DATASHEET

EL5493, EL5493A

Quad 300MHz Current Feedback Amplifier with Enable

FN7202
Rev 1.00
April, 2003

The EL5493 and EL5493A are quad current feedback amplifiers with a bandwidth of 300MHz. This makes these amplifiers ideal for today's high speed video and monitor applications.

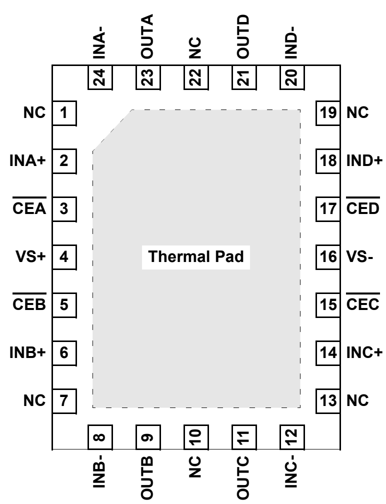
With a supply current of just 4mA per amplifier and the ability to run from a single supply voltage from 5V to 10V, these amplifiers are also ideal for hand held, portable or battery powered equipment.

The EL5493A also incorporates an enable and disable function to reduce the supply current to 100µA typical per amplifier. Allowing the $\overline{CE}$ pin to float or applying a low logic level will enable the amplifier.

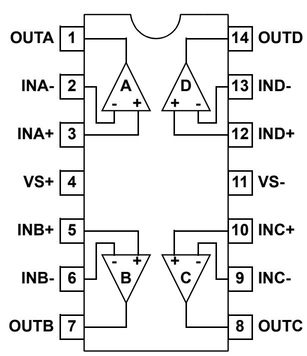
The EL5493 is offered in the industry-standard 14-pin SO (0.150") package and the EL5493A in the ultra-small 24-pin LPP package. Both operate over the industrial temperature range of -40°C to +85°C.

Pinouts

EL5493A
(24-PIN LPP)
TOP VIEW



EL5493
[14-PIN SO (0.150")]
TOP VIEW



Features

- 300MHz -3dB bandwidth
- 4mA supply current (per amplifier)
- Single and dual supply operation, from 5V to 10V
- Fast enable/disable (EL5493A only)
- Single (EL5193), dual (EL5293), and triple (EL5393) available
- High speed, 1GHz product available (EL5191)
- High speed, 6mA, 600MHz product available (EL5192, EL5292, EL5392 & EL5492)

Applications

- Battery-powered equipment
- Hand-held, portable devices
- Video amplifiers
- Cable drivers
- RGB amplifiers
- Test equipment
- Instrumentation
- Current to voltage converters

Ordering Information

PART NUMBER	PACKAGE	TAPE & REEL	PKG. NO.
EL5493CS	14-Pin SO (0.150")	-	MDP0027
EL5493CS-T7	14-Pin SO (0.150")	7”	MDP0027
EL5493CS-T13	14-Pin SO (0.150")	13”	MDP0027
EL5493ACL	24-Pin LPP	-	MDP0046
EL5493ACL-T7	24-Pin LPP	7”	MDP0046
EL5493ACL-T13	24-Pin LPP	13”	MDP0046

Absolute Maximum Ratings ($T_A = 25°C$)

Supply Voltage between V_S+ and V_S- 11V
Maximum Continuous Output Current 50mA
Operating Junction Temperature . . . . 125°C
Power Dissipation . . . . See Curves

Pin Voltages. . . . . V_S- -0.5V to V_S+ +0.5V
Storage Temperature. . . . . -65°C to +150°C
Ambient Operating Temperature . . . . -40°C to +85°C

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, R_F = 750Ω for A_V = 1, R_F = 375Ω for A_V = 2, 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		300		MHz
		A_V = +2		200		MHz
BW1	0.1dB Bandwidth			20		MHz
SR	Slew Rate	V_O = -2.5V to +2.5V, A_V = +2	1900	2200		V/µs
t_S	0.1% Settling Time	V_{OUT} = -2.5V to +2.5V, A_V = -1		12		ns
C_S	Channel Separation	f = 5MHz		60		dB
e_N	Input Voltage Noise			4.4		nV/√Hz
i_N-	IN- Input Current Noise			17		pA/√Hz
i_N+	IN+ Input Current Noise			50		pA/√Hz
dG	Differential Gain Error (Note 1)	A_V = +2		0.03		%
dP	Differential Phase Error (Note 1)	A_V = +2		0.04		°
DC PERFORMANCE						
V_{OS}	Offset Voltage		-10	1	10	mV
T_CV_{OS}	Input Offset Voltage Temperature Coefficient	Measured from T_{MIN} to T_{MAX}		5		µV/°C
R_{OL}	Transimpedance		300	600		kΩ
INPUT CHARACTERISTICS						
CMIR	Common Mode Input Range		±3	±3.3		V
CMRR	Common Mode Rejection Ratio		42	50		dB
$+I_{IN}$	+ Input Current		-60	1	80	µA
$-I_{IN}$	- Input Current		-35	1	35	µA
R_{IN}	Input Resistance			45		kΩ
C_{IN}	Input Capacitance			0.5		pF
OUTPUT CHARACTERISTICS						
V_O	Output Voltage Swing	R_L = 150Ω to GND	±3.4	±3.7		V
		R_L = 1kΩ to GND	±3.8	±4.0		V
I_{OUT}	Output Current	R_L = 10Ω to GND	95	120		mA
SUPPLY						
I_{SON}	Supply Current - Enabled (per amplifier)	No load, V_{IN} = 0V	3	4	5	mA
I_{SOFF}	Supply Current - Disabled	No load, V_{IN} = 0V		100	150	µA
PSRR	Power Supply Rejection Ratio	DC, V_S = ±4.75V to ±5.25V	55	75		dB
-IPSR	- Input Current Power Supply Rejection	DC, V_S = ±4.75V to ±5.25V	-2		2	µA/V

Electrical Specifications $V_S+ = +5V$, $V_S- = -5V$, $R_F = 750\Omega$ for $A_V = 1$, $R_F = 375\Omega$ for $A_V = 2$, $R_L = 150\Omega$, $T_A = 25°C$ unless otherwise specified. **(Continued)**

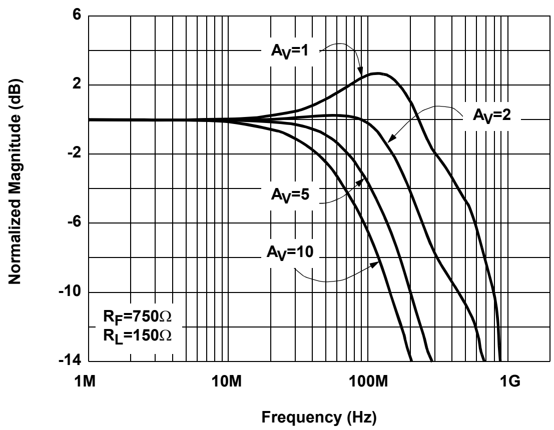
PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
ENABLE (EL5493A ONLY)						
t_{EN}	Enable Time			40		ns
t_{DIS}	Disable Time (Note 2)			600		ns
I_{IHCE}	CE Pin Input High Current	$\overline{CE} = V_S+$		0.8	6	µA
I_{ILCE}	CE Pin Input Low Current	$\overline{CE} = V_S-$		0	-0.1	µA
V_{IHCE}	CE Input High Voltage for Power-down		V_S+ -1			V
V_{ILCE}	CE Input Low Voltage for Power-down				V_S+ -3	V

