# MIC5307

## 300mA Micropower µCap Baseband LDO

## General Description

The MIC5307 is a micropower, µCap low dropout regulator designed for optimal performance where smaller packages are required. It is capable of sourcing 300mA of output current while only drawing 20µA of operating current. This high performance LDO offers fast transient response and good PSRR while consuming a minimum of current.

Ideal for battery operated applications; the MIC5307 offers 1% initial accuracy, extremely low dropout voltage and is equipped with a TTL logic compatible enable pin. The MIC5307 can be put into a zero-off-mode current state, drawing no current when disabled.

The MIC5307 is a µCap design, operating with very small ceramic output capacitors for stability, reducing required board space and component cost.

The MIC5307 is available in fixed output voltages in the Thin SOT23-5 package and the 6-pin 2mm x 2mm Thin MLF® package.

Data sheets and support documentation can be found on Micrel's web site at www.micrel.com.

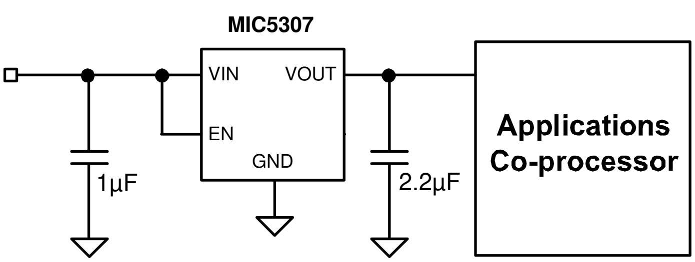
## Features

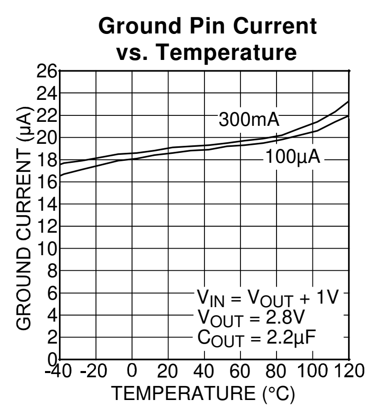
- Input voltage range: 2.4V to 5.5V
- Ultra-low IQ: Only 20µA operating current
- Stable with ceramic output capacitor
- Low dropout voltage of 120mV @ 300mA
- High output accuracy
  - ±1.0% initial accuracy
  - ±2.0% over temperature
- Thermal Shutdown Protection
- Current Limit Protection

## Applications

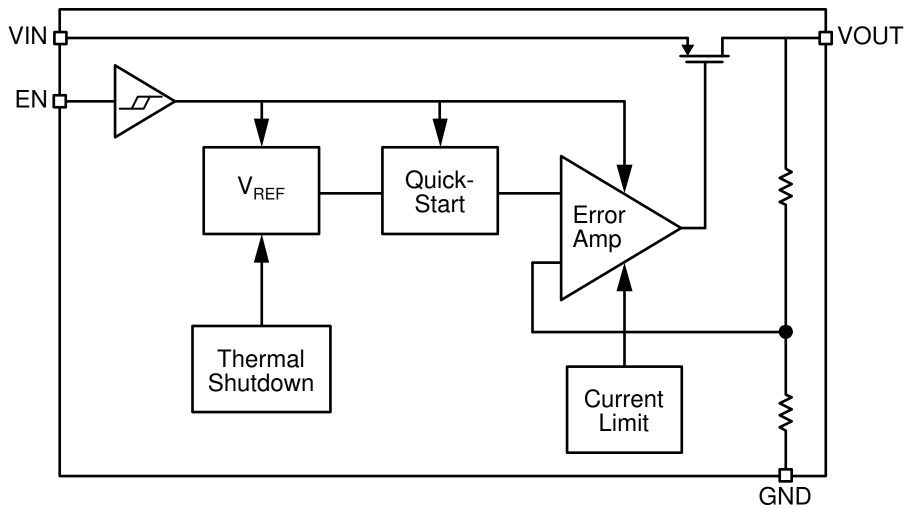
- Digital Logic Power Supply
- Stand-by power supply
- Cellular phones
- PDAs
- Portable electronics
- Notebook PCs

