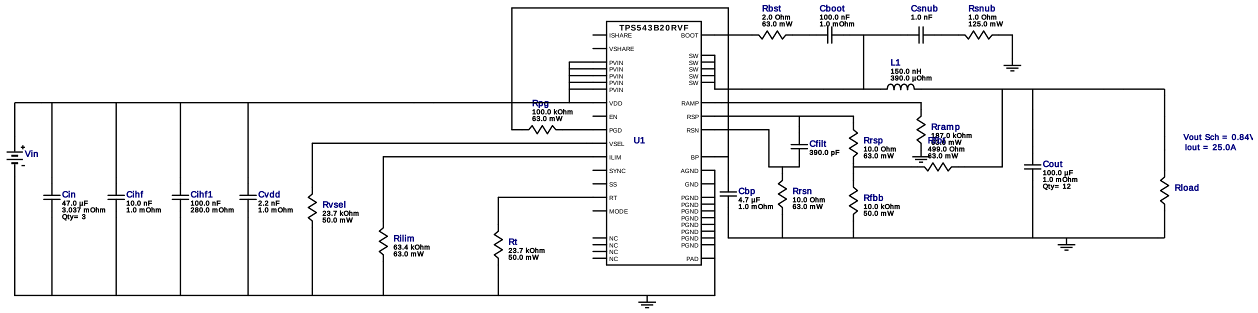
VinMin = 4.0V
VinMax = 6.0V
Vout = 0.84V
Vout Sch = 0.84V
Iout = 25.0A

Device = TPS543B20RVFR
Topology = Buck
Created = 2022-09-26 04:51:22.052
BOM Cost = $7.06
BOM Count = 37
Total Pd = 4.54W

WEBENCH ® Design Report

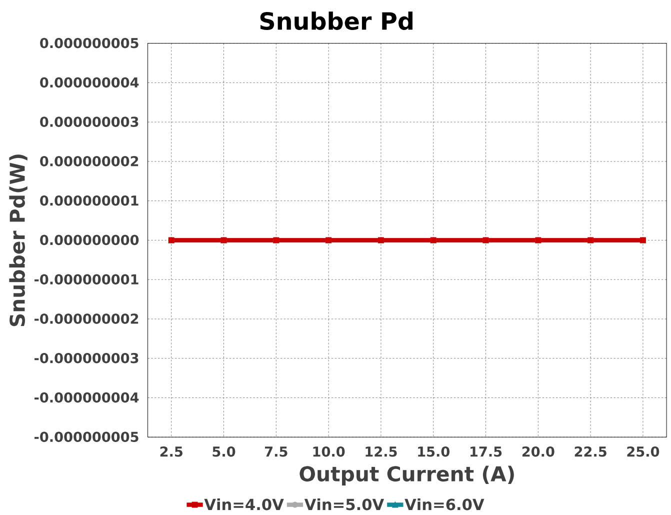
Design : 185 TPS543B20RVFR
TPS543B20RVFR 4V-6V to .84V @ 25A

