

Using the PWR594 EVM Dual Output DC/DC Analog with PMBus Interface

The PWR594EVM evaluation module (EVM) uses the TPS40425 or TPS40428 controller. Both TPS40425 and TPS40428 are dual output, 2-phase, stackable PMBus synchronous buck, driverless controllers that operate from a nominal 4.5-V to 20-V supply. The controllers allow programming and monitoring via the PMBus interface.

TPS40425 is in non smart-power mode (DCR mode) in factory default, it uses inductor DCR for current sense and external thermal transistor for temperature sense. TPS40428 is in smart-power mode in factory default, it obtains current and temperature signals from TI smart power stage.

Contents

1	Description	. 3
	1.1 Typical Applications	. 3
	1.2 Features	. 3
2	Electrical Performance Specifications	. 4
3	Schematic	. 5
4	Test Setup	. 7
	4.1 Test and Configuration Software	. 7
	4.2 Test Equipment	. 7
	4.3 Power Sequence Between Soft-Start and +5 V for Power Stage	8
	4.4 Recommended Test Setup	. 8
	4.5 USB Interface Adapter and Cable	. 9
	4.6 List of Test Points and Connectors	. 9
5	EVM Configuration Using the Fusion GUI	11
	5.1 Configuration Procedure	11
6	Test Procedure	12
	6.1 Line/Load Regulation and Efficiency Measurement Procedure	12
	6.2 Control Loop Gain and Phase Measurement Procedure	12
	6.3 Efficiency	13
	6.4 Equipment Turn On and Shutdown	13
7	Performance Data and Typical Characteristic Curves	14
	7.1 Efficiency	14
	7.2 Load Regulation	15
	7.3 Bode Plot	16
	7.4 Transient Response	17
	7.5 Output Ripple	19
	7.6 Enable Turn On and Turn Off Waveforms	20
8	EVM Assembly Drawing and PCB Layout	22
9	Bill of Materials	26
10	Screenshots	28
	10.1 Fusion GUI Screenshots	28
11	Two-Phase Configuration	38

List of Figures

1	TPS40425EVM-PWR594 Schematic	5
2	TPS40428EVM-PWR594 Schematic	6



www.ti.com

3	PWR594 EVM Recommended Test Set Up	8
4	Texas Instruments USB-to-GPIO Adapter and Connections	9
5	Tip and Barrel Measurement	9
6	Test Setup for Efficiency Measurement	13
7	Efficiency of 1.2-V Output Versus Line and Load	14
8	Efficiency of 1.8-V Output Versus Line and Load	14
9	Load Regulation of 1.2-V Output	15
10	Load Regulation of 1.8-V Output	15
11	Bode Plot (12 V _{IN} , 1.2 V _{OUT} , 20 A)	16
12	Bode Plot (12 V _{IN} , 1.8 V _{OUT} , 20 A)	16
13	Transient Response (12 V_{IN} , 1.2 V_{OUT} , Load Step 10 A to 20 A, 5 A/µs)	17
14	Transient Response (12 V_{IN} , 1.2 V_{OUT} , Load Step 20 A to 10 A, 5 A/µs)	17
15	Transient Response (12 V_{IN} , 1.8 V_{OUT} , Load Step 10 A to 20 A, 5 A/µs)	18
16	Transient Response (12 V_{IN} , 1.8 V_{OUT} , Load Step 20 A to 10 A, 5 A/µs)	18
17	Output Ripple (12 V _{IN} , 1.2 V _{OUT} , 20 A)	19
18	Output Ripple (12 V _{IN} , 1.8 V _{OUT} , 20 A)	19
19	Enable Startup (12 V _{IN} , 1.2 V _{OUT} , 0 A)	20
20	Enable Startup (12 V _{IN} , 1.8 V _{OUT} , 0 A)	20
21	Enable Startup (12 V _{IN} , 1.2 V _{OUT} , 0.1 A)	21
22	Enable Startup (12 V _{IN} , 1.8 V _{OUT} , 0.1 A)	21
23	PWR594 EVM Top Layer Assembly Drawing (Top View)	22
24	PWR594 EVM Bottom Assembly Drawing (Bottom View)	22
25	PWR594 EVM Top Copper (Top View)	23
26	PWR594 EVM Internal Layer 1 (Top View)	23
27	PWR594 EVM Internal Layer 2 (Top View)	24
28	PWR594 EVM Internal Layer 3 (Top View)	24
29	PWR594 EVM Internal Layer 4 (Top View)	25
30	PWR594 EVM Bottom Copper (Top View)	25
31	Select Device Scanning Mode	28
32	Configure- Limits and On/Off	29
33	Configure - Device Information	30
34	Configure - All Config	31
35	Configure - Limits and On/Off- On/Off Config Pop-up	32
36	Change Screens to Other V _{out} Rail	33
37	Monitor Screen	34
38	System Dashboard	35
39	Status Screen	36
40	Import Configuration File	37
41	TPS40425EVM 2-Phase Schematic	38
42	TPS40428EVM 2-Phase Schematic	39

List of Tables

1	PWR594 EVM-001 Electrical Performance Specifications	4
2	Test Point Functions	9
3	Connector Functions	10
4	Key Factory Configuration Parameters	11
5	List of Test Points for Loop Response Measurements	12
6	TPS40425EVM-PWR594 Components List	26
7	TPS40428EVM-PWR594 Components List	27



www.ti.com	Descrip	tion
8	TPS40425EVM 2-Phase Components List	40

9	TPS40428EVM 2-Phase Components List	41

1 Description

The PWR594EVM is designed as a dual-output converter in default. It uses a nominal 12-V bus to produce a regulated 1.2-V output at up to 20 A of load current, and a regulated 1.8-V output at up to 20 A of load current. The PWR594EVM is designed to demonstrate the controllers in a typical low-voltage application while providing a number of test points to evaluate the performance of the controllers. The PWR594EVM can be configured as 2-phase by changing the bill of materials (BOM). Refer to the TPS40425 (<u>SLUSB06</u>) and TPS40428 (<u>SLUSBV0</u>) datasheets for more information on multi-phase configuration.

To simplify the BOM, power stage CSD95378B is used for both TPS40425 EVM and TPS40428 EVM. In user's application, power stage CSD95372A can be considered for a TPS40425 design at non smart-power mode.

1.1 Typical Applications

- Wireless infrastructure
- Switcher/Router Network/Server/Storage

1.2 Features

- Regulated 1.2-V output up to 20-A DC steady-state output current
- Regulated 1.8-V output up to 20-A DC steady-state output current
- Both outputs are marginable and trimmable via the PMBus interface
 - Programmable UVLO, soft start, and enable via the PMBus interface
 - Programmable overcurrent warning and fault limits and programmable response to faults via the PMBus interface
 - Programmable overvoltage and undervoltage fault limit via the PMBus interface
 - Programmable high- and low-output margin voltages with a maximum range of +10%, -20% of nominal output voltage
- Convenient test points for probing critical waveforms

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2 Electrical Performance Specifications

Table 1 lists the electrical performance specifications.

Parameter	Test Conditions	MIN	TYP	MAX	Unit
Input Characteristics					
Voltage range	V _{IN}	7	12	14	V
Maximum input current	V _{IN} = 7 V, I _{O1} = 20 A, I _{O2} = 20 A		10		А
No load input current	V _{IN} = 12 V, I _{O1} = 0 A, I _{O2} = 0 A		80		mA
Output Characteristics					
Output voltage, V _{OUT1}			1.2		V
Output voltage, V _{OUT2}			1.8		V
Output load current, I _{OUT1} ⁽¹⁾		0		20	А
Output load current, I _{OUT2} ⁽¹⁾		0		20	А
	Line Regulation: Input voltage = 7 V to 14 V			0.5%	
Output voltage regulation	Load Regulation: Output current = 0 A to 20 A, both outputs			0.5%	
Output voltage ripple, V _{OUT1}	V _{IN} = 12 V, I _{OUT} = 20 A		10		mVpp
Output voltage ripple, V _{OUT2}	V _{IN} = 12 V, I _{OUT} = 20 A		10		mVpp
	Inductor peak current, TPS40425EVM		30		А
Output overcurrent	Inductor peak current, TPS40428EVM		40		А
Systems Characteristics					
Switching frequency	V _{IN} = 12 V		500		kHz
Full load efficiency, V _{OUT1}	V_{IN} = 12 V, I_{O1} = 20 A, V_{OUT2} disabled		90%		
Full load efficiency, V _{OUT2}	V_{IN} = 12 V, I_{O2} = 20 A, V_{OUT1} disabled		92%		
Operating temperature	T _{oper}		25		°C

Table 1. PWR594 EVM-001 Electrical Performance Specifications

⁽¹⁾ The output current I_{OUT1} and I_{OUT2} can be up to 25 A, if the output overcurrent limit (IOUT_OC_FAULT_LIMIT) is set to 40 A.



3 Schematic

Figure 1 and Figure 2 illustrate the TPS40425 EVM and TPS40428 EVM schematics.



Figure 1. TPS40425EVM-PWR594 Schematic









4 Test Setup

4.1 Test and Configuration Software

In order to change any of the default configuration parameters on the EVM, it is necessary to obtain the TI Fusion Digital Power Designer software.

4.1.1 Description

Fusion Digital Power Designer is the Graphical User Interface (GUI) used to configure and monitor the controller on this EVM. The application uses the PMBus protocol to communicate with the controller over serial bus via TI USB adapter (see Figure 4).

4.1.2 Features

Some of the tasks you can perform 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 output voltage, output current, temperature, warnings and faults which are continuously monitored and displayed by the GUI.
- Configure common operating characteristics such as V_{OUT} trim and margin, UVLO, soft-start time, warning and fault thresholds, fault response, and ON/OFF modes.

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

4.2 Test Equipment

Voltage Source: The input voltage source V_{IN} should be a 0-V to 14-V variable DC source capable of supplying 15 ADC. Connect VIN to J5 as shown in Figure 3.

Multimeters: It is recommended to use three separate multimeters as shown in Figure 3. One meter to measure V_{IN} , the other two to measure V_{OUT1} and V_{OUT2} .

Output Load: Two variable electronic loads are recommended for the test setup as shown in Figure 3. Both Load 1 and Load 2 should be capable of 20 A.

Oscilloscope: An oscilloscope is recommended for measuring output noise and ripple. Output ripple should be measured using a *Tip-and-Barrel* method or better as shown in Figure 5.

Fan: During prolonged operation at high loads, it may be necessary to provide forced air cooling with a small fan aimed at the EVM. The temperature of the devices on the EVM should be maintained at less than 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, see Figure 4. This adapter can be purchased here: <u>http://www.ti.com/tool/usb-to-gpio</u>.

4.2.1 Recommended Wire Gauge

- VIN to J5 (12-V input) The recommended wire size is 2xAWG #10, with the total length of wire less than 4 feet (2 feet input, 2 feet return).
- Load1 to J6 (1.2-V output) The minimum recommended wire size is 2xAWG #10, with the total length of wire less than 4 feet (2 feet OUTPUT, 2 feet return).
- Load2 to J11 (1.8-V output) The minimum recommended wire size is 2xAWG #10, with the total length of wire less than 4 feet (2 feet OUTPUT, 2 feet return).



Test Setup

4.3 Power Sequence Between Soft-Start and +5 V for Power Stage

A +5-V power supply is required by power stage CSD95378B and must be prepared before soft-start. Without preparation, the controller outputs the PWM signal at maximum duty cycle because the power stage is not working and output voltage is not regulated. The +5 V for power stage needs to be provided until the controller is turned off.

There is an onboard +5 V generated by the TPS62125 circuit. In default, a jumper is placed on J1 and the onboard +5 V is used for power stage. The FLT1 and FLT2 pins of the controller are connected to the PG pin of TPS62125 via diodes for power sequence between soft-start and onboard +5 V. Only when onboard +5 V is regulated, the FLT pins will be released to allow soft-start. Therefore, if onboard +5 V is selected, the power sequence is provided by the EVM design and no other procedure need to be conducted by user.

If an external +5 V is used for power stage, the external +5 V must be prepared before soft-start, and +5 V need to be provided until the controller is turned off.

The following list shows the jumper configurations for onboard and external +5 V:

- Onboard +5 V (In default): place jumpers on J1 and J3, remove jumper on J2
- External +5 V: place jumpers on J2 and J3, remove jumper on J1

4.4 Recommended Test Setup

Figure 3 shows the recommended test setup.



Figure 3. PWR594 EVM Recommended Test Set Up

4.5 USB Interface Adapter and Cable

Figure 4 illustrates the USB interface adapter and cable.

Figure 4. Texas Instruments USB-to-GPIO Adapter and Connections

Figure 5 illustrates the tip and barrel measurement.

Figure 5. Tip and Barrel Measurement

4.6 List of Test Points and Connectors

Table 2 lists the test point functions.

