



THE DATASHEET OF LM2904VN



LM258, LM358, LM358A, LM358E, LM2904, LM2904A, LM2904E, LM2904V, NCV2904

Single Supply Dual Operational Amplifiers

Utilizing the circuit designs perfected for Quad Operational Amplifiers, these dual operational amplifiers feature low power drain, a common mode input voltage range extending to ground/ V_{EE} , and single supply or split supply operation. The LM358 series is equivalent to one-half of an LM324.

These amplifiers have several distinct advantages over standard operational amplifier types in single supply applications. They can operate at supply voltages as low as 3.0 V or as high as 32 V, with quiescent currents about one-fifth of those associated with the MC1741 (on a per amplifier basis). The common mode input range includes the negative supply, thereby eliminating the necessity for external biasing components in many applications. The output voltage range also includes the negative power supply voltage.

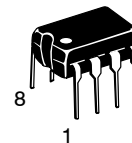
Features

- Short Circuit Protected Outputs
- True Differential Input Stage
- Single Supply Operation: 3.0 V to 32 V
- Low Input Bias Currents
- Internally Compensated
- Common Mode Range Extends to Negative Supply
- Single and Split Supply Operation
- ESD Clamps on the Inputs Increase Ruggedness of the Device without Affecting Operation
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



ON Semiconductor®

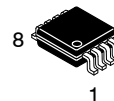
www.onsemi.com



PDIP-8
N, AN, VN SUFFIX
CASE 626

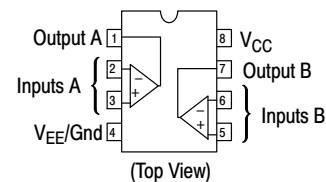


SOIC-8
D, VD SUFFIX
CASE 751



Micro8™
DMR2 SUFFIX
CASE 846A

PIN CONNECTIONS



ORDERING INFORMATION

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

DEVICE MARKING INFORMATION

See general marking information in the device marking section on page 11 of this data sheet.



Figure 1.

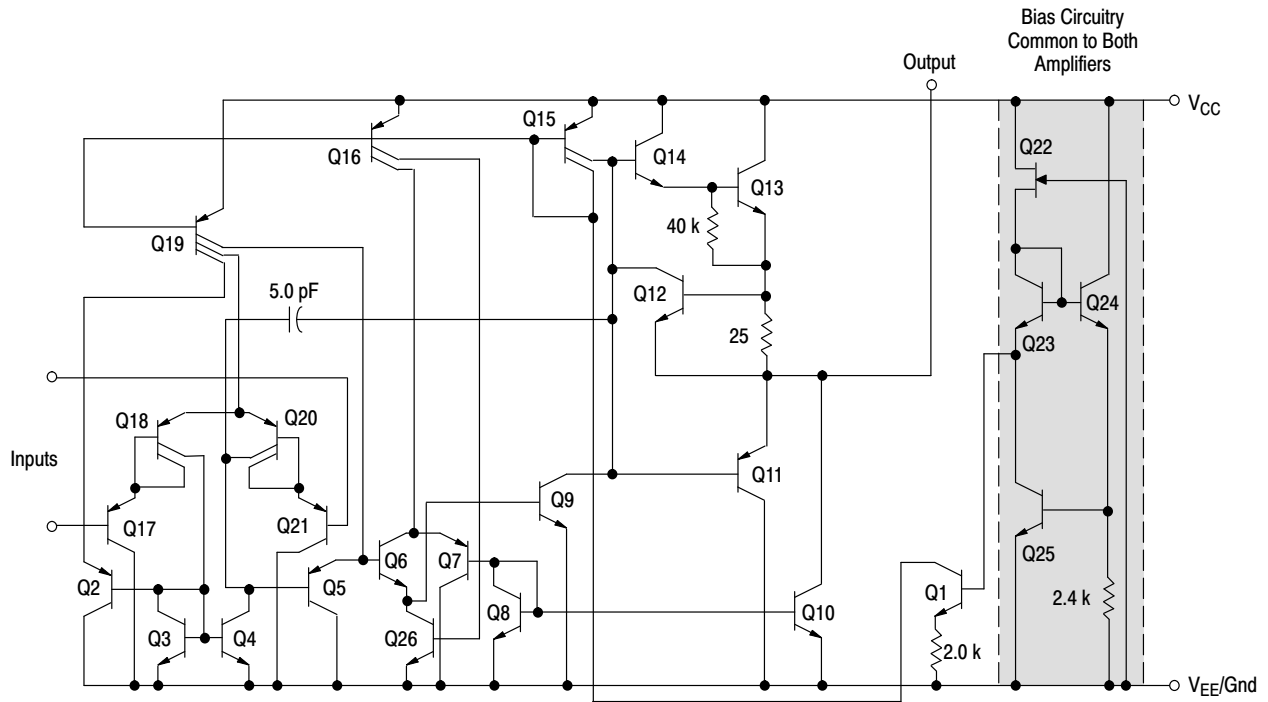


Figure 2. Representative Schematic Diagram
(One-Half of Circuit Shown)

LM258, LM358, LM358A, LM358E, LM2904, LM2904A, LM2904E, LM2904V, NCV2904

MAXIMUM RATINGS ($T_A = +25^\circ\text{C}$, unless otherwise noted.)

