



**MOTOROLA**

Order this document by MC34181/D

# MC34181,2,4 MC33181,2,4

## Low Power, High Slew Rate, Wide Bandwidth, JFET Input Operational Amplifiers

Quality bipolar fabrication with innovative design concepts are employed for the MC33181/2/4, MC34181/2/4 series of monolithic operational amplifiers. This JFET input series of operational amplifiers operates at 210  $\mu$ A per amplifier and offers 4.0 MHz of gain bandwidth product and 10 V/ $\mu$ s slew rate. Precision matching and an innovative trim technique of the single and dual versions provide low input offset voltages. With a JFET input stage, this series exhibits high input resistance, low input offset voltage and high gain. The all NPN output stage, characterized by no deadband crossover distortion and large output voltage swing, provides high capacitance drive capability, excellent phase and gain margins, low open loop high frequency output impedance and symmetrical source/sink AC frequency response.

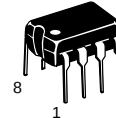
The MC33181/2/4, MC34181/2/4 series of devices are specified over the commercial or industrial/vehicular temperature ranges. The complete series of single, dual and quad operational amplifiers are available in the plastic DIP as well as the SOIC surface mount packages.

- Low Supply Current: 210  $\mu$ A (Per Amplifier)
- Wide Supply Operating Range:  $\pm 1.5$  V to  $\pm 18$  V
- Wide Bandwidth: 4.0 MHz
- High Slew Rate: 10 V/ $\mu$ s
- Low Input Offset Voltage: 2.0 mV
- Large Output Voltage Swing:  $-14$  V to  $+14$  V (with  $\pm 15$  V Supplies)
- Large Capacitance Drive Capability: 0 pF to 500 pF
- Low Total Harmonic Distortion: 0.04%
- Excellent Phase Margin: 67°
- Excellent Gain Margin: 6.7 dB
- Output Short Circuit Protection

### ORDERING INFORMATION

| Op Amp Function | Device               | Operating Temperature Range              | Package              |
|-----------------|----------------------|------------------------------------------|----------------------|
| Single          | MC34181P<br>MC34181D | $T_A = 0^\circ$ to $+70^\circ\text{C}$   | Plastic DIP<br>SO-8  |
|                 | MC33181P<br>MC33181D | $T_A = -40^\circ$ to $+85^\circ\text{C}$ | Plastic DIP<br>SO-8  |
| Dual            | MC34182P<br>MC34182D | $T_A = 0^\circ$ to $+70^\circ\text{C}$   | Plastic DIP<br>SO-8  |
|                 | MC33182P<br>MC33182D | $T_A = -40^\circ$ to $+85^\circ\text{C}$ | Plastic DIP<br>SO-8  |
| Quad            | MC34184P<br>MC34184D | $T_A = 0^\circ$ to $+70^\circ\text{C}$   | Plastic DIP<br>SO-14 |
|                 | MC33184P<br>MC33184D | $T_A = -40^\circ$ to $+85^\circ\text{C}$ | Plastic DIP<br>SO-14 |

### LOW POWER JFET INPUT OPERATIONAL AMPLIFIERS

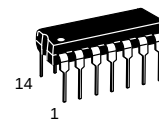
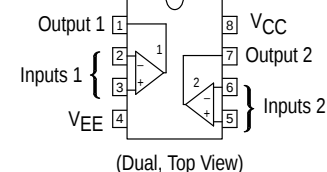
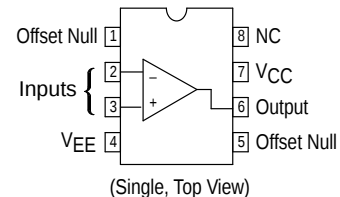


**P SUFFIX**  
PLASTIC PACKAGE  
CASE 626

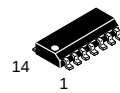


**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751  
(SO-8)

#### PIN CONNECTIONS

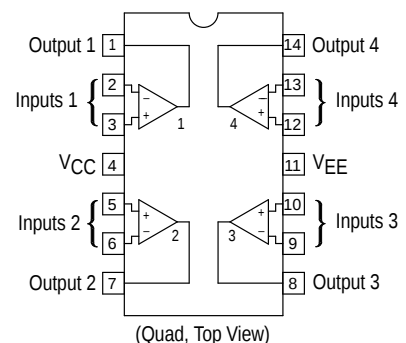


**P SUFFIX**  
PLASTIC PACKAGE  
CASE 646



**D SUFFIX**  
PLASTIC PACKAGE  
CASE 751A  
(SO-14)

#### PIN CONNECTIONS



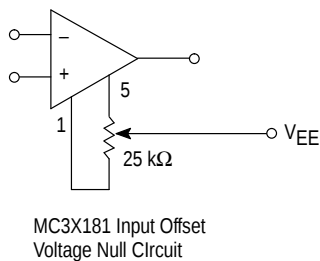
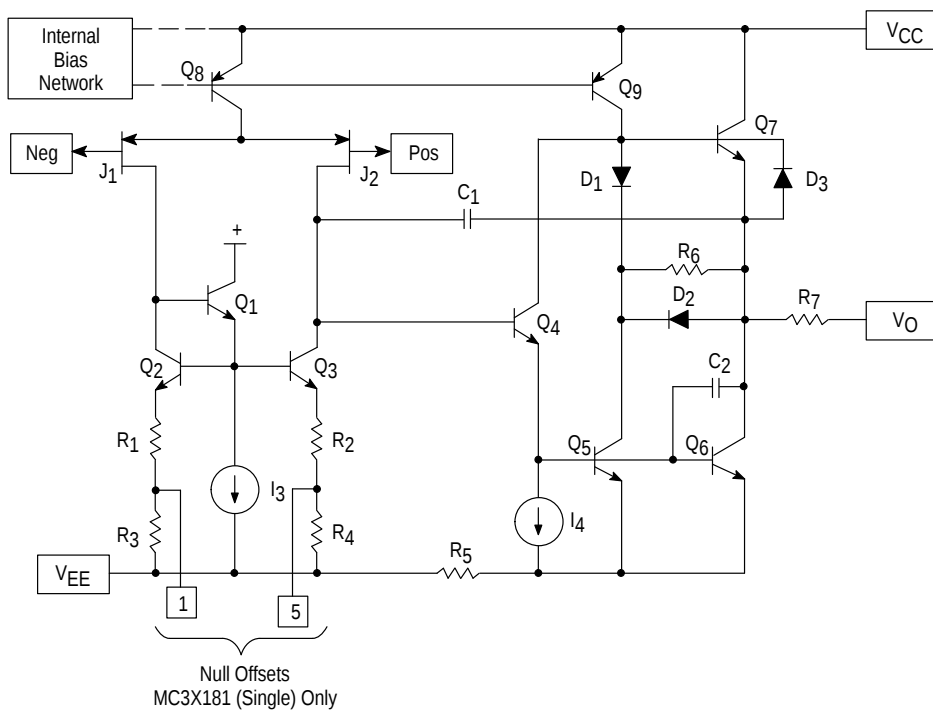
# MC34181,2,4 MC33181,2,4

