

# MC13159

## Advance Information

### Wideband FM IF Subsystem

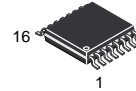
The MC13159 is a wideband FM IF subsystem that is designed for high performance data and digital applications. Excellent high frequency performance is achieved, with low cost, through the use of Motorola's RF bipolar process. The MC13159 includes a mixer, local oscillator buffer amplifier, IF amplifier, limiter amplifier and RSSI functions. The mixer is useful for a 240 MHz input used in a single-ended/balanced differential configuration. The IF and limiter amplifier are separated so that an external filter can be used in series, or connected directly with an external capacitor. The RSSI output is derived by summing the output of both the IF and Limiter sections. An enable control is provided to power down the IC for power management in battery powered applications.

Suitable applications include PHS, DECT, PDC, and PCS telephones, wideband wireless data links, and other battery powered radio systems.

- Designed for PHS Applications
- 2.7 to 5.5 V Operating Voltage
- Low Drain Current: 5.5 mA (Typ)
- Wide Input Dynamic Range of Mixer (Maximum -16 dBm Input)
- Enable Function for Power Down Mode
- Over 80 dB of RSSI Dynamic Range (AC Coupling between IF Amplifier and Limiter Amplifier)
- Few External Components Required

### WIDEBAND FM IF SUBSYSTEM FOR PHS AND DIGITAL APPLICATIONS

#### SEMICONDUCTOR TECHNICAL DATA

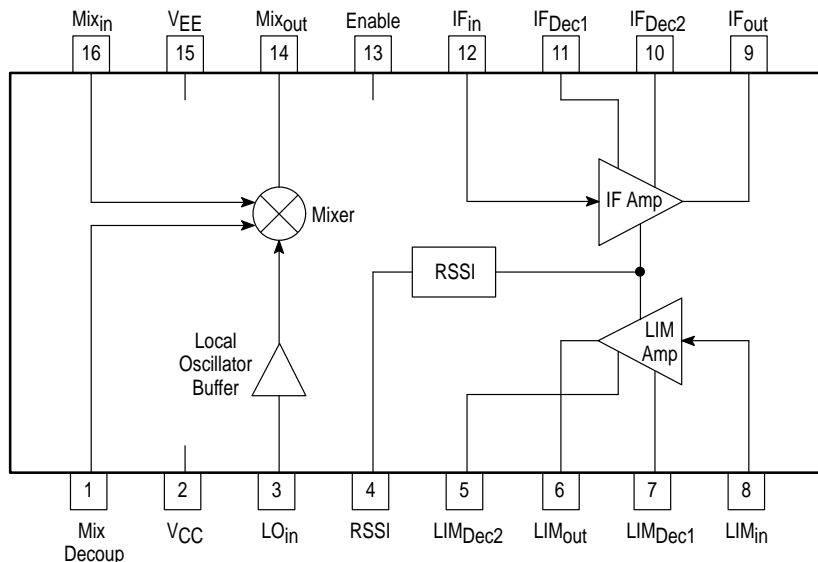


**DTB SUFFIX**  
PLASTIC PACKAGE  
CASE 948F  
(TSSOP-16)

#### ORDERING INFORMATION

| Device     | Operating Temperature Range    | Package  |
|------------|--------------------------------|----------|
| MC13159DTB | T <sub>A</sub> = -30° to +85°C | TSSOP-16 |

**Simplified Block Diagram**



This device contains 164 active transistors.

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## MAXIMUM RATINGS

| Rating                    | Symbol       | Value       | Unit |
|---------------------------|--------------|-------------|------|
| Power Supply Voltage      | $V_{S(max)}$ | 6.0         | Vdc  |
| Junction Temperature      | $T_{Jmax}$   | 150         | °C   |
| Storage Temperature Range | $T_{stg}$    | -65 to +150 | °C   |

NOTE: ESD data available upon request.

## RECOMMENDED OPERATING CONDITIONS

| Rating                            | Symbol   | Value      | Unit |
|-----------------------------------|----------|------------|------|
| Power Supply Voltage              | $V_S$    | 2.7 to 5.5 | Vdc  |
| Input Frequency                   | $f_{in}$ | 10 to 600  | MHz  |
| Ambient Temperature Range         | $T_A$    | -30 to +85 | °C   |
| Input Signal Level at Local Input | $V_{in}$ | -10        | dBm  |

