Using the TPS544B25EVM-681 and TPS544C25EVM-681

User's Guide



Literature Number: SLUUB60A May 2015–Revised September 2015



TPS544B25EVM-681 and TPS544C25EVM-681, Single-**Output DC-to-DC Converters with PMBus Interface**

1 Introduction

The PWR681EVM evaluation module uses either the TPS544B25 or TPS544C25 devices. The TPS544B25 and TPS544C25 are highly integrated synchronous buck converters that are designed for up to 20-A or 30-A current output, respectively.

2 Description

The PWR681EVM is designed as a single output DC-DC converter that demonstrates either the TPS544B25 or the TPS544C25 in a typical low-voltage application while providing a number of test points to evaluate the performance. It uses a nominal 12-V input bus to produce a regulated 0.95-V output at up to either 20-A or 30-A of load current, depending on the device installed.

2.1 Typical End-User Applications

- High-Density Power Solutions
- Communications Equipment
- Servers and Computing Equipment
- Smart Power Systems

2.2 EVM Features

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- Regulated 0.95-V output up to 30-ADC, steady-state output current
- Configuarable features via the PMBus interface include:
 - Programmable Output Voltage via the PMBus Interface
 - Programmable UVLO, Soft Start, and Enable via the PMBus Interface
 - Programmable Overcurrent Warning, Fault Limits and Programmable Response to Faults via the **PMBus** Interface
 - Programmable Overvoltage, Undervoltage Warning, Fault Limit and Programmable Response to Faults via the PMBus Interface
 - Programmable external Overtemperature Warning, Fault Limit and Programmable Response to Faults via the PMBus Interface
- Convenient Test Points for Probing Critical Waveforms
- **Optional External Temperature Sensor**



3 EVM Electrical Performance Specifications

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Input	Characteristics				1	
	Voltage range	V _{IN}	4.5	12	18	V
	Maximum input current	V _{IN} = 8 V, I _O = 30 A			5	А
	No load input current	$V_{IN} = 12 \text{ V}, I_{O} = 0 \text{ A}$		42		mA
Outpu	ut Characteristics	-				
V _{OUT}	Output voltage	Output current = 10 A		0.95		V
I _{OUT}	Output load current	I _{OUT(min)} to I _{OUT(max)}	0		30	А
		Line regulation: input voltage = 4.5 V to 18 V		0.5%		
	Output voltage regulation	Load regulation: output current = 0 A to $I_{OUT(max)}$		0.5%		
V _{OUT}	Output voltage ripple	V _{IN} = 12 V, I _{OUT} = 30 A		20		mV_{PP}
V _{OUT}	Output overcurrent			36		А
Syste	ms Characteristics				1	
	Switching frequency	F _{sw}		500		kHz
V _{OUT}	Peak efficiency	V _{IN} = 12 V, I _O = 13 A, F _{SW} = 500 kHz		88%		
	Operating temperature	T _{oper}	0		105	°C

Table 1. PWR-681EVM Electrical Performance Specifications

Schematic

4 Schematic

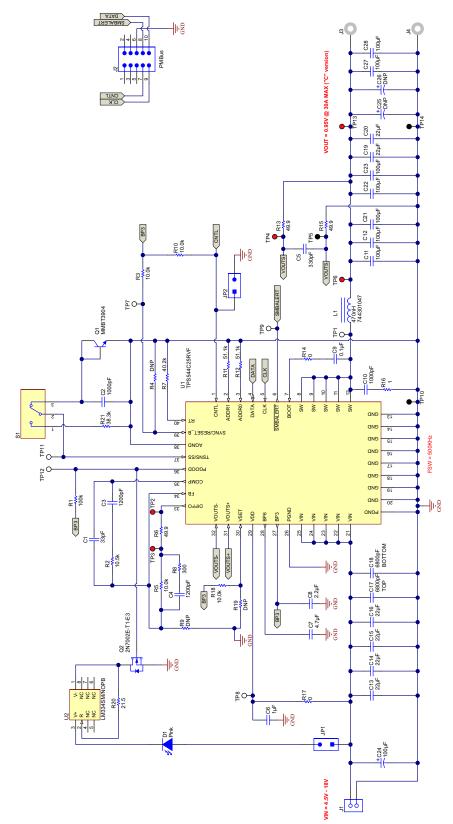


Figure 1. PWR-681EVM Schematic



5 Test Setup

5.1 Test and Configuration Software

To change any of the default configuration parameters on the EVM, it is necessary to obtain the TI Fusion Digital Power Designer software. This can be downloaded from the TI website.

5.1.1 Description

The Fusion Digital Power Designer is the graphical user interface (GUI) used to configure and monitor the Texas Instruments TPS544B25 or TPS544C25 power converter installed on this evaluation module. The application uses the PMBus protocol to communicate with the controller over serial bus by way of a TI USB adapter. This adapter can be purchased at http://www.ti.com/tool/usb-to-gpio.

NOTE: The TI USB adapter must be purchased separately. It is not included with this EVM kit.

5.1.2 Features

Some of the tasks performed with the GUI include:

- Turn on or off the power supply output, either through the hardware control line or the PMBus operation command.
- Monitor real-time data. Items such as input voltage, output voltage, output current, temperature, and warnings and faults are continuously monitored and displayed by the GUI.
- Configure common operating characteristics such as VOUT, UVLO, soft-start time, warning and fault thresholds, fault response, and ON/OFF.

This software is available for download at http://www.ti.com/tool/fusion_digital_power_designer



Test Setup

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5.2 Test Equipment

Voltage Source: The input voltage source VIN must be a 0-V to 18-V variable dc source capable of supplying at least 8 A_{DC} . Connect VIN to J1 Figure 2.

Multimeters: It is recommended to use two separate multimeters Figure 2. One meter is used to measure V_{IN} and one to measure V_{OUT} .

Output Load: A variable electronic load is recommended for testing Figure 2. It must be capable of 30 A at voltages as low as 0.9 V.

Oscilloscope: An oscilloscope is recommended for measuring output noise and ripple. Output ripple must be measured using a tip-and-barrel method or better as shown in Figure 3. The scope must be adjusted to 20-MHz bandwidth, ac coupling at 50 mV/division, and must be set to 1-µs/division.

Fan: During prolonged operation at high loads, it may be necessary to provide forced air cooling with a small fan aimed at the EVM. Temperature of the devices on the EVM must be maintained below 105°C.

USB-to-GPIO Interface Adapter: A communications adapter is required between the EVM and the host computer. This EVM was designed to use the Texas Instruments USB-to-GPIO Adapter. This adapter can be purchased at http://www.ti.com/tool/usb-to-gpio.

Recommended Wire Gauge: The voltage drop in the load wires must be kept as low as possible in order to keep the working voltage at the load within its operating range. See the following table for recommended wire gauge and length to achieve a voltage drop of no more than 0.2 V at the maximum 30-A load.

AWG GAUGE	OHMS PER FOOT (Ω)	LOAD WIRES COMBINED LENGTH (Ft)	EACH WIRE LENGTH (Ft)
12	1.59E-3	6.30	3.15
14	2.53E-3	3.96	1.98
16	4.02E-3	2.49	1.25
18	6.39E-3	1.57	0.78

NOTE: If AWG 12 wire is used, no more than 3.15 feet of wire must be used between the EVM and the load.



Test Setup

5.3 The PWR-681EVM

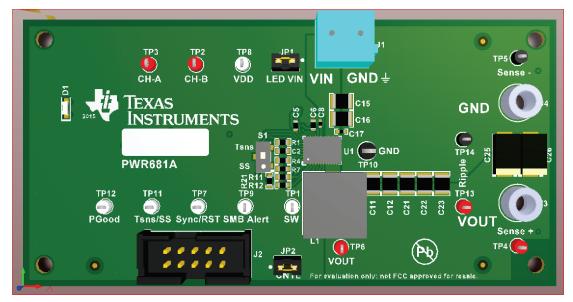
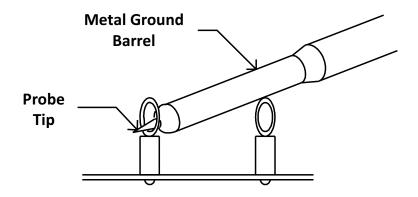


Figure 2. PWR-681EVM Overview



Tip and Barrel V_{OUT} Ripple Measurement Figure 3. Tip and Barrel Measurement

Test Setup

5.4 List of Test Points, Jumpers ans Switch

ITEM	TYPE	NAME	DESCRIPTION			
TP1	T-H loop	SW	Power supply Switch Node			
TP2	T-H loop	CH-B	Measure loop stability			
TP3	T-H loop	CH-A	Measure loop stability			
TP4	T-H loop	V_sense +	Remote sense +			
TP5	T-H loop	V_sense –	Remote sense –			
TP6	T-H loop	Vout	Use this V _{OUT} for efficiency measurements			
TP7	Т-Н Іоор	SYNC/RST	Input a sync signal from a clock source; or apply logic low signal to RESET V_{OUT} to initial boot-up voltage set by VSET pin. Refer to the Datasheet for details.			
TP8	T-H loop	VDD	Supplies the internal circuitry			
TP9	T-H loop	SMB_Alert	Monitor alerts			
TP10	T-H loop	GND	Common GND			
TP11	T-H loop	Tsns/SS	Monitor the voltage on the TSNS/SS pin			
TP12	T-H loop	PGOOD	PGOOD (also drives LED lamp)			
TP13	T-H loop	V _{OUT}	Use for tip-barrel ripple measurement			
TP14	T-H loop	GND	Use for tip-barrel ripple measurement			
JP1	2-pin jumper	LED Vin	Remove jumper to measure Vin for efficiency. Replace jumper and LED lights with PGOOD.			
JP2	2-pin jumper	CNTL	Shunts control pin to GND (turns off the IC for default configuration of ON_OFF_CONFIG, refer to the Datasheet for details)			
S1	SPDT switch	TSNS and SS Switch	Switch between external temperature sensor and SS resistor to be connected to TSNS/SS pin			

Table 2. The Function of Each Test Point



6 EVM Configuration Using the Fusion GUI

The TPS544B25 or TPS544C25 installed on this EVM leave the factory pre-configured. See Table 3 for a short list of key factory configuration parameters as obtained from the configuration file.

