High Speed, Low Power Dual Op Amp

AD827

FEATURES

HIGH SPEED
50 MHz Unity Gain Stable Operation
300 V/μs Slew Rate
120 ns Settling Time
Drives Unlimited Capacitive Loads

EXCELLENT VIDEO PERFORMANCE
0.04% Differential Gain @ 4.4 MHz
0.19° Differential Phase @ 4.4 MHz

GOOD DC PERFORMANCE
2 mV max Input Offset Voltage
15 μV/°C Input Offset Voltage Drift
Available in Tape and Reel in Accordance with EIA-481A Standard

LOW POWER
Only 10 mA Total Supply Current for Both Amplifiers
±5 V to ±15 V Supplies

PRODUCT DESCRIPTION

The AD827 is a dual version of Analog Devices' industry-standard AD847 op amp. Like the AD847, it provides high speed, low power performance at low cost. The AD827 achieves a 300 V/μs slew rate and 50 MHz unity-gain bandwidth while consuming only 100 mW when operating from ±5 volt power supplies. Performance is specified for operation using ±5 V to ±15 V power supplies.

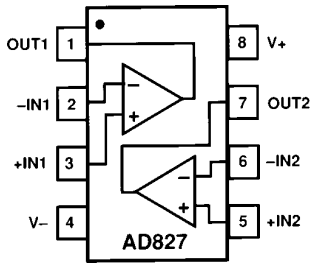
The AD827 offers an open-loop gain of 3,500 V/V into 500 Ω loads. It also features a low input voltage noise of 15 nV/√Hz, and a low input offset voltage of 2 mV maximum. Common-mode rejection ratio is a minimum of 80 dB. Power supply rejection ratio is maintained at better than 20 dB with input frequencies as high as 1 MHz, thus minimizing noise feedthrough from switching power supplies.

The AD827 is also ideal for use in demanding video applications, driving coaxial cables with less than 0.04% differential gain and 0.19° differential phase errors for 643 mV p-p into a 75 Ω reverse terminated cable.

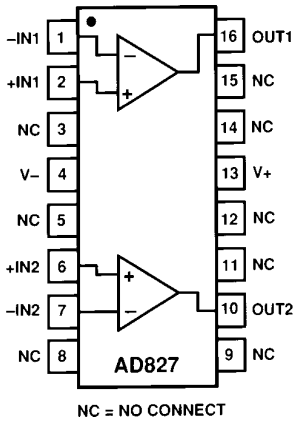
The AD827 is also useful in multichannel, high speed data conversion systems where its fast (120 ns to 0.1%) settling time is of importance. In such applications, the AD827 serves as an input buffer for 8-bit to 10-bit A/D converters and as an output amplifier for high speed D/A converters.

CONNECTION DIAGRAMS

8-Pin Plastic (N) and Cerdip (Q) Packages

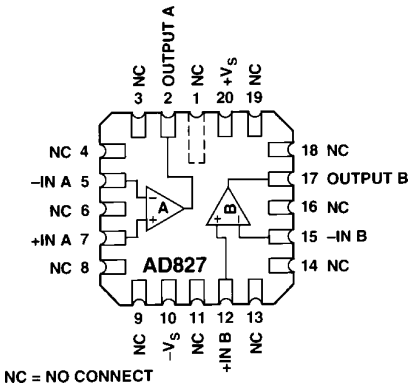


16-Pin Small Outline (R) Package



NC = NO CONNECT

20-Pin LCC (E) Package



NC = NO CONNECT

APPLICATION HIGHLIGHTS

1. Performance is fully specified for operation using ±5 V to ±15 V supplies.
2. A 0.04% differential gain and 0.19° differential phase error at the 4.4 MHz color subcarrier frequency, together with its low cost, make it ideal for many video applications.
3. The AD827 can drive unlimited capacitive loads, while its 30 mA output current allows 50 Ω and 75 Ω reverse-terminated loads to be driven.
4. The AD827's 50 MHz unity-gain bandwidth makes it an ideal candidate for multistage active filters.
5. The AD827 is available in 8-pin plastic mini-DIP and cerdip, 20-pin LCC, and 16-pin SOIC packages. Chips and MIL-STD-883B processing are also available.

REV. B

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AD827—SPECIFICATIONS (@ T_A = +25°C, unless otherwise noted)

