



Precision Monolithics Inc.

# OP-20

MICROPOWER OPERATIONAL AMPLIFIER  
(SINGLE OR DUAL SUPPLY)

## FEATURES

- Low Supply Current ..... 55µA Max
- Single-Supply Operation ..... +5V to +30V
- Dual-Supply Operation ..... ±2.5V to ±15V
- Low Input Offset Voltage ..... 250µV Max
- Low Input Offset Voltage Drift ..... 1.5µV/°C Max
- High Common-Mode Input Range ..... V- to V+ (-1.5V)
- High CMRR and PSRR ..... 100dB Min
- High Open-Loop Gain ..... 120dB Min
- No External Components Required
- 741 Pinout and Nulling
- Available in Die Form

## ORDERING INFORMATION †

| T <sub>a</sub> = +25°C<br>V <sub>OS</sub> MAX<br>(mV) | PACKAGE |                 |                  | OPERATING<br>TEMPERATURE<br>RANGE |
|-------------------------------------------------------|---------|-----------------|------------------|-----------------------------------|
|                                                       | TO-99   | CERDIP<br>8-PIN | PLASTIC<br>8-PIN |                                   |
| 250                                                   | OP20BJ* | OP20BZ          | -                | MIL                               |
| 250                                                   | OP20FJ  | OP20FZ          | -                | IND                               |
| 250                                                   | -       | -               | OP20FP           | COM                               |
| 500                                                   | -       | OP20CZ          | -                | MIL                               |
| 500                                                   | OP20GJ  | OP20GZ          | -                | IND                               |
| 500                                                   | -       | -               | OP20GP           | COM                               |
| 1000                                                  | OP20HJ  | OP20HZ          | OP20HS††         | XIND                              |
| 1000                                                  | -       | -               | OP20HP           | XIND                              |

\* For devices processed in total compliance to MIL-STD-883, add /883 after part number. Consult factory for 883 data sheet.

† Burn-in is available on commercial and industrial temperature range parts in cerDIP, plastic DIP, and TO-can packages. For ordering information, see 1990/91 Data Book, Section 2.

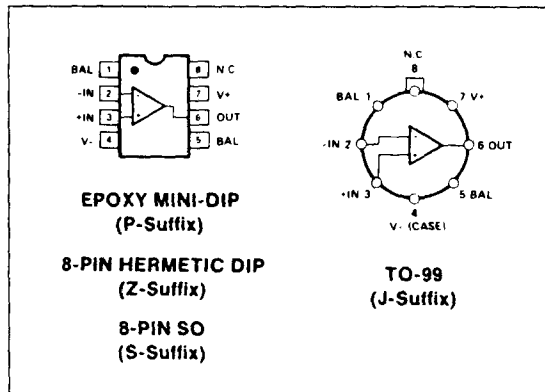
†† For availability and burn-in information on SO and PLCC packages, contact your local sales office.

## GENERAL DESCRIPTION

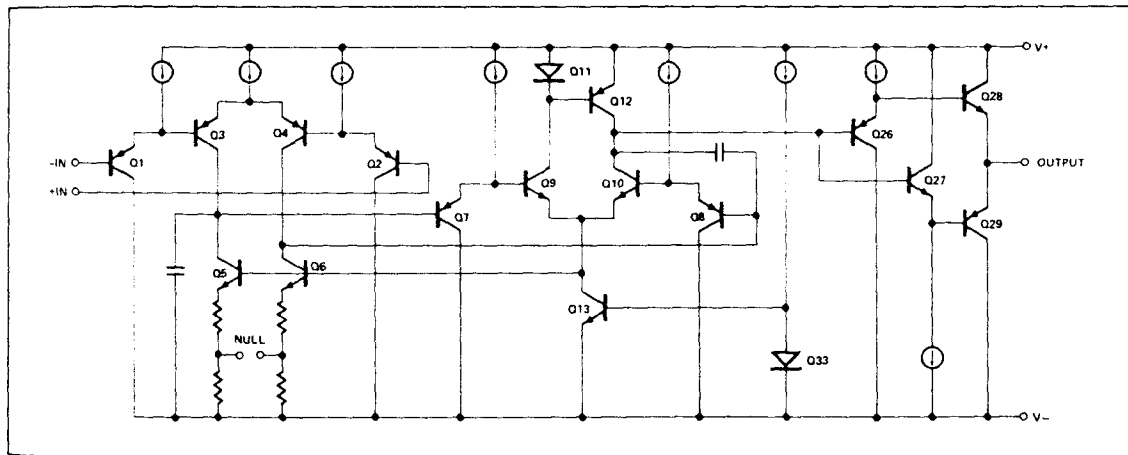
The OP-20 is a monolithic micropower operational amplifier that can be operated from a single power supply of +5V to +30V, or from dual supplies of ±2.5V to ±15V. The input voltage range extends to the negative rail, therefore input signals down to zero volts can be accommodated when operating from a single supply.

