MICROCHIP

MIC5363/4

High-PSRR, 300 mA, µCap LDO

Features

- 2.5V to 5.5V Input Voltage Range
- 300 mA Output Current LDOs
- High Output Accuracy: ±2%
- Low Quiescent Current: Typically 38 µA
- Stable with 1 µF Ceramic Output Capacitors
- High PSRR (70 dB @1 kHz)
- Low Dropout Voltage: 225 mV at 300 mA
- Thermal Shutdown Protection
- Current Limit Protection
- Active Output Discharge Circuit (MIC5364)
- 6-Pin 1.2 mm × 1.2 mm Thin DFN Package

Applications

- Mobile Phones
- GPS, PMP, and DSC
- Battery Powered Electronics
- Moise Sensitive Applications

General Description

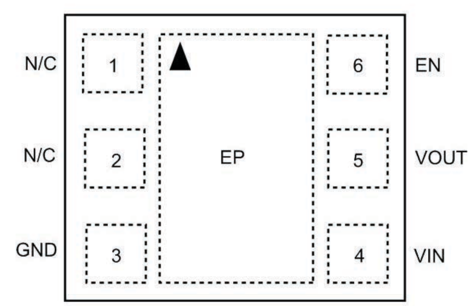
The MIC5363/4 is an advanced, 300 mA LDO ideal for powering general purpose portable devices requiring a high power supply rejection ratio (PSRR). The MIC5363/4 integrates a high-performance, 300 mA LDO into a tiny 1.2 mm x 1.2 mm Thin DFN package.

The MIC5363/4 is designed to reject input noise and provide a low output noise regulator with fast transient response to respond to any load change quickly. The MIC5364 also incorporates an active discharge feature that switches a 30Ω NFET from VOUT to GND to discharge output capacitors when the part is disabled.

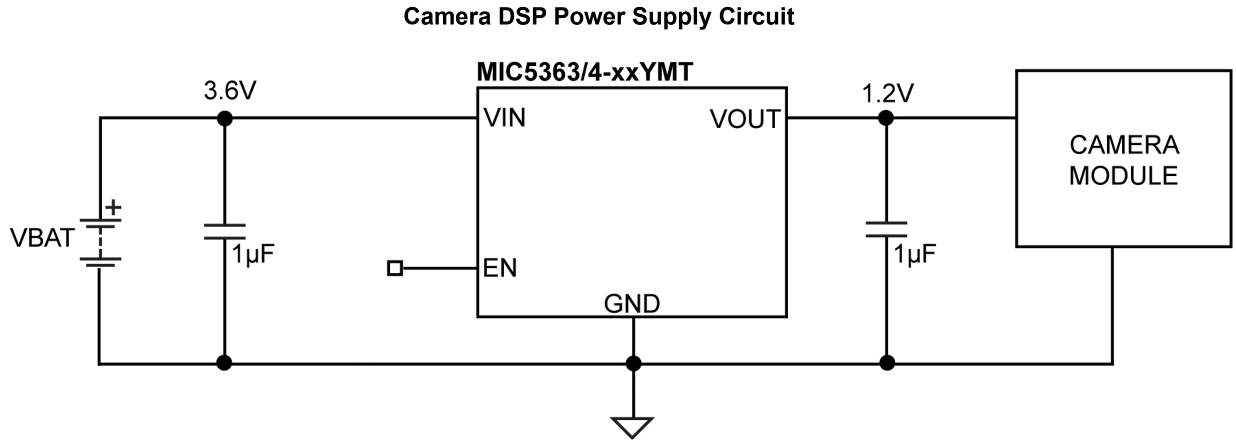
The MIC5363/4 is available in fixed output voltages in lead-free (RoHS-compliant) 6-Pin 1.2 mm x 1.2 mm Thin DFN leadless package.

Package Type

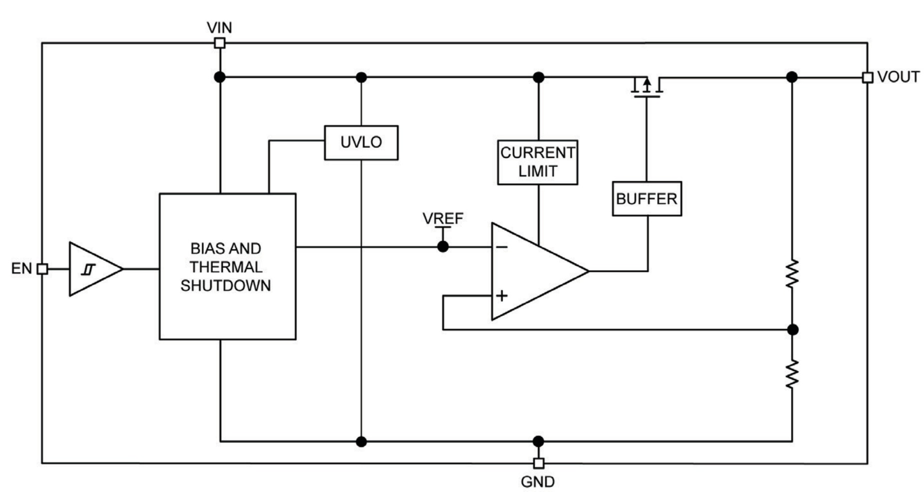
MIC5363/4
TDFN-6 (MT)
(Top View)

