EL5156, EL5157, EL5256, EL5257

<1mV Voltage Offset, 600MHz Amplifiers

The EL5156, EL5157, EL5256, and EL5257 are 600MHz bandwidth -3dB voltage mode feedback amplifiers with DC accuracy of <0.01%, 1mV offsets and 40kV/V open loop gains. These amplifiers are ideally suited for applications ranging from precision measurement instrumentation to high speed video and monitor applications demanding the very highest linearity at very high frequency. Capable of operating with as little as 6.0mA of current from a single supply ranging from 5V to 12V and dual supplies ranging from ±2.5V to ±5.0V these amplifiers are also well suited for handheld, portable and battery-powered equipment. With their capability to output as much as 140mA, member of this family is comfortable with demanding load conditions.

Single amplifiers are available in SOT-23 packages and duals in a 10-pin MSOP package for applications where board space is critical. Additionally, singles and duals are available in the industry-standard 8-pin SO package. All parts operate over the industrial temperature range of -40°C to +85°C.

Ordering Information

PART NUMBER	PACKAGE	TAPE & REEL	PKG. DWG. #
EL5156IS	8-Pin SO	-	MDP0027
EL5156IS-T7	8-Pin SO	7”	MDP0027
EL5156IS-T13	8-Pin SO	13”	MDP0027
EL5157IW-T7	5-Pin SOT-23	7” (3K pcs)	MDP0038
EL5157IW-T7A	5-Pin SOT-23	7” (250 pcs)	MDP0038
EL5256IY	10-Pin MSOP	-	MDP0043
EL5256IY-T7	10-Pin MSOP	7”	MDP0043
EL5256IY-T13	10-Pin MSOP	13”	MDP0043
EL5257IS	8-Pin SO	-	MDP0027
EL5257IS-T7	8-Pin SO	7”	MDP0027
EL5257IS-T13	8-Pin SO	13”	MDP0027
EL5257IY	8-Pin MSOP	-	MDP0043
EL5257IY-T7	8-Pin MSOP	7”	MDP0043
EL5257IY-T13	8-Pin MSOP	13”	MDP0043

Features

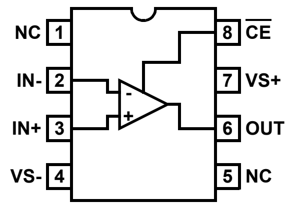
- 600MHz -3dB bandwidth, 240MHz 0.1dB bandwidth
- 700V/µs slew rate
- <1mV input offset
- Very high open loop gains 92dB
- Low supply current = 6mA
- 140mA output current
- Single supplies from 5V to 12V
- Dual supplies from ±2.5V to ±5V
- Fast disable on the EL5156 and EL5256
- Low cost

Applications

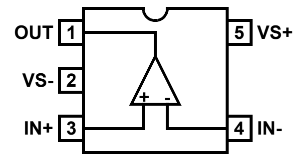
- Imaging
- Instrumentation
- Video
- Communications devices

Pinouts

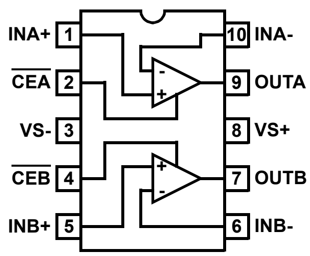
EL5156
(8-PIN SO)
TOP VIEW



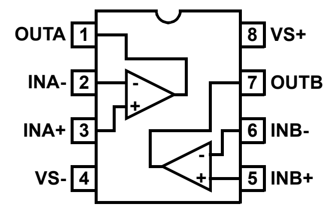
EL5157
(5-PIN SOT-23)
TOP VIEW



EL5256
(10-PIN MSOP)
TOP VIEW



EL5257
(8-PIN SO)
TOP VIEW



Absolute Maximum Ratings (T_A = 25°C)

Supply Voltage between V_S and GND 13.2V
Maximum Continuous Output Current 50mA
Pin Voltages . . . . GND -0.5V to V_S +0.5V
Power Dissipation . . . . See Curves
Junction Temperature . . . . +125°C
Storage Temperature . . . .-65°C to +150°C
Ambient Operating Temperature . . . .-40°C to +85°C
Current into I_N+, I_N-, CE 5mA

CAUTION: Stresses above those listed in “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

IMPORTANT NOTE: All parameters having Min/Max specifications are guaranteed. Typical values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: $T_J = T_C = T_A$

