

# TPS55289 Buck-Boost Converter Evaluation Module User's Guide



## ABSTRACT

This user's guide describes the characteristics, operation, and the use of the TPS55289EVM-093 evaluation module (EVM). The EVM contains the TPS55289, a high-performance, high-efficiency synchronous buck-boost converter that integrates four MOSFETs. The user's guide includes the following:

- EVM specifications
- Recommended test setup
- Schematic diagram
- Bill of materials
- Board layout

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## 1 Introduction

### 1.1 Performance Specification

Table 1-1 provides a summary of the TPS55289 EVM performance specifications. All specifications are given for an ambient temperature of 25°C.

**Table 1-1. Performance Specification Summary**

Parameter	Test Condition	Value	Unit
Input voltage		3.0–30	V
Output voltage		0.8–22	V
Maximum output current	$V_{IN} \geq 5\text{ V}, V_{OUT} = 10\text{ V}$	3	A
	$V_{IN} \geq 6\text{ V}, V_{OUT} = 12\text{ V}$		
	$V_{IN} \geq 12\text{ V}, V_{OUT} = 20\text{ V}$		
Default switching frequency		400	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.

#### 1.2.1 Modification

This EVM requires an appropriate I<sup>2</sup>C interface, such as the TI USB2ANY, to configure the TPS55289.

## 2 Connector, Test Point, and Jumper Descriptions

This section describes how to properly connect, set up, and use the TPS55289EVM-093.

### 2.1 Connector and Test Point Descriptions

This EVM includes I/O connectors and test points as shown in [Table 2-1](#). The power supply must be connected to input connectors, J1 and J2. The load must be connected to output connectors, J3 and J4.

**Table 2-1. Connectors and Test Points**

Reference Designator	Description
J1	Input voltage positive connection
J2	Input voltage return connection
J3	Output voltage connection
J4	Output voltage return connection
JP4	I <sup>2</sup> C connector

### 2.2 Jumper Configuration

#### 2.2.1 JP1 (ENABLE)

The JP1 jumper enables the device. By default, this jumper is set to the OFF position. Put this jumper in the ON position to enable the device.

#### 2.2.2 JP6 (SYNC)

The JP6 jumper is for frequency dithering selection. Placing a jumper across JP6 disables the frequency dithering function. Leave JP6 open when using the frequency dithering function.

#### 2.2.3 JP7 (I<sup>2</sup>C Target Address Selection)

The JP7 jumper is for the I<sup>2</sup>C target address selection. By default, this jumper is set to the VCC position and device I<sup>2</sup>C target address is 74H. Place a jumper across MODE and AGND to set the I<sup>2</sup>C target address to 75H.

#### 2.2.4 JP8 (Internal or External VCC Selection)

The JP8 jumper is for the internal LDO or external VCC selection. By default, the jumper is set to the VCC position and the device selects an internal LDO as the VCC source.

To minimize the power dissipation of the internal LDO when both input voltage and output voltage are high, an external 5-V power supply can be applied at the VCC pin to supply the TPS55289. Place a jumper across EXT<sub>VCC</sub> and AGND to set the device VCC source externally. The external 5-V power supply must have at least 100-mA output current capability and must be within the 4.75-V to 5.5-V regulation range.

#### 2.2.5 JP9 and JP10 (External Feedback and Internal Feedback Selection)

The JP9 jumper is for the external feedback or the internal feedback selection. By default, this jumper is set to the FB\_INT position. Place this jumper in the FB\_EXT position for the external output voltage feedback.

The JP10 jumper is for the external feedback connection. Place a jumper across JP10 when using external feedback. Leave JP10 open when uses internal feedback.

When using external output voltage feedback, the output voltage is determined by [Equation 1](#):

$$V_{\text{OUT}} = V_{\text{REF}} \times \left( 1 + \frac{R_{\text{FB\_UP}}}{R_{\text{FB\_BT}}} \right) \quad (1)$$

It is recommended to use 100 kΩ for the up resistor, R<sub>FB\_UP</sub>. The reference voltage, V<sub>REF</sub>, at the FB/INT pin is programmable from 45 mV to 1.2 V by writing a 11-bit data into registers 00H and 01H.

