MIC5338/9

Dual 300mA µCap LDO
in 1.6mm x 1.6mm Thin MLF®

General Description

The MIC5338/9 is an advanced dual 300mA LDO ideal for powering general purpose portable devices requiring low output noise and excellent Power Supply Rejection Ratio (PSRR). The MIC5338/9 provides two independently controlled, high performance, 300mA LDOs in a tiny 1.6mm x 1.6mm Thin MLF® package.

The MIC5338/9 provides two low noise outputs with fast transient response. Additionally the MIC5338/9 provides low quiescent current operation, using only 70µA with both outputs enabled. The MIC5339 also incorporates an active discharge feature that pulls down the output of the regulator when the part is disabled.

The MIC5338/9 is available in fixed output voltages in a lead-free (RoHS compliant) 6-pin 1.6mm x 1.6mm Thin MLF® leadless package.

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

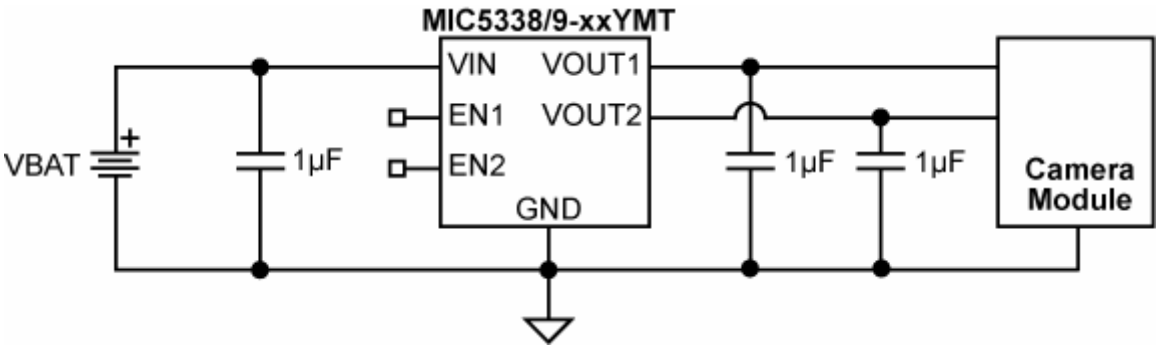
Features

- 2.5V to 5.5V input voltage range
- Two 300mA outputs
- High output accuracy – 2%
- Low quiescent current – 70µA total
- Stable with ceramic output capacitors
- Independent enable pins
- Low dropout voltage – 220mV at 300mA
- Low output noise
- Thermal shutdown protection
- Current limit protection
- Output discharge circuit – MIC5339
- 6-pin 1.6mm x 1.6mm Thin MLF® package

Applications

- Mobile phones
- Camera phones
- GPS, PMP, PDAs and handhelds
- Portable electronics

Typical Application



Camera Module Power Supply

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Ordering Information

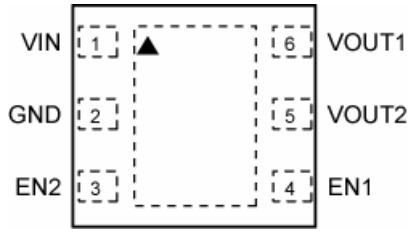
Part Number	Manufacturing Part Number	Marking Code	Voltage[1]	Junction Temp. Range	Package[2]	Lead Finish[3]
MIC5338-3.3/2.8YMT[1]	MIC5338-SMYMT	S82	3.3V/2.8V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free
MIC5338-2.8/1.8YMT	MIC5338-MGYMT	S83	2.8V/1.8V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free
MIC5338-2.8/1.2YMT[1]	MIC5338-M4YMT	S84	2.8V/1.2V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free
MIC5338-1.8/1.2YMT[1]	MIC5338-G4YMT	S85	1.8V/1.2V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free
MIC5338-1.2/1.0YMT[1]	MIC5338-4CYMT	S86	1.2V/1.0V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free
MIC5339-3.3/2.8YMT*[1]	MIC5339-SMYMT	S92	3.3V/2.8V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free
MIC5339-2.8/1.8YMT*	MIC5339-MGYMT	S93	2.8V/1.8V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free
MIC5339-2.8/1.2YMT*[1]	MIC5339-M4YMT	S94	2.8V/1.2V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free
MIC5339-1.8/1.2YMT*[1]	MIC5339-G4YMT	S95	1.8V/1.2V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free
MIC5339-1.2/1.0YMT*[1]	MIC5339-4CYMT	S96	1.2V/1.0V	–40° to +125°C	6-Pin 1.6x1.6 Thin MLF®	Pb-Free

Note:

1. Contact Micrel for availability.
2. Thin MLF® Pin 1 Identifier= "▲"
3. Thin MLF® is a GREEN RoHS compliant package. Level finish is NiPdAu. Mold compound is Halogen Free.

