MIC5249

300mA µCap LDO with Programmable Power-On Reset Delay

Advance Information

General Description

The MIC5249 is an efficient, precise 300mA CMOS voltage regulator with power-on reset delay which can be implemented via an external capacitor. It offers 1% initial accuracy, extremely-low-dropout voltage (typically 400mV @ 300mA), and low ground current (typically 85µA) over load.

Designed specifically for noise-critical applications in hand-held or battery-powered devices, the MIC5249 comes equipped with a noise reduction feature to filter the output noise via an external capacitor. Other features of the MIC5249 include a logic compatible enable pin, current limit, thermal shutdown, ultra-fast transient response, and an active clamp to speed up device turnoff.

The MIC5249 also works with low-ESR ceramic capacitors, reducing the amount of board space necessary for power applications, critical in hand-held wireless devices.

The MIC5249 is available in the MSOP-8 package.

Features

- 300mA output current
- High PSRR: 65dB@120Hz
- Stable with ceramic output capacitor
- Power-on RESET Output with adjustable delay time
- High output accuracy:
    +1.0% initial accuracy
    +2.0% over temperature
- Low dropout voltage of 400mV @ 300mA
- Low quiescent current: 85µA
- Zero current shutdown mode
- Thermal shutdown protection
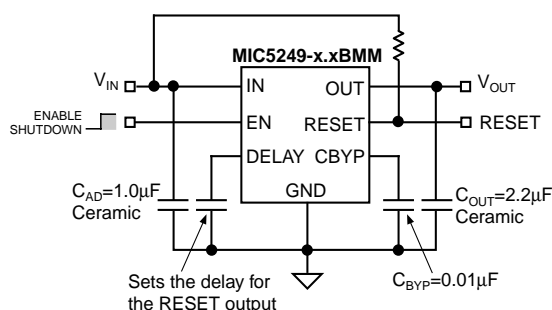- Current-limit protection
- Tiny MSOP-8 package

Applications

- Cellular phones
- PDAs
- Fiber optic modules

Ordering Information

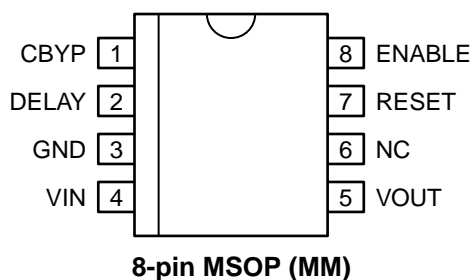| Part Number	Voltage	Junction Temp. Range	Package
MIC5249-2.85BMM	2.85V	−40°C to 125°C	MSOP-8

Other voltages available. Contact Micrel for details.

Typical Application

Ultra-Low-Noise Application

Pin Configuration

8-pin MSOP (MM)

Pin Description

Pin No.	Pin Name	Pin Function
1	CBYP	Reference Bypass: Connect external 0.01µF capacitor to GND to reduce output noise. May be left open.
2	DELAY	Delay Set Input: Connect external capacitor to GND to set the delay of the Error Flag.
3	GND	Ground
4	VIN	Supply Input
5	VOUT	Regulator Output
6	NC	No Connect.
7	RESET	RESET Output: Open-drain output. Active low indicates an output undervoltage condition.
8	ENABLE	Enable Input: CMOS compatible input. Logic high = enable; Logic low = shutdown. Do not leave open.

Absolute Maximum Ratings (Note 1)

Supply Input Voltage (V_{IN}) .... 0V to 7V
Power Dissipation (P_D) .... Internally Limited, **Note 3**
Junction Temperature .... −40°C to +125°C
Lead Temperature (soldering, 5 sec.) .... 260°C
Storage Temperature (T_S) .... −65°C to 150°C
ESD Rating, **Note 4**

Operating Ratings (Note 2)

Supply Input Voltage (V_{IN}) .... 2.7V to 6V
Enable Input Voltage (V_{EN}) .... 0V to V_{IN}
Junction Temperataure (T_J) .... −40°C to +125°C
Package Thermal Resistance
    MSOP-8 (θ_{JA}) .... 200°C/W

