

DATA SHEET

NE/SE5539

High frequency operational amplifier

Product data
Supersedes data of 2001 Aug 03
File under Integrated Circuits, IC11 Data Handbook

2002 Jan 25

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: 350 MHz
 - Full power: 48 MHz
 - GBW: 1.2 GHz at 17 dB
- Slew rate: 600/V μ s
- A_{VOL}: 52 dB typical
- Low noise: 4 nV/√Hz typical

PIN CONFIGURATION

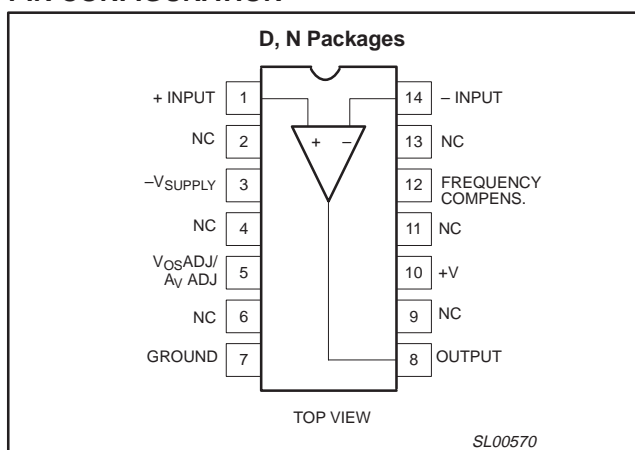


Figure 1. Pin Configuration

APPLICATIONS

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

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE	DWG #
14-Pin Plastic Dual In-Line Package (DIP)	0 °C to +70 °C	NE5539N	SOT27-1
14-Pin Plastic Small Outline (SO) package	0 °C to +70 °C	NE5539D	SOT108-1
14-Pin Plastic Dual In-Line Package (DIP)	–55 °C to +125 °C	SE5539N	SOT27-1

ABSOLUTE MAXIMUM RATINGS¹

SYMBOL	PARAMETER	RATING	UNITS
V _{CC}	Supply voltage	±12	V
P _{D(max)}	Maximum power dissipation; T _{amb} = 25 °C (still-air) ²		
	N package	1.45	W
	D package	0.99	W
T _{amb}	Operating temperature range		
	NE5539D, NE5539N	0 to +70	°C
	SE5539N	–55 to +125	°C
T _{stg}	Storage temperature range	–65 to +150	°C
T _j	Max junction temperature	+150	°C
T _{sld}	Lead soldering temperature (10 sec max)	+230	°C

NOTES:

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

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EQUIVALENT CIRCUIT

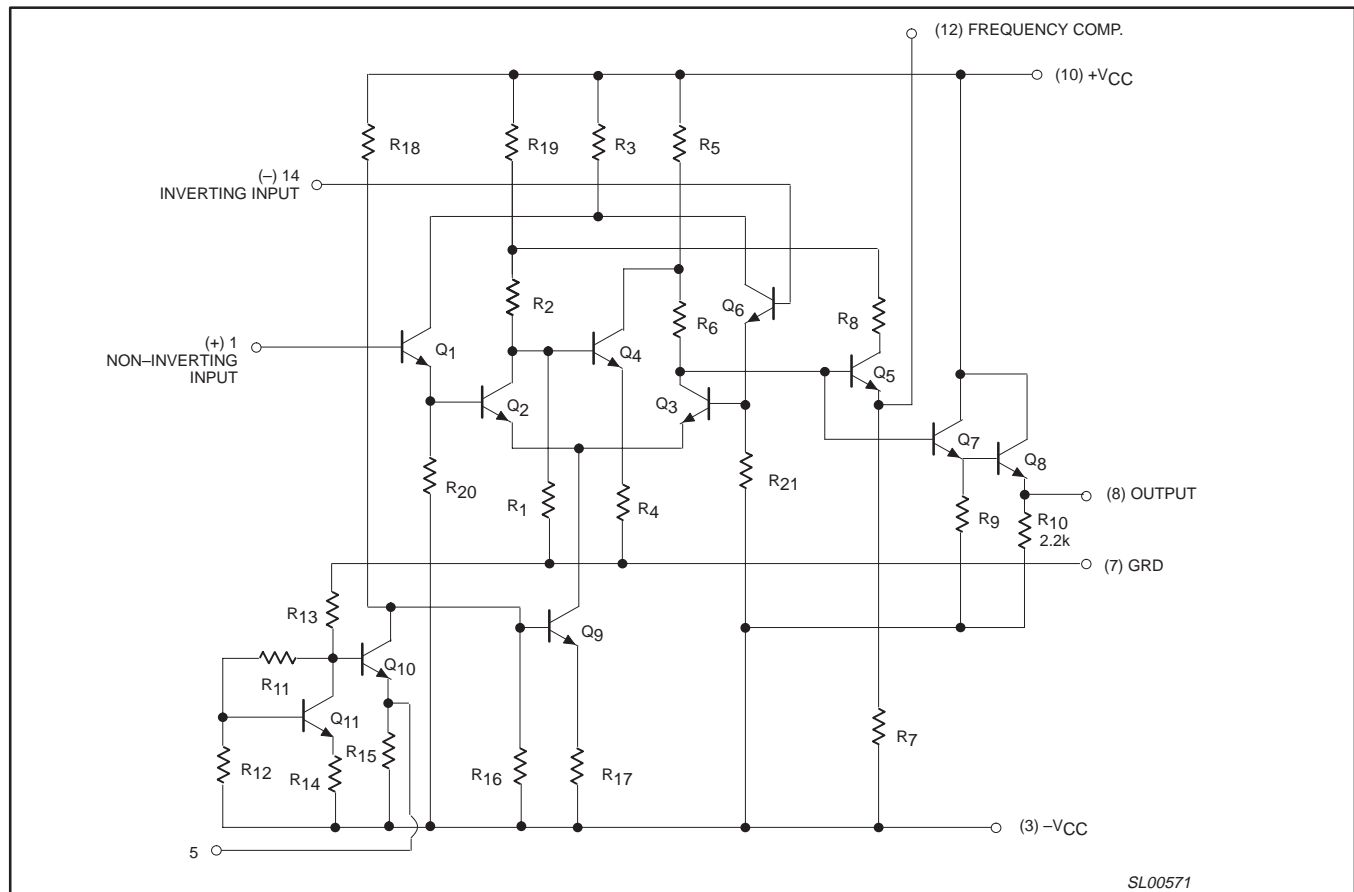


Figure 2. Equivalent Circuit

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DC ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 8\text{ V}$, $T_{amb} = 25\text{ }^{\circ}\text{C}$; unless otherwise specified.

SYMBOL	PARAMETER	TEST CONDITIONS	SE5539			NE5539			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{OS}	Input offset voltage	$V_O = 0\text{ V}$; $R_S = 100\text{ }\Omega$	Over temp.	2	5				mV
			$T_{amb} = 25\text{ }^{\circ}\text{C}$	2	3		2.5	5	
$\Delta V_{OS}/\Delta T$				5			5		$\mu\text{V}/^{\circ}\text{C}$
I_{OS}	Input offset current		Over temp.	0.1	3				μA
			$T_{amb} = 25\text{ }^{\circ}\text{C}$	0.1	1			2	
$\Delta I_{OS}/\Delta T$				0.5			0.5		$\text{nA}/^{\circ}\text{C}$
I_B	Input bias current		Over temp.	6	25				μA
			$T_{amb} = 25\text{ }^{\circ}\text{C}$	5	13		5	20	
$\Delta I_B/\Delta T$				10			10		$\text{nA}/^{\circ}\text{C}$
CMRR	Common mode rejection ratio	$F = 1\text{ kHz}$; $R_S = 100\text{ }\Omega$; $V_{CM} \pm 1.7\text{ V}$	70	80		70	80		dB
			Over temp.	70	80				
R_{IN}	Input impedance			100			100		$\text{k}\Omega$
R_{OUT}	Output impedance			10			10		Ω
V_{OUT}	Output voltage swing	$R_L = 150\text{ }\Omega$ to GND and $470\text{ }\Omega$ to $-V_{CC}$	+Swing			+2.3	+2.7		V
			–Swing			–1.7	–2.2		
		$R_L = 25\text{ }\Omega$ to GND Over temp.	+Swing	+2.3	+3.0				V
			–Swing	–1.5	–2.1				
		$R_L = 25\text{ }\Omega$ to GND $T_{amb} = 25\text{ }^{\circ}\text{C}$	+Swing	+2.5	+3.1				V
			–Swing	–2.0	–2.7				
I_{CC+}	Positive supply current	$V_O = 0\text{ V}$, $R_1 = \infty$; Over temp.		14	18				mA
		$V_O = 0\text{ V}$, $R_1 = \infty$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		14	17		14	18	
I_{CC-}	Negative supply current	$V_O = 0\text{ V}$, $R_1 = \infty$; Over temp.		11	15				mA
		$V_O = 0\text{ V}$, $R_1 = \infty$; $T_{amb} = 25\text{ }^{\circ}\text{C}$		11	14		11	15	
PSRR	Power supply rejection ratio	$\Delta V_{CC} = \pm 1\text{ V}$; Over temp.		300	1000				$\mu\text{V}/\text{V}$
		$\Delta V_{CC} = \pm 1\text{ V}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$					200	1000	
A_{VOL}	Large signal voltage gain	$V_O = +2.3\text{ V}$, -1.7 V ; $R_L = 150\text{ }\Omega$ to GND, $470\text{ }\Omega$ to $-V_{CC}$				47	52	57	dB
		$V_O = +2.3\text{ V}$, -1.7 V ; $R_L = 2\text{ }\Omega$ to GND	Over temp.						dB
			$T_{amb} = 25\text{ }^{\circ}\text{C}$			47	52	57	
		$V_O = +2.5\text{ V}$, -2.0 V ; $R_L = 2\text{ }\Omega$ to GND	Over temp.	46	60				dB
			$T_{amb} = 25\text{ }^{\circ}\text{C}$	48	53	58			

