MIC5337

1.2mm x 1.6mm 300mA Low I_Q LDO Ultra Low Dropout with Auto Discharge

General Description

The MIC5337 is a low quiescent current, low dropout regulator with an internal auto discharge feature designed for optimal performance in a small space. The MIC5337 is capable of sourcing 300mA of output current while only consuming 24µA of operating current. When the MIC5337 is disabled an internal resistive load is automatically applied to the output to discharge the output capacitor. This high performance LDO offers fast transient response as well as maintaining a high PSRR.

The MIC5337 is an ideal solution for battery operated applications due to ultra low operating current and extremely low dropout voltage of 180mV at 300mA. Equipped with a TTL logic compatible enable pin, the MIC5337 can be put into a zero-off-mode current state, drawing virtually no current when disabled.

Board space and component cost is minimized because the MIC5337 operates with very small 1µF ceramic capacitors, provides fixed output voltages, and is available in the tiny 1.2mm x 1.6mm Thin MLF package.

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

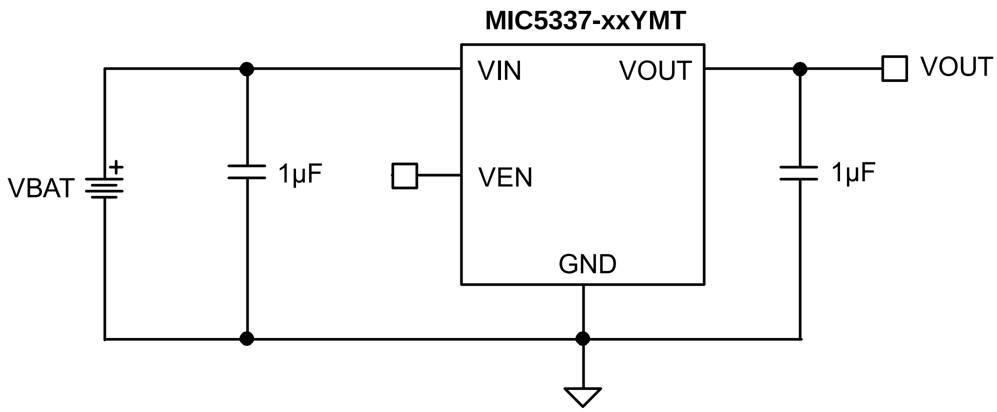
Features

- 300mA output current
- Low I_Q: only 24µA operating current
- Low dropout voltage of 180mV @ 300mA
- Active discharge when enable pin is low
- Input voltage range: 2.3V to 5.5V
- Fixed output voltages
- Stable with 1µF ceramic capacitors
- Thermal shutdown and current limit protection
- Tiny 4-pin 1.2mm x 1.6mm Thin MLF® package

Applications

- Mobile phones
- GPS and navigation devices
- Portable media players
- Digital still and video cameras
- PDAs
- Portable electronics

Typical Application



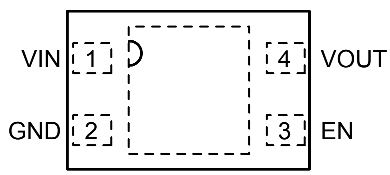
Ordering Information

Part Number	Marking[(1)]	Voltage[(2)]	Temperature Range	Package[(3)]
MIC5337-2.8YMT	281	2.8V	–40° to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®
MIC5337-1.8YMT	181	1.8V	–40° to +125°C	4-Pin 1.2mm x 1.6mm Thin MLF®

Note:

1. Pin 1 identifier= "▲".
2. For other voltage options contact Micrel Marketing.
3. MLF is a GREEN RoHS compliant package. Lead finish is NiPdAu, Mold compound is Halogen Free.

Pin Configuration



4-Pin 1.2mm x 1.6mm Thin MLF® (MT)

Pin Description

Pin Number	Pin Name	Pin Function
1	VIN	Supply Input.
2	GND	Ground.
3	EN	Enable Input: Active High Input. Logic High = On; Logic Low = Off. Do not leave floating.
4	VOUT	Output Voltage.
HS Pad	EPAD	Exposed heatsink pad connected to ground internally.

