élantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

EL5191C - Preliminary

1GHz Current Feedback Amplifier

Features

- 1GHz -3dB bandwidth
- 9mA supply current
- Single and dual supply operation, from 5V to 10V supply span
- Power-down (8-pin SOIC and SOT23-6 only)
- Available in SOT23-5 and SOT23-6
- High speed, 600MHz product available (EL5192C, EL5292C, and EL5392C)
- Lower power, 300MHz product available (EL5193C, EL5293C, EL5393C)

Applications

- Video Amplifiers
- Cable Drivers
- RGB Amplifiers
- Test Equipment
- Instrumentation
- Current to Voltage Converters

Ordering Information

Part No	Package	Tape & Reel	Outline #
EL5191CW5-T7	SOT23-5	7”	MDP0038
EL5191CW5-T13	SOT23-5	13”	MDP0038
EL5191CW6-T7	SOT23-6	7”	MDP0038
EL5191CW6-T13	SOT23-6	13”	MDP0038
EL5191CS	8-Pin SOIC	-	MDP0027
EL5191CS-T7	8-Pin SOIC	7”	MDP0027
EL5191CS-T13	8-Pin SOIC	13”	MDP0027

General Description

The EL5191C amplifier is of the current feedback variety and exhibits a very high bandwidth of 1GHz. This makes this amplifier ideal for today’s high speed video and monitor applications, as well as a number of RF and IF frequency designs.

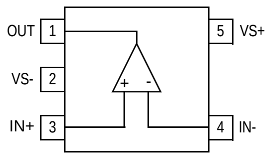
With a supply current of just 9mA and the ability to run from a single supply voltage from 5V to 10V, these amplifiers offer very high performance for little power consumption.

The EL5191C is also available with a disable function. Upon being disabled, the outputs are tri-stated and the power supply current reduces to less than 150µA. Allowing the $\overline{CE}$ pin to float, or applying a low logic level, will enable the amplifier.

For applications where board space is critical, the EL5191C is offered in both the SOT23-5 and SOT23-6 packages, as well as an industry standard 8-pin SOIC. The EL5191C operates over the industrial temperature range of -40°C to +85°C.

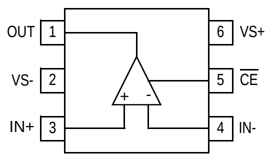
Pin Configurations

SOT23-5



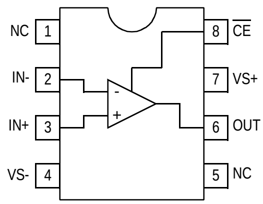
EL5191CW5

SOT23-6



EL5191CW6

SOIC-8



EL5191CS

Note: All information contained in this data sheet has been carefully checked and is believed to be accurate as of the date of publication; however, this data sheet cannot be a “controlled document”. Current revisions, if any, to these specifications are maintained at the factory and are available upon your request. We recommend checking the revision level before finalization of your design documentation.

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Absolute Maximum Ratings (T_A = 25°C)

Values beyond absolute maximum ratings can cause the device to be prematurely damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

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
Operating Temperature	-40°C to +85°C
Lead Temperature	260°C

Important Note:

All parameters having Min/Max specifications are guaranteed. Typ 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 Characteristics

V_S+ = +5V, V_S- = -5V, R_F = 392Ω for A_V = 1, R_F = 250Ω 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		1000		MHz
		A_V = +2		600		MHz
BW1	0.1dB Bandwidth			30		MHz
SR	Slew Rate	V_O = -2.5V to +2.5V, A_V = +2	TBD	-2600		V/µs
ts	0.1% Settling Time	V_{OUT} = -2.5V to +2.5V, A_V = -1		7		ns
e_n	Input Voltage Noise			3.8		nV/√Hz
i_n-	IN- input current noise			25		pA/√Hz
i_n+	IN+ input current noise			55		pA/√Hz
dG	Differential Gain Error [1]	A_V = +2		0.035		%
dP	Differential Phase Error [1]	A_V = +2		0.04		°
DC Performance						
V_{OS}	Offset Voltage		-15	1	15	mV
T_CV_{OS}	Input Offset Voltage Temperature Coefficient	Measured from T_{MIN} to T_{MAX}		5		µV/°C
R_{OL}	Transimpedance		150	300		kΩ
Input Characteristics						
CMIR	Common Mode Input Range		±3V	±3.3V		V
CMRR	Common Mode Rejection Ratio		42	50		dB
-ICMR	- Input Current Common Mode Rejection		-6		6	µA/V
$+I_{IN}$	+ Input Current		-120	40	120	µA
$-I_{IN}$	- Input Current		-40	5	40	µA
R_{IN}	Input Resistance			27		kΩ
C_{IN}	Input Capacitance			0.5		pF
Output Characteristics						
V_O	Output Voltage Swing	R_L = 150Ω to GND	±3.4V	±3.7V		V
		R_L = 1KΩ to GND	±3.8V	±4.0V		V
I_{OUT}	Output Current	R_L = 10Ω to GND	95	120		mA
Enable (selected packages only)						
t_{EN}	Enable Time			40		ns
t_{DIS}	Disable Time					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 pin Input High Voltage for Power Down		V_S+ - 0.5			V

Electrical Characteristics

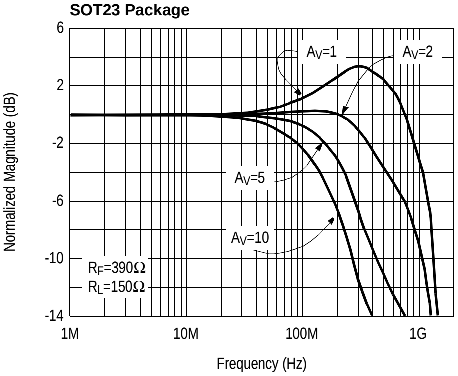
V_S+ = +5V, V_S- = -5V, R_F = 392Ω for A_V = 1, R_F = 250Ω for A_V = 2, R_L = 150Ω, T_A = 25°C unless otherwise specified.