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

SYMBOL	PARAMETER	TEST CONDITIONS		SE5539			UNITS
				MIN	TYP	MAX	
V_{OS}	Input offset voltage		Over temp.		2	5	mV
			$T_{amb} = 25\text{ }^{\circ}\text{C}$		2	3	
I_{OS}	Input offset current		Over temp.		0.1	3	μA
			$T_{amb} = 25\text{ }^{\circ}\text{C}$		0.1	1	
I_B	Input bias current		Over temp.		5	20	μA
			$T_{amb} = 25\text{ }^{\circ}\text{C}$		4	10	
CMRR	Common-mode rejection ratio	$V_{CM} = \pm 1.3\text{ V}$; $R_S = 100\text{ }\Omega$		70	85		dB
I_{CC+}	Positive supply current		Over temp.		11	14	mA
			$T_{amb} = 25\text{ }^{\circ}\text{C}$		11	13	
I_{CC-}	Negative supply current		Over temp.		8	11	mA
			$T_{amb} = 25\text{ }^{\circ}\text{C}$		8	10	
PSRR	Power supply rejection ratio	$\Delta V_{CC} = \pm 1\text{ V}$	Over temp.		300	1000	$\mu\text{V/V}$
			$T_{amb} = 25\text{ }^{\circ}\text{C}$				
V_{OUT}	Output voltage swing	$R_L = 150\text{ }\Omega$ to GND and $390\text{ }\Omega$ to $-V_{CC}$	Over temp.	+Swing	+1.4	+2.0	V
				–Swing	–1.1	–1.7	
			$T_{amb} = 25\text{ }^{\circ}\text{C}$	+Swing	+1.5	+2.0	
				–Swing	–1.4	–1.8	

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AC ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 8\text{ V}$, $R_L = 150\ \Omega$ 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	$A_{CL} = 7$, $V_O = 0.1\text{ V}_{P-P}$		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	$R_S = 50\ \Omega$, 1 MHz		4			4		nV/ $\sqrt{\text{Hz}}$
	Input noise current	1 MHz		6			6		pA/ $\sqrt{\text{Hz}}$

NOTE:

1. External compensation.

AC ELECTRICAL CHARACTERISTICS

$V_{CC} = \pm 6\text{ V}$, $R_L = 150\ \Omega$ 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/ 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

