

General Description

The MIC5271 is a μCap 100mA negative regulator in a SOT-23-5 package. With better than 2% initial accuracy, this regulator provides a very accurate supply voltage for applications that require a negative rail. The MIC5271 sinks 100mA of output current at very low dropout voltage (600mV maximum at 100mA of output current).

The μCap regulator design is optimized to work with low-value, low-cost ceramic capacitors. The output typically requires only a 1μF capacitance for stability.

Designed for applications where small packaging and efficiency are critical, the MIC5271 combines LDO design expertise with IttyBitty® packaging to improve performance and reduce power dissipation. Ground current is optimized to help improve battery life in portable applications. The MIC5271 also includes a TTL-compatible enable pin, allowing the user to put the part into a zero-current off mode.

The MIC5271 is available in the 5-pin SOT-23 package for space saving applications and it is available with an adjustable output.

Datasheets and support documentation are available on Micrel's web site at: www.micrel.com.

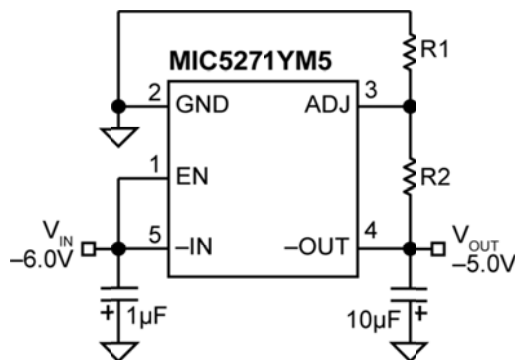
Features

- Stable with ceramic or tantalum capacitor
- Positive and negative enable thresholds
- Low dropout voltage: $-500\text{mV} @ -100\text{mA}$
- Low ground current: $-25\mu\text{A} @ \text{load} = -100\mu\text{A}$
- Tight initial accuracy: $\pm 2\%$
- Tight load and line regulation
- Thermal shutdown and current-limit protection
- IttyBitty 5-pin SOT-23 packaging
- Zero-current off mode

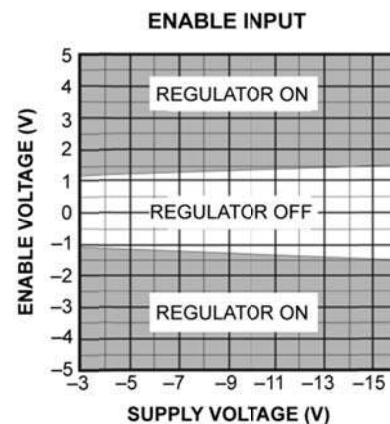
Applications

- GaAsFET bias
- Portable cameras and video recorders
- PDAs
- Battery-powered equipment
- Post-regulation of DC-to-DC converters

Typical Application



Regulator with Adjustable Negative Voltage Output



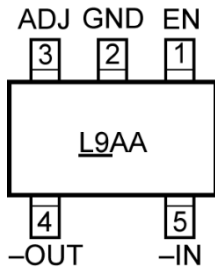
Ordering Information

Part Number ⁽¹⁾	Marking ⁽²⁾	Voltage	Junction Temperature Range	Package
MIC5271YM5	<u>L</u> 9AA	Adjustable	-40°C to +125°C	SOT-23-5
MIC5271-3.0YM5	<u>L</u> 930	-3.0V	-40°C to +125°C	SOT-23-5
MIC5271-5.0YM5	<u>L</u> 950	-5.0V	-40°C to +125°C	SOT-23-5

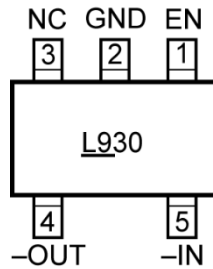
Note:

- Other voltages are available. Contact Micrel for details.
- Underbar () symbol may not be to scale.

