MIC94066/7/8/9

Dual High-Side Power Switches

Features

- 1.7V to 5.5V Input Voltage Range
- 2A Continuous Operating Current
- 85 mΩ (typ.) ON-Resistance
- Built-In Level Shift for Control Logic; Can be Operated by 1.5V Logic
- Low 2 µA Quiescent Current
- Soft-Start: MIC94068 and MIC94069
- Micropower Shutdown <1 µA
- Load Discharge Circuit: MIC94067 and MIC94069
- Space Saving 2 mm x 2 mm 8-Lead VDFN

Applications

- Load Switch in Portable Applications:
  - Cellular Phones
  - PDAs
  - MP3 Players
  - Digital Cameras
  - Portable Instruments
- Battery Switch-Over Circuits
- Level Translators

General Description

The MIC94066, MIC94067, MIC94068, and MIC94069 are dual high-side load switches designed for operation between 1.7V to 5.5V. The devices contain a pair of low ON-resistance, 115 mΩ (max.) P-channel MOSFETs that support over 2A of continuous current. The MIC94067 and MIC94069 feature an active load discharge circuit which ensures capacitive loads retain no charge when the main switch is in an OFF state.

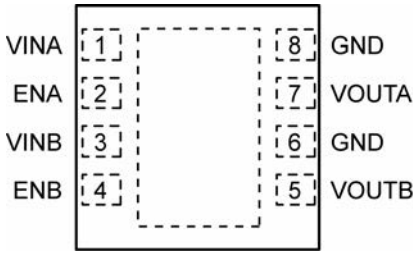
An active pull-down on the enable input keeps MIC94066/7/8/9 in a default OFF state until the EN pin is pulled to a high level. The built-in level shift circuitry allows for a logic signal that may be different from the supply voltage to switch the high-side P-channel MOSFET on or off.

MIC94066 and MIC94067 feature rapid turn-on, while MIC94068 and MIC94069 provide a slew rate controlled soft-start turn-on of 800 µs (typical) to prevent in-rush current from glitching supply rails.

MIC94066/7/8/9's voltage range makes them suitable for 1-cell Lithium-ion and 2-cell to 3-cell NiMH/NiCad/Alkaline powered systems, as well as all 5V applications. Their low operating current of 2 µA and low shutdown current of <1 µA maximize battery life.

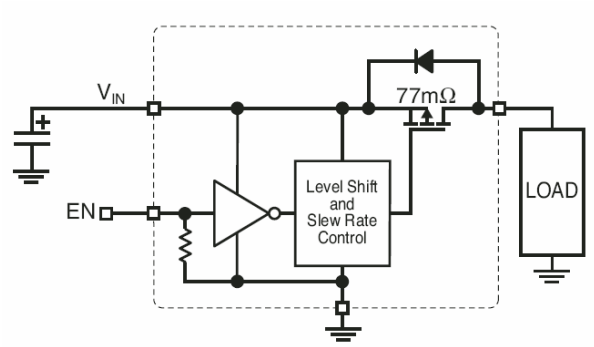
Package Type

MIC94066/7/8/9
8-Lead VDFN (ML)
(Top View)

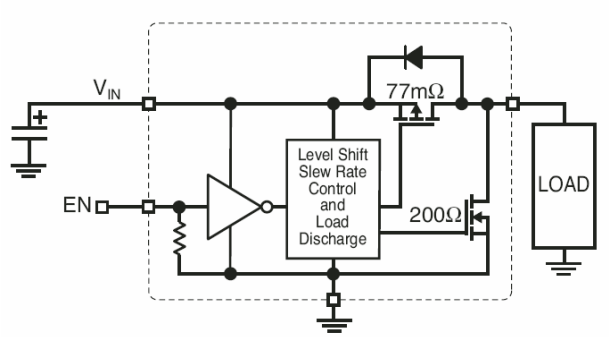


Typical Application Circuits

1/2 MIC94066, MIC94068
Load Switch Application



1/2 MIC94067, MIC94069
Load Switch with Capacitive Load Discharge



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Voltage (V_{IN}) ..... +6V
Enable Voltage (V_{EN}) ..... +6V
Continuous Drain Current (I_D, Note 1)
T_A = +25°C ..... ±2A
T_A = +85°C ..... ±1.4A
Pulsed Drain Current (I_{DP}, Note 2) ..... ±6A
Continuous Diode Current (I_S, Note 3) ..... –50 mA
ESD Rating, HBM (Note 4) ..... 4 kV

Operating Ratings ‡

Input Voltage (V_{IN}) ..... +1.7V to +5.5V

† 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: With backside thermal contact to PCB.

2: Pulse width <300 µs with <2% duty cycle.

3: Continuous body diode current conduction (reverse conduction, i.e. V_{OUT} to V_{IN}) is not recommended.