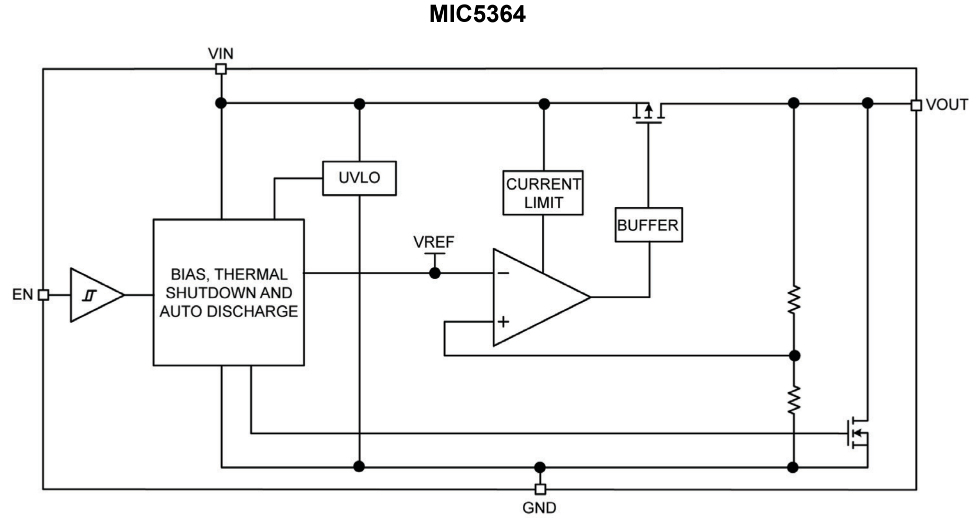


Typical Application Circuit



Functional Block Diagrams





1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage (V_{IN}) .... –0.3V to +6V
Enable Voltage (V_{EN}) .... –0.3V to V_{IN} +0.3V
Power Dissipation (P_D), Note 1 .... Internally Limited
ESD Rating, Note 2 .... 2 kV

Operating Ratings ‡

Supply Voltage (V_{IN}) .... +2.5V to +5.5V
Enable Voltage (V_{EN}) .... 0V to V_{IN}

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

‡ Notice: The device is not guaranteed to function outside its operating ratings.

Note 1: 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.

2: Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: $V_{IN} = V_{EN} = V_{OUT}$ + 1V; if $V_{OUT} \leq$ 1.5V; I_{OUT} = 100µA; C_{OUT} = 1 µF; T_J = +25°C; **Bold** values are valid for –40°C to +125°C unless noted. (**Note 1**).

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage Accuracy	V_{OUT}	–2.0	—	+2.0	%	Variation from nominal V_{OUT}
		–3.0	—	**+3.0**		Variation from nominal V_{OUT}; –40°C to +125°C
Line Regulation, Note 2	$\Delta V_{OUT}/(V_{OUT} \times \Delta V_{IN})$	—	0.02	**0.2**	%/V	V_{IN} = Max (V_{OUT} + 1V, 2.5V) to 5.5V, I_{OUT} = 100 µA
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	—	0.3	**0.7**	%	I_{OUT} = 100 µA to 300 mA
Dropout Voltage, Note 3	V_{DO}	—	35	**65**	mV	I_{OUT} = 50 mA; $V_{OUT} \geq$ 2.8V
		—	225	**380**		I_{OUT} = 50 mA; $V_{OUT} \geq$ 2.8V
		—	55	**100**		I_{OUT} = 50 mA; 2.5V ≤ V_{OUT} < 2.8V
		—	300	**600**		I_{OUT} = 50 mA; 2.5V ≤ V_{OUT} < 2.8V
Ground Pin Current	I_{GND}	—	38	**53**	µA	V_{EN} = High; I_{OUT} = 0 mA
		—	55	**70**		V_{EN} = High; I_{OUT} = 300 mA
Shutdown Current	I_{SHDN}	—	0.1	1	µA	V_{EN} = 0V
Supply Ripple Rejection	PSRR	—	70	—	dB	f = 1 kHz; C_{OUT} = 1 µF
Current Limit	I_{LIM}	325	520	680	mA	V_{OUT} = 0V
Output Voltage Noise	e_N	—	200	—	μV_{RMS}	C_{OUT} = 1µF, 10 Hz to 100 kHz
Auto-Discharge NFET Resistance	R_{DSCG}	—	30	—	Ω	MIC5364 Only; V_{EN} = 0V, V_{IN} = 3.6V, I_{OUT} = –3 mA
Enable Inputs (EN1/EN2)						
Enable Input Voltage	V_{IL}	—	—	**0.2**	V	Logic Low
	V_{IH}	**1.2**	—	—		Logic High

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: $V_{IN} = V_{EN} = V_{OUT} + 1V$; if $V_{OUT} \le 1.5V$; $I_{OUT} = 100\mu A$; $C_{OUT} = 1\ \mu F$; $T_J = +25°C$; **Bold** values are valid for –40°C to +125°C unless noted. (**Note 1**).