ADDRESS HEX	ADDRESS DEC	PART ID				
0x24	36	TPS544x25				
		GENERAL				
CMD Code	CMD CODE HEX	ENCODED HEX	DECODED	COMMENTS		
VIN_OFF	0x36	0xF010	4.0 V	Turn OFF voltage		
VIN_ON	0x35	0xF012	4.5 V	Turn ON voltage		
IOUT_CAL_OFFSET	0x39	0xE000	0.0000 A	Current offset for GUI readout		
IOUT_OC_FAULT_LIMIT	0x46	0xF848 (TPS544C25)	36 A	OC fault level		
	0,,40	0xF830 (TPS544B25)	24 A			
IOUT_OC_FAULT_RESPONSE	0x47	0xBF	Restart	Response to OC fault		
IOUT_OC_WARN_LIMIT	0x4A	0xF844 (TPS544C25)	34 A	OC warning level		
	0,44	0xF82C (TPS544B25)	22 A			
VOUT_COMMAND	0x21	0x01E6	0.95 V	output voltage		
VOUT_MAX	0x24	0x0300	1.5 V	maximum output voltage		
VOUT_TRANSITION_RATE	0x27	0xD03C	1 mV/us	Vout transition rate		
VOUT_SCALE_LOOP	0x29	0xF004	1	Output sense scaling ratio for main control loop		
VOUT_OV_FAULT_LIMIT	0x40	0x0290	1.281 V	Output overvoltage fault threshold		
VOUT_OV_FAULT_RESPONSE	0x41	0xBF	Restart	Output overvoltage fault response		
VOUT_OV_WARN_LIMIT	0x42	0x0267	1.201 V	Output overvoltage warn threshold		
VOUT_UV_WARN_LIMIT	0x43	0x0143	0.631 V	Output undervoltage warn threshold		
VOUT_UV_FAULT_LIMIT	0x44	0x0130	0.594 V	Output undervoltage fault threshold		
VOUT_UV_FAULT_RESPONSE	0x45	0xBF	Restart	Output undervoltage fault response		
ON_OFF_CONFIG	0x02	0x16	CNTL only, Active High	Control signal and operation command not required		
OPERATION	0x01	0x00	Operation is not used to enable regulation; Unit: immediate off			
OT_FAULT_LIMIT	0x4F	0x007D	125°C	OT fault level		
OT_WARN_LIMIT	0x51	0x0064	100°C	OT warn level		
TON_DELAY	0x60	0x0000	0 ms	Turn-on delay		
TON_RISE	0x61	0x0005	5 ms	Soft-start time		
TON_MAX_FAULT_LIMIT	0x62	0x0064	100 ms	Upper limit for Vout reaching regulation		
TOFF_DELAY	0x64	0x0000	0 ms	Turn-off delay		
TOFF_FALL	0x65	0x0000	1 ms	Soft-stop fall time		
MFR_VOUT_MIN	0xA4	0x0100	0.5 V	minimum output voltage		

Table 3. Key Factory Configuration Parameters

If it is desired to configure the EVM to settings other than the factory settings shown in Table 3, the TI Fusion Digital Power Designer software can be used for reconfiguration. It is necessary to have input voltage applied to the EVM prior to launching the software so that the TPS544B25 or TPS544C25 installed is active and able to respond to the GUI and the GUI can recognize the device. The default configuration for the EVM is to start converting at an input voltage of 4.5 V; therefore, to avoid any converter activity during configuration, an input voltage less than 4.5 V must be applied. An input voltage of 4 V is recommended.



EVM Configuration Using the Fusion GUI

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6.1 Configuration Procedure

- 1. Adjust the input supply to provide 4 $V_{\text{DC}},$ current limited to 1 $A_{\text{DC}}.$
- 2. Apply the input voltage to the EVM. See Figure 2 for overview of the EVM and its connections.
- 3. Launch the Fusion GUI software. See the screen shots in Section 9 for more information.
- 4. Configure the EVM operating parameters as desired.
- 5. VSET pin is pulled up to BP3 on the EVM, so the VOUT_COMMAND at boot up is restored from the internal EEPROM. The SYNC/RESET_B pin is configured to SYNC function under this setup. In order to use VSET or RESET_B function, proper resistor of R19 should be populated and resistor R18 should be removed. Please see Datasheet for more details.
- 6. S1 on the EVM provides the option to use the external temperature sensor Q1 on the EVM.

NOTE: To read the external temprature value on PMBus, the bit 8 (SS_DET_DIS) in (E5h) MFR_SPECIFIC _21 register needs to be set to 1. Otherwise, the READ_TEMPERATURE_2 will always return 25°C.

7. With an input of 4 V_{DC}, the internal configuration circuitry will be powered and active but the device will still be in UVLO and outputs off.



7 Test Procedure

7.1 Line/Load Regulation Measurement Procedure

- 1. Ensure that the electronic load is set to draw 0 A_{DC} .
- 2. Increase V_{IN} from 0 V to 12 V using the digital multimeter to measure input voltage.
- 3. Use the other digital multimeter to measure output voltage V_{out} at TP4 and TP5.

Test Procedure

TEST POINT	NODE NAME	DESCRIPTION
JP1	VIN	Measurement point for VIN +VE (remove the jumper, LED will not light)
TP10	GND	Measurement point for VIN –VE
TP4	V_sense +	Measurement point for VOUT +VE
TP5	V_sense -	Measurement point for VOUT –VE

- 4. Vary the load from 0 A_{DC} to maximum rated output A_{DC} (TPS544B25 = 20 A, TPS544C25 = 30 A) . V_{OUT} must remain in regulation as defined in Table 1.
- 5. Vary V_{IN} from 4.5 V to 18 V. V_{OUT} must remain in regulation as defined in Table 1.
- 6. Decrease the load to 0 A.
- 7. Decrease V_{IN} to 0 V or turn off the supply.

7.2 Efficiency

To measure the efficiency of the power train on the EVM, it is important to measure the voltages at the correct location. This is necessary because otherwise the measurements will include losses in efficiency that are not related to the power train itself. Losses incurred by the voltage drop in the copper traces and in the input and output connectors are not related to the efficiency of the power train, and they must not be included in efficiency measurements.

TEST POINT	NODE NAME	DESCRIPTION
JP1	VIN	Measurement point for VIN +VE (remove the jumper, LED will not light)
TP10	GND	Measurement point for VIN –VE
TP6	VOUT	Measurement point for VOUT +VE
TP10	GND	Measurement point for VOUT –VE

Table 5. List of Test Points for Efficiency Measurements

Input current can be measured at any point in the input wires, and output current can be measured anywhere in the output wires of the output being measured. Using these measurement points result in efficiency measurements that do not include losses due to the connectors and PCB traces.



Test Procedure

7.3 Bode Plot Measurement Procedure

- 1. Follow Section 7.1 to set VIN and Load to desired operating condition.
- 2. Connect the AC small signal injection out of isolation transformer to test points TP2 and TP3.
- 3. Connect input signal amplitude measurement probe (Channel A) to TP3.
- 4. Connect output signal amplitude measurement probe (Channel B) to TP2.
- 5. Connect ground lead of Channel A and Channel B to TP10.
- 6. Inject 10 mV or less signal through the isolation transformer.
- 7. Sweep the frequency from 500 Hz to 500 kHz with 10-Hz or lower post filter.
- 8. Control loop gain can be measured by 20 x log (ChannelB/ChannelA).
- 9. Control loop phase can be measured by the phase difference between Channel A and Channel B.
- 10. Follow Section 7.4 to power off the device.

7.4 Equipment Shutdown

- 1. Reduce the load current to 0 A.
- 2. Reduce input voltage to 0 V.
- 3. Shut down the external fan if in use.
- 4. Shut down equipment.



8 Performance Data and Typical Characteristic Curves

Figure 4 through Figure 16 present typical performance curves for the PWR-681EVM.

8.1 Efficiency

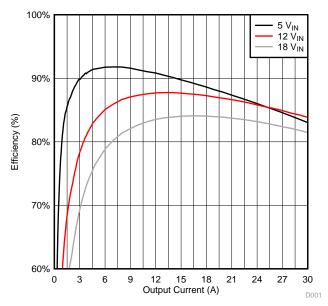


Figure 4. Efficiency of 0.95-V Output vs Line and Load

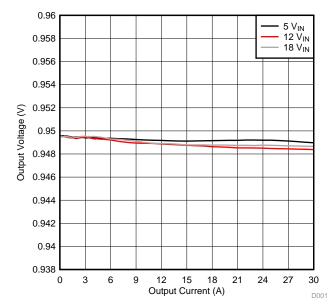


Figure 5. Load Regulation of 0.95-V Output

8.2 Load Regulation



8.3 Line Regulation

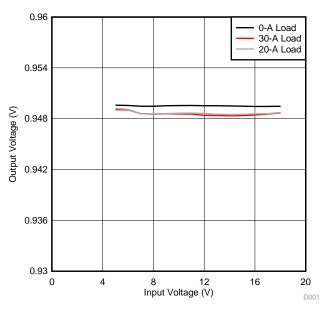
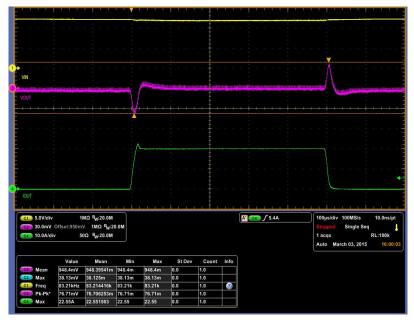


Figure 6. Line Regulation of 0.95-V Output

8.4 Transient Response

14

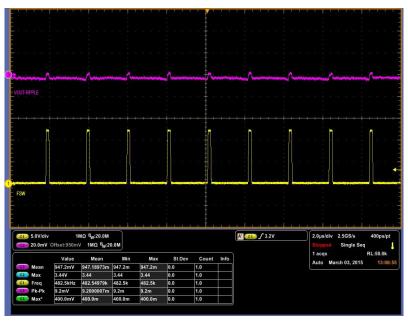


Ch1 = V_{IN} at 5 V/division, Ch3 = V_{OUT} at 30 mV/division, Ch4 = I_{OUT} at 10 A/division

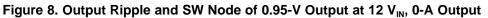
Figure 7. Transient Response of 0.95-V Output at 12 V_{IN} , Transient is 0 A to 20 A, 2.5 A/µs

