MIC5306

150 mA Micropower µCap Baseband LDO

Features

- Input Voltage Range: 2.25V to 5.5V
- Ultra-Low IQ: Only 16 µA Operating Current
- Stable with Ceramic Output Capacitors
- Low Dropout Voltage of 45 mV @ 100 mA
- High Output Accuracy:
  - ±1.0% Initial Accuracy
  - ±2.0% over Temperature
- Thermal Shutdown Protection
- Current Limit Protection

Applications

- Digital Logic Power Supply
- Stand-By Power Supply
- Cellular Phones
- PDAs
- Portable Electronics
- Notebook PCs

General Description

The MIC5306 is a micropower, µCap low dropout regulator designed for optimal performance in a small space. It is capable of sourcing 150 mA of output current and only draws 16 µA of operating current. This high performance LDO offers fast transient response and good PSRR while consuming a minimum of current.

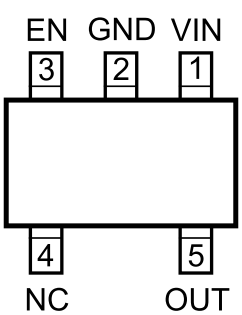
Ideal for battery operated applications; the MIC5306 offers 1% accuracy, extremely low dropout voltage (45 mV @ 100 mA). Equipped with a TTL logic compatible enable pin, the MIC5306 can be put into a zero-off-mode current state, drawing no current when disabled.

The MIC5306 is a µCap design, operating with very small ceramic output capacitors for stability, reducing required board space and component cost.

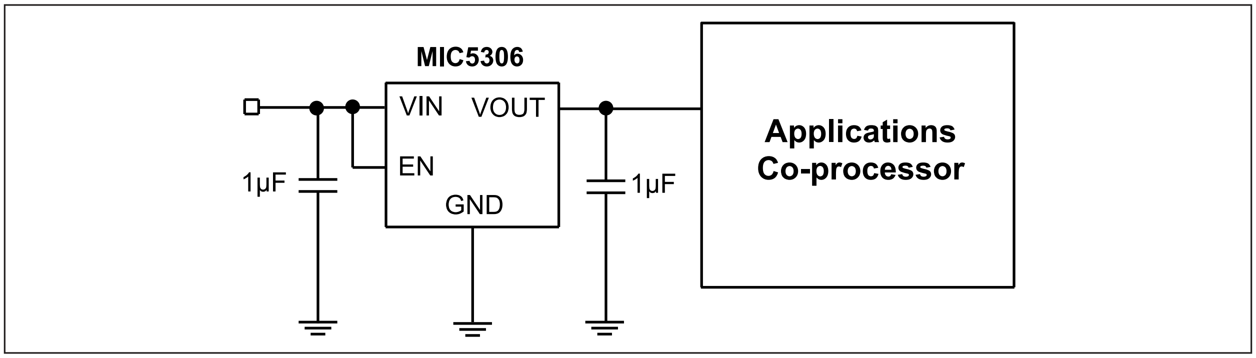
The MIC5306 is available in fixed output voltages in Thin SOT23-5 packaging.

