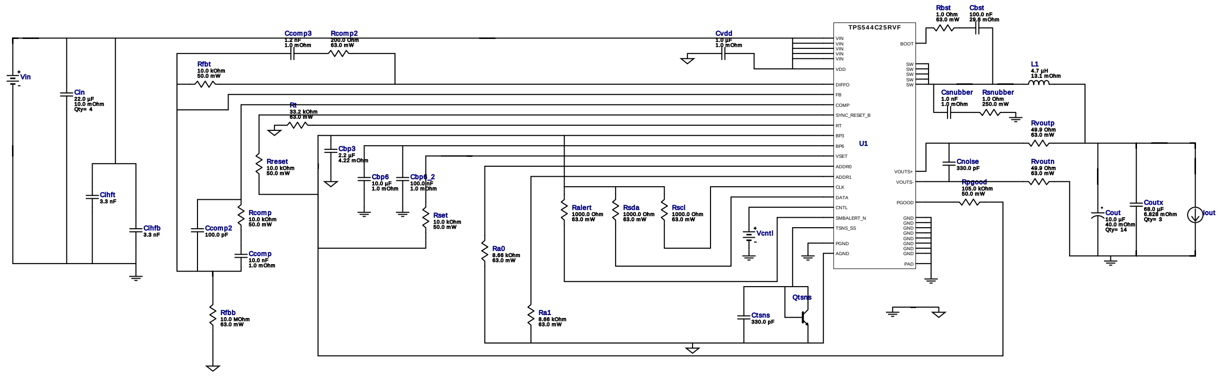
VinMin = 10.0V
VinMax = 12.5V
Vout = 5.0V
Vout Sch = 5.0V
Iout = 5.19A

Device = TPS544C25RVFR
Topology = Buck
Created = 2022-02-17 04:34:20.536
BOM Cost = $24.34
BOM Count = 54
Total Pd = 1.94W

WEBENCH ® Design Report

Design : 32 TPS544C25RVFR
TPS544C25RVFR 10V-12.5V to 5.00V @ 5.19A



Design Alerts

Component Selection Information

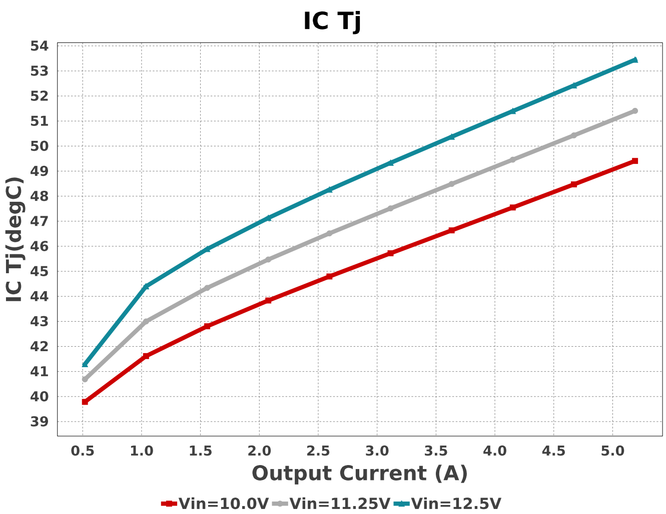
The TPS544C25 is a PMBus(TM) device with key features listed below. PMBus(TM) features marked with * are included in WEBENCH(R) Power Designer. - Adaptive Voltage Scaling (AVS) through VOUT_COMMAND * - Programmable output transition rate* - UVLO*, Soft-Start*, and Soft-Stop - Output voltage and current 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 TPS544C25 datasheet and visit http://www.ti.com/pmbus for more information.

