MIC5216

500 mA-Peak Output LDO Regulator

Features

- Error Flag Indicates Undervoltage Fault
- Guaranteed 500 mA-Peak Output over the Full Operating Temperature Range
- Low 500 mV Maximum Dropout Voltage at Full Load
- Extremely Tight Load and Line Regulation
- Tiny SOT-23-5 and MSOP-8 Package
- Low-Noise Output
- Low Temperature Coefficient
- Current and Thermal Limiting
- Reversed Input Polarity Protection
- CMOS/TTL-Compatible Enable/Shutdown Control
- Near-Zero Shutdown Current

Applications

- Laptop, Notebook, and Palmtop Computers
- Cellular Telephones and Battery-Powered Equipment
- Consumer and Personal Electronics
- PC Card VCC and VPP Regulation and Switching
- SMPS Post-Regulator/DC-to-DC Modules
- High-Efficiency Linear Power Supplies

General Description

The MIC5216 is an efficient linear voltage regulator with high peak output current capability, very low dropout voltage, and better than 1% output voltage accuracy. Dropout is typically 10 mV at light loads and less than 500 mV at full load.

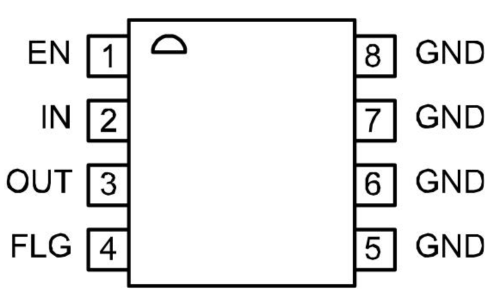
The MIC5216 is designed to provide a peak output current for startup conditions where higher inrush current is demanded. It features a 500 mA peak output rating. Continuous output current is limited only by package and layout.

The MIC5216 has an internal undervoltage monitor with a flag output. It also can be enabled or shutdown by a CMOS- or TTL-compatible signal. When disabled, power consumption drops nearly to zero. Dropout ground current is minimized to help prolong battery life. Other key features include reversed-battery protection, current limiting, overtemperature shutdown, and low noise performance.

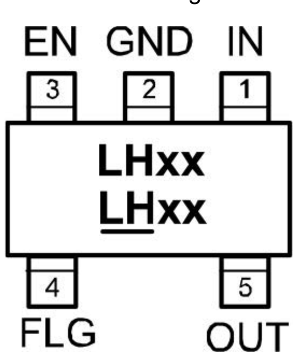
The MIC5216 is available in fixed output voltages in space-saving 5-lead SOT-23 and 8-lead MSOP packages. (For higher power requirements, please refer to the data sheets for MIC5209 or MIC5237.)

Package Types

MIC5216-xxYMM
MSOP-8
Fixed Voltages

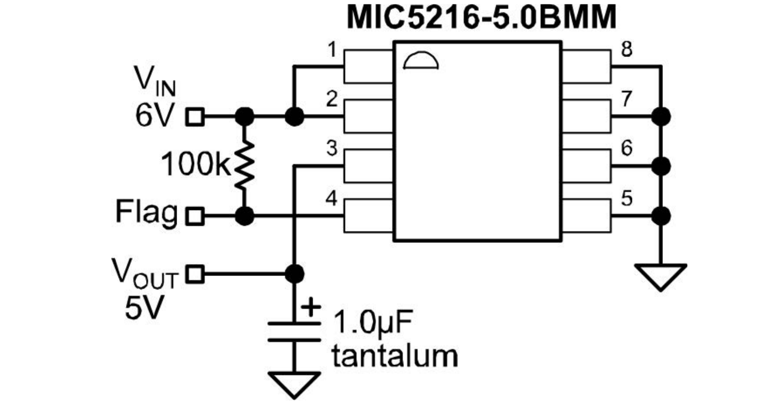


MIC5216-xxYM5
SOT-23-5
Fixed Voltages

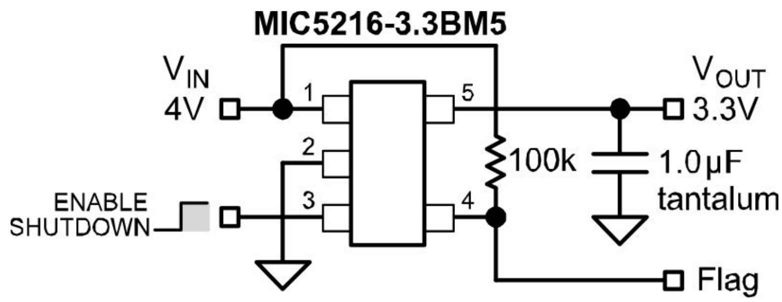


Typical Application Circuits

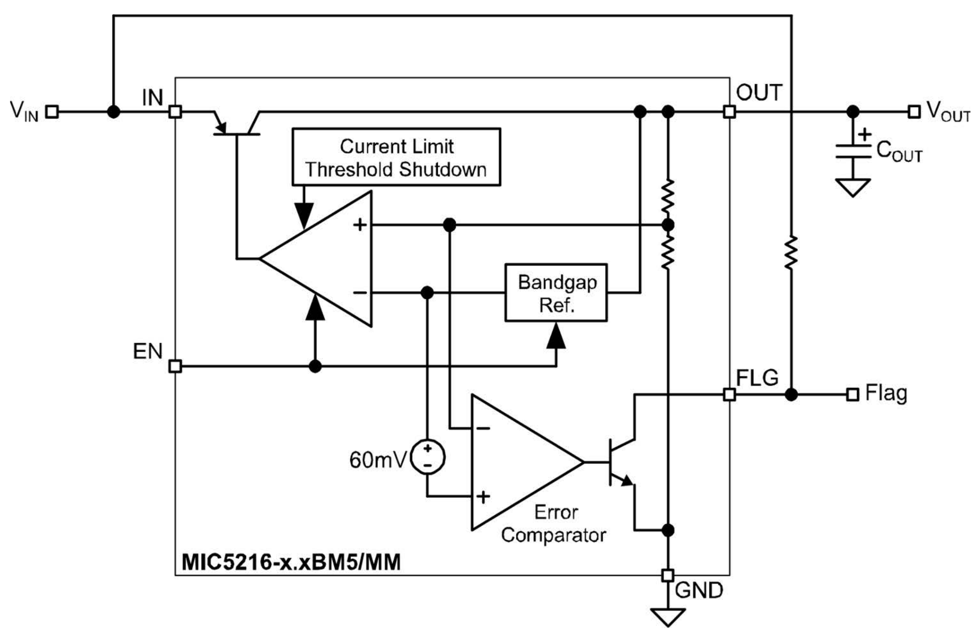
5V Low-Noise Regulator



3.3V Low-Noise Regulator



Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Input Voltage (V_{IN}) .... –20V to +20V
Power Dissipation (P_D) .... .Internally Limited

Operating Ratings ‡

Supply Input Voltage (V_{IN}) .... 2.5V to 12V
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 guaranteed to function outside its operating ratings.

Note 1: Devices are ESD sensitive. Handling precautions recommended.

