

MC33078, MC33079, NCV33078, NCV33079

Low Noise Dual/Quad Operational Amplifiers

The MC33078/9 series is a family of high quality monolithic amplifiers employing Bipolar technology with innovative high performance concepts for quality audio and data signal processing applications. This family incorporates the use of high frequency PNP input transistors to produce amplifiers exhibiting low input voltage noise with high gain bandwidth product and slew rate. The all NPN output stage exhibits no deadband crossover distortion, large output voltage swing, excellent phase and gain margins, low open loop high frequency output impedance and symmetrical source and sink AC frequency performance.

The MC33078/9 family offers both dual and quad amplifier versions and is available in the plastic DIP and SOIC packages (P and D suffixes).

Features

- Dual Supply Operation: $\pm 5.0\text{ V}$ to $\pm 18\text{ V}$
- Low Voltage Noise: $4.5\text{ nV}/\sqrt{\text{Hz}}$
- Low Input Offset Voltage: 0.15 mV
- Low T.C. of Input Offset Voltage: $2.0\text{ }\mu\text{V}/^\circ\text{C}$
- Low Total Harmonic Distortion: 0.002%
- High Gain Bandwidth Product: 16 MHz
- High Slew Rate: $7.0\text{ V}/\mu\text{s}$
- High Open Loop AC Gain: $800 @ 20\text{ kHz}$
- Excellent Frequency Stability
- Large Output Voltage Swing: $+14.1\text{ V}/-14.6\text{ V}$
- ESD Diodes Provided on the Inputs
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

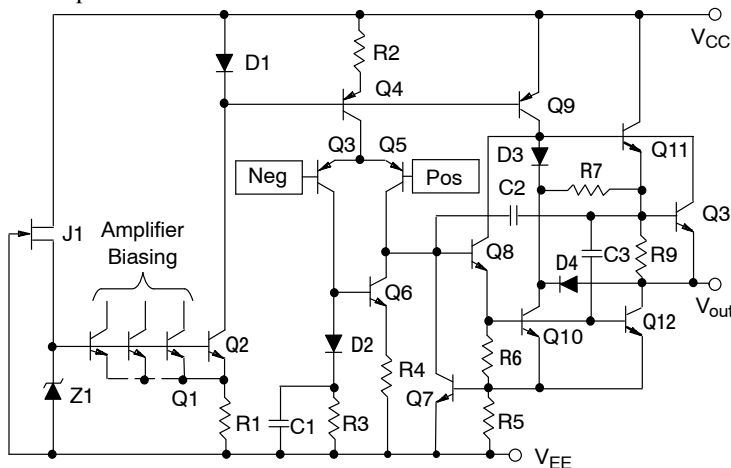


Figure 1. Representative Schematic Diagram
(Each Amplifier)

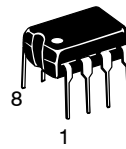


ON Semiconductor®

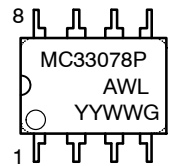
<http://onsemi.com>

MARKING DIAGRAMS

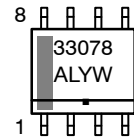
DUAL



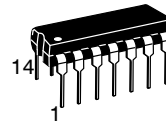
PDIP-8
P SUFFIX
CASE 626



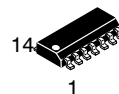
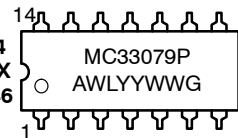
SOIC-8
D SUFFIX
CASE 751



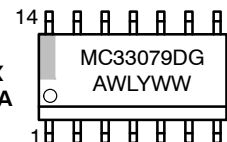
QUAD



PDIP-14
P SUFFIX
CASE 646



SOIC-14
D SUFFIX
CASE 751A



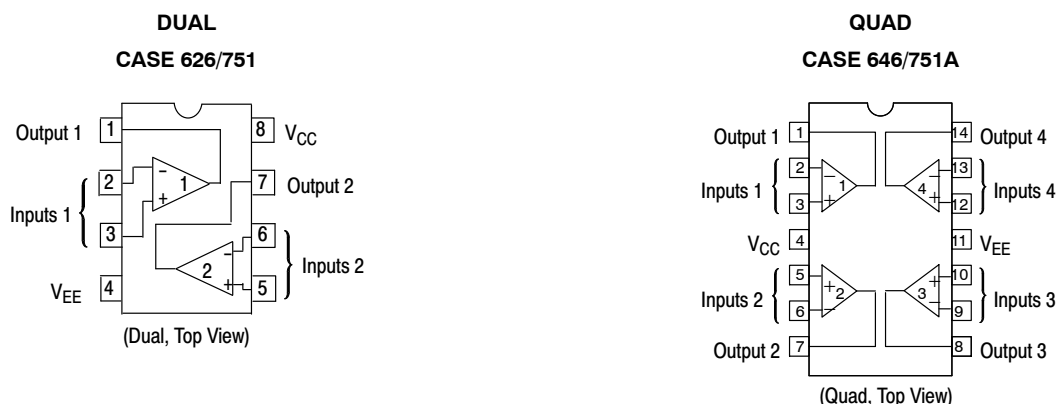
A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week
G or ■ = Pb-Free Package

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 10 of this data sheet.

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PIN CONNECTIONS



MAXIMUM RATINGS

| Rating | Symbol | Value | Unit |
|---|-----------|--------------------------|------|
| Supply Voltage (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 |
| Maximum Junction Temperature | T_J | +150 | °C |
| Storage Temperature | T_{stg} | -60 to +150 | °C |
| ESD Protection at any Pin MC33078/NCV33078 MC33079/NCV33079 | V_{esd} | 600 200 550 150 | V |
| Maximum Power Dissipation | P_D | Note 2 | mW |
| Operating Temperature Range | T_A | -40 to +85 | °C |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Either or both input voltages must 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 2).

