NE5533/5533A-N,F • NE/SE5534/5534A-N,FE
NE5534-D

## DESCRIPTION

The 5533/5534 are dual and single high-performance low noise operational amplifiers. Compared to other operational amplifiers, such as TL083, they show better noise performance, improved output drive capability and considerably higher small-signal and power bandwidths.

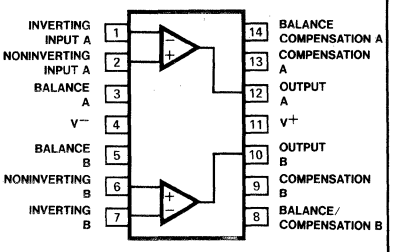
This makes the devices especially suitable for application in high quality and professional audio equipment, in instrumentation and control circuits and telephone channel amplifiers. The op amps are internally compensated for gain equal to, or higher than, three. The frequency response can be optimized with an external compensation capacitor for various applications (unity gain amplifier, capacitive load, slew-rate, low overshoot, etc.) If very low noise is of prime importance, it is recommended that the 5533A/5534A version be used which has guaranteed noise specifications.

## FEATURES

- **Small-signal bandwidth: 10MHz**
- **Output drive capability: 600Ω, 10V (rms) at $V_S = \pm 18V$**
- **Input noise voltage: 4nV/$\sqrt{Hz}$**
- **DC voltage gain: 100000**
- **AC voltage gain: 6000 at 10kHz**
- **Power bandwidth: 200kHz**
- **Slew-rate: 13V/$\mu$s**
- **Large supply voltage range: ±3 to ±20V**