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Enable Input Current	I_{IL}	—	0.01	**1**	µA	$V_{IL} \le 0.2V$
	I_{IH}	—	0.01	**1**		$V_{IH} \ge 1.2V$
Turn-On Time	t_{ON}	—	60	**150**	µs	$C_{OUT} = 1\ \mu F$

Note 1: Specification for packaged product only.

2: 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.

3: Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal value.

TEMPERATURE SPECIFICATIONS

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Temperature Range	T_J	–40	—	+125	°C	Note 1
Storage Temperature Range	T_S	–65	—	+150	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 10 sec.
Package Thermal Resistances						
Thermal Resistance, TDFN-6	θ_{JA}	—	173	—	°C/W	—

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

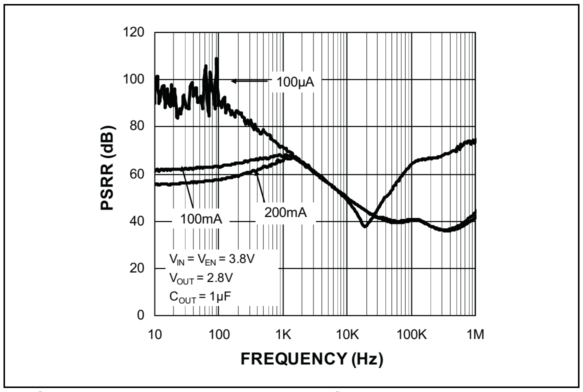


FIGURE 2-1: *Power Supply Rejection Ratio.*

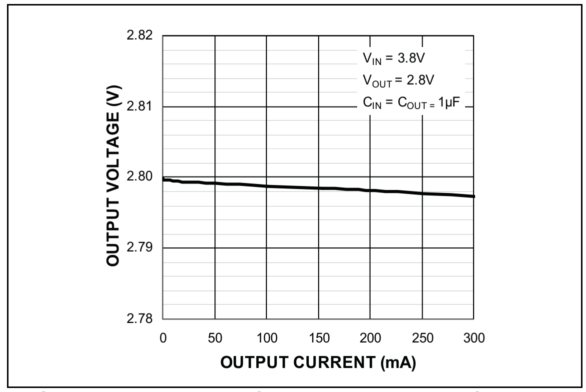


