MIC5302

150mA ULDO™ in Ultra-Small 1.2mm x 1.6mm Thin MLF®

General Description

The MIC5302 is an ultra-small, ultra-low dropout CMOS regulator, ULDO™ that is ideal for today's most demanding portable applications including cellular phone RF power, camera modules, imaging sensors for digital still and video cameras, PDAs, portable media players (PMP) and PC cameras where board space is limited. It offers extremely-low dropout voltage, very-low output noise and can operate from a 2.3V to 5.5V input while delivering up to 150mA.

It offers 2% initial accuracy, low ground current (typically 85µA total), thermal- and current-limit protection. The MIC5302 can also be put into a zero-off-mode current state, drawing no current when disabled.

The MIC5302 is available in the ultra small 4-pin 1.2mm x 1.6mm Thin MLF® package, occupying only 1.92mm^2 of PCB area, a 50% reduction in board area compared to SC-70 and 2mm x 2mm MLF® packages. Its operating junction temperature range is –40°C to +125°C and is available in fixed output voltages in lead-free (RoHS compliant) Thin MLF® package.

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

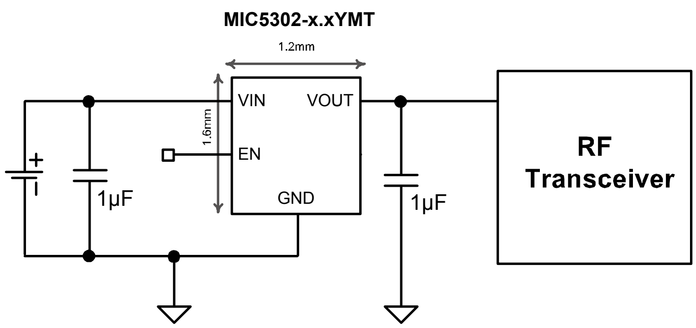
Features

- Ultra-small 1.2mm x 1.6mm Thin MLF® package
- Low dropout voltage: 50mV at 150mA
- Output noise 120µVrms
- Input voltage range: 2.3V to 5.5V
- 150mA guaranteed output current
- Stable with ceramic output capacitors
- Low quiescent current 85µA total
- 35µs turn-on time
- High output accuracy
  - ±2% initial accuracy
  - ±3% over temperature
- Thermal-shutdown and current-limit protection

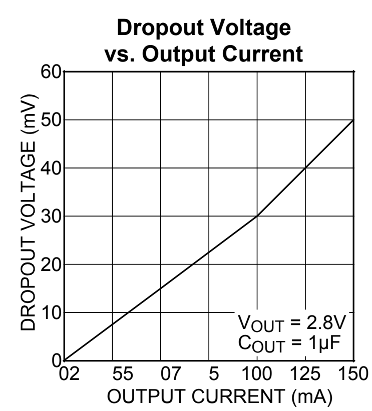
Applications

- Mobile Phones
- PDAs
- GPS Receivers
- Portable Media Players
- Portable Electronics
- Digital Still & Video Cameras

Typical Application



RF LDO Application



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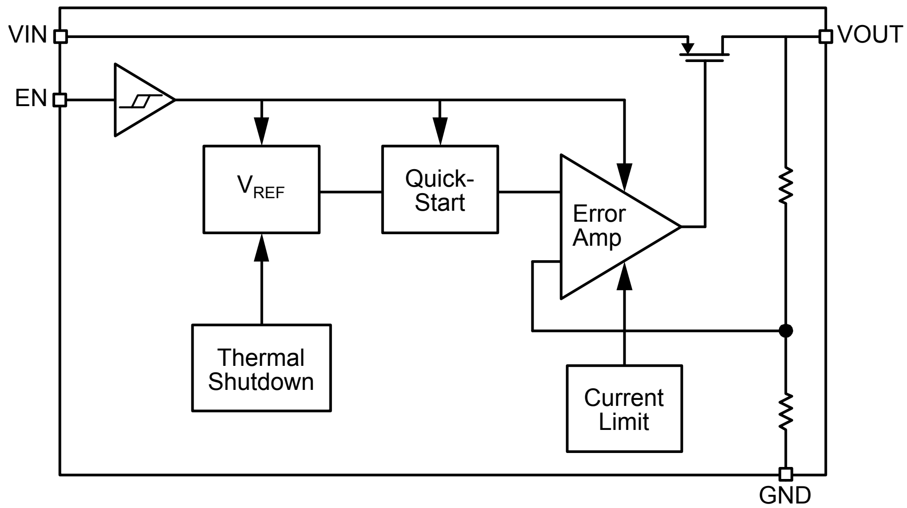
Block Diagram



