MIC5357

High Performance, Low Noise Dual 500mA ULDO™

General Description

The MIC5357 is a tiny Dual Ultra Low Dropout (ULDO™) linear regulator ideally suited for portable electronics due to its low output noise. The MIC5357 provides two independently controlled high performance 500mA LDOs with typical dropout voltage of 130mV at rated load. In addition, the MIC5357 provides a bypass pin to reduce the output noise.

The MIC5357 is designed to be stable with small ceramic output capacitors thereby reducing required board space and component cost. The combination of extremely low dropout voltage, low output noise and exceptional thermal package characteristics makes it ideal for powering RF and noise sensitive circuitry, cellular phone camera modules, imaging sensors for digital still cameras, PDAs, MP3 players and WebCam applications.

The MIC5357 ULDO™ is available in fixed output voltages in the small 8-pin ePad MSOP package. Additional voltage options are available. For more information, contact Micrel marketing.

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

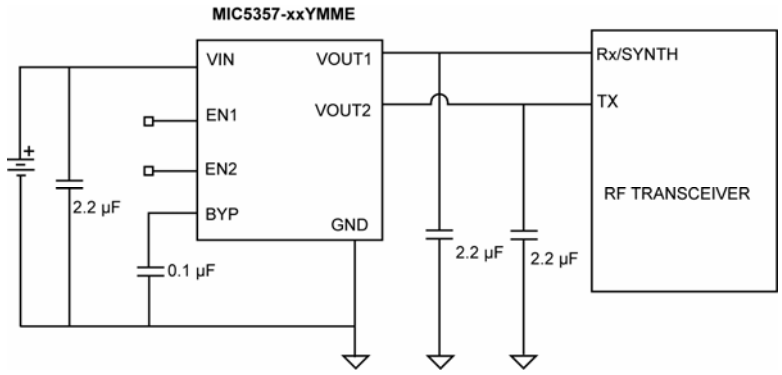
Features

- 2.6V to 5.5V input voltage range
- Ultra low dropout voltage: 130mV @ 500mA
- Ultra low output noise: 51µV_{RMS}
- ±2% initial output accuracy
- Small 8-pin ePad MSOP package
- Excellent Load/Line transient response
- Fast start up time: 38µs
- µCap stable with 2.2µF ceramic capacitors
- Thermal shutdown protection
- Low quiescent current: 160µA with both outputs at maximum load
- Current-limit protection

Applications

- Battery-Powered Applications
- PDAs
- GPS receivers
- Portable electronics
- Portable media players
- Digital still and video cameras

