

TLVx379

Cost-Optimized, Low-Voltage, 4- μ A, Rail-to-Rail I/O Operational Amplifiers

1 Features

- Cost-Optimized Precision Amplifiers
- microPower: 4 μ A (Typical)
- Low Offset Voltage: 0.8 mV (Typical)
- Rail-to-Rail Input and Output
- Unity-Gain Stable
- Wide Supply Voltage Range: 1.8 V to 5.5 V
- microSize Packages:
 - 5-Pin SC70
 - 5-Pin SOT-23
 - 8-Pin SOIC
 - 14-Pin TSSOP

2 Applications

- Power Banks
- Solar Inverters
- Low-Power Motor Controls
- Battery-Powered Instruments
- Portable Devices
- Medical Instruments
- Handheld Test Equipment

3 Description

The TLV379 family of single, dual, and quad operational amplifiers represents a cost-optimized generation of low-voltage and micropower amplifiers. Operating on a supply voltage as low as 1.8 V (± 0.9 V) and consuming extremely low quiescent current of 4 μ A per channel, these amplifiers are well-suited for power-sensitive applications. In addition, the rail-to-rail input and output capability allows the TLV379 family to be used in virtually any single-supply application.

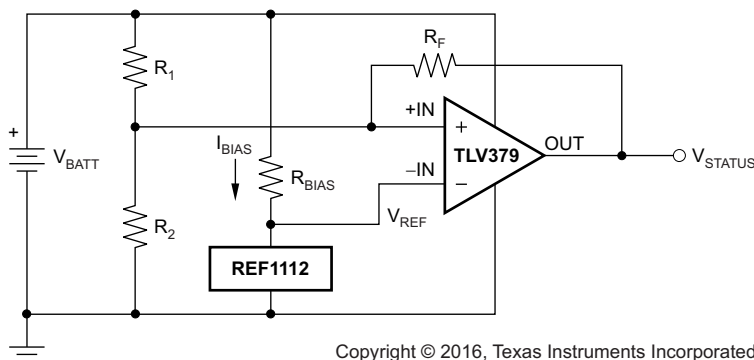
The TLV379 (single) is available in 5-pin SC70 and SOT23, and 8-pin SOIC packages. The TLV2379 (dual) comes in an 8-pin SOIC package. The TLV4379 (quad) is offered in a 14-pin TSSOP package. All versions are specified from -40°C to $+125^{\circ}\text{C}$.

Device Information⁽¹⁾

| PART NUMBER | PACKAGE | BODY SIZE (NOM) |
|-------------|------------|-------------------|
| TLV379 | SC70 (5) | 2.00 mm x 1.25 mm |
| | SOT-23 (5) | 2.90 mm x 1.60 mm |
| | SOIC (8) | 4.90 mm x 3.91 mm |
| TLV2379 | SOIC (8) | 4.90 mm x 3.91 mm |
| TLV4379 | TSSOP (14) | 5.00 mm x 4.40 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.

TLV379 in a Battery-Monitoring Application



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Revision A (September 2016) to Revision B | Page |
|---|-------------|
| • Added underscores to pin names in Pin Functions tables to match connection diagrams | 4 |

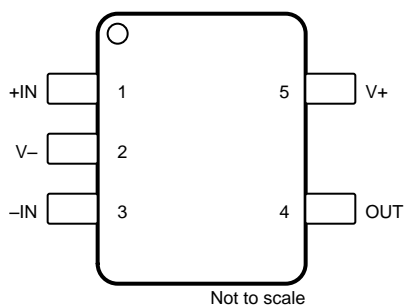
| Changes from Original (April 2016) to Revision A | Page |
|---|-------------|
| • Changed DBV pinout | 3 |

5 Device Comparison Table

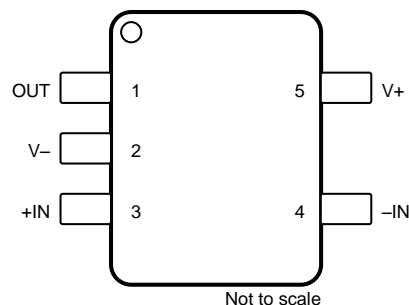
| FEATURES | PRODUCT |
|--|---------|
| 1 μ A, 70 kHz, 2-mV V_{OS} , 1.8-V to 5.5-V supply | OPA349 |
| 1 μ A, 5.5 kHz, 390- μ V V_{OS} , 2.5-V to 16-V supply | TLV240x |
| 1 μ A, 5.5 kHz, 0.6-mV V_{OS} , 2.5-V to 12-V supply | TLV224x |
| 7 μ A, 160 kHz, 0.5-mV V_{OS} , 2.7-V to 16-V supply | TLV27Lx |
| 7 μ A, 160 kHz, 0.5-mV V_{OS} , 2.7-V to 16-V supply | TLV238x |
| 20 μ A, 350 kHz, 2-mV V_{OS} , 2.3-V to 5.5-V supply | OPA347 |
| 20 μ A, 500 kHz, 550- μ V V_{OS} , 1.8-V to 3.6-V supply | TLV276x |
| 45 μ A, 1 MHz, 1-mV V_{OS} , 2.1-V to 5.5-V supply | OPA348 |

6 Pin Configuration and Functions

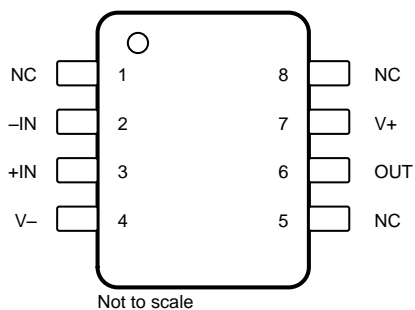
**TLV379: DCK Package
5-Pin SC70
Top View**



**TLV379: DBV Package
5-Pin SOT23
Top View**

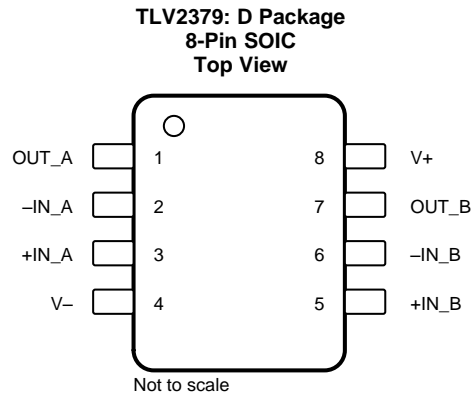


**TLV379: D Package
8-Pin SOIC
Top View**



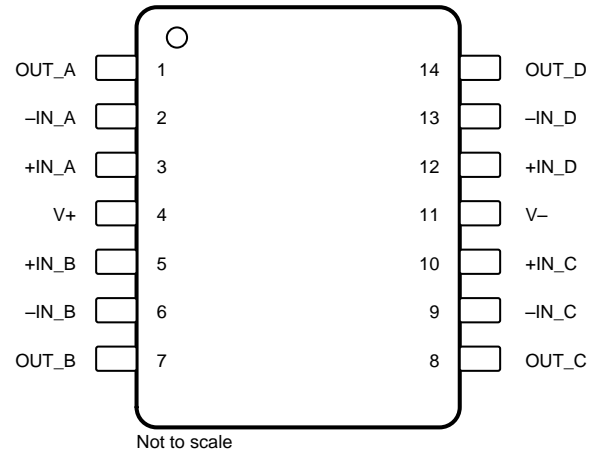
Pin Functions: TLV379

| NAME | NO. | | | I/O | DESCRIPTION |
|------|-----|-----|---------|-----|---|
| | DCK | DBV | D | | |
| -IN | 3 | 4 | 2 | I | Negative (inverting) input |
| +IN | 1 | 3 | 3 | I | Positive (noninverting) input |
| NC | — | — | 1, 5, 8 | — | No internal connection (can be left floating) |
| OUT | 4 | 1 | 6 | O | Output |
| V- | 2 | 2 | 4 | — | Negative (lowest) power supply |
| V+ | 5 | 5 | 7 | — | Positive (highest) power supply |


