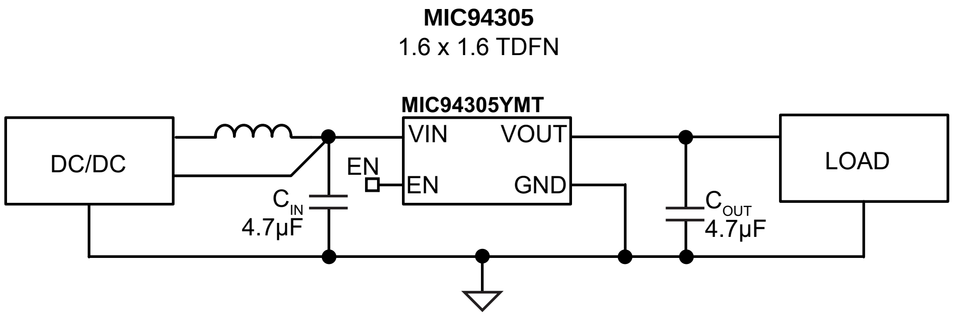
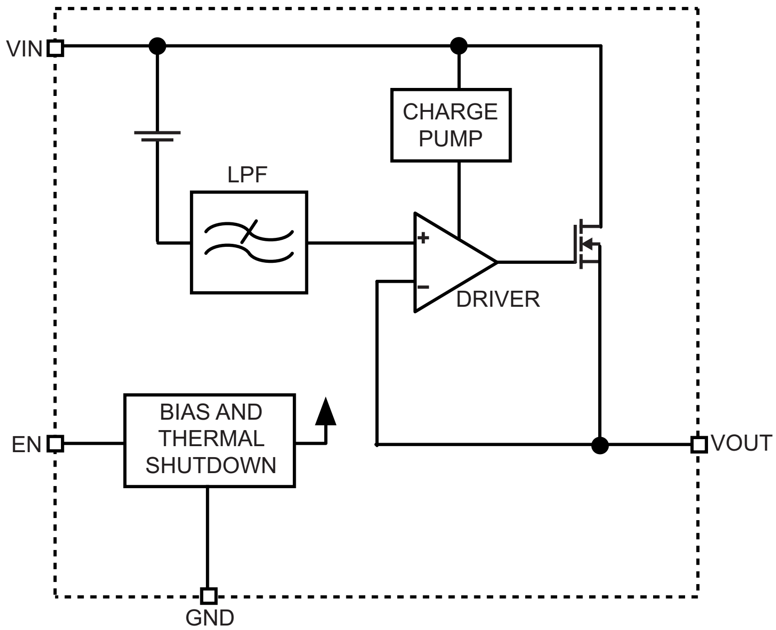
Typical Application Circuit



Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Voltage (V_{IN}) .... –0.3V to +4.0V
Output Voltage (V_{OUT}) .... –0.3V to +4.0V
Enable Voltage (V_{EN}) .... –0.3V to V_{IN}+0.3V or +4.0V
ESD Rating (Note 1) .... +3 kV

Operating Ratings ††

Input Voltage (V_{IN}) .... +1.8V to +3.6V
Enable 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 are recommended. Human body model, 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: V_{IN} = V_{EN} = 3.6V; I_{OUT} = 1 mA; C_{OUT} = 4.7 µF; T_A = +25°C, **bold** values indicate –40°C ≤ T_J ≤ +125°C, unless noted. Note 1

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
Input Voltage	V_{IN}	**1.8**	—	**3.6**	V	—
Voltage Drop	V_{DROP}	—	170	**250**	mV	V_{IN} – V_{OUT}, –40°C ≤ T_J ≤ +85°C
V_{IN} Ripple Rejection	PSRR	—	45	—	dB	f = 20 kHz, I_{OUT} = 500 mA
		—	55	—		f = 100 kHz to 5 MHz, I_{OUT} = 500 mA
Total Output Noise	e_N	—	98	—	$µV_{RMS}$	f = 10 Hz to 100 kHz
Current Limit	I_{LIM}	**530**	725	**1100**	mA	V_{OUT} = 0V
Turn-On Time	t_{ON}	—	90	**150**	µs	EN controlled
Load Regulation	—	—	10	—	mV	100 µA to 100 mA
Ground Current	I_{GND}	—	150	200	µA	I_{OUT} = 100 µA
Shutdown Current	I_{SHDN}	—	0.2	5	µA	V_{EN} = 0V
Enable						
Input Logic Low	—	—	—	**0.4**	V	—
Input Logic High	—	**1.0**	—	—	V	—
Input Current	I_{IN}	—	0.01	1	µA	—

Note 1: Specification for packaged product only.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Operating Temperature	T_J	–40	—	+125	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 10 sec.
Storage Temperature Range	T_S	–65	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance, TDFN 6-Ld	θ_{JA}	—	92	—	°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.