* MIC5339 offers Auto-Discharge function.

Pin Configuration



6-Pin 1.6mm x 1.6mm Thin MLF® (MT)

Pin Description

Pin Number	Pin Name	Pin Function
1	VIN	Supply Input.
2	GND	Ground.
3	EN2	Enable Input LDO2. Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
4	EN1	Enable Input LDO1. Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
5	VOUT2	LDO2 Output.
6	VOUT1	LDO1 Output.
EPAD	HSPAD	Heatsink pad. Connect to ground.

Absolute Maximum Ratings[1]

Supply Voltage (V_{IN}) ..... –0.3V to +6V
Enable Voltage (V_{EN1}, V_{EN2}) ..... –0.3V to V_{IN}
Power Dissipation (P_D) ..... Internally Limited[3]
Lead Temperature (soldering, 10sec.) ..... 260°C
Junction Temperature (T_J) ..... –40°C to +125°C
Storage Temperature (T_s) ..... –65°C to +150°C
ESD Rating[4] ..... ESD Sensitive

Operating Ratings[2]

Supply Voltage (V_{IN}) ..... +2.5V to 5.5V
Enable Voltage (V_{EN1}, V_{EN2}) ..... 0V to V_{IN}
Junction Temperature (T_J) ..... –40°C to +125°C
Junction Thermal Resistance
1.6mm x 1.6mm Thin MLF® (θ_{JA}) ..... 92.4°C/W

Electrical Characteristics[5]

$V_{IN} = V_{EN1} = V_{EN2} = V_{OUT} + 1V$; higher of the two outputs; $I_{OUTLDO1} = I_{OUTLDO2} = 100\mu A$; $C_{OUT1} = C_{OUT2} = 1\mu F$;
$T_J = 25°C$, **bold** values indicate –40°C to +125°C, unless noted.

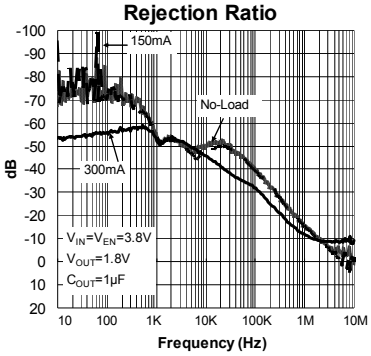
Parameter	Condition	Min	Typ	Max	Units
Output Voltage Accuracy	Variation from nominal V_{OUT}	-2.0		+2.0	%
	Variation from nominal V_{OUT}	**-3.0**		**+3.0**	%
Line Regulation	$V_{IN} = V_{OUT}$ +1V to 5.5V, I_{OUT} = 100µA		0.02	**0.3**	%/V
Load Regulation	I_{OUT} = 100µA to 300mA		0.3	1	%
Dropout Voltage	I_{OUT} = 50mA		35	**65**	mV
	I_{OUT} = 300mA		220	**380**	mV
Ground Pin Current	V_{EN1} = High; V_{EN2} = Low; I_{OUT1} = 0mA		38	**58**	µA
	V_{EN1} = Low; V_{EN2} = High; I_{OUT2} = 0mA		38	**58**	µA
	$V_{EN1} = V_{EN2}$ = High; $I_{OUT1} = I_{OUT2}$ = 0mA		70	**110**	µA
	V_{EN1} = High; V_{EN2} = Low; I_{OUT1} = 300mA		55	**70**	µA
	V_{EN1} = Low; V_{EN2} = High; I_{OUT2} = 300mA		55	**70**	µA
	$V_{EN1} = V_{EN2}$ = High; $I_{OUT1} = I_{OUT2}$ = 300mA		105	**135**	µA
Shutdown Current	$V_{EN1} = V_{EN2} \leq 0.2V$		0.05	1	µA
Ripple Rejection	f = 1kHz; C_{OUT} = 1µF		55		dB
Current Limit	V_{OUT} = 0V	**325**	500	680	mA
Output Voltage Noise	C_{OUT} = 1µF, 10Hz to 100kHz		200		μV_{RMS}
Auto-Discharge NFET Resistance	MIC5339 Only; $V_{EN1} = V_{EN2}$ = 0V; V_{IN} = 3.6V; I_{OUT} = -3mA		30		Ω
Enable Inputs (EN1/EN2)					
Enable Input Voltage	Logic Low			**0.2**	V
	Logic High	**1.2**			V
Enable Input Current	$V_{IL} \leq 0.2V$		0.01	**1**	µA
	$V_{IH} \geq 1.2V$		0.01	**1**	µA
Turn-on Time			50	**125**	µs

