SGM41541/2 Demo Board Test Report

High Input Voltage, 3.78A Single-Cell Battery Charger with NVDC Power Path Management

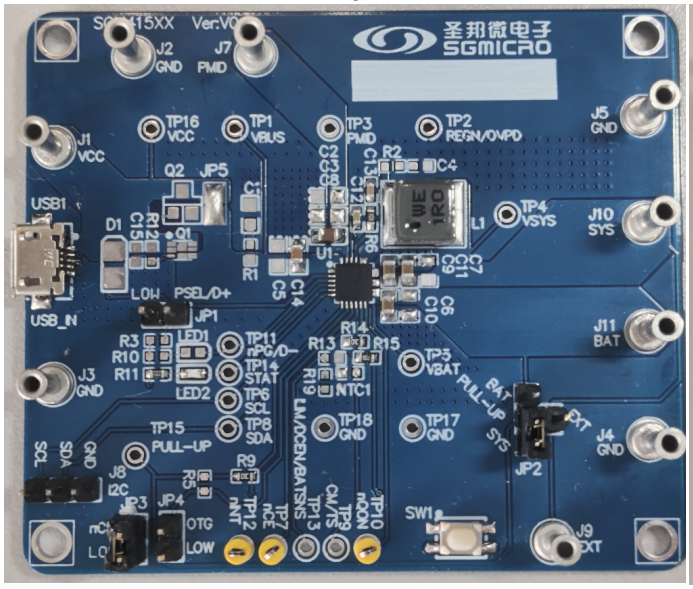
Input Voltage Range: 3.9V to 13.5V

Battery Voltage Range: 3.856V to 4.624V (Default 4.208V)

Charge Current Range: 0A to 3.78A (Default 2040mA)

Demo Board Pictures:

Top



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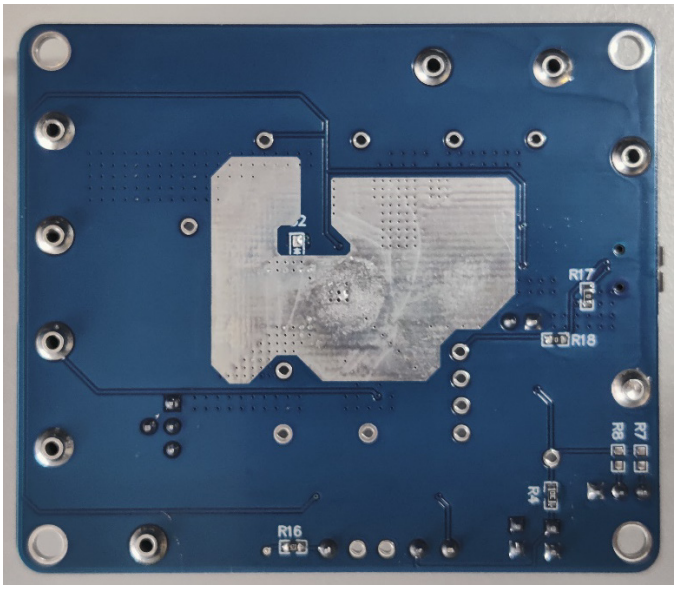

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1 Test Setup

1.1 Equipment Setup

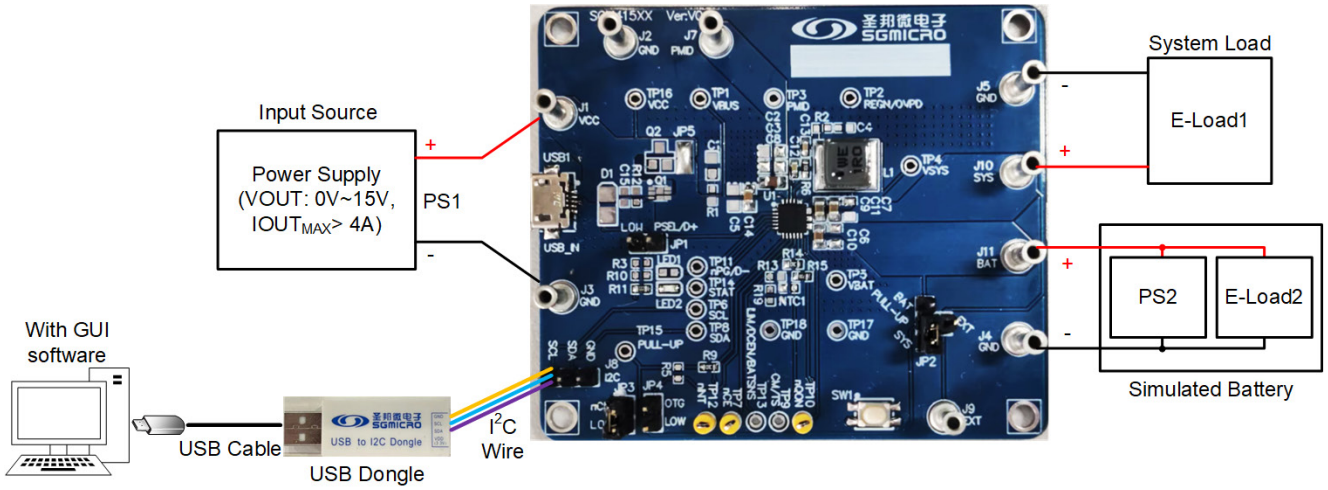


Figure 1. Test Setup for Charge Mode

As shown in Figure 1, set up the equipment according to the following steps:

1) Connect a power supply (PS1) between VCC and GND for Input Source.
   - PS1 output range: 0V ~ 15V, $IOUT_{MAX}$ > 4A.
2) Connect an electronic load (E-Load 1) between SYS and GND for System Load.
   E-Load 1 sink current range: 0A ~ 10A.
3) Connect a power supply (PS2) and an electronic load (E-Load 2) in parallel between BAT and GND for Simulated Battery (1).
   - PS2 output range: 0V ~ 6V, $IOUT_{MAX}$ > 10A.

   E-Load 2 sink current range: 0A ~ 5A.
4) Connect the USB Dongle (2) to the computer (Installed with GUI software (2)) with a USB cable or plug the dongle in the USB port of computer directly, and connect the Dongle I^2C interface to SGM41541/2 I^2C interface with wire.

NOTES:

(1). The simulated battery can be replaced by a real battery.

(2). Please contact the FAE or Sales from SGMICRO and apply for the USB Dongle and GUI software, the software must be properly installed.

1.2 Test Procedure

1) Ensure that the equipment has been setup as required in Equipment Setup.
2) Set the output voltage of PS1 to 5V/12V, the output voltage of PS2 to 3.8V, and the sink current of E-Load 2 to 5A. Then turn on PS2, E-Load 2 and PS1 in turn.
3) Launch the GUI software and select the target IC SGM41541/2 as shown in Figure 2. Then click the Entry button to enter the GUI interface for SGM41541/2 demo board, as shown in Figure 3. If the Dongle is connected properly, the bottom left corner of the page will display "USB-TO-I2C Dongle has been plugged in!", otherwise it will display "USB-TO-I2C Dongle has been plugged out!".

Figure 2. SGM USB GUI Interface

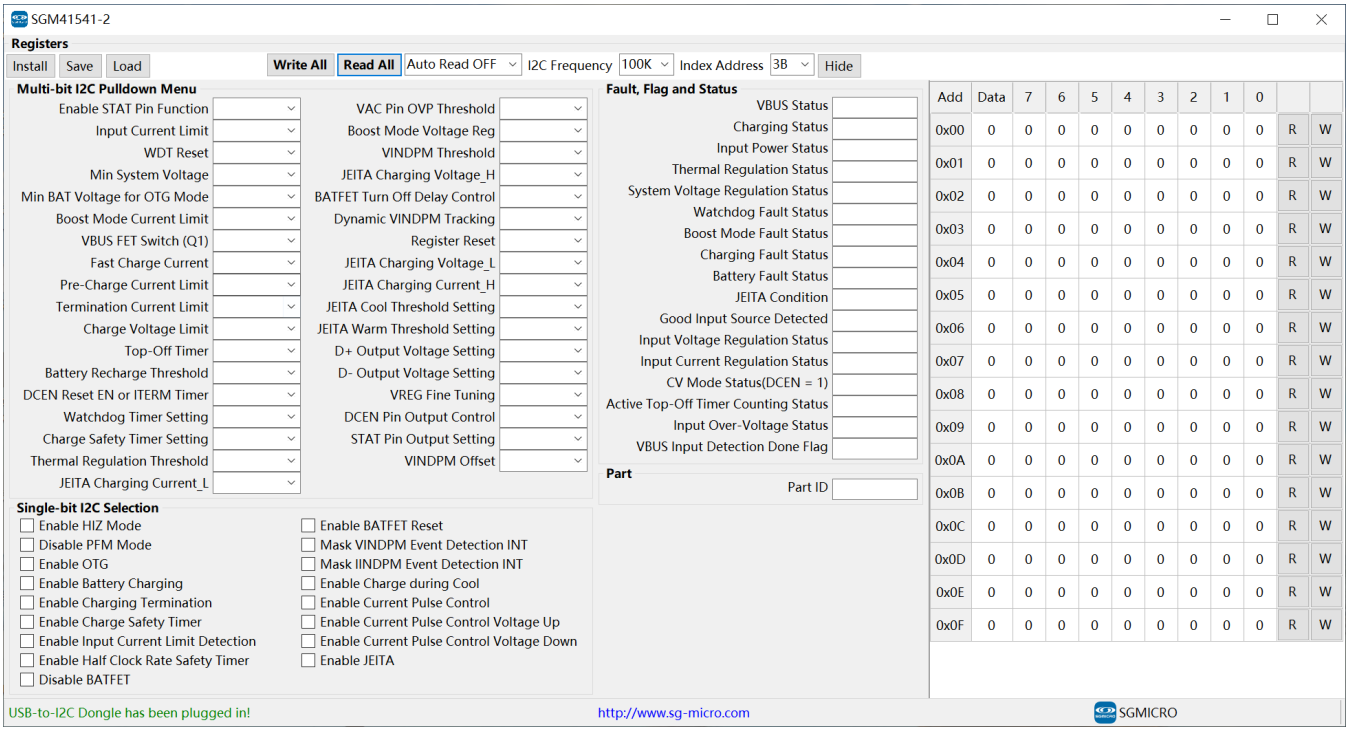


Figure 3. GUI Interface for SGM41541/2 Demo Board

1.3 Communication Verification

Base on the GUI interface for SGM41541/2 demo board as shown in Figure 3, verify the I²C communication according to the following steps:

1) Select the I²C frequency to 100kbits/s (standard mode) or 400kbits/s (fast mode).

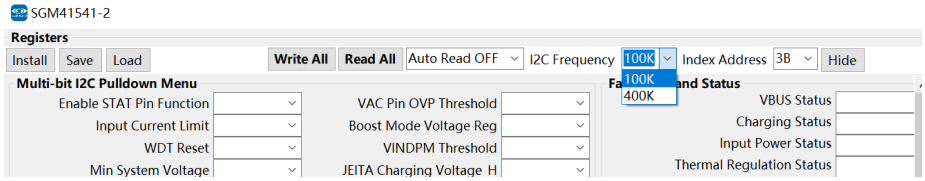


Figure 4. I²C Frequency Selection

2) Check the index address 0x3B of SGM41541/2.

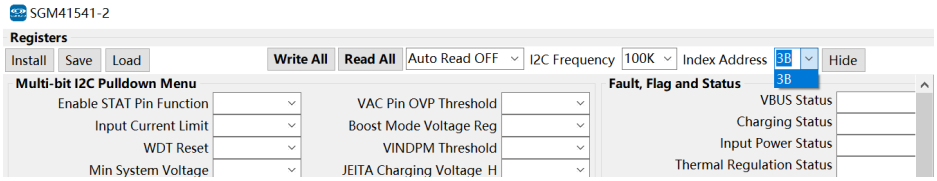


Figure 5. Index Address

3) Click the Read All button and check whether the registers are updated to the correct values in real time.

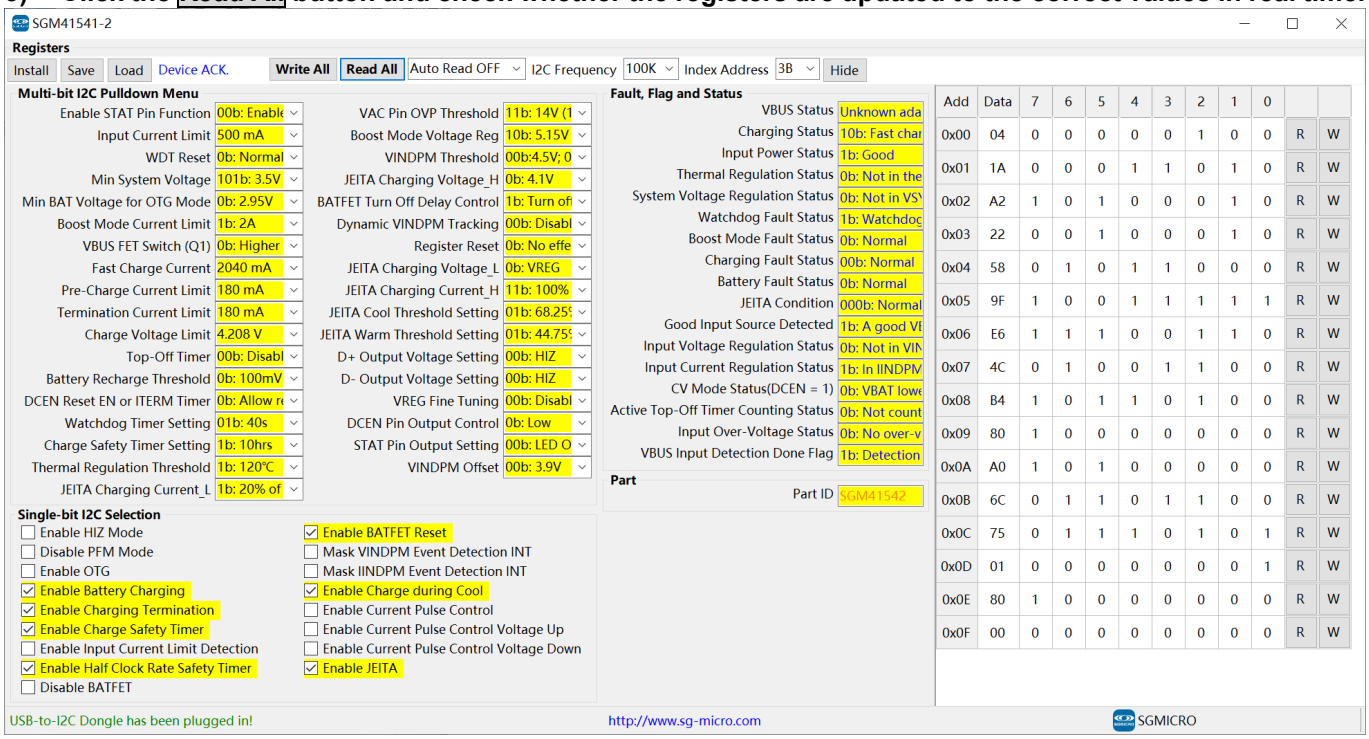


Figure 6. Read the Registers Values in Real Time

1.4 Charge Mode Verification

Taking the fast charging stage as an example, verify the charge mode according to the following steps:

1) **Disable the watchdog timer by setting WATCHDOG[1:0] = 00b.**

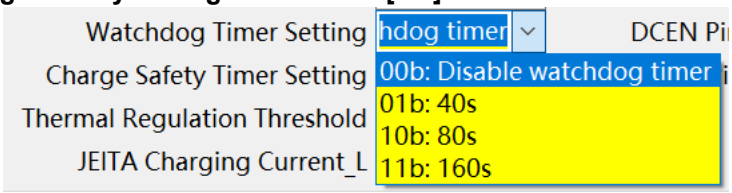


Figure 7. Disable Watchdog timer

2) **Set the input current limit to 3.8A by writing IINDPM[4:0] = 11111b to prevent triggering IINDPM.**

Figure 8. IINDPM

3) **Set the fast charge current by ICHG[5:0]. (I_{CHG} defaults to 2040mA and can be programmed to other values).**

Figure 9. I_{CHG}

4) **Click the Read All button twice, verify that all the fault statuses display "Normal" and charging status displays "Fast charging".**

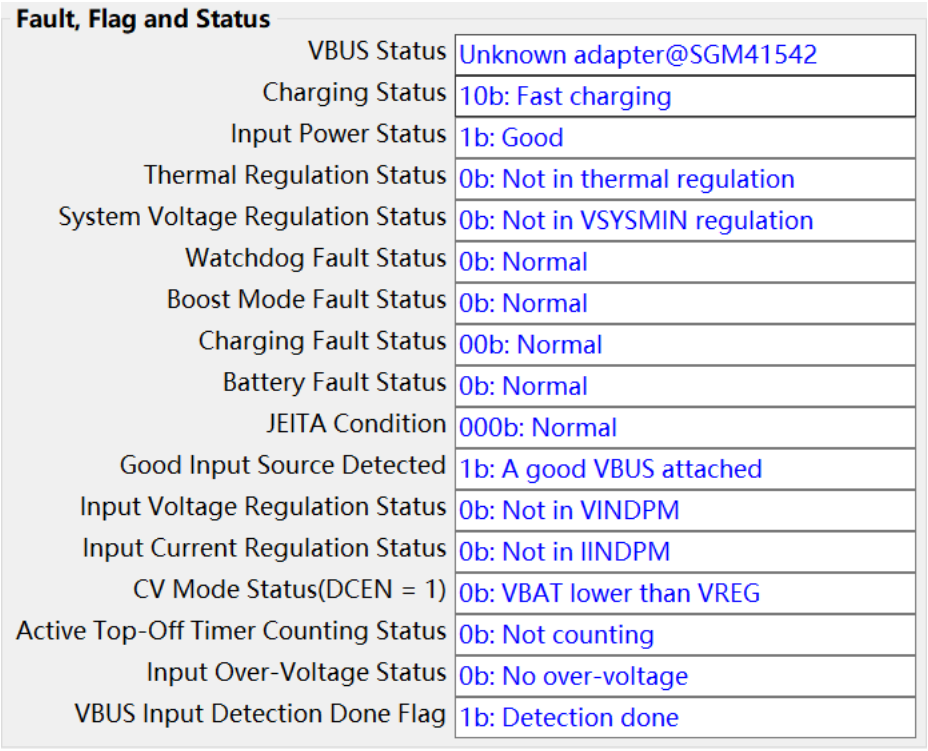


Figure 10. Fault, Flag and Status

After completing the above steps, the demo board is working normally in the fast charging stage.

1.5 Boost Mode Verification

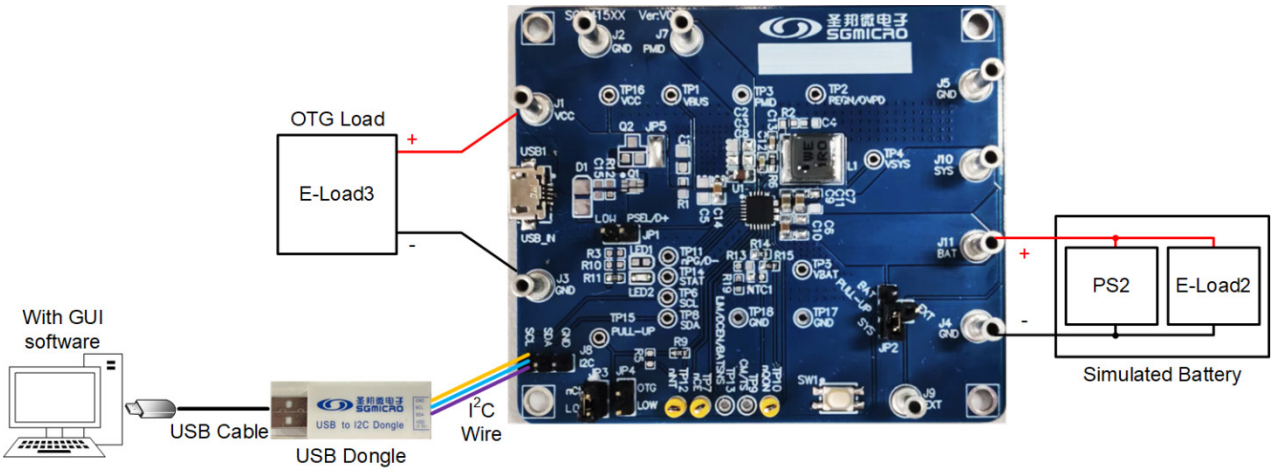


Figure 11. Test Setup for Boost Mode

As illustrated in Figure 11, remove the PS1 and connect an electronic load (E-Load 3) between VCC and GND, and verify the Boost mode according to the following steps:

1) Set the output voltage of PS2 to 4.2V, and the sink current of E-Load 3 to 1A. Then turn on PS2 and E-Load 3 in turn.
2) Disable the watchdog timer by setting WATCHDOG[1:0] = 00b.
3) Set the Boost mode voltage regulation by BOOSTV[1:0]. (V_{OTG_REG} defaults to 5.15V and can be programmed to other values.)

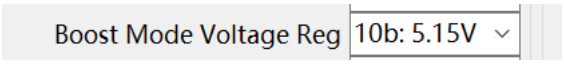


Figure 12. V_{OTG_REG}

4) Set the Boost mode current limit by BOOST_LIM bit. (I_{OTG} defaults to 2A and can be programmed to 1.2A.)

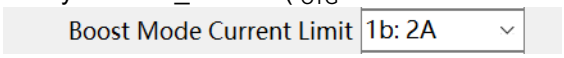


Figure 13. I_{OTG}

5) Enable OTG by setting OTG_CONFIG = 1b.

Figure 14. Enable OTG

6) Click the Read All button twice, verify that the Boost mode fault status displays “Normal” and the VBUS status displays “OTG”. Then the demo board is working normally in the Boost mode.

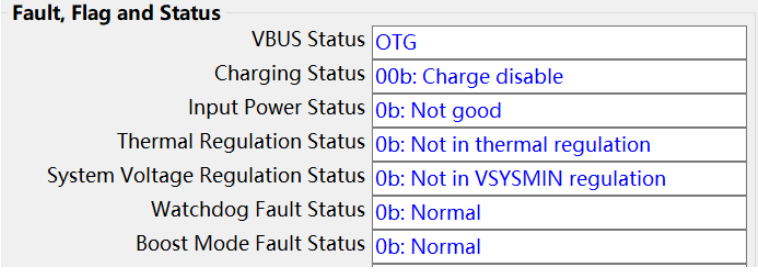


Figure 15. OTG Status

1.6 Efficiency and Regulation Voltage Test

The demo board provides test points for multiple signals to facilitate testing. The charge efficiency and regulation voltage in charge mode can be tested according to the setup illustrated in Figure 16. And the efficiency and regulation voltage in Boost mode can be tested according to Figure 17.

1.6.1 Charge Mode

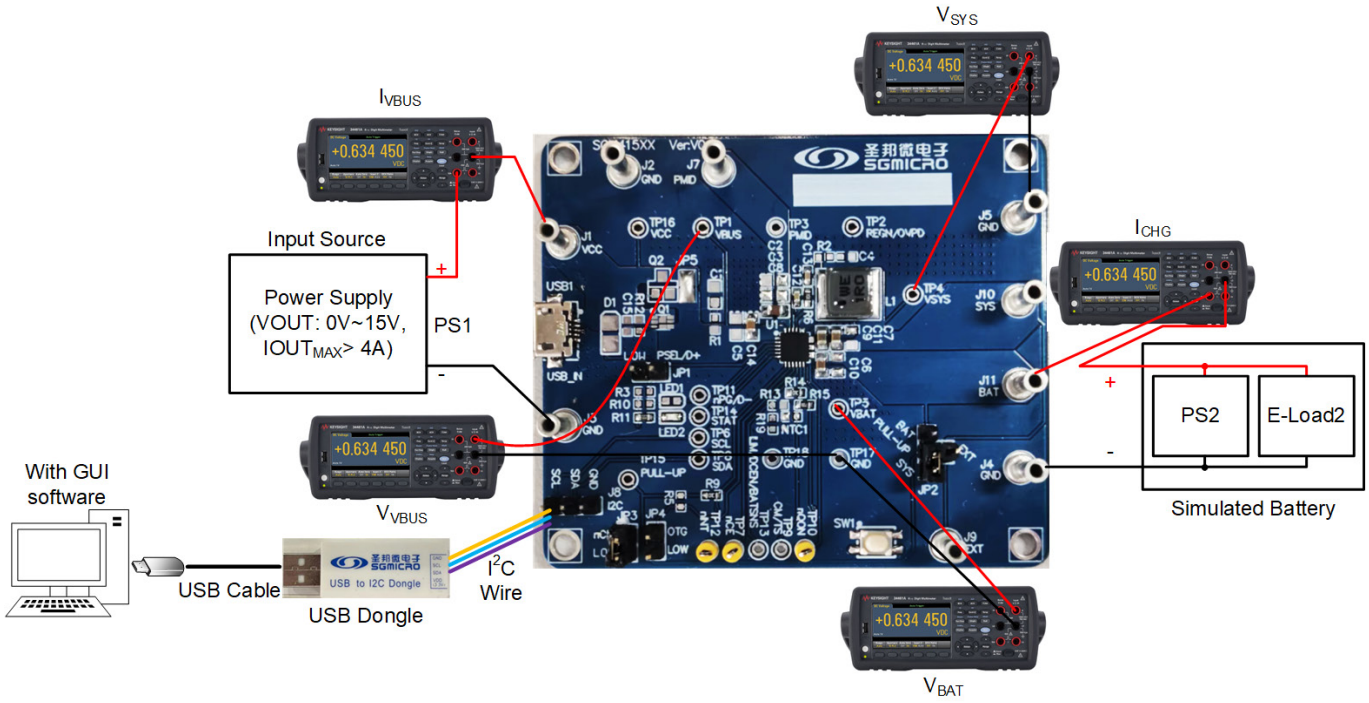


Figure 16. Efficiency and Regulation Voltage Test for Charge Mode

1.6.2 Boost Mode

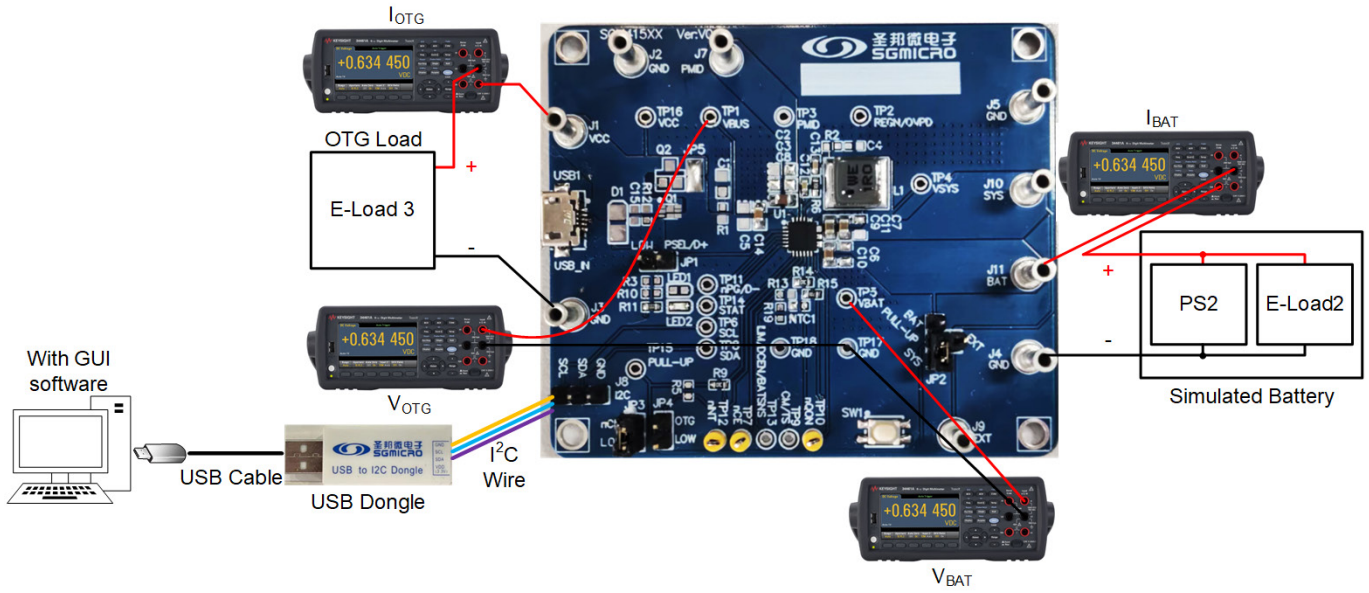
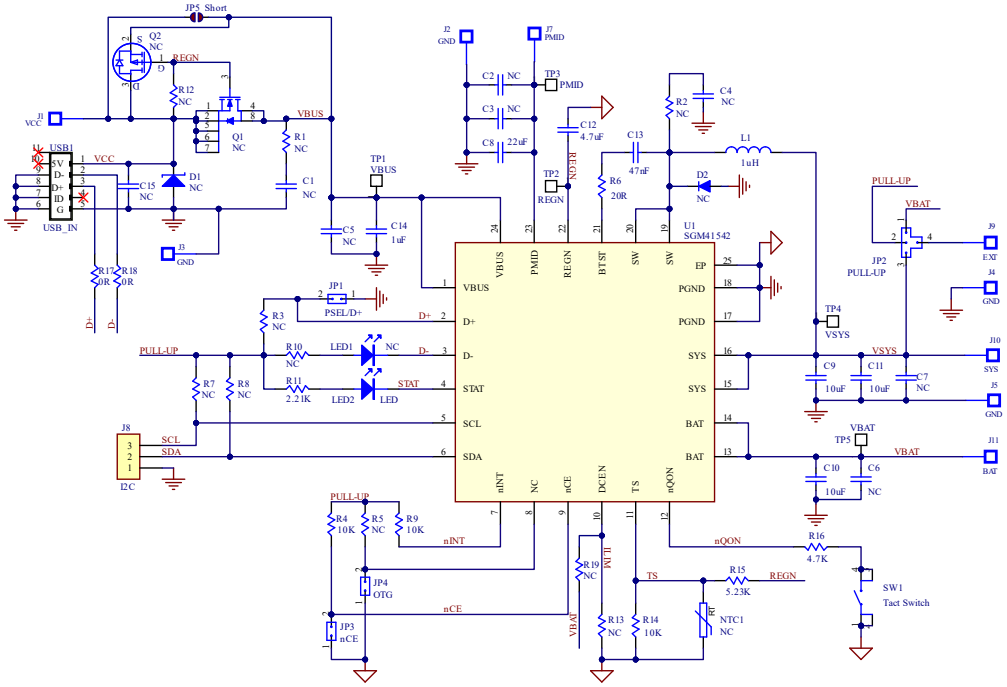


