

# DATA SHEET

## **NE/SE5539**

High frequency operational amplifier

Product specification

April 15, 1992

IC11

**Philips Semiconductors**



**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: 600V/ $\mu$ s
- $A_{VOL}$ : 52dB typical
- Low noise - 4nV/ $\sqrt{\text{Hz}}$  typical
- MIL-STD processing available

### APPLICATIONS

- High speed datacom
- Video monitors & TV

### PIN CONFIGURATION

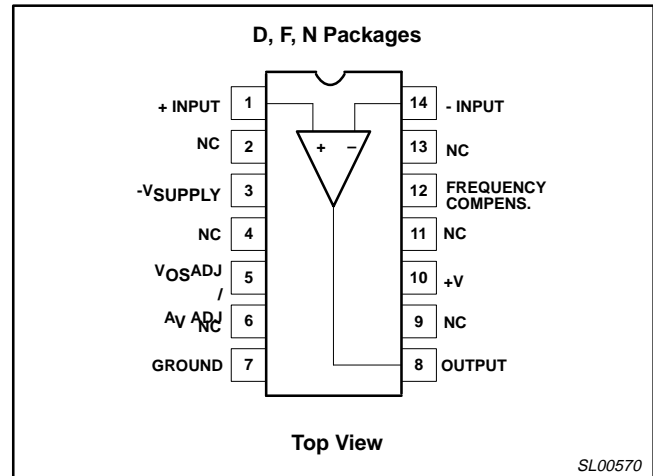


Figure 1. Pin Configuration

- 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	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<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

