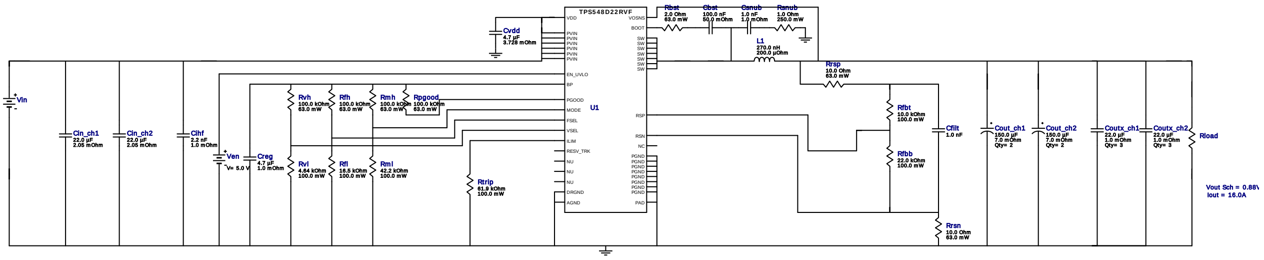
VinMin = 12.0V
VinMax = 12.0V
Vout = 0.88V
Vout Sch = 0.88V
Iout = 16.0A

Device = TPS548D22RVFR
Topology = Buck
Created = 2023-12-18 02:22:30.090
BOM Cost = $8.80
BOM Count = 34
Total Pd = 1.95W

WEBENCH ® Design Report

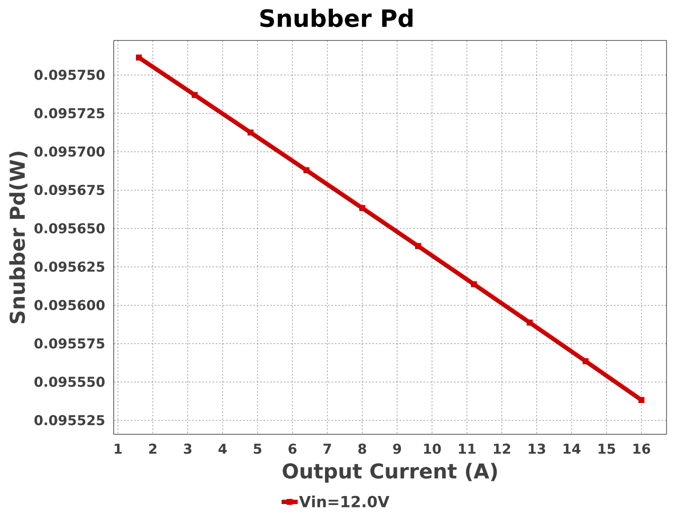
Design : 98 TPS548D22RVFR
TPS548D22RVFR 12V-12V to .88V @ 16A

