MIC5200

100 mA Low-Dropout Regulator

Features

- High Output Voltage Accuracy
- Variety of Output Voltages
- Guaranteed 100 mA 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
- Barcode Scanners
- SMPS Post-Regulator/DC-to-DC Modules
- High Efficiency Linear Power Supplies

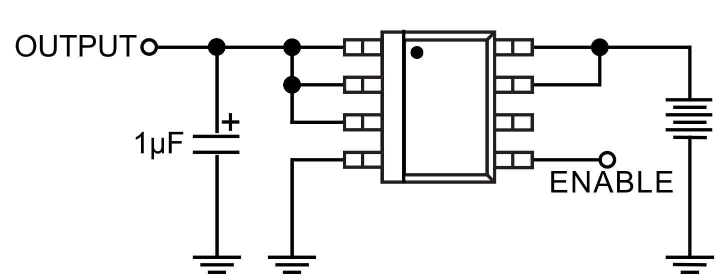
General Description

The MIC5200 is an efficient linear voltage regulator with very low dropout voltage (typically 17 mV at light loads and 200 mV at 100 mA), and very low ground current (1 mA at 100 mA 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 overtemperature shutdown.

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

Typical Application Schematic

MIC5200-3.3



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Supply Voltage .... –20V to +60V
Enable Input Voltage .... –20V to +60V
Power Dissipation.. Internally Limited

Operating Ratings ‡

Input Voltage .... +2.5V to +26V
Enable Input Voltage .... –20V 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.

TABLE 1-1: ELECTRICAL CHARACTERISTICS

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 = 1 mA, C_L = 3.3 µF, and $V_{ENABLE} = V_{DD}$. **(Note 1)**.

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

Note 1: Specification for packaged product only.

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

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 0.1 mA to 100 mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

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.

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.

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 100 mA load pulse at V_{IN} = 26V for t = 10 ms.

TABLE 1-1: ELECTRICAL CHARACTERISTICS (CONTINUED)

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 = 1 mA, C_L = 3.3 µF, and V_{ENABLE} = V_{DD}. **(Note 1)**.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
ENABLE Input						
Input Voltage Level, Logic Low	V_{IL}	—	—	0.7	V	OFF
Input Voltage Level, Logic High	V_{IH}	2.0	—	—		ON
Enable Input Current	I_{IL}	—	0.01	1	µA	V_{IL} ≤ 0.7V
	I_{IH}	—	15	**50**		V_{IH} ≥ 2.0V

Note 1: Specification for packaged product only.

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

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 0.1 mA to 100 mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

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.

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.

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 100 mA load pulse at V_{IN} = 26V for t = 10 ms.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Operating Temperature Range	T_J	–40	—	+125	°C	Note 1
Lead Temperature	—	—	—	+260	°C	Soldering, 5s
Package Thermal Resistances						
Thermal Resistance, SOT-223	θ_{JC}	—	15	—	°C/W	—
Thermal Resistance, SOIC-8	θ_{JA}	—	160	—	°C/W	Note 2

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

2: 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-x.xYS is 15°C/W and θ_{JA} for the MIC5200YM is 160°C/W mounted on a PC board (see Thermal Considerations for further details).

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.

