

Ordering Information

Device	Package Code	Offset Voltage	Operating Temperature Range	Packaging (Note 4)	13" Tape and Reel	
					Quantity	Part Number Suffix
TLC27L1CS-13	S	10mV	0 to +70°C	SO-8	2500/Tape & Reel	-13
TLC27L1ACS-13	S	5mV	0 to +70°C	SO-8	2500/Tape & Reel	-13
TLC27L1BCS-13	S	2mV	0 to +70°C	SO-8	2500/Tape & Reel	-13
TLC27L1IS-13	S	10mV	-40 to +85°C	SO-8	2500/Tape & Reel	-13
TLC27L1AIS-13	S	5mV	-40 to +85°C	SO-8	2500/Tape & Reel	-13
TLC27L1BIS-13	S	2mV	-40 to +85°C	SO-8	2500/Tape & Reel	-13

Note: 4. Pad layout as shown on Diodes Inc. suggested pad layout document AP02001, which can be found on our website at <http://www.diodes.com/datasheets/ap02001.pdf>.

Pin Descriptions

Pin Name	Pin Number	Description
OFFSET N1	1	Offset Control Inverting Input
IN-	2	Inverting Input
IN+	3	Non-Inverting Input
GND	4	Ground
OFFSET N2	5	Offset Control Non-Inverting Input
OUT	6	Output
V _{DD}	7	Supply
V _{DD}	8	Supply

Absolute Maximum Ratings (Notes 5, 6, 7, 8, 9)

Symbol	Parameter		Rating	Unit
V_{DD}	Supply Voltage: (Note 6)		18	V
V_{ID}	Differential Input Voltage (Note 7)		$\pm V_{DD}$	V
V_{IN}	Input Voltage Range (either input)		-0.3 to V_{DD}	V
I_{IN}	Input Current		± 5	mA
I_O	Output current		± 30	mA
	Output Short-Circuit to GND (Note 8)		Continuous	—
P_D	Power Dissipation (Note 9)		1065	mW
T_A	Operating Temperature Range	C Grade	0 to +70	°C
		I Grade	-40 to +85	
T_J	Operating Junction Temperature		150	°C
T_{ST}	Storage Temperature Range		-65 to +150	°C
ESD HBM	Human Body Model ESD Protection (1.5k Ω in series with 100pF)		1.5	kV

- Notes:
- 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.
 - All voltage values, except differential voltages, are with respect to ground.
 - Differential input voltages are at IN+ with respect to IN-.
 - The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.
 - For operating at high temperatures, the TLC27L1 must be derated 8.5mW/°C to zero based on a +150°C maximum junction temperature and a thermal resistance of +117 °C/W when the device is soldered to a printed circuit board, operating in a still air ambient.

Recommended Operating Conditions

Symbol	Parameter		C grade		I grade		Unit
			Min	Max	Min	Max	
V_{DD}	Supply Voltage		3	16	4	16	V
V_{IC}	Common Mode Input Voltage	$V_{DD} = 5V$	-0.2	3.5	-0.2	3.5	V
		$V_{DD} = 10V$	-0.2	8.5	-0.2	8.5	
T_A	Operating Free Air Temperature		0	+70	-40	+85	°C

Electrical Characteristics

Parameter			Conditions	T _A	TLC27L1C, TLC27L1AC, TLC27L1BC						Unit
					V _{DD} = 5V			V _{DD} = 10V			
					Min	Typ	Max	Min	Typ.	Max	
V _{IO}	Input Offset Voltage	TLC27L1C	V _O = 1.4V	+25°C	—	1.1	10	—	1.1	10	mV
		0 to +70°C		—	—	12	—	—	12		
		TLC27L1AC	V _{IC} = 0V R _S = 50Ω	+25°C	—	0.9	5	—	0.9	5	
		0 to +70°C		—	—	6.5	—	—	6.5		
		TLC27L1BC	R _L = 1MΩ	+25°C	—	0.24	2	—	0.26	2	
		0 to +70°C		—	—	3	—	—	3		
α _{VIO}	Average Temperature Coefficient of Input Offset Voltage		—	+25 to +70°C	1.1			1			μV/°C
I _{IO}	Input Offset Current (Note 10)		V _O = V _{DD} /2, V _{IC} = V _{DD} /2	+25°C	—	0.1	60	—	0.1	60	pA
				+70°C	—	7	300	—	8	300	
I _{IB}	Input Bias Current (Note 10)		V _O = V _{DD} /2, V _{IC} = V _{DD} /2	+25°C	—	0.6	60	—	0.7	60	pA
				+70°C	—	40	600	—	50	600	
V _{ICR}	Common Mode Input Voltage (Note 11)		—	+25°C	-0.2 to 4	-0.3 to 4.2	—	-0.2 to 9	-0.3 to 9.2	—	V
				0°C to +70°C	-0.2 to 3.5	—	—	-0.2 to 8.5	—	—	V
V _{OH}	High Level Output Voltage		V _{ID} = 100mV, R _L = 1MΩ	+25°C	3.2	4.1	—	8	8.9	—	V
				0°C	3	4.1	—	7.8	8.9	—	
				+70°C	3	4.2	—	7.8	8.9	—	
V _{OL}	Low Level Output Voltage		V _{ID} = -100mV, I _{OL} = 0	+25°C	—	0	50	—	0	50	mV
				0°C	—	0	50	—	0	50	
				+70°C	—	0	50	—	0	50	
A _{VD}	Large Signal Differential Voltage Gain		R _L = 1MΩ (Note 12)	+25°C	50	520	—	50	870	—	V/mV
				0°C	50	700	—	50	1030	—	
				+70°C	50	380	—	50	660	—	
CMRR	Common Mode Rejection Ratio		V _{IC} = V _{ICRmin}	+25°C	65	94	—	65	97	—	dB
				0°C	60	95	—	60	97	—	
				+70°C	60	95	—	60	97	—	
k _{SVR}	Supply Voltage Rejection Ratio (ΔV _{DD} /ΔV _{IO})		V _{DD} = 5V to 10V V _O = 1.4V	+25°C	70	97	—	70	97	—	dB
				0°C	60	97	—	60	97	—	
				+70°C	60	98	—	60	98	—	
I _{DD}	Supply Current		V _O = V _{DD} /2, V _{IC} = V _{DD} /2, No Load	+25°C	—	10	17	—	14	23	μA
				0°C	—	12	21	—	18	33	
				+70°C	—	8	14	—	11	20	

Notes: 10. The typical values of input bias current and input offset current below 5pA were calculated.
11. This range also applies to each input individually.
12. At V_{DD} = 5V, V_O = 0.25V to 2V; at V_{DD} = 10V, V_O = 1V to 6V.

Electrical Characteristics

Parameter			Conditions	T _A	TLC27L1I, TLC27L1AI, TLC27L1BI						Unit
					V _{DD} = 5V			V _{DD} = 10V			
					Min	Typ	Max	Min	Typ.	Max	
V _{IO}	Input Offset Voltage	TLC27L1I	V _O = 1.4V V _{IC} = 0V R _S = 50Ω R _L = 1MΩ	+25°C	—	1.1	10	—	1.1	10	mV
		TLC27L1AI		-40° to 85°C	—	—	13	—	—	13	
				+25°C	—	0.9	5	—	0.9	5	
		TLC27L1BI		-40° to +85°C	—	—	7	—	—	7	
				+25°C	—	0.24	2	—	0.26	2	
		-40° to +85°C		—	—	3.5	—	—	3.5		
α _{VIO}	Average Temperature Coefficient of Input Offset Voltage	—	+25°C to +85°C	1.1			1			μV/°C	
I _{IO}	Input Offset Current (Note 13)	V _O = V _{DD} /2 V _{IC} = V _{DD} /2	+25°C	—	0.1	60	—	0.1	60	pA	
			+85°C	—	24	1000	—	26	1000		
I _{IB}	Input Bias Current (Note 13)	V _O = V _{DD} /2 V _{IC} = V _{DD} /2	+25°C	—	0.6	60	—	0.7	60	pA	
			+85°C	—	200	2000	—	220	2000		
V _{ICR}	Common Mode Input Voltage (Note 14)	—	+25°C	-0.2 to 4	-0.3 to 4.2	—	-0.2 to 9	-0.3 to 9.2	—	V	
			-40° to +85°C	-0.2 to 3.5	—	—	-0.2 to 8.5	—	—	V	
V _{OH}	High Level Output Voltage	V _{ID} = 100mV, R _L = 1MΩ	+25°C	3	4.1	—	8	8.9	—	V	
			-40°C	3	4.1	—	7.8	8.9	—		
			+85°C	3	4.2	—	7.8	8.9	—		
V _{OL}	Low Level Output Voltage	V _{ID} = -100mV, I _{OL} = 0	+25°C	—	0	50	—	0	50	mV	
			-40°C	—	0	50	—	0	50		
			+85°C	—	0	50	—	0	50		
A _{VD}	Large Signal Differential Voltage Gain	R _L = 1MΩ (Note 15)	+25°C	50	520	—	50	870	—	V/mV	
			-40°C	50	900	—	50	1550	—		
			+85°C	50	330	—	50	585	—		
CMRR	Common Mode Rejection Ratio	V _{IC} = V _{ICRmin}	+25°C	65	94	—	65	97	—	dB	
			-40°C	60	95	—	60	97	—		
			+85°C	60	95	—	60	98	—		
k _{SVR}	Supply Voltage Rejection Ratio (ΔV _{DD} /ΔV _{IO})	V _{DD} = 5V to 10V V _O = 1.4V	+25°C	70	97	—	70	97	—	dB	
			-40°C	60	97	—	60	97	—		
			+85°C	60	98	—	60	98	—		
I _{DD}	Supply Current	V _O = V _{DD} /2 V _{IC} = V _{DD} /2 No load	+25°C	—	10	17	—	14	23	μA	
			-40°C	—	16	27	—	25	43		
			+85°C	—	17	13	—	10	18		

Notes: 13. The typical values of input bias current and input offset current below 5pA were calculated.
14. This range also applies to each input individually.
15. At V_{DD} = 5V, V_O = 0.25V to 2V; at V_{DD} = 10V, V_O = 1V to 6V.

