User's Guide

TPS61289EVM-113 Evaluation Module

TEXAS INSTRUMENTS

ABSTRACT

This user's guide describes the characteristics, operation, and the use of the TPS61289EVM-113 evaluation module (EVM). The EVM contains the TPS61289 device, which is a high-performance, high-efficiency bi-direction buck/boost synchronous converter integrates the high side synchronous rectifier FET and uses an external FET. This user's guide includes EVM specifications, recommended test setup, test process, schematic diagram, bill of materials, and the board layout.

CAUTION

Hot surface! Contact can cause burns. Do not touch!

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Trademarks

All trademarks are the property of their respective owners.

1 Introduction

1.1 Performance Specification

Table 1-1 provides a summary of the TPS61289 EVM performance specifications. All specifications are given for an ambient temperature of 25°C.

• Operating voltage ranges

VHIGH / Vbus – up to 20 V

VLOW / Vbat – up to 5 V

• Operating current

– 15-A maximum charge / discharge current

• Switching frequency:

– Fsw 250 kHz when VLOW > 1.7 V

– Fsw down to 100 kHz when VLOW < 1.5 V

– Fsw down to 50 kHz when VLOW < 0.5 V

• Efficiency: > 95 % at VLOW= 4.2 V, VHIGH= 15 V, Icharge or Idischarge = 7 A

Table 1-1. Performance Specification Summary

Parameter	MIN	TYP	MAX	Unit
V_{LOW}	0.5	3.6	5	V
V_{HIGH}	10	15	20	V
Default Switching Frequency		250		kHz

1.2 Modification

The printed-circuit board (PCB) for this EVM is designed to accommodate some modifications by the user. The external component can be changed according to the real application.

2 EVM Configuration

This section describes how to properly connect, set up, and use the TPS61289EVM-113.

2.1 EVM Top View and Circuit Layout Partitions

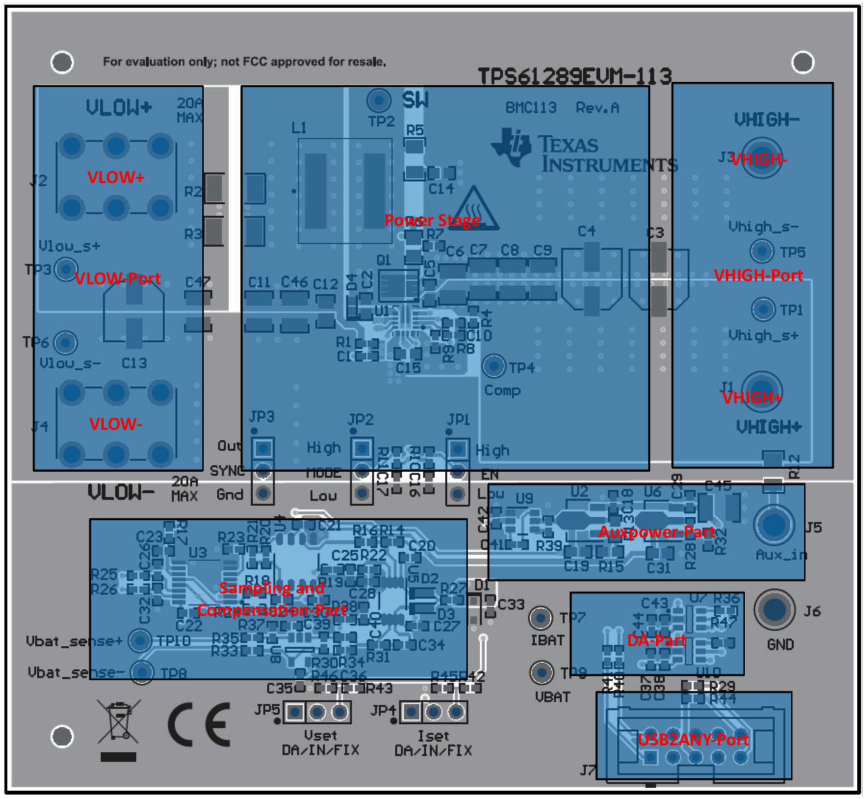


Figure 2-1. EVM Board Top View and Layout Partitions

Figure 2-1 shows the EVM board top view and circuit layout partitions. The EVM has the following parts:

- VLOW-Port: connected to Vbat rail
- VHIGH-Port: connected to Vbus rail
- Power Stage: TPS61289 power circuit
- Auxpower Part: this part provides 10 V, 5 V and -5 V to the control circuits
- Sampling and Compensation Part: sampling the battery remote voltage and charging/discharging current, generate the compensation signal
- DA Part: generate DA signals as the settings of the battery voltage and current
- USB2ANY Port: connection for USB2ANY

2.2 Connector, Test Point and Jumper Descriptions

2.2.1 Connector and Test Point Description

This EVM includes connectors and test points as shown in Table 2-1.

Table 2-1. Connectors and Test Points

Reference Designator	Description
J1	VHIGH voltage positive connection / Vbus positive connection
J2	VLOW voltage positive connection / Vbat positive connection
J3	VHIGH voltage negative connection / Vbus negative connection
J4	VLOW voltage negative connection / Vbat negative connection
J5	External auxpower input connection
J6	External auxpower return connection/Power ground
J7	USB2ANY connection port
TP1	Vhigh_s+ is for VHIGH voltage sensing positive
TP2	Test point for measuring SW waveform
TP3	Vlow_s+ is for VLOW voltage sensing positive
TP4	Compensation signal sensing/External compensation input
TP5	Vhigh_s- is for VHIGH voltage sensing negative
TP6	Vlow_s- is for VLOW voltage sensing negative
TP7	IBAT is sensing of pretreatment circuit result of battery charge/discharge current
TP8	Vbat_sense- is for battery remote sense negative
TP9	VBAT is sensing of pretreatment circuit result of battery voltage
TP10	Vbat_sense+ is for battery remote sense positive

2.2.2 Jumper Configuration

Table 2-2 list the function of the EVM jumpers, it can be configured with different cases.

Table 2-2. Three-pin Jumper Configuration Description

Reference Designator	Signal	Pins	Signal Description	Default
JP1	EN	--(1)	External EN control/ EN controlled by USB2ANY	
		(1,2)(2)	Device Enabled	
		(2,3)(3)	Device Disabled	Y
JP2	MODE	--	External MODE control/ MODE controlled by USB2ANY	
		(1,2)	Buck mode selected	
		(2,3)	Boost mode selected	Y
JP3	SYNC	--	For external sync clock input	
		(1,2)	Default frequency used	
		(2,3)	Default frequency used	Y
JP4	Iset	--	External current target setting used	
		(1,2)	Current target setting controlled by inner DA device	
		(2,3)	Current target setting to be a default fixed value	Y
JP5	Vset	--	External voltage target setting used	
		(1,2)	Voltage target setting controlled by inner DA device	
		(2,3)	Voltage target setting to be a default fixed value	Y

(1) --=All jumper pins are open.
(2) (1,2) = Pins 1 and 2 closed
(3) (2,3) = Pins 2 and 3 closed.

3 Test Procedure

3.1 Bench Setup

Figure 3-1 shows the typical bench setup to operate the EVM.

The combination of the E-Load, Power supply and Capacitor emulates a battery at VLOW side. The emulated battery provides energy at Boost Mode or Battery Discharge Mode and absorbs energy at Buck Mode or Battery Charge Mode.

The combination of the E-Load and Power supply emulates a stable voltage bus at VHIGH side. The voltage bus provides energy at Buck Mode or Battery Charge Mode and absorbs energy at Boost Mode or Battery Discharge Mode.

The Vbat_sense+ and Vbat_sense- are connected for battery remote voltage sense.

