

# 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 $\mu$ s
- A<sub>VOL</sub>: 52 dB typical
- Low noise: 4 nV $\sqrt$ Hz typical

## PIN CONFIGURATION

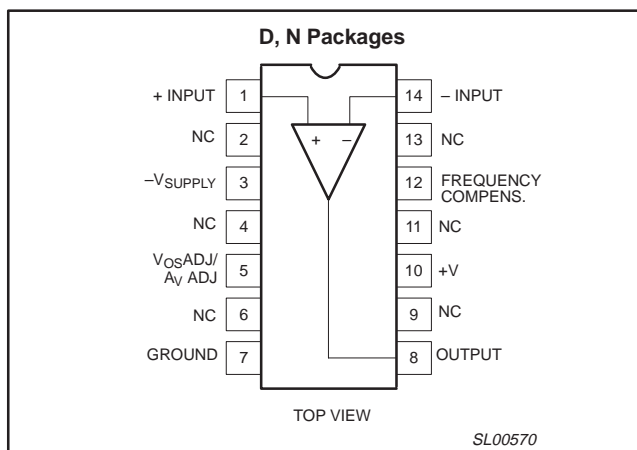


Figure 1. Pin Configuration

## 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<sup>1</sup>

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

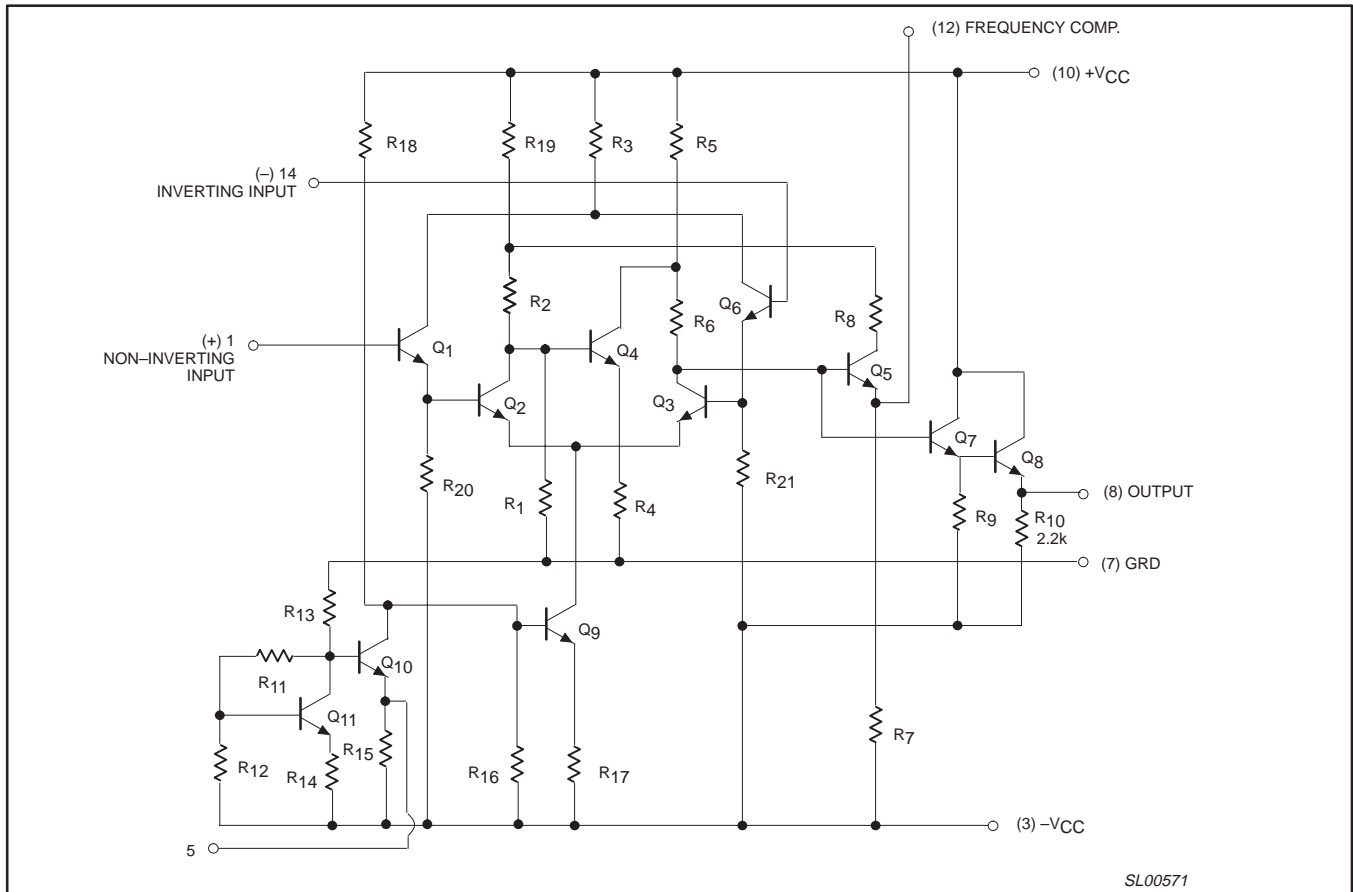
### NOTES:

