# MC33272A, MC33274A

## Single Supply, High Slew Rate, Low Input Offset Voltage Operational Amplifiers

The MC33272/74 series of monolithic operational amplifiers are quality fabricated with innovative Bipolar design concepts. This dual and quad operational amplifier series incorporates Bipolar inputs along with a patented Zip–R–Trim element for input offset voltage reduction. The MC33272/74 series of operational amplifiers exhibits low input offset voltage and high gain bandwidth product. Dual–doublet frequency compensation is used to increase the slew rate while maintaining low input noise characteristics. Its all NPN output stage exhibits no deadband crossover distortion, large output voltage swing, and an excellent phase and gain margin. It also provides a low open loop high frequency output impedance with symmetrical source and sink AC frequency performance.

The MC33272/74 series is specified over –40° to +85°C and are available in plastic DIP and SOIC surface mount packages.

- Input Offset Voltage Trimmed to 100 μV (Typ)
- Low Input Bias Current: 300 nA
- Low Input Offset Current: 3.0 nA
- High Input Resistance: 16 MΩ
- Low Noise: 18 nV/$\sqrt{Hz}$ @ 1.0 kHz
- High Gain Bandwidth Product: 24 MHz @ 100 kHz
- High Slew Rate: 10 V/μs
- Power Bandwidth: 160 kHz
- Excellent Frequency Stability
- Unity Gain Stable: w/Capacitance Loads to 500 pF
- Large Output Voltage Swing: +14.1 V/ –14.6 V
- Low Total Harmonic Distortion: 0.003%
- Power Supply Drain Current: 2.15 mA per Amplifier
- Single or Split Supply Operation: +3.0 V to +36 V or ±1.5 V to ±18 V
- ESD Diodes Provide Added Protection to the Inputs

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### MARKING DIAGRAMS

**DUAL**
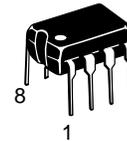
PDIP–8
P SUFFIX
CASE 626

```
MC33272AP
AWL
YYWW
```

SO–8
D SUFFIX
CASE 751

```
33272
ALYWA
```

**QUAD**

PDIP–14
P SUFFIX
CASE 646

```
MC33274AP
AWLYYWW
```

SO–14
D SUFFIX
CASE 751A

```
MC33274AD
AWLYWW
```
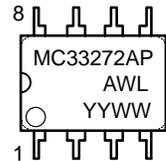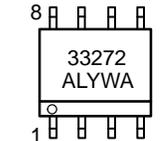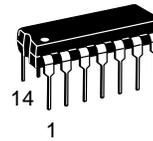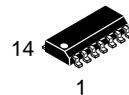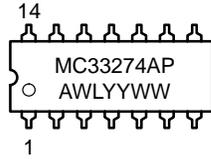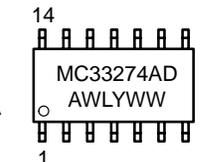
| | |
|---|---|
| A | = Assembly Location |
| WL, L | = Wafer Lot |
| YY, Y | = Year |
| WW, W | = Work Week |

### ORDERING INFORMATION

| Device | Package | Shipping |
|---|---|---|
| MC33272AD | SO–8 | 98 Units/Rail |
| MC33272ADR2 | SO–8 | 2500 Tape & Reel |
| MC33272AP | PDIP–8 | 50 Units/Rail |
| MC33274AD | SO–14 | 55 Units/Rail |
| MC33274ADR2 | SO–14 | 2500 Tape & Reel |
| MC33274AP | PDIP–14 | 25 Units/Rail |

# MC33272A, MC33274A

## PIN CONNECTIONS

### DUAL

**CASE 626/751**

Output 1 — 1 | 8 — $V_{CC}$
Inputs 1 — 2, 3 | 7 — Output 2
$V_{EE}$ — 4 | 6, 5 — Inputs 2

(Top View)

### QUAD

**CASE 646/751A**

Output 1 — 1 | 14 — Output 4
Inputs 1 — 2, 3 | 13, 12 — Inputs 4
$V_{CC}$ — 4 | 11 — $V_{EE}$
Inputs 2 — 5, 6 | 10, 9 — Inputs 3
Output 2 — 7 | 8 — Output 3

(Top View)
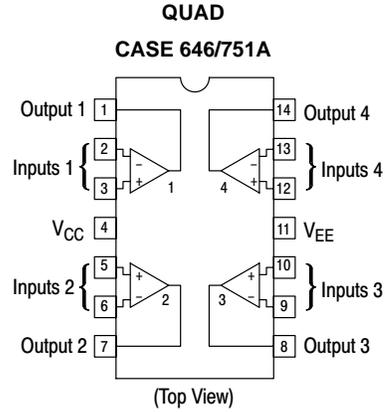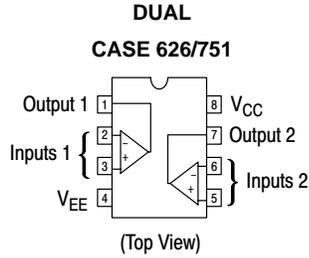
## MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Supply Voltage | $V_{CC}$ to $V_{EE}$ | +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 |
| Maximum Junction Temperature | $T_J$ | +150 | °C |
| Storage Temperature | $T_{stg}$ | −60 to +150 | °C |
| Maximum Power Dissipation | $P_D$ | Note 2 | mW |
| Operating Temperature Range | $T_A$ | −40 to +85 | °C |