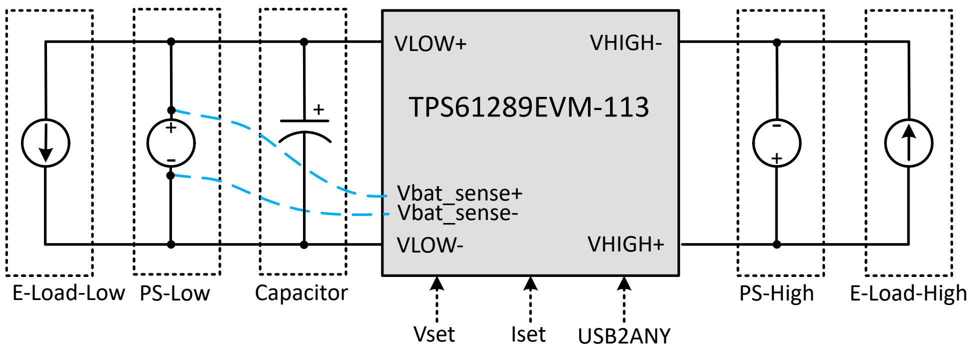


Figure 3-1. Bench Setup for Battery Charge and Discharge

Power Supplies: PS-High needs to be capable of 20 V/10 A , and PS-Low needs 5 V/ 25 A.

Electronic Loads: The E-Load-High needs to be capable of 20 V/10 A and E-Load-Low needs 5 V/ 25 A.

Capacitor: The capacitor needs to be above 5 V rated voltage and gets a capacitance of several hundred microfacies to make sure the port voltage stable during charge/discharge process.

Meters: Most current meters are rated only to 10 A, current probe or shunt are recommended to measure the current.

Oscilloscope: An oscilloscope and 10x probes with at least 20-MHz bandwidth is required. Current probe capable of 30 A is required to monitor the inductor current via a wire loop inserted to the non-switching side of the inductor.

3.2 Boost Mode or Battery Discharge Mode Test Procedure

When TPS61289EVM-113 working in Boost Mode or Battery Discharge Mode, the constant discharge current is set and controlled.

To enable the discharge mode, voltage target setting need to be higher than battery voltage.

3.2.1 Power up and Power down Sequence

1. Setup the bench as shown in Figure 3-1.
2. Refer to the jumper setting described in Table 2-2.

JP1 needs to be set as Enabled.

JP2 needs to be set as Boost Mode.

JP3 needs to be default.

JP4 needs to be set all open for the external current reference setting.

JP5 needs to be set all open for the external voltage reference setting.

The EVM provides a sight negative voltage bias on the current reference to disable the switching when current reference setting Iset is 0 V. When the device starts switching, the relationship between actually discharge current and current setting is shown in Equation 1.

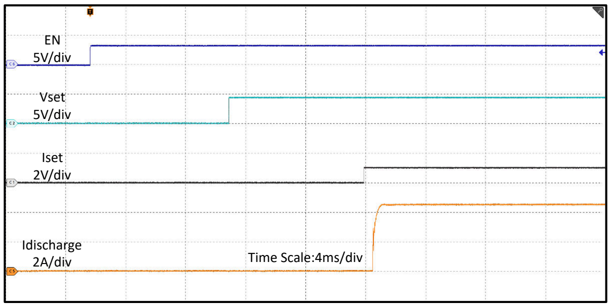
$$I_{discharge}\left(\mathrm{A}\right) = 5\left(I_{set}\left(\mathrm{V}\right) \times 0.987 - 0.064\right) \tag{1}$$

3. Set PS-High to 15 V and PS-Low to 3.6 V and turn on.
4. Set E-Load-High to CC mode 5 A and turn on.
5. Set the voltage setting Vset, the voltage must be higher than voltage of PS-Low(3.6 V).
6. Set the current setting Iset, the converter starts switching when the comp voltage reaches 0.65 V typically.
7. Perform the test.
8. After all the tests are done, the converter can be disabled by setting the EN pin to Low.
9. Turn off all the Power supplies and E-Loads.

3.2.2 Test Waveform

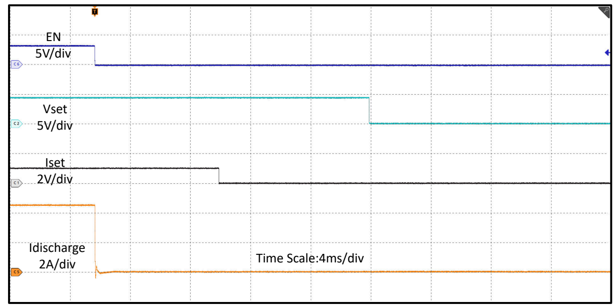
Figure 3-2 and Figure 3-3 show the power up and power down sequence wavefroms of Boost Mode or Battery Discharge Mode.

Figure 3-4 and Figure 3-5 show the working wavefroms of Boost Mode or Battery Discharge Mode.



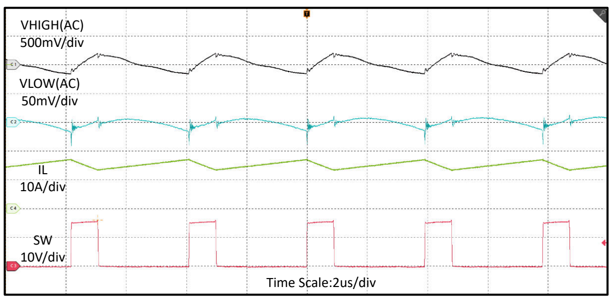
V_{High} = 15 V V_{Low} = 3.6 V $I_{discharge}$ = 5 A

Figure 3-2. Boost Mode Start Up Sequence



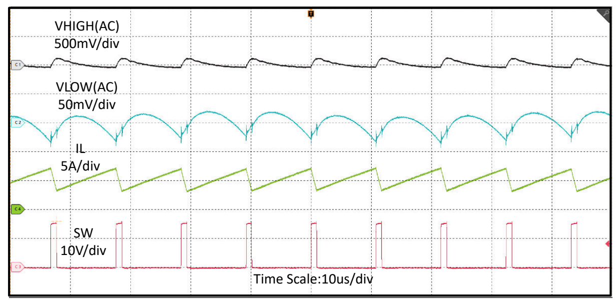
V_{High} = 15 V V_{Low} = 3.6 V $I_{discharge}$ = 5 A

Figure 3-3. Boost Mode Shut Down Sequence



V_{High} = 15 V $I_{discharge}$ = 15 A

Figure 3-4. Switching Waveforms in Boost Mode (V_{Low} =3.6 V)



V_{High} = 15 V $I_{discharge}$ = 5 A

Figure 3-5. Switching Waveforms in Boost Mode (V_{Low} =1.5 V)

3.3 Buck Mode or Battery Charge Mode Test Procedure

When TPS61289EVM-113 working in Buck Mode or Battery Charge Mode, the constant charge current and constant charge voltage are both set and contreolled.

3.3.1 Power-up and Power-down sequence

1. Set up the bench as shown in Figure 3-1.

2. Refer to the jumper setting described in Table 2-2.

JP1 needs to be set as Enabled.

JP2 needs to be set as Buck Mode.

JP3 needs to be default.

JP4 needs to be set all open for the external current reference setting.

JP5 needs to be set all open for the external voltage reference setting.

The EVM provides a sight negative voltage bias on the current reference to disable the switching when current setting is 0 V. When the device starts switching, the relationship between actually charge current and current setting is shown in Equation 2.

$$I_{charge}(\mathrm{A}) = 5\left(I_{set}(\mathrm{V}) \times 0.987 - 0.064\right) \tag{2}$$

The voltage reference setting is the constant voltage charge target, as in Equation 3.

$$V_{charge\_target}(\mathrm{V}) = V_{set}(\mathrm{V}) \tag{3}$$

3. Set PS-High to 15 V and PS-Low to 3.6 V and turn on.

4. Set E-Load-Low to CC mode 20 A and turn on.

5. Set the voltage setting Vset, the voltage must be higher than voltage of PS-Low(3.6 V).

6. Set the current setting Iset, the converter starts switching when the comp voltage reaches 0.65 V typically.

7. Perform the test.

8. The charging mode automaticly charges from constant current to constant voltage when battery voltage is close to voltage setting.

