

# LM258/A, LM358/A, LM2904 DUAL OPERATIONAL AMPLIFIER

## DUAL OPERATIONAL AMPLIFIERS

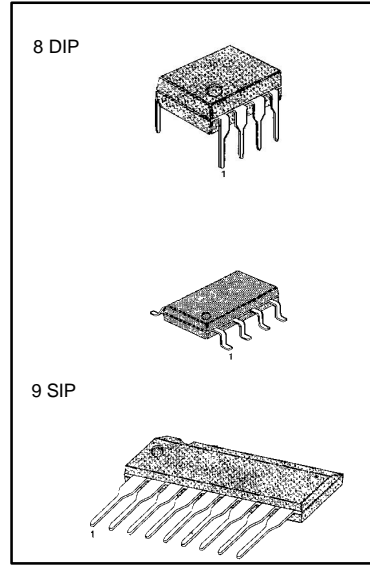
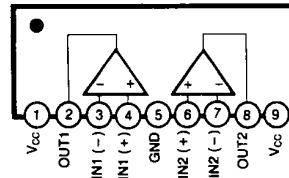
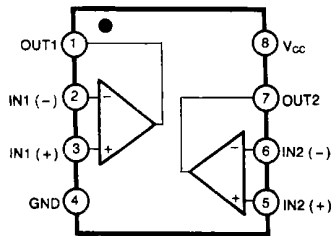
The LM258 series consists of four independent, high gain, internally Frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltage.

Operation from split power supplies is also possible and the low power Supply current drain is independent of the magnitude of the power Supply voltage. Application areas include transducer amplifier, DC gain blocks and all the conventional OP amp circuits which now can be easily implemented in single 8 SOP power supply system.

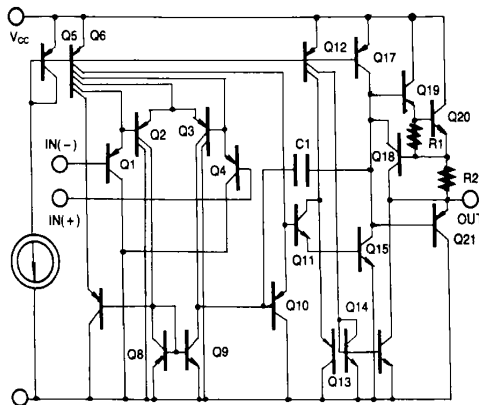
## FEATURES

- Internally frequency compensated for unity gain
- Large DC voltage gain: 100dB
- Wide power supply range: LM258/A, LM358/A: 3V~32V (or  $\pm 1.5V\sim 16V$ )  
LM2904: 3V~26V (or  $\pm 1.5V\sim 13V$ )
- Input common-mode voltage range Includes ground
- Large output voltage swing: 0V DC to  $V_{cc} - 1.5V$  DC
- Power drain suitable for battery operation.

## BLOCK DIAGRAM



## SCHEMATIC DIAGRAM (One section only)



## ORDERING INFORMATION

| Device  | Package | Operating Temperature |
|---------|---------|-----------------------|
| LM358N  | 8 DIP   | 0 ~ + 70°C            |
| LM358AN |         |                       |
| LM358S  | 9 SIP   |                       |
| LM358AS |         |                       |
| LM358M  | 8 SOP   | -25 ~ + 85°C          |
| LM358AM |         |                       |
| LM258N  | 8 DIP   |                       |
| LM258AN |         |                       |
| LM258S  | 9 SIP   |                       |
| LM258AS |         |                       |
| LM258M  | 8 SOP   | -40 ~ + 85°C          |
| LM258AM |         |                       |
| LM2904N | 8 DIP   |                       |
| LM2904S | 9 SIP   |                       |
| LM2904M | 8 SOP   |                       |

