

# 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.

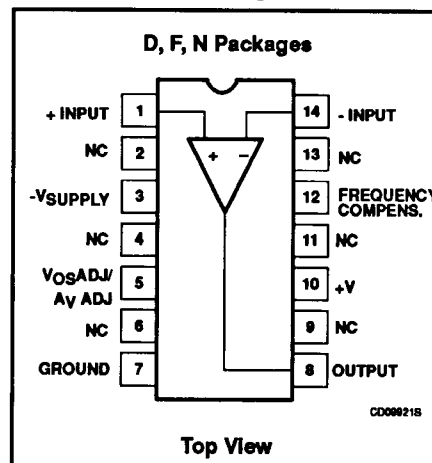
## FEATURES

- 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 datcom
- Video monitors & TV
- Satellite communications
- Image processing
- RF instrumentation & oscillators
- Magnetic storage
- Military communications

## PIN CONFIGURATION



## ORDERING INFORMATION

| DESCRIPTION        | TEMPERATURE RANGE | ORDER CODE | DWG # |
|--------------------|-------------------|------------|-------|
| 14-Pin Plastic DIP | 0 to +70°C        | NE5539N    | 0405  |
| 14-Pin Plastic SO  | 0 to +70°C        | NE5539D    | 0175  |
| 14-Pin Cerdip      | 0 to +70°C        | NE5539F    | 0581  |
| 14-Pin Cerdip      | -55 to +125°C     | SE5539F    | 0581  |

## ABSOLUTE MAXIMUM RATINGS<sup>1</sup>

| SYMBOL     | PARAMETER  | RATING                 | UNITS                                |
|------------|--|------------------------|--------------------------------------|
| $V_{CC}$   | Supply voltage   | $\pm 12$               | V                                    |
| $P_{DMAX}$ | Maximum power dissipation,<br>$T_A = 25^\circ\text{C}$ (still-air) <sup>2</sup><br>F package<br>N package<br>D package | 1.17<br>1.45<br>0.99   | W<br>W<br>W                          |
| $T_A$      | Operating temperature range<br>NE<br>SE  | 0 to 70<br>-55 to +125 | $^\circ\text{C}$<br>$^\circ\text{C}$ |
| $T_{STG}$  | Storage temperature range  | -65 to +150            | $^\circ\text{C}$                     |
| $T_J$      | Max junction temperature   | 150                    | $^\circ\text{C}$                     |
| $T_{SOLD}$ | Lead soldering temperature (10sec max)   | +300                   | $^\circ\text{C}$                     |

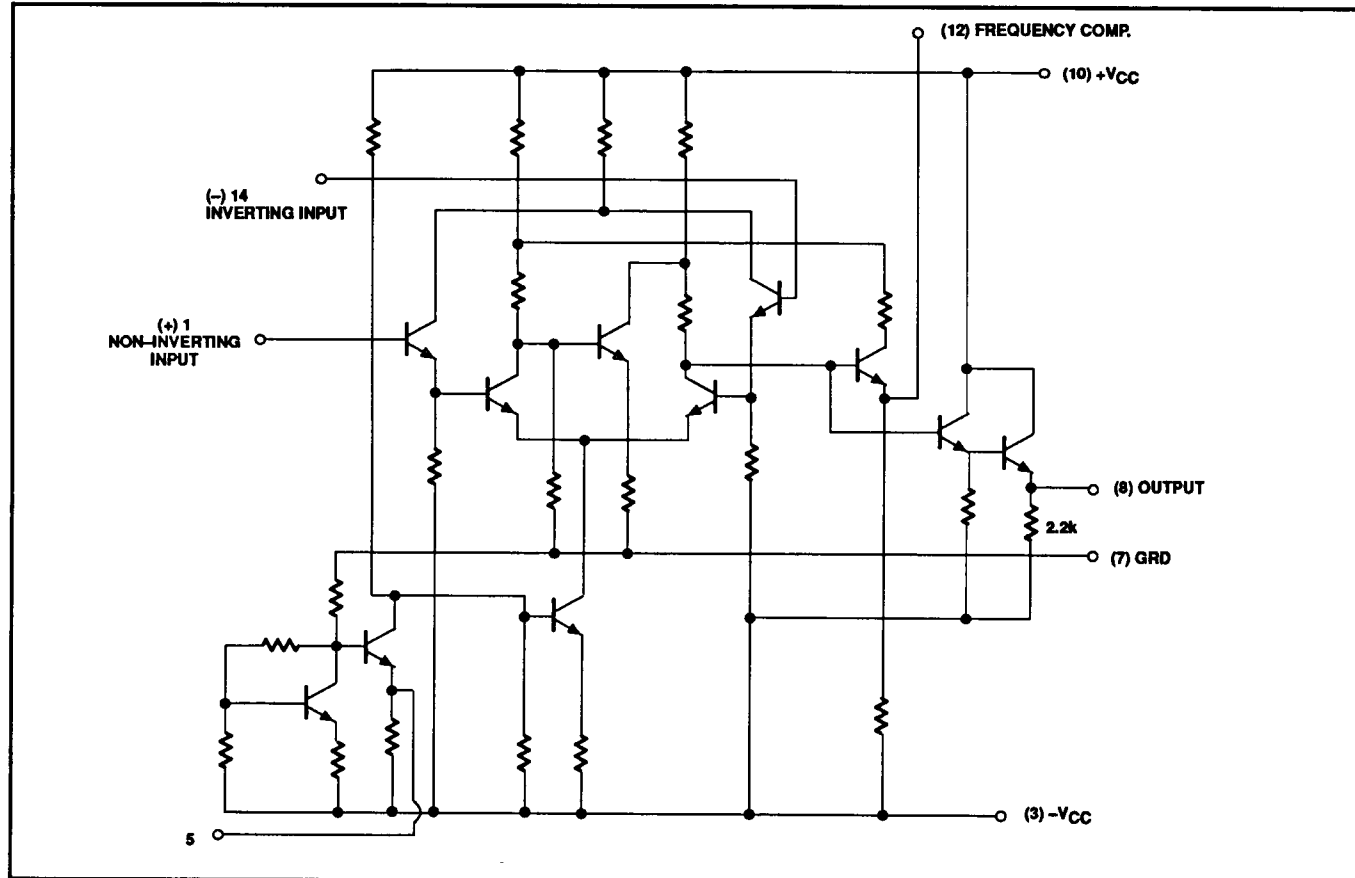
### NOTES:

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/ $^\circ\text{C}$   
N package at 11.6mW/ $^\circ\text{C}$   
D package at 7.9mW/ $^\circ\text{C}$

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## EQUIVALENT CIRCUIT



## High frequency operational amplifier

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## 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  |           |
| $V_{OUT}$ | Output voltage swing         | $R_L = 150\Omega$ to GND and $470\Omega$ to $-V_{CC}$                        | +Swing<br>-Swing   |              |              | +2.3<br>-1.7 | +2.7<br>-2.2 |      | V         |
| $V_{OUT}$ | Output voltage swing         | $R_L = 25\Omega$ to GND<br>Over temp   | +Swing<br>-Swing   | +2.3<br>-1.5 | +3.0<br>-2.1 |              |              |      | V         |
|           |                              | $R_L = 25\Omega$ to GND<br>$T_A = 25^\circ C$                                | +Swing<br>-Swing   | +2.5<br>-2.0 | +3.1<br>-2.7 |              |              |      | V         |
| $I_{CC+}$ | Positive supply current      | $V_O = 0$ , $R_1 = \infty$ , Over temp                                       |                    | 14           | 18           |              | 2.8          | 3.5  | mA        |
|           |                              | $V_O = 0$ , $R_1 = \infty$ , $T_A = 25^\circ C$                              |                    | 14           | 17           |              | 14           | 18   | mA        |
| $I_{CC-}$ | Negative supply current      | $V_O = 0$ , $R_1 = \infty$ , Over temp                                       |                    | 11           | 15           |              | 2.8          | 3.5  | mA        |
|           |                              | $V_O = 0$ , $R_1 = \infty$ , $T_A = 25^\circ C$                              |                    | 11           | 14           |              | 11           | 15   | mA        |
| 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 | $\mu V/V$ |
| $A_{VOL}$ | 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    | $V_O = +2.3V$ , $-1.7V$<br>$R_L = 2\Omega$ to GND                            | Over temp          |              |              |              |              |      | dB        |
|           |                              |  | $T_A = 25^\circ C$ |              |              | 47           | 52           | 57   |           |
| $A_{VOL}$ | Large signal voltage gain    | $V_O = +2.5V$ , $-2.0V$<br>$R_L = 2\Omega$ 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 <sub>OS</sub>  | Input offset voltage         |  | Over temp             |                       | 2    | 5    | mV    |      |
|                  |                              |  | T <sub>A</sub> = 25°C |                       | 2    | 3    |       |      |
| I <sub>OS</sub>  | Input offset current         |  | Over temp             |                       | 0.1  | 3    | μA    |      |
|                  |                              |  | T <sub>A</sub> = 25°C |                       | 0.1  | 1    |       |      |
| I <sub>B</sub>   | Input bias current           |  | Over temp             |                       | 5    | 20   | μA    |      |
|                  |                              |  | T <sub>A</sub> = 25°C |                       | 4    | 10   |       |      |
| CMRR             | Common-mode rejection ratio  | V <sub>CM</sub> = ±1.3V, R <sub>S</sub> = 100Ω               |                       |                       | 70   | 85   |       | dB   |
| I <sub>CC+</sub> | Positive supply current      |  | Over temp             |                       | 11   | 14   | mA    |      |
|                  |                              |  | T <sub>A</sub> = 25°C |                       | 11   | 13   |       |      |
| I <sub>CC-</sub> | Negative supply current      |  | Over temp             |                       | 8    | 11   | mA    |      |
|                  |                              |  | T <sub>A</sub> = 25°C |                       | 8    | 10   |       |      |
| PSRR             | Power supply rejection ratio | ΔV <sub>CC</sub> = ±1V                                       |                       | Over temp             |      | 300  | 1000  | μV/V |
|                  |                              |  |                       | T <sub>A</sub> = 25°C |      |      |       |      |
| V <sub>OUT</sub> | Output voltage swing         | R <sub>L</sub> = 150Ω to GND<br>and 390Ω to -V <sub>CC</sub> | Over temp             | +Swing                | +1.4 | +2.0 |       | V    |
|                  |                              |  |                       | -Swing                | -1.1 | -1.7 |       |      |
|                  |                              |  | T <sub>A</sub> = 25°C | +Swing                | +1.5 | +2.0 |       |      |
|                  |                              |  |                       | -Swing                | -1.4 | -1.8 |       |      |

