

### FEATURES

- Low Supply Current ..... 200 $\mu$ A Max @  $V_S = +5V$
- Single-Supply Operation ..... +5V to +30V
- Dual-Supply Operation .....  $\pm 2.5V$  to  $\pm 15V$
- Low Input Offset Voltage ..... 500 $\mu$ V Typ
- Low Input Offset Voltage Drift ..... 5 $\mu$ V/ $^{\circ}$ C Typ
- High Common-Mode Input Range ... V- to (V+ - 1.5V)
- High CMRR ..... 100dB Typ
- High Open-Loop Gain ..... 1100V/mV Typ
- LM 148 Pinout
- Available in Die Form

### ORDERING INFORMATION <sup>†</sup>

| $T_A = +25^{\circ}C$<br>$V_{OS}^{MAX}$<br>(mV) | PACKAGE          |                   |         | OPERATING<br>TEMPERATURE<br>RANGE |
|--|------------------|-------------------|---------|-----------------------------------|
|  | CERDIP<br>14-PIN | LCC<br>20-CONTACT | PLASTIC |                                   |
| 2.5  | OP420BY          | -                 | -       | MIL                               |
| 2.5  | OP420FY          | -                 | -       | IND                               |
| 4.0  | OP420CY          | OP420CRC/883      | -       | MIL                               |
| 4.0  | OP420GY          | -                 | OP420GP | XIND                              |
| 4.0  | -                | -                 | OP420GS | XIND                              |
| 6.0  | OP420HY          | -                 | OP420HP | XIND                              |
| 6.0  | -                | -                 | OP420HS | XIND                              |

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

<sup>†</sup> Burn-in is available on commercial and industrial temperature range parts in CerDIP, plastic DIP, and TO-can packages.

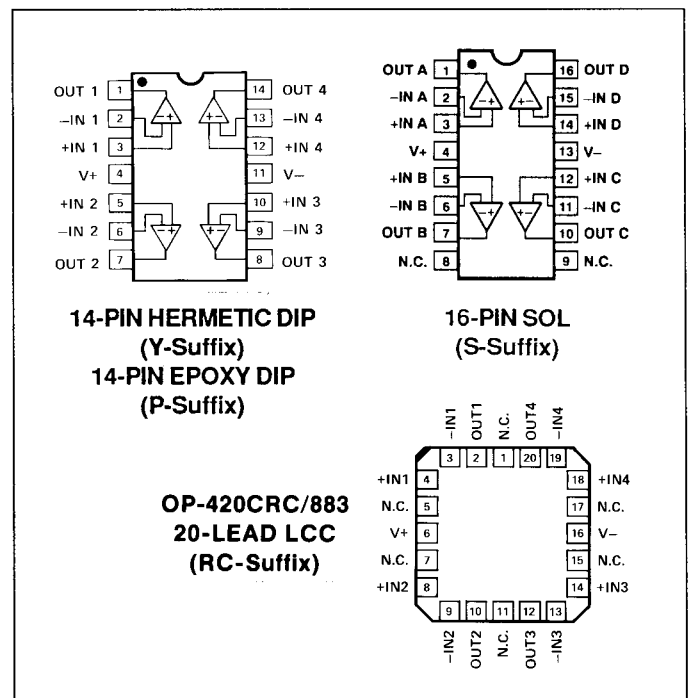
### GENERAL DESCRIPTION

The OP-420 quad micropower operational amplifier is a single-chip quad patterned after the OP-20 precision micropower single operational amplifier. A Darlington PNP input stage allows the input common-mode voltage to include V-. The wide input range combined with low power-supply drain

