SC8885S EVM User Guide

1. Description

SC8885S EVM is a demo board used to demonstrate and evaluate SC8885S integrated high efficiency, synchronous, bidirectional charger/discharger and SMBus interface. Through SC8885S EVM, user can adjust parameters conveniently through SMBus interface and evaluate the functions of SC8885S, such as buck-boost charging management, power path management, buck-boost reverse discharging management and other performance.

SC8885S EVM key parameters are as follows:

Table 1 SC8885S EVM key parameters

Parameter	Value
EVM device model	SC8885X/SC8886X EVM_C83.1
Battery cell number	1-4 cell batteries application
Bidirectional charging and discharging operation	Yes
SMBus control	Yes
Power path management	Yes, support NVDC power path management
Input voltage (VBUS) range under charging mode	3.5V~ 24V (support 29V absolute rating voltage)
Vsys operation voltage range under charging mode	1.024V ~ 19.2V (support 29V absolute rating voltage)
Output voltage range (VBAT) range under charging mode	2.4V ~ 19.2V (support 29V absolute rating voltage)
Input voltage (VBAT) range under discharging mode	3.5V ~ 24V (support 29V absolute rating voltage)
Output voltage range (VBUS) range under discharging mode	3V~ 24V(support 29V absolute rating voltage)
Maximum average inductor current IL	6A/10A/15A(default) /No limit
Maximum input current under charging mode (IBUS)	6.4A (configurable by SMBus) or No limit
Maximum charge current (IBAT)	8.128A (configurable by SMBus)
IBUS sense resistor	10mΩ
IBAT sense resistor	10mΩ
Switching frequency	800kHz (Default)/1200kHz. (configurable by SMBus)
Efficiency	Charging efficiency up to 97%
VBUS capacitors	100nF/50V x1 + 10µF/50V x 6 + 47µF/35V
VSYS capacitors	100nF/50V x1 + 10µF/50V x 6 + 47µF/35V
VBAT capacitors	10µF/50V x 2
EVM dimension	60mm x 60mm (four-layer board)

2. Interface and SMBus configuration

2.1 Input and output interface

Table 2 describes the functions and configurations of each input and output interface.

Table 2 Interface function description

Pin	Name	Description
P1	SMBus interface	P1 pins are AGND/AGND/+3.3V/SDA/SCL from left to right. SCL/SDA are communication signal of SMBus；+3.3V is 3.3V pull up power (external supply, can be supplied by SMBus tool which connected to computer)；AGND is analog ground.
P2	OTG/VAP	OTG/VAP enable Pin Shorted to +3.3V, can enter OTG/VAP operation.
P3	ILIM_HIZ	Shorted to AGND, system will enter HI-Z mode.
P4	CMPIN/CMPOUT	Input/output pins of independent comparator.
P5	CELL_CONTROL	Short P5 will make CELL_PRES connect to AGND and IC will receive battery removal signal.
P6	R_IADPT	Used to configure inductor value: Short 1-2pin: 1µH Short 3-4pin: 2.2µH Short 5-6pin: 3.3µH
P7, P9	CELL_PRES	Used to configure battery cell number: Float P7 and P9, 1 cell battery Short P7 only, 2 cell batteries Short P9 only, 3 cell batteries Short P7 and P9, 4 cell batteries
P8	CELL_REMOVAL	Short P8 will make CELL_PRES connect to AGND and IC will receive battery removal signal.
P10	VBUS	Input power interface under charging mode, output power interface under discharging mode.
P11	VSYS	System output power interface, connect to system load.
P12	VBAT	Connect to battery, charging and discharging interface.

2.2 Test point

Table 3 describes the functions of each test point.

Table 3 test point function description

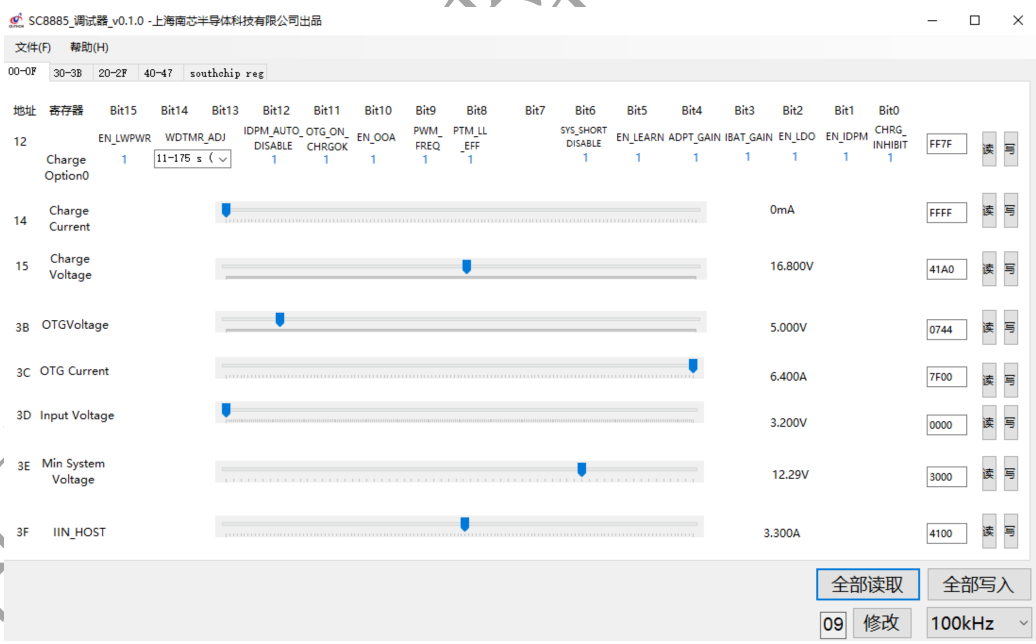
Label	Name	Description
TP1, TP3	AGND	Analog ground of IC
TP4	/PROCHOT	/PROCHOT test point
TP5	HD1	High side switch driver signal of buck side
TP6	LD1	Low side switch driver signal of buck side
TP7	SW1	Buck switching node test point
TP8	HD2	High side switch driver signal of boost side

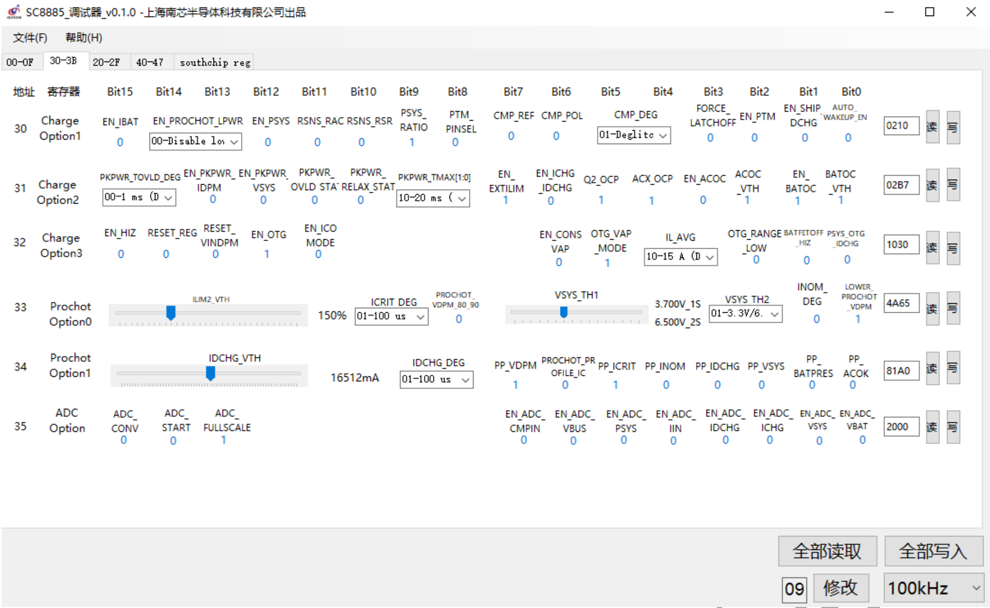
TP9	LD2	Low side switch driver signal of boost side
TP10	SW2	Boost switching node test point
TP13	REGN	Power supply pin, used as IC power driver
TP14	EN_OTG	OTG/VAP pin test point
TP15	COMPOUT	Output of independent comparator test point
TP16	/BATDRV	BATFET driver signal
TP17	CELL_PRES	Battery cell number configuration test point
TP18	IADPT	IBUS current monitor test point
TP19	IBAT	Charging and discharge current monitor test point
TP20	PSYS	System power monitor test point

2.3 SMBus configuration

SC8885S integrates SMBus control interface, user can configure many functions through SMBus, such as charge and discharge mode、switching frequency、watchdog timer、Charge Current、Max Charge Voltage、Min system voltage、VINDPM、IINDPM、OTG discharge voltage、 OTG discharge current、 Peak Power mode、 pass through mode、 ICO function、 VAP function、 ADC and so on, besides user can read registers to obtain IC's real-time status under different operation and protection.

The address of SMBus is 0X09 (7bits). The following is a brief introduction of voltage or current register setting and reading using SMBus Interface, specific registers description please refer SC8885S_datasheet.