Package Type

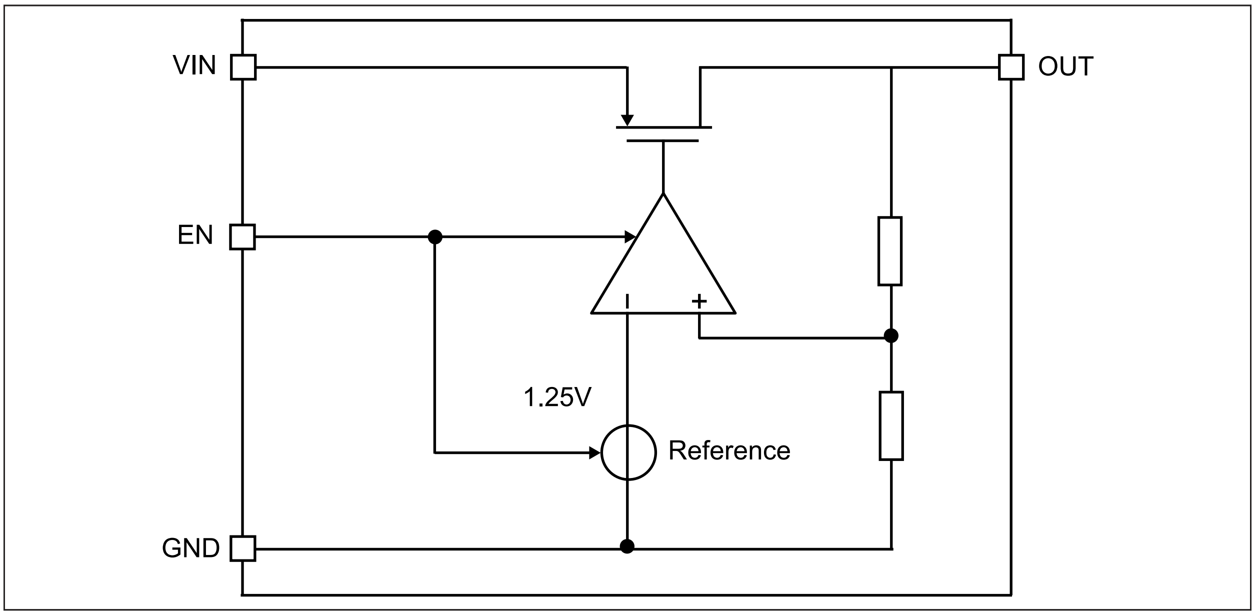
MIC5306
5-Lead Thin SOT-23 (D5)
(Top View)



Typical Application Circuit



Functional Block Diagram



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) .... Internally Limited (Note 1)

Operating Ratings ††

Supply Input Voltage (V_{IN}) .... +2.25V to +5.5V
Enable Input Voltage ($V_{EN1/EN2/LOWQ}$) .... 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 $P_{D(MAX)} = T_{J(MAX)} – T_A/θ_{JA}$. Exceeding the maximum allowable power dissipation will result in excessive die temperature, and the regulator will go into thermal shutdown.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: $V_{IN} = V_{OUT} + 1.0V$; $C_{OUT} = 1.0$ µF, $I_{OUT} = 100$ µA; $T_J = +25°C$, **bold** values indicate –40°C to +125, unless noted.

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Output Voltage Accuracy	V_{OUT}	V_R – 1%	—	V_R + 1%	V	Variation from nominal V_{OUT}
		V_R – 2%	—	**V_R + 2%**		Variation from nominal V_{OUT}; –40°C to +125°C
Line Regulation	$ΔV_{OUT}/(V_{OUT} \times ΔV_{IN})$	—	0.01	0.3	%/V	$V_{IN} = V_{OUT}$ + 1V to 5.5V
		—	—	**0.5**		—
Load Regulation	$ΔV_{OUT}/V_{OUT}$	—	0.5	1.0	%	I_{OUT} = 100 µA to 150 mA
		—	—	**1.5**		
Dropout Voltage, Note 1	V_{DO}	—	25	—	mV	I_{OUT} = 50 mA
		—	45	—		I_{OUT} = 100 mA
		—	65	**200**		I_{OUT} = 150 mA
Ground Pin Current	I_{GND}	—	16	**30**	µA	I_{OUT} = 0 mA to 150 mA; V_{IN} = 5.5V
Ground Pin Current in Shutdown	I_{SHDN}	—	0.01	**1**	µA	V_{EN} ≤ 0.2V; V_{IN} = 5.5V
Ripple Rejection	PSRR	—	62	—	dB	f = 10 Hz to 1 kHz; C_{OUT} = 1 µF; I_{OUT} = 150 mA
		—	35	—		f = 20 kHz; C_{OUT} = 1 µF; I_{OUT} = 150 mA
Current Limit	I_{LIM}	175	285	500	mA	V_{OUT} = 0V

Note 1: 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. For outputs below 2.25V, dropout voltage is the input-to-output differential with the minimum input voltage 2.25V.

2: Turn-on time is measured from V_{EN} = 1V of the positive edge of the enable signal to 90% of the rising edge of the output voltage of the regulator.

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: $V_{IN} = V_{OUT} + 1.0V$; $C_{OUT} = 1.0$ µF, $I_{OUT} = 100$ µA; $T_J = +25°C$, **bold** values indicate –40°C to +125, unless noted.

