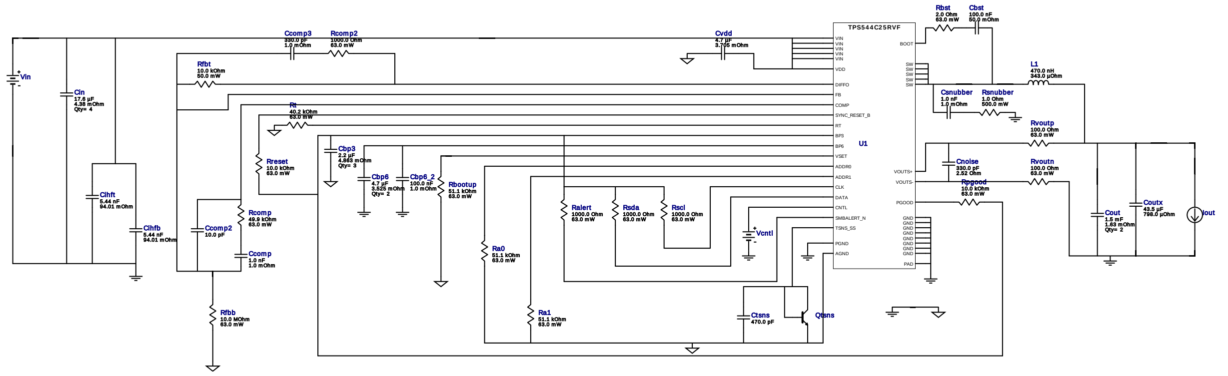
VinMin = 4.5V
VinMax = 18.0V
Vout = 1.0V
Vout Sch = 1.0V
Iout = 12.36A

Device = TPS544C25RVFR
Topology = Buck
Created = 2023-07-24 05:17:49.513
BOM Cost = NA
BOM Count = 43
Total Pd = 2.96W

WEBENCH ® Design Report

Design : 7 TPS544C25RVFR
TPS544C25RVFR 4.5V-18V to 1.00V @ 12.358A



Design Alerts

Component Selection Information

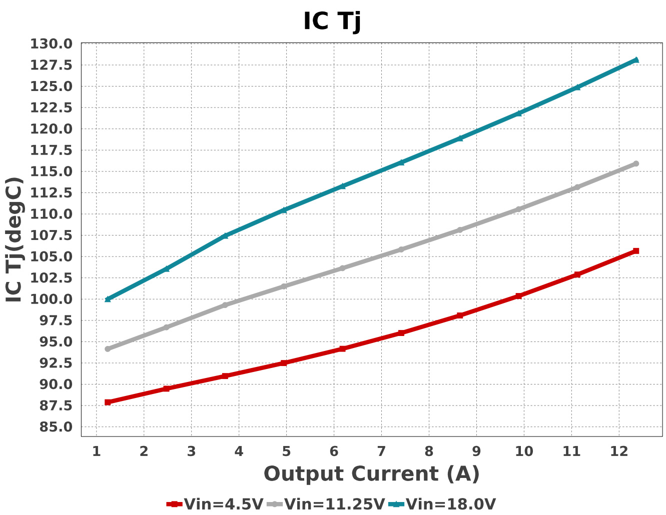
The TPS544C25 is a PMBus(TM) device with key features listed below. PMBus(TM) features marked with * are included in WEBENCH(R) Power Designer. - Adaptive Voltage Scaling (AVS) through VOUT_COMMAND * - Programmable output transition rate* - UVLO*, Soft-Start*, and Soft-Stop - Output voltage and current 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.

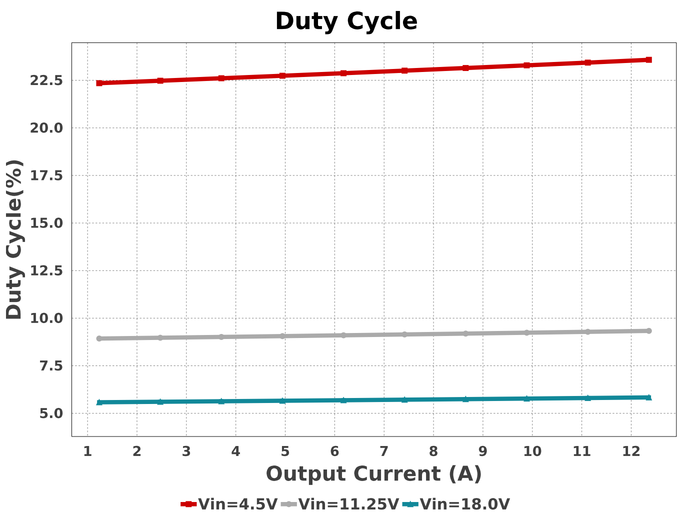
Electrical BOM

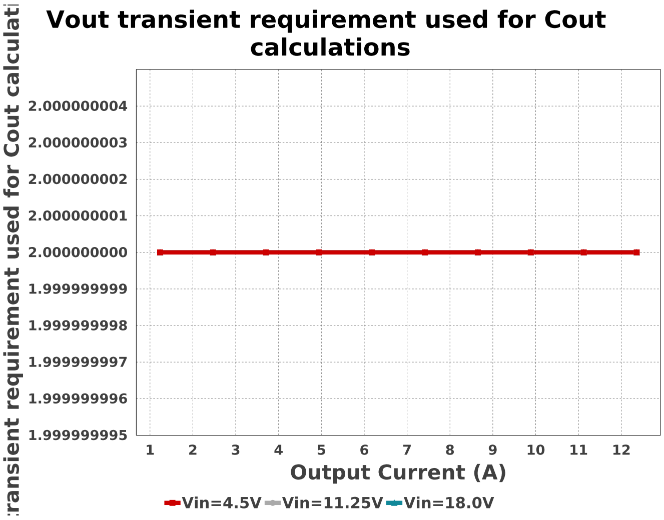
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbp3	TDK	C2012X7R1C225K125AB Series= X7R	Cap= 2.2 uF ESR= 4.863 mOhm VDC= 16.0 V IRMS= 0.0 A	3	NA	0805 7 mm^2
Cbp6	MuRata	GRM31CR61E475KA88L Series= X5R	Cap= 4.7 uF ESR= 3.525 mOhm VDC= 25.0 V IRMS= 2.97852 A	2	$0.10	1206_190 11 mm^2
Cbp6_2	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	AVX	06033C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 50.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Ccomp	MuRata	GRM155R71H102KA01D Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	Kemet	C0402C100J3GACTU Series= C0G/NP0	Cap= 10.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp3	MuRata	GRM155R71H331KA01D Series= X7R	Cap= 330.0 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cihfb	AVX	04025C682KAT2A Series= C0G/NP0	Cap= 5.44 nF ESR= 94.01 mOhm VDC= 50.0 V IRMS= 0.0 A	1	NA	0805 0 mm^2