NOTES:

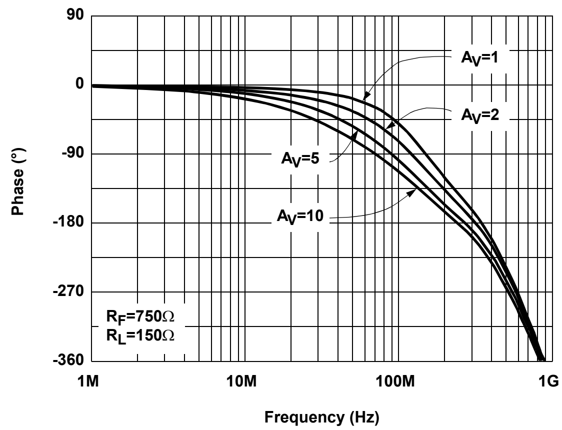
1. Standard NTSC test, AC signal amplitude = $286mV_{P-P}$, f = 3.58MHz
2. Measured from the application of $\overline{CE}$ logic signal until the output voltage is at the 50% point between initial and final values

Typical Performance Curves

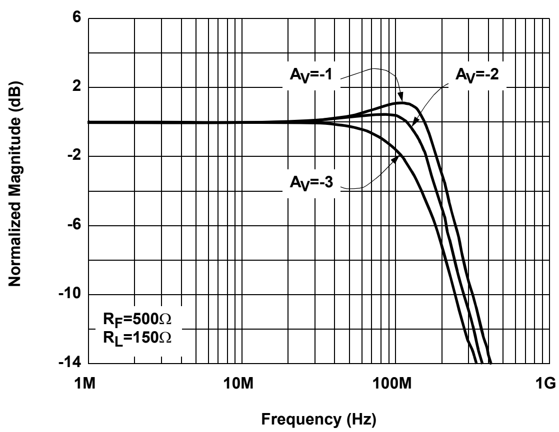
Non-Inverting Frequency Response (Gain)



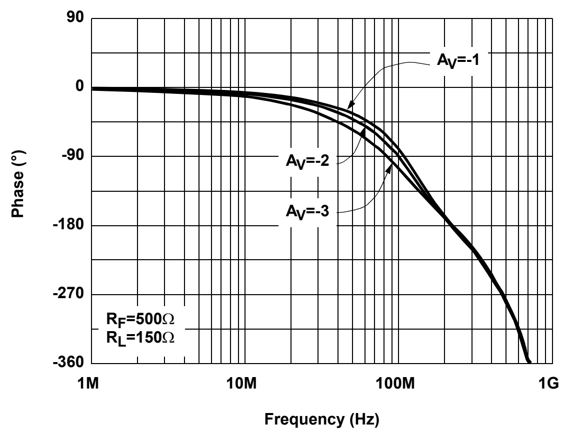
Non-Inverting Frequency Response (Phase)



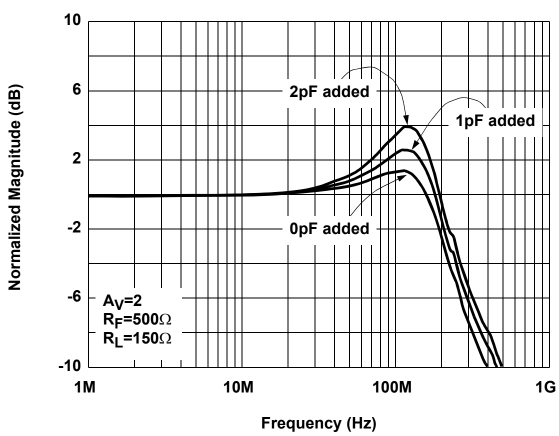
Inverting Frequency Response (Gain)



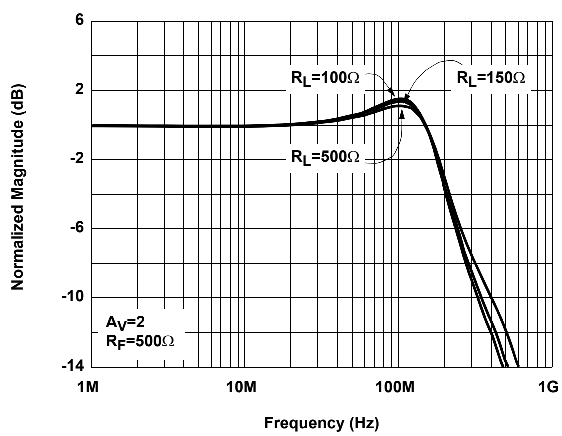
Inverting Frequency Response (Phase)



Frequency Response for Various C_{IN}-

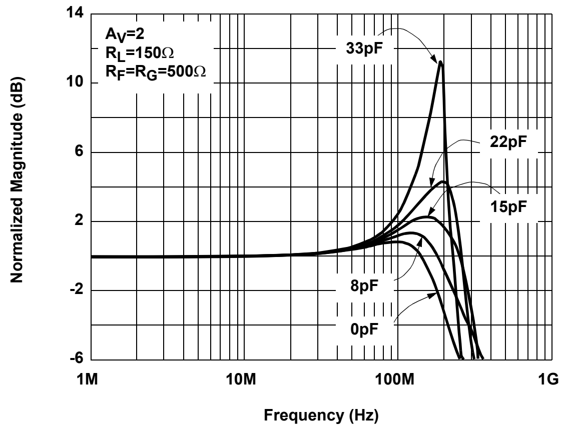


Frequency Response for Various R_L

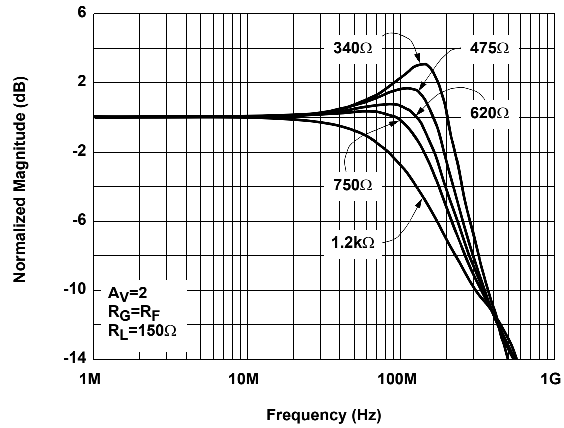


Typical Performance Curves (Continued)