Model	Conditions	V_S	AD827J Min	AD827J Typ	AD827J Max	AD827A/S Min	AD827A/S Typ	AD827A/S Max	Units
DC PERFORMANCE									
Input Offset Voltage[1]		±5 V		0.5	2		0.3	2	mV
	T_{MIN} to T_{MAX}				3.5			4	mV
		±15 V			4			4	mV
	T_{MIN} to T_{MAX}				6			6	mV
Offset Voltage Drift		±5 V to ±15 V		15			15		µV/°C
Input Bias Current		±5 V to ±15 V		3.3	7		3.3	7	µA
	T_{MIN} to T_{MAX}				8.2			9.5	µA
Input Offset Current		±5 V to ±15 V		50	300		50	300	nA
	T_{MIN} to T_{MAX}				400			400	nA
Offset Current Drift		±5 V to ±15 V		0.5			0.5		nA/°C
Common-Mode Rejection Ratio	V_{CM} = ±2.5 V	±5 V	78	95		80	95		dB
	V_{CM} = ±12 V	±15 V	78	95		80	95		dB
	T_{MIN} to T_{MAX}	±5 V to ±15 V	75			75			dB
Power Supply Rejection Ratio		±5 V to ±15 V	75	86		75	86		dB
	T_{MIN} to T_{MAX}		72			72			dB
Open-Loop Gain									
	V_O = ±2.5 V	±5 V							
	R_{LOAD} = 500 Ω		2	3.5		2	3.5		V/mV
	T_{MIN} to T_{MAX}		1			1			V/mV
	R_{LOAD} = 150 Ω			1.6			1.6		V/mV
	V_{OUT} = ±10 V	±15 V							
	R_{LOAD} = 1 kΩ		3	5.5		3	5.5		V/mV
	T_{MIN} to T_{MAX}		1.5			1.5			V/mV
MATCHING CHARACTERISTICS									
Input Offset Voltage		±5 V		0.4			0.2		mV
Crosstalk	f = 5 MHz	±5 V		85			85		dB
DYNAMIC PERFORMANCE									
Unity-Gain Bandwidth		±5 V		35			35		MHz
		±15 V		50			50		MHz
Full Power Bandwidth[2]	V_O = 5 V p-p,								
	R_{LOAD} = 500 Ω	±5 V		12.7			12.7		MHz
	V_O = 20 V p-p,								
	R_{LOAD} = 1 kΩ	±15 V		4.7			4.7		MHz
Slew Rate[3]	R_{LOAD} = 500 Ω	±5 V		200			200		V/µs
	R_{LOAD} = 1 kΩ	±15 V		300			300		V/µs
Settling Time to 0.1%	A_V = –1								
	–2.5 V to +2.5 V	±5 V		65			65		ns
	–5 V to +5 V	±15 V		120			120		ns
Phase Margin	C_{LOAD} = 10 pF	±15 V							
	R_{LOAD} = 1 kΩ			50			50		Degrees
Differential Gain Error	f = 4.4 MHz	±15 V		0.04			0.04		%
Differential Phase Error	f = 4.4 MHz	±15 V		0.19			0.19		Degrees
Input Voltage Noise	f = 10 kHz	±15 V		15			15		nV/$\sqrt{\text{Hz}}$
Input Current Noise	f = 10 kHz	±15 V		1.5			1.5		pA/$\sqrt{\text{Hz}}$
Input Common-Mode									
Voltage Range		±5 V		+4.3			+4.3		V
				–3.4			–3.4		V
		±15 V		+14.3			+14.3		V
				–13.4			–13.4		V
Output Voltage Swing	R_{LOAD} = 500 Ω	±5 V	3.0	3.6		3.0	3.6		±V
	R_{LOAD} = 150 Ω	±5 V	2.5	3.0		2.5	3.0		±V
	R_{LOAD} = 1 kΩ	±15 V	12	13.3		12	13.3		±V
	R_{LOAD} = 500 Ω	±15 V	10	12.2		10	12.2		±V
Short-Circuit Current Limit		±5 V to ±15 V		32			32		mA
INPUT CHARACTERISTICS									
Input Resistance				300			300		kΩ
Input Capacitance				1.5			1.5		pF

Model	Conditions	V_S	AD827J Min	AD827J Typ	AD827J Max	AD827A/S Min	AD827A/S Typ	AD827A/S Max	Units
OUTPUT RESISTANCE	Open Loop			15				15	Ω
POWER SUPPLY									
Operating Range			±4.5		±18	±4.5		±18	V
Quiescent Current		±5 V		10	13		10	13	mA
	T_{MIN} to T_{MAX}				16			16.5/17.5	mA
		±15 V		10.5	13.5		10.5	13.5	mA
	T_{MIN} to T_{MAX}				16.5			17/18	mA
TRANSISTOR COUNT				92			92		

NOTES
[1]Offset voltage for the AD827 is guaranteed after power is applied and the device is fully warmed up. All other specifications are measured using high speed test equipment, approximately 1 second after power is applied.
[2]Full Power Bandwidth = Slew Rate/2 π V_{PEAK}.
[3]Gain = +1, rising edge.
All min and max specifications are guaranteed.

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS[1]

Supply Voltage . . . . . ±18 V
Internal Power Dissipation[2]
Plastic (N) Package (Derate at 10 mW/°C) . . . . . 1.5 W
Cerdip (Q) Package (Derate at 8.7 mW/°C) . . . . . 1.3 W
Small Outline (R) Package (Derate at 10 mW/°C) . . . 1.5 W
LCC (E) Package (Derate at 6.7 mW/°C) . . . . . 1.0 W
Input Common Mode Voltage . . . . . ±V_S
Differential Input Voltage . . . . . 6 V
Output Short Circuit Duration[3] . . . . . Indefinite
Storage Temperature Range (N, R) . . . . . –65°C to +125°C
Storage Temperature Range (Q) . . . . . –65°C to +150°C
Operating Temperature Range
AD827J . . . . . 0°C to +70°C
AD827A . . . . . –40°C to +85°C
AD827S . . . . . –55°C to +125°C
Lead Temperature Range
(Soldering to 60 sec) . . . . . +300°C