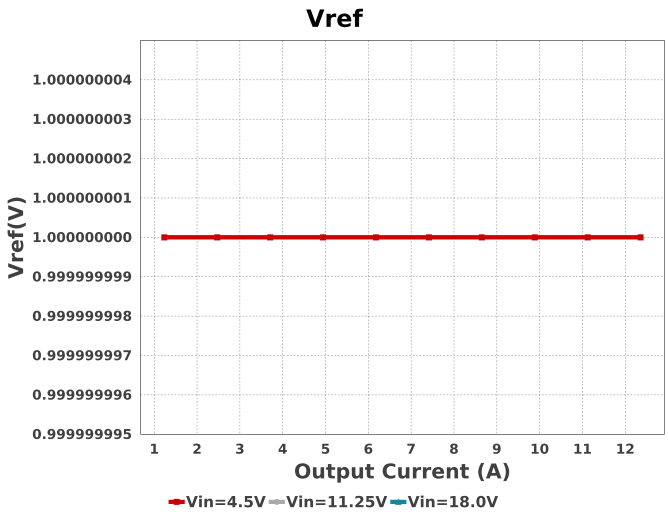
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cihft	AVX	04025C682KAT2A Series= C0G/NP0	Cap= 5.44 nF ESR= 94.01 mOhm VDC= 50.0 V IRMS= 0.0 A	1	NA	0805 0 mm²
Cin	AVX	1206ZC226KAT2A Series= X5R	Cap= 17.6 uF ESR= 4.38 mOhm VDC= 50.0 V IRMS= 4.9 A	4	NA	1206_180 0 mm²
Cnoise	AVX	04025C331K4T2A Series= C0G/NP0	Cap= 330.0 pF ESR= 2.52 Ohm VDC= 50.0 V IRMS= 0.0 A	1	NA	0805 0 mm²
Cout	Kemet	T530X158M2R5ATE005 x2 Series= ?	Cap= 1.5 mF ESR= 1.63 mOhm VDC= 10.0 V IRMS= 1.058 A	2	NA	CUSTOM 0 mm²
Coutx	AVX	1206ZC226KAT2A x2 + 0603ZC224KAT2A x2 Series= X7R	Cap= 43.5 uF ESR= 798.0 uOhm VDC= 6.3 V IRMS= 5.302 A	1	NA	1206_180 0 mm²
Csnubber	MuRata	GRM1885C1H102JA01D Series= C0G/NP0	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Ctsns	Samsung Electro-Mechanics	CL21C471JBANNNC Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cvdd	MuRata	GRM31CR71C475KA01L Series= X7R	Cap= 4.7 uF ESR= 3.705 mOhm VDC= 16.0 V IRMS= 3.0989 A	1	$0.08	1206_190 11 mm²
L1	Wurth Elektronik	744301047	L= 470.0 nH 343.0 µOhm	1	$1.36	WE-HCM_1190 173 mm²
Qtsns	Fairchild Semiconductor	MMBT3904	Bipolar Transistor	1	$0.06	SOT-23 14 mm²
Ra0	Vishay-Dale	CRCW040251K1FKED Series= CRCW..e3	Res= 51.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Ra1	Vishay-Dale	CRCW040251K1FKED Series= CRCW..e3	Res= 51.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Ralert	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rbootup	Vishay-Dale	CRCW040251K1FKED Series= CRCW..e3	Res= 51.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rbst	Vishay-Dale	CRCW04022R00FKED Series= CRCW..e3	Res= 2.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rcomp	Vishay-Dale	CRCW040249K9FKED Series= CRCW..e3	Res= 49.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rcomp2	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Vishay-Dale	CRCW040210M0FKED Series= CRCW..e3	Res= 10.0 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²

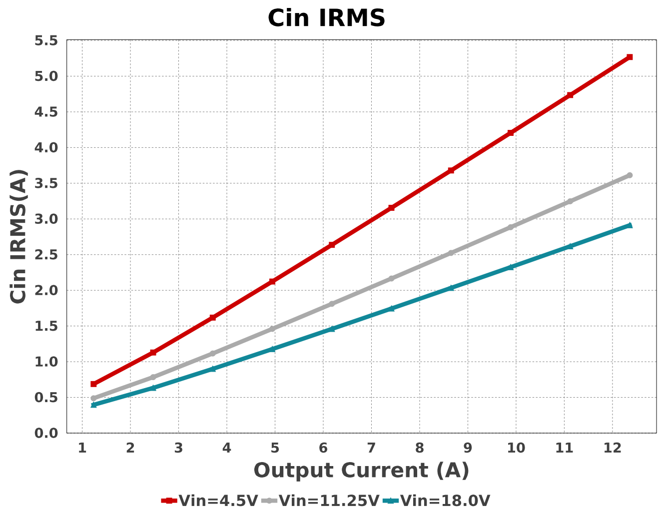
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rpgood	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rreset	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rscl	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
Rsnubber	Stackpole Electronics Inc	CSR1206FT1R00 Series= ?	Res= 1.0 Ohm Power= 500.0 mW Tolerance= 1.0%	1	$0.04	1206 11 mm^2
Rt	Vishay-Dale	CRCW040240K2FKED Series= CRCW..e3	Res= 40.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvoutn	Vishay-Dale	CRCW0402100RFKED Series= CRCW..e3	Res= 100.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvoutp	Vishay-Dale	CRCW0402100RFKED Series= CRCW..e3	Res= 100.0 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