Precision performance in high-gain applications is readily obtained when using the OP-20. The B/F grade features a maximum input offset voltage of 250µV, minimum CMRR of 95dB, and open-loop gain of over 500,000. Quiescent supply current is a maximum of only 55µA at ±2.5V or 80µA at ±15V. The low input offset, high gain, and low power consumption brings precision performance to portable instruments, satellites, missile control systems, and many other battery-powered applications.

## PIN CONNECTIONS



## SIMPLIFIED SCHEMATIC



5 OPERATIONAL AMPLIFIERS/BUFFERS

he inverting input) to  
le. In many instances  
ter than the expected  
in and consequently  
argin. However, if the  
ately six times the  
tor should be placed  
ne op amp. The value  
h that the RC time-  
stance it parallels is  
feedback pole time

**ABSOLUTE MAXIMUM RATINGS (Note 1)**

|                                                  |                 |
|--------------------------------------------------|-----------------|
| Supply Voltage .....                             | ±18V            |
| Differential Input Voltage .....                 | ±30V            |
| Input Voltage .....                              | Supply Voltage  |
| Output Short-Circuit Duration .....              | Indefinite      |
| Storage Temperature Range                        |                 |
| J and Z Packages .....                           | -65°C to +150°C |
| P Package .....                                  | -65°C to +125°C |
| Operating Temperature Range                      |                 |
| OP-20B, OP-20C (J, Z) .....                      | -55°C to +125°C |
| OP-20F, OP-20G (J, Z) .....                      | -25°C to +85°C  |
| OP-20H (S, P, J, Z) .....                        | -40°C to +85°C  |
| OP-20FP, OP-20GP .....                           | 0°C to +70°C    |
| Lead Temperature Range (Soldering, 60 sec) ..... | 300°C           |
| Junction Temperature .....                       | -65°C to +150°C |

| PACKAGE TYPE           | $\theta_{JA}$ (NOTE 2) | $\theta_{JC}$ | UNITS |
|------------------------|------------------------|---------------|-------|
| TO-99 (J)              | 150                    | 18            | °C/W  |
| 8-Pin Hermetic DIP (Z) | 148                    | 16            | °C/W  |
| 8-Pin Plastic DIP (P)  | 103                    | 43            | °C/W  |
| 8-Pin SO (S)           | 158                    | 43            | °C/W  |

**NOTES:**

- Absolute maximum ratings apply to both DICE and packaged parts, unless otherwise noted.
- $\theta_{JA}$  is specified for worst case mounting conditions, i.e.,  $\theta_{JA}$  is specified for device in socket for TO, CerDIP and P-DIP packages;  $\theta_{JA}$  is specified for device soldered to printed circuit board for SO package.