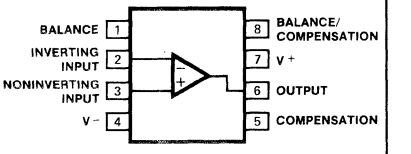
## PIN CONFIGURATIONS

**F,N PACKAGE**



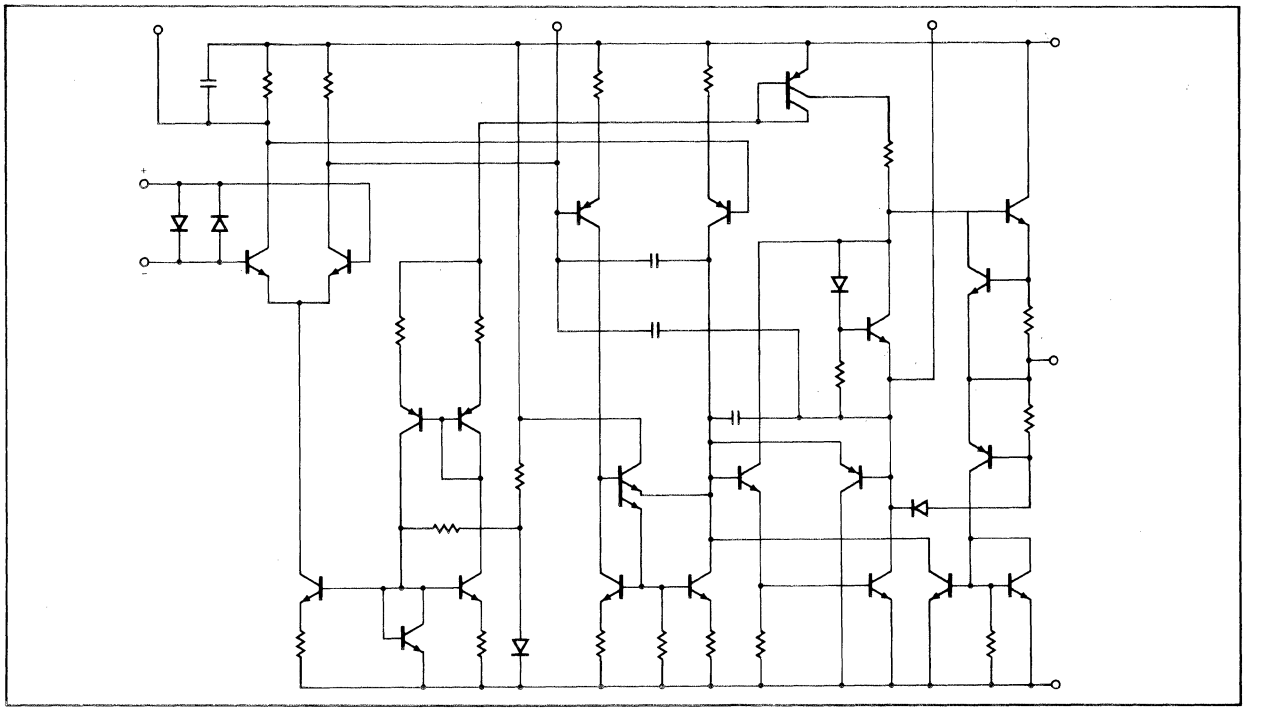

**ORDER PART NO.**
NE5533N,F
NE5533AN,AF

**D,N,FE PACKAGE**




**ORDER PART NO.**
NE/SE5534N,FE
NE/SE5534AN,AFE
NE5534D

## EQUIVALENT SCHEMATIC



NE5533/5533A-N,F • NE/SE5534/5534A-N,FE
NE5534-D

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | | RATING | UNIT |
|---|---|---|---|
| $V_S$ | Supply voltage | ±22 | V |
| $V_{IN}$ | Input voltage | ±V supply | V |
| $V_{DIFF}$ | Differential input voltage[1] | ±.5 | V |
| $T_A$ | Operating temperature range | | |
| | SE5534/5534A | -55 to +125 | °C |
| | NE5533/5533A/5534/5534A | 0 to +70 | °C |
| $T_{STG}$ | Storage temperature | -65 to +150 | °C |
| $T_J$ | Junction temperature | 150 | °C |
| $P_D$ | Power dissipation at 25°C[2] | | |
| | 5533N, 5534N, 5534FE | 800 | mW |
| | 5533F | 1000 | mW |
| | Output short circuit duration[3] | indefinite | |
| | Lead temperature (soldering 10 sec) | 300 | °C |

NOTES

1. Diodes protect the inputs against over-voltage. Therefore, unless current-limiting resistors are used, large currents will flow if the differential input voltage exceeds 0.6V. Maximum current should be limited to ±10mA.
2. For operation at elevated temperature, derate packages based on the following junction-to-ambient thermal resistances:
   8-pin ceramic (FE) 140°C/W
   14-pin ceramic (F) 110°C/W
   8-pin plastic (N) 162°C/W
   14-pin plastic (N) 150°C/W
3. Output may be shorted to ground at $V_S$ = ±15V, $T_A$ = 25°C. Temperature and/or supply voltages must be limited to ensure dissipation rating is not exceeded.