Absolute Maximum Ratings[1]

Supply Voltage (V_{IN}) .... –0.3V to +6V
Enable Voltage (V_{EN}). .... –0.3V to V_{IN}
Power Dissipation (P_D) .... Internally Limited[3]
Lead Temperature (soldering, 5µsec.) .... 260°C
Junction Temperature(T_J)………… ....-40°C to +125°C
Storage Temperature (T_s) ....–65°C to +150°C
ESD Rating[4] 2kV

Operating Ratings[2]

Supply Voltage (V_{IN}) .... +2.3V to 5.5V
Enable Voltage (V_{EN}). .... 0V to V_{IN}
Junction Temperature (T_J) ....–40°C to +125°C
Junction Thermal Resistance
1.2mm x 1.6mm Thin MLF-4 (θ_{JA}) ....173°C/W

Electrical Characteristics[5]

$V_{IN} = V_{EN} = V_{OUT}$ + 1V; C_{OUT} = 1µF; I_{OUT} = 100µA; T_J = 25°C, **bold** values indicate –40°C to +125°C, unless noted.

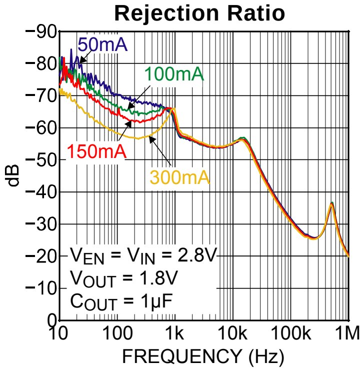
Parameter	Condition	Min	Typ	Max	Units
Output Voltage Accuracy	Variation from nominal V_{OUT}	–1.5		+1.5	%
	Variation from nominal V_{OUT}	**–2.0**		**+2.0**	%
Line Regulation	$V_{IN} = V_{OUT}$ +1V to 5.5V, I_{OUT} = 100µA		0.01	0.3	%/V
	$V_{IN} = V_{OUT}$ +1V to 5.5V, I_{OUT} = 100µA			**0.5**	%/V
Load Regulation[6]	I_{OUT} = 100µA to 300mA		0.05	**1**	%
Dropout Voltage[7]	I_{OUT} = 50mA		30		mV
	I_{OUT} = 100mA		60		mV
	I_{OUT} = 150mA		90	**150**	mV
	I_{OUT} = 300mA		180	**300**	mV
Ground Pin Current[8]	I_{OUT} = 100µA to 300mA		24	**35**	µA
Ground Pin Current in Shutdown	V_{EN} = 0V		0.01	1	µA
Ripple Rejection	f = 1kHz; C_{OUT} = 1µF; I_{OUT} = 300mA		65		dB
	f = 20kHz; C_{OUT} = 1µF; I_{OUT} = 300mA		50		dB
Current Limit	V_{OUT} = 0V	400	600	950	mA
Output Voltage Noise	C_{OUT} = 1µF, 10Hz to 100kHz		90		$µV_{RMS}$
Auto-Discharge NFET Resistance	V_{EN}=0V, V_{IN}=3.6V		280	400	Ω
Enable Voltage					
Enable Voltage	Logic Low			**0.2**	V
	Logic High	**1.2**			V
Enable Current	$V_{IL} \leq 0.2V$		0.01	**1**	µA
	$V_{IH} \geq 1.2V$		0.01	**1**	µA
Turn-on Time	C_{OUT} = 1µF; I_{OUT} = 300mA		150	**500**	µs

Notes:

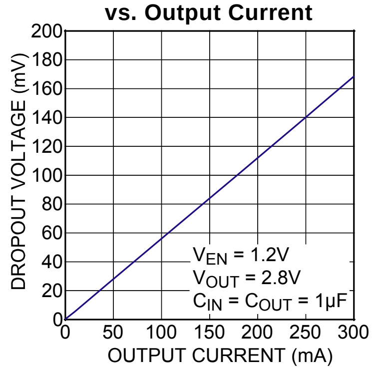
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. The maximum allowable power dissipation of any T_A (ambient temperature) is $P_{D(max)} = (T_{J(max)} - T_A) / \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature and the regulator will go into thermal shutdown.
4. Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5kΩ in series with 100pF.
5. Specification for packaged product only.
6. 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.
7. Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal V_{OUT}.
8. 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