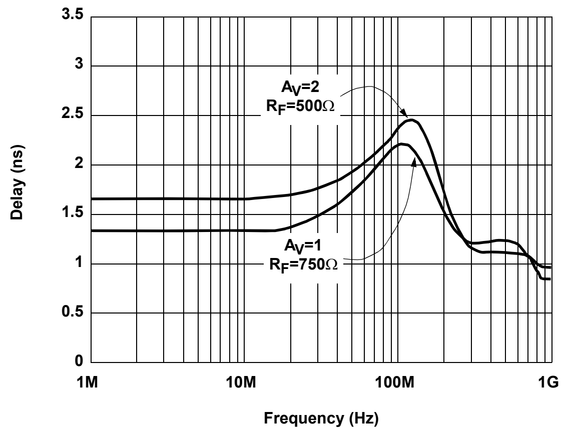
Frequency Response for Various C_L



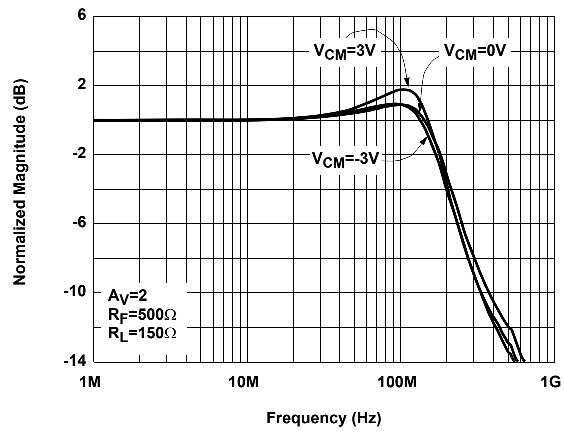
Frequency Response for Various R_F



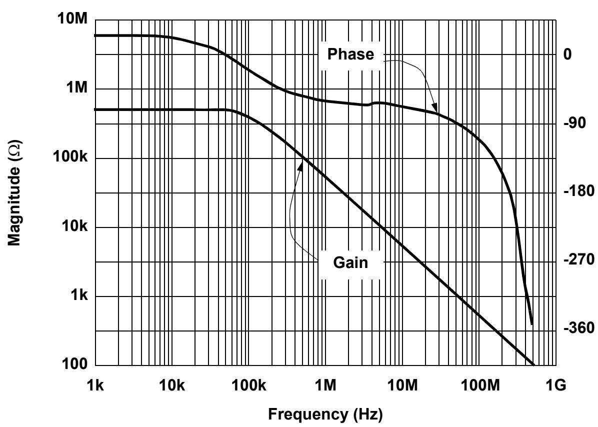
Group Delay vs Frequency



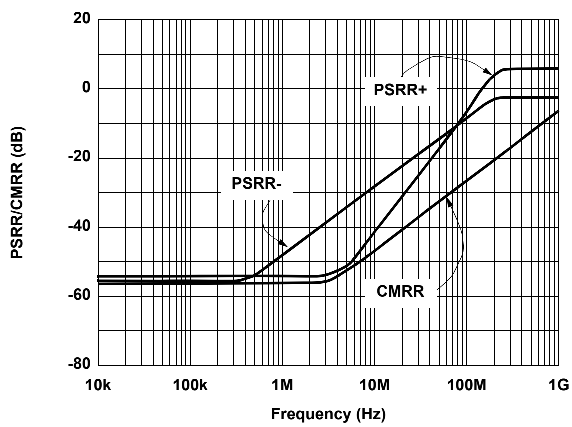
Frequency Response for Various Common-Mode Input Voltages



Transimpedance (ROL) vs Frequency

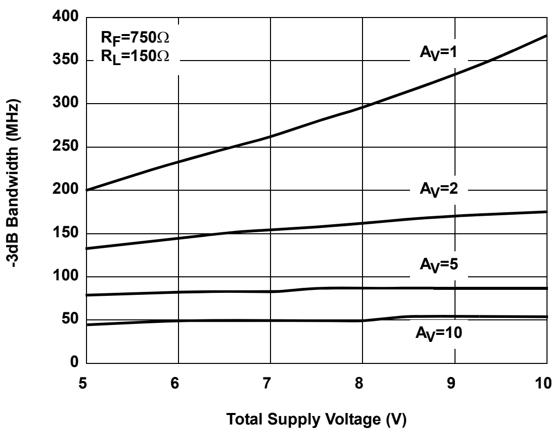


PSRR and CMRR vs Frequency

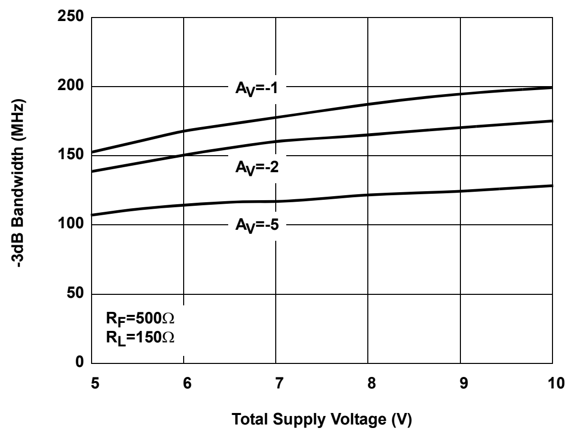


Typical Performance Curves (Continued)

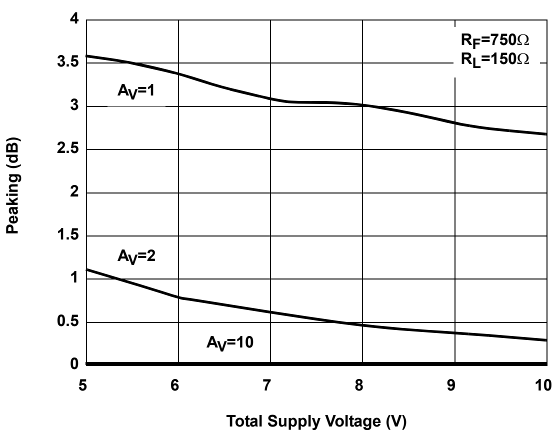
-3dB Bandwidth vs Supply Voltage for Non-Inverting Gains



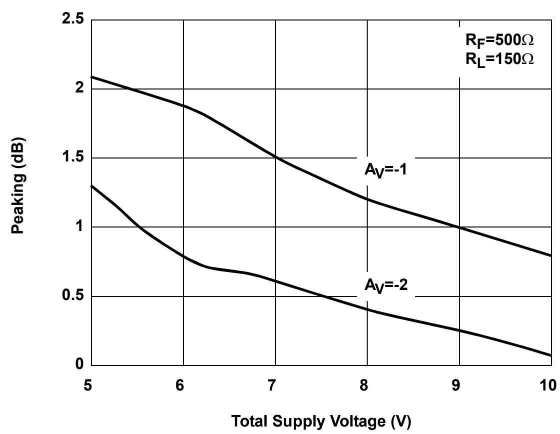
-3dB Bandwidth vs Supply Voltage for Inverting Gains



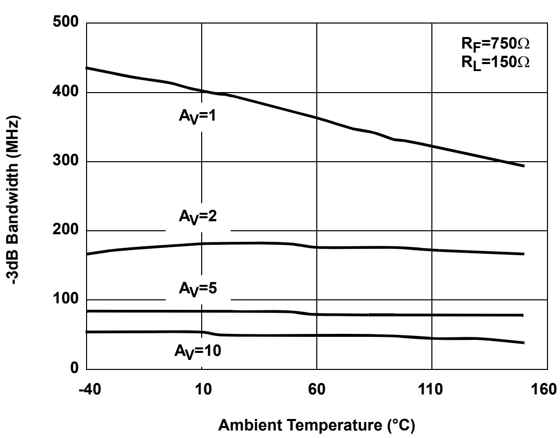
Peaking vs Supply Voltage for Non-Inverting Gains



