MIC94070/71/72/73

High Side Power Switches

General Description

The MIC94070-73 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 1.2A of continuous current. The MIC94071 and MIC94073 feature an active load discharge circuit which insures capacitive loads retain no charge when the main switch is in an OFF state.

MIC94070-71 feature rapid turn on while MIC94072-73 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 MIC94070-73 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.

MIC94070-73'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.

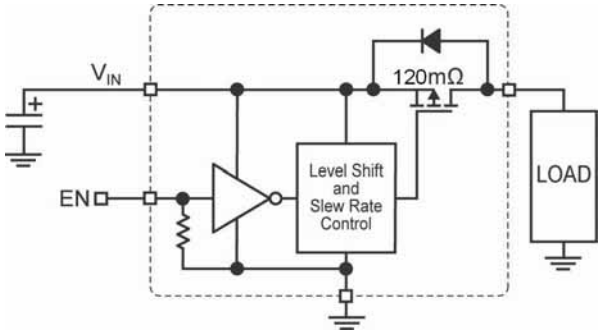
Features

- 1.7V to 5.5V input voltage range
- 1.2A continuous operating current
- 3A pulse current
- 120mΩ R_{DSON} (typical)
- Built-in level shift for control logic; can be operated by 1.5V logic.
- Low 2µA quiescent current
- Soft-Start: MIC94072/73
- Micro-power shutdown <1µA
- Load discharge circuit: MIC94071, MIC94073
- Space saving 1.2mm × 1.6mm Thin MLF® package

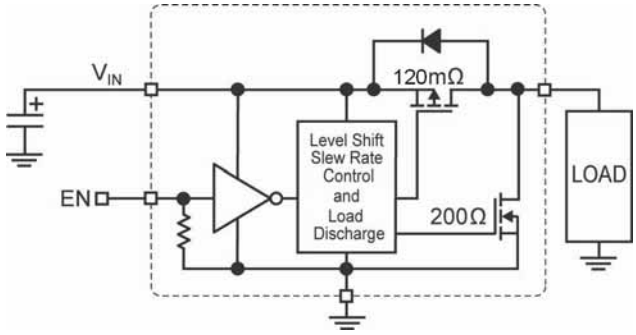
Applications

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

Typical Application



MIC94070, 72
Load Switch Application



MIC94071, 73
Load Switch with Capacitive Load Discharge

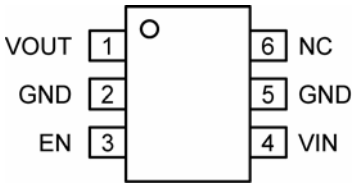
Ordering Information

Part Number		Part Marking[1]		Fast Turn On	Soft-Start	Load Discharge	Package
Standard	Pb-Free	Standard	Pb-Free				
—	MIC94070YC6	—	70P	•			SC-70-6
—	MIC94071YC6	—	71P	•		•	SC-70-6
—	MIC94072YC6	—	72P		•		SC-70-6
—	MIC94073YC6	—	73P		•	•	SC-70-6
—	MIC94070YMT	—	P70	•			1.2mm x 1.6mm Thin MLF®
—	MIC94071YMT	—	P71	•		•	1.2mm x 1.6mm Thin MLF®
—	MIC94072YMT	—	P72		•		1.2mm x 1.6mm Thin MLF®
—	MIC94073YMT	—	P73		•	•	1.2mm x 1.6mm Thin MLF®

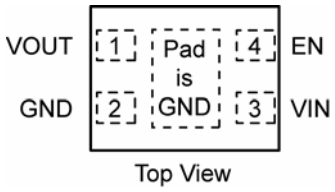
Notes

1. Under-bar symbol on SC-70 Pb-free packages may not be to scale.

Pin Configuration



SC-70-6 (C6)



1.2x1.6 mm Thin MLF® (MT)

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 (MLF®) ..... ±1.2A
T_A = 25°C (SC-70) ..... ±1.2A
Pulsed Drain Current (I_{DP}) (4) ..... ±3.0A
Continuous Diode Current (I_S) (4) ..... –50mA
Storage Temperature (T_s) ..... –55°C to +150°C
ESD Rating – HBM (6) 4KV

Operating Ratings (2)

Input Voltage (V_{IN}) ..... +1.7 to +5.5V
Junction Temperature (T_J) ..... –40°C to +125°C
Package Thermal Resistance
SC-70-6 (θ_{JA}) ..... 240°C/W
1.2mm × 1.6mm MLF® (θ_{JA}) ..... 172°C/W
1.2mm × 1.6mm MLF® (θ_{JC}) (3) ..... 134°C/W

