3.8V-40V Vin, 5A High Efficiency Synchronous Step-down DCDC Converter Evaluation Board

FEATURES

- Wide Input Range: 3.8V-40V (42V ABS MAX)
- Up to 5A Continuous Output Current
- 0.8V ±1%Feedback Reference Voltage
- Integrated 45mΩ High-Side Rdson and 20mΩ Low-Side Rdson Power MOSFETs
- 25uA Low Quiescent Current with Pulse Skipping Mode PSM at Light Load
- 100KHz to 1.1MHz Adjustable Frequency and External Clock Synchronization (SCT2450)
- Adjustable Soft-start (SCT2451)
- Low Dropout Mode Operation
- Derivable Inverting Voltage Regulator
- EMI Reduction with Frequency Spread Spectrum FSS
- Over-voltage and Over Temperature Protection
- Available in an ESOP-8 Package

APPLICATIONS

- Industrial Distributed Power Supplies
- Battery Pack Powered System - Cordless Power Tools, Cordless Home Appliance, Drone etc.
- Cigarette Lighter Adapters, USB Chargers
- USB Type-C Power Delivery
- Optical Communication and Networking System
- Automotive System

DESCRIPTION

The EV2450-B-03A Evaluation Board is designed to demonstrate the capabilities of SCT2450 and SCT2451, high efficiency fully integrated synchronous step-down DCDC converter supporting up to 5A continuous output current from an input source from 3.8V to 40V. The SCT2450 offers adjustable switching frequency ranging from 100kHz to 1.1MHz with internal 4ms soft-start, which provides flexibility to optimize either efficiency or external component size. The SCT2451 features adjustable soft-start with fixed 570KHz switching frequency. Both devices are available in an easy-soldering 8-pin eSOP package.

This user's guide describes the characteristics, operation and the use of the EV2450-B-03A Evaluation Module including EVM specifications, recommended test setup, test result, schematic diagram, bill of materials, and the board layout.

Board Number	IC Number
EV2450-B-03A	SCT2450, SCT2451

PERFORMANCE SUMMARY

Table 1. Performance   Specifications are at TA = 25°C

Parameter	Condition	Value
Input Voltage	DC up to 40V	4.5V-36V
Output Voltage	Iout=0A~5A	3.3V ± 1%
Output Current	Continuous DC current	5A
Frequency	Default R3=200KΩ	500KHz
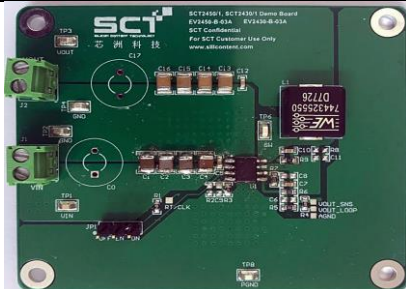
EV2450-B-03A Evaluation Board Top View
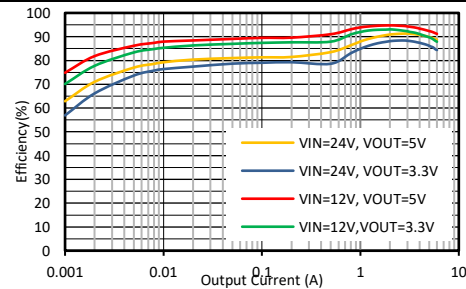
SCT2450 Efficiency, Freq.=500KHz

QUICK START PROCESURE

Evaluation board EV2450-B-03A is easy to set up to evaluate the performance of SCT2450 and SCT2451 synchronous step-down DCDC converter. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

