

200 mA Switch with Ripple Blocker™ Technology

Features

- 1.8V to 3.6V Input Voltage Range
- Active Noise Rejection over a Wide Frequency Band
 - >60 dB from 40 kHz to 5 MHz
- Rated to 200 mA Output Current
- Current-Limit and Thermal-Limit Protected
- 1.2 mm x 1.6 mm, 4-lead UDFN
- Logic-Controlled Enable Pin
- -40°C to +125°C Junction Temperature Range

Applications

- Smart Phones
- Tablet PC/Notebooks and Webcams
- Digital Still and Video Cameras
- Video Conferencing
- Barcode Scanners
- Global Positioning Systems
- Automotive and Industrial Applications

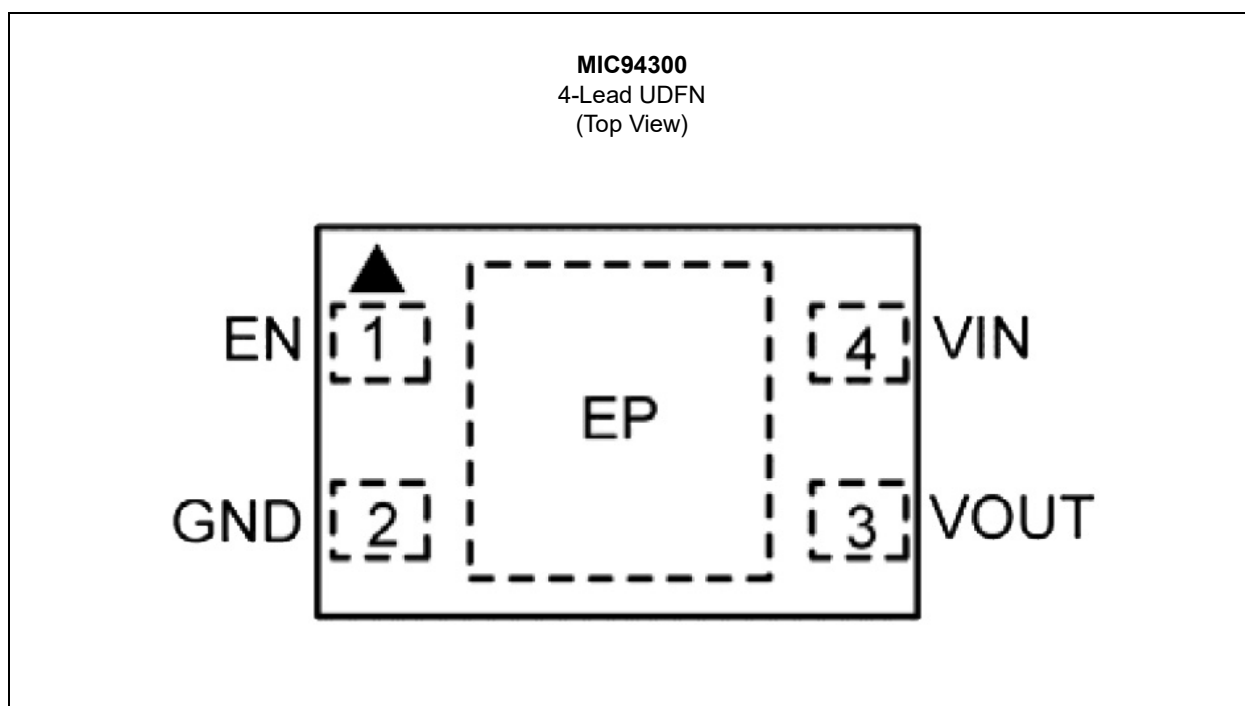
General Description

The MIC94300 is an integrated load switch that incorporates Microchip's Ripple Blocker™ active filter technology. The MIC94300 provides high-frequency ripple attenuation (switching noise rejection) for applications where a switching noise cannot be tolerated by sensitive downstream circuits such as in RF applications. A low-voltage logic enable pin disconnects the pass element and places the MIC94300 into a low current-shutdown state when disabled.

The MIC94300 operates from an input voltage of 1.8V to 3.6V, allowing true load switching of low-voltage power rails in any electronic device. The output voltage (V_{OUT}) is set at a fixed drop (typically 170 mV) from the input voltage ($V_{OUT} = V_{IN} - 170 \text{ mV}$). This maintains high efficiency independent of given load conditions and currents.

