MIC5317

High-Performance Single 150mA LDO

General Description

The MIC5317 is a high performance 150mA low dropout regulator offering high power supply rejection (PSRR) in an ultra-small 1mm × 1mm package for stringent space requirements and demanding performance. The MIC5317 operates from an input voltage from 2.5V to 6.0V and is capable of providing the output voltages of 1.0V to 3.6V making it ideal for USB port or 6V AC adaptor applications.

The MIC5317 offers 2% initial accuracy, low dropout voltage (155mV @ 150mA), and low ground current (typically 29µA). The MIC5317 can also be put into a zero-off-mode current state, drawing virtually no current when disabled.

The MIC5317 is available in several advanced packages including a lead-free (RoHS-compliant) 1mm × 1mm Thin DFN occupying only $1mm^2$ of PCB area, a 75% reduction in board area compared to SC-70 and 2mm × 2mm DFN packages. It is also available in a SOT23-5 and TSOT23-5 package.

The MIC5317 has an operating junction temperature range of –40°C to 125°C.

Datasheets and support documentation are available on Micrel's web site at: www.micrel.com.

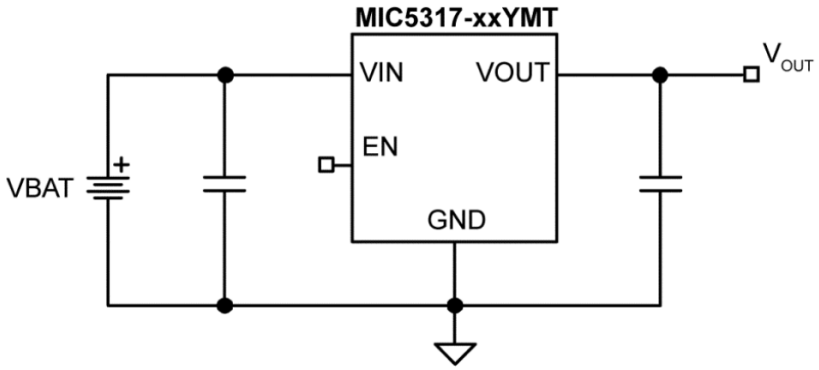
Features

- Tiny 1mm × 1mm Thin DFN, SOT23-5 and TSOT23-5 packages
- Wide 2.5V to 6V operating range
- 150mA guaranteed output current
- Stable with 1µF ceramic output capacitors
- Low dropout voltage: 155mV @ 150mA
- Excellent load/line transient response
- Low quiescent current: 29µA
- High PSRR: 70dB
- Thermal-shutdown and current-limit protection

Applications

- USB dongles
- Wireless LANs
- PC Desktops, laptops, and tablets
- Battery-powered equipment
- Digital still and video cameras
- 5V general purpose

Typical Application



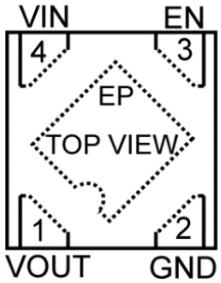
Ordering Information

Part Number	Marking Code	Output Voltage[1]	Temperature Range	Packages[2]	Lead Finish[3]
MIC5317-1.0YMT	71	1.0V	–40°C to +125°C	4-Pin 1mm × 1mm Thin DFN	Pb-Free
MIC5317-1.2YMT	72	1.2V	–40°C to +125°C	4-Pin 1mm × 1mm Thin DFN	Pb-Free
MIC5317-1.5YMT	73	1.5V	–40°C to +125°C	4-Pin 1mm × 1mm Thin DFN	Pb-Free
MIC5317-1.8YMT	74	1.8V	–40°C to +125°C	4-Pin 1mm × 1mm Thin DFN	Pb-Free
MIC5317-2.5YMT	76	2.5V	–40°C to +125°C	4-Pin 1mm × 1mm Thin DFN	Pb-Free
MIC5317-2.8YMT	77	2.8V	–40°C to +125°C	4-Pin 1mm × 1mm Thin DFN	Pb-Free
MIC5317-3.0YMT	78	3.0V	–40°C to +125°C	4-Pin 1mm × 1mm Thin DFN	Pb-Free
MIC5317-3.3YMT	79	3.3V	–40°C to +125°C	4-Pin 1mm × 1mm Thin DFN	Pb-Free
MIC5317-1.0YM5	1C7	1.0V	–40°C to +125°C	5-Pin SOT23	Pb-Free
MIC5317-1.2YM5	147	1.2V	–40°C to +125°C	5-Pin SOT23	Pb-Free
MIC5317-1.5YM5	1F7	1.5V	–40°C to +125°C	5-Pin SOT23	Pb-Free
MIC5317-1.8YM5	1G7	1.8V	–40°C to +125°C	5-Pin SOT23	Pb-Free
MIC5317-2.5YM5	1J7	2.5V	–40°C to +125°C	5-Pin SOT23	Pb-Free
MIC5317-2.8YM5	1M7	2.8V	–40°C to +125°C	5-Pin SOT23	Pb-Free
MIC5317-3.0YM5	1P7	3.0V	–40°C to +125°C	5-Pin SOT23	Pb-Free
MIC5317-3.3YM5	1S7	3.3V	–40°C to +125°C	5-Pin SOT23	Pb-Free
MIC5317-1.0YD5	1C7	1.0V	–40°C to +125°C	5-Pin Thin SOT23	Pb-Free
MIC5317-1.2YD5	147	1.2V	–40°C to +125°C	5-Pin Thin SOT23	Pb-Free
MIC5317-1.5YD5	1F7	1.5V	–40°C to +125°C	5-Pin Thin SOT23	Pb-Free
MIC53171.8YD5	1G7	1.8V	–40°C to +125°C	5-Pin Thin SOT23	Pb-Free
MIC5317-2.5YD5	1J7	2.5V	–40°C to +125°C	5-Pin Thin SOT23	Pb-Free
MIC5317-2.8YD5	1M7	2.8V	–40°C to +125°C	5-Pin Thin SOT23	Pb-Free
MIC5317-3.0YD5	1P7	3.0V	–40°C to +125°C	5-Pin Thin SOT23	Pb-Free
MIC5317-3.3YD5	1S7	3.3V	–40°C to +125°C	5-Pin Thin SOT23	Pb-Free