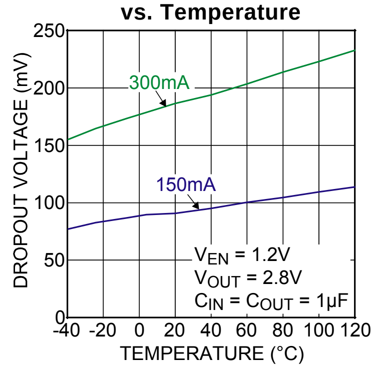
Power Supply Rejection Ratio



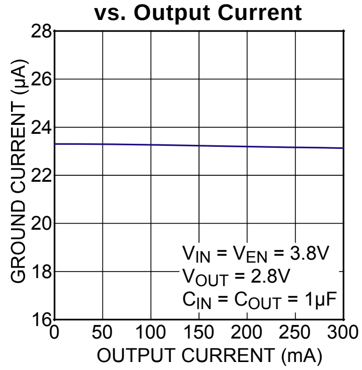
Dropout Voltage vs. Output Current



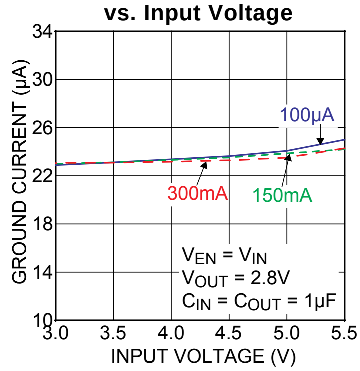
Dropout Voltage vs. Temperature



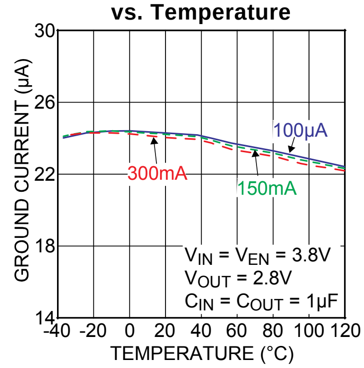
Ground Current vs. Output Current



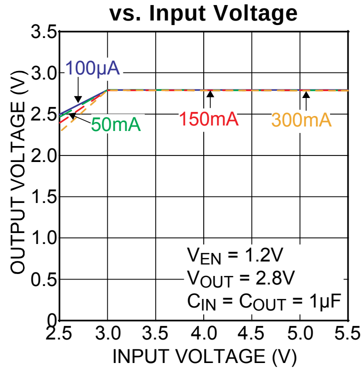
Ground Current vs. Input Voltage



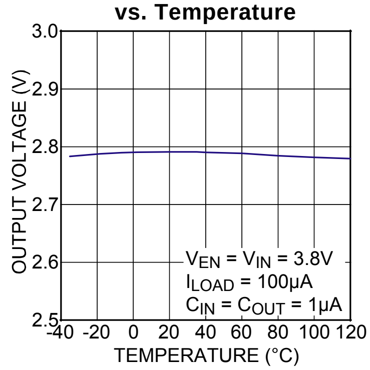
Ground Current vs. Temperature



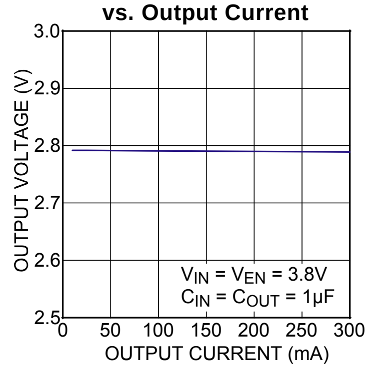
Output Voltage vs. Input Voltage



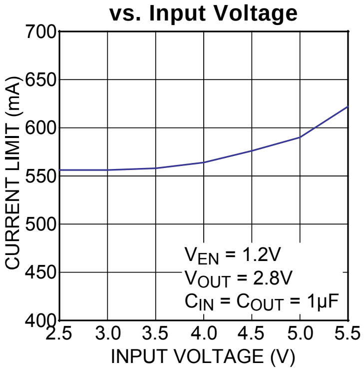
Output Voltage vs. Temperature



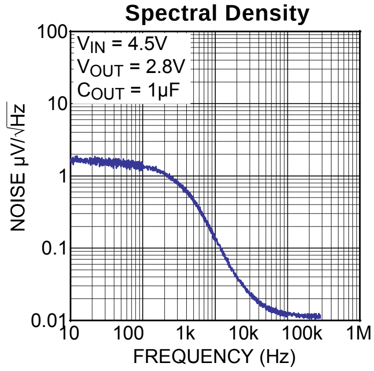
Output Voltage vs. Output Current



Current Limit vs. Input Voltage

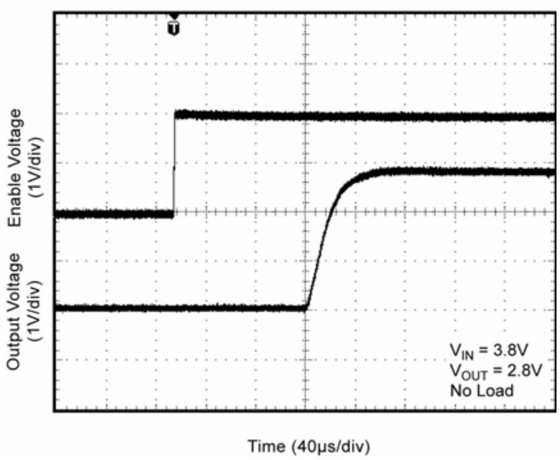


Output Noise Spectral Density

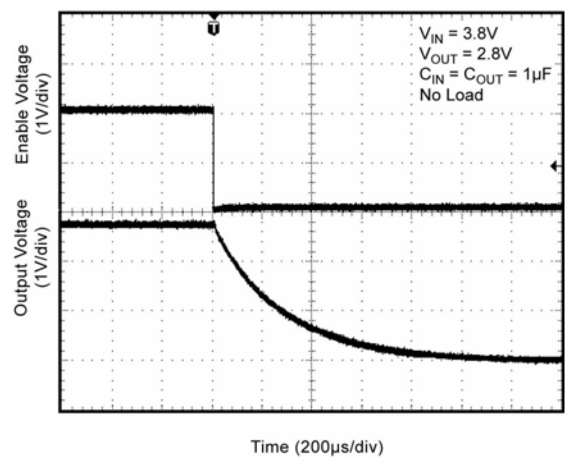


Functional Characteristics

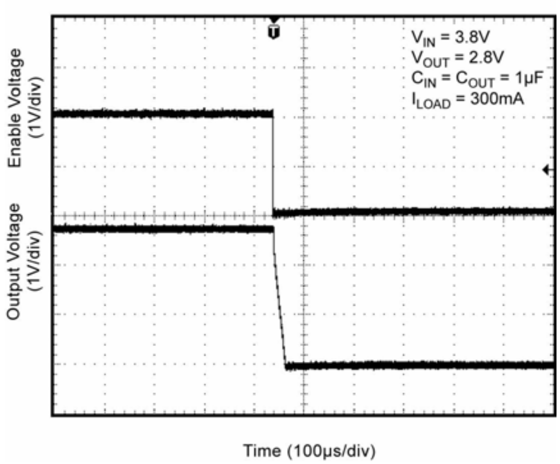