1. Place jumpers in the following positions:
   - J1: Connect the power supply to the input of converter.
   - J2: Connect the load to the output of converter.
   - JP1: Enable. ON Connect EN pin to V_{in} through a 100KΩ resistor to enable IC. OFF Disable IC
2. With power off, connect the input power supply to J1 V_{IN} connector and J1 GND connector. Make sure that the input voltage does not exceed 40V, and supports sufficient current limit. Turn on the power at the input.
3. Check the output voltage at J2. The output voltage should be 3.3V typical. Once the proper output voltage is established, adjust the load within the operating range and observe the output voltage regulation, output voltage ripple, efficiency and other parameters.
4. To use the enable function, apply a digital input to the EN pin of JP3.
5. Users can place C0 if input wire is long and C17 for better load transient performance.
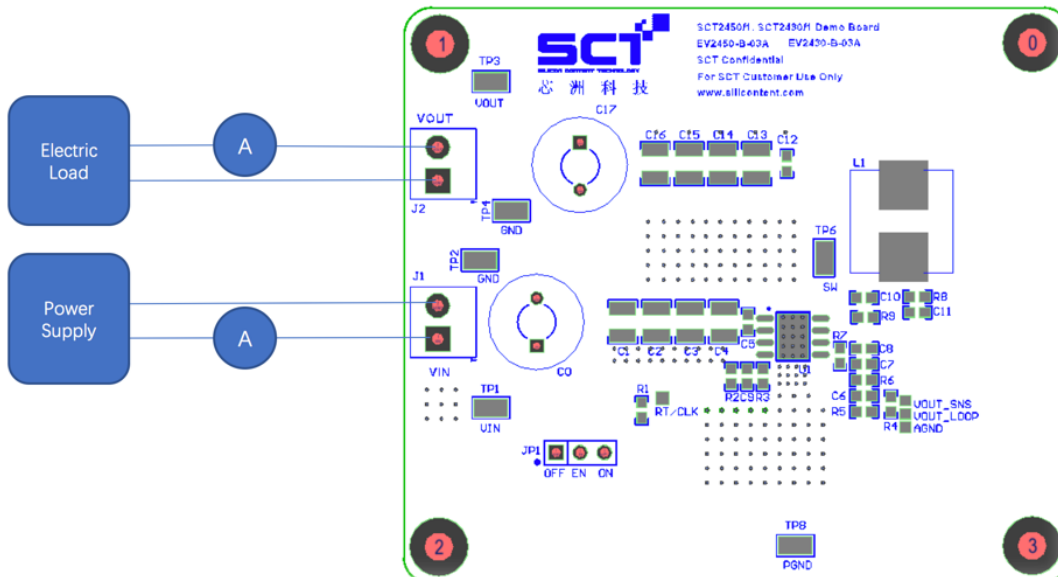

Figure 1. Power Supply, Load and Measurement Equipment Setup

NOTE: When measuring the voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across relevant capacitor of VIN or VOUT. See Figure 2 for proper scope probe technique.

Figure 2. Measuring Voltage Ripple Across Terminals or Directly Across Ceramic Capacitor
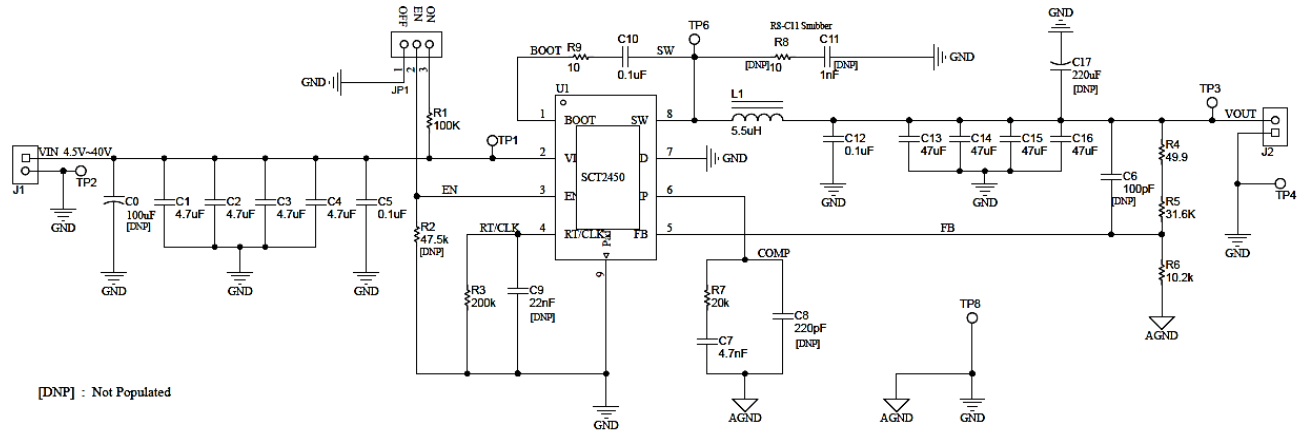
SCHEMATIC DIAGRAM