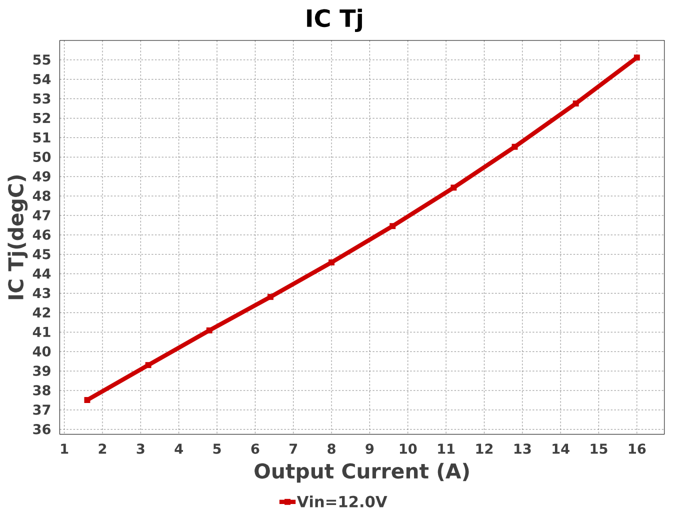


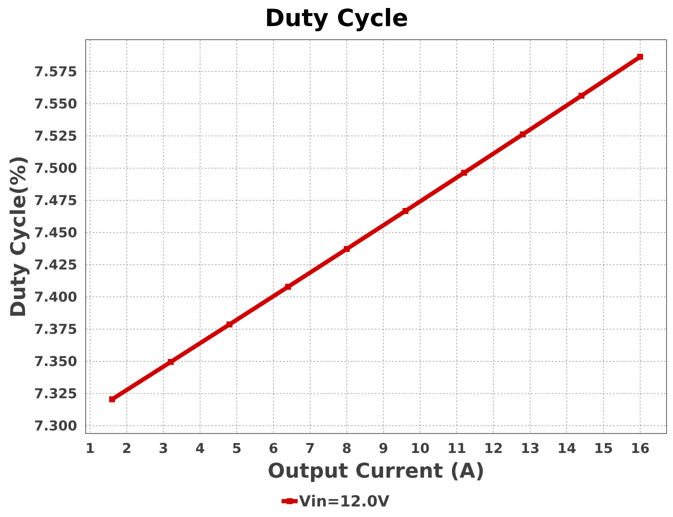
Electrical BOM

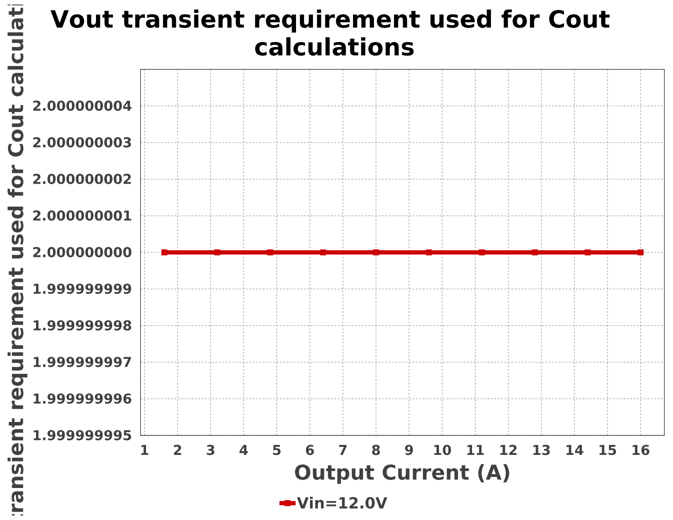
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	AVX	06033C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 50.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cfilt	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cihf	MuRata	GRM155R71E222KA01D Series= X7R	Cap= 2.2 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin_ch1	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	1	$0.31	0805 7 mm^2
Cin_ch2	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	1	$0.31	0805 7 mm^2
Cout_ch1	Panasonic	EEFSX0G151E7 Series= SX	Cap= 150.0 uF ESR= 7.0 mOhm VDC= 4.0 V IRMS= 7.0 A	2	$0.85	7343-20 59 mm^2
Cout_ch2	Panasonic	EEFSX0G151E7 Series= SX	Cap= 150.0 uF ESR= 7.0 mOhm VDC= 4.0 V IRMS= 7.0 A	2	$0.85	7343-20 59 mm^2
Coutx_ch1	MuRata	GRM188R60J226MEA0D Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	3	$0.04	0603 5 mm^2
Coutx_ch2	MuRata	GRM188R60J226MEA0D Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	3	$0.04	0603 5 mm^2
Creg	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
Csnub	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 mm^2

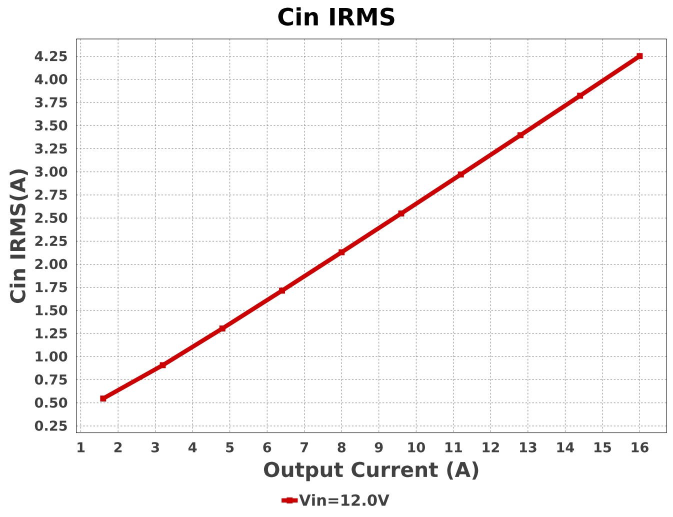
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvdd	TDK	C1608X5R1V475K080AC Series= X5R	Cap= 4.7 uF ESR= 3.728 mOhm VDC= 35.0 V IRMS= 2.69359 A	1	$0.10	0603 5 mm^2
L1	Coilcraft	SLC1175-271MEB	L= 270.0 nH 200.0 µOhm	1	$0.48	SLC1175 125 mm^2
Rbst	Vishay-Dale	CRCW04022R00FKED Series= CRCW..e3	Res= 2.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Susumu Co Ltd	RG1608P-223-B-T5 Series= RG1608	Res= 22.0 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.04	0603 5 mm^2
Rfbt	Yageo	RT0603BRD0710KL Series= ?	Res= 10.0 kOhm Power= 100.0 mW Tolerance= 0.1%	1	$0.04	0603 5 mm^2
Rfh	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfl	Yageo	RC0603FR-0716K5L Series= ?	Res= 16.5 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rmh	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rml	Vishay-Dale	CRCW060342K2FKEA Series= CRCW..e3	Res= 42.2 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rpgood	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rrsn	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rrsp	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rsnub	Vishay-Dale	CRCW12061R00FKEA Series= CRCW..e3	Res= 1.0 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rtrip	Yageo	RC0603FR-0761K9L Series= ?	Res= 61.9 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rvh	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvl	Yageo	RC0603FR-074K64L Series= ?	Res= 4.64 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	TPS548D22RVFR	Switcher	1	$3.66	RVF0040A 63 mm^2

