

# NE/SE538

## High Slew Rate Op Amp

### Product Specification

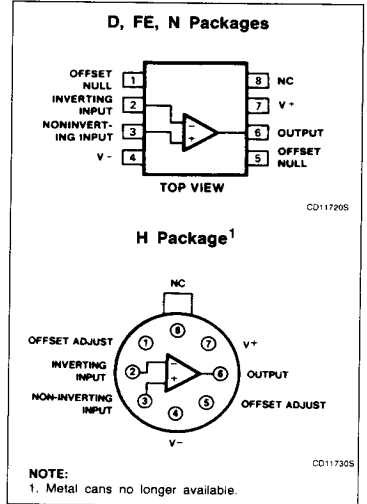
#### DESCRIPTION

The NE/SE538 is a new generation operational amplifier featuring high slew rates combined with improved input characteristics. Internally-compensated for gains of 5 or larger, the SE538 offers guaranteed minimum slew rates of  $40V/\mu s$  or larger. Industry standard pinout and internal compensation allow the user to upgrade system performance by directly replacing general purpose amplifiers, such as 748, 101A and 741.

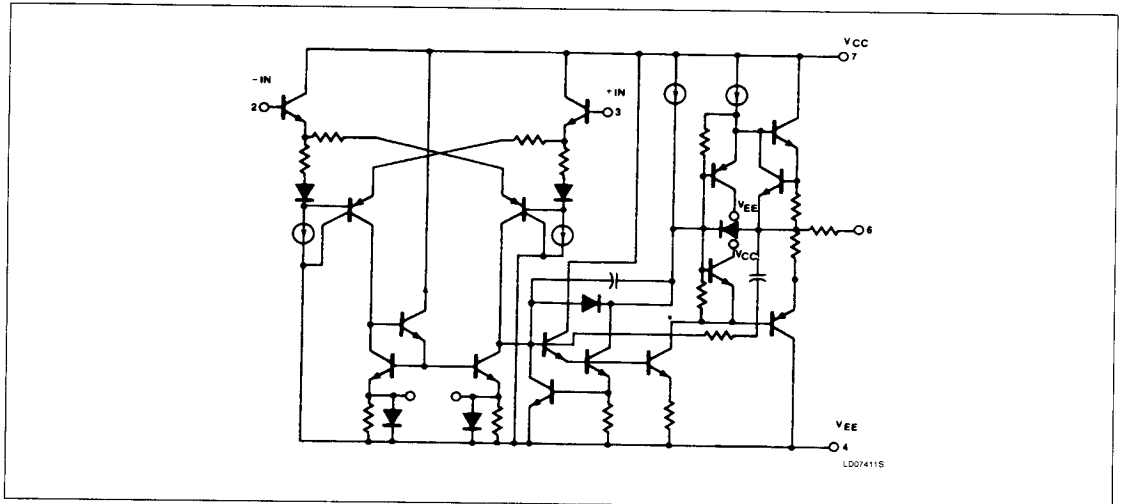
#### FEATURES

- 2mV typical input offset voltage
- 80nA max input offset current
- Short-circuit protected
- Offset null capability
- Large common-mode and differential voltage ranges
- $60V/\mu s$  typical slew rate (gain of +5, -4 min)
- 6MHz typical gain bandwidth product (gain +5, -4 minimum)
- Internal frequency compensation (gain of +5, -4 minimum)
- Pinout: standard single op amp (748, 101A, 741, etc).

#### PIN CONFIGURATIONS



#### EQUIVALENT SCHEMATIC (EACH AMPLIFIER)



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## ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
8-Pin Plastic SO	0 to +70°C	NE538D
8-Pin Plastic DIP	0 to +70°C	NE538N
8-Pin Ceramic DIP	0 to +70°C	NE538FE
8-Pin Plastic DIP	-55°C to +125°C	SE538N
8-Pin Ceramic DIP	-55°C to +125°C	SE538FE

## ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	RATING	UNIT
V <sub>CC</sub>	Supply voltage	± 22	V
	SE military grade NE commercial grade	± 18	V
P <sub>D</sub>	Maximum power dissipation, T <sub>A</sub> =25°C (still air) <sup>1</sup>		
	D package	790	mW
	F package	830	mW
	N package	1200	mW
V <sub>DIFF</sub>	Differential input voltage	± 30	V
V <sub>IN</sub>	Input voltage <sup>2</sup>	± 15	V
T <sub>A</sub>	Operating ambient temperature range		
	SE military grade	-55 to +125	°C
	NE commercial grade	0 to 70	°C
	Output short-circuit <sup>3</sup>	indefinite	
T <sub>STG</sub>	Storage temperature range	-65 to +150	°C
T <sub>SOLD</sub>	Lead soldering temperature (10sec max)	300	°C