ELECTRICAL CHARACTERISTICS

V_{IN} = V_{OUT} +1V; C_{OUT} = 4.7 µF; I_{OUT} = 100 µA; T_J = 25°C, **bold** values indicate –40°C < T_J < +125°C, unless otherwise noted.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Output Voltage Accuracy	V_{OUT}	–1	—	1	%	Variation from nominal V_{OUT}
		–2	—	**2**		
Output Voltage Temperature Coefficient	$\Delta V_{OUT}/\Delta T$	—	**40**	—	ppm/°C	Note 1
Line Regulation	$\Delta V_{OUT}/(V_{OUT} \times \Delta V_{IN})$	—	0.009	0.05	%/V	V_{IN} = V_{OUT} +1V to 12V
		—	—	**0.1**		
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	—	0.05	0.5	%	I_{OUT} = 100 µA to 150 mA (Note 2)
		—	—	**0.7**		

Note 1: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

2: Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 100 mA to 500 mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

3: 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.

4: 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.

5: V_{EN} is the voltage externally applied to devices with the EN (enable) input pin.

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 500 mA load pulse at V_{IN} = 12V for t = 10 ms.

7: The error flag comparator includes 3% hysteresis.

ELECTRICAL CHARACTERISTICS (CONTINUED)

$V_{IN} = V_{OUT}$ +1V; C_{OUT} = 4.7 µF; I_{OUT} = 100 µA; T_J = 25°C, **bold** values indicate –40°C < T_J < +125°C, unless otherwise noted.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Dropout Voltage (Note 3)	$V_{IN} - V_{OUT}$	—	10	60	mV	I_{OUT} = 100 µA
		—	—	**80**		
		—	115	175		I_{OUT} = 50 mA
		—	—	**250**		
		—	165	300		I_{OUT} = 150 mA
		—	—	**400**		
		—	300	500		I_{OUT} = 500 mA
		—	—	**600**		
Ground Current (per regulator) (Note 4 and Note 5)	I_{GND}	—	80	130	µA	V_{EN} ≥ 3.0V, I_{OUT} = 100 µA
		—	—	**170**		
		—	350	650		V_{EN} ≥ 3.0V, I_{OUT} = 50 mA
		—	—	**900**		
		—	1.8	2.5	mA	V_{EN} ≥ 3.0V, I_{OUT} = 150 mA
		—	—	**3.0**		
		—	8	20		V_{EN} ≥ 3.0V, I_{OUT} = 500 mA
		—	—	**25**		
Quiescent Current (Note 5)	I_Q	—	0.05	**3**	µA	V_{EN} ≤ 0.4V
		—	0.10	**8**		V_{EN} ≤ 0.18V
Ripple Rejection	PSRR	—	75	—	dB	Frequency = 120 Hz
Current Limit	I_{LIMIT}	—	700	**1000**	mA	V_{OUT} = 0V
Thermal Regulation	$\Delta V_{OUT}/\Delta P_D$	—	0.05	—	%/W	Note 6
Output Noise	e_{no}	—	500	—	nV/√Hz	I_{OUT} = 50 mA, C_{OUT} = 2.2 µF

Note 1: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

2: Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 100 mA to 500 mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

3: 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.

4: 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.

5: V_{EN} is the voltage externally applied to devices with the EN (enable) input pin.

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 500 mA load pulse at V_{IN} = 12V for t = 10 ms.

7: The error flag comparator includes 3% hysteresis.

ELECTRICAL CHARACTERISTICS (CONTINUED)

V_{IN} = V_{OUT} +1V; C_{OUT} = 4.7 µF; I_{OUT} = 100 µA; T_J = 25°C, **bold** values indicate –40°C < T_J < +125°C, unless otherwise noted.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Enable Input						
Enable Input Voltage	V_{ENL}	—	—	0.4	V	V_{EN} = logic low (regulator shutdown)
		—	—	**0.18**		
	V_{ENH}	2.0	—	—		V_{EN} = logic high (regulator enabled)
Enable Input Current	I_{ENL}	—	0.01	–1	µA	V_{ENL} ≤ 0.4V
		—	**0.01**	**–2**		V_{ENL} ≤ 0.18V
	I_{ENH}	—	5	20		V_{ENH} ≥ 2.0V
		—		**25**		
Error Flag Output						
Flag Threshold	V_{ERR}	–2	–6	–10	%	Undervoltage condition (below nominal) (Note 7
Output Logic-Low Voltage	V_{IL}	—	0.2	**0.4**	V	I_L = 1 mA, undervoltage condition
Flag Leakage Current	I_{FL}	–1	0.1	+1	µA	Flag off, V_{FLAG} = 0V to 12V

Note 1: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

2: Regulation is measured at constant junction temperature using low duty cycle pulse testing. Parts are tested for load regulation in the load range from 100 mA to 500 mA. Changes in output voltage due to heating effects are covered by the thermal regulation specification.

3: 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.

4: 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.

5: V_{EN} is the voltage externally applied to devices with the EN (enable) input pin.

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 500 mA load pulse at V_{IN} = 12V for t = 10 ms.

7: The error flag comparator includes 3% hysteresis.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Operating Junction Temperature Range	T_J	–40	—	+125	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 5 seconds
Thermal Resistance, SOT-23-5	θ_{JA}	—	220	—	°C/W	Note 1
Thermal Resistance, MSOP-8	θ_{JA}	—	160	—	°C/W	Note 1

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 operating ratings. The maximum allowable power dissipation is a function of the maximum junction temperature, TJ(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: $P_{D(MAX)} = (T_{J(MAX)} - T_A) / \theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown. See Table 4-1 and Section 4.6, Thermal Considerations for 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.