Pin Functions: TLV2379

| NAME | NO. | I/O | DESCRIPTION |
|-------|-----|-----|---------------------------------|
| -IN_A | 2 | I | Inverting input, channel A |
| +IN_A | 3 | I | Noninverting input, channel A |
| -IN_B | 6 | I | Inverting input, channel B |
| +IN_B | 5 | I | Noninverting input, channel B |
| OUT_A | 1 | O | Output, channel A |
| OUT_B | 7 | O | Output, channel B |
| V- | 4 | — | Negative (lowest) power supply |
| V+ | 8 | — | Positive (highest) power supply |

**TLV4379: PW Package
14-Pin TSSOP
Top View**



Pin Functions: TLV4379

| NAME | NO. | I/O | DESCRIPTION |
|-------|-----|-----|---------------------------------|
| -IN_A | 2 | I | Inverting input, channel A |
| +IN_A | 3 | I | Noninverting input, channel A |
| -IN_B | 6 | I | Inverting input, channel B |
| +IN_B | 5 | I | Noninverting input, channel B |
| -IN_C | 9 | I | Inverting input, channel C |
| +IN_C | 10 | I | Noninverting input, channel C |
| -IN_D | 13 | I | Inverting input, channel D |
| +IN_D | 12 | I | Noninverting input, channel D |
| OUT_A | 1 | O | Output, channel A |
| OUT_B | 7 | O | Output, channel B |
| OUT_C | 8 | O | Output, channel C |
| OUT_D | 14 | O | Output, channel D |
| V- | 11 | — | Negative (lowest) power supply |
| V+ | 4 | — | Positive (highest) power supply |

7 Specifications

7.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

| | | MIN | MAX | UNIT |
|-------------|-------------------------------------|--------------|--------------|------|
| Voltage | Supply, $V_S = (V+) - (V-)$ | 7 | | V |
| | Signal input pin ⁽²⁾ | $(V-) - 0.5$ | $(V+) + 0.5$ | |
| Current | Signal input pin ⁽²⁾ | ±10 | | mA |
| | Output short-circuit ⁽³⁾ | Continuous | | |
| Temperature | Operating, T_A | -40 | 125 | °C |
| | Junction, T_J | 150 | | |
| | Storage, T_{stg} | -65 | 150 | |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Input pins are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5 V beyond the supply rails must be current-limited to 10 mA or less.
- (3) Short-circuit to ground, one amplifier per package.

7.2 ESD Ratings

| | | | VALUE | UNIT |
|-------------|-------------------------|--|-------|------|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾ | ±2000 | V |
| | | Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾ | ±1000 | |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

7.3 Recommended Operating Conditions

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

| | | MIN | NOM | MAX | UNIT |
|-------|-----------------------|---------------|------|-------|------|
| V_S | Supply voltage | Single supply | 1.8 | 5.5 | V |
| | | Dual supply | ±0.9 | ±2.75 | |
| T_A | Operating temperature | -40 | | 125 | °C |

7.4 Thermal Information: TLV379

| THERMAL METRIC ⁽¹⁾ | | TLV379 | | | UNIT |
|-------------------------------|--|------------|-------------|----------|------|
| | | DCK (SC70) | DBV (SOT23) | D (SOIC) | |
| | | 5 PINS | 5 PINS | 8 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 262.2 | 220.8 | 130.8 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 99.7 | 148.3 | 77.2 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 49.0 | 48.2 | 71.1 | °C/W |
| Ψ_{JT} | Junction-to-top characterization parameter | 3.3 | 28.6 | 30.7 | °C/W |
| Ψ_{JB} | Junction-to-board characterization parameter | 18.2 | 47.3 | 70.6 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | n/a | n/a | n/a | °C/W |

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

7.5 Thermal Information: TLV2379

| THERMAL METRIC ⁽¹⁾ | | TLV2379 | UNIT |
|-------------------------------|--|----------|------|
| | | D (SOIC) | |
| | | 8 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 116.4 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 59.5 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 57.6 | °C/W |
| Ψ_{JT} | Junction-to-top characterization parameter | 17.2 | °C/W |
| Ψ_{JB} | Junction-to-board characterization parameter | 57.0 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | n/a | °C/W |

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

7.6 Thermal Information: TLV4379

| THERMAL METRIC ⁽¹⁾ | | TLV4379 | UNIT |
|-------------------------------|--|------------|------|
| | | PW (TSSOP) | |
| | | 14 PINS | |
| $R_{\theta JA}$ | Junction-to-ambient thermal resistance | 110.8 | °C/W |
| $R_{\theta JC(top)}$ | Junction-to-case (top) thermal resistance | 35.2 | °C/W |
| $R_{\theta JB}$ | Junction-to-board thermal resistance | 53.6 | °C/W |
| Ψ_{JT} | Junction-to-top characterization parameter | 2.6 | °C/W |
| Ψ_{JB} | Junction-to-board characterization parameter | 52.9 | °C/W |
| $R_{\theta JC(bot)}$ | Junction-to-case (bottom) thermal resistance | n/a | °C/W |

