

LS2406ERQ23 Evaluation Board

Quick Reference Guide

About this document

This user manual describes an advanced 24 V / 6 A rated efuse with reverse current blocking using built-in 24 mΩ ultra low RDS(ON) MOSFET. It contains the specification, PCB layout, schematic, bill of materials (BOM), current limit setting, Vin OVP setting, soft start, SW1 dip switch setting and terminal pins setting.

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1. Introduction

This reference board allows the user to evaluate the LS2406ERQ23 efuse. LS2406ERQ23 integrates multiple control and protection features, which provides enhanced controllability and reliability with simplified designs and minimal external components.

The LS2406ERQ23 is an advanced 28 V / 6 A rated eFuse. It protects power source and downstream circuitry connected to the switch from overloads, short circuits, voltage surges, and excessive inrush currents.

The output current limit can be set by a single external resistor. VIN overvoltage protection can be also set by a single external resistor and undervoltage lockout. VIN inrush current requirements can be set with a single external soft start capacitor.

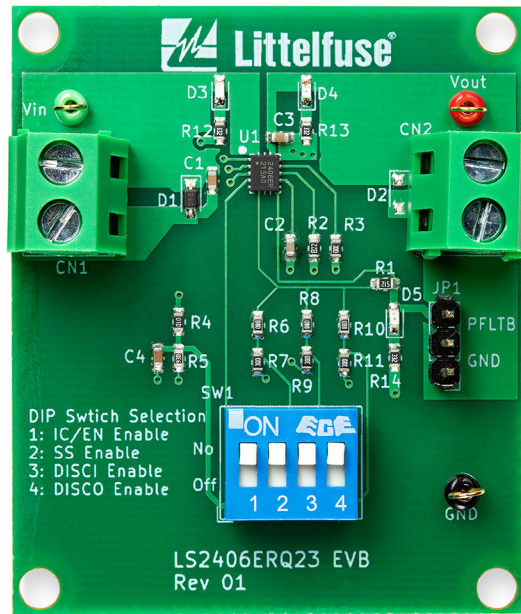
Vout voltage can be set by pulling pin DISCO high to help it discharge quickly.

The switch can be restarted by resetting the EN or VIN. It will recover automatically if there is no OCP, OTP, OVP or short circuit faults.

2. LS2406ERQ23 Evaluation Board (EVB)

This section covers LS2406ERQ23 28 V 6 A eFuse with reverse current blocking, PCB layout, schematic and BOM.

Figure 1. LS0502SCD33 Evaluation Board



2.1 PCB layout

Figure 2. Top-side Copper and Component

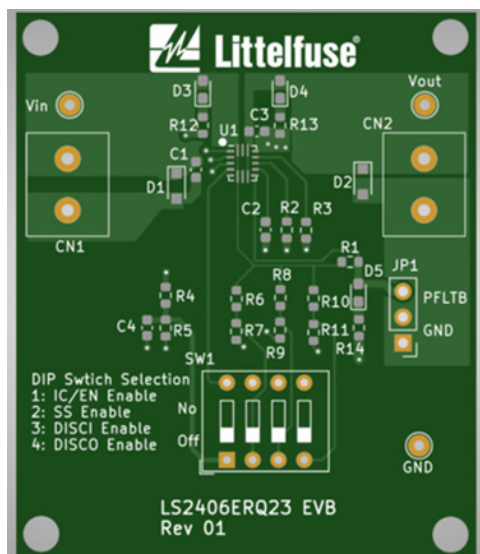
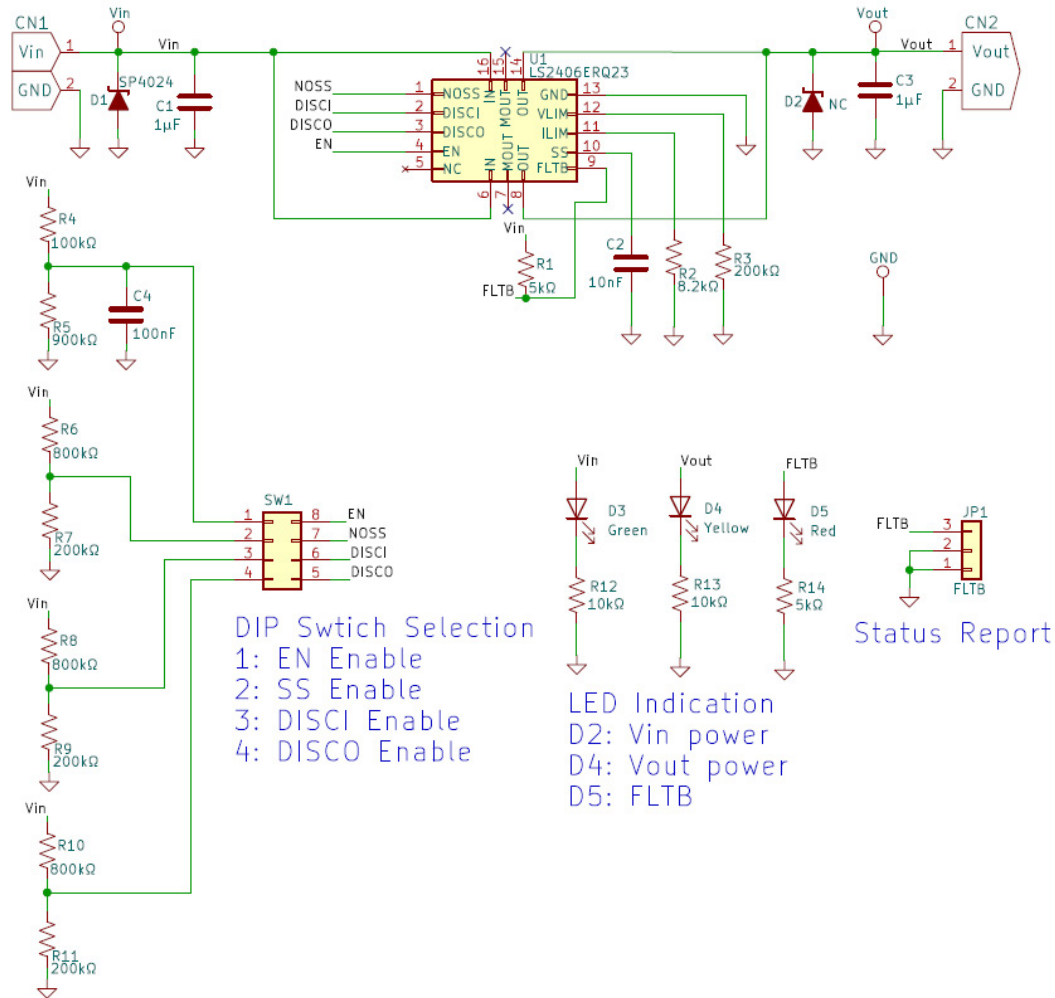


