# LOW POWER DUAL OPERATIONAL AMPLIFIERS SA/SE/NE532/LM158/258/358

## DESCRIPTION

The 532/358 consists of two independent, high gain, internally frequency compensated operational amplifiers designed specifically to operate from a single power supply over a wide range of voltages. Operation from dual power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

## FEATURES

- **Internally frequency compensated for unity gain**
- **Large dc voltage gain—(100dB)**
- **Wide bandwidth (unity gain)—1MHz (temperature compensated)**
- **Wide power supply range**
  **single supply—(3Vdc to 30Vdc)**
  **or dual supplies—(±1.5Vdc to ±15Vdc)**
- **Very low supply current drain (400μA)—essentially independent of supply voltage (1mW/op amp at +5Vdc)**
- **Low input biasing current—(45nA dc temperature compensated)**
- **Low input offset voltage—(2mVdc) and offset current—(5nA dc)**
- **Differential input voltage range equal to the power supply voltage**
- **Large output voltage—(0Vdc to V+—-1.5Vdc swing)**
- **SE532 MIL-STD-883A,B,C available**

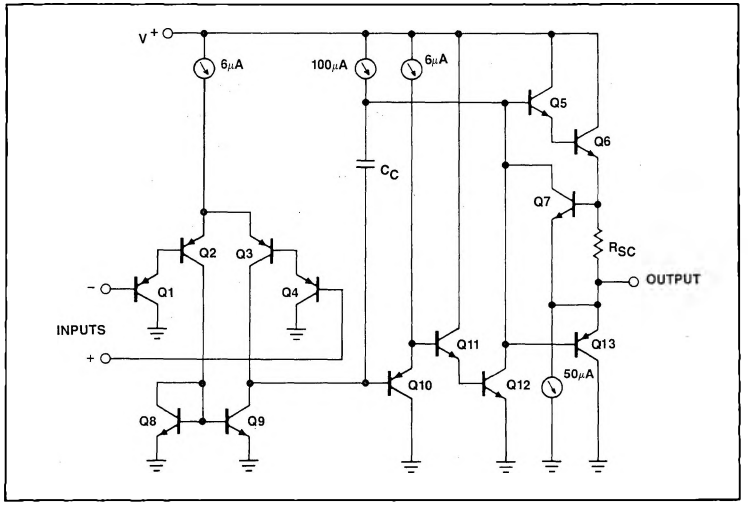
## UNIQUE FEATURES

In the linear mode the input common-mode voltage range includes ground and the output voltage can also swing to ground, even though operated from only a single power supply voltage. The unity gain cross frequency is temperature compensated. The input bias current is also temperature compensated.

## ABSOLUTE MAXIMUM RATINGS

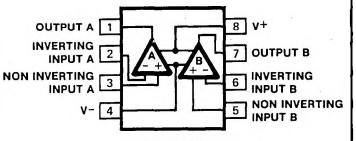
| PARAMETER | RATING | UNIT |
|---|---|---|
| Supply voltage, V+ | 32 or ±16 | Vdc |
| Differential input voltage | 32 | Vdc |
| Input voltage | -0.3 to +32 | Vdc |
| Power dissipation[1] | | |
| FE package | 900 | mW |
| H package | 680 | mW |
| N package | 500 | mW |
| Output short-circuit to GND[5] | | |
| V+ < 15 Vdc and $T_A$ = 25°C | Continuous | |
| Operating temperature range | | |
| NE532/LM358 | 0 to +70 | °C |
| LM258 | -25 to +85 | °C |
| SA532N | -40 to +85 | °C |
| SE532/LM158 | -55 to +125 | °C |
| Storage temperature range | -65 to +150 | °C |
| Lead temperature (soldering, 10sec) | 300 | °C |