Turn-On Time



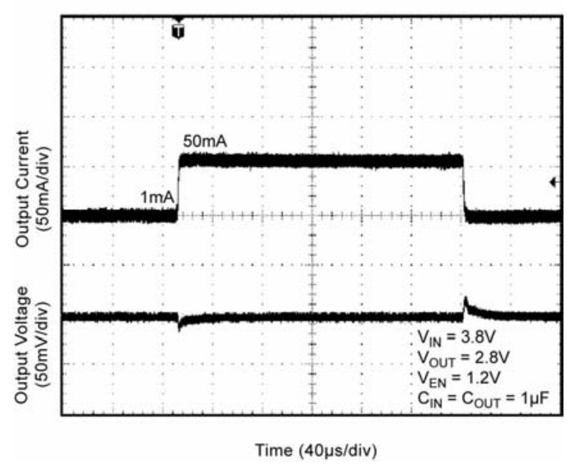
Turn-Off Time



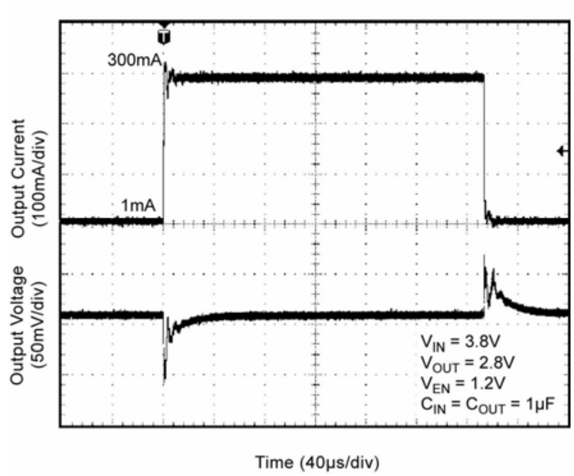
Turn-Off Time



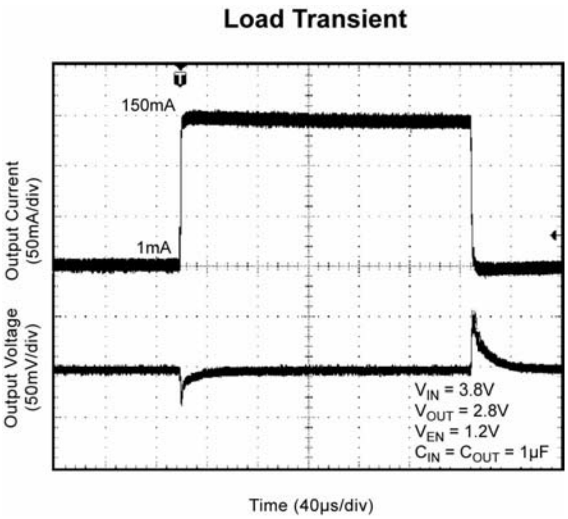
Load Transient

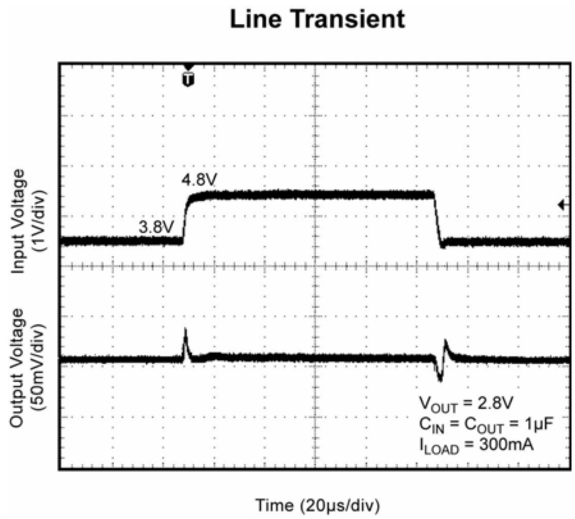


Load Transient

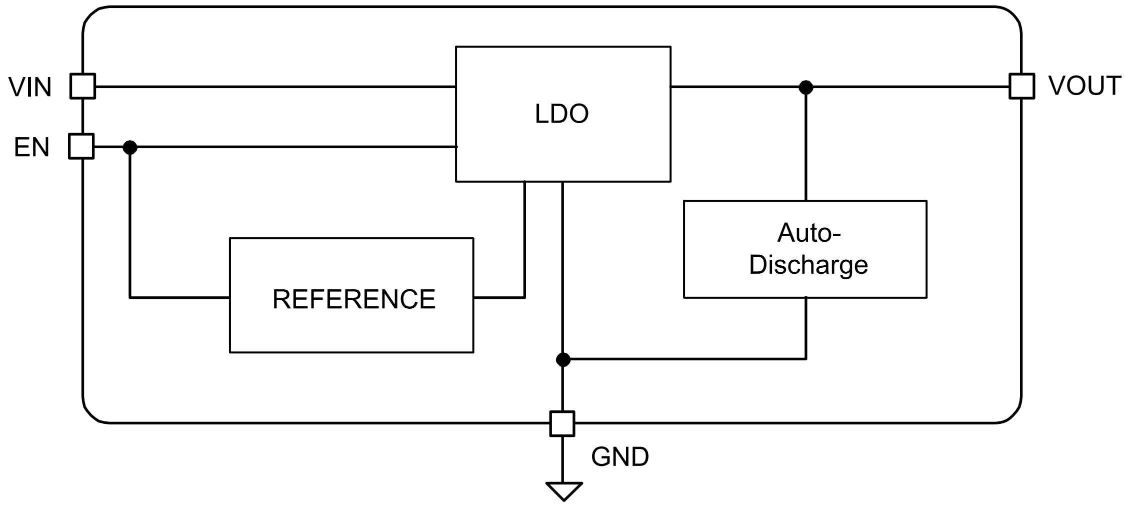


Functional Characteristics (continued)





Functional Diagram



Applications Information

The MIC5337 is a low quiescent current, low dropout regulator designed for optimal performance in a small space. The MIC5337 regulator is fully protected from damage due to fault conditions, offering linear current limiting and thermal shutdown.

Input Supply Voltage

V_{IN} provides the supply to power the LDO. The minimum input voltage is 2.3V allowing conversion from typical lithium ion batteries and low voltage supplies.

Input Capacitor

The MIC5337 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 with minimum space required. Additional high frequency capacitors, such as small value NPO dielectric type capacitors, help filter out high frequency noise and are good practice in any RF circuit.

Output Capacitor

The MIC5337 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. 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. 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.

Minimum Load Current

The MIC5337 does not require a minimum load to maintain output voltage regulation.

Enable/Shutdown

The MIC5337 comes with an active high enable pin that enables the regulator. 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. When disabled, the MIC5337 switches a 280Ω load on the regulator output to discharge the external capacitor. The active high enable pin uses CMOS technology and cannot be left floating; a floating enable pin may cause an unknown output state.

Thermal Considerations

The MIC5337 is designed to provide 300mA continuous output current from a very small footprint package. Maximum ambient operating temperature can be calculated based on the output current and the voltage drop across the part. For example: given that the input voltage is 3.6V, the output voltage is 2.8V and the output current is 300mA. The power dissipation of the regulator circuit can be determined using the equation:

$$P_D = (V_{IN} – V_{OUT1})\, I_{OUT} + V_{IN}\, I_{GND}$$

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.

$$P_D = (3.6V – 2.8V) \times 300mA$$

$$P_D = 0.24W$$

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

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

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

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 maximum power dissipation must not be exceeded for proper operation.