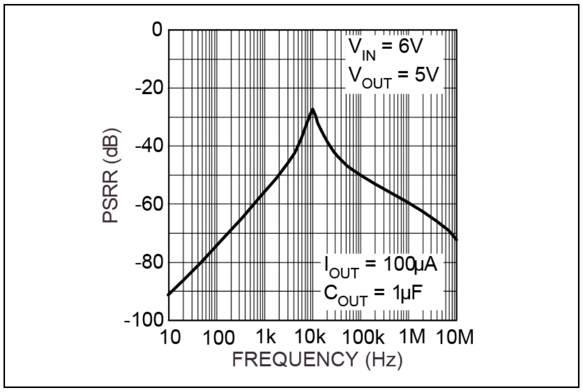


FIGURE 2-1: *Power Supply Rejection Ratio.*

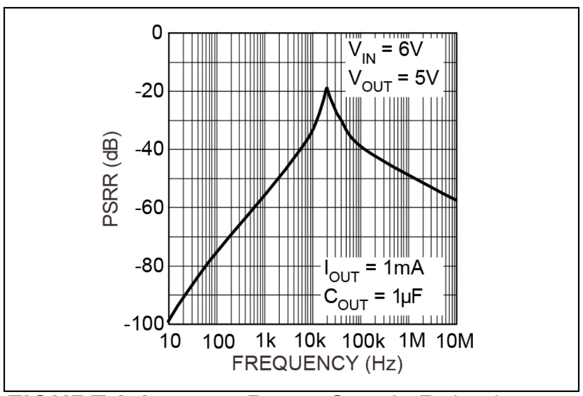


FIGURE 2-2: *Power Supply Rejection Ratio.*

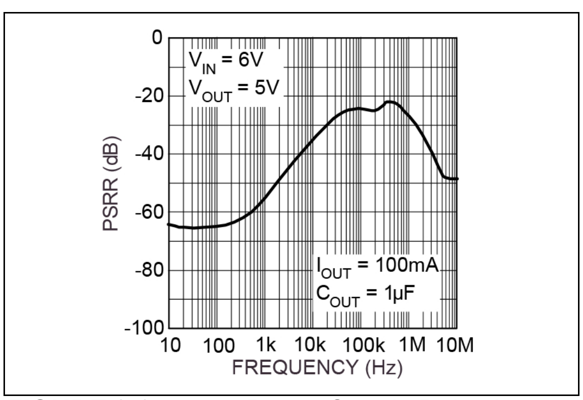


FIGURE 2-3: *Power Supply Rejection Ratio.*

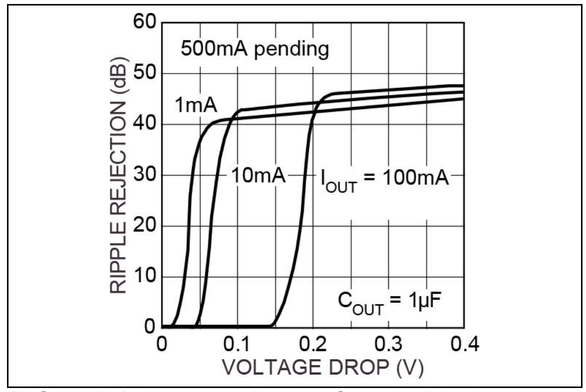


FIGURE 2-4: *Power Supply Ripple Rejection vs. Voltage Drop.*

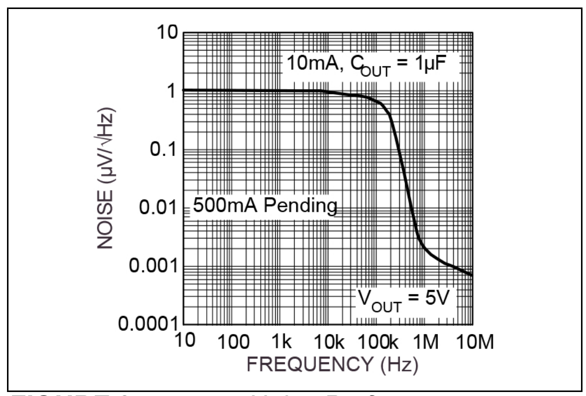


FIGURE 2-5: *Noise Performance.*

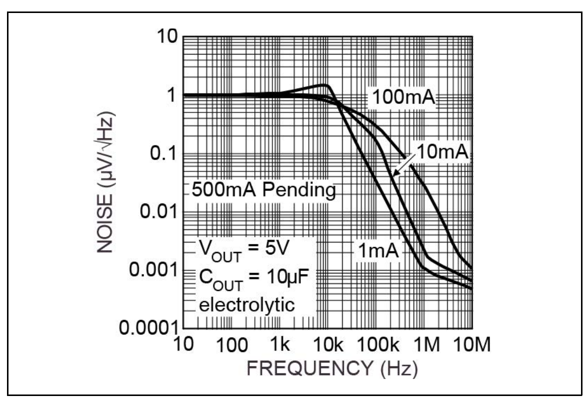


FIGURE 2-6: *Noise Performance.*

3.0 PIN DESCRIPTIONS

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

TABLE 3-1: PIN FUNCTION TABLE

Pin Number MSOP-8	Pin Number SOT-23-5	Pin Name	Description
2	1	IN	Supply Input.
5–8	2	GND	Ground: MSOP-8 pins 5 through 8 are internally connected.
3	5	OUT	Regulator Output.
1	3	EN	Enable (Input): CMOS compatible control input. Logic high = enable; logic low or open = shutdown.
4	4	FLG	Error Flag (Output): Open-Collector output. Active low indicates an output undervoltage condition.

4.0 APPLICATION INFORMATION

The MIC5216 is designed for 150 mA to 200 mA output current applications where a high current spike (500 mA) is needed for short, startup conditions. Basic application of the device will be discussed initially followed by a more detailed discussion of higher current applications.

4.1 Enable/Shutdown

Forcing EN (enable/shutdown) high (> 2V) enables the regulator. EN is compatible with CMOS logic. If the enable/shutdown feature is not required, connect EN to IN (supply input). See Figure 4-5.

4.2 Input Capacitor

A 1 µF capacitor should be placed from IN to GND 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.

4.3 Output Capacitor

An output capacitor is required between OUT and GND to prevent oscillation. 1 µF minimum is recommended. Larger values improve the regulator's transient response. The output capacitor value may be increased without limit.

The output capacitor should have an ESR (equivalent series resistance) of about 5Ω or less and a resonant frequency above 1 MHz. Ultralow-ESR capacitors could cause oscillation and/or underdamped transient response.

Most tantalum or aluminum electrolytic capacitors are adequate; film types will work, but they are more expensive. Many aluminum electrolytics have electrolytes that freeze at about –30°C, so solid tantalums are recommended for operation below –25°C.

At lower values of output current, less output capacitance is needed for stability. The capacitor can be reduced to 0.47 µF for current below 10 mA or 0.33 µF for currents below 1 mA.

4.4 No-Load Stability

The MIC5216 will remain stable and in regulation with no load (other than the internal voltage divider) unlike many other voltage regulators. This is especially important in CMOS RAM keep-alive applications.

4.5 Error Flag Output

The error flag is an open-collector output and is active (low) when an undervoltage of approximately 5% below the nominal output voltage is detected. A pull-up resistor from IN to FLG is shown in all schematics.

If an error indication is not required, FLG may be left open and the pull-up resistor may be omitted.

4.6 Thermal Considerations

The MIC5216 is designed to provide 200 mA of continuous current in two very small profile packages. 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 thermal resistance, junction-to-ambient, of the device and the following basic equation.

EQUATION 4-1:

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

$T_{J(MAX)}$ is the maximum junction temperature of the die, 125°C, and T_A is the ambient operating temperature. θ_{JA} is layout dependent; Table 4-1 shows examples of thermal resistance, junction-to-ambient, for the MIC5216.

TABLE 4-1: MIC5216 THERMAL RESISTANCE

Package	θ_{JA} Recommended Minimum Footprint	θ_{JA} 1" Square Copper Clad	θ_{JC}
MSOP-8 (MM)	160°C/W	70°C/W	30°C/W
SOT-23-5 (M5)	220°C/W	170°C/W	130°C/W

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

EQUATION 4-2:

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

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, if we are operating the MIC5216-3.3BM5 at room temperature, with a minimum footprint layout, we can determine the maximum input voltage for a set output current.

EQUATION 4-3:

$$P_{D(MAX)} = \frac{(125°C - 25°C)}{220°C/W}$$
$$P_{D(MAX)} = 455mW$$

The thermal resistance, junction-to-ambient, for the minimum footprint is 220°C/W, taken from Table 4-1. The maximum power dissipation number cannot be exceeded for proper operation of the device. Using the output voltage of 3.3V, and an output current of 150mA, we can determine the maximum input voltage. Ground current, maximum of 3 mA for 150 mA of output current, can be taken from the Electrical Characteristics table.

