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

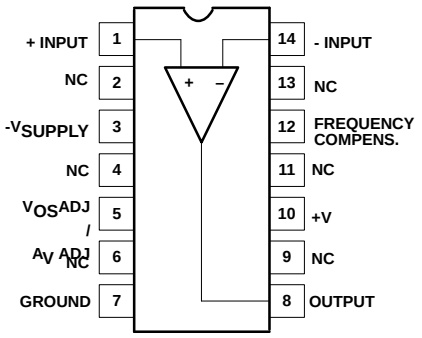
- Bandwidth
  - Unity gain - 350MHz
  - Full power - 48MHz
  - GBW - 1.2GHz at 17dB
- Slew rate: 600/Vμs
- A_{VOL}: 52dB typical
- Low noise - 4nV$\sqrt{}$Hz typical
- MIL-STD processing available

APPLICATIONS

- High speed datacom
- Video monitors & TV

PIN CONFIGURATION

D, F, N Packages



Top View

- 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

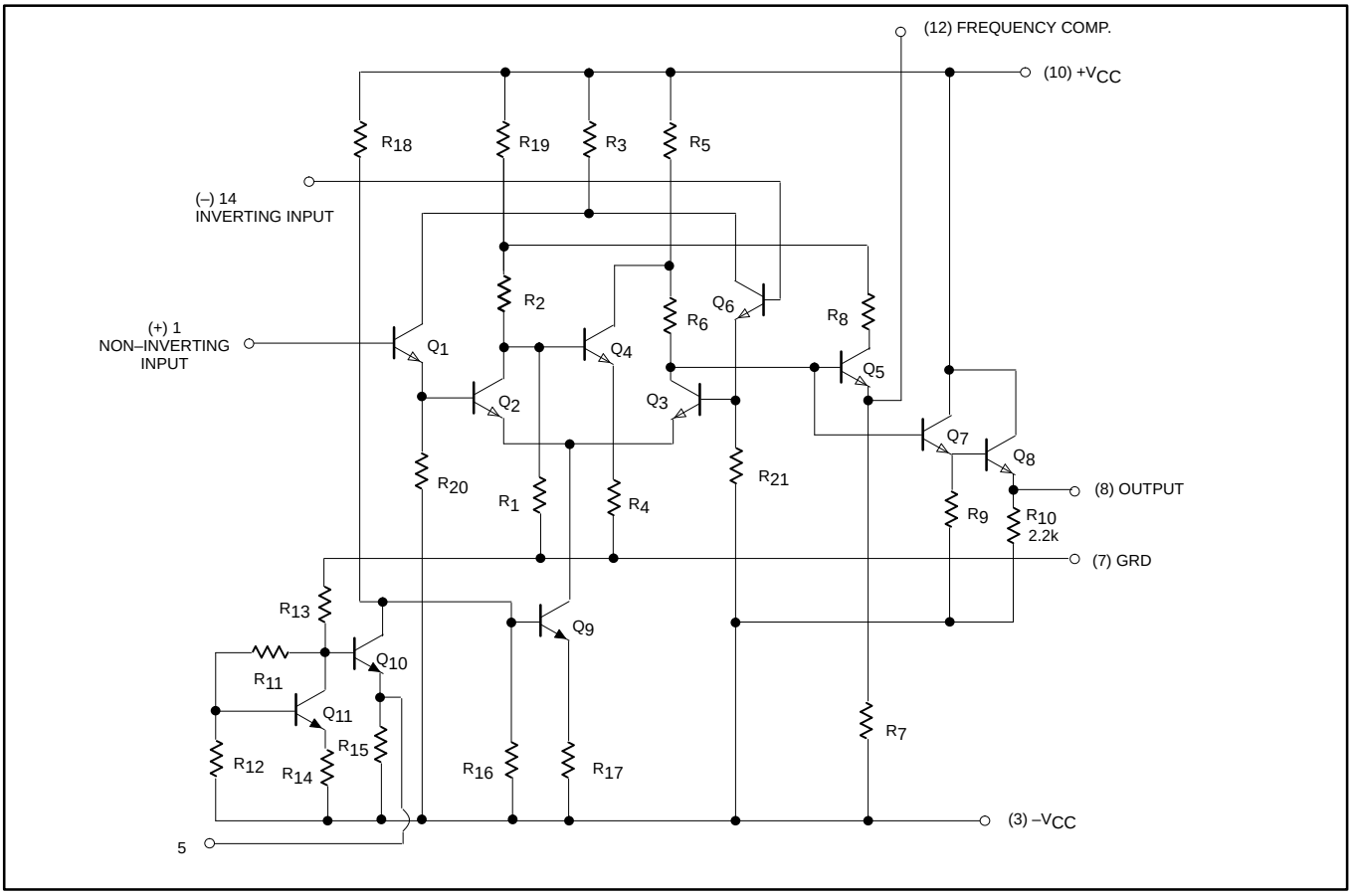
ABSOLUTE MAXIMUM RATINGS[1]