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## 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:

1. External compensation.

## AC ELECTRICAL CHARACTERISTICS

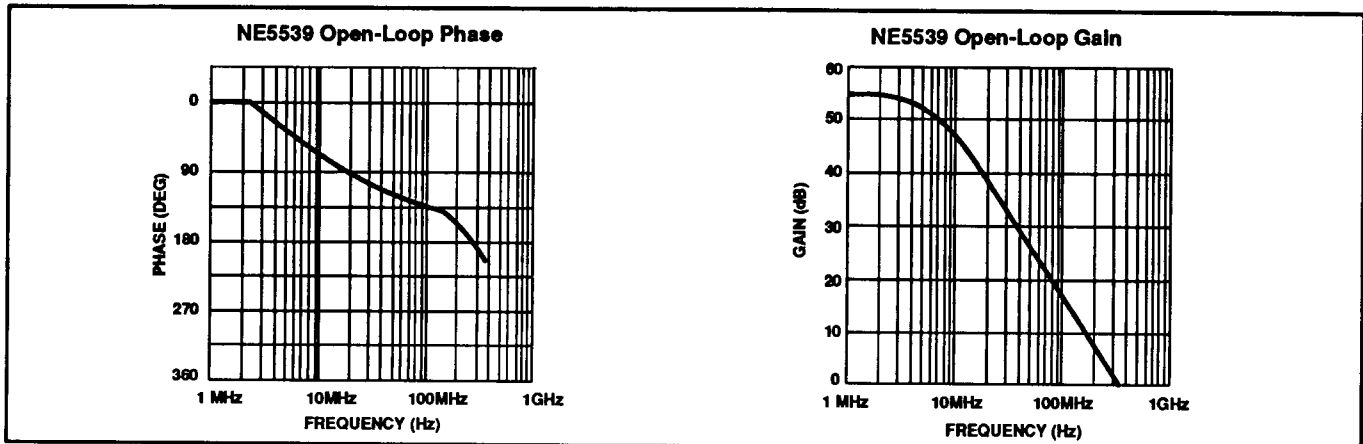
 $V_{CC} = \pm 6V$ ,  $R_L = 150\Omega$  to GND and  $390\Omega$  to  $-V_{CC}$ , unless otherwise specified.

| 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 |     | MHz        |
| $t_s$    | 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:

1. External compensation.

## TYPICAL PERFORMANCE CURVES

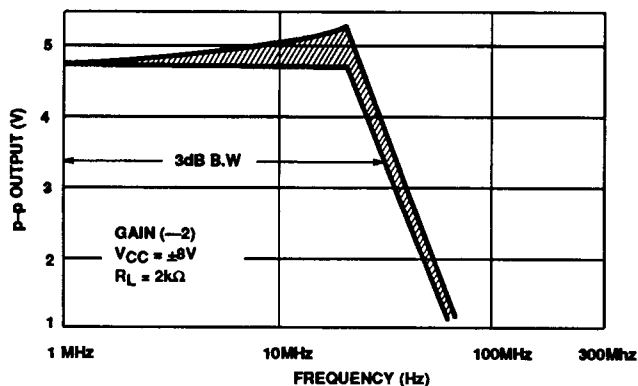


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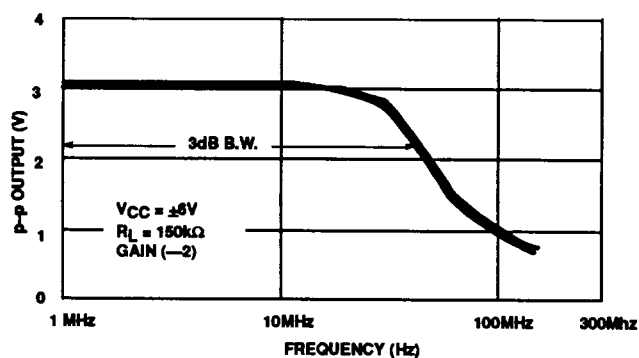
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## TYPICAL PERFORMANCE CURVES (Continued)

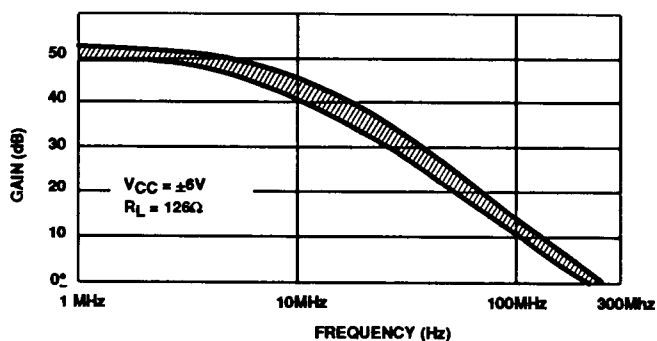
Power Bandwidth (SE)