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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 ($R_S = 10\ \Omega$, $V_{CM} = 0\text{ V}$, $V_O = 0\text{ V}$) (MC33078) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ (MC33079) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | $ V_{IO} $ | - | 0.15 | 2.0 | mV |
| Average Temperature Coefficient of Input Offset Voltage $R_S = 10\ \Omega$, $V_{CM} = 0\text{ V}$, $V_O = 0\text{ V}$, $T_A = T_{low}$ to T_{high} | $\Delta V_{IO}/\Delta T$ | - | 2.0 | - | $\mu\text{V}/^\circ\text{C}$ |
| Input Bias Current ($V_{CM} = 0\text{ V}$, $V_O = 0\text{ V}$) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | I_{IB} | - | 300 | 750 | nA |
| Input Offset Current ($V_{CM} = 0\text{ V}$, $V_O = 0\text{ V}$) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | I_{IO} | - | 25 | 150 | nA |
| Common Mode Input Voltage Range ($\Delta V_{IO} = 5.0\text{ mV}$, $V_O = 0\text{ V}$) | V_{ICR} | ± 13 | ± 14 | - | V |
| Large Signal Voltage Gain ($V_O = \pm 10\text{ V}$, $R_L = 2.0\text{ k}\Omega$) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | A_{VOL} | 90 | 110 | - | dB |
| Output Voltage Swing ($V_{ID} = \pm 1.0\text{ V}$) $R_L = 600\ \Omega$ $R_L = 600\ \Omega$ $R_L = 2.0\text{ k}\Omega$ $R_L = 2.0\text{ k}\Omega$ $R_L = 10\text{ k}\Omega$ $R_L = 10\text{ k}\Omega$ | V_{O+} V_{O-} V_{O+} V_{O-} V_{O+} V_{O-} | - | +10.7 | - | V |
| Common Mode Rejection ($V_{in} = \pm 13\text{ V}$) | CMR | 80 | 100 | - | dB |
| Power Supply Rejection (Note 3) $V_{CC}/V_{EE} = +15\text{ V}/-15\text{ V}$ to $+5.0\text{ V}/-5.0\text{ V}$ | PSR | 80 | 105 | - | dB |
| Output Short Circuit Current ($V_{ID} = 1.0\text{ V}$, Output to Ground) Source Sink | I_{SC} | +15 -20 | +29 -37 | - - | mA |
| Power Supply Current ($V_O = 0\text{ V}$, All Amplifiers) (MC33078) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ (MC33079) $T_A = +25^\circ\text{C}$ $T_A = -40^\circ$ to $+85^\circ\text{C}$ | I_D | - | 4.1 | 5.0 | mA |

3. Measured with V_{CC} and V_{EE} differentially varied simultaneously.

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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 ($V_{in} = -10\text{ V to } +10\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $C_L = 100\text{ pF}$, $A_V = +1.0$) | SR | 5.0 | 7.0 | - | V/ μs |
| Gain Bandwidth Product ($f = 100\text{ kHz}$) | GBW | 10 | 16 | - | MHz |
| Unity Gain Bandwidth (Open Loop) | BW | - | 9.0 | - | MHz |
| Gain Margin ($R_L = 2.0\text{ k}\Omega$ $C_L = 0\text{ pF}$ $C_L = 100\text{ pF}$) | A_m | - | -11 | - | dB |
| Phase Margin ($R_L = 2.0\text{ k}\Omega$ $C_L = 0\text{ pF}$ $C_L = 100\text{ pF}$) | ϕ_m | - | 55 | - | Deg |
| Channel Separation ($f = 20\text{ Hz to } 20\text{ kHz}$) | CS | - | -120 | - | dB |
| Power Bandwidth ($V_O = 27\text{ V}_{pp}$, $R_L = 2.0\text{ k}\Omega$, THD $\pm 1.0\%$) | BW_p | - | 120 | - | kHz |
| Total Harmonic Distortion ($R_L = 2.0\text{ k}\Omega$, $f = 20\text{ Hz to } 20\text{ kHz}$, $V_O = 3.0\text{ V}_{rms}$, $A_V = +1.0$) | THD | - | 0.002 | - | % |
| Open Loop Output Impedance ($V_O = 0\text{ V}$, $f = 9.0\text{ MHz}$) | $ Z_O $ | - | 37 | - | Ω |
| Differential Input Resistance ($V_{CM} = 0\text{ V}$) | R_{in} | - | 175 | - | $\text{k}\Omega$ |
| Differential Input Capacitance ($V_{CM} = 0\text{ V}$) | C_{in} | - | 12 | - | pF |
| Equivalent Input Noise Voltage ($R_S = 100\ \Omega$, $f = 1.0\text{ kHz}$) | e_n | - | 4.5 | - | $\text{nV}/\sqrt{\text{Hz}}$ |
| Equivalent Input Noise Current ($f = 1.0\text{ kHz}$) | i_n | - | 0.5 | - | $\text{Hz}\sqrt{\text{pA}}$ |