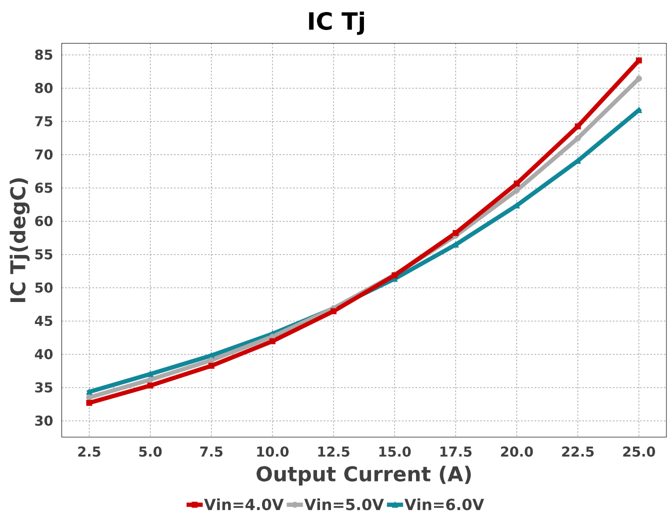


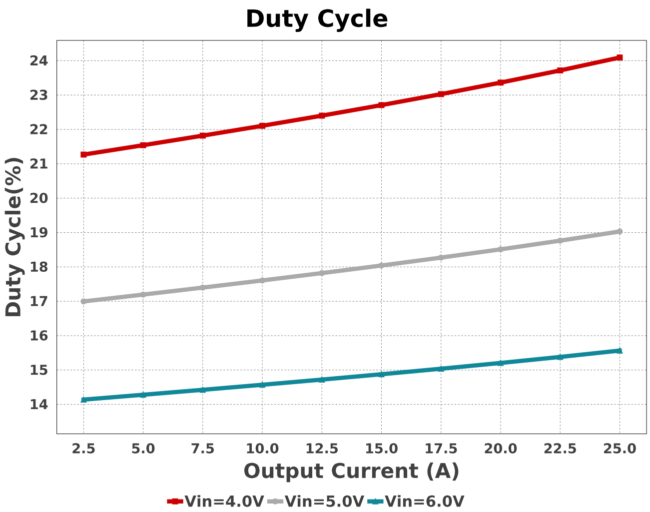
Electrical BOM

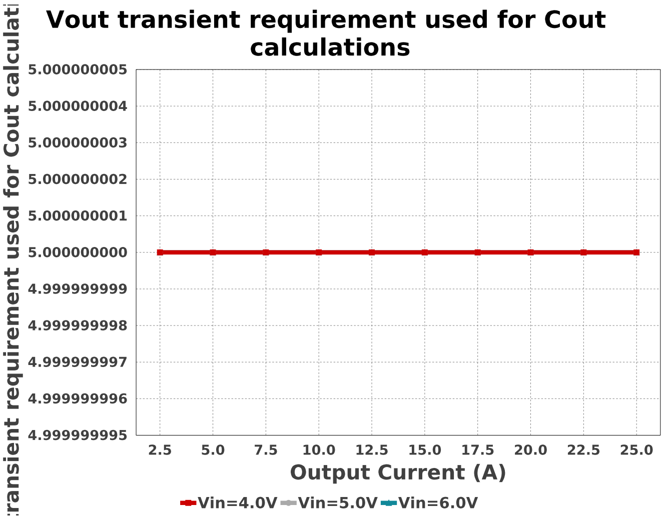
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	Kemet	C0603C104K3RACTU Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cbp	Taiyo Yuden	TMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm^2
Cfilt	MuRata	GRM1555C1H391JA01J Series= C0G/NP0	Cap= 390.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cihf	MuRata	GRM155R71C103KA01D Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cihf1	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cin	MuRata	GRM32ER61C476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	3	$0.18	1210_280 15 mm^2
Cinx	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	2	$0.01	0402 3 mm^2
Cout	MuRata	GRM32EC80J107ME20L Series= X6S	Cap= 100.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	12	$0.17	1210_270 15 mm^2
Csnub	Yageo	CC0603JRNPO8BN102 Series= C0G/NP0	Cap= 1.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
Cvdd	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

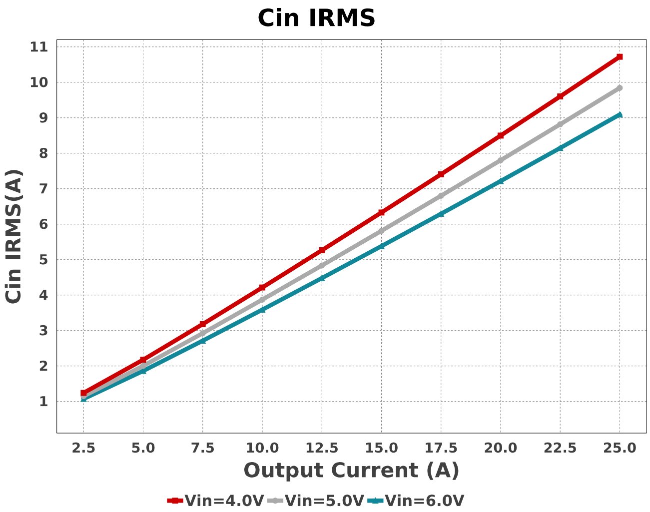
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Coiltronics	FP1005R1-R15-R	L= 150.0 nH 390.0 µOhm	1	$0.75	FP1005 110 mm^2
Rbst	Vishay-Dale	CRCW04022R00FKED Series= CRCW..e3	Res= 2.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbt	Vishay-Dale	CRCW0402499RFKED Series= CRCW..e3	Res= 499.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rilim	Vishay-Dale	CRCW040263K4FKED Series= CRCW..e3	Res= 63.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rramp	Vishay-Dale	CRCW0402187KFKED Series= CRCW..e3	Res= 187.0 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	CRCW08051R00FKEA Series= CRCW..e3	Res= 1.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rt	Yageo	RC0201FR-0723K7L Series= ?	Res= 23.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rvsel	Yageo	RC0201FR-0723K7L Series= ?	Res= 23.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
U1	Texas Instruments	TPS543B20RVFR	Switcher	1	$3.48	RVF0040A 63 mm^2