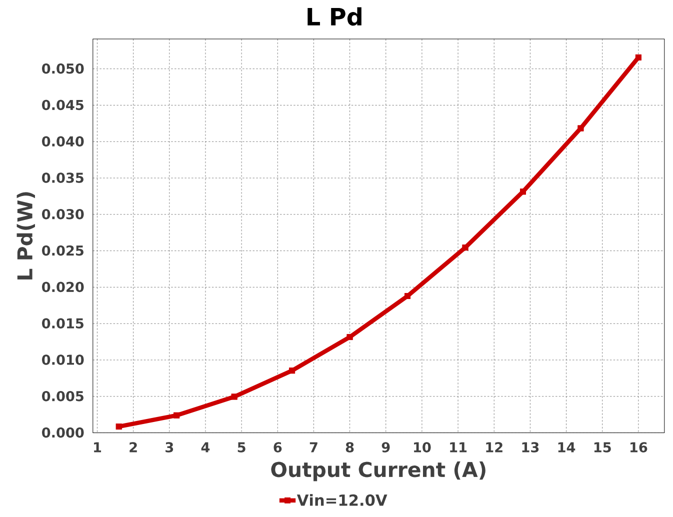

Snubber Pd
Snubber Pd(W)
Output Current (A)
Vin=12.0V

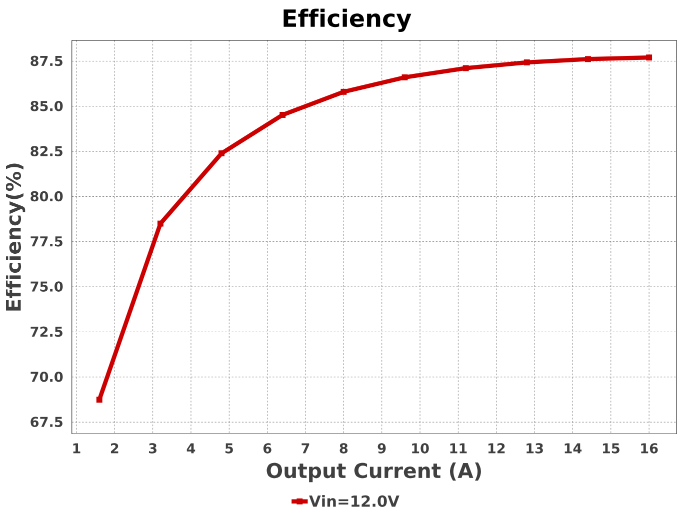

IC Tj
IC Tj(degC)
Output Current (A)
Vin=12.0V

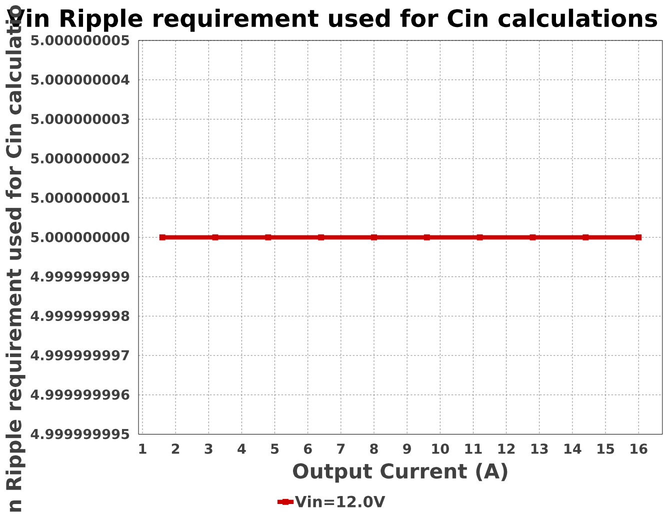

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=12.0V

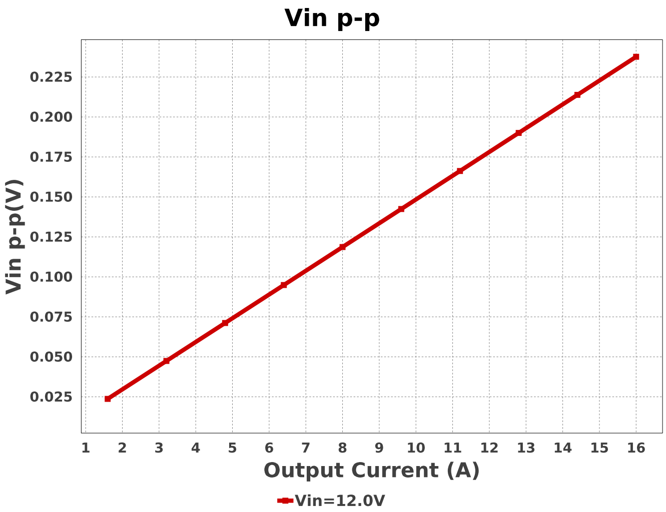

Vout transient requirement used for Cout calculations
ransient requirement used for Cout calculati
Output Current (A)
Vin=12.0V