**ELECTRICAL CHARACTERISTICS at  $V_S = \pm 2.5V$  to  $\pm 15V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.**

| PARAMETER                    | SYMBOL   | CONDITIONS                                                                                                    | OP-20B/F |      |     | OP-20C/G |      |     | OP-20H  |      |      | UNITS      |
|------------------------------|----------|---------------------------------------------------------------------------------------------------------------|----------|------|-----|----------|------|-----|---------|------|------|------------|
|                              |          |                                                                                                               | MIN      | TYP  | MAX | MIN      | TYP  | MAX | MIN     | TYP  | MAX  |            |
| Input Offset Voltage         | $V_{OS}$ | $V_S = \pm 15V$                                                                                               | —        | 55   | 250 | —        | 150  | 500 | —       | 300  | 1000 | $\mu V$    |
| Input Offset Current         | $I_{OS}$ | $V_{CM} = 0$                                                                                                  | —        | 0.15 | 1.5 | —        | 0.2  | 2.5 | —       | 0.3  | 4.0  | nA         |
| Input Bias Current           | $I_B$    | $V_{CM} = 0$                                                                                                  | —        | 12   | 25  | —        | 14   | 30  | —       | 16   | 40   | nA         |
| Input Voltage Range          | IVR      | $V_+ = +5V$ ,<br>$V_- = 0V$<br>$V_S = \pm 15V$                                                                | 0/3.5    | —    | —   | 0/3.5    | —    | —   | 0/3.5   | —    | —    | V          |
| Common-Mode Rejection Ratio  | CMRR     | $V_+ = +5V$ , $V_- = 0V$<br>$0V \leq V_{CM} \leq 3.5V$<br>$V_S = \pm 15V$                                     | 95       | 105  | —   | 90       | 95   | —   | 85      | 90   | —    | dB         |
|                              |          | $-15V \leq V_{CM} \leq 13.5V$                                                                                 | 100      | 110  | —   | 94       | 105  | —   | 90      | 100  | —    |            |
| Power Supply Rejection Ratio | PSRR     | $V_S = \pm 2.5V$ to $\pm 15V$<br>and $V_- = 0V$ ,<br>$V_+ = 5V$ to $30V$                                      | —        | 4    | 6   | —        | 6    | 10  | —       | 10   | 32   | $\mu V/V$  |
| Large-Signal Voltage Gain    | $A_{VO}$ | $V_+ = +5V$ , $V_- = 0V$<br>$1V \leq V_O \leq 3.5V$<br>$V_S = \pm 15V$ , $V_O = \pm 10V$<br>$R_L = 25k\Omega$ | 300      | 500  | —   | 200      | 500  | —   | —       | 500  | —    | V/mV       |
|                              |          | $V_+ = 5V$ , $V_- = 0V$<br>$R_L = 10k\Omega$<br>$V_S = \pm 15V$ ,<br>$R_L = 25k\Omega$                        | 1000     | 2000 | —   | 800      | 2000 | —   | —       | 500  | 1000 | —          |
| Output Voltage Swing         | $V_O$    | $V_+ = 5V$ , $V_- = 0V$<br>$R_L = 10k\Omega$<br>$V_S = \pm 15V$ ,<br>$R_L = 25k\Omega$                        | 0.6/4.1  | —    | —   | 0.7/4.1  | —    | —   | 0.8/4.0 | —    | —    | V          |
| Closed-Loop Bandwidth        | BW       | $A_{VCL} = +1.0$ ,<br>$R_L = 10k\Omega$                                                                       | —        | 100  | —   | —        | 100  | —   | —       | 100  | —    | kHz        |
| Slew Rate                    | SR       | $V_S = \pm 15V$<br>$R_L = 25k\Omega$                                                                          | —        | 0.05 | —   | —        | 0.05 | —   | —       | 0.05 | —    | V/ $\mu s$ |
| Supply Current               | $I_{SY}$ | $V_S = \pm 2.5V$ ,<br>No Load                                                                                 | —        | 40   | 55  | —        | 44   | 63  | —       | 45   | 70   | $\mu A$    |
|                              |          | $V_S = \pm 15V$ ,<br>No Load                                                                                  | —        | 55   | 80  | —        | 57   | 85  | —       | 60   | 95   |            |