Electrical Characteristics

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_Q	Supply Current	V_{IN} = V_{EN} = 5.5V, I_D = OPEN Measured on the V_{IN} pin (7)		50nA	5	µA
I_{EN}	Enable Input Current	V_{IN} = V_{EN} = 5.5V, I_D = OPEN		2	4	µA
I_{SHUT-Q}	Shutdown Current	V_{IN} = +5.5V, V_{EN} = 0V, I_D = OPEN Measured on the V_{IN} pin (7)		25nA	1	µA
$I_{SHUT-SWITCH}$	OFF State Leakage Current	V_{IN} = +5.5V, V_{EN} = 0V, I_D = SHORT Measured on V_{OUT} (7)		50nA	1	µA
$R_{DS(ON)}$	P-Channel Drain to Source ON Resistance SC-70 Package	V_{IN} = +5.0V, I_D = –100mA, V_{EN} = 1.5V		120	170	mΩ
		V_{IN} = +4.5V, I_D = –100mA, V_{EN} = 1.5V		130	185	mΩ
		V_{IN} = +3.6V, I_D = –100mA, V_{EN} = 1.5V		145	210	mΩ
		V_{IN} = +2.5V, I_D = –100mA, V_{EN} = 1.5V		165	225	mΩ
		V_{IN} = +1.8V, I_D = –100mA, V_{EN} = 1.5V		200	260	mΩ
		V_{IN} = +1.7V, I_D = –100mA, V_{EN} = 1.5V		210	285	mΩ
$R_{DS(ON)}$	P-Channel Drain to Source ON Resistance MLF Package	V_{IN} = +5.0V, I_D = –100mA, V_{EN} = 1.5V		100	160	mΩ
		V_{IN} = +4.5V, I_D = –100mA, V_{EN} = 1.5V		110	165	mΩ
		V_{IN} = +3.6V, I_D = –100mA, V_{EN} = 1.5V		125	180	mΩ
		V_{IN} = +2.5V, I_D = –100mA, V_{EN} = 1.5V		145	200	mΩ
		V_{IN} = +1.8V, I_D = –100mA, V_{EN} = 1.5V		180	240	mΩ
		V_{IN} = +1.7V, I_D = –100mA, V_{EN} = 1.5V		190	265	mΩ
$R_{SHUTDOWN}$	Turn-Off Resistance	V_{IN} = +3.6V, I_{TEST} = 1mA, V_{EN} = 0V MIC94071, 73		200	400	Ω

Electrical Characteristics (Dynamic)

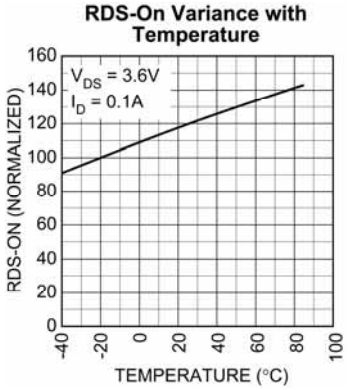
V_{IN} = 5V; T_A = 25°C, bold values indicate –40°C≤ T_A ≤ +85°C, unless noted.

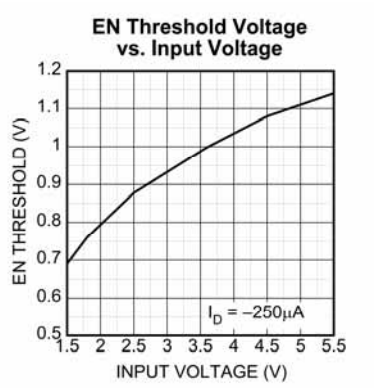
Symbol	Parameter	Condition	Min	Typ	Max	Units
t_{ON_DLY}	Turn-On Delay Time	V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94070, 71		0.85	1.5	µs
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94072, 73		700	1200	µs
t_{ON_RISE}	Turn-On Rise Time	V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94070, 71	0.5	1	5	µs
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94072, 73	500	800	1500	µs
t_{OFF_DLY}	Turn-Off Delay Time	V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94070, 71		100	200	ns
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94072, 73		60	200	ns
t_{OFF_FALL}	Turn-Off Fall Time	V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94070, 71		60	100	ns
		V_{IN} = +3.6V, ID = –100mA, V_{EN} = 1.5V MIC94072, 73		60	100	ns

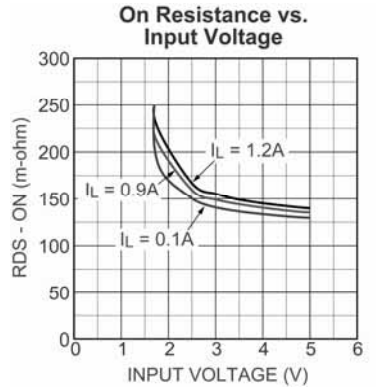
Notes:

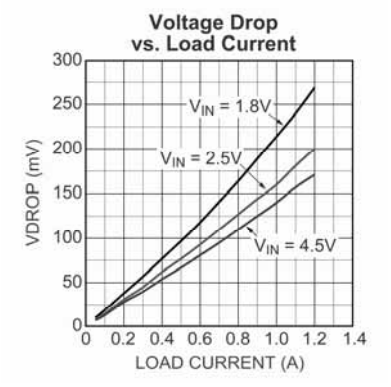
1. Exceeding the absolute maximum rating may damage the device.
2. The device is not guaranteed to function outside its operating rating.
3. With backside thermal contact to PCB.
4. Pulse width <300µs with < 2% duty cycle.
5. Continuous body diode current conduction (reverse conduction, i.e. V_{OUT} to V_{IN}) is not recommended.
6. Devices are ESD sensitive. Handling precautions recommended. HBM (Human body model), 1.5k in series with 100pF.
7. Measured on the MIC94070YMT, for other part numbers, please contact Micrel.