Parameter	Description	Conditions	Min	Typ	Max	Unit
V_{ILCE}	CE pin Input Low Voltage for Power Up				V_S+ -3	V
Supply						
I_{SON}	Supply Current - Enabled	No Load, V_{IN} = 0V, $\overline{CE}$ = -5V	8	9	10.5	mA
I_{SOFF}	Supply Current - Disabled	No Load, V_{IN} = 0V, $\overline{CE}$ = +4.5V		95	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

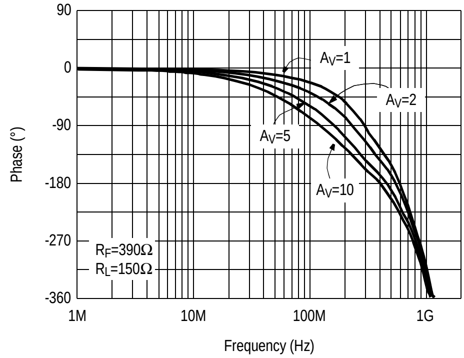
1. Standard NTSC test, AC signal amplitude = 286mV$_{P-P}$, f = 3.58MHz

Typical Performance Curves

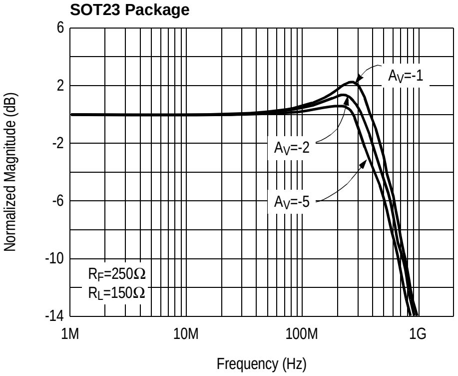
Non-Inverting Frequency Response (Gain)
SOT23 Package



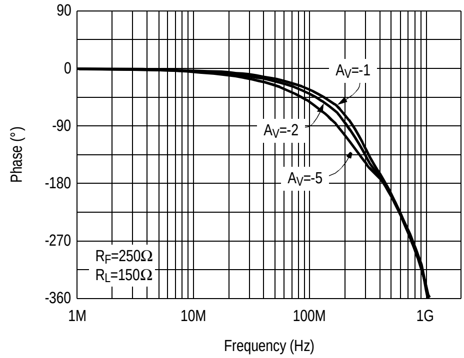
Non-Inverting Frequency Response (Phase)



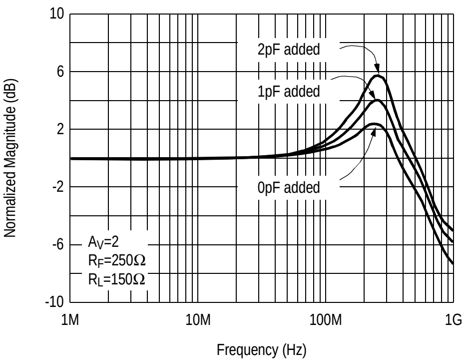
Inverting Frequency Response (Gain)
SOT23 Package



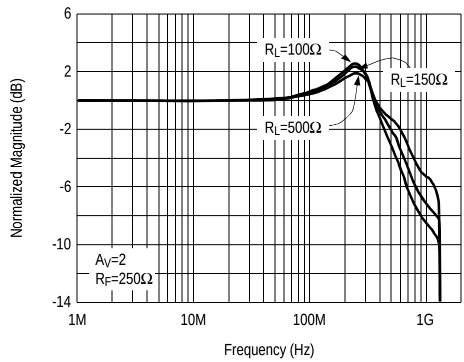
Inverting Frequency Response (Phase)