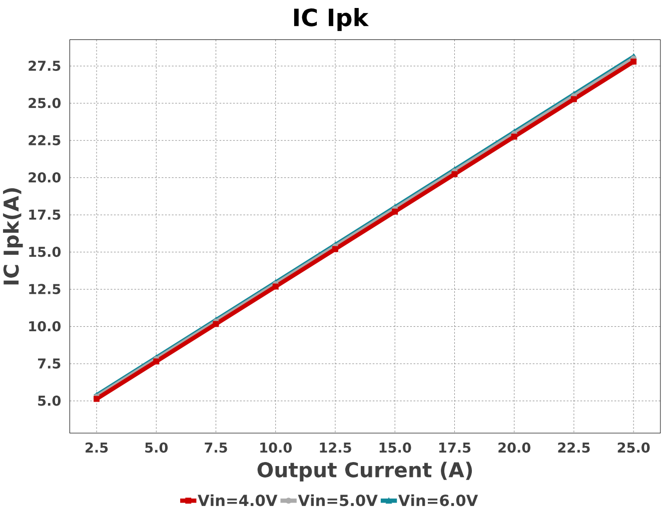


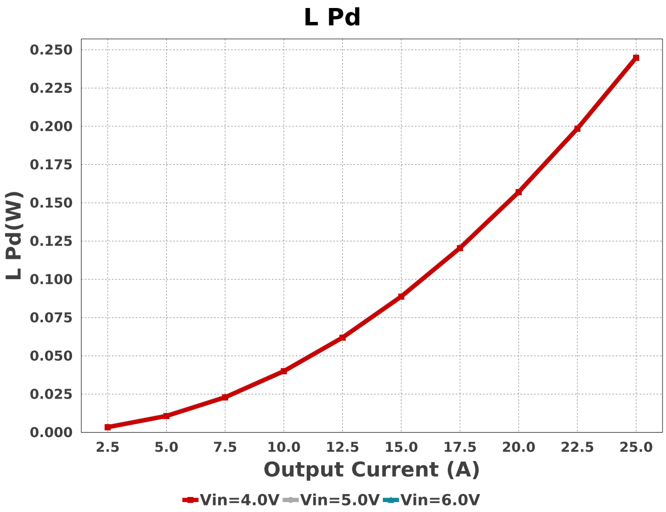


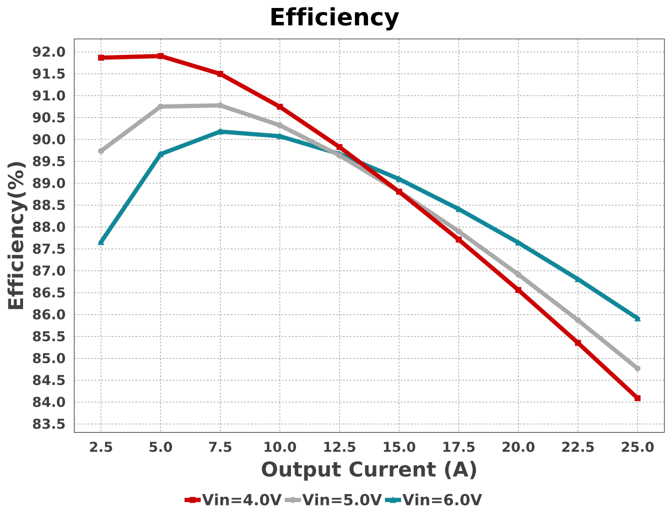

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

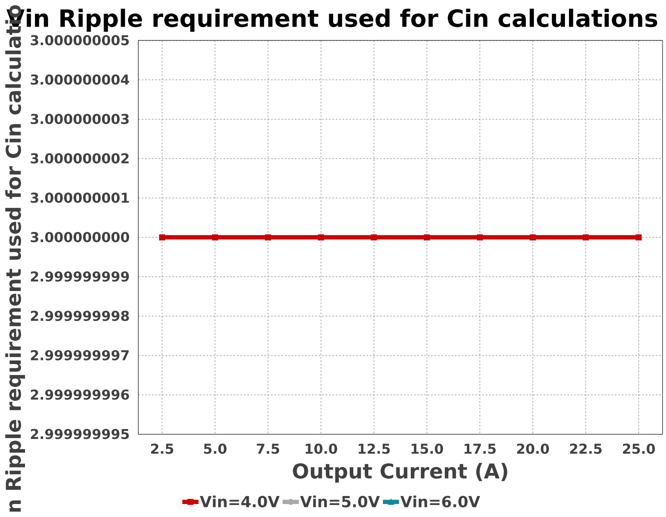

Vout transient requirement used for Cout calculations
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

