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

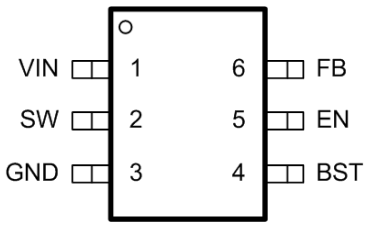
Revision 1.0: Production
Revision 1.1: Update EC for OC and OT value

PART NUMBER	PACKAGE MARKING	PACKAGE DISCRIPTION
SCT2230DTVA	230D	SOT563-6L

* (1) FOR TAPE & REEL, ADD SUFFIX R (E.G. SCT2230DTVAR).

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

SYMBOL	RATING	UNIT
V_{IN}	-0.3 to 19	V
V_{SW}	-1 to 19	V
V_{SW} (<10ns)	-2.5 to 21	V
V_{BST}	V_{SW}-0.3 to V_{SW}+6	V
V_{FB}	-0.3 to 6.5	V
V_{EN}	-0.3 to 6.5	V
T_J (2)	-40 to 125	°C
T_{STG}	-65 to 150	°C



SOT563 Top View

(1.6mm x 1.6mm)

(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

NAME	PIN	PIN FUNCTION
VIN	1	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	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	Power ground. Must be soldered directly to ground plane.
BST	4	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	Enable logic input. The device has precision enable thresholds 1.215V rising / 1.12V falling for programmable UVLO threshold and hysteresis.
FB	6	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.

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

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

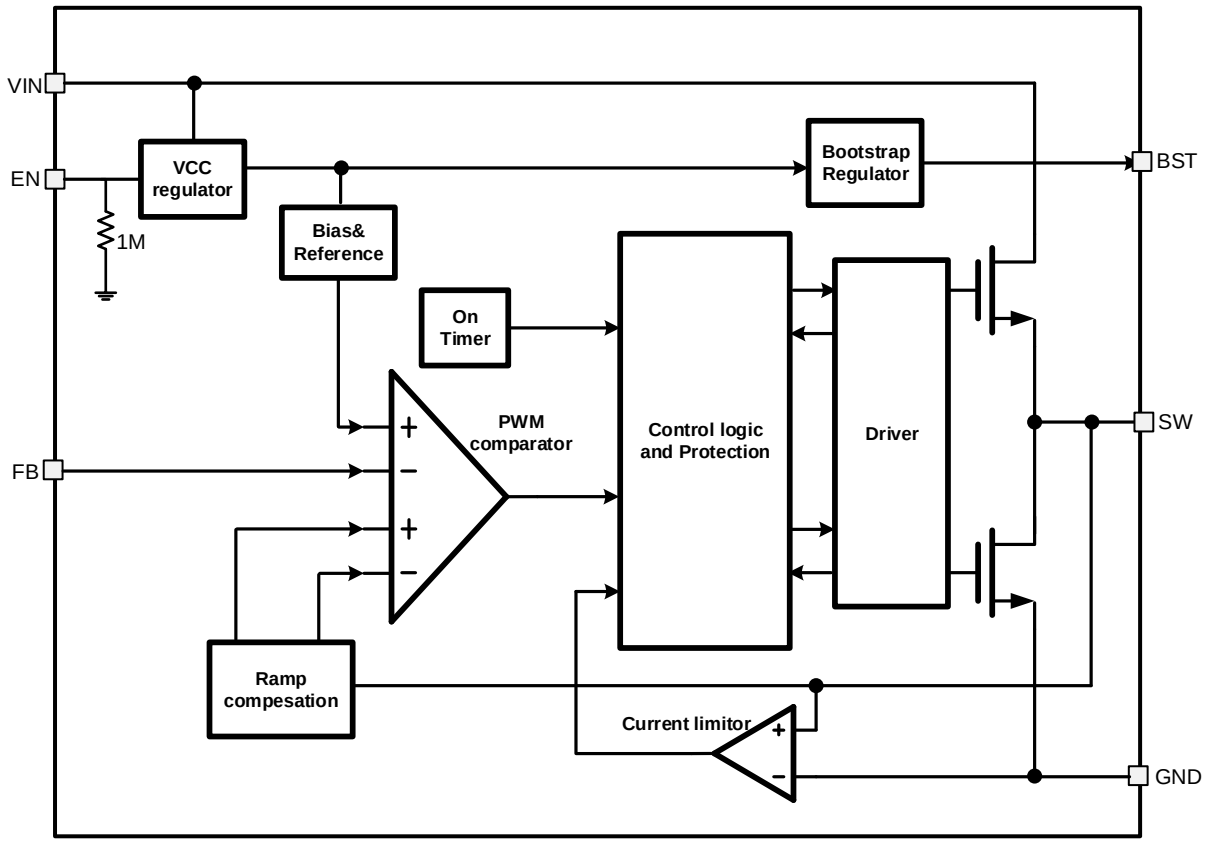
(1) HBM and CDM stressing are done in accordance with the ANSI/ESDA/JEDEC JS-001-2014 specification