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

**DC ELECTRICAL CHARACTERISTICS** ($V_{CC}$ = +15 V, $V_{EE}$ = −15 V, $T_A$ = 25°C, unless otherwise noted.)

| Characteristics | Figure | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Input Offset Voltage ($R_S$ = 10 Ω, $V_{CM}$ = 0 V, $V_O$ = 0 V)<br>($V_{CC}$ = +15 V, $V_{EE}$ = −15 V)<br>　　$T_A$ = +25°C<br>　　$T_A$ = −40° to +85°C<br>($V_{CC}$ = 5.0 V, $V_{EE}$ = 0)<br>　　$T_A$ = +25°C | 3 | $|V_{IO}|$ | <br><br>−<br>−<br><br>− | <br><br>0.1<br>−<br><br>− | <br><br>1.0<br>1.8<br><br>2.0 | mV |
| Average Temperature Coefficient of Input Offset Voltage<br>$R_S$ = 10 Ω, $V_{CM}$ = 0 V, $V_O$ = 0 V, $T_A$ = −40° to +85°C | 3 | $\Delta V_{IO}/\Delta T$ | <br>− | <br>2.0 | <br>− | μV/°C |
| Input Bias Current ($V_{CM}$ = 0 V, $V_O$ = 0 V)<br>　　$T_A$ = +25°C<br>　　$T_A$ = −40° to +85°C | 4, 5 | $I_{IB}$ | <br>−<br>− | <br>300<br>− | <br>650<br>800 | nA |
| Input Offset Current ($V_{CM}$ = 0 V, $V_O$ = 0 V)<br>　　$T_A$ = +25°C<br>　　$T_A$ = −40° to +85°C | | $|I_{IO}|$ | <br>−<br>− | <br>3.0<br>− | <br>65<br>80 | nA |
| Common Mode Input Voltage Range ($\Delta V_{IO}$ = 5.0 mV, $V_O$ = 0 V)<br>　　$T_A$ = +25°C | 6 | $V_{ICR}$ | $V_{EE}$ to ($V_{CC}$ −1.8) | | | V |
| Large Signal Voltage Gain ($V_O$ = 0 V to 10 V, $R_L$ = 2.0 kΩ)<br>　　$T_A$ = +25°C<br>　　$T_A$ = −40° to +85°C | 7 | $A_{VOL}$ | <br>90<br>86 | <br>100<br>− | <br>−<br>− | dB |
| Output Voltage Swing ($V_{ID}$ = ±1.0 V)<br>($V_{CC}$ = +15 V, $V_{EE}$ = −15 V)<br>　　$R_L$ = 2.0 kΩ<br>　　$R_L$ = 2.0 kΩ<br>　　$R_L$ = 10 kΩ<br>　　$R_L$ = 10 kΩ<br>($V_{CC}$ = 5.0 V, $V_{EE}$ = 0 V)<br>　　$R_L$ = 2.0 kΩ<br>　　$R_L$ = 2.0 kΩ | 8, 9, 12<br><br><br><br><br><br>10, 11 | <br><br>$V_O$+<br>$V_O$−<br>$V_O$+<br>$V_O$−<br><br>$V_{OL}$<br>$V_{OH}$ | <br><br>13.4<br>−<br>13.4<br>−<br><br>−<br>3.7 | <br><br>13.9<br>−13.9<br>14<br>−14.7<br><br>−<br>− | <br><br>−<br>−13.5<br>−<br>−14.1<br><br>0.2<br>5.0 | V |
| Common Mode Rejection ($V_{in}$ = +13.2 V to −15 V) | 13 | CMR | 80 | 100 | − | dB |
| Power Supply Rejection<br>$V_{CC}/V_{EE}$ = +15 V/ −15 V, +5.0 V/ −15 V, +15 V/ −5.0 V | 14, 15 | PSR | <br>80 | <br>105 | <br>− | dB |
| Output Short Circuit Current ($V_{ID}$ = 1.0 V, Output to Ground)<br>　Source<br>　Sink | 16 | $I_{SC}$ | <br>+25<br>−25 | <br>+37<br>−37 | <br>−<br>− | mA |
| Power Supply Current Per Amplifier ($V_O$ = 0 V)<br>($V_{CC}$ = +15 V, $V_{EE}$ = −15 V)<br>　　$T_A$ = +25°C<br>　　$T_A$ = −40° to +85°C<br>($V_{CC}$ = 5.0 V, $V_{EE}$ = 0 V)<br>　　$T_A$ = +25°C | 17 | $I_{CC}$ | <br><br>−<br>−<br><br>− | <br><br>2.15<br>−<br><br>− | <br><br>2.75<br>3.0<br><br>2.75 | mA |

**AC ELECTRICAL CHARACTERISTICS** ($V_{CC}$ = +15 V, $V_{EE}$ = −15 V, $T_A$ = 25°C, unless otherwise noted.)

| Characteristics | Figure | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Slew Rate<br>($V_{in}$ = −10 V to +10 V, $R_L$ = 2.0 kΩ, $C_L$ = 100 pF, $A_V$ = +1.0 V) | 18, 33 | SR | 8.0 | 10 | – | V/μs |
| Gain Bandwidth Product (f = 100 kHz) | 19 | GBW | 17 | 24 | – | MHz |
| AC Voltage Gain ($R_L$ = 2.0 kΩ, $V_O$ = 0 V, f = 20 kHz) | 20, 21, 22 | $A_{VO}$ | – | 65 | – | dB |
| Unity Gain Bandwidth (Open Loop) | | BW | – | 5.5 | – | MHz |
| Gain Margin ($R_L$ = 2.0 kΩ, $C_L$ = 0 pF) | 23, 24, 26 | $A_m$ | – | 12 | – | dB |
| Phase Margin ($R_L$ = 2.0 kΩ, $C_L$ = 0 pF) | 23, 25, 26 | $\phi_m$ | – | 55 | – | Deg |
| Channel Separation (f = 20 Hz to 20 kHz) | 27 | CS | – | −120 | – | dB |
| Power Bandwidth ($V_O$ = 20 $V_{pp}$, $R_L$ = 2.0 kΩ, THD ≤ 1.0%) | | $BW_P$ | – | 160 | – | kHz |
| Total Harmonic Distortion<br>($R_L$ = 2.0 kΩ, f = 20 Hz to 20 kHz, $V_O$ = 3.0 $V_{rms}$, $A_V$ = +1.0) | 28 | THD | – | 0.003 | – | % |
| Open Loop Output Impedance ($V_O$ = 0 V, f = 6.0 MHz) | 29 | $|Z_O|$ | – | 35 | – | Ω |
| Differential Input Resistance ($V_{CM}$ = 0 V) | | $R_{in}$ | – | 16 | – | MΩ |
| Differential Input Capacitance ($V_{CM}$ = 0 V) | | $C_{in}$ | – | 3.0 | – | pF |
| Equivalent Input Noise Voltage ($R_S$ = 100 Ω, f = 1.0 kHz) | 30 | $e_n$ | – | 18 | – | nV/$\sqrt{Hz}$ |
| Equivalent Input Noise Current (f = 1.0 kHz) | 31 | $i_n$ | – | 0.5 | – | pA/$\sqrt{Hz}$ |
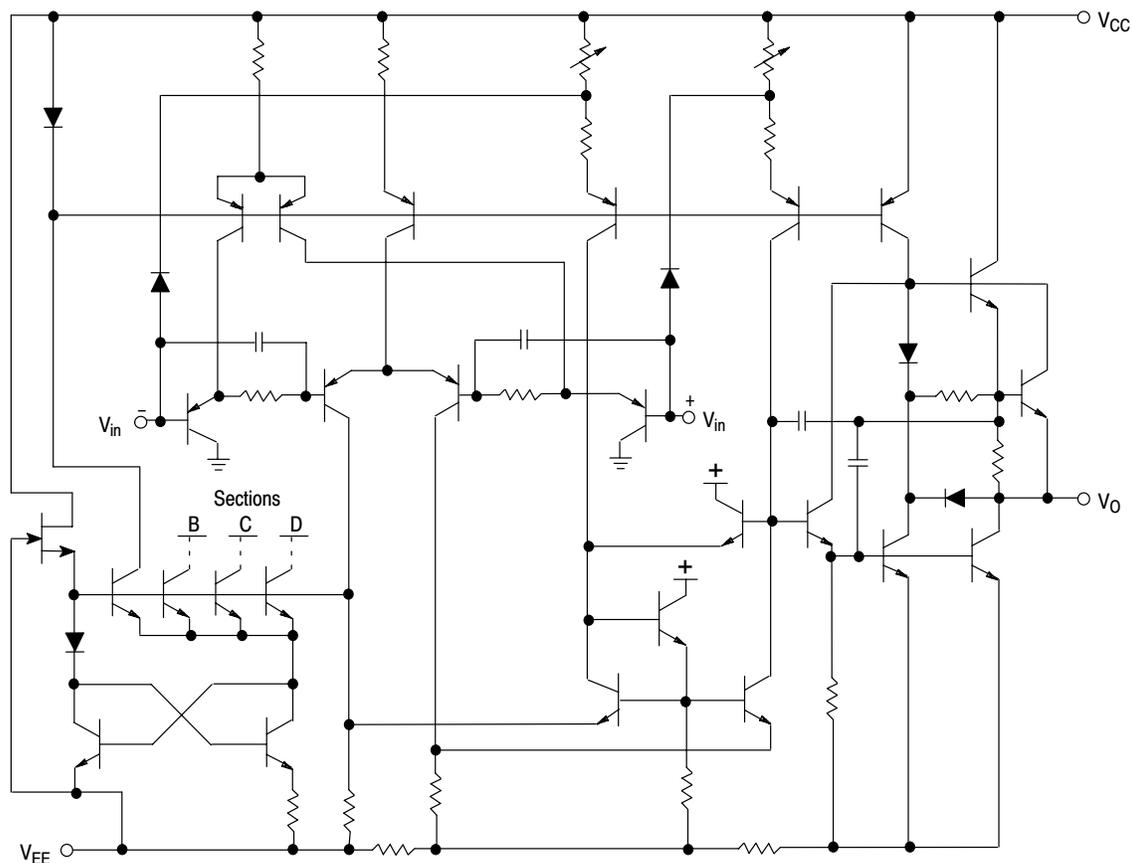