Frequency Response for Various C_{IN}-

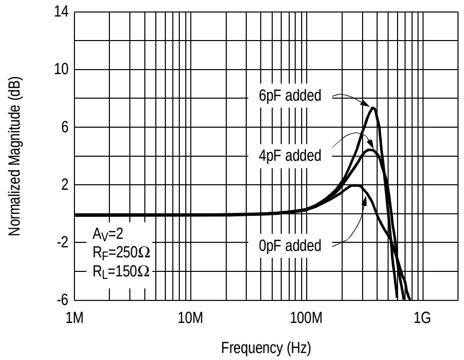


Frequency Response for Various R_L

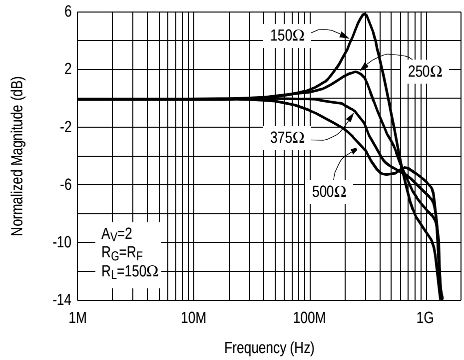


Typical Performance Curves

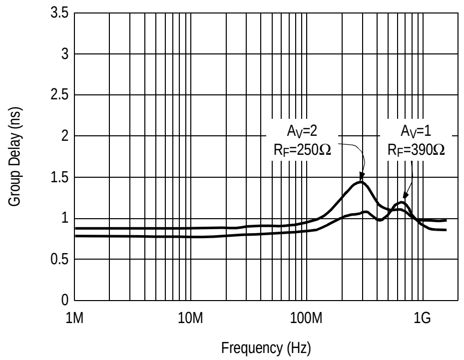
Frequency Response for Various C_L



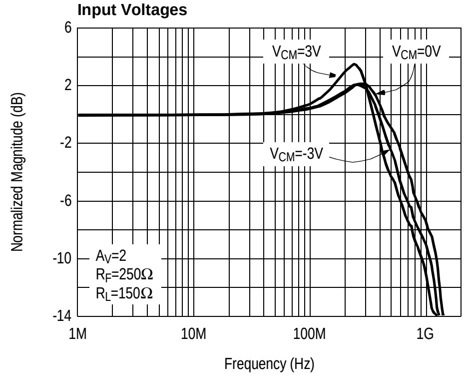
Frequency Response for Various R_F



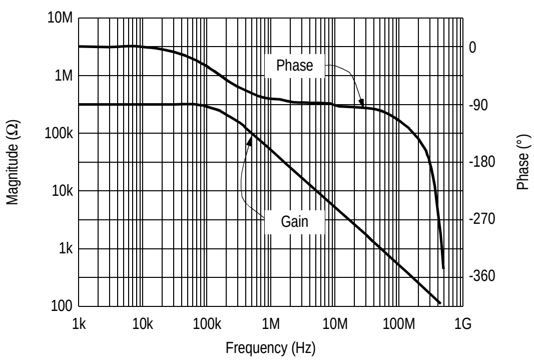
Group Delay vs Frequency



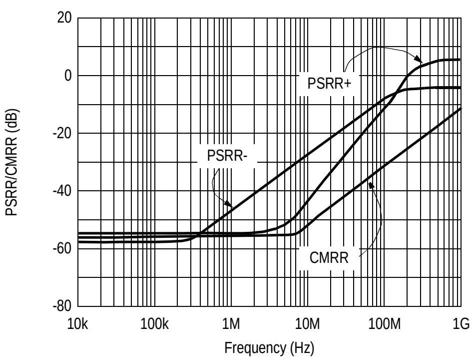
Frequency Response for Various Common-mode Input Voltages



Transimpedance (ROL) vs Frequency



PSRR and CMRR vs Frequency



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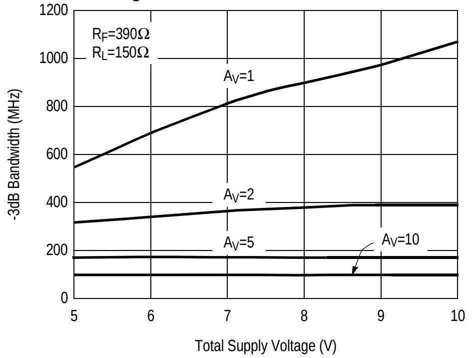
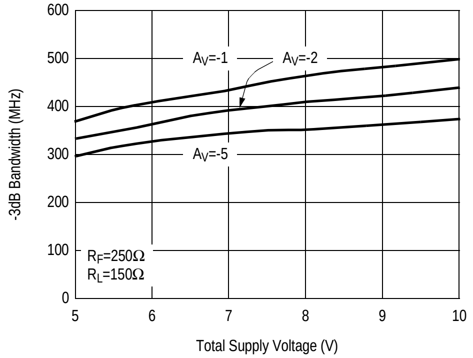
Typical Performance Curves

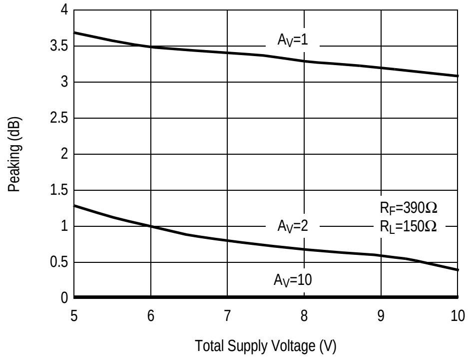
-3dB Bandwidth vs Supply Voltage for Non-inverting Gains



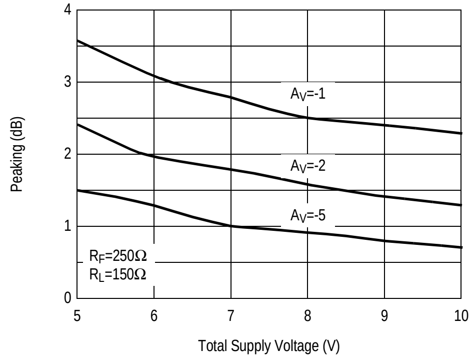
-3dB Bandwidth vs Supply Voltage for Inverting Gains



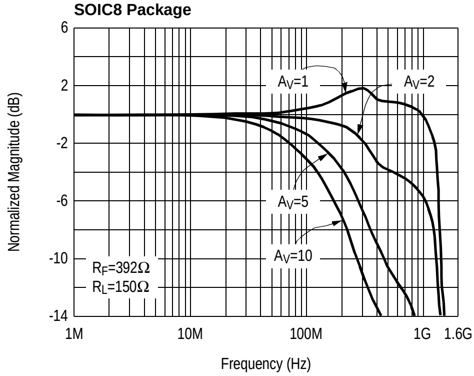
Peaking vs Supply Voltage for Non-inverting Gains