PARAMETER	THERMAL METRIC	SOT563	UNIT
R	Junction to ambient thermal resistance(1)	120	°C/W
R	Junction to case thermal resistance(1)	8	

(1) SCT provides R and R numbers only as reference to estimate junction temperatures of the devices. R and R 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 SCT2230D are mounted, and external environmental factors. The PCB board is a heat sink that is soldered to the leads and thermal pad of the SCT2230D. Changing the design or configuration of the PCB board changes the efficiency of the heat sink and therefore the actual R and R .

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		4.0 350		V mV
I_{SD}	Shutdown current	EN=0, No load, VIN=12V		1.2		uA
I_Q	Quiescent current	EN=2V, No load, No switching. VIN=12V. BST-SW=5V		220		uA
Enable, Soft Start and Working Modes						
V_{EN_H}	Enable high threshold			1.215		V
V_{EN_L}	Enable low threshold			1.12		V
Power MOSFETs						
R_{DSON_H}	High side FET on-resistance			50		
R_{DSON_L}	Low side FET on-resistance			24		
Feedback and Error Amplifier						
V_{FB}	Feedback Voltage	T_J=25°C, CCM	0.788	0.8	0.812	V
Current Limit						
I_{LIM_LSD}	LSD valley current limit		3.5	4.4	5.3	A
Switching Frequency						
F_{SW}	Switching frequency	V_{IN}=12V, V_{OUT}=5V		800		kHz
t_{ON_MIN}	Minimum on-time			70		ns
t_{OFF_MIN}	Minimum off-time			220		ns
Soft Start Time						
t_{SS}	Internal soft-start time			3		ms
Protection						
T_{SD}	Thermal shutdown threshold Hysteresis	T_J rising		165 22		°C



Adaptive On-time Control

The SCT2230D 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 transient response and easy loop stabilization. At the beginning of each cycle, the high-side MOSFET is turned on for a fixed one shot time ON-time period. The one shot time cycle-by-cycle based to maintain a pseudo-fixed frequency over the input voltage range, hence it is called adaptive on-time control. SCT2230D turns off high-side MOSFET after the fixed on time and turns on the low-side MOSFET. SCT2230D turns off the low-side MOSFET once the output voltage dropped below the output regulation, the one-shot timer then reset and the high-side MOSFET is turned on again. The on-time is inversely proportional to the input voltage and proportional to the output voltage. It can be calculated using the following equation (1):

$$t_{ON} \quad \frac{V_{OUT}}{V_{IN} \quad f_S} \tag{1}$$

Where:

VOUT is the output voltage.
VIN is the input voltage.
fs is the switching frequency.

After an ON-time period, the regulator goes into the OFF-time period. The OFF-time period length depends on VFB in most cases. It will end when the FB voltage decreases below 0.8V, at which point the ON-time period is triggered. If the OFF-time period is less than the minimum OFF time, the minimum OFF time will be applied, which is around 220ns typical.

