ABSOLUTE MAXIMUM RATINGS

IN, $\overline{EN}$ to GND ....-0.3V to +6V
OUT to GND ....-0.3V to (V_{IN} + 0.3V)
Maximum Switch Current.........................2.3A (internally limited)
OUT Short Circuit to GND ....Continuous
Continuous Power Dissipation (T_A = +70°C)
8-Pin SO (derate 5.88mW/°C above +70°C)................471mW
Operating Temperature Range (extended).........-40°C to +85°C
Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10s) ....+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} = 5V, **T_A = 0°C to +85°C**, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OPERATING CONDITION							
Input Voltage	V_{IN}			2.7		5.5	V
POWER SWITCH							
Switch Static Drain-Source On-Resistance	$R_{DS(ON)}$	T_A = +25°C	V_{IN} = 4.4V to 5.5V		70	100	mΩ
		T_A = 0°C to +85°C	V_{IN} = 4.4V to 5.5V			125	
			V_{IN} = 3V		72	150	
Switch Turn-On Time	t_{ON}	I_{LOAD} = 400mA			80	200	µs
Switch Turn-Off Time	t_{OFF}	I_{LOAD} = 400mA		3	6	20	µs
ENABLE INPUT ($\overline{EN}$)							
$\overline{EN}$ High-Level Input Voltage	V_{IH}	V_{IN} = 2.7V to 3.6V		2.0			V
		V_{IN} = 3.7V to 5.5V		2.4			
$\overline{EN}$ Low-Level Input Voltage	V_{IL}	V_{IN} = 2.7V to 5.5V				0.8	V
$\overline{EN}$ Input Current		$V_{\overline{EN}}$ = V_{IN} or GND		-1		+1	µA
Startup Time		V_{IN} = 5V, C_{OUT} = 150µF from $\overline{EN}$ driven low to 50% full V_{OUT}			1		ms
CURRENT LIMIT							
Overload Output Current	I_{LIMIT}	Force V_{OUT} to 4.5V		1.2	1.75	2.3	A
Short-Circuit Output Current	I_{SC}	OUT shorted to GND			1	1.5	A
SUPPLY CURRENT							
Supply Current, Low-Level Input		$V_{\overline{EN}}$ = V_{IN} = V_{OUT} = 5.5V			0.002	1	µA
Supply Current, High-Level Input	I_Q	$V_{\overline{EN}}$ = 0, I_{OUT} = 0	Timer not running		16	25	µA
			Timer running		35		
Supply Leakage Current		$V_{\overline{EN}}$ = V_{IN} = 5.5V, V_{OUT} = 0	T_A = +25°C		0.01	2	µA
			T_A = 0°C to +85°C			15	
UNDERVOLTAGE LOCKOUT							
Undervoltage Lockout	UVLO	Rising edge, 100mV hysteresis		2.0	2.4	2.6	V
THERMAL SHUTDOWN							
Thermal-Shutdown Threshold					165		°C

ELECTRICAL CHARACTERISTICS

(V_{IN} = 5V, **T_A = -40°C to +85°C**, unless otherwise noted.) (Note 1)

