

High frequency operational amplifier

NE/SE5539

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 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.

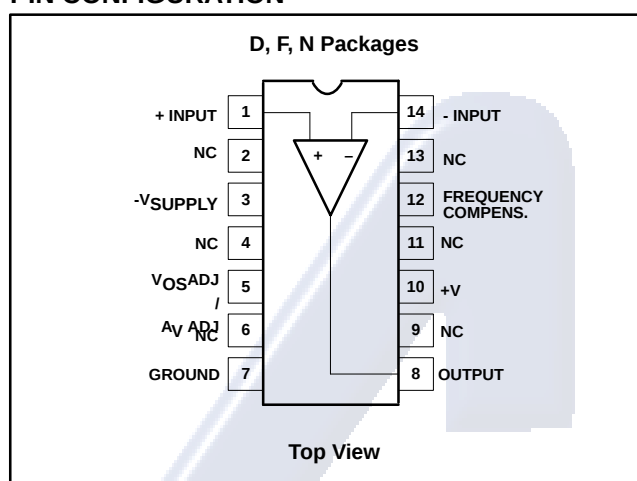
FEATURES

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

APPLICATIONS

- High speed datacom
- Video monitors & TV

PIN CONFIGURATION



- Satellite communications
- Image processing
- RF instrumentation & oscillators
- Magnetic storage
- Military communications

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
14-Pin Plastic Dual In-Line Package (DIP)	0 to +70°C	NE5539N	0405B
14-Pin Plastic Small Outline (SO) package	0 to +70°C	NE5539D	0175D
14-Pin Ceramic Dual In-Line Package	0 to +70°C	NE5539F	0581B
14-Pin Ceramic Dual In-Line Package	-55 to +125°C	SE5539F	0581B

ABSOLUTE MAXIMUM RATINGS¹

SYMBOL	PARAMETER	RATING	UNITS
V_{CC}	Supply voltage	± 12	V
P_{DMAX}	Maximum power dissipation, $T_A = 25^\circ\text{C}$ (still-air) ² F package N package D package	1.17 1.45 0.99	W W W
T_A	Operating temperature range NE SE	0 to 70 -55 to +125	$^\circ\text{C}$ $^\circ\text{C}$
T_{STG}	Storage temperature range	-65 to +150	$^\circ\text{C}$
T_J	Max junction temperature	150	$^\circ\text{C}$
T_{SOLD}	Lead soldering temperature (10sec max)	+300	$^\circ\text{C}$