## Typical Application



## Block Diagram



## Ordering Information[1]

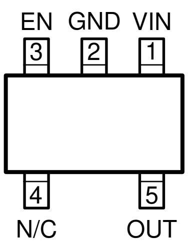
| Part Number | Marking Code | Voltage | Temperature Range | Package | Lead Finish |
|---|---|---|---|---|---|
| MIC5307-1.5YD5 | QQ15* | 1.5V | –40°C to +125°C | 5-Pin TSOT23 | Pb-Free |
| MIC5307-1.8YD5 | QQ18* | 1.8V | –40°C to +125°C | 5-Pin TSOT23 | Pb-Free |
| MIC5307-2.8YD5 | QQ28* | 2.8V | –40°C to +125°C | 5-Pin TSOT23 | Pb-Free |
| MIC5307-3.0YD5 | QQ30* | 3.0V | –40°C to +125°C | 5-Pin TSOT23 | Pb-Free |
| MIC5307-2.8YMT | Q28** | 2.8V | –40°C to +125°C | 6-Pin 2mm x 2mm Thin MLF® | Pb-Free |

**Notes**

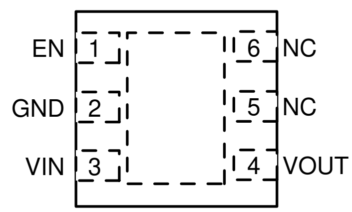
* Underbar ( _ ) symbol may not be to scale.

** 2x2mm Thin MLF® is a GREEN RoHS compliant package. Lead finish is NiPdAu. Mold compound is Halogen Free.

## Pin Configuration




**MIC5307-x.xYD5**
**5-Pin Thin SOT23 (D5)**




**MIC5307-x.xYMT**
**6-Pin 2mm x 2mm Thin MLF® (MT)**

## Pin Description

| Pin Number TSOT23 | Pin Number Thin MLF® | Pin Name | Pin Function |
|---|---|---|---|
| 1 | 3 | VIN | Supply Input |
| 2 | 2 | GND | Ground |
| 3 | 1 | EN | Enable Input. Active High. High = on, low = off. Do not leave floating |
| 4 | 5 | NC | No Connect |
| 5 | 4 | VOUT | Output Voltage |
| – | 6 | NC | No Connect |

## Absolute Maximum Ratings[1]

Supply Voltage ($V_{IN}$) .............................................. 0V to 6V
Enable Input Voltage ($V_{EN}$) .................................... 0V to 6V
Power Dissipation ($P_D$)[3] ........................... Internally Limited
Junction Temperature ($T_J$) ........................ –40°C to +125°C
Lead Temperature (soldering, 5sec.) ......................... 260°C
Storage Temperature ($T_s$) ......................... –65°C to +150°C
ESD Rating[4] .................................................................. 2kV

## Operating Ratings[2]

Supply voltage ($V_{IN}$) ...................................... 2.4V to +5.5V
Enable Input Voltage ............................................. 0V to $V_{IN}$
Junction Temperature ($T_J$) ........................ –40°C to +125°C
Thermal Resistance
TSOT23-5 ($\theta_{JA}$) ................................................ 235°C/W
2x2 Thin MLF-6 ($\theta_{JA}$) ........................................ 93°C/W

## Electrical Characteristics[5]

$V_{IN} = V_{OUT} + 1.0V$; $C_{OUT} = 2.2\mu F$; $I_{OUT} = 100\mu A$; $T_J = 25°C$, **bold** values indicate –40°C to +125°C, unless noted.