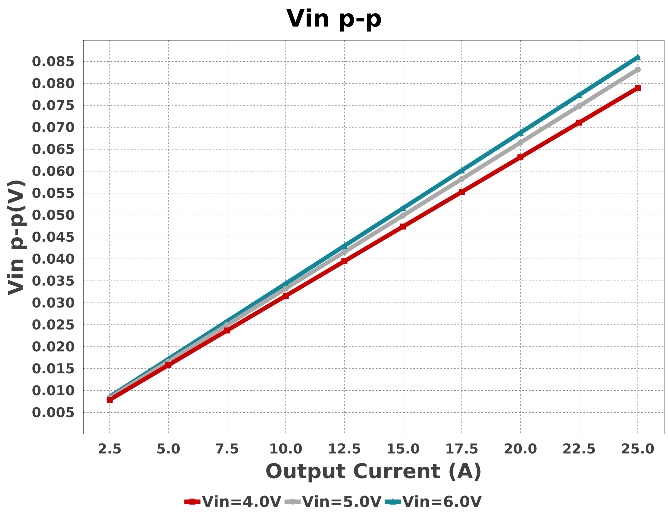

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

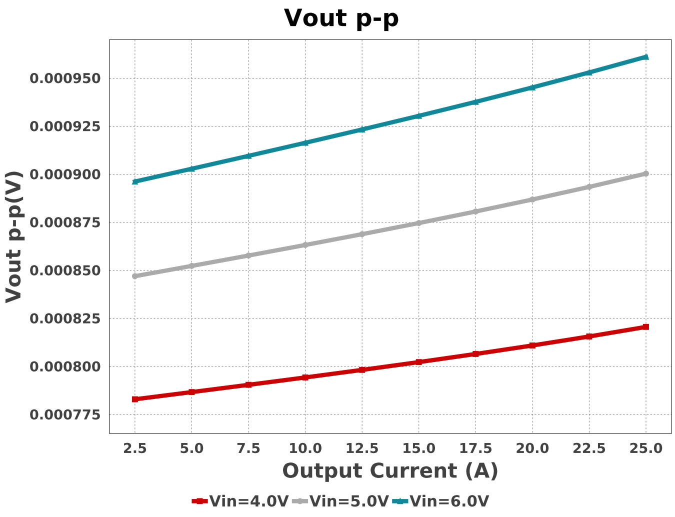

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

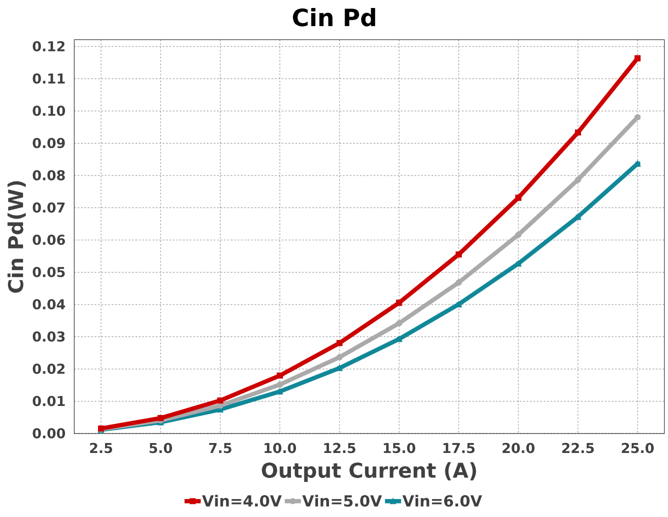

L Pd
L Pd(W)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

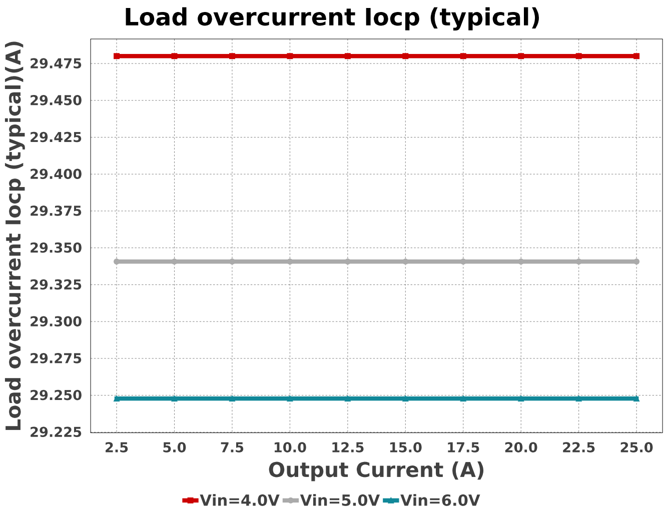

Efficiency
Efficiency(%)
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