Figure 3. Bottom-side Copper



2.2 Schematic

Figure 4. Schematic



2.3 BOM

Table 1. BOM List

Item	Qty	Reference Designator	Description	Part Number	Manufacture	Package size
1	1	R1	RES 5 k OHM 1% 1/10 W 0603		Yageo	0603
2	1	R2	RES 8.2 k OHM 1% 1/10 W 0603		Yageo	0603
3	1	R3	RES 200 k OHM 1% 1/10 W 0603		Yageo	0603
4	1	R4	RES SMD 100 k OHM 1% 1/10 W 0603		Yageo	0603
5	1	R5	RES 900 k OHM 1% 1/10 W 0603		Yageo	0603
6	3	R6, R8, R10	RES 800 k OHM 1% 1/10 W 0603		Yageo	0603
7	3	R7, R9, R11	RES 200 k OHM 1% 1/10 W 0603		Yageo	0603
8	2	R12, R13	RES 10 k OHM 1% 1/10 W 0603		Yageo	0603
9	1	R14	RES 5 k OHM 1% 1/10 W 0603		Yageo	0603
10	2	C1, C3	CAP CER 1 µF 50 V X5R 0603		Yageo	0603
11	1	C2	CAP CER 10 µF 50 V X5R 0603		Yageo	0603
12	1	C4	CAP CER 10 µF 50 V X5R 0603		Yageo	0603
13	1	D1	TVS	SP4024	Littelfuse	SOD-123
14	1	D2	NC			
15	1	D3	LED GREEN CLEAR SMD	LTST-C191KGKT	LITE-ON	0603
16	1	D4	LED YELLOW CLEAR SMD	LTST-C191KSKT	LITE-ON	0603
17	1	D5	LED RED CLEAR SMD	LTST-C191KRKT	LITE-ON	0603
18	1	U1	eFuse IC	LS2406ERQ23	Littelfuse	QFN2.5x3.2
19	3	Vin, Vout, GND	PC TEST POINT MINIATURE	5000		
20	2	CN1, CN2	TERMINAL BLOCK, PLUGGABLE, 2P5.08	282836-2		
21	1	SW1	DIP SWITCH	5 PINS		
22	1	JP1	TERMINAL PINS	3 PINS		

3. Function Setting

Current Limit, Vin overvoltage protection and soft start time are adjustable. Current limit can be set by an external resistor. Vin overvoltage protection level can be also set by an external resistor. Otherwise, soft start time can be adjusted by an external capacitor. See the following for details.

3.1 Current Limit - RLIM Setting

For current limited adaptors or power sources, users can program the input current limit level to prevent the load current overload the source. The LS2406ERQ23 current limit is set with an external resistor RLIM connected between ILIM and GND. If over-load occurs, the internal circuitry limits the input current based on the value of RLIM and pulls FLTB pin LOW to report the fault condition. ILIM pin can't be short to GND. If the system requires a single component fail safe, choose two resistors in series to program input current limit. The current limit resistor RLIM is selected with Equation:

$$RLIM = 28 A * k\Omega / ILIM$$

Table 2. RLIM vs. Current Limit Relation

R _{LIM}	28	14	9.33	7	5.3	4.6
Current Limit I _{LIM}	1	2	3	4	5	6

3.2 Vin Overvoltage Protection

When EN pin is Logic Hi, the LS2406ERQ23 monitors the input supply voltage VIN. The input over-voltage protection circuit disables the power switch and pulls FLTB pin LOW to report the fault condition. If the input voltage is above input over-voltage threshold VOVP. Once the input voltage drops below input over-voltage threshold VOVP and no other protection circuit is active, the power switch resumes ON.

