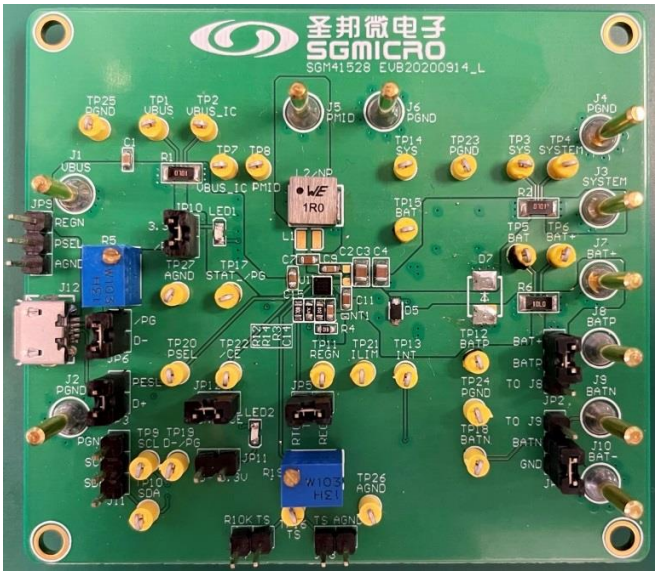
SGM41528 Demo Board Test Report

I²C Controlled, 2-Cell Battery Charger with Boost Mode for USB Input

Input Voltage Range: 3.9V to 6.2V

Fast Charge Current Range: 0.1A to 2.2A

Demo Board Picture:



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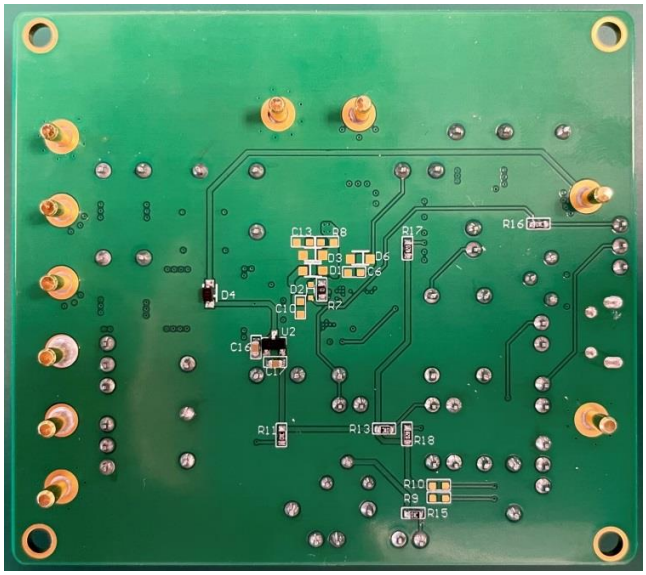

Bottom Layer

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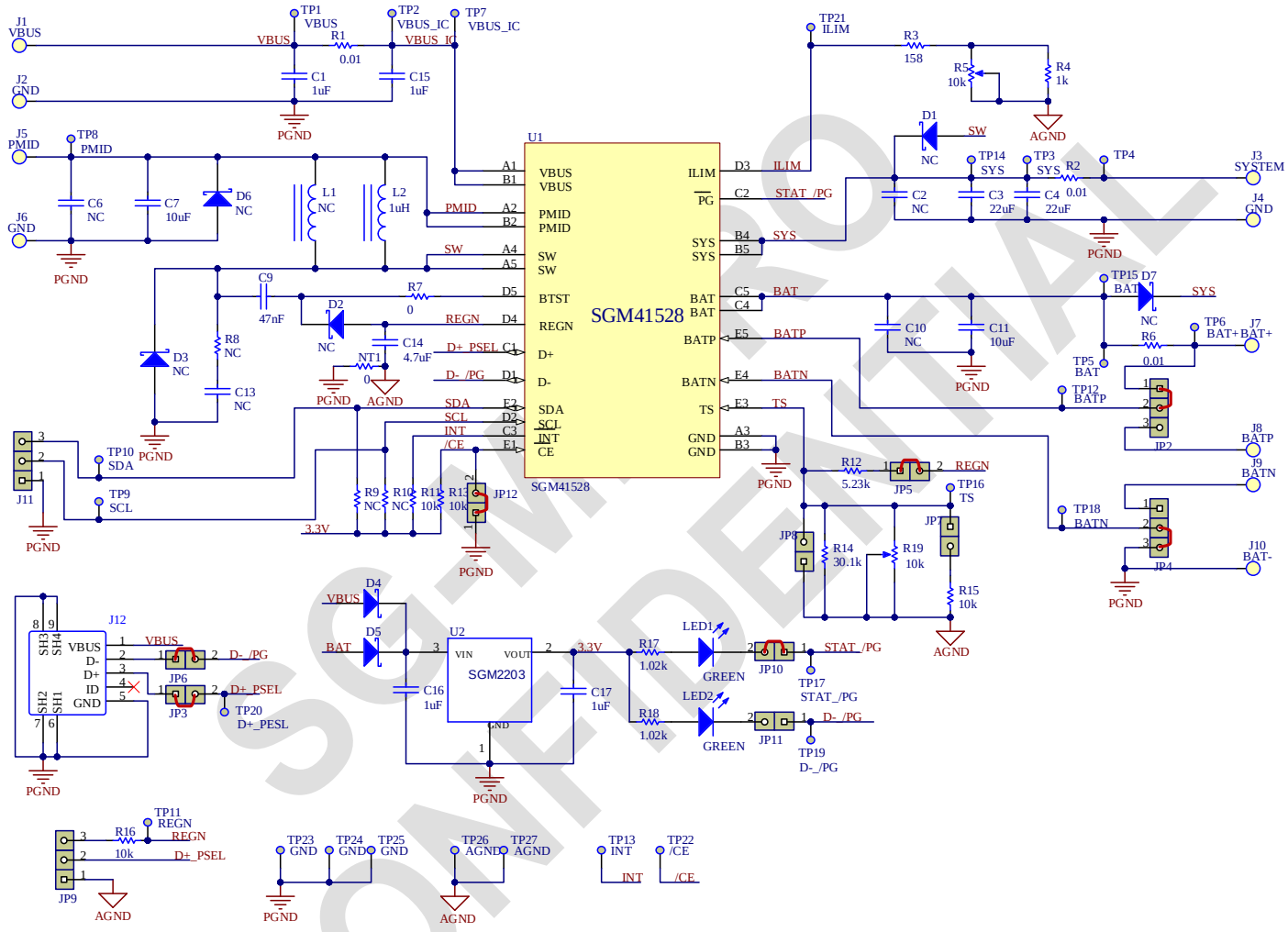
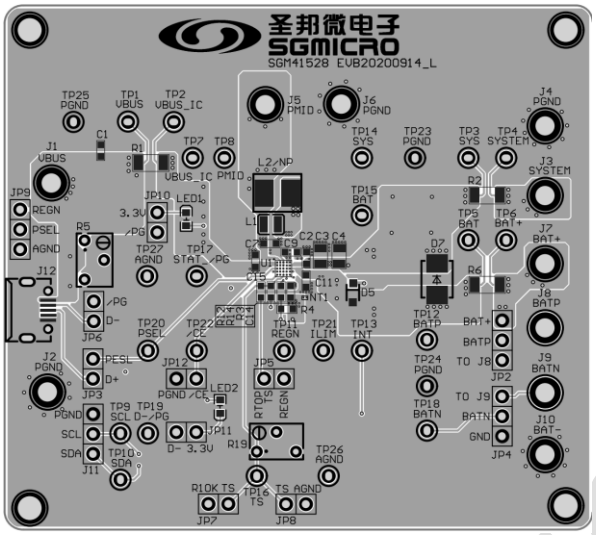


1.1.2 PCB Layout



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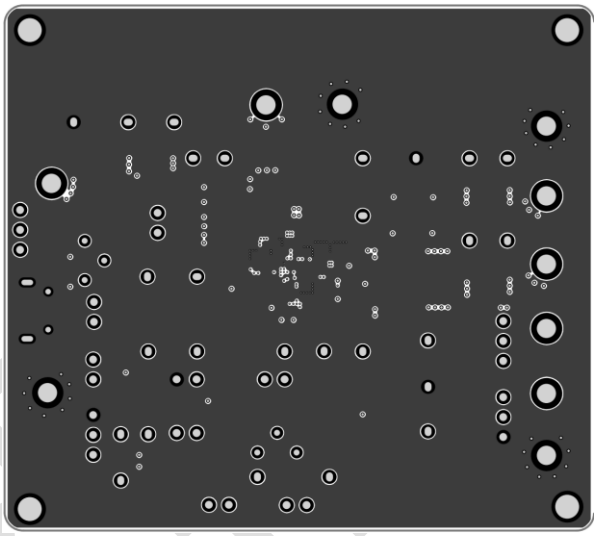

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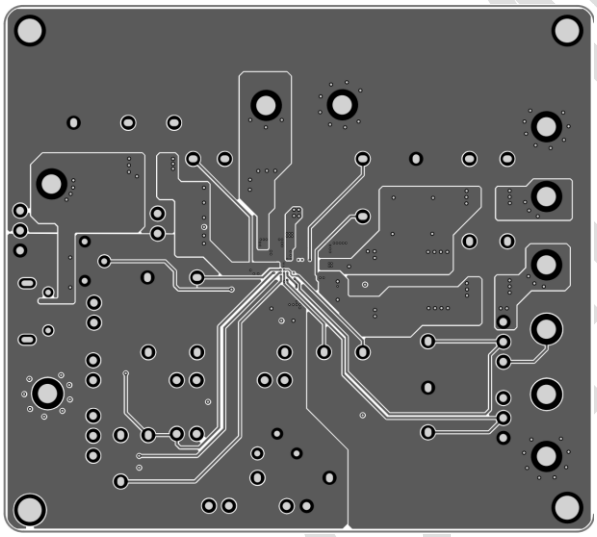

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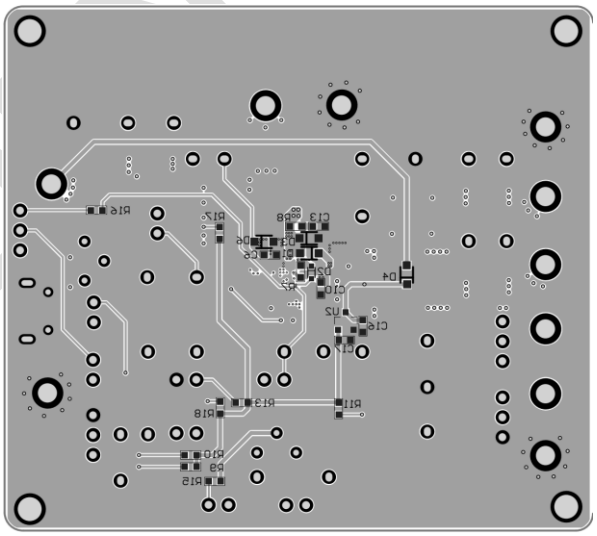

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1.1.3 BOM List

Item	Quantity	Designator	Description	Manufactory
1	2	C1, C15	Ceramic Capacitor, 1μF, 25V, ±10%, X7R, 0603	
2	0	C2, C6, C10, C13	NC	
3	2	C3, C4	Ceramic Capacitor, 22μF, 25V, ±20%, X5R, 0805	
4	2	C7, C11	Ceramic Capacitor, 10μF, 25V, ±20%, X5R, 0603	
5	1	C9	Ceramic Capacitor, 47nF, 25V, ±10%, X7R, 0603	
6	1	C14	Ceramic Capacitor, 4.7μF, 10V, ±20%, X5R, 0603	
7	2	C16, C17	Ceramic Capacitor, 1μF, 16V, ±10%, X7R, 0603	
8	0	D1, D2, D3, D6, D7	NC	
9	2	D4, D5	Diode, 1N4148, SOD-323	
10	0	L1	NC	
11	1	L2	Inductor, 1μH, I_S=11.2A, I_R=7.3A, DCR=14mΩ, 5030	Wurth: 74437336010
12	2	LED1, LED2	LED Green, 0603	
13	3	R1, R2, R6	Sense Resistor, 10mΩ, 0.5W, 1%, 1206	
14	1	R3	Film Resistor, 158Ω, 0.1W, 1%, 0603	
15	1	R4	Film Resistor, 1kΩ, 0.1W, 1%, 0603	
16	2	R5, R19	Trimmer, 10kΩ, 0.25W, RES-ADJ-TH_3P-3266W	
17	1	R7	Film Resistor, 0Ω, 0.1W, 5%, 0603	
18	0	R8, R9, R10	NC	
19	4	R11, R13, R15, R16	Film Resistor, 10kΩ, 0.1W, 1%, 0603	
20	1	R12	Film Resistor, 5.23kΩ, 0.1W, 1%, 0603	
21	1	R14	Film Resistor, 30.1kΩ, 0.1W, 1%, 0603	
22	2	R17, R18	Film Resistor, 1.02kΩ, 0.1W, 1%, 0603	
23	1	U1	I^2C Controlled, 2-Cell Boost Battery Charger, WLCSP-2.1×2.1-25B	SGMICRO: SGM41528
24	1	U2	3.3V LDO, SOT-23	SGMICRO: SGM2203
Conclusion: Total 33 Components				

1.2 Demo Board Features

The SGM41528 demo board is a complete charger module for evaluating the I²C-controlled, 2-cell Boost battery charger in WLCSP-2.1×2.1-25B package. It has below key features:

1. Easily evaluate the Boost charger in forward mode, with onboard system output and battery output connection point.

2. Easily evaluate the adapter identification with the onboard USB Micro-B connector.

3. With the SGM USB-to-I²C dongle and GUI, it is easily to evaluate the SGM41528 other features, such as OTG mode, ADC reading, status and flag reading, *etc*.

