The Infinite Bandwidth Company™

MIC5200

100mA Low-Dropout Regulator

Final Information

General Description

The MIC5200 is an efficient linear voltage regulator with very low dropout voltage (typically 17mV at light loads and 200mV at 100mA), and very low ground current (1mA at 100mA output), offering better than 1% initial accuracy with a logic compatible ON/OFF switching input. Designed especially for hand-held battery powered devices, the MIC5200 is switched by a CMOS or TTL compatible logic signal. The ENABLE control may be tied directly to V_{IN} if unneeded. When disabled, power consumption drops nearly to zero. The ground current of the MIC5200 increases only slightly in dropout, further prolonging battery life. Key MIC5200 features include protection against reversed battery, current limiting, and over-temperature shutdown.

The MIC5200 is available in several fixed voltages and accuracy configurations. Other options are available; contact Micrel for details.

Features

- High output voltage accuracy
- Variety of output voltages
- Guaranteed 100mA output
- Low quiescent current
- Low dropout voltage
- Extremely tight load and line regulation
- Very low temperature coefficient
- Current and thermal limiting
- Zero OFF mode current
- Logic-controlled electronic shutdown
- Available in 8-lead SOIC, MM8™ 8-lead MSOP, and SOT-223 packages

Applications

- Cellular Telephones
- Laptop, Notebook, and Palmtop Computers
- Battery Powered Equipment
- PCMCIA V_{CC} and V_{PP} Regulation/Switching
- Bar Code Scanners
- SMPS Post-Regulator/ DC to DC Modules
- High Efficiency Linear Power Supplies

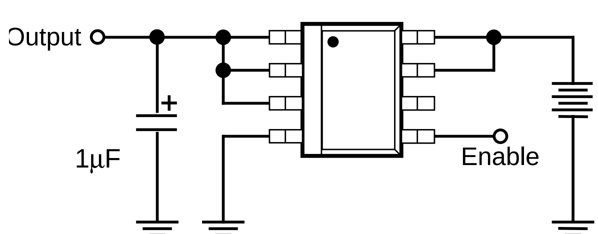
Ordering Information

Part Number	Voltage	Accuracy	Junction Temp. Range*	Package
MIC5200-3.0BM	3.0	1%	–40°C to +125°C	8-Pin SOP
MIC5200-3.3BM	3.3	1%	–40°C to +125°C	8-Pin SOP
MIC5200-4.8BM	4.85	1%	–40°C to +125°C	8-Pin SOP
MIC5200-5.0BM	5.0	1%	–40°C to +125°C	8-Pin SOP
MIC5200-3.3BMM	3.3V	1%	–40°C to +125°C	8-Pin MSOP
MIC5200-5.0BMM	5.0V	1%	–40°C to +125°C	8-Pin MSOP
MIC5200-3.0BS	3.0	1%	–40°C to +125°C	SOT-223
MIC5200-3.3BS	3.3	1%	–40°C to +125°C	SOT-223
MIC5200-4.8BS	4.85	1%	–40°C to +125°C	SOT-223
MIC5200-5.0BS	5.0	1%	–40°C to +125°C	SOT-223

Other voltages available. Contact Micrel for details.

Typical Application

MIC5200-3.3



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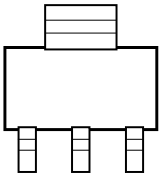
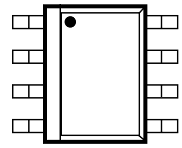
Pin Configuration



MIC5200-x.xBS
(SOT-223)



MIC5200-x.xBM
(SO-8)
MIC5200-x.xBMM
(MSOP-8)

EN may be tied directly to V_{IN}

Pin Description

Pin Number SOT-223	Pin Number SO-8, MSOP-8	Pin Name	Pin Function
3	1, 2	OUT	Output: Pins 1 and 2 must be externally connected together.
	3, 6	NC	(not internally connected): Connect to ground plane for lowest thermal resistance.
2, TAB	4	GND	Ground: Ground pin and TAB are internally connected.
	5	EN	Enable/Shutdown (Input): TTL compatible input. High = enabled; low = shutdown.
1	7, 8	IN	Supply Input: Pins 7 and 8 must be extenally connected together.