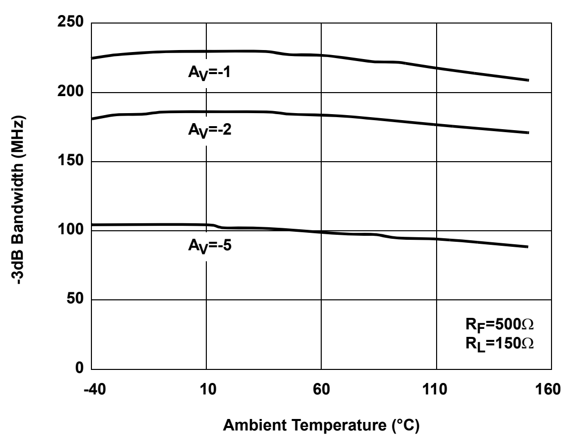
Peaking vs Supply Voltage for Inverting Gains



-3dB Bandwidth vs Temperature for Non-Inverting Gains

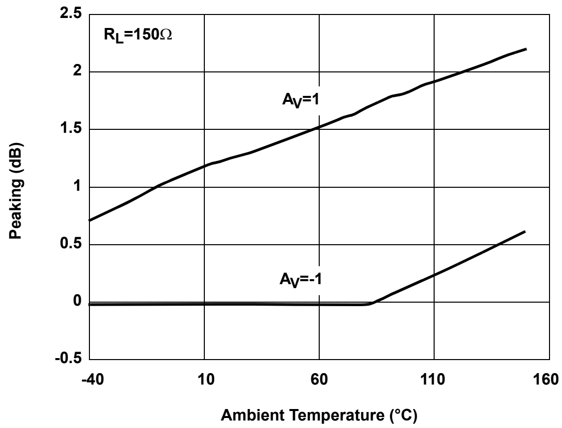


-3dB Bandwidth vs Temperature for Inverting Gains

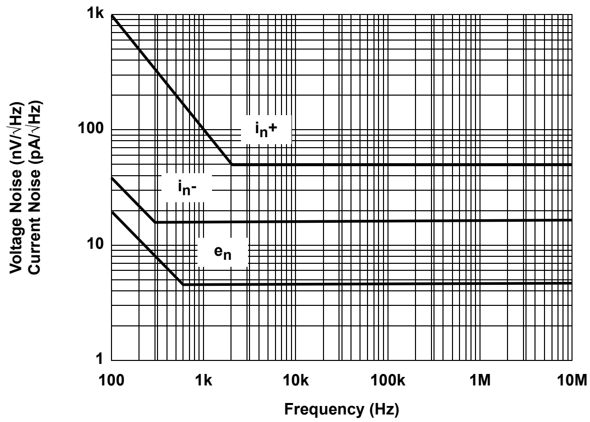


Typical Performance Curves (Continued)

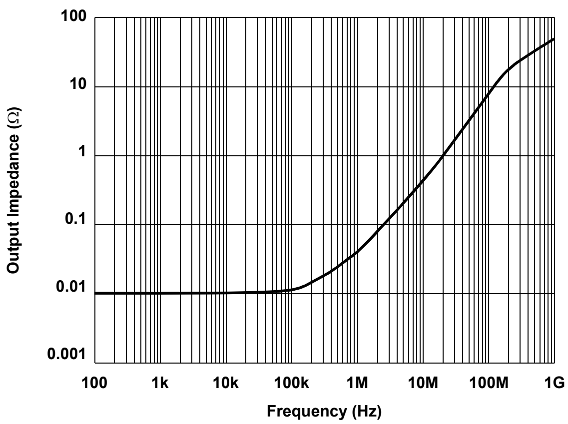
Peaking vs Temperature



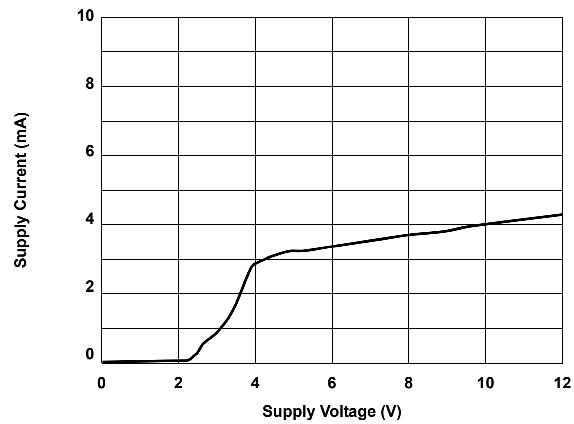
Voltage and Current Noise vs Frequency



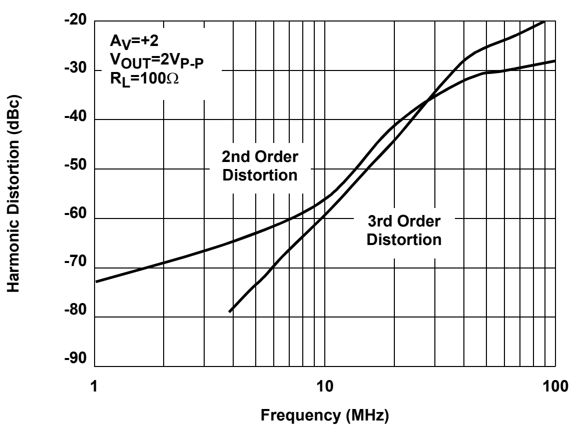
Closed Loop Output Impedance vs Frequency



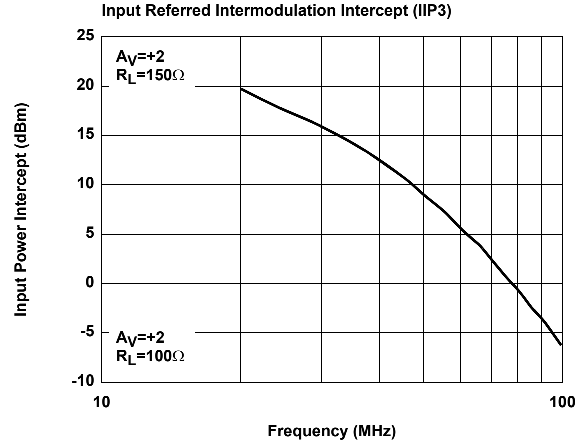
Supply Current vs Supply Voltage



2nd and 3rd Harmonic Distortion vs Frequency

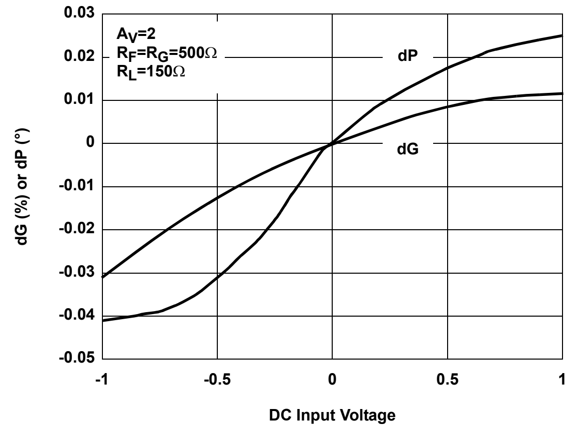


Two-Tone 3rd Order
Input Referred Intermodulation Intercept (IIP3)