4. With the onboard high-accuracy sense resistors and test points, it is easily to measure the current and voltage regulation and accuracy.

Note: This demo board does not include the SGM USB-to-I²C dongle board.

Table 1 lists the recommended operating conditions for the demo board.

Table 1. Recommended Operation Conditions

Parameters	Range
The Input Voltage Range in Forward Mode	3.9V to 6.2V, typical 5V
Battery Voltage in Forward Mode	0V to 9.2V (or floating), typical 7.6V
Battery Voltage in OTG Mode	6V to 9.2V, typical 7.6V
The Output Voltage Range in OTG Mode	4.5V to 5.5V, default 5.1V
Fast Charging Current	0.1A to 2.2A, default 1A
Input Current Limit in Forward Mode	0.5A to 3.3A
Output Current Limit in OTG Mode	0.5A to 2A, default 2A
Operating Ambient Temperature Range	-40℃ to +85℃

1.3 Test Setup

1.3.1 Forward Mode

1.3.1.1 Demo Board Setup

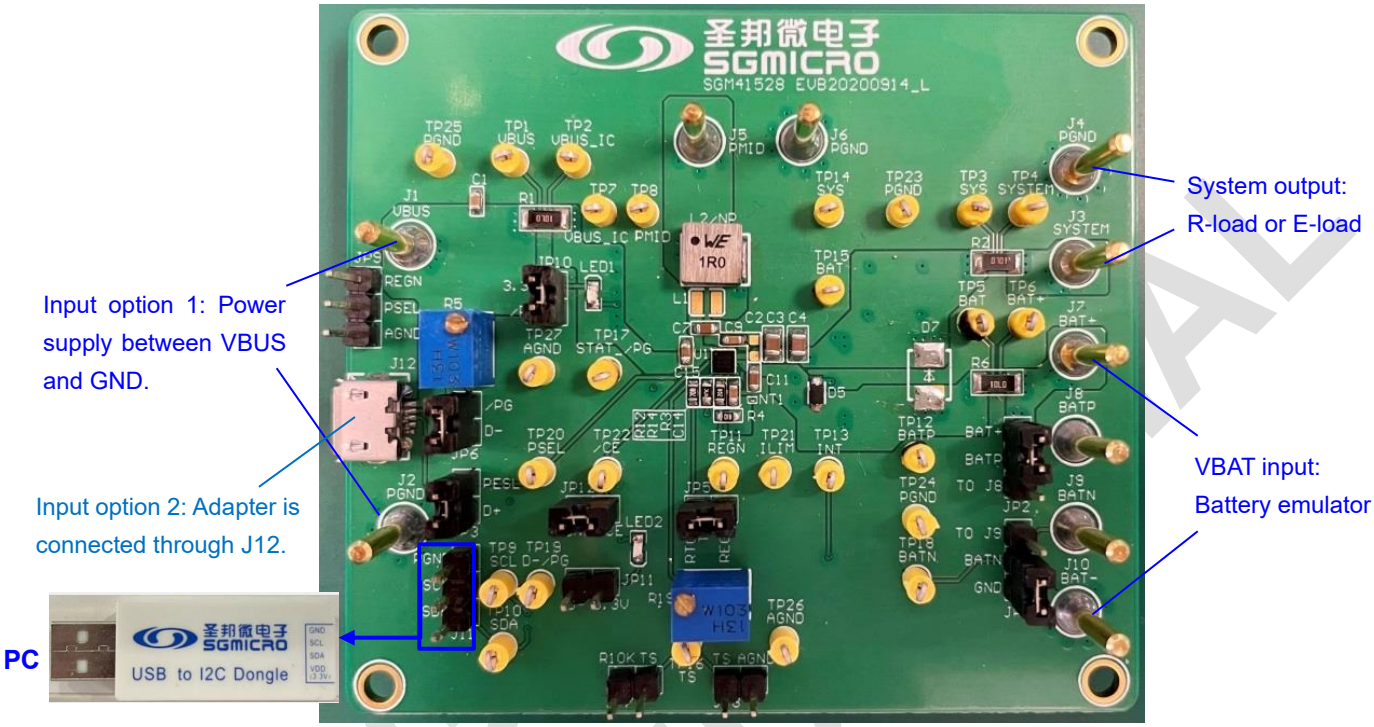

Fig-1: SGM41528 Demo Board Setup in Forward Mode

1. The equipment required in this test include:
   a. A battery emulator set to 7.6V/2.5A (larger than the fast charge current).
   b. An input power supply set to 5V with larger than 3.5A current limit (larger than the IINDPM limit).
   c. The E-load for the system load.

Note: The battery emulator also can be replaced by one of following equipment:
   a. A power supply with larger than 2.5A sink current capacity (larger than the fast charge current);
   b. A power supply (without sink current capacity) with a parallel E-load 2.5A (larger than the fast charge current);
   c. A real battery.

2. Turn off and connect the battery emulator to the demo board according Fig-1 setup.

3. Turn off and connect the input power supply to the demo board according Fig-1 setup. If a real adapter is applied, connect it through J12 connector instead of the input power supply.

4. Connect the E-load to system output on the demo board according Fig-1 setup.

5. Connect the SGM USB-to-I^2C dongle to the demo board according Fig-1 setup, and connect the dongle to PC.

6. Turn on the battery emulator, input power supply, system E-load. And then follow *1.3.1.2* to set the I^2C registers by GUI.

1.3.1.2 I²C Register Setting

1. After hardware setup done as shown in *1.3.1.1*, and connect the USB-to-I²C dongle to PC, then open the SGM USB GUI interface as Fig-2, choose the “SGM41528” and click “Entry” button to entry the SGM41528 GUI interface.

Fig-2: SGM USB GUI Interface

2. After entry the SGM41528 GUI interface as shown in Fig-3, click the “Read All” button, if "Device ACK" is displayed, it means the I²C communication is normal.

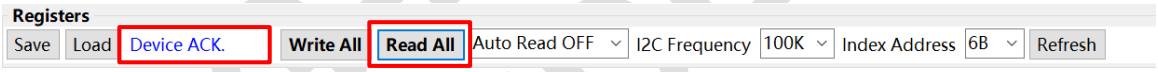

Fig-3: SGM41528 GUI Interface

3. After both the hardware and software setup done, the registers can be read/written normally according to the test. Ensure/change the registers setting as following:

a. Disable Watchdog Timer (REG0x05[5:4] = 00).
b. Disable ILIM pin (REG0x01[6] = 0).
c. Disable HIZ mode (default, REG0x01[7] = 0).
d. Input Current Limit = 3.3A (REG0x03[4:0] = 11100).
e. Input Voltage Limit = 4.4V (default, REG0x02[4:0] = 00101).
f. Minimum System Voltage = 7V (default, REG0x07[3:0] = 1010).
g. Charge Voltage Limit = 8.4V (default, REG0x00[7:0] = 10100000).
h. Fast Charge Current = 1A (default, REG0x01[5:0] = 010100).
i. Pre-Charge Current = 150mA (default, REG0x04[7:4] = 0010).
j. If charge enabled, write EN_CHG = 1 (REG0x06[3] = 1), and pull down nCE pin by shorting JP12 on demo board.
k. If charge disabled, write EN_CHG = 0 (REG0x06[3] = 0), or disconnect JP12 on demo board.

Below GUI interface screenshot is for reference.

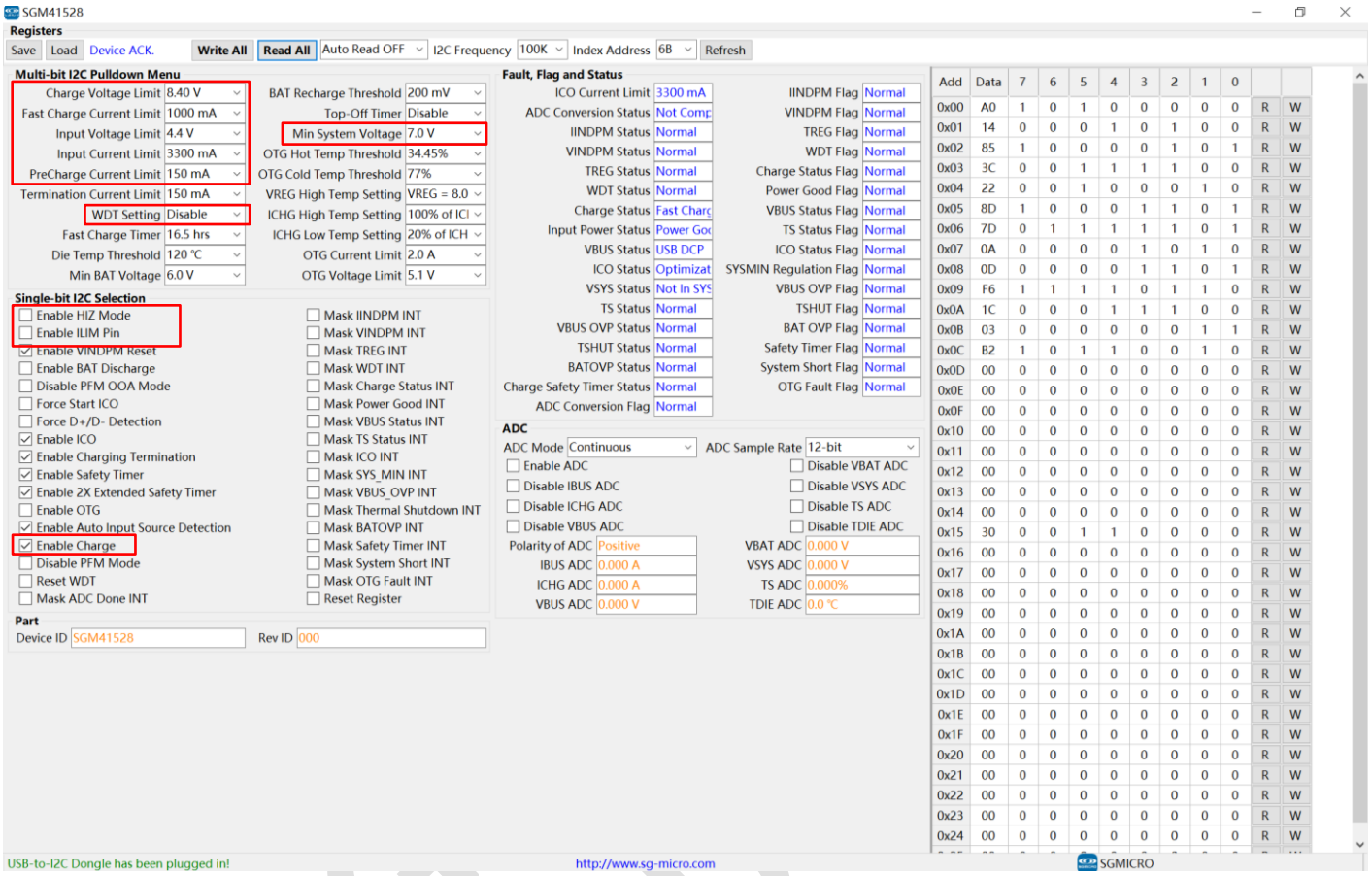

Fig-4: SGM41528 register setting example in forward charging mode

1.3.1.3 Test Procedure

After both hardware and software setup done as shown in *1.3.1.1* and *1.3.1.2*, the LED1 is on to indicate power good. The SGM41528 forward charging mode is enabled. Follow Fig-5 and below steps for demo board forward charging mode measurement and verification:

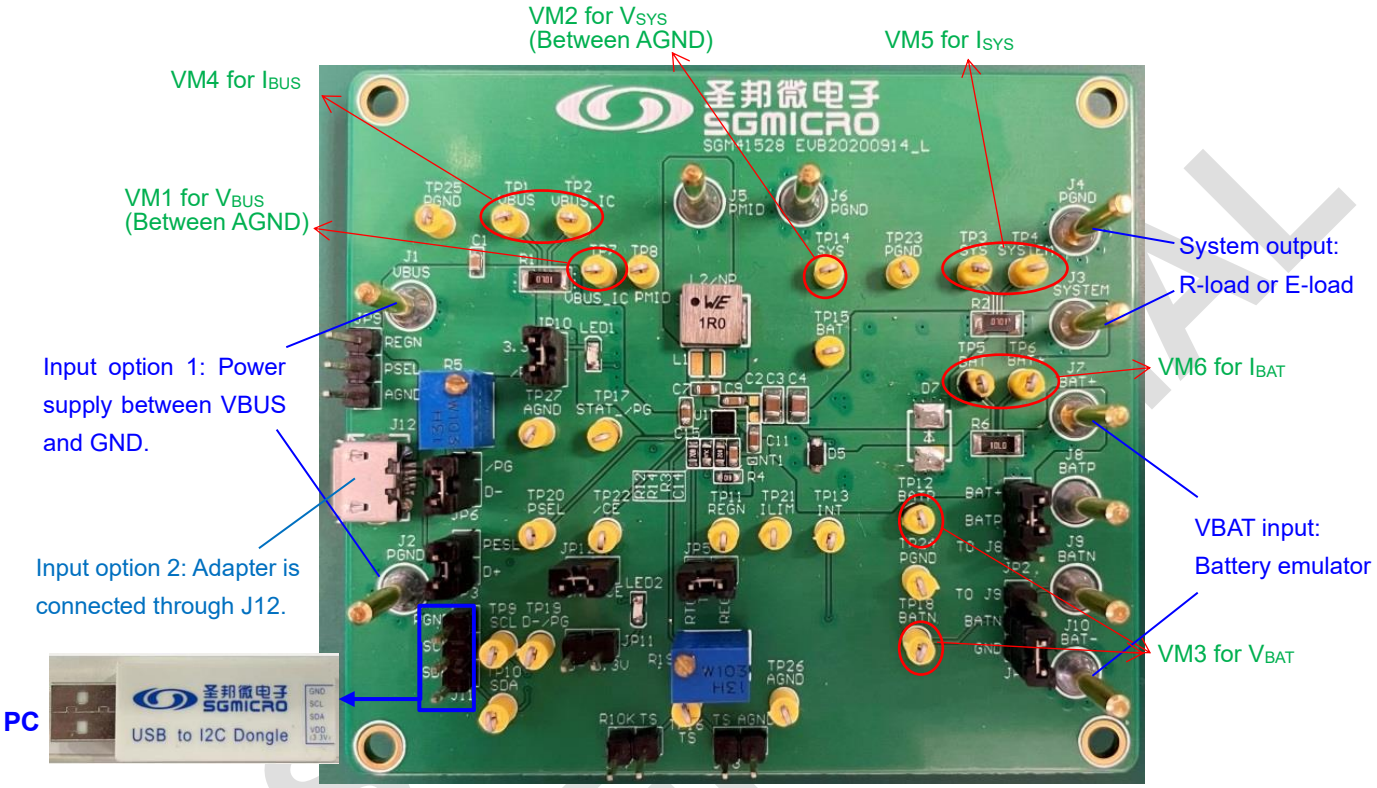

Fig-5: SGM41528 Demo Board Test Measurement in Forward Mode

1. When the SGM41528 enters forward mode, the V_{BUS}, V_{SYS}, V_{BAT}, I_{BUS}, I_{SYS}, I_{BAT} can all be measured.

2. The current sense resistor R1, R2, R6 are all 10mΩ, and the VM4, VM5 and VM6 measure the sense resistor voltage to give the I_{BUS}, I_{SYS} and I_{BAT}, respectively.

3. Optional, in this setup, change the power supply voltage or I²C register setting can observe the SGM41528 other features as following. During the test, the corresponding STAT and FLAG registers are helpful to judge the IC operation status.

   a. Change the battery emulator voltage can observe different charge phase and VBAT_OVP behavior.
   b. Change the input power supply voltage can observe the VBUS_OVP behavior.
   c. Increase the system load to trigger IINDPM/VINDPM regulation and enter supplement mode.
   d. Enable/disable charge by I²C register (REG0x06[3]) or external nCE pin (JP12).
   e. Other functions and protections.

4. Optional, when the quiescent current is tested, remove the D4 and D5, which provide the power path from VBUS/VBAT to external circuit.

1.3.2 OTG Mode

1.3.2.1 Demo Board Setup

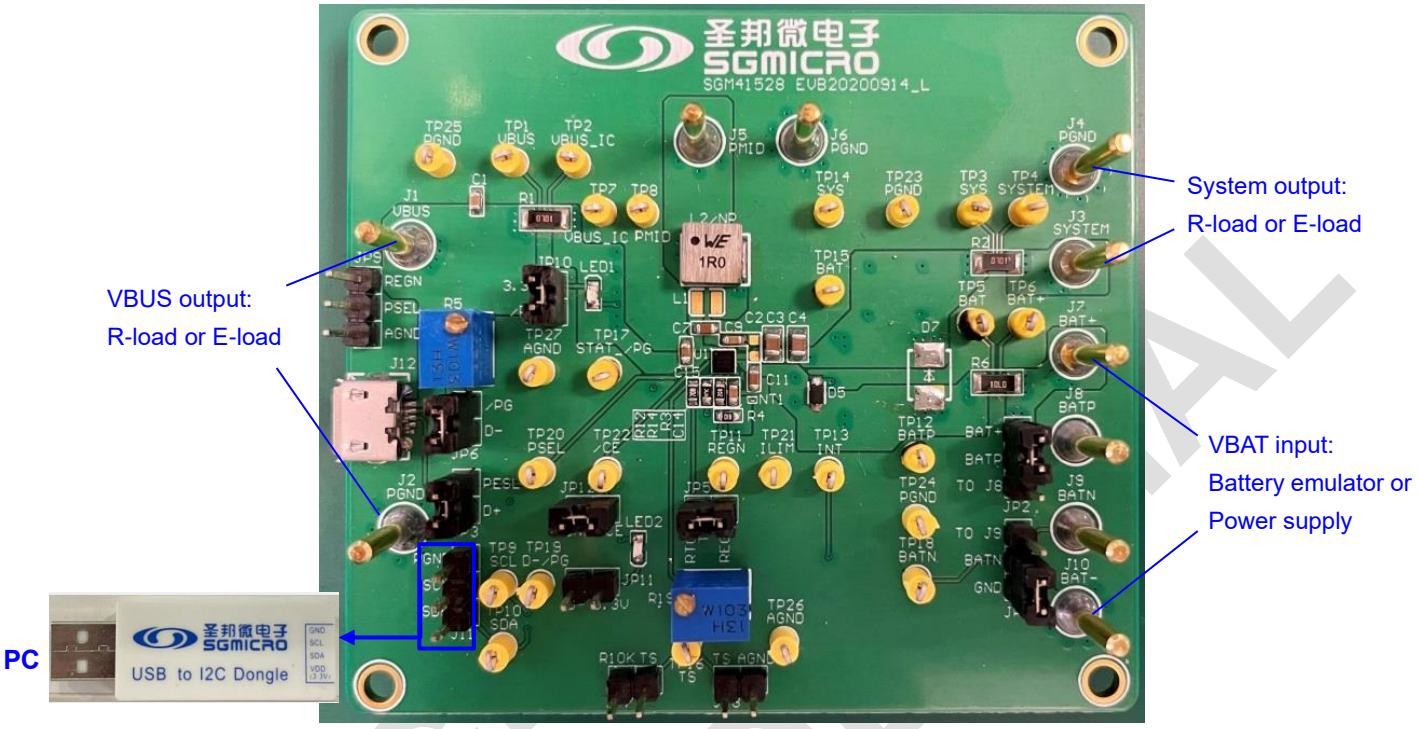

Fig-6: SGM41528 Demo Board Setup in OTG Mode

1. Set the battery emulator to 7.6V with enough current limit, turn off and connect the battery emulator to demo board according to Fig-6 setup.

2. Connect the E-loads to system output and VBUS output.

3. Connect the SGM USB-to-I^{2}C dongle to the demo board according to Fig-6 setup, and then connect the dongle to PC.

4. Turn on the battery emulator.

5. Follow *1.3.2.2* setup to set the I^{2}C registers by GUI.

1.3.2.2 I²C Register Setting

After hardware setup done as shown in *1.3.2.1*, open the SGM41528 GUI (refer to *1.3.1.2*), ensure/change the registers setting as following:

a. Disable Watchdog Timer (REG0x05[5:4] = 00).
b. Disable HIZ mode (default, REG0x01[7] = 0).
c. OTG Voltage Limit = 5.1V (default, REG0x09[3:0] = 0110).
d. OTG Current Limit = 2A (default, REG0x09[7:4] = 1111).
e. Enable OTG mode (REG0x06[7] = 1).

Below GUI Interface screenshot is for reference.

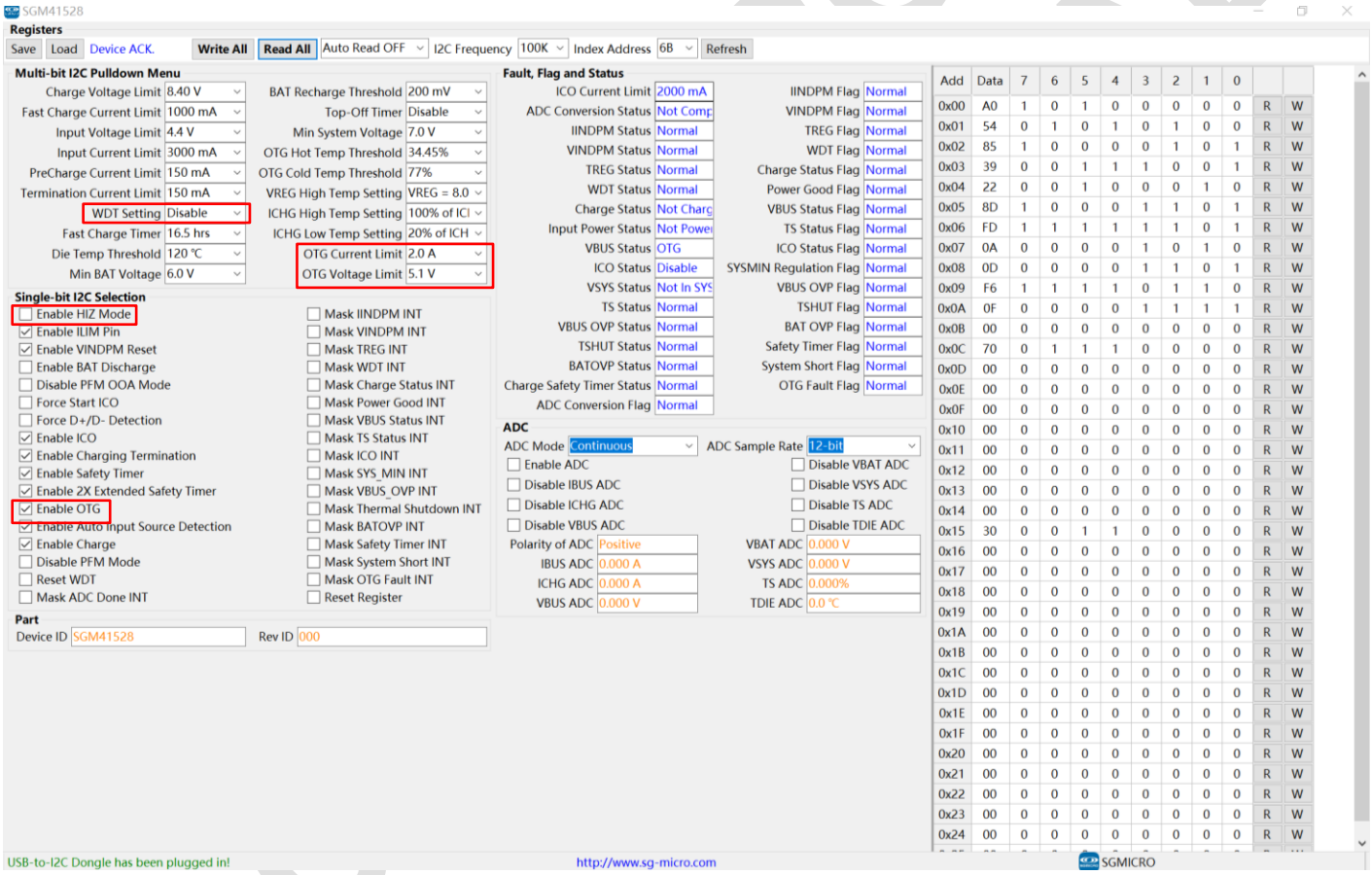

Fig-7: SGM41528 register setting example in OTG mode

1.3.2.3 Test Procedure

After both hardware and software setup done as shown in *1.3.2.1* and *1.3.2.2*, the SGM41528 OTG mode is enabled. Follow Fig-8 and below steps for demo board OTG mode measurement and verification:

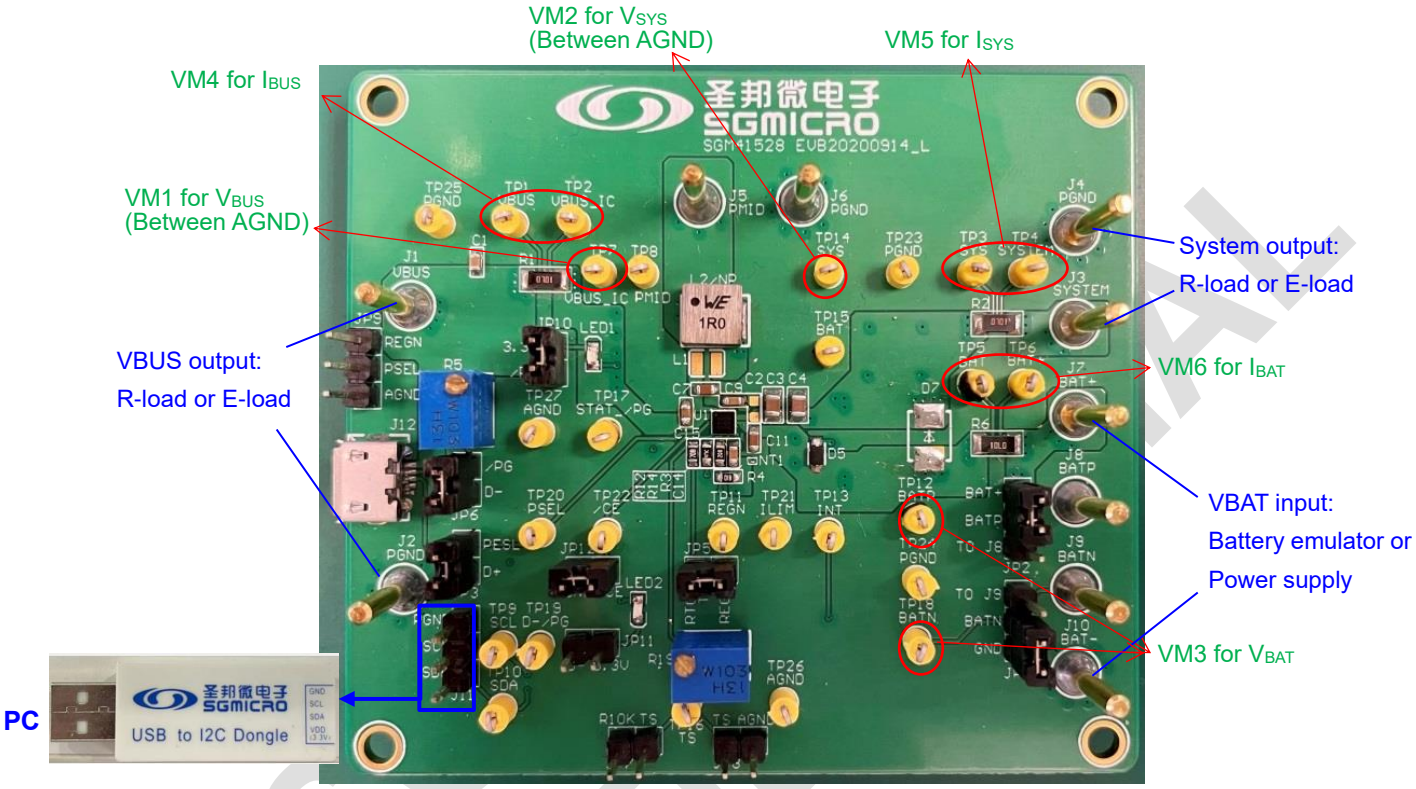

Fig-8: SGM41528 Demo Board Test Measurement in OTG Mode

1. When the SGM41528 enters OTG mode, the V_{BUS}, V_{SYS}, V_{BAT}, I_{BUS}, I_{SYS}, I_{BAT} can all be measured.

2. The current sense resistor R1, R2, R6 are all 10mΩ, and the VM4, VM5 and VM6 measure the sense resistor voltage to give the I_{BUS}, I_{SYS} and I_{BAT}, respectively.

3. Optional, in this setup, change the OTG output load or I^2C register setting can observe the SGM41528 other features as following. During the test, the corresponding STAT and FLAG registers are helpful to judge the IC operation status.

   a. Change VBUS output load can observe OTG mode load regulation and OTG output current limit.
   b. Change battery emulator voltage can observe the OTG mode line regulation.
   c. Other functions and protections.

2. Test Item

Note for test conditions: disable watchdog timer, disable ILIM pin, other registers are in default setting, unless otherwise noted.

2.1 Trickle Charge Current

Test conditions: V_{BUS}=5V, enable charge, measure the trickle charge current at different battery voltage.

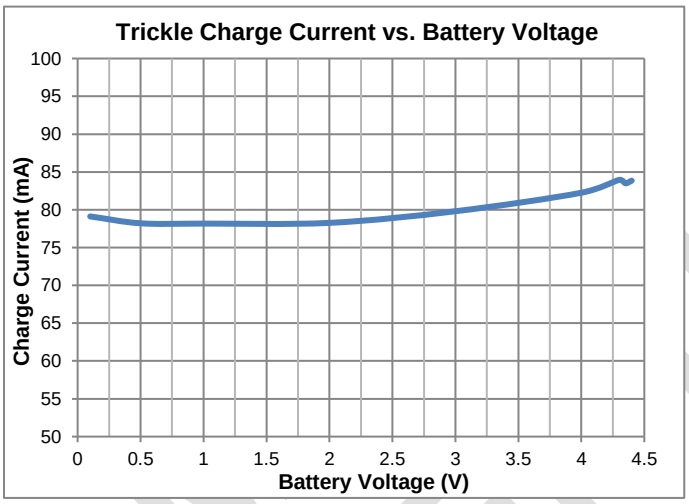

Fig-9: Trickle Charge Current vs. Battery Voltage

2.2 Pre-Charge Current

Test conditions: V_{BUS}=5V, enable charge, set different pre-charge current, measure the pre-charge current at different battery voltage.

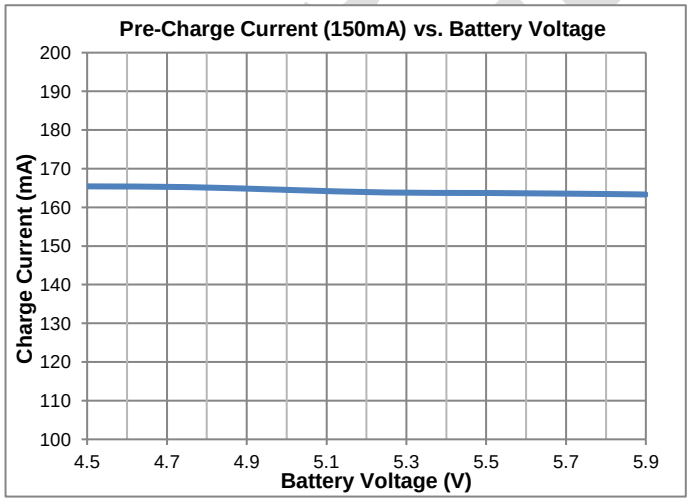

Fig-10: Pre-Charge Current vs. Battery Voltage
I_{PRECHG}=150mA

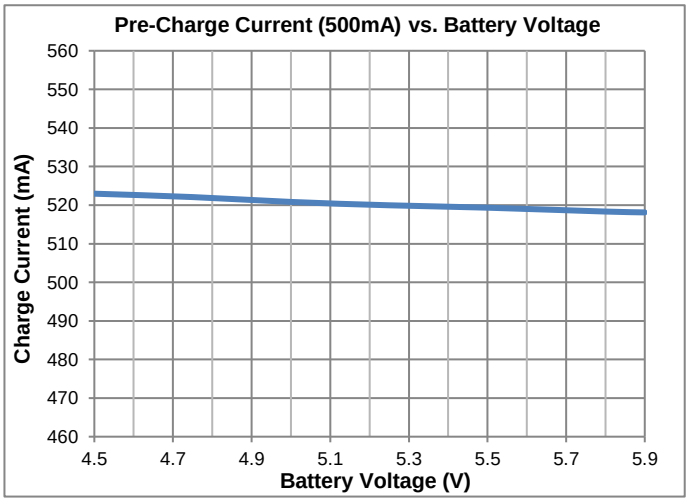

Fig-11: Pre-Charge Current vs. Battery Voltage
I_{PRECHG}=500mA

2.3 Fast Charge Current

Test conditions: V_{BUS}=5V, V_{REG}=9.2V, V_{SYSMIN}=7V, enable charge, set different fast charge current and measure the charge current at different battery voltage.

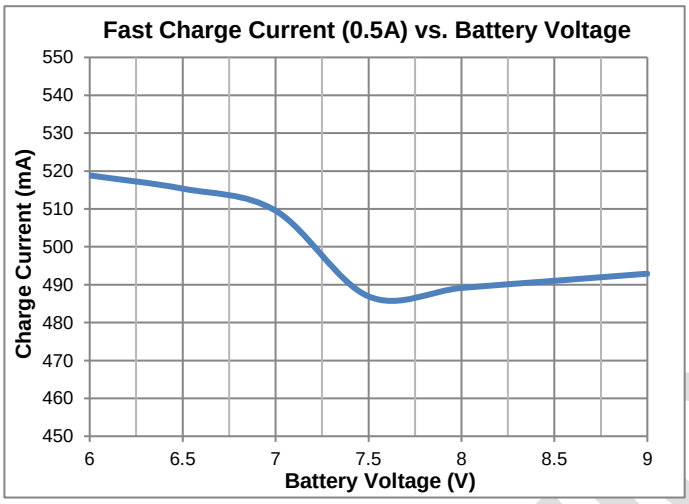

Fig-12: Fast Charge Current vs. Battery Voltage
I_{CHG}=0.5A

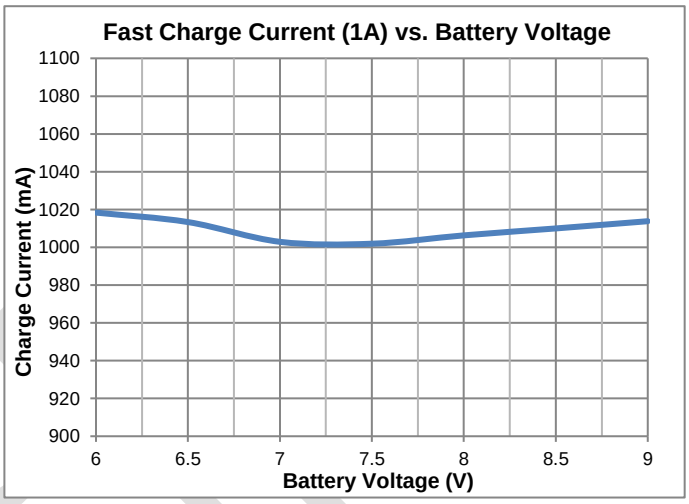

Fig-13: Fast Charge Current vs. Battery Voltage
I_{CHG}=1A

2.4 Charge Voltage Accuracy

Test conditions: V_{BUS}=5V, I_{CHG_SET}=1A, set V_{REG}=6.8V to 9.2V, increase V_{BAT} slowly close to V_{REG}, and measure the constant charge voltage accuracy.

