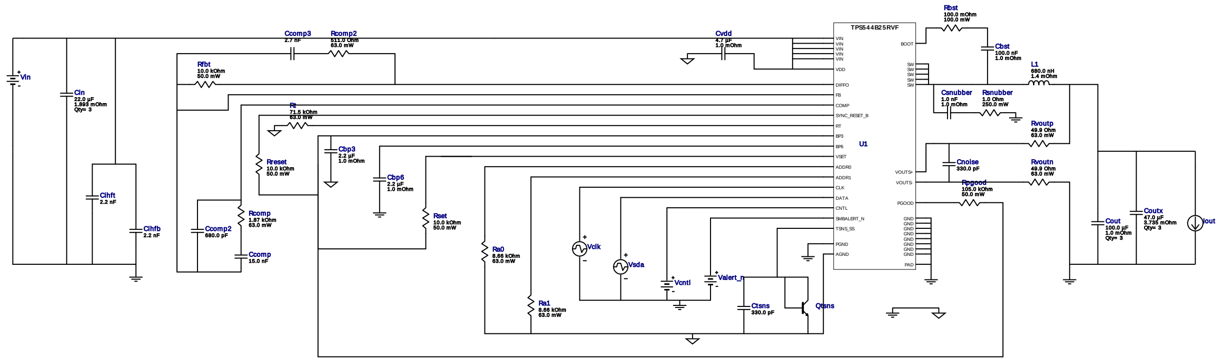
VinMin = 10.0V
VinMax = 14.0V
Vout = 0.72V
Vout Sch = 0.72V
Iout = 20.0A

Device = TPS544B25RVFR
Topology = Buck
Created = 2019-09-09 03:01:06.433
BOM Cost = $10.45
BOM Count = 37
Total Pd = 3.13W

WEBENCH ® Design Report

Design : 136 TPS544B25RVFR
TPS544B25RVFR 10V-14V to .72V @ 20A



Design Alerts

TPS544B25 Design

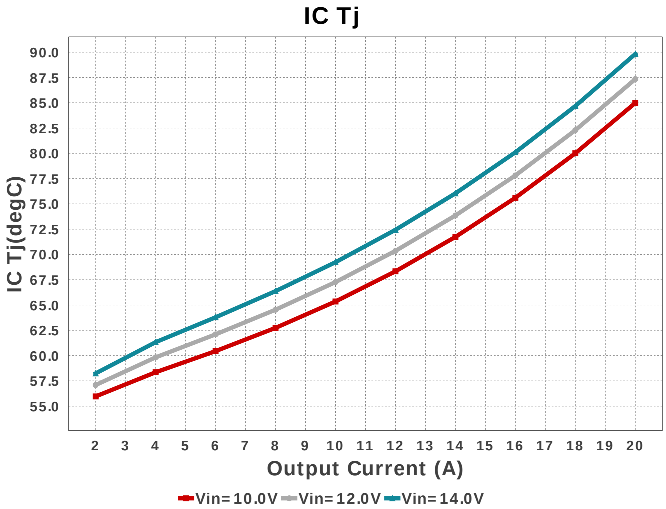
The TPS544B25 is a PMBus(TM) device with key features listed below. PMBus(TM) features marked with * are included in WEBENCH(R) Power Designer. - Adaptive Voltage Scaling (AVS) through VOUT_COMMAND * - Programmable output transition rate* - UVLO*, Soft-Start*, and Soft-Stop - Output voltage and current monitoring - External temperature sensing and reporting - Programmable over current protection with Thermal Compensation - OV, UV, OT Levels - Turn-On and Turn-Off DelaysUse the Advanced Options on the left side to set the PMBus(TM) commands.Please refer to the TPS544B25 datasheet and visit http://www.ti.com/pmbus for more information.