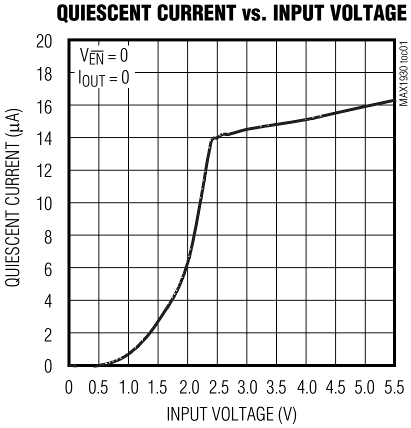
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
OPERATING CONDITION						
Input Voltage	V_{IN}		3.0		5.5	V
POWER SWITCH						
Switch Static Drain-Source On-Resistance	$R_{DS(ON)}$	V_{IN} = 4.4V to 5.5V			125	mΩ
		V_{IN} = 3V			150	
Switch Turn-On Time	t_{ON}	I_{LOAD} = 400mA			200	µs
Switch Turn-Off Time	t_{OFF}	I_{LOAD} = 400mA	1		20	µs
ENABLE INPUT ($\overline{EN}$)						
$\overline{EN}$ High-Level Input Voltage	V_{IH}	V_{IN} = 3V to 3.6V	2.0			V
		V_{IN} = 3.7V to 5.5V	2.4			
$\overline{EN}$ Low-Level Input Voltage	V_{IL}	V_{IN} = 3V to 5.5V			0.8	V
$\overline{EN}$ Input Current		$V_{\overline{EN}}$ = V_{IN} or GND	-1		+1	µA
CURRENT LIMIT						
Overload Output Current	I_{LIMIT}	Force V_{OUT} to 4.5V	1.2		2.3	A
Short-Circuit Output Current	I_{SC}	OUT shorted to GND			1.5	A
SUPPLY CURRENT						
Supply Current, Low-Level Input		$V_{\overline{EN}}$ = V_{IN} = V_{OUT} = 5.5V			2	µA
Supply Current, High-Level Input	I_Q	$V_{\overline{EN}}$ = GND, I_{OUT} = 0, timer not running			25	µA
Supply Leakage Current		$V_{\overline{EN}}$ = V_{IN} = 5.5V, V_{OUT} = GND			15	µA
UNDERVOLTAGE LOCKOUT						
Undervoltage Lockout	UVLO	Rising edge, 100mV hysteresis	2.0		2.9	V

Note 1: Specifications to -40°C are guaranteed by design, not production tested.

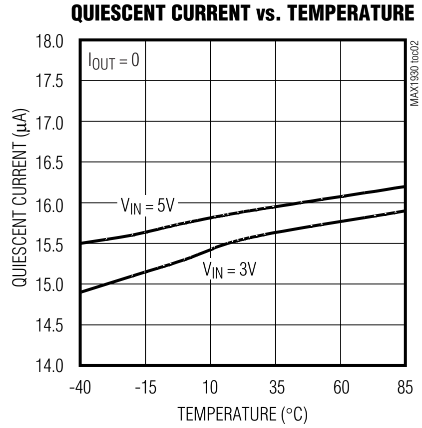
Typical Operating Characteristics

(Circuit of Figure 2, V_{IN} = 5V, T_A = +25°C, unless otherwise noted.)

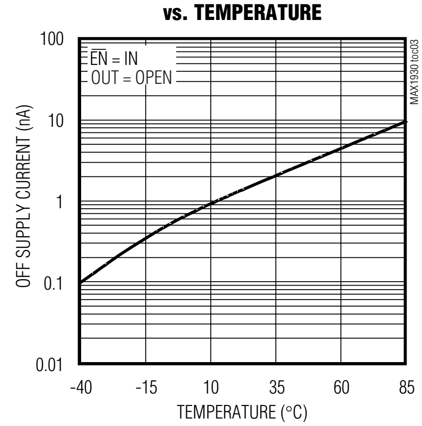
QUIESCENT CURRENT vs. INPUT VOLTAGE



QUIESCENT CURRENT vs. TEMPERATURE



OFF SUPPLY CURRENT vs. TEMPERATURE

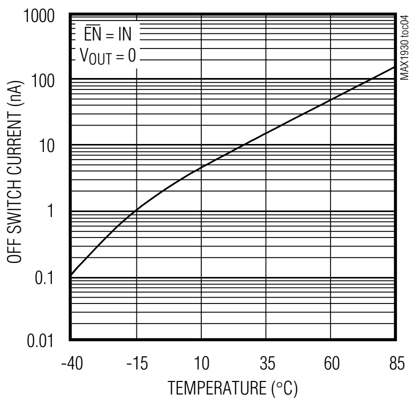


Current-Limited Switch for Two USB Ports

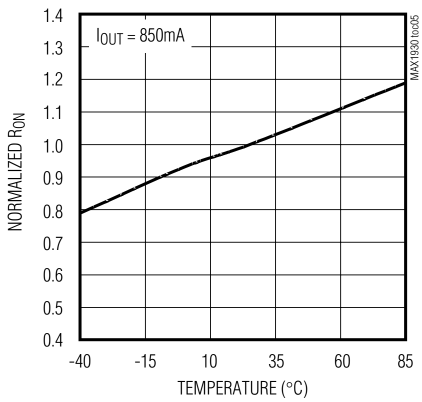
Typical Operating Characteristics (continued)

(Circuit of Figure 2, V_{IN} = 5V, T_A = +25°C, unless otherwise noted.)