4: Devices are ESD sensitive. Handling precautions recommended. HBM (Human body model), 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: V_{IN} = 5V; T_A = +25°C, **bold** values valid for –40°C ≤ T_A ≤ +85°C, unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Enable Threshold Voltage	V_{EN_TH}	0.5	—	1.2	V	V_{IN} = 1.8V to 4.5V, I_D = –250 µA
		0.4	—	1.2		V_{IN} = 1.7V to 4.5V, I_D = –250 µA
Enable Input Current	I_{EN}	—	2	4	µA	V_{IN} = V_{EN} = 5.5V
OFF State Leakage Current	I_{VIN}	—	—	1	µA	V_{IN} = +5.5V, V_{EN} = 0V
P-Channel Drain-to-Source ON-Resistance	$R_{DS(ON)}$	—	85	115	mΩ	V_{IN} = +4.5V, I_D = –100 mA, V_{EN} = 1.5V
		—	100	140		V_{IN} = +3.6V, I_D = –100 mA, V_{EN} = 1.5V
		—	145	200		V_{IN} = +2.5V, I_D = –100 mA, V_{EN} = 1.5V
		—	155	215		V_{IN} = +1.8V, I_D = –100 mA, V_{EN} = 1.5V
		—	165	225		V_{IN} = +1.7V, I_D = –100 mA, V_{EN} = 1.5V
Turn-Off Impedance	R_{SHDN}	—	200	300	Ω	
Dynamic						
Turn-On Delay Time	t_{ON_DLY}	—	0.85	1.5	µs	V_{IN} = +3.6V, I_D = –100 mA, V_{EN} = 1.5V MIC94066, 67
		—	700	1200		V_{IN} = +3.6V, I_D = –100 mA, V_{EN} = 1.5V MIC94068, 69

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: V_{IN} = 5V; T_A = +25°C, **bold** values valid for –40°C ≤ T_A ≤ +85°C, unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Turn-On Rise Time	t_{ON_RISE}	0.5	1	5	µs	V_{IN} = +3.6V, I_D = –100 mA, V_{EN} = 1.5V MIC94066, 67
		500	800	1500		V_{IN} = +3.6V, I_D = –100 mA, V_{EN} = 1.5V MIC94068, 69
Turn-Off Delay Time	t_{OFF_DLY}	—	115	200	ns	V_{IN} = +3.6V, I_D = –100 mA, V_{EN} = 1.5V MIC94066, 67
		—	100	200		V_{IN} = +3.6V, I_D = –100 mA, V_{EN} = 1.5V MIC94068, 69
Turn-Off Fall Time	t_{OFF_FALL}	—	60	100	ns	V_{IN} = +3.6V, I_D = –100 mA, V_{EN} = 1.5V MIC94066, 67
		—	60	100		V_{IN} = +3.6V, I_D = –100 mA, V_{EN} = 1.5V MIC94068, 69

Note 1: Specification for packaged product only.

2: Timer High Voltage along with Delay pin current (1 µA nominal) determines the delay per µF of capacitance. Typical delay is 1.1 sec/µF.

3: Discharge current is the current drawn from the output to ground to actively discharge the output capacitor during the shutdown process.

4: V_{TARGET} is the output voltage of an adjustable with customer resistor divider installed between VOUT and the ADJ/SNS pin, or the rated output voltage of a fixed device.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Temperature Range	T_J	–40	—	+125	°C	—
Storage Temperature	T_S	–55	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance, VDFN 8-Ld	θ_{JA}	—	90	—	°C/W	—
	θ_{JC}	—	45	—	°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.

I_L = 100 mA, C_L = 0 µF for Figure 2-1 through Figure 2-12.