MIC5302 Block Diagram

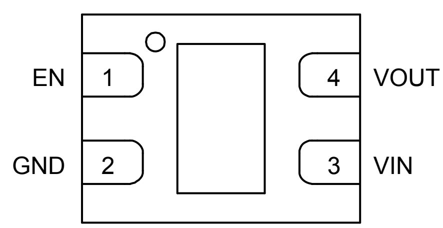
Ordering Information[1]

Part Number	Marking Code	Voltage	Temperature Range	Package	Lead Finish
MIC5302-1.3YMT	H13	1.3V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-1.5YMT	H15	1.5V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-1.8YMT	H18	1.8V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-2.1YMT	H21	2.1V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-2.5YMT	H25	2.5V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-2.6YMT	H26	2.6V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-2.8YMT	H28	2.8V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-2.85YMT	H2J	2.85V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-2.9YMT	H29	2.9V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-3.0YMT	H30	3.0V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-3.3YMT	H33	3.3V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free
MIC5302-4.6YMT	H46	4.6V	–40°C to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®	Pb-Free

Note:

1. Other voltages available. Contact Micrel Marketing for details.

Pin Configuration



4-Pin 1.2mm x 1.6mm Thin MLF® (MT)

Pin Description

Pin Number	Pin Name	Pin Function
1	EN	Enable Input. Active High. High = on, low = off. Do not leave floating.
2	GND	Ground
3	VIN	Supply Input
4	VOUT	Output Voltage
HS Pad	EPAD	Exposed heatsink pad connected to ground internally.

Absolute Maximum Ratings[1]

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

Operating Ratings[2]

Supply voltage (V_{IN}) .... +2.3V to +5.5V
Enable Input (V_{EN}) .... 0V to V_{IN}
Junction Temperature (T_A) .... –40°C to +125°C
Junction Thermal Resistance
Thin MLF® -4 (θ_{JA}) .... 173°C/W

Electrical Characteristics[4]

$V_{IN} = V_{OUT} + 1V$; $C_{OUT} = 1.0\mu F$; $I_{OUT} = 100\mu A$; $T_J = 25°C$, **bold** values indicate –40°C to +125°C, unless noted.

