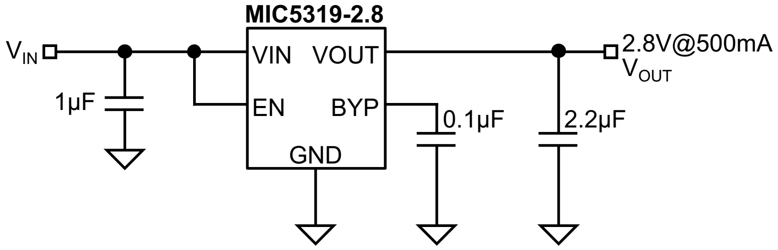
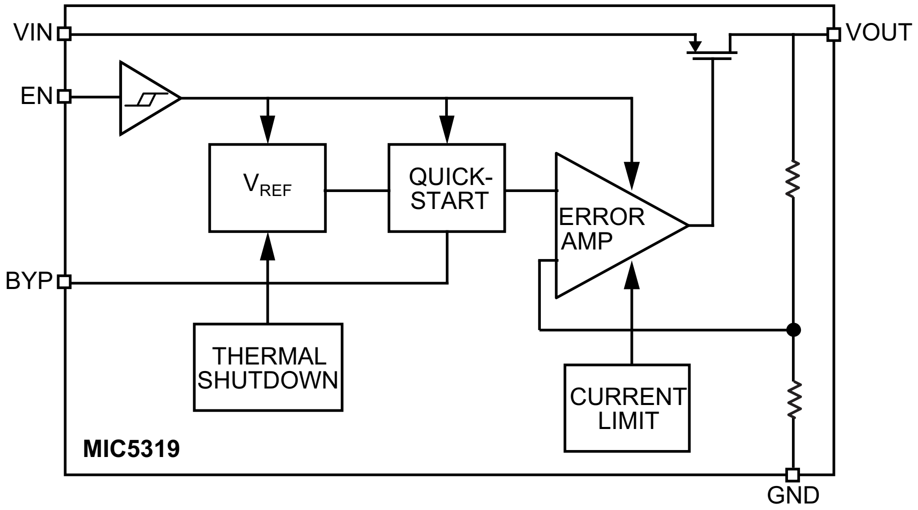
Typical Application Circuit

MIC5319
DFN-6 or SOT23-5

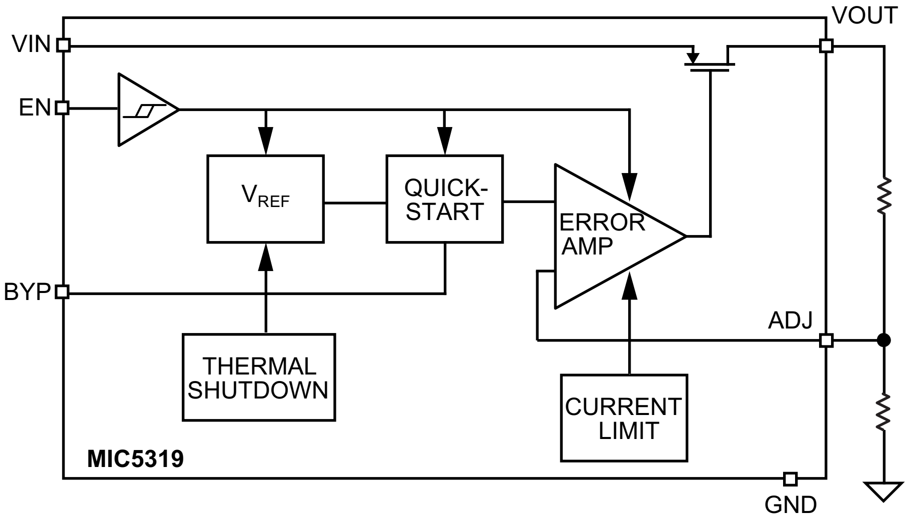


Functional Block Diagrams

MIC5319
(Fixed Output Voltage)



MIC5319
(Adjustable Output Voltage)



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Input Voltage (V_{IN}) ..... 0V to +6V
Enable Input Voltage (V_{EN}) ..... 0V to +6V
Power Dissipation (P_D) (Note 1) ..... Internally Limited
ESD Rating (Note 2) ..... 3 kV, HBM

Operating Ratings ‡

Supply Input Voltage (V_{IN}) ..... +2.5V to +5.5V
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: The maximum allowable power dissipation of any T_A (ambient temperature) is $P_{D(MAX)} = (T_{J(MAX)} – T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator may go into thermal shutdown.

2: Devices are ESD sensitive. Handling precautions recommended.

TABLE 1-1: ELECTRICAL CHARACTERISTICS

Electrical Characteristics: $V_{IN} = V_{OUT} + 1.0V$; C_{OUT} = 2.2 µF; I_{OUT} = 100 µA; T_A = +25°C, **bold** values are available for the –40°C to +125°C junction temperature range, unless otherwise noted. (Note 1)

