MIC94060/61/62/63

High Side Power Switches

General Description

The MIC94060-63 are high-side load switches designed for operation between 1.7V to 5.5V. The devices contain a low on-resistance P-channel MOSFET that supports over 2A of continuous current. The MIC94061and MIC94063 features an active load discharge circuit which insures capacitive loads retain no charge when the main switch is in an OFF state.

MIC94060-61 feature rapid turn on while MIC94062-63 provide a slew rate controlled Soft-Start turn-on of 800µs (typical) to prevent in-rush current from glitching supply rails.

An active pull-down on the enable input keeps MIC94060-63 in a default OFF state until the EN pin is pulled to a high level. Built-in level shift circuitry allows low voltage logic signals to switch higher supply voltages, or vice versa; high level logic signals can control low level voltages.

MIC94060-63's operating voltage range makes them suitable for 1-cell Lithium ion and 2- to 3-cell NiMH/NiCad/Alkaline powered systems, as well as all 5V applications. Their low operating current of 2µA and low shutdown current of <1µA maximize battery life.

Data sheets and support documentation can be found on Micrel's web site at www.micrel.com.

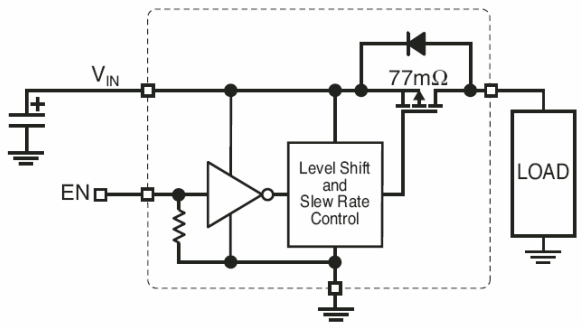
Features

- 1.7V to 5.5V input voltage range
- 2A continuous operating current
- 77mΩ (typ) R_{ON}
- Built-in level shift for control logic; can be operated by 1.5V logic.
- Low 2µA quiescent current
- Soft-Start: MIC94062-63
- Micro-power shutdown <1µA
- Load discharge circuit: MIC94061, MIC94063
- Space saving 1.2x1.6 mm MLF® and Thin MLF® packages.

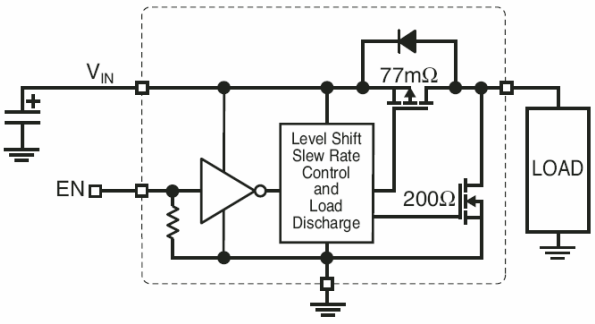
Applications

- Load switch in portable applications:
  - Cellular phones
  - PDAs
  - MP3 players
  - Digital Cameras
  - Portable instrumentation
- Battery switch-over circuits
- Level translator

Typical Application



MIC94060, 62
Load Switch Application



MIC94061, 63
Load Switch with Capacitive Load Discharge

MLF and Micro*Lead* Frame is a registered trademark of Amkor Technologies

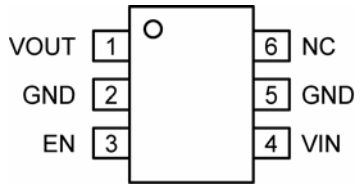
Ordering Information

Part Number		Part Marking[1]		Soft-Start	Load Discharge	Package
Standard	Pb-Free	Standard	Pb-Free			
MIC94060BC6	MIC94060YC6	P54	P54			SC-70-6
MIC94061BC6	MIC94061YC6	P55	P55		•	
MIC94062BC6	MIC94062YC6	P56	P56	•		
MIC94063BC6	MIC94063YC6	P57	P57	•	•	
—	MIC94060YML	—	P54			1.2mm x 1.6mm MLF®
—	MIC94061YML	—	P55		•	
—	MIC94062YML	—	P56	•		
—	MIC94063YML	—	P57	•	•	
—	MIC94060YMT[2]	—	P54			1.2mm x 1.6mm TMLF®
—	MIC94061YMT[2]	—	P55		•	
—	MIC94062YMT[2]	—	P56	•		
—	MIC94063YMT[2]	—	P57	•	•	

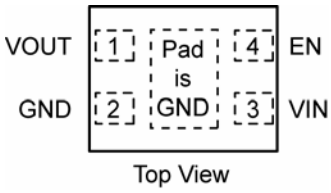
Notes

1. Underbar symbol on SC-70 Pb-free packages may not be to scale.
2. Consult factory for availability.

Pin Configuration



SC-70-6 (C6)



1.2x1.6 mm MLF™ (ML)

Pin Description

Pin Number		Pin Name	Pin Function
SC-70	MLF		
1	1	V_{OUT}	Drain of P-channel MOSFET.
2,5	2	GND	Ground and the backside pad (MLF only) should both be connected to electrical ground.
4	3	V_{IN}	Source of P-channel MOSFET.
3	4	EN	Enable (Input): Active-high CMOS compatible control input for switch A. Do not leave floating.
6	--	NIC	No Internal Connection. A signal or voltage applied to this pin will have no effect on device operation.