| Rating | Symbol | Value | Unit |
|--|-----------------------------------|---|---------------------------|
| Power Supply Voltages Single Supply Split Supplies | V_{CC} V_{CC}, V_{EE} | 32 ± 16 | Vdc |
| Input Differential Voltage Range (Note 1) | V_{IDR} | ± 32 | Vdc |
| Input Common Mode Voltage Range | V_{ICR} | -0.3 to 32 | Vdc |
| Output Short Circuit Duration | t_{SC} | Continuous | |
| Junction Temperature | T_J | 150 | $^\circ\text{C}$ |
| Thermal Resistance, Junction-to-Air (Note 2) | Case 846A Case 751 Case 626 | $R_{\theta JA}$ 238 212 161 | $^\circ\text{C}/\text{W}$ |
| Storage Temperature Range | T_{stg} | -65 to +150 | $^\circ\text{C}$ |
| Operating Ambient Temperature Range | T_A | LM258 LM358, LM358A, LM358E LM2904, LM2904A, LM2904E LM2904V, NCV2904 (Note 3) -25 to +85 0 to +70 -40 to +105 -40 to +125 | $^\circ\text{C}$ |

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Split Power Supplies.
2. All $R_{\theta JA}$ measurements made on evaluation board with 1 oz. copper traces of minimum pad size. All device outputs were active.
3. NCV2904 is qualified for automotive use.

ESD RATINGS

| Rating | HBM | MM | Unit |
|--|------|-----|------|
| ESD Protection at any Pin (Human Body Model – HBM, Machine Model – MM) | | | |
| NCV2904 (Note 3) | 2000 | 200 | V |
| LM358E, LM2904E | 2000 | 200 | V |
| LM358DG/DR2G, LM2904DG/DR2G | 250 | 100 | V |
| All Other Devices | 2000 | 200 | V |

LM258, LM358, LM358A, LM358E, LM2904, LM2904A, LM2904E, LM2904V, NCV2904

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

| Characteristic | Symbol | LM258 | | | LM358, LM358E | | | LM358A | | | Unit |
|---|--------------------------|-------|------|----------|---------------|------|----------|--------|------|----------|------------------------------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage $V_{CC} = 5.0\text{ V}$ to 30 V , $V_{IC} = 0\text{ V}$ to $V_{CC} - 1.7\text{ V}$, $V_O \approx 1.4\text{ V}$, $R_S = 0\ \Omega$ $T_A = 25^\circ\text{C}$ $T_A = T_{\text{high}}$ (Note 4) $T_A = T_{\text{low}}$ (Note 4) | V_{IO} | - | 2.0 | 5.0 | - | 2.0 | 7.0 | - | 2.0 | 3.0 | mV |
| Average Temperature Coefficient of Input Offset Voltage $T_A = T_{\text{high}}$ to T_{low} (Note 4) | $\Delta V_{IO}/\Delta T$ | - | 7.0 | - | - | 7.0 | - | - | 7.0 | - | $\mu\text{V}/^\circ\text{C}$ |
| Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 4) | I_{IO} | - | 3.0 | 30 | - | 5.0 | 50 | - | 5.0 | 30 | nA |
| Input Bias Current $T_A = T_{\text{high}}$ to T_{low} (Note 4) | I_{IB} | - | -45 | -150 | - | -45 | -250 | - | -45 | -100 | nA |
| Average Temperature Coefficient of Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 4) | $\Delta I_{IO}/\Delta T$ | - | 10 | - | - | 10 | - | - | 10 | - | $\text{pA}/^\circ\text{C}$ |
| Input Common Mode Voltage Range (Note 5), $V_{CC} = 30\text{ V}$ $V_{CC} = 30\text{ V}$, $T_A = T_{\text{high}}$ to T_{low} | V_{ICR} | 0 | - | 28.3 | 0 | - | 28.3 | 0 | - | 28.5 | V |
| Differential Input Voltage Range | V_{IDR} | - | - | V_{CC} | - | - | V_{CC} | - | - | V_{CC} | V |
| Large Signal Open Loop Voltage Gain $R_L = 2.0\text{ k}\Omega$, $V_{CC} = 15\text{ V}$, For Large V_O Swing, $T_A = T_{\text{high}}$ to T_{low} (Note 4) | A_{VOL} | 50 | 100 | - | 25 | 100 | - | 25 | 100 | - | V/mV |
| Channel Separation $1.0\text{ kHz} \leq f \leq 20\text{ kHz}$, Input Referenced | CS | - | -120 | - | - | -120 | - | - | -120 | - | dB |
| Common Mode Rejection $R_S \leq 10\text{ k}\Omega$ | CMR | 70 | 85 | - | 65 | 70 | - | 65 | 70 | - | dB |
| Power Supply Rejection | PSR | 65 | 100 | - | 65 | 100 | - | 65 | 100 | - | dB |
| Output Voltage-High Limit $T_A = T_{\text{high}}$ to T_{low} (Note 4) $V_{CC} = 5.0\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $T_A = 25^\circ\text{C}$ $V_{CC} = 30\text{ V}$, $R_L = 2.0\text{ k}\Omega$ $V_{CC} = 30\text{ V}$, $R_L = 10\text{ k}\Omega$ | V_{OH} | 3.3 | 3.5 | - | 3.3 | 3.5 | - | 3.3 | 3.5 | - | V |
| Output Voltage-Low Limit $V_{CC} = 5.0\text{ V}$, $R_L = 10\text{ k}\Omega$, $T_A = T_{\text{high}}$ to T_{low} (Note 4) | V_{OL} | - | 5.0 | 20 | - | 5.0 | 20 | - | 5.0 | 20 | mV |
| Output Source Current $V_{ID} = +1.0\text{ V}$, $V_{CC} = 15\text{ V}$ $T_A = T_{\text{high}}$ to T_{low} (LM358A Only) | I_{O+} | 20 | 40 | - | 20 | 40 | - | 20 | 40 | - | mA |
| Output Sink Current $V_{ID} = -1.0\text{ V}$, $V_{CC} = 15\text{ V}$ $T_A = T_{\text{high}}$ to T_{low} (LM358A Only) $V_{ID} = -1.0\text{ V}$, $V_O = 200\text{ mV}$ | I_{O-} | 10 | 20 | - | 10 | 20 | - | 10 | 20 | - | mA |
| Output Short Circuit to Ground (Note 6) | I_{SC} | - | 40 | 60 | - | 40 | 60 | - | 40 | 60 | mA |
| Power Supply Current (Total Device) $T_A = T_{\text{high}}$ to T_{low} (Note 4) $V_{CC} = 30\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ $V_{CC} = 5\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ | I_{CC} | - | 1.5 | 3.0 | - | 1.5 | 3.0 | - | 1.5 | 2.0 | mA |