**Figure 1. Equivalent Circuit Schematic**
(Each Amplifier)
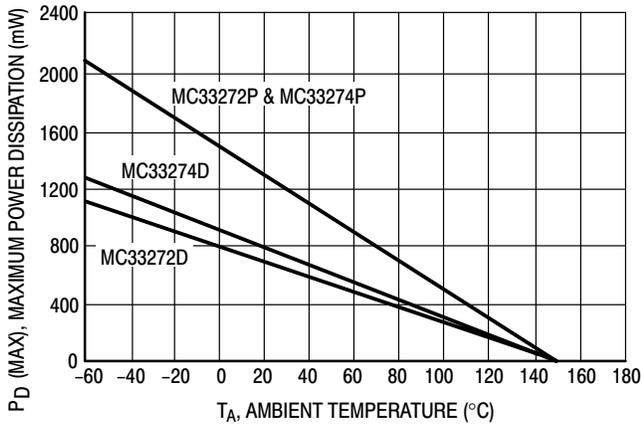
**Figure 2. Maximum Power Dissipation
versus Temperature**
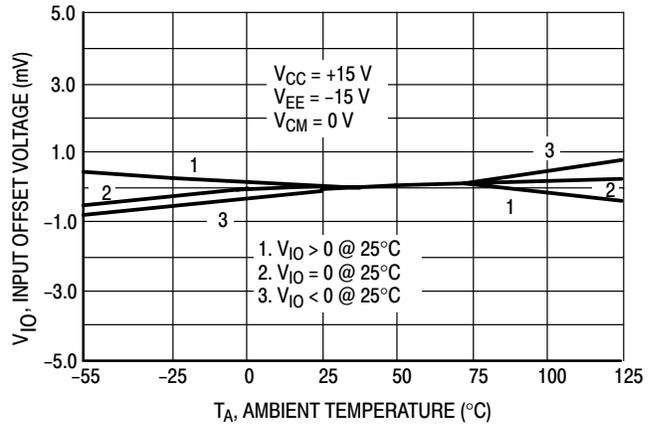


