# MC33178, MC33179

# Low Power, Low Noise Operational Amplifiers

The MC33178/9 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 device family incorporates the use of high frequency PNP input transistors to produce amplifiers exhibiting low input offset voltage, noise and distortion. In addition, the amplifier provides high output current drive capability while consuming only 420 μA of drain current per amplifier. The NPN output stage used, exhibits no deadband crossover distortion, large output voltage swing, excellent phase and gain margins, low open−loop high frequency output impedance, symmetrical source and sink AC frequency performance.

The MC33178/9 family offers both dual and quad amplifier versions in several package options.

### Features

- 600 Ω Output Drive Capability
- Large Output Voltage Swing
- Low Offset Voltage: 0.15 mV (Mean)
- Low T.C. of Input Offset Voltage: 2.0 μV/°C
- Low Total Harmonic Distortion: 0.0024% (@ 1.0 kHz w/600 Ω Load)
- High Gain Bandwidth: 5.0 MHz
- High Slew Rate: 2.0 V/μs
- Dual Supply Operation: ±2.0 V to ±18 V
- ESD Clamps on the Inputs Increase Ruggedness without Affecting Device Performance
- Pb−Free Packages are Available

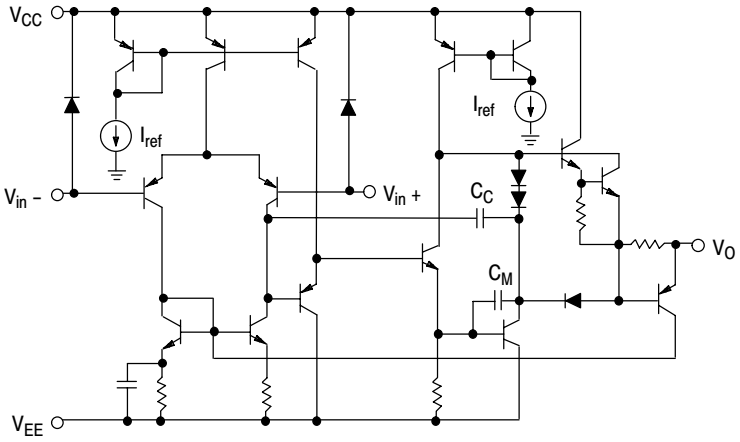


**Figure 1. Representative Schematic Diagram**
(Each Amplifier)

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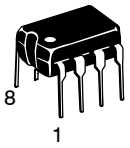
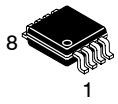
**DUAL**



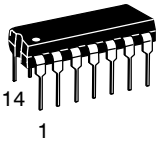

**PDIP−8**
**P SUFFIX**
**CASE 626**


**SOIC−8**
**D SUFFIX**
**CASE 751**

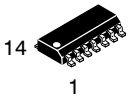



**Micro8**
**DM SUFFIX**
**CASE 846A**

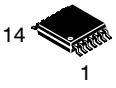
**QUAD**




**PDIP−14**
**P SUFFIX**
**CASE 646**




**SOIC−14**
**D SUFFIX**
**CASE 751A**




**TSSOP−14**
**DTB SUFFIX**
**CASE 948G**

## ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

## DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 4 of this data sheet.

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## 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 Range | $T_{stg}$ | −60 to +150 | °C |
| 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 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 power dissipation performance characteristic, Figure 2.)

## ORDERING INFORMATION

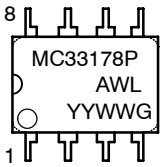
| Device | Package | Shipping† |
|---|---|---|
| MC33178D | SOIC−8 | 98 Units / Rail |
| MC33178DG | SOIC−8 (Pb−Free) | |
| MC33178DR2 | SOIC−8 | 2500 / Tape & Reel |
| MC33178DR2G | SOIC−8 (Pb−Free) | |
| MC33178P | PDIP−8 | 50 Units / Rail |
| MC33178PG | PDIP−8 (Pb−Free) | |
| MC33178DMR2 | Micro8 | 4000 / Tape & Reel |
| MC33178DMR2G | Micro8 (Pb−Free) | |
| MC33179D | SOIC−14 | 55 Units / Rail |
| MC33179DG | SOIC−14 (Pb−Free) | |
| MC33179DR2 | SOIC−14 | 2500 / Tape & Reel |
| MC33179DR2G | SOIC−14 (Pb−Free) | |
| MC33179P | PDIP−14 | 25 Units / Rail |
| MC33179PG | PDIP−14 (Pb−Free) | |
| MC33179DTBR2G | TSSOP−14 (Pb−Free) | 2500 / Tape & Reel |

†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.

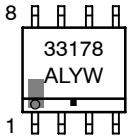
## MARKING DIAGRAMS

**DUAL**

**PDIP−8**
**CASE 626**

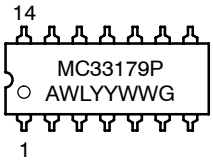



**SOIC−8**
**CASE 751**

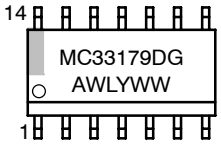



**QUAD**

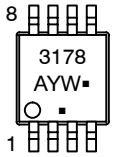
**PDIP−14**
**CASE 646**



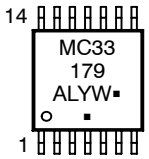

**SOIC−14**
**CASE 751A**




**Micro8**
**CASE 846A**




**TSSOP−14**
**CASE 948G**

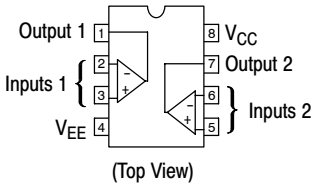



| | |
|---|---|
| A | = Assembly Location |
| WL, L | = Wafer Lot |
| YY, Y | = Year |
| WW, W | = Work Week |
| G or ▪ | = Pb−Free Package |

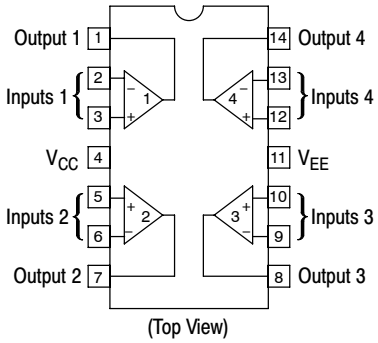
(Note: Microdot may be in either location)

## PIN CONNECTIONS

**DUAL**
**CASE 626/751/846A**




**QUAD**
**CASE 646/751A/948G**



**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 ($R_S$ = 50 Ω, $V_{CM}$ = 0 V, $V_O$ = 0 V) | 3 | $\|V_{IO}\|$ | | | | mV |
| ($V_{CC}$ = +2.5 V, $V_{EE}$ = −2.5 V to $V_{CC}$ = +15 V, $V_{EE}$ = −15 V) | | | | | | |
| $T_A$ = +25°C | | | – | 0.15 | 3.0 | |
| $T_A$ = −40° to +85°C | | | – | – | 4.0 | |
| Average Temperature Coefficient of Input Offset Voltage | 3 | $\Delta V_{IO}/\Delta T$ | | | | μV/°C |
| ($R_S$ = 50 Ω, $V_{CM}$ = 0 V, $V_O$ = 0 V) | | | | | | |
| $T_A$ = −40° to +85°C | | | – | 2.0 | – | |
| Input Bias Current ($V_{CM}$ = 0 V, $V_O$ = 0 V) | 4, 5 | $I_{IB}$ | | | | nA |
| $T_A$ = +25°C | | | – | 100 | 500 | |
| $T_A$ = −40° to +85°C | | | – | – | 600 | |
| Input Offset Current ($V_{CM}$ = 0 V, $V_O$ = 0 V) | | $\|I_{IO}\|$ | | | | nA |
| $T_A$ = +25°C | | | – | 5.0 | 50 | |
| $T_A$ = −40° to +85°C | | | – | – | 60 | |
| Common Mode Input Voltage Range | 6 | $V_{ICR}$ | −13 | −14 | – | V |
| ($\Delta V_{IO}$ = 5.0 mV, $V_O$ = 0 V) | | | – | +14 | +13 | |
| Large Signal Voltage Gain ($V_O$ = −10 V to +10 V, $R_L$ = 600 Ω) | 7, 8 | $A_{VOL}$ | | | | kV/V |
| $T_A$ = +25°C | | | 50 | 200 | – | |
| $T_A$ = −40° to +85°C | | | 25 | – | – | |
| Output Voltage Swing ($V_{ID}$ = ±1.0 V) | 9, 10, 11 | | | | | V |
| ($V_{CC}$ = +15 V, $V_{EE}$ = −15 V) | | | | | | |
| $R_L$ = 300 Ω | | $V_O$+ | – | +12 | – | |
| $R_L$ = 300 Ω | | $V_O$− | – | −12 | – | |
| $R_L$ = 600 Ω | | $V_O$+ | +12 | +13.6 | – | |
| $R_L$ = 600 Ω | | $V_O$− | – | −13 | −12 | |
| $R_L$ = 2.0 kΩ | | $V_O$+ | +13 | +14 | – | |
| $R_L$ = 2.0 kΩ | | $V_O$− | – | −13.8 | −13 | |
| ($V_{CC}$ = +2.5 V, $V_{EE}$ = −2.5 V) | | | | | | |
| $R_L$ = 600 Ω | | $V_O$+ | 1.1 | 1.6 | – | |
| $R_L$ = 600 Ω | | $V_O$− | – | −1.6 | −1.1 | |
| Common Mode Rejection ($V_{in}$ = ±13 V) | 12 | CMR | 80 | 110 | – | dB |
| Power Supply Rejection | 13 | PSR | | | | dB |
| $V_{CC}/V_{EE}$ = +15 V/ −15 V, +5.0 V/ −15 V, +15 V/ −5.0 V | | | 80 | 110 | – | |
| Output Short Circuit Current ($V_{ID}$ = ±1.0 V, Output to Ground) | 14, 15 | $I_{SC}$ | | | | mA |
| Source ($V_{CC}$ = 2.5 V to 15 V) | | | +50 | +80 | – | |
| Sink ($V_{EE}$ = −2.5 V to −15 V) | | | −50 | −100 | – | |
| Power Supply Current ($V_O$ = 0 V) | 16 | $I_D$ | | | | mA |
| ($V_{CC}$ = 2.5 V, $V_{EE}$ = −2.5 V to $V_{CC}$ = +15 V, $V_{EE}$ = −15 V) | | | | | | |
| MC33178 (Dual) | | | | | | |
| $T_A$ = +25°C | | | – | – | 1.4 | |
| $T_A$ = −40° to +85°C | | | – | – | 1.6 | |
| MC33179 (Quad) | | | | | | |
| $T_A$ = +25°C | | | – | 1.7 | 2.4 | |
| $T_A$ = −40° to +85°C | | | – | – | 2.6 | |