### 3 Test Procedure

1. Set the power supply current limit to 10 A. Set the power supply to approximately 12 V. Turn off the power supply. Connect the positive output of the power supply to J1 and the negative output to J2.
2. Connect the load to J3 for the positive connection and connect the load J4 for the negative connection.
3. Turn on the power supply.
4. Set the JP1 jumper across EN and ON. Enable the IC with the GUI. The default output voltage is 5 V.
5. Set the output voltage to the target value on the GUI user interface page.
6. Slowly increase the load while monitoring the output voltage between J3 and J4. The output voltage must remain in regulation when the load current is lower than 5 A.
7. Slowly sweep the input voltage from 5 V to 20 V. The output voltage must remain in regulation when the load current is lower than the maximum load current specified in [Table 2-1](#).
8. Turn off the load and power supply. Then, turn on the load to discharge the output capacitors.

## 4 Software User Interface

### 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.

### 4.2 GUI Installation

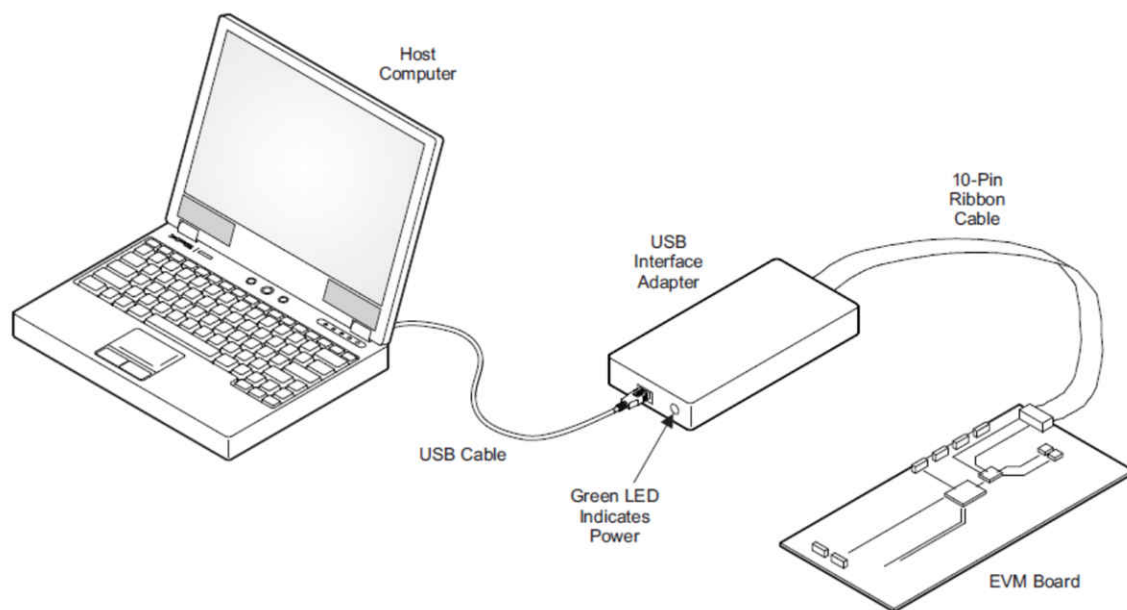
A graphical user interface (GUI) is available from on <https://dev.ti.com/gallery/info/TPS55289/TPS55289>. The GUI allows simple and convenient programming of the device through the TI USB2ANY device.

1. Download the zip file for the desired platform.
2. Download GUI Composer Runtime.
3. Extract the zip folder and install the GUI.
4. Run through the installation steps. The installation wizard might prompt for GUI Composer Runtime. This should be done automatically.
5. Open the GUI – TPS55289.

### 4.3 Interface Hardware Setup

Connect the USB2ANY adapter to your PC using the supplied USB cable. Connect the TPS55289EVM connector JP4 to the USB2ANY adapter using the supplied 10-pin ribbon cable. The connectors on the ribbon cable are keyed to prevent incorrect installation.

Figure 4-1 shows a quick connection overview.

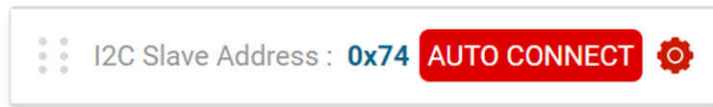


**Figure 4-1. Quick Connection Overview**

### 4.4 User Interface Operation

The TPS55289EVM board can be enabled to work by the following steps:

1. Set JP1 to the ON position. Turn on the power supply.
2. Open the TPS55289EVM GUI.
3. Click the auto connect button on the target address widget (Figure 4-2). It will automatically check for target addresses (0x74, 0x75) and connect the GUI with the device. After the GUI and device are connected, the GUI reads all eight registers and shows a notification (Figure 4-3).