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage Accuracy	ΔV_{OUT}	–1.0	—	1.0	%	Variation from nominal V_{OUT}
		–2.0	—	**2.0**		Variation from nominal V_{OUT}, I_{OUT} = 100 µA to 500 mA
Feedback Voltage (Adj. Option)	V_{ADJ}	1.2375	1.25	1.2625	V	—
		1.225	1.25	**1.275**		
Line Regulation	$\Delta V_{OUT}/(V_{OUT}$ x $\Delta V_{IN})$	—	0.04	**0.3**	%/V	$V_{IN} = V_{OUT}$ +1V to +5.5V
Load Regulation (Note 2)	$\Delta V_{OUT}/V_{OUT}$	—	0.1	**0.5**	%	I_L = 100 µA to 500 mA
Dropout Voltage (Note 3, Note 4)	V_{DO}	—	20	**40**	mV	I_{OUT} = 50 mA
		—	200	**400**		I_{OUT} = 500 mA
Ground Pin Current (Note 5)	I_{GND}	—	90	**150**	µA	I_{OUT} = 0 mA to 500 mA
Ground Pin Current in Shutdown Mode	I_{SHDN}	—	0.5	—	µA	V_{EN} ≤ 0.2V
Power Supply Ripple Rejection	PSRR	—	70	—	dB	f = up to 1 kHz; C_{OUT} = 2.2 µF ceramic; C_{BYP} = 0.1 µF
		—	60	—	dB	f = 10 kHz; C_{OUT} = 2.2 µF ceramic; C_{BYP} = 0.1 µF
Current Limit	I_{LIMIT}	**600**	700	—	mA	V_{OUT} = 0V
Output Voltage Noise	e_N	—	40	—	μV_{RMS}	C_{OUT} = 2.2 µF; C_{BYP} = 0.1 µF; 10 Hz to 100 kHz
Turn-On Time	t_{ON}	—	40	**100**	µs	C_{OUT} = 2.2 µF; C_{BYP} = 0.1 µF
Enable Input Voltage	V_{ENABLE}	—	—	**0.2**	V	Logic Low (Regulator Shutdown)
		1.2	—	—		Logic High (Regulator Enabled)
Enable Input Current	I_{ENABLE}	—	0.01	**1**	µA	V_{IL} = ≤ 0.2V (Regulator Shutdown)
		—	0.01	**1**		V_{IH} = ≥ 1.0V (Regulator Shutdown)

Note 1: Specification for packaged product only.

2: Regulation is measured at constant junction temperature using low duty cycle pulse testing.

3: Dropout voltage is defined as the input-to-output differential at which the output voltage drops 2% below its nominal V_{OUT}. For outputs below 2.5V, dropout voltage spec does not apply, as the part is limited by minimum V_{IN} spec of 2.5V. There may be some typical dropout degradation at V_{OUT} < 3V.

4: For Adjustable option, V_{OUT} = 3V for dropout specification.

5: Ground pin current is the regulator quiescent current. The total current drawn from the supply is the sum of the load current plus the ground pin current.

TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Operating Temperature Range	T_J	–40	—	+125	°C	—
Storage Temperature Range	T_S	–65	—	+150	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 5s
Package Thermal Resistances						
Thermal Resistance DFN-6	θ_{JA}	—	93	—	°C/W	—
Thermal Resistance Thin SOT23-5	θ_{JA}	—	235	—	°C/W	—

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.

