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## Ultra-Low Quiescent Current 150 mA $\mu$ Cap Low Dropout Regulator

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### Features

- Wide Input Voltage Range: 2.3V to 16V
- High Output Accuracy of  $\pm 2.0\%$  Over Temperature
- Guaranteed 150 mA Output
- Very Low Ground Current: 29  $\mu$ A
- Low Dropout Voltage of 310 mV at 150 mA
- $\mu$ Cap: Stable with Ceramic or Tantalum Capacitors
- Excellent Line and Load Regulation Specifications
- Reverse Battery Protection
- Reverse Leakage Protection
- Zero Shutdown Current
- Thermal Shutdown and Current Limit Protection
- SOT23-5 Package

### Applications

- Cellular Phones
- Keep Alive Supply in Notebook and Portable Computers
- Battery-Powered Equipment
- Consumer/Personal Electronics
- High-Efficiency Linear Power Supplies
- Automotive Electronics

### General Description

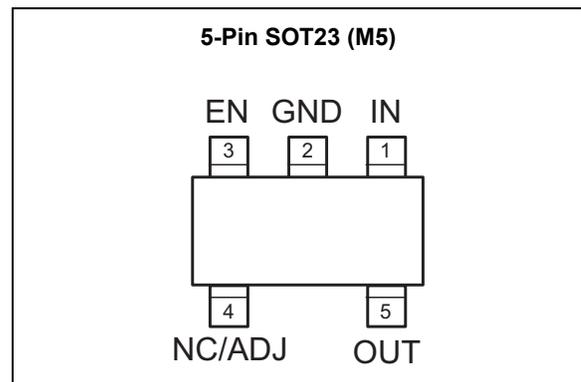
The MIC5225 is a 150 mA highly accurate, low dropout regulator with high input voltage and ultra-low ground current. This combination of high voltage and low ground current makes the MIC5225 ideal for a wide variety of applications including USB and portable electronics applications, using 1-cell, 2-cell or 3-cell Li-Ion battery inputs.

A  $\mu$ Cap LDO design, the MIC5225 is stable with either a ceramic or tantalum output capacitor. It only requires a 2.2  $\mu$ F capacitor for stability.

Features of the MIC5225 includes enable input, thermal shutdown, current limit, reverse battery protection, and reverse leakage protection.

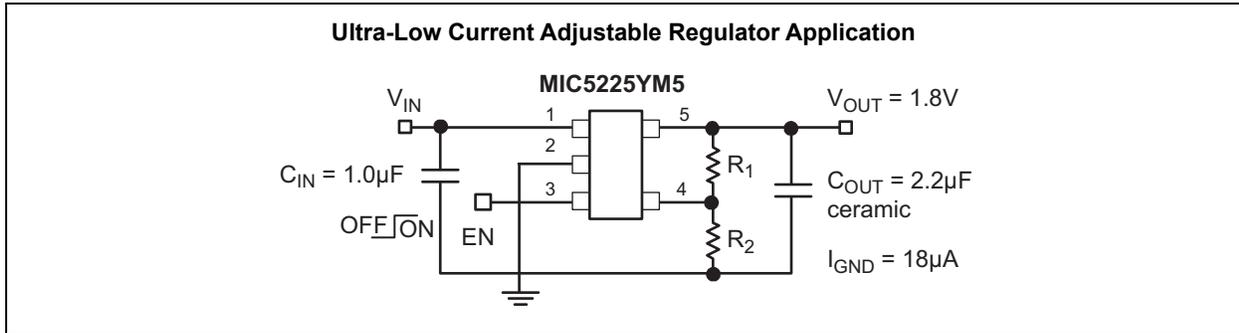
Available in fixed and adjustable output voltage versions, the MIC5225 is offered in the SOT23-5 package with a junction temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .