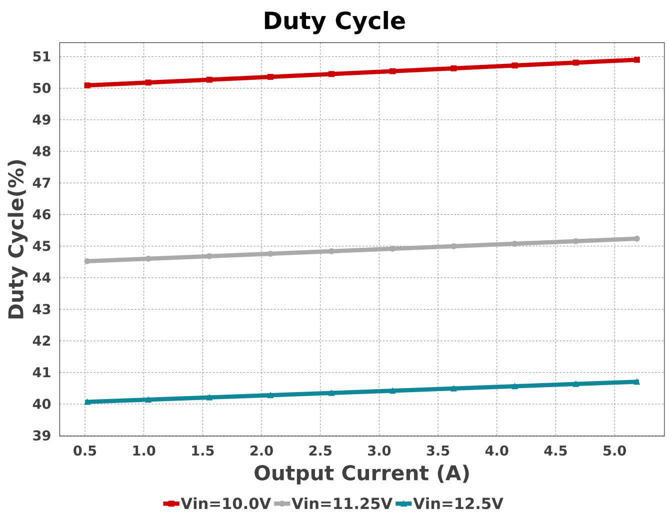
Electrical BOM

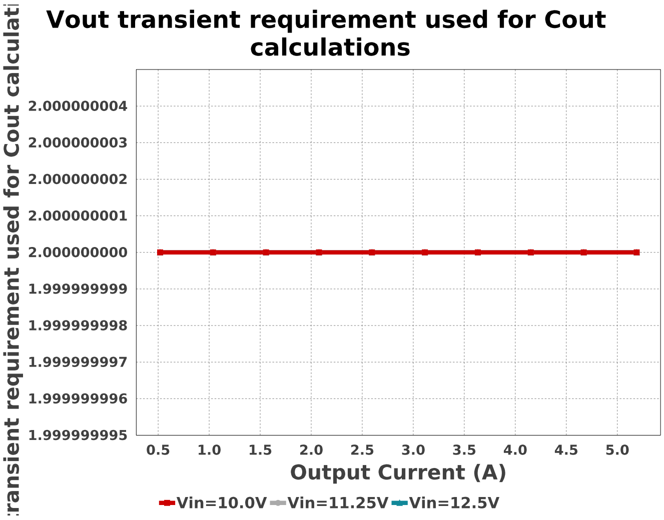
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbp3	MuRata	GRM21BR71C225KA12L Series= X7R	Cap= 2.2 uF ESR= 4.22 mOhm VDC= 16.0 V IRMS= 1.94677 A	1	$0.06	0805 7 mm^2
Cbp6	MuRata	GRT31CR61H106KE01L Series= X5R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.21	1206_180 11 mm^2
Cbp6_2	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
Cbst	TDK	CGA3E2X7R1H104K080AA Series= X7R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	$0.01	0603 5 mm^2
Ccomp	MuRata	LLL215R71H103MA11L Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.08	0508 7 mm^2
Ccomp2	MuRata	GRM1555C1H101JA01J Series= C0G/NP0	Cap= 100.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp3	MuRata	GRM155R71H122KA01D Series= X7R	Cap= 1.2 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cihfb	TDK	C2012C0G1H332J060AA Series= C0G/NP0	Cap= 3.3 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2

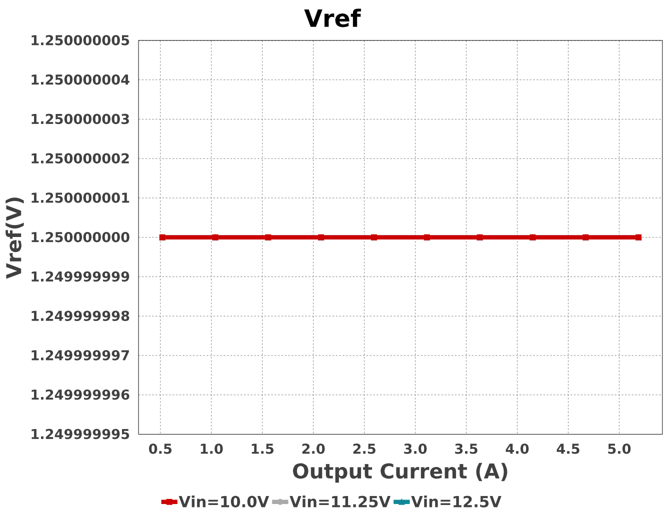
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cihft	TDK	C2012C0G1H332J060AA Series= C0G/NP0	Cap= 3.3 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2
Cin	TDK	CKG57NX5R1H226M500JH Series= X5R	Cap= 22.0 uF ESR= 10.0 mOhm VDC= 50.0 V IRMS= 4.6 A	4	$1.93	CKG57N 56 mm^2
Cnoise	Samsung Electro-Mechanics	CL21C331JBANNNC Series= C0G/NP0	Cap= 330.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cout	Panasonic	20SVPA10M Series= SVPA	Cap= 10.0 uF ESR= 40.0 mOhm VDC= 20.0 V IRMS= 1.7 A	14	$0.56	CAPSMT_62_E61 53 mm^2
Coutx	TDK	C5750X5R1A686M230KA Series= X5R	Cap= 68.0 uF ESR= 6.828 mOhm VDC= 10.0 V IRMS= 3.4939 A	3	$1.07	2220_250 54 mm^2
Csnubber	Kemet	C0603C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 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	GMK212B7105KG-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 35.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm^2
L1	Coilcraft	XAL6060-472MEB	L= 4.7 µH 13.1 mOhm	1	$0.82	XAL6060 72 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
Ralert	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rbst	Vishay-Dale	CRCW04021R00FKED Series= CRCW..e3	Res= 1.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcomp	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rcomp2	Vishay-Dale	CRCW0402200RFKED Series= CRCW..e3	Res= 200.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW040210M0FKED Series= CRCW..e3	Res= 10.0 MOhm 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

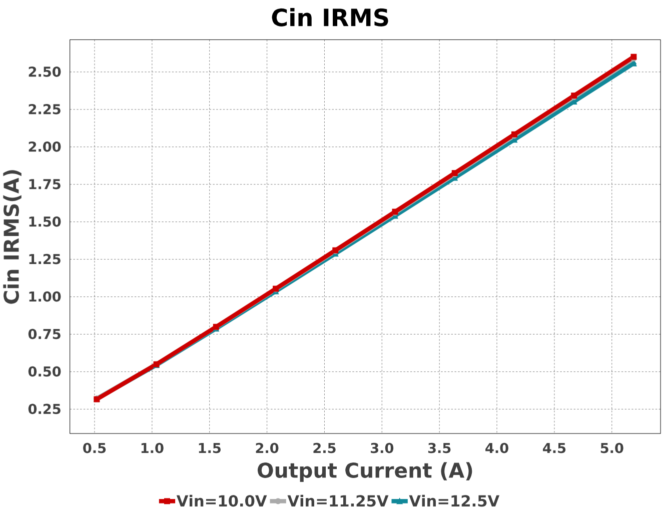
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rreset	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rscl	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsda	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 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	CRCW040233K2FKED Series= CRCW..e3	Res= 33.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
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	TPS544C25RVFR	Switcher	1	$3.96	RVF0040A 63 mm^2