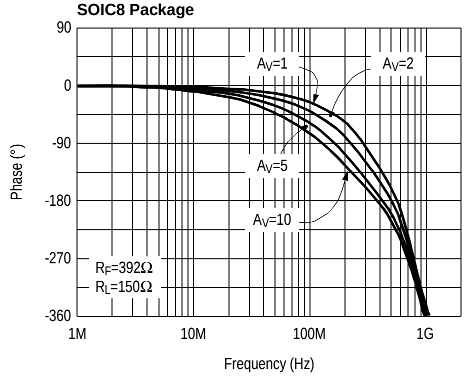
Peaking vs Supply Voltage for Inverting Gains



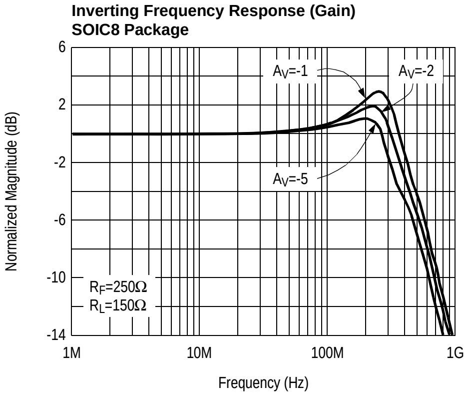
Non-inverting Frequency Response (Gain) SOIC8 Package

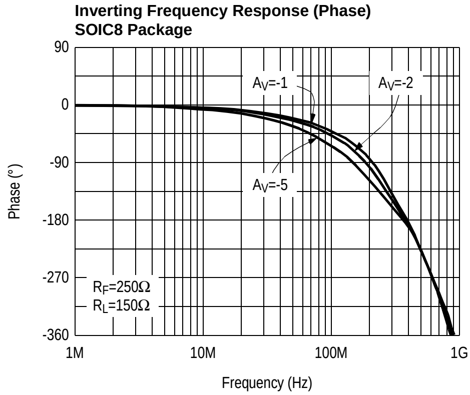


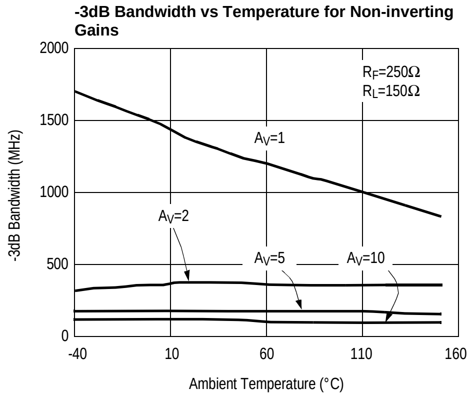
Non-inverting Frequency Response (Phase) SOIC8 Package

