MIC5213

SC-70 µCap Low Dropout Regulator

Features

- SC-70-5 Package
- Wide Selection of Output Voltages
- Ensured 80 mA Output
- Low Quiescent Current
- Low Dropout Voltage
- Tight Load and Line Regulation
- Low Temperature Coefficient
- Current and Thermal Limiting
- Reversed Input Polarity Protection
- Zero Off-Mode Current
- Logic-Controlled Shutdown
- Stable with Low-ESR Ceramic Capacitors

Applications

- Cellular Phones
- Laptop, Notebook, and Palmtop Computers
- Battery-Powered Equipment
- Barcode Scanners
- SMPS Post-Regulator/DC-DC Modules
- High-Efficiency Linear Power Supplies

General Description

The MIC5213 is a µCap 80 mA linear voltage regulator in the 5-lead SC-70 package. Featuring half the footprint of the standard SOT-23 package, this SC-70 regulator has very low dropout voltage (typically 20 mV at light loads and 300 mV at 80 mA) and very low ground current (225 µA at 20 mA output). It also offers better than 3% initial accuracy and includes a logic-compatible enable input.

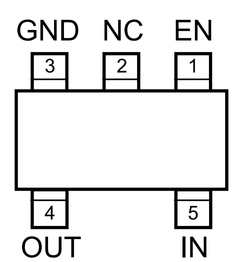
The µCap regulator design is optimized to work with low-value, low-cost ceramic capacitors. The outputs typically require only 0.47 µF of output capacitance for stability.

Designed especially for hand-held, battery-powered devices, the MIC5213 can be controlled by a CMOS or TTL compatible logic signal. When disabled, power consumption drops nearly to zero. If on-off control is not required, the enable pin may be tied to the input for 3-terminal operation. The ground current of the MIC5213 increases only slightly in dropout, further prolonging battery life. Key MIC5213 features include current limiting, over temperature shutdown, and protection against reversed battery.

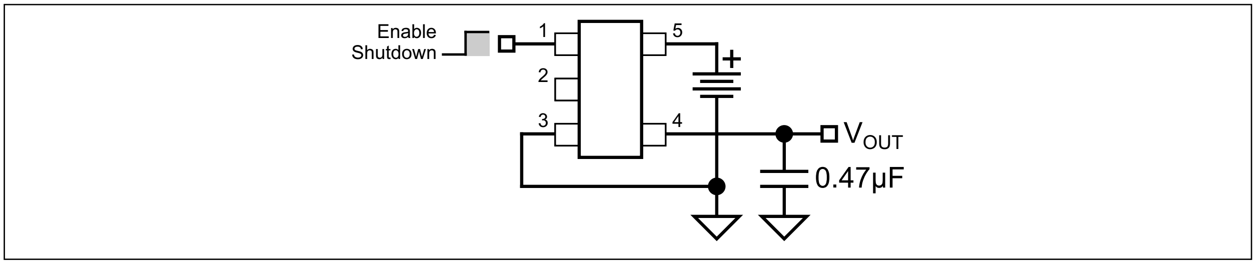
The MIC5213 is available in 2.5V, 2.6V, 2.7V, 2.8V, 3.0V, 3.3V, 3.6V, and 5.0V fixed voltages. Other voltages are available; contact Microchip for details.

Package Type

MIC5213
5-Lead SC-70 (C5)
(Top View)



Typical Application Circuit



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Supply Voltage (V_{IN}) .... –20V to +20V
Enable Input Voltage (V_{EN}) .... –20V to +20V
Power Dissipation (P_D, Note 1) .... Internally Limited
ESD Rating .... Note 2

Operating Ratings ‡

Input Voltage (V_{IN}) .... +2.5V to +16V
Enable Input 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 is a function of the maximum junction temperature, $T_{J(MAX)}$, the junction-to-ambient thermal resistance, θ_{JA}, and the ambient temperature, T_A. The maximum allowable power dissipation at any ambient temperature is calculated using: $P_{D(MAX)} = (T_{J(MAX)} – T_A) \div \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature and the regulator will go into thermal shutdown.

2: Device is ESD sensitive. Handling precautions recommended.