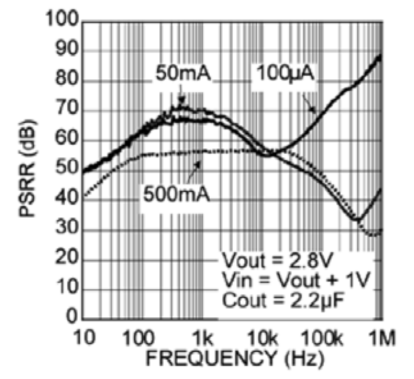


FIGURE 2-1: *PSRR (Bypass Pin Capacitor = 0.1 µF).*

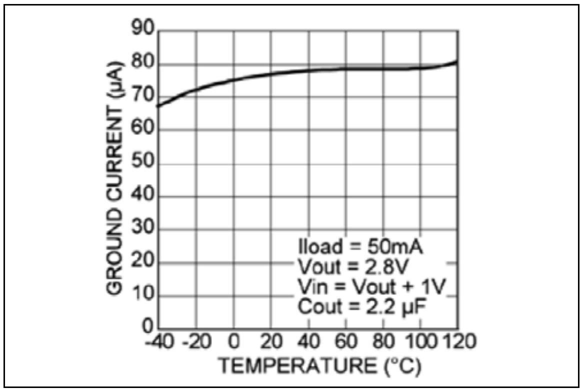


FIGURE 2-4: *Ground Current vs. Temperature.*

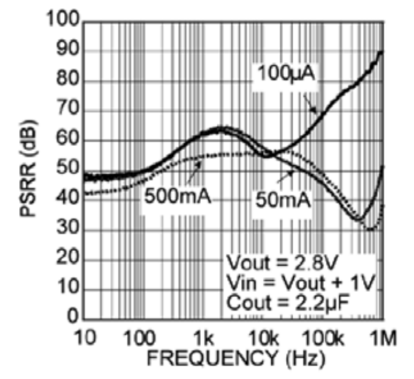


FIGURE 2-2: *PSRR (Bypass Pin Capacitor = 0.01 µF).*

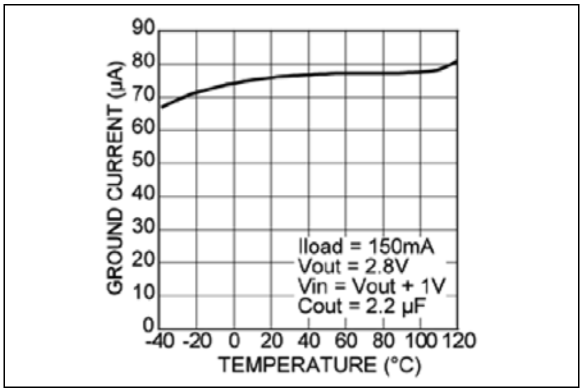


FIGURE 2-5: *Ground Current vs. Temperature.*

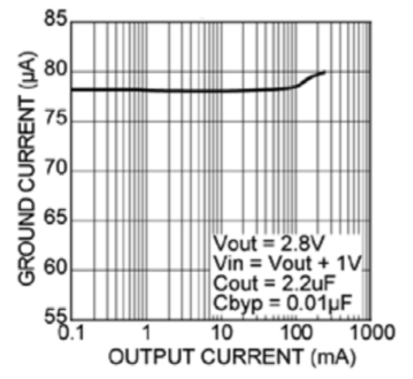


FIGURE 2-3: *Ground Current vs. Output Current.*

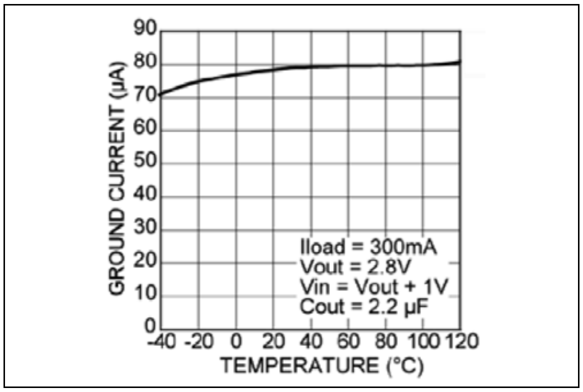


FIGURE 2-6: *Ground Current vs. Temperature.*

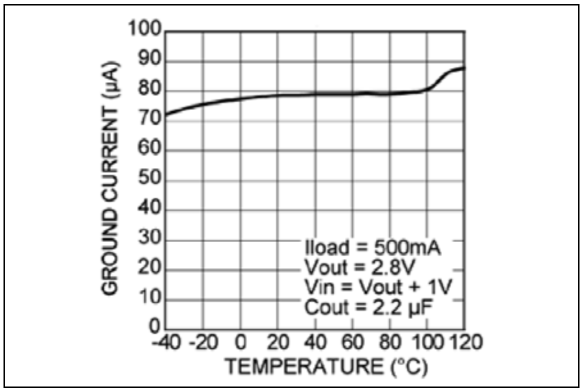


FIGURE 2-7: *Ground Current vs. Temperature.*

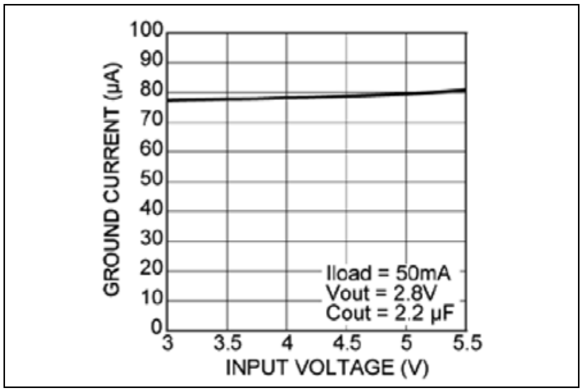


FIGURE 2-8: *Ground Current vs. Input Voltage.*

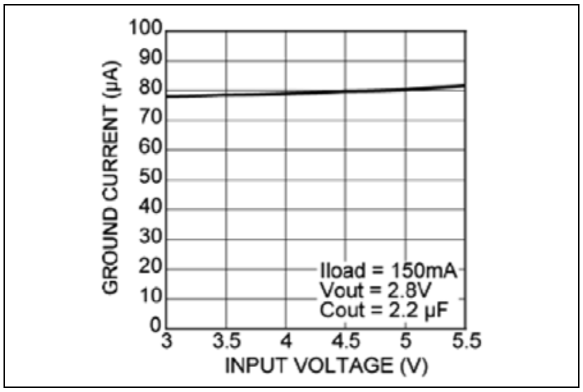


FIGURE 2-9: *Ground Current vs. Input Voltage.*

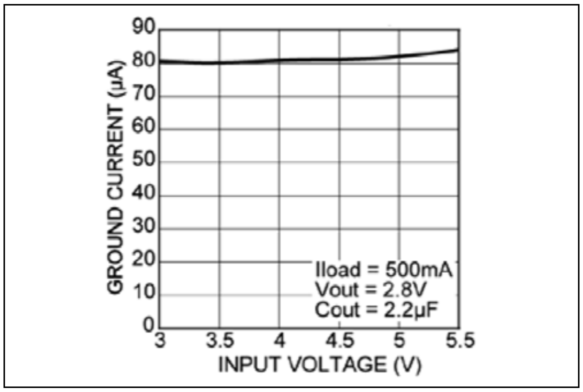


FIGURE 2-10: *Ground Current vs. Input Voltage.*

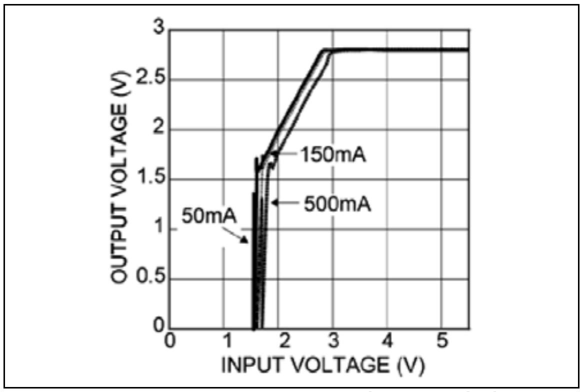


FIGURE 2-11: *Dropout Characteristics.*

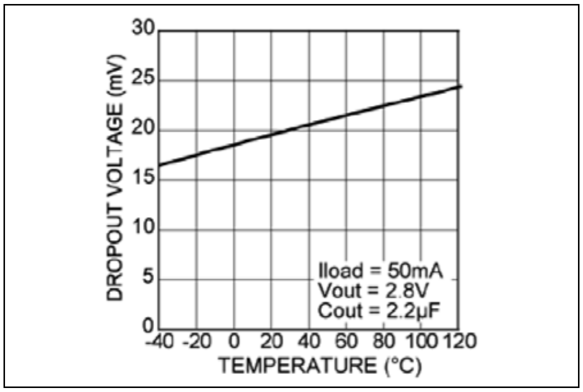


FIGURE 2-12: *Dropout Voltage vs. Temperature.*

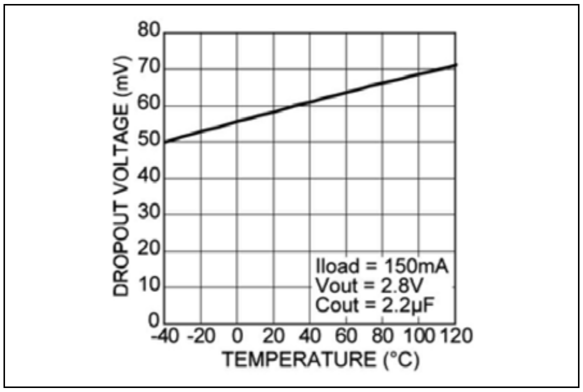


FIGURE 2-13: *Dropout Voltage vs. Temperature.*

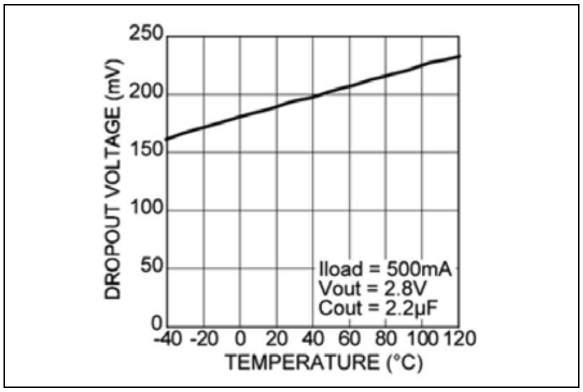


FIGURE 2-14: *Dropout Voltage vs. Temperature.*

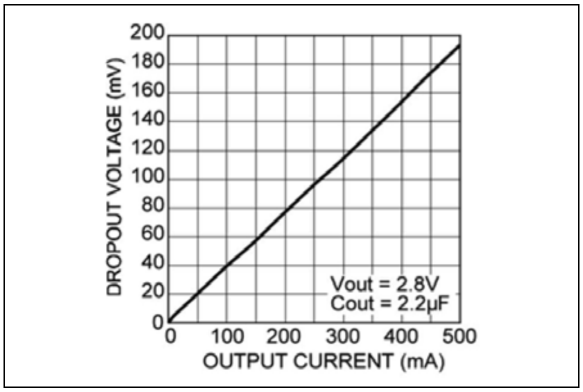


FIGURE 2-15: *Dropout Voltage vs. Load Current.*

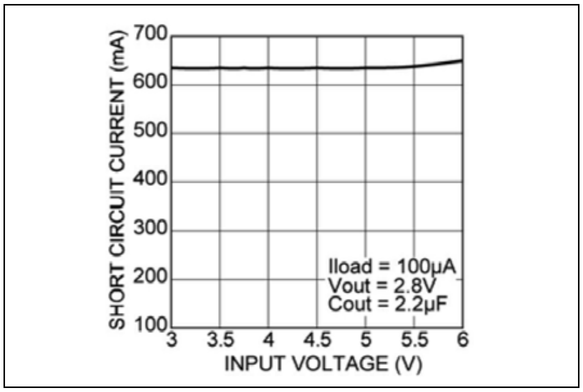


FIGURE 2-16: *Short-Circuit Current vs. Input Voltage.*

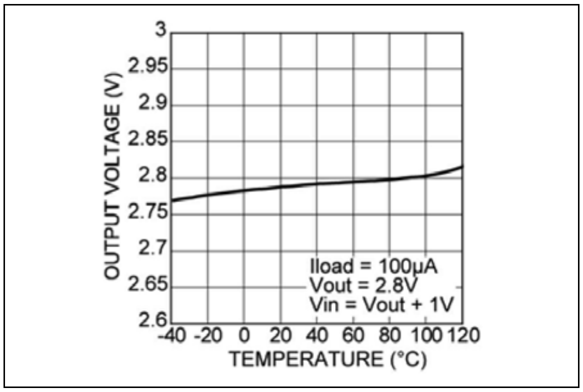


FIGURE 2-17: *Output Voltage vs. Temperature.*

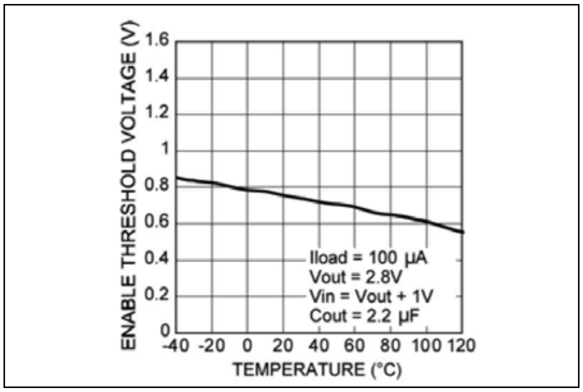


FIGURE 2-18: *Enable Threshold vs. Temperature.*