Notes:

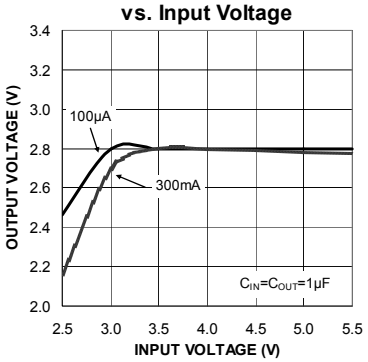
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. The maximum allowable power dissipation of any T_A (ambient temperature) is $P_{D(max)} = (T_{J(max)} - T_A) / \theta_{JA}$. Exceeding the maximum allowable power 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.

Typical Characteristics

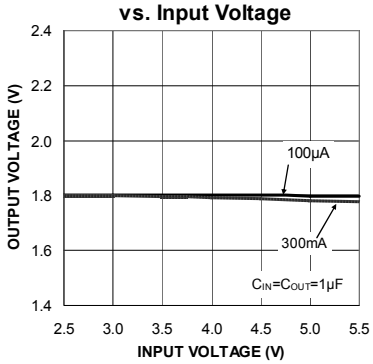
Power Supply Rejection Ratio



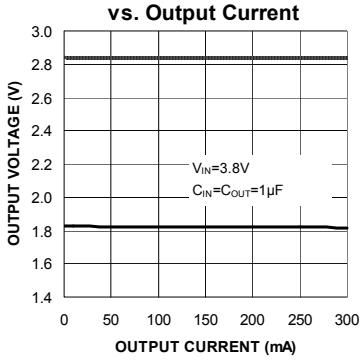
Output Voltage vs. Input Voltage



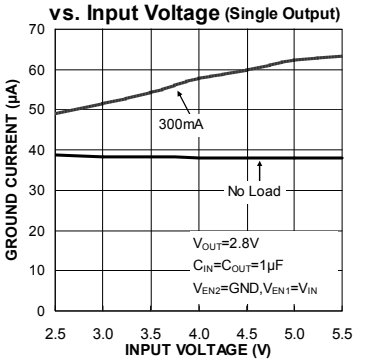
Output Voltage vs. Input Voltage



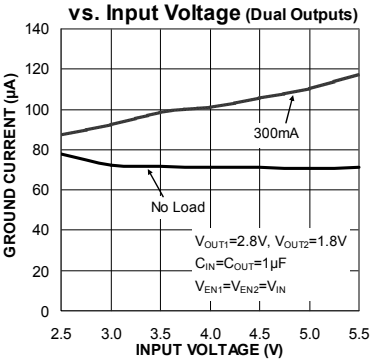
Output Voltage vs. Output Current



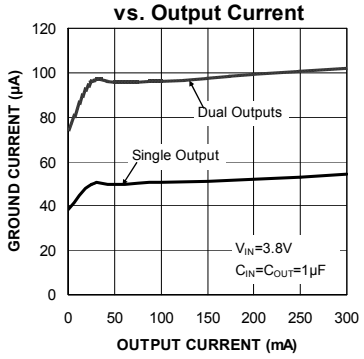
Ground Current vs. Input Voltage (Single Output)



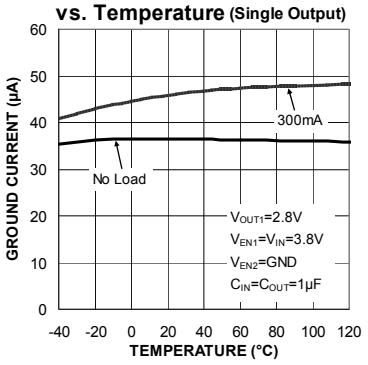
Ground Current vs. Input Voltage (Dual Outputs)