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



SL00571

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	$V_O = 0\text{ V}$ ; $R_S = 100\ \Omega$	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				$\mu\text{A}$	
			$T_{amb} = 25\text{ }^{\circ}\text{C}$	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				$\mu\text{A}$	
			$T_{amb} = 25\text{ }^{\circ}\text{C}$	5	13		5	20		
$\Delta I_B/\Delta T$				10			10		$\text{nA}/^{\circ}\text{C}$	
CMRR	Common mode rejection ratio	$F = 1\text{ kHz}$ ; $R_S = 100\ \Omega$ ; $V_{CM} \pm 1.7\text{ V}$	Over temp.	70	80		70	80	dB	
				70	80					
$R_{IN}$	Input impedance			100			100		$\text{k}\Omega$	
$R_{OUT}$	Output impedance			10			10		$\Omega$	
$V_{OUT}$	Output voltage swing	$R_L = 150\ \Omega$ to GND and $470\ \Omega$ to $-V_{CC}$	+Swing				+2.3	+2.7	V	
			-Swing				-1.7	-2.2		
		$R_L = 25\ \Omega$ to GND Over temp.	+Swing	+2.3	+3.0					V
			-Swing	-1.5	-2.1					
		$R_L = 25\ \Omega$ 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	$V_O = +2.3\text{ V}$ , $-1.7\text{ V}$ ; $R_L = 150\ \Omega$ to GND, $470\ \Omega$ to $-V_{CC}$	Over temp.				47	52	57	dB
			$T_{amb} = 25\text{ }^{\circ}\text{C}$				47	52	57	
		$V_O = +2.5\text{ V}$ , $-2.0\text{ V}$ ; $R_L = 2\ \Omega$ 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	
				$T_{amb} = 25\text{ }^{\circ}\text{C}$		3		
$I_{OS}$	Input offset current			Over temp.	0.1	3	$\mu\text{A}$	
				$T_{amb} = 25\text{ }^{\circ}\text{C}$		1		
$I_B$	Input bias current			Over temp.	5	20	$\mu\text{A}$	
				$T_{amb} = 25\text{ }^{\circ}\text{C}$		10		
CMRR	Common-mode rejection ratio	$V_{CM} = \pm 1.3\text{ V}$ ; $R_S = 100\ \Omega$		70	85		dB	
$I_{CC+}$	Positive supply current			Over temp.	11	14	mA	
				$T_{amb} = 25\text{ }^{\circ}\text{C}$		13		
$I_{CC-}$	Negative supply current			Over temp.	8	11	mA	
				$T_{amb} = 25\text{ }^{\circ}\text{C}$		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	$R_L = 150\ \Omega$ to GND and $390\ \Omega$ 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/ $\mu$ 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	$R_S = 50\ \Omega$ , 1 MHz		4			4		nV/ $\sqrt{\text{Hz}}$
	Input noise current	1 MHz		6			6		pA/ $\sqrt{\text{Hz}}$

**NOTE:**

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

**NOTE:**

- External compensation.