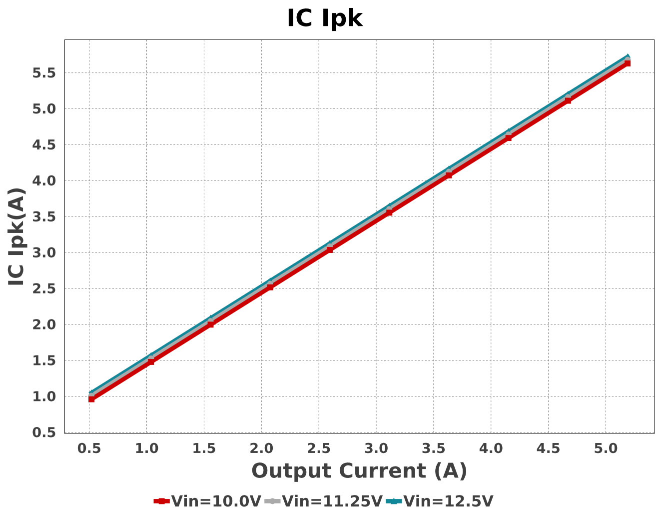


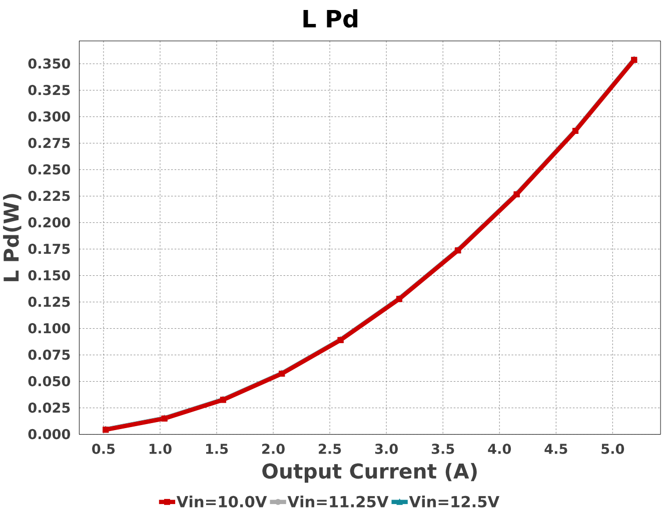


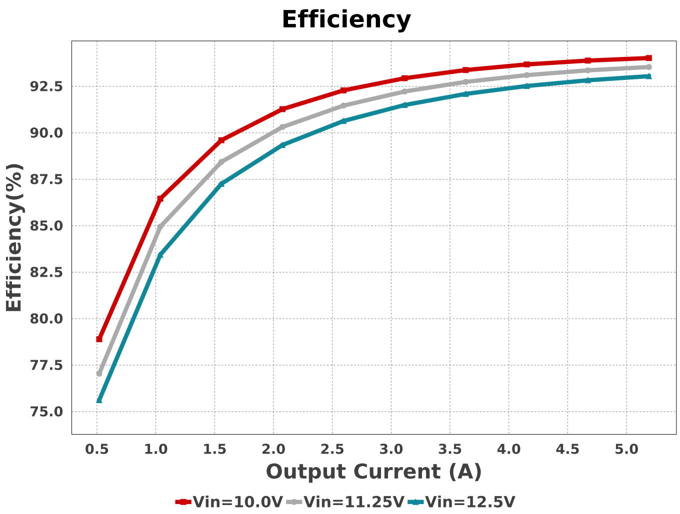

Vout transient requirement used for Cout calculations
2.000000004
2.000000003
2.000000002
2.000000001
2.000000000
1.999999999
1.999999998
1.999999997
1.999999996
1.999999995
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V


Vref
Vref(V)
1.250000005
1.250000004
1.250000003
1.250000002
1.250000001
1.250000000
1.249999999
1.249999998
1.249999997
1.249999996
1.249999995
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V