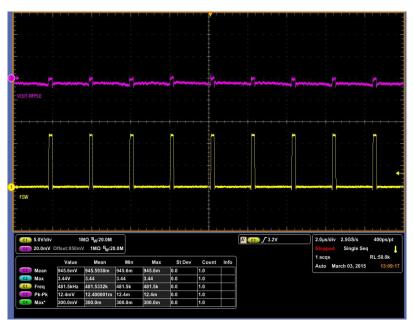


8.5 **Output Ripple**

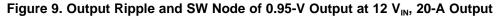


Ch1 = SW at 5 V/division, Ch3 = V_{OUT} ripple at 20 mV/division



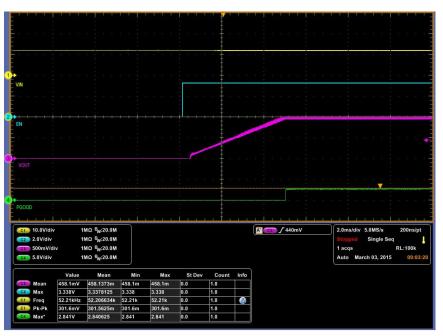


Ch1 = SW at 5 V/division, Ch3 = V_{OUT} ripple at 20 mV/division

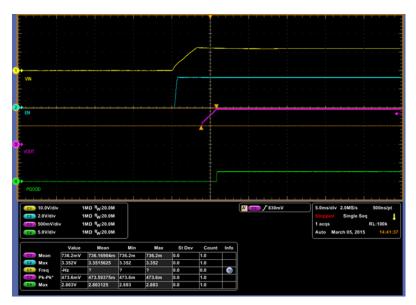


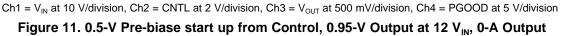


8.6 Control On



Ch1 = V_{IN} at 10 V/division, Ch2 = CNTL at 2 V/division, Ch3 = V_{OUT} at 500 mV/division, Ch4 = PGOOD at 5 V/division Figure 10. Start up from Control, 0.95-V Output at 12 V_{IN} , 20-A Output





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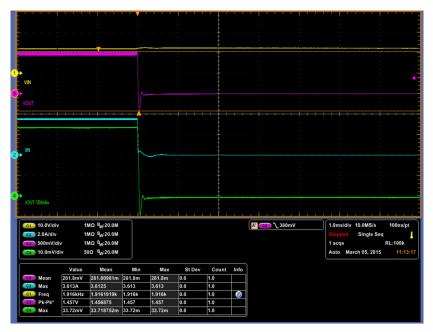


8.7 Control Off



Ch1 = V_{IN} at 10 V/division, Ch2 = CNTL at 2 V/division, Ch3 = V_{OUT} at 500 mV/division, Ch4 = PGOOD at 5 V/division Figure 12. Soft Stop from Control, 0.95-V Output at 12 V_{IN} , 20-A Output

8.8 Overcurrent Protection



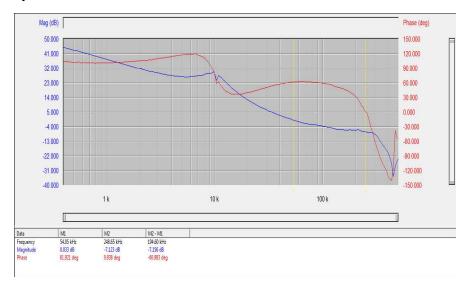
 $\label{eq:ch1} \begin{array}{l} \text{Ch1} = \text{V}_{\text{IN}} \text{ at 10 V/division, Ch2} = \text{I}_{\text{IN}} \text{ at 2 A/division, Ch3} = \text{V}_{\text{OUT}} \text{ at 500 mV/division, Ch4} = \text{I}_{\text{OUT}} \text{ at 10 A/division} \\ \hline \\ \textbf{Figure 13. Overcurrent Protection, 0.95-V Output at 12 V}_{\text{IN}}, \textbf{36-A Output} \end{array}$



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VIN														
				1										
					1	. † .					 . i			
														.0µs/pt
c1 10.0V/div	v 1	MΩ ^B W:20.0M		-2.94V]			A' C3	380	mV	 20.0ms	/div 500kS/	s 4	
C1 10.0V/div C3 500mV/d		ΜΩ ^B W:20.0M						A' C3) / 380	mV	 20.0ms			.ops/pt
	liv 1			1.133V				A' C3	380	mV			e Seq	
C3 500mV/d	liv 1	MΩ ^B W:20.0M	V2	1.133V				A' C3	380	mV	Preview 0 acqs		e Seq RL	:100k
C3 500mV/d	liv 1	MΩ ^B W:20.0M	V2	1.133V				A' C3	∑ 380	mV	Preview 0 acqs	Singl	e Seq RL	:100k
C3 500mV/d C4 10.0mV/d	div 1 div 5 Value	MΩ ^B W:20.0M 60Ω ^B W:20.0M Mean	Min	1.133V 4.073V Max	St Dev	Count	Info	A' C3	5 380	mV	Preview 0 acqs	Singl	e Seq RL	:100k
C3 500mV/d C4 10.0mV/d C3 Mean	div 1 div 5 Value 34.54mV	MΩ ^E W:20.0M 50Ω ^E W:20.0M Mean 34:541041m	Min 34.54m	1.133V 4.073V Max 34.54m	0.0	1.0	Info	A' C3	380	mV	Preview 0 acqs	Singl	e Seq RL	:100k
C3 500mV/d C4 10.0mV/d C3 Mean C2 Max	div 1 div 5 Value 34.54mV 3.326V	MΩ ^E W:20.0M 50Ω ^E W:20.0M Mean 34.541041m 3.32625	Min 34.54m 3.326	1.133V 4.073V Max 34.54m 3.326	0.0	1.0 1.0	\square	A' _ C3	380	mV	Preview 0 acqs	Singl	e Seq RL	:100k
C3 500mV/d C4 10.0mV/d C3 Mean C2 Max C1 Freq	div 1 div 5 Value 34.54mV 3.326V 11.63kHz	MΩ ^B _W :20.0M ioΩ ^B _W :20.0M Mean 34.541041m 3.32625 11.625654k	Min 34.54m 3.326 11.63k	1.133V 4.073V Max 34.54m 3.326 11.63k	0.0 0.0 0.0	1.0 1.0 1.0	Info	A' C3	380	mV	Preview 0 acqs	Singl	e Seq RL	:100k
C3 500mV/d C4 10.0mV/d C3 Mean C2 Max	div 1 div 5 Value 34.54mV 3.326V	MΩ ^E W:20.0M 50Ω ^E W:20.0M Mean 34.541041m 3.32625	Min 34.54m 3.326 11.63k 44.93m	1.133V 4.073V Max 34.54m 3.326	0.0	1.0 1.0	\square	A 63	5 380	mV	Preview 0 acqs	Singl	e Seq RL	1

Ch1 = V_{IN} at 10 V/division, Ch2 = I_{IN} at 2 A/division, Ch3 = V_{OUT} at 500 mV/division, Ch4 = I_{OUT} at 10 A/division **Figure 14. Restart from Overcurrent Protection, 0.95-V Output at 12 V**_{IN}

8.9 Control Loop Bode Plot







Performance Data and Typical Characteristic Curves

8.10 Thermal Image

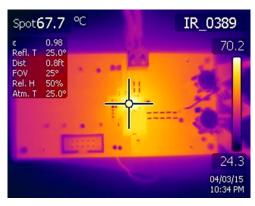


Figure 16. Thermal Image at 0.95-V Output at 12 V_{IN}, 20-A Output

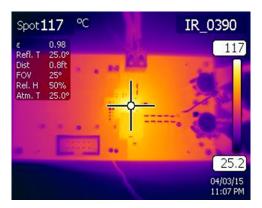


Figure 17. Thermal Image at 0.95-V Output at 12 $\rm V_{\rm IN},$ 30-A Output



Fusion GUI

9 **Fusion GUI**

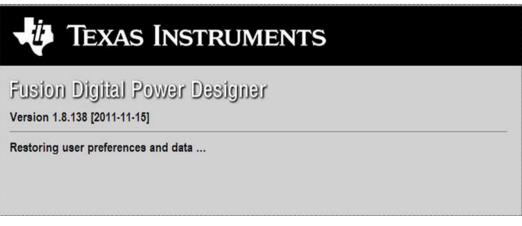


Figure 18. First Window at Fusion Launch

Texas Instruments	
Fusion Digital Power Designer Version 1.8.138 [2011-11-15]	
Scanning USB Adapter #1 for devices 1 device found Device Found	

Figure 19. Scan Finds Device Successfully



Fusion GUI



Fusion Digital Power Designer

Version 1.8.138 [2011-11-15]

1 device found; continuing with GUI startup ...

Figure 20. Software Launch Continued



Figure 21. Software Launch Continued



Use this next screen to configure (Figure 22):

- OV and UV Fault and Warn Limit •
- OC Fault and OC Warn Limit •
- OT Fault and OT Warn Limit •
- Fault Response •
- UVLO ٠
- **On/Off Configuration** •
- Sequencing •
- V_{OUT} Command Voltage •

🕀 Fusion Digital Powe	r Designer - TPS544C25 @	Address 36d - Texas Instruments			. 8
File Device Tools	Debug Help				TPS544C25 @ Address 36d - Rail #1
Configure	Limits & On/Off Debug Mode	Test Mode Advanced Device Info SMBA	LERT # Mask All Config		
Write to Hardware	Voltage Limits)
	Vout Mode:	EXP -9			
Auto write on rail or device change	Vout Command:	0.949 💭 V			
Discard Changes	Vout OV Warn Limit:	1.201 🗘 V	Vout UV Warn Limit:	0.631 V	
Store Config to NVM	Vout OV Fault Limit:	1.281 💭 V	Vout UV Fault Limit:	0.594 🗣 V	
	Vout OV Fault Response:	Respo 🗸	Vout UV Fault Response		
Restore NVM Config	MFR Vout Min:	0.500 💭 V			
Clear Restore Notices	Vout Max	1.500 💭 V			
	Current Limits		Temperature Limits)
	Iout OC Warn Limit:	34.0 🚔 A	Temp Warn Limit:	100 💭 ℃	
	Iout OC Fault Limit:	36.0 💭 A	Temp Fault Limit:	125 😴 °C	
	Iout OC Fault Response:	Respo 🗸	OT Fault Response:	Respo v	
	Turn On/Off				
	Vin On:	4.50 V	Vin Off:	4.00 V	
	Turn On Rise:	5 ∨ ms	Turn Off Fall:	0 🗸 ms	
	Turn On Delay:	0 🗸 ms	Turn Off Delay:	0 ∨ ms	
	Turn On Max Fault Limit:	100 🗸 ms			
	Turn On Max Fault Response:	Respo 🖂			
	On/Off Config:	0x16 🗸			
		Mode: CONTROL Pin Only; Control: Active High, Use			
		TOFF_DELAY/TOFF_FALL			
	Tips & Hints			PMBus Log	Ē
	VOUT_UV_WARN_LIMIT [0x43	3]		5	
🚸 Configure	Sets the value of the output voltage warning. This value is typically great	ge at the sense or output pins that causes an ou ater than the output undervoltage fault threshold	tput voltage low		
Monitor			~		~
Status				PMBus Log	
Fusion Digital Power D	Designer v2.0.37 [2015-03-	-27] TPS544C25 @ Address 36d U	SB Adapter v1.0.11 []	PEC: 400 kHz]	TEXAS INSTRUMENTS fusion digital power

Fusion Digital Power Designer v2.0.37 [2015-03-27] TPS544C25 @ Address 36d USB Adapter v1.0.11 [PEC; 400 kHz]

Figure 22. First Screen After Successful Launch Configure: Limits and On/Off



Fusion GUI

Changing the on/off configuration prompts a pop-up window with details of the options Figure 23).