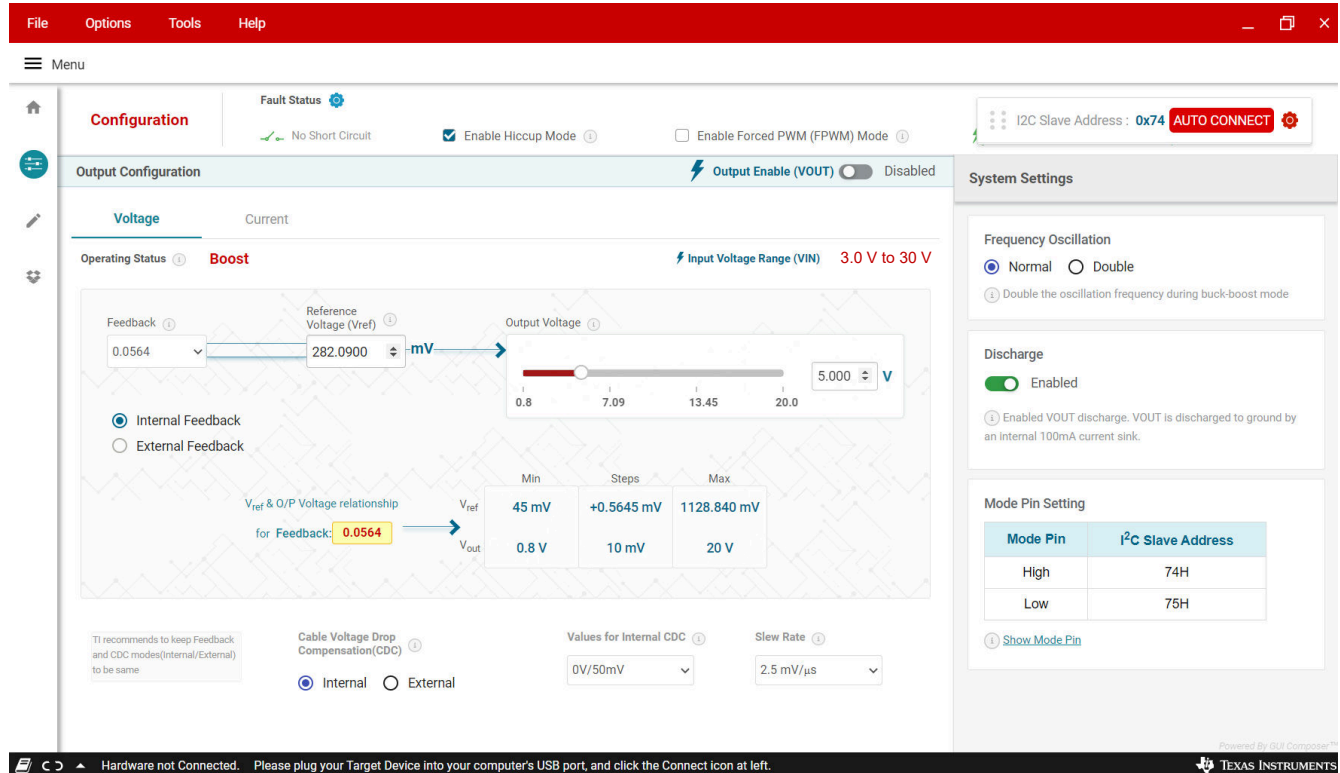


**Figure 4-2. GUI Auto Connect Button**



**Figure 4-3. GUI Auto Connect Notification**

4. Click the start button. It will show the GUI user interface of TPS55289EVM-093 (Figure 4-4).



**Figure 4-4. GUI User Interface of TPS55289EVM-093**

5. Click the Enable button (Figure 4-5). The default output voltage is 5 V.

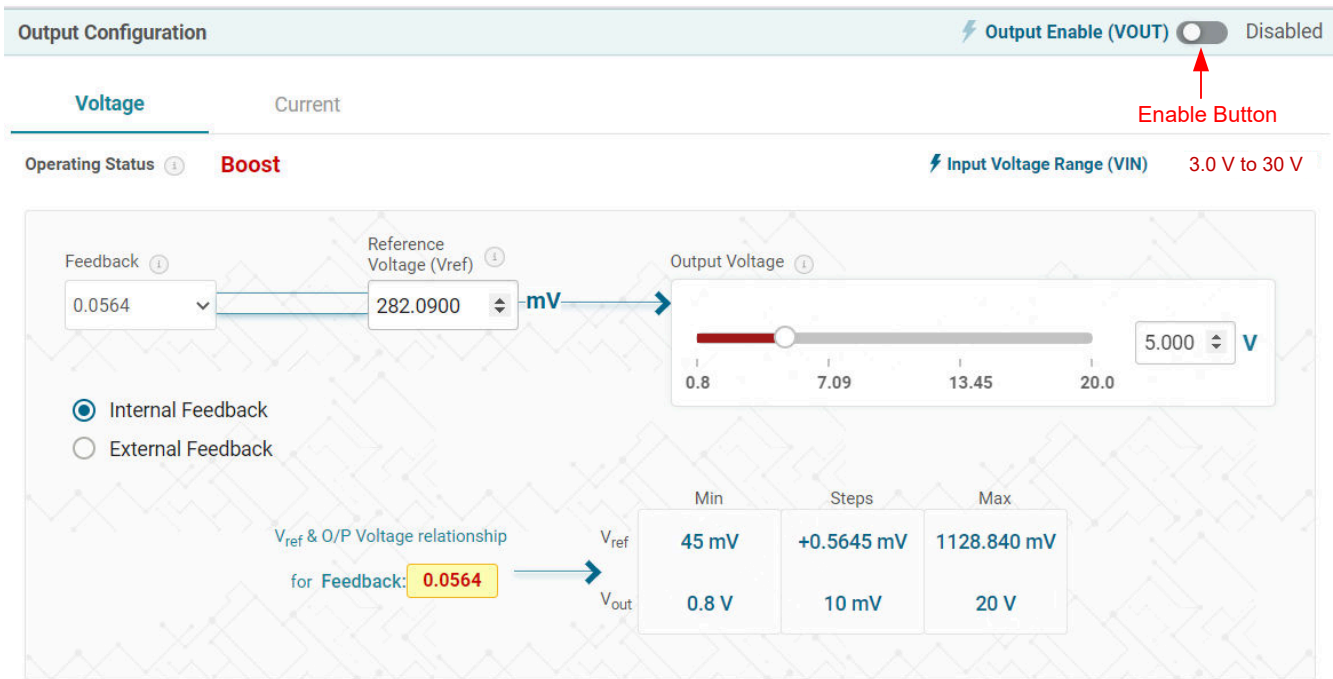


