

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/ μ 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

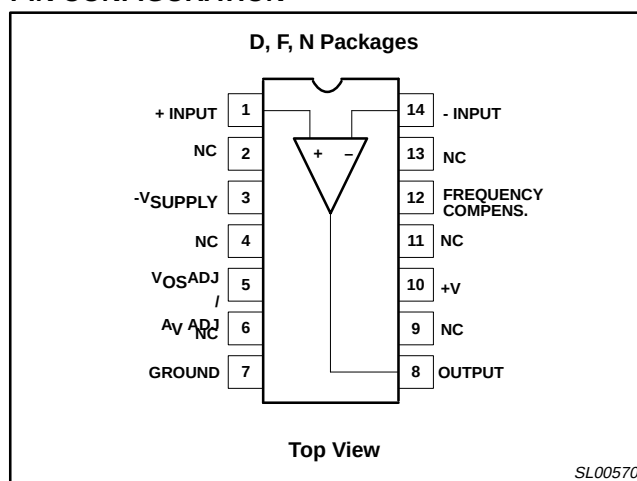


Figure 1. Pin Configuration

- 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 RATINGS¹

SYMBOL	PARAMETER	RATING	UNITS
V_{CC}	Supply voltage	± 12	V
P_{DMAX}	Maximum power dissipation, $T_A = 25^\circ\text{C}$ (still-air) ²		
	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:

- 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.
- 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