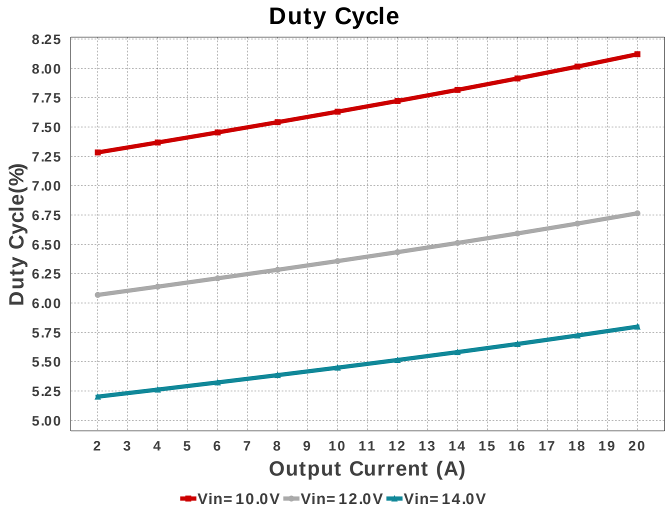
Electrical BOM

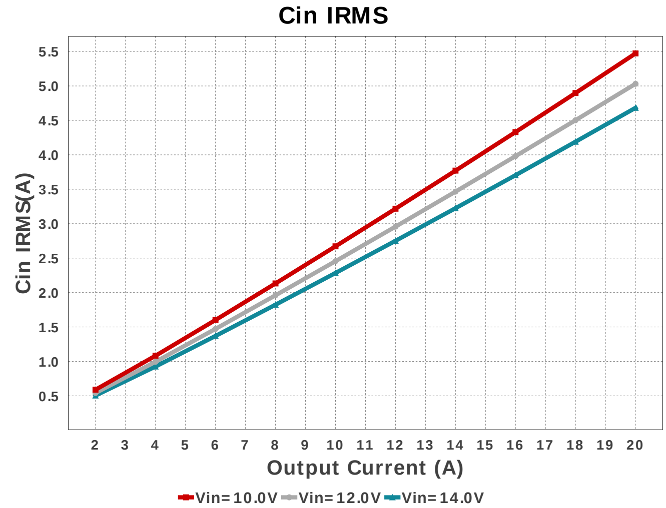
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbp3	Taiyo Yuden	EMK212BJ225KG-T Series= X5R	Cap= 2.2 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2
Cbp6	Taiyo Yuden	EMK212BJ225KG-T Series= X5R	Cap= 2.2 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2
Cbst	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp	Kemet	C0603C153J3GACTU Series= C0G/NP0	Cap= 15.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.11	0603 5 mm^2
Ccomp2	Samsung Electro-Mechanics	CL10C681JB8NFNC Series= C0G/NP0	Cap= 680.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Ccomp3	TDK	CGA4C2C0G1H272J060AA Series= C0G/NP0	Cap= 2.7 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm^2
Cihfb	Samsung Electro-Mechanics	CL21C222JBFNNNE Series= C0G/NP0	Cap= 2.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2
Cihft	Samsung Electro-Mechanics	CL21C222JBFNNNE Series= C0G/NP0	Cap= 2.2 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2
Cin	TDK	CGA9P2X7R1E226M250KA Series= X7R	Cap= 22.0 uF ESR= 1.893 mOhm VDC= 25.0 V IRMS= 6.635 A	3	$0.92	2220_280 54 mm^2

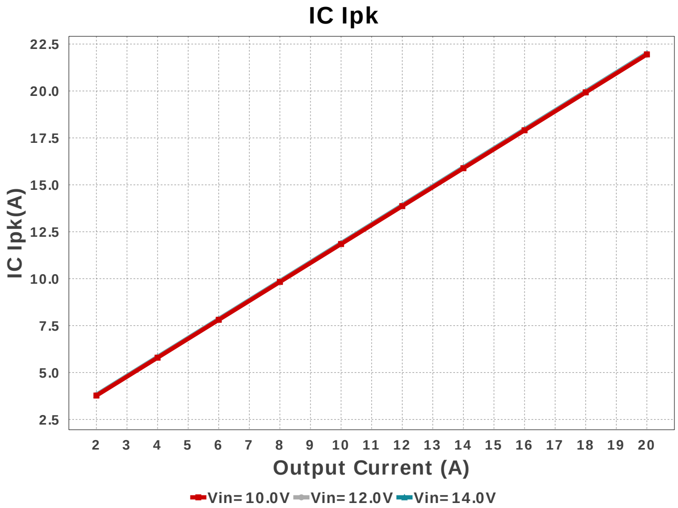
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cnoise	Samsung Electro-Mechanics	CL21C331JBANNNC Series= C0G/NP0	Cap= 330.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cout	MuRata	GRM32ER60J107ME20L Series= X5R	Cap= 100.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	3	$0.52	1210_270 15 mm^2
Coutx	MuRata	GRM31CC80J476KE18L Series= X6S	Cap= 47.0 uF ESR= 3.735 mOhm VDC= 6.3 V IRMS= 4.0522 A	3	$0.20	1206_190 11 mm^2
Csnubber	Yageo	CC0805KRX7R9BB102 Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Ctsns	Samsung Electro-Mechanics	CL21C331JBANNNC Series= C0G/NP0	Cap= 330.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cvdd	Taiyo Yuden	TMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm^2
L1	Coilcraft	XAL8080-681MEB	L= 680.0 nH 1.4 mOhm	1	$1.55	XAL8080 107 mm^2
Qtsns	Fairchild Semiconductor	MMBT3904	Bipolar Transistor	1	$0.05	SOT-23 14 mm^2
Ra0	Vishay-Dale	CRCW04028K66FKED Series= CRCW..e3	Res= 8.66 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ra1	Vishay-Dale	CRCW04028K66FKED Series= CRCW..e3	Res= 8.66 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rbst	Panasonic	ERJ-3RSFR10V Series= ERJ-3R	Res= 100.0 mOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.03	0603 5 mm^2
Rcomp	Vishay-Dale	CRCW04021K87FKED Series= CRCW..e3	Res= 1.87 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcomp2	Vishay-Dale	CRCW0402511RFKED Series= CRCW..e3	Res= 511.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rpgood	Yageo	RC0201FR-07105KL Series= ?	Res= 105.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rreset	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rset	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rsnubber	Vishay-Dale	CRCW12061R00FKEA Series= CRCW..e3	Res= 1.0 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rt	Vishay-Dale	CRCW040271K5FKED Series= CRCW..e3	Res= 71.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