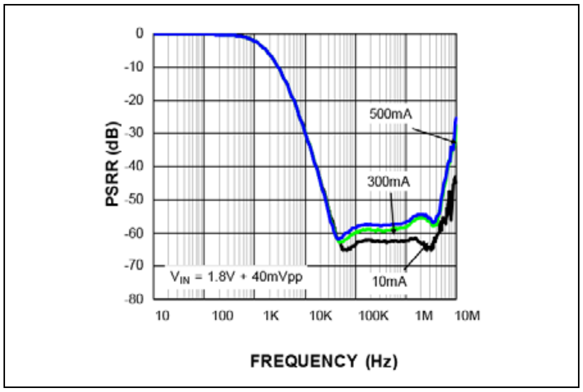


FIGURE 2-1: *PSRR C_{OUT} = 4.7 µF.*

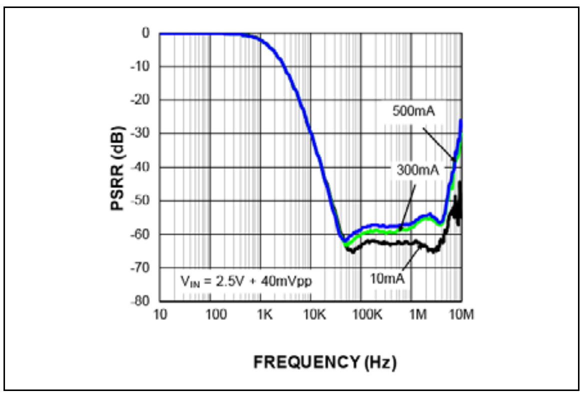


FIGURE 2-2: *PSRR C_{OUT} = 4.7 µF.*

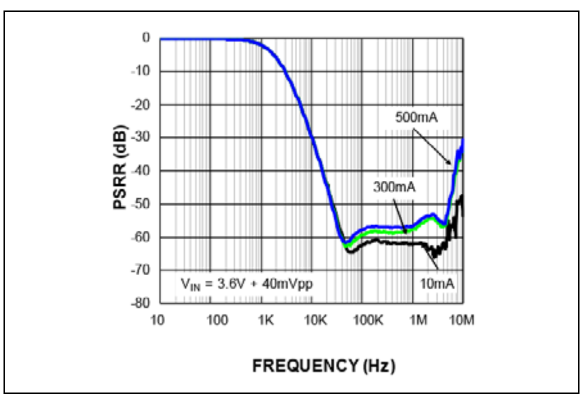


FIGURE 2-3: *PSRR C_{OUT} = 4.7 µF.*

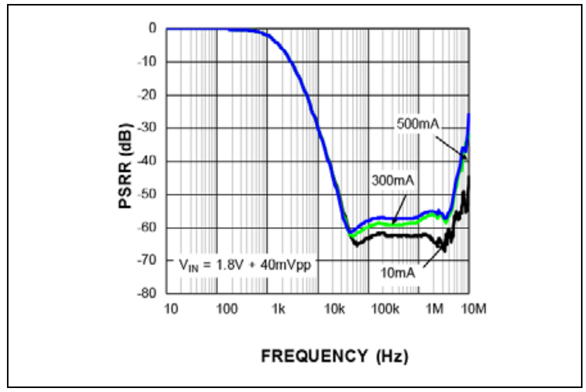


FIGURE 2-4: *PSRR C_{OUT} = 10 µF.*

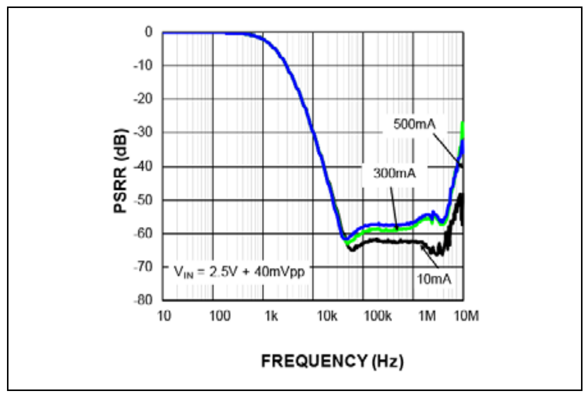


FIGURE 2-5: *PSRR C_{OUT} = 10 µF.*