SYMBOL	PARAMETER	RATING	UNITS
V_{CC}	Supply voltage	±12	V
P_{DMAX}	Maximum power dissipation, T_A = 25°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	 °C °C
T_{STG}	Storage temperature range	-65 to +150	°C
T_J	Max junction temperature	150	°C
T_{SOLD}	Lead soldering temperature (10sec max)	+300	°C

NOTES:

1. Differential input voltage should not exceed 0.25V to prevent excesive 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 9.3mW/°C
   N package at 11.6mW/°C
   D package at 7.9mW/°C

EQUIVALENT CIRCUIT



DC ELECTRICAL CHARACTERISTICS

V_{CC} = ±8V, T_A = 25°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 = 100Ω	Over temp		2	5				mV
			T_A = 25°C		2	3		2.5	5	
	$\Delta V_{OS}/\Delta T$				5			5		µV/°C
I_{OS}	Input offset current		Over temp		0.1	3				µA
			T_A = 25°C		0.1	1			2	
	$\Delta I_{OS}/\Delta T$				0.5			0.5		nA/°C
I_B	Input bias current		Over temp		6	25				µA
			T_A = 25°C		5	13		5	20	
	$\Delta I_B/\Delta T$				10			10		nA/°C
CMRR	Common mode rejection ratio	F = 1kHz, R_S = 100Ω, V_{CM} ±1.7V		70	80		70	80		dB
			Over temp	70	80					
R_{IN}	Input impedance				100			100		kΩ
R_{OUT}	Output impedance				10			10		Ω

DC ELECTRICAL CHARACTERISTICS (Continued)

V_{CC} = ±8V, T_A = 25°C; unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS		SE5539			NE5539			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OUT}	Output voltage swing	R_L = 150Ω 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 = 25Ω to GND Over temp	+Swing -Swing	+2.3 -1.5	+3.0 -2.1					V
		R_L = 25Ω to GND T_A = 25°C	+Swing -Swing	+2.5 -2.0	+3.1 -2.7					
I_{CC+}	Positive supply current	V_O = 0, R_1 = ∞, Over temp			14	18				mA
		V_O = 0, R_1 = ∞, T_A = 25°C			14	17		14	18	
I_{CC-}	Negative supply current	V_O = 0, R_1 = ∞, Over temp			11	15				mA
		V_O = 0, R_1 = ∞, T_A = 25°C			11	14		11	15	
PSRR	Power supply rejection ratio	ΔV_{CC} = ±1V, Over temp			300	1000				µV/V
		ΔV_{CC} = ±1V, T_A = 25°C						200	1000	
A_{VOL}	Large signal voltage gain	V_O = +2.3V, -1.7V, R_L = 150Ω to GND, 470Ω to -V_{CC}					47	52	57	dB
A_{VOL}	Large signal voltage gain	V_O = +2.3V, -1.7V	Over temp							dB
		R_L = 2Ω to GND	T_A = 25°C				47	52	57	
A_{VOL}	Large signal voltage gain	V_O = +2.5V, -2.0V	Over temp	46		60				dB
		R_L = 2Ω to GND	T_A = 25°C	48	53	58				