Figure 17. Efficiency and Regulation Voltage Test for Boost Mode

1.7 Schematic, BOM List and PCB Layout

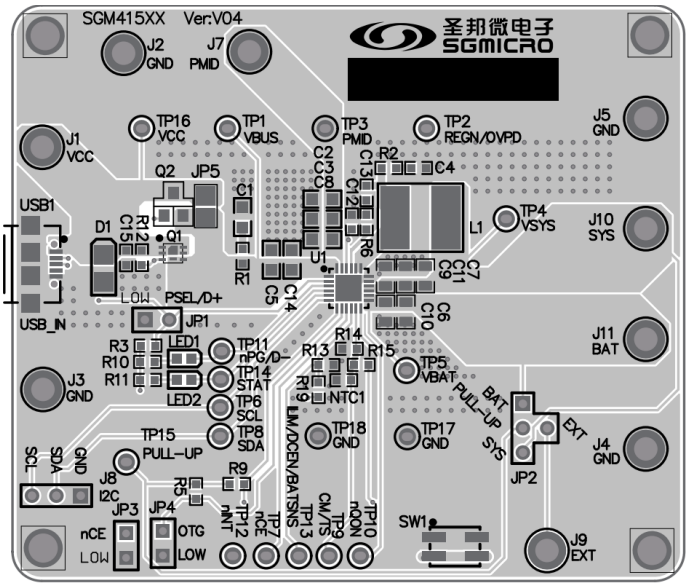
1.7.1 Schematic



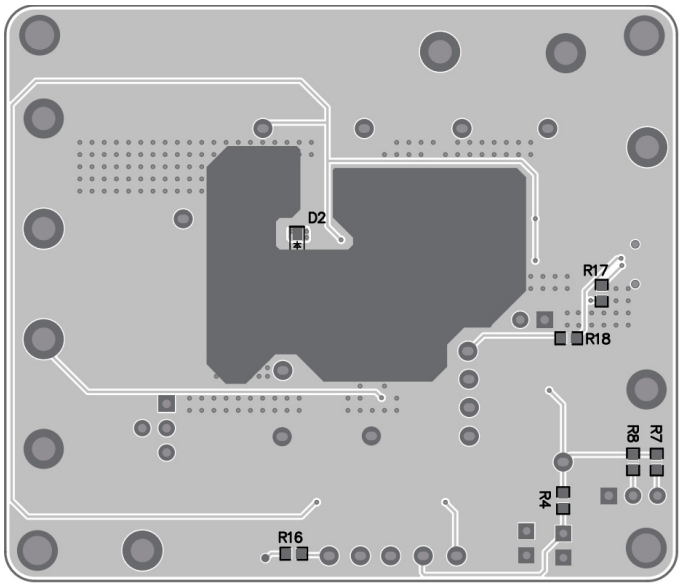
1.7.2 BOM List

Item	Quantity	Designator	Description	Manufactory
1	0	C1, C2, C3, C4, C5, C6, C7, C15	NC	
2	1	C8	22μF, 25V, X5R, 0805	muRata
3	3	C9, C10, C11	10μF, 10V, X7R, 0805	muRata
4	1	C12	4.7μF, 10V, X5R, 0603	muRata
5	1	C13	47nF, 25V, X7R, 0603	muRata
6	1	C14	1μF, 25V, X7R, 0805	SAMSUNG
7	0	D1, D2	NC	
8	1	L1	1μH, Is=27.5A, Ir =12A, DCR=5.5mΩ, 74439344010	Wurth
9	0	LED1	SGM41541: LED, 0603, Green SGM41542: NC	
10	1	LED2	LED, 0603, Green	
11	0	NTC1	NC	
12	0	Q1, Q2	NC	
13	0	R1, R2, R3, R5, R7, R8, R10, R12, R13, R19	SGM41541: R3=10kΩ, R10=2.21kΩ SGM41542: NC	
14	1	R6	20Ω, ±1%, SMD res.,0603	
15	2	R17, R18	SGM41541: NC SGM41542: 0Ω, ±5%, SMD res.,0603	
16	3	R4, R9, R14	10kΩ, ±1%, SMD res.,0603	
17	1	R11	2.21kΩ, ±1%, SMD res.,0603	
18	1	R15	5.23kΩ, ±1%, SMD res.,0603	
19	1	R16	4.7kΩ, ±5%, SMD res.,0603	
20	1	SW1	Tact Switch, SKRPACE010	ALPS
21	1	USB1	Micro USB 2.0 Type-B, SMT, 619105136821	Wurth
22	1	U1	Buck/Boost charger, SGM41541/2, TQFN-4×4-24L	SGMICRO
Conclusion: Total 21 components				

1.7.3 PCB Layout



PCB Top Layer

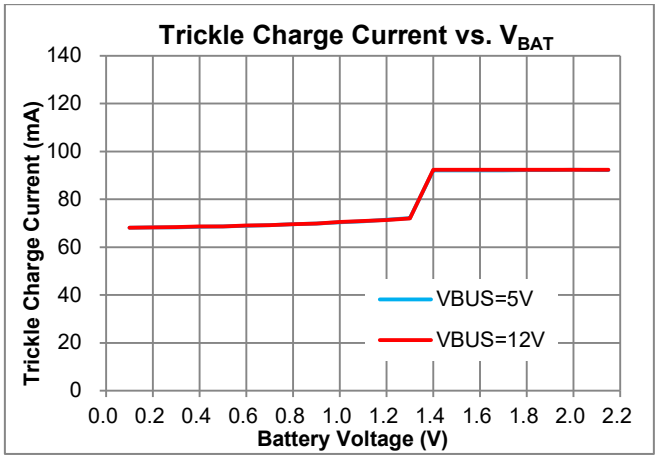


PCB Bottom Layer

2 Test Item

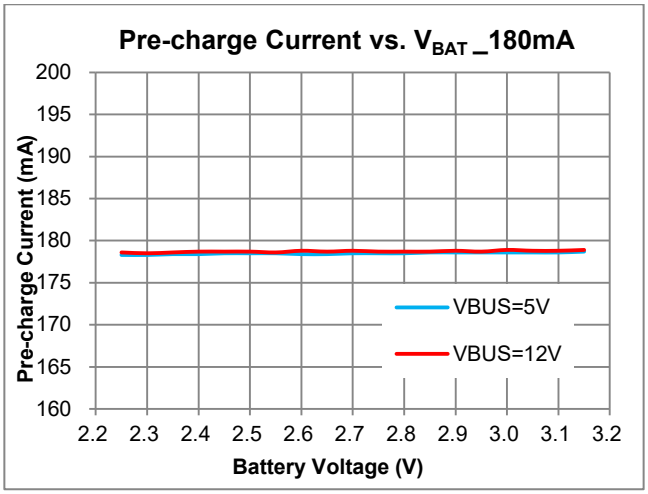
2.1 Trickle Charge Current

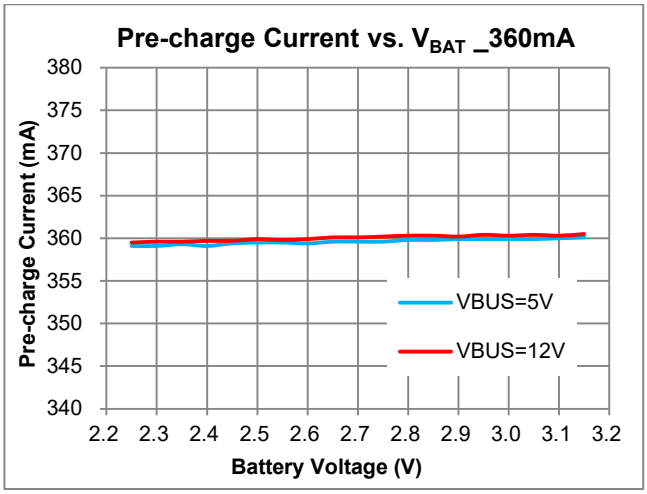
Test conditions: V_{BUS}=5V/12V, V_{BAT}=0.1V~2.15V, V_{INDPM}=3.9V, charge enable, measure the charge current at different battery voltage.



2.2 Pre-charge Current

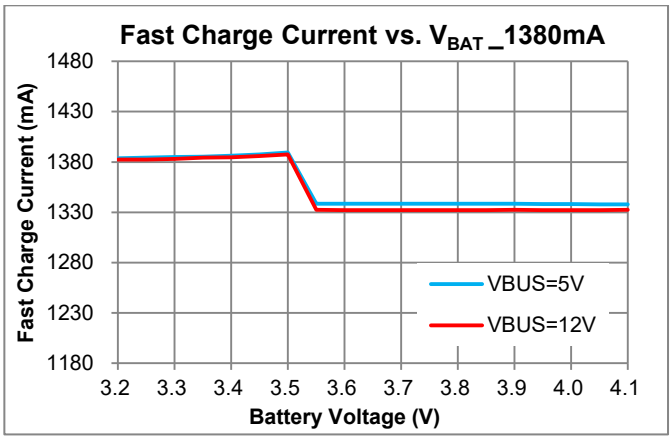
Test conditions: V_{BUS}=5V/12V, V_{BAT}=2.25V~3.15V, I_{PRECHG_SET}=180mA/360mA, V_{INDPM}=3.9V, charge enable, measure the charge current at different battery voltage.

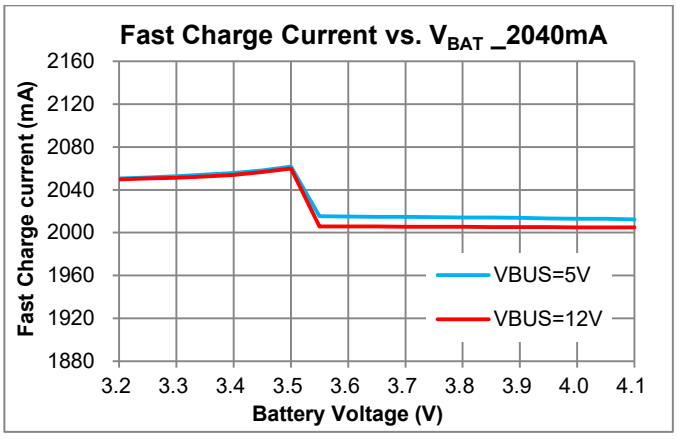




2.3 Fast Charge Current

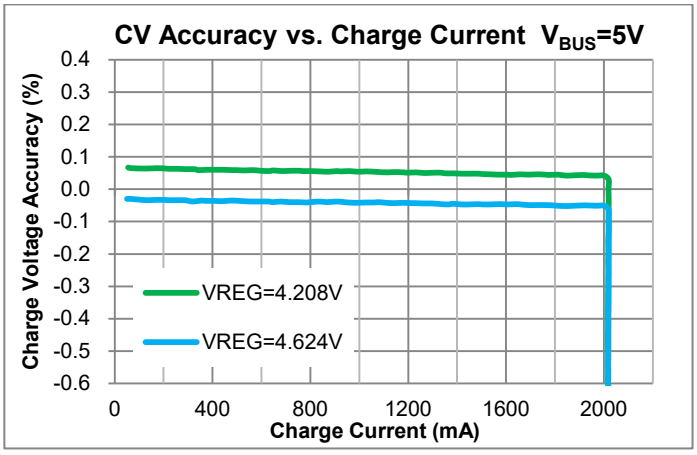
Test conditions: V_{BUS}=5V/12V, V_{BAT}=3.2V~4.1V, V_{BAT_REG}=4.208V, measure the charge current at different battery voltage.

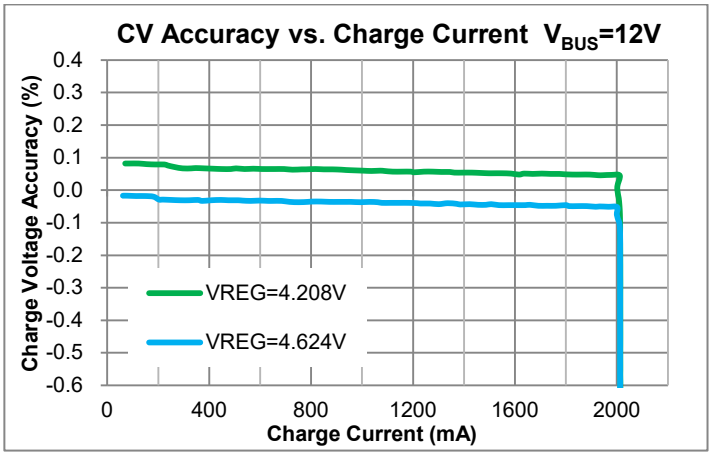




2.4 CV Accuracy

Test conditions: V_{BUS}=5V/12V, V_{BAT_REG}=4.208V/4.624V, I_{CHG_SET}=2040mA, V_{INDPM}=3.9V, charge enable, increase V_{BAT} to enter CV charge, measure V_{BAT} at different charge current.