Note:

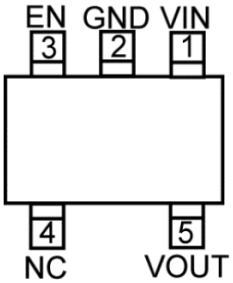
1. Other voltages are available. Contact Micrel for details.
2. Thin DFN ▲ = Pin 1 identifier.
3. Thin DFN is a GREEN, RoHS-compliant package. Lead finish is NiPdAu. Mold compound is Halogen Free.

Pin Configuration



4-Pin 1mm × 1mm Thin DFN (MT)

(Top View)



5-Pin SOT23 (D5) / TSOT23 (M5)

(Top View)

Pin Description

Pin Number	Pin Name TDFN-4	Pin Name SOT23-5	Pin Name TSOT23-5	Pin Function
1	VOUT	–	–	Output Voltage.
1	–	VIN	VIN	Supply Input.
2	GND	GND	GND	Ground.
3	EN	EN	EN	Enable Input: Active High. High = ON; Low = OFF. Do not leave floating.
4	VIN	–	–	Supply Input.
4	–	NC	NC	No connect. Not internally connected.
5	–	VOUT	VOUT	Output Voltage.
EP	ePad	NA	NA	Exposed Heatsink Pad, connect to Ground.

Absolute Maximum Ratings[4]

Supply Voltage (V_{IN}) ..... 0V to 7V
Enable Voltage (V_{EN}) ..... 0V to V_{IN}
Power Dissipation (P_D) ..... Internally Limited[6]
Lead Temperature (soldering, 10sec) ..... 260°C
Junction Temperature (T_J) ..... –40°C to +150°C
Storage Temperature (T_s) ..... –65°C to +150°C
ESD Rating[7] 2kV

Operating Ratings[5]

Supply Voltage (V_{IN}) ..... 2.5V to 6V
Enable Voltage (V_{EN}) ..... 0V to V_{IN}
Junction Temperature (T_J) ..... –40°C to +125°C
Junction Thermal Resistance
1mm × 1mm Thin DFN-4 (θ_{JA}) ..... 240°C/W
SOT23-5 (θ_{JA}) ..... 253°C/W
TSOT23-5 (θ_{JA}) ..... 253°C/W

Electrical Characteristics[8]

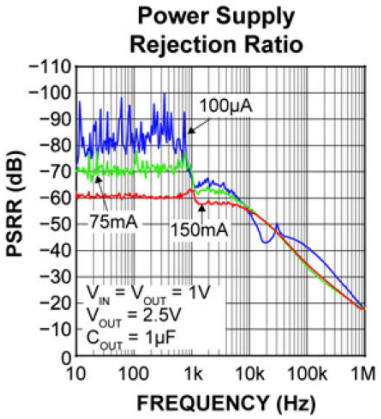
$V_{IN} = V_{EN} = V_{OUT} + 1V$; $C_{IN} = C_{OUT} = 1\mu F$; $I_{OUT} = 100\mu A$; $T_J = 25°C$, **bold** values indicate –40°C to +125°C, unless noted.

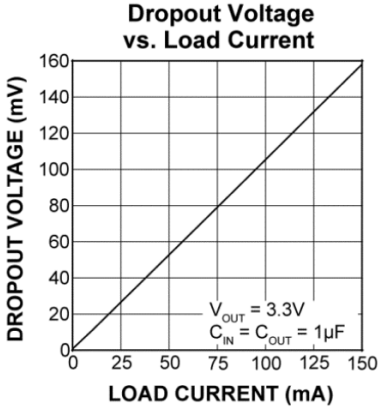
Parameter	Condition	Min	Typ	Max	Units
Output Voltage Accuracy	Variation from nominal V_{OUT}	–2.0		+2.0	%
	Variation from nominal V_{OUT}; –40°C to +125°C	**–3.0**		**+3.0**	
Line Regulation	$V_{IN} = V_{OUT}$ +1V to 6V; $I_{OUT} = 100\mu A$		0.02	**0.3**	%
Load Regulation[9]	$I_{OUT} = 100\mu A$ to 150mA		10	25	mV
Dropout Voltage[10]	I_{OUT} = 50mA; $V_{OUT} \geq$ 2.8V I_{OUT} = 150mA; $V_{OUT} \geq$ 2.8V I_{OUT} = 50mA; V_{OUT} < 2.8V I_{OUT} = 150mA; V_{OUT} < 2.8V		55 155 60 180	**110** **310** **135** **380**	mV
Ground Pin Current[11]	I_{OUT} = 0mA		29	**39**	µA
Ground Pin Current in Shutdown	V_{EN} = 0V		0.05	1	µA
Ripple Rejection	f = up to 1kHz; $C_{OUT} = 1\mu F$ f = 1kHz – 10kHz; $C_{OUT} = 1\mu F$		80 65		dB
Current Limit	V_{OUT} = 0V	200	325	550	mA
Output Voltage Noise	$C_{OUT} = 1\mu F$, 10Hz to 100kHz		200		μV_{RMS}
Enable Input					
Enable Input Voltage	Logic Low			**0.2**	V
	Logic High	**1.2**			
Enable Input Current	$V_{IL} \leq$ 0.2V		0.01	**1**	µA
	$V_{IH} \geq$ 1.2V		0.01	**1**	
Turn-on Time	$C_{OUT} = 1\mu F$; I_{OUT} = 150mA		50	**125**	µs