## MAXIMUM RATINGS

| Rating                                      | Symbol    | Value       | Unit |
|---------------------------------------------|-----------|-------------|------|
| Supply Voltage (from $V_{CC}$ to $V_{EE}$ ) | $V_S$     | +36         | V    |
| Input Differential Voltage Range            | $V_{IDR}$ | Note 1      | V    |
| Input Voltage Range                         | $V_{IR}$  | Note 1      | V    |
| Output Short Circuit Duration (Note 2)      | $t_{SC}$  | Indefinite  | sec  |
| Operating Junction Temperature              | $T_J$     | +150        | °C   |
| Storage Temperature Range                   | $T_{stg}$ | -60 to +150 | °C   |

**NOTES:** 1. Either or both input voltages should not exceed the magnitude of  $V_{CC}$  or  $V_{EE}$ .  
2. Power dissipation must be considered to ensure maximum junction temperature ( $T_J$ ) is not exceeded (see Figure 1).

## Representative Schematic Diagram (Each Amplifier)



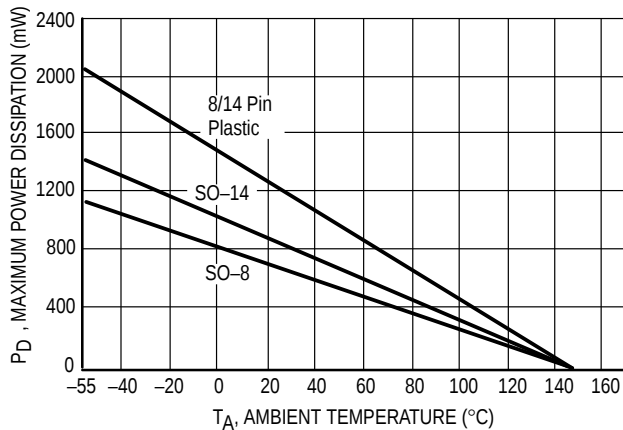
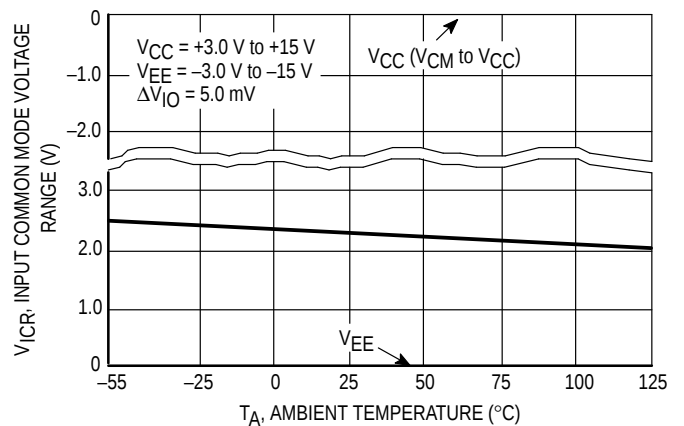
# MC34181,2,4 MC33181,2,4

## DC ELECTRICAL CHARACTERISTICS ( $V_{CC} = +15\text{ V}$ , $V_{EE} = -15\text{ V}$ , $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

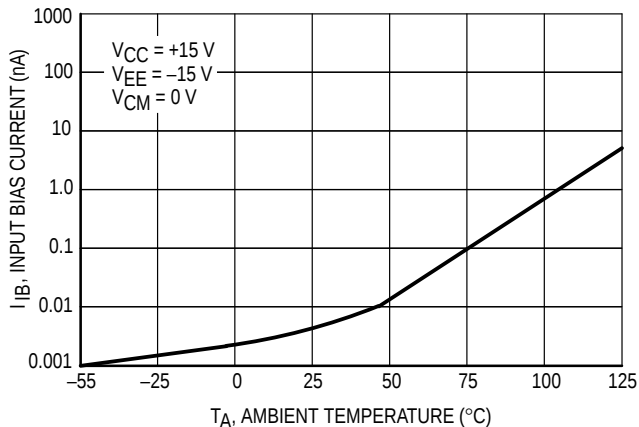
| Characteristics                                                                            | Symbol                   | Min                                                          | Typ        | Max        | Unit                         |
|--------------------------------------------------------------------------------------------|--------------------------|--------------------------------------------------------------|------------|------------|------------------------------|
| Input Offset Voltage ( $R_S = 50\ \Omega$ , $V_O = 0\text{ V}$ )                           | $V_{IO}$                 |                                                              |            |            | mV                           |
| Single                                                                                     |                          |                                                              |            |            |                              |
| $T_A = +25^\circ\text{C}$                                                                  |                          | —                                                            | 0.5        | 2.0        |                              |
| $T_A = 0^\circ\text{ to }+70^\circ\text{C}$ (MC34181)                                      |                          | —                                                            | —          | 3.0        |                              |
| $T_A = -40^\circ\text{ to }+85^\circ\text{C}$ (MC33181)                                    |                          | —                                                            | —          | 3.5        |                              |
| Dual                                                                                       |                          |                                                              |            |            |                              |
| $T_A = +25^\circ\text{C}$                                                                  |                          | —                                                            | 1.0        | 3.0        |                              |
| $T_A = 0^\circ\text{ to }+70^\circ\text{C}$ (MC34182)                                      |                          | —                                                            | —          | 4.0        |                              |
| $T_A = -40^\circ\text{ to }+85^\circ\text{C}$ (MC33182)                                    |                          | —                                                            | —          | 4.5        |                              |
| Quad                                                                                       |                          |                                                              |            |            |                              |
| $T_A = +25^\circ\text{C}$                                                                  |                          | —                                                            | 4.0        | 10         |                              |
| $T_A = 0^\circ\text{ to }+70^\circ\text{C}$ (MC34184)                                      |                          | —                                                            | —          | 11         |                              |
| $T_A = -40^\circ\text{ to }+85^\circ\text{C}$ (MC33184)                                    |                          | —                                                            | —          | 11.5       |                              |
| Average Temperature Coefficient of $V_{IO}$ ( $R_S = 50\ \Omega$ , $V_O = 0\text{ V}$ )    | $\Delta V_{IO}/\Delta T$ | —                                                            | 10         | —          | $\mu\text{V}/^\circ\text{C}$ |
| Input Offset Current ( $V_{CM} = 0\text{ V}$ , $V_O = 0\text{ V}$ )                        | $I_{IO}$                 |                                                              |            |            | nA                           |
| $T_A = +25^\circ\text{C}$                                                                  |                          | —                                                            | 0.001      | 0.05       |                              |
| $T_A = 0^\circ\text{ to }+70^\circ\text{C}$                                                |                          | —                                                            | —          | 1.0        |                              |
| $T_A = -40^\circ\text{ to }+85^\circ\text{C}$                                              |                          | —                                                            | —          | 2.0        |                              |
| Input Bias Current ( $V_{CM} = 0\text{ V}$ , $V_O = 0\text{ V}$ )                          | $I_{IB}$                 |                                                              |            |            | nA                           |
| $T_A = +25^\circ\text{C}$                                                                  |                          | —                                                            | 0.003      | 0.1        |                              |
| $T_A = 0^\circ\text{ to }+70^\circ\text{C}$                                                |                          | —                                                            | —          | 2.0        |                              |
| $T_A = -40^\circ\text{ to }+85^\circ\text{C}$                                              |                          | —                                                            | —          | 4.0        |                              |
| Input Common Mode Voltage Range                                                            | $V_{ICR}$                | $(V_{EE} + 4.0\text{ V})\text{ to } (V_{CC} - 2.0\text{ V})$ |            |            | V                            |
| Large Signal Voltage Gain ( $R_L = 10\text{ k}\Omega$ , $V_O = \pm 10\text{ V}$ )          | $A_{VOL}$                |                                                              |            |            | V/mV                         |
| $T_A = +25^\circ\text{C}$                                                                  |                          | 25                                                           | 60         | —          |                              |
| $T_A = T_{low}\text{ to }T_{high}$                                                         |                          | 15                                                           | —          | —          |                              |
| Output Voltage Swing ( $V_{ID} = 1.0\text{ V}$ , $R_L = 10\text{ k}\Omega$ )               | $V_{O+}$<br>$V_{O-}$     | +13.5<br>—                                                   | +14<br>-14 | —<br>-13.5 | V                            |
| Common Mode Rejection ( $R_S = 50\ \Omega$ , $V_{CM} = V_{ICR}$ , $V_O = 0\text{ V}$ )     | CMR                      | 70                                                           | 86         | —          | dB                           |
| Power Supply Rejection ( $R_S = 50\ \Omega$ , $V_{CM} = 0\text{ V}$ , $V_O = 0\text{ V}$ ) | PSR                      | 70                                                           | 84         | —          | dB                           |
| Output Short Circuit Current ( $V_{ID} = 1.0\text{ V}$ , Output to Ground)                 | $I_{SC}$                 |                                                              |            |            | mA                           |
| Source                                                                                     |                          | 3.0                                                          | 8.0        | —          |                              |
| Sink                                                                                       |                          | 8.0                                                          | 11         | —          |                              |
| Power Supply Current (No Load, $V_O = 0\text{ V}$ )                                        | $I_D$                    |                                                              |            |            | $\mu\text{A}$                |
| Single                                                                                     |                          |                                                              |            |            |                              |
| $T_A = +25^\circ\text{C}$                                                                  |                          | —                                                            | 210        | 250        |                              |
| $T_A = T_{low}\text{ to }T_{high}$                                                         |                          | —                                                            | —          | 250        |                              |
| Dual                                                                                       |                          |                                                              |            |            |                              |
| $T_A = +25^\circ\text{C}$                                                                  |                          | —                                                            | 420        | 500        |                              |
| $T_A = T_{low}\text{ to }T_{high}$                                                         |                          | —                                                            | —          | 500        |                              |
| Quad                                                                                       |                          |                                                              |            |            |                              |
| $T_A = +25^\circ\text{C}$                                                                  |                          | —                                                            | 840        | 1000       |                              |
| $T_A = T_{low}\text{ to }T_{high}$                                                         |                          | —                                                            | —          | 1000       |                              |

