                                                   |                                      | 25°C       | 10 <sup>12</sup> |     | $\Omega$         |
| $c_{i(c)}$     | Common-mode input capacitance                                      | $f = 10$ kHz                                      |                                      | 25°C       | 8                |     | pF               |
| $z_o$          | Closed-loop output impedance                                       | $f = 100$ kHz, $A_V = 10$                         |                                      | 25°C       | 25               |     | $\Omega$         |
| CMRR           | Common-mode rejection ratio                                        | $V_{IC} = 0$ to 1.5 V,<br>$R_S = 50\ \Omega$      | $V_O = V_{DD}/2$ ,                   | 25°C       | 60               | 84  | dB               |
|                |                                                                    |                                                   |                                      | Full range | 60               | 82  |                  |
| $k_{SVR}$      | Supply voltage rejection ratio ( $\Delta V_{DD} / \Delta V_{IO}$ ) | $V_{DD} = 2.7$ V to 5 V,<br>No load               | $V_{IC} = V_{DD}/2$ ,                | 25°C       | 70               | 89  | dB               |
|                |                                                                    |                                                   |                                      | Full range | 70               | 84  |                  |
| $I_{DD}$       | Supply current (per channel)                                       | $V_O = V_{DD}/2$ ,<br>No load                     |                                      | 25°C       | 1                | 2   | mA               |
|                |                                                                    |                                                   |                                      | Full range |                  | 2   |                  |
| $I_{DD(SHDN)}$ | Supply current in shutdown (per channel)                           |                                                   |                                      | 25°C       | 0.8              | 1.5 | $\mu A$          |
|                |                                                                    |                                                   |                                      | Full range | 1.3              | 2   |                  |
| $V_{(ON)}$     | Turnon voltage level                                               | TLV2770                                           | $A_V = 5$                            | 25°C       | 1.47             |     | V                |
|                |                                                                    | TLV2773                                           |                                      |            | 1.43             |     |                  |
|                |                                                                    | TLV2775                                           |                                      |            | 1.40             |     |                  |
| $V_{(OFF)}$    | Turnoff voltage level                                              | TLV2770                                           | $A_V = 5$                            | 25°C       | 1.27             |     | V                |
|                |                                                                    | TLV2773                                           |                                      |            | 1.21             |     |                  |
|                |                                                                    | TLV2775                                           |                                      |            | 1.20             |     |                  |

<sup>†</sup> Full range is 0°C to 70°C.

**TLV277x, TLV277xA**  
**FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

operating characteristics at specified free-air temperature,  $V_{DD} = 2.7\text{ V}$  (unless otherwise noted)

| PARAMETER              |                                             | TEST CONDITIONS                                                                           |                         | T <sub>A</sub> <sup>†</sup> | TLV277xC |     |        | UNIT |
|------------------------|---------------------------------------------|-------------------------------------------------------------------------------------------|-------------------------|-----------------------------|----------|-----|--------|------|
|                        |                                             |                                                                                           |                         |                             | MIN      | TYP | MAX    |      |
| SR                     | Slew rate at unity gain                     | V <sub>O(PP)</sub> = 0.8 V, C <sub>L</sub> = 100 pF,<br>R <sub>L</sub> = 10 kΩ            |                         | 25°C                        | 5        | 9   | V/μs   |      |
|                        |                                             |                                                                                           |                         | Full range                  | 4.7      | 6   |        |      |
| V <sub>n</sub>         | Equivalent input noise voltage              | f = 1 kHz                                                                                 |                         | 25°C                        | 21       |     | nV/√Hz |      |
|                        |                                             | f = 10 kHz                                                                                |                         | 25°C                        | 17       |     |        |      |
| V <sub>N(PP)</sub>     | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz                                                                        |                         | 25°C                        | 0.33     |     | μV     |      |
|                        |                                             | f = 0.1 Hz to 10 Hz                                                                       |                         |                             | 0.86     |     |        |      |
| I <sub>n</sub>         | Equivalent input noise current              | f = 100 Hz                                                                                |                         | 25°C                        | 0.6      |     | fA/√Hz |      |
| THD + N                | Total harmonic distortion plus noise        | R <sub>L</sub> = 600 Ω,<br>f = 1 kHz                                                      | A <sub>V</sub> = 1      | 25°C                        | 0.0085%  |     |        |      |
|                        |                                             |                                                                                           | A <sub>V</sub> = 10     |                             | 0.025%   |     |        |      |
|                        |                                             |                                                                                           | A <sub>V</sub> = 100    |                             | 0.12%    |     |        |      |
| Gain-bandwidth product |                                             | f = 10 kHz,<br>C <sub>L</sub> = 100 pF                                                    | R <sub>L</sub> = 600 Ω, | 25°C                        | 4.8      |     | MHz    |      |
| t <sub>s</sub>         | Settling time                               | A <sub>V</sub> = −1,<br>Step = 1 V,<br>R <sub>L</sub> = 600 Ω,<br>C <sub>L</sub> = 100 pF | 0.1%                    | 25°C                        | 0.186    |     | μs     |      |
|                        |                                             |                                                                                           | 0.01%                   | 25°C                        | 0.3      |     |        |      |
| φ <sub>m</sub>         | Phase margin at unity gain                  | R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 100 pF                                           |                         | 25°C                        | 46°      |     |        |      |
|                        | Gain margin                                 |                                                                                           |                         | 25°C                        | 12       |     | dB     |      |

$^\dagger$  Full range is 0°C to 70°C.

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

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

| PARAMETER      |                                                                    | TEST CONDITIONS                                              | $T_A^\dagger$ | TLV277xC   |                  |     | UNIT                         |
|----------------|--------------------------------------------------------------------|--------------------------------------------------------------|---------------|------------|------------------|-----|------------------------------|
|                |                                                                    |                                                              |               | MIN        | TYP              | MAX |                              |
| $V_{IO}$       | Input offset voltage                                               | $V_{IC} = 0,$<br>$R_S = 50\ \Omega,$<br>No load              | 25°C          |            | 0.5              | 2.5 | mV                           |
|                |                                                                    |                                                              |               | Full range | 0.6              | 2.7 |                              |
|                |                                                                    |                                                              | 25°C          |            | 0.7              | 2.5 |                              |
|                |                                                                    |                                                              | Full range    |            | 0.78             | 2.7 |                              |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage                    |                                                              | 25°C to 125°C |            | 2                |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$       | Input offset current                                               | $V_{IC} = 0,$<br>$R_S = 50\ \Omega$                          | 25°C          |            | 1                | 60  | pA                           |
|                |                                                                    |                                                              | Full range    |            | 2                | 100 |                              |
| $I_{IB}$       | Input bias current                                                 |                                                              | 25°C          |            | 2                | 60  | pA                           |
|                |                                                                    |                                                              | Full range    |            | 6                | 100 |                              |
| $V_{OH}$       | High-level output voltage                                          | $I_{OH} = -1.3\text{ mA}$                                    | 25°C          |            | 4.9              |     | V                            |
|                |                                                                    |                                                              | Full range    |            | 4.8              |     |                              |
|                |                                                                    | $I_{OH} = -4.2\text{ mA}$                                    | 25°C          |            | 4.7              |     |                              |
|                |                                                                    |                                                              | Full range    |            | 4.4              |     |                              |
| $V_{OL}$       | Low-level output voltage                                           | $V_{IC} = 2.5\text{ V},$<br>$I_{OL} = 1.3\text{ mA}$         | 25°C          |            | 0.1              |     | V                            |
|                |                                                                    |                                                              | Full range    |            | 0.2              |     |                              |
|                |                                                                    | $V_{IC} = 2.5\text{ V},$<br>$I_{OL} = 4.2\text{ mA}$         | 25°C          |            | 0.21             |     |                              |
|                |                                                                    |                                                              | Full range    |            | 0.6              |     |                              |
| $A_{VD}$       | Large-signal differential voltage amplification                    | $V_{IC} = 2.5\text{ V},$<br>$V_O = 1\text{ V to }4\text{ V}$ | 25°C          |            | 20               | 450 | V/mV                         |
|                |                                                                    |                                                              | Full range    |            | 13               |     |                              |
| $r_{i(d)}$     | Differential input resistance                                      |                                                              | 25°C          |            | 10 <sup>12</sup> |     | $\Omega$                     |
| $c_{i(c)}$     | Common-mode input capacitance                                      | $f = 10\text{ kHz}$                                          | 25°C          |            | 8                |     | pF                           |
| $z_o$          | Closed-loop output impedance                                       | $f = 100\text{ kHz},$<br>$A_V = 10$                          | 25°C          |            | 20               |     | $\Omega$                     |
| CMRR           | Common-mode rejection ratio                                        | $V_{IC} = 0\text{ to }3.7\text{ V},$<br>$R_S = 50\ \Omega$   | 25°C          |            | 70               | 96  | dB                           |
|                |                                                                    |                                                              | Full range    |            | 70               | 93  |                              |
| $k_{SVR}$      | Supply voltage rejection ratio ( $\Delta V_{DD} / \Delta V_{IO}$ ) | $V_{DD} = 2.7\text{ V to }5\text{ V},$<br>No load            | 25°C          |            | 70               | 89  | dB                           |
|                |                                                                    |                                                              | Full range    |            | 70               | 84  |                              |
| $I_{DD}$       | Supply current (per channel)                                       | $V_O = V_{DD}/2,$<br>No load                                 | 25°C          |            | 1                | 2   | mA                           |
|                |                                                                    |                                                              | Full range    |            |                  | 2   |                              |
| $I_{DD(SHDN)}$ | Supply current in shutdown (per channel)                           |                                                              | 25°C          |            | 0.8              | 1.5 | $\mu\text{A}$                |
|                |                                                                    |                                                              | Full range    |            | 1.3              | 2   |                              |
| $V_{(ON)}$     | Turnon voltage level                                               | $A_V = 5$                                                    | 25°C          |            | 2.59             |     | V                            |
|                |                                                                    |                                                              |               |            | 2.47             |     |                              |
|                |                                                                    |                                                              |               |            | 2.48             |     |                              |
| $V_{(OFF)}$    | Turnoff voltage level                                              | $A_V = 5$                                                    | 25°C          |            | 2.41             |     | V                            |
|                |                                                                    |                                                              |               |            | 2.32             |     |                              |
|                |                                                                    |                                                              |               |            | 2.29             |     |                              |

$^\dagger$  Full range is 0°C to 70°C.



**TLV277x, TLV277xA**  
**FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

operating characteristics at specified free-air temperature,  $V_{DD} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER              |                                             |  | TEST CONDITIONS                                                                  |                                                                  | T <sub>A</sub> <sup>†</sup> | TLV277xC |         |        | UNIT |
|------------------------|---------------------------------------------|--|----------------------------------------------------------------------------------|------------------------------------------------------------------|-----------------------------|----------|---------|--------|------|
|                        |                                             |  |                                                                                  |                                                                  |                             | MIN      | TYP     | MAX    |      |
| SR                     | Slew rate at unity gain                     |  | V <sub>O(PP)</sub> = 2 V, C <sub>L</sub> = 100 pF, R <sub>L</sub> = 10 kΩ        |                                                                  | 25°C                        | 5        | 10.5    | V/μs   |      |
|                        |                                             |  |                                                                                  |                                                                  | Full range                  | 4.7      | 6       |        |      |
| V <sub>n</sub>         | Equivalent input noise voltage              |  | f = 1 kHz                                                                        |                                                                  | 25°C                        | 17       |         | nV/√Hz |      |
|                        |                                             |  | f = 10 kHz                                                                       |                                                                  | 25°C                        | 12       |         |        |      |
| V <sub>N(PP)</sub>     | Peak-to-peak equivalent input noise voltage |  | f = 0.1 Hz to 1 Hz                                                               |                                                                  | 25°C                        | 0.33     |         | μV     |      |
|                        |                                             |  | f = 0.1 Hz to 10 Hz                                                              |                                                                  |                             | 0.86     |         |        |      |
| I <sub>n</sub>         | Equivalent input noise current              |  | f = 100 Hz                                                                       |                                                                  | 25°C                        | 0.6      |         | fA/√Hz |      |
| THD + N                | Total harmonic distortion plus noise        |  | R <sub>L</sub> = 600 Ω, f = 1 kHz                                                | A <sub>V</sub> = 1                                               | 25°C                        | 0.005%   |         |        |      |
|                        |                                             |  |                                                                                  | A <sub>V</sub> = 10                                              |                             | 0.016%   |         |        |      |
|                        |                                             |  |                                                                                  | A <sub>V</sub> = 100                                             |                             | 0.095%   |         |        |      |
| Gain-bandwidth product |                                             |  | f = 10 kHz, R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 100 pF                      |                                                                  | 25°C                        | 5.1      |         | MHz    |      |
| t <sub>s</sub>         | Settling time                               |  | A <sub>V</sub> = -1, Step = 2 V, R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 100 pF | 0.1%                                                             | 25°C                        | 0.335    |         | μs     |      |
|                        |                                             |  |                                                                                  | 0.01%                                                            | 25°C                        | 0.6      |         |        |      |
| φ <sub>m</sub>         | Phase margin at unity gain                  |  | R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 100 pF                                  |                                                                  | 25°C                        | 46°      |         |        |      |
| Gain margin            |                                             |  |                                                                                  |                                                                  | 25°C                        | 12       |         | dB     |      |
| t <sub>(ON)</sub>      | Amplifier turnon time                       |  | TLV2770                                                                          | A <sub>V</sub> = 5, R <sub>L</sub> = Open, Measured to 50% point | 25°C                        | 1.2      |         | μs     |      |
|                        |                                             |  |                                                                                  |                                                                  |                             | TLV2773  | 2.4     |        |      |
|                        |                                             |  |                                                                                  |                                                                  |                             |          | TLV2775 |        | 1.9  |
| t <sub>(OFF)</sub>     | Amplifier turnoff time                      |  | TLV2770                                                                          | A <sub>V</sub> = 5 R <sub>L</sub> = Open, Measured to 50% point  | 25°C                        | 335      |         | ns     |      |
|                        |                                             |  |                                                                                  |                                                                  |                             | TLV2773  | 444     |        |      |
|                        |                                             |  |                                                                                  |                                                                  |                             |          | TLV2775 |        | 345  |

$^\dagger$  Full range is 0°C to 70°C.

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

electrical characteristics at specified free-air temperature,  $V_{DD} = 2.7\text{ V}$  (unless otherwise noted)

| PARAMETER      |                                                                    | TEST CONDITIONS                                                                                  | $T_A^\dagger$ | TLV277xI         |     |     | TLV277xAI        |     |     | UNIT                         |
|----------------|--------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------|------------------|-----|-----|------------------|-----|-----|------------------------------|
|                |                                                                    |                                                                                                  |               | MIN              | TYP | MAX | MIN              | TYP | MAX |                              |
| $V_{IO}$       | Input offset voltage                                               | $V_{IC} = 0, V_O = 0,$<br>$R_S = 50\ \Omega$<br>$V_{DD} = \pm 1.35\text{ V},$<br>No load         | 25°C          | 0.48             | 2.5 |     | 0.48             | 1.6 |     | mV                           |
|                |                                                                    |                                                                                                  | Full range    | 0.53             | 2.7 |     | 0.53             | 1.9 |     |                              |
|                |                                                                    |                                                                                                  | 25°C          | 0.8              | 2.7 |     | 0.8              | 2.1 |     |                              |
|                |                                                                    |                                                                                                  | Full range    | 0.86             | 2.9 |     | 0.86             | 2.2 |     |                              |
| $\alpha_{VIO}$ | Temperature coefficient of input offset voltage                    |                                                                                                  | 25°C to 125°C | 2                |     |     | 2                |     |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$       | Input offset current                                               | $V_{IC} = 0, V_O = 0,$<br>$R_S = 50\ \Omega$                                                     | 25°C          | 1                | 60  |     | 1                | 60  |     | pA                           |
|                |                                                                    |                                                                                                  | Full range    | 2                | 125 |     | 2                | 125 |     |                              |
| $I_{IB}$       | Input bias current                                                 |                                                                                                  | 25°C          | 2                | 60  |     | 2                | 60  |     | pA                           |
|                |                                                                    |                                                                                                  | Full range    | 6                | 350 |     | 6                | 350 |     |                              |
| $V_{OH}$       | High-level output voltage                                          | $I_{OH} = -0.675\text{ mA}$                                                                      | 25°C          | 2.6              |     |     | 2.6              |     |     | V                            |
|                |                                                                    |                                                                                                  | Full range    | 2.5              |     |     | 2.5              |     |     |                              |
|                |                                                                    | $I_{OH} = -2.2\text{ mA}$                                                                        | 25°C          | 2.4              |     |     | 2.4              |     |     |                              |
|                |                                                                    |                                                                                                  | Full range    | 2.1              |     |     | 2.1              |     |     |                              |
| $V_{OL}$       | Low-level output voltage                                           | $V_{IC} = 1.35\text{ V},$<br>$I_{OL} = 0.675\text{ mA}$                                          | 25°C          | 0.1              |     |     | 0.1              |     |     | V                            |
|                |                                                                    |                                                                                                  | Full range    | 0.2              |     |     | 0.2              |     |     |                              |
|                |                                                                    | $V_{IC} = 1.35\text{ V},$<br>$I_{OL} = 2.2\text{ mA}$                                            | 25°C          | 0.21             |     |     | 0.21             |     |     |                              |
|                |                                                                    |                                                                                                  | Full range    | 0.6              |     |     | 0.6              |     |     |                              |
| $A_{VD}$       | Large-signal differential voltage amplification                    | $V_{IC} = 1.35\text{ V},$<br>$R_L = 10\text{ k}\Omega,$<br>$V_O = 0.6\text{ V to } 2.1\text{ V}$ | 25°C          | 20               | 380 |     | 20               | 380 |     | V/mV                         |
|                |                                                                    |                                                                                                  | Full range    | 13               |     |     | 13               |     |     |                              |
| $r_{i(d)}$     | Differential input resistance                                      |                                                                                                  | 25°C          | 10 <sup>12</sup> |     |     | 10 <sup>12</sup> |     |     | $\Omega$                     |
| $c_{i(c)}$     | Common-mode input capacitance                                      | $f = 10\text{ kHz},$                                                                             | 25°C          | 8                |     |     | 8                |     |     | pF                           |
| $z_o$          | Closed-loop output impedance                                       | $f = 100\text{ kHz},$<br>$A_V = 10$                                                              | 25°C          | 25               |     |     | 25               |     |     | $\Omega$                     |
| CMRR           | Common-mode rejection ratio                                        | $V_{IC} = 0\text{ to } 1.5\text{ V},$<br>$V_O = V_{DD}/2,$<br>$R_S = 50\ \Omega$                 | 25°C          | 60               | 84  |     | 60               | 84  |     | dB                           |
|                |                                                                    |                                                                                                  | Full range    | 60               | 82  |     | 60               | 82  |     |                              |
| $k_{SVR}$      | Supply voltage rejection ratio ( $\Delta V_{DD} / \Delta V_{IO}$ ) | $V_{DD} = 2.7\text{ V to } 5\text{ V},$<br>$V_{IC} = V_{DD}/2,$<br>No load                       | 25°C          | 70               | 89  |     | 70               | 89  |     | dB                           |
|                |                                                                    |                                                                                                  | Full range    | 70               | 84  |     | 70               | 84  |     |                              |
| $I_{DD}$       | Supply current (per channel)                                       | $V_O = V_{DD}/2,$<br>No load                                                                     | 25°C          | 1                | 2   |     | 1                | 2   |     | mA                           |
|                |                                                                    |                                                                                                  | Full range    |                  | 2   |     |                  | 2   |     |                              |
| $I_{DD(SHDN)}$ | Supply current in shutdown (per channel)                           |                                                                                                  | 25°C          | 0.8              | 1.5 |     | 0.8              | 1.5 |     | $\mu\text{A}$                |
|                |                                                                    |                                                                                                  | Full range    | 1.3              | 2   |     | 1.3              | 2   |     |                              |

<sup>†</sup> Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

**TLV277x, TLV277xA**  
**FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

**electrical characteristics at specified free-air temperature,  $V_{DD} = 2.7$  V (unless otherwise noted)**  
**(continued)**

| PARAMETER          |                       | TEST CONDITIONS | T <sub>A</sub> <sup>†</sup> | TLV277xI |      |     | TLV277xAI |      |     | UNIT |   |
|--------------------|-----------------------|-----------------|-----------------------------|----------|------|-----|-----------|------|-----|------|---|
|                    |                       |                 |                             | MIN      | TYP  | MAX | MIN       | TYP  | MAX |      |   |
| V <sub>(ON)</sub>  | Turnon voltage level  | TLV2770         | A <sub>V</sub> = 5          | 25°C     | 1.47 |     |           | 1.47 |     |      | V |
|                    |                       | TLV2773         |                             |          | 1.43 |     |           | 1.43 |     |      |   |
|                    |                       | TLV2775         |                             |          | 1.40 |     |           | 1.4  |     |      |   |
| V <sub>(OFF)</sub> | Turnoff voltage level | TLV2770         | A <sub>V</sub> = 5          | 25°C     | 1.27 |     |           | 1.27 |     |      | V |
|                    |                       | TLV2773         |                             |          | 1.21 |     |           | 1.21 |     |      |   |
|                    |                       | TLV2775         |                             |          | 1.20 |     |           | 1.2  |     |      |   |

$^\dagger$  Full range is – 40°C to 125°C.

**operating characteristics at specified free-air temperature,  $V_{DD} = 2.7$  V (unless otherwise noted)**

| PARAMETER              |                                             | TEST CONDITIONS                                                                               |                      | T <sub>A</sub> <sup>†</sup> | TLV277xI |     |     | TLV277xAI |     |     | UNIT   |
|------------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------|----------------------|-----------------------------|----------|-----|-----|-----------|-----|-----|--------|
|                        |                                             |                                                                                               |                      |                             | MIN      | TYP | MAX | MIN       | TYP | MAX |        |
| SR                     | Slew rate at unity gain                     | V <sub>O(PP)</sub> = 0.8 V, C <sub>L</sub> = 100 pF, R <sub>L</sub> = 10 kΩ                   |                      | 25°C                        | 5        | 9   |     | 5         | 9   |     | V/μs   |
|                        |                                             |                                                                                               |                      | Full range                  | 4.7      | 6   |     | 4.7       | 6   |     |        |
| V <sub>n</sub>         | Equivalent input noise voltage              | f = 1 kHz                                                                                     |                      | 25°C                        | 21       |     |     | 21        |     |     | nV/√Hz |
|                        |                                             | f = 10 kHz                                                                                    |                      | 25°C                        | 17       |     |     | 17        |     |     |        |
| V <sub>N(PP)</sub>     | Peak-to-peak equivalent input noise voltage | f = 0.1 Hz to 1 Hz                                                                            |                      | 25°C                        | 0.33     |     |     | 0.33      |     |     | μV     |
|                        |                                             | f = 0.1 Hz to 10 Hz                                                                           |                      | 25°C                        | 0.86     |     |     | 0.86      |     |     | μV     |
| I <sub>n</sub>         | Equivalent input noise current              | f = 100 Hz                                                                                    |                      | 25°C                        | 0.6      |     |     | 0.6       |     |     | fA/√Hz |
| THD + N                | Total harmonic distortion plus noise        | R <sub>L</sub> = 600 Ω, f = 1 kHz                                                             | A <sub>V</sub> = 1   | 25°C                        | 0.0085%  |     |     | 0.0085%   |     |     |        |
|                        |                                             |                                                                                               | A <sub>V</sub> = 10  |                             | 0.025%   |     |     | 0.025%    |     |     |        |
|                        |                                             |                                                                                               | A <sub>V</sub> = 100 |                             | 0.12%    |     |     | 0.12%     |     |     |        |
| Gain-bandwidth product |                                             | f = 10 kHz, R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 100 pF                                   |                      | 25°C                        | 4.8      |     |     | 4.8       |     |     | MHz    |
| t <sub>s</sub>         | Settling time                               | A <sub>V</sub> = −1, Step = 0.85 V to 1.85 V, R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 100 pF | 0.1%                 | 25°C                        | 0.186    |     |     | 0.186     |     |     | μs     |
|                        |                                             |                                                                                               | 0.01%                | 25°C                        | 3.92     |     |     | 3.92      |     |     |        |
| φ <sub>m</sub>         | Phase margin at unity gain                  | R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 100 pF                                               |                      | 25°C                        | 46°      |     |     | 46°       |     |     |        |
| Gain margin            |                                             |                                                                                               |                      | 25°C                        | 12       |     |     | 12        |     |     | dB     |

$^\dagger$  Full range is – 40°C to 125°C.

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

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

| PARAMETER                 |                                                                         | TEST CONDITIONS                                                                                           | T <sub>A</sub> <sup>†</sup> | TLV277xI                  |                           |      | TLV277xAI        |       |     | UNIT |
|---------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-----------------------------|---------------------------|---------------------------|------|------------------|-------|-----|------|
|                           |                                                                         |                                                                                                           |                             | MIN                       | TYP                       | MAX  | MIN              | TYP   | MAX |      |
| V <sub>IO</sub>           | Input offset voltage                                                    | V <sub>IC</sub> = 0, No load<br>V <sub>O</sub> = 0,<br>R <sub>S</sub> = 50 Ω,<br>V <sub>DD</sub> = ±2.5 V | 25°C                        | 0.5                       | 2.5                       | 0.5  | 1.6              | mV    |     |      |
|                           |                                                                         |                                                                                                           | Full range                  | 0.6                       | 2.7                       | 0.6  | 1.9              |       |     |      |
|                           | 25°C                                                                    |                                                                                                           | 0.7                         | 2.5                       | 0.7                       | 2.1  |                  |       |     |      |
|                           | Full range                                                              |                                                                                                           | 0.78                        | 2.7                       | 0.78                      | 2.2  |                  |       |     |      |
| α <sub>VIO</sub>          | Temperature coefficient of input offset voltage                         | V <sub>IC</sub> = 0,<br>V <sub>O</sub> = 0,<br>R <sub>S</sub> = 50 Ω,<br>V <sub>DD</sub> = ±2.5 V         | 25°C to 125°C               | 2                         |                           | 2    |                  | μV/°C |     |      |
| I <sub>IO</sub>           | Input offset current                                                    |                                                                                                           | 25°C                        | 1                         | 60                        | 1    | 60               | pA    |     |      |
| I <sub>IB</sub>           | Input bias current                                                      |                                                                                                           | Full range                  | 2                         | 125                       | 2    | 125              |       |     |      |
|                           |                                                                         |                                                                                                           | 25°C                        | 2                         | 60                        | 2    | 60               | pA    |     |      |
|                           |                                                                         |                                                                                                           | Full range                  | 6                         | 350                       | 6    | 350              |       |     |      |
|                           |                                                                         |                                                                                                           | V <sub>OH</sub>             | High-level output voltage | I <sub>OH</sub> = −1.3 mA | 25°C | 4.9              | 4.9   | V   |      |
| Full range                | 4.8                                                                     | 4.8                                                                                                       |                             |                           |                           |      |                  |       |     |      |
| I <sub>OH</sub> = −4.2 mA | 25°C                                                                    | 4.7                                                                                                       |                             | 4.7                       |                           |      |                  |       |     |      |
|                           | Full range                                                              | 4.4                                                                                                       |                             | 4.4                       |                           |      |                  |       |     |      |
| V <sub>OL</sub>           | Low-level output voltage                                                | V <sub>IC</sub> = 2.5 V,<br>I <sub>OL</sub> = 1.3 mA                                                      | 25°C                        | 0.1                       | 0.1                       | V    |                  |       |     |      |
|                           |                                                                         |                                                                                                           | Full range                  | 0.2                       | 0.2                       |      |                  |       |     |      |
|                           |                                                                         | V <sub>IC</sub> = 2.5 V,<br>I <sub>OL</sub> = 4.2 mA                                                      | 25°C                        | 0.21                      | 0.21                      |      |                  |       |     |      |
|                           |                                                                         |                                                                                                           | Full range                  | 0.6                       | 0.6                       |      |                  |       |     |      |
| A <sub>VD</sub>           | Large-signal differential voltage amplification                         | V <sub>IC</sub> = 2.5 V,<br>R <sub>L</sub> = 10 kΩ,<br>V <sub>O</sub> = 1 V to 4 V                        | 25°C                        | 20                        | 450                       | 20   | 450              | V/mV  |     |      |
|                           |                                                                         |                                                                                                           | Full range                  | 13                        |                           | 13   |                  |       |     |      |
| r <sub>i(d)</sub>         | Differential input resistance                                           |                                                                                                           | 25°C                        | 10 <sup>12</sup>          |                           |      | 10 <sup>12</sup> | Ω     |     |      |
| c <sub>i(c)</sub>         | Common-mode input capacitance                                           | f = 10 kHz                                                                                                | 25°C                        | 8                         |                           |      | 8                | pF    |     |      |
| z <sub>o</sub>            | Closed-loop output impedance                                            | f = 100 kHz,<br>A <sub>V</sub> = 10                                                                       | 25°C                        | 20                        |                           |      | 20               | Ω     |     |      |
| CMRR                      | Common-mode rejection ratio                                             | V <sub>IC</sub> = 0 to 3.7 V,<br>V <sub>O</sub> = V <sub>DD</sub> /2,<br>R <sub>S</sub> = 50 Ω            | 25°C                        | 60                        | 96                        | 70   | 96               | dB    |     |      |
|                           |                                                                         |                                                                                                           | Full range                  | 60                        | 93                        | 70   | 93               |       |     |      |
| 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 5 V,<br>V <sub>IC</sub> = V <sub>DD</sub> /2,<br>No load                       | 25°C                        | 70                        | 89                        | 70   | 89               | dB    |     |      |
|                           |                                                                         |                                                                                                           | Full range                  | 70                        | 84                        | 70   | 84               |       |     |      |
| I <sub>DD</sub>           | Supply current (per channel)                                            | V <sub>O</sub> = V <sub>DD</sub> /2,<br>No load                                                           | 25°C                        | 1                         | 2                         | 1    | 2                | mA    |     |      |
|                           |                                                                         |                                                                                                           | Full range                  | 2                         |                           | 2    |                  |       |     |      |
| I <sub>DD</sub> (SHDN)    | Supply current shutdown (per channel)                                   |                                                                                                           | 25°C                        | 0.8                       | 1.5                       | 0.8  | 1.5              | μA    |     |      |
|                           |                                                                         |                                                                                                           | Full range                  | 1.3                       | 2                         | 1.3  | 2                |       |     |      |