Electrical Specifications

V_S+ = +5V, V_S- = -5V, $\overline{CE}$ = +5V, $R_F = R_G$ = 562Ω, R_L = 150Ω, T_A = 25°C, unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
AC PERFORMANCE						
BW	-3dB Bandwidth	A_V = +1, R_L = 500Ω, C_L = 4.7pF		600		MHz
		A_V = +2, R_L = 150Ω		180		MHz
GBWP	Gain Bandwidth Product	R_L = 150Ω		210		MHz
BW1	0.1dB Bandwidth	A_V = +2		70		MHz
SR	Slew Rate	V_O = -3.2V to +3.2V, A_V = +2, R_L = 150Ω	500	640		V/µs
		V_O = -3.2V to +3.2V, A_V = +1, R_L = 500Ω		700		V/µs
t_S	0.1% Settling Time	A_V = +1		15		ns
dG	Differential Gain Error	A_V = +2, R_L = 150Ω		0.005		%
dP	Differential Phase Error	A_V = +2, R_L = 150Ω		0.04		°
V_N	Input Referred Voltage Noise			12		nV/√Hz
I_N	Input Referred Current Noise			5.5		pA/√Hz
DC PERFORMANCE						
V_{OS}	Offset Voltage		-1	0.5	1	mV
T_CV_{OS}	Input Offset Voltage Temperature Coefficient	Measured from T_{MIN} to T_{MAX}		-3		µV/°C
A_{VOL}	Open Loop Gain	V_O is from -2.5V to 2.5V	10	40		kV/V
INPUT CHARACTERISTICS						
CMIR	Common Mode Input Range	Guaranteed by CMRR test	-2.5		+2.5	V
CMRR	Common Mode Rejection Ratio	V_{CM} = 2.5V to -2.5V	80	108		dB
I_B	Input Bias Current	EL5156 & EL5157	-1	-0.4	+1	µA
		EL5256 & EL5257	-600	-200	+600	nA
I_{OS}	Input Offset Current		-250	100	+250	nA
R_{IN}	Input Resistance		10	25		MΩ
C_{IN}	Input Capacitance			1		pF
OUTPUT CHARACTERISTICS						
V_{OUT}	Output Voltage Swing	R_L = 150Ω to GND	±3.4	±3.6		V
		R_L = 500Ω to GND	±3.6	±3.8		V
I_{OUT}	Peak Output Current	R_L = 10Ω to GND	±80	±140		mA
ENABLE (EL5156 and EL5256 ONLY)						
t_{EN}	Enable Time			200		ns
t_{DIS}	Disable Time			300		ns

Electrical Specifications $V_S+ = +5V$, $V_S- = -5V$, $\overline{CE} = +5V$, $R_F = R_G = 562\Omega$, $R_L = 150\Omega$, $T_A = 25°C$, unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
I_{IHCE}	$\overline{CE}$ Pin Input High Current	$\overline{CE} = V_S+$		0	-1	µA
I_{ILCE}	$\overline{CE}$ Pin Input Low Current	$\overline{CE} = V_S-$	5	13	25	µA
V_{IHCE}	$\overline{CE}$ Input High Voltage for Power-down		V_S+ -1			V
V_{ILCE}	$\overline{CE}$ Input Low Voltage for Power-up				V_S+ -3	V
SUPPLY						
I_{SON}	Supply Current - Enabled (per amplifier)	No load, $V_{IN} = 0V$, $\overline{CE} = +5V$	5.1	6.0	6.9	mA
I_{SOFF}	Supply Current - Disabled (per amplifier)	No load, $V_{IN} = 0V$, $\overline{CE} = 5V$	5	13	25	µA
PSRR	Power Supply Rejection Ratio	DC, $V_S = \pm3.0V$ to $\pm6.0V$	75	90		dB

Typical Performance Curves

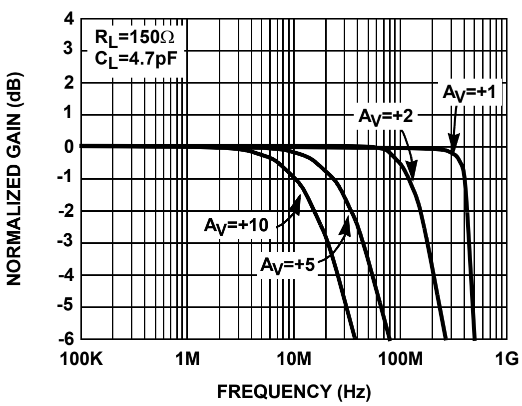


FIGURE 1. SMALL SIGNAL FREQUENCY RESPONSE - GAIN

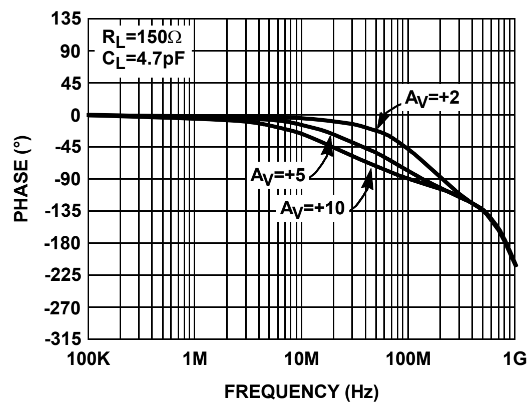


FIGURE 2. SMALL SIGNAL FREQUENCY RESPONSE - PHASE FOR VARIOUS GAINS

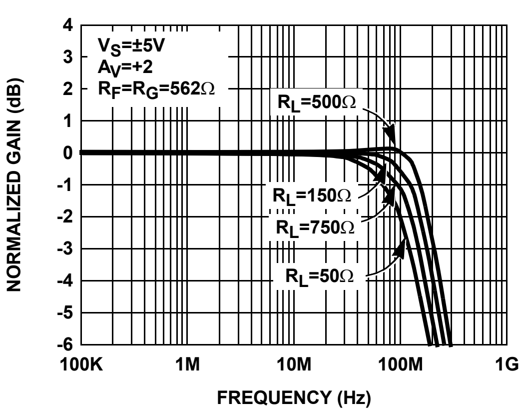


FIGURE 3. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS R_L

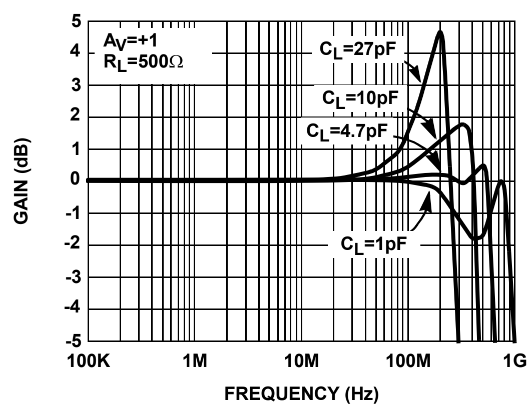


FIGURE 4. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS C_L

Typical Performance Curves (Continued)

