

FAMILY OF MICROPOWER RAIL-TO-RAIL OUTPUT OPERATIONAL AMPLIFIERS

FEATURES

- **BiMOS Rail-to-Rail Output**
- **Input Bias Current . . . 1 pA**
- **High Wide Bandwidth . . . 160 kHz**
- **High Slew Rate . . . 0.1 V/μs**
- **Supply Current . . . 7 μA (per channel)**
- **Input Noise Voltage . . . 89 nV/√Hz**
- **Supply Voltage Range . . . 2.7 V to 16 V**
- **Specified Temperature Range**
 - **–40°C to 125°C . . . Industrial Grade**
 - **0°C to 70°C . . . Commercial Grade**
- **Ultra-Small Packaging**
 - **5 Pin SOT-23 (TLV27L1)**

APPLICATIONS

- **Portable Medical**
- **Power Monitoring**
- **Low Power Security Detection Systems**
- **Smoke Detectors**

DESCRIPTION

The TLV27Lx single supply operational amplifiers provide rail-to-rail output capability. The TLV27Lx takes the minimum operating supply voltage down to 2.7 V over the extended industrial temperature range, while adding the rail-to-rail output swing feature. The TLV27Lx also provides 160-kHz bandwidth from only 7 μA. The maximum recommended supply voltage is 16 V, which allows the devices to be operated from (±8-V supplies down to ±1.35 V) two rechargeable cells.

The rail-to-rail outputs make the TLV27Lx good upgrades for the TLC27Lx family—offering more bandwidth at a lower quiescent current. The TLV27Lx offset voltage is equal to that of the TLC27LxA variant. Their cost effectiveness makes them a good alternative to the TLC/V225x, where offset and noise are not of premium importance.

The TLV27L1/2 are available in the commercial temperature range to enable easy migration from the equivalent TLC27Lx. The TLV27L1 is not available with the power saving/performance boosting programmable pin 8.

The TLV27L1 is available in the small SOT-23 package—something the TLC27(L)1 was not—enabling performance boosting in a smaller package. The TLV27L2 is available in the 3mm x 5mm MSOP, providing PCB area savings over the 8-pin SOIC and 8-pin TSSOP.

SELECTION GUIDE

| DEVICE | V _S [V] | I _Q /ch [μA] | V _{ICR} [V] | V _{IO} [mV] | I _{IB} [pA] | GBW [MHz] | SLEW RATE [V/μs] | V _n , 1 kHz [nV/√Hz] |
|---------|-----------------------|----------------------------|-----------------------------|-------------------------|-------------------------|--------------|---------------------|------------------------------------|
| TLV27Lx | 2.7 to 16 | 11 | –0.2 to V _S +1.2 | 5 | 60 | 0.18 | 0.06 | 89 |
| TLV238x | 2.7 to 16 | 10 | –0.2 to V _S –0.2 | 4.5 | 60 | 0.18 | 0.06 | 90 |
| TLC27Lx | 4 to 16 | 17 | –0.2 to V _S –1.5 | 10/5/2 | 60 | 0.085 | 0.03 | 68 |
| OPAx349 | 1.8 to 5.5 | 2 | –0.2 to V _S +0.2 | 10 | 10 | 0.070 | 0.02 | 300 |
| OPAx347 | 2.3 to 5.5 | 34 | –0.2 to V _S +0.2 | 6 | 10 | 0.35 | 0.01 | 60 |
| TLC225x | 2.7 to 16 | 62.5 | 0 to V _S –1.5 | 1.5/0.85 | 60 | 0.200 | 0.02 | 19 |

NOTE: All dc specs are maximums while ac specs are typicals.



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

PACKAGE/ORDERING INFORMATION

| PRODUCT | PACKAGE | PACKAGE CODE | SYMBOL | SPECIFIED TEMPERATURE RANGE | ORDER NUMBER | TRANSPORT MEDIA |
|-------------|---------|--------------|--------|-----------------------------|--------------|-----------------|
| TLV27L1CD | SOIC-8 | D | 27V1C | 0°C to 70°C | TLV27L1CD | Tube |
| | | | | | TLV27L1CDR | Tape and Reel |
| TLV27L1CDBV | SOT-23 | DBV | VBIC | | TLV27L1CDBVR | Tape and Reel |
| | | | | | TLV27L1CDBVT | |
| TLV27L1ID | SOIC-8 | D | 27V1I | -40°C to 125°C | TLV27L1ID | Tube |
| | | | | | TLV27L1IDR | Tape and Reel |
| TLV27L1IDBV | SOT-23 | DBV | VBII | | TLV27L1IDBVR | Tape and Reel |
| | | | | | TLV27L1IDBVT | |
| TLV27L2CD | SOIC-8 | D | 27V2C | 0°C to 70°C | TLV27L2CD | Tube |
| | | | | | TLV27L2CDR | Tape and Reel |
| TLV27L2ID | SOIC-8 | D | 27V2I | -40°C to 125°C | TLV27L2ID | Tube |
| | | | | | TLV27L2IDR | Tape and Reel |

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

| | |
|--|------------------------------|
| Supply voltage, V_S | 16.5 V |
| Input voltage, V_I (see Note 1) | V_S |
| Output current, I_O | 100 mA |
| Differential input voltage, V_{ID} | V_S |
| Continuous total power dissipation | See Dissipation Rating Table |
| Maximum junction temperature, T_J | 150°C |
| Operating free-air temperature range, T_A : C suffix | 0°C to 70°C |
| I suffix | -40°C to 125°C |
| Storage temperature range, T_{stg} | -65°C to 125°C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | 300°C |

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: Relative to GND pin.