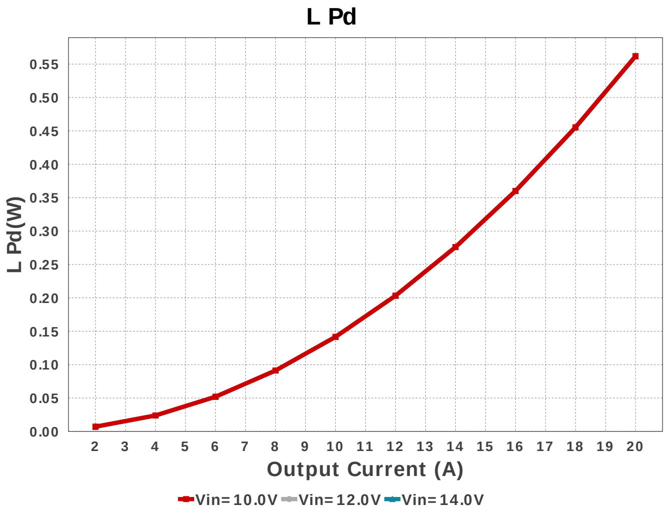
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rvoutn	Vishay-Dale	CRCW040249R9FKED Series= CRCW..e3	Res= 49.9 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvoutp	Vishay-Dale	CRCW040249R9FKED Series= CRCW..e3	Res= 49.9 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS544B25RVFR	Switcher	1	$3.40	RVF0040A 63 mm^2