### Package Type

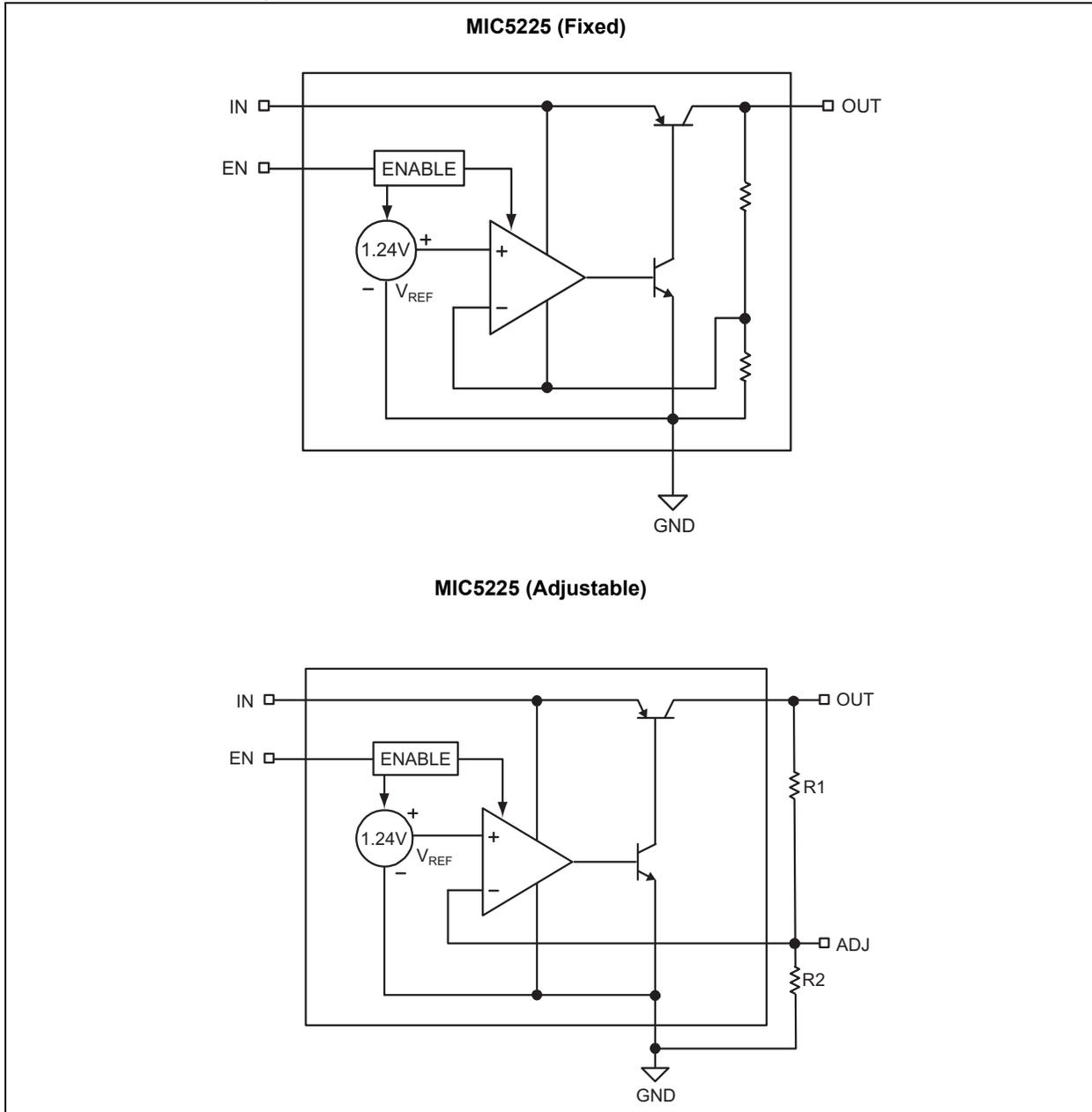


# MIC5225

## Typical Application Schematic



## Functional Block Diagrams



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

Supply Voltage ( $V_{IN}$ ) .....	-20V to +18V
Enable Input Voltage ( $V_{EN}$ ) .....	-0.3V to 18V
Power Dissipation ( $P_D$ ), <a href="#">Note 1</a> .....	Internally Limited
Lead Temperature (soldering, 3sec.) .....	260°C
Junction Temperature ( $T_J$ ) .....	-40°C to +125°C
Storage Temperature ( $T_S$ ) .....	-65°C to +150°C
ESD Rating, <a href="#">Note 2</a> .....	2 kV

### Operating Ratings ‡

Supply Voltage ( $V_{IN}$ ) .....	+2.3V to +16V
Enable Input Voltage ( $V_{EN}$ ) .....	0V to 16V
Junction Temperature ( $T_J$ ) .....	-40°C to +125°C
Package Thermal Resistance SOT23-5 ( $\theta_{JA}$ ) .....	235°C/W