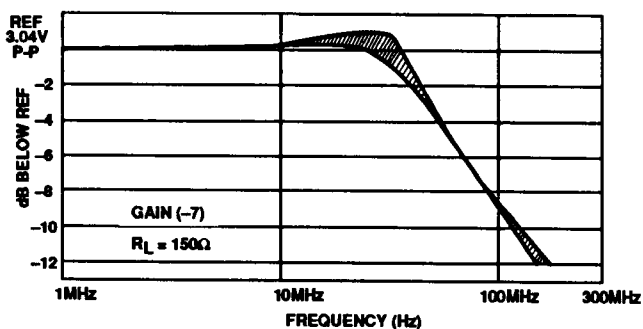
Power Bandwidth (NE)



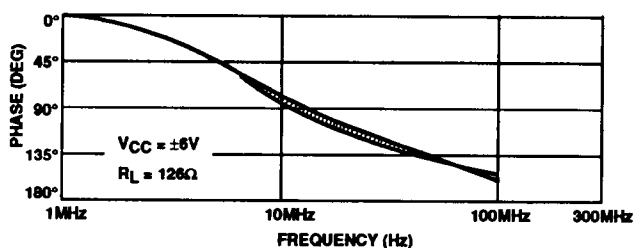
SE5539 Open-Loop Gain vs Frequency



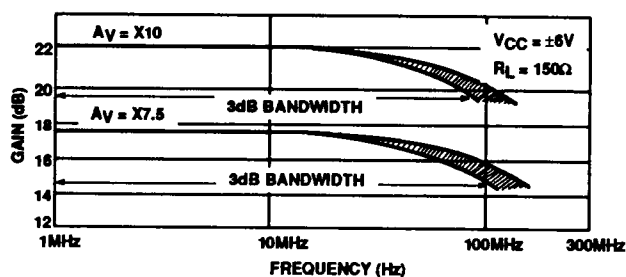
Power Bandwidth



SE5539 Open-Loop Phase vs Frequency



Gain Bandwidth Product vs Frequency



## NOTE:



Indicates typical  
distribution  $-55^\circ\text{C} \leq T_A \leq 125^\circ\text{C}$

## High frequency operational amplifier

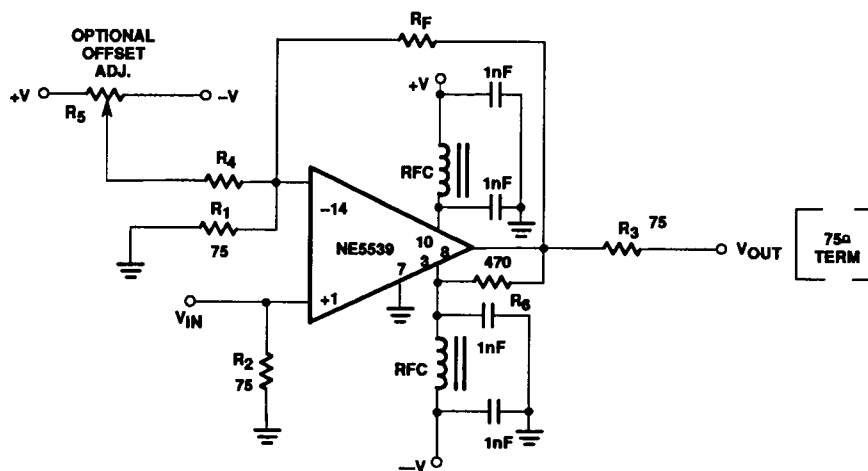
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CIRCUIT LAYOUT  
CONSIDERATIONS

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 1.

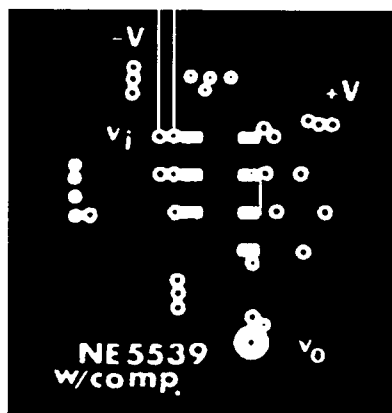


$R_1 = 75\Omega$  5% CARBON  
 $R_2 = 75\Omega$  5% CARBON  
 $R_3 = 75\Omega$  5% CARBON  
 $R_4 = 36K$  5% CARBON

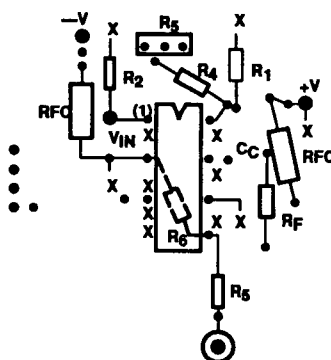
$R_5 = 20k$  TRIMPOT (CERMET)  
 $R_F = 1.5k$  (28dB GAIN)  
 $R_6 = 470\Omega$  5% CARBON

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

Top Plane Copper<sup>1</sup>  
(Component Side)



Component Side  
(Component Layout)