ELECTRICAL CHARACTERISTICS

$V_{IN} = V_{OUT} + 1V$; $I_L = 1$ mA; $C_L = 0.47$ µF; $V_{EN} \geq 2.0V$; $T_J = +25°C$, **bold** values valid for $–40°C \leq T_J \leq +125°C$; unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage Accuracy	V_O	–3	—	3	%	—
		–4	—	**4**		
Output Voltage Temperature Coefficient	$\Delta V_O/\Delta T$	—	**50**	**200**	ppm/°C	Note 1
Line Regulation	$\Delta V_O/V_O$	—	0.008	0.3	%	$V_{IN} = V_{OUT}$ + 1V to 16V
		—	—	**0.5**		
Load Regulation	$\Delta V_O/V_O$	—	0.08	0.3	%	I_L = 0.1 mA to 80 mA, Note 2
		—	—	**0.5**		
Dropout Voltage (Note 3)	$V_{IN} – V_O$	—	20	—	mV	I_L = 100 µA
		—	200	**350**		I_L = 20 mA
		—	250	—		I_L = 50 mA
		—	280	**600**		I_L = 80 mA
Quiescent Current	I_Q	—	0.01	10	µA	$V_{EN} \leq 0.4V$ (shutdown)
Ground Pin Current (Note 4)	I_{GND}	—	180	—	µA	I_L = 100 µA, $V_{EN} \geq 2.0V$ (active)
		—	225	**750**		I_L = 20 mA, $V_{EN} \geq 2.0V$ (active)
		—	850	—		I_L = 50 mA, $V_{EN} \geq 2.0V$ (active)
		—	1800	**3000**		I_L = 80 mA, $V_{EN} \geq 2.0V$ (active)
Ground Pin Current in Dropout	I_{GNDDO}	—	200	**300**	µA	$V_{IN} = V_{OUT(NOM)} – 0.5V$, Note 4
Current Limit	I_{LIM}	—	180	**250**	mA	V_{OUT} = 0V
Thermal Regulation	$\Delta V_O/\Delta P_D$	—	0.05	—	%/W	Note 5

ELECTRICAL CHARACTERISTICS (CONTINUED)

$V_{IN} = V_{OUT} + 1V$; I_L = 1 mA; C_L = 0.47 µF; $V_{EN} \geq 2.0V$; T_J = +25°C, **bold** values valid for –40°C ≤ T_J ≤ +125°C; unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Enable Input						
Enable Input Voltage Level	V_{IL}	—	—	**0.6**	V	Logic low (off)
	V_{IH}	**2.0**	—	—		Logic high (on)
Enable Input Current	I_{IL}	—	0.01	1	µA	$V_{IL} \leq 0.6V$
	I_{IH}	—	8	**50**		$V_{IH} \geq 2.0V$

Note 1: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

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 measured at 1V differential.

4: Ground pin current is the regulator quiescent current plus pass transistor base current. The total current drawn from the supply is the sum of the load current plus the ground current.

5: Thermal regulation is defined as the change in out voltage at a time (t) after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for an 80 mA load pulse at V_{IN} = 16V for t = 10 ms.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Temperature Range	T_J	–40	—	+125	°C	—
Storage Temperature	T_S	–60	—	+150	°C	—
Lead Temperature	T_{LEAD}	—	—	+260	°C	Soldering, 5 sec.
Package Thermal Resistances						
Thermal Resistance, SC-70 5-Ld	θ_{JA}	—	450	—	°C/W	—

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.