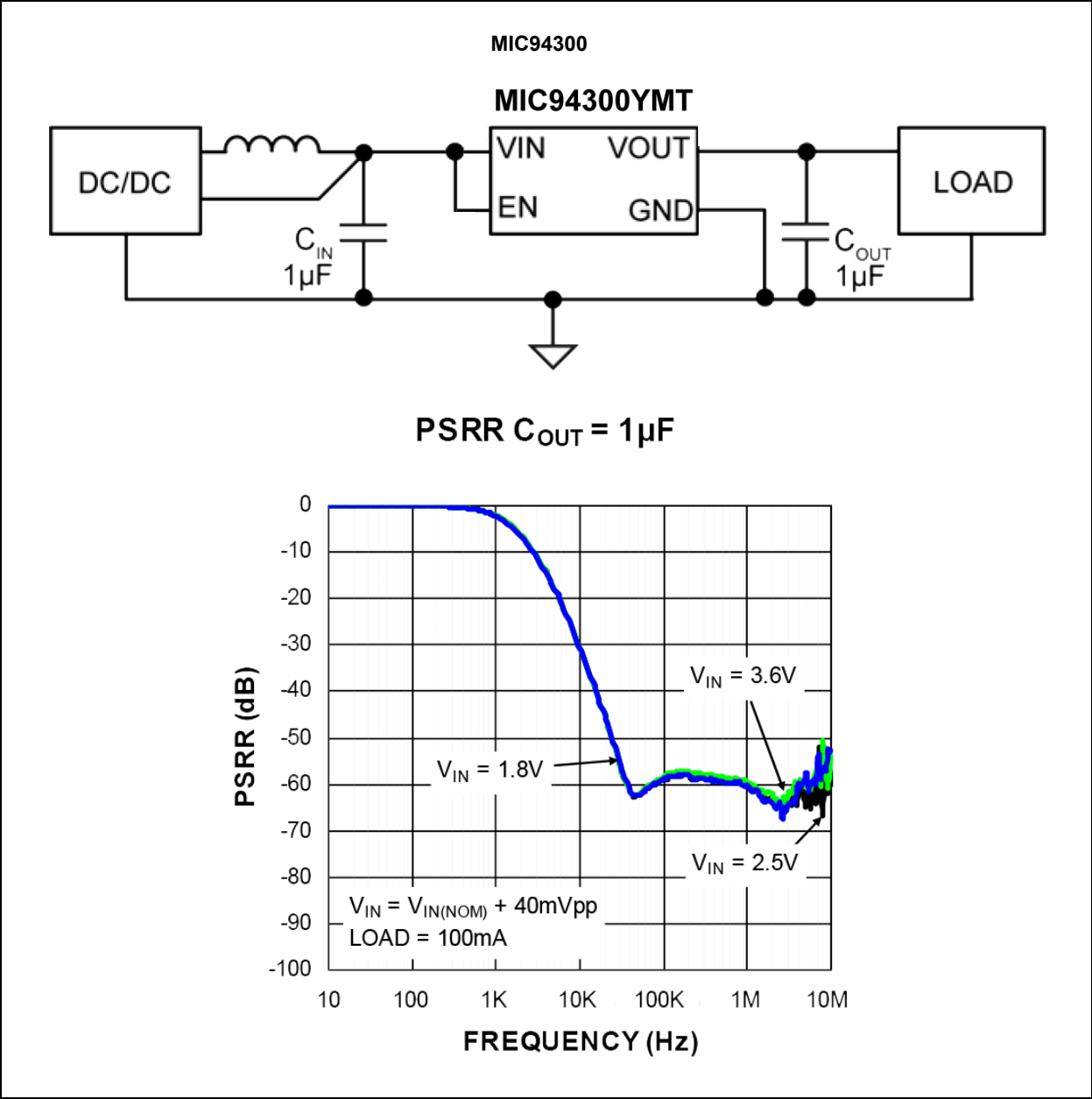
Packaged in a 4-lead 1.2 mm x 1.6 mm ultra-thin dual flatpack no-leads (UDFN) package, the MIC94300 has a junction operating temperature range of -40°C to +125°C.

Package Types

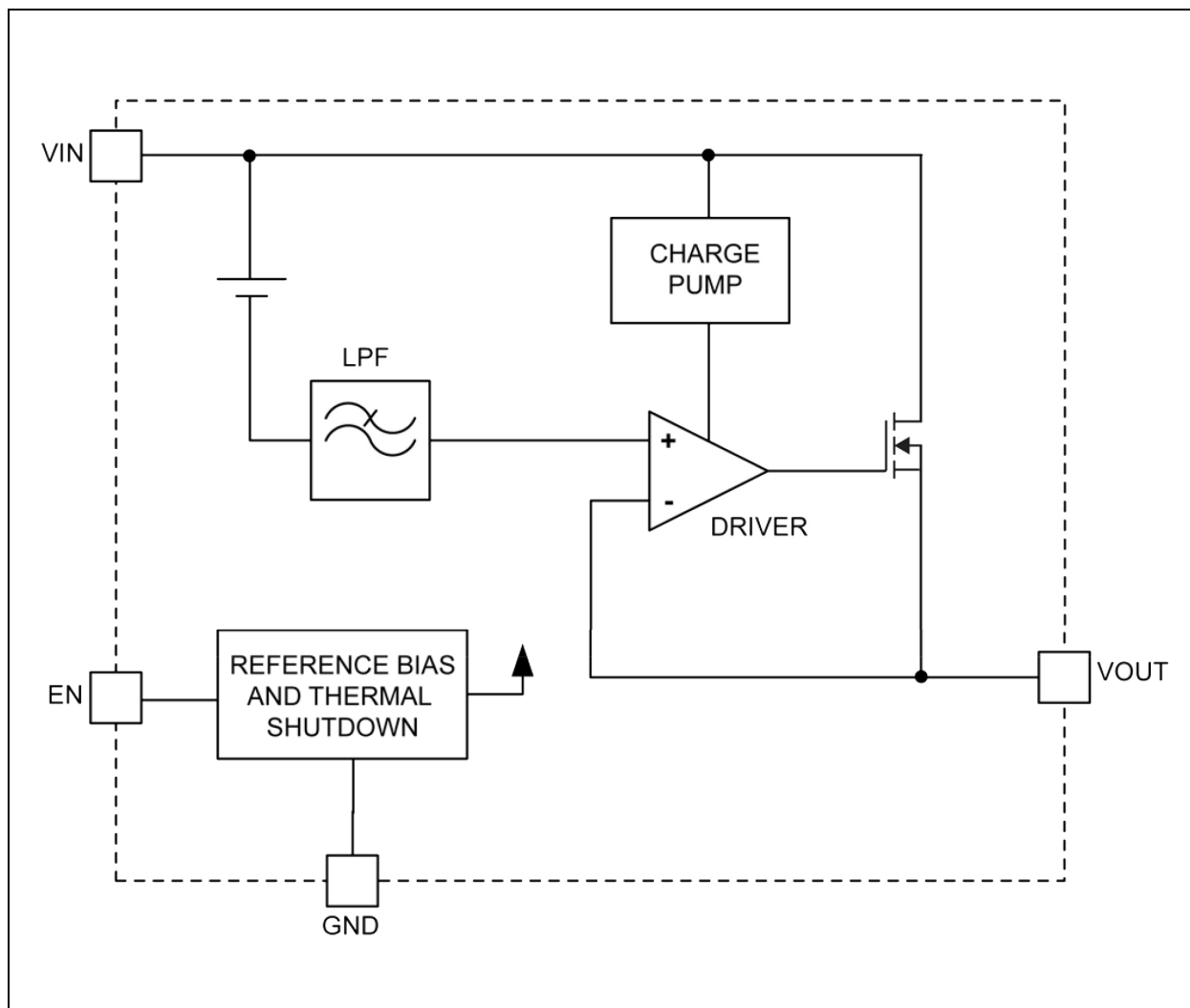


MIC94300

Typical Application Circuits



Functional Block Diagram



MIC94300

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply 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 recommended. Human body model: 1.5 k Ω in series with 100 pF.