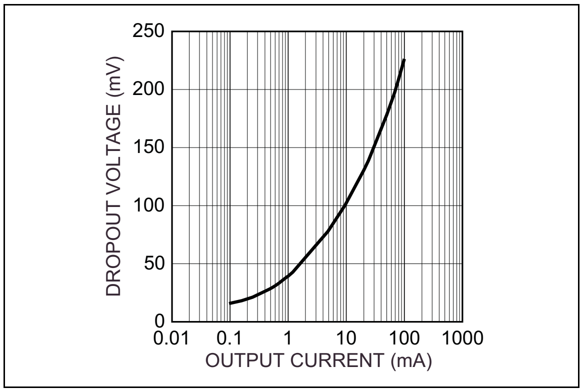


FIGURE 2-1: *Dropout Voltage vs. Output Current.*

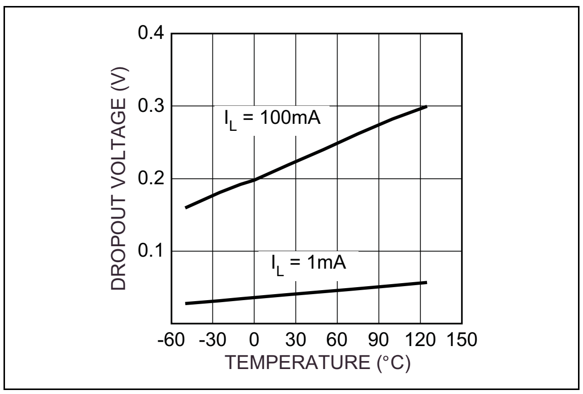


FIGURE 2-2: *Dropout Voltage vs. Temperature.*

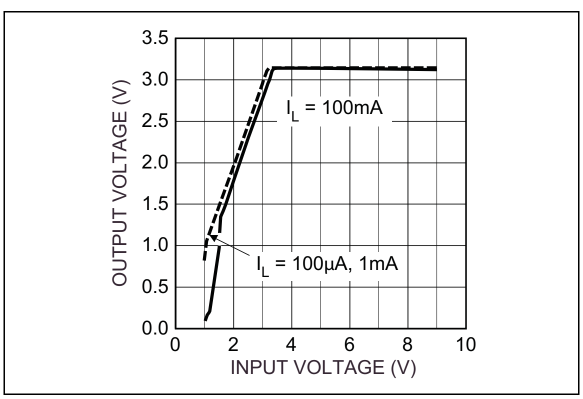


FIGURE 2-3: *Dropout Characteristics.*

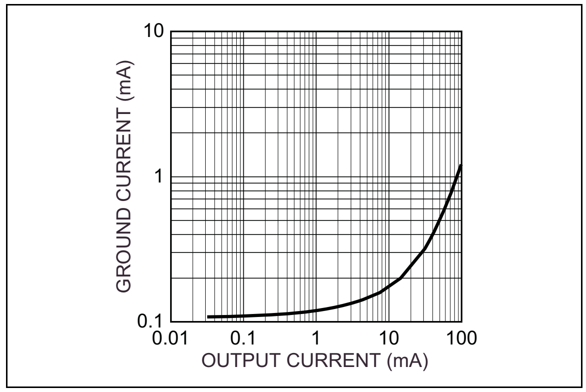


FIGURE 2-4: *Ground Current vs. Output Current.*

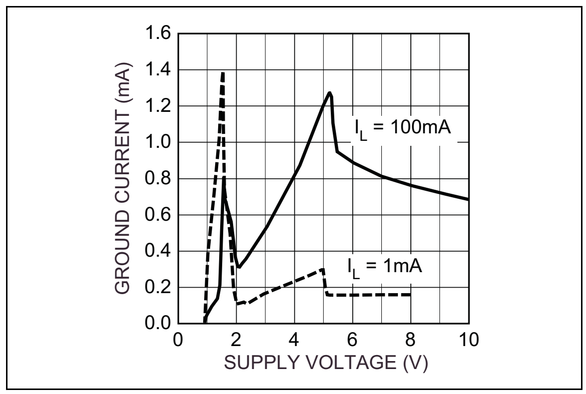


FIGURE 2-5: *Ground Current vs. Supply Voltage.*

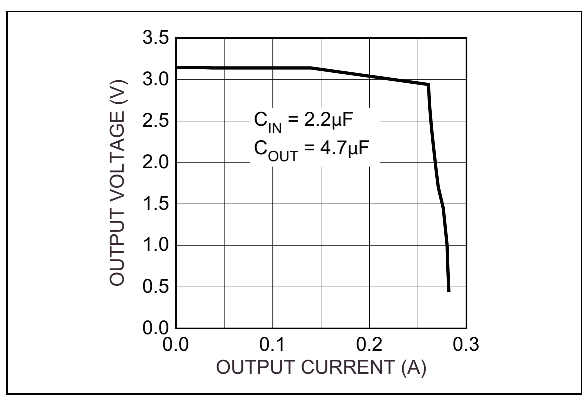


FIGURE 2-6: *Output Voltage vs. Output Current.*

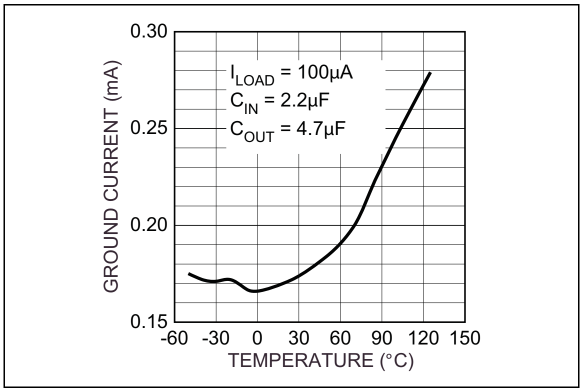


