MIC5201

150 mA Low-Dropout Regulator

Features

- AEC-Q100 for Fixed Option
- High Output Voltage Accuracy
- Variety of Output Voltages
- Ensured 150 mA Output
- Low Quiescent Current
- Low-Dropout Voltage
- Extremely Tight Load and Line Regulation
- Very Low-Temperature Coefficient
- Current and Thermal Limiting
- Reverse-Battery Protection
- Load-Dump Protection (Fixed Voltage Versions)
- Zero Off Mode Current
- Logic-Controlled Electronic Enable
- Available in 8-Lead SOIC 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 and DC/DC Modules
- High-Efficiency Linear Power Supplies

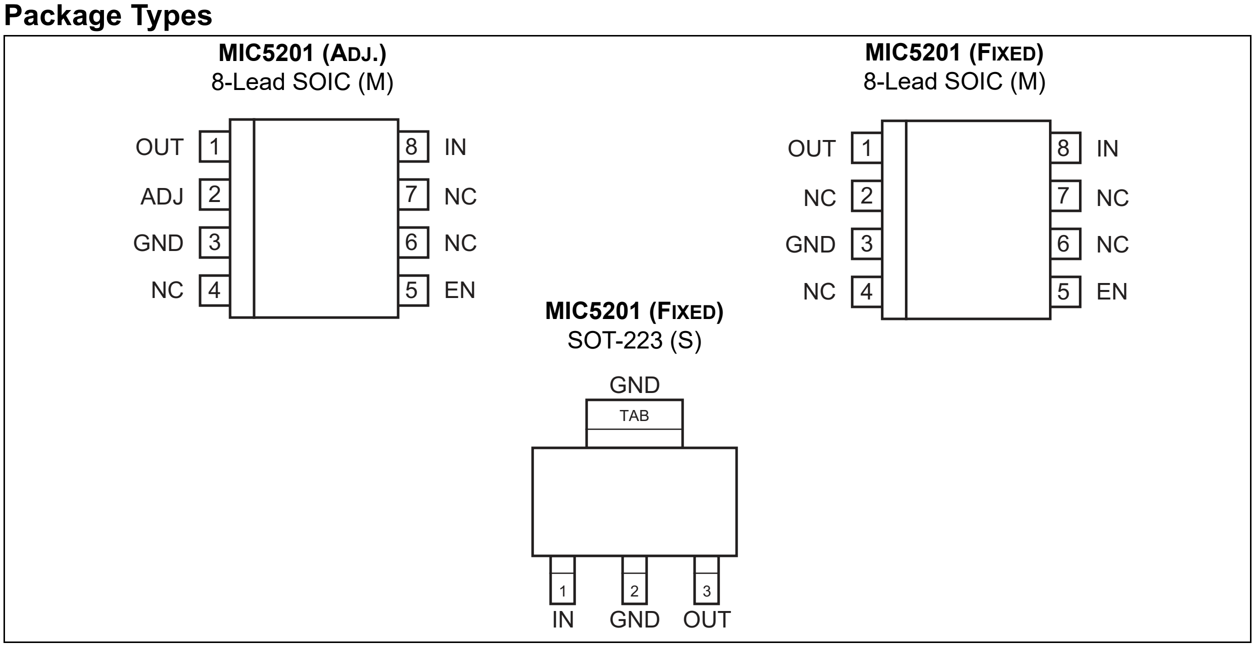
General Description

The MIC5201 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 handheld battery-powered devices, the MIC5201 can be switched by a CMOS compatible enable signal. This enable control may be connected directly to V_{IN} if unneeded. When disabled, power consumption drops nearly to zero. The ground current of the MIC5201 increases only slightly in dropout, further prolonging battery life. Key MIC5201 features include current limiting, overtemperature shutdown and protection against reversed battery.

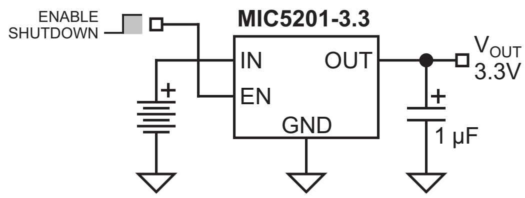
The MIC5201 is available in several fixed voltages and accuracy configurations. It features the same pinout as the LT1121 with better performance. Other options are available; contact Microchip for details.

Package Types



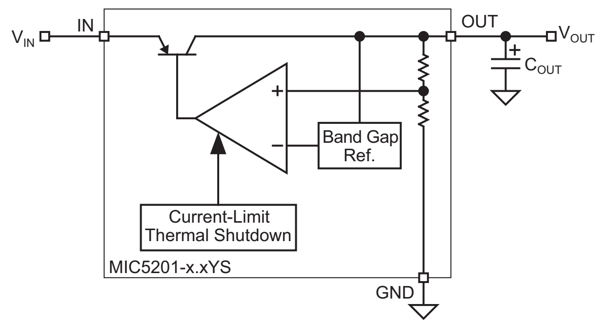
Typical Application Circuit

MIC5201

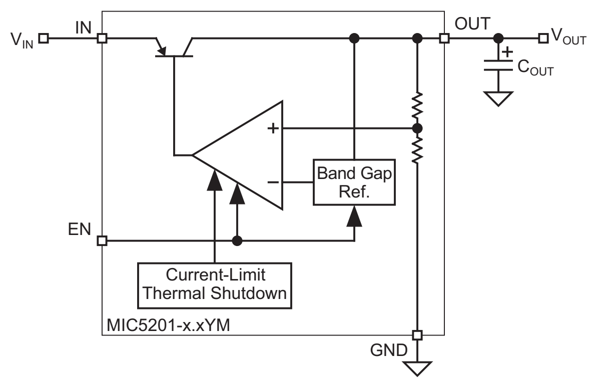


Functional Diagrams

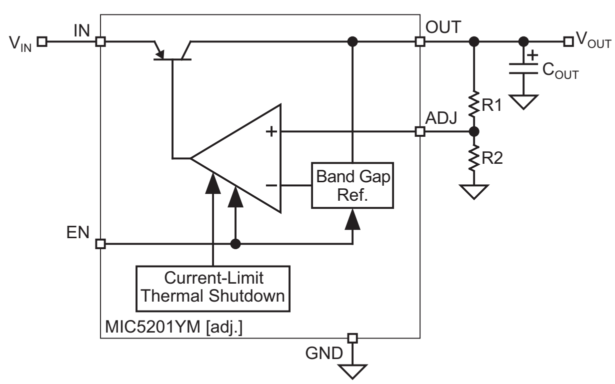
Fixed Regulator
(SOT-223 Version Only)