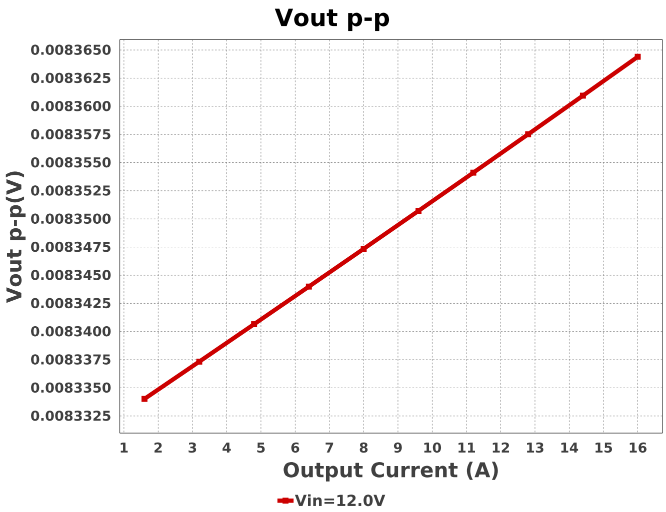

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=12.0V

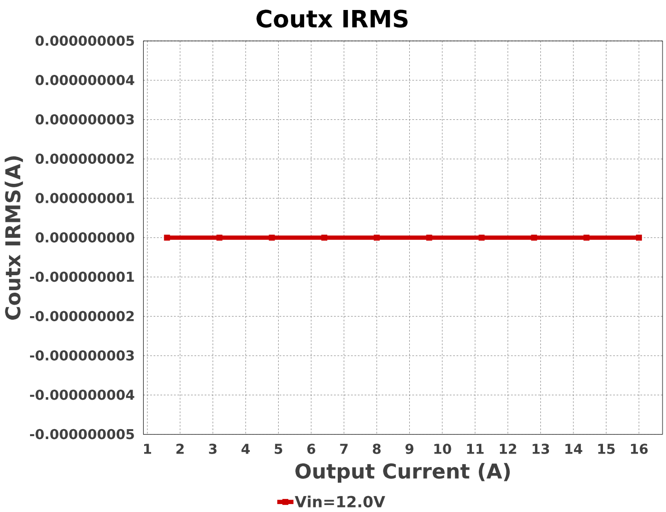

L Pd
L Pd(W)
Output Current (A)
Vin=12.0V

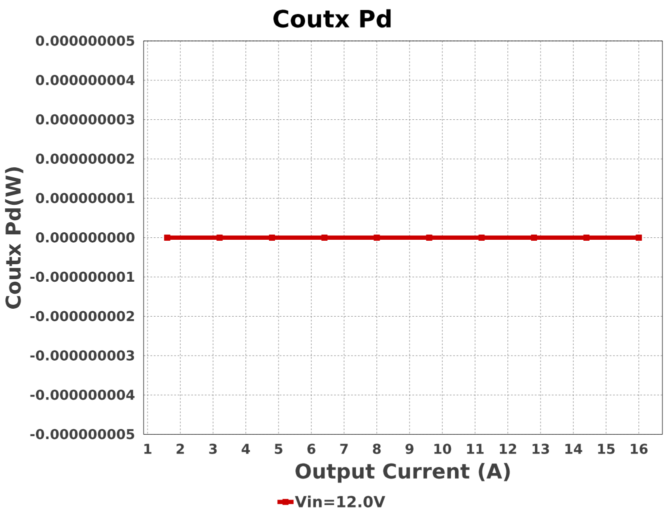

Efficiency
Efficiency(%)
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
67.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

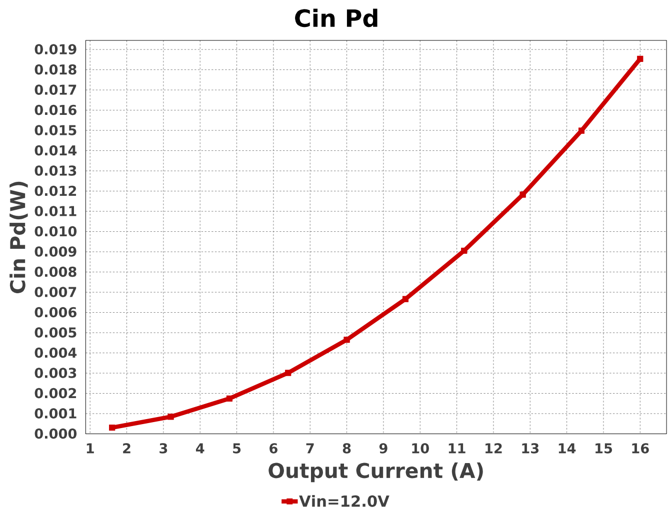

Vin Ripple requirement used for Cin calculations
n Ripple requirement used for Cin calculatio
5.000000005
5.000000004
5.000000003
5.000000002
5.000000001
5.000000000
4.999999999
4.999999998
4.999999997
4.999999996
4.999999995
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

