

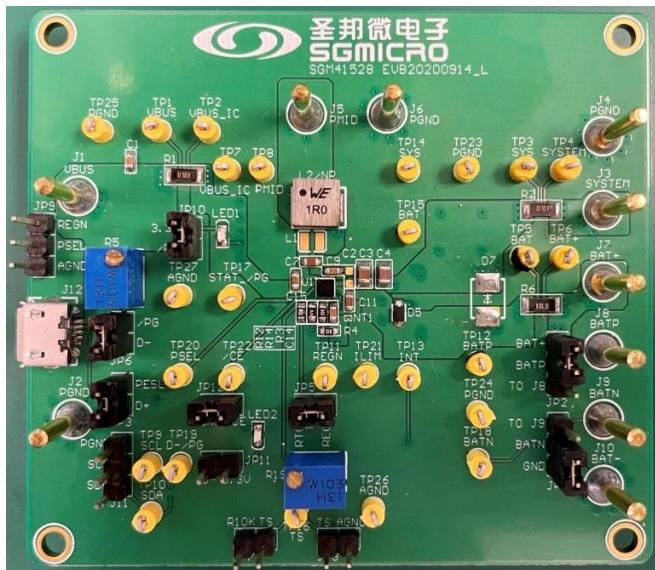
## **SGM41528 Demo Board Test Report**

**I<sup>2</sup>C Controlled, 2-Cell Battery Charger with Boost Mode for USB Input**

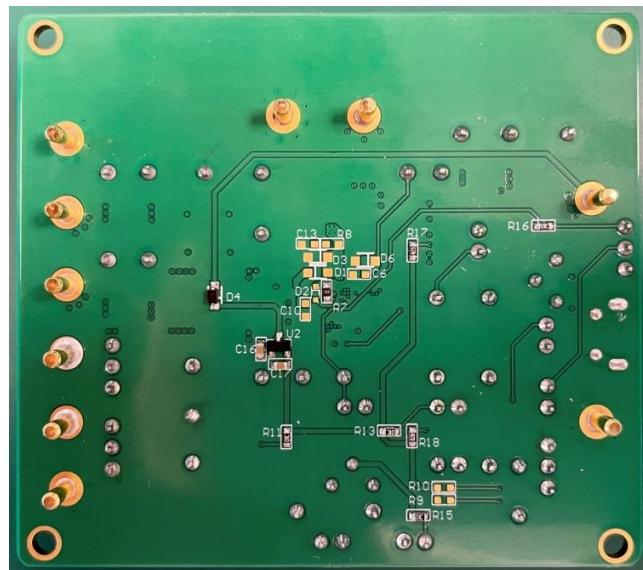
**Input Voltage Range: 3.9V to 6.2V**

**Fast Charge Current Range: 0.1A to 2.2A**

### **Demo Board Picture:**



**Top Layer**



**Bottom Layer**

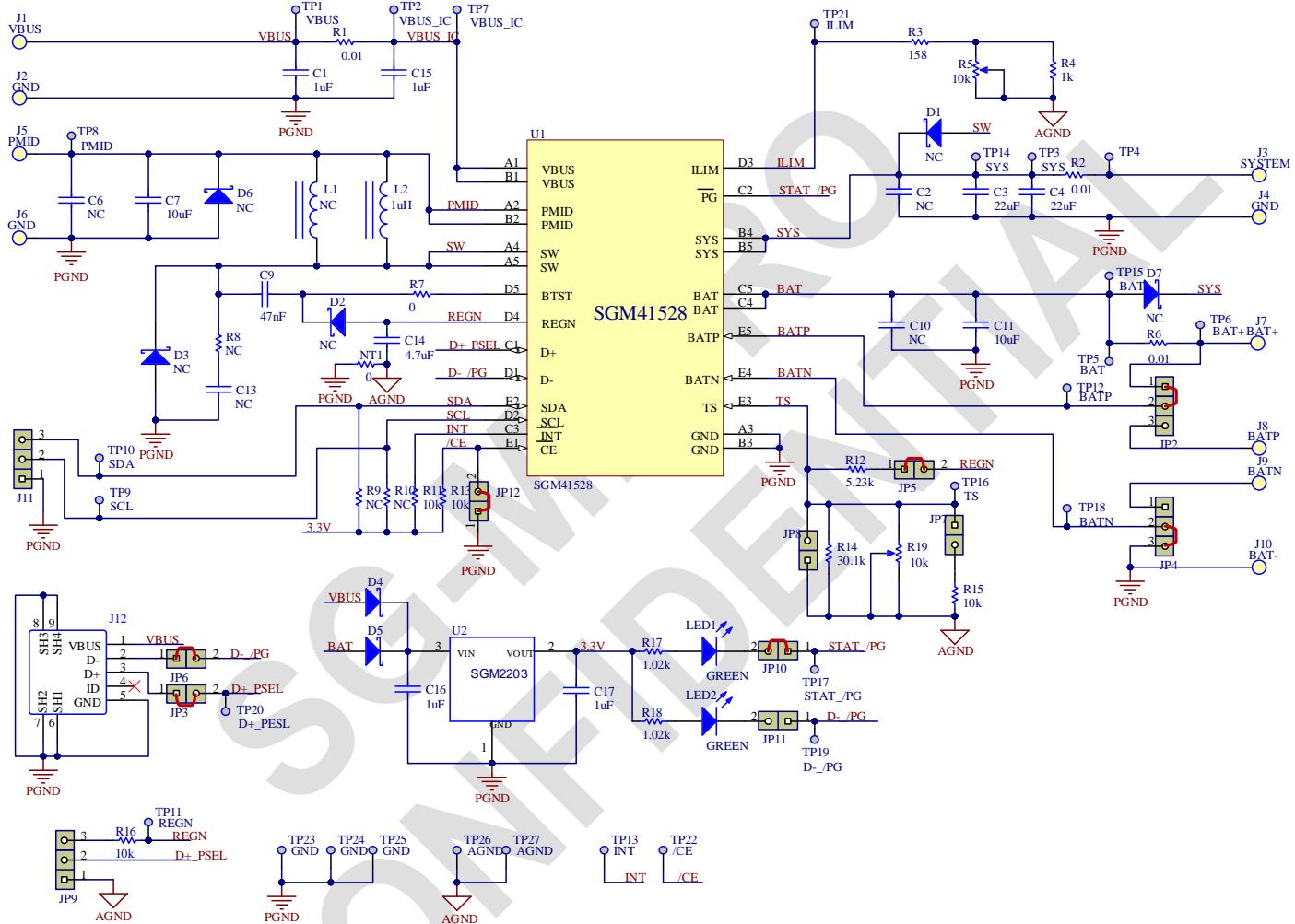
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## 1. Demo Board User's Guide

### 1.1 Demo Board Information

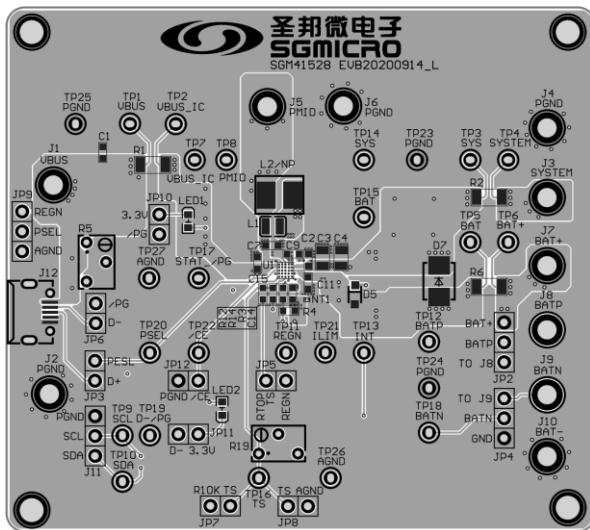
#### 1.1.1 Schematic



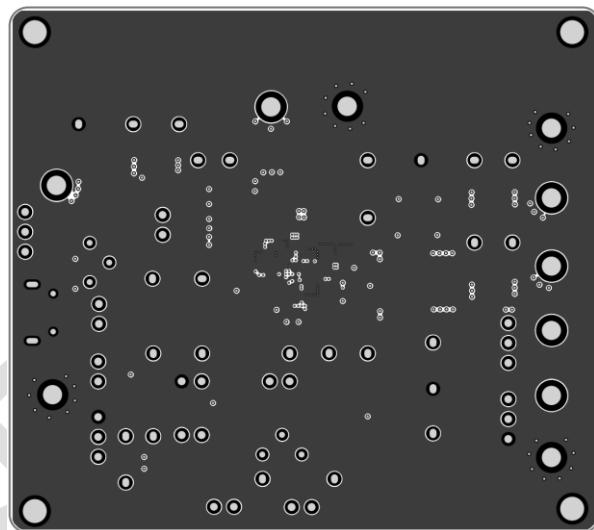
**SGM41528**

# Demo Board Test Report

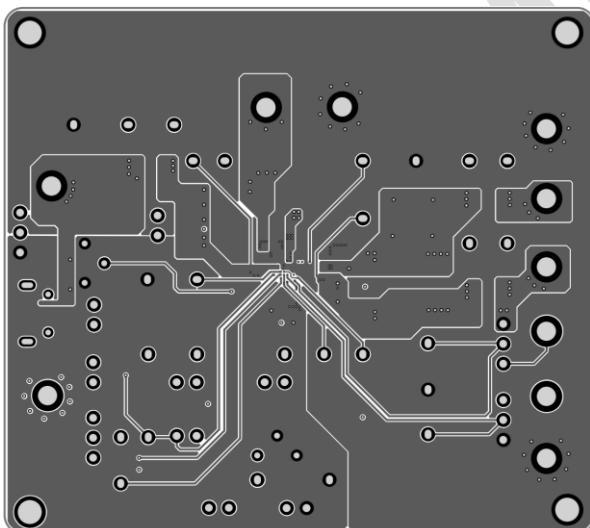
## 1.1.2 PCB Layout



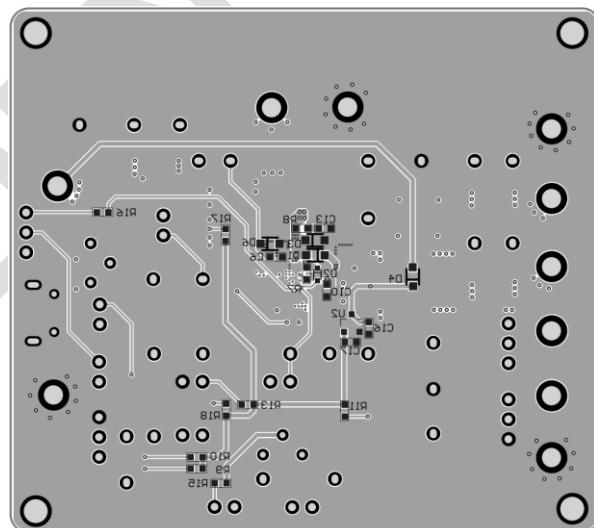
## Top Layer



Inner Layer1



Inner Layer2



## Bottom Layer

## 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 <sup>2</sup> C 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 I<sup>2</sup>C-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-I<sup>2</sup>C 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-I<sup>2</sup>C 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°C to +85°C