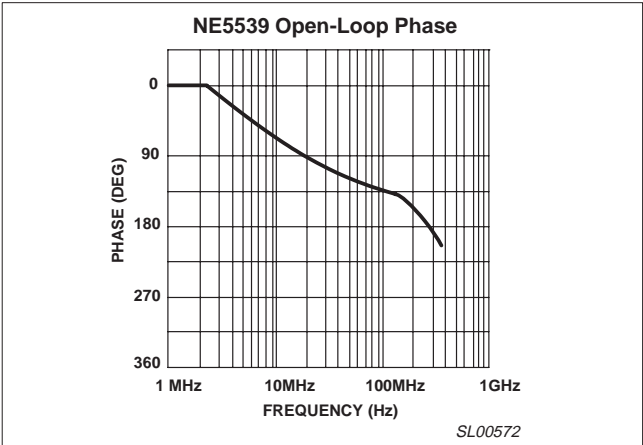


Figure 3. NE5539 Open-Loop Phase

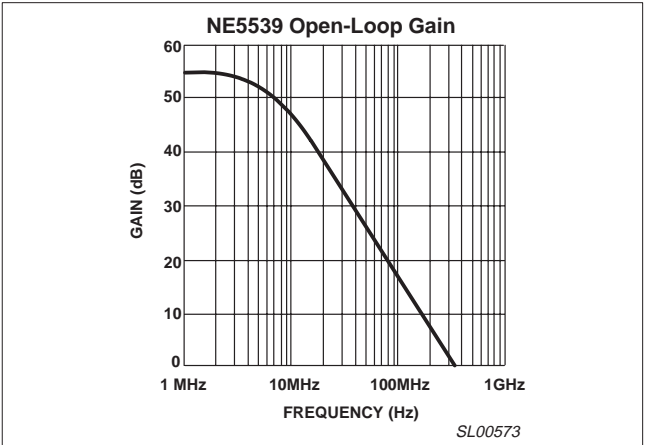


Figure 4. NE5539 Open-Loop Gain

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TYPICAL PERFORMANCE CURVES (Continued)

