

# 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.

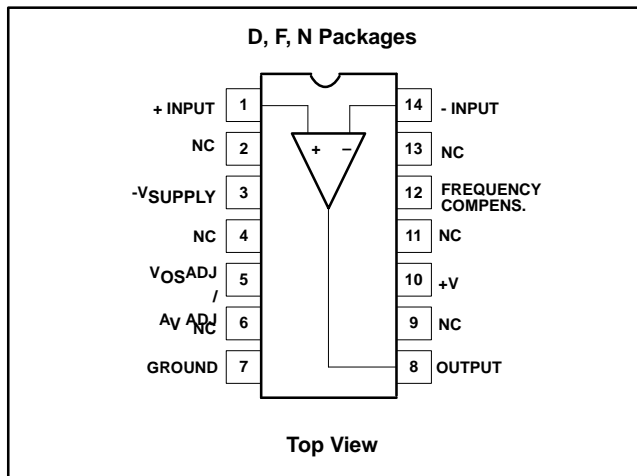
## FEATURES

- Bandwidth
  - Unity gain - 350MHz
  - Full power - 48MHz
  - GBW - 1.2GHz at 17dB
- Slew rate: 600V/ $\mu$ s
- $A_{VOL}$ : 52dB typical
- Low noise - 4nV/ $\sqrt$ 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 RATINGS<sup>1</sup>

SYMBOL	PARAMETER	RATING	UNITS
$V_{CC}$	Supply voltage	$\pm 12$	V
$P_{DMAX}$	Maximum power dissipation, $T_A = 25^\circ\text{C}$ (still-air) <sup>2</sup>		
	F package	1.17	W
	N package	1.45	W
	D package	0.99	W
$T_A$	Operating temperature range		
	NE	0 to 70	°C
	SE	-55 to +125	°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

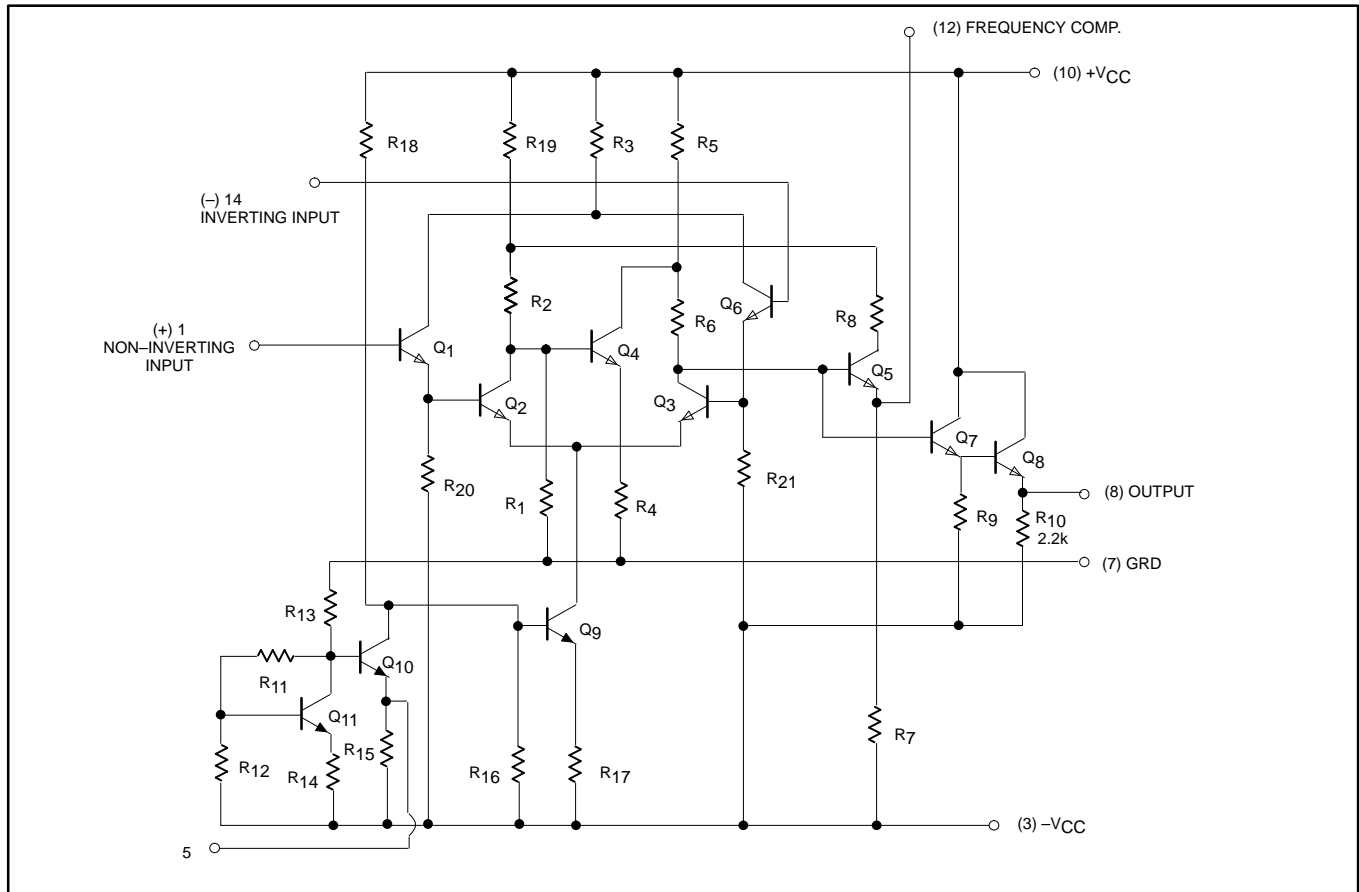
### NOTES:

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

# High frequency operational amplifier

## NE/SE5539

### 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				$\mu A$
			$T_A = 25^\circ C$	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				$\mu A$
			$T_A = 25^\circ C$	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		$\Omega$	

# High frequency operational amplifier

# NE/SE5539

## 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 $470\Omega$ 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, $470\Omega$ 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							dB
			$T_A = 25^\circ C$				47	52	57	
$A_{VOL}$	Large signal voltage gain	$V_O = +2.5V$ , $-2.0V$ $R_L = 2\Omega$ 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			UNITS	
			MIN	TYP	MAX		
$V_{OS}$	Input offset voltage		Over temp		2	5	mV
			$T_A = 25^\circ C$		2	3	
$I_{OS}$	Input offset current		Over temp		0.1	3	$\mu A$
			$T_A = 25^\circ C$		0.1	1	
$I_B$	Input bias current		Over temp		5	20	$\mu A$
			$T_A = 25^\circ C$		4	10	
CMRR	Common-mode rejection ratio	$V_{CM} = \pm 1.3V$ , $R_S = 100\Omega$		70	85	dB	
$I_{CC+}$	Positive supply current		Over temp		11	14	mA
			$T_A = 25^\circ C$		11	13	
$I_{CC-}$	Negative supply current		Over temp		8	11	mA
			$T_A = 25^\circ C$		8	10	
PSRR	Power supply rejection ratio	$\Delta V_{CC} = \pm 1V$	Over temp		300	1000	$\mu V/V$
			$T_A = 25^\circ C$				
$V_{OUT}$	Output voltage swing	$R_L = 150\Omega$ to GND and $390\Omega$ to $-V_{CC}$	Over temp	+Swing	+1.4	+2.0	V
				-Swing	-1.1	-1.7	
			$T_A = 25^\circ C$	+Swing	+1.5	+2.0	
				-Swing	-1.4	-1.8	

# High frequency operational amplifier

NE/SE5539

## AC ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 8V$ ,  $R_L = 150\Omega$  to GND and  $470\Omega$  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/ $\mu$ 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:**

- External compensation.