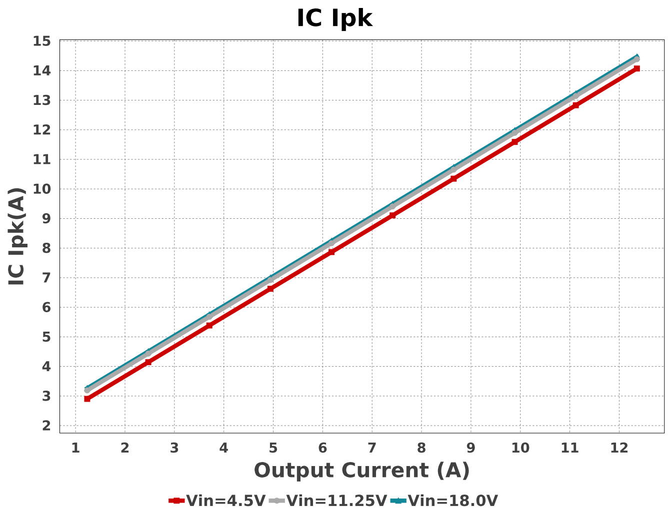


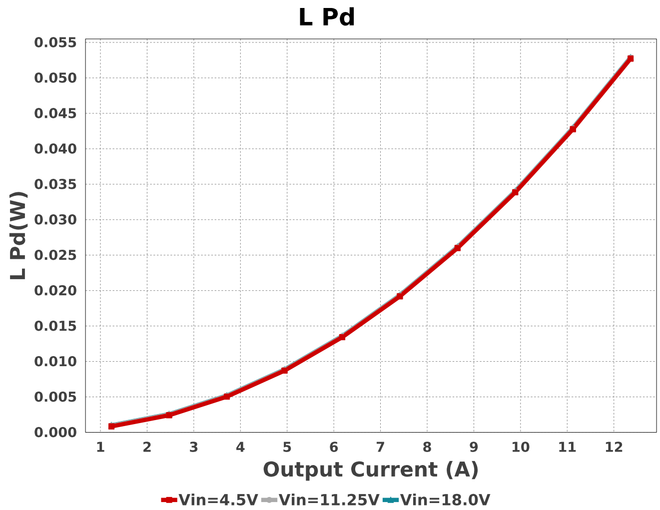


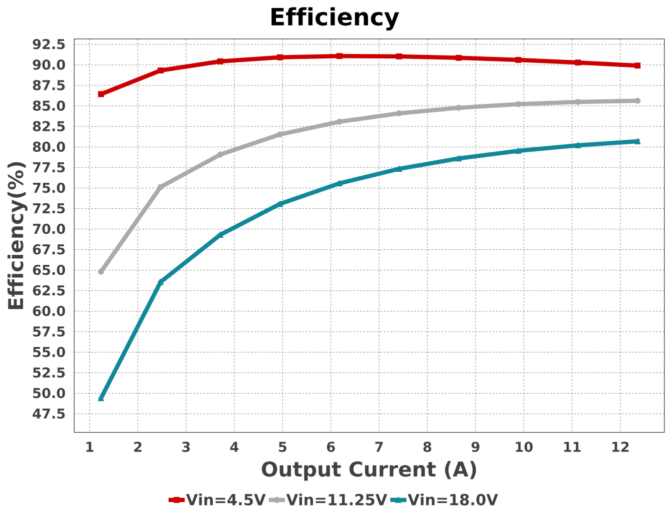

Vout transient requirement used for Cout calculations
ransient requirement used for Cout calculati
2.000000004
2.000000003
2.000000002
2.000000001
2.000000000
1.999999999
1.999999998
1.999999997
1.999999996
1.999999995
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

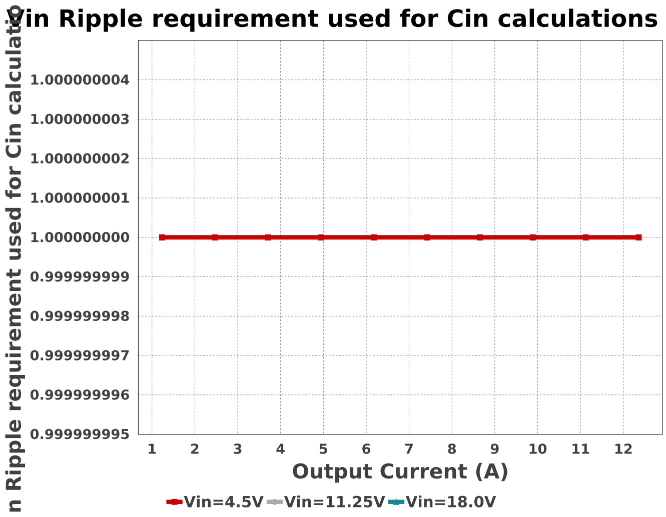

Vref
Vref(V)
1.000000004
1.000000003
1.000000002
1.000000001
1.000000000
0.999999999
0.999999998
0.999999997
0.999999996
0.999999995
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

