DATA SHEET

NE/SE5539
High frequency operational amplifier

Product specification

April 15, 1992

IC11

PHILIPS

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

PIN CONFIGURATION

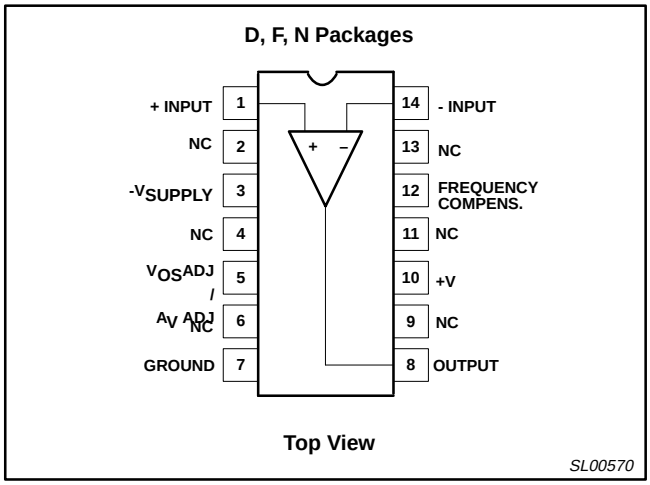


Figure 1. Pin Configuration

ORDERING INFORMATION

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