**† 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.

# MIC5225

## ELECTRICAL CHARACTERISTICS **Note 1**

<b>Electrical Characteristics:</b> $V_{IN} = V_{OUT} + 1V$ ; $I_{OUT} = 100 \mu A$ ; $T_A = +25^\circ C$ ; <b>Bold</b> values indicate $-40^\circ C \leq T_J \leq +125^\circ C$ unless noted.						
Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage Accuracy	$V_{OUT}$	-1.0	—	+1.0	%	Variation from nominal $V_{OUT}$
		-2.0	—	+2.0		Variation from nominal $V_{OUT}$ ; $-40^\circ C$ to $+125^\circ C$
Line Regulation	$\frac{\Delta V_{OUT}}{(V_{OUT} \times \Delta V_{IN})}$	—	0.04	0.3	%	$V_{IN} = V_{OUT} + 1V$ to 16V
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	—	0.25	1	%	$I_{OUT} = 100 \mu A$ to 150 mA
Dropout Voltage	$V_{DO}$	—	50	—	mV	$I_{OUT} = 100 \mu A$
		—	230	300		$I_{OUT} = 50$ mA
		—	310	450		$I_{OUT} = 150$ mA
Reference Voltage	—	1.22	1.24	1.26	—	—
Ground Current	$I_{GND}$	—	29	50	$\mu A$	$I_{OUT} = 100 \mu A$
		—	0.5	0.9	mA	$I_{OUT} = 50$ mA
		—	3	5		$I_{OUT} = 150$ mA
Ground Current in Shutdown	$I_{SHDN}$	—	0.1	5	$\mu A$	$V_{EN} \leq 0.6V$ ; $V_{IN} = 16V$
Short Circuit Current	—	600	300	500	mA	$V_{OUT} = 0V$
Output Leakage, Reverse Polarity Input	$e_N$	—	-1.0	—	$\mu A$	$I_{OUT} = 500\Omega$ , $V_{IN} = -16V$
<b>Enable Input</b>						
Input Low Voltage	$V_{IL}$	—	—	0.6	V	Regulator OFF
Input High Voltage	$V_{IH}$	2.0	—	—		Regulator ON
Enable Input Current	$I_{EN}$	-1.0	0.01	+1.0	$\mu A$	$V_{EN} = 0.6V$ ; Regulator OFF
		—	0.15	1.0		$V_{EN} = 2.0V$ ; Regulator ON
		—	0.5	2.5		$V_{EN} = 16V$ ; Regulator ON

**Note 1:** Specification for packaged product only.

## TEMPERATURE SPECIFICATIONS

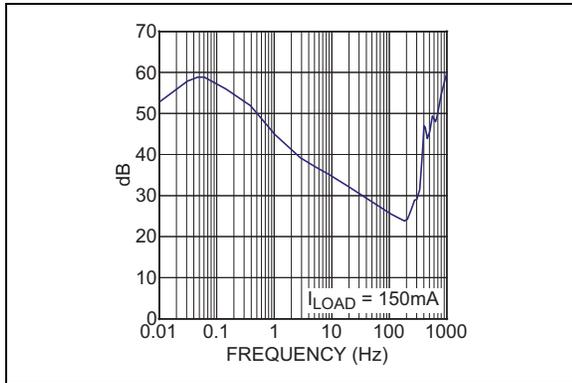
Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
<b>Temperature Ranges</b>						
Junction Temperature Range	$T_J$	-40	—	+125	°C	<a href="#">Note 1</a>
Storage Temperature Range	$T_S$	-65	—	+150	°C	—
<b>Package Thermal Resistances</b>						
Thermal Resistance, SOT23-5	$\theta_{JA}$	—	235	—	°C/W	—

**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.,  $T_A$ ,  $T_J$ ,  $\theta_{JA}$ ). 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.

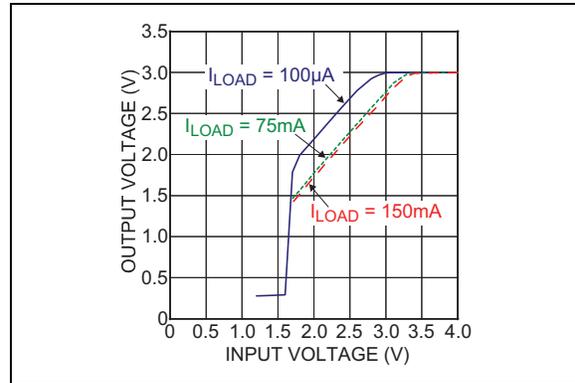
# MIC5225

## 2.0 TYPICAL PERFORMANCE CURVES

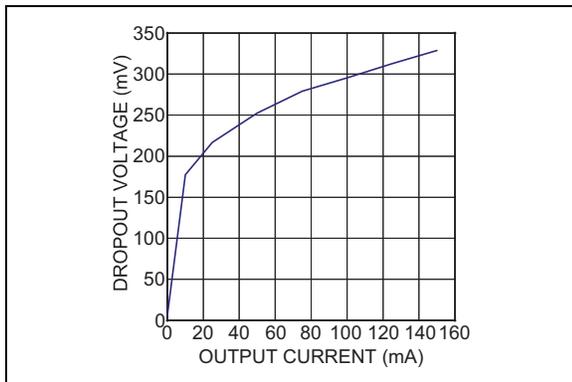
**Note:** The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be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



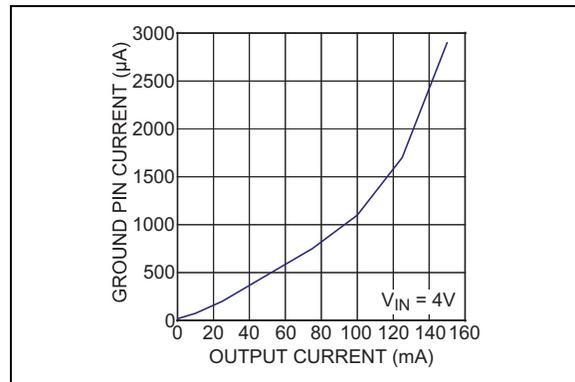
**FIGURE 2-1:** Power Supply Rejection Ratio.