DC ELECTRICAL CHARACTERISTICS

V_{CC} = ±6V, T_A = 25°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		

AC ELECTRICAL CHARACTERISTICS

V_{CC} = ±8V, R_L = 150Ω 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 = 150Ω[1]		110			110		MHz
t_S	Settling time	A_{CL} = 2, R_L = 150Ω[1]		15			15		ns
SR	Slew rate	A_{CL} = 2, R_L = 150Ω[1]		600			600		V/µs
t_{PD}	Propagation delay	A_{CL} = 2, R_L = 150Ω[1]		7			7		ns
	Full power response	A_{CL} = 2, R_L = 150Ω[1]		48			48		MHz
	Full power response	A_V = 7, R_L = 150Ω[1]		20			20		MHz
	Input noise voltage	R_S = 50Ω, 1MHz		4			4		nV/√Hz
	Input noise current	1MHz		6			6		pA/√Hz

NOTES:
1. External compensation.

AC ELECTRICAL CHARACTERISTICS

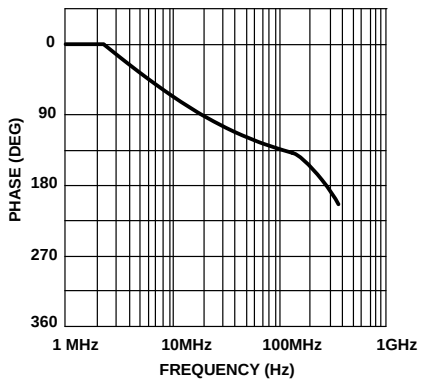
V_{CC} = ±6V, R_L = 150Ω to GND and 390Ω to -V_{CC}, unless otherwise specified.

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/µs
t_{PD}	Propagation delay	A_{CL} = 2[1]		4.5		ns
	Full power response	A_{CL} = 2[1]		20		MHz

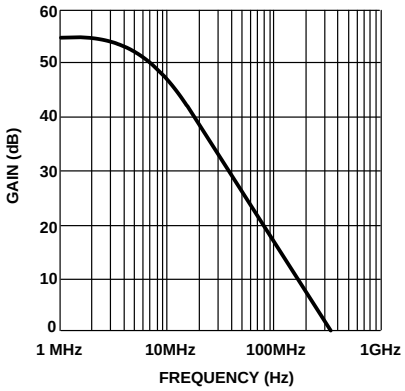
NOTES:
1. External compensation.

TYPICAL PERFORMANCE CURVES

NE5539 Open-Loop Phase

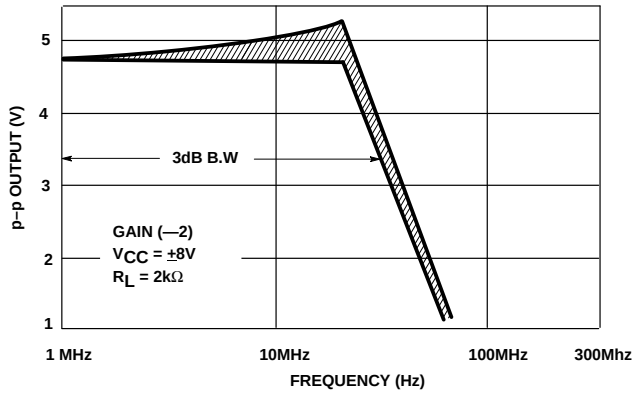


NE5539 Open-Loop Gain

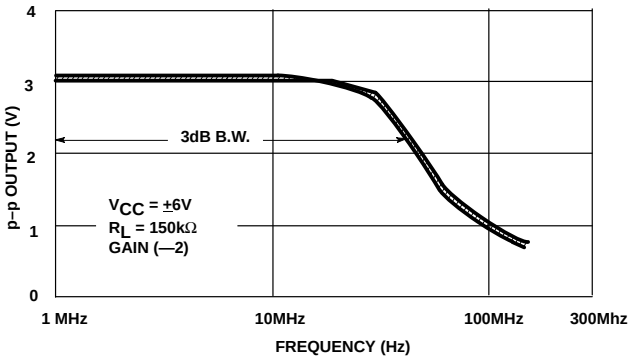


TYPICAL PERFORMANCE CURVES (Continued)