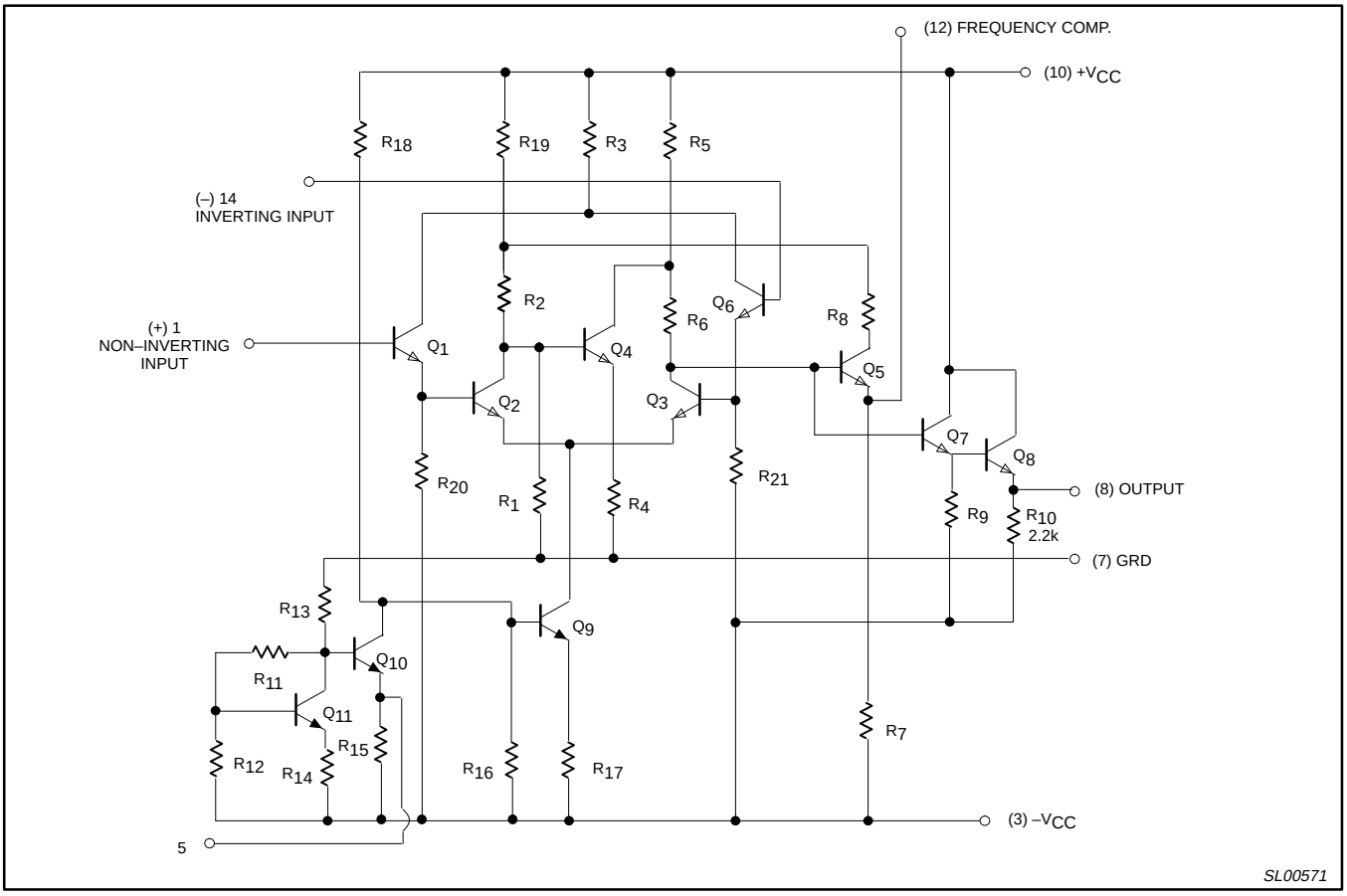


Figure 2. Equivalent Circuit

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

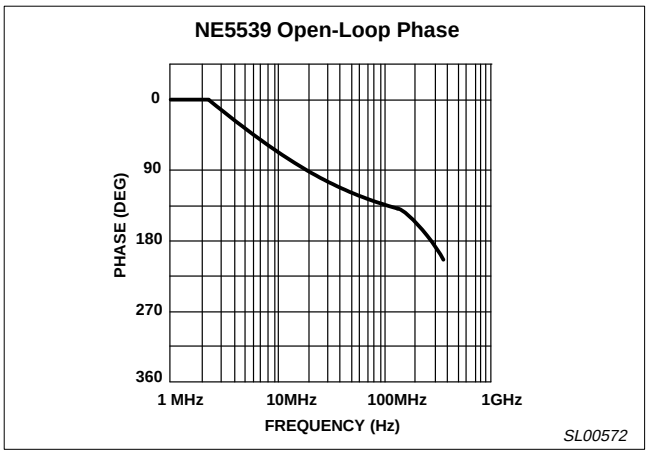


Figure 3. NE5539 Open-Loop Phase

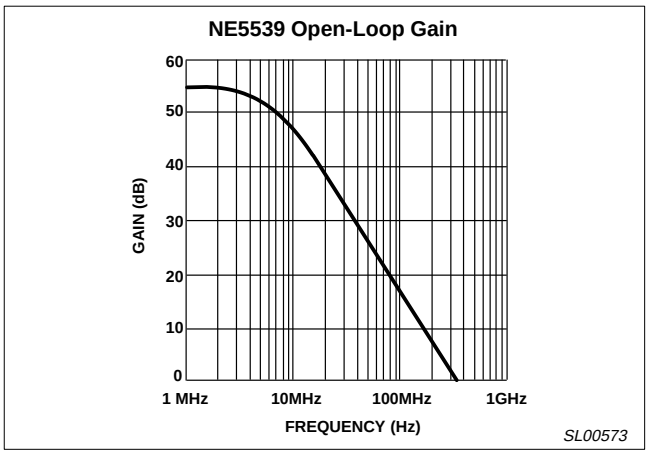
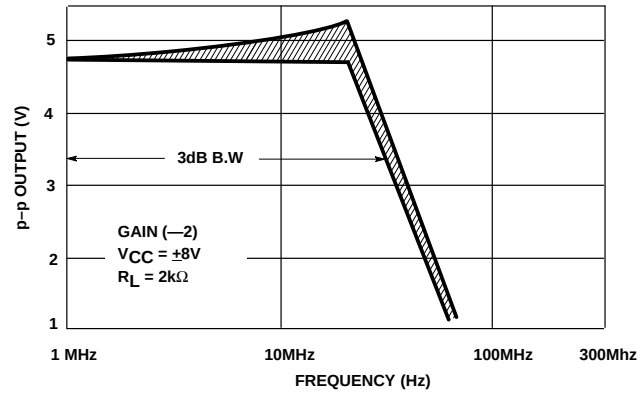