Table 2. Test Point Functions

Test Point	Туре	Name	Description	
TP1	T-H Loop	VIN	V _{IN} + measurement point	
TP4	T-H Loop	GND	V _{IN} - measurement point	
TP12	T-H Loop	VOUT1	V _{OUT1} + measurement point	

Using the PWR594 EVM Dual Output DC/DC Analog with PMBus Interface

Test Setup

Test Point	Туре	Name	Description	
TP17	T-H Loop	GND	V _{OUT1} - measurement point	
TP9	T-H Loop	VSNS1	VSNS1 measurement point	
TP11	T-H Loop	GSNS1	GSNS1 measurement point	
TP13	T-H Loop	SW1	Switching point of Channel 1	
TP21	T-H Loop	PWM1	PWM signal of Channel1	
TP18	T-H Loop	PG1	PGOOD signal of Channel 1	
TP10	T-H Loop	COMP1	COMP signal of Channel 1	
TP2	T-H Loop	FLT1	FLT signal of Channel 1	
TP8	T-H Loop	CH1A	Input for control loop measurements for Channel 1	
TP7	T-H Loop	CH1B	OUTPUT for control loop measurements for Channel 1	
TP24	T-H Loop	VOUT2	V _{OUT2} + measurement point	
TP27	T-H Loop	GND	V _{OUT2} - measurement point	
TP5	T-H Loop	VSNS2	VSNS2 measurement point	
TP6	T-H Loop	GSNS2	GSNS2 measurement point	
TP25	T-H Loop	SW2	Switching point of Channel 2	
TP22	T-H Loop	PWM2	PWM signal of Channel2	
TP23	T-H Loop	PG2	PGOOD signal of Channel 2	
TP26	T-H Loop	COMP2	COMP signal of Channel 2	
TP3	T-H Loop	FLT2	FLT signal of Channel 2	
TP28	T-H Loop	CH2A	Input for control loop measurements for Channel 2	
TP29	T-H Loop	CH2B	OUTPUT for control loop measurements for Channel 2	
TP19	T-H Loop	SYNC	SYNC signal	
TP20	T-H Loop	PHSET	PHSET signal	
TP30	T-H Loop	SMB	SMBALERT signal	
TP31	T-H Loop	3.3V	3.3V pull-up voltage of PMBus	

Table 2. Test Point Functions (continued)

Table 3 lists the EVM connector functions.

Table 3. Connector Functions

Connector	Туре	Description
J1	PEC02SAAN	Use onboard +5 V for power stage
J2	PEC02SAAN	Use external +5 V for power stage
J3	PEC02SAAN	Connect the input of onboard +5-V converter to VIN
J4	ED120/2DS	External +5-V connector
J5	ED120/2DS	VIN connector
J6	ED120/2DS	VOUT1 connector
J7	PEC02SAAN	CNTL1 connector
J8	PEC02SAAN	CNTL2 connector
J9	PEC02SAAN	AVSDATA connector
J10	PEC02SAAN	AVSCLK connector
J11	ED120/2DS	VOUT2 connector
J12	PEC05DAAN	PMBus connector

5 EVM Configuration Using the Fusion GUI

The controller on this EVM leaves the factory pre-configured. See Table 4 for a short list of key factory configuration parameters as obtained from the configuration file.

Cmd NAME	CmdCodeHex	EncodedHex	Decoded	Comments
VIN_OFF	0x36	0xF014	4.0 V	Turn OFF voltage
VIN_ON	0x35	0xF01C	4.25 V	Turn ON voltage
IOUT_CAL_GAIN	0x38	0x8021	0.5 mΩ	Equivalent DCR value
IOUT_CAL_OFFSET	0x39	0xE000	0.0000 A	Current offset for GUI readout
IOUT_OC_FAULT_LIMIT	0x46	0xF83C	30.0 A	TPS40425EVM, OC fault level
		0xF850	40.0 A	TPS40428EVM, OC fault level
IOUT_OC_FAULT_RESPONSE	0x47	0x3C	Restart continuously	Response to OC fault
IOUT_OC_WARN_LIMIT	0x4A	0xF836	27.0 A	TPS40425EVM, OC warning level
		0xF84A	37.0 A	TPS40428EVM, OC warning level
MFR_04 (VREF_TRIM)	0xD4	0x0000	0.000 V	Trim voltage
ON_OFF_CONFIG	0x02	0x16	Control only, logic high	Control signal and OPERATION command not required
OT_FAULT_LIMIT	0x4F	0x007D	125 C	TPS40425 EVM, OT fault level
		0x0091	145 C	TPS40428 EVM, OT fault level
OT_WARN_LIMIT	0x51	0x0064	100 C	TPS40425 EVM, OT warn level
		0x007D	125 C	TPS40428 EVM, OT warn level
TON_RISE	0x61	0xE02B	2.7 ms	Soft-start time

Table 4. Key Factory Configuration Parameters

If it is desired to configure the EVM to settings other than the factory settings shown above, 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 controller may respond to the GUI and the GUI can recognize the controller. In order to avoid any converter activity during configuration, an input voltage less than VIN_ON voltage should be applied. An input voltage of 4 V is recommended.

5.1 Configuration Procedure

- 1. Adjust the input supply to provide 4 VDC, current limited to 1 A.
- 2. Apply the input voltage to the EVM. Refer to Figure 3 and Figure 4 for connections and test setup.
- 3. Launch the Fusion GUI software. Refer to the screenshots in Section 10 for more information.
- 4. Configure the EVM operating parameters as desired.

The *TON_RISE* parameter may affect proper startup if the rise time and output capacitance bank result in a current that exceeds the OC Fault level. The startup surge current in the output capacitance bank is added to the load current, so the sum of these two currents must be less than the OC Fault level for proper startup.

NOTE: The *IOUT_CAL_GAIN* parameter is used by the controller in the calculation of output current level. In the TPS40425 EVM, the controller is at non smart-power mode in default, the IOUT_CAL_GAIN needs to be equal to the equivalent inductor DCR value for accurate current readout. In the TPS40428 EVM, the controller is at smart-power mode in default, IOUT_CAL_GAIN must be set to 0.5 m Ω for accurate current readout. The incorrect IOUT_CAL_GAIN value also affects OC Fault and OC Warn performance.

6 Test Procedure

6.1 Line/Load Regulation and Efficiency Measurement Procedure

- 1. Set up the EVM as described in Figure 3.
- 2. Ensure both electronic loads are set to draw 0 Adc.
- 3. Increase V_{IN} from 0 V to 12 V using voltage meter #3 to measure input voltage.
- 4. Use voltage meter #1 to measure output voltage V_{OUT1} .
- 5. Vary the load from 0 to 20 Adc. V_{OUT1} should remain in regulation as defined in Table 1.
- 6. Vary V_{IN} from 7 V to 14 V. V_{OUT1} should remain in regulation as defined in Table 1.
- 7. Decrease the load to 0 A.
- 8. Use voltage meter #2 to measure output voltage V_{OUT2} .
- 9. Vary the load from 0 to 20 Adc. V_{OUT2} should remain in regulation as defined in Table 1.
- 10. Vary V_{IN} from 7 V to 14 V. V_{OUT2} should remain in regulation as defined in Table 1.
- 11. Decrease the load to 0 A.
- 12. Decrease V_{IN} to 0 V.

6.2 Control Loop Gain and Phase Measurement Procedure

The PWR594 EVM includes a 49.9- Ω series resistor in the feedback loop for both V_{OUT1} and V_{OUT2}. These resistors are used for loop response analysis, and are accessible at the test points TP7 and TP8 for V_{OUT1}, and TP28 and TP29 for V_{OUT2}. Those test points should be used during loop response measurements as the injection points for the loop perturbation. See the description in Table 5.

Table 5. List of Te	st Points for Loop	Response Measurements
---------------------	--------------------	------------------------------

Test Point	Node Name	Description	Comment
TP8	INPUT1	Input to feedback divider of V _{OUT1}	The amplitude of the perturbation at this node should be limited to less than 100 mV
TP7	OUTPUT1	Resulting output of V _{OUT1}	Bode can be measured by a network analyzer as TP7/TP8
TP28	INPUT2	Input to feedback divider of V _{OUT2}	The amplitude of the perturbation at this node should be limited to less than 100 mV
TP29	VOUT2	Resulting output of V _{OUT2}	Bode can be measured by a network analyzer as TP29/TP28

Measure only one output at a time, with the following procedure:

- 1. Set up the EVM as described in Figure 3.
- 2. For V_{OUT1}, connect the network analyzer's isolation transformer from TP7 to TP8,
- 3. Connect the input signal measurement probe to TP8. Connect the output signal measurement probe to TP7.
- 4. Connect the ground leads of both probe channels to TP16.
- 5. On the network analyzer, measure the Bode as TP7/TP8 (Out/In).
- 6. For V_{OUT2} , connect the network analyzer's isolation transformer from TP29 to TP28.
- 7. Connect the input signal measurement probe to TP28. Connect output signal measurement probe to TP29.
- 8. Connect the ground leads of both probe channels to TP15.
- 9. On the network analyzer, measure the Bode as TP29/TP28 (Out/In).
- 10. Disconnect the isolation transformer from the bode plot test points before making other measurements, because the signal injection into the feedback loop may interfere with the accuracy of other measurements.

6.3 Efficiency

In order 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 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 should not be included in efficiency measurements.

Test Procedure

When measuring the efficiency of V_{OUT1} , disable V_{OUT2} via the Fusion GUI. Likewise, when measuring the efficiency of V_{OUT2} , disable V_{OUT1} .

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.

Figure 6 shows the measurement points for input voltage and output voltage. VIN1 and VOUT1 are measured to calculate the efficiency of channel 1, and VIN2 and VOUT2 are measured to calculate the efficiency of channel 2. Using these measurement points will result in efficiency measurements that do not include losses due to the connectors and PWB traces.

Figure 6. Test Setup for Efficiency Measurement

6.4 Equipment Turn On and Shutdown

- Turn on sequence:
 - Turn on external +5 V if in use. Skip this step if onboard +5 V is in use.
 - Turn on input power supply and increase V_{IN} above 7 V.
 - Turn on PWM.
 - Adjust load current on both outputs, as desired.
- Shutdown sequence:
 - Reduce the load current on both outputs to zero amperes.
 - Turn off PWM.
 - Reduce input voltage to zero volts.
 - Shut down external +5 V, if in use. Skip this step if onboard +5 V is in use.
 - Shut down the external FAN if in use.

7.1

7 Performance Data and Typical Characteristic Curves

Figure 7 to Figure 22 present typical performance curves and waveforms for the TPS40425EVM (TPS40425 EVM). Collect curves and waveforms on the TPS40428EVM with the test procedures in the previous section.

Efficiency 94.00% 92.00% 90.00% 88.00% 7Vin 86.00% 12Vin 84.00% 14Vin 82.00% 80.00% 5.00 10.00 15.00 20.00 Figure 7. Efficiency of 1.2-V Output Versus Line and Load

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7.3 Bode Plot

Figure 12. Bode Plot (12 V_{IN} , 1.8 V_{OUT} , 20 A)

7.4 Transient Response

 $Ch1 = V_{OUT1}$ at 20 mV/division, Ch2 = Iout1 at 10 A/division

Figure 13. Transient Response (12 V_{IN}, 1.2 V_{OUT}, Load Step 10 A to 20 A, 5 A/µs)

 $Ch1 = V_{OUT1}$ at 20 mV/division, Ch2 = Iout1 at 10 A/division

Figure 14. Transient Response (12 $V_{\text{IN}},$ 1.2 $V_{\text{out}},$ Load Step 20 A to 10 A, 5 A/µs)

Figure 15. Transient Response (12 V_{IN}, 1.8 V_{OUT}, Load Step 10 A to 20 A, 5 A/µs)

Figure 16. Transient Response (12 V_{IN} , 1.8 V_{OUT} , Load Step 20 A to 10 A, 5 A/µs)

7.5 Output Ripple

 $Ch1 = V_{OUT1}$ at 10 mV/division, Ch2 = SW node at 5 V/division

Figure 17. Output Ripple (12 V_{IN}, 1.2 V_{OUT}, 20 A)

Performance Data and Typical Characteristic Curves

7.6 Enable Turn On and Turn Off Waveforms

Ch1 = V_{OUT1} at 500 mV/division, Ch2 = SW node at 10 V/division, Ch3 = CNTL1 at 2 V/division

Figure 19. Enable Startup (12 V_{IN}, 1.2 V_{OUT}, 0 A)

 $\label{eq:ch1} Ch1 = V_{\text{OUT2}} \text{ at } 1 \text{ V/division, Ch2} = SW \text{ node at } 10 \text{ V/division, Ch3} = CNTL2 \text{ at } 2 \text{ V/division} \\ \textbf{Figure 20. Enable Startup (12 V_{\text{IN}}, 1.8 V_{\text{OUT}}, 0 \text{ A})}$

Ch1 = V_{OUT1} at 500 mV/division, Ch2 = SW node at 10 V/division, Ch3 = CNTL1 at 2 V/division Figure 21. Enable Startup (12 V_{IN}, 1.2 V_{OUT}, 0.1 A)

 $\label{eq:ch1} Ch1 = V_{\text{OUT2}} \text{ at } 1 \text{ V/division, Ch2} = SW \text{ node at } 10 \text{ V/division, Ch3} = CNTL2 \text{ at } 2 \text{ V/division} \\ \textbf{Figure 22. Enable Startup (12 V_{\text{IN}}, \textbf{1.8 V}_{\text{OUT}}, \textbf{0.1 A)} \\ \end{array}$

8 EVM Assembly Drawing and PCB Layout

Figure 23 through Figure 30 show the design of the PWR594 EVM printed circuit board.

Figure 23. PWR594 EVM Top Layer Assembly Drawing (Top View)

Figure 25. PWR594 EVM Top Copper (Top View)

Figure 26. PWR594 EVM Internal Layer 1 (Top View)

Figure 27. PWR594 EVM Internal Layer 2 (Top View)

Figure 28. PWR594 EVM Internal Layer 3 (Top View)

Figure 29. PWR594 EVM Internal Layer 4 (Top View)

Figure 30. PWR594 EVM Bottom Copper (Top View)

9 Bill of Materials

Table 6 lists the BOM for the PWR594-001 (TPS40425 EVM). Table 7 lists the BOM for the PWR594-002 (TPS40428 EVM).