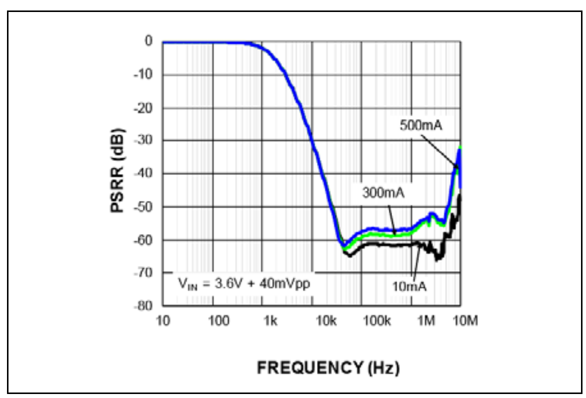


FIGURE 2-6: *PSRR C_{OUT} = 10 µF.*

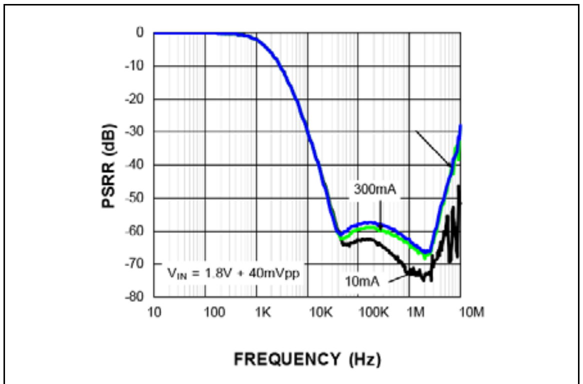


FIGURE 2-7: PSRR C_{OUT} = 22 µF.

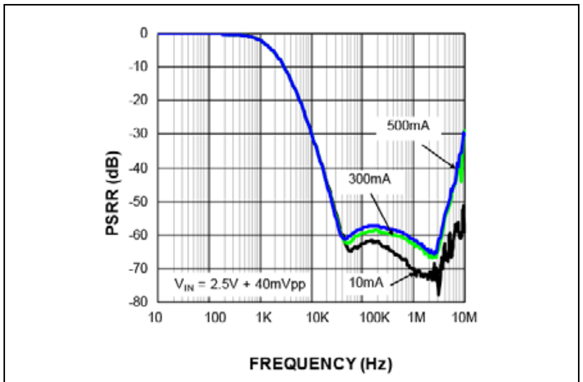


FIGURE 2-8: PSRR C_{OUT} = 22 µF.

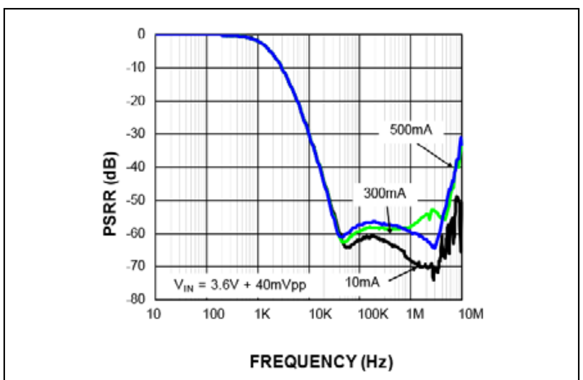


FIGURE 2-9: PSRR C_{OUT} = 22 µF.

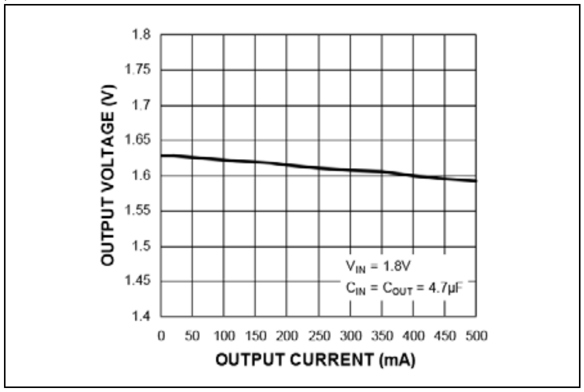


FIGURE 2-10: Output Voltage vs. Output Current.