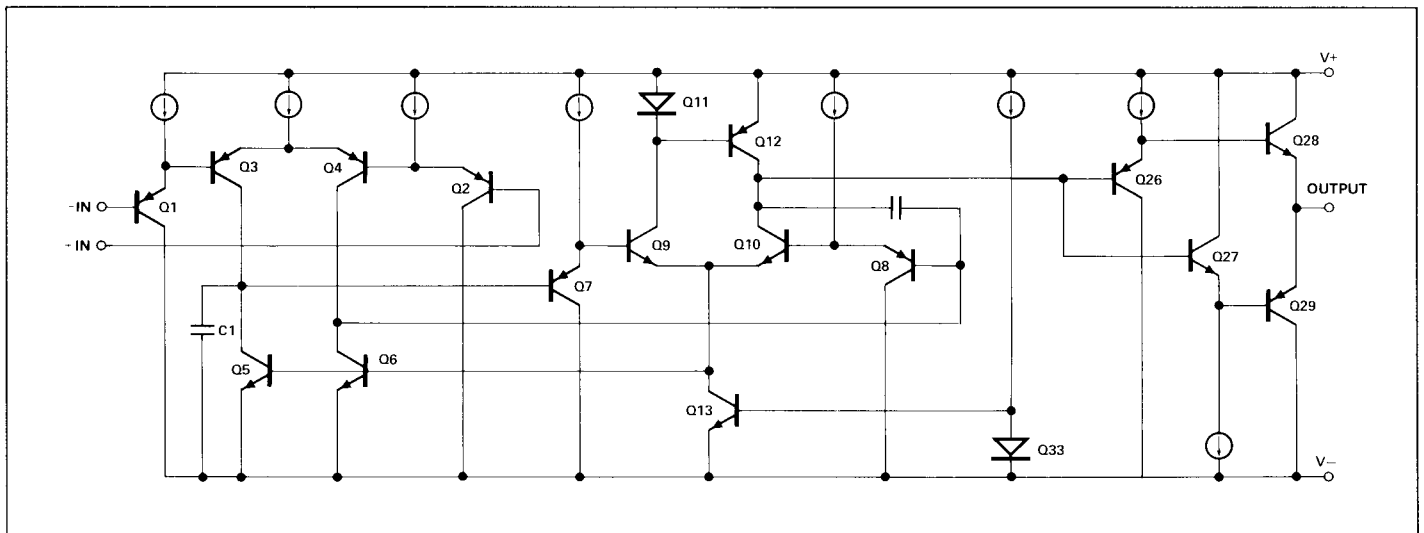
(~40 $\mu$ A/section at 5V), provides a unique solution for designs requiring high functional density and portable operation. Applications include two-wire transmitters for process control loops, battery-operated remote-line filters, signal preconditioning amplifiers, and a variety of multiple-gain block arrays.

For micropower applications requiring offset nulling, see the OP-20, OP-21 and OP-22 data sheets.

### PIN CONNECTIONS



### SIMPLIFIED SCHEMATIC (1/4 Shown)



# OP-420

## ABSOLUTE MAXIMUM RATINGS (Note 1)

|  |                 |
|--|-----------------|
| Supply Voltage .....                             | ±18V            |
| Differential Input Voltage .....                 | ±30V            |
| Input Voltage .....                              | Supply Voltage  |
| Output Short-Circuit Duration .....              | Continuous      |
| (One Amplifier Only)                             |                 |
| Storage Temperature Range .....                  | -65°C to +150°C |
| Lead Temperature Range (Soldering, 60 sec) ..... | 300°C           |
| Operating Temperature Range                      |                 |
| OP-420BY, OP-420CY, OP-420CRC .....              | -55°C to +125°C |
| OP-420FY .....                                   | -25°C to +85°C  |
| OP-420G, OP-420H .....                           | -40°C to +85°C  |
| Junction Temperature( $T_j$ ) .....              | -65°C to +150°C |

| PACKAGE TYPE            | $\theta_{JA}$ (Note 2) | $\theta_{JC}$ | UNITS |
|-------------------------|------------------------|---------------|-------|
| 14-Pin Hermetic DIP (Y) | 99                     | 12            | °C/W  |
| 14-Pin Plastic DIP (P)  | 76                     | 33            | °C/W  |
| 16-Pin SOL (S)          | 92                     | 27            | °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 CerDIP and P-DIP packages;  $\theta_{JA}$  is specified for device soldered to printed circuit board for SOL package.