DISSIPATION RATING TABLE

| PACKAGE | θ_{JC} (°C/W) | θ_{JA} (°C/W) | $T_A \leq 25^\circ\text{C}$ POWER RATING | $T_A = 85^\circ\text{C}$ POWER RATING |
|---------|-------------------------|-------------------------|---|--|
| D (8) | 38.3 | 176 | 710 mW | 370 mW |
| DBV (5) | 55 | 324.1 | 385 mW | 201 mW |
| DBV (6) | 55 | 294.3 | 425 mW | 221 mW |

recommended operating conditions

| | | MIN | MAX | UNIT |
|---------------------------------------|---------------|-------|-------------|------|
| Supply voltage, (V_S) | Dual supply | ±1.35 | ±8 | V |
| | Single supply | 2.7 | 16 | |
| Input common-mode voltage range | | -0.2 | $V_S - 1.2$ | V |
| Operating free-air temperature, T_A | C-suffix | 0 | 70 | °C |
| | I-suffix | -40 | 125 | |

electrical characteristics at recommended operating conditions, $V_S = 2.7\text{ V}$, 5 V , and 10 V (unless otherwise noted)

dc performance

| PARAMETER | | TEST CONDITIONS | T_A † | MIN | TYP | MAX | UNIT |
|----------------|---|---|------------|-----|-----|-----|------------------------------|
| V_{IO} | Input offset voltage | $V_{IC} = V_S/2$, $R_L = 100\text{ k}\Omega$, $V_O = V_S/2$, $R_S = 50\ \Omega$ | 25°C | 0.5 | | 5 | mV |
| | | | Full range | | | 7 | |
| α_{VIO} | Offset voltage drift | | 25°C | | 1.1 | | $\mu\text{V}/^\circ\text{C}$ |
| CMRR | Common-mode rejection ratio | $V_{IC} = 0\text{ V to }V_S - 1.2\text{ V}$, $R_S = 50\ \Omega$ | 25°C | 71 | 86 | | dB |
| | | | Full range | 70 | | | |
| A_{VD} | Large-signal differential voltage amplification | $V_{O(PP)} = V_S/2$, $R_L = 100\text{ k}\Omega$ | 25°C | 80 | 100 | | dB |
| | | | | | | | |
| | | | 25°C | 77 | 82 | | |
| | | | | | | | |

† Full range is -40°C to 125°C for I suffix.

input characteristics

| PARAMETER | | TEST CONDITIONS | T_A | MIN | TYP | MAX | UNIT |
|------------|-------------------------------|---|--------------------------|-----|------|------|------------|
| I_{IO} | Input offset current | $V_{IC} = V_S/2$, $R_L = 100\text{ k}\Omega$, $V_O = V_S/2$, $R_S = 50\ \Omega$ | $\leq 25^\circ\text{C}$ | | 1 | 60 | pA |
| | | | $\leq 70^\circ\text{C}$ | | | 100 | |
| | | | $\leq 125^\circ\text{C}$ | | | 1000 | |
| I_{IB} | Input bias current | | $\leq 25^\circ\text{C}$ | | 1 | 60 | pA |
| | | | $\leq 70^\circ\text{C}$ | | | 200 | |
| | | | $\leq 125^\circ\text{C}$ | | | 1000 | |
| $r_{i(d)}$ | Differential input resistance | | 25°C | | 1000 | | G Ω |
| C_{IC} | Common-mode input capacitance | $f = 1\text{ kHz}$ | 25°C | | 8 | | pF |

power supply

| PARAMETER | | TEST CONDITIONS | T_A † | MIN | TYP | MAX | UNIT |
|-----------|---|--|------------|-----|-----|-----|---------------|
| I_Q | Quiescent current (per channel) | $V_O = V_S/2$ | 25°C | | 7 | 11 | μA |
| | | | Full range | | | 16 | |
| PSRR | Power supply rejection ratio ($\Delta V_S/\Delta V_{IO}$) | $V_S = 2.7\text{ V to }16\text{ V}$, $V_{IC} = V_S/2\text{ V}$, No load, | 25°C | 74 | 82 | | dB |
| | | | Full range | 70 | | | |

† Full range is -40°C to 125°C for I suffix.

electrical characteristics at recommended operating conditions, $V_S = 2.7\text{ V}$, 5 V , and $\pm 5\text{ V}$ (unless otherwise noted) (continued)

output characteristics

| PARAMETER | | TEST CONDITIONS | T_A^\dagger | MIN | TYP | MAX | UNIT |
|------------------------|--------------------------------|---|----------------------|------------|-----|-----|---------------|
| V_O | Output voltage swing from rail | $V_{IC} = V_S/2$, $I_{OL} = 100\ \mu\text{A}$ | $V_S = 2.7\text{ V}$ | 25°C | 200 | 160 | V |
| | | | | Full range | 220 | | |
| | | | $V_S = 5\text{ V}$ | 25°C | 120 | 85 | |
| | | | | Full range | 200 | | |
| | | $V_S = \pm 5\text{ V}$ | 25°C | 120 | 50 | | |
| | | | Full range | 150 | | | |
| | | $V_{IC} = V_S/2$, $I_{OL} = 500\ \mu\text{A}$ | $V_S = 5\text{ V}$ | 25°C | 800 | 420 | |
| | | | | Full range | 900 | | |
| $V_S = \pm 5\text{ V}$ | 25°C | | 400 | 200 | | | |
| | Full range | | 500 | | | | |
| I_O | Output current | $V_O = 0.5\text{ V}$ from rail | $V_S = 2.7\text{ V}$ | 25°C | | 400 | μA |

† Full range is -40°C to 125°C for I suffix.