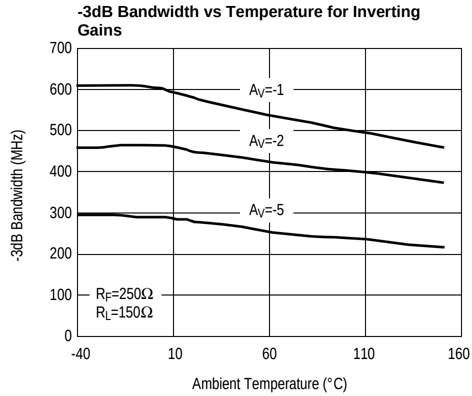


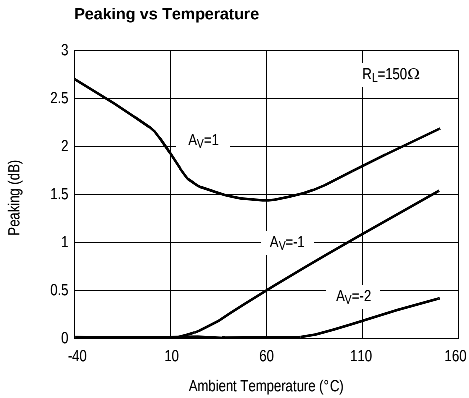
Typical Performance Curves

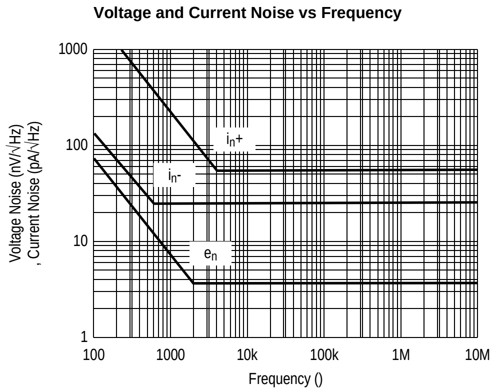






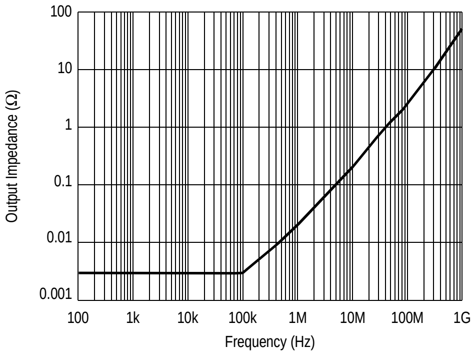




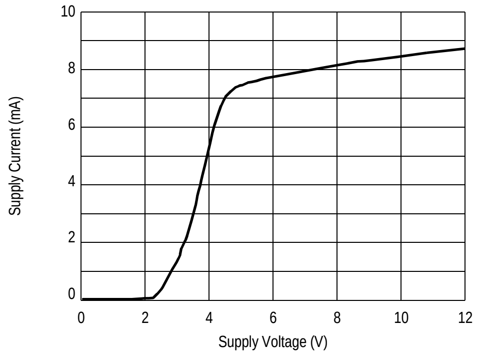


Typical Performance Curves

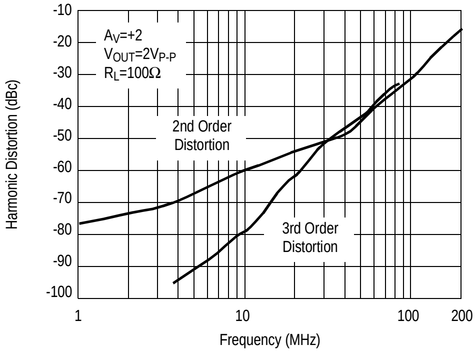
Closed Loop Output Impedance vs Frequency



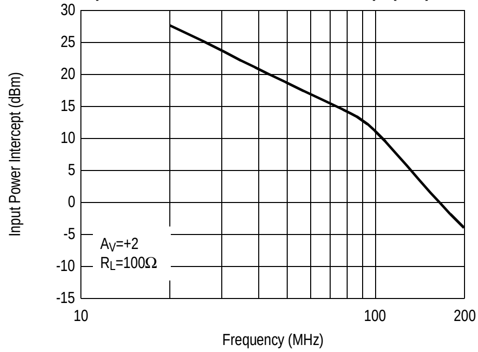
Supply Current vs Supply Voltage



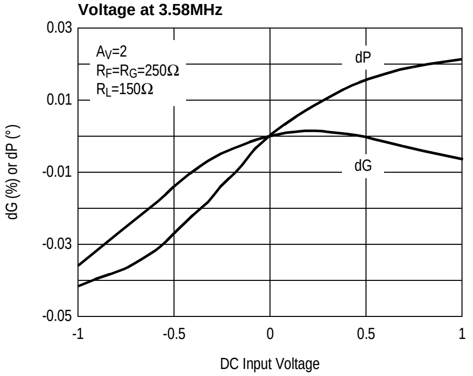
2nd and 3rd Harmonic Distortion vs Frequency



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



Differential Gain/Phase vs DC Input Voltage at 3.58MHz



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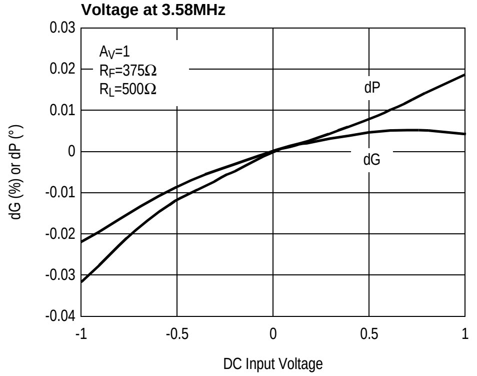
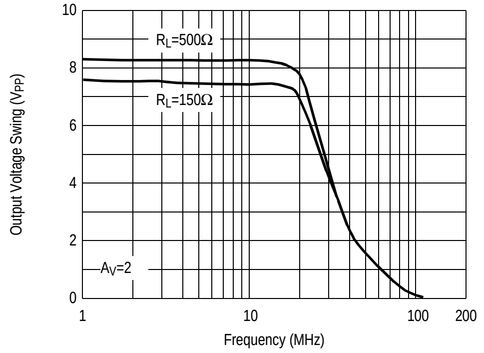
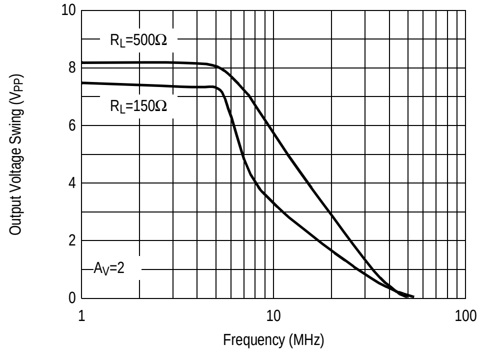


Typical Performance Curves

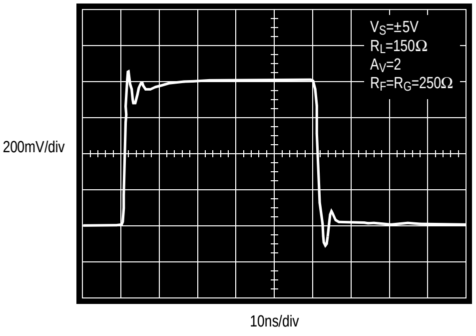
Output Voltage Swing vs Frequency
THD<1%



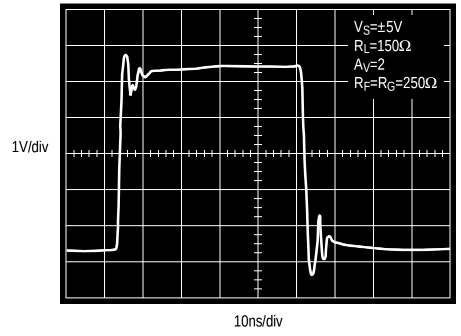
Output Voltage Swing vs Frequency
THD<0.1%



