V Vin, 3A Synchronous Step-down DCDC Converter

FEATURES

- Wide Input Voltage: 4.2-17V
- 3A Continuous Output Current with Integrated 75m /45m FETs
- Wide Output Voltage Range:0.8V-7V
- Quiescent Current 150uA
- Cycle-by-Cycle Current Limiting
- Internal 2.5ms Soft-Start Limits the inrush current
- Fixed 750kHz Switching Frequency
- Input Under-Voltage Lockout
- Power save mode at light load
- Over-Temperature Protection
- Available in a SOT563 and TSOT23 Package

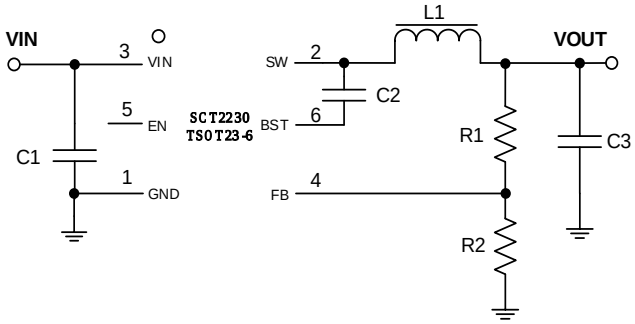
APPLICATIONS

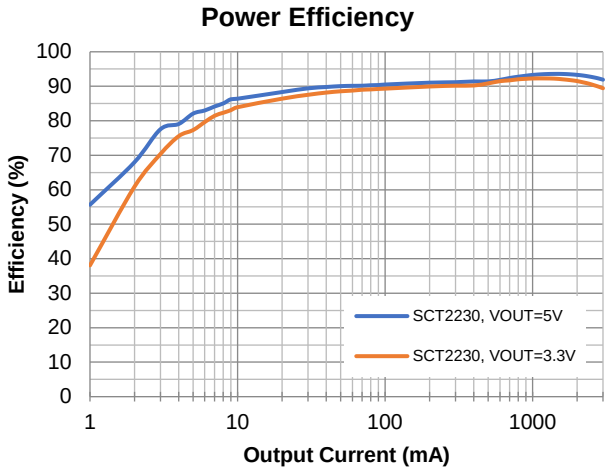
- Flat Panel Digital TV and Monitors
- Surveillance
- Set Top Boxes
- Networking Systems
- Consumer Electronics
- General Purpose

DESCRIPTION

The SCT2230 is a fully integrated high efficiency synchronous step-down DCDC converter capable of delivering 3A current. The devices operate over a wide input voltage range from 4.2V to 17V and fully integrate high-side power MOSFETs and synchronous MOSFETs with very low Rdson to minimize the conduction loss.

With 750 kHz switching frequency, low output voltage ripple, small external inductor and capacitor size are achieved. SCT2230 adopts adaptive constant ON-time control architecture to achieve fast load transient





REVISION HISTORY

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

Rev 1.0 Released to Market.

DEVICE ORDER INFORMATION

PART NUMBER	PACKAGE MARKING	PACKAGE DISCRIPTION
SCT2230TVA	2230	SOT563-6L
SCT2230TVB	2230	TSOT23-6L

* (1) FOR TAPE & REEL, ADD SUFFIX R (E.G. SCT2230TVAR).

ABSOLUTE MAXIMUM RATING

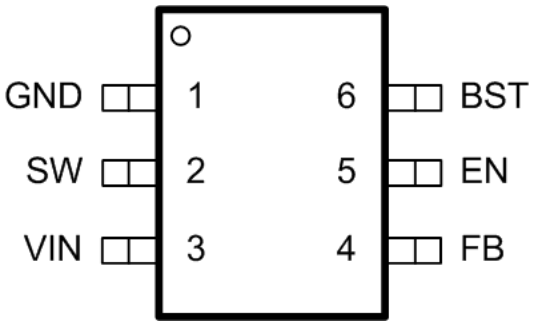
Over operating free-air temperature unless otherwise noted(1)

SYMBOL	PARAMETER	RATING	UNIT
V_{IN}	Supply Voltage	-0.3 to 20	V
V_{SW}	Switch Node Voltage	-1 to VIN+0.3	V
V_{BST}	Bootstrap	V_{SW}-0.3 to V_{SW}+6	V
V_{FB}	Feedback Voltage	-0.3 to 6.5	V
V_{EN}	Enable/UVLO Voltage	-0.3 to 6.5	V
T_J	Operating junction temperature(2)	-40 to 125	C
T_{STG}	Storage temperature	-65 to 150	C

(1) Stresses beyond those listed under Absolute Maximum Rating may cause device permanent damage. The device is not guaranteed to function outside of its Recommended Operation Conditions.