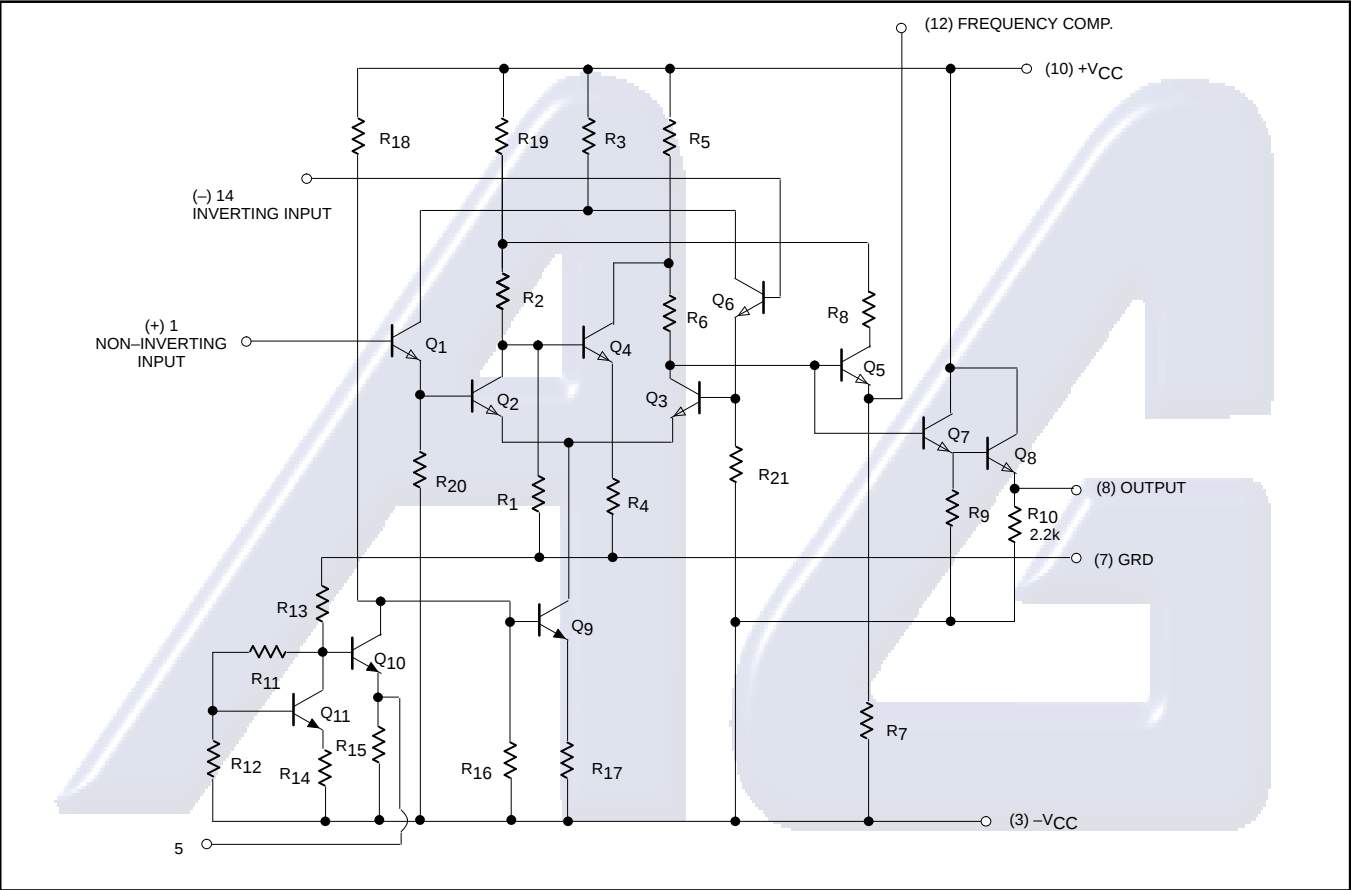
NOTES:

- 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.
- Derate above 25°C, at the following rates:
 - F package at 9.3mW/ $^\circ\text{C}$
 - N package at 11.6mW/ $^\circ\text{C}$
 - D package at 7.9mW/ $^\circ\text{C}$

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

DC ELECTRICAL CHARACTERISTICS

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

SYMBOL	PARAMETER	TEST CONDITIONS			SE5539			UNITS
					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°CmA		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 and 470Ω to $-V_{CC}$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE5539			NE5539			UNITS
			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/ $\sqrt{Hz}$

NOTES:

1. External compensation.

AC ELECTRICAL CHARACTERISTICS

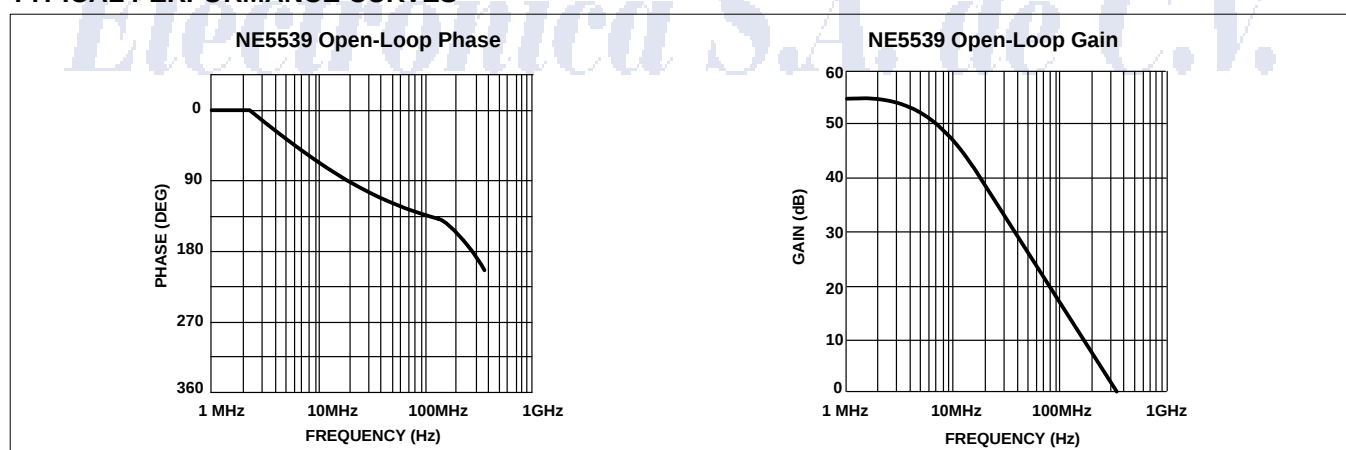
$V_{CC} = \pm 6V$, $R_L = 150\Omega$ to GND and 390Ω to $-V_{CC}$, unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE5539			UNITS
			MIN	TYP	MAX	
BW	Gain bandwidth product	$A_{CL} = 7$		700		MHz
	Small signal bandwidth	$A_{CL} = 2^1$		120		
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

NOTES:

1. External compensation.

TYPICAL PERFORMANCE CURVES

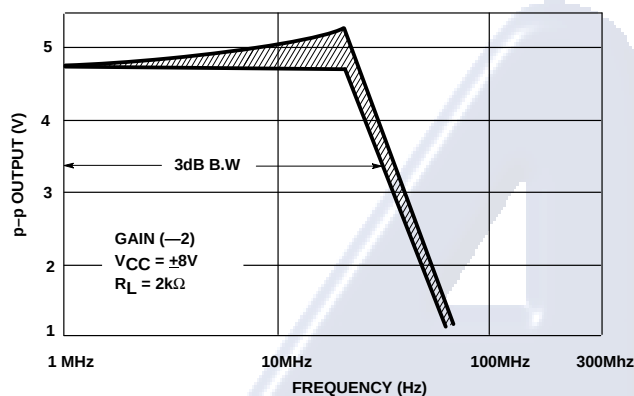


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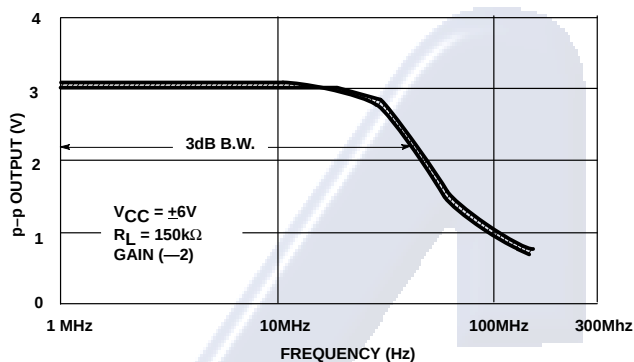
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TYPICAL PERFORMANCE CURVES (Continued)