**AC ELECTRICAL CHARACTERISTICS** ( $V_{CC} = +15\text{ V}$ ,  $V_{EE} = -15\text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

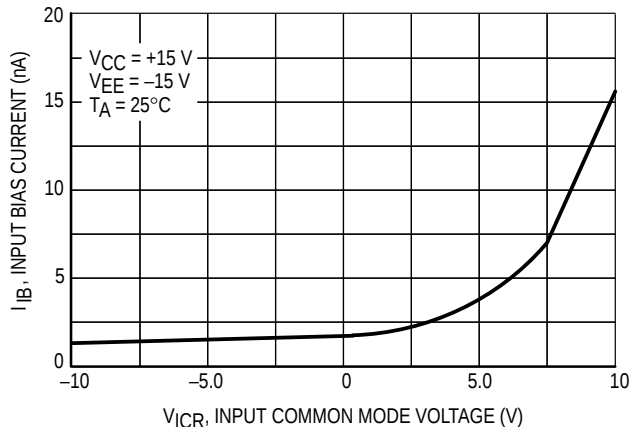
| Characteristics                                                                                                                             | Symbol  | Min      | Typ        | Max    | Unit                   |
|---------------------------------------------------------------------------------------------------------------------------------------------|---------|----------|------------|--------|------------------------|
| Slew Rate ( $V_{in} = -10\text{ V to } +10\text{ V}$ , $R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$ )<br>$A_V = +1.0$<br>$A_V = -1.0$  | SR      | 7.0<br>— | 10<br>10   | —<br>— | V/ $\mu\text{s}$       |
| Settling Time ( $A_V = -1.0$ , $R_L = 10\text{ k}\Omega$ , $V_O = 0\text{ V to } +10\text{ V Step}$ )<br>To Within 0.10%<br>To Within 0.01% | $t_s$   | —<br>—   | 1.1<br>1.5 | —<br>— | $\mu\text{s}$          |
| Gain Bandwidth Product ( $f = 100\text{ kHz}$ )                                                                                             | GBW     | 3.0      | 4.0        | —      | MHz                    |
| Power Bandwidth ( $A_V = +1.0$ , $R_L = 10\text{ k}\Omega$ , $V_O = 20\text{ V}_{pp}$ , THD = 5.0%)                                         | $BW_p$  | —        | 120        | —      | kHz                    |
| Phase Margin ( $-10\text{ V} < V_O < +10\text{ V}$ )<br>$R_L = 10\text{ k}\Omega$<br>$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$      | $f_m$   | —<br>—   | 67<br>34   | —<br>— | Degrees                |
| Gain Margin ( $-10\text{ V} < V_O < +10\text{ V}$ )<br>$R_L = 10\text{ k}\Omega$<br>$R_L = 10\text{ k}\Omega$ , $C_L = 100\text{ pF}$       | $A_m$   | —<br>—   | 6.7<br>3.4 | —<br>— | dB                     |
| Equivalent Input Noise Voltage<br>$R_S = 100\text{ }\Omega$ , $f = 1.0\text{ kHz}$                                                          | $e_n$   | —        | 38         | —      | nV/ $\sqrt{\text{Hz}}$ |
| Equivalent Input Noise Current<br>$f = 1.0\text{ kHz}$                                                                                      | $i_n$   | —        | 0.01       | —      | pA/ $\sqrt{\text{Hz}}$ |
| Differential Input Capacitance                                                                                                              | $C_i$   | —        | 3.0        | —      | pF                     |
| Differential Input Resistance                                                                                                               | $R_i$   | —        | $10^{12}$  | —      | $\Omega$               |
| Total Harmonic Distortion<br>$A_V = 10$ , $R_L = 10\text{ k}\Omega$ , $2.0\text{ V}_{pp} < V_O < 20\text{ V}_{pp}$ , $f = 1.0\text{ kHz}$   | THD     | —        | 0.04       | —      | %                      |
| Channel Separation ( $R_L = 10\text{ k}\Omega$ , $-10\text{ V} < V_O < +10\text{ V}$ , $0\text{ Hz} < f < 10\text{ kHz}$ )                  | —       | —        | 120        | —      | dB                     |
| Open Loop Output Impedance<br>( $f = 1.0\text{ MHz}$ )                                                                                      | $ Z_o $ | —        | 200        | —      | $\Omega$               |