## 1.3 Test Setup

### 1.3.1 Forward Mode

#### 1.3.1.1 Demo Board Setup

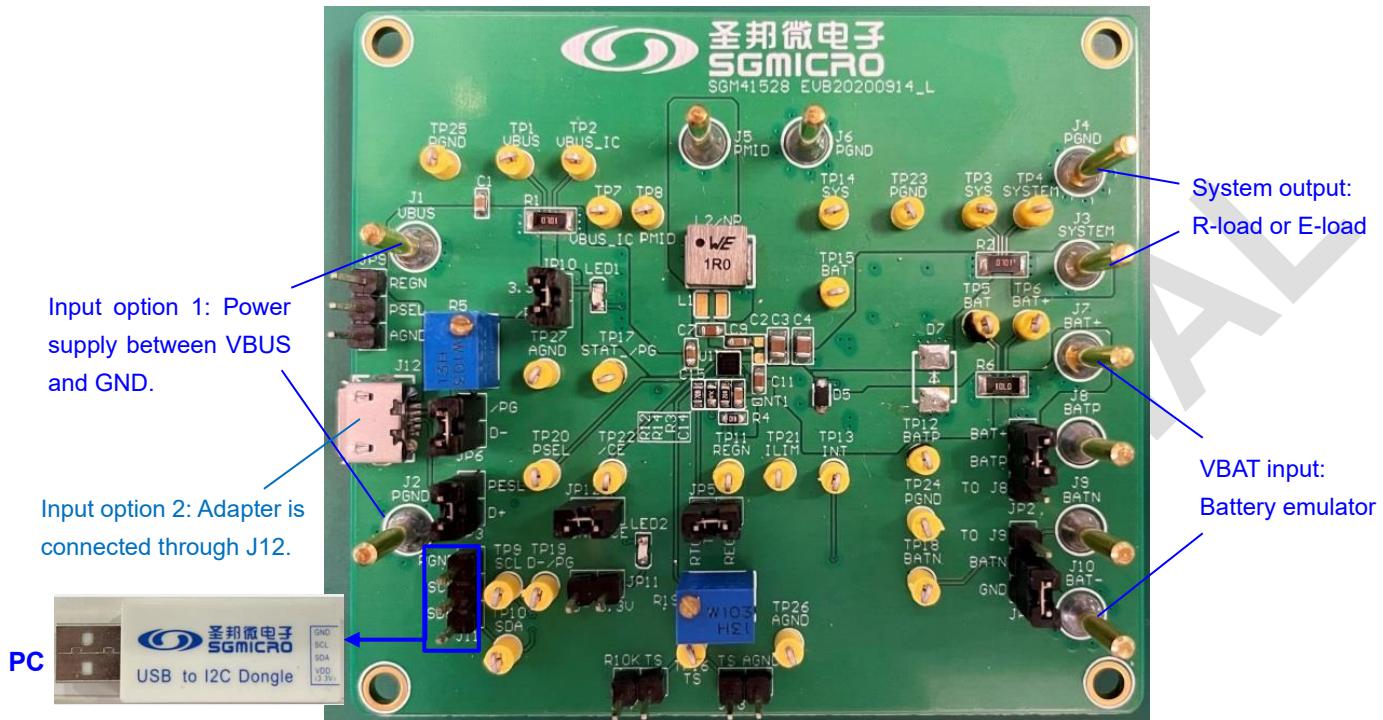


Fig-1: SGM41528 Demo Board Setup in Forward Mode

1. The equipment required in this test include:

- A battery emulator set to 7.6V/2.5A (larger than the fast charge current).
- An input power supply set to 5V with larger than 3.5A current limit (larger than the IINDPM limit).
- The E-load for the system load.

Note: The battery emulator also can be replaced by one of following equipment:

- A power supply with larger than 2.5A sink current capacity (larger than the fast charge current);
- A power supply (without sink current capacity) with a parallel E-load 2.5A (larger than the fast charge current);
- A real battery.

- Turn off and connect the battery emulator to the demo board according Fig-1 setup.
- 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.
- Connect the E-load to system output on the demo board according Fig-1 setup.
- Connect the SGM USB-to-I<sup>2</sup>C dongle to the demo board according Fig-1 setup, and connect the dongle to PC.
- Turn on the battery emulator, input power supply, system E-load. And then follow [1.3.1.2](#) to set the I<sup>2</sup>C registers by GUI.

### 1.3.1.2 I<sup>2</sup>C Register Setting

1. After hardware setup done as shown in [1.3.1.1](#), and connect the USB-to-I<sup>2</sup>C 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 I<sup>2</sup>C communication is normal.

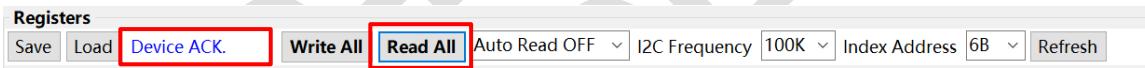


Fig-3: SGM41528 GUI Interface

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:

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

Below GUI interface screenshot is for reference.

**SGM41528**

**Registers**

Save | Load | Device ACK | **Write All** | **Read All** | Auto Read OFF | I2C Frequency | 100K | Index Address | 6B | Refresh

**Multi-bit I2C Pulldown Menu**

Charge Voltage Limit	8.40 V
Fast Charge Current Limit	1000 mA
Input Voltage Limit	4.4 V
Input Current Limit	3300 mA
PreCharge Current Limit	150 mA
Termination Current Limit	150 mA
WDT Setting	Disable
Fast Charge Timer	16.5 hrs
Die Temp Threshold	120 °C
Min BAT Voltage	6.0 V

**Single-bit I2C Selection**

<input type="checkbox"/> Enable HIZ Mode
<input type="checkbox"/> Enable IILM Pin
<input checked="" type="checkbox"/> Enable VINDPM Reset
<input type="checkbox"/> Enable BAT Discharge
<input type="checkbox"/> Disable PFM OOA Mode
<input type="checkbox"/> Force Start ICO
<input type="checkbox"/> Force D+/D- Detection
<input checked="" type="checkbox"/> Enable ICO
<input checked="" type="checkbox"/> Enable Charging Termination
<input checked="" type="checkbox"/> Enable Safety Timer
<input checked="" type="checkbox"/> Enable 2X Extended Safety Timer
<input type="checkbox"/> Enable OTG
<input checked="" type="checkbox"/> Enable Auto Input Source Detection
<input checked="" type="checkbox"/> Enable Charge
<input type="checkbox"/> Disable PFM Mode
<input type="checkbox"/> Reset WDT
<input type="checkbox"/> Mask ADC Done INT

**Fault, Flag and Status**

IICO Current Limit	3300 mA
IINDPM Status	Not Comp.
IIINDPM Status	Normal
VINDPM Status	Normal
TREG Status	Normal
WDT Status	Normal
Charge Status	Fast Charg
Input Power Status	Power Good
VBUS Status	USB DCP
ICO Status	Optimizat
VSYS Status	Not In SYS
TS Status	Normal
VBUS OVP Status	Normal
TSHUT Status	Normal
BATOVP Status	Normal
Charge Safety Timer Status	Normal
ADC Conversion Flag	Normal

**SYSMIN Regulation Flag**

VBUS OVP Flag	Normal
TSHUT Flag	Normal
BAT OVP Flag	Normal
Safety Timer Flag	Normal
System Short Flag	Normal
OTG Fault Flag	Normal

**ADC**

ADC Mode	Continuous
<input type="checkbox"/> Enable ADC	
<input type="checkbox"/> Disable IBUS ADC	
<input type="checkbox"/> Disable ICHG ADC	
<input type="checkbox"/> Disable VBUS ADC	
Polarity of ADC	Positive
IBUS ADC	0.000 A
VSYS ADC	0.000 V
ICHG ADC	0.000 A
VBUS ADC	0.000 V
ADC Sample Rate	12-bit
<input type="checkbox"/> Disable VBAT ADC	
<input type="checkbox"/> Disable VSYS ADC	
<input type="checkbox"/> Disable TS ADC	
<input type="checkbox"/> Disable TDIE ADC	
VBAT ADC	0.000 V
VSYS ADC	0.000 V
TS ADC	0.000%
TDIE ADC	0.0 °C

**Memory Map**

Add	Data	7	6	5	4	3	2	1	0		
0x00	A0	1	0	1	0	0	0	0	0	R	W
0x01	14	0	0	0	1	0	1	0	0	R	W
0x02	85	1	0	0	0	0	1	0	1	R	W
0x03	3C	0	0	1	1	1	1	0	0	R	W
0x04	22	0	0	1	0	0	0	1	0	R	W
0x05	8D	1	0	0	0	1	1	0	1	R	W
0x06	7D	0	1	1	1	1	1	0	1	R	W
0x07	0A	0	0	0	0	1	0	1	0	R	W
0x08	0D	0	0	0	0	1	1	0	1	R	W
0x09	F6	1	1	1	1	0	1	1	0	R	W
0x0A	1C	0	0	0	1	1	1	0	0	R	W
0x0B	03	0	0	0	0	0	0	1	1	R	W
0x0C	B2	1	0	1	1	0	0	1	0	R	W
0x0D	00	0	0	0	0	0	0	0	0	R	W
0x0E	00	0	0	0	0	0	0	0	0	R	W
0x0F	00	0	0	0	0	0	0	0	0	R	W
0x10	00	0	0	0	0	0	0	0	0	R	W
0x11	00	0	0	0	0	0	0	0	0	R	W
0x12	00	0	0	0	0	0	0	0	0	R	W
0x13	00	0	0	0	0	0	0	0	0	R	W
0x14	00	0	0	0	0	0	0	0	0	R	W
0x15	30	0	0	1	1	0	0	0	0	R	W
0x16	00	0	0	0	0	0	0	0	0	R	W
0x17	00	0	0	0	0	0	0	0	0	R	W
0x18	00	0	0	0	0	0	0	0	0	R	W
0x19	00	0	0	0	0	0	0	0	0	R	W
0x1A	00	0	0	0	0	0	0	0	0	R	W
0x1B	00	0	0	0	0	0	0	0	0	R	W
0x1C	00	0	0	0	0	0	0	0	0	R	W
0x1D	00	0	0	0	0	0	0	0	0	R	W
0x1E	00	0	0	0	0	0	0	0	0	R	W
0x1F	00	0	0	0	0	0	0	0	0	R	W
0x20	00	0	0	0	0	0	0	0	0	R	W
0x21	00	0	0	0	0	0	0	0	0	R	W
0x22	00	0	0	0	0	0	0	0	0	R	W
0x23	00	0	0	0	0	0	0	0	0	R	W
0x24	00	0	0	0	0	0	0	0	0	R	W