## DC ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , $V_S = 3.0\text{ V}$ ; No Input Signal)

| Characteristics       | Conditions   | Symbol    | Min | Typ | Max | Unit          |
|-----------------------|--------------|-----------|-----|-----|-----|---------------|
| Total Drain Current 1 | Active Mode  | $I_{CC1}$ | 4.5 | 5.5 | 7.5 | mA            |
| Total Drain Current 2 | Disable Mode | $I_{CC2}$ | -   | 0.1 | 10  | $\mu\text{A}$ |

## AC ELECTRICAL CHARACTERISTICS

| Characteristics | Conditions | Symbol | Min | Typ | Max | Unit |
|-----------------|------------|--------|-----|-----|-----|------|
|-----------------|------------|--------|-----|-----|-----|------|

### MIXER ( $T_A = 25^\circ\text{C}$ ; $V_S = 3.0$ ; $f_{RF} = 240\text{ MHz}$ , $f_{LO} = 229.3\text{ MHz}$ )

|                           |  |                |         |            |         |                         |
|---------------------------|--|----------------|---------|------------|---------|-------------------------|
| Mixer Conversion Gain     | 50 $\Omega$ Termination<br>Input Matched | -              | 11<br>- | 14<br>21   | 17<br>- | dB                      |
| Noise Figure              | Input Matched                            | NF             | -       | 14         | -       | dB                      |
| Mixer Input Impedance     | Single-Ended                             | $R_p$<br>$C_p$ | -<br>-  | 400<br>4.0 | -<br>-  | $\Omega$<br>$\text{pF}$ |
| Mixer Output Impedance    | -  | -              | -       | 330        | -       | $\Omega$                |
| 1.0 dB Gain Compression   | @ $Mix_{in}$                             | $V_{icp}$      | -       | -16        | -       | dBm                     |
| 3rd Order Input Intercept | 50 $\Omega$ Termination                  | IIP3           | -       | -8.0       | -       | dBm                     |

### IF AMPLIFIER SECTION ( $T_A = 25^\circ\text{C}$ ; $V_S = 3.0\text{ V}$ ; $f_{IF} = 10.7\text{ MHz}$ )

|                  |                       |   |    |     |    |          |
|------------------|-----------------------|---|----|-----|----|----------|
| IF Gain          | $f = 10.7\text{ MHz}$ | - | 32 | 36  | 45 | dB       |
| Input Impedance  | -                     | - | -  | 330 | -  | $\Omega$ |
| Output Impedance | -                     | - | -  | 330 | -  | $\Omega$ |