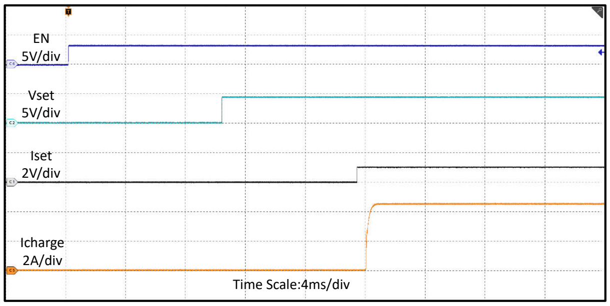
9. After all the tests are done, the converter can be disabled by setting the EN pin to Low.

10. Turn off all the power supplies and E-loads.

3.3.2 Test Waveform

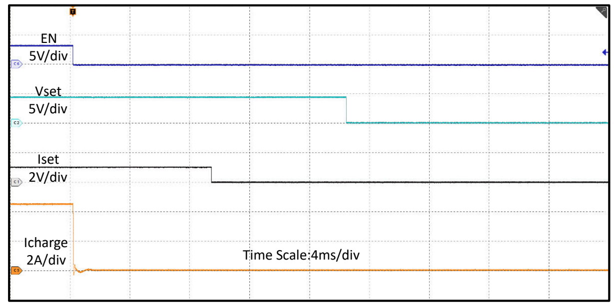
Figure 3-6 and Figure 3-7 show the power up and power down sequence wavefroms of Buck Mode or Battery Charge Mode.

Figure 3-8 and Figure 3-9 show the working wavefroms of Buck Mode or Battery Charge Mode.



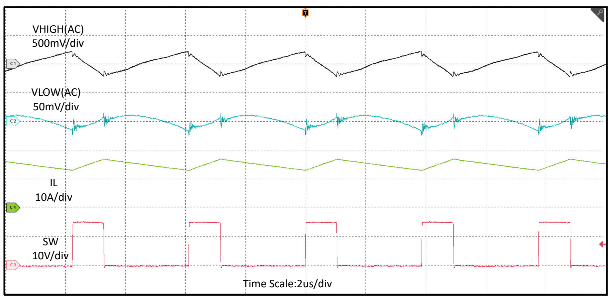
V_{High} = 15 V V_{Low} = 3.6 V I_{charge} = 5 A

Figure 3-6. Buck Mode Start Up Sequence



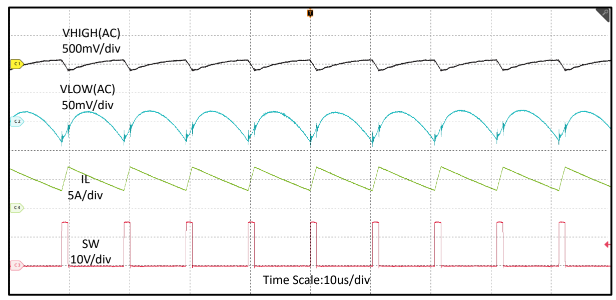
V_{High} = 15 V V_{Low} = 3.6 V I_{charge} = 5 A

Figure 3-7. Buck Mode Shut Down Sequence



V_{High} = 15 V I_{charge} = 15 A

Figure 3-8. Switching Waveforms in Buck Mode (V_{Low} =3.6 V)



V_{High} = 15 V I_{charge} = 5 A

Figure 3-9. Switching Waveforms in Buck Mode (V_{Low} =1.5 V)

3.4 Operating the EVM with USB2ANY

The EVM contains 2 DA devices which can be controlled by I2C to generate voltage and current reference settings.

The I2C and two main GPIOs(EN and MODE signals) are connected to USB2ANY port. When USB2ANY Interface is connected, the EVM can easily perform Buck mode or Boost mode tests by simple operation from host comperter.

This section describes how to use USB2ANY to perform the test.

3.4.1 Install USB2ANY Explorer

Download and install the USB2ANY explorer from http://www.ti.com/tool/USB2ANY. Upgrade the firmware version to 2.8.2.0.

3.4.2 USB2ANY Connection

Figure 3-10 shows the USB2ANY connection overview.