USB-to-I2C Dongle has been plugged in! | <http://www.sg-micro.com> | SGMICRO

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:

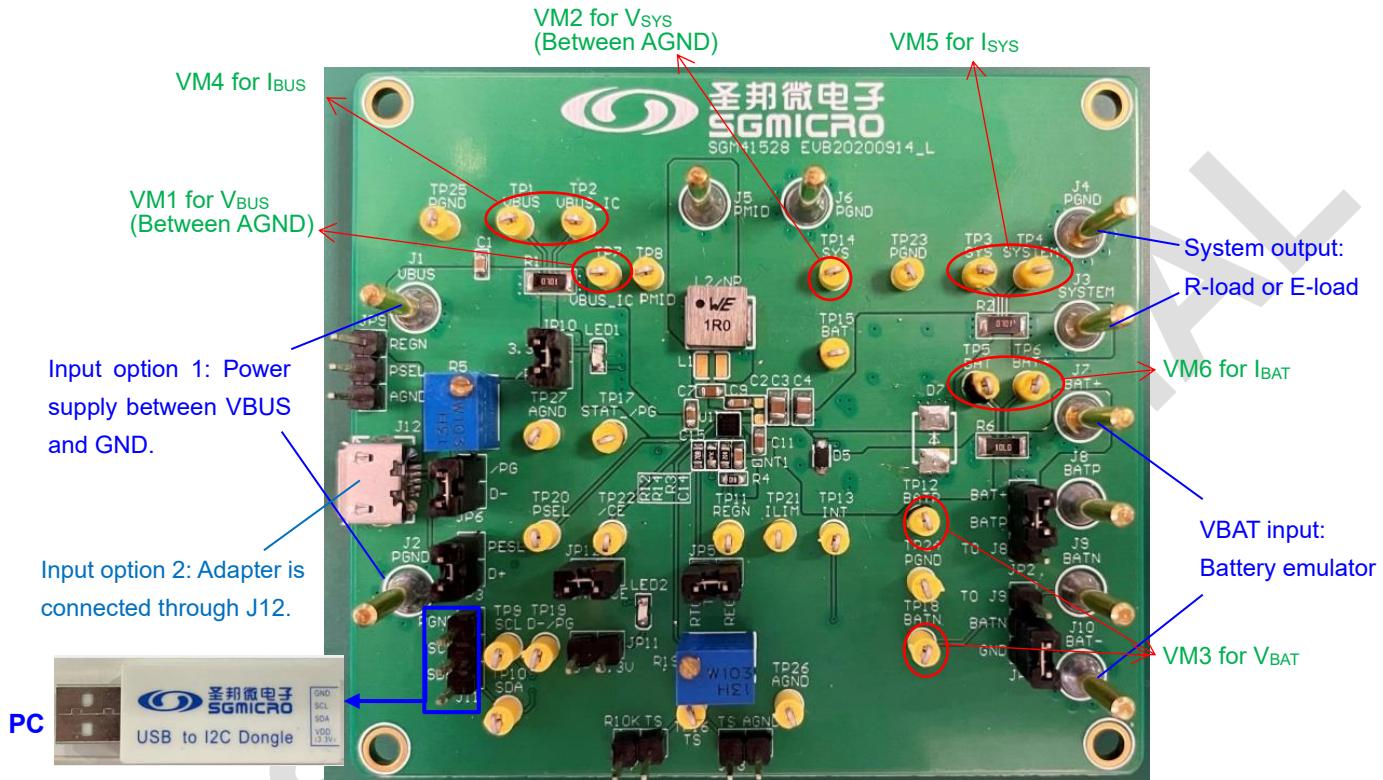


Fig-5: SGM41528 Demo Board Test Measurement in Forward Mode

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  $R_1$ ,  $R_2$ ,  $R_6$  are all  $10m\Omega$ , and the  $VM_4$ ,  $VM_5$  and  $VM_6$  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  $I^2C$  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 the battery emulator voltage can observe different charge phase and  $V_{BAT\_OVP}$  behavior.
  - b. Change the input power supply voltage can observe the  $V_{BUS\_OVP}$  behavior.
  - c. Increase the system load to trigger  $IINDPM/VINDPM$  regulation and enter supplement mode.
  - d. Enable/disable charge by  $I^2C$  register ( $REG0x06[3]$ ) or external nCE pin (JP12).
  - e. Other functions and protections.
4. Optional, when the quiescent current is tested, remove the  $D_4$  and  $D_5$ , which provide the power path from  $V_{BUS}/V_{BAT}$  to external circuit.

## 1.3.2 OTG Mode

## 1.3.2.1 Demo Board Setup

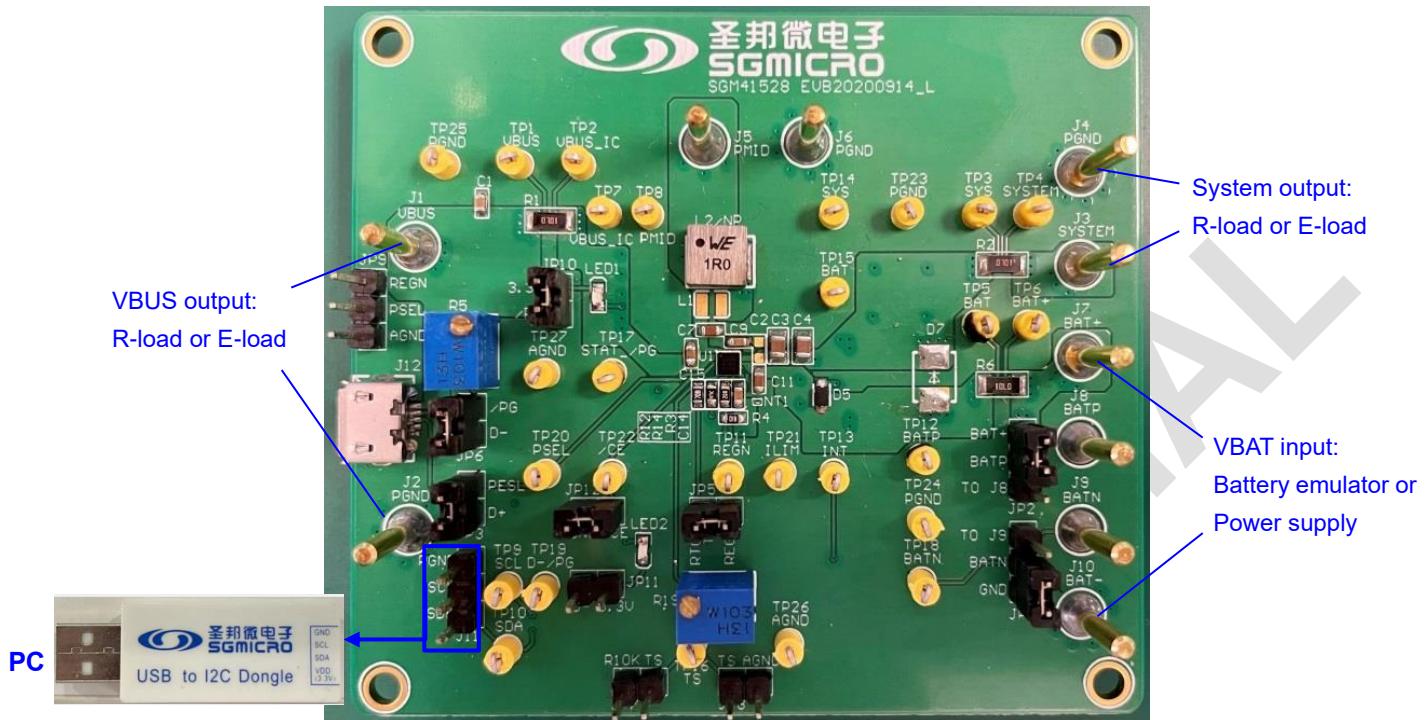


Fig-6: SGM41528 Demo Board Setup in OTG Mode

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<sup>2</sup>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<sup>2</sup>C registers by GUI.

### 1.3.2.2 I<sup>2</sup>C 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:

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

Below GUI Interface screenshot is for reference.

The screenshot shows the SGM41528 GUI interface with the following settings highlighted:

- Multi-bit I<sup>2</sup>C Pulldown Menu:**
  - Charge Voltage Limit: 8.40 V
  - Fast Charge Current Limit: 1000 mA
  - Input Voltage Limit: 4.4 V
  - Input Current Limit: 3000 mA
  - PreCharge Current Limit: 150 mA
  - Termination Current Limit: 150 mA (highlighted)
  - WDT Setting: Disable (highlighted)
  - Fast Charge Timer: 16.5 hrs
  - Die Temp Threshold: 120 °C
  - Min BAT Voltage: 6.0 V
- Single-bit I<sup>2</sup>C Selection:**
  - Enable HIZ Mode (highlighted)
  - Enable ILIM Pin
  - Enable VINDPM Reset
  - Enable BAT Discharge
  - Disable PFM OOA Mode
  - Force Start ICO
  - Force D+/D- Detection
  - Enable ICO
  - Enable Charging Termination
  - Enable Safety Timer
  - Enable 2X Extended Safety Timer
  - Enable OTG (highlighted)
  - Enable Auto Input Source Detection
  - Enable Charge
  - Disable PFM Mode
  - Reset WDT
  - Mask ADC Done INT
- Fault, Flag and Status:**

ICO Current Limit	2000 mA	IINDPM Flag	Normal
ADC Conversion Status	Not Comp	VINDPM Flag	Normal
IINDPM Status	Normal	TREG Flag	Normal
VINDPM Status	Normal	WDT Flag	Normal
OTG Hot Temp Threshold	34.45%	Charge Status Flag	Normal
OTG Cold Temp Threshold	77%	Power Good Flag	Normal
VREG High Temp Setting	VREG = 8.0	VBUS Status Flag	Normal
ICHG High Temp Setting	100% of ICI	TS Status Flag	Normal
ICHG Low Temp Setting	20% of ICH	ICO Status Flag	Normal
OTG Current Limit	2.0 A	SYSMIN Regulation Flag	Normal
OTG Voltage Limit	5.1 V	VBUS OVP Flag	Normal
		TS Status	Normal
		VBUS OVP Status	Normal
		TSHUT Status	Normal
		BAT OVP Flag	Normal
		Safety Timer Flag	Normal
		System Short Flag	Normal
		OTG Fault Flag	Normal
		ADC Conversion Flag	Normal
- ADC:**

ADC Mode	Continuous	ADC Sample Rate	12-bit
<input type="checkbox"/> Enable ADC		<input type="checkbox"/> Disable VBAT ADC	
<input type="checkbox"/> Disable IBUS ADC		<input type="checkbox"/> Disable VSYS ADC	
<input type="checkbox"/> Disable ICHG ADC		<input type="checkbox"/> Disable TS ADC	
<input type="checkbox"/> Disable VBUS ADC		<input type="checkbox"/> Disable TDIE ADC	
Polarity of ADC	Positive	VBAT ADC	0.000 V
IBUS ADC	0.000 A	VSYS ADC	0.000 V
ICHG ADC	0.000 A	TS ADC	0.000%
VBUS ADC	0.000 V	TDIE ADC	0.0 °C

At the bottom left, it says "USB-to-I<sup>2</sup>C Dongle has been plugged in!" and the URL "http://www.sg-micro.com" is at the bottom center.