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Thermal Shutdown	T_{SD}	—	150	—	°C	—
Thermal Shutdown Hysteresis	ΔT_{SD}	—	15	—	°C	—
Output Voltage Noise	e_N	—	91	—	$µV_{RMS}$	$C_{OUT} = 1$ µF; 10 Hz to 100 kHz
Enable Input						
Enable Input Voltage	V_{EN}	—	—	**0.2**	V	Logic low
		1	—	—		Logic high
Enable Input Current	I_{EN}	—	0.01	**1**	µA	$V_{IL} \leq 0.2V$
		—	0.01	**1**		$V_{IH} \geq 1.0V$
Turn-On Time, Note 2	t_{ON}	—	250	**500**	µs	$C_{OUT} = 1$ µF

Note 1: 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. For outputs below 2.25V, dropout voltage is the input-to-output differential with the minimum input voltage 2.25V.

2: Turn-on time is measured from $V_{EN} = 1V$ of the positive edge of the enable signal to 90% of the rising edge of the output voltage of the regulator.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Temperature Range	T_J	–40	—	+125	°C	—
Storage Temperature Range	T_S	–65	—	+150	°C	—
Lead Temperature	—	—	+260	—	°C	Soldering, 5 sec.
Package Thermal Resistance						
Thermal Resistance, TSOT-23 5-Ld	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.