<sup>†</sup> Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

**TLV277x, TLV277xA**  
**FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

**electrical characteristics at specified free-air temperature,  $V_{DD} = 5\text{ V}$  (unless otherwise noted) (continued)**

| PARAMETER          |                       | TEST CONDITIONS | T <sub>A</sub> <sup>†</sup> | TLV277xI |      |     | TLV277xAI |      |     | UNIT |   |
|--------------------|-----------------------|-----------------|-----------------------------|----------|------|-----|-----------|------|-----|------|---|
|                    |                       |                 |                             | MIN      | TYP  | MAX | MIN       | TYP  | MAX |      |   |
| V <sub>(ON)</sub>  | Turnon voltage level  | TLV2770         | A <sub>V</sub> = 5          | 25°C     | 2.59 |     |           | 2.59 |     |      | V |
|                    |                       | TLV2773         |                             |          | 2.47 |     |           | 2.47 |     |      |   |
|                    |                       | TLV2775         |                             |          | 2.48 |     |           | 2.48 |     |      |   |
| V <sub>(OFF)</sub> | Turnoff voltage level | TLV2770         | A <sub>V</sub> = 5          | 25°C     | 2.41 |     |           | 2.41 |     |      | V |
|                    |                       | TLV2773         |                             |          | 2.32 |     |           | 2.32 |     |      |   |
|                    |                       | TLV2775         |                             |          | 2.29 |     |           | 2.29 |     |      |   |

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

**operating characteristics at specified free-air temperature,  $V_{DD} = 5\text{ V}$  (unless otherwise noted)**

| PARAMETER              |                                             |         | TEST CONDITIONS                                                                                      |                      | T <sub>A</sub> <sup>†</sup> | TLV277xI |      |     | TLV277xAI |      |     | UNIT   |
|------------------------|---------------------------------------------|---------|------------------------------------------------------------------------------------------------------|----------------------|-----------------------------|----------|------|-----|-----------|------|-----|--------|
|                        |                                             |         |                                                                                                      |                      |                             | MIN      | TYP  | MAX | MIN       | TYP  | MAX |        |
| SR                     | Slew rate at unity gain                     |         | V <sub>O(PP)</sub> = 1.5 V, C <sub>L</sub> = 100 pF,<br>R <sub>L</sub> = 10 kΩ                       |                      | 25°C                        | 5        | 10.5 |     | 5         | 10.5 |     | V/μs   |
|                        |                                             |         |                                                                                                      |                      | Full range                  | 4.7      | 6    |     | 4.7       | 6    |     |        |
| V <sub>n</sub>         | Equivalent input noise voltage              |         | f = 1 kHz                                                                                            |                      | 25°C                        | 17       |      |     | 17        |      |     | nV/√Hz |
|                        |                                             |         | f = 10 kHz                                                                                           |                      | 25°C                        | 12       |      |     | 12        |      |     |        |
| V <sub>N(PP)</sub>     | Peak-to-peak equivalent input noise voltage |         | f = 0.1 Hz to 1 Hz                                                                                   |                      | 25°C                        | 0.33     |      |     | 0.33      |      |     | μV     |
|                        |                                             |         | f = 0.1 Hz to 10 Hz                                                                                  |                      | 25°C                        | 0.86     |      |     | 0.86      |      |     | μV     |
| I <sub>n</sub>         | Equivalent input noise current              |         | f = 100 Hz                                                                                           |                      | 25°C                        | 0.6      |      |     | 0.6       |      |     | fA/√Hz |
| THD + N                | Total harmonic distortion plus noise        |         | R <sub>L</sub> = 600 Ω,<br>f = 1 kHz                                                                 | A <sub>V</sub> = 1   | 25°C                        | 0.005%   |      |     | 0.005%    |      |     |        |
|                        |                                             |         |                                                                                                      | A <sub>V</sub> = 10  |                             | 0.016%   |      |     | 0.016%    |      |     |        |
|                        |                                             |         |                                                                                                      | A <sub>V</sub> = 100 |                             | 0.095%   |      |     | 0.095%    |      |     |        |
| Gain-bandwidth product |                                             |         | f = 10 kHz, R <sub>L</sub> = 600 Ω,<br>C <sub>L</sub> = 100 pF                                       |                      | 25°C                        | 5.1      |      |     | 5.1       |      |     | MHz    |
| t <sub>s</sub>         | Settling time                               |         | A <sub>V</sub> = −1,<br>Step = 1.5 V to 3.5 V,<br>R <sub>L</sub> = 600 Ω,<br>C <sub>L</sub> = 100 pF | 0.1%                 | 25°C                        | 0.134    |      |     | 0.134     |      |     | μs     |
|                        |                                             |         |                                                                                                      | 0.01%                | 25°C                        | 1.97     |      |     | 1.97      |      |     |        |
| φ <sub>m</sub>         | Phase margin at unity gain                  |         | R <sub>L</sub> = 600 Ω, C <sub>L</sub> = 100 pF                                                      |                      | 25°C                        | 46°      |      |     | 46°       |      |     |        |
| Gain margin            |                                             |         |                                                                                                      |                      | 25°C                        | 12       |      |     | 12        |      |     | dB     |
| t <sub>(ON)</sub>      | Amplifier<br>turnon<br>time                 | TLV2770 | A <sub>V</sub> = 5,<br>R <sub>L</sub> = Open,<br>Measured to 50% point                               |                      | 25°C                        | 1.2      |      |     | 1.2       |      |     | μs     |
|                        |                                             | TLV2773 |                                                                                                      |                      |                             | 2.4      |      |     | 2.4       |      |     |        |
|                        |                                             | TLV2775 |                                                                                                      |                      |                             | 1.9      |      |     | 1.9       |      |     |        |
| t <sub>(OFF)</sub>     | Amplifier<br>turnoff<br>time                | TLV2770 | A <sub>V</sub> = 5,<br>R <sub>L</sub> = Open,<br>Measured to 50% point                               |                      | 25°C                        | 335      |      |     | 335       |      |     | ns     |
|                        |                                             | TLV2773 |                                                                                                      |                      |                             | 444      |      |     | 444       |      |     |        |
|                        |                                             | TLV2775 |                                                                                                      |                      |                             | 345      |      |     | 345       |      |     |        |

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$ .

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

electrical characteristics at specified free-air temperature,  $V_{DD} = 2.7\text{ V}$  (unless otherwise noted)

| PARAMETER                                                                  | TEST CONDITIONS                                                                                            | $T_A^\dagger$ | TLV2772Q<br>TLV2772M |             |     | TLV2772AQ<br>TLV2772AM |             |     | UNIT                         |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|---------------|----------------------|-------------|-----|------------------------|-------------|-----|------------------------------|
|                                                                            |                                                                                                            |               | MIN                  | TYP         | MAX | MIN                    | TYP         | MAX |                              |
| $V_{IO}$ Input offset voltage                                              | $V_{DD} = \pm 1.35\text{ V}$ ,<br>$V_{IC} = 0$ ,<br>$R_S = 50\ \Omega$<br>$V_O = 0$                        | 25°C          |                      | 0.44        | 2.5 |                        | 0.44        | 1.6 | mV                           |
|                                                                            |                                                                                                            | Full range    |                      | 0.47        | 2.7 |                        | 0.47        | 1.9 |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage             |                                                                                                            | 25°C to 125°C |                      | 2           |     |                        | 2           |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                              |                                                                                                            | 25°C          |                      | 1           | 60  |                        | 1           | 60  | pA                           |
|                                                                            |                                                                                                            | Full range    |                      | 2           | 125 |                        | 2           | 125 |                              |
| $I_{IB}$ Input bias current                                                |                                                                                                            | 25°C          |                      | 2           | 60  |                        | 2           | 60  | pA                           |
|                                                                            |                                                                                                            | Full range    |                      | 6           | 350 |                        | 6           | 350 |                              |
| $V_{ICR}$ Common-mode input voltage range                                  | CMRR > 60 dB, $R_S = 50\ \Omega$                                                                           | 25°C          | 0 to 1.4             | -0.3 to 1.7 |     | 0 to 1.4               | -0.3 to 1.7 |     | V                            |
|                                                                            |                                                                                                            | Full range    | 0 to 1.4             | -0.3 to 1.7 |     | 0 to 1.4               | -0.3 to 1.7 |     |                              |
| $V_{OH}$ High-level output voltage                                         | $I_{OH} = -0.675\text{ mA}$                                                                                | 25°C          |                      | 2.6         |     |                        | 2.6         |     | V                            |
|                                                                            |                                                                                                            | Full range    |                      | 2.45        |     |                        | 2.45        |     |                              |
|                                                                            | $I_{OH} = -2.2\text{ mA}$                                                                                  | 25°C          |                      | 2.4         |     |                        | 2.4         |     |                              |
|                                                                            |                                                                                                            | Full range    |                      | 2.1         |     |                        | 2.1         |     |                              |
| $V_{OL}$ Low-level output voltage                                          | $V_{IC} = 1.35\text{ V}$ , $I_{OL} = 0.675\text{ mA}$                                                      | 25°C          |                      | 0.1         |     |                        | 0.1         |     | V                            |
|                                                                            |                                                                                                            | Full range    |                      | 0.2         |     |                        | 0.2         |     |                              |
|                                                                            | $V_{IC} = 1.35\text{ V}$ , $I_{OL} = 2.2\text{ mA}$                                                        | 25°C          |                      | 0.21        |     |                        | 0.21        |     |                              |
|                                                                            |                                                                                                            | Full range    |                      | 0.6         |     |                        | 0.6         |     |                              |
| $A_{VD}$ Large-signal differential voltage amplification                   | $V_{IC} = 1.35\text{ V}$ ,<br>$V_O = 0.6\text{ V to } 2.1\text{ V}$<br>$R_L = 10\text{ k}\Omega,^\ddagger$ | 25°C          | 20                   | 380         |     | 20                     | 380         |     | V/mV                         |
|                                                                            |                                                                                                            | Full range    | 13                   |             |     | 13                     |             |     |                              |
| $r_{i(d)}$ Differential input resistance                                   |                                                                                                            | 25°C          |                      | $10^{12}$   |     |                        | $10^{12}$   |     | $\Omega$                     |
| $C_{i(c)}$ Common-mode input capacitance                                   | $f = 10\text{ kHz}$                                                                                        | 25°C          |                      | 8           |     |                        | 8           |     | pF                           |
| $z_o$ Closed-loop output impedance                                         | $f = 100\text{ kHz}$ , $A_V = 10$                                                                          | 25°C          |                      | 25          |     |                        | 25          |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                           | $V_{IC} = V_{ICR}(\text{min})$ ,<br>$R_S = 50\ \Omega$ , $V_O = 1.5\text{ V}$                              | 25°C          | 60                   | 84          |     | 60                     | 84          |     | dB                           |
|                                                                            |                                                                                                            | Full range    | 60                   | 82          |     | 60                     | 82          |     |                              |
| $k_{SVR}$ Supply voltage rejection ratio ( $\Delta V_{DD}/\Delta V_{IO}$ ) | $V_{DD} = 2.7\text{ V to } 5\text{ V}$ ,<br>No load, $V_{IC} = V_{DD}/2$                                   | 25°C          | 70                   | 89          |     | 70                     | 89          |     | dB                           |
|                                                                            |                                                                                                            | Full range    | 70                   | 84          |     | 70                     | 84          |     |                              |
| $I_{DD}$ Supply current (per channel)                                      | $V_O = 1.5\text{ V}$ , No load                                                                             | 25°C          |                      | 1           | 2   |                        | 1           | 2   | mA                           |
|                                                                            |                                                                                                            | Full range    |                      | 2           |     |                        | 2           |     |                              |

$^\dagger$  Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

$^\ddagger$  Referenced to 1.35 V

**TLV277x, TLV277xA**  
**FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

operating characteristics at specified free-air temperature,  $V_{DD} = 2.7\text{ V}$  (unless otherwise noted)

| PARAMETER                                               | TEST CONDITIONS                                                                                  | $T_A^\dagger$                       | TLV2772Q<br>TLV2772M |         |     | TLV2772AQ<br>TLV2772AM |         |     | UNIT                   |
|---------------------------------------------------------|--------------------------------------------------------------------------------------------------|-------------------------------------|----------------------|---------|-----|------------------------|---------|-----|------------------------|
|                                                         |                                                                                                  |                                     | MIN                  | TYP     | MAX | MIN                    | TYP     | MAX |                        |
| SR      Slew rate at unity gain                         | $V_{O(PP)} = 0.8\text{ V}$ , $C_L = 100\text{ pF}$ ,<br>$R_L = 10\text{ k}\Omega$                | 25°C                                | 5                    | 9       |     | 5                      | 9       |     | V/ $\mu\text{s}$       |
|                                                         |                                                                                                  | Full range                          | 4.7                  | 6       |     | 4.7                    | 6       |     |                        |
| $V_n$ Equivalent input noise voltage                    | $f = 1\text{ kHz}$                                                                               | 25°C                                |                      | 21      |     |                        | 21      |     | nV/ $\sqrt{\text{Hz}}$ |
|                                                         | $f = 10\text{ kHz}$                                                                              | 25°C                                |                      | 17      |     |                        | 17      |     |                        |
| $V_{N(PP)}$ Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                                               | 25°C                                |                      | 0.33    |     |                        | 0.33    |     | $\mu\text{V}$          |
|                                                         | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                              | 25°C                                |                      | 0.86    |     |                        | 0.86    |     | $\mu\text{V}$          |
| $I_n$ Equivalent input noise current                    | $f = 100\text{ Hz}$                                                                              | 25°C                                |                      | 0.6     |     |                        | 0.6     |     | fA/ $\sqrt{\text{Hz}}$ |
| THD + N      Total harmonic distortion plus noise       | $R_L = 600\text{ }\Omega$ ,<br>$f = 1\text{ kHz}$                                                | $A_V = 1$                           |                      | 0.0085% |     |                        | 0.0085% |     |                        |
|                                                         |                                                                                                  | $A_V = 10$                          |                      | 0.025%  |     |                        | 0.025%  |     |                        |
|                                                         |                                                                                                  | $A_V = 100$                         |                      | 0.12%   |     |                        | 0.12%   |     |                        |
| Gain-bandwidth product                                  | $f = 10\text{ kHz}$ ,<br>$C_L = 100\text{ pF}$                                                   | $R_L = 600\text{ }\Omega$ ,<br>25°C |                      | 4.8     |     |                        | 4.8     |     | MHz                    |
| $t_s$ Settling time                                     | $A_V = -1$ ,<br>Step = 0.85 V to 1.85 V,<br>$R_L = 600\text{ }\Omega$ ,<br>$C_L = 100\text{ pF}$ | 0.1%                                | 25°C                 | 0.186   |     |                        | 0.186   |     | $\mu\text{s}$          |
|                                                         |                                                                                                  | 0.01%                               | 25°C                 | 3.92    |     |                        | 3.92    |     |                        |
| $\phi_m$ Phase margin at unity gain                     | $R_L = 600\text{ }\Omega$ ,<br>$C_L = 100\text{ pF}$                                             | 25°C                                |                      | 46°     |     |                        | 46°     |     |                        |
| Gain margin                                             |                                                                                                  | 25°C                                |                      | 12      |     |                        | 12      |     | dB                     |

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q level part,  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for M level part.

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

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

| PARAMETER                                                                    | TEST CONDITIONS                                                                      | $T_A^\dagger$ | TLV2772Q<br>TLV2772M |             |     | TLV2772AQ<br>TLV2772AM |             |     | UNIT                         |
|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------|----------------------|-------------|-----|------------------------|-------------|-----|------------------------------|
|                                                                              |                                                                                      |               | MIN                  | TYP         | MAX | MIN                    | TYP         | MAX |                              |
| $V_{IO}$ Input offset voltage                                                | $V_{DD} = \pm 2.5\text{ V}$ ,<br>$V_{IC} = 0$ ,<br>$V_O = 0$ ,<br>$R_S = 50\ \Omega$ | 25°C          |                      | 0.36        | 2.5 |                        | 0.36        | 1.6 | mV                           |
|                                                                              |                                                                                      | Full range    |                      | 0.4         | 2.7 |                        | 0.4         | 1.9 |                              |
| $\alpha_{VIO}$ Temperature coefficient of input offset voltage               |                                                                                      | 25°C to 125°C |                      | 2           |     |                        | 2           |     | $\mu\text{V}/^\circ\text{C}$ |
| $I_{IO}$ Input offset current                                                |                                                                                      | 25°C          |                      | 1           | 60  |                        | 1           | 60  | pA                           |
|                                                                              |                                                                                      | Full range    |                      | 2           | 125 |                        | 2           | 125 |                              |
| $I_{IB}$ Input bias current                                                  |                                                                                      | 25°C          |                      | 2           | 60  |                        | 2           | 60  | pA                           |
|                                                                              |                                                                                      | Full range    |                      | 6           | 350 |                        | 6           | 350 |                              |
| $V_{ICR}$ Common-mode input voltage range                                    | CMRR > 60 dB, $R_S = 50\ \Omega$                                                     | 25°C          | 0 to 3.7             | -0.3 to 3.8 |     | 0 to 3.7               | -0.3 to 3.8 |     | V                            |
|                                                                              |                                                                                      | Full range    | 0 to 3.7             | -0.3 to 3.8 |     | 0 to 3.7               | -0.3 to 3.8 |     |                              |
| $V_{OH}$ High-level output voltage                                           | $I_{OH} = -1.3\text{ mA}$                                                            | 25°C          |                      | 4.9         |     |                        | 4.9         |     | V                            |
|                                                                              |                                                                                      | Full range    |                      | 4.8         |     |                        | 4.8         |     |                              |
|                                                                              | $I_{OH} = -4.2\text{ mA}$                                                            | 25°C          |                      | 4.7         |     |                        | 4.7         |     |                              |
|                                                                              |                                                                                      | Full range    |                      | 4.4         |     |                        | 4.4         |     |                              |
| $V_{OL}$ Low-level output voltage                                            | $V_{IC} = 2.5\text{ V}$ , $I_{OL} = 1.3\text{ mA}$                                   | 25°C          |                      | 0.1         |     |                        | 0.1         |     | V                            |
|                                                                              |                                                                                      | Full range    |                      | 0.2         |     |                        | 0.2         |     |                              |
|                                                                              | $V_{IC} = 2.5\text{ V}$ , $I_{OL} = 4.2\text{ mA}$                                   | 25°C          |                      | 0.21        |     |                        | 0.21        |     |                              |
|                                                                              |                                                                                      | Full range    |                      | 0.6         |     |                        | 0.6         |     |                              |
| $A_{VD}$ Large-signal differential voltage amplification                     | $V_{IC} = 2.5\text{ V}$ , $V_O = 1\text{ V to }4\text{ V}$                           | 25°C          | 20                   | 450         |     | 20                     | 450         |     | V/mV                         |
|                                                                              |                                                                                      | Full range    | 13                   |             |     | 13                     |             |     |                              |
| $r_{i(d)}$ Differential input resistance                                     |                                                                                      | 25°C          |                      | $10^{12}$   |     |                        | $10^{12}$   |     | $\Omega$                     |
| $C_{i(c)}$ Common-mode input capacitance                                     | $f = 10\text{ kHz}$                                                                  | 25°C          |                      | 8           |     |                        | 8           |     | pF                           |
| $z_o$ Closed-loop output impedance                                           | $f = 100\text{ kHz}$ , $A_V = 10$                                                    | 25°C          |                      | 20          |     |                        | 20          |     | $\Omega$                     |
| CMRR Common-mode rejection ratio                                             | $V_{IC} = V_{ICR}(\text{min})$ , $R_S = 50\ \Omega$                                  | 25°C          | 60                   | 96          |     | 60                     | 96          |     | dB                           |
|                                                                              | $V_O = 3.7\text{ V}$                                                                 | Full range    | 60                   | 93          |     | 60                     | 93          |     |                              |
| $k_{SVR}$ Supply voltage rejection ratio ( $\Delta V_{DD} / \Delta V_{IO}$ ) | $V_{DD} = 2.7\text{ V to }5\text{ V}$ , No load                                      | 25°C          | 70                   | 89          |     | 70                     | 89          |     | dB                           |
|                                                                              |                                                                                      | Full range    | 70                   | 84          |     | 70                     | 84          |     |                              |
| $I_{DD}$ Supply current (per channel)                                        | $V_O = 1.5\text{ V}$ , No load                                                       | 25°C          |                      | 1           | 2   |                        | 1           | 2   | mA                           |
|                                                                              |                                                                                      | Full range    |                      |             | 2   |                        |             | 2   |                              |

$^\dagger$  Full range is -40°C to 125°C for Q level part, -55°C to 125°C for M level part.

$^\ddagger$  Referenced to 2.5 V



**TLV277x, TLV277xA**  
**FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

operating characteristics at specified free-air temperature,  $V_{DD} = 5\text{ V}$  (unless otherwise noted)

| PARAMETER   | TEST CONDITIONS                             |                                                                                                | $T_A^\dagger$ | TLV2772Q<br>TLV2772M |        |     | TLV2772AQ<br>TLV2772AM |        |     | UNIT                   |
|-------------|---------------------------------------------|------------------------------------------------------------------------------------------------|---------------|----------------------|--------|-----|------------------------|--------|-----|------------------------|
|             |                                             |                                                                                                |               | MIN                  | TYP    | MAX | MIN                    | TYP    | MAX |                        |
| SR          | Slew rate at unity gain                     | $V_{O(PP)} = 1.5\text{ V}$ , $C_L = 100\text{ pF}$ ,<br>$R_L = 10\text{ k}\Omega$              | 25°C          | 5                    | 10.5   |     | 5                      | 10.5   |     | V/ $\mu\text{s}$       |
|             |                                             |                                                                                                | Full range    | 4.7                  | 6      |     | 4.7                    | 6      |     |                        |
| $V_n$       | Equivalent input noise voltage              | $f = 1\text{ kHz}$                                                                             | 25°C          |                      | 17     |     |                        | 17     |     | nV/ $\sqrt{\text{Hz}}$ |
|             |                                             | $f = 10\text{ kHz}$                                                                            | 25°C          |                      | 12     |     |                        | 12     |     |                        |
| $V_{N(PP)}$ | Peak-to-peak equivalent input noise voltage | $f = 0.1\text{ Hz to }1\text{ Hz}$                                                             | 25°C          |                      | 0.33   |     |                        | 0.33   |     | $\mu\text{V}$          |
|             |                                             | $f = 0.1\text{ Hz to }10\text{ Hz}$                                                            | 25°C          |                      | 0.86   |     |                        | 0.86   |     | $\mu\text{V}$          |
| $I_n$       | Equivalent input noise current              | $f = 100\text{ Hz}$                                                                            | 25°C          |                      | 0.6    |     |                        | 0.6    |     | fA/ $\sqrt{\text{Hz}}$ |
| THD + N     | Total harmonic distortion plus noise        | $R_L = 600\text{ }\Omega$ ,<br>$f = 1\text{ kHz}$                                              | 25°C          |                      | 0.005% |     |                        | 0.005% |     |                        |
|             |                                             |                                                                                                |               |                      | 0.016% |     |                        | 0.016% |     |                        |
|             |                                             |                                                                                                |               |                      | 0.095% |     |                        | 0.095% |     |                        |
|             | Gain-bandwidth product                      | $f = 10\text{ kHz}$ ,<br>$C_L = 100\text{ pF}$                                                 | 25°C          |                      | 5.1    |     |                        | 5.1    |     | MHz                    |
| $t_s$       | Settling time                               | $A_V = -1$ ,<br>Step = 1.5 V to 3.5 V,<br>$R_L = 600\text{ }\Omega$ ,<br>$C_L = 100\text{ pF}$ | 25°C          |                      | 0.134  |     |                        | 0.134  |     | $\mu\text{s}$          |
|             |                                             |                                                                                                | 25°C          |                      | 1.97   |     |                        | 1.97   |     |                        |
| $\phi_m$    | Phase margin at unity gain                  | $R_L = 600\text{ }\Omega$ ,<br>$C_L = 100\text{ pF}$                                           | 25°C          |                      | 46°    |     |                        | 46°    |     |                        |
|             | Gain margin                                 |                                                                                                | 25°C          |                      | 12     |     |                        | 12     |     | dB                     |

$^\dagger$  Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for Q level part,  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  for M level part.

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

Table of Graphs

|                 |                                                                  |                                                              | FIGURE            |
|-----------------|------------------------------------------------------------------|--------------------------------------------------------------|-------------------|
| $V_{IO}$        | Input offset voltage                                             | Distribution<br>vs Common-mode input voltage<br>Distribution | 1,2<br>3,4<br>5,6 |
| $I_{IB}/I_{IO}$ | Input bias and input offset currents                             | vs Free-air temperature                                      | 7                 |
| $V_{OH}$        | High-level output voltage                                        | vs High-level output current                                 | 8,9               |
| $V_{OL}$        | Low-level output voltage                                         | vs Low-level output current                                  | 10,11             |
| $V_{O(PP)}$     | Maximum peak-to-peak output voltage                              | vs Frequency                                                 | 12,13             |
| $I_{OS}$        | Short-circuit output current                                     | vs Supply voltage<br>vs Free-air temperature                 | 14<br>15          |
| $V_O$           | Output voltage                                                   | vs Differential input voltage                                | 16                |
| $A_{VD}$        | Large-signal differential voltage amplification and phase margin | vs Frequency                                                 | 17,18             |
| $A_{VD}$        | Differential voltage amplification                               | vs Load resistance<br>vs Free-air temperature                | 19<br>20,21       |
| $z_o$           | Output impedance                                                 | vs Frequency                                                 | 22,23             |
| CMRR            | Common-mode rejection ratio                                      | vs Frequency<br>vs Free-air temperature                      | 24<br>25          |
| $k_{SVR}$       | Supply-voltage rejection ratio                                   | vs Frequency                                                 | 26,27             |
| $I_{DD}$        | Supply current (per channel)                                     | vs Supply voltage                                            | 28                |
| SR              | Slew rate                                                        | vs Load capacitance<br>vs Free-air temperature               | 29<br>30          |
| $V_O$           | Voltage-follower small-signal pulse response                     |                                                              | 31,32             |
| $V_O$           | Voltage-follower large-signal pulse response                     |                                                              | 33,34             |
| $V_O$           | Inverting small-signal pulse response                            |                                                              | 35,36             |
| $V_O$           | Inverting large-signal pulse response                            |                                                              | 37,38             |
| $V_n$           | Equivalent input noise voltage                                   | vs Frequency                                                 | 39,40             |
|                 | Noise voltage (referred to input)                                | Over a 10-second period                                      | 41                |
| THD + N         | Total harmonic distortion plus noise                             | vs Frequency                                                 | 42,43             |
|                 | Gain-bandwidth product                                           | vs Supply voltage                                            | 44                |
| $B_1$           | Unity-gain bandwidth                                             | vs Load capacitance                                          | 45                |
| $\phi_m$        | Phase margin                                                     | vs Load capacitance                                          | 46                |
|                 | Gain margin                                                      | vs Load capacitance                                          | 47                |
|                 | Amplifier with shutdown pulse turnon/off characteristics         |                                                              | 48 – 50           |
|                 | Supply current with shutdown pulse turnon/off characteristics    |                                                              | 51 – 53           |
|                 | Shutdown supply current                                          | vs Free-air temperature                                      | 54                |
|                 | Shutdown forward/reverse isolation                               | vs Frequency                                                 | 55, 56            |