🖗 Fusion Digital Pow	er Designer - TPS544C25 @ .	Address 36d	- Texas Instruments		- E 🗄
File Device Tool	is Debug Help				TPS544C25 @ Address 36d - Rail #1
Configure	Limits & On/Off Debug Mode	Test Mode Ac	Ivanced Device Info SMBALERT # Mask All Config		
Write to Hardware	Voltage Limits		×		
With to Hardware With to Hardware Discard Change Discard Change Store Config to NMM Restore NVM Config Clear Restore Notices	Voltage Limits Vout Mode: DP -9 Vout Command: 0.949 ⊕ Vout OV Warn Limit: 1.201 ⊕ Vout OV Fault Response: Response MFR Vout Min: 0.500 ⊕ Vout OV Fault Response: Response Uout Max 1.500 ⊕ Lout OC Warn Limit: 34.0 ⊕ Lout OC Fault Response: Response Uout OF Fault Response: Response Turn On/Off Vin On:		On / Off Control Anays Converting Anays Converted view of the onjoif portion of the OPERATION command for averable. OPERATION The device ignores the CONTROL pin. Power is converted when the onjoif portion of the OPERATION OPERATION Command averable. OPERATION Command for averable pin must be extree and the on for the device to converte and the on for the device to converted memory. Control Pin Polarity Active high (Pull high to start the unit) o. Active high (Pull high to start the unit) use the turn of fdely configured by	0.631 ⊕ v 0.594 ⊕ v e: Respo v 100 ⊕ °C 125 ⊕ °C Respo v 4.00 ∨ v 0 ∨ ms	
	Tum On Delay: Tum On Max Fault Limit: Tum On Max Fault Response: On/Off Config:	0 V 100 V Respo V 0x16 V Mode: CONTR Active High, U TOFF_DELAY/		0 () ms	
	Tips & Hints			PMBus Log	Ţ.
🚸 Configure	ON_OFF_CONFIG [0x02]		nd serial bus commands needed to turn the unit on wer is applied.		
Monitor			~		
Status			R	PMBus Log	Fa 🕄
Fusion Digital Power	Designer v2.0.37 [2015-03-	27] TPS5440	C25 @ Address 36d USB Adapter v1.0.11	[PEC; 400 kHz]	TEXAS INSTRUMENTS fusion digital power

Figure 23. Configure: Limits and On/Off- On/Off Configuration Pop-up



Fusion GUI

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After a change is selected, orange **U** icon is displayed to offer *Undo Change* option. Change is not retained until either *Write to Hardware* or *Store Config to NVM* is selected. When *Write to Hardware* is selected, change is committed to volatile memory and defaults back to previous setting on input power cycle. When *Store Config to NVM* is selected, change is committed to nonvolatile memory and becomes the new default (Figure 24).

😲 Fusion Digital Powe	er Designer - TPS544C25 @ /	Address 36d	- Texas Instruments		- 🖻 🎽
File Device Tools	s Debug Help				TPS544C25 @ Address 36d - Rail #1
Configure	Limits & On/Off Debug Mode	Test Mode Ad	dvanced Device Info SMBALERT# Mask All Confid	<u>ا</u>	
_	Voltage Limits				
Write to Hardware	Voitage Linits	FXP -9	On / Off Control	3	
Auto write on rail or device change	Vout Command:	0.949 🕀	O Always Converting		
Discard Changes	Vout OV Warn Limit:	1.201	Unit powers up any time power is present, regardless of state of the CONTROL pin or	0.631 🔍 V	
Store Config to NVM	Vout OV Fault Limit:	1.282 😴	OPERATION command.	0.594 🗘 V	
Restore NVM Config	Vout OV Fault Response:	Respo ~	The device ignores the on/off portion of the OPERATION command from serial bus. Power	e: Respo V	
	MFR Vout Min:	0.500 💭	is converted when the CONTROL pin is active.		
Clear Restore Notices	Vout Max	1.500 💭	OPERATION Only The device ignores the CONTROL pin. Power is		
			converted when the on/off portion of the OPERATION command is on.		
	Current Limits		O Both CONTROL Pin & OPERATION		
	Iout OC Warn Limit:	34.0 💭 A	The CONTROL pin must be active and the on/off portion of the OPERATION command	100 🗢 °C	
	Iout OC Fault Limit:	36.0 🕀 A	on for the device to convert power.	125 😴 ℃	
	Iout OC Fault Response:	Respo 🗸	Control Pin Polarity Active low (Pull pin low to start the unit)	Respo 🗸	
	Turn On/Off		Active high (Pull high to start the unit)		
	Vin On:	4.50 🗸		4.00 V	
	Turn On Rise:	5 🗸	Control Pin Turn Off Configuration Use the turn off delay configured by	0 ∨ ms	
	Turn On Delay:	0 🗸	 TOFF_DELAY and fall time configured by TOFF_FALL 	0 🖂 ms	
	Turn On Max Fault Limit:	100 🗸	Turn off the output and stop transferring		
	Turn On Max Fault Response:	Respo 🗸	energy to the output as fast as possible		
	On/Off Config:	U 0x1A 🗸			
		Mode: OPERA	TION Only		
	Tips & Hints			PMBus Log	Ŧ
	MFR_VOUT_MIN [0xA4] Minimum rated value, in volts, to w	hich the output v	oltage may be set.		<u>^</u>
Configure					
Monitor				×	\checkmark
🕀 Status				PMBus Log	5 G

Fusion Digital Power Designer v2.0.37 [2015-03-27] TPS544C25 @ Address 36d USB Adapter v1.0.11 [PEC; 400 kHz]

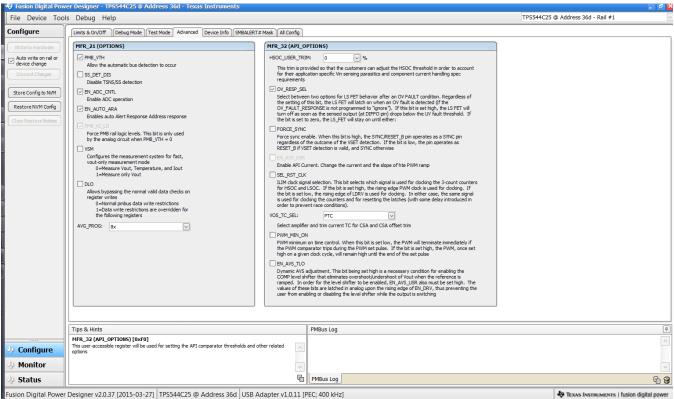
TEXAS INSTRUMENTS | fusion digital power

Figure 24. Configure: Limits and On/Off- On/Off Config Pop-Up with Change



Use "Advanced" tag to configure (Figure 25) :

- E5h OPTIONS (MFR_SPECIFIC_21) ٠
- F0h MISC_CONFIG_OPTIONS options (MFR_SPECIFIC_32) •



Fusion Digital Power Designer v2.0.37 [2015-03-27] TPS544C25 @ Address 36d USB Adapter v1.0.11 [PEC; 400 kHz]





Fusion GUI

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The device information, User Scratch Pad, Write Protection options, the configuration of Vout Scale loop, Vout Transition Rate and lout Offset can be found on "Device Info" tag (Figure 26). The I_{OUT} offset can be typed in or scrolled to a new value. The range for I_{OUT} cal offset is -4 A to 3.9375 A and the resolution step is 62.5 mA. If a value is typed in that is between the available discrete steps, the typed-in value does not change but the nearest discrete step is retained. The actual step is displayed on relaunch of the Fusion GUI.

🕀 Fusion Digital Pow	er Designer - TPS544C25 @ Address 36d - Texas Instruments		
File Device Tool	s Debug Help		TPS544C25 @ Address 36d - Rail #1
Configure	Limits & On/Off Debug Mode Test Mode Advanced Device Info SMBA	ALERT# Mask All Config	
Configure Write to Hardware Write to Hardware Discard Change Discard Change Store Config to NMM Restore NVM Config Clear Restore NVMconfig	Limits & On/Off Debug Mode Test Mode Advanced Device Info SM82 Device Constants IC Device Constants IC Device Constants IC Device ID: 0x2700 (TPS544C25) IC Device ID: 0x2700 (TPS544C25) IC Device REV: 0x0000 Revision: 0x00 PMBus Revision: 1.0, 1.2 - Part I: 1.0, Part II: 1.2 Capability: Naximum Supported Ibs Speed: 400 Mrtz Packet Error Checking (PEC) Supported: Yes SHBALERT# Supported: Yes Whether the davice has an SMALERT# pin and supports the SMALERT# Supported. Yes SMBus Alert Response protocol. Vout Mode: EIP-9 EIP-9 EIP-9 EIP-9	NERT # Mask. All Config Write Protect Disable all writes except to the WRITE_PROTECT command Disable all writes except to the WRITE_PROTECT, OPERATION, and PAGE commands Dasable all writes except to the WRITE_PROTECT, OPERATION, PAGE, ON OFF_CONFIG and VOUT_COMMAND commands © Enable writes to all commands Calibration Yout Transition Rate: L0000 [=] A	
	MFR_SPECIFIC_00 15 14 13 12 11 10 9 8 7 6 5 User Scratch Ped: 0x0052 0 0 0 0 0 0 10 0 10 </th <th>5 4 3 2 1 0</th> <th></th>	5 4 3 2 1 0	
	Tips & Hints	PMBus Log	ŧ
Configure	MFR_21 (OPTIONS) [0xE5] Used for setting user selectable options for the Top Avatar controller.	<u>^</u>	
Monitor		~	×
🔄 Status		PMBus Log	
Fusion Digital Power	Designer v2.0.37 [2015-03-27] TPS544C25 @ Address 36d U	SB Adapter v1.0.11 [PEC; 400 kHz]	TEXAS INSTRUMENTS fusion digital power

Figure 26. Configure: Device Info



Fusion GUI

The sources of SMBALERT which can be masked can be found and configured on the "SMBALERT # Mast" screen (Figure 27)

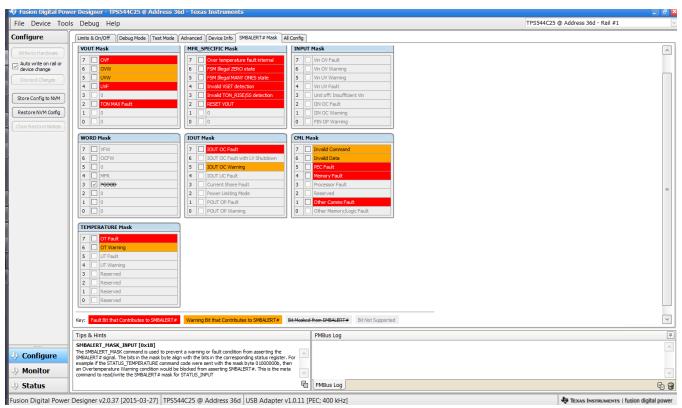


Figure 27. Configure: SMBALERT # Mask



Fusion GUI

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Use "All Config" tag to configure all of the configurable parameters (Figure 28). The screen also shows other details like hexadecimal (hex) encoding.