Fixed Regulator



Adjustable Regulator



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Supply Input Voltage (V_{IN}) Fixed .... -20V to +60V
Supply Input Voltage (V_{IN}) Adjustable .... -20V to +20V
Enable Input Voltage (V_{EN}) Fixed .... -20V to +60V
Enable Input Voltage (V_{EN}) Adjustable .... -20V to +20V
Power Dissipation (**Note 1**) .... Internally Limited

Operating Ratings‡

Supply Input Voltage (V_{IN}) Fixed .... +2.5V to +26V
Supply Input Voltage (V_{IN}) Adjustable .... +2.5V to +16V
Enable Input Voltage (V_{EN}) .... 0V 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 ensured to function outside its operating ratings.

Note 1: 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.

TABLE 1-1: ELECTRICAL CHARACTERISTICS[(1)]

Electrical Characteristics: $V_{IN} = V_{OUT} + 1V$; $I_L = 100\ \mu A$; $C_L = 3.3\ \mu F$; $V_{EN} \geq 2.0V$; $T_J = +25°C$, **bold** values indicate $-40°C \leq T_J \leq +85°C$ unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage Accuracy	V_O	**-2**	1	**2**	%	Variation from specified V_{OUT}
Output Voltage Temperature Coefficient	$\Delta V_O/\Delta T$	—	40	**150**	ppm/°C	Note 2
Line Regulation, Fixed	$\Delta V_O/\Delta V_{IN}$	—	0.004	0.20	%	$V_{IN} = V_{OUT} + 1V$ to 26V
		—	—	**0.40**		
Line Regulation, Adjustable	$\Delta V_O/\Delta V_{IN}$	—	0.004	0.20	%	$V_{IN} = V_{OUT} + 1V$ to 16V
		—	—	**0.40**		
Load Regulation	$\Delta V_O/V_O$	—	0.04	0.30	%	I_L = 0.1 mA to 150 mA (**Note 3**)
		—	—	**0.40**		
Dropout Voltage (**Note 4**)	$V_{IN} – V_O$	—	17	—	mV	I_L = 100 µA (**Note 7**)
		—	130	—		I_L = 20 mA (**Note 7**)
		—	180	—		I_L = 50 mA (**Note 7**)
		—	225	—		I_L = 100 mA (**Note 7**)
		—	270	**400**		I_L = 150 mA
Quiescent Current	I_{GND}	—	0.01	—	µA	$V_{ENABLE} \leq 0.5V$ (shutdown) (**Note 7**)
Ground Pin Current	I_{GND}	—	130	—	µA	I_L = 100 µA (**Note 7**)
		—	270	400		I_L = 20 mA
		—	500	—		I_L = 50 mA (**Note 7**)
		—	1000	**2000**		I_L = 100 mA
		—	3000	—		I_L = 150 mA (**Note 7**)
Ripple Rejection	PSRR	—	75	—	dB	**Note 7**
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}	—	280	500	mA	$V_{OUT} = 0V$
Thermal Regulation	$\Delta V_O/\Delta P_D$	—	0.05	—	%/W	**Note 6**
Output Noise	e_n	—	100	—	µV	**Note 7**
Enable Input						
Input Voltage Level	V_{IL}	—	—	**0.5**	V	Logic low (off)
Input Voltage Level	V_{IH}	**2.0**	—	—	V	Logic high (on)
Enable Input Current	I_{IL}	—	0.01	**1**	µA	$V_{IL} \leq 0.5V$
Enable Input Current	I_{IH}	—	15	**70**	µA	$V_{IH} \geq 2.0V$

Note 1: Specification for packaged product only. Devices are ESD-sensitive. Handling precautions recommended.

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 150 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 150 mA load pulse at V_{IN} = 26V for fixed and V_{IN} = 16V for adjustable at t = 10 ms.

7: Design guidance only, not production tested.

TABLE 1-1: ELECTRICAL CHARACTERISTICS[1] (CONTINUED)

Electrical Characteristics: $V_{IN} = V_{OUT} + 1V$; $I_L = 100\ \mu A$; $C_L = 3.3\ \mu F$; $V_{EN} \geq 2.0V$; $T_J = +25°C$, **bold** values indicate -40°C ≤ T_J ≤ +85°C unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Reference (MIC5201 Adjustable Version Only)						
Reference Voltage	V_{REF}	1.223	1.242	1.255	V	
		1.217	—	**1.267**		
Reference Voltage Temperature Coefficient	$\Delta V_{REF}/\Delta T$	—	20	—	ppm/°C	Note 7

Note 1: Specification for packaged product only. Devices are ESD-sensitive. Handling precautions recommended.

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

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7: Design guidance only, not production tested.

TEMPERATURE SPECIFICATIONS[(1)]

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Storage Temperature Range	T_J	-40	—	+125	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 5 sec.
Package Thermal Resistance						
Thermal Resistance SOT-223	θ_{JC}	—	15	—	°C/W	See **Section 4.6 “Thermal Considerations Layout”** for more information.
	θ_{JA}	—	62	—		
Thermal Resistance 8-Lead SOIC	θ_{JA}	—	160	—	°C/W	See **Section 4.6 “Thermal Considerations Layout”** for more information.

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.

2.0 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.

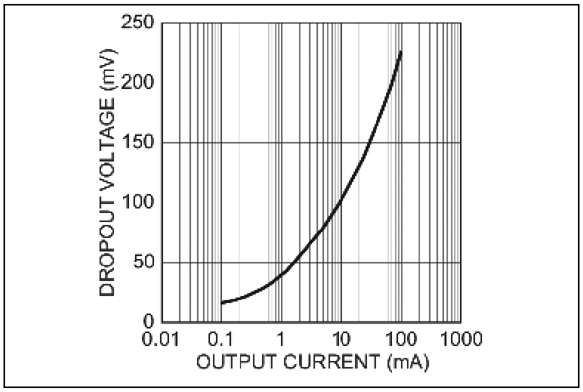


FIGURE 2-1: Dropout Voltage vs. Output Current.