### LIMITING AMPLIFIER SECTION ( $T_A = 25^\circ\text{C}$ ; $V_S = 3.0\text{ V}$ ; $f_{IF} = 10.7\text{ MHz}$ )

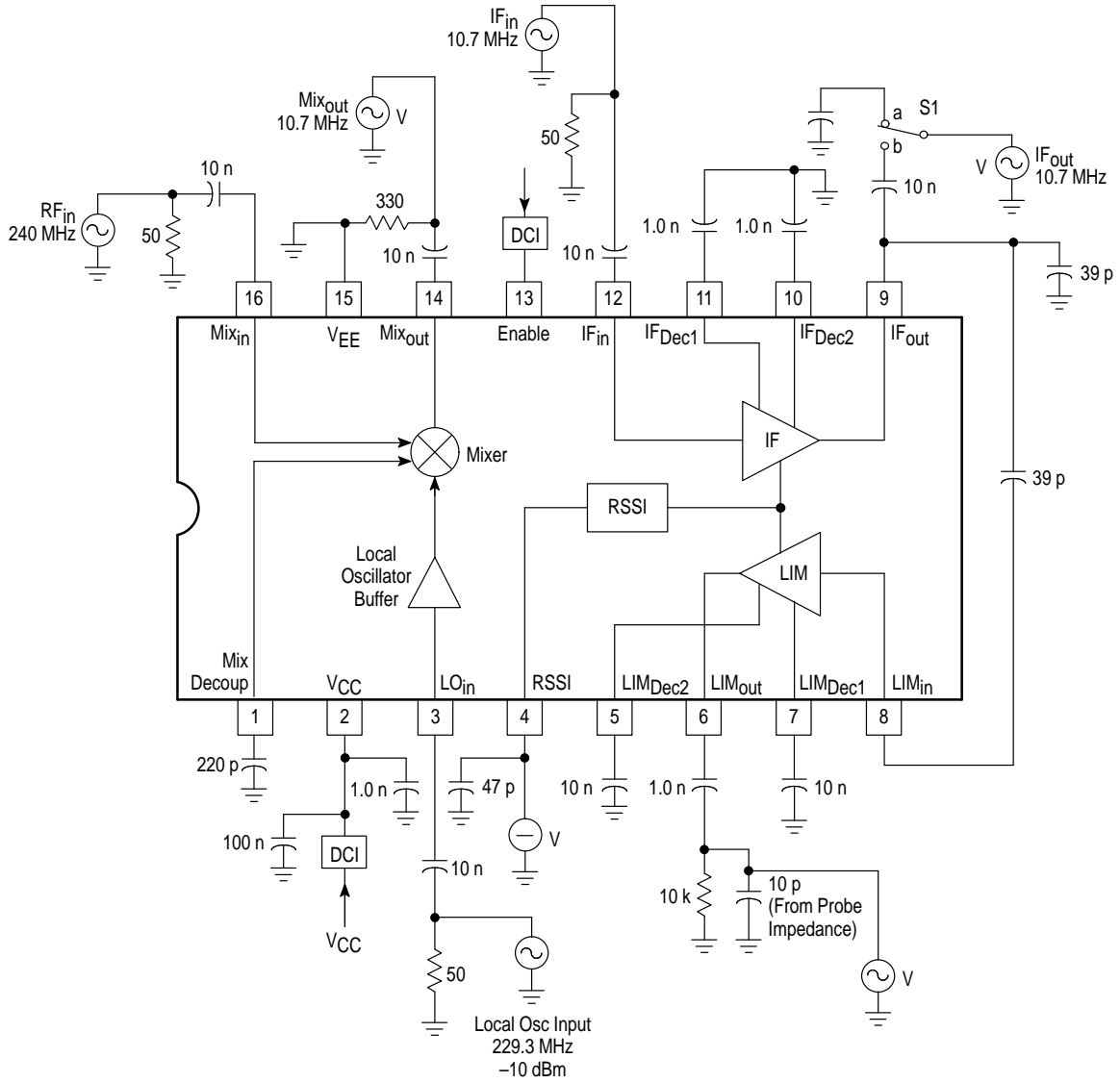
|                  |                       |   |     |     |     |          |
|------------------|-----------------------|---|-----|-----|-----|----------|
| Limiter Gain     | $f = 10.7\text{ MHz}$ | - | -   | 70  | -   | dB       |
| Input Impedance  | -                     | - | -   | 330 | -   | $\Omega$ |
| Output Swing     | -                     | - | 400 | 500 | 600 | mVpp     |
| Output Rise Time | -                     | - | -   | 10  | -   | ns       |
| Output Fall Time | -                     | - | -   | 20  | -   | ns       |

### RSSI SECTION ( $T_A = 25^\circ\text{C}$ ; $V_S = 3.0\text{ V}$ ; $f_{IF} = 10.7\text{ MHz}$ )

|                          |                           |   |      |      |      |       |
|--------------------------|---------------------------|---|------|------|------|-------|
| RSSI Slope               | -                         | - | 10   | 14   | 18   | mV/dB |
| RSSI Output DC Voltage 1 | No Input Signal           | - | 0.8  | 0.9  | 1.0  | V     |
| RSSI Output DC Voltage 2 | $V_{IF} = -85\text{ dBm}$ | - | 0.82 | 0.95 | 1.02 | V     |
| RSSI Output DC Voltage 3 | $V_{IF} = -80\text{ dBm}$ | - | 0.85 | 1.0  | 1.15 | V     |
| RSSI Output DC Voltage 4 | $V_{IF} = -40\text{ dBm}$ | - | 1.4  | 1.5  | 1.6  | V     |
| RSSI Output DC Voltage 5 | $V_{in} = 0\text{ dBm}$   | - | 1.95 | 2.1  | 2.25 | V     |