## NOTES:

1. Derate above 25°C, at the following rates:

- D package at 6.3mW/°C
- F package at 6.7mW/°C
- N package at 9.6mW/°C

2. For supply voltages less than ± 15V, the absolute maximum input voltage is equal to the supply voltage.

3. Short-circuit may be to ground or either supply. Rating applies to 125°C case temperature or 75°C ambient temperature.

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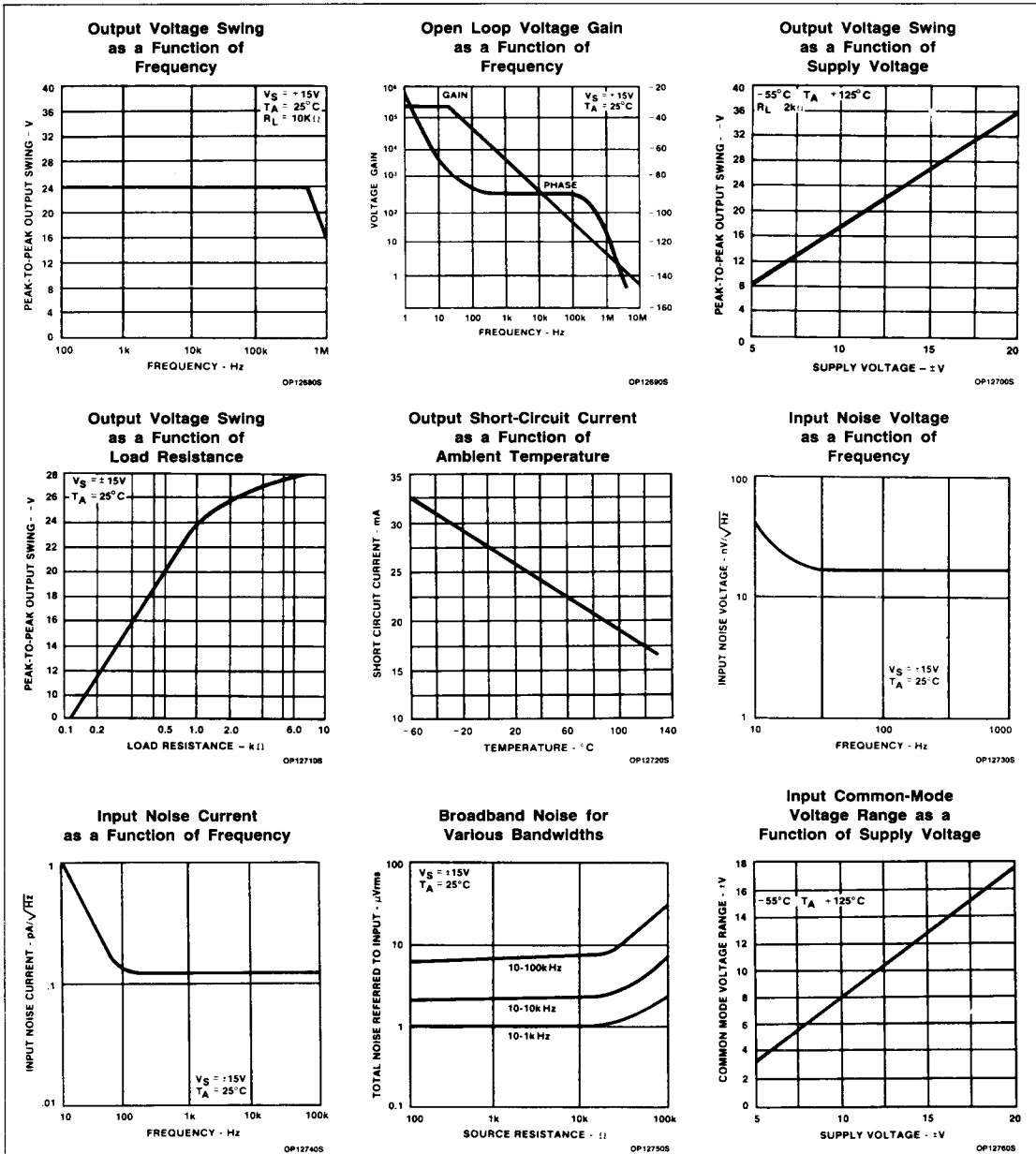
**DC ELECTRICAL CHARACTERISTICS**  $T_A = 25^\circ\text{C}$ ,  $V_S = \pm 15\text{V}$ , unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE538			NE538			UNIT
			Min	Typ	Max	Min	Typ	Max	
$V_{OS}$	Input offset voltage	$R_S \leq 10\text{k}\Omega$ $R_S \leq 10\text{k}\Omega$ , over temp.		0.7	4.0 5.0		2.0	6.0 7.0	mV mV
$\Delta V_{OS}$	Input offset voltage drift	$R_S = 0\Omega$ , over temp.		4.0			6.0		$\mu\text{V}/^\circ\text{C}$
$I_{OS}$	Input offset current	Over temp.		5	20 40		15	40 80	nA nA
$\Delta I_{OS}$	Input offset current	Over temp.		25			40		$\text{pA}/^\circ\text{C}$
$I_B$	Input current	Over temp.		45	80 200		65	150 200	nA nA
$\Delta I_B$	Input current	Over temp.		50			80		$\text{pA}/^\circ\text{C}$
$V_{CM}$	Input common-mode voltage range		$\pm 12$	$\pm 13$		$\pm 12$	$\pm 13$		V
CMRR	Common-mode rejection ratio	$R_S \leq 10\text{k}\Omega$ , over temp.	70	90		70	90		dB
PSRR	Power supply rejection ratio	$R_S \leq 10\text{k}\Omega$ , over temp.		30	150		30	150	$\mu\text{V}/\text{V}$
$R_{IN}$	Input resistance		3	10		1	6		$\text{M}\Omega$
$A_{VOL}$	Large-signal voltage gain	$R_L \geq 2\text{k}\Omega$ , $V_{OUT} = \pm 10\text{V}$ Over temp., $R_L \geq 2\text{k}\Omega$ , $V_{OUT} = \pm 10\text{V}$	50 25	200		50 25	200		V/mV V/mV
$V_{OUT}$	Output voltage swing	Over temp., $R_L \geq 2\text{k}\Omega$ Over temp., $R_L \geq 10\text{k}\Omega$	$\pm 10$ $\pm 12$	$\pm 13$ $\pm 14$		$\pm 10$ $\pm 12$	$\pm 13$ $\pm 14$		V V
$I_{CC}$	Supply current	Over temp.		2 2.2	3 3.6		2 2.2	3 3.6	mA mA
$P_D$	Power dissipation	Over temp.		60 66	90 108		60 66	90 108	mW mW
$I_{SC}$	Output short-circuit current		10	25	50	10	25	50	mA
$R_{OUT}$	Output resistance			100			100		$\Omega$