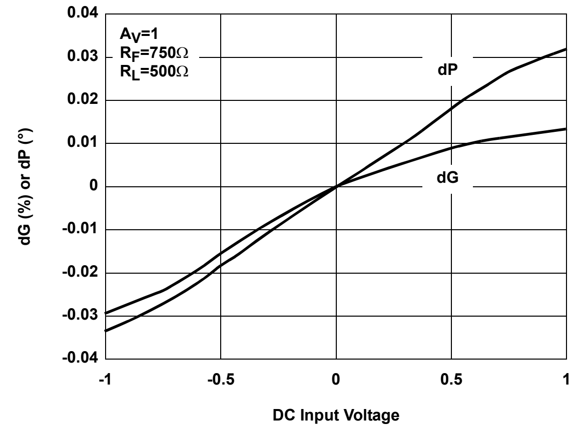


Typical Performance Curves (Continued)

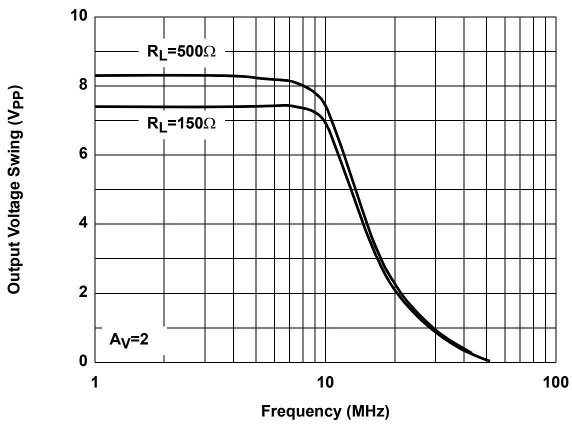
Differential Gain/Phase vs DC Input Voltage at 3.58MHz



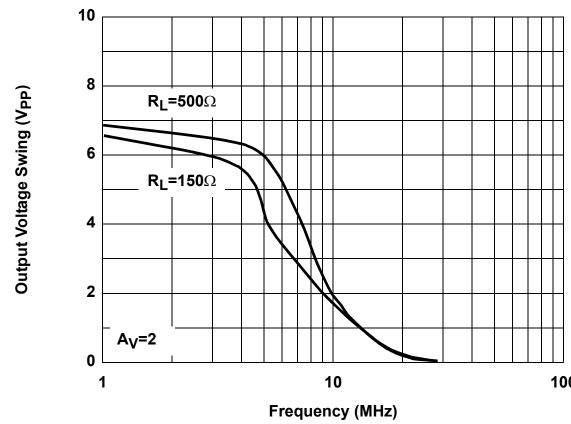
Differential Gain/Phase vs DC Input Voltage at 3.58MHz



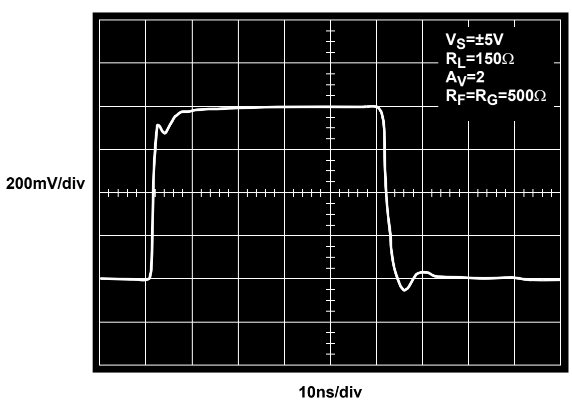
Output Voltage Swing vs Frequency THD<1%



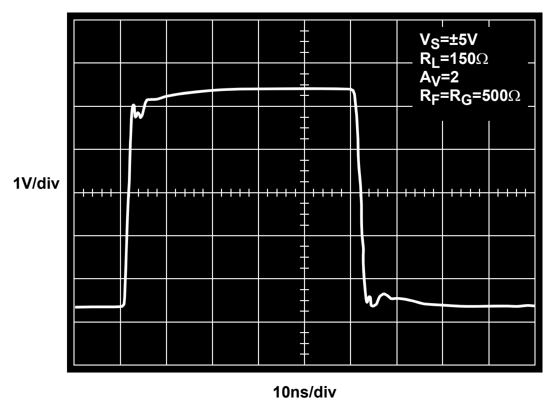
Output Voltage Swing vs Frequency THD<0.1%



Small Signal Step Response

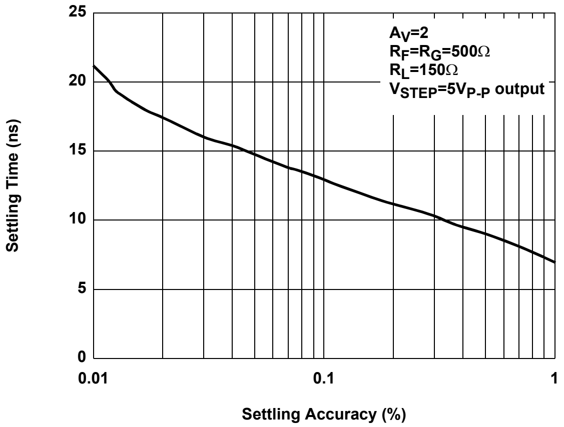


Large Signal Step Response

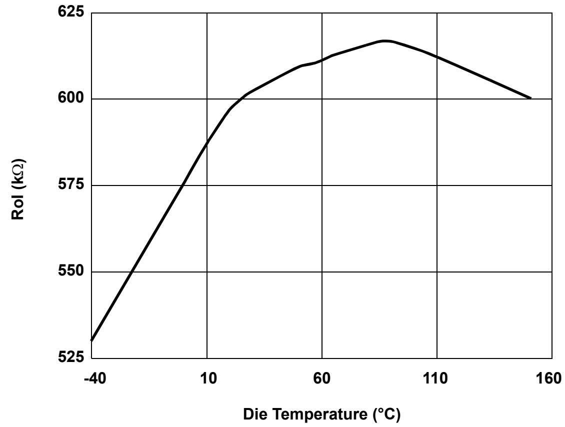


Typical Performance Curves (Continued)