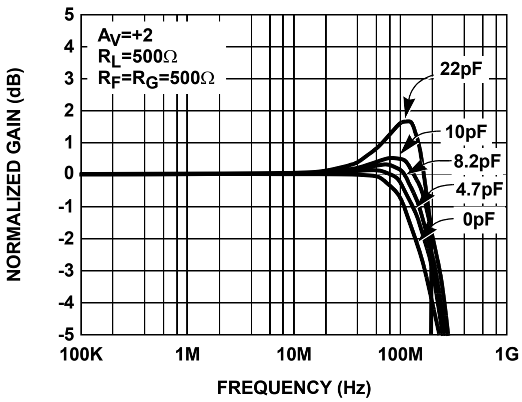


FIGURE 5. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS C_L

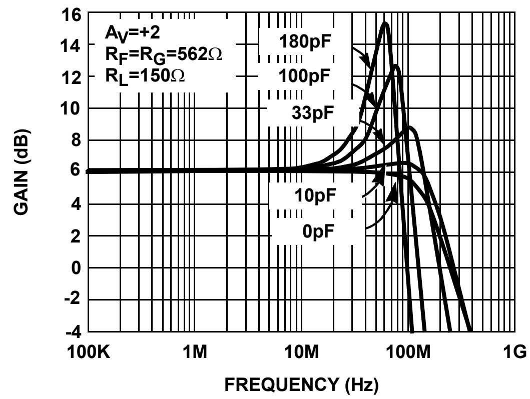


FIGURE 6. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS C_L

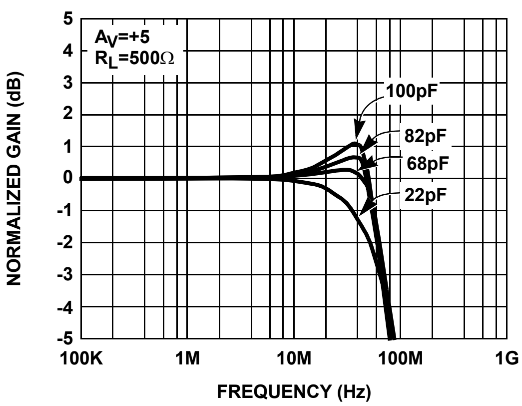


FIGURE 7. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS C_L

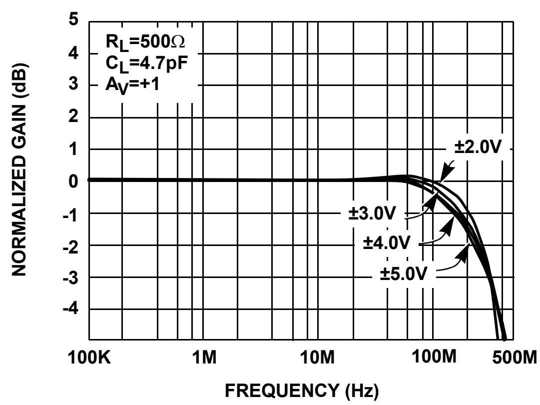


FIGURE 8. FREQUENCY RESPONSE vs POWER SUPPLY

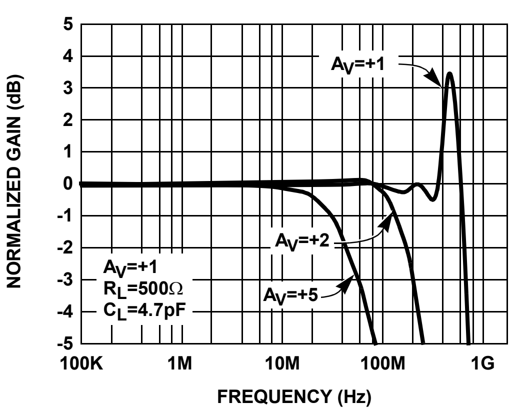


FIGURE 9. EL5256 SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS GAINS

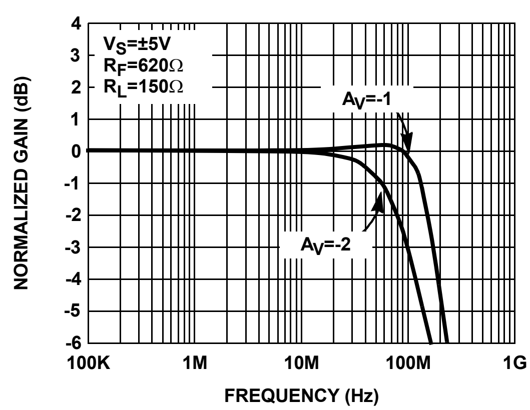


FIGURE 10. SMALL SIGNAL INVERTING FREQUENCY RESPONSE FOR VARIOUS GAINS

Typical Performance Curves (Continued)