Qty	Designator	Description	Part Number	Manufacturer
2	C1, C2	CAP, AL, 100 μF, 25 V, ±20%, 0.3 Ω, SMD	EEE-FC1E101P	Panasonic
11	C3–C7, C10– C15	CAP, CERM, 22 μF, 25 V, ±10%, X5R, 1210	STD	STD
2	C8, C9	CAP, CERM, 10 μF, 10 V, ±10%, X5R, 0805	STD	STD
2	C16, C70	CAP, CERM, 1500 pF, 25 V, ±10%, X7R, 0603	STD	STD
2	C17, C67	CAP, CERM, 100 pF, 50 V, ±5%, C0G/NP0, 0603	STD	STD
7	C18, C30, C31, C45, C52, C56, C57	CAP, CERM, 0.1 μF, 25 V, ±10%, X7R, 0603	STD	STD
20	C20–C24, C33–C37, C46–C50, C59–C63	CAP, CERM, 100 μF, 6.3 V, ±20%, X5R, 1210	STD	STD
2	C26, C69	CAP, CERM, 3300 pF, 25 V, ±10%, X7R, 0603	STD	STD
4	C27, C29, C54, C55	CAP, CERM, 470 pF, 50 V, ±10%, X7R, 0603	STD	STD
5	C28, C42–C44, C53	CAP, CERM, 1 µF, 25 V, ±10%, X5R, 0603	STD	STD
2	C32, C65	CAP, CERM, 3300 pF, 50 V, ±10%, X7R, 0603	STD	STD
4	C39, C41, C58, C68	CAP, CERM, 1000 pF, 50 V, ±10%, X7R, 0603	STD	STD
2	C40, C66	CAP, CERM, 0.22 µF, 25 V, ±10%, X7R, 0603	STD	STD
2	D1, D2	Diode, Schottky, 30 V, 0.2 A, SOD-323	BAT54HT1G	ON Semiconductor
7	J1–J3, J7–J10	Header, 100 mil, 2x1, Tin plated, TH	PEC02SAAN	Sullins Connector Solutions
1	J4	TERMINAL BLOCK 5.08 mm VERT 2POS, TH	ED120/2DS	On-Shore Technology
3	J5, J6, J11	TERMINAL BLOCK 5.08 mm VERT 4POS, TH	ED120/4DS	On-Shore Technology
1	J12	Header, 100 mil, 5x2, Tin plated, TH	PEC05DAAN	Sullins Connector Solutions
1	L1	Inductor, Shielded Drum Core, Ferrite, 10 $\mu H,$ 0.7 A, 0.33 $\Omega,$ SMD	LPS3314-103MLB	Coilcraft
2	L2, L3	Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 $\Omega,$ SMD	744355147	Wurth Elektronik eiSos
2	Q1, Q3	Synchronous Buck NexFET Power Stage, DQP0012A	CSD95378BQ5M	Texas Instruments
2	Q2, Q4	Transistor, NPN, 20 V, 0.2 A, SOT-523	MMBT3904T-7-F	Diodes Inc.
1	R2	RES, 1.10 MΩ, 1%, 0.1 W, 0603	STD	STD
5	R3, R22, R29, R51, R59	RES, 0 Ω, 5%, 0.1 W, 0603	STD	STD
1	R6	RES, 210 kΩ, 1%, 0.1 W, 0603	STD	STD
2	R8, R64	RES, 49.9 Ω, 1%, 0.1 W, 0603	STD	STD
6	R1, R9, R13, R30, R40, R63	RES, 10.0 kΩ, 1%, 0.1 W, 0603	STD	STD
2	R12, R67	RES, 280 Ω, 1%, 0.1 W, 0603	STD	STD
3	R16, R54, R66	RES, 4.99 kΩ, 1%, 0.1 W, 0603	STD	STD
7	R17, R25, R26, R35, R44, R55, R56	RES, 1.00 Ω, 1%, 0.1 W, 0603	STD	STD
2	R18, R47	RES, 121 kΩ, 1%, 0.1 W, 0603	STD	STD
4	R20, R27, R45, R53	RES, 10.0 Ω, 1%, 0.1 W, 0603	STD	STD
2	R23, R52	RES, 4.22 kΩ, 1%, 0.1 W, 0603	STD	STD
1	R24	RES, 40.2 kΩ, 1%, 0.1 W, 0603	STD	STD
2	R28, R58	RES, 12.4 kΩ, 1%, 0.1 W, 0603	STD	STD
2	R37, R42	RES, 100 Ω, 1%, 0.1 W, 0603	STD	STD
2	R48, R49	RES, 16.2 kΩ, 1%, 0.1 W, 0603	STD	STD
2	SH-J1, SH-J3	Shunt, 100 mil, Gold plated, Black	969102-0000-DA	3M
6	TP1, TP5, TP9, TP12, TP24, TP31	Test Point, Miniature, Red, TH	5000	Keystone
17	TP2, TP3, TP7, TP8, TP10, TP13, TP18–TP23, TP25_TP26_TP28–TP30	Test Point, Miniature, White, TH	5002	Keystone

Table 6. TPS40425EVM-PWR594 Components List

		-		
Qty	Designator	Description	Part Number	Manufacturer
9	TP4, TP6, TP11, TP14–TP17, TP27, TP32	Test Point, Miniature, Black, TH	5001	Keystone
1	U1	IC, 3 V–17 V, 200 mA High Efficient Buck Converter	TPS62125DSG	ТІ
1	U2	IC, Dual output, 2-Phase, Stackable PMBUS Synchronous Buck Driverless Controller with AVS Bus	TPS40425RHA	ті

Table 6. TPS40425EVM-PWR594 Components List (continued)

Table 7. TPS40428EVM-PWR594 Components List

Qty	Designator	Description	Part Number	Manufacturer
2	C1, C2	CAP, AL, 100 μF, 25 V, ±20%, 0.3 Ω, SMD	EEE-FC1E101P	Panasonic
11	C3–C7, C10–C15	CAP, CERM, 22 μF, 25 V, ±10%, X5R, 1210	STD	STD
2	C8, C9	CAP, CERM, 10 µF, 10 V, ±10%, X5R, 0805	STD	STD
2	C16, C70	CAP, CERM, 1500 pF, 25 V, ±10%, X7R, 0603	STD	STD
2	C17, C67	CAP, CERM, 100 pF, 50 V, ±5%, C0G/NP0, 0603	STD	STD
7	C18, C30, C31, C45, C52, C56, C57	CAP, CERM, 0.1 μF, 25 V, ±10%, X7R, 0603	STD	STD
20	C20–C24, C33–C37, C46–C50, C59–C63	CAP, CERM, 100 μF, 6.3 V, ±20%, X5R, 1210	STD	STD
2	C26, C69	CAP, CERM, 3300 pF, 25 V, ±10%, X7R, 0603	STD	STD
4	C27, C29, C54, C55	CAP, CERM, 470 pF, 50 V, ±10%, X7R, 0603	STD	STD
5	C28, C42–C44, C53	CAP, CERM, 1 µF, 25 V, ±10%, X5R, 0603	STD	STD
2	C32, C65	CAP, CERM, 3300 pF, 50 V, ±10%, X7R, 0603	STD	STD
2	C39, C58	CAP, CERM, 1000 pF, 50 V, ±10%, X7R, 0603	STD	STD
2	D1, D2	Diode, Schottky, 30 V, 0.2 A, SOD-323	BAT54HT1G	ON Semiconductor
7	J1–J3, J7–J10	Header, 100 mil, 2x1, Tin plated, TH	PEC02SAAN	Sullins Connector Solutions
1	J4	TERMINAL BLOCK 5.08 mm VERT 2POS, TH	ED120/2DS	On-Shore Technology
3	J5, J6, J11	TERMINAL BLOCK 5.08 mm VERT 4POS, TH	ED120/4DS	On-Shore Technology
1	J12	Header, 100 mil, 5x2, Tin plated, TH	PEC05DAAN	Sullins Connector Solutions
1	L1	Inductor, Shielded Drum Core, Ferrite, 10 μ H, 0.7 A, 0.33 Ω , SMD	LPS3314-103MLB	Coilcraft
2	L2, L3	Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 $\Omega,$ SMD	744355147	Wurth Elektronik eiSos
1	LBL1	Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll	THT-13-457-10	Brady
2	Q1, Q3	Synchronous Buck NexFET Power Stage, DQP0012A	CSD95378BQ5M	Texas Instruments
1	R2	RES, 1.10 MΩ, 1%, 0.1 W, 0603	STD	STD
7	R3, R7, R10, R15, R36, R38, R43	RES, 0 Ω, 5%, 0.1 W, 0603	STD	STD
1	R6	RES, 210 kΩ, 1%, 0.1 W, 0603	STD	STD
2	R8, R64	RES, 49.9 Ω, 1%, 0.1 W, 0603	STD	STD
6	R1, R9, R13, R30, R40, R63	RES, 10.0 kΩ, 1%, 0.1 W, 0603	STD	STD
2	R12, R67	RES, 280 Ω, 1%, 0.1 W, 0603	STD	STD
3	R16, R54, R66	RES, 4.99 kΩ, 1%, 0.1 W, 0603	STD	STD
7	R17, R25, R26, R35, R44, R55, R56	RES, 1.00 Ω, 1%, 0.1 W, 0603	STD	STD
2	R18, R47	RES, 121 kΩ, 1%, 0.1 W, 0603	STD	STD
4	R20, R27, R45, R53	RES, 10.0 Ω, 1%, 0.1 W, 0603	STD	STD
1	R24	RES, 40.2 kΩ, 1%, 0.1 W, 0603	STD	STD
2	R37, R42	RES, 100 Ω, 1%, 0.1 W, 0603	STD	STD
2	R48, R49	RES, 16.2 kΩ, 1%, 0.1 W, 0603	STD	STD
2	SH-J1, SH-J3	Shunt, 100 mil, Gold plated, Black	969102-0000-DA	3M
6	TP1, TP5, TP9, TP12, TP24, TP31	Test Point, Miniature, Red, TH	5000	Keystone

			(,	
Qty	Designator	Description	Part Number	Manufacturer
17	TP2, TP3, TP7, TP8, TP10, TP13, TP18–TP23, TP25, TP26, TP28–TP30	Test Point, Miniature, White, TH	5002	Keystone
9	TP4, TP6, TP11, TP14–TP17, TP27, TP32	Test Point, Miniature, Black, TH	5001	Keystone
1	U1	IC, 3 V-17 V, 200-mA High Efficient Buck Converter	TPS62125DSG	ТІ
1	U2	IC, Dual output, 2-Phase, Stackable PMBUS Synchronous Buck Driverless Controller with AVS Bus	TPS40428RHA	ті

Table 7. TPS40428EVM-PWR594 Components List (continued)

10 Screenshots

10.1 Fusion GUI Screenshots

When launching the Fusion GUI, select DEVICE_CODE as scanning mode to find TPS40425 or TPS40428.

TEXAS INSTRUMENTS
Fusion Digital Power Designer Version 1.9.41 [2014-05-13]
Select Device Scanning Mode Select the method the GUI should use to scan for device(s) on the I2C bus: UCD Controllers and Sequencers, Isolated Controllers (DEVICE_ID) UCD92xx, UCD91xx, UCD90xx, Isolated, etc. The GUI will scan the bus for devices that respond to the DEVICE_ID command. This is a Texas Instruments manufacturing specific command (read block 0xFD).
TPS40400, TPS4042x, TPS544x20, etc. (DEVICE_CODE) Analog power converters and controllers. The GUI will scan for devices that respond to the Texas Instruments DEVICE_CODE command (read word 0xFC).
TPS544x24, etc (IC_DEVICE_ID) Analog power converters and controllers. The GUI will scan for devices that respond to the Texas Instruments IC_DEVICE_ID command (read block 0xAD).
DEVICE ID and DEVICE CODE Scan for DEVICE_ID and DEVICE_CODE. Use this option if you have a mix of devices on the bus or do not know which of DEVICE_ID or DEVICE_CODE your device supports. Scanning takes longer in this mode.
Define Custom Scan List You can configure only certain addresses to be scanned by clicking this link. For each address, you can select the scan mode to use.
Device scan may cause STATUS_CML faults. <u>Click for more information</u> . Your selection will be used to scan immediately and the next time Fusion Digital Power Designer launches.
Adapter Mode Offline Mode Exit Program

Figure 31. Select Device Scanning Mode

- Use the screen displayed in Figure 32 to configure the following:
 - OC Fault and OC Warn
 - OT Fault and OT Warn
 - Power Good Limits
 - Fault response
 - UVLO
 - On/Off Config
 - Soft Start time
 - Margin voltage