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

7.7 Electrical Characteristics: $V_S = 1.8\text{ V to }5.5\text{ V}$

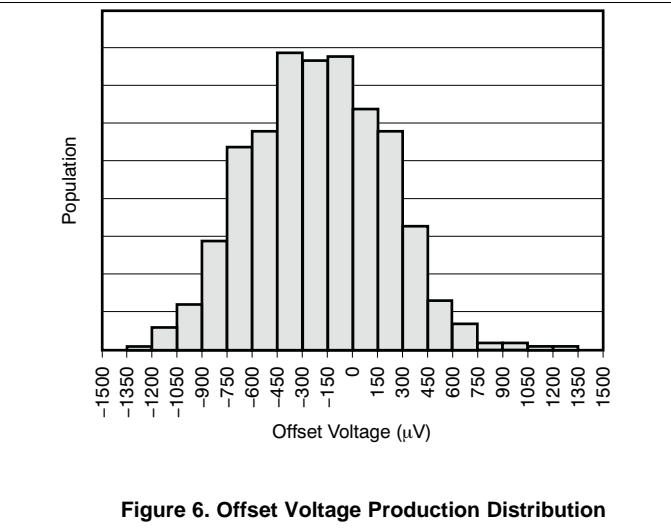
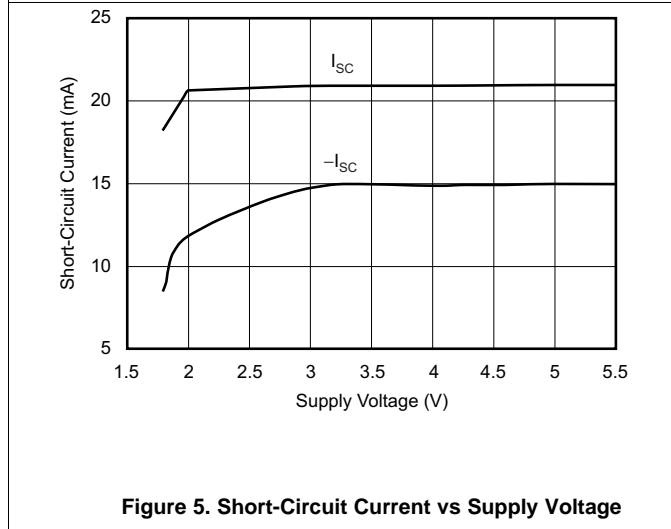
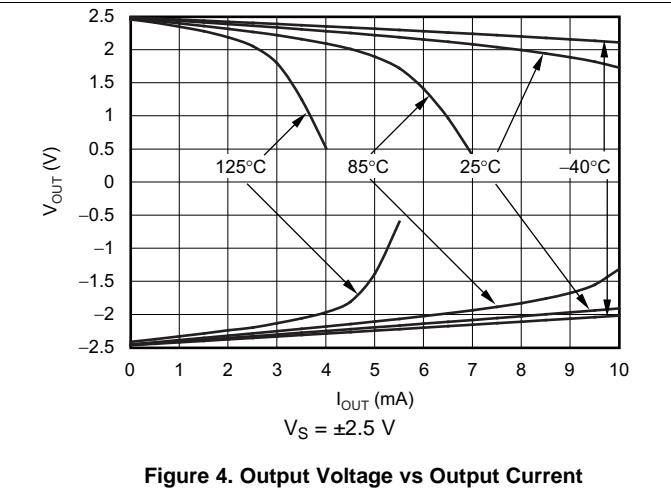
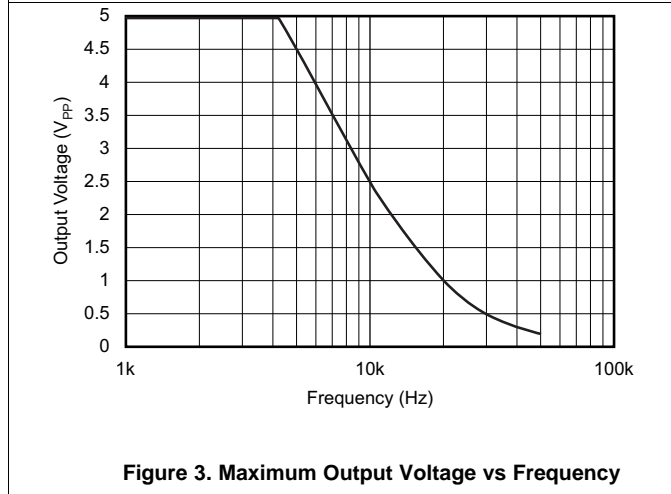
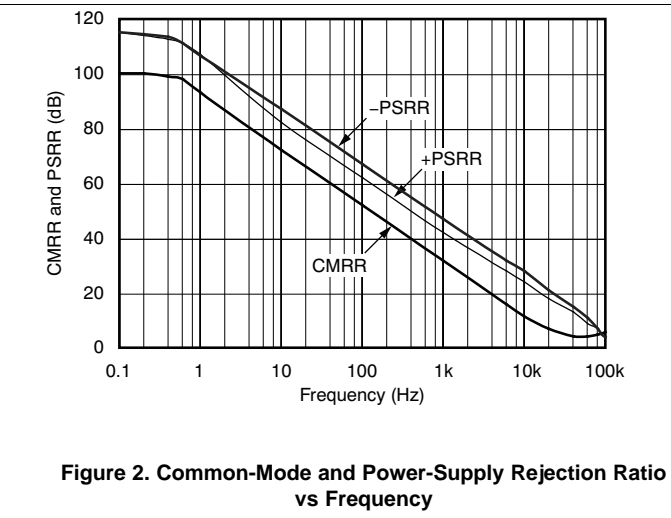
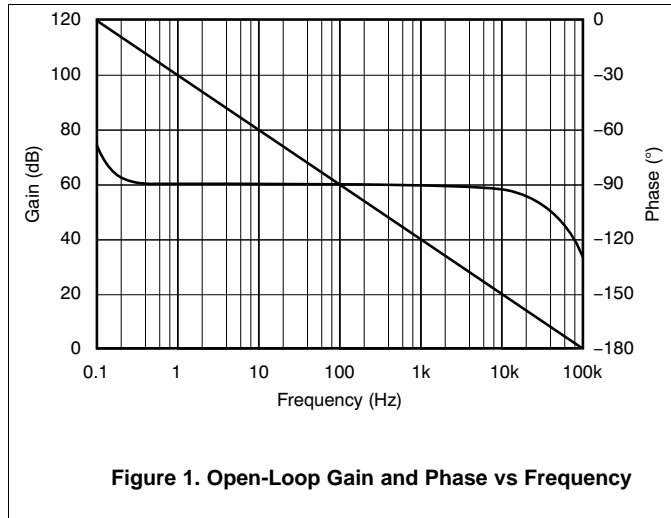
 at $T_A = 25^\circ\text{C}$, $R_L = 25\text{ k}\Omega$ connected to $V_S / 2$, and $V_{CM} < (V+) - 1\text{ V}$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|--|---|--------------|---|--------------|------------------------------|
| OFFSET VOLTAGE | | | | | | |
| V_{OS} | Input offset voltage | $V_S = 5\text{ V}$ | | 0.8 | 2.5 | mV |
| dV_{OS}/dT | V_{OS} drift | $T_A = -40^\circ\text{C to }+125^\circ\text{C}$ | | 3 | | $\mu\text{V}/^\circ\text{C}$ |
| PSRR | Power-supply rejection ratio | | 92 | 104 | | dB |
| INPUT VOLTAGE RANGE | | | | | | |
| V_{CM} | Common-mode voltage range | | $(V-) - 0.1$ | | $(V+) + 0.1$ | V |
| CMRR | Common-mode rejection ratio ⁽¹⁾ | $(V-) < V_{CM} < (V+) - 1\text{ V}$ | 85 | 100 | | dB |
| | | $T_A = -40^\circ\text{C to }+125^\circ\text{C}$, $(V-) < V_{CM} < (V+) - 1\text{ V}$ | 62 | | | |
| INPUT BIAS CURRENT | | | | | | |
| I_{IB} | Input bias current | $V_S = 5\text{ V}$, $V_{CM} \leq V_S / 2$ | | ± 5 | | pA |
| I_{IO} | Input offset current | $V_S = 5\text{ V}$ | | ± 5 | | pA |
| INPUT IMPEDANCE | | | | | | |
| | Differential | | | $10^{13} \parallel 3$ | | $\Omega \parallel \text{pF}$ |
| | Common-mode | | | $10^{13} \parallel 6$ | | $\Omega \parallel \text{pF}$ |
| NOISE | | | | | | |
| | Input voltage noise | $f = 0.1\text{ Hz to }10\text{ Hz}$ | | 2.8 | | μV_{PP} |
| e_n | Input voltage noise density | $f = 1\text{ kHz}$ | | 83 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| OPEN-LOOP GAIN | | | | | | |
| A_{OL} | Open-loop voltage gain | $V_S = 5\text{ V}$, $R_L = 5\text{ k}\Omega$, $500\text{ mV} < V_O < (V+) - 500\text{ mV}$ | 90 | 110 | | dB |
| OUTPUT | | | | | | |
| | Voltage output swing from rail | $R_L = 5\text{ k}\Omega$ | | 25 | 50 | mV |
| | | $T_A = -40^\circ\text{C to }+125^\circ\text{C}$, $R_L = 5\text{ k}\Omega$ | | | 75 | |
| I_{SC} | Short-circuit current | | | ± 5 | | mA |
| C_{LOAD} | Capacitive load drive | | | See Capacitive Load and Stability section | | |
| R_{OUT} | Closed-loop output impedance | $G = 1$, $f = 1\text{ kHz}$, $I_O = 0$ | | 10 | | Ω |
| R_O | Open-loop output impedance | $f = 100\text{ kHz}$, $I_O = 0$ | | 28 | | k Ω |
| FREQUENCY RESPONSE ($C_{LOAD} = 30\text{ pF}$) | | | | | | |
| GBW | Gain bandwidth product | | | 90 | | kHz |
| SR | Slew rate | $G = 1$ | | 0.03 | | V/ μs |
| | Overload recovery time | $V_{IN} \times \text{Gain} > V_S$ | | 25 | | μs |
| t_{ON} | Turn-on time | | | 1 | | ms |
| POWER SUPPLY | | | | | | |
| V_S | Specified, operating voltage range | | 1.8 | | 5.5 | V |
| I_Q | Quiescent current per amplifier | $V_S = 5\text{ V}$, $T_A = -40^\circ\text{C to }+125^\circ\text{C}$ | | 4 | 12 | μA |
| TEMPERATURE | | | | | | |
| T_A | Specified, operating range | | -40 | | 125 | $^\circ\text{C}$ |
| T_{stg} | Storage range | | -65 | | 150 | $^\circ\text{C}$ |

 (1) See typical characteristic graph, *Common-Mode Rejection Ratio vs Frequency* (Figure 2).