Fig-7: SGM41528 register setting example in OTG mode

**SGM41528**

## Demo Board Test Report

### **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:

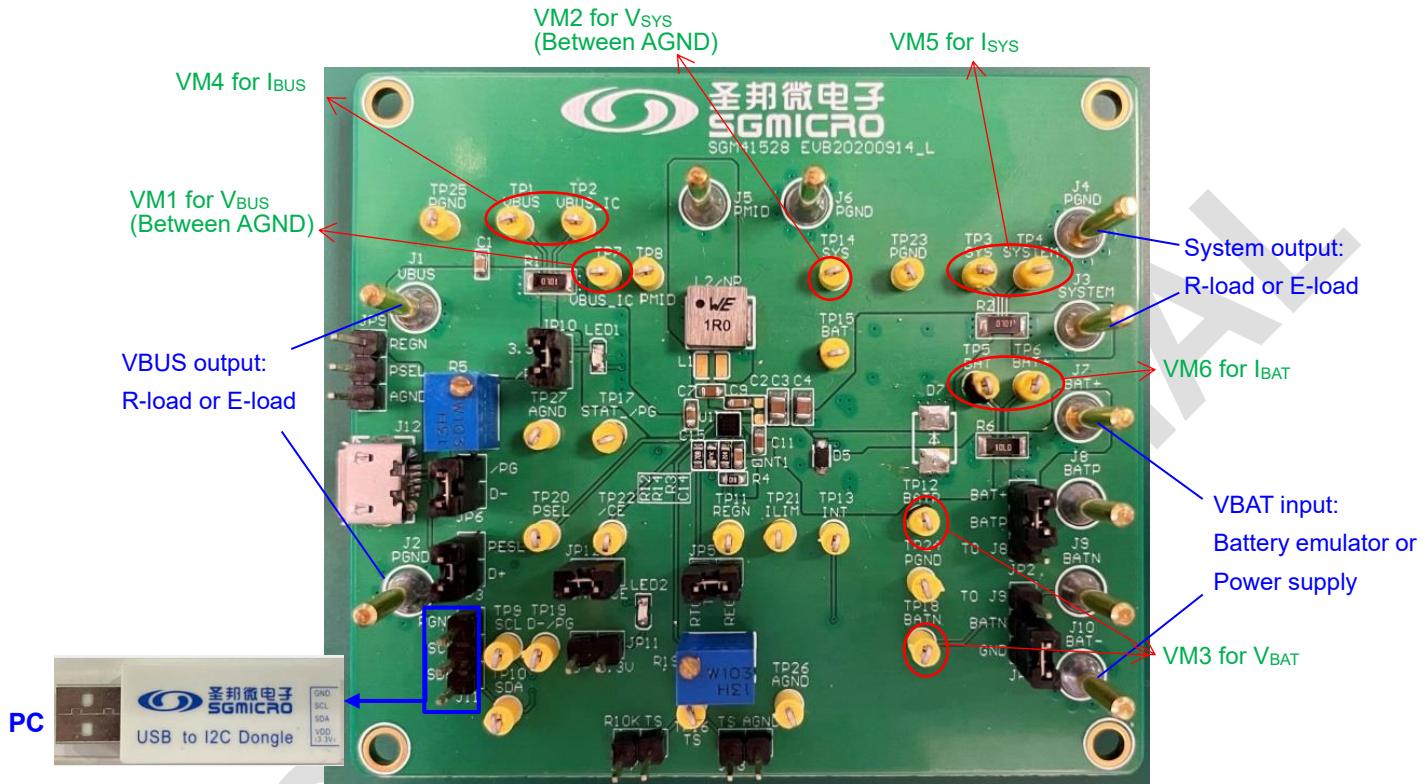


Fig-8: SGM41528 Demo Board Test Measurement in OTG Mode

- When the SGM41528 enters OTG mode, the  $V_{BUS}$ ,  $V_{SYS}$ ,  $V_{BAT}$ ,  $I_{BUS}$ ,  $I_{SYS}$ ,  $I_{BAT}$  can all be measured.
  - The current sense resistor R1, R2, R6 are all  $10m\Omega$ , and the VM4, VM5 and VM6 measure the sense resistor voltage to give the  $I_{BUS}$ ,  $I_{SYS}$  and  $I_{BAT}$ , respectively.
  - Optional, in this setup, change the OTG output load or I<sup>2</sup>C 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.
    - Change  $V_{BUS}$  output load can observe OTG mode load regulation and OTG output current limit.
    - Change battery emulator voltage can observe the OTG mode line regulation.
    - 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.