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EQUIVALENT CIRCUIT

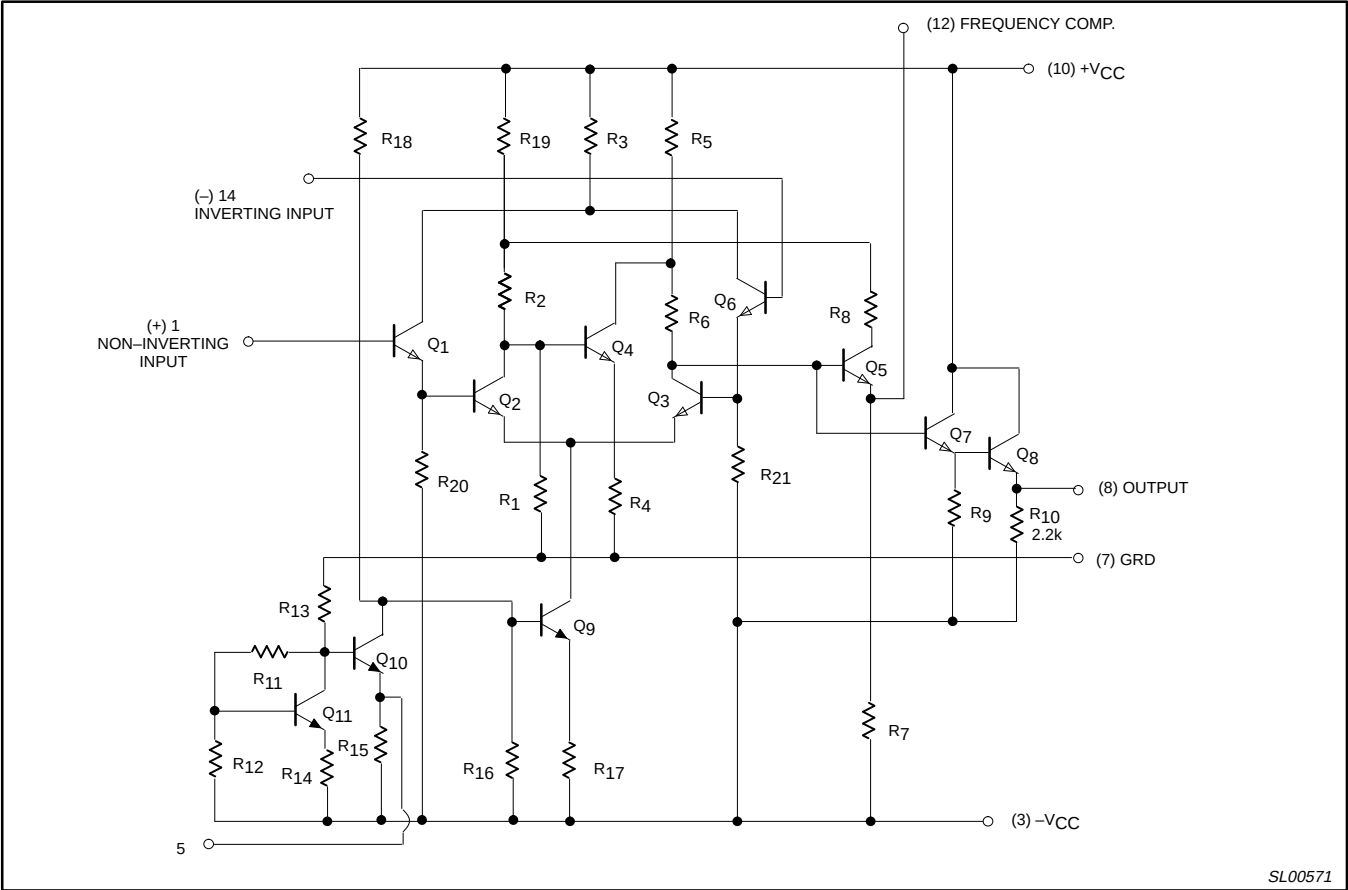


Figure 2. Equivalent Circuit

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	5	
	$\Delta V_{OS}/\Delta T$			5			5		$\mu V/^{\circ}C$
I_{OS}	Input offset current		Over temp	0.1	3				μA
			$T_A = 25^{\circ}C$	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				μA
			$T_A = 25^{\circ}C$	5	13		5	20	
	$\Delta I_B/\Delta T$			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		Ω

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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 470Ω 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, 470Ω 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	57	
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°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		

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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

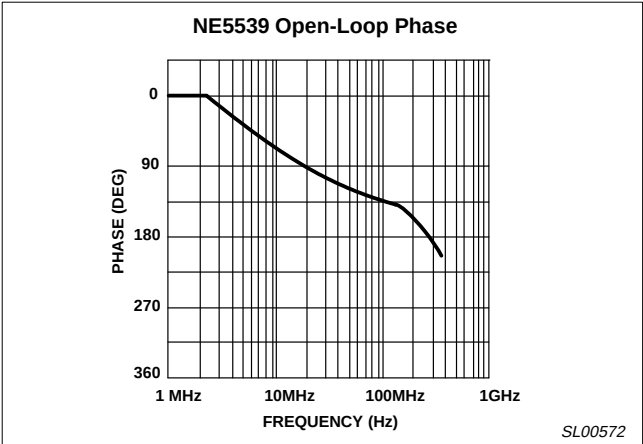


Figure 3. NE5539 Open-Loop Phase

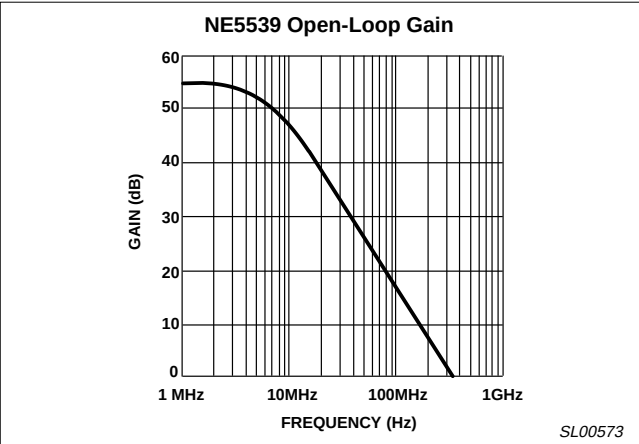


Figure 4. NE5539 Open-Loop Gain

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TYPICAL PERFORMANCE CURVES (Continued)