## TYPICAL PERFORMANCE CURVES

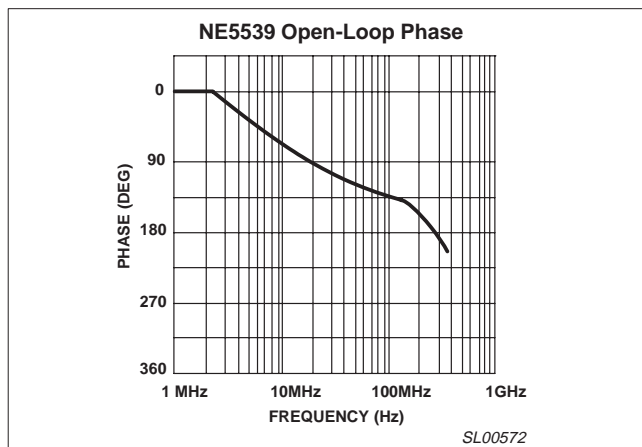


Figure 3. NE5539 Open-Loop Phase

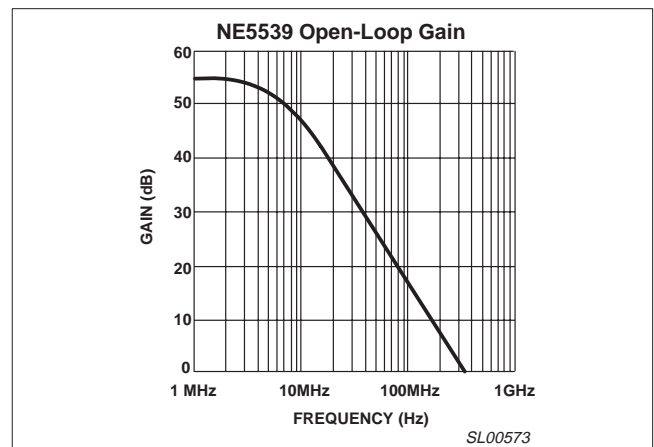
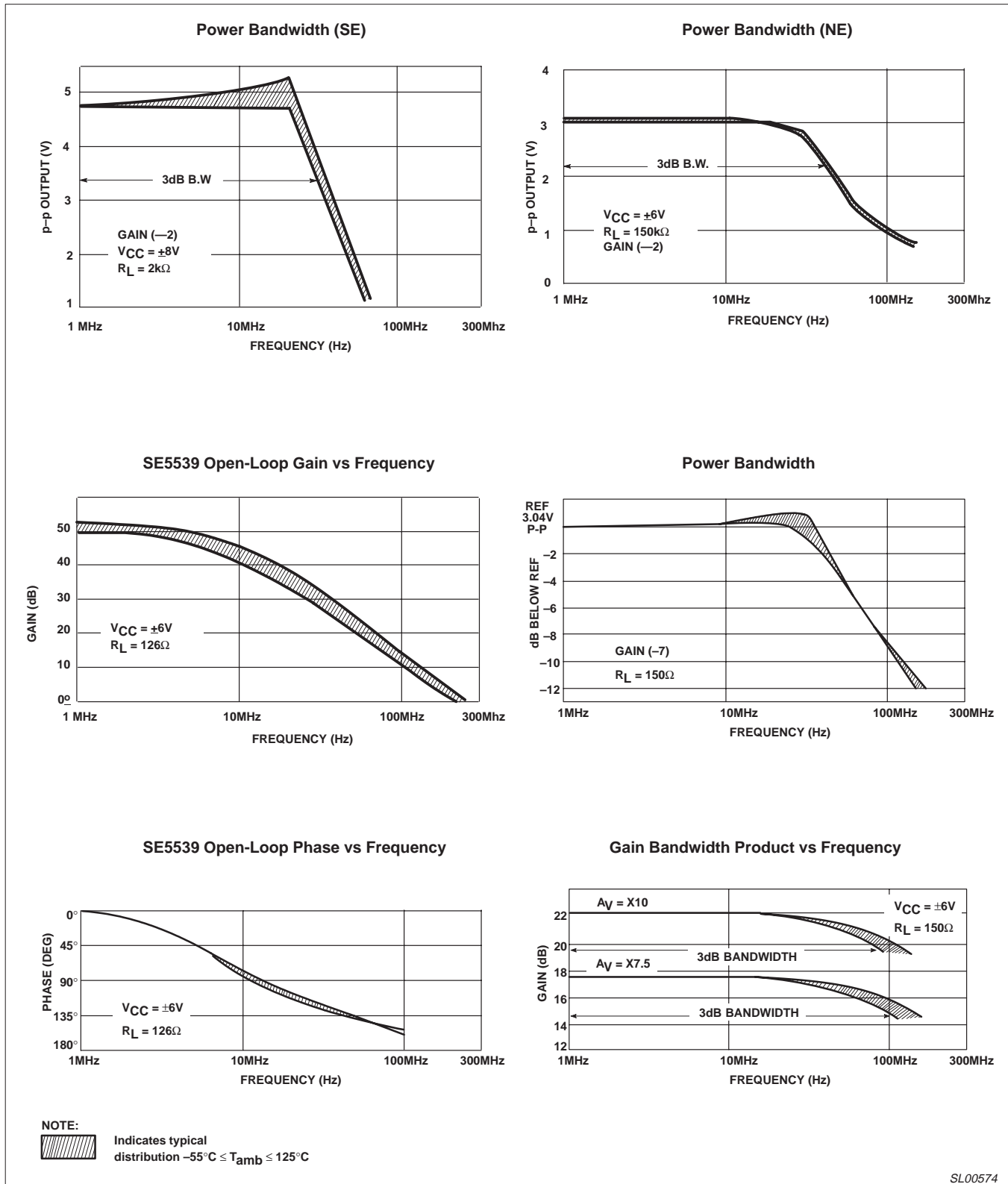