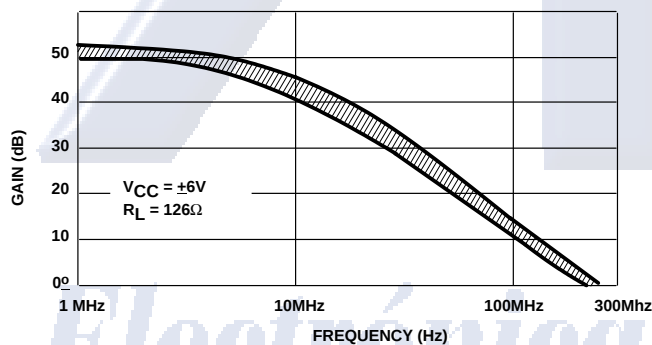
Power Bandwidth (SE)



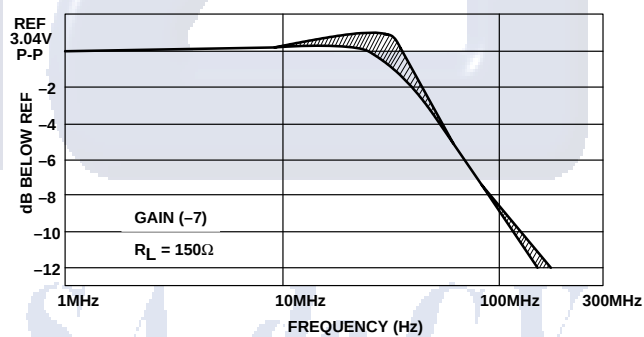
Power Bandwidth (NE)



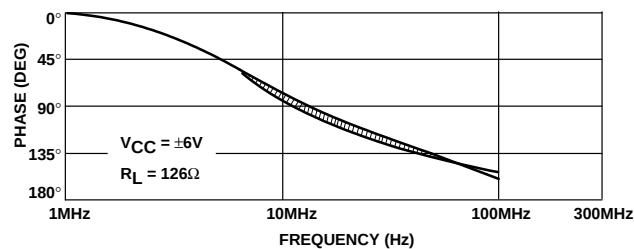
SE5539 Open-Loop Gain vs Frequency



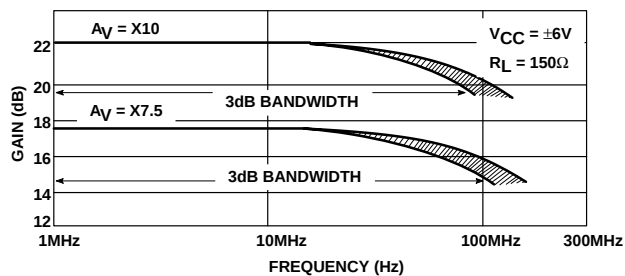
Power Bandwidth



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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CIRCUIT LAYOUT CONSIDERATIONS

As may be expected for an ultra-high frequency, wide-gain bandwidth amplifier, the physical circuit is extremely critical.

Bread-boarding 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.