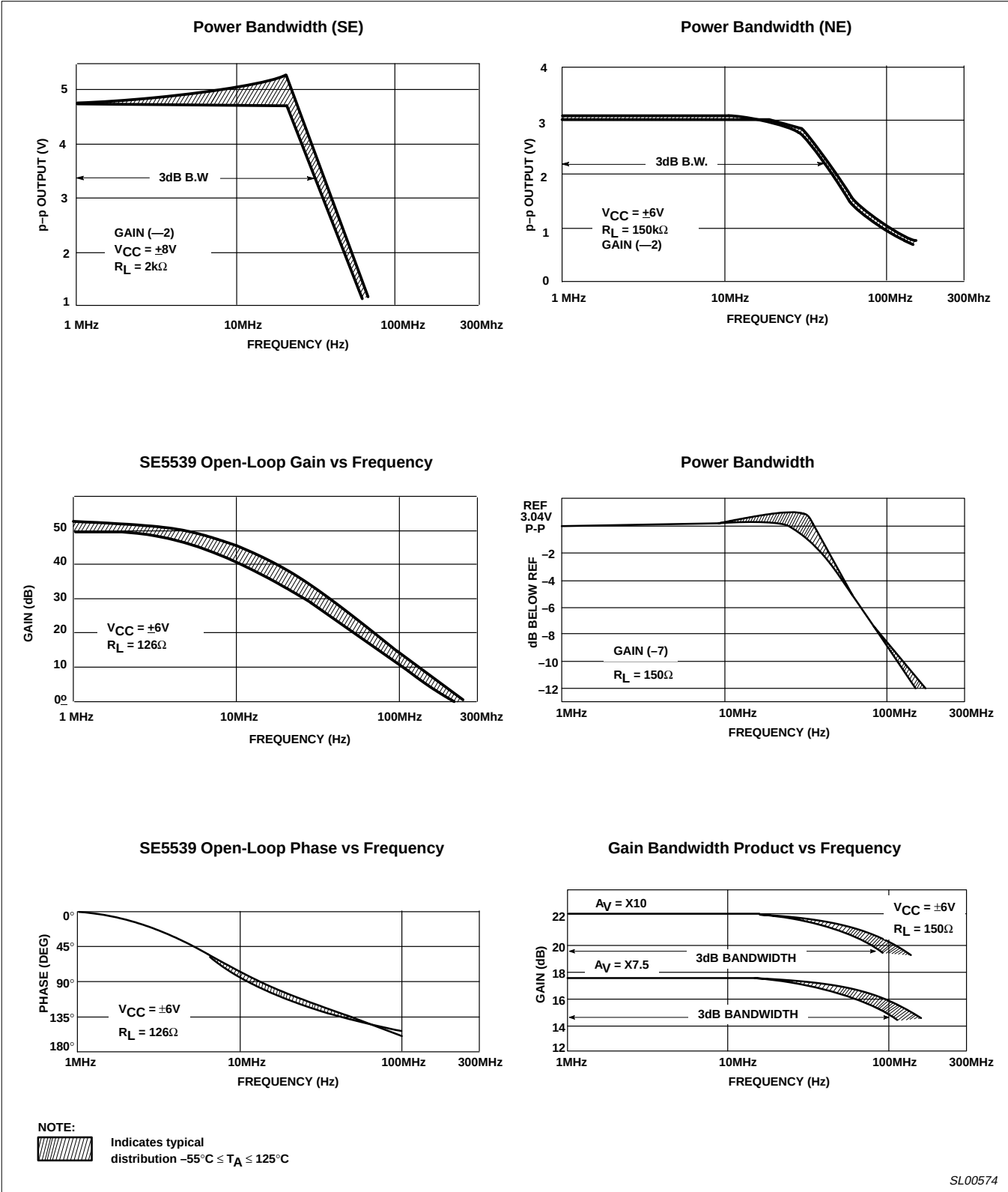


Figure 5. Typical Performance Curves

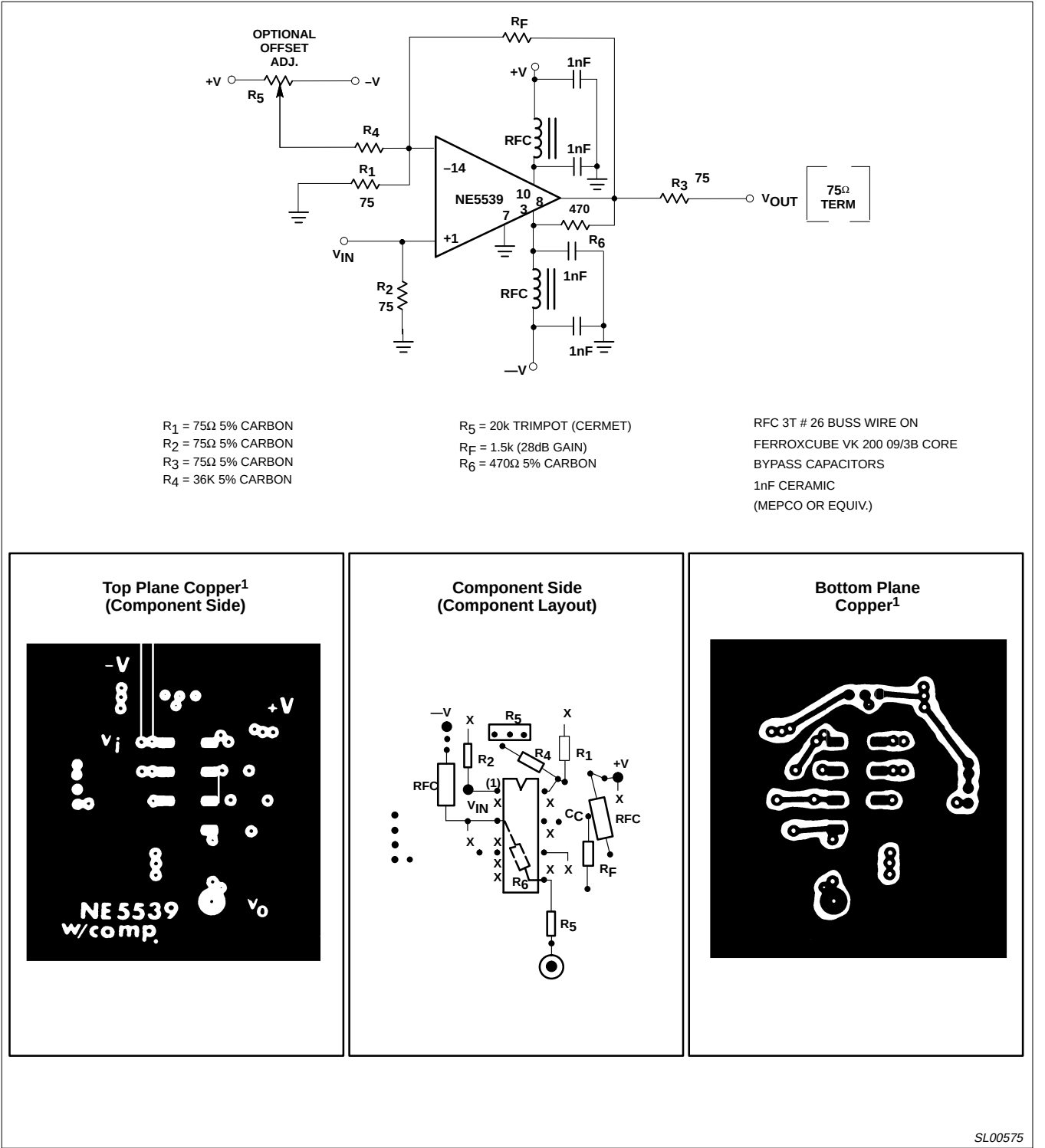
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CIRCUIT LAYOUT CONSIDERATIONS

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



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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-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 termination impedance with a gain of approximately 10 (20dB).

NOTE:

- 1. The input signal was 200mV and the output 2V. V_{CC} was ±8V.