## EQUIVALENT CIRCUIT




## PIN CONFIGURATIONS

D,FE,N PACKAGE

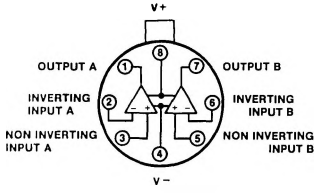



TOP VIEW

ORDER NUMBERS

| | |
|---|---|
| LM158N, FE | NE532D, N, FE |
| LM258N, FE | SA532FE, N |
| LM358D, N, FE | SE532N, FE |

H PACKAGE*




ORDER NUMBERS

LM158/258/358H
NE/SE532H

*Metal cans (H) not recommended for new designs

## DC ELECTRICAL CHARACTERISTICS $T_A = 25°C$, $V+ = +5V$ unless otherwise specified.

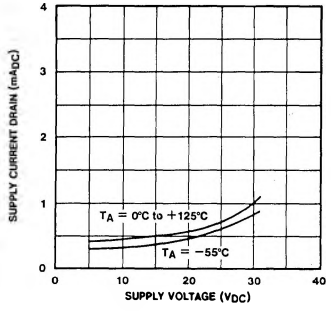
| PARAMETER | | TEST CONDITIONS | SE532, LM158/258 | | | NE/SA532/LM358 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| $V_{OS}$ | Offset voltage[1] | $R_S \leq 0\Omega$ | | ±2 | ±5 | | ±2 | ±7 | mV |
| | | $R_S \leq 0\Omega$, over temp. | | | ±7 | | | ±9 | mV |
| $V_{OS}$ | Drift | $R_S = 0\Omega$, over temp. | | 7 | | | 7 | | μV/°C |
| $I_{OS}$ | Offset current | $I_{IN}(+) - I_{IN}(-)$ | | ±3 | ±30 | | ±5 | ±50 | nA |
| | | Over temp. | | | ±100 | | | ±150 | nA |
| $I_{OS}$ | Drift | Over temp. | | 10 | | | 10 | | pA/°C |
| $I_{BIAS}$ | Input current[2] | $I_{IN}(+)$ or $I_{IN}(-)$ | | 45 | 150 | | 45 | 250 | nA |
| | | Over temp., $I_{IN}(+)$ or $I_{IN}(-)$ | | 40 | 300 | | 40 | 500 | nA |
| $I_B$ | Drift | Over temp | | 50 | | | 50 | | pA/°C |
| $V_{CM}$ | Common mode voltage range[3] | $V+ = 30V$ | 0 | | V+ −1.5 | 0 | | V+ −1.5 | V |
| | | Over temp., $V+ = 30V$ | 0 | | V+ −2.0 | 0 | | V+ −2.0 | V |
| $C_{MRR}$ | Common mode rejection ratio | $V+ = 30V$ | 70 | 85 | | 65 | 70 | | dB |
| $V_{OUT}$ | Output voltage swing ($V_{OH}$) | $R_L \geq 2k\Omega$, $V+ = 30V$, over temp. | 26 | | | 26 | | | V |
| | | $R_L \geq 10k\Omega$, $V+ = 30V$, over temp. | 27 | 28 | | 27 | 28 | | V |
| $V_{OUT}$ | Output voltage swing ($V_{OL}$) | $R_L \leq 10k\Omega$, over temp. | | 5 | 20 | | 5 | 20 | mV |
| $I_{CC}$ | Supply current | $R_L = \infty$, $V+ = 30V$ | | 1.0 | 2.0 | | 1.0 | 2.0 | mA |
| | | $R_L = \infty$ on all amplifiers, over temp. | | 0.5 | 1.2 | | 0.5 | 1.2 | mA |
| $A_{VOL}$ | Large signal voltage gain | $R_L \geq 2k\Omega$, $V_{OUT} \pm 10V$, $V+ = 15V$ | 50 | 100 | | 25 | 100 | | V/mV |
| | | (for large $V_O$ swing) over temp. | 25 | | | 15 | | | V/mV |
| PSRR | Supply voltage rejection ratio | $R_S \leq 0\Omega$ | 65 | 100 | | 65 | 100 | | dB |
| | Amplifier-to-amplifier coupling[4] | f = 1kHz to 20kHz (input referred) | | −120 | | | −120 | | dB |
| | Output current Source | $V_{IN+} = +1Vdc$, $V_{IN-} = 0Vdc$, $V+ = 15Vdc$ | 20 | 40 | | 20 | 40 | | mA |
| | | $V_{IN+} = +1Vdc$, $V_{IN-} = 0Vdc$, $V+ = 15Vdc$, over temp. | 10 | 20 | | 10 | 20 | | mA |
| | Sink | $V_{IN-} = +1Vdc$, $V_{IN+} = 0Vdc$, $V+ = 15Vdc$ | 10 | 20 | | 10 | 20 | | mA |
| | | $V_{IN-} = +1Vdc$, $V_{IN+} = 0Vdc$, $V+ = 15Vdc$, over temp. | 5 | 8 | | 5 | 8 | | mA |
| | | $V_{IN+} = 0V$, $V_{IN-} = +1Vdc$, $V_O = 200mV$ | 12 | 50 | | 12 | 50 | | μA |
| $I_{SC}$ | Short circuit current[5] | | | 40 | 60 | | 40 | 60 | mA |
| | Differential input voltage[6] | | | | V+ | | | V+ | V |
| GBW | Unity gain bandwidth | $T_A = 25°C$ | | 1 | | | 1 | | MHz |
| S.R. | Slew rate | $T_A = 25°C$ | | 0.3 | | | 0.3 | | V/μs |
| Noise | Input Noise Voltage | $T_A = 25°C$, f = 1kHz | | 40 | | | 40 | | nV/√Hz |