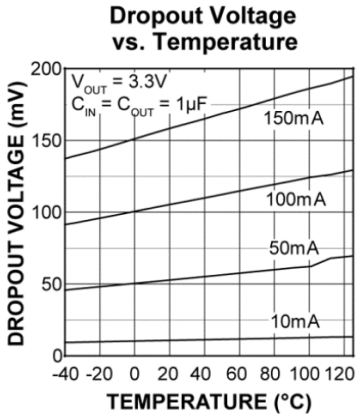
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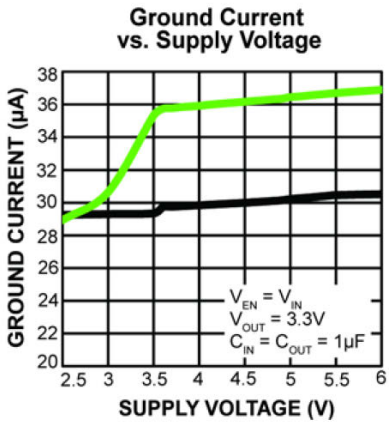
4. Exceeding the absolute maximum ratings may damage the device.
5. The device is not guaranteed to function outside its operating ratings.
6. The maximum allowable power dissipation of any TA (ambient temperature) is PD(max) = (TJ(max) – TA) / θJA. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.
7. Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5kΩ in series with 100pF.
8. Specification for packaged product only.
9. 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
10. 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. For outputs below 2.5V, dropout voltage is the input-to-output differential with the minimum input voltage 2.5V.
11. 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.

