DATA SHEET

NE/SE5539
High frequency operational amplifier

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

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Philips
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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/Vµs
- A_{VOL}: 52 dB typical
- Low noise: 4 nV√Hz typical

PIN CONFIGURATION

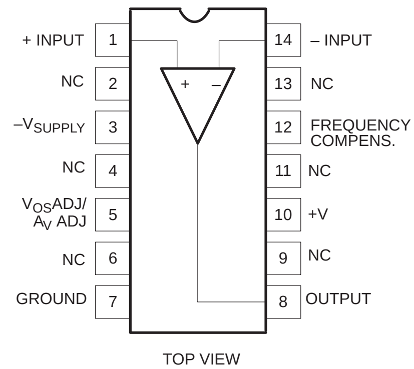


Figure 1. Pin Configuration

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 RATINGS[1]

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 D package	 1.45 0.99	 W W
T_{amb}	Operating temperature range NE5539D, NE5539N SE5539N	 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_{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

EQUIVALENT CIRCUIT

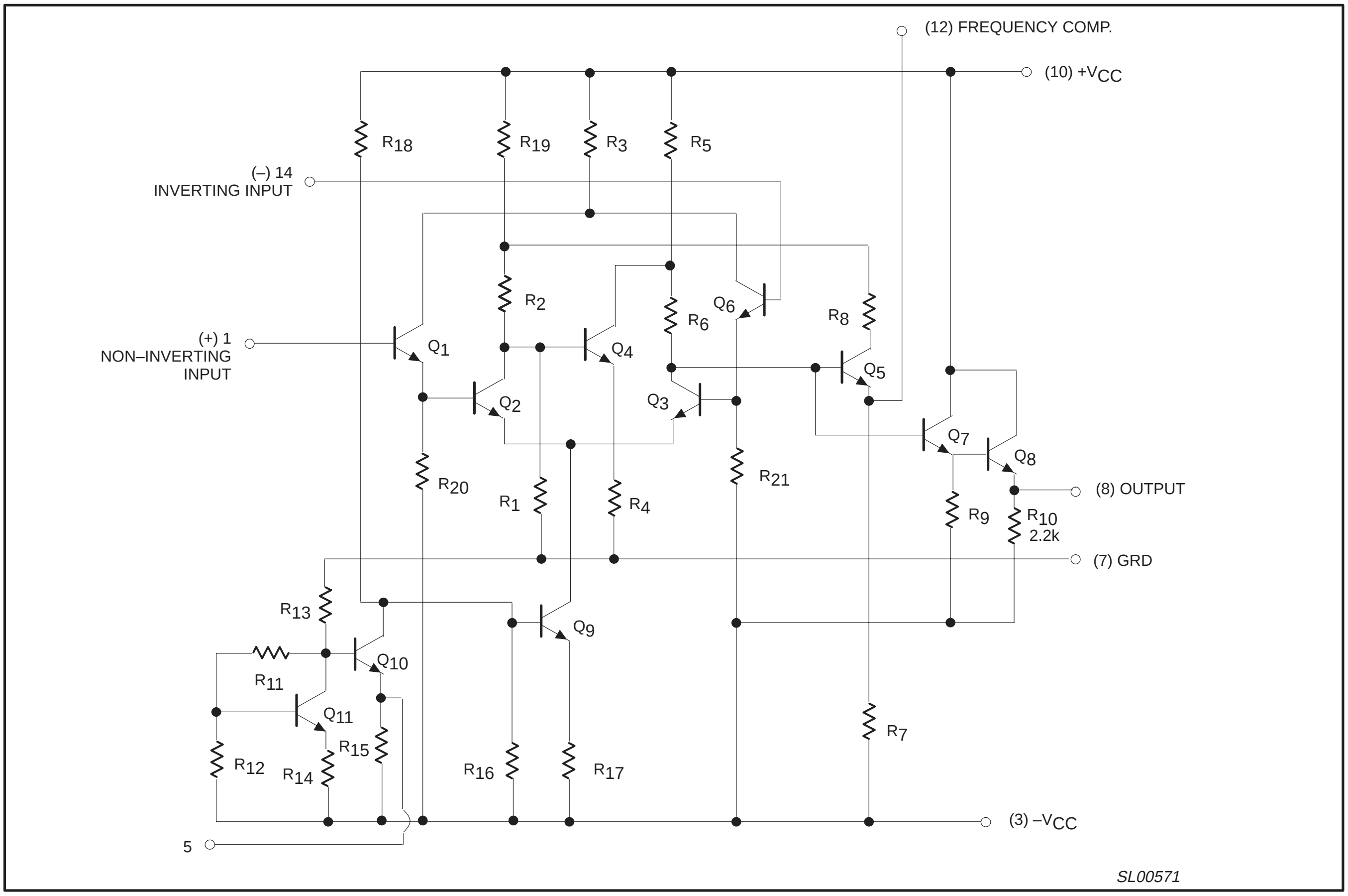


Figure 2. Equivalent Circuit

DC ELECTRICAL CHARACTERISTICS

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

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

DC ELECTRICAL CHARACTERISTICS

V_{CC} = ±6 V, T_{amb} = 25 °C; unless otherwise specified.

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

AC ELECTRICAL CHARACTERISTICS

V_{CC} = ±8 V, R_L = 150 Ω to GND and 470 Ω 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 Ω[1]		110			110		MHz
t_S	Settling time	A_{CL} = 2, R_L = 150 Ω[1]		15			15		ns
SR	Slew rate	A_{CL} = 2, R_L = 150 Ω[1]		600			600		V/µs
t_{PD}	Propagation delay	A_{CL} = 2, R_L = 150 Ω[1]		7			7		ns
	Full power response	A_{CL} = 2, R_L = 150 Ω[1]		48			48		MHz
	Full power response	A_V = 7, R_L = 150 Ω[1]		20			20		MHz
	Input noise voltage	R_S = 50 Ω, 1 MHz		4			4		nV/√Hz
	Input noise current	1 MHz		6			6		pA/√Hz

NOTE:
1. External compensation.

AC ELECTRICAL CHARACTERISTICS

V_{CC} = ±6 V, R_L = 150 Ω to GND and 390 Ω 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

NOTE:
1. External compensation.