Electrical Characteristics

V _{DD} = 5V								
Parameter		Conditions		T _A	TLC27L1C, TLC27L1AC, TLC27L1BC			Unit
					Min	Typ	Max	—
SR	Slew Rate at Unity Gain	R _L = 1MΩ C _L = 20pF See Figure 31	V _{I(PP)} = 1V	+25°C	—	0.03	—	V/μs
				0°C	—	0.04	—	
				+70°C	—	0.03	—	
			V _{I(PP)} = 2.5V	+25°C	—	0.03	—	
				0°C	—	0.03	—	
				+70°C	—	0.02	—	
V _n	Equivalent Input Noise Voltage	F = 1kHz, R _S = 20Ω See Figure 32		+25°C	—	68	—	nV/√Hz
B _{OM}	Maximum Output Swing Bandwidth	V _O = V _{OH} , C _L = 20pF, R _L = 1MΩ See Figure 31		+25°C	—	5	—	kHz
				0°C	—	6	—	
				+70°C	—	4.5	—	
B ₁	Unity Gain Bandwidth	V _I = 10mV, C _L = 20pF See Figure 33		+25°C	—	85	—	MHz
				0°C	—	100	—	
				+70°C	—	65	—	
ϕ _m	Phase Margin	F = B ₁ , V _I = 10mV, C _L = 20pF See Figure 33		+25°C	—	34°	—	—
				0°C	—	36°	—	
				+70°C	—	30°	—	
V _{DD} = 10V								
Parameter		Conditions		T _A	TLC27L1C, TLC27L1AC, TLC27L1BC			Unit
					Min	Typ	Max	—
SR	Slew Rate at Unity Gain	R _L = 1MΩ, C _L = 20pF See Figure 31	V _{I(PP)} = 1V	+25°C	—	0.05	—	V/μs
				0°C	—	0.05	—	
				+70°C	—	0.04	—	
			V _{I(PP)} = 5.5V	+25°C	—	0.04	—	
				0°C	—	0.05	—	
				+70°C	—	0.04	—	
V _n	Equivalent Input Noise Voltage	F = 1kHz, R _S = 20Ω See Figure 32		+25°C	—	68	—	nV/√Hz
B _{OM}	Maximum Output Swing Bandwidth	V _O = V _{OH} , C _L = 20pF, R _L = 1MΩ See Figure 31		+25°C	—	1	—	kHz
				0°C	—	1.3	—	
				+70°C	—	0.9	—	
B ₁	Unity Gain Bandwidth	V _I = 10mV, C _L = 20pF See Figure 33		+25°C	—	110	—	MHz
				0°C	—	125	—	
				+70°C	—	90	—	
ϕ _m	Phase Margin	F = B ₁ , V _I = 10mV, C _L = 20pF See Figure 33		+25°C	—	38°	—	—
				0°C	—	40°	—	
				+70°C	—	34°	—	

Electrical Characteristics

V _{DD} = 5V								
Parameter		Conditions		T _A	TLC27L1I, TLC27L1AI, TLC27L1BI			Unit
					Min	Typ	Max	—
SR	Slew Rate at Unity Gain	R _L = 1MΩ C _L = 20pF See Figure 31	V _{I(PP)} = 1V	+25°C	—	0.03	—	V/μs
				-40°	—	0.04	—	
				+85°C	—	0.03	—	
		V _{I(PP)} = 2.5V	+25°C	—	0.03	—		
			-40°	—	0.04	—		
			+85°C	—	0.02	—		
V _n	Equivalent Input Noise Voltage	F = 1kHz, R _S = 20Ω See Figure 32		+25°C	—	68	—	nV/√Hz
B _{OM}	Maximum Output Swing Bandwidth	V _O = V _{OH} , C _L = 20pF, R _L = 1MΩ See Figure 31		+25°C	—	5	—	kHz
				-40°	—	7	—	
				+85°C	—	4	—	
B ₁	Unity Gain Bandwidth	V _I = 10mV, C _L = 20pF See Figure 33		+25°C	—	85	—	MHz
				-40°	—	130	—	
				+85°C	—	55	—	
ϕ _m	Phase Margin	F = B ₁ , V _I = 10mV, C _L = 20pF See Figure 33		+25°C	—	34°	—	—
				-40°	—	38°	—	
				+85°C	—	28°	—	
V _{DD} = 10V								
Parameter		Conditions		T _A	TLC27L1I, TLC27L1AI, TLC27L1BI			Unit
					Min	Typ	Max	—
SR	Slew Rate at Unity Gain	R _L = 1MΩ C _L = 20pF See Figure 31	V _{I(PP)} = 1V	+25°C	—	0.05	—	V/μs
				-40°	—	0.06	—	
				+85°C	—	0.03	—	
		V _{I(PP)} = 5.5V	+25°C	—	0.04	—		
			-40°	—	0.05	—		
			+85°C	—	0.03	—		
V _n	Equivalent Input Noise Voltage	F = 1kHz, R _S = 20Ω See Figure 32		+25°C	—	68	—	nV/√Hz
B _{OM}	Maximum Output Swing Bandwidth	V _O = V _{OH} , C _L = 20pF, R _L = 1MΩ See Figure 31		+25°C	—	1	—	kHz
				-40°	—	1.4	—	
				+85°C	—	0.8	—	
B ₁	Unity Gain Bandwidth	V _I = 10mV, C _L = 20pF See Figure 33		+25°C	—	110	—	MHz
				-40°	—	155	—	
				+85°C	—	80	—	
ϕ _m	Phase Margin	F = B ₁ , V _I = 10mV, C _L = 20pF See Figure 33		+25°C	—	38°	—	—
				-40°	—	42°	—	
				+85°C	—	32°	—	

Typical Performance Characteristics Table Index of Graphs

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Typical Performance Characteristics