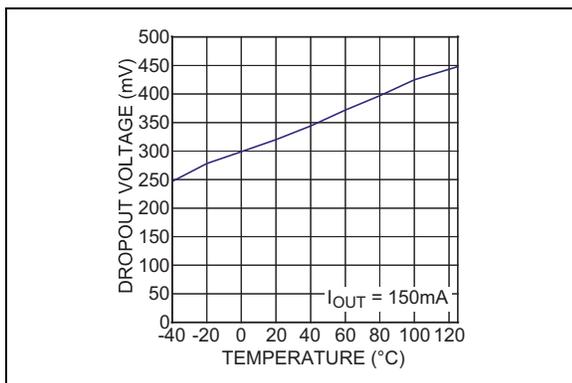
**FIGURE 2-4:** Output Voltage vs. Input Voltage.



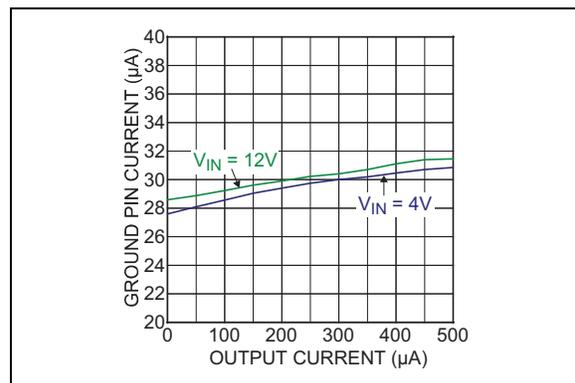
**FIGURE 2-2:** Dropout Voltage vs. Output Current.



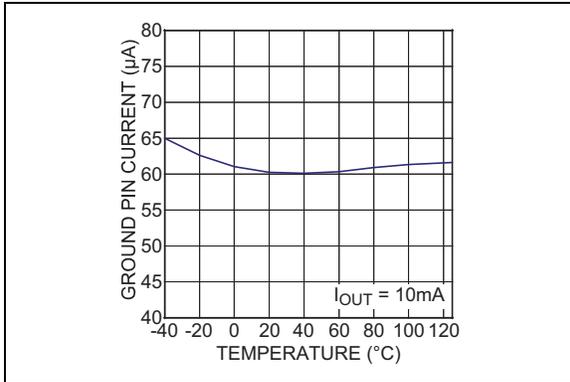
**FIGURE 2-5:** Ground Pin Current vs. Output Current.



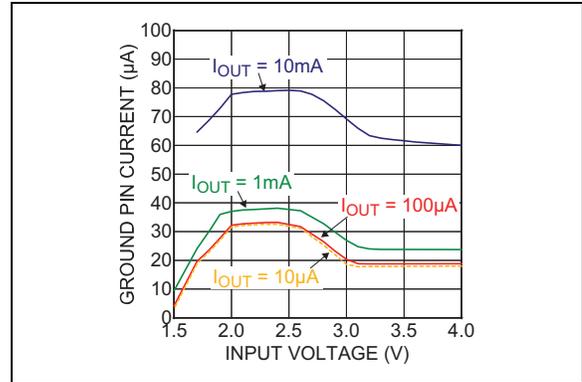
**FIGURE 2-3:** Dropout Voltage vs. Temperature.



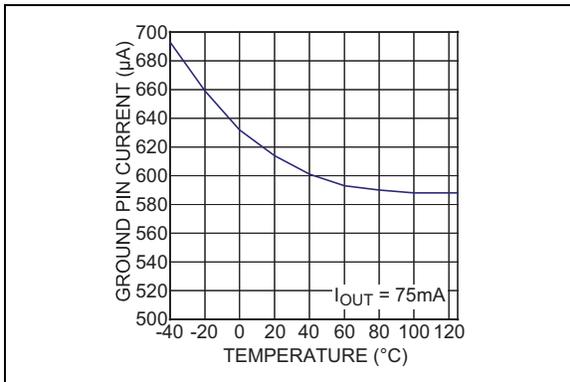
**FIGURE 2-6:** Ground Pin Current vs. Output Current.