TYPICAL PERFORMANCE CURVES

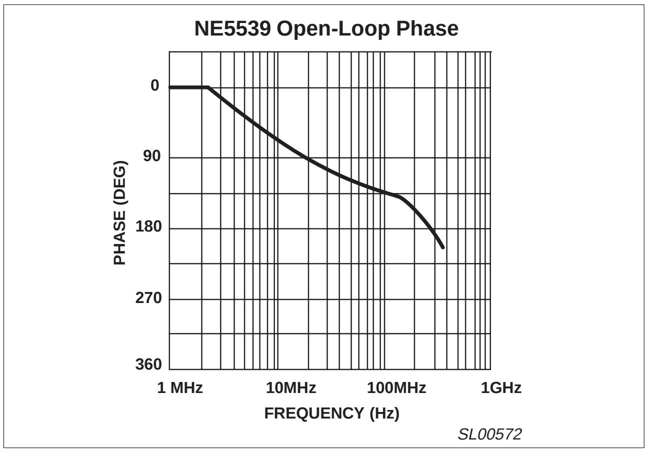


Figure 3. NE5539 Open-Loop Phase

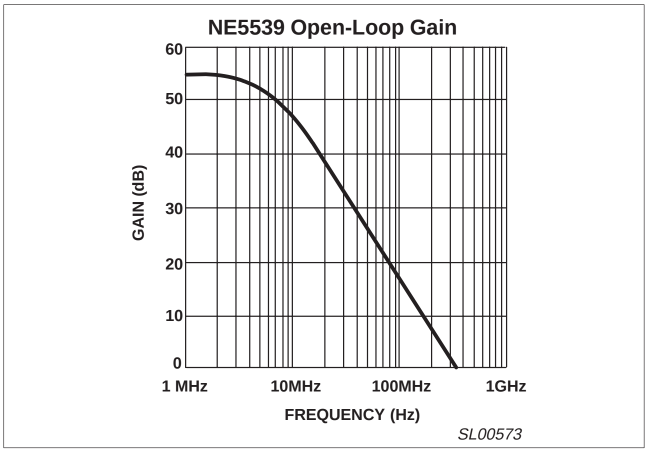