2.5 Termination Current Accuracy

Test conditions: V_{BUS}=5V/12V, V_{BAT_REG}=4.208V, I_{CHG_SET}=2040mA, I_{TERM_SET}=180mA/540mA, charge enable, adjust V_{BAT} to check termination current.

V_{BUS}=5V			
I_{CHG_SET}(V)	I_{TERM_SET}(mA)	180	540
2040	I_{TERM}(mA)	163	518
	ACC.(%)	-9.44%	-4.07%
V_{BUS}=12V			
I_{CHG_SET}(V)	I_{TERM_SET}(mA)	180	540
2040	I_{TERM}(mA)	165	513
	ACC.(%)	-8.33%	-5.00%

2.6 IINDPM

Test conditions: V_{BUS}=5V/12V, V_{BAT}=3.8V, V_{SYS_MIN}=3.5V, charge disable, increase I_{SYS} to check I_{INMAX} at different IINDPM bits setting.

V_{BUS}=5V			V_{BUS}=12V		
IINDPM Setting(A)	I_{INMAX}(A)	Accuracy(%)	IINDPM Setting(A)	I_{INMAX}(A)	Accuracy(%)
0.9	0.923	2.6%	0.9	0.881	-2.1%
2.0	1.926	-3.7%	1.5	1.55	3.3%
3.0	2.876	-4.1%	2.0	2.144	7.2%
3.8	3.654	-3.8%	2.4	2.552	6.3%

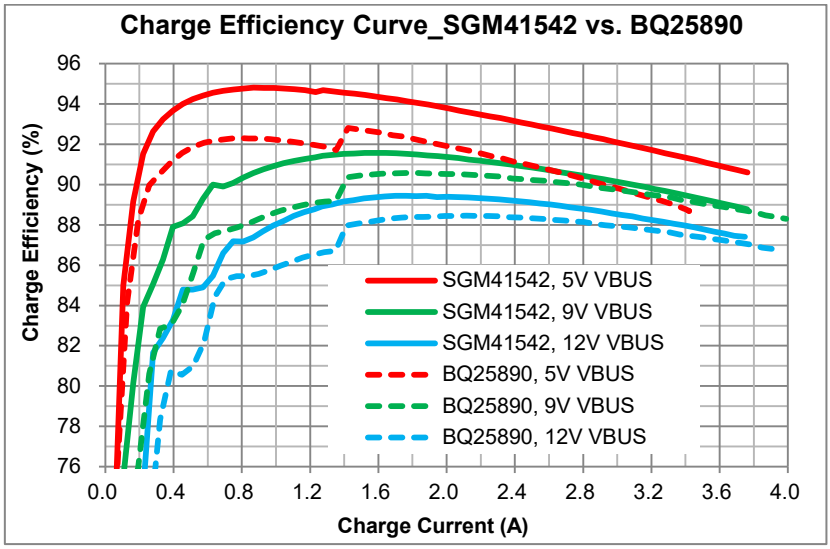
2.7 VINDPM

Test conditions: V_{BUS}=13V/0.5A, VBUS_OV set to 14V, V_{BAT}=3.8V, V_{SYS_MIN}=3.5V, I_{CHG_SET}=2040mA, IINLIM set to 3.8A, charge enable, measure V_{BUS} at different VINDPM setting.

VINDPM Setting(A)	V_{INMIN}(A)	Accuracy(%)
4.4	4.414	0.318
5.0	5.013	0.260
7.0	7.015	0.214
9.0	9.016	0.178
10.5	10.512	0.114
12.0	12.008	0.067

2.8 Efficiency

Test conditions: V_{BUS}=5V/9V/12V, V_{BAT}=3.8V, I_{SYS}=0A, DCR of inductor is 5.5mΩ, check charge efficiency.

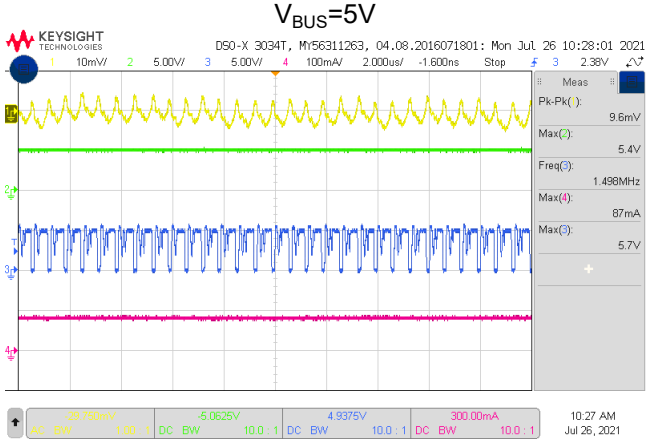


2.9 Steady State Operation

2.9.1 Charge Mode

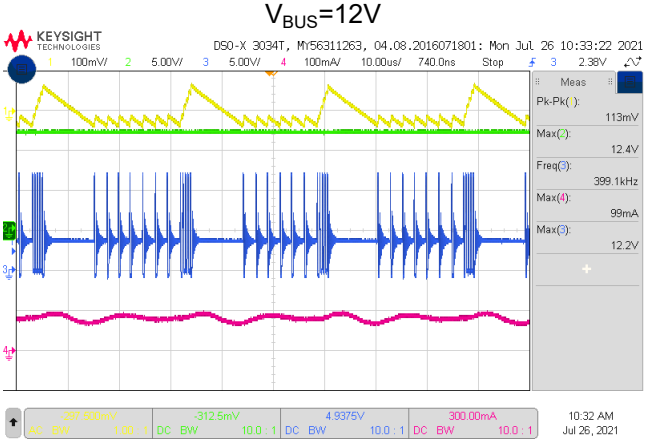
A. Trickle charge: V_{BUS}=5V/12V, V_{BAT}=0V, charge enable.

V_{BUS}=5V



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

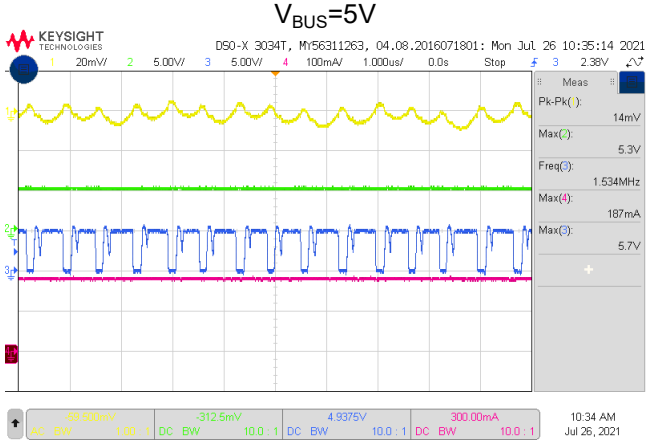
V_{BUS}=12V



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

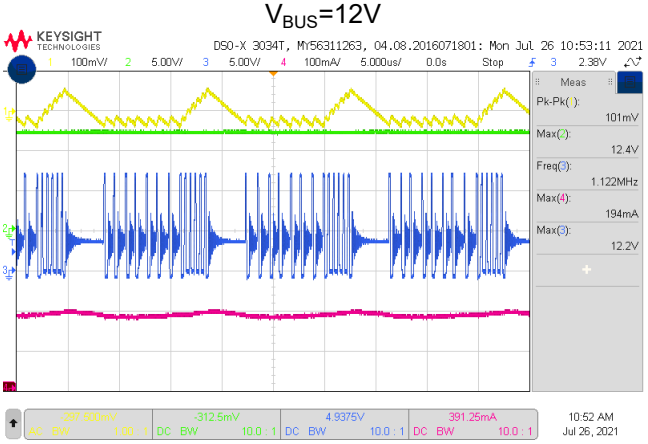
B. Pre-charge: V_{BUS}=5V/12V, V_{BAT}=2.3V, I_{PRECHG}=180mA, charge enable.

V_{BUS}=5V



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

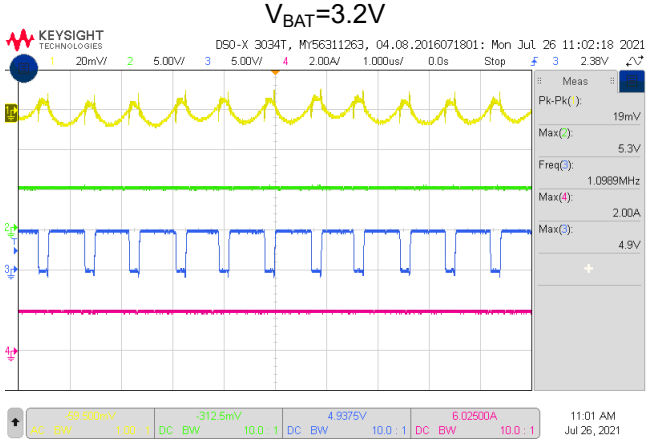
V_{BUS}=12V



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

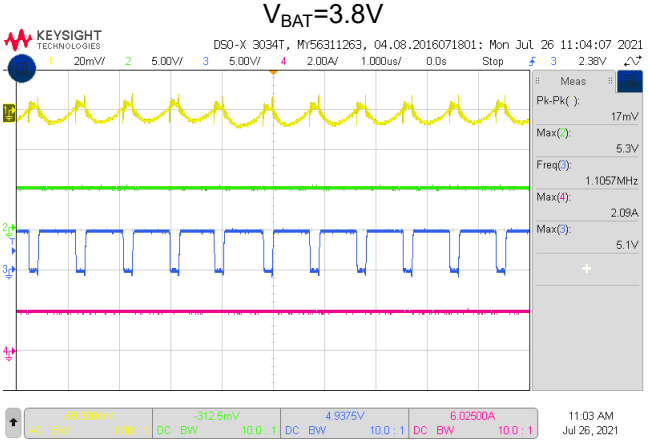
C. Fast charge: V_{BUS}=5V, V_{BAT}=3.2V/3.8V, I_{CHG}=2040mA, charge enable.

V_{BAT}=3.2V



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

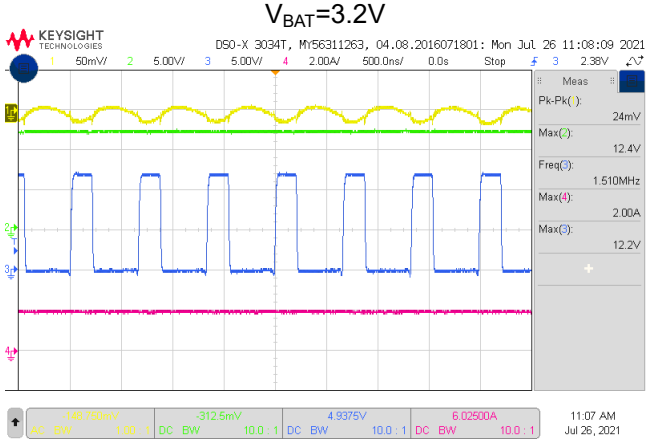
V_{BAT}=3.8V



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

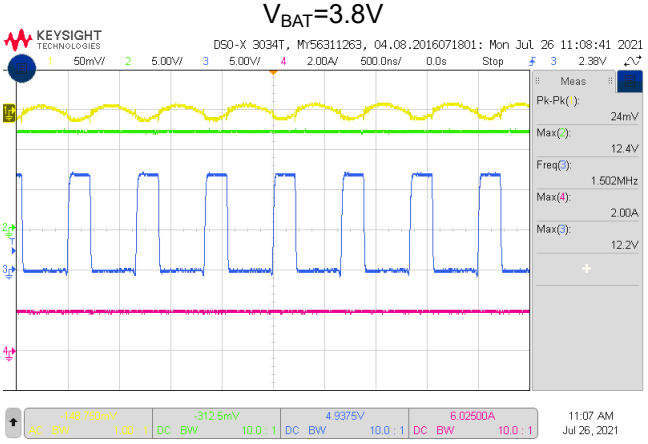
Fast charge: V_{BUS}=12V, V_{BAT}=3.2V/3.8V, I_{CHG}=2040mA, charge enable.

V_{BAT}=3.2V



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

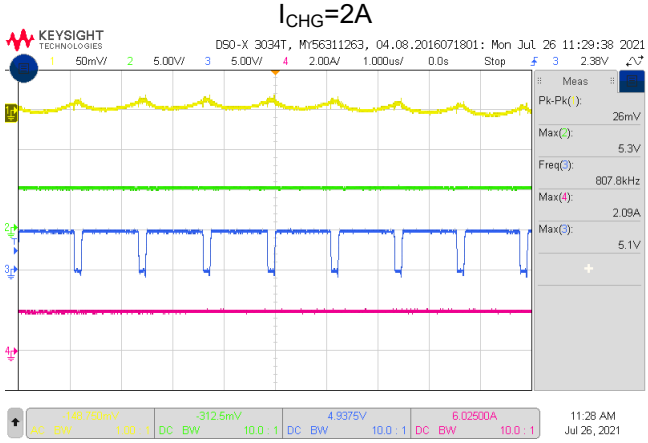
V_{BAT}=3.8V



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

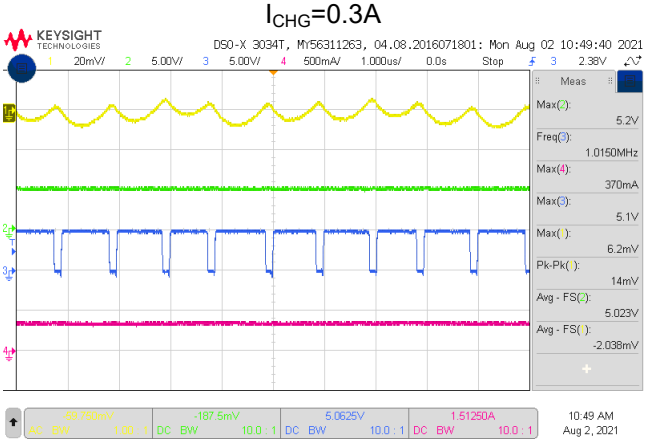
D. Constant voltage charge: V_{BUS}=5V, V_{BAT_REG}=4.208V, constant voltage charge.