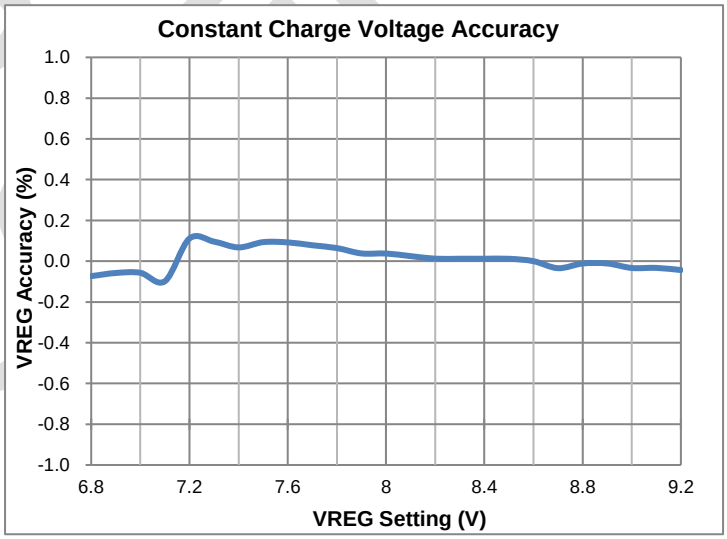

Fig-14: Constant Charge Voltage Accuracy

2.5 Termination Current

Test conditions: V_{BUS}=5V, V_{REG}=8.4V, set different termination current, increase V_{BAT} slowly to trigger charge termination and measure the termination current accuracy.

I_{TERM} Setting (mA)	50	150	300	800
I_{TERM} Test (mA)	48	137.5	275	775

2.6 Recharge Threshold

Test conditions: V_{BUS}=5V, V_{REG}=8.4V, set different recharge threshold, increase V_{BAT} to trigger termination, and then decrease V_{BAT} to trigger recharge, measure the recharge threshold accuracy.

Setting Recharge Threshold (mV)	100	200	300	400
Test V_{BAT} to Termination (V)	8.401	8.401	8.401	8.401
Test V_{BAT} to Recharge (V)	8.279	8.179	8.079	7.979
Test Recharge Threshold (mV)	122	222	322	422

2.7 VINDPM Accuracy

Test conditions: V_{BUS}=5.6V with 500mΩ resistor in series, V_{BAT}=7.6V, I_{INDPM}=3.3A, disable ILIM pin, set I_{CHG}=2.2A, enable charge, disable ICO, set different VINDPM register value and measure VINDPM accuracy.

VINDPM Setting (V)	4.2	4.4	4.7	5
The Limited V_{BUS} (V)	4.185	4.383	4.682	4.981
VINDPM Accuracy (%)	-0.36	-0.39	-0.38	-0.38

2.8 IINDPM & ILIM Setting Accuracy

2.8.1 IINDPM Register

Test conditions: V_{BUS}=5V, V_{BAT}=7.6V, disable ILIM pin, set I_{CHG}=2.2A, enable charge, disable ICO, set different IINDPM register value and measure IINDPM accuracy.

IINDPM Setting (mA)	500	1500	2000	3000
The Limited I_{BUS} (mA)	454.9	1398.2	1869.2	2830
IINDPM Accuracy (%)	-9.02	-6.79	-6.54	-5.67

2.8.2 ILIM Pin Setting

Test conditions: V_{BUS}=5V, no battery, disable charge, set I_{INDPM}=3.3A, measure the input current limit I_{INMAX} with different external resistor R_{ILIM} between ILIM pin and GND.

R_{ILIM} (Ω)	I_{INMAX_TEST} (A)	I_{INMAX_TYP} (A)	Error (mA)	Accuracy (%)
<300	Set by IINDPM register	-	-	-
360	2.932	3.000	-68	-2.27
498	2.112	2.169	-56.67	-2.61
592	1.769	1.824	-55.32	-3.03
720	1.438	1.500	-62	-4.13
800	1.285	1.350	-65	-4.81
1000	1.006	1.080	-74	-6.85
1493	0.703	0.723	-20.38	-2.82
2000	0.53	0.540	-10	-1.85
2490	0.42	0.434	-13.73	-3.17

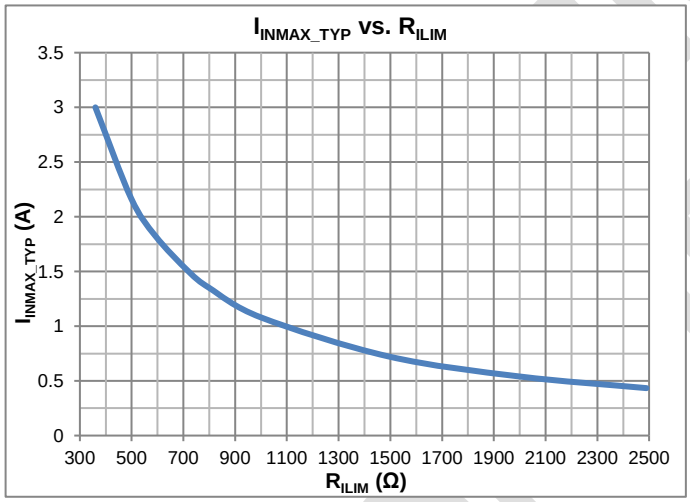

Fig-15: I_{INMAX_TYP} vs. R_{ILIM} setting

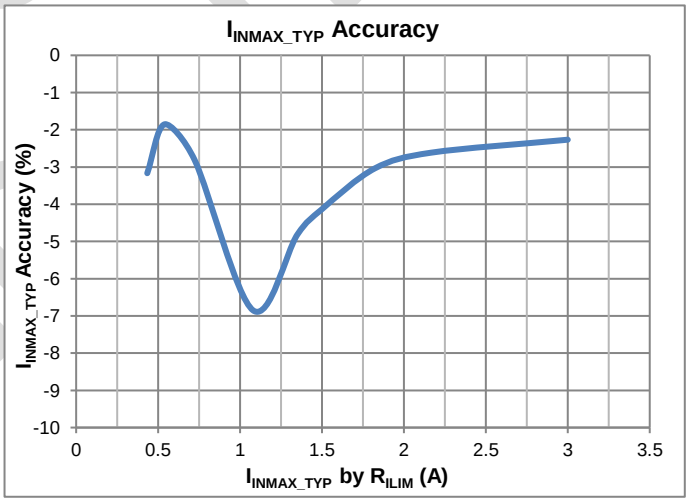

Fig-16: I_{INMAX_TYP} Accuracy

2.9 Charge Efficiency

Test conditions: V_{BUS}=5V, V_{BAT}=7.6V/8V, I_{INDPM}=3.3A, enable charge, I_{SYS}=0A, set different fast charge current and measure the charge efficiency.

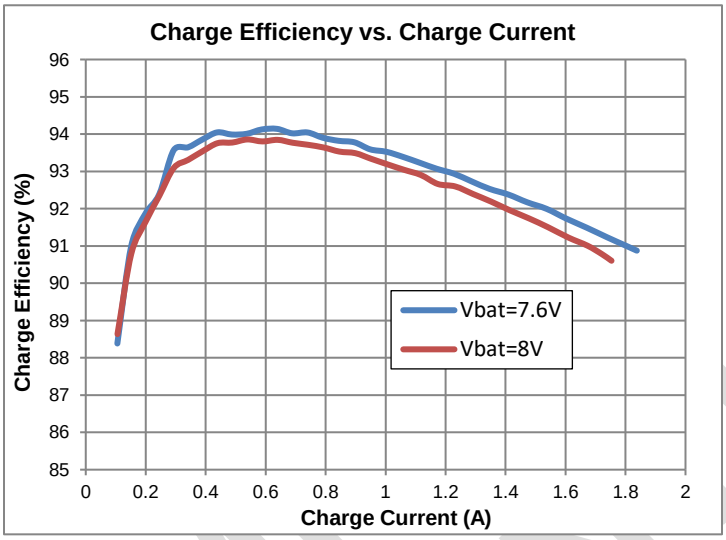

Fig-17: Charge Efficiency vs. Charge Current

2.10 Real Battery Charging Profile

Test conditions: V_{BUS}=5V, V_{REG}=8.4V, V_{SYSMIN}=7V, V_{BATLOW}=6V, I_{CHG}=1A, I_{PRECHG}=150mA, I_{TERM}=150mA, connect real 2-cell battery to the demo board and record the real battery charge profile.

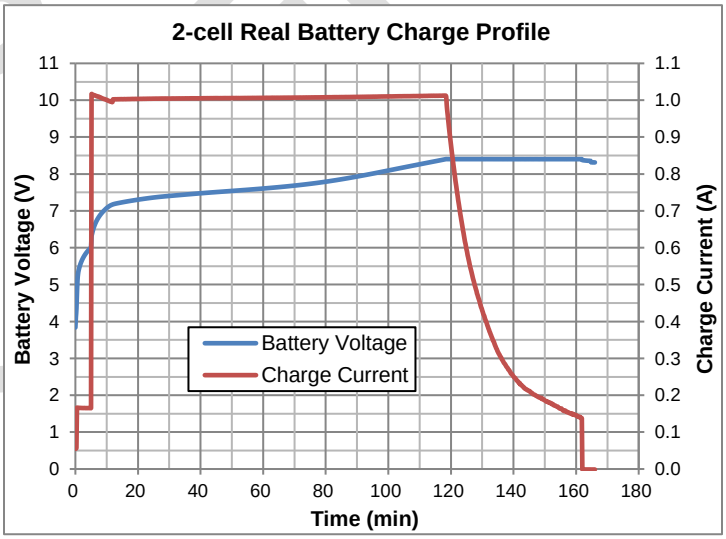

Fig-18: 2-cell real battery charge profile

2.11 Steady State Operation

2.11.1 Forward Boost Mode

Test conditions: V_{BUS}=5V, V_{BAT}=7.6V/5V, V_{SYSMIN}=7V, I_{INDPM}=3.3A, I_{CHG}=1A, enable charge, enable PFM OOA.

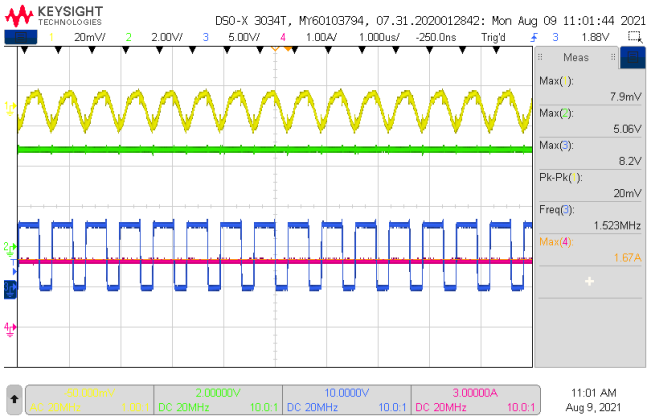

Fig-19: V_{BAT}=7.6V, I_{CHG}=1A, I_{SYS}=0A.
CH1-$V_{SYS/AC}$, CH2-V_{PMID}, CH3-V_{SW}, CH4-I_{BUS}

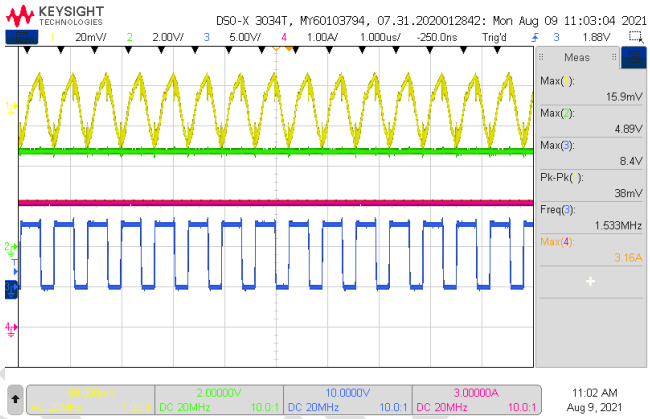

Fig-20: V_{BAT}=7.6V, I_{CHG}=1A, I_{SYS}=1A.
CH1-$V_{SYS/AC}$, CH2-V_{PMID}, CH3-V_{SW}, CH4-I_{BUS}

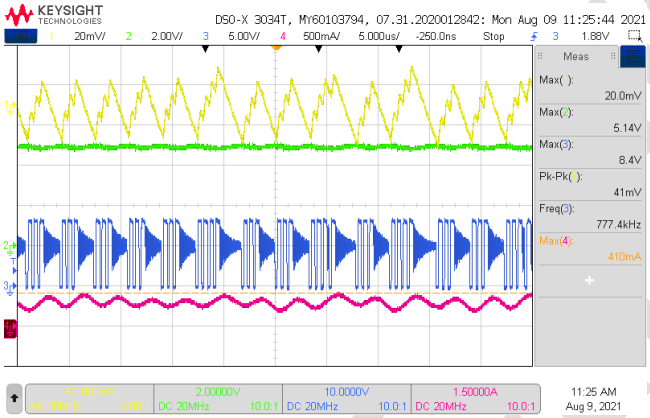

Fig-21: V_{BAT}=5V, I_{PRECHG}=150mA, I_{SYS}=0A, enable PFM OOA. CH1-$V_{SYS/AC}$, CH2-V_{PMID}, CH3-V_{SW}, CH4-I_{BUS}