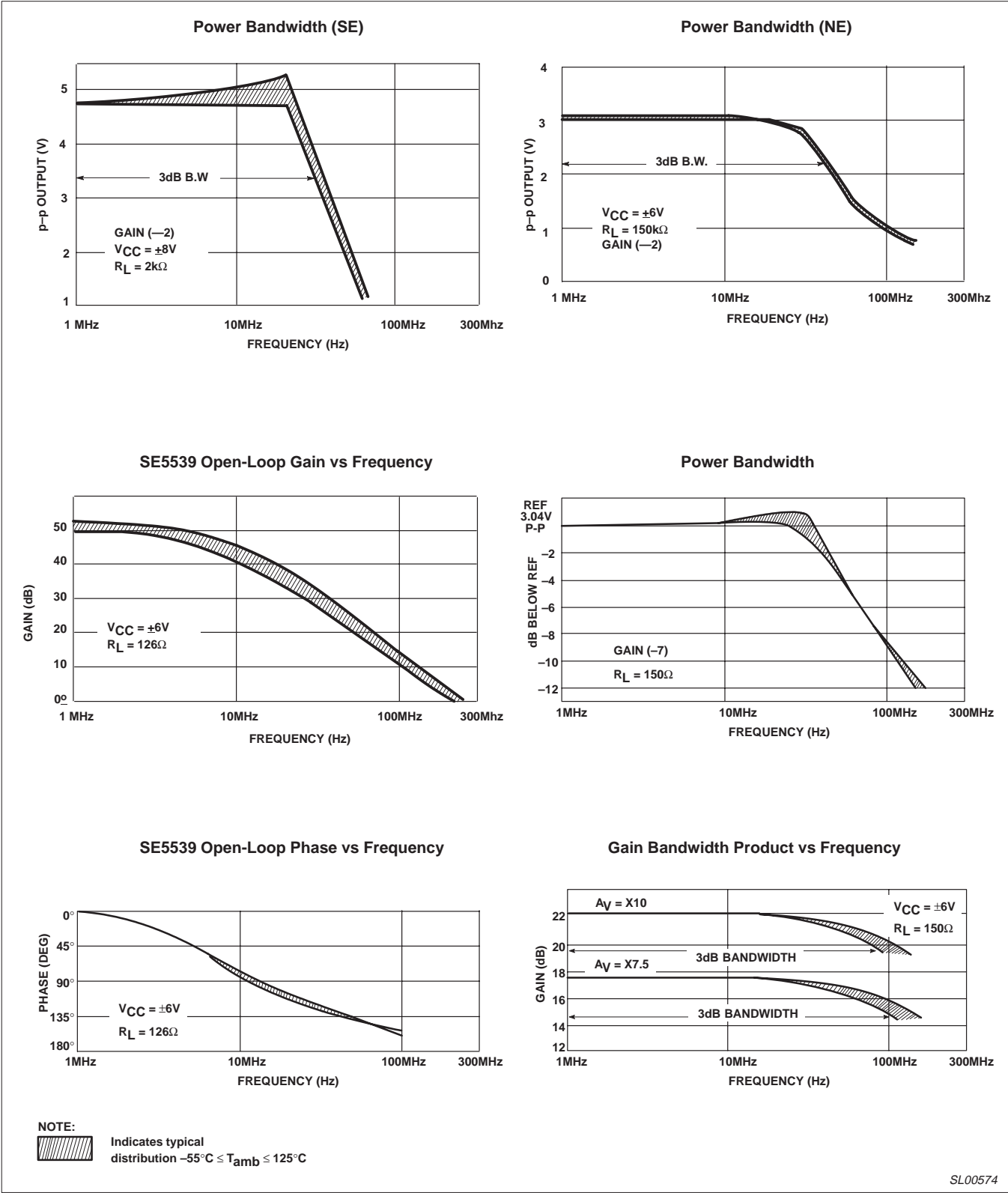


Figure 5. Typical Performance Curves

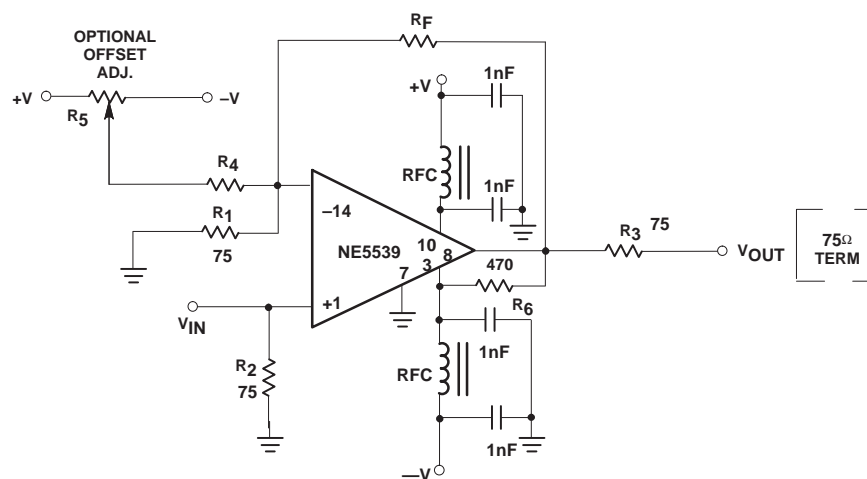
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CIRCUIT LAYOUT CONSIDERATIONS

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

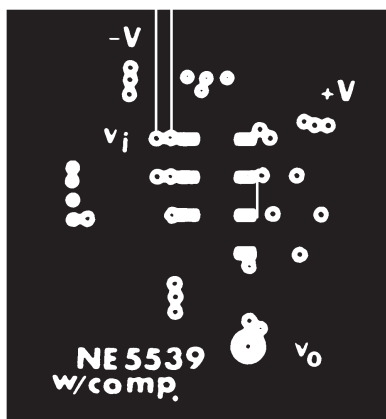
Bread-boarding is not recommended. A double-sided copper-clad printed circuit board will result in more favorable system operation. An example utilizing a 28 dB non-inverting amp is shown in Figure 6.



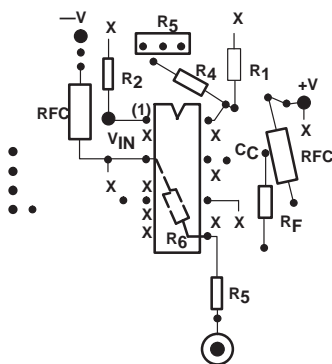
R₁ = 75Ω 5% CARBON
R₂ = 75Ω 5% CARBON
R₃ = 75Ω 5% CARBON
R₄ = 36K 5% CARBON

$R_5 = 20k$ 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.)



**Component Side
(Component Layout)**



**Bottom Plane
Copper¹**

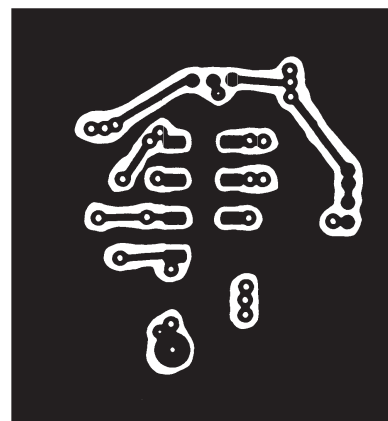


Figure 6. 28dB Non-Inverting Amp Sample PC Layout

SL00575

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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 7 along with vector-scope photographs showing the amplifier differential gain and phase response to a standard five-step modulated staircase linearity signal (Figures 8, 9 and 10). As can be seen in Figure 9, the gain varies less than 0.5% from the bottom to the top of the staircase. The maximum differential phase shown in Figure 10 is approximately $+0.1^\circ$.