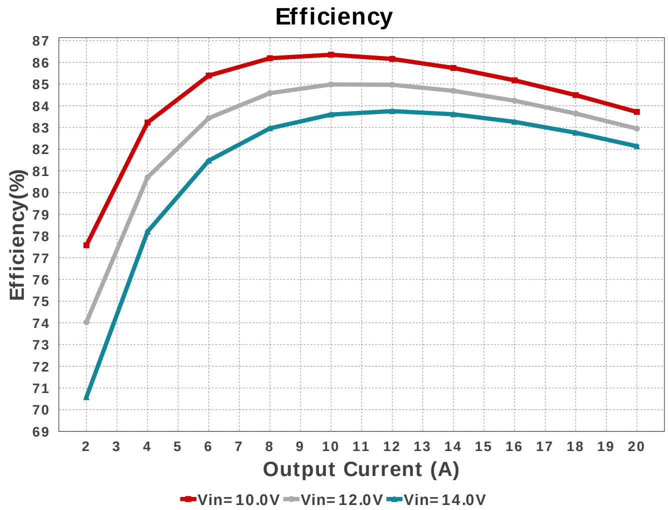


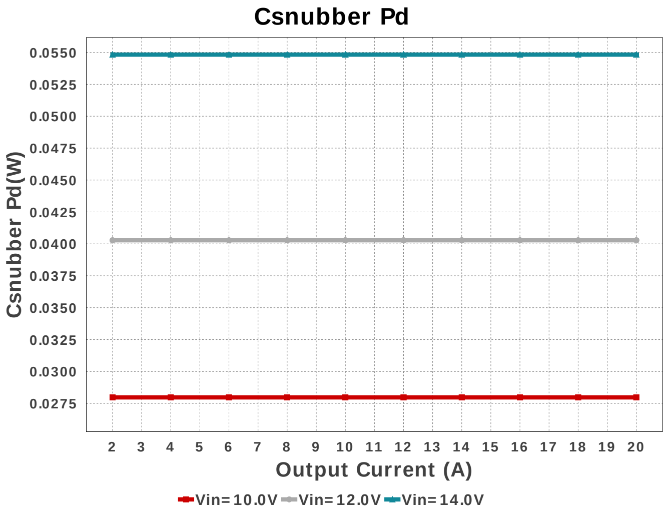


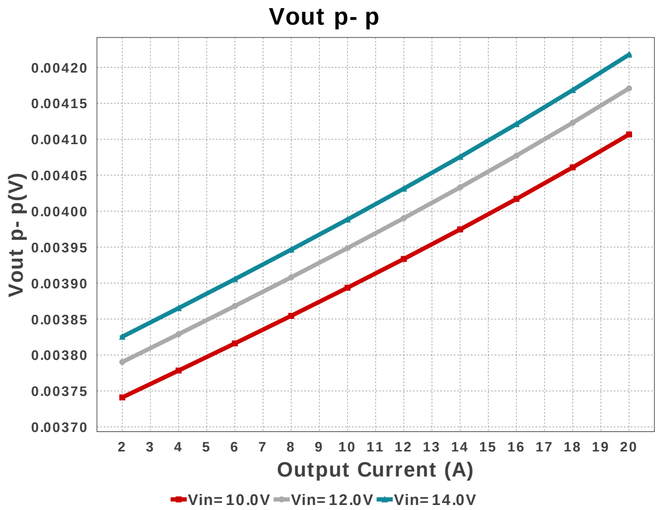


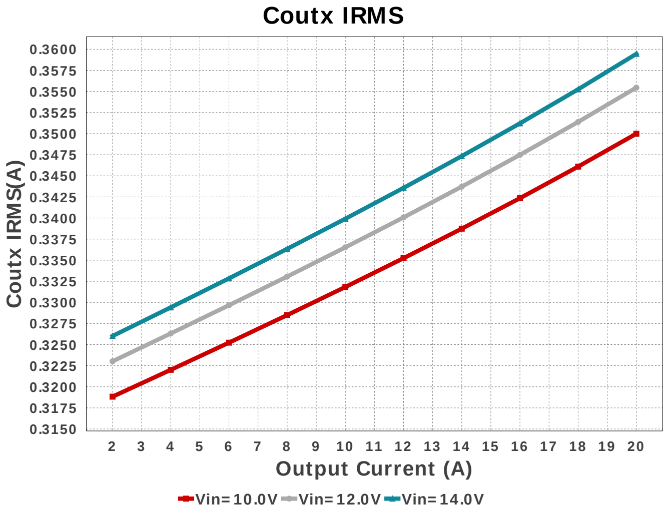


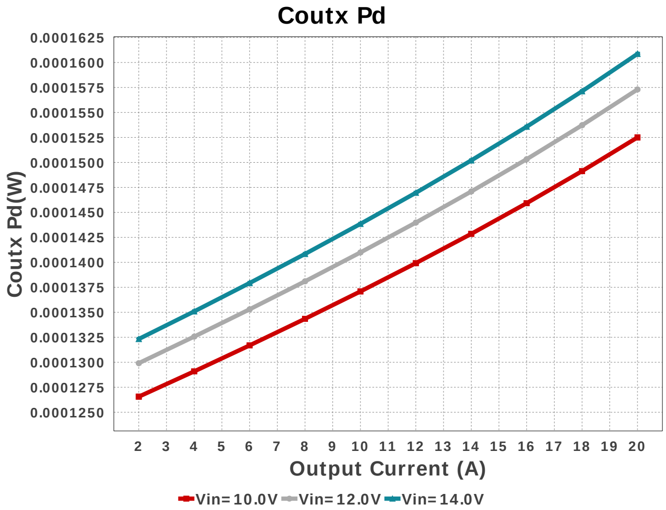


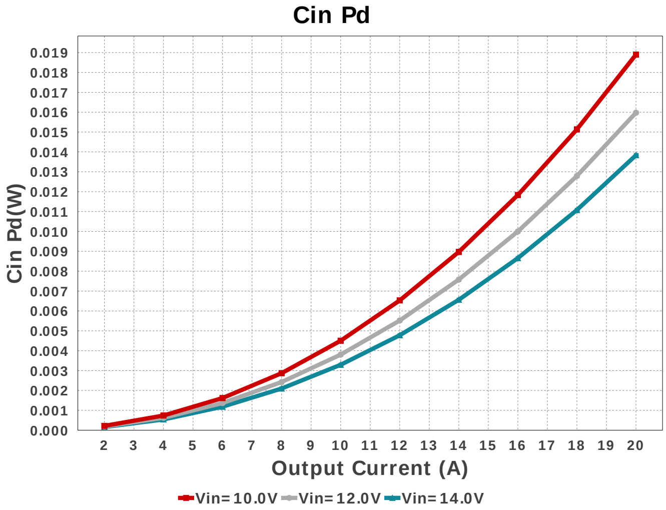


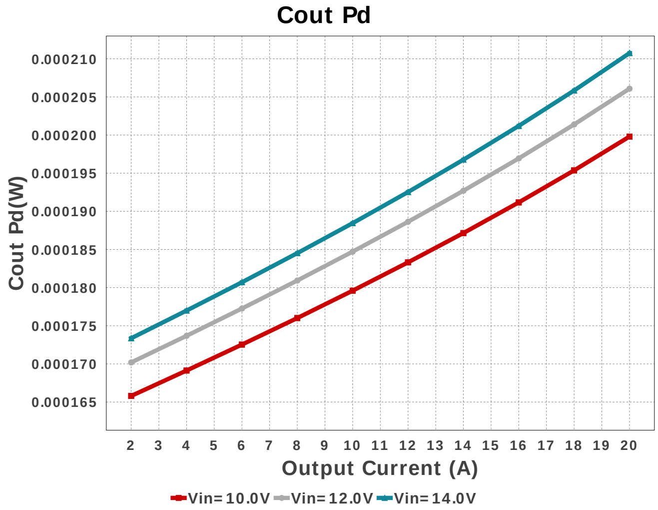

Csnubber Pd
