

NE/SE5539

High Frequency Operational Amplifier

Product Specification

Linear Products

DESCRIPTION

The NE/SE5539 is a very wide bandwidth, high slew rate, monolithic operational amplifier for use in video amplifiers, RF amplifiers, and extremely high slew rate amplifiers.

Emitter-follower inputs provide a true differential high input impedance device. Proper external compensation will allow design operation over a wide range of closed-loop gains, both inverting and non-inverting, to meet specific design requirements.

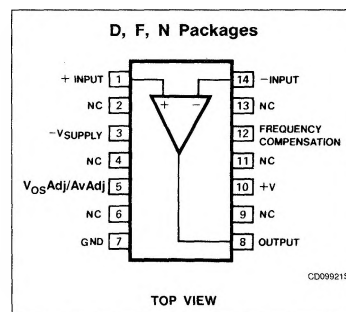
FEATURES

- **Bandwidth**
 - Unity gain - 350MHz
 - Full power - 48MHz
 - GBW - 1.2 GHz at 17dB
- **Slew rate: 600V/ μ s**
- **A_{VOL}: 52dB typical**
- **Low noise - 4nV/ $\sqrt$ Hz typical**
- **MIL-STD processing available**

APPLICATIONS

- High speed datacomm
- Video monitors & TV
- Satellite communications
- Image processing
- RF instrumentation & oscillators
- Magnetic storage
- Military communications

PIN CONFIGURATION



ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
14-Pin Plastic DIP	0 to +70°C	NE5539N
14-Pin Plastic SO	0 to +70°C	NE5539D
14-Pin Cerdip	0 to +70°C	NE5539F
14-Pin Plastic DIP	-55°C to +125°C	SE5539N
14-Pin Cerdip	-55°C to +125°C	SE5539F

ABSOLUTE MAXIMUM RATINGS¹

SYMBOL	PARAMETER	RATING	UNIT
V _{CC}	Supply voltage	± 12	V
P _{DMAX}	Maximum power dissipation, T _A = 25°C (still-air) ²		
	F package	1.17	W
	N package	1.45	W
	D package	0.99	W
T _{STG}	Storage temperature range	-65 to +150	°C
T _J	Max junction temperature	150	°C
T _A	Operating temperature range		
	NE	0 to 70	°C
	SE	-55 to +125	°C
T _{SOLD}	Lead temperature (10sec max)	300	°C

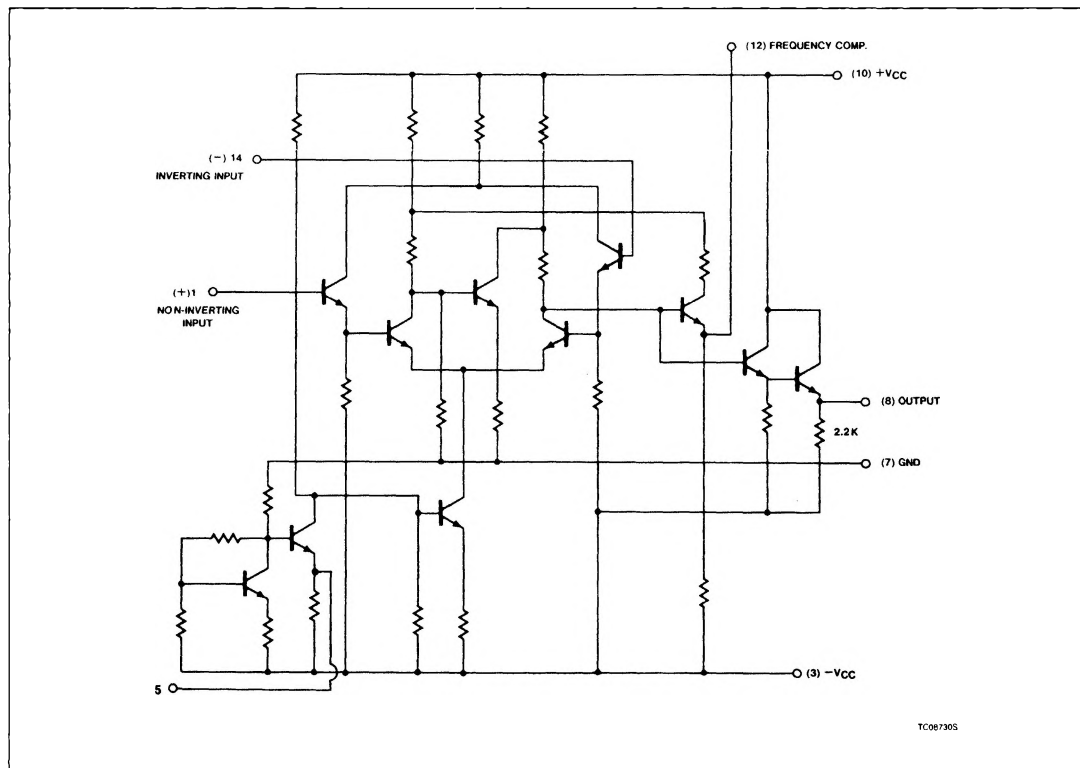
NOTES:

1. Differential input voltage should not exceed 0.25V to prevent excessive input bias current and common-mode voltage 2.5V. These voltage limits may be exceeded if current is limited to less than 10mA.
2. Derate above 25°C, at the following rates:
 - F package at 9.3 mW/°C
 - N package at 11.6 mW/°C
 - D package at 7.9 mW/°C

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EQUIVALENT CIRCUIT

DC ELECTRICAL CHARACTERISTICS $V_{CC} = \pm 8V$, $T_A = 25^\circ C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE5539			NE5539			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OS}	Input offset voltage	$V_O = 0V$, $R_S = 100\Omega$	Over temp	2	5				mV
			$T_A = 25^\circ C$	2	3		2.5	5	
	$\Delta V_{OS}/\Delta T$			5			5		$\mu V/^\circ C$
I_{OS}	Input offset current		Over temp	0.1	3				μA
			$T_A = 25^\circ C$	0.1	1			2	
	$\Delta I_{OS}/\Delta T$			0.5			0.5		$nA/^\circ C$
I_B	Input bias current		Over temp	6	25				μA
			$T_A = 25^\circ C$	5	13		5	20	
	$\Delta I_B/\Delta T$			10			10		$nA/^\circ C$
CMRR	Common-mode rejection ratio	$F = 1kHz$, $R_S = 100\Omega$, $V_{CM} \pm 1.7V$	70	80		70	80		dB
			Over temp	70	80				
R_{IN}	Input impedance			100			100		$k\Omega$
R_{OUT}	Output impedance			10			10		Ω

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DC ELECTRICAL CHARACTERISTICS (Continued) $V_{CC} = \pm 8V$, $T_A = 25^\circ C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE5539			NE5539			UNIT
			Min	Typ	Max	Min	Typ	Max	
V_{OUT}	Output voltage swing	$R_L = 150\Omega$ to GND and 470Ω to $-V_{CC}$	+ Swing			+2.3	+2.7		V
			- Swing			-1.7	-2.2		
V_{OUT}	Output voltage swing	$R_L = 2k\Omega$ to GND $T_A = 25^\circ C$	+ Swing	+2.3	+3.0				V
			- Swing	-1.5	-2.1				
			+ Swing	+2.5	+3.1				V
			- Swing	-2.0	-2.7				
I_{CC+}	Positive supply current	$V_O = 0$, $R_1 = \infty$	Over temp		14	18			mA
			$T_A = 25^\circ C$		14	17		14	18
I_{CC-}	Negative supply current	$V_O = 0$, $R_1 = \infty$	Over temp		11	15			mA
			$T_A = 25^\circ C$		11	14		11	15
PSRR	Power supply rejection ratio	$\Delta V_{CC} = \pm 1V$	Over temp		300	1000			$\mu V/V$
			$T_A = 25^\circ C$				200	1000	
A_{VOL}	Large signal voltage gain	$V_O = +2.3V$, $-1.7V$ $R_L = 150\Omega$ to GND, 470Ω to $-V_{CC}$				47	52	57	dB
A_{VOL}	Large signal voltage gain	$V_O = +2.3V$, $-1.7V$ $R_L = 2\Omega$ to GND							dB
			$T_A = 25^\circ C$			47	52	57	
A_{VOL}	Large signal voltage gain	$V_O = +2.5V$, $-2.0V$ $R_L = 2k\Omega$ to GND	Over temp	46	60				dB
			$T_A = 25^\circ C$	48	53	58			