ELECTRI  
+85°C for  
20HJ, and**PARAMETE**Average Inpu  
Offset Volta  
Drift Note  
Input Offset  
Input Offset  
Input Bias C  
Input Voltage  
RangeCommon-M  
Rejection FPower Supp  
Rejection FLarge-Sign  
Voltage Ga

Output Volt

Supply Cur

**NOTE:**  
1. Sampl

|          |               |               |
|----------|---------------|---------------|
| (NOTE 2) | $\theta_{JC}$ | UNITS         |
| 150      | 18            | $^{\circ}C/W$ |
| 148      | 16            | $^{\circ}C/W$ |
| 103      | 43            | $^{\circ}C/W$ |
| 158      | 43            | $^{\circ}C/W$ |

with DICE and packaged parts, unless otherwise specified.  
 Operating conditions, i.e.,  $\theta_{JA}$  is specified for P-DIP packages;  $\theta_{JA}$  is specified for SO package.

| OP-20H |     |      | UNITS      |
|--------|-----|------|------------|
| MIN    | TYP | MAX  |            |
| —      | 300 | 1000 | $\mu V$    |
| —      | 0.3 | 4.0  | nA         |
| —      | 16  | 40   | nA         |
| 3.5    | —   | —    | V          |
| 3.5    | —   | —    | V          |
| 35     | —   | —    | dB         |
| 10     | 32  | —    | $\mu V/V$  |
| 500    | —   | —    | V/mV       |
| 1000   | —   | —    | V          |
| 100    | —   | —    | kHz        |
| 0.05   | —   | —    | V/ $\mu s$ |
| 45     | 70  | —    | $\mu A$    |
| 60     | 95  | —    | $\mu A$    |

**ELECTRICAL CHARACTERISTICS** at  $V_S = \pm 2.5V$  to  $\pm 15V$ ,  $-55^{\circ}C \leq T_A \leq +125^{\circ}C$  for OP-20BJ/BZ and OP-20CZ,  $-25^{\circ}C \leq T_A \leq +85^{\circ}C$  for OP-20FJ/FZ and OP-20GJ/GZ, and  $0^{\circ}C \leq T_A \leq +70^{\circ}C$  for OP-20FP, OP-20GP, and  $-40^{\circ}C \leq T_A \leq +85^{\circ}C$  for OP-20HZ, OP-20HU, and OP-20HP/HS, unless otherwise noted.