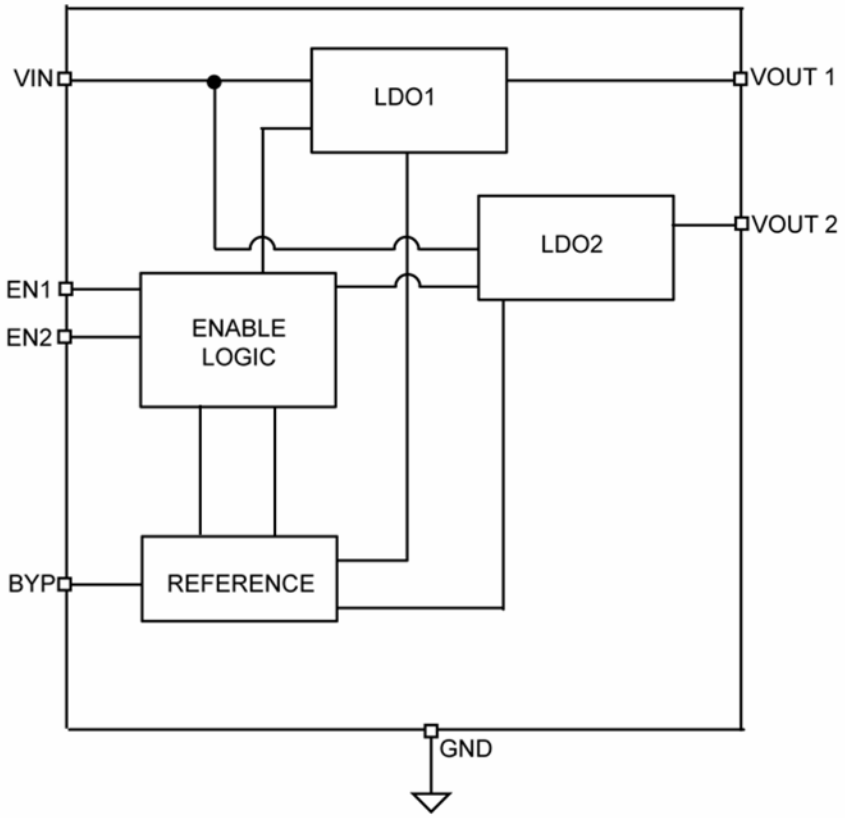
Typical Application



RF Power Supply Circuit

ULDO is a trademark of Micrel, Inc

Block Diagram



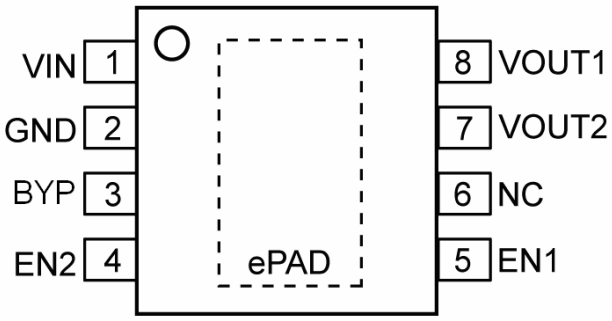
Ordering Information

Part Number [1]	Manufacturing Part Number	Marking	Voltage(V)		Junction Temperature Range	Package
			V_{OUT1}	V_{OUT2}		
MIC5357-3.3/2.8YMME	MIC5357-SMYMME	57SM	3.3V	2.8V	–40°C to +125°C	8-Pin ePAD MSOP
MIC5357-3.3/1.8YMME	MIC5357-SGYMME	57SG	3.3V	1.8V	–40°C to +125°C	8-Pin ePAD MSOP
MIC5357-2.8/1.8YMME	MIC5357-MGYMME	57MG	2.8V	1.8V	–40°C to +125°C	8-Pin ePAD MSOP
MIC5357-1.8/1.5YMME	MIC5357-GFYMME	57GF	1.8V	1.5V	–40°C to +125°C	8-Pin ePAD MSOP

Notes

1. For other voltage options contact Micrel Marketing.

Pin Configuration



8-Pin ePAD MSOP (MME)

TOP VIEW

Pin Description

Pin Number	Pin Name	Pin Function
1	VIN	Supply Input.
2	GND	Ground.
3	BYP	Reference Bypass: Connect external 0.1µF to GND to reduce output noise. May be left open when bypass capacitor is not required.
4	EN2	Enable Input (regulator 2). Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
5	EN1	Enable Input (regulator 1). Active High Input. Logic High = On; Logic Low = Off; Do not leave floating.
6	NC	Not internally connected.
7	VOUT2	Regulator Output – LDO2.
8	VOUT1	Regulator Output – LDO1.
ePAD	HS Pad	Heatsink Pad internally connected to ground.

Absolute Maximum Ratings[1]

Supply Voltage (V_{IN}) ..... –0.3V to +6V
Enable Input Voltage (V_{EN1} , V_{EN2}) ..... –0.3V to V_{IN}
Power Dissipation ..... Internally Limited[3]
Lead Temperature (soldering, 3sec) ..... 260°C
Storage Temperature (T_S) ..... –65°C to +150°C
ESD Rating[4] 2kV

Operating Ratings[2]

Supply Voltage (V_{IN}) ..... +2.6V to +5.5V
Enable Input Voltage (V_{EN1}, V_{EN2}) ..... 0V to V_{IN}
Junction Temperature ..... –40°C to +125°C
Junction Thermal Resistance
8-Pin ePAD MSOP (θ_{JA}) ..... 64.4°C/W

Electrical Characteristics[5]

$V_{IN} = V_{EN1} = V_{EN2} = V_{OUT} + 1.0V$; higher of the two regulator outputs, $I_{OUTLDO1} = I_{OUTLDO2} = 100\mu A$; $C_{OUT1} = C_{OUT2} = 2.2\mu F$; $C_{BYP} = 0.1\mu F$; $T_J = 25°C$, **bold** values indicate $–40°C \le T_J \le +125°C$, unless noted.