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

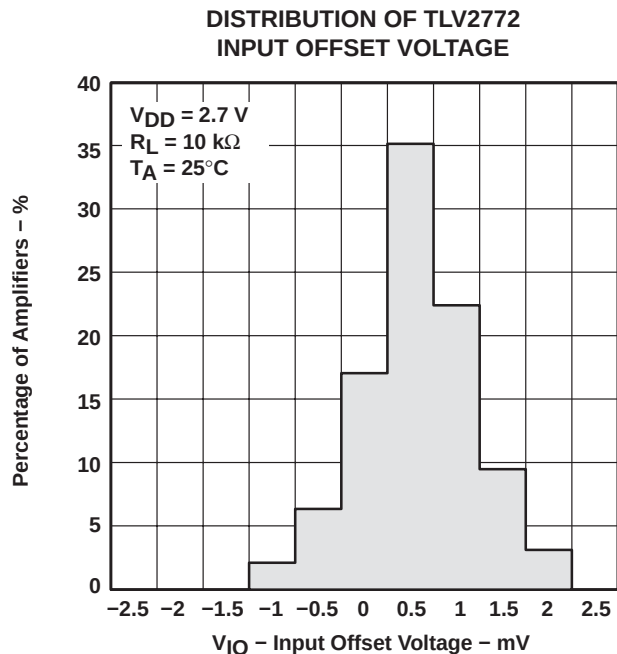


Figure 1

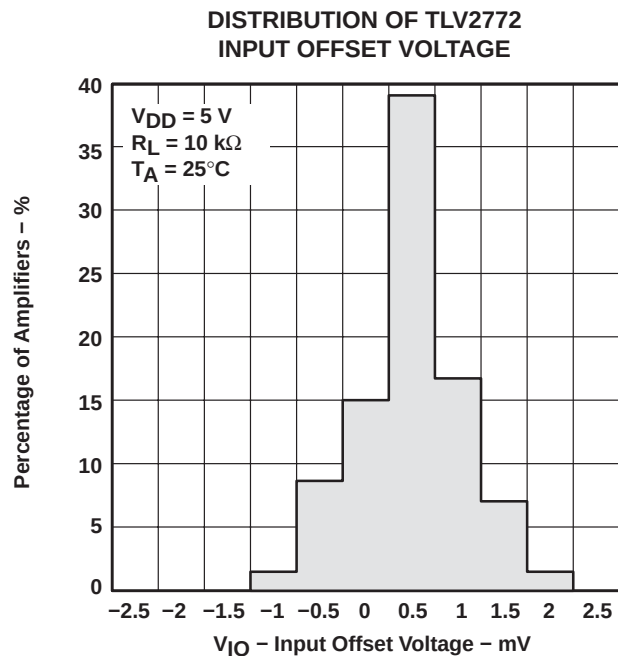


Figure 2

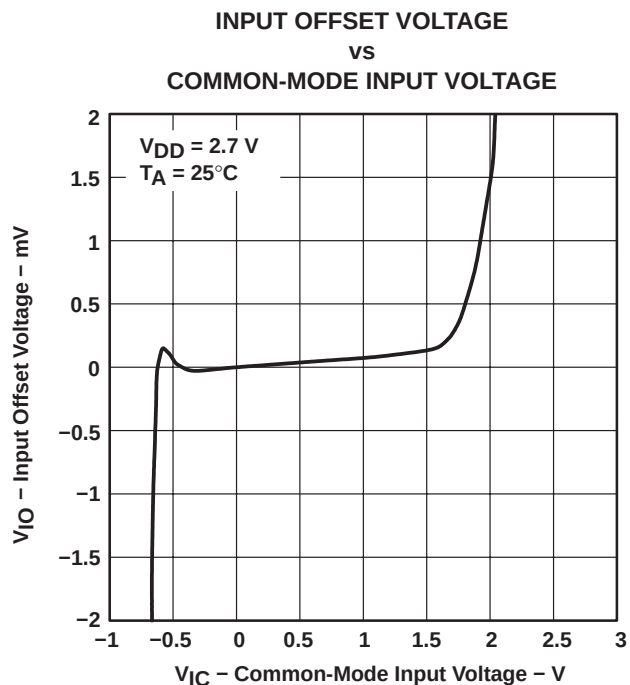


Figure 3

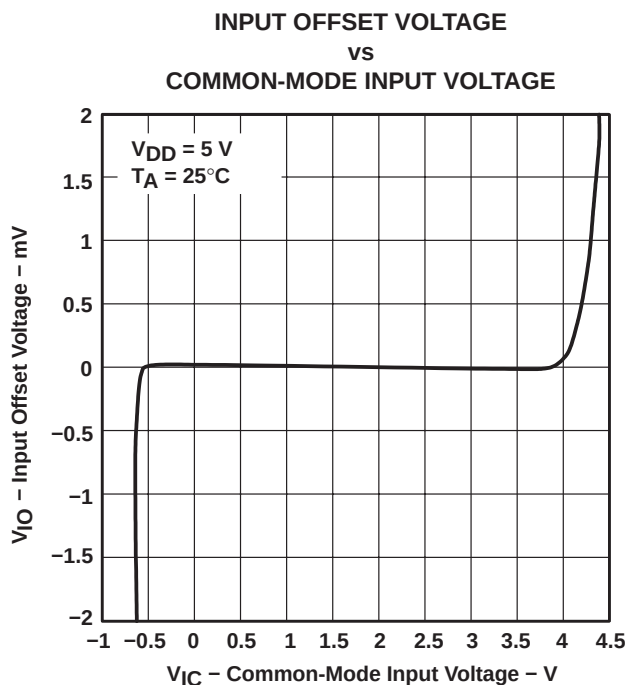


Figure 4

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

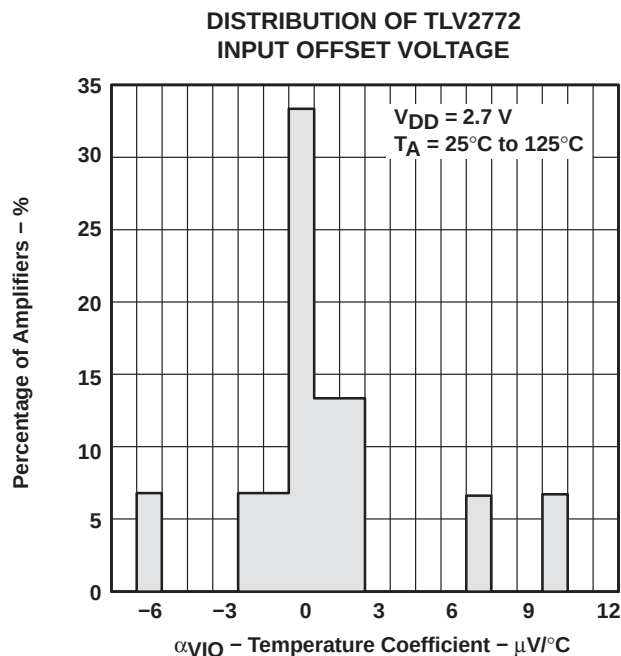


Figure 5

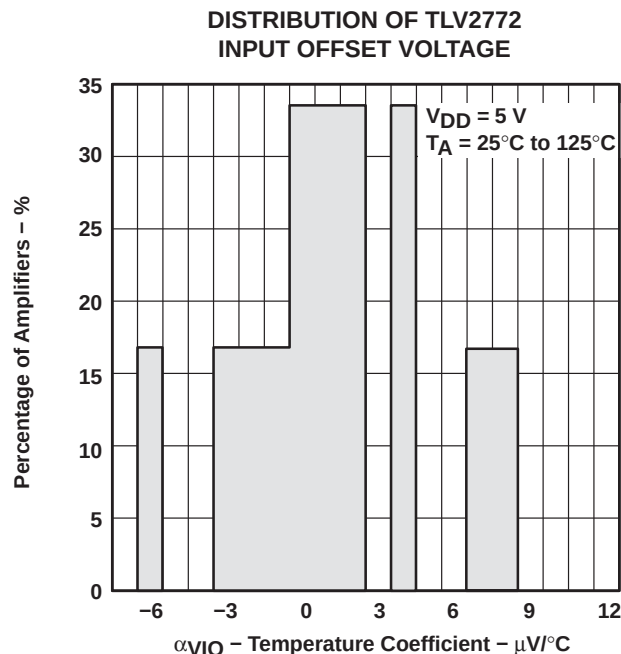


Figure 6

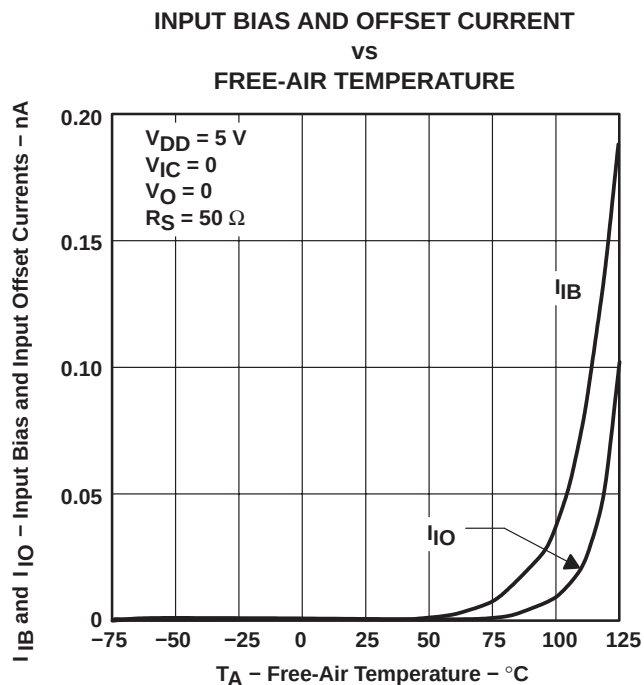


Figure 7

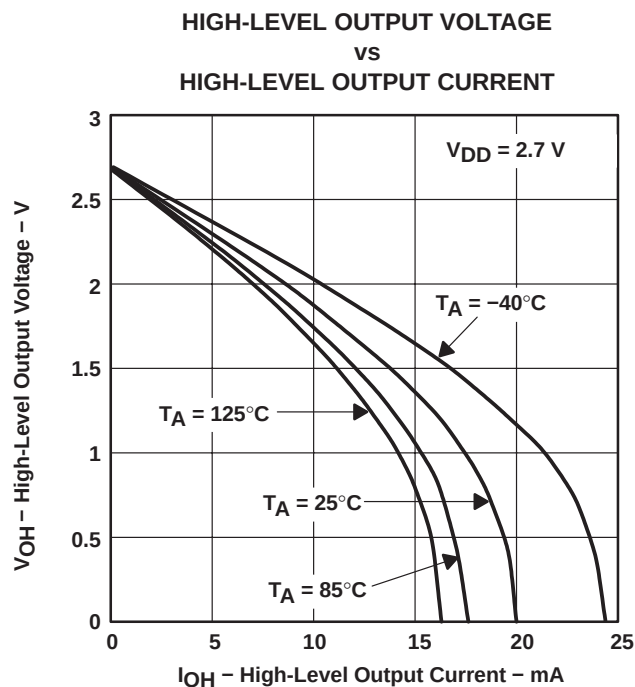


Figure 8

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

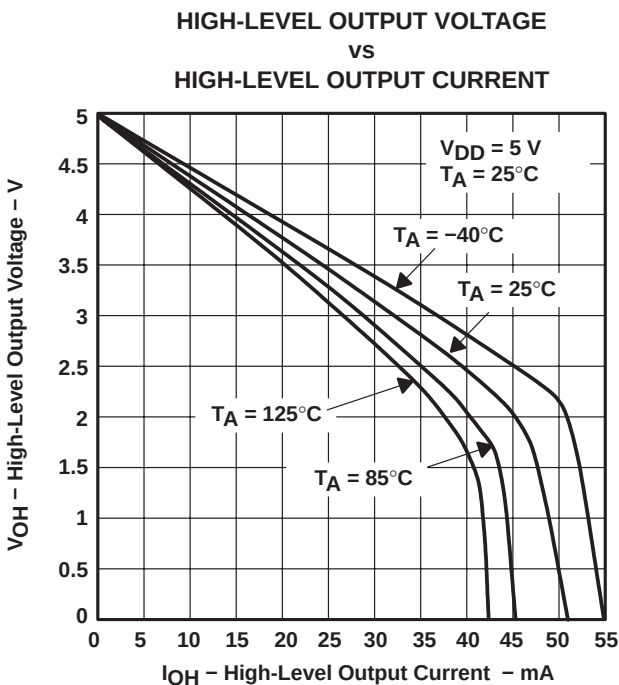


Figure 9

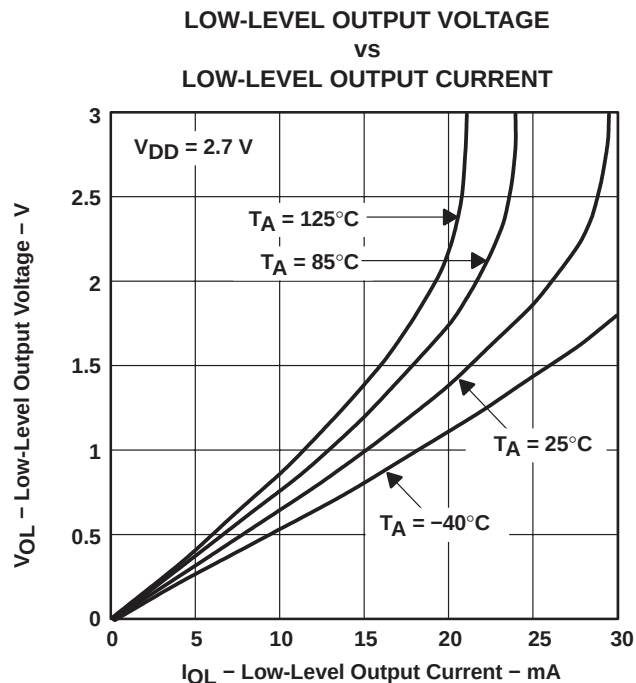


Figure 10

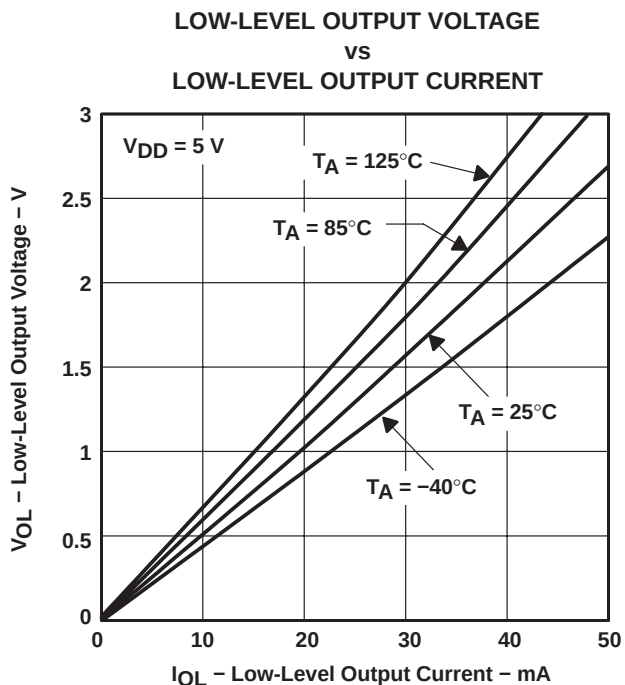


Figure 11

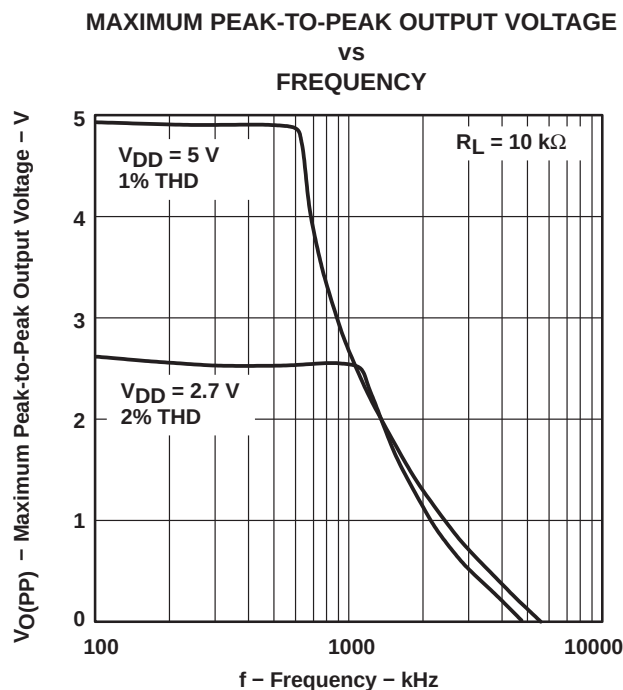


Figure 12

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

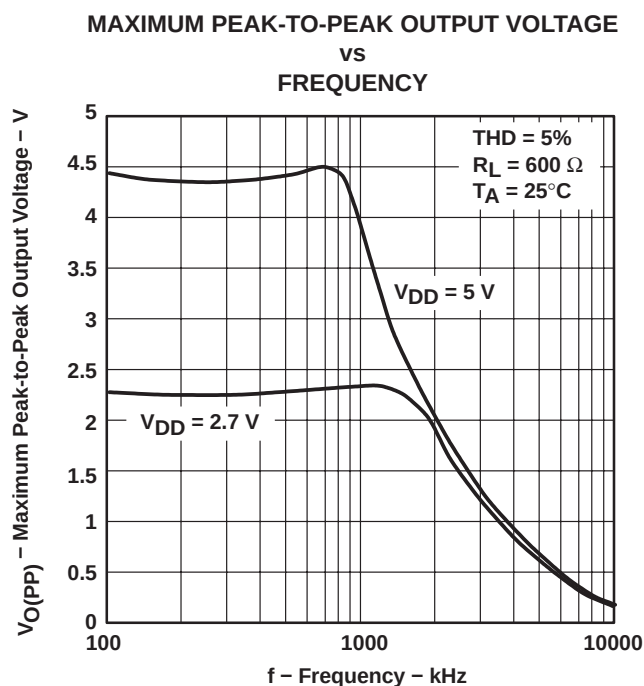


Figure 13

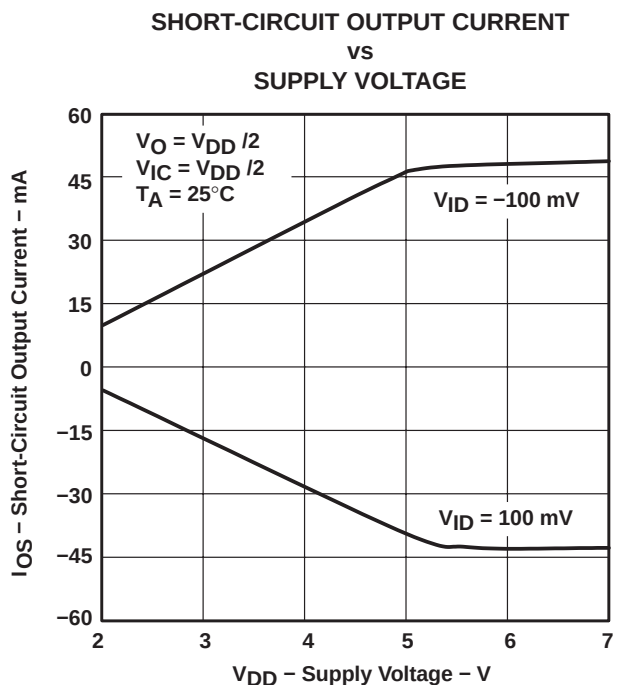


Figure 14

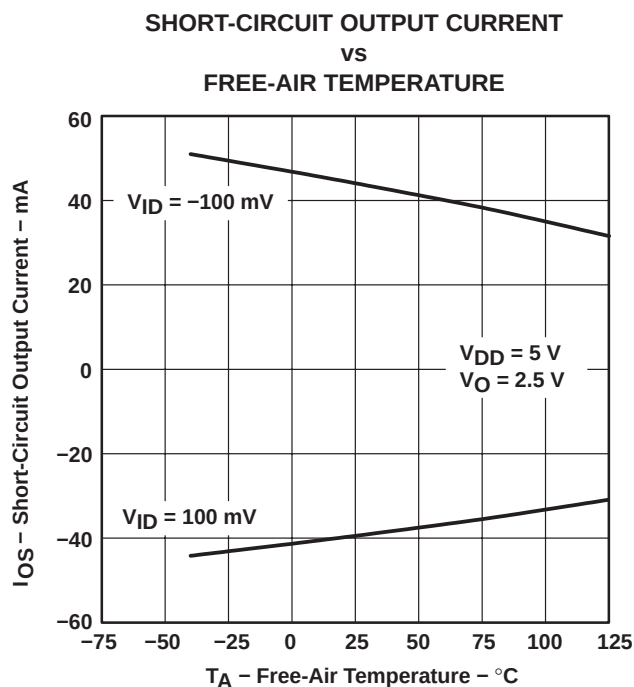


Figure 15

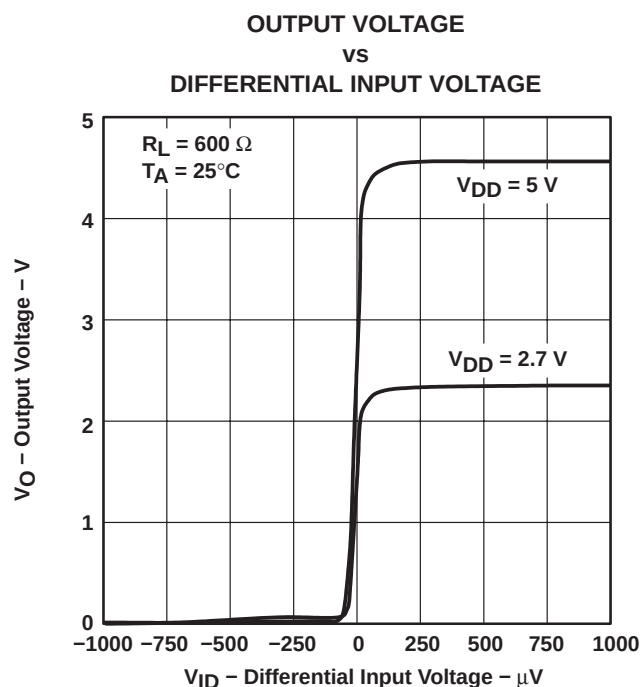


Figure 16

**TLV277x, TLV277xA**  
**FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

**TYPICAL CHARACTERISTICS**

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION  
AND PHASE MARGIN**

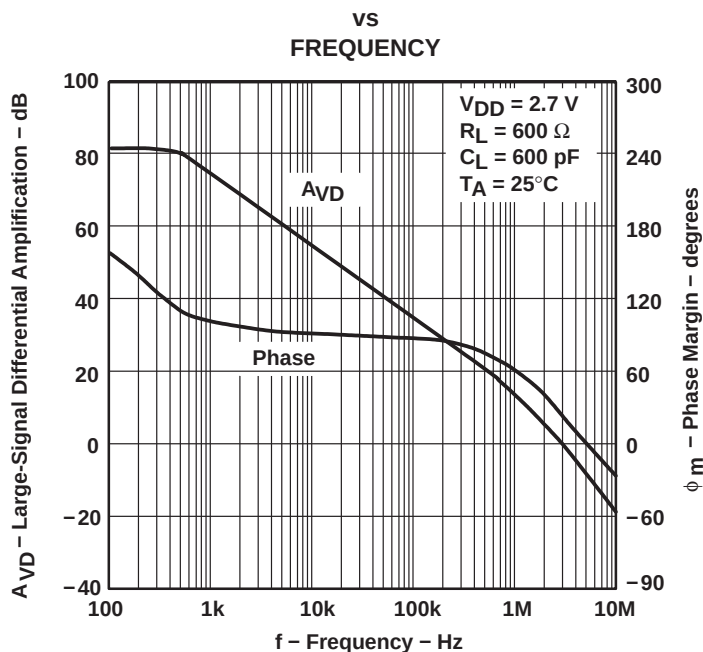


Figure 17

**LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION  
AND PHASE MARGIN**

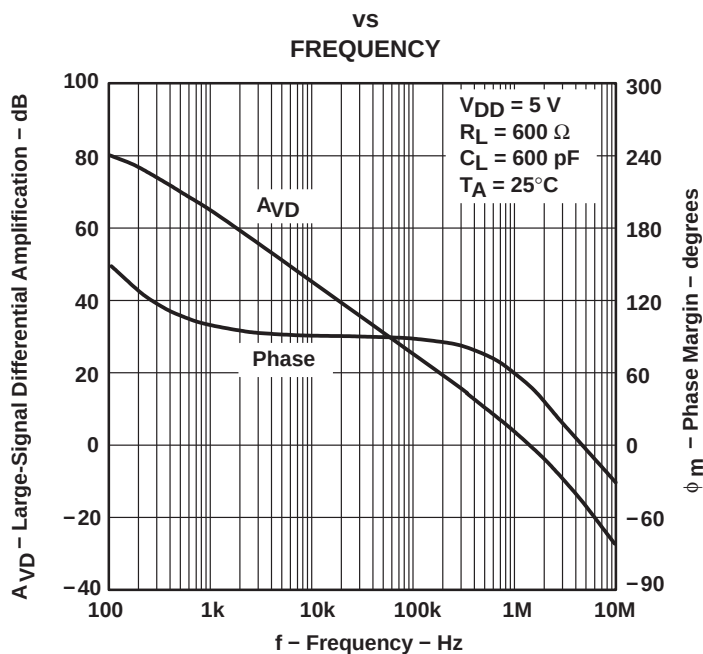


Figure 18

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

DIFFERENTIAL VOLTAGE AMPLIFICATION  
vs  
LOAD RESISTANCE

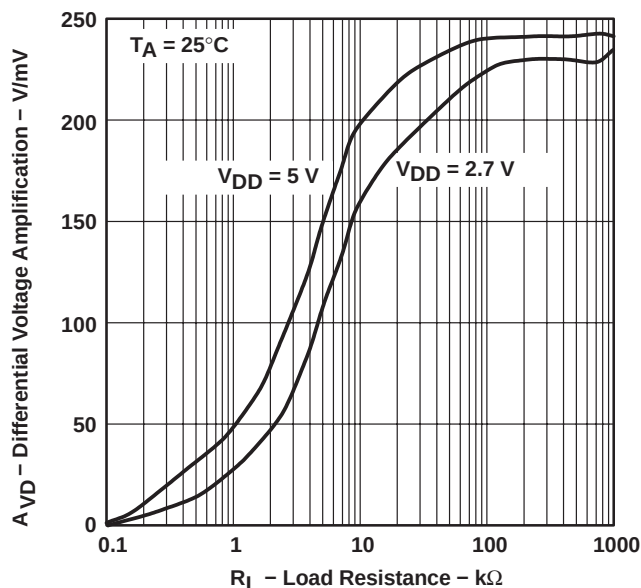


Figure 19

DIFFERENTIAL VOLTAGE AMPLIFICATION  
vs  
FREE-AIR TEMPERATURE

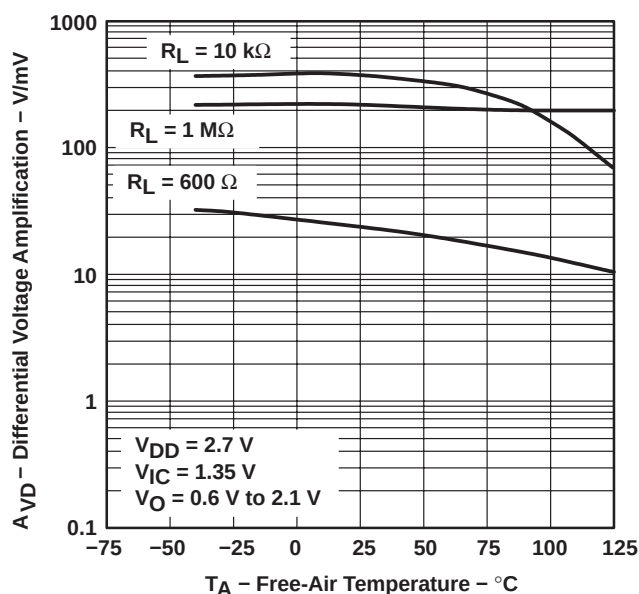


Figure 20

DIFFERENTIAL VOLTAGE AMPLIFICATION  
vs  