[DNP] : Not Populated

Figure 3. Evaluation Board Schematic

BILL OF MATERIALS

Table 2. Bills of Materials

Manufacture	Comment	Designator	Description	Quantity
Silicon Content Technology	SCT2450	U1	SCT2450, 8V-40V Vin, 5A, Low Quiescent Current Synchronous Step-down Converter ESOP-8, 4.0mmX5.0mm with thermal pad	1
Wurth Elektronix	613 002 111 21	JP1	Header, 100mil, 2x1, Tin, TH	1
Wurth Elektronix	691 214 110 002S	J1, J2	Terminal Block, 6A, 3.5mm Pitch, 2-Pos, TH	2
Wurth Elektronix	860 040 775 006	C0	WCAP-ATUL Aluminum Electrolytic Capacitors 100uF, 63V, Dimension 10x12.5	Not Installed
Wurth Elektronix	860 040 575 007	C17	WCAP-ATUL Aluminum Electrolytic Capacitors 220uF, 35V, Dimension 10x12.5	Not Installed
Wurth Elektronix	885 012 209 048	C1, C2, C3, C4	CAP, CERM, 4.7uF, 50V, +/-10%, X7R, 1210	4
Wurth Elektronix	885 012 206 095	C5	CAP, CERM, 100nF, 50V, +/-10%, X7R, 0603	1
Wurth Elektronix	885 012 206 067	C9	CAP, CERM, 22nF, 25 V, +/- 10%, X7R, 0603	Not Installed
Wurth Elektronix	885 012 206 071	C10	CAP, CERM, 100nF, 25 V, +/- 10%, X7R, 0603	1
Wurth Elektronix	885 012 109 011	C13, C14, C15, C16	CAP, CERM, 47uF, 50 V, +/- 10%, X5R, 1210	4
Wurth Elektronix	885 012 206 095	C12	CAP, CERM, 100nF, 50V , +/- 10%, X7R, 0603	1
Wurth Elektronix	885 012 206 077	C6	CAP, CERM, 100pF, 50V , +/- 10%, X7R, 0603	Not Installed
Wurth Elektronix	885 012 206 069	C7	CAP, CERM, 4.7nF, 25 V, +/- 10%, X7R, 0603	1
Wurth Elektronix	885 012 206 055	C8	CAP, CERM, 220pF, 25 V, +/- 10%, X7R, 0603	Not Installed
Wurth Elektronix	885 012 206 059	C11	CAP, CERM, 1000pF, 25 V, +/- 10%, X7R, 0603	Not Installed
Wurth Elektronix	744325550	L1	Inductor, Shielded Drum Core, WE-HCI SMD Flat Wire High Current, 5.5 uH, Rate current IR 10A, Saturation Current ISAT 12A, DCR 0.0123 ohm,	1
Vishay	RC0603JR-07100KL	R1	RES 100k OHM 5% 1/10W 0603	1
Vishay	CRCW060347K5FKEA	R2	RES, 47.5k, 1%, 0.1 W, 0603	1
Vishay	RC0603FR-07200KL	R3	RES, 200k OHM 1% 1/10W 0603	1
Vishay	CRCW060349R9FKEA	R4	RES, 49.9, 1%, 0.1 W, 0603	1
Vishay	CR0603-FX-3162ELF	R5	RES, 31.6k, 1%, 0.1 W, 0603	1
Vishay	CRCW060310K2FKEA	R6	RES, 10.2k, 1%, 0.1 W, 0603	1
Vishay	RC0603FR-0720KL	R7	RES SMD 20k OHM 1% 1/10W 0603	1
Vishay	CRCW06030000Z0EC	R9	RES, 0, 0.1 W, 0603	1
Vishay	CRCW060310RFKEA	R8,	RES, 10, 1%, 0.1 W, 0603	Not Installed
Vishay	CRCW06030000Z0EC	R11	RES, 0, 0.1 W, 0603	1
Keystone	5015	TP1~TP4, TP6, TP8	Test Point, Miniature, SMT	6