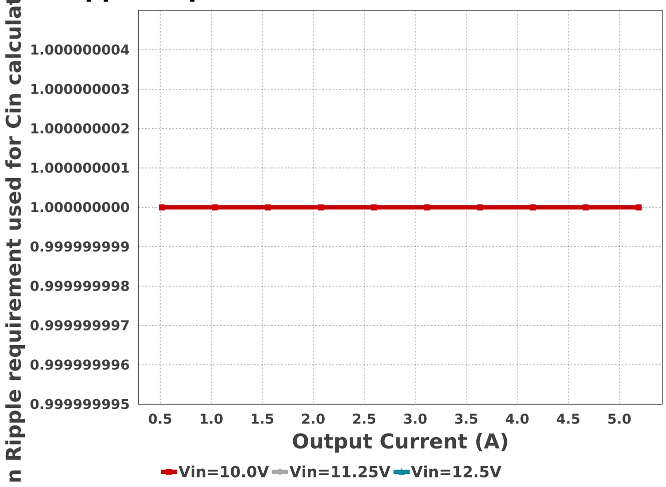

Cin IRMS
Cin IRMS(A)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V


IC Ipk
IC Ipk(A)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V

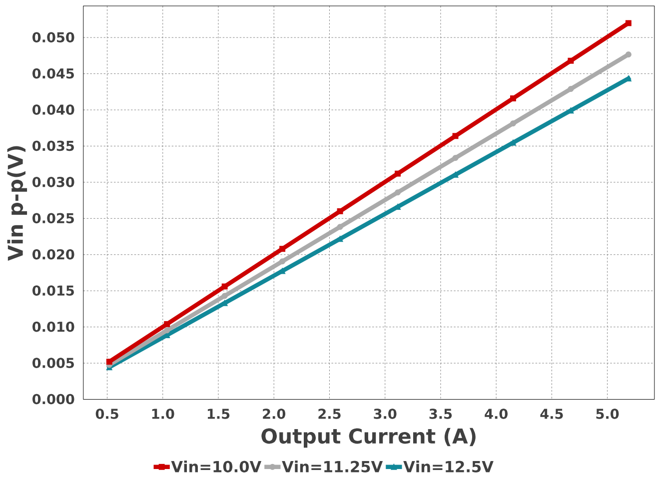

L Pd
L Pd(W)
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V


Efficiency
Efficiency(%)
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V

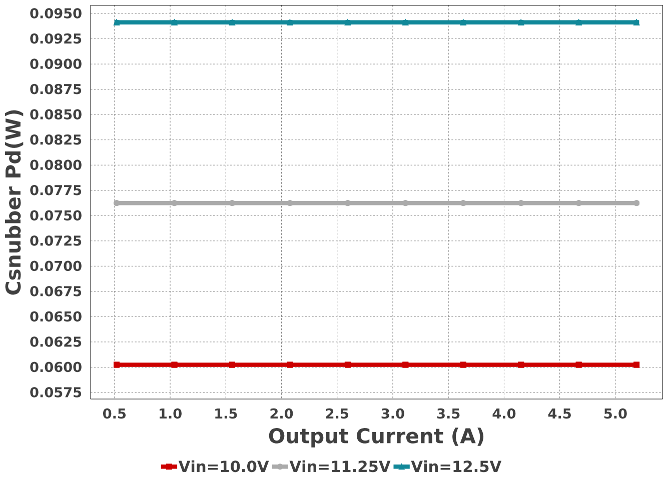
Vin Ripple requirement used for Cin calculations