NOTES

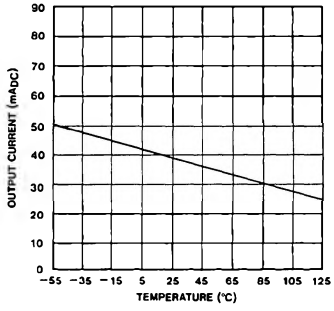
1. $V_O \cong 1.4V$, $R_S = 0\Omega$ with $V+$ from 5V to 30V; and over the full input common-mode range (0V to $V+ - 1.5V$).
2. The direction of the input current is out of the IC due to the pnp input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
3. The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is $V+ - 1.5V$, but either or both inputs can go to +32V without damage.
4. Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitance coupling increases at higher frequencies.
5. Short circuits from the output to $V+$ can cause excessive heating and eventual destruction. The maximum output current is approximately 40mA independent of the magnitude of $V+$. At values of supply voltage in excess of +15Vdc, continuous short-circuits can exceed the power dissipation ratings and cause eventual destruction.
6. The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is $V+ - 1.5V$, buteither or both inputs can go to +32Vdc without damage.
7. For operating at high temperatures, all devices must be derated based on a +125°C maximum junction temperature and a thermal resistance of 175°C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient.

## TYPICAL PERFORMANCE CHARACTERISTICS

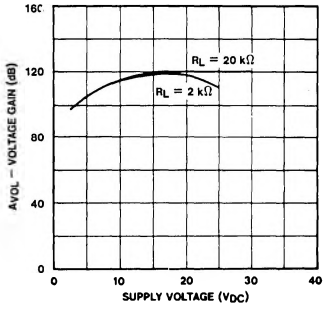
### SUPPLY CURRENT



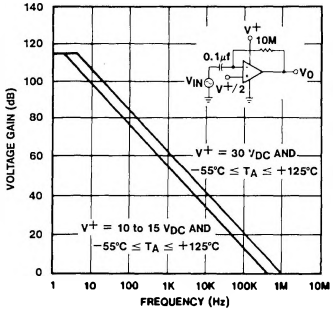

### CURRENT LIMITING



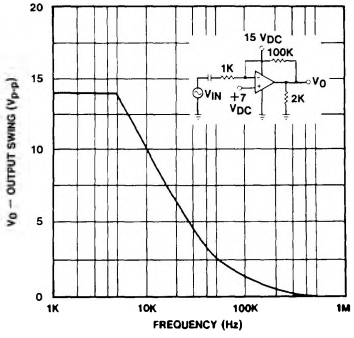

### VOLTAGE GAIN



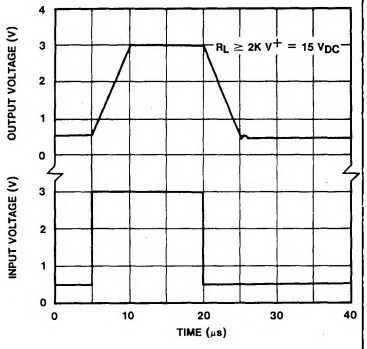