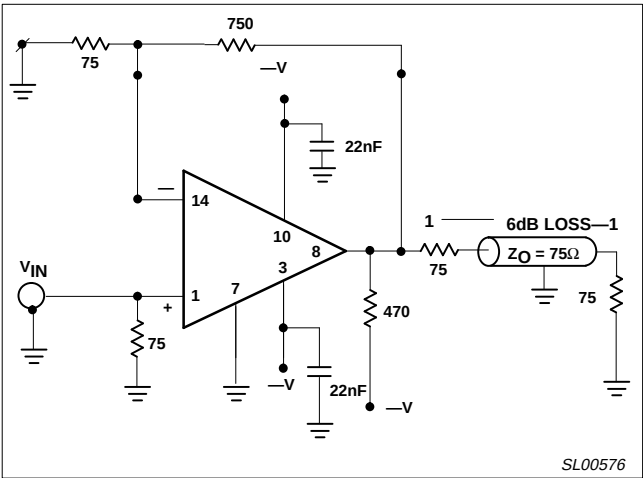


Figure 7. NE5539 Video Amplifier

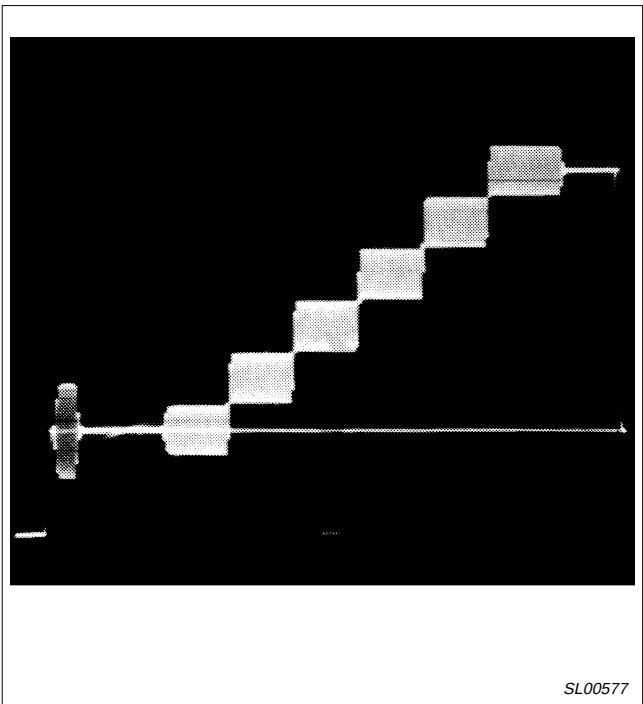


Figure 8. Input Signal



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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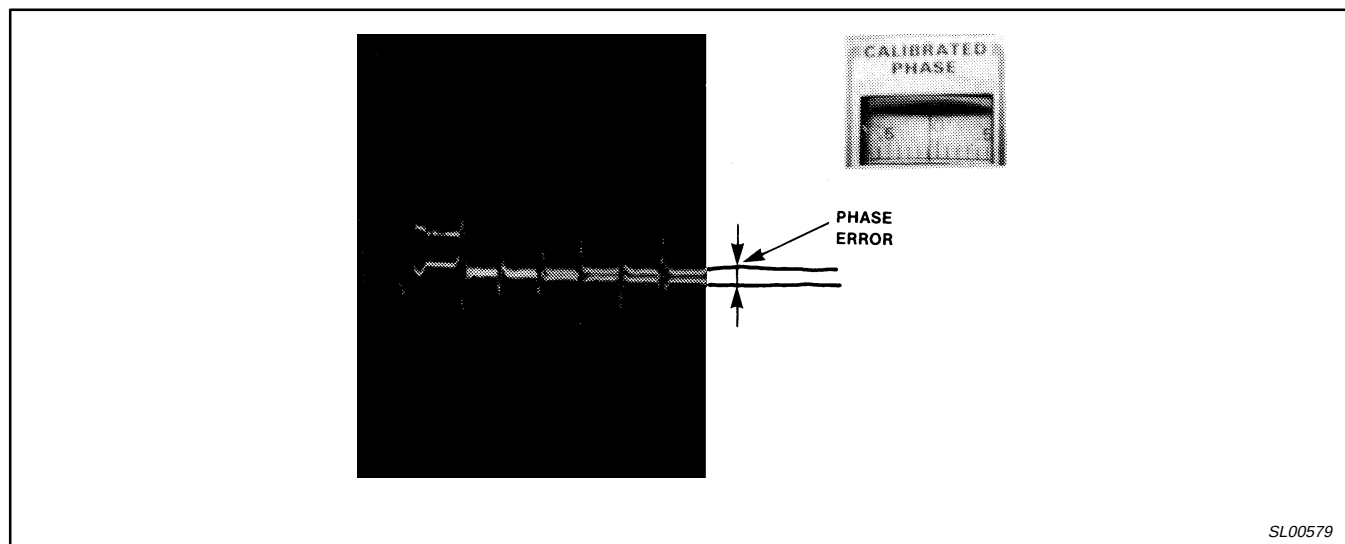