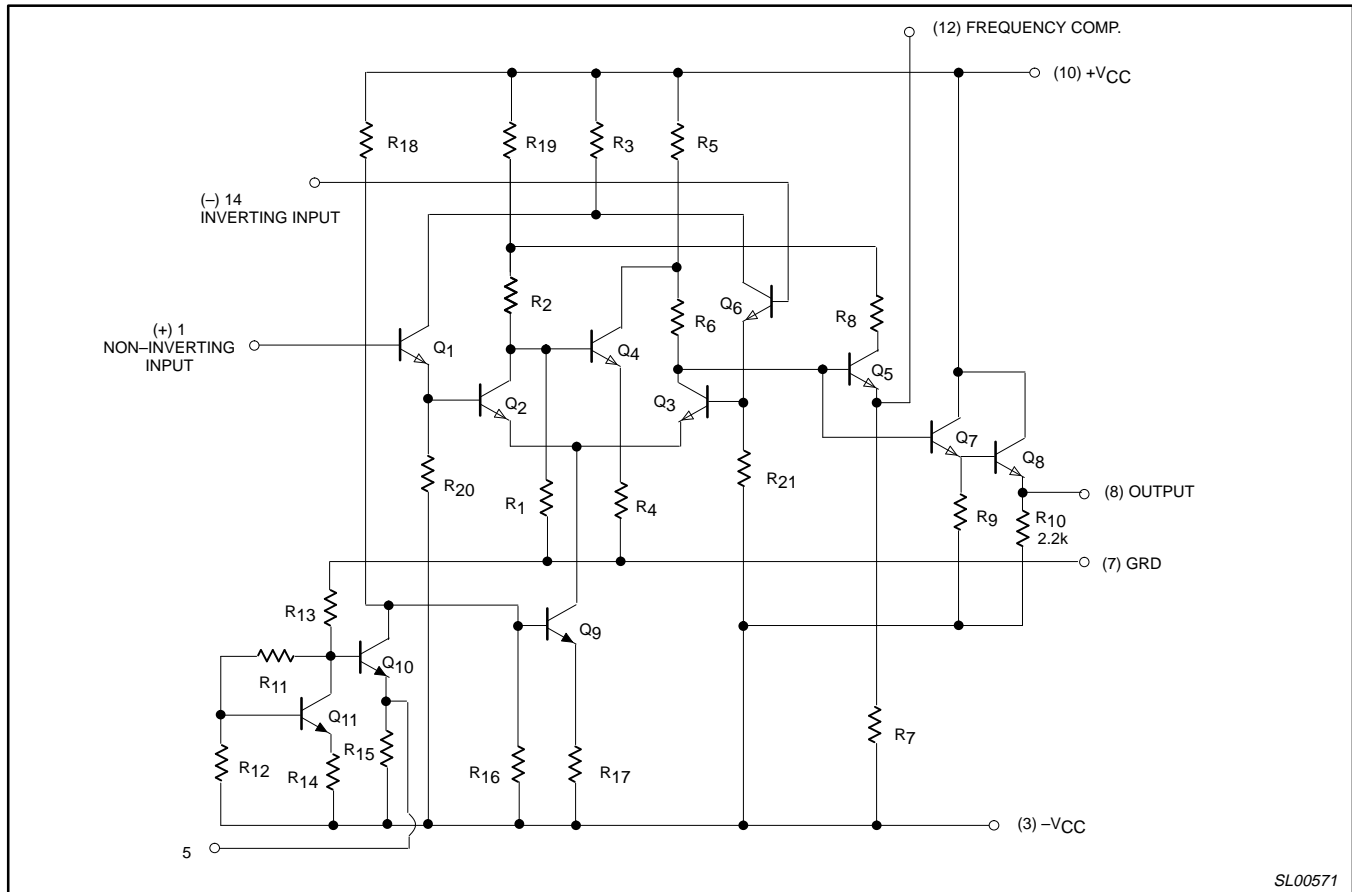


Figure 2. Equivalent Circuit

## 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	
	$\Delta V_{OS}/\Delta T$			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	
	$\Delta I_B/\Delta T$			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	
$A_{VOL}$	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 -Swing	+1.4 -1.1	+2.0 -1.7	V
			$T_A = 25^\circ C$	+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

