

## TLVx379

### Cost-Optimized, Low-Voltage, 4- $\mu$ A, Rail-to-Rail I/O Operational Amplifiers

#### 1 Features

- Cost-Optimized Precision Amplifiers
- microPower: 4  $\mu$ 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 ( $\pm 0.9$  V) and consuming extremely low quiescent current of 4  $\mu$ 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.

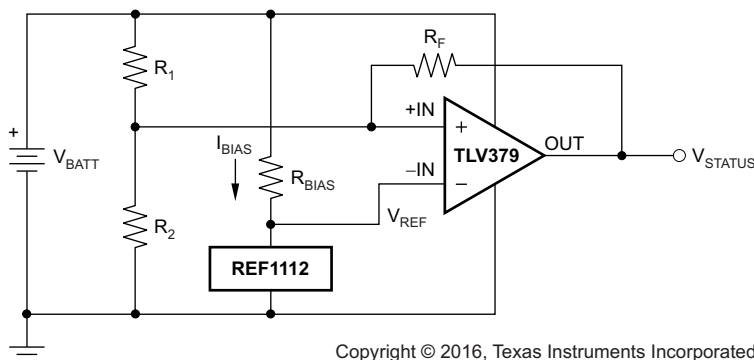
The TLV379 (single) is available in 5-pin SC70 and SOT23, and 8-pin SOIC packages. The TLV2379 (dual) comes in an 8-pin SOIC package. The TLV4379 (quad) is offered in a 14-pin TSSOP package. All versions are specified from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

#### Device Information<sup>(1)</sup>

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.

<b>Changes from Revision A (September 2016) to Revision B</b>	<b>Page</b>
• Added underscores to pin names in Pin Functions tables to match connection diagrams .....	<b>4</b>

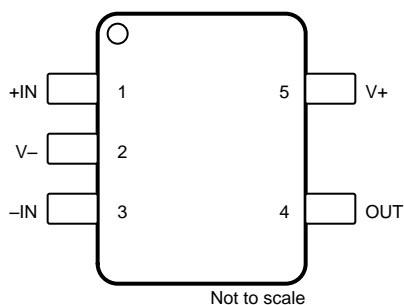
<b>Changes from Original (April 2016) to Revision A</b>	<b>Page</b>
• Changed DBV pinout .....	<b>3</b>

## 5 Device Comparison Table

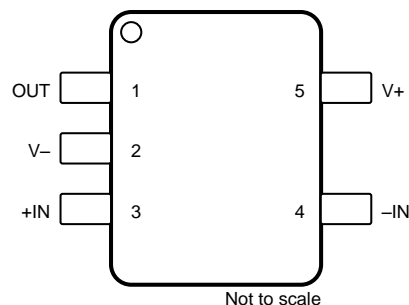
FEATURES	PRODUCT
1 $\mu$ A, 70 kHz, 2-mV $V_{OS}$ , 1.8-V to 5.5-V supply	OPA349
1 $\mu$ A, 5.5 kHz, 390- $\mu$ V $V_{OS}$ , 2.5-V to 16-V supply	TLV240x
1 $\mu$ A, 5.5 kHz, 0.6-mV $V_{OS}$ , 2.5-V to 12-V supply	TLV224x
7 $\mu$ A, 160 kHz, 0.5-mV $V_{OS}$ , 2.7-V to 16-V supply	TLV27Lx
7 $\mu$ A, 160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

## 6 Pin Configuration and Functions

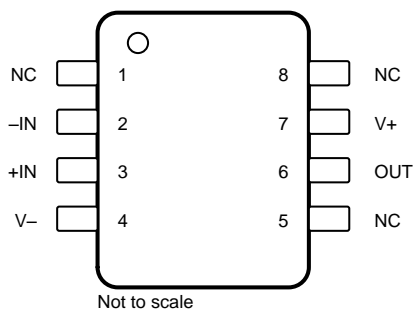
**TLV379: DCK Package  
5-Pin SC70  
Top View**