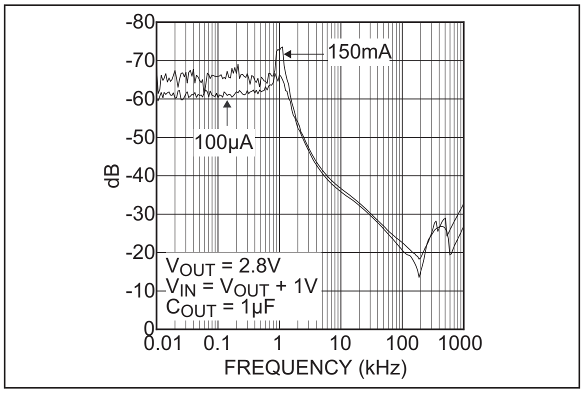


FIGURE 2-1: *Ripple Rejection.*

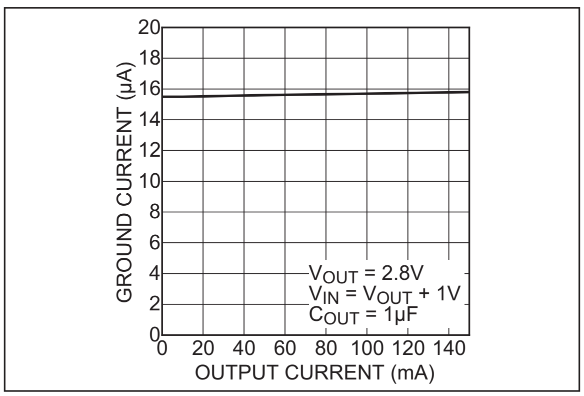


FIGURE 2-2: *Ground Pin Current vs. Output Current.*

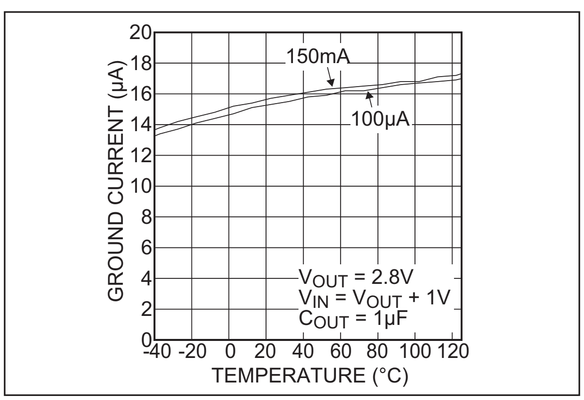


FIGURE 2-3: *Ground Pin Current vs. Temperature.*

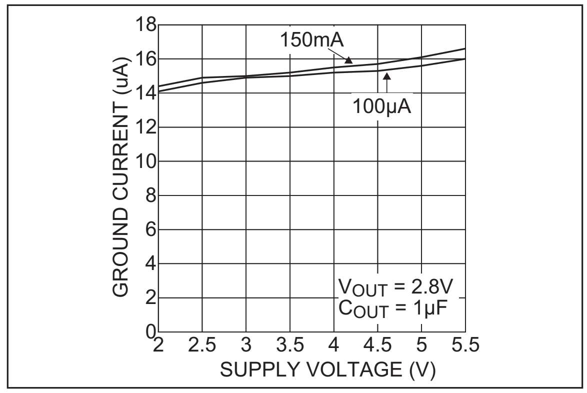


FIGURE 2-4: *Ground Pin Current vs. Supply Voltage.*

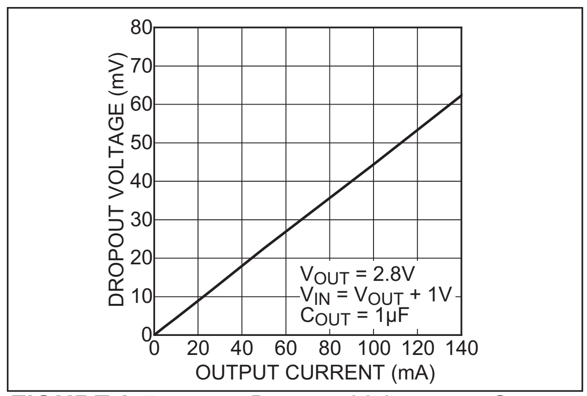


FIGURE 2-5: *Dropout Voltage vs. Output Current.*

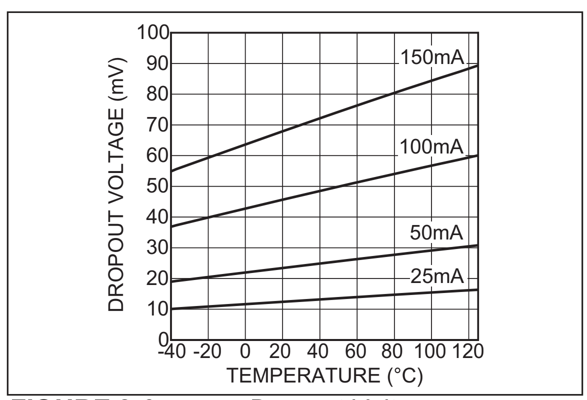


FIGURE 2-6: *Dropout Voltage vs. Temperature.*

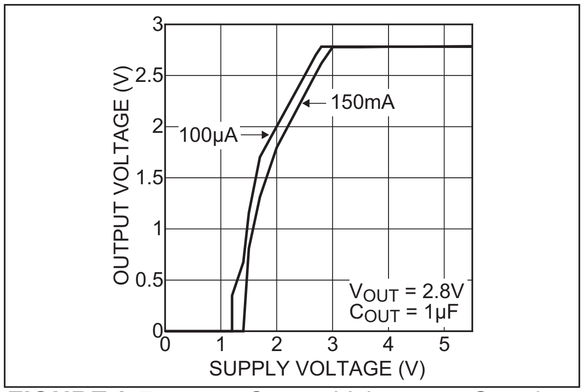


FIGURE 2-7: *Output Voltage vs. Supply Voltage.*

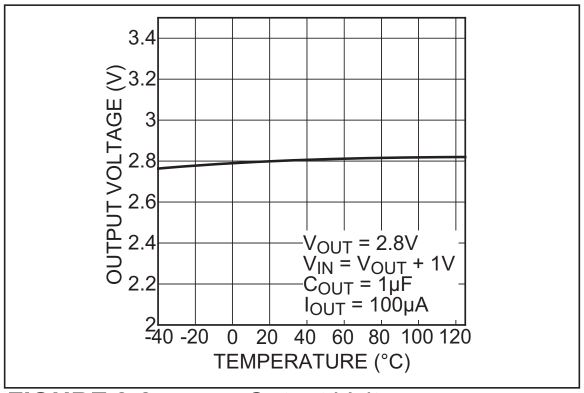


FIGURE 2-8: *Output Voltage vs. Temperature.*

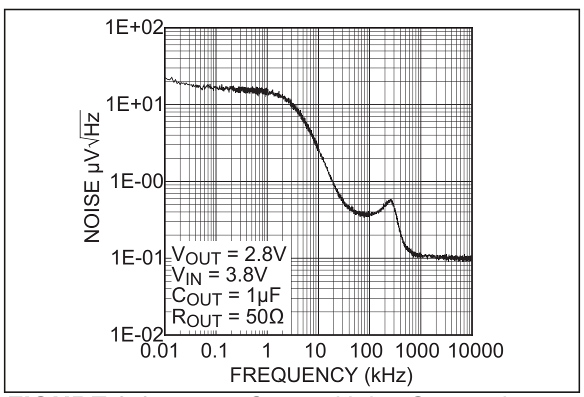