Figure 4. NE5539 Open-Loop Gain

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### TYPICAL PERFORMANCE CURVES (Continued)



SL00574

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.

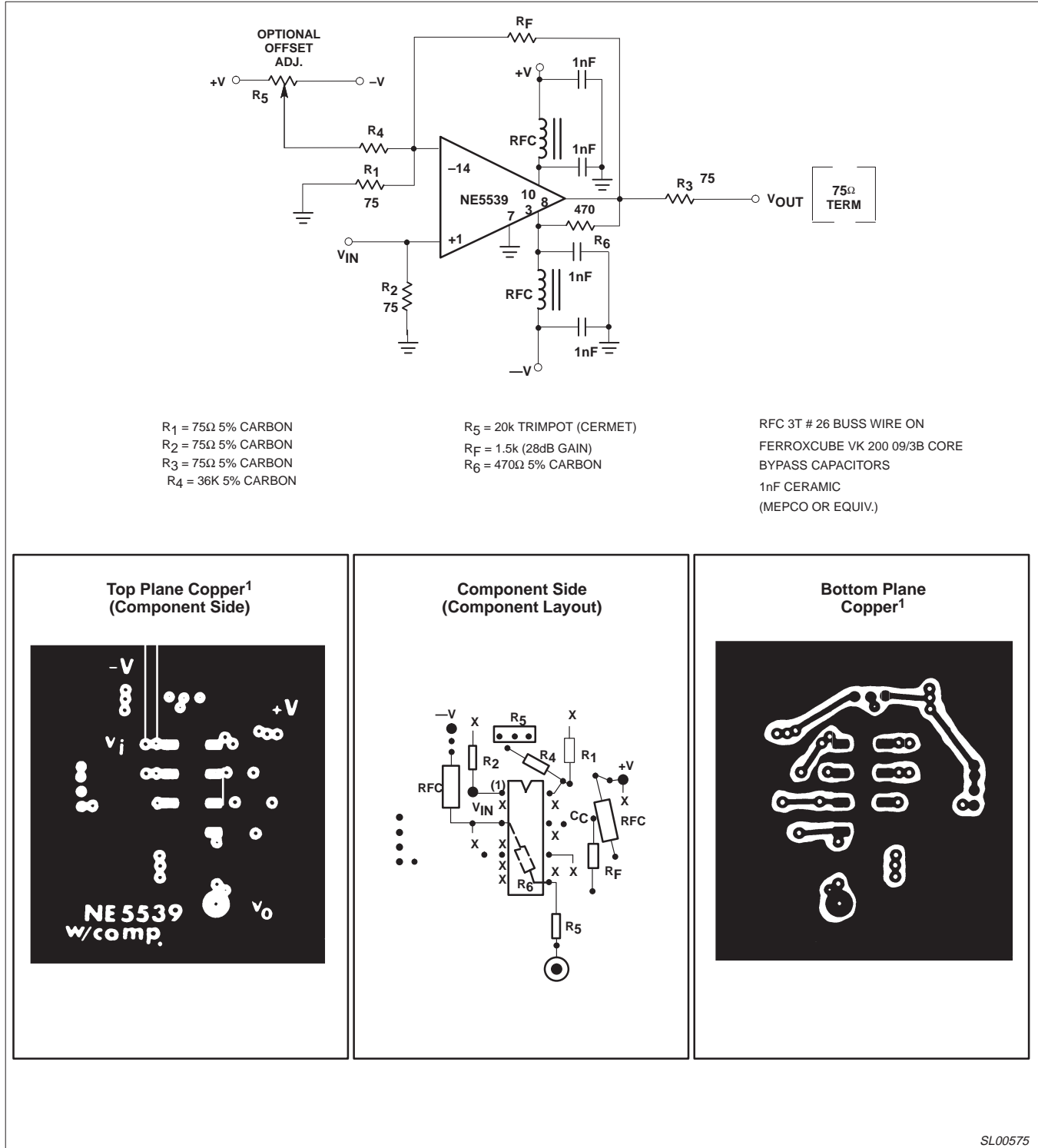


Figure 6. 28dB Non-Inverting Amp Sample PC Layout



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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°.

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.