Csnubber Pd(W)
0.0550
0.0525
0.0500
0.0475
0.0450
0.0425
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V

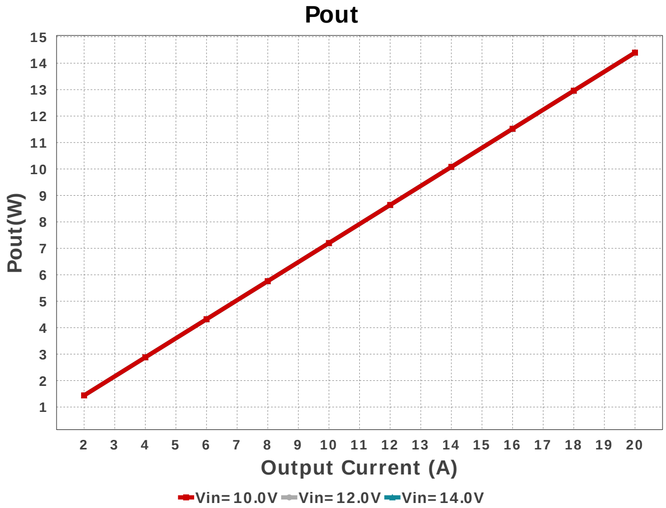

Vout p-p
Vout p-p(V)
0.00420
0.00415
0.00410
0.00405
0.00400
0.00395
0.00390
0.00385
0.00380
0.00375
0.00370
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V