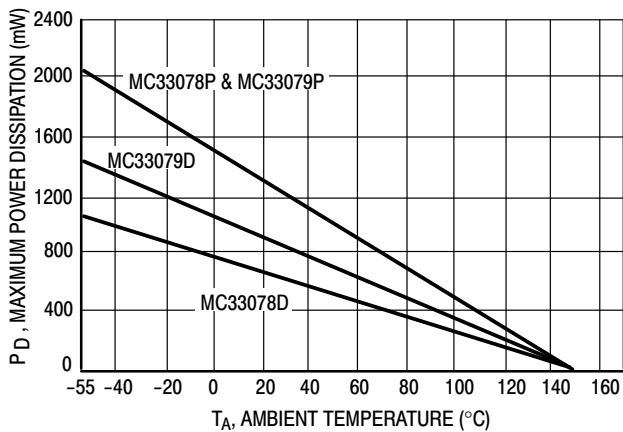


Figure 2. Maximum Power Dissipation versus Temperature

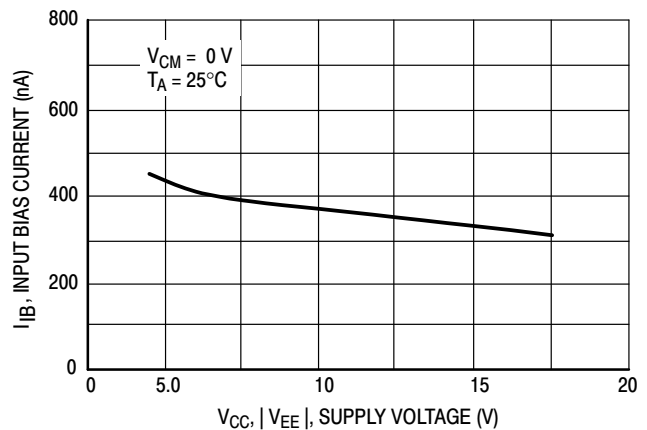


Figure 3. Input Bias Current versus Supply Voltage

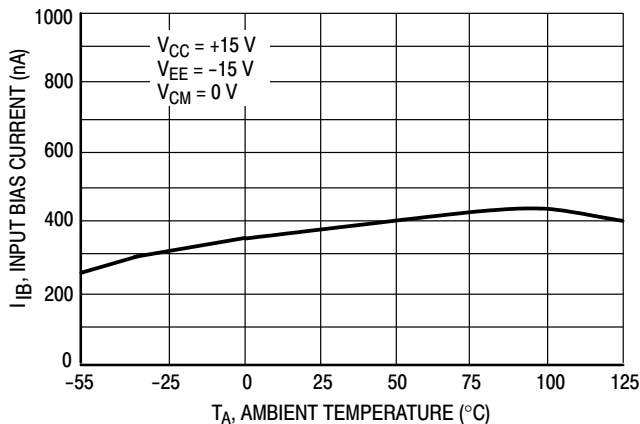


Figure 4. Input Bias Current versus Temperature

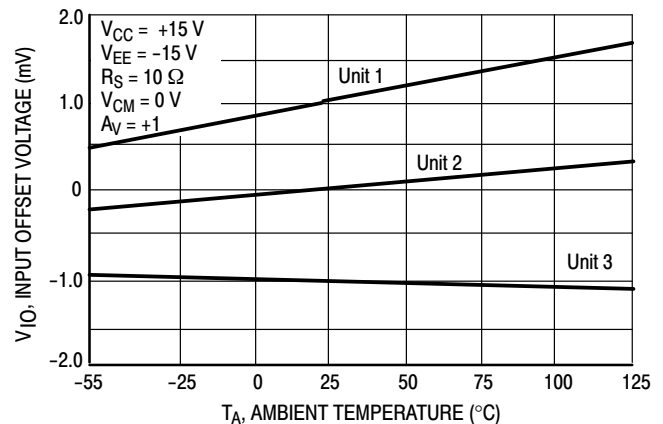


Figure 5. Input Offset Voltage versus Temperature

MC33078, MC33079, NCV33078, NCV33079



Figure 6. Input Bias Current versus Common Mode Voltage

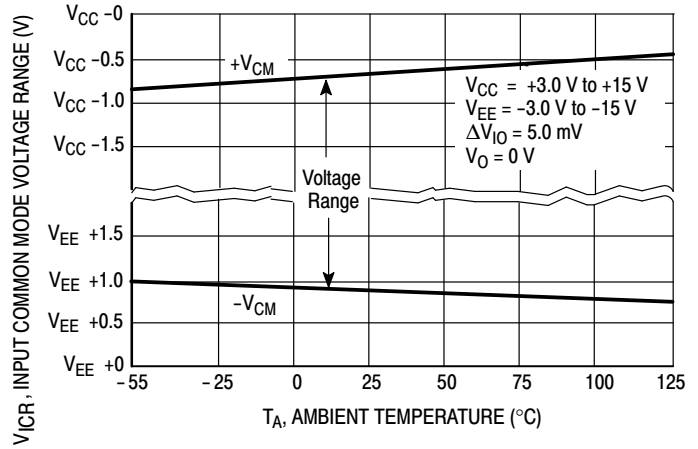


Figure 7. Input Common Mode Voltage Range versus Temperature



Figure 8. Output Saturation Voltage versus Load Resistance to Ground



Figure 9. Output Short Circuit Current versus Temperature



Figure 10. Supply Current versus Temperature

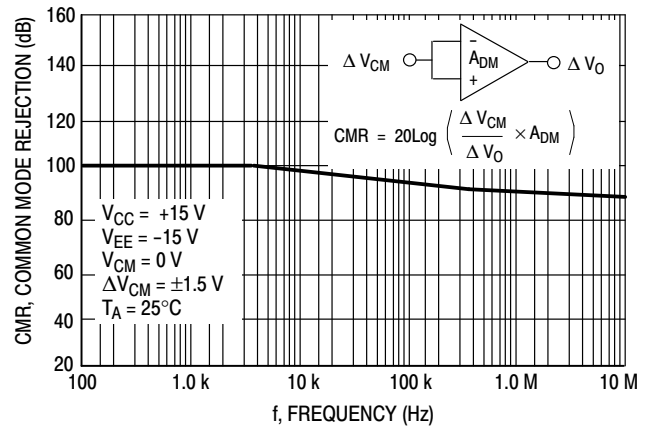


Figure 11. Common Mode Rejection versus Frequency

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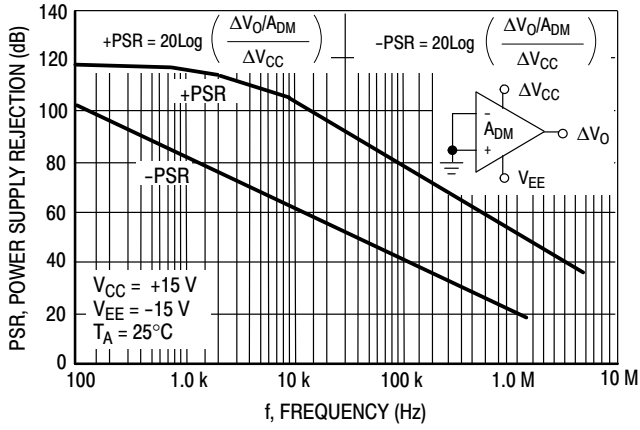