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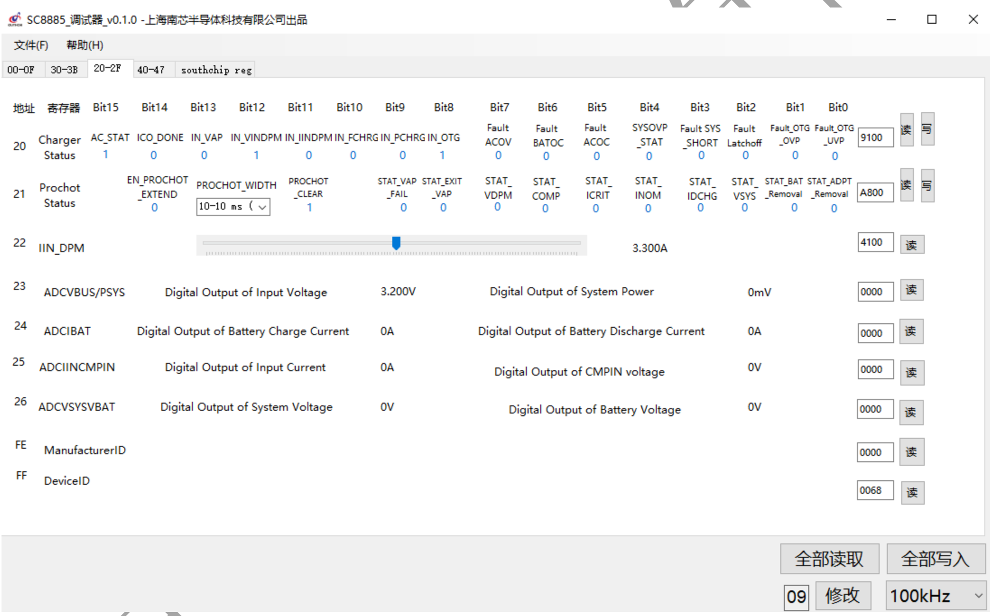
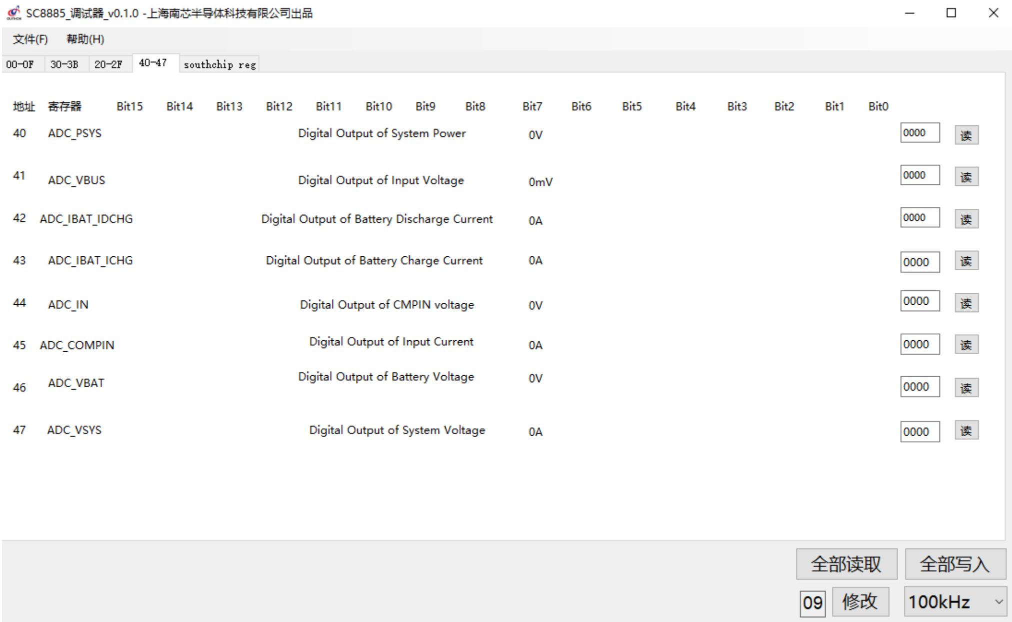
文件(F) 帮助(H)
00-0F 30-3B 20-2F 40-47 southchip reg
地址 寄存器 Bit15 Bit14 Bit13 Bit12 Bit11 Bit10 Bit9 Bit8 Bit7 Bit6 Bit5 Bit4 Bit3 Bit2 Bit1 Bit0
30 Charge Option1
31 Charge Option2
32 Charge Option3
33 Prochot Option0
34 Prochot Option1
35 ADC Option
0210
02B7
1030
4A65
81A0
2000
全部读取 全部写入
09 修改 100kHz


SC8885_调试器_v0.1.0 -上海南芯半导体科技有限公司出品
文件(F) 帮助(H)
00-0F 30-3B 20-2F 40-47 southchip reg
地址 寄存器 Bit15 Bit14 Bit13 Bit12 Bit11 Bit10 Bit9 Bit8 Bit7 Bit6 Bit5 Bit4 Bit3 Bit2 Bit1 Bit0
20 Charger Status
21 Prochot Status
22 IIN_DPM 3.300A
23 ADCVBUS/PSYS Digital Output of Input Voltage 3.200V Digital Output of System Power 0mV
24 ADCIBAT Digital Output of Battery Charge Current 0A Digital Output of Battery Discharge Current 0A
25 ADCIINCMPIN Digital Output of Input Current 0A Digital Output of CMPIN voltage 0V
26 ADCVSYSVBAT Digital Output of System Voltage 0V Digital Output of Battery Voltage 0V
FE ManufacturerID
FF DeviceID
9100
A800
4100
0000
0068
全部读取 全部写入
09 修改 100kHz



2.3.1 Forward charging mode

2.3.1.1 Steps to enter charging mode

- Step 1: configure battery cell number and inductor value, then VBUS powers up, read all the default value of registers
- Step 2: configure watchdog timer
- Step 3: configure VINDPM
- step 4: configure IINDPM
- step 5: configure charge voltage
- step 6: configure Vsysmin voltage
- Step 7: configure charge current

2.3.1.2 Configure battery cell number and inductor value

Battery cell number depends on the voltage divider ratio of VDRV connected to CELL_PRES pin. After VBUS powers up, the cell number of batteries are detected. Then SC8885S will configure maximum charge voltage/VSYSMIN /SYSOVP. User can configure different battery cell number through P7 and P9 on the EVM.

EVM configuration	CELL_PRES Voltage	Max charge voltage	VSYSMIN	Description
Float P7 and P9	25%*VDRV	4.192V	3.584V	1 cell application
Short P7, float P9	40%*VDRV	8.400V	6.144V	2 cell application
Float P7, short P9	55%*VDRV	12.592V	9.216V	3 cell application
Short P7 and P9	75%*VDRV	16.800V	12.288V	4 cell application

Note: Max charge voltage and Vsysmin are configurable even after power-up configuration. But SYSOVP is latched after power-up configuration. IC will be latched off once SYSOVP is triggered.

Inductor value configuration depends on P6. The default inductor value on the EVM is 2.2uH.

EVM Configuration	IADPT resistor	Inductor value
Short left side of P6	93kΩ	1μH
Short middle side of P6	137kΩ	2.2μH
Short right side of P6	169kΩ	3.3μH

2.3.1.3 Watchdog timer configuration

Watchdog timer can be configured as disable/5s/88s/175s (default value) through Reg0x12<14:13>. After watchdog timer is triggered, Reg0x14 will be reset. If user wants to restore charging, charge current value needs to be re-written. Watchdog timer will be reset each time after charge current is written to register.

2.3.1.4 VINDPM configuration

After SC8885S powers up, it will detect VBUS automatically and configure VINDPM to VBUS-1.28V. If the adapter capability is insufficient to afford the system load, SC8885S will reduce charge current automatically to maintain the input voltage at VINDPM.

VINDPM can be configured through Reg0x3D, the configurable range of VINDPM of SC8885S is 3.2V-19.52V.

$$\text{VINDPM} = (\text{Reg0x3D}<13:6>) \times 64\text{mV} + 3200\text{mV}$$

Note: After SC8885S powers up, VINDPM is configured as VINDPM=VBUS-1.28V. If VBUS is reduced lower than VINDPM, it will cause the input cannot be loaded normally only when VINDPM is configured to appropriate voltage.

2.3.1.5 IINDPM configuration

SC8885S affords two ways to limit IBUS. The actual limit current depends on the lower value of the external current limit and the register current limit, where external current limit can be disabled through Reg0x31<7>=0.

a. Use ILIM_HIZ pin to configure input current limit

$$\text{IINDPM} = \frac{\text{VILIM\_HIZ} - 1}{40 \times \text{Rs1}}$$

Where VILIM_HIZ is the bias voltage of ILIM_HIZ pin. On the EVM, VILIM_HIZ is obtained by dividing VDRV through R6 and R7. (R6=383kΩ, R7=220kΩ, VDRV=5.25V, V_{ILIM_HIZ}=1.915V)

Rs1 is IBUS current sense resistor R11, default value is 10mΩ on the EVM.

So, the default input current limit is EVM 2.29A on the board.

b. Use Reg0x0F/0x0E to configure input current limit

Input current limit can be configured by Reg0x3F, the configurable range of input current limit of SC8885S is 50mA-6.4A. IINDPM has 50mA bias.

$$\text{IINDPM} = \text{Reg0x3F}<14:8> \times 50\text{mA} + 50\text{mA}$$

At this time, the default current limit value is 3.3A.

2.3.1.6 Charge voltage configuration

Charge voltage can be configured through Reg0x15, the configurable range of charge voltage of SC8885S is 1.024V-19.2V.

Charge Voltage = (Reg0x15<14:3>) x 8mV

Note: 1. If charge voltage (Reg0x15<14:3>) is written to zero, it will recover charge voltage register to default value corresponding to battery cell number.

2. It will not be loaded to register if the written value to charge voltage register beyond 1.024V~19.2V.

2.3.1.7 Vsysmin voltage configuration

Vsysmin can be configured through Reg0x3E, the configurable range of Vsysmin voltage of SC8885S is 1.024V-16.128V. The actual Vsysmin is register configuration value plus 160mV offset.

Vsysmin = Reg0x3E<13:8> x 256mV+160mV

When VBAT<Vsysmin, SC8885S will enter pre-charge phase, the maximum charge current is clamped to 384mA in pre-charge phase;

When VBAT>Vsysmin, SC8885S will enter CC fast charge phase, the charge current depends on charge current register;

2.3.1.8 Charge current configuration

Charge current can be configured through Reg0x14, the configurable range of charge current of SC8885S is 64mA-8.128A.

Charge Current = Reg0x14<12:6> x 64mA

2.3.2 Reverse discharge mode configuration

2.3.2.1 Steps to enter OTG

- Step 1: Configure battery cell number and power VBAT up, then ensure VBAT cannot trigger SYSOVP, otherwise OTG will not work;
- Step 2: Configure OTG discharge voltage;
- Step 3: Configure OTG discharge current;
- Step 4: Pull OTG_VAP pin up (short P2 OTG pin to +3.3V on the EVM) and set Reg0x32<12>=1, then OTG discharge mode is enabled.

2.3.2.2 OTG discharge voltage configuration

OTG output voltage can be configured through Reg0x3B, the configurable range of OTG output voltage of SC8885S is 3V-20.8V. OTG output voltage has two level offset voltage: 0V and 1.28V.

OTG voltage = (Reg0x3B<13:2>) x 8mV +offset

Where offset voltage depends on Reg0x32<2>:

a. Reg0x32<2>=1, offset voltage is 0V, OTG output voltage range is 3V~22.72V.

b. Reg0x32<2>=0, offset voltage is 1.28V, OTG output voltage range is 4.28V~24V.

Note: OTG output voltage will be clamped if it is set beyond above range.

2.3.2.3 OTG discharge current configuration

OTG output current can be configured through Reg0x3C, the configurable range of OTG output current of SC8885S is 0V-6.35A.

OTG current = Reg0x3C<14:8> x 50mA

Note: When OTG output current exceeds set value, OTG output voltage will be pulled down, triggering OTG UVP and exiting OTG. It is need to set Reg0x32<12>=1 to enable OTG mode.

Note: During enable OTG process, it is not allowed to start-up with higher than 300mA load, otherwise may start-up unsuccessfully.

2.3.3 Instructions for using SMBus tool provided by SouthChip

SouthChip has made SMBus tool for each chip, which is convenient for customers to debug and use.

2.4 Other configurations

2.4.1 Loop compensation configuration

COMP1 and COMP2 are used to set loop compensation parameters. On the EVM, the parameters are COMP1 (R15=68kΩ, C13=220pF), COMP2(R29=27kΩ, C29=330pF). It can meet the requirements of typical applications without changing the compensation parameters. If the loop is unstable, self-adjustment of compensation parameters are necessary.

2.4.2 Switching frequency configuration

The default switching frequency is 800kHz, it can be configured to 1200kHz by SMBus.

3. Test precautions

- Before starting up, if ILIM is connected to GND, IC will enter HI-Z mode and cannot work normally.
- In charge mode, battery is charged through VBUS, power path is from VBUS to VSYS and VBAT; in discharge mode, battery will discharge to USB, power path is from VBAT to VBUS.
- Pull CELL_PRES pin down will cause DCDC stop working.
- If inductor is changed, it is need to re-power up IC to configure inductor, otherwise IC may work unstably.

