NEW PRODUCT

TLV271/TLV272

CMOS RAIL TO RAIL OUTPUT OPERATIONAL AMPLIFIERS

Description

The TLV27x provides a higher performance alternative to the TLC27x series of op-amps. These devices take the minimum operating supply voltage down to 2.7V over the extended industrial temperature range while adding the rail-to-rail output swing feature.

This makes it an ideal alternative to the TLC27x family for applications where rail-to-rail output swings are essential. The TLV27x also provides 2-MHz bandwidth from only 550µA supply current.

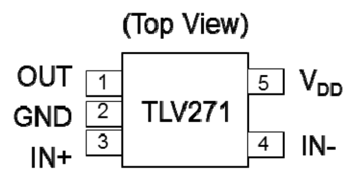
The TLV27x is fully specified for 5V and ±5V supplies. The maximum recommended supply voltage is 16V. The devices can be operated from a variety of rechargeable cells from ±8V down to ±1.35V.

The CMOS inputs enable use in high-impedance sensor interfaces, with the lower voltage operation making an attractive alternative for the TLC27x in battery-powered applications.

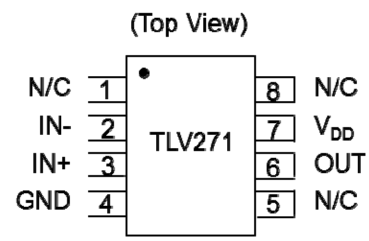
The 2.7-V operation makes it compatible with Li-Ion powered systems and the operating supply voltage range of many micro-power micro-controllers available today.

All parts are available in SOIC packaging; the TLV271 is additionally available in the SOT25 package. Two temperature grades are available for the parts; C grade offers 0 to +70°C operating, I grade offers -40°C to +125°C operating.

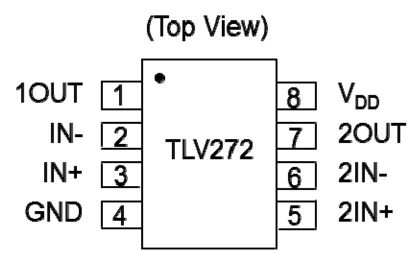
Pin Assignments



SOT25



SO-8



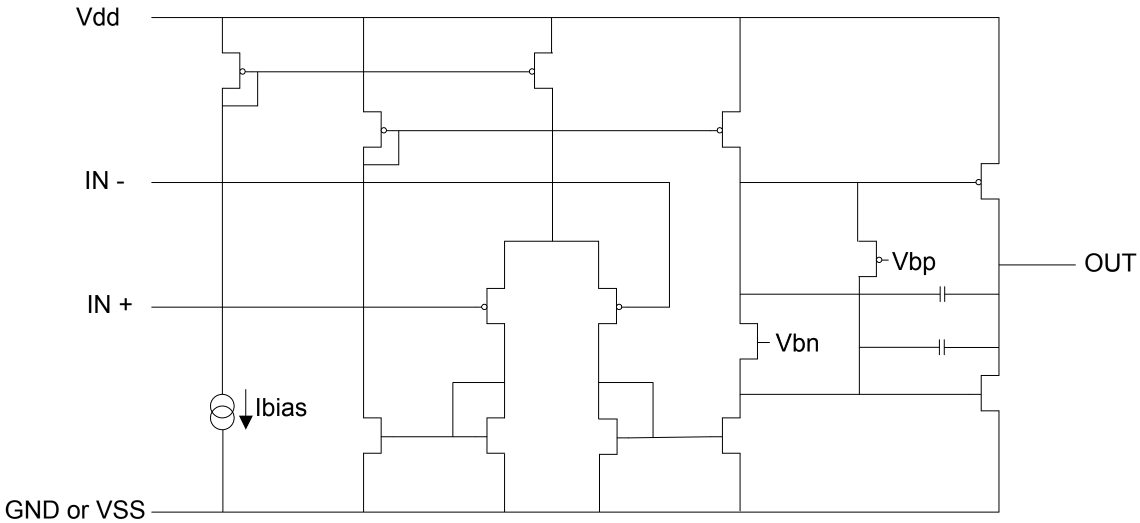
SO-8, MSOP-8

Features

- High performance alternative to TLC27x series
- Rail to rail output
- Wide bandwidth: 2MHz
- High slew rate: 2.0 V/µs
- Wide range of supply voltages: 2.7V to 16V
- Low supply current: 550µA per channel
- Low input noise voltage: 35nV/√Hz
- Low input bias current: 1pA
- Specified temperature ranges:
  - 0°C to +70°C: commercial grade
  - -40°C to +125°C: industrial grade
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See http://www.diodes.com/quality/lead_free.html for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

Simplified Schematic Diagram



Pin Descriptions

Pin Number		TLV271		TLV272	
SOT25	**SO-8/ MSOP-8**	**Pin Name**	**Function**	**Pin Name**	**Function**
	1	N/C	No connection	1OUT	Output op-amp 1
4	2	IN-	Inverting input	1IN-	Inverting input op-amp 1
3	3	IN+	Non-inverting input	1IN+	Non-inverting input op-amp 1
2	4	GND	Ground	GND	Ground
	5	N/C	No connection	2IN+	Non inverting input op-amp 2
1	6	OUT	Output	2IN-	Inverting input op-amp 2
5	7	V_{DD}	Supply	2OUT	Output op-amp 2
	8	N/C	No connection	V_{DD}	Supply

Absolute Maximum Ratings (Note 4)

Symbol	Parameter		Rating	Unit
V_{DD}	Supply Voltage: (Note 5)		16.5	V
V_{ID}	Differential Input Voltage		$\pm V_{DD}$	V
V_{IN}	Input Voltage Range (Note 5)		-0.2 to V_{DD} +0.2V	V
I_{IN}	Input Current Range		±10	mA
I_O	Output Current Range		±100	mA
P_D	Power Dissipation (Note 6)	TLV271 SOT25	220 mW	mW
		TLV271 SO-8	396 mW	
		TLV272 SO-8	396 mW	
		TLV272 MSOP-8	300 mW	
T_A	Operating Temperature Range	C grade	0 to +70	°C
		I grade	-40 to +125	
T_J	Operating Junction Temperature		150	°C
T_{ST}	Storage Temperature Range		-65 to +150	°C
ESD HBM	Human Body Model ESD Protection (1.5kΩ in series with 100pF)		2	kV
ESD MM	Machine Model ESD Protection		150	V

Notes:
4. Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only; 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.
5. All voltage values, except differential voltages, are with respect to ground
6. For operating at high temperatures, the TLV27x must be derated to zero based on a +150°C maximum junction temperature and a thermal resistance as below when the device is soldered to a printed circuit board, operating in a still air ambient:

Package	θ_{JA}	Unit
SOT25	180	°C/W
SO-8	150	
MSOP-8	155	

Recommended Operating Conditions

Symbol	Parameter		C grade		I grade		Unit
			Min	Max	Min	Max	
V_{DD}	Supply Voltage	Single Supply	2.7	16	2.7	16	V
		Split Supply	±1.35	±8	±1.35	±8	
V_{IC}	Common Mode Input Voltage		0	V_{DD} -1.35	0	V_{DD} -1.35	V
T_A	Operating Free Air Temperature		0	+70	-40	+125	°C

Electrical Characteristics (@T_A = +25°C and V_{DD} = 2.7V, 5V, ±5V unless otherwise specified.)