ELECTRICAL CHARACTERISTICS

$V_{IN} = V_{EN} = 3.6V$; $I_{OUT} = 100 \mu A$; $C_{OUT} = 1 \mu F$; $T_A = 25^\circ C$, **bold** values indicate $-40^\circ C \leq T_J \leq +125^\circ C$, unless noted.

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Input Voltage	V_{IN}	1.8		3.6	V	—
Voltage Drop	V_{DROP}	—	170	250	mV	$V_{IN} - V_{OUT}$, $-40^\circ C \leq T_J \leq +85^\circ C$
V_{IN} Ripple Rejection	PSRR	—	45	—	dB	$f = 20 \text{ kHz}$, $I_{OUT} = 100 \text{ mA}$
		—	60	—		$f = 10 \text{ Hz to } 100 \text{ kHz}$
Total Output Noise	e_{NO}	—	98	—	μV_{RMS}	$V_{OUT} = 0V$
Current Limit	I_{LIMIT}	200	315	400	mA	EN controlled
Turn-On Time	t_{ON}	—	40	150	μs	100 μA to 100 mA
Load Regulation	ΔV_{LDR}	—	10	—	mV	$I_{OUT} = 100 \mu A$
Ground Current	I_{GND}	—	138	200	μA	$V_{EN} = 0V$
Shutdown Current	I_{SD}	—	0.2	—	μA	—
Enable						
Input Logic Low	V_{EN_LOW}	—	—	0.4	V	—
Input Logic High	V_{EN_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
Operating Junction Temperature Range	T_J	-40	—	+125	°C	—
Storage Temperature Range	T_s	-65	—	+150	°C	—
Lead Temperature	—	—	+260	—	°C	Soldering, 10 seconds
Thermal Resistance						
1.2 mm x 1.2 mm UDFN	θ_{JA}	—	173	—	°C/W	—

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.

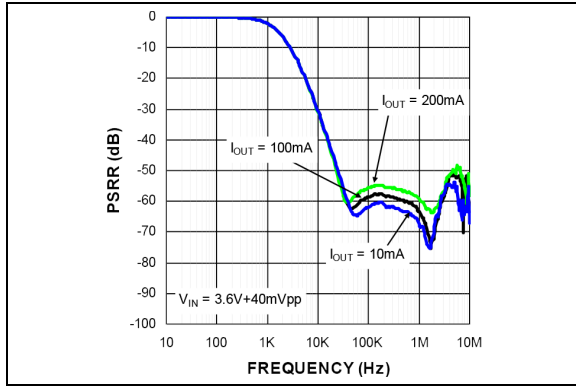


FIGURE 2-1: PSRR $C_{OUT} = 0.47 \mu F$ vs. Frequency.

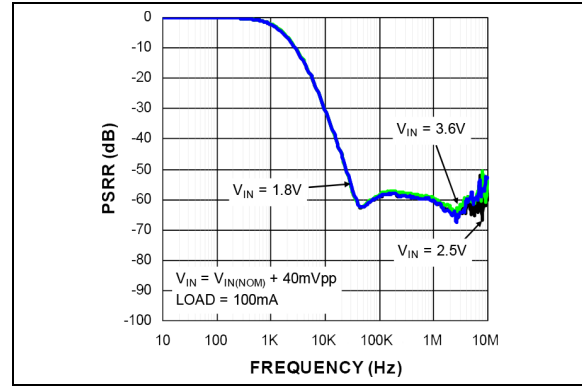


FIGURE 2-4: PSRR $C_{OUT} = 1 \mu F$ vs. Frequency.

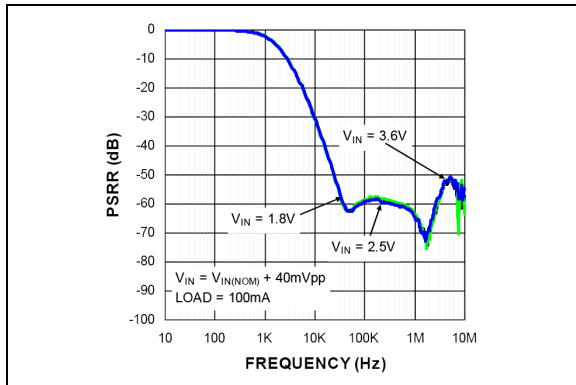


FIGURE 2-2: PSRR $C_{OUT} = 0.47 \mu F$ vs. Frequency.

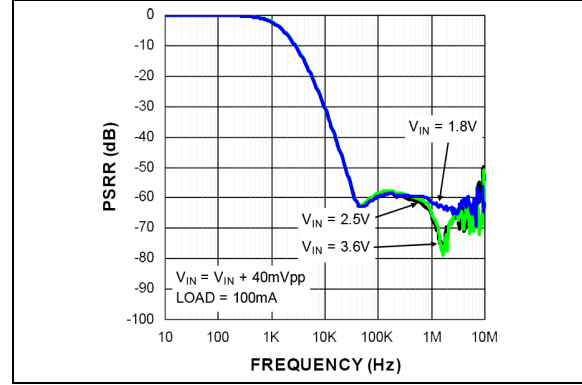


FIGURE 2-5: PSRR $C_{OUT} = 2.2 \mu F$ vs. Frequency.