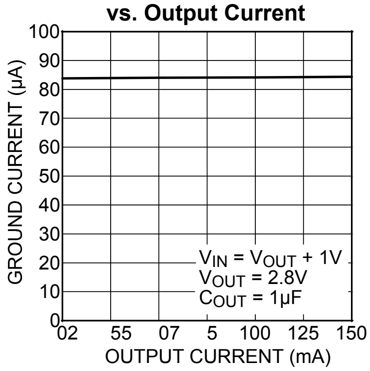
Parameter	Condition	Min	Typ	Max	Units
Output Voltage Accuracy	Variation from nominal V_{OUT}	–2		+2	%
	Variation from nominal V_{OUT}; –40°C to +125°C	**–3**		**+3**	%
Line Regulation	$V_{IN} = V_{OUT}$ +1V to 5.5V; $I_{OUT} = 100\mu A$		0.02	0.3 **0.6**	%/V
Load Regulation[5]	$I_{OUT} = 100\mu A$ to 150mA		0.5	**2.0**	%
Dropout Voltage[6]	$I_{OUT} = 100\mu A$ I_{OUT} = 50mA I_{OUT} = 100mA I_{OUT} = 150mA		0.1 15 30 50	 **35** **100**	mV mV mV mV
Ground Pin Current[7]	I_{OUT} = 0 to 150mA, EN = High		85	**120**	µA
Ground Pin Current in Shutdown	V_{EN} = 0V		0.1	2	µA
Ripple Rejection	f = up to 1kHz; $C_{OUT} = 1.0\mu F$ f = 1kHz – 20kHz; $C_{OUT} = 1.0\mu F$		65 42		dB dB
Current Limit	V_{OUT} = 0V	**250**	400	**725**	mA
Output Voltage Noise	C_{OUT} =1µF, 10Hz to 100kHz		120		μV_{RMS}
Enable Input					
Enable Input Voltage	Logic Low			**0.2**	V
	Logic High	**1.1**			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	$C_{OUT} = 1.0\mu F$		35	**100**	µs

Notes:

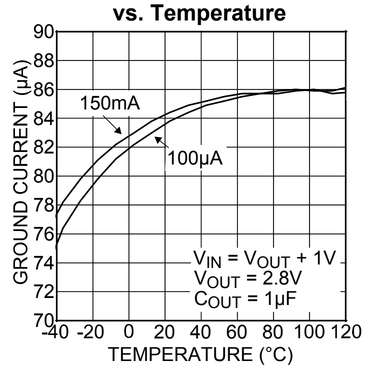
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. The maximum allowable power dissipation of any T_A (ambient temperature) is $P_{D(max)} = (T_{J(max)} - T_A) / \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.
4. Specification for packaged product only.
5. Regulation is measured at constant junction temperature using low duty cycle pulse testing, changes in output voltage due to heating effects are covered by the thermal regulation specification.
6. Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal value measured at 1V differential.
7. Ground pin current is the regulator quiescent current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

