4.5V-100V Vin, 0.6A, High Efficiency Synchronous Step-down DCDC Converter with Programmable Frequency

- Wide Input Range: 4.5V-100V
- 0.6A Continuous Output Current
- 0.8V ±1% Feedback Reference Voltage
- Integrated 750mΩ High-Side and 500mΩ Low-Side Power MOSFETs
- Pulse Frequency Modulation (PFM) with 100uA Quiescent Current in Sleep Mode
- 4ms Internal Soft-start Time
- Adjustable Frequency 300KHz to 800KHz
- Precision Enable Threshold for Programmable Input Voltage Under-Voltage Lock Out Protection (UVLO) Threshold and Hysteresis
- Cycle-by-Cycle Current Limiting
- Over-Voltage Protection
- Over-Temperature Protection
- Available in an ESOP-8 Package

- E-Tools
- E-bike, Scooter
- GPS Tracker

The SCT2A10A is 0.6A synchronous buck converters with wide input voltage, ranging from 4.5V to 100V, which integrates an 750mΩ high-side MOSFET and a 500mΩ low-side MOSFET. The SCT2A10A, adopting the constant-on time (COT)

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Revision 1.0: Release to Market.

Revision 1.1: Add application waveforms.

Revision 1.2: Update R1 and R2 calculation value in page 11.

Revision 1.3: Update figure 8.

Revision 1.4: Update DEVICE ORDER INFORMATION.

SCT2A10ASTER	Tape & Reel	4000	A10A	8	ESOP-8

Over operating free-air temperature unless otherwise noted(1)

VIN, EN	-0.3	105	V
BOOT	-0.3	111	V
SW	-1	105	V
BOOT-SW	-0.3	6	V

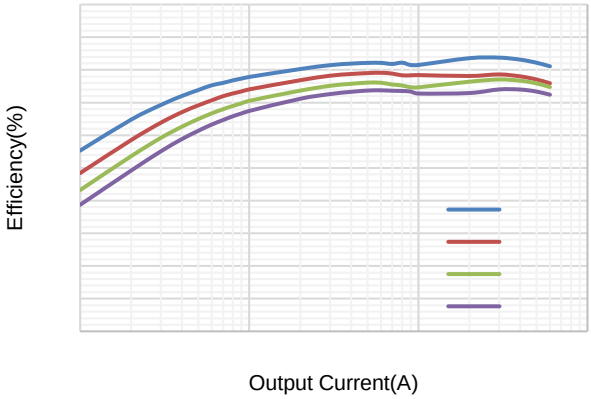


Figure 2. Efficiency vs Load Current (Vout=5V)

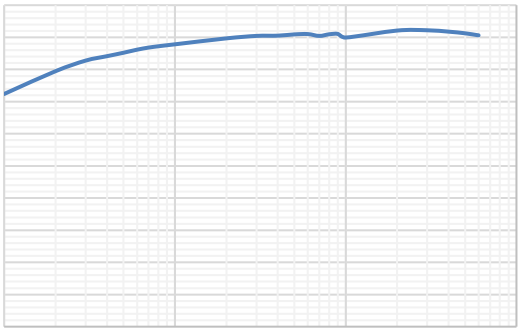


Figure 3. Efficiency vs Load Current (Vout=12V)

Figure 4. Load Regulation (Vout=12V)

Figure 5 Frequency vs Temperature

Figure 6. Shut-down Current vs Temperature

Figure 7. Iq vs Temperature

The SCT2A10A is a 4.5V-100V input, 0.6A output, internal-compensated synchronous buck converter with built-in 750mΩ Rdson high-side and 500mΩ Rdson low-side power MOSFETs. It implements constant on time control to regulate output voltage, providing excellent line and load transient response.

The switching frequency is programmable from 300kHz to 800KHz with resistor setting to optimizes either the power efficiency or the external components' sizes. The SCT2A10A features an internal 4ms soft-start time to avoid large inrush current and output voltage overshoot during startup. The device also supports monolithic startup with pre-biased output condition. The seamless mode-transition between PWM mode and PFM mode operations ensure high efficiency over wide load current range. The quiescent current is typically 100uA under no load non-switching condition to achieve high efficiency at light load.

The SCT2A10A has a default input start-up voltage of 3.5V with 400mV hysteresis. The EN pin is a high-voltage pin with a precision threshold that can be used to adjust the input voltage lockout thresholds with two external resistors to meet accurate higher UVLO system requirements. Floating EN pin enables the device with the internal pull-up current to the pin. Connecting EN pin to VIN directly starts up the device automatically.