Figure 12. Power Supply Rejection versus Frequency

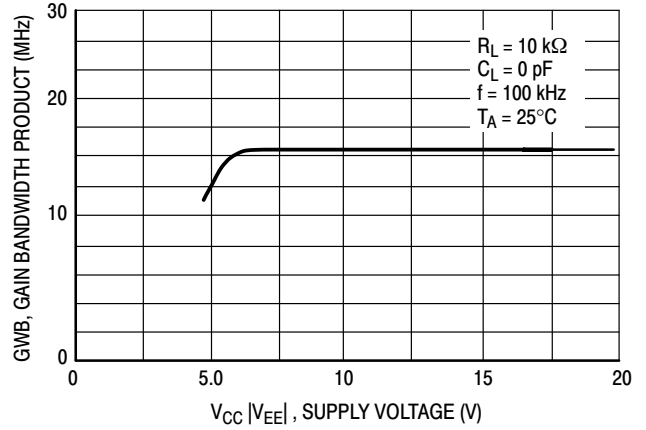


Figure 13. Gain Bandwidth Product versus Supply Voltage

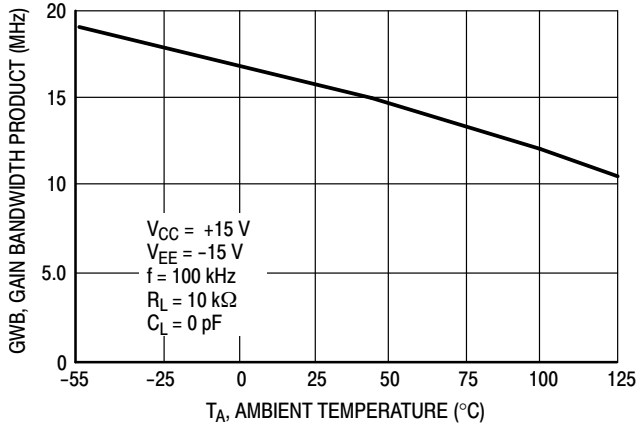


Figure 14. Gain Bandwidth Product versus Temperature

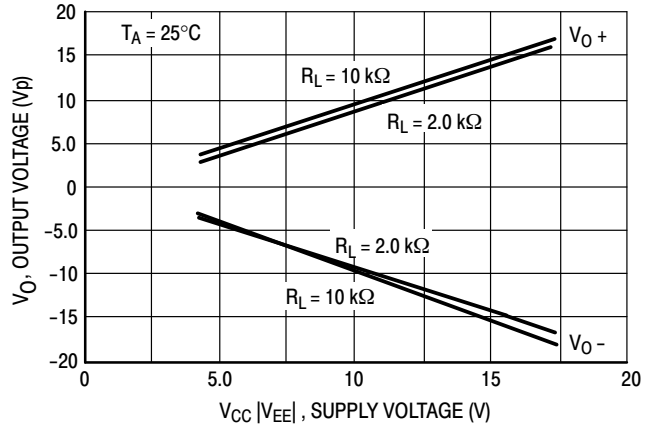


Figure 15. Maximum Output Voltage versus Supply Voltage

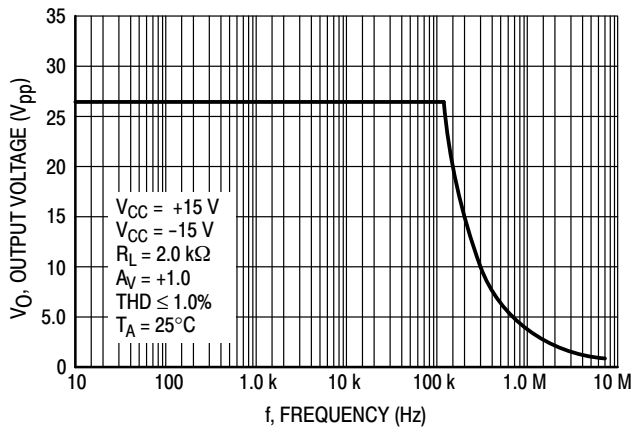


Figure 16. Output Voltage versus Frequency

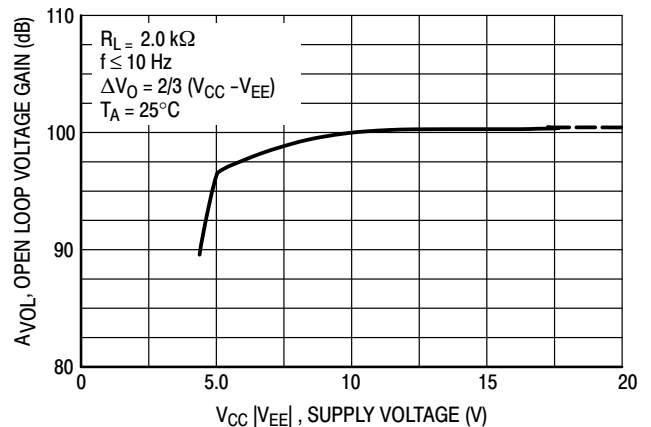


Figure 17. Open Loop Voltage Gain versus Supply Voltage

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Figure 18. Open Loop Voltage Gain versus Temperature