Absolute Maximum Ratings

Power Dissipation .... Internally Limited
Lead Temperature (soldering, 5 sec.) .... 260°C
Operating Junction Temperature Range .... –40°C to +125°C
Input Supply Voltage .... –20V to +60V
Enable Input Voltage .... –20V to +60V
Thermal Characteristics
SOT-223 (θ_{JC}) .... 15°C/W
SO-8 (θ_{JA}) .... See Note 1

Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device beyond its specified **Operating Ratings.**

Recommended Operating Conditions

Input Voltage .... 2.5V to 26V
Operating Junction Temperature Range .... –40°C to +125°C
Enable Input Voltage .... –20V to V_{IN}

Electrical Characteristics

Limits in standard typeface are for $T_J = 25°C$ and limits in **boldface** apply over the junction temperature range of –40°C to +125°C. Unless otherwise specified, $V_{IN} = V_{OUT} + 1V$, $I_L = 1mA$, $C_L = 3.3\mu F$, and $V_{ENABLE} \geq 2.0V$

Symbol	Parameter	Conditions	Min	Typical	Max	Units
V_O	Output Voltage Accuracy	Variation from specified V_{OUT}	–1 **–2**		1 **2**	%
$\frac{\Delta V_O}{\Delta T}$	Output Voltage Temperature Coef.	(Note 2)		**40**	**150**	ppm/°C
$\frac{\Delta V_O}{V_{IN}}$	Line Regulation	$V_{IN} = V_{OUT} + 1$ V to 26V		0.004	0.10 **0.40**	%
$\frac{\Delta V_O}{V_{OUT}}$	Load Regulation	I_L = 0.1mA to 100mA (Note 3)		0.04	0.16 **0.30**	%
$V_{IN} – V_O$	Dropout Voltage (Note 4)	$I_L = 100\mu A$ $I_L = 20mA$ $I_L = 30mA$ $I_L = 50mA$ $I_L = 100mA$		17 130 150 190 230	 **350**	mV
I_{GND}	Quiescent Current	$V_{ENABLE} \leq 0.7V$ (Shutdown)		0.01	10	µA
I_{GND}	Ground Pin Current	$V_{ENABLE} \geq 2.0V$, $I_L = 100\mu A$ $I_L = 20mA$ $I_L = 30mA$ $I_L = 50mA$ $I_L = 100mA$		130 270 330 500 1000	 350 **1500**	µA
PSRR	Ripple Rejection			70		dB
I_{GNDDO}	Ground Pin Current at Dropout	V_{IN} = 0.5V less than specified V_{OUT} $I_L = 100\mu A$ (Note 5)		270	**330**	µA
I_{LIMIT}	Current Limit	$V_{OUT} = 0V$	100	**250**		mA
$\frac{\Delta V_O}{\Delta P_D}$	Thermal Regulation	(Note 6)		0.05		%/W
e_n	Output Noise			100		µV

ENABLE Input

Symbol	Parameter	Conditions	Min	Typical	Max	Units
V_{IL}	Input Voltage Level Logic Low Logic High	 OFF ON	 **2.0**		 **0.7**	V
I_{IL} I_{IH}	ENABLE Input Current	$V_{IL} \leq 0.7V$ $V_{IH} \geq 2.0V$		0.01 15	1 **50**	µA

Note 1: Absolute maximum ratings indicate limits beyond which damage to the component may occur. Electrical specifications do not apply when operating the device outside of its rated operating conditions. 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: $P_{(MAX)} = (T_{J(MAX)} – T_A) \div \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown. The θ_{JC} of the MIC5200-xxBS is 15°C/W and θ_{JA} for the MIC5200BM is 160°C/W mounted on a PC board (see “Thermal Considerations” section for further details).