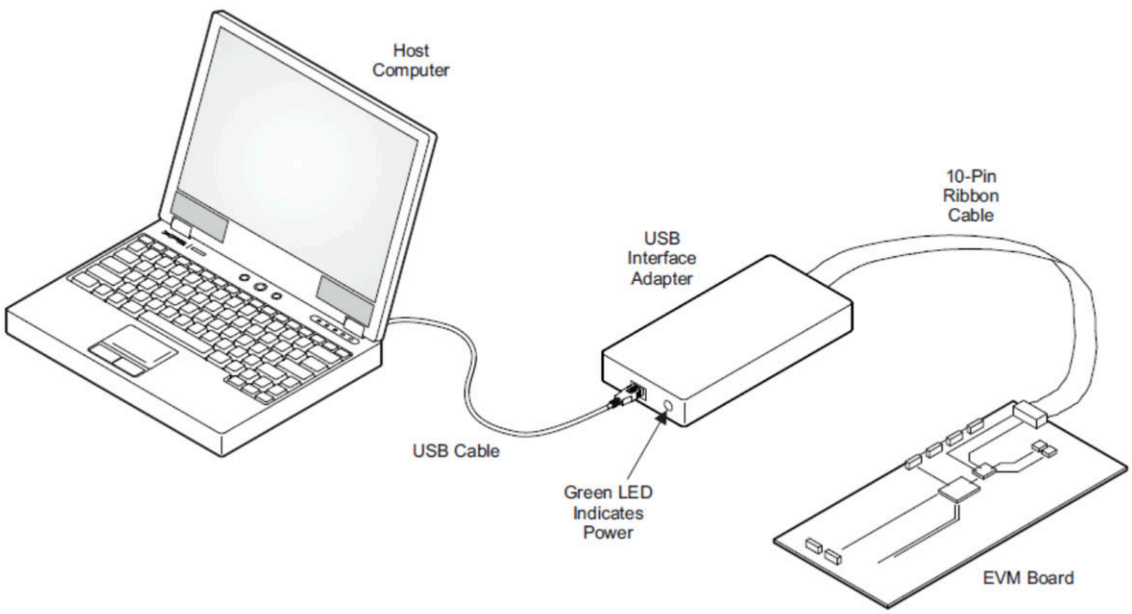


Figure 3-10. USB2ANY Connection Overview

3.4.3 USB2ANY Interface Introduction

1. After opening the USB2ANY Explorer, the main interface is illustrated in Figure 3-11.

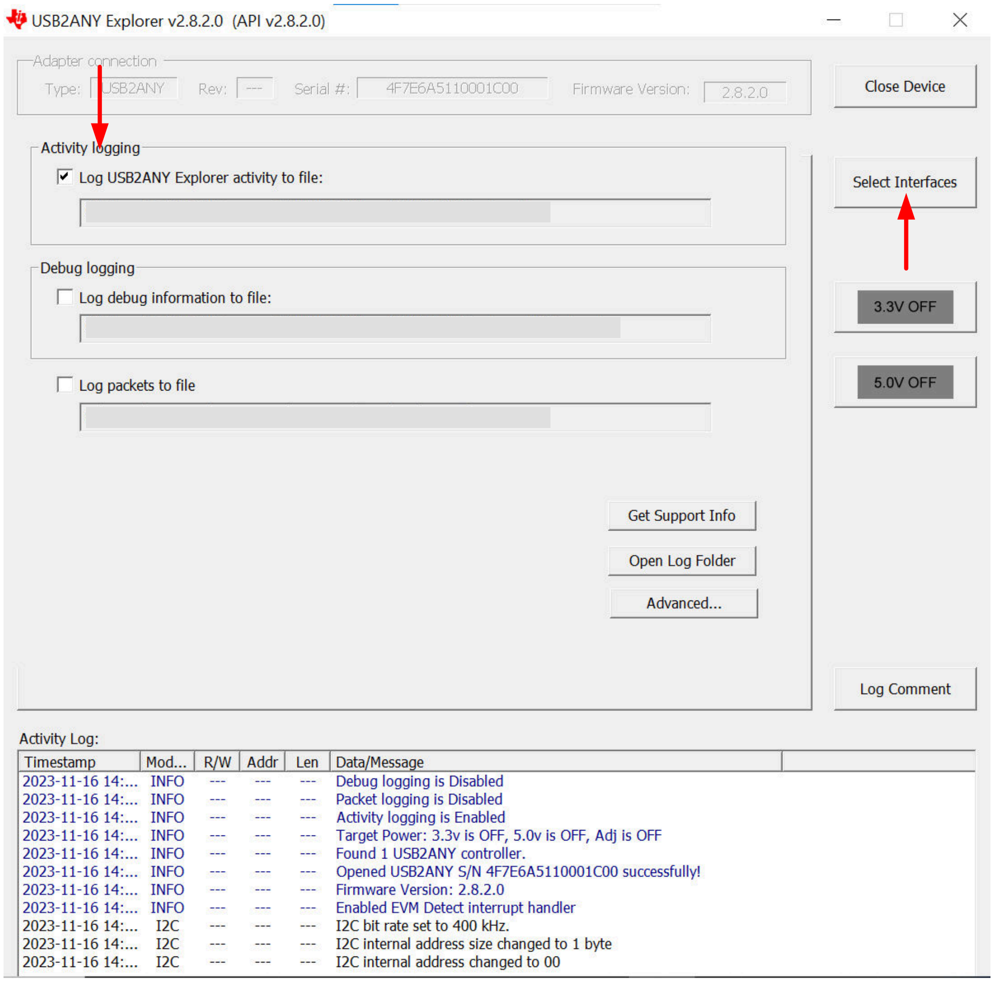


Figure 3-11. USB2ANY Main Interface

2. Click 'Select Interfaces' Button, the 'Select USB2ANY Configeration' interface comes out.

Select the 'GPIO' and '12C' as shown in Figure 3-12.

Close the 'Select USB2ANY Configuration Interface' and go back to 'Main Interface' by clicking 'Close' button.

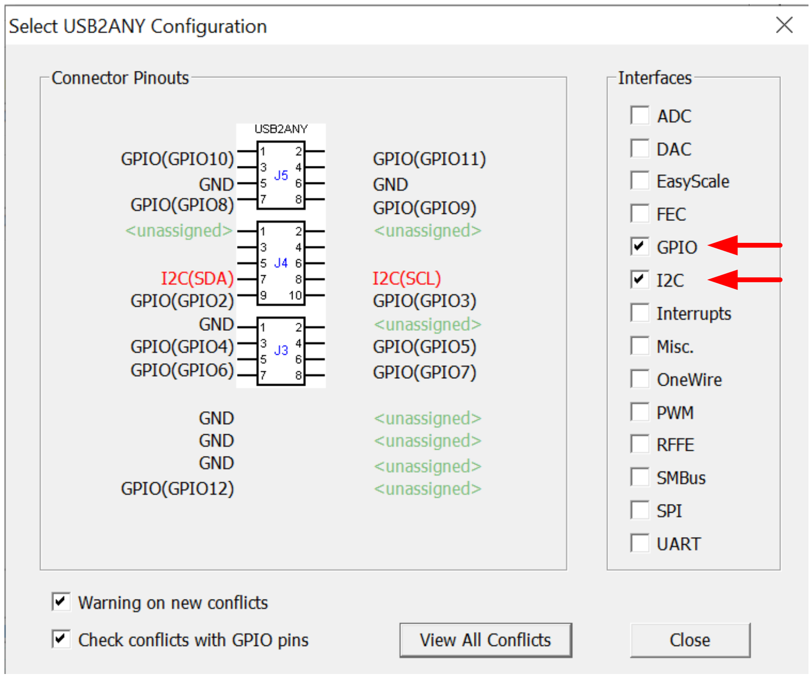


Figure 3-12. Select USB2ANY Configuration Interface

3. By clikcing upper left coner of the main interface, as shown in Figure 3-11, GPIO interface and I2C interface can be open.

4. Figure 3-13 shows the I2C interface. The I2C can be used to control the DA devices that generate voltage setting Vset and current setting Iset.

Before sending codes, click '3.3V OFF' button, and warit for the button to turn green and becomes '3.3V ON'.

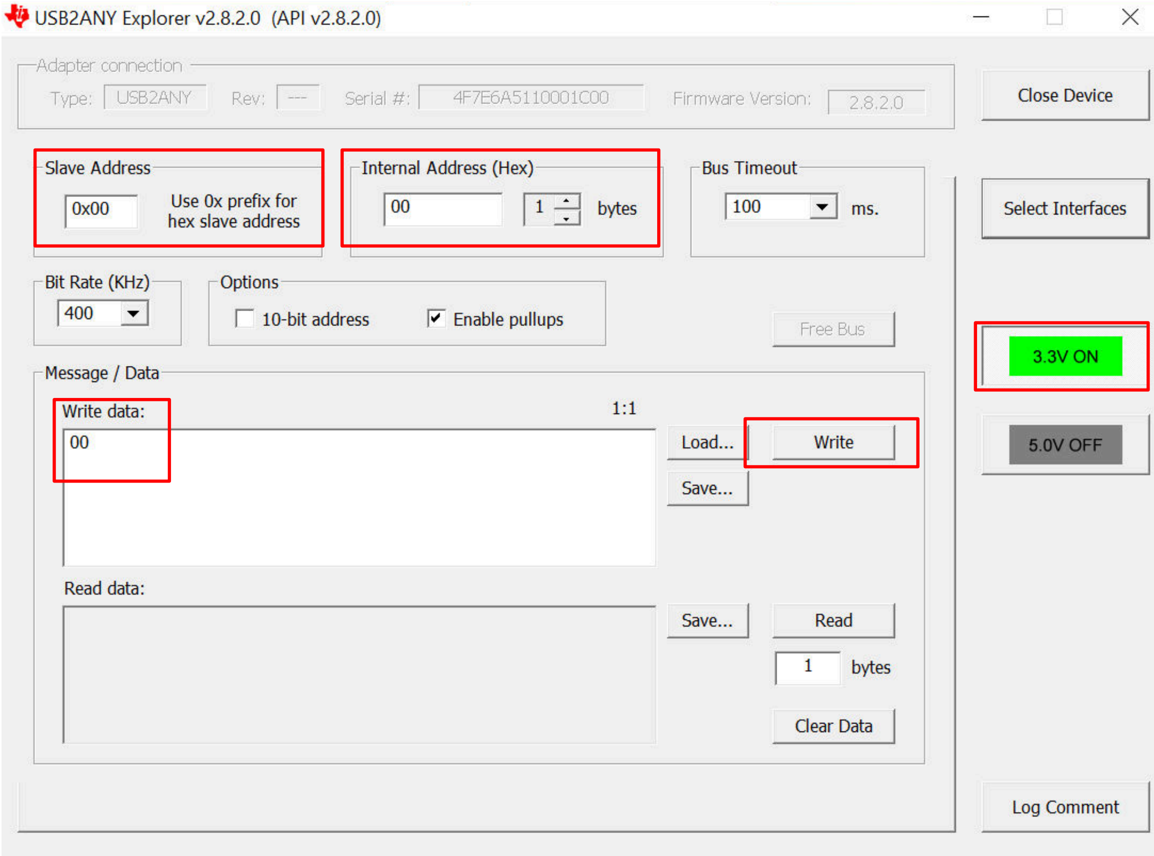


Figure 3-13. USB2ANY I2C Interface

The 'Slave address', 'Internal Address(Hex)' and 'Write data' , are combined to configure the Voltage and Current settings.