re			Device Info SMBAL	COT # March	U Coofie				
						1			
Hardware	Command	Lode	Value/Edit	Hex/Edit	Command	Lode	Value/Edit	Hex/Edit	
rite on rail or change	▼ Calibration IOUT_CAL_OFFSET	0x39	0.0000 🕀 A	0xE000	On/Off Configuration ON_OFF_CONFIG	0x02	0x16 ~	0x16	
d Changes	YOUT_SCALE_LOOP	0x39	1.00 V	0xE000	OPERATION	0x02	0x10 V		
<u> </u>	▼ Configuration	0,29	1.00 🔍	0XF004	TOFF DELAY	0x64	0 🗸 ms	0x00	
nfig to NVM	IC_DEVICE_ID	0×AD	0x2700 ~	0x2 🗸	TOFF_DELAT	0x64 0x65		0x0000	
NVM Config	IC_DEVICE_REV	0×AE	0x0000 ~	0x0 🗸	TON_DELAY	0x65	0 ∨ ms	0x0000	
tore Notices	MFR 21 (OPTIONS)	0xE5	PMB_V ~	0x00C7	TON_DELAT	0x60	100 🗸 ms	0x0000	
eters By:	MFR_32 (API_OPTIONS)	0×F0	OV_RE ~	0x0001	TON_MAX_FAULT_LIMIT	0x62 0x63		0x0064	
hand Name	SMBALERT_MASK_CML	0×1B	000000 ~	0x0001	TON_MAX_FAULT_RESPONSE	0x65	Click 🗸	0xBF	
and Code	SMBALERT_MASK_INPUT	0×1B	000000 🗸	0x00	▼ Status	0281	5 🛩 ms	0x0005	
oy Category	SMBALERT_MASK_IOUT	0×1B	000000 ~	0x00	READ_IOUT	0x8C	0.00 A	0xE000	
	SMBALERT_MASK_MFR_SPECIFIC	0x1B	000000 🗸	0x00	READ_TEMPERATURE_2	0x8E	25 °C	0x0019	
	5MBALERT_MASK_TEMPERATURE	0×1B	000000 🗸	0x00	READ YOUT	0×88	0.010 V	0x0005	
	SMBALERT MASK VOUT	0×1B	000000 🗸	0x00	- STATUS BYTE	0×78	010000 🗸	0x42	
	5MBALERT_MASK_WORD	0×1B	000010 🗸	0x08	- STATUS_CML	0×7E	100000 ~	0x82	
	YOUT_COMMAND	0x21	0.949 ⊕ v	0x01E6	STATUS INPUT	0x7C	000000 🗸	0x02	
	VOUT_MAX	0x24	1.500 🗘 V	0x0300	STATUS_IOUT	0×78	000000 🗸	0x00	
	VOUT_MODE	0x20	EXP -9		STATUS_MFR_SPECIFIC	0×80	000100 ~	0x10	
	VOUT_TRANSITION_RATE	0x27	1.000 V mV	0xD03C	STATUS_TEMPERATURE	0x7D	000000 🗸	0x00	
	WRITE_PROTECT	0×10	0x00 🗸	0x00	STATUS_VOUT	0x7A	000000 🗸	0x00	
	▼ Limits				STATUS_WORD	0x79	Click 🗸	0x0842	
	IOUT_OC_FAULT_LIMIT	0x46	36.0 🌐 A	0xF848	▼ User Parameters				
	IOUT_OC_FAULT_RESPONSE	0x47	Click 🗸	0xBF	MFR_00 (FOR USER)	0xD0	0x0052 🗸	0x0052	
	Tips & Hints				PMBus Log				
figure nitor	ON_OFF_CONFIG [0x02] Configures the combination of CONTROL pin in and off. This includes how the unit responds wi			to turn the unit	on A				

Figure 28. Configure: All

On/Off configuration can also be configured from the "All Config" screens, and the same process applies (Figure 29).

Tools Deb	oug Help							TPS544C25 @ Address 36d - Rail #1	
Limits 8	& On/Off Debug Mode Test Mode	Advanced	Device Info SMBAL	ERT# Mask A	I Config				
are Com	mand	Code	Value/Edit	Hex/Edit	Command	Code	Value/Edit	Hex/Edit	
ail or	alibration				On/Off Configuration				
	_CAL_OFFSET	0×39	0.0000 🕀 A	0xE000	ON_OFF_CONFIG	0x02	0x1A 🖂	0x1A	
	_SCALE_LOOP	0x29	1.00 🗸	0xF004	OPERATION	0×01	0x00 🖂	On / Off Control	
VM	configuration				TOFF_DELAY	0×64	0 🗸	Always Converting Unit powers up any time power is present,	
nfig IC_DI	EVICE_ID	0×AD	0x2700 🗸	0x2 🗹	TOFF_FALL	0×65	0 🗸	regardless of state of the CONTROL pin or OPERATION command.	
tices	EVICE_REV	0×AE	0x0000 🗸	0x0 ∨	TON_DELAY	0×60	0 🗸	O CONTROL Pin Only	
MFR_	_21 (OPTIONS)	0xE5	PMB_V 🖂	0x00C7	TON_MAX_FAULT_LIMIT	0×62	100 🗸	The device ignores the on/off portion of the OPERATION command from serial bus. Power	
/: MFR_	_32 (API_OPTIONS)	0xF0	OV_RE ∨	0x0001	TON_MAX_FAULT_RESPONSE	0×63	Click 🗸	is converted when the CONTROL pin is active. OPERATION Only	
	ALERT_MASK_CML	0×1B	000000 🖂	0x00	TON_RISE	0×61	5 🗸	The device ignores the CONTROL pin. Power is	
SMBA	ALERT_MASK_INPUT	0×1B	000000 🖂	0x00	▼ Status			converted when the on/off portion of the OPERATION command is on.	
smbA	LERT_MASK_IOUT	0×1B	000000 🗸	0x00	READ_IOUT	0×8C	0.00	O Both CONTROL Pin & OPERATION The CONTROL pin must be active and the	
SMBA	ALERT_MASK_MFR_SPECIFIC	0×1B	000000 🖂	0x00	READ_TEMPERATURE_2	0×8E	25	on/off portion of the OPERATION command on for the device to convert power.	
SMBA	ALERT_MASK_TEMPERATURE	0×18	000000 🖂	0x00	READ_VOUT	0×8B	0.010	Control Pin Polarity	
SMBA	ALERT_MASK_VOUT	0×1B	000000 🖂	0x00	STATUS_BYTE	0×78	010000 🗸	Active low (Pull pin low to start the unit)	
SMBA	ALERT_MASK_WORD	0x1B	000010 🗸	0x08	STATUS_CML	0×7E	100000 🗸	Active high (Pull high to start the unit)	
YOUT	_COMMAND	0×21	0.949 🕀 v	0x01E6	STATUS_INPUT	0x7C	000000 🗸		
YOUT	_MAX	0x24	1.500 🕆 V	0x0300	STATUS_IOUT	0×7B	000000 🗸	Control Pin Turn Off Configuration Use the turn off delay configured by	
VOUT	_MODE	0×20			STATUS_MFR_SPECIFIC	0×80	000100 🗸	TOFF_DELAY and fall time configured by TOFF_FALL	
YOUT	_TRANSITION_RATE	0x27	1.000 V mV	0xD03C	STATUS_TEMPERATURE	0×7D	000000 🗸	Turn off the output and stop transferring	
WRIT	TE_PROTECT	0×10	0x00 ~	0x00	STATUS_VOUT	0×7A	000000 🗸	energy to the output as fast as possible	
V Li	imits				STATUS_WORD	0×79	Click V		
IOUT	_OC_FAULT_LIMIT	0×46	36.0 🕀 A	0xF848	▼ User Parameters				
IOUT	_OC_FAULT_RESPONSE	0x47	Click 🗸	0xBF	MFR_00 (FOR USER)	0xD0	0x0052 🗸	0x0052	
Tips &	Hints				PMBus Log				
	F_CONFIG [0x02] ures the combination of CONTROL pin in								
	This includes how the unit responds w			to turn the dhit					
					~				
					PMBus Log				

Figure 29. Configure: All Config- On/Off Config Pop-up



Fusion GUI

After making changes to one or more configurable parameters, the changes can be committed to nonvolatile memory by selecting *Store Config to NVM*. This action prompts a *confirm selection* pop-up, and if confirmed, the changes are committed to nonvolatile memory (Figure 30).

e Device Tool	ls Debug Help								TPS544C25 @ Address 36d - Rail #1	
figure	Limits & On/Off Debug Mode Test Mode	Advanced	Device Info SMBA	LERT# Mask A	ll Config					
rite to Hardware	Command	Code	Value/Edit	Hex/Edit	Command	Code	Value/Edit	Hex/Edit		
uto write on rail or	▼ Calibration				On/Off Configuration					
evice change	IOUT_CAL_OFFSET	0x39	0.0000 🌐 A	0xE000	ON_OFF_CONFIG	0×02	0x16 ~	0x16		
Discard Changes	VOUT_SCALE_LOOP	0x29	1.00 🗸	0xF004	OPERATION	0×01	0x00 ~	0x00		
re Config to NVM	▼ Configuration				TOFF_DELAY	0x64	0 🗸 ms	0x0000		
tore NVM Config	IC_DEVICE_ID	0×AD	0x2700 🗸	0x2 ⊻	TOFF_FALL	0×65	0 🗸 ms	0x0000		
	IC_DEVICE_REV	0×AE	0x0000 🖂	0x0 🗸	TON_DELAY	0×60	0 🗸 ms	0x0000		
Restore Notices	MFR_21 (OPTIONS)	0×E5	PMB_V ∨	0x00C7	TON_MAX_FAULT_LIMIT	0x62	100 🗸 ms	0x0064		
rameters By:	MFR_32 (API_OPTIONS)	0xF0	OV_RE ∨	0x0001	TON_MAX_FAULT_RESPONSE	0x63	Click 🗸	0xBF		
ommand Name ommand Code	SMBALERT_MASK_CML	0×1B	000000 🖂	0x00	TON_RISE	0×61	5 🗸 ms	0x0005		
	SMBALERT_MASK_INPUT	0×1B	00000	0.00						
up by Category	SMBALERT_MASK_IOUT	0×1B	00000 Confir	m Store to FI	ash	-		0×E000		
	SMBALERT_MASK_MFR_SPECIFIC	0×1B	00000				°C	0x0019		
	SMBALERT_MASK_TEMPERATURE	0×1B	00000		eration will store all configuration			0x0005		
	SMBALERT_MASK_VOUT	0×1B	00000	memor procee	y on the TPS544C25 @ Address 36	d. Do you w	ish to	0x42		
	SMBALERT_MASK_WORD	0×1B	00001	procee	ur			0x82		
	VOUT_COMMAND	0×21	0.					0x00		
	VOUT_MAX	0x24	1.		Ye		No	0x00		
	VOUT_MODE	0×20	EXP -9			·		0x10		
	VOUT_TRANSITION_RATE	0x27	1.000 yr	0xD03C	STATUS_TEMPERATURE	UX/D	000000	0x00		
	WRITE_PROTECT	0×10	0x00 🗸	0x00	STATUS_VOUT	0x7A	000000 🗸	0x00		
	▼ Limits				STATUS_WORD	0×79	Click 🗸	0x0842		
	IOUT_OC_FAULT_LIMIT	0×46	36.0 🗘 A	0xF848	▼ User Parameters					
	IOUT_OC_FAULT_RESPONSE	0×47	Click 🗸	0xBF	MFR_00 (FOR USER)	0×D0	0x0052 🖂	0x0052		
	Tips & Hints				PMBus Log					
onfigure	IC_DEVICE_ID [0xAD] IC Device ID.				<u>^</u>					
onitor										
					PMBus Log					
tatus					PMBus Log					(