### OPEN LOOP FREQUENCY RESPONSE



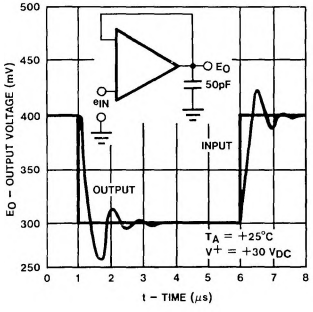

### LARGE SIGNAL FREQUENCY RESPONSE



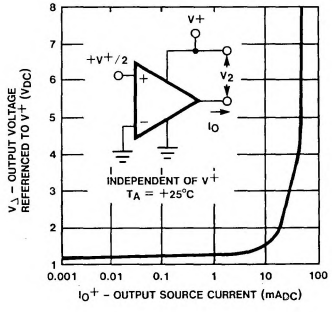

### VOLTAGE FOLLOWER PULSE RESPONSE



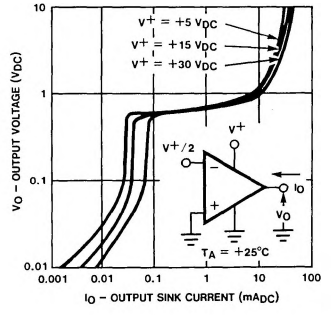

### VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)




### OUTPUT CHARACTERISTICS CURRENT SOURCING



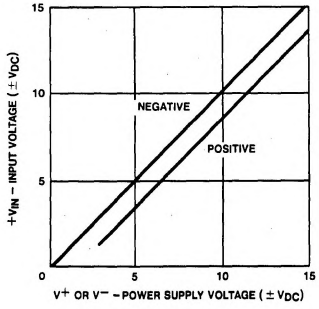

### OUTPUT CHARACTERISTICS CURRENT SINKING



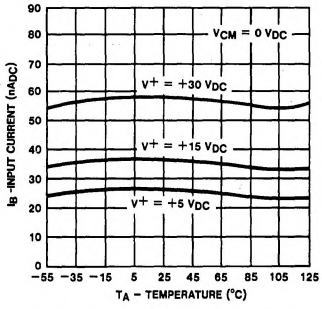
# LOW POWER DUAL OPERATIONAL AMPLIFIERS SA/SE/NE532/LM158/258/358

## TYPICAL PERFORMANCE CHARACTERISTICS (Cont'd)

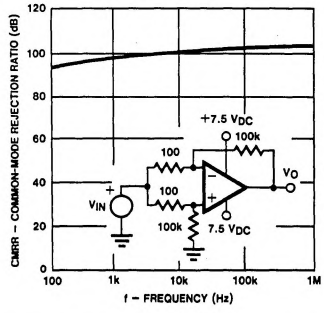
**INPUT VOLTAGE RANGE**




**INPUT CURRENT**

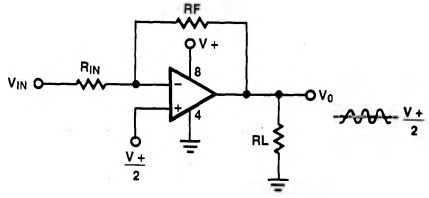



**COMMON MODE REJECTION RATIO**

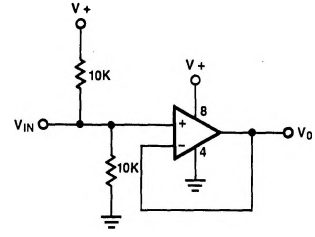



## TYPICAL APPLICATIONS

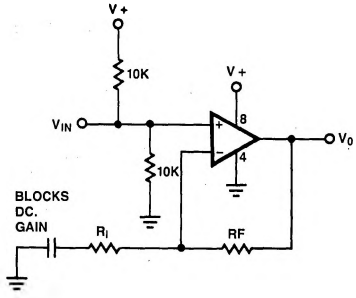
**SINGLE SUPPLY INVERTING AMPLIFIER**




**INPUT BIASING *VOLTAGE FOLLOWER**




**NON-INVERTING AMPLIFIER**



# GENERAL PURPOSE OPERATIONAL AMPLIFIER — MC/SA1458/MC1558

## DESCRIPTION

The MC1458 is a high performance operational amplifier with high open loop gain, internal compensation, high common mode range and exceptional temperature stability. The MC1458 is short-circuit protected and allows for nulling of offset voltage.

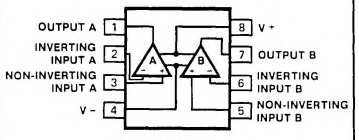
The MC1458/SA1458/MC1558 consists of a pair of 741 operational amplifiers on a single chip.