FIGURE 2-7: *Ground Current vs. Temperature.*

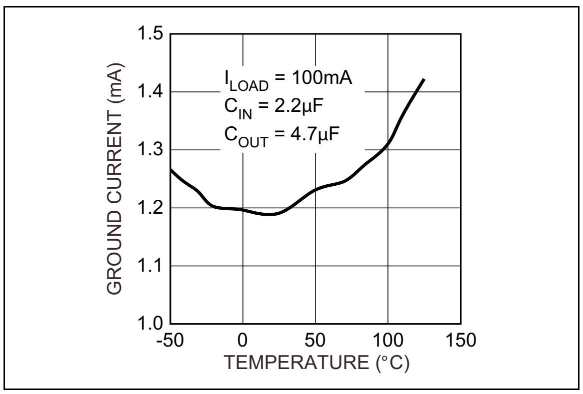


FIGURE 2-8: *Ground Current vs. Temperature.*

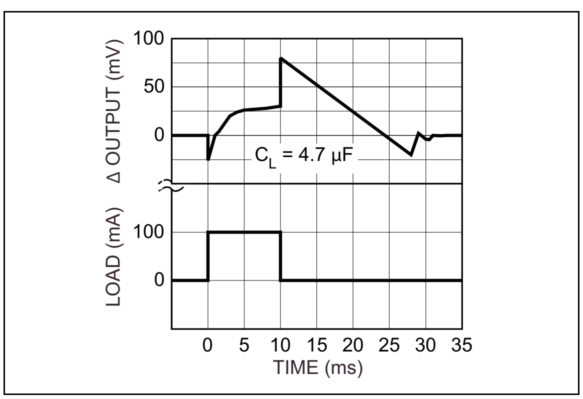


FIGURE 2-9: *Thermal Regulation (3.3V Version).*

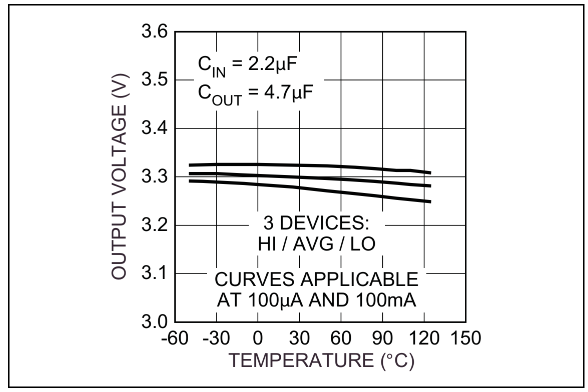


FIGURE 2-10: *Output Voltage vs. Temperature (3.3V Version).*

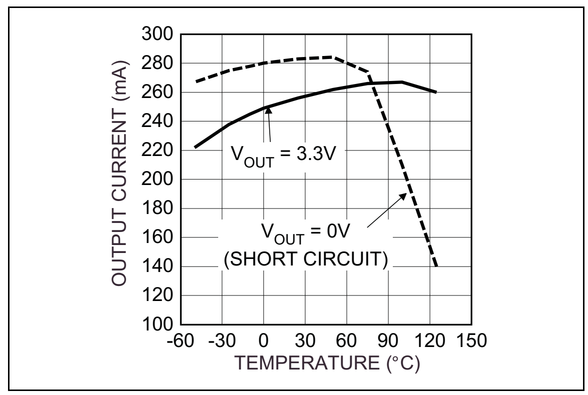


FIGURE 2-11: *Output Current vs. Temperature.*

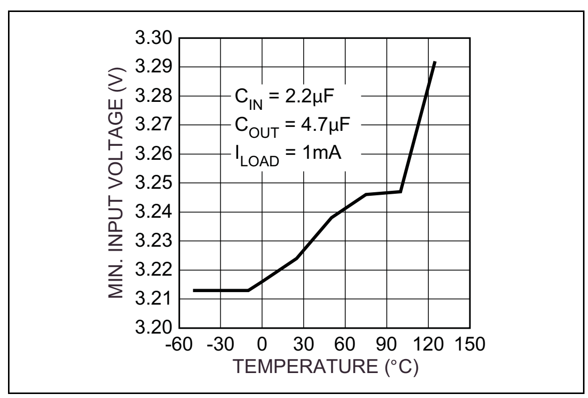


FIGURE 2-12: *Minimum Input Voltage vs. Temperature.*

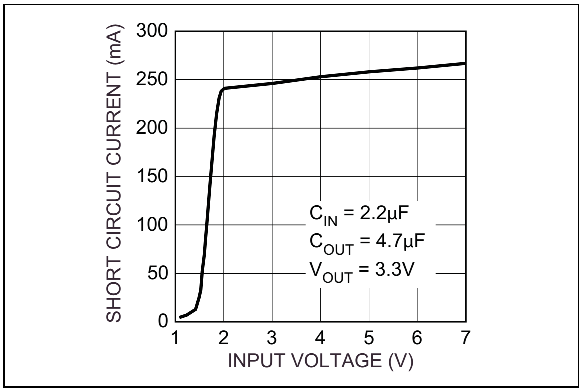


FIGURE 2-13: *Short Circuit Current vs. Input Voltage.*