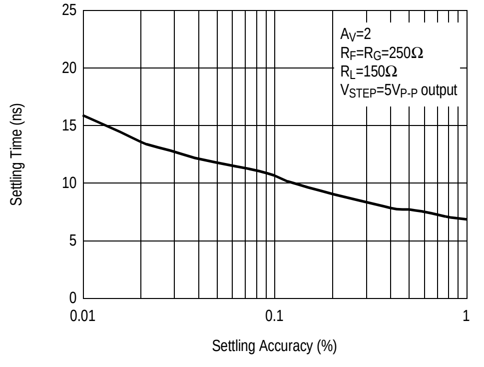
Small Signal Step Response



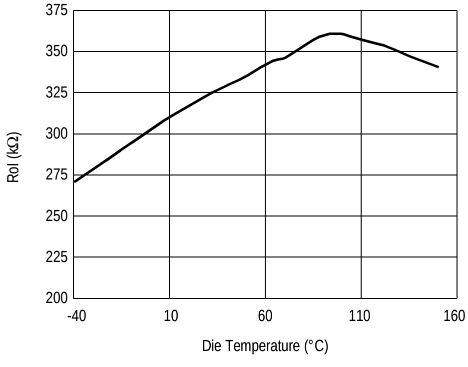
Large Signal Step Response



Settling Time vs Settling Accuracy

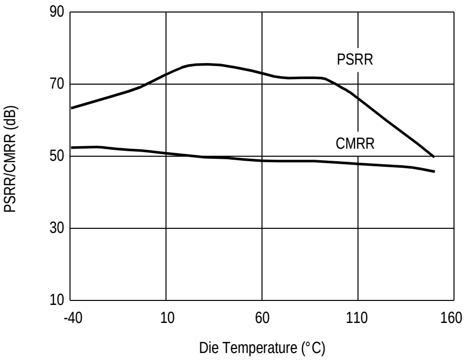


Transimpedance (RoI) vs Temperature

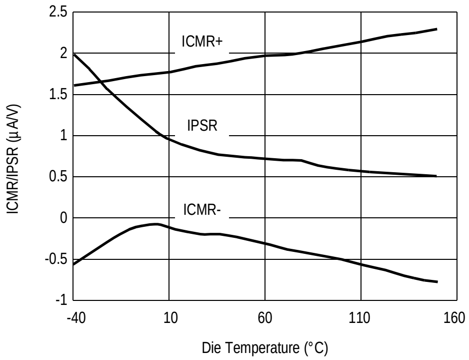


Typical Performance Curves

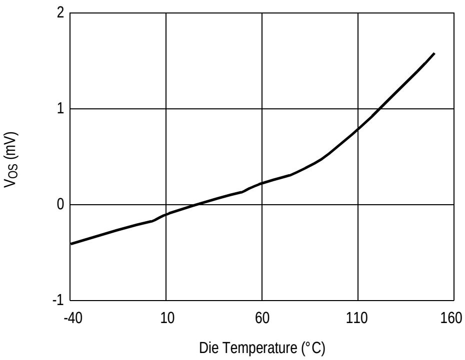
PSRR and CMRR vs Temperature



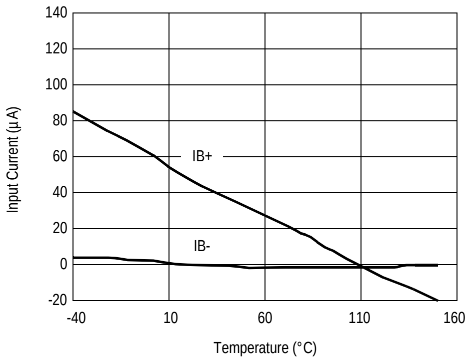
ICMR and IPSR vs Temperature



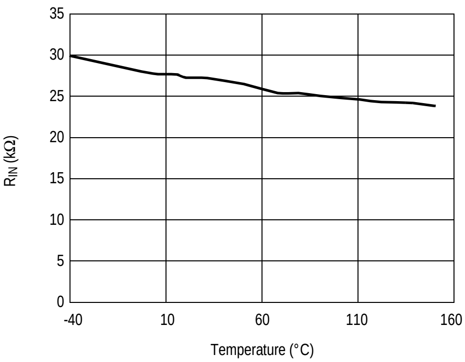
Offset Voltage vs Temperature



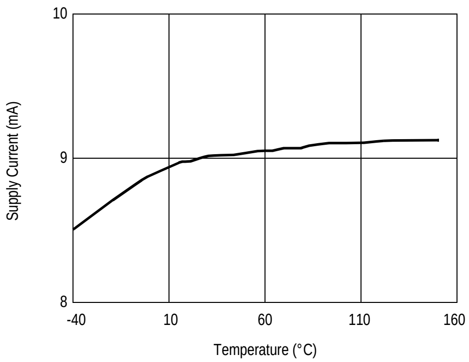
Input Current vs Temperature



Positive Input Resistance vs Temperature

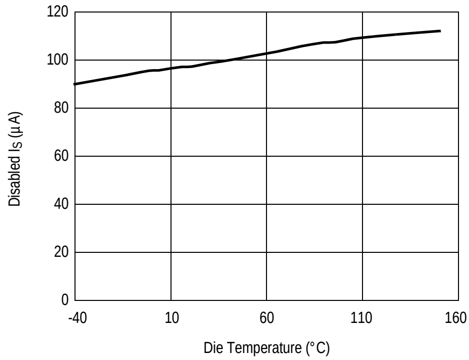


Supply Current vs Temperature

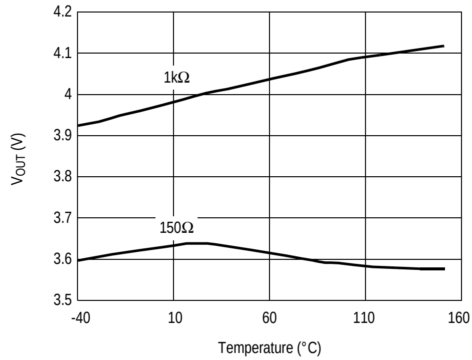


Typical Performance Curves

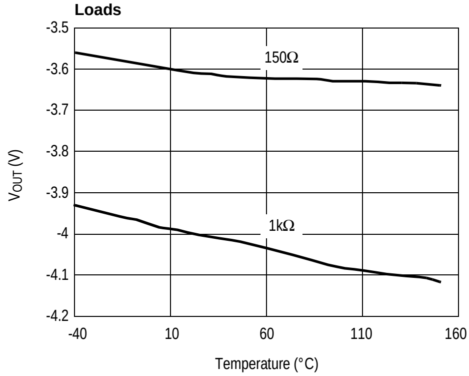
Supply Current (Disabled) vs Temperature



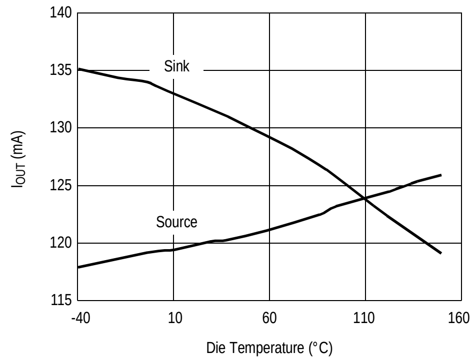
Positive Output Swing vs Temperature for Various Loads



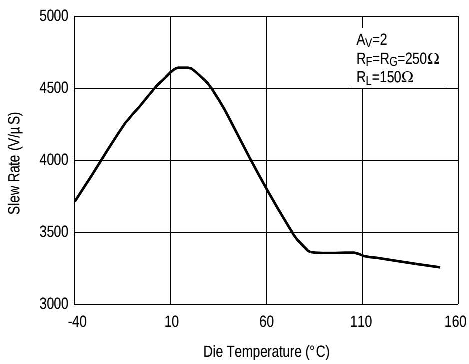