Figure 4-5. ENABLE Button

- Set the output voltage, current limit point, and so forth according to the design target. If the maximum load current is  $\geq 5$  A, uncheck the 'Enable Current Limit' check box or increase the current limit value (Figure 4-6).



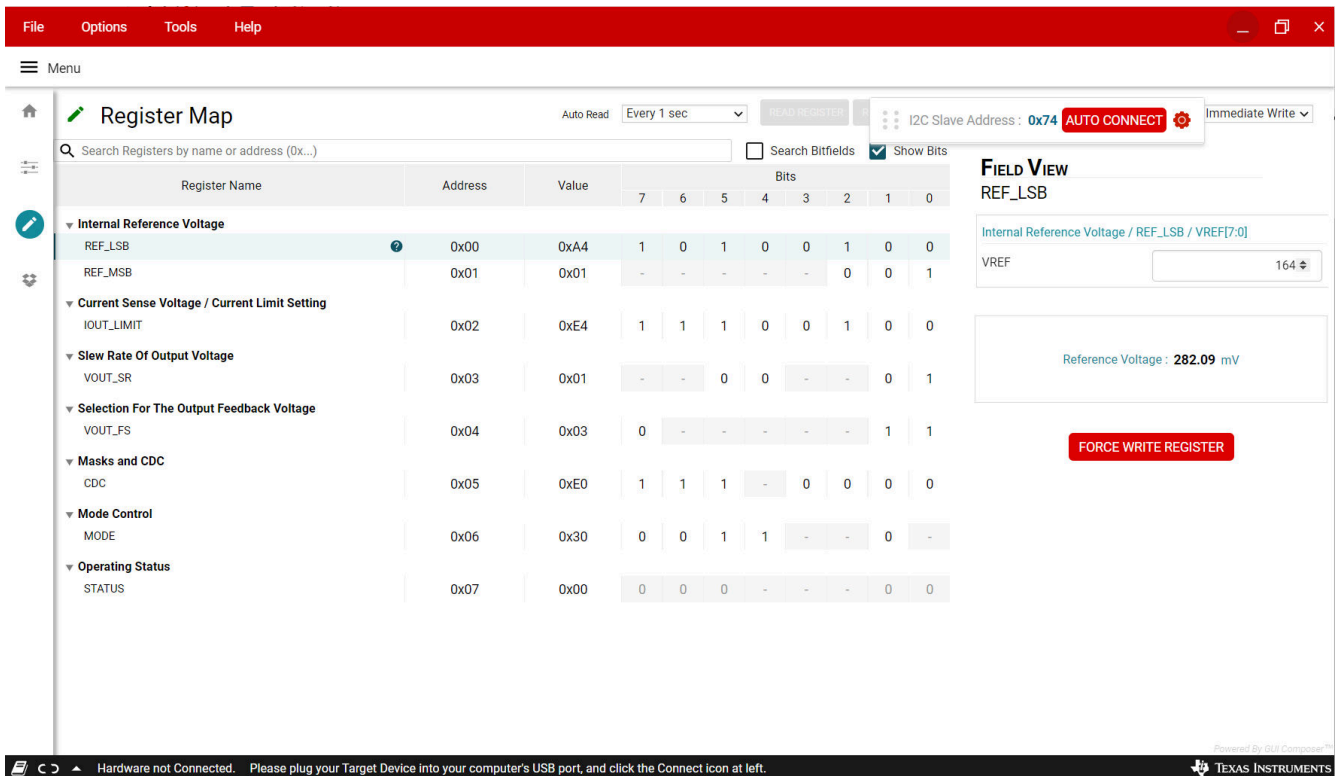
When  $I_{out} \geq 5A$ :  
 untick the 'Enable Current Limit' check box  
 or  
 increase the current limit value