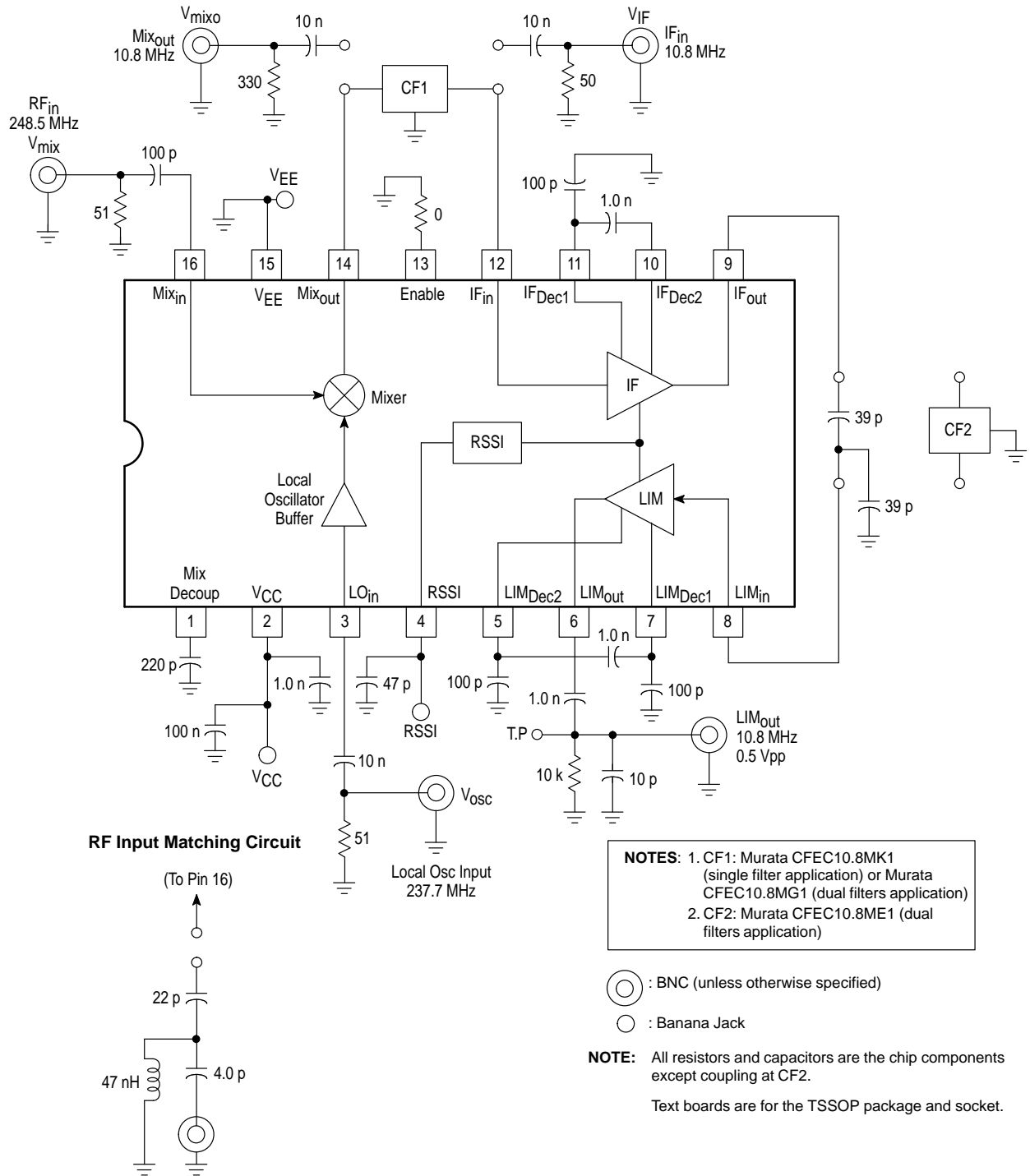
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Figure 1. Test Circuit



# MC13159

Figure 2. Test Circuit for Evaluation



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## PIN FUNCTION DESCRIPTION

| Pin    | Symbol                                     | Internal Equivalent Circuit | Description  |
|--------|--|-----------------------------|--|
| 1      | Mix Decoup                                 |                             | <b>Mixer Decoupling</b><br>Mixer decoupling pin. 220 pF is decoupled to the RF ground. This pin also can be used for differential input with Mix <sub>in</sub> .   |
| 16     | Mix <sub>in</sub>                          |                             | <b>Mixer Input</b><br>Input impedance is about 400 Ω at 240 MHz. Single-ended matching section at 240 MHz is referenced at application circuit.                    |
| 2      | V <sub>CC</sub>                            |                             | <b>Supply Voltage</b><br>Supply voltage range is from 2.7 Vdc to 5.5 Vdc. 1.0 nF of decoupling capacitor is placed directly at this pin to reduce the floor noise. |
| 3      | LO <sub>in</sub>                           |                             | <b>Local Oscillator Input</b><br>Connected to external local oscillator. Input impedance is about 900 Ω at 230 MHz.  |
| 4      | RSSI                                       |                             | <b>RSSI</b><br>The RSSI current creates a voltage drop across an internal 15 kΩ resistor.  |
| 5<br>7 | LIM <sub>Dec2</sub><br>LIM <sub>Dec1</sub> |                             | <b>Limiter Decoupling</b><br>Limiter decoupling pins. Decoupling capacitors are connected to the RF ground, and one is placed between Dec1 and Dec2.               |
| 8      | LIM <sub>in</sub>                          |                             | <b>Limiter Input</b><br>The input impedance is 330 Ω; it matches the 330 input resistance of a 10.7/10.8 MHz ceramic filter.                                       |
| 6      | LIM <sub>out</sub>                         |                             | <b>Limiter Output</b><br>The output level is about 0.5 V <sub>pp</sub> .   |