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

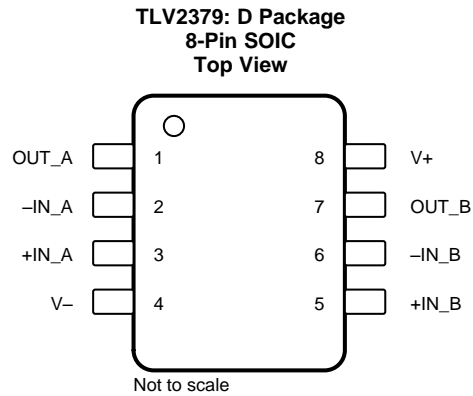


**TLV379: D Package  
8-Pin SOIC  
Top View**



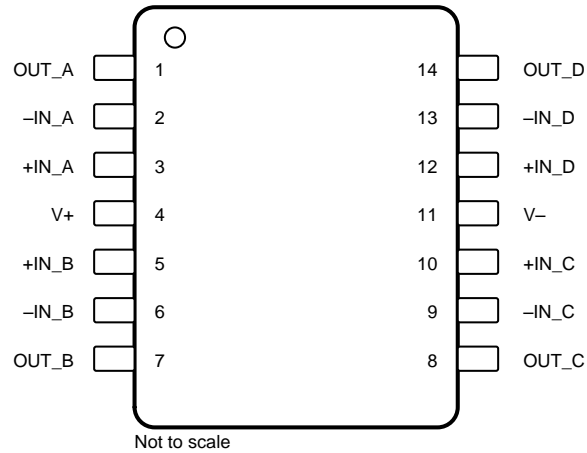
### Pin Functions: TLV379

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)<sup>(1)</sup>

		MIN	MAX	UNIT
Voltage	Supply, $V_S = (V+) - (V-)$	7		V
	Signal input pin <sup>(2)</sup>	$(V-) - 0.5$	$(V+) + 0.5$	
Current	Signal input pin <sup>(2)</sup>	±10		mA
	Output short-circuit <sup>(3)</sup>	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 <sup>(1)</sup>	±2000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±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 <sup>(1)</sup>		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
$\Psi_{JT}$	Junction-to-top characterization parameter	3.3	28.6	30.7	°C/W
$\Psi_{JB}$	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 <sup>(1)</sup>		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
$\Psi_{JT}$	Junction-to-top characterization parameter	17.2	°C/W
$\Psi_{JB}$	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 <sup>(1)</sup>		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
$\Psi_{JT}$	Junction-to-top characterization parameter	2.6	°C/W
$\Psi_{JB}$	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: $V_S = 1.8\text{ V to }5.5\text{ V}$