Power Designer v2.0.37 [2015-03-27] | TPS544C25 @ Address 36d | USB Adapter v1.0.11 [PEC; 400 kHz]

Figure 30. Configure: Store Config to NVM



In the lower left corner, the different view screens can be changed. The view screens can be changed between *Configure*, *Monitor* and *Status* as needed (Figure 31).

😲 Fusion Digital Pow	er Designer - TPS544C25 @ /	Address 36d - Texas Instruments				_ 2 🖉 🞽
File Device Tool	s Debug Help				TPS544C25 @ Address 36d - Rail #1	~
Configure	Limits & On/Off Debug Mode	Test Mode Advanced Device Info SME	BALERT # Mask All Config			
Write to Hardware	Voltage Limits					
	Vout Mode:	EXP -9				
Auto write on rail or device change	Vout Command:	0.949 🗘 V				
Discard Changes	Vout OV Warn Limit:	1.201 🗘 V	Vout UV Warn Limit:	0.631 🗘 V		
Store Config to NVM	Vout OV Fault Limit:	1.281 💭 V	Vout UV Fault Limit:	0.594 💭 V		
	Vout OV Fault Response:	Respo 🗸	Vout UV Fault Response			
Restore NVM Config	MFR Vout Min:	0.500 🗘 V		(capon)		
Clear Restore Notices	Vout Max	1.500 💭 V				
	Current Limits		Temperature Limits			
	Iout OC Warn Limit:	34.0 🔨 A	Temp Warn Limit:	100 👽 ℃		
	Iout OC Fault Limit:	36.0 💭 A	Temp Fault Limit:	125 🕀 ℃		
	Iout OC Fault Response:	Respo 🗸	OT Fault Response:	Respo v		
	Turn On/Off				_	
	Vin On:	4.50 V	Vin Off:	4.00 V		
	Turn On Rise:	5 🖂 ms	Turn Off Fall:	0 🖂 ms		
	Turn On Delay: Turn On Max Fault Limit:	0 🖂 ms	Turn Off Delay:	0 🖂 ms		
	Turn On Max Fault Limit:	Respo V				
	On/Off Config:	0x16 V				
	conjoir comigi	Mode: CONTROL Pin Only; Control:				
		Active High, Use TOFF_DELAY/TOFF_FALL				
					J	
	Tips & Hints			PMBus Log		Į.
	ON_OFF_CONFIG [0x02] Configures the combination of CON	ITROL pin input and serial bus commands need	ed to turn the unit on 📃			^
Configure	and off. This includes how the unit	responds when power is applied.				
🚸 Monitor			~			\sim
🚸 Status			E.	PMBus Log		68
Eusion Digital Dower	Designer v2.0.27 [2015_02.1	271 TDSEAACOE @ Address 26d	USB Adapter v1 0 11 f		In Traves because the large	digital power

Figure 31. Change View Screen to Monitor Screen



Fusion GUI

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When the Monitor screen is selected (Figure 32), the screen changes to display real-time data of the parameters that are measured by the controller. This screen provides access to:

- Graphs of V_{OUT} , I_{OUT} , and Temperature. As shown, Pout display is turned off. •
- Start/Stop polling which turns on or off the real-time display of data. ٠
- Clear Faults to clear any prior fault flags •
- Quick access to on/off configuration ٠
- Control pin activation, and operation command. ٠
- PMBus log which displays activity on the PMBus.
- Tips and hints which displays additional information when the cursor is hovered over configurable • parameters.

At first GUI launch, faults may occur due to communications during power up. These faults can be cleared once the device is enabled.

🕀 Fusion Digital Pow	ver Designer - TPS544C25 @ Address 3	36d - T	exas Instr	uments									- 2 🎽
File Device Tool	ls Debug Help									TPS544	4C25 @ Addres	s 36d - Rail #1	~
Monitor	PMBus Readings	^	Vout - Out	tput Voltage				×	Iout - Output Cu	urrent			×
Show/Hide Plots: Vout Vout Pout(calc V Temp	Vout: 0.945 V Iout: 31.13 A Temp: 73 °C		OVF: UVW:	1.281 ↔ V OV 0.631 ↔ V U\		1.201 ♥ Vout:	0.949 🚭 1.500 🚭		OC Fault:	36.0 🗘 A OC Warn	1: 34	A Write	
 Fit All Plots on Screen Scale Plots to Screen Width: 200 ⊕ Width: 400 ⊕ Youra & Fault Limit Editors Show Value Labels on Plots Poling Rate: 5 ⊕ 	Status Registers/Lines Vout: OK Iout: OK Iout: OK Input: OK CML: OK CML: OK Misc: OK Mir: OK SMBALERT# Not Asserted	_	MIN: 1.60 1.40 1.20 1.00 0.80 0.60 0.40 0.20	0.500 😨 V 🕤	Write			0.945 V	30.00				31.13 A
Stop Polling	Clear Faults On/Off Config		0.00	59:20 ture	59	:40	00:00	00:20	0.00	59:20	59:40	00:00	00:20
Device Dashboard System Dashboard			OT Fault: 140.00	: 125 ♀ ℃	OT Warn:	100 🐳 প	Write						
	On/Off: On Immediate Off Soft Off		120.00										
	Margining: None Low High		80.00 60.00					73.0 °C					
	Margin Act On Fault Fault Act On Fault		40.00 20.00										
	Control Line	~	0.00	59:20		59:40	00:00	00:20					
	Tips & Hints					PMBus Log							Ţ.
 Configure Monitor 	IOUT_CAL_OFFSET [0x39] Most often used in conjunction with the IOUT_CA sensing circuit.	CAL_GAI	N command to	minimize the error of the	current	13:47:19.474: TPS 13:47:31.479: TPS PMB_HI_LO:1 [0x0] 13:48:42.320: TPS PMB_HI_LO:1 [0x0]	544C25 @ 36d: MFR_ 1C7] to RAM 544C25 @ 36d: MFR_ 187] to RAM	_21 (OPTIONS) [_21 (OPTIONS) [H:1, SS_DET_DIS:1, EN_ADC_ H:1, SS_DET_DIS:1, EN_ADC_			0_ARA:1,
Status					E.	PMBus Log							Fa 🗑
Fusion Digital Power	Designer v2.0.42 [2015-05-01] TPS54	544C25	0 @ Addre	ss 36d USB Adapt	ter v1.0.11 [P	EC; 400 kHz]					TEXA	s Instruments fusi	on digital power

Figure 32. Monitor Screen



Selecting System Dashboard from mid-left screen adds a new window which displays system-level information (Figure 33).

		er - TPS544C25 @ Addres	5 300 - Texas Instruments	
File Device Too	ls Debug	g Help	TPS	S544C25 @ Address 36d - Rail #1
Monitor	PMBus F			
now/Hide Plots:	Vout:		Fusion Digital Power Designer	34.0 🌩 A Write
🗸 Vout 🖂 Iout	Iout:	Layout Devices		34.0 💭 A Write
Pout(calc 🖂 Temp	Temp:	System-Level Actions a	ind Settings	
Fit All Plots on Screen	Status R	On/Off Config	OPERATION Control Line (USB) Fault Management Other	
Scale Plots to Screen Width	Vout:	CONTROL Pin Only	Write Setting Margining Turn On Immed Off Immed High O Low Clear Faults Store to Flash	
Height: 200 🗢	lout:		Soft Off	
Width: 400 হ	Temp:			
Show Warn & Fault Limit Editors	Input:			
	CML:	Rails		
Show Value Labels on Plots	Misc:	Device Rail	Vout Iout Temp Operation On/Off Config	
lling Rate: 500 🕀	Mfr:	TPS544C25 @ 36d 1 Rail;	#1 0.943 V 0.44 A 25 ℃ 🔿 On 💿 Immediate Off 🔿 Soft O 0x16 🖂 CONTROL Pin Only	
msec)	SMBAL			0.44
Stop Polling				5:20 55:40 56:00
	On/Off (
Device Dashboard				
System Dashboard				
	OPERAT			
	On/Off:			
	0, 0	Status Registers		
		STATUS_WORD	ОК	
	Marginir	STATUS_VOUT	ок	
		STATUS_IOUT	ок	
		STATUS_IOUT STATUS_TEMPERATURE	ОК ОК	
	Margin	-		
	Margin Fault Action:	STATUS_TEMPERATURE	ОК	
	Fault	STATUS_TEMPERATURE STATUS_INPUT	ОК ОК ОК	
	Fault	STATUS_TEMPERATURE STATUS_INPUT STATUS_CML	ОК ОК ОК	
	Fault Action:	STATUS_TEMPERATURE STATUS_INPUT STATUS_CML	ОК ОК ОК	
	Fault Action: Control I Tips & H VOUT_U	STATUS_TEMPERATURE STATUS_INPUT STATUS_CML STATUS_MFR_SPECIFIC	ОК ОК ОК	
Configure	Fault Action: Control I Tips & H	STATUS_TEMPERATURE STATUS_INPUT STATUS_CML STATUS_MFR_SPECIFIC	OK OK OK OK OK OK OK Interview	
_	Fault Action: Control I Tips & H VOUT_U Sets the	STATUS_TEMPERATURE STATUS_INPUT STATUS_CML STATUS_MFR_SPECIFIC	0K 0K 0K 0K	
Configure	Fault Action: Control I Tips & H VOUT_U Sets the	STATUS_TEMPERATURE STATUS_INPUT STATUS_CML STATUS_MFR_SPECIFIC	OK OK OK OK OK OK OK Intervision 177, USB-SAA # 11 CONTROL 3 now Low Intervision 174, 273, 181: USB-SAA # 11 CONTROL 3 now Low Intervision 144, 273, 181: USB-SAA # 11 CONTROL 3 now Low	