Bottom Plane Copper<sup>1</sup>

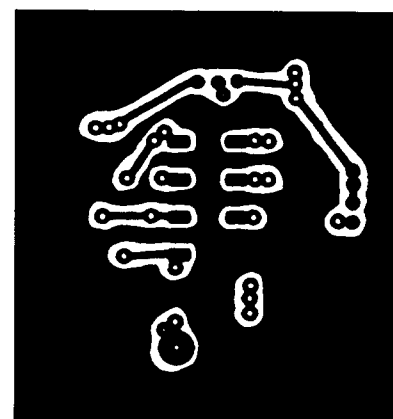


Figure 1. 28dB Non-Inverting Amp Sample PC Layout

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**NE5539 COLOR VIDEO AMPLIFIER**

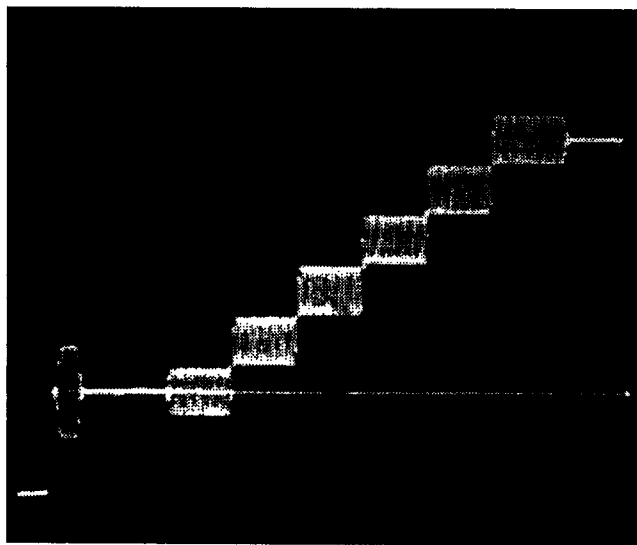
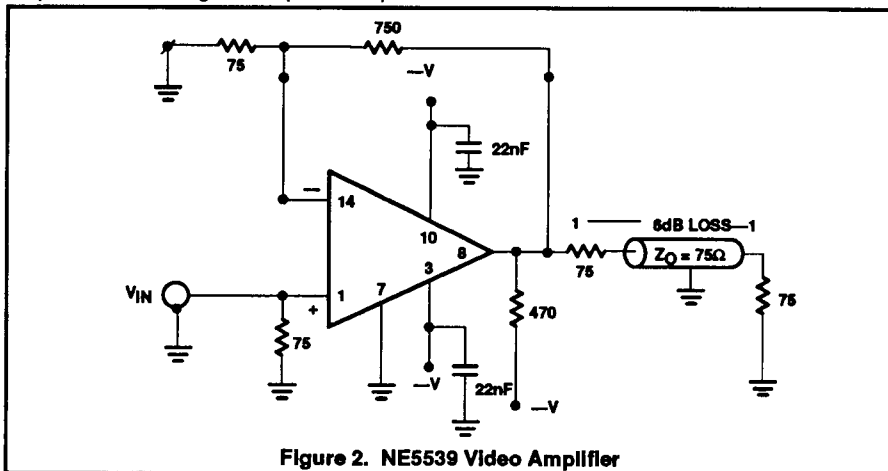
The NE5539 wideband operational amplifier is easily adapted for use as a color video amplifier. A typical circuit is shown in 2 along with vector-scope photographs showing the amplifier differential gain and phase response

to a standard five-step modulated staircase linearity signal (Figures 3, 4 and 5). As can be seen in 4, the gain varies less than 0.5% from the bottom to the top of the staircase. The maximum differential phase shown in 5 is approximately  $+0.1^\circ$ .

The amplifier circuit was optimized for a 75W 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  $\pm 8V$ .

**Figure 3. Input Signal****Figure 4. Differential Gain <0.5%****NOTE:**

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

## High frequency operational amplifier

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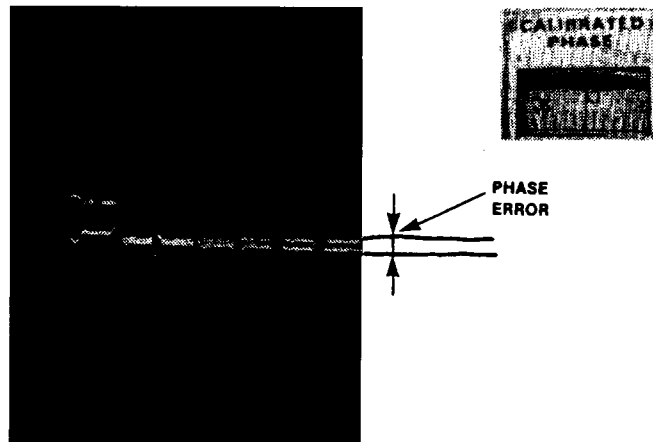
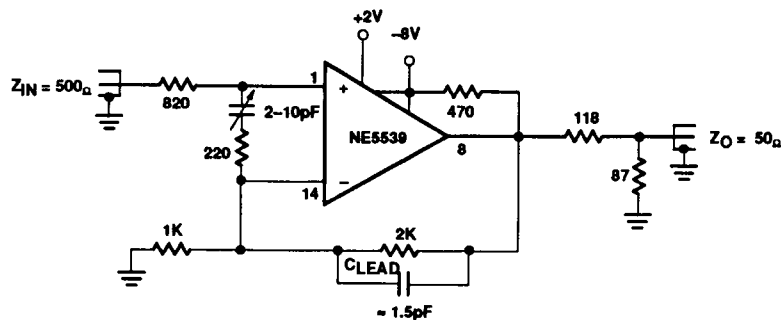
Figure 5. Differential Gain  $+0.1^\circ$ 