7.8 Typical Characteristics

at $T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$, and $R_L = 25\text{ k}\Omega$ connected to $V_S / 2$ (unless otherwise noted)



Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$, and $R_L = 25\text{ k}\Omega$ connected to $V_S / 2$ (unless otherwise noted)

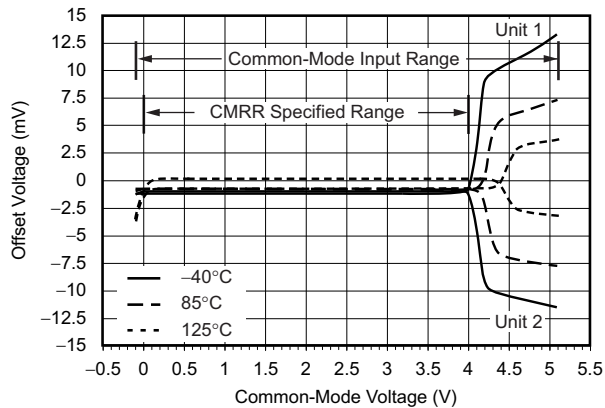


Figure 7. Offset Voltage vs Common-Mode Voltage and Temperature

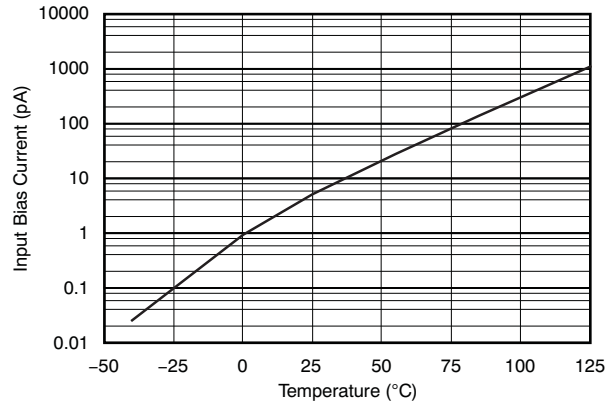


Figure 8. Input Bias Current vs Temperature

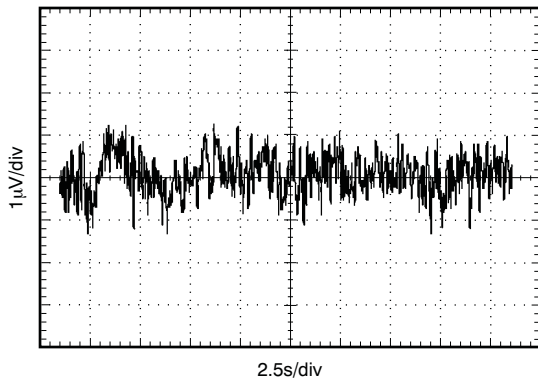


Figure 9. 0.1-Hz to 10-Hz Noise

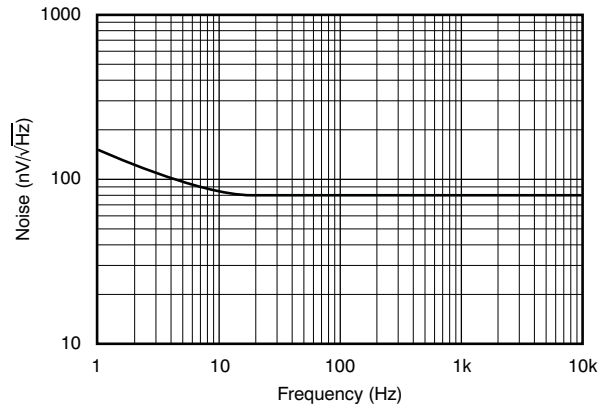


Figure 10. Noise vs Frequency

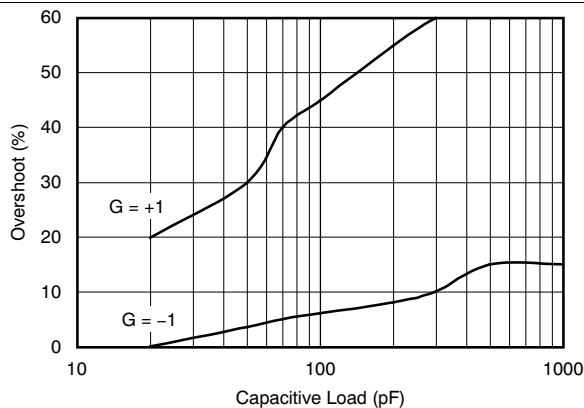


Figure 11. Small-Signal Overshoot vs Capacitive Load

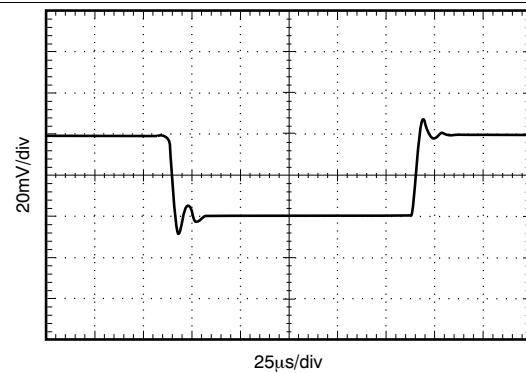


Figure 12. Small-Signal Step Response

Typical Characteristics (continued)

at $T_A = 25^\circ\text{C}$, $V_S = 5\text{ V}$, and $R_L = 25\text{ k}\Omega$ connected to $V_S / 2$ (unless otherwise noted)

