

General Description

The MAX891L/MAX892L smart, low-voltage, P-channel, MOSFET power switches are intended for high-side load-switching applications. These switches operate with inputs from 2.7V to 5.5V, making them ideal for both 3V and 5V systems. Internal current-limiting circuitry protects the input supply against overload. Thermaloverload protection limits power dissipation and junction temperatures.

The MAX891L/MAX892L's maximum current limits are 500mA and 250mA, respectively. The current limit through the switch is programmed with a resistor from SET to ground. When the switch is on, the guiescent supply current is a low 13µA. When the switch is off, the quiescent current decreases to 0.1µA.

The MAX891L/MAX892L are available in 8-pin µMAX packages.

Applications

PCMCIA Slots Access Bus Slots Portable Equipment

Features

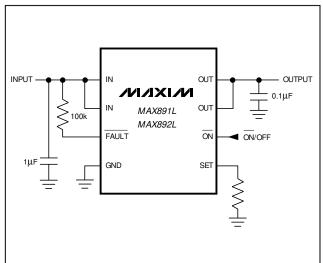
- ♦ Ultra-Small µMAX Package—Only 1.11mm High
- ♦ 2.7V to 5.5V Input Range
- **♦ Programmable Current Limit**
- ♦ Low 13µA Quiescent Current at V_{IN} = 3.3V, 0.1µA Switch Off
- **♦ Thermal Shutdown**
- **♦ FAULT Indicator Output**
- ♦ On-Resistances: 0.12Ω (MAX891L) 0.25Ω (MAX892L)

Ordering Information

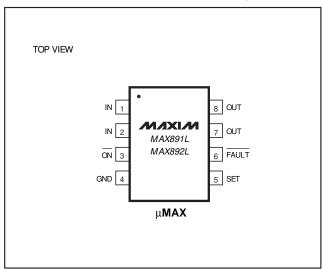
PART	TEMP. RANGE	PIN- PACKAGE	CURRENT LIMIT	
MAX891LC/D	0°C to +70°C	Dice**	500mA	
MAX891LEUA*	-40°C to +85°C	8 μMAX	500mA	
MAX892LC/D	0°C to +70°C	Dice**	250mA	
MAX892LEUA*	-40°C to +85°C	8 μMAX	250mA	

^{*} To order these units in tape and reel, add (-T) to the end of the part number.

Typical Operating Circuit



Pin Configuration



NIXIN

Maxim Integrated Products 1

^{**} Dice are tested at TA = +25°C.

ABSOLUTE MAXIMUM RATINGS

IN to GND	0.3V to 6V
ON, FAULT to GND	0.3V to 6V
SET, OUT to GND	$0.3V$ to $(V_{IN} + 0.3V)$
Maximum Continuous Switch Current	
MAX891L	0.75A
MAX892L	0.375A

Continuous Power Dissipation $(T_A = +70)$	°C)
μMAX (derate 4.1mW/°C above +70°C)	330mW
Operating Temperature Range	
MAX891LEUA/MAX892LEUA	40°C to +85°C
Storage Temperature Range	
Lead Temperature (soldering, 10sec)	+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

 $(V_{IN} = 3V, T_A = 0^{\circ}C \text{ to } +85^{\circ}C, \text{ unless otherwise noted.}$ Typical values are at $T_A = +25^{\circ}C.)$