**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 ($V_{in}$ = −10 V to +10 V, $R_L$ = 2.0 kΩ, $C_L$ = 100 pF, $A_V$ = +1.0 V) | 17, 32 | SR | 1.2 | 2.0 | – | V/μs |
| Gain Bandwidth Product (f = 100 kHz) | 18 | GBW | 2.5 | 5.0 | – | MHz |
| AC Voltage Gain ($R_L$ = 600 Ω, $V_O$ = 0 V, f = 20 kHz) | 19, 20 | $A_{VO}$ | – | 50 | – | dB |
| Unity Gain Bandwidth (Open−Loop) ($R_L$ = 600 Ω, $C_L$ = 0 pF) | | BW | – | 3.0 | – | MHz |
| Gain Margin ($R_L$ = 600 Ω, $C_L$ = 0 pF) | 21, 23, 24 | $A_m$ | – | 15 | – | dB |
| Phase Margin ($R_L$ = 600 Ω, $C_L$ = 0 pF) | 22, 23, 24 | $\phi_m$ | – | 60 | – | Deg |
| Channel Separation (f = 100 Hz to 20 kHz) | 25 | CS | – | −120 | – | dB |
| Power Bandwidth ($V_O$ = 20 $V_{pp}$, $R_L$ = 600 Ω, THD ≤ 1.0%) | | $BW_p$ | – | 32 | – | kHz |
| Total Harmonic Distortion ($R_L$ = 600 Ω,, $V_O$ = 2.0 $V_{pp}$, $A_V$ = +1.0 V)<br>(f = 1.0 kHz)<br>(f = 10 kHz)<br>(f = 20 kHz) | 26 | THD | <br>–<br>–<br>– | <br>0.0024<br>0.014<br>0.024 | <br>–<br>–<br>– | % |
| Open Loop Output Impedance ($V_O$ = 0 V, f = 3.0 MHz, $A_V$ = 10 V) | 27 | $\|Z_O\|$ | – | 150 | – | Ω |
| Differential Input Resistance ($V_{CM}$ = 0 V) | | $R_{in}$ | – | 200 | – | kΩ |
| Differential Input Capacitance ($V_{CM}$ = 0 V) | | $C_{in}$ | – | 10 | – | pF |
| Equivalent Input Noise Voltage ($R_S$ = 100 Ω,)<br>f = 10 Hz<br>f = 1.0 kHz | 28 | $e_n$ | <br>–<br>– | <br>8.0<br>7.5 | <br>–<br>– | $nV/\sqrt{Hz}$ |
| Equivalent Input Noise Current<br>f = 10 Hz<br>f = 1.0 kHz | 29 | $i_n$ | <br>–<br>– | <br>0.33<br>0.15 | <br>–<br>– | $pA/\sqrt{Hz}$ |