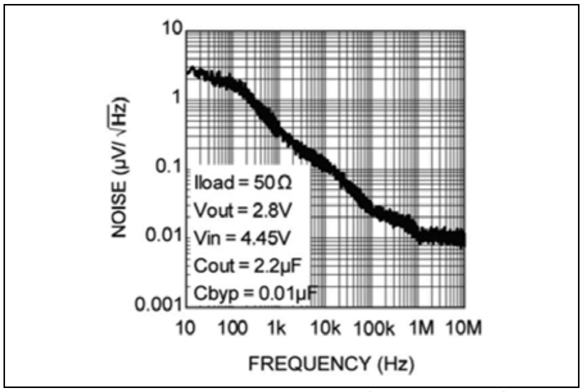


FIGURE 2-19: *Output Noise Spectral Density.*

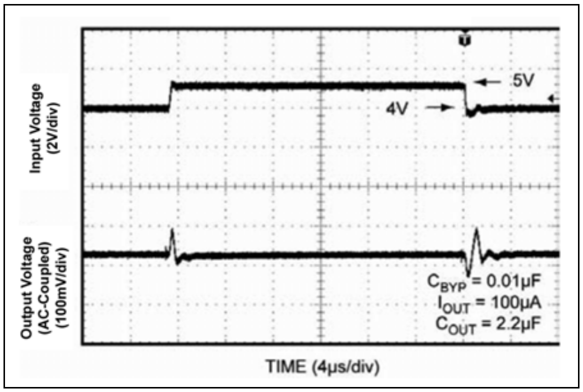


FIGURE 2-20: *Line Transient Response (3.0V Fixed Output Version).*

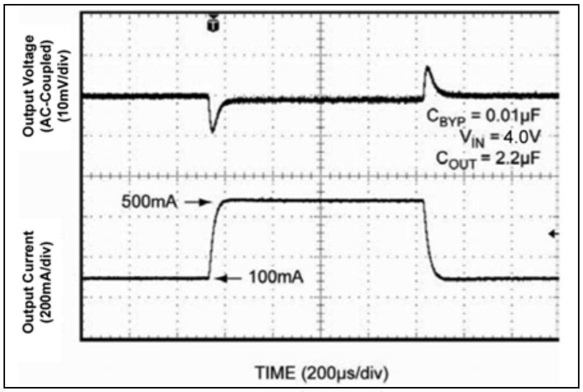


FIGURE 2-21: *Load Transient Response (3.0V Fixed Output Version).*

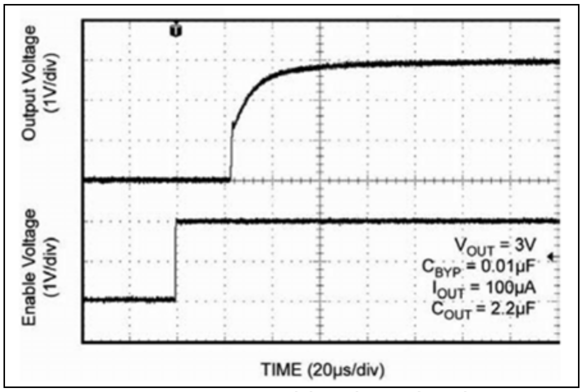


FIGURE 2-22: *Enable Pin Delay (3.0V Fixed Output Version).*

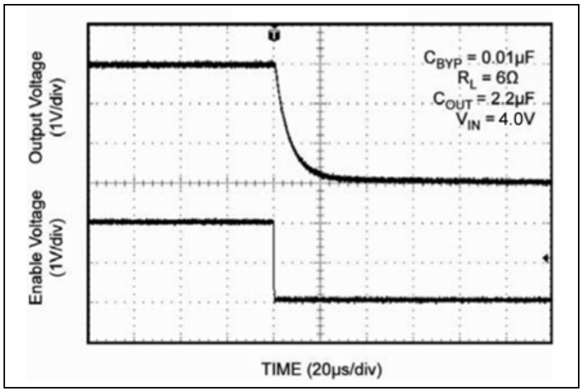


FIGURE 2-23: *Shutdown Delay (3.0V Fixed Output Version).*

3.0 PIN DESCRIPTIONS

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

TABLE 3-1: PIN FUNCTION TABLE

Pin Number DFN-6, Fixed	Pin Number DFN-6, Adj.	Pin Number SOT23-5	Pin Name	Description
1	1	3	EN	Enable Input: Active-High. High = Regulator ON, Low = Regulator OFF. Do not leave floating.
2	2	2	GND	Ground.
3	3	1	VIN	Input Voltage.
4	4	5	VOUT	Output Voltage.
—	5	—	ADJ	Adjustable Input: Connect to the external resistor voltage divider network to set the desired output voltage.
5	—	—	NC	Not connected for the DFN fixed output voltage version.
6	6	4	BYP	Reference Bypass: Connect external 0.1 µF to GND for reduced output noise. May be left open.
EP	EP	—	EP	Exposed Pad connected to ground internally. Must be connected to the ground plane of the application board for optimal heat dissipation.

4.0 APPLICATION INFORMATION

4.1 Enable/Shutdown

The MIC5319 features an active-high enable pin that allows the regulator to be disabled. Forcing the enable pin low disables the regulator and sends it into a “zero” off-mode current state. In this state, the current consumed by the regulator is typically only 0.5 µA. Forcing the enable pin high enables the output voltage. The active-high enable pin uses CMOS technology and the enable pin cannot be left floating, as this may cause an undetermined state on the output.