Distribution of TLC27L1 Input Offset Voltage

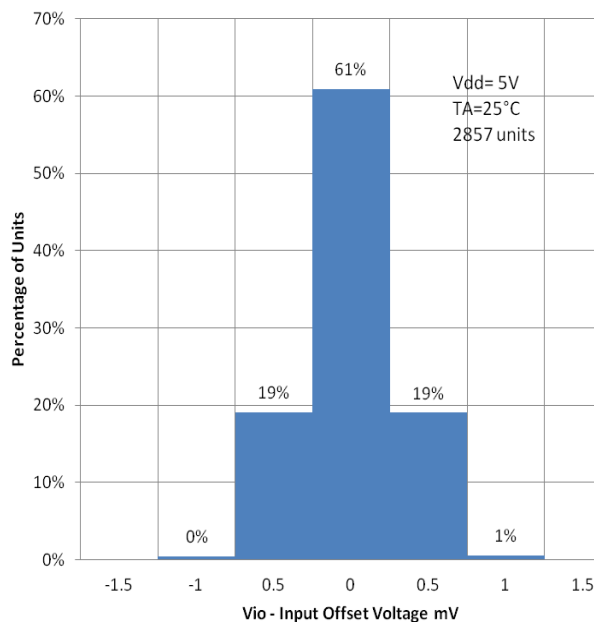


Figure 1

Distribution of TLC27L1 Input Offset Voltage

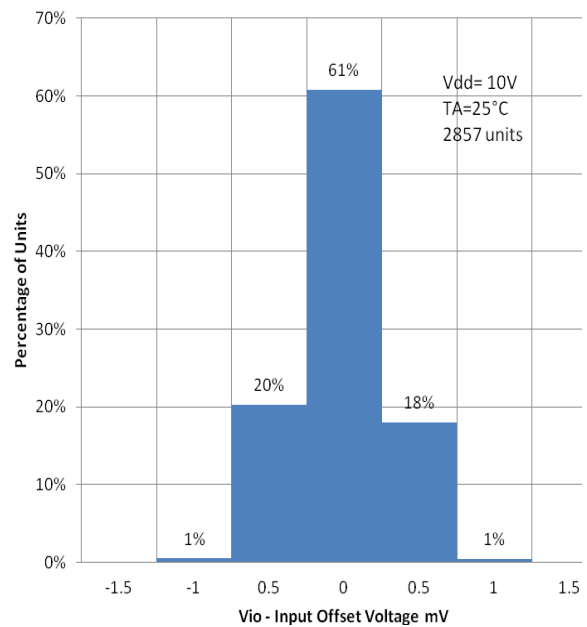


Figure 2

High-Level output voltage
vs
High-Level output current

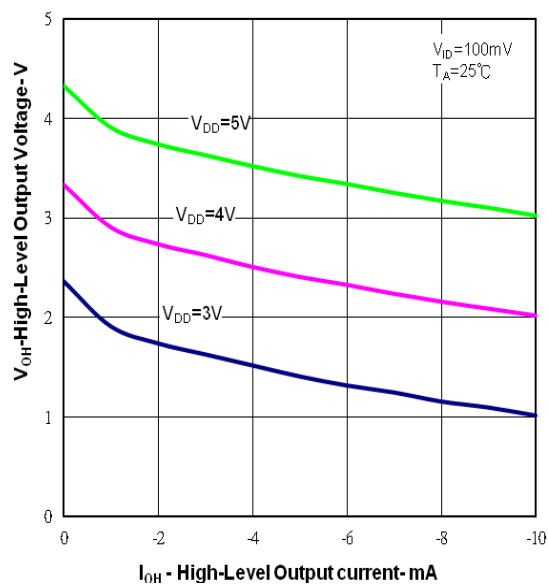


Figure 3

High-Level output voltage
vs
High-Level output current

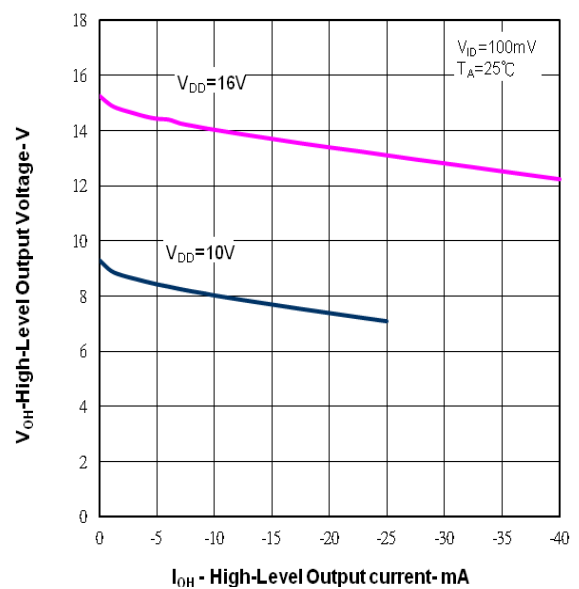


Figure 4

Typical Performance Characteristics

High-Level output voltage
vs
Supply Voltage

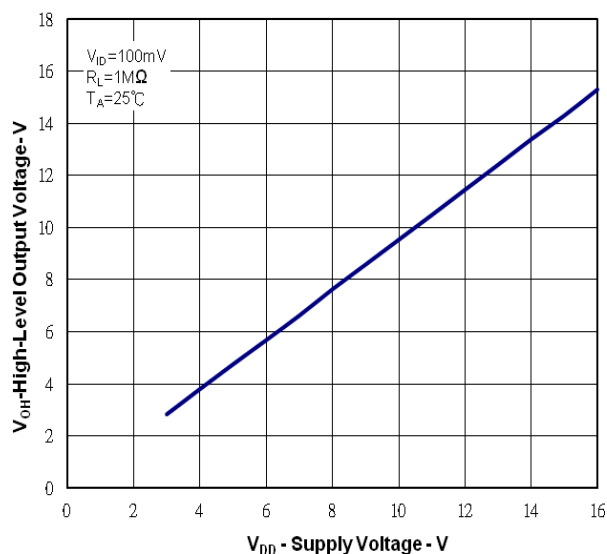


Figure 5

High-Level output voltage
vs
Free Air Temperature

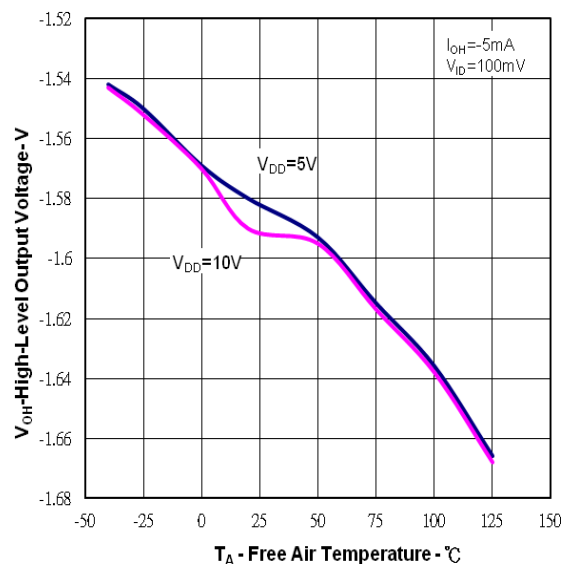


Figure 6

Low-level output voltage
vs
common-mode input voltage

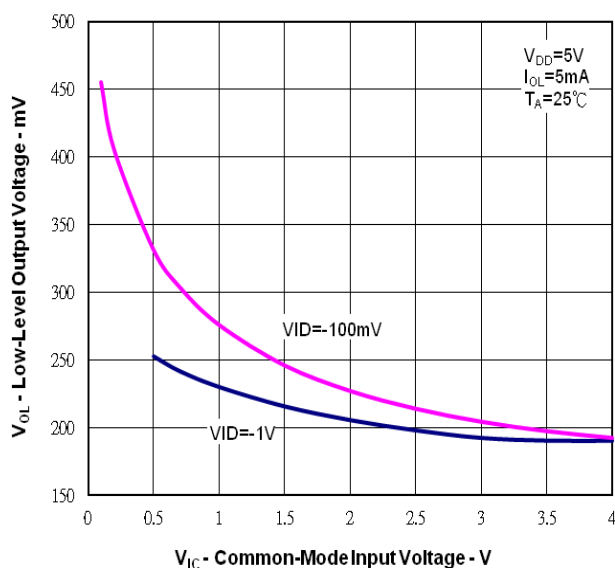


Figure 7

Low-level output voltage
vs
common-mode input voltage

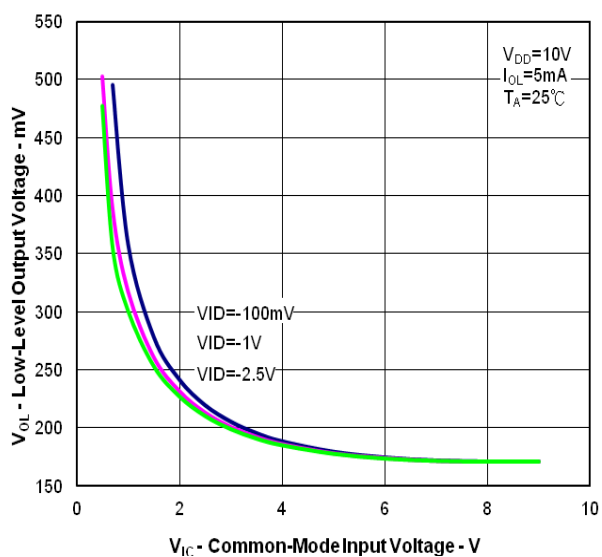


Figure 8

Typical Performance Characteristics

Low-level output voltage
vs
Differential input voltage

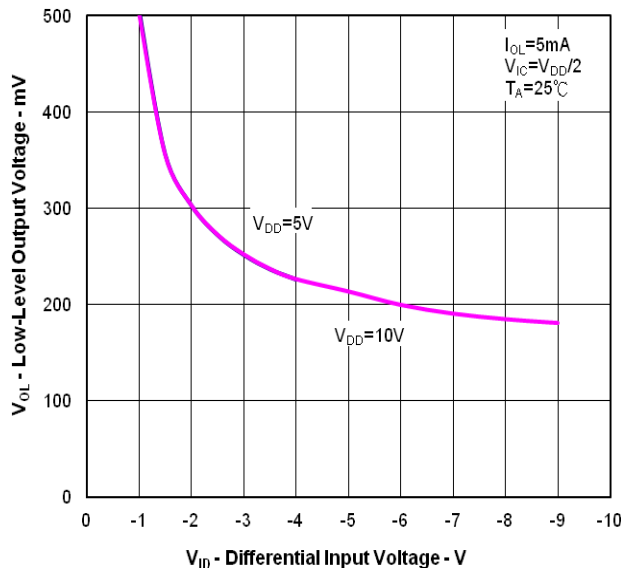


Figure 9

Low-level output voltage
vs
Differential input voltage

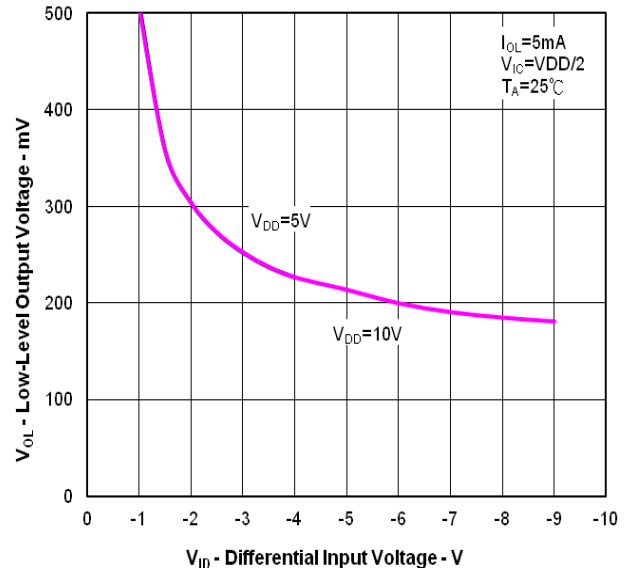


Figure 10