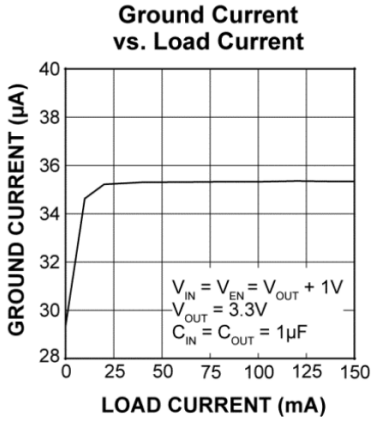
Typical Characteristics

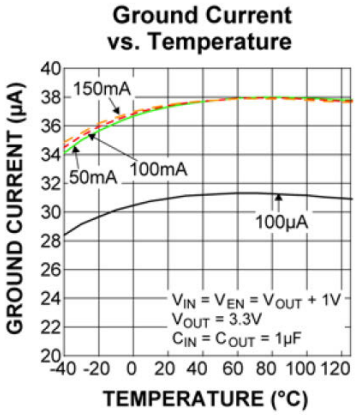


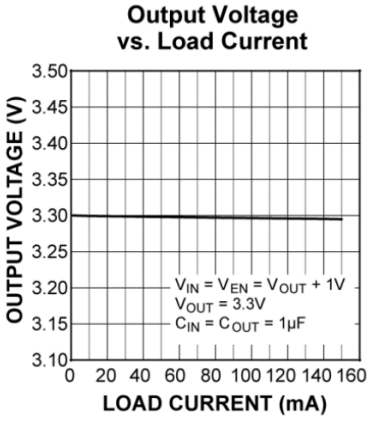


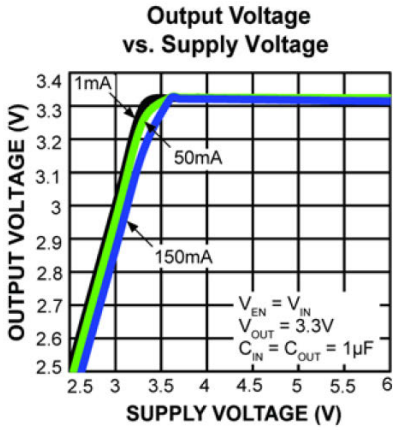


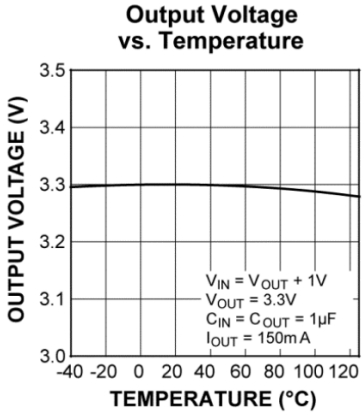




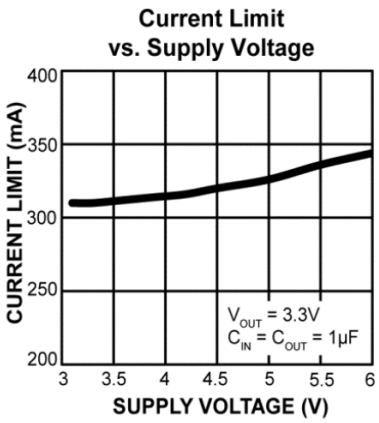


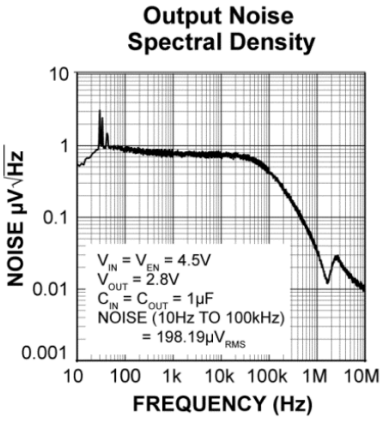






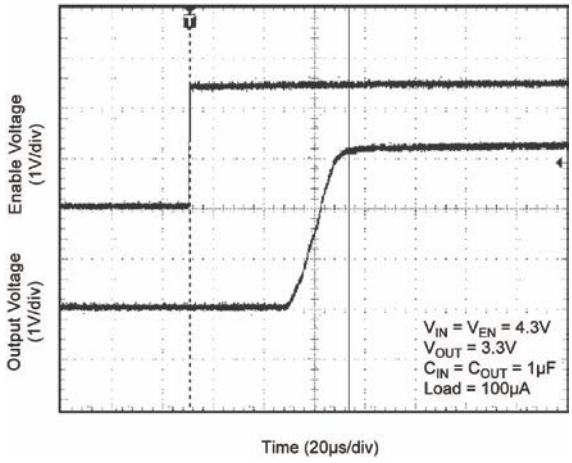
Typical Characteristics (Continued)