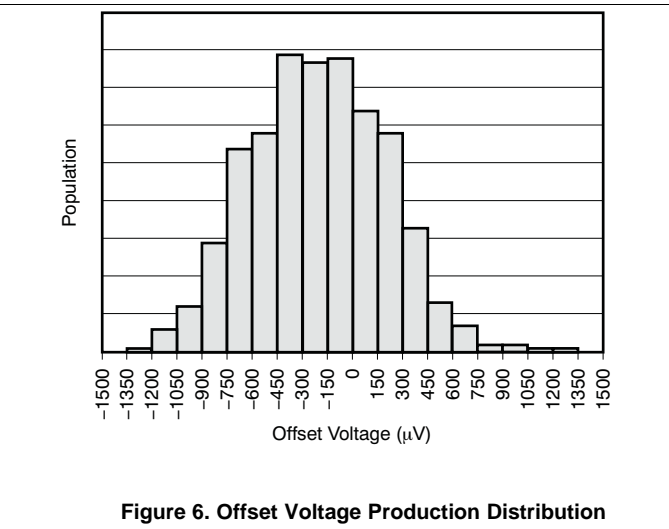
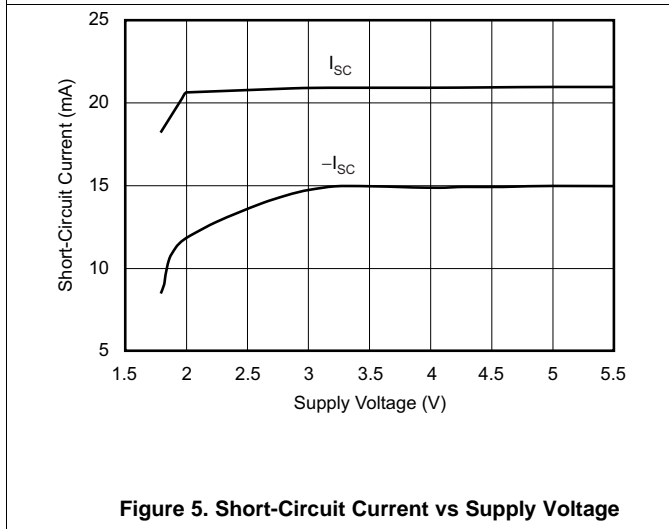
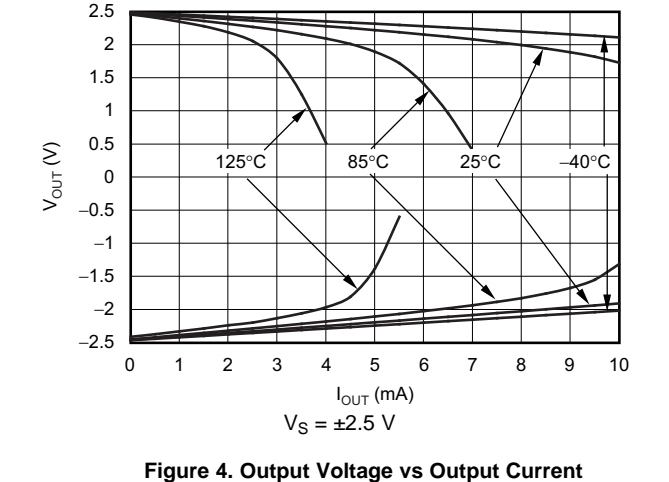
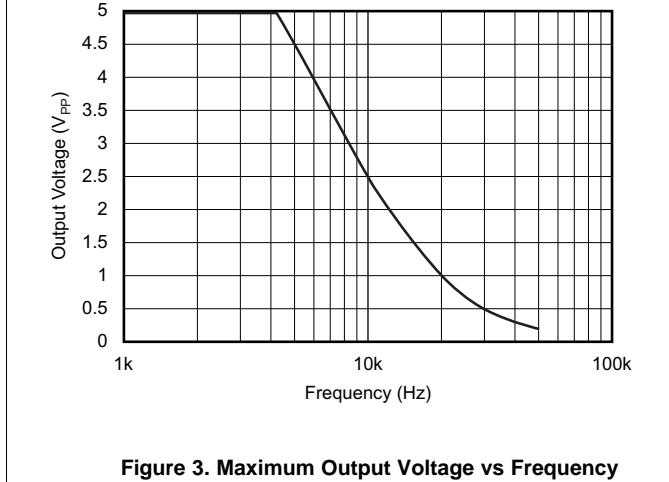
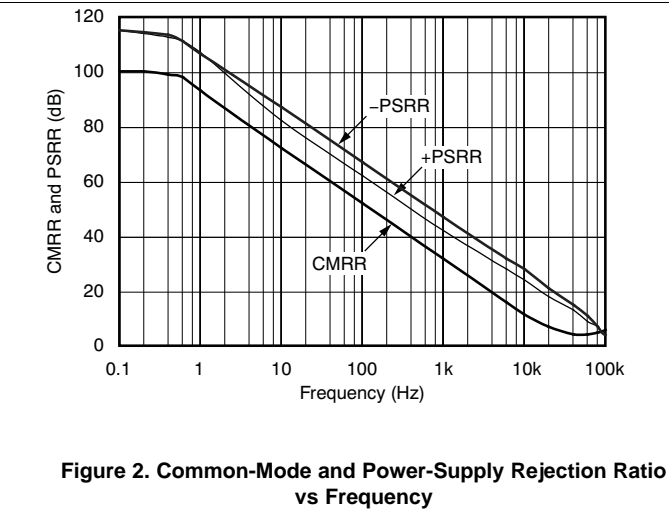
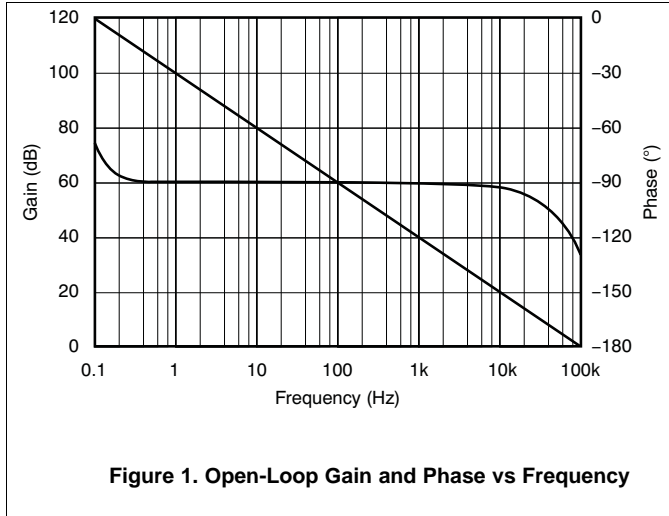
 at  $T_A = 25^\circ\text{C}$ ,  $R_L = 25\text{ k}\Omega$  connected to  $V_S / 2$ , and  $V_{CM} < (V+) - 1\text{ V}$  (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>OFFSET VOLTAGE</b>						
$V_{OS}$	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
<b>INPUT VOLTAGE RANGE</b>						
$V_{CM}$	Common-mode voltage range		$(V-) - 0.1$		$(V+) + 0.1$	V
CMRR	Common-mode rejection ratio <sup>(1)</sup>	$(V-) < V_{CM} < (V+) - 1\text{ V}$	85	100		dB
		$T_A = -40^\circ\text{C to }+125^\circ\text{C}$ , $(V-) < V_{CM} < (V+) - 1\text{ V}$	62			
<b>INPUT BIAS CURRENT</b>						
$I_{IB}$	Input bias current	$V_S = 5\text{ V}$ , $V_{CM} \leq V_S / 2$		$\pm 5$		$\mu\text{A}$
$I_{IO}$	Input offset current	$V_S = 5\text{ V}$		$\pm 5$		$\mu\text{A}$
<b>INPUT IMPEDANCE</b>						
	Differential			$10^{13} \parallel 3$		$\Omega \parallel \text{pF}$