DC ELECTRICAL CHARACTERISTICS $V_{CC} = \pm 6V$, $T_A = 25^\circ C$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS		SE5539			UNIT
				Min	Typ	Max	
V _{OS}	Input offset voltage		Over temp		2	5	mV
			T _A = 25°C		2	3	
I _{OS}	Input offset current		Over temp		0.1	3	μA
			T _A = 25°C		0.1	1	
I _B	Input bias current		Over temp		5	20	μA
			T _A = 25°C		4	10	
CMRR	Common-mode rejection ratio	V _{CM} = ± 1.3V, R _S = 100Ω		70	85		dB
I _{CC} +	Positive supply current		Over temp		11	14	mA
			T _A = 25°C		11	13	
I _{CC} -	Negative supply current		Over temp		8	11	mA
			T _A = 25°C		8	10	
PSRR	Power supply rejection ratio	ΔV _{CC} = ± 1V	Over temp		300	1000	μV/V
			T _A = 25°C				
V _{OUT}	Output voltage swing	R _L = 150Ω to GND and 390Ω to -V _{CC}	Over temp	+ Swing	+1.4	+2.0	V
				- Swing	-1.1	-1.7	
			T _A = 25°C	+ Swing	+1.5	+2.0	
				- Swing	-1.4	-1.8	

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AC ELECTRICAL CHARACTERISTICS $V_{CC} = \pm 8V$, $R_L = 150\Omega$ to GND & 470Ω to $-V_{CC}$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE5539			NE5539			UNIT
			Min	Typ	Max	Min	Typ	Max	
BW	Gain bandwidth product	$A_{CL} = 7$, $V_O = 0.1 V_{P,P}$		1200			1200		MHz
	Small-signal bandwidth	$A_{CL} = 2$, $R_L = 150\Omega^1$		110			110		MHz
t_S	Settling time	$A_{CL} = 2$, $R_L = 150\Omega^1$		15			15		ns
SR	Slew rate	$A_{CL} = 2$, $R_L = 150\Omega^1$		600			600		V/ μ s
t_{PD}	Propagation delay	$A_{CL} = 2$, $R_L = 150\Omega^1$		7			7		ns
	Full power response	$A_{CL} = 2$, $R_L = 150\Omega^1$		48			48		MHz
	Full power response	$A_V = 7$, $R_L = 150\Omega^1$		20			20		MHz
	Input noise voltage	$R_S = 50\Omega$, 1MHz		4			4		nV/ $\sqrt{Hz}$
	Input noise current	1MHz		6			6		pA/ $\sqrt{Hz}$

NOTE:

1. External compensation.

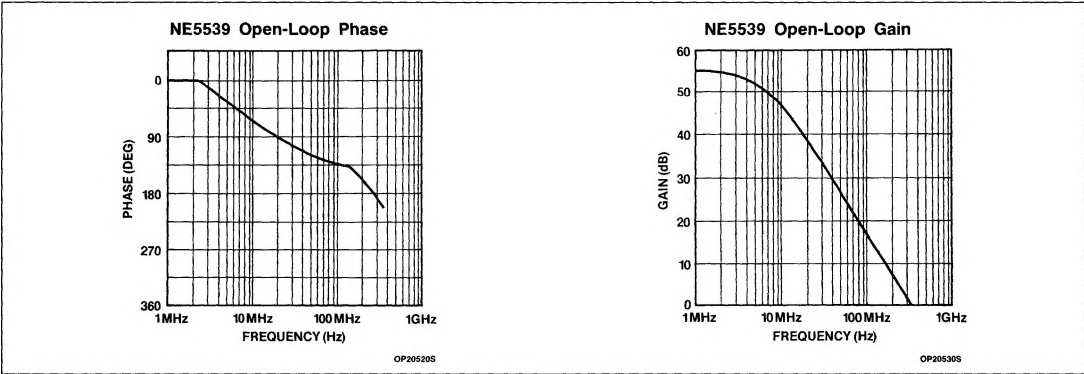
AC ELECTRICAL CHARACTERISTICS $V_{CC} = \pm 6V$, $R_L = 150\Omega$ to GND and 390Ω to $-V_{CC}$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE5539			UNIT
			Min	Typ	Max	
BW	Gain bandwidth product	$A_{CL} = 7$		700		MHz
	Small-signal bandwidth	$A_{CL} = 2^1$		120		MHz
t_S	Settling time	$A_{CL} = 2^1$		23		ns
SR	Slew rate	$A_{CL} = 2^1$		330		V/ μ s
t_{PD}	Propagation delay	$A_{CL} = 2^1$		4.5		ns
	Full power response	$A_{CL} = 2^1$		20		MHz

