



**OPA511**

## High Current—High Power OPERATIONAL AMPLIFIER

### FEATURES

- WIDE SUPPLY RANGE:  $\pm 10V$  to  $\pm 30V$
- HIGH OUTPUT CURRENT: 5A Peak
- CLASS A/B OUTPUT STAGE:  
Low Distortion
- SMALL TO-3 PACKAGE

### APPLICATIONS

- SERVO AMPLIFIER
- MOTOR DRIVER
- SYNCRO EXCITATION
- AUDIO AMPLIFIER
- TEST PIN DRIVER

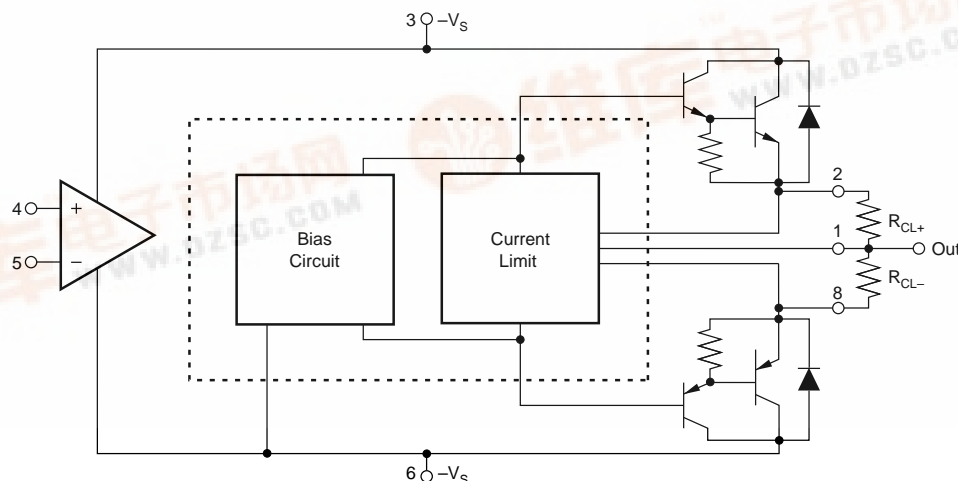
### DESCRIPTION

The OPA511 is a high voltage, high current operational amplifier designed to drive a wide variety of resistive and reactive loads. Its complementary class A/B output stage provides superior performance in applications requiring freedom from cross-over distortion. User-set current limit circuitry provides protection to the amplifier and load in fault conditions.

The OPA511 employs a laser-trimmed monolithic integrated circuit to bias the output transistors,

providing excellent low-level signal fidelity and high output voltage swing. The reduced internal parts count made possible with this bias IC improves performance and reliability.

This hybrid integrated circuit is housed in a hermetically sealed TO-3 package and all circuitry is electrically isolated from the case. This allows direct mounting to a chassis or heat sink without cumbersome insulating hardware and provides optimum heat transfer.



# SPECIFICATIONS

## ELECTRICAL

At  $T_c = +25^\circ\text{C}$  and  $V_s = \pm 28\text{VDC}$  unless otherwise noted.