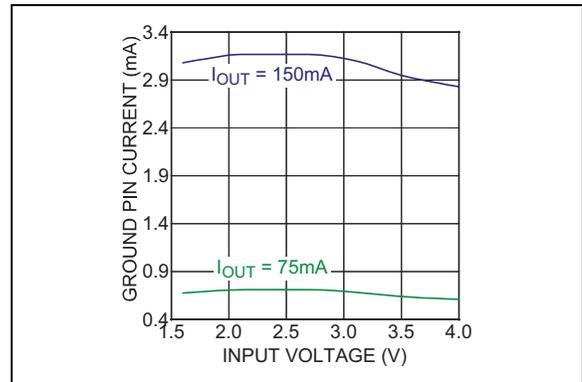
**FIGURE 2-7:** Ground Pin Current vs. Temperature.



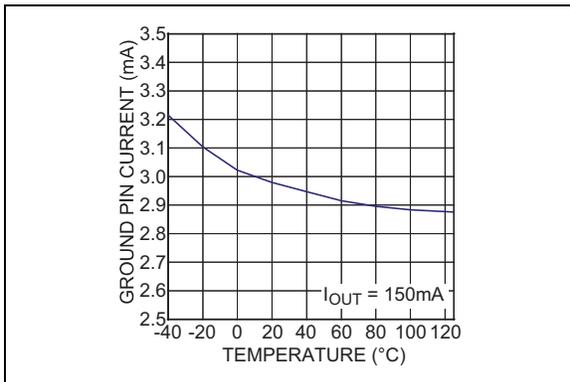
**FIGURE 2-10:** Ground Pin Current vs. Input Voltage.



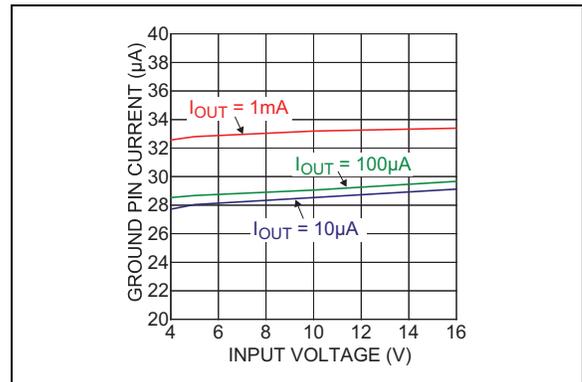
**FIGURE 2-8:** Ground Pin Current vs. Temperature.