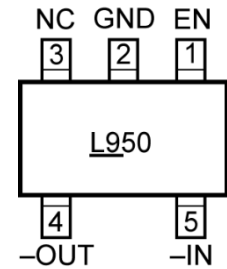
Pin Configurations



MIC5271YM5
Adjustable Output Voltage
(Top View)



MIC5271-3.0YM5
Fixed Output Voltage
(Top View)



MIC5271-5.0YM5
Fixed Output Voltage
(Top View)

Pin Description

Pin Number	MIC5271YM5	MIC5271-3.0YM5	MIC5271-5.0YM5	Pin Function
	Pin Name	Pin Name	Pin Name	
1	EN	EN	EN	Enable Input. TTL logic-compatible enable input. Logic HIGH = ON, Logic LOW or open = OFF.
2	GND	GND	GND	Ground
3	ADJ	-	-	Adjustable (Input): Adjustable feedback output connects to resistor voltage divider.
	-	NC	NC	No Connect. Leave unconnected.
4	-OUT	-OUT	-OUT	Negative Regulator Output.
5	-IN	-IN	-IN	Negative Supply Input.

Absolute Maximum Ratings⁽³⁾

Input Voltage (V_{IN})	-20V to +0.3V
Enable Voltage (V_{EN})	-20V to +20V
Power Dissipation (P_D)	Internally Limited
Junction Temperature (T_J)	-40°C to +125°C
Lead Temperature (soldering, 10s)	260°C
Storage Temperature (T_S)	-65°C to +150°C
ESD Rating	Note 6

Operating Ratings⁽⁴⁾

Input Voltage (V_{IN})	-16V to -3.3V
Enable Voltage (V_{EN})	-16V to +16V
Junction Temperature (T_J)	-40°C to +125°C
Thermal Resistance (θ_{JA}) ⁽⁵⁾	235°C/W

Electrical Characteristics⁽⁷⁾

$V_{IN} = V_{OUT} - 1.0V$; $C_{OUT} = 4.7\mu F$, $I_{OUT} = 100\mu A$; $T_J = +25^\circ C$, **bold** values indicate $-40^\circ C \leq T_J \leq +125^\circ C$; unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
V_{OUT}	Output Voltage Accuracy	Variation from nominal V_{OUT}	-2		+2	%
			-3		+3	
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient	Note 8		100		ppm/°C
$\Delta V_{OUT}/V_{OUT}$	Line Regulation	$V_{IN} = V_{OUT} - 1V$ to -16V		0.04	0.15 0.2	%/V
$\Delta V_{OUT}/V_{OUT}$	Load Regulation	$I_{OUT} = -100\mu A$ to -100mA, Note 9		0.4	1.8 2.0	%
$V_{IN} - V_{OUT}$	Dropout Voltage, Note 10	$I_{OUT} = -100\mu A$		-55		mV
		$I_{OUT} = -50mA$		-360	-500	
		$I_{OUT} = -100mA$		-500	-700 -900	
I_{GND}	Ground Current, Note 11	$I_{OUT} = -100\mu A$		-25	-100	μA
		$I_{OUT} = -50mA$		-0.9		mA
		$I_{OUT} = -100mA$		-2.0	-3.0	
I_{GND_SD}	Ground Current in Shutdown	$V_{EN} = \pm 0.6V$	-1.0	0.1	+1.0	μA
PSRR	Ripple Rejection	$f = 120Hz$		50		dB
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$		235	350	mA

Notes:

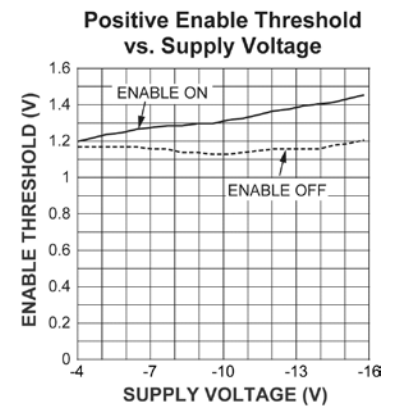
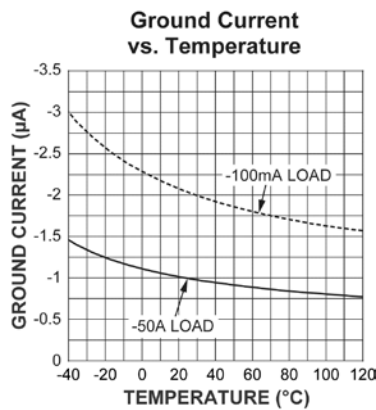
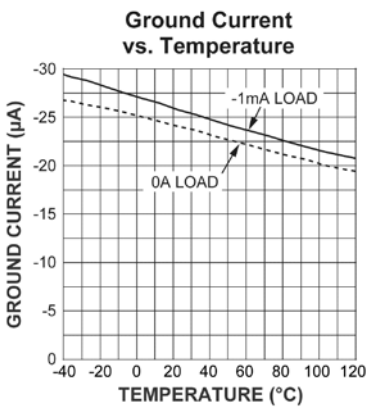
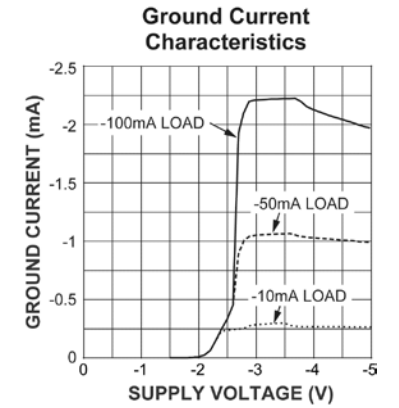
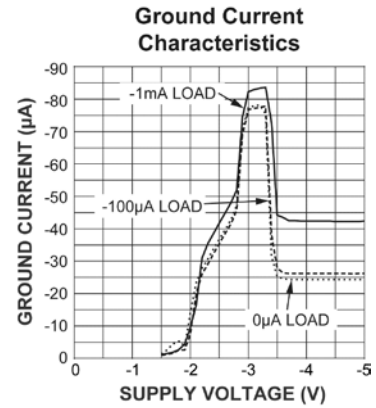
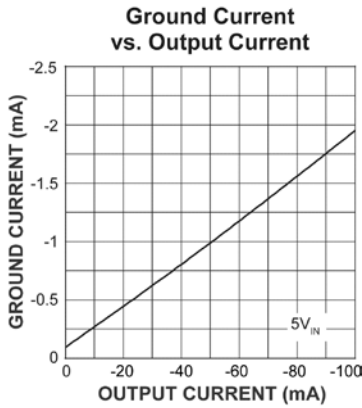
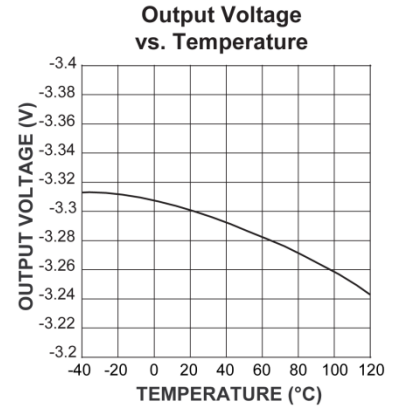
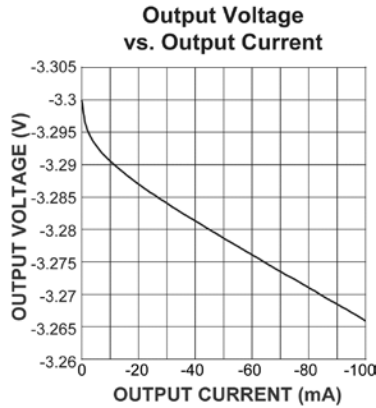
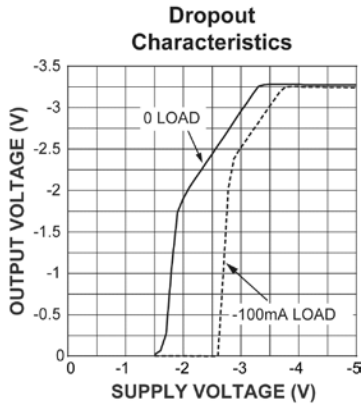
- Exceeding the absolute maximum ratings may damage the device.
- The device is not guaranteed to function outside its operating ratings.
- The maximum allowable power dissipation is a function of the maximum junction temperature, $T_{J(max)}$ the junction-to-ambient thermal resistance, θ_{JA} , and the ambient temperature, T_A . The maximum allowable power dissipation at any ambient temperature is calculated using: $P_{D(max)} = (T_{J(max)} - T_A) \div \theta_{JA}$, where θ_{JA} is 235°C/W. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown. See the "Thermal Considerations" sub-section in the [Application Information](#) for details.
- Devices are ESD sensitive. Handling precautions are recommended.
- Specification for packaged product only.
- Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.
- Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 100 μA to 100mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.
- 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.
- 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 pin current.