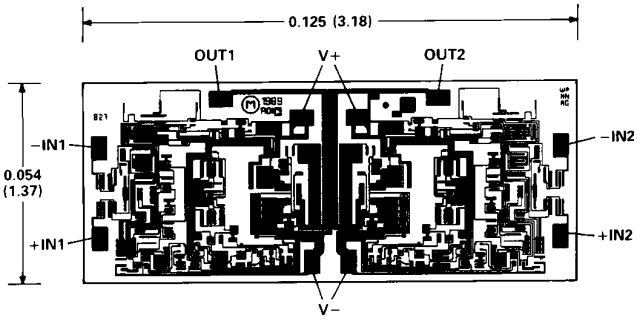
NOTES
[1]Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only, and functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.
[2]Maximum internal power dissipation is specified so that T_J does not exceed +175°C at an ambient temperature of +25°C.
Thermal Characteristics:
Mini-DIP: θ_{JA} = 100°C/Watt; θ_{JC} = 33°C/ Watt
Cerdip: θ_{JA} = 110°C/Watt; θ_{JC} = 30°C/Watt
16-Pin Small Outline Package: θ_{JA} = 100°C/Watt
20-Pin LCC: θ_{JA} = 150°C/Watt; θ_{JC} = 35°C/Watt
[3]Indefinite short circuit duration is only permissible as long as the absolute maximum power rating is not exceeded.

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
AD827JN	0°C to +70°C	8-Pin Plastic DIP	N-8
AD827JR	0°C to +70°C	16-Pin Plastic SO	R-16
AD827AQ	–40°C to +85°C	8-Pin Cerdip	Q-8
AD827SQ	–55°C to +125°C	8-Pin Cerdip	Q-8
AD827SQ/883B	–55°C to +125°C	8-Pin Cerdip	Q-8
5962-9211701MPA	–55°C to +125°C	8-Pin Cerdip	Q-8
AD827SE/883B	–55°C to +125°C	20-Pin LCC	E-20A
5962-9211701M2A	–55°C to +125°C	20-Pin LCC	E-20A
AD827JR-REEL	0°C to +70°C	Tape & Reel	
AD827JChips	0°C to +70°C	Die	
AD827SChips	–55°C to +125°C	Die	

METALIZATION PHOTOGRAPHY

Contact factory for latest dimensions.
Dimensions shown in inches and (mm).
Substrate is connected to V+.



AD827–Typical Characteristics (@ +25°C & ±15 V, unless otherwise noted)