DC Performance

Parameter		Conditions		T_A	Min	Typ	Max	Unit
V_{IO}	Input Offset Voltage	$V_{IC} = V_{DD}/2$, $V_O = V_{DD}/2$, $R_S = 50\Omega$, $R_L = 10k\Omega$		+25°C	—	0.5	5	mV
				-40°C to +125°C	—	—	7	
α_{VIO}	Offset Voltage Drift			+25°C	—	6	—	µV/°C
A_{VD}	Large Signal Differential Voltage Gain	$V_{O(PP)} = V_{DD}/2$, $R_L = 10k\Omega$	V_{DD} = 2.7V	+25°C	97	106	—	dB
				-40°C to +125°C	76	—	—	
			V_{DD} = 5V	+25°C	100	110	—	
				-40°C to +125°C	86	—	—	
			V_{DD} = ±5V	+25°C	100	115	—	
				-40°C to +125°C	90	—	—	
CMRR	Common Mode Rejection Ratio	V_{IC} = 0 to V_{DD} -1.35V, $R_S = 50\Omega$	V_{DD} = 2.7V	+25°C	58	70	—	dB
				-40°C to +125°C	55	—	—	
			V_{DD} = 5V	+25°C	65	80	—	
				-40°C to +125°C	62	—	—	
		V_{IC} = -5 to V_{DD} -1.35V, $R_S = 50\Omega$	V_{DD} = ±5V	+25°C	69	85	—	
				-40°C to +125°C	66	—	—	

Input Characteristics

Parameter		Conditions	T_A	Min	Typ	Max	Unit
I_{IO}	Input Offset Current	V_{DD} = 5V, $V_{IC} = V_{DD}/2$, $V_O = V_{DD}/2$, $R_S = 50\Omega$	+25°C	—	1	60	pA
			+70°C	—	—	100	
			+125°C	—	—	1000	
I_{IB}	Input Bias Current		+25°C	—	1	60	
			+70°C	—	—	100	
			+125°C	—	—	1000	
$r_{i(d)}$	Differential Input Resistance	—	+25°C	—	100	—	MΩ
C_{IC}	Common Mode Input Capacitance	f = 21kHz	+25°C	—	12	—	pF

Electrical Characteristics (cont.) (@T_A = +25°C and V_{DD} = 2.7V, 5V, ±5V unless otherwise specified.)

Output Characteristics

Parameter		Conditions		T_A	Min	Typ	Max	Unit
V_{OH}	High Level Output Voltage	$V_{IC} = V_{DD}/2$, I_{OH} = -1mA	V_{DD} = 2.7V	+25°C	2.55	2.58	—	V
				-40°C to +125°C	2.48	—	—	
			V_{DD} = 5V	+25°C	4.9	4.93	—	
				-40°C to +125°C	4.85	—	—	
			V_{DD} = ±5V	+25°C	4.92	4.96	—	
				-40°C to +125°C	4.9	—	—	
		$V_{IC} = V_{DD}/2$, I_{OH} = -5mA	V_{DD} = 2.7V	+25°C	1.9	2.1	—	
				-40°C to +125°C	1.5	—	—	
			V_{DD} = 5V	+25°C	4.6	4.68	—	
				-40°C to +125°C	4.5	—	—	
			V_{DD} = ±5V	+25°C	4.7	4.84	—	
				-40°C to +125°C	4.65	—	—	
V_{OL}	Low Level Output Voltage	$V_{IC} = V_{DD}/2$, I_{OL} = 1mA	V_{DD} = 2.7V	+25°C	—	0.1	0.15	V
				-40°C to +125°C	—	—	0.22	
			V_{DD} = 5V	+25°C	—	0.05	0.1	
				-40°C to +125°C	—	—	0.15	
			V_{DD} = ±5V	+25°C	—	-4.95	-4.92	
				-40°C to +125°C	—	—	-4.9	
		$V_{IC} = V_{DD}/2$, I_{OL} = 5mA	V_{DD} = 2.7V	+25°C	—	0.5	0.7	
				-40°C to +125°C	—	—	1.1	
			V_{DD} = 5V	+25°C	—	0.28	0.4	
				-40°C to +125°C	—	—	0.5	
			V_{DD} = ±5V	+25°C	—	-4.84	-4.7	
				-40°C to +125°C	—	—	-4.65	
I_O	Output Current	V_O = 0.5V from rail, V_{DD} = 2.7V	Positive rail	+25°C	—	4	—	mA
			Negative rail	+25°C	—	5	—	
		V_O = 0.5V from rail, V_{DD} = 5V	Positive rail	+25°C	—	7	—	
			Negative rail	+25°C	—	8	—	
		V_O = 0.5V from rail, V_{DD} = 10V	Positive rail	+25°C	—	13	—	
			Negative rail	+25°C	—	12	—	

Power Supply

Parameter		Conditions		T_A	Min	Typ	Max	Unit
I_{DD}	Supply Current (per op-amp)	$V_O = V_{DD}/2$	V_{DD} = 2.7V	+25°C	—	470	560	µA
			V_{DD} = 5V	+25°C	—	550	660	
			V_{DD} = 10V	+25°C	—	625	800	
				-40°C to +125°C	—	—	1000	
I_{IB}	Power Supply Rejection Ratio ($\Delta V_{DD}/\Delta V_{IO}$)	V_{DD} = 2.7V to 16V, $V_{IC} = V_{DD}/2$, No load		+25°C	70	80	—	
				-40°C to +125°C	65	—	—	dB

Electrical Characteristics (cont.) (@T_A = +25°C and V_{DD} = 2.7V, 5V, ±5V unless otherwise specified.)

Dynamic Performance

Symbol	Parameter	Conditions		T_A	Min	Typ	Max	Unit
UGBW	Unity Gain Bandwidth	R_L = 2kΩ, C_L = 10pF	V_{DD} = 2.7V	+25°C	—	1.7	—	MHz
			V_{DD} = 5V to 10V	+25°C	—	1.9	—	
SR	Slew Rate At Unity Gain	$V_{O(PP)}$ = V_{DD}/2, C_L = 50pF, R_L = 10kΩ	V_{DD} = 2.7V	+25°C	1.2	2.1	—	V/µs
				-40°C to +125°C	1	—	—	
			V_{DD} = 5V	+25°C	1.25	2.0	—	
				-40°C to +125°C	1.05	—	—	
			V_{DD} = 10V	+25°C	1.3	2.2	—	
				-40°C to +125°C	1.1	—	—	
Φ_m	Phase Margin	R_L = 2kΩ, C_L = 10pF		+25°C	—	65°C	—	—
	Gain Margin	R_L = 2kΩ, C_L = 10pF		+25°C	—	12	—	dB
t_S	Settling Time	V_{DD} = 2.7V, $V_{(STEP)PP}$ = 1V, A_V = -1, C_L = 10pF, R_L = 2kΩ	0.1%	+25°C	—	2.9	—	µs
		V_{DD} = 5V, ±5V $V_{(STEP)PP}$ = 1V, A_V = -1, C_L = 47pF, R_L = 2kΩ	0.1%	+25°C	—	2	—	