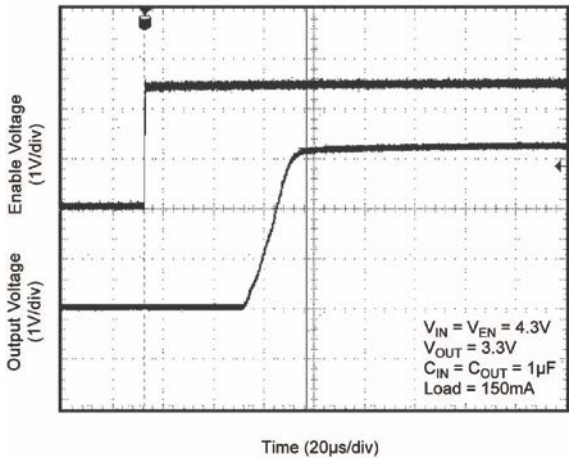


Functional Characteristics

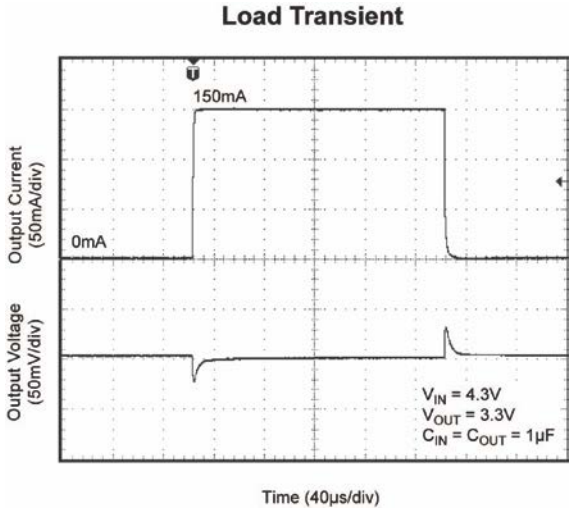
Enable Turn-On



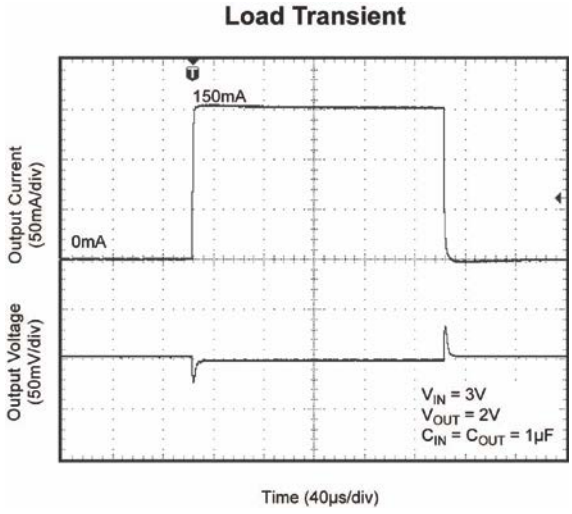
Enable Turn-On



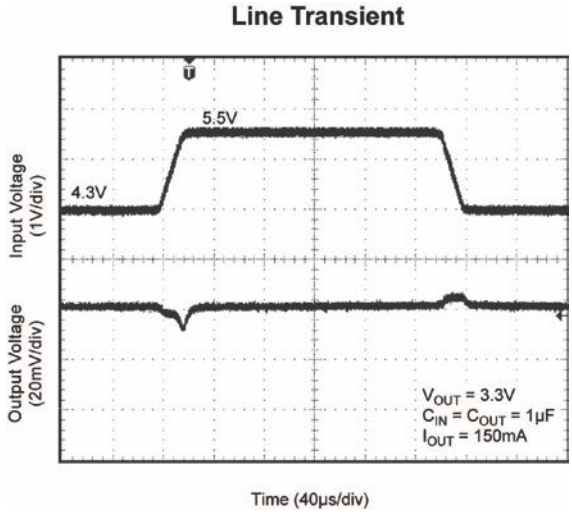
Load Transient



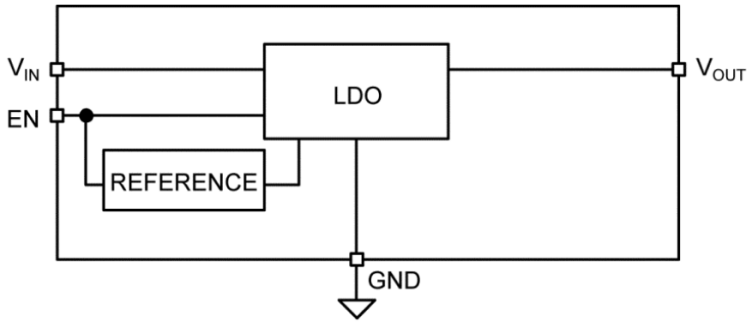
Load Transient



Line Transient



Functional Block Diagram



Application Information

MIC5317 is a low-noise 150mA LDO. The MIC5317 regulator is fully protected from damage due to fault conditions, offering linear current limiting and thermal shutdown.

Input Capacitor

The MIC5317 is a high-performance, high-bandwidth device. An input capacitor of 1µF 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. X5R or X7R dielectrics are recommended for the input capacitor. Y5V dielectrics lose most of their capacitance over temperature and are therefore, not recommended.

Output Capacitor

The MIC5317 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 are not recommended because they 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 MIC5317 will remain stable and in regulation with no load. This is especially important in CMOS RAM keep-alive applications.

Enable/Shutdown

The MIC5317 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.

Thermal Considerations

The MIC5317 is designed to provide 150mA 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. For example if 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 Equation 1:

$$P_D = (V_{IN} - V_{OUT1})\, I_{OUT} + V_{IN}\, I_{GND} \qquad \text{Eq. 1}$$

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 Equation 2:

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

$$P_D = 0.120W \qquad \text{Eq. 2}$$

To determine the maximum ambient operating temperature of the package, use the junction-to-ambient thermal resistance of the device and Equation 3:

$$P_{D(MAX)} = \left(\frac{T_{J(max)} - T_A}{\theta_{JA}} \right) \qquad \text{Eq. 3}$$

$T_{J(max)}$ = 125°C, the maximum junction temperature of the die, θ_{JA} thermal resistance = 240°C/W for the YMT package, and 253°C/W for the SOT23-5 and TSOT23-5 packages.

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 240°C/W.

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

For example, when operating the MIC5317-2.8YMT 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 shown in Equation 4:

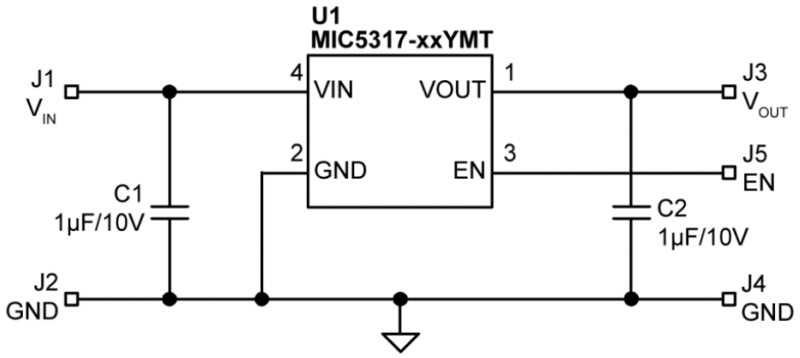
$$0.120W = (125°C - T_A)/(240°C/W)$$

$$T_A = 96°C \qquad \text{Eq. 4}$$

Therefore the maximum ambient operating temperature of 96°C is allowed in a 1mm × 1mm DFN 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

MIC5317-xxYMT Typical Application Schematic



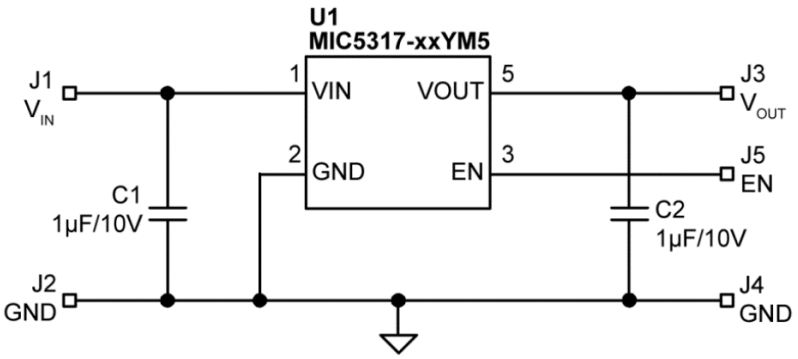
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2	GRM155R61A105KE15D	Murata[12]	Capacitor, 1µF Ceramic, 10V, X5R, Size 0402	2
U1	**MIC5317-xxYMT**	**Micrel, Inc.**[13]	**High-Performance Single 150mA LDO**	**1**