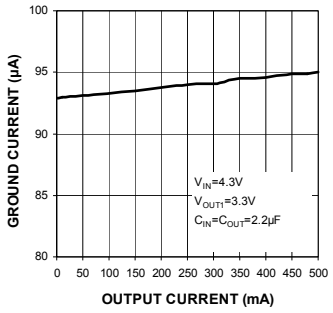
Parameter	Conditions	Min.	Typ.	Max.	Units
Output Voltage Accuracy	Variation from nominal V_{OUT}	-2.0		+2.0	%
	Variation from nominal V_{OUT}; –40°C to +125°C	**-3.0**		**+3.0**	
Line Regulation	$V_{IN} = V_{OUT}$ + 1V to 5.5V; I_{OUT} = 100µA		0.05	0.3 **0.6**	%/V
Load Regulation	$I_{OUT1\&2}$ =100µA to 500mA		0.7	**2.5**	%
Dropout Voltage[6]	$I_{OUT1,2}$ = 100µA		0.1		mV
	$I_{OUT1,2}$ = 50mA		12	**50**	
	$I_{OUT1,2}$ = 500mA		130	**300**	
Ground Current	$V_{EN1} \ge 1.2V$; $V_{EN2} \le 0.2V$; I_{OUT} = 0mA to 500mA		95	**175**	µA
	$V_{EN1} \le 0.2V$; $V_{EN2} \ge 1.2V$; I_{OUT2} = 0mA to 500mA		95	**175**	
	$V_{EN1} = V_{EN2} \ge 1.2V$; I_{OUT1} = 500mA, I_{OUT2} = 500mA		160	**240**	
Ground Current in Shutdown	$V_{EN1} = V_{EN2} = 0V$		0.01	2	µA
Ripple Rejection	f = 1kHz; C_{OUT} = 2.2µF; C_{BYP} = 0.1µF		70		dB
	f = 20kHz; C_{OUT} = 2.2µF; C_{BYP} = 0.1µF		45		
Current Limit	$V_{OUT1} = 0V$	**550**	950	**1300**	mA
	$V_{OUT2} = 0V$	**550**	950	**1300**	
Output Voltage Noise	C_{OUT} = 2.2µF; C_{BYP} = 0.1µF; 10Hz to 100kHz		51		μV_{RMS}
Enable Inputs (EN1 / EN2)					
Enable Input Voltage	Logic Low			**0.2**	V
	Logic High	**1.2**			
Enable Input Current	$V_{IL} \le 0.2V$		0.01		µA
	$V_{IH} \ge 1.2V$		0.01		
Turn-on Time (See Timing Diagram)					
Turn-on Time (LDO1 and 2)	C_{OUT} = 2.2µF; C_{BYP} = 0.1µF		38	**100**	µs

Notes:

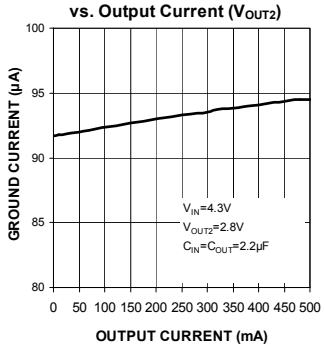
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. The maximum allowable power dissipation of any T_A (ambient temperature) is $P_{D(max)} = (T_{J(max)} – T_A) / \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.
4. Devices are ESD sensitive. Handling precautions recommended. Human body model 1.5kΩ in series with 100pF.
5. Specification for packaged product only.
6. Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal V_{OUT}. For outputs below 2.6V, the dropout voltage is the input-to-output differential with the minimum input voltage 2.6V.