## AC ELECTRICAL CHARACTERISTICS

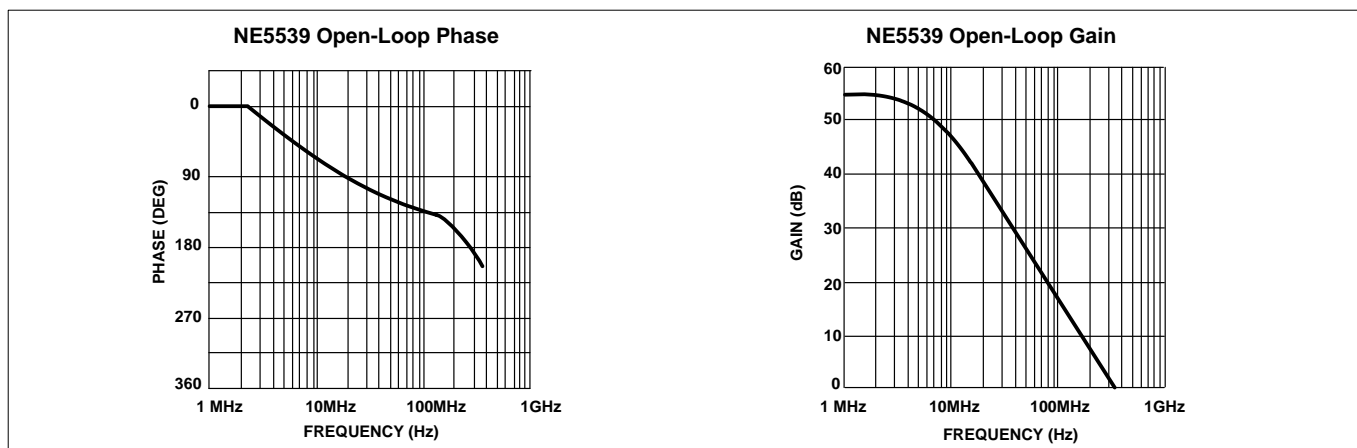
$V_{CC} = \pm 6V$ ,  $R_L = 150\Omega$  to GND and  $390\Omega$  to  $-V_{CC}$ , unless otherwise specified.

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/ $\mu$ s
$t_{PD}$	Propagation delay	$A_{CL} = 2^1$		4.5		ns
	Full power response	$A_{CL} = 2^1$		20		MHz

**NOTES:**

- External compensation.