## FEATURES

- **Internal frequency compensation**
- **Short circuit protection**
- **Excellent temperature stability**
- **High input voltage range**
- **No latch-up**
- **1558/1458 are 2 "op amps" in space of one 741 package**
- **MC1558 MIL-STD-883A,B,C available**

## PIN CONFIGURATIONS

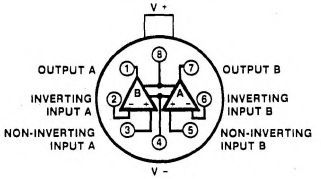
**D,N, PACKAGE**




TOP VIEW

ORDER NUMBERS
MC1458N
MC1558N
SA1458N

**H PACKAGE***




ORDER NUMBERS
MC1458H
MC1558H

*Metal cans (H) not recommended for new designs

## ABSOLUTE MAXIMUM RATINGS

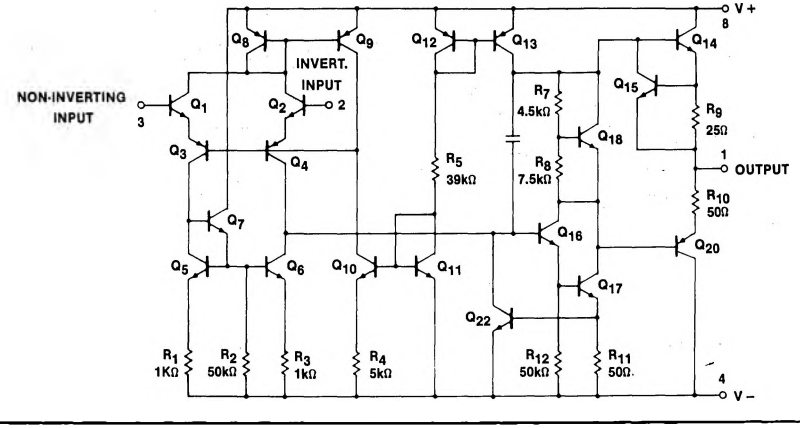
| PARAMETER | RATING | UNIT |
|---|---|---|
| Supply voltage | | |
| MC1458 | ±18 | V |
| SA1458 | ±18 | V |
| MC1558 | ±22 | V |
| Internal power dissipation | | |
| N package | 500 | mW |
| H package[1] | 800 | mW |
| F,FE package | 1000 | mW |
| Differential input voltage | ±30 | V |
| Input voltage[2] | ±15 | V |
| Output short-circuit duration | Continuous | |
| Operating temperature range | | |
| MC1458 | 0 to +70 | °C |
| SA1458 | -40 to +85 | °C |
| MC1558 | -55 to +125 | °C |
| Storage temperature range | -65 to +150 | °C |
| Lead temperature (soldering 60sec) | 300 | °C |

NOTES

1. Ratings based on thermal resistances, junction to ambient, of 240°C/W, 150°C/W, 110°C/W for N, H, F and FE packages respectively, and a maximum junction temperature of 150°C.
2. For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