FREE-AIR TEMPERATURE

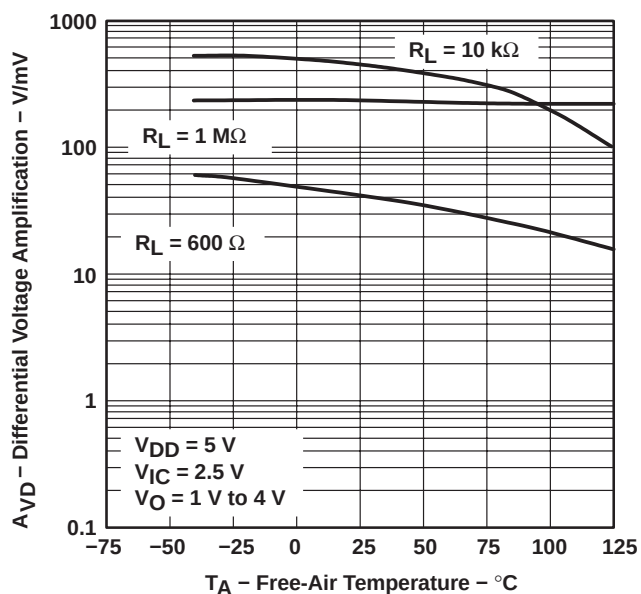


Figure 21

OUTPUT IMPEDANCE  
vs  
FREQUENCY

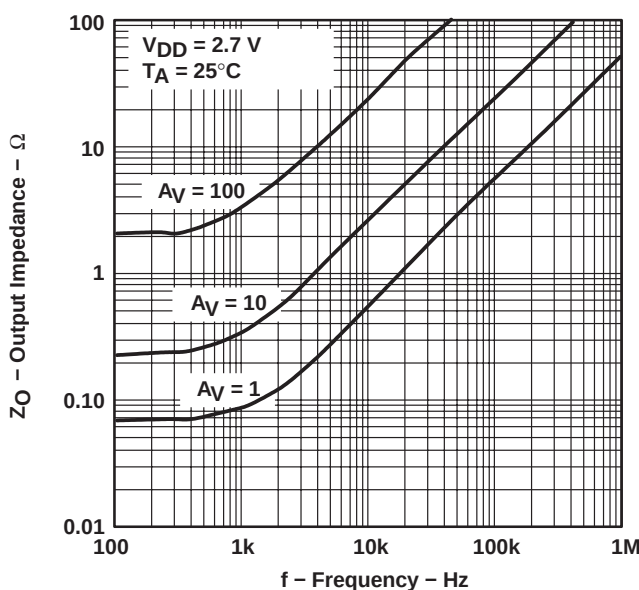


Figure 22



# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

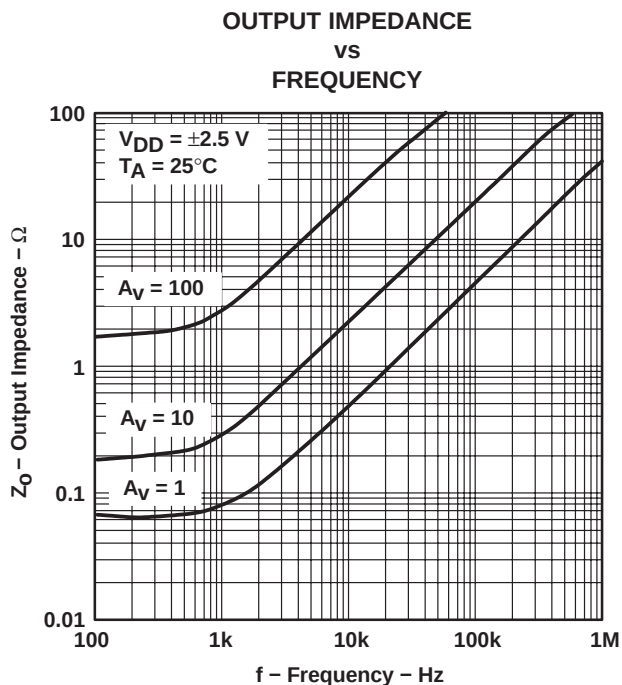


Figure 23

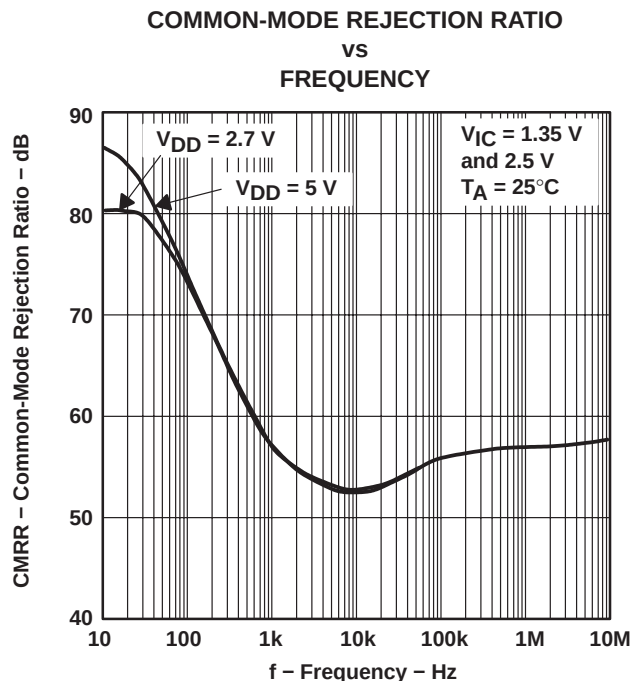


Figure 24

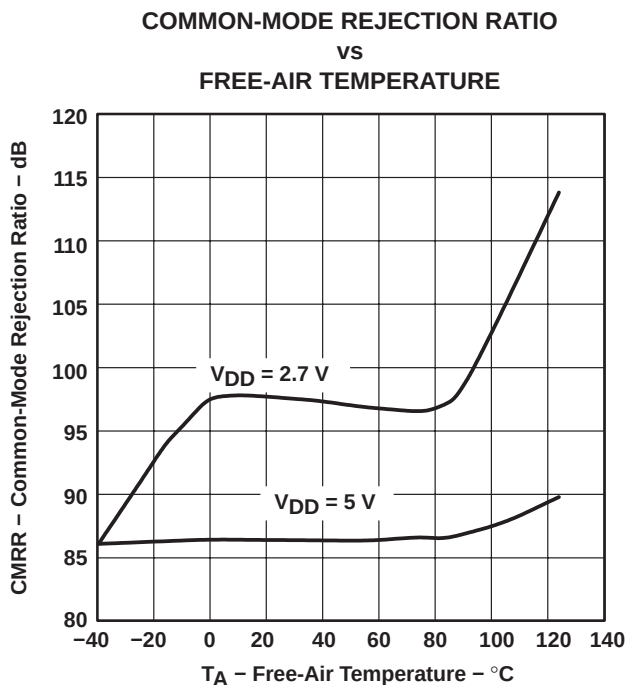


Figure 25

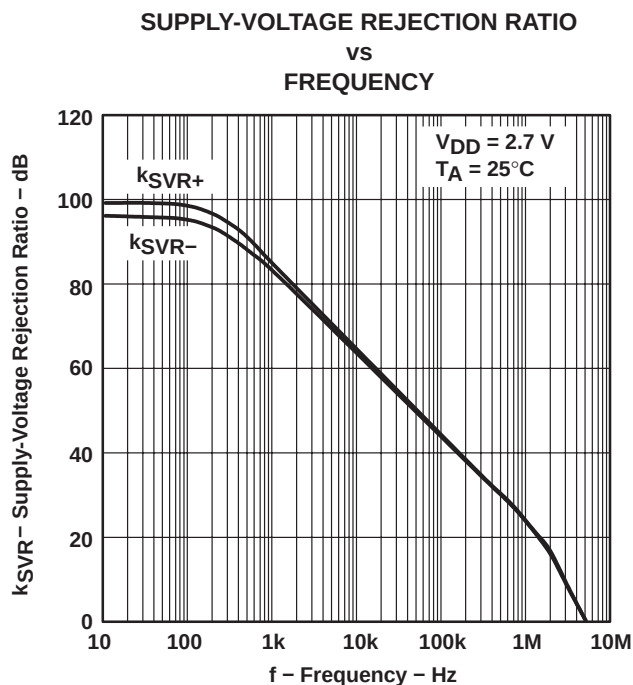


Figure 26

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

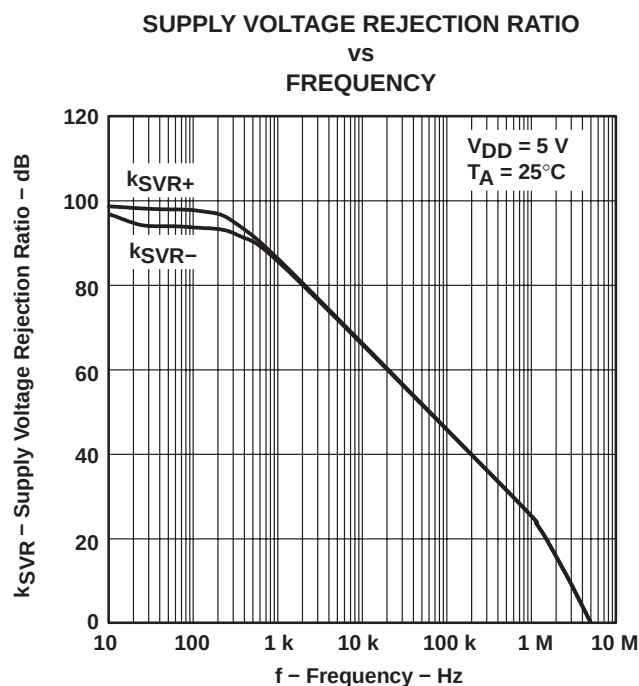


Figure 27

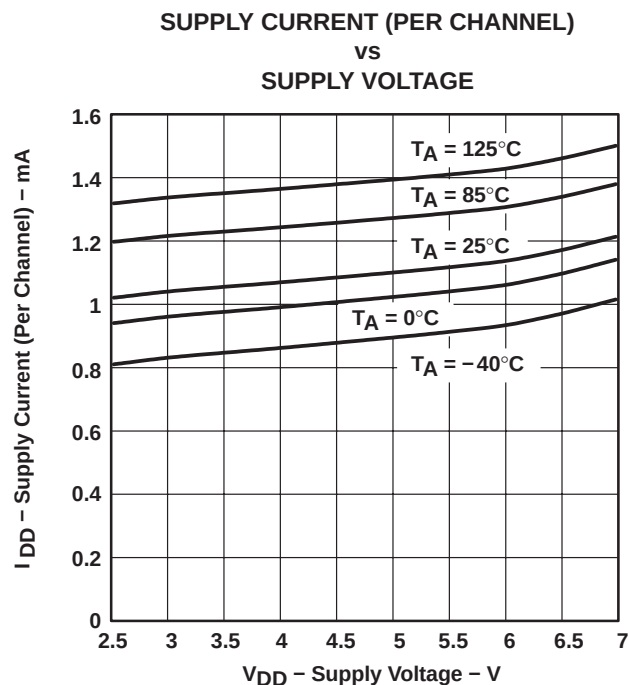


Figure 28

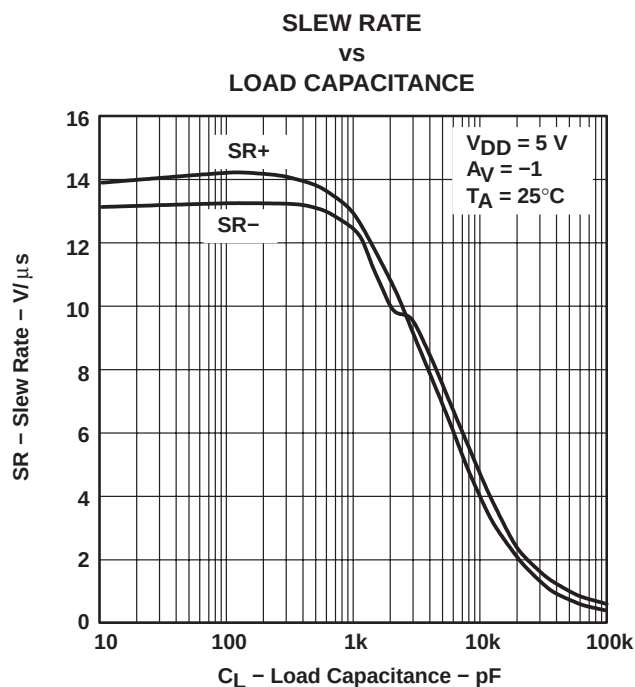


Figure 29

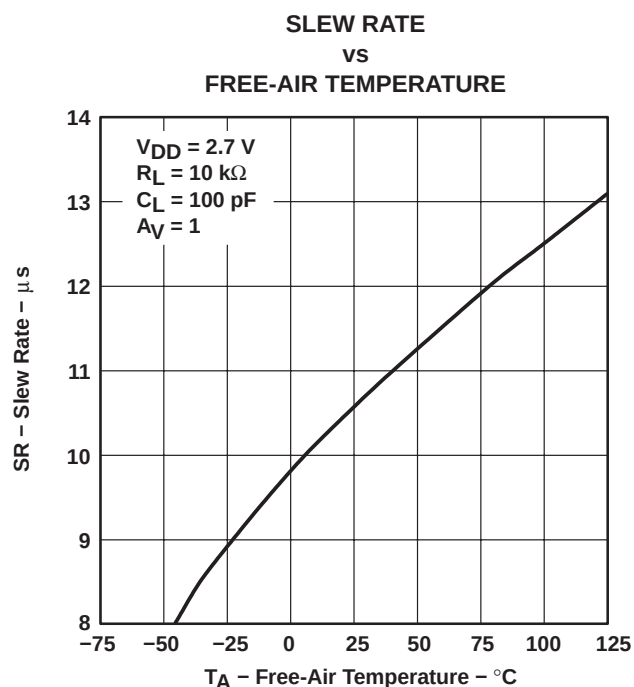


Figure 30

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER  
SMALL-SIGNAL PULSE RESPONSE

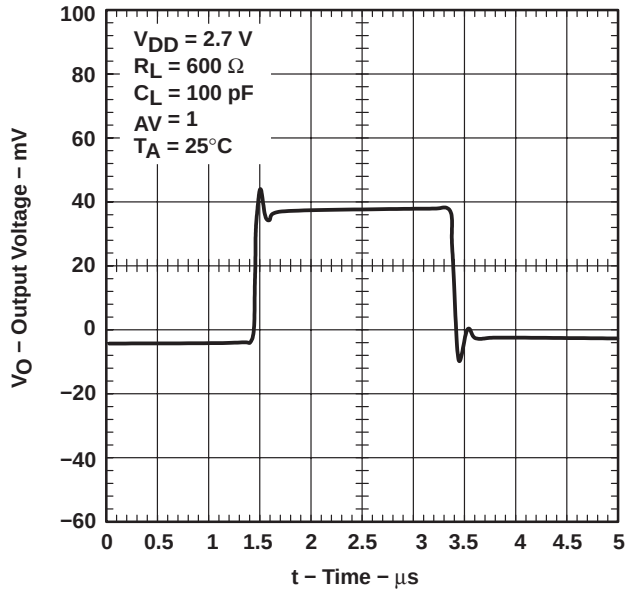


Figure 31

VOLTAGE-FOLLOWER  
SMALL-SIGNAL PULSE RESPONSE

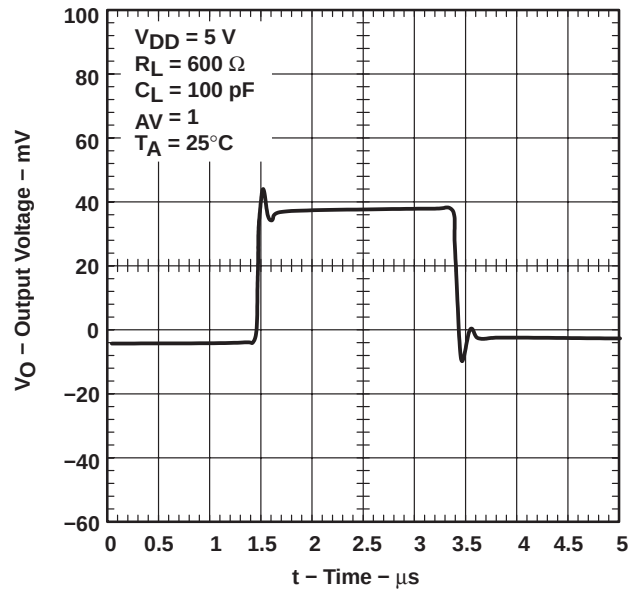


Figure 32

VOLTAGE-FOLLOWER  
LARGE-SIGNAL PULSE RESPONSE

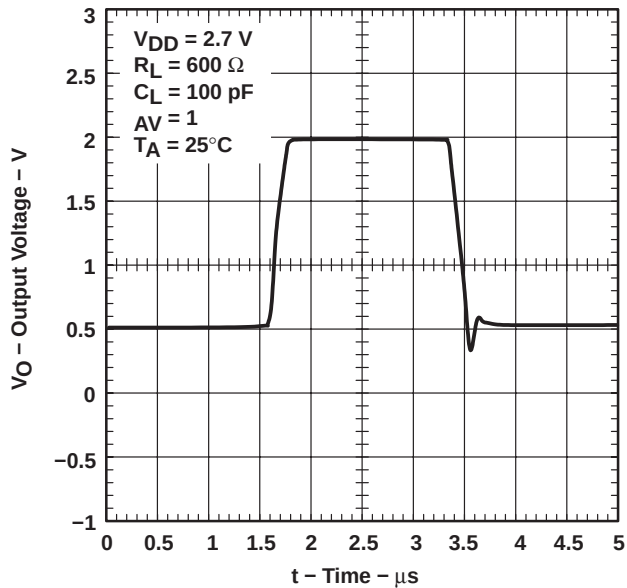


Figure 33

VOLTAGE-FOLLOWER  
LARGE-SIGNAL PULSE RESPONSE

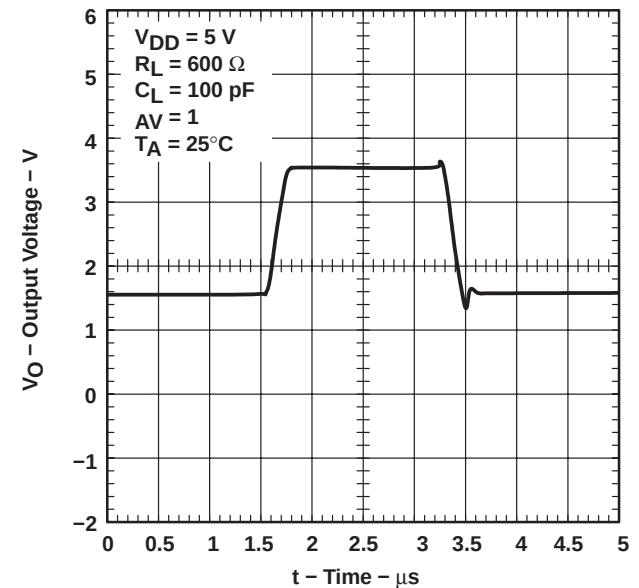


Figure 34

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

INVERTING SMALL-SIGNAL PULSE RESPONSE

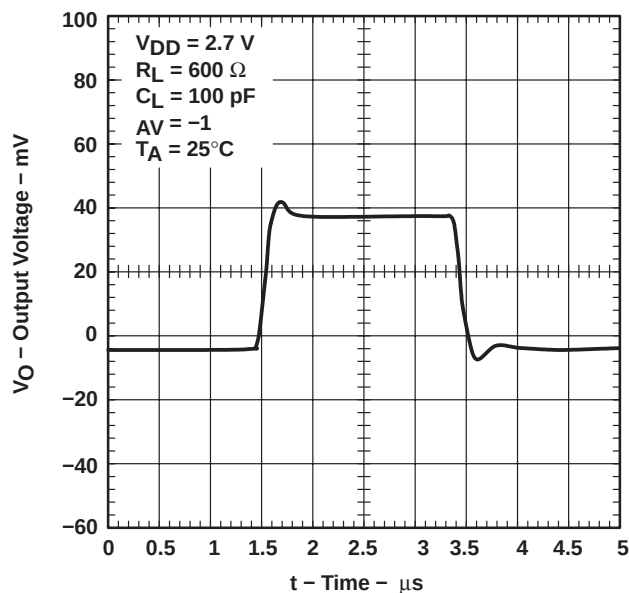


Figure 35

INVERTING SMALL-SIGNAL PULSE RESPONSE

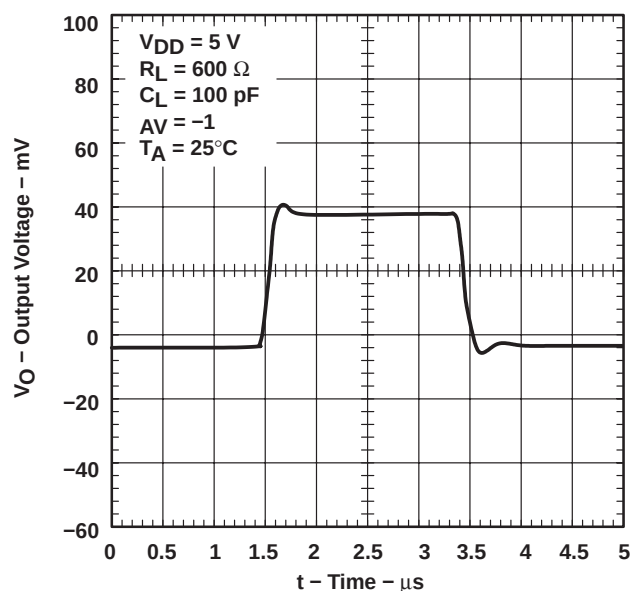


Figure 36

INVERTING LARGE-SIGNAL PULSE RESPONSE

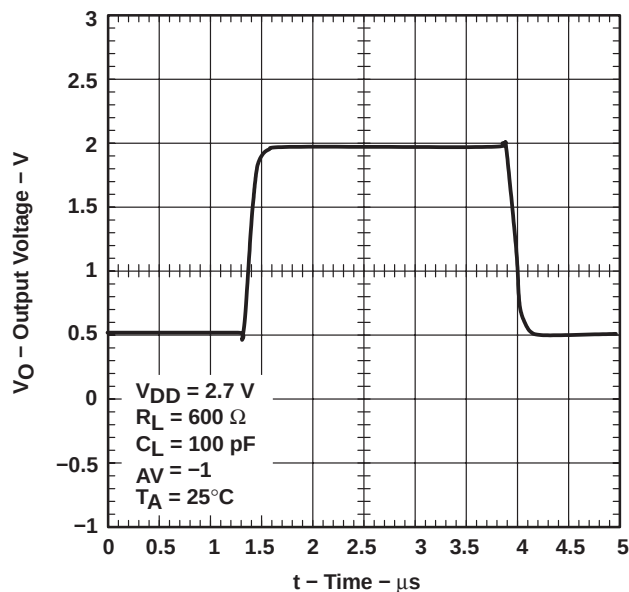


Figure 37

INVERTING LARGE-SIGNAL PULSE RESPONSE

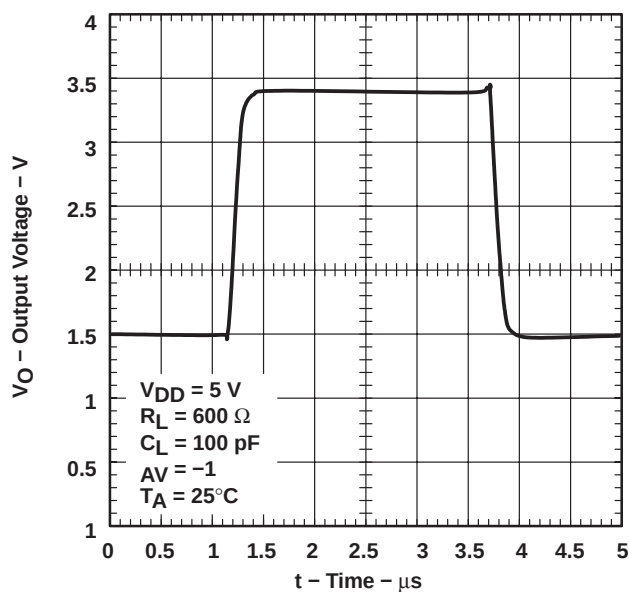
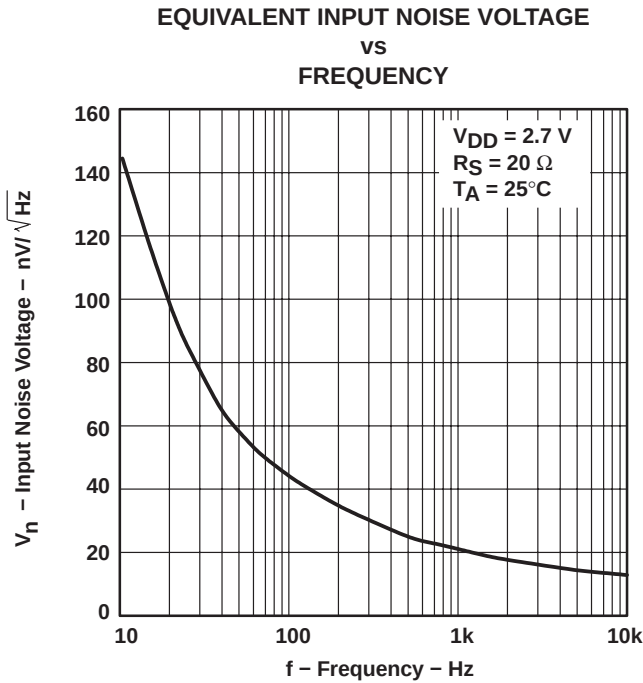


Figure 38

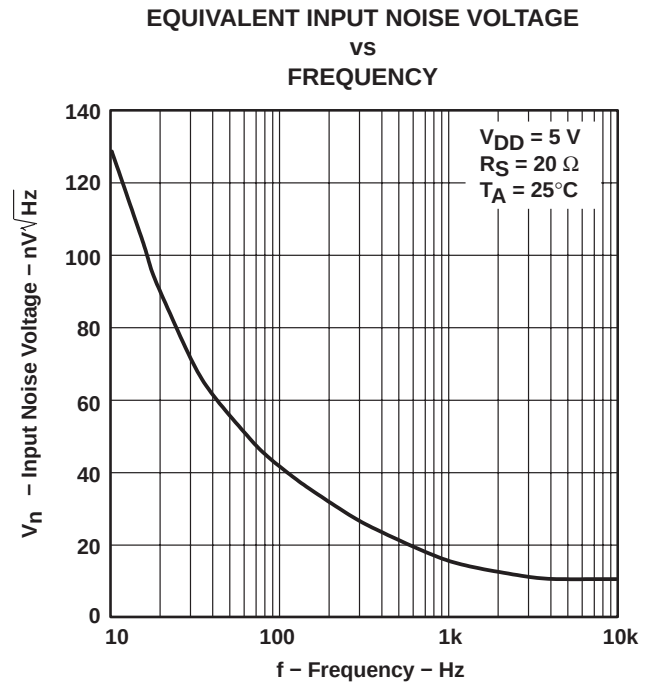
**TLV277x, TLV277xA**  
**FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT**  
**OPERATIONAL AMPLIFIERS WITH SHUTDOWN**