FIGURE 2-4: *Output Voltage vs.Output Current.*

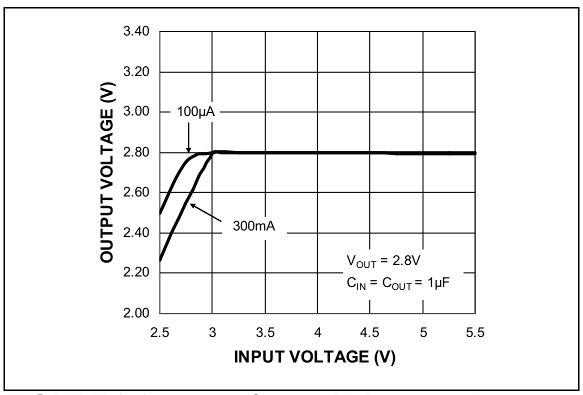


FIGURE 2-2: *Output Voltage vs. Input Voltage (V_{OUT} = 2.8V).*

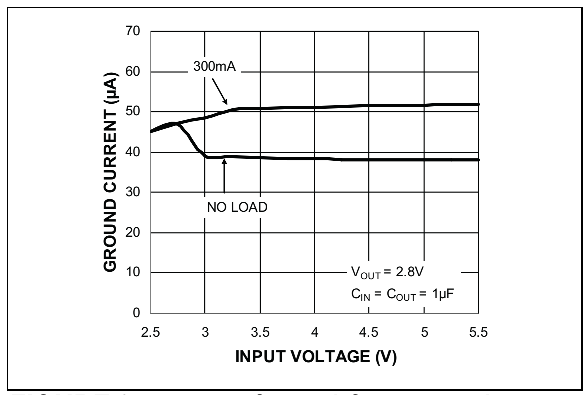


FIGURE 2-5: *Ground Current vs. Input Voltage.*

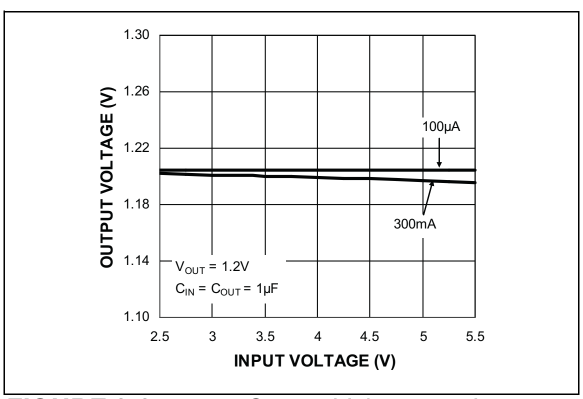


FIGURE 2-3: *Output Voltage vs. Input Voltage (V_{OUT} = 1.2V).*

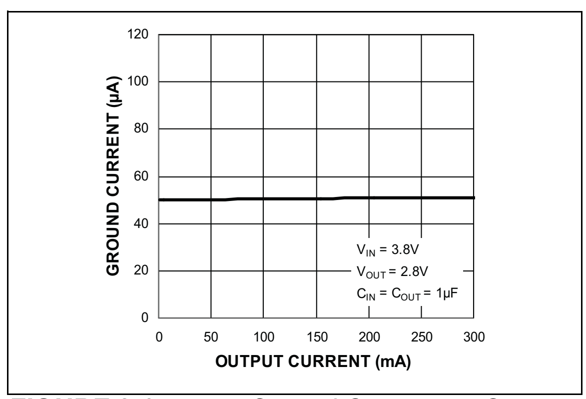


FIGURE 2-6: *Ground Current vs. Output Current.*

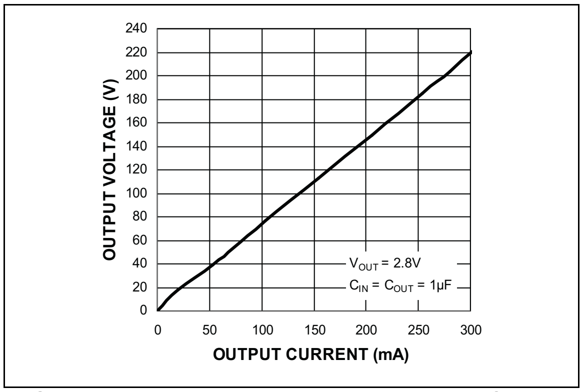


FIGURE 2-7: Dropout Voltage vs. Output Current.

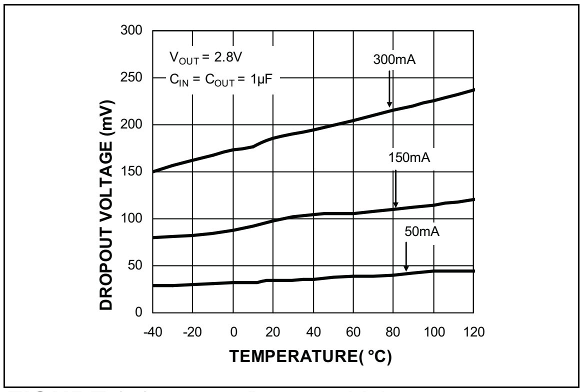


FIGURE 2-8: Dropout Voltage vs. Temperature.

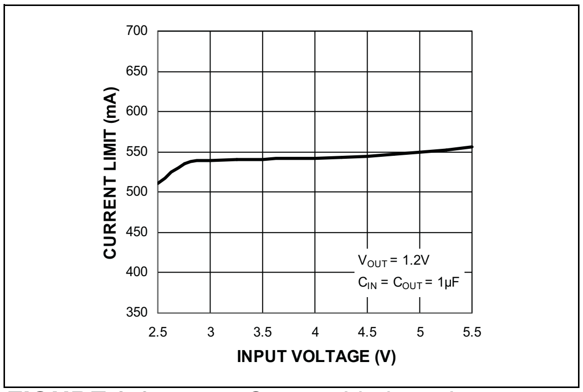


FIGURE 2-9: Current Limit vs. Input Voltage.

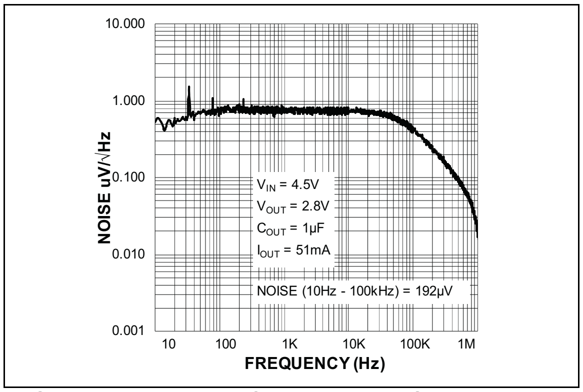


FIGURE 2-10: Output Noise Spectral Density.

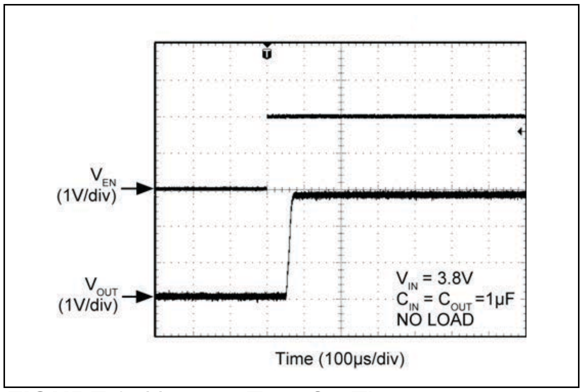


FIGURE 2-11: Turn-On Time.