Low-level output voltage
vs
Low-level output current

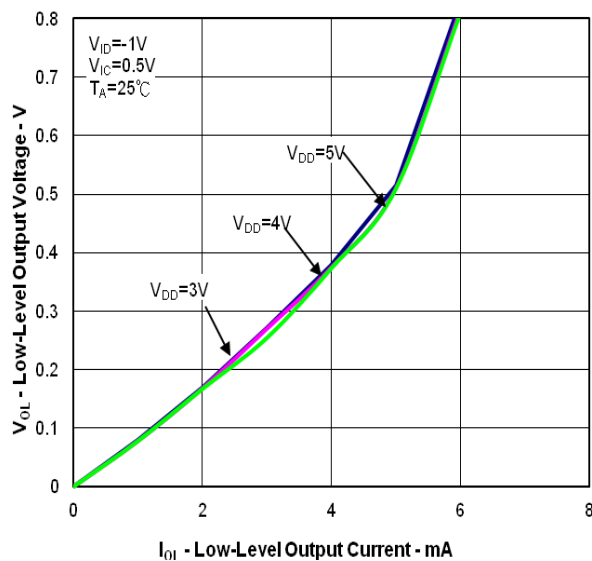


Figure 11

Low-level output voltage
vs
Low-level output current

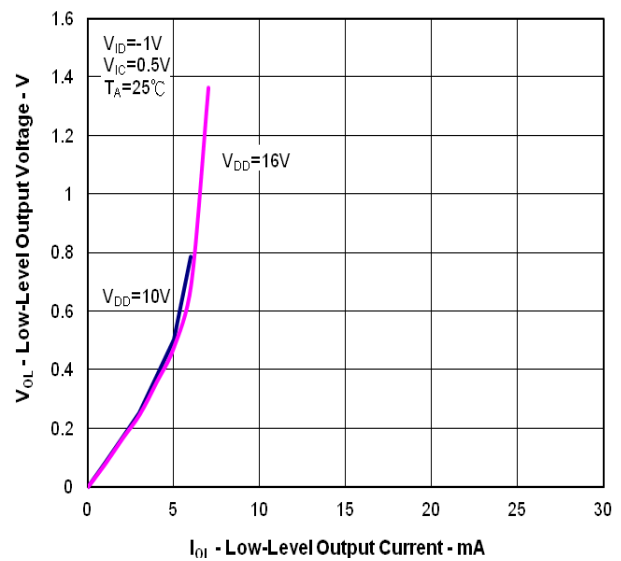


Figure 12

Typical Performance Characteristics

Large-Signal Differential Voltage Amplification
vs
Supply Voltage

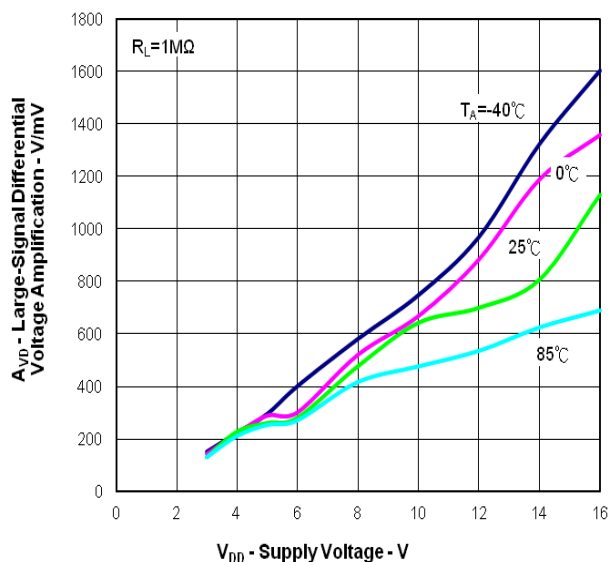


Figure 13

Large-Signal Differential Voltage Amplification
vs
Free-Air Temperature

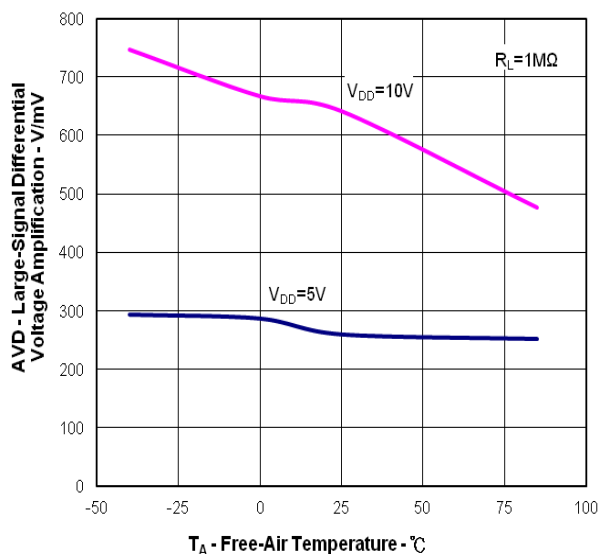


Figure 14

Input Bias Current and Input Offset Current
vs
Free-Air Temperature

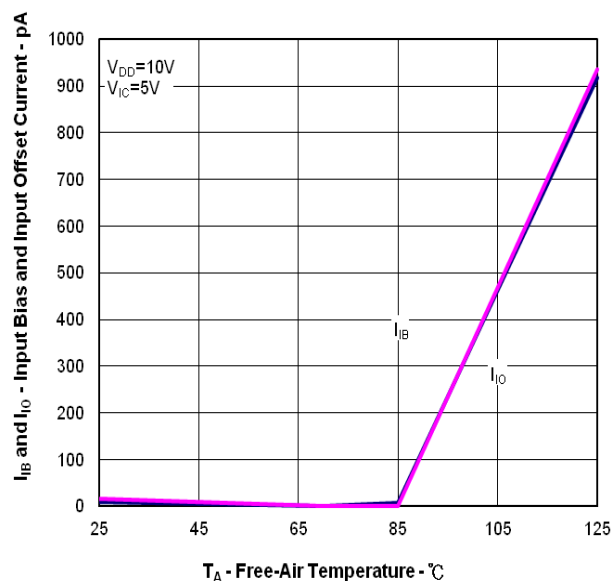


Figure 15

Common-mode input voltage
(positive limit)
vs
Supply Voltage

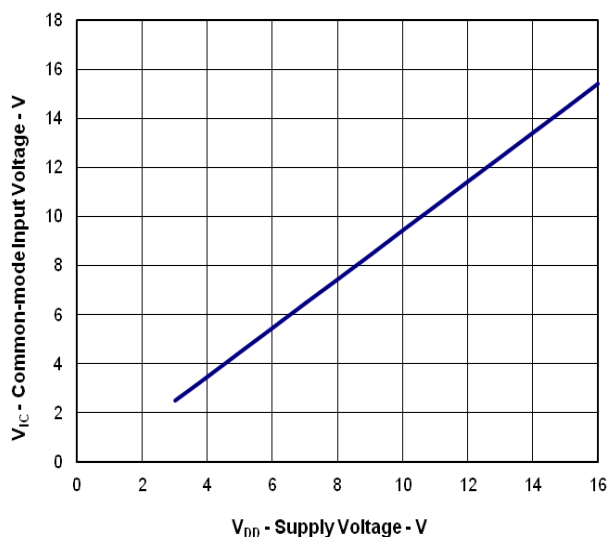


Figure 16

Typical Performance Characteristics

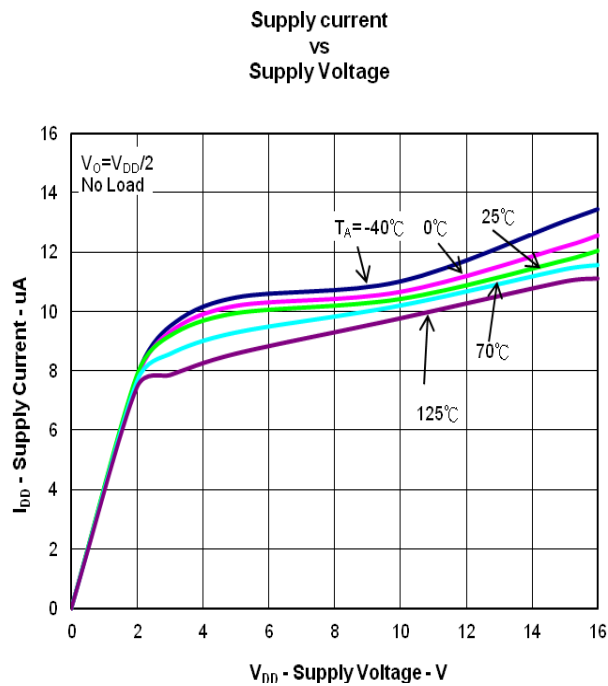


Figure 17

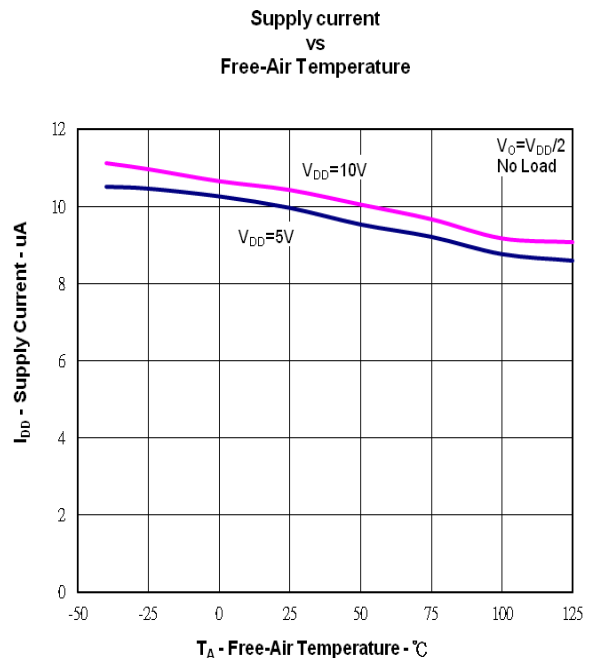


Figure 18

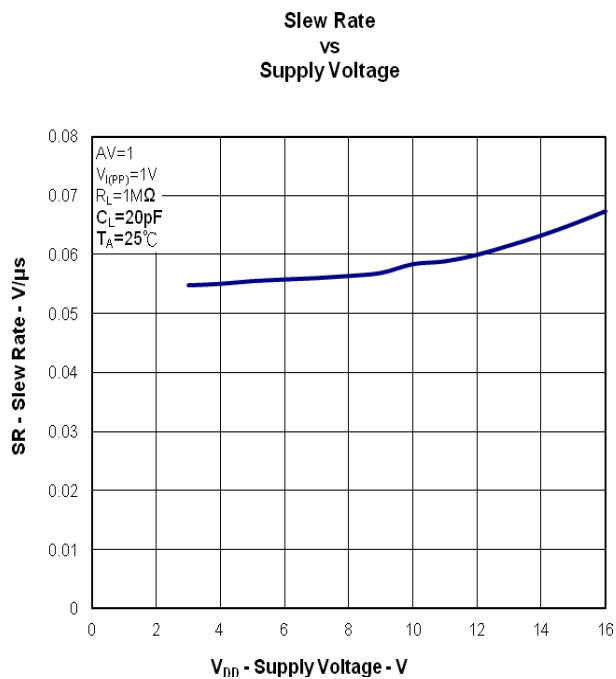


Figure 19

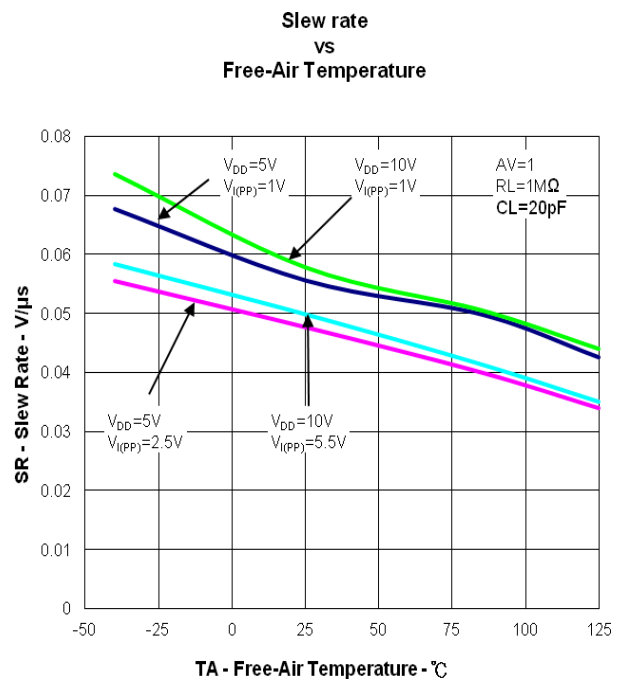
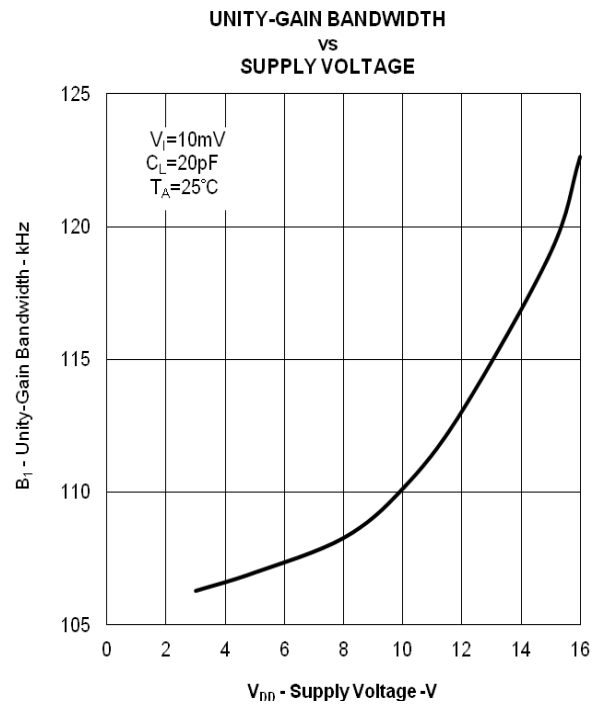
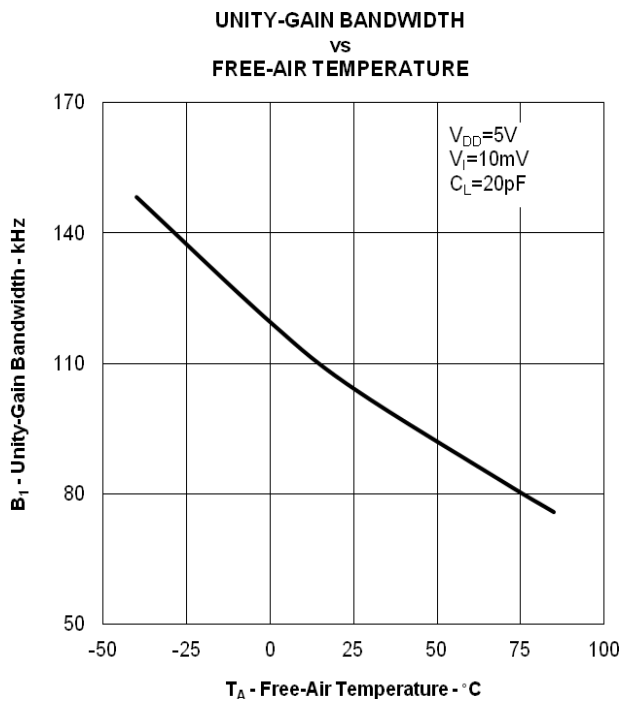
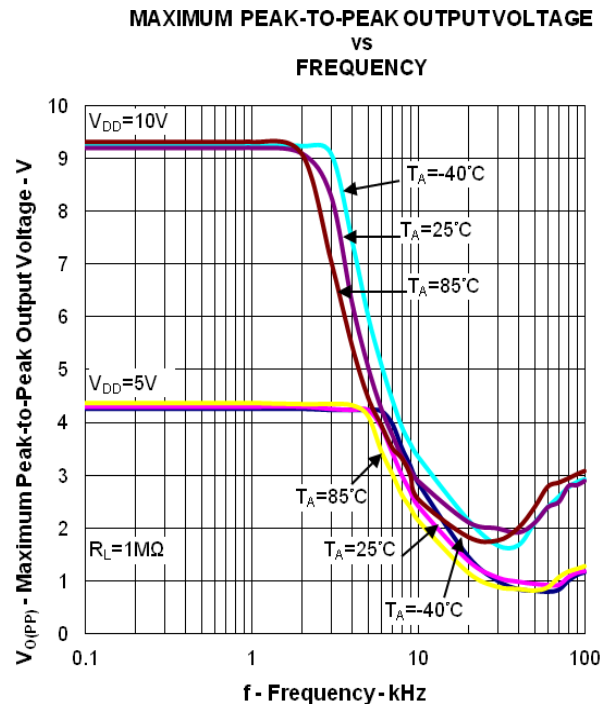
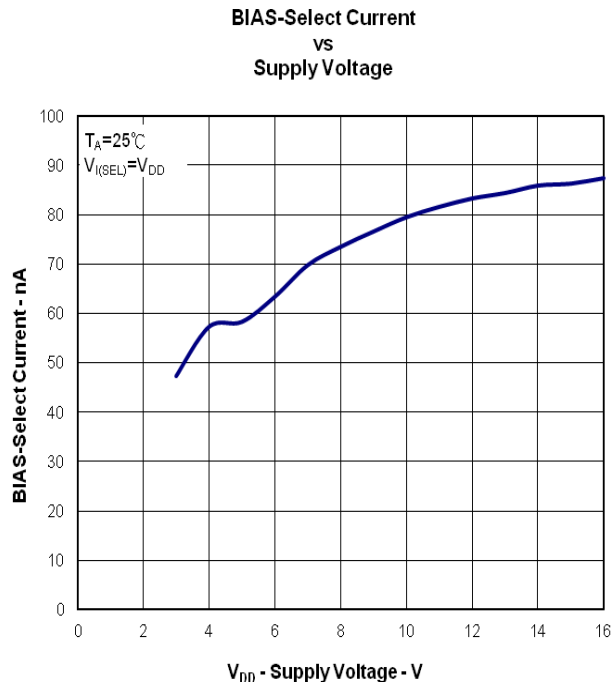