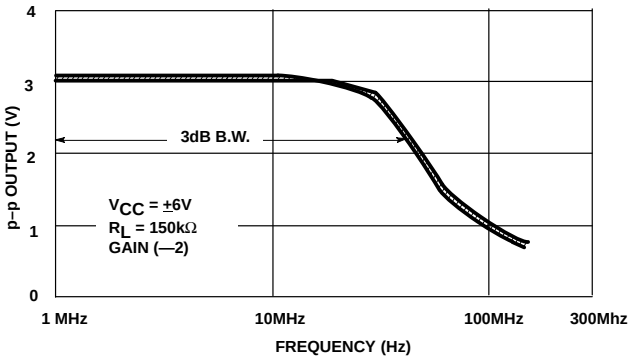
Figure 4. NE5539 Open-Loop Gain

TYPICAL PERFORMANCE CURVES (Continued)

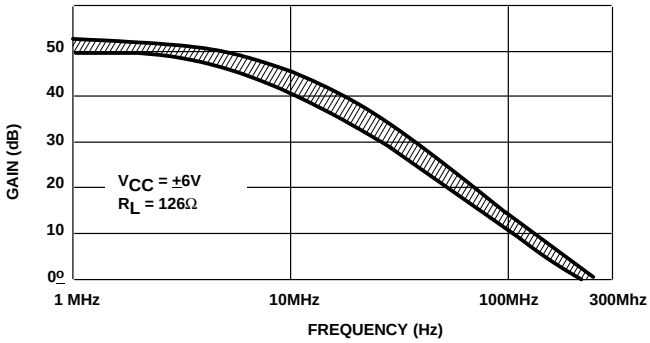
Power Bandwidth (SE)



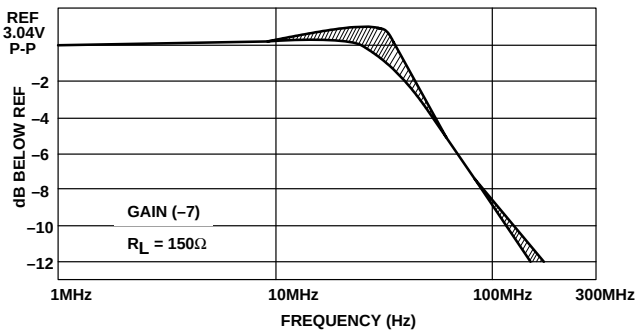
Power Bandwidth (NE)



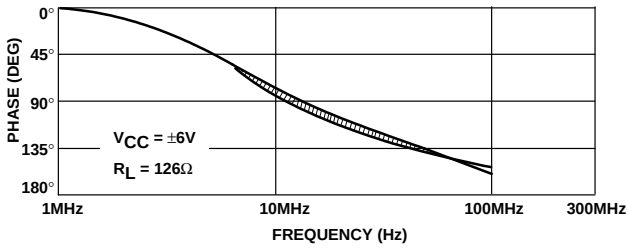
SE5539 Open-Loop Gain vs Frequency



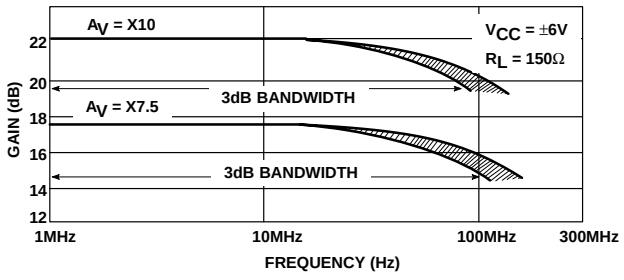
Power Bandwidth



SE5539 Open-Loop Phase vs Frequency



Gain Bandwidth Product vs Frequency



NOTE:

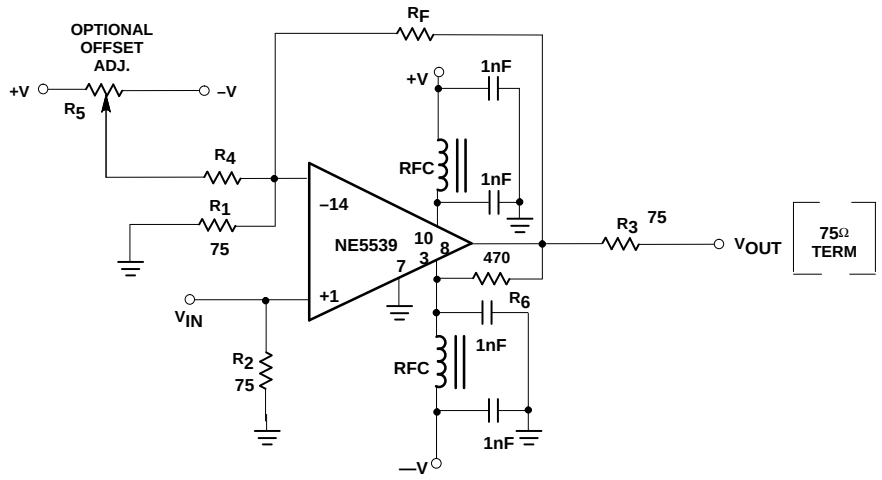
Indicates typical distribution $-55°C \leq T_A \leq 125°C$