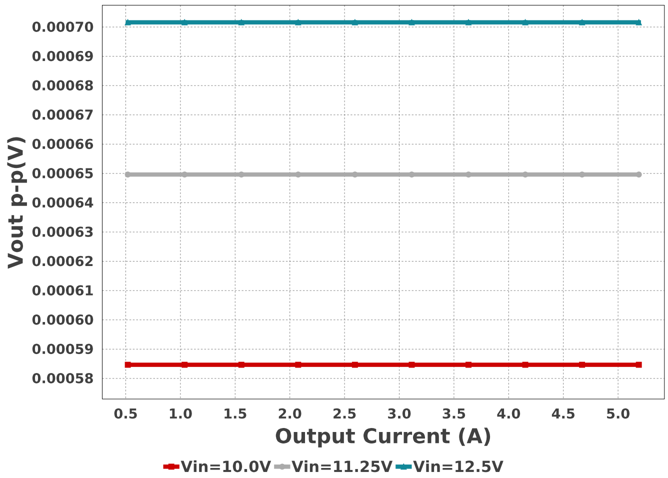
Vin p-p



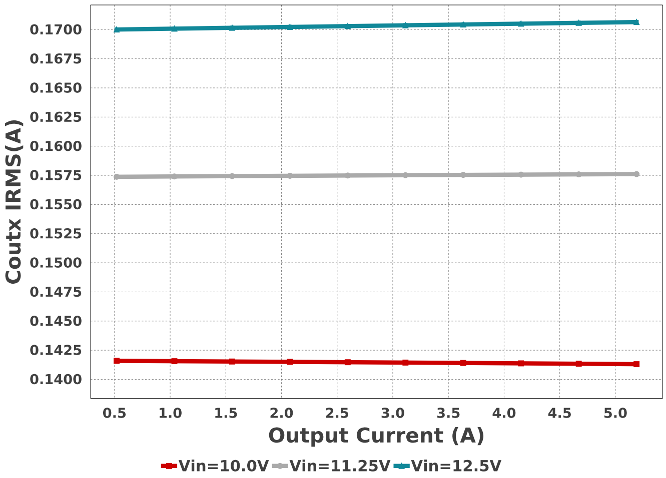
Csnubber Pd



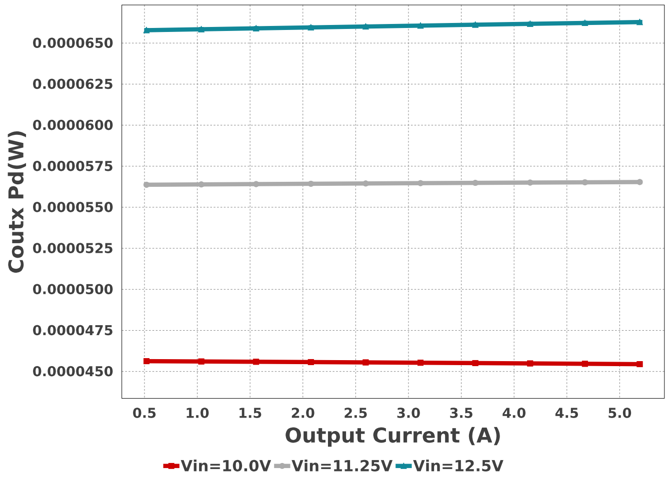
Vout p-p

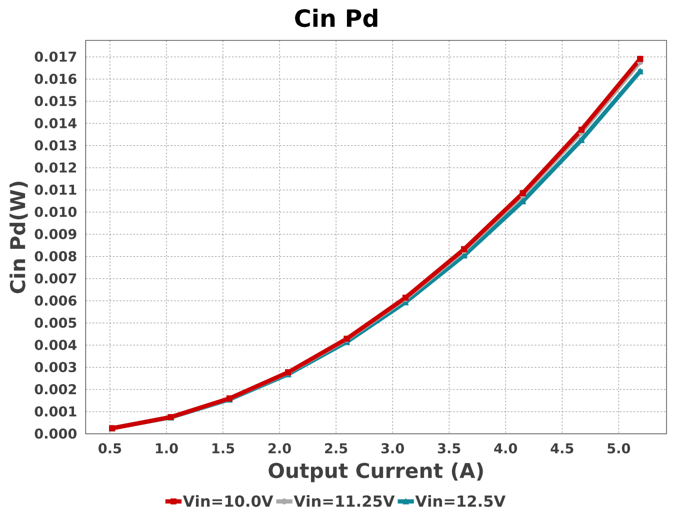


Coutx IRMS

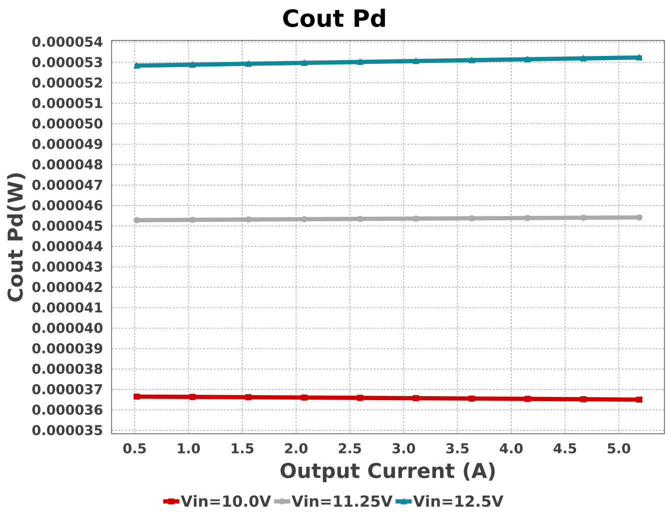


Coutx Pd

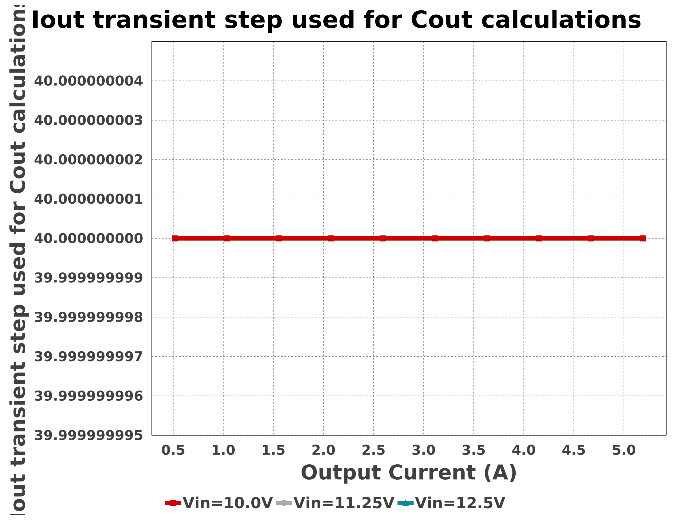




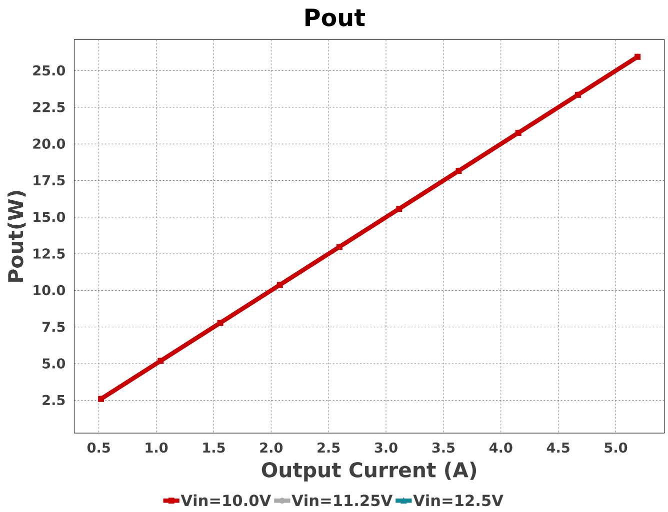
Cin Pd
Cin Pd(W)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V



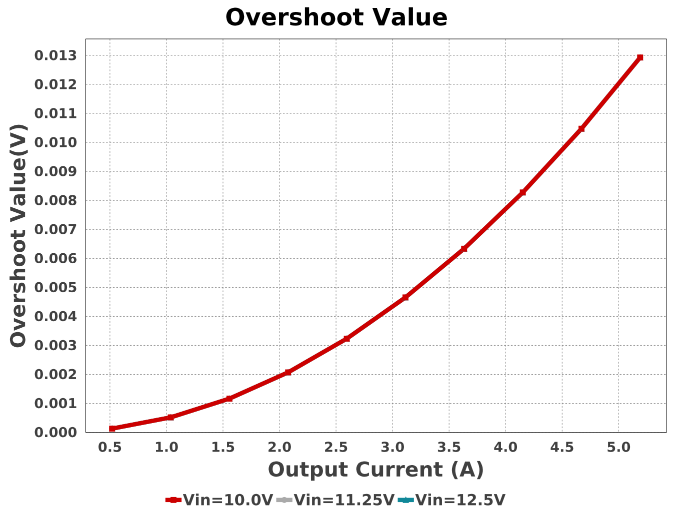
Cout Pd
Cout Pd(W)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V