Figure 4-6. Output Current Limit Point Setting

## 4.5 Register Map Screen

The Register Map screen shows a register-wise view of all parameters. Here, single registers can be read or written to the device (if applicable). Refer to the [TPS55289 30-V, 8-A Buck-Boost Converter with I<sup>2</sup>C Interface Data Sheet](#) for a detailed description of the TPS55289 registers.





The screenshot displays the 'Register Map' interface. At the top, there is a red header bar with 'File', 'Options', 'Tools', and 'Help' menus. Below this is a 'Menu' icon. The main area is titled 'Register Map' and includes an 'Auto Read' dropdown set to 'Every 1 sec', a 'READ REGISTER' button, an 'I2C Slave Address' field set to '0x74', an 'AUTO CONNECT' button, and an 'Immediate Write' dropdown. A search bar is present with the text 'Search Registers by name or address (0x...)'. There are also checkboxes for 'Search Bitfields' and 'Show Bits'.

Register Name	Address	Value	Bits							
			7	6	5	4	3	2	1	0
<b>Internal Reference Voltage</b>										
REF_LSB	0x00	0xA4	1	0	1	0	0	1	0	0
REF_MSB	0x01	0x01	-	-	-	-	-	0	0	1
<b>Current Sense Voltage / Current Limit Setting</b>										
IOUT_LIMIT	0x02	0xE4	1	1	1	0	0	1	0	0
<b>Slew Rate Of Output Voltage</b>										
VOUT_SR	0x03	0x01	-	-	0	0	-	-	0	1
<b>Selection For The Output Feedback Voltage</b>										
VOUT_FS	0x04	0x03	0	-	-	-	-	-	1	1
<b>Masks and CDC</b>										
CDC	0x05	0xE0	1	1	1	-	0	0	0	0
<b>Mode Control</b>										
MODE	0x06	0x30	0	0	1	1	-	-	0	-
<b>Operating Status</b>										
STATUS	0x07	0x00	0	0	0	-	-	-	0	0

On the right side, the 'FIELD VIEW' for 'REF\_LSB' is shown. It includes the text 'Internal Reference Voltage / REF\_LSB / VREF[7:0]', a 'VREF' input field with a value of '164', and a 'Reference Voltage' display showing '282.09 mV'. A red 'FORCE WRITE REGISTER' button is located below the field view.

At the bottom of the interface, a status bar indicates 'Hardware not Connected. Please plug your Target Device into your computer's USB port, and click the Connect icon at left.' and includes the Texas Instruments logo.

Figure 4-7. GUI Register Map Screen

## 5 Schematic, Bill of Materials, and Board Layout

This section provides the TPS55289EVM-093 schematic, bill of materials (BOM), and board layout.