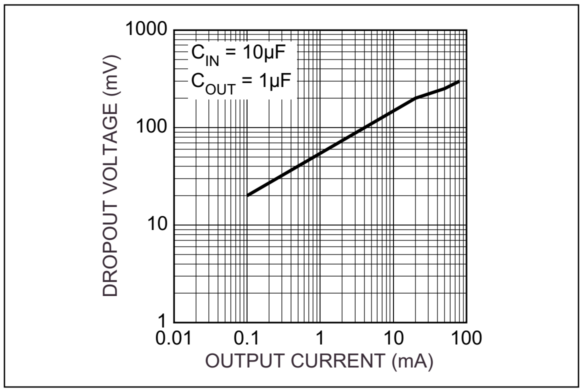


FIGURE 2-1: *Dropout Voltage vs. Output Current.*

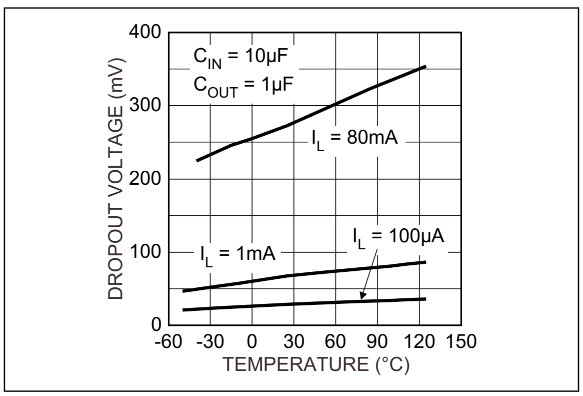


FIGURE 2-2: *Dropout Voltage vs. Temperature.*

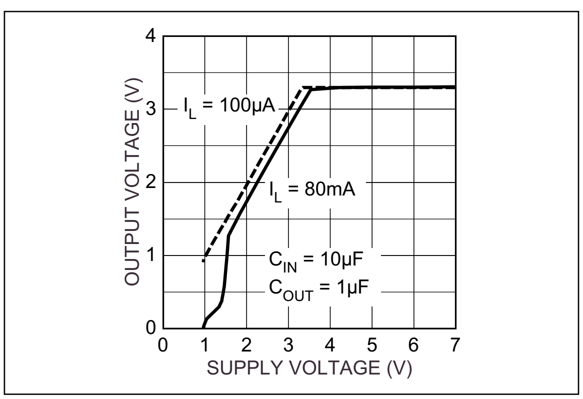


FIGURE 2-3: *Dropout Characteristics.*

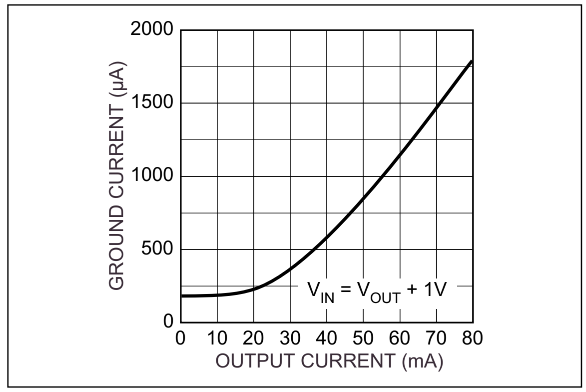


FIGURE 2-4: *Ground Current vs. Output Current.*

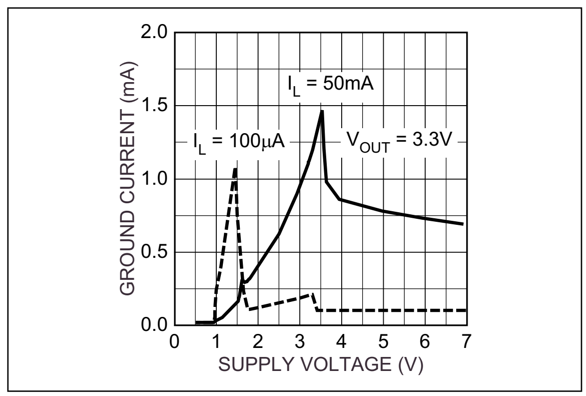


FIGURE 2-5: *Ground Current vs. Supply Voltage.*

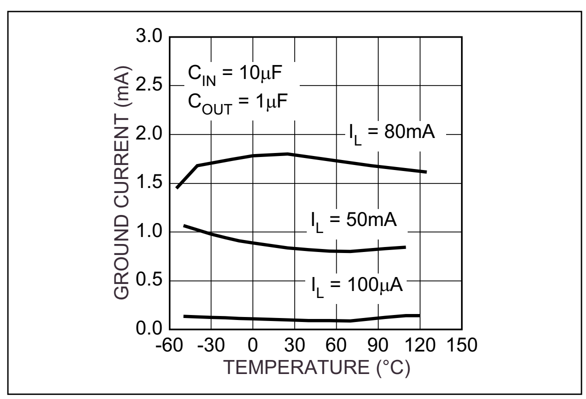


FIGURE 2-6: *Ground Current vs. Temperature.*

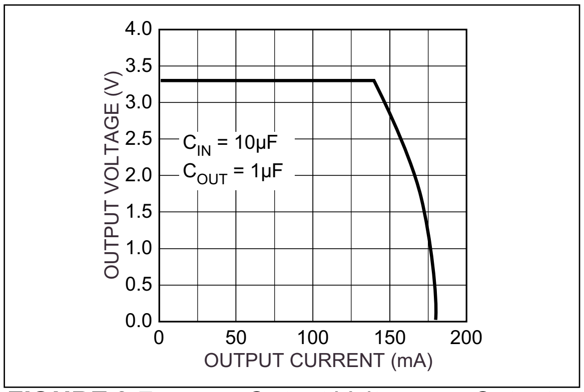