Noise/Distortion Performance

Symbol	Parameter	Conditions		T_A	Min	Typ	Max	Unit
THD+N	Total Harmonic Distortion Plus Noise	V_{DD} = 2.7V, $V_{O(PP)}$ = V_{DD}/2, R_L = 2kΩ, f = 10kHz	A_V = 1	+25°C	—	0.02	—	%
			A_V = 10	+25°C	—	0.05	—	
			A_V = 100	+25°C	—	0.18	—	
		V_{DD} = 5V, ±5V $V_{O(PP)}$ = V_{DD}/2, R_L = 2kΩ, f = 10kHz	A_V = 1	+25°C	—	0.02	—	
			A_V = 10	+25°C	—	0.09	—	
			A_V = 100	+25°C	—	0.5	—	
V_n	Equivalent Input Noise Voltage	f = 1kHz		+25°C	—	35	—	nV/√Hz
		f = 10kHz		+25°C	—	25	—	
I_n	Equivalent Input Noise Current	f = 1kHz		+25°C	—	0.6	—	fA/√Hz

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Typical Performance Characteristics

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		vs. free air temperature	5
CMRR	Common Mode Rejection Ratio	vs. frequency	6
		vs. free air temperature	7
V_{OH}	High Level Output Voltage	vs. high level output current	8, 9, 10
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—	Inverting Large Signal Response	—	24, 25
—	Inverting Small Signal Response	—	26
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Typical Performance Characteristics (cont.)