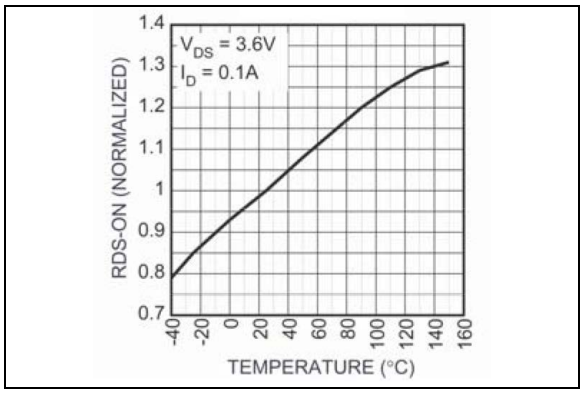


FIGURE 2-1: *$R_{DS(ON)}$ Variance with Temperature.*

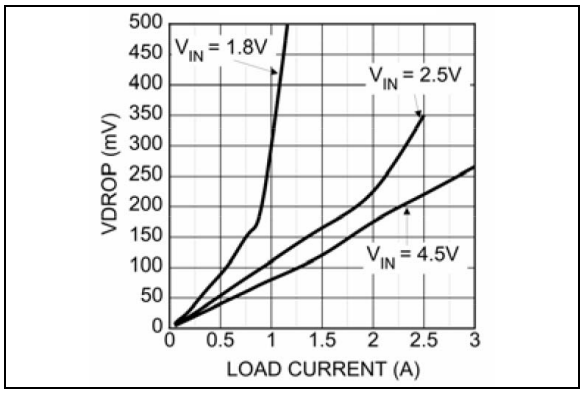


FIGURE 2-4: *Voltage Drop vs. Load Current.*

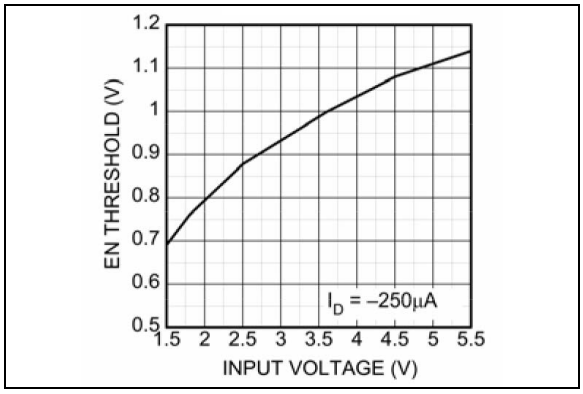


FIGURE 2-2: *EN Threshold Voltage vs. Input Voltage.*

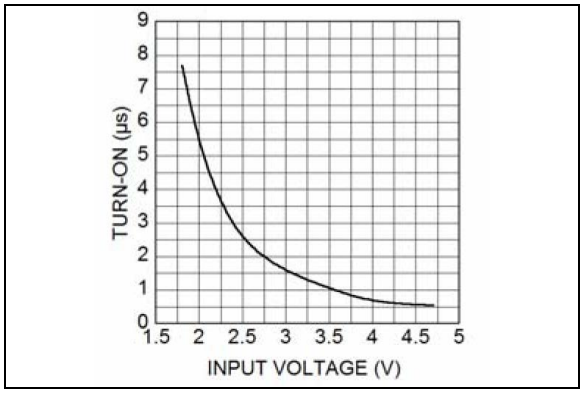


FIGURE 2-5: *MIC94066/67 Turn-On Delay vs. Input Voltage.*

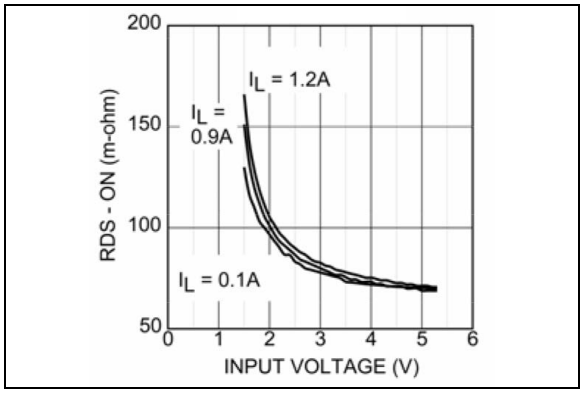


FIGURE 2-3: *ON Resistance vs. Input Voltage.*

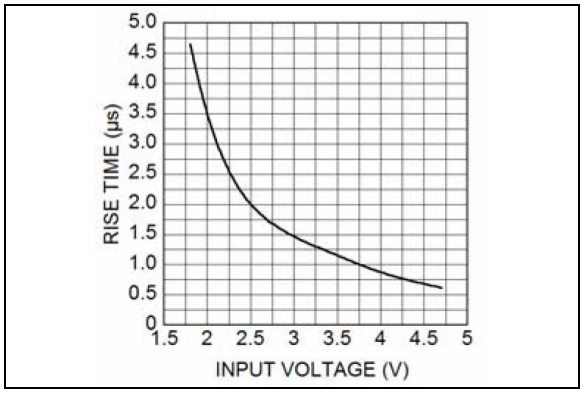


FIGURE 2-6: *MIC94066/67 Rise Time vs. Input Voltage.*

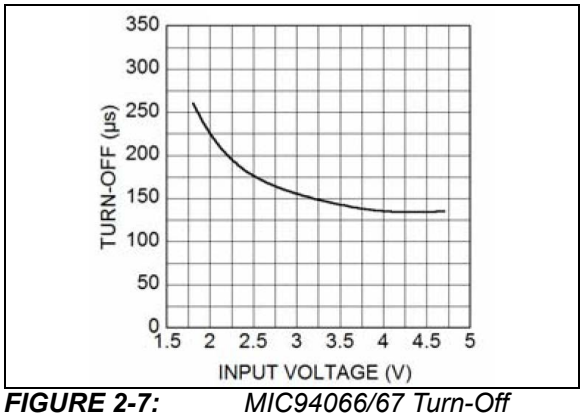


FIGURE 2-7: *MIC94066/67 Turn-Off Delay vs. Input Voltage.*

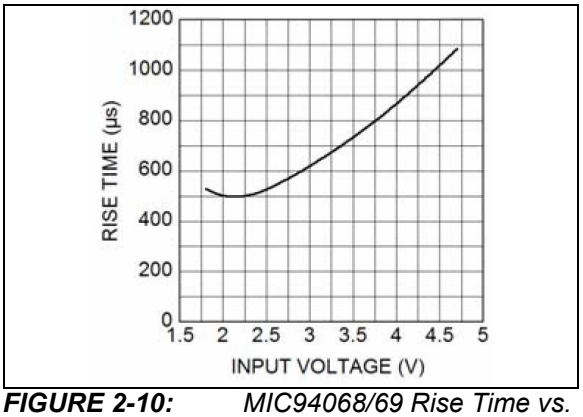