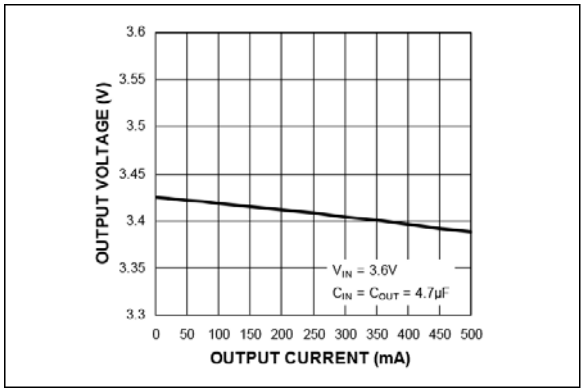


FIGURE 2-11: Output Voltage vs. Output Current.

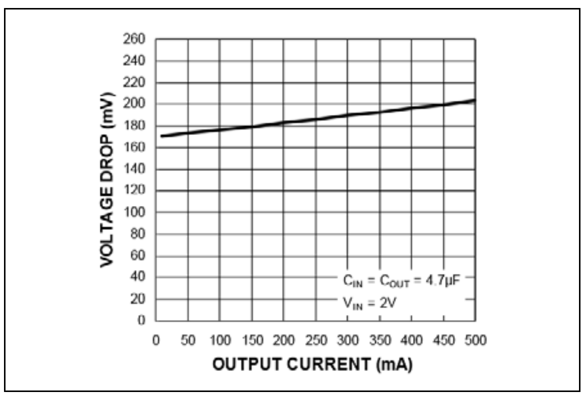


FIGURE 2-12: Voltage Drop vs. Output Current.