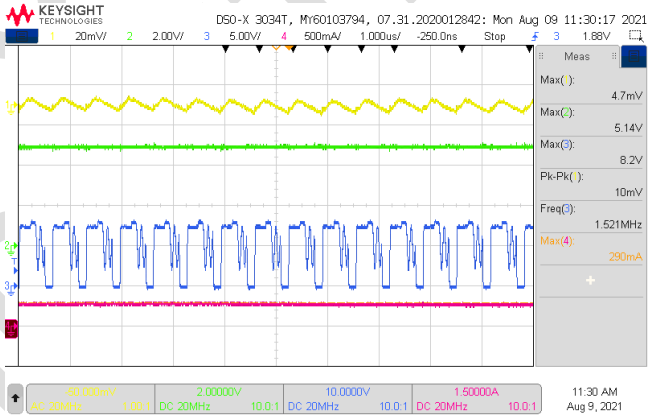

Fig-22: V_{BAT}=5V, I_{PRECHG}=150mA, I_{SYS}=0A, disable PFM. CH1-$V_{SYS/AC}$, CH2-V_{PMID}, CH3-V_{SW}, CH4-I_{BUS}

2.11.2 OTG Buck Mode

Test conditions: V_{BAT}=7.6V, V_{OTG}=5.1V, I_{OTG_LIM}=2A, enable OTG mode, enable PFM OOA.

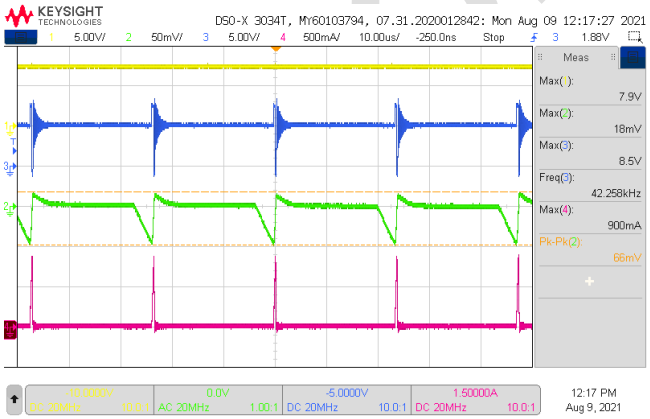

Fig-23: I_{BUS}=0A.
CH1-V_{BAT}, CH2-$V_{BUS/AC}$, CH3-V_{SW}, CH4-I_L

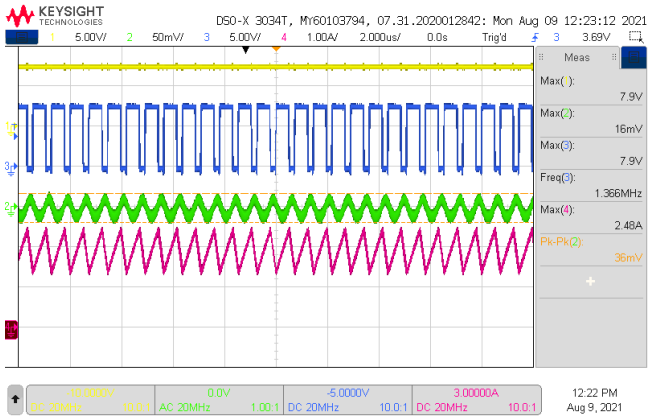

Fig-24: I_{BUS}=1.9A.
CH1-V_{BAT}, CH2-$V_{BUS/AC}$, CH3-V_{SW}, CH4-I_L

2.12 Adapter Type Detection

Test conditions: V_{BAT}=7.6V, V_{SYSMIN}=7V, I_{CHG}=1A, enable charge, I_{SYS}=0A. Plug in different type adapter to check the adapter recognition function.

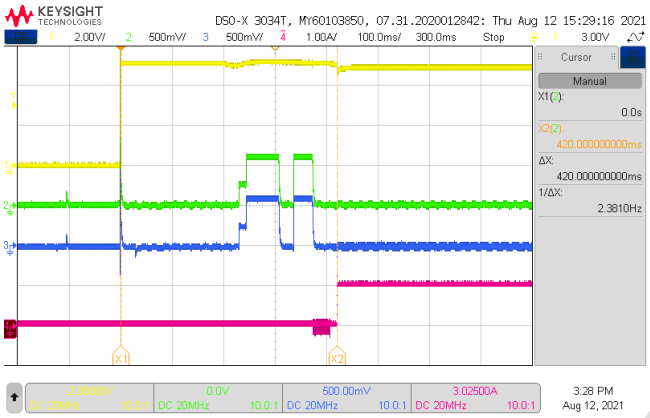

Fig-25: DCP adapter plug in.
CH1-V_{BUS}, CH2-V_{DP}, CH3-V_{DM}, CH4-I_{CHG}

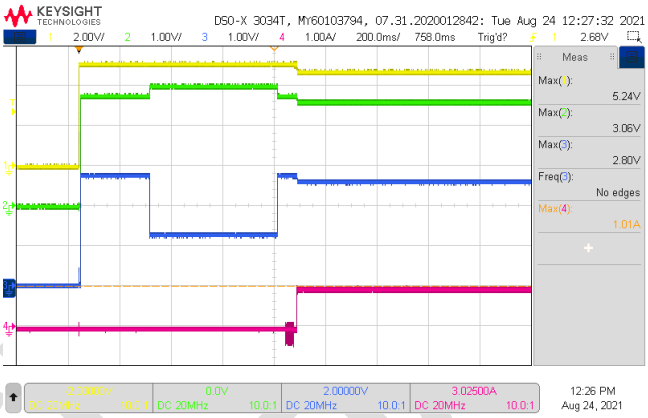

Fig-26: Non-standard adapter plug in.
CH1-V_{BUS}, CH2-V_{DP}, CH3-V_{DM}, CH4-I_{CHG}

2.13 Adapter Plug in/out without Battery

Test conditions: No battery, enable charge (nCE=low), plug in/out 5V DCP adapter.

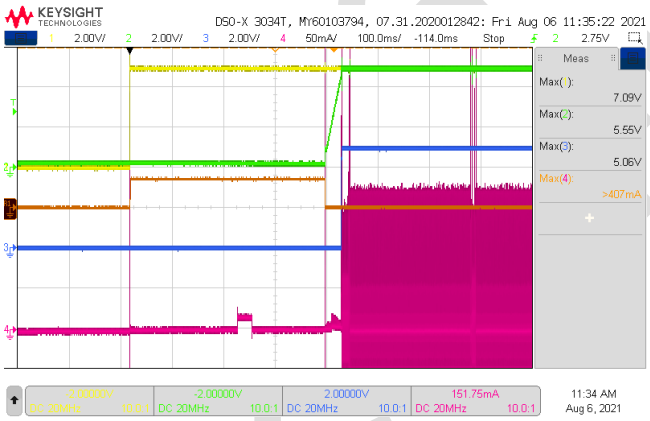

Fig-27: I_{SYS}=0A, 5V DCP adapter plug in.
CH1-V_{BUS}, CH2-V_{PMID}, CH3-V_{REGN}, CH4-I_{BUS}

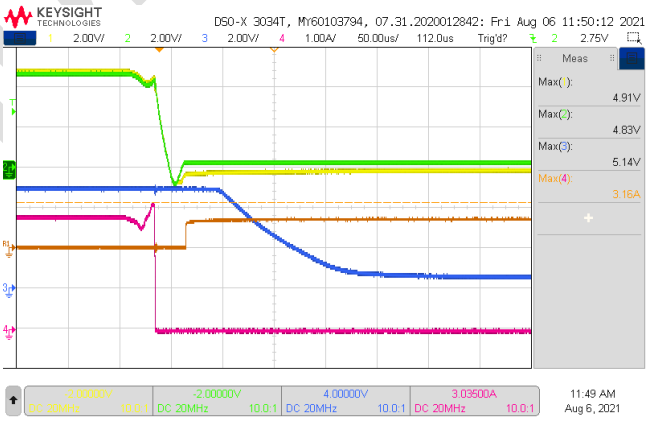

Fig-28: I_{SYS}=1.5A, 5V DCP adapter plug out.
CH1-V_{BUS}, CH2-V_{PMID}, CH3-V_{REGN}, CH4-I_{BUS}

2.14 Adapter Plug in/out with Battery

Test conditions: V_{BAT}=7.6V/5V, V_{SYSMIN}=7V, enable charge, I_{CHG}=1A, I_{SYS}=0A, plug in/out 5V DCP adapter.

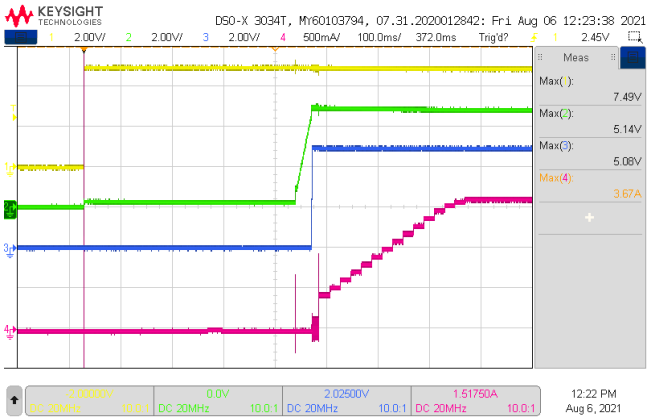

Fig-29: V_{BAT}=7.6V, I_{SYS}=0A, 5V DCP adapter plug in

CH1-V_{BUS}, CH2-V_{PMID}, CH3-V_{REGN}, CH4-I_{BUS}

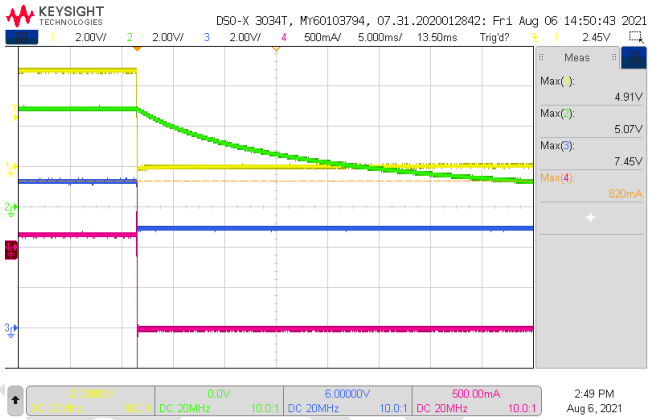

Fig-30: V_{BAT}=5V, I_{SYS}=1A, 5V DCP adapter plug out

CH1-V_{PMID}, CH2-V_{REGN}, CH3-V_{SYS}, CH4-I_{CHG}

2.15 Enter/Exit OTG Mode

Test conditions: V_{BAT}=7.6V, V_{OTG}=5.1V, enable/disable the OTG Buck mode.