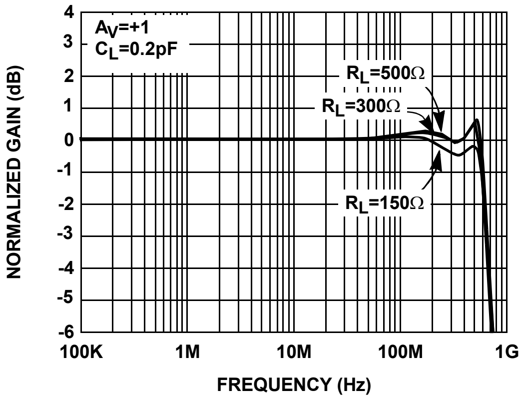


FIGURE 11. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS R_L

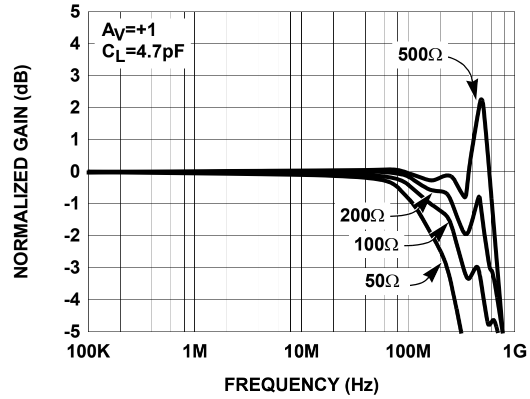


FIGURE 12. EL5256 SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS R_L

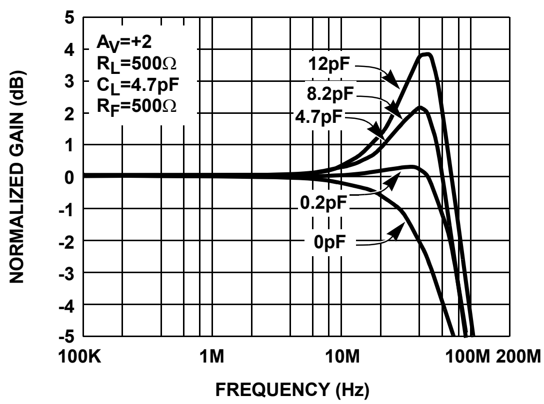


FIGURE 13. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS C_{IN}

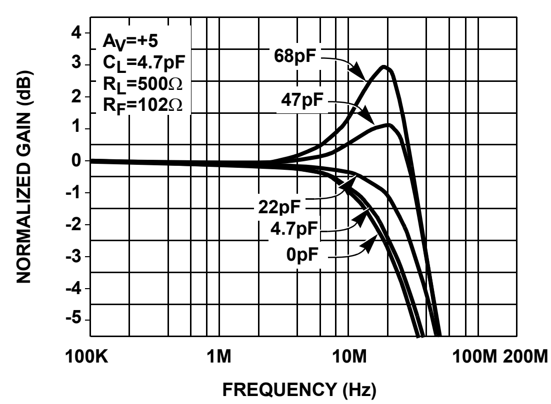


FIGURE 14. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS C_{IN}

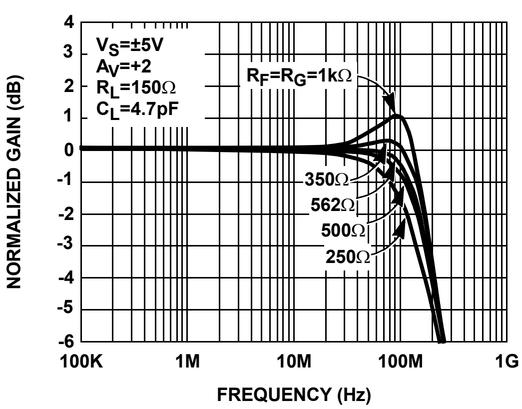


FIGURE 15. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS R_F AND R_G

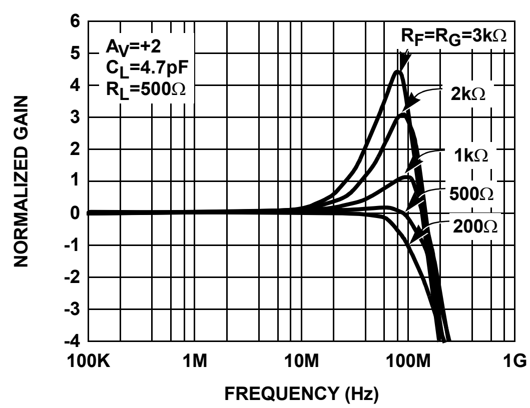


FIGURE 16. EL5256 SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS R_F/R_G

Typical Performance Curves (Continued)