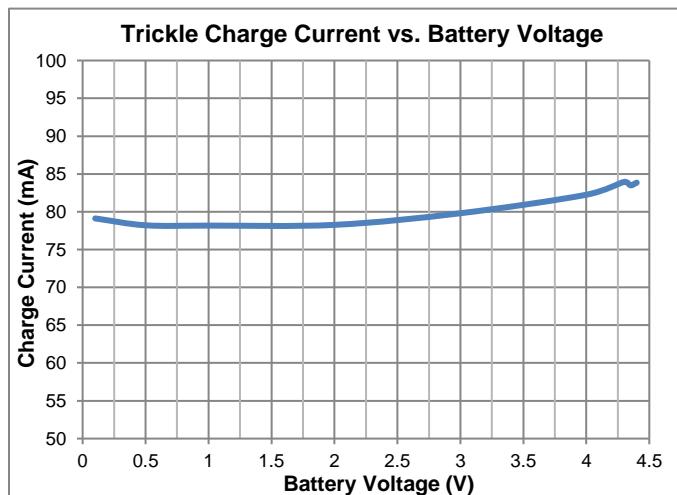


Fig-9: Trickle Charge Current vs. Battery Voltage

### 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.

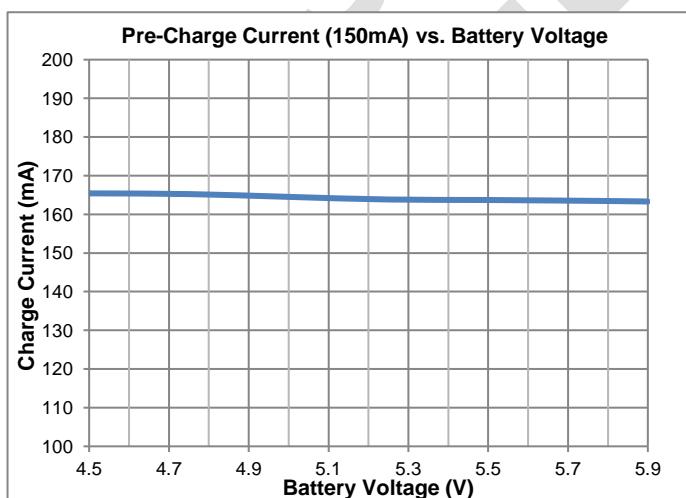


Fig-10: Pre-Charge Current vs. Battery Voltage

$$I_{PRECHG}=150\text{mA}$$

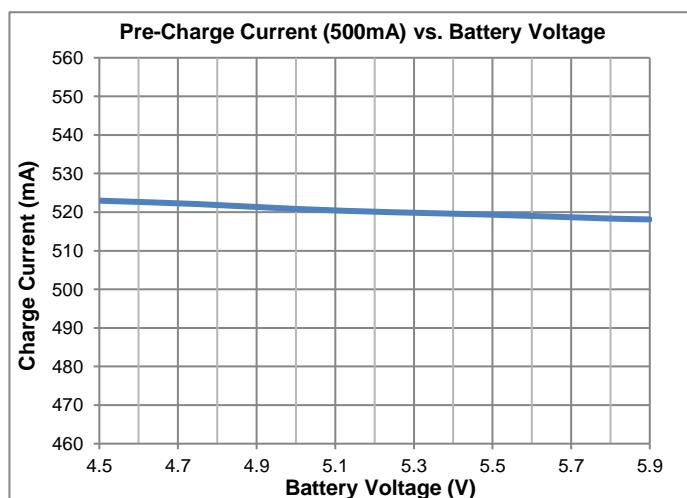


Fig-11: Pre-Charge Current vs. Battery Voltage

$$I_{PRECHG}=500\text{mA}$$

## 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.

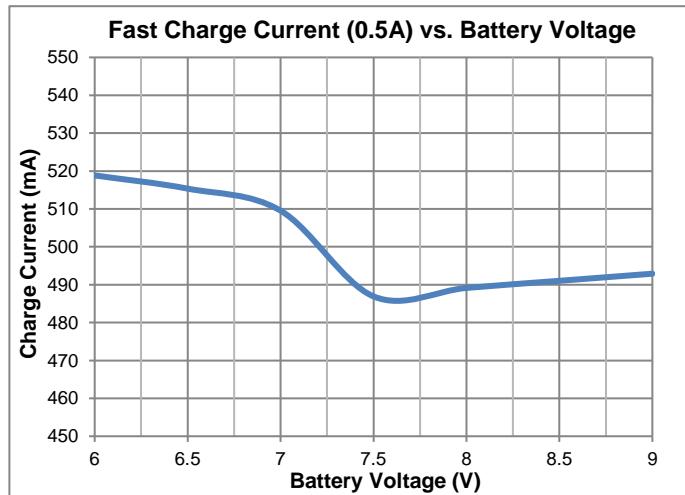


Fig-12: Fast Charge Current vs. Battery Voltage  
 $I_{CHG}=0.5A$

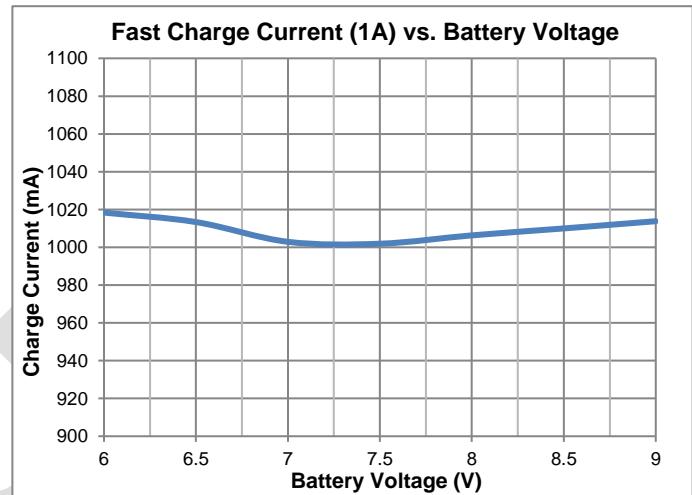


Fig-13: Fast Charge Current vs. Battery Voltage  
 $I_{CHG}=1A$

## 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.

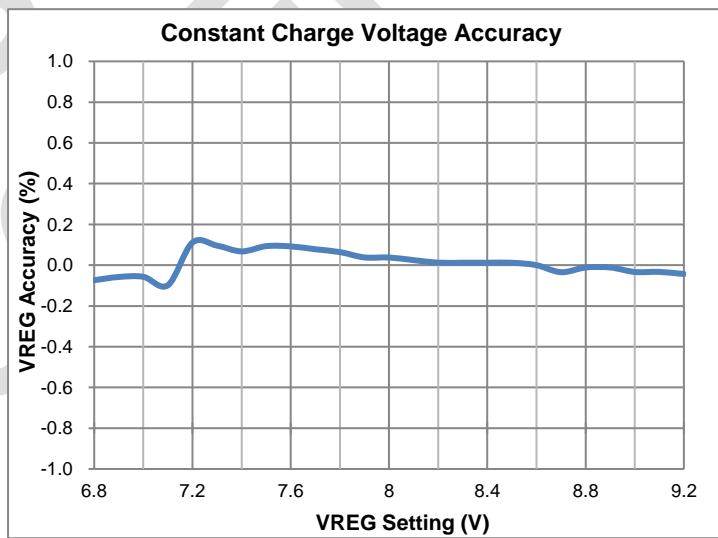


Fig-14: Constant Charge Voltage Accuracy

**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  $500m\Omega$  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.

$R_{ILIM} (\Omega)$	$I_{INMAX\_TEST} (A)$	$I_{INMAX\_TYP} (A)$	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

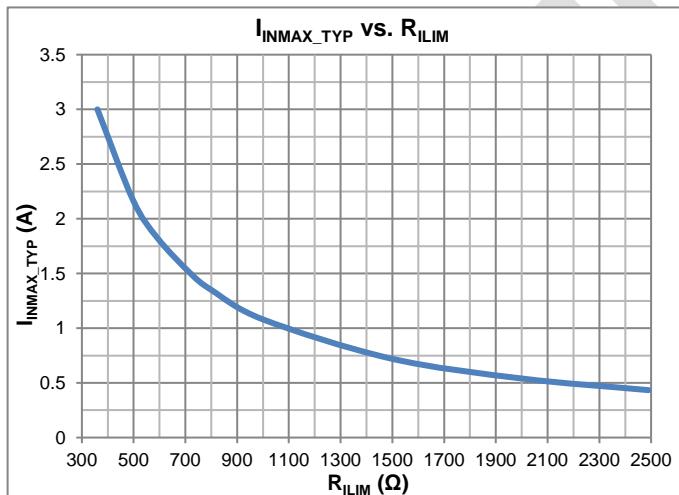


Fig-15:  $I_{INMAX\_TYP}$  vs.  $R_{ILIM}$  setting

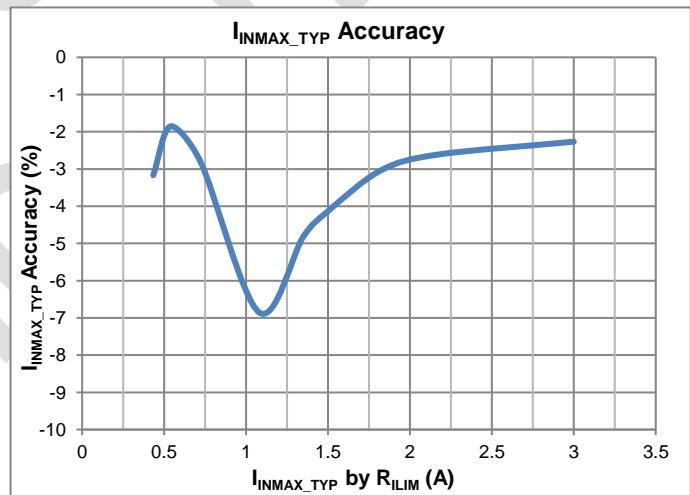


Fig-16:  $I_{INMAX\_TYP}$  Accuracy

## 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.

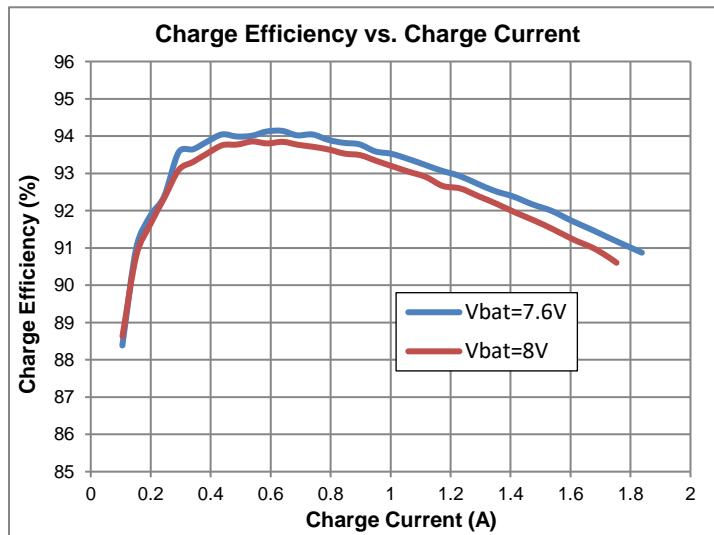


Fig-17: Charge Efficiency vs. Charge Current

## 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.

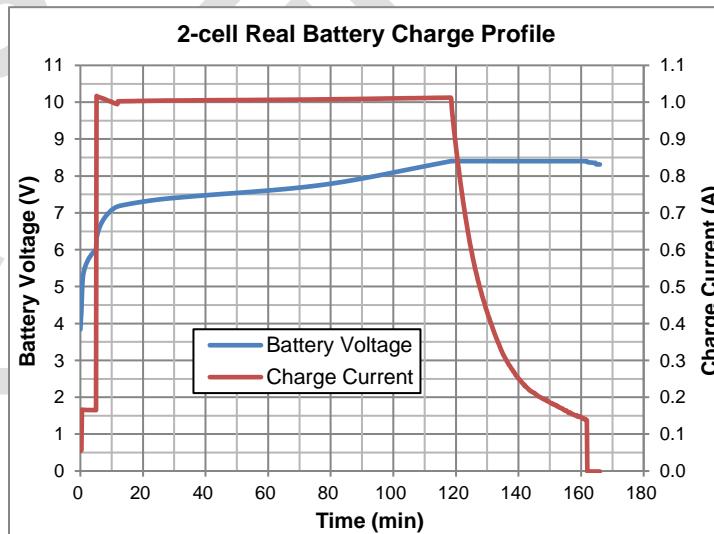


Fig-18: 2-cell real battery charge profile

## 2.11 Steady State Operation

### 2.11.1 Forward Boost Mode

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

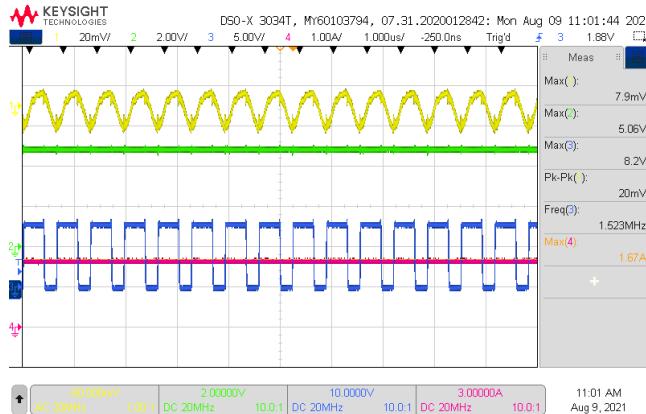


Fig-19:  $V_{BAT}=7.6V$ ,  $I_{CHG}=1A$ ,  $I_{SYS}=0A$ .

CH1- $V_{SYS/AC}$ , CH2- $V_{PMID}$ , CH3- $V_{SW}$ , CH4- $I_{BUS}$

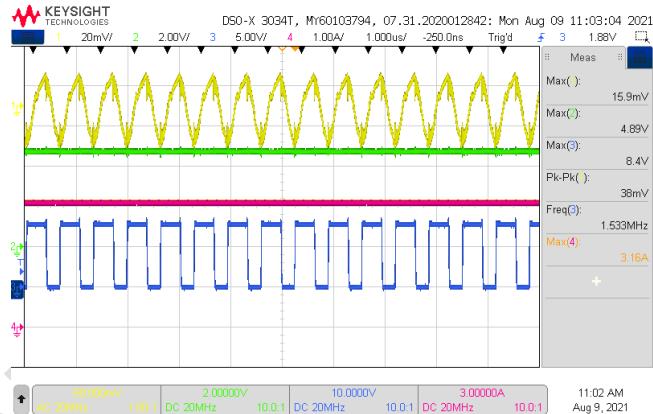


Fig-20:  $V_{BAT}=7.6V$ ,  $I_{CHG}=1A$ ,  $I_{SYS}=1A$ .