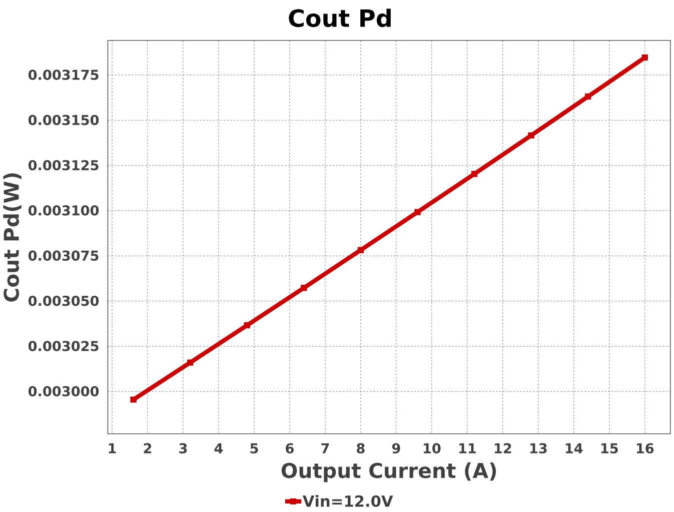

Vin p-p
Vin p-p(V)
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

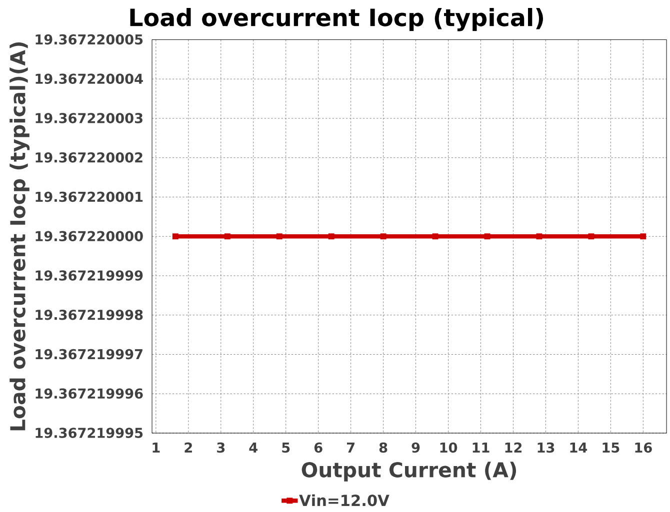

Vout p-p
Vout p-p(V)
0.0083650
0.0083625
0.0083600
0.0083575
0.0083550
0.0083525
0.0083500
0.0083475
0.0083450
0.0083425
0.0083400
0.0083375
0.0083350
0.0083325
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

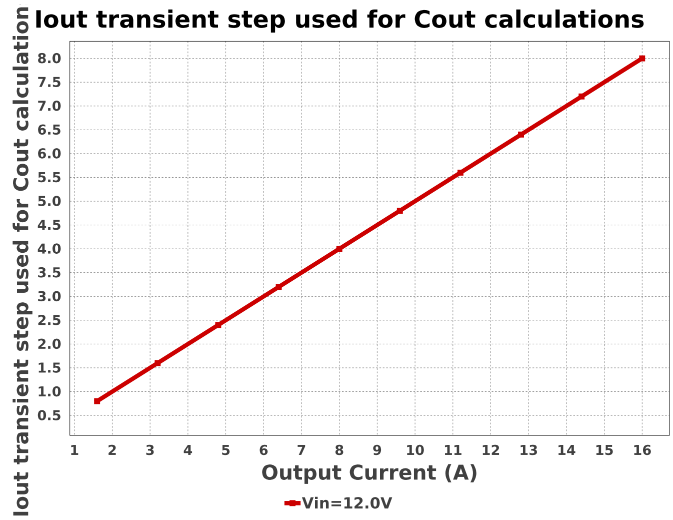

Coutx IRMS
Coutx IRMS(A)
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
-0.000000001
-0.000000002
-0.000000003
-0.000000004
-0.000000005
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

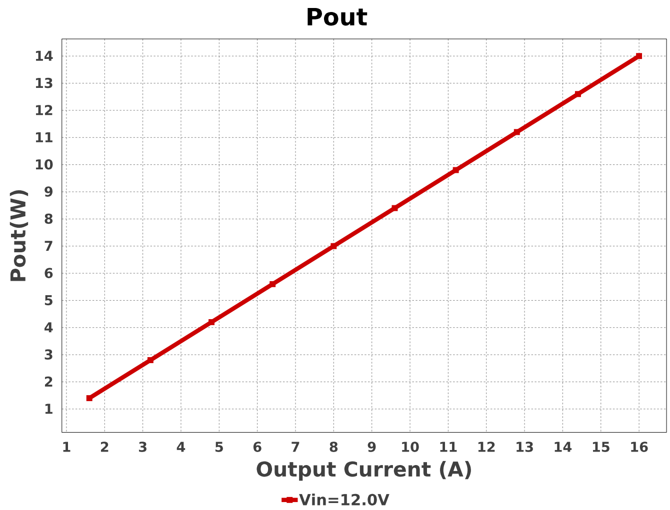

Coutx Pd
Coutx Pd(W)
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
-0.000000001
-0.000000002
-0.000000003
-0.000000004
-0.000000005
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