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

| PARAMETER                           | SYMBOL   | CONDITIONS   | OP-420B<br>OP-420F    |      |     | OP-420C<br>OP-420G    |      |     | OP-420H               |      |     | UNITS          |
|-------------------------------------|----------|--|-----------------------|------|-----|-----------------------|------|-----|-----------------------|------|-----|----------------|
|                                     |          |  | MIN                   | TYP  | MAX | MIN                   | TYP  | MAX | MIN                   | TYP  | MAX |                |
| Input Offset Voltage                | $V_{OS}$ | $V_S = \pm 2.5V$ to $\pm 15V$  | —                     | 0.5  | 2.5 | —                     | 1    | 4   | —                     | 2    | 6   | mV             |
| Input Offset Current<br>(Note 1)    | $I_{OS}$ | $V_S = \pm 2.5V$ to $\pm 15V$  | —                     | 0.5  | 1.5 | —                     | 0.8  | 2.5 | —                     | 1.2  | 6   | nA             |
| Input Bias Current<br>(Note 1)      | $I_B$    | $V_S = \pm 2.5V$ to $\pm 15V$  | —                     | 9    | 20  | —                     | 12   | 30  | —                     | 18   | 40  | nA             |
| Input Noise Voltage<br>Density      | $e_n$    | $f_O = 10Hz$<br>$f_O = 100Hz$  | —                     | 50   | —   | —                     | 50   | —   | —                     | 50   | —   | $nV/\sqrt{Hz}$ |
| Input Noise Current<br>Density      | $i_n$    | $f_O = 10Hz$<br>$f_O = 100Hz$  | —                     | 0.12 | —   | —                     | 0.12 | —   | —                     | 0.12 | —   | $pA/\sqrt{Hz}$ |
| 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              |
| Common-Mode<br>Rejection Ratio      | CMRR     | $V_+ = +5V$ , $V_- = 0V$<br>$0V \leq V_{CM} \leq 3.5V$<br>$V_S = \pm 15V$                | 83                    | 100  | —   | 80                    | 96   | —   | 76                    | 90   | —   | dB             |
|                                     |          | $-15V \leq V_{CM} \leq 13.5V$  | 83                    | 100  | —   | 80                    | 96   | —   | 76                    | 90   | —   |                |
| Power Supply<br>Rejection Ratio     | PSRR     | $V_S = \pm 2.5V$ to $\pm 15V$ ; &<br>$V_- = 0V$ , $V_+ = 5V$ to $30V$                    | —                     | 10   | 30  | —                     | 20   | 50  | —                     | 30   | 80  | $\mu V/V$      |
| Large-Signal<br>Voltage Gain        | $A_{VO}$ | $R_L = 25k\Omega$ ,<br>$V_O = \pm 10V$   | 600                   | 1100 | —   | 400                   | 900  | —   | 200                   | 800  | —   | V/mV           |
| Slew Rate                           | SR       |  | —                     | 0.05 | —   | —                     | 0.05 | —   | —                     | 0.05 | —   | V/ $\mu s$     |
| Closed-Loop<br>Bandwidth            | BW       | $A_{VCL} = +1.0$<br>$R_L = 10k\Omega$  | —                     | 150  | —   | —                     | 150  | —   | —                     | 150  | —   | kHz            |
| Output Voltage<br>Swing             | $V_O$    | $V_+ = 5V$ , $V_- = 0V$ ,<br>$R_L = 10k\Omega$<br>$V_S = \pm 15V$ ,<br>$R_L = 25k\Omega$ | 0.7/4.1<br>$\pm 14.0$ | —    | —   | 0.8/4.0<br>$\pm 14.0$ | —    | —   | 0.9/3.8<br>$\pm 13.8$ | —    | —   | V              |
| Supply Current<br>(Four Amplifiers) | $I_{SY}$ | $V_S = \pm 2.5V$ , No Load   | —                     | 140  | 200 | —                     | 170  | 300 | —                     | 200  | 400 | $\mu A$        |
|                                     |          | $V_S = \pm 15V$ , No Load  | —                     | 330  | 360 | —                     | 360  | 460 | —                     | 390  | 600 |                |

### NOTE:

- $I_B$  and  $I_{OS}$  are measured at  $V_{CM} = 0$ .

**ELECTRICAL CHARACTERISTICS** at  $V_S = \pm 15V$ ,  $-55^\circ C \leq +125^\circ C$  for OP-420B and OP-420C,  $-25^\circ C \leq T_A \leq +85^\circ C$  for OP-420F,  $-40^\circ C \leq T_A \leq +85^\circ C$  for OP-420G and OP-420H, unless otherwise noted.