EQUATION 4-4:

$$455mW = (V_{IN} - 3.3V) \times 150mA + V_{IN} \times 3mA$$
$$V_{IN} \times \frac{455mW + 3.3V \times 150mA}{150mA + 3mA}$$
$$V_{IN} = 6.2V_{MAX}$$

Therefore, a 3.3V application at 150mA of output current can accept a maximum input voltage of 6.2V in a SOT- 23-5 package. For a full discussion of heat sinking and thermal effects on voltage regulators, refer to the Regulator Thermals section of Micrel's Designing with Low-Dropout Voltage Regulators handbook.

4.7 Peak Current Applications

The MIC5216 is designed for applications where high start-up currents are demanded from space constrained regulators. This device will deliver 500 mA start-up current from a SOT-23-5 or MM8 package, allowing high power from a very low profile device.

The MIC5216 can subsequently provide output current that is only limited by the thermal characteristics of the device. You can obtain higher continuous currents from the device with the proper design. This is easily proved with some thermal calculations.

If we look at a specific example, it may be easier to follow. The MIC5216 can be used to provide up to 500 mA continuous output current. First, calculate the maximum power dissipation of the device, as was done in the thermal considerations section. Worst case thermal resistance (θ_{JA} = 220°C/W for the MIC5216-x.xBM5), will be used for this example.

EQUATION 4-5:

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

Assuming room temperature, we have a maximum power dissipation number of

EQUATION 4-6:

$$P_{D(MAX)} = \frac{(125°C - 25°C)}{220°C/W}$$
$$P_{D(MAX)} = 455mW$$

Then we can determine the maximum input voltage for a five-volt regulator operating at 500mA, using worst case ground current.

EQUATION 4-7:

$$P_{D(MAX)} = 455mW = (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN}I_{GND}$$
$$I_{OUT} = 500mA$$
$$V_{OUT} = 5V$$
$$I_{GND} = 20mA$$
$$455mW = (V_{IN} - 5V) \times 500mA + (V_{IN} \times 20mA)$$
$$2.995mA = 520mA \times V_{IN}$$
$$V_{IN(MAX)} = \frac{2.995mW}{520mA} = 5.683V$$

Therefore, to be able to obtain a constant 500 mA output current from the 5216-5.0BM5 at room temperature, you need extremely tight input-output voltage differential, barely above the maximum dropout voltage for that current rating.

You can run the part from larger supply voltages if the proper precautions are taken. Varying the duty cycle using the enable pin can increase the power dissipation of the device by maintaining a lower average power figure. This is ideal for applications where high current is only needed in short bursts.

Figure 4-1 shows the safe operating regions for the MIC5216-x.xBM5 at three different ambient temperatures and at different output currents. The data used to determine this figure assumed a minimum footprint PCB design for minimum heat sinking.

Figure 4-2 incorporates the same factors as the first figure, but assumes a much better heat sink. A 1" square copper trace on the PC board reduces the thermal resistance of the device. This improved thermal resistance improves power dissipation and allows for a larger safe operating region.

Figure 4-3 and Figure 4-4 show, safe operating regions for MIC5216-x.xBMM, the power MSOP package part. These graphs show three typical operating regions at different temperatures. The lower the temperature, the larger the operating region. The graphs were obtained in a similar way to the graphs for the MIC5216-x.xBM5, taking all factors into consideration and using two different board layouts, minimum footprint and 1" square copper PC board heat sink.

For further discussion of PC board heat sink characteristics, refer to Application Hint 17, "Designing PC Board Heat Sinks".

The information used to determine the safe operating regions can be obtained in a similar manner to that used in determining typical power dissipation, already discussed. Determining the maximum power dissipation based on the layout is the first step, this is done in the same manner as in the previous two sections. Then, a larger power dissipation number multiplied by a set maximum duty cycle would give that maximum power dissipation number for the layout.

This is best shown through an example. If the application calls for 5V at 500 mA for short pulses, but the only supply voltage available is 8V, then the duty cycle has to be adjusted to determine an average power that does not exceed the maximum power dissipation for the layout.

EQUATION 4-8:

$$Av\ddot{e}P_D = \left(\frac{\%DC}{100}\right) \times (V_{IN} - V_{OUT}) \times I_{OUT} + V_{IN}I_{GND}$$
$$455mW = \left(\frac{\%DC}{100}\right) \times (8V - 5V) \times 500mA + (8V \times 20mA)$$
$$455mW = \left(\frac{\%DC}{100}\right) \times 1.66W$$
$$0.274 = \left(\frac{\%DC}{100}\right)$$
$$\%DCmax = 27.4\%$$

With an output current of 500 mA and a three-volt drop across the MIC5216-xxBMM, the maximum duty cycle is 27.4%.

Applications also call for a set nominal current output with a greater amount of current needed for short durations. This is a tricky situation, but it is easily remedied. Calculate the average power dissipation for each current section, then add the two numbers giving the total power dissipation for the regulator.

For example, if the regulator is operating normally at 50 mA, but for 12.5% of the time it operates at 500 mA output, the total power dissipation of the part can be easily determined. First, calculate the power dissipation of the device at 50 mA. We will use the MIC5216-3.3BM5 with 5V input voltage as our example.

EQUATION 4-9:

$$P_D \times 50mA = (5V - 3.3V) \times 50mA + 5V \times 650\mu A$$
$$P_D \times 50mA = 173mW$$

However, this is continuous power dissipation, the actual on-time for the device at 50 mA is (100%-12.5%) or 87.5% of the time, or 87.5% duty cycle. Therefore, PD must be multiplied by the duty cycle to obtain the actual average power dissipation at 50 mA.

EQUATION 4-10:

$$P_D \times 50mA = 0.875 \times 173mW$$
$$P_D \times 50mA = 151mW$$

The power dissipation at 500 mA must also be calculated.

EQUATION 4-11:

$$P_D \times 500mA = (5V - 3.3V) \times 500mA \times 5V + 20mA$$
$$P_D \times 500mA = 950mW$$

This number must be multiplied by the duty cycle at which it would be operating, 12.5%.

EQUATION 4-12:

$$P_D = 0.125mA \times 950mW$$
$$P_D = 119mW$$

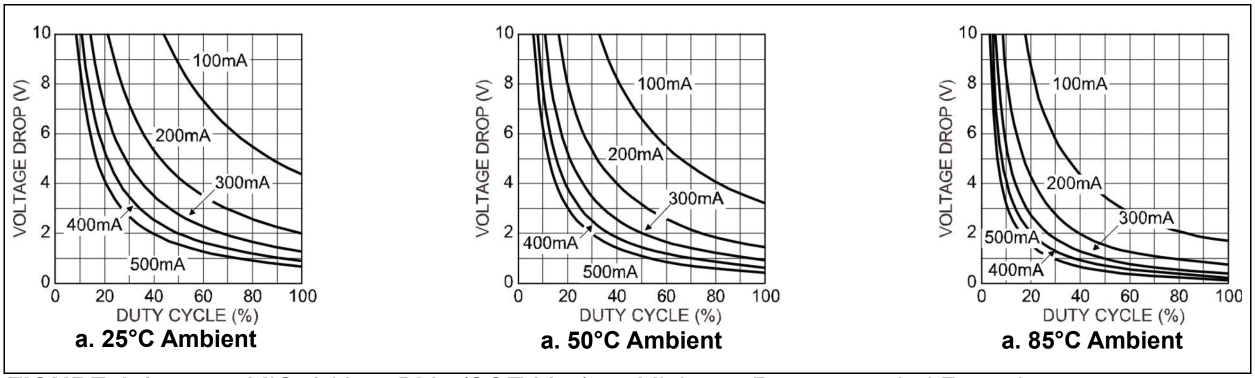


FIGURE 4-1: MIC5216-x.xBM5 (SOT-23-5) on Minimum Recommended Footprint.