(2) The IC includes over temperature protection to protect the device during overload conditions. Junction temperature will exceed 150°C when over temperature protection is active. Continuous operation above the specified maximum operating junction temperature will reduce lifetime

PIN CONFIGURATION



SOT563 Top View
(1.6mm x 1.6mm)

TSOT23-6 Top View
(2.8mm x 2.8mm)

PIN FUNCTIONS

NAME	PIN NUMBER		PIN FUNCTION
	SOT563	TSOT23-6	
VIN	1	3	Power supply input. VIN supplies the power to the IC, as well as the step-down converter switches. Drive VIN with a 4.2V to 17V power source. Bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC. See Input Capacitor.
SW	2	2	Power Switching Output. SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load. Note that a capacitor is required from SW to BST to power the high-side switch.
GND	3	1	Power ground. Must be soldered directly to ground plane.
BST	4	6	Power supply for the high-side power MOSFET gate driver. Must connect a 0.1uF or greater ceramic capacitor between BST pin and SW node.
EN	5	5	Enable logic input. Floating the pin enables the device. Connect 100K resistor to VIN to enable the device. The device has precision enable thresholds 1.18V rising / 1.1V falling for programmable UVLO threshold and hysteresis.
FB	6	4	Buck converter output feedback sensing voltage. Connect a resistor divider from VOUT to FB to set up output voltage. The device regulates FB to the internal reference of 0.8V typical.

RECOMMENDED OPERATING CONDITIONS

Over operating free-air temperature range unless otherwise noted

PARAMETER	DEFINITION	MIN	MAX	UNIT
V_{IN}	Input voltage range	4.2	17	V
T_J	Operating junction temperature	-40	125	°C

ESD RATINGS

PARAMETER	DEFINITION	MIN	MAX	UNIT
V_{ESD}	Human Body Model(HBM), per ANSI-JEDEC-JS-001-2014 specification, all pins(1)	-2	+2	kV
	Charged Device Model(CDM), per ANSI-JEDEC-JS-002-2014specification, all pins(1)	-0.5	+0.5	kV

(1) HBM and CDM stressing are done in accordance with the ANSI/ESDA/JEDEC JS-001-2014 specification

THERMAL INFORMATION

PARAMETER	THERMAL METRIC	SOT563	TSOT23-6	UNIT
$R_{\theta JA}$	Junction to ambient thermal resistance(1)	120	88	°C/W
$R_{\theta JC}$	Junction to case thermal resistance(1)	8	12	

(1) SCT provides $R_{\theta JA}$ and $R_{\theta JC}$ numbers only as reference to estimate junction temperatures of the devices. $R_{\theta JA}$ and $R_{\theta JC}$ are not a characteristic of package itself, but of many other system level characteristics such as the design and layout of the printed circuit board (PCB) on which the SCT2230 are mounted, and external environmental factors. The PCB board is a heat sink that is soldered to the leads and thermal pad of the SCT2230. Changing the design or configuration of the PCB board changes the efficiency of the heat sink and therefore the actual $R_{\theta JA}$ and $R_{\theta JC}$.

ELECTRICAL CHARACTERISTICS

V_{IN}=12V, T_J=-40°C~125°C, typical values are tested under 25°C.

SYMBOL	PARAMETER	TEST CONDITION	MIN	TYP	MAX	UNIT
Power Supply and Output						
V_{IN}	Operating input voltage		4.2		17	V
V_{IN_UVLO}	Input UVLO Hysteresis	V_{IN} rising		4.0 300	4.15	V mV
I_{SD}	Shutdown current	EN=0, No load, VIN=12V		1.5	5	uA
I_Q	Quiescent current	EN=2V, No load, No switching. VIN=12V. BST-SW=5V		155		uA
Enable, Soft Start and Working Modes						
V_{EN_H}	Enable high threshold			1.18	1.25	V
V_{EN_L}	Enable low threshold		1.03	1.1		V
I_{EN}	Enable pin input current	EN=1V	1	1.5	2	uA
I_{EN_HYS}	Enable pin hysteresis current	EN=1.5V		6.8		uA
Power MOSFETs						
R_{DSON_H}	High side FET on-resistance			75		mΩ
R_{DSON_L}	Low side FET on-resistance			45		mΩ
Feedback and Error Amplifier						
V_{FB}	Feedback Voltage		0.78	0.8	0.82	V
Current Limit						
I_{LIM_LSD}	LSD valley current limit		3.2	3.7	4.2	A
Switching Frequency						
F_{SW}	Switching frequency	V_{IN}=12V, V_{OUT}=5V		750		kHz
t_{ON_MIN}	Minimum on-time			90		ns
t_{OFF_MIN}	Minimum off-time			220		ns
Soft Start Time						
t_{SS}	Internal soft-start time			2.5		ms
Protection						
T_{SD}	Thermal shutdown threshold Hysteresis	T_J rising		160 20		°C