PARAMETER	COND	MIN	TYP	MAX	UNITS			
Operating Voltage						5.5	V	
Quiescent Current	$V_{IN} = 5V, \overline{ON} = GND, I_{OU}$	Γ = 0mA			13	20	μΑ	
Off-Supply Current	$\overline{ON} = IN, V_{IN} = V_{OUT} = 5.5$	δV			0.02	1	μΑ	
Off-Switch Current	\overline{ON} = IN, V_{IN} = 5.5V, V_{OUT}	r = 0V			0.02	3	μΑ	
Undervoltage Lockout	Rising edge, 1% hysteresi	S		2.0	2.3	2.6	V	
	V _{IN} = 4.5V MAX891L MAX892L				120	225		
					250	420	mΩ	
On-Resistance		MAX891L			150	300		
	$V_{IN} = 3.0V$	MAX892L		300	500	mΩ		
Current-Limit-Amplifier Accuracy	V _{SET} required to turn the s	witch off (Note	e 1)	1.178	1.240	1.302	V	
M : 0 : 10 : 1	MAX891L		500					
Maximum Output Current	MAX892L		250		mA			
	1 0 1 1 0 0 1	MAX891L, I	OUT = 250mA	840	965	1130	0.70	
I _{OUT} to I _{SET} Current Ratio	V _{OUT} = 1.6V to 2.8V MAX892L, I _O		OUT = 125mA	840	965	1130	A/A	
ON Input Low Voltage	V _{IN} = 2.7V to 5.5V					0.8	V	
	V _{IN} = 2.7V to 3.6V							
ON Input High Voltage	$V_{IN} = 4.5V \text{ to } 5.5V$	2.4			V			
ON Input Leakage	V ON = 5.5V			-1	0.01	1	μΑ	
I _{SET} Bias Current	V _{SET} = 1.24V, I _{OUT} = 0mA	ı			0.5	3	μΑ	
FAULT Logic Output Low Voltage	I _{SINK} = 1mA, V _{SET} = 1.4V				0.4	V		
FAULT Logic Output High Leakage	V FAULT = 5.5V, VSET = 1V				0.05	1	μΑ	
Slow-Current-Loop Response Time	20% current overdrive, V _{IN} = 5V				5		μs	
Fast-Current-Loop Response Time					2		μs	
Town On Town	I _{OUT} = 250mA (MAX891L), or 125mA (MAX892L)		V _{IN} = 5V		100	200		
Turn-On Time			V _{IN} = 3V		150		μs	
Turn-Off Time	V _{IN} = 5V			0.8	2	20	μs	

ELECTRICAL CHARACTERISTICS

 $(V_{IN} = 3V, T_A = -40$ °C to +85°C, unless otherwise noted.) (Note 2)

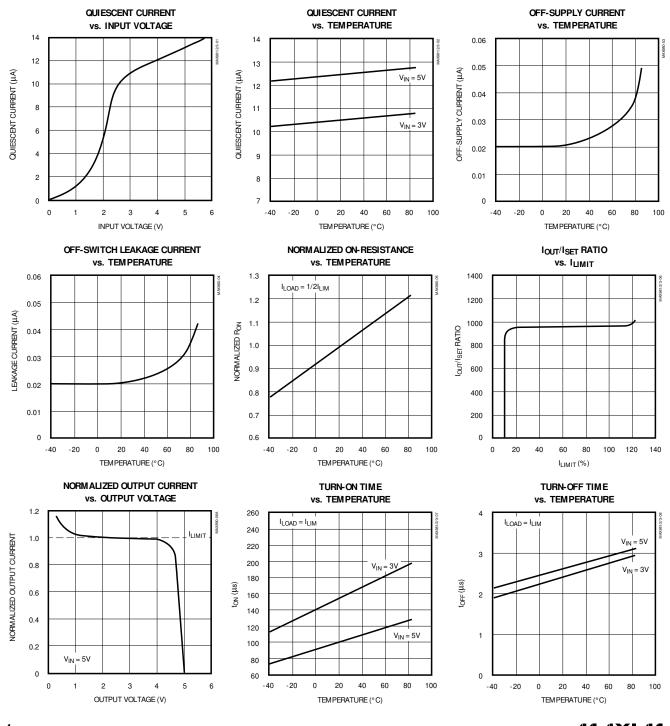
PARAMETER	COND	MIN	TYP	MAX	UNITS		
Operating Voltage		3.0		5.5	V		
Quiescent Current	V _{IN} = 5V, $\overline{\text{ON}}$ = GND, I _{OU}	T = 0mA			50	μΑ	
Off-Supply Current	$\overline{ON} = IN, V_{IN} = V_{OUT} = 5.5$	5V			2.2	μΑ	
Off-Switch Current	$\overline{ON} = IN, V_{IN} = 5.5V, V_{OU}$	T = 0V			8	μΑ	
Undervoltage Lockout	Rising edge, 1% hysteres	Rising edge, 1% hysteresis				V	
On-Resistance	V _{IN} = 4.5V	MAX891L			225	mΩ	
	VIN = 4.5V	MAX892L			420		
	V _{IN} = 3.0V	MAX891L			300	mΩ	
	VIN = 3.0V	MAX892L			500		
Current-Limit-Amplifier Accuracy	V _{SET} required to turn the s	1.14		1.34	V		
IOUT to ISET Current Ratio	V _{OUT} = 1.6V to 2.8V	MAX891L, I _{OUT} = 250mA	805		1210	A/A	
100) to ISE1 Current natio	MAX892L, I _{OUT} = 1.8V to 2.8V		805		1210		
FAULT Logic Output Low Voltage	ISINK = 1mA, V _{SET} = 1.4V			0.4	V		
Turn-On Time	V _{IN} = 5V				200	μs	
Turn-Off Time	V _{IN} = 5V	0.25		20	μs		

Note 1: Tested with I_{OUT} = 50mA for the MAX891L, 25mA for the MAX892L, and V_{SET} raised until V_{IN} - $V_{OUT} \ge 0.8V$.