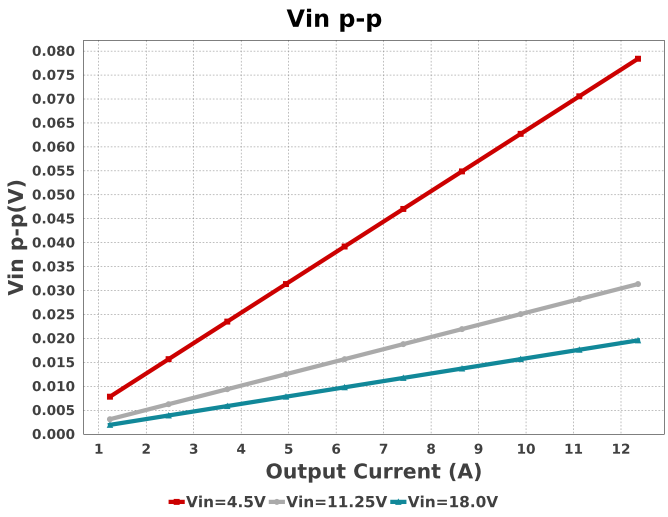

Cin IRMS
Cin IRMS(A)
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

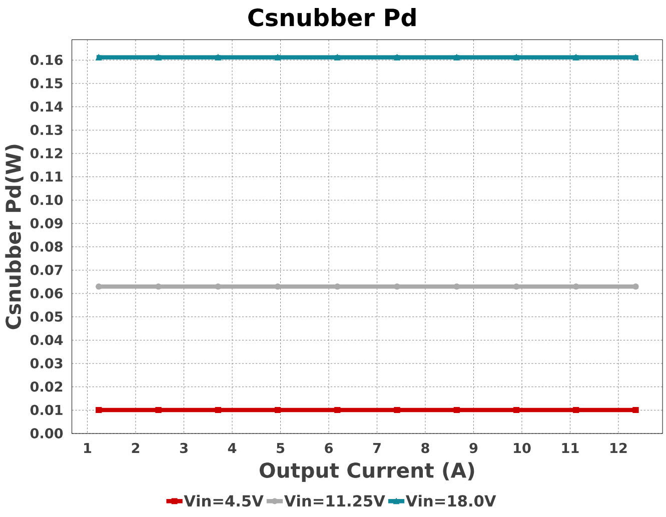

IC Ipk
IC Ipk(A)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

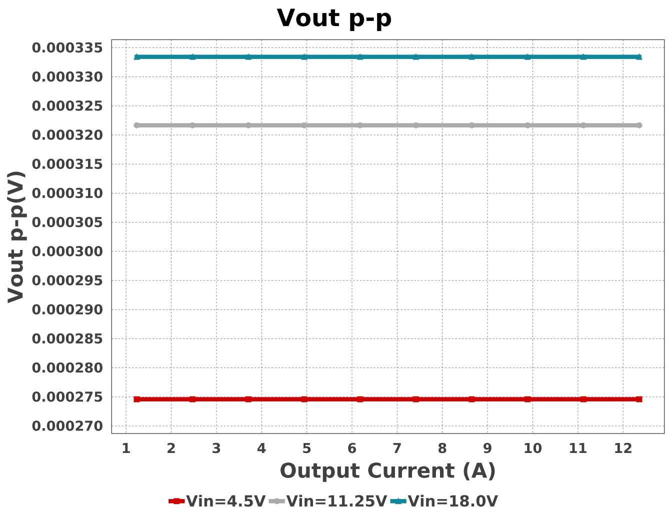

L Pd
L Pd(W)
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

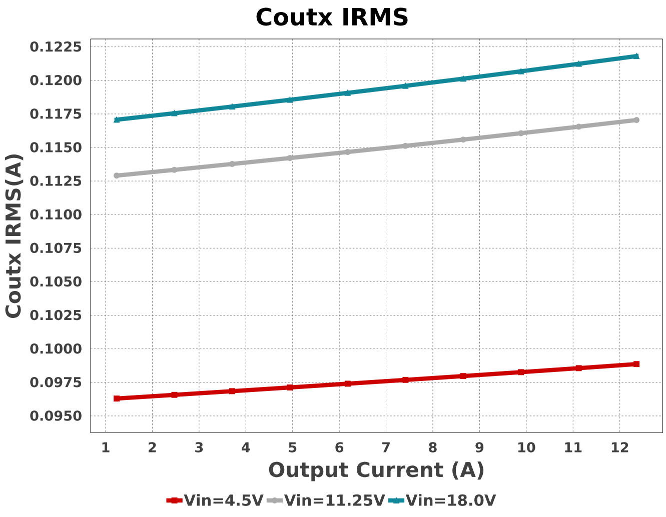

Efficiency
Efficiency(%)
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
65.0
62.5
60.0
57.5
55.0
52.5
50.0
47.5
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

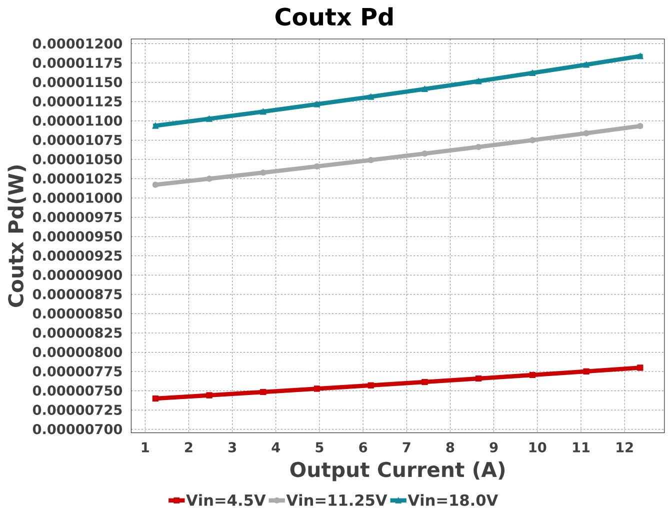

Vin Ripple requirement used for Cin calculations
1.000000004
1.000000003
1.000000002
1.000000001
1.000000000
0.999999999
0.999999998
0.999999997
0.999999996
0.999999995
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