### 5.1 Schematic

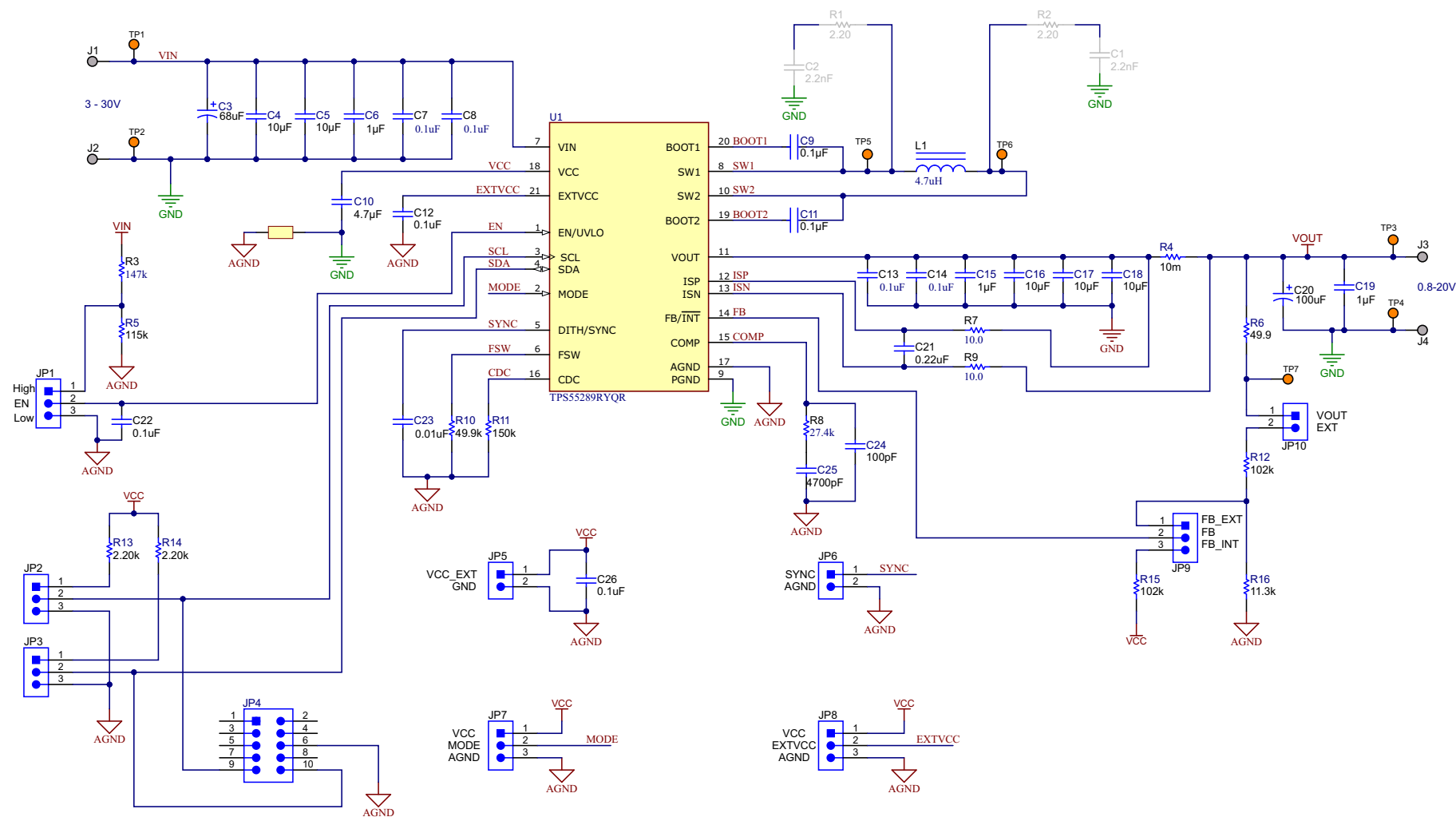


Figure 5-1. TPS55289EVM-093 Schematic

## 5.2 List of Materials

**Table 5-1. List of Materials**

Designator	Qty	Value	Description	Package	Part Number	Manufacturer
C3	1	68 $\mu$ F	CAP, Polymer Hybrid, 68 $\mu$ F, 50 V, $\pm$ 20%, 30 $\Omega$ , 8 $\times$ 10 SMD	8 $\times$ 10	EEHZA1H680P	Panasonic
C4, C5, C16–C18	5	10 $\mu$ F	CAP, CERM, 10 $\mu$ F, 50 V, $\pm$ 10%, X7R, AEC-Q200 Grade 1, 1206	1206	CGA5L1X7R1H106K160AC	TDK
C6, C15, C19	3	1 $\mu$ F	CAP, CERM, 1 $\mu$ F, 50 V, $\pm$ 20%, X5R, AEC-Q200 Grade 3, 0603	603	GRT188R61H105ME13D	MuRata
C7, C8, C13, C14	4	0.1 $\mu$ F	CAP, CERM, 0.1 $\mu$ F, 50 V, $\pm$ 20%, X7R, 0402	402	GRM155R71H104ME14D	MuRata
C9, C11	2		0.1 $\mu$ F $\pm$ 10% 50-V Ceramic Capacitor X8L 0603 (1608 Metric)	603	GCM188L81H104KA57D	Murata Electronics North America
C10	1	4.7 $\mu$ F	CAP, CERM, 4.7 $\mu$ F, 16 V, $\pm$ 10%, X5R, AEC-Q200 Grade 3, 0603	603	GRT188R61C475KE13D	MuRata
C12, C21, C22, C26	4	0.1 $\mu$ F	CAP, CERM, 0.1 $\mu$ F, 50 V, $\pm$ 10%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B3X7R1H104K050BB	TDK
C20	1	100 $\mu$ F	CAP, AL, 100 $\mu$ F, 35 V, AEC-Q200 Grade 2, SMD	D6.3 $\times$ L5.8mm	EEHZK1V101XP	Panasonic
C23	1	0.01 $\mu$ F	CAP, CERM, 0.01 $\mu$ F, 50 V, $\pm$ 10%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B3X7R1H103K050BB	TDK
C24	1	100 pF	CAP, CERM, 100 pF, 50 V, $\pm$ 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	402	CGA2B2C0G1H101J050BA	TDK
C25	1	4700 pF	CAP, CERM, 4700 pF, 50 V, $\pm$ 10%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B2X7R1H472K050BA	TDK
J1–J4	4		Terminal, Turret, TH, Double	Keystone1502-2	1502-2	Keystone
JP1–JP3, JP7–JP9	6		Header, 2.54 mm, 3 $\times$ 1, Gold, TH	Header, 2.54 mm, 3 $\times$ 1, TH	61300311121	Würth Elektronik
JP4	1		Header (shrouded), 100 mil, 5 $\times$ 2, Gold, TH	5 $\times$ 2 Shrouded header	5103308-1	TE Connectivity