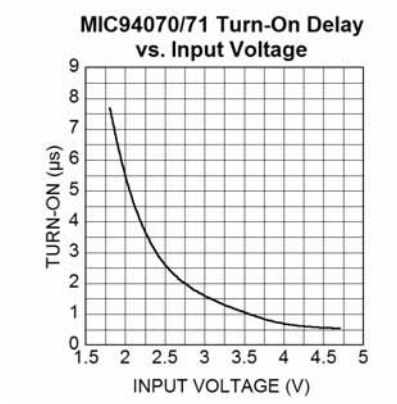
Typical Characteristics

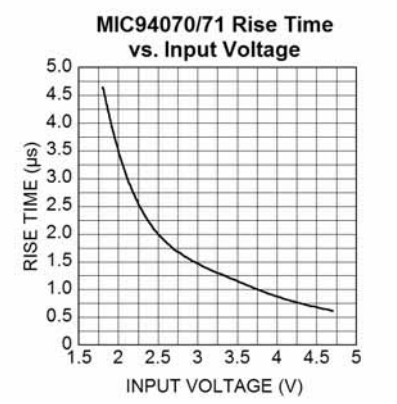


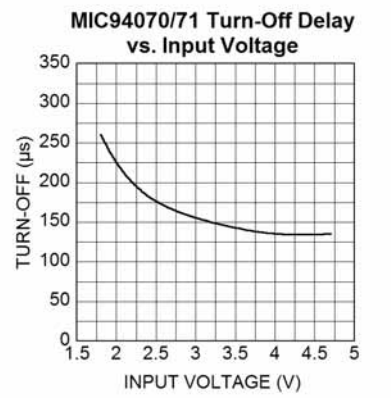


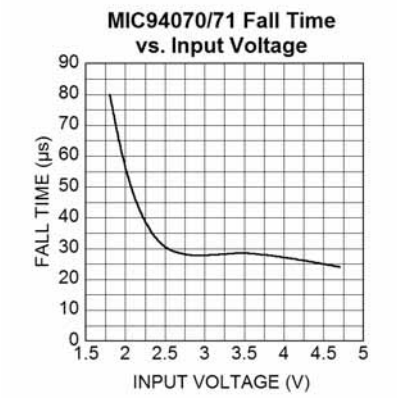


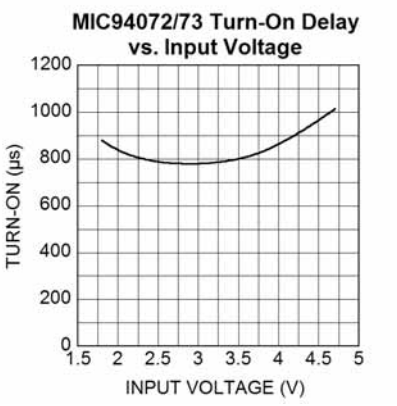


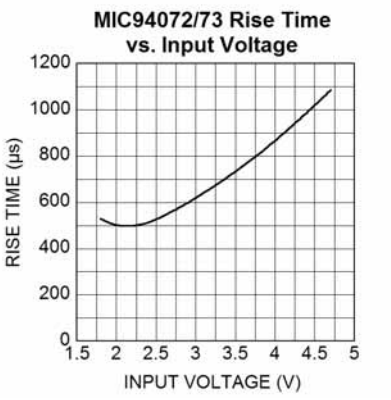


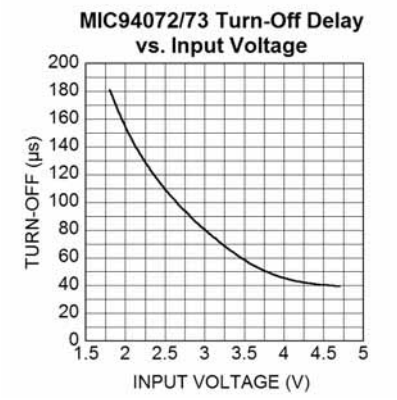


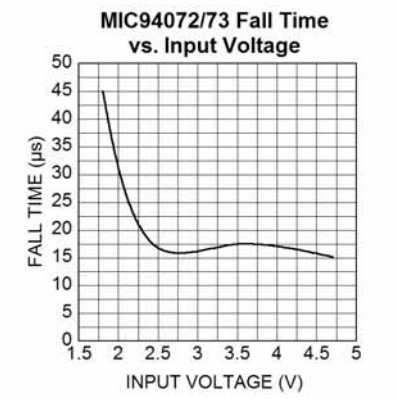