Typical Characteristics

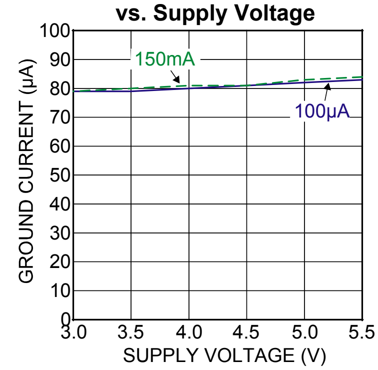
Ground Pin Current vs. Output Current



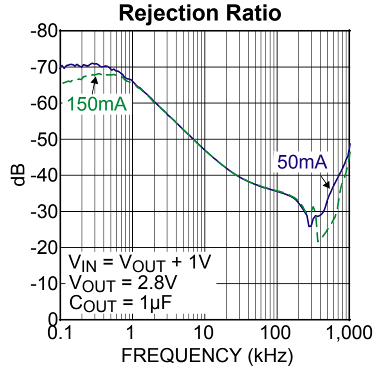
Ground Pin Current vs. Temperature



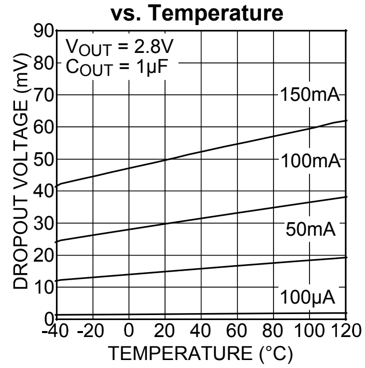
Ground Pin Current vs. Supply Voltage



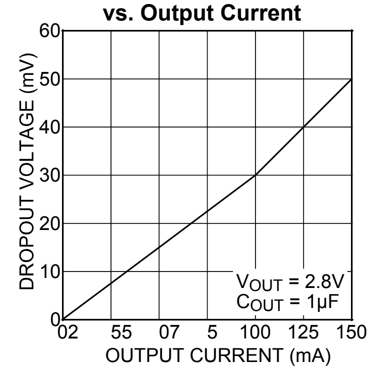
Power Supply Rejection Ratio



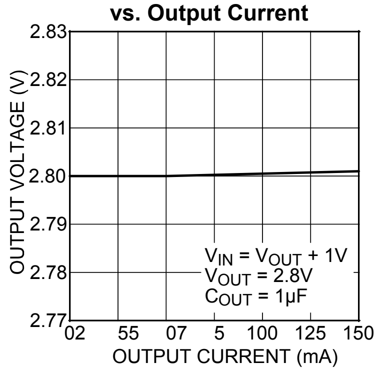
Dropout Voltage vs. Temperature



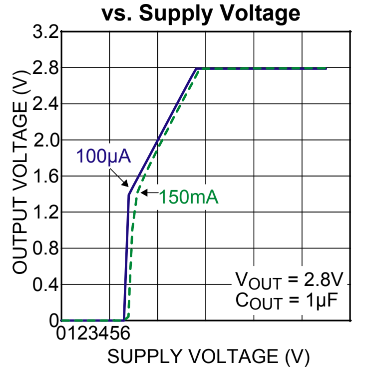
Dropout Voltage vs. Output Current



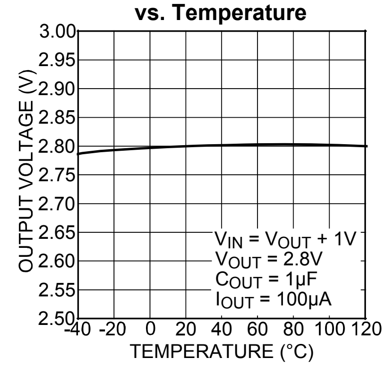
Output Voltage vs. Output Current



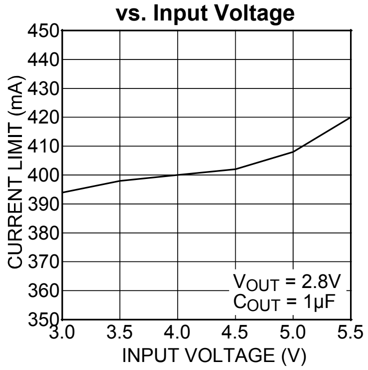
Output Voltage vs. Supply Voltage



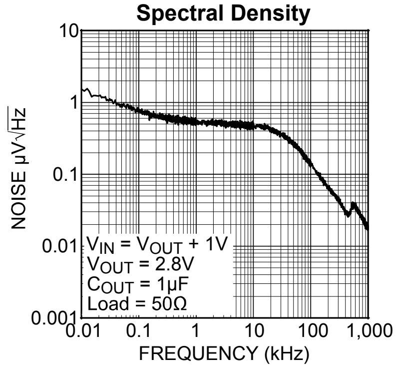
Output Voltage vs. Temperature



Current Limit vs. Input Voltage

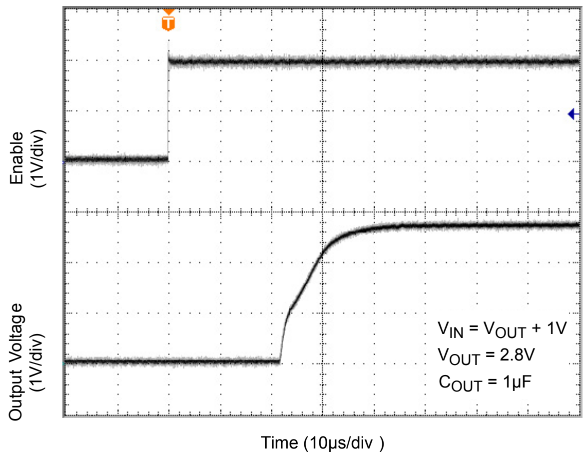


Output Noise Spectral Density

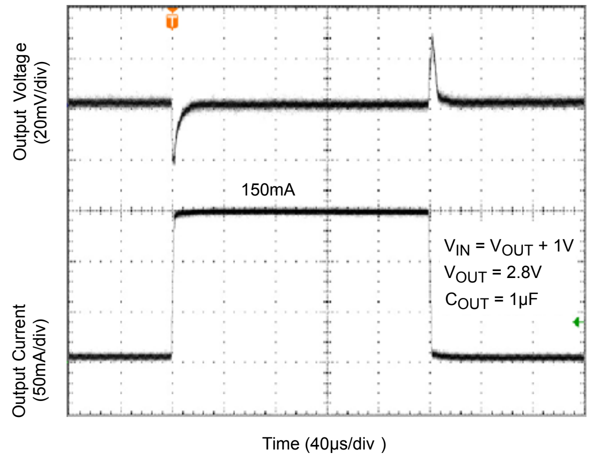


Functional Characteristics

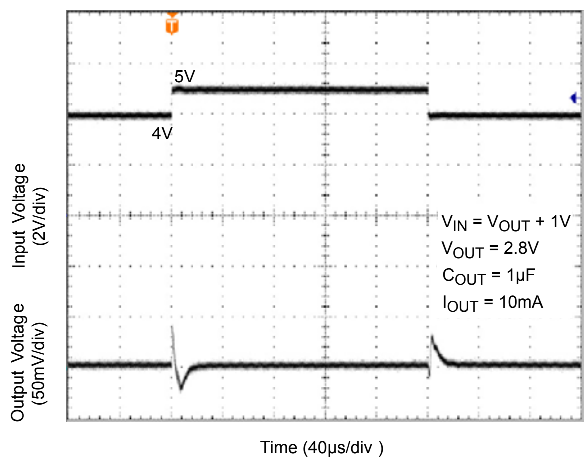
Enable Turn-On



Load Transient Response



Line Transient Response



Application Information

Enable/Shutdown

The MIC5302 comes with an active-high enable pin that allows the regulator to be disabled. Forcing the enable pin low disables the regulator and sends it into a “zero” off-mode-current state. In this state, current consumed by the regulator goes nearly to zero. Forcing the enable pin high enables the output voltage. The active-high enable pin uses CMOS technology and the enable pin cannot be left floating; a floating enable pin may cause an indeterminate state on the output.

Input Capacitor