**Figure 1. Maximum Power Dissipation versus Temperature for Package Variations****Figure 2. Input Common Mode Voltage Range versus Temperature**

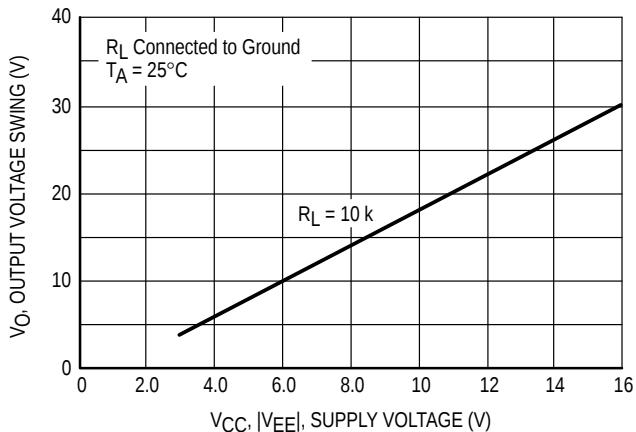
**Figure 3. Input Bias Current versus Temperature**



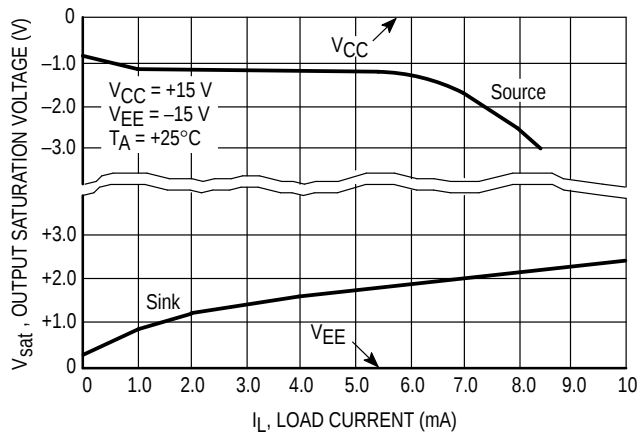
**Figure 4. Input Bias Current versus Input Common Mode Voltage**



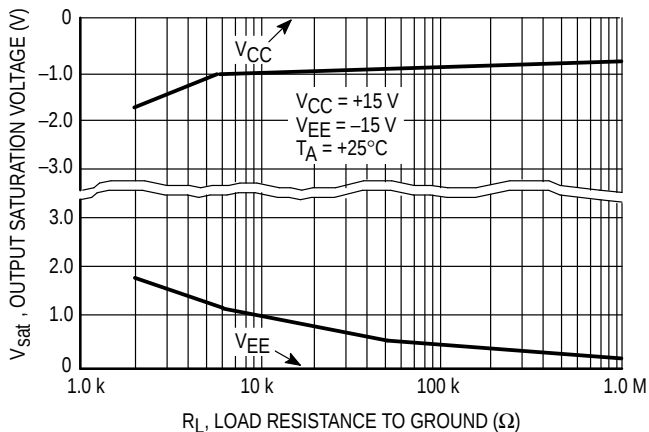
**Figure 5. Output Voltage Swing versus Supply Voltage**



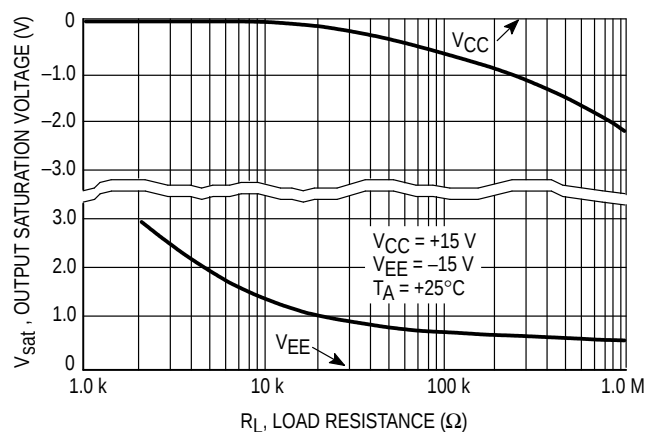
**Figure 6. Output Saturation Voltage versus Load Current**