FIGURE 2-7: *Output Voltage vs. Output Current.*

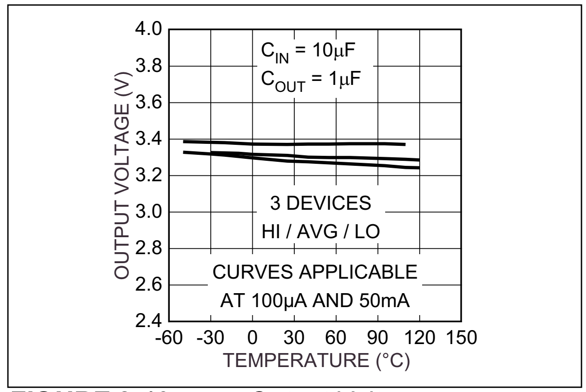


FIGURE 2-10: *Output Voltage vs. Temperature.*

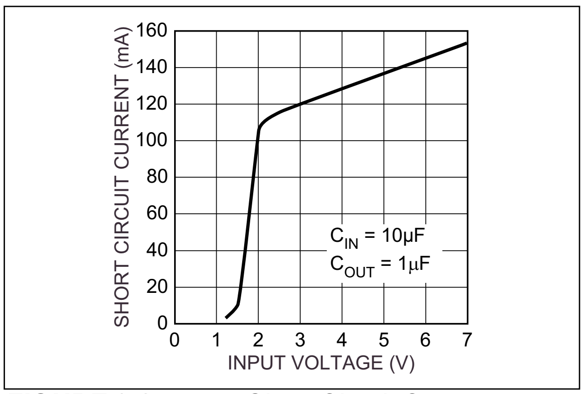


FIGURE 2-8: *Short-Circuit Current vs. Input Voltage.*

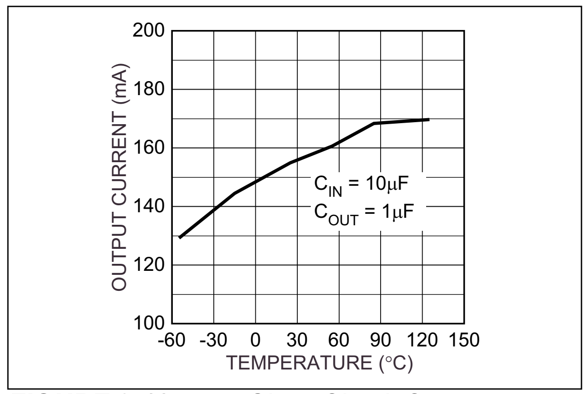


FIGURE 2-11: *Short-Circuit Current vs. Temperature.*

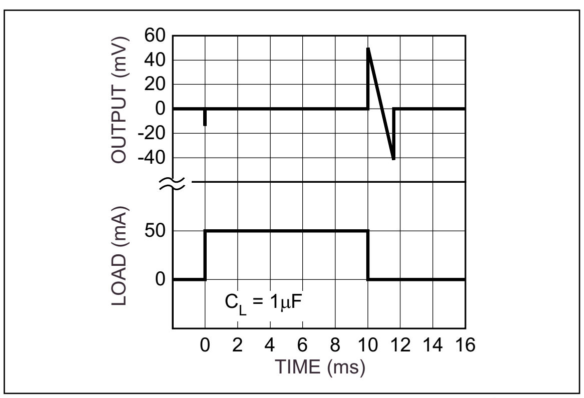


FIGURE 2-9: *Thermal Regulation (3.3V Version).*

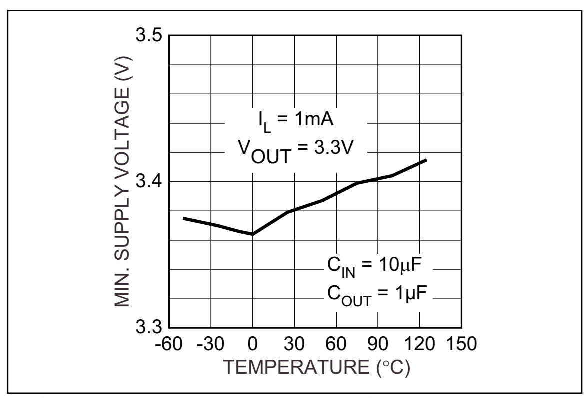


FIGURE 2-12: *Minimum Supply Voltage vs. Temperature.*

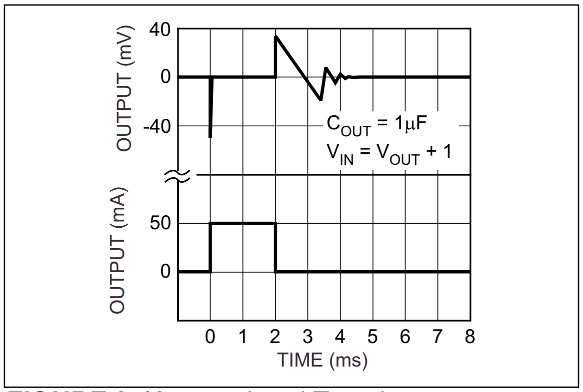


FIGURE 2-13: *Load Transient.*