**AC ELECTRICAL CHARACTERISTICS**  $T_A = 25^\circ\text{C}$ , unless otherwise specified.

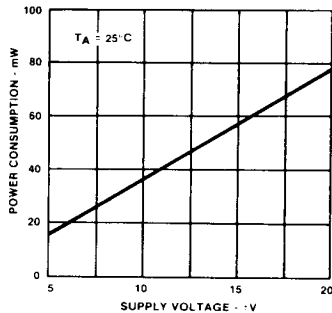
SYMBOL	PARAMETER	TEST CONDITIONS	SE538			NE538			UNIT
			Min	Typ	Max	Min	Typ	Max	
GBW	Gain bandwidth product (Gain +5, -4 minimum)			6			6		MHz
$t_R$	Transient response Small-signal rise time Small-signal overshoot			0.25 6			0.25 6		$\mu\text{s}$ %
$t_S$	Settling time	To 0.1%		1.2			1.2		$\mu\text{s}$
SR	Slew rate	Minimum gain = 5 Noninverting $R_L \geq 2\text{k}\Omega$	40	60			60		V/ $\mu\text{s}$
$V_{NOISE}$	Input noise voltage	$f = 1\text{kHz}$ , $T_A = 25^\circ\text{C}$		30			30		nV/ $\sqrt{\text{Hz}}$