Figure 10. Differential Gain +0.1°

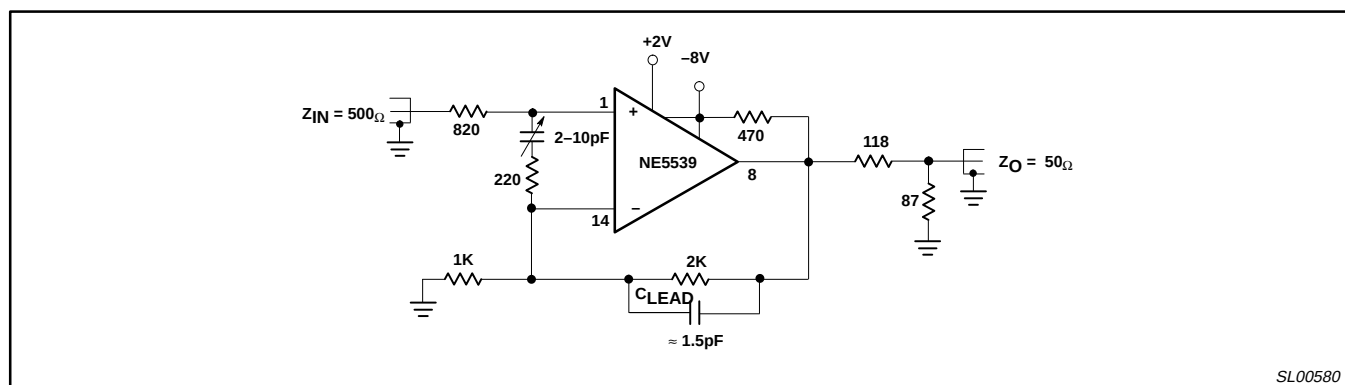


Figure 11. Non-Inverting Follower

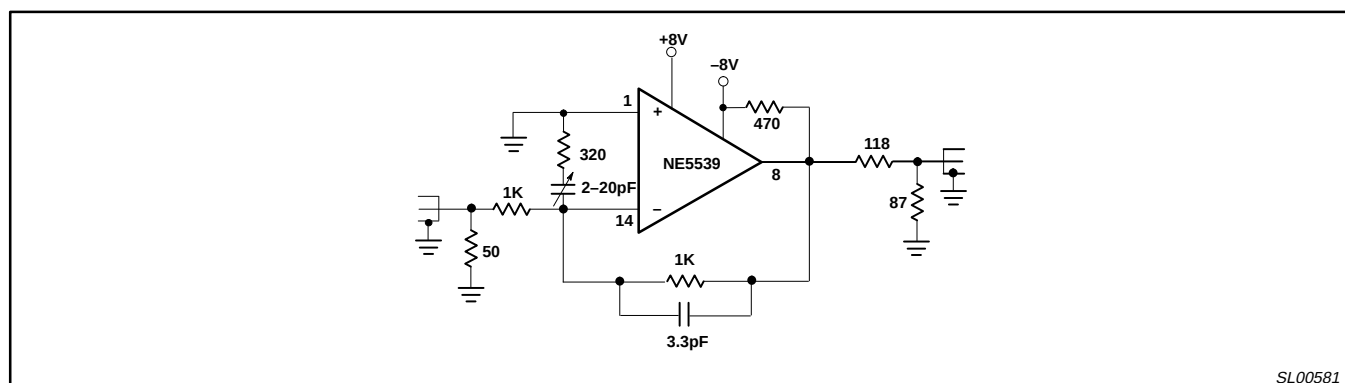


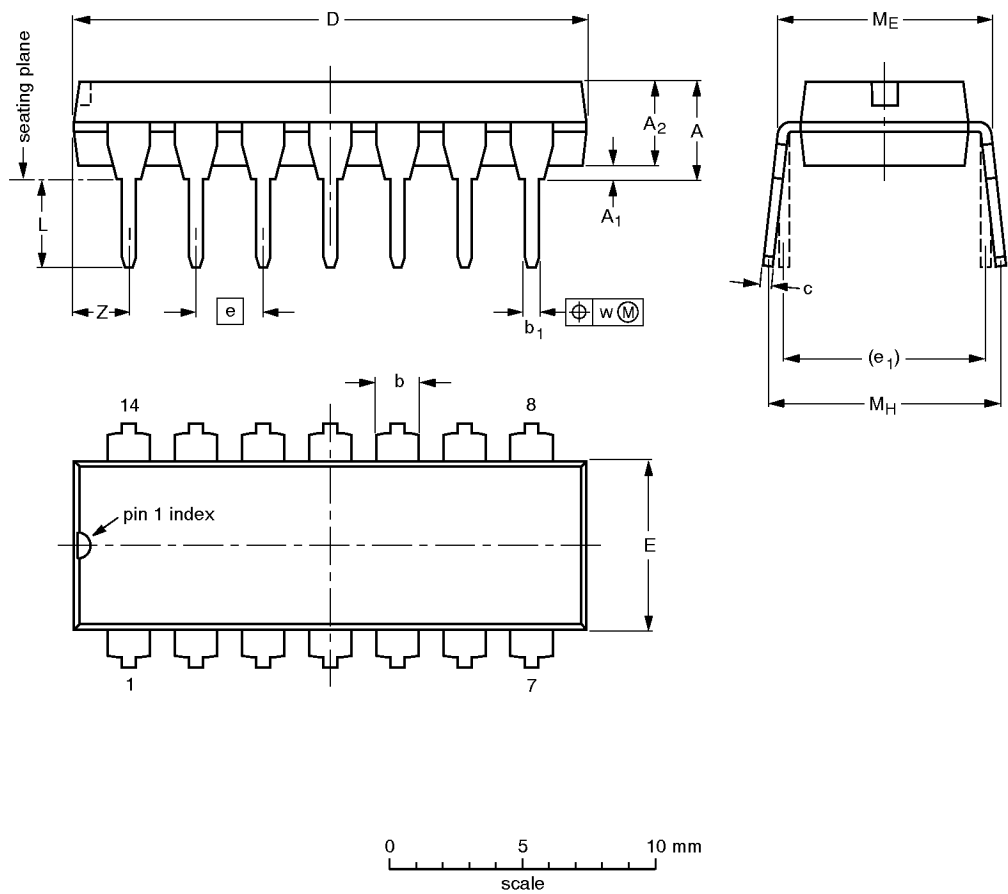
Figure 12. Inverting Follower

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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 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.