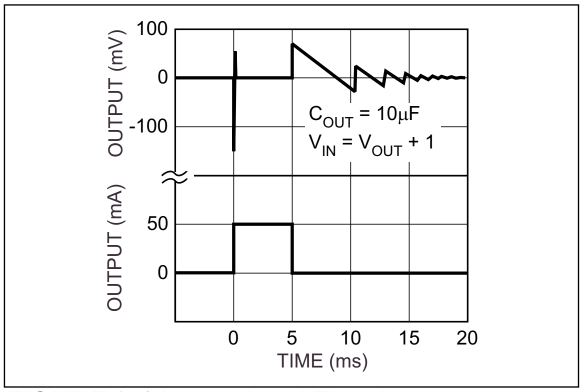


FIGURE 2-14: *Load Transient.*

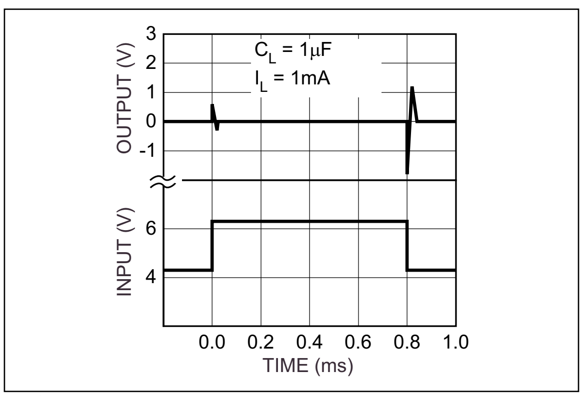


FIGURE 2-15: *Line Transient.*

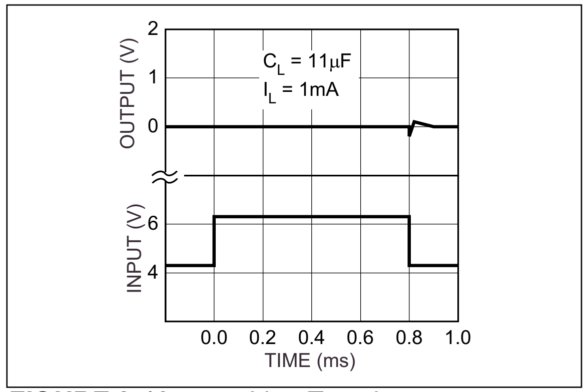


FIGURE 2-16: *Line Transient.*

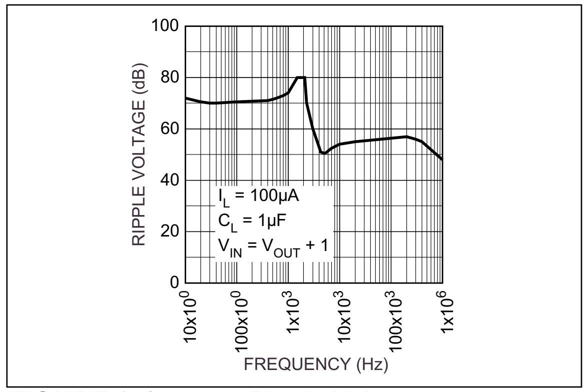


FIGURE 2-17: *Ripple Voltage vs. Frequency.*

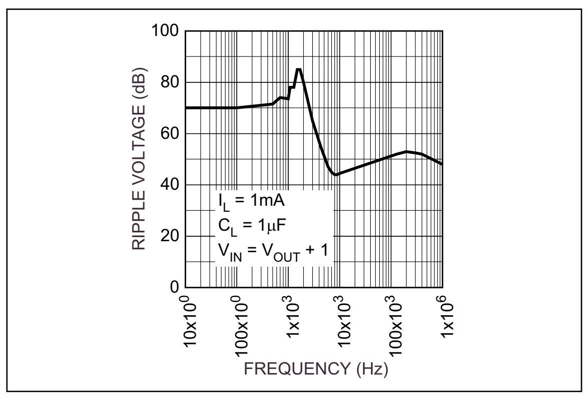


FIGURE 2-18: *Ripple Voltage vs. Frequency.*

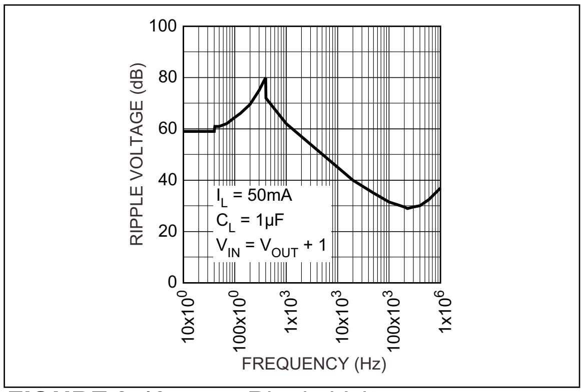


FIGURE 2-19: *Ripple Voltage vs. Frequency.*

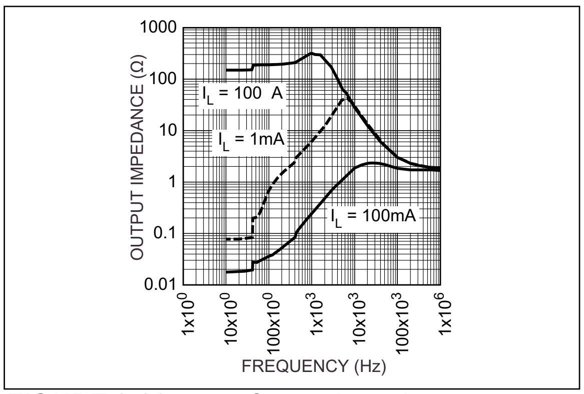


FIGURE 2-20: *Output Impedance.*

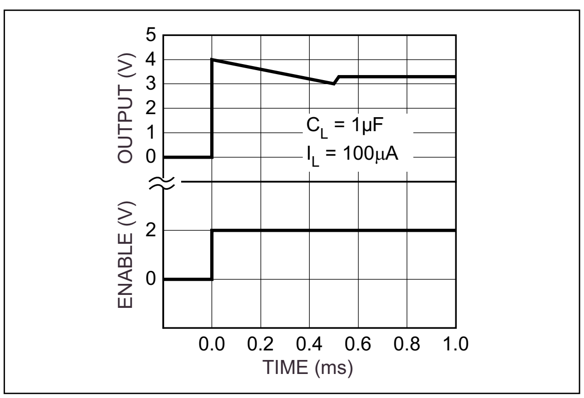