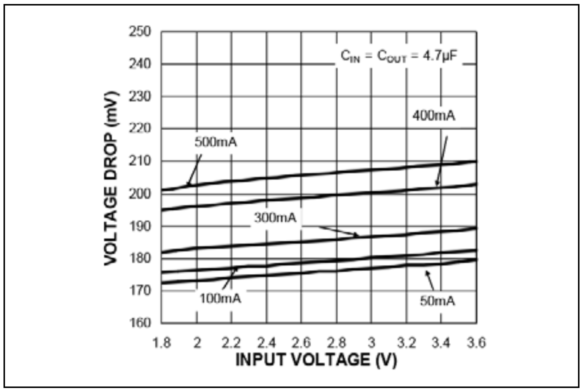


FIGURE 2-13: *Voltage Drop vs. Input Current.*

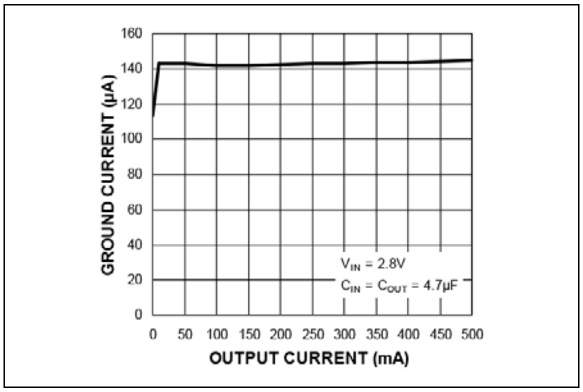


FIGURE 2-14: *Ground Current vs. Output Current.*

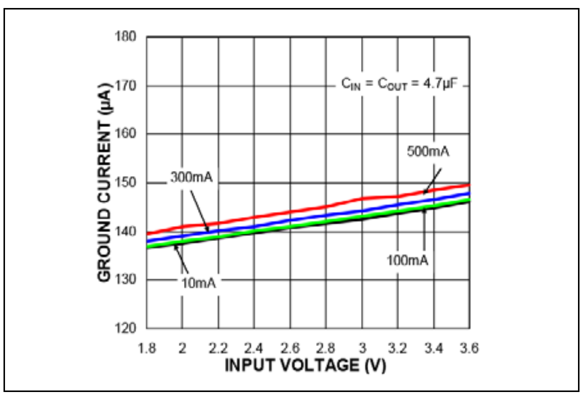


FIGURE 2-15: *Ground Current vs. Input Voltage.*

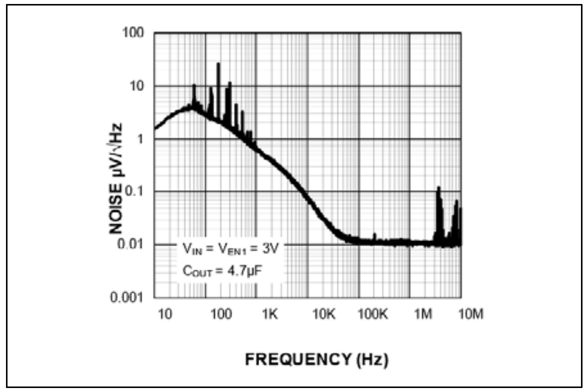


FIGURE 2-16: *Output Noise Spectral Density.*

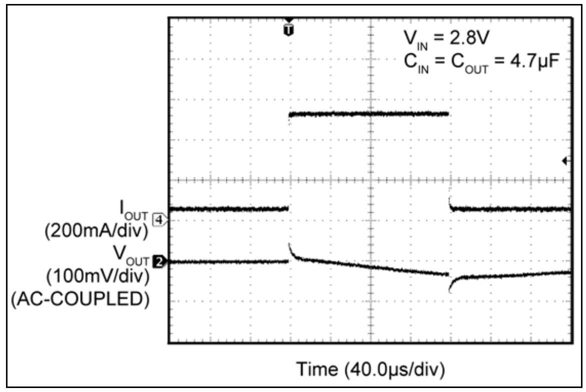


FIGURE 2-17: *Load Transient.*

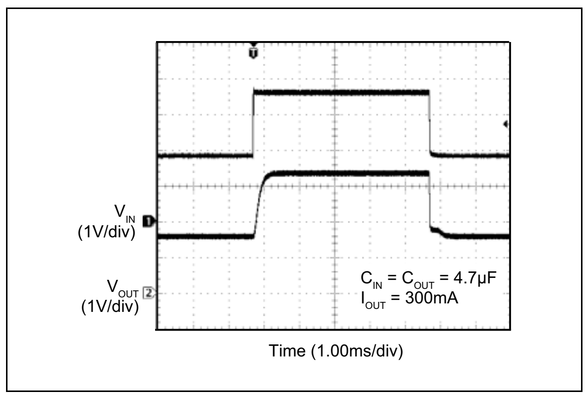


FIGURE 2-18: *Line Transient.*

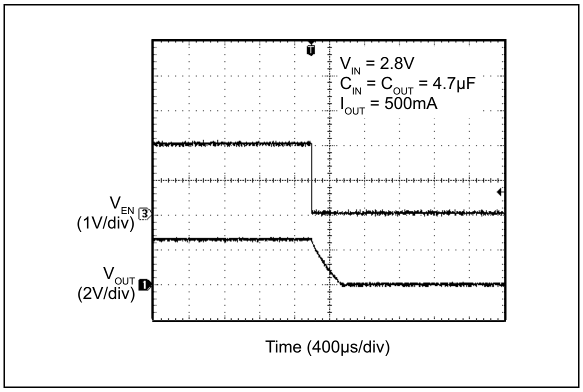


FIGURE 2-19: *Enable Turn-Off.*

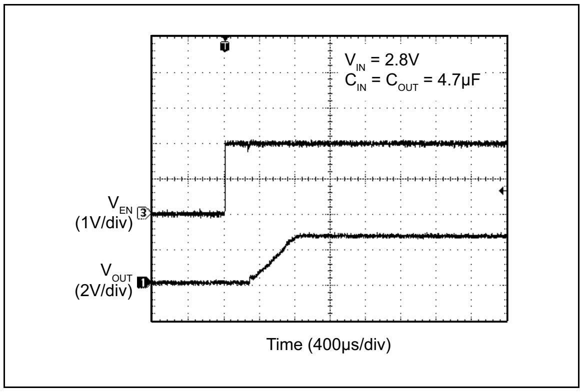


FIGURE 2-20: *Enable Turn-On.*

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, 2	VOUT	Power switch output.
3	GND	Ground.
4	EN	Enable Input. A logic-high signal on this pin enables the part. Logic-low disables the part. Do not leave floating.
5, 6	VIN	Power switch input and chip supply.
ePad	EP	Exposed heatsink pad. Connect to Ground for best thermal performance.