dynamic performance

| PARAMETER | | TEST CONDITIONS | T_A | MIN | TYP | MAX | UNIT |
|-----------|-------------------------|--|---------------------|------|------|-----|------------------|
| GBP | Gain bandwidth product | $R_L = 100\text{ k}\Omega$, $C_L = 10\text{ pF}$, $f = 1\text{ kHz}$ | 25°C | | 160 | | kHz |
| SR | Slew rate at unity gain | $V_{O(pp)} = 1\text{ V}$, $R_L = 100\text{ k}\Omega$, $C_L = 50\text{ pF}$ | 25°C | | 0.06 | | V/ μs |
| | | | -40°C | | 0.05 | | |
| | | | 125°C | | 0.8 | | |
| ϕ_M | Phase margin | $R_L = 100\text{ k}\Omega$, $C_L = 50\text{ pF}$ | 25°C | | 62 | | $^\circ$ |
| t_s | Settling time (0.1%) | $V(\text{STEP})_{pp} = 1\text{ V}$, $A_V = -1$, $C_L = 50\text{ pF}$, $R_L = 100\text{ k}\Omega$ | Rise | 25°C | 62 | | μs |
| | | | Fall | | 44 | | |

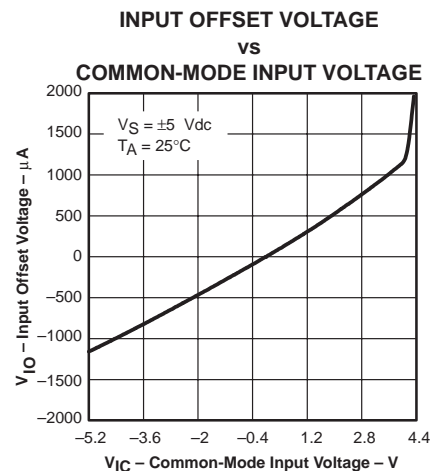
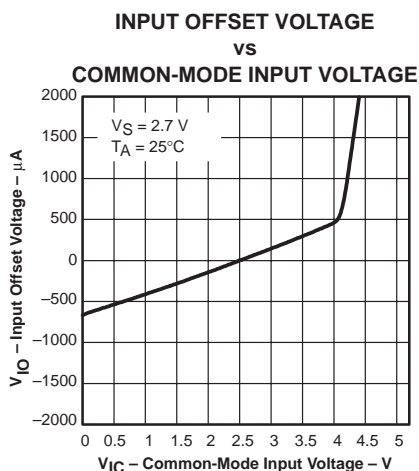
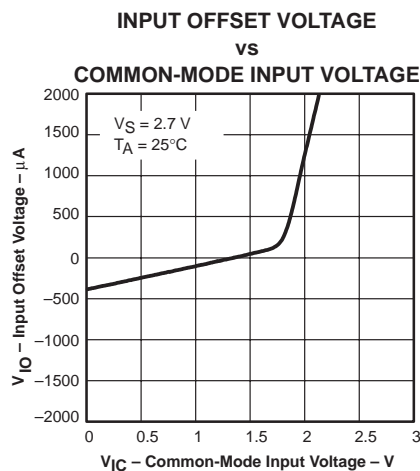
noise/distortion performance

| PARAMETER | | TEST CONDITIONS | T_A | MIN | TYP | MAX | UNIT |
|-----------|--------------------------------|--------------------|-------|-----|-----|-----|------------------------------|
| V_n | Equivalent input noise voltage | $f = 1\text{ kHz}$ | 25°C | | 89 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| I_n | Equivalent input noise current | $f = 1\text{ kHz}$ | 25°C | | 0.6 | | $\text{fA}/\sqrt{\text{Hz}}$ |

TYPICAL CHARACTERISTICS

Table of Graphs

| | | | FIGURE |
|----------------|---|---------------------------------|--------------|
| V_{IO} | Input offset voltage | vs Common-mode input voltage | 1, 2, 3 |
| I_{B}/I_{IO} | Input bias and offset current | vs Free-air temperature | 4 |
| V_{OH} | High-level output voltage | vs High-level output current | 5, 7, 9 |
| V_{OL} | Low-level output voltage | vs Low-level output current | 6, 8, 10 |
| I_Q | Quiescent current | vs Supply voltage | 11 |
| | | vs Free-air temperature | 12 |
| | Supply voltage and supply current ramp up | | 13 |
| A_{VD} | Differential voltage gain and phase shift | vs Frequency | 14 |
| GBP | Gain-bandwidth product | vs Free-air temperature | 15 |
| ϕ_m | Phase margin | vs Load capacitance | 16 |
| CMRR | Common-mode rejection ratio | vs Frequency | 17 |
| PSRR | Power supply rejection ratio | vs Frequency | 18 |
| | | Input referred noise voltage | vs Frequency |
| SR | Slew rate | vs Free-air temperature | 20 |
| $V_{O(PP)}$ | Peak-to-peak output voltage | vs Frequency | 21 |
| | | Inverting small-signal response | 22 |
| | | Inverting large-signal response | 23 |
| | Crosstalk | vs Frequency | 24 |