	Common-mode			$10^{13} \parallel 6$		$\Omega \parallel \text{pF}$
<b>NOISE</b>						
	Input voltage noise	$f = 0.1\text{ Hz to }10\text{ Hz}$		2.8		$\mu\text{V}_{PP}$
$e_n$	Input voltage noise density	$f = 1\text{ kHz}$		83		$\text{nV}/\sqrt{\text{Hz}}$
<b>OPEN-LOOP GAIN</b>						
$A_{OL}$	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
<b>OUTPUT</b>						
	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			$\pm 5$		mA
$C_{LOAD}$	Capacitive load drive			See <a href="#">Capacitive Load and Stability</a> section		
$R_{OUT}$	Closed-loop output impedance	$G = 1$ , $f = 1\text{ kHz}$ , $I_O = 0$		10		$\Omega$
$R_O$	Open-loop output impedance	$f = 100\text{ kHz}$ , $I_O = 0$		28		k $\Omega$
<b>FREQUENCY RESPONSE (<math>C_{LOAD} = 30\text{ pF}</math>)</b>						
GBW	Gain bandwidth product			90		kHz
SR	Slew rate	$G = 1$		0.03		V/ $\mu\text{s}$
	Overload recovery time	$V_{IN} \times \text{Gain} > V_S$		25		$\mu\text{s}$
$t_{ON}$	Turn-on time			1		ms
<b>POWER SUPPLY</b>						
$V_S$	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	$\mu\text{A}$
<b>TEMPERATURE</b>						
$T_A$	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)