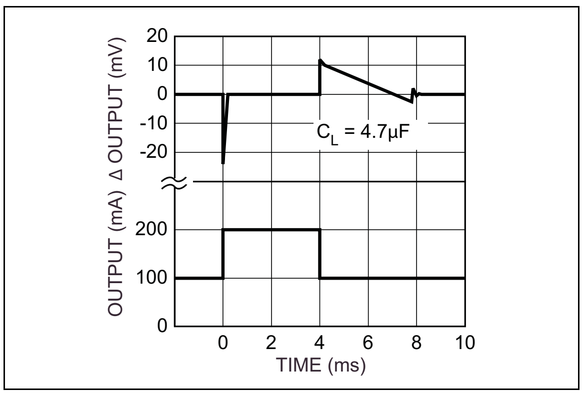


FIGURE 2-14: *Load Transient.*

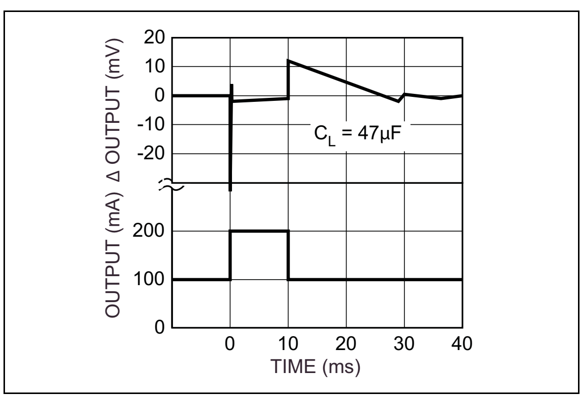


FIGURE 2-15: *Load Transient.*

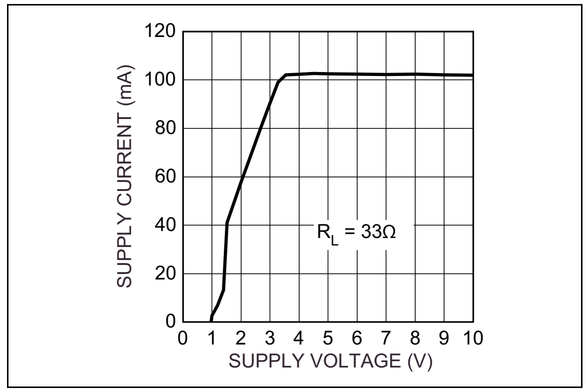


FIGURE 2-16: *Supply Current vs. Supply Voltage (3.3V Version).*

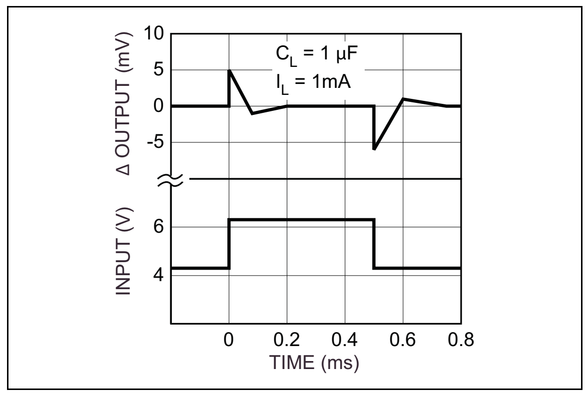


FIGURE 2-17: *Line Transient.*

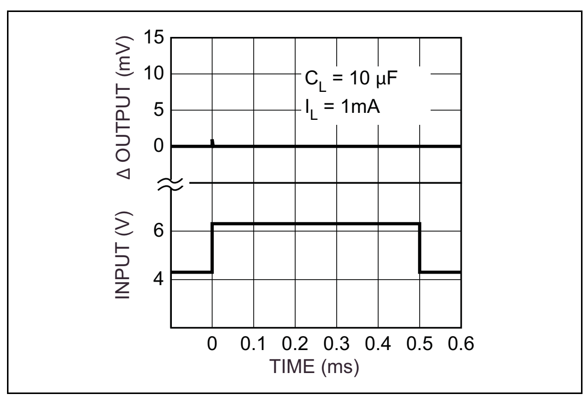


FIGURE 2-18: *Line Transient.*

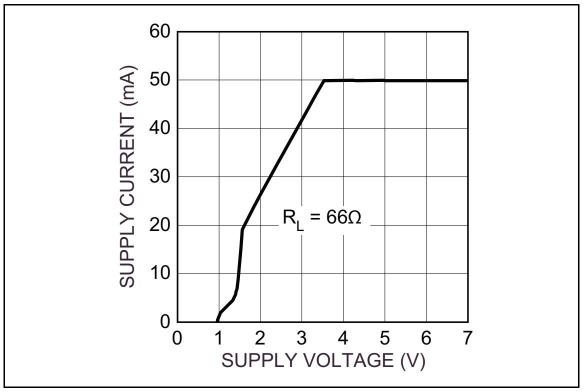


FIGURE 2-19: *Supply Current vs. Supply Voltage (3.3V Version).*

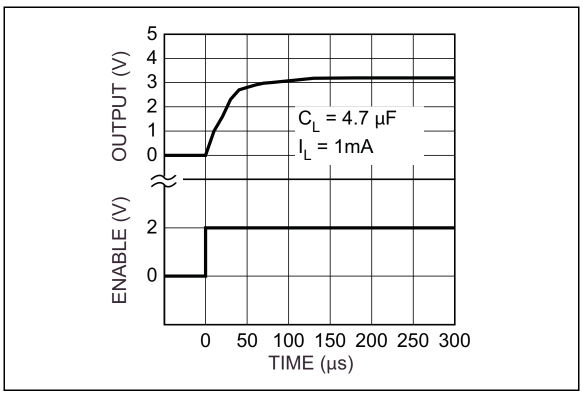


FIGURE 2-20: *Enable Transient (3.3V Version).*