Note 2: Parameters to -40°C are guaranteed by design, not production tested.

Typical Operating Characteristics

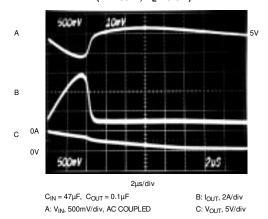
(Typical Operating Circuit, T_A = +25°C, unless otherwise noted.)



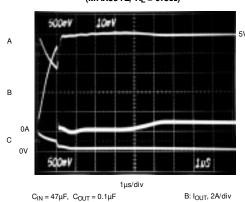
Typical Operating Characteristics (continued)

(Typical Operating Circuit, T_A = +25°C, unless otherwise noted.)

CURRENT-LIMIT RESPONSE (MAX891L, $R_L = 0.8\Omega$)



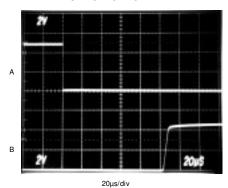
CURRENT-LIMIT RESPONSE (MAX891L, $R_L = 0.5\Omega$)



 $C_{IN} = 47\mu F$, $C_{OUT} = 0.1\mu F$ A: V_{IN} , 500mV/div, AC COUPLED

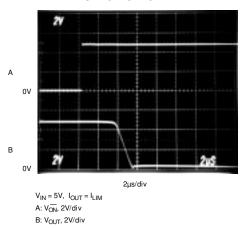
C: V_{OUT}, 5V/div

SWITCH TURN-ON TIME

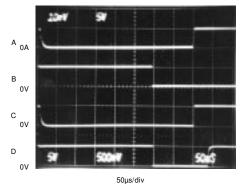


 $V_{IN} = 5V$, $I_{OUT} = I_{LIM}$ A: V_{ON}^{-} , 2V/divB: V_{OUT} , 2V/div

SWITCH TURN-OFF TIME



SWITCH TIMING CHARACTERISTICS



V_{IN} = 5V A: I_{LOAD}, 0.1A/div B: V_{ON}, 5V/div

C: V_{OUT}, 5V/div D: V_{FAULT}, 5V/div

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PIN	NAME	FUNCTION
1, 2	IN	Input. P-channel MOSFET source. Bypass IN with a 1μF capacitor to ground.
3	ŌN	Active-Low Switch On Input. A logic low turns the switch on.
4	GND	Ground
5	SET	Set Current-Limit Input. A resistor from SET to ground sets the current limit for the switch. See Setting the Current Limit section.
6	FAULT	Fault-Indicator Output. This open-drain output goes low when in current limit or when the die temperature exceeds +135°C.
7, 8	OUT	Switch Output. P-channel MOSFET drain. Bypass OUT with a 0.1µF capacitor to ground.

Detailed Description

The MAX891L/MAX892L P-channel MOSFET power switches limit output current to a user-programmed level. When the output current is increased beyond the set current level, the current is also increased through the replica switch (IOUT/965) and through RSET (Figure 1). The current-limit error amplifier compares the voltage across RSET to the internal 1.24V reference and regulates the current back to the lesser of the programmed current limit (ILIMIT) or the maximum current limit (IMAX).

These switches are not bidirectional; therefore, the input voltage must be higher than the output voltage.

Setting the Current Limit

The MAX891L/MAX892L feature internal current-limiting circuitry with maximum programmable values (I_{MAX}) of 500mA and 250mA, respectively. For best performance, set the current limit (I_{LIMIT}) between $0.2I_{MAX} \le I_{LIMIT} \le I_{MAX}$. This current limit remains in effect throughout the input supply-voltage range.

Program the current limit with a resistor (RSET) from SET to ground (Figure 2) as follows:

ISET = ILIMIT / IRATIO RSET = 1.240 / ISET

where I_{LIMIT} is the desired current limit, and I_{RATIO} is the I_{OUT} to I_{SET} current ratio (965).

Short-Circuit Protection

The MAX891L/MAX892L are short-circuit-protected switches. In the event of an output short circuit or current-overload condition, the current through the switch is limited by the internal current-limiting error amplifier to 1.5 x I_{LIMIT}. When the fault condition is removed, the replica error amplifier sets the current limit back to I_{LIMIT}.