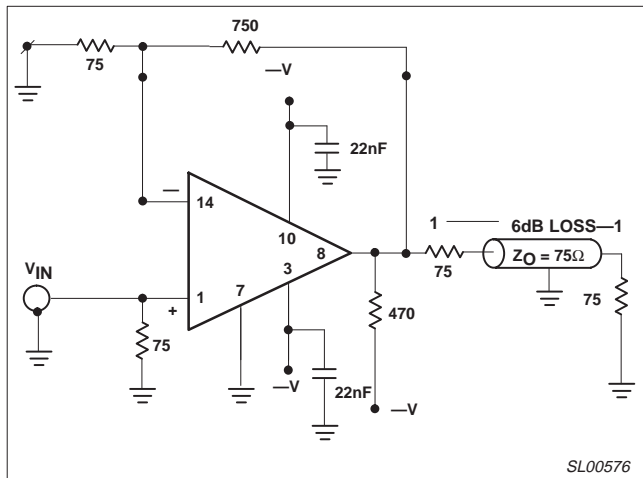


Figure 7. NE5539 Video Amplifier

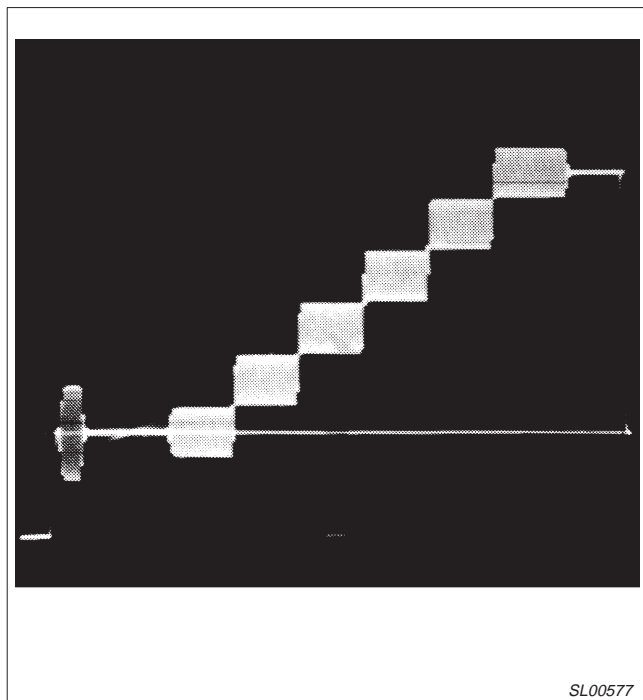


Figure 8. Input Signal

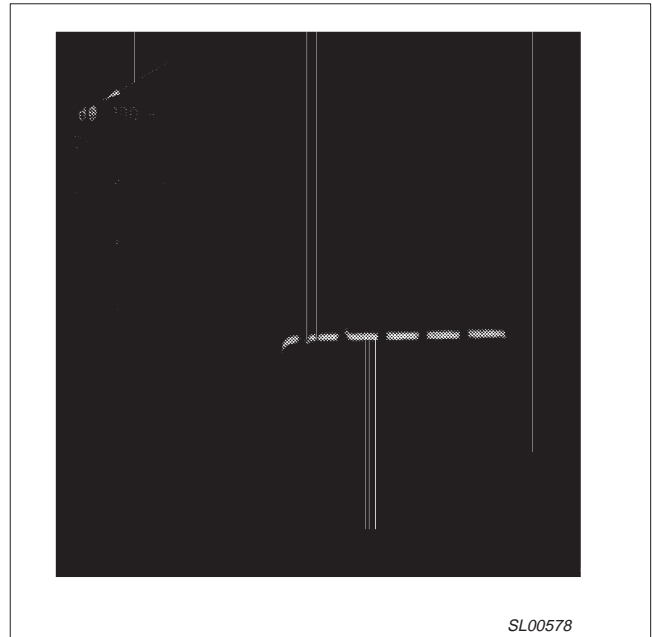