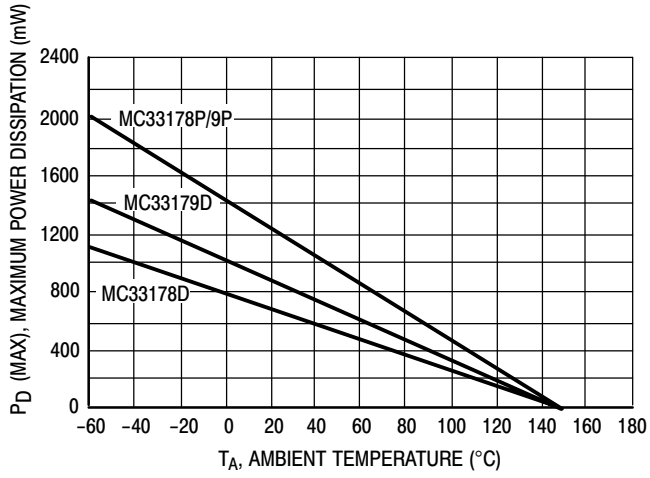



**Figure 2. Maximum Power Dissipation versus Temperature**

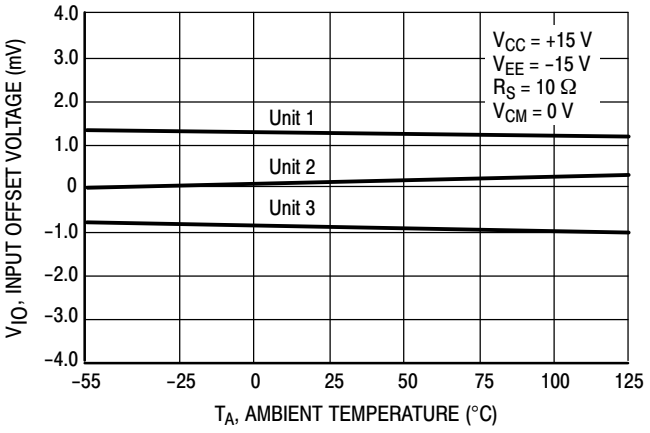



**Figure 3. Input Offset Voltage versus Temperature for 3 Typical Units**

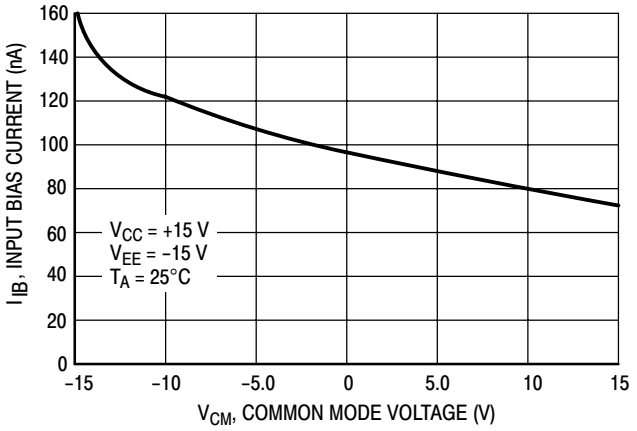



**Figure 4. Input Bias Current versus Common Mode Voltage**

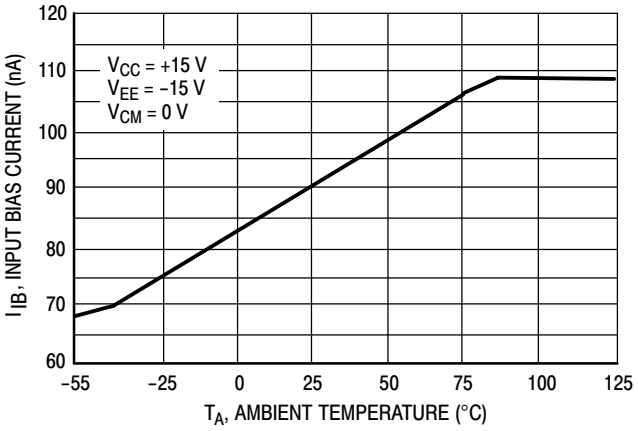



**Figure 5. Input Bias Current versus Temperature**

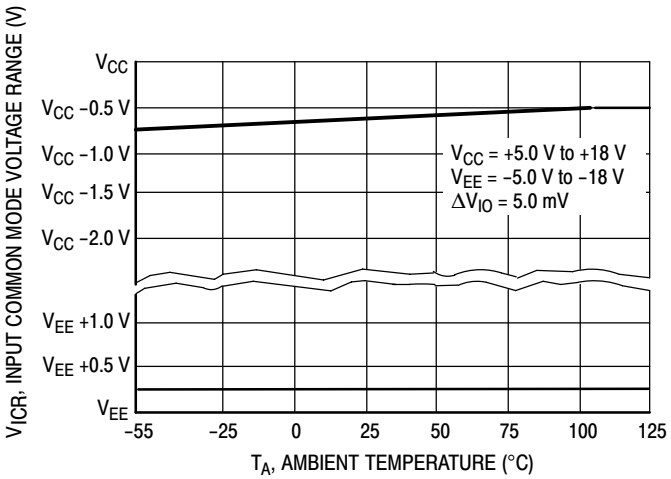



**Figure 6. Input Common Mode Voltage Range versus Temperature**

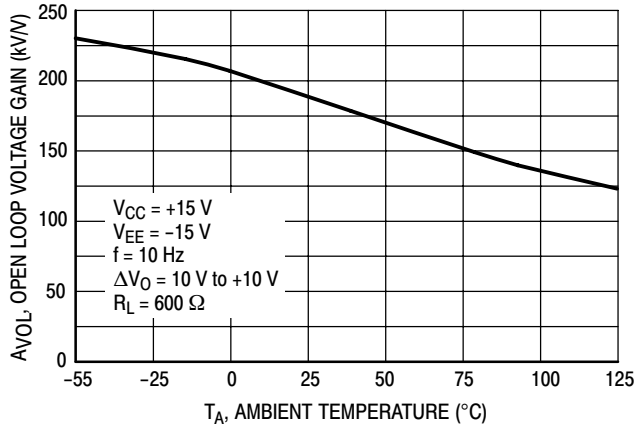



**Figure 7. Open Loop Voltage Gain versus Temperature**

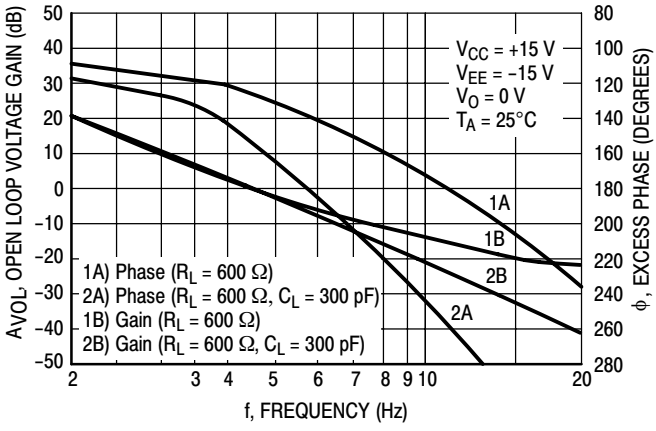



**Figure 8. Voltage Gain and Phase versus Frequency**

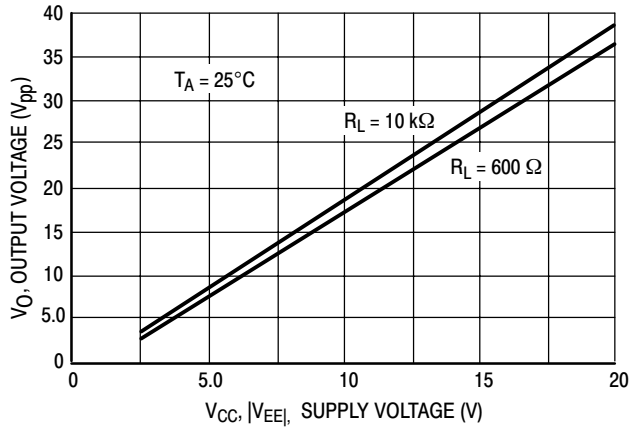



**Figure 9. Output Voltage Swing versus Supply Voltage**

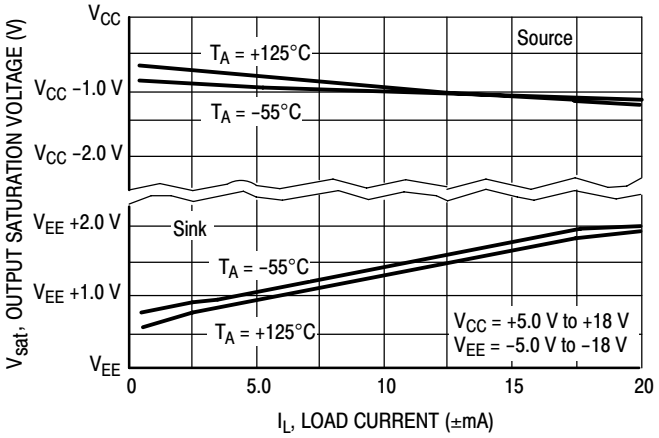



**Figure 10. Output Saturation Voltage versus Load Current**

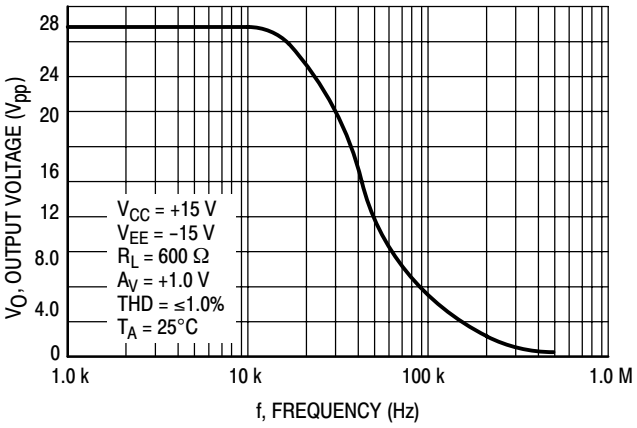



**Figure 11. Output Voltage versus Frequency**

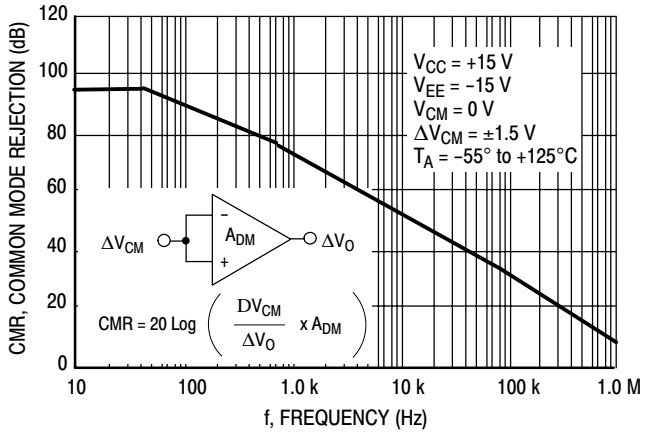



**Figure 12. Common Mode Rejection versus Frequency Over Temperature**

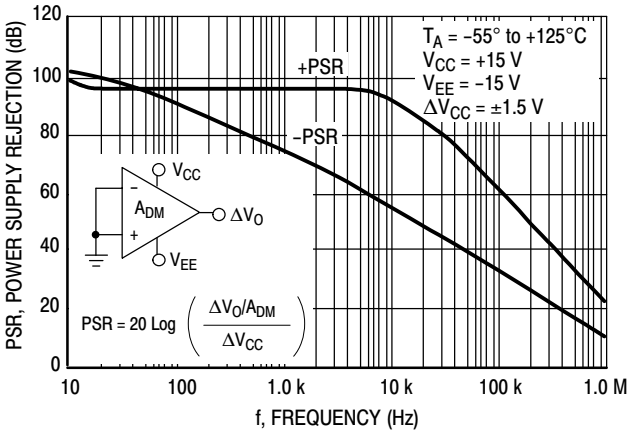



**Figure 13. Power Supply Rejection versus Frequency Over Temperature**

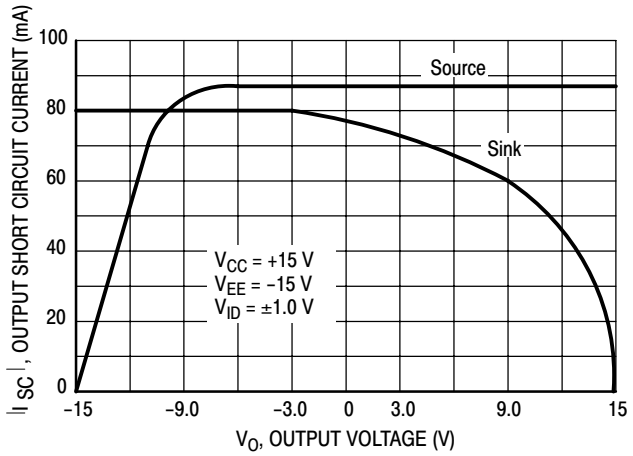



**Figure 14. Output Short Circuit Current versus Output Voltage**

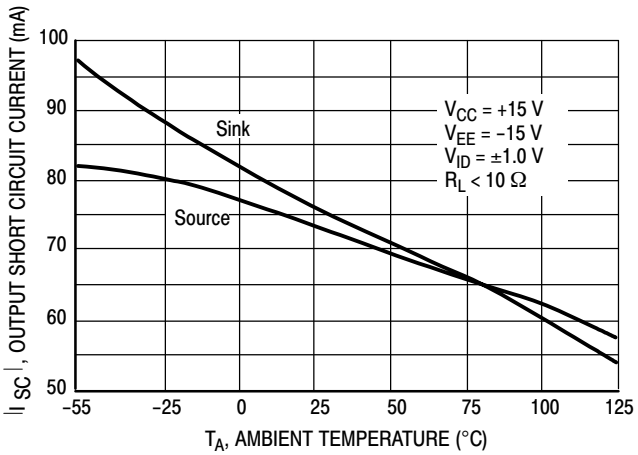



**Figure 15. Output Short Circuit Current versus Temperature**

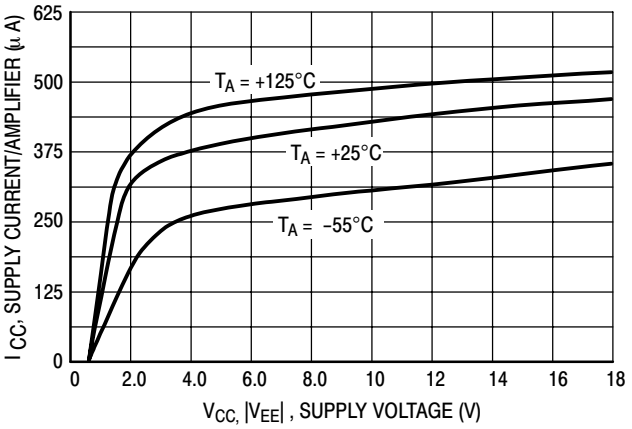



**Figure 16. Supply Current versus Supply Voltage with No Load**

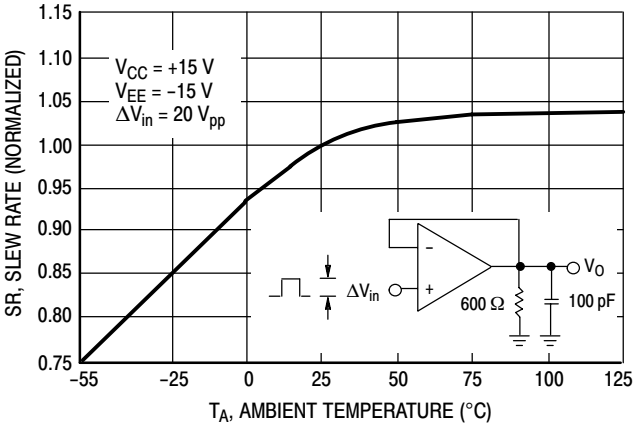



**Figure 17. Normalized Slew Rate versus Temperature**

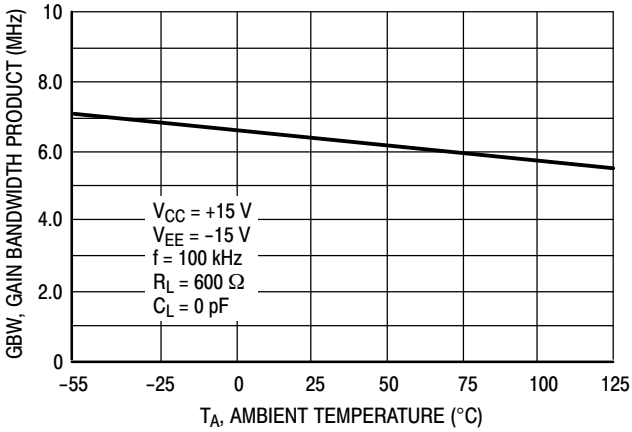



**Figure 18. Gain Bandwidth Product versus Temperature**

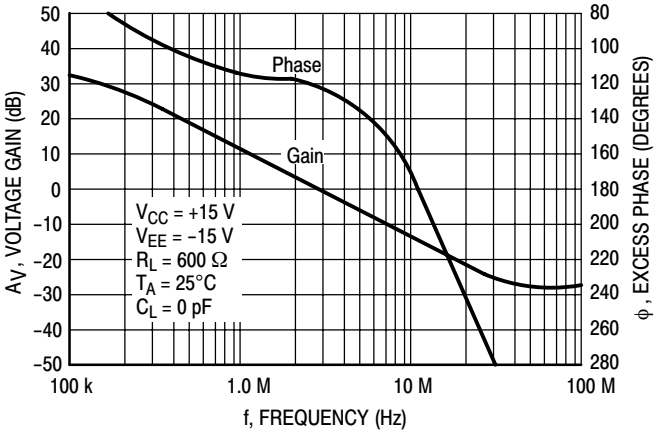



**Figure 19. Voltage Gain and Phase versus Frequency**

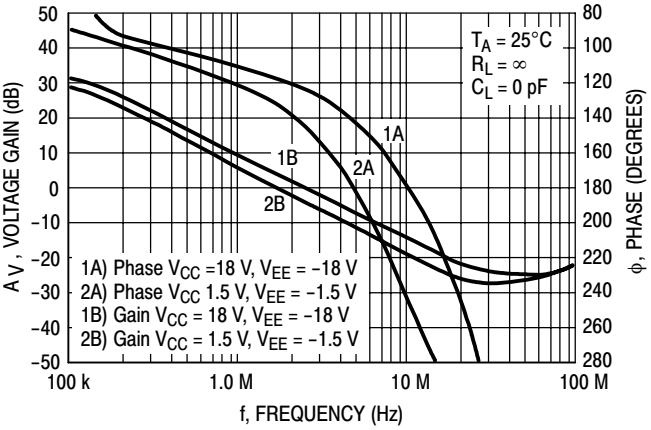



**Figure 20. Voltage Gain and Phase versus Frequency**

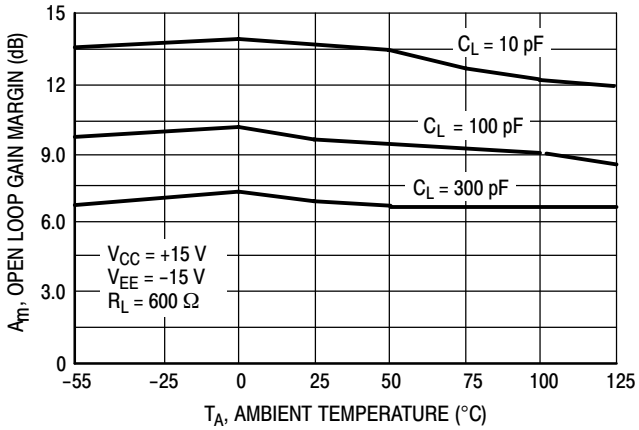



**Figure 21. Open Loop Gain Margin versus Temperature**

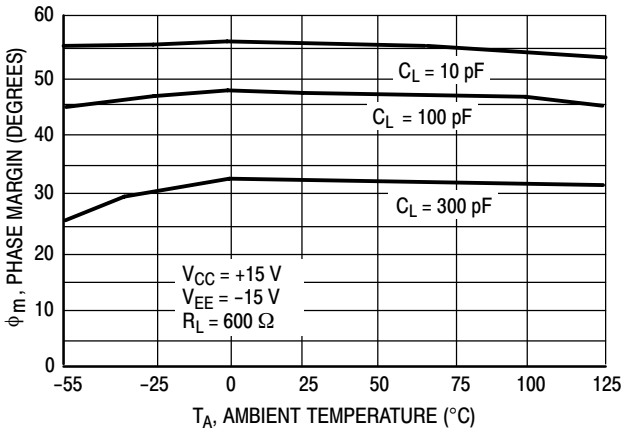



**Figure 22. Phase Margin versus Temperature**

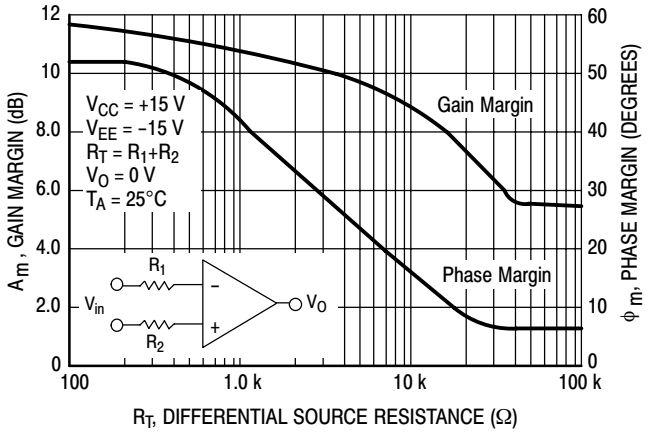



**Figure 23. Phase Margin and Gain Margin versus Differential Source Resistance**

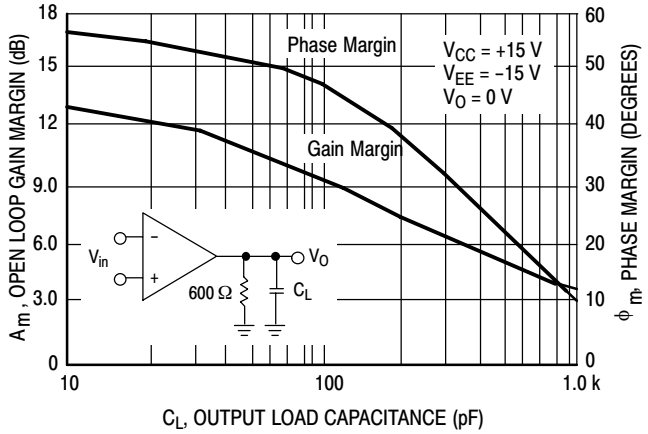



**Figure 24. Open Loop Gain Margin and Phase Margin versus Output Load Capacitance**

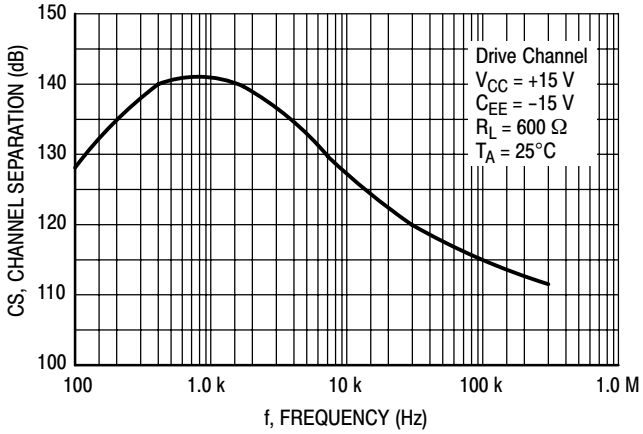