4.2 Input Capacitor

The MIC5319 is a high-performance, high bandwidth device. Therefore, it requires a well-bypassed input supply for optimal performance. A minimum 1 µF capacitor is required from the input-to-ground to provide stability. Low-ESR ceramic capacitors provide optimal performance at a minimum of space. Additional high-frequency capacitors, such as small-valued NPO dielectric-type capacitors, help filter out high-frequency noise and are good design practice in any RF-based circuit.

4.3 Output Capacitor

The MIC5319 requires an output capacitor of 2.2 µF or greater to maintain stability. The design is optimized for use with low-ESR ceramic chip capacitors. High ESR capacitors may cause high-frequency oscillation. The output capacitor can be increased, but performance has been optimized for a 2.2 µF ceramic output capacitor and does not improve significantly with larger capacitance.

X7R/X5R dielectric-type ceramic capacitors are recommended because of their temperature performance. X7R-type capacitors change capacitance by 15% over their operating temperature range and are the most stable type of ceramic capacitors. Z5U and Y5V dielectric capacitors change value by as much as 50% and 60%, respectively, over their operating temperature ranges. To use a ceramic chip capacitor with Y5V dielectric, the value must be much higher than an X7R ceramic capacitor to ensure the same minimum capacitance over the equivalent operating temperature range.