## EQUIVALENT SCHEMATIC

**AMPLIFIER "A" OF MC1458, SA1458, MC1558**



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

| PARAMETER | | TEST CONDITIONS | MC1558 | | | UNIT |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| $V_{OS}$ | Offset voltage | $R_S = 10k\Omega$ | | 1.0 | 5.0 | mV |
| | | $R_S = 10k\Omega$, over temperature | | | 6.0 | mV |
| $\Delta V_{OS}$ | Offset voltage | Over temperature | | 10 | | $\mu V/°C$ |
| $I_{OS}$ | Offset current | | | 20 | 200 | nA |
| | | Over temperature | | | 500 | nA |
| $\Delta I_{OS}$ | Offset current | Over temperature | | 0.10 | | nA/°C |
| $I_{BIAS}$ | Input bias current | | | 80 | 500 | nA |
| | | Over temperature | | | 1500 | nA |
| $\Delta I_B$ | Bias current | Over temperature | | 1.0 | | nA/°C |
| $V_{OUT}$ | Output voltage swing | $R_L = 10k\Omega$, over temperature | ± 12 | ± 14 | | V |
| | | $R_L = 2k\Omega$, over temperature | ± 10 | ± 13 | | V |
| $A_{VOL}$ | Large signal voltage gain | $R_L = 2k\Omega$, $V_O = \pm 10V$ | 50 | 100 | | V/mV |
| | | $R_L = 2k\Omega$, $V_O = \pm 10V$, over temperature | 20 | | | V/mV |
| | Offset voltage adjustment range | | | ± 30 | | mV |
| PSRR | Supply voltage rejection ratio | $R_S \leq 10k\Omega$ | | 30 | 150 | $\mu V/V$ |
| CMRR | Common mode rejection ratio | | 70 | 90 | | dB |
| $I_{CC}$ | Supply current | | | 2.3 | 5.0 | mA |
| $V_{IN}$ | Input voltage range | | ± 12 | ± 13 | | V |
| $P_d$ | Power consumption | | | 70 | 150 | mW |
| | Channel separation | | | 120 | | dB |
| $R_{OUT}$ | Output resistance | | | 75 | | Ω |
| $I_{SC}$ | Output short-circuit current | | 10 | 26 | 60 | mA |

**DC ELECTRICAL CHARACTERISTICS** (Cont'd) $T_A = 25°C$, $V_{CC} = \pm 15V$, unless otherwise specified.[1]

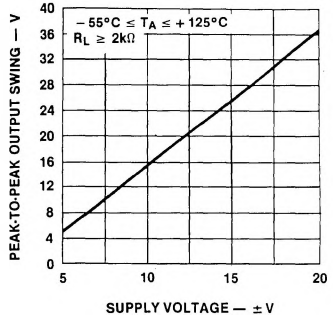
| PARAMETER | | TEST CONDITIONS | MC1458 | | | SA1458 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| $V_{OS}$ | Offset voltage | $R_S = 10k\Omega$ | | 2.0 | 6.0 | | 2.0 | 6.0 | mV |
| | | $R_S = 10k\Omega$, over temp. | | | 7.5 | | | 7.5 | mV |
| $\Delta V_{OS}$ | Offset voltage | Over temperature | | 12 | | | 12 | | $\mu V/°C$ |
| $I_{OS}$ | Offset current | | | 20 | 200 | | 20 | 200 | nA |
| | | Over temperature | | | 300 | | | 500 | nA |
| $\Delta I_{OS}$ | Offset current | Over temperature | | 0.10 | | | 0.10 | | nA/°C |
| $I_{BIAS}$ | Input bias current | | | 80 | 500 | | 80 | 500 | nA |
| | | Over temperature | | | 800 | | | 1500 | nA |
| $\Delta I_B$ | Bias current | Over temperature | | 1.0 | | | 1.0 | | nA/°C |
| $V_{OUT}$ | Output voltage swing | $R_L = 10k\Omega$ | ± 12 | ± 14 | | ± 12 | ± 14 | | V |
| | | $R_L = 2k\Omega$, over temp. | ± 10 | ± 13 | | ± 10 | ± 13 | | V |
| $A_{VOL}$ | Large signal voltage gain | $R_L = 2k\Omega$, $V_O = \pm 10V$ | 25 | 200 | | 20 | 200 | | V/mV |
| | | $R_L = 2k\Omega$, $V_O = \pm 10V$, Over temperature | 15 | | | 15 | | | V/mV |
| | Offset voltage adjustment range | | | ± 30 | | | ± 30 | | mV |
| PSRR | Supply voltage rejection ratio | $R_S \leq 10k\Omega$ | | 30 | 150 | | 30 | 150 | $\mu V/V$ |
| CMRR | Common mode rejection ratio | | 70 | 90 | | 70 | 90 | | dB |
| $I_{CC}$ | Supply current | | | 2.3 | 5.6 | | 2.3 | 5.6 | mA |
| $V_{IN}$ | Input voltage range | | ± 12 | ± 13 | | ± 12 | ± 13 | | V |
| $R_{IN}$ | Input resistance | | | | | | | | MΩ |
| $P_d$ | Power consumption | | | 70 | 170 | | 70 | 170 | mW |
| | Channel separation | | | 120 | | | 120 | | dB |
| $I_{SC}$ | Output short-circuit current | | | 25 | | | 25 | | mA |