Figure 4. NE5539 Open-Loop Gain

TYPICAL PERFORMANCE CURVES (Continued)

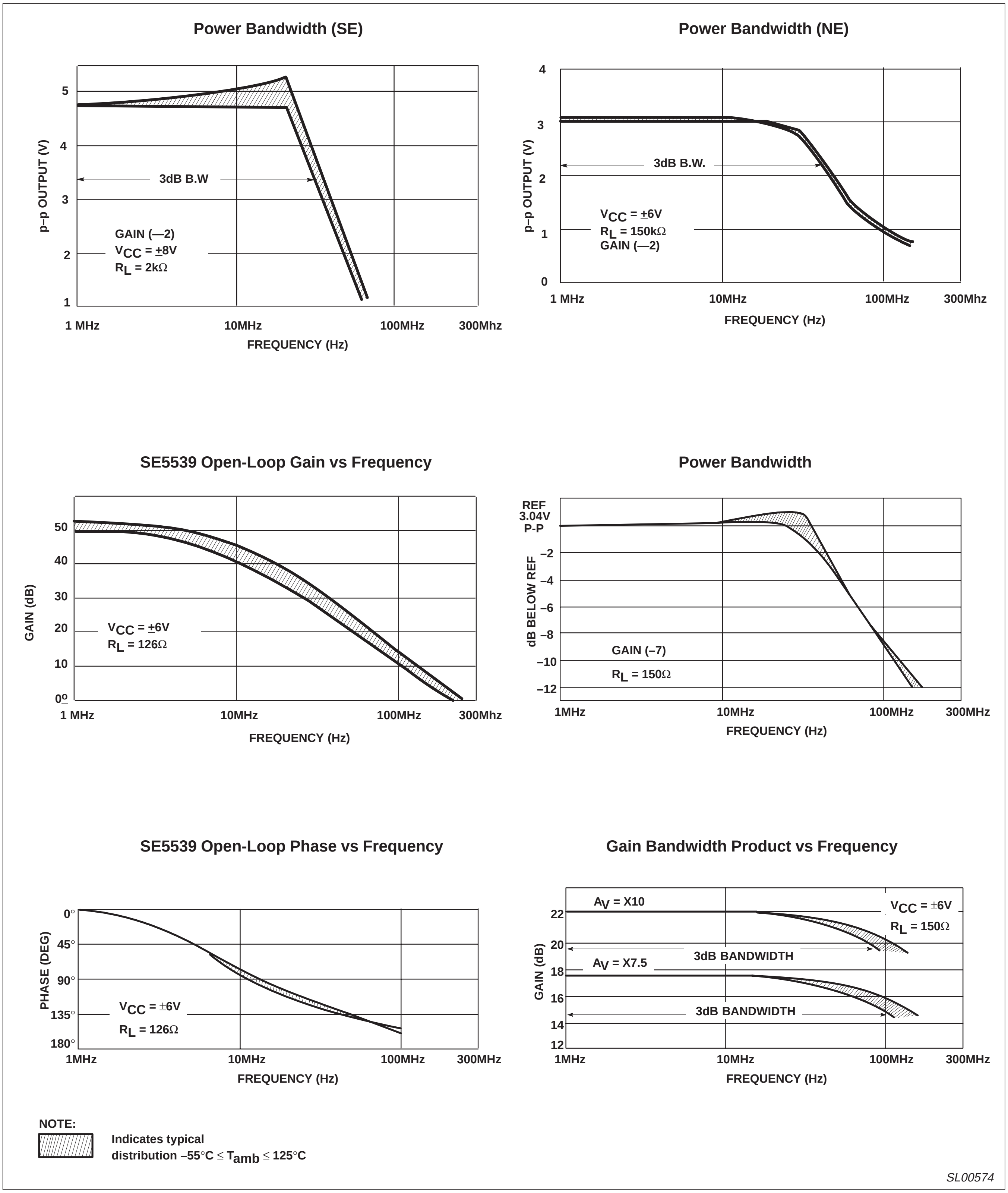
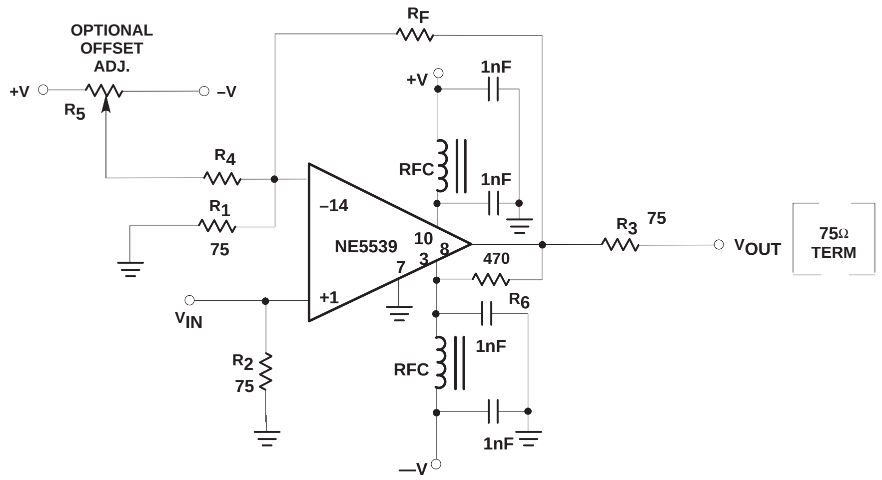