🜵 Fusion Digital Power [esigner - TP540428 @ Address 9d - Channel #1 - Texas Instruments	_ B 🛛
File Device Tools	felp	TPS40428 @ Address 9d - Channel #1
Configure	Limits & On/Off Advanced Device Info All Config	
Write to Hardware	Current limits	
Auto write on rail or	Channel #1 Channel #2 Channel #1 Channel #2	
device change	Iout OC Warn Limit: 37.0 🗘 A 37.0 🗘 A Temp Warn Limit: 125 🚔 °C 125 🛱 °C	
Discard Changes	Iout OC Fault Limit: 40.0 ⊕ A 40.0 ⊕ A Temp Fault Limit: 145 ⊕ °C 145 ⊕ °C	
Store Config to NVM	Voltage & Power Good Limits	
Restore NVM Config	Channel #1: Input VOUT NOMINAL: 1.2 🐑 V Channel #2: Input VOUT NOMINAL: 1.2 🐑 V	
Clear Restore Notices	UV Fault PG Low PG High OV Fault UV Fault PG Low PG High OV Fault	
	○ -16.80 % -12.50 % +12.50 % 800 mV ○ -16.80 % -12.50 % +12.50 % 800 mV	=
	○ -28.00 % -22.00 % +7.00 % 800 mV ○ -28.00 % -22.00 % +7.00 % 800 mV	
	○ -28.00 % -22.00 % +7.00 % 700 mV ○ -28.00 % -22.00 % +7.00 % 700 mV	
	Calculated Values: 1.056 V 1.116 V 1.284 V 1.9 V 1.056 V 1.116 V 1.284 V 1.9 V	
	Over-Current Fault Response	
	Channel #1: O Do Not Restart Channel #2: O Do Not Restart	
	The device does not attempt to restart. The output The device does not attempt to restart. The output remains disabled until the fault is cleared. disabled until the fault is deared.	
	Restart Continuously Restart Continuously The day is a second starter (Set start)	
	continuously, without limitation, until it is commanded continuously, without limitation, until it is commanded off or continuously, without limitation, until it is commanded continuously.	
	condition causes the unit to shutdown. Unit to shutdown.	
	Turn On/Off Margining	
	Channel #1 Channel #2	× _
	Tips & Hints PMBus Log	Ŧ
	MFR_07 (PCT_VOUT_FAULT_PG_LIMIT) [0x07,Chan #2] 16:23:26.944: USB-SAA #1: CONTROL1 now Low	<u>^</u>
🤣 Configure	(OV) Limits as a percentage of nominal.	ndByte
🚸 Monitor		
🔅 Status	PMBus Log	Fi 🗑
Fusion Digital Power Desig	ner v1.9.38 [2014-04-22] TPS40428 @ Address 9d USB Adapter v1.0.10 [PEC; 400 kHz]	TEXAS INSTRUMENTS fusion digital power

Figure 32. Configure- Limits and On/Off

Screenshots

- Use the screen in Figure 33 to configure:
 - Vref Trim
 - IOUT_CAL_GAIN
 - Write Protect
 - MFR_SPECIFIC_21 register

V Fusion Digital Power	Designer - TP540428 @ Address 9d - Channel #1 - Texas Instruments		_
File Device Tools	Help		TPS40428 @ Address 9d - Channel #1
Configure	Limits & On/Off Advanced Device Info All Config		
Write to Hardware	Device Constants	MFR_21 (ADC & Dead Time)	
Auto write on rail or device change Discard Changes Store Config to NVM Restore NVM Config Clear Restore Notices	Device Code: Identifier: 0x01E (TPS40428) Revision: 0x0 PMBus Revision: 1.0,1.1-Part I: 1.0, Part Capability: Maximum Supported Bus Speed: 400 kHz Packet Error Checking (PEC) Supported: Yes SMBALERT# Supported: Yes Whether the device has an SMBALERT# pin and supports the SMBALERT# pin and supports the SMBUS Alert Response protocol. Vout Mode: EVP-9	MSPS_FLT Mask SMBALERT ✓ EN_SPS Enable smart power-stage ✓ EN_TSNS_FLT Enable fault input from TSNSx pins ✓ EN_ADC_CTL Enable ADC operation CH1_CSGAIN_SEL: 20 ∨ V/V gain CH2_CSGAIN_SEL: 20 ∨ V/V gain	
	Calibration	Write Protect	
	Channel #1 Channel #2 Vref Trim: 0.000 ^C / ₂ V 0.000 ^C / ₂ V Iout Cal Gain: 0.50354 ^C / ₂ mΩ 0.50354 ^C / ₂ mΩ Iout Cal Offset: 0.0000 ^C / ₂ A 0.0000 ^C / ₂ A	Disable all writes except to the WRITE_PROTECT command Disable all writes except to the WRITE_PROTECT, OPERATION and PAGE commands Disable all writes except to the WRITE_PROTECT_OPERATION, PAGE, ON_OFF_CONFIG and VOUT_COMMAND commands Foshle writes to all commands	
	Tips & Hints	PMBus Log	Ţ.
🔆 Configure	MFR_21 (OPTIONS) [0xE5,Chan #1] This register will be used for setting user selectable options for the Kingfisher/IC controller.	16:23:26.944: USB-SAA #1: CONTROL1 now Low 16:23:27.133: USB-SAA #1: CONTROL2 now Low 16:23:29.654: TPS40428 @ 9d: CLEAR_FAULTS [0x03,All Rails]: ex	Kecuted SendByte
Monitor		\checkmark	
🔶 Status		PMBus Log	Fe 🗑
Full Distribution	TECHNIC C C C C C C C C C C C C C C C C C C	FC- 400 H H-1	An and a second s

Figure 33. Configure - Device Information

Use this screen (Figure 34) to configure all of the configurable parameters, also shows other details like Hex encoding.

File Device Tools	Help						TPS4042	8 @ Address 9d - (Channel #1
Configure	Limits & On/Off Advanced Device Info A	l Config							
Write to Hardware	Command	Code	Value/Edit	Hex/Edit	Command	Code	Value/Edit	Hex/Edit	ļ
Auto write on rail or	▼ Calibration				▼ On/Off Configuration				
Discard Change	IOUT_CAL_GAIN	0x38	0.50354 ⊕ mΩ	0x8021	MFR_05 (STEP_¥REF_MARGIN_HIGH)	0xD5	0.059 🗘 V	0x001E	
	IOUT_CAL_OFFSET	0x39	0.0000 🕀 A	0xE000	MFR_06 (STEP_WREF_MARGIN_LOW)	0xD6	-0.059 💭 V	0xFFE2	
Store Config to NVM	MFR_04 (VREF_TRIM)	0xD4	0.000 🕀 V	0x0000	MFR_08 (SEQUENCE_TON_TOFF_DELAY)	0xD8	TON_DE 🗸 ms	0x00	
Restore NVM Config	▼ Configuration				ON_OFF_CONFIG	0x02	0x16 🖂	0x16	
Clear Restore Notices	MFR_22 (PWM_05C_SELECT)	0xE6	PHASE:0 🗸	0x0000	OPERATION	0×01	0x00 🗸	0x00	
	MFR_23 (MASK_SMBALERT)	0xE7	mVIN_U 🗸	0x0000	TON_RISE	0x61	2.7 🗸 ms	0xE02B	
how:	MFR_30 (TEMP_OFFSET)	0×EE	0.0 ⊕ ℃	0xF800	▼ Status				
Parameters	MFR_44 (DEVICE CODE)	0xFC	0x01E0 🗸	0x01E0	READ_IOUT	0x8C	0.00 A	0xE000	
 Parameters for this Rail 	VOUT_MODE	0x20			READ_TEMPERATURE_2	0x8E	25 °C	0xF063	
All Parameters	WRITE_PROTECT	0×10	0x00 🗸	0x00	READ_VOUT	0x8B	0.000 V	0x0000	
ort Parameters By:	▼ Limits				STATUS_BYTE	0x78	01000000 🗸	0x40	
Command Name	IOUT_OC_FAULT_LIMIT	0x46	40.0 🗘 A	0xF850	STATUS_CML	0×7E	00000000	0x00	
Command Code	IOUT_OC_WARN_LIMIT	0x4A	37.0 🗢 A	0xF84A	STATUS_IOUT	0×78	00000000	0x00	
Group by Category	MFR_07 (PCT_VOUT_FAULT_PG_LIMIT)	0xD7	PGL: 01b 🗸 %	0x01	STATUS_MFR_SPECIFIC	0x80	00000000 🗸	0x00	
	OT_FAULT_LIMIT	0x4F	145 👽 ℃	0x0091	STATUS_TEMPERATURE	0x7D	00000000	0x00	l
	OT_WARN_LIMIT	0x51	125 💭 °C	0x007D	STATUS_YOUT	0x7A	00000000 🗸	0x00	
	VIN_OFF	0x36	4.25 V	0xF011	STATUS_WORD	0x79	Click 🗸	0x0040	
	VIN_ON	0x35	4.50 🗸 V	0xF012					
									>
	Tips & Hints			PME	Bus Log				
Configure	READ_VOUT [0x88,Chan #1] 16:23:25,94:14:U85-SAA #1: CONTROL 1 now Low The actual, measured (not commanded) output voltage in the same format as set by the VOUT [3:22:25,94:13:U85-SAA #1: CONTROL 2 now Low 16:23:25,94:13:U85-SAA #1: CONTROL 2 now Low								
Monitor				\sim					
Status				E PM	Bus Log				

Figure 34. Configure - All Config

Screenshots

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After a change is selected, an orange "U" icon is displayed, offering an *Undo Change* option. Change is not retained until either *Write to Hardware* or *Store User Defaults* is selected. When *Write to Hardware* is selected, the change is committed to volatile memory and defaults back to previous setting upon input power cycle. When *Store User Defaults* is selected, the change is committed to non-volatile memory and becomes the new default (Figure 35)

Fusion Digital Power	lesigner - TP540428 @ Address 9d - Channel #1 - Texas Instruments	_ @ <mark>×</mark>
File Device Tools	Help	TPS40428 @ Address 9d - Channel #1
Configure	Limits & On/Off Advanced Device Info All Config	
Write to Hardware	Current Limits Temperature Limits	
Auto write on rail or	Channel #1 Channel #2 Channel #1 Channel #2	
device change	Iout OC Warn Limit: 37.0 ⊕ A 37.0 ⊕ A Temp Warn Limit: 125 ⊕ ℃ 125 ⊕ ℃	
Discard Changes	Iout OC Fault Limit: 0 45.0 (A 40.0 (A Temo Fault Limit: 145 () ℃ 145 () ℃	
Store Config to NM		
	Voltage & Power Good Limits	
Restore NVM Config	Channel #1: Input VOUT NOMINAL: 1.2 💬 V Channel #2: Input VOUT NOMINAL: 1.2 💬 V	
Clear Restore Notices	UV Fault PG Low PG High OV Fault UV Fault OV Fault OV Fault OV Fault OV Fault	
	○ -16.80 % -12.50 % +12.50 % 800 mV ○ -16.80 % -12.50 % +12.50 % 800 mV	=
	● -12.00 % -7.00 % +7.00 % 700 mV ● -12.00 % -7.00 % +7.00 % 700 mV	
	○ -28.00 % -22.00 % +7.00 % 800 mV ○ -28.00 % -22.00 % +7.00 % 800 mV	
	○ -28.00 % -22.00 % +7.00 % 700 mV ○ -28.00 % -22.00 % +7.00 % 700 mV	
	Calculated Values: 1.056 V 1.116 V 1.284 V 1.9 V 1.056 V 1.116 V 1.284 V 1.9 V	
	Over-Current Fault Response	
	Channel #1: O Do Not Restart Channel #2: O Do Not Restart	
	The device does not attempt to restart. The output The device does not attempt to restart. The output remains remains disabled until the fault is deared. disabled until the fault is deared.	
	Restart Continuously O Restart Continuously	
	The device goes through a normal startup (Soft start) The device goes through a normal startup (Soft start) continuously, without limitation, until it is commanded off or	
	off or bias power is removed or another fault bias power is removed or another fault condition causes the condition causes the unit to shutdown. unit to shutdown.	
	Turn On/Off Margining	
	Channel #1 Channel #2	\checkmark
	Tips & Hints PMBus Log	<u>ل</u>
	IOUT_OC_FAULT_LIMIT [0x46,Chan #1] 16:23:26.944: USB-SAA #1: CONTROL1 now Low	
💠 Configure	Sets the value of the output current, in amperes, that causes the over-current detector to indicate an over-current fault condition 16:23:27.133: USP-SAA #1: CONTROL2 now Low 16:23:29.654: TPS40428 @ 9d: CLEAR_FAULTS [0x03,All Rails]: executed Set	endByte
🚸 Monitor		
🚸 Status	PMBus Log	
Fusion Digital Power Desig	ner v1.9.38 [2014-04-22] TPS40428 @ Address 9d USB Adapter v1.0.10 [PEC: 400 kHz]	TEXAS INSTRUMENTS fusion digital power

Figure 35. Configure - Limits and On/Off- On/Off Config Pop-up

A scroll-down menu in the upper right corner can be selected to change the view screens to one output rail or the other (Figure 36).

Figure 36. Change Screens to Other Vout Rail

Screenshots

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When the *Monitor* screen is selected (Figure 37), 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}, *lout*, *Temperature*, and *Pout*. As shown, the *Pout* display is turned OFF.
- Start/Stop Polling which turns ON or OFF the real-time display of data.
- · Quick access to On/Off config
- Control pin activation, and OPERATION command.
- Margin control.
- Clear Fault. Selecting Clear Faults clears any prior fault flags.

Figure 37. Monitor Screen

Screenshots

Selecting *System Dashboard* from mid-left screen adds a new window which displays system level information (Figure 38).