SL00574

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 28dB non-inverting amp is shown in Figure 6.

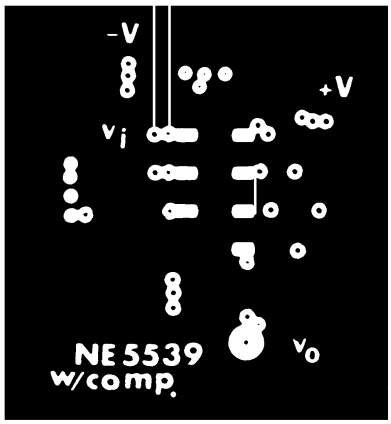


R_1 = 75Ω 5% CARBON
R_2 = 75Ω 5% CARBON
R_3 = 75Ω 5% CARBON
R_4 = 36K 5% CARBON

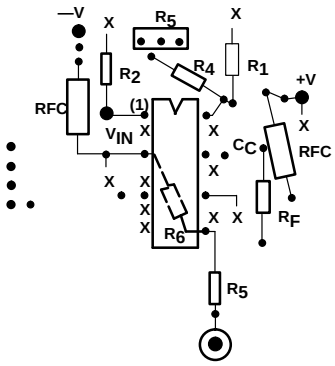
R_5 = 20k TRIMPOT (CERMET)
R_F = 1.5k (28dB GAIN)
R_6 = 470Ω 5% CARBON

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

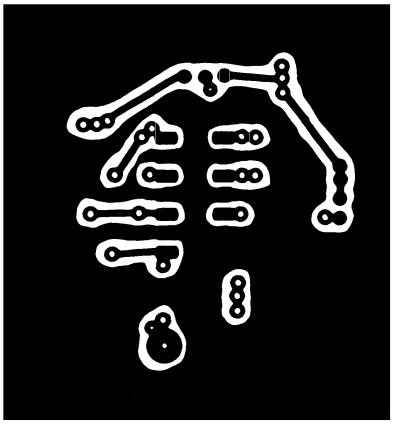
Top Plane Copper[1] (Component Side)



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 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.