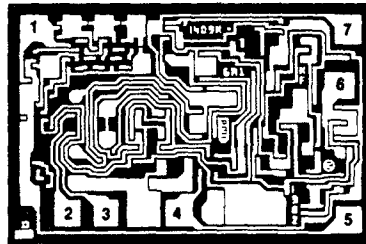
| PARAMETER                                   | SYMBOL            | CONDITIONS                                                                                                                                                   | OP-20B/F              |            |          | OP-20C/G              |           |           | OP-20H                |           |           | UNITS             |
|---------------------------------------------|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|------------|----------|-----------------------|-----------|-----------|-----------------------|-----------|-----------|-------------------|
|                                             |                   |                                                                                                                                                              | MIN                   | TYP        | MAX      | MIN                   | TYP       | MAX       | MIN                   | TYP       | MAX       |                   |
| Average Input Offset Voltage Drift (Note 1) | TCV <sub>OS</sub> | Unloaded                                                                                                                                                     | —                     | 0.75       | 1.5      | —                     | 1.0       | 3.0       | —                     | 1.5       | 7.0       | $\mu V/^{\circ}C$ |
| Input Offset Voltage                        | V <sub>OS</sub>   | V <sub>S</sub> = $\pm 15V$                                                                                                                                   | —                     | 155        | 400      | —                     | 250       | 800       | —                     | 500       | 1700      | $\mu V$           |
| Input Offset Current                        | I <sub>OS</sub>   | V <sub>CM</sub> = 0                                                                                                                                          | —                     | 0.5        | 2.5      | —                     | 1.0       | 3.5       | —                     | 1.5       | 5.0       | nA                |
| Input Bias Current                          | I <sub>B</sub>    | V <sub>CM</sub> = 0                                                                                                                                          | —                     | 12         | 27       | —                     | 14        | 33        | —                     | 16        | 45        | nA                |
| Input Voltage Range                         | IVR               | V <sub>+</sub> = +5V, V <sub>-</sub> = 0V<br>V <sub>S</sub> = $\pm 15V$                                                                                      | 0/3.2<br>-15/13.2     | —          | —        | 0/3.2<br>-15/13.2     | —         | —         | 0/3.2<br>-15/13.2     | —         | —         | V                 |
| Common-Mode Rejection Ratio                 | CMRR              | V <sub>+</sub> = +5V, V <sub>-</sub> = 0V<br>0V $\leq$ V <sub>CM</sub> $\leq$ 3.2V<br>V <sub>S</sub> = $\pm 15V$<br>-15V $\leq$ V <sub>CM</sub> $\leq$ 13.2V | 90<br>96              | 100<br>110 | —        | 85<br>90              | 90<br>105 | —         | 80<br>85              | 85<br>100 | —         | dB                |
| Power Supply Rejection Ratio                | PSRR              | V <sub>S</sub> = $\pm 2.5V$ to $\pm 15V$<br>V <sub>-</sub> = 0V,<br>V <sub>+</sub> = 5V to 30V                                                               | —                     | 4          | 10       | —                     | 6         | 18        | —                     | 10        | 32        | $\mu V/V$         |
| Large-Signal Voltage Gain                   | A <sub>VO</sub>   | V <sub>S</sub> = $\pm 15V$ , V <sub>O</sub> = $\pm 10V$<br>R <sub>L</sub> = 50k $\Omega$                                                                     | 500                   | 700        | —        | 400                   | 600       | —         | 250                   | 400       | —         | V/mV              |
| Output Voltage Swing                        | V <sub>O</sub>    | V <sub>+</sub> = 5V, V <sub>-</sub> = 0V,<br>R <sub>L</sub> = 50k $\Omega$<br>V <sub>S</sub> = $\pm 15V$ ,<br>R <sub>L</sub> = 50k $\Omega$                  | 0.8/4.0<br>$\pm 14.0$ | —          | —        | 0.9/3.9<br>$\pm 13.9$ | —         | —         | 1.0/3.8<br>$\pm 13.9$ | —         | —         | V                 |
| Supply Current                              | I <sub>SV</sub>   | V <sub>S</sub> = $\pm 2.5V$ , No Load or +5V, 0V<br>V <sub>S</sub> = $\pm 15V$ ,<br>No Load                                                                  | —                     | 50<br>64   | 65<br>95 | —                     | 53<br>68  | 75<br>100 | —                     | 55<br>72  | 85<br>115 | $\mu A$           |

NOTE:  
1. Sample tested.

5

OPERATIONAL AMPLIFIERS/BUFFERS

DICE CHARACTERISTICS



DIE SIZE 0.069 × 0.046 inch, 3174 sq. mils  
(1.75 × 1.17 mm, 2.05 sq. mm)

1. BALANCE
2. INVERTING INPUT
3. NONINVERTING INPUT
4. V-
5. BALANCE
6. OUTPUT
7. V+

For additional DICE ordering information, refer to 1990/91 Data Book, Section 2.

WAFER TEST LIMITS at  $V_S = \pm 15V$ ,  $T_A = 25^\circ C$ , unless otherwise noted.