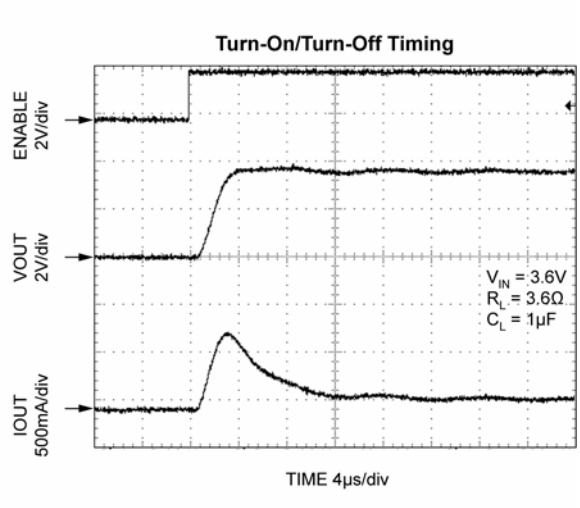


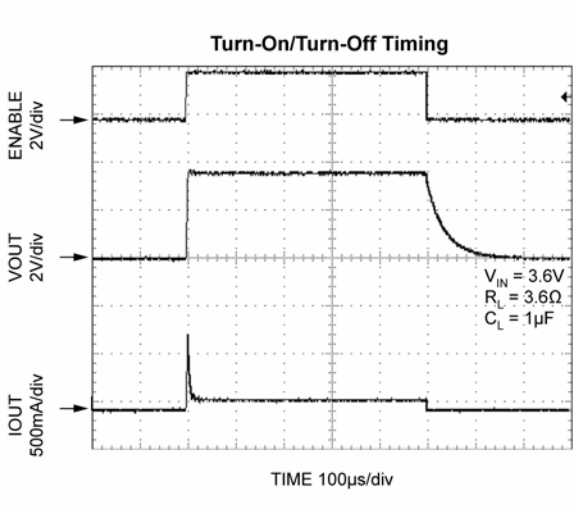


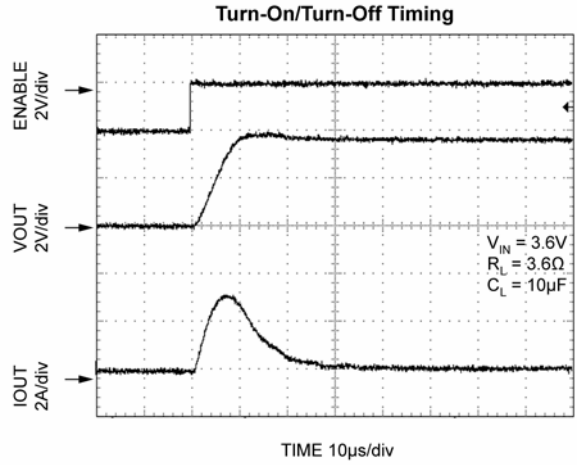


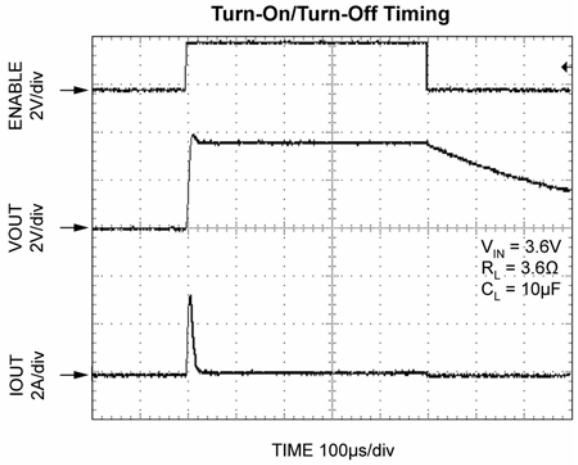
Functional Characteristics

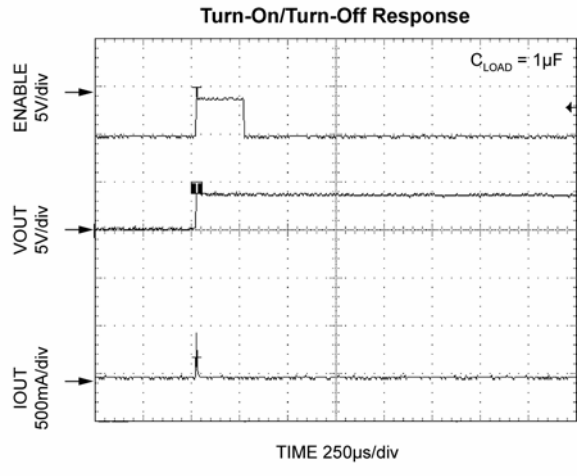
MIC94070

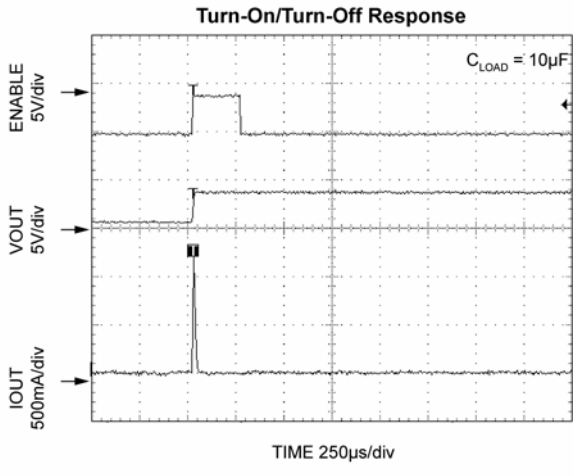




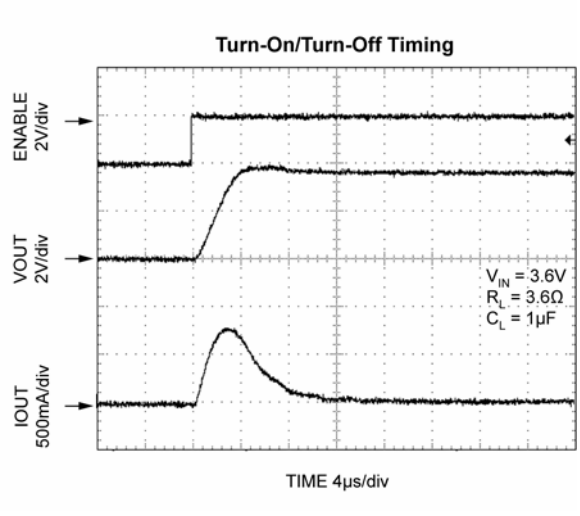