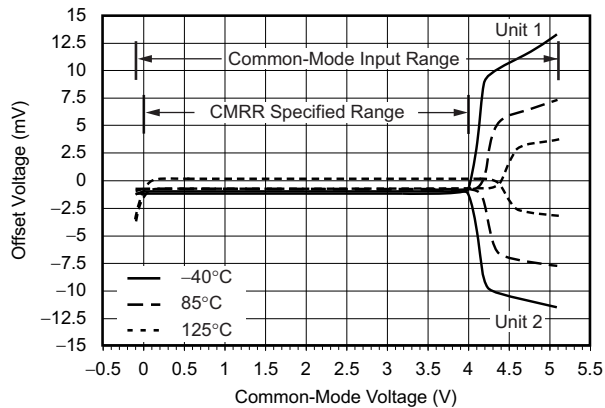


Figure 7. Offset Voltage vs Common-Mode Voltage and Temperature

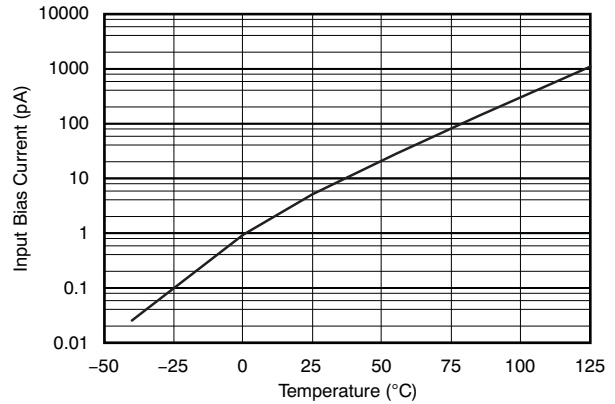


Figure 8. Input Bias Current vs Temperature

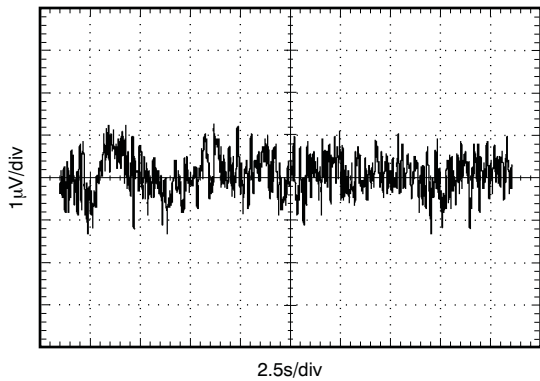


Figure 9. 0.1-Hz to 10-Hz Noise

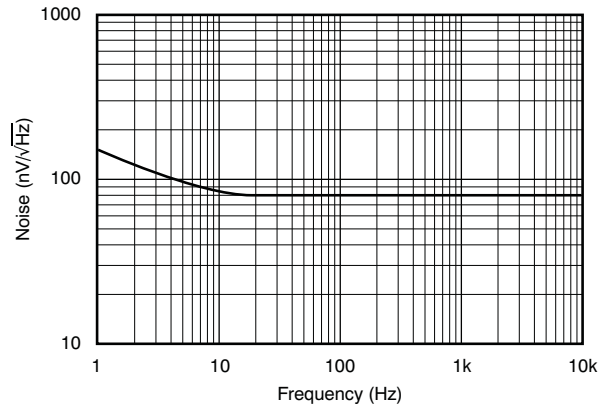


Figure 10. Noise vs Frequency

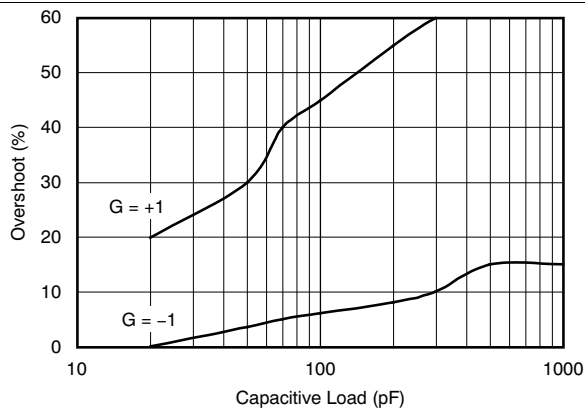


Figure 11. Small-Signal Overshoot vs Capacitive Load

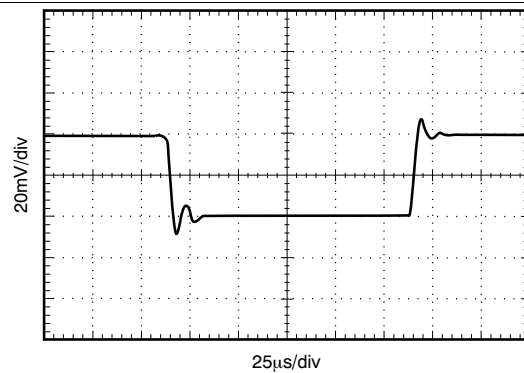
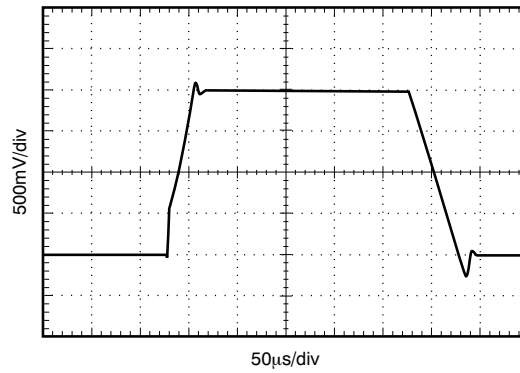


Figure 12. Small-Signal Step Response

**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)



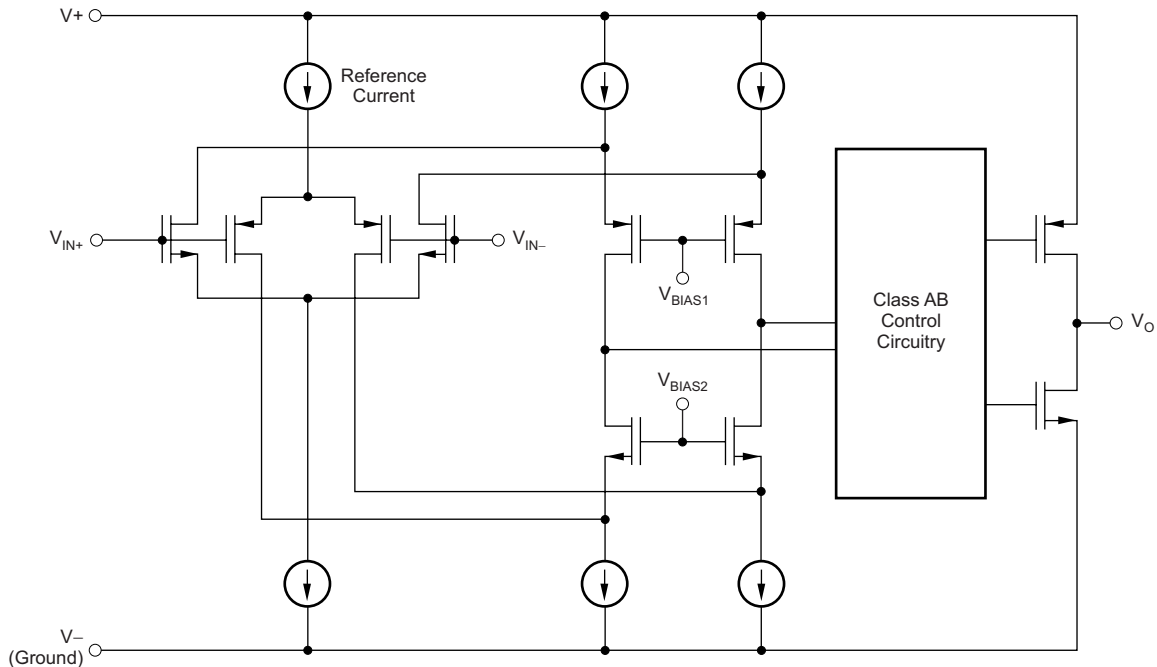
**Figure 13. Large-Signal Step Response**

## 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/ $\sqrt{\text{Hz}}$ ), and consumes very low quiescent current of only 12  $\mu\text{A}$  (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 ( $\pm 0.9$  V to  $\pm 2.75$  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).