4.4 Bypass Capacitor

A capacitor can be placed from the bypass pin-to-ground to reduce output voltage noise. The capacitor bypasses the internal reference. A 0.1 µF capacitor is recommended for applications that require low-noise outputs. The bypass capacitor can be increased, further reducing noise and improving PSRR. Turn-on time increases slightly with respect to bypass capacitance.

A unique, quick-start circuit allows the MIC5319 to drive a large capacitor on the bypass pin without significantly slowing turn-on time.

4.5 No-Load Stability

Unlike many other voltage regulators, the MIC5319 will remain stable and in regulation with no load. This is especially important in CMOS RAM keep-alive applications.

4.6 Adjustable Regulator Application

Adjustable regulators use a two-resistor divider to multiply the reference voltage and to produce the desired output voltage.

The MIC5319 output voltage can be adjusted from 1.25V to 5.5V by using two external resistors (Figure 4-1). The resistors set the output voltage based on the following equation:

EQUATION 4-1:

$$V_{OUT} = V_{REF}\left(1 + \frac{R1}{R2}\right)$$

Where:

V_{REF} = 1.25V

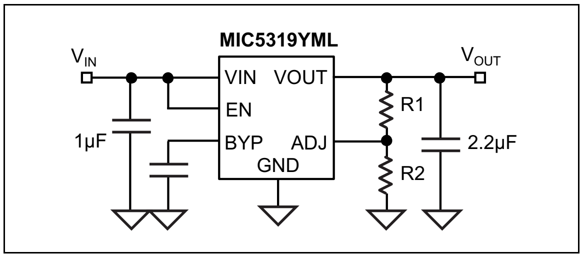


FIGURE 4-1: *Adjustable Voltage Typical Application.*

4.7 Thermal Considerations

The MIC5319 is designed to provide 500 mA of continuous current in a very small DFN package. Maximum ambient operating temperature can be calculated based on the output current and the voltage drop across the part. Given an input voltage of 3.3V, output voltage of 2.8V, and output current of 500 mA, the actual power dissipation of the regulator circuit can be determined using the equation:

EQUATION 4-2:

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

Because this device is CMOS and the ground current is typically <100 µA over the load range, the power dissipation contributed by the ground current is <1% and can be ignored for this calculation:

EQUATION 4-3:

$$P_D = (3.3V - 2.8V) \times 500mA = 0.25W$$

To determine the maximum ambient operating temperature of the package, use the junction-to-ambient thermal resistance of the device and the following basic equation:

EQUATION 4-4:

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

Where:

$T_{J(MAX)}$ = 125°C
θ_{JA} = 93°C/W (for the DFN package)

Substituting 0.25W for $P_{D(MAX)}$ and solving for the ambient operating temperature will give the maximum operating conditions for the regulator circuit. The maximum power dissipation must not be exceeded for proper operation.

EQUATION 4-5:

$$0.25W = \frac{125°C - T_A}{93°C/W}$$

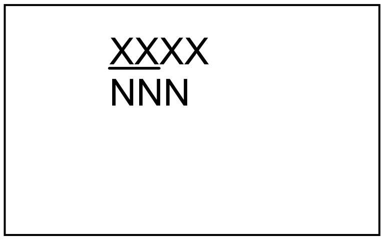
$$T_A = 101.75°C$$

Therefore, a 2.8V application at 500 mA of output current can accept an ambient operating temperature of 101.75°C in a 2 mm x 2 mm DFN package. For a full discussion of heat sinking and thermal effects on voltage regulators, refer to the “Regulator Thermals” section of Microchip’s Designing with Low-Dropout Voltage Regulators handbook.

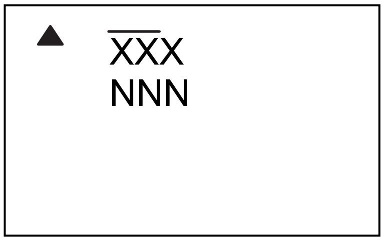
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

5-Pin TSOT23*

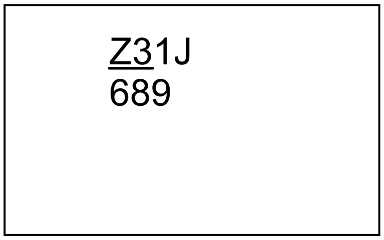


6-Pin DFN*

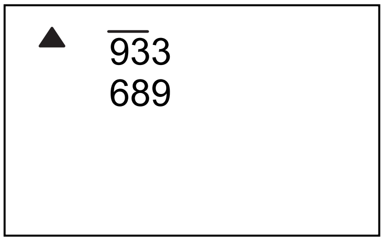


Part Number	Marking
MIC5319YML-TR	$\overline{\text{9A}}$A
MIC5319-5.0YML-TR	$\overline{\text{95}}$0
MIC5319-5.0YD5-TR	$\underline{\text{N9}}$50
MIC5319-3.3YML-TR	$\overline{\text{93}}$3
MIC5319-3.3YD5-TR	$\underline{\text{N9}}$33
MIC5319-3.0YML-TR	$\overline{\text{93}}$0
MIC5319-3.0YD5-TR	$\underline{\text{N9}}$30
MIC5319-2.9YML-TR	$\underline{\text{N9}}$29
MIC5319-2.8YML-TR	$\overline{\text{92}}$8
MIC5319-2.8YD5-TR	$\underline{\text{N9}}$28
MIC5319-2.85YML-TR	$\overline{\text{92}}$J
MIC5319-2.7YML-TR	$\overline{\text{92}}$7
MIC5319-2.7YD5-TR	$\underline{\text{N9}}$27
MIC5319-2.6YML-TR	$\overline{\text{92}}$6
MIC5319-2.6YD5-TX	$\underline{\text{N9}}$26
MIC5319-2.6YD5-TR	$\underline{\text{N9}}$26
MIC5319-2.5YML-TR	$\overline{\text{92}}$5
MIC5319-2.5YD5-TX	$\underline{\text{N9}}$25
MIC5319-2.5YD5-TR	$\underline{\text{N9}}$25
MIC5319-1.8YML-TR	$\overline{\text{91}}$8
MIC5319-1.8YD5-TX	$\underline{\text{N9}}$18
MIC5319-1.8YD5-TR	$\underline{\text{N9}}$18
MIC5319-1.85YML-TR	$\overline{\text{91}}$J
MIC5319-1.85YD5-TX	$\underline{\text{N9}}$1J
MIC5319-1.85YD5-TR	$\underline{\text{N9}}$1J
MIC5319-1.3HYML-TR	$\overline{\text{13}}$H
MIC5319-1.3HYD5-TR	$\underline{\text{N1}}$3H