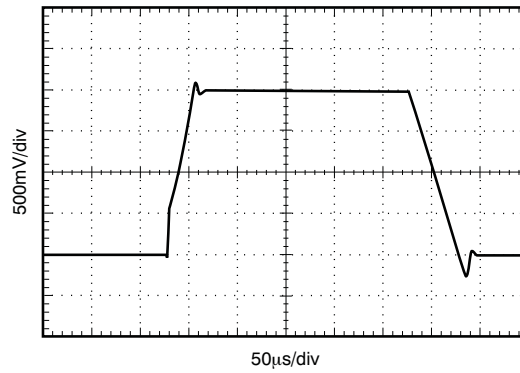


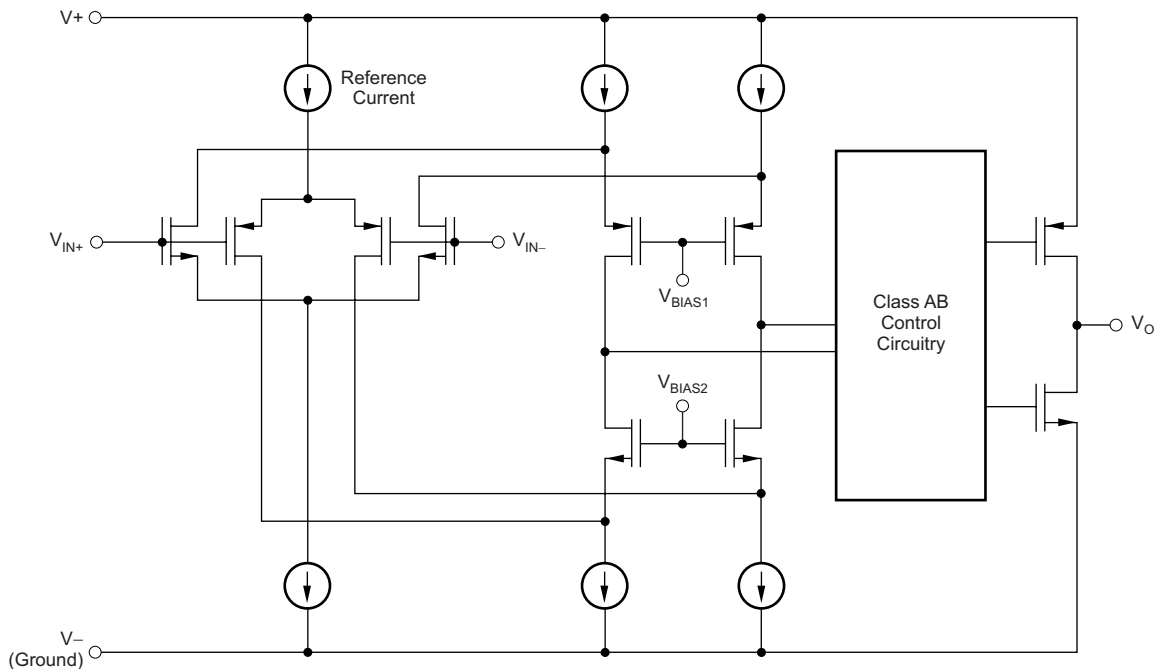
Figure 13. Large-Signal Step Response

8 Detailed Description

8.1 Overview

The TLV379 devices are a family of micropower, low-voltage, rail-to-rail input and output operational amplifiers designed for battery-powered applications. This family of amplifiers features impressive bandwidth (90 kHz), low bias current (5 pA), low noise (83 nV/√Hz), and consumes very low quiescent current of only 12 μA (maximum) per channel.

8.2 Functional Block Diagram



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8.3 Feature Description

8.3.1 Operating Voltage

The TLV379 series is fully specified and tested from 1.8 V to 5.5 V (± 0.9 V to ± 2.75 V). Parameters that vary with supply voltage are illustrated in the [Typical Characteristics](#) section.

8.3.2 Rail-to-Rail Input

The input common-mode voltage range of the TLV379 family typically extends 100 mV beyond each supply rail. This rail-to-rail input is achieved using a complementary input stage. CMRR is specified from the negative rail to 1 V below the positive rail. Between $(V+) - 1$ V and $(V+) + 0.1$ V, the amplifier operates with higher offset voltage because of the transition region of the input stage. See the typical characteristic graph, *Offset Voltage vs Common-Mode Voltage vs Temperature* ([Figure 7](#)).

Feature Description (continued)

8.3.3 Rail-to-Rail Output

Designed as a micropower, low-noise operational amplifier, the TLV379 delivers a robust output drive capability. A class AB output stage with common-source transistors is used to achieve full rail-to-rail output swing capability. For resistive loads up to 25 k Ω , the output typically swings to within 5 mV of either supply rail, regardless of the power-supply voltage applied.

8.3.4 Capacitive Load and Stability

Follower configurations with load capacitance in excess of 30 pF can produce extra overshoot (see the typical characteristic graph, *Small-Signal Overshoot vs Capacitive Load*, Figure 11) and ringing in the output signal. Increasing the gain enhances the ability of the amplifier to drive greater capacitive loads. In unity-gain configurations, capacitive load drive can be improved by inserting a small (10 Ω to 20 Ω) resistor, R_S , in series with the output as shown in Figure 14. This resistor significantly reduces ringing and maintains direct current (dc) performance for purely capacitive loads. However, if a resistive load is in parallel with the capacitive load, a voltage divider is created, introducing a dc error at the output and slightly reducing the output swing. The error introduced is proportional to the ratio of R_S / R_L and is generally negligible.

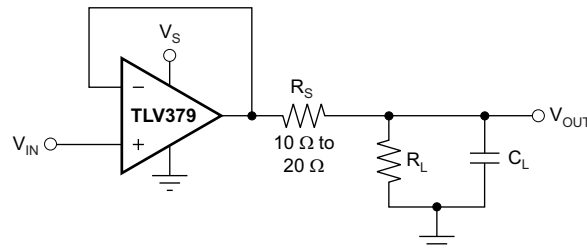


Figure 14. Series Resistor in Unity-Gain Buffer Configuration Improves Capacitive Load Drive

In unity-gain inverter configuration, phase margin can be reduced by the reaction between the capacitance at the operational amplifier (op amp) input and the gain-setting resistors. Best performance is achieved by using smaller-value resistors. However, when large-value resistors cannot be avoided, a small (4 pF to 6 pF) capacitor (C_{FB}) can be inserted in the feedback, as shown in Figure 15. This configuration significantly reduces overshoot by compensating the effect of capacitance (C_{IN}) that includes the amplifier input capacitance (3 pF) and printed circuit board (PCB) parasitic capacitance.

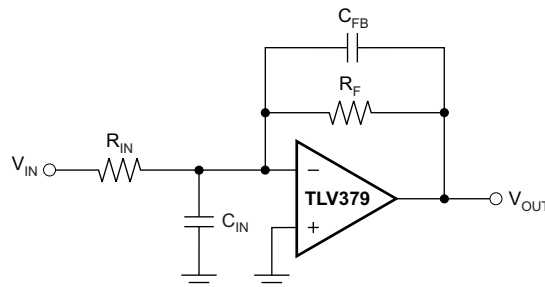


Figure 15. Improving Stability for Large R_F and R_{IN}

8.4 Device Functional Modes

The TLV379 family has a single functional mode. These devices are powered on as long as the power-supply voltage is between 1.8 V (± 0.9 V) and 5.5 V (± 2.75 V).

9 Application and Implementation

NOTE

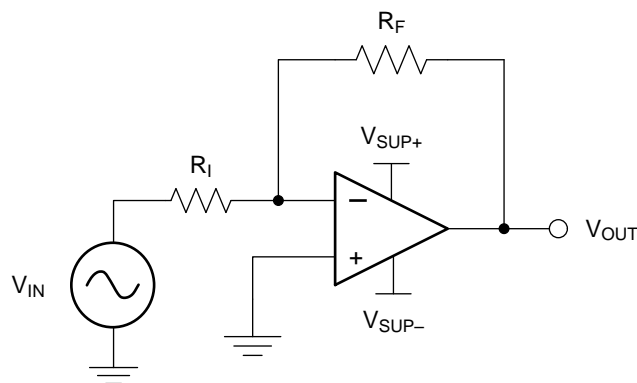
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

9.1 Application Information

When designing for ultra-low power, choose system components carefully. To minimize current consumption, select large-value resistors. Any resistors can react with stray capacitance in the circuit and the input capacitance of the operational amplifier. These parasitic RC combinations can affect the stability of the overall system. Use of a feedback capacitor assures stability and limits overshoot or gain peaking.

9.2 Typical Application

A typical application for an operational amplifier is an inverting amplifier, as shown in [Figure 16](#). An inverting amplifier takes a positive voltage on the input and outputs a signal inverted to the input, making a negative voltage of the same magnitude. In the same manner, the amplifier also makes negative input voltages positive on the output. In addition, amplification can be added by selecting the input resistor R_I and the feedback resistor R_F .



Copyright © 2016, Texas Instruments Incorporated

Figure 16. Application Schematic

9.2.1 Design Requirements

The supply voltage must be chosen to be larger than the input voltage range and the desired output range. The limits of the input common-mode range (V_{CM}) and the output voltage swing to the rails (V_O) must also be considered. For instance, this application scales a signal of ± 0.5 V (1 V) to ± 1.8 V (3.6 V). Setting the supply at ± 2.5 V is sufficient to accommodate this application.