**FIGURE 2-11:** Ground Pin Current vs. Input Voltage.

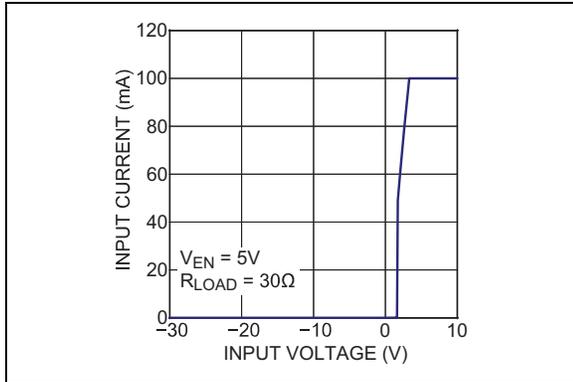


**FIGURE 2-9:** Ground Pin Current vs. Temperature.

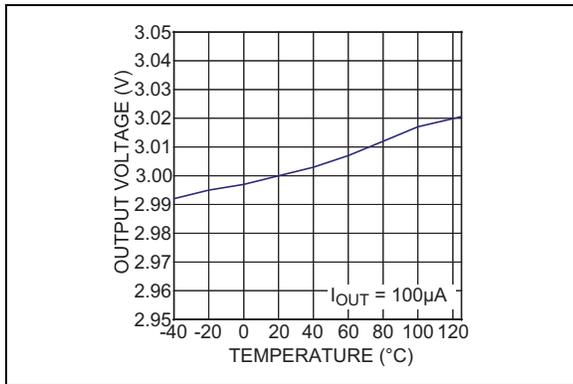


**FIGURE 2-12:** Ground Pin Current vs. Input Voltage.

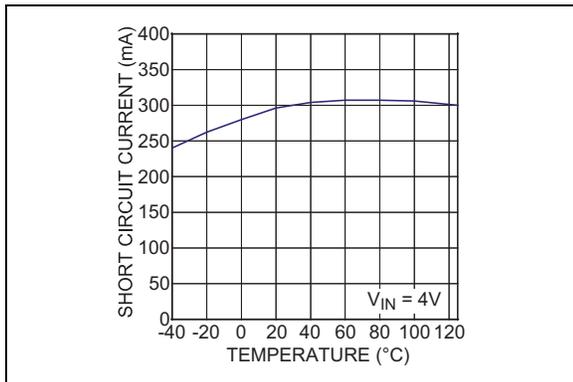
# MIC5225



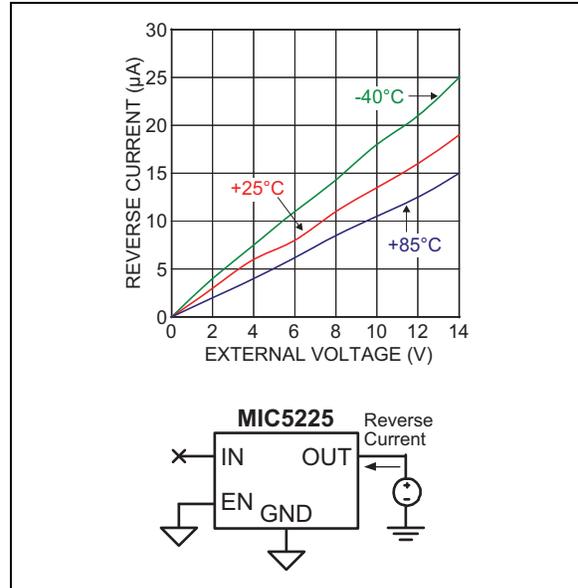
**FIGURE 2-13:** Input Current vs. Input Voltage.



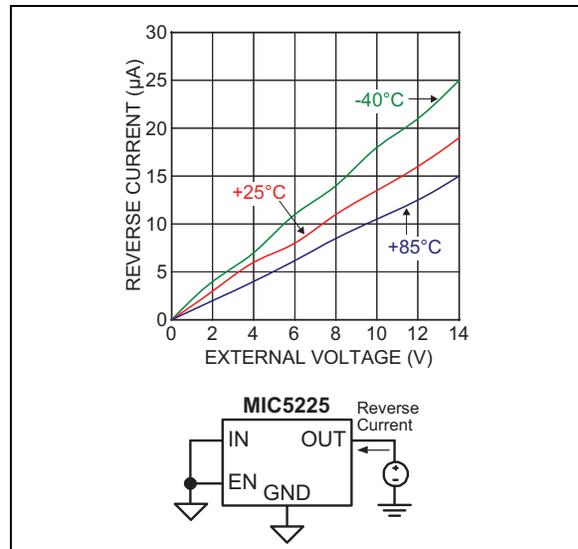
**FIGURE 2-14:** Output Voltage vs. Temperature.



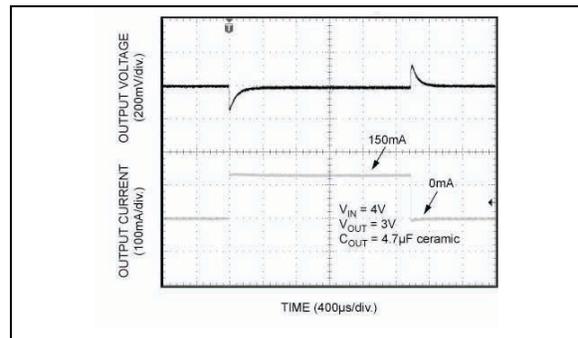
**FIGURE 2-15:** Short Circuit Current vs. Temperature.



**FIGURE 2-16:** Reverse Current (Open Input).



**FIGURE 2-17:** Reverse Current (Grounded Input).



**FIGURE 2-18:** Load Transient Response.

## 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	IN	Supply input.
2	GND	Ground.
3	EN	Enable (Input): Logic low or Open = Shutdown; Logic high = Enable.
4	NC (Fixed)	Output voltage.
	ADJ	Adjust (Input): Feedback input. Connect to resistive voltage-divider network.
5	OUT	Regulator Output.

## 4.0 APPLICATION INFORMATION

### 4.1 Enable/Shutdown

The MIC5225 comes with an active-high enable pin that allows the regulator to be disabled. Forcing the enable pin lows 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.

### 4.2 Input Capacitor

The MIC5225 has a wide input voltage capability up to 16V. The input capacitor must be rated to sustain voltages that may be used on the input. An input capacitor may be required when the device is not near the source power supply or when supplied by a battery. Small, surface mount, ceramic capacitors can be used for bypassing. Larger value may be required if the source supply has high ripple.

### 4.3 Output Capacitor

The MIC5225 requires an output capacitor for stability. The design requires 1.0  $\mu\text{F}$  or greater on the output to maintain stability. The design is optimized for use with low-ESR ceramic chip capacitors. High ESR capacitors may cause high frequency oscillation. The maximum recommended ESR is 300 m $\Omega$ . The output capacitor can be increased, but performance has been optimized for a 1.0  $\mu\text{F}$  ceramic output capacitor and does not improve significantly with the use of a larger 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.

### 4.4 No-Load Stability

The MIC5225 will remain stable and in regulation with no load unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive application.