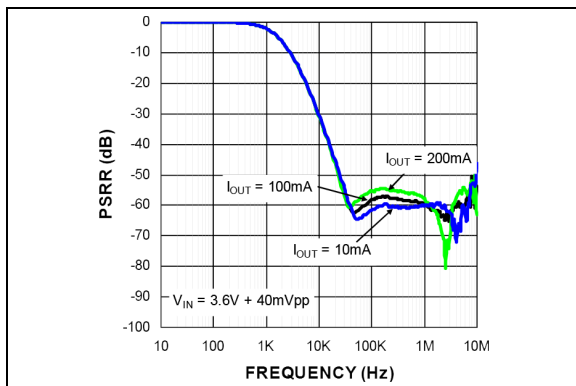


FIGURE 2-3: PSRR $C_{OUT} = 1 \mu F$ vs. Frequency.

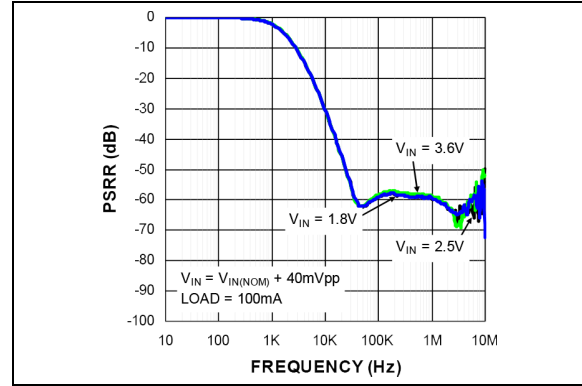


FIGURE 2-6: PSRR $C_{OUT} = 2.2 \mu F$ vs. Frequency.

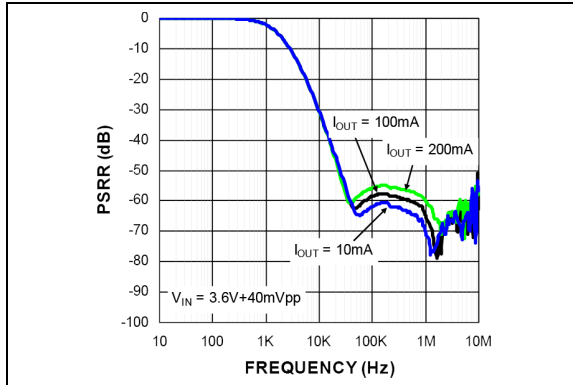


FIGURE 2-7: PSRR $C_{OUT} = 4.7 \mu F$ vs. Frequency.

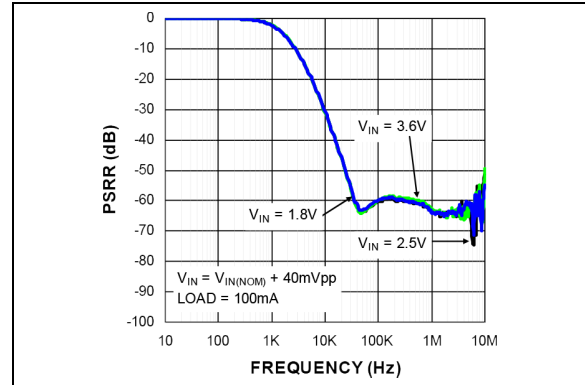


FIGURE 2-10: PSRR $C_{OUT} = 10 \mu F$ vs. Frequency.

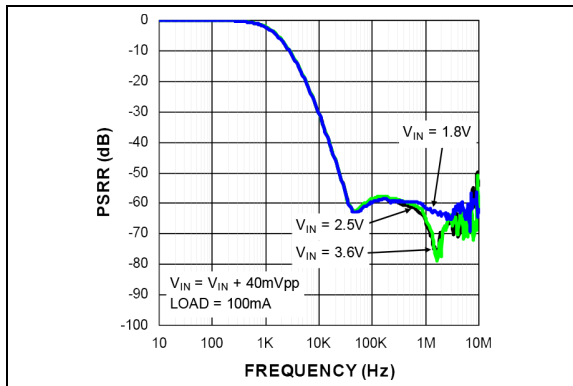


FIGURE 2-8: PSRR $C_{OUT} = 4.7 \mu F$ vs. Frequency.

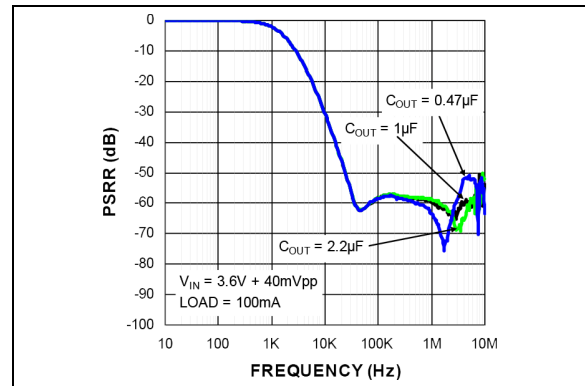


FIGURE 2-11: PSRR $C_{OUT} = 10 \mu F$ vs. Frequency.

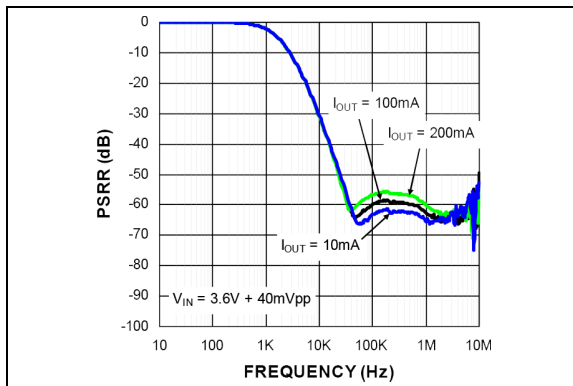


FIGURE 2-9: PSRR $C_{OUT} = 10 \mu F$ vs. Frequency.