Notes:

12. Murata: www.murata.com.
13. **Micrel, Inc.:** www.micrel.com.

MIC5317-xxYM5/YD5 Typical Application Schematic



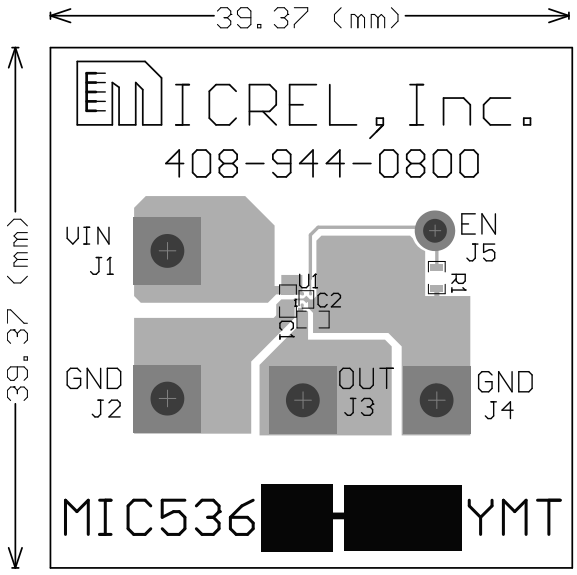
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2	C1005X5R1A105K	TDK[14]	Capacitor, 1µF Ceramic, 10V, X5R, Size 0402	2
U1	**MIC5317-xxYM5/YD5**	**Micrel, Inc.**[15]	**High-Performance Single 150mA LDO**	**1**

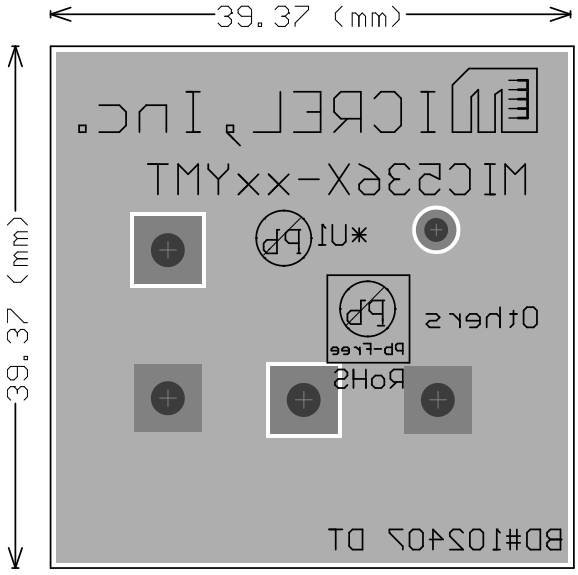
Notes:

14. TDK: www.tdk.com.
15. **Micrel, Inc.:** www.micrel.com.

PCB Layout Recommendations (1mm × 1mm Thin DFN)