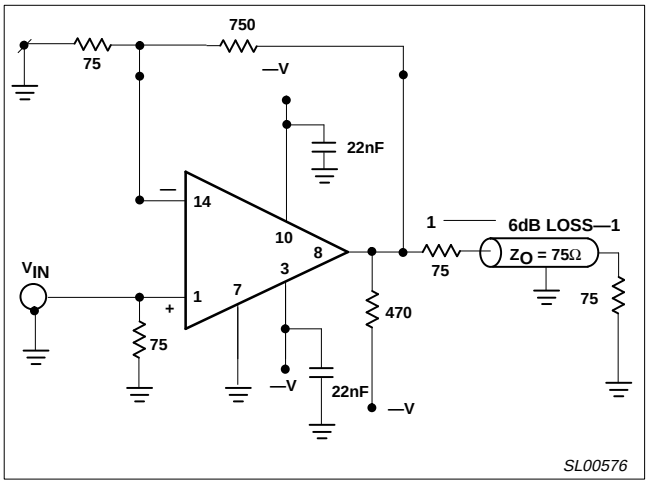


Figure 7. NE5539 Video Amplifier

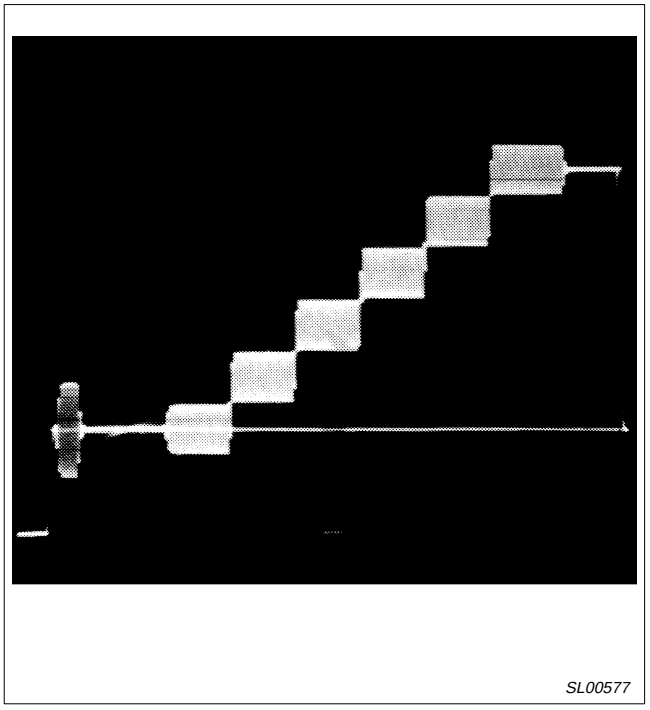


Figure 8. Input Signal

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.