4. LM258: $T_{\text{low}} = -25^\circ\text{C}$, $T_{\text{high}} = +85^\circ\text{C}$
 LM2904/A/E: $T_{\text{low}} = -40^\circ\text{C}$, $T_{\text{high}} = +105^\circ\text{C}$
 NCV2904 is qualified for automotive use.

LM358, LM358A, LM358E: $T_{\text{low}} = 0^\circ\text{C}$, $T_{\text{high}} = +70^\circ\text{C}$
 LM2904V & NCV2904: $T_{\text{low}} = -40^\circ\text{C}$, $T_{\text{high}} = +125^\circ\text{C}$

5. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V . The upper end of the common mode voltage range is $V_{CC} - 1.7\text{ V}$.
6. Short circuits from the output to V_{CC} can cause excessive heating and eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

LM258, LM358, LM358A, LM358E, LM2904, LM2904A, LM2904E, LM2904V, NCV2904

ELECTRICAL CHARACTERISTICS ($V_{CC} = 5.0\text{ V}$, $V_{EE} = \text{Gnd}$, $T_A = 25^\circ\text{C}$, unless otherwise noted.)

| Characteristic | Symbol | LM2904/LM2904E | | | LM2904A | | | LM2904V, NCV2904 | | | Unit |
|---|--------------------------|-----------------|----------------|-------------|-----------------|----------------|-------------|------------------|----------------|-------------|------------------------------|
| | | Min | Typ | Max | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage $V_{CC} = 5.0\text{ V}$ to 30 V , $V_{IC} = 0\text{ V}$ to $V_{CC} - 1.7\text{ V}$, $V_O \approx 1.4\text{ V}$, $R_S = 0\ \Omega$ $T_A = 25^\circ\text{C}$ $T_A = T_{\text{high}}$ (Note 7) $T_A = T_{\text{low}}$ (Note 7) | V_{IO} | - | 2.0 | 7.0 | - | 2.0 | 7.0 | - | - | 7.0 | mV |
| Average Temperature Coefficient of Input Offset Voltage $T_A = T_{\text{high}}$ to T_{low} (Note 7) | $\Delta V_{IO}/\Delta T$ | - | 7.0 | - | - | 7.0 | - | - | 7.0 | - | $\mu\text{V}/^\circ\text{C}$ |
| Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 7) | I_{IO} | - | 5.0 | 50 | - | 5.0 | 50 | - | 5.0 | 50 | nA |
| Input Bias Current $T_A = T_{\text{high}}$ to T_{low} (Note 7) | I_{IB} | - | -45 | -250 | - | -45 | -100 | - | -45 | -250 | nA |
| Average Temperature Coefficient of Input Offset Current $T_A = T_{\text{high}}$ to T_{low} (Note 7) | $\Delta I_{IO}/\Delta T$ | - | 10 | - | - | 10 | - | - | 10 | - | $\text{pA}/^\circ\text{C}$ |
| Input Common Mode Voltage Range (Note 8), $V_{CC} = 30\text{ V}$ $V_{CC} = 30\text{ V}$, $T_A = T_{\text{high}}$ to T_{low} | V_{ICR} | 0 | - | 28.3 | 0 | - | 28.3 | 0 | - | 28.3 | V |
| Differential Input Voltage Range | V_{IDR} | - | - | V_{CC} | - | - | V_{CC} | - | - | V_{CC} | V |
| Large Signal Open Loop Voltage Gain $R_L = 2.0\text{ k}\Omega$, $V_{CC} = 15\text{ V}$, For Large V_O Swing, $T_A = T_{\text{high}}$ to T_{low} (Note 7) | A_{VOL} | 25 15 | 100 - | - - | 25 15 | 100 - | - - | 25 15 | 100 - | - - | V/mV |
| Channel Separation $1.0\text{ kHz} \leq f \leq 20\text{ kHz}$, Input Referenced | CS | - | -120 | - | - | -120 | - | - | -120 | - | dB |
| Common Mode Rejection $R_S \leq 10\text{ k}\Omega$ | CMR | 50 | 70 | - | 50 | 70 | - | 50 | 70 | - | dB |
| Power Supply Rejection | PSR | 50 | 100 | - | 50 | 100 | - | 50 | 100 | - | dB |
| Output Voltage-High Limit $T_A = T_{\text{high}}$ to T_{low} (Note 7) $V_{CC} = 5.0\text{ V}$, $R_L = 2.0\text{ k}\Omega$, $T_A = 25^\circ\text{C}$ $V_{CC} = 30\text{ V}$, $R_L = 2.0\text{ k}\Omega$ $V_{CC} = 30\text{ V}$, $R_L = 10\text{ k}\Omega$ | V_{OH} | 3.3 26 27 | 3.5 - 28 | - - - | 3.3 26 27 | 3.5 - 28 | - - - | 3.3 26 27 | 3.5 - 28 | - - - | V |
| Output Voltage-Low Limit $V_{CC} = 5.0\text{ V}$, $R_L = 10\text{ k}\Omega$, $T_A = T_{\text{high}}$ to T_{low} (Note 7) | V_{OL} | - | 5.0 | 20 | - | 5.0 | 20 | - | 5.0 | 20 | mV |
| Output Source Current $V_{ID} = +1.0\text{ V}$, $V_{CC} = 15\text{ V}$ | I_{O+} | 20 | 40 | - | 20 | 40 | - | 20 | 40 | - | mA |
| Output Sink Current $V_{ID} = -1.0\text{ V}$, $V_{CC} = 15\text{ V}$ $V_{ID} = -1.0\text{ V}$, $V_O = 200\text{ mV}$ | I_{O-} | 10 - | 20 - | - - | 10 - | 20 - | - - | 10 - | 20 - | - - | mA μA |
| Output Short Circuit to Ground (Note 9) | I_{SC} | - | 40 | 60 | - | 40 | 60 | - | 40 | 60 | mA |
| Power Supply Current (Total Device) $T_A = T_{\text{high}}$ to T_{low} (Note 7) $V_{CC} = 30\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ $V_{CC} = 5\text{ V}$, $V_O = 0\text{ V}$, $R_L = \infty$ | I_{CC} | - - | 1.5 0.7 | 3.0 1.2 | - - | 1.5 0.7 | 3.0 1.2 | - - | 1.5 0.7 | 3.0 1.2 | mA |