Electrical Characteristics⁽⁷⁾ (Continued)

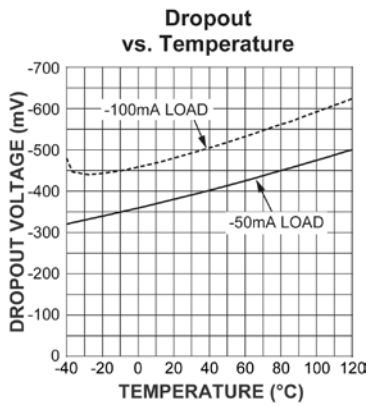
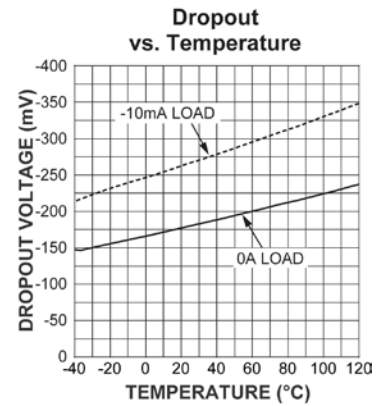
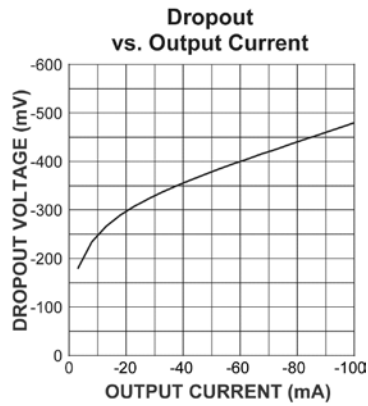
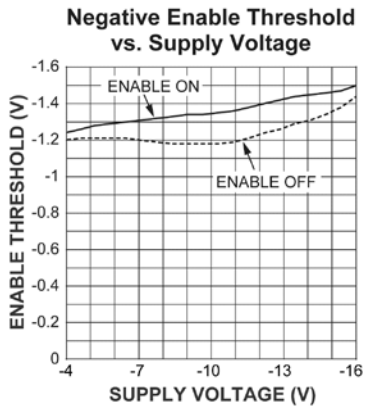
$V_{IN} = V_{OUT} - 1.0V$; $C_{OUT} = 4.7\mu F$, $I_{OUT} = 100\mu A$; $T_J = +25^\circ C$, **bold** values indicate $-40^\circ C \leq T_J \leq +125^\circ C$; unless otherwise noted.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Units
T_{ON}	Turn-On Time	Time to $V_{OUT} = 90\%$ (nominal)		60		μs
V_{EN}	Input Low Voltage	Regulator OFF			± 0.6	V
	Input high Voltage	Regulator ON	± 2.0			
I_{EN}	Enable Input Current	$V_{EN} = \pm 0.6V$ and $-2.0V$			0.1	μA
		$V_{EN} = +2.0V$		5.6	10.0	