CH1- $V_{SYS/AC}$ , CH2- $V_{PMID}$ , CH3- $V_{SW}$ , CH4- $I_{BUS}$

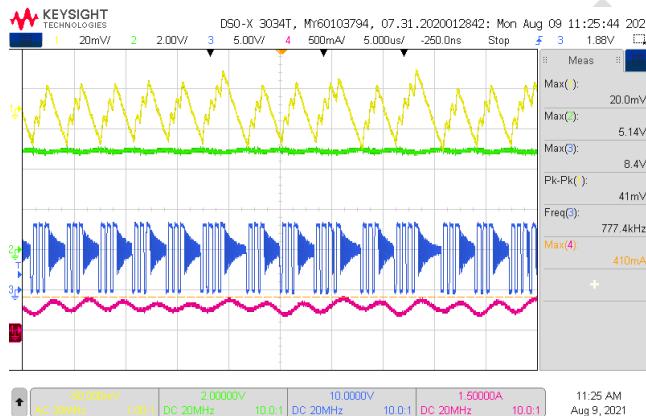


Fig-21:  $V_{BAT}=5V$ ,  $I_{PRECHG}=150mA$ ,  $I_{SYS}=0A$ , enable PFM OOA. CH1- $V_{SYS/AC}$ , CH2- $V_{PMID}$ , CH3- $V_{SW}$ , CH4- $I_{BUS}$

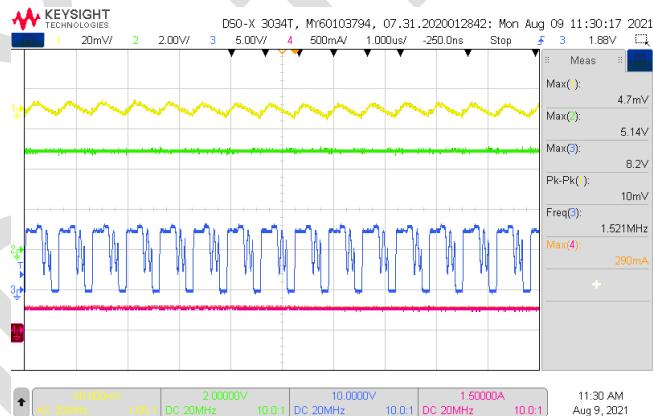


Fig-22:  $V_{BAT}=5V$ ,  $I_{PRECHG}=150mA$ ,  $I_{SYS}=0A$ , disable PFM. CH1- $V_{SYS/AC}$ , CH2- $V_{PMID}$ , CH3- $V_{SW}$ , CH4- $I_{BUS}$

### 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.

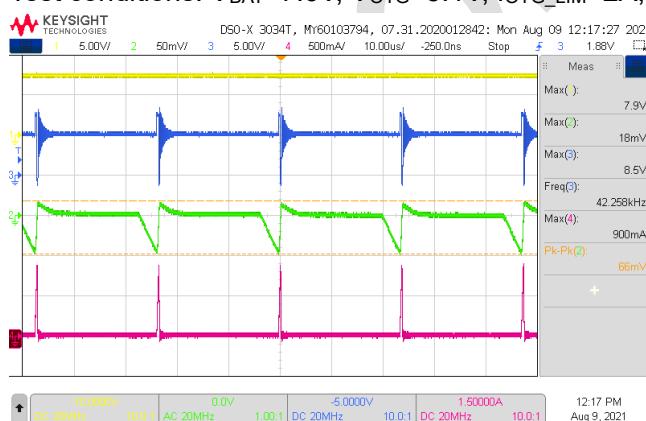


Fig-23:  $I_{BUS}=0A$ .

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

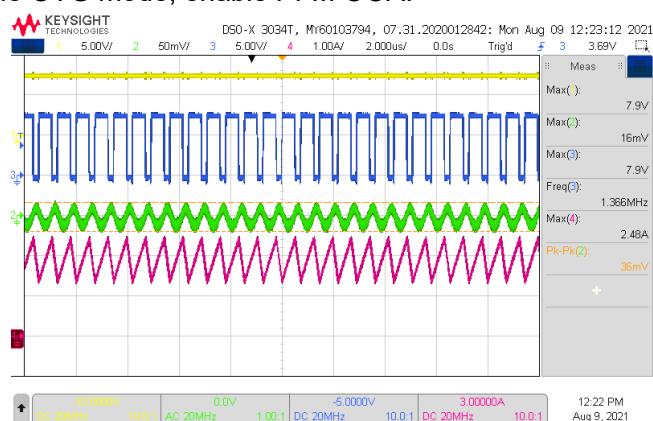
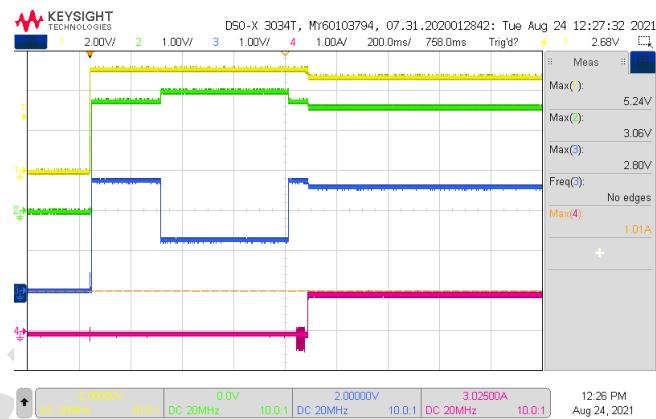
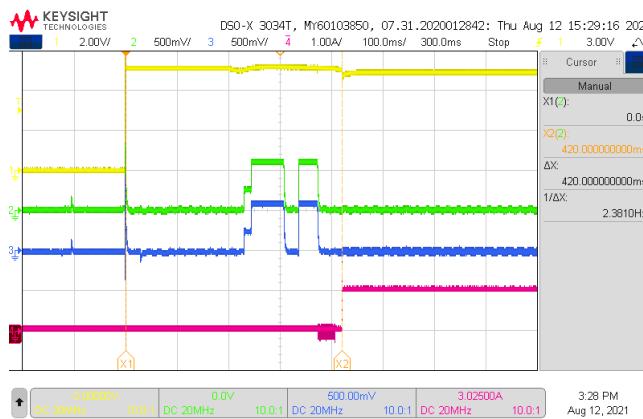


Fig-24:  $I_{BUS}=1.9A$ .

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

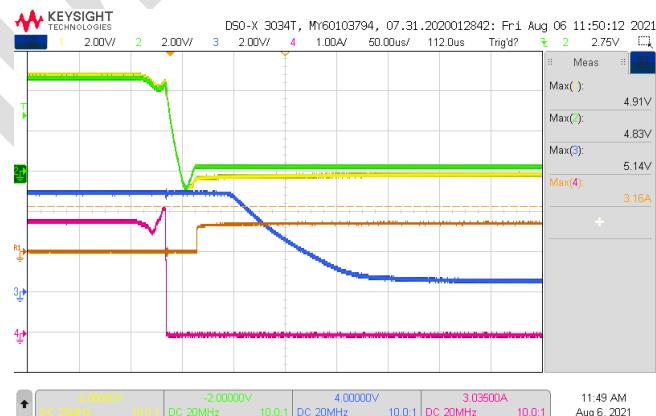
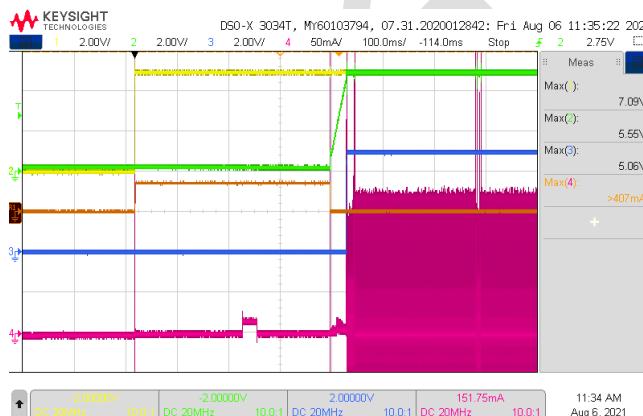
## 2.12 Adapter Type Detection

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.



## 2.13 Adapter Plug in/out without Battery

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



## 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.

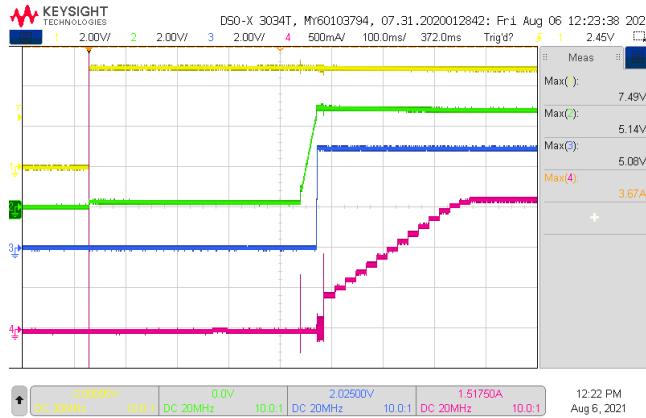


Fig-29:  $V_{BAT}=7.6V$ ,  $I_{SYS}=0A$ , 5V DCP adapter plug in  
CH1- $V_{BUS}$ , CH2- $V_{PMID}$ , CH3- $V_{REGN}$ , CH4- $I_{BUS}$

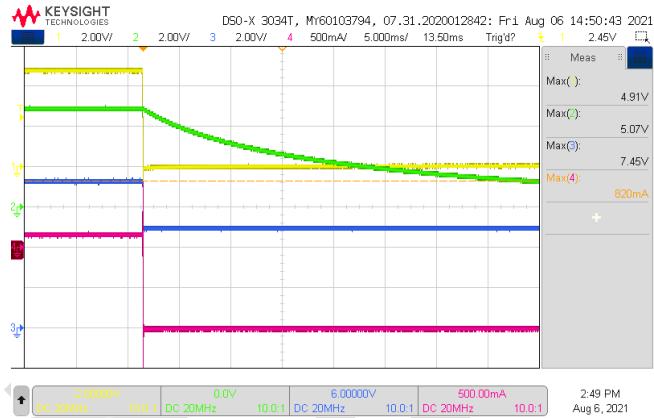


Fig-30:  $V_{BAT}=5V$ ,  $I_{SYS}=1A$ , 5V DCP adapter plug out  
CH1- $V_{PMID}$ , CH2- $V_{REGN}$ , CH3- $V_{SYS}$ , CH4- $I_{CHG}$

## 2.15 Enter/Exit OTG Mode

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

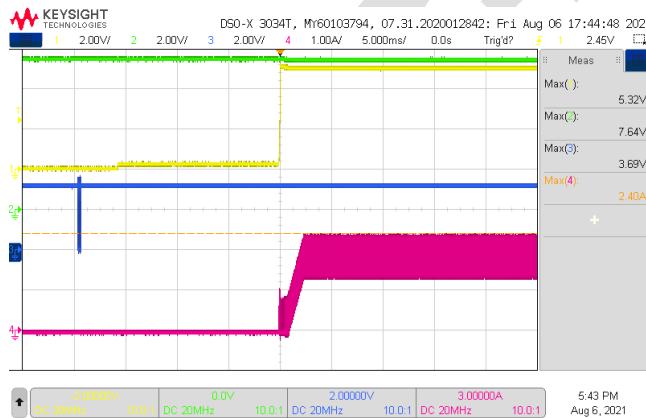


Fig-31:  $I_{BUS}=1.9A$ , enable OTG mode.  
CH1- $V_{BUS}$ , CH2- $V_{BAT}$ , CH3- $V_{SDA}$ , CH4- $I_L$