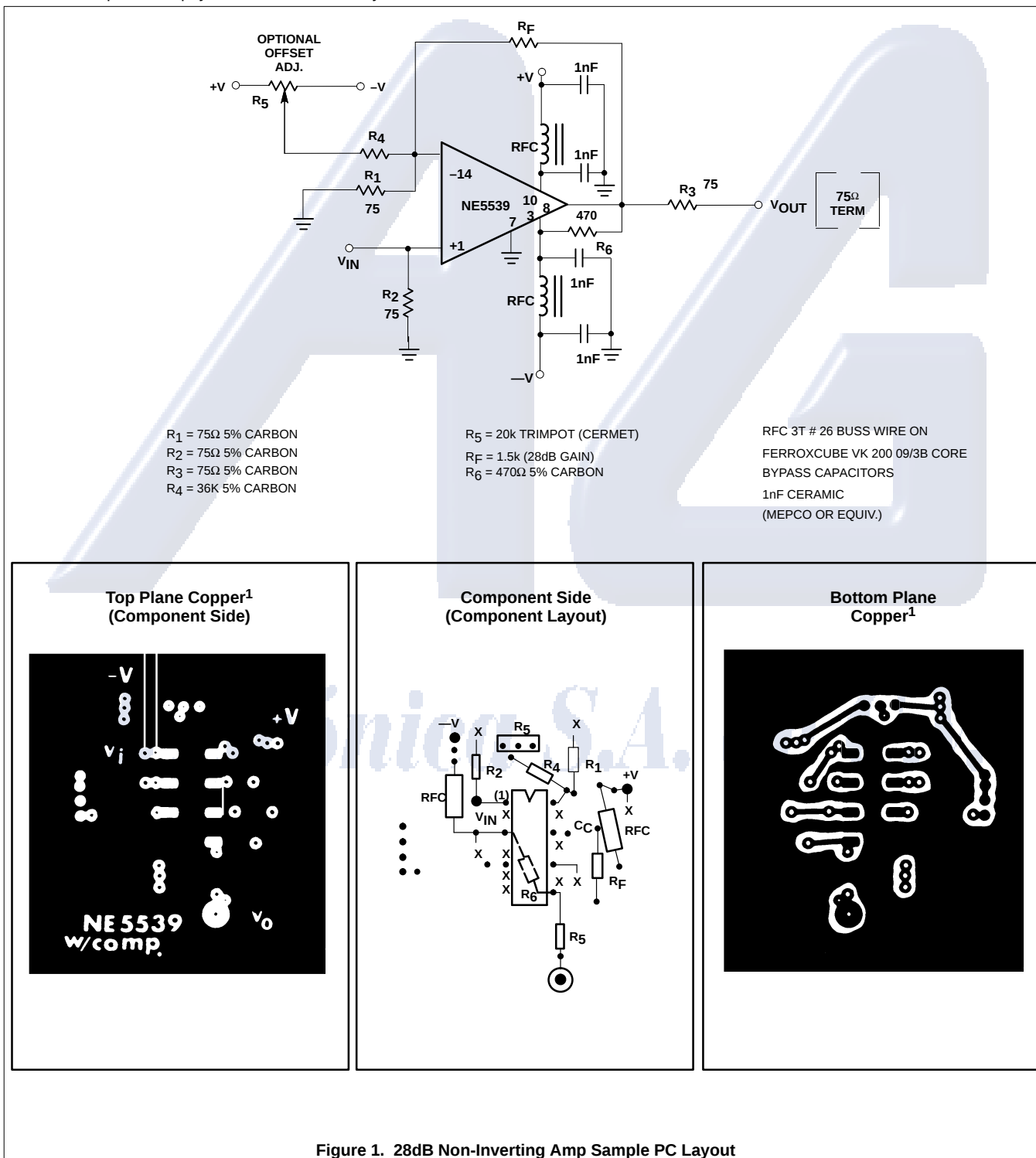


Figure 1. 28dB Non-Inverting Amp Sample PC Layout

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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-scope 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 $\pm 8V$.