TYPICAL CHARACTERISTICS

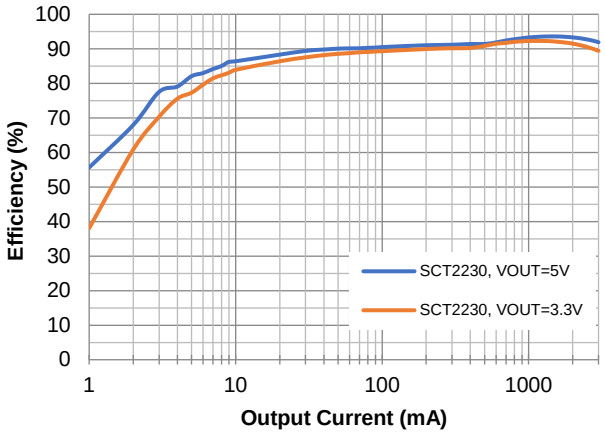


Figure 1. SCT2230 Efficiency, Vin=12V

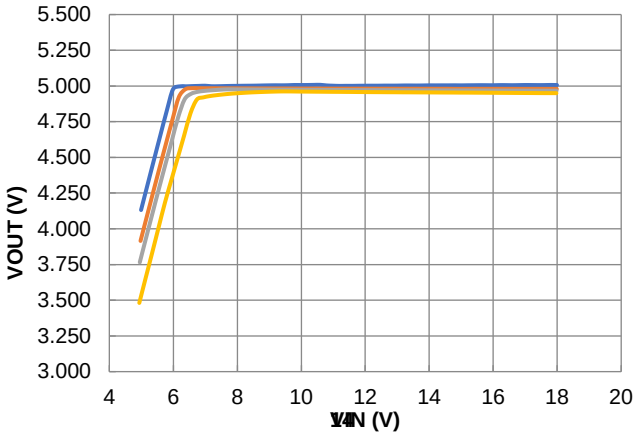


Figure 2. VOUT Vs. VIN

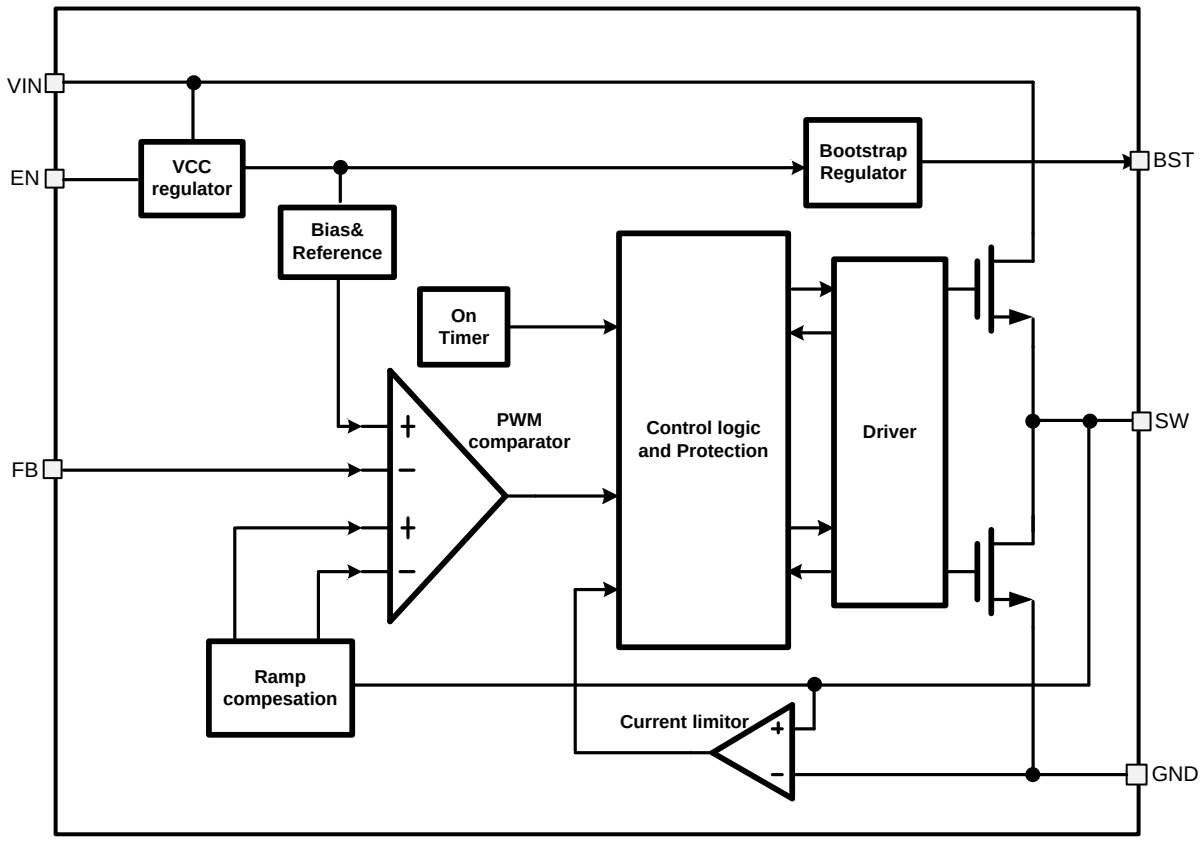
Figure 2. Load Regulation

Figure 4. FB Voltage Vs. Temperature

Figure 5. UVLO Vs. Temperature

Figure 6. Quiescent Current Vs. Temperature

FUNCTIONAL BLOCK DIAGRAM



OPERATION

Adaptive On-time Control

The SCT2230 device is 4.2-17V input, 3A output, synchronous step-down converters with internal power MOSFETs. Adaptive constant on-time (ACOT) control is employed to provide fast

Under Voltage Lockout UVLO

The SCT2230 Under Voltage Lock Out (UVLO) default startup threshold is typical 3.9V with VIN rising and shutdown threshold is 3.6V with VIN falling. The more accurate UVLO threshold can be programmed through the precision enable threshold of EN pin.

Enable and Start up

When applying a voltage higher than the EN high threshold (typical 1.18V/rise), the SCT2230 enables all functions and the device starts soft-start phase. The SCT2230 has the built in 2.5ms soft-start time to prevent the output overshoot and inrush current. When EN pin is pulled low, the internal SS net will be discharged to ground. Buck operation is disabled when EN voltage falls below its lower threshold (typically 1.1V/fall).