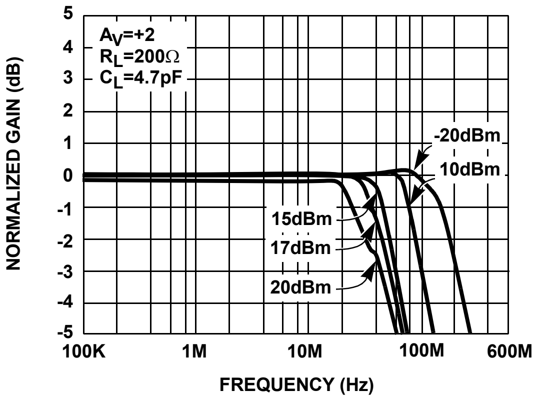


FIGURE 17. LARGE SIGNAL FREQUENCY RESPONSE FOR VARIOUS INPUT AMPLITUDES

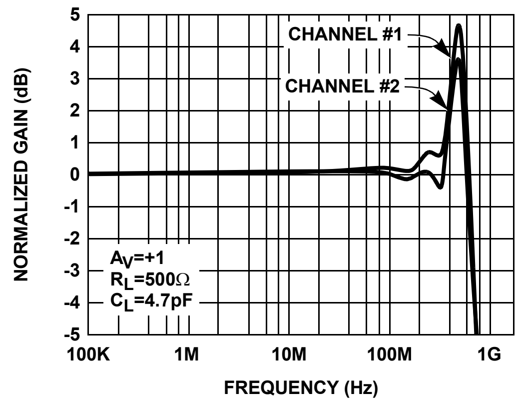


FIGURE 18. CHANNEL TO CHANNEL FREQUENCY RESPONSE

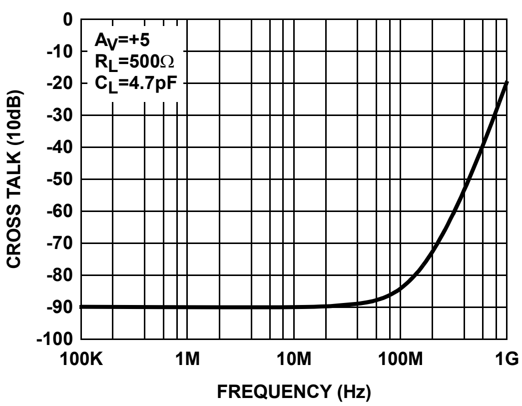


FIGURE 19. EL5256 CROSS TALK vs FREQUENCY CHANNEL A TO B & B TO A

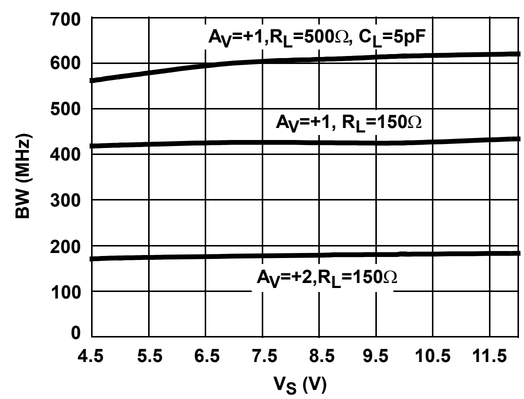


FIGURE 20. BANDWIDTH vs SUPPLY VOLTAGE

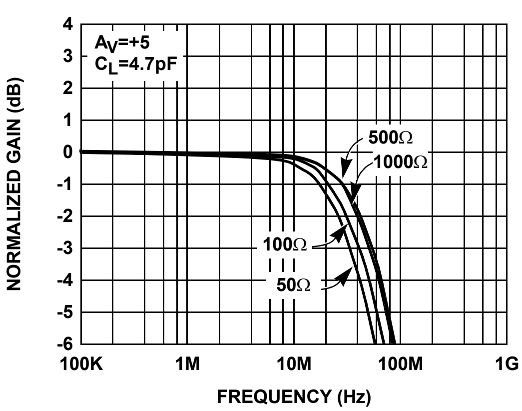


FIGURE 21. SMALL SIGNAL FREQUENCY RESPONSE FOR VARIOUS R_L

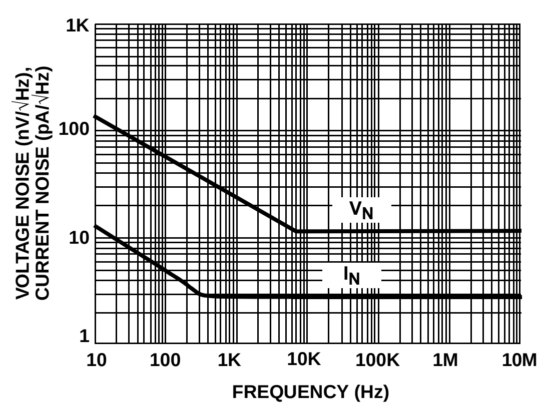


FIGURE 22. VOLTAGE AND CURRENT NOISE vs FREQUENCY

Typical Performance Curves (Continued)