| PARAMETER                    | SYMBOL   | CONDITIONS                                                                                         | OP-20N<br>LIMIT       | OP-20G<br>LIMIT       | OP-20GR<br>LIMIT      | UNITS         |
|------------------------------|----------|----------------------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|---------------|
| Input Offset Voltage         | $V_{OS}$ |                                                                                                    | 300                   | 600                   | 1000                  | $\mu V$ MAX   |
| Input Offset Current         | $I_{OS}$ |                                                                                                    | 1.5                   | 2.5                   | 4.0                   | nA MAX        |
| Input Bias Current           | $I_B$    |                                                                                                    | 25                    | 30                    | 40                    | nA MAX        |
| Input Voltage Range          | IVR      | $V+ = +5V, V- = 0V$<br>$V_S = \pm 15V$                                                             | 0/3.5<br>-15/13.5     | 0/3.5<br>-15/13.5     | 0/3.5<br>-15/13.5     | V MIN         |
| Common-Mode Rejection Ratio  | CMRR     | $V+ = +5V, V- = 0V, 0V \leq V_{CM} \leq +3.5V$<br>$V_S = \pm 15V, -15V \leq V_{CM} \leq \pm 13.5V$ | 95<br>100             | 90<br>94              | 85<br>90              | dB MIN        |
| Power Supply Rejection Ratio | PSRR     | $V_S = \pm 2.5V$ to $\pm 15V$<br>$V- = 0V, V+ = +5V$<br>to $+30V$                                  | 6                     | 10                    | 32                    | $\mu V/V$ MAX |
| Large-Signal Voltage Gain    | $A_{VO}$ | $R_L = 25k\Omega$<br>$V_O = \pm 10V$                                                               | 1000                  | 800                   | 500                   | V/mV MIN      |
| Output Voltage Swing         | $V_O$    | $R_L = 10k\Omega, V+ = +5V, V- = 0V$<br>$R_L = 25k\Omega, V_S = \pm 15V$                           | 0.7/4.1<br>$\pm 14.1$ | 0.8/4.1<br>$\pm 14.1$ | 0.9/4.0<br>$\pm 14.0$ | V MIN         |
| Supply Current               | $I_{SV}$ | $V_S = \pm 2.5V$ , No Load<br>$V_S = \pm 15V$ , No Load                                            | 55<br>80              | 63<br>85              | 70<br>95              | $\mu A$ MAX   |

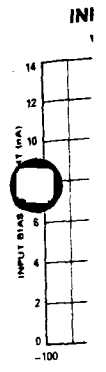
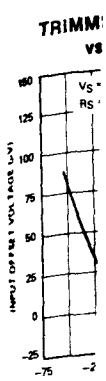
NOTE:

Electrical tests are performed at wafer probe to the limits shown. Due to variations in assembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualification through sample lot assembly and testing.

TYPICAL ELECTRICAL CHARACTERISTICS at  $V_S = \pm 15V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.

| PARAMETER                          | SYMBOL      | CONDITIONS                | OP-20N<br>TYPICAL | OP-20G<br>TYPICAL | OP-20GR<br>TYPICAL | UNITS            |
|------------------------------------|-------------|---------------------------|-------------------|-------------------|--------------------|------------------|
| Average Input Offset Voltage Drift | $TCV_{OS}$  | Unnulled                  | 1.0               | 1.5               | 2.5                | $\mu V/^\circ C$ |
| Offset Voltage Drift               | $TCV_{OSn}$ | Nulled, $R_p = 10k\Omega$ | 1.0               | 1.5               | 2.5                | $\mu V/^\circ C$ |
| Large-Signal Voltage Gain          | $A_{VO}$    | $R_L = 25k\Omega$         | 2000              | 2000              | 1000               | V/mV             |