# LM258/A, LM358/A, LM2904 DUAL OPERATIONAL AMPLIFIER

## ABSOLUTE MAXIMUM RATINGS

| Characteristic   | Symbol        | LM258/LM258A   | LM358/LM358A   | LM2904         | Unit             |
|--|---------------|----------------|----------------|----------------|------------------|
| Supply Voltage   | $V_{CC}$      | $\pm 16$ or 32 | $\pm 16$ or 32 | $\pm 13$ or 26 | V                |
| Differential Input Voltage   | $V_{I(DIFF)}$ | 32             | 32             | 26             | V                |
| Input Voltage  | $V_I$         | -0.3 to +32    | -0.3 to +32    | -0.3 to +26    | V                |
| Output Short Circuit to GND<br>$V_{CC} \leq V, T_A = 25^\circ\text{C}$ (One Amp) |               | Continuous     | Continuous     | Continuous     |                  |
| Operating Temperature Range  | $T_{OPR}$     | -25 ~ +85      | 0 ~ +70        | -40 ~ +85      | $^\circ\text{C}$ |
| Storage Temperature Range  | $T_{STG}$     | -65 ~ +150     | -65 ~ +150     | -65 ~ +150     | $^\circ\text{C}$ |

## ELECTRICAL CHARACTERISTICS

( $V_{CC} = 5.0\text{V}$ ,  $V_{EE} = \text{GND}$ ,  $T = 25^\circ\text{C}$ , unless otherwise specified)

| Characteristic                  | Symbol                     | Test Conditions  | LM258 |     |                | LM358 |     |                | LM2904 |     |                | Unit |
|---------------------------------|----------------------------|--|-------|-----|----------------|-------|-----|----------------|--------|-----|----------------|------|
|                                 |                            |  | Min   | Typ | Max            | Min   | Typ | Max            | Min    | Typ | Max            |      |
| Input Offset Voltage            | $V_{IO}$                   | $V_{CM} = 0\text{V}$ to $V_{CC} - 1.5\text{V}$<br>$V_{O(P)} = 1.4\text{V}$ , $R_S = 0\Omega$         |       | 2.9 | 5.0            |       | 2.9 | 7.0            |        | 2.9 | 7.0            | mV   |
| Input Offset Current            | $I_{IO}$                   |  |       | 3   | 30             |       | 5   | 50             |        | 5   | 50             | nA   |
| Input Bias Current              | $I_{BIAS}$                 |  |       | 45  | 150            |       | 45  | 250            |        | 45  | 250            | nA   |
| Input Common-Mode Voltage Range | $V_{I(R)}$                 | $V_{CC} = 30\text{V}$<br>(KA2904, $V_{CC} = 26\text{V}$ )  | 0     |     | $V_{CC} - 1.5$ | 0     |     | $V_{CC} - 1.5$ | 0      |     | $V_{CC} - 1.5$ | V    |
| Supply Current                  | $I_{CC}$                   | $R_L = \infty$ , $V_{CC} = 30\text{V}$<br>(KA2902, $V_{CC} = 26\text{V}$ )                           |       | 0.8 | 2.0            |       | 0.8 | 2.0            |        | 0.8 | 2.0            | mA   |
|                                 |                            | $R_L = \infty$ , over full temperature range   |       | 0.5 | 1.2            |       | 0.5 | 1.2            |        | 0.5 | 1.2            | mA   |
| Large Signal Voltage Gain       | $G_V$                      | $V_{CC} = 15\text{V}$ , $R_L \geq 2\text{K}\Omega$<br>$V_{O(P)} = 1\text{V}$ to $11\text{V}$         | 50    | 100 |                | 25    | 100 |                | 25     | 100 |                | V/mV |
| Output Voltage Swing            | $V_{O(H)}$<br>$V_{O(L)}$   | $V_{CC} = 30\text{V}$ , $R_L = 2\text{K}\Omega$  | 26    |     |                | 26    |     |                | 22     |     |                | V    |
|                                 |                            | $V_{CC} = 26\text{V}$ for 2904, $R_L = 10\text{K}\Omega$   | 27    | 28  |                | 27    | 28  |                | 23     | 24  |                | V    |
|                                 |                            | $V_{CC} = 5\text{V}$ , $R_L \geq 10\text{K}\Omega$   |       | 5   | 20             |       | 5   | 20             |        | 5   | 100            |      |
| Common-Mode Rejection Ratio     | CMRR                       |  | 70    | 85  |                | 65    | 80  |                | 50     | 80  |                | dB   |
| Power Supply Rejection Ratio    | PSRR                       |  | 65    | 100 |                | 65    | 100 |                | 50     | 100 |                | dB   |
| Channel Separation              | CS                         | $f = 1\text{KHz}$ to $20\text{KHz}$  |       | 120 |                |       | 120 |                |        | 120 |                | dB   |
| Short Circuit to GND            | $I_{SC}$                   |  |       | 40  | 60             |       | 40  | 60             |        | 40  | 60             | mA   |
| Output Current                  | $I_{SOURCE}$<br>$I_{SINK}$ | $V_{I(+)} = 1\text{V}$ , $V_{I(-)} = 0\text{V}$<br>$V_{CC} = 15\text{V}$ , $V_{O(P)} = 2\text{V}$    | 10    | 30  |                | 10    | 30  |                | 10     | 30  |                | mA   |
|                                 |                            | $V_{I(+)} = 0\text{V}$ , $V_{I(-)} = 1\text{V}$<br>$V_{CC} = 15\text{V}$ , $V_{O(P)} = 2\text{V}$    | 10    | 15  |                | 10    | 15  |                | 10     | 15  |                | mA   |
|                                 |                            | $V_{I(+)} = 0\text{V}$ , $V_{I(-)} = 1\text{V}$<br>$V_{CC} = 15\text{V}$ , $V_{O(P)} = 200\text{mA}$ | 12    | 100 |                | 12    | 100 |                |        |     |                |      |
| Differential Input Voltage      | $V_{I(DIFF)}$              |  |       |     | $V_{CC}$       |       |     | $V_{CC}$       |        |     | $V_{CC}$       | V    |