4. EVM schematic and BOM

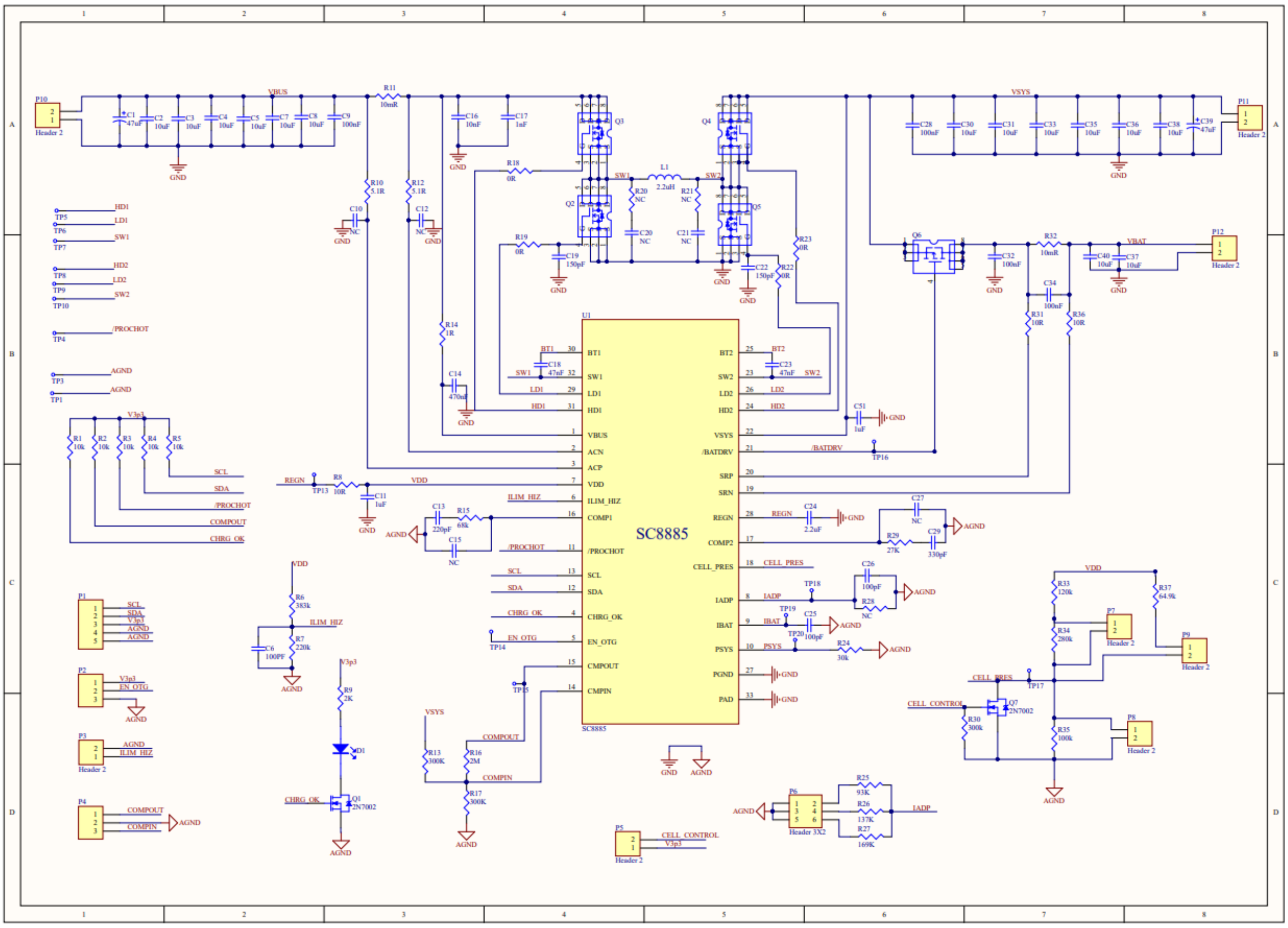


Figure 2 SC8885S EVM schematic

BOM list:

Table 5 SC8885S EVM BOM list

Designator	Description	Value	Part Number	Vendor	Quantity
U1	QFN4x4-32	SC8885S	SC8885S	Southchip	1
C1, C39	Electrolytic Capacitor, 35V	47uF	875105645005	Wurth	2
C2, C3, C4, C5, C7, C8, C30, C31, C33, C35, C36, C37, C38, C40	Capacitor, X5R, 1206, 50V, 10%,10uF	10uF			14
C6, C25, C26	Capacitor, X5R, 0603, 50V, 10%,100pF	100pF			3
C9, C28, C32, C34	Capacitor, X5R, 0603, 50V, 10%,100nF	100nF			4
C11, C51	Capacitor, X5R, 0603, 50V, 10%,1uF	1uF			2

C13	Capacitor, X5R, 0603, 50V, 10%,2,2nF	220pF			1
C14	Capacitor, X5R, 0603, 50V, 10%,470nF	470nF			1
C15	Capacitor, X5R, 0603, 50V, 10%	NC			1
C10, C12, C15, C20, C21	Capacitor, X5R, 0603, 50V, 10%	NC			1
C27	Capacitor, X5R, 0603, 50V, 10%	NC			1
C16	Capacitor, X5R, 0603, 50V, 10%,10nF	10nF			1
C17	Capacitor, X5R, 0603, 50V, 10%,1nF	1nF			1
C29	Capacitor, X5R, 0603, 50V, 10%,330pF	330pF			1
C18, C23	Capacitor, X5R, 0603, 50V, 10%,150pF	47nF			2
C19, C22	Capacitor, X5R, 0603, 50V, 10%,150pF	150pF			2
C24	Capacitor, X5R, 0603, 50V, 10%,2.2uF	2.2uF			1
D1	Blue-LED	BLUE-LED	std	std	1
L1	Inductor, DCR=6.5mΩ, IR=10A, Isat=28A	2.2uH	74437368022	Wurth	1
P1	Header, 5-Pin	Header 5	std	std	1
P2, P4	Header, 3-Pin	Header 3	std	std	2
P3, P5, P7, P8, P9	Header, 2-Pin	Header 2	std	std	5
P6	Header, 3-Pin, Dual row	Header 3X2	std	std	1
P10, P11, P12	Header, 2-Pin	Header 2	std	std	3
Q1, Q7	NMOS SOT23-3, 60V, Id=300mA	2N7002	2N7002		2
Q2, Q3, Q4, Q5	NMOS DFN3x3, 30V, Rdson<5.3mΩ	TDM3536	TDM3536	Techcode Semiconductor	4
Q6	PMOS_DFN3X3, 30V, Rdson<12.3mΩ	AONR21357	AONR21357	Alpha&Omega Semiconductor	1
R1, R2, R3, R4, R5	Resistor, 0603, 1/4W, 1%	10k	std	std	5

R6	Resistor, 0603, 1/4W, 1%	383k	std	std	1
R7	Resistor, 0603, 1/4W, 1%	220k	std	std	1
R8, R31, R36	Resistor, 0603, 1/4W, 1%	10R	std	std	3
R9	Resistor, 0603, 1/4W, 1%	2K	std	std	1
R10, R12, R18, R19, R22, R23	Resistor, 0603, 1/4W, 1%	0R	std	std	6
R11, R32	Metal resistor, 1206, 1W, 1%	10mΩ	std	std	2
R13, R16, R17, R20, R21	Resistor, 0603, 1/4W, 1%	NC	std	std	5
R14	Resistor, 0603, 1/4W, 1%	1R	std	std	1
R15	Resistor, 0603, 1/4W, 1%	27k	std	std	1
R24	Resistor, 0603, 1/4W, 1%	30k	std	std	1
R25	Resistor, 0603, 1/4W, 1%	93K	std	std	1
R26, R28	Resistor, 0603, 1/4W, 1%	137K	std	std	2
R27	Resistor, 0603, 1/4W, 1%	169K	std	std	1
R29	Resistor, 0603, 1/4W, 1%	27k	std	std	1
R30	Resistor, 0603, 1/4W, 1%	300k	std	std	1
R33	Resistor, 0603, 1/4W, 1%	120k	std	std	1
R34	Resistor, 0603, 1/4W, 1%	280k	std	std	1
R35	Resistor, 0603, 1/4W, 1%	100k	std	std	1
R37	Resistor, 0603, 1/4W, 1%	64.9k	std	std	1
TP1, TP3, TP4, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20	test point	TP	std	std	11
TP5, TP6, TP7, TP8, TP9, TP10	test point	TP	std	std	6

5. Layout

SC8885S EVM_C83.1 PCB layout:

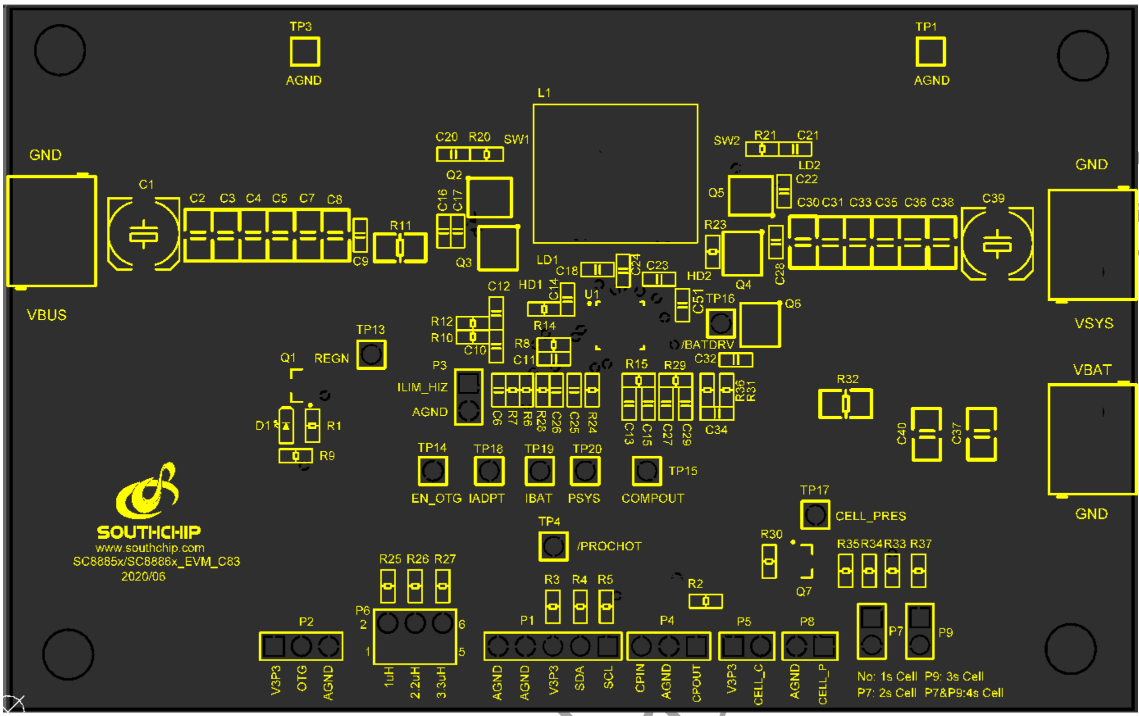


图 3 Top Silkscreen

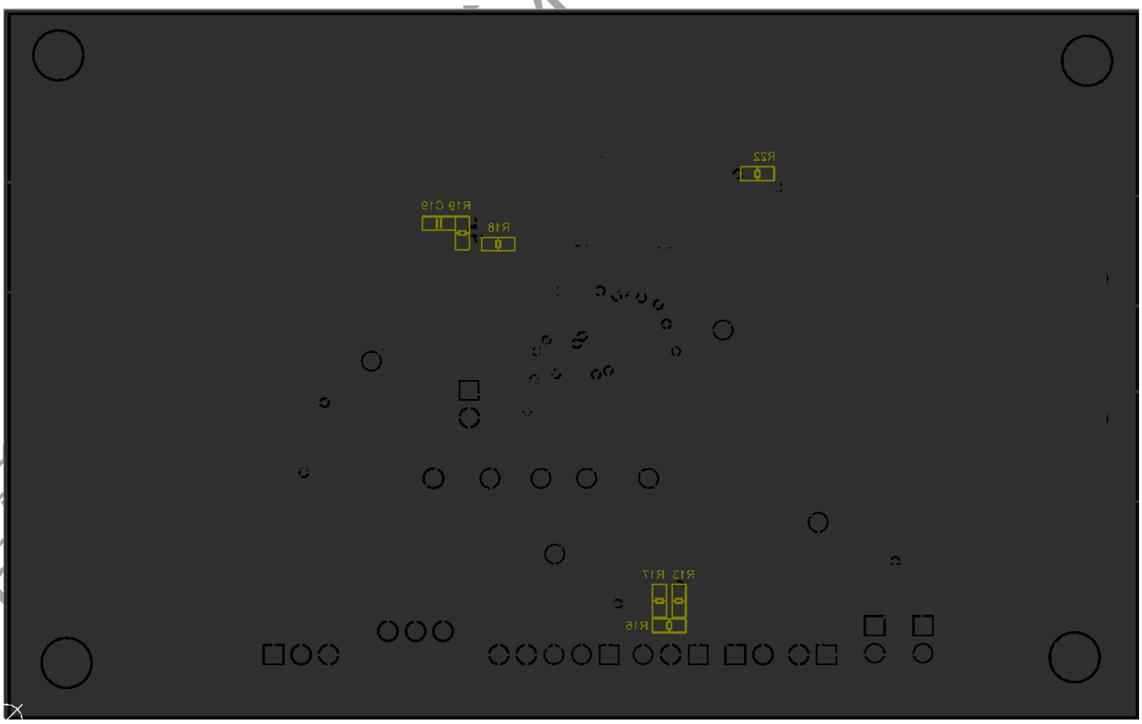


图 4 Bottom Silkscreen

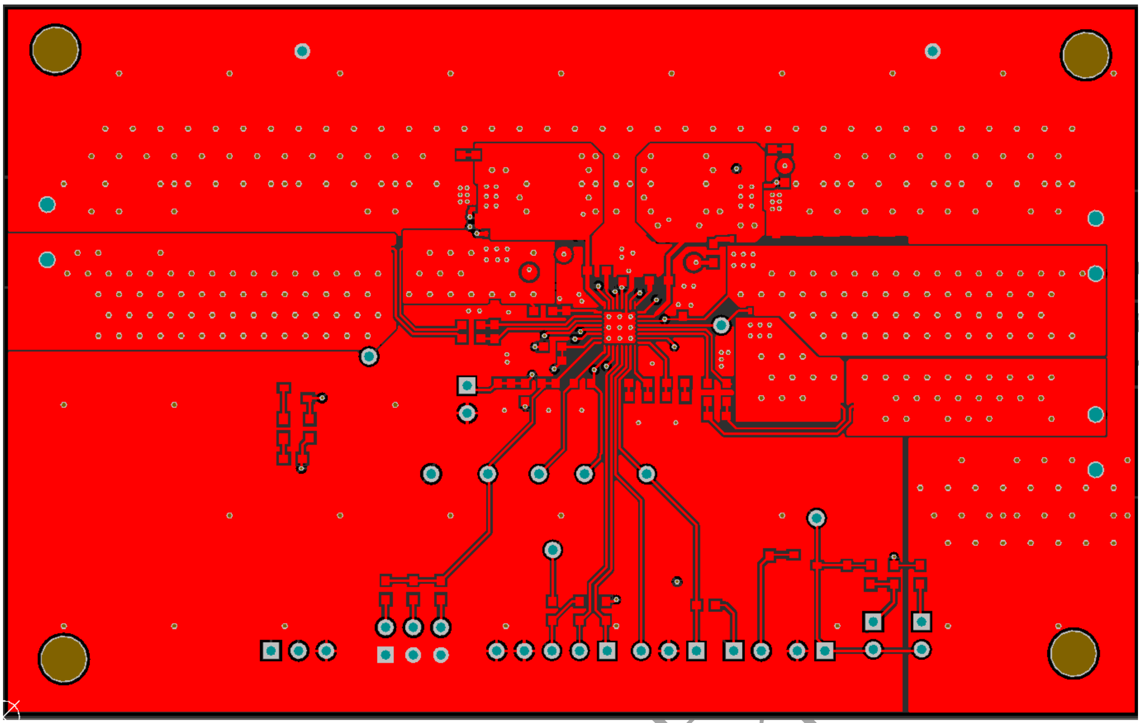


图 5 Top Layer

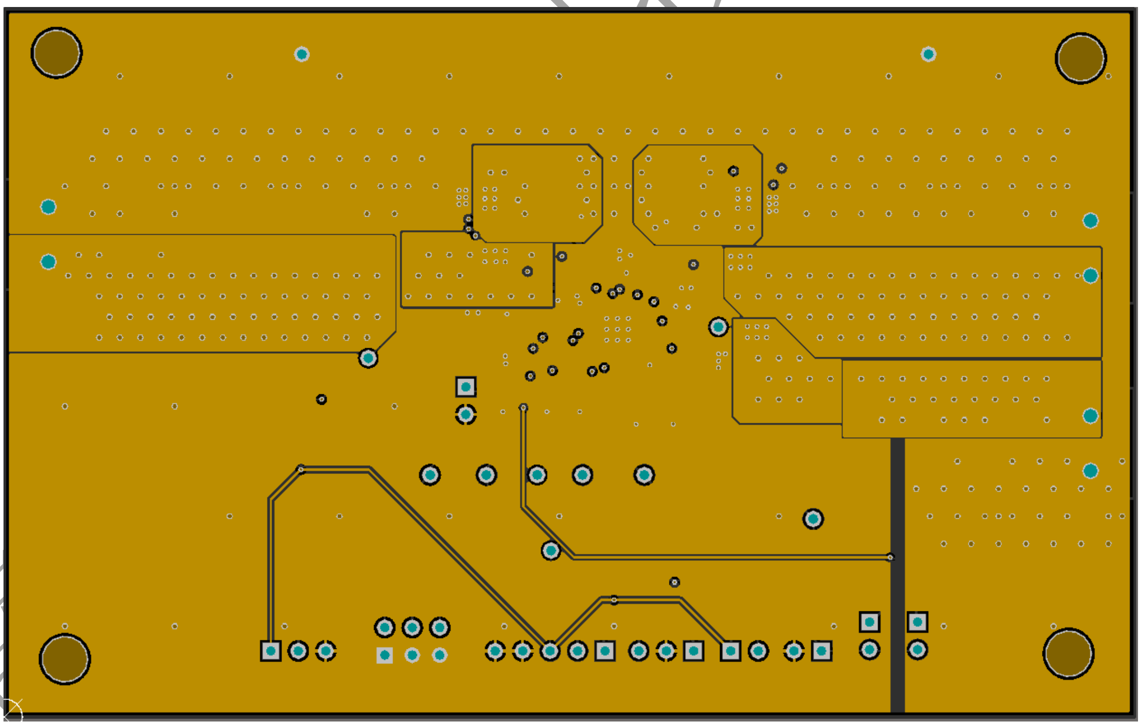


图 6 Mid Layer1

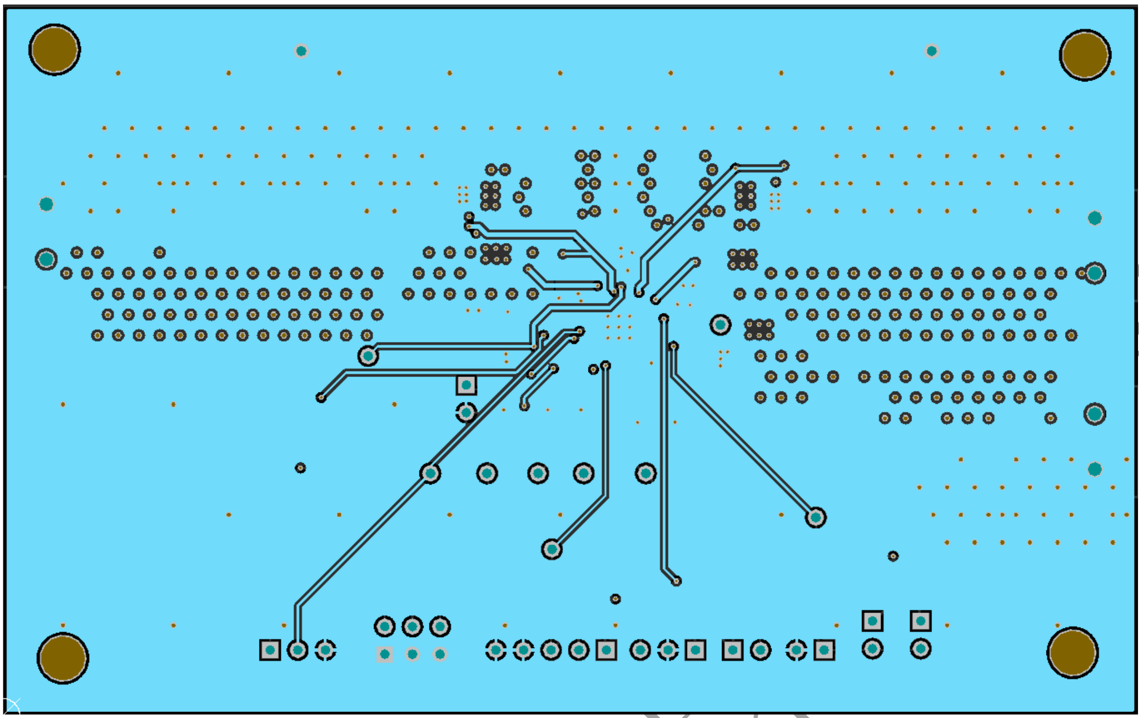


图 7 Mid Layer2

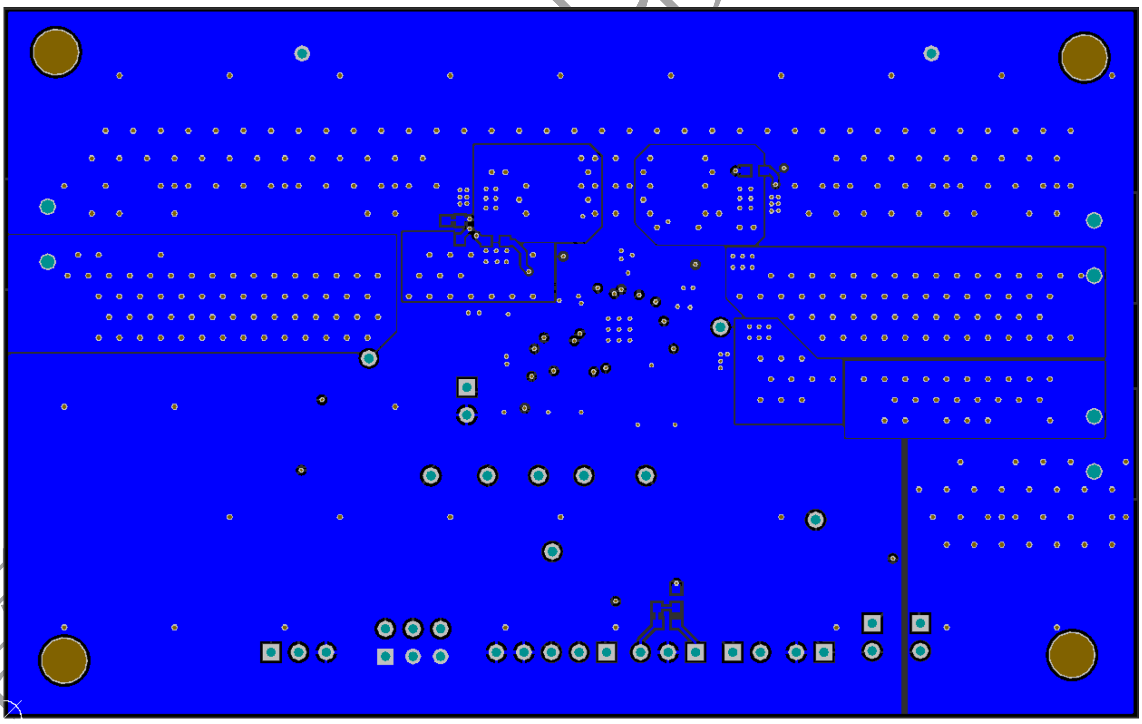


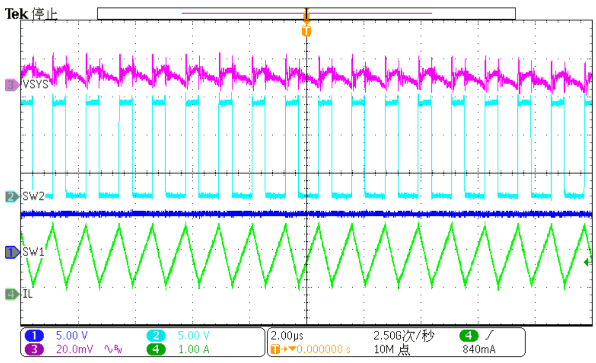
图 8 Bottom Layer

6. Key test data and waveforms

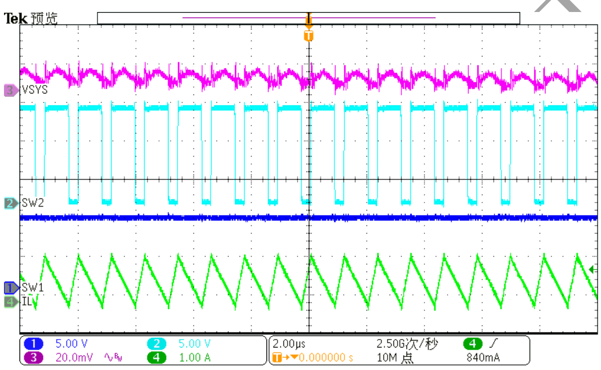
6.1 Charge mode waveforms

fsw = 800KHz, 3 cell batteries

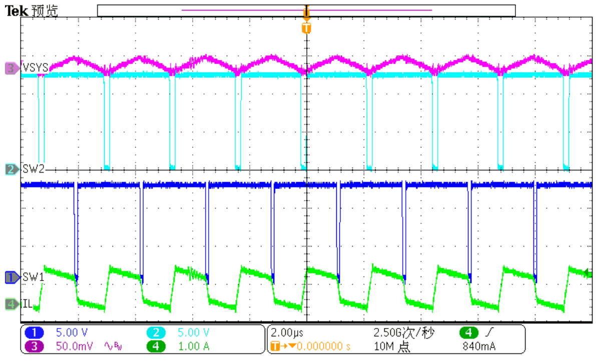
VBUS = 5V, VBAT=9V, IPRECHARGE=384mA, pre-charge