Figure 6. Non-Inverting Follower

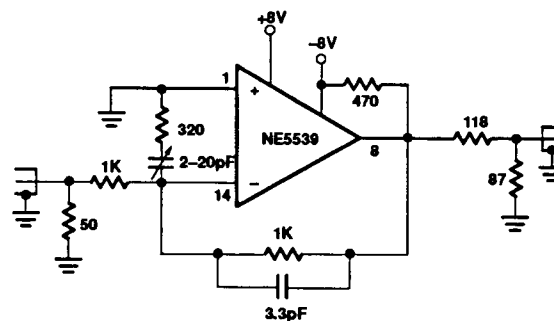


Figure 7. Inverting Follower

## Packaging Information

T-90-20

SIGNETICS STANDARD  
PACKAGE DESCRIPTIONS

All Military package case outlines and physical dimensions conform with the current revision MIL-M-38510, Appendix C, except for package types which are not included in that specification.

The physical dimensions for standard package types which are not included in Appendix C are included herein in Appendix C format. Case outline letters are assigned to these packages according to JEDEC Publication 101 as follows:

- U: Leadless chip carriers
- X: Dual-in-line packages
- Y: Flat packages
- Z: All other configurations

A case outline suffix number is assigned herein for identification purposes only, and is not marked on the product.

Signetics Military products are offered in a wide range of package configurations to optimally fit our customer needs.

- Dual-in-line Packages; Frit glass sealed CERDIP (F package family) with 8-40 leads, and side-brazed ceramic (I package family) with 48-64 leads.
- Flat Packages; Frit glass sealed alumina CERPAC (W package family) with 14-28 leads, and brazed leaded ceramic (Q package family) with 52 leads.

- Ceramic Chip Carriers; triple laminated, metal-lidded LCC (G package family) with 20-68 terminals.

- Pin Grid Array; metal-lidded ceramic pin grid (P package family) with 68-100 leads.

- Shown in Table 1 are the case outline letters assigned according to Appendix C of MIL-M-38510 and JEDEC publication 101. Unless otherwise noted, all package types are Configuration 1 and all lead finishes are hot solder dip Finish "A".

Table 1.

| Package Description | Type Designation  | Case Outline   | Theta-JC °C/Watt <sup>4</sup> |
|---------------------|-------------------|----------------|-------------------------------|
| 8DIP3               | D-4               | P              | 28                            |
| 14DIP3              | D-1               | C              | 28                            |
| 16DIP3              | D-2               | E              | 28                            |
| 18DIP3              | D-6               | V              | 28                            |
| 20DIP3              | D-8               | R              | 28                            |
| 22DIP4              | D-7               | W              | 28                            |
| 24DIP3              | D-9               | L              | 28                            |
| 24DIP4              | D-11              | X <sup>2</sup> | 28                            |
| 24DIP6              | D-3               | J              | 28                            |
| 28DIP6              | D-10              | X <sup>2</sup> | 28                            |
| 40DIP6              | D-5               | Q              | 28                            |
| 48DIP6              | D-14 <sup>1</sup> | X <sup>2</sup> | 28                            |
| 50DIP9              | D-12 <sup>1</sup> | X <sup>2</sup> | 28                            |
| 64DIP9              | D-13 <sup>1</sup> | X <sup>2</sup> | 28                            |
| 14FLAT              | F-2               | D              | 22                            |
| 16FLAT              | F-5               | F              | 22                            |
| 18FLAT              | F-10              | Y <sup>2</sup> | 22                            |
| 20FLAT              | F-9               | S              | 22                            |
| 24FLAT              | F-6               | K              | 22                            |
| 28FLAT              | F-11              | Y <sup>2</sup> | 22                            |
| 52FLAT              | Y-1 <sup>1</sup>  | Y <sup>2</sup> | 22                            |
| 18LLCC              | C-9               | U <sup>2</sup> | 20                            |
| 20LLCC              | C-2 <sup>3</sup>  | 2              | 20                            |
| 28LLCC              | C-4 <sup>3</sup>  | 3              | 20                            |
| 32LLCC              | C-12              | U <sup>2</sup> | 20                            |
| 44LLCC              | C-5               | U <sup>2</sup> | 20                            |
| 68LLCC              | C-7               | U <sup>2</sup> | 20                            |
| 68PGA               | P-AB              | Z <sup>2</sup> | 20                            |
| 84PGA               | P-AB              | Z <sup>2</sup> | 20                            |