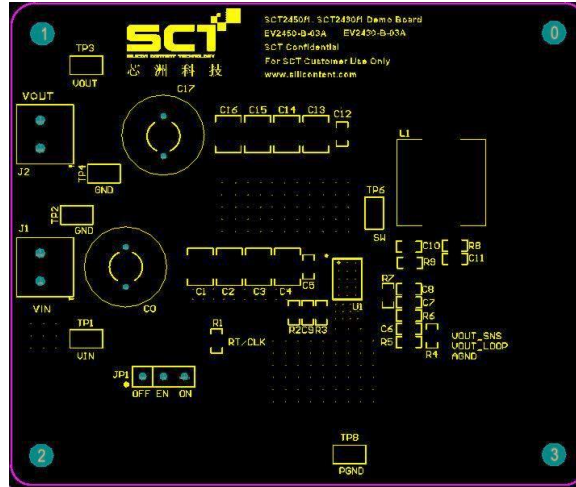## PRINTED CIRCUIT BOARD LAYOUT
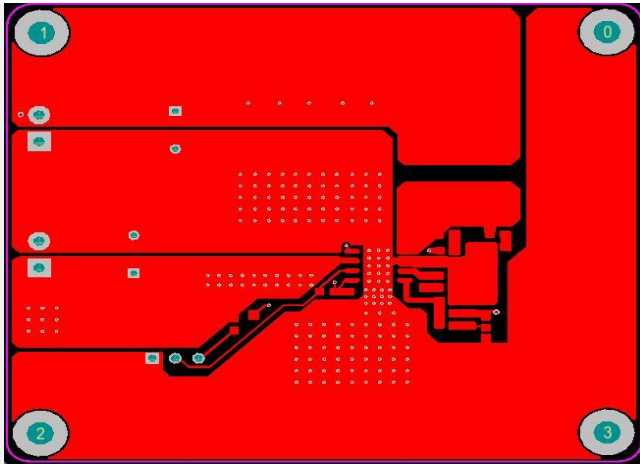