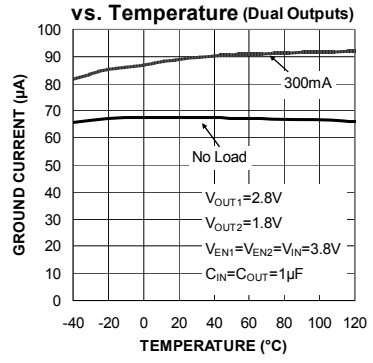
Ground Current vs. Output Current



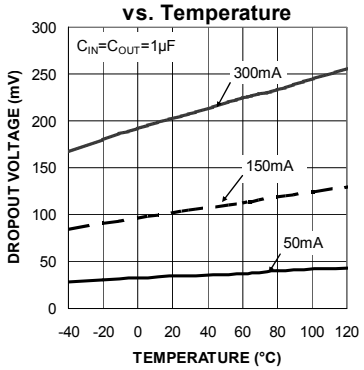
Ground Current vs. Temperature (Single Output)



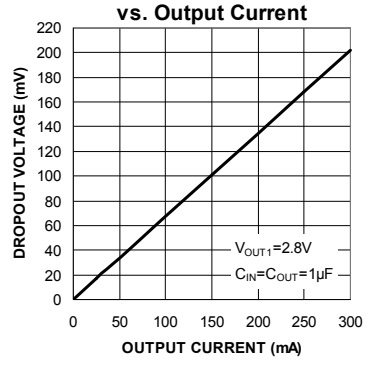
Ground Current vs. Temperature (Dual Outputs)



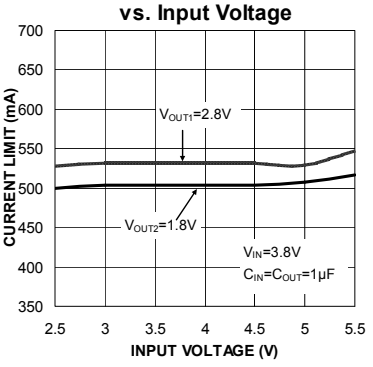
Dropout Voltage vs. Temperature

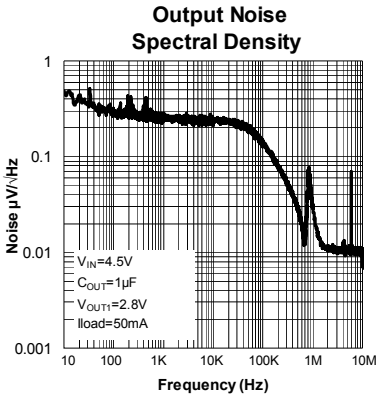


Dropout Voltage vs. Output Current



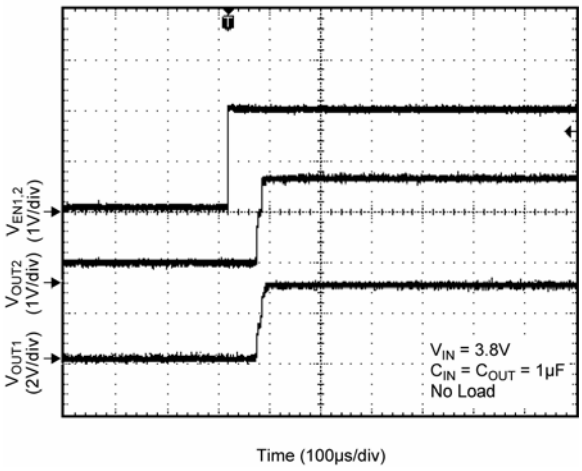
Current Limit vs. Input Voltage



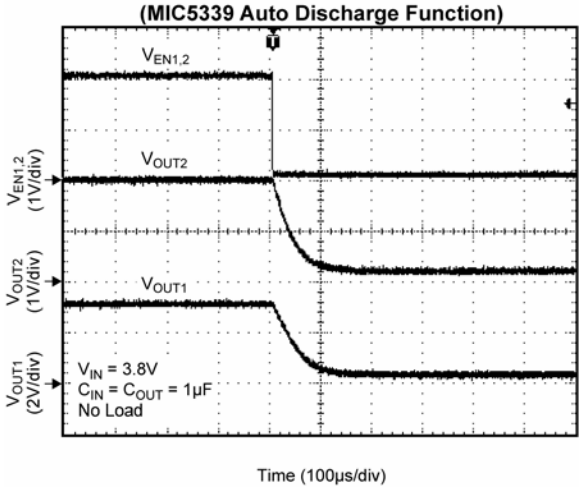

Output Noise
Spectral Density
1
0.1
0.01
0.001
Noise µV/√Hz
VIN=4.5V
COUT=1µF
VOUT1=2.8V
Iload=50mA
10
100
1K
10K
100K
1M
10M
Frequency (Hz)