7. LM258: $T_{\text{low}} = -25^\circ\text{C}$, $T_{\text{high}} = +85^\circ\text{C}$
 LM2904/A/E: $T_{\text{low}} = -40^\circ\text{C}$, $T_{\text{high}} = +105^\circ\text{C}$
 NCV2904 is qualified for automotive use.

LM358, LM358A, LM358E: $T_{\text{low}} = 0^\circ\text{C}$, $T_{\text{high}} = +70^\circ\text{C}$
 LM2904V & NCV2904: $T_{\text{low}} = -40^\circ\text{C}$, $T_{\text{high}} = +125^\circ\text{C}$

8. The input common mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common mode voltage range is $V_{CC} - 1.7\text{ V}$.

9. Short circuits from the output to V_{CC} can cause excessive heating and eventual destruction. Destructive dissipation can result from simultaneous shorts on all amplifiers.

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

CIRCUIT DESCRIPTION

The LM358 series is made using two internally compensated, two-stage operational amplifiers. The first stage of each consists of differential input devices Q20 and Q18 with input buffer transistors Q21 and Q17 and the differential to single ended converter Q3 and Q4. The first stage performs not only the first stage gain function but also performs the level shifting and transconductance reduction functions. By reducing the transconductance, a smaller compensation capacitor (only 5.0 pF) can be employed, thus saving chip area. The transconductance reduction is accomplished by splitting the collectors of Q20 and Q18. Another feature of this input stage is that the input common mode range can include the negative supply or ground, in single supply operation, without saturating either the input devices or the differential to single-ended converter. The second stage consists of a standard current source load amplifier stage.

Each amplifier is biased from an internal-voltage regulator which has a low temperature coefficient thus giving each amplifier good temperature characteristics as well as excellent power supply rejection.