## DC ELECTRICAL CHARACTERISTICS $T_A$ = 25°C, $V_S$ = ±15V unless otherwise specified.[1,2]

| PARAMETER | | TEST CONDITIONS | SE5534/5534A | | | NE5533/5533A 5534/5534A | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| $V_{OS}$ | Offset voltage | | | .5 | 2 | | .5 | 4 | mV |
| | | Over temperature | | | 3 | | | 5 | mV |
| $I_{OS}$ | Offset current | | | 10 | 200 | | 20 | 300 | nA |
| | | Over temperature | | | 500 | | | 400 | nA |
| $I_B$ | Input current | | | 400 | 800 | | 500 | 1500 | nA |
| | | Over temperature | | | 1500 | | | 2000 | nA |
| $I_{CC}$ | Supply current | | | 4 | 6.5 | | 4 | 8 | mA |
| | Per op amp | Over temperature | | | 9 | | | | mA |
| $V_{CM}$ | Common mode input range | | ±12 | ±13 | | ±12 | ±13 | | V |
| CMRR | Common mode rejection ratio | | 80 | 100 | | 70 | 100 | | dB |
| PSRR | Power supply rejection ratio | | | 10 | 50 | | 10 | 100 | μV/V |
| $A_{VOL}$ | Large signal voltage gain | $R_L \geq 600\Omega$, $V_O$ = ±10V | 50 | 100 | | 25 | 100 | | V/mV |
| | | Over temperature | 25 | | | 15 | | | V/mV |
| $V_{OUT}$ | Output swing | $R_L \geq 600\Omega$ | ±12 | ±13 | | ±12 | ±13 | | V |
| | | $R_L \geq 600\Omega$ $V_S$ = ±18V | ±15 | ±16 | | ±15 | ±16 | | V |
| $R_{IN}$ | Input resistance | | 50 | 100 | | 30 | 100 | | kΩ |
| $I_{SC}$ | Output short circuit current | | | 38 | | | 38 | | mA |

NOTES

1. For NE5533/5533A/5534/5534A, $T_{MIN}$ = 0°C, $T_{MAX}$ = 70°C
2. For SE5534/5534A, $T_{MIN}$ = −55°C, $T_{MAX}$ = +125°C

NE5533/5533A-N,F • NE/SE5534/5534A-N,FE
NE5534-D

## AC ELECTRICAL CHARACTERISTICS $T_A = 25°C$, $V_S = \pm 15V$ unless otherwise specified.

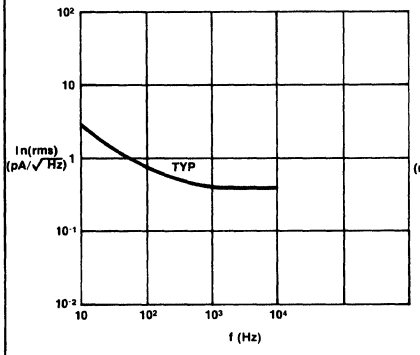
| PARAMETER | TEST CONDITIONS | SE5534/5534A | | | NE5533/5533A 5534/5534A | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | Min | Typ | Max | Min | Typ | Max | |
| $R_{OUT}$ Output resistance | $A_V$ = 30dB closed loop<br>f = 10kHz, $R_L$ = 600Ω, $C_C$ = 22pF | | 0.3 | | | 0.3 | | Ω |
| Transient response | Voltage follower, $V_{IN}$ = 50mV<br>$R_L$ = 600Ω, $C_C$ = 22pF, $C_L$ = 100pF | | | | | | | |
| $T_R$ Rise time | | | 20 | | | 20 | | ns |
| Overshoot | | | 20 | | | 20 | | % |
| Transient response | $V_{IN}$ = 50mv, $R_L$ = 600Ω<br>$C_C$ = 47pF, $C_L$ = 500pF | | | | | | | |
| $T_R$ Rise time | | | 50 | | | 50 | | ns |
| Overshoot | | | 35 | | | 35 | | % |
| AC Gain | f = 10kHz, $C_C$ = 0 | | 6 | | | 6 | | V/mV |
| | f = 10kHz, $C_C$ = 22pF | | 2.2 | | | 2.2 | | V/mV |
| Gain bandwidth product | $C_C$ = 22pF, $C_L$ = 100pF | | 10 | | | 10 | | mHz |
| Slew rate | $C_C$ = 0 | | 13 | | | 13 | | V/μS |
| | $C_C$ = 22pF | | 6 | | | 6 | | V/μS |
| Power bandwidth | $V_{OUT}$ = ±10V, $C_C$ = 0 | | 200 | | | 200 | | kHz |
| | $V_{OUT}$ = ±10V, $C_C$ = 22pF | | 95 | | | 95 | | kHz |
| | $V_{OUT}$ = ±14V, $R_L$ = 600Ω<br>$C_C$ = 22pF, $V_{CC}$ = ±18V | | 70 | | | 70 | | kHz |