Note 2: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 3: Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 0.1mA to 100mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

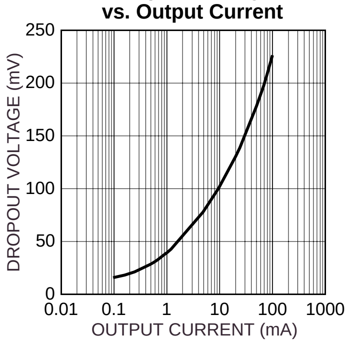
Note 4: Dropout Voltage is defined as the input to output differential at which the output voltage drops 2% below its nominal value measured at 1V differential.

Note 5: 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.

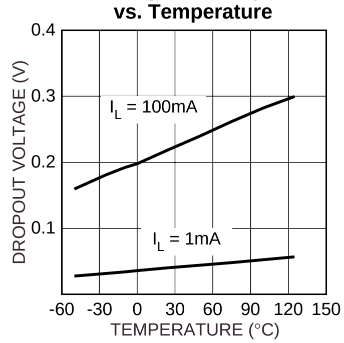
Note 6: Thermal regulation is defined as the change in output voltage at a time t after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 100mA load pulse at $V_{IN} = 26V$ for t = 10ms.

Typical Characteristics

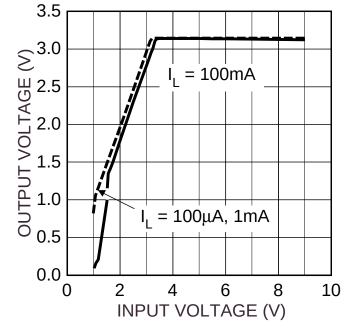