4.0 APPLICATION INFORMATION

The MIC94305 uses Ripple Blocker technology to integrate a load switch with a high-performance active filter. The MIC94305 includes a low voltage logic enable pin and is fully protected from damage caused by fault conditions, offering linear current-limiting and thermal shutdown.

4.1 Input Capacitor

The MIC94305 is a high-performance, high-bandwidth device. An input capacitor of 0.47 µF 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 practice in any RF-based circuit. X5R or X7R dielectrics are recommended for the input capacitor. Y5V dielectrics lose most of their capacitance over temperature and are not recommended.

4.2 Output Capacitance

The MIC94305 requires an output capacitor of 4.7 µF or greater to maintain stability. For optimal ripple rejection performance, a 4.7 µF capacitor is recommended. The design is optimized for use with low-ESR ceramic-chip capacitors. High-ESR capacitors are not recommended because they may cause high-frequency oscillation. The output capacitor can be increased, but performance has been optimized for a 4.7 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. If you use a ceramic-chip capacitor with a 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.

4.3 No-Load Stability

The MIC94305 will remain stable with no load. This is especially important in CMOS RAM keep-alive applications.

4.4 Enable/Shutdown

The MIC94305 comes with an active-high enable pin that allows the Ripple Blocker to be disabled. Forcing the enable pin low disables the MIC94305 and sends it into a “zero” off mode current state. In this state, current consumed by the MIC94305 goes to nearly zero. Forcing the enable pin high enables the output voltage. The active-high enable pin uses CMOS technology and cannot be left floating; a floating enable pin may cause an indeterminate state on the output.

4.5 Thermal Considerations

The MIC94305 is designed to provide 500 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, which is fixed at 170 mV typical, 250 mV worst case. For example if the input voltage is 2.75V, the output voltage is 2.5V, and the output current equals 500 mA. The actual power dissipation of the Ripple Blocker™ can be determined using Equation 4-1:

EQUATION 4-1:

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

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 the calculation shown in Equation 4-2.

EQUATION 4-2:

$$P_D = (2.75V - 2.5V) \times 500\ \text{mA}$$

$$P_D = 0.125W$$

To determine the maximum ambient operating temperature of the package, use the junction-to-ambient thermal resistance of the device and the Equation 4-3:

EQUATION 4-3:

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

Where:

$T_{J(MAX)}$ = +125°C; the max. junction temp. of the die.

θ_{JA} = 92°C/W for the 6-lead TDFN.

Substituting P_D for $P_{D(MAX)}$ and solving for the ambient operating temperature will give the maximum operating conditions for the regulator circuit.

For proper operation, the maximum power dissipation must not be exceeded.

For example, when operating the MIC94305YMT at a 2.75V input voltage and 500 mA load with a minimum footprint layout, the maximum ambient operating temperature T_A can be determined as follows:

EQUATION 4-4:

$$0.125W = (125°C - T_A)/(92°C/W)$$

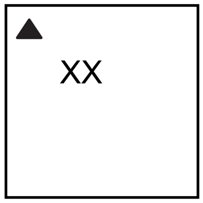
$$T_A = 113.5°C$$

It follows from this equation that the maximum ambient operating temperature of 113.5°C is allowed in a 1.6 mm x 1.6 mm TDFN 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.

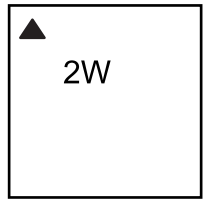
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

6-Lead TDFN*



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
	(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).