Figure 5. Typical Performance Curves

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.

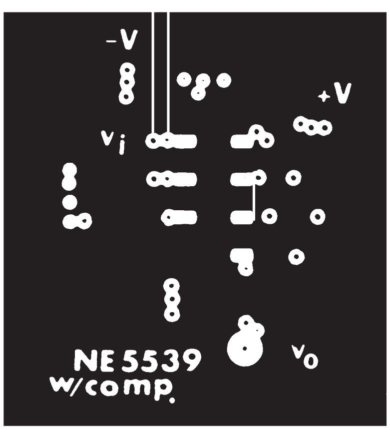


R_1 = 75Ω 5% CARBON
R_2 = 75Ω 5% CARBON
R_3 = 75Ω 5% CARBON
R_4 = 36K 5% CARBON

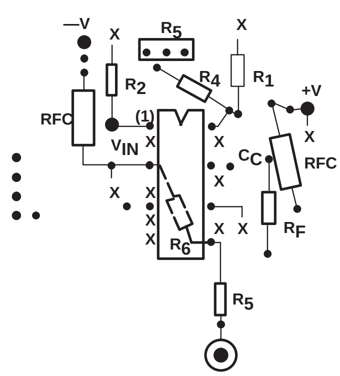
R_5 = 20k TRIMPOT (CERMET)
R_F = 1.5k (28dB GAIN)
R_6 = 470Ω 5% CARBON

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

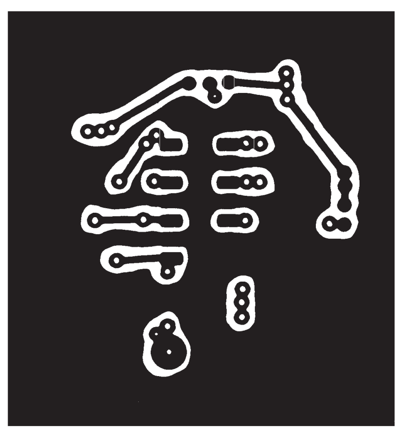
Top Plane Copper[1] (Component Side)



Component Side (Component Layout)



Bottom Plane Copper[1]



SL00575

Figure 6. 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 7 along with vector-scope1 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°.