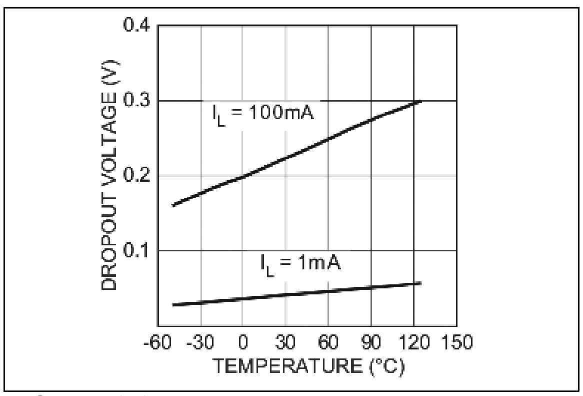


FIGURE 2-2: Dropout Voltage vs. Temperature.

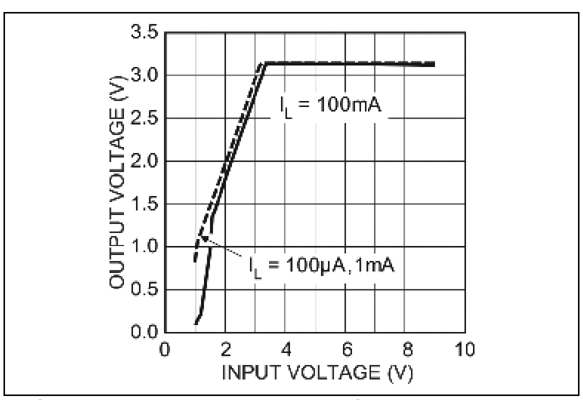


FIGURE 2-3: Dropout Characteristics.

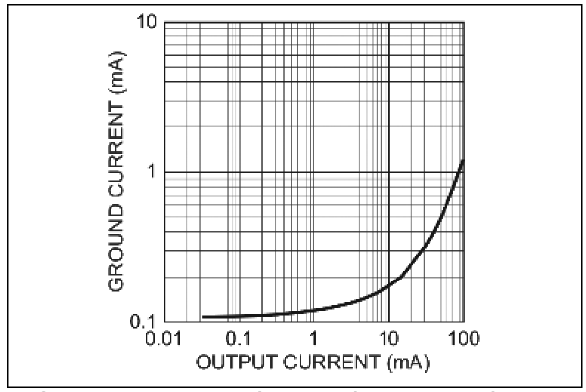


FIGURE 2-4: Ground Current vs. Output Current.

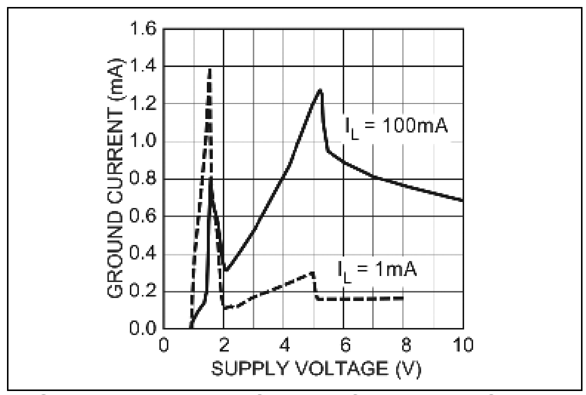


FIGURE 2-5: Ground Current vs. Supply Voltage.

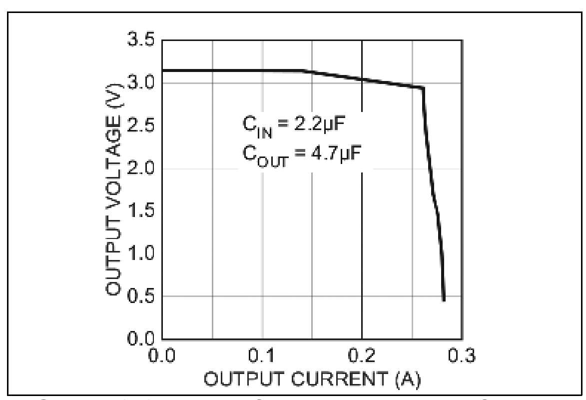


FIGURE 2-6: Output Voltage vs. Output Current.