Negative Output Swing vs Temperature for Various Loads



Output Current vs Temperature



Slew Rate vs Temperature



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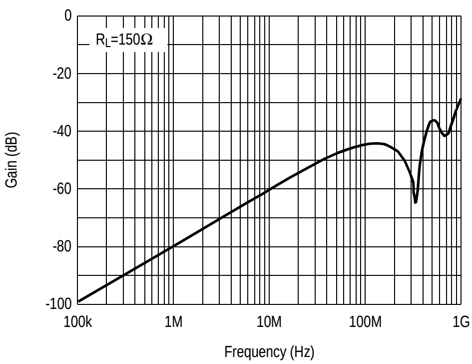
Off Isolation

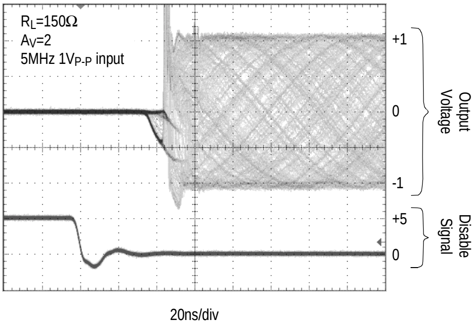


EL5191C - Preliminary

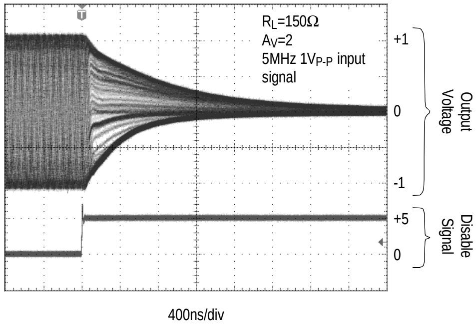
1GHz Current Feedback Amplifier

Typical Performance Curves

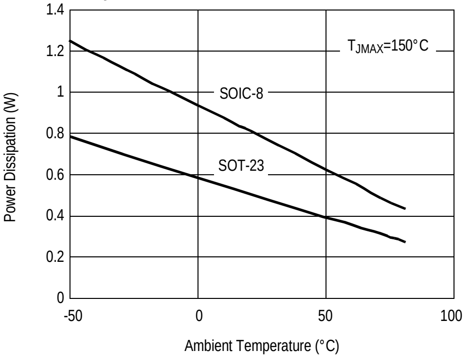
Enable Response



Disable Response



Maximum Power Dissipation vs Ambient Temperature



Applications Information

Product Description

The EL5191C is a current-feedback operational amplifier that offers a wide -3dB bandwidth of 1GHz and a low supply current of 9mA per amplifier. The EL5191C 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 their current-feedback topology, the EL5191C 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 EL5191C the ideal choice for many low-power/high-bandwidth applications such as portable, handheld, or battery-powered equipment.