Power Saving Mode (PSM)

The SCT2230D is designed with Power Save Mode (PSM) at light load conditions for high power efficiency. The regulator automatically reduces the switching frequency and extends Toff while no Ton changing during the light load condition to get high efficiency and low output ripple. As the output current decreases from heavy load condition, the inductor current decreases as well, eventually nearing zero current, this is the boundary between CCM and DCM. The low side MOSFET is turned off when the inductor current reaches zero level. The load is provided only by output capacitor, when FB voltage is lower than 0.8V, the next ON cycle begins. When the output current increases from light to heavy load the switching frequency increases to keep output voltage. The transition point to light load operation can be calculated using the following equation (2):

$$I_{LOAD} \quad \frac{V_{IN} \quad V_{OUT}}{2L} \quad T_{ON} \tag{2}$$

Where:

TON is on-time

VIN Power

The SCT2230D is designed to operate from an input voltage supply range between 4.2V to 17V, at leasQ6 Tf1 0 0 1 345.31

Under Voltage Lockout UVLO

The SCT2230D Under Voltage Lock Out (UVLO) default startup threshold is typical 4V with VIN rising and shutdown threshold is 3.65V 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 1.215V/rise), the SCT2230D enables all functions and the device starts soft-start phase. The SCT2230D has the built in 3ms 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 1.12V/fall).

An internal 1M resistor from EN to GND allow EN float to shut down the chip. EN is clamped internally using a 5V series diode. For applications where a specified VIN UVLO voltage needs to be set, EN connects a resistor R3 to VIN to form a voltage divider with a 1M resistor inside the chip for the configuration of VIN UVLO voltage, as shown in Figure 7. The resistor distributor R3 is calculated by Equation (3).

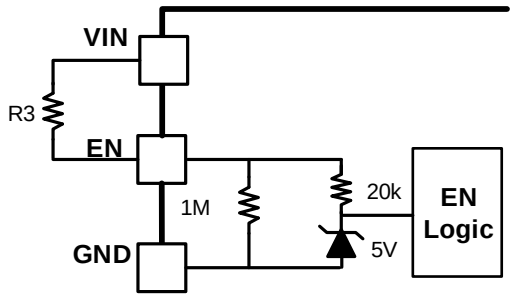


Figure 7. Adjustable VIN UVLO

(3)

(4)

Where:

- Vstart: Vin rise threshold to enable the device
- Vstop: Vin fall threshold to disable the device
- V_{ENR}=1.215V
- V_{EMF}=1.12V
- R

Over Current Protection (OCP) and Hiccup Mode

In each switching cycle, the inductor current is sensed by monitoring the low-side MOSFET during the OFF period. When the voltage between GND pin and SW pin is lower than the over current threshold voltage, the OCP will be

triggered and the controller keeps the OFF state. A new switching cycle will begin only when the measured voltage is higher than limit voltage. If output loading continues to increase, output will drop below the UVP, and SS pin is discharged such that output is 0V. Then the device will count for 7 cycles of soft-start time for hiccup waiting time and restart normally after 7 cycles soft-start period.

Bootstrap Voltage Regulator

An external bootstrap capacitor between BST and SW pin powers floating high-side (g)-9(.00000912 0 6q0.000002/F1 9.621v

Typical Application

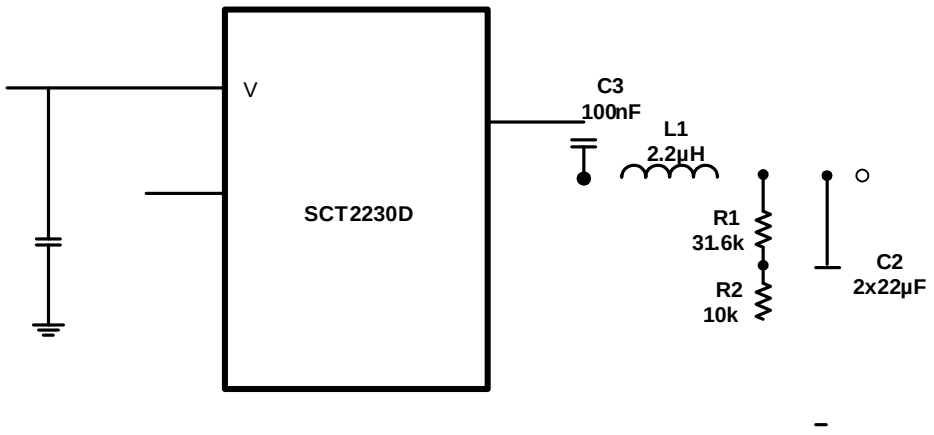


Figure 8. 12V Input, 3.3V/3A Output

Design Parameters

Design Parameters	Example Value
Input Voltage	12V
Output Voltage	3.3V
Output Current	3A
Switching Frequency	800kHz