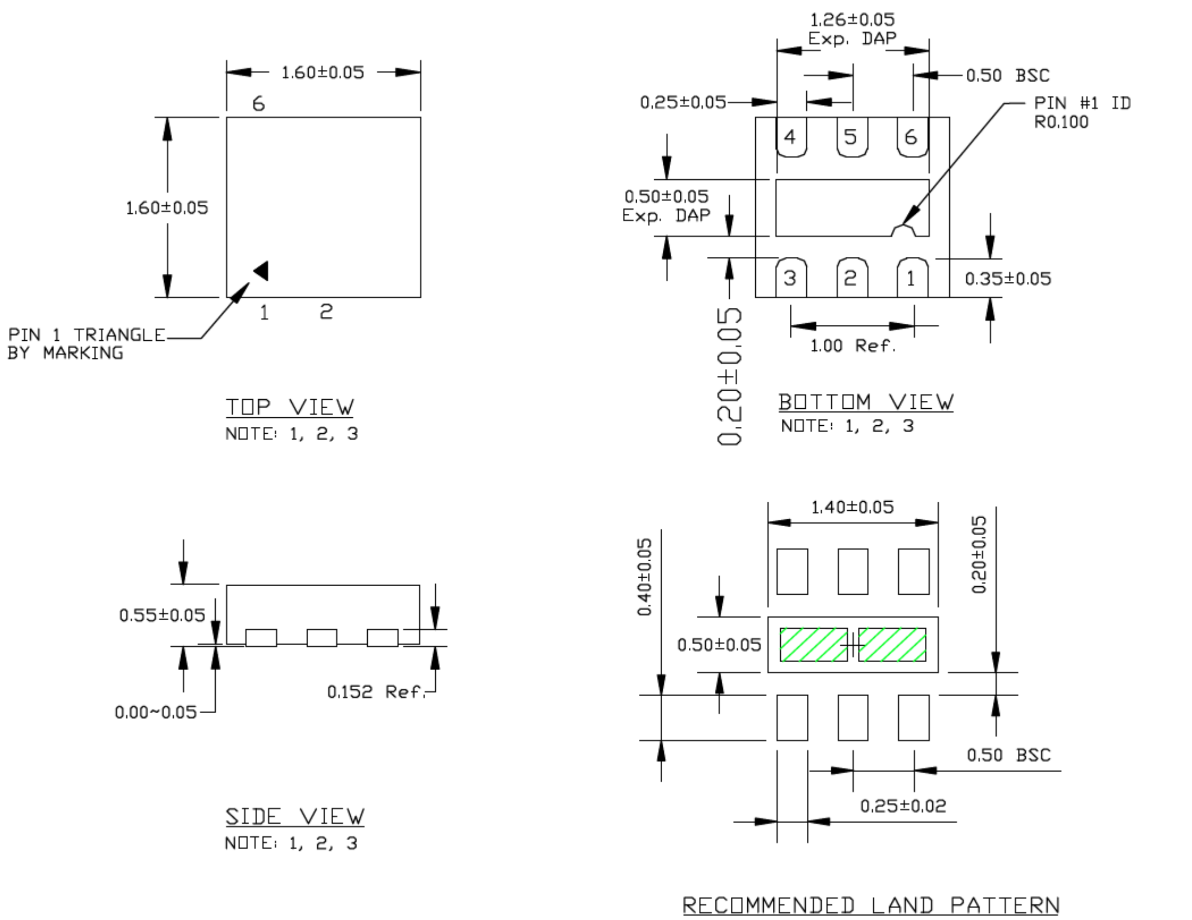
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

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

6-Lead 1.6 mm × 1.6 mm Thin DFN Package Outline & Recommended Land Pattern

TITLE
6 LEAD TDFN 1.6x1.6mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	TDFN1616-6LD-PL-1	UNIT	MM



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. GREEN SHADED AREA REPRESENT SOLDER STENCIL OPENING (OPTIONAL) FOR IMPROVED THERMAL PERFORMANCE. SIZE: 0.55x0.30MM

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 A (May 2018)

- Converted Micrel document MIC94305 to Microchip data sheet template DS20006029A.
- Minor grammatical text changes throughout.
- Added soldering conditions to Lead Temperature value in Temperature Specifications.
- Added voltage drop information to **Section 4.5 "Thermal Considerations"**.

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	XX	-XX
Part No.	Junction Temp. Range	Package	Media Type

Device:	MIC94305:		500 mA Switch with Ripple Blocker Technology
Junction Temperature Range:	Y	=	–40°C to +125°C, RoHS-Compliant
Package:	MT	=	6-Lead 1.6 mm x 1.6 mm TDFN
Media Type:	T5 TR	= =	500/Reel 5,000/Reel

Examples:

a) MIC94305YMT-T5: MIC94305, –40°C to +125°C Temperature Range, 6-Lead TDFN, 500/Reel

b) MIC94305YMT-TR: MIC94305, –40°C to +125°C Temperature Range, 6-Lead TDFN, 5,000/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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- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
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