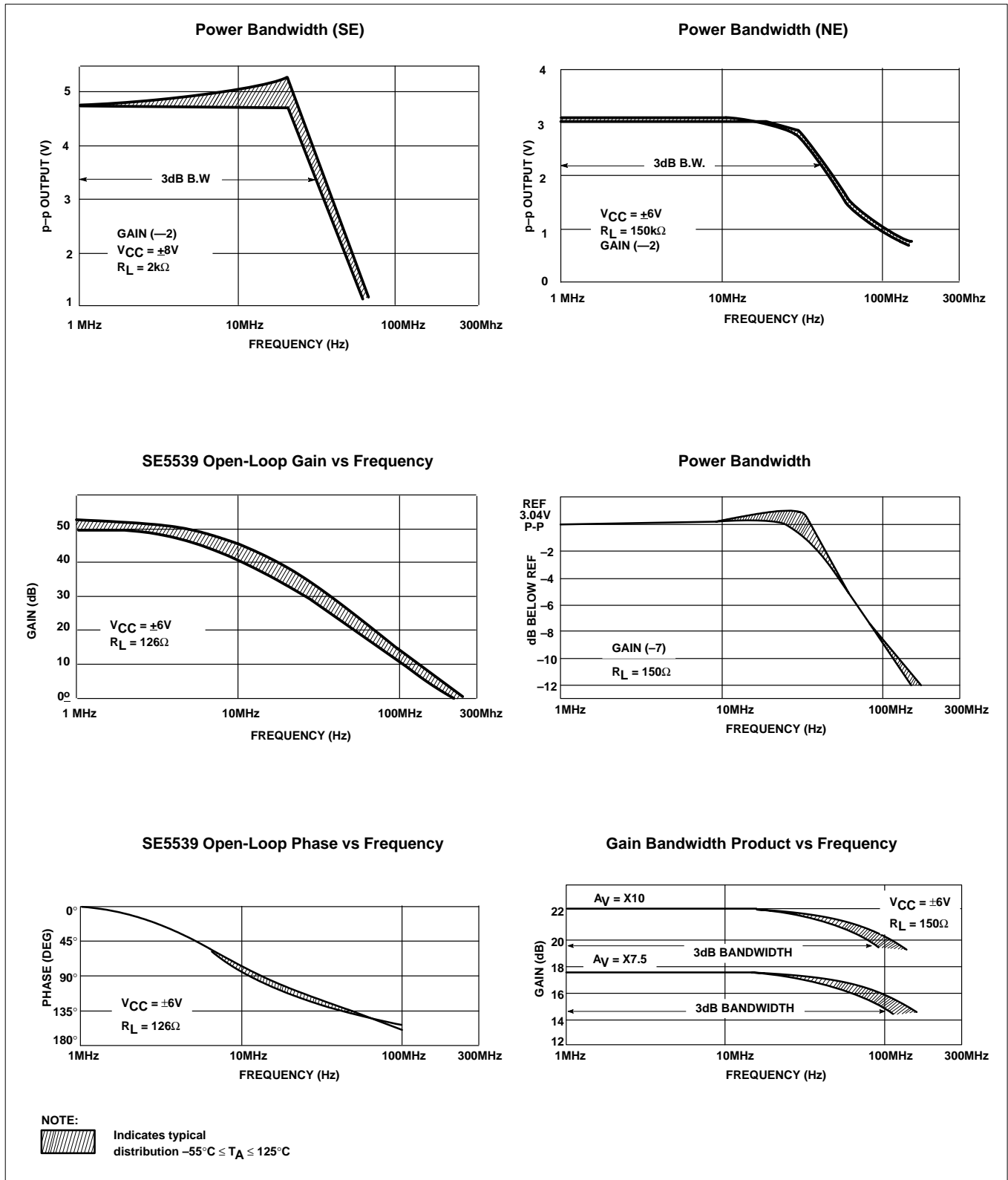
## TYPICAL PERFORMANCE CURVES



# High frequency operational amplifier

## NE/SE5539

### TYPICAL PERFORMANCE CURVES (Continued)



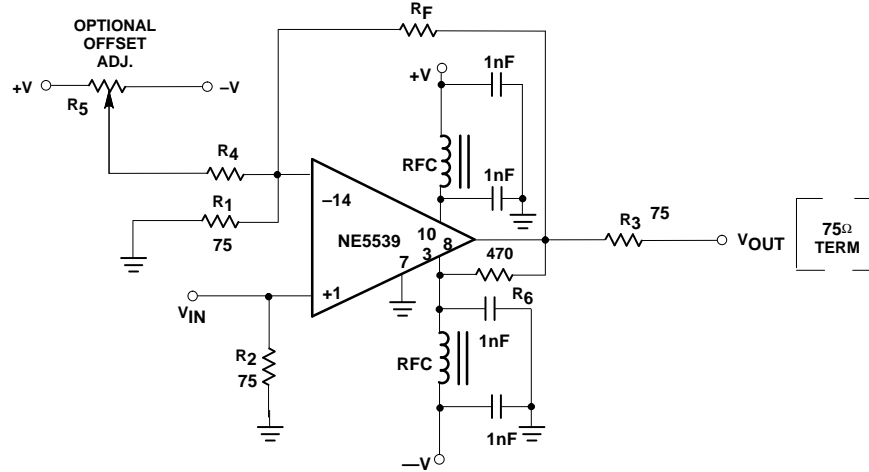
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# NE/SE5539

## 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.



$R_1 = 75\Omega$  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.)