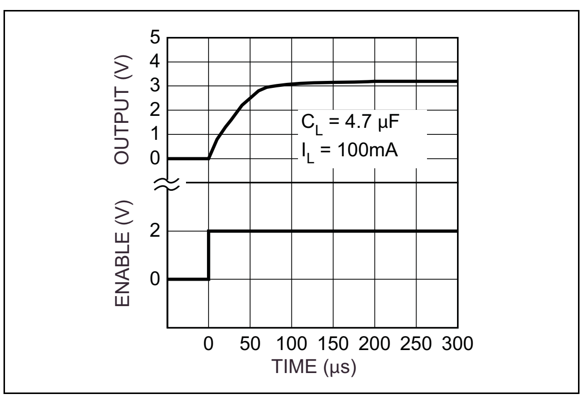


FIGURE 2-21: *Enable Transient (3.3V Version).*

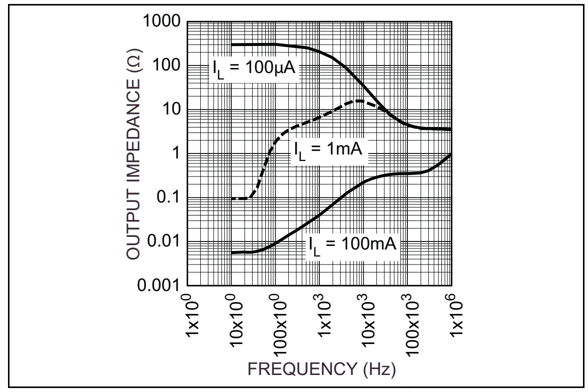


FIGURE 2-22: *Output Impedance.*

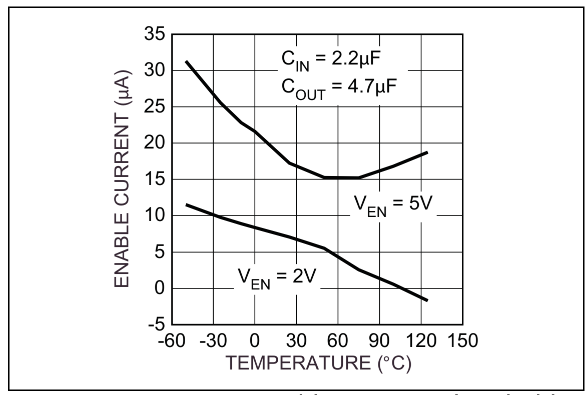


FIGURE 2-23: *Enable Current Threshold vs. Temperature.*

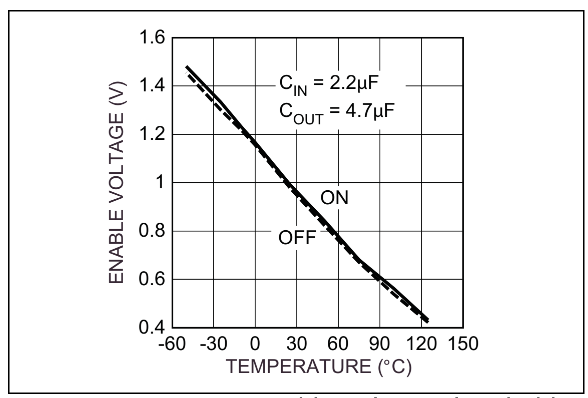


FIGURE 2-24: *Enable Voltage Threshold vs. Temperature.*

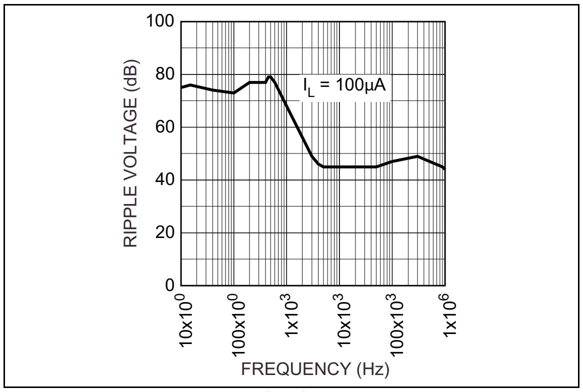


FIGURE 2-25: *Ripple vs. Frequency.*

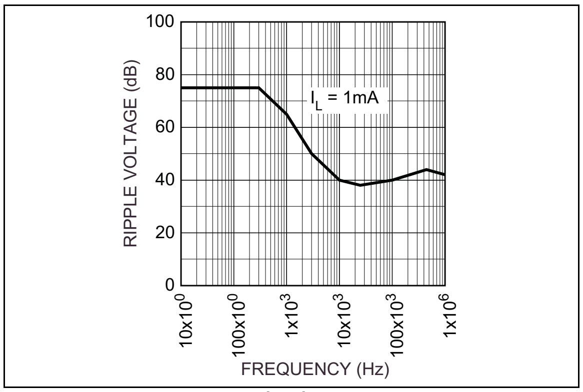


FIGURE 2-26: *Ripple vs. Frequency.*

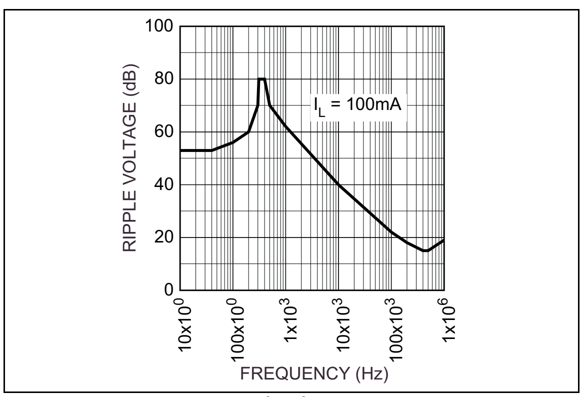
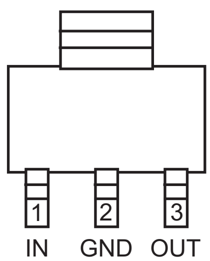