9.2.2 Detailed Design Procedure

Determine the gain required by the inverting amplifier using [Equation 1](#) and [Equation 2](#):

$$A_V = \frac{V_{OUT}}{V_{IN}} \tag{1}$$

$$A_V = \frac{1.8}{-0.5} = -3.6 \tag{2}$$

Typical Application (continued)

When the desired gain is determined, choose a value for R_1 or R_F . Choosing a value in the kilohm range is desirable for general-purpose applications because the amplifier circuit uses currents in the milliamp range. This milliamp current range ensures the device does not draw too much current. The trade-off is that very large resistors (100s of kilohms) draw the smallest current but generate the highest noise. Very small resistors (100s of ohms) generate low noise but draw high current. This example uses 10 k Ω for R_1 , meaning 36 k Ω is used for R_F . These values are determined by Equation 3:

$$A_V = -\frac{R_F}{R_1} \tag{3}$$

9.2.3 Application Curve

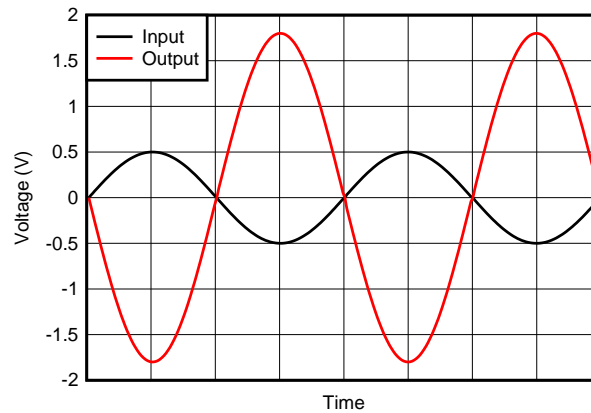


Figure 17. Inverting Amplifier Input and Output

9.3 System Examples

Figure 18 shows the basic configuration for a bridge amplifier using the TLV379.

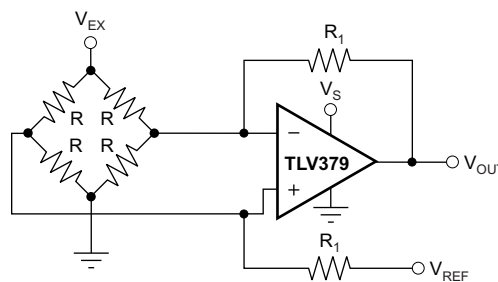


Figure 18. Single Op Amp Bridge Amplifier

System Examples (continued)

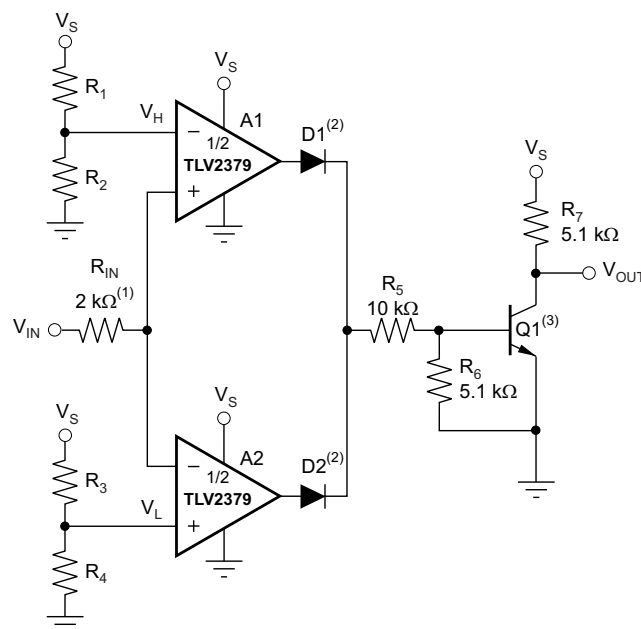
Figure 19 shows the TLV2379 used as a window comparator. The threshold limits are set by V_H and V_L , with $V_H > V_L$. When $V_{IN} < V_H$, the output of A1 is low. When $V_{IN} > V_L$, the output of A2 is low. Therefore, both op amp outputs are at 0 V as long as V_{IN} is between V_H and V_L . This architecture results in no current flowing through either diode, Q1 in cutoff, with the base voltage at 0 V, and V_{OUT} forced high.

If V_{IN} falls below V_L , the output of A2 is high, current flows through D2, and V_{OUT} is low. Likewise, if V_{IN} rises above V_H , the output of A1 is high, current flows through D1, and V_{OUT} is low.

The window comparator threshold voltages are set using Equation 4 and Equation 5.

$$V_H = \frac{R_2}{R_1 + R_2} \times V_S \quad (4)$$

$$V_L = \frac{R_4}{R_3 + R_4} \times V_S \quad (5)$$



- (1) R_{IN} protects A1 and A2 from possible excess current flow.
- (2) IN4446 or equivalent diodes.
- (3) 2N2222 or equivalent NPN transistor.

Figure 19. TLV2379 as a Window Comparator

10 Power Supply Recommendations

The TLV379 family is specified for operation from 1.8 V to 5.5 V (± 0.9 V to ± 2.75 V); many specifications apply from -40°C to $+125^{\circ}\text{C}$. The [Typical Characteristics](#) section presents parameters that can exhibit significant variance with regard to operating voltage or temperature.

CAUTION

Supply voltages larger than 7 V can permanently damage the device (see the [Absolute Maximum Ratings](#) table).

Place 0.1- μF bypass capacitors close to the power-supply pins to reduce errors coupling in from noisy or high-impedance power supplies. For more detailed information on bypass capacitor placement; see the [Layout Guidelines](#) section.

10.1 Input and ESD Protection

The TLV379 family incorporates internal electrostatic discharge (ESD) protection circuits on all pins. In the case of input and output pins, this protection primarily consists of current-steering diodes connected between the input and power-supply pins. These ESD protection diodes also provide in-circuit, input overdrive protection, as long as the current is limited to 10 mA as stated in the [Absolute Maximum Ratings](#) table. [Figure 20](#) shows how a series input resistor can be added to the driven input to limit the input current. The added resistor contributes thermal noise at the amplifier input that must be kept to a minimum in noise-sensitive applications.

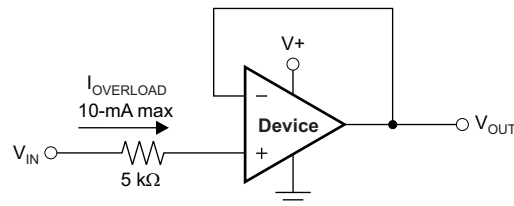


Figure 20. Input Current Protection

11 Layout

11.1 Layout Guidelines

For best operational performance of the device, use good printed circuit board (PCB) layout practices, including:

- Noise can propagate into analog circuitry through the power pins of the circuit as a whole and the operational amplifier. Use bypass capacitors to reduce the coupled noise by providing low-impedance power sources local to the analog circuitry.
 - Connect low-ESR, 0.1- μ F ceramic bypass capacitors between each supply pin and ground, placed as close as possible to the device. A single bypass capacitor from V+ to ground is applicable for single-supply applications.
- Separate grounding for analog and digital portions of the circuitry is one of the simplest and most effective methods of noise suppression. One or more layers on multilayer PCBs are usually devoted to ground planes. A ground plane helps distribute heat and reduces EMI noise pickup. Make sure to physically separate digital and analog grounds, paying attention to the flow of the ground current. For more detailed information, see *Circuit Board Layout Techniques*, [SLOA089](#).
- To reduce parasitic coupling, run the input traces as far away from the supply or output traces as possible. If these traces cannot be kept separate, crossing the sensitive trace perpendicularly is much better than crossing in parallel with the noisy trace.
- Place the external components as close as possible to the device. Keep R_F and R_G close to the inverting input in order to minimize parasitic capacitance, as shown in [Figure 21](#).
- Keep the length of input traces as short as possible. Always remember that the input traces are the most sensitive part of the circuit.
- Consider a driven, low-impedance guard ring around the critical traces. A guard ring can significantly reduce leakage currents from nearby traces that are at different potentials.