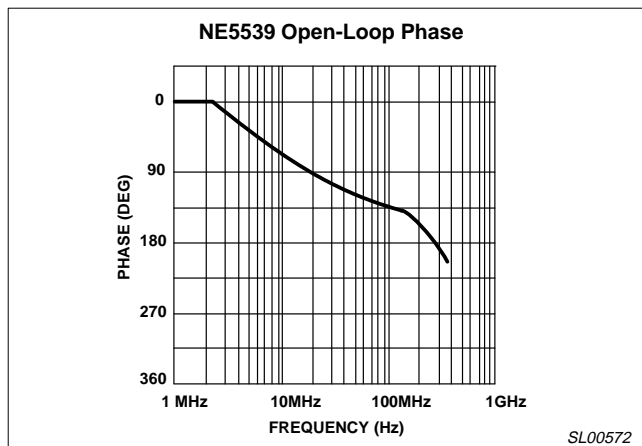


Figure 3. NE5539 Open-Loop Phase

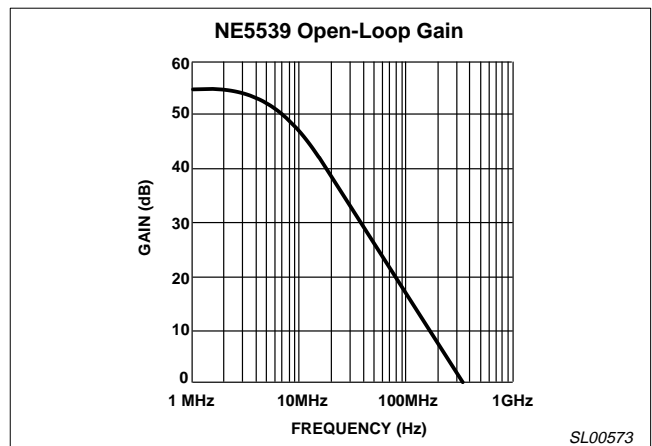
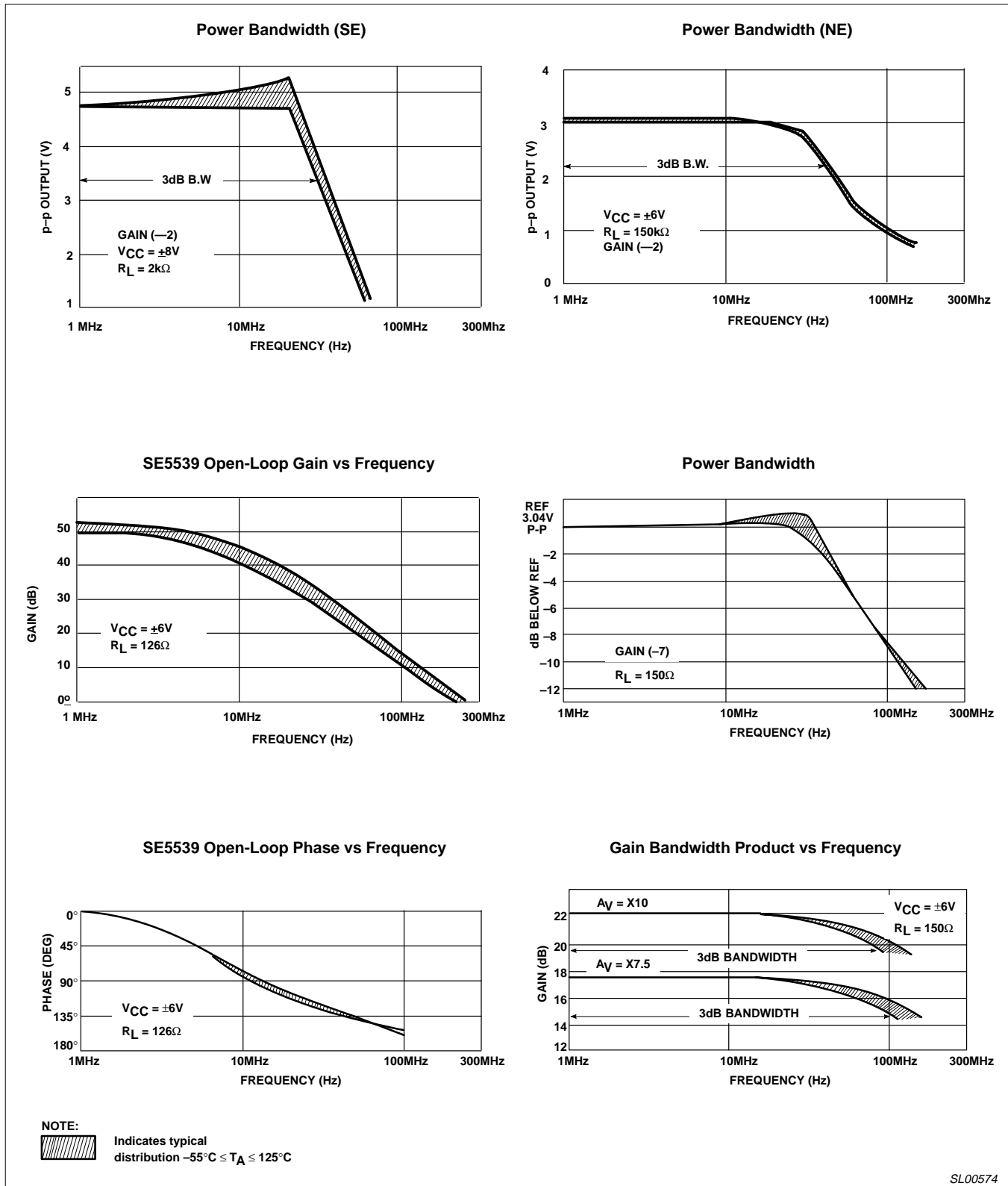