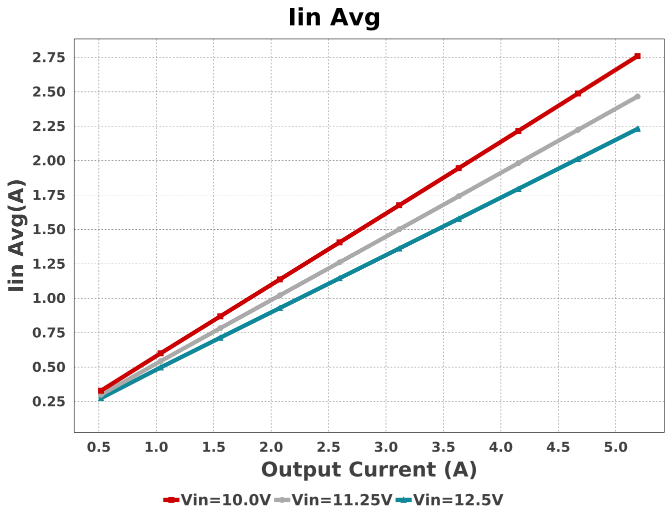
Iout transient step used for Cout calculations
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V



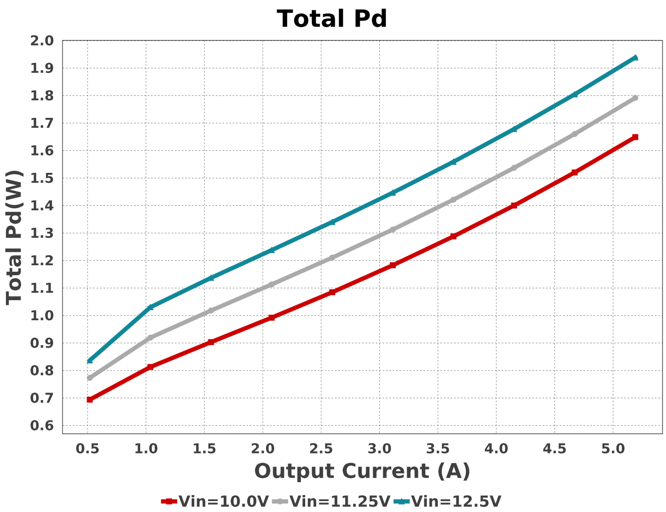
Pout
Pout(W)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V

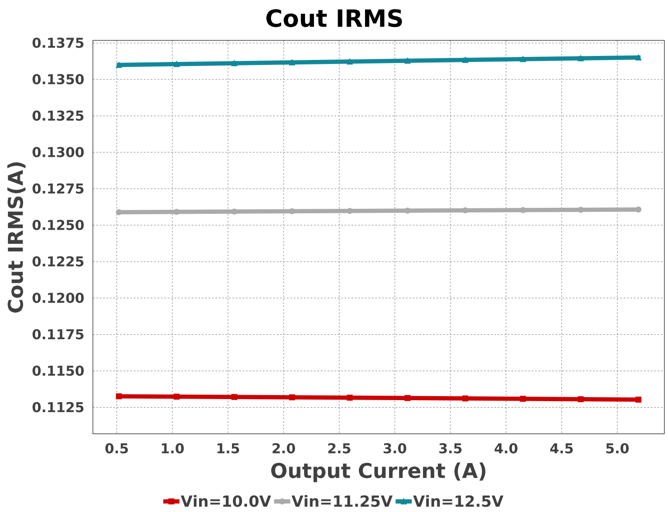


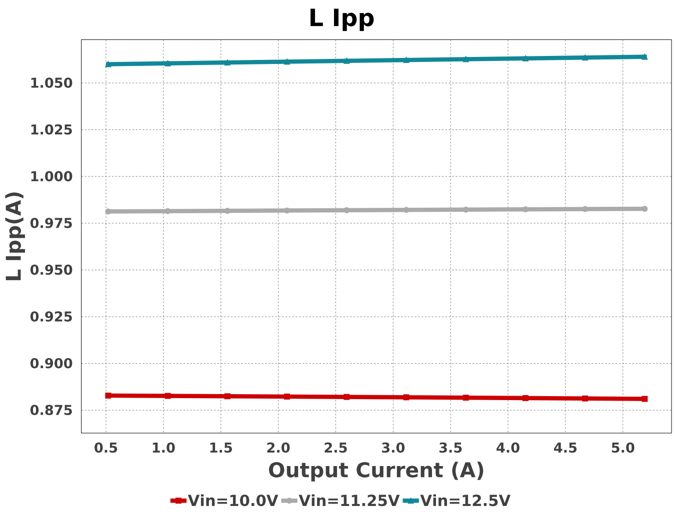
Overshoot Value
Overshoot Value(V)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V