11.2 Layout Example

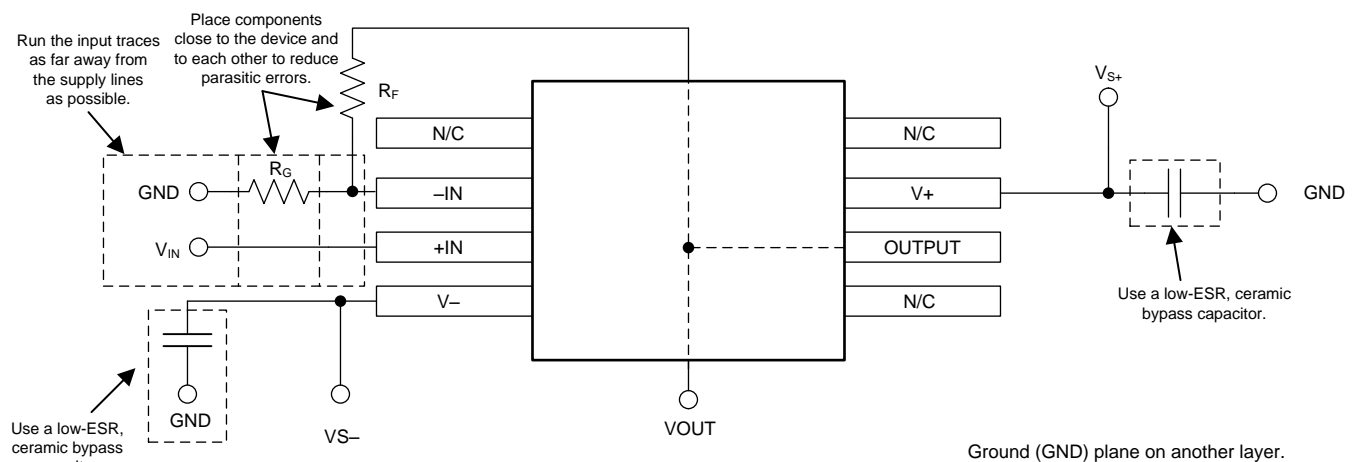


Figure 21. Operational Amplifier Board Layout for Noninverting Configuration

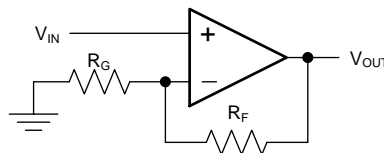


Figure 22. Schematic Representation of [Figure 21](#)

12 Device and Documentation Support

12.1 Documentation Support

12.1.1 Related Documentation

For related documentation, see the following:

- [EMI Rejection Ratio of Operational Amplifiers](#) (SBOA128)
- [Circuit Board Layout Techniques](#) (SLOA089)
- [QFN/SON PCB Attachment](#) (SLUA271)
- [Quad Flatpack No-Lead Logic Packages](#) (SCBA017)

12.2 Related Links

Table 1 lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 1. Related Links

| PARTS | PRODUCT FOLDER | SAMPLE & BUY | TECHNICAL DOCUMENTS | TOOLS & SOFTWARE | SUPPORT & COMMUNITY |
|---------|----------------------------|----------------------------|----------------------------|----------------------------|----------------------------|
| TLV379 | Click here | Click here | Click here | Click here | Click here |
| TLV2379 | Click here | Click here | Click here | Click here | Click here |
| TLV4379 | Click here | Click here | Click here | Click here | Click here |

12.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

12.4 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

12.5 Trademarks

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12.6 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

12.7 Glossary

SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

13 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

| Orderable part number | Status (1) | Material type (2) | Package Pins | Package qty Carrier | RoHS (3) | Lead finish/ Ball material (4) | MSL rating/ Peak reflow (5) | Op temp (°C) | Part marking (6) |
|-----------------------------|---------------|----------------------|------------------|-----------------------|-------------|--------------------------------------|-----------------------------------|--------------|---------------------|
| TLV2379IDR | Active | Production | SOIC (D) 8 | 2500 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | V2379 |
| TLV379IDBVR | Active | Production | SOT-23 (DBV) 5 | 3000 LARGE T&R | Yes | NIPDAU SN NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 12N |
| TLV379IDBVT | Active | Production | SOT-23 (DBV) 5 | 250 SMALL T&R | Yes | NIPDAU SN NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 12N |
| TLV379IDCKR | Active | Production | SC70 (DCK) 5 | 3000 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 12O |
| TLV379IDCKT | Active | Production | SC70 (DCK) 5 | 250 SMALL T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | 12O |
| TLV379IDR | Active | Production | SOIC (D) 8 | 2500 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | TLV 379 |
| TLV4379IPWR | Active | Production | TSSOP (PW) 14 | 2000 LARGE T&R | Yes | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | TLV4379 |

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*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 |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLV2379IDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TLV379IDBVR | SOT-23 | DBV | 5 | 3000 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV379IDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV379IDBVT | SOT-23 | DBV | 5 | 250 | 180.0 | 8.4 | 3.2 | 3.2 | 1.4 | 4.0 | 8.0 | Q3 |
| TLV379IDCKR | SC70 | DCK | 5 | 3000 | 178.0 | 9.0 | 2.4 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TLV379IDCKT | SC70 | DCK | 5 | 250 | 178.0 | 9.0 | 2.4 | 2.5 | 1.2 | 4.0 | 8.0 | Q3 |
| TLV379IDR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TLV4379IPWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLV2379IDR | SOIC | D | 8 | 2500 | 356.0 | 356.0 | 35.0 |
| TLV379IDBVR | SOT-23 | DBV | 5 | 3000 | 210.0 | 185.0 | 35.0 |
| TLV379IDBVT | SOT-23 | DBV | 5 | 250 | 210.0 | 185.0 | 35.0 |
| TLV379IDBVT | SOT-23 | DBV | 5 | 250 | 210.0 | 185.0 | 35.0 |
| TLV379IDCKR | SC70 | DCK | 5 | 3000 | 180.0 | 180.0 | 18.0 |
| TLV379IDCKT | SC70 | DCK | 5 | 250 | 180.0 | 180.0 | 18.0 |
| TLV379IDR | SOIC | D | 8 | 2500 | 356.0 | 356.0 | 35.0 |
| TLV4379IPWR | TSSOP | PW | 14 | 2000 | 356.0 | 356.0 | 35.0 |

EXAMPLE BOARD LAYOUT

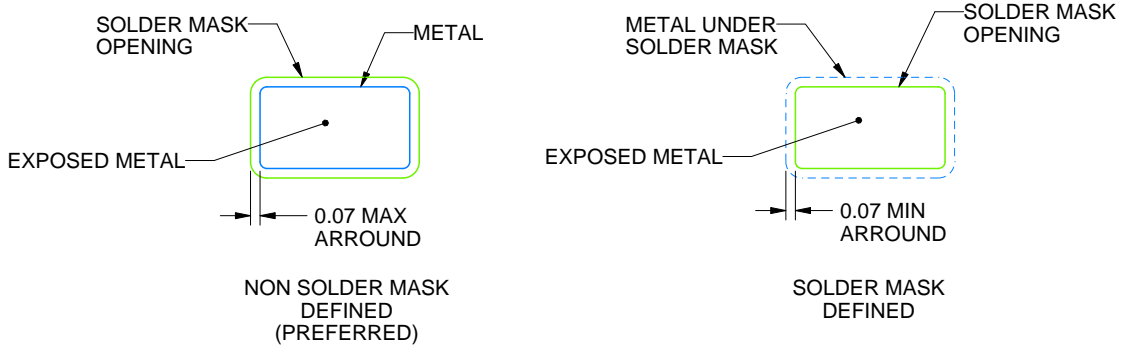
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

4214839/K 08/2024

NOTES: (continued)

- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

4214839/K 08/2024

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

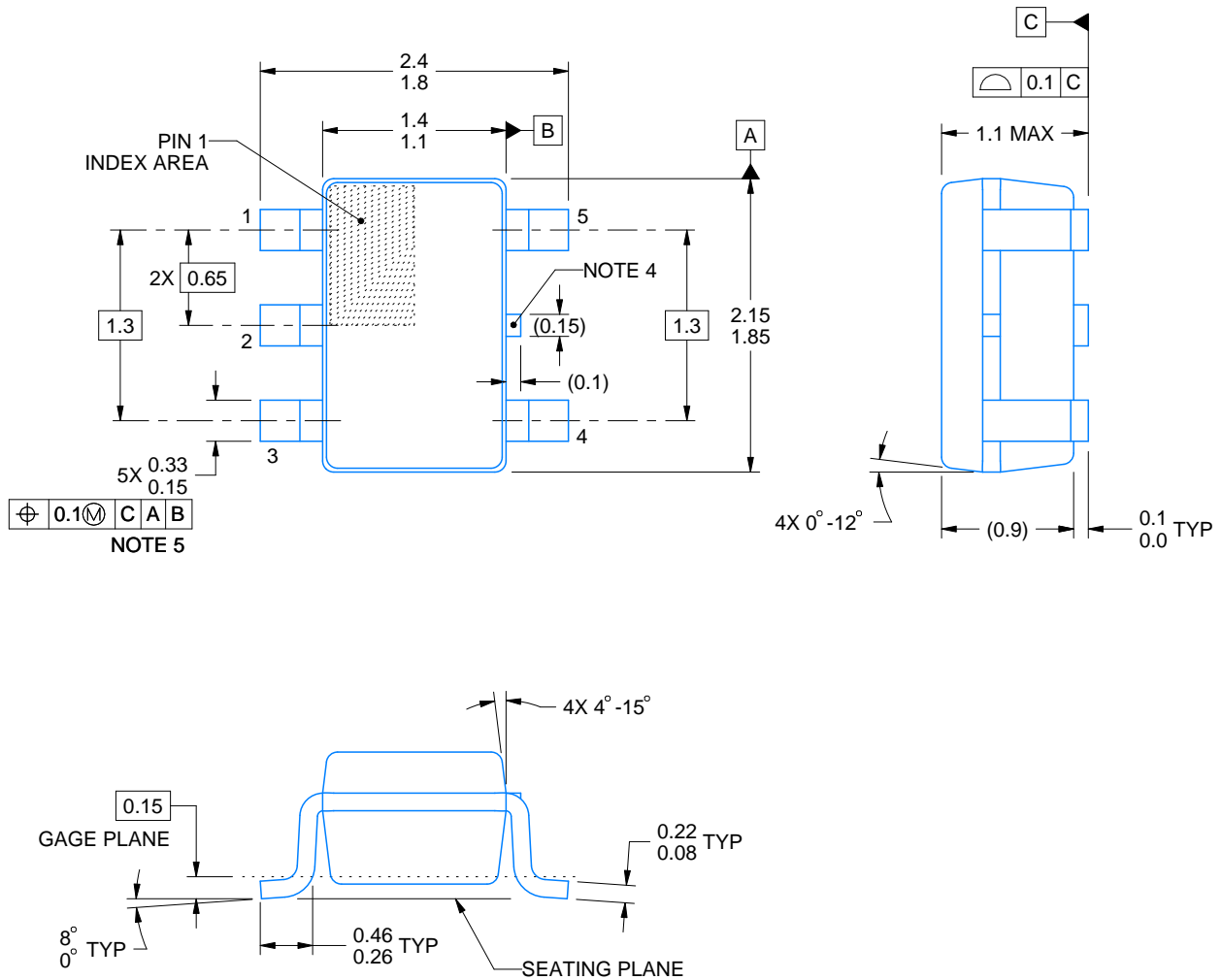
DCK0005A



PACKAGE OUTLINE

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



4214834/G 11/2024

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-203.
4. Support pin may differ or may not be present.
5. Lead width does not comply with JEDEC.
6. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side

EXAMPLE BOARD LAYOUT

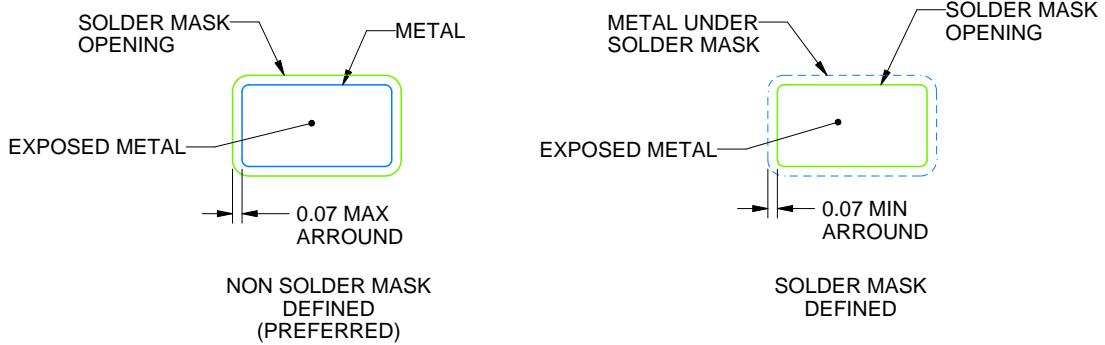
DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X



SOLDER MASK DETAILS

4214834/G 11/2024

NOTES: (continued)

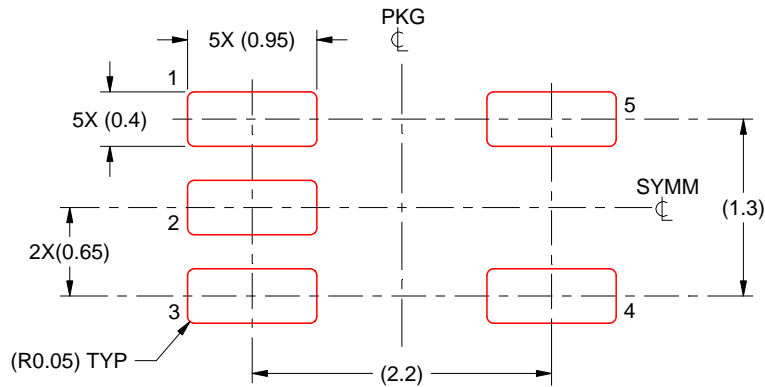
- 7. Publication IPC-7351 may have alternate designs.
- 8. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE: 18X

4214834/G 11/2024

NOTES: (continued)

9. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
10. Board assembly site may have different recommendations for stencil design.



D0008A

PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4214825/C 02/2019

NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed $.006$ [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.

EXAMPLE BOARD LAYOUT

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



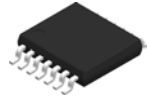
SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

PW0014A



PACKAGE OUTLINE
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4220202/B 12/2023

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

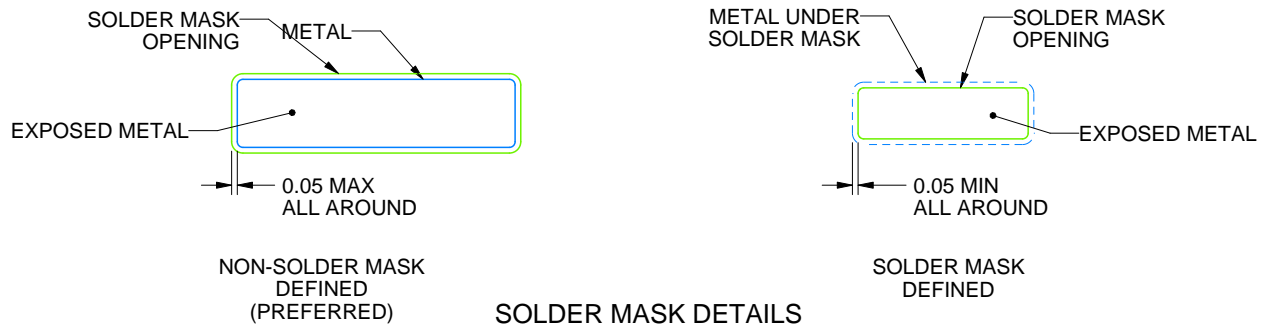
PW0014A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



4220202/B 12/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0014A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220202/B 12/2023

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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