FIGURE 2-9: *Output Noise Spectral Density.*

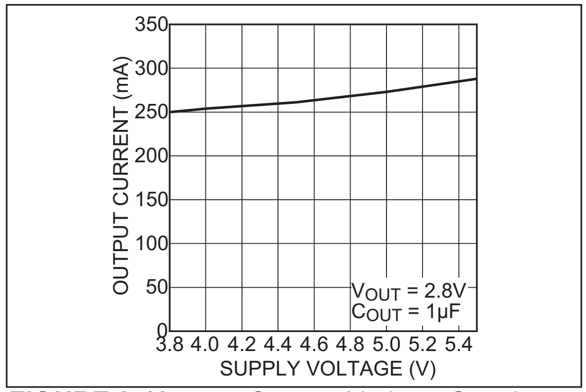


FIGURE 2-10: *Current Limit vs. Supply Voltage.*

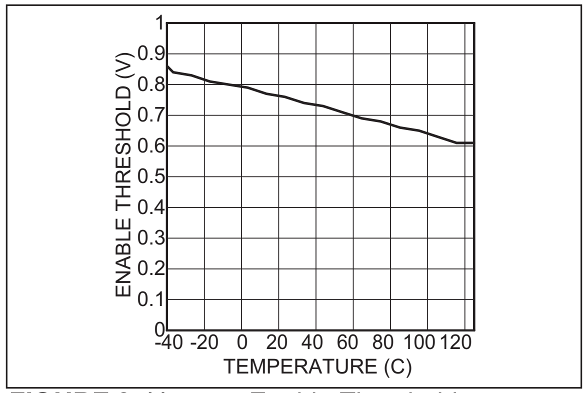


FIGURE 2-11: *Enable Threshold vs. Temperature.*

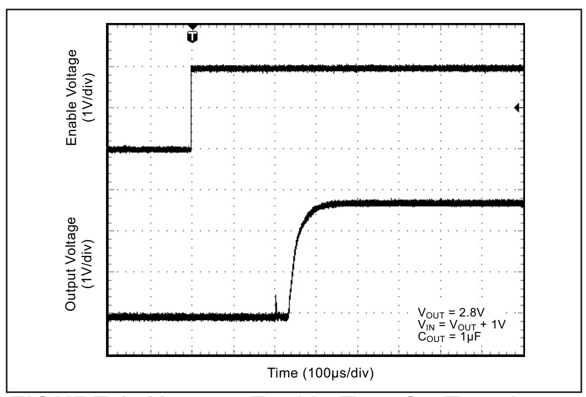


FIGURE 2-12: *Enable Turn-On Transient.*

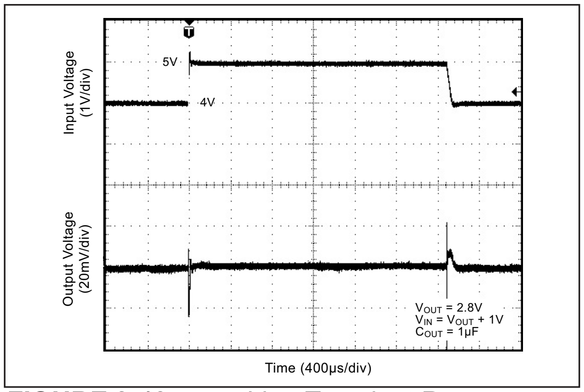


FIGURE 2-13: *Line Transient Response.*

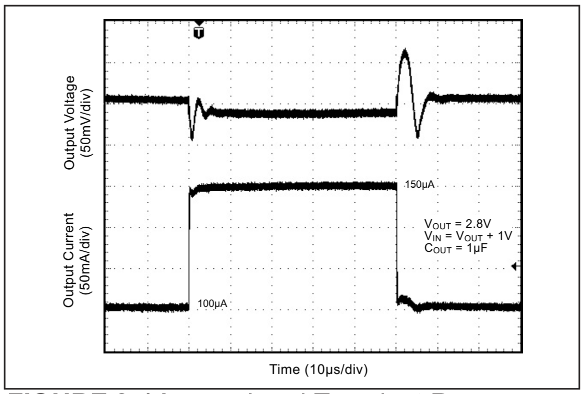


FIGURE 2-14: *Load Transient Response.*

3.0 PIN DESCRIPTIONS

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

TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	VIN	Supply input.
2	GND	Ground.
3	EN	Enable Input. Active High. High = on, low = off. Do not leave floating.
4	NC	No connect.
5	OUT	Output voltage.