An internal 1.5uA pull up current source connected from internal LDO power rail to EN pin guarantees that floating EN pin automatically enables the device. For the application requiring higher VIN UVLO voltage than the default setup, there is a 6.8uA hysteresis pull up current source on EN pin which configures the VIN UVLO voltage with an off-chip resistor divider R3 and R4, shown in Figure 7. The resistor divider R3 and R4 are calculated by equation (3) and (4).

EN pin is a high voltage pin, and can be directly connected to VIN to automatically start up the device with VIN rising to its internal UVLO threshold.

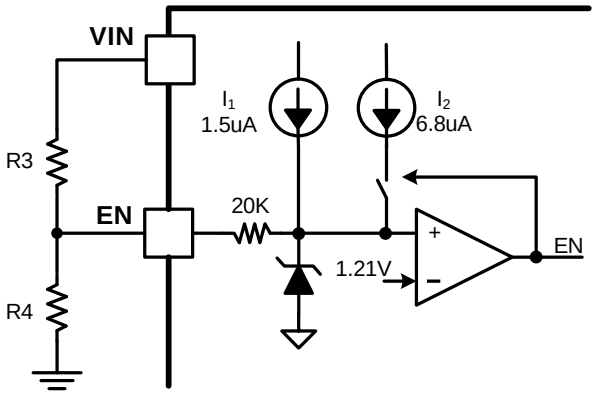


Figure 7. Adjustable VIN UVLO

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

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

44

APPLICATION INFORMATION

Typical Application

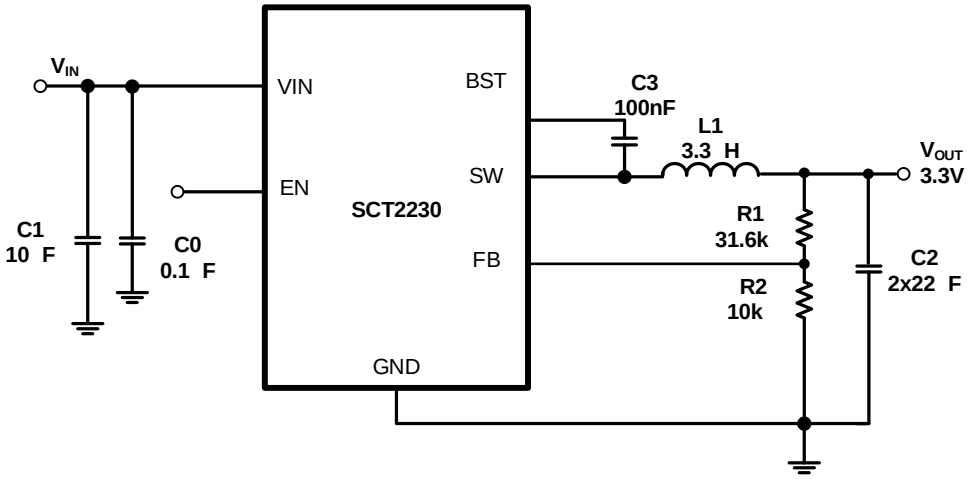


Figure 8. 12V Input, 3.3V/3A Output

Design Parameters

Design Parameters	Example Value
Input Voltage	12V
Output Voltage	3.3V
Output Current	3A
Switching Frequency	750kHz