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

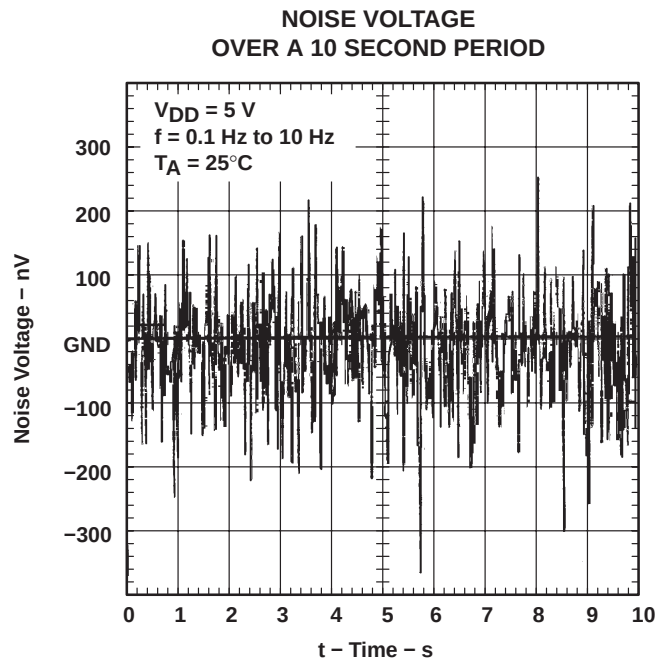
**TYPICAL CHARACTERISTICS**



**Figure 39**



**Figure 40**



**Figure 41**

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

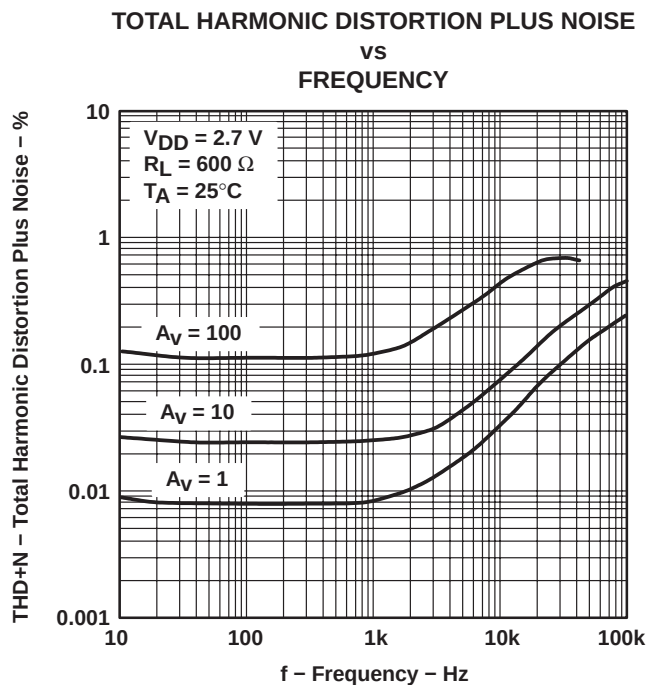


Figure 42

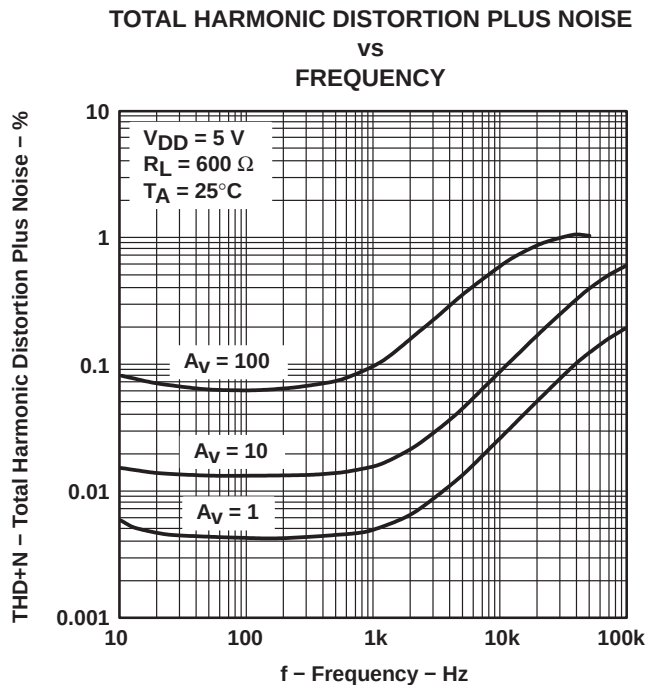


Figure 43

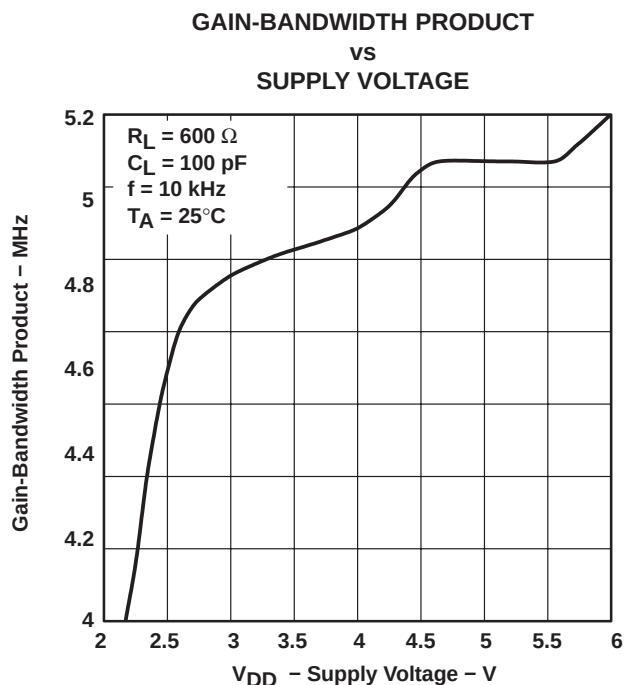


Figure 44

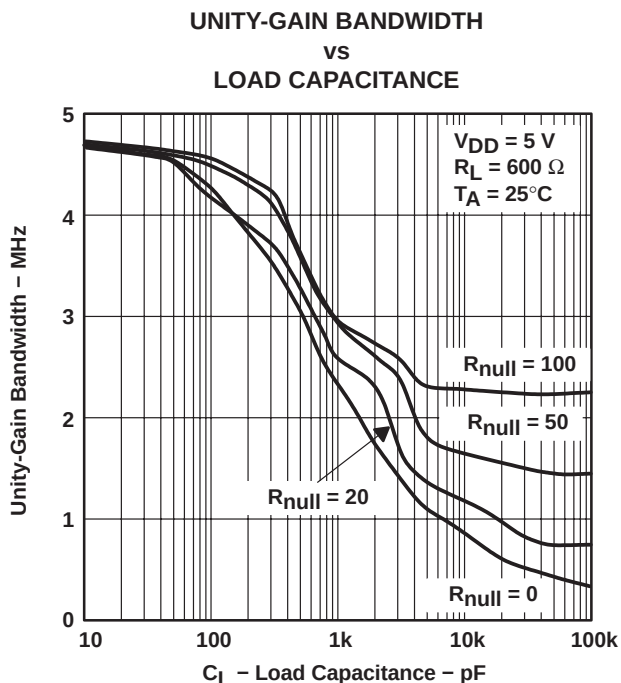


Figure 45

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

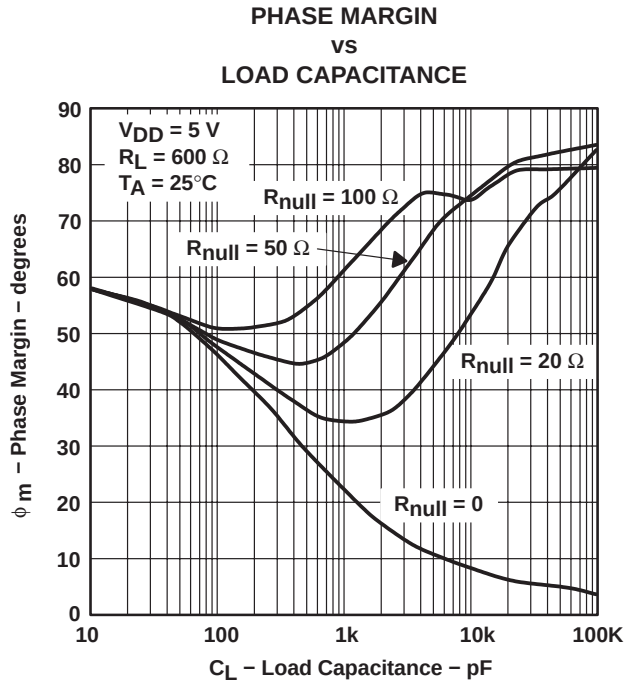


Figure 46

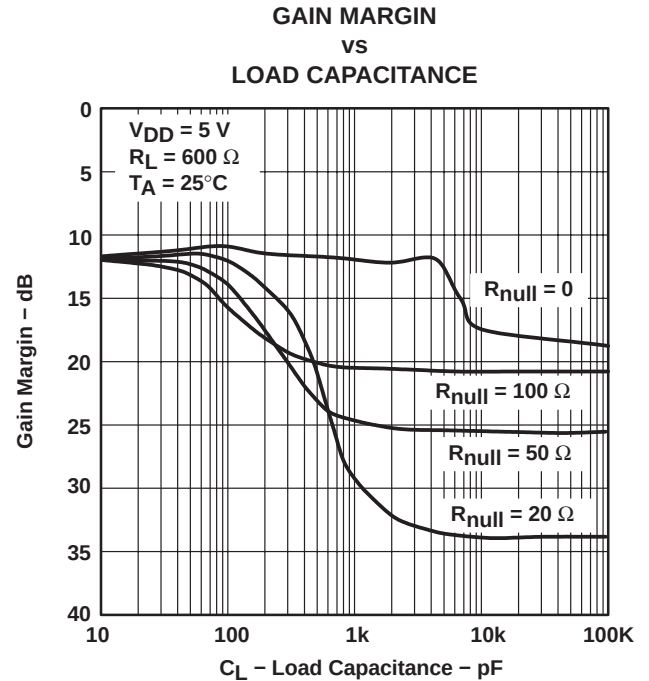


Figure 47

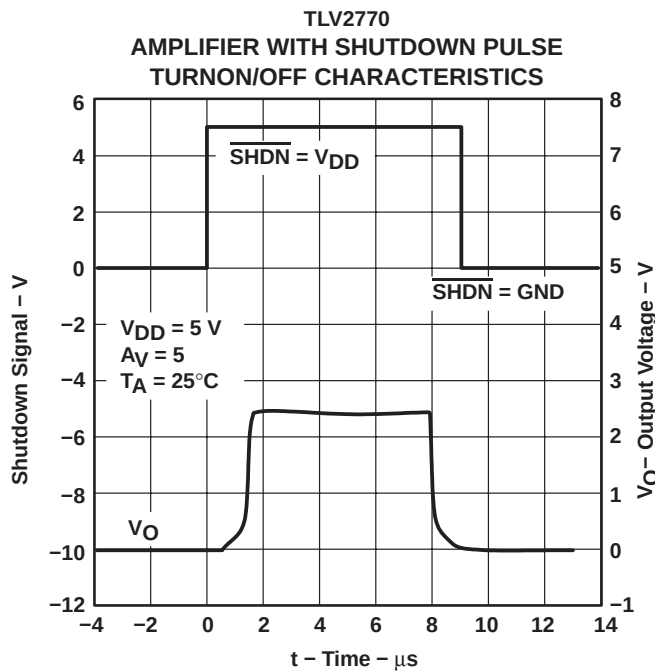


Figure 48

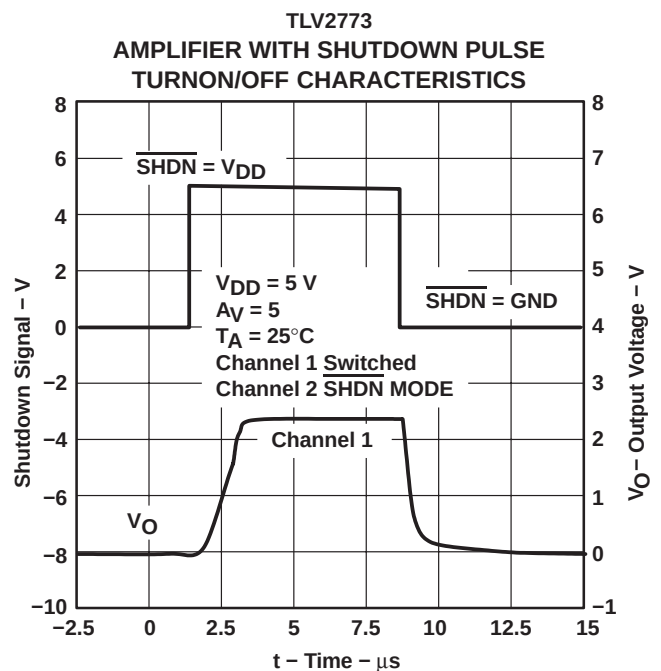


Figure 49

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

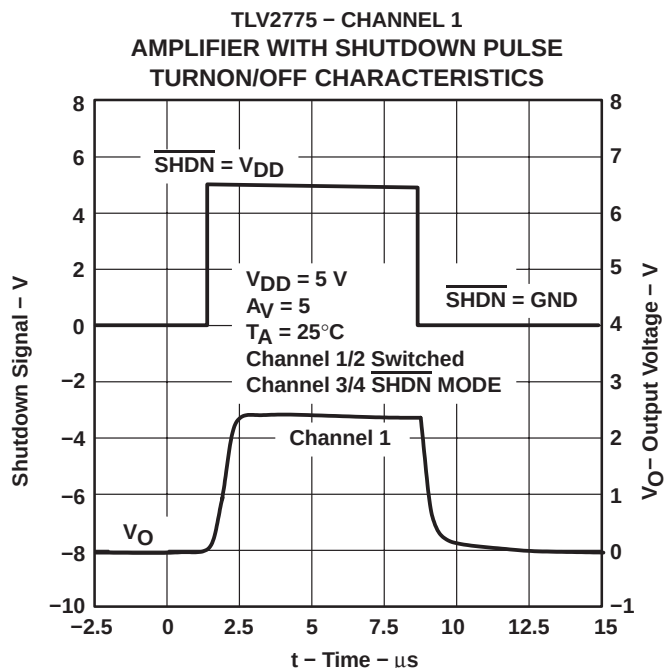


Figure 50

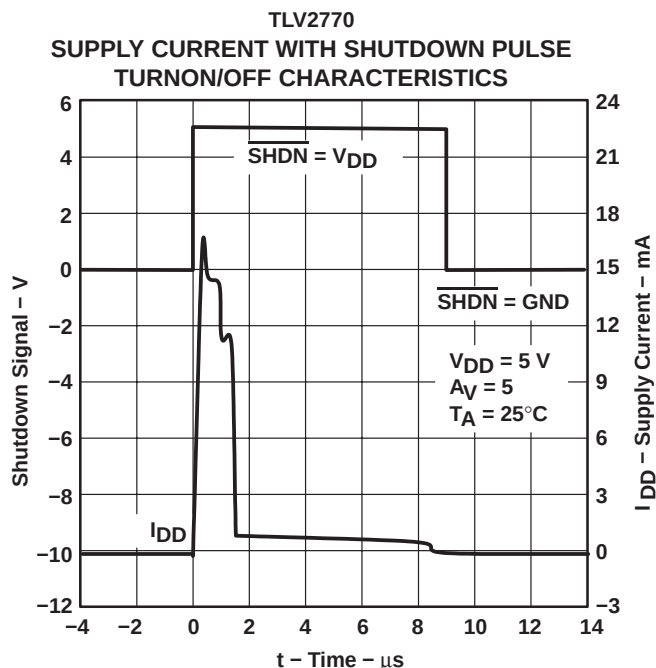


Figure 51

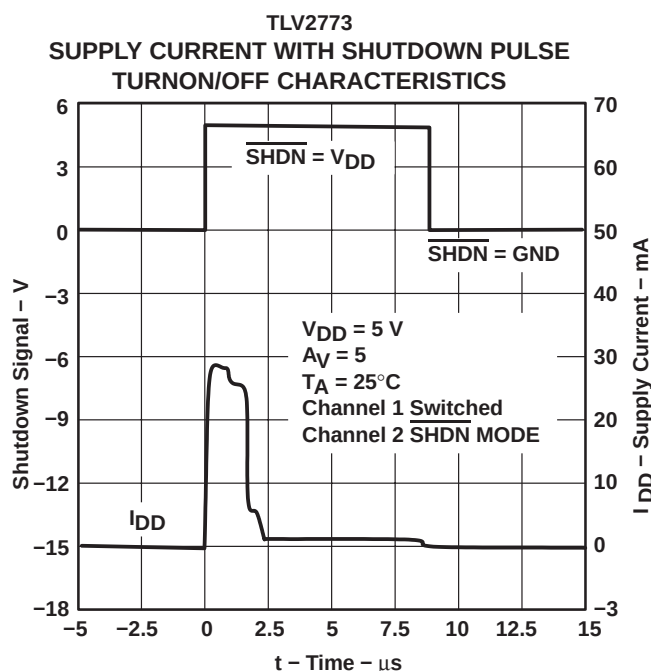


Figure 52

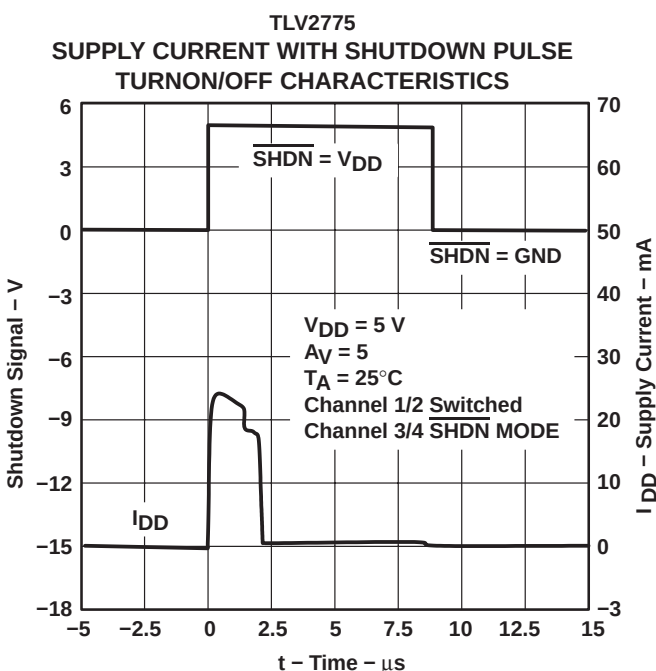


Figure 53



# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### TYPICAL CHARACTERISTICS

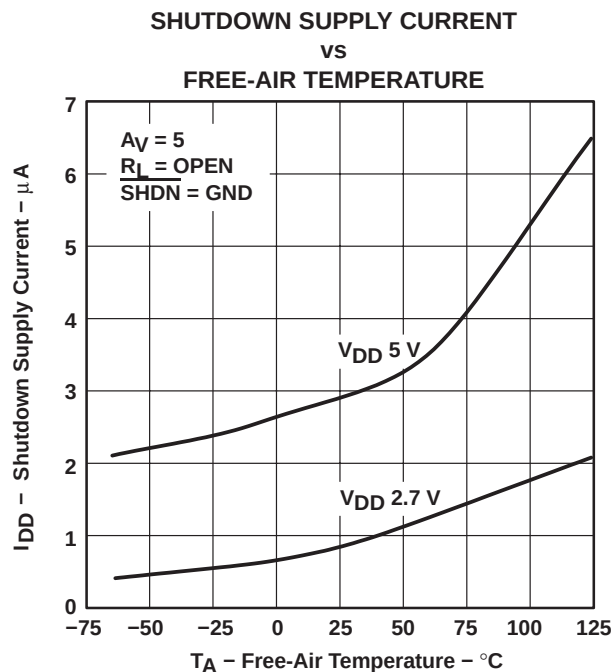


Figure 54

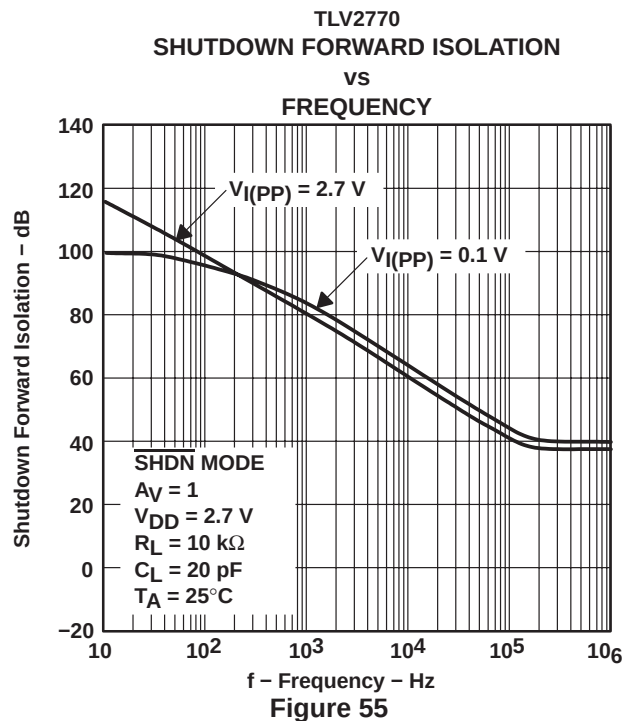


Figure 55

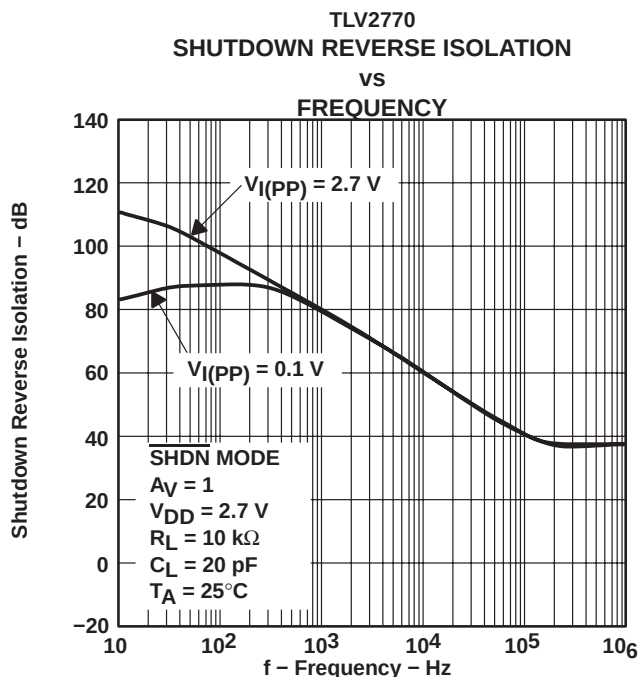


Figure 56

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### PARAMETER MEASUREMENT INFORMATION

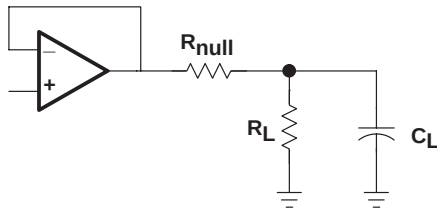


Figure 57

### 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 58. A minimum value of 20  $\Omega$  should work well for most applications.

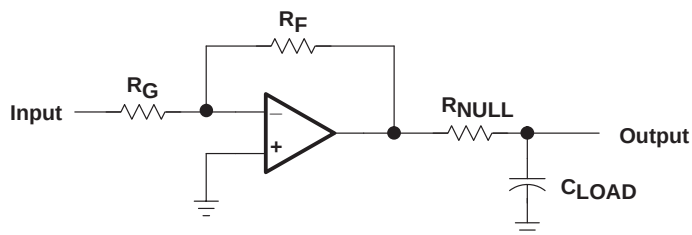
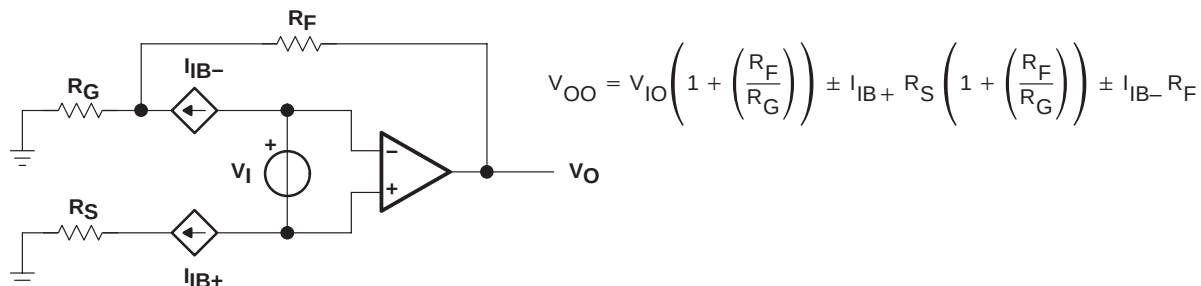


Figure 58. Driving a Capacitive Load

## APPLICATION INFORMATION

### offset voltage

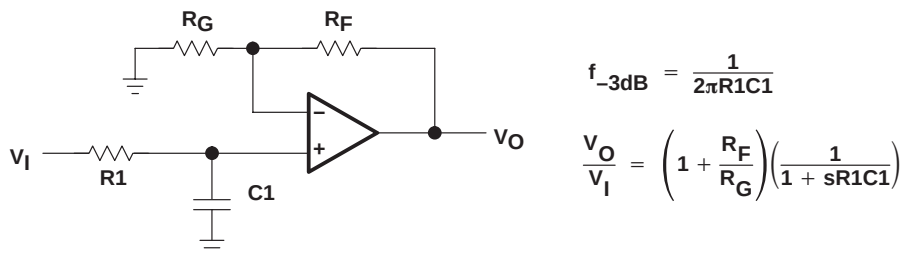
The output offset voltage, ( $V_{OO}$ ) is the sum of the input offset voltage ( $V_{IO}$ ) and both input bias currents ( $I_{IB}$ ) times the corresponding gains. The following schematic and formula can be used to calculate the output offset voltage:



**Figure 59. Output Offset Voltage Model**

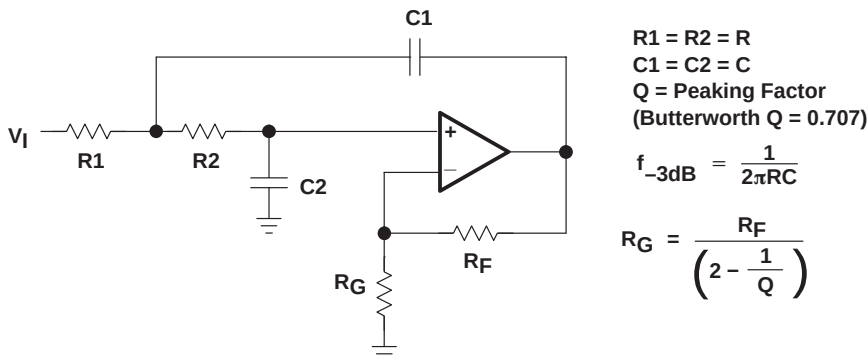
### general configurations

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 60).



**Figure 60. 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 61. 2-Pole Low-Pass Sallen-Key Filter**

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

### APPLICATION INFORMATION

#### using the TLV2772 as an accelerometer interface

The schematic, shown in Figure 62, shows the ACH04-08-05 interfaced to the TLV1544 10-bit analog-to-digital converter (ADC).

The ACH04-08-05 is a shock sensor designed to convert mechanical acceleration into electrical signals. The sensor contains three piezoelectric sensing elements oriented to simultaneously measure acceleration in three orthogonal, linear axes (x, y, z). The operating frequency is 0.5 Hz to 5 kHz. The output is buffered with an internal JFET and has a typical output voltage of 1.80 mV/g for the x and y axis and 1.35 mV/g for the z axis.

Amplification and frequency shaping of the shock sensor output is done by the TLV2772 rail-to-rail operational amplifier. The TLV2772 is ideal for this application as it offers high input impedance, good slew rate, and excellent dc precision. The rail-to-rail output swing and high output drive are perfect for driving the analog input of the TLV1544 ADC.

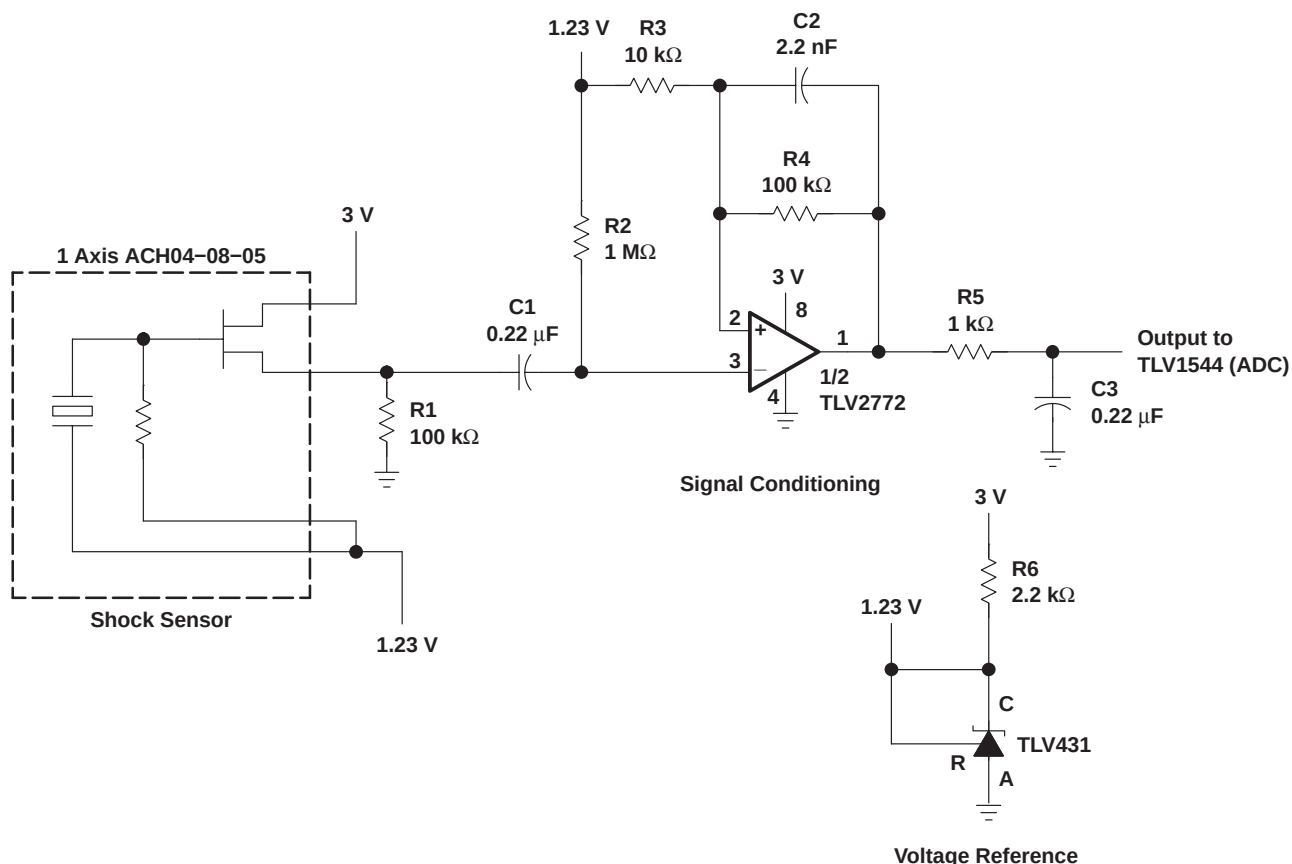


Figure 62. Accelerometer Interface Schematic

The sensor signal must be amplified and frequency-shaped to provide a signal the ADC can properly convert into the digital domain. Figure 62 shows the topology used in this application for one axis of the sensor. This system is powered from a single 3-V supply. Configuring the TLV431 with a 2.2-kΩ resistor produces a reference voltage of 1.23 V. This voltage is used to bias the operational amplifier and the internal JFETs in the shock sensor.

## APPLICATION INFORMATION

### gain calculation

Since the TLV2772 is capable of rail-to-rail output using a 3-V supply,  $V_O = 0$  (min) to 3 V (max). With no signal from the sensor, nominal  $V_O$  = reference voltage = 1.23 V. Therefore, the maximum negative swing from nominal is  $0\text{ V} - 1.23\text{ V} = -1.23\text{ V}$  and the maximum positive swing is  $3\text{ V} - 1.23\text{ V} = 1.77\text{ V}$ . By modeling the shock sensor as a low impedance voltage source with output of 2.25 mV/g (max) in the x and y axis and 1.70 mV/g (max) in the z axis, the gain of the circuit is calculated by equation 1.

$$\text{Gain} = \frac{\text{Output Swing}}{\text{Sensor Signal} \times \text{Acceleration}} \quad (1)$$

To avoid saturation of the operational amplifier, the gain calculations are based on the maximum negative swing of  $-1.23\text{ V}$  and the maximum sensor output of 2.25 mV/g (x and y axis) and 1.70 mV/g (z axis).

$$\text{Gain (x, y)} = \frac{-1.23\text{ V}}{2.25\text{ mV/g} \times -50\text{ g}} = 10.9 \quad (2)$$

and

$$\text{Gain (z)} = \frac{-1.23\text{ V}}{1.70\text{ mV/g} \times -50\text{ g}} = 14.5 \quad (3)$$

By selecting  $R_3 = 10\text{ k}\Omega$  and  $R_4 = 100\text{ k}\Omega$ , in the x and y channels, a gain of 11 is realized. By selecting  $R_3 = 7.5\text{ k}\Omega$  and  $R_4 = 100\text{ k}\Omega$ , in the z channel, a gain of 14.3 is realized. The schematic shows the configuration for either the x- or y-axis.

### bandwidth calculation

To calculate the component values for the frequency shaping characteristics of the signal conditioning circuit, 1 Hz and 500 Hz are selected as the minimum required 3-dB bandwidth.

To minimize the value of the input capacitor (C1) required to set the lower cutoff frequency requires a large value resistor for R2 is required. A 1-M $\Omega$  resistor is used in this example. To set the lower cutoff frequency, the required capacitor value for C1 is:

$$C1 = \frac{1}{2\pi f_{\text{LOW}} R_2} = 0.159\text{ }\mu\text{F} \quad (4)$$

Using a value of 0.22  $\mu\text{F}$ , a more common value of capacitor, the lower cutoff frequency is 0.724 Hz.

To minimize the phase shift in the feedback loop caused by the input capacitance of the TLV2772, it is best to minimize the value of the feedback resistor R4. However, to reduce the required capacitance in the feedback loop a large value for R4 is required. Therefore, a compromise for the value of R4 must be made. In this circuit, a value of 100 k $\Omega$  has been selected. To set the upper cutoff frequency, the required capacitor value for C2 is:

$$C2 = \frac{1}{2\pi f_{\text{HIGH}} R_4} = 3.18\text{ }\mu\text{F} \quad (5)$$

Using a 2.2-nF capacitor, the upper cutoff frequency is 724 Hz.

R5 and C3 also cause the signal response to roll off. Therefore, it is beneficial to design this roll-off point to begin at the upper cutoff frequency. Assuming a value of 1 k $\Omega$  for R5, the value for C3 is calculated to be 0.22  $\mu\text{F}$ .

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

---

### APPLICATION INFORMATION

#### circuit layout considerations

To achieve the levels of high performance of the TLV277x, follow proper printed-circuit board design techniques. A general set of guidelines is given in the following.

- Ground planes—It is highly recommended that a ground plane be used on the board to provide all components with a low inductive ground connection. However, in the areas of the amplifier inputs and output, the ground plane can be removed to minimize the stray capacitance.
- Proper power supply decoupling—Use a 6.8- $\mu$ F tantalum capacitor in parallel with a 0.1- $\mu$ F ceramic capacitor on each supply terminal. It may be possible to share the tantalum among several amplifiers depending on the application, but a 0.1- $\mu$ F ceramic capacitor should always be used on the supply terminal of every amplifier. In addition, the 0.1- $\mu$ F capacitor should be placed as close as possible to the supply terminal. As this distance increases, the inductance in the connecting trace makes the capacitor less effective. The designer should strive for distances of less than 0.1 inches between the device power terminals and the ceramic capacitors.
- Sockets—Sockets can be used but are not recommended. The additional lead inductance in the socket pins will often lead to stability problems. Surface-mount packages soldered directly to the printed-circuit board is the best implementation.
- Short trace runs/compact part placements—Optimum high performance is achieved when stray series inductance has been minimized. To realize this, the circuit layout should be made as compact as possible, thereby minimizing the length of all trace runs. Particular attention should be paid to the inverting input of the amplifier. Its length should be kept as short as possible. This will help to minimize stray capacitance at the input of the amplifier.
- Surface-mount passive components—Using surface-mount passive components is recommended for high performance amplifier circuits for several reasons. First, because of the extremely low lead inductance of surface-mount components, the problem with stray series inductance is greatly reduced. Second, the small size of surface-mount components naturally leads to a more compact layout thereby minimizing both stray inductance and capacitance. If leaded components are used, it is recommended that the lead lengths be kept as short as possible.

## APPLICATION INFORMATION

### general power dissipation considerations

For a given  $\theta_{JA}$ , the maximum power dissipation is shown in Figure 63 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 TLV277x IC (watts)

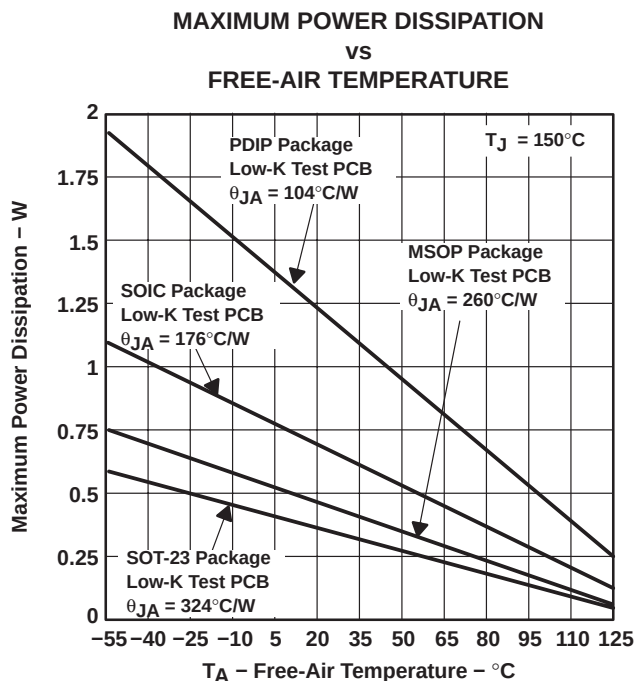
$T_{MAX}$  = Absolute maximum junction temperature (150°C)

$T_A$  = 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 63. Maximum Power Dissipation vs Free-Air Temperature**

# TLV277x, TLV277xA

## FAMILY OF 2.7-V HIGH-SLEW-RATE RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS WITH SHUTDOWN

SLOS209G – JANUARY 1998 – REVISED FEBRUARY 2004

---

### APPLICATION INFORMATION

#### shutdown function

Three members of the TLV277x family (TLV2770/3/5) have a shutdown terminal for conserving battery life in portable applications. When the shutdown terminal is tied low, the supply current is reduced to 0.8  $\mu\text{A}/\text{channel}$ , the amplifier is disabled, and the outputs are placed in a high impedance mode. To enable the amplifier, the shutdown terminal can either be left floating or pulled high. When the shutdown terminal is left floating, care needs to be taken to ensure that parasitic leakage current at the shutdown terminal does not inadvertently place the operational amplifier into shutdown. The shutdown terminal threshold is always referenced to  $V_{DD}/2$ . Therefore, when operating the device with split supply voltages (e.g.  $\pm 2.5\text{ V}$ ), the shutdown terminal needs to be pulled to  $V_{DD-}$  (not GND) to disable the operational amplifier.

The amplifier's output with a shutdown pulse is shown in Figures 48, 49, and 50. 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. The *bump* on the rising edge of the TLV2770 output waveform is due to the start-up circuit on the bias generator. For the dual and quad (TLV2773/5), this *bump* is attributed to the bias generator's start-up circuit as well as the crosstalk between the other channel(s), which are in shutdown.

Figures 55 and 56 show the amplifier's forward and reverse isolation in shutdown. The operational amplifier is powered by  $\pm 1.35\text{-V}$  supplies and configured as a voltage follower ( $A_V = 1$ ). The isolation performance is plotted across frequency for both 0.1  $V_{PP}$  and 2.7  $V_{PP}$  input signals. During normal operation, the amplifier would not be able to handle a 2.7- $V_{PP}$  input signal with a supply voltage of  $\pm 1.35\text{ V}$  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.