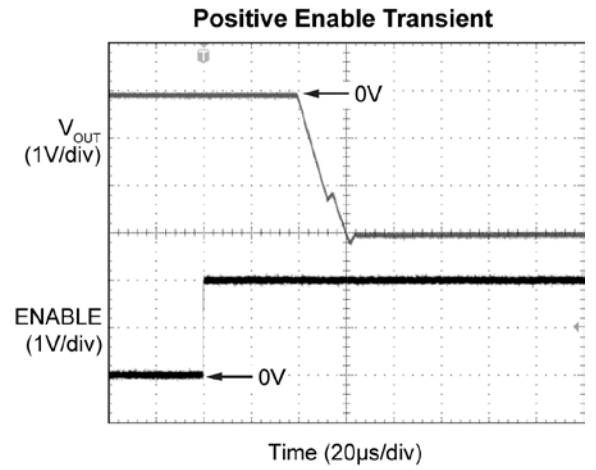
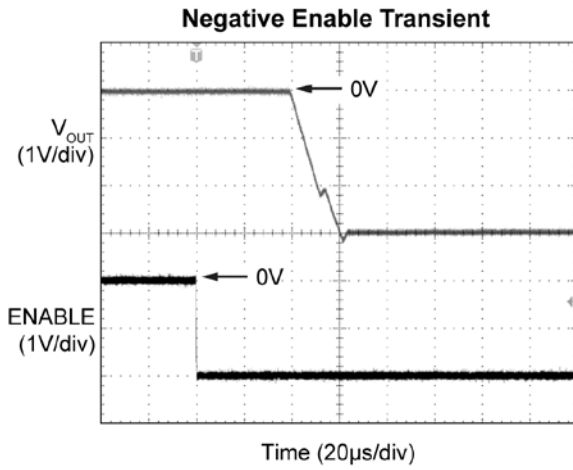
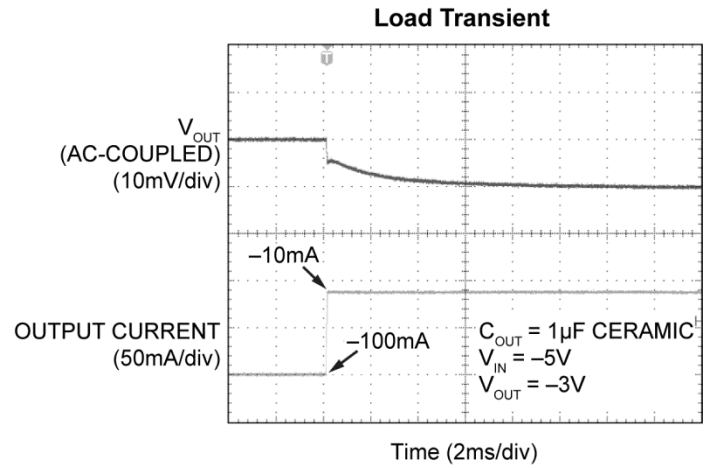
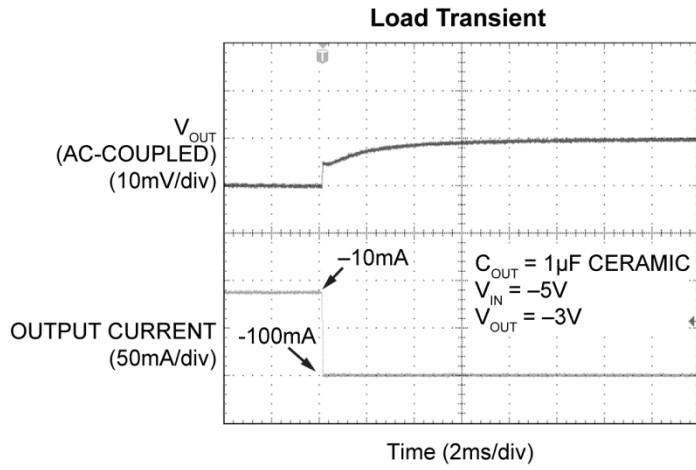
Typical Characteristics



Typical Characteristics (Continued)