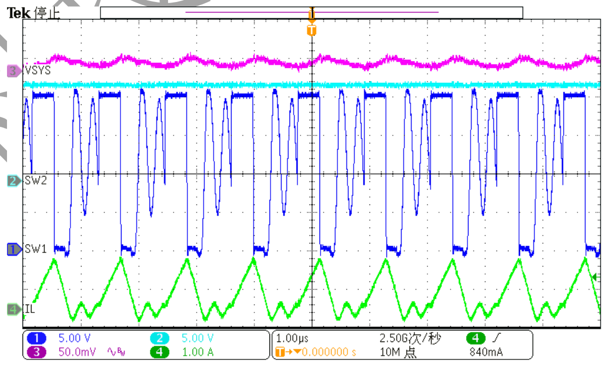
VBUS = 9V, VBAT=9V, IPRECHARGE=384mA, pre-charge



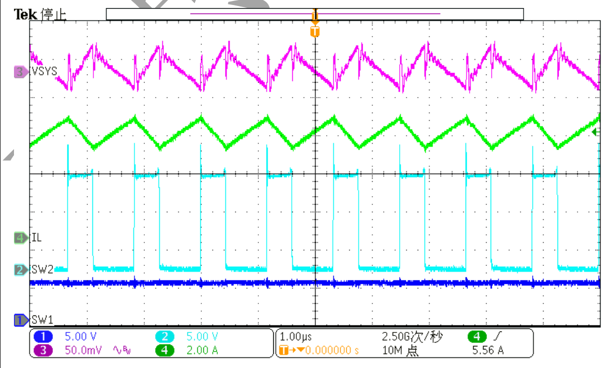
VBUS = 12V, VBAT=9V, IPRECHARGE=384mA, pre-charge



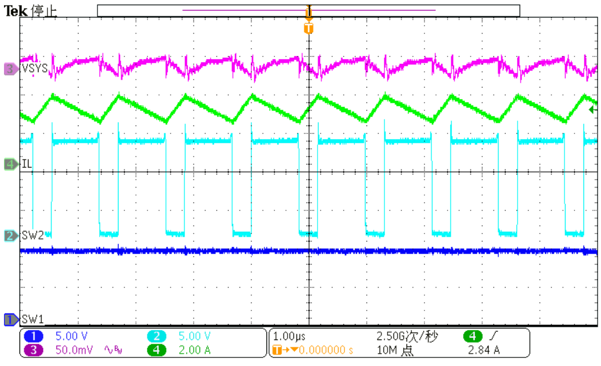
VBUS = 20V, VBAT=9V, IPRECHARGE=384mA, pre-charge



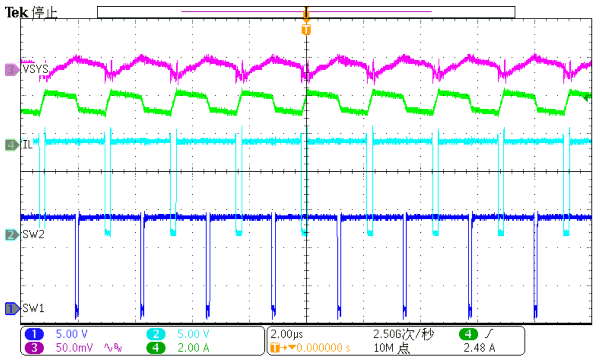
VBUS=5V, VBAT=12V, ICHARGE=2048mA, CC charge



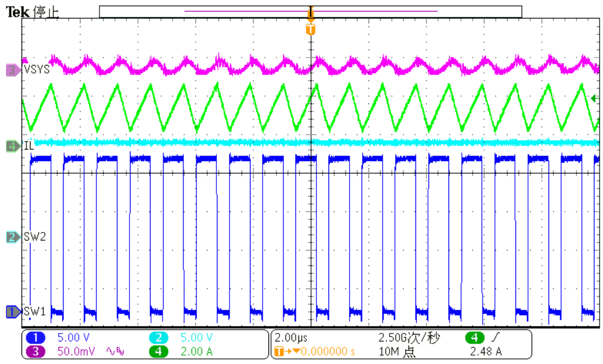
VBUS = 9V, VBAT=12V, ICHARGE=2048mA, CC charge



VBUS=12V, VBAT=12V, ICHARGE=2048mA, CC charge



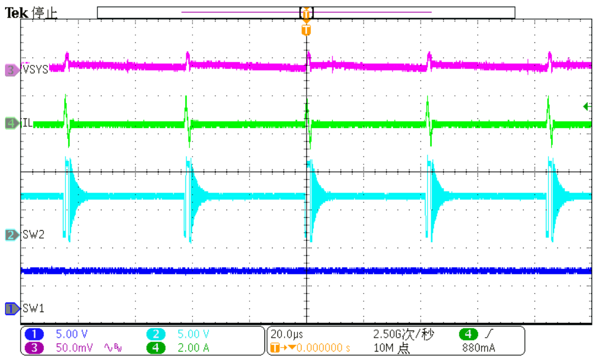
VBUS = 20V, VBAT=12V, ICHARGE=2048mA, CC charge