Figure 20

Typical Performance Characteristics



Typical Performance Characteristics

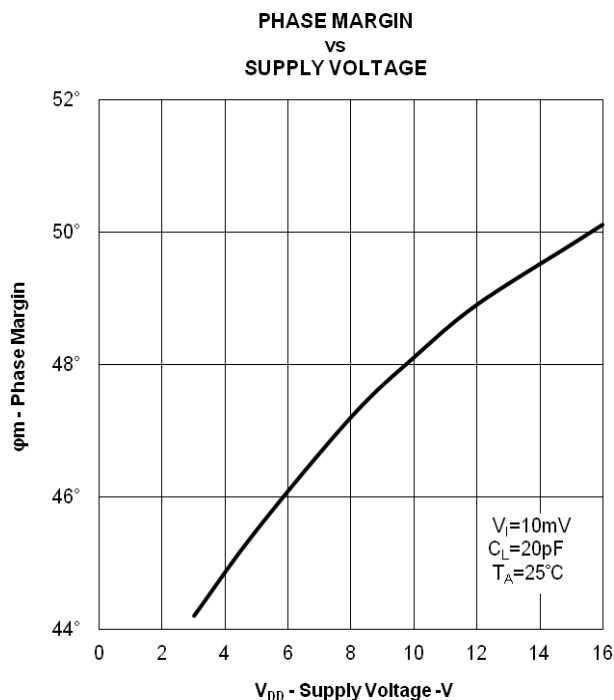


Figure 25

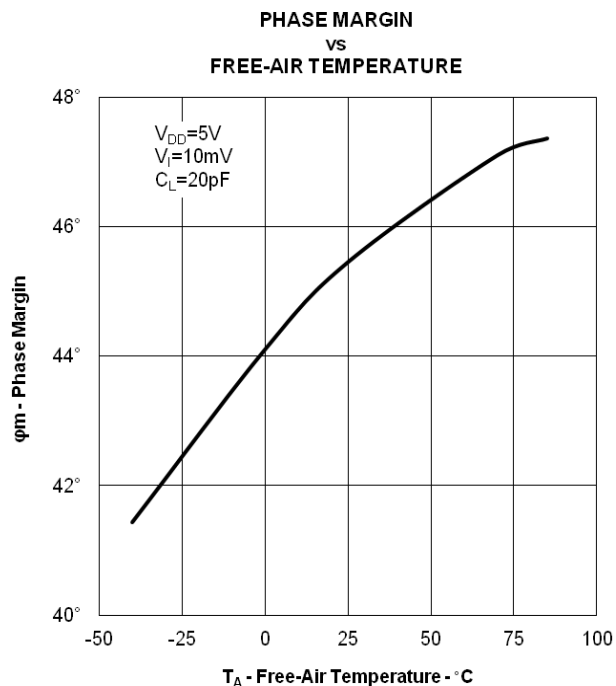


Figure 26

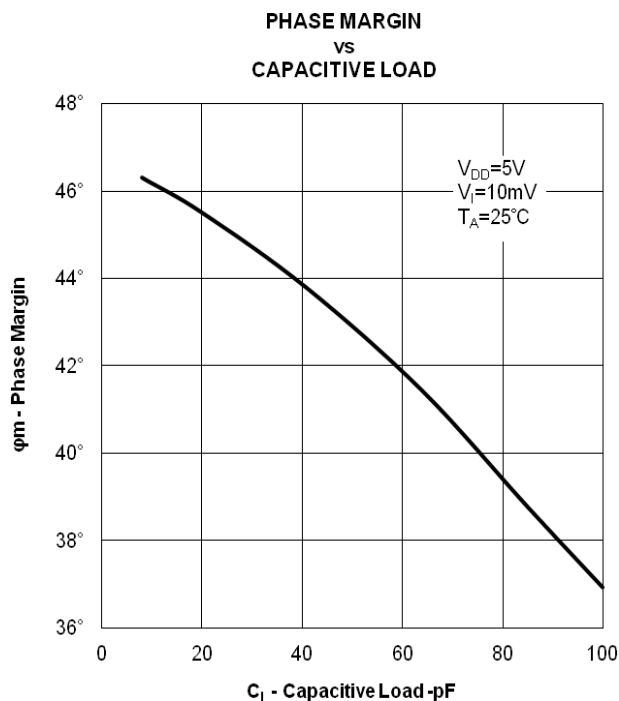


Figure 27

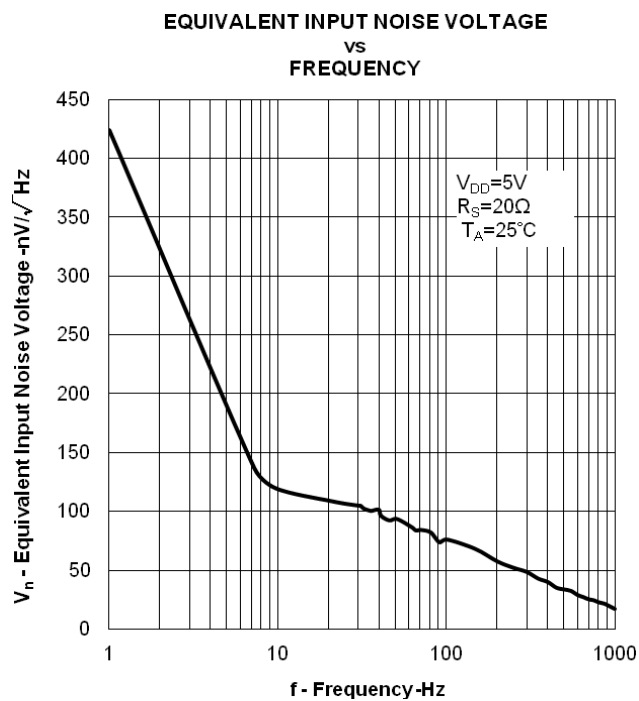


Figure 28

Typical Performance Characteristics

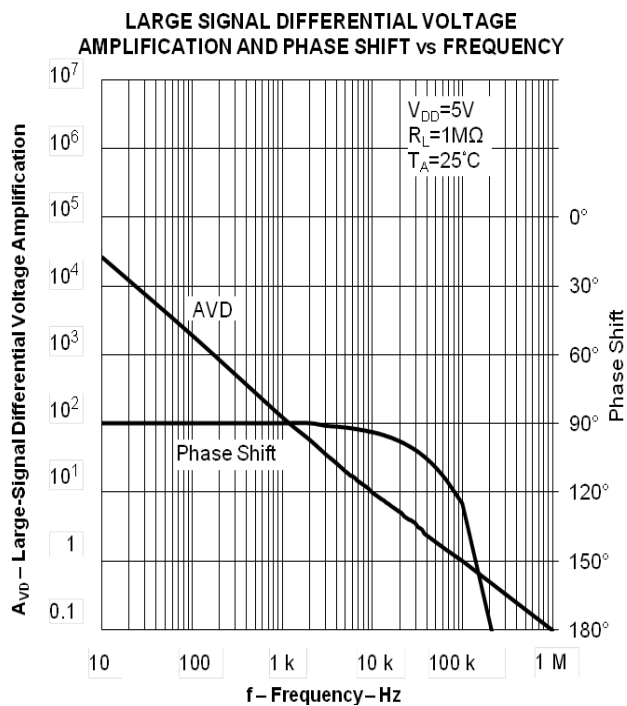


Figure 29

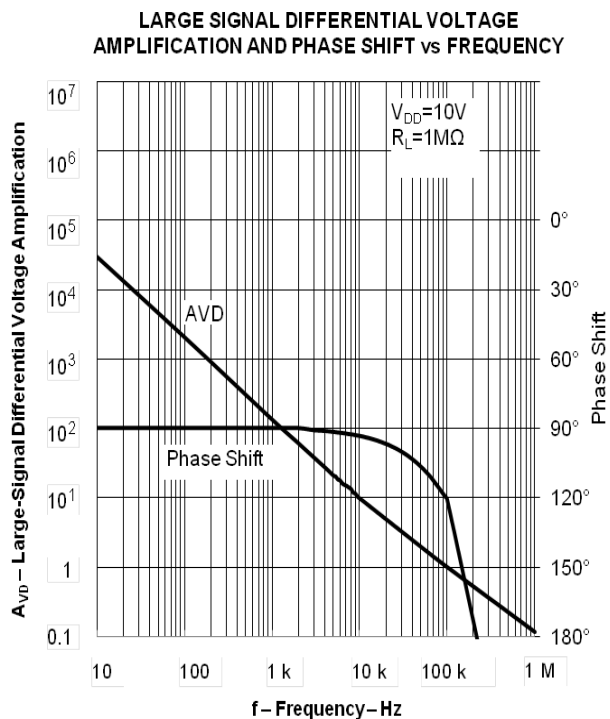


Figure 30

Application Information

Parameter measurement circuits

Because the TLC27L1 is optimized for single-supply operation, circuit configurations used for the various tests can present some difficulties since the input signal must be offset from ground. This issue can be avoided by testing the device with split supplies and the output load tied to the negative rail. Example circuits are shown below.