Figure 9. Differential Gain <0.5%

**NOTE:**

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

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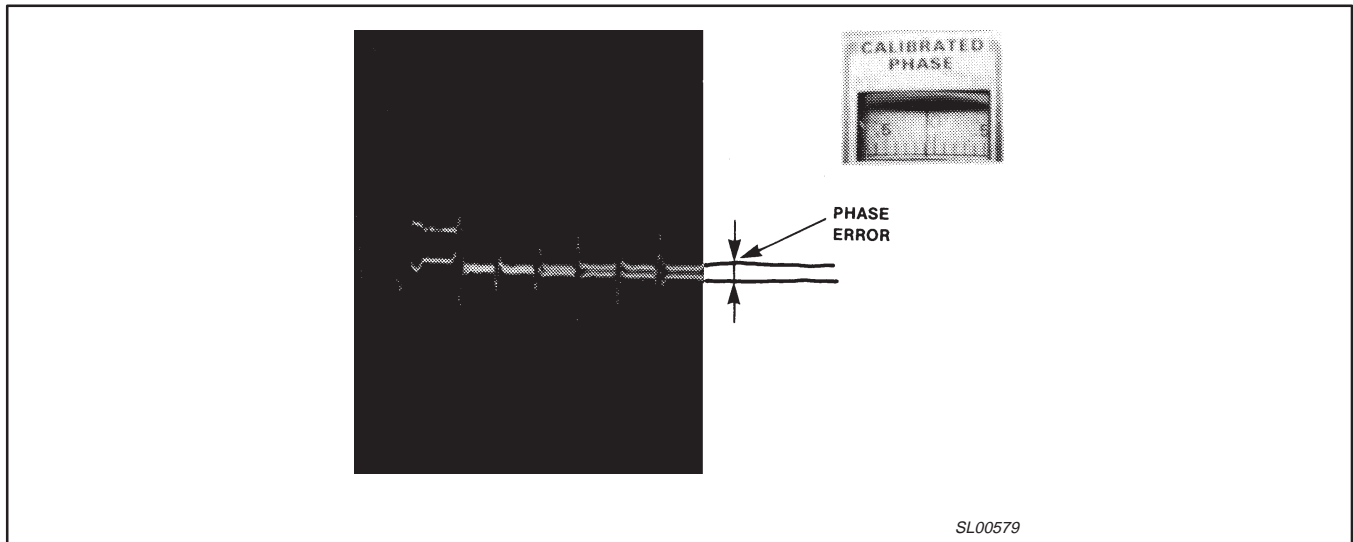