The amplifier circuit was optimized for a 75 Ω 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 ±8 V.

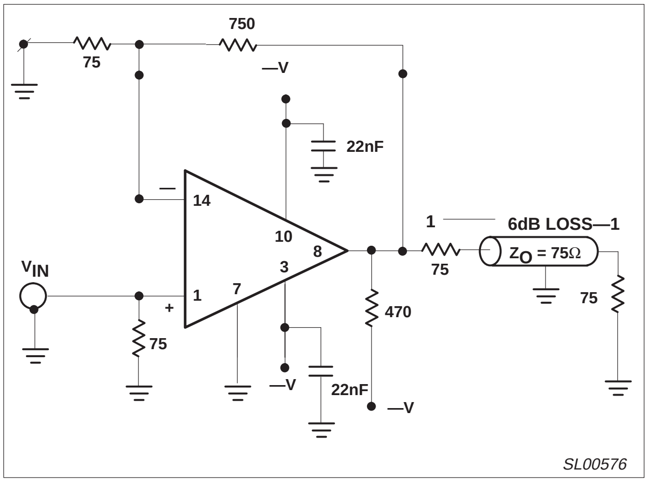


Figure 7. NE5539 Video Amplifier

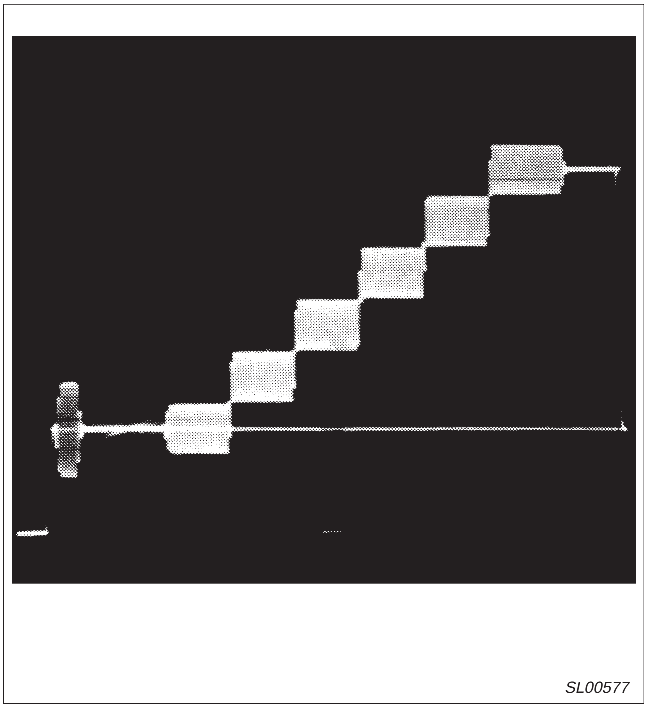


Figure 8. Input Signal

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.