Fusion Digital Power	Designer - TP540428 @ Addi	ess 9d - Channel #:	l - Texas Instruments					
File Device Tools	Help					TPS40428	Address 9d - Char	nnel #1
Monitor	PMBus Readings	us Readings 🔊 Vout - Output Voltage 🛞 Tout - Output Current						
Show/Hide Plots:	😽 System Dashboard -	Fusion Digital Powe	r Designer			_ 0		r
Vout Vout(all)	Layout Devices							
Pout(calc Temp	System-Level Actions a	nd Settings						
	On/Off Config		OPERATION	Fau	t Management EEPRON	1 Power-On Defaults		
Fit All Plots on Screen Scale Plots to Screen	CONTROL Pin Only	Write Setting	Margining 🗸 Turn On	Immed Off	Clear Faults Stor	e User Defaults Restore User Defaults]	
Width								
Height: 200 🗢								
Width: 400 😇								
 Show Warn & Fault Limit Editors 	Rails							
Show Value Labels	Device Rail	Vout	Iout Temp Cont	rol Line (USB) Opera	ion	On/Off Config		
on Plots	TP540428 @ 9d 1	thannel #1 1.19	7 V 0.00 A 28 ℃ ⊙ Hi	ah O Low O	On 💿 Immediate Off	0x16 CONTROL Pin Only		
Polling Rate: 500 💭	TP540428 @ 9d 2	hannel #2 0.00	0 V 0.00 A 28 ℃ ⊖ Hi	ah @low O	on () Immediate Off	0x16 CONTROL Pin Only		0.00 A
(indee)			014				46:20	46:40
Stop Polling							D	
Device Dashboard	Status Registers							
	Status negisters	Channel #1			Channel #2			
System Dashboard	STATUS_WORD	ОК			OFF			
	STATUS_VOUT	ОК			ОК			
	STATUS_IOUT	ок			ОК			
	STATUS_TEMPERATURI	OK			OK			
	STATUS_CML	OK						
	SINIUS_IIIK_SICCIII							
							_	
10 co-6	Status Registers Log							
	Control Line #2 O High		0.00					
🚸 Monitor			45:40	46:00 46:20	46:40			
💩 Status	3 New PMBus Log Messag	es Show PMBus Log				Unique open/close set	ings for Configure,	Monitor, and Status 🗜
	10.20 (2014 04 22)						b.e.	

Figure 38. System Dashboard

Screenshots

Figure 39. 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 (Figure 40). This action results in a browse-type sequence where the desired configure file can be located and loaded.

Figure 40. Import Configuration File

11 Two-Phase Configuration

The PWR594 EVM can be configured as 2-phase by changing the BOM. Figure 41 and Figure 42 show the schematics of 2-phase configuration. Table 8 and Table 9 are the components lists of 2-phase configuration.

Table 8. TPS40425EVM 2-Phase Components List

Qty	Designator	Description	Part Number	Manufacturer
2	C1, C2	CAP, AL, 100 μF, 25 V, ±20%, 0.3 Ω, SMD	EEE-FC1E101P	Panasonic
11	C3–C7, C10–C15	CAP, CERM, 22 µF, 25 V, ±10%, X5R, 1210	STD	STD
2	C8, C9	CAP, CERM, 10 µF, 10 V, ±10%, X5R, 0805	STD	STD
1	C16	CAP, CERM, 1500 pF, 25 V, ±10%, X7R, 0603	STD	STD
1	C17	CAP, CERM, 100 pF, 50 V, ±5%, C0G/NP0, 0603	STD	STD
7	C18, C30, C31, C45, C52, C56, C57	CAP, CERM, 0.1 µF, 25 V, ±10%, X7R, 0603	STD	STD
20	C20–C24, C33–C37, C46–C50, C59–C63	CAP, CERM, 100 µF, 6.3 V, ±20%, X5R, 1210	STD	STD
1	C26	CAP, CERM, 3300 pF, 25 V, ±10%, X7R, 0603	STD	STD
4	C27, C29, C54, C55	CAP, CERM, 470 pF, 50 V, ±10%, X7R, 0603	STD	STD
5	C28, C42–C44, C53	CAP, CERM, 1 µF, 25 V, ±10%, X5R, 0603	STD	STD
2	C32, C65	CAP, CERM, 3300 pF, 50 V, ±10%, X7R, 0603	STD	STD
4	C39, C41, C58, C68	CAP, CERM, 1000 pF, 50 V, ±10%, X7R, 0603	STD	STD
2	C40, C66	CAP, CERM, 0.22µFF, 25 V, ±10%, X7R, 0603	STD	STD
2	D1, D2	Diode, Schottky, 30 V, 0.2 A, SOD-323	BAT54HT1G	ON Semiconductor
7	J1– J3, J7–J10	Header, 100 mil, 2x1, Tin plated, TH	PEC02SAAN	Sullins Connector Solutions
1	J4	TERMINAL BLOCK 5.08 mm VERT 2POS, TH	ED120/2DS	On-Shore Technology
3	J5, J6, J11	TERMINAL BLOCK 5.08 mm VERT 4POS, TH	ED120/4DS	On-Shore Technology
1	J12	Header, 100 mil, 5x2, Tin plated, TH	PEC05DAAN	Sullins Connector Solutions
1	L1	Inductor, Shielded Drum Core, Ferrite, 10 $\mu H,$ 0.7 A, 0.33 $\Omega,$ SMD	LPS3314- 103MLB	Coilcraft
2	L2, L3	Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 $\Omega,$ SMD	744355147	Wurth Elektronik eiSos
1	LBL1	Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll	THT-13-457-10	Brady
2	Q1, Q3	Synchronous Buck NexFET Power Stage, DQP0012A	CSD95378BQ5M	Texas Instruments
2	Q2, Q4	Transistor, NPN, 20 V, 0.2 A, SOT-523	MMBT3904T-7-F	Diodes Inc.
1	R2	RES, 1.10 MΩ, 1%, 0.1 W, 0603	STD	STD
12	R3, R14, R21, R22, R29, R31, R41, R50, R51, R57, R59, R65	RES, 0 Ω, 5%, 0.1 W, 0603	STD	STD
1	R6	RES, 210 kΩ, 1%, 0.1 W, 0603	STD	STD
1	R8	RES, 49.9 Ω, 1%, 0.1 W, 0603	STD	STD
5	R1, R9, R13, R30, R40	RES, 10.0 kΩ, 1%, 0.1 W, 0603	STD	STD
1	R12	RES, 280 Ω, 1%, 0.1 W, 0603	STD	STD
1	R16	RES, 4.99 kΩ, 1%, 0.1 W, 0603	STD	STD
7	R17, R25, R26, R35, R44, R55, R56	RES, 1.00 Ω, 1%, 0.1 W, 0603	STD	STD
2	R18, R47	RES, 121 kΩ, 1%, 0.1 W, 0603	STD	STD
4	R20, R27, R45, R53	RES, 10.0 Ω, 1%, 0.1 W, 0603	STD	STD
2	R23, R52	RES, 4.22 kΩ, 1%, 0.1 W, 0603	STD	STD
1	R24	RES, 40.2 kΩ, 1%, 0.1 W, 0603	STD	STD
2	R28, R58	RES, 12.4 kΩ, 1%, 0.1 W, 0603	STD	STD
3	R32, R33, R34	RES, 0.001 Ω, 1%, 1W, 2512	STD	STD
2	R37, R42	RES, 100 Ω, 1%, 0.1 W, 0603	STD	STD
2	R48, R49	RES, 16.2 kΩ, 1%, 0.1 W, 0603	STD	STD
2	SH-J1, SH-J3	Shunt, 100 mil, Gold plated, Black	969102-0000-DA	3M
6	TP1, TP5, TP9, TP12, TP24, TP31	Test Point, Miniature, Red, TH	5000	Keystone
17	TP2, TP3, TP7, TP8, TP10, TP13, TP18–TP23, TP25, TP26, TP28–TP30	Test Point, Miniature, White, TH	5002	Keystone
9	TP4, TP6, TP11, TP14–TP17, TP27, TP32	Test Point, Miniature, Black, TH	5001	Keystone

			-	
Qty	Designator	Description	Part Number	Manufacturer
1	U1	IC, 3 V-17 V, 200-mA High Efficient Buck Converter	TPS62125DSG	ТІ
1	U2	IC, Dual output, 2-Phase, Stackable PMBUS Synchronous Buck Driverless Controller with AVS Bus	TPS40425RHA	ТІ

Table 8. TPS40425EVM 2-Phase Components List (continued)