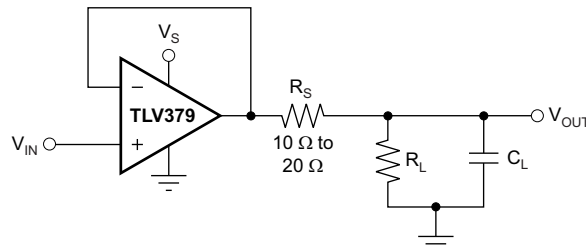
## Feature Description (continued)

### 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 $\Omega$ , the output typically swings to within 5 mV of either supply rail, regardless of the power-supply voltage applied.

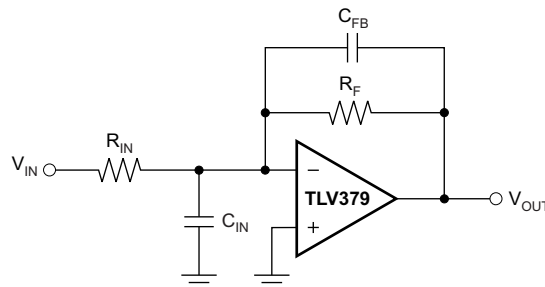
### 8.3.4 Capacitive Load and Stability

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  $\Omega$  to 20  $\Omega$ ) 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 ( $\pm 0.9$  V) and 5.5 V ( $\pm 2.75$  V).

## 9 Application and Implementation

### NOTE

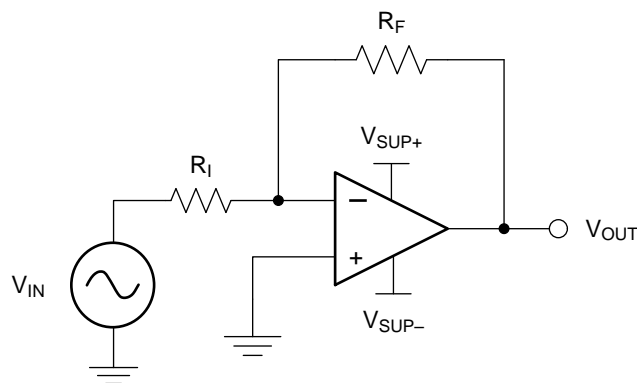
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation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



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**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  $\pm 0.5$  V (1 V) to  $\pm 1.8$  V (3.6 V). Setting the supply at  $\pm 2.5$  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](#):

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

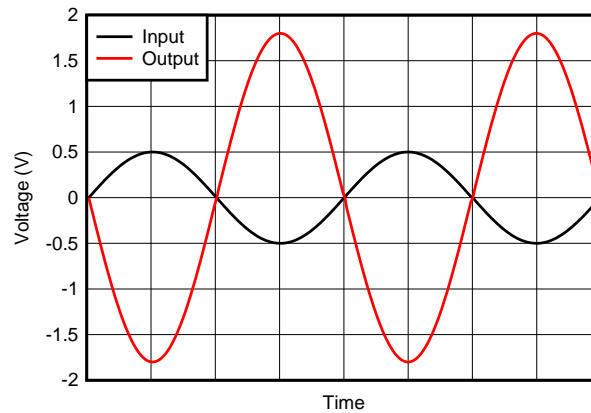
$$A_V = \frac{1.8}{-0.5} = -3.6 \tag{2}$$

### 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 $\Omega$  for  $R_1$ , meaning 36 k $\Omega$  is used for  $R_F$ . These values are determined by [Equation 3](#):

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

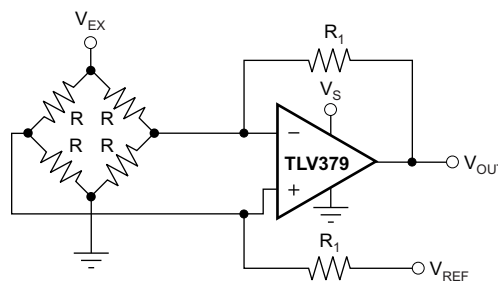
### 9.2.3 Application Curve



**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)

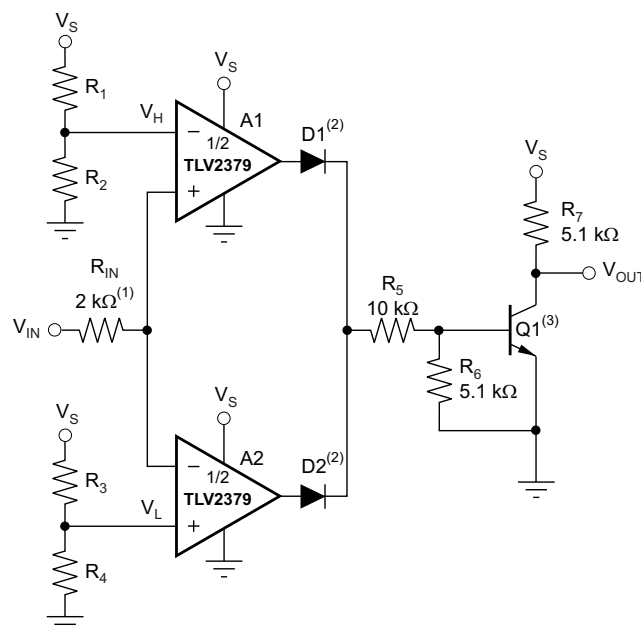
Figure 19 shows the TLV2379 used as a window comparator. The threshold limits are set by  $V_H$  and  $V_L$ , with  $V_H > V_L$ . When  $V_{IN} < V_H$ , the output of A1 is low. When  $V_{IN} > V_L$ , the output of A2 is low. Therefore, both op amp outputs are at 0 V as long as  $V_{IN}$  is between  $V_H$  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 ( $\pm 0.9$  V to  $\pm 2.75$  V); many specifications apply from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . The [Typical Characteristics](#) section presents parameters that can exhibit significant variance with regard to operating voltage or temperature.