I_{CHG}=2A



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

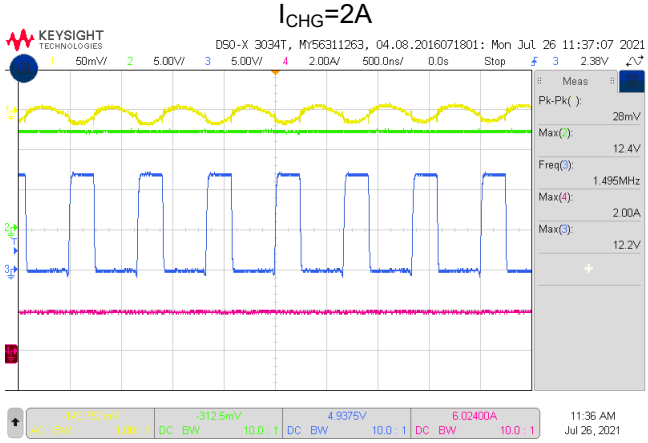
I_{CHG}=0.3A



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

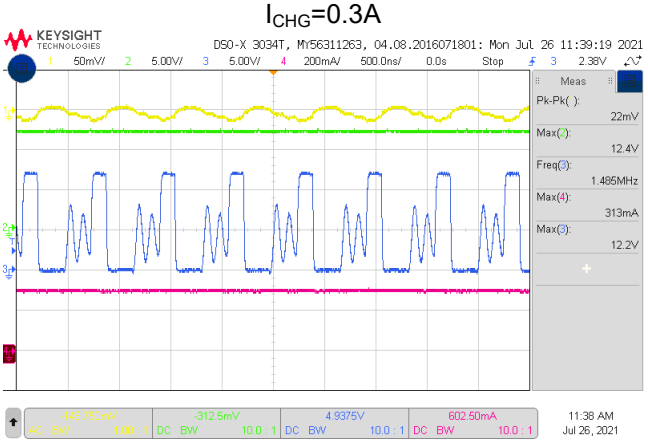
Constant voltage charge: V_{BUS}=12V, V_{BAT_REG}=4.208V, constant voltage charge.

I_{CHG}=2A



CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

I_{CHG}=0.3A

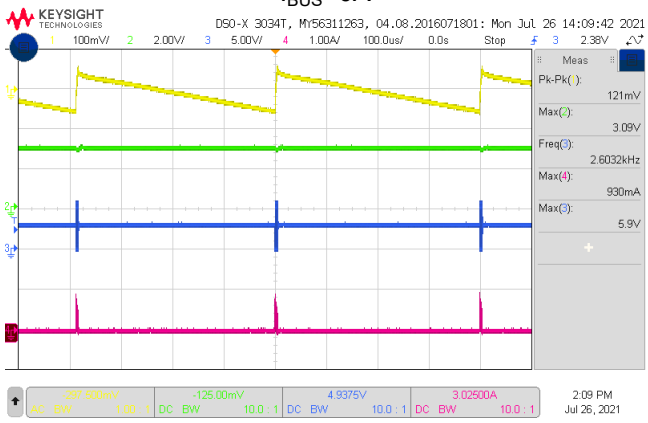


CH1-$V_{SYS/ac}$, CH2-V_{BUS}, CH3-SW, CH4-I_{CHG}

2.9.2 Boost Mode

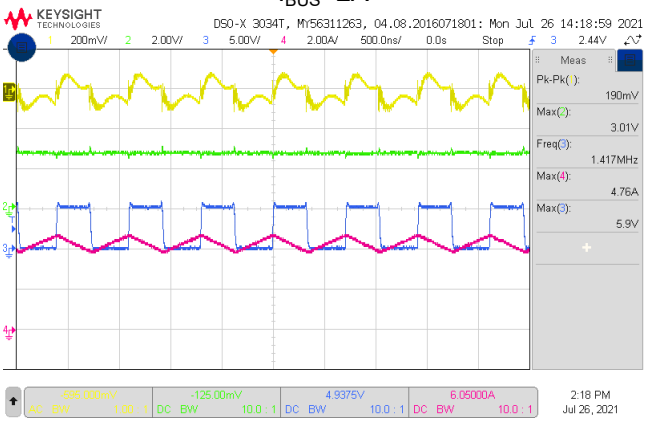
Test conditions: OTG mode, V_{BAT}=3V.

I_{BUS}=0A



CH1-$V_{BUS/ac}$, CH2-V_{BAT}, CH3-SW, CH4-I_L

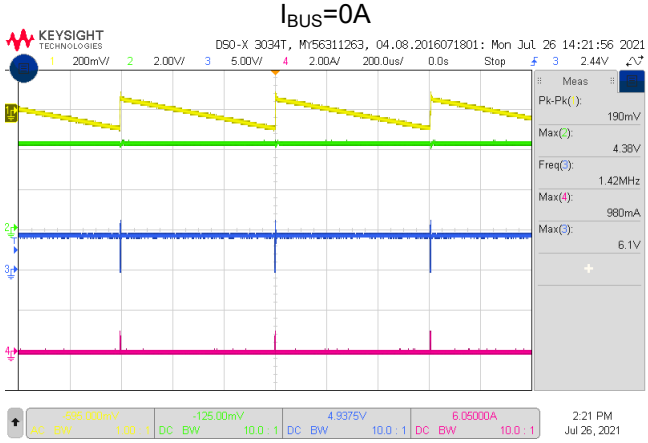
I_{BUS}=2A



CH1-$V_{BUS/ac}$, CH2-V_{BAT}, CH3-SW, CH4-I_L

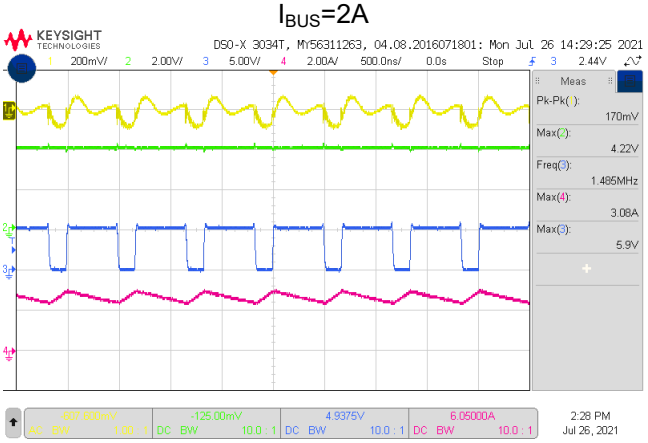
Test conditions: OTG mode, V_{BAT}=4.3V.

I_{BUS}=0A



CH1-$V_{BUS/ac}$, CH2-V_{BAT}, CH3-SW, CH4-I_L

I_{BUS}=2A

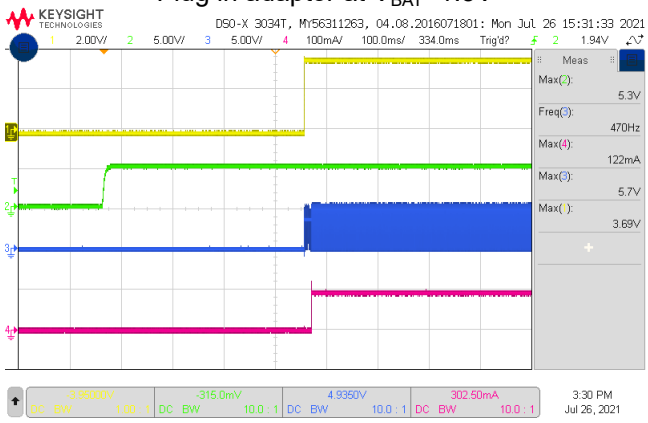


CH1-$V_{BUS/ac}$, CH2-V_{BAT}, CH3-SW, CH4-I_L

2.10 Charger Startup/Shutdown through VBUS

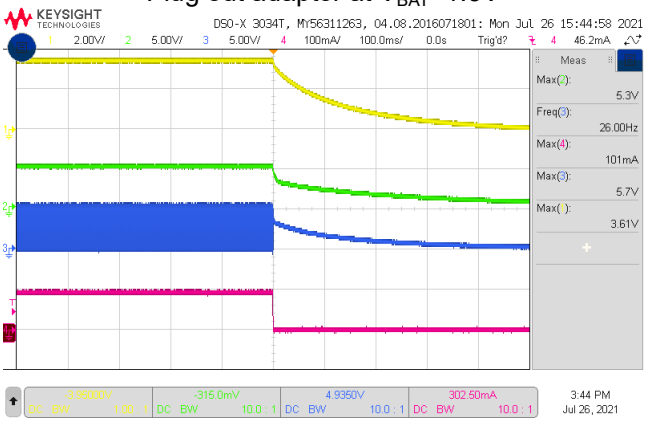
Test conditions: V_{BUS}=5V, registers default setting, plug in/out adaptor at different battery voltage.

Plug in adaptor at V_{BAT}=1.5V



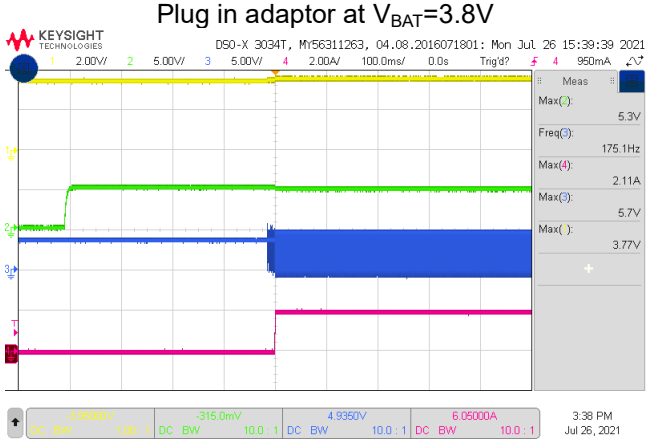
CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{SW}, CH4-I_{CHG}

Plug out adaptor at V_{BAT}=1.5V



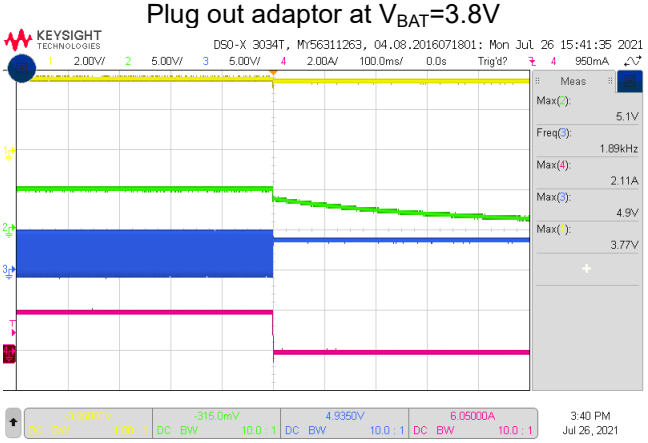
CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{SW}, CH4-I_{CHG}

Plug in adaptor at V_{BAT}=3.8V



CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{SW}, CH4-I_{CHG}

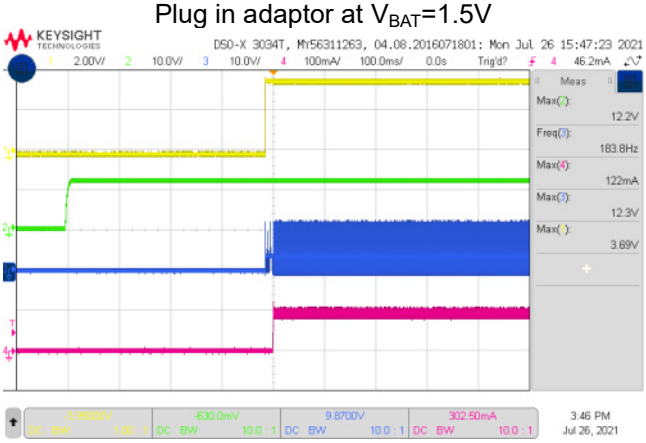
Plug out adaptor at V_{BAT}=3.8V



CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{SW}, CH4-I_{CHG}

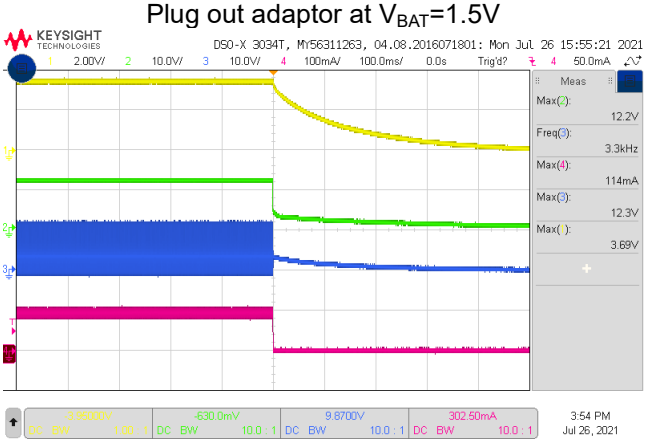
Test conditions: V_{BUS}=12V, registers default setting, plug in/out adaptor at different battery voltage.