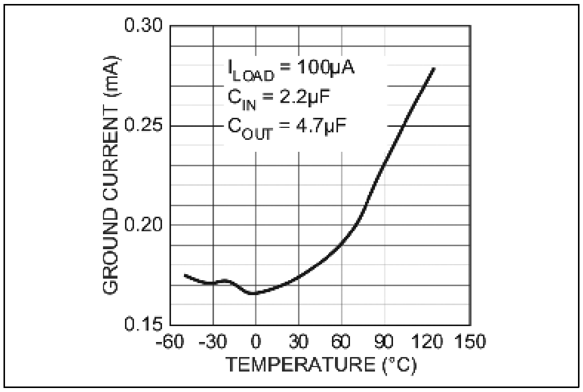


FIGURE 2-7: *Ground Current vs. Temperature.*

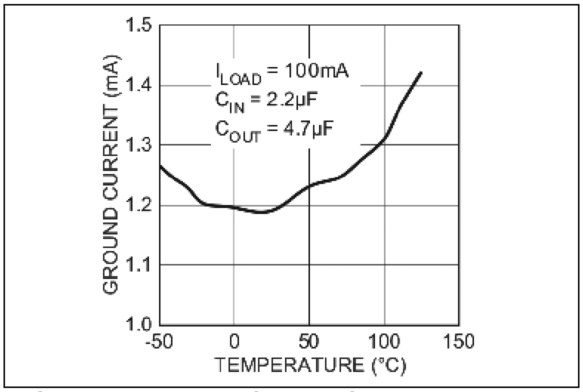


FIGURE 2-8: *Ground Current vs. Temperature.*

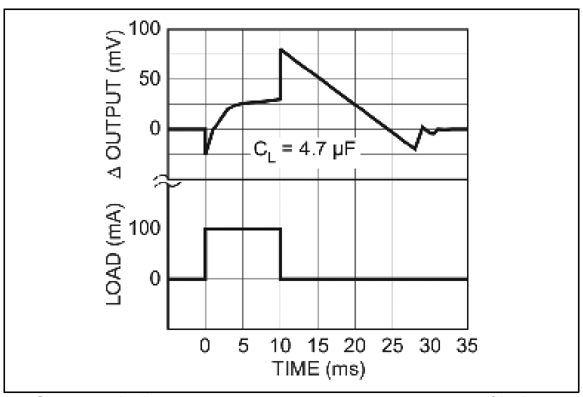


FIGURE 2-9: *Thermal Regulation (3.3V Version).*

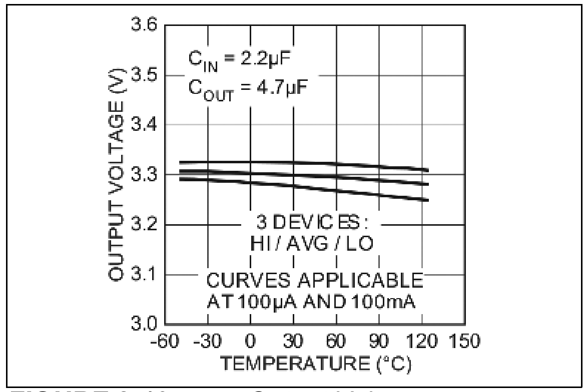


FIGURE 2-10: *Output Voltage vs. Temperature (3.3V Version).*

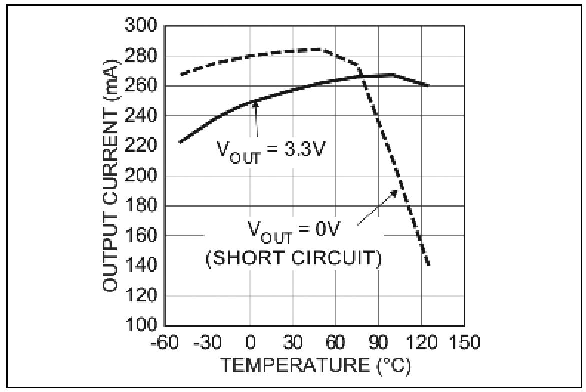


FIGURE 2-11: *Output Current vs. Temperature.*

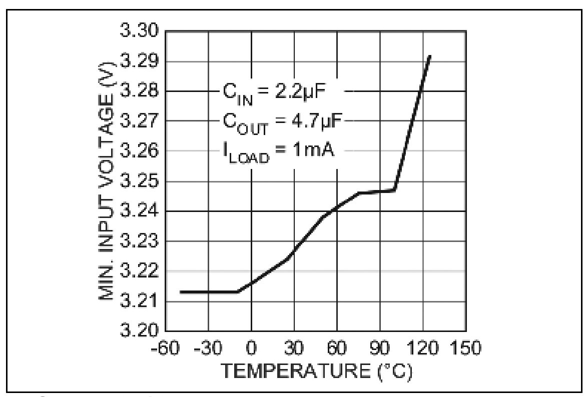


FIGURE 2-12: *Minimum Input Voltage vs. Temperature.*

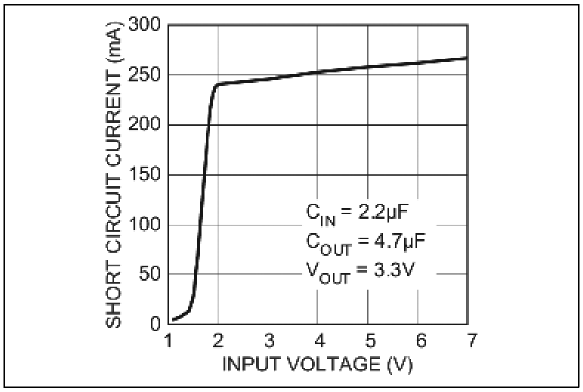


FIGURE 2-13: *Short-Circuit Current vs. Input Voltage.*

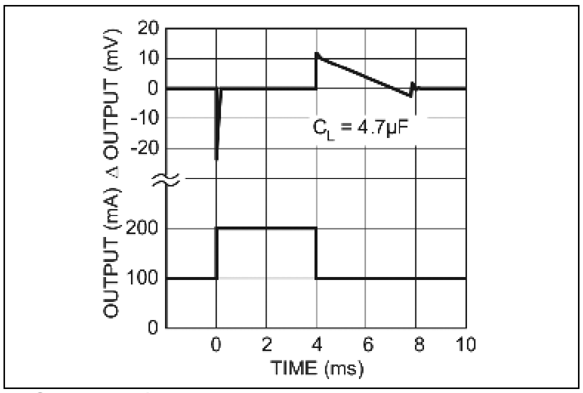


FIGURE 2-14: *Load Transient.*

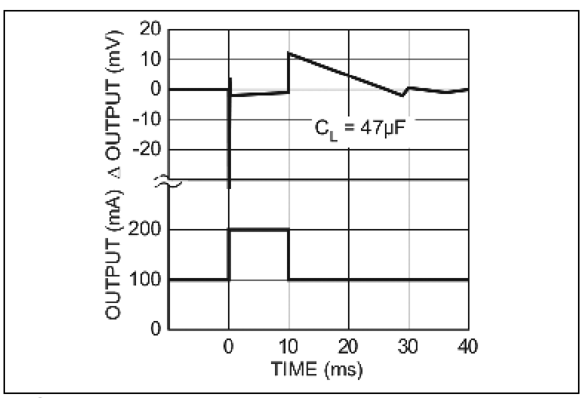