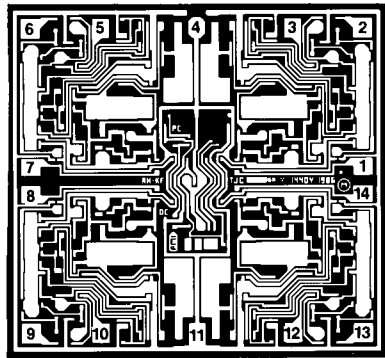
| PARAMETER                                   | SYMBOL     | CONDITIONS   | OP-420B<br>OP-420F |     |     | OP-420C<br>OP-420G |     |     | OP-420H           |     |     | UNITS            |
|---|------------|--|--------------------|-----|-----|--------------------|-----|-----|-------------------|-----|-----|------------------|
|   |            |  | MIN                | TYP | MAX | MIN                | TYP | MAX | MIN               | TYP | MAX |                  |
| Average Input Offset Voltage Drift (Note 1) | $TCV_{OS}$ | Unnulled   | —                  | 5   | 10  | —                  | 8   | 15  | —                 | 15  | 25  | $\mu V/^\circ C$ |
| Input Offset Voltage                        | $V_{OS}$   | $V_S = \pm 2.5V$ to $\pm 15V$  | —                  | —   | 3.5 | —                  | —   | 5.5 | —                 | —   | 7.5 | mV               |
| Input Offset Current (Note 2)               | $I_{OS}$   | $V_S = \pm 2.5V$ to $\pm 15V$  | —                  | —   | 3   | —                  | —   | 4   | —                 | —   | 8   | nA               |
| Input Bias Current (Note 2)                 | $I_B$      | $V_S = \pm 2.5V$ to $\pm 15V$  | —                  | —   | 30  | —                  | —   | 40  | —                 | —   | 60  | nA               |
| Input Voltage Range                         | IVR        | $V_+ = +5V$ , $V_- = 0V$<br>$V_S = \pm 15V$                              | 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       | $V_+ = +5V$ , $V_- = 0V$ ,<br>$0V \leq V_{CM} \leq 3.2V$                 | 76                 | 96  | —   | 73                 | 92  | —   | 73                | 86  | —   | dB               |
|   |            | $V_S = \pm 15V$ ,<br>$-15V \leq V_{CM} \leq 13.2V$                       | 76                 | 96  | —   | 73                 | 92  | —   | 73                | 86  | —   |                  |
| Power Supply Rejection Ratio                | PSRR       | $V_S = \pm 2.5V$ to $\pm 15V$<br>and $V_- = 0V$ , $V_+ = 5V$<br>to $30V$ | —                  | 15  | 50  | —                  | 25  | 80  | —                 | 40  | 100 | $\mu V/V$        |
| Large-Signal Voltage Gain                   | $A_{VO}$   | $V_S = \pm 15V$ , $R_L = 50k\Omega$ ,<br>$V_O = \pm 10V$                 | 300                | 800 | —   | 200                | 650 | —   | 100               | 400 | —   | V/mV             |
| Output Voltage Swing                        | $V_O$      | $V_+ = 5V$ , $V_- = 0V$ ,<br>$R_L = 20k\Omega$                           | 0.9/3.9            | —   | —   | 1.0/3.8            | —   | —   | 1.1/3.6           | —   | —   | V                |
|   |            | $V_S = \pm 15V$ ,<br>$R_L = 50k\Omega$                                   | $\pm 13.8$         | —   | —   | $\pm 13.8$         | —   | —   | $\pm 13.6$        | —   | —   |                  |
| Supply Current (Four Amplifiers)            | $I_{SY}$   | $V_S = \pm 2.5V$ , No Load   | —                  | 170 | 300 | —                  | 210 | 400 | —                 | 250 | 600 | $\mu A$          |
|   |            | $V_S = \pm 15V$ , No Load  | —                  | 390 | 500 | —                  | 420 | 640 | —                 | 500 | 800 |                  |

**NOTES:**

1. Sample tested.
2.  $I_B$  and  $I_{OS}$  are measured at  $V_{CM} = 0$ .

# OP-420

## DICE CHARACTERISTICS



1. OUTPUT 1
2. INVERTING INPUT 1
3. NONINVERTING INPUT 1
4. V+
5. NONINVERTING INPUT 2
6. INVERTING INPUT 2
7. OUTPUT 2
8. OUTPUT 3
9. INVERTING INPUT 3
10. NONINVERTING INPUT 3
11. V-
12. NONINVERTING INPUT 4
13. INVERTING INPUT 4
14. OUTPUT 4