Absolute Maximum Ratings [1]

Input Voltage (V_{IN}) ..... +6V
Enable Voltage (V_{EN}) ..... +6V
Continuous Drain Current (I_D) [3]
T_A = 25°C ..... ±2A
T_A = 85°C ..... ±1.4A
Pulsed Drain Current (I_{DP}) [4] ..... ±6A
Continuous Diode Current (I_S) [4] ..... –50mA
Storage Temperature (T_s) ..... –55°C to +150°C
EDS Rating – HBM [6] 4KV

Operating Ratings [2]

Input Voltage (V_{IN}) ..... +1.7 to +5.5V
Junction Temperature (T_A) ..... –40°C to +125°C
Package Thermal Resistance
SC-70-6 (Θ_{JA}) ..... 240°C/W
1.2x1.6 MLF (Θ_{JA}) ..... 172°C/W
1.2x1.6 MLF (Θ_{JC}) [3] ..... 134°C/W

Electrical Characteristics

V_{IN} = 5V; T_A = 25°C, bold values indicate –40°C≤ T_A ≤ +85°C, unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{EN_TH}	Enable Threshold Voltage	V_{IN} = 1.8V to 4.5V, I_D = –250µA	0.5		1.2	V
		V_{IN} = 1.7V to 4.5V, I_D = –250µA	0.4		1.2	V
I_{EN}	Enable Input Current	V_{IN} = V_{EN} = 5.5V		2	4	µA
I_{VIN}	OFF State Leakage Current	V_{IN} = +5.5V, V_{EN} = 0V			1	µA
$R_{DS(ON)}$	P-Channel Drain to Source ON Resistance SC-70 Package	V_{IN} = +4.5V, ID = –100mA, V_{EN} = 1.5V		77	110	mΩ
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V		85	115	mΩ
		V_{IN} = +2.5V, ID = –100mA, V_{EN} = 1.5V		100	140	mΩ
		V_{IN} = +1.8V, ID = –100mA, V_{EN} = 1.5V		145	200	mΩ
		V_{IN} = +1.7V, ID = –100mA, V_{EN} = 1.5V		155	215	mΩ
$R_{DS(ON)}$	P-Channel Drain to Source ON Resistance MLF Package	V_{IN} = +4.5V, ID = –100mA, V_{EN} = 1.5V		85	115	mΩ
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V		100	140	mΩ
		V_{IN} = +2.5V, ID = –100mA, V_{EN} = 1.5V		145	200	mΩ
		V_{IN} = +1.8V, ID = –100mA, V_{EN} = 1.5V		155	215	mΩ
		V_{IN} = +1.7V, ID = –100mA, V_{EN} = 1.5V		165	225	mΩ
$R_{SHUTDOWN}$	Turn-Off Resistance	V_{IN} = +3.6V, I_{TEST} = 1mA, V_{EN} = 0V MIC94061, 63		200	300	Ω

Dynamic

Symbol	Parameter	Condition	Min	Typ	Max	Units
t_{ON_DLY}	Turn-On Delay Time	V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94060, 61		0.85	1.5	µs
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94062, 63		700	1200	µs
t_{ON_RISE}	Turn-On Rise Time	V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94060, 61	0.5	1	5	µs
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94062, 63	500	800	1500	µs

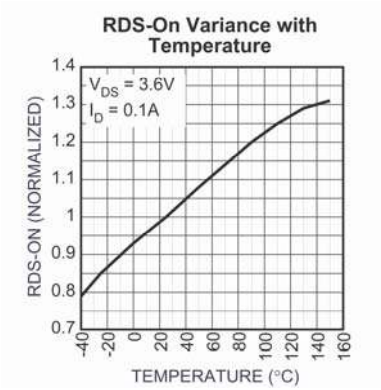
Dynamic (cont.)