FIGURE 2-15: *Load Transient.*

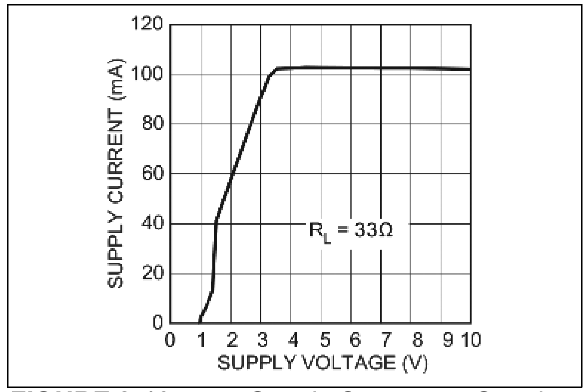


FIGURE 2-16: *Supply Current vs. Supply Voltage (3.3V Version).*

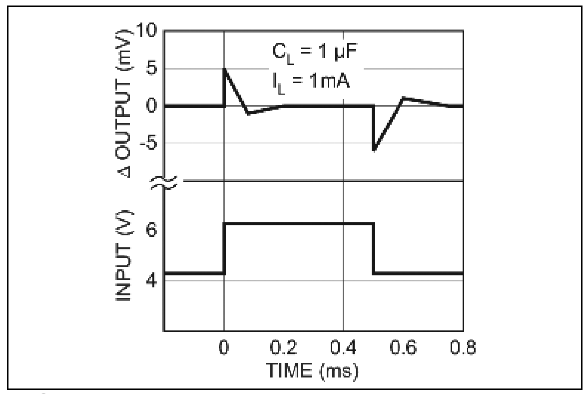


FIGURE 2-17: *Line Transient.*

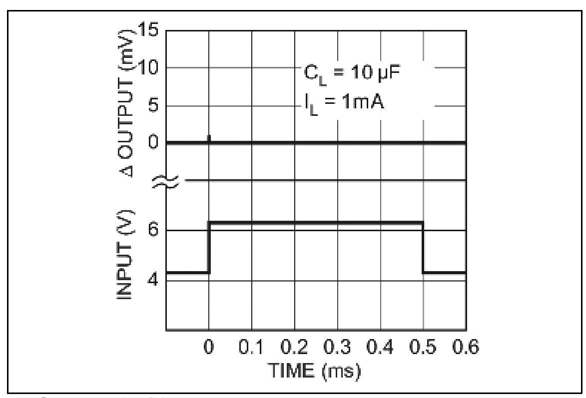


FIGURE 2-18: *Line Transient.*

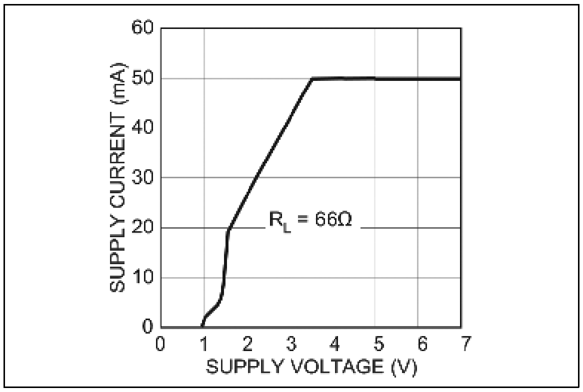


FIGURE 2-19: Supply Current vs. Supply Voltage (3.3V Version).

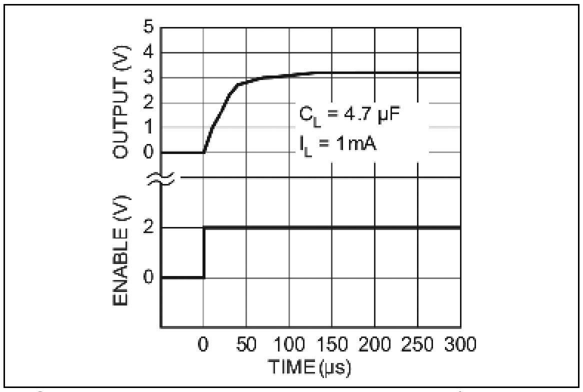


FIGURE 2-20: Enable Transient (3.3V Version).

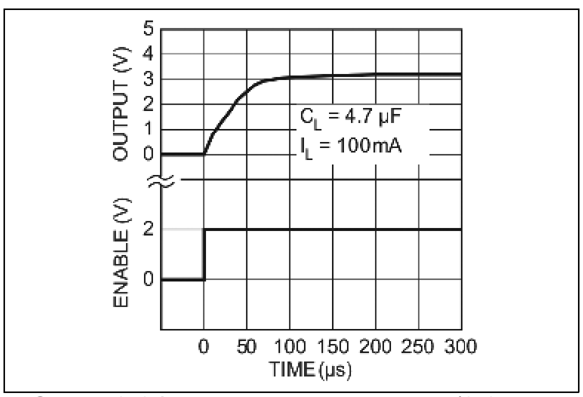


FIGURE 2-21: Enable Transient (3.3V Version).

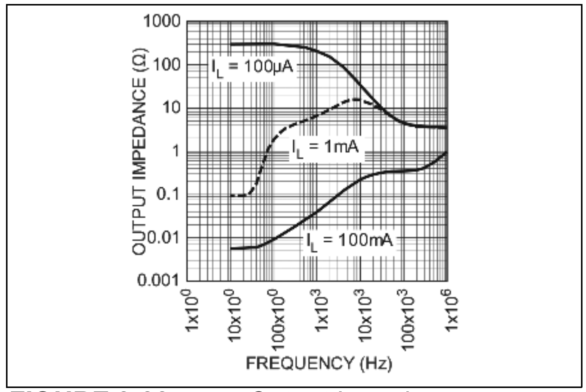


FIGURE 2-22: Output Impedance.

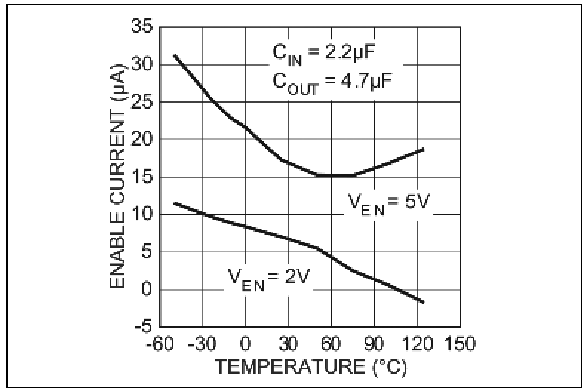


FIGURE 2-23: Enable Current Threshold vs. Temperature.