Table 3-1 shows the relationship among I2C codes, corresponding Vset, Iset and desired Voltage/ Current target.

Table 3-1. I2C code range and corresponding Vset, Iset

Slave address (Hex)	Internal Address (Hex)	Write data(Hex)	Voltage/ Current Setting (Hex)	Voltage/ Current Setting (Dec)	Vset/Iset voltage(V)	Desired Voltage tatget(V)/ Current target(A)
4D	00	00	000	0	0	0
4D	0F	FF	FFF	4095	5	5(1)
4C	00	00	000	0	0	-0.3
4C	0F	FF	FFF	4095	5	24.4(2)

(1) The relationship between desired voltage charge target and the voltage setting is the same as in Equation 3 .
(2) The relationship between desired charge/discharge current and current setting is the same as in Equation 1 and Equation 2.

The 'Slave address' determines which parameter to be set. '4D' is for voltage setting and '4C' is for current setting.

'Internal Address(Hex)' and 'Write data' are combined into one value ranges from 0x000 to 0xFFF, representing the DA devices output from 0 to 5 V. The relationship is linear. For a typicl desired voltage/current setting, choose a value between 0x000 and 0xFFF.

Below is the code explames:

when target Vbat is 4 V, we can calculate that the Voltage setting(Dec) is 3276 and the Voltage setting(Hex) is 0xCCC;

The sent codes are as following:

Slave address = 0D, Internal Address = 0C and Write Data = CC.

When target Icharge/Idischarge is 5 A, we can calculate that the Current setting(Dec) is 883 and the Current setting(Hex) is 0x373;

The sent codes are as following:

Slave address = 0C, Internal Address = 03 and Write Data = 73.

After filling in the proper codes, click 'Write' button to enable the setting.

5. Figure 3-14 shows the GPIO interface.

GPIO6 and GPIO7 need to be set as Output.

GPIO6 controls the EN signal, 1 is High and 0 is Low.

GPIO7 controls the MODE signal, 1 is for Buck Mode selected and 0 is for Boost Mode selected.

Figure 3-14. USB2ANY GPIO Interface

3.4.4 Test Procedure with USB2ANY

For EVM operating with USB2ANY for Boost Mode or Battery Discharge Mode,

1. Set up the bench as shown in Figure 3-1.

2. Refer to the jumper setting described in Table 2-2.

JP1 needs to be set as all open.

JP2 needs to be set as all open.

JP3 needs to be default.

JP4 needs to be set as (1,2) closed for DA reference as current setting.

JP5 needs to be set as (1,2) closed for DA reference as voltage setting.

3. Set PS-High to 15 V and PS-Low to 3.6 V and turn on.

4. Set E-Load-High to CC mode 5 A and turn on.

5. Open USB2ANY explorer, click 'Select Interfaces' , choose the 'GPIO' and '12C'.

6. Open GPIO interface, set GPIO6 and GPIO7 to be output, 'GPIO6 =1' and 'GPIO7 = 0'.

7. Open I2C interface, write in proper codes to set the voltage reference setting Vset, Vset needs to be higher than battery voltage(3.6 V).

8. Write in proper codes to set the current reference setting Iset. The converter starts switching when the comp voltage reaches 0.65 V typically.

9. After the tests are done, the converter can be disabled by setting 'GPIO6 = 0'.

10. Turn off all the Power supplies and E-Loads.

For EVM operating with USB2ANY for Buck Mode or Battery Charge Mode,

1. Set up the bench as shown in Figure 3-1.

2. Refer to the jumper setting described in Table 2-2.

JP1 needs to be set as all open.

JP2 needs to be set as all open.

JP3 needs to be default.

JP4 needs to be set as (1,2) closed for DA reference as current setting.

JP5 needs to be set as (1,2) closed for DA reference as voltage setting.

3. Set PS-High to 15 V and PS-Low to 3.6 V and turn on.

4. Set E-Load-Low to CC mode 20 A and turn on.

5. Open USB2ANY explorer, Click 'Select Interfaces', then select 'GPIO' and 'I2C'.

6. Open GPIO interface, set GPIO6 and GPIO7 to be output, 'GPIO6 =1' and 'GPIO7 =1'.

7. Open I2C interface, write in proper codes to set the voltage reference setting Vset, Vset need to be higher than battery voltage(3.6 V).

8. Write in proper codes to set the current reference setting Iset. The converter starts switching when the comp voltage reaches 0.65 V typically.

9. After all the tests are done, the converter can be disabled by setting 'GPIO6 = 0'.

10. Turn off all the Power supplies and E-Loads.

4 Schematic, Bill of Materials, and Board Layout

This section provides the TPS61289EVM-113 schematic, bill of materials (BOM), and board layout.

4.1 Schematic

Figure 4-1 shows the schematic of the TPS61289EVM-113.

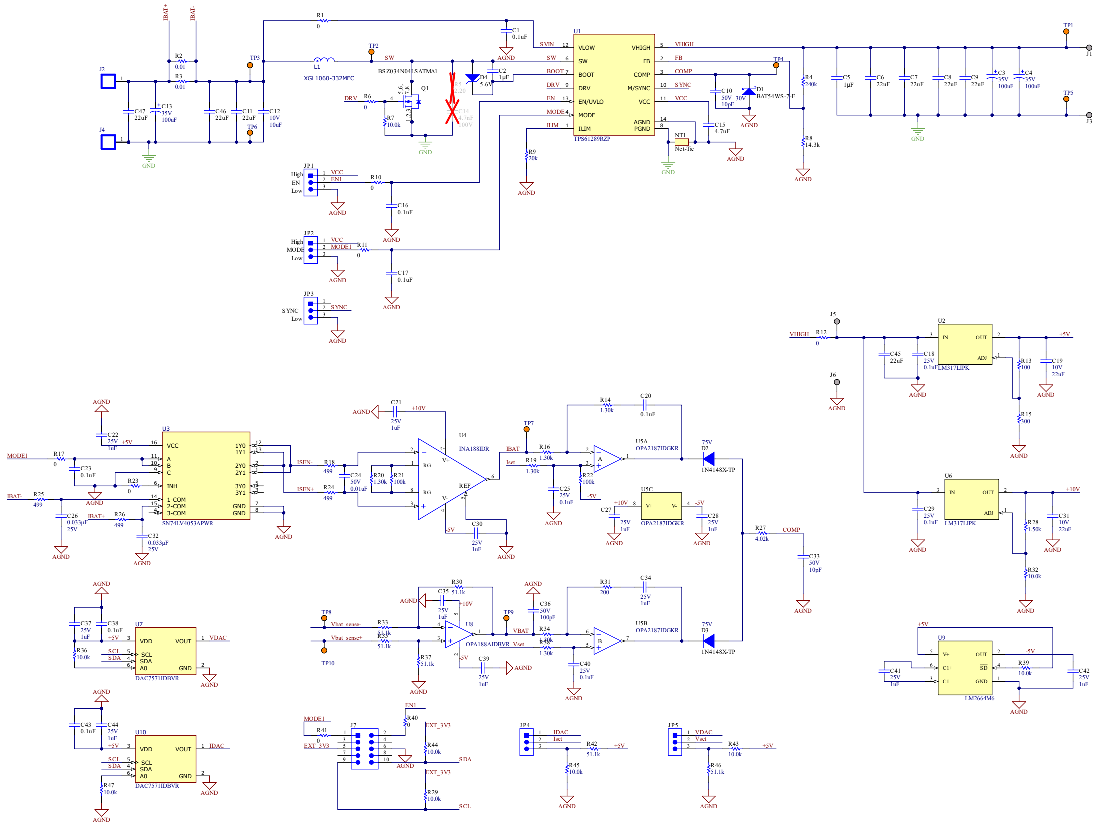


Figure 4-1. TPS61289EVM-113 Schematic

4.2 Bill of Materials

Table 4-1 lists the BOM of the TPS61289EVM-113.