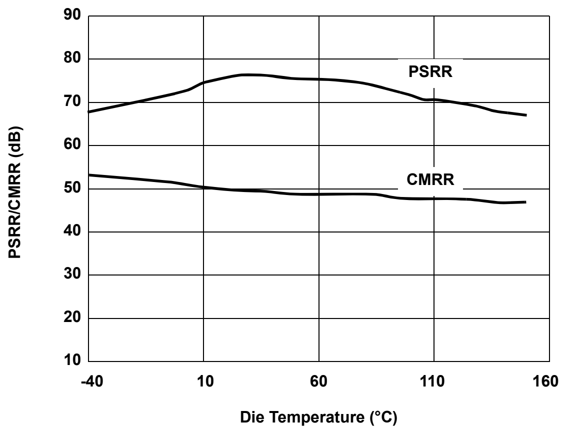
Settling Time vs Settling Accuracy



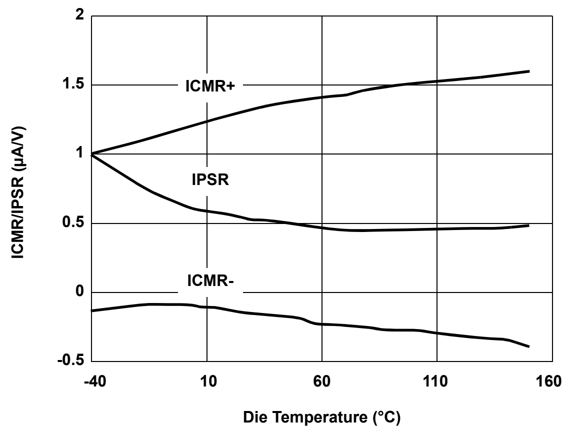
Transimpedance (Rol) vs Temperature



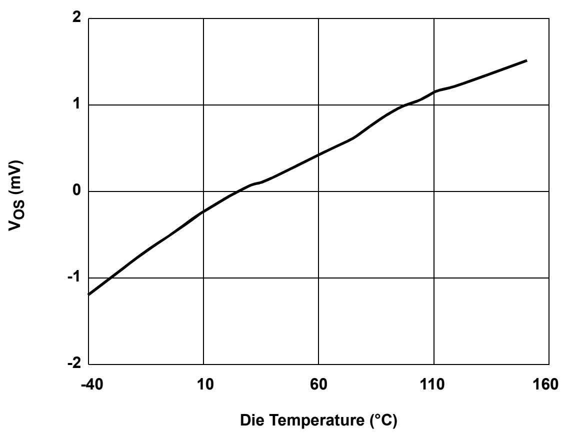
PSRR and CMRR vs Temperature



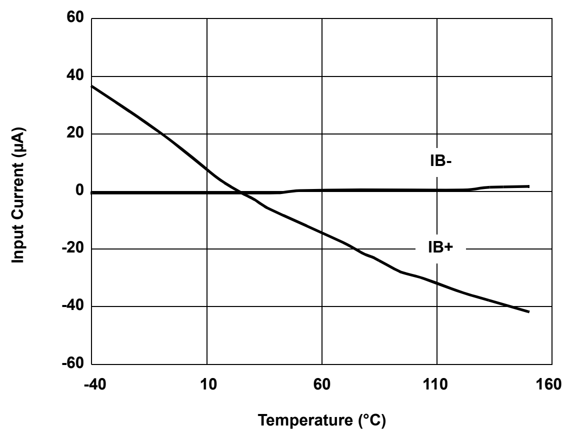
ICMR and IPSR vs Temperature



Offset Voltage vs Temperature

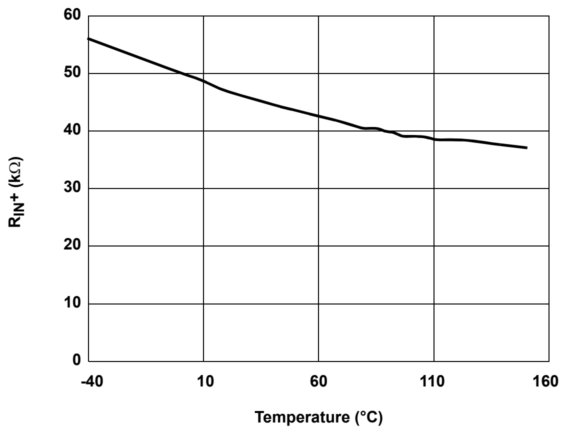


Input Current vs Temperature

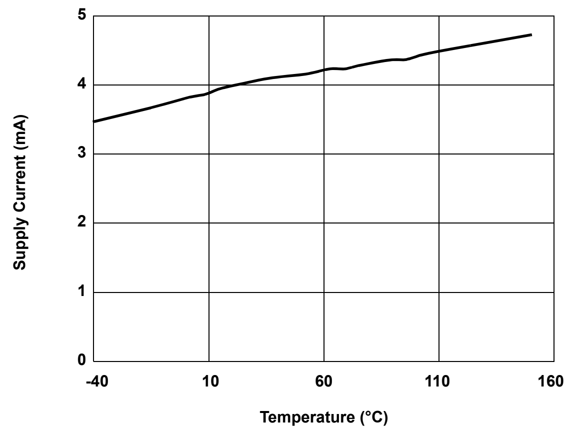


Typical Performance Curves (Continued)

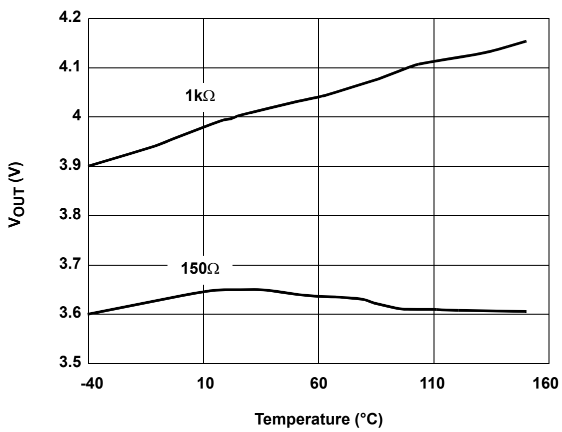
Positive Input Resistance vs Temperature



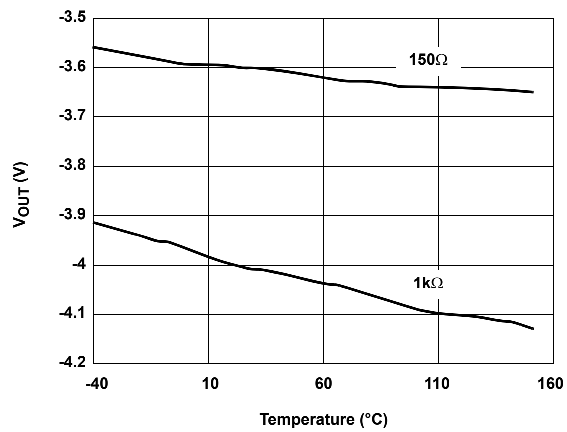
Supply Current vs Temperature



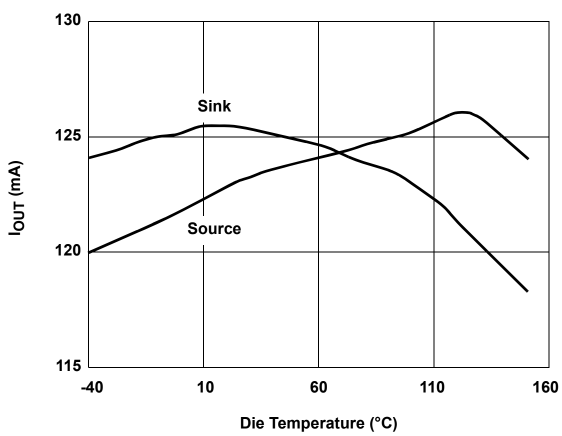
Positive Output Swing vs Temperature for Various Loads



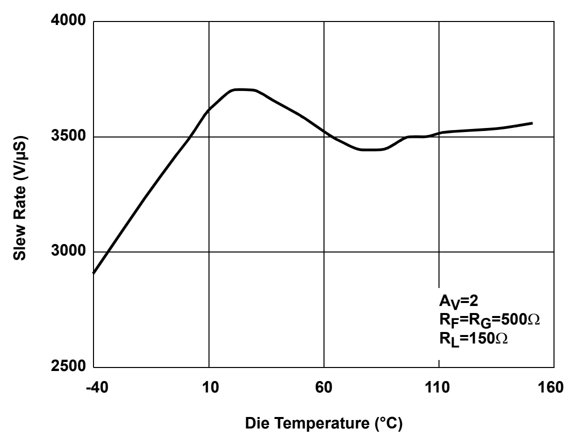
Negative Output Swing vs Temperature for Various Loads