DIE SIZE 0.093 × 0.087 inch, 8091 sq. mils  
(2.36 × 2.21 mm, 5.22 sq. mm)

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

| PARAMETER                    | SYMBOL   | CONDITIONS   | OP-420N<br>LIMIT | OP-420G<br>LIMIT | OP-420GR<br>LIMIT | UNITS         |
|------------------------------|----------|--|------------------|------------------|-------------------|---------------|
| Input Offset Voltage         | $V_{OS}$ | $V_S = \pm 2.5V$ to $\pm 15V$  | 2.5              | 4                | 6                 | mV MAX        |
| Input Offset Current         | $I_{OS}$ | $V_S = \pm 2.5V$ to $\pm 15V$ , (Note 1)                                   | 1.5              | 2.5              | 6                 | nA MAX        |
| Input Bias Current           | $I_B$    | $V_S = \pm 2.5V$ to $\pm 15V$ , (Note 1)                                   | 20               | 30               | 40                | nA MAX        |
| Input Voltage Range          | IVR      |  | -15/13.5         | -15/13.5         | -15/13.5          | V MIN         |
| Common-Mode Rejection Ratio  | CMRR     | $V_+ = +5V, V_- = 0V$  | 83               | 80               | 76                | dB MIN        |
|                              |          | $0V \leq V_{CM} \leq 3.5V$<br>$V_S = \pm 15V, -15V \leq V_{CM} \leq 13.5V$ | 83               | 80               | 76                |               |
| Power Supply Rejection Ratio | PSRR     | $V_S = \pm 2.5V$ to $\pm 15V$<br>$V_- = 0V, V_+ = +5V$ to $+30V$           | 30               | 50               | 80                | $\mu V/V$ MAX |
| Large-Signal Voltage Gain    | $A_{VO}$ | $R_L = 25k\Omega, V_O = \pm 10V$   | 600              | 400              | 200               | V/mV MIN      |
| Output Voltage Swing         | $V_O$    | $V_+ = +5V, V_- = 0V$<br>$R_L = 10k\Omega$                                 | 0.7/4.1          | 0.8/4.0          | 0.9/3.8           | V MAX         |
|                              |          | $V_S = \pm 15V$<br>$R_L = 25k\Omega$                                       | $\pm 14.0$       | $\pm 14.0$       | $\pm 13.8$        | V MIN         |
| Supply Current               | $I_{SY}$ | No Load, (Four Amplifiers)   | 360              | 460              | 600               | $\mu A$ MAX   |

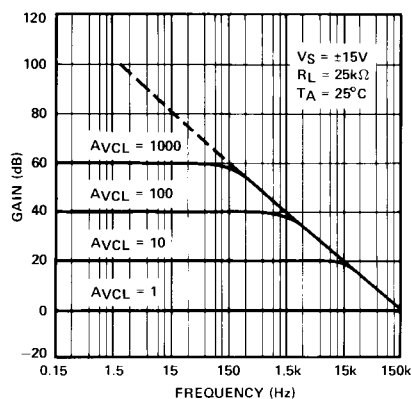
**NOTES:**

1.  $I_B$  and  $I_{OS}$  are measured at  $V_{CM} = 0$ .

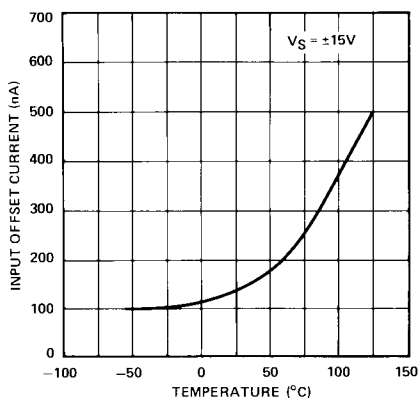
Electrical tests are performed at wafer probe to the limits shown. Due to variations in assembly methods and normal yield loss, yield after packaging is not guaranteed for standard product dice. Consult factory to negotiate specifications based on dice lot qualification through sample lot assembly and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