TYPICAL CHARACTERISTICS

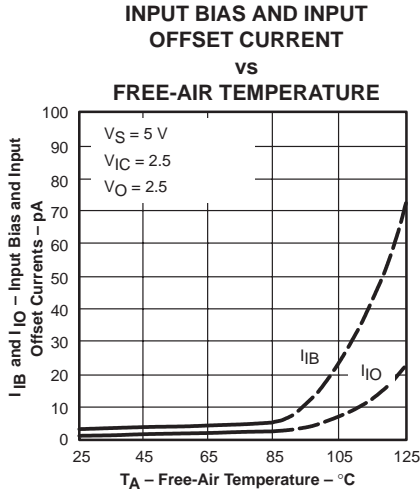


Figure 4

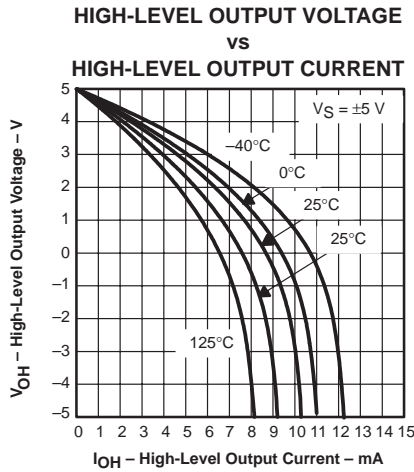


Figure 5

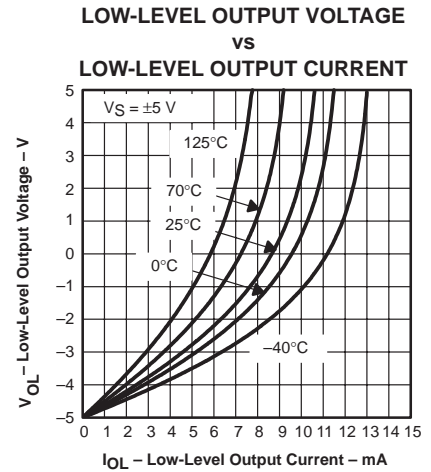


Figure 6

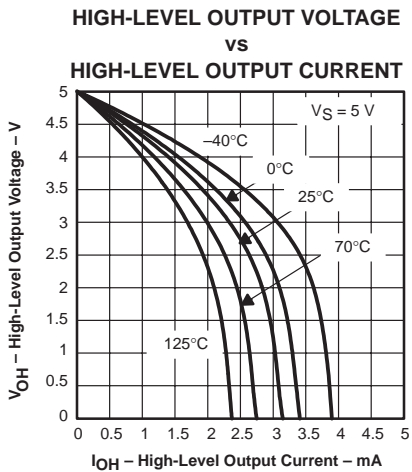


Figure 7

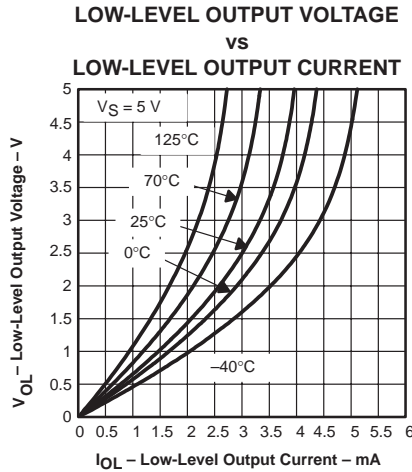


Figure 8

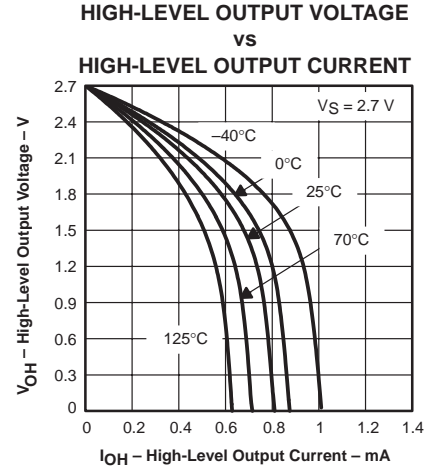


Figure 9

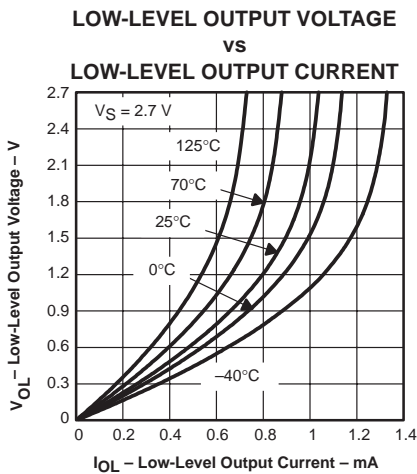


Figure 10

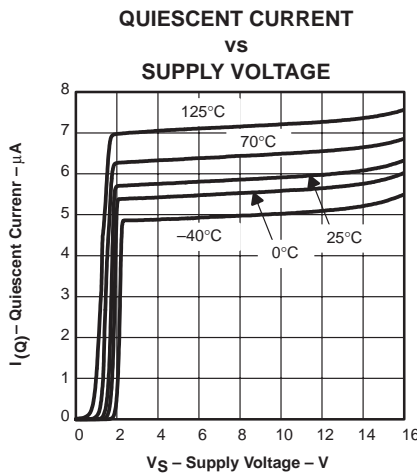


Figure 11

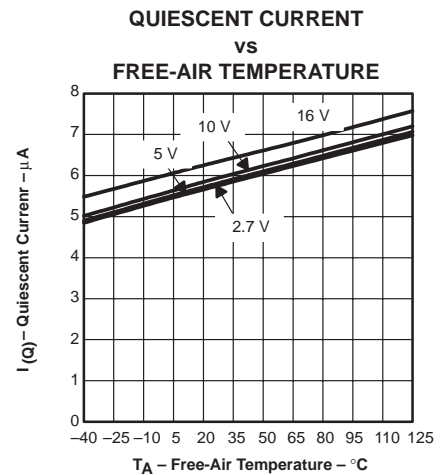


Figure 12

TYPICAL CHARACTERISTICS

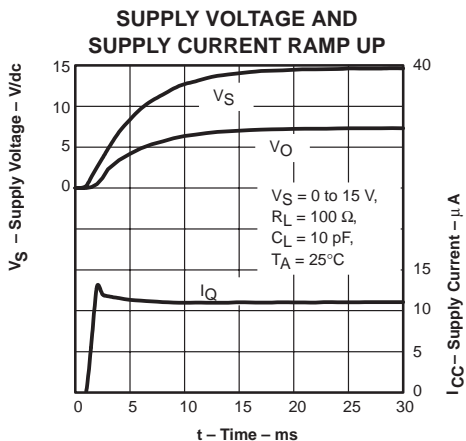


Figure 13

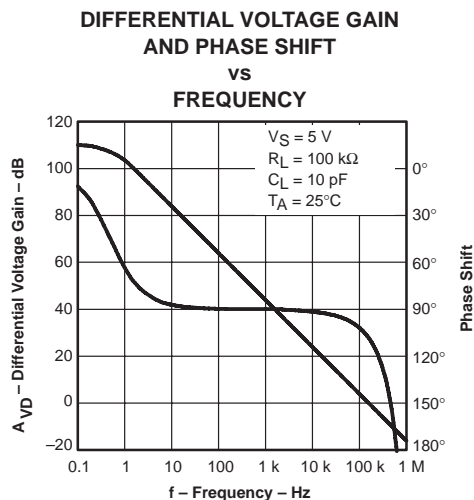


Figure 14

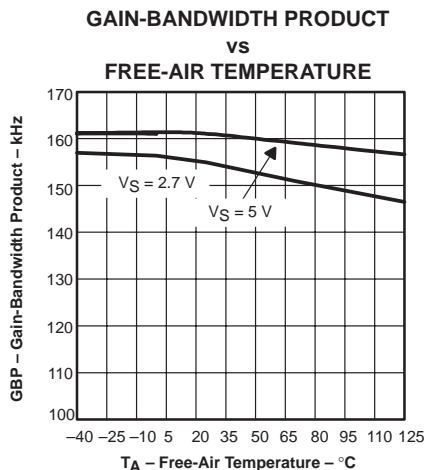