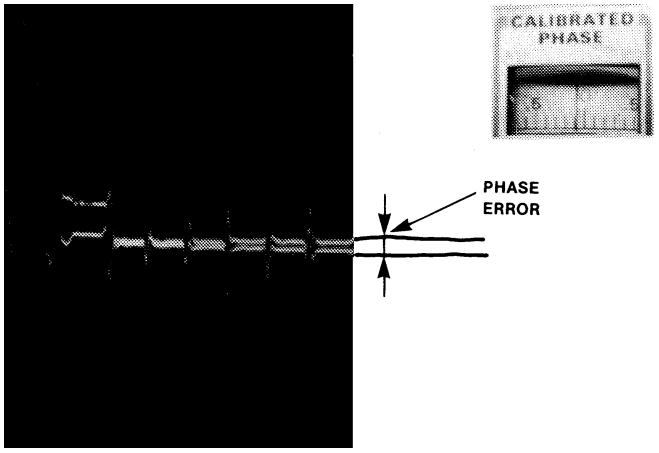


Figure 10. Differential Gain +0.1°

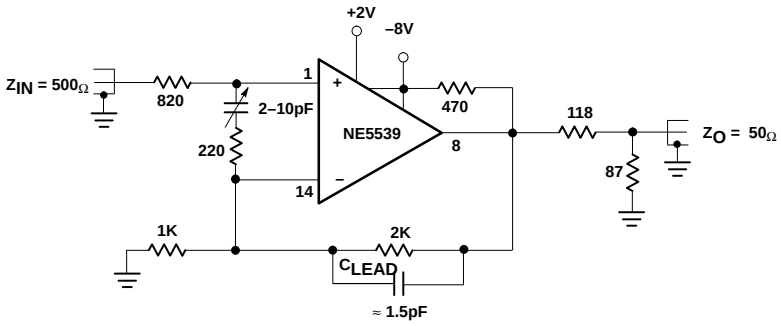


Figure 11. Non-Inverting Follower

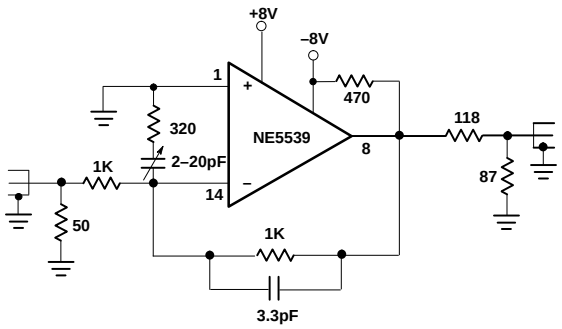
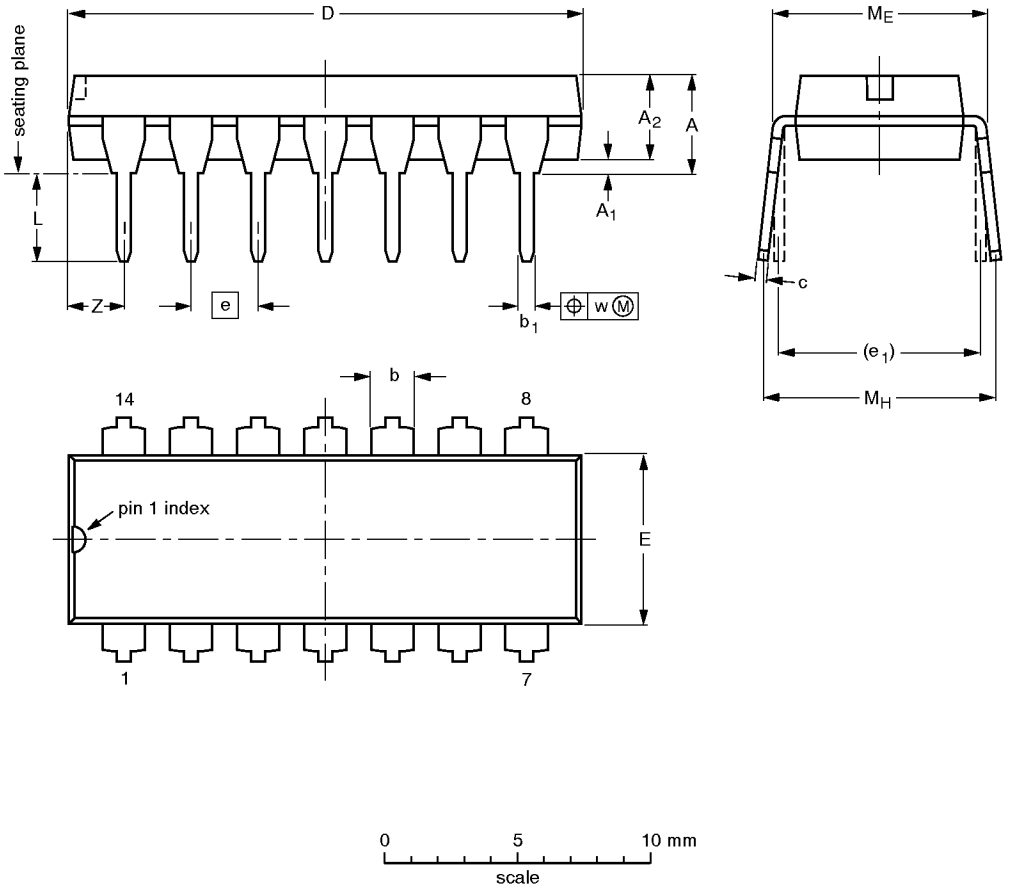


Figure 12. Inverting Follower

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



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

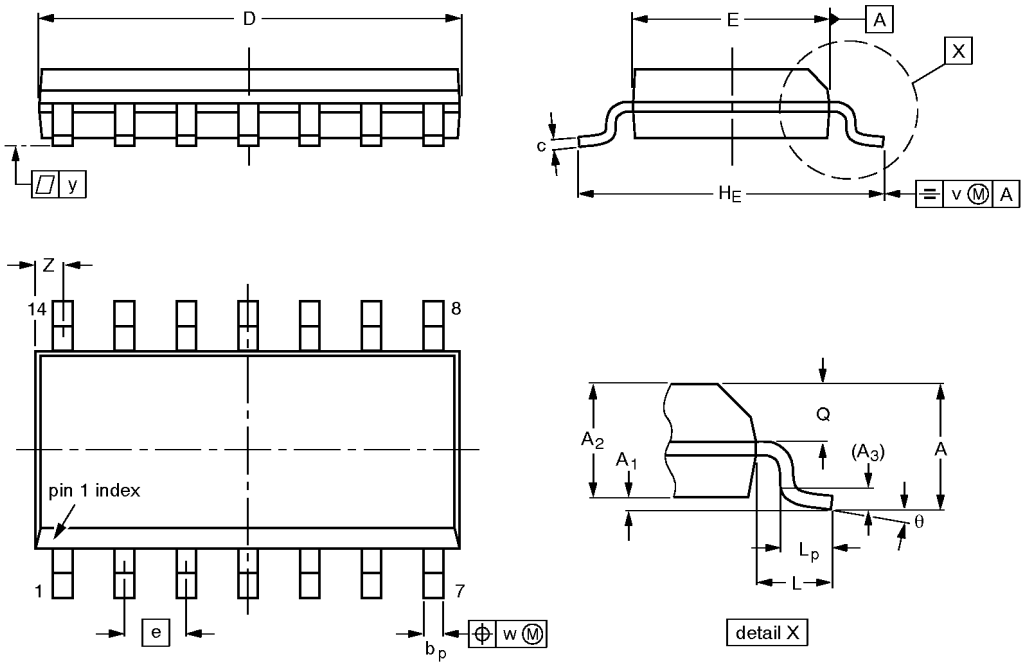
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.13	0.53 0.38	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.2
inches	0.17	0.020	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.087