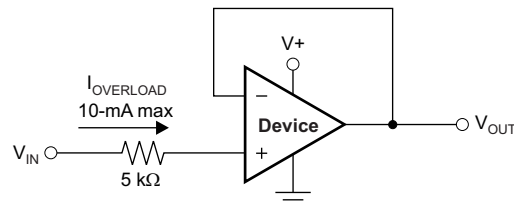
### CAUTION

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

Place 0.1- $\mu\text{F}$  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- $\mu$ 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

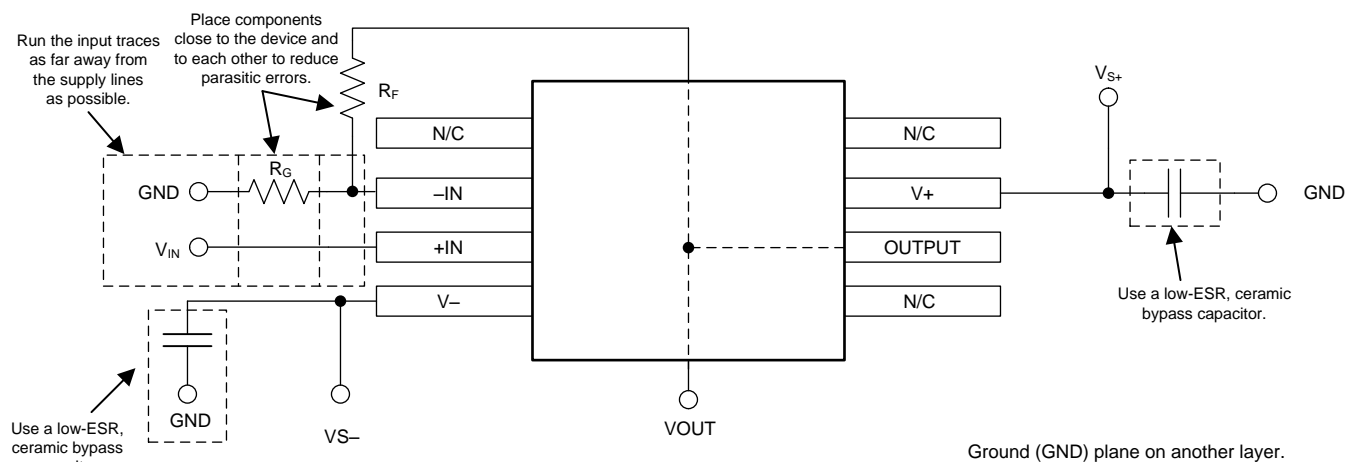


Figure 21. Operational Amplifier Board Layout for Noninverting Configuration

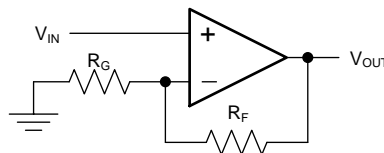


Figure 22. Schematic Representation of [Figure 21](#)

## 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	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>
TLV2379	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>
TLV4379	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>	<a href="#">Click here</a>