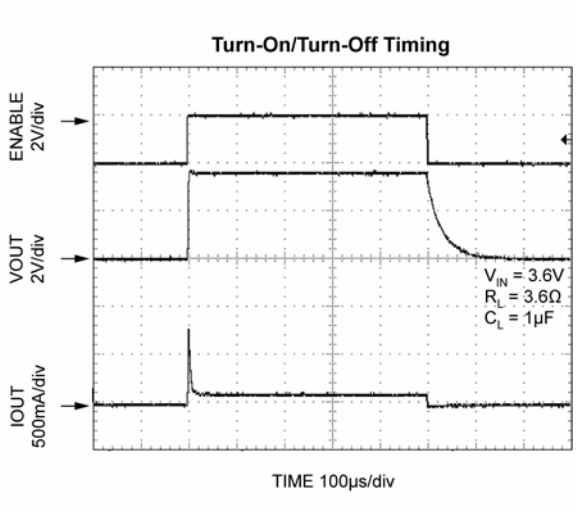


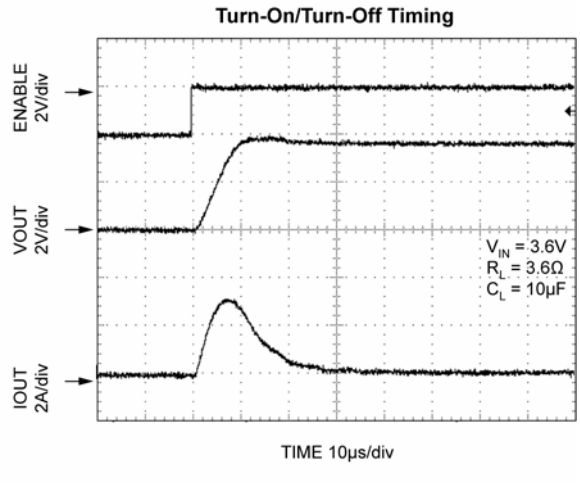


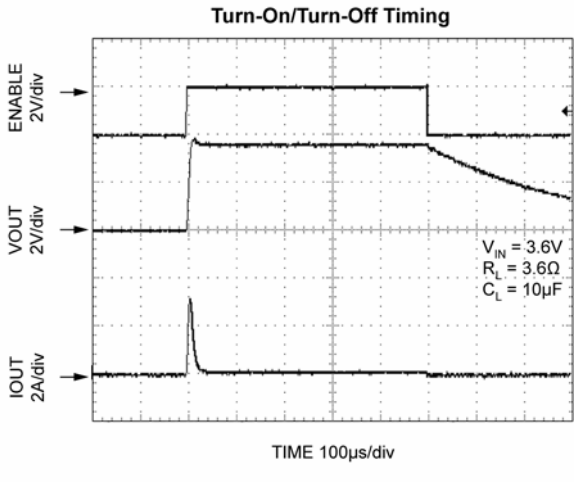


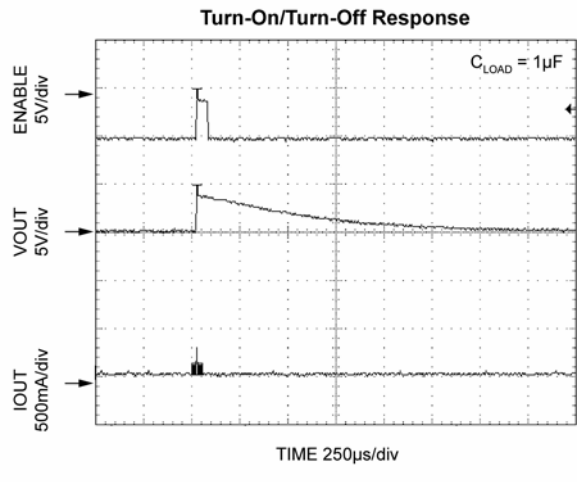
MIC94071

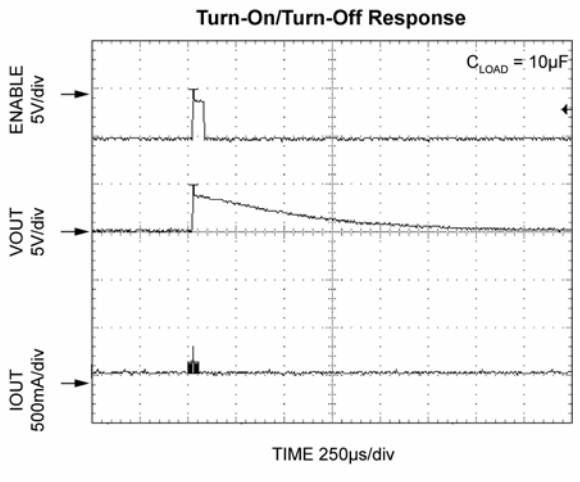

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 500mA/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 1µF
TIME 4µs/div