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

NOTE:

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

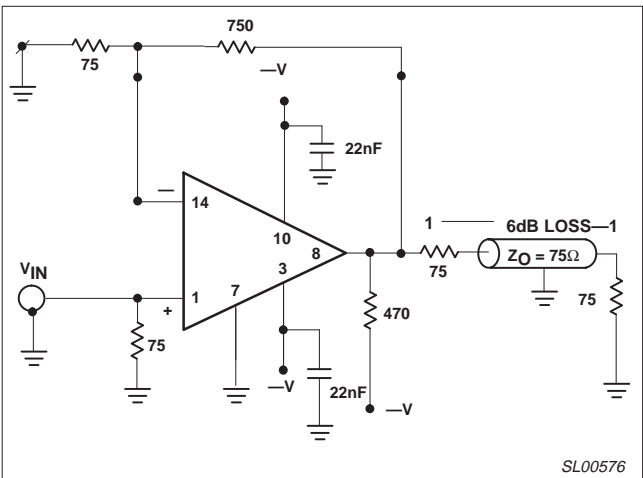


Figure 7. NE5539 Video Amplifier

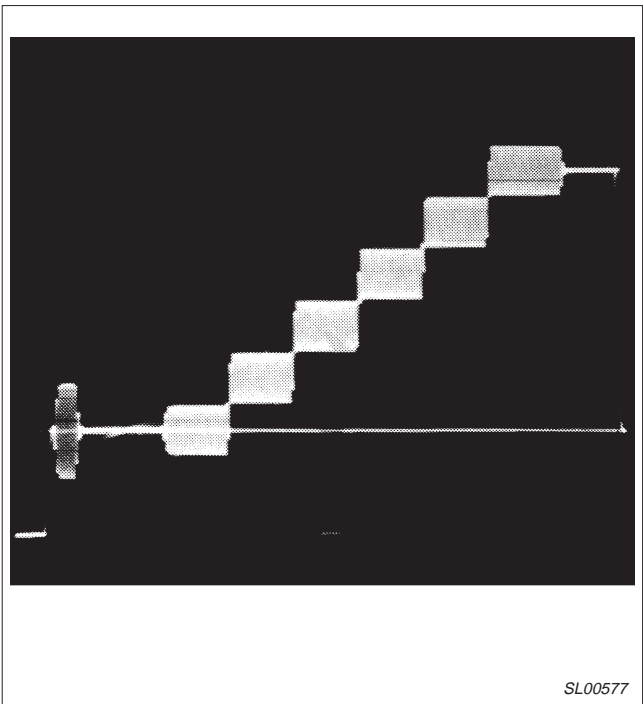


Figure 8. Input Signal

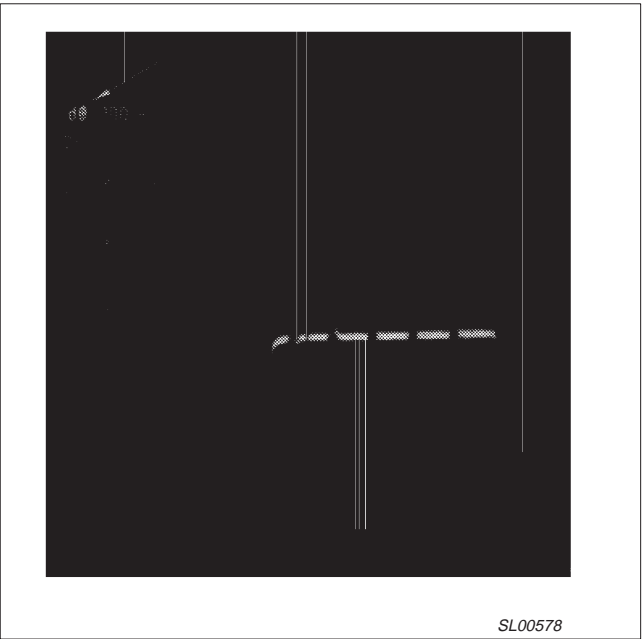


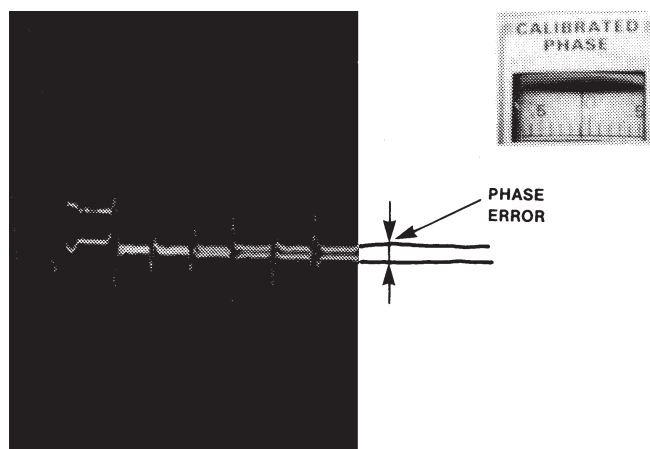
Figure 9. Differential Gain $<0.5\%$

NOTE:

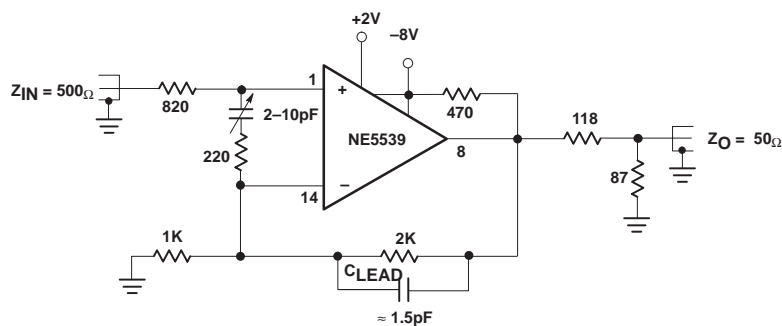
Instruments used for these measurements were Tektronix 146 NTSC test signal generator, 520A NTSC vectorscope, and 1480 waveform monitor.

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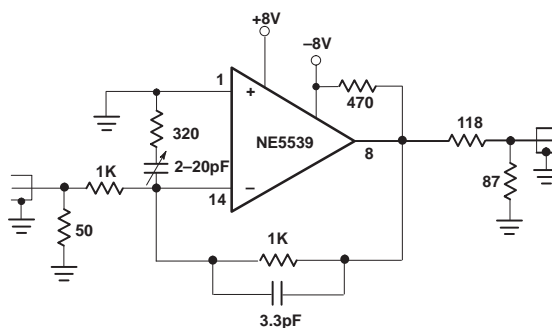