## ELECTRICAL CHARACTERISTICS $T_A = 25°C$, $V_S = \pm 15V$ unless otherwise specified.

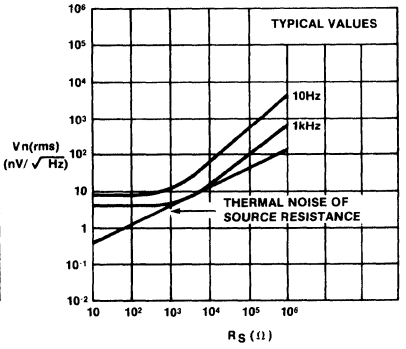
| PARAMETER | TEST CONDITIONS | 5533/5534 | | | 5533A/5534A | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | Min | Typ | Max | Min | Typ | Max | |
| Input noise voltage | $f_o$ = 30Hz | | 7 | | | 5.5 | 7 | $nV/\sqrt{Hz}$ |
| | $f_o$ = 1kHz | | 4 | | | 3.5 | 4.5 | $nV/\sqrt{Hz}$ |
| Input noise current | $f_o$ = 30Hz | | 2.5 | | | 1.5 | | $pA/\sqrt{Hz}$ |
| | $f_o$ = 1kHz | | 0.6 | | | 0.4 | | $pA/\sqrt{Hz}$ |
| Broadband noise figure | f = 10Hz – 20kHz, $R_S$ = 5kΩ | | | | | 0.9 | | dB |
| Channel separation | f = 1kHz, $R_S$ = 5kΩ | | 110 | | | 110 | | dB |