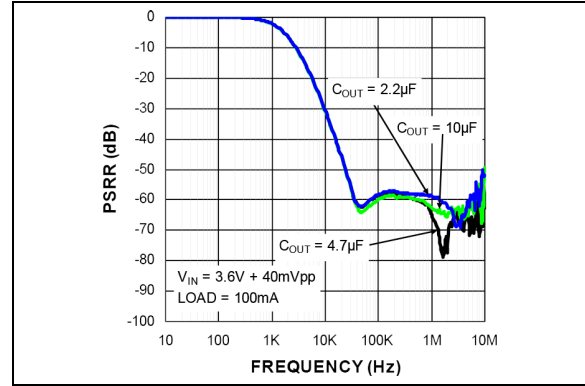


FIGURE 2-12: PSRR (Varying C_{OUT}) vs. Frequency.

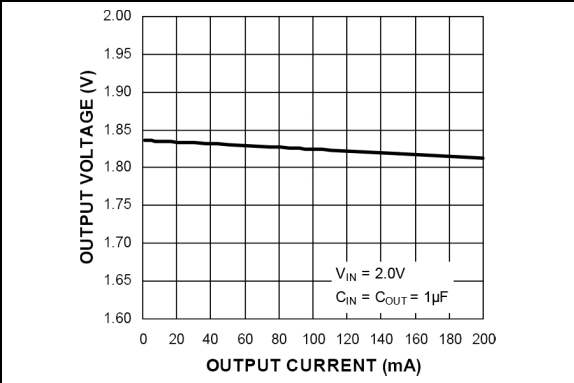


FIGURE 2-13: Output Voltage vs. Output Current.

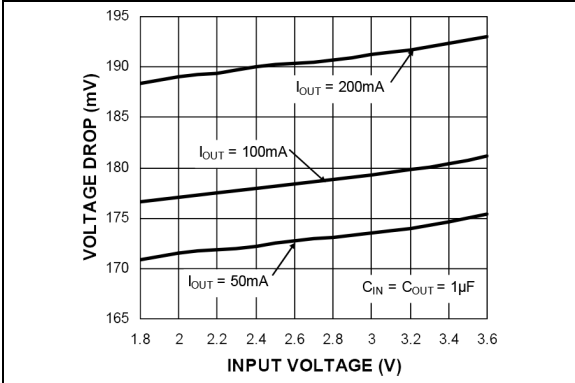


FIGURE 2-16: Voltage Drop vs. Input Voltage.

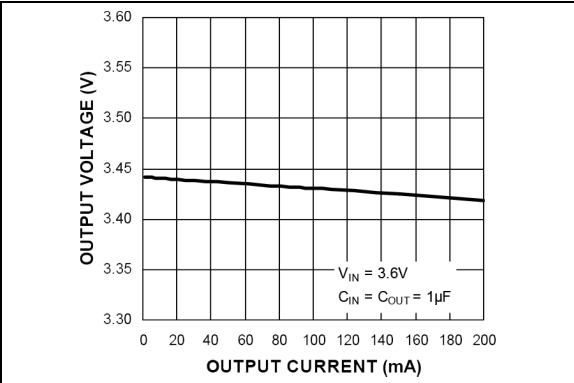


FIGURE 2-14: Output Voltage vs. Output Current.

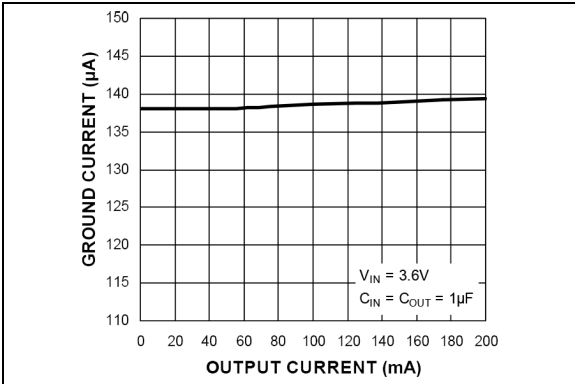


FIGURE 2-17: Ground Current vs. Output Current.

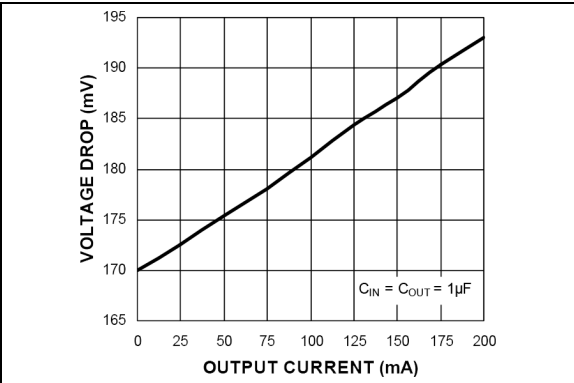


FIGURE 2-15: Dropout Voltage vs. Output Current.

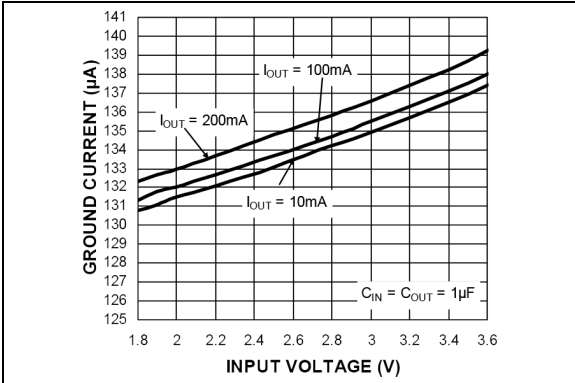


FIGURE 2-18: Ground Current vs. Input Voltage.

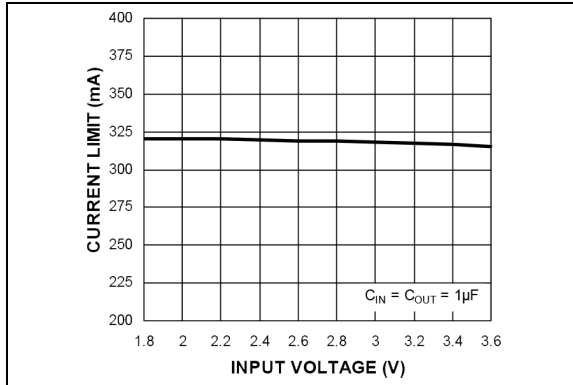


FIGURE 2-19: Current Limit vs. Input Voltage.