TYPICAL PERFORMANCE CHARACTERISTICS

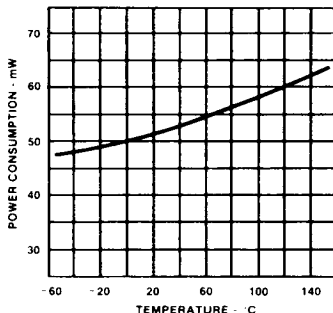


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

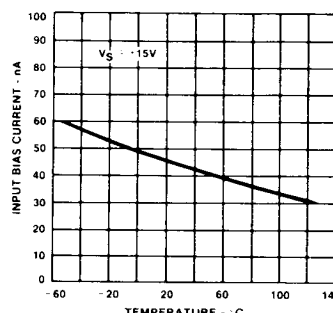
Power Consumption as a Function of Supply Voltage



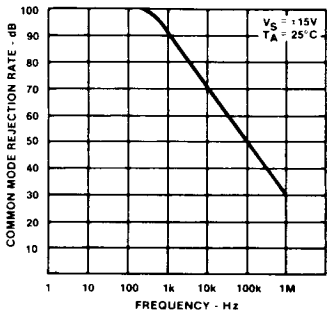
Power Consumption as a Function of Ambient Temperature



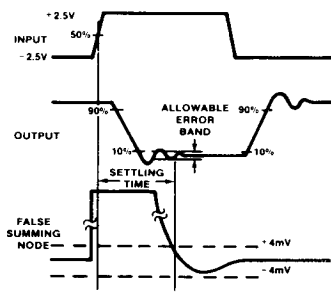
Input Bias Current as a Function of Ambient Temperature



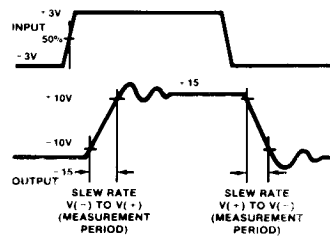
Common-Mode Rejection Ratio as a Function of Frequency



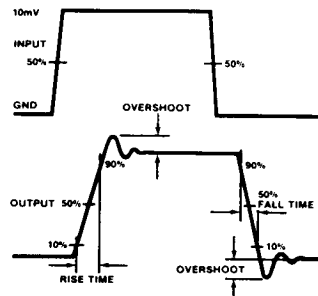
Settling Time Measurement Waveforms



Slew Rate Measurement VCC = ±20V



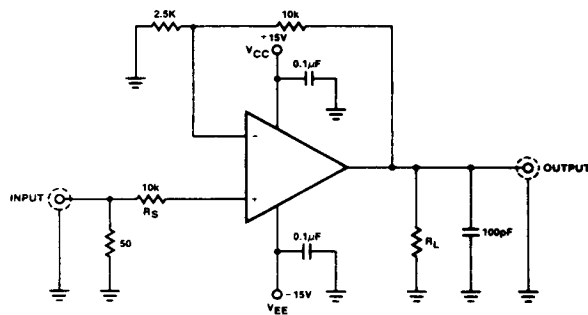
Small-Signal Transient Response Definitions



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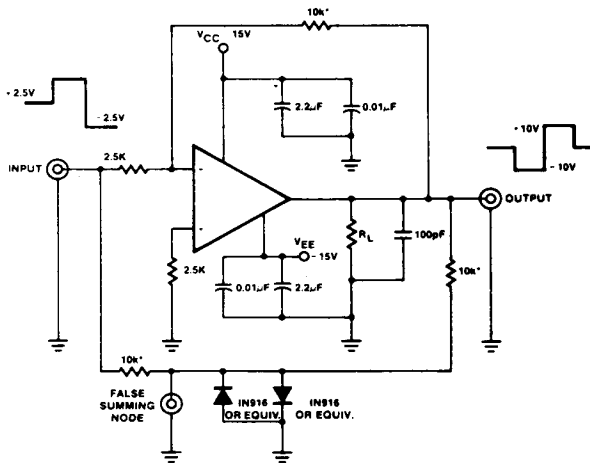
## TEST LOAD CIRCUITS



TC153008

**NOTES:**

Pins not shown are not connected.  
All resistor values are typical and in ohms.

**Slew Rate and Small-Signal Transient Response Test Circuit**

TC148818

**NOTES:**

\*Match to within 0.01%.  
Pins not shown are not connected.  
All resistor values are typical and in ohms.

**Settling Time Test Circuit**

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## APPLICATIONS

The internal frequency compensation is designed for a minimum inverting gain of 4 and a minimum non-inverting gain of 5. Below these gains the NE538 will be unstable and will need external compensation (see Figures 1 and 2).