# LM258/A, LM358/A, LM2904 DUAL OPERATIONAL AMPLIFIER

## ELECTRICAL CHARACTERISTICS

( $V_{CC}=5.0V$ ,  $V_{EE}=GND$ , unless otherwise specified)

The following specifications apply over the range of  $-25\text{ }^{\circ}\text{C} \leq T_A \leq +85\text{ }^{\circ}\text{C}$  for the LM258; and the  $0\text{ }^{\circ}\text{C} \leq T_A \leq +70\text{ }^{\circ}\text{C}$  for the LM358; and the  $-40\text{ }^{\circ}\text{C} \leq T_A \leq +85\text{ }^{\circ}\text{C}$  for the LM2904

| Characteristic                  | Symbol                   | Test Conditions   | LM258             |     |                | LM358 |     |                | LM2904 |     |                | Unit                         |
|---------------------------------|--------------------------|---|-------------------|-----|----------------|-------|-----|----------------|--------|-----|----------------|------------------------------|
|                                 |                          |   | Min               | Typ | Max            | Min   | Typ | Max            | Min    | Typ | Max            |                              |
| Input Offset Voltage            | $V_{IO}$                 | $V_{CM} = 0V$ to $V_{CC} = 1.5V$<br>$V_{O(P)} = 1.4V$ , $R_S = 0\Omega$ |                   |     | 7.0            |       |     | 9.0            |        |     | 10.0           | mV                           |
| Input Offset Voltage Drift      | $V_{IO}$                 | $R_S = 0\Omega$   |                   | 7.0 |                |       | 7.0 |                |        | 7.0 |                | $\mu V/^{\circ}\text{C}$     |
| Input Offset Current            | $I_{IO}$                 |   |                   |     | 100            |       |     | 150            |        | 45  | 200            | nA                           |
| Input Offset Current Drift      | $\Delta I_{IO}/\Delta T$ |   |                   | 10  |                |       | 10  |                |        | 10  |                | $\text{pA}/^{\circ}\text{C}$ |
| Input Bias Current              | $I_{BIAS}$               |   |                   | 40  | 300            |       | 40  | 500            |        | 40  | 500            | nA                           |
| Input Common-Mode Voltage Range | $V_{I(R)}$               | $V_{CC} = 30V$<br>(KA2904, $V_{CC} = 26V$ )                             | 0                 |     | $V_{CC} = 2.0$ | 0     |     | $V_{CC} = 2.0$ | 0      |     | $V_{CC} = 2.0$ | V                            |
| Large Signal Voltage Gain       | $G_V$                    | $V_{CC} = 15V$ , $R_L \geq 2.0K\Omega$<br>$V_{O(P)} = 1V$ to $11V$      | 25                |     |                | 15    |     |                | 15     |     |                | V/mV                         |
| Output Voltage Swing            | $V_{O(H)}$               | $V_{CC} = 30V$  | $R_L = 2K\Omega$  | 26  |                | 26    |     |                | 26     |     |                | V                            |
|                                 |                          | $V_{CC} = 26V$ for 2904   | $R_L = 10K\Omega$ | 27  | 28             |       | 27  | 28             |        | 27  | 28             |                              |
|                                 | $V_{O(L)}$               | $V_{CC} = 5V$ , $R_L \geq 10K\Omega$                                    |                   | 5   | 20             |       | 5   | 20             |        | 5   | 20             | mV                           |
| Output Current                  | $I_{SOURCE}$             | $V_{I(+)} = 1V$ , $V_{I(-)} = 0V$<br>$V_{CC} = 15V$ , $V_{O(P)} = 2V$   | 10                | 30  |                | 10    | 30  |                | 10     | 30  |                | mA                           |
|                                 | $I_{SINK}$               | $V_{I(+)} = 0V$ , $V_{I(-)} = 1V$<br>$V_{CC} = 15V$ , $V_{O(P)} = 2V$   | 5                 | 8   |                | 5     | 9   |                | 5      | 9   |                | mA                           |
| Differential Input Voltage      | $V_{I(DIFF)}$            |   |                   |     | $V_{CC}$       |       |     | $V_{CC}$       |        |     | $V_{CC}$       | V                            |