Dropout Voltage vs. Output Current



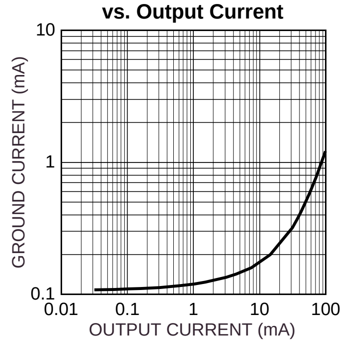
Dropout Voltage vs. Temperature



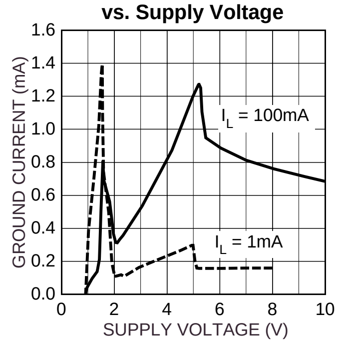
Dropout Characteristics



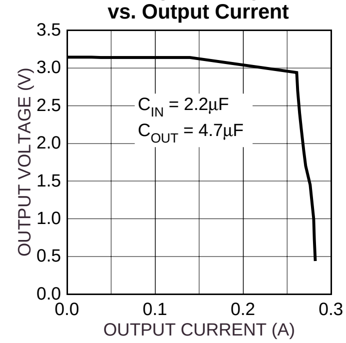
Ground Current vs. Output Current



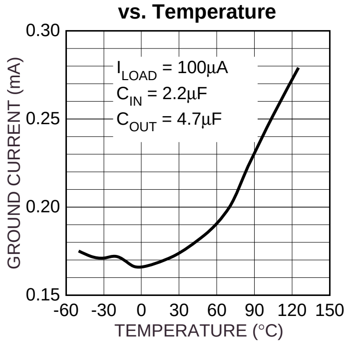
Ground Current vs. Supply Voltage



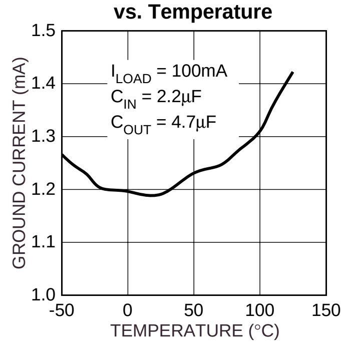
Output Voltage vs. Output Current



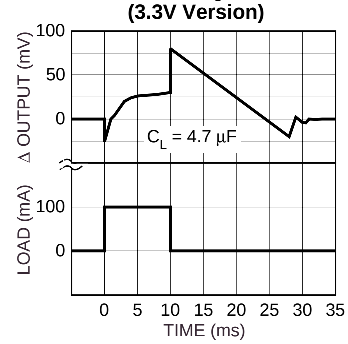
Ground Current vs. Temperature



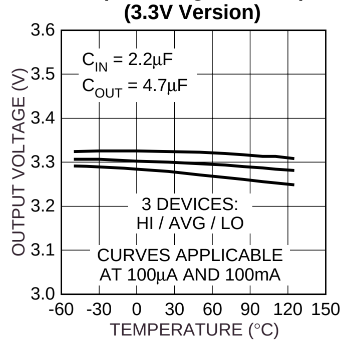
Ground Current vs. Temperature



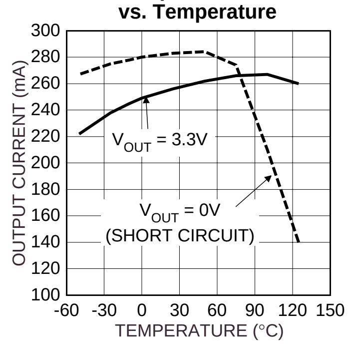
Thermal Regulation (3.3V Version)



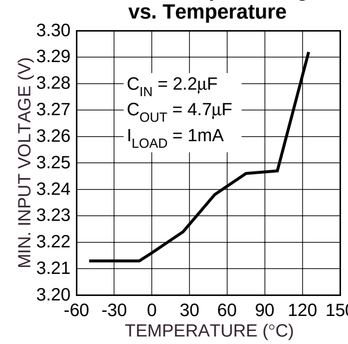
Output Voltage vs. Temp. (3.3V Version)