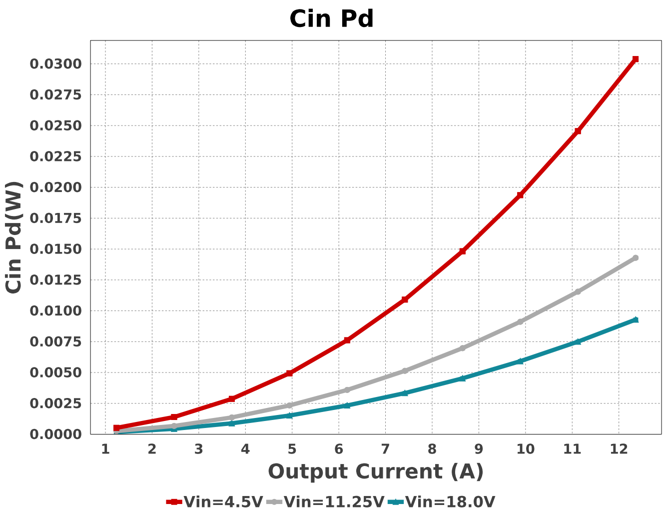

Vin p-p
Vin p-p(V)
0.080 0.075 0.070 0.065 0.060 0.055 0.050 0.045 0.040 0.035 0.030 0.025 0.020 0.015 0.010 0.005 0.000
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

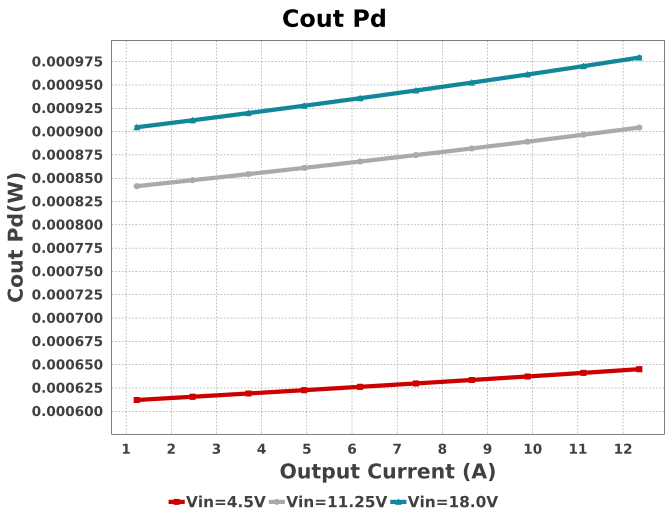

Csnubber Pd
Csnubber Pd(W)
0.16 0.15 0.14 0.13 0.12 0.11 0.10 0.09 0.08 0.07 0.06 0.05 0.04 0.03 0.02 0.01 0.00
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

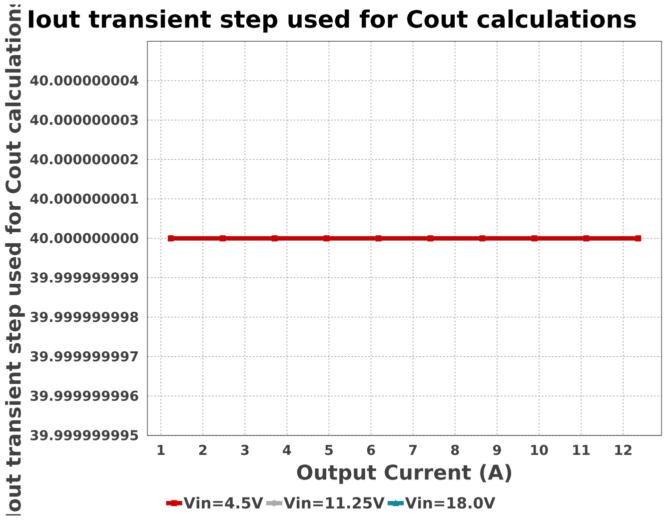

Vout p-p
Vout p-p(V)
0.000335 0.000330 0.000325 0.000320 0.000315 0.000310 0.000305 0.000300 0.000295 0.000290 0.000285 0.000280 0.000275 0.000270
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

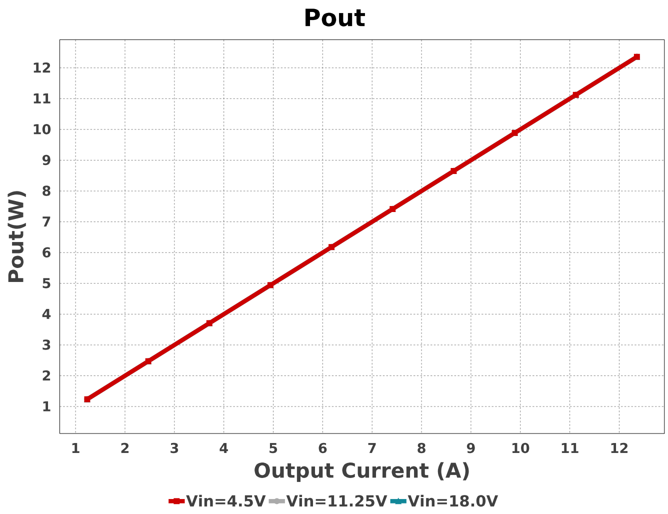

Coutx IRMS
Coutx IRMS(A)
0.1225 0.1200 0.1175 0.1150 0.1125 0.1100 0.1075 0.1050 0.1025 0.1000 0.0975 0.0950
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