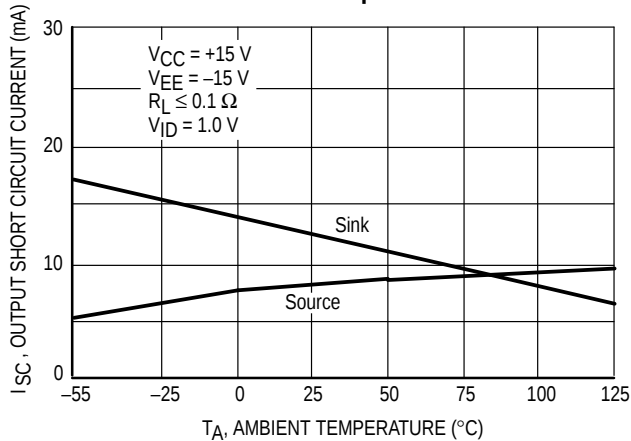
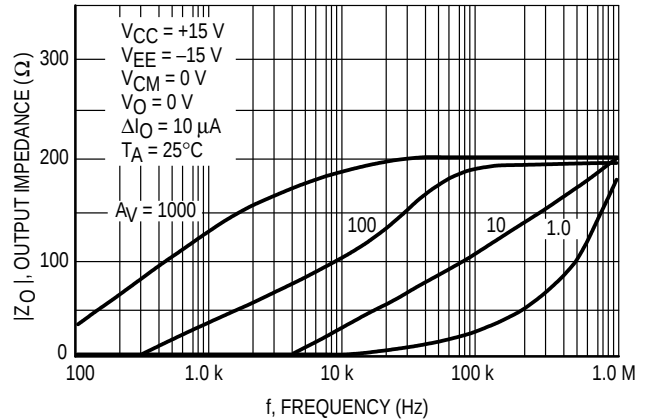
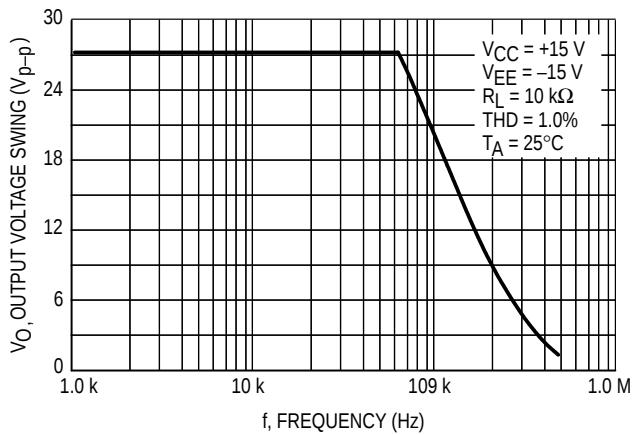
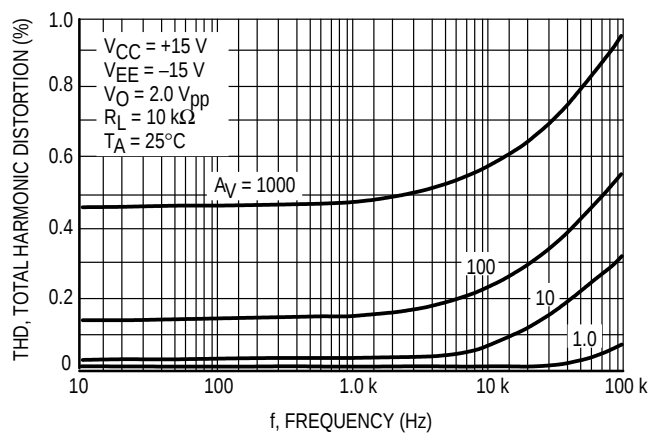
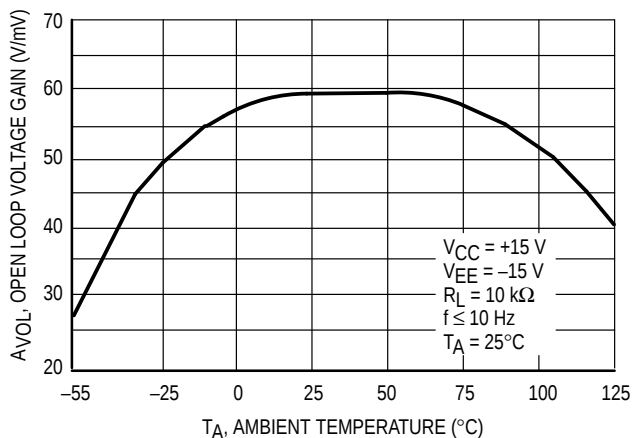
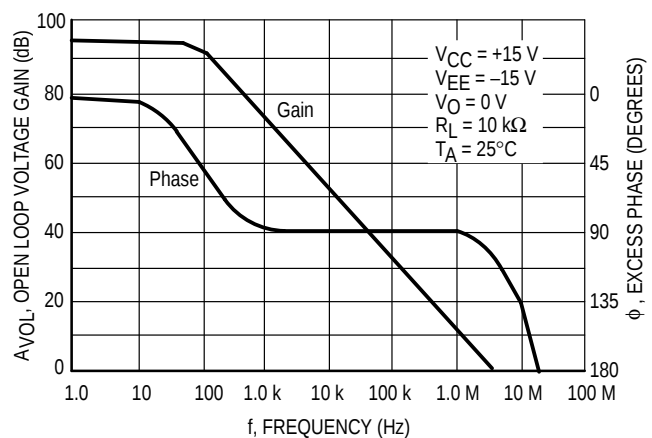


**Figure 7. Output Saturation Voltage versus Load Resistance to Ground**

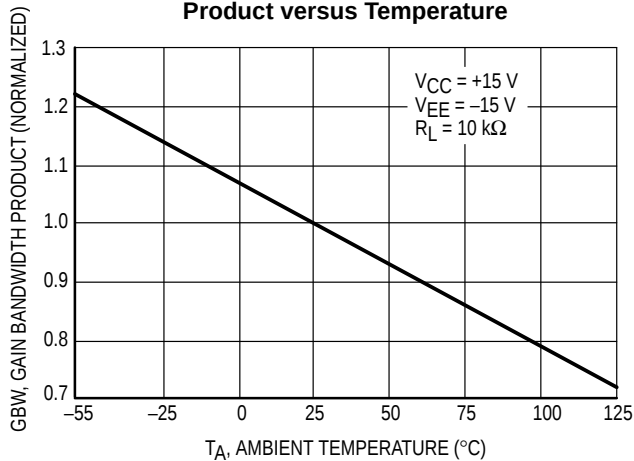


**Figure 8. Output Saturation Voltage versus Load Resistance to V<sub>CC</sub>**

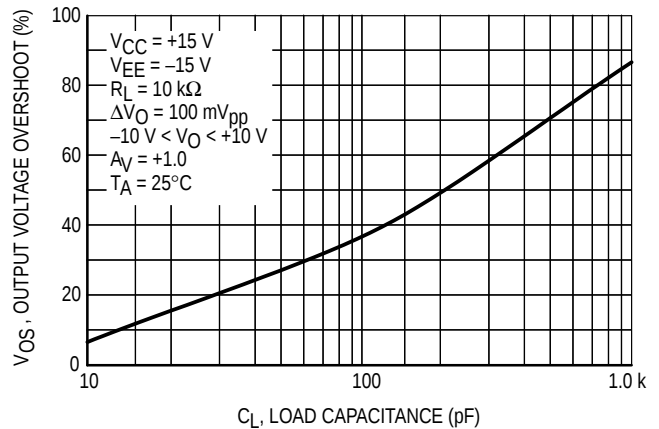


**Figure 9. Output Short Circuit Current versus Temperature****Figure 10. Output Impedance versus Frequency****Figure 11. Output Voltage Swing versus Frequency****Figure 12. Output Distortion versus Frequency****Figure 13. Open Loop Voltage Gain versus Temperature****Figure 14. Open Loop Voltage Gain and Phase versus Frequency**

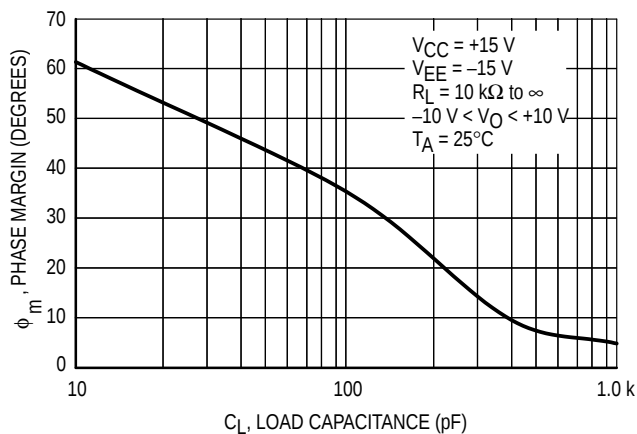
**Figure 15. Normalized Gain Bandwidth Product versus Temperature**