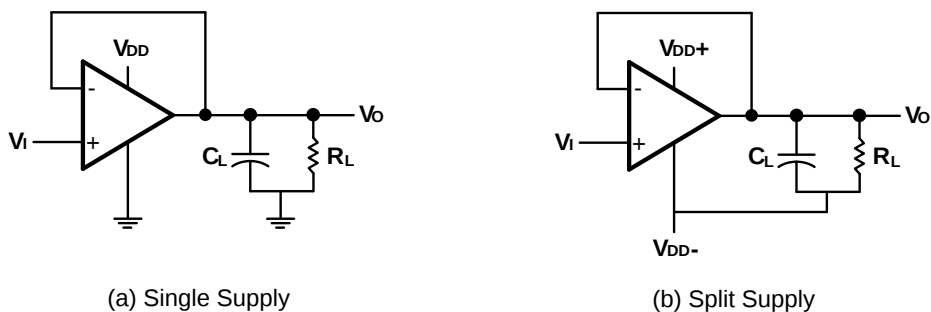


Figure 31 Measurement circuit with either single or split supply

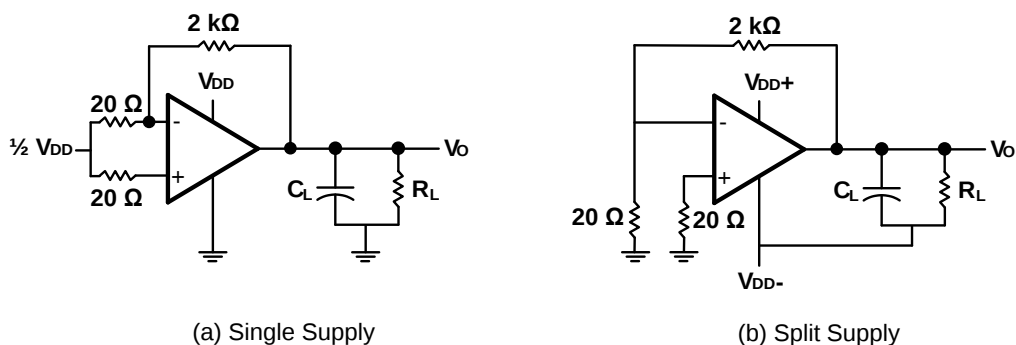


Fig 32 Noise measurement with single or split supply

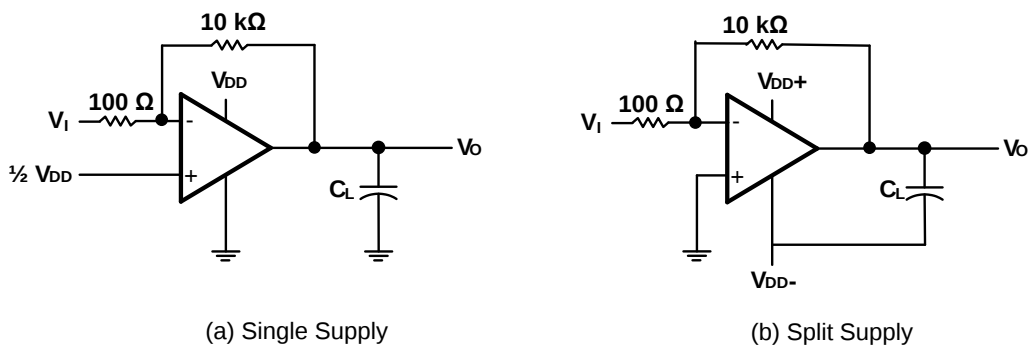


Figure 33 Gain of 100 with single or split supply

Application Notes

Offset Voltage Nulling Circuit

The TLC27L1 offers external input offset null control. Nulling of the input off set voltage may be achieved by adjusting a 100-k Ω potentiometer connected between the offset null terminals with the wiper connected as shown in Figure 31.

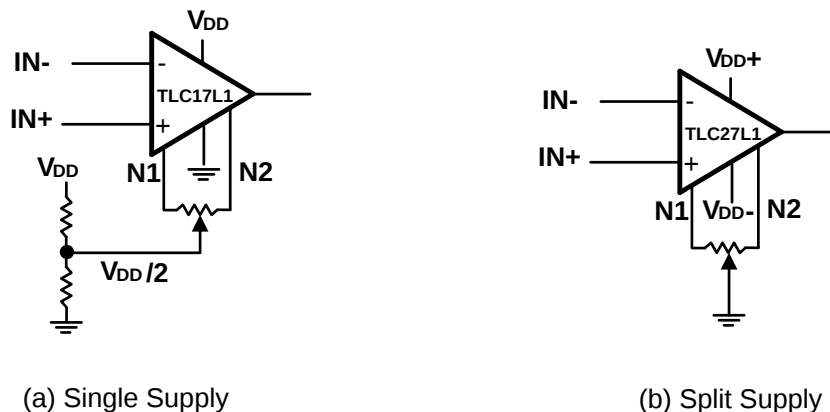


Figure 31 Offset Nulling Circuits

Input Bias Current – Error Protection

The TLC27L1 has an extremely high input impedance. To use the inputs as a high impedance node, for example, greater than 100K, or to accurately measure bias current, it is necessary to place a guard ring around the input pins and drive the ring to a potential equivalent to the common mode input voltage. In many cases this common mode potential may exist as a part of the feedback circuit and can be obtained from one of the appropriate nodes. In the case for the SO8 package, pin 4 is connected to ground or Vdd-. Input pins 2 and 3 are normally well above the voltage on pin 4, so a large potential voltage on the order of several volts is likely between pins 3 and 4. To prevent interference with a 1 pA bias current, the board resistance will need to be in the order of gigaohms to have a minimum impact. The goal is to have the common mode potential on the guard ring, therefore reducing the stray voltage near the input pins to millivolts in normal applications. Any solder flux residue, excess moisture, humidity or board contamination will be detrimental to using the device in a high impedance input mode.

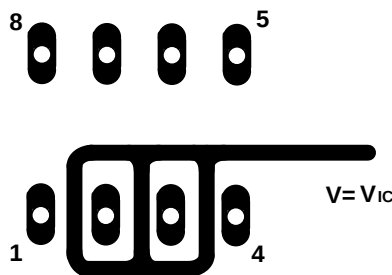


Figure 32 Bias Current Guarding for High Input Impedance Applications

Typical Application Circuits

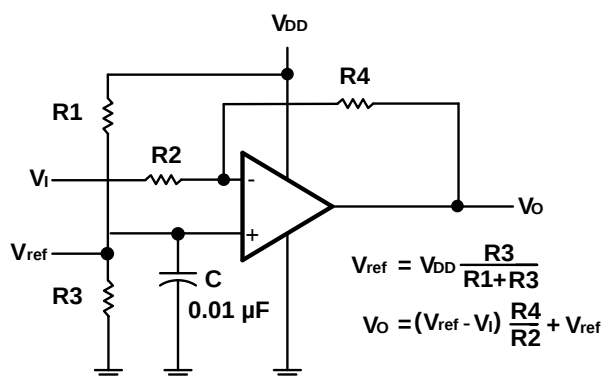


Figure 33 Inverting Amplifier With Voltage Reference

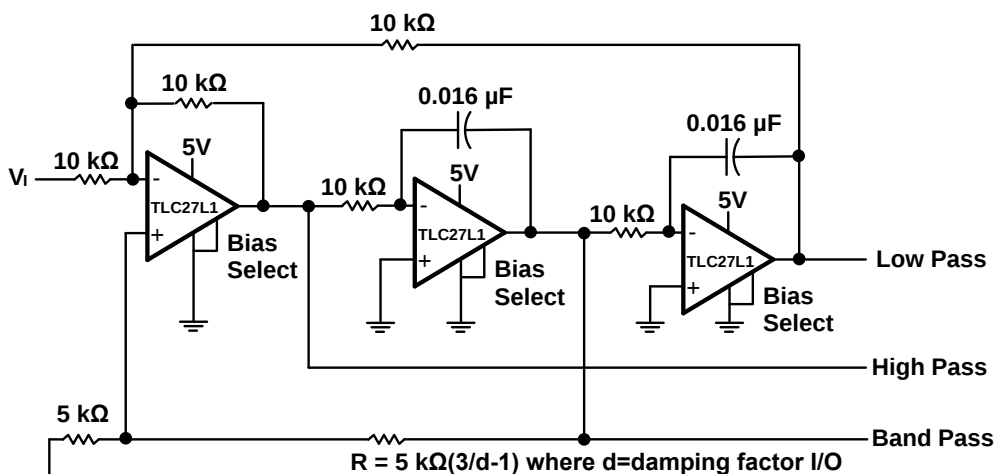


Figure 34 State Variable Filter

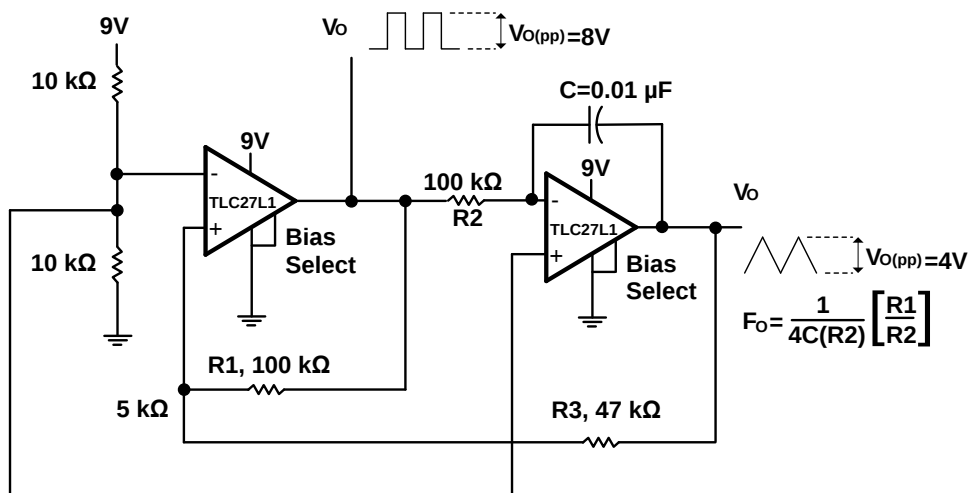


Figure 35 Single Supply Function Generator

Typical Application Circuits (cont.)