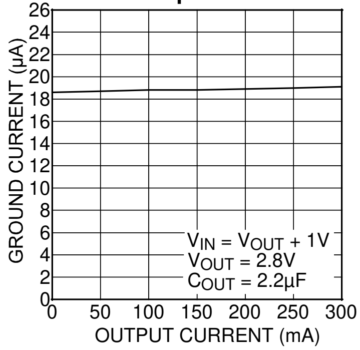
| Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Output Voltage Accuracy | Variation from nominal $V_{OUT}$ | –1 | | +1 | % |
| | Variation from nominal $V_{OUT}$; –40°C to +125°C | **–2** | | **+2** | % |
| Line Regulation | $V_{IN} = V_{OUT}$ +1V to 5.5V | | 0.01 | 0.3<br>**0.5** | %/V<br>%/V |
| Load Regulation | $I_{OUT}$ = 100µA to 300mA | | 0.5 | 1<br>**1.5** | %<br>% |
| Dropout Voltage[4] | $I_{OUT}$ = 50mA<br>$I_{OUT}$ = 100mA<br>$I_{OUT}$ = 150mA<br>$I_{OUT}$ = 300mA | | 20<br>40<br>60<br>120 | <br><br><br>**250** | mV<br>mV<br>mV<br>mV |
| Ground Pin Current | $I_{OUT}$ = 0mA to 150mA; $V_{IN}$ = 5.5V<br>$I_{OUT}$ = 0mA to 300mA; $V_{IN}$ = 5.5V | | 18<br>20 | <br>**30** | µA<br>µA |
| Ground Pin Current in Shutdown | $V_{EN} \leq 0.2V$; $V_{IN}$ = 5.5V | | 0.01 | **1** | µA |
| Ripple Rejection | f = 10Hz to 1kHz; $C_{OUT}$ = 2.2µF; $I_{OUT}$ = 300mA<br>f = 20kHz; $C_{OUT}$ = 2.2µF; $I_{OUT}$ = 300mA | | 62<br>35 | | dB<br>dB |
| Current Limit | $V_{OUT}$ = 0V | 350 | 500 | 800 | mA |
| Thermal Shutdown | | | 160 | | °C |
| Thermal Shutdown Hysteresis | | | 20 | | °C |
| Output Voltage Noise | $C_{OUT}$ = 2.2µF; 10Hz to 100kHz | | 80 | | $\mu V_{RMS}$ |
| **Enable Input** | | | | | |
| Enable Input Voltage | Logic Low | | | **0.2** | V |
| | Logic High | **1.0** | | | V |
| Enable Input Current | $V_{IL} \leq 0.2V$ | | 0.01 | **1** | µA |
| | $V_{IH} \geq 1.0V$ | | 0.01 | **1** | µA |
| Turn-on Time[6] | $C_{OUT}$ = 2.2µF | | 270 | **500** | µs |

Notes:

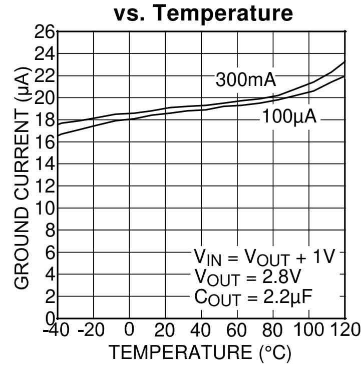
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. The maximum allowable power dissipation of any $T_A$ (ambient temperature) is $P_{D(max)} = T_{J(max)} – T_A / \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.
4. Devices are ESD sensitive. Handling precautions recommended.
5. Specification for packaged product only.
6. Turn-on time is measured from $V_{EN}$ = 1V of the positive edge of the enable signal to 90% of the rising edge of the output voltage of the regulator.

# Typical Characteristics

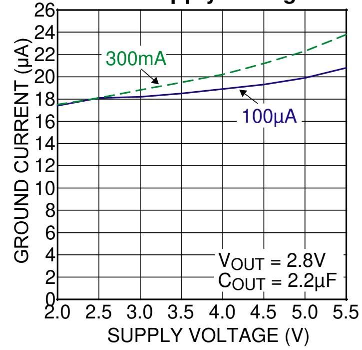
**Ground Pin Current vs. Output Current**