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

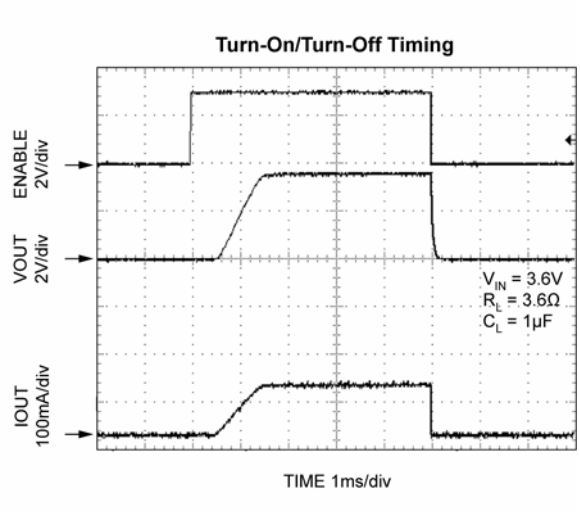

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 2A/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 10µF
TIME 10µs/div

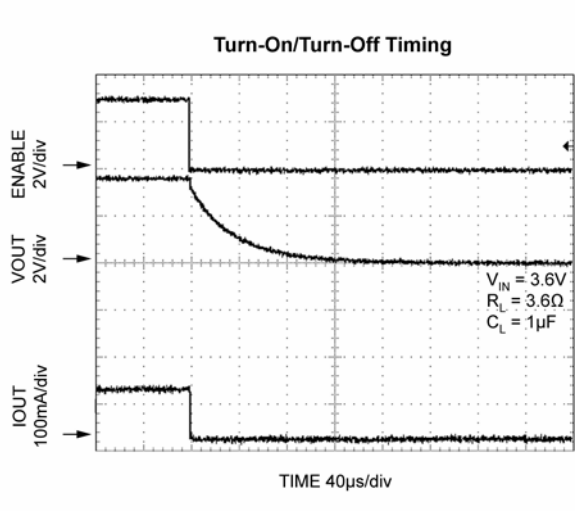

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 2A/div
V_{IN} = 3.6V
R_L = 3.6Ω
C_L = 10µF
TIME 100µs/div

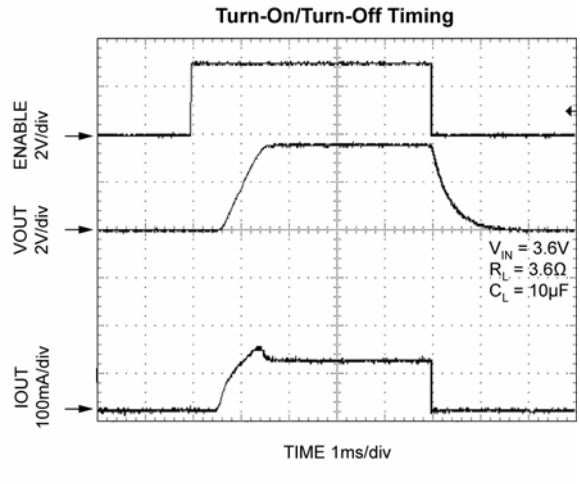

Turn-On/Turn-Off Response
ENABLE 5V/div
VOUT 5V/div
IOUT 500mA/div
C_{LOAD} = 1µF
TIME 250µs/div

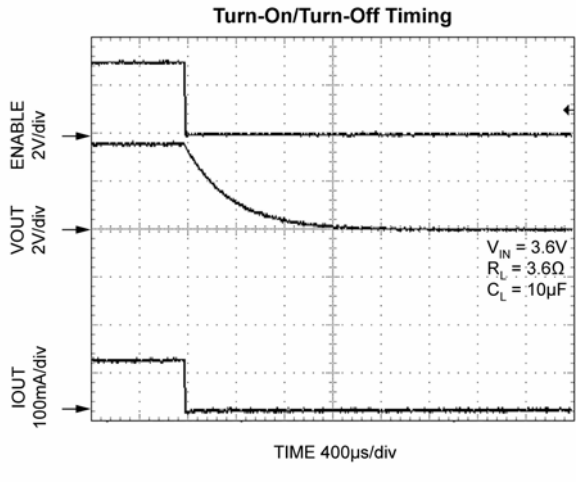

Turn-On/Turn-Off Response
ENABLE 5V/div
VOUT 5V/div
IOUT 500mA/div
C_{LOAD} = 10µF
TIME 250µs/div

MIC94072

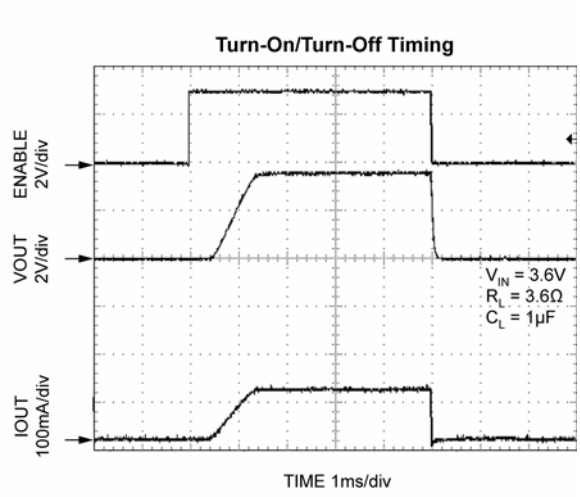

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
VIN = 3.6V
RL = 3.6Ω
CL = 1µF
TIME 1ms/div