**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup>    | Lead/<br>Ball Finish | MSL Peak Temp <sup>(3)</sup> | Samples<br>(Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| 5962-9858801Q2A  | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                        | Call TI              | Call TI                      |                             |
| 5962-9858801QHA  | ACTIVE                | CFP          | U               | 10   | 1           | TBD                        | Call TI              | Call TI                      |                             |
| 5962-9858801QPA  | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                        | Call TI              | Call TI                      |                             |
| 5962-9858802Q2A  | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                        | Call TI              | Call TI                      |                             |
| 5962-9858802QHA  | ACTIVE                | CFP          | U               | 10   | 1           | TBD                        | Call TI              | Call TI                      |                             |
| 5962-9858802QPA  | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                        | Call TI              | Call TI                      |                             |
| TLV2770AID       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770AIDG4     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770AIP       | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2770AIPe4     | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2770CD        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770CDG4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770CDR       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770CDRG4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770CP        | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2770CPE4      | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2770IDGKR     | ACTIVE                | VSSOP        | DGK             | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770IDGKRG4   | ACTIVE                | VSSOP        | DGK             | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770IDR       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770IDRG4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2770IP        | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2770IPE4      | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup>    | Lead/<br>Ball Finish | MSL Peak Temp <sup>(3)</sup> | Samples<br>(Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| TLV2771AIDR      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771AIDRG4    | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771CD        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771CDBVR     | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771CDBVRG4   | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771CDBVT     | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771CDBVTG4   | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771CDG4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771CDR       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771CDRG4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771ID        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771IDBVR     | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771IDBVRG4   | ACTIVE                | SOT-23       | DBV             | 5    | 3000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771IDBVT     | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771IDBVTG4   | ACTIVE                | SOT-23       | DBV             | 5    | 250         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771IDG4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771IDR       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2771IDRG4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup>    | Lead/<br>Ball Finish | MSL Peak Temp <sup>(3)</sup> | Samples<br>(Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| TLV2772AID       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AIDG4     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AIDR      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AIDRG4    | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AIP       | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2772AIPe4     | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2772AMD       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AMDG4     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AMDR      | ACTIVE                | SOIC         | D               | 8    |             | TBD                        | Call TI              | Call TI                      |                             |
| TLV2772AMDRG4    | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AMFKB     | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                        | POST-PLATE           | N / A for Pkg Type           |                             |
| TLV2772AMJGB     | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                        | A42                  | N / A for Pkg Type           |                             |
| TLV2772AMUB      | ACTIVE                | CFP          | U               | 10   | 1           | TBD                        | A42                  | N / A for Pkg Type           |                             |
| TLV2772AQD       | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AQDG4     | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AQDR      | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AQDRG4    | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AQPW      | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AQPWG4    | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772AQPWR     | ACTIVE                | TSSOP        | PW              | 8    |             | TBD                        | Call TI              | Call TI                      |                             |
| TLV2772AQPWRG4   | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup>    | Lead/<br>Ball Finish | MSL Peak Temp <sup>(3)</sup> | Samples<br>(Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| TLV2772CD        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772CDG4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772CDGK      | ACTIVE                | VSSOP        | DGK             | 8    | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772CDGKG4    | ACTIVE                | VSSOP        | DGK             | 8    | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772CDGKR     | ACTIVE                | VSSOP        | DGK             | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772CDGKRG4   | ACTIVE                | VSSOP        | DGK             | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772CDR       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772CDRG4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772CP        | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2772CPE4      | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2772ID        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772IDG4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772IDGK      | ACTIVE                | VSSOP        | DGK             | 8    | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772IDGKG4    | ACTIVE                | VSSOP        | DGK             | 8    | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772IDGKR     | ACTIVE                | VSSOP        | DGK             | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772IDGKRG4   | ACTIVE                | VSSOP        | DGK             | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772IDR       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772IDRG4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772IP        | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup>    | Lead/<br>Ball Finish | MSL Peak Temp <sup>(3)</sup> | Samples<br>(Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| TLV2772IPE4      | ACTIVE                | PDIP         | P               | 8    | 50          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2772MD        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772MDG4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772MDR       | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772MDRG4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772MFKB      | ACTIVE                | LCCC         | FK              | 20   | 1           | TBD                        | POST-PLATE           | N / A for Pkg Type           |                             |
| TLV2772MJGB      | ACTIVE                | CDIP         | JG              | 8    | 1           | TBD                        | A42                  | N / A for Pkg Type           |                             |
| TLV2772MUB       | ACTIVE                | CFP          | U               | 10   | 1           | TBD                        | A42                  | N / A for Pkg Type           |                             |
| TLV2772QD        | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772QDG4      | ACTIVE                | SOIC         | D               | 8    | 75          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772QDR       | ACTIVE                | SOIC         | D               | 8    | 1500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772QDRG4     | ACTIVE                | SOIC         | D               | 8    | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772QPW       | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772QPWG4     | ACTIVE                | TSSOP        | PW              | 8    | 150         | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772QPWR      | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2772QPWRG4    | ACTIVE                | TSSOP        | PW              | 8    | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2773AIN       | ACTIVE                | PDIP         | N               | 14   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2773AINE4     | ACTIVE                | PDIP         | N               | 14   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2773CDGS      | ACTIVE                | MSOP         | DGS             | 10   | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2773CDGSG4    | ACTIVE                | MSOP         | DGS             | 10   | 80          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2773CDGSR     | ACTIVE                | MSOP         | DGS             | 10   |             | TBD                        | Call TI              | Call TI                      |                             |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup>    | Lead/<br>Ball Finish | MSL Peak Temp <sup>(3)</sup> | Samples<br>(Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| TLV2773CDGSRG4   | ACTIVE                | MSOP         | DGS             | 10   |             | TBD                        | Call TI              | Call TI                      |                             |
| TLV2773CDR       | ACTIVE                | SOIC         | D               | 14   |             | TBD                        | Call TI              | Call TI                      |                             |
| TLV2773CDRG4     | ACTIVE                | SOIC         | D               | 14   |             | TBD                        | Call TI              | Call TI                      |                             |
| TLV2773IDGSR     | ACTIVE                | MSOP         | DGS             | 10   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2773IDGSRG4   | ACTIVE                | MSOP         | DGS             | 10   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2773IDR       | ACTIVE                | SOIC         | D               | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2773IDRG4     | ACTIVE                | SOIC         | D               | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2773IN        | ACTIVE                | PDIP         | N               | 14   |             | TBD                        | Call TI              | Call TI                      |                             |
| TLV2773INE4      | ACTIVE                | PDIP         | N               | 14   |             | TBD                        | Call TI              | Call TI                      |                             |
| TLV2774AID       | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774AIDG4     | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774AIDR      | ACTIVE                | SOIC         | D               | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774AIDRG4    | ACTIVE                | SOIC         | D               | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774AIN       | ACTIVE                | PDIP         | N               | 14   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2774AINE4     | ACTIVE                | PDIP         | N               | 14   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2774AIPW      | ACTIVE                | TSSOP        | PW              | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774AIPWG4    | ACTIVE                | TSSOP        | PW              | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774CD        | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774CDG4      | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774CDR       | ACTIVE                | SOIC         | D               | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774CDRG4     | ACTIVE                | SOIC         | D               | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup>    | Lead/<br>Ball Finish | MSL Peak Temp <sup>(3)</sup> | Samples<br>(Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| TLV2774CN        | ACTIVE                | PDIP         | N               | 14   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2774CNE4      | ACTIVE                | PDIP         | N               | 14   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2774CPW       | ACTIVE                | TSSOP        | PW              | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774CPWG4     | ACTIVE                | TSSOP        | PW              | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774CPWR      | ACTIVE                | TSSOP        | PW              | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774CPWRG4    | ACTIVE                | TSSOP        | PW              | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774ID        | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774IDG4      | ACTIVE                | SOIC         | D               | 14   | 50          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774IDR       | ACTIVE                | SOIC         | D               | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774IDRG4     | ACTIVE                | SOIC         | D               | 14   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774IN        | ACTIVE                | PDIP         | N               | 14   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2774INE4      | ACTIVE                | PDIP         | N               | 14   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2774IPW       | ACTIVE                | TSSOP        | PW              | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774IPWG4     | ACTIVE                | TSSOP        | PW              | 14   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774IPWR      | ACTIVE                | TSSOP        | PW              | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2774IPWRG4    | ACTIVE                | TSSOP        | PW              | 14   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2775AIN       | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2775AINE4     | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2775AIPW      | ACTIVE                | TSSOP        | PW              | 16   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2775AIPWG4    | ACTIVE                | TSSOP        | PW              | 16   | 90          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2775CD        | ACTIVE                | SOIC         | D               | 16   |             | TBD                        | Call TI              | Call TI                      |                             |



| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup>    | Lead/<br>Ball Finish | MSL Peak Temp <sup>(3)</sup> | Samples<br>(Requires Login) |
|------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| TLV2775CDG4      | ACTIVE                | SOIC         | D               | 16   |             | TBD                        | Call TI              | Call TI                      |                             |
| TLV2775CN        | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2775CNE4      | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2775ID        | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2775IDG4      | ACTIVE                | SOIC         | D               | 16   | 40          | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2775IDR       | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2775IDRG4     | ACTIVE                | SOIC         | D               | 16   | 2500        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2775IN        | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2775INE4      | ACTIVE                | PDIP         | N               | 16   | 25          | Pb-Free (RoHS)             | CU NIPDAU            | N / A for Pkg Type           |                             |
| TLV2775IPWR      | ACTIVE                | TSSOP        | PW              | 16   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |
| TLV2775IPWRG4    | ACTIVE                | TSSOP        | PW              | 16   | 2000        | Green (RoHS<br>& no Sb/Br) | CU NIPDAU            | Level-1-260C-UNLIM           |                             |

<sup>(1)</sup> 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.

<sup>(2)</sup> 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.

---

**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.

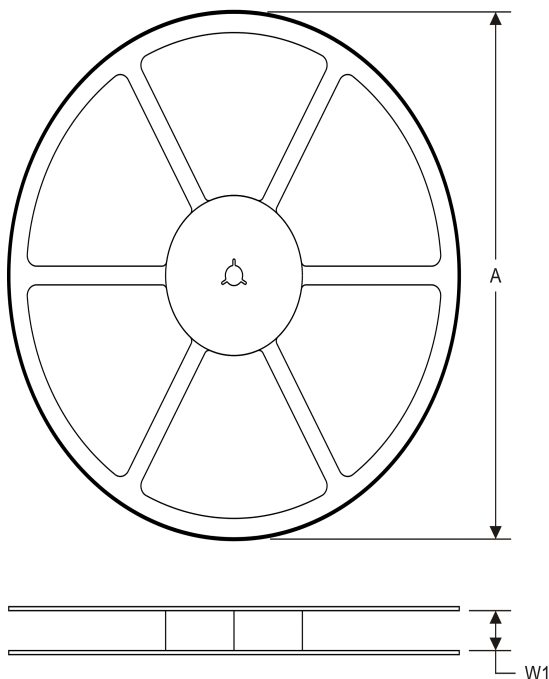
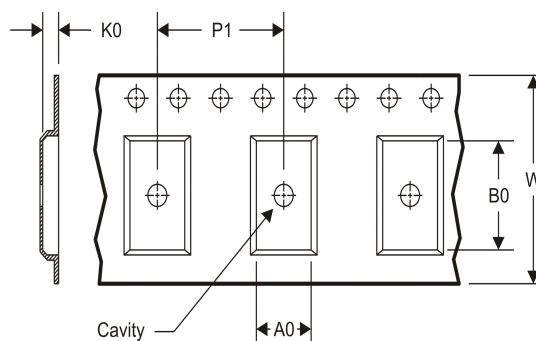
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TLV2771, TLV2772, TLV2772A, TLV2772AM, TLV2772M, TLV2774, TLV2774A :**

- Catalog: [TLV2772A](#), [TLV2772](#)
- Automotive: [TLV2771-Q1](#), [TLV2772-Q1](#), [TLV2772A-Q1](#), [TLV2772A-Q1](#), [TLV2772-Q1](#)
- Enhanced Product: [TLV2772A-EP](#), [TLV2772A-EP](#), [TLV2774-EP](#), [TLV2774A-EP](#)
- Military: [TLV2772M](#), [TLV2772AM](#)

**NOTE: Qualified Version Definitions:**

- Catalog - TI's standard catalog product
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects
- Enhanced Product - Supports Defense, Aerospace and Medical Applications
- Military - QML certified for Military and Defense Applications

**TAPE AND REEL INFORMATION**
**REEL DIMENSIONS**

**TAPE DIMENSIONS**


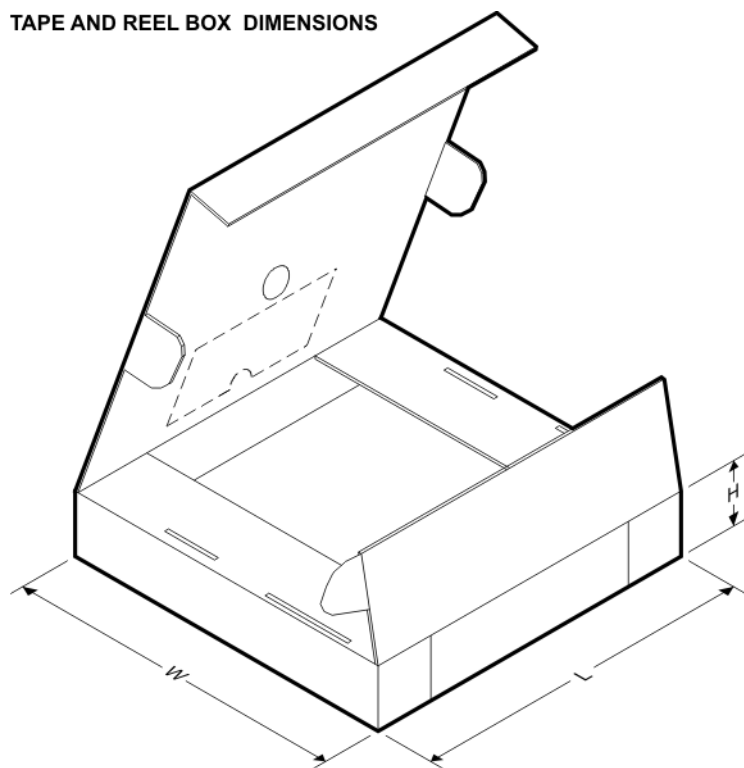
|    |                                                           |
|----|-----------------------------------------------------------|
| A0 | Dimension designed to accommodate the component width     |
| B0 | Dimension designed to accommodate the component length    |
| K0 | Dimension designed to accommodate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

**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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLV2770CDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2770IDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2770IDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2771AIDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2771CDBVR | SOT-23       | DBV             | 5    | 3000 | 180.0              | 9.0                | 3.15    | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV2771CDBVR | SOT-23       | DBV             | 5    | 3000 | 178.0              | 9.0                | 3.23    | 3.17    | 1.37    | 4.0     | 8.0    | Q3            |
| TLV2771CDBVT | SOT-23       | DBV             | 5    | 250  | 178.0              | 9.0                | 3.23    | 3.17    | 1.37    | 4.0     | 8.0    | Q3            |
| TLV2771CDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2771IDBVR | SOT-23       | DBV             | 5    | 3000 | 178.0              | 9.0                | 3.23    | 3.17    | 1.37    | 4.0     | 8.0    | Q3            |
| TLV2771IDBVT | SOT-23       | DBV             | 5    | 250  | 178.0              | 9.0                | 3.23    | 3.17    | 1.37    | 4.0     | 8.0    | Q3            |
| TLV2771IDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2772AIDR  | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2772CDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2772CDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2772CDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2772IDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2772IDGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2772IDR   | 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 |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLV2772MDR   | SOIC         | D               | 8    | 2500 | 330.0              | 12.4               | 6.4     | 5.2     | 2.1     | 8.0     | 12.0   | Q1            |
| TLV2772QPWR  | TSSOP        | PW              | 8    | 2000 | 330.0              | 12.4               | 7.0     | 3.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TLV2773IDGSR | MSOP         | DGS             | 10   | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV2773IDR   | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLV2774AIDR  | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLV2774CDR   | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLV2774CPWR  | TSSOP        | PW              | 14   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TLV2774IDR   | SOIC         | D               | 14   | 2500 | 330.0              | 16.4               | 6.5     | 9.0     | 2.1     | 8.0     | 16.0   | Q1            |
| TLV2774IPWR  | TSSOP        | PW              | 14   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TLV2775IDR   | SOIC         | D               | 16   | 2500 | 330.0              | 16.4               | 6.5     | 10.3    | 2.1     | 8.0     | 16.0   | Q1            |
| TLV2775IPWR  | TSSOP        | PW              | 16   | 2000 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |

**TAPE AND REEL BOX DIMENSIONS**


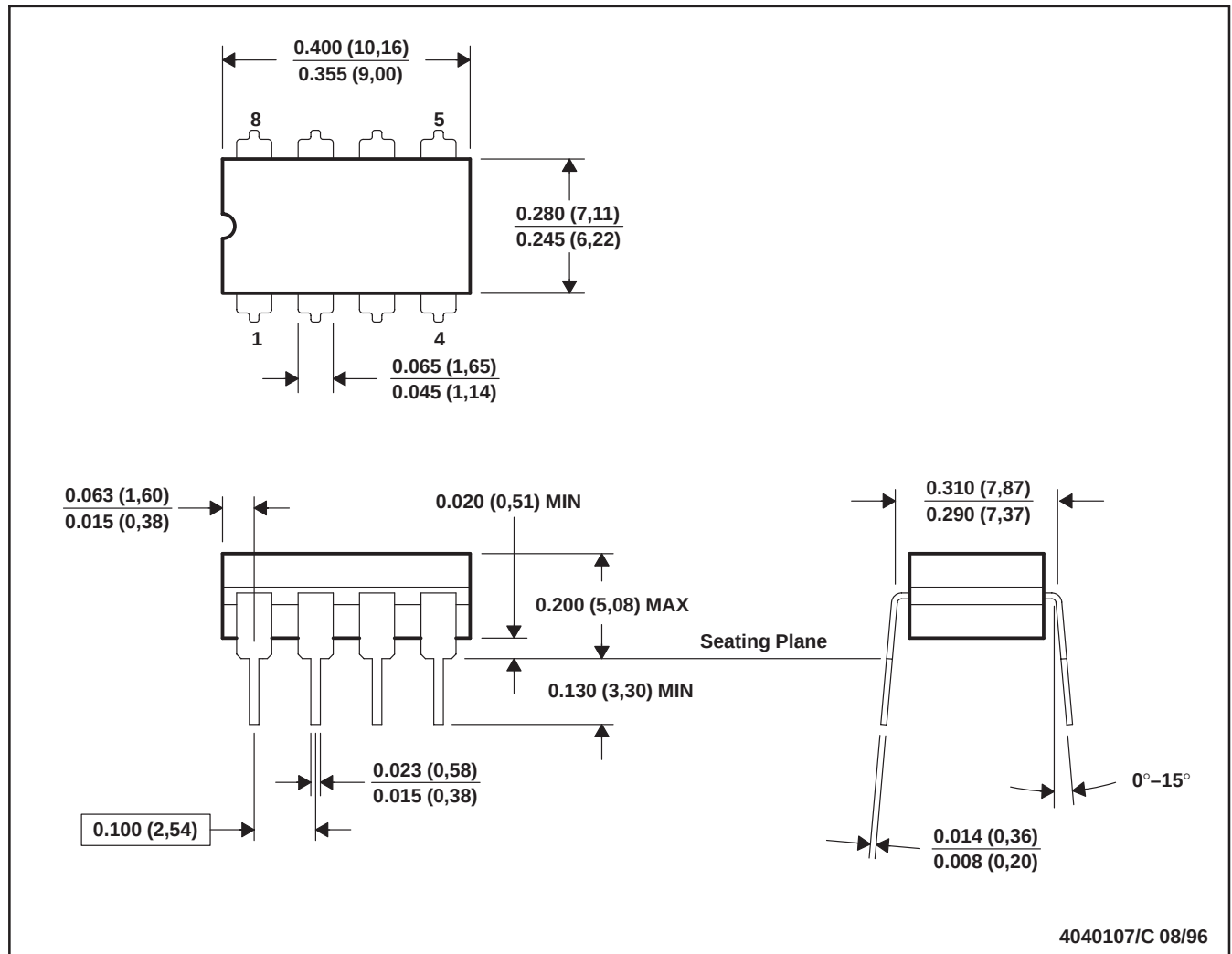
\*All dimensions are nominal

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLV2770CDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2770IDGKR | VSSOP        | DGK             | 8    | 2500 | 358.0       | 335.0      | 35.0        |
| TLV2770IDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2771AIDR  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2771CDBVR | SOT-23       | DBV             | 5    | 3000 | 182.0       | 182.0      | 20.0        |
| TLV2771CDBVR | SOT-23       | DBV             | 5    | 3000 | 180.0       | 180.0      | 18.0        |

| Device       | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLV2771CDBVT | SOT-23       | DBV             | 5    | 250  | 180.0       | 180.0      | 18.0        |
| TLV2771CDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2771IDBVR | SOT-23       | DBV             | 5    | 3000 | 180.0       | 180.0      | 18.0        |
| TLV2771IDBVT | SOT-23       | DBV             | 5    | 250  | 180.0       | 180.0      | 18.0        |
| TLV2771IDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2772AIDR  | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2772CDGKR | VSSOP        | DGK             | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| TLV2772CDGKR | VSSOP        | DGK             | 8    | 2500 | 358.0       | 335.0      | 35.0        |
| TLV2772CDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2772IDGKR | VSSOP        | DGK             | 8    | 2500 | 364.0       | 364.0      | 27.0        |
| TLV2772IDGKR | VSSOP        | DGK             | 8    | 2500 | 358.0       | 335.0      | 35.0        |
| TLV2772IDR   | SOIC         | D               | 8    | 2500 | 340.5       | 338.1      | 20.6        |
| TLV2772MDR   | SOIC         | D               | 8    | 2500 | 367.0       | 367.0      | 35.0        |
| TLV2772QPWR  | TSSOP        | PW              | 8    | 2000 | 367.0       | 367.0      | 35.0        |
| TLV2773IDGSR | MSOP         | DGS             | 10   | 2500 | 358.0       | 335.0      | 35.0        |
| TLV2773IDR   | SOIC         | D               | 14   | 2500 | 367.0       | 367.0      | 38.0        |
| TLV2774AIDR  | SOIC         | D               | 14   | 2500 | 367.0       | 367.0      | 38.0        |
| TLV2774CDR   | SOIC         | D               | 14   | 2500 | 367.0       | 367.0      | 38.0        |
| TLV2774CPWR  | TSSOP        | PW              | 14   | 2000 | 367.0       | 367.0      | 35.0        |
| TLV2774IDR   | SOIC         | D               | 14   | 2500 | 367.0       | 367.0      | 38.0        |
| TLV2774IPWR  | TSSOP        | PW              | 14   | 2000 | 367.0       | 367.0      | 35.0        |
| TLV2775IDR   | SOIC         | D               | 16   | 2500 | 367.0       | 367.0      | 38.0        |
| TLV2775IPWR  | TSSOP        | PW              | 16   | 2000 | 367.0       | 367.0      | 35.0        |

## JG (R-GDIP-T8)

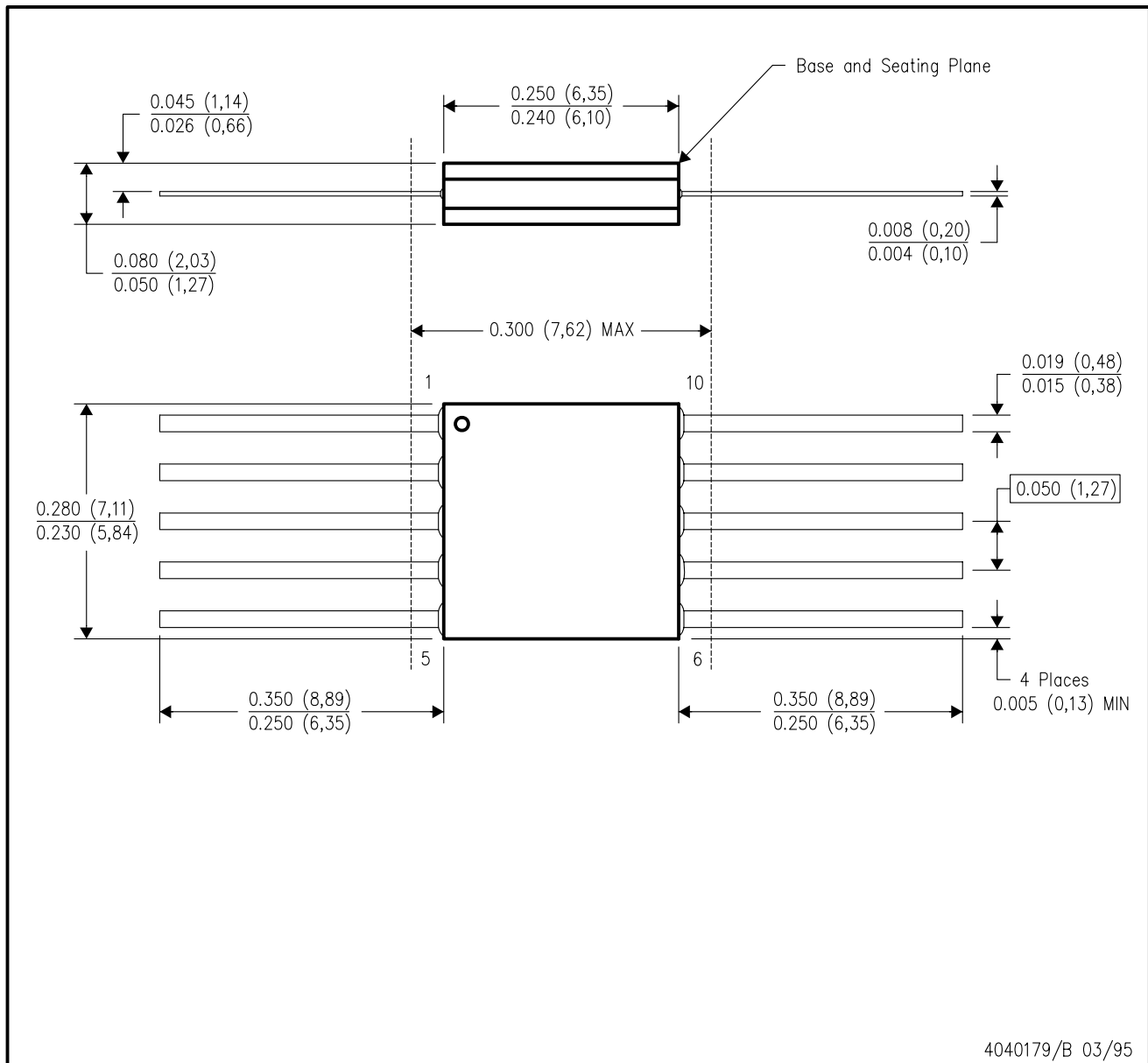
## CERAMIC DUAL-IN-LINE



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification.
  - Falls within MIL STD 1835 GDIP1-T8

U (S-GDFP-F10)

CERAMIC DUAL FLATPACK

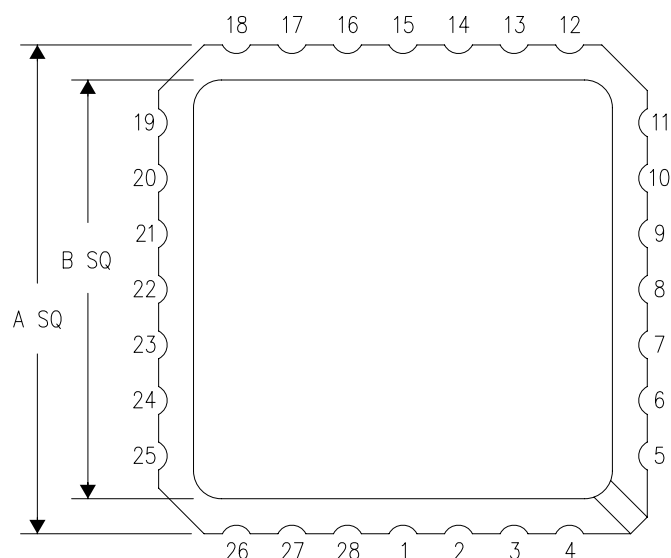


- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification only.
  - Falls within MIL STD 1835 GDFP1-F10 and JEDEC MO-092AA

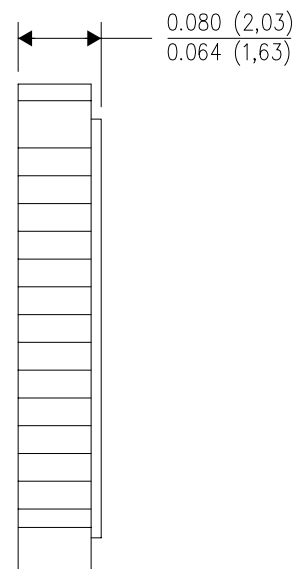
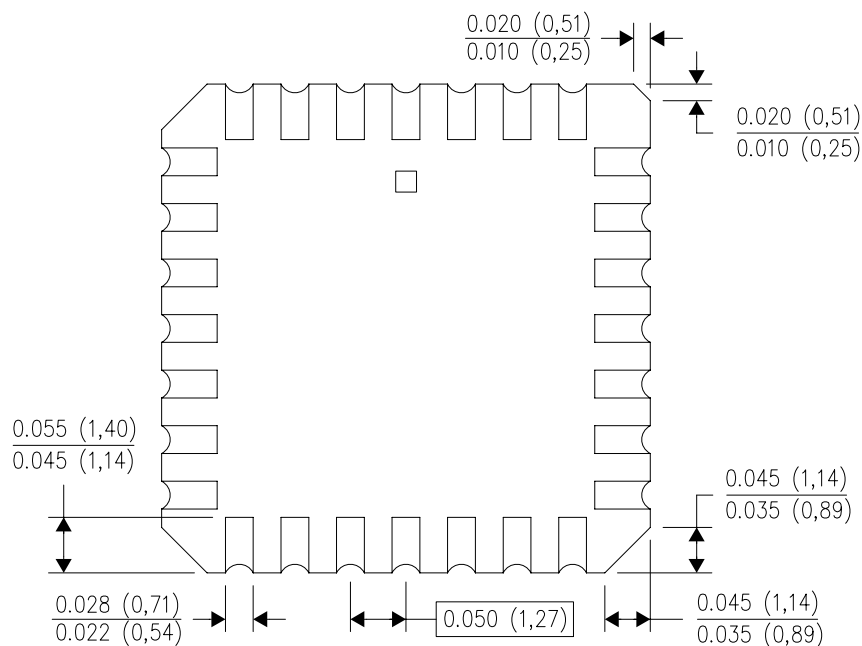
FK (S-CQCC-N\*\*)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



| NO. OF<br>TERMINALS<br>** | A                |                  | B                |                  |
|---------------------------|------------------|------------------|------------------|------------------|
|                           | MIN              | MAX              | MIN              | MAX              |
| 20                        | 0.342<br>(8,69)  | 0.358<br>(9,09)  | 0.307<br>(7,80)  | 0.358<br>(9,09)  |
| 28                        | 0.442<br>(11,23) | 0.458<br>(11,63) | 0.406<br>(10,31) | 0.458<br>(11,63) |
| 44                        | 0.640<br>(16,26) | 0.660<br>(16,76) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 52                        | 0.740<br>(18,78) | 0.761<br>(19,32) | 0.495<br>(12,58) | 0.560<br>(14,22) |
| 68                        | 0.938<br>(23,83) | 0.962<br>(24,43) | 0.850<br>(21,6)  | 0.858<br>(21,8)  |
| 84                        | 1.141<br>(28,99) | 1.165<br>(29,59) | 1.047<br>(26,6)  | 1.063<br>(27,0)  |