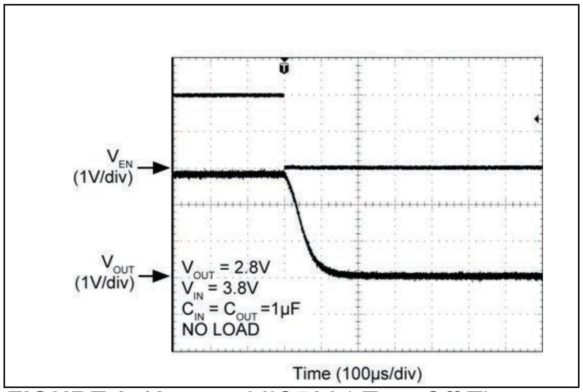


FIGURE 2-12: MIC5364 Turn-Off Time (Auto-Discharge).

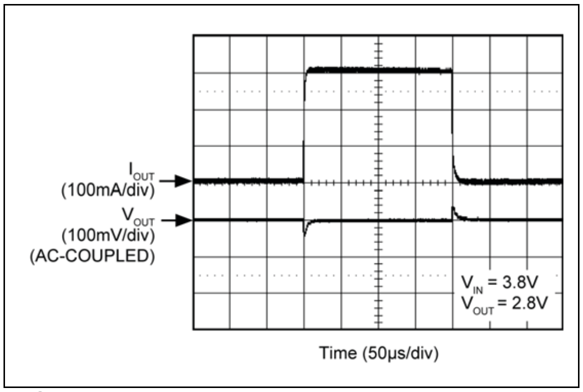


FIGURE 2-13: *Load Transient.*

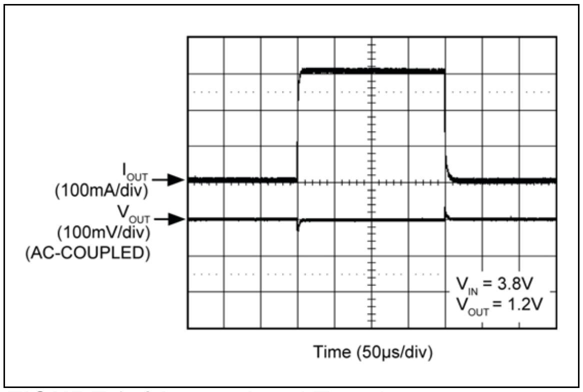


FIGURE 2-14: *Load Transient.*

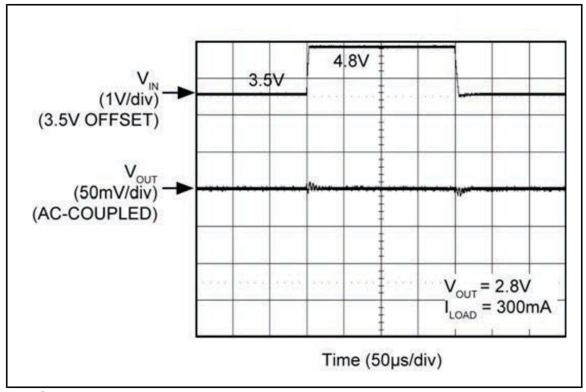


FIGURE 2-15: *Line Transient.*

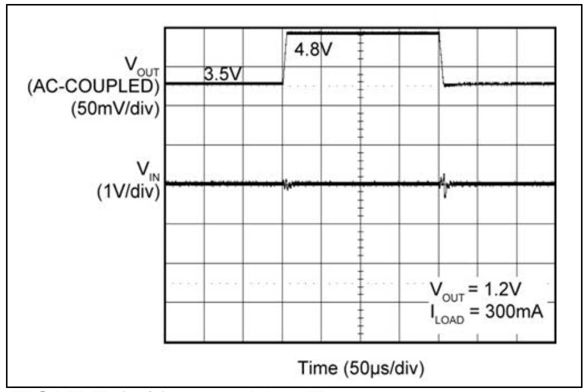


FIGURE 2-16: *Line Transient.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	NC	Not internally connected.
2	NC	Not internally connected.
3	GND	Ground.
4	VIN	Supply Input. Decouple with 1 µF ceramic capacitor.
5	VOUT	Output Voltage. Decouple with 1 µF ceramic capacitor.
6	EN1	Enable Input. Active-High. Logic High = ON, Logic Low = OFF. Do not leave floating.
EP	ePad	Exposed Heatsink Pad. Connect to ground for best thermal performance.