#### 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](http://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)
<a href="#">TLV2379IDR</a>	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	V2379
TLV2379IDR.A	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	V2379
<a href="#">TLV379IDBVR</a>	Active	Production	SOT-23 (DBV)   5	3000   LARGE T&R	Yes	NIPDAU   SN	Level-2-260C-1 YEAR	-40 to 125	12N
TLV379IDBVR.A	Active	Production	SOT-23 (DBV)   5	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	12N
<a href="#">TLV379IDBVT</a>	Active	Production	SOT-23 (DBV)   5	250   SMALL T&R	Yes	NIPDAU   SN	Level-2-260C-1 YEAR	-40 to 125	12N
TLV379IDBVT.A	Active	Production	SOT-23 (DBV)   5	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	12N
<a href="#">TLV379IDCKR</a>	Active	Production	SC70 (DCK)   5	3000   LARGE T&R	Yes	NIPDAU   SN	Level-2-260C-1 YEAR	-40 to 125	12O
TLV379IDCKR.A	Active	Production	SC70 (DCK)   5	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	12O
<a href="#">TLV379IDCKRG4</a>	Active	Production	SC70 (DCK)   5	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	12O
TLV379IDCKRG4.A	Active	Production	SC70 (DCK)   5	3000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	12O
<a href="#">TLV379IDCKT</a>	Active	Production	SC70 (DCK)   5	250   SMALL T&R	Yes	NIPDAU   SN	Level-2-260C-1 YEAR	-40 to 125	12O
TLV379IDCKT.A	Active	Production	SC70 (DCK)   5	250   SMALL T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	12O
<a href="#">TLV379IDR</a>	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	TLV 379
TLV379IDR.A	Active	Production	SOIC (D)   8	2500   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 125	TLV 379
<a href="#">TLV4379IPWR</a>	Active	Production	TSSOP (PW)   14	2000   LARGE T&R	Yes	NIPDAU   SN	Level-2-260C-1 YEAR	-40 to 125	TLV4379
TLV4379IPWR.A	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	178.0	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
TLV379IDCKR	SC70	DCK	5	3000	180.0	8.4	2.3	2.5	1.2	4.0	8.0	Q3
TLV379IDCKRG4	SC70	DCK	5	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TLV379IDCKT	SC70	DCK	5	250	180.0	8.4	2.3	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	353.0	353.0	32.0
TLV379IDBVR	SOT-23	DBV	5	3000	208.0	191.0	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
TLV379IDCKR	SC70	DCK	5	3000	210.0	185.0	35.0
TLV379IDCKRG4	SC70	DCK	5	3000	180.0	180.0	18.0
TLV379IDCKT	SC70	DCK	5	250	210.0	185.0	35.0
TLV379IDCKT	SC70	DCK	5	250	180.0	180.0	18.0
TLV379IDR	SOIC	D	8	2500	353.0	353.0	32.0
TLV4379IPWR	TSSOP	PW	14	2000	356.0	356.0	35.0



# EXAMPLE BOARD LAYOUT

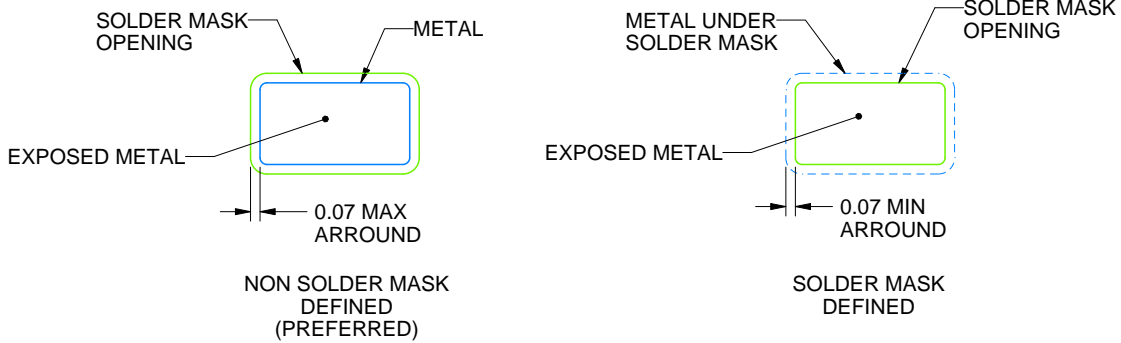
DBV0005A

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.



# EXAMPLE BOARD LAYOUT

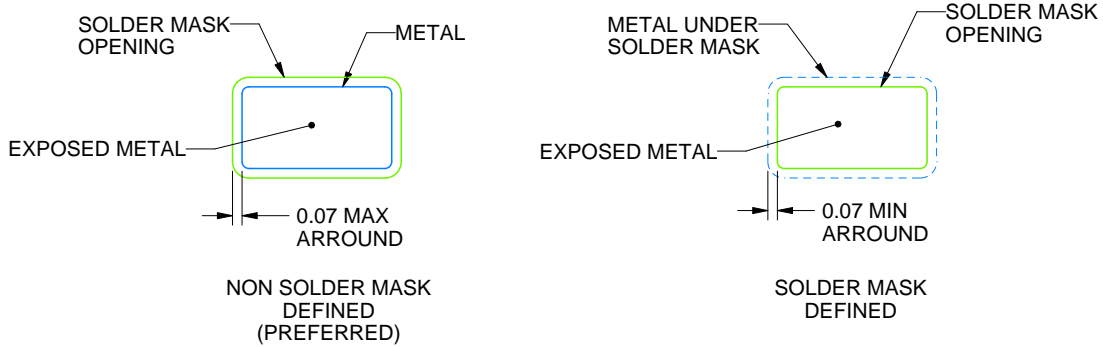
DCK0005A

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.



# 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



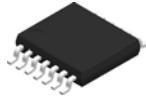
SOLDER PASTE EXAMPLE  
BASED ON .005 INCH [0.125 MM] THICK STENCIL  
SCALE:8X

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



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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