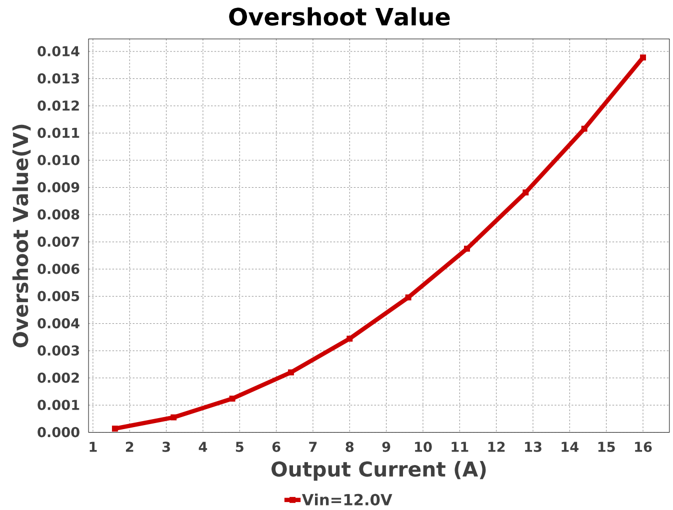

Cin Pd
Cin Pd(W)
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

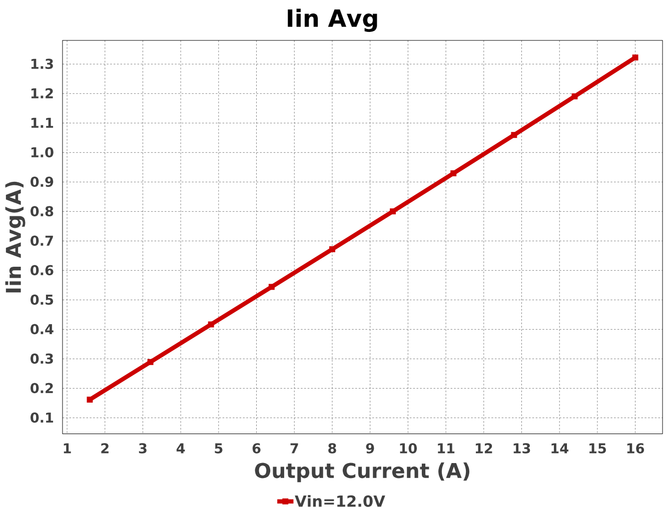

Cout Pd
Cout Pd(W)
0.003175
0.003150
0.003125
0.003100
0.003075
0.003050
0.003025
0.003000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

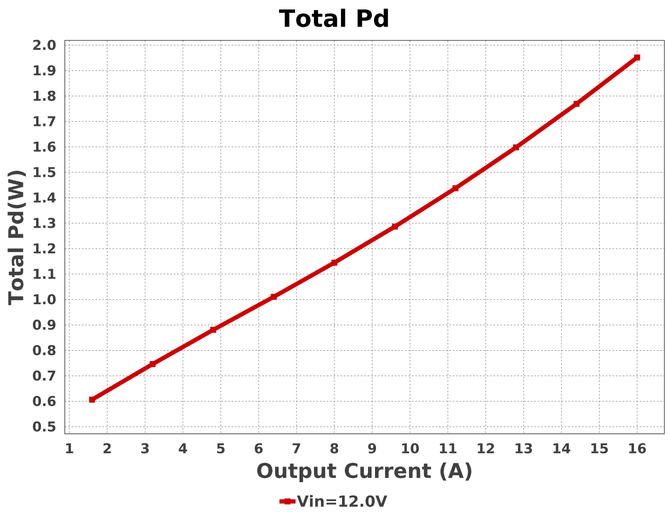

Load overcurrent Iocp (typical)
Load overcurrent Iocp (typical)(A)
19.367220005
19.367220004
19.367220003
19.367220002
19.367220001
19.367220000
19.367219999
19.367219998
19.367219997
19.367219996
19.367219995
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

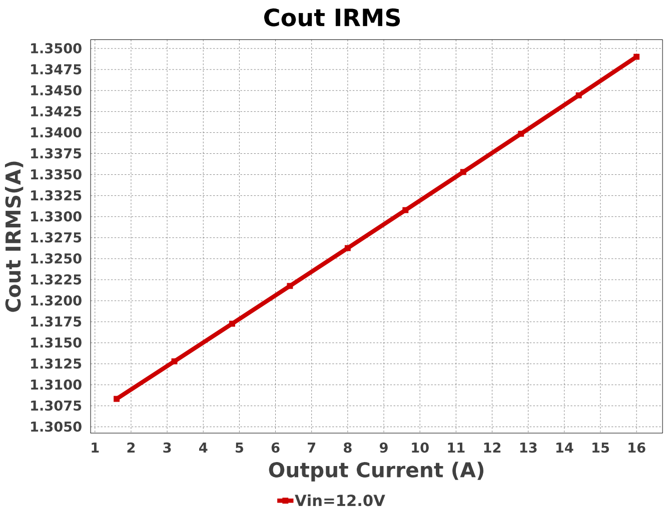

Iout transient step used for Cout calculations
Iout transient step used for Cout calculation
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