**Figure 25. Channel Separation versus Frequency**

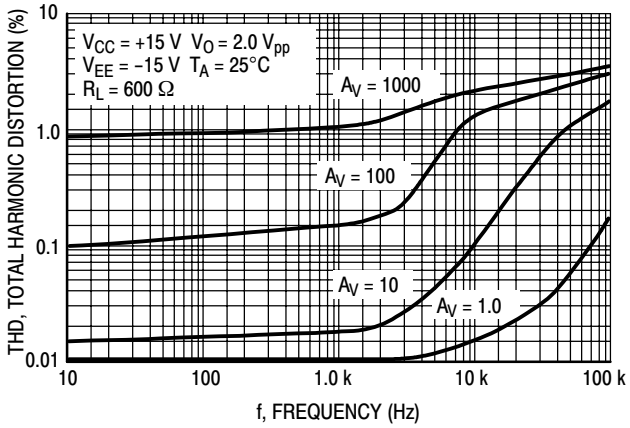



**Figure 26. Total Harmonic Distortion versus Frequency**

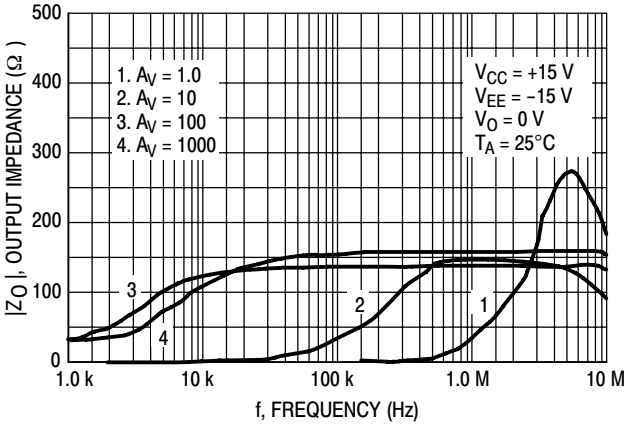



**Figure 27. Output Impedance versus Frequency**

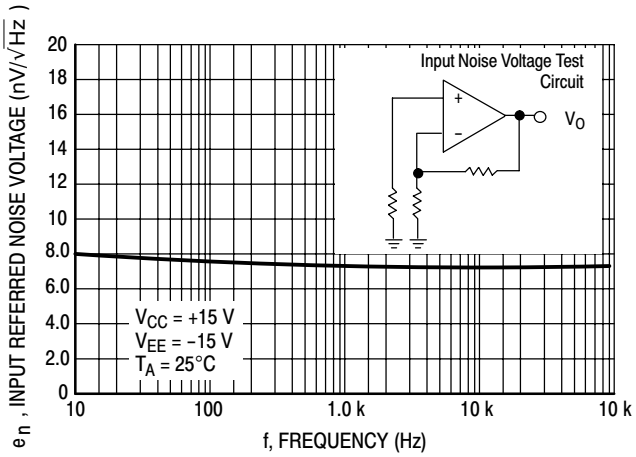



**Figure 28. Input Referred Noise Voltage versus Frequency**

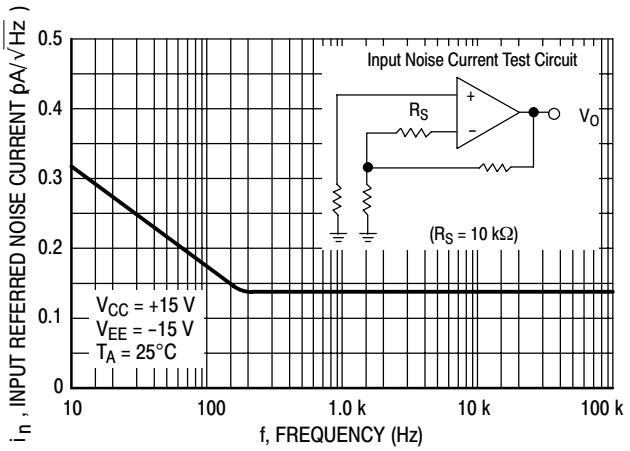



**Figure 29. Input Referred Noise Current versus Frequency**

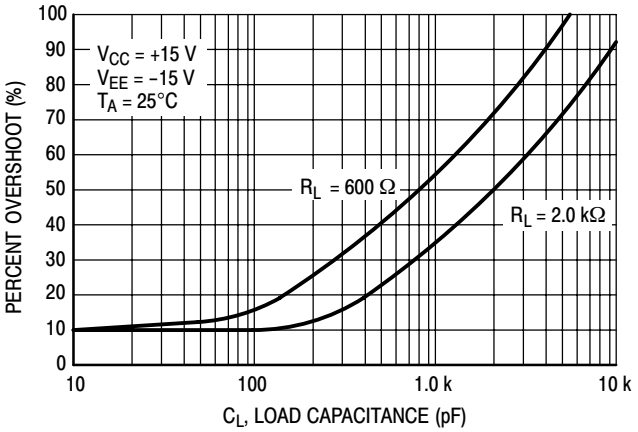



**Figure 30. Percent Overshoot versus Load Capacitance**

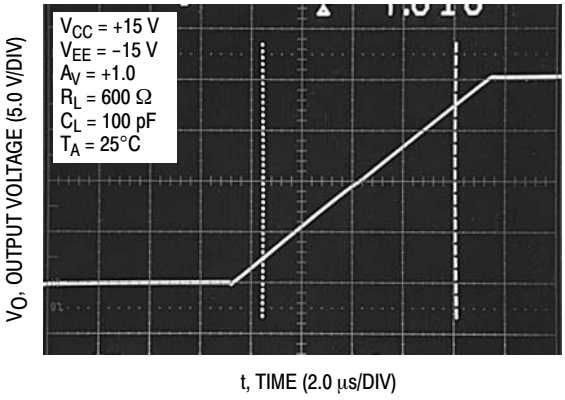



**Figure 31. Non−inverting Amplifier Slew Rate**

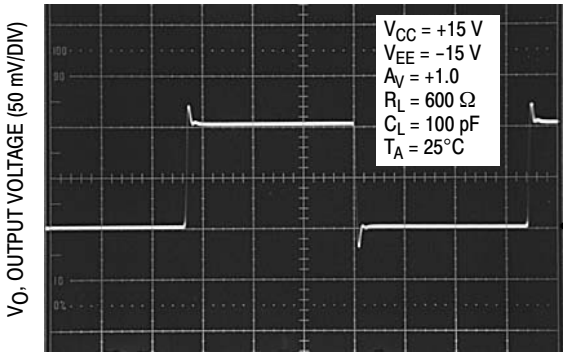



**Figure 32. Small Signal Transient Response**

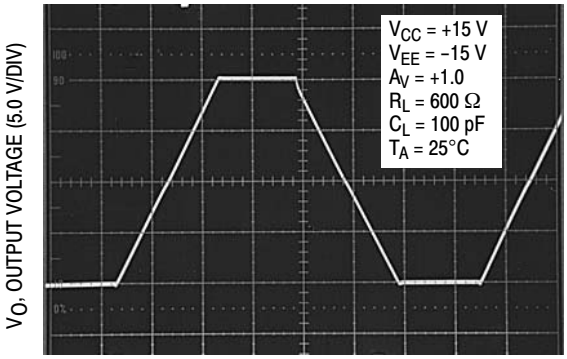



**Figure 33. Large Signal Transient Response**

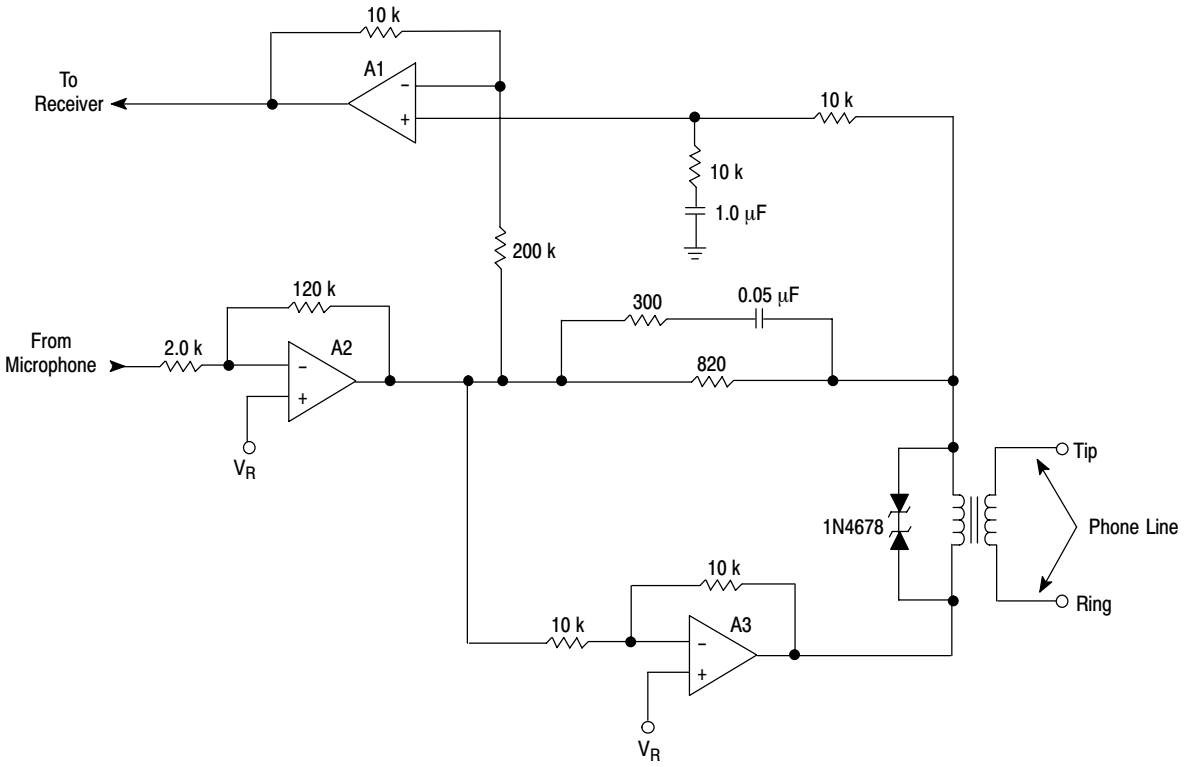



**Figure 34. Telephone Line Interface Circuit**

## APPLICATION INFORMATION

This unique device uses a boosted output stage to combine a high output current with a drain current lower than similar bipolar input op amps. Its 60° phase margin and 15 dB gain margin ensure stability with up to 1000 pF of load capacitance (see Figure 24). The ability to drive a minimum 600 Ω load makes it particularly suitable for telecom applications. Note that in the sample circuit in Figure 34 both A2 and A3 are driving equivalent loads of approximately 600 Ω .

The low input offset voltage and moderately high slew rate and gain bandwidth product make it attractive for a variety of other applications. For example, although it is not single supply (the common mode input range does not include ground), it is specified at +5.0 V with a typical common mode rejection of 110 dB. This makes it an excellent choice for use with digital circuits. The high common mode rejection, which is stable over temperature, coupled with a low noise figure and low distortion, is an ideal op amp for audio circuits.

The output stage of the op amp is current limited and therefore has a certain amount of protection in the event of a short circuit. However, because of its high current output, it is especially important not to allow the device to exceed the maximum junction temperature, particularly with the MC33179 (quad op amp). Shorting more than one amplifier could easily exceed the junction temperature to the extent of causing permanent damage.