4.0 APPLICATION INFORMATION

4.1 Input Capacitance

A 1 µF capacitor should be placed from VIN to GND if there are more than 10 inches of wire between the input and the AC filter capacitor or if a battery is used as the input.

4.2 Output Capacitance

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

The output capacitor should have below ESR 300 mΩ and a resonant frequency above 1 MHz. Ultra-low ESR capacitors can cause a low amplitude oscillation on the output and/or underdamped transient response. Most tantalum or aluminum electrolytic capacitors are adequate; film types will work, but are more expensive. Because many aluminum electrolytics have electrolytes that freeze at about –30°C, solid tantalums are recommended for operation below –25°C.

4.3 Enable

Forcing EN (enable/shutdown) high (>1V) enables the regulator. EN is compatible with CMOS logic gates. If the enable/shutdown feature is not required, connect EN (pin 3) to VIN (supply input, pin 1).

4.4 Current Limit

There is overcurrent protection circuitry built into the MIC5306. Even with the output grounded, current will be limited to approximately 285 mA. Further protection is provided by thermal shutdown.

4.5 Thermal Considerations

The MIC5306 is designed to provide 150 mA of continuous current in a very small package. Maximum ambient operating temperature can be calculated based on the output current and the voltage drop across the part. Given that the input voltage is 3.8V, the output voltage is 2.8V and the output current equals 150 mA.

The actual power dissipation of the regulator circuit can be determined using the equation:

EQUATION 4-1:

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

Because this device is CMOS and the ground current is typically <50 µA over the load range, the power dissipation contributed by the ground current is < 1% and can be ignored for this calculation.

EQUATION 4-2:

$$P_D = (3.8V - 2.8V) \times 150mA = 0.15W$$

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 4-3:

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

Where:

$T_{J(MAX)}$ = 125°C, the maximum junction temperature of the die.

θ_{JA} = The thermal resistance, 235°C/W

Table 4-1 shows junction-to-ambient thermal resistance for the MIC5306 in the TSOT23-5 package.

TABLE 4-1: TSOT23-5 THERMAL RESISTANCE

θ_{JA} Recommended Minimum Footprint	θ_{JC}
235°C/W	2°C/W

Substituting P_D for $P_{D(MAX)}$ and solving for the ambient operating temperature will give the maximum operating conditions for the regulator circuit. The junction-to-ambient thermal resistance for the minimum footprint is 235°C/W, from Table 4-1. The maximum power dissipation must not be exceeded for proper operation.

For example, when operating the MIC5306-2.8 at an input voltage of 3.8V and 150 mA load with a minimum footprint layout, the maximum ambient operating temperature T_A can be determined as follows:

EQUATION 4-4:

$$0.15W = (125°C - T)/(235°C/W)$$

$$T = 89.75°C$$

Therefore, a 2.8V application at 150 mA of output current can accept an ambient operating temperature of 89.8°C in a TSOT23-5 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-Lead TSOT23* (Front)	Example
XXXX	N918

5-Lead TSOT23* (Back)	Example
NNN	710

TABLE 5-1: MARKING CODES

Part Number	Marking Code	Output Voltage
MIC5306-1.5YD5	N915	1.5V
MIC5306-1.8YD5	N918	1.8V
MIC5306-2.5YD5	N925	2.5V
MIC5306-2.6YD5	N926	2.6V
MIC5306-2.8YD5	N928	2.8V
MIC5306-3.0YD5	N930	3.0V
MIC5306-3.1YD5	N931	3.1V

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).