Table 4-1. Bill of Materials

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
C1, C16, C17, C20, C23, C38, C43	7	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H104K050BB	TDK
C2, C5	2	1uF	CAP, CERM, 1 µF, 50 V,+/- 20%, X5R, AEC-Q200 Grade 3, 0603	0603	GRT188R61H105ME13D	MuRata
C3, C4, C13	3	100uF	CAP, AL, 100 uF, 35 V, +/- 20%, 0.34 ohm, AEC-Q200 Grade 2, SMD	SMT Radial D8	EEE-FK1V101XP	Panasonic
C6, C7, C8, C9, C11, C45, C46, C47	8	22uF	CAP, CERM, 22 uF, 25 V, +/- 10%, X7R, 1210	1210	GRM32ER71E226KE15L	MuRata
C10, C33	2	10pF	CAP, CERM, 10 pF, 50 V,+/- 2.5%, C0G/NP0, AEC-Q200 Grade 1, 0402	0402	04025U100CAT2A	AVX
C12	1	10uF	CAP, CERM, 10 uF, 10 V, +/- 10%, X6S, 0805	0805	GRM21BC81A106KE18L	MuRata
C15	1	4.7uF	CAP, CERM, 4.7 uF, 10 V, +/- 10%, X5R, 0603	0603	0603ZD475KAT2A	AVX
C18, C25, C29, C40	4	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0402	0402	GRM155R71E104KE14D	MuRata
C19, C31	2	22uF	CAP, CERM, 22 uF, 10 V, +/- 20%, X5R, 0603	0603	GRM188R61A226ME15D	MuRata
C21, C22, C27, C28, C30, C34, C35, C37, C39, C41, C42, C44	12	1uF	CAP, CERM, 1 uF, 25 V, +/- 10%, X5R, 0402	0402	C1005X5R1E105K050BC	TDK
C24	1	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, 0402	0402	GRM155R71H103KA88D	MuRata
C26, C32	2	0.033uF	CAP, CERM, 0.033 µF, 25 V,+/- 10%, X7R, 0402	0402	CC0402KRX7R8BB333	Yageo
C36	1	100pF	CAP, CERM, 100 pF, 50 V, +/- 10%, X7R, 0402	0402	CC0402KRX7R9BB101	Yageo America
D1	1	30V	Diode, Schottky, 30 V, 0.2 A, SOD-323	SOD-323	BAT54WS-7-F	Diodes Inc.
D2, D3	2	75V	Diode, Switching, 75 V, 0.3 A, SOD-523	SOD-523	1N4148X-TP	Micro Commercial Components
D4	1	5.6V	Diode, Zener, 5.6 V, 300 mW, SOD-523	SOD-523	BZT52C5V6T-7	Diodes Inc.
FID1, FID2, FID3	3		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A

Table 4-1. Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
J1, J3, J5, J6	4		Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
J2, J4	2		TERMINAL SCREW PC 30AMP, TH	12.9x6.3x7.9 mm	8199	Keystone
J7	1		Header (shrouded), 100mil, 5x2, Gold, TH	TH, 10-Leads, Body 8.5x20mm, Pitch 2.54mm	XG4C-1031	Omron Electronic Components
JP1, JP2, JP3, JP4, JP5	5		Header, 100mil, 3x1, Tin, TH	Header, 3 PIN, 100mil, Tin	PEC03SAAN	Sullins Connector Solutions
L1	1	3.3uH	Shielded Power Inductors 3.3uH 22A 5.7mOhm	SMT2_10MM0_11MM3	XGL1060-332MEC	Coilcraft
Q1	1	40V	MOSFET, N-CH, 40 V, 40 A, 8-PG-TSDSON	8-PG-TSDSON	BSZ034N04LSATMA1	Infineon Technologies
R1, R10, R11, R17, R23, R40, R41	7	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R2, R3	2	0.01	RES, 0.01, 1%, 1 W, 2010	2010	CSRN2010FK10L0	Stackpole Electronics Inc
R4	1	240k	RES, 240 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402240KJNED	Vishay-Dale
R6	1	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	0805	ERJ-6GEY0R00V	Panasonic
R7	1	10.0k	RES, 10.0 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1002X	Panasonic
R8	1	14.3k	RES, 14.3 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040214K3FKED	Vishay-Dale
R9	1	20k	RES, 20 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040220K0JNED	Vishay-Dale
R12	1	0	RES, 0, 5%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	CRCW12060000Z0EA	Vishay-Dale
R13	1	100	RES, 100, 1%, 0.1 W, 0603	0603	RC0603FR-07100RL	Yageo
R14, R16, R19, R20, R34, R38	6	1.30k	RES, 1.30 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K30FKED	Vishay-Dale
R15	1	300	RES, 300, 1%, 0.1 W, 0603	0603	RC0603FR-07300RL	Yageo
R18, R24, R25, R26	4	499	RES, 499, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402499RFKED	Vishay-Dale
R21, R22	2	100k	RES, 100 k, 1%, 0.0625 W, 0402	0402	RC0402FR-07100KL	Yageo America
R27	1	4.02k	RES, 4.02 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K02FKED	Vishay-Dale
R28	1	1.50k	RES, 1.50 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K50FKED	Vishay-Dale
R29, R32, R36, R39, R43, R44, R45, R47	8	10.0k	RES, 10.0 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K0FKED	Vishay-Dale

Table 4-1. Bill of Materials (continued)

Designator	QTY	Value	Description	Package Reference	Part Number	Manufacturer
R30, R33, R35, R37, R42, R46	6	51.1k	RES, 51.1 k, 1%, 0.0625 W, 0402	0402	RC0402FR-0751K1L	Yageo
R31	1	200	RES, 200, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402200RJNED	Vishay-Dale
SH-JP1, SH-JP2, SH-JP3, SH-JP4, SH-JP5	5		Shunt, 100mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10	10		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone Electronics
U1	1		26-V, 20-A Stackable Bi-directional BUCK/BOOST Converter	VQFN-HR14	TPS61289RZP	Texas Instruments
U2, U6	2		3/8 Pin 100mA Adjustable Positive Regulator, PK0003A (SOT-3)	PK0003A	LM317LIPK	Texas Instruments
U3	1		3 Circuit IC Switch 2:1 75Ohm 16-TSSOP	TSSOP16	SN74LV4053APWR	Texas Instruments
U4	1		36-V, Zero-Drift, Rail-to-Rail-Out Instrumentation Amplifier, D0008A (SOIC-8)	D0008A	INA188IDR	Texas Instruments
U5	1		1μV Vos, 0.005μV/°C, Rail-to-Rail Output, Low-Power 36V Zero-Drift Operational Amplifier, DGK0008A (VSSOP-8)	DGK0008A	OPA2187IDGKR	Texas Instruments
U7, U10	2		Low-Power Rail-To-Rail Output 12-Bit I2C Input DAC 6-SOT-23 -40 to 105	SOT23-6	DAC7571IDBVR	Texas Instruments
U8	1		Precision, Low Noise, Rail-to-Rail Output, Zero-Drift Operational Amplifier, 4 to 36 V, -40 to 125 degC, 5-pin SOT23 (DBV5), Green (RoHS & no Sb/Br)	DBV0005A	OPA188AIDBVR	Texas Instruments
U9	1		Switched Capacitor Voltage Converter, 6-pin SOT-23	DBV0006A	LM2664M6	Texas Instruments
C14	0	4700pF	CAP, CERM, 4700 pF, 100 V, +/- 10%, X7R, 0603	0603	06031C472KAT2A	AVX
R5	0	2.2	RES, 2.20, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	ERJ-8RQF2R2V	Panasonic

4.3 Board Layout

The TPS61289EVM-113 board is a 4-layer PCB. The top and bottom layers copper thickness are 2-oz. The two inner layers copper thickness are 1-oz. Figure 4-2 and Figure 4-5 show the top view and bottom view, respectively. Figure 4-3 and Figure 4-4 show the inner layer 1 and inner layer 2, respectively.