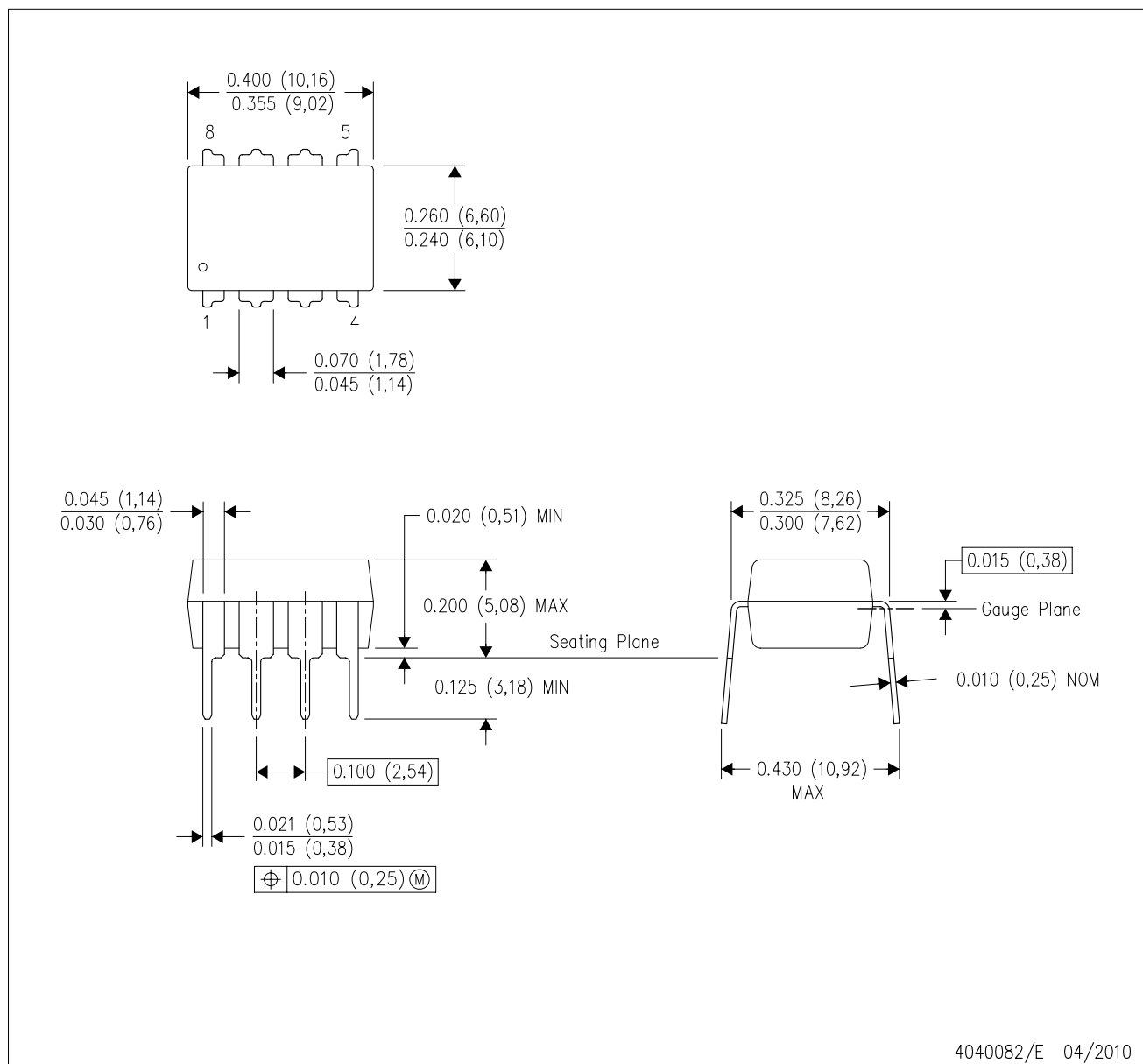
4040140/D 01/11

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - Falls within JEDEC MS-004



P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE PACKAGE

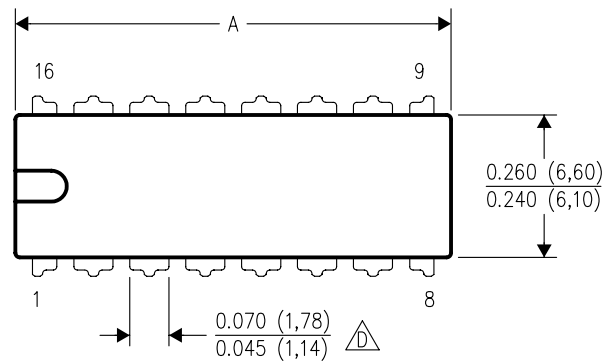


- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Falls within JEDEC MS-001 variation BA.

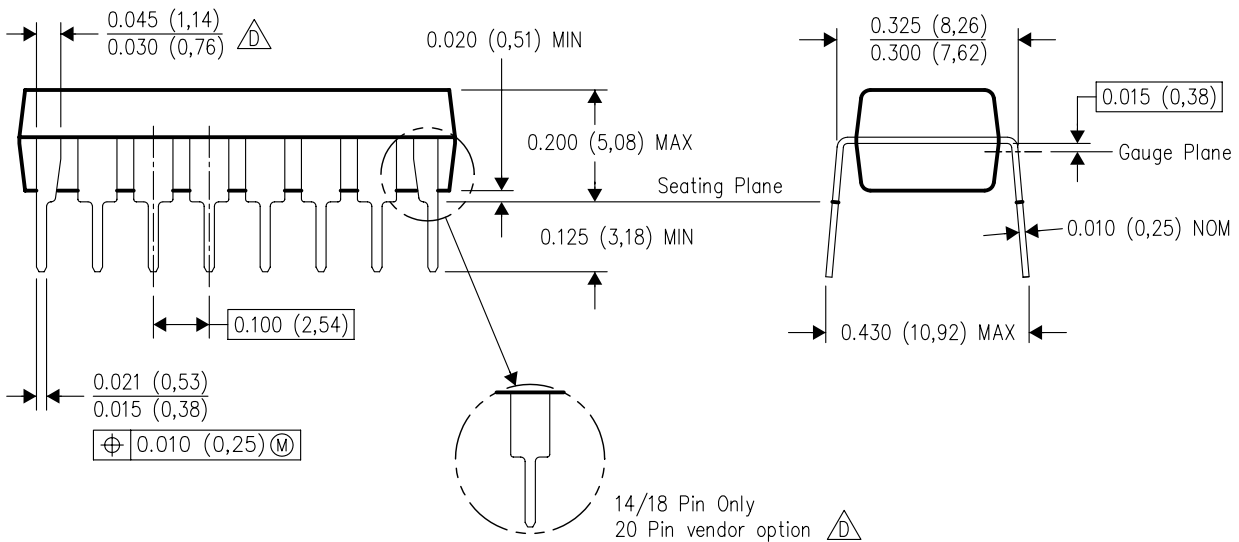
## N (R-PDIP-T\*\*)

16 PINS SHOWN

## PLASTIC DUAL-IN-LINE PACKAGE



| PINS **             | 14               | 16               | 18               | 20               |
|---------------------|------------------|------------------|------------------|------------------|
| DIM                 |                  |                  |                  |                  |
| A MAX               | 0.775<br>(19,69) | 0.775<br>(19,69) | 0.920<br>(23,37) | 1.060<br>(26,92) |
| A MIN               | 0.745<br>(18,92) | 0.745<br>(18,92) | 0.850<br>(21,59) | 0.940<br>(23,88) |
| MS-001<br>VARIATION | AA               | BB               | AC               | AD               |



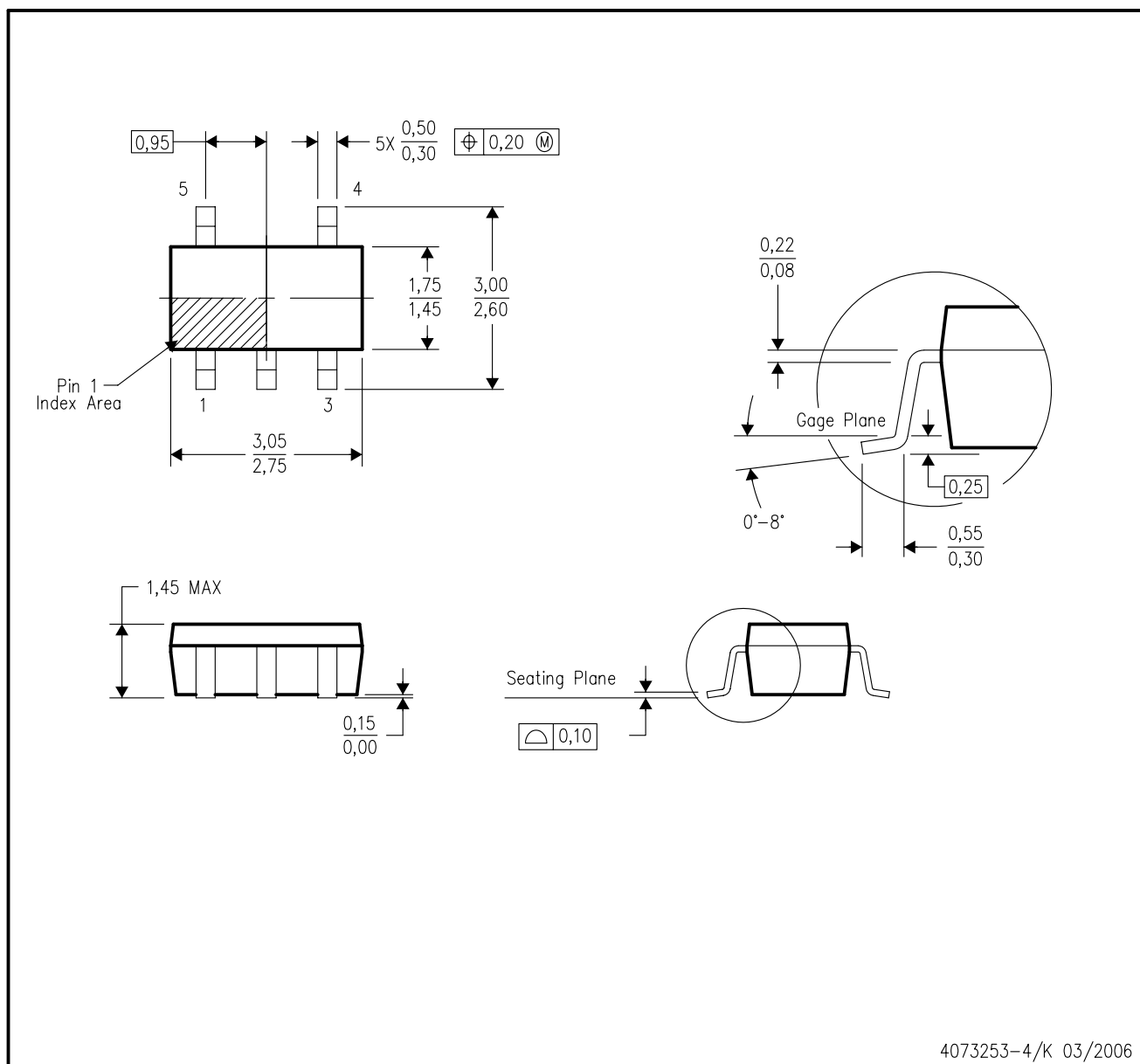
14/18 Pin Only  
20 Pin vendor option

4040049/E 12/2002

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - The 20 pin end lead shoulder width is a vendor option, either half or full width.

## DBV (R-PDSO-G5)

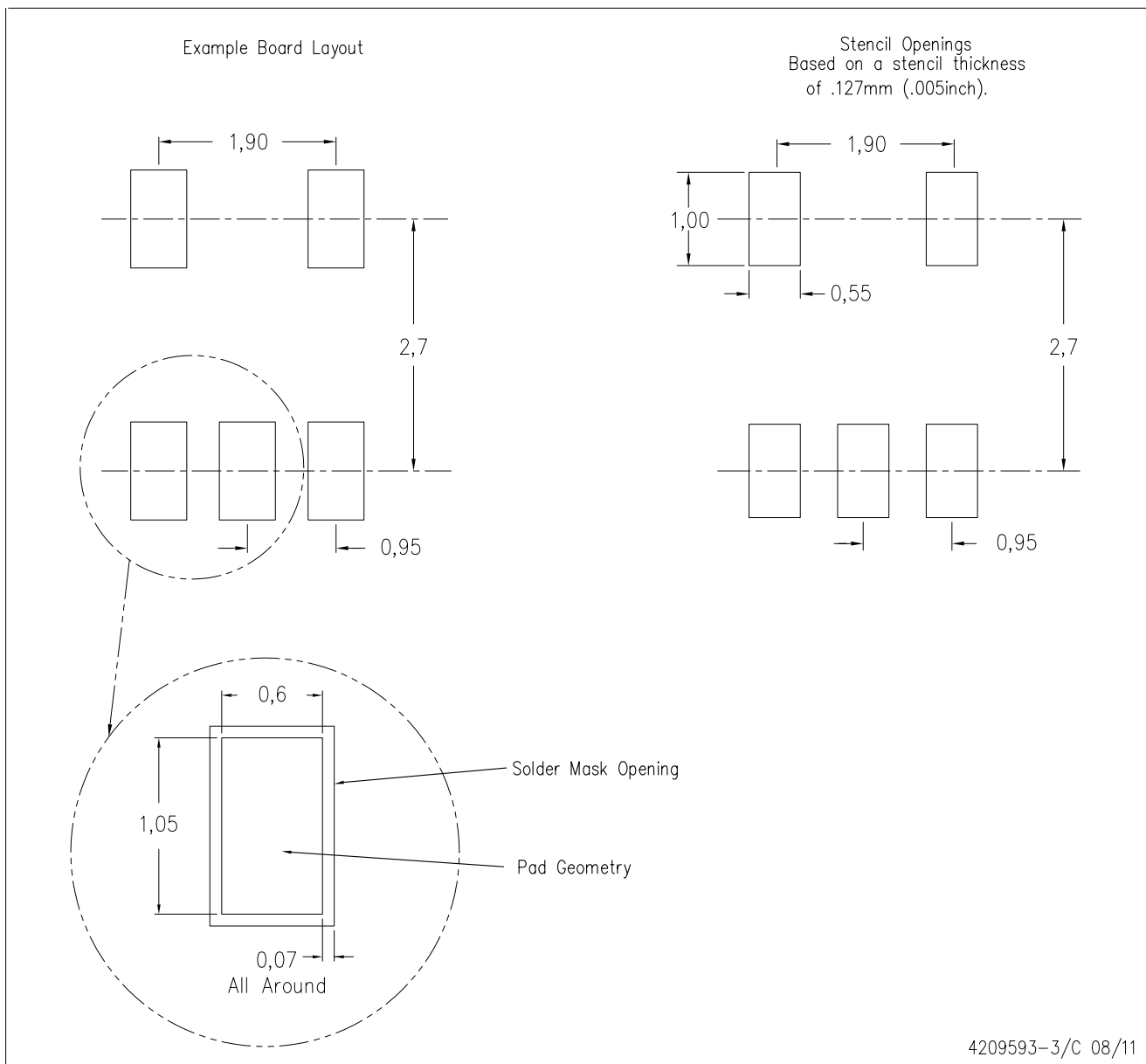
## PLASTIC SMALL-OUTLINE PACKAGE



- 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)

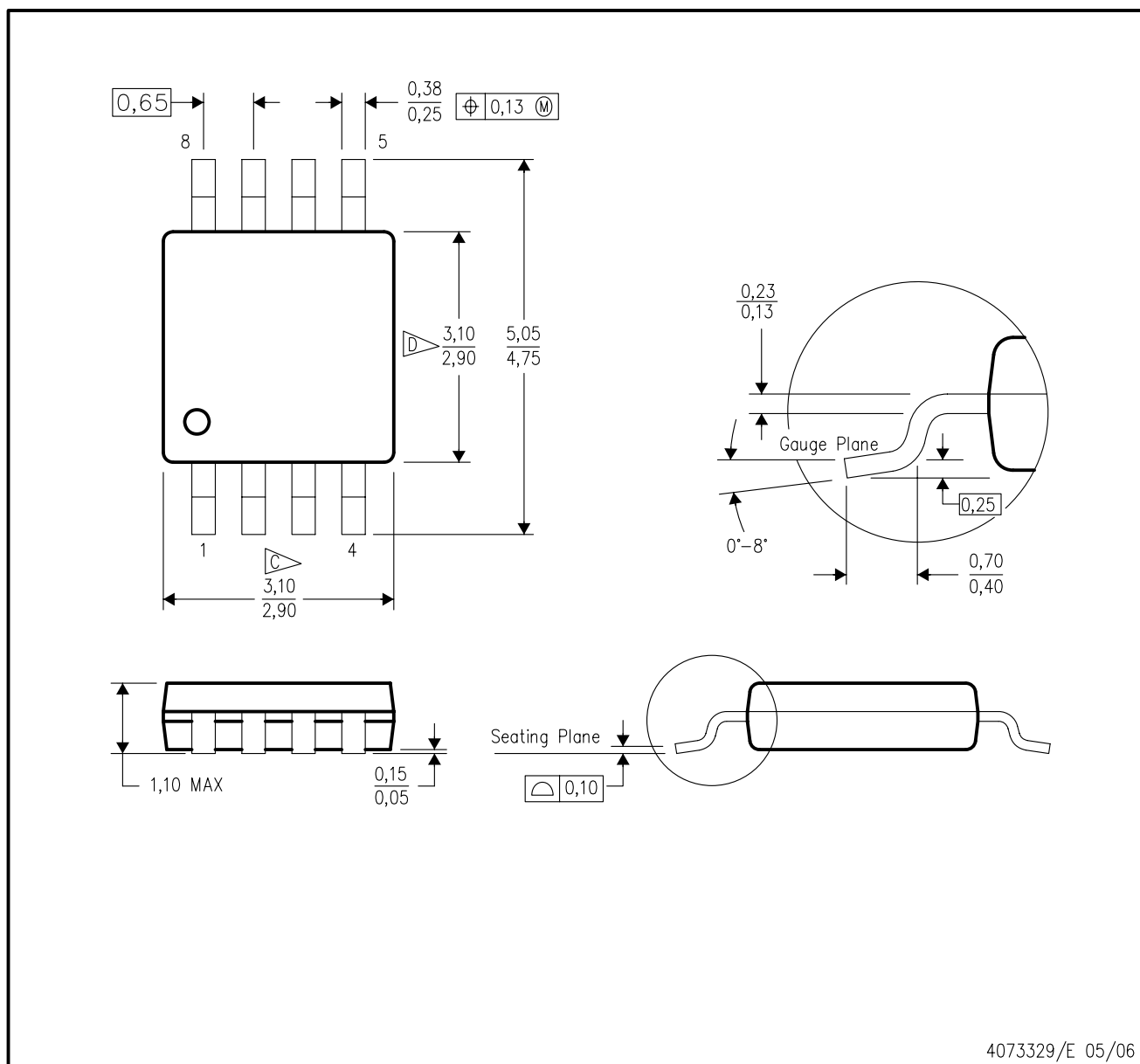
PLASTIC SMALL OUTLINE



- 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.

DGK (S-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE

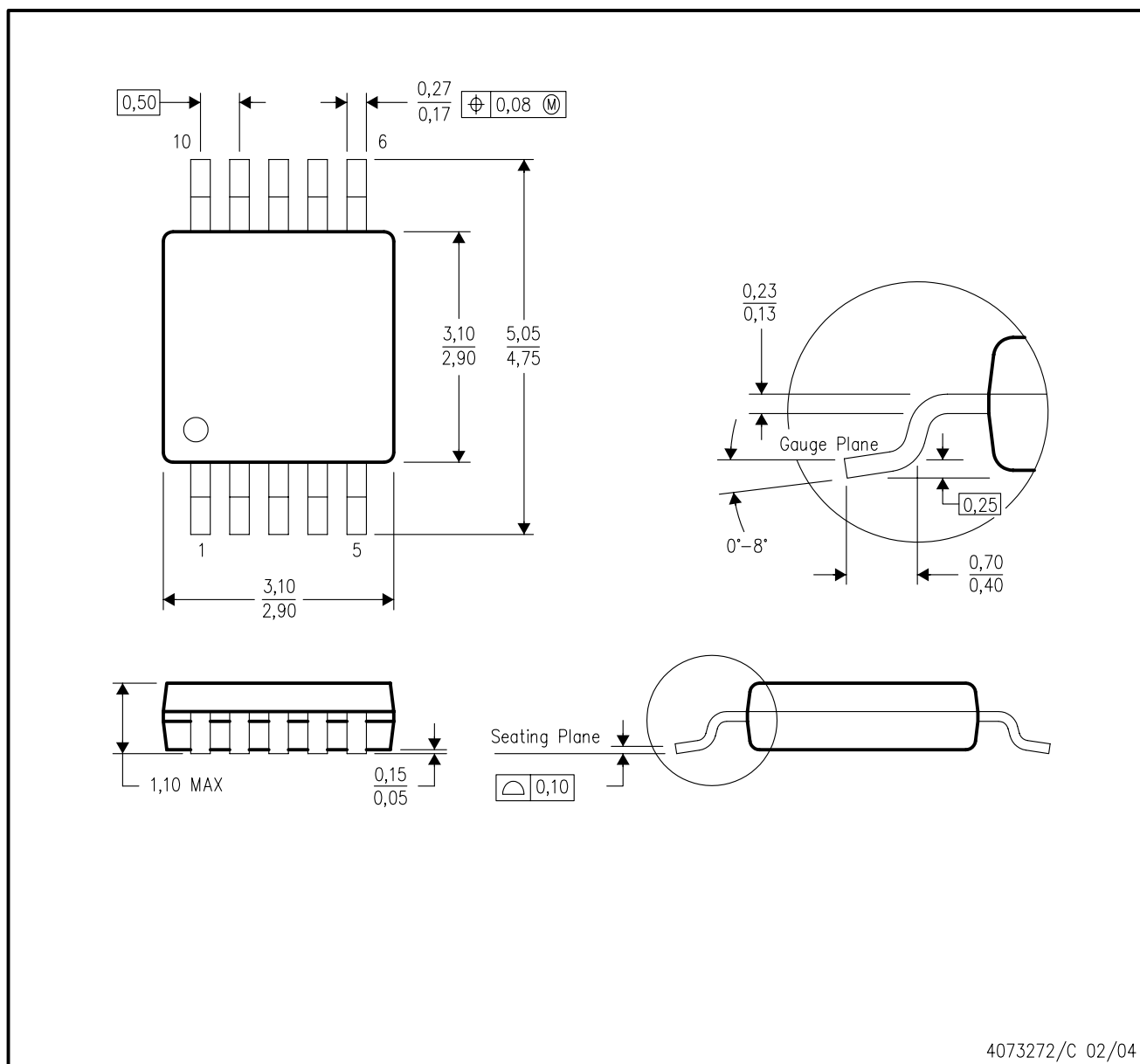


## NOTES:

- 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)

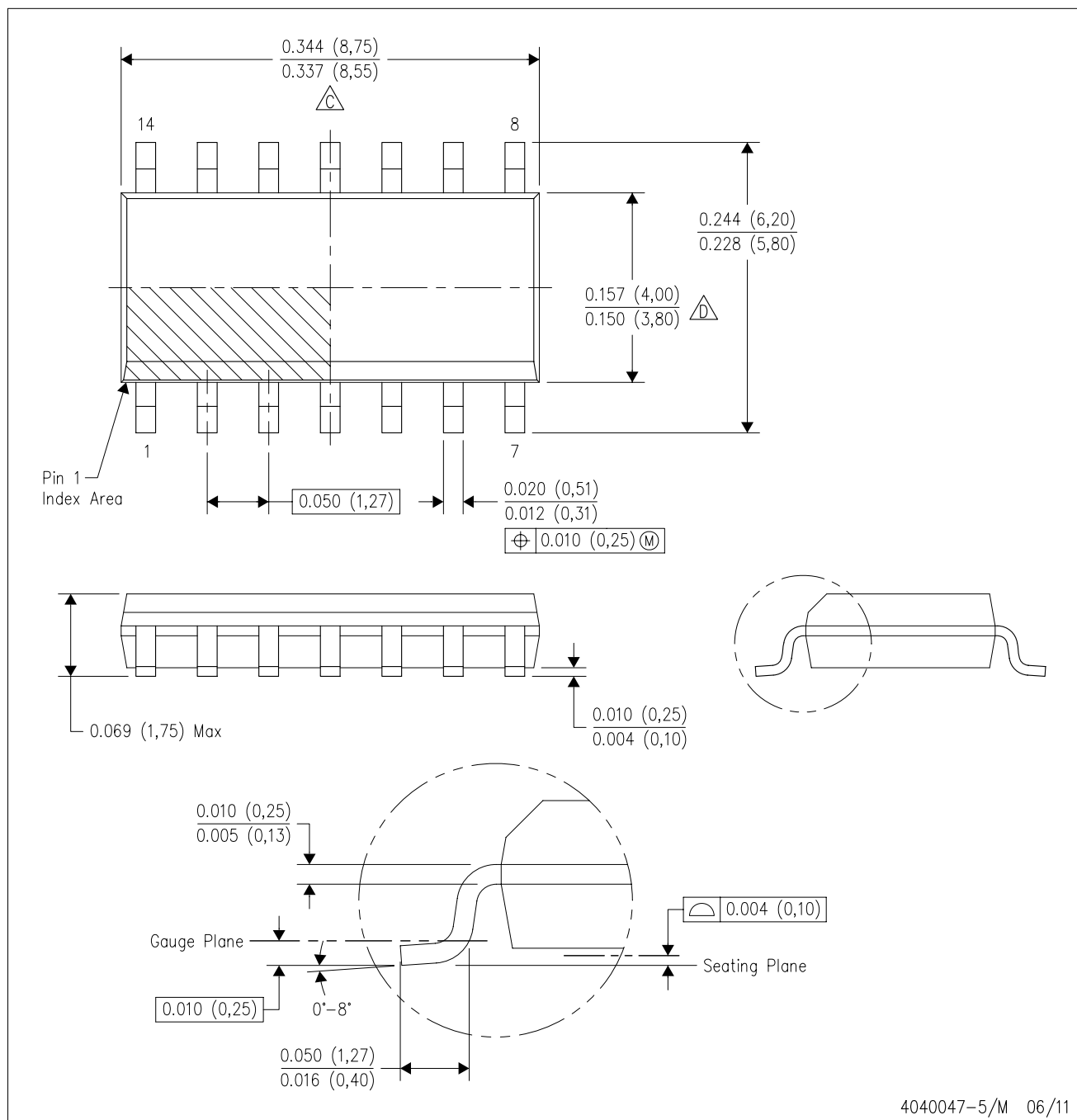
## PLASTIC SMALL-OUTLINE PACKAGE



- 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



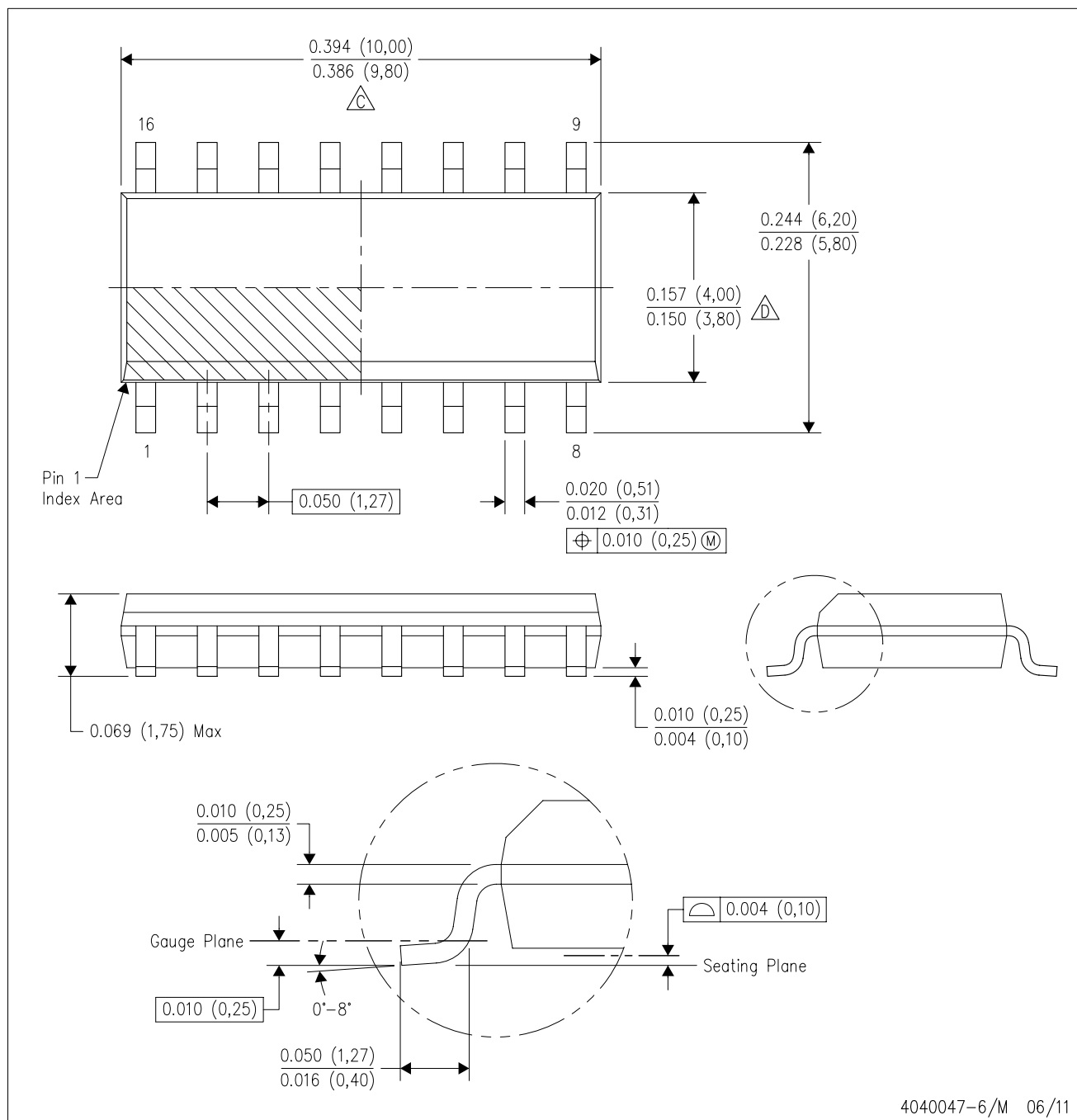
4040047-5/M 06/11

NOTES:

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

D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



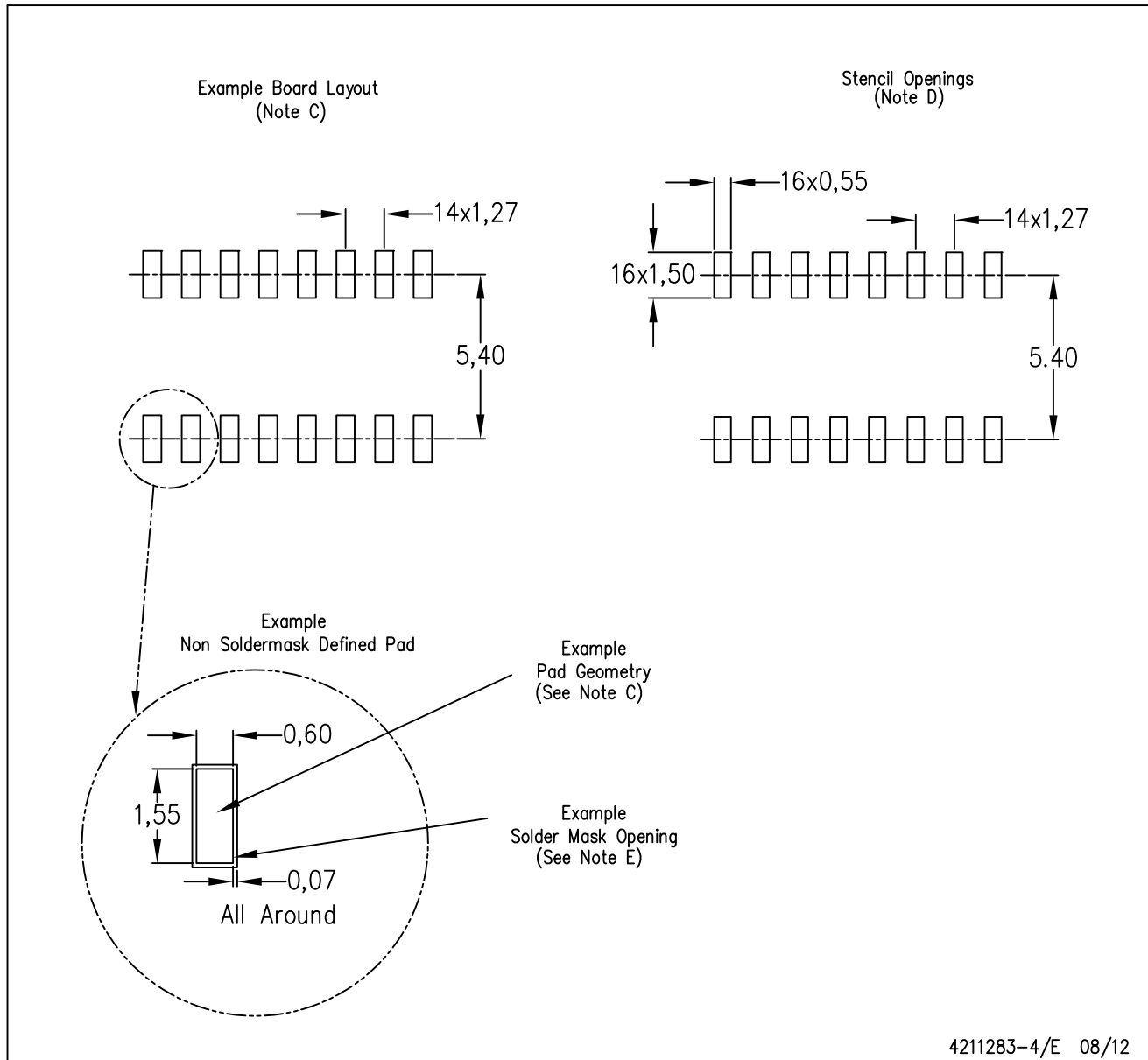
NOTES:

- 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 AC.