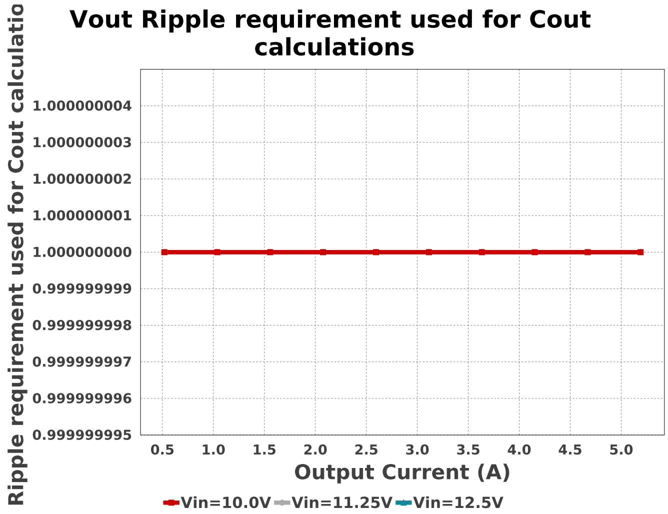


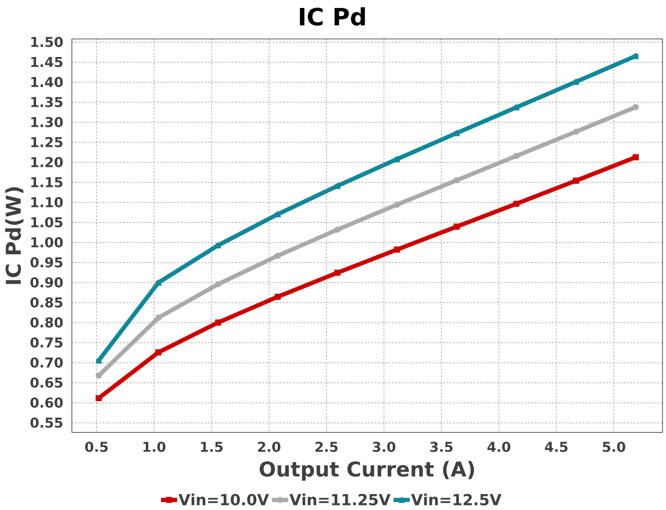
Iin Avg
Iin Avg(A)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V

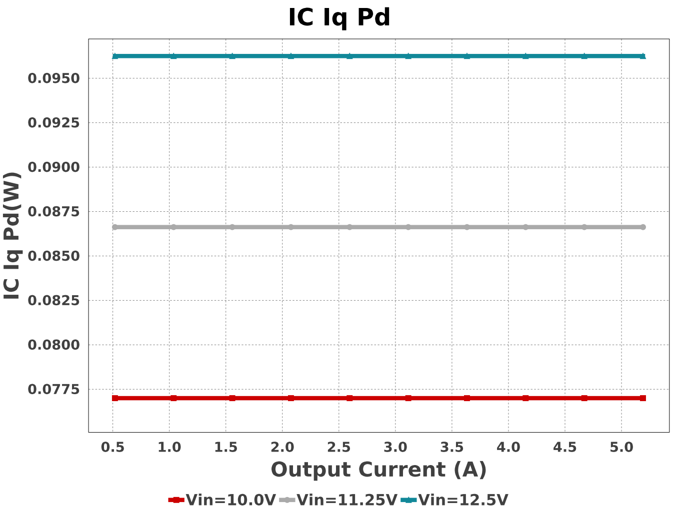

Total Pd
Total Pd(W)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V

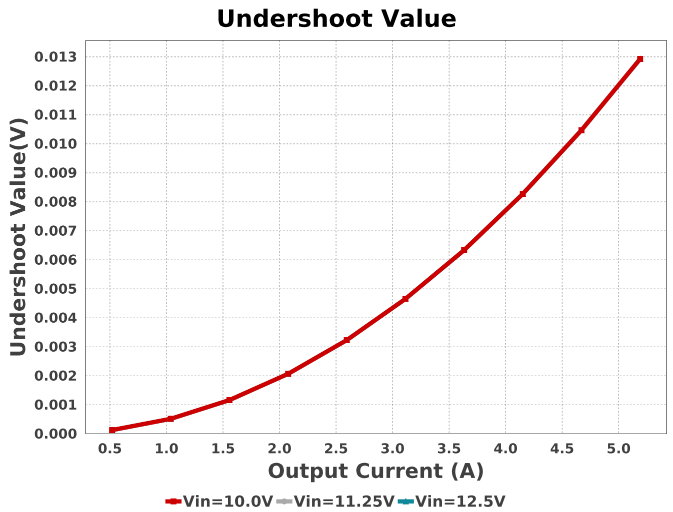

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V

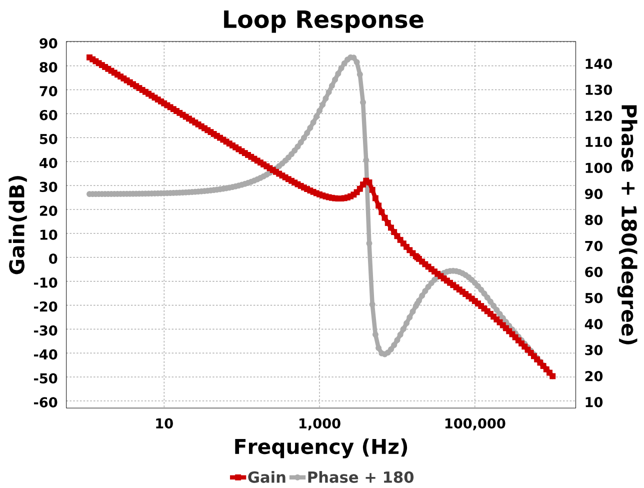

L Ipp
L Ipp(A)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V


Vout Ripple requirement used for Cout calculations
Ripple requirement used for Cout calculatio
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V