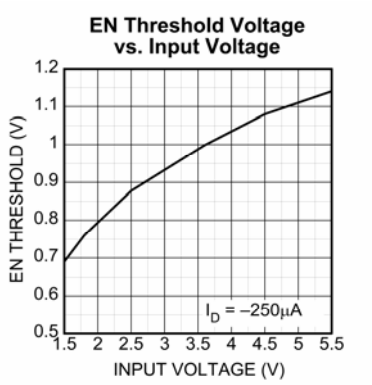
t_{OFF_DLY}	Turn-Off Delay Time	V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94060, 61		100	200	ns
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94062, 63		60	200	ns
t_{OFF_FALL}	Turn-Off Fall Time	V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94060, 61		60	100	ns
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94062, 63		60	100	ns

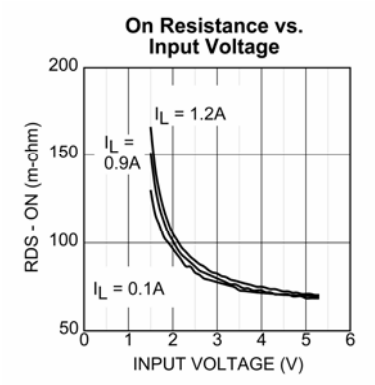
Notes:

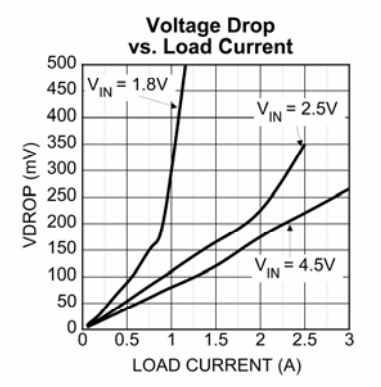
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. With backside thermal contact to PCB.
4. Pulse width <300µs with < 2% duty cycle.
5. Continuous body diode current conduction (reverse conduction, i.e. V_{OUT} to V_{IN}) is not recommended.
6. Devices are ESD sensitive. Handling precautions recommended. HBM (Human body model), 1.5k in series with 100pF.