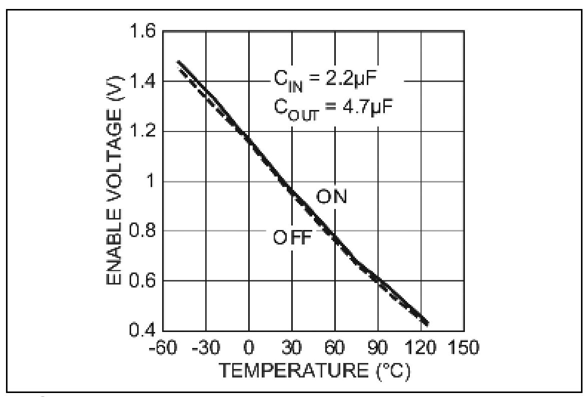


FIGURE 2-24: Enable Voltage Threshold vs. Temperature.

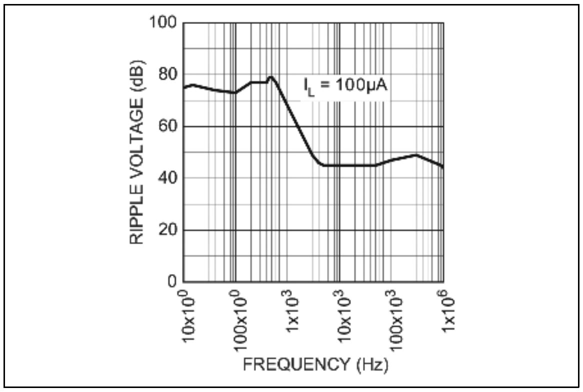


FIGURE 2-25: *Ripple vs. Frequency.*

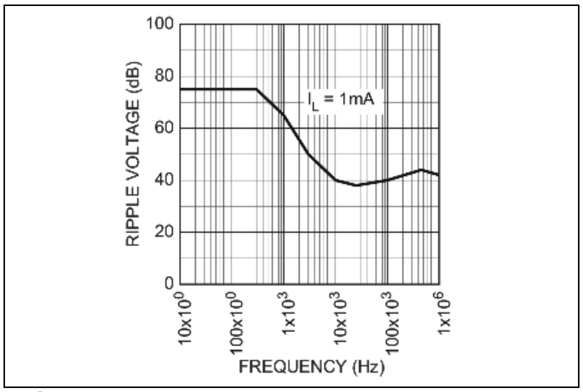


FIGURE 2-26: *Ripple vs. Frequency.*

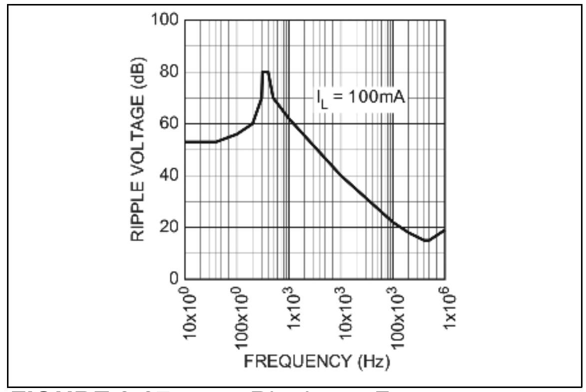


FIGURE 2-27: *Ripple vs. Frequency.*

3.0 PIN DESCRIPTIONS

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

TABLE 3-1: PIN FUNCTION TABLE

Pin Number SOT-223	Pin Number 8-Lead SOIC (Adj.)	Pin Number 8-Lead SOIC (Fixed)	Pin Name	Description
3	1	1	OUT	Regulated output.
—	2	—	ADJ	Feedback input. Adjustable version only.
—	4, 6, 7	2, 4, 6, 7	NC	Not internally connected. Connect to ground plane for lowest thermal resistance.
2	3	3	GND	Ground.
—	5	5	EN	Enable (input): High = enable. Low or open = off/disable.
1	8	8	V_{IN}	Unregulated supply input.

4.0 APPLICATIONS INFORMATION

Figure 4-1 shows a basic fixed voltage application with the unused enable input connected to V_{IN}.

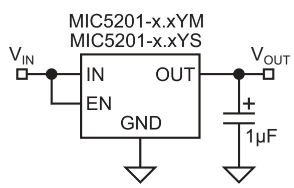


FIGURE 4-1: Fixed Application.

Adjustable regulators require two resistors to set the output voltage. See Figure 4-2.

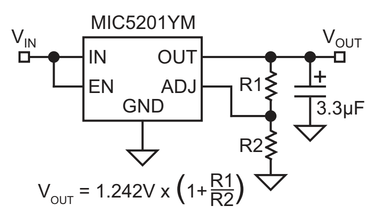


FIGURE 4-2: Adjustable Application.

Resistor values are not critical because ADJ (adjust) has a high-impedance, but for best results, use resistors of 470 kΩ or less.

4.1 Output Capacitors

A 1 µF capacitor is recommended between the MIC5201 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 tantalums 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.

4.2 Input Capacitors

A 1 µF capacitor should be placed from the MIC5201 input to ground if there is more than ten inches of wire between the input and the AC filter capacitor, or if a battery is used as the input.

4.3 Noise Reduction Capacitors

On adjustable devices, a capacitor from ADJ to GND will decrease high-frequency noise on the output. See Figure 4-3.

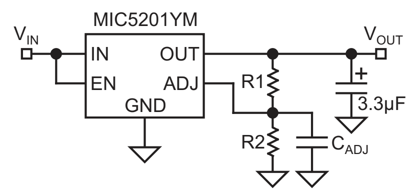


FIGURE 4-3: Decreasing Output Noise.

4.4 Minimum Load

The MIC5201 will remain stable and in regulation with no load unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications.

4.5 Dual Supply Systems

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.

4.6 Thermal Considerations Layout

The MIC5201-x.xYM (8-pin surface mount package) has the following thermal characteristics when mounted on a single layer copper-clad Printed Circuit Board (PCB).

TABLE 4-1: THERMAL CHARACTERISTICS

PCB Dielectric	θ_{JA}
FR4	160ºC/W
Ceramic	120ºC/W

Multilayer 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.

4.7 Nominal Power Dissipation and Die Temperature

The MIC5201-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 MIC5201-x.xYS (SOT-223 package) heat sink characteristics, please refer to Application Hint 17, P.C. Board Heat Sinking.