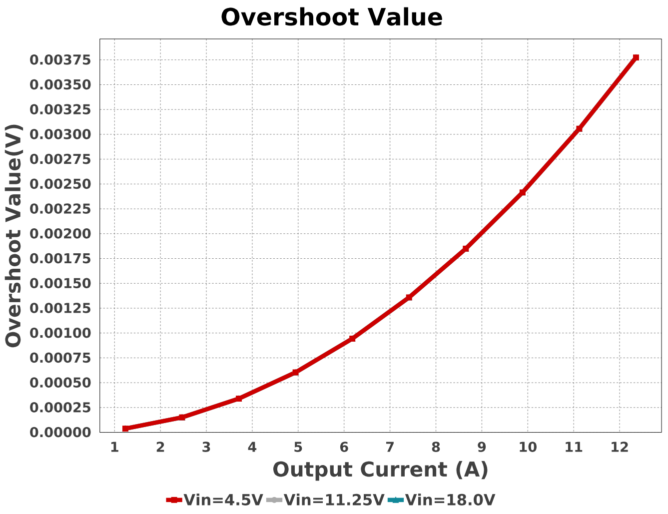

Coutx Pd
Coutx Pd(W)
0.00001200 0.00001175 0.00001150 0.00001125 0.00001100 0.00001075 0.00001050 0.00001025 0.00001000 0.00000975 0.00000950 0.00000925 0.00000900 0.00000875 0.00000850 0.00000825 0.00000800 0.00000775 0.00000750 0.00000725 0.00000700
1 2 3 4 5 6 7 8 9 10 11 12
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

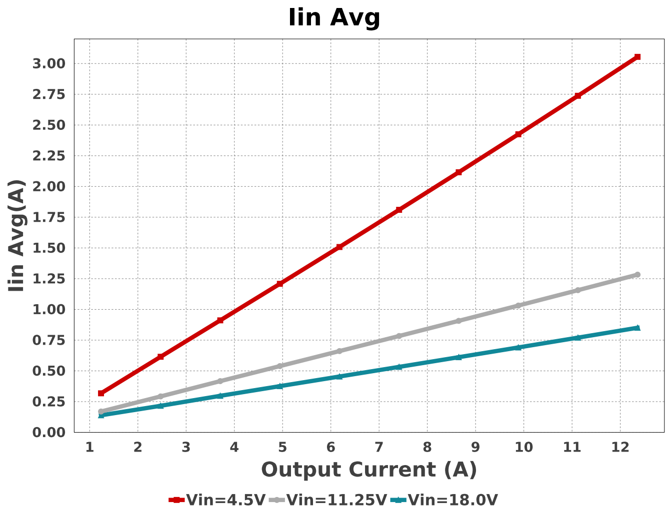

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

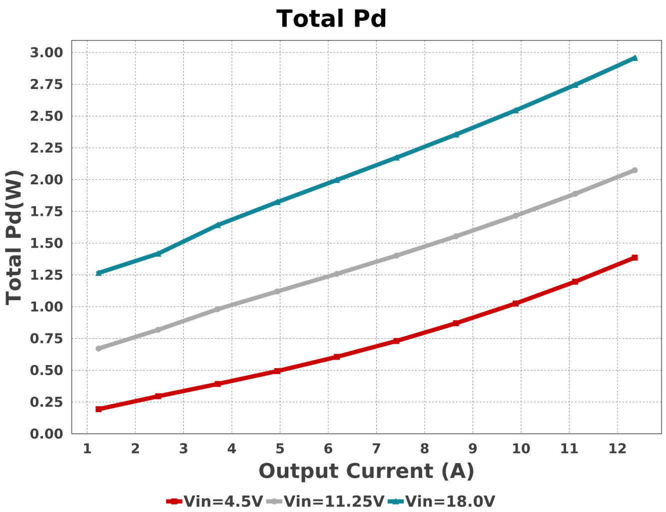

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

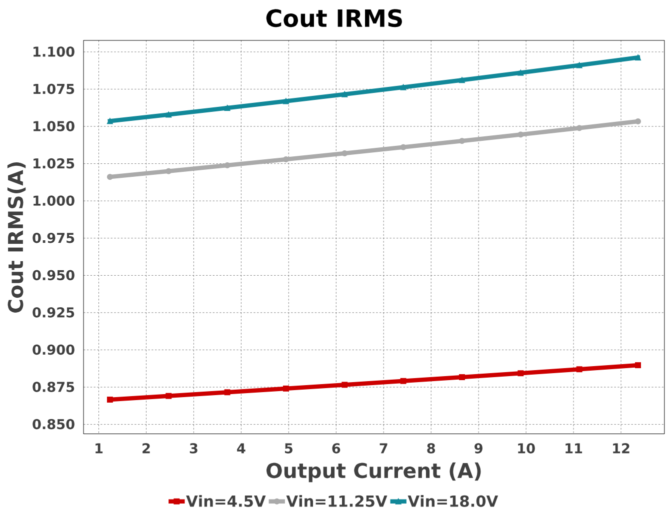

Iout transient step used for Cout calculations
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