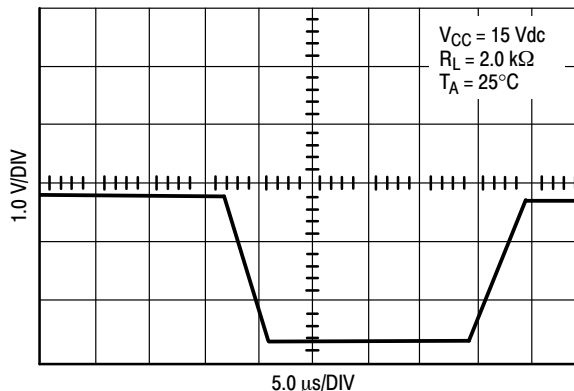


Figure 3. Large Signal Voltage Follower Response

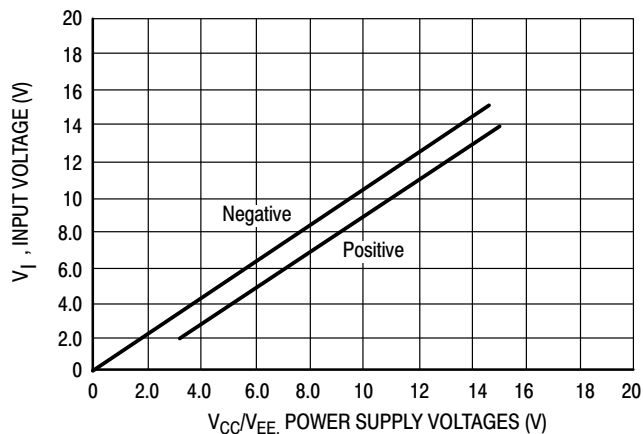


Figure 4. Input Voltage Range

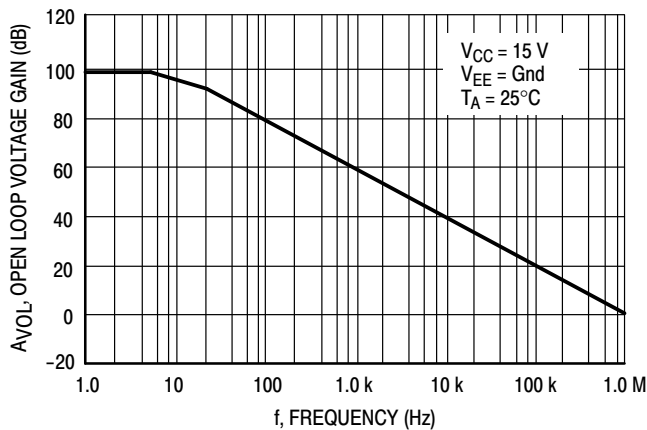


Figure 5. Large-Signal Open Loop Voltage Gain

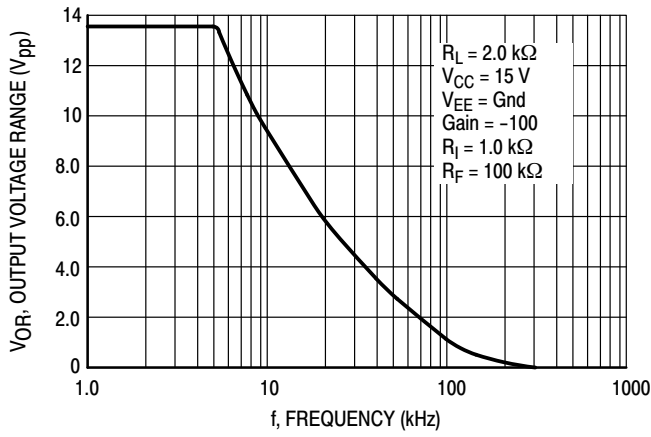


Figure 6. Large-Signal Frequency Response

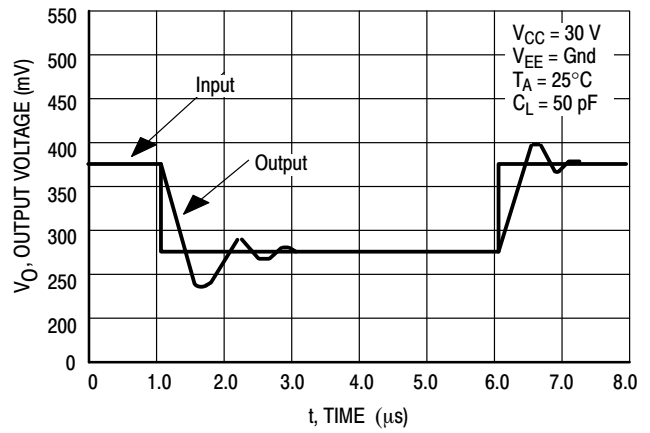


Figure 7. Small Signal Voltage Follower Pulse Response (Noninverting)