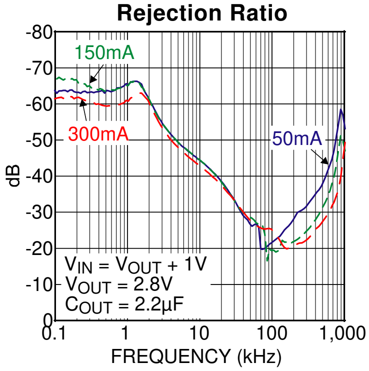

**Ground Pin Current vs. Temperature**



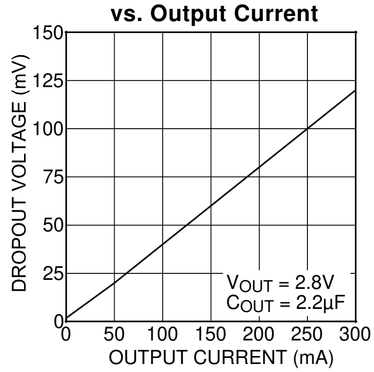

**Ground Pin Current vs. Supply Voltage**



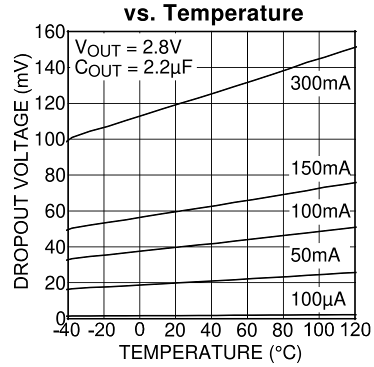

**Power Supply Rejection Ratio**



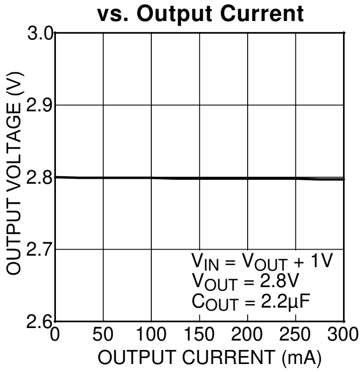

**Dropout Voltage vs. Output Current**



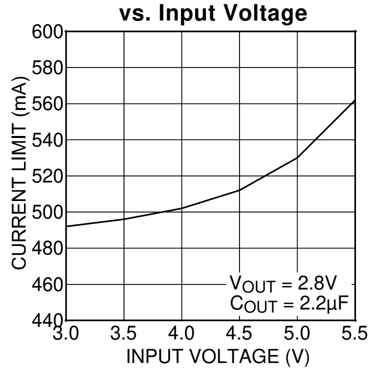

**Dropout Voltage vs. Temperature**



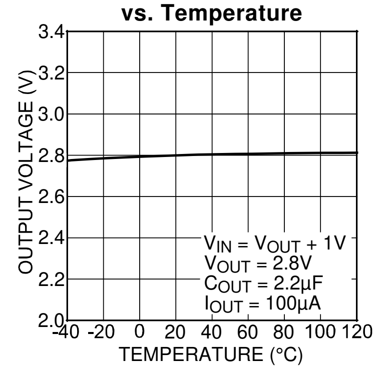

**Output Voltage vs. Output Current**



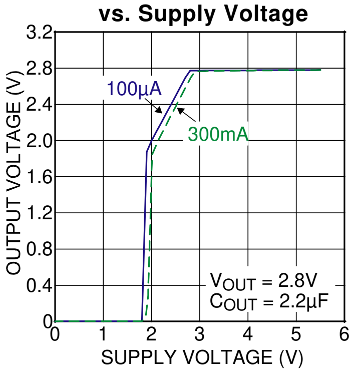

**Current Limit vs. Input Voltage**



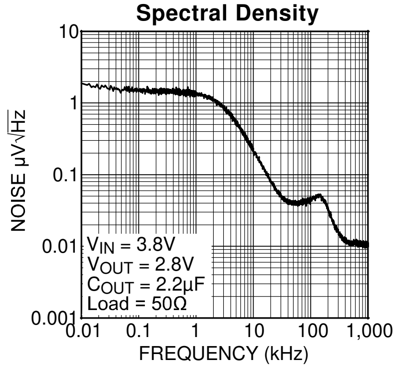

**Output Voltage vs. Temperature**




**Output Voltage vs. Supply Voltage**

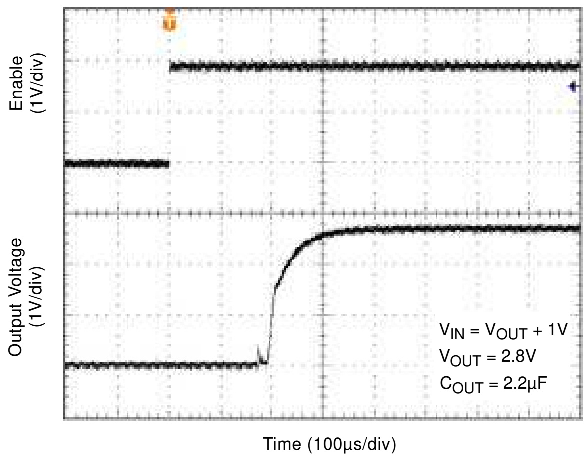



**Output Noise Spectral Density**

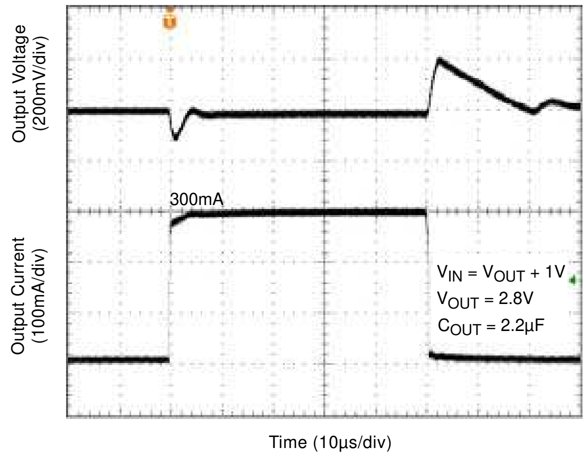


## Functional Characteristics

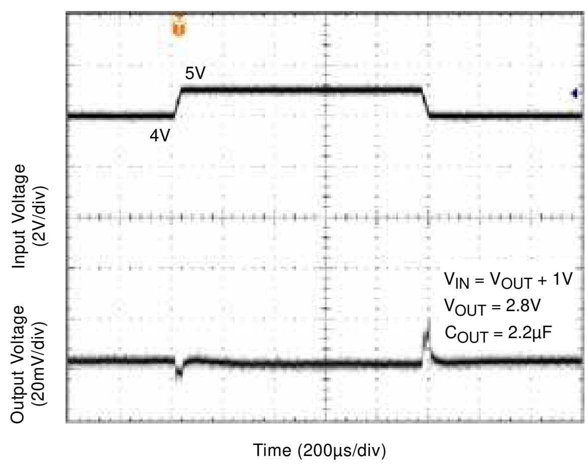
### Enable Turn-On




### Load Transient Response




### Line Transient Response



# Application Information

## Input Capacitance

A 1µF capacitor should be placed from IN to GND if there is more than 10 inches of wire between the input and the ac filter capacitor or if a battery is used as the input.

## Output Capacitance

The MIC5307 requires an output capacitor of 2.2µF or greater to maintain stability. The design is optimized for use with low-ESR ceramic chip capacitors. High ESR capacitors may cause high frequency oscillation. The output capacitor can be increased, but performance has been optimized for a 2.2µF ceramic output capacitor and does not improve significantly with larger capacitance.

X7R/X5R dielectric-type ceramic capacitors are recommended because of their temperature performance. X7R-type capacitors change capacitance by 15% over their operating temperature range and are the most stable type of ceramic capacitors. Z5U and Y5V dielectric capacitors change value by as much as 50% and 60%, respectively, over their operating temperature ranges. To use a ceramic chip capacitor with Y5V dielectric, the value must be much higher than an X7R ceramic capacitor to ensure the same minimum capacitance over the equivalent operating temperature range.