Figure 4. NE5539 Open-Loop Gain

# High frequency operational amplifier

NE/SE5539

## TYPICAL PERFORMANCE CURVES (Continued)



SL00574

Figure 5. Typical Performance Curves

# High frequency operational amplifier

# 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 6.

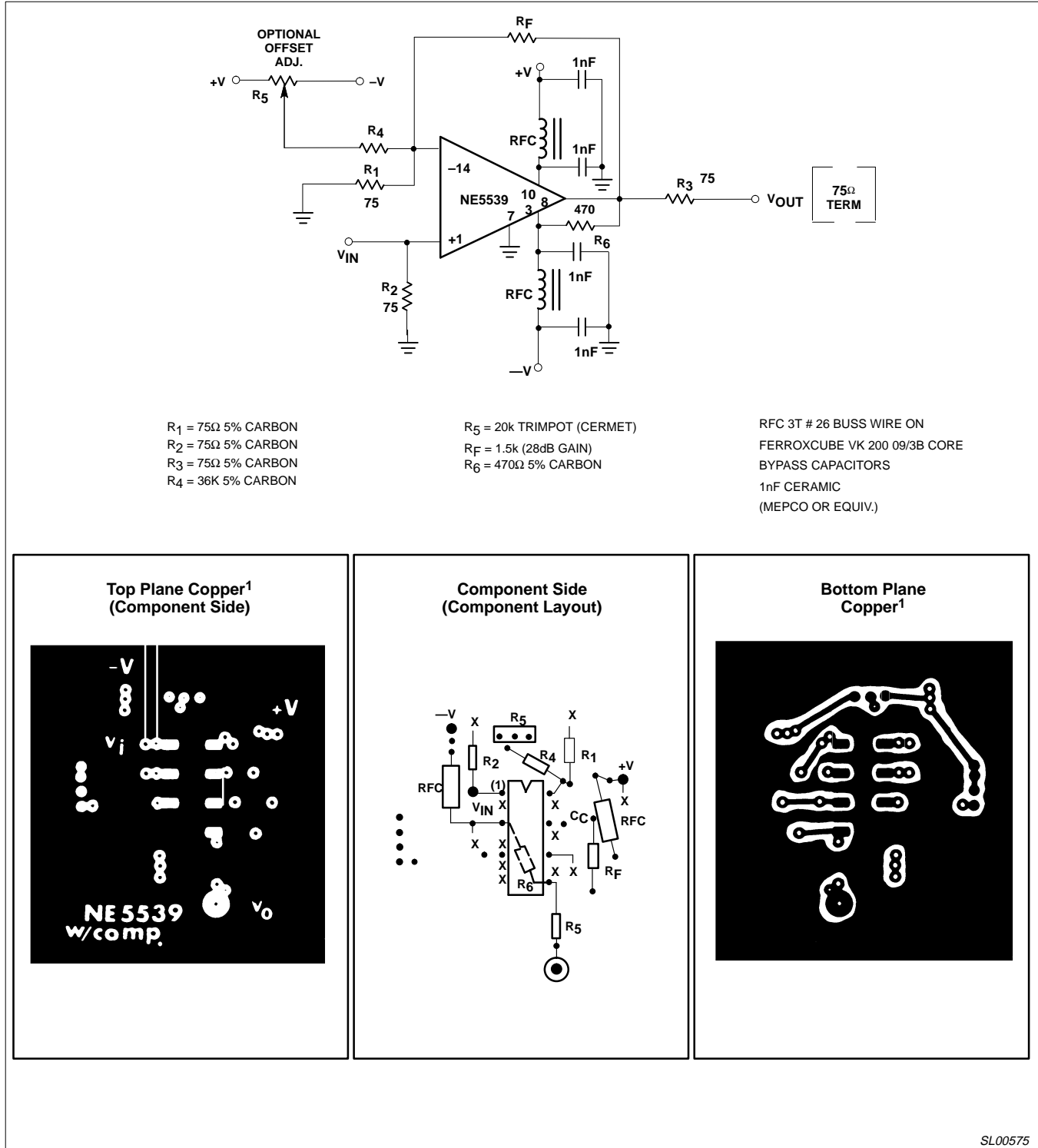


Figure 6. 28dB Non-Inverting Amp Sample PC Layout

SL00575

# High frequency operational amplifier

# 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 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 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 ±8V.

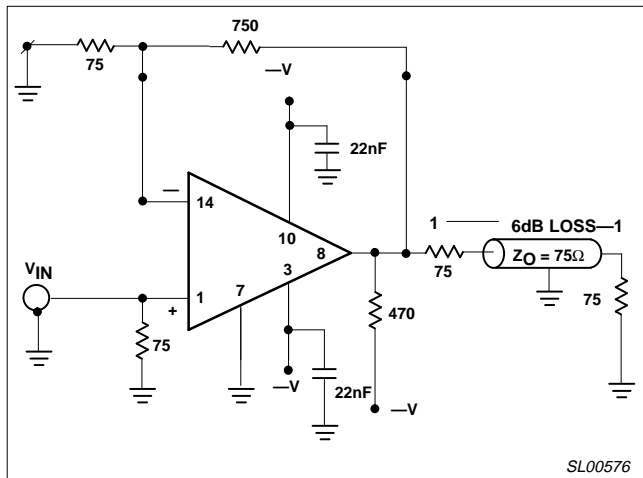


Figure 7. NE5539 Video Amplifier



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.