Functional Characteristics



Functional Diagrams

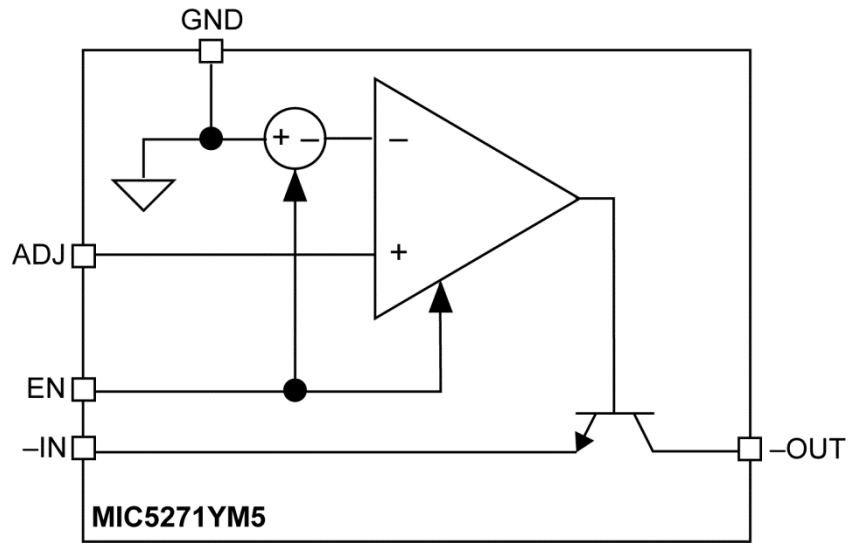


Figure 1. MIC5271YM5 (Adjustable Voltage)

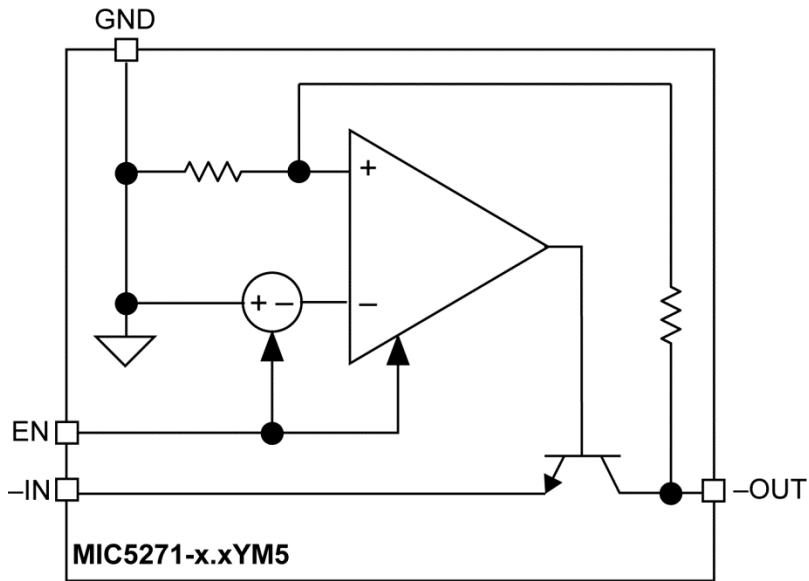


Figure 2. MIC5271-xxYM5 (Fixed Voltage)

Application Information

The MIC5271 is a general-purpose negative voltage regulator that can be used in a system that requires a clean negative voltage. This includes the post regulation of DC-to-DC converters (transformer or charge pump based voltage converters). These negative voltages typically require a negative low dropout voltage regulator to provide a clean output from noisy input power.

Input Capacitor

A 1 μ F input capacitor should be placed from –IN to GND if there is more than two inches of wire or trace between the input and the AC filter capacitor or if a battery is used as the input.

Output Capacitor

The MIC5271 requires an output capacitor for stable operation. A minimum of 1 μ F of output capacitance is required. The output capacitor can be increased without limitation to improve transient response. The output does not require ESR to maintain stability; therefore a ceramic capacitor can be used. High-ESR capacitors may cause instability. Capacitors with an ESR of 3 Ω or greater at 100kHz can cause a high-frequency oscillation.

Low-ESR tantalums are recommended due to the tight capacitance tolerance over temperature. The Z5U dielectric can change capacitance value by as much 50% over temperature, and the Y5V dielectric can change capacitance value by as much as 60% over temperature. To use a ceramic chip capacitor with the Y5V dielectric, the value must be much higher than a tantalum to ensure the same minimum capacitor value over temperature.

No-Load Stability

The MIC5271 does not require a load for stability.

Enable Input

The MIC5271 comes with an enable pin that allows the regulator to be disabled. Forcing the enable pin higher than the negative threshold and lower than the positive threshold 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. The MIC5271 will be in the “on” mode when the voltage applied to the enable pin is either greater than the positive threshold or less than the negative threshold.