PARAMETER	CONDITIONS	OPA511AM			UNITS
		MIN	TYP	MAX	
<b>INPUT</b>					
<b>OFFSET VOLTAGE</b>					
Initial Offset	Full Temperature Range		$\pm 5$	$\pm 10$	mV
vs Temperature			$\pm 10$	$\pm 65$	$\mu\text{V}/^\circ\text{C}$
vs Supply Voltage			$\pm 35$	$\pm 200$	$\mu\text{V}/\text{V}$
vs Power			$\pm 20$		$\mu\text{V}/\text{W}$
<b>BIAS CURRENT</b>					
Initial	Full Temperature Range		$\pm 15$	$\pm 40$	nA
vs Temperature			$\pm 0.05$	$\pm 0.4$	$\text{nA}/^\circ\text{C}$
vs Supply voltage			$\pm 0.02$		$\text{nA}/\text{V}$
<b>OFFSET CURRENT</b>					
Initial	Full Temperature Range		$\pm 5$	$\pm 10$	nA
vs Temperature			$\pm 0.01$		$\text{nA}/^\circ\text{C}$
<b>INPUT IMPEDANCE</b>					
Common Mode			200		$\text{M}\Omega$
Differential			10		$\text{M}\Omega$
<b>VOLTAGE RANGE <sup>(1)</sup></b>					
Common-Mode Voltage	Full Temperature Range	$\pm( V_s  - 6)$	$\pm( V_s  - 3)$		V
Common-Mode Rejection		70	110		dB
<b>GAIN</b>					
Open-Loop Gain at 10Hz	Full Temperature Range, full load	91	113		dB
Gain-Bandwidth Product at 1MHz			1		MHz
Power Bandwidth		15	23		kHz
Phase Margin			45		Degrees
<b>OUTPUT</b>					
Voltage Swing	$I_o = 5\text{A}$ $\pm( V_s  - 6)$ Full Temperature Range, $I_o = 56\text{mA}$	$\pm( V_s  - 8)$ $\pm( V_s  - 5)$	$\pm( V_s  - 5)$	V V	V
Current, Peak		$\pm 5$			A
Settling Time to 0.1%			2		$\mu\text{s}$
Slew Rate	2V step $R_L = 2.5\Omega$	$\pm 1.0$	1.8		$\text{V}/\mu\text{s}$
Capacitive Load: Unity Gain	Full Temperature Range			3.3	nF
Gain > 4				SOA <sup>(2)</sup>	
<b>POWER SUPPLY</b>					
Voltage	Full Temperature Range	$\pm 10$	$\pm 28$	$\pm 30$	V
Current, Quiescent			20	30	mA
<b>THERMAL RESISTANCE</b>					
AC Junction to Case <sup>(3)</sup>	f > 60Hz		1.9	2.1	$^\circ\text{C}/\text{W}$
DC Junction to Case			2.4	2.6	$^\circ\text{C}/\text{W}$
Junction to Air			30		$^\circ\text{C}/\text{W}$
<b>TEMPERATURE RANGE</b>					
Case		-25		+85	$^\circ\text{C}$

NOTES: (1)  $+V_s$  and  $-V_s$  denote the positive and negative supply voltage respectively. Total  $V_s$  is measured from  $+V_s$  to  $-V_s$ . (2) SOA = Safe Operating Area. (3) Rating applies if the output current alternates between both output transistors at a rate faster than 60Hz.



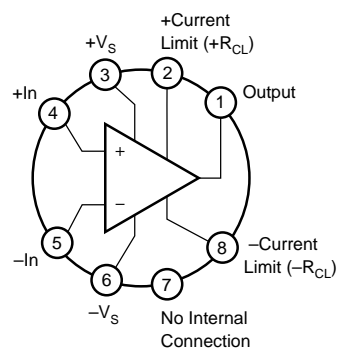
## ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$	68V
Output Current: Source	5A
Sink	see SOA
Power Dissipation, internal <sup>(1)</sup>	67W
Input Voltage: Differential	$\pm( V_S  - 3V)$
Common-mode	$\pm V_S$
Temperature: Junction <sup>(1)</sup>	+200°C
Pin solder(10s)	+300°C
Temperature Range: Storage	-65°C to +150°C
Operating (case)	-25°C to +85°C

NOTE: (1) Long term operation at the maximum junction temperature will result in reduced product life. Derate internal power dissipation to achieve high MTTF.