Figure 4. Top Silkscreen Layer
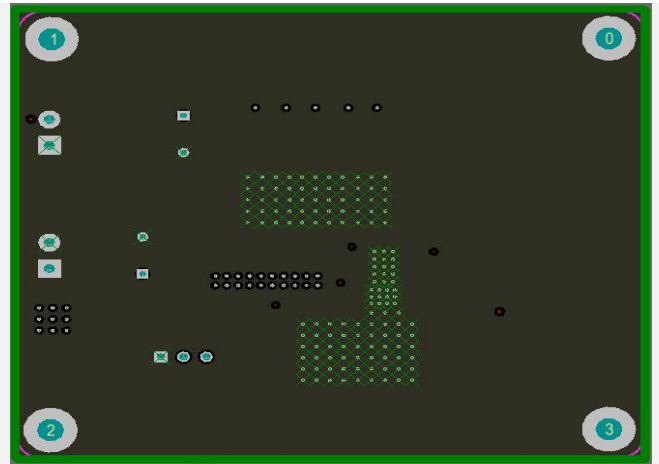

Figure 5. Top Layer
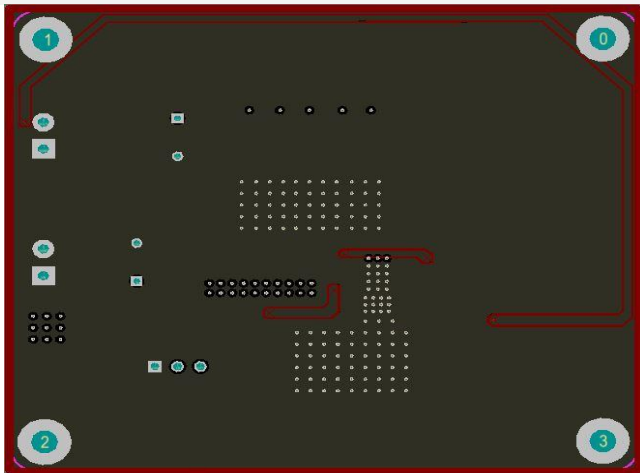

Figure 6. Internal 1 Layer
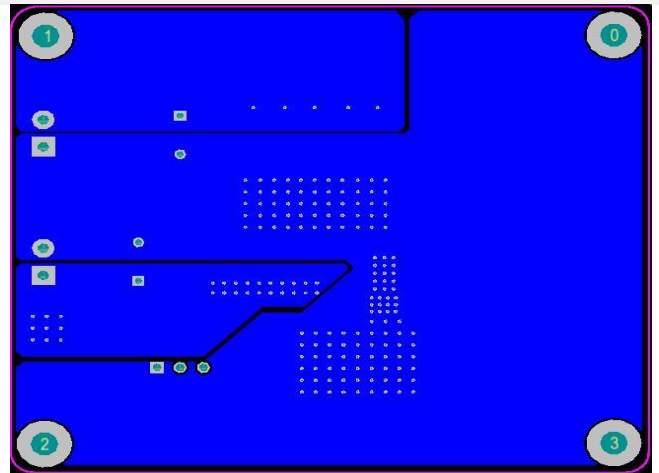

Figure 7. Internal 2 Layer

Figure 8. Bottom Layer

EVB TEST RESULTS

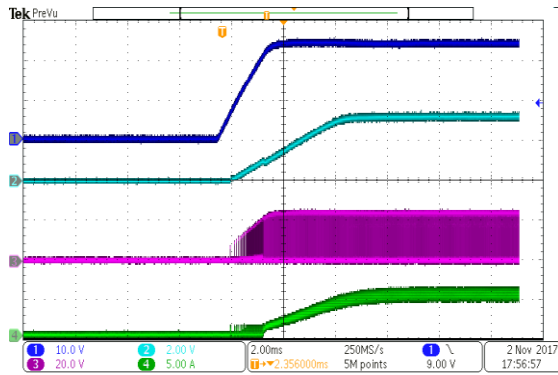Vin=24V, Vout=3.3V, unless otherwise noted

Figure 9. Power Up
(CH-1: Vin, CH-2: Vout, CH-3: SW, CH-IL)
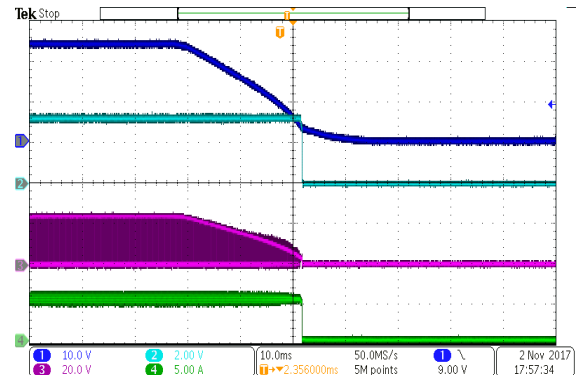

Figure 10. Power Down
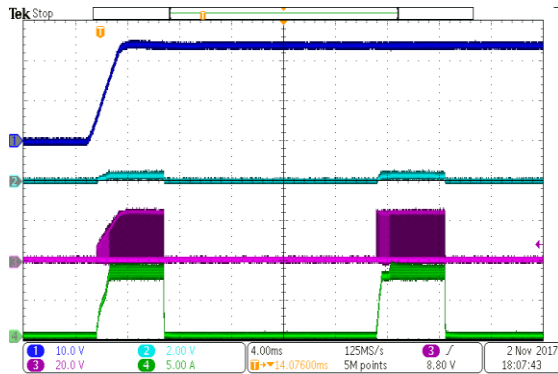(CH-1: Vin, CH-2: Vout, CH-3: SW, CH-IL)