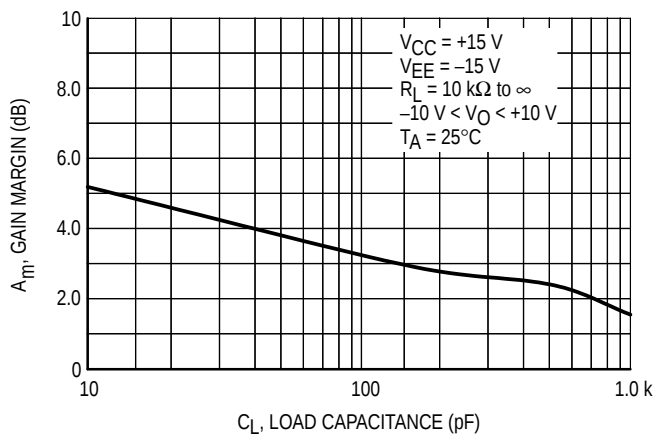
**Figure 16. Output Voltage Overshoot versus Load Capacitance**



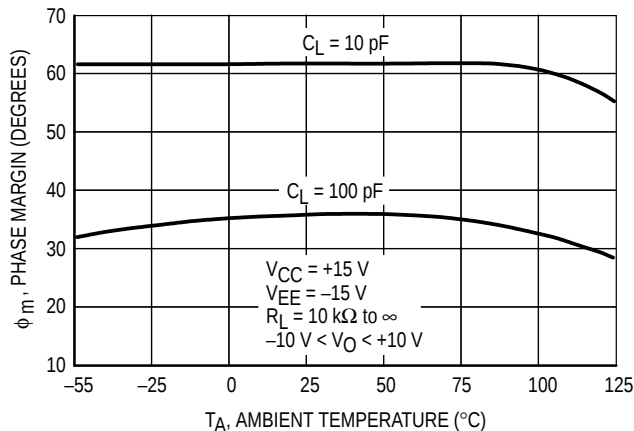
**Figure 17. Phase Margin versus Load Capacitance**