Input Capacitor Selection

For good input voltage filtering, choose low-ESR ceramic capacitors. A ceramic capacitor 10μF is recommended for the decoupling capacitor anda0.1μF ceramic bypass capacitor is recommended to be placed as close as possible to the VIN pin of the SCT2230.

Use Equation (5) to calculate the input voltage ripple:

$$\Delta \quad = \frac{\quad}{\times} \times \frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{\quad}{\quad}\right) \tag{5}$$

Where:

- C_{IN} is the input capacitor value
- f_{sw} is the converter switching frequency
- I_{OUT} is the maximum load current

Due to the inductor current ripple, the input voltage changes if there is parasitic inductance and resistance between the power supply and the VIN pin. It is recommended to have enough input capacitance to make the input voltage

ripple less than 100mV. Generally, a 25V/10uF input ceramic capacitor is recommended for most of applications. Choose the right capacitor value carefully with considering high-capacitance ceramic capacitors DC bias effect, which has a strong influence on the final effective capacitance.

Inductor Selection

The performance of inductor affects the power supply's steady state operation, transient behavior, loop stability, and buck converter efficiency. The inductor value, DC resistance (DCR), and saturation current influences both efficiency and the magnitude of the output voltage ripple. Larger inductance value reduces inductor current ripple and therefore leads to lower output voltage ripple. For a fixed DCR, a larger value inductor yields higher efficiency via reduced RMS and core losses. However, a larger inductor within a given inductor family will generally have a greater series resistance, thereby counteracting this efficiency advantage.

Inductor values can have ±20% or even ±30% tolerance with no current bias. When the inductor current approaches saturation level, its inductance can decrease 20% to 35% from the value at 0-A current depending on how the inductor vendor defines saturation. When selecting an inductor, choose its rated current especially the saturation current larger than its peak current during the operation.

To calculate the current in the worst case, use the maximum input voltage, minimum output voltage, maxim load current and minimum switching frequency of the application, while considering the inductance with -30% tolerance and low-power conversion efficiency.

For a buck converter, calculate the inductor minimum value as shown in equation (6).

$$= \frac{\times (\quad - \quad)}{\times \quad \times \quad \times} \tag{6}$$

Where:

- K_{IND} is the coefficient of inductor ripple current relative to the maximum output current.

Therefore, the peak switching current of inductor, I_{LPEAK}, is calculated as in equation (7).

=

Output Feedback Resistor Divider Selection

The SCT2230 features external programmable output voltage by using a resistor divider network R1 and R2 as shown in the typical application circuit Figure 8. Use equation (8) to calculate the resistor divider values.

$$_1 = \frac{(\quad - \quad) \times \ _2}{\quad} \tag{8}$$

Table 2. Recommended Component Selections

Output Voltage (V)	SCT2231		L (µH)	C1 (µF)	C2 (µF)	C3 (nF)
1.2	4.99	10	1.5	10	2 x 22	100
1.5	8.66	10	1.5	10	2 x 22	100
1.8	12.4	10	2.2	10	2 x 22	100
2.5	21.5	10	2.2	10	2 x 22	100
3.3	31.6	10	3.3	10	2 x 22	100
5.0	52.3	10	3.3	10	2 x 22	100