**Figure 3. Input Offset Voltage versus
Temperature for Typical Units**
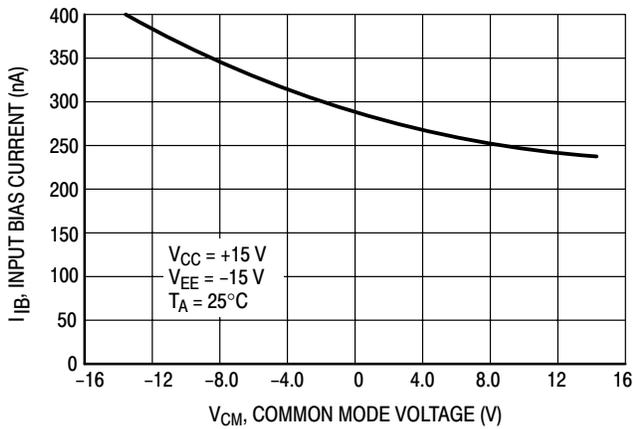


**Figure 4. Input Bias Current versus
Common Mode Voltage**
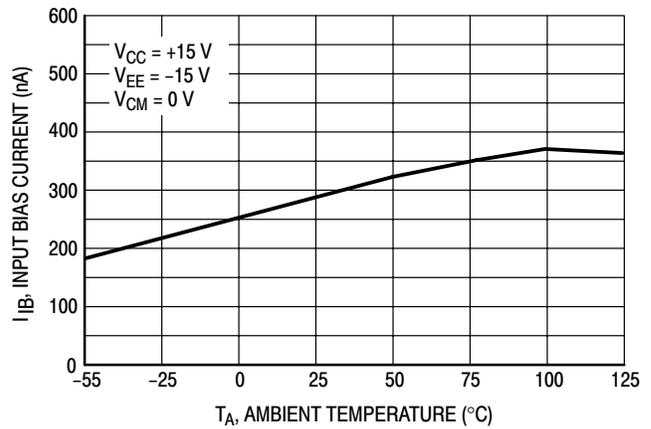


**Figure 5. Input Bias Current
versus Temperature**
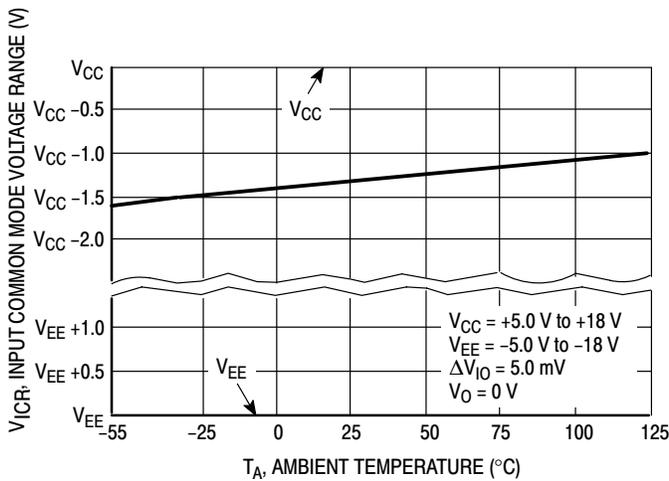


**Figure 6. Input Common Mode Voltage
Range versus Temperature**
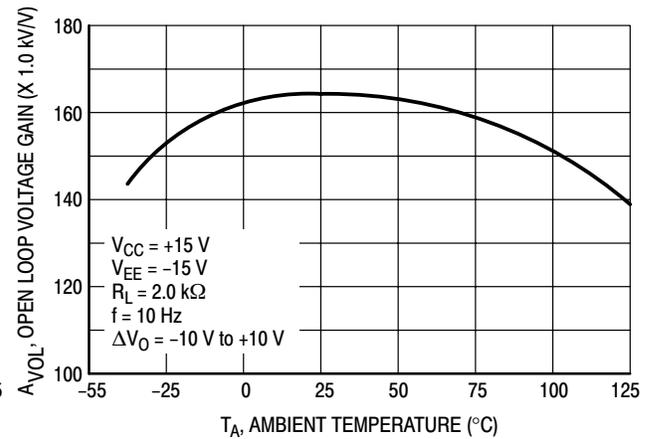


**Figure 7. Open Loop Voltage Gain
versus Temperature**
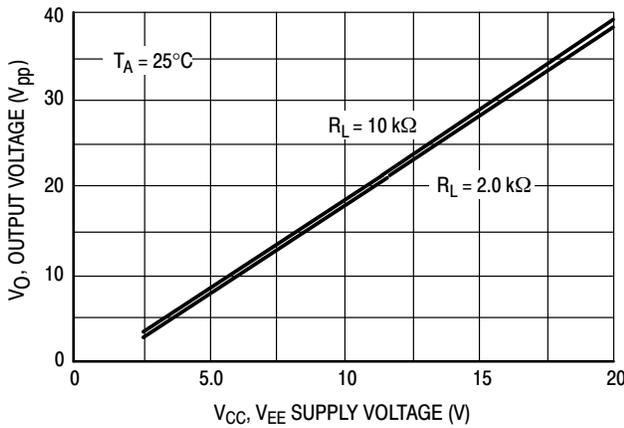
**Figure 8. Split Supply Output Voltage Swing
versus Supply Voltage**
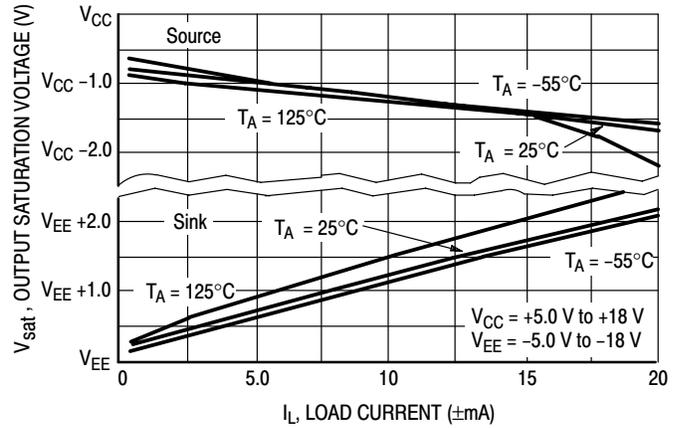


**Figure 9. Split Supply Output Saturation
Voltage versus Load Current**
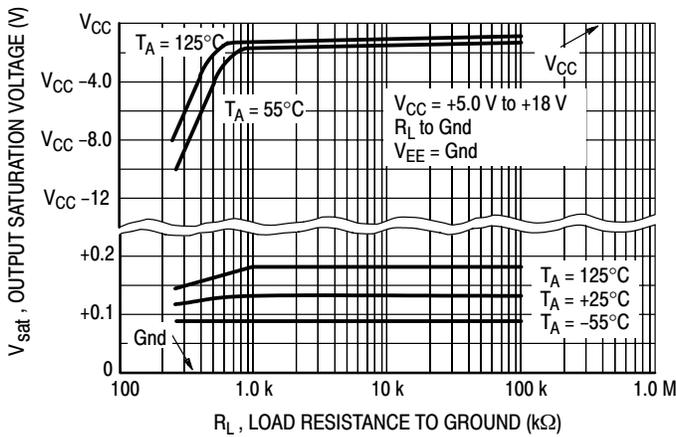


**Figure 10. Single Supply Output Saturation
Voltage versus Load Resistance to Ground**
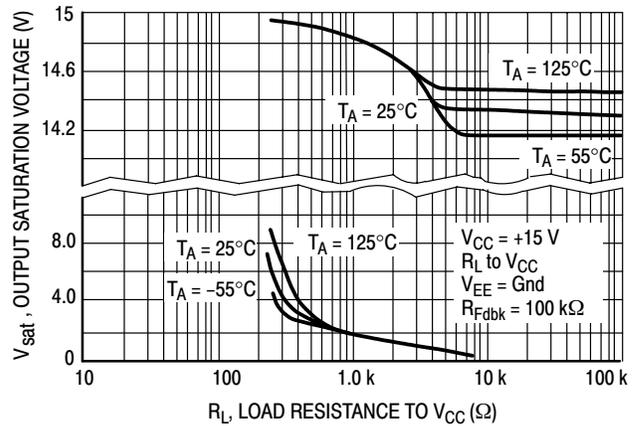


**Figure 11. Single Supply Output Saturation
Voltage versus Load Resistance to $V_{CC}$**
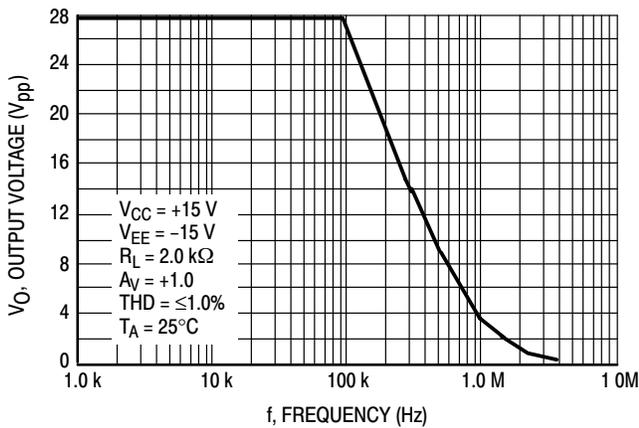