FIGURE 2-10: *MIC94068/69 Rise Time vs. Input Voltage.*

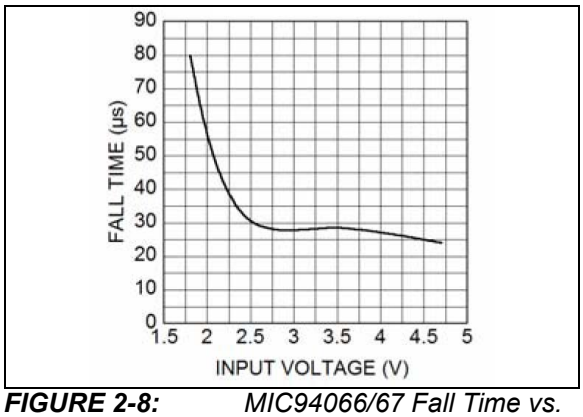


FIGURE 2-8: *MIC94066/67 Fall Time vs. Input Voltage.*

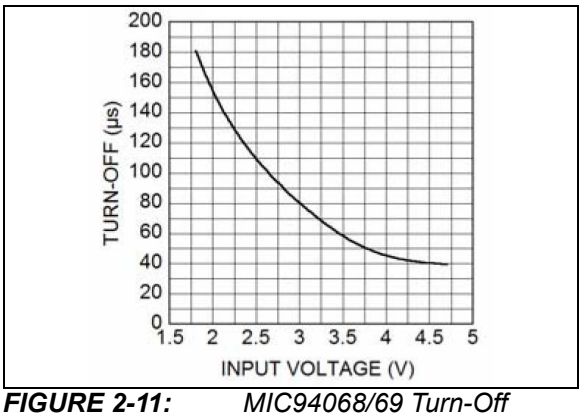


FIGURE 2-11: *MIC94068/69 Turn-Off Delay vs. Input Voltage.*

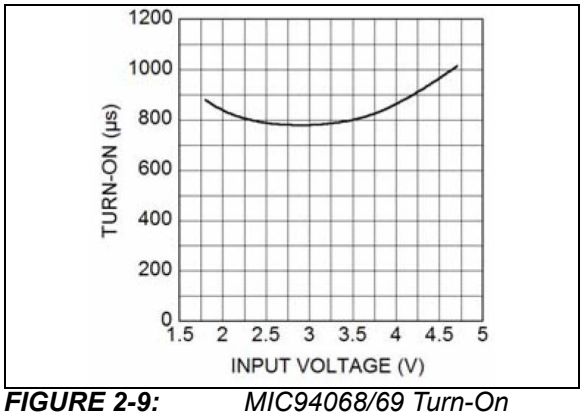


FIGURE 2-9: *MIC94068/69 Turn-On Delay vs. Input Voltage.*

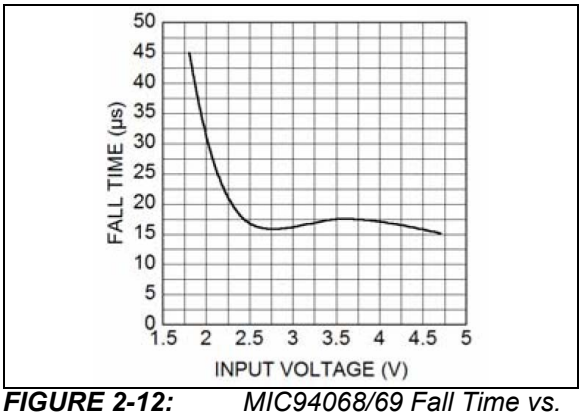


FIGURE 2-12: *MIC94068/69 Fall Time vs. Input Voltage.*

MIC94066

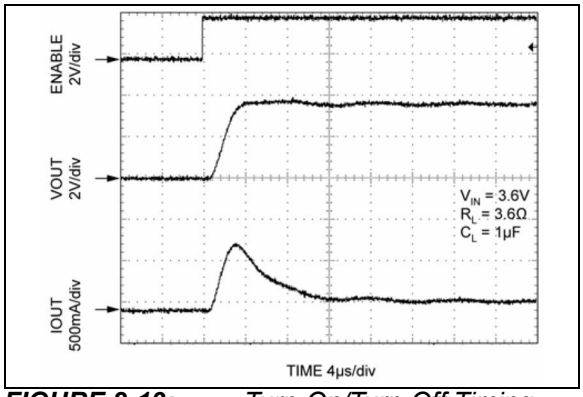


FIGURE 2-13: *Turn-On/Turn-Off Timing.*

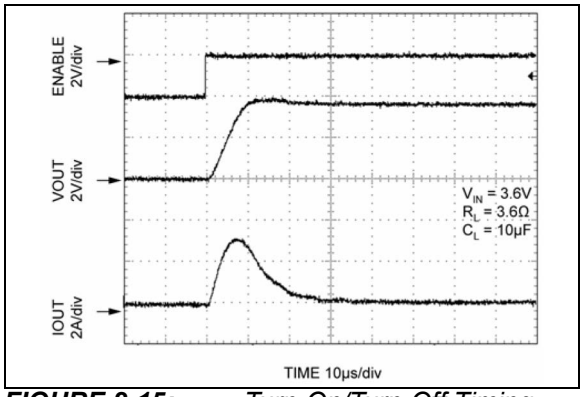


FIGURE 2-15: *Turn-On/Turn-Off Timing.*

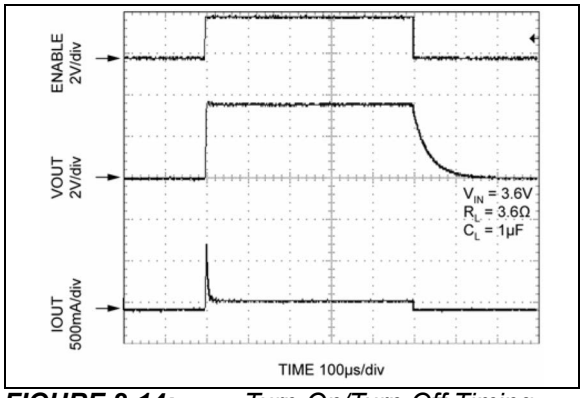