Figure 15

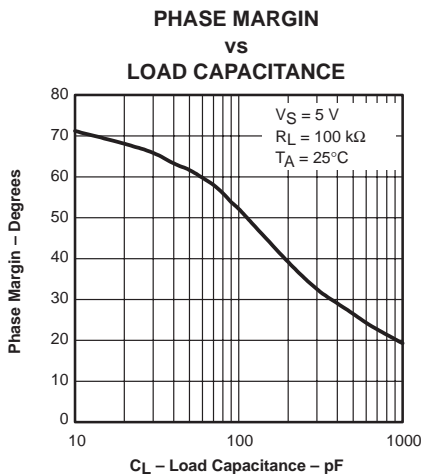


Figure 16

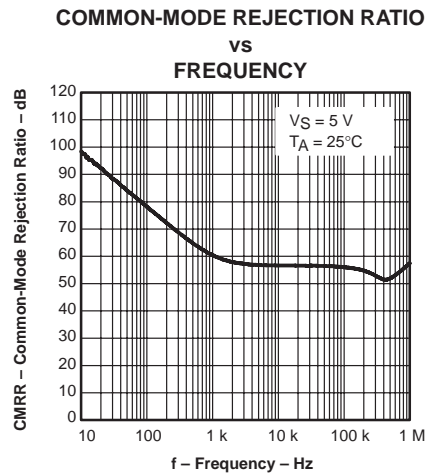


Figure 17

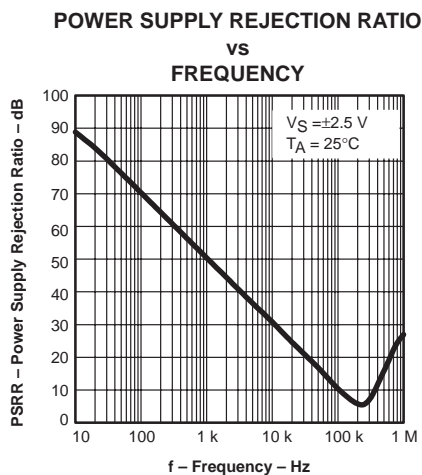


Figure 18

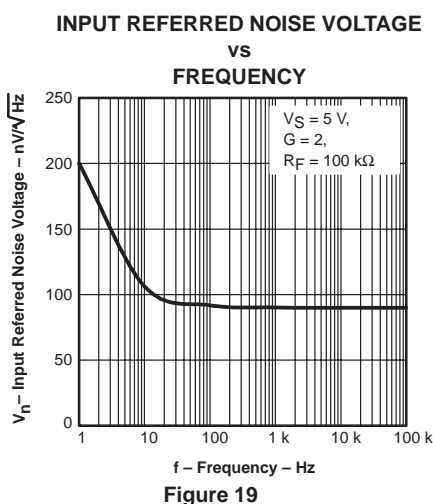


Figure 19

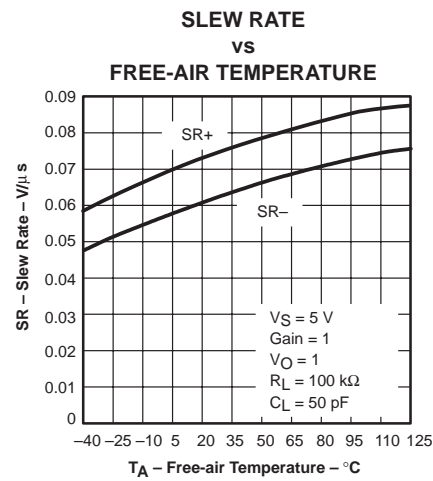
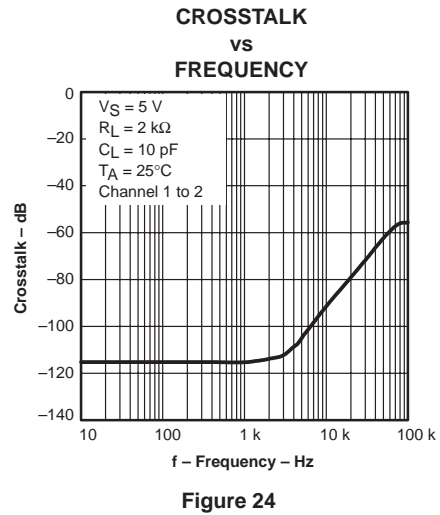
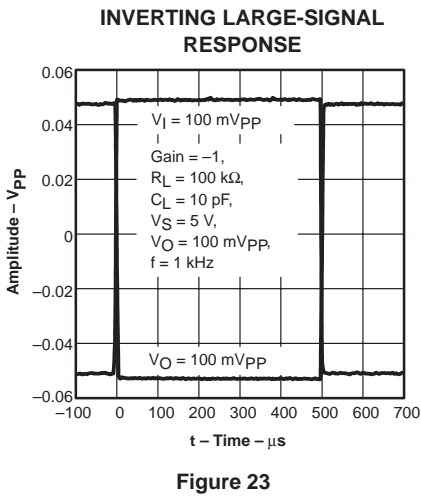
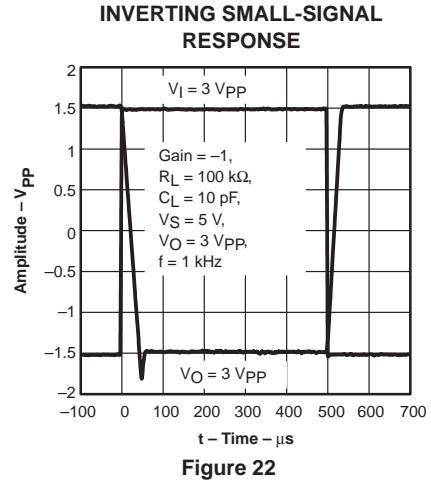
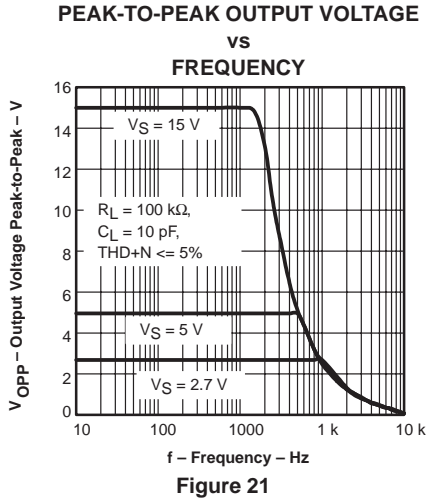


Figure 20

TYPICAL CHARACTERISTICS



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:

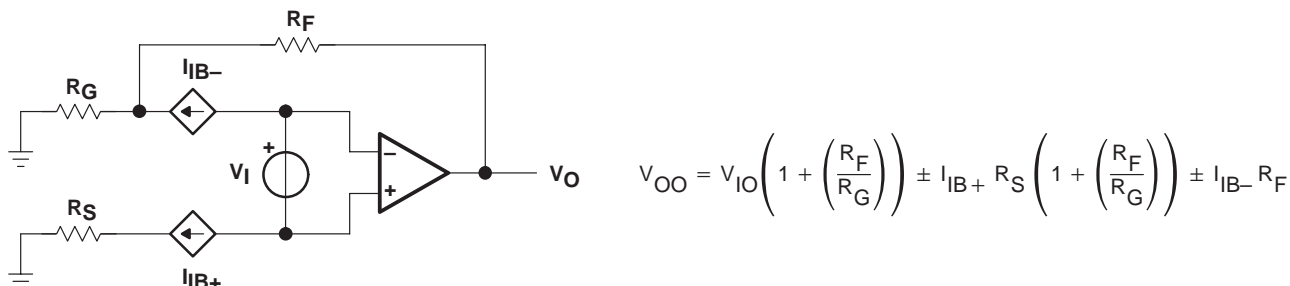


Figure 25. Output Offset Voltage Model

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 26).