### Stability

As usual with most high frequency amplifiers, proper lead dress, component placement, and PC board layout should be exercised for optimum frequency performance. For example, long unshielded input or output leads may result in unwanted input/output coupling. In order to preserve the relatively low input capacitance associated with these amplifiers, resistors connected to the inputs should be immediately adjacent to the input pin to minimize additional stray input capacitance. This not only minimizes the input pole frequency for optimum frequency response, but also minimizes extraneous “pick up” at this node. Supplying decoupling with adequate capacitance immediately adjacent to the supply pin is also important, particularly over temperature, since many types of decoupling capacitors exhibit great impedance changes over temperature.

Additional stability problems can be caused by high load capacitances and/or a high source resistance. Simple compensation schemes can be used to alleviate these effects.

If a high source of resistance is used (R1 > 1.0 kΩ), a compensation capacitor equal to or greater than the input capacitance of the op amp (10 pF) placed across the feedback resistor (see Figure 35) can be used to neutralize that pole and prevent outer loop oscillation. Since the closed loop transient response will be a function of that capacitance, it is important to choose the optimum value for that capacitor. This can be determined by the following Equation:

$$C_C = (1 + [R1/R2])^2 \times C_L (Z_O/R_2) \quad (1)$$

where: $Z_O$ is the output impedance of the op amp.

For moderately high capacitive loads (500 pF < $C_L$ < 1500 pF) the addition of a compensation resistor on the order of 20 Ω between the output and the feedback loop will help to decrease miller loop oscillation (see Figure 36). For high capacitive loads ($C_L$ > 1500 pF), a combined compensation scheme should be used (see Figure 37). Both the compensation resistor and the compensation capacitor affect the transient response and can be calculated for optimum performance. The value of $C_C$ can be calculated using Equation 1. The Equation to calculate $R_C$ is as follows:

$$R_C = Z_O \times R1/R2 \quad (2)$$

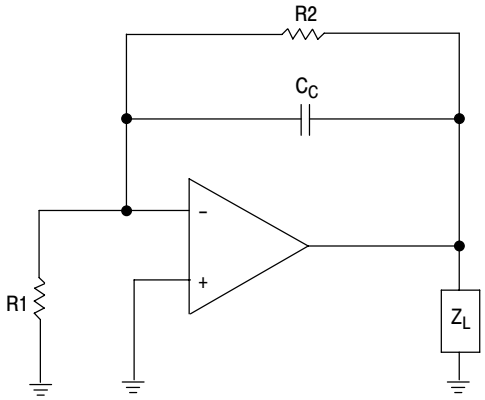



**Figure 35. Compensation for High Source Impedance**

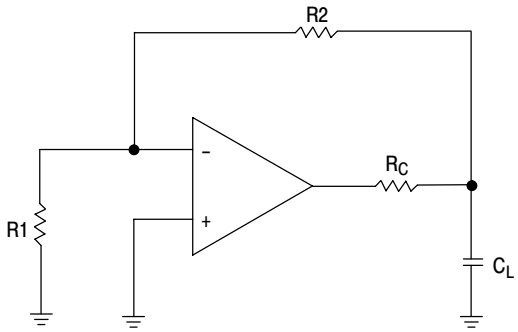



**Figure 36. Compensation Circuit for Moderate Capacitive Loads**

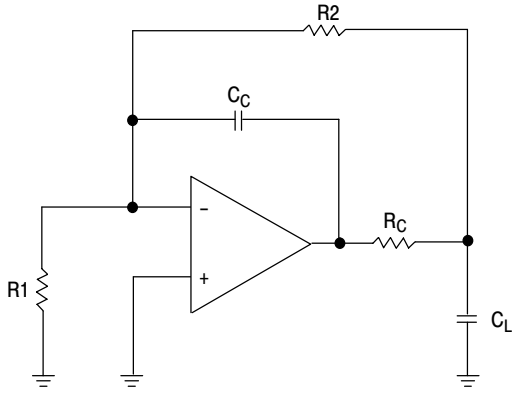



**Figure 37. Compensation Circuit for High Capacitive Loads**

# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

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**PDIP–8**
CASE 626–05
ISSUE P