FIGURE 2-14: *Turn-On/Turn-Off Timing.*

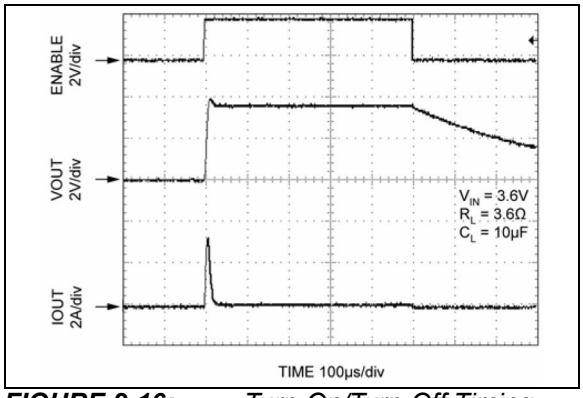


FIGURE 2-16: *Turn-On/Turn-Off Timing.*

MIC94067

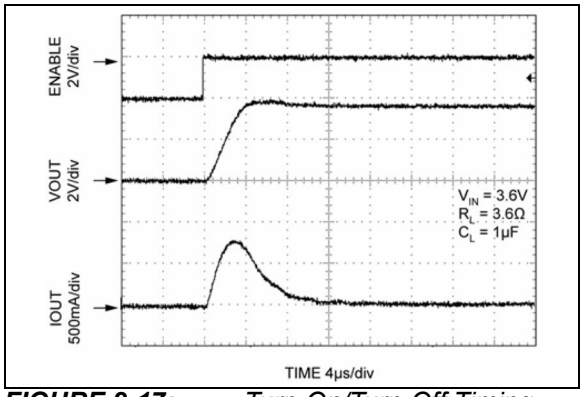


FIGURE 2-17: *Turn-On/Turn-Off Timing.*

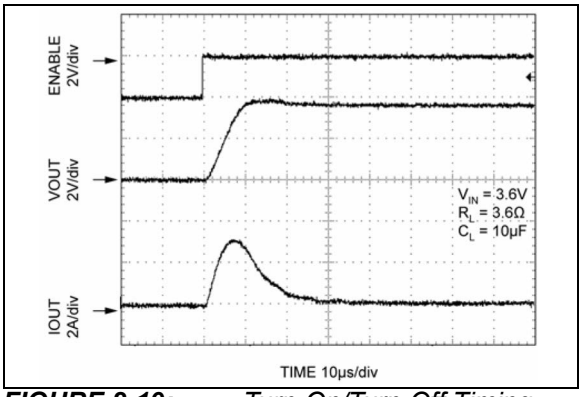


FIGURE 2-19: *Turn-On/Turn-Off Timing.*

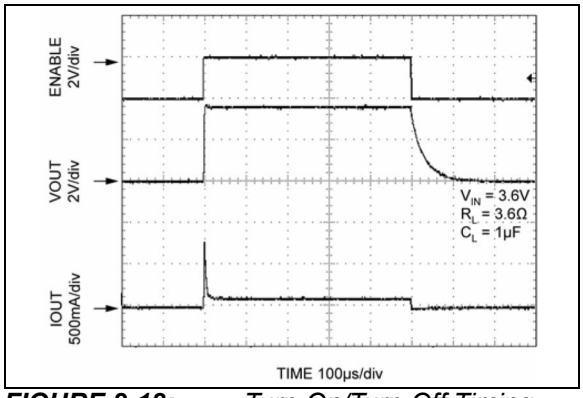


FIGURE 2-18: *Turn-On/Turn-Off Timing.*

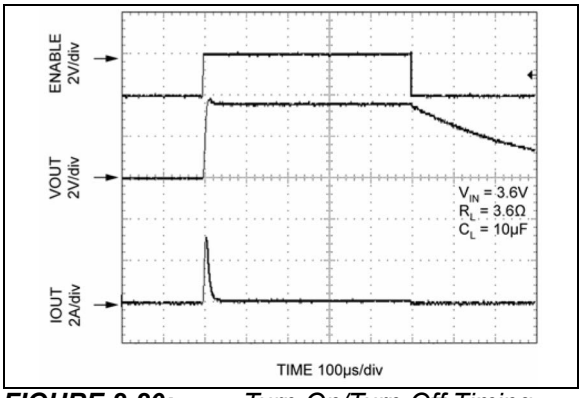


FIGURE 2-20: *Turn-On/Turn-Off Timing.*

MIC94068

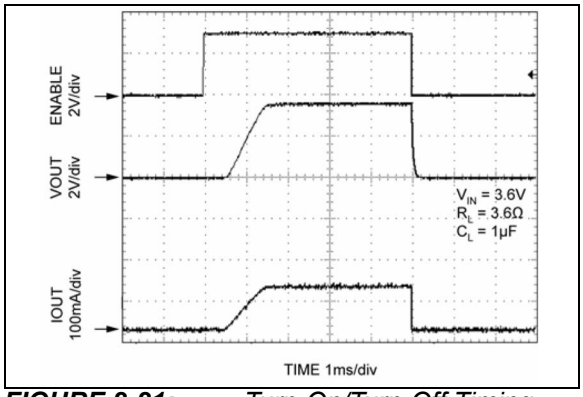


FIGURE 2-21: *Turn-On/Turn-Off Timing.*

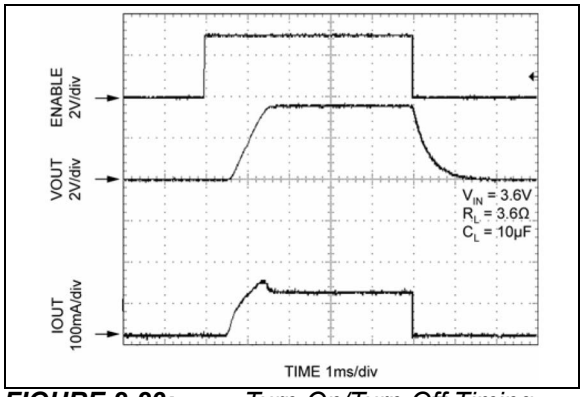


FIGURE 2-23: *Turn-On/Turn-Off Timing.*

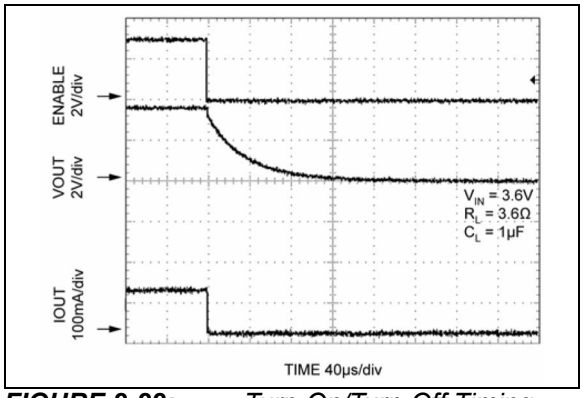


FIGURE 2-22: *Turn-On/Turn-Off Timing.*