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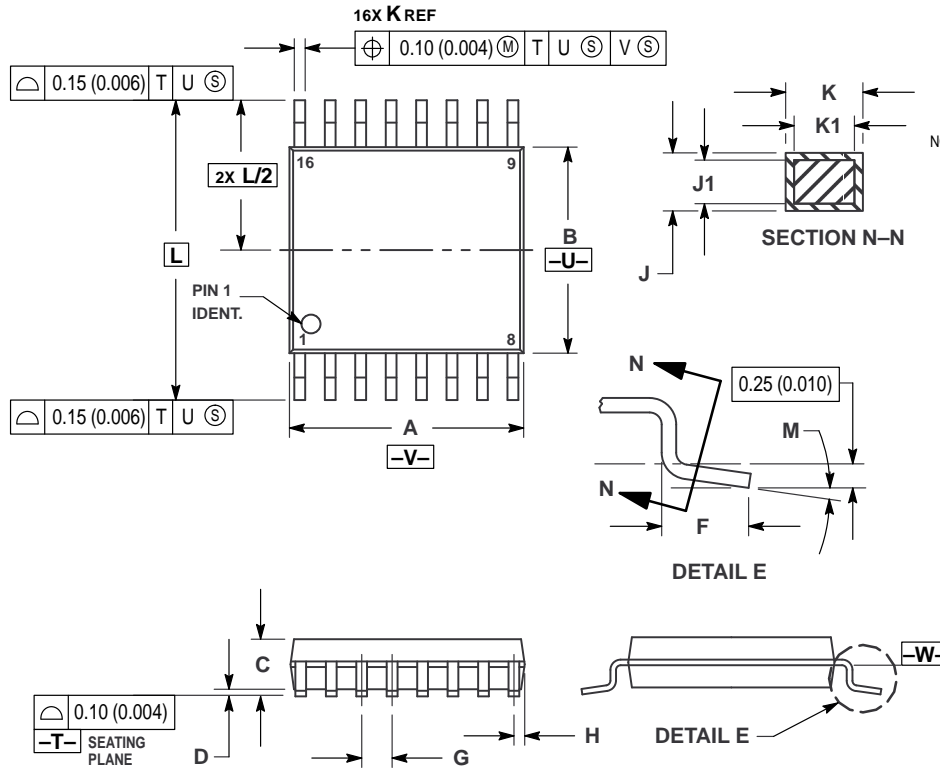
## PIN FUNCTION DESCRIPTION (continued)

| Pin      | Symbol                                   | Internal Equivalent Circuit | Description  |
|----------|--|-----------------------------|--|
| 9        | IF <sub>out</sub>                        |                             | <b>IF Output</b><br>The output impedance is 330 Ω; it matches the 330 input resistance of a 10.7/10.8 MHz ceramic filter.                          |
| 10<br>11 | IF <sub>Dec2</sub><br>IF <sub>Dec1</sub> |                             | <b>IF Decoupling</b><br>IF decoupling pins. Decoupling capacitor is connected from Dec1 to the RF ground, and one is placed between Dec1 and Dec2. |
| 12       | IF <sub>in</sub>                         |                             | <b>IF Input</b><br>The input impedance is 330 Ω; it matches the 330 input resistance of a 10.7/10.8 MHz ceramic filter.                            |
| 13       | Enable                                   |                             | <b>Enable</b><br>The IC regulators are enabled by placing this pin at VEE.   |
| 14       | Mix <sub>out</sub>                       |                             | <b>Mixer Output</b><br>The mixer output impedance is 330 Ω; it matches the 330 input resistance of a 10.7/10.8 MHz ceramic filter.                 |
| 15       | V <sub>EE</sub>                          |                             | <b>Supply Ground</b>   |

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## OUTLINE DIMENSIONS


DTB SUFFIX  
PLASTIC PACKAGE  
CASE 948F-01  
(TSSOP-16)  
ISSUE O



### 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-.

| DIM | MILLIMETERS |      | INCHES    |       |
|-----|-------------|------|-----------|-------|
|     | 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   | 0.18        | 0.28 | 0.007     | 0.011 |
| 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°    |

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