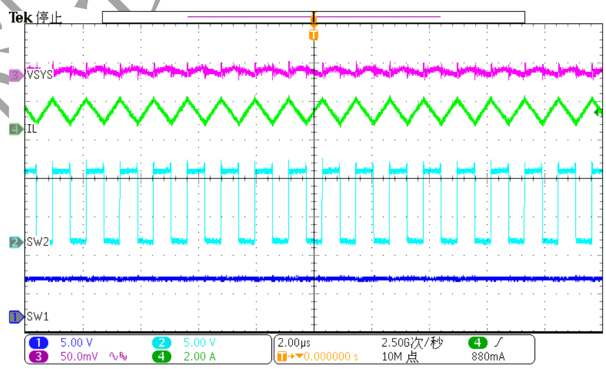
6.2 VSYS loaded waveforms

fsw = 800KHz, VBAT=7.2V

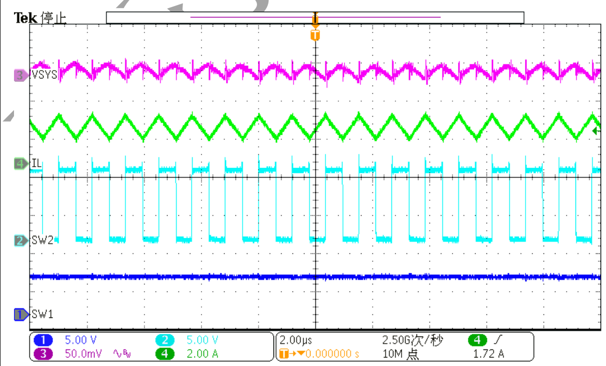
VBUS = 5V, VSYS= 9.376V, ISYS=0A



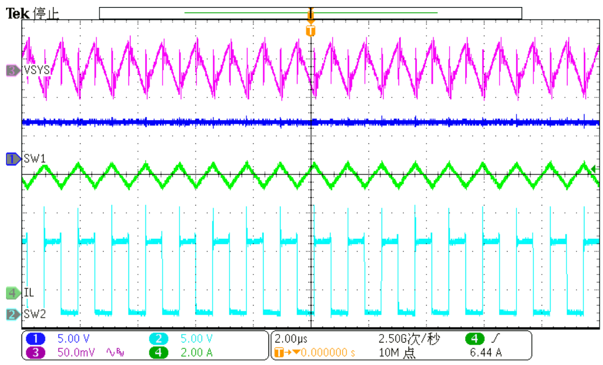
VBUS = 5V, VSYS= 9.376V, ISYS=0.5A



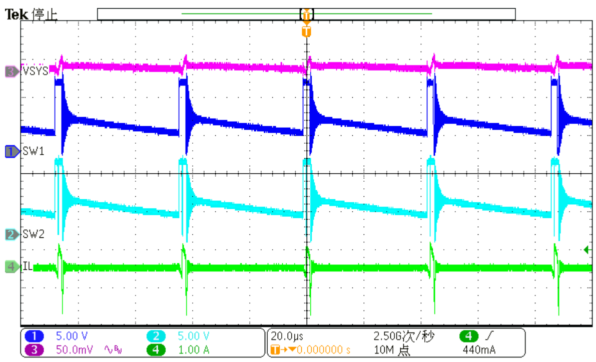
VBUS = 5V, VSYS= 9.376V, ISYS=1A



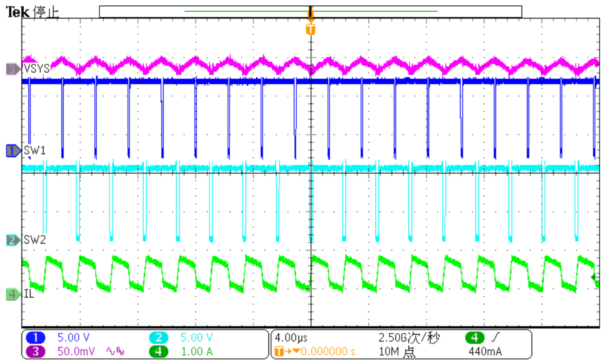
VBUS = 5V, VSYS= 9.376V, ISYS=3A



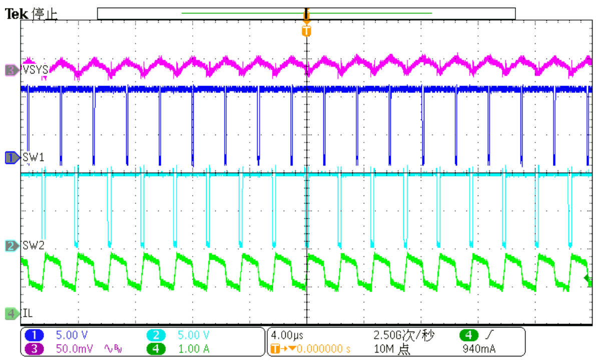
VBUS = 9V, VSYS= 9.376V, ISYS=0A



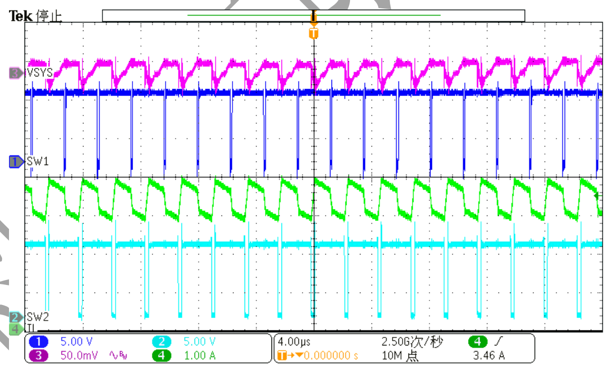
VBUS = 9V, VSYS= 9.376V, ISYS=0.5A



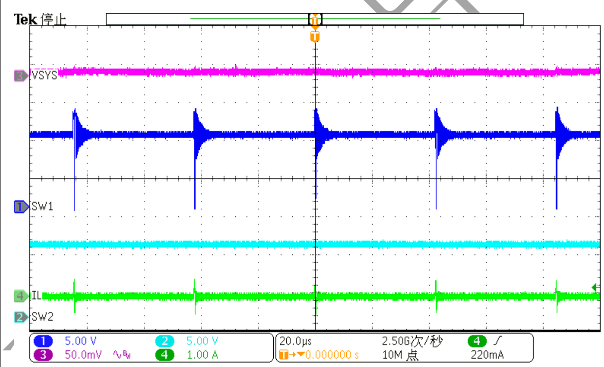
VBUS = 9V, VSYS= 9.376V, ISYS=1A



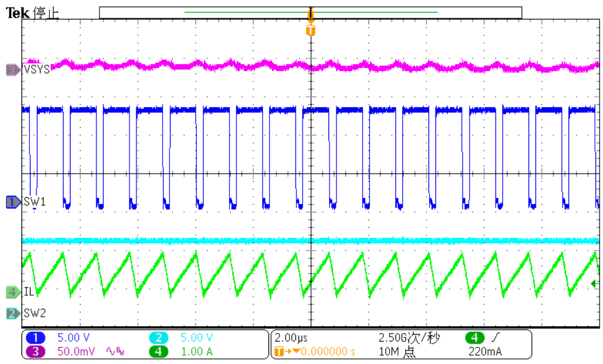
VBUS = 9V, VSYS= 9.376V, ISYS=3A



VBUS = 12V, VSYS= 9.376V, ISYS=0A

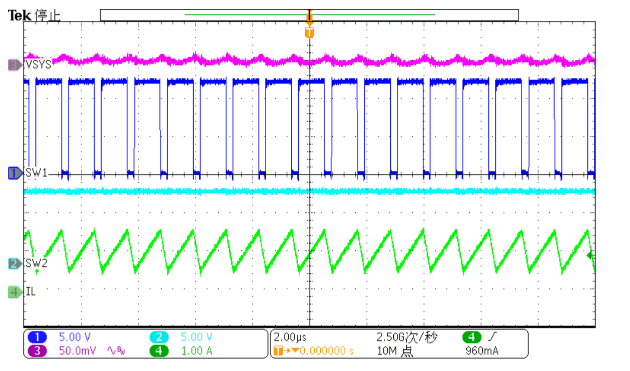


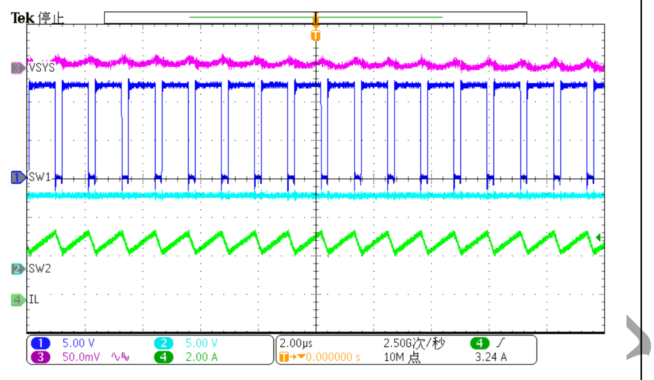
VBUS = 12V, VSYS= 9.376V, ISYS=0.5A



VBUS = 12V, VSYS= 9.376V, ISYS=1A

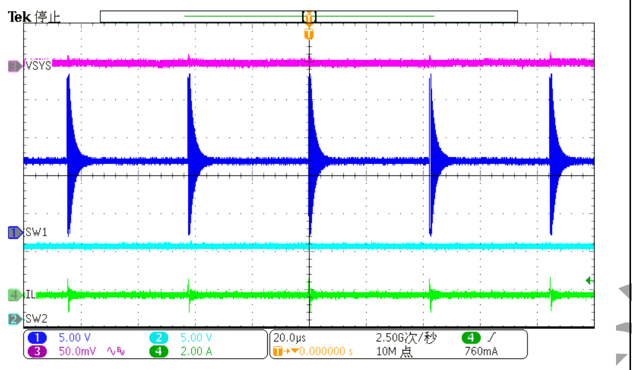
VBUS = 12V, VSYS= 9.376V, ISYS=3A

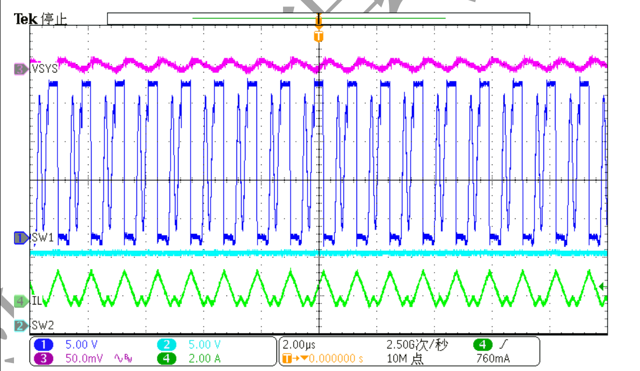




VBUS = 20V, VSYS= 9.376V, ISYS=0A

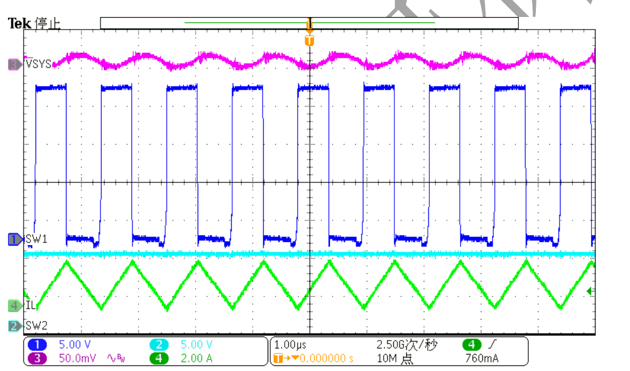
VBUS = 20V, VSYS= 9.376V, ISYS=0.5A

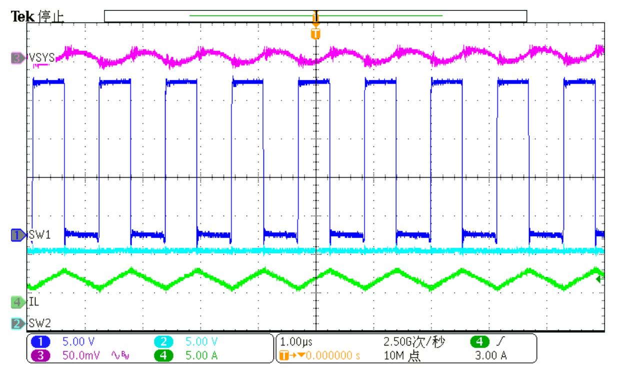




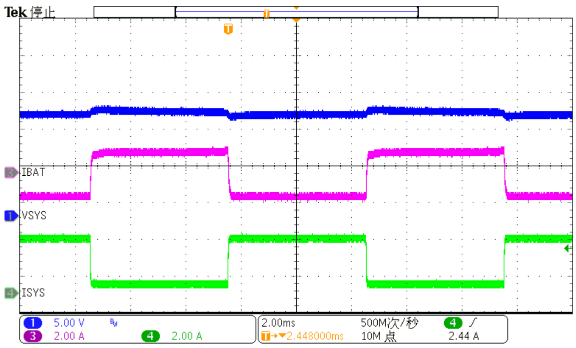
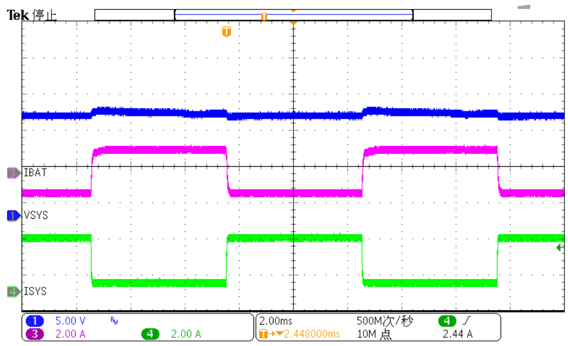
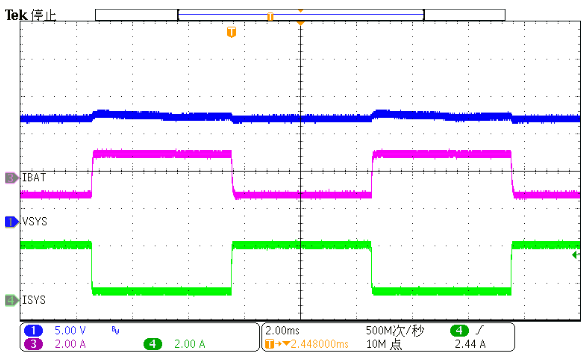
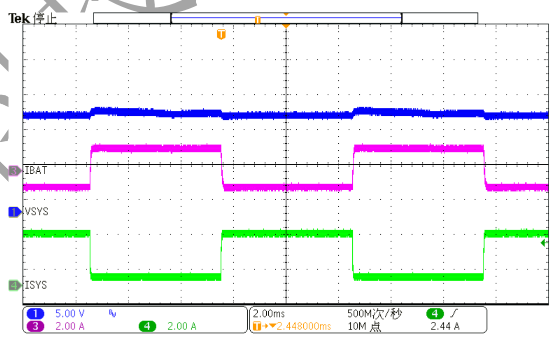
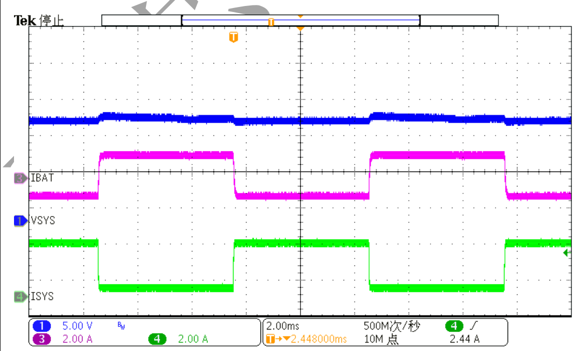
VBUS = 20V, VSYS= 9.376V, ISYS=1A

VBUS = 20V, VSYS= 9.376V, ISYS=3A

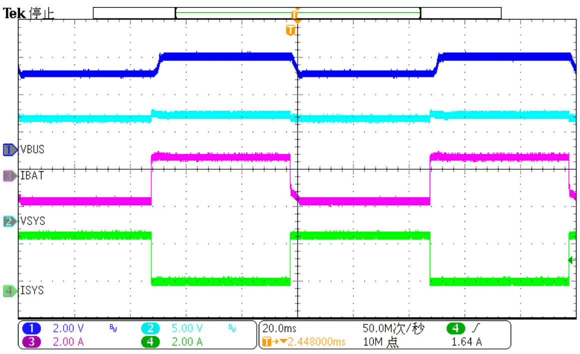