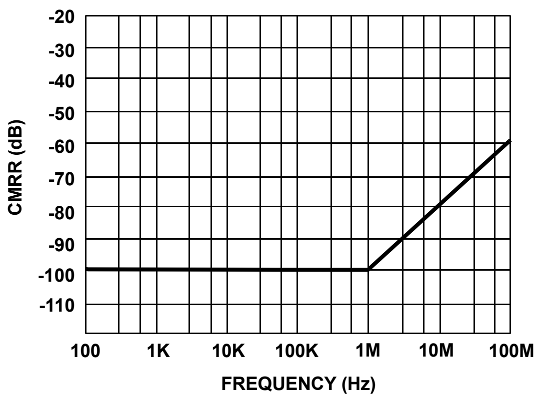


FIGURE 23. CMRR

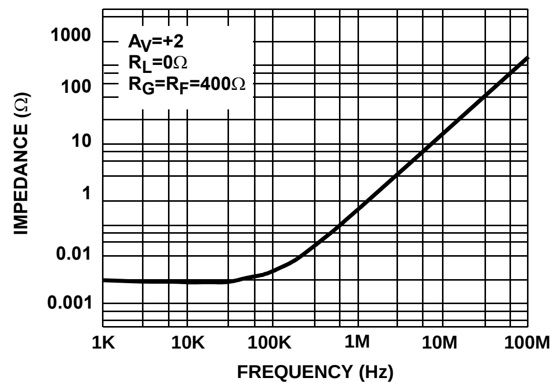


FIGURE 24. OUTPUT IMPEDANCE

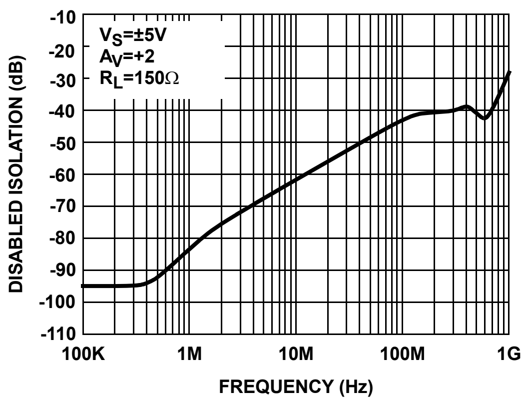


FIGURE 25. INPUT TO OUTPUT ISOLATION vs FREQUENCY - DISABLE

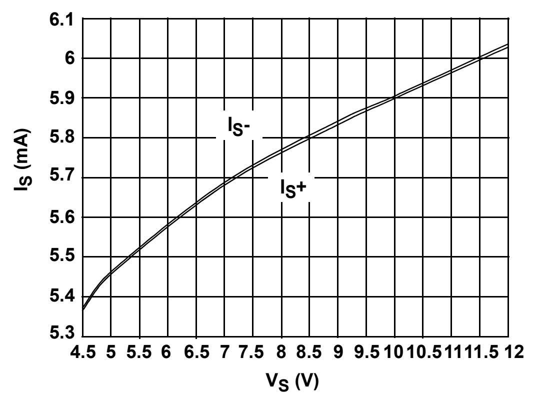


FIGURE 26. SUPPLY CURRENT vs SUPPLY VOLTAGE

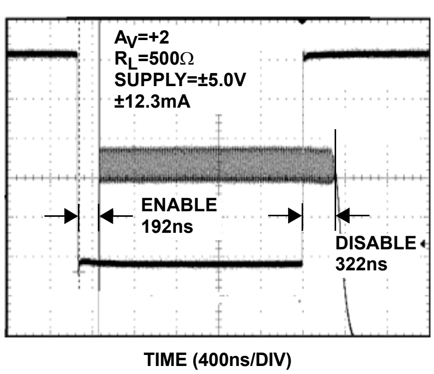


FIGURE 27. ENABLE/DISABLE RESPONSE

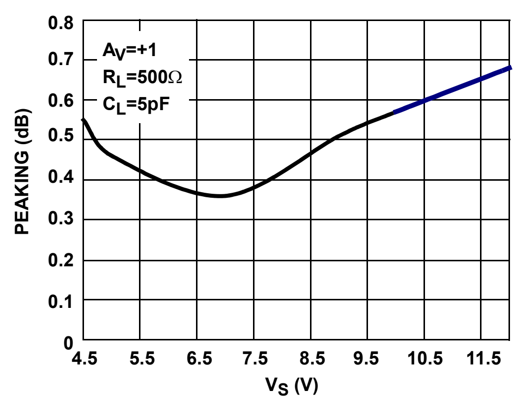


FIGURE 28. PEAKING vs SUPPLY VOLTAGE

Typical Performance Curves (Continued)