SL00579

Figure 10. Differential Gain $+0.1^\circ$ 

SL00580

Figure 11. Non-Inverting Follower



SL00581

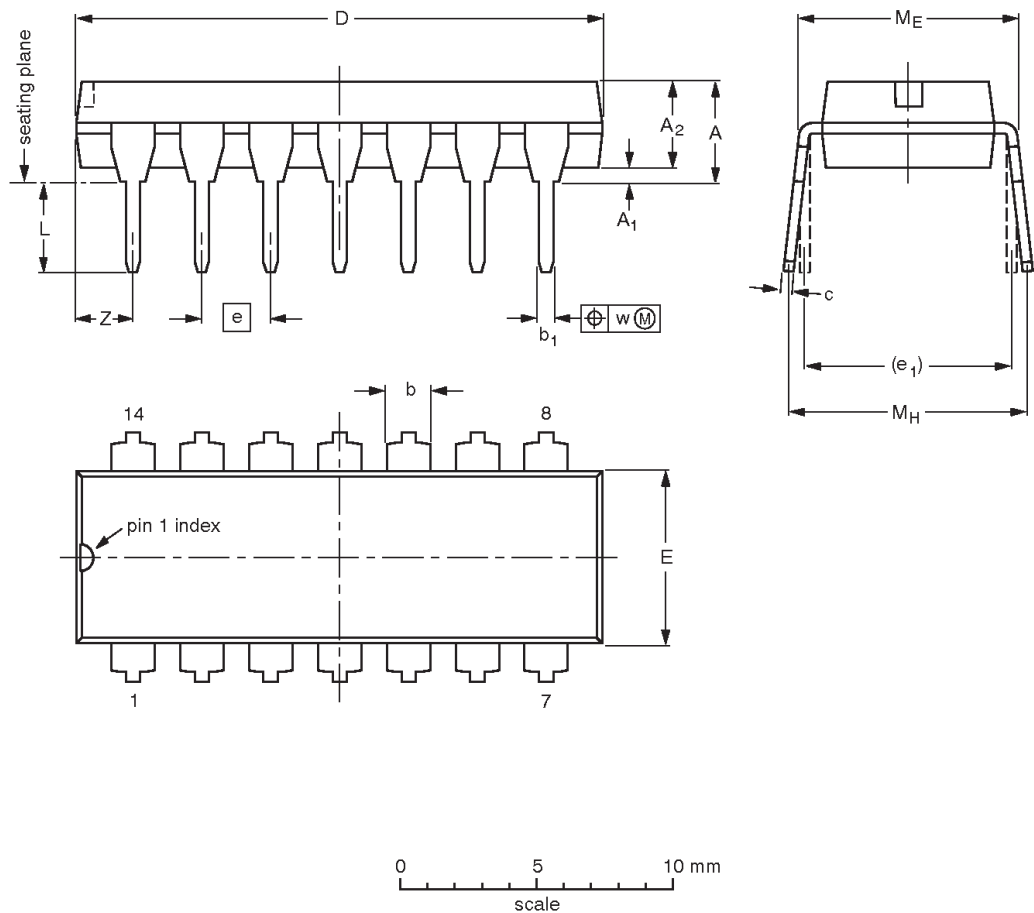
Figure 12. Inverting Follower

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DIP14: plastic dual in-line package; 14 leads (300 mil)

SOT27-1




DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁ min.	A ₂ max.	b	b ₁	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	L	M _E	M _H	w	Z ⁽¹⁾ max.
mm	4.2	0.51	3.2	1.73 1.13	0.53 0.38	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.2
inches	0.17	0.020	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.087

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

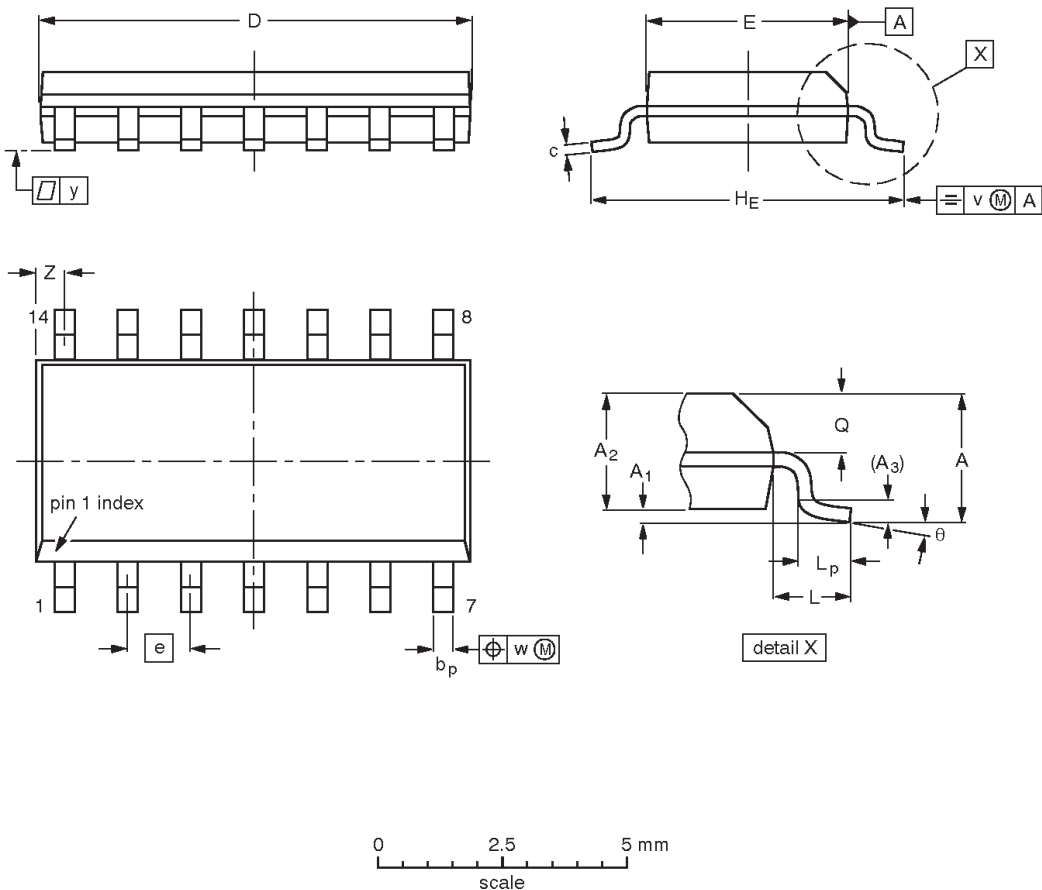
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT27-1	050G04	MO-001	SC-501-14			95-03-11 99-12-27

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SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1




DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.35 0.34	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT108-1	076E06	MS-012				97-05-22 99-12-27

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NOTES

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Data sheet status

Data sheet status ^[1]	Product status ^[2]	Definitions
Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
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