Figure 10. Differential Gain +0.1°

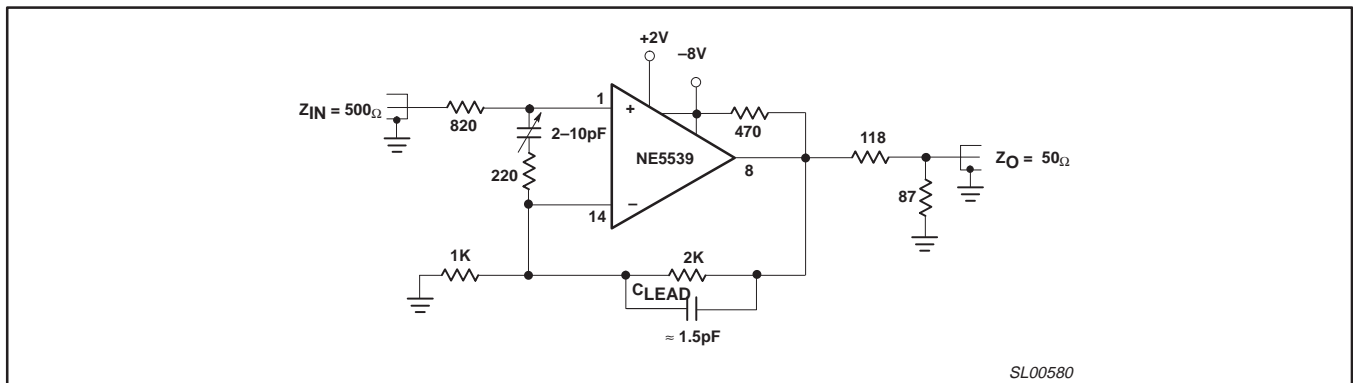


Figure 11. Non-Inverting Follower

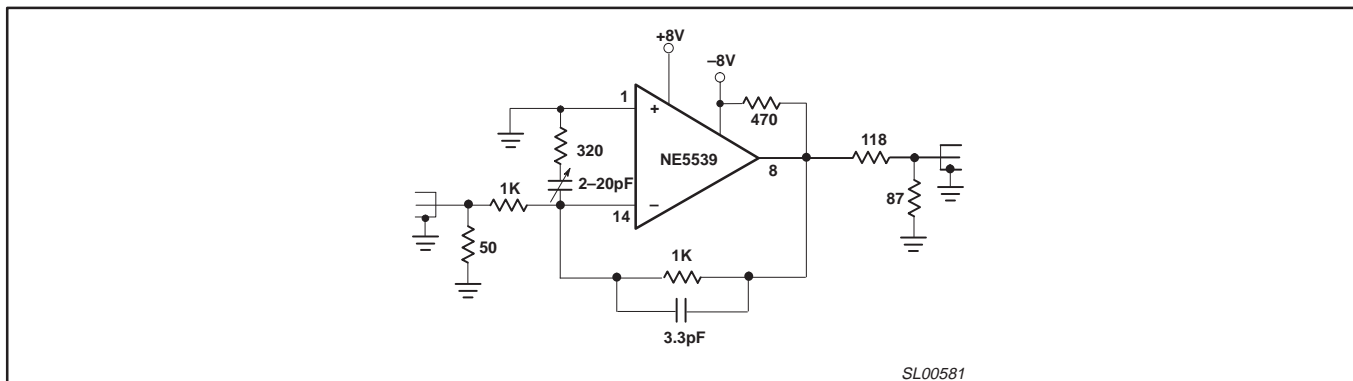


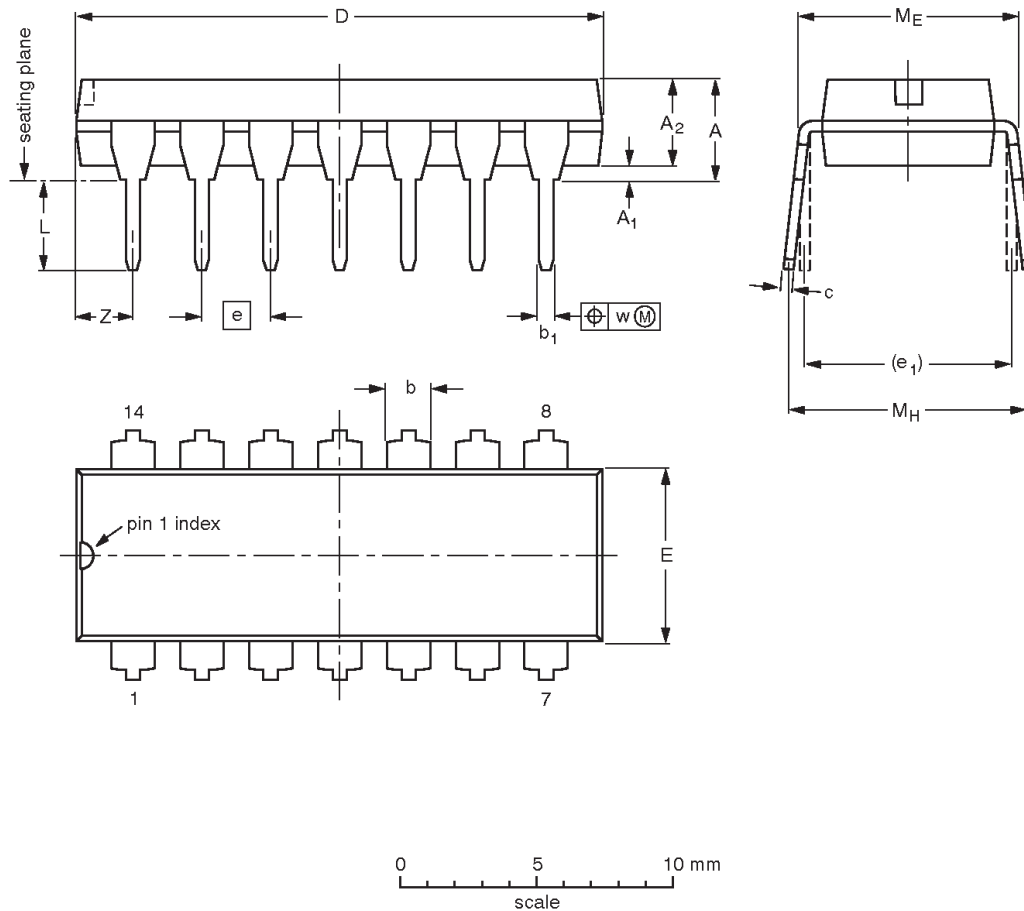
Figure 12. Inverting Follower

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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 <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	e <sub>1</sub>	L	M <sub>E</sub>	M <sub>H</sub>	w	Z <sup>(1)</sup> 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.