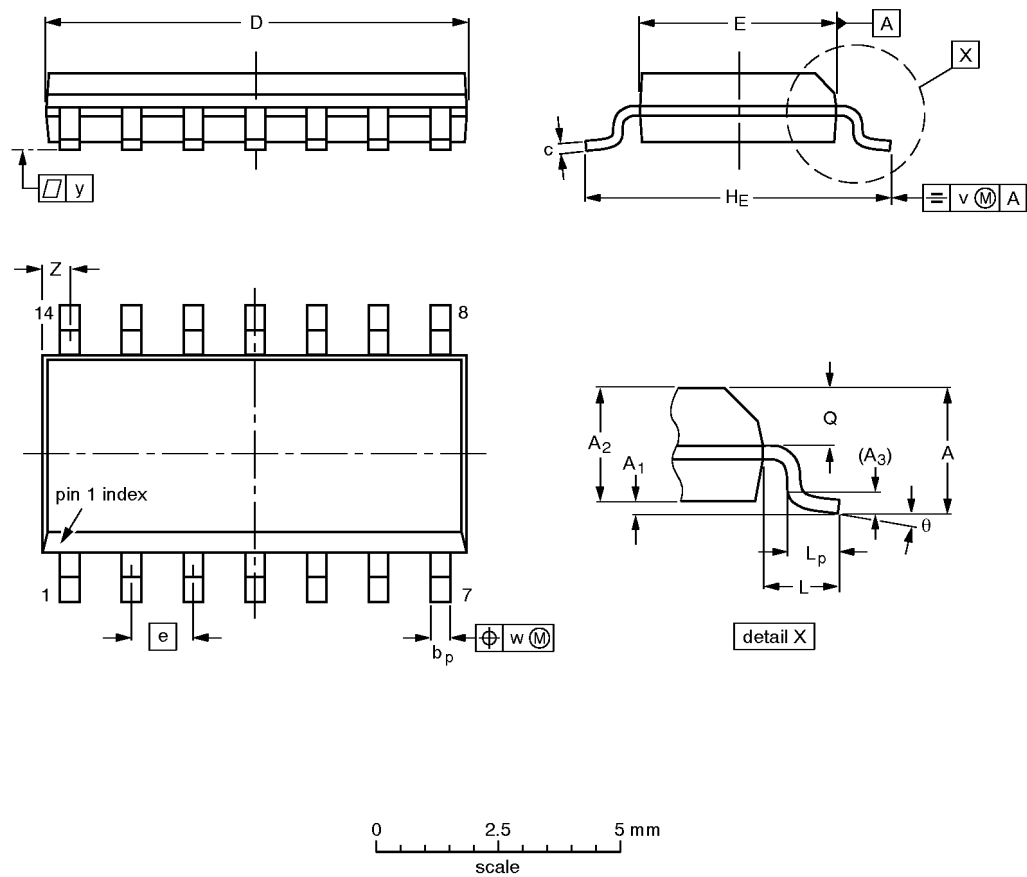
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT27-1	050G04	MO-001AA				92-11-17 95-03-11

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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	0.0098 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.