Functional Characteristics

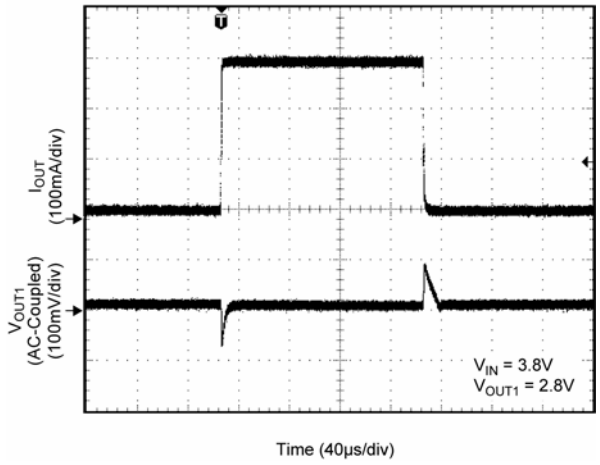
Turn-On Time



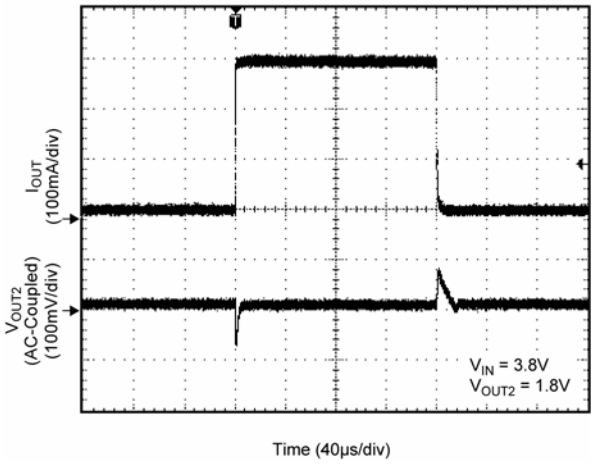
Turn-Off Time
(MIC5339 Auto Discharge Function)