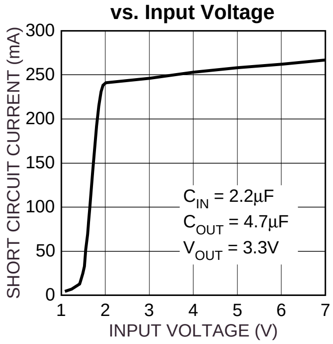
Output Current vs. Temperature



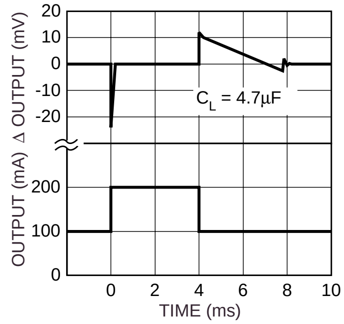
Minimum Input Voltage vs. Temperature



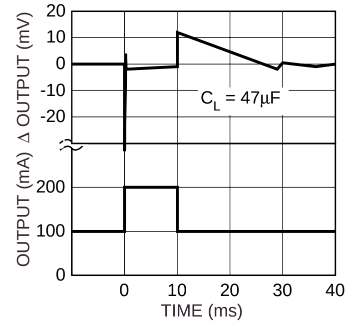
Short Circuit Current vs. Input Voltage



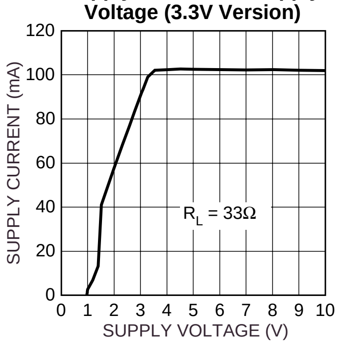
Load Transient



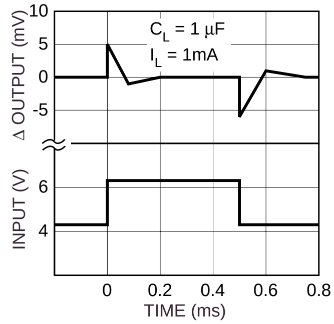
Load Transient



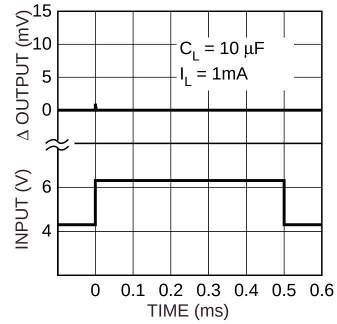
Supply Current vs. Supply Voltage (3.3V Version)



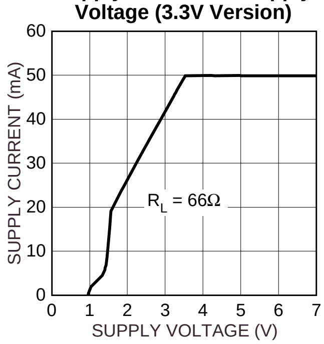
Line Transient



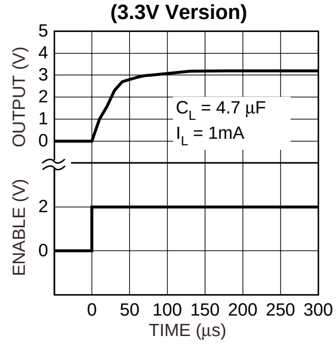
Line Transient



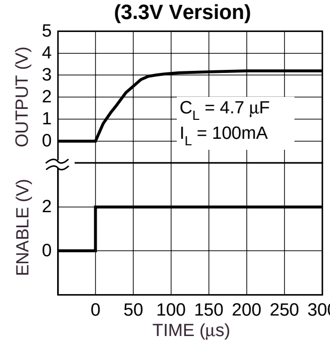
Supply Current vs. Supply Voltage (3.3V Version)



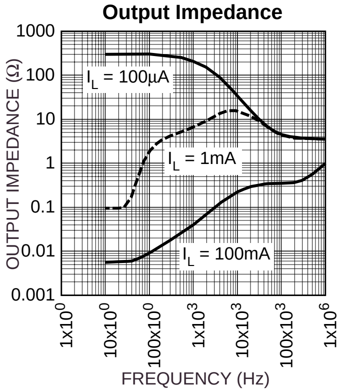
Enable Transient (3.3V Version)



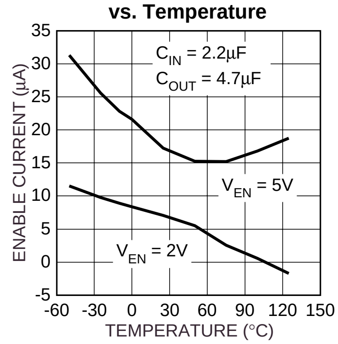
Enable Transient (3.3V Version)



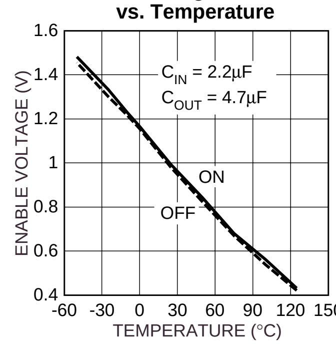
Output Impedance



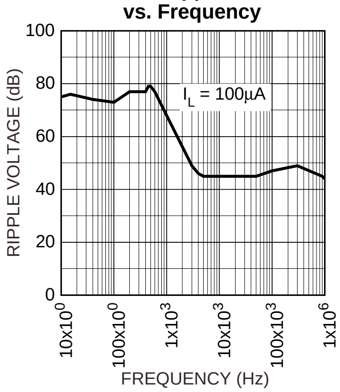
Enable Current Threshold vs. Temperature