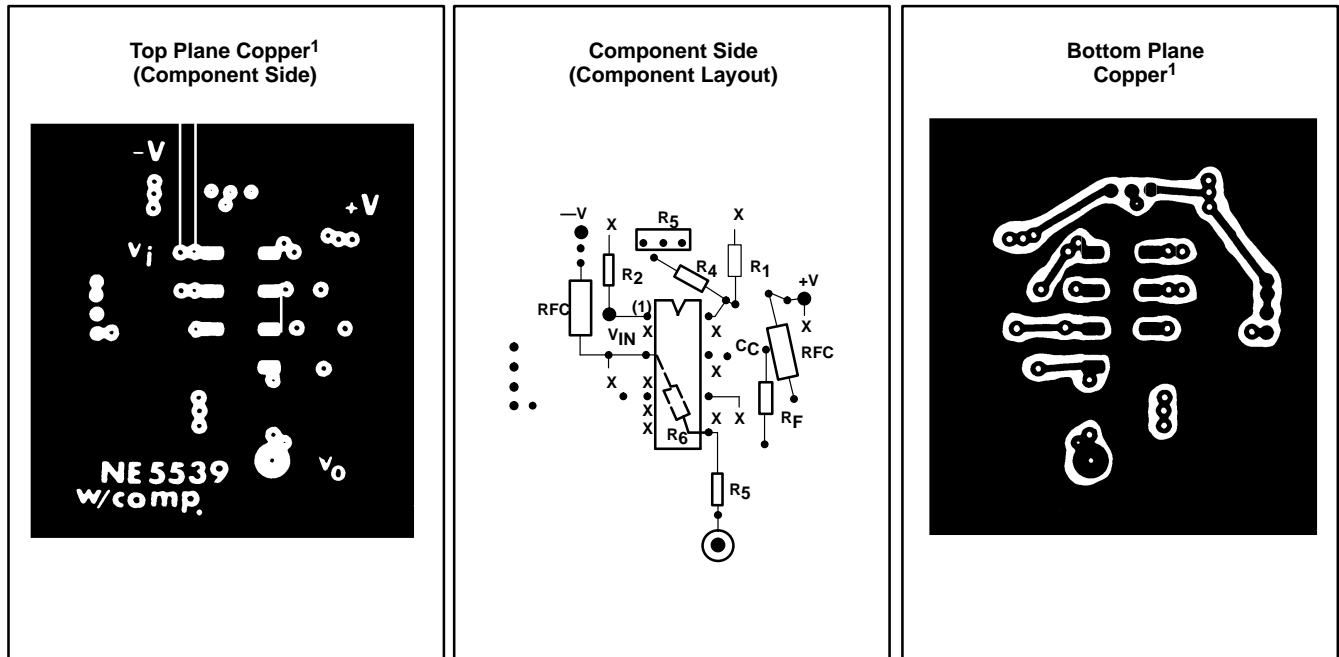


Figure 1. 28dB Non-Inverting Amp Sample PC Layout

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# NE/SE5539

## 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  $\pm 8V$ .

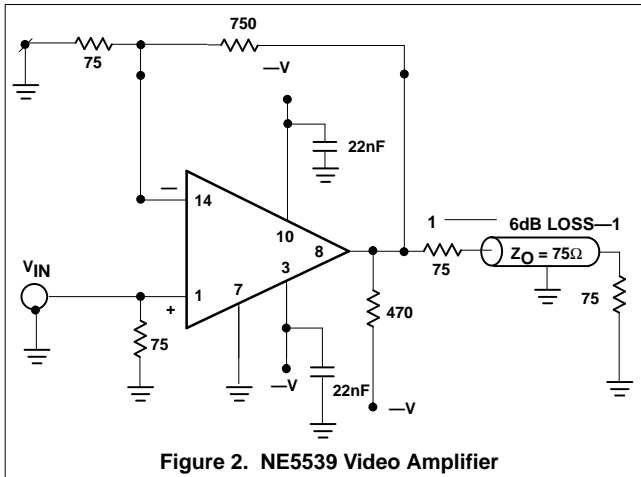


Figure 2. NE5539 Video Amplifier

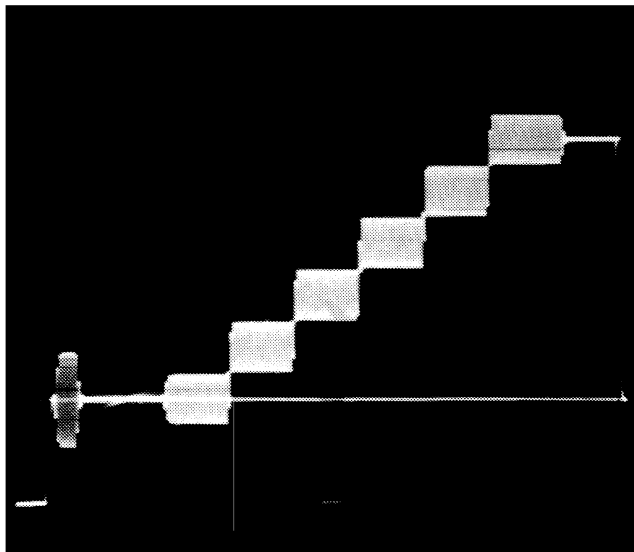


Figure 3. Input Signal



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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