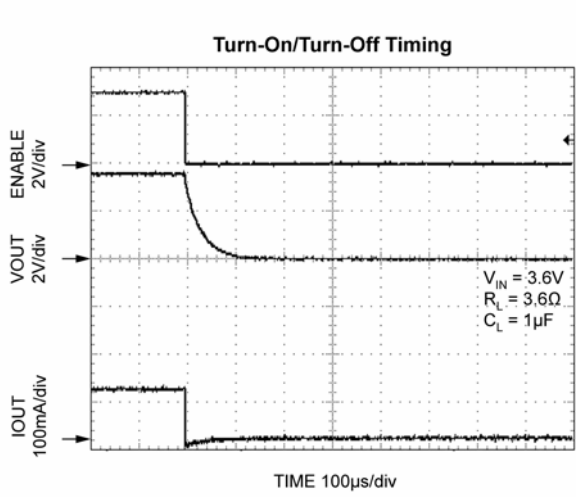

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
VIN = 3.6V
RL = 3.6Ω
CL = 1µF
TIME 40µs/div

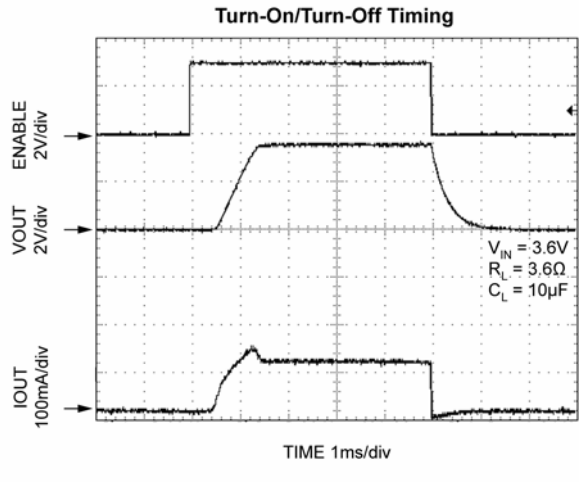

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
VIN = 3.6V
RL = 3.6Ω
CL = 10µF
TIME 1ms/div

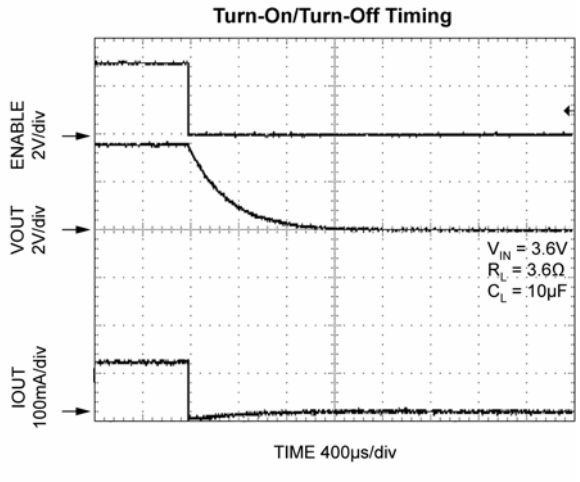

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
VIN = 3.6V
RL = 3.6Ω
CL = 10µF
TIME 400µs/div

MIC94073

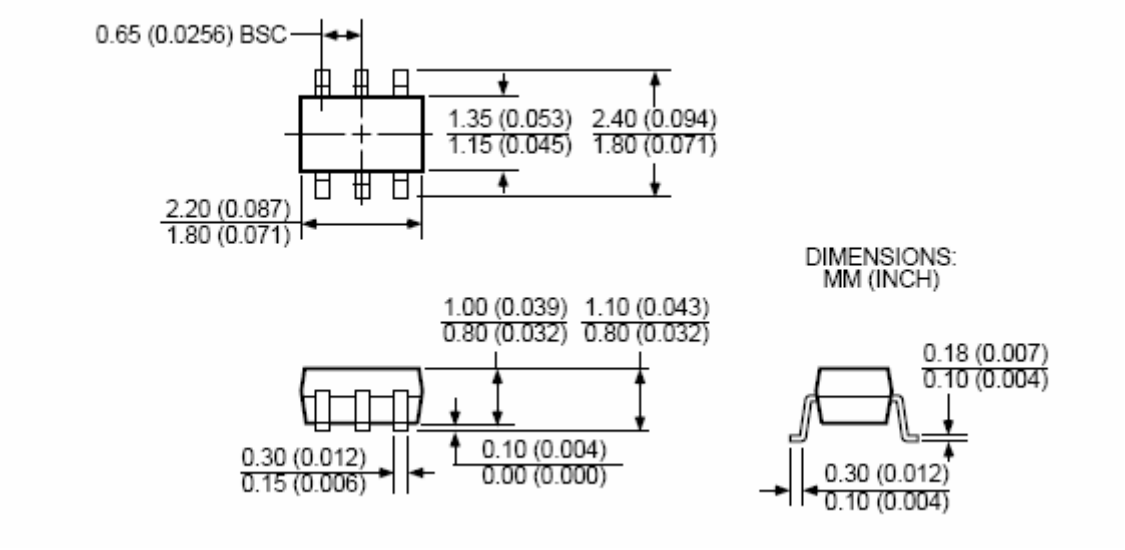

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
VIN = 3.6V
RL = 3.6Ω
CL = 1µF
TIME 1ms/div


Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
VIN = 3.6V
RL = 3.6Ω
CL = 1µF
TIME 100µs/div

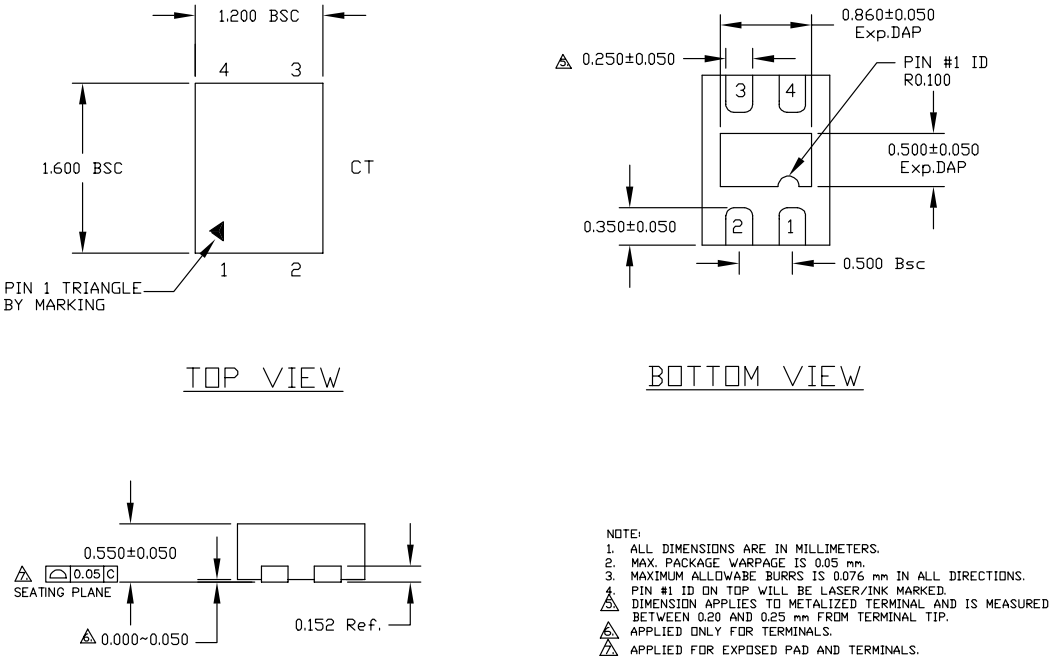

Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
VIN = 3.6V
RL = 3.6Ω
CL = 10µF
TIME 1ms/div


Turn-On/Turn-Off Timing
ENABLE 2V/div
VOUT 2V/div
IOUT 100mA/div
VIN = 3.6V
RL = 3.6Ω
CL = 10µF
TIME 400µs/div

Package Information

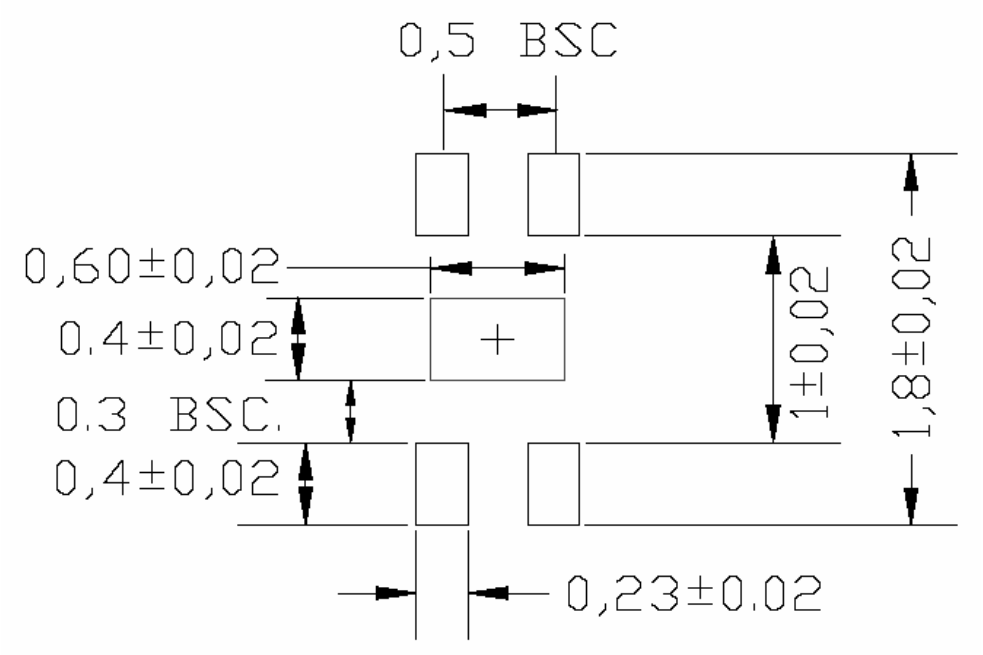


6-Pin SC-70 (C6)



4-Pin Thin MLF® (MT)

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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