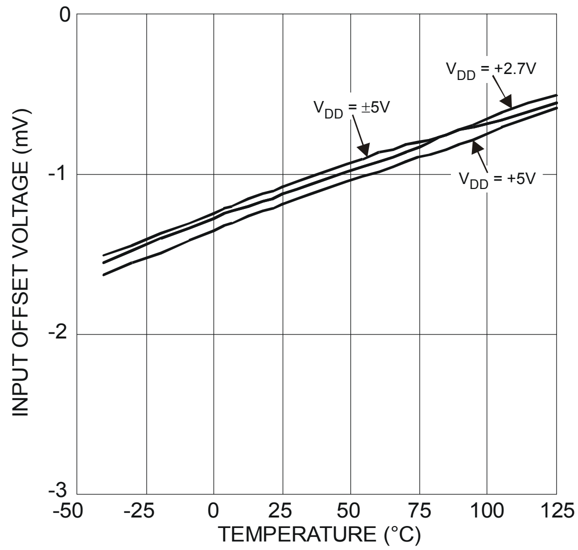

Figure 1 Input Offset Voltage vs. Temperature

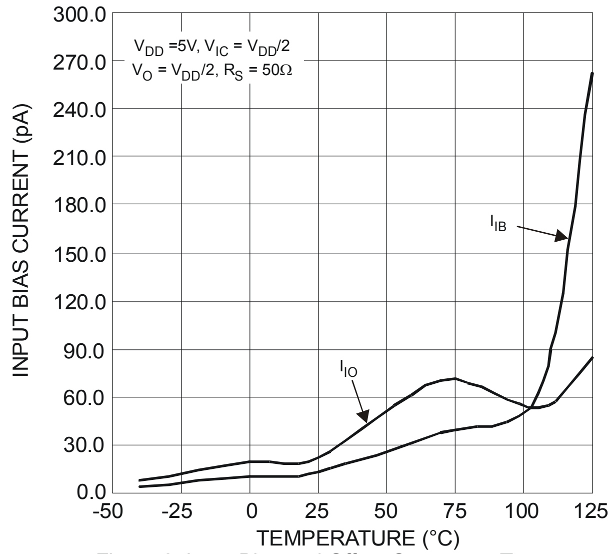

Figure 2 Input Bias and Offset Current vs. Temperature

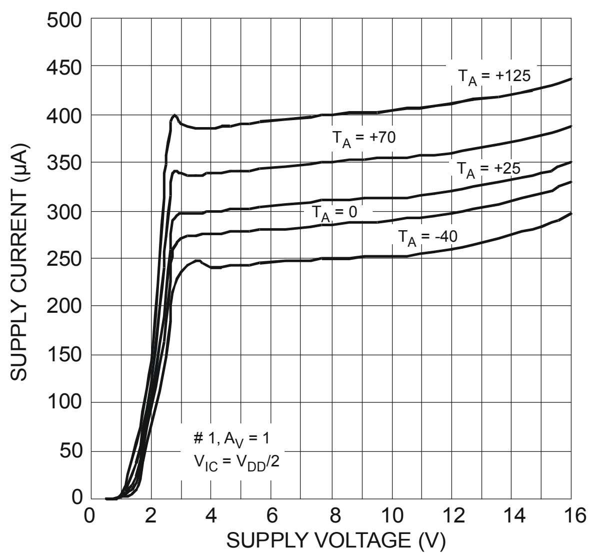

Figure 3 Supply Current vs. Supply Voltage

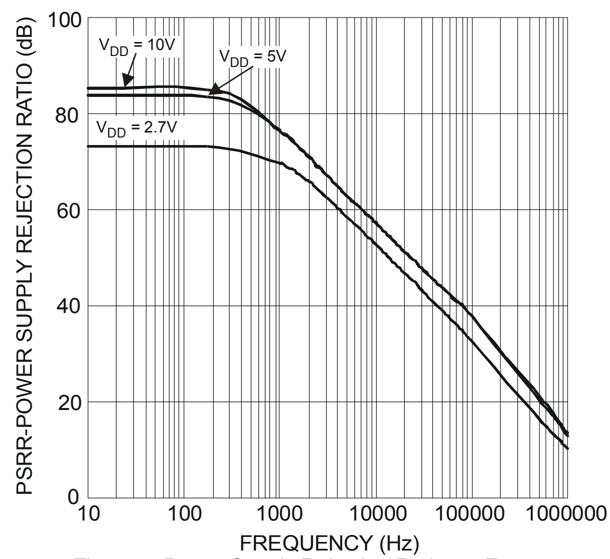

Figure 4 Power Supply Rejection Ratio vs. Frequency

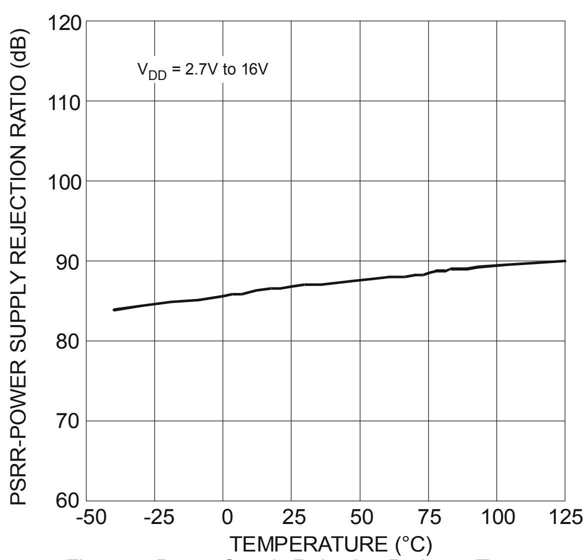

Figure 5 Power Supply Rejection Ratio vs. Temperature

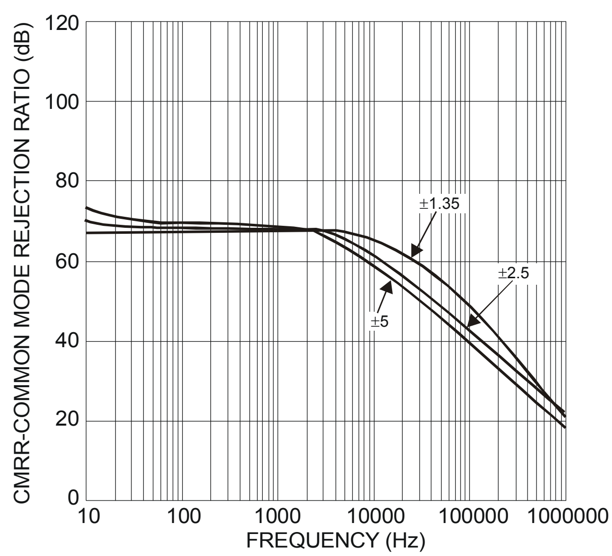

Figure 6 Common Mode Rejection Ratio vs. Frequency

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Typical Performance Characteristics (cont.)

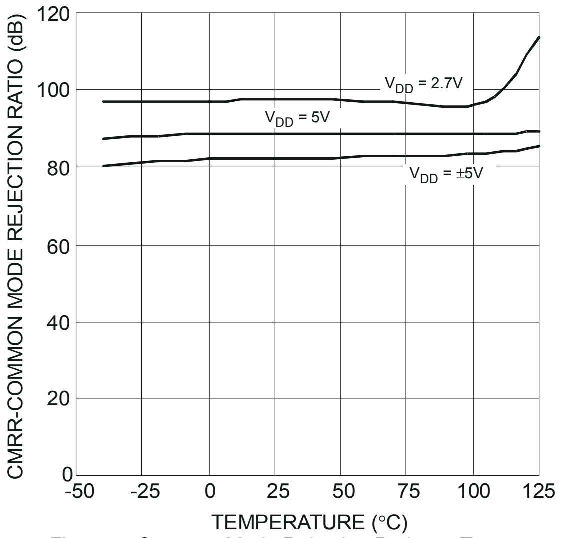

Figure 7 Common Mode Rejection Ratio vs. Temperaure

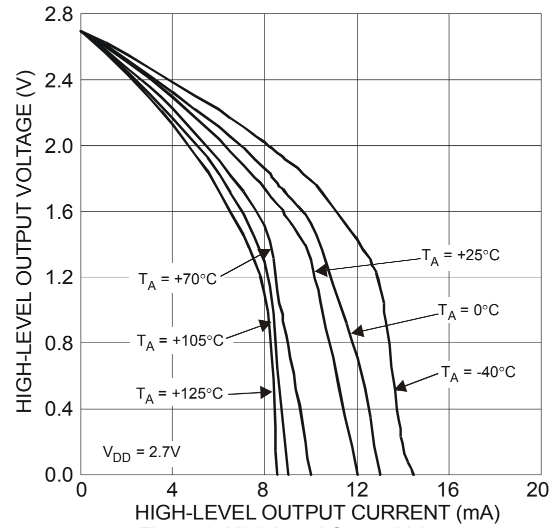

Figure 8 High-Level Output Voltage vs. High-Level Output Current

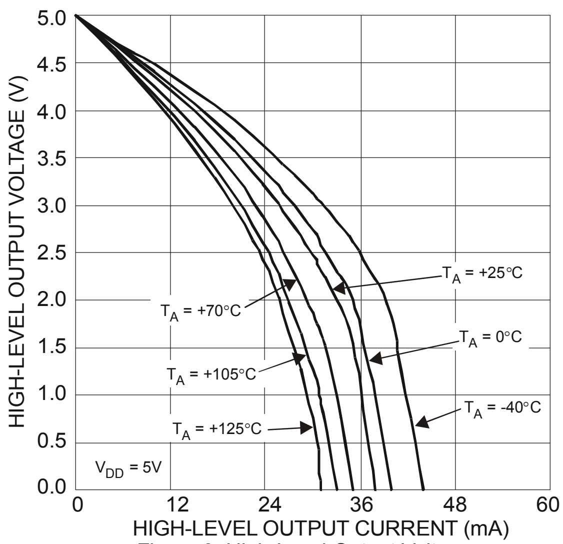

Figure 9 High-Level Output Voltage vs. High-Level Output Current

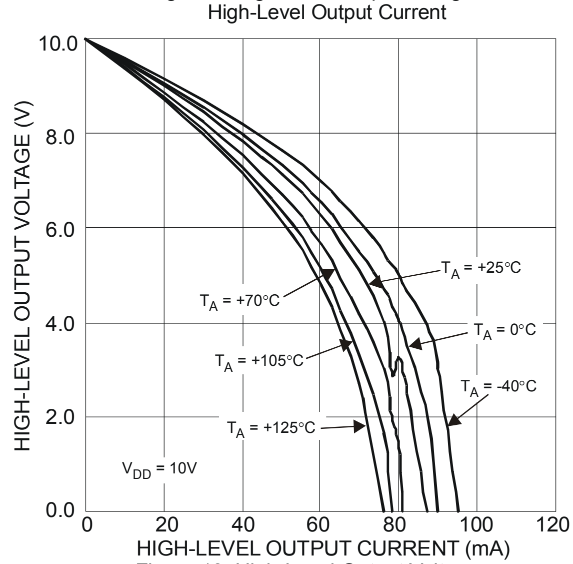

Figure 10 High-Level Output Voltage vs. High-Level Output Current

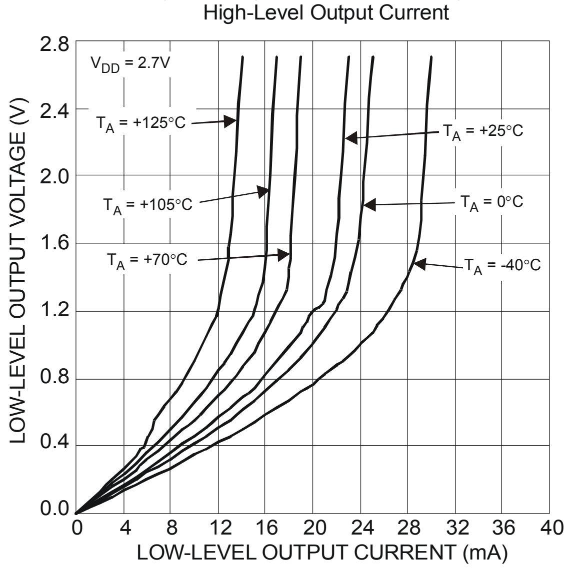

Figure 11 Low-Level Output Voltage vs. Low-Level Output Current

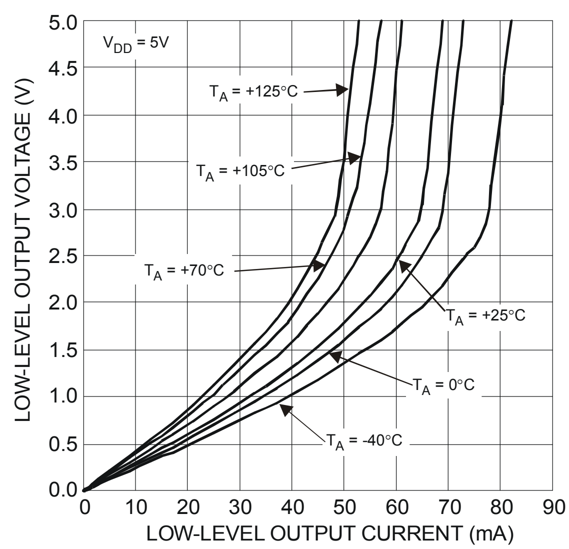

Figure 12 Low-Level Output Voltage vs. Low-Level Output Current

Typical Performance Characteristics (cont.)