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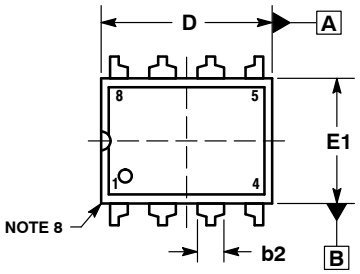
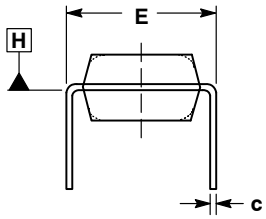
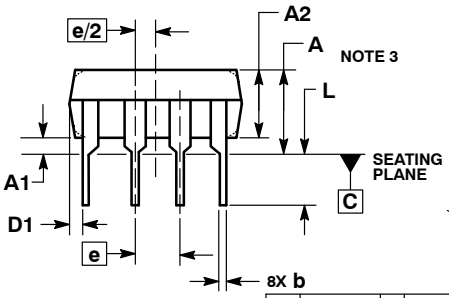


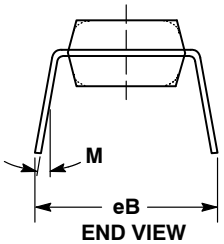

TOP VIEW




END VIEW
WITH LEADS CONSTRAINED
NOTE 5




SIDE VIEW



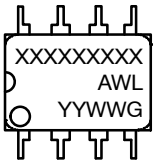

END VIEW
NOTE 6

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSIONS A, A1 AND L ARE MEASURED WITH THE PACKAGE SEATED IN JEDEC SEATING PLANE GAUGE GS–3.
4. DIMENSIONS D, D1 AND E1 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS. MOLD FLASH OR PROTRUSIONS ARE NOT TO EXCEED 0.10 INCH.
5. DIMENSION E IS MEASURED AT A POINT 0.015 BELOW DATUM PLANE H WITH THE LEADS CONSTRAINED PERPENDICULAR TO DATUM C.
6. DIMENSION eB IS MEASURED AT THE LEAD TIPS WITH THE LEADS UNCONSTRAINED.
7. DATUM PLANE H IS COINCIDENT WITH THE BOTTOM OF THE LEADS, WHERE THE LEADS EXIT THE BODY.
8. PACKAGE CONTOUR IS OPTIONAL (ROUNDED OR SQUARE CORNERS).

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | ---- | 0.210 | --- | 5.33 |
| A1 | 0.015 | ---- | 0.38 | --- |
| A2 | 0.115 | 0.195 | 2.92 | 4.95 |
| b | 0.014 | 0.022 | 0.35 | 0.56 |
| b2 | 0.060 TYP | | 1.52 TYP | |
| C | 0.008 | 0.014 | 0.20 | 0.36 |
| D | 0.355 | 0.400 | 9.02 | 10.16 |
| D1 | 0.005 | ---- | 0.13 | --- |
| E | 0.300 | 0.325 | 7.62 | 8.26 |
| E1 | 0.240 | 0.280 | 6.10 | 7.11 |
| e | 0.100 BSC | | 2.54 BSC | |
| eB | ---- | 0.430 | --- | 10.92 |
| L | 0.115 | 0.150 | 2.92 | 3.81 |
| M | ---- | 10° | --- | 10° |

STYLE 1:
PIN 1. AC IN
2. DC + IN
3. DC – IN
4. AC IN
5. GROUND
6. OUTPUT
7. AUXILIARY
8. $V_{CC}$

### GENERIC MARKING DIAGRAM*




XXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week
G = Pb–Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb–Free indicator, “G” or microdot “ ▪”, may or may not be present.

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# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

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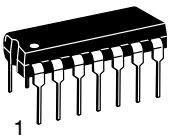
**PDIP−14**
CASE 646−06
ISSUE S

DATE 22 APR 2015



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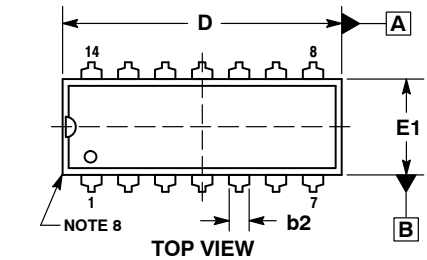
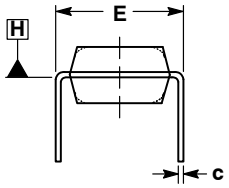
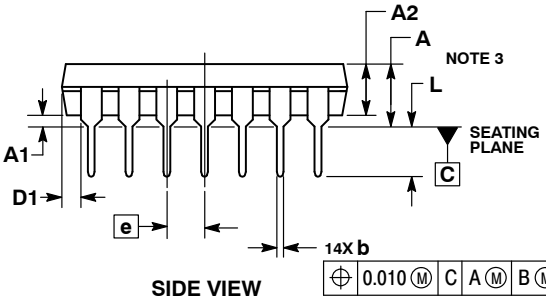


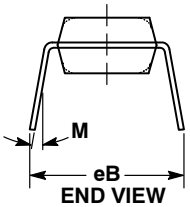

TOP VIEW




END VIEW
WITH LEADS CONSTRAINED
NOTE 5




SIDE VIEW




END VIEW
NOTE 6

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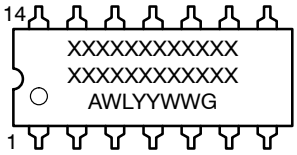
| A2 | 0.115 | 0.195 | 2.92 | 4.95 |
| b | 0.014 | 0.022 | 0.35 | 0.56 |
| b2 | 0.060 TYP | | 1.52 TYP | |
| C | 0.008 | 0.014 | 0.20 | 0.36 |
| D | 0.735 | 0.775 | 18.67 | 19.69 |
| D1 | 0.005 | ---- | 0.13 | --- |
| E | 0.300 | 0.325 | 7.62 | 8.26 |
| E1 | 0.240 | 0.280 | 6.10 | 7.11 |
| e | 0.100 BSC | | 2.54 BSC | |
| eB | ---- | 0.430 | --- | 10.92 |
| L | 0.115 | 0.150 | 2.92 | 3.81 |
| M | ---- | 10° | --- | 10° |

### GENERIC MARKING DIAGRAM*

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A = Assembly Location
WL = Wafer Lot
YY = Year
WW = Work Week
G = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

STYLES ON PAGE 2

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CASE 646−06
ISSUE S

DATE 22 APR 2015

STYLE 1:
PIN 1. COLLECTOR
2. BASE
3. EMITTER
4. NO CONNECTION
5. EMITTER
6. BASE
7. COLLECTOR
8. COLLECTOR
9. BASE
10. EMITTER
11. NO CONNECTION
12. EMITTER
13. BASE
14. COLLECTOR

STYLE 2:
CANCELLED

STYLE 3:
CANCELLED

STYLE 4:
PIN 1. DRAIN
2. SOURCE
3. GATE
4. NO CONNECTION
5. GATE
6. SOURCE
7. DRAIN
8. DRAIN
9. SOURCE
10. GATE
11. NO CONNECTION
12. GATE
13. SOURCE
14. DRAIN

STYLE 5:
PIN 1. GATE
2. DRAIN
3. SOURCE
4. NO CONNECTION
5. SOURCE
6. DRAIN
7. GATE
8. GATE
9. DRAIN
10. SOURCE
11. NO CONNECTION
12. SOURCE
13. DRAIN
14. GATE

STYLE 6:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. NO CONNECTION
7. ANODE/CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. NO CONNECTION
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 7:
PIN 1. NO CONNECTION
2. ANODE
3. ANODE
4. NO CONNECTION
5. ANODE
6. NO CONNECTION
7. ANODE
8. ANODE
9. ANODE
10. NO CONNECTION
11. ANODE
12. ANODE
13. NO CONNECTION
14. COMMON CATHODE

STYLE 8:
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2. CATHODE
3. CATHODE
4. NO CONNECTION
5. CATHODE
6. NO CONNECTION
7. CATHODE
8. CATHODE
9. CATHODE
10. NO CONNECTION
11. CATHODE
12. CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 9:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. ANODE/CATHODE
7. COMMON ANODE
8. COMMON ANODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. NO CONNECTION
12. ANODE/CATHODE
13. ANODE/CATHODE
14. COMMON CATHODE

STYLE 10:
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2. ANODE/CATHODE
3. ANODE/CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. NO CONNECTION
7. COMMON ANODE
8. COMMON CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 11:
PIN 1. CATHODE
2. CATHODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE
7. CATHODE
8. ANODE
9. ANODE
10. ANODE
11. ANODE
12. ANODE
13. ANODE
14. ANODE

STYLE 12:
PIN 1. COMMON CATHODE
2. COMMON ANODE
3. ANODE/CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. COMMON ANODE
7. COMMON CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. ANODE/CATHODE
12. ANODE/CATHODE
13. ANODE/CATHODE
14. ANODE/CATHODE




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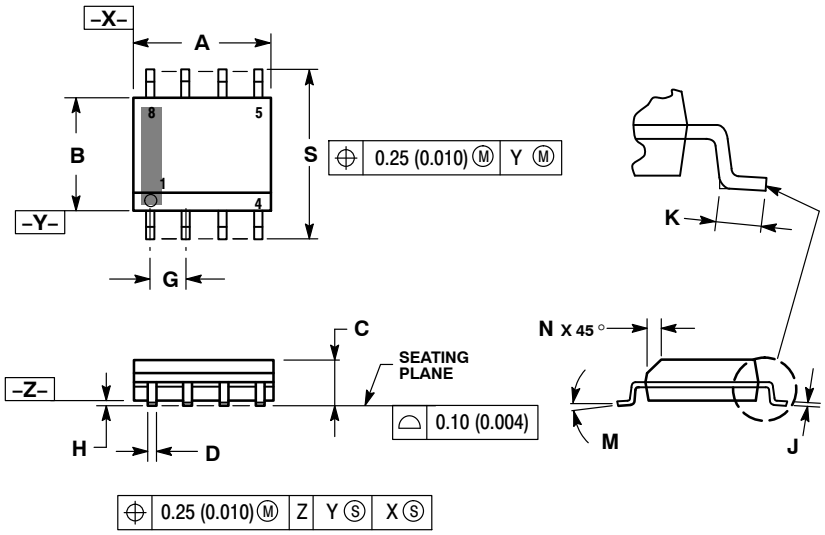
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

ON Semiconductor®

**SCALE 1:1**

**SOIC−8 NB**
CASE 751−07
ISSUE AK

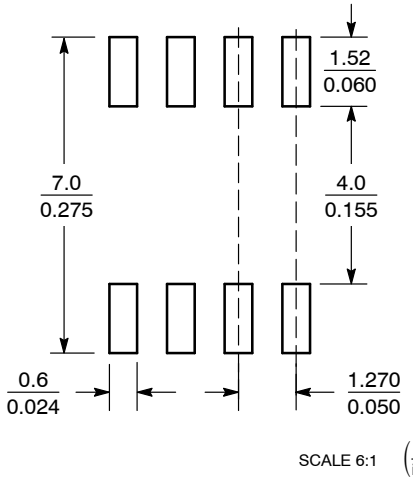
DATE 16 FEB 2011




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.