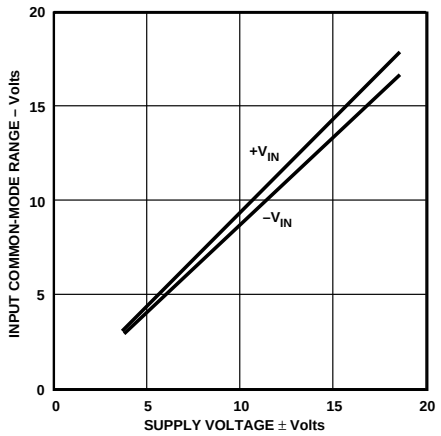


Figure 1. Input Common-Mode Range vs. Supply Voltage

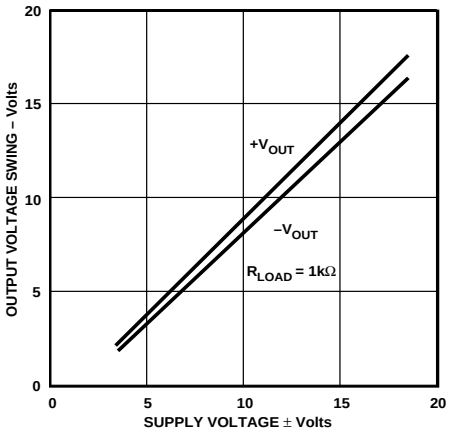


Figure 2. Output Voltage Swing vs. Supply Voltage

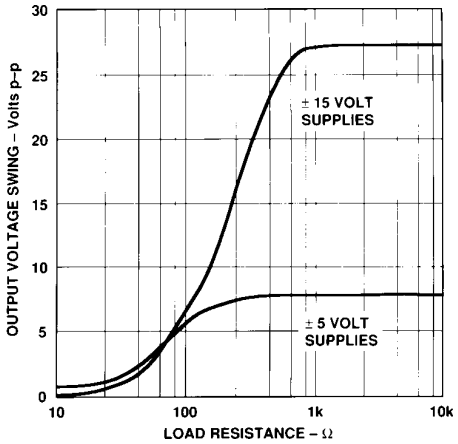


Figure 3. Output Voltage Swing vs. Load Resistance

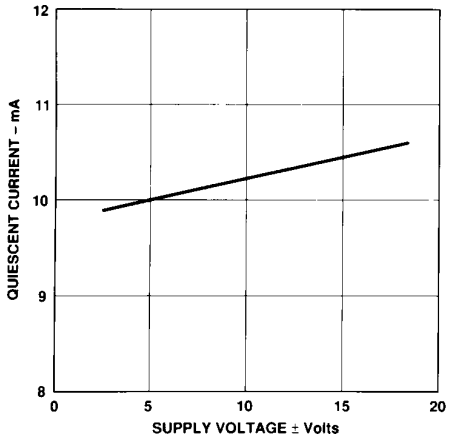


Figure 4. Quiescent Current vs. Supply Voltage

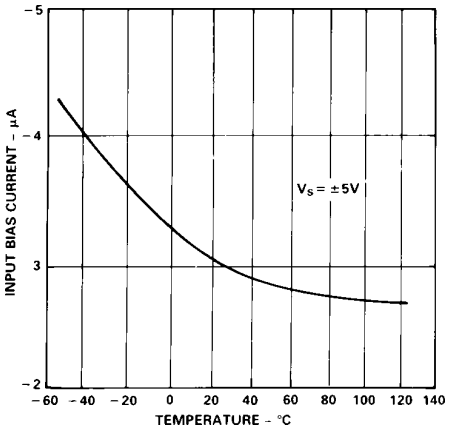


Figure 5. Input Bias Current vs. Temperature

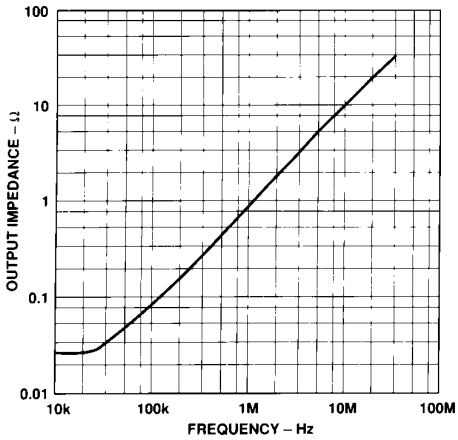


Figure 6. Closed-Loop Output Impedance vs. Frequency, Gain = +1

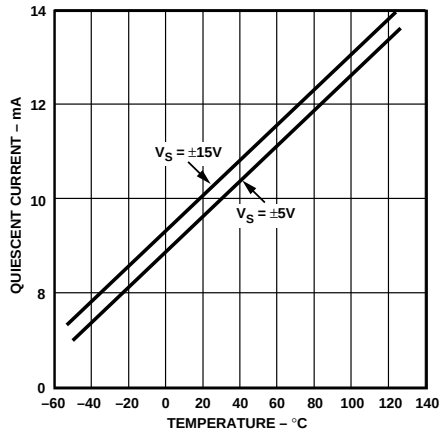


Figure 7. Quiescent Current vs. Temperature

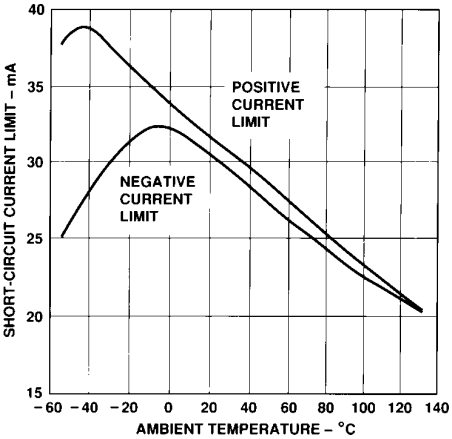


Figure 8. Short-Circuit Current Limit vs. Temperature

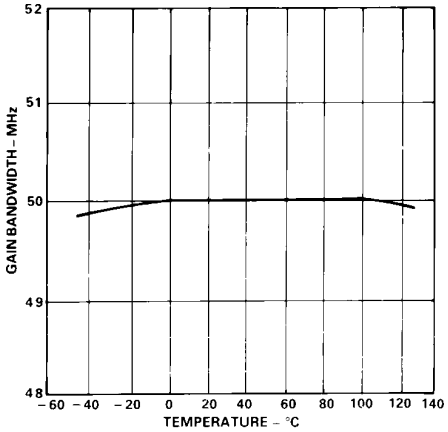


Figure 9. Gain Bandwidth vs. Temperature

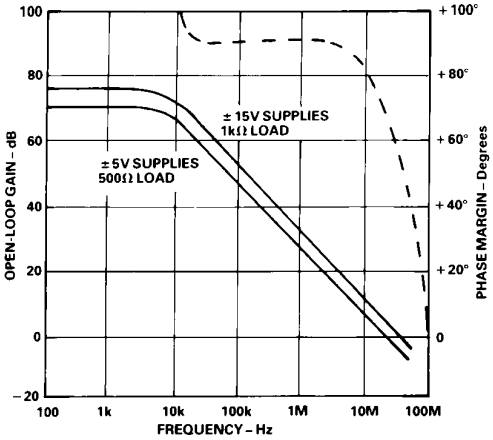


Figure 10. Open-Loop Gain and Phase Margin vs. Frequency

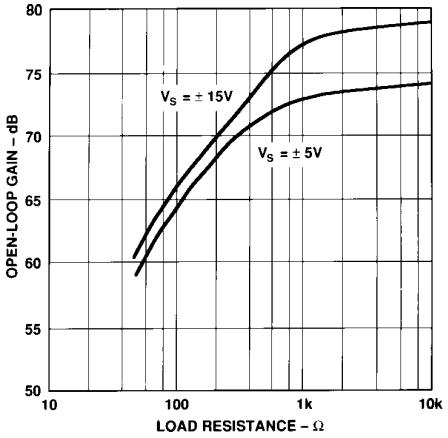


Figure 11. Open-Loop Gain vs. Load Resistance

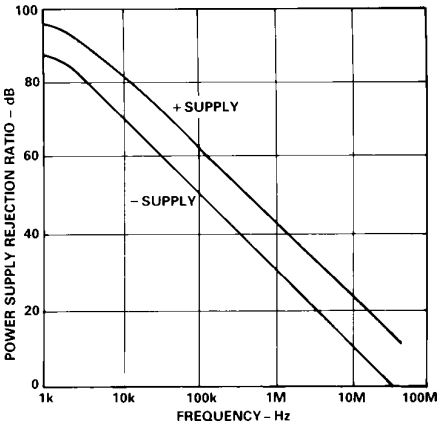