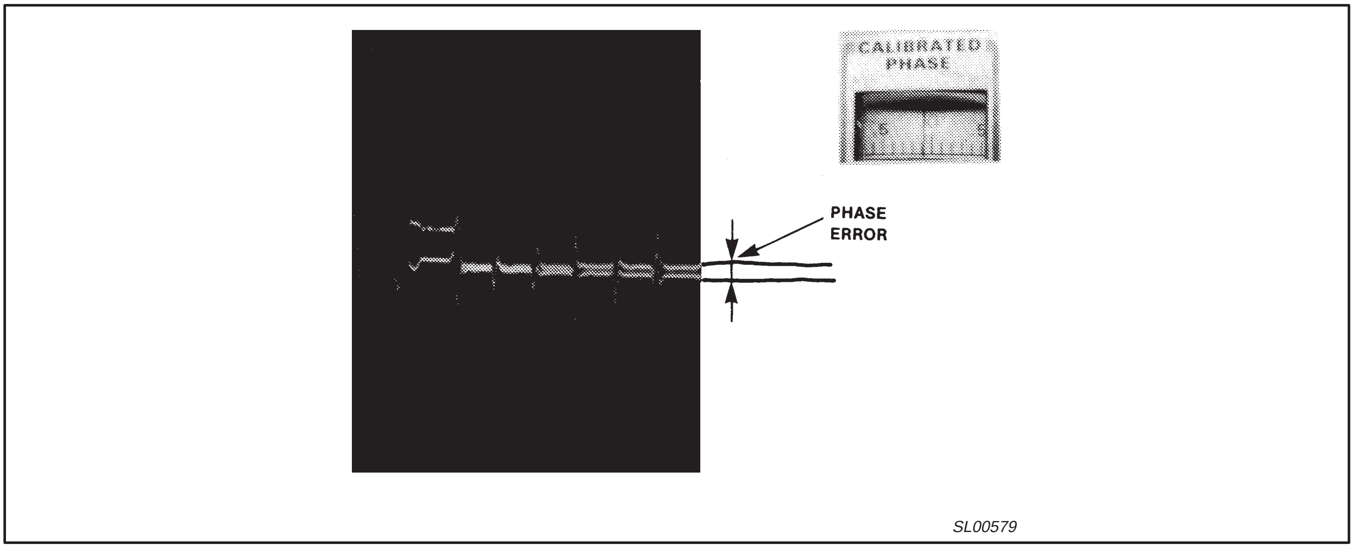


Figure 10. Differential Gain +0.1º

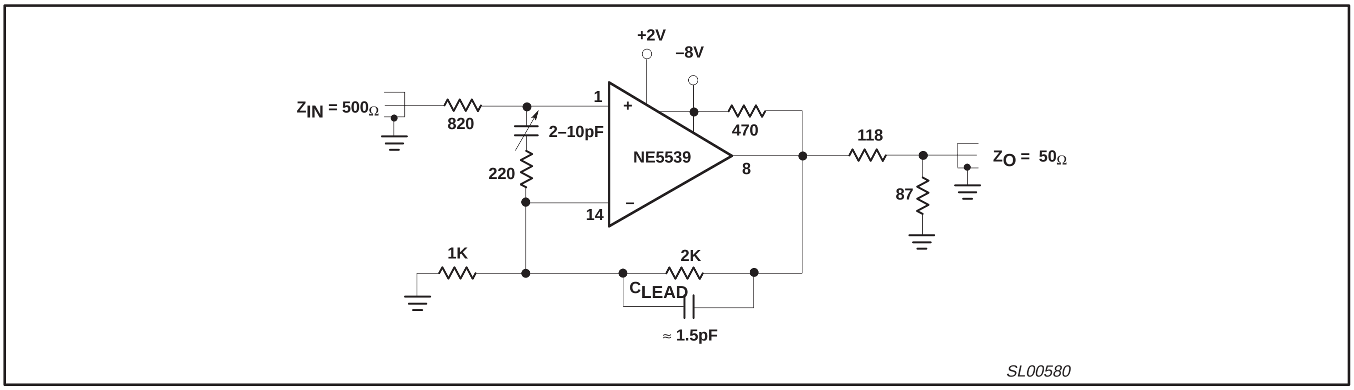