## Enable

Forcing EN (enable/shutdown) high (>1V) enables the regulator. EN is compatible with CMOS logic gates. If the enable/shutdown feature is not required, connect EN (pin 3) to IN (supply input, pin 1).

## Current Limit

There is overcurrent protection circuitry built into the MIC5307. Even with the output grounded, current will be limited to approximately 500mA. Further protection is provided by thermal shutdown.

## Thermal Considerations

The MIC5307 is designed to provide 300mA of continuous current in a very small package. Maximum ambient operating temperature can be calculated based on the output current and the voltage drop across the part. Given that the input voltage is 3.8V, the output voltage is 2.8V and the output current equals 300mA.

The actual power dissipation of the regulator circuit can be determined using the equation:

$$P_D = (V_{IN} - V_{OUT})\, I_{OUT} + V_{IN}\, I_{GND}$$

Because this device is CMOS and the ground current is typically < 50µA over the load range, the power dissipation contributed by the ground current is < 1% and can be ignored for this calculation.

$$P_D = (3.8V - 2.8V) \cdot 300mA$$

$$P_D = 0.3W$$

To determine the maximum ambient operating temperature of the package, use the junction-to-ambient thermal resistance of the device and the following basic equation:

$$P_D(max) = \frac{T_J(max) - T_A}{\theta_{JA}}$$

$T_J$(max) = 125°C, the maximum junction temperature of the die $\theta_{JA}$ thermal resistance = 235°C/W

Table 1 shows junction-to-ambient thermal resistance for the MIC5307 in the TSOT23-5 package.

| Package | $\theta_{JA}$ Recommended Minimum Footprint |
|---|---|
| TSOT23-5 | 235°C/W |

**Table 1. TSOT23-5 Thermal Resistance**

Substituting $P_D$ for $P_D$ (max) and solving for the ambient operating temperature will give the maximum operating conditions for the regulator circuit. The junction-to-ambient thermal resistance for the minimum footprint is 235°C/W, from Table 1. The maximum power dissipation must not be exceeded for proper operation.