6.3 In charge mode, enter and exit supplement mode under IINDPM

<table>
<tr><th colspan="2">fsw = 800KHz, VBAT=14V, ICHG = 1024mA</th></tr>
<tr><th>VBUS = 5V, ISYS=0.5A~3A, Slew-Rate=1A/us, IINDPM 5A</th><th>VBUS = 9V, ISYS=0.5A~3A, Slew-Rate=1A/us, IINDPM 3A</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>VBUS = 12V, ISYS =0.5A~3A, Slew-Rate=1A/us, IINDPM 2.5A</th><th>VBUS = 15V, ISYS =0.5A~3A, Slew-Rate=1A/Us, IINDPM 2A</th></tr>
<tr><td>
</td><td>
</td></tr>
<tr><th>VBUS = 20V, ISYS =0.5A~3A, Slew-Rate=1A/us, IINDPM 1.5A</th><th></th></tr>
<tr><td>
</td><td></td></tr>
</table>

6.4 In charge mode, enter and exit supplement mode under VINDPM

<table>
<tr><th colspan="2">fsw = 800KHz, VBAT=14V, ICHG = 1024mA, ISYS=0.5A~3A, Slew-Rate=1A/us</th></tr>
<tr><th>VBUS = 5V, I_{BUS_limit}=5A, VINDPM =4.032V</th><th>VBUS = 9V, I_{BUS_limit}=3A, VINDPM =8V</th></tr>
<tr><td>


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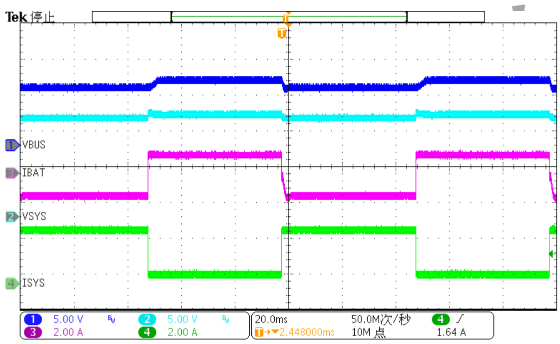
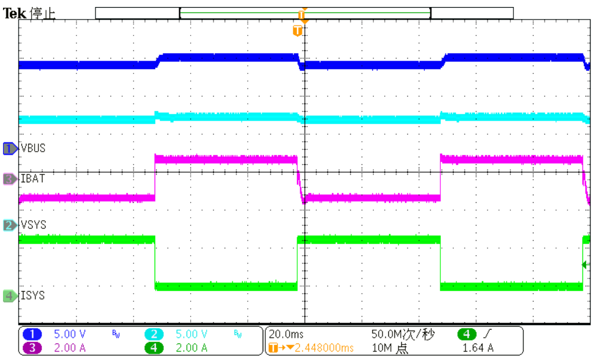
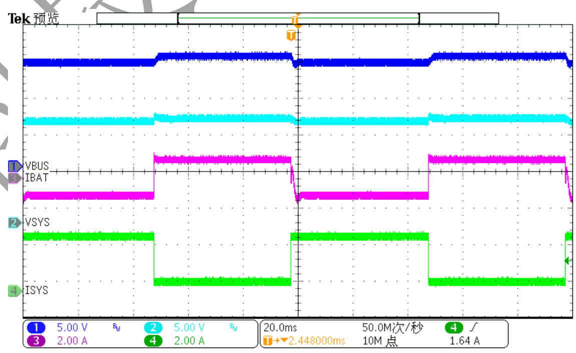
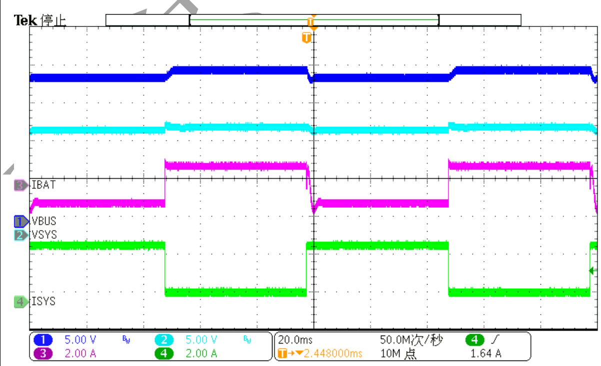


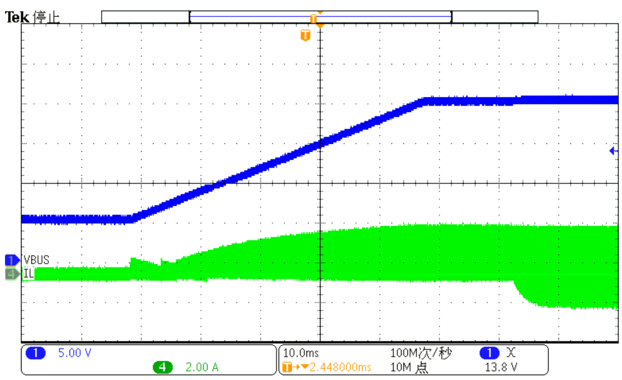
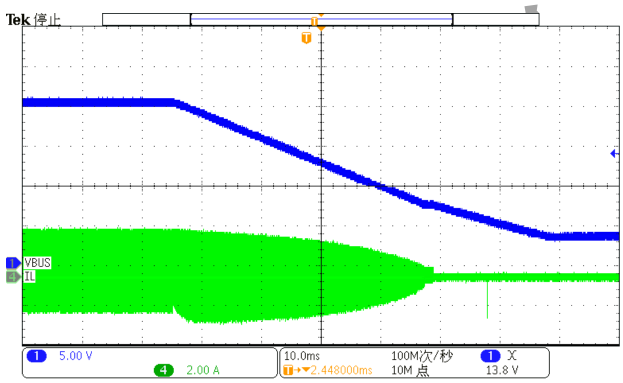
</td></tr>
<tr><th>VBUS = 12V, I_{BUS_limit}=2.5A, VINDPM =11.008V</th><th>VBUS = 15V, I_{BUS_limit}=2A, VINDPM =14.144V</th></tr>
<tr><td>


</td><td>


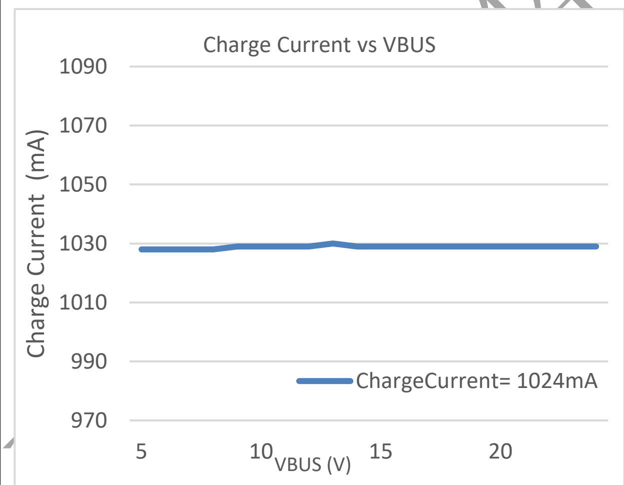
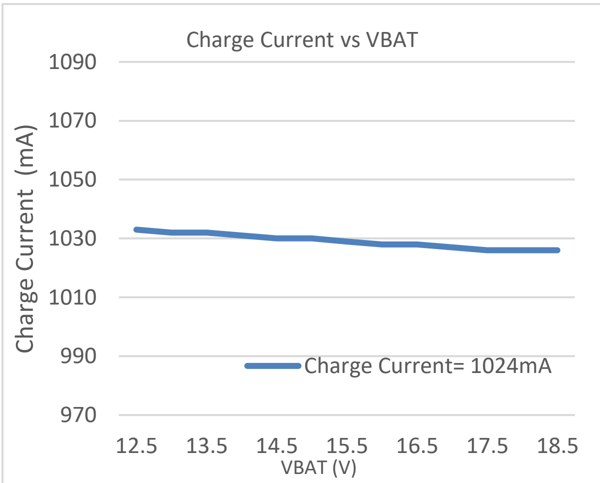
</td></tr>
<tr><th>VBUS = 20V, I_{BUS_limit}=1A, VINDPM =19.008V</th><th></th></tr>
<tr><td>