TYPICAL PERFORMANCE CHARACTERISTICS

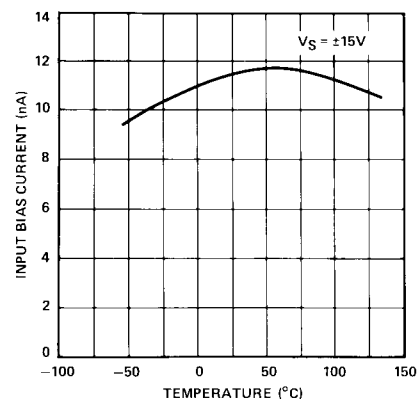
CLOSED-LOOP GAIN vs FREQUENCY



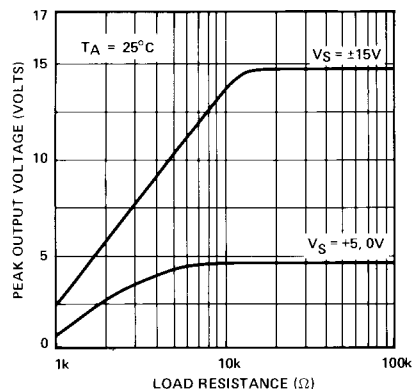
INPUT OFFSET CURRENT vs TEMPERATURE



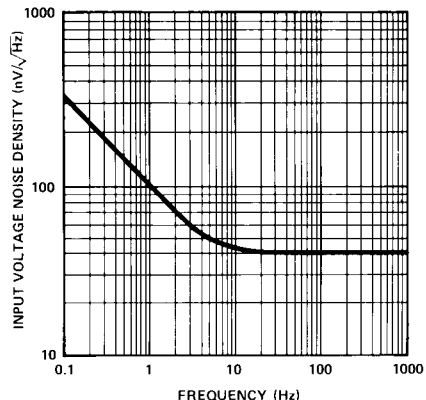
INPUT BIAS CURRENT vs TEMPERATURE



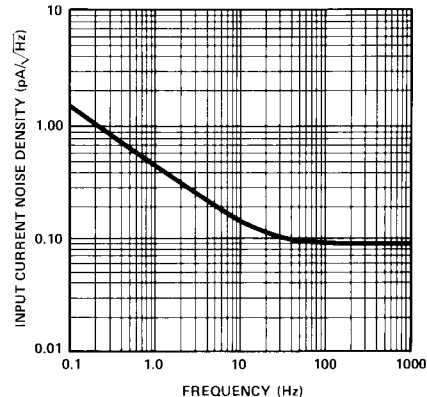
MAXIMUM OUTPUT VOLTAGE vs LOAD RESISTANCE



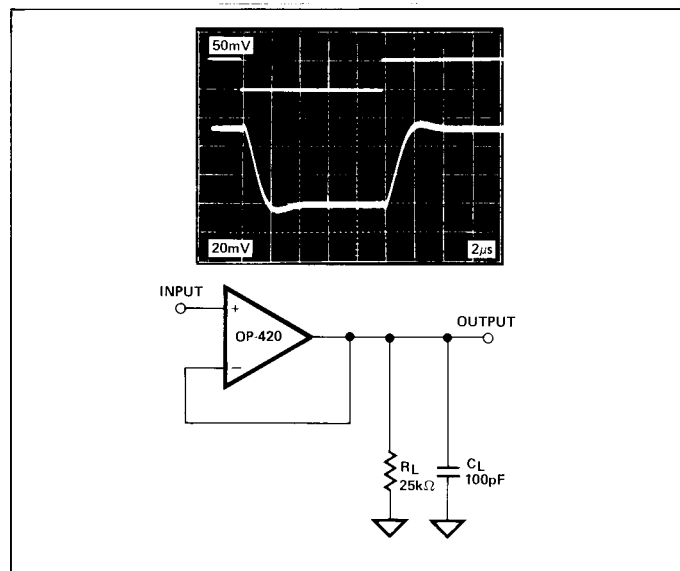
INPUT VOLTAGE NOISE DENSITY ( $e_n$ ) vs FREQUENCY



INPUT CURRENT NOISE DENSITY ( $i_n$ ) vs FREQUENCY



SMALL-SIGNAL TRANSIENT RESPONSE



LARGE-SIGNAL TRANSIENT RESPONSE