**Figure 12. Output Voltage versus Frequency**
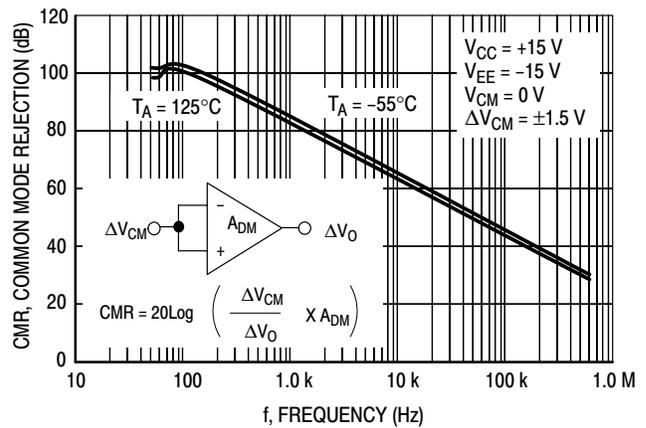


**Figure 13. Common Mode Rejection
versus Frequency**
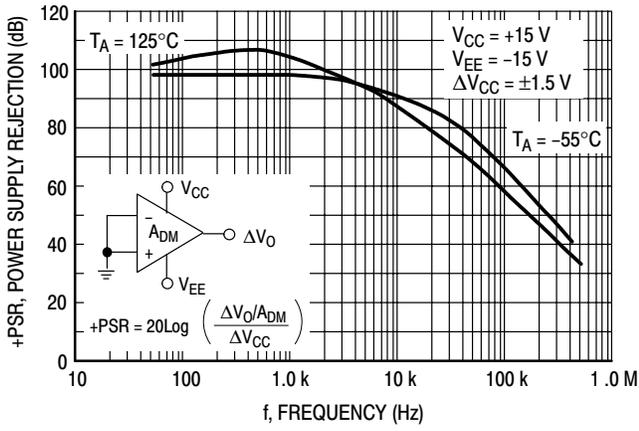
**Figure 14. Positive Power Supply Rejection
versus Frequency**
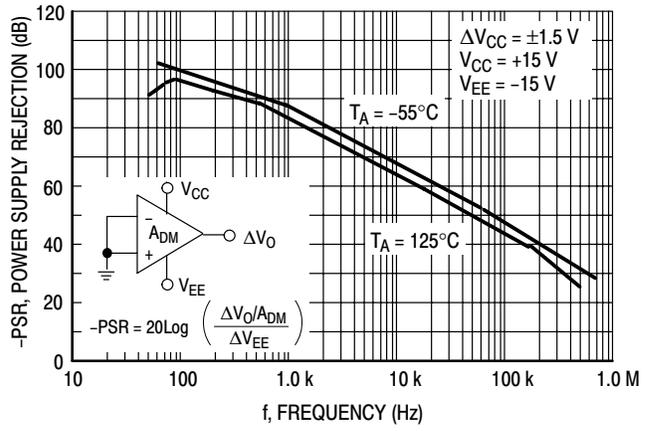


**Figure 15. Negative Power Supply Rejection
versus Frequency**
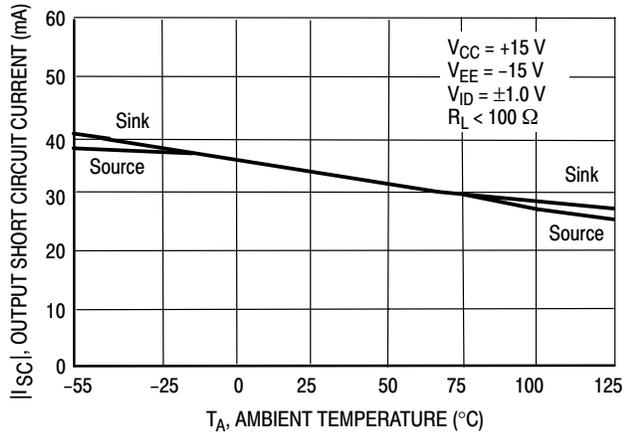


**Figure 16. Output Short Circuit Current
versus Temperature**
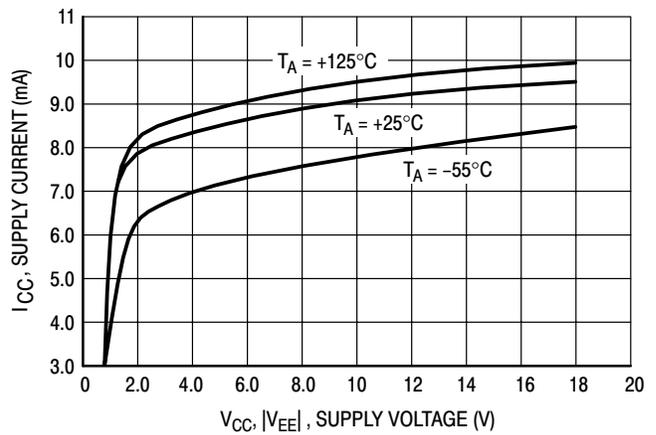


**Figure 17. Supply Current versus
Supply Voltage**
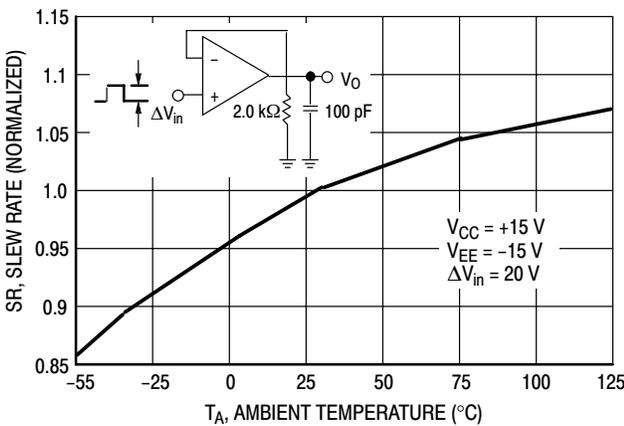


**Figure 18. Normalized Slew Rate
versus Temperature**
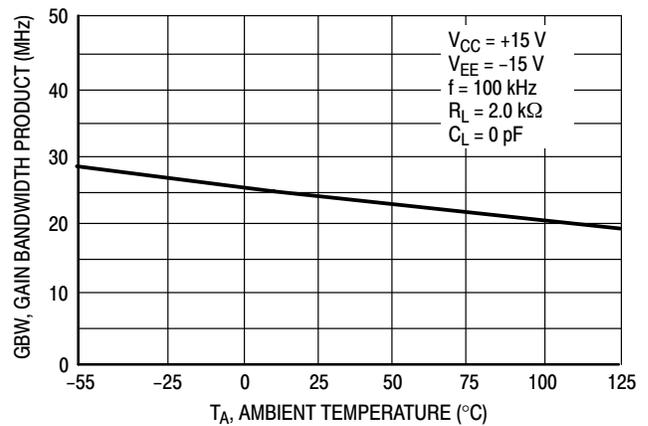


**Figure 19. Gain Bandwidth Product
versus Temperature**
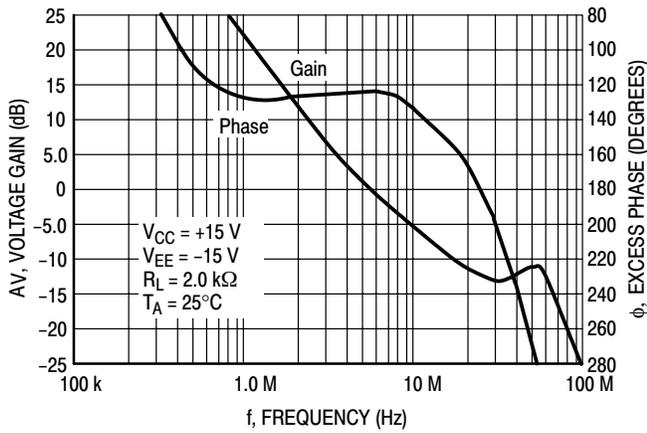
Figure 20. Voltage Gain and Phase
versus Frequency
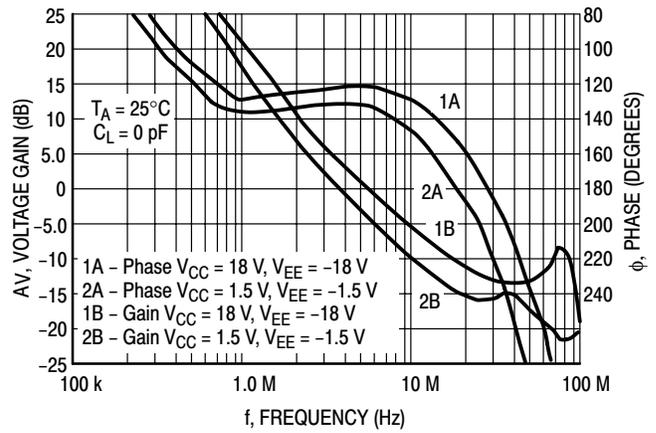