FIGURE 2-27: *Ripple vs. Frequency.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

Package Types



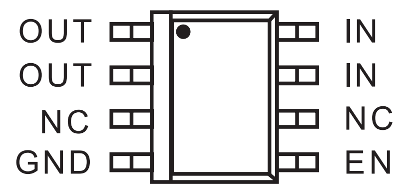


TABLE 3-1: PIN FUNCTION TABLE

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

4.0 APPLICATION INFORMATION

4.1 External Capacitors

A 1 µF 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 500 kHz. 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 0.47 µF for current below 10 mA or 0.33 µF for currents below 1 mA. A 1 µF 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.

4.2 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 15 µA. While the logic threshold is TTL/CMOS compatible, ENABLE may be pulled as high as 30V, independent of the voltage on V_{IN}.

5.0 THERMAL CONSIDERATIONS

5.1 Layout

The MIC5200-x.xYM (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.

5.2 Nominal Power Dissipation and Die Temperature

The MIC5200-x.xYM at a 25°C ambient temperature will operate reliably at up to 625 mW power dissipation when mounted in the "worst case" manner described above. At an ambient temperature of 55°C, the device may safely dissipate 440 mW. 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-x.xYS (SOT-223 package) heat sink characteristics, please refer to Application Hint 17, “Calculating P.C. Board Heat Sink Area for Surface Mount Packages”.

6.0 PACKAGING INFORMATION

6.1 Package Marking Information

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 (_) symbol may not be to scale.

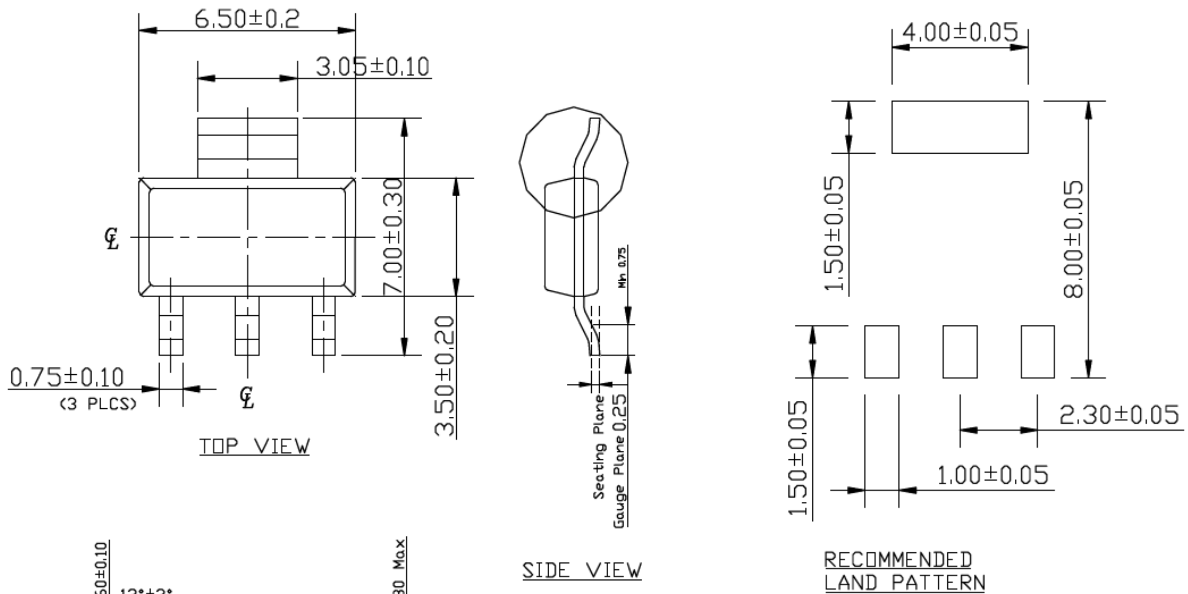
SOT-223 Package Outline and Recommended Land Pattern

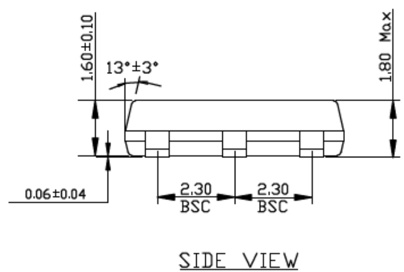
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

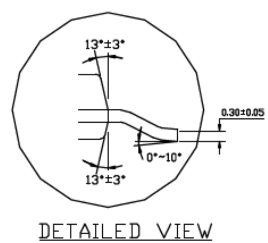
TITLE

3 LEAD SOT223 PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	SOT223-3LD-PL-1	**UNIT**	MM







NOTE:

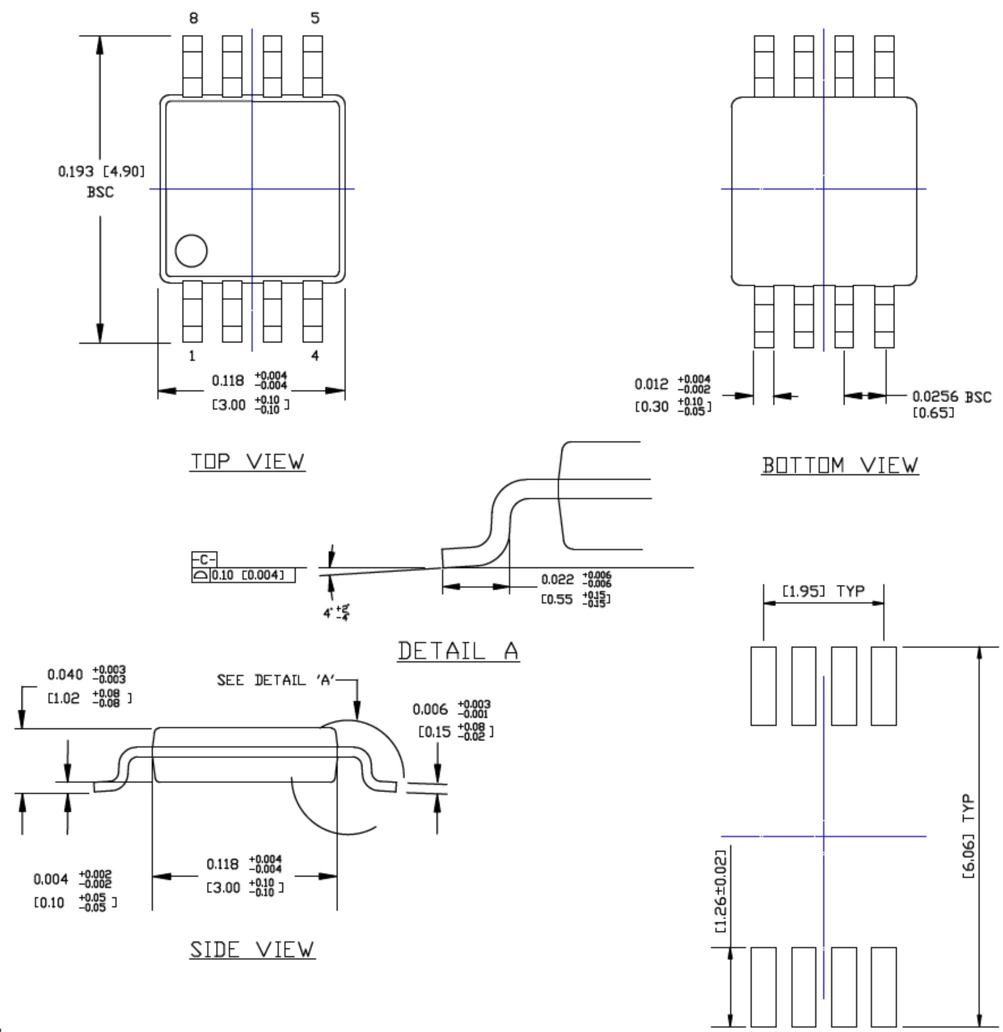
1. Dimensions and tolerances are as per ANSI Y14.5M, 1982.
2. Controlling dimension: Millimeters.
3. Dimensions are exclusive of mold flash and gate burr.
4. All specification comply to Jedec spec TO261 Issue C.

8-Lead MSOP Package Outline and Recommended Land Pattern

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

TITLE
8 LEAD MSOP PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	MSOP-8LD-PL-1	**UNIT**	INCH [MM]