Figure 12. Power Supply Rejection Ratio vs. Frequency

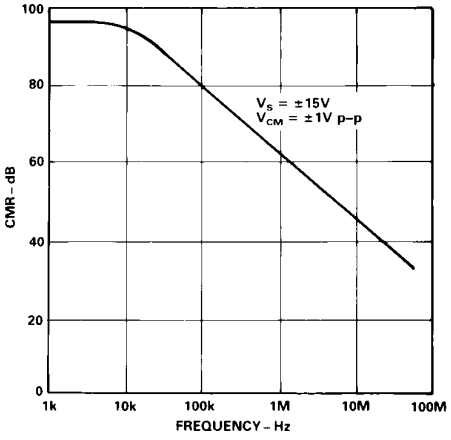


Figure 13. Common-Mode Rejection Ratio vs. Frequency

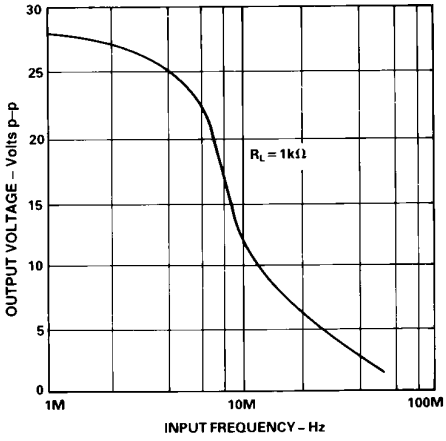


Figure 14. Large Signal Frequency Response

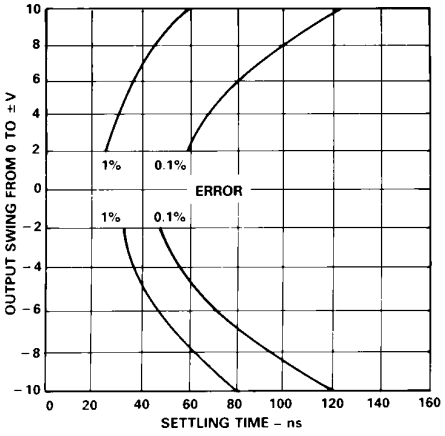


Figure 15. Output Swing and Error vs. Settling Time

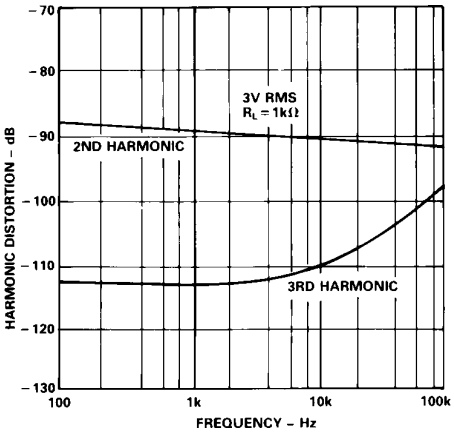


Figure 16. Harmonic Distortion vs. Frequency

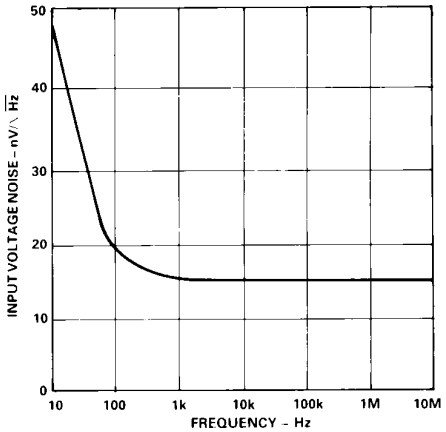


Figure 17. Input Voltage Noise Spectral Density

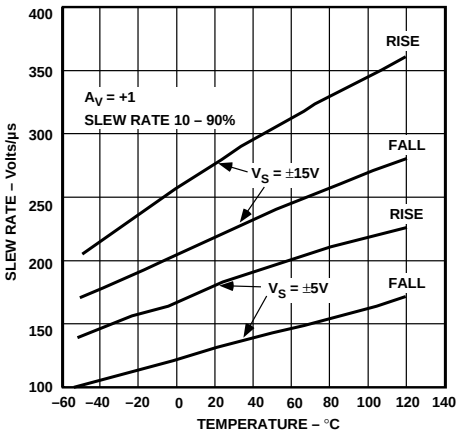


Figure 18. Slew Rate vs. Temperature

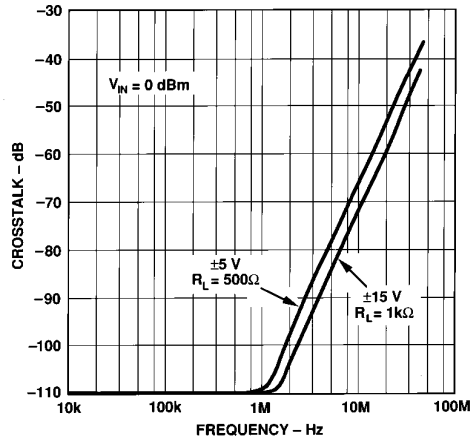


Figure 19. Crosstalk vs. Frequency

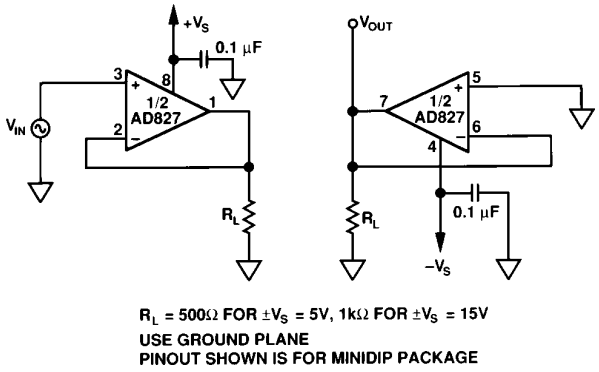


Figure 20. Crosstalk Test Circuit

INPUT PROTECTION PRECAUTIONS

An input resistor (resistor R_{IN} of Figure 21a) is recommended in circuits where the input common-mode voltage to the AD827 may exceed (on a transient basis) the positive supply voltage. This resistor provides protection for the input transistors by limiting the maximum current that can be forced into their bases.