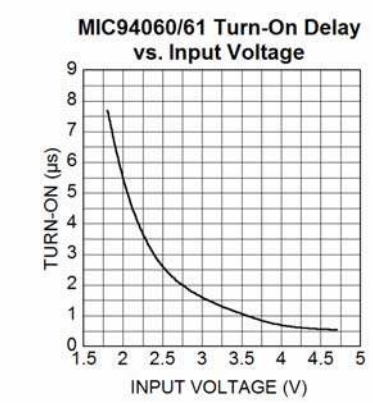
Typical Characteristics

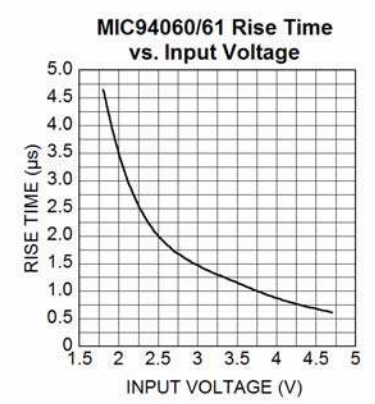


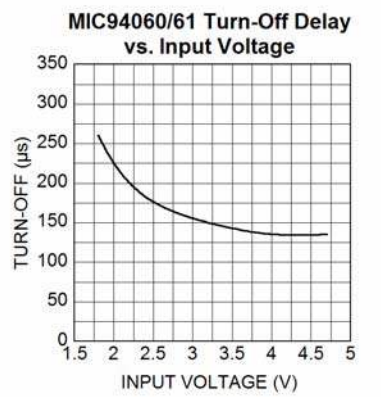


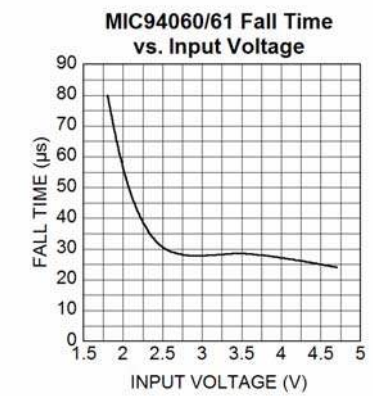


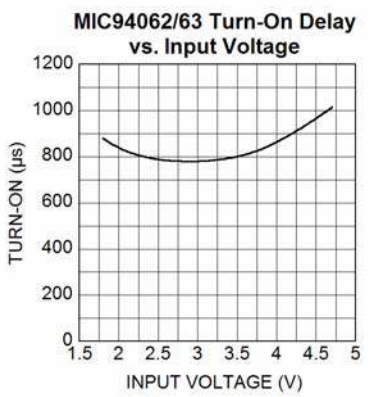


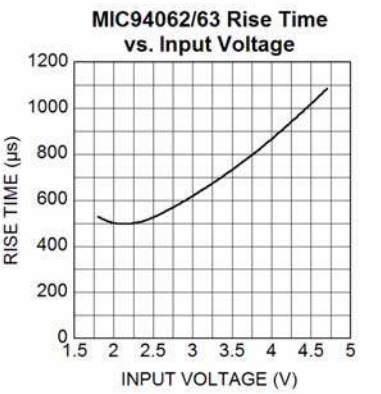


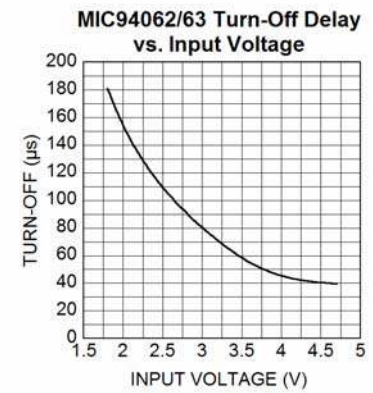


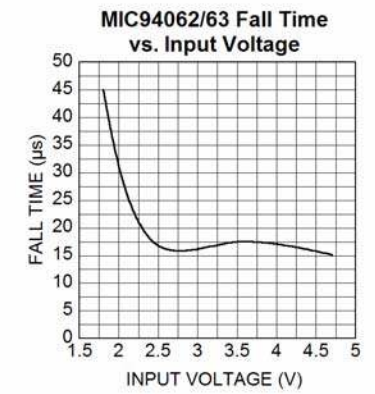






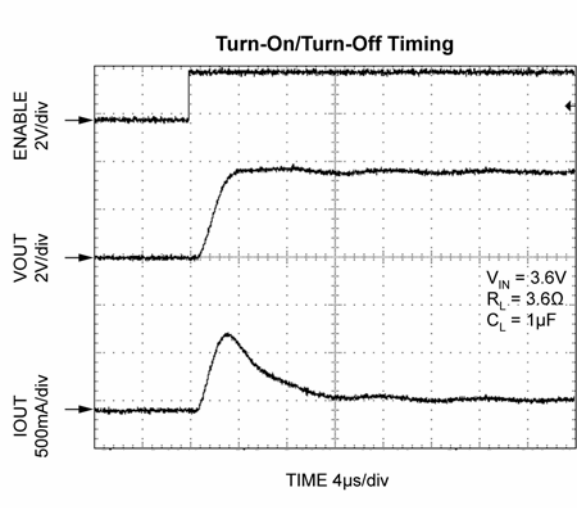


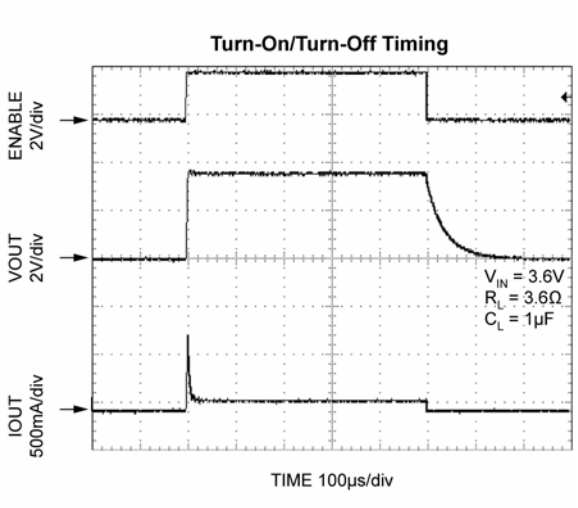


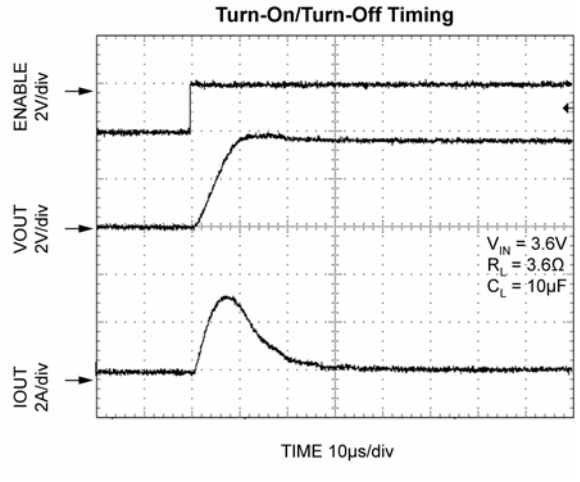


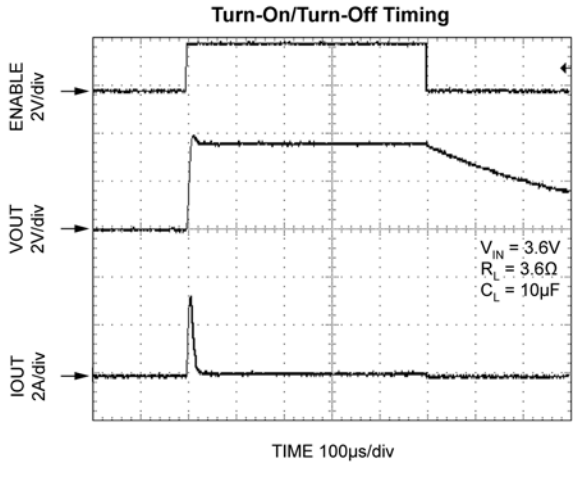
Functional Characteristics

MIC94060

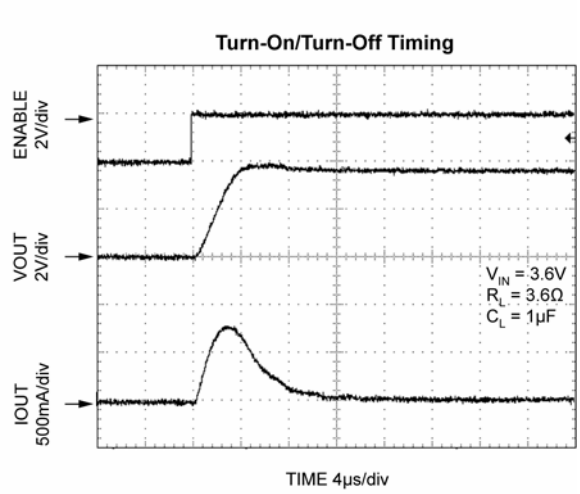