</td><td></td></tr>
</table>

6.5 OTG output voltage dynamic regulation

fsw = 800KHz, VBAT=7.2V	
IBUS=0A, VOUT = 5~20V(PFM)	IBUS=0A, VOUT = 20~5V(PFM)
	

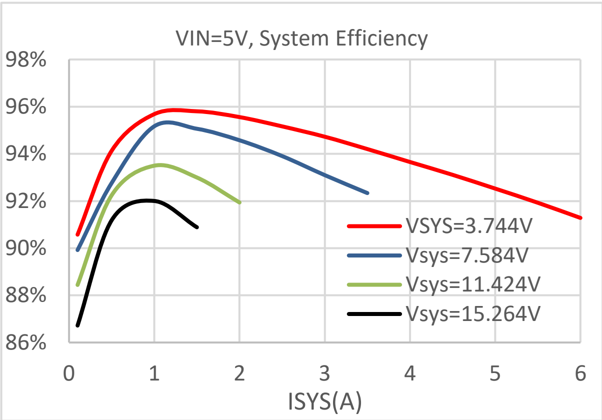
6.6 Accuracy and stability of charge current

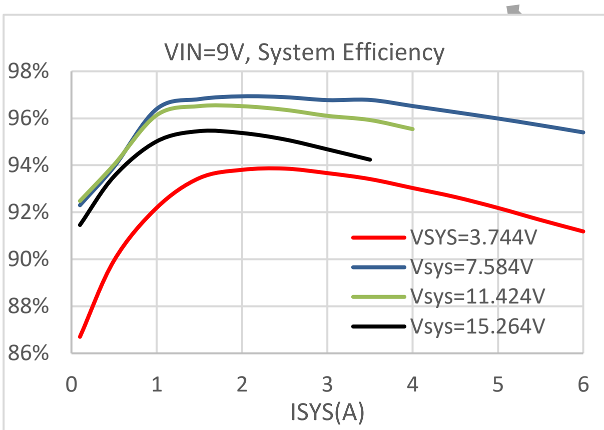
Line Regulation /Load Regulation of charge current in charge mode	
VBUS = 5~24V, VBAT=16V, Charge Current=1024mA	VBUS = 12V, VBAT=12.5V-18.5V, Charge Current=1024mA
	

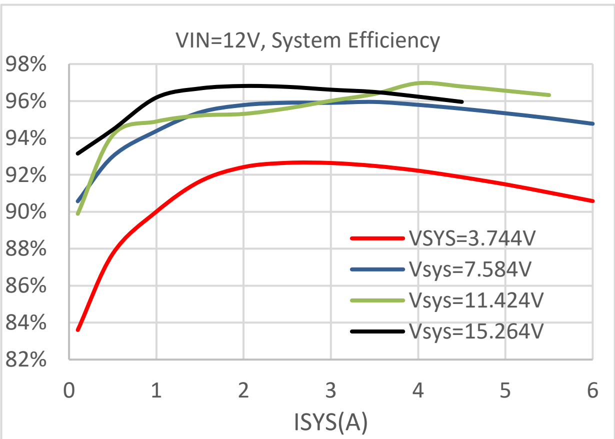
6.7 VSYS loaded efficiency

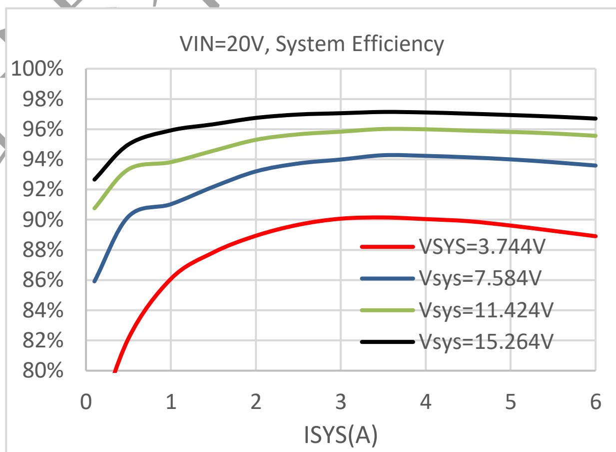
fsw = 800KHz

VBUS=5V/9V/12V/20V, VSYS=3.744V/7.584V/11.424V/15.264V





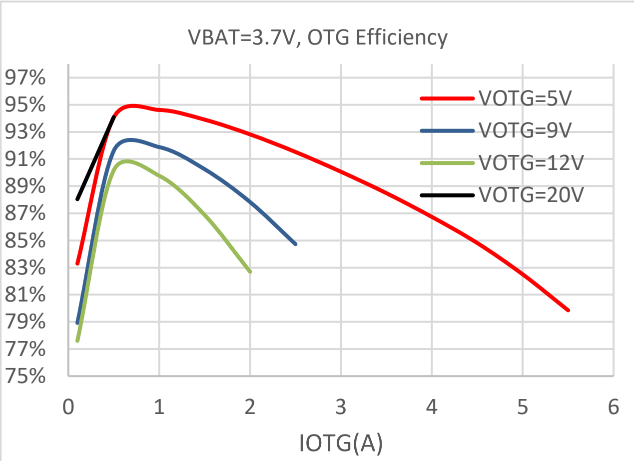


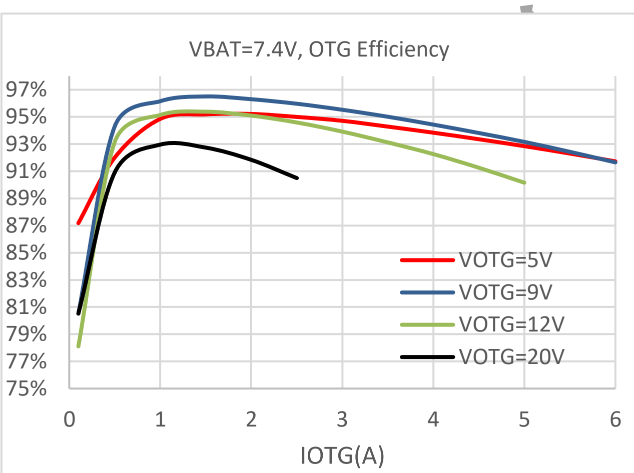


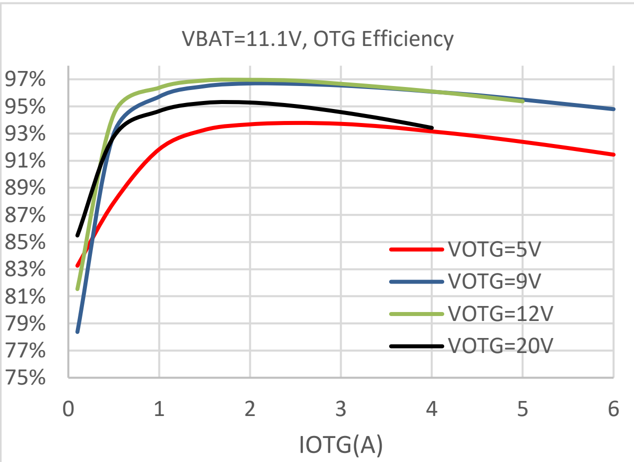
6.8 OTG loaded efficiency

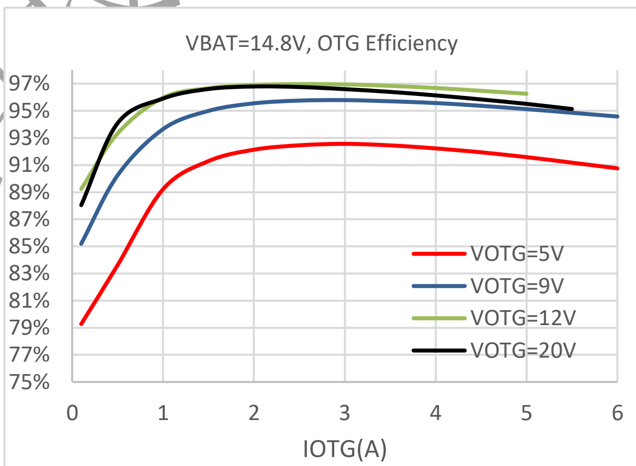
fsw = 800KHz

VBAT=3.7V/7.4V/11.1V/14.8/, VOTG=5V/9V/12V/20V



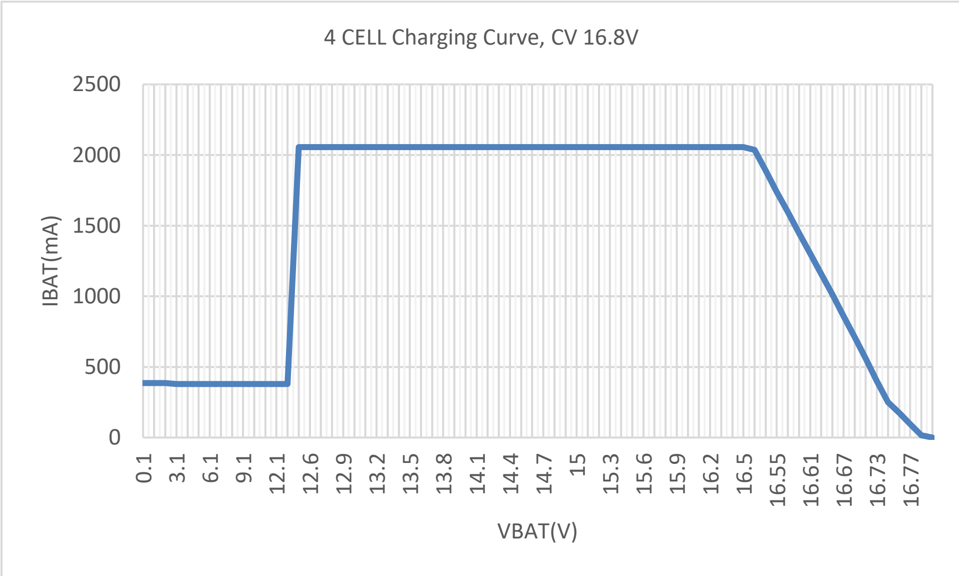






6.9 Charging Curve

fsw = 800KHz
Charge mode, VBUS = 20V, Set $I_{Pre\text{-}Charge}$ = 384mA, ICC= VBAT=0.1~16.8V, CV target=16.8V



6.10 Quiescent current

fsw = 800KHz	
Test Conditions	Test Data
Only battery exists and in low power mode: VBAT=18V, Reg0x12<15>=1	Iq_VBAT=49uA
Only battery exists and in performance mode: VBAT=18V, Reg0x12<15>=0. (Excluding CELL_PRES pin voltage divider resistors)	Iq_VBAT=1.059mA
Adapter plugs in and in HI-Z mode: VBUS=20V, EN_HIZ=1 (Reg0x32<15>=1)	Iq_VBUS=391uA
Adapter plugs in, VBUS=20V, VSYS=9.376V, ISYS no load, charge current is 0A, OOA enable (Reg0x12<10>=1)	Iq_VBUS_switching=4.131mA
Battery connected, VBAT=12.6V, VOTG=5V, IOTG no load, OOA enable (Reg0x12<10>=1)	Iq_OTG_switching=3.524mA