4.0 APPLICATION INFORMATION

The MIC5363/4 is a 300 mA LDO, packaged in a 1.2 mm x 1.2 mm Thin DFN package. The MIC5364 includes an auto-discharge feature which automatically discharges the output capacitor when the output is disabled. The MIC5363/4 consists of an internal reference, error amplifier, P-channel pass transistor, and internal feedback resistors. The error amplifier compares the feedback voltage with that of the reference. Depending upon whether the feedback is lower or higher than the reference determines whether the gate of the pass transistor is pulled low to allow more current and increase output voltage or pulled high to reduce current. The MIC5363/4 regulator is fully protected from damage due to fault conditions through linear current limiting and thermal shutdown.

4.1 Input Capacitor

The MIC5363/4 is a high-performance, high-bandwidth device. An input capacitor of 1 µF 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. X5R or X7R dielectrics are recommended for the input capacitor. Y5V dielectrics lose most of their capacitance over temperature and are therefore, not recommended.

4.2 Output Capacitor

The MIC5392/3 requires an output capacitor of 1 µF 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 1 µF 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 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.

4.3 No-Load Stability

The MIC5363/4 will remain stable and in regulation without the need of a minimum load. This reduces the amount and therefore cost of external components.

4.4 Enable/Shutdown

The MIC5363/4 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 an off-mode current state drawing virtually zero current. When disabled, the MIC5364 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.

4.5 Thermal Considerations

The MIC5392/3 is designed to provide 150 mA of continuous current for both outputs 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 = 300 mA. The actual power dissipation of the regulator circuit can be determined using Equation 4-1:

EQUATION 4-1:

$$P_D = (V_{IN} - V_{OUT})I_{OUT} + V_{IN} \times I_{GND}$$

Because this device is CMOS and the ground current is typically <60 µA over the load range, the power dissipation contributed by the ground current is <1% and can be ignored for the calculation in Equation 4-2:

EQUATION 4-2:

$$P_D = (3.6V - 2.8V) \times 300mA$$

$$P_D = 0.24W$$

To determine the maximum ambient operating temperature of the package, use the junction-to-ambient thermal resistance of the device and the following basic formula in Equation 4-3:

EQUATION 4-3:

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

Where:

$T_{J(MAX)}$ = 125°C

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 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 a 2.8V application with an input voltage of 3.6V and 300 mA output with a standard footprint layout, the maximum ambient operating temperature T_A can be determined in Equation 4-4:

EQUATION 4-4:

$$0.24W = (125°C - T_A)/(173°C/W)$$

$$T_A = 83°C$$

Therefore, a MIC5363-2.8YMT application with 300 mA of output current can accept an ambient operating temperature of 83°C in a 1.2 mm × 1.2 mm TDFN package. For a full discussion of heat sinking and thermal effects of voltage regulators, refer to the "Regulator Thermals" section of Designing with Low-Dropout Voltage Regulators handbook.

5.0 TYPICAL APPLICATION SCHEMATIC

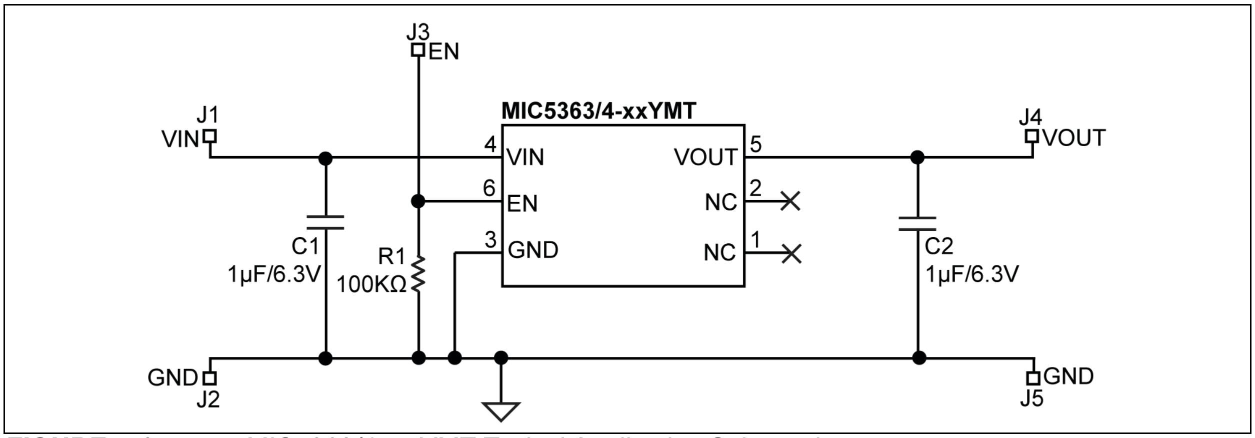


FIGURE 5-1: *MIC5363/4-x.xYMT Typical Application Schematic.*

BILL OF MATERIALS

Item	Part Number	Manufacturer	Description	Qty.
C1, C2	GRM155R61A105KE15D	Murata	Capacitor, 1 µF Ceramic, 10V, X5R, Size 0402	2
R1	CRCW04021003FKED	Vishay	Resistor, 100 kΩ (0403 size), 1%	1
U1	**MIC5363/4-x.xYMT**	**Microchip**	**300 mA µCap LDO in 1.2mm x 1.2mm Thin DFN**	**1**