Figure 21. Gain and Phase
versus Frequency
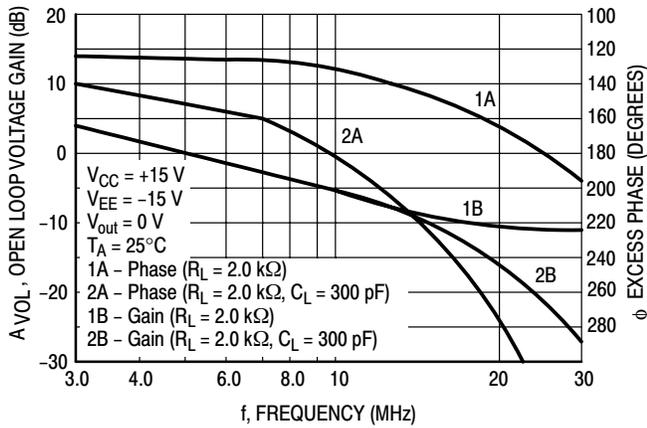


Figure 22. Open Loop Voltage Gain and
Phase versus Frequency
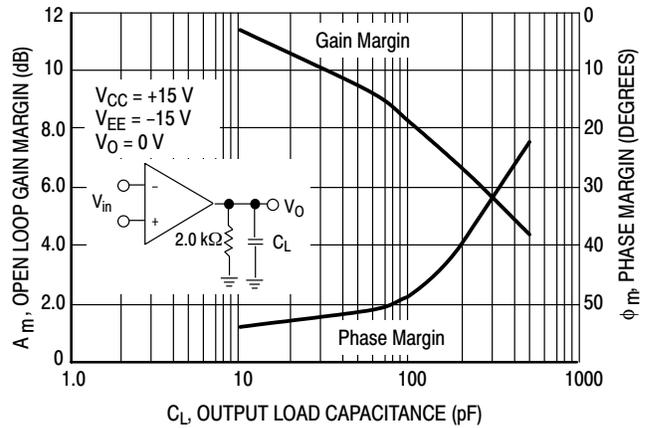


Figure 23. Open Loop Gain Margin and Phase
Margin versus Output Load Capacitance
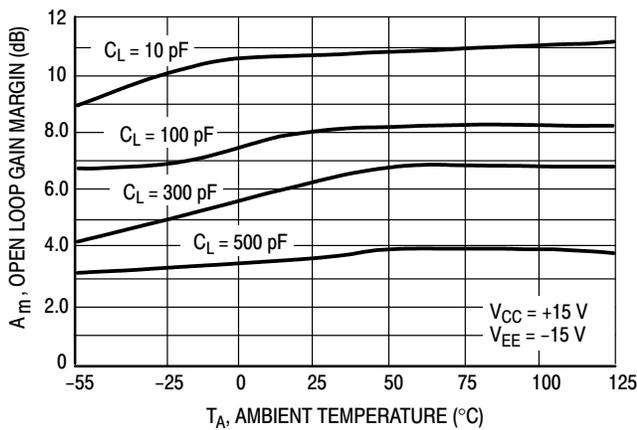


Figure 24. Open Loop Gain Margin
versus Temperature
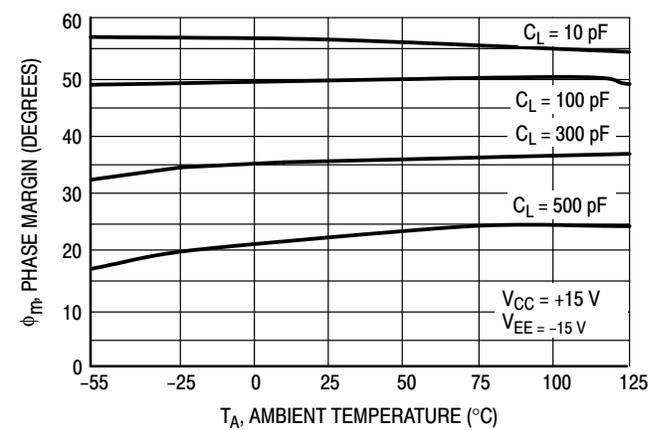