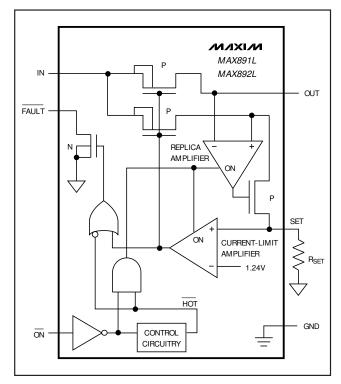


Figure 1. Functional Diagram

For a high $\Delta D_{\rm DS}/\Delta$ during an output short-circuit condition, the switch turns off and disconnects the input supply from the output. The current-limiting amplifier then slowly turns the switch on with the output current limited to 1.5 x I_{LIMIT}. When the fault condition is removed, the current limit is set back to I_{LIMIT}. Refer to the Current-Limit Response graphs in the *Typical Operating Characteristics*.

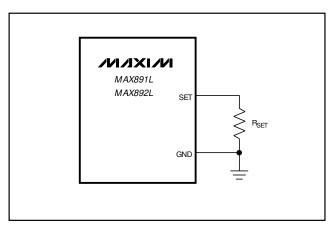


Figure 2. Setting the Current Limit

Thermal Shutdown

The MAX891L/MAX892L feature thermal shutdown. The switch turns off when the junction temperature exceeds +135°C. Once the device cools by 10°C, the switch turns back on. If the fault short-circuit condition is not removed, the switch will cycle on and off, resulting in a pulsed output.

Fault Indicator

The MAX891L/MAX892L provide a fault output (\overline{FAULT}). This open-drain output goes low when in current limit or when the die temperature exceeds +135°C. During start-up, \overline{FAULT} is low until the switch is fully on and no over-current condition exists. A $100k\Omega$ pull-up resistor from \overline{FAULT} to IN provides a logic-control signal.

Applications Information

Input Capacitor

To limit input voltage drop during momentary output short-circuit conditions, connect a capacitor from IN to GND. A 1µF ceramic capacitor is adequate for most applications; however, higher capacitor values further reduce voltage drop at the input.

Output Capacitor

Connect a 0.1µF capacitor from OUT to GND. One function of this capacitor is to prevent inductive parasitics from pulling OUT negative during turn-off.

Layout and Thermal-Dissipation Consideration

To take full advantage of the switch-response time to output short-circuit conditions, it is very important to keep all traces as short as possible to reduce the effect of undesirable parasitic inductance. Place input and output capacitors as close as possible to the device (no more than 5mm).

Under normal operating conditions, the package dissipates and channels heat away. Calculate maximum power as follows:

$P = I^2LIM \times RON$

where RON is the on-resistance of the switch.

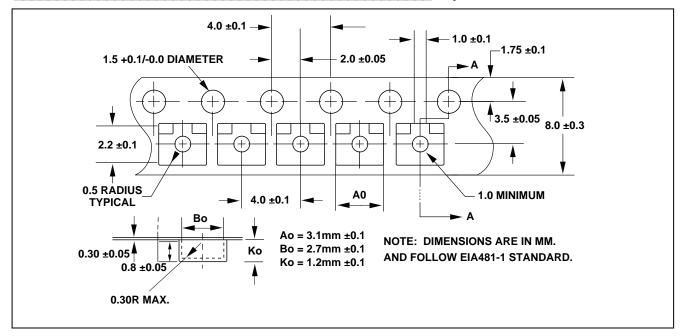
When the output is short circuited, voltage drop across the switch equals the input supply. Hence, the power dissipated across the switch increases, as does the die temperature. If the fault condition is not removed, the thermal-overload-protection circuitry turns the switch off until the die temperature falls by 10°C. A ground plane in contact with the device helps dissipate additional heat.

_Chip Information

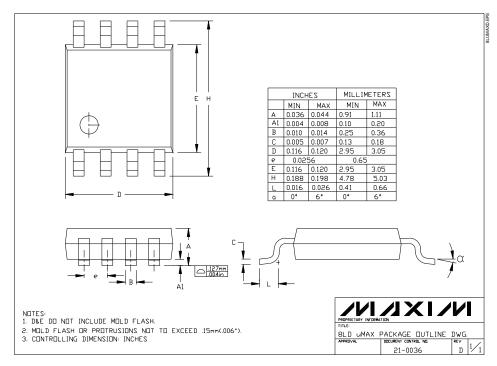
TRANSISTOR COUNT: 396

SUBSTRATE CONNECTED TO GND

Tape-and-Reel Information



Package Information



Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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