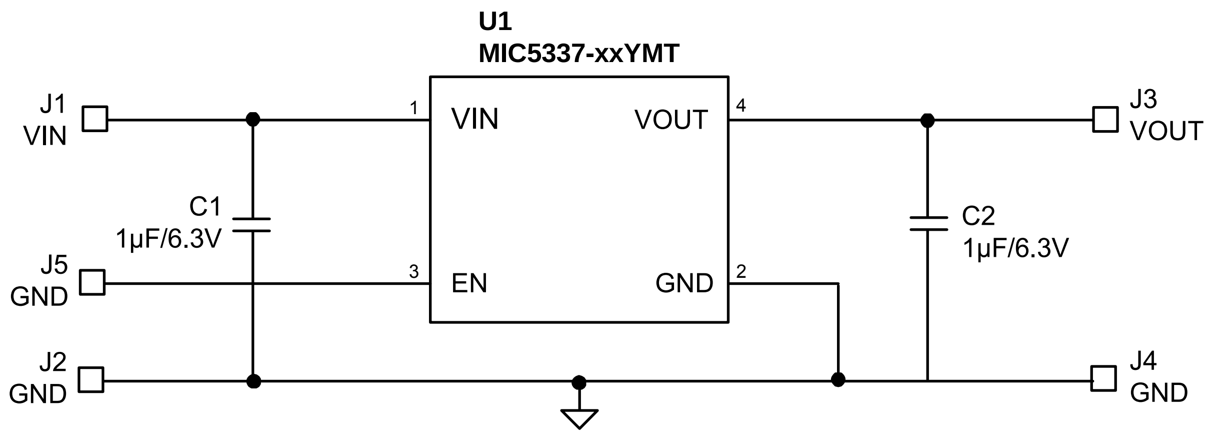
For example, when operating the MIC5337 at an input voltage of 3.6V and 300mA load with a minimum footprint layout, the maximum ambient operating temperature T_A can be determined as follows:

$$0.24W = (125°C – T_A)/(173°C/W)$$

$$T_A = 83°C$$

Therefore a 2.8V 300mA application can accept an ambient operating temperature of 83.0°C in a 1.2mm x 1.6mm Thin 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



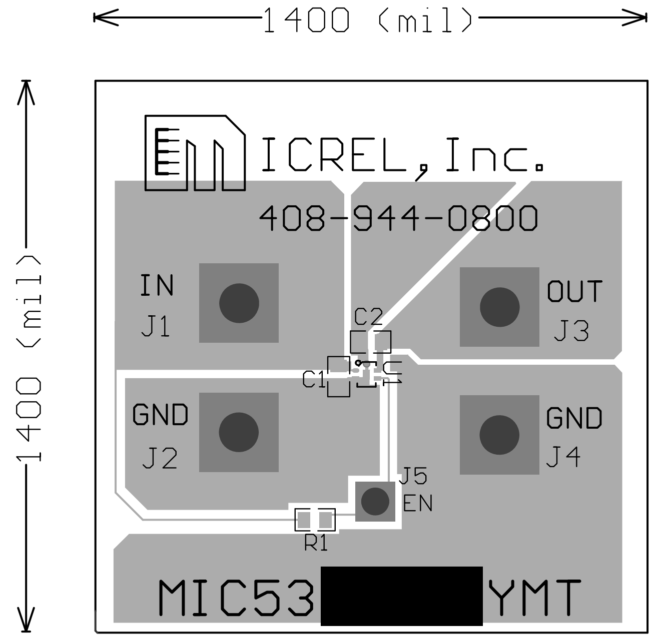
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2	C1608X5R0J105M	TDK[1]	Capacitor, 1µF, 6.3, X5R, Size 0603	2
U1	**MIC5337-xxYMT**	**Micrel, Inc.[3]**	**300mA low I_Q LDO with Auto Discharge**	**1**

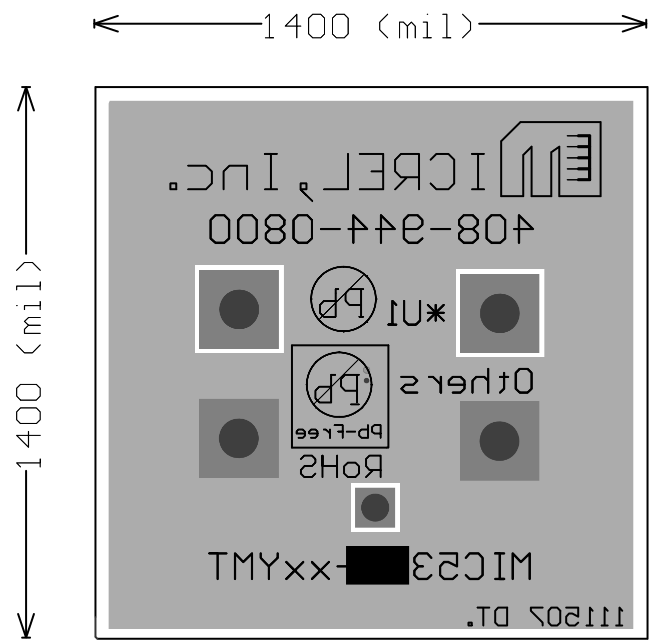
Notes:

1. TDK: www.tdk.com
2. Vishay Dale: Vishay.com
3. **Micrel, Inc.: www.micrel.com**

PCB Layout Recommendations

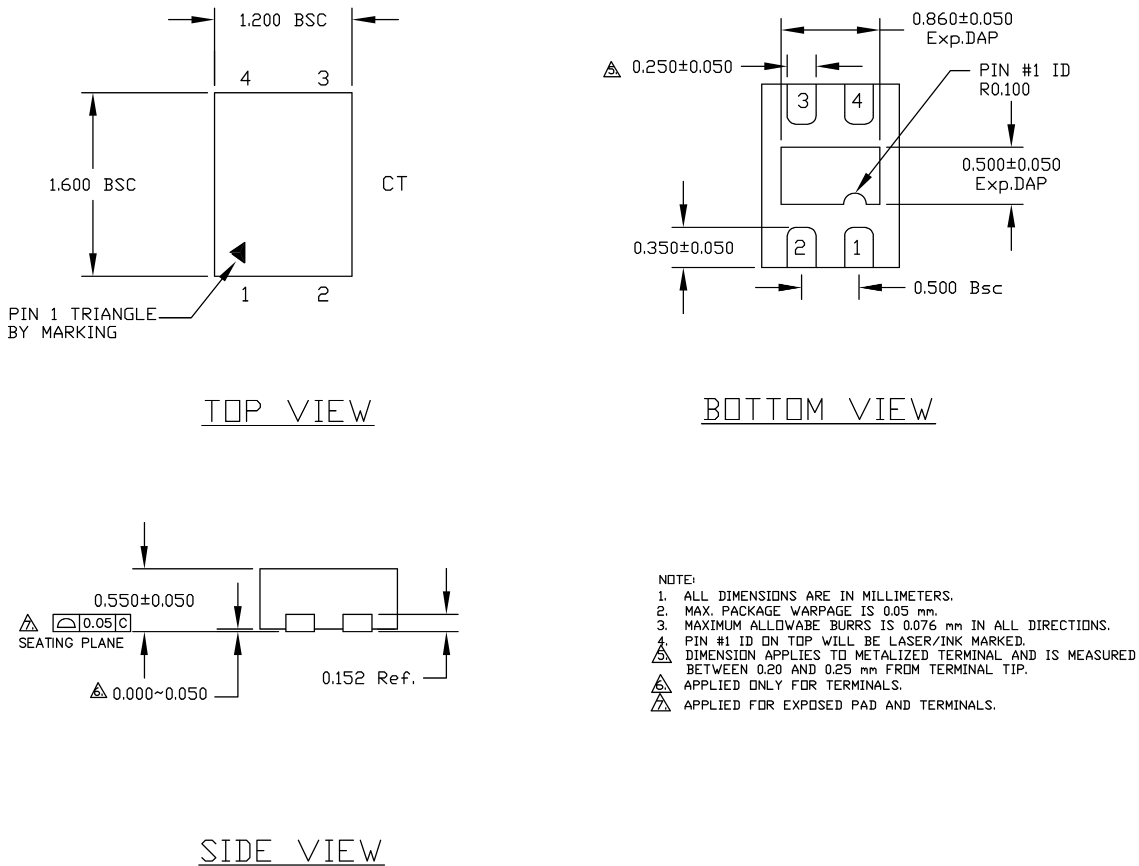


Top Layer



Bottom Layer

Package Information



4-Pin 1.2mm x 1.6mm 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