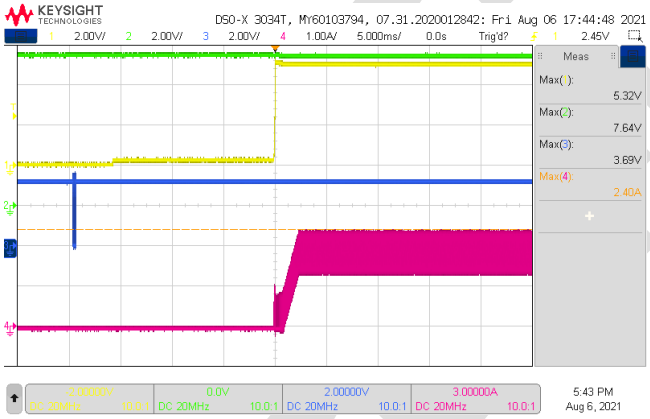

Fig-31: I_{BUS}=1.9A, enable OTG mode.

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

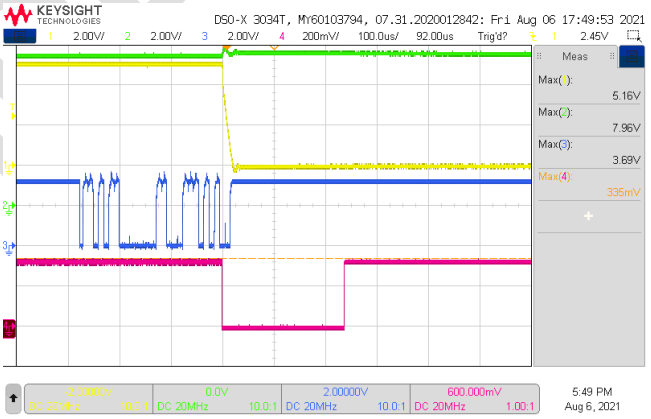

Fig-32: I_{BUS}=1A, disable OTG mode.

CH1-V_{BUS}, CH2-V_{BAT}, CH3-V_{SDA}, CH4-V_{INT}

2.16 System Load Transient

Test conditions: V_{BUS}=5V, V_{BAT}=7.6V, V_{SYSMIN}=7V, I_{INDPM}=3A, I_{CHG}=1A, enable charge. During normal operation, change I_{SYS} quickly to check the load transient behaviors.

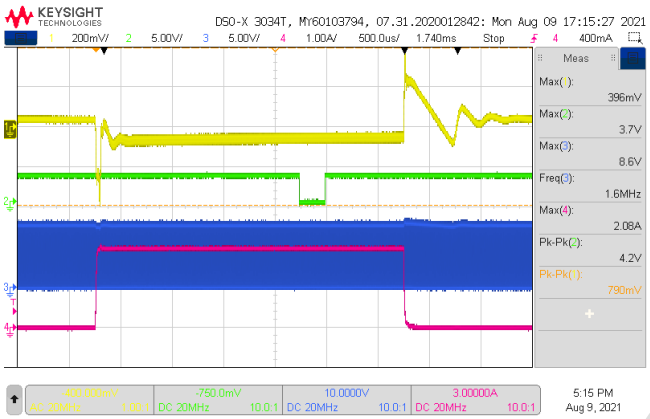

Fig-33: I_{SYS}=0A to 2A to 0A.
CH1-$V_{SYS/AC}$, CH2-V_{INT}, CH3-V_{SW}, CH4-I_{SYS}

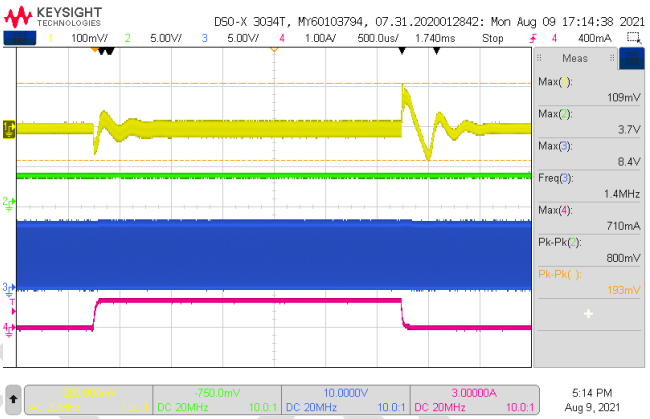

Fig-34: I_{SYS}=0A to 0.7A to 0A.
CH1-$V_{SYS/AC}$, CH2-V_{INT}, CH3-V_{SW}, CH4-I_{SYS}

2.17 OTG Load Transient

Test conditions: V_{BAT}=7.6V, V_{OTG}=5.1V, I_{OTG_LIM}=2A, enable OTG mode, I_{SYS}=0A. During normal operation, change I_{BUS} quickly to check the load transient behaviors.

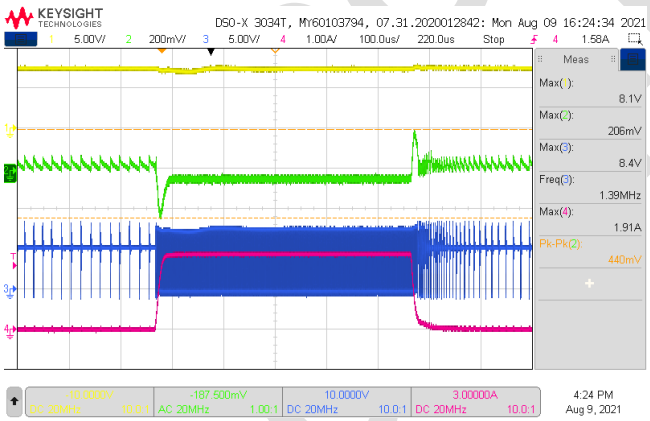

Fig-35: I_{BUS}=0A to 1.9A to 0A, enable PFM.
CH1-V_{SYS}, CH2-$V_{BUS/AC}$, CH3-V_{SW}, CH4-I_{BUS}

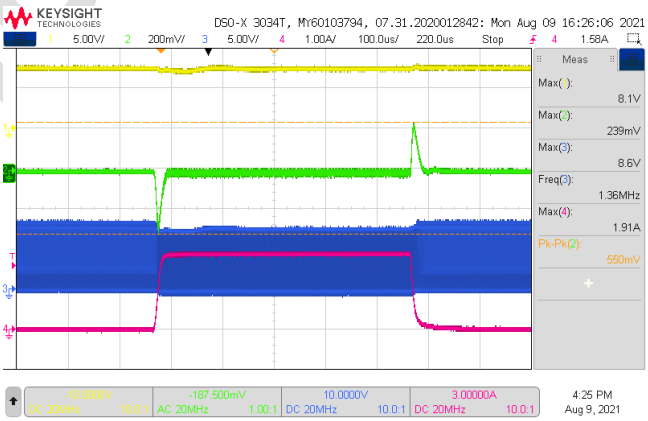

Fig-36: I_{BUS}=0A to 1.9A to 0A, disable PFM.
CH1-V_{SYS}, CH2-$V_{BUS/AC}$, CH3-V_{SW}, CH4-I_{BUS}

2.18 Input Current Optimizer (ICO)

Test conditions: V_{BUS}=5V (DCP type), V_{BAT}=7.6V, V_{SYSMIN}=7V, I_{CHG}=1A, enable charge, disable ILIM pin.

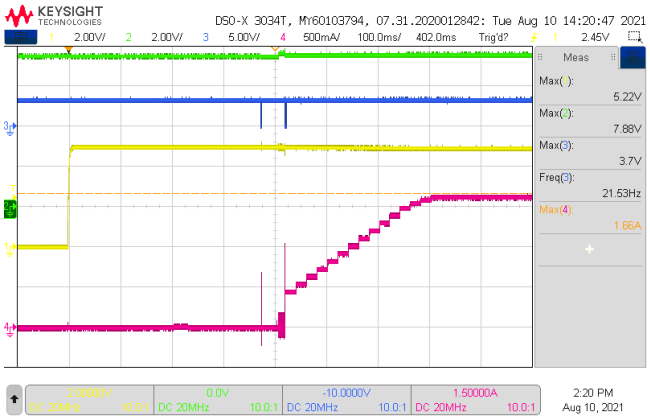

Fig-37: I_{CHG}=1A, I_{SYS}=0A, V_{BUS}=5V (DCP) plug in.
CH1-V_{BUS}, CH2-V_{SYS}, CH3-V_{INT}, CH4-I_{BUS}

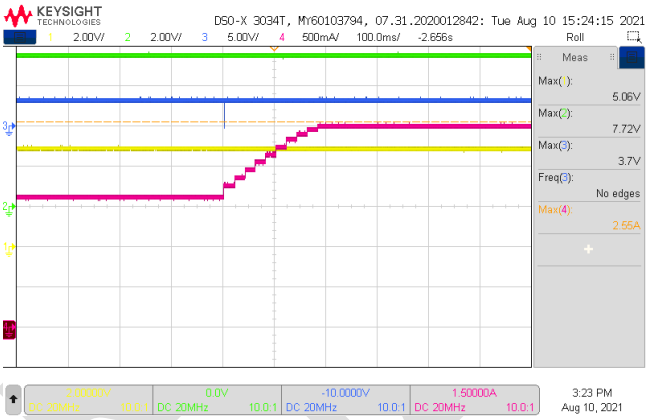

Fig-38: After V_{BUS} plug in, change I_{SYS} from 0A to 0.5A.
CH1-V_{BUS}, CH2-V_{SYS}, CH3-V_{INT}, CH4-I_{BUS}

2.19 VBUS_OVP in Forward Mode

Test conditions: V_{BAT}=7.6V, V_{SYSMIN}=7V, I_{SYS}=0A, disable charge, increase V_{BUS} to trigger VBUS_OVP and then decrease V_{BUS} to recovery.

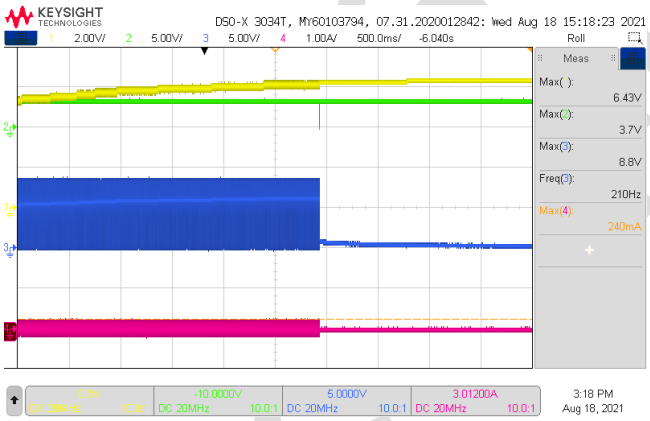

Fig-39: Increase V_{BUS} slowly to trigger VBUS_OVP.
CH1-V_{BUS}, CH2-V_{INT}, CH3-V_{SW}, CH4-I_{BUS}

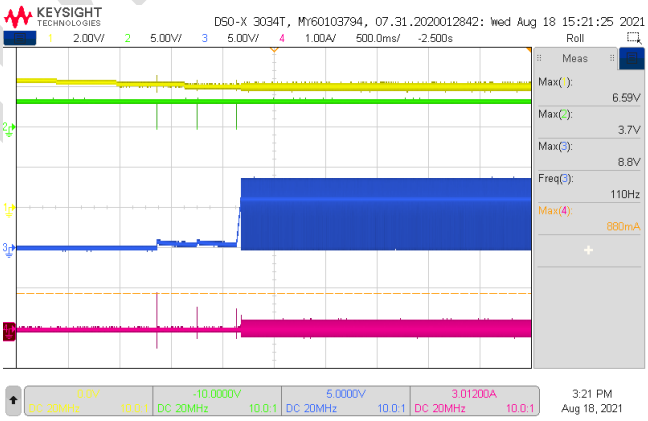

Fig-40: Decrease V_{BUS} slowly to recovery.
CH1-V_{BUS}, CH2-V_{INT}, CH3-V_{SW}, CH4-I_{BUS}

2.20 VBUS_UVP in Forward Mode

Test conditions: V_{BAT}=7.6V, ramp down V_{BUS} to trigger VBUS_UVP.