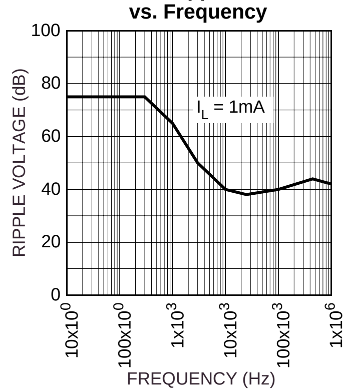
Enable Voltage Threshold vs. Temperature



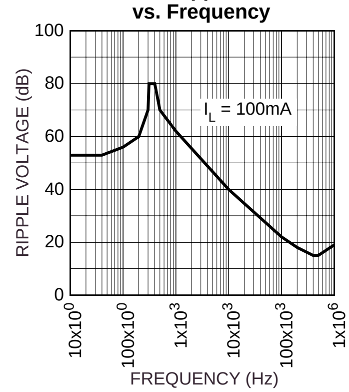
Ripple vs. Frequency



Ripple vs. Frequency



Ripple vs. Frequency



Applications Information

External Capacitors

A 1µF capacitor is recommended between the MIC5200 output and ground to prevent oscillations due to instability. Larger values serve to improve the regulator's transient response. Most types of tantalum or aluminum electrolytics will be adequate; film types will work, but are costly and therefore not recommended. Many aluminum electrolytics have electrolytes that freeze at about –30°C, so solid tantalum capacitors are recommended for operation below –25°C. The important parameters of the capacitor are an effective series resistance of about 5Ω or less and a resonant frequency above 500kHz. The value of this capacitor may be increased without limit.

At lower values of output current, less output capacitance is required for output stability. The capacitor can be reduced to 0.47µF for current below 10mA or 0.33µF for currents below 1 mA. A 1µF capacitor should be placed from the MIC5200 input to ground if there is more than 10 inches of wire between the input and the AC filter capacitor or if a battery is used as the input.

The MIC5200 will remain stable and in regulation with no load in addition to the internal voltage divider, unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications.

When used in dual supply systems where the regulator load is returned to a negative supply, the output voltage must be diode clamped to ground.

ENABLE Input

The MIC5200 features nearly zero OFF mode current. When the ENABLE input is held below 0.7V, all internal circuitry is powered off. Pulling this pin high (over 2.0V) re-enables the device and allows operation. The ENABLE pin requires a small amount of current, typically 15µA. While the logic threshold is TTL/CMOS compatible, ENABLE may be pulled as high as 30V, independent of the voltage on V_{IN}.

Thermal Considerations

Part I. Layout

The MIC5200-xxBM (8-pin surface mount package) has the following thermal characteristics when mounted on a single layer copper-clad printed circuit board.

PC Board Dielectric	θ_{JA}
FR4	160°C/W
Ceramic	120°C/W

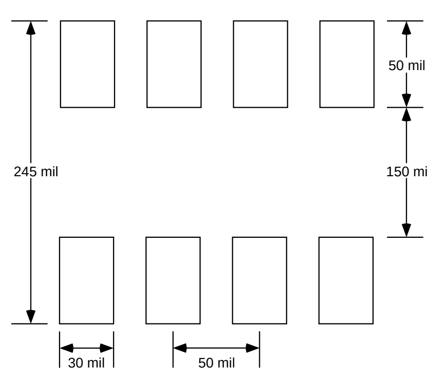
Multi-layer boards having a ground plane, wide traces near the pads, and large supply bus lines provide better thermal conductivity.

The "worst case" value of 160°C/W assumes no ground plane, minimum trace widths, and a FR4 material board.