Figure 19. Output Impedance versus Frequency



Figure 20. Channel Separation versus Frequency



Figure 21. Total Harmonic Distortion versus Frequency

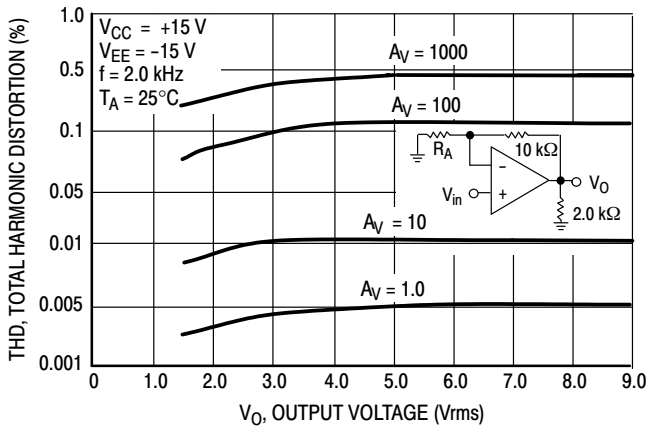


Figure 22. Total Harmonic Distortion versus Output Voltage

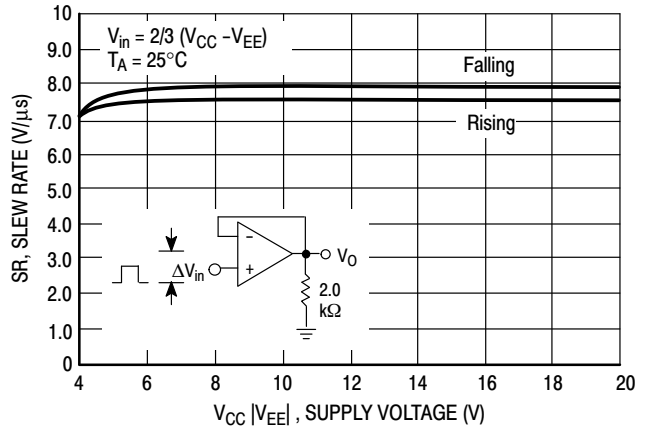


Figure 23. Slew Rate versus Supply Voltage



Figure 24. Slew Rate versus Temperature

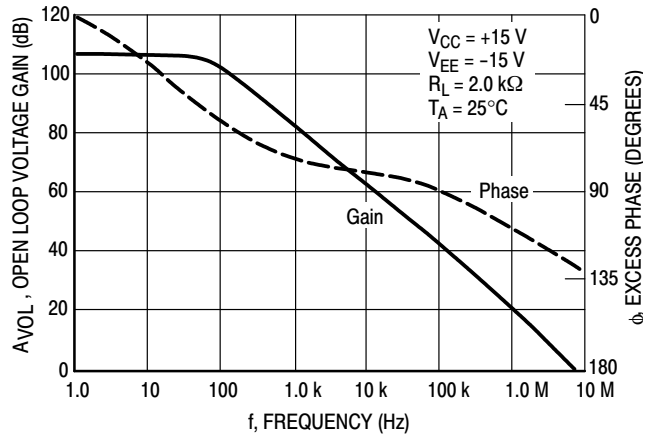


Figure 25. Voltage Gain and Phase versus Frequency



Figure 26. Open Loop Gain Margin and Phase Margin versus Load Capacitance

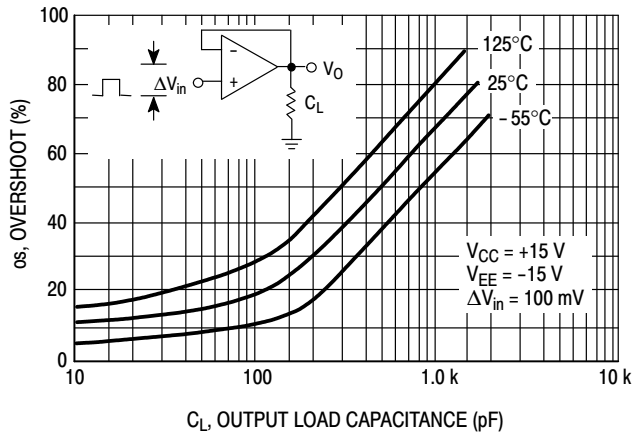


Figure 27. Overshoot versus Output Load Capacitance