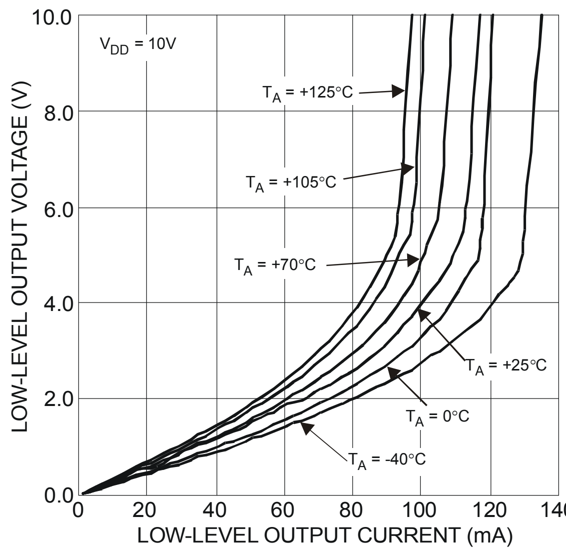

Figure 13 Low-Level Output Voltage vs. Low-Level Output Current

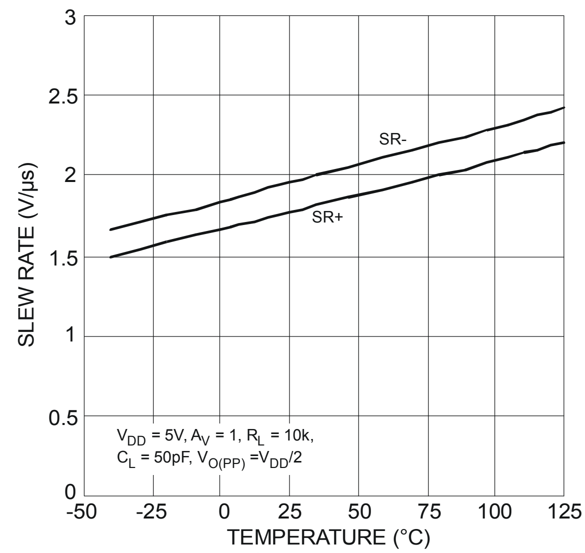

Figure 14 Slew Rate vs. Temperature

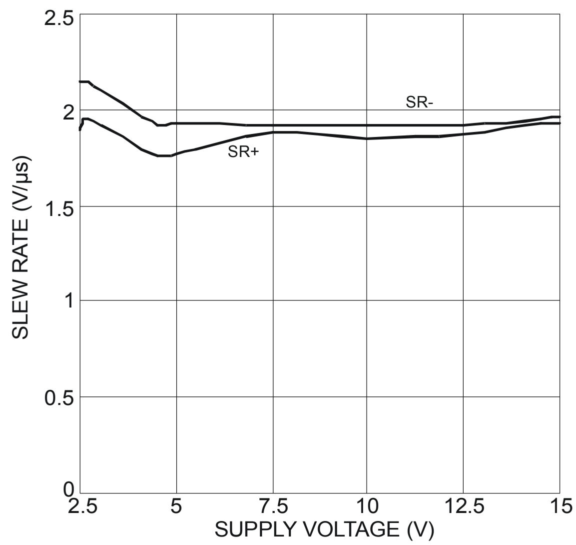

Figure 15 Slew Rate vs. Supply Voltage

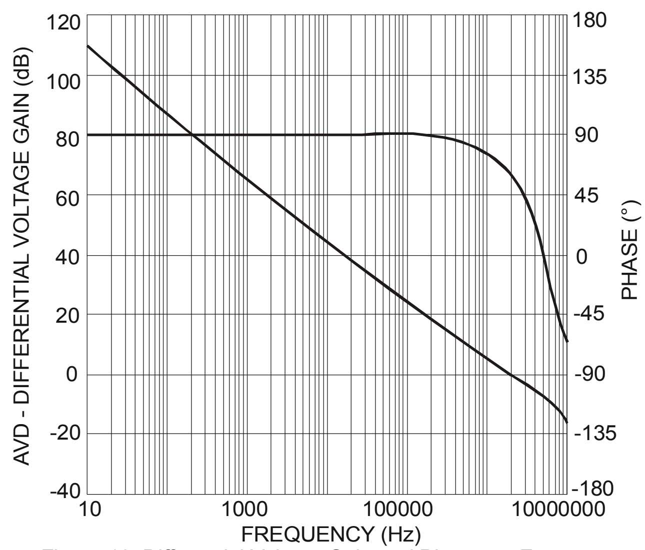

Figure 16 Differential Voltage Gain and Phase vs. Frequency

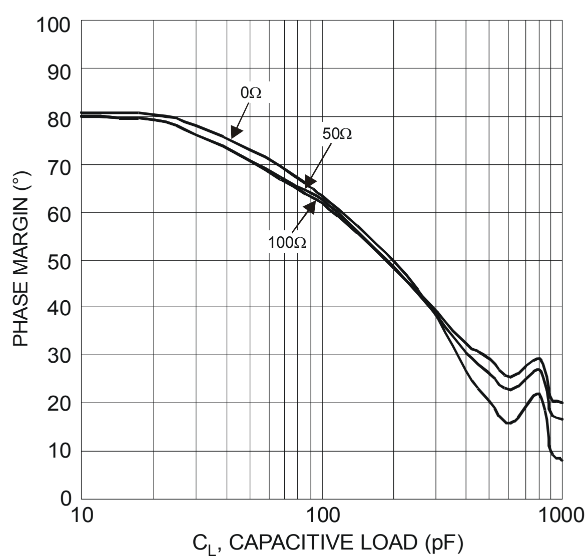

Figure 17 Phase Margin vs. Capacitive Load

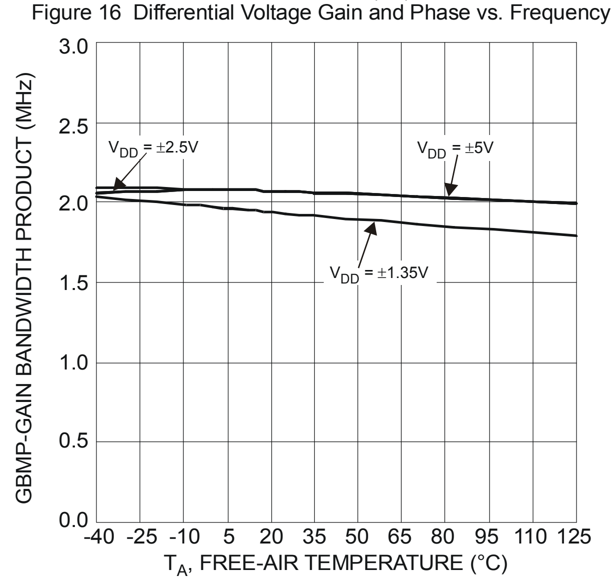

Figure 18 Gain Bandwidth Product vs. Free Air Temperature

Typical Performance Characteristics (cont.)