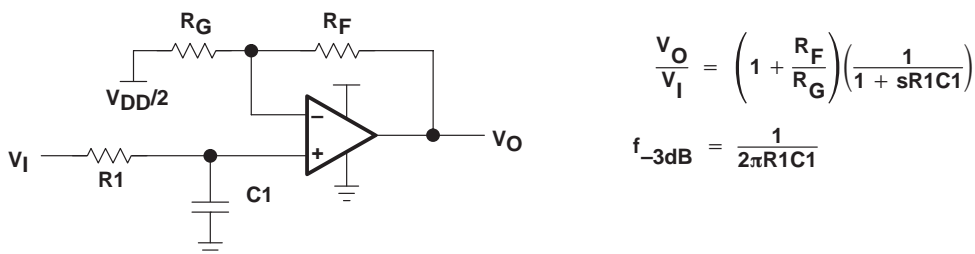


Figure 26. Single-Pole Low-Pass Filter

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.

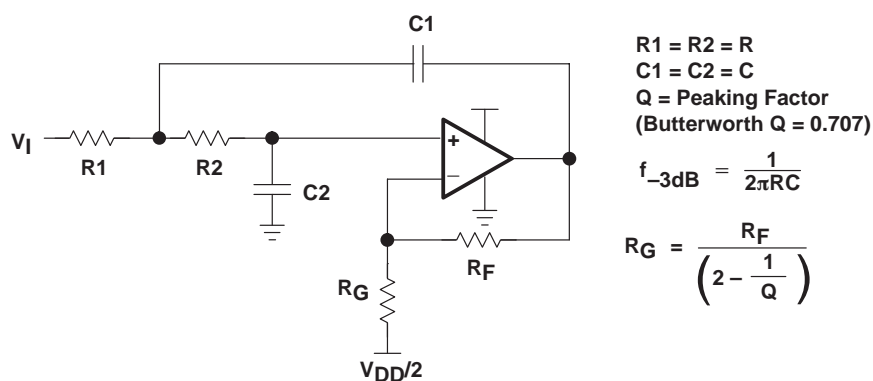


Figure 27. 2-Pole Low-Pass Sallen-Key Filter

APPLICATION INFORMATION

circuit layout considerations

To achieve the levels of high performance of the TLV27Lx, 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- μ F tantalum capacitor in parallel with a 0.1- μ 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- μ F ceramic capacitor should always be used on the supply terminal of every amplifier. In addition, the 0.1- μ 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