For high performance circuits, it is recommended that a second resistor (R_B in Figures 21a and 22a) be used to reduce bias-current errors by matching the impedance at each input. This resistor reduces the error caused by offset voltages by more than an order of magnitude.

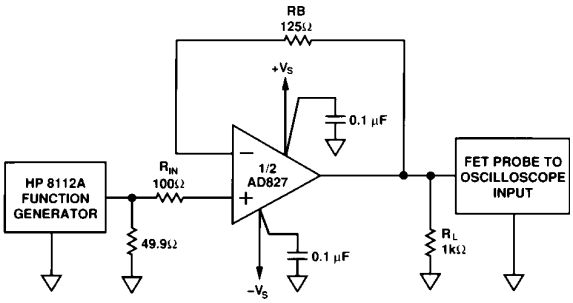


Figure 21a. Follower Connection

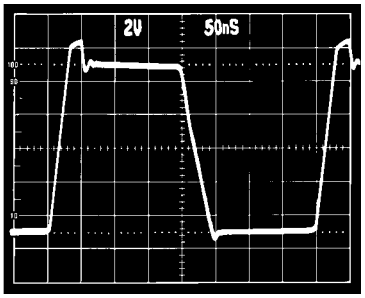


Figure 21b. Follower Large Signal Pulse Response

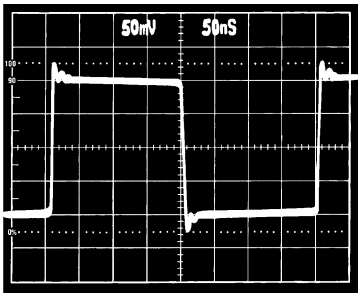


Figure 21c. Follower Small Signal Pulse Response

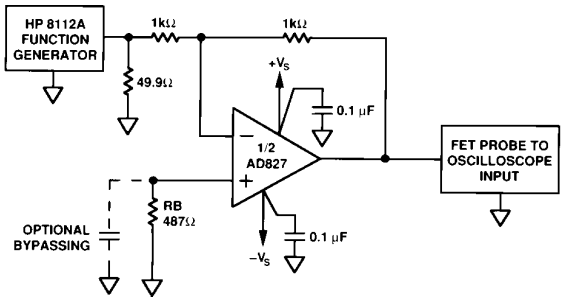


Figure 22a. Inverter Connection

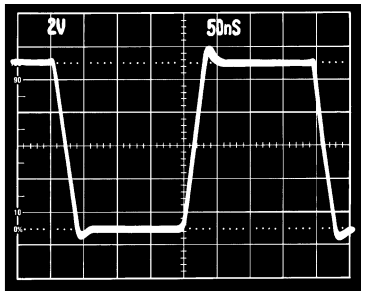


Figure 22b. Inverter Large Signal Pulse Response

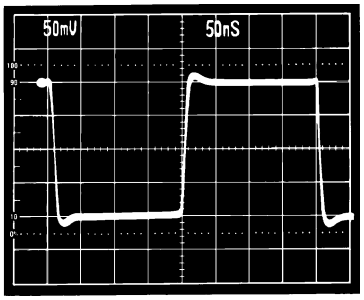


Figure 22c. Inverter Small Signal Pulse Response

VIDEO LINE DRIVER

The AD827 functions very well as a low cost, high speed line driver for either terminated or unterminated cables. Figure 23 shows the AD827 driving a doubly terminated cable in a follower configuration.