Plug in adaptor at V_{BAT}=1.5V



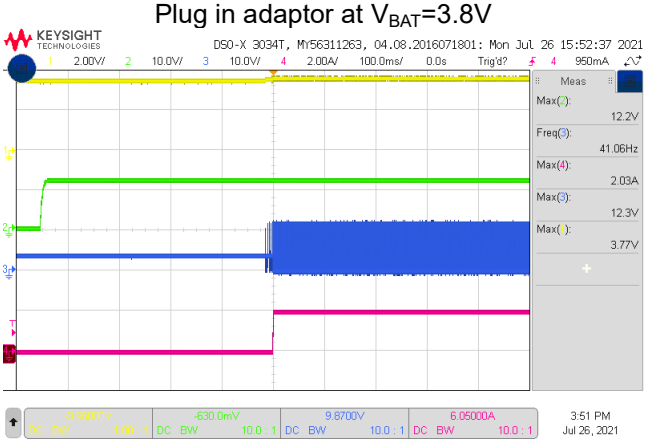
CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{SW}, CH4-I_{CHG}

Plug out adaptor at V_{BAT}=1.5V



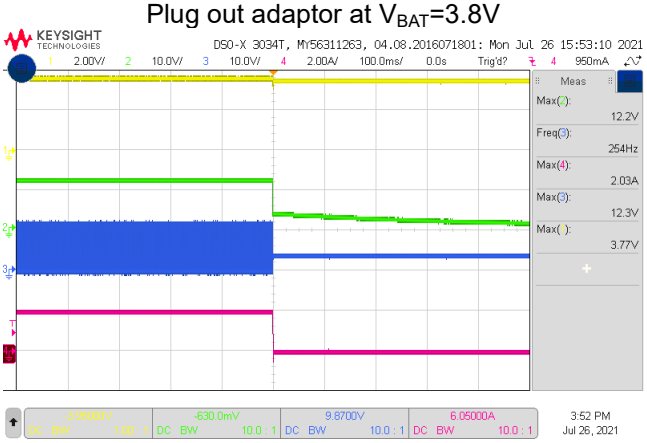
CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{SW}, CH4-I_{CHG}

Plug in adaptor at V_{BAT}=3.8V



CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{SW}, CH4-I_{CHG}

Plug out adaptor at V_{BAT}=3.8V

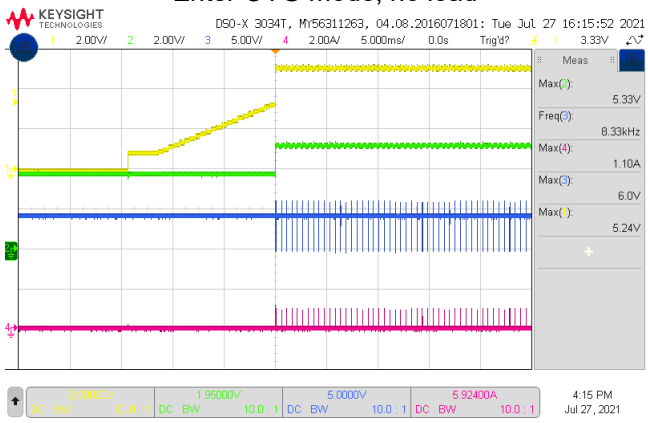


CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{SW}, CH4-I_{CHG}

2.11 Enter/Exit OTG Mode

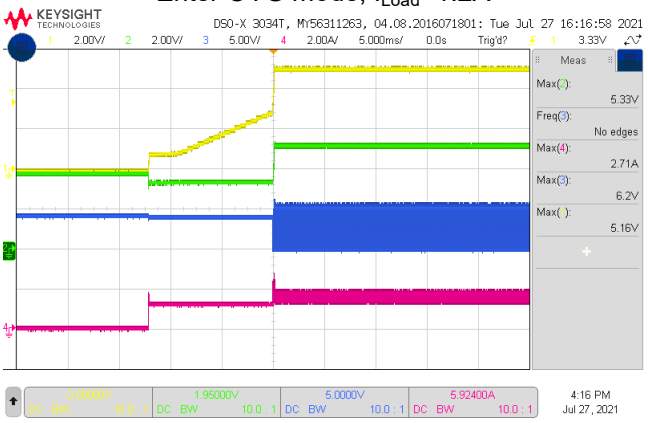
Test conditions: V_{BAT}=4.2V, enable OTG, enter OTG mode with different load.

Enter OTG mode, no load



CH1-V_{BUS}, CH2-PMID, CH3-SW, CH4-I_L

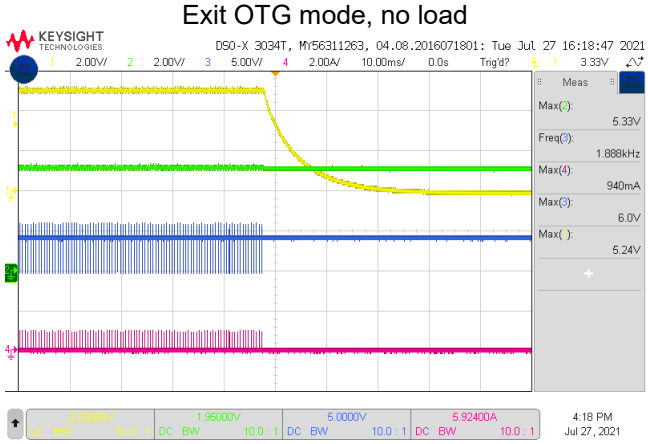
Enter OTG mode, I_{Load}=1.2A



CH1-V_{BUS}, CH2-PMID, CH3-SW, CH4-I_L

Test conditions: V_{BAT}=4.2V, disable OTG, exit OTG mode with different load.

Exit OTG mode, no load



CH1-V_{BUS}, CH2-PMID, CH3-SW, CH4-I_L

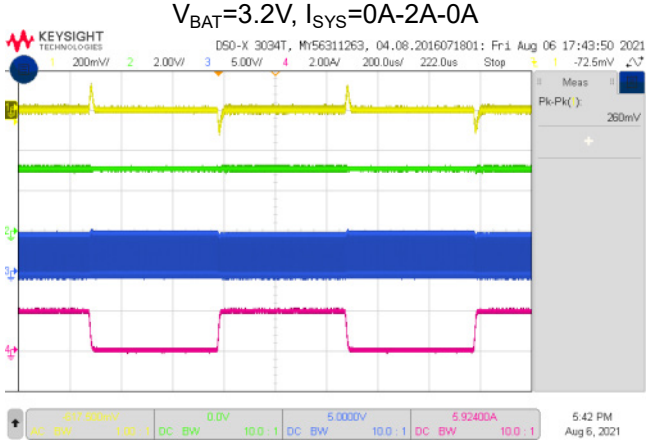
Exit OTG mode, I_{Load}=1.2A

CH1-V_{BUS}, CH2-PMID, CH3-SW, CH4-I_L

2.12 Charger System Load Transient

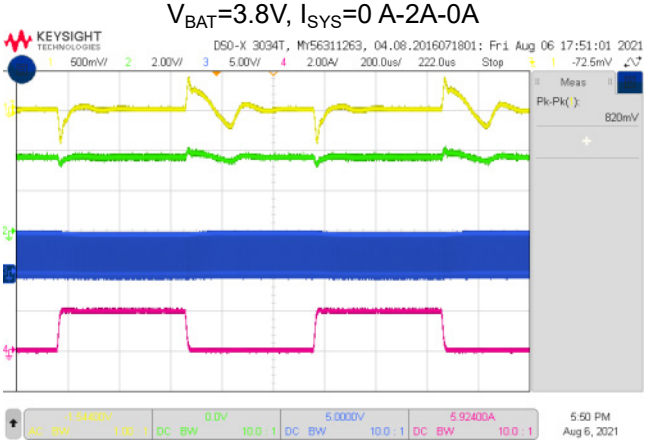
Test conditions: V_{BUS}=5V, V_{BAT}=3.2V/3.8V, I_{CHG_SET}=2040mA, I_{INDPM}=3800mA, dynamic I_{SYS}=0A-2A-0A.

V_{BAT}=3.2V, I_{SYS}=0A-2A-0A



CH1-V_{SYS}, CH2-V_{BAT}, CH3-SW, CH4-I_{SYS}

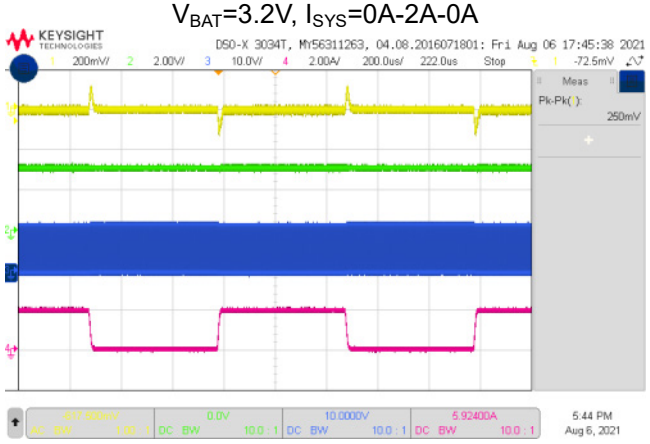
V_{BAT}=3.8V, I_{SYS}=0 A-2A-0A



CH1-V_{SYS}, CH2-V_{BAT}, CH3-SW, CH4-I_{SYS}

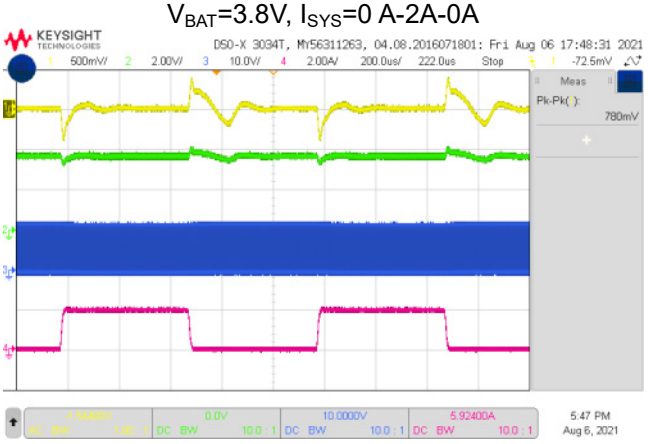
Test conditions: V_{BUS}=12V, V_{BAT}=3.2V/3.8V, I_{CHG_SET}=2040mA, I_{INDPM}=3800mA, dynamic I_{SYS}=0A-2A-0A.

V_{BAT}=3.2V, I_{SYS}=0A-2A-0A



CH1-V_{SYS}, CH2-V_{BAT}, CH3-SW, CH4-I_{SYS}

V_{BAT}=3.8V, I_{SYS}=0 A-2A-0A

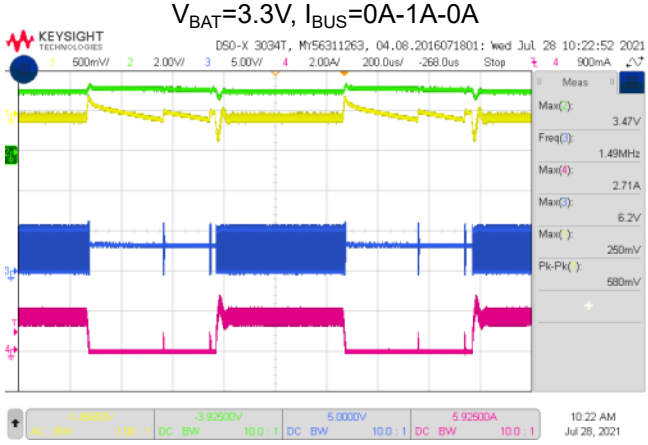


CH1-V_{SYS}, CH2-V_{BAT}, CH3-SW, CH4-I_{SYS}

2.13 OTG Load Transient

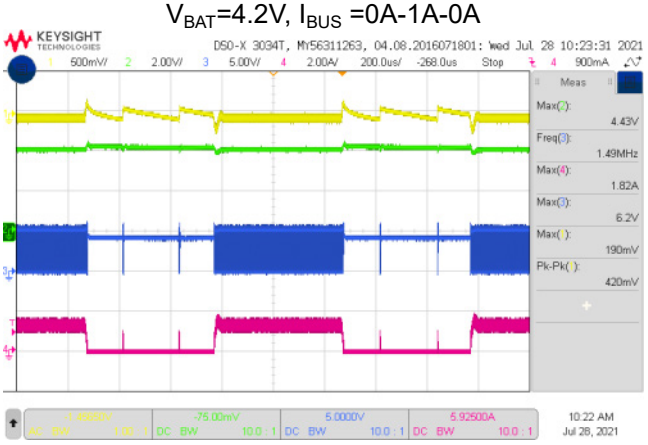
Test conditions: OTG mode, V_{BAT}=3.3V/4.2V, I_{BUS}=0A-1A-0A/1A-2A (slew rate: 1A/μs).

V_{BAT}=3.3V, I_{BUS}=0A-1A-0A



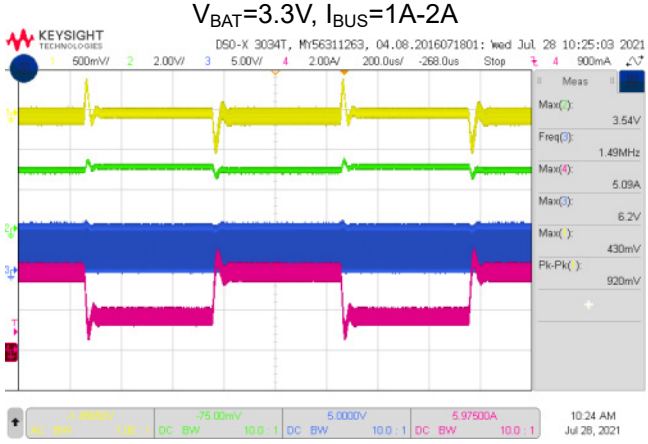
CH1-$V_{BUS/ac}$, CH2-V_{BAT}, CH3-SW, CH4-I_L

V_{BAT}=4.2V, I_{BUS} =0A-1A-0A



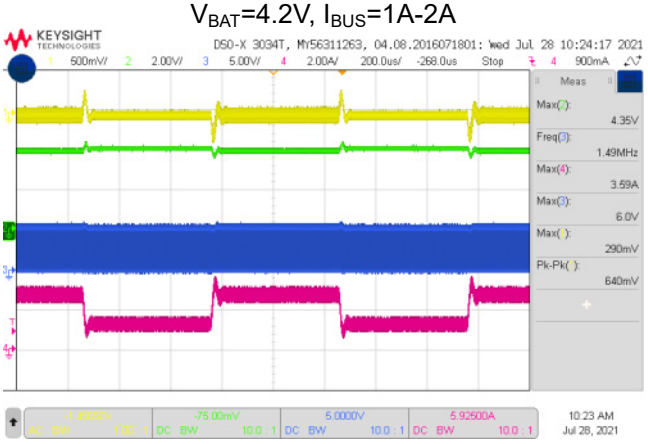
CH1- $V_{BUS/ac}$, CH2-V_{BAT}, CH3-SW, CH4-I_L

V_{BAT}=3.3V, I_{BUS}=1A-2A



CH1- $V_{BUS/ac}$, CH2-V_{BAT}, CH3-SW, CH4-I_L

V_{BAT}=4.2V, I_{BUS}=1A-2A

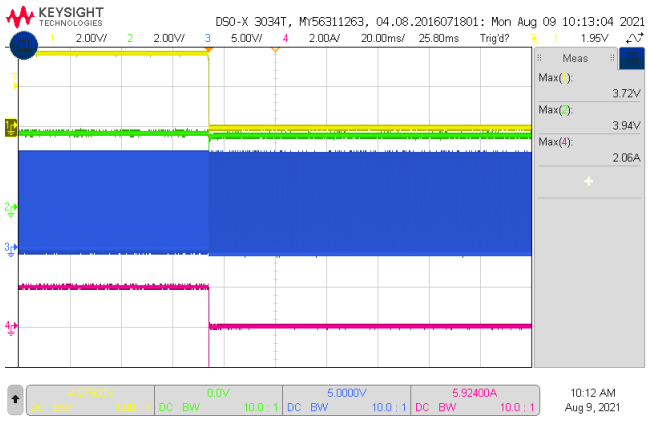


CH1- $V_{BUS/ac}$, CH2-V_{BAT}, CH3-SW, CH4-I_L

2.14System SCP

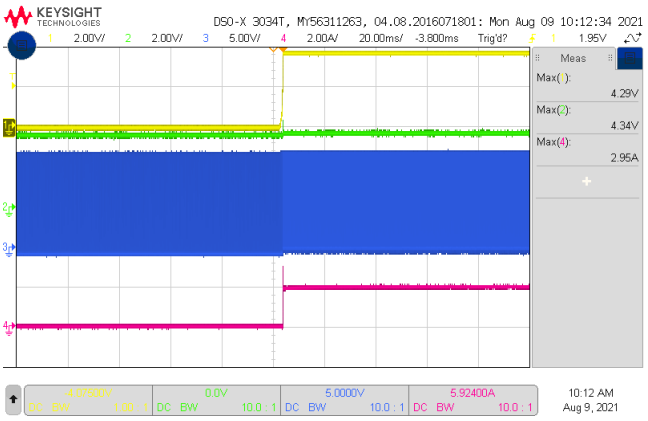
Test conditions: V_{BUS}=12V, V_{BAT}=3.8V, I_{CHG}=2040mA, charge enable, short system to GND, then release.