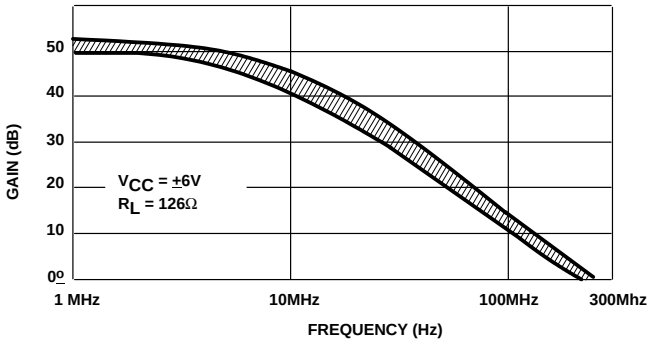
Power Bandwidth (SE)



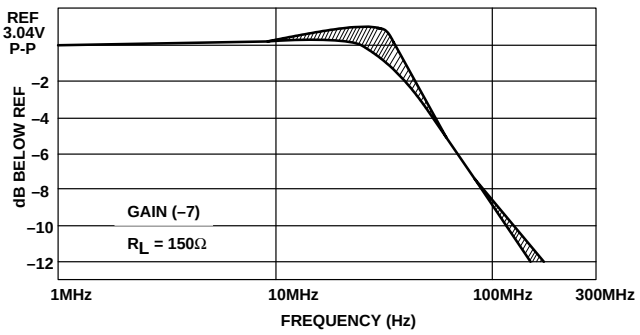
Power Bandwidth (NE)



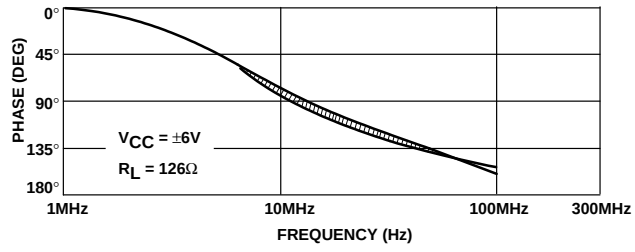
SE5539 Open-Loop Gain vs Frequency



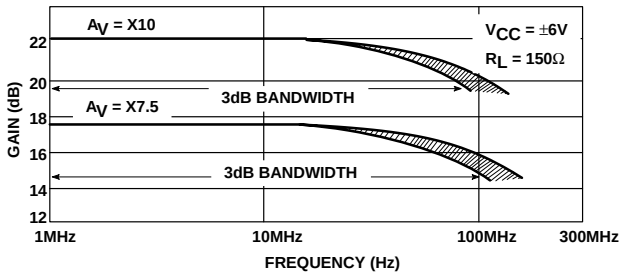
Power Bandwidth



SE5539 Open-Loop Phase vs Frequency



Gain Bandwidth Product vs Frequency

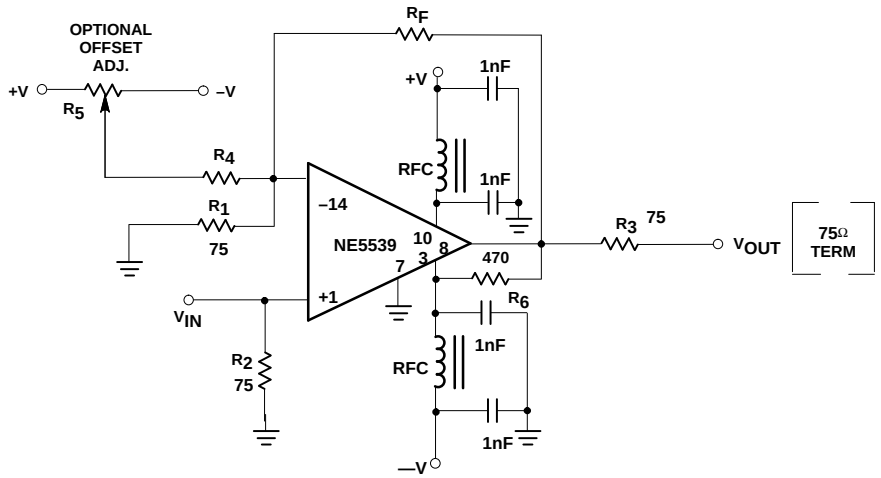


NOTE:

Indicates typical distribution $-55°C \leq T_A \leq 125°C$

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.