FIGURE 2-21: *Enable Characteristics (3.3V Version).*

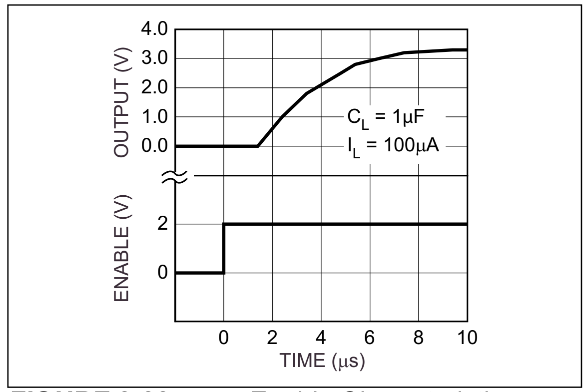


FIGURE 2-22: *Enable Characteristics (3.3V Version).*

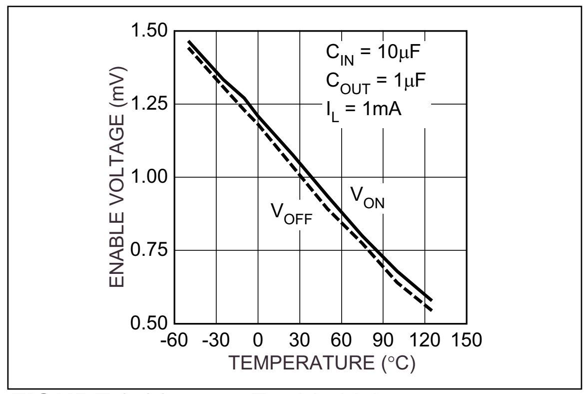


FIGURE 2-23: *Enable Voltage vs. Temperature*

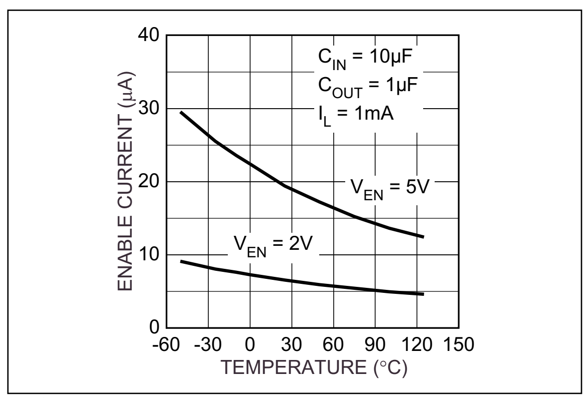


FIGURE 2-24: *Enable Current vs. Temperature.*

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	EN	Enable (Input): TTL/CMOS compatible control input. Logic high = enabled; logic low or open = shutdown.
2	NC	Not internally connected.
3	GND	Ground.
4	OUT	Regulator output.
5	IN	Supply input.