Short



CH1-V_{SYS}, CH2-V_{BAT}, CH3-SW, CH4-I_{CHG}

Release

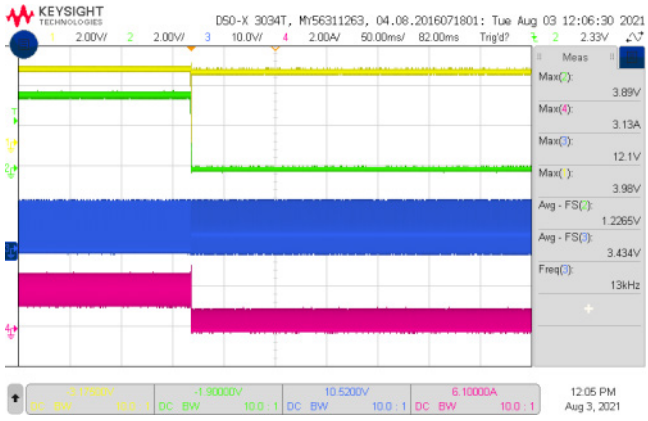


CH1-V_{SYS}, CH2-V_{BAT}, CH3-SW, CH4-I_{CHG}

2.15Battery SCP

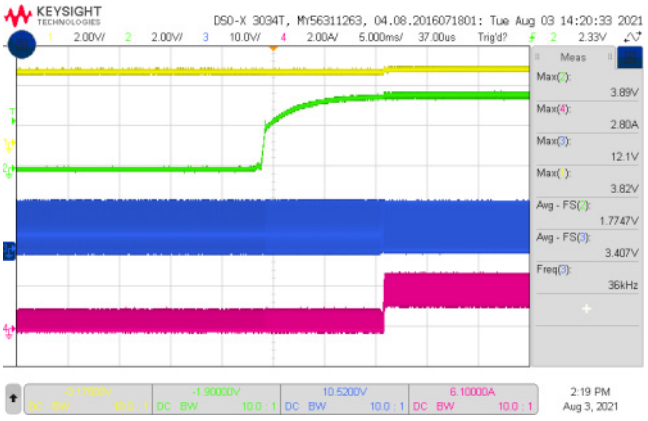
Test conditions: V_{BUS}=12V, V_{BAT}=3.8V, I_{CHG}=2040mA, charge enable, short battery to GND, then release.

Short



CH1-V_{SYS}, CH2-V_{BAT}, CH3-SW, CH4-I_L

Release

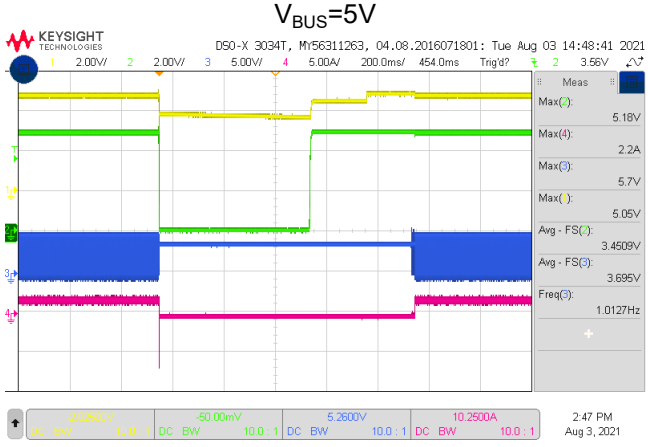


CH1-V_{SYS}, CH2-V_{BAT}, CH3-SW, CH4-I_L

2.16VBUS SCP

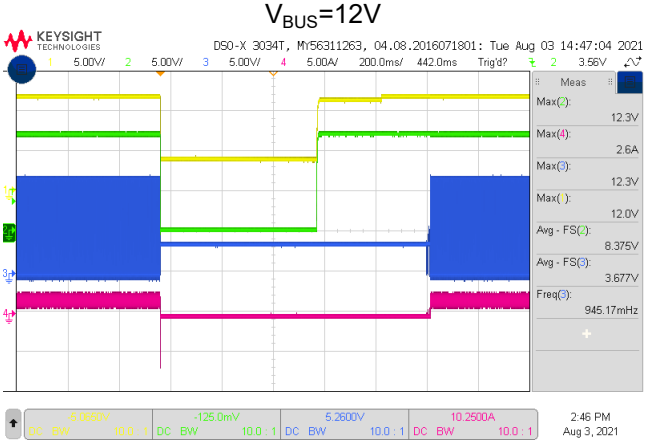
Test conditions: V_{BUS}=5V/12V, V_{BAT}=3.8V, short VBUS to GND, then release.

V_{BUS}=5V



CH1-PMID, CH2-V_{BUS}, CH3-SW, CH4-I_L

V_{BUS}=12V

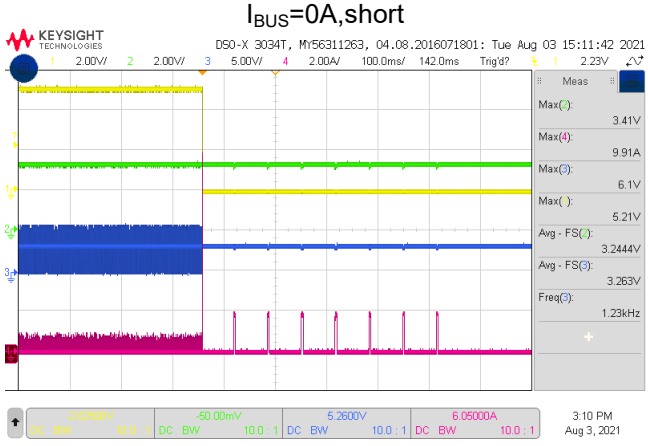


CH1-PMID, CH2-V_{BUS}, CH3-SW, CH4-I_L

2.17VBUS OCP&SCP in OTG Mode

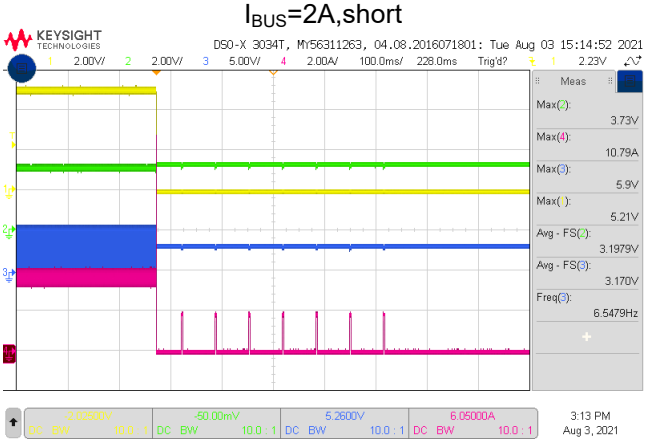
Test conditions: V_{BAT}=3.3V, BOOST I_{LIM}=2A, enable OTG mode, then short V_{BUS} to GND

I_{BUS}=0A,short



CH1-V_{BUS}, CH2-V_{BAT}, CH3-SW, CH4-I_L

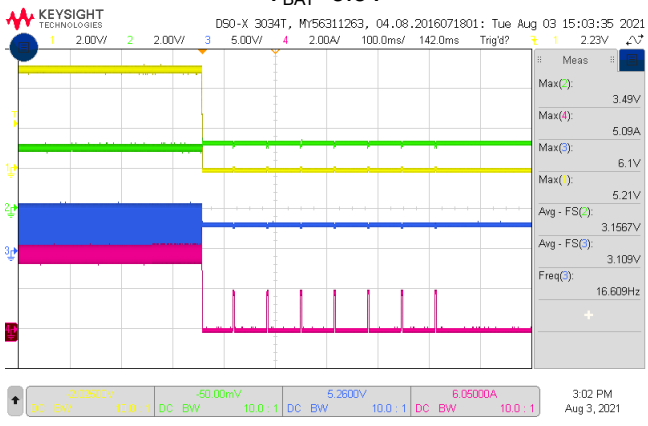
I_{BUS}=2A,short



CH1-V_{BUS}, CH2-V_{BAT}, CH3-SW, CH4-I_L

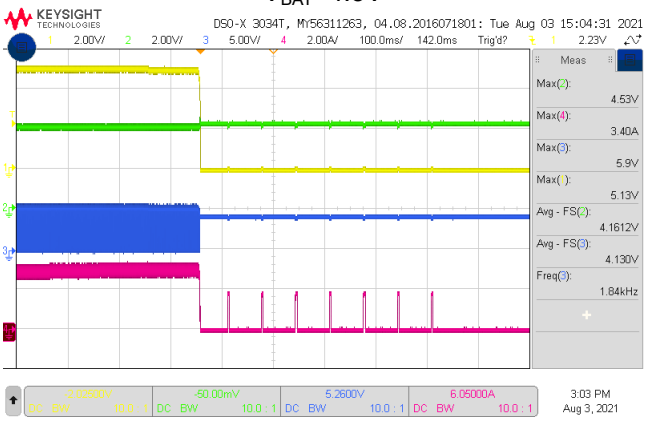
Test conditions: BOOST I_{LIM}=2A, enable OTG mode, increase I_{BUS} till OCP.

V_{BAT}=3.3V



CH1-V_{BUS}, CH2-V_{BAT}, CH3-SW, CH4-I_L

V_{BAT}=4.3V

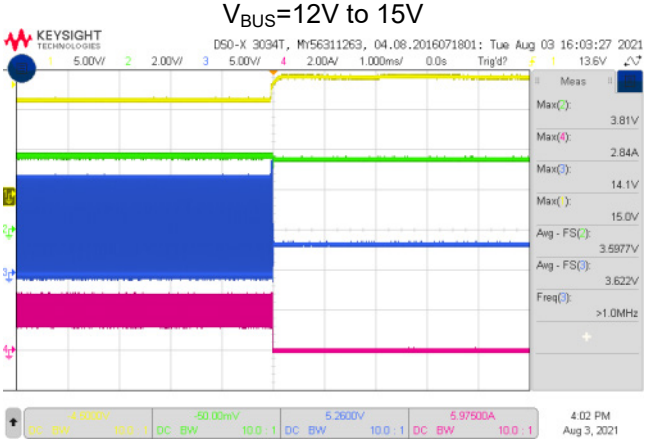


CH1-V_{BUS}, CH2-V_{BAT}, CH3-SW, CH4-I_L

2.18VBUS OVP

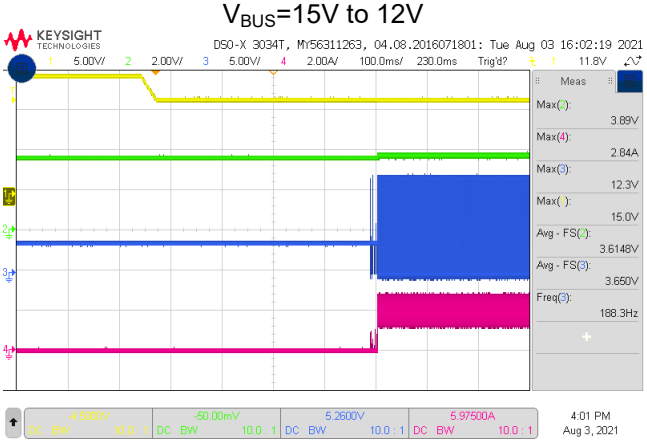
Test conditions: OVP set to 14V, V_{BUS}=12V, V_{BAT}=3.8V, charge enable, V_{BUS} ramp to 15V.