Application Waveforms

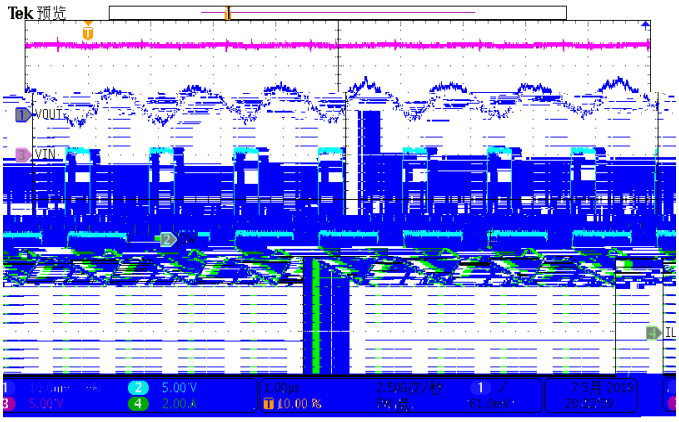


Figure 9. SW node waveform and Output Ripple
VIN=12V, IOUT=3A

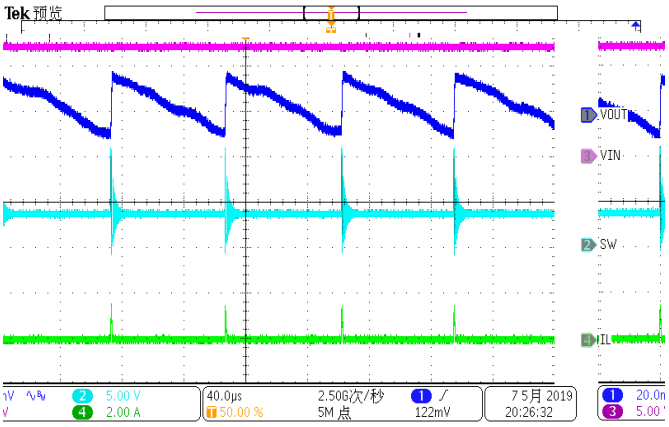


Figure 10. SW node Waveform and Output Ripple
VIN=12V, IOUT=10mA

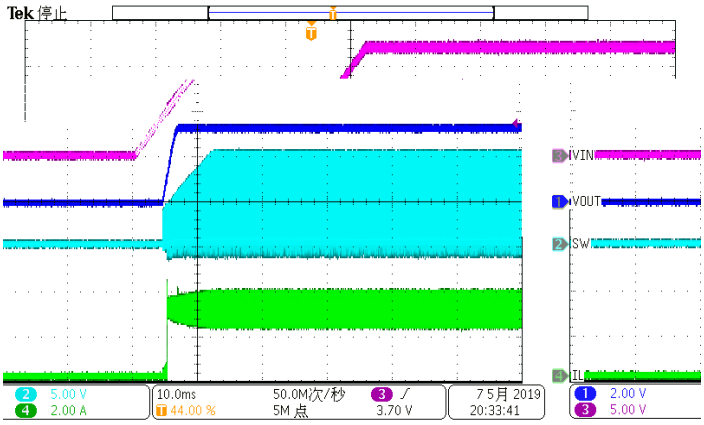


Figure 11. Power Up
VIN=12V, VOUT=3.3V, IOUT=3A

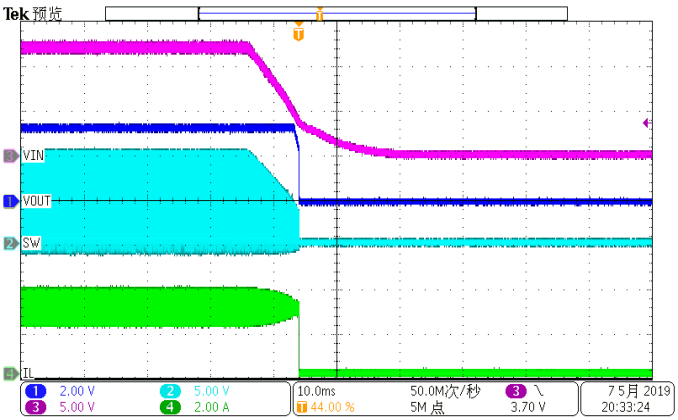


Figure 12. Power Down
VIN=12V, VOUT=3.3V, IOUT=3A

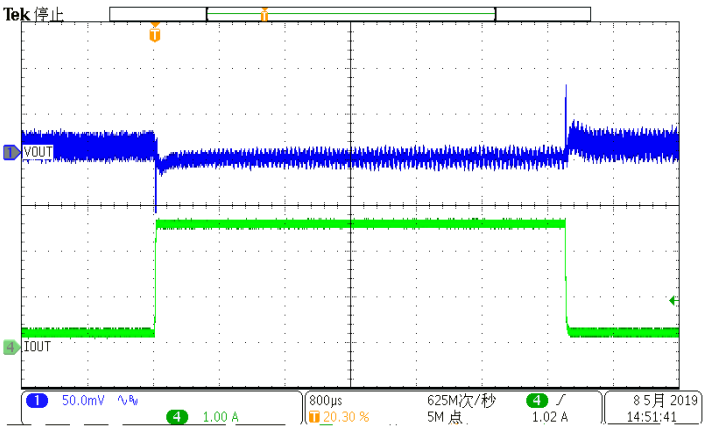


Figure 13. Load Transient
VOUT=3.3V, IOUT=0.3A to 2.7A, SR=250mA/us

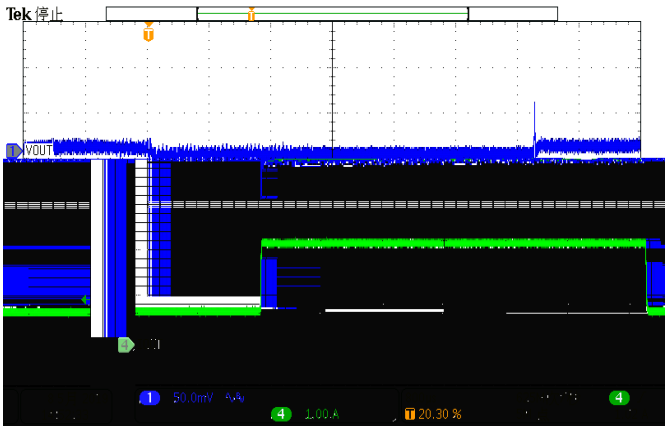


Figure 14. Load Transient
VOUT=3.3V, IOUT=0.75A to 2.25A, SR=250mA/us

Layout Guideline

The regulator could suffer from instability and noise problems without carefully layout of PCB. Radiation of high-frequency noise induces EMI, so proper layout of the high-frequency switching path is