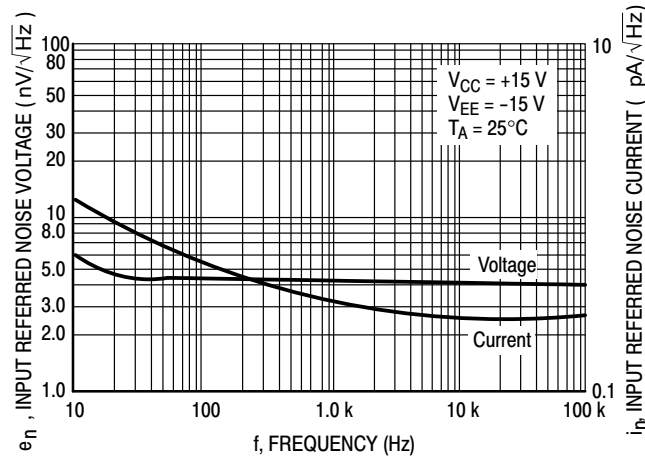


Figure 28. Input Referred Noise Voltage and Current versus Frequency

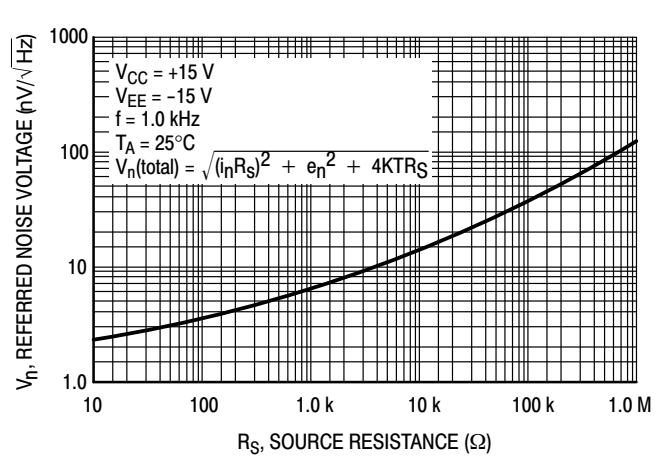


Figure 29. Total Input Referred Noise Voltage versus Source Resistance

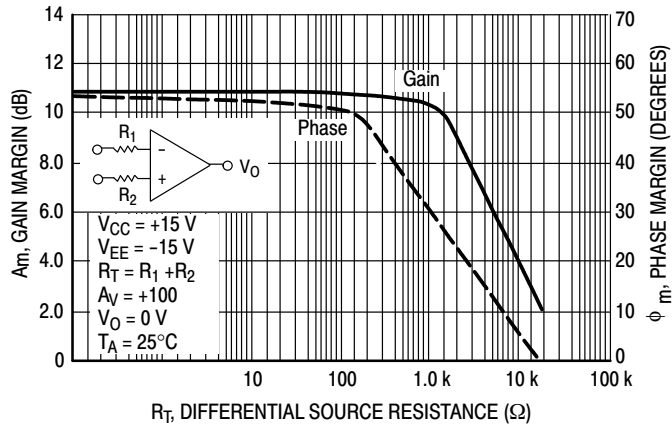


Figure 30. Phase Margin and Gain Margin versus Differential Source Resistance

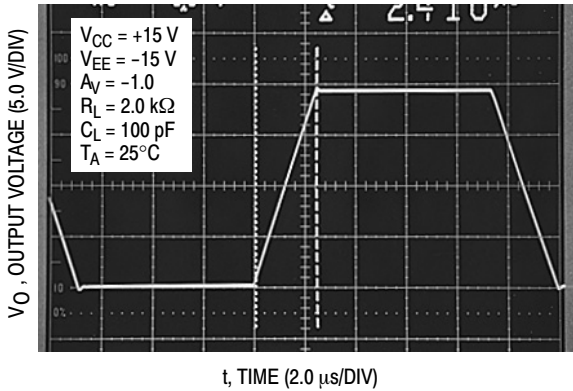


Figure 31. Inverting Amplifier Slew Rate

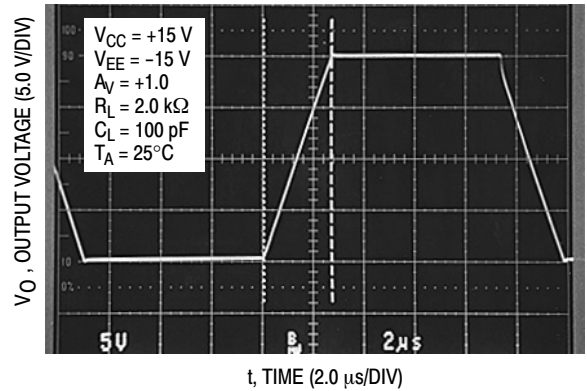


Figure 32. Non-inverting Amplifier Slew Rate

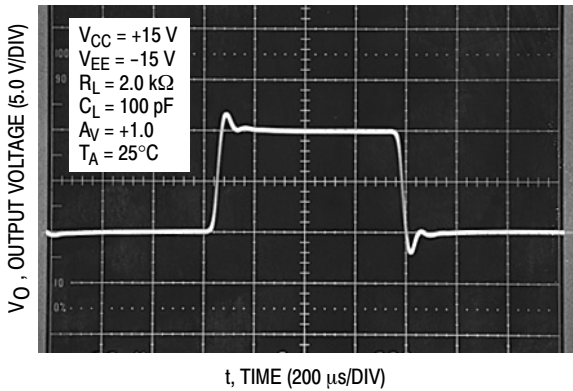


Figure 33. Non-inverting Amplifier Overshoot

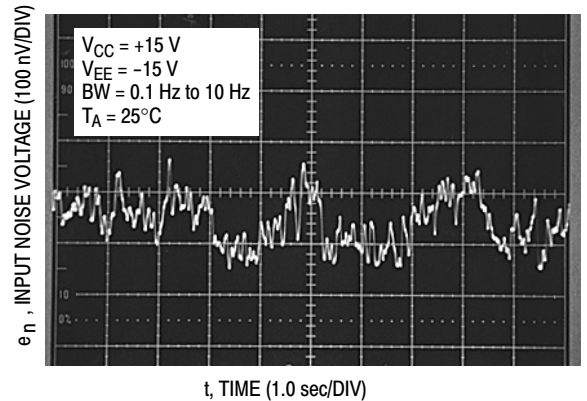
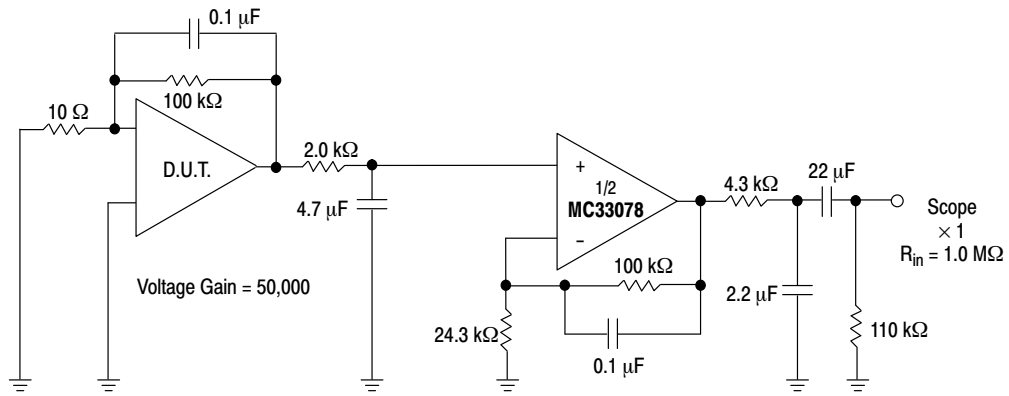