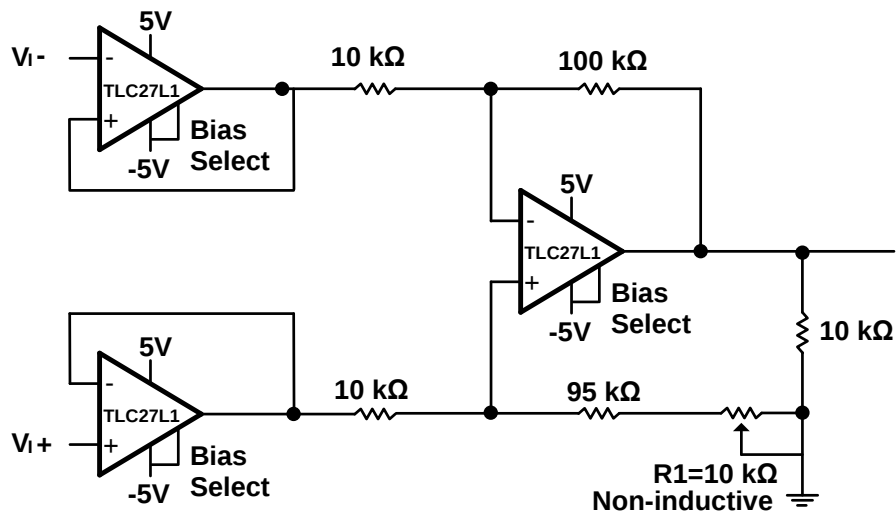


Figure 36 Low Power Instrumentation Amplifier

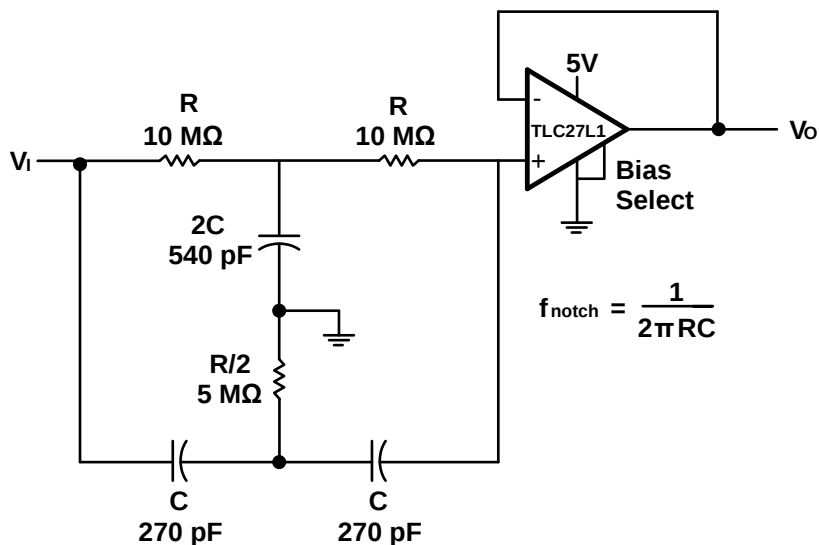


Figure 37 Single Supply Twin-T Notch Filter

Typical Application Circuits (cont.)

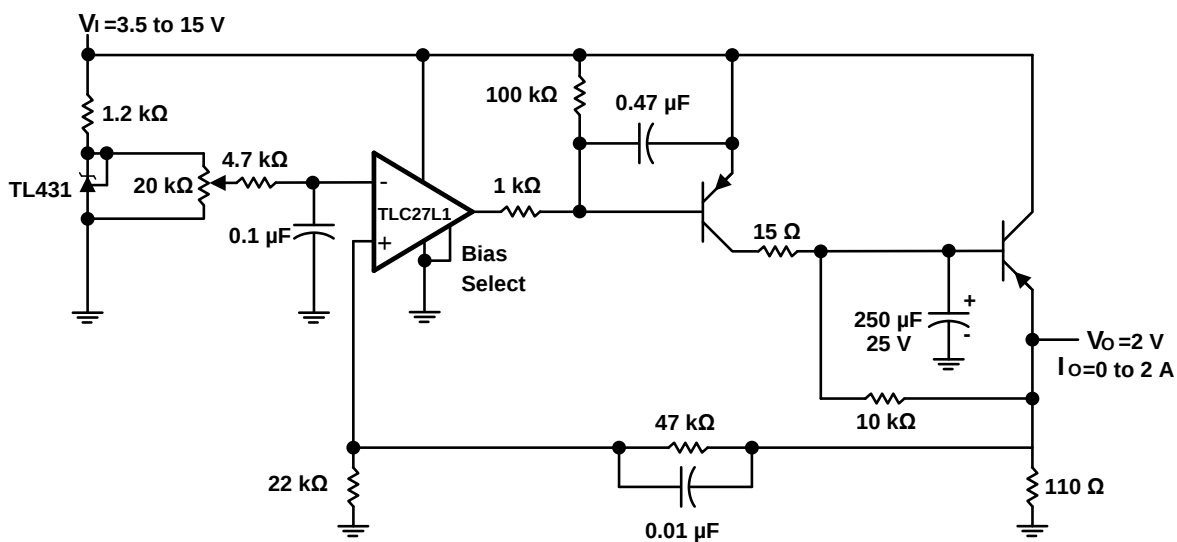


Figure 38 Power Supply

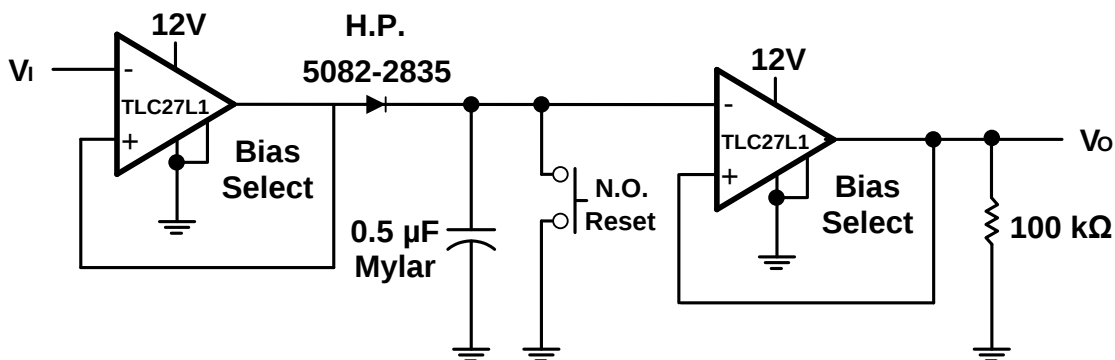


Figure 39 Positive Peak Detector

Typical Application Circuits (cont.)

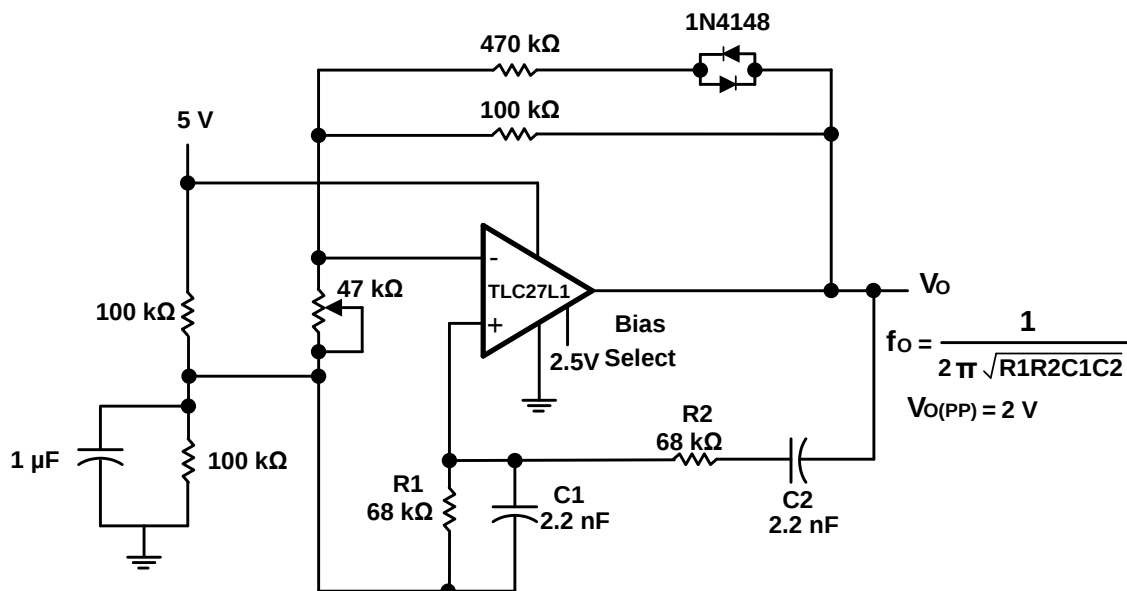


Figure 40 Wein Oscillator

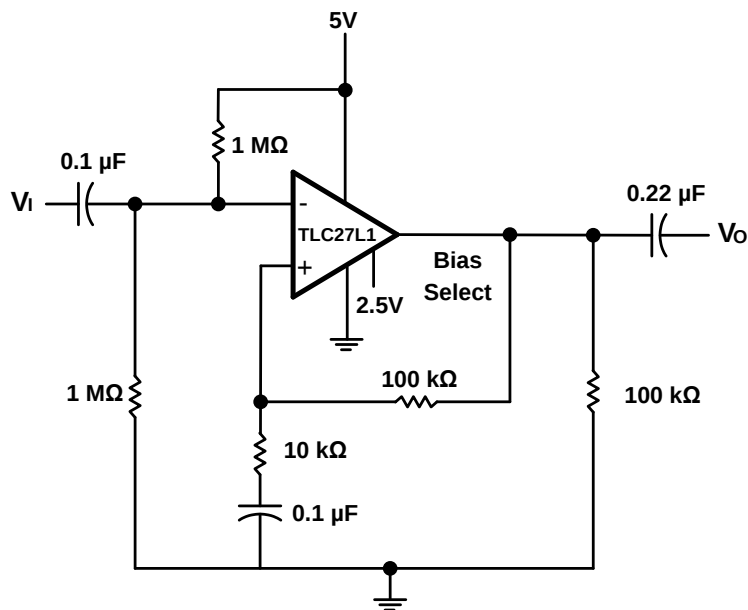


Figure 41 Single-Supply AC Amplifier

Typical Application Circuits (cont.)