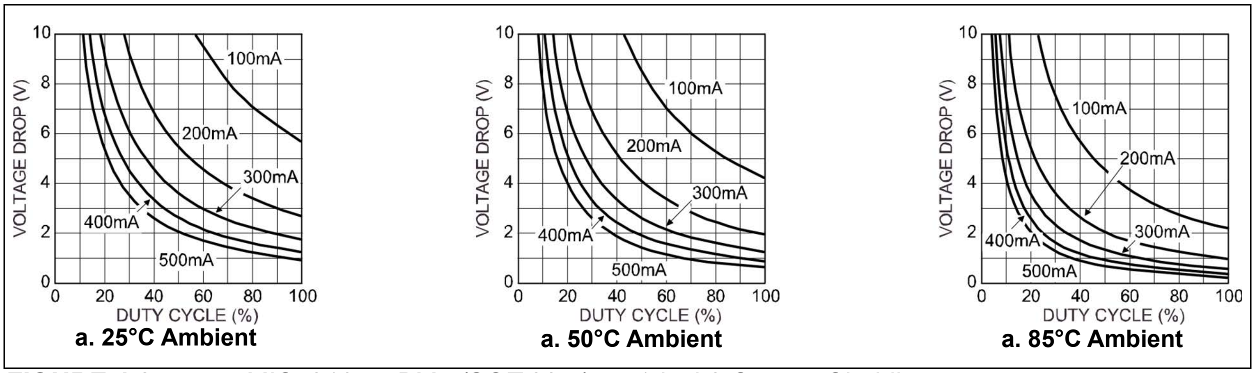


FIGURE 4-2: MIC5216-x.xBM5 (SOT-23-5) on 1-inch2 Copper Cladding.

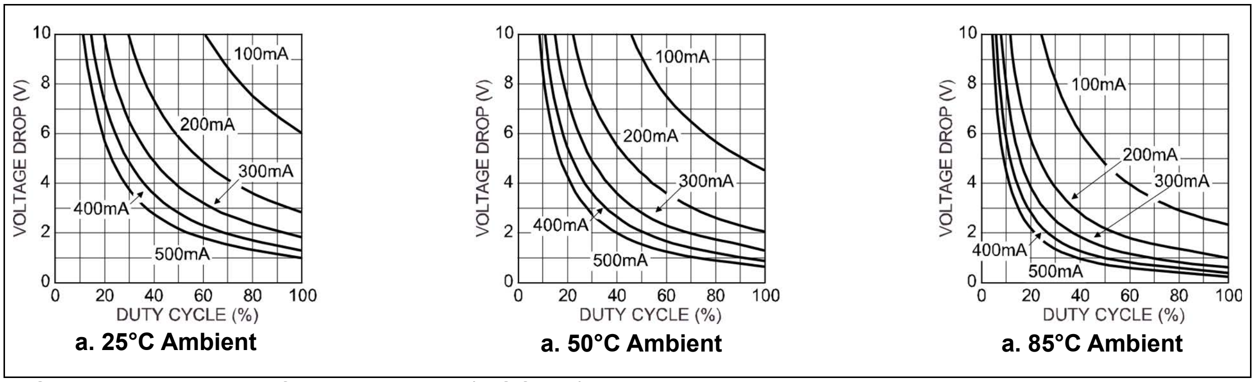


FIGURE 4-3: MIC5216-x.xBMM (MSOP-8) on Minimum Recommended Footprint.

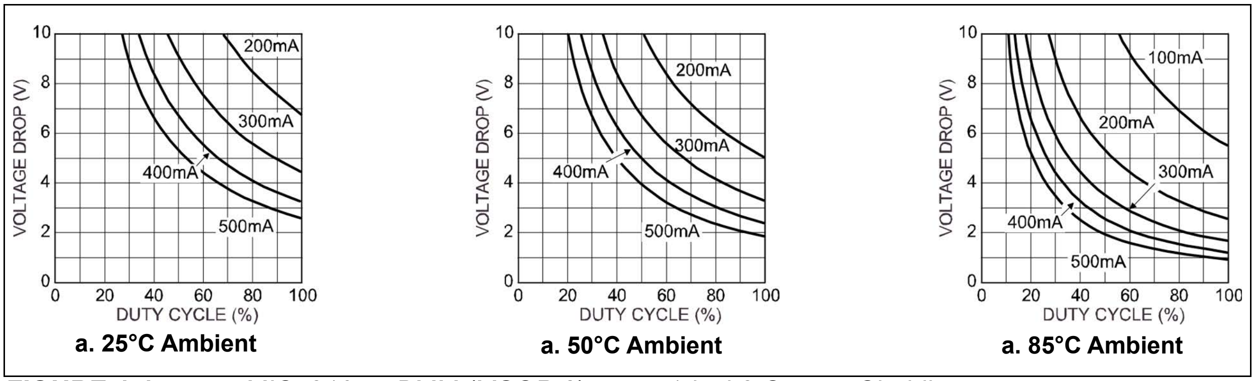


FIGURE 4-4: MIC5216-x.xBMM (MSOP-8) on on 1-inch2 Copper Cladding.

The total power dissipation of the device under these conditions is the sum of the two power dissipation figures.

EQUATION 4-13:

$$P_{D(total)} = P_D \times 50mA + P_D \times 500mA$$
$$P_{D(total)} = 151mW + 119mW$$
$$P_{D(total)} = 270mW$$

The total power dissipation of the regulator is less than the maximum power dissipation of the SOT-23-5 package at room temperature, on a minimum footprint board and therefore would operate properly.

Multilayer boards with a ground plane, wide traces near the pads, and large supply-bus lines will have better thermal conductivity.

For additional heat sink characteristics, please refer to Micrel Application Hint 17. 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.