D (R-PDSO-G16)

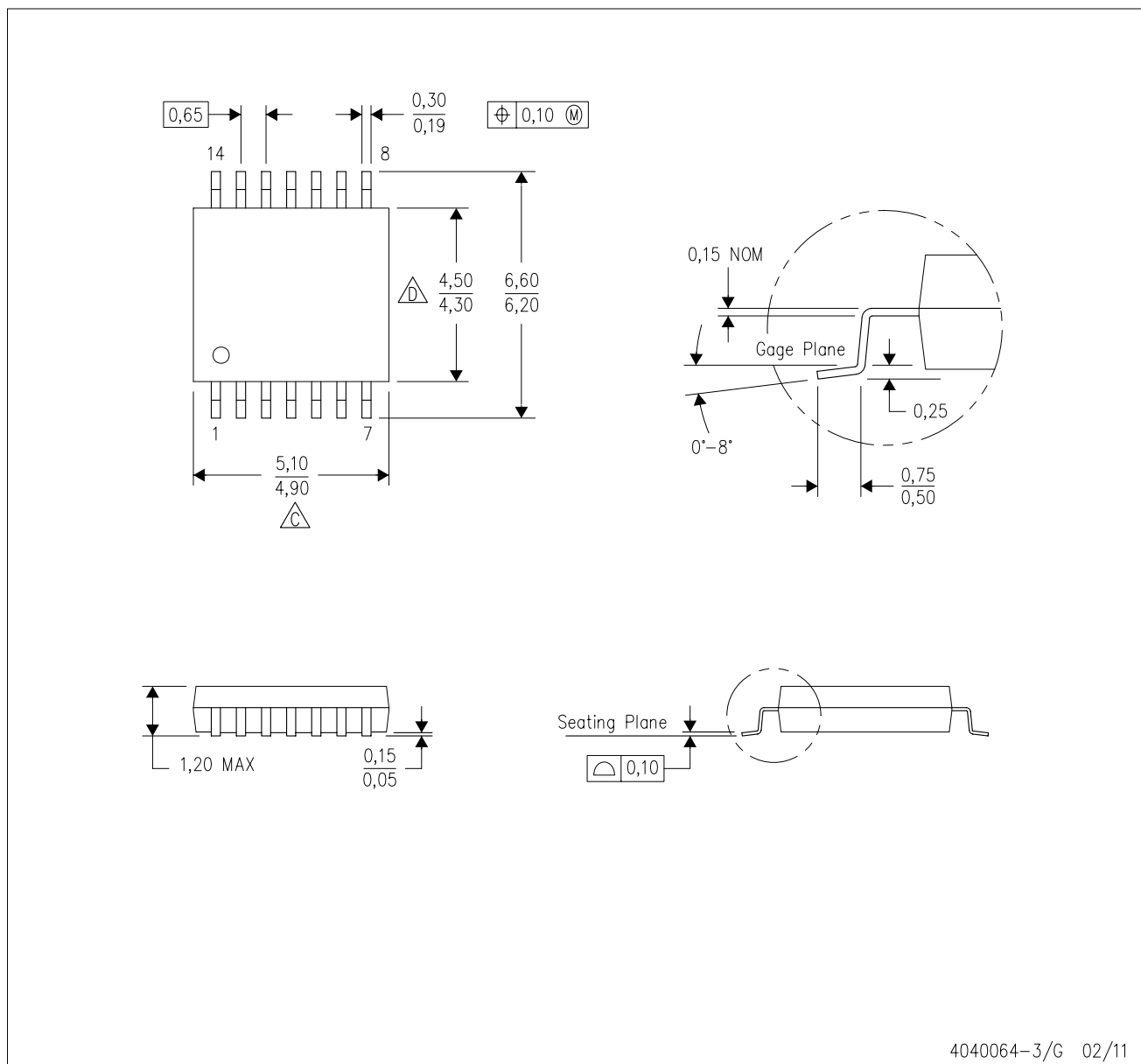
PLASTIC SMALL OUTLINE



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

PW (R-PDSO-G14)

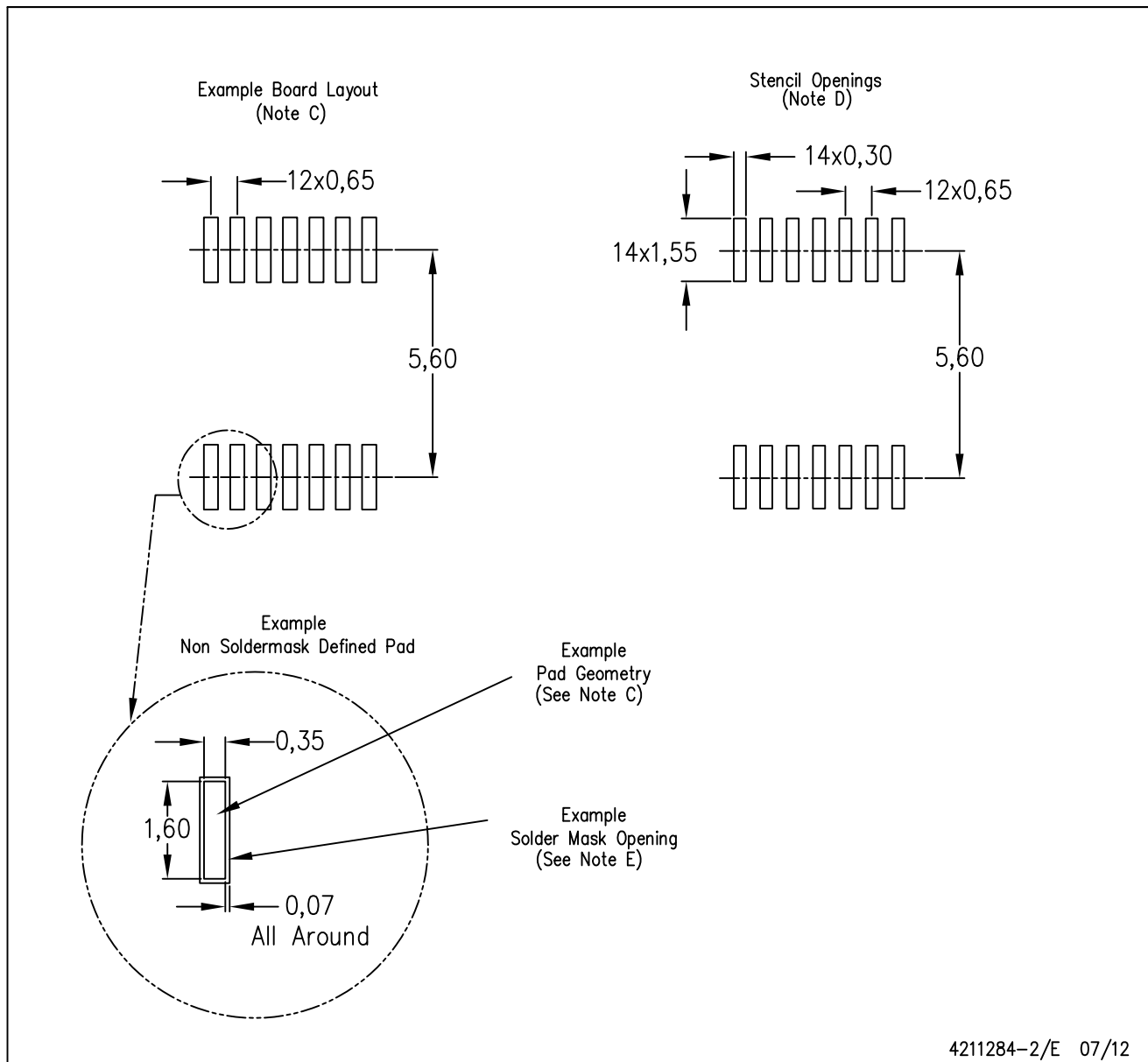
PLASTIC SMALL OUTLINE



4040064-3/G 02/11

PW (R-PDSO-G14)

# PLASTIC SMALL OUTLINE

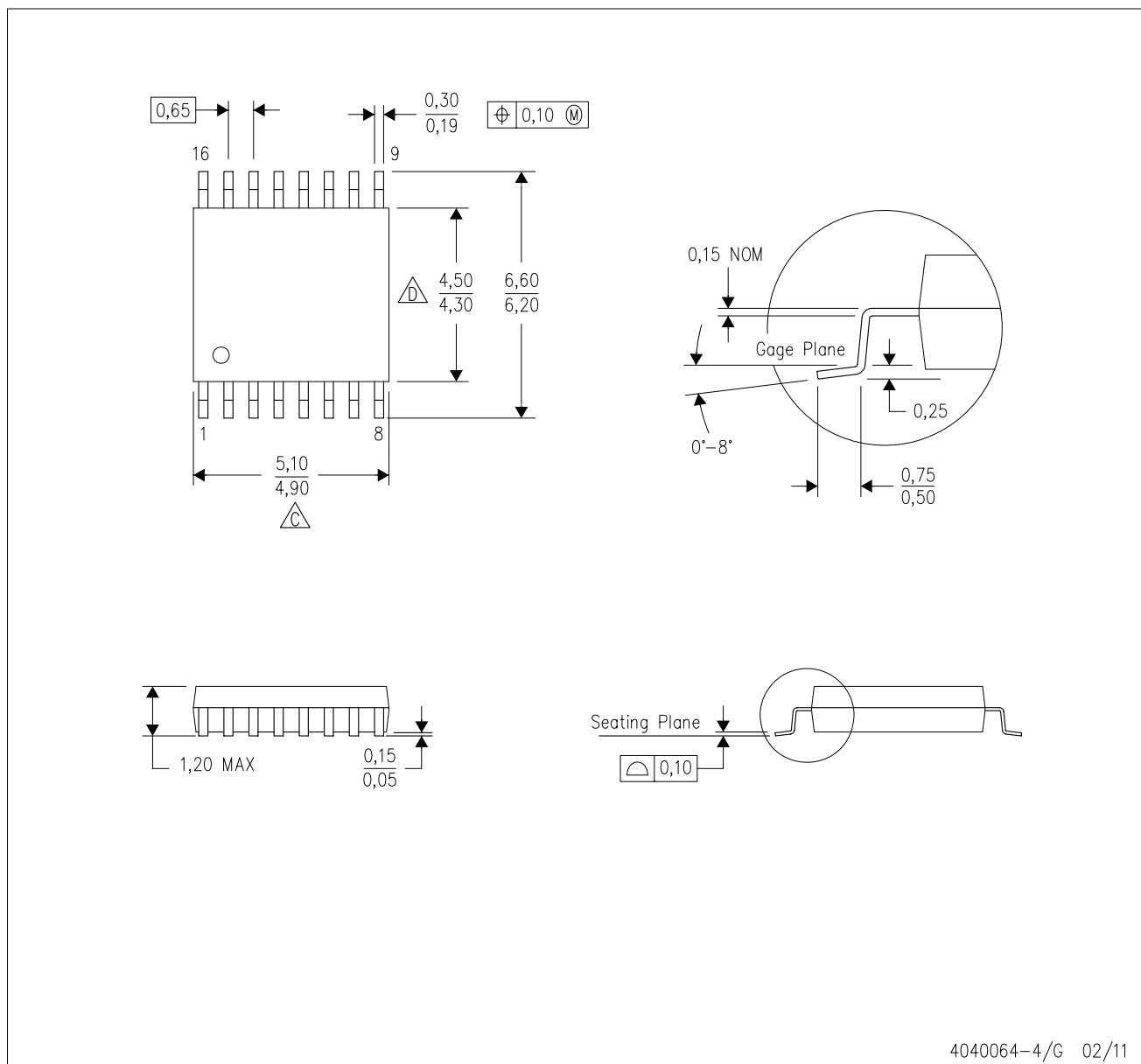


NOTES:

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

PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE

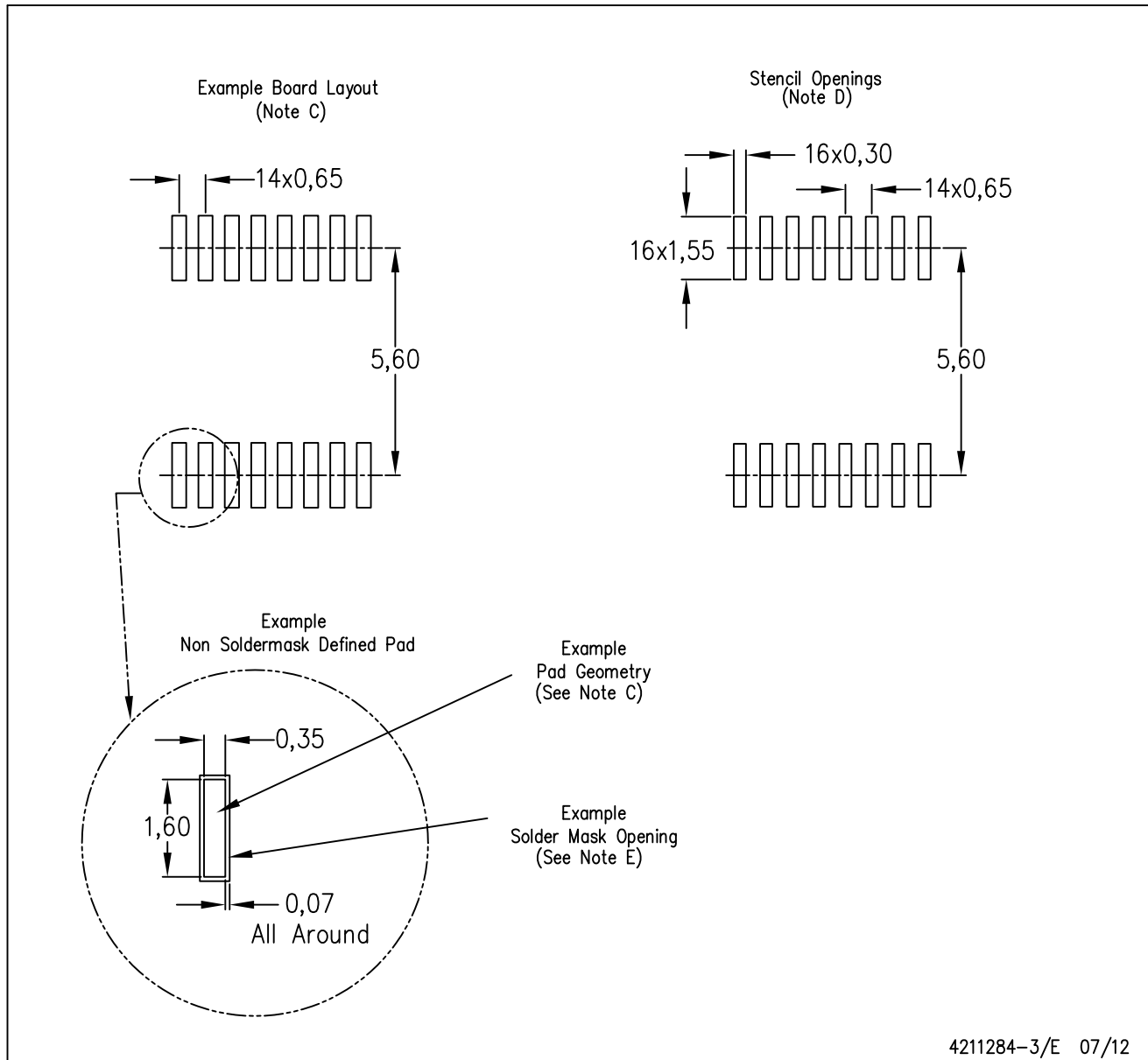


4040064-4/G 02/11

- 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)

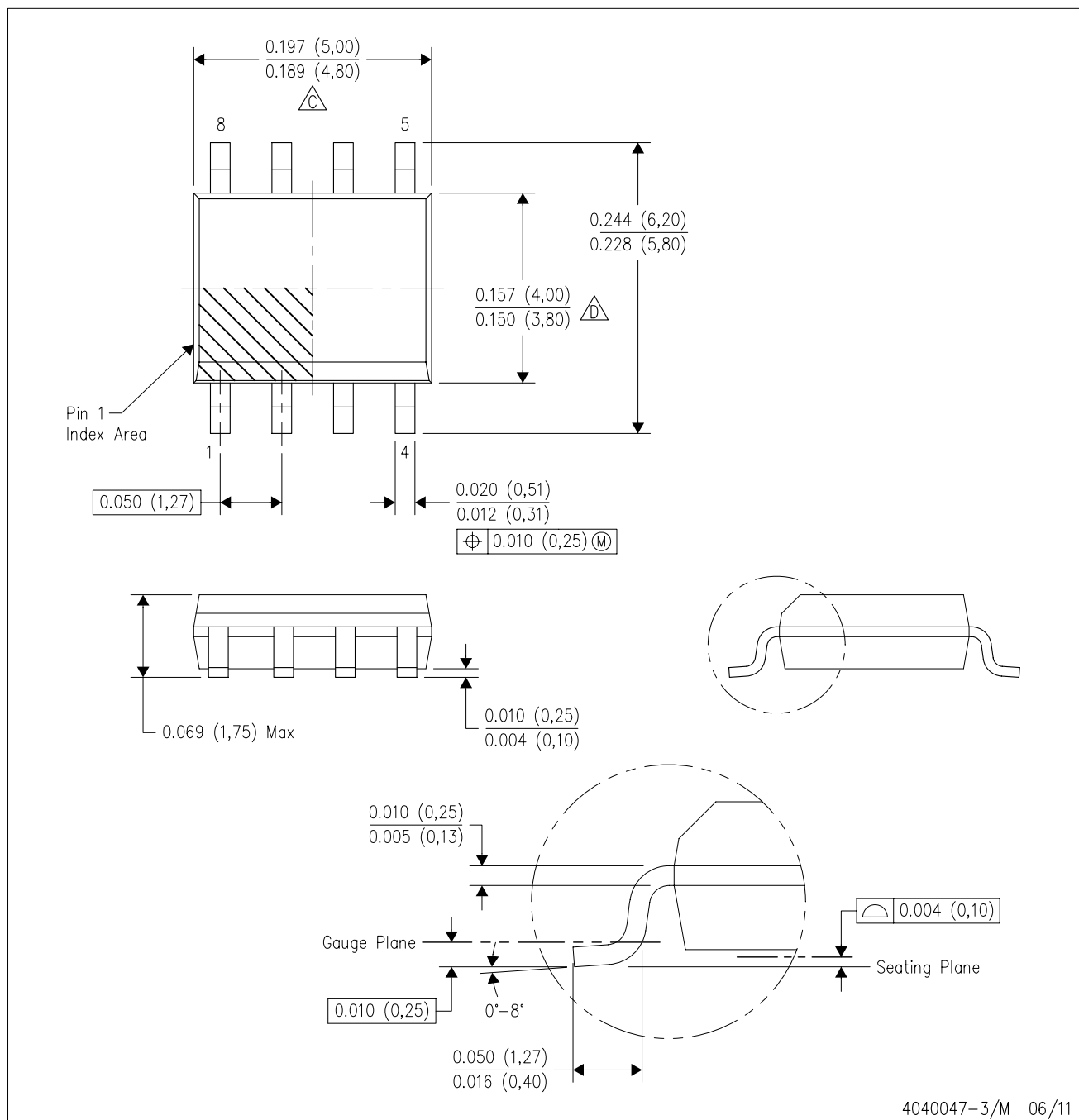
PLASTIC SMALL OUTLINE



- 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)

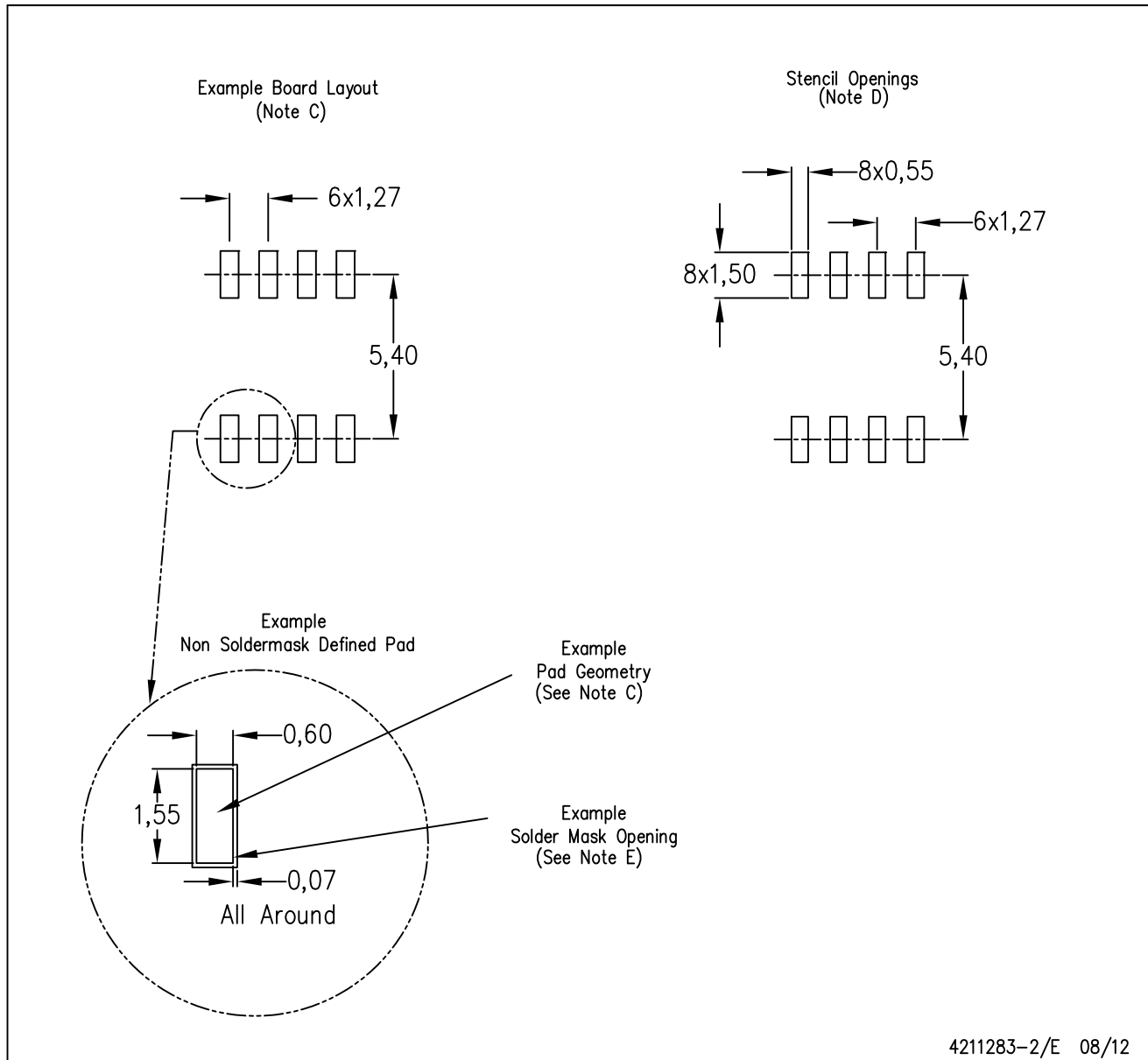
PLASTIC SMALL OUTLINE



- 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)

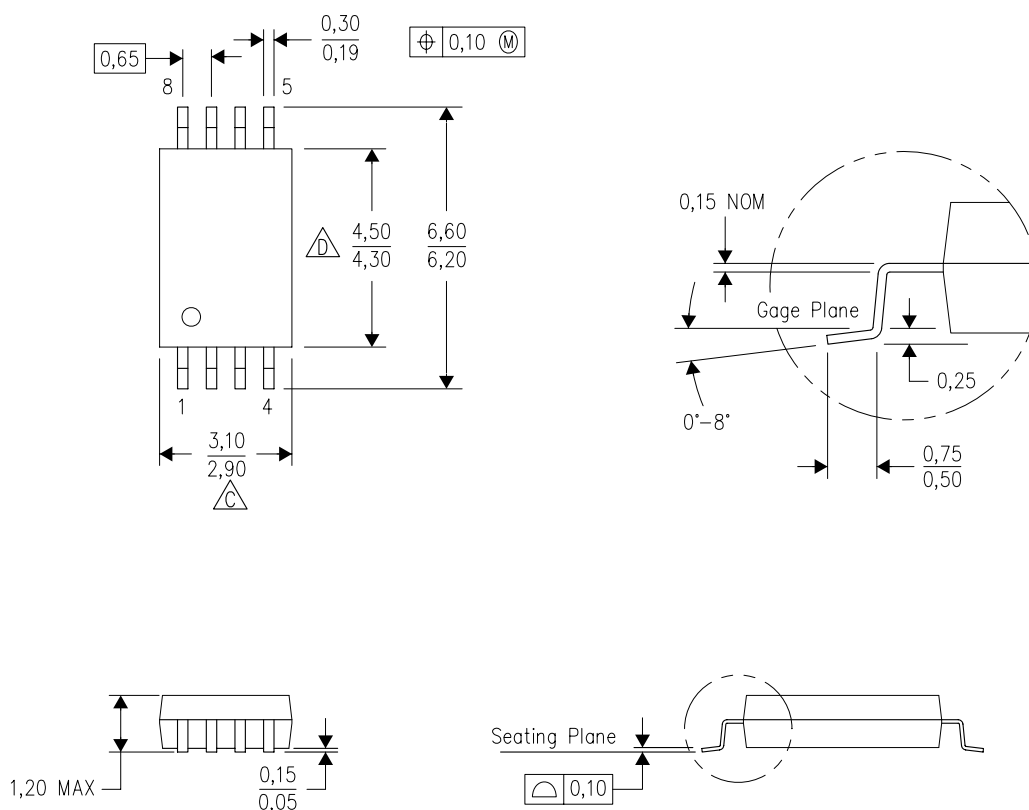
PLASTIC SMALL OUTLINE



- 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.

PW (R-PDSO-G8)

PLASTIC SMALL OUTLINE



4040064-2/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



## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46C and to discontinue any product or service per JESD48B. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

### Products

|                        |                                                                                      |
|------------------------|--------------------------------------------------------------------------------------|
| Audio                  | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                               |
| Amplifiers             | <a href="http://amplifier.ti.com">amplifier.ti.com</a>                               |
| Data Converters        | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>                       |
| DLP® Products          | <a href="http://www.dlp.com">www.dlp.com</a>                                         |
| DSP                    | <a href="http://dsp.ti.com">dsp.ti.com</a>                                           |
| Clocks and Timers      | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>                             |
| Interface              | <a href="http://interface.ti.com">interface.ti.com</a>                               |
| Logic                  | <a href="http://logic.ti.com">logic.ti.com</a>                                       |
| Power Mgmt             | <a href="http://power.ti.com">power.ti.com</a>                                       |
| Microcontrollers       | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a>                   |
| RFID                   | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>                                 |
| OMAP Mobile Processors | <a href="http://www.ti.com/omap">www.ti.com/omap</a>                                 |
| Wireless Connectivity  | <a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a> |

### Applications

|                               |                                                                                          |
|-------------------------------|------------------------------------------------------------------------------------------|
| Automotive and Transportation | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| Communications and Telecom    | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals     | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics and Defense   | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| Video and Imaging             | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |

**TI E2E Community** [e2e.ti.com](http://e2e.ti.com)