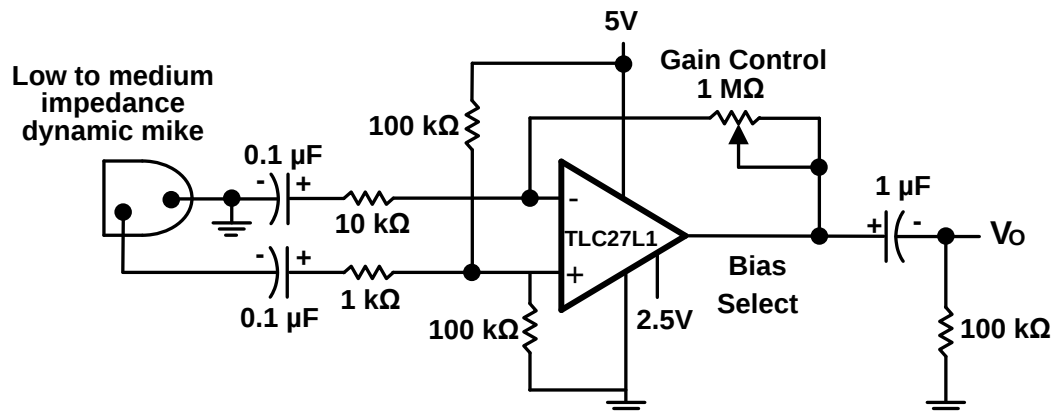


Figure 42 Microphone Preamplifier

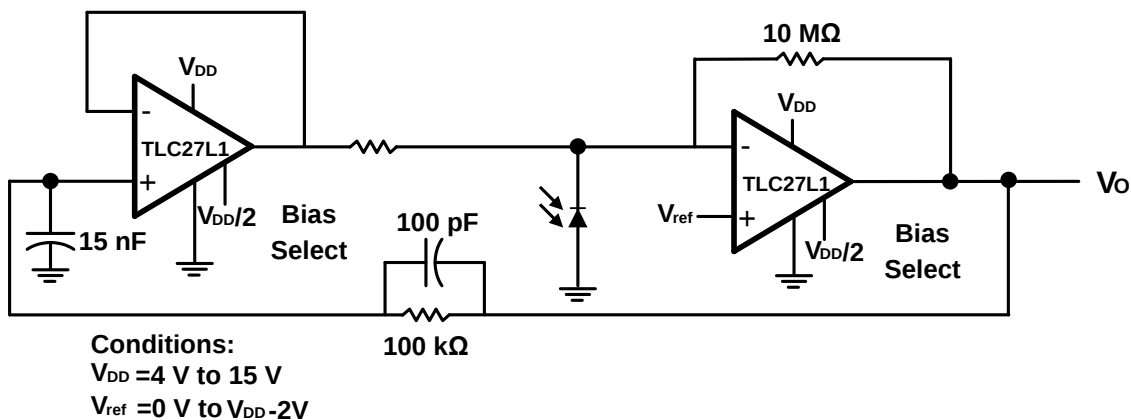


Figure 43 Photo-Diode Amplifier With Ambient Light Rejection

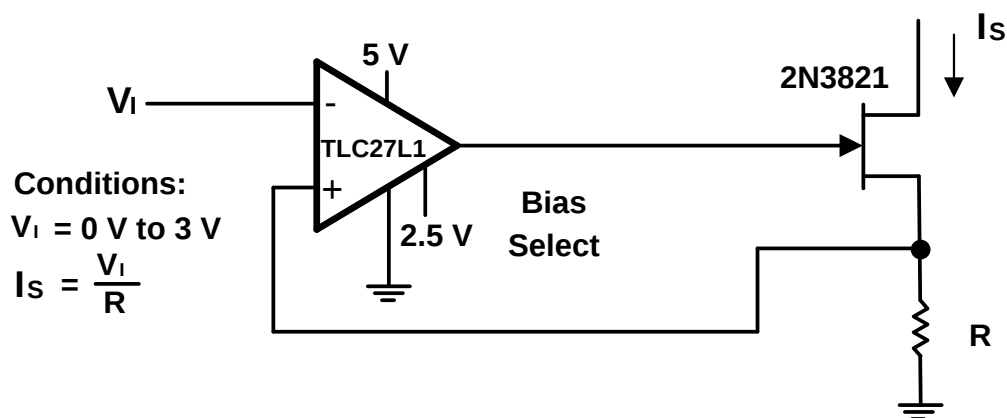


Figure 44 Precision Low-Current Sink

Typical Application Circuits (cont.)

Select	S1	S2
A_v	10	100

$V_{DD} = 5\text{ V to }12\text{ V}$

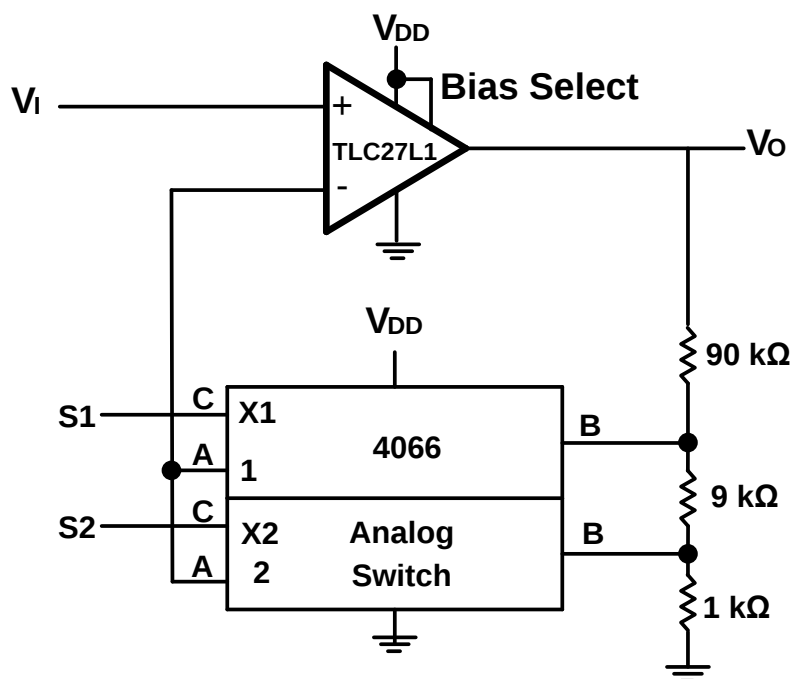


Figure 45 Amplifier With Digital Gain Selection

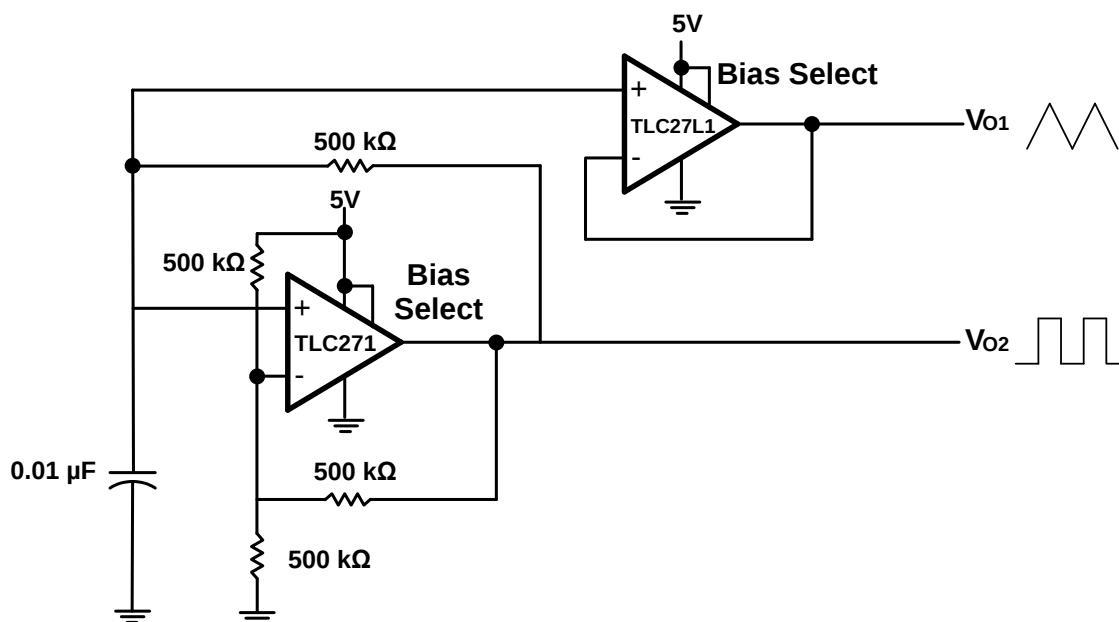


Figure 46 Multivibrator

Typical Application Circuits (cont.)

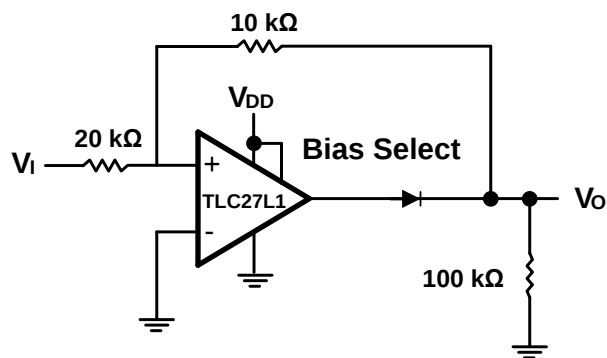
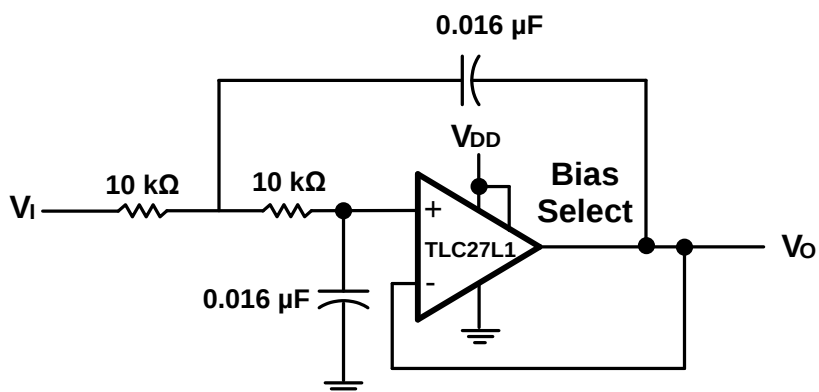


Figure 47 Full Wave Rectifier



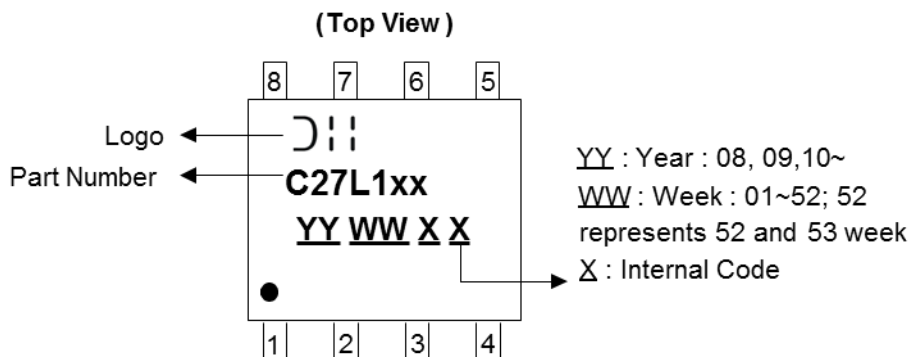
Normalized to $F_C = 1\text{ kHz}$ and $R_L = 10\text{ k}\Omega$

Figure 48 Two-Pole Low-Pass Butterworth Filter

Marking Information

SO-8

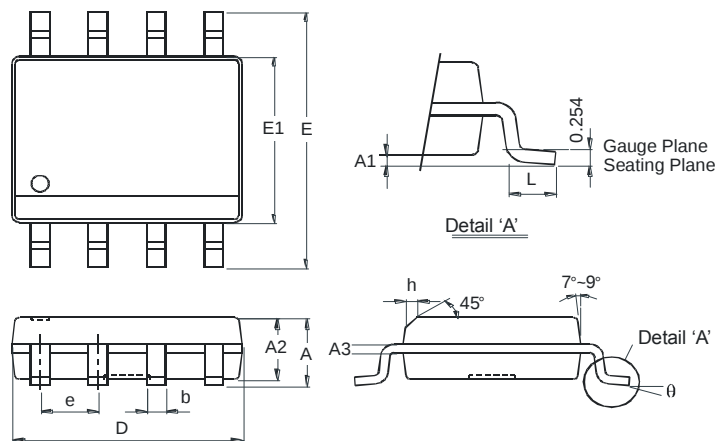
Part mark	Part number
C27L1C	TLC27L1CS
C27L1AC	TLC27L1ACS
C27L1BC	TLC27L1BCS
C27L1I	TLC27L1IS
C27L1AI	TLC27L1AIS
C27L1BI	TLC27L1BIS



Package Outline Dimensions

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

Package Type: 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		

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