The SCT2A10A full protection features include the input under-voltage lockout, the output over-voltage protection, over current protection with cycle-by-cycle current limiting and hiccup mode, output hard short protection and thermal shutdown protection.

The SCT2A10A employs Constant-On-Time Mode control providing fast transient with pseudo fixed switching frequency. At the beginning of each switching cycle, the high-side MOSFET (Q1) is turned on for a fixed interval and the inductor current rises to charge up the output voltage. When the high-side MOSFET (Q1) is turned off and the low-side MOSFET (Q2) is turned on after a dead time duration. When sensed the valley current passing on the low side MOSFET lower than the COMP current threshold, the device turns on Q1 and the low-side MOSFET (Q2) turns off. Based on Vin and Vout voltage, the device predicts required off-time and turns off low-side MOSFET Q2. This repeats on cycle-by-cycle based.

$$3 = \frac{(\text{——}) -}{{}_1(1 - \text{——}) + {}_2} \qquad (1)$$

$$4 = \frac{{}_3 \times}{- \quad + \ {}_3({}_1 + {}_2)} \qquad (2)$$

Where

Vstart: Vin rise threshold to enable the device
Vstop: Vin fall threshold to disable the device
I_1=1uA
I_2=3uA
V_{ENR}=1.21V
V

.

An external bootstrap capacitor between BOOT pin and SW pin powers the floating gate driver to high-side power MOSFET. The bootstrap capacitor voltage is charged from an integrated voltage regulator when high-side power MOSFET is off and low-side power MOSFET is on.

The inductor current is monitored during low-side MOSFET Q2 on. The SCT2A10A implen M

Input Voltage	48V Normal 24V to 100V
Output Voltage	12V
Maximum Output Current	600mA
Switching Frequency	500 KHz
Output voltage ripple (peak to peak)	50mV
Transient Response 60mA to 540mA load step	ΔVout = 400mV

The output voltage is set by an external resistor divider R5 and R6 in typical application schematic. Recommended R6 resistance is 10.2KΩ. Use equation 5 to calculate R5.

$$_{5} = ($$

The voltage rating of the input capacitor must be greater than the maximum input voltage. And the capacitor must also have a ripple current rating greater than the maximum input current ripple. The RMS current in the input capacitor can be calculated using Equation 12.

$$I_{CINRMS} = I_{OUT} \sqrt{\frac{V_{OUT}}{V_{IN}} (1 - \frac{V_{OUT}}{V_{IN}})} \quad (12)$$

The worst case condition occurs at V_{IN}=2*V_{OUT}, where:

$$I_{CINRMS} = 0.5 \quad I_{OUT} \quad (13)$$

For simplification, choose an input capacitor with an RMS current rating greater than half of the maximum load current.

When selecting ceramic capacitors, it needs to consider the effective value of a capacitor decreasing as the DC bias voltage across a capacitor increases.

The input capacitance value determines the input ripple voltage of the regulator. The input voltage ripple can be calculated using Equation 14 and the maximum input voltage ripple occurs at 50% duty cycle.

$$\Delta V_{IN} = \frac{I_{OUT}}{f_{SW} \quad C_{IN}} \quad \frac{V_{OUT}}{V_{IN}} \quad (1 - \frac{V_{OUT}}{V_{IN}}) \quad (14)$$

For this example, three 2.2μF, X7R ceramic capacitors rated for 100V in parallel are used. And a 0.1 μF for high-frequency filtering capacitor is placed as close as possible to the device pins.