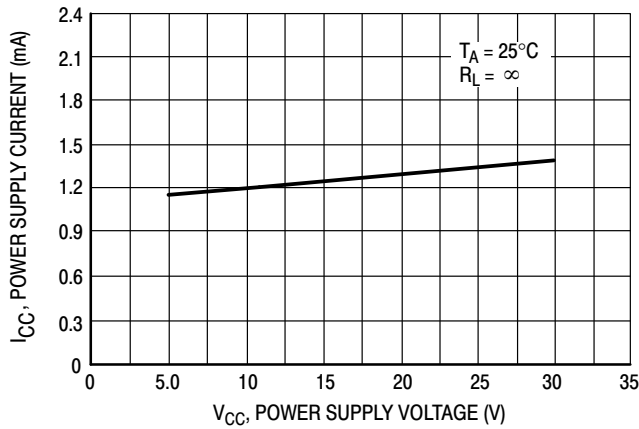


Figure 8. Power Supply Current versus Power Supply Voltage

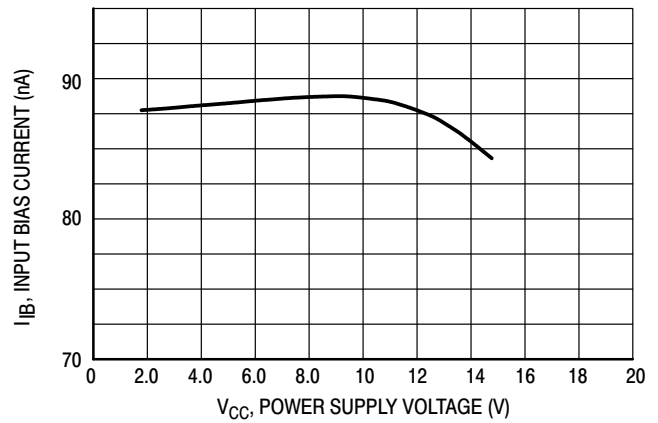


Figure 9. Input Bias Current versus Supply Voltage

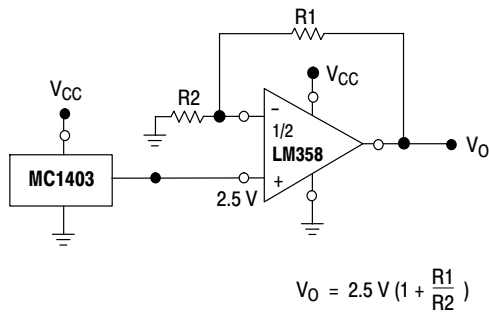


Figure 10. Voltage Reference

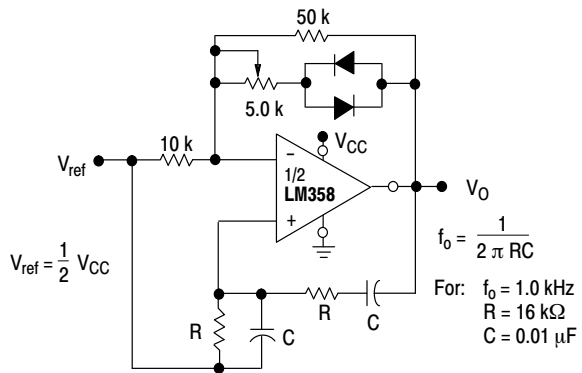


Figure 11. Wien Bridge Oscillator

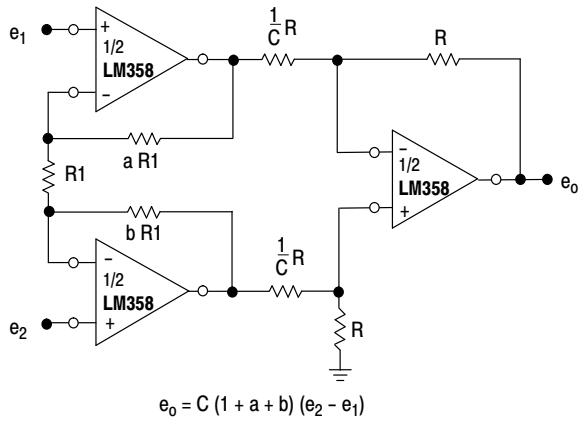


Figure 12. High Impedance Differential Amplifier

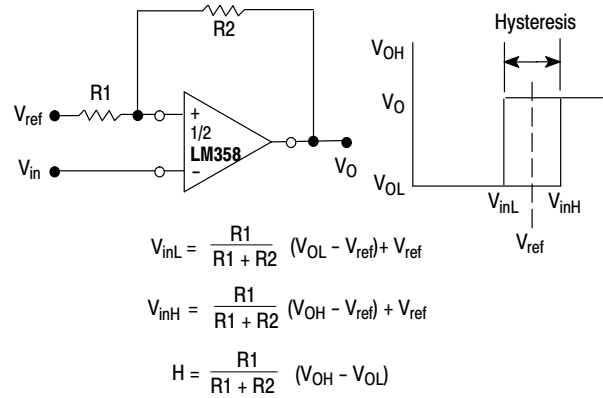


Figure 13. Comparator with Hysteresis

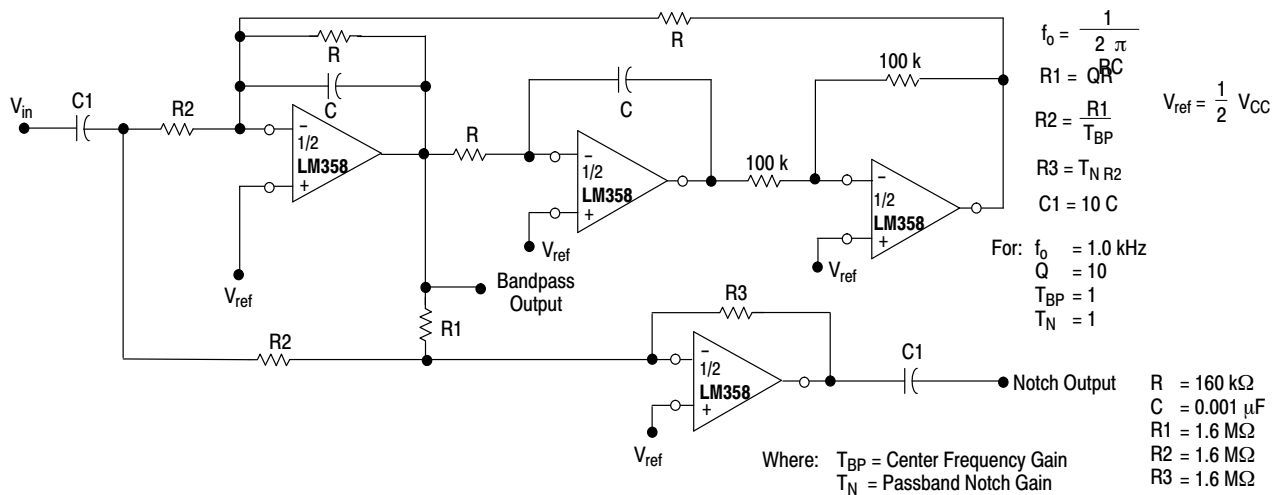


Figure 14. Bi-Quad Filter

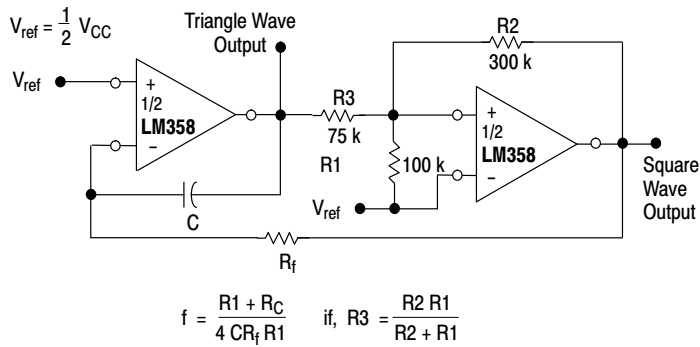
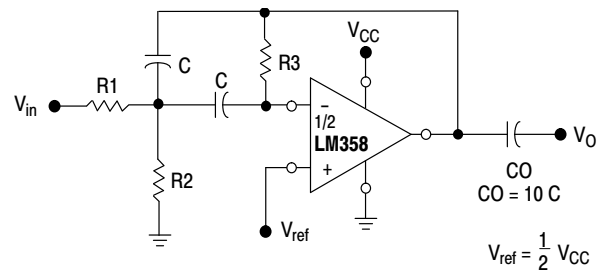


Figure 15. Function Generator



Given: f_0 = center frequency
 $A(f_0)$ = gain at center frequency

Choose value f_0, C

Then: $R3 = \frac{Q}{\pi f_0 C}$

$R1 = \frac{R3}{2 A(f_0)}$

$R2 = \frac{R1 R3}{4Q^2 R1 - R3}$

For less than 10% error from operational amplifier. $\frac{Q_0 f_0}{BW} < 0.1$

Where f_0 and BW are expressed in Hz.