Figure 11. Startup at Output Hard-short
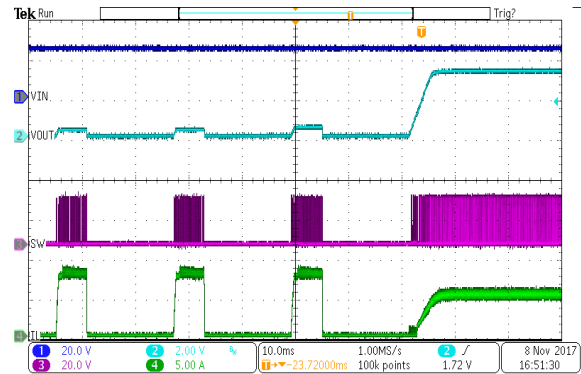(CH-1: Vin, CH-2: Vout, CH-3: SW, CH-IL)

Figure 12. Output Hard-short and Recovery with 5A Load
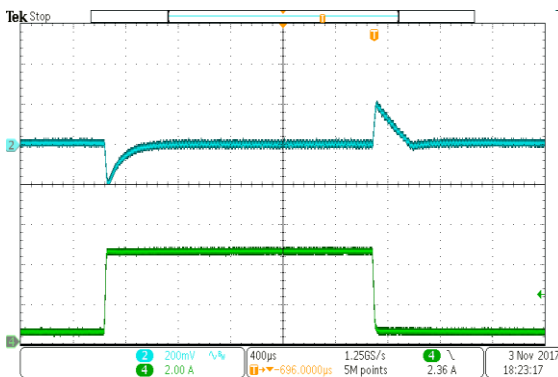(CH-1: Vin, CH-2: Vout, CH-3: SW, CH-IL)

Figure 13. Load Transient
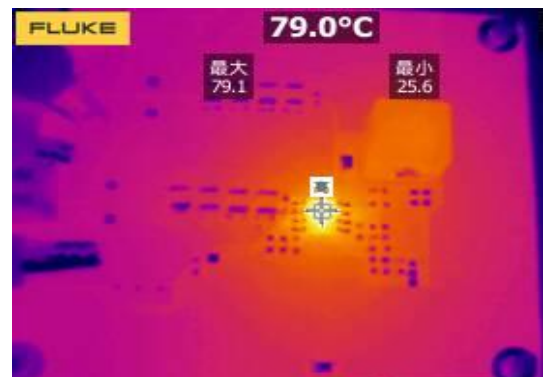(0.5A-4.5A, SR=250mA/us, CH-1: Iout, CH-2: Vout)

Figure 14. Infrared Thermal Image
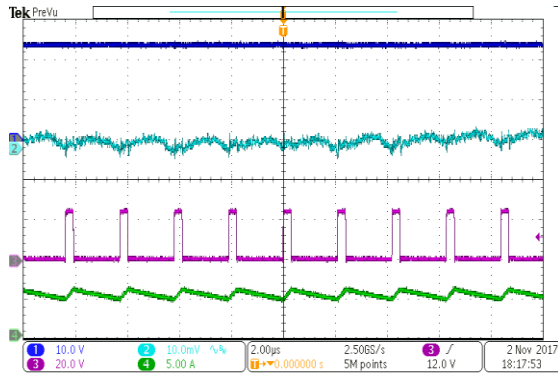(Vin=24V, Vout=3.3V, Iout=5A)

Figure 15. Output Ripple, PWM, Iout=5A
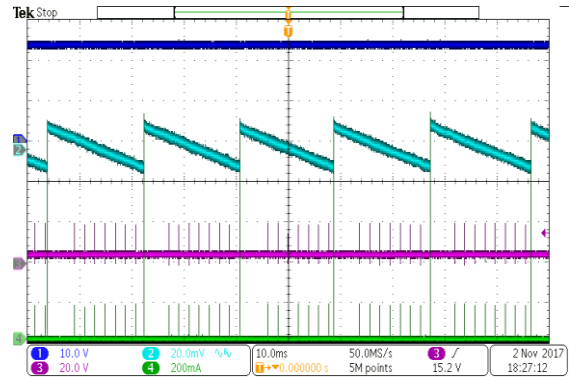(CH-1: Vin, CH-2: Vout, CH-3: SW, CH-4: IL)

Figure 16. Output Ripple, PSM, Iout=0A
(CH-1: Vin, CH-2: Vout, CH-3: SW, CH-4: IL)

OPTIONAL MODIFICATION

Switching Frequency

The resistor R3 connected from SCT2450 RT/CLK pin to ground (Default 200KΩ) sets switching frequency of the converter. Use equation 1 to set a desired frequency.