4.0 APPLICATION INFORMATION

4.1 Input Capacitor

A 0.1 µF capacitor should be placed from IN to GND if there is more than 10 inches of wire between the input and the AC filter capacitor or when a battery is used as the input.

4.2 Output Capacitor

Typical PNP-based regulators require an output capacitor to prevent oscillation. The MIC5213 is ultra-stable, requiring only 0.47 µF of output capacitance for stability. The regulator is stable with all types of capacitors, including the tiny, low-ESR ceramic chip capacitors. The output capacitor value can be increased without limit to improve transient response.

4.3 No-Load Stability

The MIC5213 will remain stable and in regulation with no load (other than the internal voltage divider) unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications.

4.4 Enable Input

The MIC5213 features nearly zero off-mode current. When EN (enable input) is held below 0.6V, all internal circuitry is powered off. Pulling EN high (over 2.0V) re-enables the device and allows operation. When EN is held low, the regulator typically draws only 10 nA of current. While the logic threshold is TTL/CMOS compatible, EN may be pulled as high as 20V, independent of V_{IN}.

4.5 Thermal Behavior

The MIC5213 is designed to provide 80 mA of continuous current in a very small profile 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:

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

Where:

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

T_A is the maximum ambient temperature.

θ_{JA} is the junction to ambient thermal resistance of the regulator (450°C/W).

The actual power dissipation of the regulator circuit can be determined using one simple equation.

EQUATION 4-2:

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

Substituting $P_{D(MAX)}$, determined above, 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, if we are operating the MIC5213-3.0YC5 at room temperature, with a minimum footprint layout, we can determine the maximum input voltage for a set output current.

EQUATION 4-3:

$$P_{D(MAX)} = \frac{125 - 25}{450°\text{C/W}}$$

$$P_{D(MAX)} = 222mW$$

To prevent the device from entering thermal shutdown, maximum power dissipation cannot be exceeded. Using the output voltage of 3.0V, and an output current of 80 mA, we can determine the maximum input voltage. Ground current, maximum of 3 mA for 80 mA of output current, can be taken from the Electrical Characteristics table.

EQUATION 4-4:

$$222mW = (V_{IN} - 3.0V) \times 80mA + V_{IN} \times 3mA$$

$$222mW = (80mA \times V_{IN} + 3mA \times V_{IN}) - 240mW$$

$$462mW = 83mA \times V_{IN}$$

$$V_{IN} = 5.57V \text{ max.}$$

Therefore, a 3.0V application at 80mA of output current can accept a maximum input voltage of 5.6V in an SC-70-5 package. For a full discussion of heat sinking and thermal effects on voltage regulators, refer to Regulator Thermals section of Microchip's Designing with Low-Dropout Voltage Regulators handbook.

4.6 Fixed Voltage Regulator

The MIC5213 is ideal for general-purpose voltage regulation in any handheld device. Applications that are tight for space can easily use the SC-70 regulator which occupies half the space of a SOT-23-5 regulator. The MIC5203 offers a smaller system solution, only requiring a small multilayer ceramic capacitor for stability.

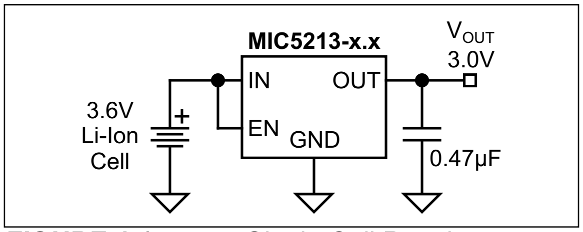


FIGURE 4-1: *Single-Cell Regulator.*

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

5-Lead SC-70* (Front)	Example
XXX	LAM

5-Lead SC-70* (Back)	Example
NNN	92H

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).