Input Capacitor Selection

For good input voltage filtering, choose low-ESR ceramic capacitors. A ceramic capacitor 10 for the decoupling capacitor and a 0.1 to be placed as close as possible to the VIN pin of the SCT2230D.

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

(5)

Where:

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

(7)

Set the current limit of the SCT2230D higher than the peak current I_{LPEAK} and select the inductor with the saturation current higher than the current limit. The the core loss significantly affect the efficiency of power conversion. Core loss is related to the core material and different inductors have different core loss. For a certain inductor, larger current ripple generates higher DCR and ESR conduction losses and higher core loss.

Table 1 lists recommended inductors for the SCT2230D. Verify whether the recommended inductor can support the user's target application with the previous calculations and bench evaluation. In this application, the WE's inductor 744311220 is used on SCT2230D evaluation board.

Table 1. Recommended Inductors

Part Number	L (uH)	DCR Max	Saturation Current/Heat Rating Current (A)	Size Max (LxWxH mm)	Vendor
744311220	2.2	11.4	13	7.3x7.2x3.8	Wurth Electronik

Output Feedback Resistor Divider Selection

The SCT2230D features external programmable output voltage by using a resistor divider network R1 and R2 as

Application Waveforms

Vin=12V, Vout=3.3V, unless otherwise noted

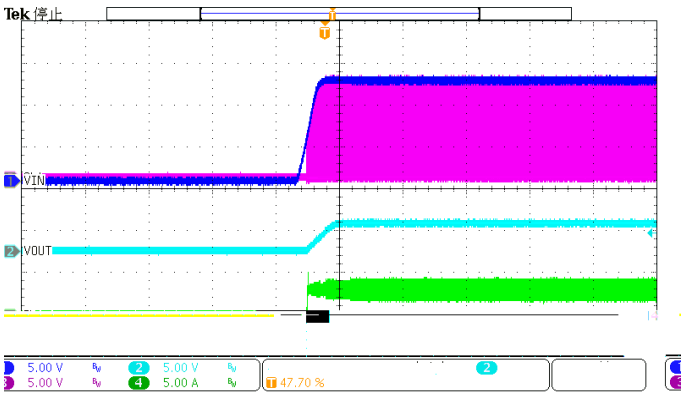


Figure 9. Power up

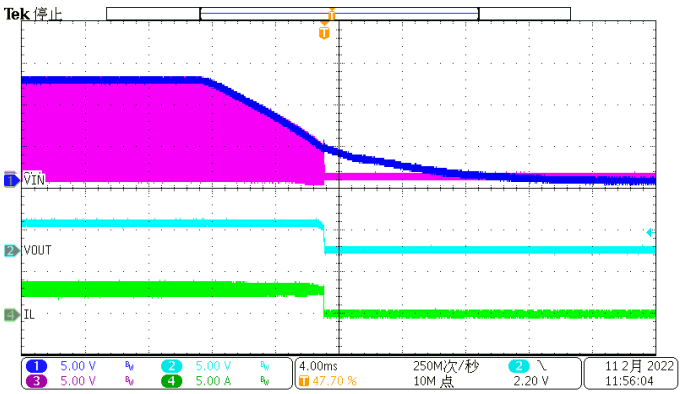


Figure 10. Power down

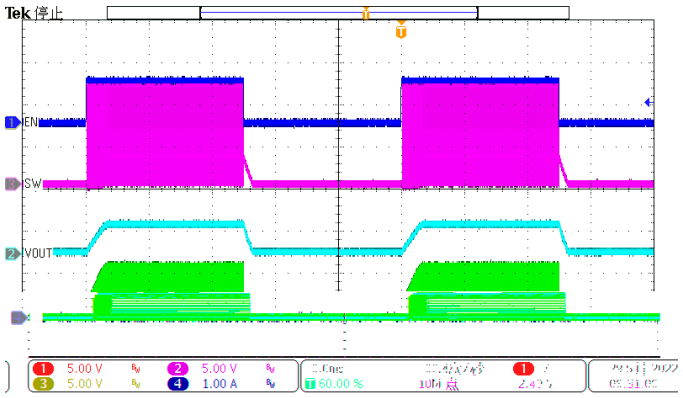


Figure 11. EN toggle（Iout=0.1A）

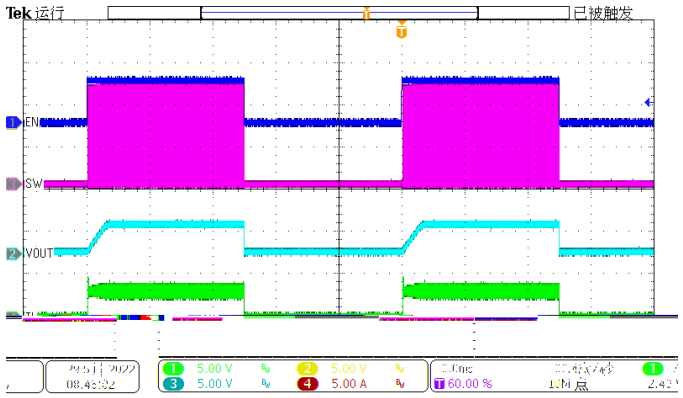


Figure 12. EN toggle（Iout=3A）

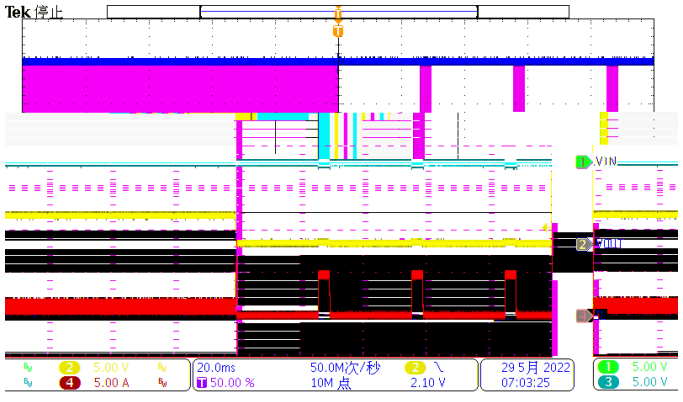


Figure 13. Over Current Protection (1A to hard short)

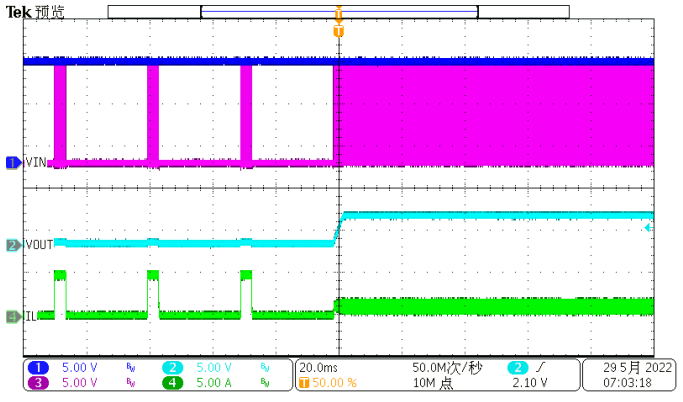


Figure 14. Over Current Release (1A to hard short)