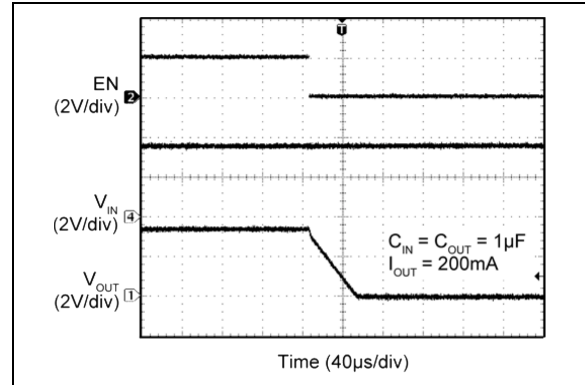


FIGURE 2-22: Enable Turn-Off.

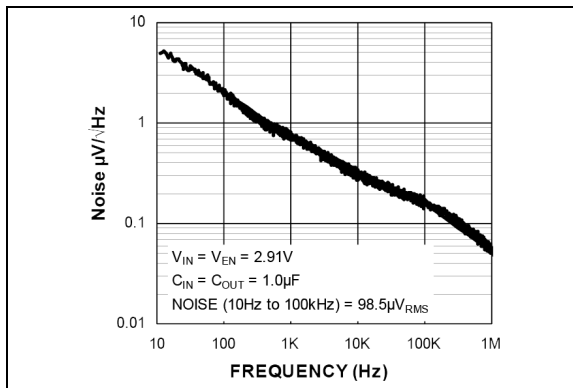


FIGURE 2-20: Output Noise Spectral Density.

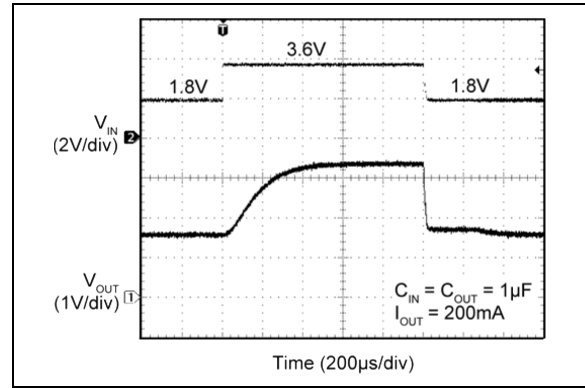


FIGURE 2-23: Line Transient ($V_{IN} = 1.8V$ to 3.6V).

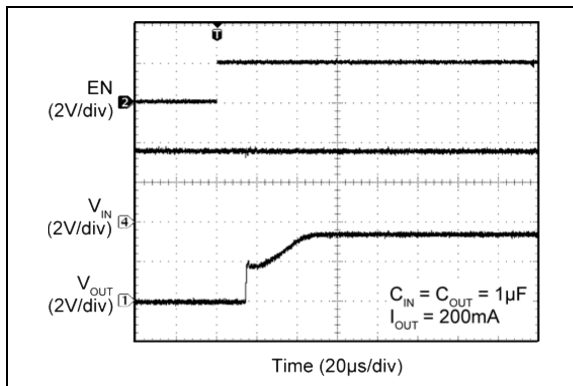


FIGURE 2-21: Enable Turn-On.

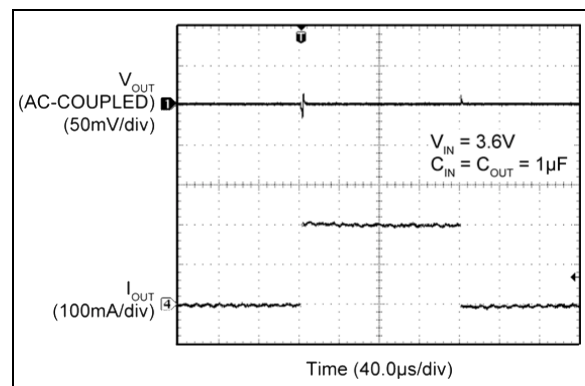


FIGURE 2-24: Load Transient (0 mA to 200 mA).

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3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 3-1](#).

TABLE 3-1: PIN FUNCTION TABLE

Pin Number (UDFN)	Pin Name	Description
1	EN	Enable input. A logic HIGH signal on this pin enables the part. Logic LOW disables the output. Do not leave floating.
2	GND	Ground.
3	VOUT	Power switch output.
4	VIN	Power switch input and chip supply.
EP	ePad	Exposed Heatsink Pad. Connect to Ground for best thermal performance.

4.0 APPLICATION INFORMATION

The MIC94300 utilizes Ripple Blocker™ technology to integrate a load switch with a high-performance active filter. The MIC94300 includes a low-voltage logic enable pin, and is fully protected from damage due to fault conditions, offering linear current limiting and thermal shutdown.

4.1 Input Capacitor

The MIC94300 is a high-performance, high-bandwidth device. An input capacitor of 470 nF 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 therefore, not recommended.

4.2 Output Capacitor

The MIC94300 requires an output capacitor of 0.47 µF or greater to maintain stability. For optimal ripple rejection performance a 1 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 1 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.

4.3 No Load Stability

The MIC94300 will remain stable with no load. This is especially important in CMOS RAM keep-alive applications.

4.4 Enable/Shutdown

The MIC94300 comes with an active-high enable pin that allows the Ripple Blocker™ to be disabled. Forcing the enable pin low disables the MIC94300 and sends it into a “zero” off mode current state.

In this state, current consumed by the MIC94300 goes nearly to zero. 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; a floating enable pin may cause an indeterminate state on the output.