Output Current vs Temperature

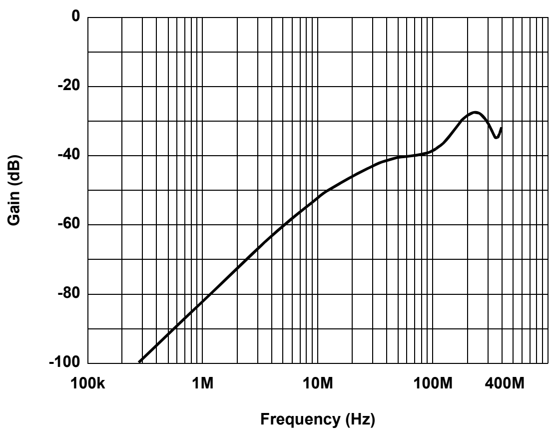


Slew Rate vs Temperature

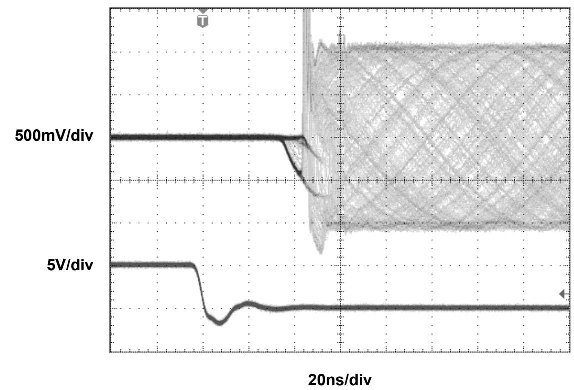


Typical Performance Curves (Continued)

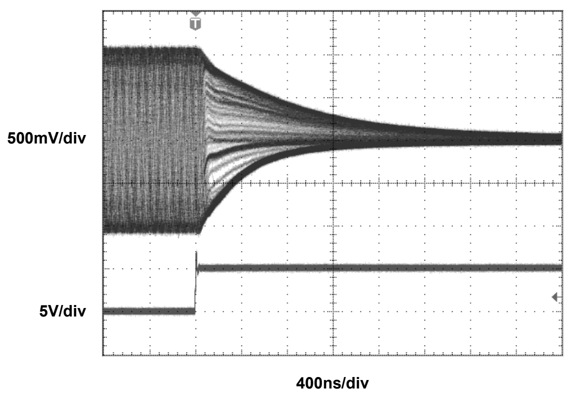
Channel-to-Channel Isolation vs Frequency



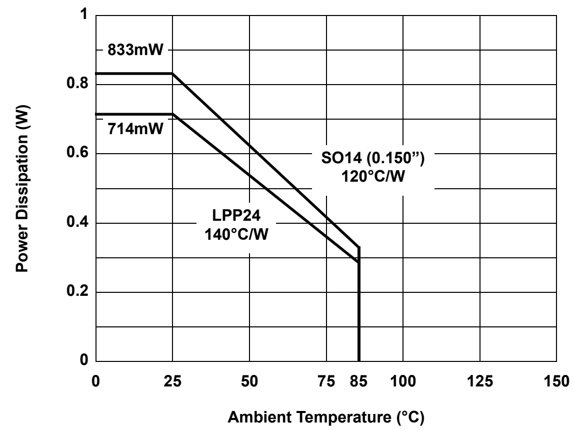
Enable Response



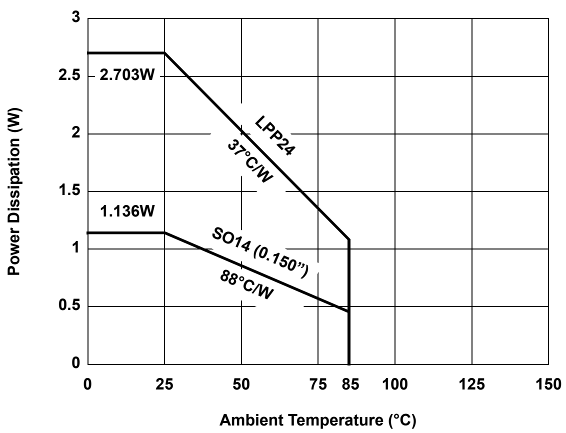
Disable Response



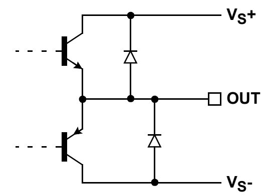
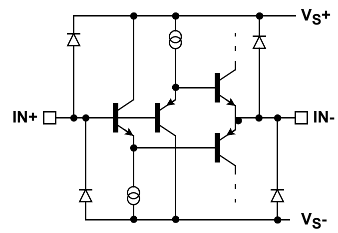
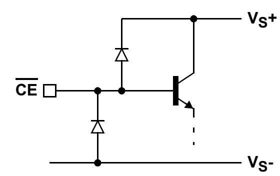
Package Power Dissipation vs Ambient Temperature
JEDEC JESD51-3 Low Effective Thermal Conductivity (Single Layer) Test Board



Package Power Dissipation vs Ambient Temperature
JEDEC JESD51-7 High Effective Thermal Conductivity (4 layer) Test Board - LPP exposed diepad soldered to PCB per JESD51-5



Pin Descriptions

14-PIN SO (0.150")	24-PIN LPP	PIN NAME	FUNCTION	EQUIVALENT CIRCUIT
1	23	OUTA	Output, channel A	 Circuit 1
2	24	INA-	Inverting input, channel A	 Circuit 2
3	2	INA+	Non-inverting input, channel A	(see circuit 2)
	3	$\overline{\text{CEA}}$	Chip enable, channel A	 Circuit 3
4	4	VS+	Positive supply	
	5	$\overline{\text{CEB}}$	Chip enable, channel B	(see circuit 3)
5	6	INB+	Non-inverting input, channel B	(see circuit 2)
6	8	INB-	Inverting input, channel B	(see circuit 2)
7	9	OUTB	Output, channel B	(see circuit 1)
8	11	OUTC	Output, channel C	(see circuit 1)
9	12	INC-	Inverting input, channel C	(see circuit 2)
10	14	INC+	Non-inverting input, channel C	(see circuit 2)
	15	$\overline{\text{CEC}}$	Chip enable, channel C	(see circuit 3)
11	16	VS-	Negative supply	
	17	CED	Chip enable, channel D	(see circuit 3)
12	18	IND+	Non-inverting input, channel D	(see circuit 2)
13	20	IND-	Inverting input, channel D	(see circuit 1)
14	21	OUTD	Output, channel D	(see circuit 1)
	1, 7, 10, 13, 19, 22	NC	No connection	

Applications Information

Product Description

The EL5493 is a current-feedback operational amplifier that offers a wide -3dB bandwidth of 300MHz and a low supply current of 4mA per amplifier. The EL5493 works with supply voltages ranging from a single 5V to 10V and they are also capable of swinging to within 1V of either supply on the output. Because of its current-feedback topology, the EL5493 does not have the normal gain-bandwidth product associated with voltage-feedback operational amplifiers. Instead, its -3dB bandwidth to remain relatively constant as closed-loop gain is increased. This combination of high bandwidth and low power, together with aggressive pricing make the EL5493 the ideal choice for many low-power/high-bandwidth applications such as portable, handheld, or battery-powered equipment.