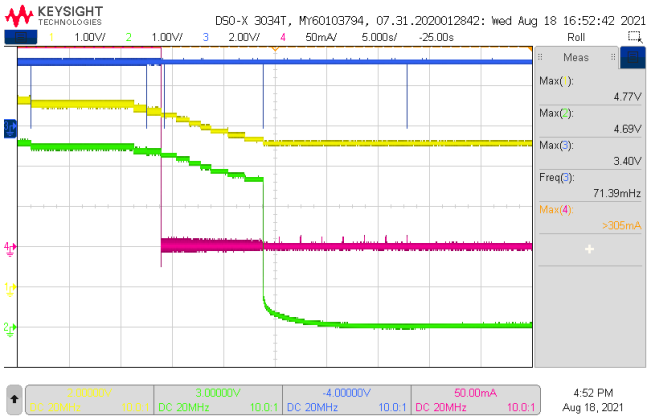

Fig-41: Ramp down V_{BUS} to trigger VBUS_UVP.
CH1-V_{BUS}, CH2-V_{PMID}, CH3-V_{INT}, CH4-I_{BUS}

2.21 SYS_OVP in Forward Mode

Test conditions: V_{BUS}=5V, V_{BAT}=6.5V/7.6V, V_{SYSMIN}=7V, I_{SYS}=0A, disable charge, force an external power supply on system to trigger SYS_OVP.

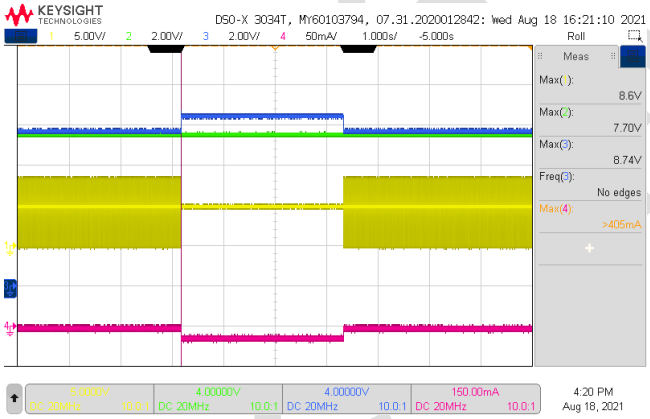

Fig-42: V_{BAT}=7.6V, disable charge, disable OOA, force and remove V_{SYS_EXT}=8.5V
CH1-V_{SW}, CH2-V_{BAT}, CH3-V_{SYS}, CH4-I_{SYS}

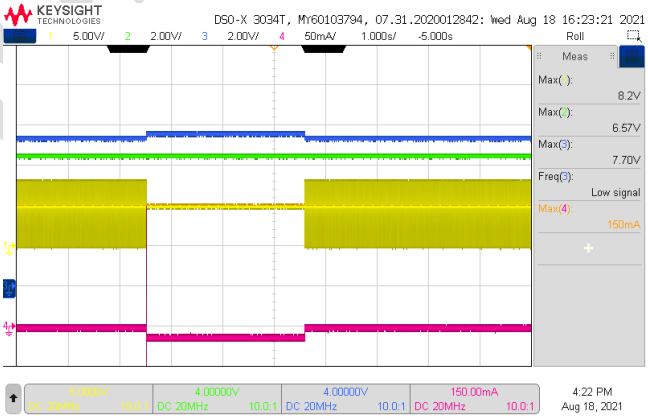

Fig-43: V_{BAT}=6.5V, disable charge, disable OOA, force and remove V_{SYS_EXT}=7.6V
CH1-V_{SW}, CH2-V_{BAT}, CH3-V_{SYS}, CH4-I_{SYS}

2.22 BAT_OVP in Forward Mode

Test conditions: V_{BUS}=5V, increase V_{BAT} to trigger BAT_OVP and then recovery.

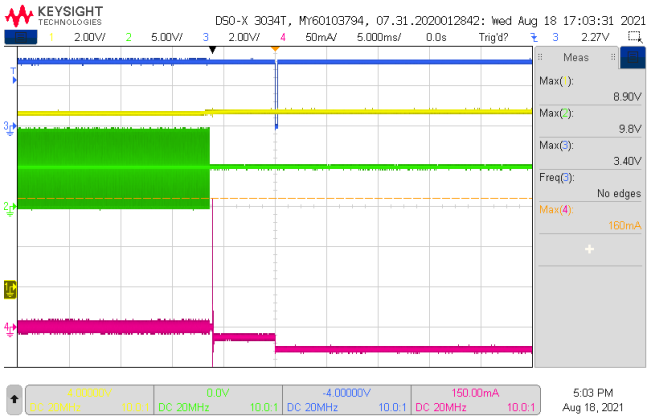

Fig-44: Increase V_{BAT} to trigger BAT_OVP.
CH1-V_{BAT}, CH2-V_{SW}, CH3-V_{INT}, CH4-I_{BAT}

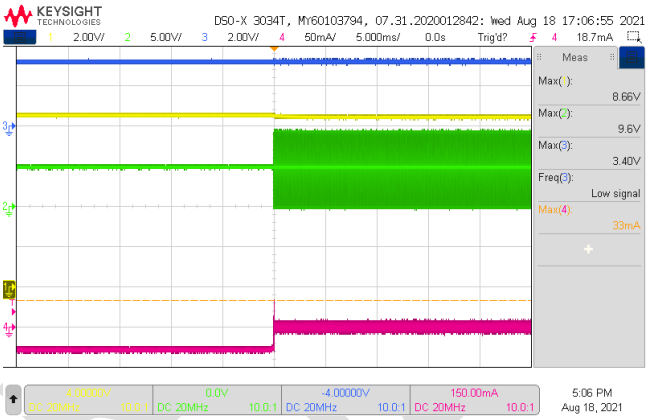

Fig-45: Decrease V_{BAT} to recovery.
CH1-V_{BAT}, CH2-V_{SW}, CH3-V_{INT}, CH4-I_{BAT}

2.23 SYS_OCP in Forward Mode

Test conditions: V_{BUS}=5V, no battery, disable charge, V_{SYSMIN}=7V, increase system load slowly.

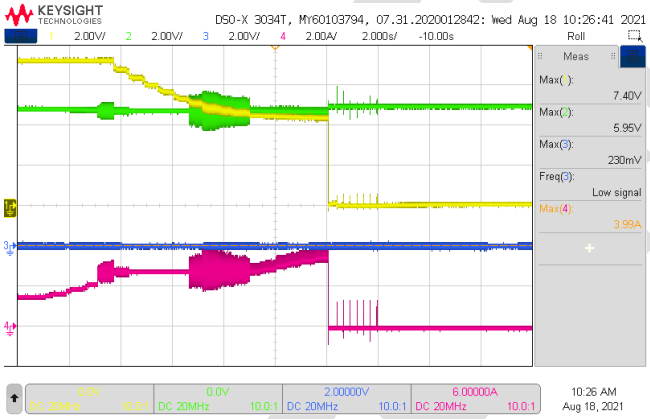

Fig-46: Increase system load I_{SYS} to trigger SYS_OCP.
CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{INT}, CH4-I_{BUS}

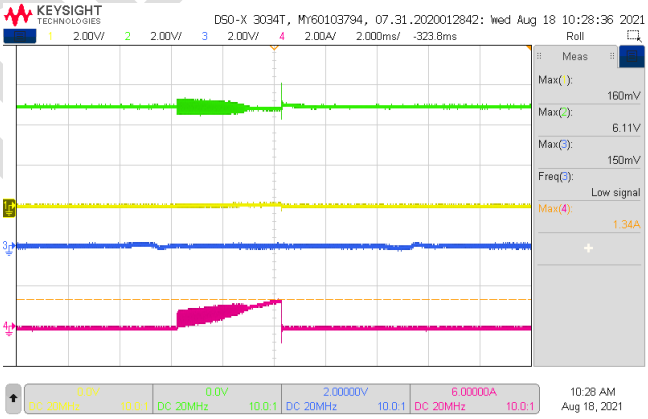

Fig-47: Zoom in the retry.
CH1-V_{SYS}, CH2-V_{BUS}, CH3-V_{INT}, CH4-I_{BUS}

2.24 VBUS_OCP in OTG Mode

Test conditions: V_{BAT}=7.6V, V_{OTG}=5.1V, I_{OTG_LIM}=2A, I_{SYS}=0A, increase I_{BUS} to trigger OTG_OCP.

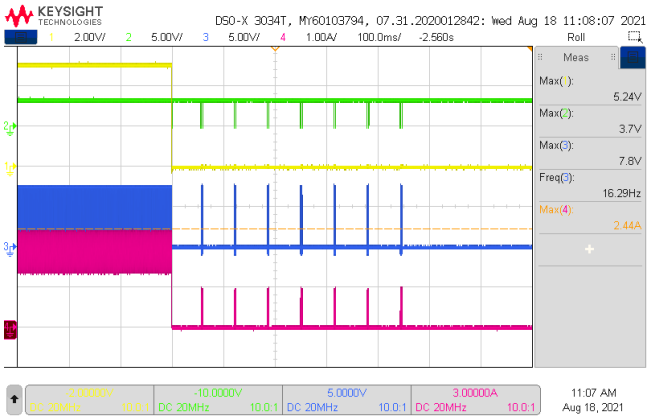

Fig-48: Increase I_{BUS} slowly to trigger OTG_OCP.
CH1-V_{BUS}, CH2-V_{INT}, CH3-V_{SW}, CH4-I_L

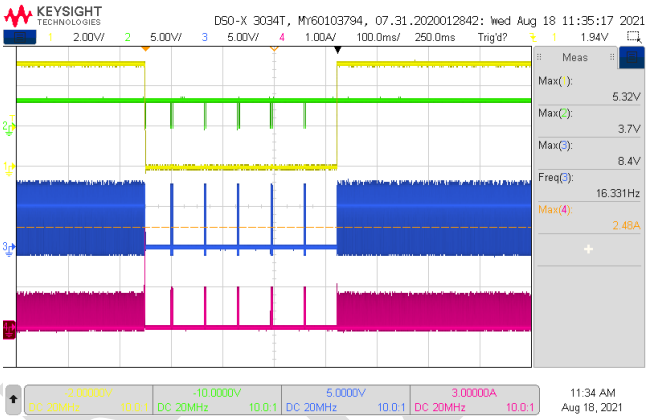

Fig-49: Short V_{BUS} to GND in OTG mode and then release short before 7 failures.
CH1-V_{BUS}, CH2-V_{INT}, CH3-V_{SW}, CH4-I_L

2.25 Thermal Shutdown

Test conditions: V_{BUS}=5V, V_{BAT}=7.6V, V_{SYSMIN}=7V, disable charge, I_{SYS}=1.5A, heat IC with the hot gun to trigger thermal shutdown.

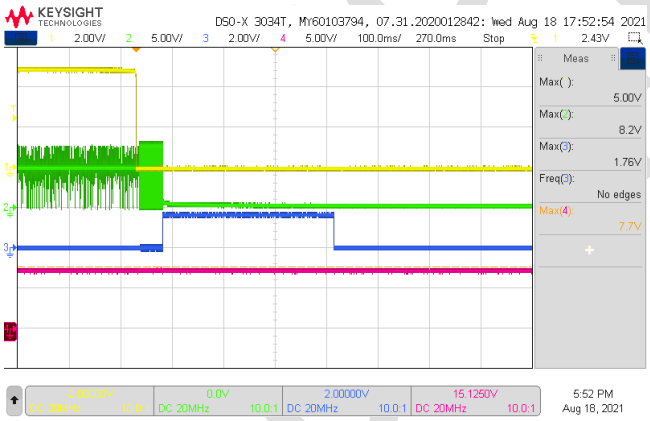

Fig-50: Thermal shutdown entry.
CH1-$V_{REGN.}$, CH2-V_{SW}, CH3-V_{PG}, CH4-V_{SYS}.

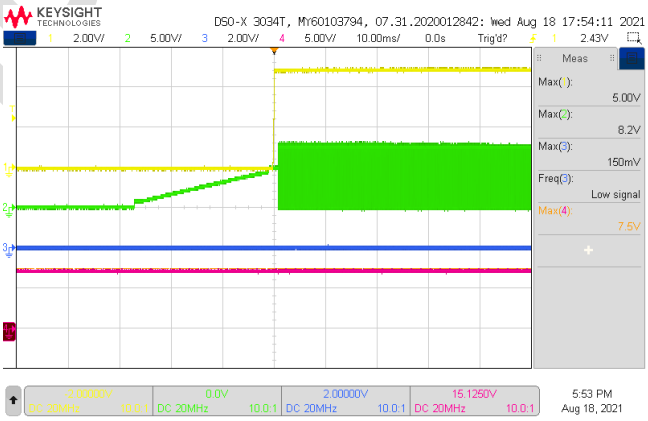

Fig-51: Thermal shutdown recovery.
CH1-$V_{REGN.}$, CH2-V_{SW}, CH3-V_{PG}, CH4-V_{SYS}.