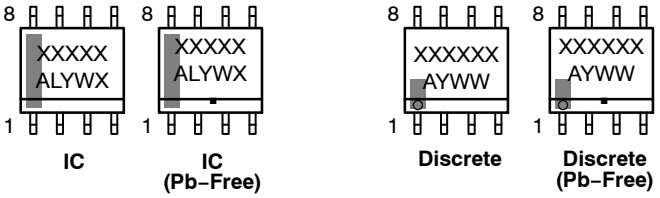
| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 4.80 | 5.00 | 0.189 | 0.197 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.053 | 0.069 |
| D | 0.33 | 0.51 | 0.013 | 0.020 |
| G | 1.27 BSC | | 0.050 BSC | |
| H | 0.10 | 0.25 | 0.004 | 0.010 |
| J | 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 |

### SOLDERING FOOTPRINT*




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

### GENERIC MARKING DIAGRAM*




XXXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

XXXXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

**STYLES ON PAGE 2**

| | | | |
|---|---|---|---|
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| **DESCRIPTION:** | **SOIC−8 NB** | | **PAGE 1 OF 2** |


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**SOIC−8 NB**
CASE 751−07
ISSUE AK

DATE 16 FEB 2011

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. COLLECTOR
4. EMITTER
5. EMITTER
6. BASE
7. BASE
8. EMITTER

STYLE 2:
PIN 1. COLLECTOR, DIE, #1
2. COLLECTOR, #1
3. COLLECTOR, #2
4. COLLECTOR, #2
5. BASE, #2
6. EMITTER, #2
7. BASE, #1
8. EMITTER, #1

STYLE 3:
PIN 1. DRAIN, DIE #1
2. DRAIN, #1
3. DRAIN, #2
4. DRAIN, #2
5. GATE, #2
6. SOURCE, #2
7. GATE, #1
8. SOURCE, #1

STYLE 4:
PIN 1. ANODE
2. ANODE
3. ANODE
4. ANODE
5. ANODE
6. ANODE
7. ANODE
8. COMMON CATHODE

STYLE 5:
PIN 1. DRAIN
2. DRAIN
3. DRAIN
4. DRAIN
5. GATE
6. GATE
7. SOURCE
8. SOURCE

STYLE 6:
PIN 1. SOURCE
2. DRAIN
3. DRAIN
4. SOURCE
5. SOURCE
6. GATE
7. GATE
8. SOURCE

STYLE 7:
PIN 1. INPUT
2. EXTERNAL BYPASS
3. THIRD STAGE SOURCE
4. GROUND
5. DRAIN
6. GATE 3
7. SECOND STAGE Vd
8. FIRST STAGE Vd

STYLE 8:
PIN 1. COLLECTOR, DIE #1
2. BASE, #1
3. BASE, #2
4. COLLECTOR, #2
5. COLLECTOR, #2
6. EMITTER, #2
7. EMITTER, #1
8. COLLECTOR, #1

STYLE 9:
PIN 1. EMITTER, COMMON
2. COLLECTOR, DIE #1
3. COLLECTOR, DIE #2
4. EMITTER, COMMON
5. EMITTER, COMMON
6. BASE, DIE #2
7. BASE, DIE #1
8. EMITTER, COMMON

STYLE 10:
PIN 1. GROUND
2. BIAS 1
3. OUTPUT
4. GROUND
5. GROUND
6. BIAS 2
7. INPUT
8. GROUND

STYLE 11:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

STYLE 12:
PIN 1. SOURCE
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 13:
PIN 1. N.C.
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 14:
PIN 1. N−SOURCE
2. N−GATE
3. P−SOURCE
4. P−GATE
5. P−DRAIN
6. P−DRAIN
7. N−DRAIN
8. N−DRAIN

STYLE 15:
PIN 1. ANODE 1
2. ANODE 1
3. ANODE 1
4. ANODE 1
5. CATHODE, COMMON
6. CATHODE, COMMON
7. CATHODE, COMMON
8. CATHODE, COMMON

STYLE 16:
PIN 1. EMITTER, DIE #1
2. BASE, DIE #1
3. EMITTER, DIE #2
4. BASE, DIE #2
5. COLLECTOR, DIE #2
6. COLLECTOR, DIE #2
7. COLLECTOR, DIE #1
8. COLLECTOR, DIE #1

STYLE 17:
PIN 1. VCC
2. V2OUT
3. V1OUT
4. TXE
5. RXE
6. VEE
7. GND
8. ACC

STYLE 18:
PIN 1. ANODE
2. ANODE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. CATHODE
8. CATHODE

STYLE 19:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. MIRROR 2
7. DRAIN 1
8. MIRROR 1

STYLE 20:
PIN 1. SOURCE (N)
2. GATE (N)
3. SOURCE (P)
4. GATE (P)
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 21:
PIN 1. CATHODE 1
2. CATHODE 2
3. CATHODE 3
4. CATHODE 4
5. CATHODE 5
6. COMMON ANODE
7. COMMON ANODE
8. CATHODE 6

STYLE 22:
PIN 1. I/O LINE 1
2. COMMON CATHODE/VCC
3. COMMON CATHODE/VCC
4. I/O LINE 3
5. COMMON ANODE/GND
6. I/O LINE 4
7. I/O LINE 5
8. COMMON ANODE/GND

STYLE 23:
PIN 1. LINE 1 IN
2. COMMON ANODE/GND
3. COMMON ANODE/GND
4. LINE 2 IN
5. LINE 2 OUT
6. COMMON ANODE/GND
7. COMMON ANODE/GND
8. LINE 1 OUT

STYLE 24:
PIN 1. BASE
2. EMITTER
3. COLLECTOR/ANODE
4. COLLECTOR/ANODE
5. CATHODE
6. CATHODE
7. COLLECTOR/ANODE
8. COLLECTOR/ANODE

STYLE 25:
PIN 1. VIN
2. N/C
3. REXT
4. GND
5. IOUT
6. IOUT
7. IOUT
8. IOUT

STYLE 26:
PIN 1. GND
2. dv/dt
3. ENABLE
4. ILIMIT
5. SOURCE
6. SOURCE
7. SOURCE
8. VCC

STYLE 27:
PIN 1. ILIMIT
2. OVLO
3. UVLO
4. INPUT+
5. SOURCE
6. SOURCE
7. SOURCE
8. DRAIN

STYLE 28:
PIN 1. SW_TO_GND
2. DASIC_OFF
3. DASIC_SW_DET
4. GND
5. V_MON
6. VBULK
7. VBULK
8. VIN

STYLE 29:
PIN 1. BASE, DIE #1
2. EMITTER, #1
3. BASE, #2
4. EMITTER, #2
5. COLLECTOR, #2
6. COLLECTOR, #2
7. COLLECTOR, #1
8. COLLECTOR, #1

STYLE 30:
PIN 1. DRAIN 1
2. DRAIN 1
3. GATE 2
4. SOURCE 2
5. SOURCE 1/DRAIN 2
6. SOURCE 1/DRAIN 2
7. SOURCE 1/DRAIN 2
8. GATE 1

| | | | |
|---|---|---|---|
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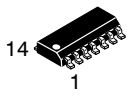
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

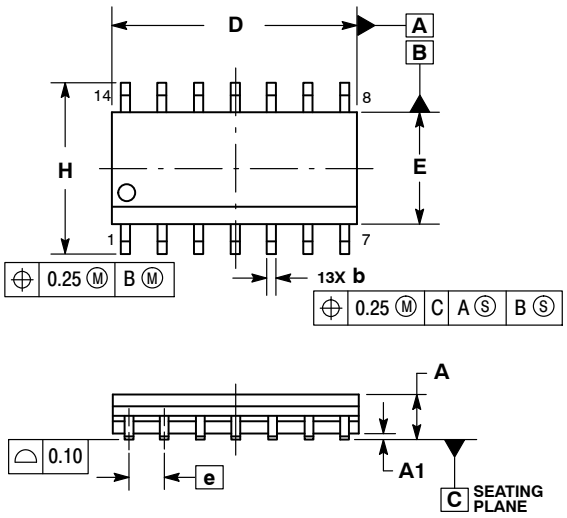
ON Semiconductor®

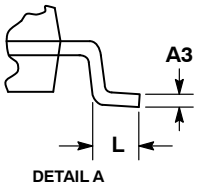


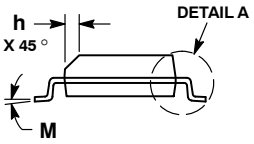

SCALE 1:1

**SOIC−14 NB**
CASE 751A−03
ISSUE L

DATE 03 FEB 2016



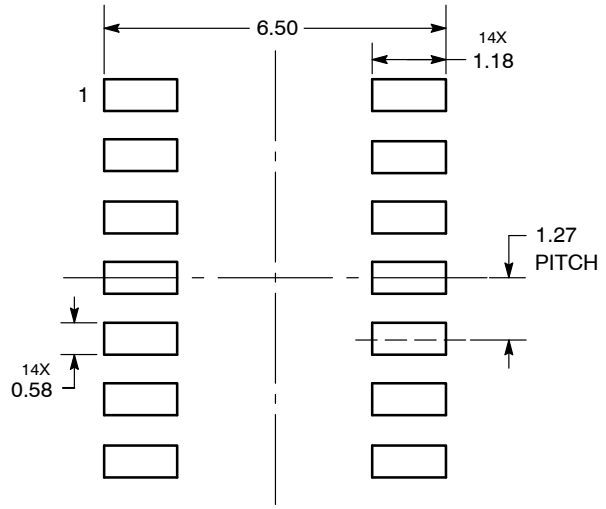




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF AT MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD PROTRUSIONS.
5. MAXIMUM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

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | 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 ° |

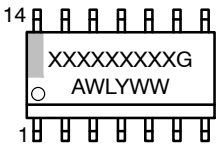
### SOLDERING FOOTPRINT*




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.