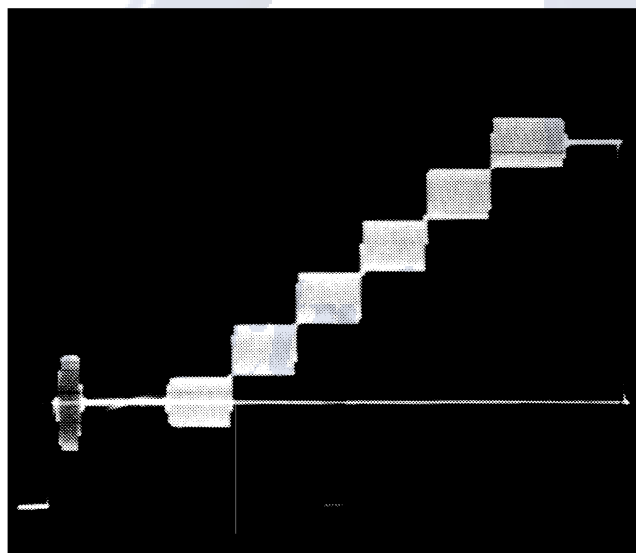
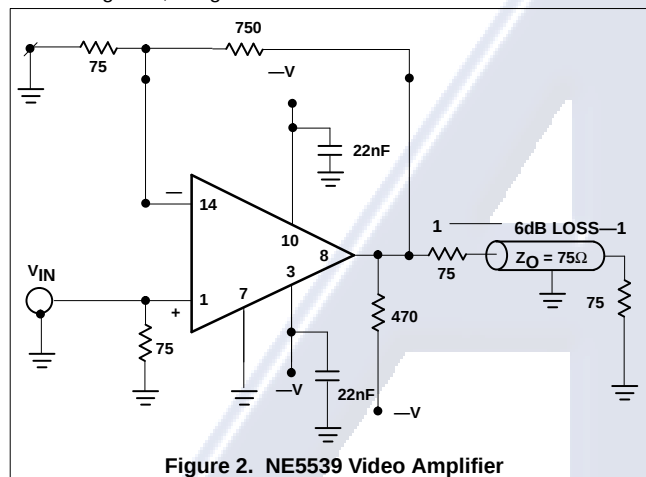


Figure 3. Input Signal



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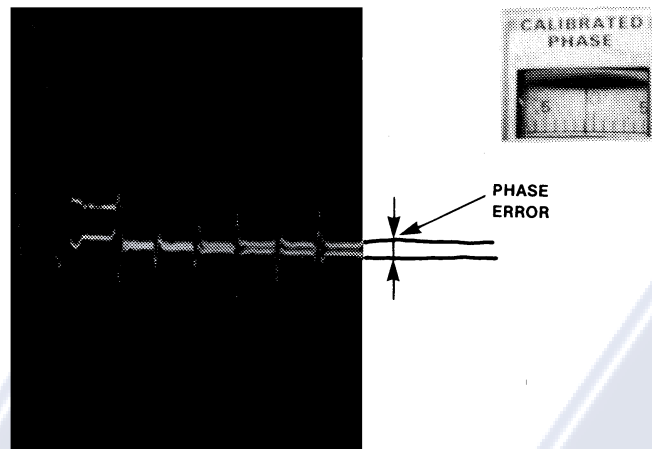
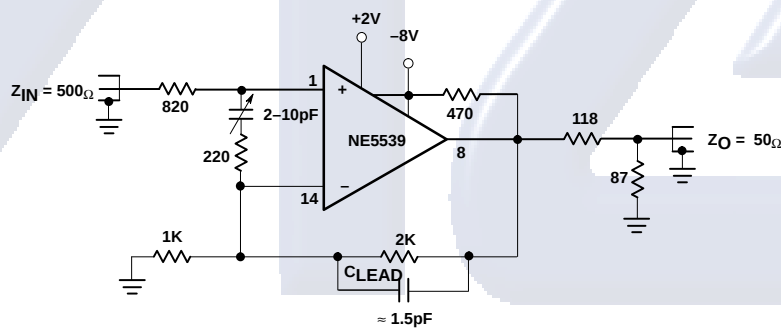
Figure 5. Differential Gain $+0.1^\circ$ 

Figure 6. Non-Inverting Follower

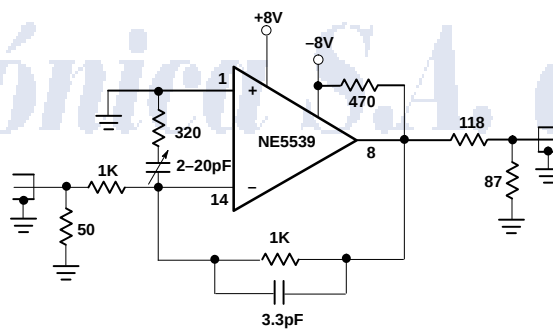


Figure 7. Inverting Follower