Part II. Nominal Power Dissipation and Die Temperature

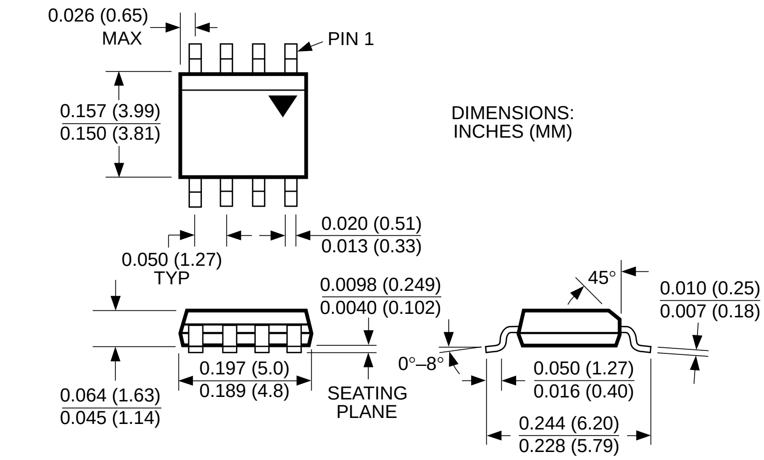
The MIC5200-xxBM at a 25°C ambient temperature will operate reliably at up to 625mW power dissipation when mounted in the "worst case" manner described above. At an ambient temperature of 55°C, the device may safely dissipate 440mW. These power levels are equivalent to a die temperature of 125°C, the recommended maximum temperature for non-military grade silicon integrated circuits.

For MIC5200-xxBS (SOT-223 package) heat sink characteristics, please refer to Micrel Application Hint 17, "Calculating P.C. Board Heat Sink Area for Surface Mount Packages".

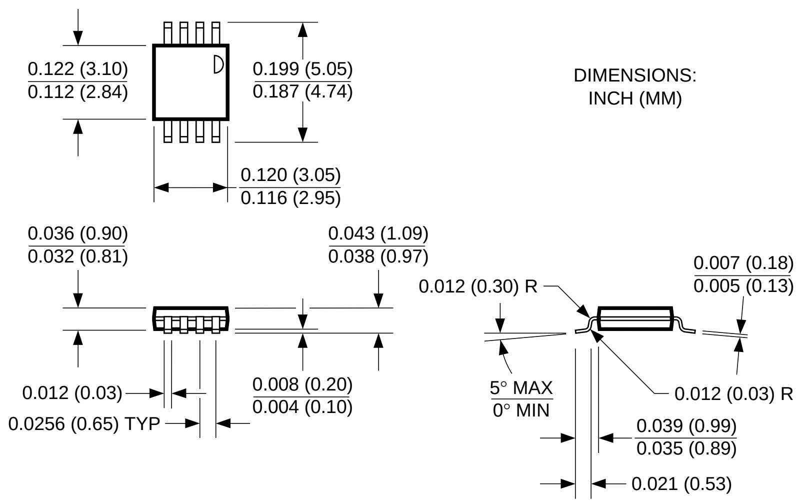


Minimum recommended board pad size, SO-8.

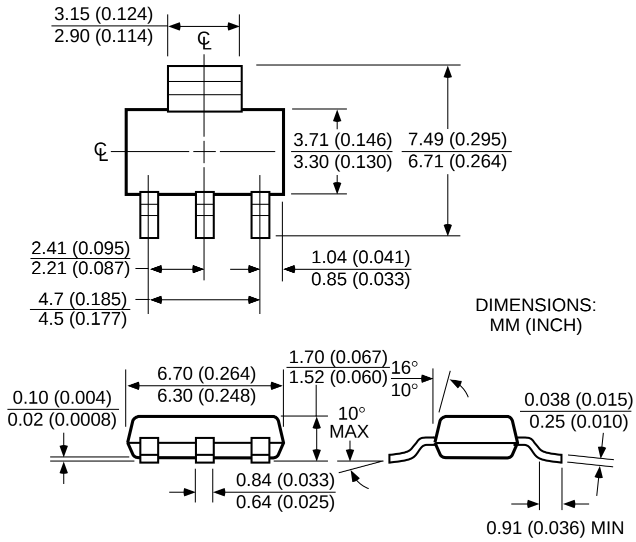
Package Information



8-Pin SOP (M)



8-Lead MSOP (MM)



SOT-223 (S)

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