MIC5270

IttyBitty™ Negative Low-Dropout Regulator

Preliminary Information

General Description

The MIC5270 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 MIC5270 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 MIC5270 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 MIC5270 is available in the SOT-23-5 package for space saving applications and it is available with fixed –3.0V, –4.1V, and –5.0V outputs.

Features

- IttyBitty™ SOT-23-5 packaging
- Low dropout voltage
- Low ground current
- Tight initial accuracy
- Tight load and line regulation
- Thermal shutdown
- Current limiting
- Stable with low-ESR ceramic capacitors

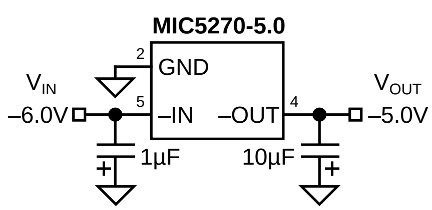
Applications

- GaAsFET bias
- Portable cameras and video recorders
- PDAs
- Battery-powered equipment

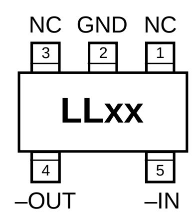
Ordering Information

Part Number	Voltage	Temperature Range	Package
MIC5270-3.0BM5	–3.0V	–40°C to +85°C	SOT-23-5
MIC5270-4.1BM5	–4.1V	–40°C to +85°C	SOT-23-5
MIC5270-5.0BM5	–5.0V	–40°C to +85°C	SOT-23-5

Typical Application



Pin Configuration



MIC5270-x.xBM5

Pin Description

Pin Number	Pin Name	Pin Function
1	NC	Not internally connected.
2	GND	Ground
3	NC	Not internally connected.
4	–OUT	Negative Regulator Output
5	–IN	Negative Supply Input

Absolute Maximum Ratings (Note 1)

Input Voltage (V_{-IN}) .... –20V to +20V
Power Dissipation (P_D) .... Internally Limited
Junction Temperature (T_J) .... –40°C to +125°C
Lead Temperature (soldering, 5 sec.) .... 260°C
Storage Temperature (T_S) .... –65°C to +150°C
ESD Rating, **Note 3**

Operating Ratings (Note 2)

Input Voltage (V_{IN}) .... –16V to –2V
Junction Temperature (T_J) .... –40°C to +125°C
Thermal Resistance (θ_{JA}).. **Note 4**

Electrical Characteristics

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{OUT}	Output Voltage Accuracy	Variation from nominal V_{OUT}	–2 **–3**		2 **3**	% %
$\Delta V_{OUT}/\Delta T$	Output Voltage Temperature Coefficient	**Note 5**		100		ppm/°C
$\Delta V_{OUT}/V_{OUT}$	Line Regulation	$V_{IN} = V_{OUT}$ – 1V to –16V		0.055	0.15	%/V
$\Delta V_{OUT}/V_{OUT}$	Load Regulation	I_{OUT} = 100µA to 100mA, **Note 6**			2.0	%
$V_{IN} – V_{OUT}$	Dropout Voltage, **Note 7**	I_{OUT} = 100µA		35		mV
		I_{OUT} = 10mA		250		mV
		I_{OUT} = 50mA		360	450	mV
		I_{OUT} = 100mA		480	600	mV
I_{GND}	Ground Current, **Note 8**	I_{OUT} = 100µA		70		µA
		I_{OUT} = 10mA		250		µA
		I_{OUT} = 50mA		0.7		mA
		I_{OUT} = 100mA		2.1	3.0	mA
PSRR	Ripple Rejection	f = 120Hz		50		dB
I_{LIMIT}	Current Limit	V_{OUT} = 0V		160	300	mA
$\Delta V_{OUT}/\Delta P_D$	Thermal Regulation	**Note 9**		0.05		%/W

Note 1. Exceeding the absolute maximum rating may damage the device.

Note 2. The device is not guaranteed to function outside its operating rating.

Note 3. Devices are ESD sensitive. Handling precautions recommended.

Note 4. 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” section for details.

Note 5. Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

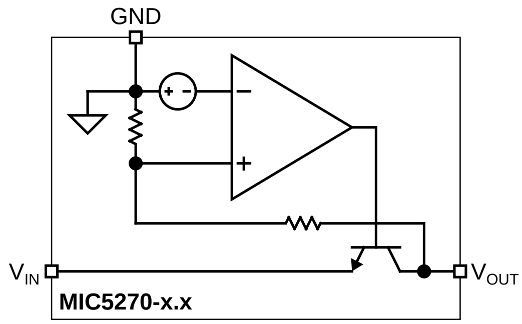
Note 6. Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 100µA to 100mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

Note 7. 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.

Note 8. 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.

Note 9. Thermal regulation is defined as the change in output voltage at a time “t” after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 100mA load pulse at V_{IN} = –16V for t = 10ms.

Functional Diagram



Applications Information

The MIC5270 is a general-purpose negative regulator that can be used in any system that requires a clean negative voltage from a negative output. This includes post regulating of dc-dc converters (transformer based or charge pump based voltage converters). These negative voltages typically require a negative low-dropout voltage regulator to provide a clean output from typically noisy lines.

Input Capacitor

A 1µF input capacitor should be placed from IN to GND if there is more than 2 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 MIC5270 requires an output capacitor for stable operation. A minimum of 1µF 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 3Ω or greater at 100kHz may cause a high frequency oscillation.

Low-ESR tantalums are recommended due to the tight capacitance tolerance over temperature.

Ceramic chip capacitors have a much greater dependence on temperature, depending upon the dielectric. The X7R is recommended for ceramic capacitors because the dielectric will change capacitance value by approximately 15% over temperature. The Z5U dielectric can change capacitance value by as much as 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 MIC5270 does not require a load for stability.

Thermal Considerations

Absolute values will be used for thermal calculations to clarify what is meant by power dissipation and voltage drops across the part.

Proper thermal design for the MIC5270-5.0BM5 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 the following equation:

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

$$P_{D(max)} = \frac{125°C - 25°C}{235°C/W}$$

$$P_{D(max)} = 425mW$$

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

$$P_D = \left(V_{IN} - V_{OUT}\right) I_{OUT} + V_{IN} \cdot I_{GND}$$

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. 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 1mA for 100mA of output current, can be taken from the Electrical Characteristics section of the data sheet.

$$425mW = \left(V_{IN} - 5.0V\right)100mA + V_{IN} \cdot 1mA$$

$$425mW = \left(100mA \cdot V_{IN} + 1mA \cdot V_{IN}\right) - 500mW$$

$$925mW = 101mA \cdot V_{IN}$$

$$V_{IN} = 9.16Vmax$$

Therefore, a –5.0V application at 100mA of output current can accept a maximum input voltage of –9.16V in a SOT-23-5 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.