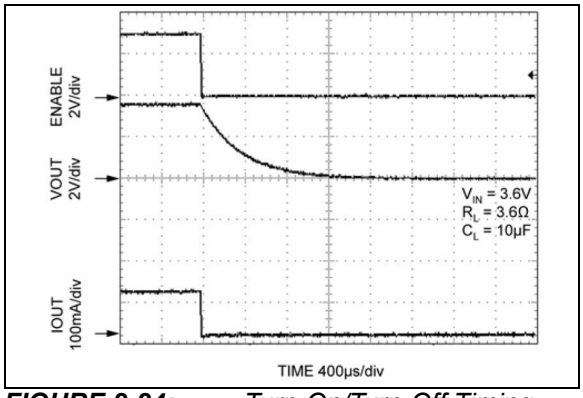


FIGURE 2-24: *Turn-On/Turn-Off Timing.*

MIC94069

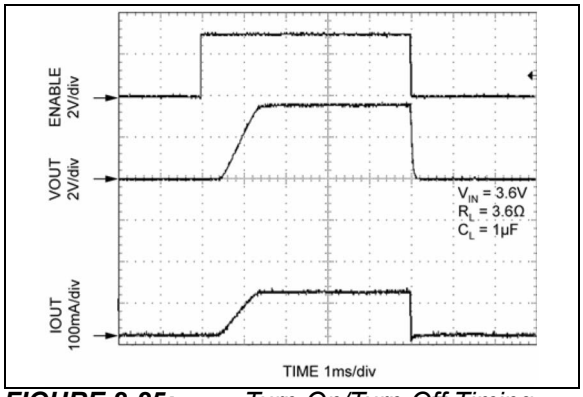


FIGURE 2-25: *Turn-On/Turn-Off Timing.*

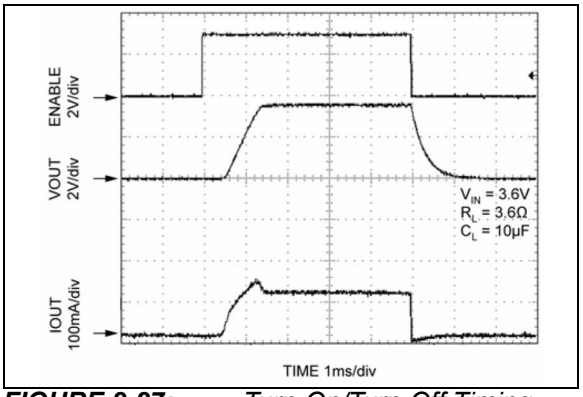


FIGURE 2-27: *Turn-On/Turn-Off Timing.*

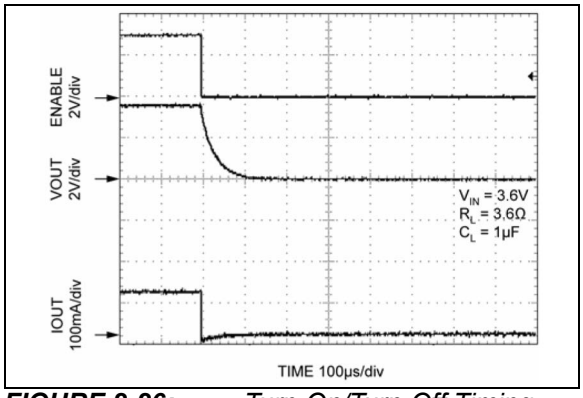


FIGURE 2-26: *Turn-On/Turn-Off Timing.*

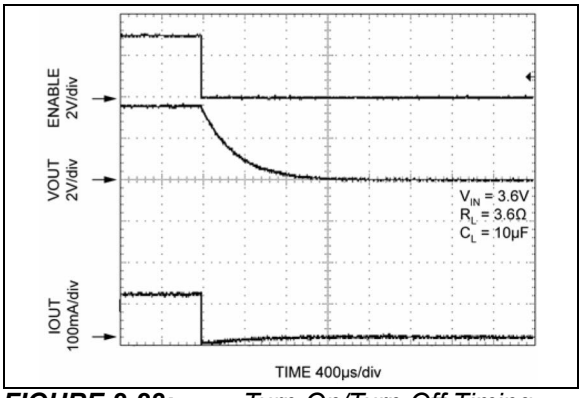


FIGURE 2-28: *Turn-On/Turn-Off Timing.*

3.0 PIN DESCRIPTIONS

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

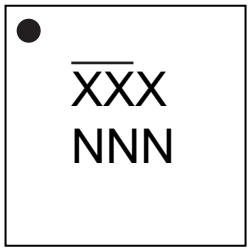
TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	$V_{IN}A$	Source of P-channel MOSFET.
2	ENA	Enable (Input): Active-high CMOS compatible control input for switch A. Do not leave floating.