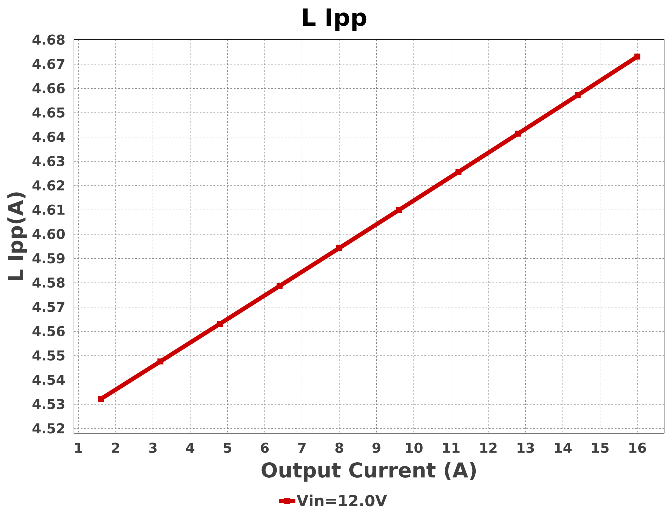

Pout
Pout(W)
14
13
12
11
10
9
8
7
6
5
4
3
2
1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

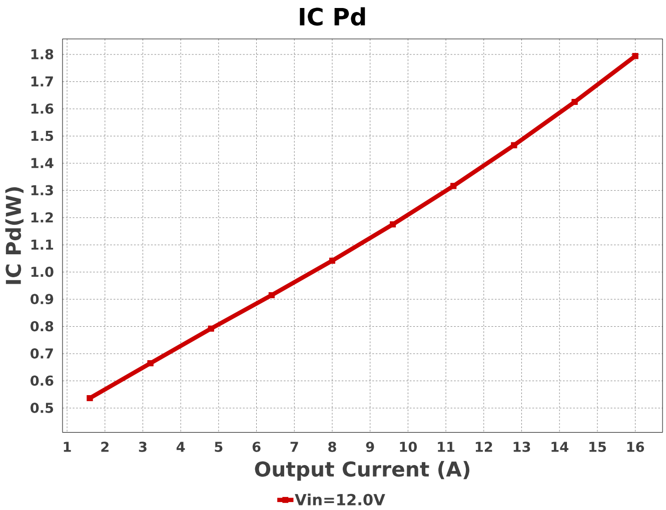

Overshoot Value
Overshoot Value(V)
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Output Current (A)
Vin=12.0V

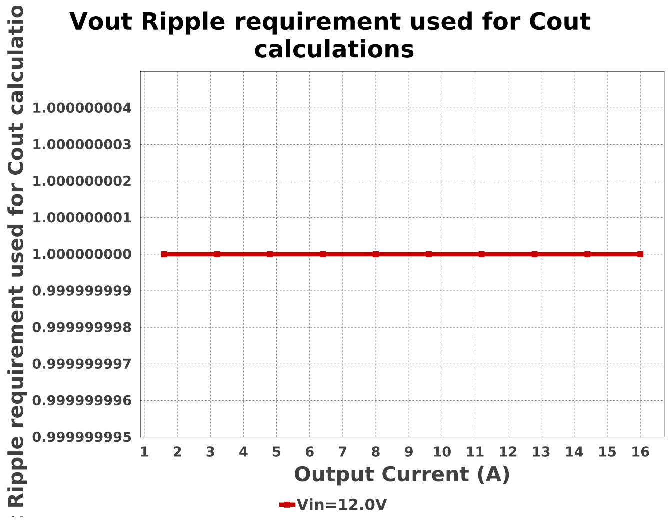

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=12.0V

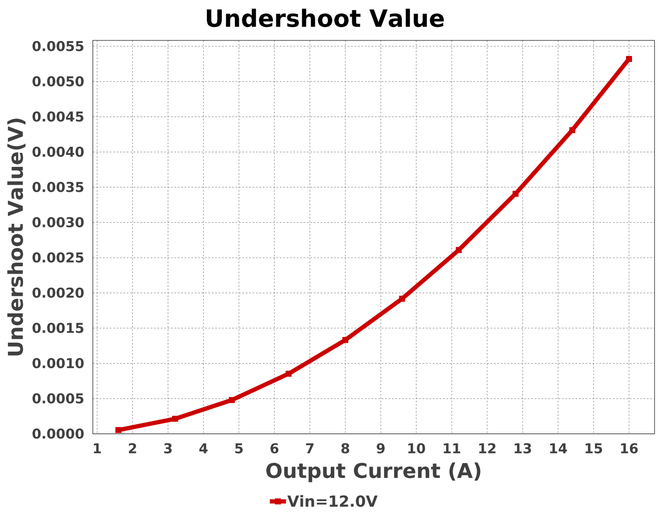

Total Pd
Total Pd(W)
Output Current (A)
Vin=12.0V


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


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


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


Vout Ripple requirement used for Cout calculations
Ripple requirement used for Cout calculatio
Output Current (A)
Vin=12.0V