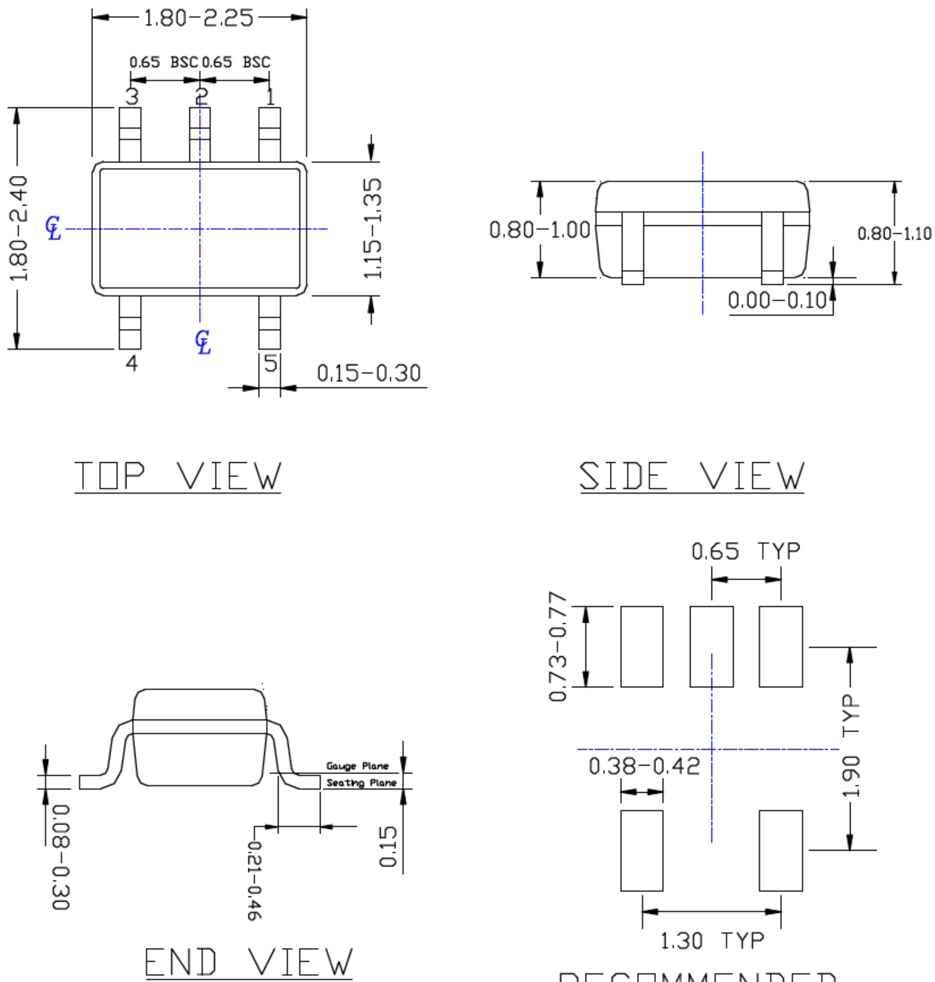
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

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

Note: If the full seven-character YYWWNNN code cannot fit on the package, the following truncated codes are used based on the available marking space:
6 Characters = YWWNNN; 5 Characters = WWNNN; 4 Characters = WNNN; 3 Characters = NNN;
2 Characters = NN; 1 Character = N

TITLE
5 LEAD SC70 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	SC70-5LD-PL-1	**UNIT**	MM



RECOMMENDED LAND PATTERN

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONS ARE INCLUSIVE OF PLATING.
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR.

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

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (August 2023)

- Converted Micrel document MIC5213 to Microchip data sheet DS20006805A.
- 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 Number	-X.X	X	XX	-XX
Device	Output Voltage	Temperature Range	Package	Media Type

Device:	MIC5213:		SC-70 µCap Low Dropout Regulator
Output Voltage:	2.5	=	2.5V
	2.6	=	2.6V
	2.7	=	2.7V
	2.8	=	2.8V
	3.0	=	3.0V
	3.3	=	3.3V
	3.6	=	3.6V
	5.0	=	5.0V
Temperature Range:	Y	=	–40°C to +125°C
Package:	C5	=	5-Lead SC-70
Media Type:	TR	=	3,000/Reel

Examples:

a) MIC5213-2.5YC5-TR: MIC5213, 2.5V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead SC-70, 3,000/Reel

b) MIC5213-2.6YC5-TR: MIC5213, 2.6V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead SC-70, 3,000/Reel

c) MIC5213-2.7YC5-TR: MIC5213, 2.7V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead SC-70, 3,000/Reel

d) MIC5213-2.8YC5-TR: MIC5213, 2.8V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead SC-70, 3,000/Reel

e) MIC5213-3.0YC5-TR: MIC5213, 3.0V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead SC-70, 3,000/Reel

f) MIC5213-3.3YC5-TR: MIC5213, 3.3V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead SC-70, 3,000/Reel

g) MIC5213-3.6YC5-TR: MIC5213, 3.6V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead SC-70, 3,000/Reel

h) MIC5213-5.0YC5-TR: MIC5213, 5.0V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead SC-70, 3,000/Reel

Note: 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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