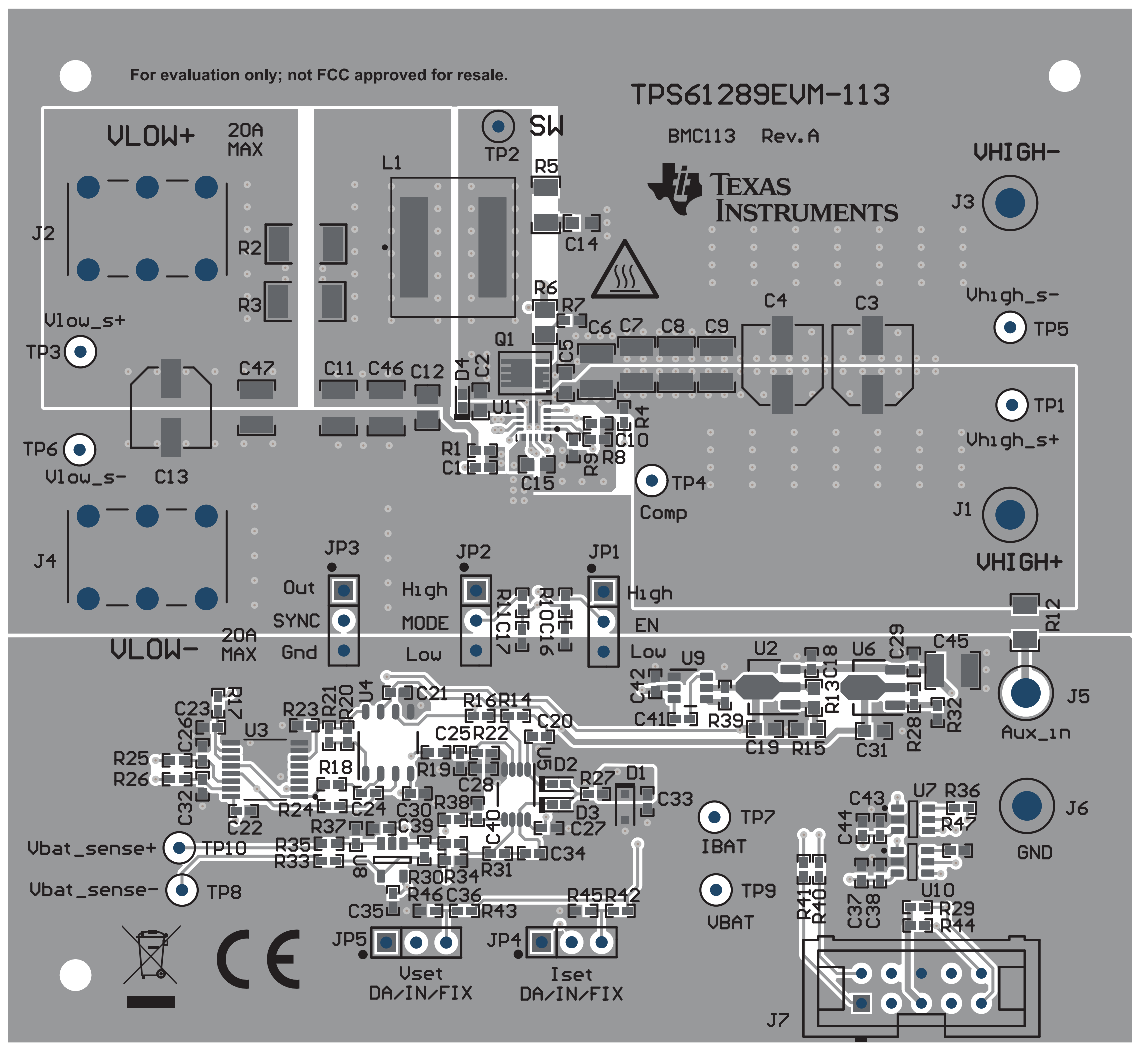


Figure 4-2. TPS61289EVM-113 Top-Side Layout

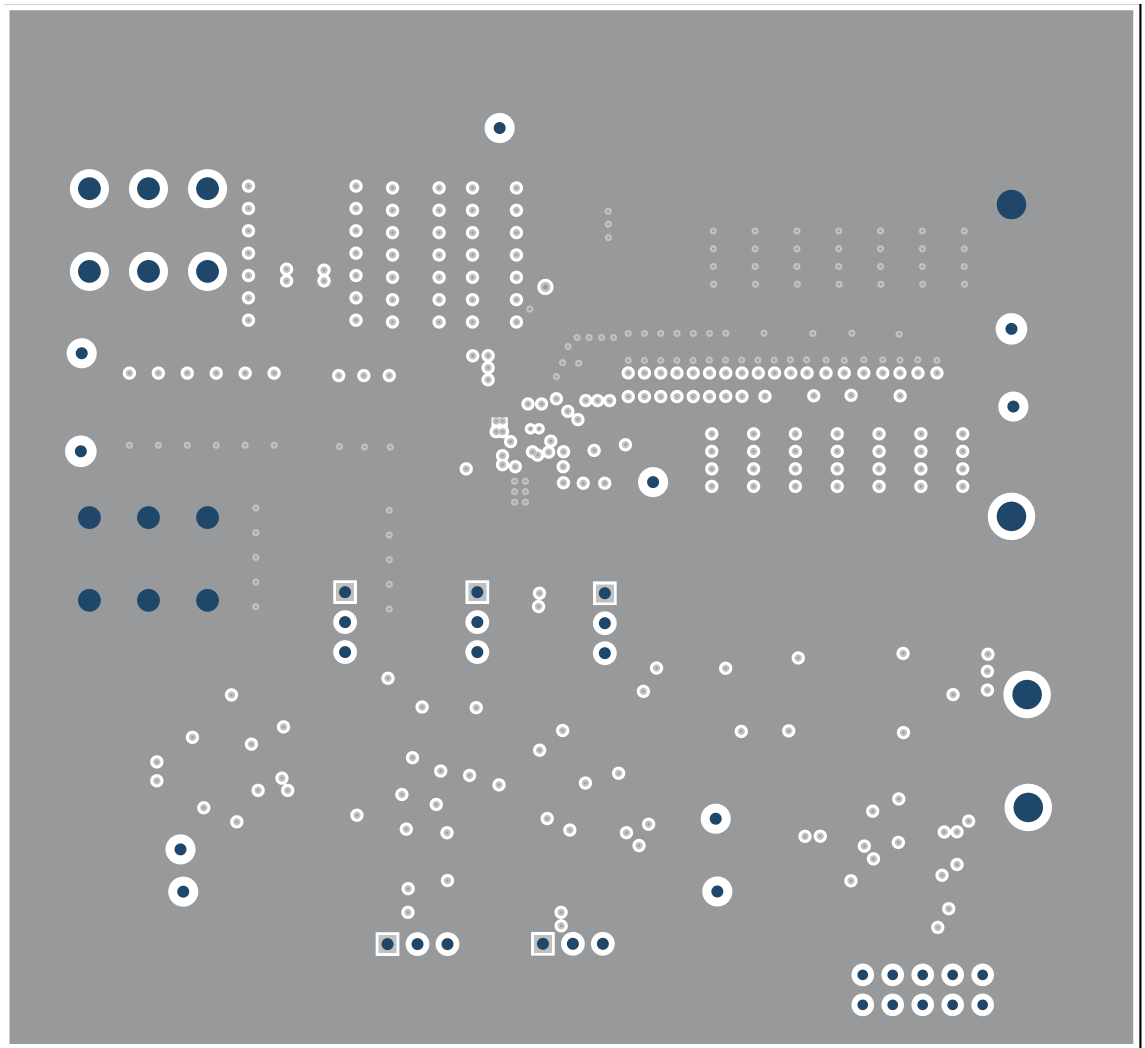


Figure 4-3. TPS61289EVM-113 Inner Layer1 Layout

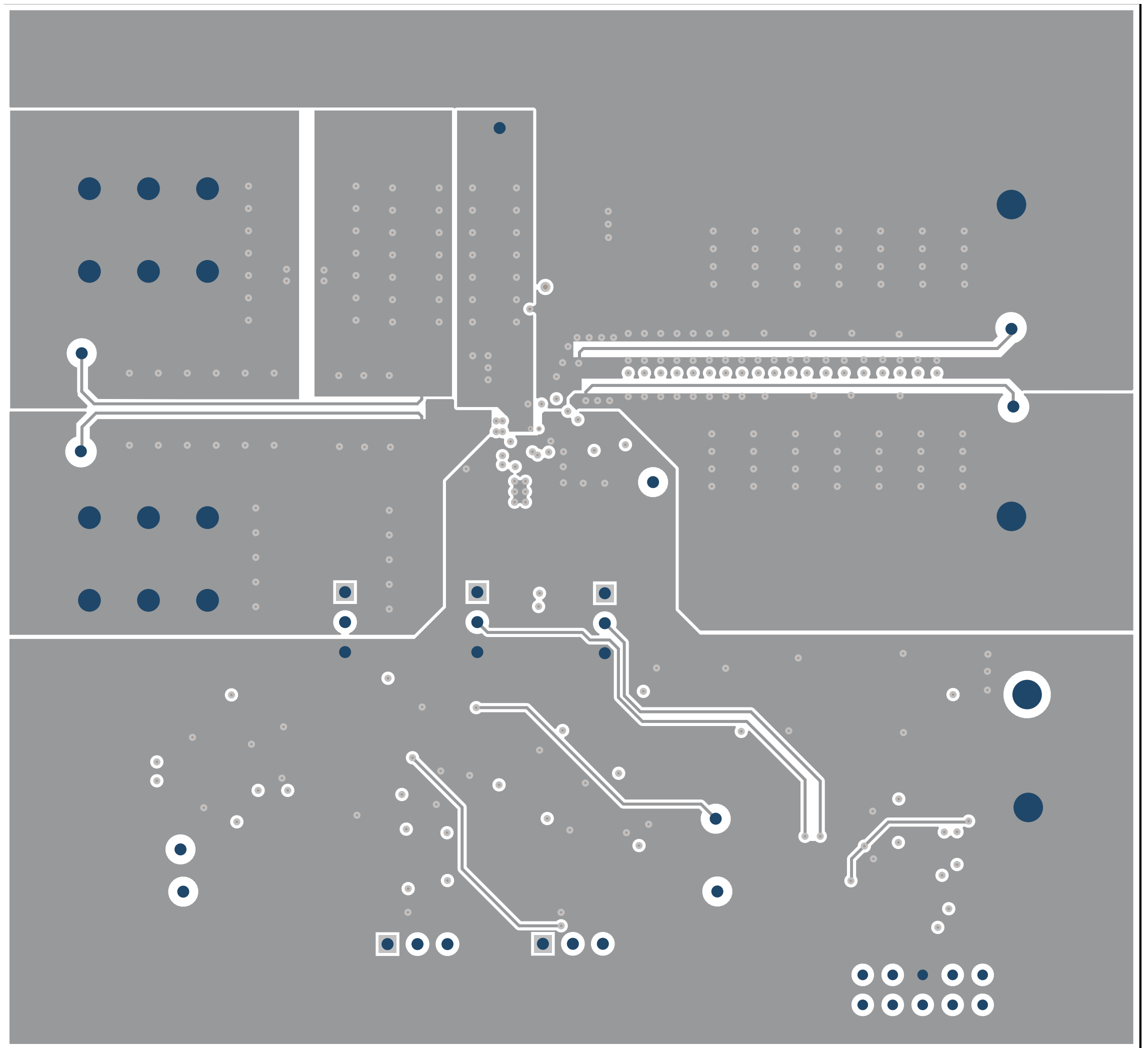