Example



Example



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
ⓔ3	Pb-free JEDEC® designator for Matte Tin (Sn)
*	This package is Pb-free. The Pb-free JEDEC designator (ⓔ3) 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).

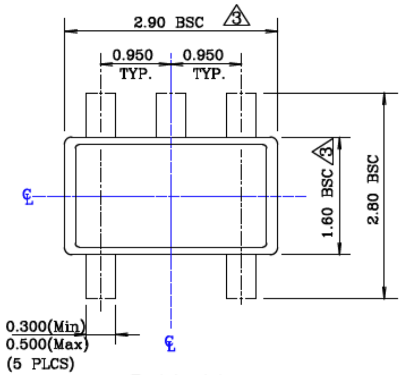
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

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

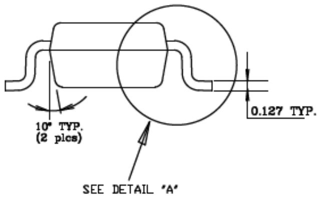
5-Lead TSOT Package Outline and Recommended Land Pattern

TITLE
5 LEAD TSOT PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

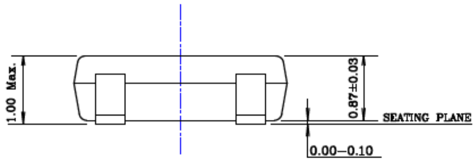
DRAWING #	TSOT-5LD-PL-1	**UNIT**	MM



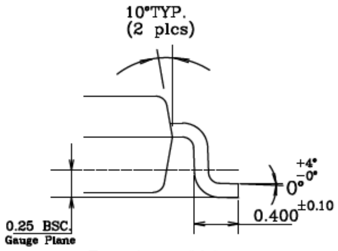
TOP VIEW
NOTES : 3, 6



END VIEW
NOTES : 2, 4, 6



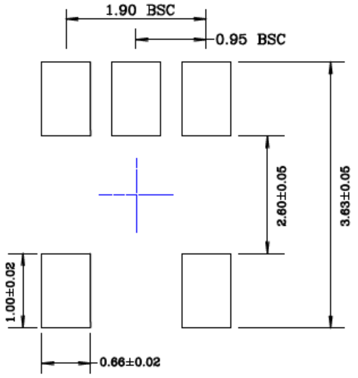
TOP VIEW
NOTES : 4, 6



DETAIL "A"

NOTE:

1. Dimensions and tolerances are as per ANSI Y14.5M, 1994.
2. Die is facing up for mold. Die is facing down for trim/form, ie. reverse trim/form.
3. Dimensions are exclusive of mold flash and gate burr.
4. The footlength measuring is based on the gauge plane method.
5. All specification comply to Jedec Spec MO193 Issue C.
6. All dimensions are in millimeters.



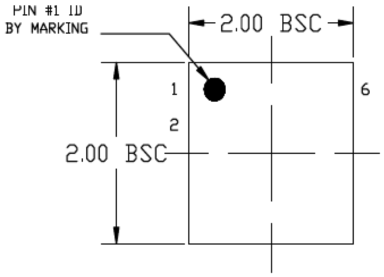
RECOMMENDED LAND PATTERN

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

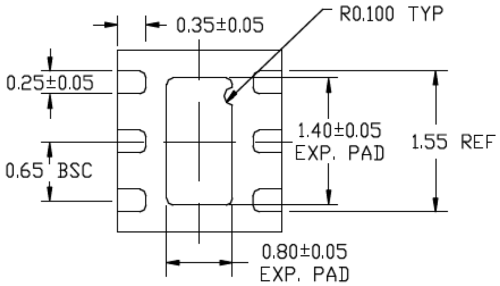
6-Lead DFN 2 mm x 2 mm Package Outline and Recommended Land Pattern

TITLE
6 LEAD DFN 2x2mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

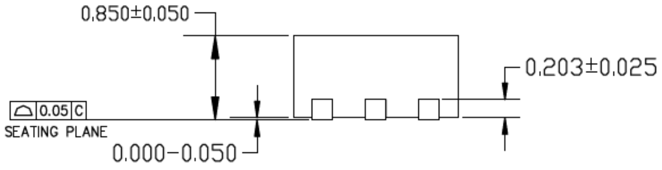
DRAWING # DFN22-6LD-PL-1 **UNIT** MM



TOP VIEW
NOTE: 1, 2, 3



BOTTOM VIEW
NOTE: 1, 2, 3



END VIEW
NOTE: 1, 2, 3

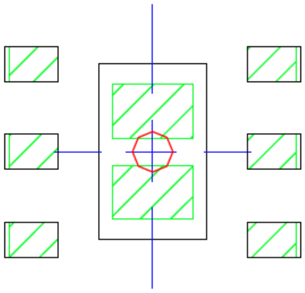
NOTE:
1. MAX PACKAGE WARPAGE IS 0.05 MM
2. MAX ALLOWABLE BURR IS 0.076MM IN ALL DIRECTIONS
3. PIN #1 IS ON TOP WILL BE LASER MARKED
4. RED CIRCLE IN LAND PATTERN INDICATE THERMAL VIA. SIZE SHOULD BE 0.30-0.3M IN DIAMETER AND SHOULD BE CONNECTED TO GND FOR MAX THERMAL PERFORMANCE
5. GREEN RECTANGLES (SHADED AREA) indicate SOLDER STENCIL OPENING ON EXPOSED PAD AREA. SIZE SHOULD BE 0.60x0.40 MM IN SIZE, 0.20 MM SPACING.