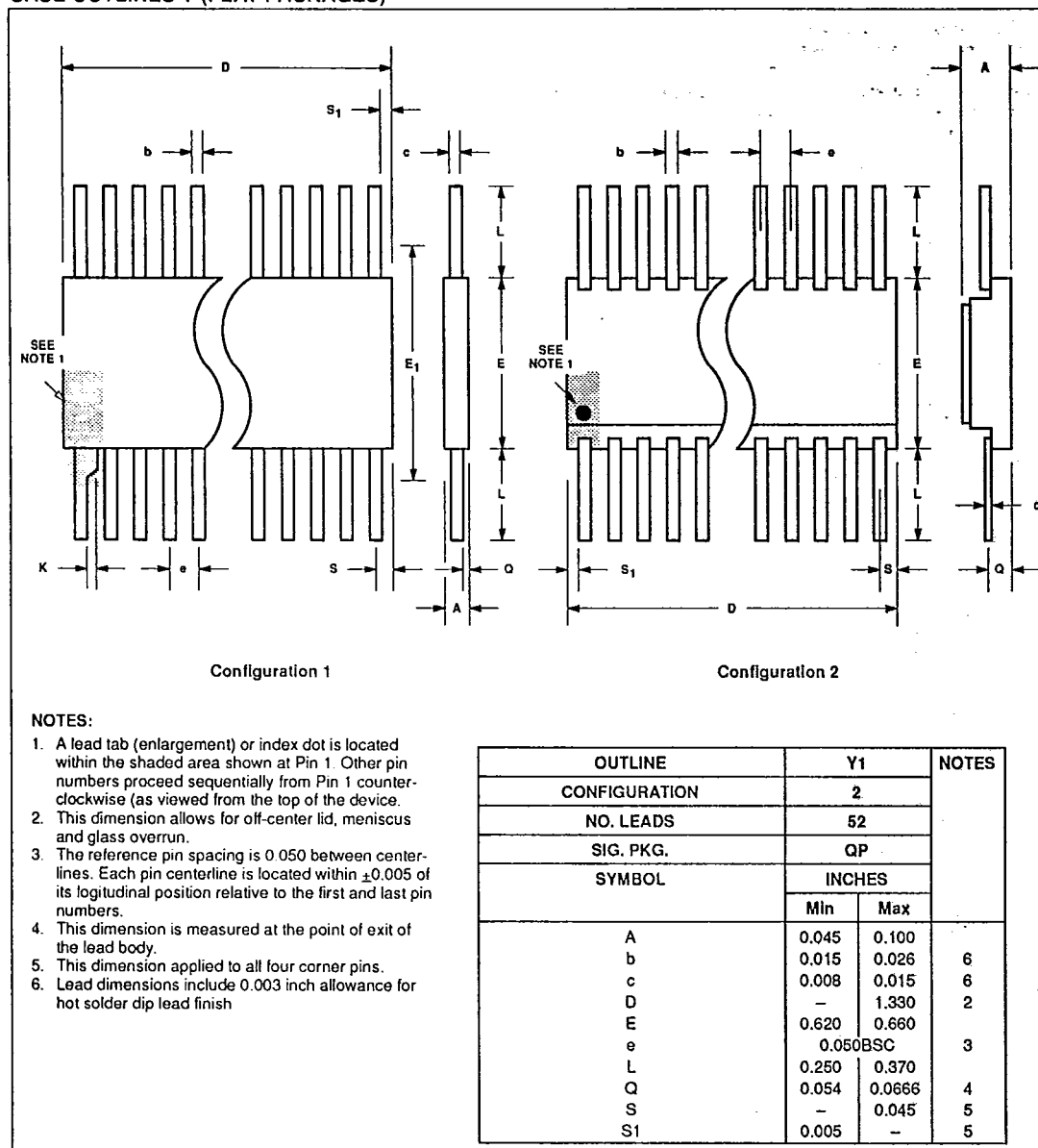
## NOTES:

1. Configuration 2.
2. Per JEDEC publication 101.
3. Dimension A (LLCC thickness) is 75mils maximum.
4. See RADC test report RADC-TR-86-97 for thermal resistance confidence and derating.

## Packaging Information

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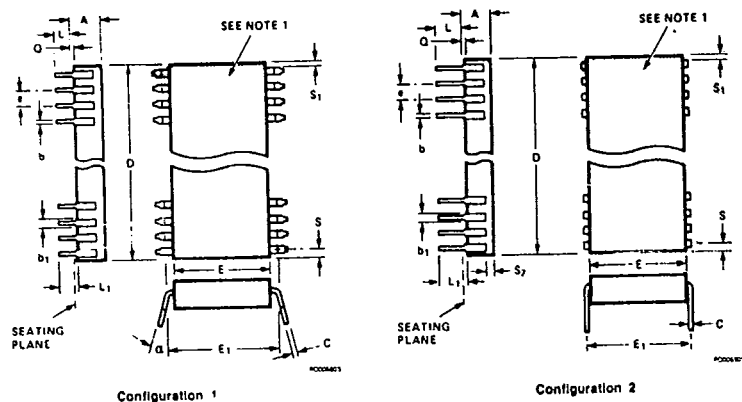
## CASE OUTLINES Y (FLAT PACKAGES)