Application Waveforms

Vin=12V, Vout=5V, unless otherwise noted

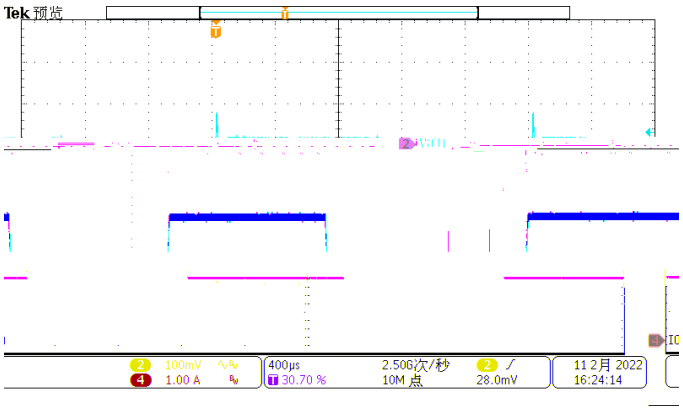


Figure 15. Load Transient (1.5A-3A, 1.6A/us)

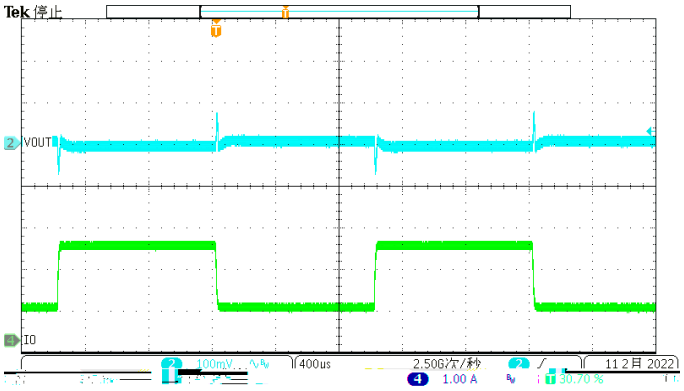


Figure 16. Load Transient (0.75A-2.25A, 1.6A/us)

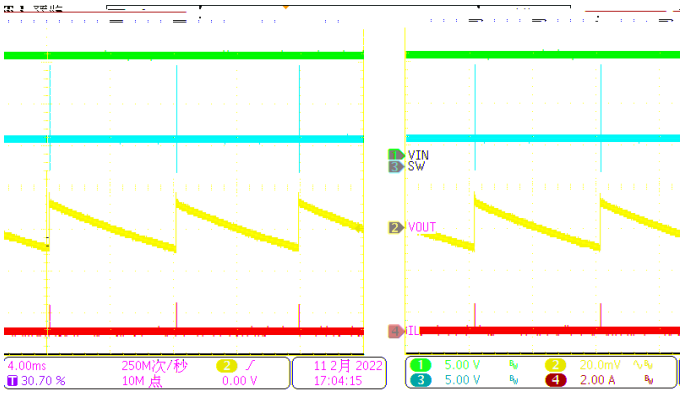


Figure 17. Output Ripple (Iload=0A)

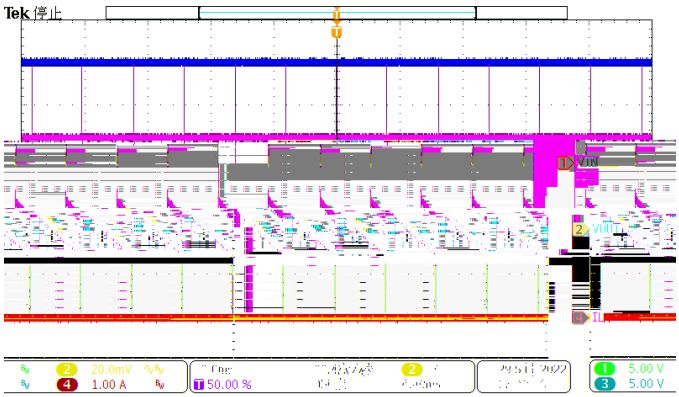


Figure 18. Output Ripple (Iload=0.1A)