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

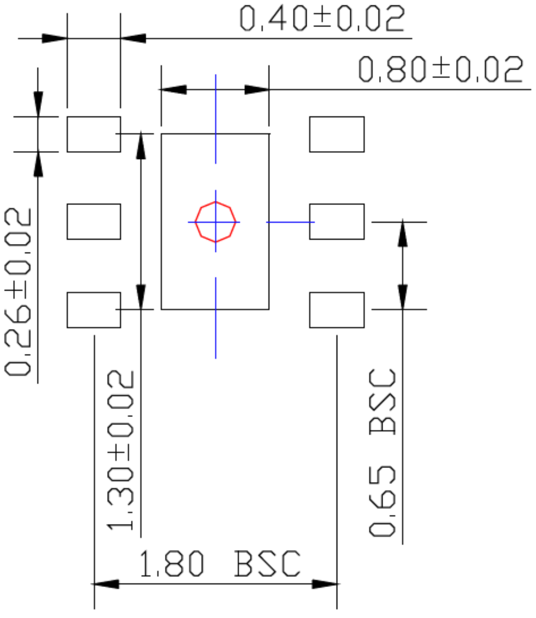
POD-Land Pattern drawing # DFN22-6LD-PL-1

RECOMMENDED LAND PATTERN

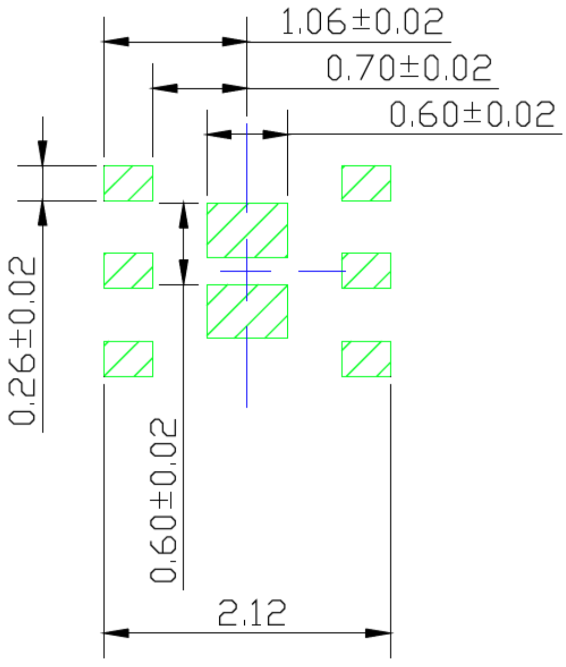
NOTE: 4,5



STACKED-UP



EXPOSED METAL TRACE



SOLDER STENCIL OPENING

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

APPENDIX A: REVISION HISTORY

Revision A (October 2017)

- Converted Micrel document MIC5319 to Microchip data sheet DS20005876A.
- Minor text changes throughout.

Revision B (February 2018)

- Replaced the incorrect DFN 2x2 package drawing with the correct version.

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	–XX
Device	Output Voltage	Junction Temp. Range	Package	Media Type

Device: MIC5319: 500 mA µCap Ultra-Low Dropout High PSRR LDO Regulator

Voltage:
<blank>= Adjustable
1.3H = 1.375V
1.8 = 1.8V
1.85 = 1.85V
2.5 = 2.5V
2.6 = 2.6V
2.7 = 2.7V
2.8 = 2.8V
2.85 = 2.85V (DFN Only)
2.9 = 2.9V (DFN Only)
3.0 = 3.0V
3.3 = 3.3V
5.0 = 5.0V

Junction Temperature Range:
Y = –40°C to +125°C RoHS-Compliant

Package:
D5 = 5-Lead TSOT23
ML = 6-Lead 2 mm x 2 mm DFN

Media Type:
TX = 3,000/Reel (with reversed Pin 1; D5 only)
TR = 3,000/Reel (D5)
TR = 5,000/Reel (ML)

Examples:

a) MIC5319-1.3HYML-TR:	500 mA µCap Ultra-Low Dropout High PSRR LDO Regulator, 1.375V Output Voltage, –40°C to +125°C, 6-Lead DFN, 5,000/Reel
b) MIC5319YD5-TX:	500 mA µCap Ultra-Low Dropout High PSRR LDO Regulator, Adjustable Output Voltage, –40°C to +125°C, 5-Lead TSOT23, 3,000/Reel w/ Reversed Pin 1
c) MIC5319-2.7YML-TR:	500 mA µCap Ultra-Low Dropout High PSRR LDO Regulator, 2.7V Output Voltage, –40°C to +125°C, 6-Lead DFN, 5,000/Reel
d) MIC5319-3.0YD5-TR:	500 mA µCap Ultra-Low Dropout High PSRR LDO Regulator, 3.0V Output Voltage, –40°C to +125°C, 5-Lead TSOT23, 3,000/Reel
e) MIC5319-2.85YML-TR:	500 mA µCap Ultra-Low Dropout High PSRR LDO Regulator, 2.85V Output Voltage, –40°C to +125°C, 6-Lead DFN, 5,000/Reel
f) MIC5319-5.0YD5-TX:	500 mA µCap Ultra-Low Dropout High PSRR LDO Regulator, 5.0V Output Voltage, –40°C to +125°C, 5-Lead TSOT23, 3,000/Reel w/ Reversed Pin 1

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:

Note the following details of the code protection feature on Microchip devices:

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- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

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