The higher slew rate of the NE538 has made this device quite appealing for high-speed designs, and the fact that it has a standard pinout will allow it to be used to upgrade existing systems that now use the  $\mu A741$  or  $\mu 748$ .

Equations:

$$f_{LAG} = \frac{1 \text{ (6MHz)}}{10} = \frac{1}{2\pi R_L C_L}$$

$$f_{LEAD} = 6\text{MHz} = \frac{1}{2\pi R_F C_F}$$

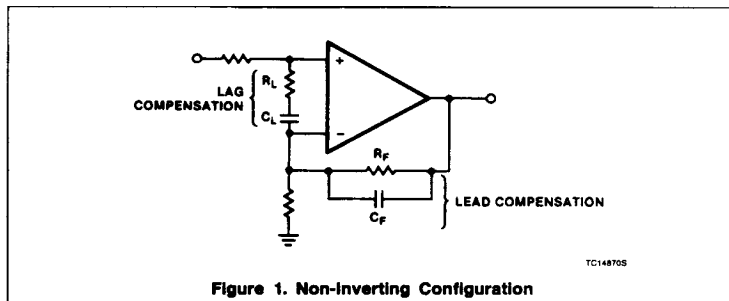


Figure 1. Non-inverting Configuration

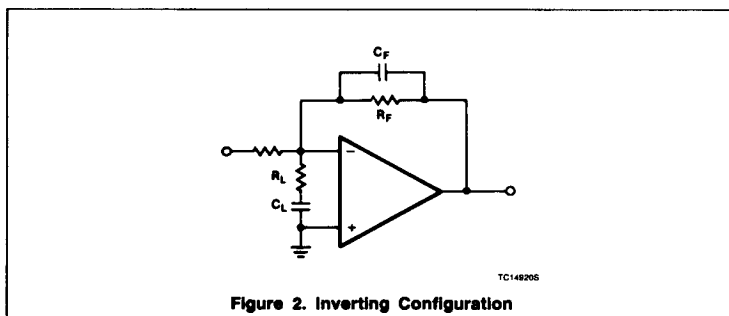


Figure 2. Inverting Configuration

## VOLTAGE COMPARATOR

Inexpensive voltage comparators with only modest parameters are often needed. The op amp is often used in the configuration because the high gain provides good selectivity. Figure 6 shows a circuit usable with most any op amp. The zener is selected for the output voltage required (5.1 volt for TTL), and the resistor provides some current protection to the op amp output structure.  $V_{REF}$  can be any voltage within the wide common-mode range of the amplifier — another advantage of using op amps for comparators.

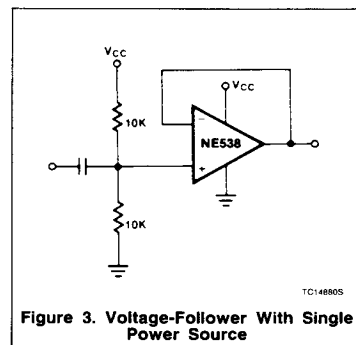


Figure 3. Voltage-Follower With Single Power Source

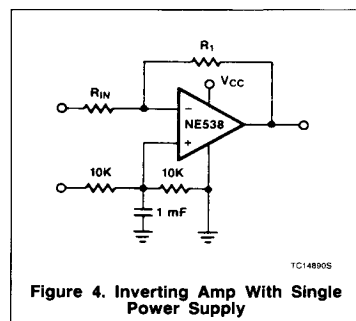


Figure 4. Inverting Amp With Single Power Supply

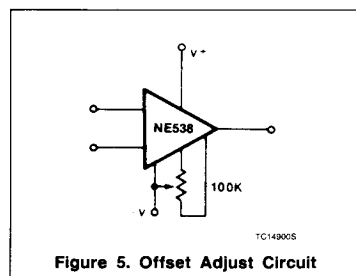
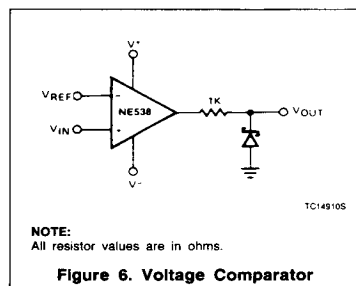


Figure 5. Offset Adjust Circuit



NOTE:  
All resistor values are in ohms.

Figure 6. Voltage Comparator