NOTE:

1. External compensation.

TYPICAL PERFORMANCE CURVES

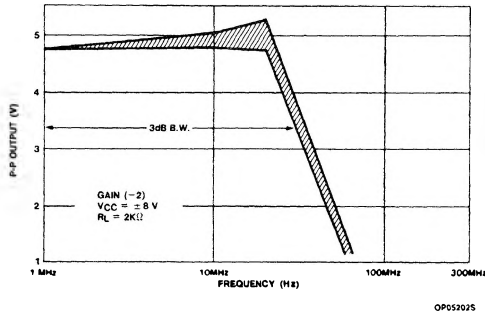


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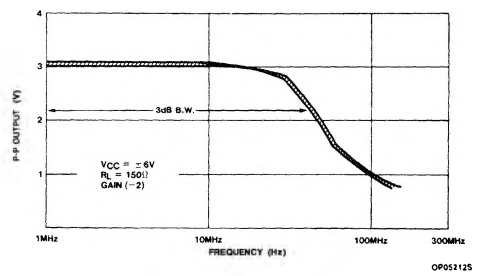
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TYPICAL PERFORMANCE CURVES (Continued)

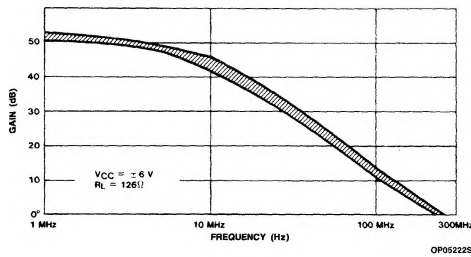
Power Bandwidth (SE)



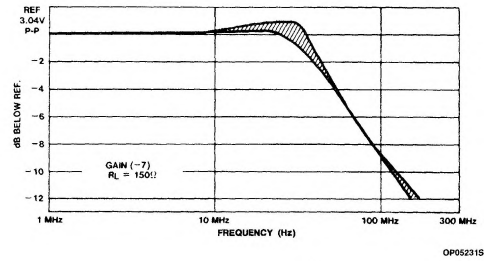
Power Bandwidth (NE)



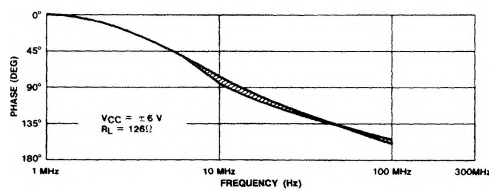
SE5539 Open-Loop Gain vs Frequency



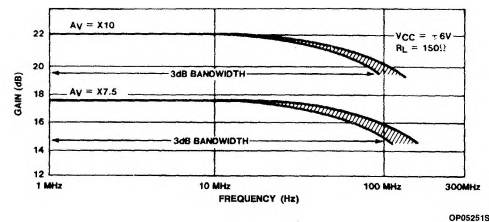
Power Bandwidth



SE5539 Open-Loop Phase vs Frequency



Gain Bandwidth Product vs Frequency



NOTE

Indicates typical distribution $-55^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$