Figure 4-4. TPS61289EVM-113 Inner Layer2 Layout

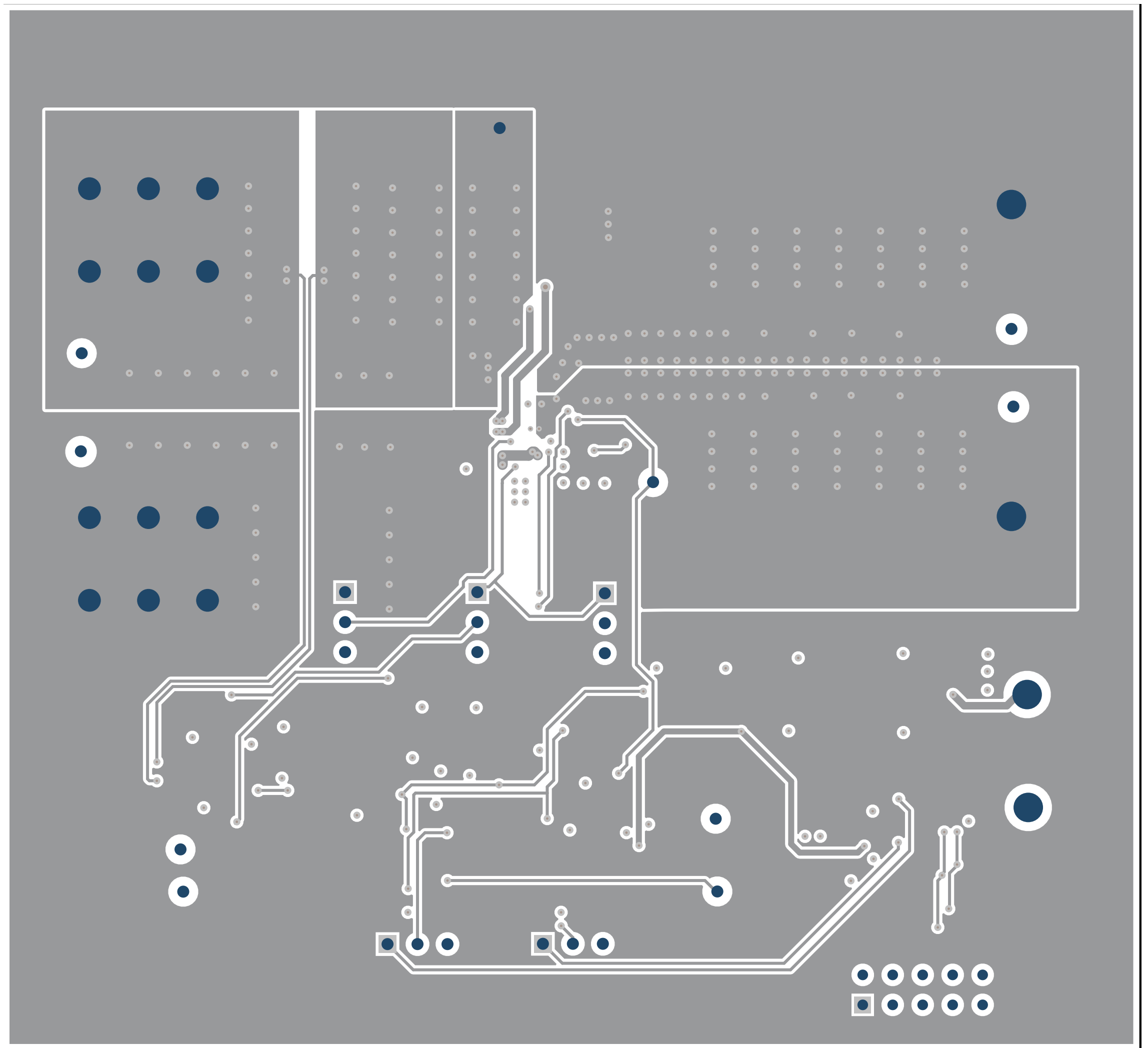


Figure 4-5. TPS61289EVM-113 Bottom-Side Layout

5 Revision History

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

DATE	REVISION	NOTES
November 2023	*	Initial Release