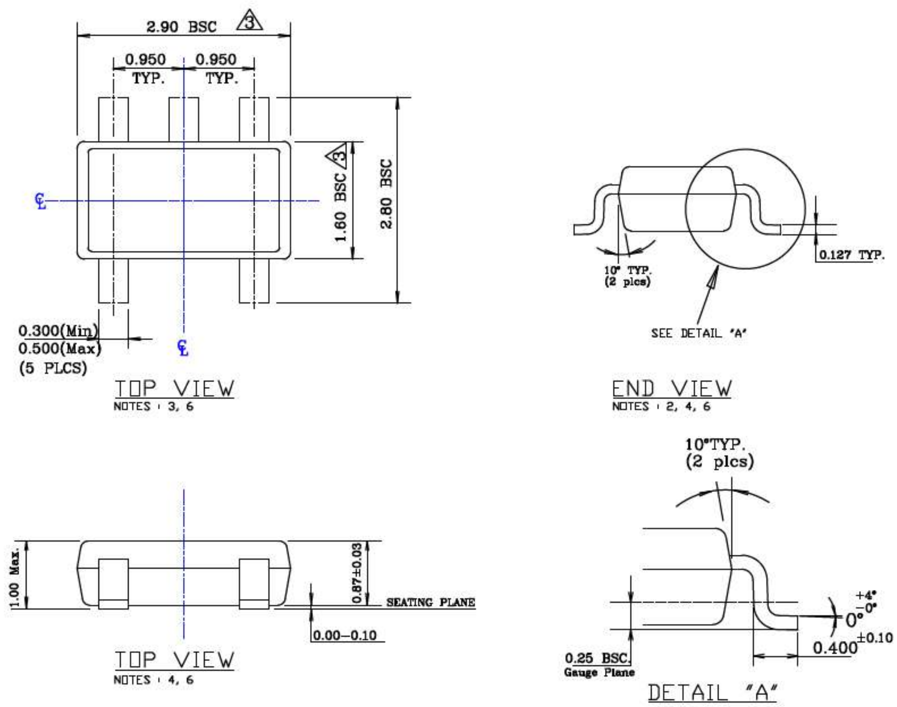
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

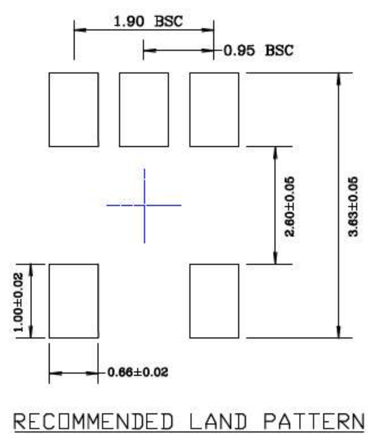
Underbar (_) and/or Overbar (‾) symbol may not be to scale.

5-Lead TSOT-23 Package Outline and Recommended Land Pattern

TITLE
5 LEAD TSOT PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

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





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.

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 (February 2020)

- Converted Micrel document MIC5306 to Microchip data sheet template DS20006304A.
- Minor grammatical 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.

Device	-X.X	X	XX	-XX
Part No.	Output Voltage	Junction Temp. Range	Package	Media Type

Device:	MIC5306:	150 mA Micropower µCap Baseband LDO
Output Voltage:	1.5 =	1.5V
	1.8 =	1.8V (TR or TX Media Type option available)
	2.5 =	2.5V (TR or TX Media Type option available)
	2.6 =	2.6V
	2.8 =	2.8V
	3.0 =	3.0V (TR or TX Media Type option available)
	3.1 =	3.1V
Junction Temperature Range:	Y =	–40°C to +125°C, RoHS-Compliant
Package:	D5 =	5-Lead TSOT23
Media Type:	TR =	3,000/Reel
	TX =	3,000/Reel (Reverse Tape & Reel)

Examples:

a) MIC5306-1.5YD5-TR: MIC5306, 1.5V Output Voltage, –40°C to +125°C Temperature Range, 5-Lead TSOT23, 3,000/Reel

b) MIC5306-1.8YD5-TX: MIC5306, 1.8V Output Voltage, –40°C to +125°C Temperature Range, 5-Lead TSOT23, 3,000/Reel (Reverse TR)

c) MIC5306-2.5YD5-TR: MIC5306, 2.5V Output Voltage, –40°C to +125°C Temperature Range, 5-Lead TSOT23, 3,000/Reel

d) MIC5306-2.8YD5-TR: MIC5306, 2.8V Output Voltage, –40°C to +125°C Temperature Range, 5-Lead TSOT23, 3,000/Reel

e) MIC5306-3.0YD5-TR: MIC5306, 3.0V Output Voltage, –40°C to +125°C Temperature Range, 5-Lead TSOT23, 3,000/Reel

f) MIC5306-3.1YD5-TR: MIC5306, 3.1V Output Voltage, –40°C to +125°C Temperature Range, 5-Lead TSOT23, 3,000/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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