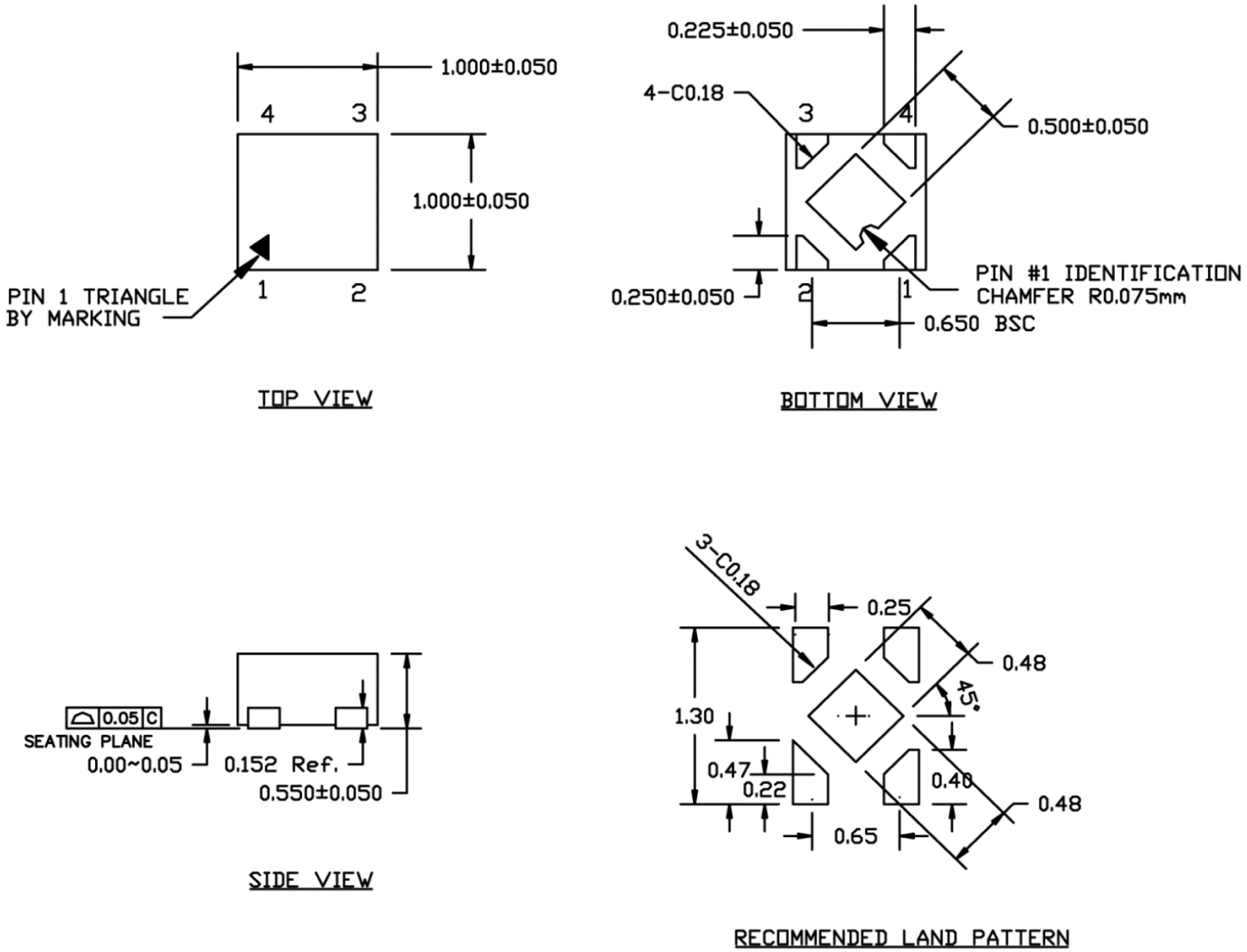


Top Layer



Bottom Layer

Package Information[16] and Recommended Landing Pattern



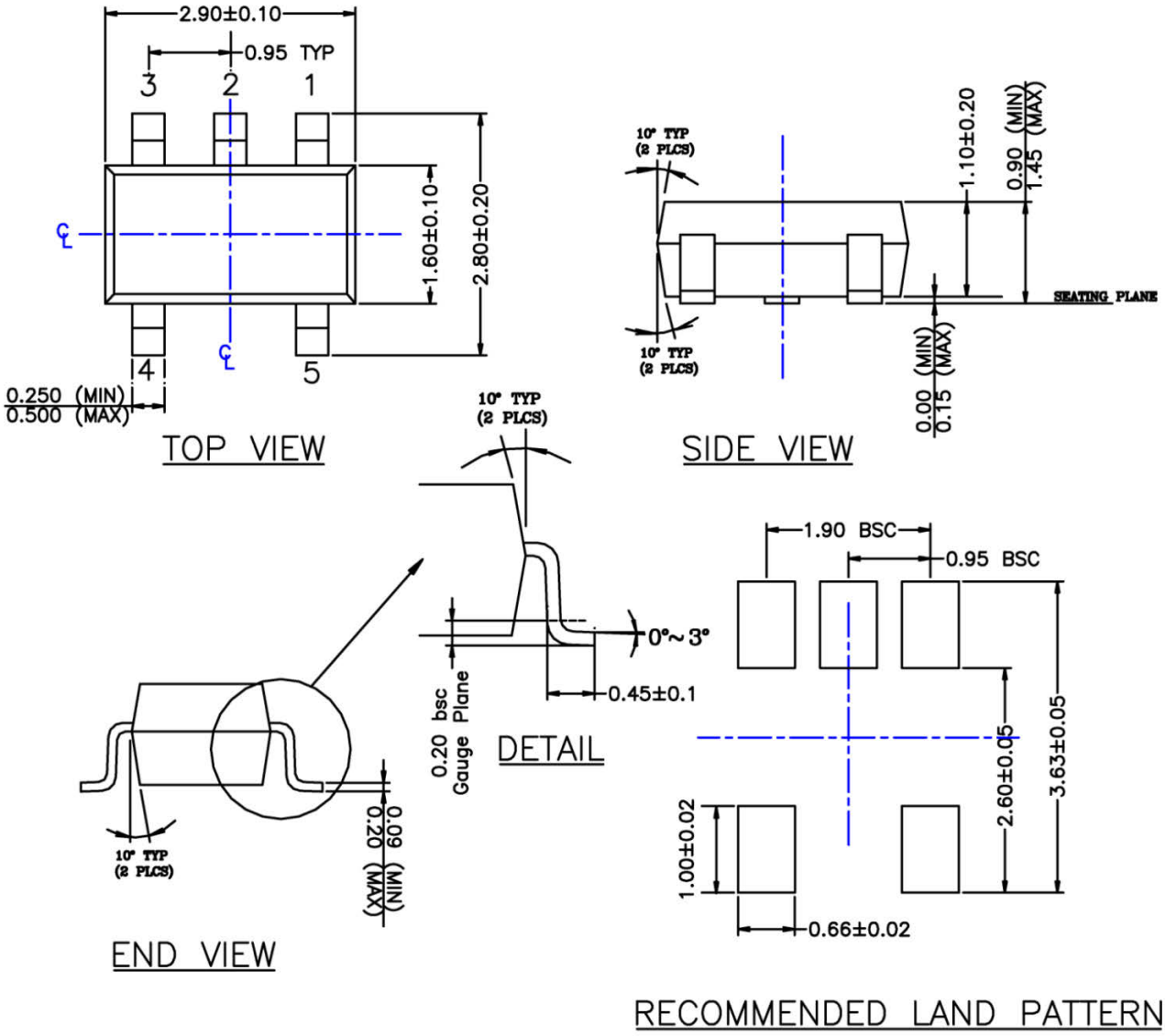
NOTE:
1. MAX PACKAGE WARPAGE IS 0.05 MM
2. MAX ALLOWABLE BURR IS 0.076MM IN ALL DIRECTIONS
3. PIN #1 IS ON TOP WILL BE LASER MARKED
4. UNSPECIFIED TOLERANCE IS +/- 0.05 MM

4-Pin 1mm × 1mm Thin DFN (MT)

Note:

16. Package information is correct as of the publication date. For updates and most current information, go to www.micrel.com.