If source impedance varies, filter may be preceded with voltage follower buffer to stabilize filter parameters.

Figure 16. Multiple Feedback Bandpass Filter

LM258, LM358, LM358A, LM358E, LM2904, LM2904A, LM2904E, LM2904V, NCV2904

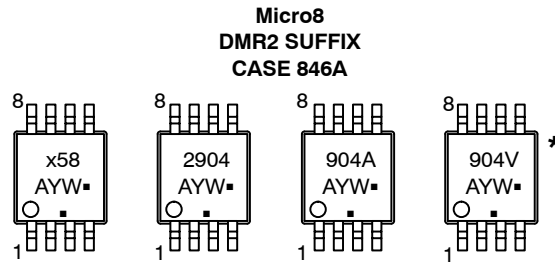
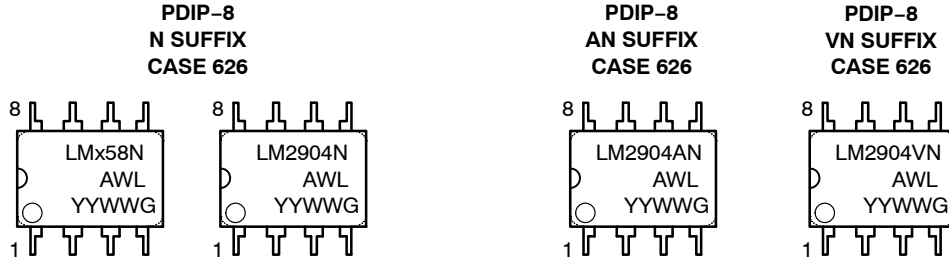
ORDERING INFORMATION

| Device | Operating Temperature Range | Package | Shipping [†] |
|---------------|-----------------------------|---------------------|-----------------------|
| LM358ADR2G | 0°C to +70°C | SOIC-8 (Pb-Free) | 2500 / Tape & Reel |
| LM358DG | | | 98 Units / Rail |
| LM358DR2G | | | 2500 / Tape & Reel |
| LM358EDR2G | | SOIC-8 (Pb-Free) | 2500 / Tape & Reel |
| LM358DMR2G | | Micro8 (Pb-Free) | 4000 / Tape & Reel |
| LM358NG | | PDIP-8 (Pb-Free) | 50 Units / Rail |
| LM258DG | -25°C to +85°C | SOIC-8 (Pb-Free) | 98 Units / Rail |
| LM258DR2G | | | 2500 / Tape & Reel |
| LM258DMR2G | | Micro8 (Pb-Free) | 4000 / Tape & Reel |
| LM258NG | | PDIP-8 (Pb-Free) | 50 Units / Rail |
| LM2904DG | -40°C to +105°C | SOIC-8 (Pb-Free) | 98 Units / Rail |
| LM2904DR2G | | | 2500 / Tape & Reel |
| LM2904EDR2G | | SOIC-8 (Pb-Free) | 2500 / Tape & Reel |
| LM2904DMR2G | | Micro8 (Pb-Free) | 2500 / Tape & Reel |
| LM2904NG | | PDIP-8 (Pb-Free) | 50 Units / Rail |
| LM2904ADMG | | Micro8 (Pb-Free) | 4000 / Tape & Reel |
| LM2904ADMR2G | | | 4000 / Tape & Reel |
| LM2904ANG | | PDIP-8 (Pb-Free) | 50 Units / Rail |
| LM2904VDG | -40°C to +125°C | SOIC-8 (Pb-Free) | 98 Units / Rail |
| LM2904VDR2G | | | 2500 / Tape & Reel |
| LM2904VDMR2G | | Micro8 (Pb-Free) | 4000 / Tape & Reel |
| LM2904VNG | | PDIP-8 (Pb-Free) | 50 Units / Rail |
| NCV2904DR2G* | | SOIC-8 (Pb-Free) | 2500 / Tape & Reel |
| NCV2904DMR2G* | | Micro8 (Pb-Free) | 4000 / 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.

*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable.

MARKING DIAGRAMS

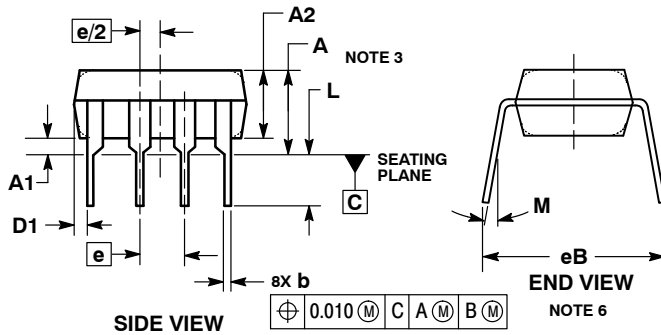
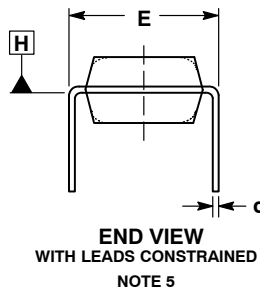
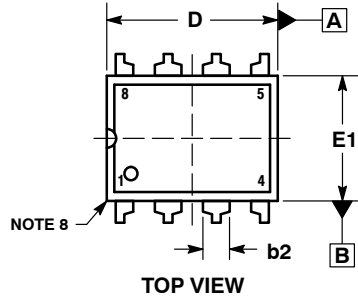


- x = 2 or 3
- A = Assembly Location
- WL, L = Wafer Lot
- YY, Y = Year
- WW, W = Work Week
- G = Pb-Free Package
- = Pb-Free Package – (Note: Microdot may be in either location)