Typical Characteristics

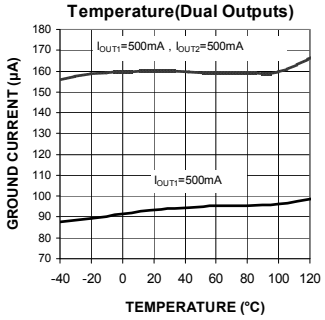
Ground Current vs. Output Current (V_{OUT1})



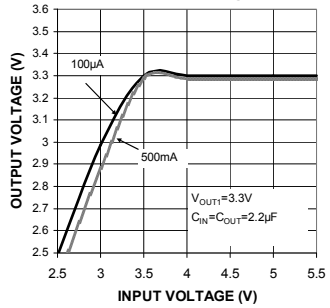
Ground Current vs. Output Current (V_{OUT2})



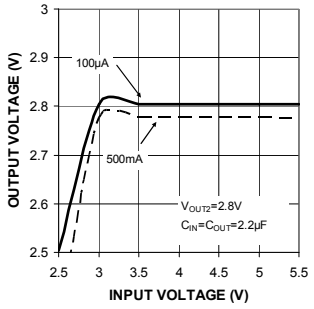
Ground Current vs. Temperature(Dual Outputs)



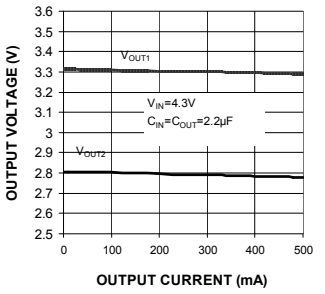
Output Voltage vs. Input Voltage



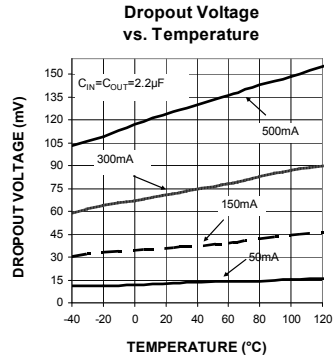
Output Voltage vs. Input Voltage



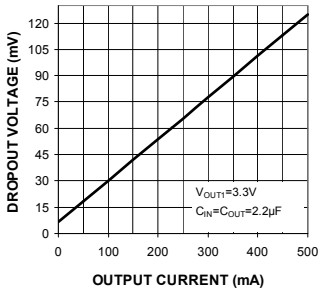
Output Voltage vs. Output Current



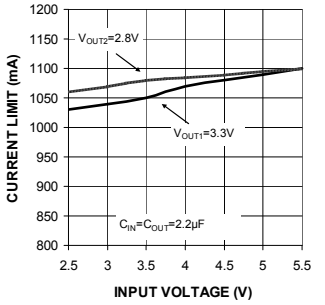
Dropout Voltage vs. Temperature



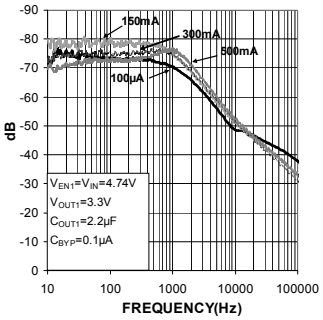
Dropout Voltage vs. Output Current



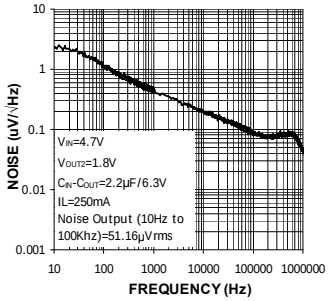
Current Limit vs. Input Voltage



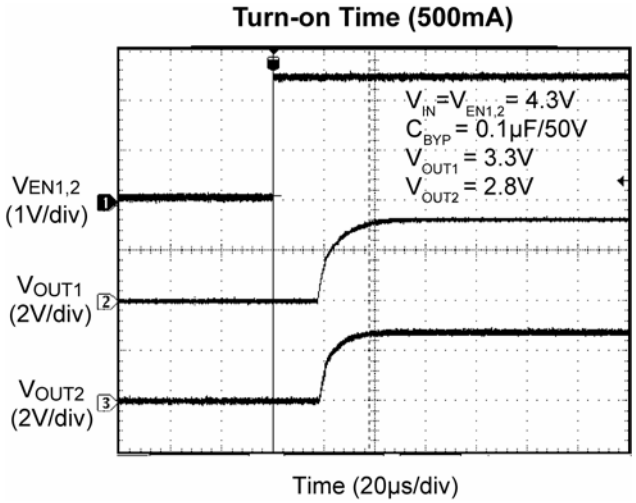
Power Supply Rejection Ratio

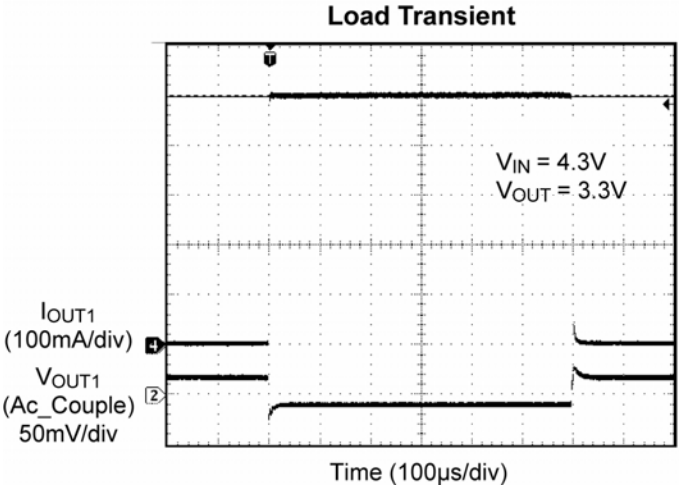


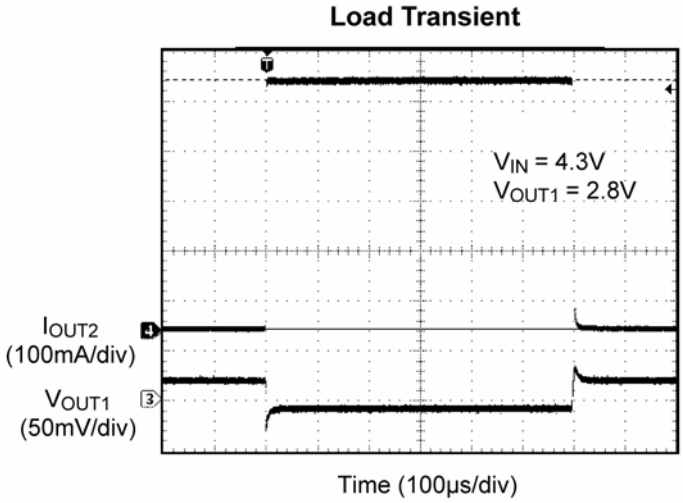
Output Noise Spectral Density

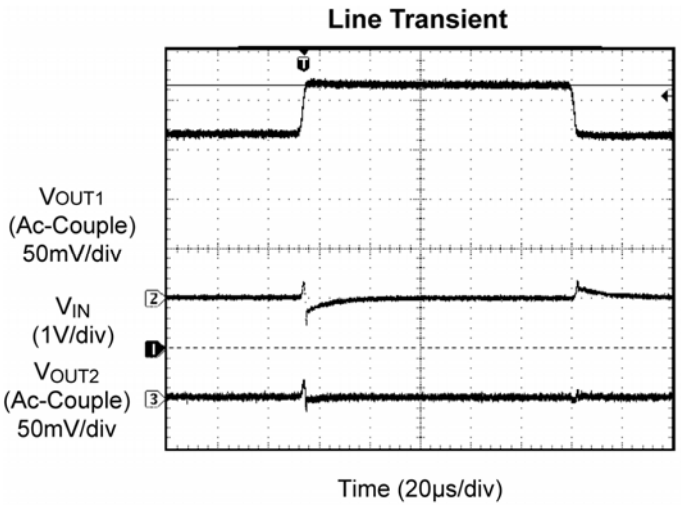


Functional Characteristics









Applications Information

Enable/Shutdown