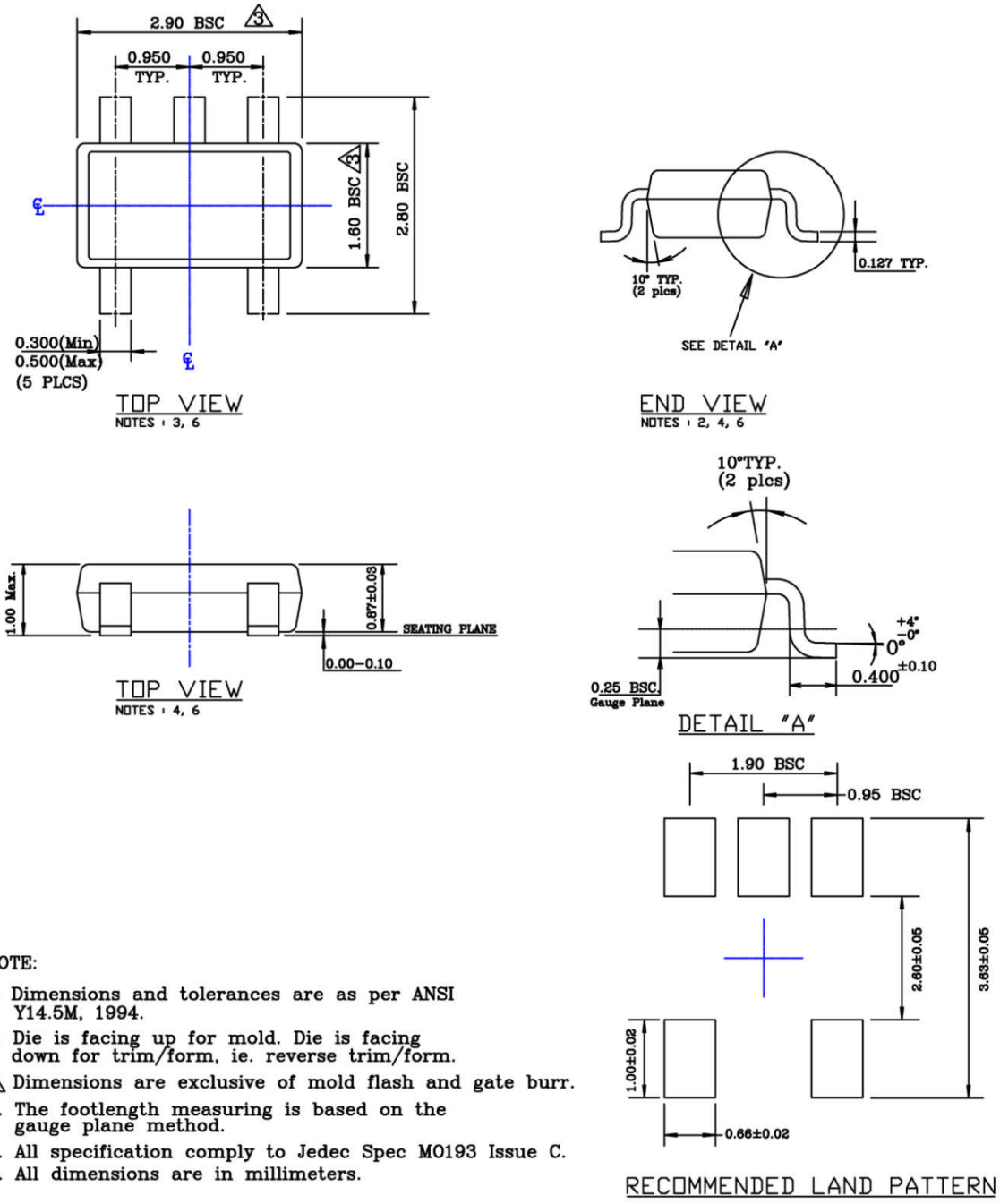
Package Information[16] and Recommended Landing Pattern (Continued)



NOTE:
1. PACKAGE OUTLINE EXCLUSIVE OF MOLD FLASH & BURR.
2. PACKAGE OUTLINE INCLUSIVE OF SOLER PLATING.
3. DIMENSION AND TOLERANCE PER ANSI Y14.5M, 1982.
4. FOOT LENGTH MEASUREMENT BASED ON GAUGE PLANE METHOD.
5. DIE FACES UP FOR MOLD, AND FACES DOWN FOR TRIM/FORM.
6. ALL DIMENSIONS ARE IN MILLIMETERS.

5-Pin SOT23 (M5)

Package Information[16] and Recommended Landing Pattern (Continued)



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 M0193 Issue C.
6. All dimensions are in millimeters.

5-Pin TSOT23 (D5)

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