MIC94061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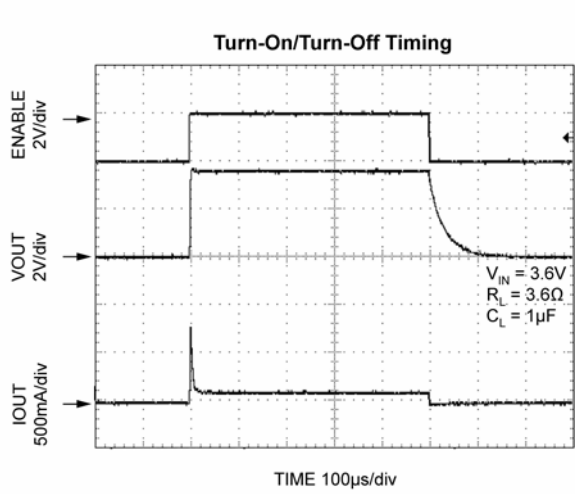
ENABLE 2V/div
VOUT 2V/div
IOUT 500mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 1µF
TIME 4µs/div


Turn-On/Turn-Off Timing
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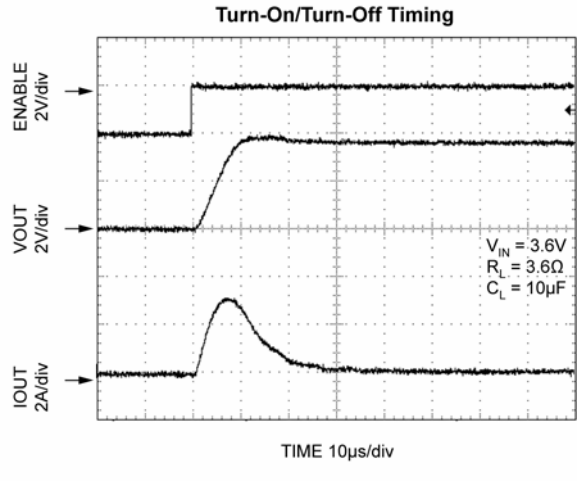
VOUT 2V/div
IOUT 500mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 1µF
TIME 100µs/div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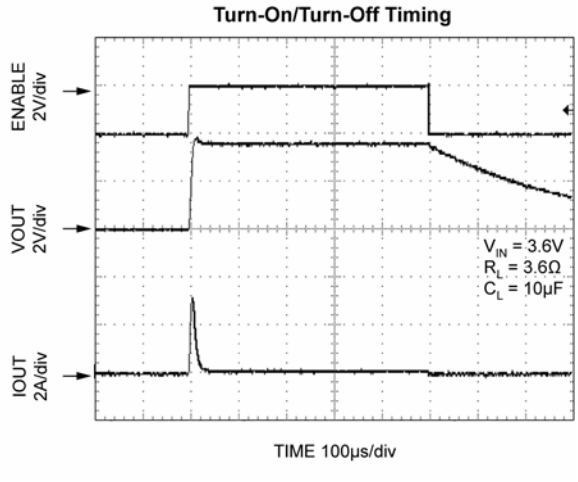
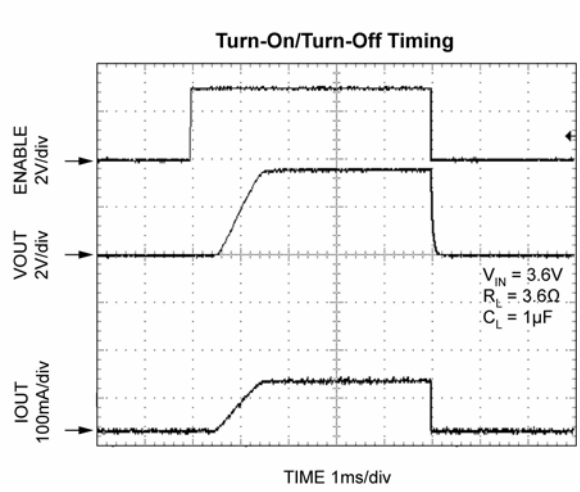
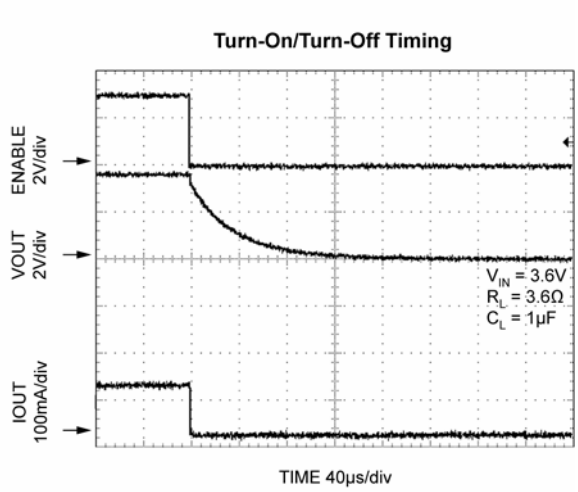
VOUT 2V/div
IOUT 2A/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 10µF
TIME 10µs/div


Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 2A/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 10µF
TIME 100µs/div

MIC94062


Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 1µF
TIME 1ms/div


Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
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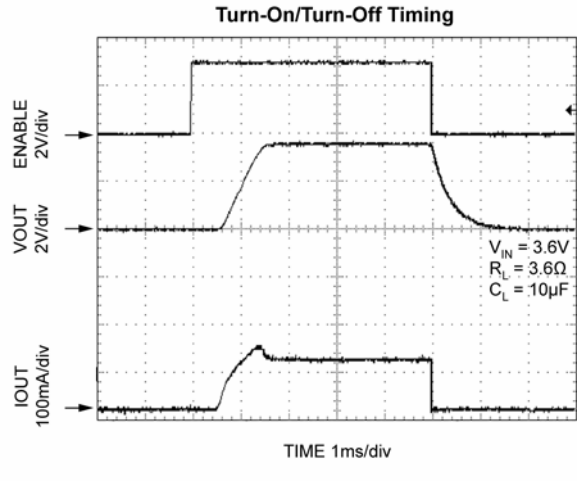
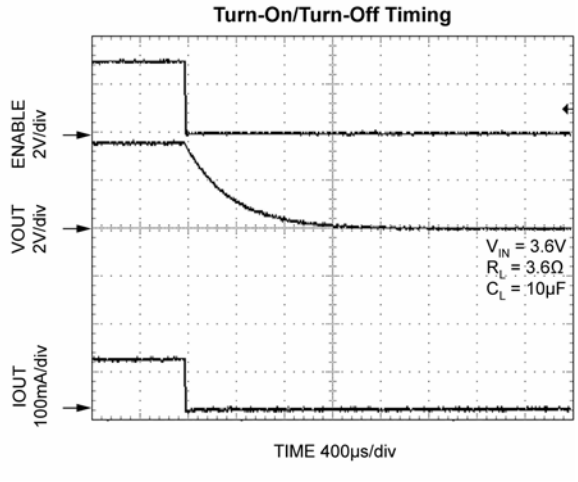
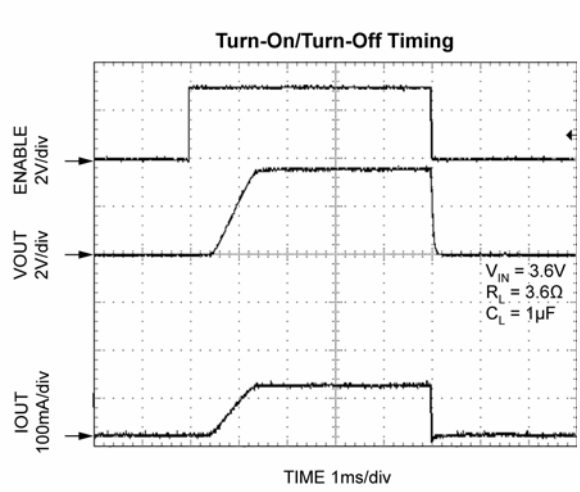
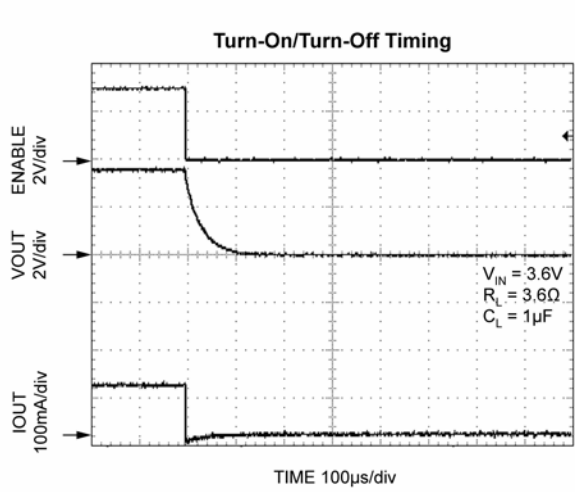
R_L = 3.6Ω
C_L = 1µF
TIME 40µs/div