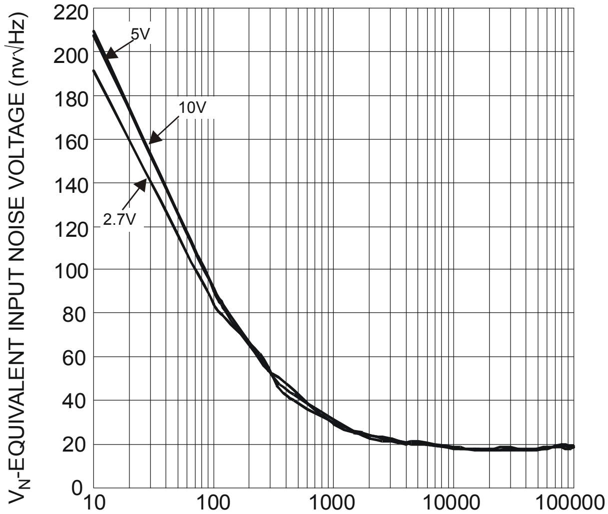

Figure 19 Equivalent Input Noise Voltage vs. Frequency

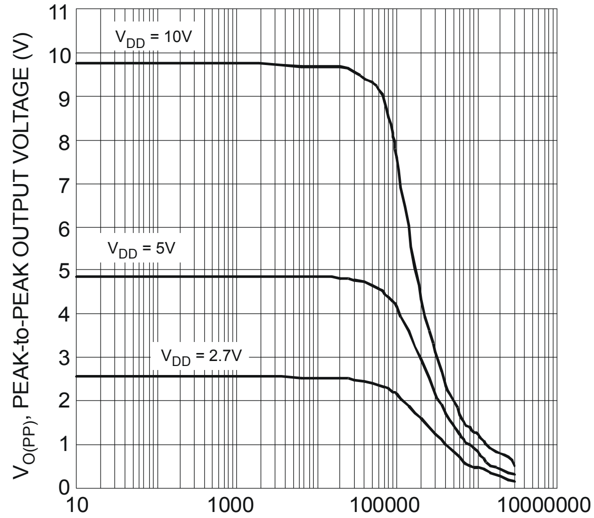

Figure 20 Peak-to-Peak Output Voltage vs. Frequency

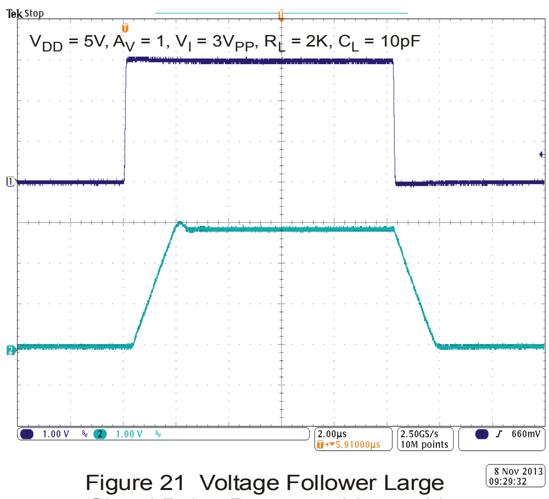

Figure 21 Voltage Follower Large Signal Pulse Response V_{DD} = 5V

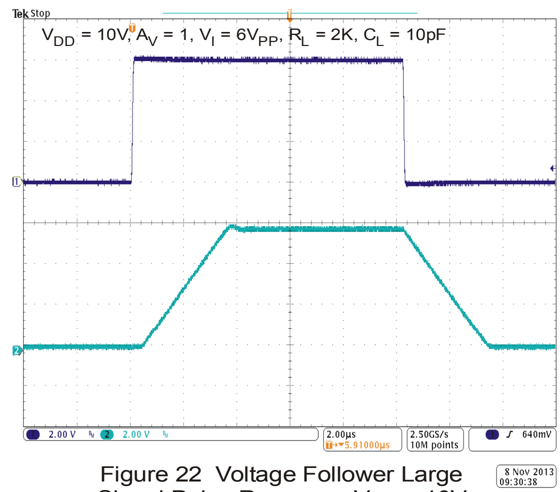

Figure 22 Voltage Follower Large Signal Pulse Response V_{DD} = 10V

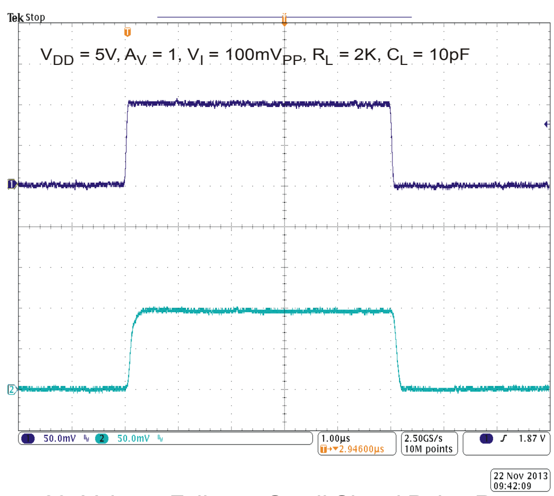

Figure 23 Voltage Follower Small Signal Pulse Response

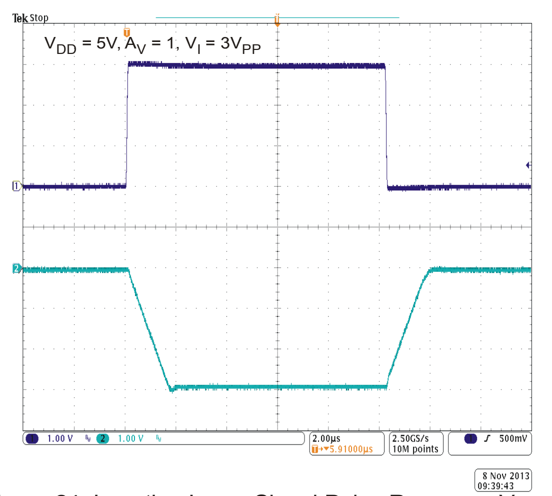

Figure 24 Inverting Large Signal Pulse Response V_{DD} = 5V

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Typical Performance Characteristics (cont.)