3	$V_{IN}B$	Source of P-channel MOSFET.
4	ENB	Enable (Input): Active-high CMOS compatible control input for switch A. Do not leave floating.
5	$V_{OUT}B$	Drain of P-channel MOSFET.
6	GND	Ground. Both ground pins must be grounded.
7	$V_{OUT}A$	Drain of P-channel MOSFET.
8	GND	Ground. Both ground pins must be grounded.

4.0 PACKAGING INFORMATION

4.1 Package Marking Information

8-Lead VDFN*



Example

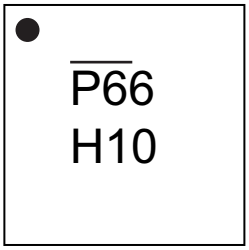


TABLE 4-1: MARKING CODES

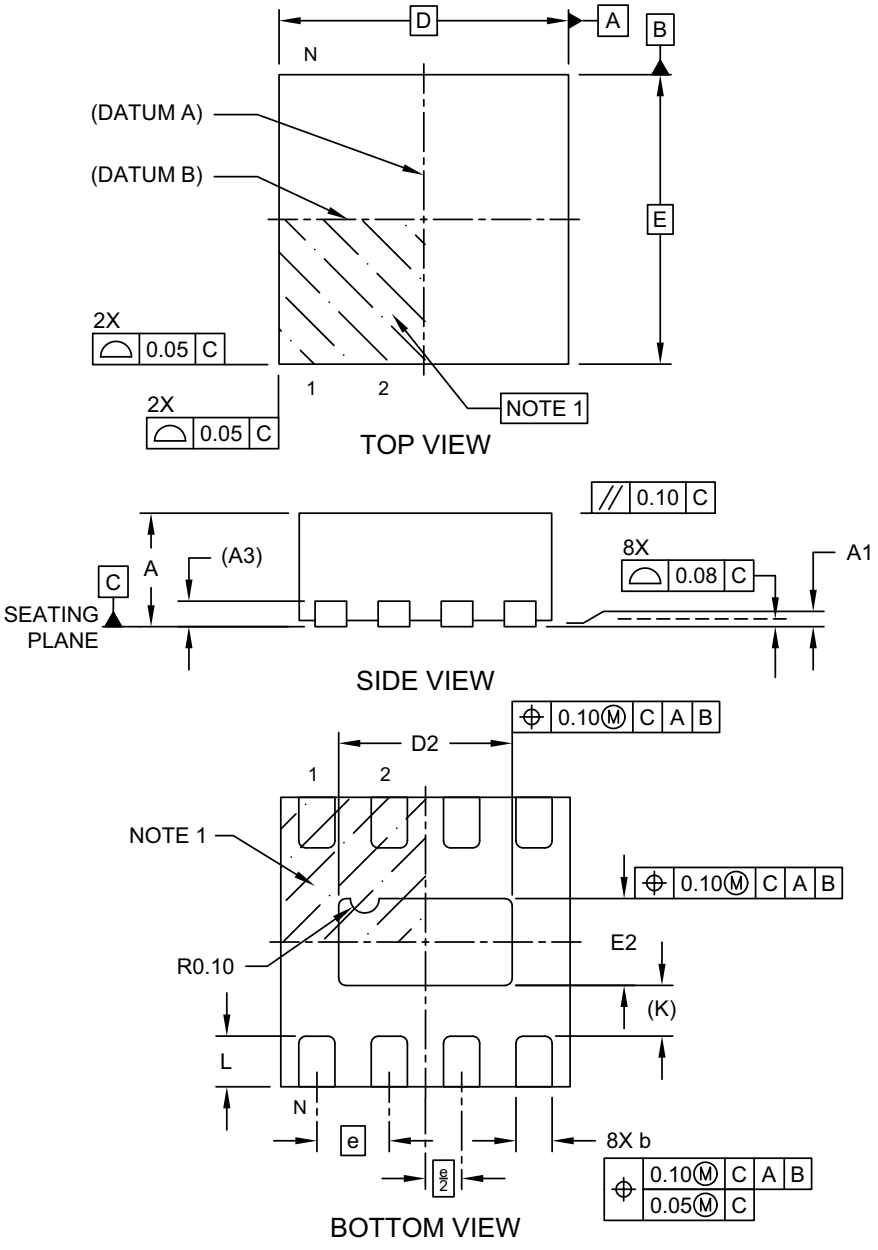
Part Number	Marking Code	Soft-Start	Load Discharge
MIC94066YML	P66	No	No
MIC94067YML	P67	No	Yes
MIC94068YML	P68	Yes	No
MIC94069YML	P69	Yes	Yes