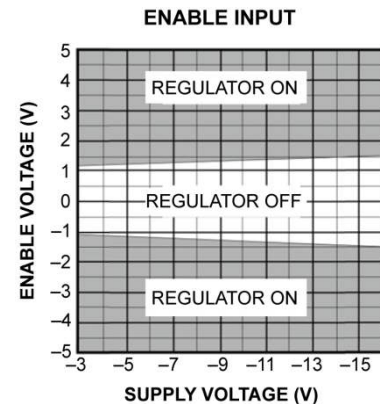


Figure 3. Positive and Negative Enable Voltage vs. Supply Voltage

Thermal Considerations

Absolute values will be used for thermal calculations to clarify the meaning of power dissipation and voltage drops across the part.

Proper thermal design for the MIC5271-5.0YM5 can be accomplished with some basic design criteria and some simple equations. The following information must be known to implement your regulator design:

- V_{IN} = Input voltage
- V_{OUT} = Output voltage
- I_{OUT} = Output current
- T_A = Ambient operating temperature
- I_{GND} = Ground current

Maximum power dissipation can be determined by knowing the ambient temperature (T_A), the maximum junction temperature (+125°C), and the thermal resistance (junction-to-ambient). The thermal resistance for this part, assuming a minimum footprint board layout, is +235°C/W. The maximum power dissipation at an ambient temperature of +25°C can be determined with Equations 1 and 2:

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}} \quad \text{Eq. 1}$$

$$P_{D(MAX)} = \frac{125^\circ\text{C} - 25^\circ\text{C}}{235^\circ\text{C/W}} \quad \text{Eq. 2}$$

Where $P_{D(MAX)} = +425\text{mW}$.

The actual power dissipation of the regulator circuit can be determined using Equation 3:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} + (V_{IN} \times I_{GND}) \quad \text{Eq. 3}$$

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. The maximum power dissipation number cannot be exceeded for proper operation of the device. The maximum input voltage can be determined using the output voltage of 5.0V and an output current of 100mA. Ground current, of 2mA for 100mA of output current, can be taken from the [Electrical Characteristics](#).

- $425\text{mW} = (V_{IN} - 5.0\text{V})100\text{mA} + V_{IN} \times 2\text{mA}$
- $425\text{mW} = (100\text{mA} \times V_{IN} + 2\text{mA} \times V_{IN}) - 500\text{mW}$
- $925\text{mW} = 102\text{mA} \times V_{IN}$
- $V_{IN} = 9.07\text{V}$ (maximum)

Therefore, a -5.0V application at -100mA of output current can accept a maximum input voltage of -9.07V in a SOT-23 package. For a full discussion of heat sinking and thermal effects on voltage regulators, refer to “Regulator Thermals” section of Micrel’s [Designing with Low Dropout Voltage Regulators](#) handbook.

Adjustable Regulator Application

The MIC5271YM5 can be adjusted from -1.20V to -14V by using two external resistors (Figure 4). The resistors set the output voltage based on Equation 4.