The MIC5302 is a high-performance, high-bandwidth device. Therefore, it requires a well-bypassed input supply for optimal performance. A 1µF capacitor is required from the input-to-ground to provide stability. Low-ESR ceramic capacitors provide optimal performance at a minimum of space. Additional high-frequency capacitors, such as small-valued NPO dielectric-type capacitors, help filter out high-frequency noise and are good practice in any RF-based circuit.

Output Capacitor

The MIC5302 requires an output capacitor of 1µF 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 1µF 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.

No-Load Stability

Unlike many other voltage regulators, the MIC5302 will remain stable and in regulation with no load. This is especially important in CMOS RAM keep-alive applications.

Thermal Considerations

The MIC5302 is designed to provide 150mA of continuous current. 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 3.6V, the output voltage is 2.8V and the output current = 150mA.

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 <100µA over the load range, the power dissipation contributed by the ground current is < 1% and can be ignored for this calculation.

$$P_D = (3.6V - 2.8V) \times 150mA$$

$$P_D = 0.12W$$

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:

$$P_{D(MAX)} = \left(\frac{T_{J(MAX)} - T_A}{\theta_{JA}}\right)$$

$T_{J(max)}$ = 125°C, the maximum junction temperature of the die θ_{JA} thermal resistance = 173°C/W.

The table below shows junction-to-ambient thermal resistance for the MIC5302 in the 4-pin 1.2mm x 1.6mm MLF® package.