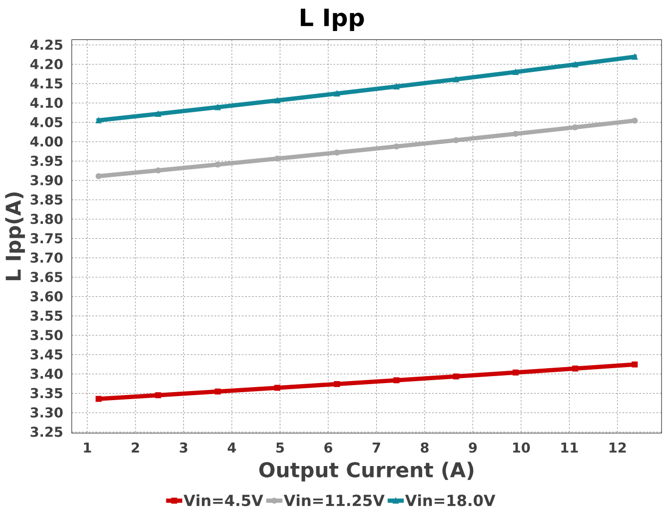

Pout
Pout(W)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

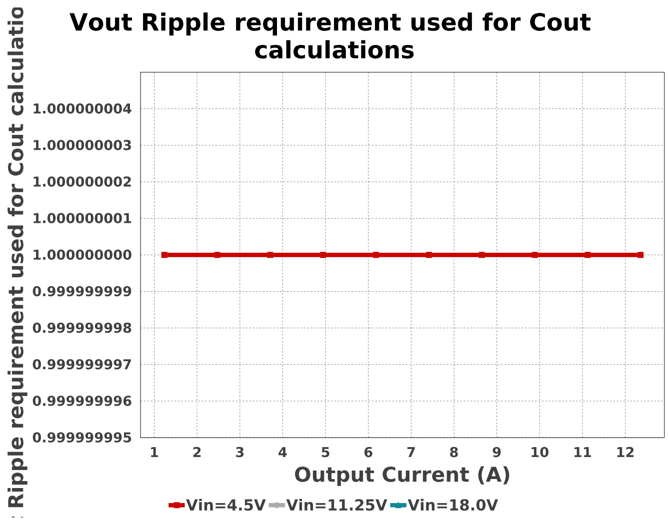

Overshoot Value
Overshoot Value(V)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

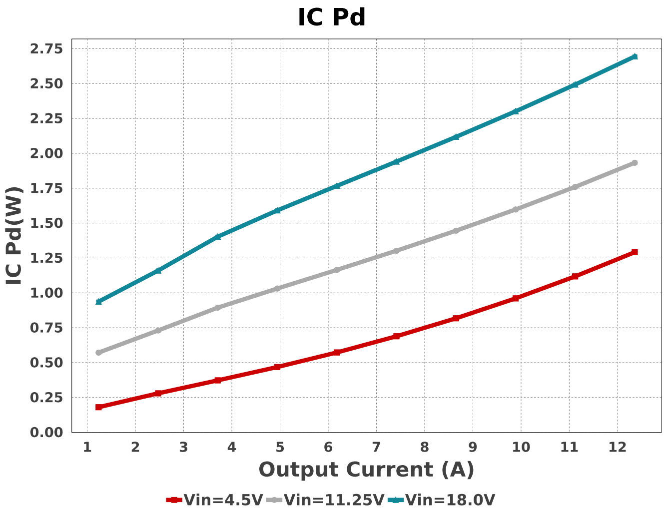

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

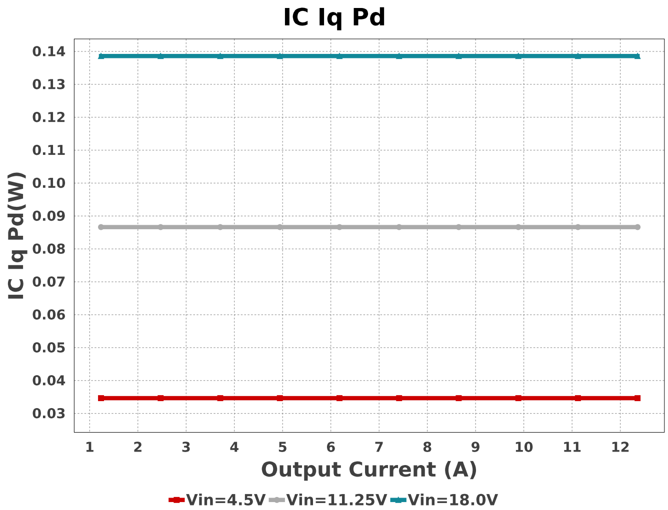

Total Pd
Total Pd(W)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

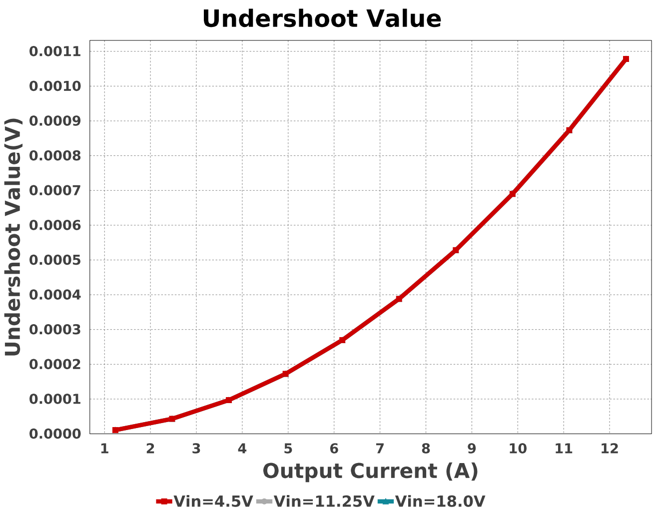

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V

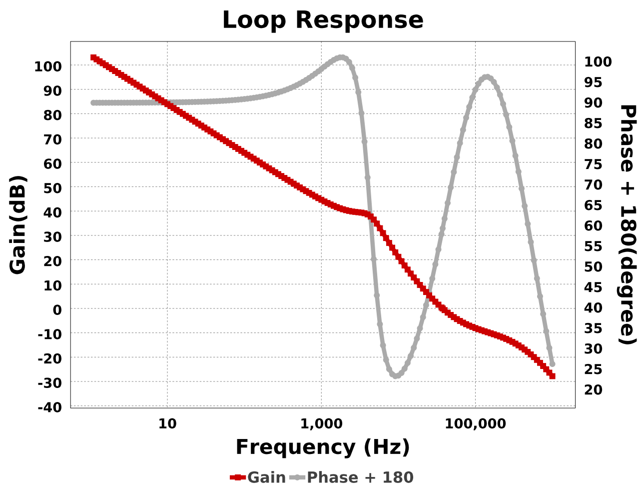

L Ipp
L Ipp(A)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V


Vout Ripple requirement used for Cout calculations
Ripple requirement used for Cout calculatio
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V