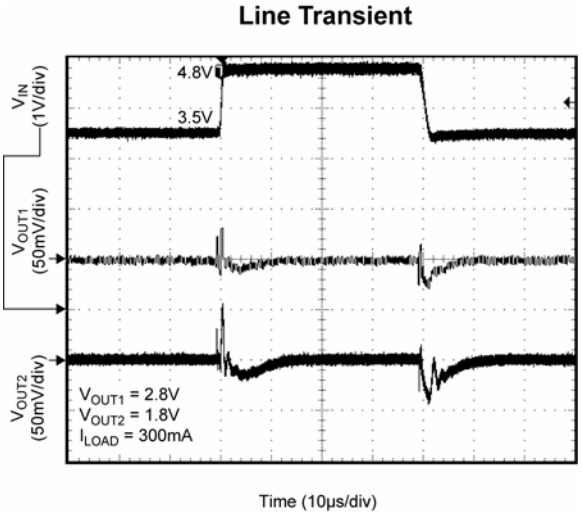
Load Transient



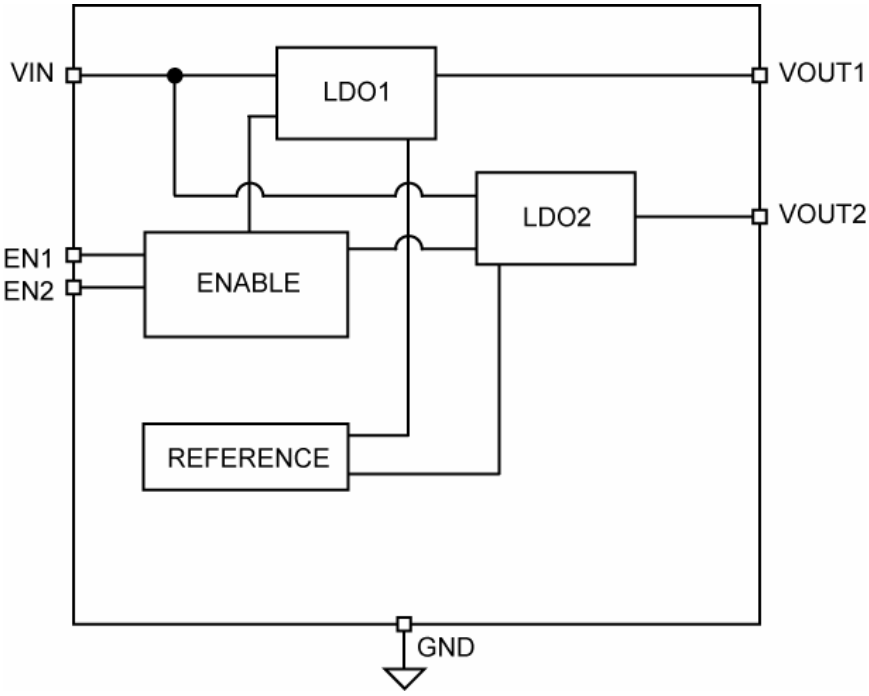
Load Transient



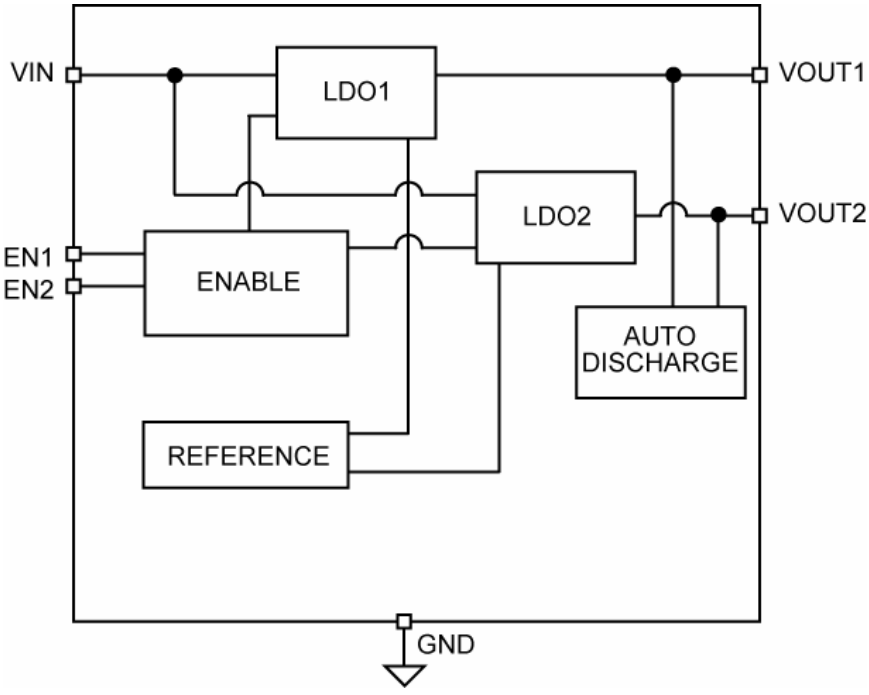
Line Transient



Functional Diagrams



MIC5338 Block Diagram



MIC5339 Block Diagram

Application Information

MIC5338/9 is a dual 300mA LDO. The MIC5339 includes an auto-discharge circuit for each LDO output that is activated when the output is disabled. The MIC5338/9 regulator is fully protected from damage due to fault conditions through linear current limiting and thermal shutdown.

Input Capacitor

The MIC5338/9 is a high performance, high bandwidth device. An input capacitor of 1µF from the input pin to ground is required to provide stability. Low ESR ceramic capacitors provide optimal performance in small board area. 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 MIC5338/9 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 and X5R dielectric ceramic capacitors are recommended because of their temperature performance. X7R 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 MIC5338/9 will remain stable and in regulation with no load.

Enable/Shutdown

The MIC5338/9 comes with two active high enable pins that allow each regulator to be disabled independently. Forcing the enable pin low disables the regulator and sends it into an off mode current state drawing virtually zero current. When disabled, the MIC5339 switches an internal 30Ω load on the regulator output to discharge the external capacitor.

Forcing the enable pin high enables the output voltage. The active high enable pin uses CMOS technology and cannot be left floating. A floating enable pin may cause an indeterminate state on the output.

Thermal Considerations

The MIC5338/9 is designed to provide two 300mA continuous current outputs in a very small package. Maximum operating temperature can be calculated based on the output currents and the voltage drop across the part. For example, if the input voltage is 3.6V, V_{OUT1} = 3.3V, V_{OUT2} = 2.8V and each with an output current = 300mA. The actual power dissipation of the regulator circuit can be determined using the equation:

$$P_D = (V_{IN} – V_{OUT1})\ I_{OUT1} + (V_{IN} – V_{OUT2})\ I_{OUT2} + V_{IN}\ I_{GND}$$

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

$$P_D = (3.6V – 3.3V) \times 300mA + (3.6V – 2.8V) \times 300mA$$

$$P_D = 0.33W$$

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

θ_{JA} = 92.4°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 junction to ambient thermal resistance for the minimum footprint is 92.4°C/W.