essential. Minimize the length and area of all traces connected to the SW pin, and always use a ground plane under the switching regulator to minimize coupling. The input capacitor needs to be very close to the VIN pin and GND pin to reduce the input supply ripple. Place the capacitor as close to VIN pin as possible to reduce high frequency ringing voltage on SW pin as well. Figure 15 is the recommended PCB layout of SCT2230.

The layout needs be done with well consideration of the thermal. A large top layer ground plate using multiple thermal vias is used to improve the thermal dissipation. The bottom layer is a large ground plane connected to the top layer ground by vias.

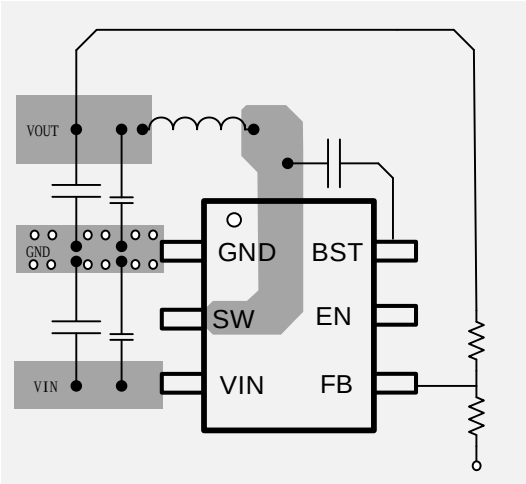
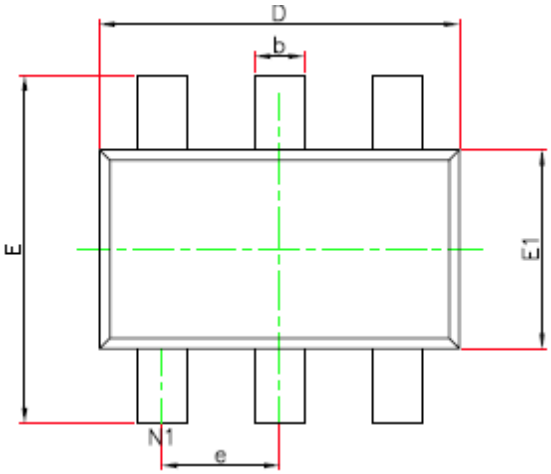
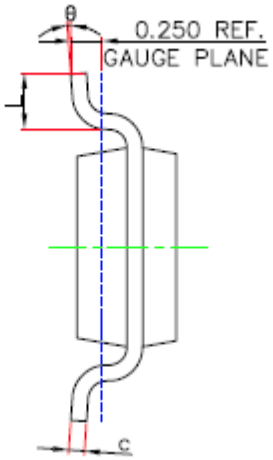


Figure 15. PCB Layout Example

PACKAGE INFORMATION (TSOT23-6)