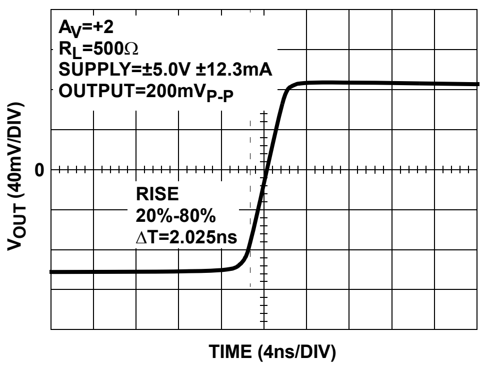


FIGURE 29. SMALL SIGNAL RISE TIME

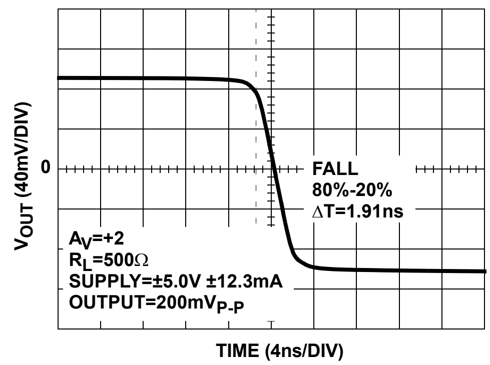


FIGURE 30. SMALL SIGNAL FALL TIME

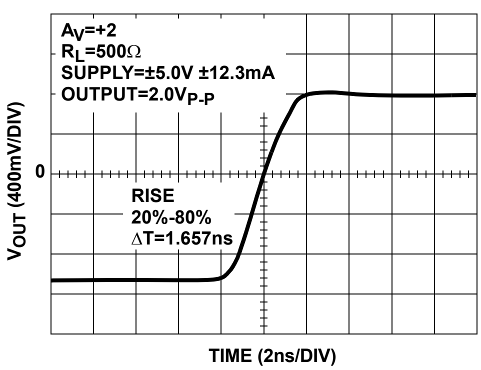


FIGURE 31. LARGE SIGNAL RISE TIME

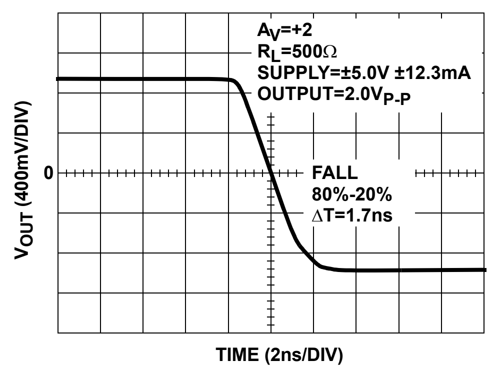


FIGURE 32. LARGE SIGNAL FALL TIME

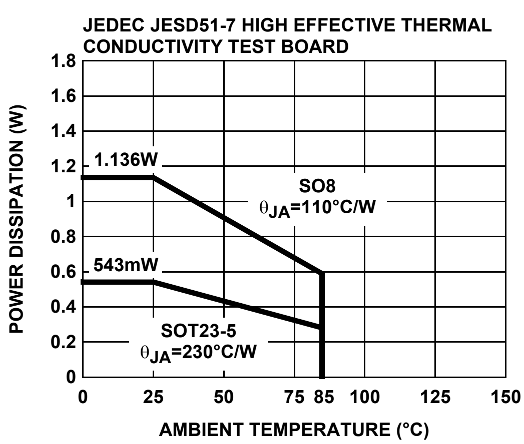


FIGURE 33. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

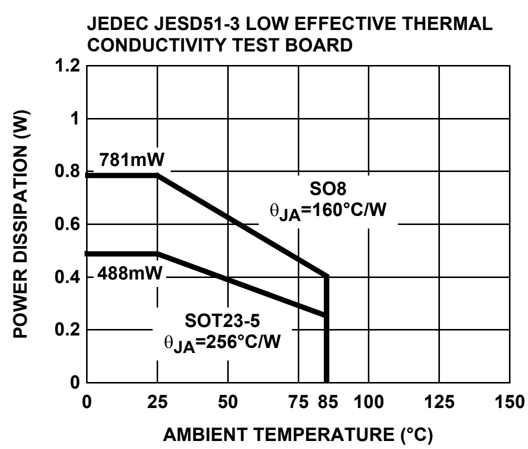


FIGURE 34. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

Typical Performance Curves (Continued)

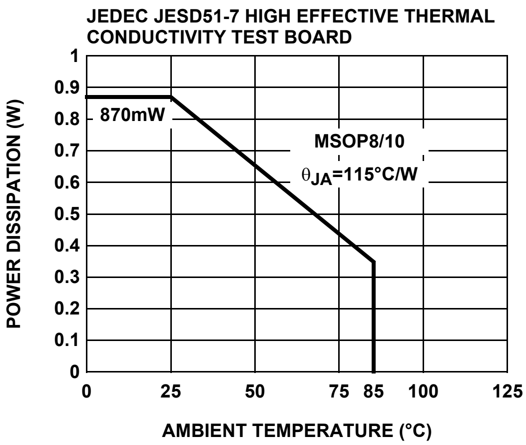


FIGURE 35. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

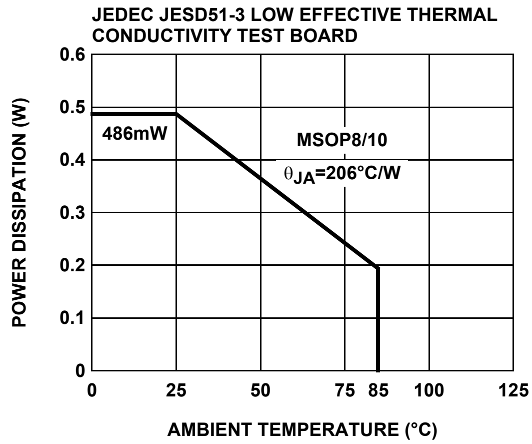


FIGURE 36. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

Product Description

The EL5156, EL5157, EL5256, and EL5257 are wide bandwidth, single or dual supply, low power and low offset voltage feedback operational amplifiers. Both amplifiers are internally compensated for closed loop gain of +1 or greater. Connected in voltage follower mode and driving a 500Ω load, the -3dB bandwidth is about 610MHz. Driving a 150Ω load and a gain of 2, the bandwidth is about 180MHz while maintaining a 600V/µs slew rate. The EL5156 and EL5256 are available with a power down pin to reduce power to 17µA typically while the amplifier is disabled.

Input, Output and Supply Voltage Range

The EL5156 and EL5157 families have been designed to operate with supply voltage from 5V to 12V. That means for single supply application, the supply voltage is from 5V to 12V. For split supplies application, the supply voltage is from ±2.5V to ±5V. The amplifiers have an input common mode voltage range from 1.5V above the negative supply (V_S- pin) to 1.5V below the positive supply (V_S+ pin). If the input signal is outside the above specified range, it will cause the output signal distorted.

The outputs of the EL5156 and EL5157 families can swing from -4V to 4V for V_S = ±5V. As the load resistance becomes lower, the output swing is lower. If the load resistor is 500Ω, the output swing is about -4V at a 4V supply. If the load resistor is 150Ω, the output swing is from -3.5V to 3.5V.