**Figure 18. Gain Margin versus Load Capacitance**



**Figure 19. Phase Margin versus Temperature**



**Figure 20. Gain Margin versus Temperature**

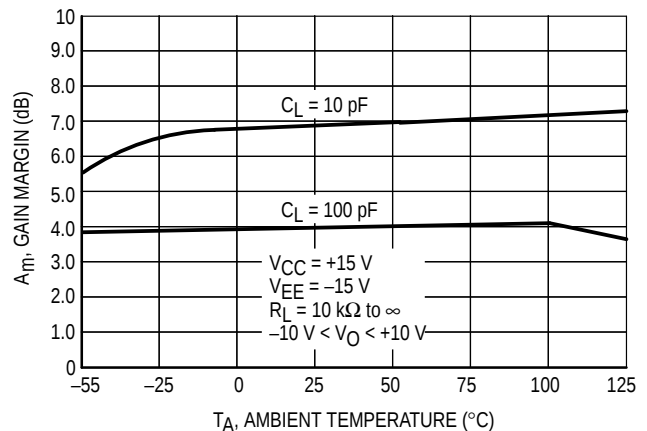


Figure 21. Normalized Slew Rate versus Temperature

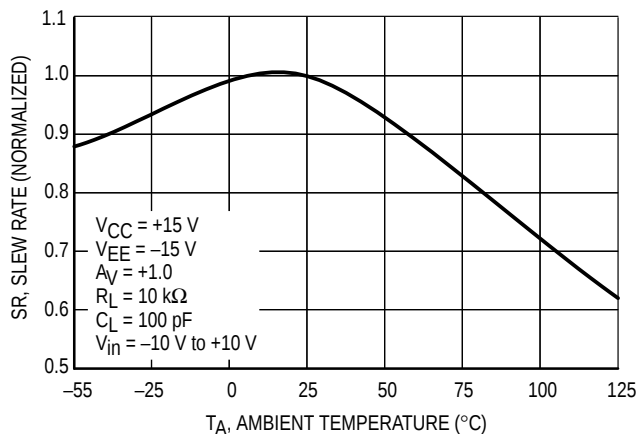


Figure 22. Common Mode Rejection versus Frequency

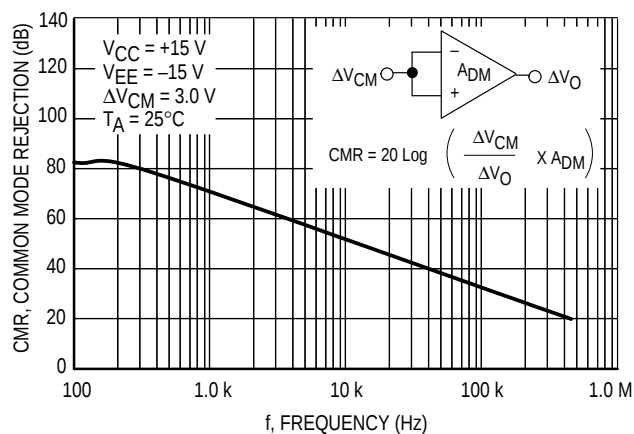


Figure 23. Input Noise Voltage versus Frequency

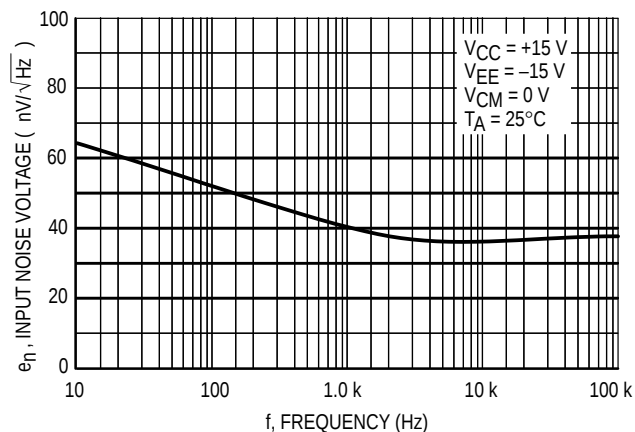


Figure 24. Power Supply Rejection versus Temperature

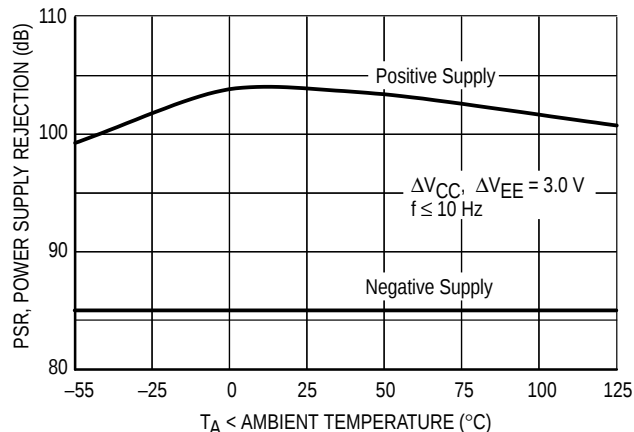


Figure 25. Power Supply Rejection versus Frequency

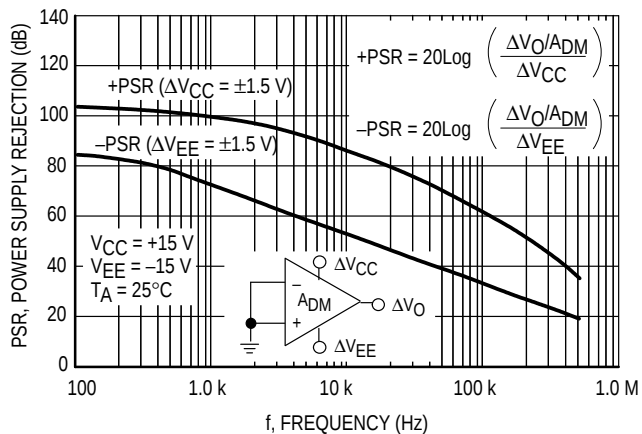


Figure 26. Normalized Supply Current versus Supply Voltage

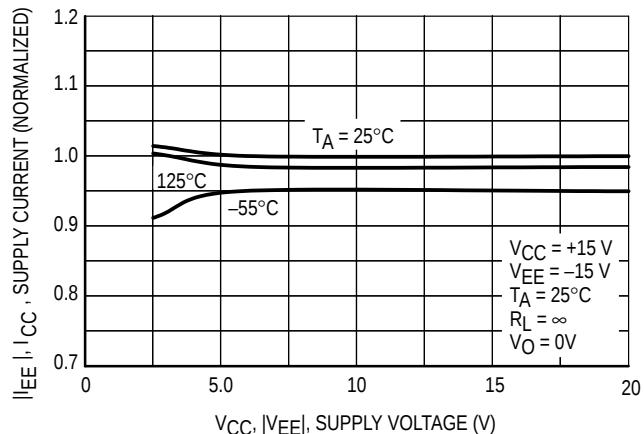


Figure 27. Channel Separation versus Frequency

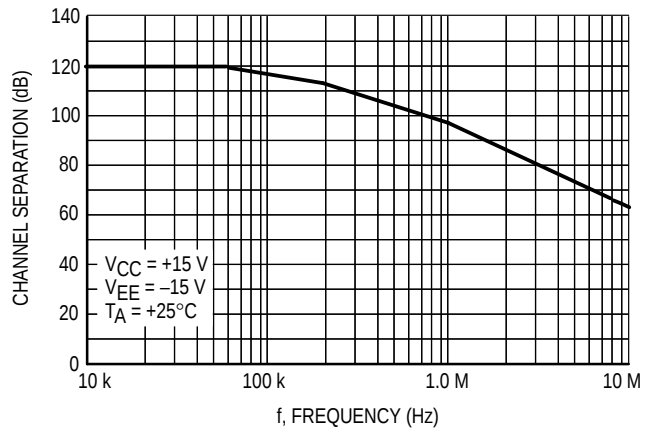


Figure 28. Transient Response

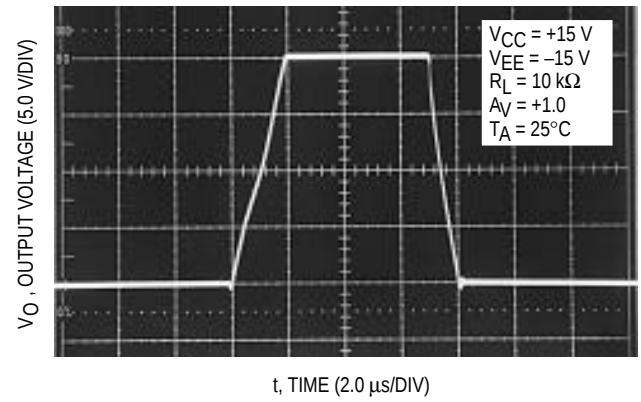
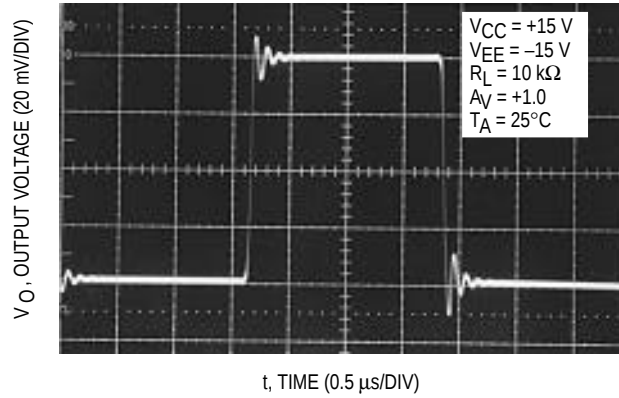
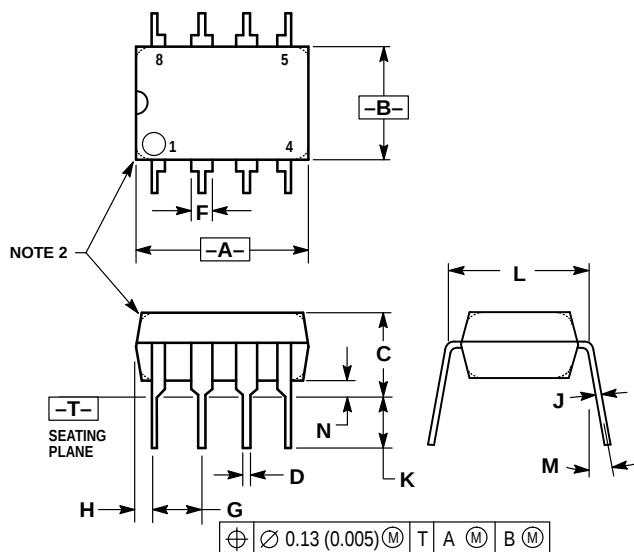