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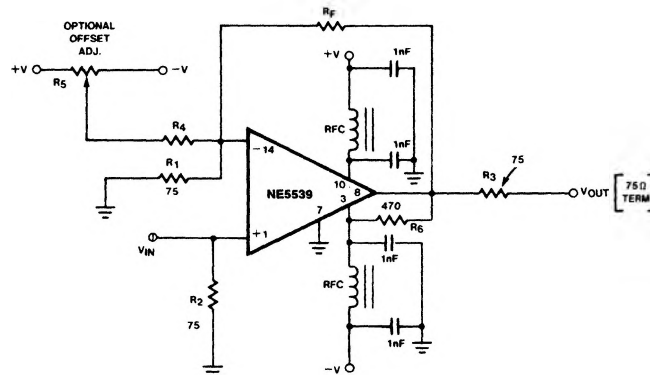
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CIRCUIT LAYOUT
CONSIDERATIONS

As may be expected for an ultra-high frequency, wide-gain bandwidth amplifier, the physi-

cal circuit layout is extremely critical. Breadboarding is not recommended. A double-sided copper-clad printed circuit board will result in more favorable system operation. An

example utilizing a 28dB non-inverting amp is shown in Figure 1.



TC087405

NOTES:

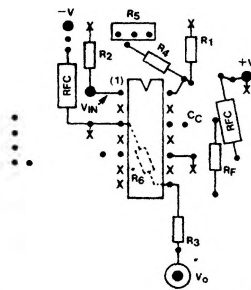
$R_1 = 75\Omega$ 5% CARBON
 $R_2 = 75\Omega$ 5% CARBON
 $R_3 = 75\Omega$ 5% CARBON
 $R_4 = 36k$ 5% CARBON

$R_5 = 20k$ TRIMPOT (CERMET)
 $R_F = 1.5k$ (28dB GAIN)
 $R_6 = 470\Omega$ 5% CARBON

RFC 3T # 26 BUSS WIRE ON
 FERROXCUBE VK 200 09/3B CORE
 BYPASS CAPACITORS
 1nF CERAMIC
 (MEPCO OR EQUIV.)

Top Plane Copper¹
(Component Side)

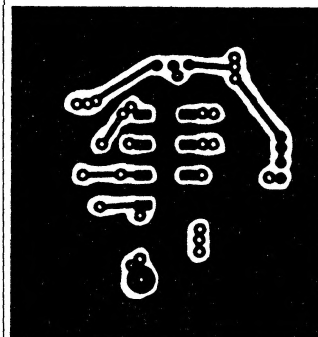
DF059105

Component Side
(Component Layout)

DF059205

NOTES:

(X) indicates ground connection to top plane.
^{*} R_6 is on bottom side.

Bottom Plane
Copper¹

DF059305

NOTE:

1. Bond edges of top and bottom ground plane copper.

Figure 1. 28dB Non-Inverting Amp Sample PC Layout

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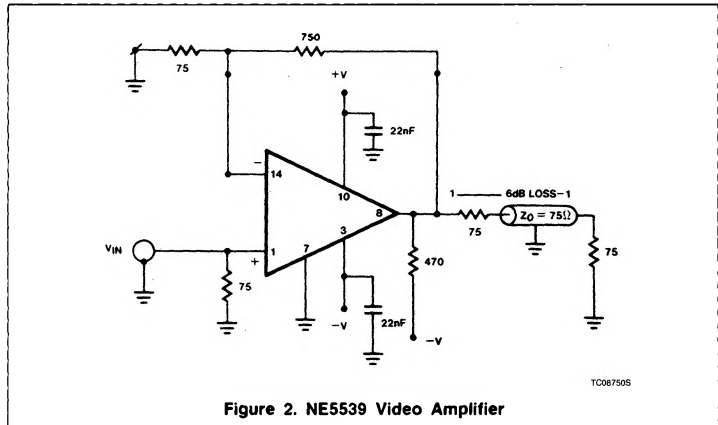
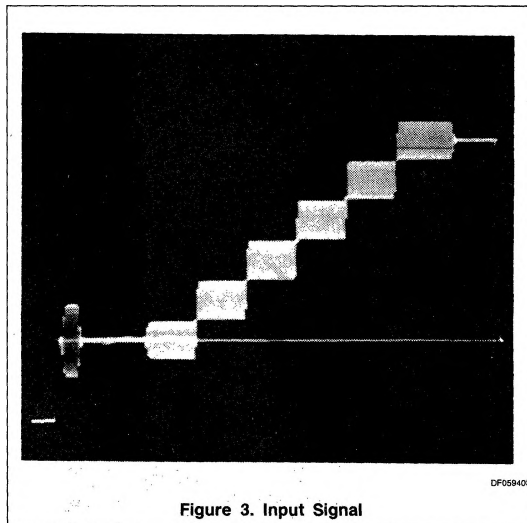
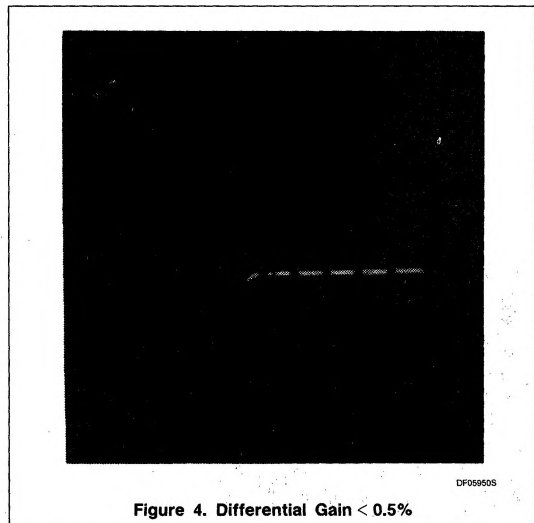
NE5539 COLOR VIDEO AMPLIFIER