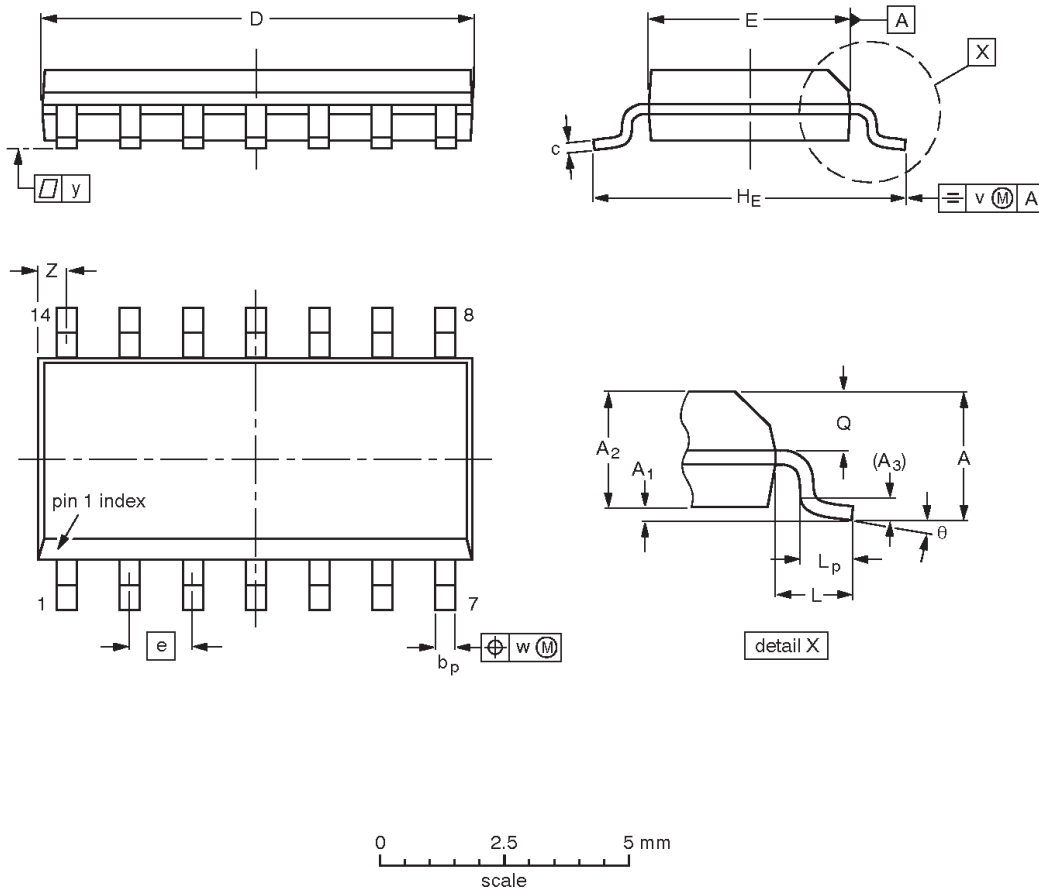
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT27-1	050G04	MO-001	SC-501-14			95-03-11 99-12-27

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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 <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	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 <sup>[1]</sup>	Product status <sup>[2]</sup>	Definitions
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