JP5, JP6, JP10	3		Header, 2.54 mm, 2 $\times$ 1, Gold, TH	Header, 2.54 mm, 2 $\times$ 1, TH	61300211121	Würth Elektronik
L1	1	4.7 $\mu$ H	Inductor, Shielded, Composite, 4.7 $\mu$ H, 13.6 A, 0.01 $\Omega$ , SMD	7.2 $\times$ 7 $\times$ 7.5 mm	XAL7070-472MEB	Coilcraft
R3	1	147 k	RES, 147 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402147KFKE D	Vishay-Dale
R4	1		10 m $\Omega$ $\pm$ 1% 1-W Chip Resistor 1206 (3216 Metric) Automotive AEC-Q200, Current Sense, Moisture Resistant Metal Element	1206	CRF1206-FZ-R010ELF	Bourns
R5	1	115 k	RES, 115 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402115KFKE D	Vishay-Dale
R6	1	49.9	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040249R9FK ED	Vishay-Dale

**Table 5-1. List of Materials (continued)**

Designator	Qty	Value	Description	Package	Part Number	Manufacturer
R7, R9	2	10	RES, 10.0, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040210R0FKED	Vishay-Dale
R8	1	27.4 k	RES, 27.4 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040227K4FKED	Vishay-Dale
R10	1	49.9 k	RES, 49.9 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040249K9FKED	Vishay-Dale
R11	1	150 k	RES, 150 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402150KFKED	Vishay-Dale
R12, R15	2	102 k	RES, 102 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402102KFKED	Vishay-Dale
R13, R14	2	2.20 k	RES, 2.20 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022K20FKED	Vishay-Dale
R16	1	11.3 k	RES, 11.3 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040211K3FKED	Vishay-Dale
SH-JP1–SH-JP6	6		Shunt, 100 mil, Gold plated, Black	Shunt 2 pos. 100 mil	881545-2	TE Connectivity
TP1–TP7	7		Test Point, Miniature, Orange, TH	Orange Miniature Testpoint	5003	Keystone
U1	1		Buck-Boost Converter, Adjustable Output 0.8 V–22 V, 8 A, VQFN21	VQFN21	TPS55289RYQR	Texas Instruments
C1, C2	0	2200 pF	CAP, CERM, 2200 pF, 250 V, ±10%, X7R, 0805	805	GRM21AR72E222KW01D	MuRata
R1, R2	0	2.2	RES, 2.20, 1%, 0.25 W, AEC-Q200 Grade 0, 1206	1206	ERJ-8RQF2R2V	Panasonic