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

For example, when operating a 3.3V/2.8V application with an input voltage of 3.6V and 300mA at each output with a minimum footprint layout, the maximum ambient operating temperature T_A can be determined as follows:

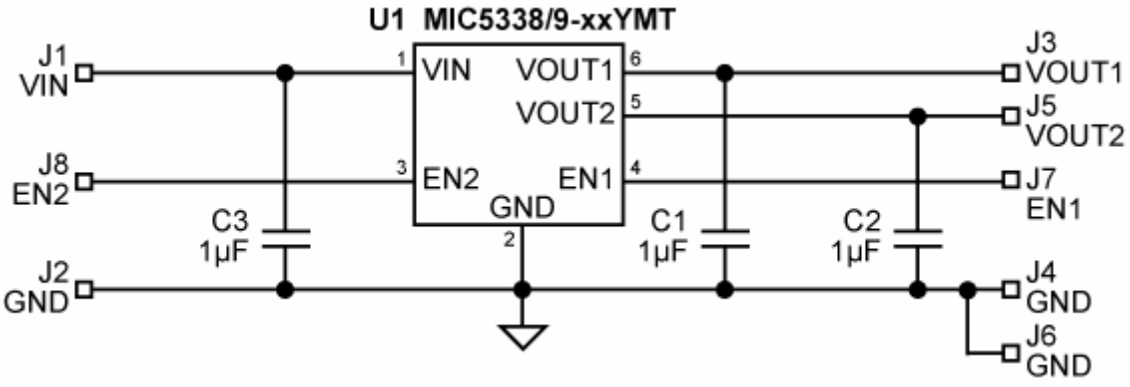
$$0.33W = (125°C – T_A)/(92.4°C/W)$$

$$T_A = 94.5°C$$

Therefore, a MIC5338-SMYMT application with 300mA at each output current can accept an ambient operating temperature of 94.5°C in a 1.6mm 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

Typical Application Schematic



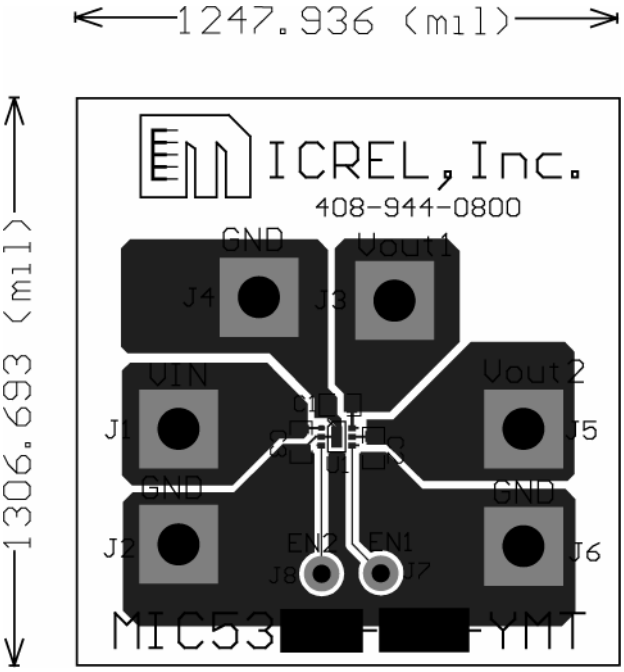
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2, C3	GRM188R60J225KE19D	Murata[1]	Capacitor, 1µF Ceramic, 6.3V, X5R, Size 0603	3
U1	**MIC5338/9-xxYMT**	**Micrel**[2]	**Dual, 300mA LDO, Size 1.6mm x 1.6mm Thin MLF®**	**1**