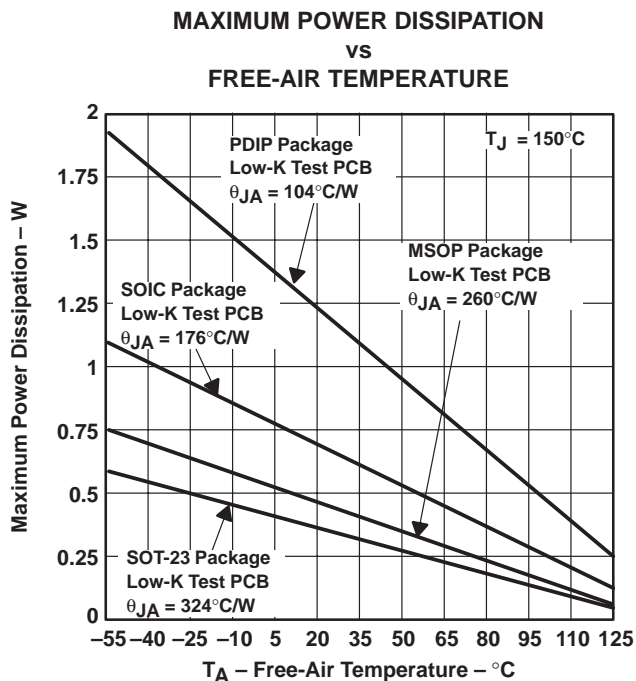
general power dissipation considerations

For a given θ_{JA} , the maximum power dissipation is shown in Figure 28 and is calculated by the following formula:

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

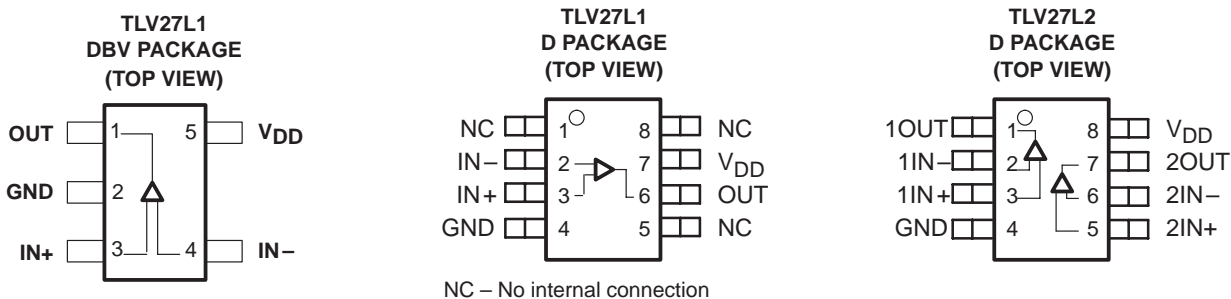
Where:

- P_D = Maximum power dissipation of TLV27Lx IC (watts)
- T_{MAX} = Absolute maximum junction temperature (150°C)
- T_A = Free-ambient air temperature (°C)
- θ_{JA} = $\theta_{JC} + \theta_{CA}$
- θ_{JC} = Thermal coefficient from junction to case
- θ_{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 28. Maximum Power Dissipation vs Free-Air Temperature



PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TLV27L1CD | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1CDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1CDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1CDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1CDBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1ID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1IDBVR | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1IDBVRG4 | ACTIVE | SOT-23 | DBV | 5 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1IDBVT | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1IDBVTG4 | ACTIVE | SOT-23 | DBV | 5 | 250 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L1IDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L2CDGK | ACTIVE | MSOP | DGK | 8 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L2CDGKR | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L2CDGKRG4 | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L2CDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L2ID | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L2IDGK | ACTIVE | MSOP | DGK | 8 | 80 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L2IDGKR | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L2IDGKRG4 | ACTIVE | MSOP | DGK | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| TLV27L2IDR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBsolete: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) 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.

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

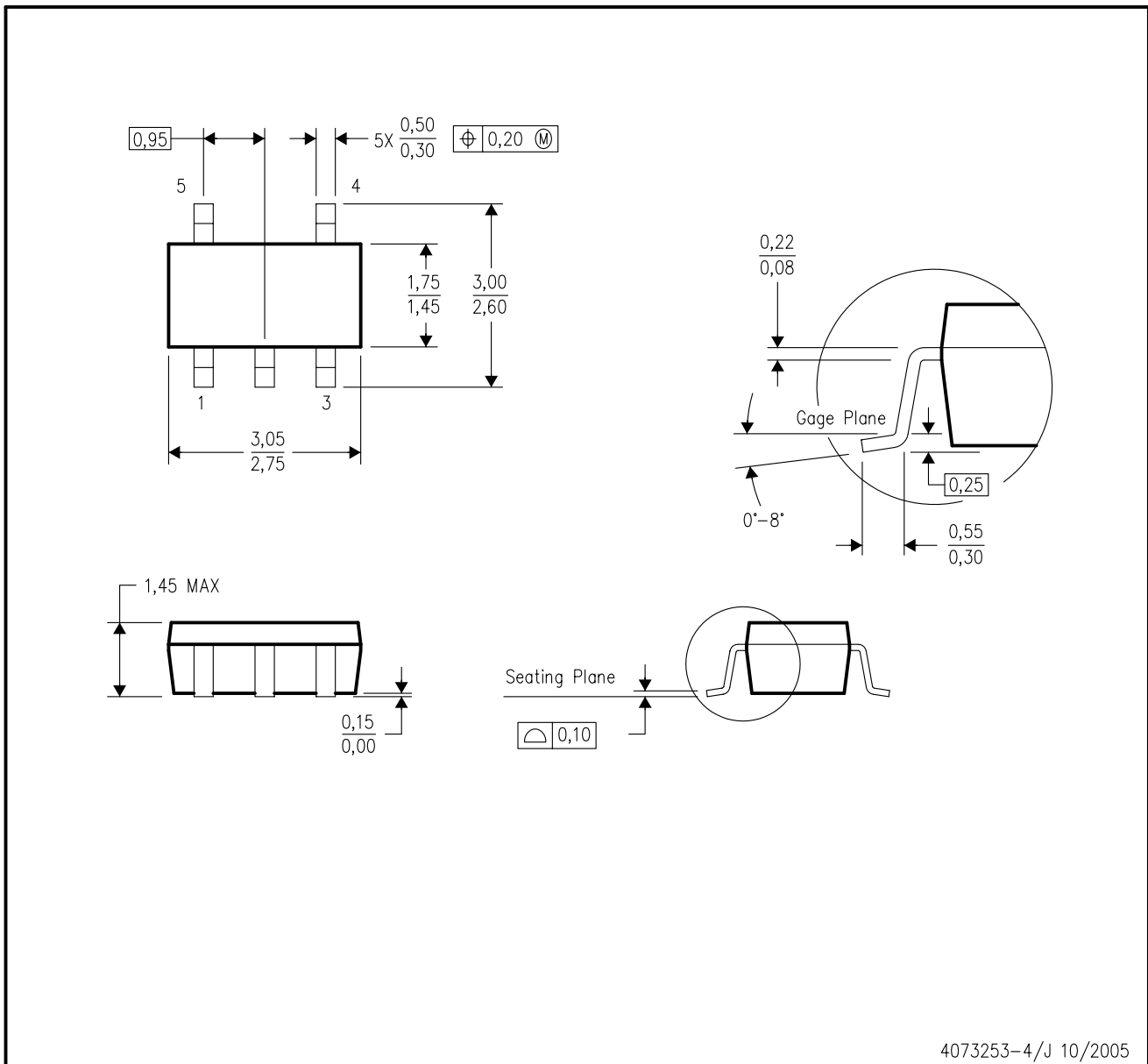
⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE

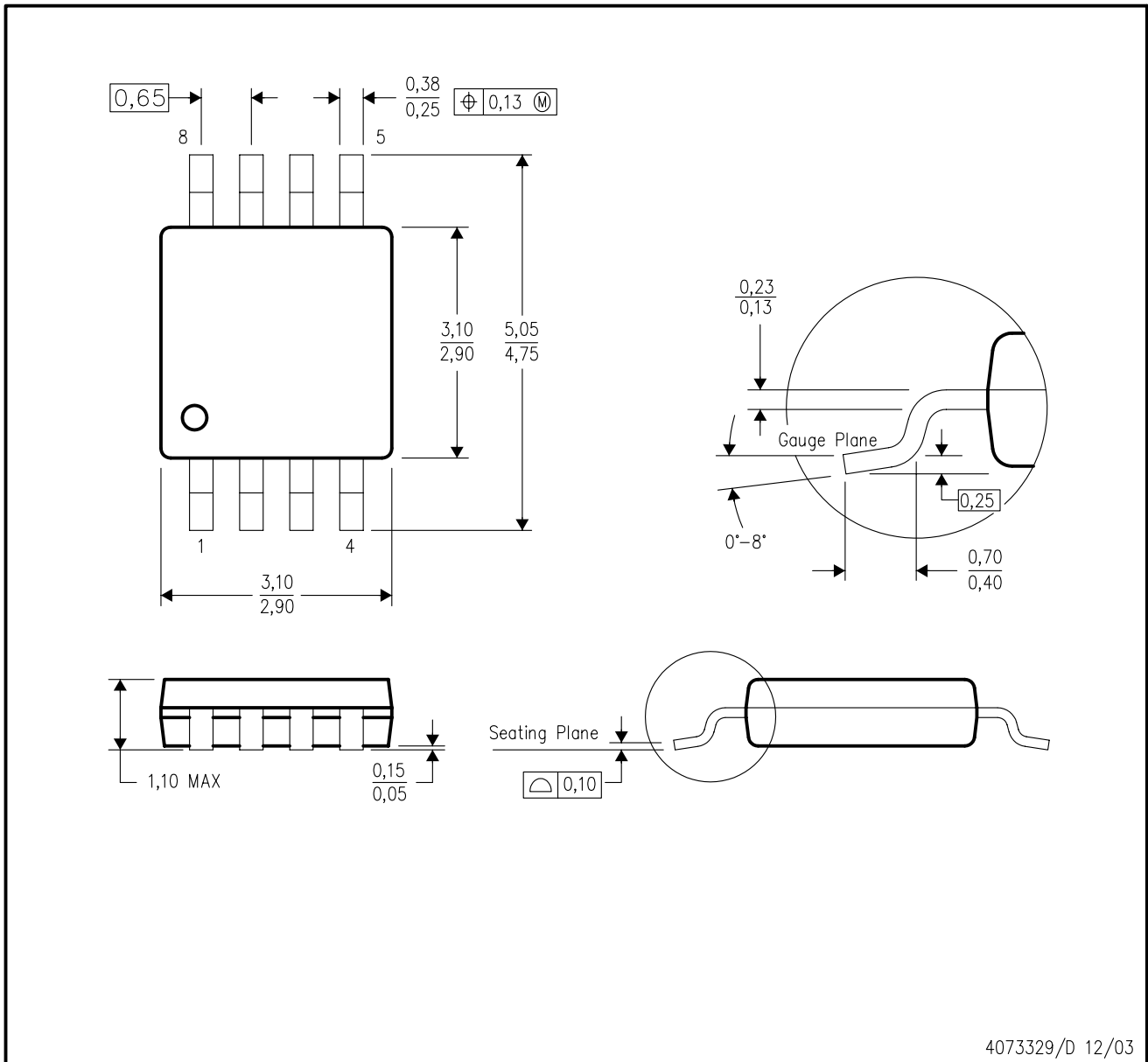


4073253-4/J 10/2005

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

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 dimensions do not include mold flash or protrusion.
 - D. Falls within JEDEC MO-187 variation AA.

D (R-PDSO-G8)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - D. Falls within JEDEC MS-012 variation AA.

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Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265