Figure 29. Small Signal Transient Reponse



## OUTLINE DIMENSIONS

**P SUFFIX**  
**PLASTIC PACKAGE**  
**CASE 626-05**  
**ISSUE K**

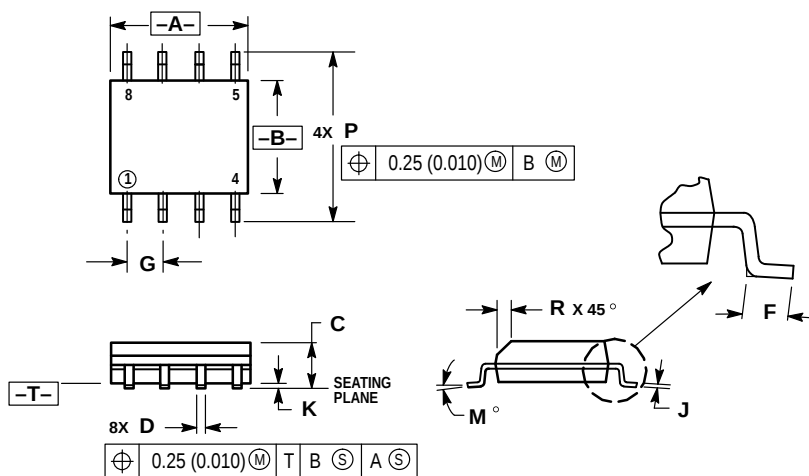


## NOTES:

1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 9.40        | 10.16 | 0.370     | 0.400 |
| B   | 6.10        | 6.60  | 0.240     | 0.260 |
| C   | 3.94        | 4.45  | 0.155     | 0.175 |
| D   | 0.38        | 0.51  | 0.015     | 0.020 |
| F   | 1.02        | 1.78  | 0.040     | 0.070 |
| G   | 2.54 BSC    |       | 0.100 BSC |       |
| H   | 0.76        | 1.27  | 0.030     | 0.050 |
| J   | 0.20        | 0.30  | 0.008     | 0.012 |
| K   | 2.92        | 3.43  | 0.115     | 0.135 |
| L   | 7.62 BSC    |       | 0.300 BSC |       |
| M   | 10°         |       | 10°       |       |
| N   | 0.76        | 1.01  | 0.030     | 0.040 |

**D SUFFIX**  
**PLASTIC PACKAGE**  
**CASE 751-05**  
**ISSUE N**  
**(SO-8)**



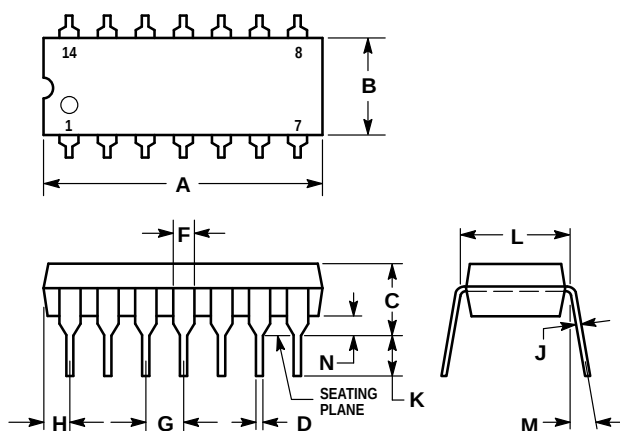
## NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 4.80        | 5.00 | 0.189     | 0.196 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.054     | 0.068 |
| D   | 0.35        | 0.49 | 0.014     | 0.019 |
| F   | 0.40        | 1.25 | 0.016     | 0.049 |
| G   | 1.27 BSC    |      | 0.050 BSC |       |
| J   | 0.18        | 0.25 | 0.007     | 0.009 |
| K   | 0.10        | 0.25 | 0.004     | 0.009 |
| M   | 0°          |      | 7°        |       |
| P   | 5.80        | 6.20 | 0.229     | 0.244 |
| R   | 0.25        | 0.50 | 0.010     | 0.019 |

## OUTLINE DIMENSIONS – continued

**P SUFFIX**  
 PLASTIC PACKAGE  
 CASE 646-06  
 ISSUE L

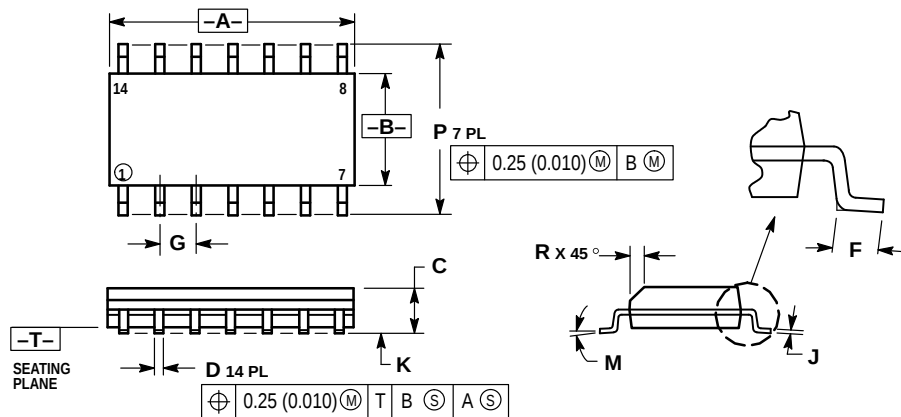


## NOTES:

- LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
- DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
- DIMENSION B DOES NOT INCLUDE MOLD FLASH.
- ROUNDED CORNERS OPTIONAL.

| DIM | INCHES    |       | MILLIMETERS |       |
|-----|-----------|-------|-------------|-------|
|     | MIN       | MAX   | MIN         | MAX   |
| A   | 0.715     | 0.770 | 18.16       | 19.56 |
| B   | 0.240     | 0.260 | 6.10        | 6.60  |
| C   | 0.145     | 0.185 | 3.69        | 4.69  |
| D   | 0.015     | 0.021 | 0.38        | 0.53  |
| F   | 0.040     | 0.070 | 1.02        | 1.78  |
| G   | 0.100 BSC |       | 2.54 BSC    |       |
| H   | 0.052     | 0.095 | 1.32        | 2.41  |
| J   | 0.008     | 0.015 | 0.20        | 0.38  |
| K   | 0.115     | 0.135 | 2.92        | 3.43  |
| L   | 0.300 BSC |       | 7.62 BSC    |       |
| M   | 0°        | 10°   | 0°          | 10°   |
| N   | 0.015     | 0.039 | 0.39        | 1.01  |

**D SUFFIX**  
 PLASTIC PACKAGE  
 CASE 751A-03  
 ISSUE F  
 (SO-14)



## NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
- CONTROLLING DIMENSION: MILLIMETER.
- DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
- MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
- DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | MIN         | MAX  | MIN       | MAX   |
| A   | 8.55        | 8.75 | 0.337     | 0.344 |
| B   | 3.80        | 4.00 | 0.150     | 0.157 |
| C   | 1.35        | 1.75 | 0.054     | 0.068 |
| D   | 0.35        | 0.49 | 0.014     | 0.019 |
| F   | 0.40        | 1.25 | 0.016     | 0.049 |
| G   | 1.27 BSC    |      | 0.050 BSC |       |
| J   | 0.19        | 0.25 | 0.008     | 0.009 |
| K   | 0.10        | 0.25 | 0.004     | 0.009 |
| M   | 0°          | 7°   | 0°        | 7°    |
| P   | 5.80        | 6.20 | 0.228     | 0.244 |
| R   | 0.25        | 0.50 | 0.010     | 0.019 |

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