### GENERIC MARKING DIAGRAM*




XXXXX = Specific Device Code
A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week
G = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

**STYLES ON PAGE 2**

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**SOIC−14**
CASE 751A−03
ISSUE L

DATE 03 FEB 2016

STYLE 1:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. NO CONNECTION
7. ANODE/CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. NO CONNECTION
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 2:
CANCELLED

STYLE 3:
PIN 1. NO CONNECTION
2. ANODE
3. ANODE
4. NO CONNECTION
5. ANODE
6. NO CONNECTION
7. ANODE
8. ANODE
9. ANODE
10. NO CONNECTION
11. ANODE
12. ANODE
13. NO CONNECTION
14. COMMON CATHODE

STYLE 4:
PIN 1. NO CONNECTION
2. CATHODE
3. CATHODE
4. NO CONNECTION
5. CATHODE
6. NO CONNECTION
7. CATHODE
8. CATHODE
9. CATHODE
10. NO CONNECTION
11. CATHODE
12. CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 5:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. NO CONNECTION
7. COMMON ANODE
8. COMMON CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. ANODE/CATHODE
12. ANODE/CATHODE
13. NO CONNECTION
14. COMMON ANODE

STYLE 6:
PIN 1. CATHODE
2. CATHODE
3. CATHODE
4. CATHODE
5. CATHODE
6. CATHODE
7. CATHODE
8. ANODE
9. ANODE
10. ANODE
11. ANODE
12. ANODE
13. ANODE
14. ANODE

STYLE 7:
PIN 1. ANODE/CATHODE
2. COMMON ANODE
3. COMMON CATHODE
4. ANODE/CATHODE
5. ANODE/CATHODE
6. ANODE/CATHODE
7. ANODE/CATHODE
8. ANODE/CATHODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. COMMON CATHODE
12. COMMON ANODE
13. ANODE/CATHODE
14. ANODE/CATHODE

STYLE 8:
PIN 1. COMMON CATHODE
2. ANODE/CATHODE
3. ANODE/CATHODE
4. NO CONNECTION
5. ANODE/CATHODE
6. ANODE/CATHODE
7. COMMON ANODE
8. COMMON ANODE
9. ANODE/CATHODE
10. ANODE/CATHODE
11. NO CONNECTION
12. ANODE/CATHODE
13. ANODE/CATHODE
14. COMMON CATHODE




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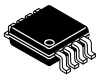
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

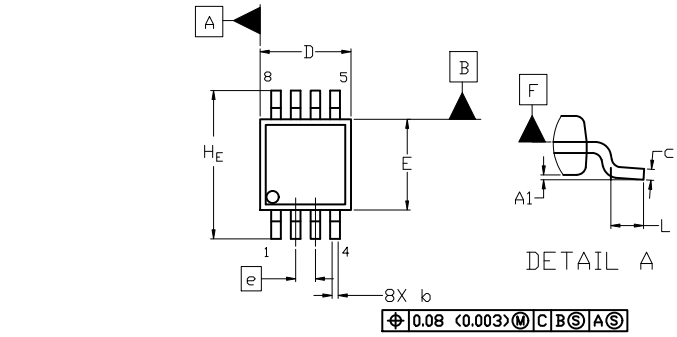
ON Semiconductor®

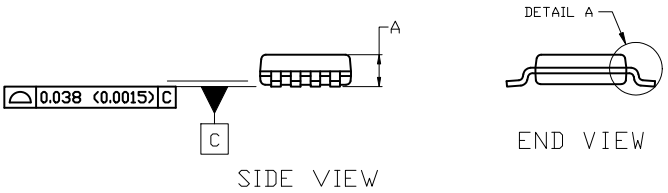


**SCALE 2:1**

**Micro8**
CASE 846A−02
ISSUE K

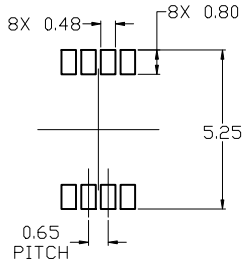
DATE 16 JUL 2020




NOTES:

1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 2009.
2. CONTROLLING DIMENSION: MILLIMETERS
3. DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE PROTRUSION SHALL BE 0.10 mm IN EXCESS OF MAXIMUM MATERIAL CONDITION.
4. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH, PROTRUSION OR GATE BURRS. MOLD FLASH, PROTRUSIONS, OR GATE BURRS SHALL NOT EXCEED 0.15 mm PER SIDE. DIMENSION E DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 mm PER SIDE. DIMENSIONS D AND E ARE DETERMINED AT DATUM F.
5. DATUMS A AND B ARE TO BE DETERMINED AT DATUM F.
6. A1 IS DEFINED AS THE VERTICAL DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT ON THE PACKAGE BODY.

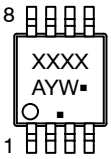



RECOMMENDED
MOUNTING FOOTPRINT

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

| DIM | MILLIMETERS | | |
|---|---|---|---|
| | MIN. | NOM. | MAX. |
| A | --- | --- | 1.10 |
| A1 | 0.05 | 0.08 | 0.15 |
| b | 0.25 | 0.33 | 0.40 |
| c | 0.13 | 0.18 | 0.23 |
| D | 2.90 | 3.00 | 3.10 |
| E | 2.90 | 3.00 | 3.10 |
| e | 0.65 BSC | | |
| $H_E$ | 4.75 | 4.90 | 5.05 |
| L | 0.40 | 0.55 | 0.70 |

### GENERIC MARKING DIAGRAM*




XXXX = Specific Device Code
A = Assembly Location
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “▪”, may or may not be present. Some products may not follow the Generic Marking.

STYLE 1:
PIN 1. SOURCE
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 2:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

STYLE 3:
PIN 1. N-SOURCE
2. N-GATE
3. P-SOURCE
4. P-GATE
5. P-DRAIN
6. P-DRAIN
7. N-DRAIN
8. N-DRAIN

| | | |
|---|---|---|
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| **DESCRIPTION:** | **MICRO8** | **PAGE 1 OF 1** |


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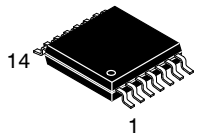
# MECHANICAL CASE OUTLINE
## PACKAGE DIMENSIONS

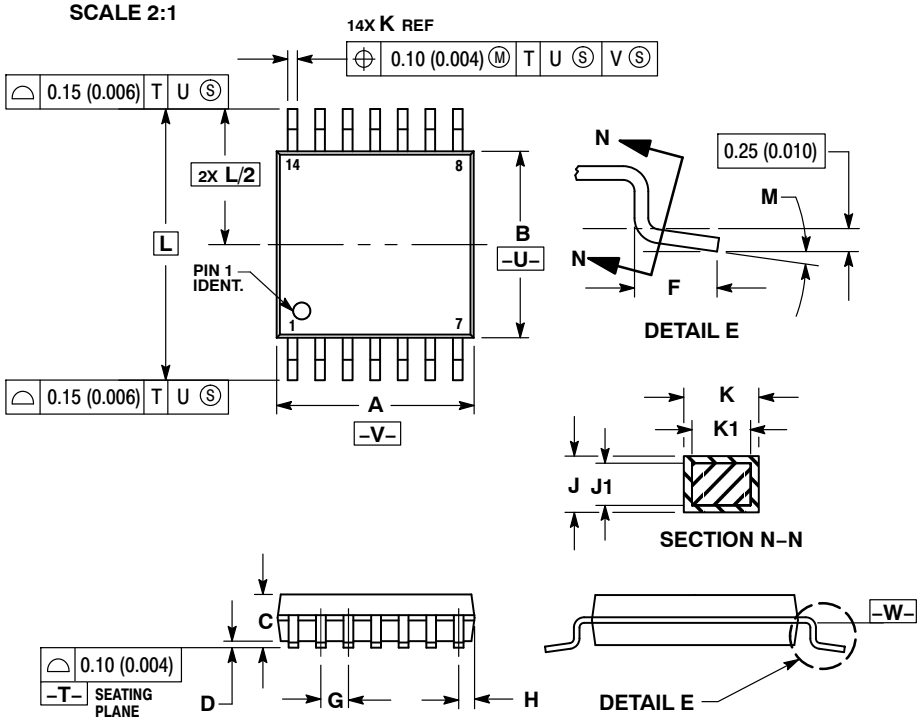
ON Semiconductor®

**TSSOP−14 WB**
CASE 948G
ISSUE C

DATE 17 FEB 2016



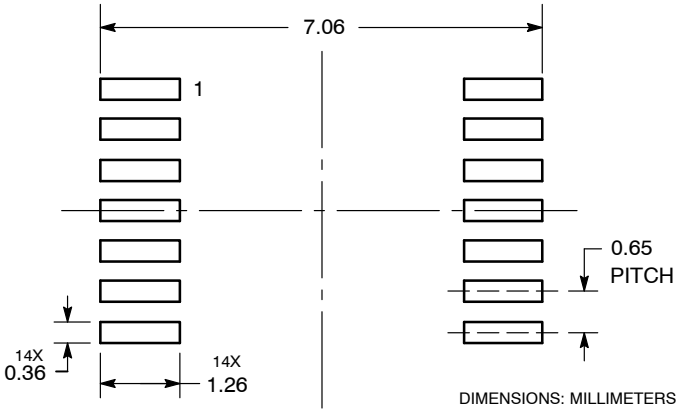

SCALE 2:1




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE −W−.

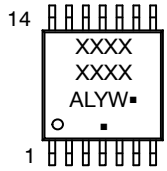
| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 4.90 | 5.10 | 0.193 | 0.200 |
| B | 4.30 | 4.50 | 0.169 | 0.177 |
| C | −−− | 1.20 | −−− | 0.047 |
| D | 0.05 | 0.15 | 0.002 | 0.006 |
| F | 0.50 | 0.75 | 0.020 | 0.030 |
| G | 0.65 BSC | | 0.026 BSC | |
| H | 0.50 | 0.60 | 0.020 | 0.024 |
| J | 0.09 | 0.20 | 0.004 | 0.008 |
| J1 | 0.09 | 0.16 | 0.004 | 0.006 |
| K | 0.19 | 0.30 | 0.007 | 0.012 |
| K1 | 0.19 | 0.25 | 0.007 | 0.010 |
| L | 6.40 BSC | | 0.252 BSC | |
| M | 0 ° | 8 ° | 0 ° | 8 ° |

### SOLDERING FOOTPRINT




DIMENSIONS: MILLIMETERS

### GENERIC MARKING DIAGRAM*




A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

(Note: Microdot may be in either location)

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, “G” or microdot “ ▪”, may or may not be present.

| | | |
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