Figure 11. Non-Inverting Follower

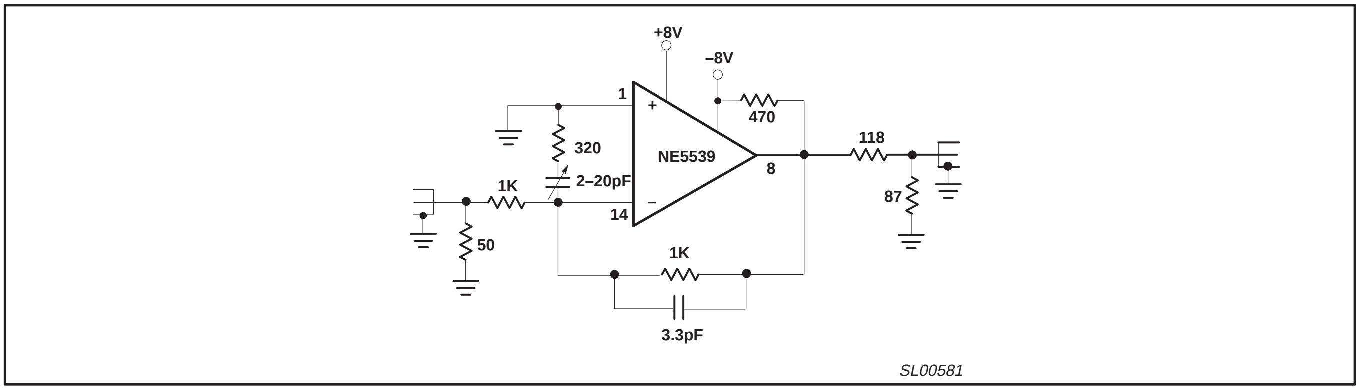
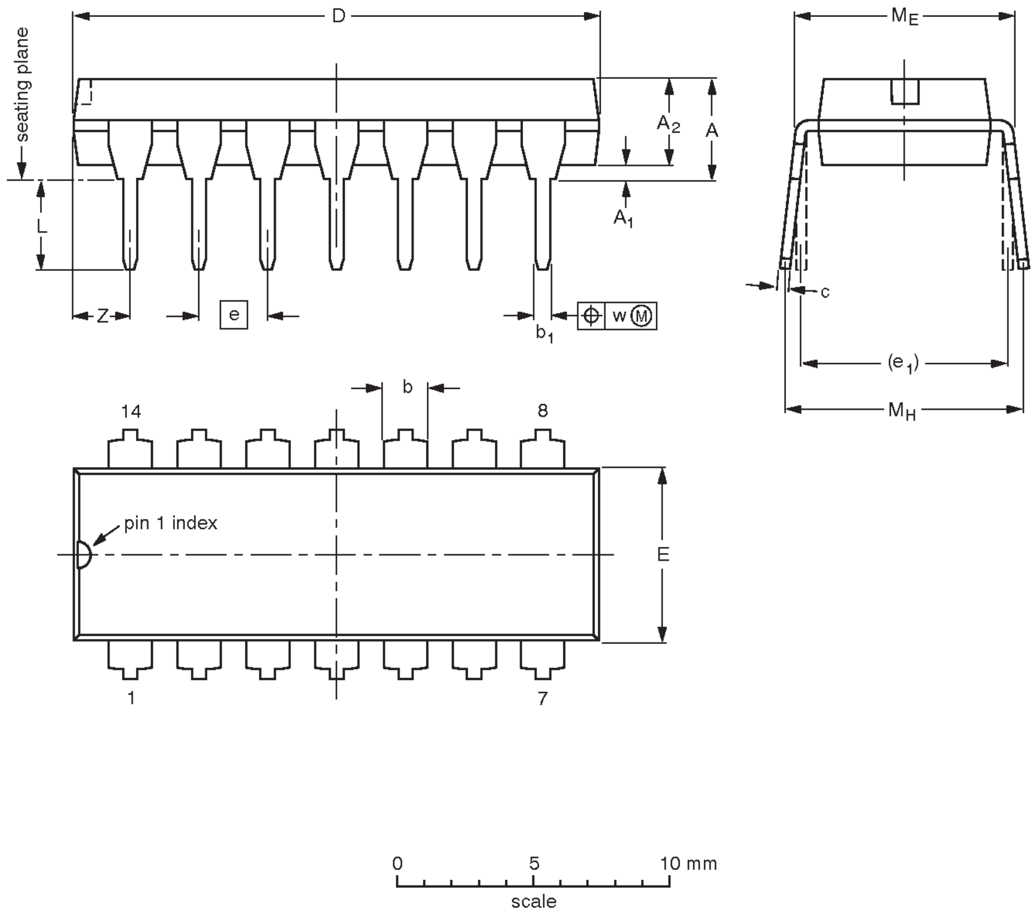