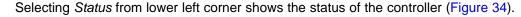
Fusion Digital Power Designer v2.0.37 [2015-03-27] TPS544C25 @ Address 36d USB Adapter v1.0.11 [PEC; 400 kHz]

Figure 33. System Dashboard



Fusion GUI

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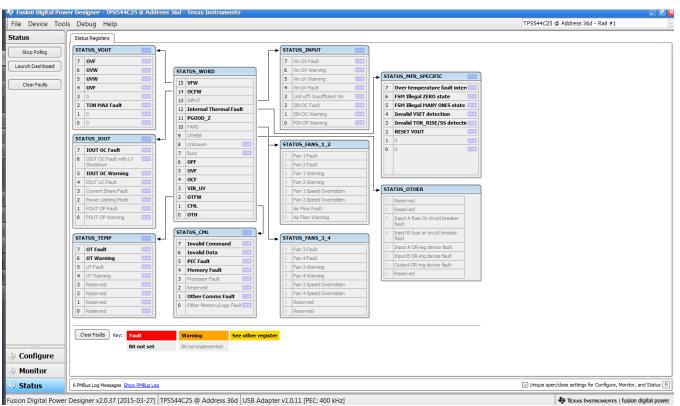


Figure 34. Status Screen



Selecting the pull-down menu *File- Import Project* from the upper left menu bar can be used to configure all parameters in the device at once with a desired configuration, or even revert back to a *known-good* configuration. This action results in a browse-type sequence where the desired configuration file can be located and loaded (Figure 35).







Fusion GUI

Selecting *Store User Configuration to Flash Memory* from the device pull-down menu has the same functionality as the *Store Config to NVM* button from the configure screen. It results in committing the current configuration to nonvolatile memory (Figure 36).



Figure 36. Store Configuration To Memory



Select *Data Logging* (Figure 37), from the Tools drop-down menu. This enables logging of common operating values such as V_{OUT} , I_{OUT} , and temperature. The user is prompted to select a location for the file to be stored as well as the type of file. Select the storage location for the file and the type of file. Logging begins when the *Start Data Logging* button is selected, and stops when it is reselected.

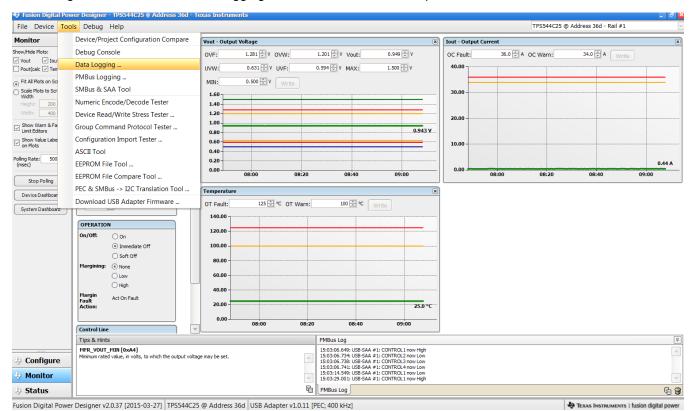


Figure 37. Data Logging



Fusion GUI

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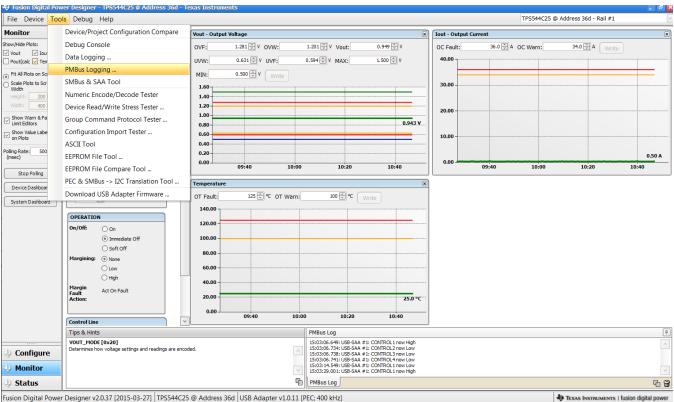
Common contents of the data log as shown in (Figure 38).

File	Home	Insert	Page Layout	Formulas	Data Revie	w View	Add-Ins Acrobat						۵ (P
Ĉ	Å Calil	ori	- 11 - A		= 들 🗞 -	Gener	al -	5			¦a⊷ Insert - Insert -	Σ· Ž	r A		
Paste		ΙŪ·	🗄 🔺 💁 •	<u>A</u> - ≡	= = # #	•a• • \$ •	% , *.0 .00	Conditional Formatting	l Format as ▼ Table ▼ \$	Cell Styles *	Format •	Sor	t& Find & r * Select		
lipbo	ard 🖫	Fo	ont	- Gi	Alignment	Es.	Number 🕞		Styles		Cells	Ed	iting		
	A1	• (*	f _x	Timestamp)										
	А	В	С	D	E	F	G		Н	I	J	К		L	
1 1	imestamp	Adapter	Part_ID	Address	READ_VOUT	READ_IOUT	READ_TEMPER	ATURE_2							
2	12:27.4	1	TPS544C25	36	0.943	0.5		25							
3	12:27.9	1	TPS544C25	36	0.943	0.4375		25							
4	12:28.4	1	TPS544C25	36	0.943	0.5		25							
5	12:29.1	1	TPS544C25	36	0.943	0.4375		25							
5	12:29.4	1	TPS544C25	36	0.943	0.4375		25							
7	12:29.9	1	TPS544C25	36	0.943	0.4375		25							
3	12:30.4	1	TPS544C25	36	0.943	0.4375		25							
9	12:30.9	1	TPS544C25	36	0.943	0.4375		25							
0	12:31.4	1	TPS544C25	36	0.943	0.4375		25							
1	12:31.8	1	TPS544C25	36	0.943	0.4375		25							
2	12:32.4	1	TPS544C25	36	0.943	0.5		25							
.3	12:32.9	1	TPS544C25	36	0.943	0.4375		25							
.4	12:33.3	1	TPS544C25	36	0.943	0.4375		25							
5	12:34.0	1	TPS544C25	36	0.943	0.4375		25							
.6	12:34.4	1	TPS544C25	36	0.943	0.4375		25							
.7	12:34.9	1	TPS544C25	36	0.943	0.4375		25							
8	12:35.2	1	TPS544C25	36	0.943	0.4375		25							
9	12:35.7	1	TPS544C25	36	0.943	0.5		25							
0	12:36.2	1	TPS544C25	36	0.943	0.5		25							

Figure 38. Data Log File



Selecting PMBus Logging (Figure 39) from the Tools drop-down menu enables the logging of all PMBus activity in the same way as the datalogging. This includes communications traffic for each polling loop between the GUI and the device. It also includes common operating values such as VOUT, IOUT, and temperature. The user is prompted to select a location for the file to be stored. See next screen (Figure 40).



Fusion Digital Power Designer v2.0.37 [2015-03-27] TPS544C25 @ Address 36d USB Adapter v1.0.11 [PEC; 400 kHz]





Fusion GUI

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Select the storage location for the file and the type of file. As shown (Figure 40), the file is a CSV file to be stored in the directory path shown. Logging begins when the *Start Logging* button is selected, and stops when it is reselected (as *Stop Logging*). This file can rapidly grow in size, so caution is advised when using this function.

File Device Too	ols Debug Help		TPS544C25 @ Address 36d - Rail #1
Monitor	PMBus Readings	Vout - Output Voltage	Tout - Output Current
Show/Hide Plots: Vout I out I out Pout(calk I Temp Fit All Plots on Screen Scale Plots to Screen Vidth Height: 200 + Vidth Hoght: 200 + Vidth Hogh	Vout: 0.943 V Iout: 0.44 A Temp: 25 °C Status Registers/Lines Vout: OK Iout: OK Iout: OK Input: OK CML: OK Misc: OK CML: OK CML: OK On/Off Config 0 0x16 ♥ On/Off On/Off: On © Immediate Off Soft Off Margining: Onne _ Low _ Hop Fault Act On Fault	OVF: 1.281 () V V 0.949 () V UVW: 0.631 () V UVF: 0.594 () V MAX: 1.500 () V MIN: 0.500 () V Write 0.594 () V MAX: 1.500 () V MIN: 0.500 () V Write 0.591 () () <t< td=""><td>OC Fault: 36.0 A OC Wam: 34.0 A Write 40.00 30.00 20.00 10.00 10:20 10:40 11:00 11:20 11:40</td></t<>	OC Fault: 36.0 A OC Wam: 34.0 A Write 40.00 30.00 20.00 10.00 10:20 10:40 11:00 11:20 11:40
	Control Line Tips & Hints	V PMBus Log	
	OT_WARN_LIMIT [0x51]	15:03:06.649: USB-SAA #1: CONTROL1 now High	
 Configure Monitor 	Set the temperature of the unit at which it sho	uld indicate an overtemperature warning alarm. 1503:06.734: USB-SAA #1: CONTROL3 now Low 1503:06.741: USB-SAA #1: CONTROL3 now Low 1503:06.741: USB-SAA #1: CONTROL4 now Low 1503:14.594: USB-SAA #1: CONTROL4 now Low 1503:25.01: USB-SAA #1: CONTROL4 now Low	
Status		PMBus Log	F
· ·		544C25 @ Address 36d USB Adapter v1.0.11 [PEC; 400 kHz]	40

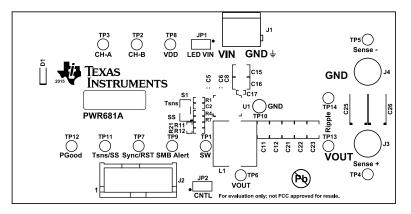
Figure 40. PMBus Log Details



EVM Assembly Drawing and PCB Layout

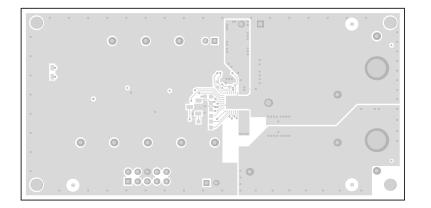
10 EVM Assembly Drawing and PCB Layout

Figure 41 through Figure 46 show the design of the PWR-681EVM printed-circuit board (PCB).



ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: PWR681	REV: A	SVN REV:	Not In VersionControl
LAYER NAME = Top Overlay				
PLOT NAME = Top Overlay	GENERATED : 3/30/2	2015 11:10:41	AM	TEXAS INSTRUMENTS

Figure 41. PWR-681EVM Top Layer Assembly Drawing (top view)



ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: PWR681	REV: A	SVN REV:	: Not In VersionControl
LAYER NAME = Top Layer				
PLOT NAME = Top Layer	GENERATED : 3/30/2	2015 11:10:42	AM	TEXAS INSTRUMENTS

Figure 42. PWR-681EVM Top Layer (top view)

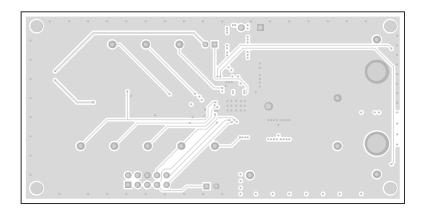


EVM Assembly Drawing and PCB Layout

:"0: 0

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: PWR681	REV: A	SVN REV	: Not In VersionControl
LAYER NAME = MidLayer1				
PLOT NAME = Inner Layer 1	GENERATED : 3/30/2	2015 11:10:42	AM	TEXAS INSTRUMENTS

Figure 43. PWR-681EVM Layer 1 (top view)

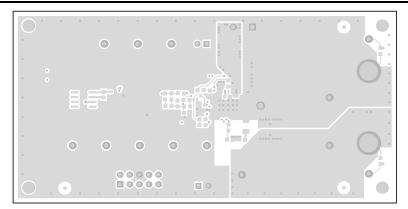


ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: PWR681	REV: A	SVN REV	: Not In VersionControl
LAYER NAME = MidLayer2				
PLOT NAME = Inner Layer 2	GENERATED : 3/30/2	2015 11:10:43	AM	TEXAS INSTRUMENTS

Figure 44. PWR-681EVM Layer 2 (top view)

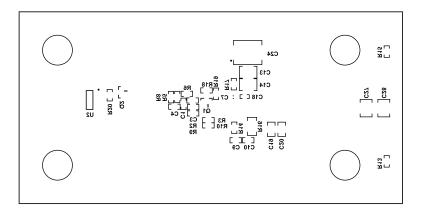






ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: PWR681	REV: A	SVN REV:	: Not In VersionControl
LAYER NAME = Bottom Layer				
PLOT NAME = Bottom Layer	GENERATED : 3/30/2	2015 11:10:43	AM	TEXAS INSTRUMENTS

Figure 45. PWR-681EVM Bottom Layer (top view)



ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: PWR681	REV: A	SVN REV	Not In VersionControl
LAYER NAME = Bottom Overlay				
PLOT NAME = Bottom Overlay	GENERATED : 3/30/2	2015 11:10:44	AM	TEXAS INSTRUMENTS

Figure 46. PWR-681EVM Bottom Layer	r Assembly Drawing (top view)
------------------------------------	-------------------------------

11 List of Materials

The EVM components list according to the schematic shown in Table 6.

NOTE: TPS544C25 version used for this example. The TPS544B25 EVM has the same List of Material as the TPS544C25 EVM with the exception of U1.

QTY	DES	DESCRIPTION	MANUFACTURER	PART NUMBER
1	PCB	Printed Circuit Board	Any	PWR681
1	C1	Capacitor, ceramic, 33 pF, 100 V, ±5%, C0G/NP0, 0603	AVX	06031A330JAT2A
2	C2, C10	Capacitor, ceramic, 1000 pF, 100 V, ±5%, X7R, 0603	AVX	06031C102JAT2A
2	C3, C4	Capacitor, ceramic, 1200 pF, 50 V, ±5%, C0G/NP0, 0603	TDK	C1608C0G1H122J
1	C5	Capacitor, ceramic, 330 pF, 50 V, ±1%, C0G/NP0, 0603	TDK	C1608C0G1H331F080 AA
1	C6	Capacitor, ceramic, 1 µF, 25 V, ±10%, X7R, 0603	MuRata	GRM188R71E105KA1 2D
1	C7	Capacitor, ceramic, 4.7 µF, 10 V, ±10%, X5R, 0603	Kemet	C0603C475K8PACTU
1	C8	Capacitor, ceramic, 2.2 µF, 6.3 V, ±10%, X6S, 0402	MuRata	GRM155C80J225KE9 5D
1	C9	Capacitor, ceramic, 0.1 µF, 25 V, ±5%, X7R, 0603	Kemet	C0603C104J3RACTU
7	C11, C12, C21, C22, C23, C27, C28	Multi-layer ceramic capacitor, 100 µF, 6.3 V, X5R, 1210	Wurth	885012109004
4	C13, C14, C15, C16	Multi-layer ceramic capacitor, 22 µF, 25 V, X5R, 1210	Wurth	885012109014
2	C17, C18	Capacitor, ceramic, 6800 pF, 25 V, ±10%, X7R, 0402	MuRata	GRM155R71E682KA0 1D
2	C19, C20	Capacitor, ceramic, 22 $\mu F,6.3$ V, ±20%, X5R, 0805	MuRata	GRM21BR60J226ME3 9L
1	C24	Capacitor, TA, 100 μF, 25 V, ±10%, 0.1 Ω, SMD	AVX	TPSV107K025R0100
1	D1	LED, pink, SMD	Bivar	SMS1105PKD
4	H1, H2, H3, H4	Bumpon, cylindrical, 0.312 X 0.200, black	3M	SJ61A1
2	H5, H6	Screw, 6-32 x 3/8" steel	B&F Fastener Supply	PMSSS 632 0038 PH
1	J1	2-pin terminal block, 0.200" spacing	Wurth	691216510002
1	J2	10-pin header, 2x5, 0.100" spacing, shrouded	Wurth	61201021621
2	J3, J4	Swage threaded standoff, brass, swage mount, TH	Keystone	1546
2	JP1, JP2	2-pin header, 0.100" spacing	Wurth	61300211121
1	L1	Inductor, shielded drum core, ferrite, 470 nH, 35 A, 0.00032 Ω , SMD	Wurth Elektronik eiSos	744301047
1	LBL1	Thermal transfer printable labels, 0.650" W x 0.200" H - 10,000 per roll	Brady	THT-14-423-10
1	Q1	Transistor, NPN, 40 V, 0.2 A, SOT-23	Fairchild Semiconductor	MMBT3904
1	Q2	MOSFET, N-Channel, 60 V, 0.24 A, SOT-23	Vishay-Siliconix	2N7002E-T1-E3
1	R1	Resistor, 100 kΩ, 1%, 0.1 W, 0603	STD	STD
1	R2	Resistor, 10.5 kΩ, 1%, 0.1 W, 0603	STD	STD
4	R3, R5, R10, R18	Resistor, 10.0 kΩ, 1%, 0.1 W, 0603	STD	STD
3	R6, R13, R15	Resistor, 49.9 Ω, 1%, 0.1 W, 0603	STD	STD
1	R7	Resistor, 40.2 kΩ, 1%, 0.1 W, 0603	STD	STD
1	R8	Resistor, 300 Ω, 1%, 0.1 W, 0603	STD	STD
-				

Table 6. PWR681 List of Materials

44 TPS544B25EVM-681 and TPS544C25EVM-681, Single-Output DC-to-DC Converters with PMBus Interface

SLUUB60A-May 2015-Revised September 2015 Submit Documentation Feedback

QTY	DES	DESCRIPTION	MANUFACTURER	PART NUMBER
2	R11, R12	Resistor, 51.1 kΩ, 1%, 0.1 W, 0603	STD	STD
1	R14	Resistor, 0 Ω, 5%, 0.1 W, 0603	STD	STD
1	R16	Resistor, 1.0 Ω, 5%, 0.25 W, 1206	STD	STD
1	R17	Resistor, 0 Ω, 5%, 0.1 W, 0603	STD	STD
1	R20	Resistor, 21.5, 1%, 0.1 W, 0603	STD	STD
1	R21	Resistor, 38.3 kΩ, 1%, 0.1 W, 0603	STD	STD
1	S1	Switch, slide, SPDT 100 mA, SMT	Copal Electronics	CAS-120TA
2	SH-JP1, SH- JP2	Shunt, 100 mil, gold plated, black	3M	969102-0000-DA
6	TP1, TP7, TP8, TP9, TP11, TP12	Test point, miniature, white, TH	Keystone	5002
5	TP2, TP3, TP4, TP6, TP13	Test point, miniature, red, TH	Keystone	5000
2	TP5, TP14	Test point, miniature, black, TH	Keystone	5001
1	TP10	Test point, multipurpose, black, TH	Keystone	5011
1	U1	18 V, 30 A PMBUS Synchronous Buck Converters, RVF0040A	Texas Instruments	TPS544C25RVF
1	U2	3-Terminal Adjustable Current Source, 8-pin Narrow SOIC, Pb-Free	Texas Instruments	LM334SM/NOPB
0	C25, C26	Capacitor, TA, 330 μF, 6.3 V, ±20%, 0.025 Ω, SMD	Sanyo	6TPE330ML
0	FID1, FID2, FID3, FID4, FID5, FID6	Fiducial mark. There is nothing to buy or mount.	N/A	N/A
0	R4	Resistor, 0 Ω, 5%, 0.1 W, 0603	Panasonic	ERJ-3GEY0R00V
0	R9, R19	Resistor, 30.1 kΩ, 1%, 0.1 W, 0603	Vishay-Dale	CRCW060330K1FKE

Table 6. PWR681 List of Materials (continued)

Revision History

Changes from Original (May 2015) to A Revision

Page

•	Added updated EVM Assembly Drawings and PCB Layout drawings	41
•	Changed C11, C12, C21, C22, C23, C27, C28 description, manufacturer and part number	44
•	Changed C13, C14, C15, C16 description, manufacturer and part number.	44
•	Changed J1 description, manufacturer and part number	44
•	Changed J2 description, manufacturer and part number	44
•	Changed JP1 and JP2 description, manufacturer and part number	44
•	Changed L1 part number	44
•	Changed all resistor manufacturer and part numbers to STD.	44

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

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- 3 Regulatory Notices:
 - 3.1 United States
 - 3.1.1 Notice applicable to EVMs not FCC-Approved:

This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

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CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

3.3 Japan

- 3.3.1 Notice for EVMs delivered in Japan: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page 日本国内に 輸入される評価用キット、ボードについては、次のところをご覧ください。 http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_01.page
- 3.3.2 Notice for Users of EVMs Considered "Radio Frequency Products" in Japan: EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

- 1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
- 2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
- 3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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- 3.3.3 Notice for EVMs for Power Line Communication: Please see http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page 電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。http://www.tij.co.jp/lsds/ti_ja/general/eStore/notice_02.page
- 4 EVM Use Restrictions and Warnings:
 - 4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.
 - 4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.
 - 4.3 Safety-Related Warnings and Restrictions:
 - 4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.
 - 4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.
 - 4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.
- Accuracy of Information: To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

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