# LM258/A, LM358/A, LM2904 DUAL OPERATIONAL AMPLIFIER

## ELECTRICAL CHARACTERISTICS

( $V_{CC} = 5.0V$ .  $V_{EE} = GND$ .  $T_A = 25^\circ C$ , unless otherwise specified)

| Characteristic                  | Symbol        | Test Conditions   | LM258A |     |                | LM358A |     |                | Unit    |
|---------------------------------|---------------|---|--------|-----|----------------|--------|-----|----------------|---------|
|                                 |               |   | Min    | Typ | Max            | Min    | Typ | Max            |         |
| Input Offset Voltage            | $V_{IO}$      | $V_{CM} = 0V$ to $V_{CC} = 1.5V$<br>$V_{O(P)} = 1.4V$ , $R_S = 0\Omega$ |        | 1.0 | 3.0            |        | 2.0 | 3.0            | mV      |
| Input Offset Current            | $I_{IO}$      |   |        | 2   | 15             |        | 5   | 30             | nA      |
| Input Bias Current              | $I_{BIAS}$    |   |        | 40  | 80             |        | 45  | 100            | nA      |
| Input Common-Mode Voltage Range | $V_{I(R)}$    | $V_{CC} = 30V$  | 0      |     | $V_{CC} = 1.5$ | 0      |     | $V_{CC} = 1.5$ | V       |
| Supply Current                  | $I_{CC}$      | $R_L = \infty$ , $V_{CC} = 30V$   |        | 0.8 | 2.0            |        | 0.8 | 2.0            | mA      |
|                                 |               | $R_L = \infty$ , over full temperature range                            |        | 0.5 | 1.2            |        | 0.5 | 1.2            | mA      |
| Large Signal Voltage Gain       | $G_V$         | $V_{CC} = 15V$ , $R_L \geq 2K\Omega$<br>$V_O = 1V$ to $11V$             | 50     | 100 |                | 25     | 100 |                | V/mV    |
| Output Voltage Swing            | $V_{OH}$      | $V_{CC} = 30V$ , $R_L = 2K\Omega$                                       | 26     |     |                | 26     |     |                | V       |
|                                 |               | $V_{CC} = 26V$ for 2904, $R_L = 10K\Omega$                              | 27     | 28  |                | 27     | 28  |                | V       |
|                                 | $V_{OL}$      | $V_{CC} = 5V$ , $R_L \geq 10K\Omega$                                    |        | 5   | 20             |        | 5   | 20             | mV      |
| Common-Mode Rejection Ratio     | CMRR          |   | 70     | 85  |                | 65     | 85  |                | dB      |
| Power Supply Rejection Ratio    | PSRR          |   | 65     | 100 |                | 65     | 100 |                | dB      |
| Channel Separation              | CS            | $f = 1KHz$ to $20KHz$   |        | 120 |                |        | 120 |                | dB      |
| Short Circuit to GND            | $I_{SC}$      |   |        | 40  | 60             |        | 40  | 60             | mA      |
| Output Current                  | $I_{SOURCE}$  | $V_{I(+)} = 1V$ , $V_{I(-)} = 0V$<br>$V_{CC} = 15V$ , $V_{O(P)} = 2V$   | 20     | 30  |                | 20     | 30  |                | mA      |
|                                 |               | $V_{I(+)} = 1V$ , $V_{I(-)} = 0V$<br>$V_{CC} = 15V$ , $V_{O(P)} = 2V$   | 10     | 15  |                | 10     | 15  |                | mA      |
|                                 | $I_{SINK}$    | $V_{in+} = 0V$ , $V_{in-} = 1V$<br>$V_{O(P)} = 200mV$                   | 12     | 100 |                | 12     | 100 |                | $\mu A$ |
| Differential Input Voltage      | $V_{I(DIFF)}$ |   |        |     | $V_{CC}$       |        |     | $V_{CC}$       | V       |