TSOT23-6 TOP VIEW



TSOT23-6 BOTTOM VIEW

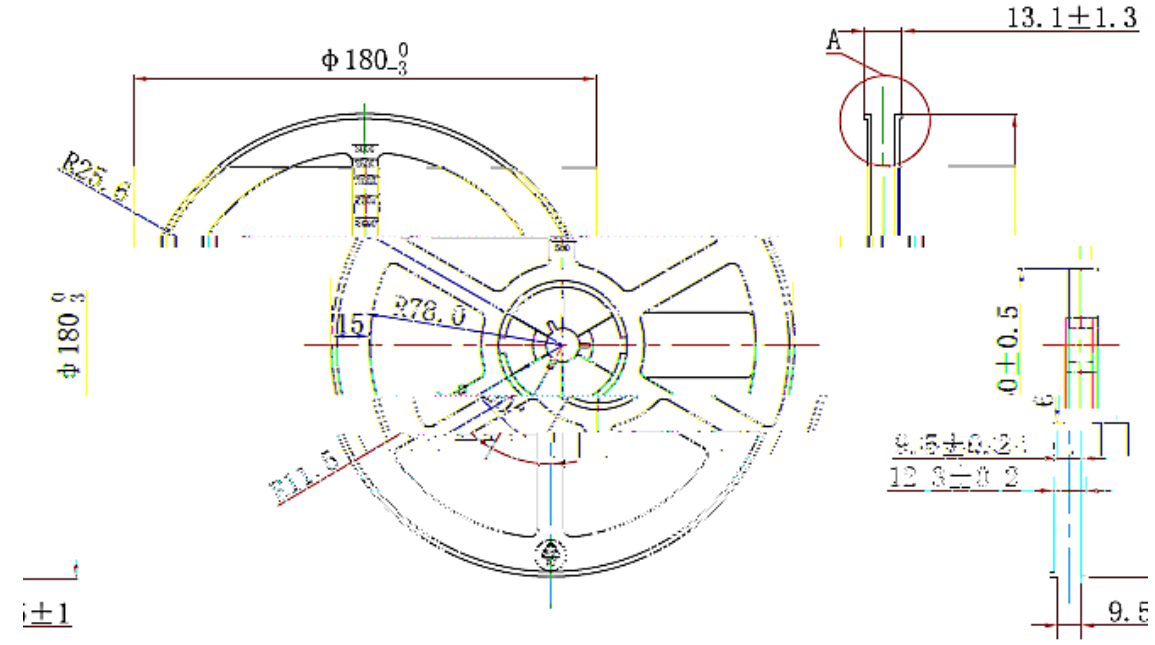
TSOT23-6 SIDE VIEW

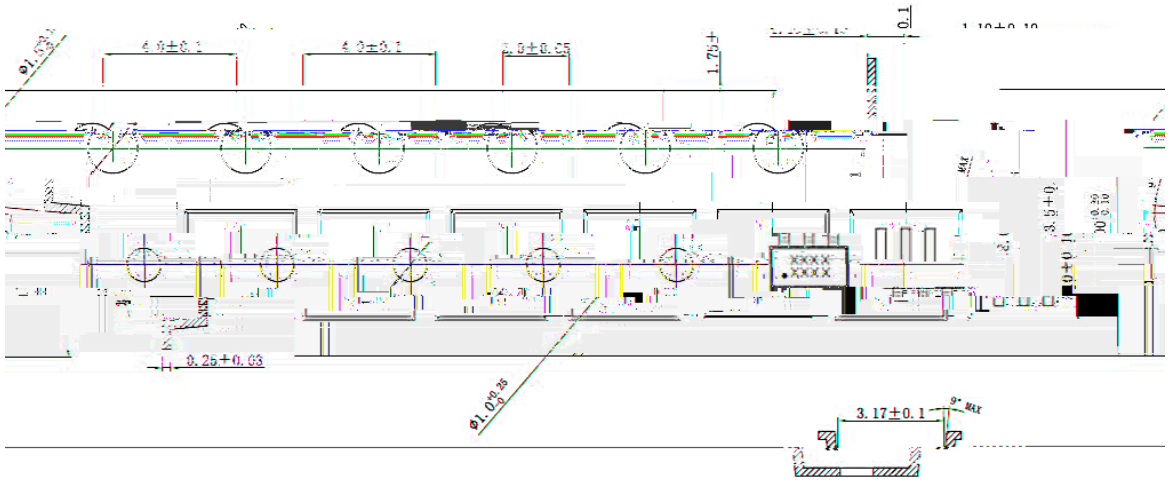
SYMBOL	Unit: Millimeter		
	MIN	TYP	MAX
A	-------		1.10
A1	0.000		0.10
A2	0.70		1.00
D	2.85		2.95
E	2.65		2.95
E1	1.55		1.65
b	0.30		0.50
c	0.08		0.20
e	0.95(BSC)		
L	0.30		0.60
θ	0°		8°

NOTE:

1. Drawing proposed to be made a JEDEC package outline MO-220 variation.
2. Drawing not to scale.
3. All linear dimensions are in millimeters.
4. Thermal pad shall be soldered on the board.
5. Dimensions of exposed pad on bottom of package do not include mold flash.
6. Contact PCB board fabrication for minimum solder mask web tolerances between the pins.

TAPE AND REEL INFORMATION (TSOT23-6)





Feeding Direction