*This diagram also applies to NCV2904

PACKAGE DIMENSIONS

PDIP-8
N, AN, VN SUFFIX
CASE 626-05
ISSUE P



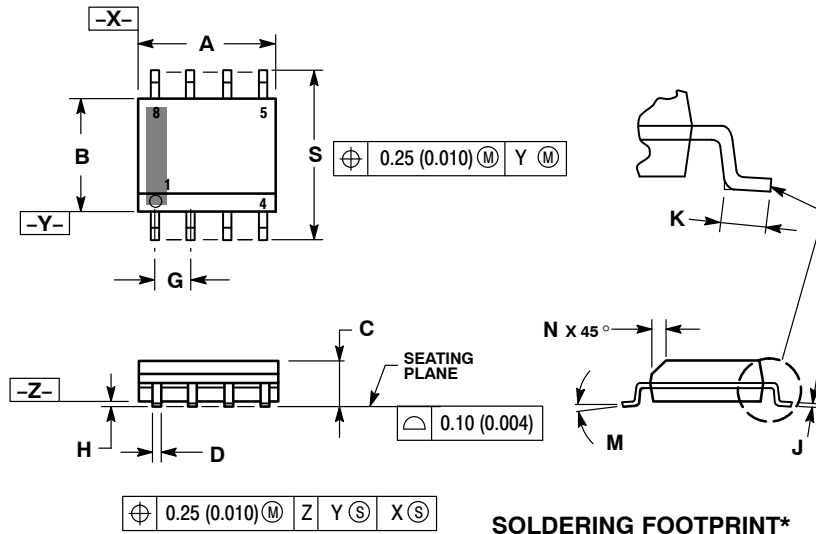
NOTES:

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).

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

PACKAGE DIMENSIONS

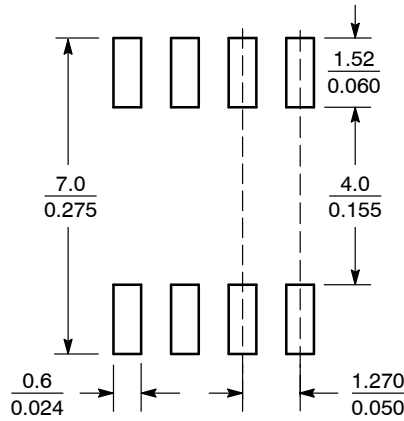
SOIC-8 NB
CASE 751-07
ISSUE AK



- 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 |

SOLDERING FOOTPRINT*

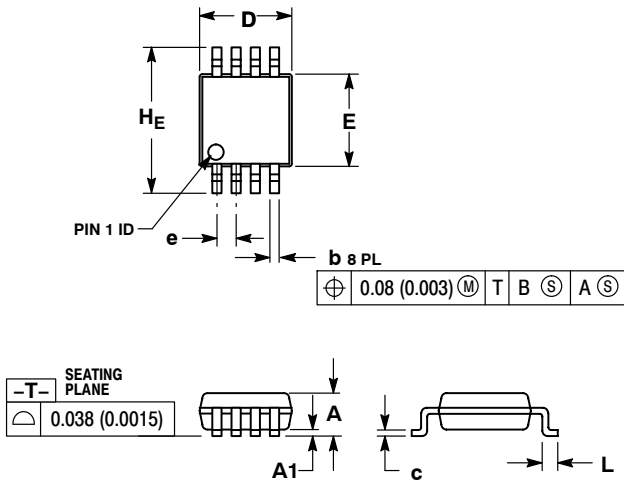


SCALE 6:1 ($\frac{\text{mm}}{\text{inches}}$)

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

PACKAGE DIMENSIONS

Micro8™
CASE 846A-02
ISSUE J

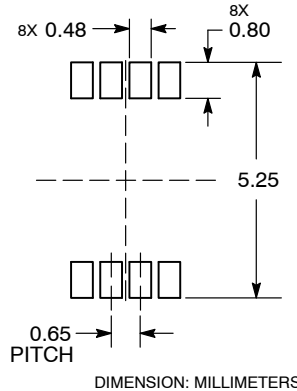


NOTES:

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, PROTRUSIONS 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. 846A-01 OBSOLETE, NEW STANDARD 846A-02.

| DIM | MILLIMETERS | | | INCHES | | |
|-----|-------------|------|------|-----------|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | --- | --- | 1.10 | --- | --- | 0.043 |
| A1 | 0.05 | 0.08 | 0.15 | 0.002 | 0.003 | 0.006 |
| b | 0.25 | 0.33 | 0.40 | 0.010 | 0.013 | 0.016 |
| c | 0.13 | 0.18 | 0.23 | 0.005 | 0.007 | 0.009 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| e | 0.65 BSC | | | 0.026 BSC | | |
| L | 0.40 | 0.55 | 0.70 | 0.016 | 0.021 | 0.028 |
| HE | 4.75 | 4.90 | 5.05 | 0.187 | 0.193 | 0.199 |

RECOMMENDED
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.

Micro8 is a trademark of International Rectifier.

ON Semiconductor and are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910

ON Semiconductor Website: www.onsemi.com
Order Literature: <http://www.onsemi.com/orderlit>

For additional information, please contact your local Sales Representative

Looking for pricing, stock, or lifecycle information?

Click below to explore more details on WIN SOURCE:

- ⊖ [View LM2904VN](#) on WIN SOURCE
- ⊖ [ON Semiconductor](#) Information

Optimize Your Supply Chain with WIN SOURCE Solutions

- ✓ Global Sourcing Solution
- ✓ Obsolete Management
- ✓ Cost Control Management
- ✓ Shortage Management
- ✓ Alternative Solution
- ✓ Excess Inventory Management