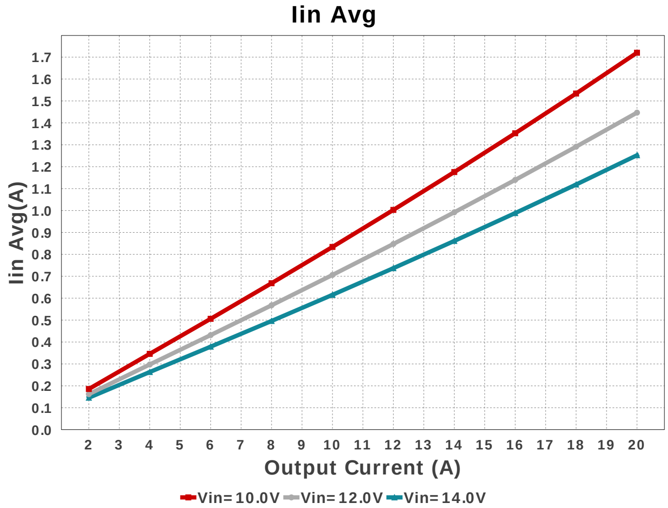

Coutx IRMS
Coutx IRMS(A)
0.3600
0.3575
0.3550
0.3525
0.3500
0.3475
0.3450
0.3425
0.3400
0.3375
0.3350
0.3325
0.3300
0.3275
0.3250
0.3225
0.3200
0.3175
0.3150
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V

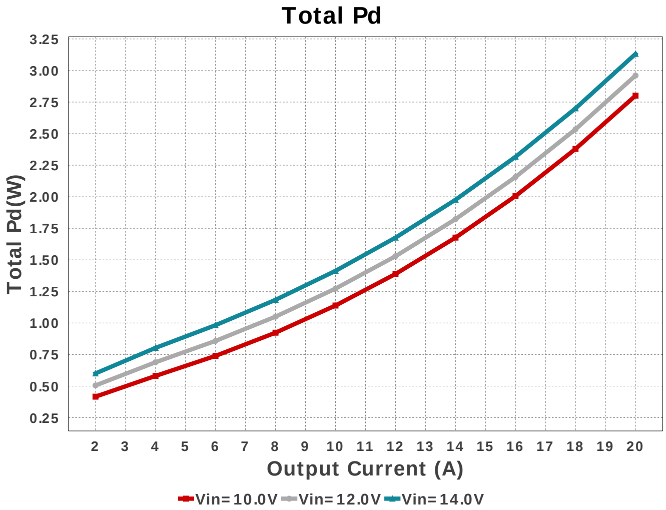

Coutx Pd
Coutx Pd(W)
0.0001625
0.0001600
0.0001575
0.0001550
0.0001525
0.0001500
0.0001475
0.0001450
0.0001425
0.0001400
0.0001375
0.0001350
0.0001325
0.0001300
0.0001275
0.0001250
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V

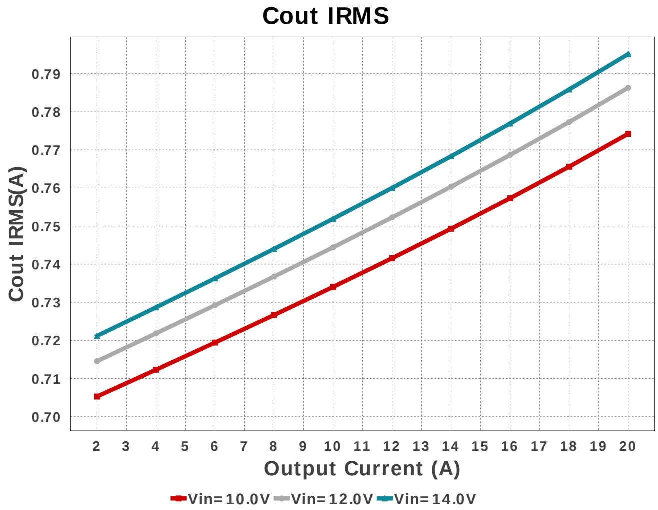

Cin Pd
Cin Pd(W)
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V

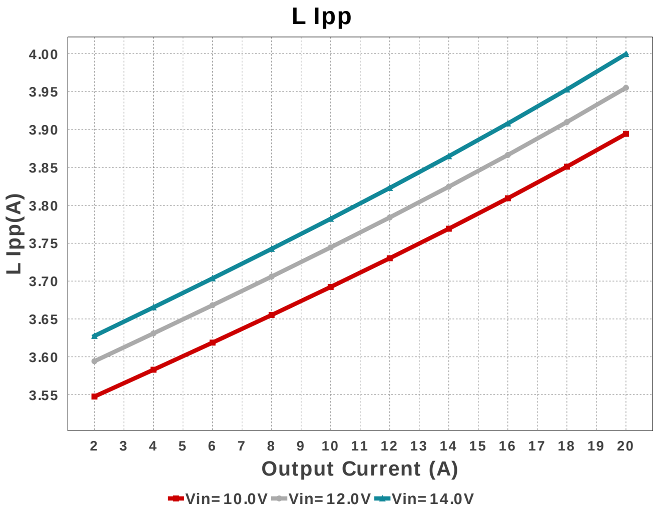

Cout Pd
Cout Pd(W)
0.000210
0.000205
0.000200
0.000195
0.000190
0.000185
0.000180
0.000175
0.000170
0.000165
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V