Figure 34. Low Frequency Noise Voltage versus Time

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Note: All capacitors are non-polarized.

**Figure 35. Voltage Noise Test Circuit
(0.1 Hz to 10 Hz_{p-p})**

ORDERING INFORMATION

| Device | Package | Shipping [†] |
|---------------|----------------------|-----------------------|
| MC33078DG | SOIC-8 (Pb-Free) | 98 Units / Rail |
| MC33078DR2G | | 2500 / Tape & Reel |
| NCV33078DR2G* | | |
| MC33078P | PDIP-8 | 50 Units / Rail |
| MC33078PG | PDIP-8 (Pb-Free) | |
| MC33079DG | SOIC-14 (Pb-Free) | 55 Units / Rail |
| MC33079DR2G | SOIC-14 (Pb-Free) | 2500 / Tape & Reel |
| NCV33079DR2G* | | |
| MC33079P | PDIP-14 | 25 Units / Rail |
| MC33079PG | PDIP-14 (Pb-Free) | |

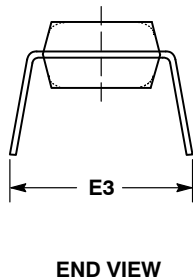
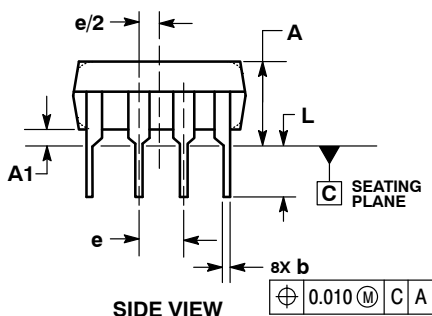
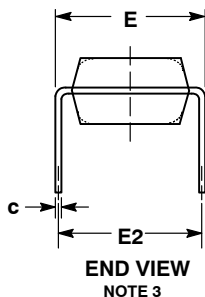
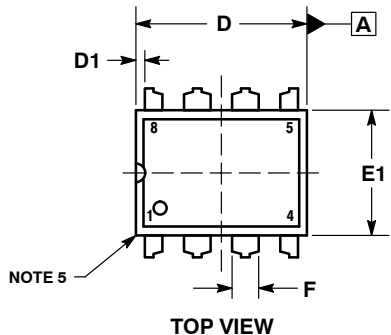
[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*NCV devices are qualified for automotive use.

MC33078, MC33079, NCV33078, NCV33079

PACKAGE DIMENSIONS

PDIP-8
N SUFFIX
CASE 626-05
ISSUE M



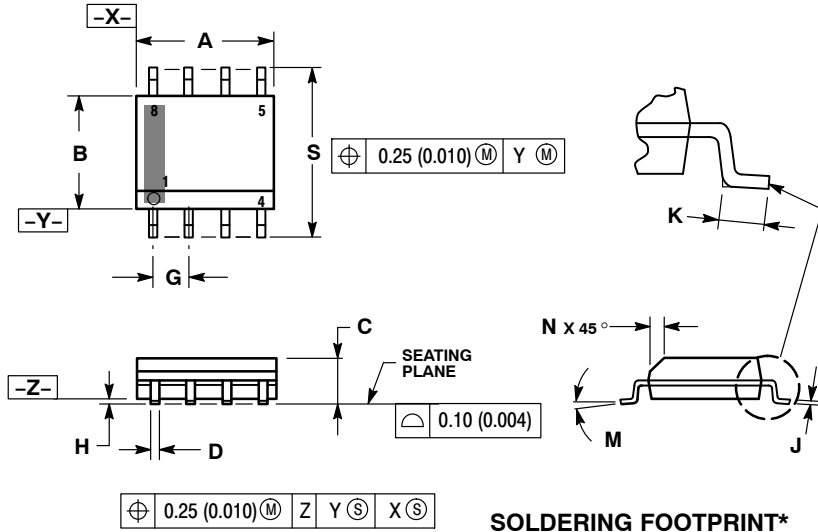
NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSION E IS MEASURED WITH THE LEADS RESTRAINED PARALLEL AT WIDTH E2.
4. DIMENSION E1 DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES | | | MILLIMETERS | | |
|-----|-----------|-------|-------|-------------|------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | ---- | ---- | 0.210 | ---- | ---- | 5.33 |
| A1 | 0.015 | ---- | ---- | 0.38 | ---- | ---- |
| b | 0.014 | 0.018 | 0.022 | 0.35 | 0.46 | 0.56 |
| C | 0.008 | 0.010 | 0.014 | 0.20 | 0.25 | 0.36 |
| D | 0.355 | 0.365 | 0.400 | 9.02 | 9.27 | 10.02 |
| D1 | 0.005 | ---- | ---- | 0.13 | ---- | ---- |
| E | 0.300 | 0.310 | 0.325 | 7.62 | 7.87 | 8.26 |
| E1 | 0.240 | 0.250 | 0.280 | 6.10 | 6.35 | 7.11 |
| E2 | 0.300 BSC | | | 7.62 BSC | | |
| E3 | ---- | ---- | 0.430 | ---- | ---- | 10.92 |
| e | 0.100 BSC | | | 2.54 BSC | | |
| L | 0.115 | 0.130 | 0.150 | 2.92 | 3.30 | 3.81 |