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

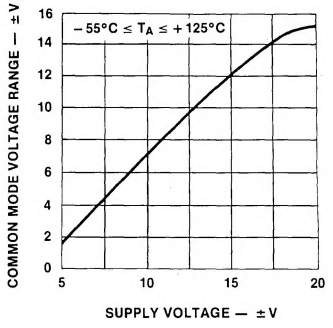
| PARAMETER | TEST CONDITIONS | MC1458, SA1458, MC1558 | | | UNIT |
|---|---|---|---|---|---|
| | | Min | Typ | Max | |
| Parallel input resistance | Open loop, f = 20Hz | 0.3 | | | MΩ |
| Common mode input impedance | f = 20Hz | | 200 | | MΩ |
| Equivalent input noise voltage | $A_V = 100$, $R_S = 10k\Omega$, $B_W = 1.0kHz$, f = 1.0kHz | | 30 | | nV $\sqrt{Hz}$ |
| Power bandwidth | $A_V = 1$, $R_L = 2.0k\Omega$, THD ≤ 5%, $V_{OUT} = 20Vp\text{-}p$ | | 14 | | kHz |
| Phase margin | | | 65 | | degrees |
| Gain margin | | | 11 | | dB |
| Unity gain crossover frequency | Open loop | | 1.0 | | MHz |
| Transient response unity gain | $V_{IN} = 20mV$, $R_L = 2k\Omega$, $C_L \leq 100pF$ | | | | |
| Rise time | | | 0.3 | | μs |
| Overshoot | | | 5.0 | | % |
| Slew rate | C ≤ 100pF, $R_L \geq 2k$, $V_{IN} = \pm 10V$ | | 0.8 | | V/μs |

## TYPICAL PERFORMANCE CHARACTERISTICS

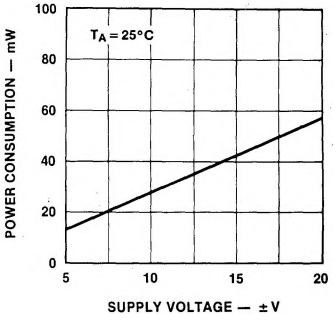
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



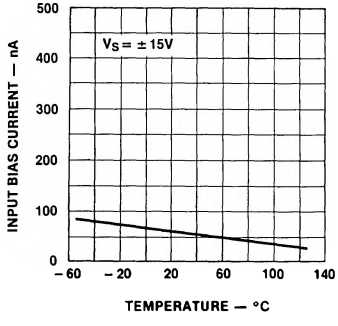

INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



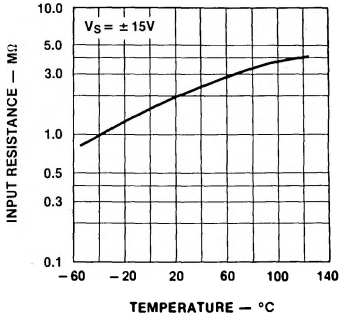

POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



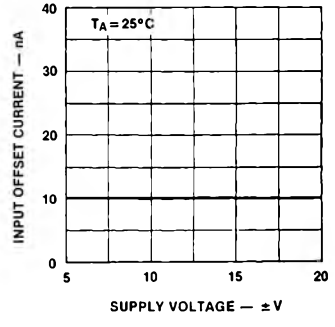

INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE




INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE

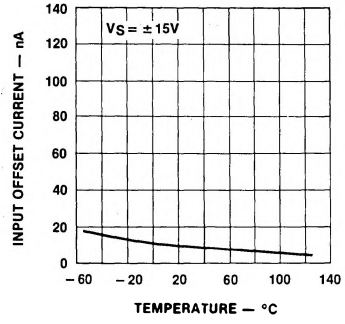



INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE

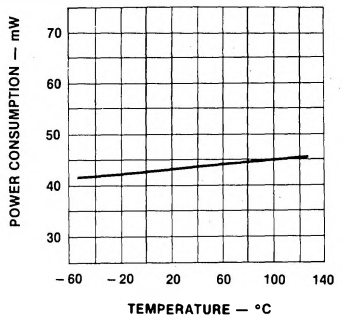


## TYPICAL PERFORMANCE CHARACTERISTICS (Cont'd)

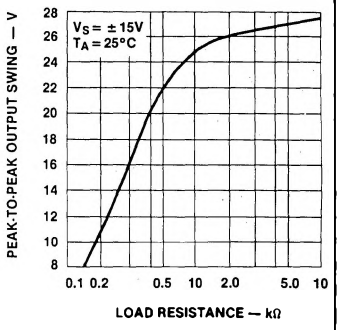
### INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