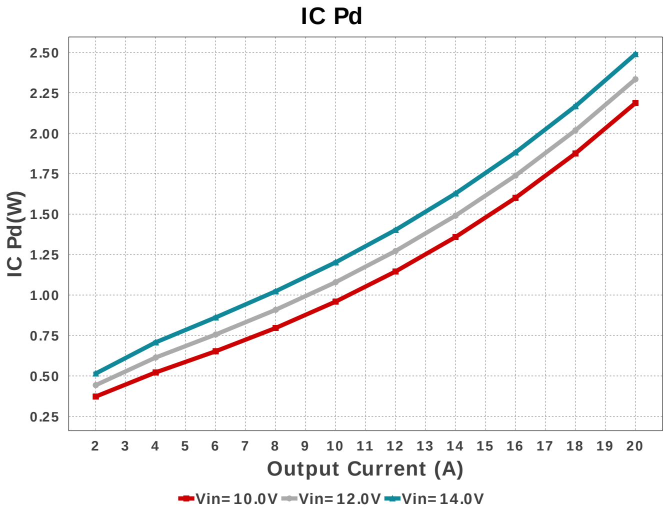

Pout
Pout(W)
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V

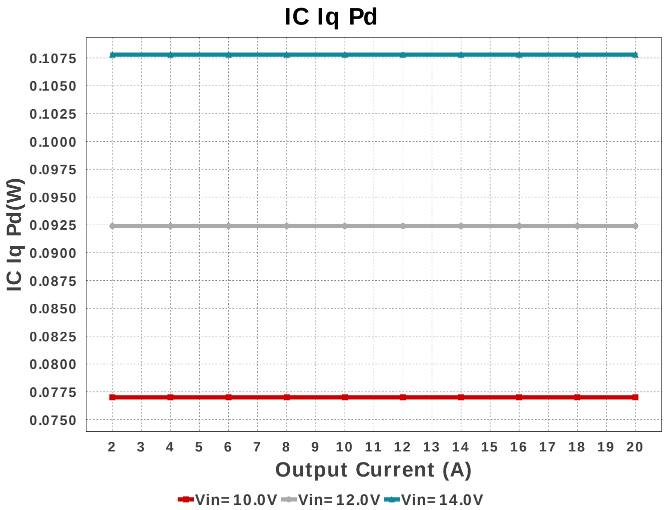

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V

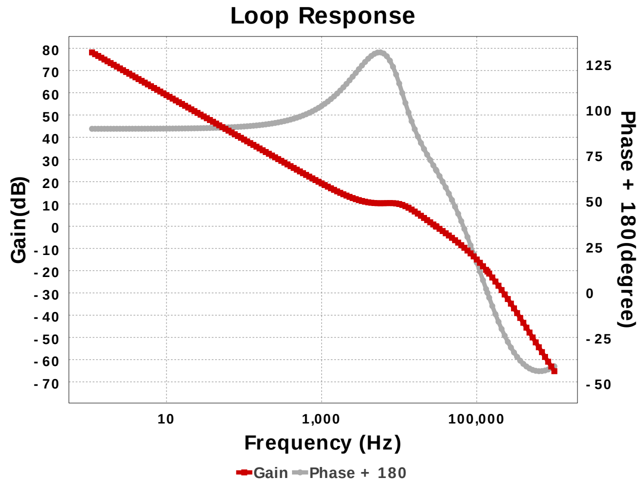

Total Pd
Total Pd(W)
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V


L Ipp
L Ipp(A)
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=10.0V Vin=12.0V Vin=14.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	4.682 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	13.835 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	795.124 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	210.74 µW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	359.448 mA	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	160.86 µW	Capacitor	Output capacitor_x power loss
7.	Csnubber Pd	54.825 mW	Capacitor	Snubber Power Dissipation
8.	IC Ipk	22.0 A	IC	Peak switch current in IC
9.	IC Iq Pd	107.8 mW	IC	IC Iq Pd
10.	IC Pd	2.489 W	IC	IC power dissipation
11.	IC Tj	89.823 degC	IC	IC junction temperature
12.	ICThetaJA Effective	16.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
13.	Iin Avg	1.252 A	IC	Average input current
14.	L Ipp	4.0 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	561.87 mW	Inductor	Inductor power dissipation
16.	PMBus Vout Command	368.0	PMBus	PMBus Vout Command
17.	PMBus Vout Scale Loop	1.0	PMBus	PMBus Vout Scale Loop
18.	Cin Pd	13.835 mW	Power	Input capacitor power dissipation
19.	Cout Pd	210.74 µW	Power	Output capacitor power dissipation
20.	Coutx Pd	160.86 µW	Power	Output capacitor_x power loss
21.	Csnubber Pd	54.825 mW	Power	Snubber Power Dissipation
22.	IC Pd	2.489 W	Power	IC power dissipation
23.	L Pd	561.87 mW	Power	Inductor power dissipation
24.	Total Pd	3.132 W	Power	Total Power Dissipation
25.	BOM Count	37	System Information	Total Design BOM count