6.0 PCB LAYOUT RECOMMENDATIONS

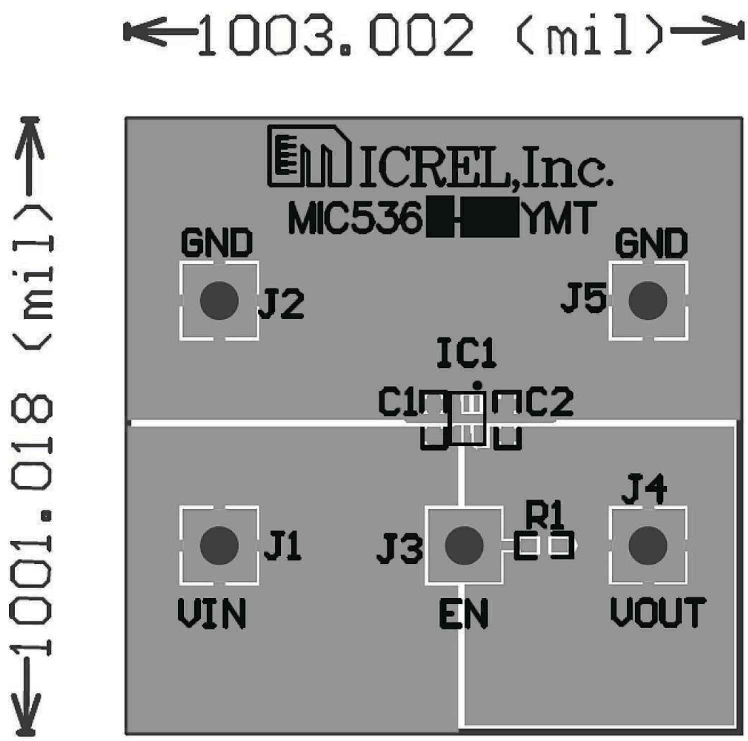


FIGURE 6-1: *Top Layer.*

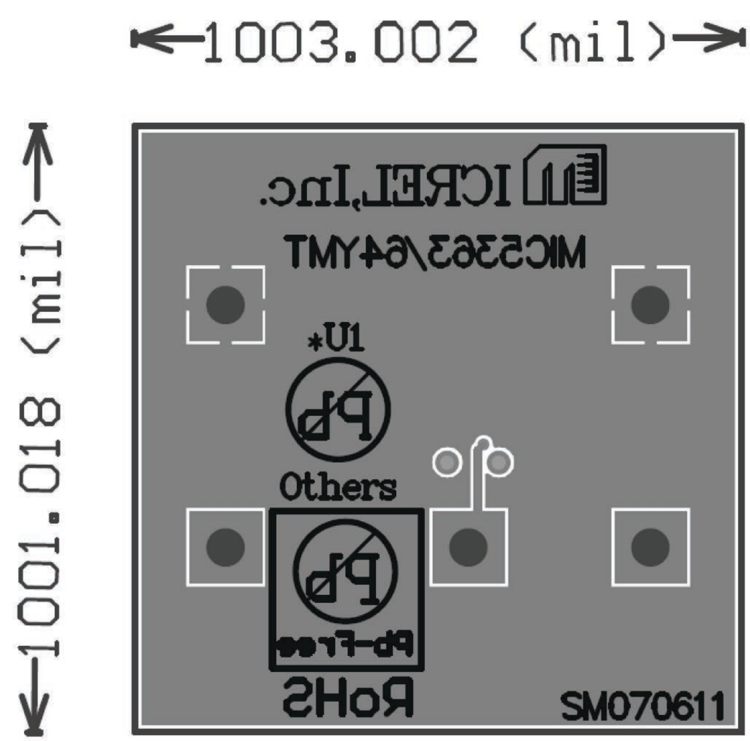
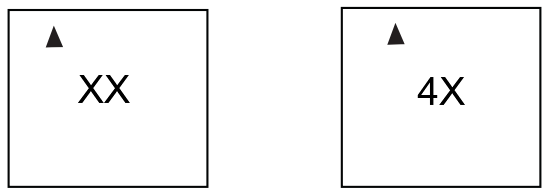