Package	θ_{JA} Recommended Minimum Footprint
4-Pin 1.2x1.6 MLF®	173°C/W

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 173°C/W.

The maximum power dissipation must not be exceeded for proper operation.

For example, when operating the MIC5302-2.8YML at an input voltage of 3.6V and 150mA load with a minimum footprint layout, the maximum ambient operating temperature T_A can be determined as follows:

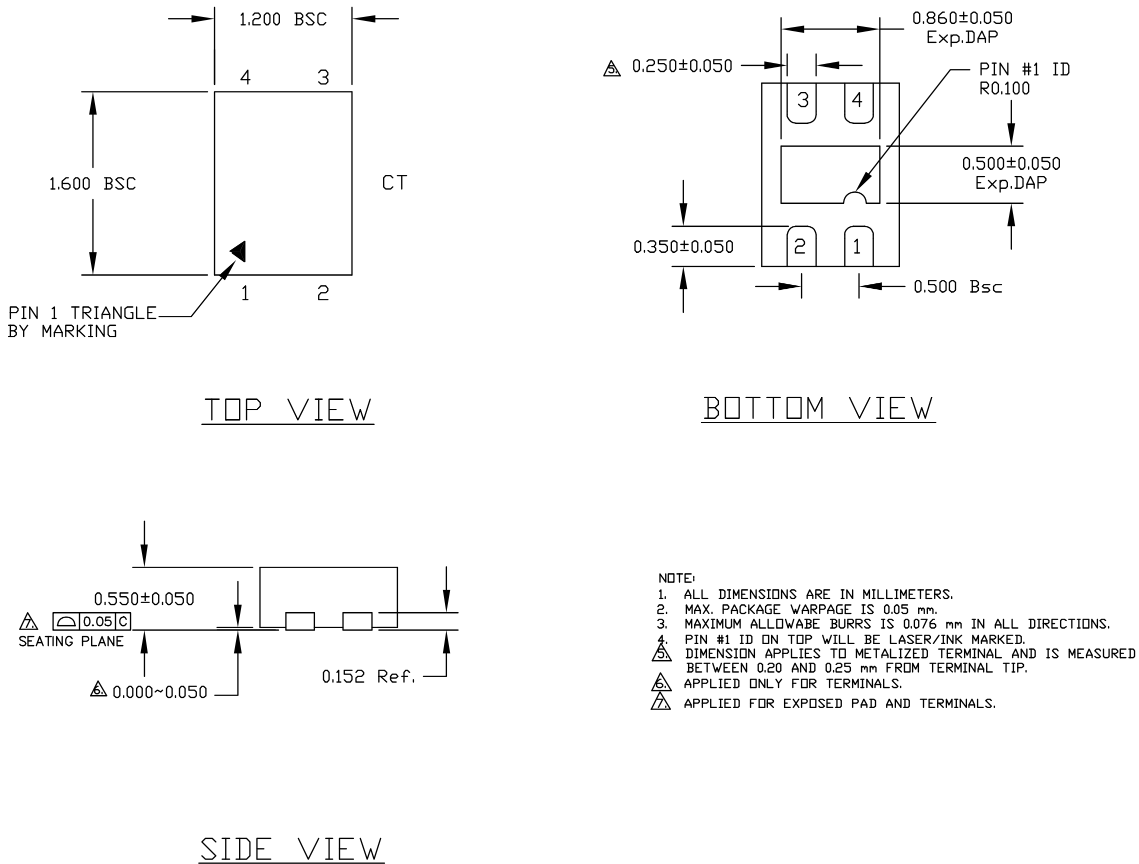
$$0.12W = (125°C - T_A)/(173°C/W)$$

$$T_A = 104°C$$

Therefore, a 2.8V application with 150mA of output current can accept an ambient operating temperature of 104°C in a 1.2mm x 1.6mm MLF® 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



4-Pin 1.2mm x 1.6mm Thin MLF® (MT)

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