4.5 Thermal Considerations

The MIC94300 is designed to provide 200 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 200 mA. The actual power dissipation of the Ripple

$$P_D = \langle V_{IN} - V_{OUT1} \rangle \times I_{OUT} + V_{IN} \times I_{GND}$$

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:

$$P_D = \langle 2.75V - 2.5V \rangle \times 200 \text{ mA}$$

$$P_D = 0.05W$$

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:

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

Where:

$$T_{J(MAX)} = 125^\circ\text{C}$$

$$\theta_{JA} = 173^\circ\text{C/W (YMT package)}$$

MIC94300

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 maximum power dissipation must not be exceeded for proper operation.

For example, when operating the MIC94300YMT at 2.75V input voltage and 200 mA load with a minimum footprint layout, the maximum ambient operating temperature (T_A) can be determined as follows:

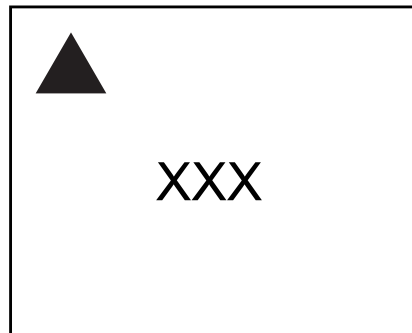
$$0.05 W = \frac{125^{\circ}C - T_A}{173^{\circ}C/W}$$
$$T_A = 116^{\circ}C$$

Therefore the maximum ambient operating temperature of 116°C is allowed. For a full discussion of heat sinking and thermal effects on voltage regulators, refer to the “Thermal Management” section of [Micrel's Guide to Designing With Low-Dropout Voltage Regulators](#) handbook.

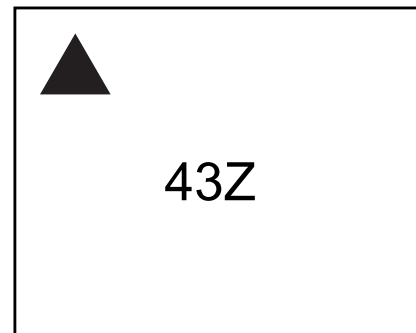
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

4-Lead UDFN



Example

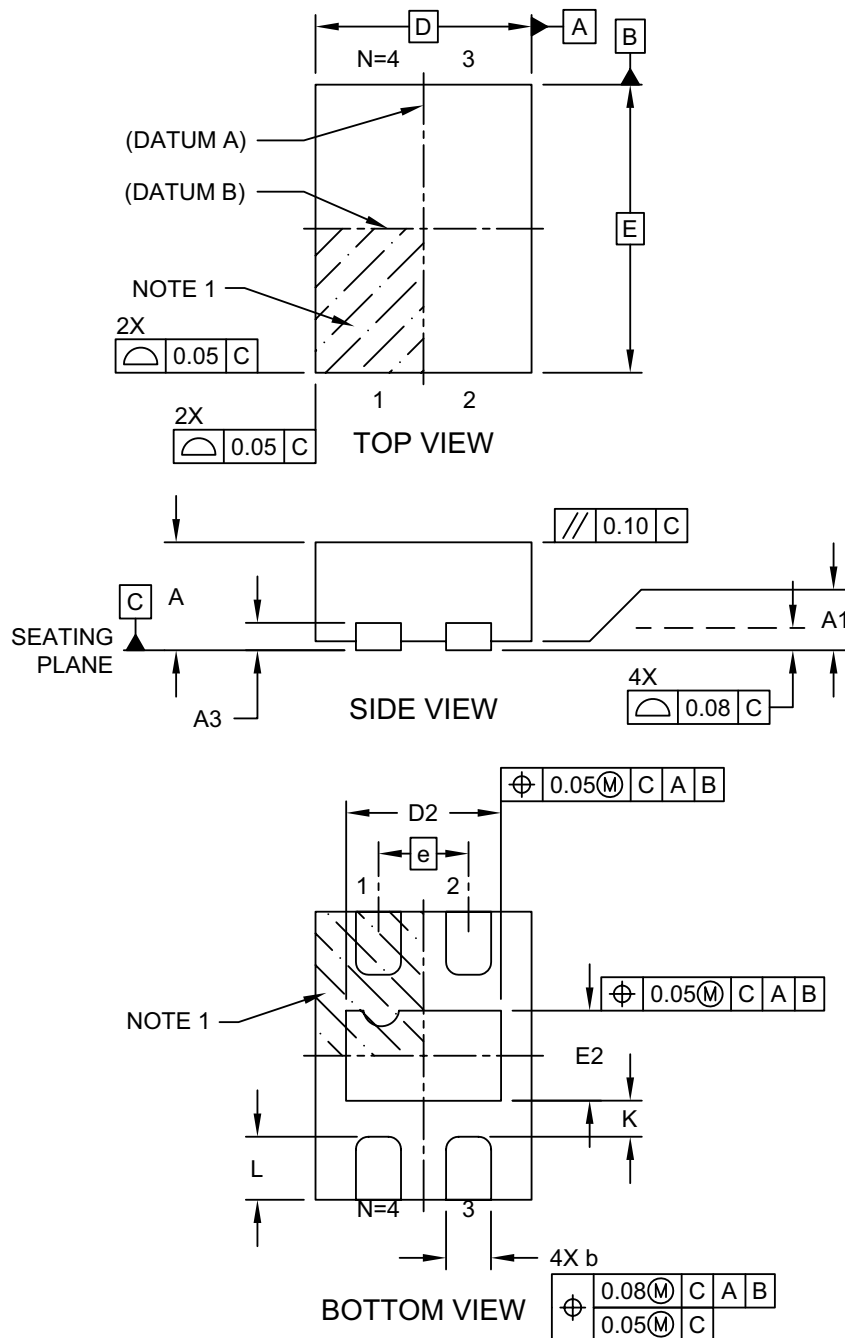


Legend	
Symbol	Definition
XX...X	Product code or customer specific information.
NNN	Alphanumeric traceability code.
(e3)	Pb-free JEDEC® designator for Matte Tin (Sn).
*	This package is Pb-free. The Pb-free JEDEC designator () can be found on the outer packaging for this package.
•, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).
Additional Information	
Note 1	If the full date code (YYWW) and alphanumeric traceability code (NNN)—usually marked together on the last or only line of a package marking as the seven-character YYWWNNN—cannot fit on the package together, the codes will be truncated based on the number of available characters, as follows: 6 characters = YWWNNN; 5 Characters = WNNNN; 4 Characters = WNNN; 3 Characters = NNN; 2 Characters = NN; 1 Character = N.
Note 2	If the full Microchip part number cannot fit on one line, it will be carried over to the next line, limiting the number of available characters for customer-specific information. The package may or may not include the corporate logo.
Note 3	Some products might have a symbol “Y” at the end of the last (or only) line in a package marking to indicate the product is Pb-free.
Note 4	Any underbar () and/or overbar () symbols shown in a package marking drawing may not be to scale.