The NE5539 wideband operational amplifier is easily adapted for use as a color video amplifier. A typical circuit is shown in Figure 2 along with vector-scope¹ photographs showing the amplifier differential gain and phase response to a standard five-step modulated staircase linearity signal (Figures 3, 4 and 5). As can be seen in Figure 4, the gain varies less than 0.5% from the bottom to the top of the staircase. The maximum differential phase shown in Figure 5 is approximately $+0.1^\circ$.

The amplifier circuit was optimized for a 75Ω input and output termination impedance with a gain of approximately 10 (20dB).

NOTE:

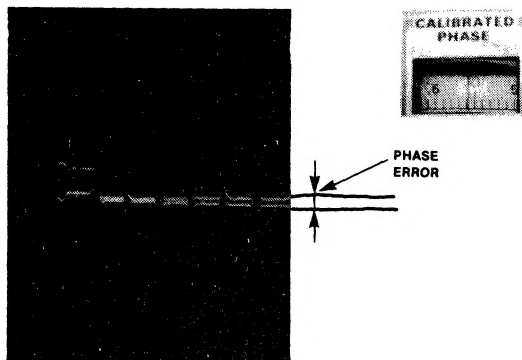
1. The input signal was 200mV and the output 2V.
 V_{CC} was $\pm 8V$.

**Figure 2. NE5539 Video Amplifier****Figure 3. Input Signal****Figure 4. Differential Gain < 0.5%****NOTE:**

Instruments used for these measurements were Tektronix 146 NTSC test signal generator, 520A NTSC vectorscope, and 1480 waveform monitor.

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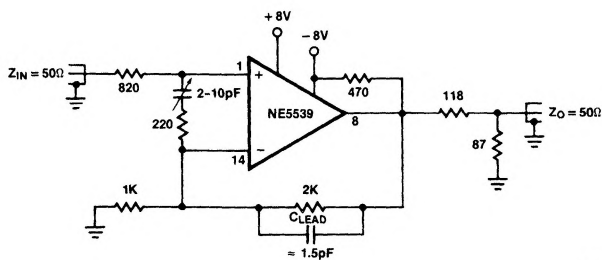
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DF05960S

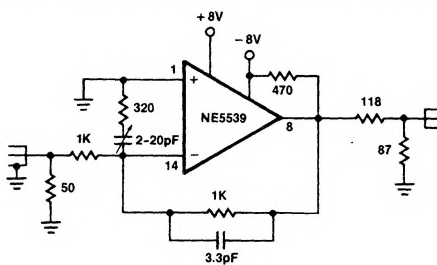
Figure 5. Differential Phase $+0.1^\circ$

APPLICATIONS



TC08760S

Figure 6. Non-Inverting Follower



TC08770S

Figure 7. Inverting Follower