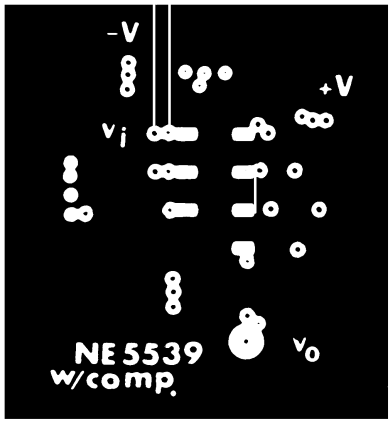


R_1 = 75Ω 5% CARBON
R_2 = 75Ω 5% CARBON
R_3 = 75Ω 5% CARBON
R_4 = 36K 5% CARBON

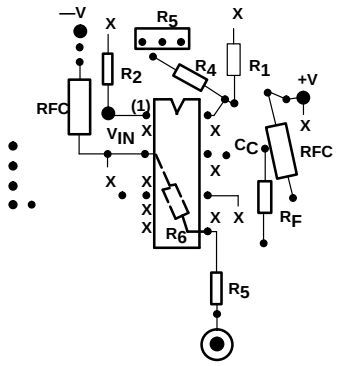
R_5 = 20k TRIMPOT (CERMET)
R_F = 1.5k (28dB GAIN)
R_6 = 470Ω 5% CARBON

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

Top Plane Copper[1] (Component Side)



Component Side (Component Layout)



Bottom Plane Copper[1]

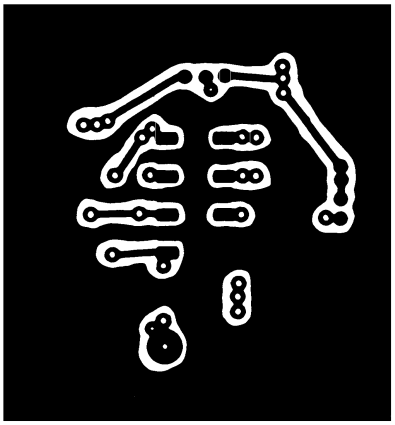


Figure 1. 28dB Non-Inverting Amp Sample PC Layout

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°.

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

NOTE:

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

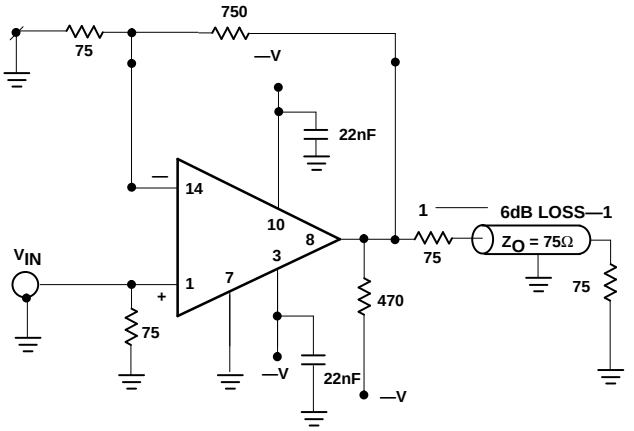


Figure 2. NE5539 Video Amplifier

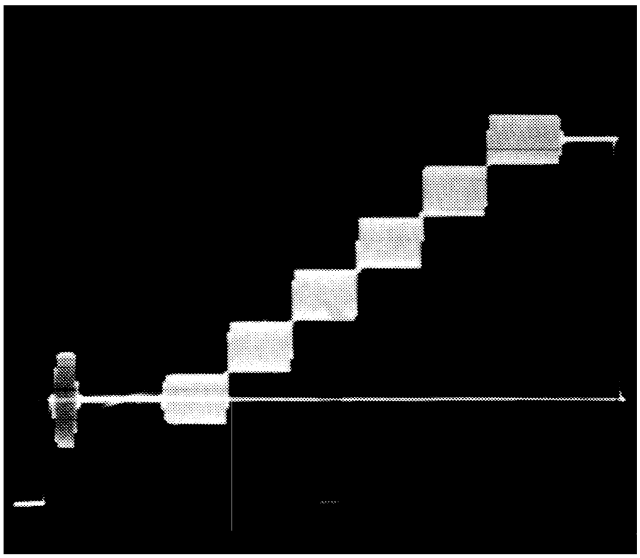


Figure 3. Input Signal

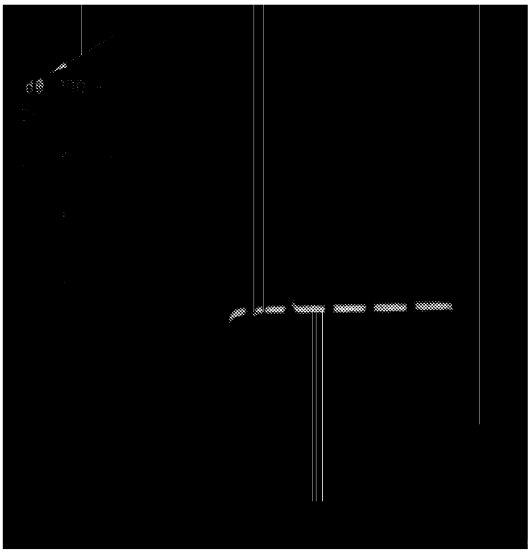


Figure 4. Differential Gain <0.5%

NOTE:

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

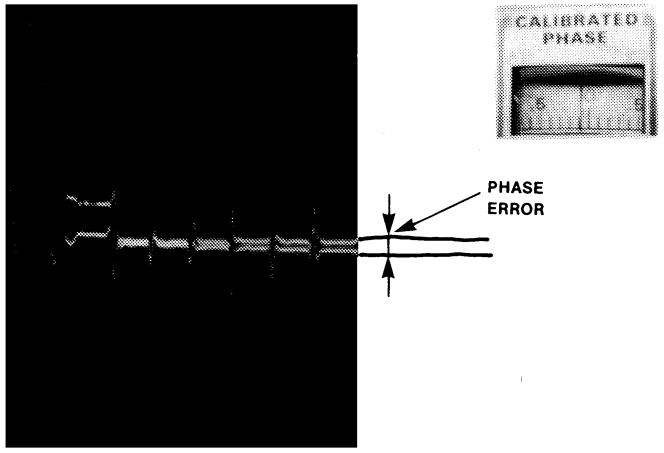


Figure 5. Differential Gain +0.1°

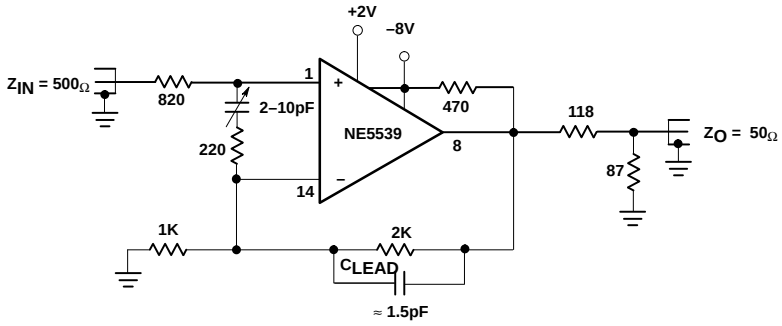


Figure 6. Non-Inverting Follower

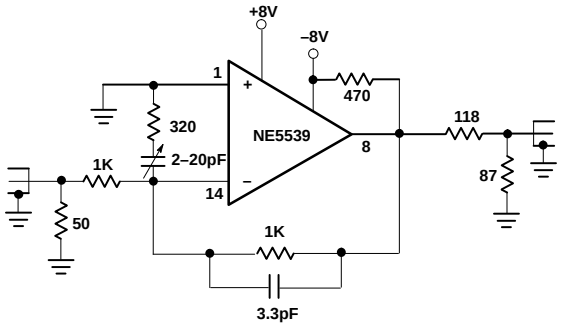


Figure 7. Inverting Follower