For varying bandwidth needs, consider the EL5192C with 600MHz on a 6mA supply current or the EL5193C with 300MHz on a 4mA supply current. The amplifiers are also available for fixed gains of 1, -1, and 2. Versions include single, dual, and triple amp packages with SOT23-5, SOT23-6, and 8-pin or 14-pin SOIC outlines.

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 package, should be avoided if possible. Sockets add parasitic inductance and capacitance which will result in additional peaking and overshoot.

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 EL5191C has been optimized with a 250Ω 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 EL5191C has been designed and specified at a gain of +2 with R_F approximately 250Ω. This value of feedback resistor gives 600MHz of -3dB bandwidth at A_V=2 with about 2dB of peaking. With A_V=-2, that same R_F gives 450MHz of bandwidth with 0.6dB of peaking. Since the EL5191C 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 EL5191C is a current-feedback amplifier, its gain-bandwidth product is not a constant for different closed-loop gains. This feature actually allows the EL5191C to maintain about the same -3dB bandwidth.

EL5191C - Preliminary

1GHz Current Feedback Amplifier

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 250Ω 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 EL5191C 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 EL5191C will operate on dual supplies ranging from ±2.5V to ±5V. With single-supply, the EL5191C 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 EL5191C has an input range which extends to within 2V of either supply. So, for example, on ±5V supplies, the EL5191C has an input range which spans ±3V. The output range of the EL5191C 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 9mA supply current of each EL5191C amplifier. Special circuitry has been incorporated in the EL5191C to reduce the variation of output impedance with current output. This results in dG and dP specifications of 0.035% and 0.04°, 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 EL5191C has dG and dP specifications of 0.02% and 0.02°, respectively.

Output Drive Capability

In spite of its low 9mA of supply current, the EL5191C is capable of providing a minimum of ±120mA of output current. With a minimum of ±120mA of output drive, the EL5191C 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 EL5191C 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 EL5191C 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 EL5191C, it is possible to exceed the 150°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 EL5191C 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

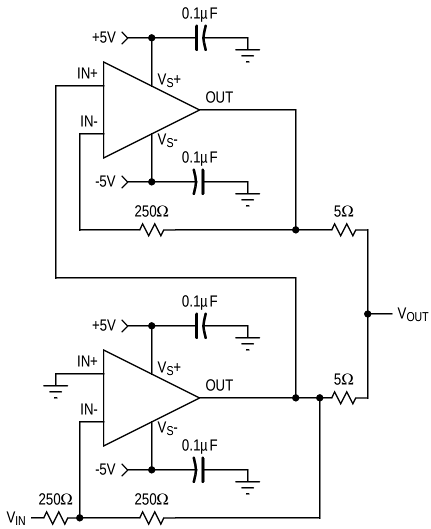
I_{SMAX} = Maximum Supply Current of 1A

V_{OUTMAX} = Maximum Output Voltage (Required)

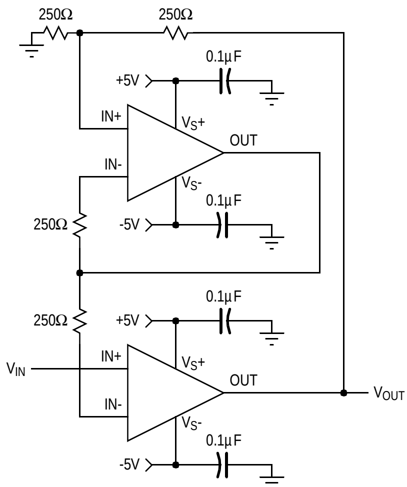
R_L = Load Resistance

Typical Application Circuits

Inverting 200mA Output Current Distribution Amplifier

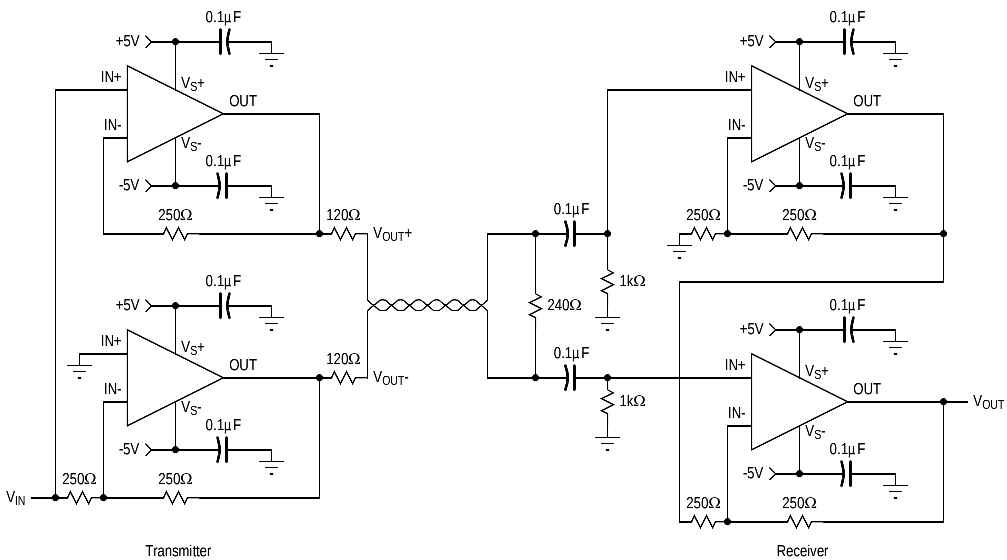


Fast-Settling Precision Amplifier



Typical Application Circuits

Differential Line Driver/Receiver



EL5191C - Preliminary

1GHz Current Feedback Amplifier

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