For varying bandwidth needs, consider the EL5191 with 1GHz on a 9mA supply current or the EL5192 with 600MHz on a 6mA supply current. Versions also include single, dual, triple, and quad amp packages.

Power Supply Bypassing and Printed Circuit Board Layout

As with any high frequency device, good printed circuit board layout is necessary for optimum performance. Low impedance ground plane construction is essential. Surface mount components are recommended, but if leaded components are used, lead lengths should be as short as possible. The power supply pins must be well bypassed to reduce the risk of oscillation. The combination of a 4.7µF tantalum capacitor in parallel with a 0.01µF capacitor has been shown to work well when placed at each supply pin.

For good AC performance, parasitic capacitance should be kept to a minimum, especially at the inverting input. (See the Capacitance at the Inverting Input section) Even when ground plane construction is used, it should be removed from the area near the inverting input to minimize any stray capacitance at that node. Carbon or Metal-Film resistors are acceptable with the Metal-Film resistors giving slightly less peaking and bandwidth because of additional series inductance. Use of sockets, particularly for the SO (0.150") package, should be avoided if possible. Sockets add parasitic inductance and capacitance which will result in additional peaking and overshoot.

Disable/Power-Down

The EL5493A amplifier can be disabled placing its output in a high impedance state. When disabled, the amplifier supply current is reduced to < 600µA. The EL5493A is disabled when its $\overline{CE}$ pin is pulled up to within 1V of the positive supply. Similarly, the amplifier is enabled by floating or pulling its $\overline{CE}$ pin to at least 3V below the positive supply. For ±5V supply, this means that an EL5493A amplifier will be enabled when $\overline{CE}$ is 2V or less, and disabled when $\overline{CE}$ is above 4V. Although the logic levels are not standard TTL, this choice of logic voltages allows the EL5493A to be enabled by tying $\overline{CE}$ to ground, even in 5V single supply applications. The $\overline{CE}$ pin can be driven from CMOS outputs.

Capacitance at the Inverting Input

Any manufacturer's high-speed voltage- or current-feedback amplifier can be affected by stray capacitance at the inverting input. For inverting gains, this parasitic capacitance has little effect because the inverting input is a virtual ground, but for non-inverting gains, this capacitance (in conjunction with the feedback and gain resistors) creates a pole in the feedback path of the amplifier. This pole, if low enough in frequency, has the same destabilizing effect as a zero in the forward open-loop response. The use of large-value feedback and gain resistors exacerbates the problem by further lowering the pole frequency (increasing the possibility of oscillation.)

The EL5493 has been optimized with a 475Ω feedback resistor. With the high bandwidth of these amplifiers, these resistor values might cause stability problems when combined with parasitic capacitance, thus ground plane is not recommended around the inverting input pin of the amplifier.

Feedback Resistor Values

The EL5493 has been designed and specified at a gain of +2 with R_F approximately 500Ω. This value of feedback resistor gives 200MHz of -3dB bandwidth at A_V=2 with 2dB of peaking. With A_V=-2, an R_F of approximately 500Ω gives 175MHz of bandwidth with 0.2dB of peaking. Since the EL5493 is a current-feedback amplifier, it is also possible to change the value of R_F to get more bandwidth. As seen in the curve of Frequency Response for Various R_F and R_G, bandwidth and peaking can be easily modified by varying the value of the feedback resistor.

Because the EL5493 is a current-feedback amplifier, its gain-bandwidth product is not a constant for different closed-loop gains. This feature actually allows the EL5493 to maintain about the same -3dB bandwidth. As gain is increased, bandwidth decreases slightly while stability increases. Since the loop stability is improving with higher closed-loop gains, it becomes possible to reduce the value of R_F below the specified 475Ω and still retain stability, resulting in only a slight loss of bandwidth with increased closed-loop gain.

Supply Voltage Range and Single-Supply Operation

The EL5493 has been designed to operate with supply voltages having a span of greater than 5V and less than 10V. In practical terms, this means that the EL5493 will operate on dual supplies ranging from ±2.5V to ±5V. With single-supply, the EL5493 will operate from 5V to 10V.

As supply voltages continue to decrease, it becomes necessary to provide input and output voltage ranges that can get as close as possible to the supply voltages. The EL5493 has an input range which extends to within 2V of either supply. So, for example, on +5V supplies, the EL5493 has an input range which spans ±3V. The output range of the EL5493 is also quite large, extending to within 1V of the supply rail. On a ±5V supply, the output is therefore capable of swinging from -4V to +4V. Single-supply output range is larger because of the increased negative swing due to the external pull-down resistor to ground.

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. Previously, good differential gain could only be achieved by running high idle currents through the output transistors (to reduce variations in output impedance.) These currents were typically comparable to the entire 4mA supply current of each EL5493 amplifier. Special circuitry has been incorporated in the EL5493 to reduce the variation of output impedance with current output. This results in dG and dP specifications of 0.03% and 0.04°C, while driving 150Ω at a gain of 2.

Video performance has also been measured with a 500Ω load at a gain of +1. Under these conditions, the EL5493 has dG and dP specifications of 0.03% and 0.04°C.

Output Drive Capability

In spite of its low 4mA of supply current, the EL5493 is capable of providing a minimum of ±95mA of output current. With a minimum of ±95mA of output drive, the EL5493 is capable of driving 50Ω loads to both rails, making it an excellent choice for driving isolation transformers in telecommunications applications.

Driving Cables and Capacitive Loads

When used as a cable driver, double termination is always recommended for reflection-free performance. For those applications, the back-termination series resistor will decouple the EL5493 from the cable and allow extensive capacitive drive. However, other applications may have high capacitive loads without a back-termination resistor. In these applications, a small series resistor (usually between 5Ω and 50Ω) can be placed in series with the output to eliminate most peaking. The gain resistor (R_G) can then be chosen to make up for any gain loss which may be created by this additional resistor at the output. In many cases it is also possible to simply increase the value of the feedback resistor (R_F) to reduce the peaking.

Current Limiting

The EL5493 has no internal current-limiting circuitry. If the output is shorted, it is possible to exceed the Absolute Maximum Rating for output current or power dissipation, potentially resulting in the destruction of the device.

Power Dissipation

With the high output drive capability of the EL5493, it is possible to exceed the 125°C Absolute Maximum junction temperature under certain very high load current conditions. Generally speaking when R_L falls below about 25Ω, it is important to calculate the maximum junction temperature (T_{JMAX}) for the application to determine if power supply voltages, load conditions, or package type need to be modified for the EL5493 to remain in the safe operating area. These parameters are calculated as follows:

$$T_{JMAX} = T_{MAX} + (\theta_{JA} \times n \times PD_{MAX})$$

where:

T_{MAX} = Maximum ambient temperature

θ_{JA} = Thermal resistance of the package

n = Number of amplifiers in the package

PD_{MAX} = Maximum power dissipation of each amplifier in the package

PD_{MAX} for each amplifier can be calculated as follows:

$$PD_{MAX} = (2 \times V_S \times I_{SMAX}) + \left[(V_S - V_{OUTMAX}) \times \frac{V_{OUTMAX}}{R_L}\right]$$

where:

V_S = Supply voltage

I_{SMAX} = Maximum supply current of 1A

V_{OUTMAX} = Maximum output voltage (required)

R_L = Load resistance