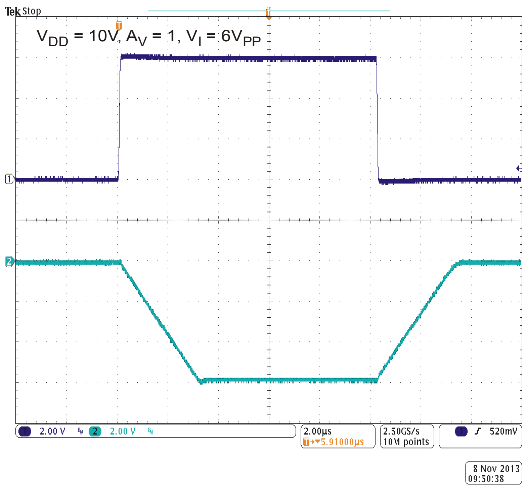


Figure 25 Inverting Large Signal Pulse Response V_{DD} = 10V

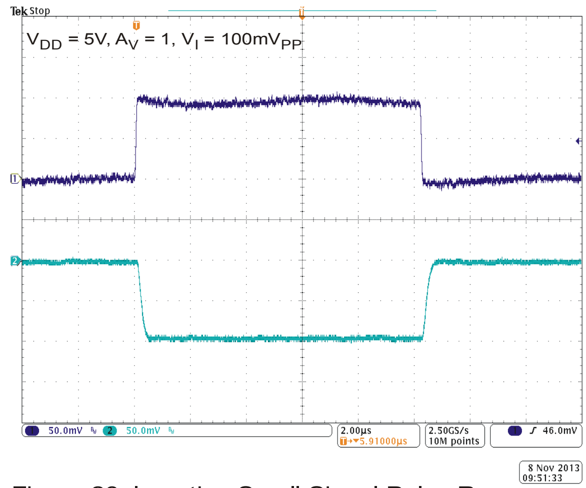


Figure 26 Inverting Small Signal Pulse Response

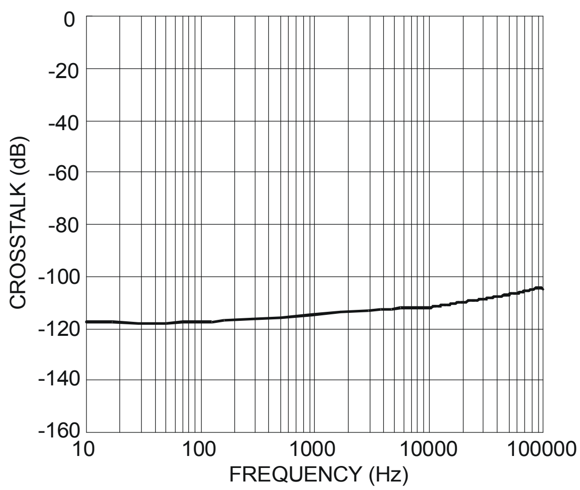


Figure 27 Crosstalk vs. Frequency TLV272

Application Information

Driving a Capacitive Load

When the amplifier is configured as below, capacitive loading directly on the output can decrease the device's phase margin leading to high frequency ringing or oscillations. Therefore, for capacitive loads of greater than 100pF, it is recommended that a resistor be placed in series (R_{NULL}) with the output of the amplifier, as shown in Figure 25. A minimum value of 20Ω should work well for most applications.

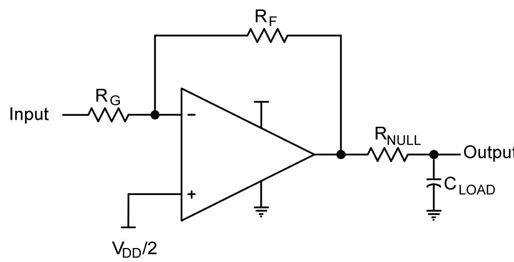
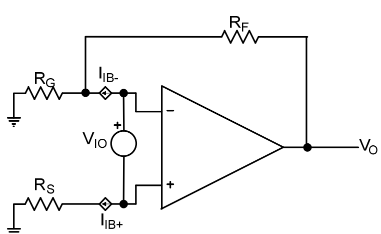


Figure 28 Driving a Capacitive Load

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:

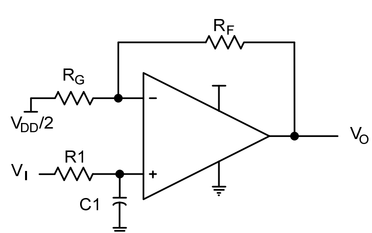


$$V_{OO} = V_{IO}\left(1+\left(\frac{R_F}{R_G}\right)\right) \pm I_{IB+}R_S\left(1+\left(\frac{R_F}{R_G}\right)\right) \pm I_{IB-}R_F$$

Figure 29 Output Offset Voltage Model

Other 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 non-inverting terminal of the amplifier (see Figure 30).

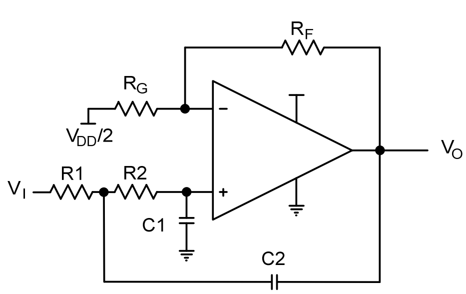


$$\frac{V_O}{V_I} = \left(1+\frac{R_F}{R_G}\right)\left(\frac{1}{1 + s\,R1C1}\right)$$

$$f_{-3dB} = \left(\frac{1}{2\pi R1C1}\right)$$

Figure 30. 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.



C1 = C2 = C
R1 = R2 = R
Q = Peaking Factor
(Butterworth Q - 0.707)

$$f_{-3dB} = \left(\frac{1}{2\pi RC}\right)$$

$$R_G = \frac{R_F}{\left(2 - \frac{1}{Q}\right)}$$

Figure 31. 2-Pole Low-Pass Sallen-Key Filter

NEW PRODUCT

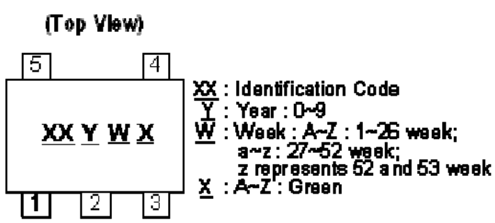
Ordering Information

Part Number	Package Code	Operating Temperature Range	Packaging	7" or 13" Tape and Reel	
				Quantity	Part Number Suffix
TLV271CW5-7	W5	0 to +70°C	SOT25	3000/Tape & Reel	-7
TLV271CS-13	S	0 to +70°C	SO-8	2500/Tape & Reel	-13
TLV271IW5-7	W5	-40°C to +125°C	SOT25	3000/Tape & Reel	-7
TLV271IS-13	S	-40°C to +125°C	SO-8	2500/Tape & Reel	-13
TLV272CS-13	S	0 to +70°C	SO-8	2500/Tape & Reel	-13
TLV272CM8-13	M8	0 to +70°C	MSOP-8	2500/Tape & Reel	-13
TLV272IS-13*	S	-40°C to +125°C	SO-8	2500/Tape & Reel	-13
TLV272IM8-13	M8	-40°C to +125°C	MSOP-8	2500/Tape & Reel	-13