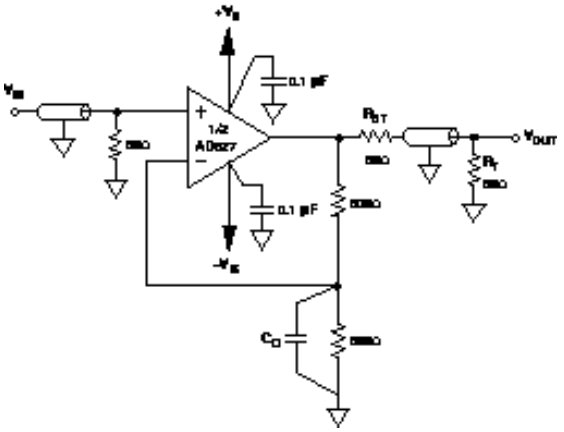


Figure 23. A Video Line Driver

The termination resistor, R_T, (when equal to the cable's characteristic impedance) minimizes reflections from the far end of the cable. While operating from ±5 V supplies, the AD827 maintains a typical slew rate of 200 V/μs, which means it can drive a ±1 V, 30 MHz signal into a terminated cable.

Table I. Video Line Driver Performance Summary

V_{IN}*	V_{SUPPLY}	C_C	–3 dB B_W	Over-shoot
0 dB or ±500 mV Step	±15	20 pF	23 MHz	4%
0 dB or ±500 mV Step	±15	15 pF	21 MHz	0%
0 dB or ±500 mV Step	±15	0 pF	13 MHz	0%
0 dB or ±500 mV Step	±5	20 pF	18 MHz	2%
0 dB or ±500 mV Step	±5	15 pF	16 MHz	0%
0 dB or ±500 mV Step	±5	0 pF	11 MHz	0%

NOTE
*–3 dB bandwidth numbers are for the 0 dBm signal input. Overshoot numbers are the percent overshoot of the 1 Volt step input.

A back-termination resistor (R_{BT}, also equal to the characteristic impedance of the cable) may be placed between the AD827 output and the cable input, in order to damp any reflected signals caused by a mismatch between R_T and the cable's characteristic impedance. This will result in a flatter frequency response, although this requires that the op amp supply ±2 V to the output in order to achieve a ±1 V swing at resistor R_T.

A HIGH SPEED 3 OP AMP INSTRUMENTATION AMPLIFIER CIRCUIT

The instrumentation amplifier circuit shown in Figure 24 can provide a range of gains. The chart of Table II details performance.

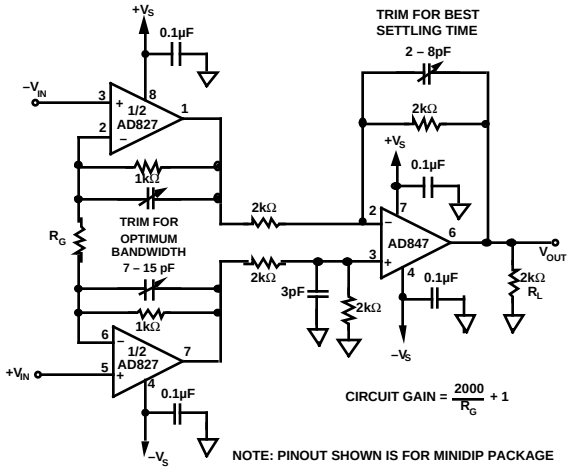


Figure 24. A High Bandwidth Three Op Amp Instrumentation Amplifier

Table II. Performance Specifications for the Three Op Amp Instrumentation Amplifier

Gain	R_G	Small Signal Bandwidth @ 1 V p-p Output
1	Open	16.1 MHz
2	2 k	14.7 MHz
10	226 Ω	4.9 MHz
100	20 Ω	660 kHz

A TWO-CHIP VOLTAGE-CONTROLLED AMPLIFIER (VCA) WITH EXPONENTIAL RESPONSE

Voltage-controlled amplifiers are often used as building blocks in automatic gain control systems. Figure 25 shows a two-chip VCA built using the AD827 and the AD539, a dual, current-output multiplier. As configured, the circuit has its two

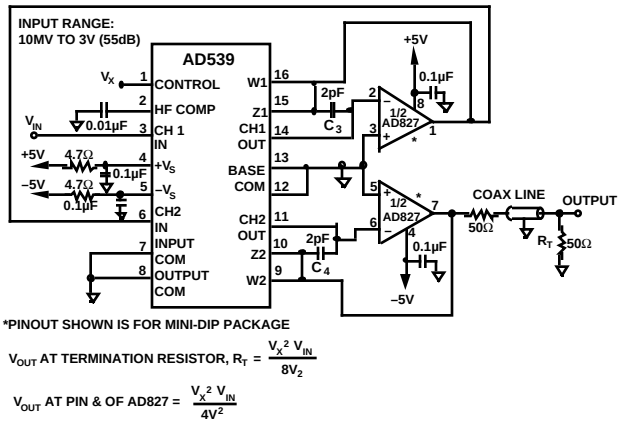


Figure 25. A Wide Range Voltage-Controlled Amplifier Circuit

multipliers connected in series. They could also be placed in parallel with an increase in bandwidth and a reduction in gain. The gain of the circuit is controlled by V_X, which can range from 0 to 3 V dc. Measurements show that this circuit easily supplies 2 V p-p into a 100 Ω load while operating from ±5 V supplies. The overall bandwidth of the circuit is approximately 7 MHz with 0.5 dB of peaking.