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4-Lead 1.2 mm × 1.6 mm UDFN [HGA] Package Outline and Recommended Land Pattern

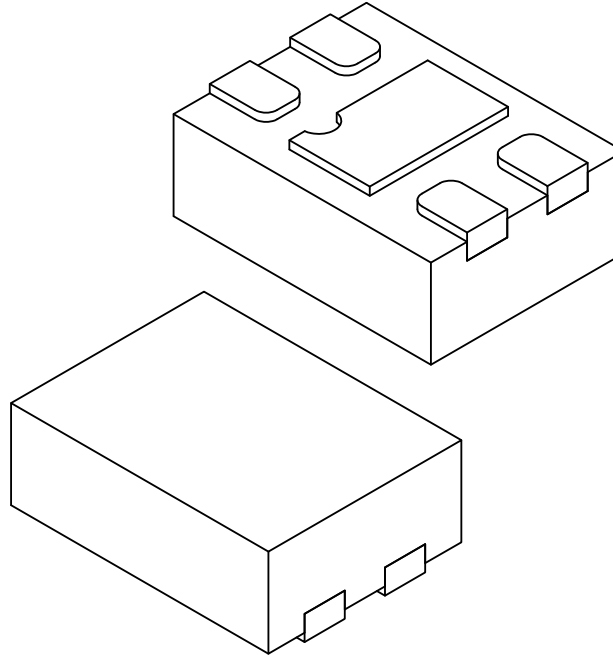
Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing C04-1152 Rev A Sheet 1 of 2

4-Lead 1.2 mm × 1.6 mm UDFN [HGA] 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>



Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Terminals	N	4		
Pitch	e	0.50 BSC		
Overall Height	A	0.50	0.55	0.60
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3	0.152 REF		
Overall Length	D	1.20 BSC		
Exposed Pad Length	D2	0.81	0.86	0.91
Overall Width	E	1.60 BSC		
Exposed Pad Width	E2	0.45	0.50	0.55
Terminal Width	b	0.20	0.25	0.30
Terminal Length	L	0.30	0.35	0.40
Terminal-to-Exposed-Pad	K	0.20	—	—

Notes:

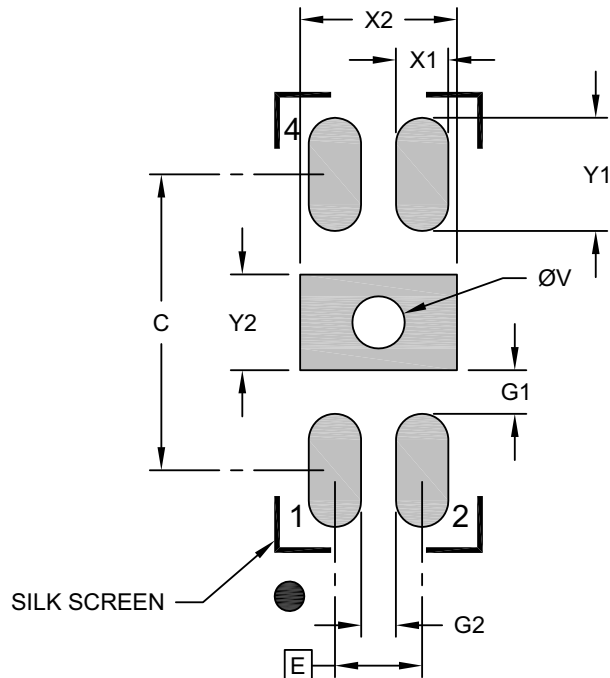
- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Package is saw singulated
- Dimensioning and tolerancing per ASME Y14.5M
 - BSC: Basic Dimension. Theoretically exact value shown without tolerances.
 - REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1152 Rev A Sheet 2 of 2

MIC94300

4-Lead 1.2 mm × 1.6 mm UDFN [HGA] 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

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Optional Center Pad Width	X2			0.90
Optional Center Pad Length	Y2			0.55
Contact Pad Spacing	C		1.70	
Contact Pad Width (X4)	X1			0.30
Contact Pad Length (X4)	Y1			0.65
Contact Pad to Center Pad (X4)	G1	0.25		
Contact Pad to Contact Pad (X2)	G2	0.20		
Thermal Via Diameter	V		0.30	

Notes:

- Dimensioning and tolerancing per ASME Y14.5M
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
- For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-3152 Rev A

APPENDIX A: REVISION HISTORY

Revision A (May 2024)

- Converted Micrel document MIC94300 to Microchip data sheet DS20006844A.
- Content related to the Schematic Diagram, Bill of Materials, and PCB Layout removed as that can be found in the MIC94300 User's Guide.
- Removed references to phased out package options.
- Minor text changes throughout.

MIC94300

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

<u>Part Number</u>	<u>X</u>	<u>XX</u>	<u>-XX</u>	Examples:
Device	Junction Temp. Range	Package	Media Type	a) MIC94300YMT-TR: MIC94300, -40°C to +125°C Temperature Range, 4-Lead UDFN, 5000/Reel
Device: MIC94300: 200 mA Switch with Ripple Blocker™ Technology Junction Temperature Range: Y = -40°C to +125°C Package: MT = 4-Lead UDFN Media Type: TR = 5000/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.

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NOTES:

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

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
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