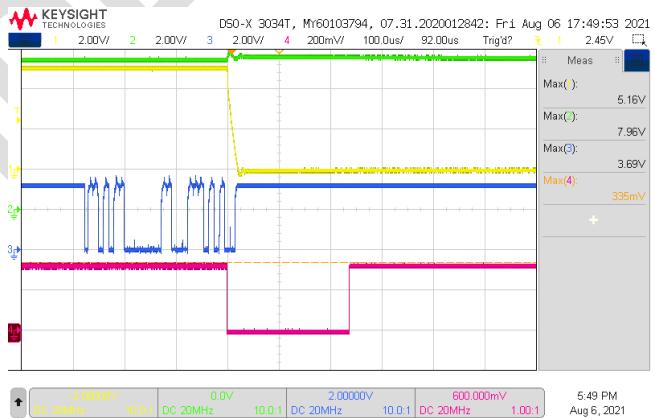


Fig-32:  $I_{BUS}=1A$ , disable OTG mode.  
CH1- $V_{BUS}$ , CH2- $V_{BAT}$ , CH3- $V_{SDA}$ , CH4- $V_{INT}$

## 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.

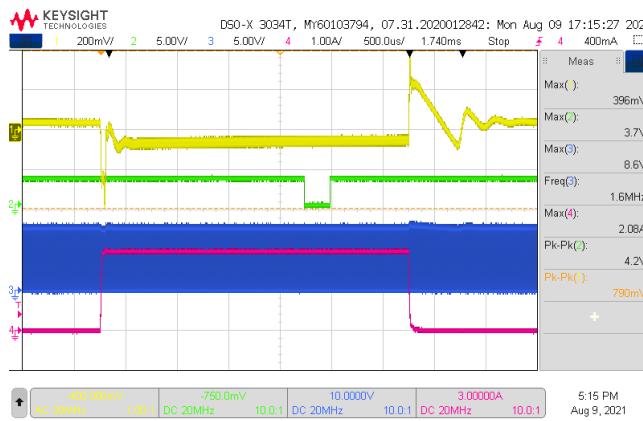


Fig-33:  $I_{SYS}=0A$  to  $2A$  to  $0A$ .

CH1- $V_{SYS/AC}$ , CH2- $V_{INT}$ , CH3- $V_{SW}$ , CH4- $I_{SYS}$

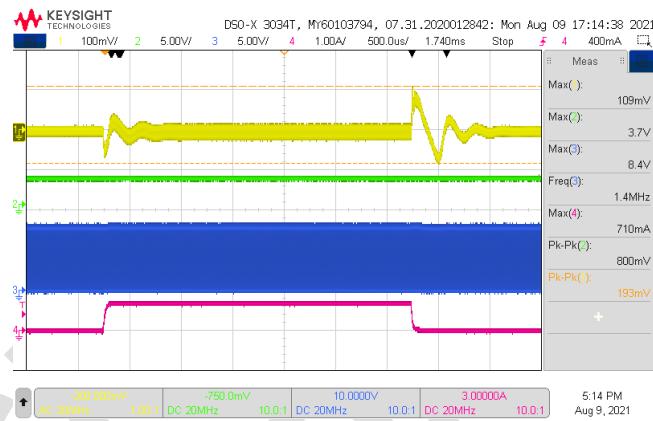


Fig-34:  $I_{SYS}=0A$  to  $0.7A$  to  $0A$ .

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.

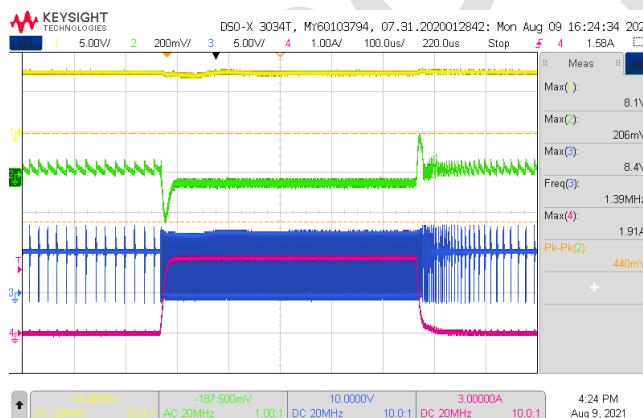


Fig-35:  $I_{BUS}=0A$  to  $1.9A$  to  $0A$ , enable PFM.

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

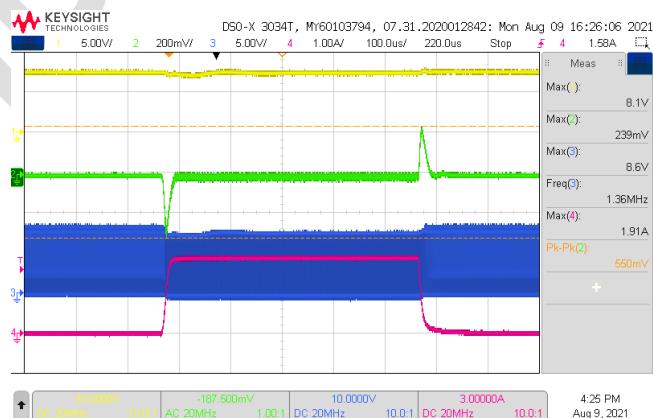


Fig-36:  $I_{BUS}=0A$  to  $1.9A$  to  $0A$ , disable PFM.

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.

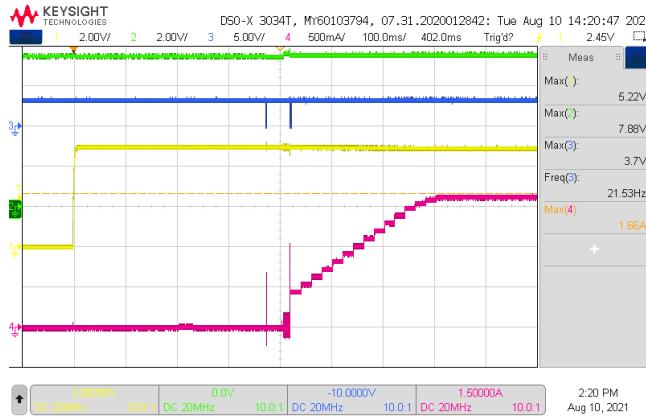


Fig-37:  $I_{CHG}=1A$ ,  $I_{SYS}=0A$ ,  $V_{BUS}=5V$  (DCP) plug in.  
CH1-V<sub>BUS</sub>, CH2-V<sub>SYS</sub>, CH3-V<sub>INT</sub>, CH4-I<sub>BUS</sub>

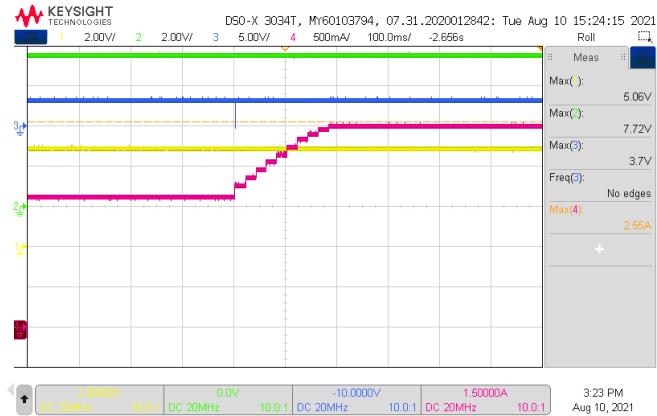


Fig-38: After  $V_{BUS}$  plug in, change  $I_{SYS}$  from 0A to 0.5A.  
CH1-V<sub>BUS</sub>, CH2-V<sub>SYS</sub>, CH3-V<sub>INT</sub>, CH4-I<sub>BUS</sub>

## 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.

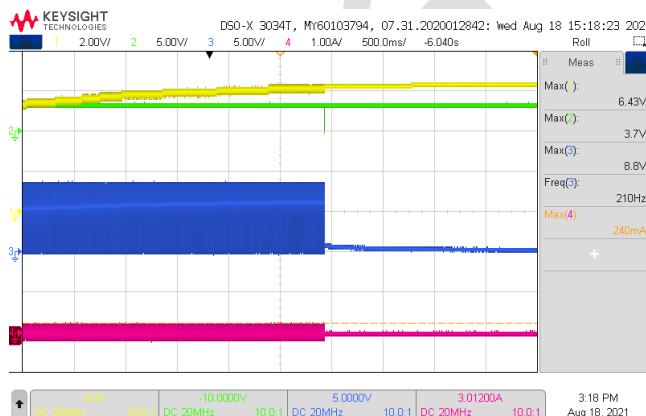


Fig-39: Increase  $V_{BUS}$  slowly to trigger VBUS\_OVP.  
CH1-V<sub>BUS</sub>, CH2-V<sub>INT</sub>, CH3-V<sub>SW</sub>, CH4-I<sub>BUS</sub>

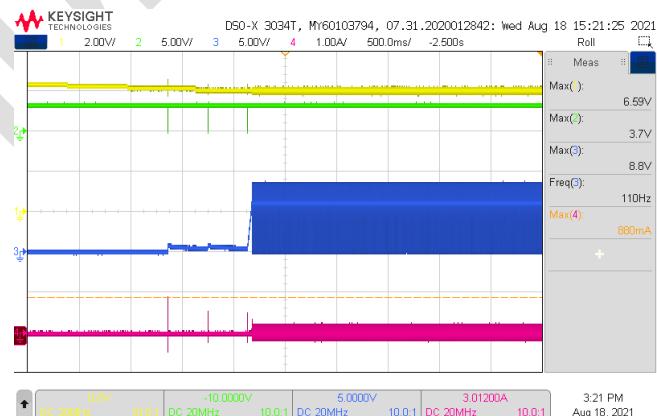


Fig-40: Decrease  $V_{BUS}$  slowly to recovery.  
CH1-V<sub>BUS</sub>, CH2-V<sub>INT</sub>, CH3-V<sub>SW</sub>, CH4-I<sub>BUS</sub>

## 2.20 VBUS\_UVP in Forward Mode

Test conditions:  $V_{BAT}=7.6V$ , ramp down  $V_{BUS}$  to trigger VBUS\_UVP.

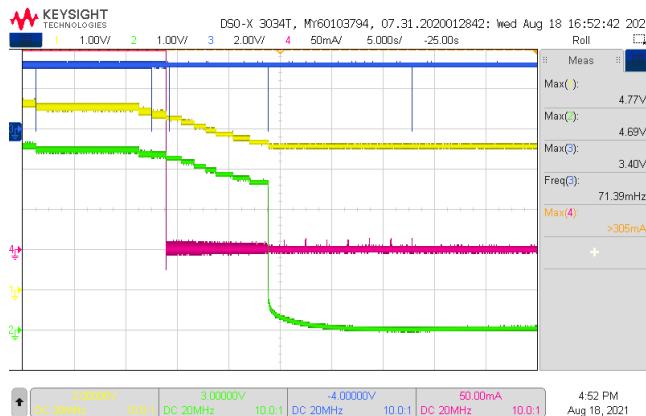


Fig-41: Ramp down  $V_{BUS}$  to trigger VBUS\_UVP.

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.