The MIC5357 is provided with dual active high enable pins that allow each regulator to be enabled independently. Forcing both enable pins low disables the regulators 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 MIC5357 is a high performance, high bandwidth device. Therefore, it requires a well bypassed input supply for optimal performance. A 2.2µF 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 MIC5357 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 superior 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.

Bypass Capacitor

A capacitor can be placed from the noise bypass pin to ground to reduce output voltage noise. The capacitor bypasses the internal reference. A 0.1µF capacitor is recommended for applications that require low noise outputs. The bypass capacitor can be increased, further reducing noise and improving PSRR. Turn on time increases slightly with respect to bypass capacitance.

A unique, quick start circuit allows the MIC5357 to drive a large capacitor on the bypass pin without significantly slowing the turn on time.

No-Load Stability

Unlike many other voltage regulators, the MIC5357 will remain stable with no load. This is especially important in CMOS RAM keep alive applications.

Thermal Considerations

The MIC5357 is designed to provide 500mA of continuous current for V_{OUT1} and 500mA for V_{OUT2} in a small package. The 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 3.3V for V_{OUT1}, 2.8V for V_{OUT2} and the output current of 500mA and 500mA respectively. 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 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.

$$P_D = (3.6V – 3.3V) \times 500mA + (3.6V - 2.8) \times 500mA$$
$$P_D = 0.55W$$

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 = 64.4°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 64.4°C/W.

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

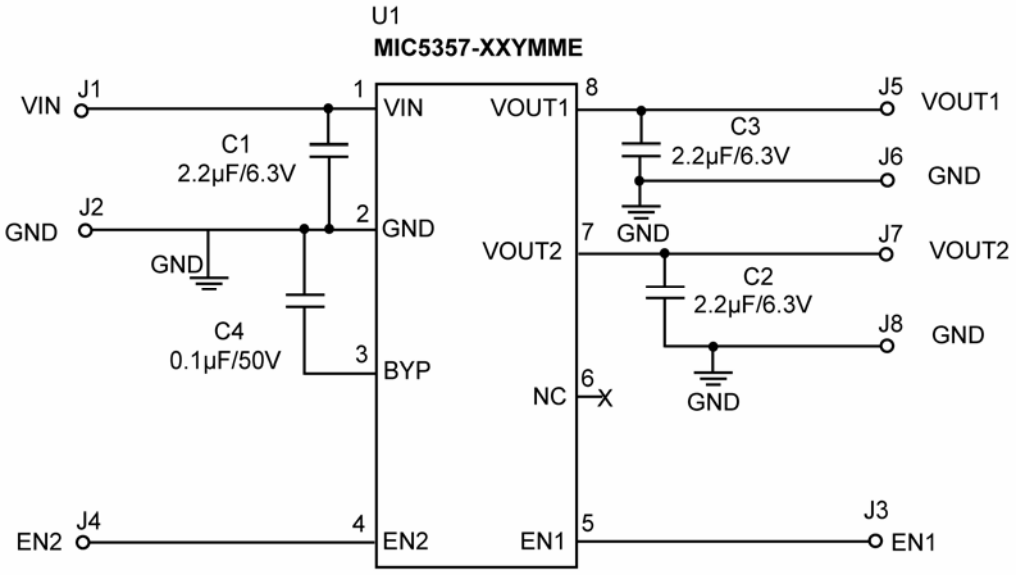
For example, when operating the MIC5357 at an input voltage of 3.6V and 500mA on V_{OUT1} and 500mA on V_{OUT2}, the maximum ambient operating temperature T_A can be determined as follows:

$$0.55W = (125°C – T_A)/(64.4°C/W)$$
$$T_A = 89.6°C$$

Therefore, a 3.3V/2.8V application with 500mA and 500mA output currents can accept an ambient operating temperature of 89.6°C in a small 8 Pin ePAD MSOP 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