An external resistor RVLIM is connected from VLIM pin to GND to set the input over-voltage protection threshold VOVP. The device sources typical 10 μA to VLIM pin. The voltage drop VVLIM across the RVLIM resistor externally adjusts the input over-voltage threshold from 5 V to 24 V using Equation:

$$VOVP = KOVP * VVLM = 12 * 10 \mu A * RVLIM$$

Table 3. VLIM vs. Overvoltage Relation

R _{VLIM}	45.8	82.5	137.5	183.3
Input Overvoltage Threshold (V)	5.5	9.9	16.5	22

3.2 Soft Start – Rise Time Setting

When EN pin is asserted high, and NOSS pin is asserted low, the soft start control circuitry controls the gate voltage of the power switch in a manner such that the output voltage is ramped up linearly until it reaches input voltage level during power on. The in-rush current at power-on is limited by the regulated output voltage ramp up rate through the soft-start time. The built-in internal soft-start time is typical 0.8 msec. If users prefer the soft-start time longer than 0.8 msec, connect an external capacitor CSS between SS pin and ground to re-adjust the soft-start time. The external soft-start time is approximately calculated by the below equation:

$$T_{ss} = C_{ss} * 1.67 * 10^5$$

Table 4. Capacitance vs. Soft Start Time Relation

C _{ss} Value (nF)	None or < 4.7nF	10	33	47	100
Soft-start Time T _{ss} (msec)	0.8	1.6	5.5	7.8	16.7

4. EN by the Dip Switch, Terminal Pins, LED Indication and EVB Default Setting

System Set-up: The following table lists a summary of the dip switch setting and terminal pins to configure the EVB for operation.

Figure 5. EVB connector and jumpers

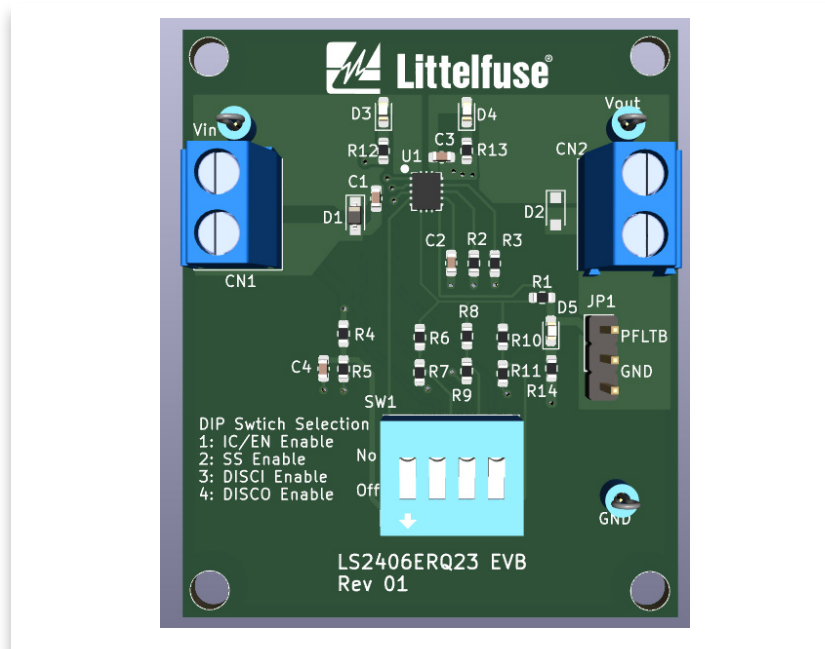


Table 5. Options for the Dip Switch Pin and Terminal Pins Setup

Dip Switch SW1 Option	Description
Pin 1	IC enable or disable
Pin 2	Soft start function enable or disable
Pin 3	Input quick discharge enable or disable
Pin 4	Output quick discharge enable or disable
Terminal Pin JP1	Description
Pin 1	Pin out for measuring pin PFLT signal
Pin 2 and Pin 3	ground
LEDs Indication	Description
D3: green	Input power
D4: yellow	Output power
D5: red	IC faults status indication

Table 6. EVB Default Summary List

EVB Default Setting is as following table for reference.

Functions	Setting	Value
Current Limit (A)	Rlim (R2)=8.2 kΩ	3.4 A
Voltage Clamping (V)	RVLIM (R1) = 200 kΩ	24 V
Soft Start	C1=10 nF	1.6 ms
IC Enable	ON	Dip switch: pin 1 ON
Soft Start	ON	Dip switch: pin 2 Off
DISC1	Off	Dip switch: pin 3 Off
DISC0	Off	Dip switch: pin 4 Off
D3, D4, D5	All light	All ON

5. References List

Protection IC eFuse LS2406ERQ23: <https://www.littelfuse.com/products/protection-ic/efuse/ls2406erq23>