Marking Information

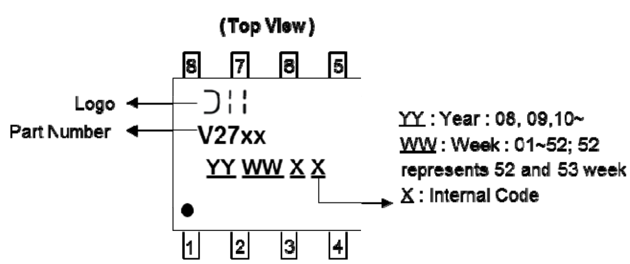
SOT25

Part mark	Part number
BV	TLV271CW5
BW	TLV271IW5



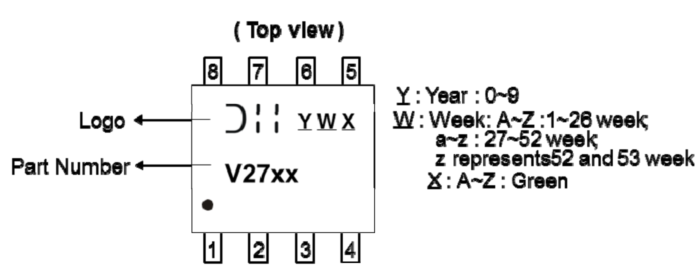
SO-8

Part mark	Part number
V271C	TLV271CS
V271I	TLV271IS
V272C	TLV272CS
V272I	TLV272IS



MSOP-8

Part mark	Part number
V272C	TLV272CM8
V272I	TLV272IM8

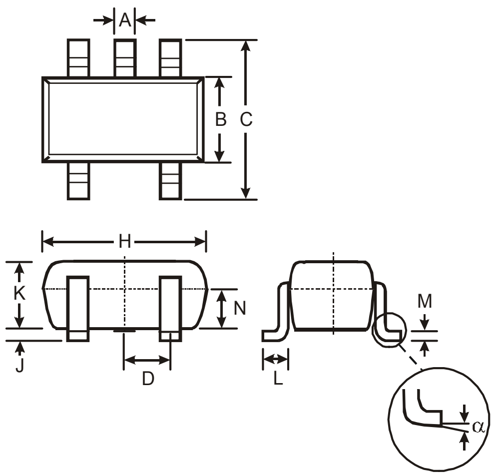


NEW PRODUCT

Package Outline Dimensions (All dimensions in mm.)

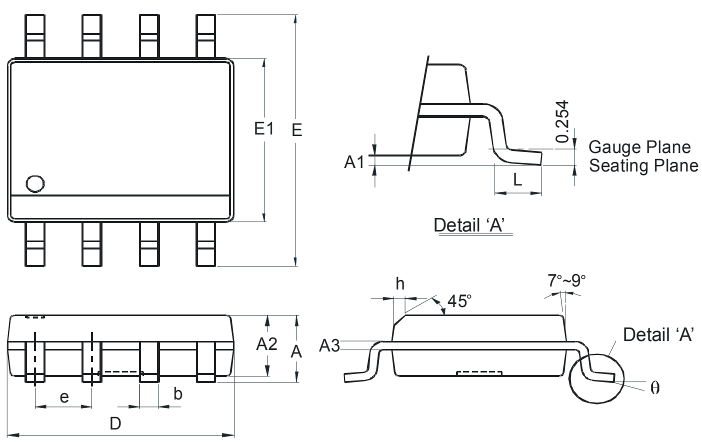
Please see AP02002 at http://www.diodes.com/datasheets/ap02002.pdf for latest version.

SOT25



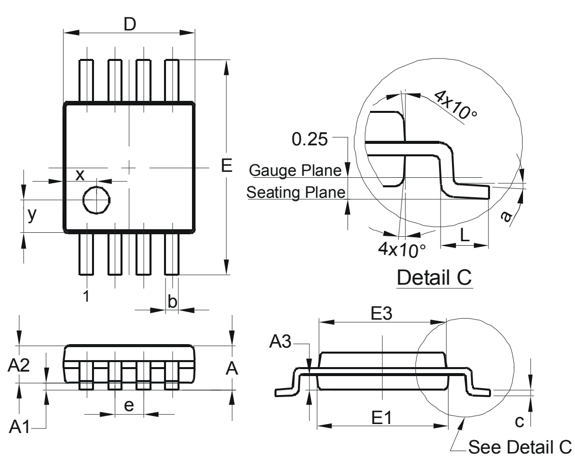
SOT25			
Dim	**Min**	**Max**	**Typ**
A	0.35	0.50	0.38
B	1.50	1.70	1.60
C	2.70	3.00	2.80
D	—	—	0.95
H	2.90	3.10	3.00
J	0.013	0.10	0.05
K	1.00	1.30	1.10
L	0.35	0.55	0.40
M	0.10	0.20	0.15
N	0.70	0.80	0.75
α	0°	8°	—
All Dimensions in mm			

SO-8



SO-8		
Dim	**Min**	**Max**
A	-	1.75
A1	0.10	0.20
A2	1.30	1.50
A3	0.15	0.25
b	0.3	0.5
D	4.85	4.95
E	5.90	6.10
E1	3.85	3.95
e	1.27 Typ	
h	-	0.35
L	0.62	0.82
θ	0°	8°
All Dimensions in mm		

MSOP-8



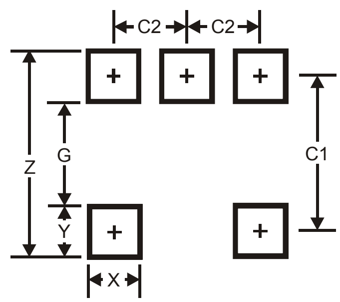
MSOP-8			
Dim	**Min**	**Max**	**Typ**
A	-	1.10	-
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E3	2.85	3.05	2.95
e	-	-	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	-	-	0.750
y	-	-	0.750
All Dimensions in mm			

NEW PRODUCT

Suggested Pad Layout

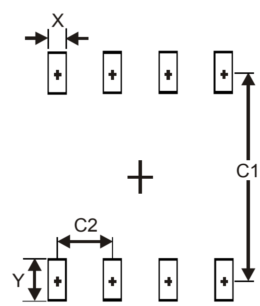
Please see AP02001 at http://www.diodes.com/datasheets/ap02001.pdf for the latest version.

SOT25



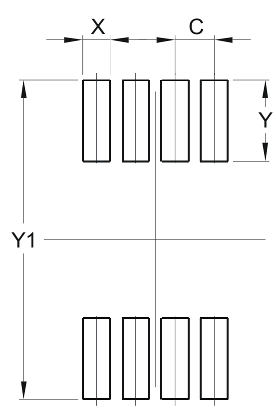
Dimensions	Value (in mm)
Z	3.20
G	1.60
X	0.55
Y	0.80
C1	2.40
C2	0.95

SO-8



Dimensions	Value (in mm)
X	0.60
Y	1.55
C1	5.4
C2	1.27

MSOP-8



Dimensions	Value (in mm)
C	0.650
X	0.450
Y	1.350
Y1	5.300