Figure 12. Inverting Follower

DIP14: plastic dual in-line package; 14 leads (300 mil) SOT27-1

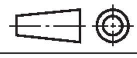


DIMENSIONS (inch dimensions are derived from the original mm dimensions)

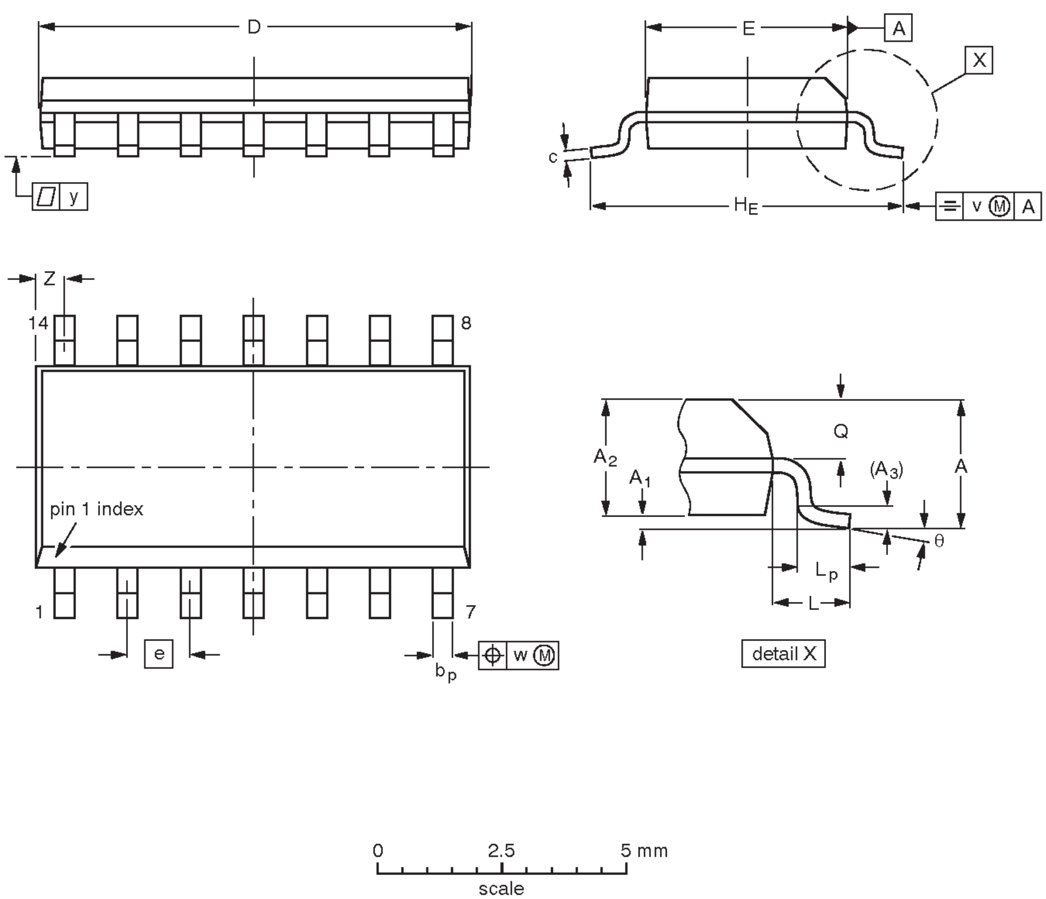
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.13	0.53 0.38	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.2
inches	0.17	0.020	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	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

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

NOTES

High frequency operational amplifier NE/SE5539

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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