Figure 25. Phase Margin versus Temperature
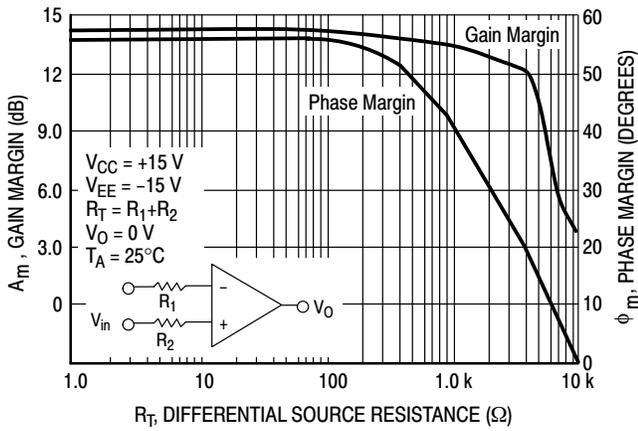
**Figure 26. Phase Margin and Gain Margin
versus Differential Source Resistance**
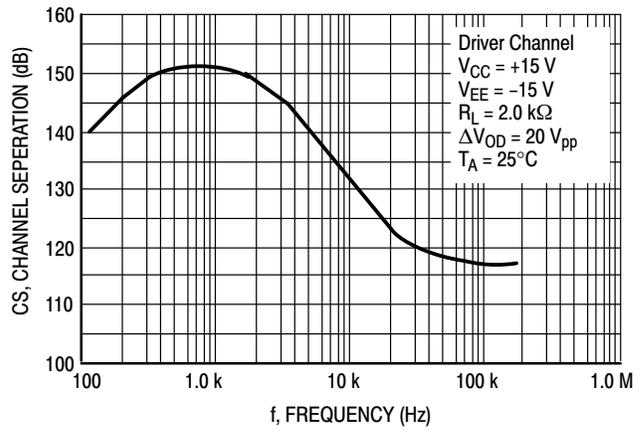
**Figure 27. Channel Separation
versus Frequency**
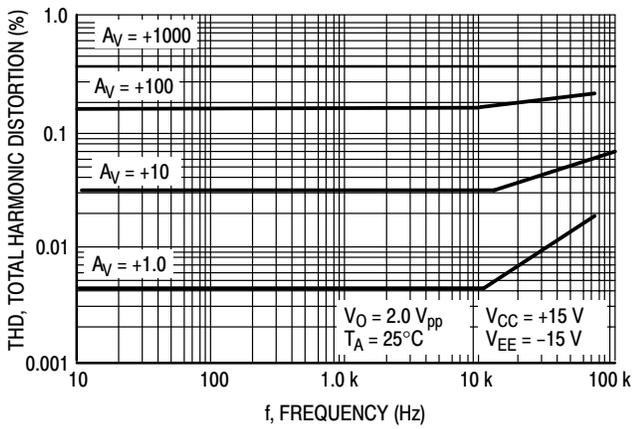
**Figure 28. Total Harmonic Distortion
versus Frequency**
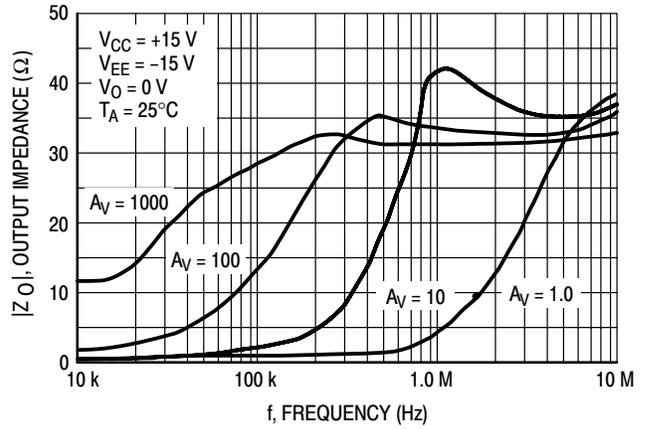
**Figure 29. Output Impedance versus Frequency**
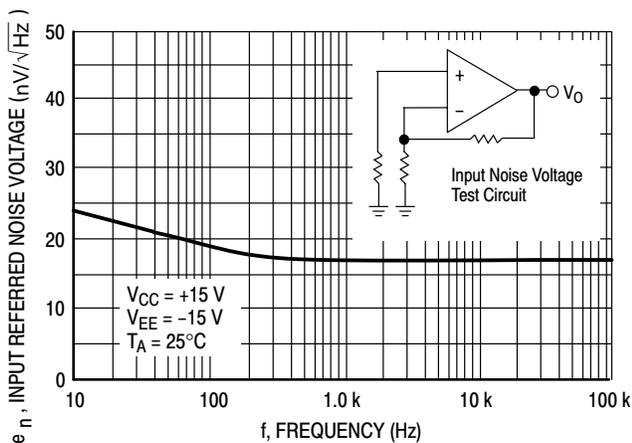
**Figure 30. Input Referred Noise Voltage
versus Frequency**
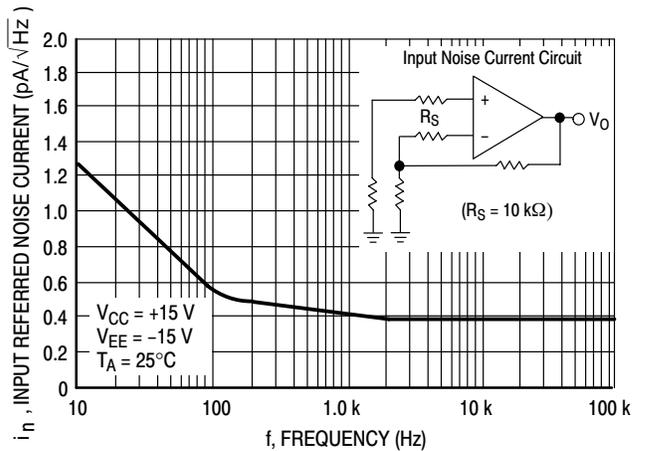
**Figure 31. Input Referred Noise Current
versus Frequency**
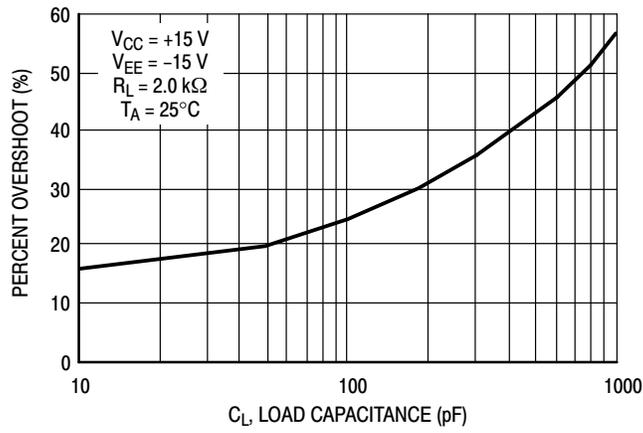
**Figure 32. Percent Overshoot versus
Load Capacitance**
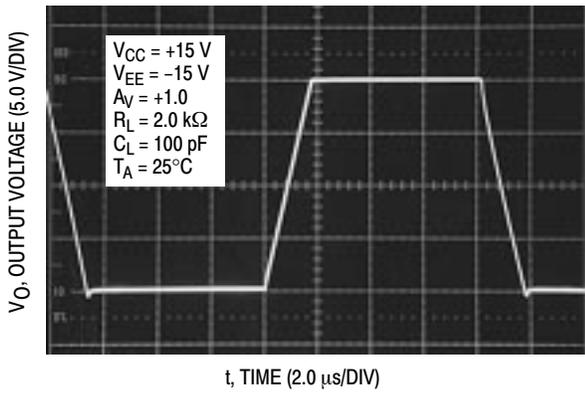