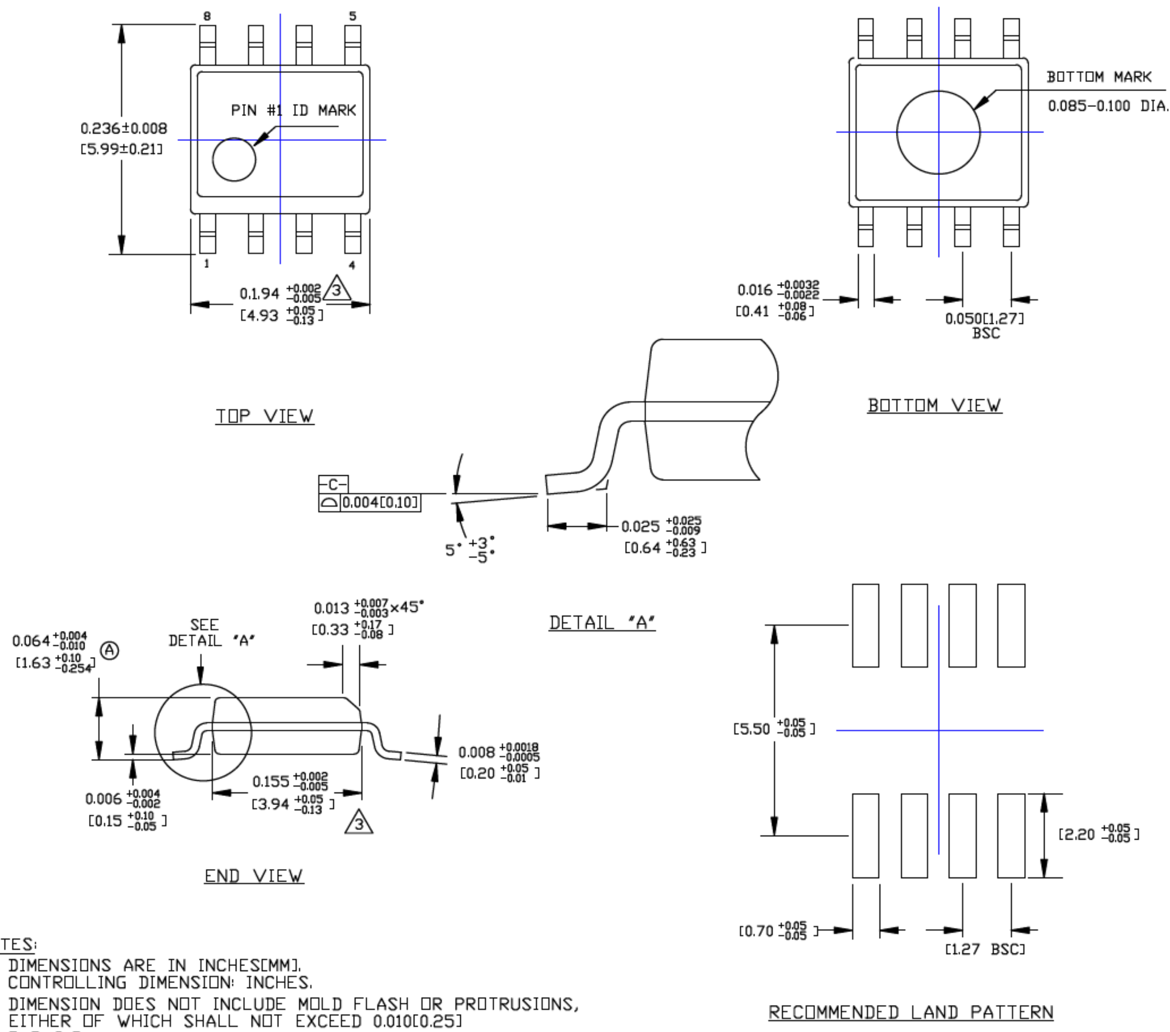
NOTES:
1. DIMENSIONS ARE IN INCHES [MM].
2. CONTROLLING DIMENSION: MM
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.008 [0.20] PER SIDE.

8-Lead SOIC-N Package Outline and Recommended Land Pattern

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

TITLE
8 LEAD SOICN PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	SOICN-8LD-PL-1	**UNIT**	INCH [MM]



NOTES:
1. DIMENSIONS ARE IN INCHES[MM].
2. CONTROLLING DIMENSION: INCHES.
3. (△) DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.010[0.25] PER SIDE.

APPENDIX A: REVISION HISTORY

Revision A (July 2016)

- Converted Micrel document MIC5200 to Microchip data sheet DS20005578A.
- 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 NO.	-	X.X	X	XX	-	X.X
Device		Voltage	Temperature	Package		Media Type

Device:	MIC5200:	100 mA Low-Dropout Regulator
Voltage: (Note 1)	3.0 = 3.0V 3.3 = 3.3V 4.8 = 4.8V 5.0 = 5.0V	
Temperature:	Y = –40°C to +125°C	
Package:	M = 8-Pin SOIC MM = 8-Pin MSOP S = SOT-223	
Media Type:	TR = 2,500/Reel blank= 95/Tube	

Note 1: The 8-Pin MSOP package (MM) is only available in 3.3V and 5.0V options.

Examples:

a) MIC5200-3.0YM: 100 mA Low-Dropout Regulator, 3.0V Voltage, –40°C to +125°C Temp. Range, 8-Pin SOIC, 95/Tube

b) MIC5200-4.8YM-TR: 100 mA Low-Dropout Regulator, 4.85 Voltage, –40°C to +125°C Temp. Range, 8-Pin SOIC, 2,500/Reel

c) MIC5200-3.3YMM: 100 mA Low-Dropout Regulator, 3.3V Voltage, –40°C to +125°C Temp. Range, 8-Pin MSOP, 95/Tube

d) MIC5200-5.0YMM-TR: 100 mA Low-Dropout Regulator, 5.0V Voltage, –40°C to +125°C Temp. Range, 8-Pin MSOP, 2,500/Reel

e) MIC5200-3.3YS: 100 mA Low-Dropout Regulator, 3.3V Voltage, –40°C to +125°C Temp. Range, SOT-223, 95/Tube

f) MIC5200-5.0YS-TR 100 mA Low-Dropout Regulator, 5.0V Voltage, –40°C to +125°C Temp. Range, SOT-223, 2,500/Reel

NOTES:

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