# LM258/A, LM358/A, LM2904 DUAL OPERATIONAL AMPLIFIER

## ELECTRICAL CHARACTERISTICS (V<sub>CC</sub> = 5.0V, V<sub>EE</sub> = GND, unless otherwise specified)

The following specifications apply over the range of -25 °C ≤ T<sub>A</sub> ≤ +85 °C for the LM258A; and the 0 °C ≤ T<sub>A</sub> ≤ +70 °C for the LM358A

| Characteristic                  | Symbol               | Test Conditions   | LM258A |     |                       | LM358A |     |                       | Unit  |
|---------------------------------|----------------------|---|--------|-----|-----------------------|--------|-----|-----------------------|-------|
|                                 |                      |   | Min    | Typ | Max                   | Min    | Typ | Max                   |       |
| Input Offset Voltage            | V <sub>IO</sub>      | V <sub>CM</sub> = 0V to V <sub>CC</sub> = 1.5V<br>V <sub>O(P)</sub> = 1.4V, R <sub>S</sub> = 0Ω |        |     | 4.0                   |        |     | 5.0                   | mV    |
| Input Offset Voltage Drift      | ΔV <sub>IO</sub> /ΔT |   |        | 7.0 | 15                    |        | 7.0 | 20                    | μV/°C |
| Input Offset Current            | I <sub>IO</sub>      |   |        |     | 30                    |        |     | 75                    | nA    |
| Input Offset Current Drift      | ΔI <sub>IO</sub> /ΔT |   |        | 10  | 200                   |        | 10  | 300                   | pA/°C |
| Input Bias Current              | I <sub>BIAS</sub>    |   |        | 40  | 100                   |        | 40  | 200                   | nA    |
| Input Common-Mode Voltage Range | V <sub>I(R)</sub>    | V <sub>CC</sub> = 30V   | 0      |     | V <sub>CC</sub> = 2.0 | 0      |     | V <sub>CC</sub> = 2.0 | V     |
| Output Voltage Swing            | V <sub>O(H)</sub>    | V <sub>CC</sub> = 30V, R <sub>L</sub> = 2KΩ   | 26     |     |                       | 26     |     |                       | V     |
|                                 | V <sub>O(L)</sub>    | V <sub>CC</sub> = 30V, R <sub>L</sub> = 10KΩ  | 27     | 28  |                       | 27     | 28  |                       | V     |
|                                 |                      | V <sub>CC</sub> = 5V, R <sub>L</sub> ≥ 10KΩ   |        | 5   | 20                    |        | 5   | 20                    | mV    |
| Large Signal Voltage Gain       | G <sub>V</sub>       | V <sub>CC</sub> = 15V, R <sub>L</sub> ≥ 2.0KΩ<br>V <sub>O(P)</sub> = 1V to 11V                  | 25     |     |                       | 15     |     |                       | V/mV  |
| Output Current                  | I <sub>SOURCE</sub>  | V <sub>I(+)</sub> = 1V, V <sub>I(-)</sub> = 0V<br>V <sub>CC</sub> = 15V, V <sub>O(P)</sub> = 2V | 10     | 30  |                       | 10     | 30  |                       | mA    |
|                                 | I <sub>SINK</sub>    | V <sub>I(+)</sub> = 1V, V <sub>I(-)</sub> = 0V<br>V <sub>CC</sub> = 15V, V <sub>O(P)</sub> = 2V | 5      | 9   |                       | 5      | 9   |                       | mA    |
| Differential Input Voltage      | V <sub>I(DIFF)</sub> |   |        |     | V <sub>CC</sub>       |        |     | V <sub>CC</sub>       | V     |