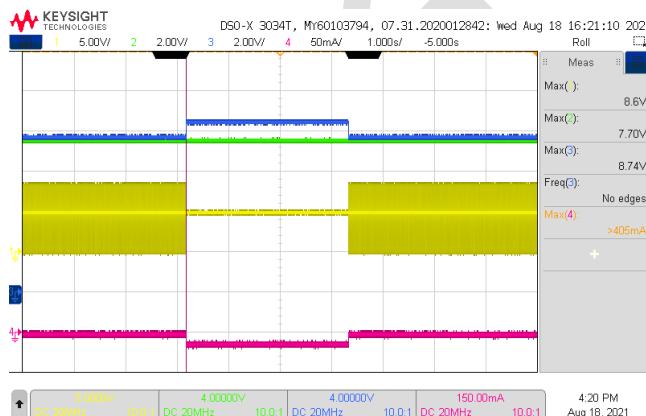


Fig-42:  $V_{BAT}=7.6V$ , disable charge, disable OOA, force and remove  $V_{SYS\_EXT}=8.5V$

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

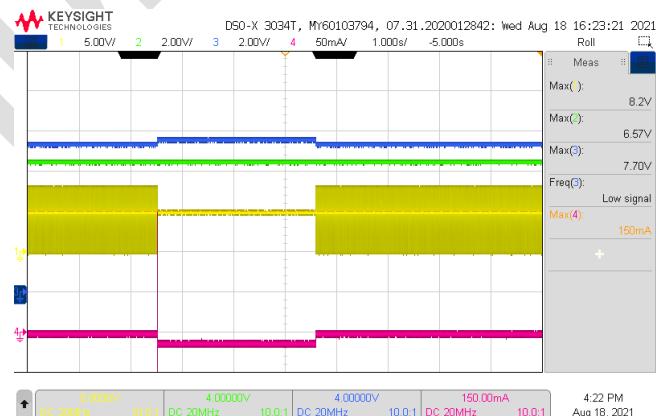


Fig-43:  $V_{BAT}=6.5V$ , disable charge, disable OOA, force and remove  $V_{SYS\_EXT}=7.6V$

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.

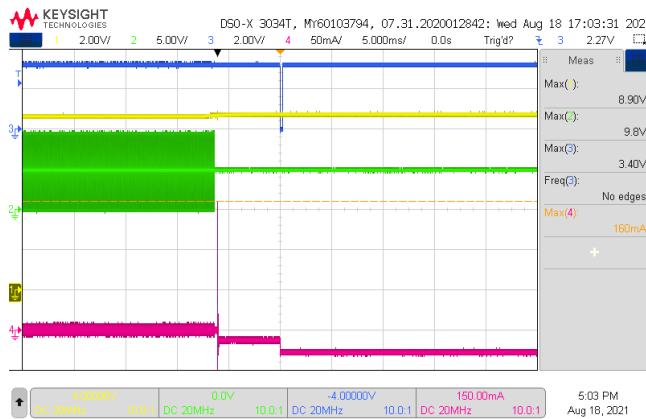


Fig-44: Increase  $V_{BAT}$  to trigger BAT\_OVP.  
CH1- $V_{BAT}$ , CH2- $V_{SW}$ , CH3- $V_{INT}$ , CH4- $I_{BAT}$

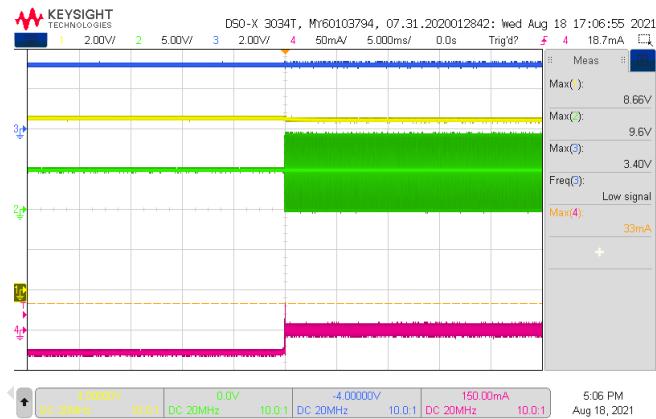


Fig-45: Decrease  $V_{BAT}$  to recovery.  
CH1- $V_{BAT}$ , CH2- $V_{SW}$ , CH3- $V_{INT}$ , CH4- $I_{BAT}$

## 2.23 SYS\_OCP in Forward Mode

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

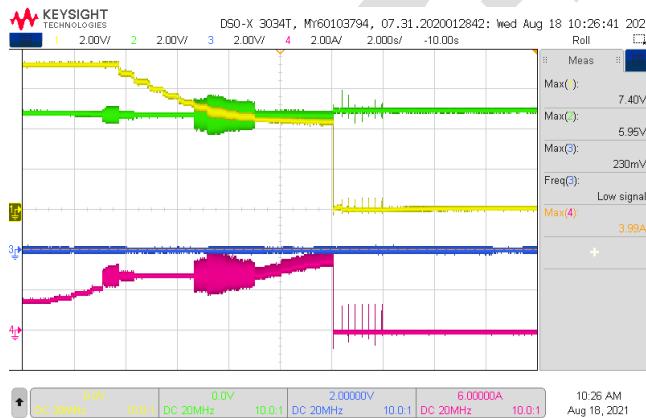


Fig-46: Increase system load  $I_{SYS}$  to trigger SYS\_OCP.  
CH1- $V_{SYS}$ , CH2- $V_{BUS}$ , CH3- $V_{INT}$ , CH4- $I_{BUS}$

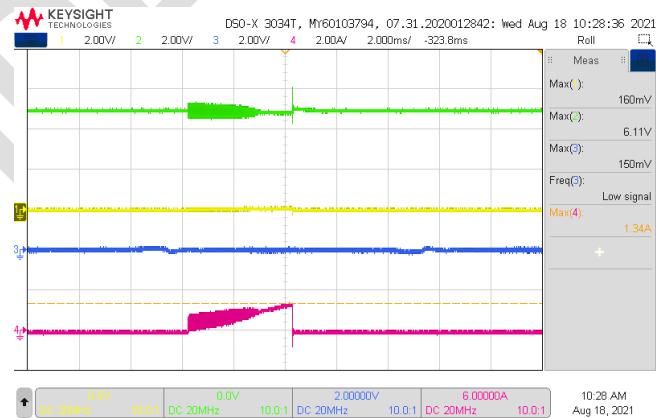


Fig-47: Zoom in the retry.  
CH1- $V_{SYS}$ , CH2- $V_{BUS}$ , CH3- $V_{INT}$ , CH4- $I_{BUS}$

## 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.

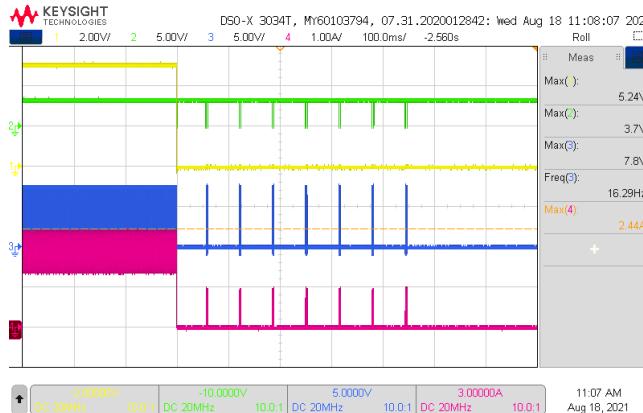


Fig-48: Increase  $I_{BUS}$  slowly to trigger OTG\_OCP.  
CH1- $V_{BUS}$ , CH2- $V_{INT}$ , CH3- $V_{SW}$ , CH4- $I_L$

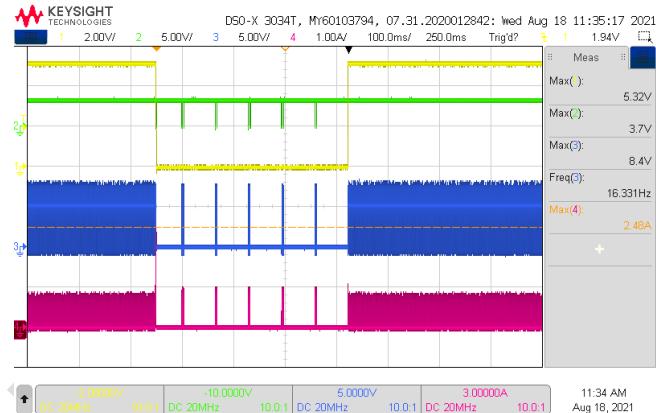


Fig-49: Short  $V_{BUS}$  to GND in OTG mode and then release short before 7 failures.  
CH1- $V_{BUS}$ , CH2- $V_{INT}$ , CH3- $V_{SW}$ , CH4- $I_L$

## 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.

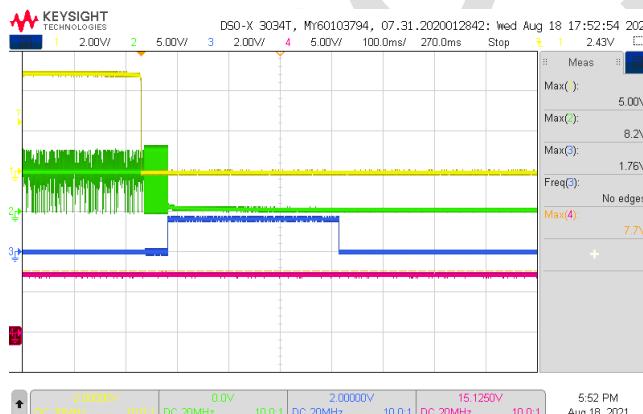


Fig-50: Thermal shutdown entry.  
CH1- $V_{REGN.}$ , CH2- $V_{SW}$ , CH3- $V_{PG}$ , CH4- $V_{SYS}$ .

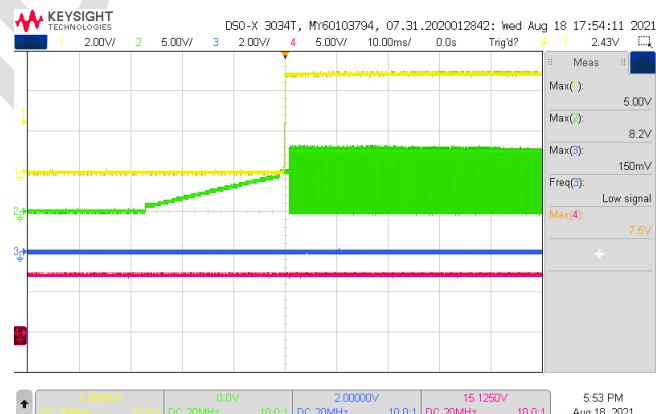


Fig-51: Thermal shutdown recovery.  
CH1- $V_{REGN.}$ , CH2- $V_{SW}$ , CH3- $V_{PG}$ , CH4- $V_{SYS}$ .