Vin=48V, Vout=12V, unless otherwise noted

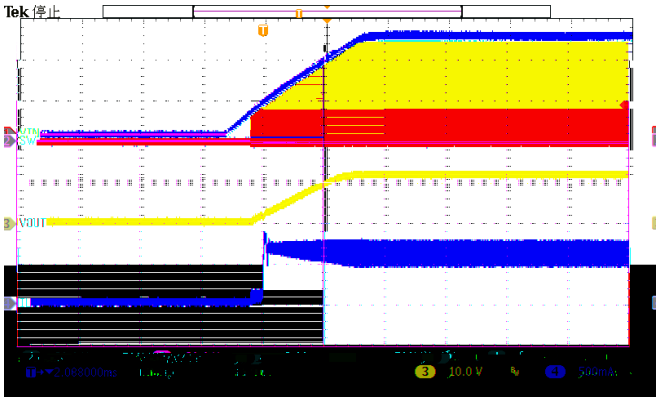


Figure 12. Power up

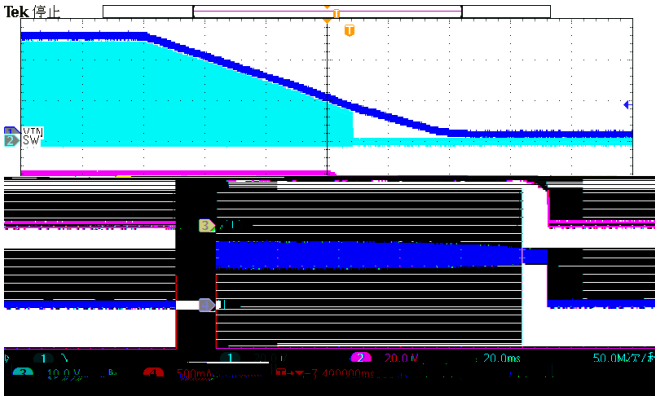


Figure 13. Power down

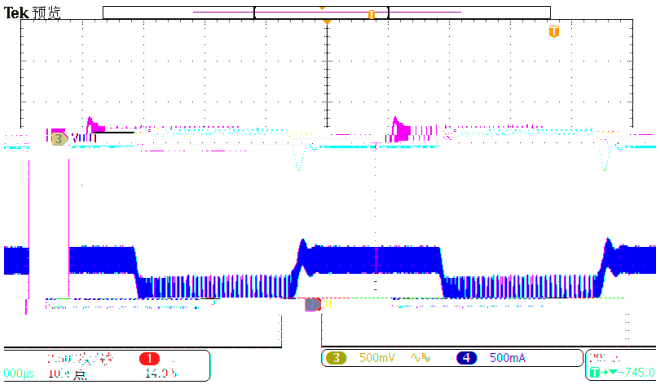


Figure 14.Load Transient (0.06A-0.54A, 0.25A/us)

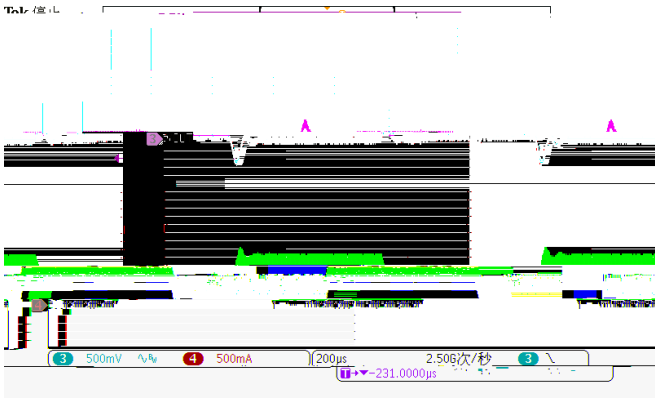


Figure 15. Load Transient (0.15A-0.45A, 0.25A/us)