The switching frequency in SCT2451 is fixed 570KHz.

Eq. (3)

$$R_3 = \frac{100000}{fsw\ (KHz)}$$
(1)

where:
- f_{SW} is the desired switching frequency

Table 3. R₃ Value for Common Switching Frequencies
(Room Temperature)

fsw	R₃
200 KHz	500 KΩ
330 KHz	301 KΩ
500 KHz	200 KΩ
1100 KHz	90.9 KΩ

Soft-Start

The SCT2450 integrates an internal soft-start circuit that ramps the reference voltage from zero volts to its final reference voltage in 4ms. If the EN pin is pulled below 1.1V, switching stops and the internal soft-start resets.
The soft-start also resets in thermal shutdown.

The SCT2451 features programmable soft-start time by easily connect a capacitor C9 from SS pin to ground. Without connecting any capacitor, the soft-start time is default 4ms generated from the internal circuitry. Using a capacitor, the programmed soft-start time should be larger than 4ms. The capacitor value can be calculated going with following Eq. (3)

$$C_9 = t_{soft-start} * \frac{5uA}{0.8V}$$
(2)

where:
- $t_{soft-start}$ is the programmed soft-start time

Output Voltage

The output voltage is set by an external resistor divider R_5 and R_6 in EVM schematic. The values of R_5 and R_6 can be calculated by equation 3A minimum current of typical 20uA flowing through feedback resistor divider gives good accuracy and noise covering.

$$R_5 = \frac{(V_{OUT} - V_{REF}) \times R_6}{V_{REF}} \qquad (3)$$

where:
- V_{REF} is the feedback reference voltage, typical 0.8V

Table 4. Feedback Resistor R_5 and R_6 Value for Output Voltage
(Room Temperature)

V_{OUT}	R_5	R_6
1.8 V	12.7 KΩ	10.2 KΩ
2.5 V	21.5 KΩ	10.2 KΩ
3.3 V	31.6 KΩ	10.2 KΩ
5 V	53.6 KΩ	10.2 KΩ
12 V	143 KΩ	10.2 KΩ
24V	294 KΩ	10.2 KΩ

Under Voltage Lockout Threshold

The SCT2450 and SCT2451 are enabled when the VIN pin voltage rises about 3.5V and the EN pin voltage exceeds the enable threshold of 1.18V. The device is disabled when the VIN pin voltage falls below 3.1V or when the EN pin voltage is below 1.1V. An internal1.5uA pull up current source to EN pin allows the device enable when EN pin is floating.

If an application requires a higher system under voltage lockout threshold, two external resistors divider (R1 and R2) in Figure 3 can be used to achieve an expected system UVLO. The UVLO rising and falling threshold can be calculated by Equation 4 and Equation 5 respectively.

$$V_{rise} = 1.18 * \left(1 + \frac{R1}{R2}\right) - 1.5uA * R1 \qquad (3)$$

$$V_{fall} = 1.1 * \left(1 + \frac{R1}{R2}\right) - 5.5uA * R1 \qquad (4)$$

where:

- V_{rise} is the rising threshold of Vin UVLO.
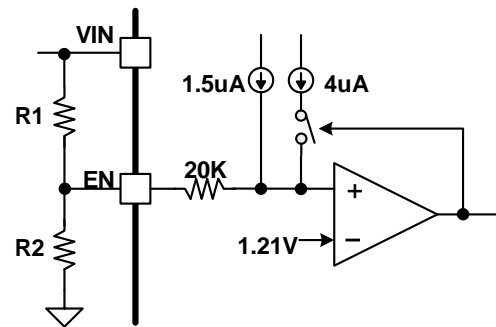- V_{fall} is the falling threshold of Vin UVLO

Figure 15. VIN UVLO Programmable by EN Dividers

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Silicon Content Technology Co., Ltd.
#1 Floor 2 Building 15, Yard 33 Dijin Road, Haidian District, Beijing 100095
(86 10) 64779806   FAX: (86 10) 64779806   www.silicontent.com   © Silicon Content Technology