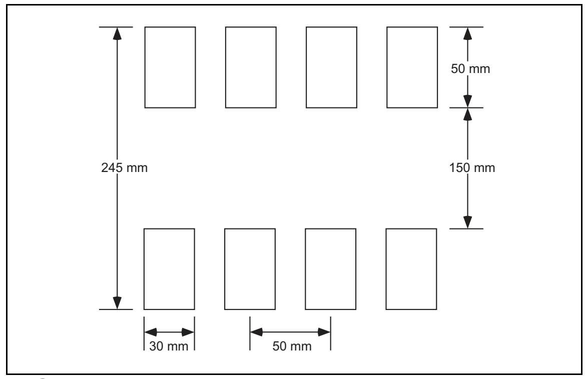


FIGURE 4-4: *Minimum Recommended 8-Lead SOIC PCB Pads Size.*

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

8-Pin SOIC*	Example
XXXX XXXX ● WNNNC	5201 33YM ● 8943C

3-Pin TO-223*	Example
XXXX XXXXNNNP	5021 48YS235P

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).

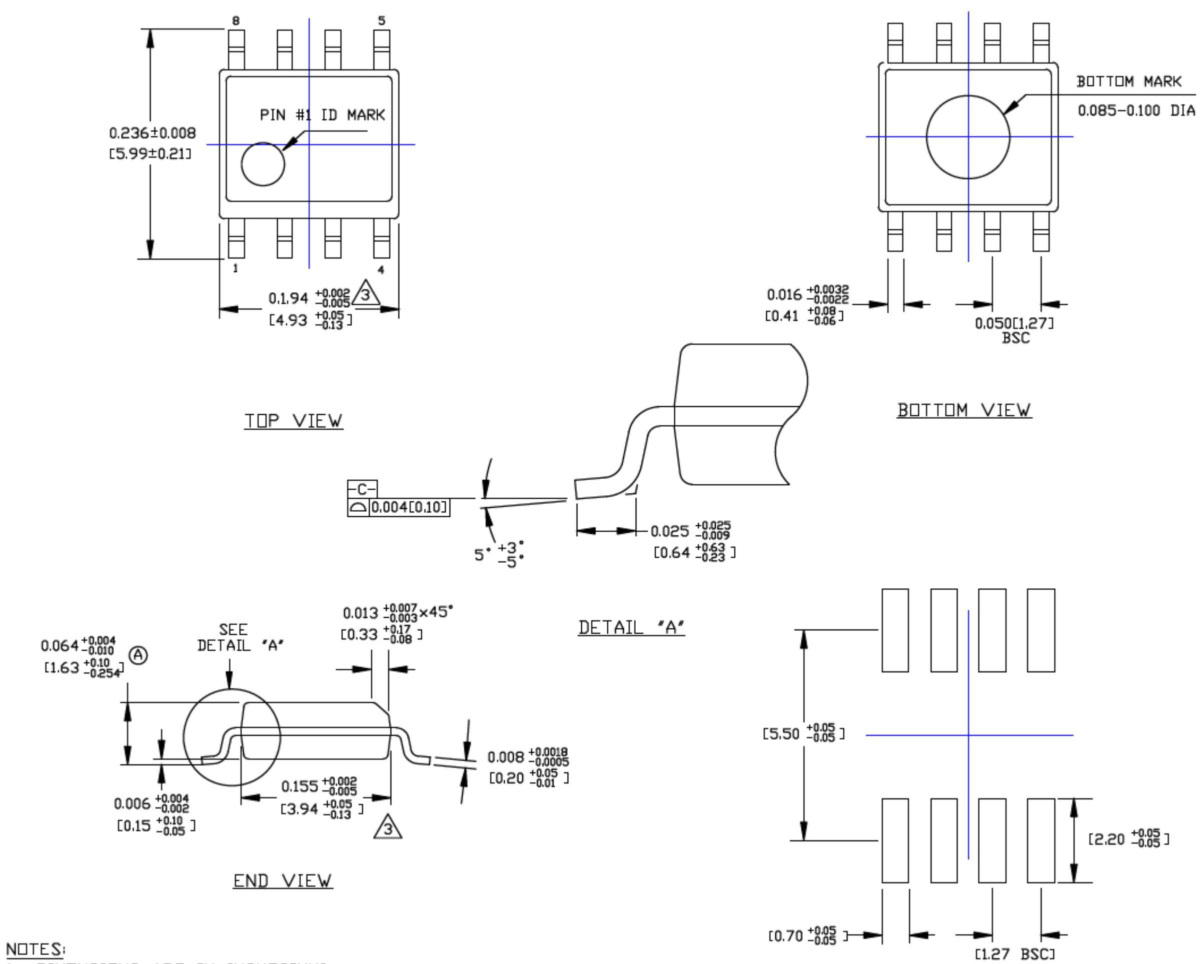
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

8-Lead SOIC Package Outline and Recommended Land Pattern

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.