TYPICAL P

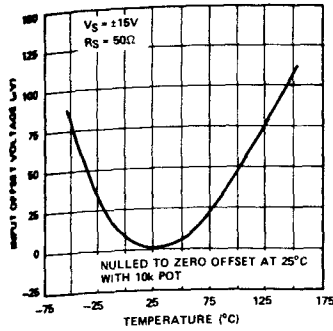


SMALL-S

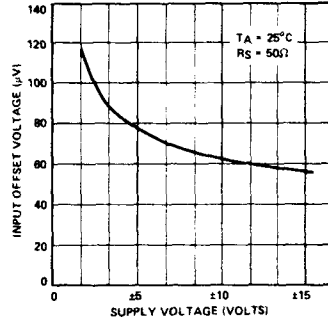


TYPICAL PERFORMANCE CHARACTERISTICS

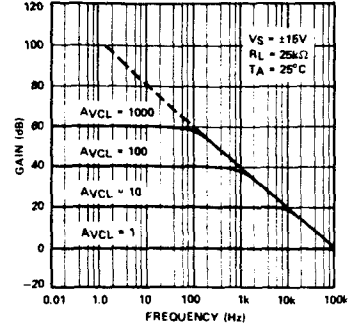
TRIMMED OFFSET VOLTAGE vs TEMPERATURE



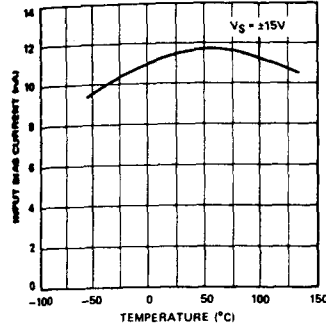
INPUT OFFSET VOLTAGE vs POWER SUPPLY VOLTAGE



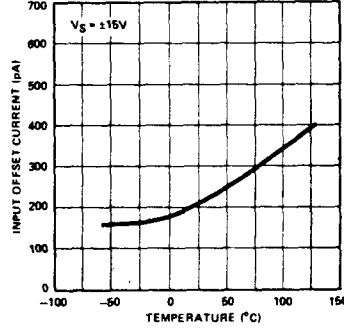
CLOSED-LOOP GAIN vs FREQUENCY



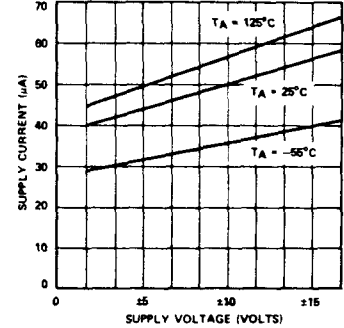
INPUT BIAS CURRENT vs TEMPERATURE



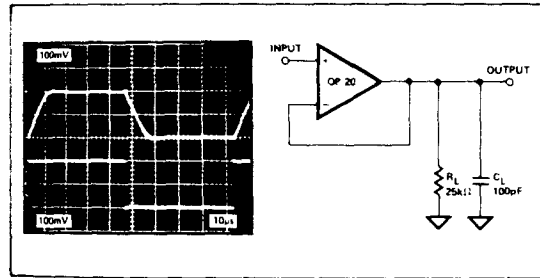
INPUT OFFSET CURRENT vs TEMPERATURE



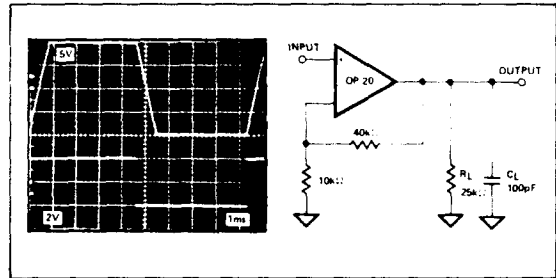
SUPPLY CURRENT vs SUPPLY VOLTAGE



SMALL-SIGNAL TRANSIENT RESPONSE



LARGE-SIGNAL TRANSIENT RESPONSE



Information, section 2.

| OP-20GR LIMIT | UNITS    |
|---------------|----------|
| 1000          | µV MAX   |
| 4.0           | nA MAX   |
| 40            | nA MAX   |
| 0/3.5         | V MIN    |
| 15/13.5       | V MIN    |
| 85            | dB MIN   |
| 90            | dB MIN   |
| 32            | µV/V MAX |
| 500           | V/mV MIN |
| 0.9/4.0       | V MIN    |
| ±14.0         | V MIN    |
| 70            | µA MAX   |
| 95            | µA MAX   |

Mass, yield after packaging is not for lot assembly and testing.