PACKAGE DIMENSIONS

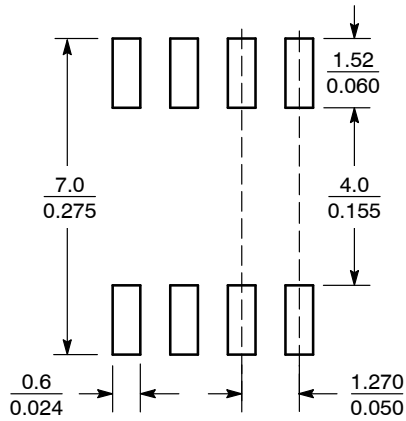
SOIC-8 NB
CASE 751-07
ISSUE AK



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.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

| 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 |



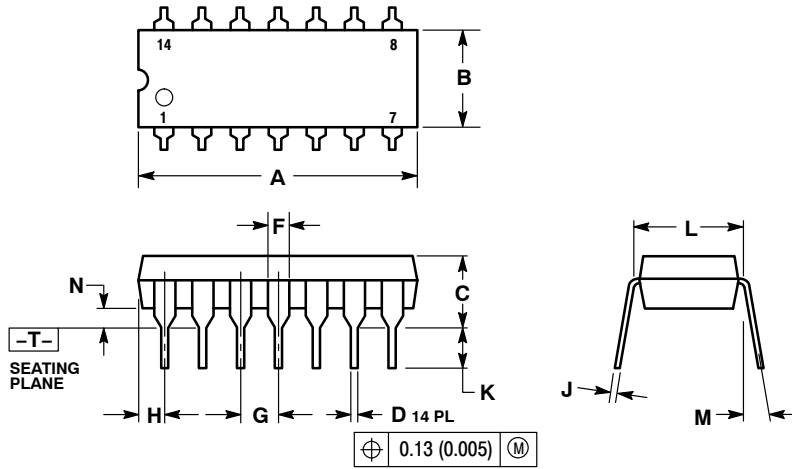
SCALE 6:1 (mm/inches)

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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PACKAGE DIMENSIONS

PDIP-14
CASE 646-06
ISSUE P



NOTES:

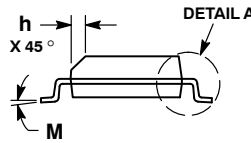
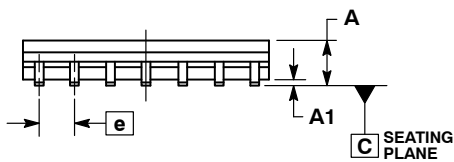
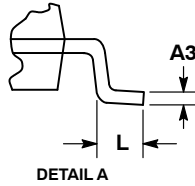
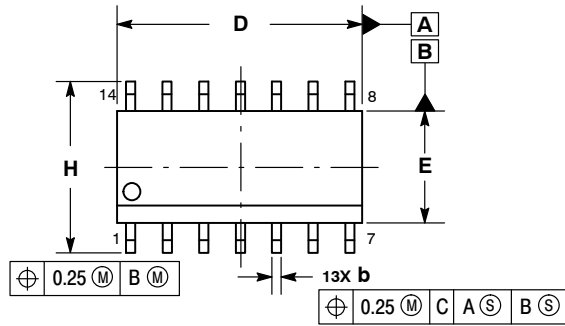
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

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

MC33078, MC33079, NCV33078, NCV33079

PACKAGE DIMENSIONS

SOIC-14 NB
CASE 751A-03
ISSUE K

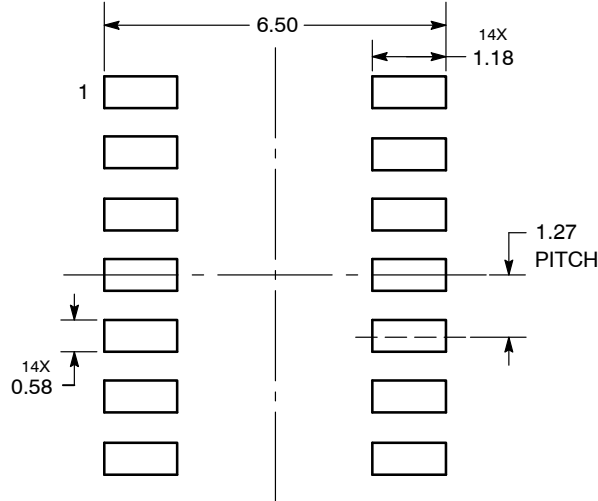


NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.

| DIM | MILLIMETERS | | INCHES | |
|-----|-------------|------|-----------|-------|
| | MIN | MAX | MIN | MAX |
| A | 1.35 | 1.75 | 0.054 | 0.068 |
| A1 | 0.10 | 0.25 | 0.004 | 0.010 |
| A3 | 0.19 | 0.25 | 0.008 | 0.010 |
| b | 0.35 | 0.49 | 0.014 | 0.019 |
| D | 8.55 | 8.75 | 0.337 | 0.344 |
| E | 3.80 | 4.00 | 0.150 | 0.157 |
| e | 1.27 BSC | | 0.050 BSC | |
| H | 5.80 | 6.20 | 0.228 | 0.244 |
| h | 0.25 | 0.50 | 0.010 | 0.019 |
| L | 0.40 | 1.25 | 0.016 | 0.049 |
| M | 0° | 7° | 0° | 7° |

SOLDERING FOOTPRINT*



DIMENSIONS: MILLIMETERS

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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