## PIN CONFIGURATION

Top View

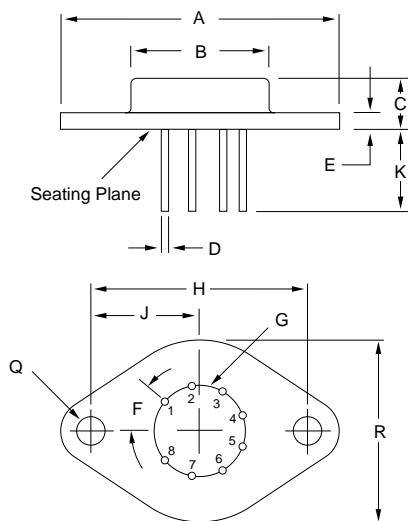


## ORDERING INFORMATION

MODEL	PACKAGE	TEMPERATURE RANGE
OPA511AM	TO-3	-25°C to +85°C

## MECHANICAL

M Package — 8-Pin Metal TO-3



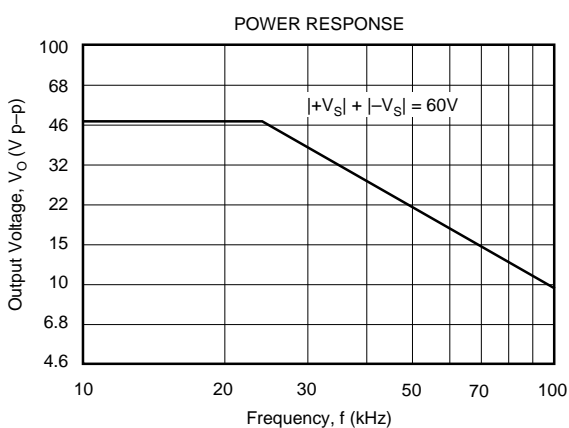
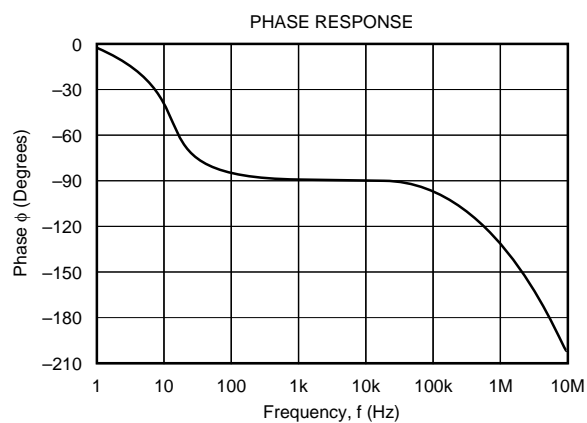
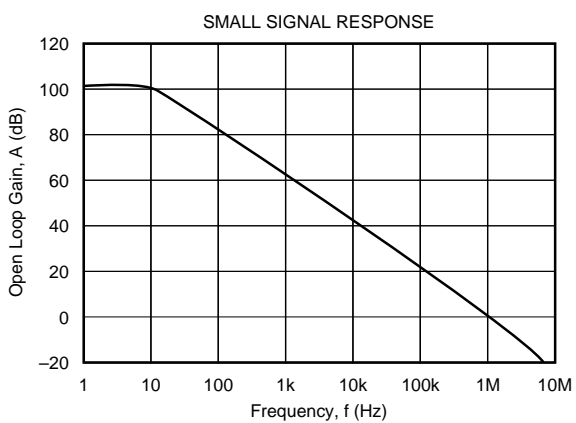
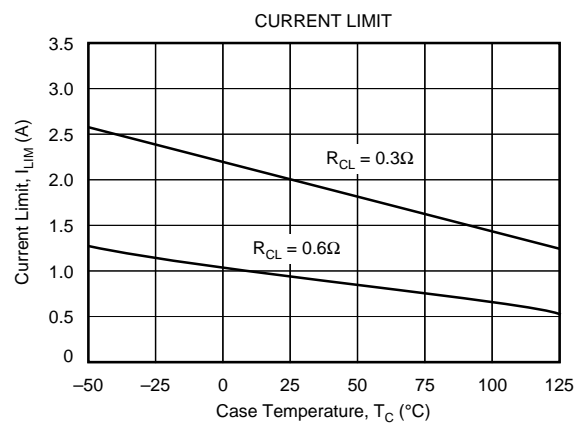
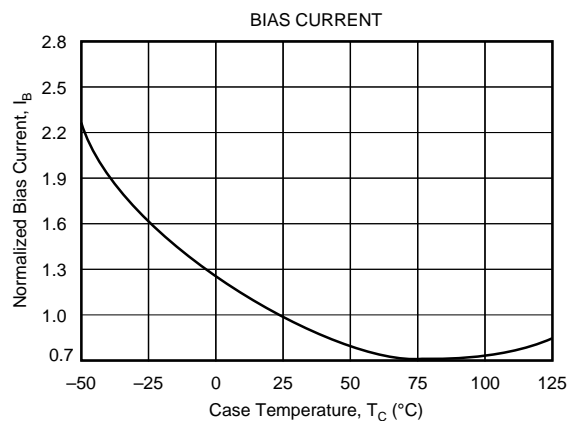
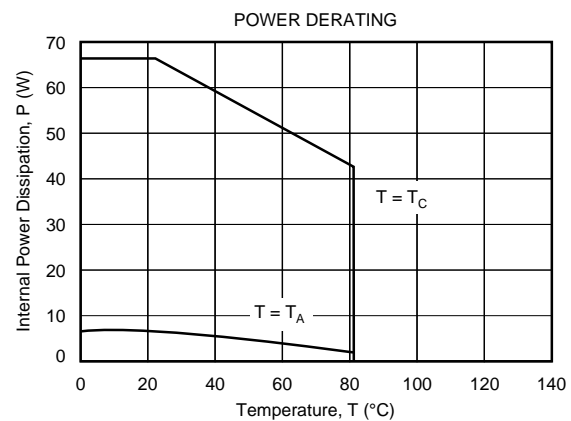
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.510	1.550	38.35	39.37
B	.745	.770	18.92	19.56
C	.260	.300	6.60	7.62
D	.038	.042	0.97	1.07
E	.080	.105	2.03	2.67
F	40° BASIC		40° BASIC	
G	.500 BASIC		12.70 BASIC	
H	1.182	1.192	30.02	30.28
J	.591	.596	15.01	15.14
K	.400	.500	10.16	12.70
Q	.151	.161	3.84	4.09
R	.980	1.020	24.89	25.91