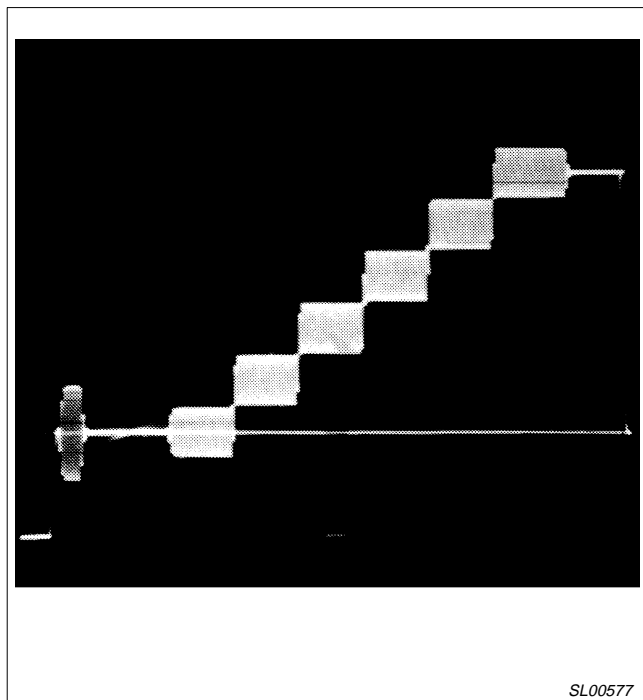


Figure 8. Input Signal



# High frequency operational amplifier

# NE/SE5539

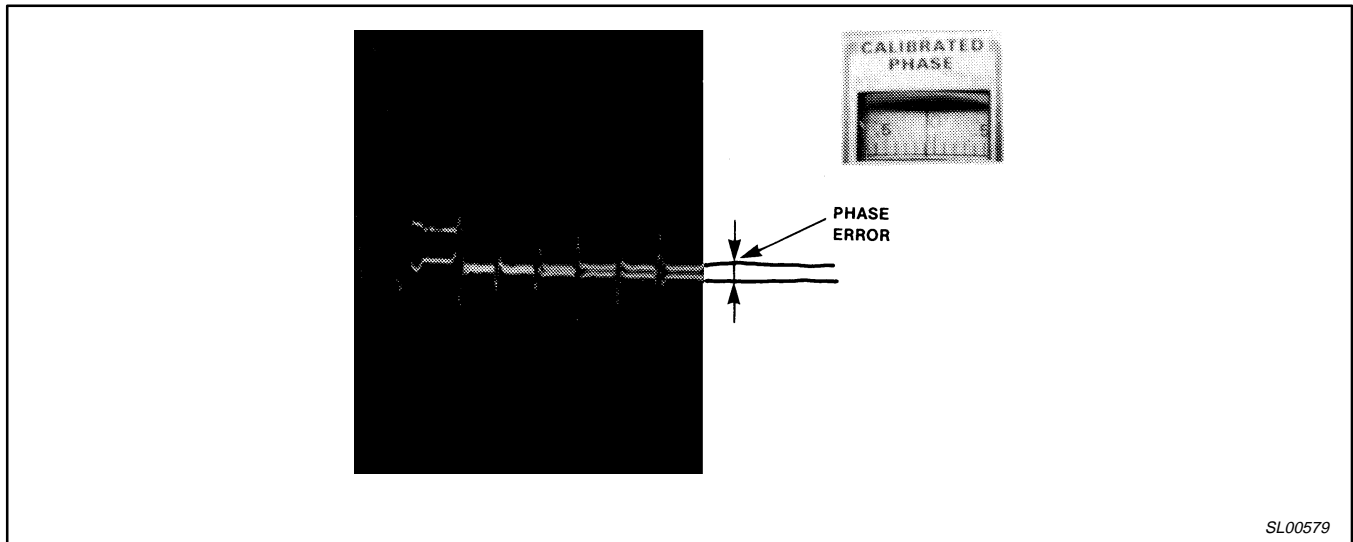


Figure 10. Differential Gain +0.1°

SL00579