IC Iq Pd
IC Iq Pd(W)
Output Current (A)
Vin=4.5V Vin=11.25V Vin=18.0V





Operating Values

#	Name	Value	Category	Description
1.	BOM Count	43		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	2.912 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	9.284 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	1.096 A	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	979.41 µW	Capacitor	Output capacitor power dissipation
7.	Coutx IRMS	121.809 mA	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	11.84 µW	Capacitor	Output capacitor_x power loss
9.	Csnubber Pd	161.19 mW	Capacitor	Snubber Power Dissipation
10.	IC Ipk	14.468 A	IC	Peak switch current in IC
11.	IC Iq Pd	138.6 mW	IC	IC Iq Pd
12.	IC Pd	2.694 W	IC	IC power dissipation
13.	IC Tj	128.107 degC	IC	IC junction temperature
14.	ICThetaJA Effective	16.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
15.	Iin Avg	850.85 mA	IC	Average input current
16.	L Ipp	4.219 A	Inductor	Peak-to-peak inductor ripple current
17.	L Pd	52.892 mW	Inductor	Inductor power dissipation
18.	PMBus Vout Command	512.0	PMBus	PMBus Vout Command
19.	PMBus Vout Scale Loop	1.0	PMBus	PMBus Vout Scale Loop
20.	Cin Pd	9.284 mW	Power	Input capacitor power dissipation
21.	Cout Pd	979.41 µW	Power	Output capacitor power dissipation
22.	Coutx Pd	11.84 µW	Power	Output capacitor_x power loss
23.	Csnubber Pd	161.19 mW	Power	Snubber Power Dissipation
24.	IC Pd	2.694 W	Power	IC power dissipation
25.	L Pd	52.892 mW	Power	Inductor power dissipation
26.	Total Pd	2.957 W	Power	Total Power Dissipation
27.	Cross Freq	37.599 kHz	System Information	Bode plot crossover frequency
28.	Duty Cycle	5.835 %	System Information	Duty cycle
29.	Efficiency	80.692 %	System Information	Steady state efficiency
30.	FootPrint	564.0 mm^2	System Information	Total Foot Print Area of BOM components
31.	Frequency	497.512 kHz	System Information	Switching frequency
32.	Gain Marg	-35.74 dB	System Information	Bode Plot Gain Margin
33.	Iout	12.358 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	103.12 dB	System Information	Gain at 1Hz
36.	Mode	CCM	System Information	Conduction Mode
37.	Overshoot Value	3.773 mV	System Information	Theoretical Vout Overshoot Value
38.	Phase Marg	59.391 deg	System Information	Bode Plot Phase Margin

#	Name	Value	Category	Description
39.	Pout	12.358 W	System Information	Total output power
40.	Undershoot Value	1.078 mV	System Information	Theoretical Vout Undershoot Value
41.	Vin	18.0 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	19.602 mV	System Information	Peak-to-peak input voltage
44.	Vout	1.0 V	System Information	Operational Output Voltage
45.	Vout Actual	1.001 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	902.036 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
48.	Vout p-p	333.432 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	1.0 V	System Information	Reference voltage

Design Inputs

	Name	Value	Description
	Iout	12.358	Maximum Output Current
	VinMax	18.0	Maximum input voltage
	VinMin	4.5	Minimum input voltage
	VinTyp	12.0	Typical input voltage
	Vout	1.0	Output Voltage
	base_pn	TPS544C25	Base Product Number
	source	DC	Input Source Type
	Ta	85.0	Ambient temperature
	UserFsw	498.0 k	Customer Selected Frequency
1.	Vout Sch	1.0	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

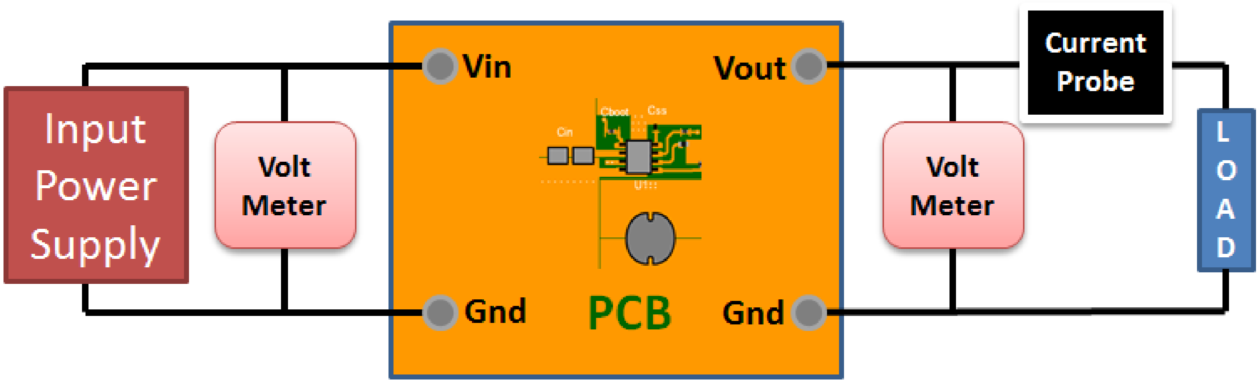
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.5V 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 : 892177D0ECBDD44413F0965774ADE44F[v1]

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

Important Notice and Disclaimer

TI provides technical and reliability data (including datasheets), design resources (including reference designs), application or other design advice, web tools, safety information, and other resources AS IS and with all faults, and disclaims all warranties. These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

Providing these resources does not expand or otherwise alter TI's applicable Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with TI products.