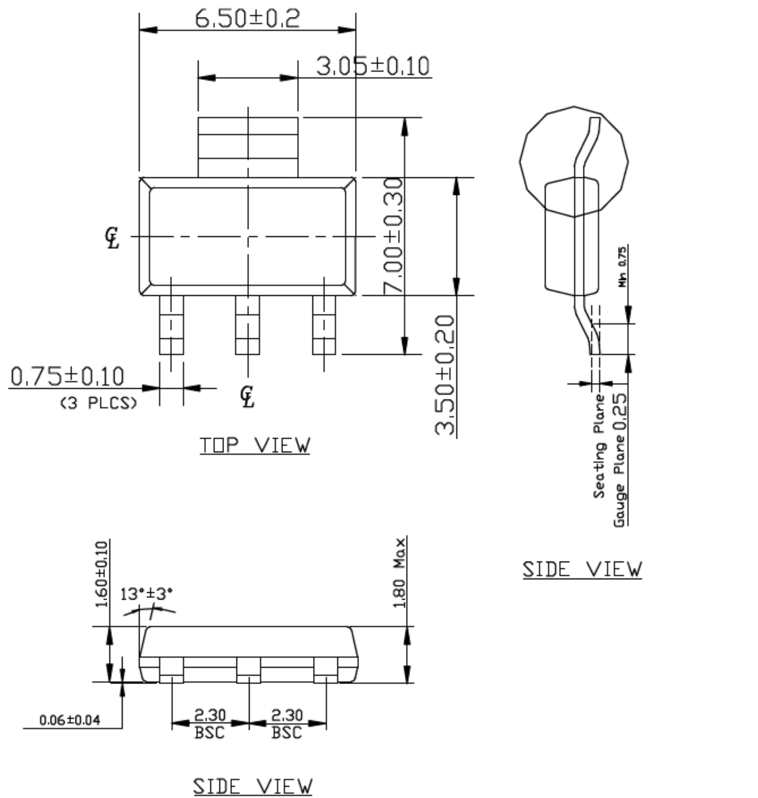
RECOMMENDED LAND PATTERN

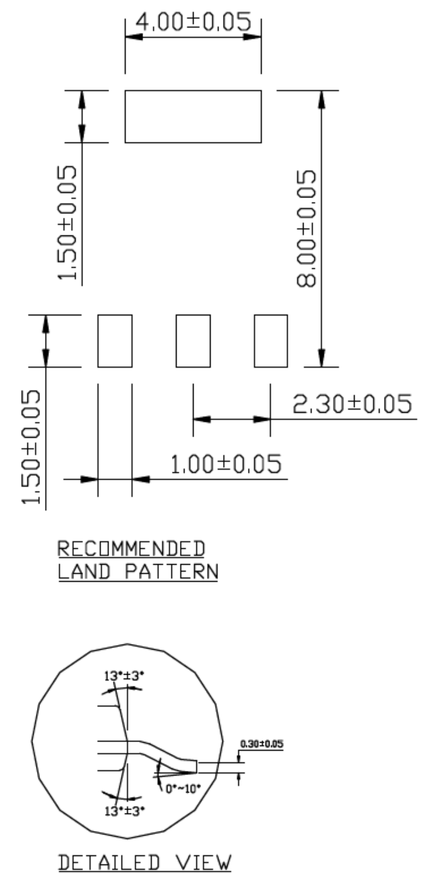
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

3-Lead TO-223 Package Outline and Recommended Land Pattern

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.

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

NOTES:

APPENDIX A: REVISION HISTORY

Revision B (July 2020)

- Updated **Features** section.
- Updated Table 1-1.
- Updated **Product Identification System** section.

Revision A (February 2017)

- Converted Micrel document MIC5201 to Microchip data sheet DS20005718B.
- Minor text changes throughout.
- Removed all reference to discontinued leaded parts.
- Added θ_{JA} value for SOT-223 package in Temperature Specifications section.

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	X	-	XXX
Device		Voltage	Junction Temperature Range	Package		Media Type

Device:	MIC5201:	150 mA Low-Dropout Regulator
Voltage:	(blank)	= Adjustable (M package only)
	3.0	= 3.0V
	3.3	= 3.3V
	4.8	= 4.8V (S package only)
	5.0	= 5.0V
Junction Temperature Range:	Y	= -40°C to +85°C
Package:	M	= 8-Lead SOIC
	S	= 3-Lead SOT-223
Media Type:	TR	= 4,000/Reel for S Package (Automotive)
	Tube	= 78/Tube for S Package (Automotive)
	TR	= 3,300/Reel for M Package (Automotive)
	Tube	= 100/Tube for M Package (Automotive)
	TR	= 2,500/Reel for S Package (Commercial)
	Tube	= 78/Tube for S Package (Commercial)
	TR	= 2,500/Reel for M Package (Commercial)
	Tube	= 95/Tube for M Package (Commercial)
Qualification:	(blank)	= Standard Qualification
	VAO	= AEC-Q100 Automotive Qualification
	Vxx	= AEC-Q100 Automotive Qualification, custom device, additional terms or conditions may apply

Examples:

a) MIC5201YM: 150 mA Low-Dropout Regulator, Adjustable Voltage, 8-Lead SOIC, -40°C to +85°C Junction Temperature Range, 95/Tube

b) MIC5201-3.0YM-TR: 150 mA Low-Dropout Regulator, 3.0V Voltage, 8-Lead SOIC, -40°C to +85°C Junction Temperature Range, 2,500/Reel

c) MIC5201-3.3YM: 150 mA Low-Dropout Regulator, 3.3V Voltage, 8-Lead SOIC, -40°C to +85°C Junction Temperature Range, 95/Tube

d) MIC5201-5.0YM-TR: 150 mA Low-Dropout Regulator, 5.0V Voltage, 8-Lead SOIC, -40°C to +85°C Junction Temperature Range, 2,500/Reel

e) MIC5201-3.0YS: 150 mA Low-Dropout Regulator, 3.0V Voltage, 3-Lead SOT-223, -40°C to +85°C Junction Temperature Range, 78/Tube

f) MIC5201-3.3YS-TR: 150 mA Low-Dropout Regulator, 3.3V Voltage, 3-Lead SOT-223, -40°C to +85°C Junction Temperature Range, 2,500/Reel

g) MIC5201-4.8YS: 150 mA Low-Dropout Regulator, 4.8V Voltage, 3-Lead SOT-223, -40°C to +85°C Junction Temperature Range, 78/Tube

h) MIC5201-5.0YS-TR: 150 mA Low-Dropout Regulator, 5.0V Voltage, 3-Lead SOT-223, -40°C to +85°C Junction Temperature Range, 2,500/Reel

i) MIC5201-5.0YM-TRVAO: 150 mA Low-Dropout Regulator, 5.0V Voltage, 8-Lead SOIC, -40°C to +85°C Junction Temperature Range, 3,300/Reel

j) MIC5201-3.3YM-TRVAO: 150 mA Low-Dropout Regulator, 3.3V Voltage, 8-Lead SOIC, -40°C to +85°C Junction Temperature Range, 3,300/Reel

k) MIC5201-5.0YS-TRVAO: 150 mA Low-Dropout Regulator, 5.0V Voltage, 3-Lead SOT-223, -40°C to +85°C Junction Temperature Range, 4,000/Reel

l) MIC5201-3.3YS-TRVAO: 150 mA Low-Dropout Regulator, 3.3V Voltage, 3-Lead SOT-223, -40°C to +85°C Junction Temperature Range, 4,000/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

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