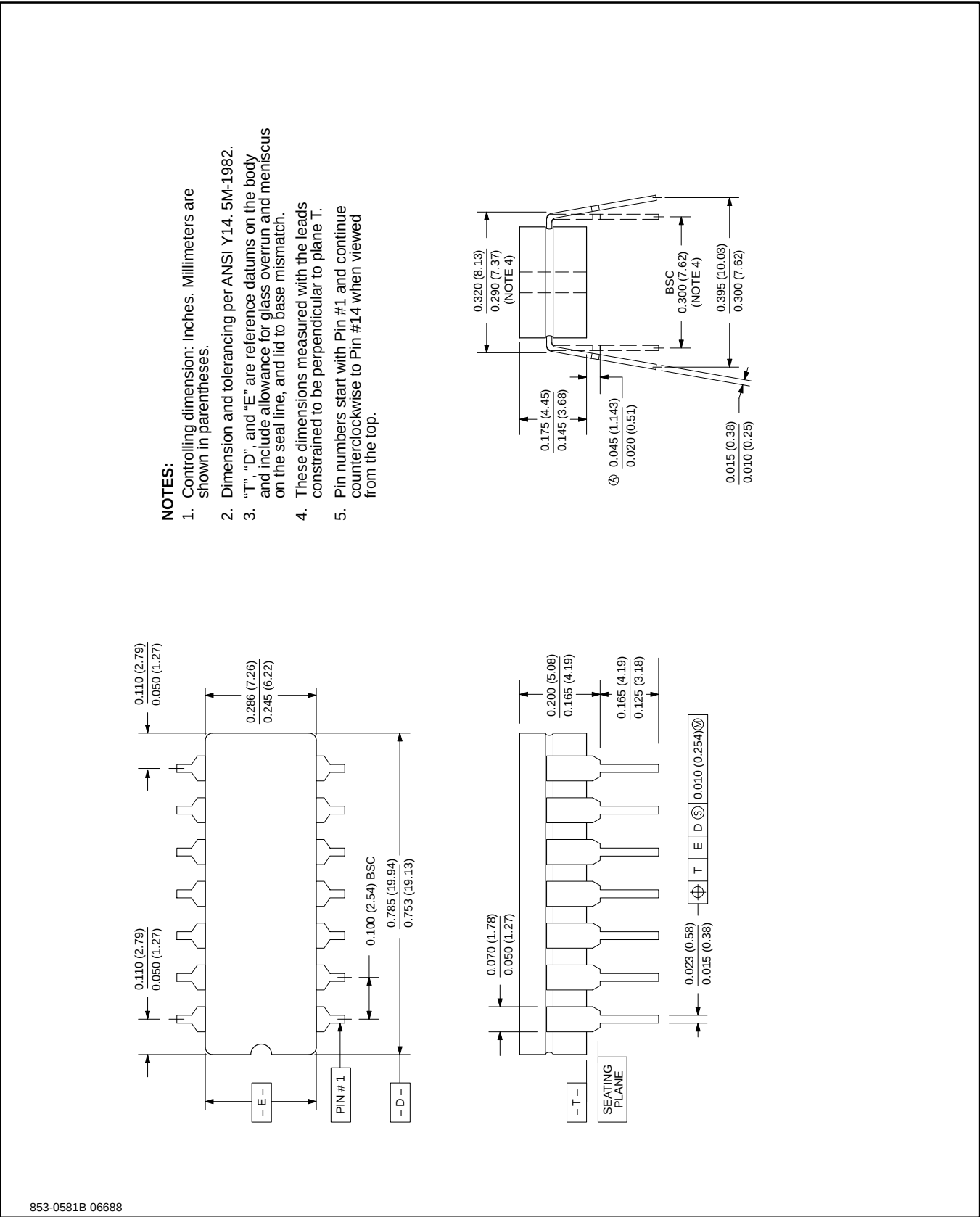
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	IEC	JEDEC	EIAJ			
SOT108-1	076E06S	MS-012AB				91-08-13 95-01-23

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0581B

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



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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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