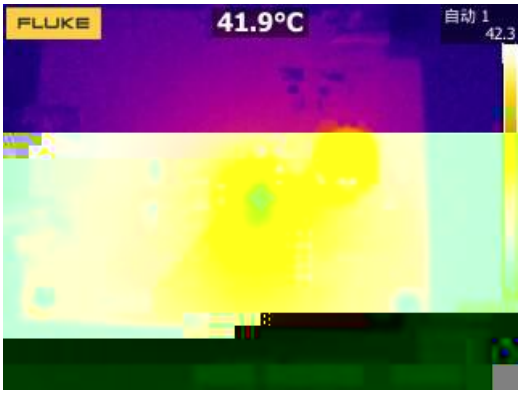


Figure 16. SW and Vout Ripple

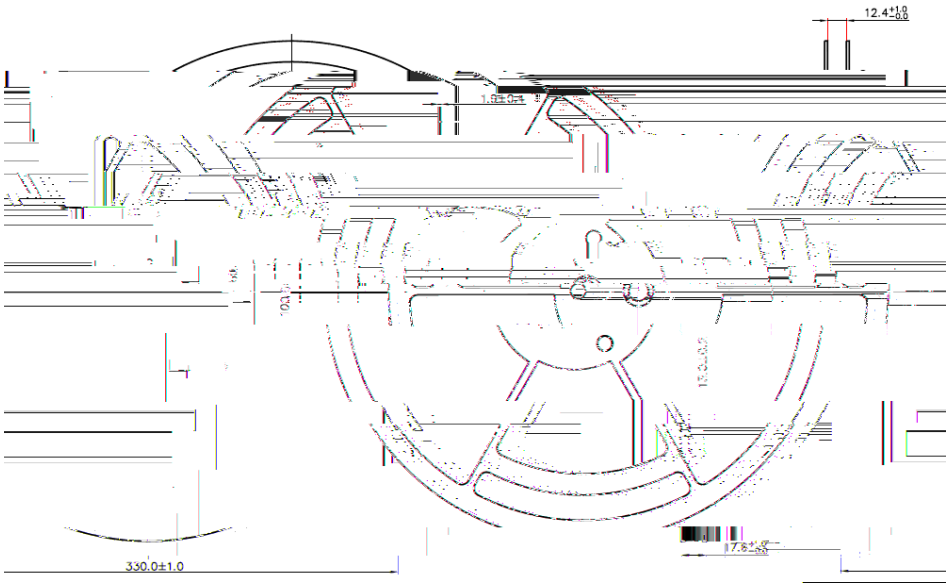
Figure 17. Thermal, 48VIN, 12Vout, 0.6A

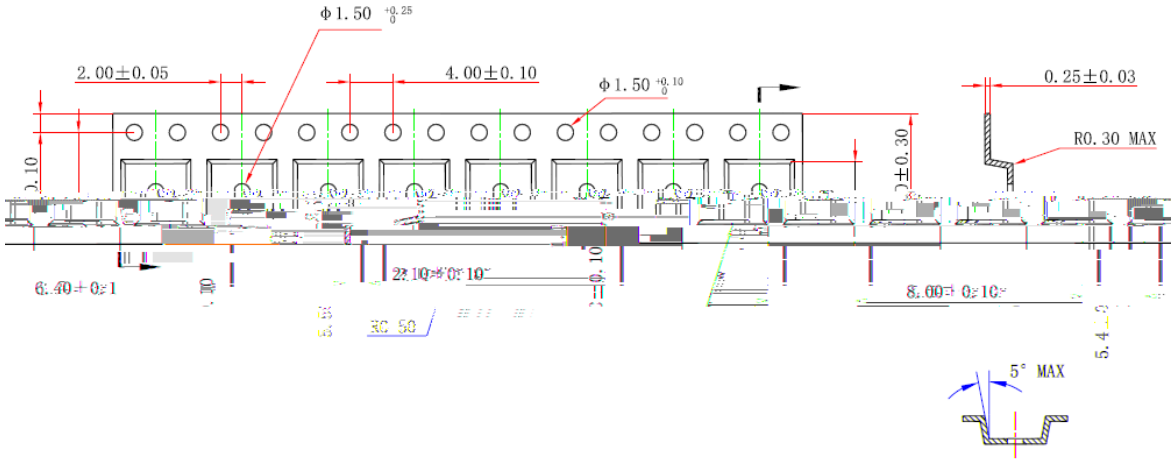
Proper PCB layout is a critical for SCT2A10A's stable and efficient operation. The traces conducting fast switching currents or voltages are easy to interact with stray inductance and parasitic capacitance to generate noise and [illegible] guidelines as below:

1. [illegible] of carrying power, thermal, and glitch/bouncing noise associated with clock frequency. The thumb [illegible] and power are distributed even[illegible] PCB. Sufficiently placing ground area [illegible] optimize thermal and not causing over heat area.
2. Place a low ESR ceramic capacitor as close to VIN pin and the ground as possible to reduce parasitic effect.
3. For operation at full rated load, the top side ground area must provide adequate heat dissipating area. Make sure top switching loop with power have lower impendence of grounding.
4. The power pad should be connected to bottom PCB ground planes using multiple vias directly under the IC. The center thermal pad should always be
5. Output inductor should be placed close to the SW pin. The area of the PCB conductor minimized to prevent excessive capacitive coupling.
6. The RT terminal is sensitive to noise so the RT resistor should be located as close as possible to the IC and routed with minimal lengths of trace.
7. UVLO adjust, RT resistors and feedback components should connect to small signal [illegible]ound which must return to the GND pin without any interleaving with power ! mM any intery

ESOP8/PP(95x130) Package Outline Dimensions

Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min.	Max.	Min.	Max.
A	1.300	1.700	0.051	0.067
A1	0.000	0.100	0.000	0.004
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D D1	4.700	5.100	0.185	0.201





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