Electrical Characteristics

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

| Parameter	Conditions	Min	Typ	Max	Units
Output Voltage Accuracy	Variation from nominal V_{OUT}	−1.0 **−2.0**		+1.0 **+2.0**	% %
Line Regulation	$V_{IN} = V_{OUT} +1V$ to 6V	−0.3	0.02	+0.3	%/V
Load Regulation	$I_{OUT} = 0.1mA$ to 300mA		1.5	3.0	%
Dropout Voltage	$I_{OUT} = 100\mu A$		1		mV
	$I_{OUT} = 150mA$		175	225 **275**	mV mV
	$I_{OUT} = 300mA$		400	500 **600**	mV mV
Ground Pin Current	$I_{OUT} = 0mA$		85	**150**	μA
	$I_{OUT} = 300mA$		100	**175**	μA
Ground Pin Current in Shutdown	$V_{EN} < 0.4V$ (Regulator OFF)		0.35	1	μA
Ripple Rejection	f = 120Hz, $C_{OUT} = 2.2\mu F$		65		dB
Current Limit	$V_{OUT} = 0V$	**330**	550		mA
Enable Input					
Enable Input Voltage	Logic Low (Regulator Shutdown)			**0.4**	V
	Logic High (Regulator Enabled)	**1.6**			V
Enable Input Current	$V_{IL} < 0.4V$ (Regulator Shutdown)		0.01		μA
	$V_{IH} > 1.6V$ (Regulator Enabled)		0.01		μA
Delay Input					
Delay Pin Current Source			0.55	1	μA
Delay Pin Threshold Voltage	Threshold for RESET = Logic High		1.40		V
RESET Output					
V_{TH}	Low Threshold, % of V_{OUT} (Flag ON)		89		%
	High Threshold, % of V_{OUT} (Flag OFF)		93		%
V_{OL}	RESET Output Logic - Low Voltage; $I_{RESET} = 100\mu A$ output in fault condition		0.020	**0.1**	V
I_{RESET}	Flag Leakage Current, Flag OFF		0.01		μA

Note 1:   Exceeding maximum rating may damage the device.

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

Note 3:   The maximum allowable power dissipation of any T_A (ambient temperature) is $P_{D(max)} = T_{J(max)}$ - TA) / θ_{JA}. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.

Note 4.   Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5k in series with 100pF.

Functional Diagram
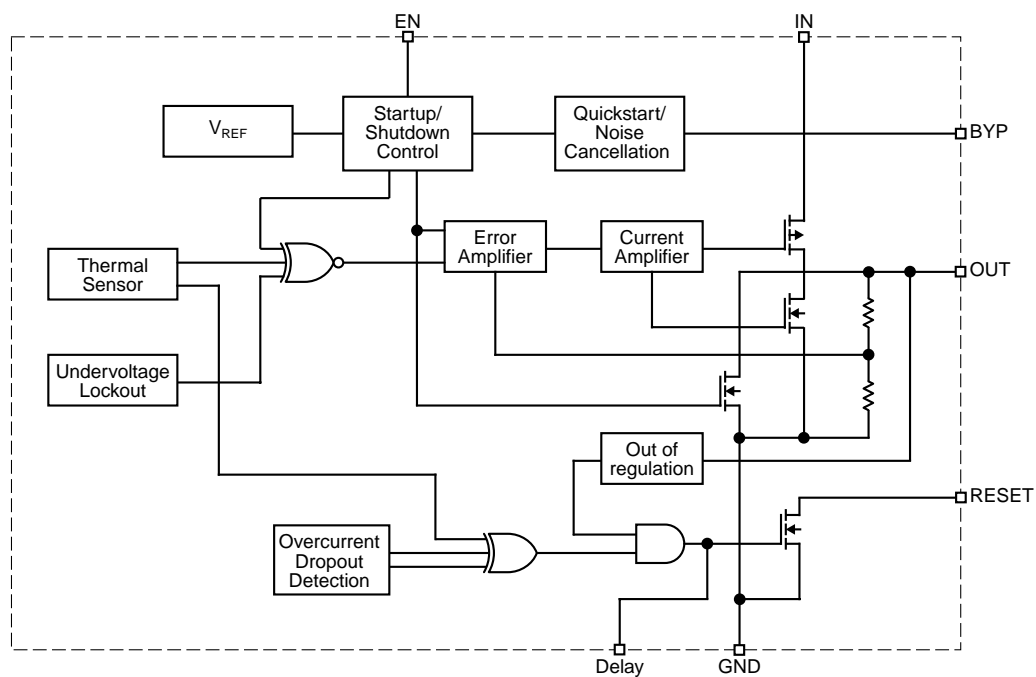
Applications Information

Enable/Shutdown

The MIC5249 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 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. This part is CMOS and the enable pin cannot be left floating; a floating enable pin may cause an indeterminate state on the output.

Input Capacitor

The MIC5249 is a high performance, high bandwidth device. Therefore, it requires a well-bypassed input supply for optimal performance. A 1.0μF 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 to filter out high frequency noise and are good practice in any RF based circuit.

Output Capacitor

The MIC5249 requires an output capacitor for stability. The design requires 2.2μF 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 300mΩ. The output capacitor can be increased, but performance has been optimized for a 2.2μF ceramic output capacitor and does not improve significantly with larger capacitance.

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.