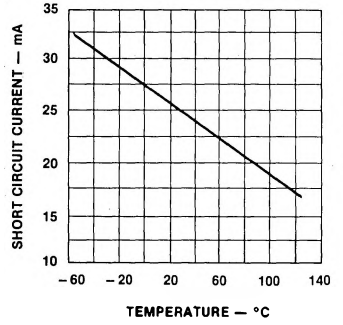

### POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



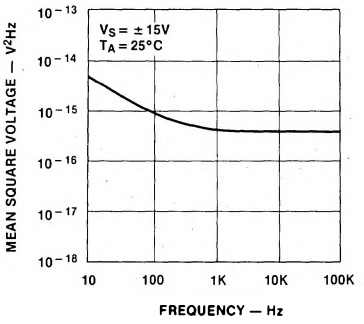

### OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



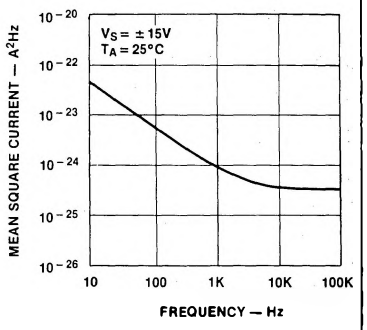

### OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



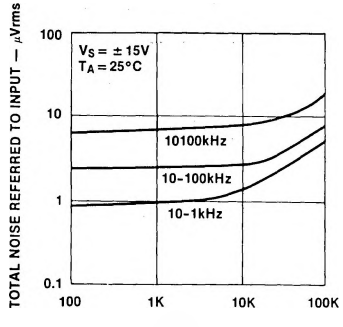

### INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



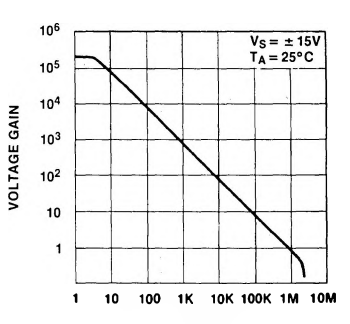

### INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY



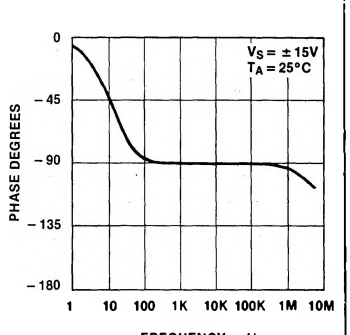

### BROADBAND NOISE FOR VARIOUS BANDWIDTHS




### OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY

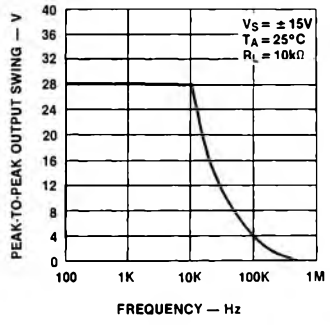



### OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY

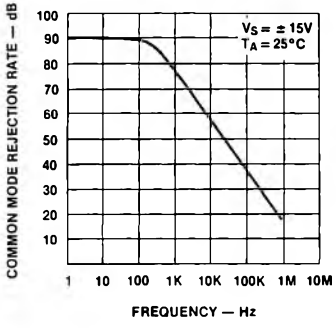


## TYPICAL PERFORMANCE CHARACTERISTICS (Cont'd)

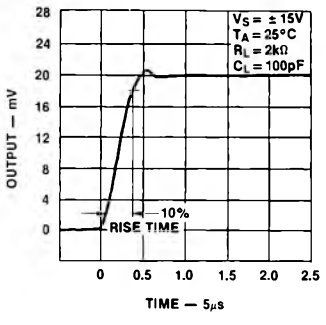
**OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY**




**COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY**




**TRANSIENT RESPONSE**




**POWER BANDWIDTH (Large Signal Swing vs Frequency)**