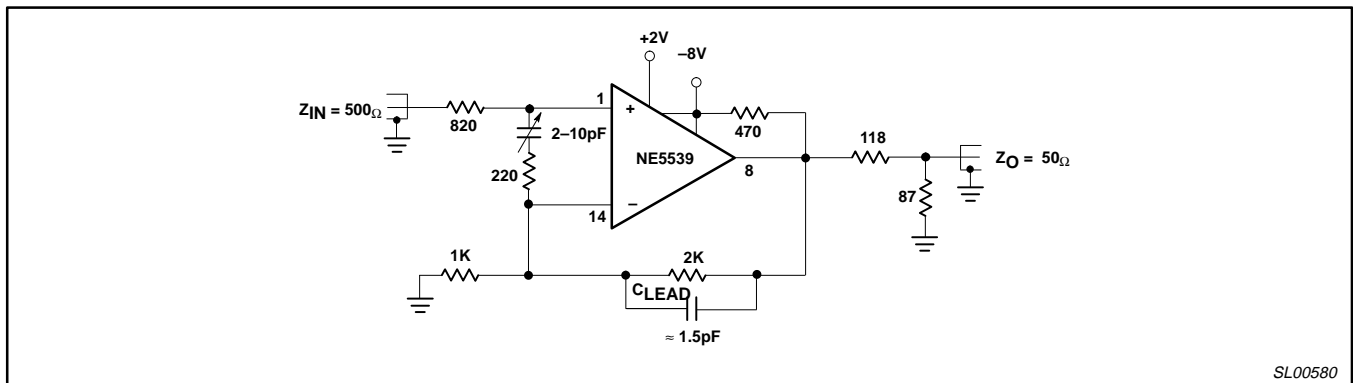


Figure 11. Non-Inverting Follower

SL00580

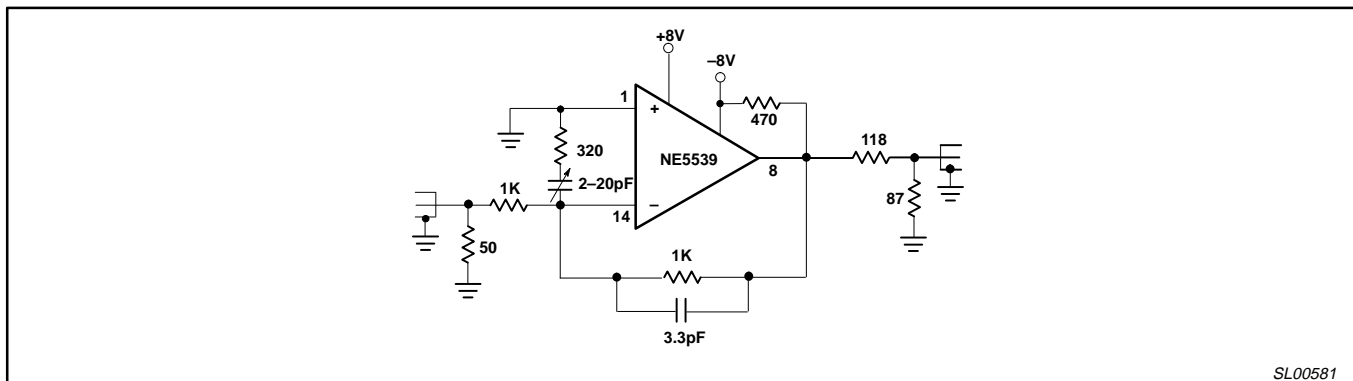


Figure 12. Inverting Follower

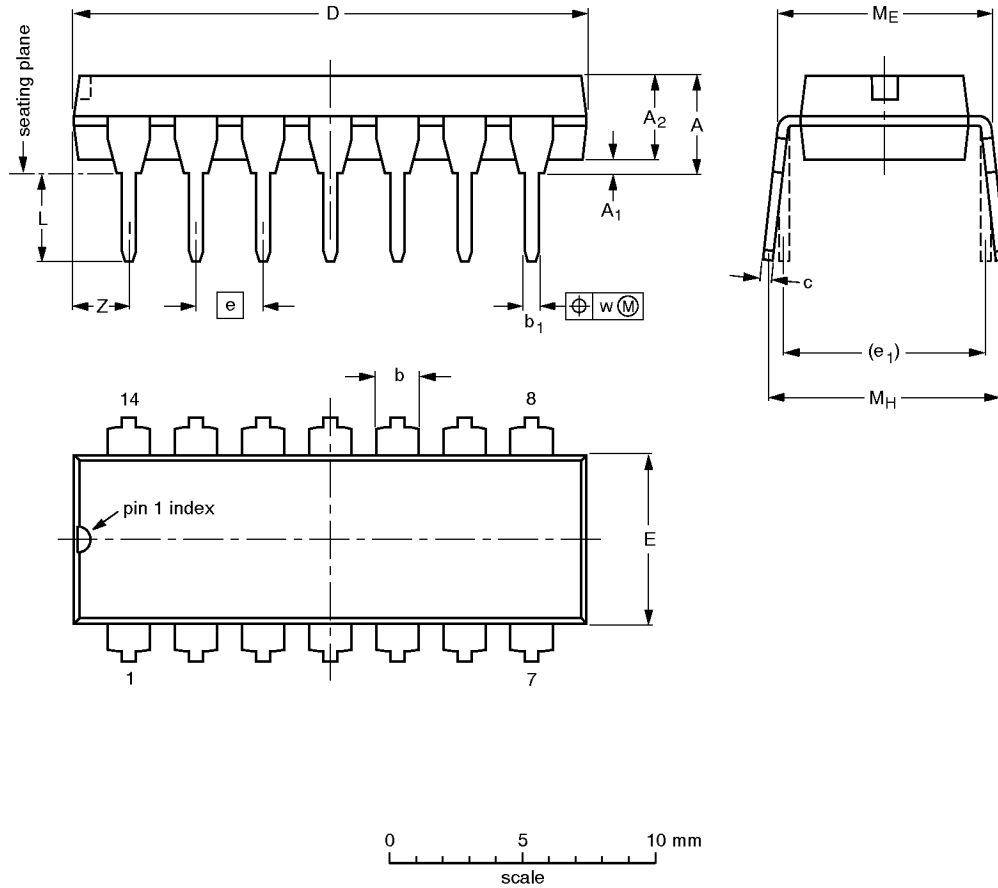
SL00581