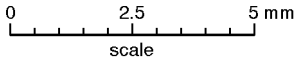
Note

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-001AA				~~92-11-17~~ 95-03-11

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	0.0098 0.0039	0.057 0.049	0.01	0.019 0.014	0.0098 0.0075	0.35 0.34	0.16 0.15	0.050	0.24 0.23	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Note

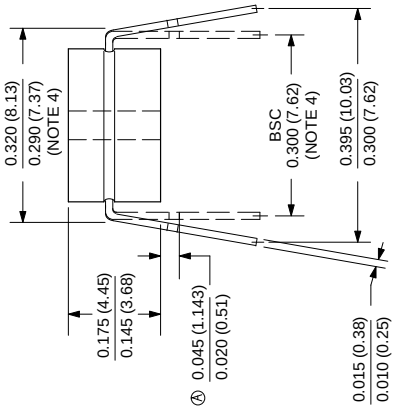
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

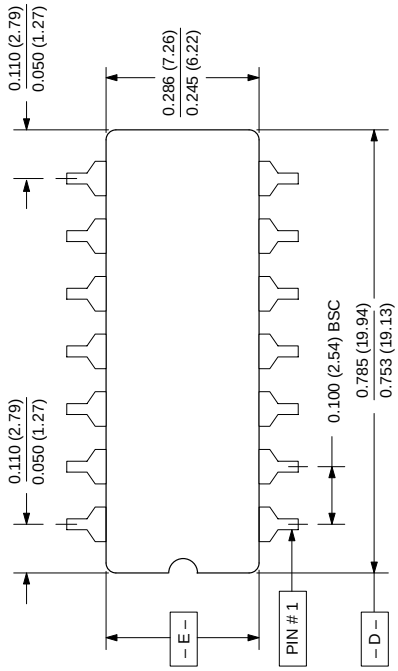
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT108-1	076E06S	MS-012AB				~~91-08-13~~ 95-01-23

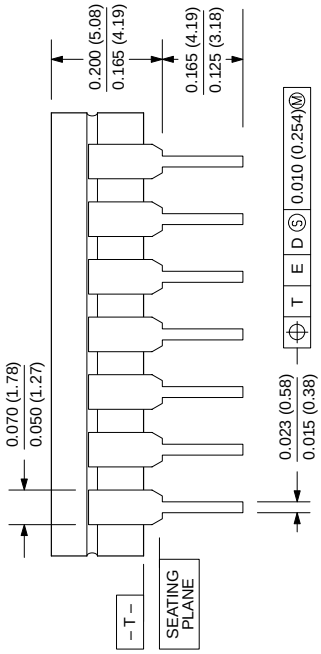
0581B 14-PIN (300 mils wide) CERAMIC DUAL IN-LINE (F) PACKAGE

NOTES:

1. Controlling dimension: Inches. Millimeters are shown in parentheses.
2. Dimension and tolerancing per ANSI Y14. 5M-1982.
3. "T", "D", and "E" are reference datums on the body and include allowance for glass overrun and meniscus on the seal line, and lid to base mismatch.
4. These dimensions measured with the leads constrained to be perpendicular to plane T.
5. Pin numbers start with Pin #1 and continue counterclockwise to Pin #14 when viewed from the top.







853-0581B 06688

DEFINITIONS

Data Sheet Identification	Product Status	Definition
Objective Specification	Formative or in Design	This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.
Preliminary Specification	Preproduction Product	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product Specification	Full Production	This data sheet contains Final Specifications. Philips Semiconductors reserves the right to make changes at any time without notice, in order to improve design and supply the best possible product.

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