4.8 Fixed Regulator Circuits

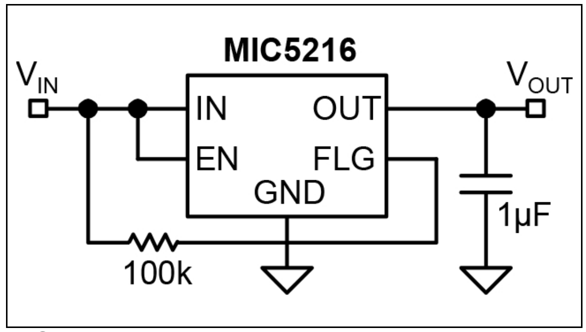


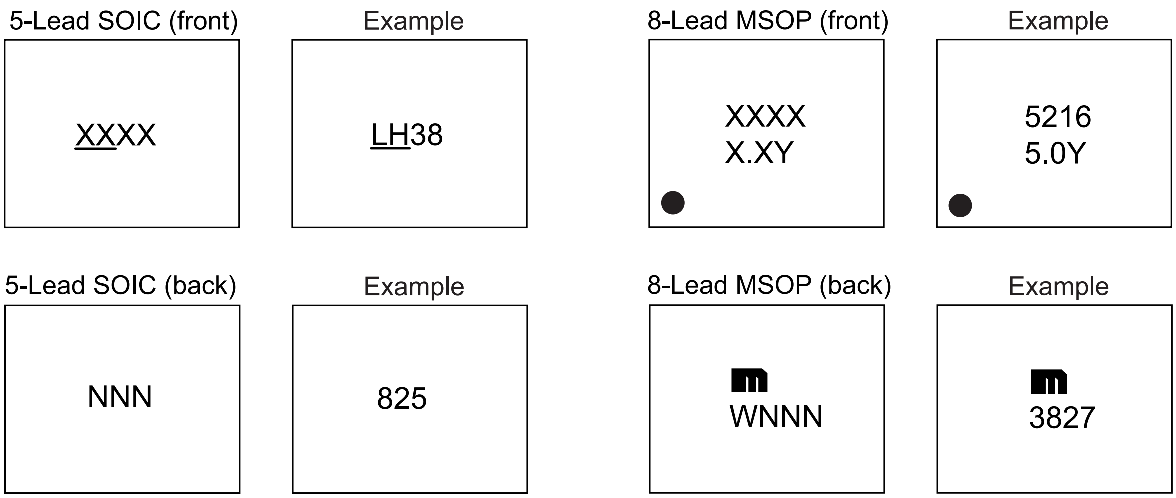
FIGURE 4-5: *Low-Noise Fixed Voltage Regulator.*

A basic MIC5216-x.xBMx fixed-voltage regulator circuit is shown in Figure 4-5. A 1 µF minimum output capacitor is required for basic fixed-voltage applications.

The flag output is an open-collector output and requires a pull-up resistor to the input voltage. The flag indicates an undervoltage condition on the output of the device.

5.0 PACKAGING INFORMATION

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

Note: If the full seven-character YYWWNNN code cannot fit on the package, the following truncated codes are used based on the available marking space:
6 Characters = YWWNNN; 5 Characters = WWNNN; 4 Characters = WNNN; 3 Characters = NNN;
2 Characters = NN; 1 Character = N.

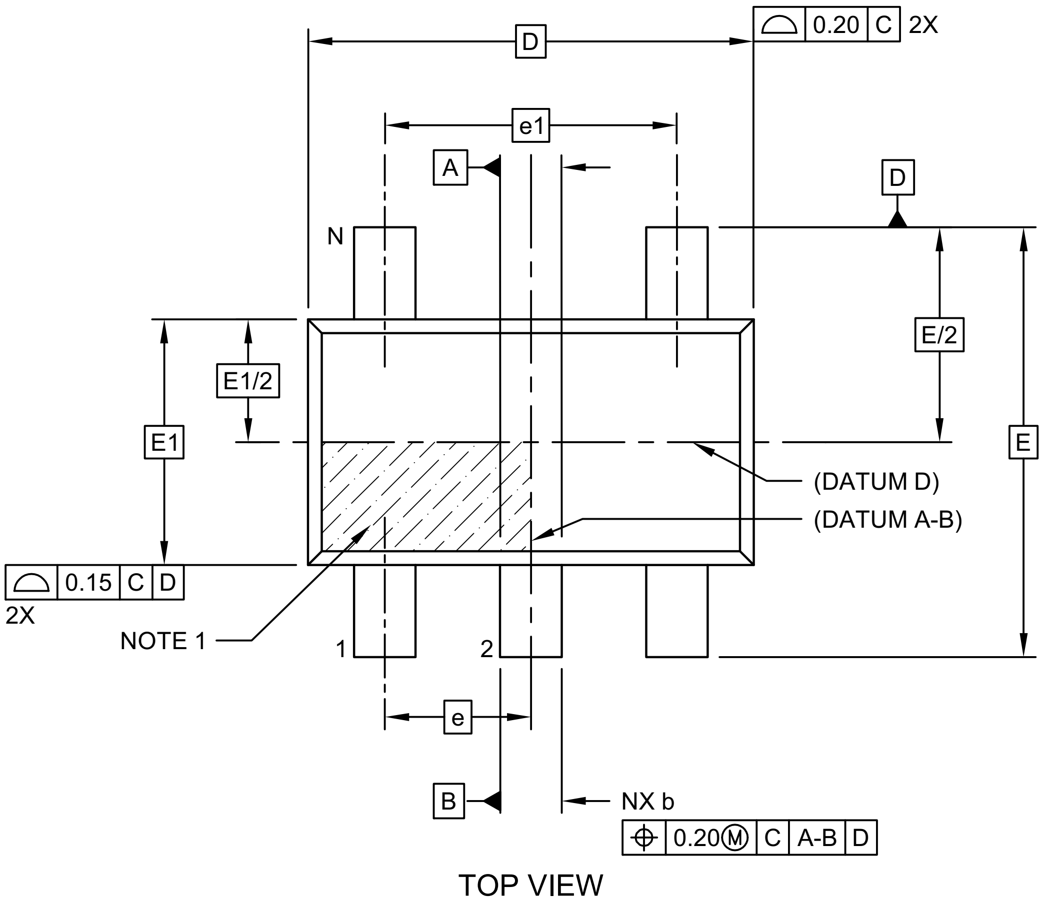
TABLE 5-1: ORDERING INFORMATION

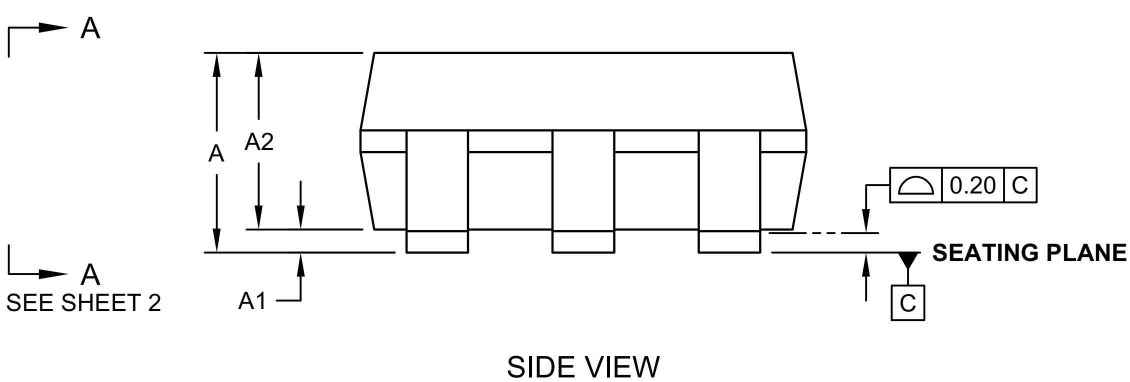
Packaging				Junction		
Standard	**Marking**	**Pb-Free**	**Marking**	**Voltage**	**Temp. Range**	**Package**
MIC5216-2.5BMM	—	MIC5216-2.5YMM	—	2.5V	–40° to +125°C	8-Pin MSOP
MIC5216-3.3BMM	—	MIC5216-3.3YMM	—	3.3V	–40° to +125°C	8-Pin MSOP
MIC5216-5.0BMM	—	MIC5216-5.0YMM	—	5.0V	–40° to +125°C	8-Pin MSOP
MIC5216-2.5BM5	LH25	MIC5216-2.5YM5	LH25	2.5V	–40° to +125°C	5-Pin SOT-23
MIC5216-3.3BM5	LH33	MIC5216-3.3YM5	LH33	3.3V	–40° to +125°C	5-Pin SOT-23
MIC5216-3.6BM5	LH36	MIC5216-3.6YM5	LH36	3.6V	–40° to +125°C	5-Pin SOT-23
MIC5216-5.0BM5	LH50	MIC5216-5.0YM5	LH50	5.0V	–40° to +125°C	5-Pin SOT-23

Note: Other voltages available. Please contact Microchip for details.