For example, when operating the MIC5307-2.8 at an input voltage of 3.8V and 300mA load with a minimum footprint layout, the maximum ambient operating temperature $T_A$ can be determined as follows:

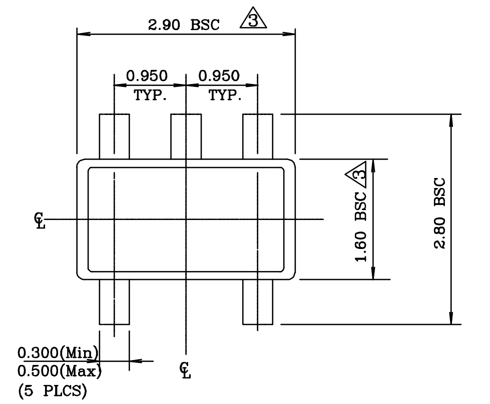
$$0.3W = (125°C - T_A) / 235C°/W$$

$$T_A = 54.5°C$$

Therefore, a 2.8V application at 300mA of output current can accept an ambient operating temperature of 89.8°C in a TSOT23-5 package. For a full discussion of heat sinking and thermal effects on voltage regulators, refer to the "Regulator Thermals" section of Micrel's *Designing with Low-Dropout Voltage Regulators* handbook. This information can be found on Micrel's website at:

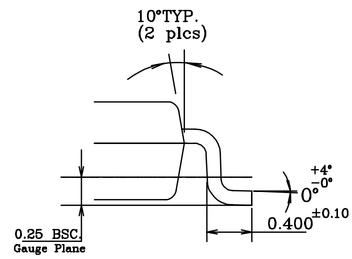
http://www.micrel.com/_PDF/other/LDOBk_ds.pdf

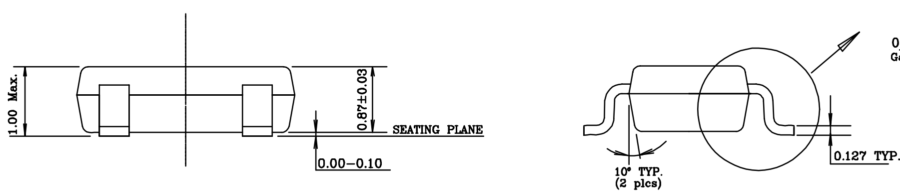
## Package Information



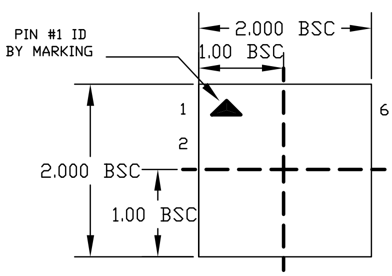

NOTE:

1. Dimensions and tolerances are as per ANSI Y14.5M, 1994.
2. Die is facing up for mold. Die is facing down for trim/form, ie. reverse trim/form.
3. Dimensions are exclusive of mold flash and gate burr.
4. The footlength measuring is based on the gauge plane method.
5. All specification comply to Jedec Spec MO193 Issue C.
6. All dimensions are in millimeters.

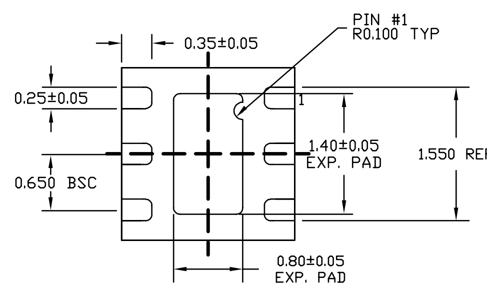


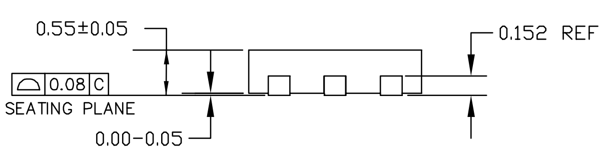

**5-Pin Thin SOT23 (D5)**




TOP VIEW




BOTTOM VIEW




SIDE VIEW

NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. MAX. PACKAGE WARPAGE IS 0.08 mm.
3. MAXIMUM ALLOWABE BURRS IS 0.076 mm IN ALL DIRECTIONS.
4. PIN #1 ID ON TOP WILL BE LASER MARKED.

**6-Pin 2mm x 2mm Thin MLF® (MT)**

**MICREL, INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA**
TEL +1 (408) 944-0800 FAX +1 (408) 474-1000 WEB http:/www.micrel.com