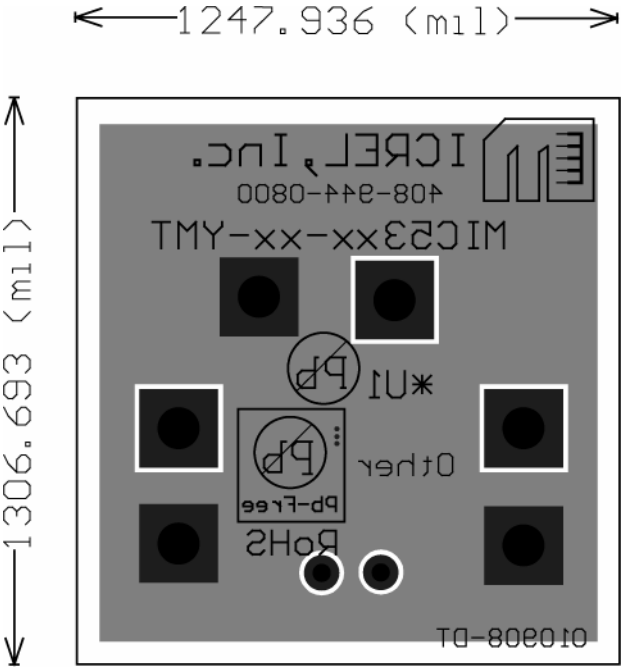
Notes:

1. Murata: www.murata.com
2. **Micrel, Inc.: www.micrel.com**

PCB Layout Recommendations

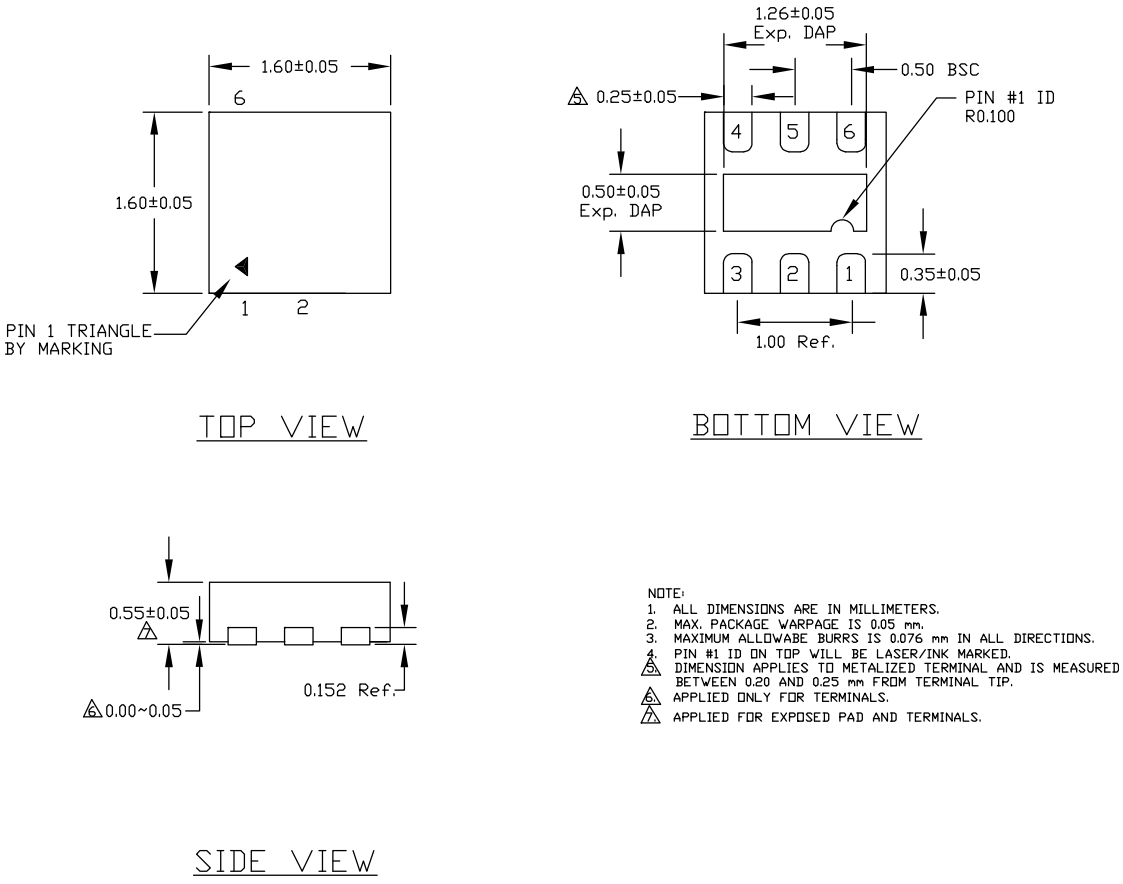


Top Layer



Bottom Layer

Package Information



6-Pin 1.6mm x 1.6mm Thin MLF® (MT)

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Parça koduyla arama

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