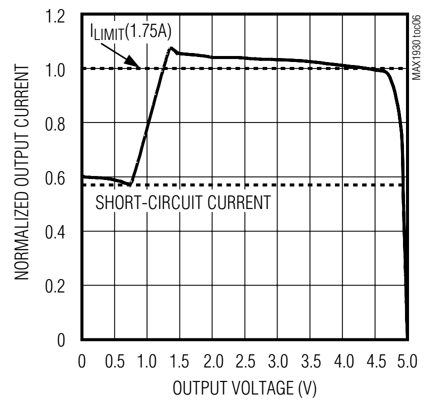
OFF SWITCH CURRENT vs. TEMPERATURE



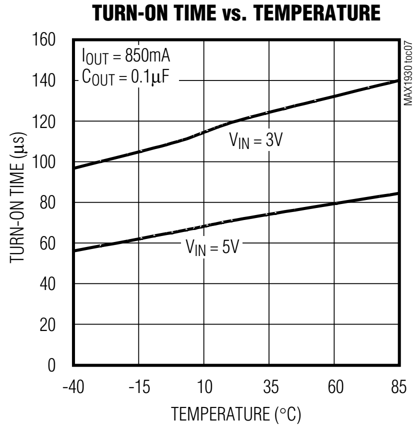
NORMALIZED ON-RESISTANCE vs. TEMPERATURE



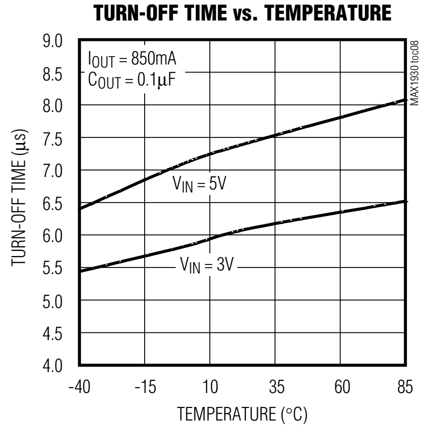
NORMALIZED OUTPUT CURRENT vs. OUTPUT VOLTAGE