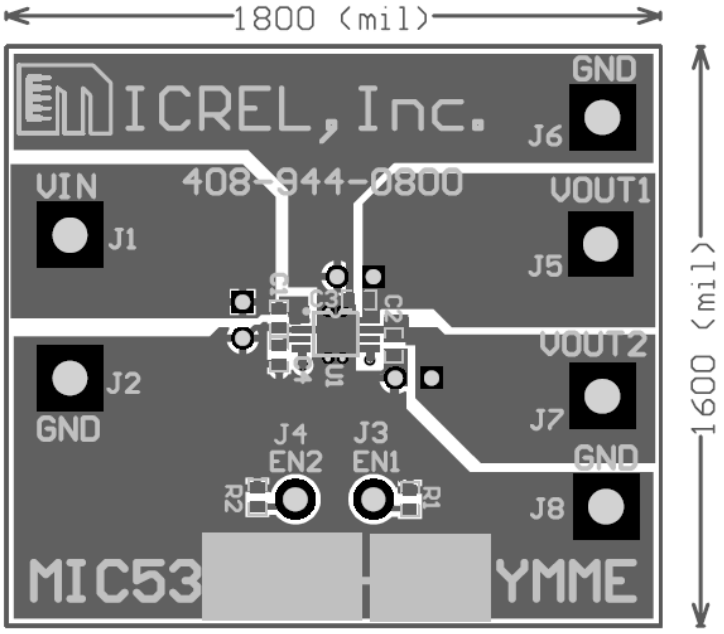
Bill of Materials

Item	Part Number	Manufacturer	Description	Qty.
C1, C2,C3	C1005X5R0J225M	TDK[1]	Capacitor, 2.2µF Ceramic, 6.3V, X5R, Size 0402	3
C4	VJ0402Y104KXX	Vishay[2]	Capacitor, 0.1µF Ceramic, 25V, X7R, Size 0402	1
U1	**MIC5357-xxYMME**	**Micrel, Inc.**[3]	**High Performance, Low Noise Dual 500mA ULDO™**	**1**

Notes:

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

PCB Layout Recommendations



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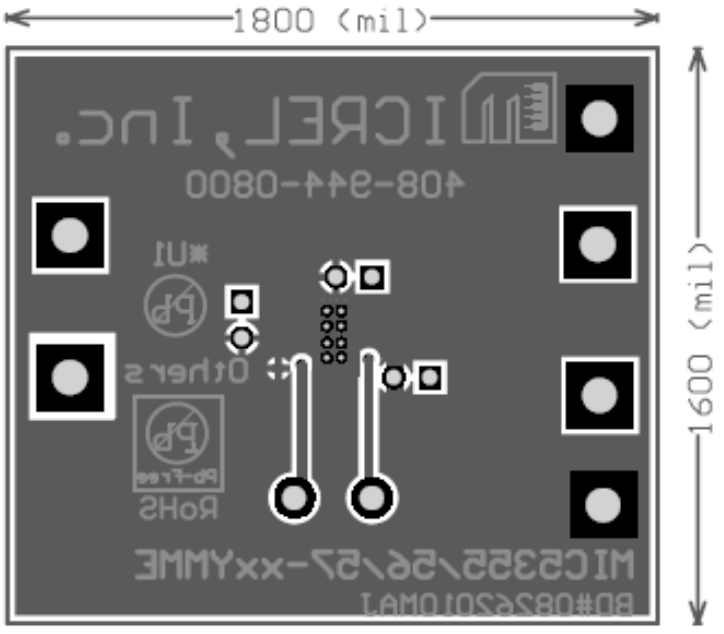
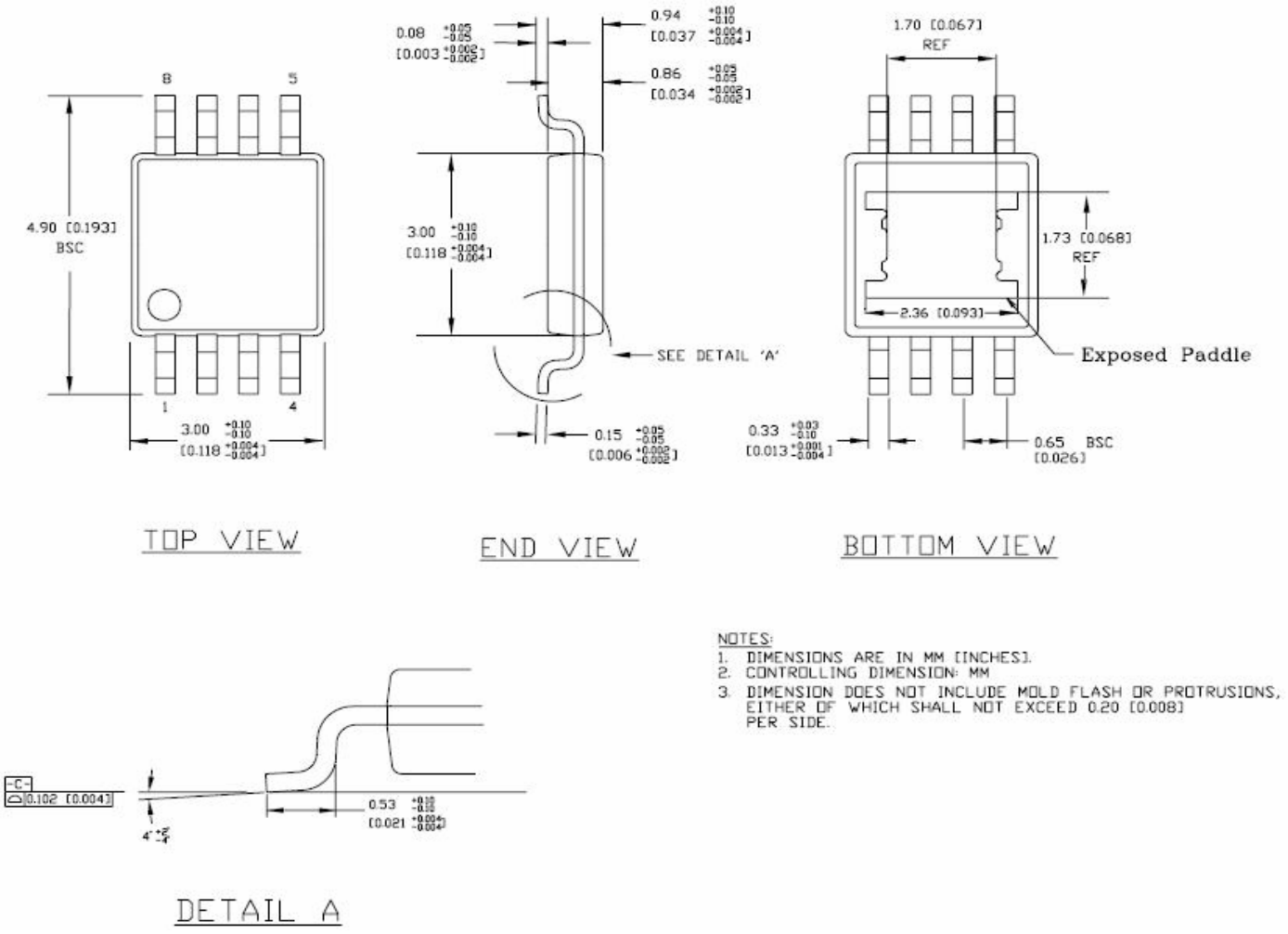


Bottom Layer

Package Information



8-Pin ePAD MSOP (MME)

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