Choice of Feedback Resistor and Gain Bandwidth Product

For applications that require a gain of +1, no feedback resistor is required. Just short the output pin to the inverting input pin. For gains greater than +1, the feedback resistor forms a pole with the parasitic capacitance at the inverting input. As this pole becomes smaller, the amplifier's phase margin is reduced. This causes ringing in the time domain and peaking in the frequency domain. Therefore, RF can't be very big for optimum performance. If a large value of RF must be used, a small capacitor in the few Pico farad range in parallel with RF can help to reduce the ringing and peaking at the expense of reducing the bandwidth.

For gain of +1, RF = 0 is optimum. For the gains other than +1, optimum response is obtained with RF between 500Ω to 750Ω.

The EL5156 and EL5157 families have a gain bandwidth product of 210MHz. For gains > = 5, its bandwidth can be predicted by the following equation: (Gain)X(BW) = 210MHz.

Video Performance

For good video performance, an amplifier is required to maintain the same output impedance and the same frequency response as DC levels are changed at the output. This is especially difficult when driving a standard video load of 150Ω, because of the change in output current with DC level. The dG and dP for these families are about 0.006% and 0.04%, while driving 150Ω at a gain of 2. Driving high impedance loads would give a similar or better dG and dP performance.

Driving Capacitive Loads and Cables

The EL5156 and EL5157 families can drive 27pF loads in parallel with 500Ω with less than 5dB of peaking at gain of +1. If less peaking is desired in applications, a small series resistor (usually between 5Ω to 50Ω) can be placed in series with the output to eliminate most peaking. However, this will reduce the gain slightly. If the gain setting is greater than 1, the gain resistor RG can then be chosen to make up for any gain loss which may be created by the additional series resistor at the output.

When used as a cable driver, double termination is always recommended for reflection-free performance. For those applications, a back-termination series resistor at the amplifier's output will isolate the amplifier from the cable and allow extensive capacitive drive. However, other applications may have high capacitive loads without a back-termination resistor. Again, a small series resistor at the output can help to reduce peaking.

Disable/Power-Down

The EL5156 and EL5256 can be disabled and their output placed in a high impedance state. The turn off time is about 330ns and the turn on time is about 130ns. When disabled, the amplifier's supply current is reduced to 17µA typically, thereby effectively eliminating the power consumption. The amplifier's power down can be controlled by standard TTL or CMOS signal levels at the ENABLE pin. The applied logic signal is relative to V_S- pin. Letting the ENABLE pin float or applying a signal that is less than 0.8V above V_S- will enable the amplifier. The amplifier will be disabled when the signal at ENABLE pin is above V_S+ -1.5V.

Output Drive Capability

The EL5156 and EL5157 families do not have internal short circuit protection circuitry. They have a typical short circuit current of 95mA and 70mA. If the output is shorted indefinitely, the power dissipation could easily overheat the die or the current could eventually compromise metal integrity. Maximum reliability is maintained if the output current never exceeds ±40mA. This limit is set by the design of the internal metal interconnect. Note that in transient applications, the part is robust.

Power Dissipation

With the high output drive capability of the EL5156 and EL5157 families, it is possible to exceed the 125°C absolute maximum junction temperature under certain load current conditions. Therefore, it is important to calculate the maximum junction temperature for the application to determine if the load conditions or package types need to be modified for the amplifier to remain in the safe operating area.

The maximum power dissipation allowed in a package is determined according to:

$$PD_{MAX} = \frac{T_{JMAX} - T_{AMAX}}{\Theta_{JA}}$$

Where:

T_{JMAX} = Maximum junction temperature

T_{AMAX} = Maximum ambient temperature

θ_{JA} = Thermal resistance of the package

The maximum power dissipation actually produced by an IC is the total quiescent supply current times the total power supply voltage, plus the power in the IC due to the load, or:

For sourcing:

$$PD_{MAX} = V_S \times I_{SMAX} + \sum_{i=1}^{n} (V_S - V_{OUTi}) \times \frac{V_{OUTi}}{R_{Li}}$$

For sinking:

$$PD_{MAX} = V_S \times I_{SMAX} + \sum_{i=1}^{n} (V_{OUTi} - V_S) \times I_{LOADi}$$

Where:

V_S = Supply voltage

IS_{MAX} = Maximum quiescent supply current

V_{OUT} = Maximum output voltage of the application

R_{LOAD} = Load resistance tied to ground

I_{LOAD} = Load current

N = number of amplifiers (Max = 2)

By setting the two PD_{MAX} equations equal to each other, we can solve the output current and R_{LOAD} to avoid the device overheat.

Power Supply Bypassing and Printed Circuit Board Layout

As with any high frequency device, a good printed circuit board layout is necessary for optimum performance. Lead lengths should be as sort as possible. The power supply pin must be well bypassed to reduce the risk of oscillation. For normal single supply operation, where the V_S- pin is connected to the ground plane, a single 4.7µF tantalum capacitor in parallel with a 0.1µF ceramic capacitor from V_S+ to GND will suffice. This same capacitor combination should be placed at each supply pin to ground if split supplies are to be used. In this case, the V_S- pin becomes the negative supply rail.

For good AC performance, parasitic capacitance should be kept to minimum. Use of wire wound resistors should be avoided because of their additional series inductance. Use of sockets should also be avoided if possible. Sockets add parasitic inductance and capacitance that can result in compromised performance. Minimizing parasitic capacitance at the amplifier's inverting input pin is very important. The feedback resistor should be placed very close to the inverting input pin. Strip line design techniques are recommended for the signal traces.