## TYPICAL PERFORMANCE CHARACTERISTICS (Cont'd)

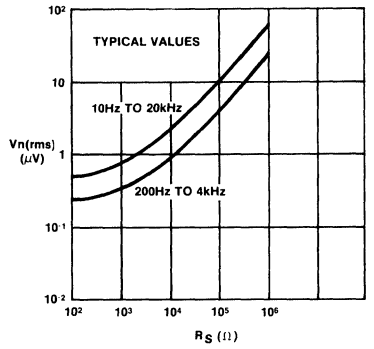
### INPUT NOISE CURRENT DENSITY




### TOTAL INPUT NOISE DENSITY

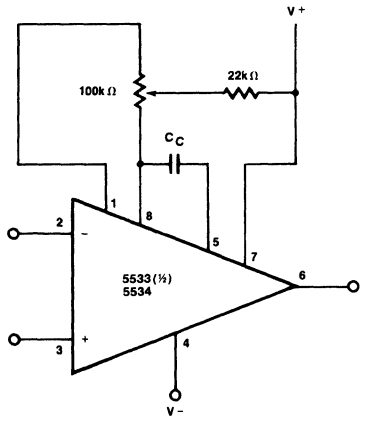



### BROADBAND INPUT NOISE VOLTAGE

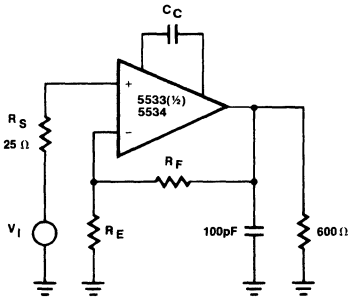



## TEST LOAD CIRCUITS

### FREQUENCY COMPENSATION AND OFFSET VOLTAGE ADJUSTMENT CIRCUIT

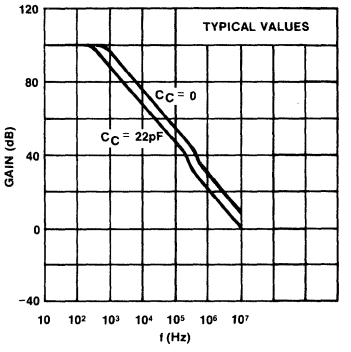



### CLOSED LOOP FREQUENCY RESPONSE

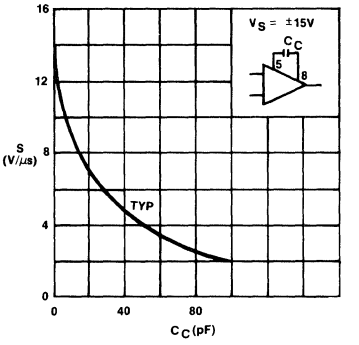


## TYPICAL PERFORMANCE CHARACTERISTICS

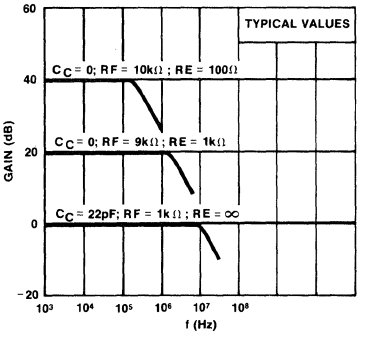
### OPEN LOOP FREQUENCY RESPONSE



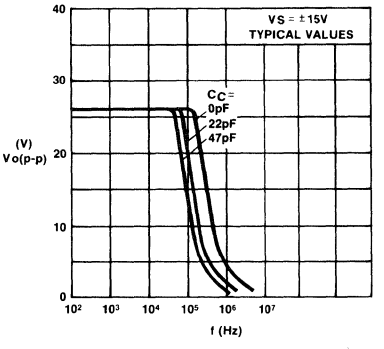

### SLEW-RATE AS A FUNCTION OF COMPENSATION CAPACITANCE



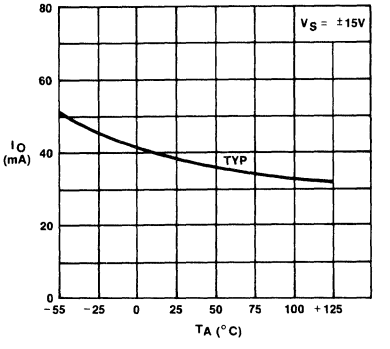

### CLOSED LOOP FREQUENCY RESPONSE



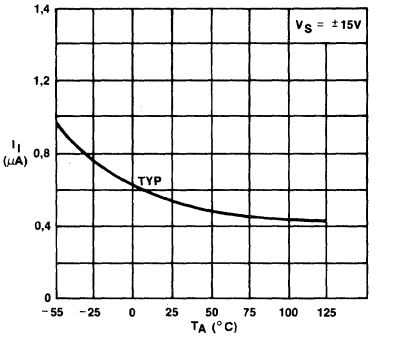

### LARGE-SIGNAL FREQUENCY RESPONSE



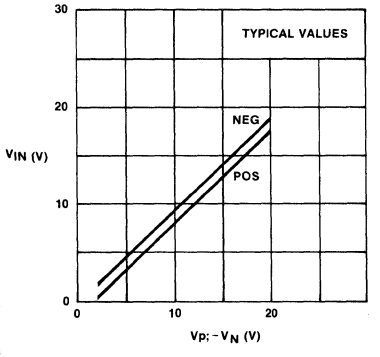

### OUTPUT SHORT-CIRCUIT CURRENT



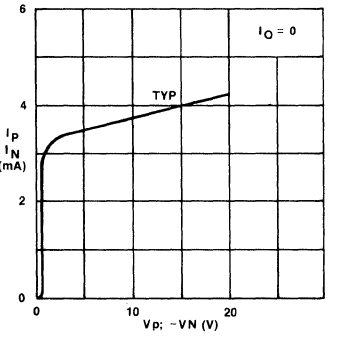

### INPUT BIAS CURRENT




### INPUT COMMON MODE VOLTAGE RANGE




### SUPPLY CURRENT PER OP AMP




### INPUT NOISE VOLTAGE DENSITY