TYPICAL PERFORMANCE CHARACTERISTICS

Fig. 1 SUPPLY CURRENT

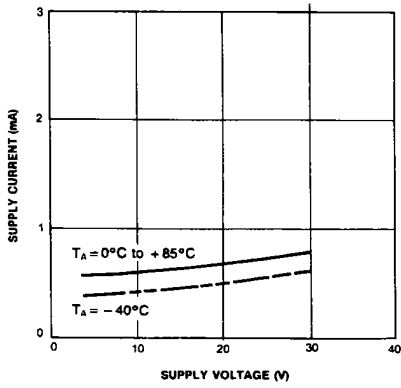


Fig. 2 VOLTAGE GAIN

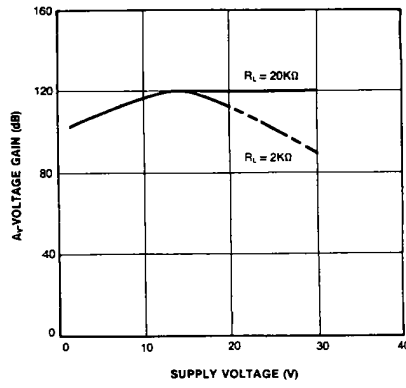


Fig. 3 OPEN LOOP FREQUENCY RESPONSE

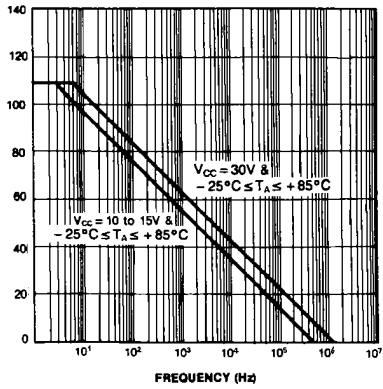


Fig. 4 LARGE SIGNAL FREQUENCY

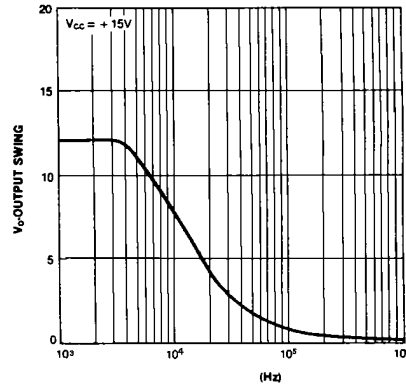


Fig. 5 OUTPUT CHARACTERISTICS CURRENT SOURCING

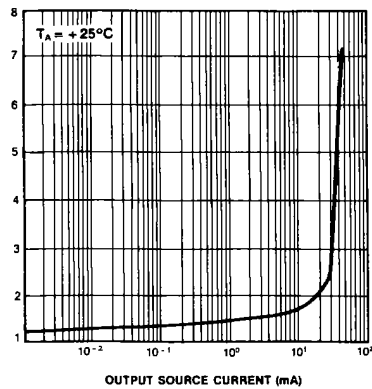


Fig. 6 OUTPUT CHARACTERISTICS CURRENT SINKING

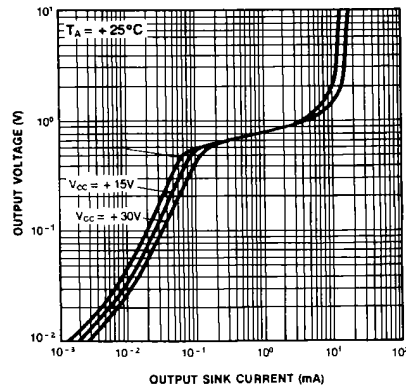


Fig. 7 INPUT VOLTAGE RANGE

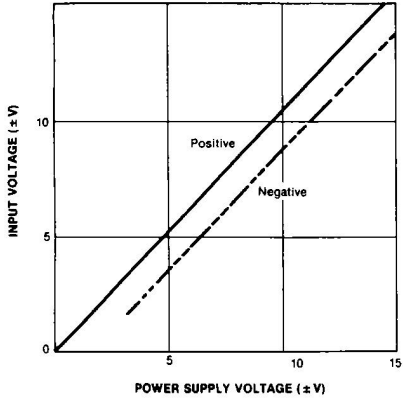


Fig. 8 COMMON-MODE REJECTION RATIO

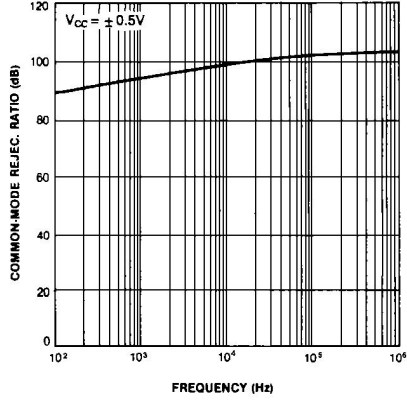


Fig. 9 CURRENT LIMITING

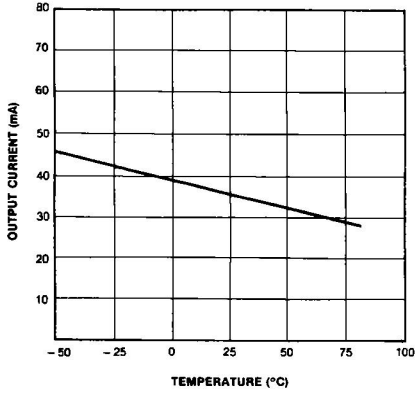