## 4.5 Thermal Considerations

The MIC5225 is designed to provide 150 mA of continuous current in a very small package. Maximum power dissipation can be calculated based on the output current and the voltage drop across the part. To determine the maximum power dissipation of the package, use the junction-to-ambient thermal resistance of the device and the following basic equation:

### EQUATION 4-1:

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

Where:

$T_{J(MAX)}$  = The maximum junction temperature of the die, 125°C

$T_A$  = The ambient operating temperature

$\theta_{JA}$  = Is layout independent

Table 4-1 shows examples of the junction-to-ambient thermal resistance for the MIC5225.

**TABLE 4-1: SOT-23-5 THERMAL RESISTANCE**

Package	$\theta_{JA}$ Recommended Minimum Footprint
SOT-23-5	235°C/W

The actual power dissipation of the regulator circuit can be determined using the equation:

### EQUATION 4-2:

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

Substituting  $P_{D(MAX)}$  for  $P_D$  and solving for the operating conditions that are critical to the application will give the maximum operating conditions for the regulator circuit. For example, when operating the MIC5225-3.0BMM at 50°C with a minimum footprint layout, the maximum input voltage for a set output current can be determined as follows:

### EQUATION 4-3:

$$P_{D(MAX)} = (125^\circ\text{C} - 50^\circ\text{C}) / (235^\circ\text{C/W})$$

$$P_{D(MAX)} = 319\text{mW}$$

The junction-to-ambient thermal resistance for the minimum footprint is 235°C/W, from [Table 4-1](#). The maximum power dissipation must not be exceeded for proper operation. Using the output voltage of 3.0V, and an output current of 150 mA, the maximum input voltage can be determined:

**EQUATION 4-4:**

$$319mW = (V_{IN} - 3.0V)150mA + V_{IN} \times 3.0mA$$

$$319mW = V_{IN} \times 153mA - 450mW$$

$$769mW = V_{IN} \times 153mA$$

$$V_{IN(MAX)} = 5.02V$$

Therefore, a 3.0V application at 150 mA of output current can accept a maximum input voltage of 5.02V in the SOT-23-5 package. For a full discussion of heat sinking and thermal effects on the voltage regulators, refer to the Regulator Thermals section of [Designing with Low-Dropout Voltage Regulators handbook](#).

## 4.6 Adjustable Regulator Application

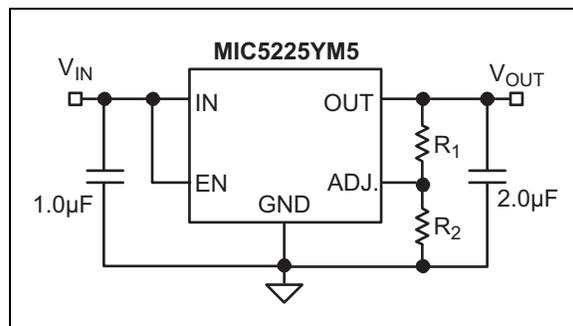
The MIC5225YM5 can be adjusted from 1.24V to 14V by using two external resistors (Figure 1). The resistors set the output voltage based on the following equation:

**EQUATION 4-5:**

$$V_{OUT} = V_{REF} \left( 1 + \left( \frac{R1}{R2} \right) \right)$$

Where:  
 $V_{REF} = 1.24V$

Feedback resistor R2 should be no larger than 300 kΩ.



# MIC5225

## 5.0 PACKAGING INFORMATION

### 5.1 Package Marking Information

5-Lead SOT-23\*

<p><u>XXXX</u> NNN</p>
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Example

<p><u>QT25</u> 415</p>
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<p><b>Legend:</b> 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).</p>
<p><b>Note:</b> 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.</p>