IC Pd
IC Pd(W)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V


IC Iq Pd
IC Iq Pd(W)
Output Current (A)
Vin=10.0V Vin=11.25V Vin=12.5V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	54		Total Design BOM count
2.	Total BOM	$24.336		Total BOM Cost
3.	Cin IRMS	2.557 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	16.35 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	136.505 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	53.239 µW	Capacitor	Output capacitor power dissipation
7.	Coutx IRMS	170.646 mA	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	66.278 µW	Capacitor	Output capacitor_x power loss
9.	Csnubber Pd	94.127 mW	Capacitor	Snubber Power Dissipation
10.	IC Ipk	5.722 A	IC	Peak switch current in IC
11.	IC Iq Pd	96.25 mW	IC	IC Iq Pd
12.	IC Pd	1.465 W	IC	IC power dissipation
13.	IC Tj	53.446 degC	IC	IC junction temperature
14.	ICThetaJA Effective	16.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
15.	Iin Avg	2.231 A	IC	Average input current
16.	L Ipp	1.064 A	Inductor	Peak-to-peak inductor ripple current
17.	L Pd	354.1 mW	Inductor	Inductor power dissipation
18.	PMBus Vout Command	2.56 k	PMBus	PMBus Vout Command
19.	PMBus Vout Scale Loop	250.0 m	PMBus	PMBus Vout Scale Loop
20.	Cin Pd	16.35 mW	Power	Input capacitor power dissipation
21.	Cout Pd	53.239 µW	Power	Output capacitor power dissipation
22.	Coutx Pd	66.278 µW	Power	Output capacitor_x power loss
23.	Csnubber Pd	94.127 mW	Power	Snubber Power Dissipation
24.	IC Pd	1.465 W	Power	IC power dissipation
25.	L Pd	354.1 mW	Power	Inductor power dissipation
26.	Total Pd	1.939 W	Power	Total Power Dissipation
27.	Cross Freq	18.108 kHz	System Information	Bode plot crossover frequency
28.	Duty Cycle	40.707 %	System Information	Duty cycle
29.	Efficiency	93.049 %	System Information	Steady state efficiency
30.	FootPrint	1.411 k mm^2	System Information	Total Foot Print Area of BOM components
31.	Frequency	602.41 kHz	System Information	Switching frequency
32.	Gain Marg	-63.18 dB	System Information	Bode Plot Gain Margin
33.	Iout	5.19 A	System Information	Iout operating point
34.	Iout transient step used for Cout calculations	40.0 %	System Information	Custom Transient current step requirement that was used for Cout selection (A).
35.	Low Freq Gain	83.541 dB	System Information	Gain at 1Hz
36.	Mode	CCM	System Information	Conduction Mode
37.	Overshoot Value	12.928 mV	System Information	Theoretical Vout Overshoot Value
38.	Phase Marg	47.956 deg	System Information	Bode Plot Phase Margin

#	Name	Value	Category	Description
39.	Pout	25.95 W	System Information	Total output power
40.	Undershoot Value	12.928 mV	System Information	Theoretical Vout Undershoot Value
41.	Vin	12.5 V	System Information	Vin operating point
42.	Vin Ripple requirement used for Cin calculations	1.0 %	System Information	Custom maximum input ripple requirement that was used for Cin selection(% of Minimum Vin).
43.	Vin p-p	44.342 mV	System Information	Peak-to-peak input voltage
44.	Vout	5.0 V	System Information	Operational Output Voltage
45.	Vout Actual	1.251 V	System Information	Vout Actual calculated based on selected voltage divider resistors
46.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
47.	Vout Tolerance	722.033 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
48.	Vout p-p	701.6 µV	System Information	Peak-to-peak output ripple voltage
49.	Vout transient requirement used for Cout calculations	2.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).
50.	Vref	1.25 V	System Information	Reference voltage

Design Inputs

	Name	Value	Description
	Iout	5.19	Maximum Output Current
	VinMax	12.5	Maximum input voltage
	VinMin	10.0	Minimum input voltage
	Vout	5.0	Output Voltage
	base_pn	TPS544C25	Base Product Number
	source	DC	Input Source Type
	Ta	30.0	Ambient temperature
1.	Vout Sch	5.0	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

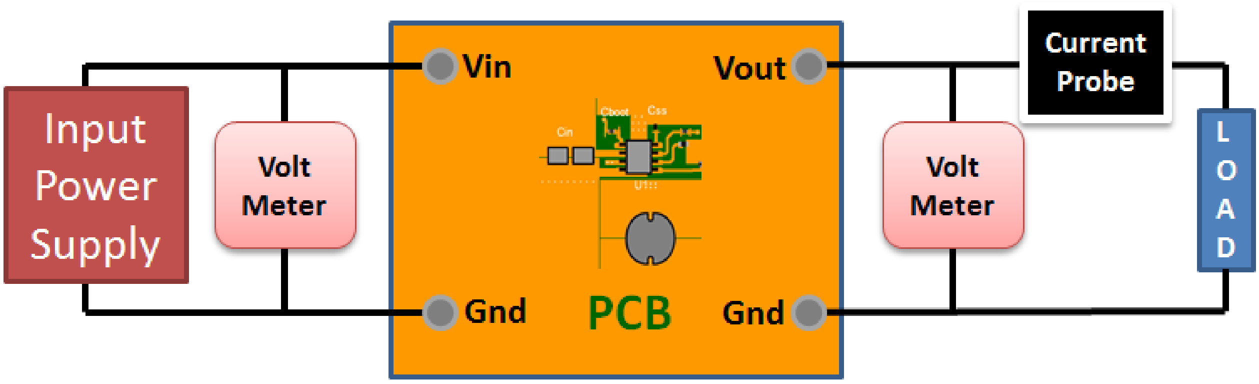
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 : 3575CB9CF11775FD[v1]

2. **TPS544C25** Product Folder : http://www.ti.com/product/TPS544C25 : contains the data sheet and other resources.

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