FIGURE 6-2: *Bottom Layer.*

7.0 PACKAGING INFORMATION

7.1 Package Marking Information

6-Lead TDFN* Example



Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

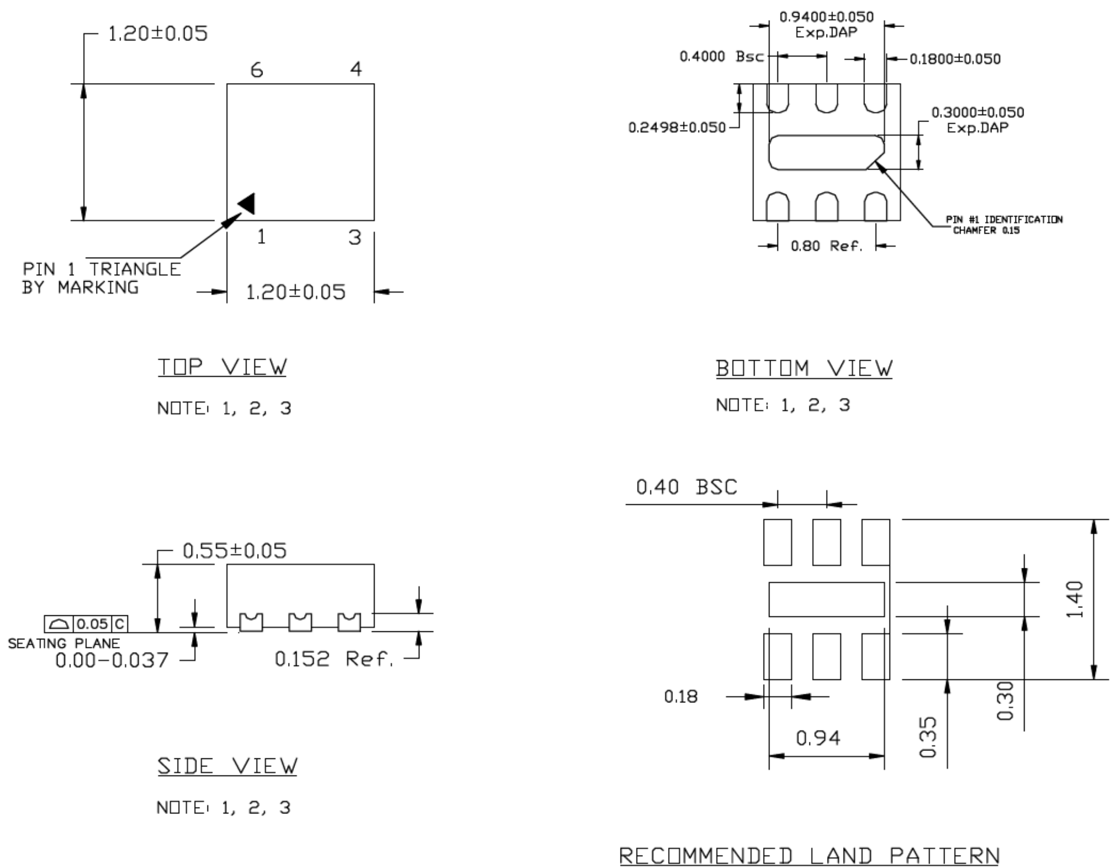
TABLE 7-1: PACKAGE MARKING CODES

Part Number	Output Voltage	Marking Codes
MIC5363-1.2YMT	1.2V	34
MIC5363-2.8YMT	2.8V	3G
MIC5363-3.3YMT	3.3V	3S
MIC5364-1.2YMT	1.2V	44
MIC5364-2.8YMT	2.8V	4X
MIC5364-3.3YMT	3.3V	4S

6-Lead TDFN Package Outline and Recommended Land Pattern

TITLE
6 LEAD TDFN 1.2x1.2mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	TDFN1212-6LD-PL-1	**UNIT**	MM



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

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

APPENDIX A: REVISION HISTORY

Revision A (October 2021)

- Converted Micrel document MIC5363/4 to Microchip data sheet DS20006604A.
- Minor text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	-XX	X	XX	-XX
Device	Voltage Option	Junction Temperature Range	Package	Media Type

Device: MIC5363: High-Performance Dual 300 mA LDO
MIC5364: High-Performance Dual 300 mA LDO with Output Discharge Circuit

Voltage Option
34 = 1.2V (MIC5363)
3G = 2.8V (MIC5363)
3S = 3.3V (MIC5363)
44 = 1.2V (MIC5364)
4X = 2.8V (MIC5364)
4S = 3.3V (MIC5364)

Junction Temperature Range: Y = –40°C to +125°C (RoHS Compliant)

Package: MT = 6-Lead 1.2 mm x 1.2 mm Thin DFN (Pb-Free)

Media Type:
T5 = 500/Reel
TR = 5,000/Reel

Examples:

a) MIC5363-34YMT-T5 High-Performance Dual 300 mA LDO, 1.2V, –40°C to +125°C, 6-Lead 1.2 mm x 1.2 mm TDFN, 500/Reel

b) MIC5363-34YMT-TR High-Performance Dual 300 mA LDO, 1.2V, –40°C to +125°C, 6-Lead 1.2 mm x 1.2 mm TDFN, 5,000/Reel

c) MIC5364-4XYMT-T5 High-Performance Dual 300 mA LDO with Output Discharge Circuit, 2.8V, –40°C to +125°C, 6-Lead 1.2 mm x 1.2 mm TDFN, 500/Reel

c) MIC5364-4XYMT-TR High-Performance Dual 300 mA LDO with Output Discharge Circuit, 2.8V, –40°C to +125°C, 6-Lead 1.2 mm x 1.2 mm TDFN, 5,000/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
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- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is “unbreakable”. Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.

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