### 5.3 Board Layout

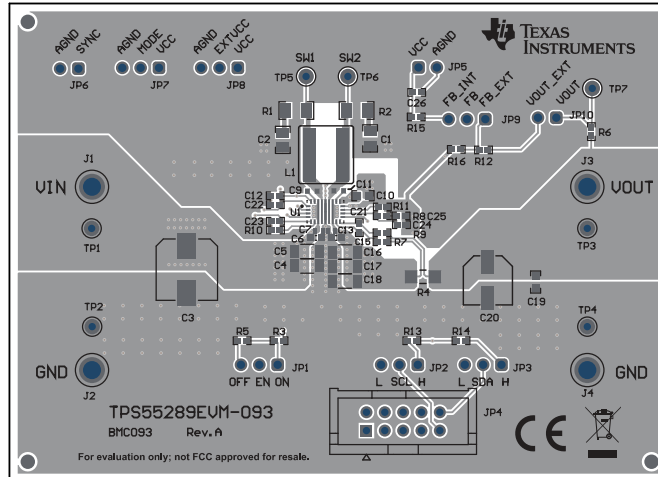


Figure 5-2. TPS55289EVM-093 Top-Side Layout

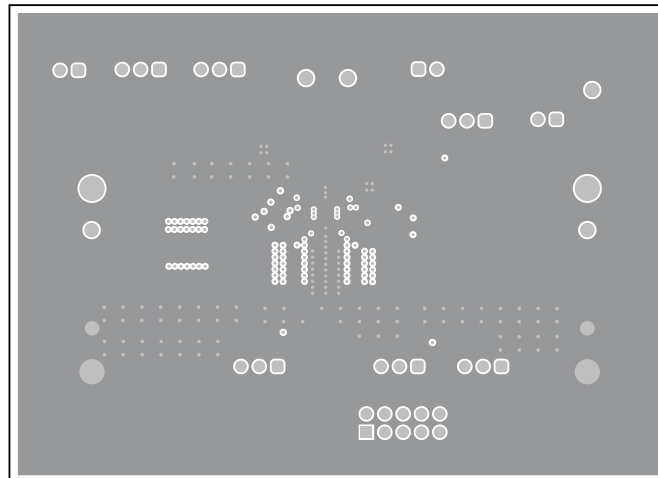


Figure 5-3. TPS55289EVM-093 Inner Layer1

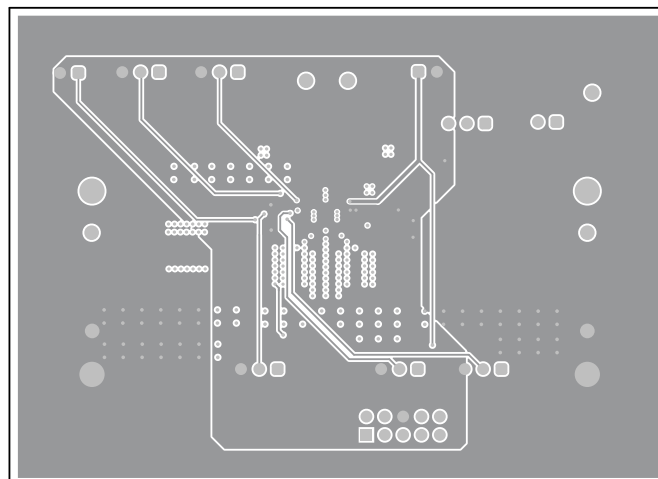
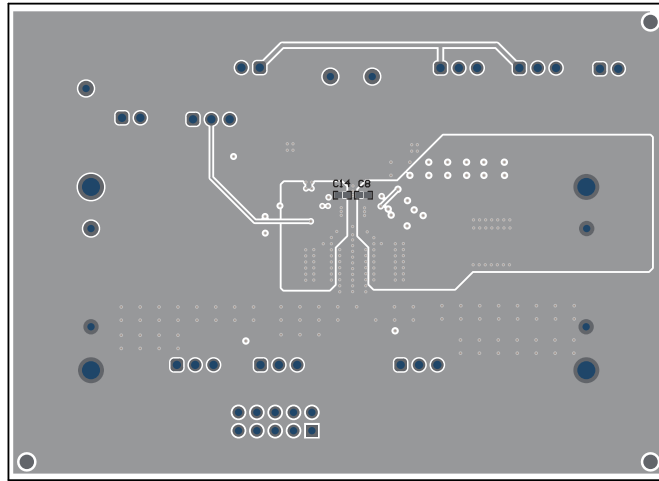


Figure 5-4. TPS55289EVM-093 Inner Layer2



**Figure 5-5. TPS55289EVM-093 Bottom-Side Layout**

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