**Figure 33. Non–inverting Amplifier Slew Rate
for the MC33274**
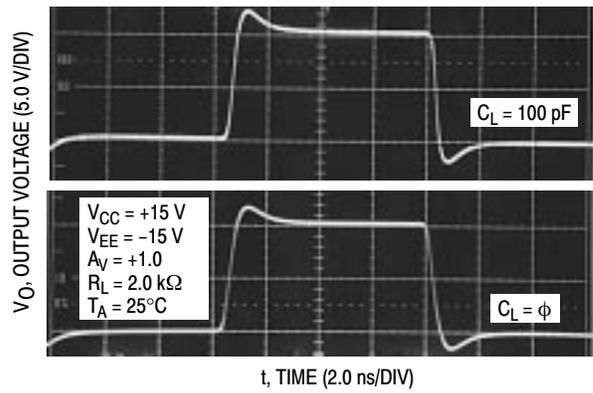


**Figure 34. Non–inverting Amplifier Overshoot
for the MC33274**
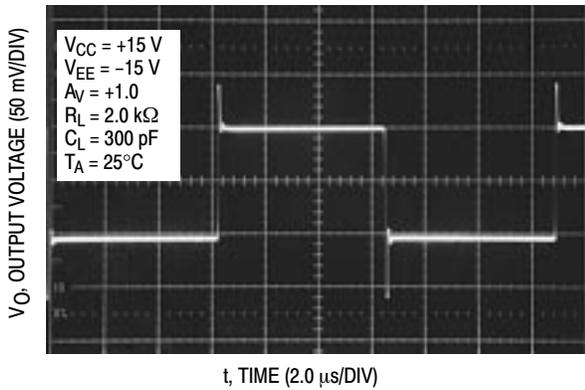


**Figure 35. Small Signal Transient Response
for MC33274**
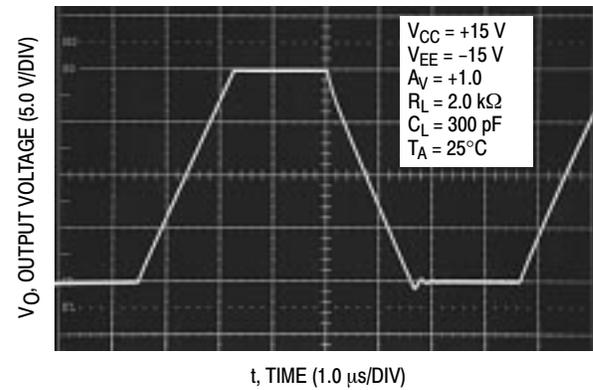


**Figure 36. Large Signal Transient Response
for MC33274**

## PACKAGE DIMENSIONS

**PDIP–8**
**P SUFFIX**
CASE 626–05
ISSUE L
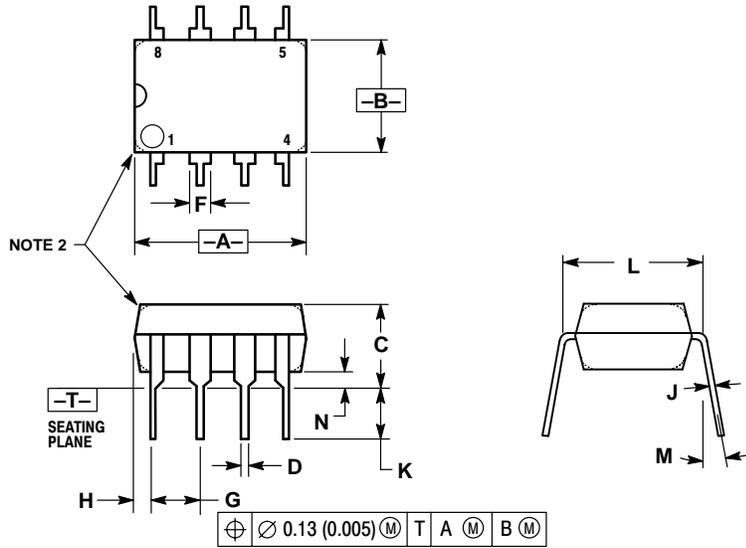
NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| 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 |

⊕ ⌀ 0.13 (0.005) Ⓜ T A Ⓜ B Ⓜ

**SO–8**
**D SUFFIX**
CASE 751–07
ISSUE W
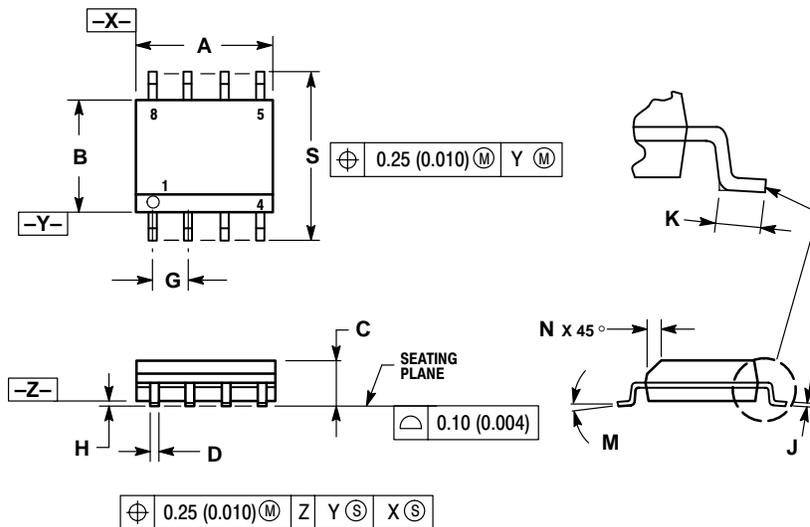
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

⊕ 0.25 (0.010) Ⓜ Y Ⓜ

N X 45°

▱ 0.10 (0.004)

⊕ 0.25 (0.010) Ⓜ Z Y Ⓢ X Ⓢ

| DIM | MILLIMETERS | | INCHES | |
|-----|-----|-----|-----|-----|
| | MIN | MAX | MIN | MAX |
| A | 4.80 | 5.00 | 0.189 | 0.197 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.053 | 0.069 |
| D | 0.33 | 0.51 | 0.013 | 0.020 |
| G | 1.27 BSC | | 0.050 BSC | |
| H | 0.10 | 0.25 | 0.004 | 0.010 |
| J | 0.19 | 0.25 | 0.007 | 0.010 |
| K | 0.40 | 1.27 | 0.016 | 0.050 |
| M | 0° | 8° | 0° | 8° |
| N | 0.25 | 0.50 | 0.010 | 0.020 |
| S | 5.80 | 6.20 | 0.228 | 0.244 |

# PACKAGE DIMENSIONS

**PDIP–14**
**P SUFFIX**
CASE 646–06
ISSUE M
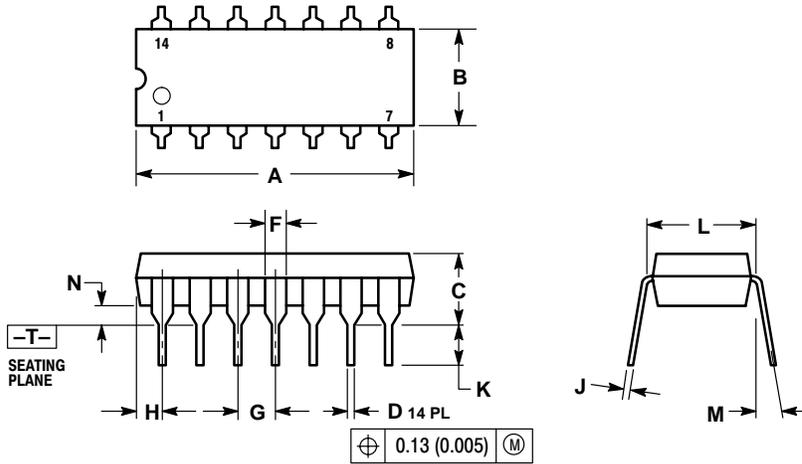


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|--------|-------------|--------|
|     | MIN    | MAX    | MIN         | MAX    |
| A   | 0.715  | 0.770  | 18.16       | 18.80  |
| 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   | 0.290  | 0.310  | 7.37        | 7.87   |
| M   | ---    | 10°    | ---         | 10°    |
| N   | 0.015  | 0.039  | 0.38        | 1.01   |

**SO–14**
**D SUFFIX**
CASE 751A–03
ISSUE F
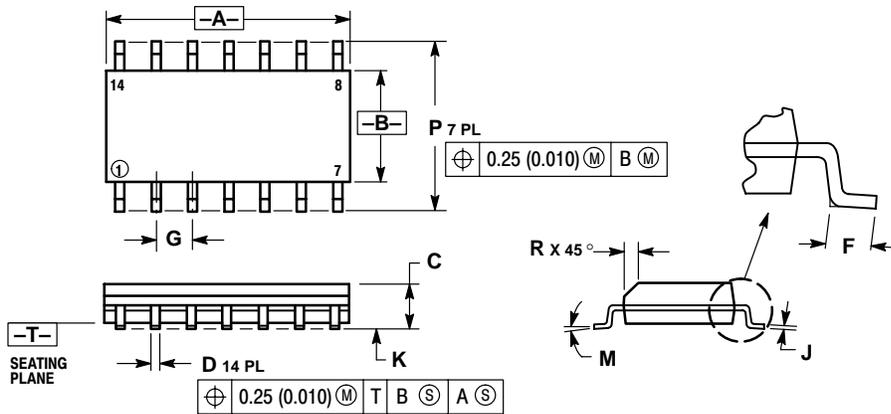


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005)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

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|--------|--------|--------|
|     | MIN         | MAX    | MIN    | MAX    |
| A   | 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  |

# <u>Notes</u>

# <u>Notes</u>

# **Notes**

MC33272A/D

**MC33272A/D**