Table 9. TPS40428EVM 2-Phase Components List

2 0.1, C2 CAP, AL, 100 µF, 25 V, 260V, 0.3 0, SMD EEE-C1210P Panasonic 1 C-C7, C10-C15 CAP, CERM, 100 µF, 10 V, s10%, X5R, 0805 STD STD 2 C6, C9 CAP, CERM, 100 µF, 25 V, 410%, X7R, 0603 STD STD 2 C11, C67 CAP, CERM, 100 µF, 25 V, 410%, X7R, 0603 STD STD 3 C11, C67 CAP, CERM, 01 µF, 25 V, 410%, X7R, 0603 STD STD 4 C27, C34, C33-C37, C34, C34, C34, C34, C34, C34, V, 400%, X7R, 0603 STD STD 2 C28, C68 CAP, CERM, 100 µF, 25 V, 410%, X7R, 0603 STD STD 2 C28, C68 CAP, CERM, 300 µF, 26 V, 410%, X7R, 0603 STD STD 2 C38, C42-C44, C53 CAP, CERM, 100 µF, 50 V, 410%, X7R, 0603 STD STD 2 C38, C42-C44, C53 CAP, CERM, 100 µF, 50 V, 410%, X7R, 0603 STD STD 2 C38, C42-C44, C53 CAP, CERM, 100 µF, 50 V, 410%, X7R, 0603 STD STD 2 01, D2 Diode, schonky, 30 V, 02 A, SDC-323 BAT3H11G ON Semiconductor 3 </th <th>Qty</th> <th>Designator</th> <th>Description</th> <th>Part Number</th> <th>Manufacturer</th>	Qty	Designator	Description	Part Number	Manufacturer
11 C-C7, C10-C15 CAP, CERM, 29, F, 25, V, 10%, X8R, 1210 STD STD 2 C6, C9 CAP, CERM, 10, F, 10V, 410%, X8R, 10603 STD STD 2 C16, C70 CAP, CERM, 10, F, 10V, 410%, X8R, 0803 STD STD 2 C17, C67 CAP, CERM, 10, P, 50V, 25%, C0GNPO, 0603 STD STD 2 C26, C37 CAP, CERM, 10, P, F, 50V, 20%, X5R, 1210 STD STD 2 C26, C63 CAP, CERM, 100, P, 50V, 20%, X5R, 1210 STD STD 2 C26, C66 CAP, CERM, 100, F, 50V, 410%, X7R, 0603 STD STD 4 C27, C26, C46, C55 CAP, CERM, 100, F, 50V, 410%, X7R, 0603 STD STD 2 C30, C66 CAP, CERM, 100, F, 50V, 410%, X7R, 0603 STD STD 2 C31, C44, C55 CAP, CERM, 100, F, 50V, 410%, X7R, 0603 STD STD 2 C32, C66 CAP, CERM, 100, F, 50V, 410%, X7R, 0603 STD STD 2 C33, C58 CAP, CERM, 100, F, 50V, 410%, X7R, 0603 STD STD 3 J5, J6, J11	2	C1, C2	CAP, AL, 100 μF, 25 V, ±20%, 0.3 Ω, SMD	EEE-FC1E101P	Panasonic
2 C8, C9 CAP, CERM, 109, F, 10V, 410%, XSR, 0805 STD STD 2 C16, C70 CAP, CERM, 100, F, 55V, 410%, X7R, 0603 STD STD 2 C17, C67 CAP, CERM, 100, F, 50V, 42%, C0GMP0, 0603 STD STD 2 C17, C67 CAP, CERM, 100, µF, 53V, 420%, X5R, 1210 STD STD 20 C2A, C3A, C3A, C3A, C43, C43, C43, C44, C53 CAP, CERM, 300 µF, 53V, 410%, X7R, 0603 STD STD 2 C28, C62, C64, C65 CAP, CERM, 300 µF, 50V, 410%, X7R, 0603 STD STD 2 C38, C63, C64, C65 CAP, CERM, 100 µF, 50V, 410%, X7R, 0603 STD STD 2 C39, C68 CAP, CERM, 100 µF, 50V, 410%, X7R, 0603 STD STD 2 C39, C68 CAP, CERM, 100 µF, 50V, 410%, X7R, 0603 STD STD 2 C39, C68 CAP, CERM, 100 µF, 50V, 410%, X7R, 0603 STD STD 2 C39, C68 CAP, CERM, 100 µF, 50V, 410%, X7R, 0603 STD STD 3 J5, J5, J1 Header, 100 ml, 2x1, Tn plated, TH ED1202DS Soliant StD	11	C–C7, C10–C15	CAP, CERM, 22 μF, 25 V, ±10%, X5R, 1210	STD	STD
2 C16, C70 CAP, CERM, 1500 pF, 50 V, 10%, X7R, 0083 STD STD 2 C17, C67 CAP, CERM, 100 pF, 50 V, 25%, C0G/NP0, 0603 STD STD 2 C18, C30, C31, C45, C52, CAP, CERM, 01 pF, 25 V, 10%, X7R, 0603 STD STD STD 20 C24, C33, C37, C45, C53, C4P, CERM, 100 pF, 53 V, 20%, X5R, 1210 STD STD STD 2 C28, C69 CAP, CERM, 100 pF, 50 V, 10%, X7R, 0603 STD STD 2 C28, C69 CAP, CERM, 100 pF, 50 V, 10%, X7R, 0603 STD STD 2 C28, C65 CAP, CERM, 100 pF, 50 V, 10%, X7R, 0603 STD STD 2 C32, C65 CAP, CERM, 100 pF, 50 V, 10%, X7R, 0603 STD STD 2 C33, C68 CAP, CERM, 100 pF, 50 V, 10%, X7R, 0603 STD STD 2 C33, C68 CAP, CERM, 100 pF, 50 V, 10%, X7R, 0603 STD STD 3 J5, J6, J11 TERMINAL BLOCK 5.08 mm VERT 2POS, TH PEC028AN Sulins Connector Solutions 1 J4 TERMINAL BLOCK 5.08 mm VERT 4POS, TH PEC035DAN Sulins Connector Solutions	2	C8, C9	CAP, CERM, 10 μF, 10 V, ±10%, X5R, 0805	STD	STD
2 C17, CG7 CAP, CERM, 100 pF, 50 V, ±5%, COGANPO, 0603 STD STD 7 C168, G27 CAP, CERM, 0.1 µF, 25 V, ±10%, X7R, 0603 STD STD 20 C26, G27 CAP, CERM, 100 µF, 6.3 V, ±2%, X7R, 0603 STD STD 21 C26, C63 CAP, CERM, 1300 pF, 50 V, ±10%, X7R, 0603 STD STD 2 C28, C64 CAP, CERM, 170, F5 OV, ±10%, X7R, 0603 STD STD 2 C32, C42, C44, C53 CAP, CERM, 190, F5 OV, ±10%, X7R, 0603 STD STD 2 C33, C68 CAP, CERM, 1000 µF, 50 V, ±10%, X7R, 0603 STD STD 2 C33, C68 CAP, CERM, 1000 µF, 50 V, ±10%, X7R, 0603 STD STD 2 C1, D2 Dode, Schottky, 30 V, 0.2, A, SOD-223 BAT54HT1G ON Semiconductor 7 J1-J3, J7-J10 Header, 100 ml, 527, Tin plated, TH ED1202DS On-Shore 1 J4 TERMINAL BLOCK 5.08 mm VERT 4POS, TH ED1204DS Sollinos 1 J12 Header, 100 ml, 527, Tin plated, TH PEC05DAAN Sollinotion 3	2	C16, C70	CAP, CERM, 1500 pF, 25 V, ±10%, X7R, 0603	STD	STD
7 C18, C30, C31, C45, C42, C56, C57 CAP, CERM, 01 µF, 25 V, ±10%, X7R, 0603 STD STD 20 C24-C24, C33-C37, C46-C50, C59-C63 CAP, CERM, 100 µF, 6.3 V, ±20%, X5R, 1210 STD STD 2 C26, C69, C59-C63 CAP, CERM, 300 µF, 25 V, ±10%, X7R, 0603 STD STD 2 C26, C40, C55 CAP, CERM, 170 µF, 50 V, ±10%, X7R, 0603 STD STD 2 C32, C64 C55 CAP, CERM, 11P, 25 V, ±10%, X7R, 0603 STD STD 2 C32, C65 CAP, CERM, 1000 µF, 50 V, ±10%, X7R, 0603 STD STD STD 2 C32, C65 CAP, CERM, 1000 µF, 50 V, ±10%, X7R, 0603 STD STD STD 2 D1, D2 Diode, Schottw, 30 V, 0.2 A, S0D-S23 BAT54HT16 ON Semiconductor 7 J1-J3, J7-J10 Header, 100 mil, 5x2, Tin plated, TH ED120/2DS On-Shote 1 J4 TERMINAL BLOCK 5.06 mm VERT 4POS, TH ED120/4DS On-Shote 1 J12 Header, 100 mil, 5x2, Tin plated, TH PECOSDANA Sulfins: Connector' Solutions Theader, 100 mil, 5x2, Ti	2	C17, C67	CAP, CERM, 100 pF, 50 V, ±5%, C0G/NP0, 0603	STD	STD
20 C22-C24, C33-C37, C42-C52, C59-C63 CAP, CERM, 100 µF, 6.3 V, ±20%, X5R, 1210 STD STD 2 C26, C69 CAP, CERM, 3300 pF, 50 V, ±10%, X7R, 0603 STD STD 4 C27, C29, C54, C55 CAP, CERM, 17P, F20 V, ±10%, X7R, 0603 STD STD 2 C32, C64, C55 CAP, CERM, 17P, F20 V, ±10%, X7R, 0603 STD STD 2 C39, C58 CAP, CERM, 1300 pF, 50 V, ±10%, X7R, 0603 STD STD 2 C39, C58 CAP, CERM, 1300 pF, 50 V, ±10%, X7R, 0603 STD STD 7 J1-J3, J7-J10 Header, 100 ml, 2x1, Tin plated, TH PEC02SAAN Sullins Connector 1 J4 TERMINAL BLOCK 5.06 mm VERT 2POS, TH ED120/2D5 On-Shore Technology 1 J12 Header, 100 ml, 5x2, Tin plated, TH PEC05DAAN Sullins Connector 1 Iductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 O, SMD LPS3314- 103MLB Coloraft 2 L1,1 Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 O, SMD TH4355147 Worth Elektronik elsos 2 Q1, Q3 Synchronous Buck Nar/ET Power	7	C18, C30, C31, C45, C52, C56, C57	CAP, CERM, 0.1 μF, 25 V, ±10%, X7R, 0603	STD	STD
2 C26, C69 CAP, CERM, 3300 PF, 25 V, ±10%, X7R, 0603 STD STD 4 C27, C29, C54, C55 CAP, CERM, 470 PF, 50 V, ±10%, X7R, 0603 STD STD 2 C32, C55 CAP, CERM, 17F, 25 V, ±10%, X5R, 0603 STD STD 2 C39, C58 CAP, CERM, 1000 PF, 50 V, ±10%, X7R, 0603 STD STD 2 D1, D2 Dides, 5chutty, 30 V, 0.2 A, SOD-323 BAT54HT1G ON Semiconductor 7 J1-J3, J7-J10 Header, 100 mil, 2x1, Tin plated, TH PEC02SAAN Sullinos Connector 1 J4 TERMINAL BLOCK 5.08 nm VERT 4POS, TH ED120/2DS On-Shore 1 J4 TERMINAL BLOCK 5.08 nm VERT 4POS, TH ED120/4DS On-Shore 1 J12 Header, 100 mil, 5x2, Tin plated, TH PEC05DAAN Sullins Connector 1 L1 Inductor, Shielded Drum Core, Ferite, 10 µH, 0.7 A, 0.33 Q, SMD 744355147 eidso 2 Q1, Q3 Synchronous buck NexFE Prover Stage, DOP0012A CS05378DGM Wurth Elektronik eidso 1 R2, R7, R10, R14, R15, R3 R8, R64 RES, 10 u, M, 1%, 0.1	20	C20–C24, C33–C37, C46–C50, C59–C63	CAP, CERM, 100 μF, 6.3 V, ±20%, X5R, 1210	STD	STD
4 C27, C29, C54, C56 CAP, CERM, 470 μF, 50 V, ±10%, X7R, 0603 STD STD 5 C28, C42-C44, C53 CAP, CERM, 1µF, 25 V, ±10%, X7R, 0603 STD STD 2 C32, C65 CAP, CERM, 1000 μF, 50 V, ±10%, X7R, 0603 STD STD 2 C39, C58 CAP, CERM, 1000 μF, 50 V, ±10%, X7R, 0603 STD STD 7 J1-J3, J7-J10 Header, 100 mil, 2x1, Tin plated, TH PEC02SAN ON-Shore Technology 1 J4 TERMINAL BLOCK 5.08 mm VERT 2POS, TH ED120/2DS On-Shore Technology 1 J12 Header, 100 mil, 5x2, Tin plated, TH ED120/AN Sullins Connector Solutions 1 J12 Heeder, 100 mil, 5x2, Tin plated, TH PEC0SDAN Sullins Connector Solutions 1 L1 Inductor, Shielded Drum Core, Ferrie, 10 µH, 0.7 A, 0.33 Ω, SMD LP3314- L03MLB Coloraft 2 L2, L3 Inductor, Shielded Drum Core, Ferrie, 10 µH, 0.7 A, 0.33 Ω, SMD TH435147 Bidos 1 LBL1 Thermal Transfer Prinnable Labels, 1.260' W x 0.250' H - 10,000 per roll TH1-13-457-10 Brady 2 Q1, Q3	2	C26, C69	CAP, CERM, 3300 pF, 25 V, ±10%, X7R, 0603	STD	STD
5 C28, C42–C44, CS3 CAP, CERM, 1 µF, 25 V, ±10%, X7R, 0603 STD STD 2 C32, C65 CAP, CERM, 3300 pF, 60 V, ±10%, X7R, 0603 STD STD STD 2 D1, D2 Diode, Schottky, 30 V, 0.2 A, SOD-323 BAT54HT16 ON Semiconductor 7 J1–J3, J7–J10 Header, 100 mil, 2x1, Tin plated, TH PEC02SAAN Sullins Connector Solutions 1 J4 TERMINAL BLOCK 5.08 mm VERT 2POS, TH ED120/2DS On-Shore Technology 3 J5, J6, J11 TERMINAL BLOCK 5.08 mm VERT 4POS, TH ED120/4DS On-Shore Technology 1 J12 Header, 100 mil, 5x2, Tin plated, TH PEC05DAAN Sullins Connector Solutions 1 L1 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Ω, SMD LPS314- L03MLB Collecraft 2 Q1, Q3 Synchronous Buck NewFET Power Stage, DOP0012A CA95578ECGM Wurth Elektronik elS0 1 L8L1 Thermal Transfer Printable Labels, 1.250' W x 0.250' H - 10,000 per roll THT-13-457-10 Brady 2 Q1, Q3 Synchronous Buck NewFET Power Stage, DOP0012A SCB95378BCGM SCB95378BCGM </td <td>4</td> <td>C27, C29, C54, C55</td> <td>CAP, CERM, 470 pF, 50 V, ±10%, X7R, 0603</td> <td>STD</td> <td>STD</td>	4	C27, C29, C54, C55	CAP, CERM, 470 pF, 50 V, ±10%, X7R, 0603	STD	STD
2 C32, C65 CAP, CERM, 3300 pF, 50 V, ±10%, X7R, 0603 STD STD 2 C39, C58 CAP, CERM, 1000 pF, 50 V, ±10%, X7R, 0603 STD STD ON Semiconductor 7 J1-J3, J7-J10 Header, 100 mil, 2x1, Tin plated, TH PEC02SAAN Sullins Connector Solutions 1 J4 TERMINAL BLOCK 5.08 nm VERT 2POS, TH ED120/2DS On-Shore Technology 3 J5, J6, J11 TERMINAL BLOCK 5.08 nm VERT 2POS, TH ED120/4DS On-Shore Technology 1 J12 Header, 100 mil, 5x2, Tin plated, TH PEC05DAAN Sullins Connector Solutions 1 L1 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Ω, SMD LPS3314- (201 call table) Collcraft 2 L2, L3 Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 Ω, SMD T44355147 Wurfn Elektronik elsos 1 LBL1 Thermal Transfer Printable Labels, 1.250' W x 0.250' H - 10,000 per roll THT-13:457-10 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DOP0012A CSD95378BQSM Texas Instruments 1 R2 R2, R7, R10, R14, R15, R3, R36, R37, R54 RES	5	C28, C42–C44, C53	CAP, CERM, 1 µF, 25 V, ±10%, X5R, 0603	STD	STD
2 C39, C58 CAP, CERM, 1000 pF, 50 V, ±10%, XPR, 0603 STD STD 2 D1, D2 Diode, Schotiky, 30 V, 0.2 A, SOD-323 BAT54HTIG ON Semiconductor 7 J1–J3, J7–J10 Header, 100 mil, 2x1, Tin plated, TH PEC02SAAN Sulins Connector Solutions 1 J4 TERMINAL BLOCK 5.08 mm VERT 2POS, TH ED120/2DS On-Shore Technology 3 J5, J6, J11 TERMINAL BLOCK 5.08 mm VERT 4POS, TH ED120/4DS On-Shore Technology 1 J12 Header, 100 mil, 5x2, Tin plated, TH PEC0SDAAN Sulins Connector Solutions 1 L1 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Ω, SMD LP3314- L03MLB Colcraft 2 L2, L3 Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 Ω, SMD T44355147 Wurth Elektronik elsos 1 LBL1 Thermal Transfer Printable Labels, 1.250' W x 0.250' H · 10.000 per roll TH1-13-457-10 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DQP0012A CSD95378DQ5M Texas Instruments 1 R2 R3, R7, R10, R14, R15, R43, R50, R59, R55 R50, 0.5%, 0.1 W, 0603 <	2	C32, C65	CAP, CERM, 3300 pF, 50 V, ±10%, X7R, 0603	STD	STD
2 D1, D2 D0de, Schottky, 30 V, 0.2 A, SOD-323 BAT54HT1G ON Semiconductor Solutions 7 JI-J3, J7-J10 Header, 100 mil, 2x1, Tin plated, TH PEC02SAAN Sullins Connector Solutions 1 J4 TERMINAL BLOCK 5.08 mm VERT 2POS, TH ED120/2DS On-Shore Technology 3 J5, J6, J11 TERMINAL BLOCK 5.08 mm VERT 4POS, TH ED120/4DS On-Shore Technology 1 L1 TERMINAL BLOCK 5.08 mm VERT 4POS, TH ED120/4DS On-Shore Technology 2 L2, L3 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Ω, SMD LP33314. Ocioraft 2 L2, L3 Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 Ω, SMD 744355147 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DQP0012A CSD93780GM Texas Instruments 1 LBL1 Thermal Transfer Printable Labels, 1.250' W x 0.250' H · 10.000 per roll TH1-13-457-10 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DQP0012A STD STD 1 R4 R5, 81, 0.0, 1.%, 0.1 W, 0603 STD STD 1 <td>2</td> <td>C39, C58</td> <td>CAP, CERM, 1000 pF, 50 V, ±10%, X7R, 0603</td> <td>STD</td> <td>STD</td>	2	C39, C58	CAP, CERM, 1000 pF, 50 V, ±10%, X7R, 0603	STD	STD
7 JI-J3, J7-J10 Header, 100 mil, 2x1, Tin plated, TH PEC02SAAN Sullins Connector Solutions 1 J4 TERMINAL BLOCK 5.08 mm VERT 2POS, TH ED120/2DS On-Shore Technology 3 J5, J6, J11 TERMINAL BLOCK 5.08 mm VERT 4POS, TH ED120/4DS On-Shore Technology 1 J12 Header, 100 mil, 5x2, Tin plated, TH EDC05DAAN Sullins Connector Solutions 1 L1 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Q, SMD LPS3314- LO3MLB Coloraft 2 L2, L3 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Q, SMD TH1-13-457-10 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DOP0012A CSD95378BQ5M Texas Instruments 1 R2 RES, 1.10 MQ, 1%, 0.1 W, 0603 STD STD 14 R3, R7, R10, R14, R15, R45, R56, R57, R65 RES, 10.0 Q, 1%, 0.1 W, 0603 STD STD 2 R1, R3, R3, R30, R40 RES, 10.0 Q, 1%, 0.1 W, 0603 STD STD 2 R1, R8, R13, R30, R40 RES, 10.0 Q, 1%, 0.1 W, 0603 STD STD 3 R16, R54, R66<	2	D1, D2	Diode, Schottky, 30 V, 0.2 A, SOD-323	BAT54HT1G	ON Semiconductor
1 J4 TERMINAL BLOCK 5.08 mm VERT 2POS, TH ED120/2DS Technology Technology 3 J5, J6, J11 TERMINAL BLOCK 5.08 mm VERT 4POS, TH ED120/4DS On-Shore Technology 1 J12 Header, 100 mil, 5x2, Tin plated, TH PC05DAAN Sultions 1 L1 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Ω, SMD LPS3314- L05MLB Coltcraft 2 L2, L3 Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 Ω, SMD 744355147 Wurth Elektronik elsos 1 LBL1 Thermal Transfer Printable Labels, 1.250' W x 0.250' H - 10,000 per roll THT-13-457-10 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DQP0012A CSD95378BOSM Texas Instruments 1 R2 RES, 1.10 MQ, 1%, 0.1 W, 0603 STD STD STD 14 R21, R31, R36, R38, R41, R43, R50, R57, R65 RES, 20 kQ, 1%, 0.1 W, 0603 STD STD 2 R8, R64 RES, 20 kQ, 1%, 0.1 W, 0603 STD STD STD 2 R1, R9, R13, R30, R40 RES, 10.0 Q, 1%, 0.1 W, 0603 STD STD STD <	7	J1–J3, J7–J10	1–J3, J7–J10 Header, 100 mil, 2x1, Tin plated, TH PEC02SAAN		Sullins Connector Solutions