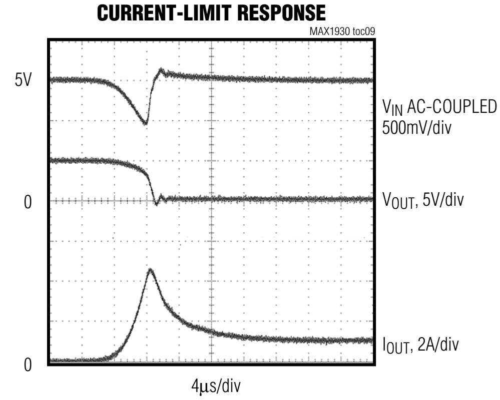
TURN-ON TIME vs. TEMPERATURE



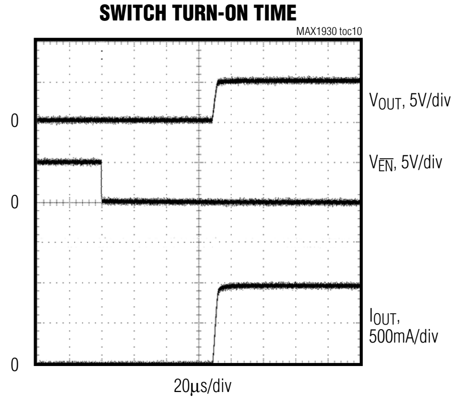
TURN-OFF TIME vs. TEMPERATURE



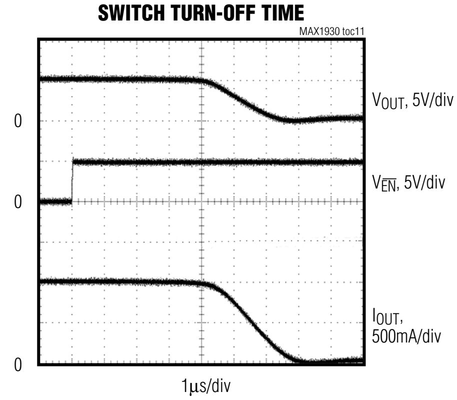
CURRENT-LIMIT RESPONSE



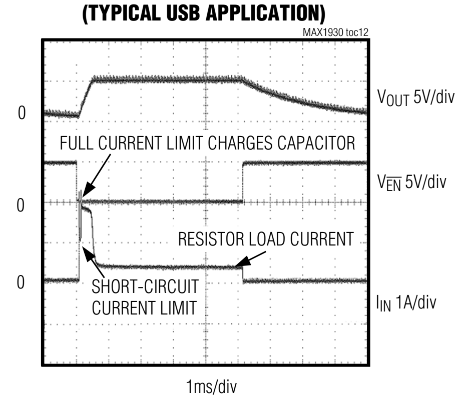
SWITCH TURN-ON TIME



SWITCH TURN-OFF TIME



STARTUP TIME (TYPICAL USB APPLICATION)



Pin Description

PIN	NAME	FUNCTION
1	GND	Ground
2, 3	IN	Input. P-channel MOSFET source—connect all IN pins together and bypass with a 1µF capacitor to ground.
4	$\overline{EN}$	Active-Low Switch Enable Input. A logic low turns on the switch.
5	OUTNC	No Connection. This pin is not internally connected and can be connected to OUT.
6, 7, 8	OUT	Switch Output. P-channel MOSFET drain—connect all OUT pins together and bypass with a 0.1µF capacitor to ground.

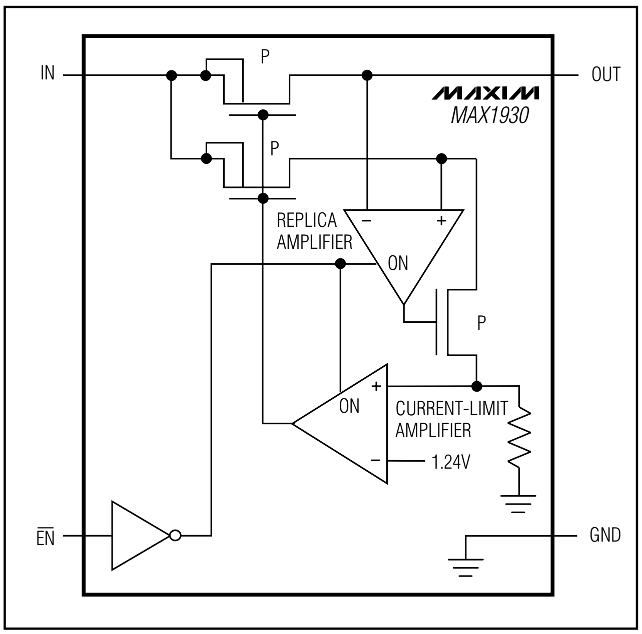


Figure 1. Functional Diagram

Detailed Description

The MAX1930 P-channel MOSFET power switch limits output current to 1.2A (min) and 2.3A (max). When the output current increases beyond the current limit (I_{LIMIT}), the current also increases through the replica switch (I_{OUT} / 13,000). The current-limit error amplifier compares the voltage to the internal 1.24V reference and regulates the current back to the I_{LIMIT} (Figure 1).

These switches are not bidirectional. As a result, the input voltage must be higher than the output voltage.

Continuous Short-Circuit Protection

The MAX1930 is a short-circuit protected switch. In the event of an output short-circuit condition, the current through the switch is foldback-current-limited to 1A continuous.

Thermal Shutdown

The MAX1930 has a thermal shutdown feature. The switch turns off when the junction temperature exceeds +165°C. When the MAX1930 cools 20°C, the switch turns back on. If the fault short-circuit condition is not removed, the switch cycles on and off, resulting in a pulsed output.

Applications Information

Input Capacitor

To limit the 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 the voltage drop at the input (Figure 2).

Output Capacitor

Connect a 0.1µF capacitor from OUT to GND. This capacitor helps to prevent inductive parasitics from pulling OUT negative during turn-off.