V_{BUS}=12V to 15V



CH1-V_{BUS}, CH2- V_{BAT}, CH3-SW, CH4-I_L

V_{BUS}=15V to 12V

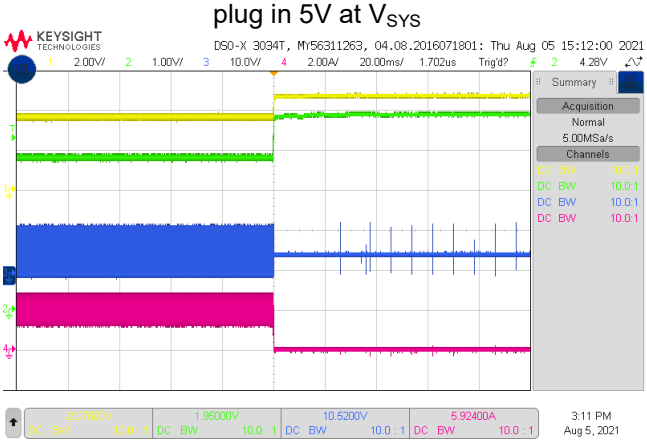


CH1-V_{BUS}, CH2- V_{BAT}, CH3-SW, CH4-I_L

2.19VSYS OVP

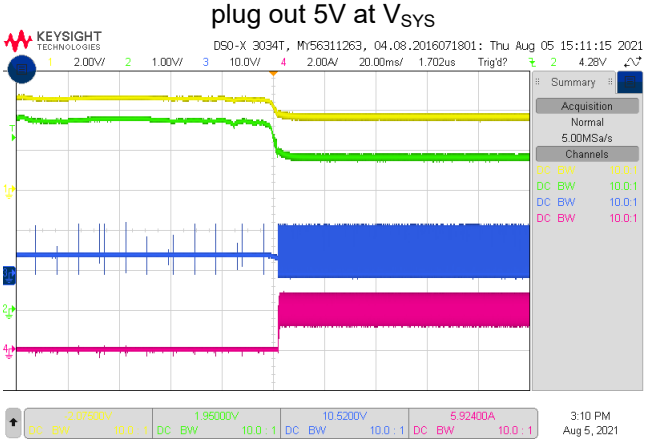
Test conditions: V_{BUS}=12V, V_{BAT}=3.8V, charge enable, I_{SYS}=0A, force a 5V external power supply on system.

plug in 5V at V_{SYS}



CH1-V_{BAT}, CH2-V_{SYS}(3.5V offset), CH3-SW, CH4-I_L

plug out 5V at V_{SYS}

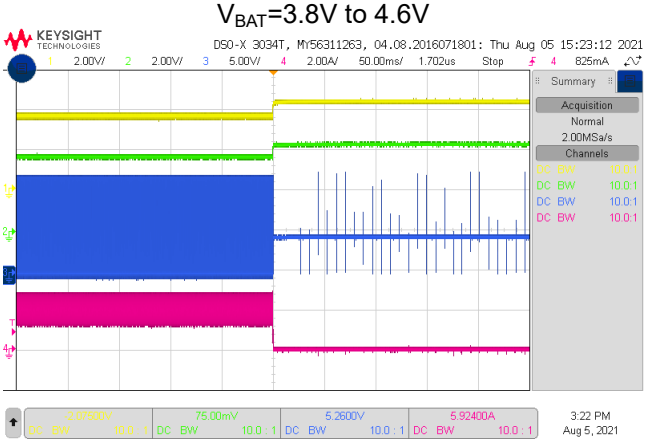


CH1-V_{BAT}, CH2-V_{SYS}(3.5V offset), CH3-SW, CH4-I_L

2.20 VBAT OVP

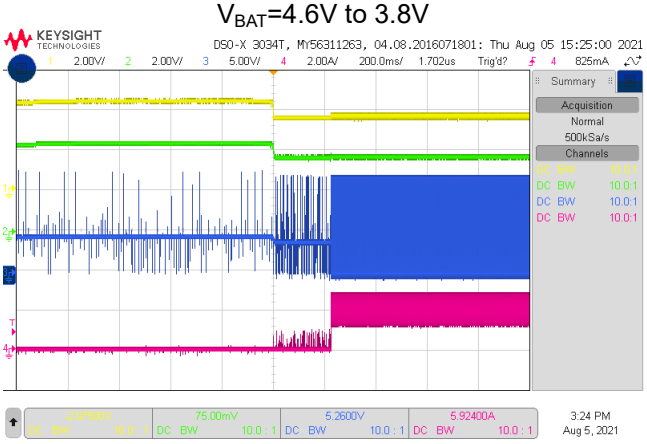
Test conditions: V_{BUS}=12V, V_{BAT}=3.8V, charge enable, V_{BAT_REG}=4.208V, V_{BAT} ramp to 4.6V.

V_{BAT}=3.8V to 4.6V



CH1-V_{BAT}, CH2-V_{SYS}, CH3-SW, CH4-I_L

V_{BAT}=4.6V to 3.8V

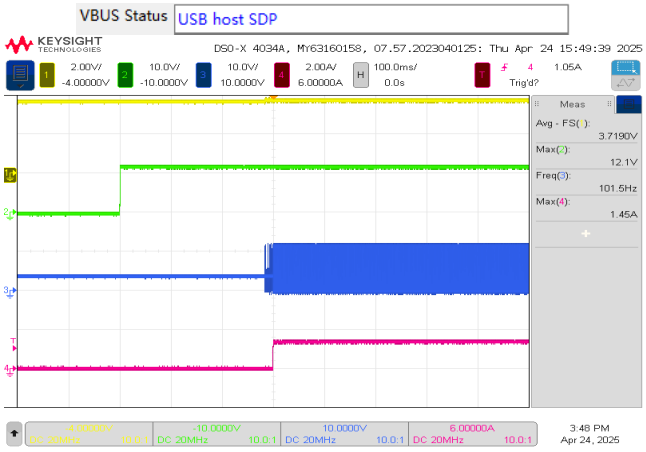


CH1-V_{BAT}, CH2-V_{SYS}, CH3-SW, CH4-I_L

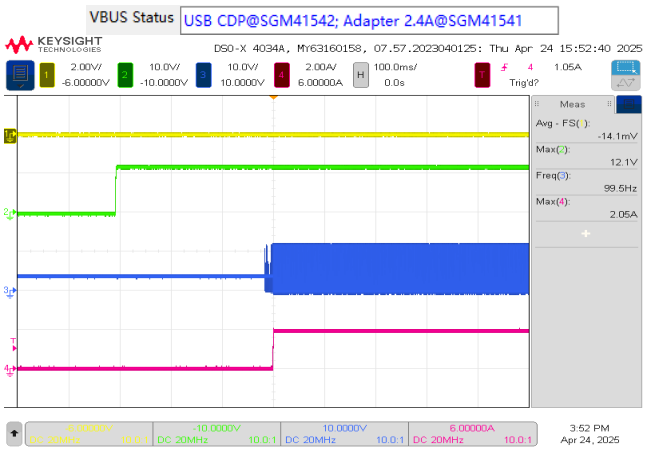
2.21 Input Power Source Type Detection

2.21.1 Input Current Limit by PSEL for SGM41541 Only

Test conditions: V_{BAT}=3.8V, V_{BUS}=12V plug in.



CH1-PSEL, CH2-V_{BUS}, CH4-SW, CH4-I_{CHG}

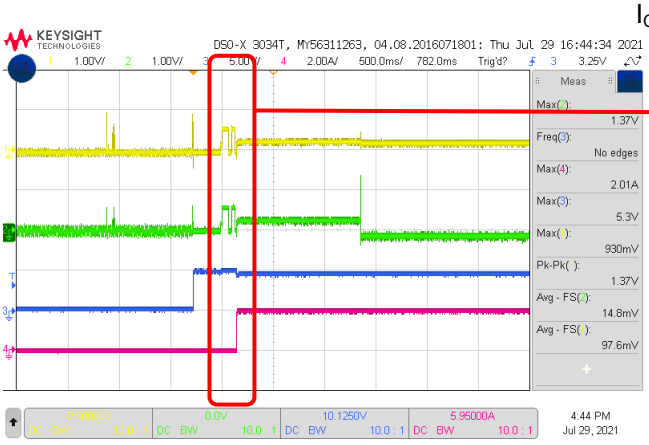


CH1-PSEL, CH2-V_{BUS}, CH4-SW, CH4-I_{CHG}

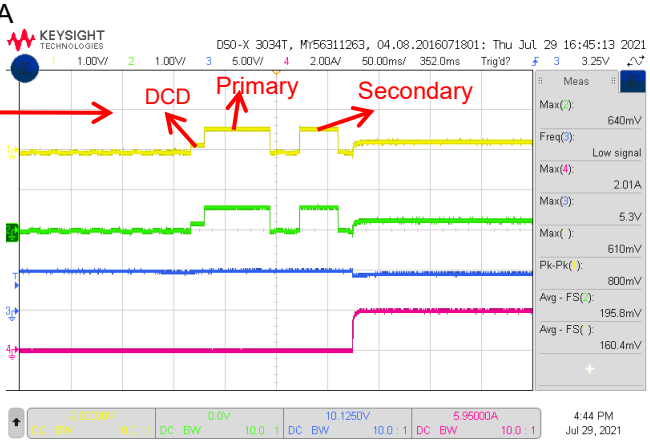
2.21.2 BC1.2 and QC2.0 Detection for SGM41542 Only

Test conditions: V_{BAT}=3.8V, insert Xiaomi adaptor (QC2.0: 5V/9V/12V).

I_{CHG}=2A



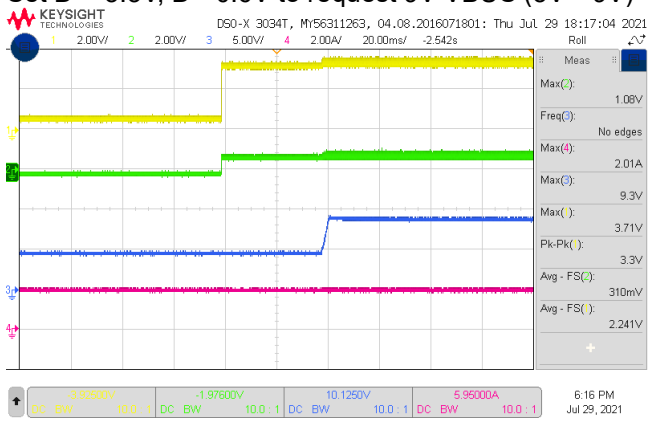
CH1-D+, CH2-D-, CH4-V_{BUS}, CH4-I_{CHG}



CH1-D+, CH2-D-, CH4-V_{BUS}, CH4-I_{CHG}

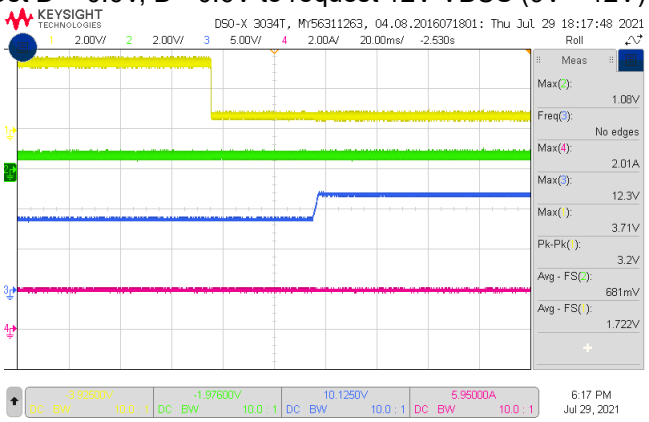
Test conditions: V_{BAT}=3.8V, I_{CHG}=2A, insert Xiaomi adaptor (QC2.0: 5V/9V/12V).

Set D+=3.3V, D-=0.6V to request 9V VBUS (5V→9V)



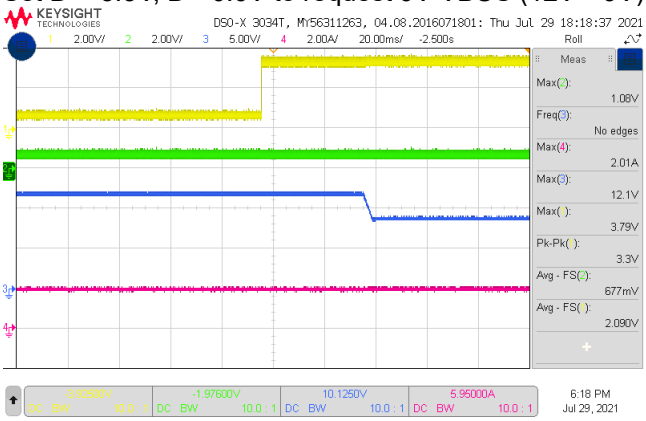
CH1-D+, CH2-D-, CH4-V_{BUS}, CH4-I_{CHG}

Set D+=0.6V, D-=0.6V to request 12V VBUS (9V→12V)



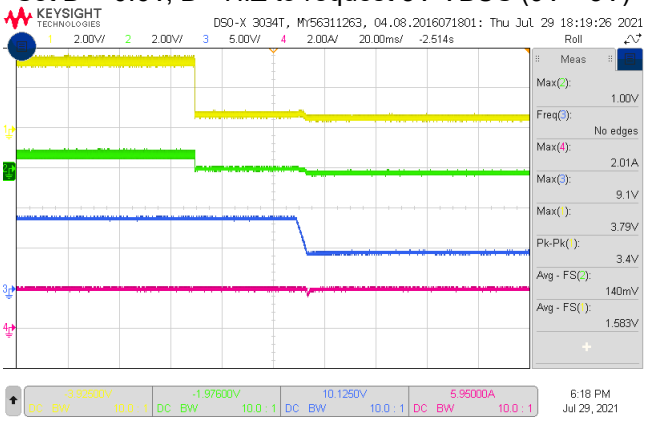
CH1-D+, CH2-D-, CH4-V_{BUS}, CH4-I_{CHG}

Set D+=3.3V, D-=0.6V to request 9V VBUS (12V→9V)



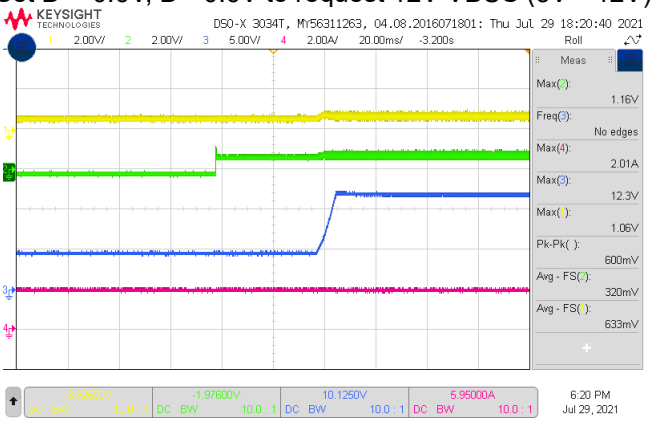
CH1-D+, CH2-D-, CH4-V_{BUS}, CH4-I_{CHG}

Set D+=0.6V, D-=HIZ to request 5V VBUS (9V→5V)



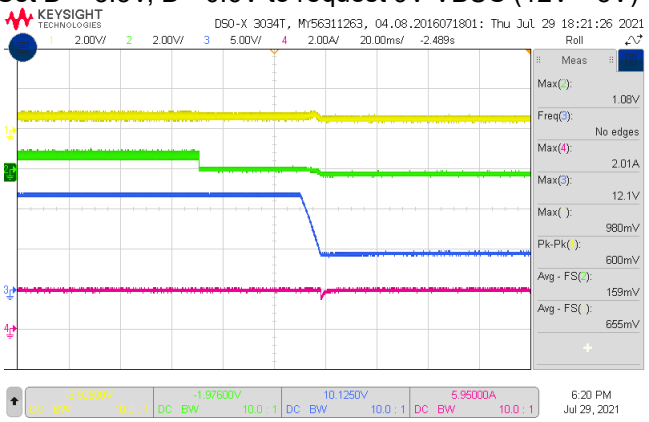
CH1-D+, CH2-D-, CH4-V_{BUS}, CH4-I_{CHG}

Set D+=0.6V, D-=0.6V to request 12V VBUS (5V→12V)



CH1-D+, CH2-D-, CH4-V_{BUS}, CH4-I_{CHG}

Set D+=3.3V, D-=0.6V to request 9V VBUS (12V→5V)



CH1-D+, CH2-D-, CH4-V_{BUS}, CH4-I_{CHG}