Fig. 10 INPUT CURRENT

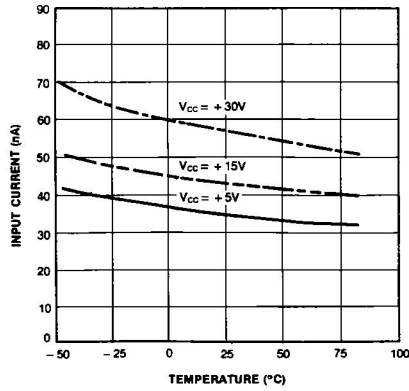


Fig. 11 VOLTAGE FOLLOWER PULSE RESPONSE

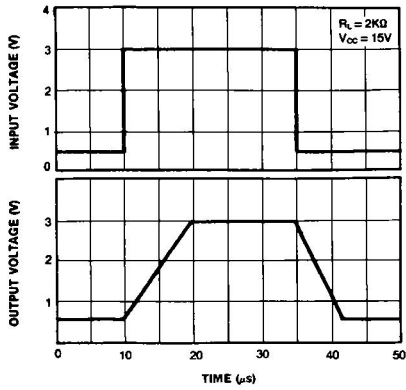
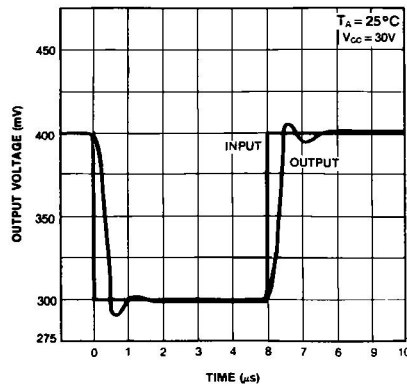


Fig. 12 VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)



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| E <sup>2</sup> CMOS™ | PowerTrench™  |
| FACT™                | QS™           |
| FACT Quiet Series™   | Quiet Series™ |
| FAST®                | SuperSOT™-3   |
| FASTr™               | SuperSOT™-6   |
| GTO™                 | SuperSOT™-8   |
| HiSeC™               | TinyLogic™    |

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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