26.	Cross Freq	29.678 kHz	System Information	Bode plot crossover frequency
27.	Duty Cycle	5.798 %	System Information	Duty cycle
28.	Efficiency	82.137 %	System Information	Steady state efficiency
29.	FootPrint	541.0 mm^2	System Information	Total Foot Print Area of BOM components
30.	Frequency	279.72 kHz	System Information	Switching frequency
31.	Gain Marg	-20.362 dB	System Information	Bode Plot Gain Margin
32.	Iout	20.0 A	System Information	Iout operating point
33.	Low Freq Gain	78.153 dB	System Information	Gain at 1Hz
34.	Mode	CCM	System Information	Conduction Mode
35.	Phase Marg	67.575 deg	System Information	Bode Plot Phase Margin
36.	Pout	14.4 W	System Information	Total output power
37.	Total BOM	$10.45	System Information	Total BOM Cost

#	Name	Value	Category	Description
38.	Vin	14.0 V	System Information	Vin operating point
39.	Vout	720.0 mV	System Information	Operational Output Voltage
40.	Vout Tolerance	694.444 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
41.	Vout p-p	4.218 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

	Name	Value	Description
	Iout	20.0	Maximum Output Current
	VinMax	14.0	Maximum input voltage
	VinMin	10.0	Minimum input voltage
	VinTyp	12.0	Typical input voltage
	Vout	720.0 m	Output Voltage
	base_pn	TPS544B25	Base Product Number
	source	DC	Input Source Type
	Ta	50.0	Ambient temperature
1.	Vout Sch	720.0 m	Output voltage selected

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

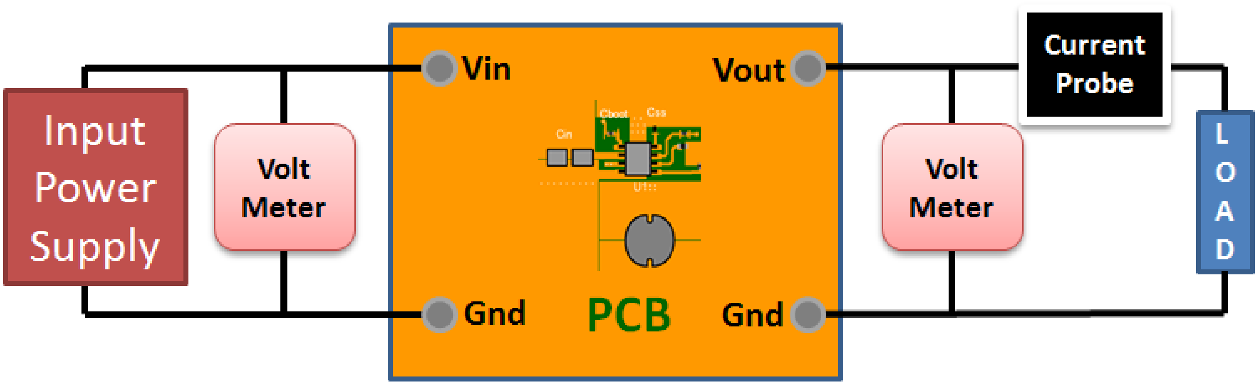
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 10.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



Design Assistance

1. Master key : 61A63FF445EB4F5B[v1]

2. **TPS544B25** Product Folder : http://www.ti.com/product/TPS544B25 : contains the data sheet and other resources.

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