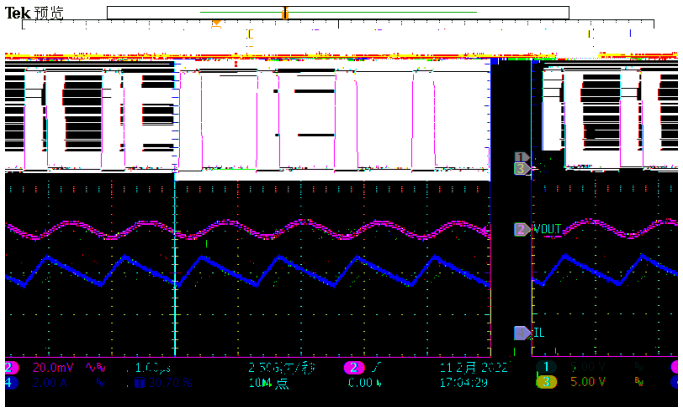


Figure 19. Output Ripple (Iload=3A)

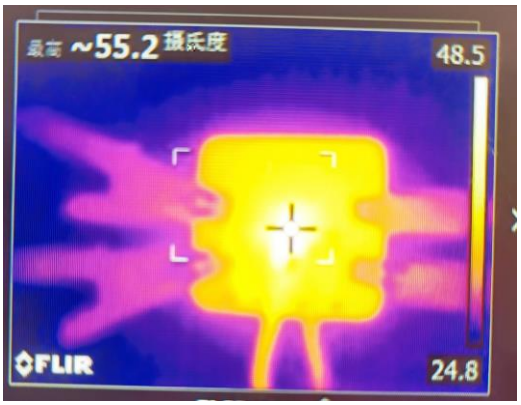
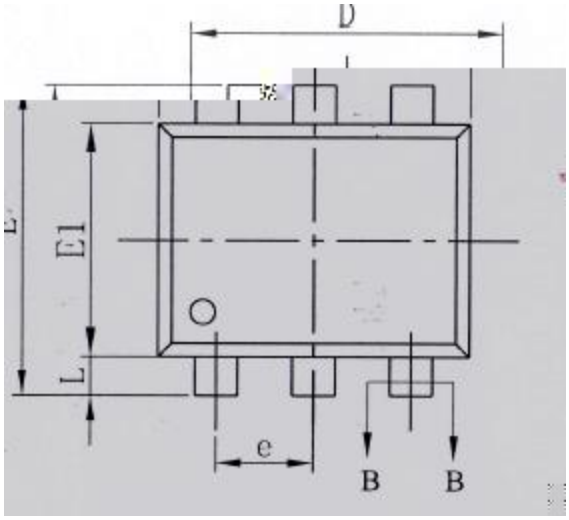
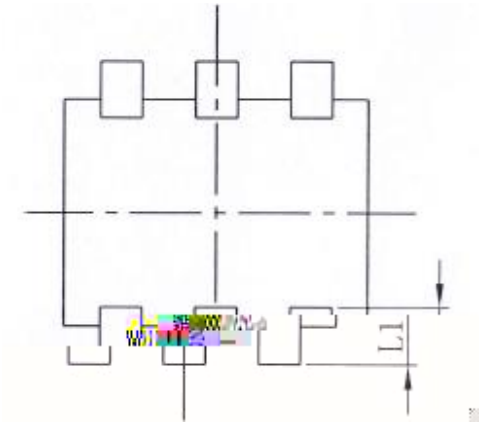


Figure 20. Thermal, 12VIN, 3.3Vout, 3A

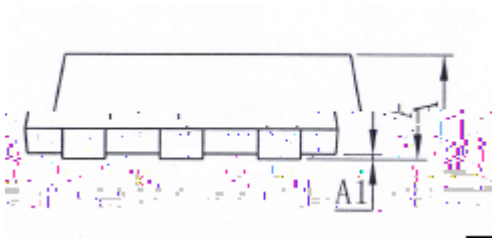
SCT2230D



SOT563 TOP VIEW



SOT563 BOTTOM VIEW



SOT563 SIDE VIEW

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.

SYMBOL	Unit: Millimeter		
	MIN	TYP	MAX
A	0.53		0.6
A1	0.000		0.05
b	0.19		0.27
b1	0.18	0.2	0.23
c	0.11		0.16
c1	0.1	0.11	0.12
D	1.5	1.6	1.7
E	1.5	1.6	1.7
E1	1.1	1.2	1.3
e	0.50BSC		
L	0.1	0.2	0.3
L1	0.2	0.5	0.4

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