3 J5, J6, J11 TERMINAL BLOCK 5.08 mm VERT 4POS, TH ED120/4DS On-Shore Technology 1 J12 Header, 100 mil, 5x2, Tin plated, TH PEC05DAAN Sullins Connector Solutions 1 L1 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Ω, SMD LPS3314- L03MLB Coleraft 2 L2, L3 Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 Ω, SMD 744355147 Wurth Elektronik elSos 1 LB1 Thermail Transfer Printable Labels, 1.250' W x 0.250' H - 10,000 per roll THT-13-457-10 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DQP0012A CSD95378BQ5M Texas Instruments 1 R2 RES, 1.10 MQ, 1%, 0.1 W, 0603 STD STD STD 14 R21, R31, R36, R38, R41, R43, R50, R57, R65 RES, 210 kΩ, 1%, 0.1 W, 0603 STD STD STD 2 R48, R64 RES, 49.9 Ω, 1%, 0.1 W, 0603 STD STD STD 3 R16, R54, R66 RES, 49.9 Ω, 1%, 0.1 W, 0603 STD STD STD 2 R12, R67 RES, 28.0 Ω, 1%, 0.1 W, 0603 STD STD </td <td>1</td> <td>J4</td> <td colspan="2">TERMINAL BLOCK 5.08 mm VERT 2POS, TH ED120/2DS</td> <td>On-Shore Technology</td>	1	J4	TERMINAL BLOCK 5.08 mm VERT 2POS, TH ED120/2DS		On-Shore Technology
1 J12 Header, 100 mil, 5x2, Tin plated, TH PEC05DAAN Sulfins Connector Solutions 1 L1 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Ω, SMD LPS3314- 103MLB Coleraft 2 L2, L3 Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 Ω, SMD 744355147 Wurth Elektronik elsos 1 LBL1 Thermal Transfer Printable Labels, 1.250' W x 0.250' H - 10,000 per roll THT-13-457-10 Brady 2 O1, 03 Synchronous Buck NexFET Power Stage, DOP0012A CS095378BQ5M Texas Instruments 1 R2 R8, R7, R10, R14, R15, R21, R31, R36, R38, R41, R43, R50, R57, R65 RES, 1.10 MQ, 1%, 0.1 W, 0603 STD STD 2 R8, R64 RES, 210 kQ, 1%, 0.1 W, 0603 STD STD STD 3 R6, R64 RES, 10.0 kQ, 1%, 0.1 W, 0603 STD STD STD 4 R47, R56, R66 RES, 49.9 Q, 1%, 0.1 W, 0603 STD STD STD 2 R1, R9, R13, R30, R40 RES, 1.00 A, 1%, 0.1 W, 0603 STD STD STD 3 R16, R54, R66 RES, 4.99 A, 1%, 0.1 W, 0603	3	J5, J6, J11	TERMINAL BLOCK 5.08 mm VERT 4POS, TH ED120/4DS		On-Shore Technology
1 L1 Inductor, Shielded Drum Core, Ferrite, 10 µH, 0.7 A, 0.33 Ω, SMD LP 3314- 103MLB Colleratt 2 L2, L3 Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 Ω, SMD 744355147 Wurth Elektronik elSos 1 LBL1 Thermal Transfer Printable Labels, 1.250° W x 0.250° H - 10,000 per roll THT-13-457-10 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DQP0012A CSD9378BQ5M Texas Instruments 1 R2 RES, 1.10 MQ, 1%, 0.1 W, 0603 STD STD STD 14 R3, R7, R10, R14, R15, R21, R31, R30, R38, R41, R3, R50, R57, R65 RES, 0.0, 5%, 0.1 W, 0603 STD STD STD 1 R6 RES, 210 kQ, 1%, 0.1 W, 0603 STD STD STD 2 R8, R64 RES, 49.9 Q, 1%, 0.1 W, 0603 STD STD STD 2 R1, R9, R13, R30, R40 RES, 1.00 Q, 1%, 0.1 W, 0603 STD STD STD 3 R16, R54, R66 RES, 4.99 kQ, 1%, 0.1 W, 0603 STD STD STD 4 R72, R25, R26, R35, R44, R55, R56 RES, 1.00 Q, 1%, 0.1 W, 0603	1	J12	Header, 100 mil, 5x2, Tin plated, TH PEC05D		Sullins Connector Solutions
2 L2, L3 Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 Ω, SMD 744355147 Wurth Elektronik elsos 1 LBL1 Thermal Transfer Printable Labels, 1.250° W x 0.250° H - 10,000 per roll THT-13-457-10 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DQP0012A CSD95378BQ5M Texas Instruments 1 R2 RES, 1.10 MΩ, 1%, 0.1 W, 0603 STD STD STD 14 R21, R31, R36, R36, R41, R43, R50, R57, R65 RES, 210 kQ, 1%, 0.1 W, 0603 STD STD STD 2 R6, R64 RES, 210 kQ, 1%, 0.1 W, 0603 STD STD STD 2 R1, R9, R13, R30, R40 RES, 10.0 kQ, 1%, 0.1 W, 0603 STD STD STD 2 R16, R64, R66 RES, 280, 0, 1%, 0.1 W, 0603 STD STD STD 2 R16, R54, R66 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD STD 2 R16, R54, R66 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD STD 2 R16, R54, R66 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD STD <td>1</td> <td>L1</td> <td colspan="2">Inductor, Shielded Drum Core, Ferrite, 10 μH, 0.7 A, 0.33 Ω, SMD</td> <td>Coilcraft</td>	1	L1	Inductor, Shielded Drum Core, Ferrite, 10 μH, 0.7 A, 0.33 Ω, SMD		Coilcraft
1 LBL1 Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll THT-13-457-10 Brady 2 Q1, Q3 Synchronous Buck NexFET Power Stage, DQP0012A CSD95378BQSM Texas Instruments 1 R2 RES, 1.10 MQ, 1%, 0.1 W, 0603 STD STD 14 R21, R31, R36, R38, R41, R43, R50, R57, R65 RES, 0.0, 5%, 0.1 W, 0603 STD STD 2 R8, R64 RES, 210 kQ, 1%, 0.1 W, 0603 STD STD 2 R8, R64 RES, 210 kQ, 1%, 0.1 W, 0603 STD STD 2 R4, R64 RES, 20.0, 1%, 0.1 W, 0603 STD STD 3 R16, R54, R66 RES, 20.0, 1%, 0.1 W, 0603 STD STD 3 R16, R54, R66 RES, 4.99 kQ, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 1.00 Q, 1%, 0.1 W, 0603 STD STD 2 R18, R47 RES, 10.0 Q, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 1.00 Q, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RE	2	L2, L3	Inductor, Shielded Drum Core, WE-Perm, 470 nH, 30 A, 0.00067 $\Omega,$ SMD	744355147	Wurth Elektronik eiSos
2 Q1, Q3 Synchronous Buck NexFET Power Stage, DQP0012A CSD95378BQ5M Texas Instruments 1 R2 RES, 1.10 MΩ, 1%, 0.1 W, 0603 STD STD 14 R21, R31, R36, R38, R38, R41, R45, R43, R50, R57, R65 RES, 0.0, 5%, 0.1 W, 0603 STD STD 1 R6 RES, 210 kΩ, 1%, 0.1 W, 0603 STD STD 2 R8, R64 RES, 49.9 Ω, 1%, 0.1 W, 0603 STD STD 5 R1, R9, R13, R30, R40 RES, 10.0 kΩ, 1%, 0.1 W, 0603 STD STD 2 R8, R64 RES, 280 Ω, 1%, 0.1 W, 0603 STD STD 3 R16, R54, R66 RES, 10.0 kΩ, 1%, 0.1 W, 0603 STD STD 4 R2, R67 RES, 280 Ω, 1%, 0.1 W, 0603 STD STD 7 R17, R25, R26, R35, R44, R55, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 7 R17, R25, R26, R35, R44, R55, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 1 R24 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 1 R24 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD	1	LBL1	Thermal Transfer Printable Labels, 1.250" W x 0.250" H - 10,000 per roll	THT-13-457-10	Brady
1 R2 RES, 1.10 MΩ, 1%, 0.1 W, 0603 STD STD 14 R3, R7, R10, R14, R15, R21, R31, R36, R38, R41, R50, R57, R65 RES, 0 Ω, 5%, 0.1 W, 0603 STD STD 1 R6 RES, 210 kΩ, 1%, 0.1 W, 0603 STD STD 2 R8, R64 RES, 49.9 Ω, 1%, 0.1 W, 0603 STD STD 5 R1, R9, R13, R30, R40 RES, 10.0 kΩ, 1%, 0.1 W, 0603 STD STD 2 R12, R67 RES, 280 Ω, 1%, 0.1 W, 0603 STD STD 3 R16, R54, R66 RES, 4.99 kΩ, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD 2 R18, R47 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD 14 R24 RES, 40.2 kΩ, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 0.01 Ω, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD S	2	Q1, Q3	Synchronous Buck NexFET Power Stage, DQP0012A	CSD95378BQ5M	Texas Instruments
14R3, R7, R10, R14, R15, R21, R31, R36, R38, R41, R21, R31, R36, R38, R41, R21, R31, R36, R38, R41, R45, R50, R57, R65RES, 0 Ω, 5%, 0.1 W, 0603STDSTD1R6RES, 210 kΩ, 1%, 0.1 W, 0603STDSTDSTD2R8, R64RES, 49.9 Ω, 1%, 0.1 W, 0603STDSTD5R1, R9, R13, R30, R40RES, 10.0 kΩ, 1%, 0.1 W, 0603STDSTD2R12, R67RES, 280 Ω, 1%, 0.1 W, 0603STDSTD3R16, R54, R66RES, 4.99 kΩ, 1%, 0.1 W, 0603STDSTD7R17, R25, R26, R35, R44, R55, R56RES, 1.00 Ω, 1%, 0.1 W, 0603STDSTD2R18, R47RES, 121 kΩ, 1%, 0.1 W, 0603STDSTD4R20, R27, R45, R53RES, 10.0 Ω, 1%, 0.1 W, 0603STDSTD1R24RES, 0.00 Ω, 1%, 0.1 W, 0603STDSTD2R37, R42RES, 10.0 Ω, 1%, 0.1 W, 0603STDSTD2R48, R49RES, 10.0 Ω, 1%, 0.1 W, 0603STDSTD2R48, R49RES, 10.0 Ω, 1%, 0.1 W, 0603STDSTD2R47RES, 10.0 Ω, 1%, 0.1 W, 0603STDSTD2R48, R49RES, 10.0 Ω, 1%, 0.1 W, 0603STDSTD2R48, R49RES, 10.2 Ω, 1%, 0.1 W, 0603STDSTD2R48, R49RES, 10.2 KΩ, 1%, 0.1 W, 0603STDSTD2R48, R49RES, 16.2 kΩ, 1%, 0.1 W, 0603STDSTD2R48, R49RES, 16.2 kΩ, 1%, 0.1 W, 0603STDSTD2 <t< td=""><td>1</td><td>R2</td><td>RES, 1.10 MΩ, 1%, 0.1 W, 0603</td><td>STD</td><td>STD</td></t<>	1	R2	RES, 1.10 MΩ, 1%, 0.1 W, 0603	STD	STD
1 R6 RES, 210 kΩ, 1%, 0.1 W, 0603 STD STD 2 R8, R64 RES, 49.9 Ω, 1%, 0.1 W, 0603 STD STD 5 R1, R9, R13, R30, R40 RES, 10.0 kΩ, 1%, 0.1 W, 0603 STD STD 2 R12, R67 RES, 280 Ω, 1%, 0.1 W, 0603 STD STD 3 R16, R54, R66 RES, 4.99 kΩ, 1%, 0.1 W, 0603 STD STD 7 R17, R25, R26, R35, R44, R55, R56 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD 2 R18, R47 RES, 121 kΩ, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 1 R24 RES, 0.001 Ω, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 0.001 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 R37, R42 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD	14	R3, R7, R10, R14, R15, R21, R31, R36, R38, R41, R43, R50, R57, R65	RES, 0 Ω, 5%, 0.1 W, 0603	STD	STD
2 R8, R64 RES, 49.9 Ω, 1%, 0.1 W, 0603 STD STD 5 R1, R9, R13, R30, R40 RES, 10.0 kΩ, 1%, 0.1 W, 0603 STD STD 2 R12, R67 RES, 280 Ω, 1%, 0.1 W, 0603 STD STD 3 R16, R54, R66 RES, 4.99 kΩ, 1%, 0.1 W, 0603 STD STD 7 R17, R25, R26, R35, R44, R55, R56, R55, R56, R55, R56, R55, R56 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD 2 R18, R47 RES, 121 kΩ, 1%, 0.1 W, 0603 STD STD STD 2 R18, R47 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD STD 4 R20, R27, R45, R53 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD STD 1 R24 RES, 40.2 kΩ, 1%, 0.1 W, 0603 STD STD STD 3 R32, R33, R34 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD STD 2 R37, R42 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD STD	1	R6	RES, 210 kΩ, 1%, 0.1 W, 0603	STD	STD
5 R1, R9, R13, R30, R40 RES, 10.0 kΩ, 1%, 0.1 W, 0603 STD STD 2 R12, R67 RES, 280 Ω, 1%, 0.1 W, 0603 STD STD 3 R16, R54, R66 RES, 4.99 kΩ, 1%, 0.1 W, 0603 STD STD 7 R17, R25, R26, R35, R44, R55, R56 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD 2 R18, R47 RES, 121 kΩ, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 1 R24 RES, 40.2 kΩ, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 0.001 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 2 R37, R42 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M	2	R8, R64	RES, 49.9 Ω, 1%, 0.1 W, 0603	STD	STD
2 R12, R67 RES, 280 Ω, 1%, 0.1 W, 0603 STD STD 3 R16, R54, R66 RES, 4.99 kΩ, 1%, 0.1 W, 0603 STD STD 7 R17, R25, R26, R35, R44, R55, R56 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD 2 R18, R47 RES, 121 kΩ, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 1 R24 RES, 40.2 kΩ, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 100 Ω, 1%, 1W, 2512 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD 2 R37, R42 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M	5	R1, R9, R13, R30, R40	RES, 10.0 kΩ, 1%, 0.1 W, 0603	STD	STD
3 R16, R54, R66 RES, 4.99 kΩ, 1%, 0.1 W, 0603 STD STD 7 R17, R25, R26, R35, R44, R55, R56 RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD 2 R18, R47 RES, 121 kΩ, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 1 R24 RES, 40.2 kΩ, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 0.001 Ω, 1%, 1W, 2512 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 2 R37, R42 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 6 TP1, TP5, TP9, TP12, TP24, TP31 Test Point, Miniature, Red, TH	2	R12, R67 RES, 280 Ω, 1%, 0.1 W, 0603		STD	STD
7 R17, R25, R26, R35, R44, RES, 1.00 Ω, 1%, 0.1 W, 0603 STD STD 2 R18, R47 RES, 121 kQ, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 1 R24 RES, 40.2 kQ, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 0.001 Q, 1%, 1W, 2512 STD STD 2 R37, R42 RES, 100 Q, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kQ, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kQ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 6 TP1, TP5, TP9, TP12, TP24, TP31 Test Point, Miniature, Red, TH 5000 Keystone	3	R16, R54, R66	RES, 4.99 kΩ, 1%, 0.1 W, 0603	STD	STD
2 R18, R47 RES, 121 kΩ, 1%, 0.1 W, 0603 STD STD 4 R20, R27, R45, R53 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 1 R24 RES, 40.2 kΩ, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 0.001 Ω, 1%, 1W, 2512 STD STD 2 R37, R42 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 6 TP1, TP5, TP9, TP12, TP24, TP31 Test Point, Miniature, Red, TH 5000 Keystone	7	R17, R25, R26, R35, R44, R55, R56	RES, 1.00 Ω, 1%, 0.1 W, 0603	STD	STD
4 R20, R27, R45, R53 RES, 10.0 Ω, 1%, 0.1 W, 0603 STD STD 1 R24 RES, 40.2 kΩ, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 0.001 Ω, 1%, 1W, 2512 STD STD 2 R37, R42 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 6 TP1, TP5, TP9, TP12, TP24, TP31 Test Point, Miniature, Red, TH 5000 Keystone	2	R18, R47	RES, 121 kΩ, 1%, 0.1 W, 0603	STD	STD
1 R24 RES, 40.2 kΩ, 1%, 0.1 W, 0603 STD STD 3 R32, R33, R34 RES, 0.001 Ω, 1%, 1W, 2512 STD STD 2 R37, R42 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 6 TP1, TP5, TP9, TP12, TP24, TP31 Test Point, Miniature, Red, TH 5000 Keystone	4	R20, R27, R45, R53	RES, 10.0 Ω, 1%, 0.1 W, 0603	STD	STD
3 R32, R33, R34 RES, 0.001 Ω, 1%, 1W, 2512 STD STD 2 R37, R42 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 6 TP1, TP5, TP9, TP12, TP24, TP31 Test Point, Miniature, Red, TH 5000 Keystone	1	R24	RES, 40.2 kΩ, 1%, 0.1 W, 0603	STD	STD
2 R37, R42 RES, 100 Ω, 1%, 0.1 W, 0603 STD STD 2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 6 TP1, TP5, TP9, TP12, TP24, TP31 Test Point, Miniature, Red, TH 5000 Keystone	3	R32, R33, R34	RES, 0.001 Ω, 1%, 1W, 2512	STD	STD
2 R48, R49 RES, 16.2 kΩ, 1%, 0.1 W, 0603 STD STD 2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 6 TP1, TP5, TP9, TP12, TP24, TP31 Test Point, Miniature, Red, TH 5000 Keystone	2	R37, R42	RES, 100 Ω, 1%, 0.1 W, 0603	STD	STD
2 SH-J1, SH-J3 Shunt, 100 mil, Gold plated, Black 969102-0000-DA 3M 6 TP1, TP5, TP9, TP12, TP24, TP31 Test Point, Miniature, Red, TH 5000 Keystone	2	R48, R49	RES, 16.2 kΩ, 1%, 0.1 W, 0603	STD	STD
6TP1, TP5, TP9, TP12, TP24, TP31Test Point, Miniature, Red, TH5000Keystone	2	SH-J1, SH-J3	Shunt, 100 mil, Gold plated, Black	969102-0000-DA	3M
	6	TP1, TP5, TP9, TP12, TP24, TP31	Test Point, Miniature, Red, TH	5000	Keystone