Layout and Thermal Dissipation

It is important to optimize the switch response time to output short-circuit conditions by keeping 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 away). All IN and OUT pins must be connected with short traces to the power bus. Wide power-bus planes provide superior heat dissipation through the MAX1930's IN and OUT pins.

Under normal operating conditions, the package can dissipate and channel heat away. Calculate the maximum power dissipation as follows:

$$P = (I_{LIMIT})^2 \times R_{ON}$$

where I_{LIMIT} is the preset current limit (2.3A max) and R_{ON} is the on-resistance of the switch (125mΩ max).

When the output is short circuited, foldback-current-limiting activates and the voltage drop across the switch equals the input supply voltage. The power dissipated across the switch increases, as does the die tempera-

Current-Limited Switch for Two USB Ports

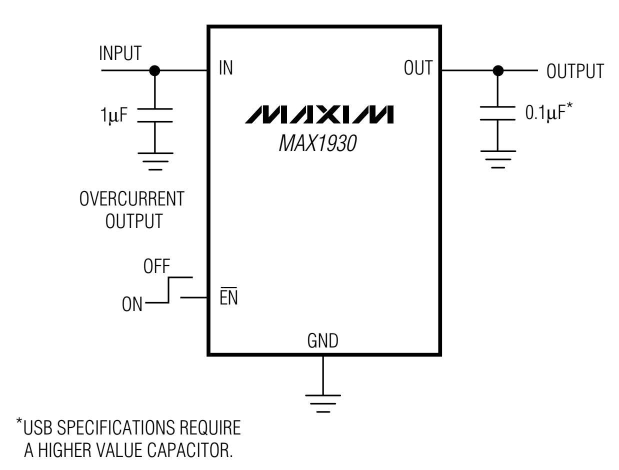


Figure 2. Typical Application Circuit

ture. If the fault condition is not removed, the thermal-overload protection circuitry activates (see the *Thermal Shutdown* section). Wide power-bus planes connected to IN and OUT and a ground plane in contact with the device help dissipate additional heat.

Driving Inductive Loads

A wide variety of devices (mice, keyboards, cameras, and printers) can load the USB port. These devices commonly connect to the port with cables, which can add an inductive component to the load. This inductance causes the output voltage at the USB port to ring during a load step. The MAX1930 is capable of driving inductive loads, but avoid exceeding the device's absolute maximum ratings. Usually the load inductance is relatively small, and the MAX1930's input includes a substantial bulk capacitance from an upstream regulator, as well as local bypass capacitors, limiting overshoot. If severe ringing occurs due to large load inductance, clamp the MAX1930 output below 6V and above -0.3V.

Chip Information

TRANSISTOR COUNT: 715

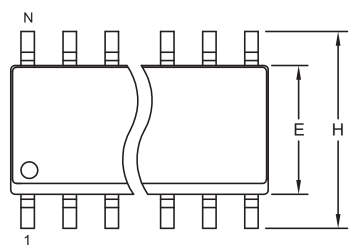
PROCESS: BiCMOS

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

SOICN .EPS

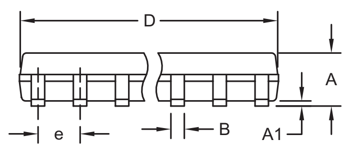
	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050 BSC		1.27 BSC	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27



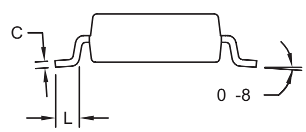
TOP VIEW

VARIATIONS:

	INCHES		MILLIMETERS			
DIM	MIN	MAX	MIN	MAX	N	MS012
D	0.189	0.197	4.80	5.00	8	AA
D	0.337	0.344	8.55	8.75	14	AB
D	0.386	0.394	9.80	10.00	16	AC



FRONT VIEW



SIDE VIEW

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. LEADS TO BE COPLANAR WITHIN 0.10mm (.004").
4. CONTROLLING DIMENSION: MILLIMETERS.
5. MEETS JEDEC MS012.
6. N = NUMBER OF PINS.

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

TITLE:

PACKAGE OUTLINE, .150" SOIC

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0041	B	1/1

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