**TABLE 5-1: PACKAGE MARKING CODES FOR MIC5353**

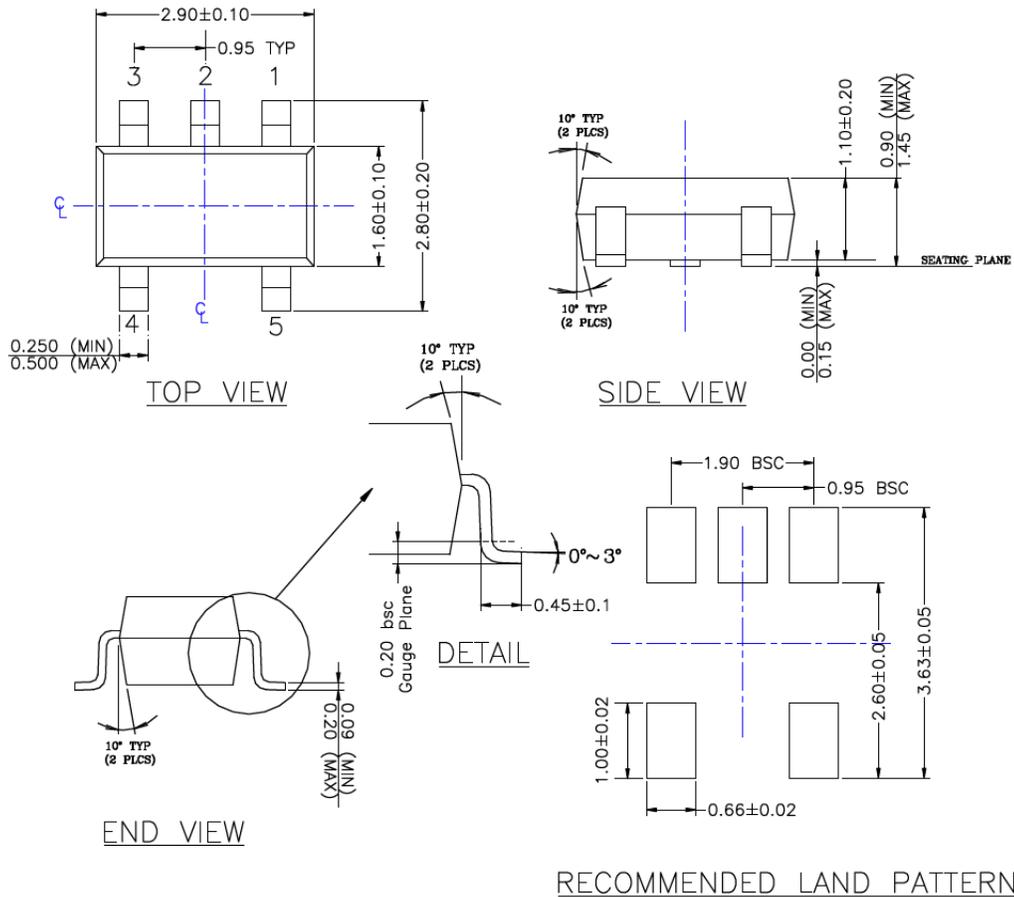
Part Number	Output Voltage	Marking Codes
MIC5225-1.5YM5	1.5V	<u>QT15</u>
MIC5225-1.8YM5	1.8V	<u>QT18</u>
MIC5225-2.5YM5	2.5V	<u>QT25</u>
MIC5225-2.7YM5	2.7V	<u>QT27</u>
MIC5225-3.0YM5	3.0V	<u>QT30</u>
MIC5225-3.3YM5	3.3V	<u>QT33</u>
MIC5225-5.0YM5	5.0V	<u>QT50</u>
MIC5225YM5	ADJ	<u>QTAA</u>

## 5-Lead SOT-23 Package Outline and Recommended Land Pattern

**TITLE**

5 LEAD SOT23 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

<b>DRAWING #</b>	SOT23-5LD-PL-1	<b>UNIT</b>	MM
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**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.

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

# MIC5225

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## APPENDIX A: REVISION HISTORY

### Revision A (May 2022)

- Converted Micrel document MIC5225 to Microchip data sheet DS20006683A.
- Minor text changes throughout.

# MIC5225

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NOTES:

## PRODUCT IDENTIFICATION SYSTEM

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

<u>PART NO.</u>	<u>-XX</u>	<u>X</u>	<u>XX</u>	<u>-XX</u>
Device	Voltage Option	Junction Temperature Range	Package	Media Type
<b>Device:</b>	MIC5225: Ultra-Low Quiescent Current 150 mA $\mu$ Cap Low Dropout Regulator			
<b>Voltage Option</b>	1.5 = 1.5V 1.8 = 1.8V 2.5 = 2.5V 2.7 = 2.7V 3.0 = 3.0V 3.3 = 3.3V 5.0 = 5.0V <blank> = ADJ			
<b>Junction Temperature Range:</b>	Y = -40°C to +125°C (RoHS Compliant)			
<b>Package:</b>	M5 = 5-Lead SOT-23 (Pb-Free)			
<b>Media Type:</b>	TR = 3,000/Reel			
<b>Examples:</b>				
a) MIC5225-1.8YM5-TR Ultra-Low Quiescent Current 150 mA $\mu$ Cap Low Dropout Regulator, 1.8V, -40°C to +125°C, 5-Lead SOT-23, 3,000/Reel				
b) MIC5225-3.3YM5-TR Ultra-Low Quiescent Current 150 mA $\mu$ Cap Low Dropout Regulator, 3.3V, -40°C to +125°C, 5-Lead SOT-23, 3,000/Reel				
c) MIC5225YM5-TR Ultra-Low Quiescent Current 150 mA $\mu$ Cap Low Dropout Regulator, ADJ, -40°C to +125°C, 5-Lead SOT-23, 3,000/Reel				
<b>Note 1:</b> 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.				

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ISBN: 978-1-6683-0496-9



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