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	34		Total Design BOM count
2.	Ramp Height	R/2		Ramp height
3.	Total BOM	$8.8		Total BOM Cost
4.	Cin IRMS	4.253 A	Capacitor	Input capacitor RMS ripple current
5.	Cin Pd	18.538 mW	Capacitor	Input capacitor power dissipation
6.	Cout IRMS	1.349 A	Capacitor	Output capacitor RMS ripple current
7.	Cout Pd	3.185 mW	Capacitor	Output capacitor power dissipation
8.	Coutx IRMS	0.0 A	Capacitor	Output capacitor_x RMS ripple current
9.	Coutx Pd	0.0 W	Capacitor	Output capacitor_x power loss
10.	IC Pd	1.794 W	IC	IC power dissipation
11.	IC Tj	55.119 degC	IC	IC junction temperature
12.	ICThetaJA Effective	14.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
13.	Iin Avg	1.322 A	IC	Average input current
14.	L Ipp	4.673 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	51.564 mW	Inductor	Inductor power dissipation
16.	Cin Pd	18.538 mW	Power	Input capacitor power dissipation
17.	Cout Pd	3.185 mW	Power	Output capacitor power dissipation
18.	Coutx Pd	0.0 W	Power	Output capacitor_x power loss
19.	IC Pd	1.794 W	Power	IC power dissipation
20.	L Pd	51.564 mW	Power	Inductor power dissipation
21.	Snubber Pd	95.538 mW	Power	Snubber Power Dissipation
22.	Total Pd	1.951 W	Power	Total Power Dissipation
23.	Duty Cycle	7.586 %	System Information	Duty cycle
24.	Efficiency	87.702 %	System Information	Steady state efficiency
25.	FootPrint	551.0 mm^2	System Information	Total Foot Print Area of BOM components
26.	Frequency	663.46 kHz	System Information	Switching frequency
27.	Iout	16.0 A	System Information	Iout operating point
28.	Iout transient step used for Cout calculations	8.0 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
29.	Load overcurrent Iocp (typical)	19.367 A	System Information	Over current protection threshold
30.	Mode	CCM	System Information	Conduction Mode
31.	Overshoot Value	13.778 mV	System Information	Theoretical Vout Overshoot Value
32.	Pout	14.0 W	System Information	Total output power
33.	Undershoot Value	5.321 mV	System Information	Theoretical Vout Undershoot Value
34.	Vin	12.0 V	System Information	Vin operating point
35.	Vin Ripple requirement used for Cin calculations	5.0 %	System Information	Custom maximum input ripple requirement that was used for Cin selection(% of Minimum Vin).
36.	Vin p-p	237.629 mV	System Information	Peak-to-peak input voltage

#	Name	Value	Category	Description
37.	Vout	875.0 mV	System Information	Operational Output Voltage
38.	Vout Actual	872.145 mV	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
40.	Vout Tolerance	813.532 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
41.	Vout p-p	8.364 mV	System Information	Peak-to-peak output ripple voltage
42.	Vout transient requirement used for Cout calculations	2.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

	Name	Value	Description
	Iout	16.0	Maximum Output Current
	VinMax	12.0	Maximum input voltage
	VinMin	12.0	Minimum input voltage
	Vout	875.0 m	Output Voltage
	base_pn	TPS548D22	Base Product Number
	source	DC	Input Source Type
	Ta	30.0	Ambient temperature
1.	Vout Sch	880.0 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

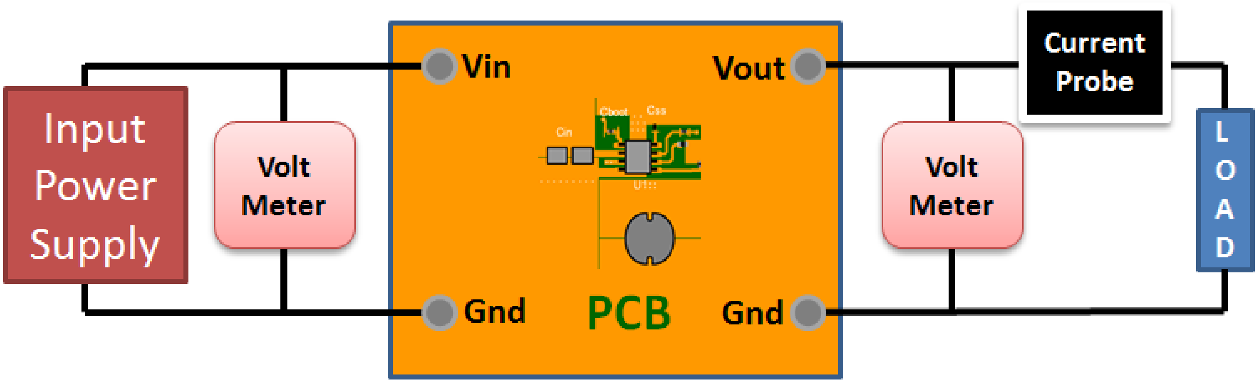
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 12.0V 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 : 663A81E598F70D67[v1]

2. **TPS548D22** Product Folder : http://www.ti.com/product/TPS548D22 : contains the data sheet and other resources.

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