5-Lead SOT-23 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

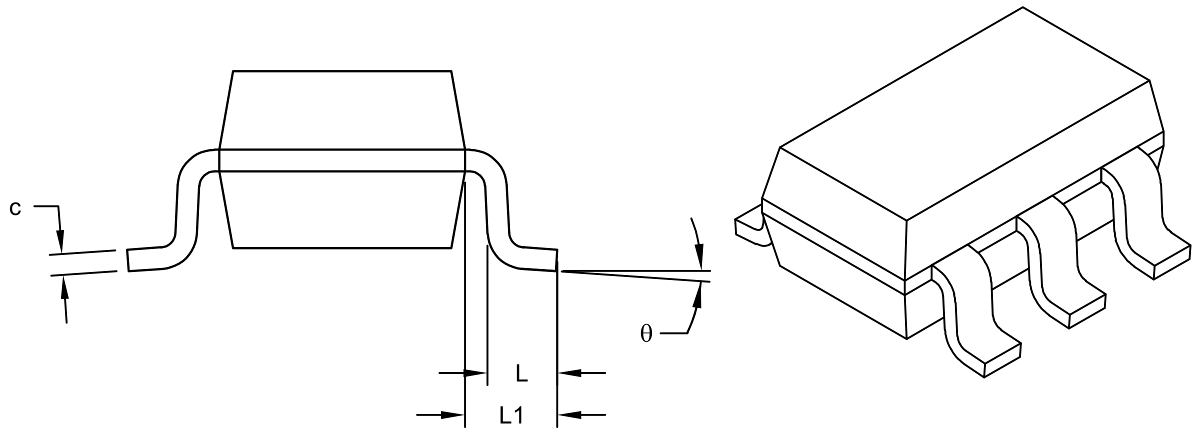




Microchip Technology Drawing C04-091-6BX Rev G Sheet 1 of 2

5-Lead SOT-23 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



VIEW A-A
SHEET 1

	Units	MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		5	
Pitch	e		0.95 BSC	
Outside lead pitch	e1		1.90 BSC	
Overall Height	A	0.90	-	1.45
Molded Package Thickness	A2	0.89	-	1.30
Standoff	A1	-	-	0.15
Overall Width	E		2.80 BSC	
Molded Package Width	E1		1.60 BSC	
Overall Length	D		2.90 BSC	
Foot Length	L	0.30	-	0.60
Footprint	L1		0.60 REF	
Foot Angle	ϕ	0°	-	10°
Lead Thickness	c	0.08	-	0.26
Lead Width	b	0.20	-	0.51

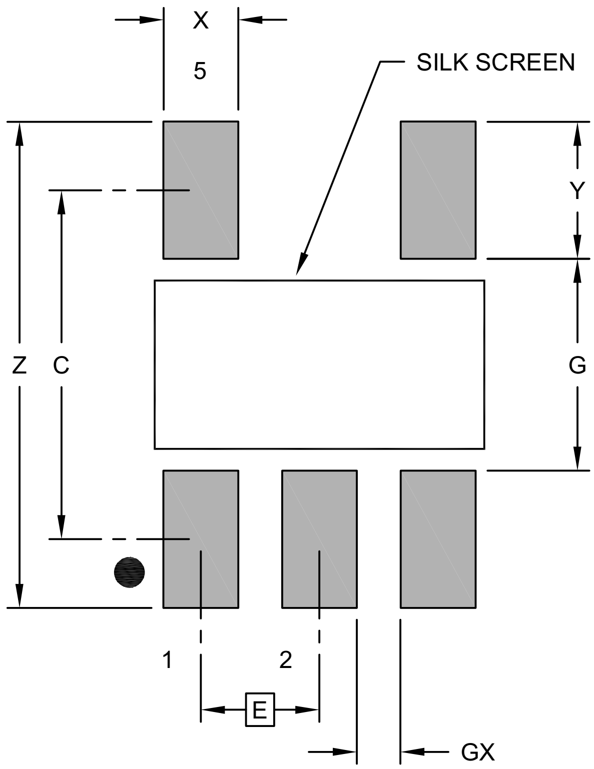
Notes:

1. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25mm per side.
2. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-091-6BX Rev G Sheet 2 of 2

5-Lead SOT-23 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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.95 BSC	
Contact Pad Spacing	C		2.80	
Contact Pad Width (X5)	X			0.60
Contact Pad Length (X5)	Y			1.10
Distance Between Pads	G	1.70		
Distance Between Pads	GX	0.35		
Overall Width	Z			3.90

Notes:

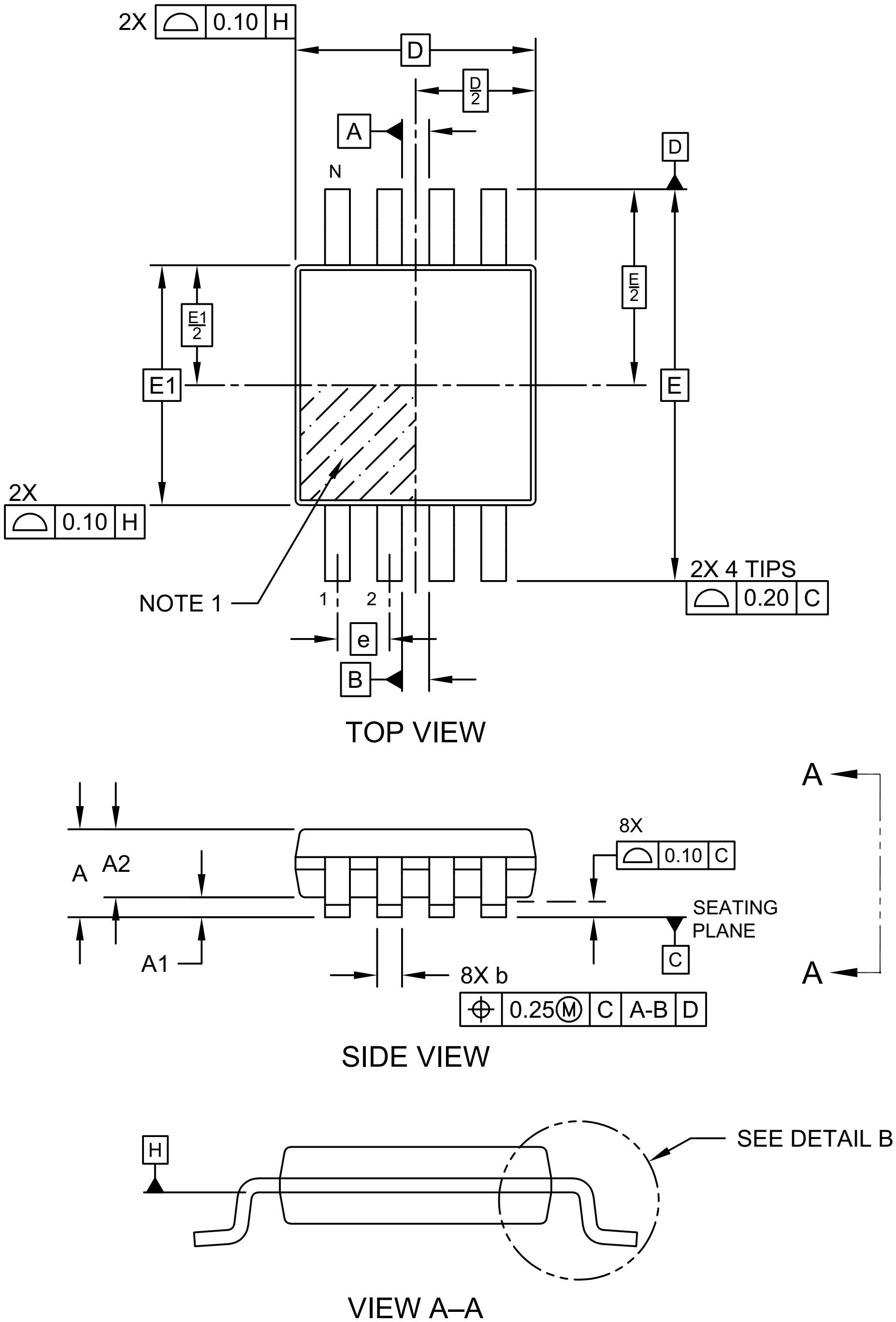
1. Dimensioning and tolerancing per ASME Y14.5M