## Packaging Information

T-90-20

## CASE OUTLINES X (DUAL IN-LINE PACKAGES)

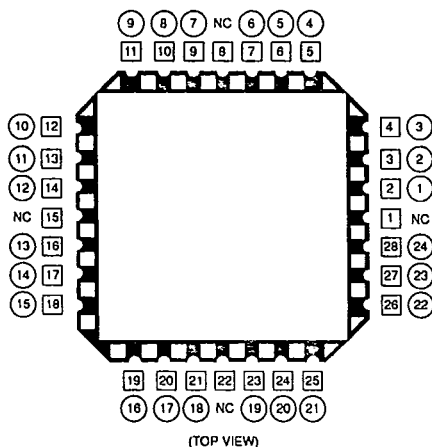


1. An index notch is located within the shaded area shown. Pin 1 is adjacent to the notch to the immediate left (as viewed from the top of the device) and other pin numbers proceed sequentially from Pin 1 counterclockwise.
2. The minimum limit for Dimension b1 is 0.023 inches for all four corner pins.
3. This dimension allows for off-center lid, meniscus, and glass overrun.
4. This dimension is measured at the centerline of the leads for Configuration 2.
5. The reference pin spacing is 0.100 between centerlines. Each pin centerline is located within  $\pm 0.010$  of its longitudinal position relative to the first and last pin numbers.
6. This dimension is measured from the seating plane to the base plane.
7. This dimension applies to all four corner pins.
8. Lead dimensions include 0.003 inch allowance for hot solder dip lead finish.

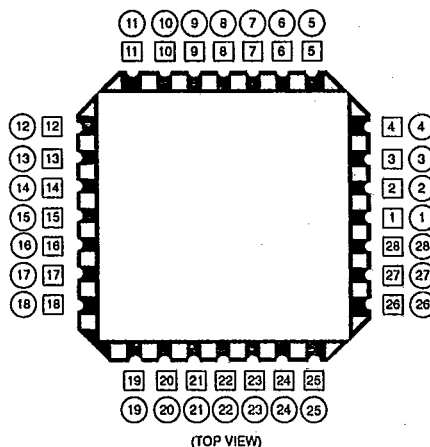
# Packaging Information

T-90-20

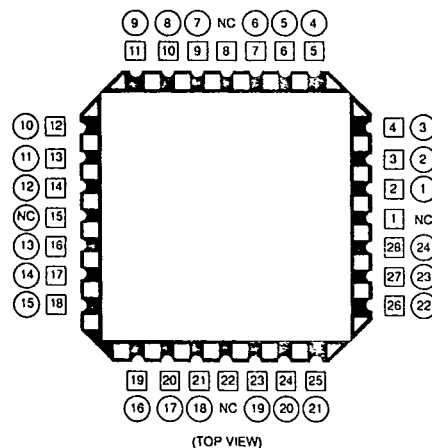
## LEADLESS CHIP CARRIER (LLCC) PINOUTS



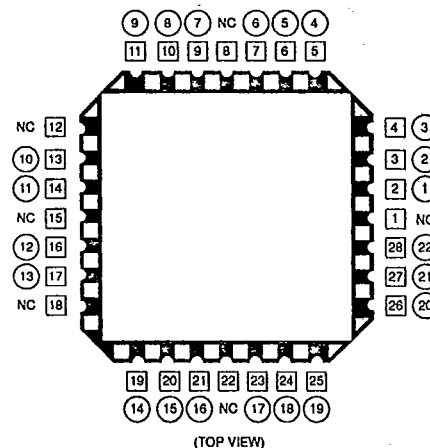
24-Lead Logic Pinout for 28 Terminal Chip Carrier



28-Lead Pinout for 28 Terminal Chip Carrier for all Device Types



24-Lead Memory Pinout for 28 Terminal Chip Carrier



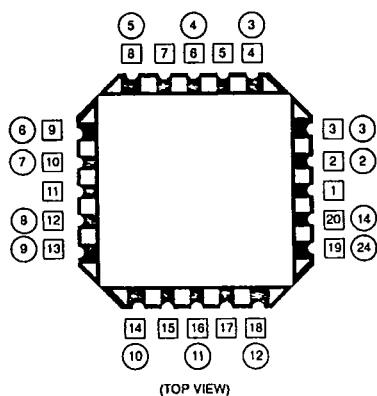
22-Lead Memory Pinout for 28 Terminal Chip Carrier

□ = Chip Carrier Terminal Number  
○ = Dual In-Line Lead Number  
NC = No Connect

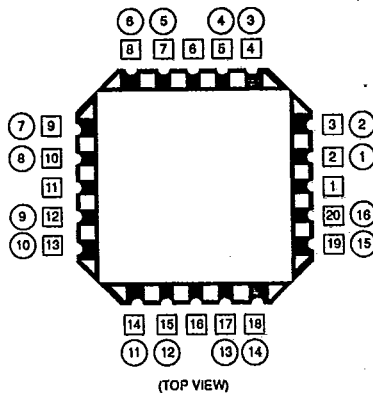
Packaging Information

T-90-20

LEADLESS CHIP CARRIER (LLCC) PINOUTS



14-Pin Logic Pinout for 20 Terminal Chip Carrier



16-Pin Logic Pinout for 20 Terminal Chip Carrier

- = Chip Carrier Terminal Number
- = Dual In-Line Lead Number