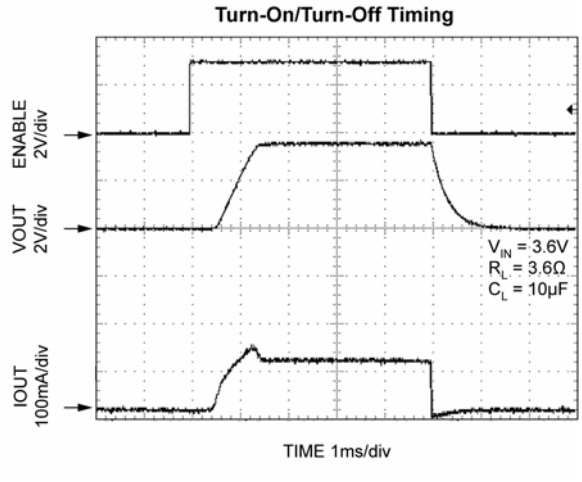

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 10µF
TIME 1ms/div

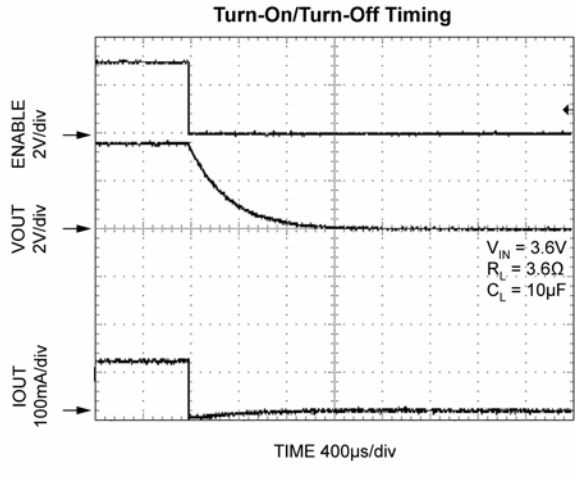

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 10µF
TIME 400µs/div

MIC94063

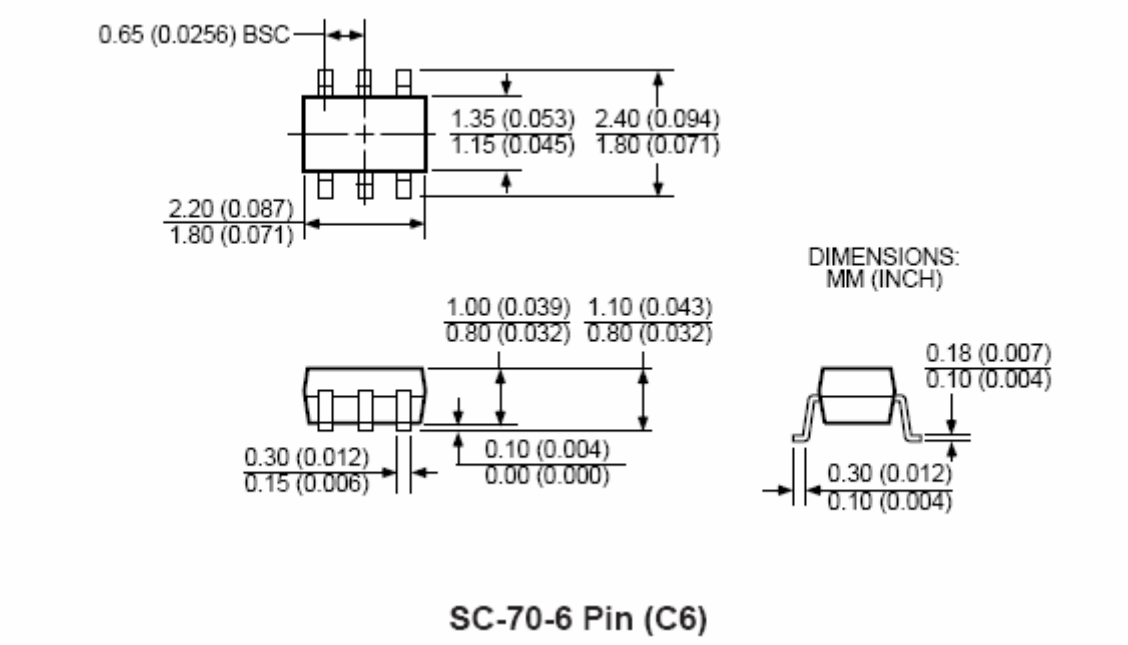

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 1µF
TIME 1ms/div


Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 1µF
TIME 100µs/div

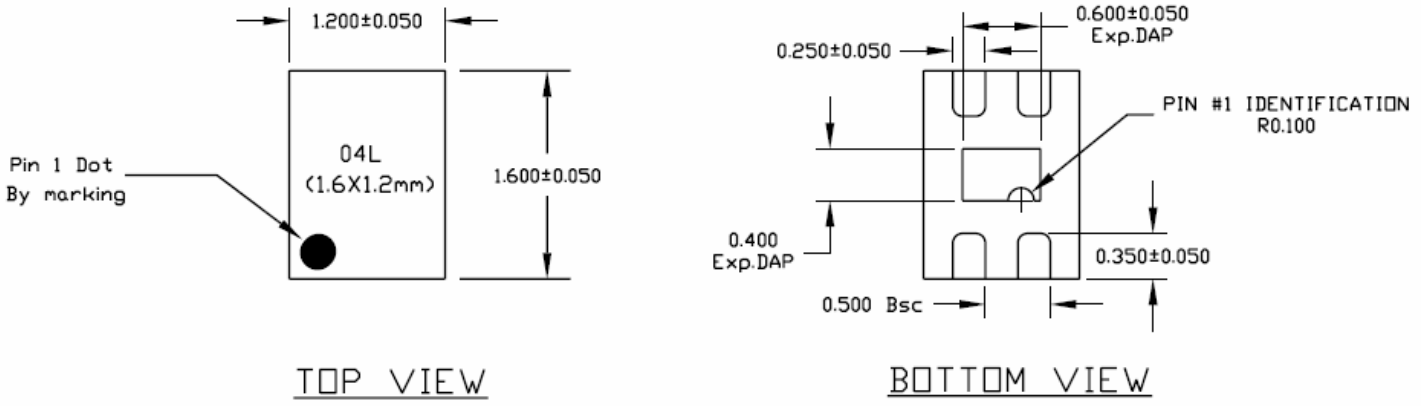

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 10µF
TIME 1ms/div


Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 10µF
TIME 400µs/div

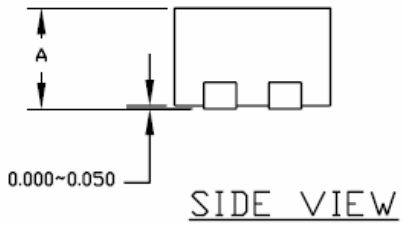
Package Information



SC-70-6 Pin (C6)



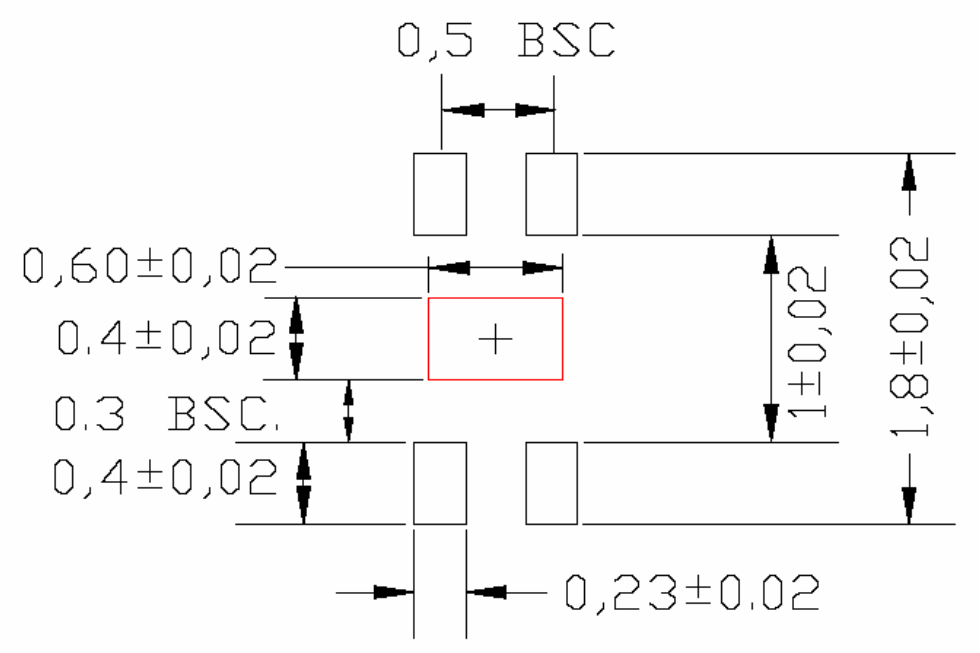
Note:
MLF and TMLF share the same exposure outline but with different thickness dimensions



		MLF	TMLF
A	MAX.	0.800	0.600
	NOM.	0.750	0.550
	MIN.	0.700	0.500

MLF and Thin MLF packages

Recommended Land Pattern for MLF 1.2x1.6 4 Lead



Optional for maximum thermal performance. Heatsink should be connected to GND plane of PCB for maximum thermal performance.

Disclaimer: This is only a recommendation based on information available to Micrel from its suppliers. Actual land pattern may have to be significantly different due to various materials and processes used in PCB assembly. Micrel makes no representation or warranty of performance based on the recommended land pattern."

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