Using the PWR594 EVM Dual Output DC/DC Analog with PMBus Interface 41

			-	
Qty	Designator	Description	Part Number	Manufacturer
17	TP2, TP3, TP7, TP8, TP10, TP13, TP18–TP23, TP25, TP26, TP28–TP30	Test Point, Miniature, White, TH	5002	Keystone
9	TP4, TP6, TP11, TP14–TP17, TP27, TP32	Test Point, Miniature, Black, TH	5001	Keystone
1	U1	IC, 3 V-17 V, 200-mA High Efficient Buck Converter	TPS62125DSG	TI
1	U2	IC, Dual output, 2-Phase, Stackable PMBUS Synchronous Buck Driverless Controller with AVS Bus	TPS40428RHA	ТІ

Table 9. TPS40428EVM 2-Phase Components List (continued)

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- 9. User assumes sole responsibility to determine whether EVMs may be subject to any applicable federal, state, or local laws and regulatory requirements (including but not limited to U.S. Food and Drug Administration regulations, if applicable) related to its handling and use of EVMs and, if applicable, compliance in all respects with such laws and regulations.
- 10. User has sole responsibility to ensure the safety of any activities to be conducted by it and its employees, affiliates, contractors or designees, with respect to handling and using EVMs. Further, user is responsible to ensure that any interfaces (electronic and/or mechanical) between EVMs 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.
- 11. User shall employ reasonable safeguards to ensure that user's use of EVMs will not result in any property damage, injury or death, even if EVMs should fail to perform as described or expected.
- 12. User shall be solely responsible for proper disposal and recycling of EVMs consistent with all applicable federal, state, and local requirements.

Certain Instructions. User shall operate EVMs within TI's recommended specifications and environmental considerations per the user's guide, accompanying documentation, and any other applicable requirements. Exceeding the specified ratings (including but not limited to input and output voltage, current, power, and environmental ranges) for EVMs may cause property damage, personal injury or death. If there are questions concerning these ratings, 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 result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the applicable EVM user's 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, some circuit components may have case temperatures greater than 60°C as long as the input and output are maintained at a normal ambient operating temperature. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors which can be identified using EVMs' schematics located in the applicable EVM user's guide. When placing measurement probes near EVMs during normal operation, please be aware that EVMs may become very warm. As with all electronic evaluation tools, only qualified personnel knowledgeable in electronic measurement and diagnostics normally found in development environments should use EVMs.

Agreement to Defend, Indemnify and Hold Harmless. User agrees to defend, indemnify, and hold TI, its directors, officers, employees, agents, representatives, affiliates, licensors and their representatives harmless from and against any and all claims, damages, losses, expenses, costs and liabilities (collectively, "Claims") arising out of, or in connection with, any handling and/or use of EVMs. User's indemnity shall apply whether Claims arise under law of tort or contract or any other legal theory, and even if EVMs fail to perform as described or expected.

Safety-Critical or Life-Critical Applications. If user intends to use EVMs in evaluations of safety critical applications (such as life support), and a failure of a TI product considered for purchase by user for use in user's product would reasonably be expected to cause severe personal injury or death such as devices which are classified as FDA Class III or similar classification, then user must specifically notify TI of such intent and enter into a separate Assurance and Indemnity Agreement.

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For EVMs not including a radio and not subject to the U.S. Federal Communications Commission (FCC) or Industry Canada (IC) regulations, TI intends EVMs to be used only for engineering development, demonstration, or evaluation purposes. EVMs are not finished products typically fit for general consumer use. EVMs may nonetheless generate, use, or radiate radio frequency energy, but have not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC or the ICES-003 rules. Operation of such EVMs may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

General Statement for EVMs including a radio

User Power/Frequency Use Obligations: For EVMs including a radio, the radio included in such EVMs is intended for development and/or professional use only in legally allocated frequency and power limits. Any use of radio frequencies and/or power availability in such EVMs and their development application(s) must comply with local laws governing radio spectrum allocation and power limits for such EVMs. It is the user's sole responsibility to only operate this radio in legally acceptable frequency space and within legally mandated power limitations. Any exceptions to this are strictly prohibited and unauthorized by TI unless user has obtained appropriate experimental and/or development licenses from local regulatory authorities, which is the sole responsibility of the user, including its acceptable authorization.

U.S. Federal Communications Commission Compliance

For EVMs Annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant

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 could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

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 its own expense.

FCC Interference Statement for Class B EVM devices

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.

Industry Canada Compliance (English)

For EVMs Annotated as IC – INDUSTRY CANADA Compliant:

This Class A or B digital apparatus complies with Canadian ICES-003.

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

Concerning EVMs Including Radio Transmitters

This device complies with Industry Canada licence-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.

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.

Canada Industry Canada Compliance (French)

Cet appareil numérique de la classe A ou B est conforme à la norme NMB-003 du Canada

Les changements ou les modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner l'équipement.

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.

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.

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Important Notice for Users of EVMs Considered "Radio Frequency Products" in Japan

EVMs entering Japan are NOT certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If user uses EVMs in Japan, user is required by Radio Law of Japan to follow the instructions below with respect to EVMs:

- 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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