Delay Pin Input

The power-on reset function can be implemented on the MIC5249 by adding an external capacitor from the delay pin to ground. This external capacitor sets the delay time (T_{DELAY}) of the RESET output. The capacitor value required can be easily calculated using the formula:

$$C_{DELAY} = \left(\frac{T_{DELAY} \times I_{DELAY}}{V_{DELAY}} \right)$$

where I_{DELAY} is 0.55μA and the V_{DELAY} is 1.4V. When no capacitor is used, there will be no delay and the POR output acts like a standard error FLAG output.

Reset Output

The RESET output of the MIC5249 provides the power-on reset signal based on the capacitor from the DELAY pin to ground when input power is applied to the regulator. The reset signal stays low for a pre-set time period after power is applied to the regulator, and then goes high (see Timing Diagram).

The reset output is an active-low, open-drain output that drives low when a fault condition AND an undervoltage detection occurs. Internal circuitry intelligently monitors overcurrent, overtemperature and dropout conditions and Ors these outputs together to indicate some fault condition. The output of that OR gate is ANDed with an output voltage monitor that detects an undervotlage condition. The output drives an open-drain transistor to indicate a fault. This prevents chattering or inadvertent triggering of the reset. The reset must be pulled up using a resistor form the RESET pin to either the input or the output.

Bypass Pin Input

A bypass capacitor is required from the noise bypass pin to ground to reduce output voltage noise. The capacitor bypasses the internal reference. A 0.01μF capacitor is recommended for applications that require low-noise outputs. The bypass capacitor can be increased, further reducing noise and improving PSRR. Turn-on time increases slightly with respect to bypass capacitance. A unique quick-start circuit allows the MIC5249 to drive a large capacitor on the bypass pin without significantly slowing the turn-on time. Refer to the "Typical Characteristics" section for performance with different bypass capacitors.

Active Shutdown

The MIC5249 also features an active shutdown clamp, which is an N-channel MOSFET that turns on when the device is disabled. This allows the output capacitor and load to discharge, de-energizing the load.

No-Load Stability

The MIC5249 will remain stable and in regulation with no load unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive application.

Thermal Consideration

The MIC5249 is designed to provide 300mA 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:

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

$T_{J(MAX)}$ is the maximum junction temperature of the die, 125°C, and T_A is the ambient operating temperature. Theta$_{JA}$ is layout dependent; Table 1 shows examples of the junction-to-ambient thermal resistance for the MIC5249.

Package	Theta$_{JA}$Recommended Minimum Footprint
MSOP-8 (MM)	200°C/W

Table 1. MSOP-8 Thermal Resistance

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

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

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 MIC5249-3.0BMM at 50°C with a minimum footprint layout, the maximum input voltage for a set output current can be determined as follows:

$$P_{D(MAX)} = \left(\frac{125°C - 50°C}{200°C\,/\,W} \right)$$

The junction-to-ambient thermal resistance for the minimum footprint is 200°C/W, from Table 1. The maximum power dissipation must not be exceeded for proper operation. Using the output voltage of 3.0V, and an output current of 300mA, the maximum input voltage can be determined. Because this device is CMOS and ghte ground current is typically 90µA over the load range, the power dissipation contributed by the ground current is < 1.0% and can be ignored for this calculation.
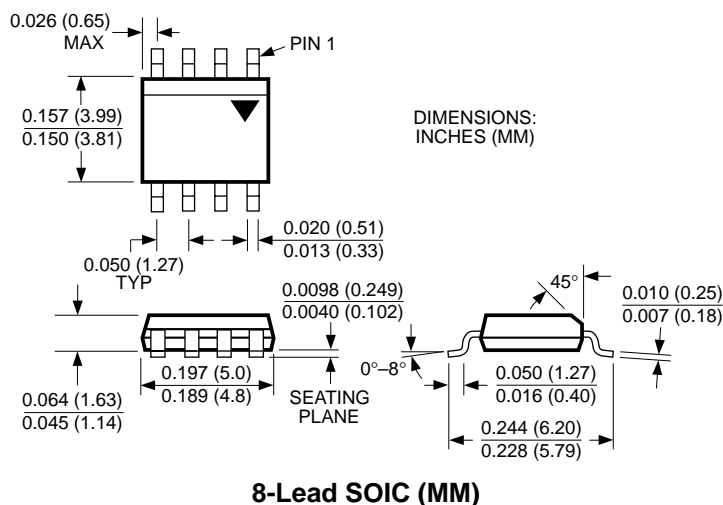
$$375mW = (V_{IN} - 3.0V)300mA$$
$$375mW = V_{IN} \times 300mA - 900mW$$
$$1275mW = V_{IN} \times 300mA$$
$$V_{IN(MAX)} = 4.25V$$

Therefore, a 3.0V application at 300mA of output current can accept a maximum input voltage of 4.25V in the MSOP-8 package. For a full discussion of eat sinking and thermal effects on the voltage regulators, refer to the "Regulator Thermals" section of *Micrel's Designing with Low-Dropout Voltage Regulators* handbook.

Package Information

8-Lead SOIC (MM)