# High frequency operational amplifier

## NE/SE5539

**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.

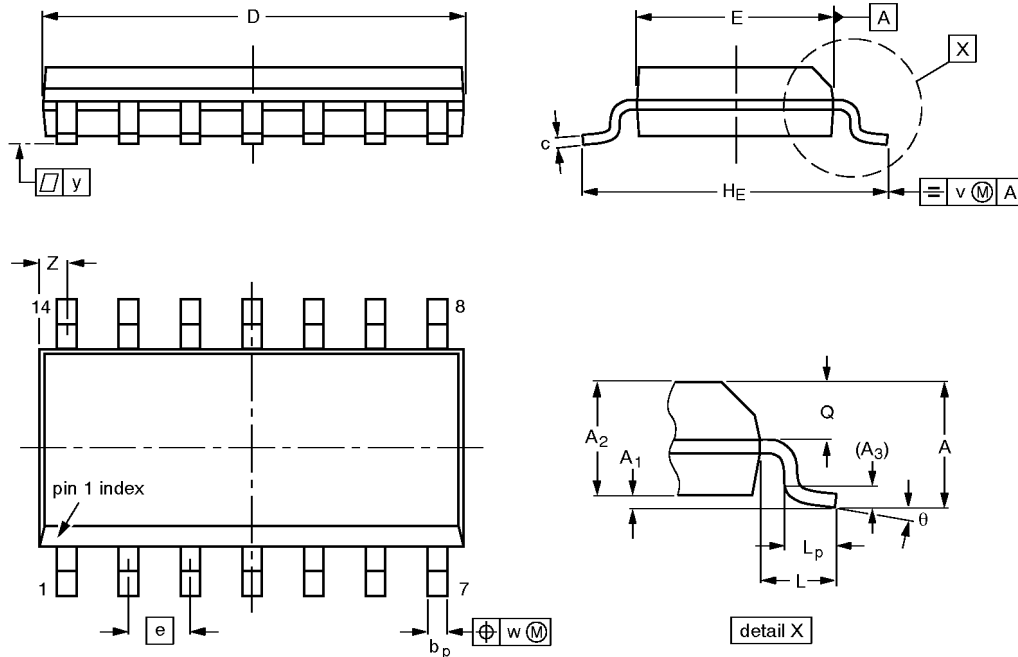
OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ		
SOT27-1	050G04	MO-001AA			92-11-17 95-03-11