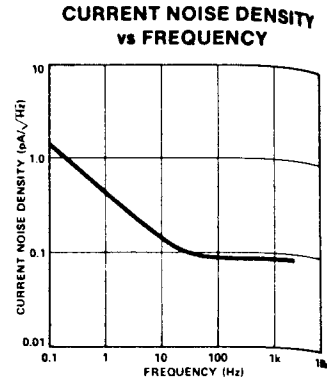
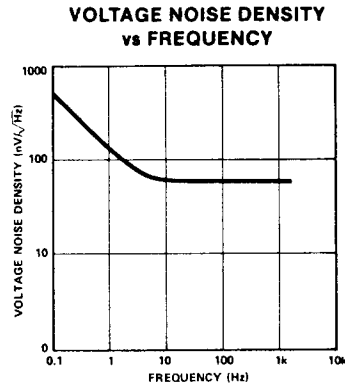
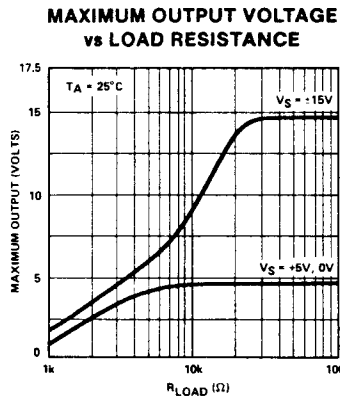
and.

| OP-20GR TYPICAL | UNITS |
|-----------------|-------|
| 2.5             | µV/°C |
| 2.5             | µV/°C |
| 1000            | V/mV  |

5 OPERATIONAL AMPLIFIERS/BUFFERS

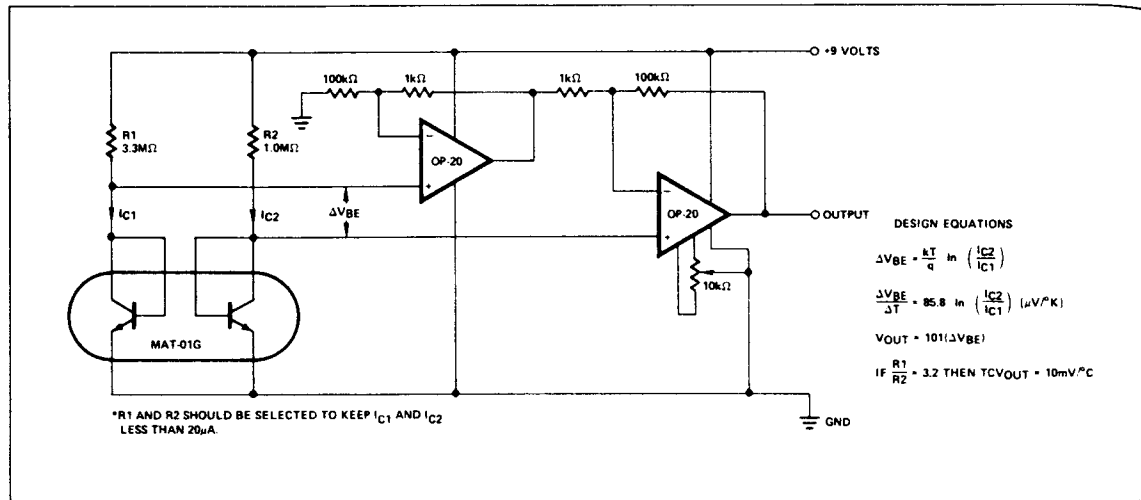


TYPICAL PERFORMANCE CHARACTERISTICS



TYPICAL APPLICATIONS

TEMPERATURE SENSOR



Precision Monolith

FEATURES

- Low Supply
- Wide Supply
- Low Input OI
- Low Input OI
- High Comm
- Input Rang
- High CMRR
- High Open-L
- 125°C Temp

ORDERING IN

| T <sub>a</sub> = +25°C<br>V <sub>os</sub> MAX<br>(mV) | TO  |
|-------------------------------------------------------|-----|
| 100                                                   | OP2 |
| 100                                                   | OP2 |
| 200                                                   | OP2 |
| 500                                                   | OP2 |
| 500                                                   | OP2 |

For details see  
number  
† Burn-in is avail:  
CerDIP, plastic  
1990/91 Data B  
†† For availability  
your local sales

SIMPLIFIED