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 (_) 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

8-Lead Very Thin Plastic Dual Flat, No Lead Package (H2A) - 2x2x0.9 mm Body [VDFN] With 1.20x0.6 mm Exposed Pad

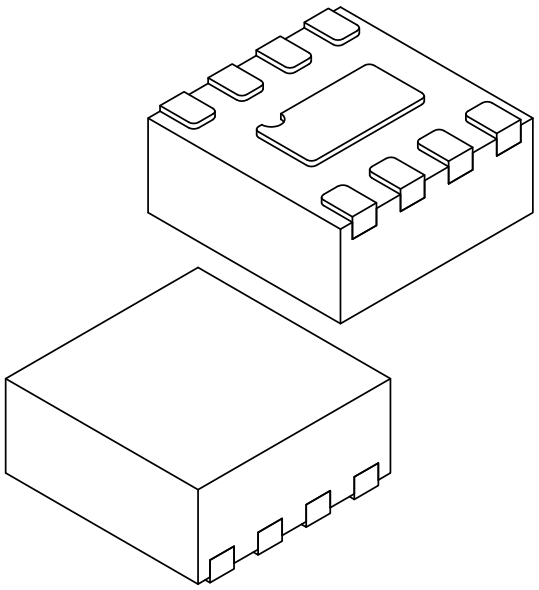
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-1247 Rev A Sheet 1 of 2

8-Lead Very Thin Plastic Dual Flat, No Lead Package (H2A) - 2x2x.9 mm Body [VDFN] With 1.20x0.6 mm Exposed Pad

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



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N		8	
Pitch	e		0.50 BSC	
Overall Height	A	0.80	0.85	0.90
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3		0.203 REF	
Overall Length	D		2.00 BSC	
Exposed Pad Length	D2	1.10	1.20	1.30
Overall Width	E		2.00 BSC	
Exposed Pad Width	E2	0.50	0.60	0.70
Terminal Width	b	0.20	0.25	0.30
Terminal Length	L	0.30	0.35	0.40
Terminal-to-Exposed-Pad	K		0.35 REF	

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M

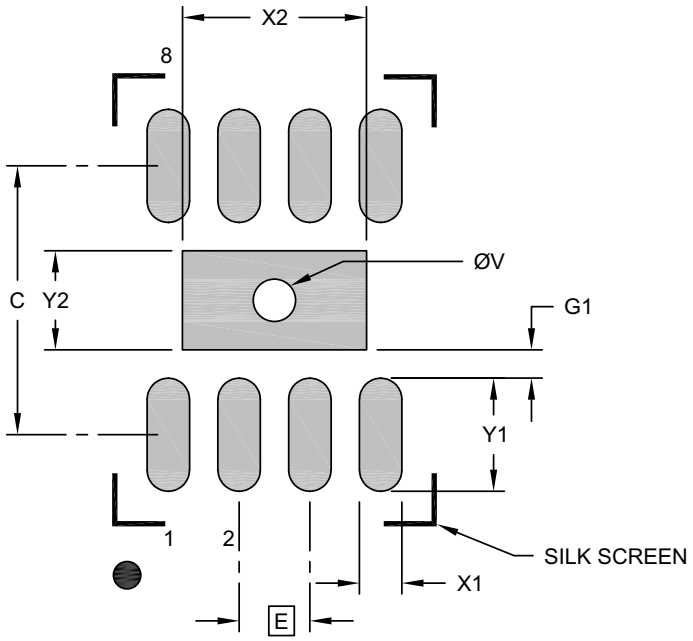
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1247 Rev A Sheet 2 of 2

8-Lead Very Thin Plastic Dual Flat, No Lead Package (H2A) - 2x2 mm Body [VDFN] Micrel Legacy Package

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		0.50 BSC	
Optional Center Pad Width	X2			0.70
Optional Center Pad Length	Y2			1.30
Contact Pad Spacing	C		1.90	
Contact Pad Width (X8)	X1			0.30
Contact Pad Length (X8)	Y1			0.80
Contact Pad to Center Pad (X8)	G1	0.20		
Thermal Via Diameter	V		0.30	

Notes:

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

Microchip Technology Drawing C04-3247 Rev. A

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (May 2023)

- Converted Micrel document MIC94066/7/8/9 to Microchip data sheet DS20006779A.
- 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 Number	X	XX	-XX
Device	Temp. Range	Package	Media Type

Device:	MIC94066: MIC94067: MIC94068: MIC94069:		Dual High-Side Power Switch Dual High-Side Power Switch with Load Discharge Dual High-Side Power Switch with Soft-Start Dual High-Side Power Switch with Soft-Start and Load Discharge
Temperature Range:	Y	=	–40°C to +125°C
Package:	ML	=	8-Lead 2 mm x 2 mm VDFN
Media Type:	TR	=	5,000/Reel

Examples:

a) MIC94066YML-TR: MIC94066, –40°C to +125°C Temp. Range, 8-Lead VDFN, 5,000/Reel

b) MIC94067YML-TR: MIC94067, –40°C to +125°C Temp. Range, 8-Lead VDFN, 5,000/Reel

c) MIC94068YML-TR: MIC94068, –40°C to +125°C Temp. Range, 8-Lead VDFN, 5,000/Reel

d) MIC94069YML-TR: MIC94069, –40°C to +125°C Temp. Range, 8-Lead VDFN, 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.

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