Each half of the AD827 serves as an I/V converter and converts the output current of one of the two multipliers in the AD539 into an output voltage. Each of the AD539's two multipliers contains two internal 6 kΩ feedback resistors; one is connected between the CH1 output and Z1, the other between the CH1 output and W1. Likewise, in the CH2 multiplier, one of the feedback resistors is connected between CH2 and Z2 and the other is connected between CH2 and Z2. In Figure 25, Z1 and W1 are tied together, as are Z2 and W2, providing a 3 kΩ feedback resistor for the op amp. The 2 pF capacitors connected between the AD539's W1 and CH1 and W2 and CH2 pins are in parallel with the feedback resistors and thus reduce peaking in the VCA's frequency response. Increasing the values of C3 and C4 can further reduce the peaking at the expense of reduced bandwidth. The 1.25 mA full-scale output current of the AD539 and the 3 kΩ feedback resistor set the full-scale output voltage of each multiplier at 3.25 V p-p.

Current limiting in the AD827 (typically 30 mA) limits the output voltage in this application to about 3 V p-p across a 100 Ω load. Driving a 50 Ω reverse-terminated load divides this value by two, limiting the maximum signal delivered to a 50 Ω load to about 1.5 V p-p, which suffices for video signal levels. The dynamic range of this circuit is approximately 55 dB and is primarily limited by feedthrough at low input levels and by the maximum output voltage at high levels.

Guidelines for Grounding and Bypassing

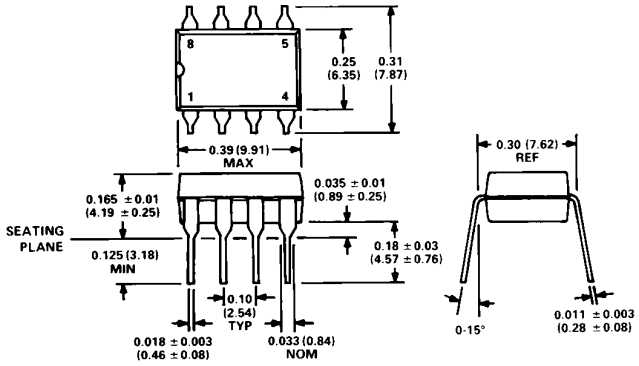
When designing practical high frequency circuits using the AD827, some special precautions are in order. Both short interconnection leads and a large ground plane are needed whenever possible to provide low resistance, low inductance circuit paths. One should remember to minimize the effects of capacitive coupling between circuits. Furthermore, IC sockets should be avoided. Feedback resistors should be of a low enough value that the time constant formed with stray circuit capacitances at the amplifier summing junction will not limit circuit performance. As a rule of thumb, use feedback resistor values that are less than 5 kΩ. If a larger resistor value is necessary, a small (<10 pF) feedback capacitor in parallel with the feedback resistor may be used. The use of 0.1 μF ceramic disc capacitors is recommended for bypassing the op amp's power supply leads.

C1407–24–4/90

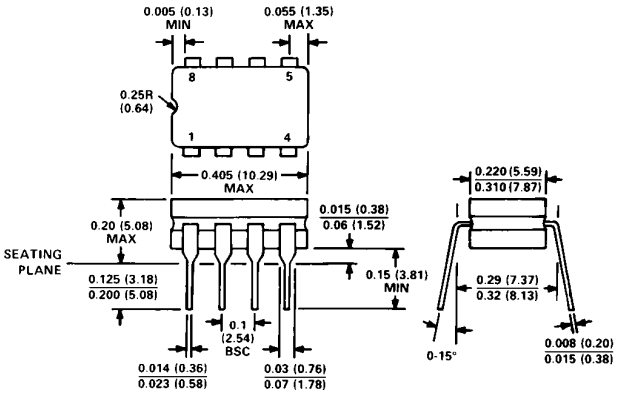
OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

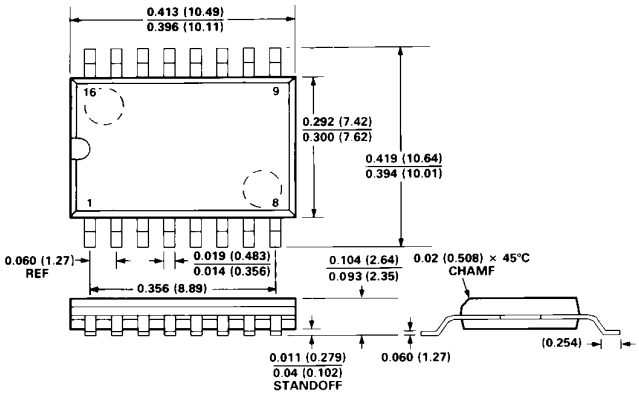
8-Pin Mini-DIP (N) Package



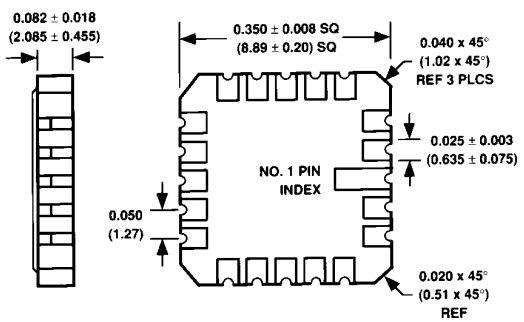
8-Pin Cerdip (Q) Package



16-Pin SOIC (R) Package



20-Terminal Leadless Ceramic Chip Carrier (E-20A)



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