# High frequency operational amplifier

# NE/SE5539

**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	0.0098 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

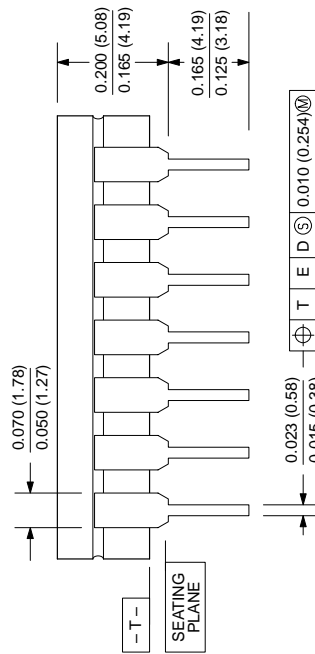
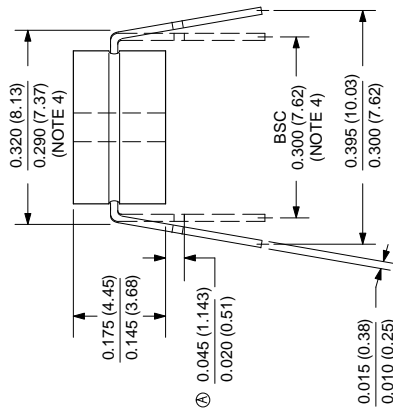
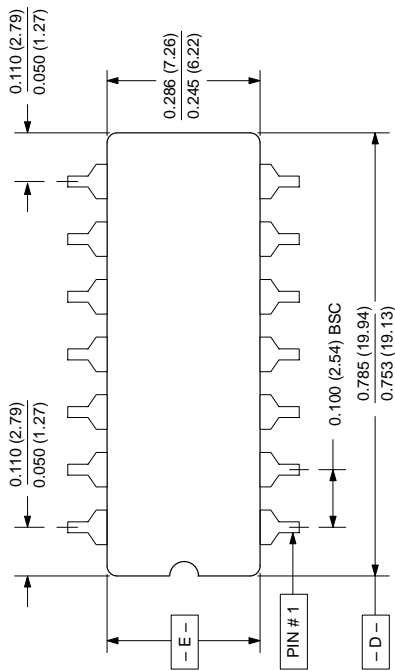
# High frequency operational amplifier

# NE/SE5539

## 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.



# High frequency operational amplifier

NE/SE5539

## DEFINITIONS

Data Sheet Identification	Product Status	Definition
<i>Objective Specification</i>	<b>Formative or in Design</b>	This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.
<i>Preliminary Specification</i>	<b>Preproduction Product</b>	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.
<i>Product Specification</i>	<b>Full Production</b>	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.

Philips Semiconductors and Philips Electronics North America Corporation reserve the right to make changes, without notice, in the products, including circuits, standard cells, and/or software, described or contained herein in order to improve design and/or performance. Philips Semiconductors assumes no responsibility or liability for the use of any of these products, conveys no license or title under any patent, copyright, or mask work right to these products, and makes no representations or warranties that these products are free from patent, copyright, or mask work right infringement, unless otherwise specified. Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

### LIFE SUPPORT APPLICATIONS

Philips Semiconductors and Philips Electronics North America Corporation Products are not designed for use in life support appliances, devices, or systems where malfunction of a Philips Semiconductors and Philips Electronics North America Corporation Product can reasonably be expected to result in a personal injury. Philips Semiconductors and Philips Electronics North America Corporation customers using or selling Philips Semiconductors and Philips Electronics North America Corporation Products for use in such applications do so at their own risk and agree to fully indemnify Philips Semiconductors and Philips Electronics North America Corporation for any damages resulting from such improper use or sale.

**Philips Semiconductors**  
**811 East Arques Avenue**  
**P.O. Box 3409**  
**Sunnyvale, California 94088-3409**  
**Telephone 800-234-7381**

Philips Semiconductors and Philips Electronics North America Corporation register eligible circuits under the Semiconductor Chip Protection Act.  
 © Copyright Philips Electronics North America Corporation 1992  
 All rights reserved. Printed in U.S.A.