NOTE: Leads in true position within 0.01" (0.25mm) R at MMC at seating plane. Pin numbers shown for reference only. Numbers may not be marked on package.



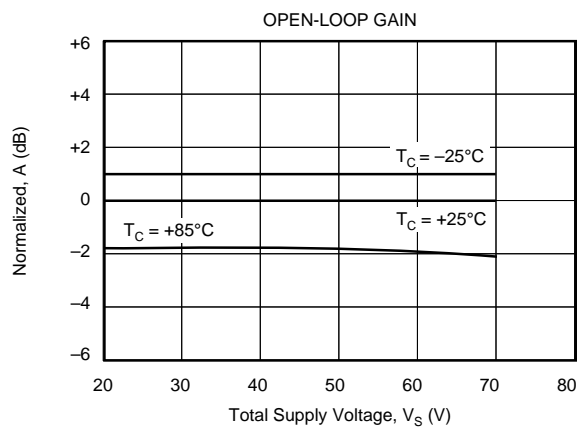
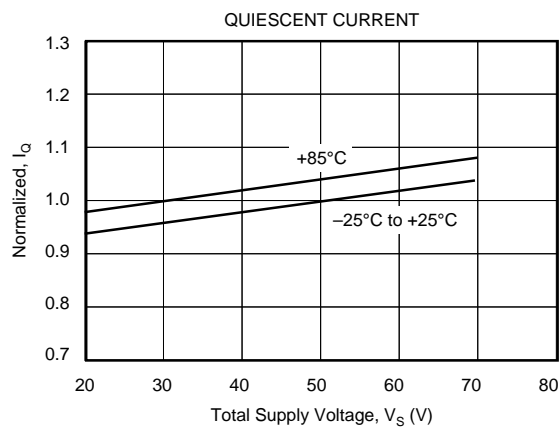
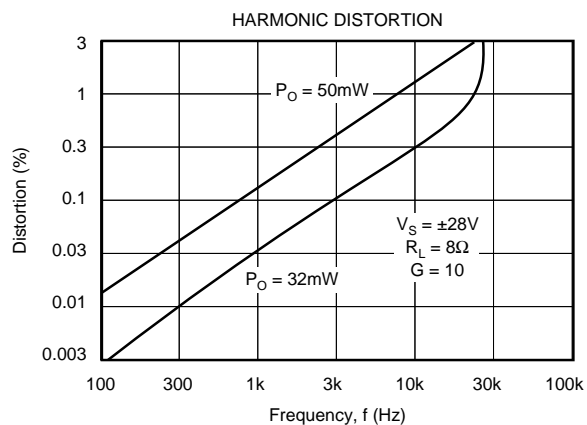
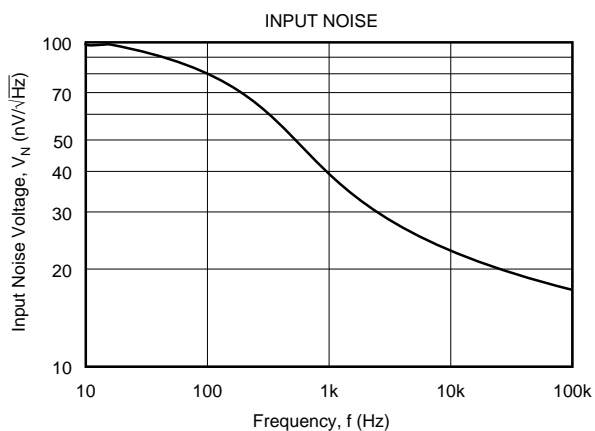
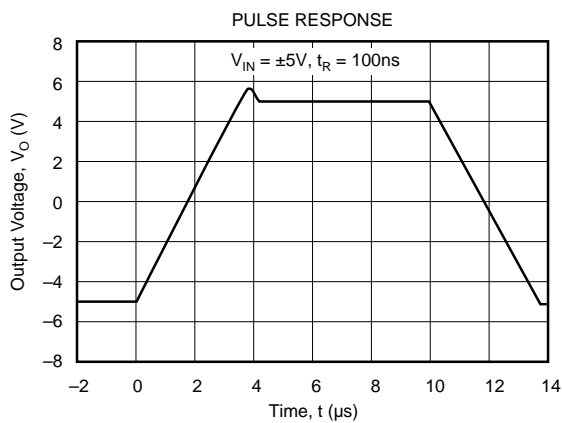
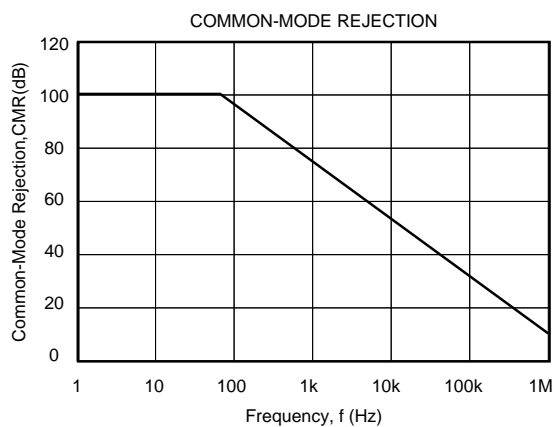
# TYPICAL PERFORMANCE CURVES