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2091-6BX Rev G

8-Lead MSOP Package Outline and Recommended Land Pattern

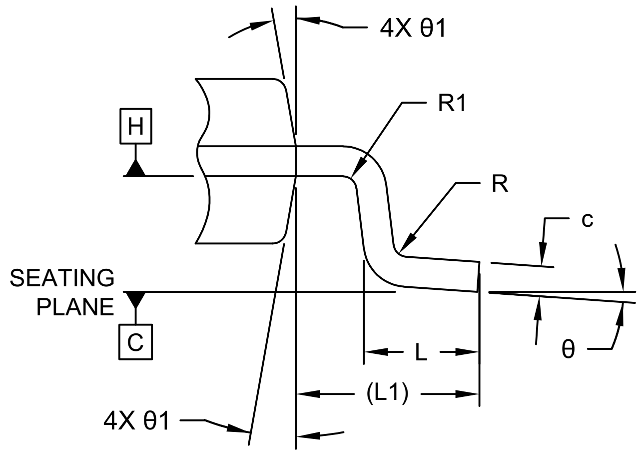
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



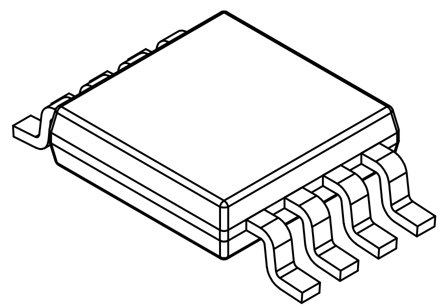
Microchip Technology Drawing C04-1082 Rev A Sheet 1 of 2

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



DETAIL B



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N	8		
Pitch	e	0.65 BSC		
Overall Height	A	0.94	1.02	1.10
Standoff	A1	0.00	–	0.15
Molded Package Thickness	A2	0.75	0.85	0.95
Overall Length	D	3.00 BSC		
Overall Width	E	4.90 BSC		
Molded Package Width	E1	3.00 BSC		
Terminal Width	b	0.25	0.30	0.40
Terminal Thickness	c	0.13	0.15	0.23
Terminal Length	L	0.45	0.55	0.70
Footprint	L1	0.95 REF		
Lead Bend Radius	R	0.07	–	–
Lead Bend Radius	R1	0.07	–	–
Foot Angle	θ	0°	–	8°
Mold Draft Angle	θ1	5°	–	15°

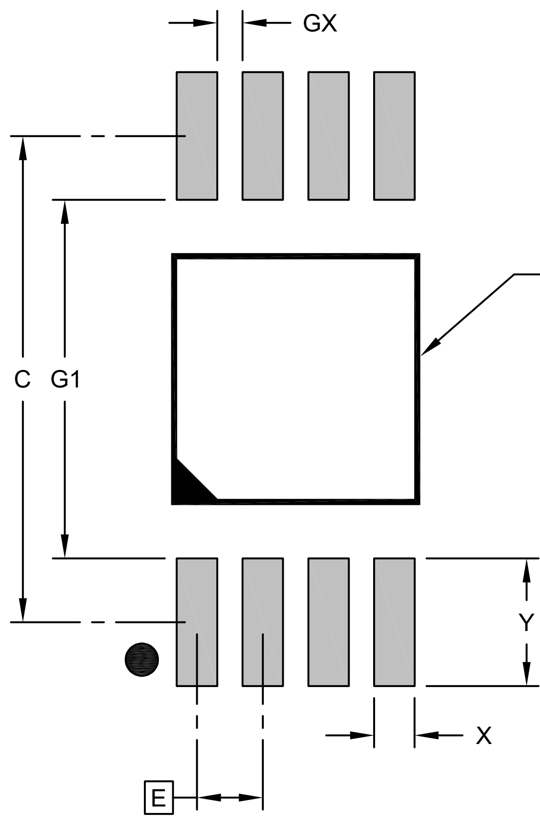
Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
3. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1082 Rev A Sheet 2 of 2

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	0.65 BSC		
Contact Pad Spacing	C		4.80	
Contact Pad Width (X8)	X			0.40
Contact Pad Length (X8)	Y			1.26
Contact Pad to Contact Pad (X4)	G1	3.54		
Contact Pad to Contact Pad (X6)	GX	0.25		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-3082 Rev A

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (September 2022)

- Converted Micrel document MIC5216 to Microchip data sheet DS20006723A.
- 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.XX	X	XX	-XX
Device	Output Voltage	Junction Temp. Range	Package	Media Type

Device:	MIC5216: 500 mA-Peak Output LDO Regulator
Output Voltage:	2.5 = 2.5V (SOT-23 option only) 3.3 = 3.3V 3.6 = 3.6V (SOT-23 option only) 3.8 = 3.8V (SOT-23 option only) 4.0 = 4.0V (SOT-23 option only) 5.0 = 5.0V Other voltages available. Contact Microchip for details.
Junction Temperature Range:	Y = –40°C to +125°C
Package:	M5 = 5-Lead SOT-23 MM = 8-Lead MSOP
Media Type:	<blank>= 100/Tube (MSOP option only) TR = 2500/Reel (MSOP option only) TR = 3000/Reel (SOT-23 option only)

Examples:

a) MIC5216-3.8YM5-TR: MIC5216, 3.8V Output Voltage, –40°C to +125°C Temp. Range, SOT-23-5, 3000/Reel

b) MIC5216-5.0YMM: MIC5216, 5.0V Output Voltage, –40°C to +125°C Temp. Range, MSOP-8, 100/Tubel

c) MIC5216-3.3YMM-TR: MIC5216, 3.3V Output Voltage, –40°C to +125°C Temp. Range, MSOP-8, 2500/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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