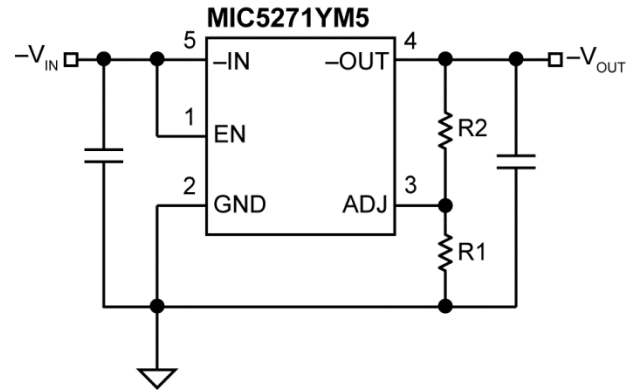
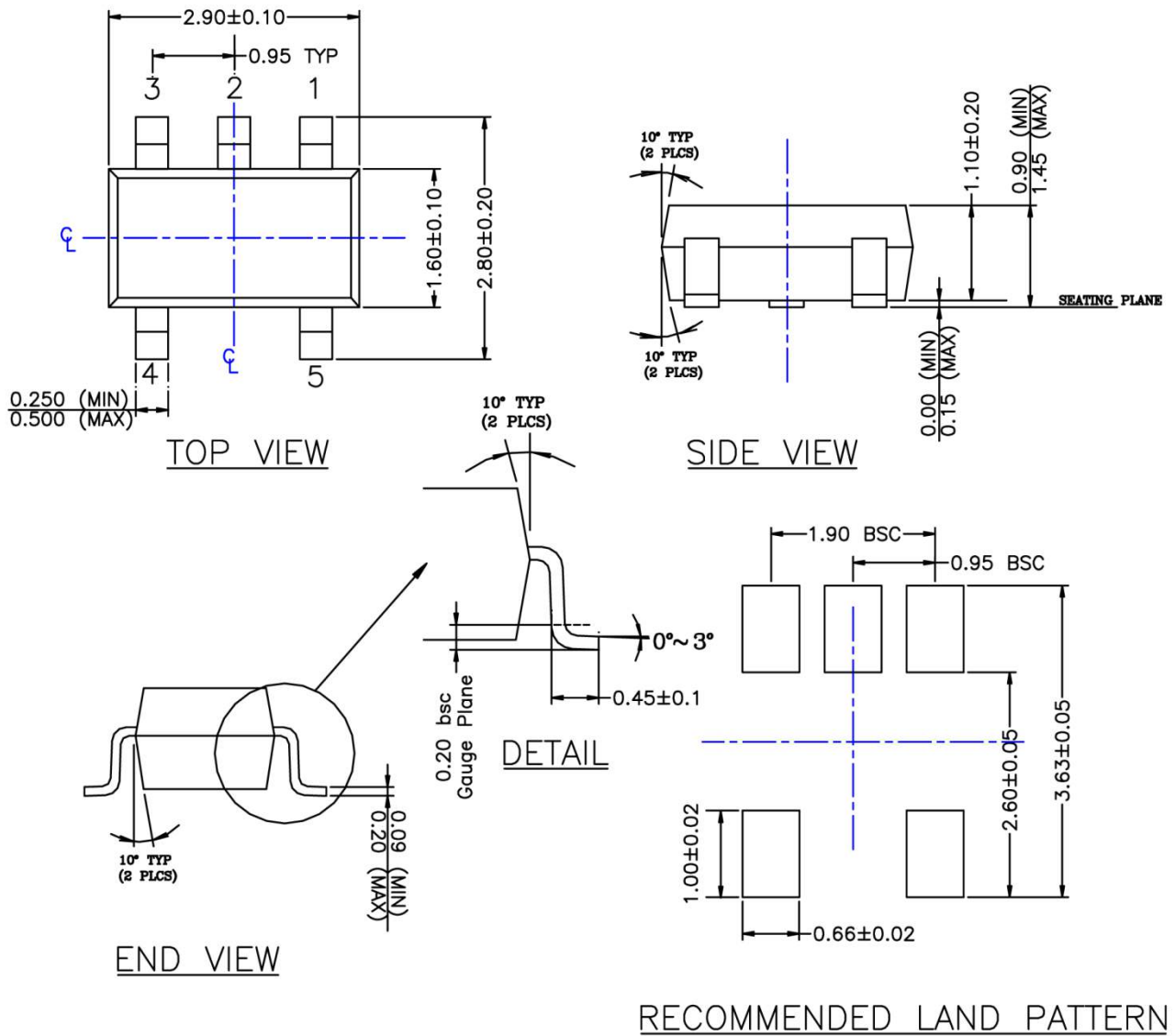


Figure 4. Adjustable Voltage Application

$$|V_{OUT}| = V_{REF} \left(1 + \frac{R2}{R1} \right) \quad \text{Eq. 4}$$

Where $V_{REF} = 1.20\text{V}$.

Package Information and Recommended Landing Pattern⁽¹²⁾



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.

5-Pin SOT-23 (M5)

Note:

12. Package information is correct as of the publication date. For updates and most current information, go to www.micrel.com.

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