$T_A = +25^{\circ}\text{C}$ ,  $V_S = \pm 28\text{VDC}$  unless otherwise noted.



## TYPICAL PERFORMANCE CURVES (CONT)

$T_A = +25^\circ\text{C}$ ,  $V_S = \pm 28\text{VDC}$  unless otherwise noted.



# APPLICATIONS INFORMATION

## POWER SUPPLIES

Specifications for the OPA511 are based on a nominal operating voltage  $\pm 28\text{V}$ . A single power supply or unbalanced supplies may be used so long as the maximum total operating voltage (total of  $+V_s$  and  $-V_s$ ) is not greater than  $68\text{V}$ .

## CURRENT LIMITS

Current limit resistors must be provided for proper operation. Independent positive and negative current limit values may be selected by choice of  $R_{CL+}$  and  $R_{CL-}$ , respectively. Resistor values are calculated by:

$$R_{CL} = 0.65/I_{LM} \text{ (amps)} - 0.01$$

This is the nominal current limit value at room temperature. The maximum output current decreases at high temperature as shown in the typical performance curve. Most wire-wound resistors are satisfactory, but some highly inductive types may cause loop stability problems. Be sure to evaluate performance with the actual resistors to be used in production.

## HEAT SINKING

Power amplifiers are rated by case temperature (not ambient temperature). The maximum allowable power dissipation is a function of the case temperature as shown in the power derating curve. Load characteristics, signal conditions, and power supply voltage determine the power dissipated by the amplifier. The case temperature will be determined by the heat sinking conditions. Sufficient heat sinking must be provided to keep the case temperature within safe bounds given the power dissipated and ambient temperature. See Application Note AN-83 for further details.

## SAFE OPERATING AREA (SOA)

The safe area plot provides a comprehensive summary of the power handling limitations of a power amplifier, including maximum current, voltage and power as well as the secondary breakdown region (see Figure 1). It shows the allowable output current as a function of the power supply to output voltage differential (voltage across the conducting power device). See Application Note AN-123 for details on SOA.

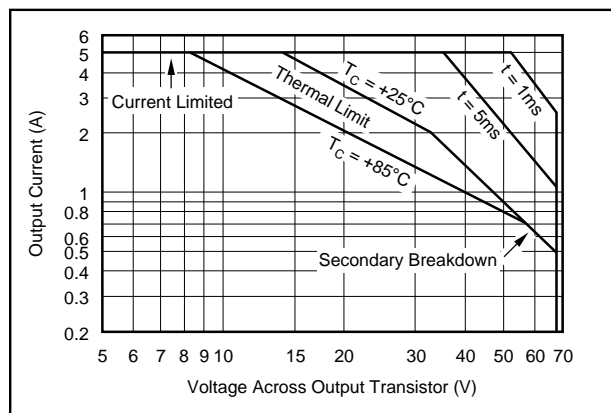


FIGURE 1. Safe Operating Area.