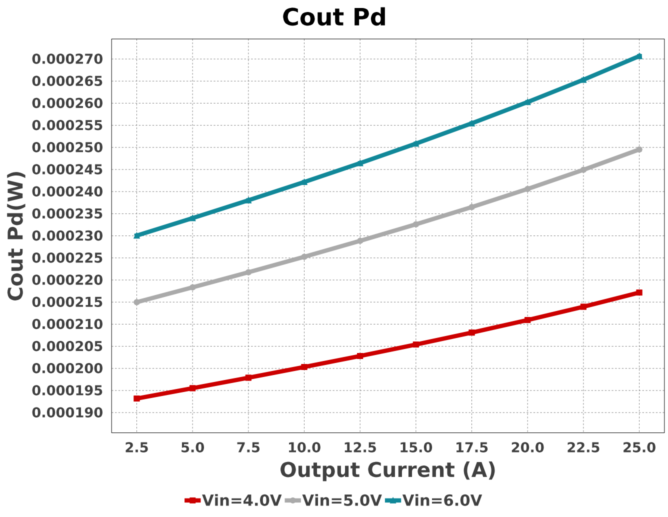

Vin Ripple requirement used for Cin calculations
Vin Ripple requirement used for Cin calculations
3.000000005
3.000000004
3.000000003
3.000000002
3.000000001
3.000000000
2.999999999
2.999999998
2.999999997
2.999999996
2.999999995
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

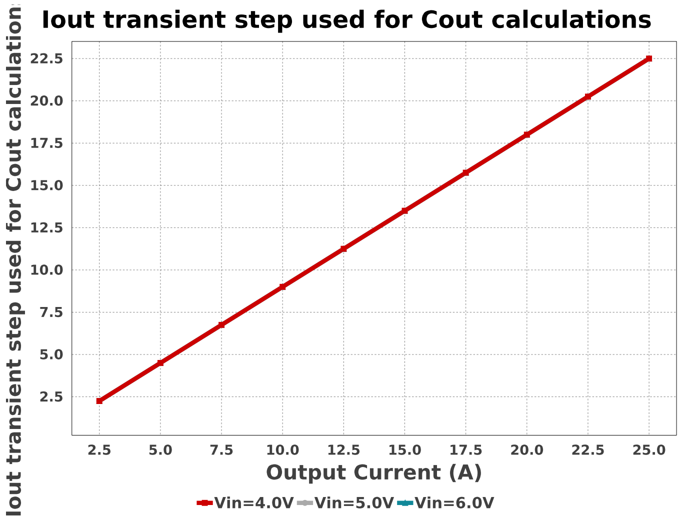

Vin p-p
Vin p-p(V)
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

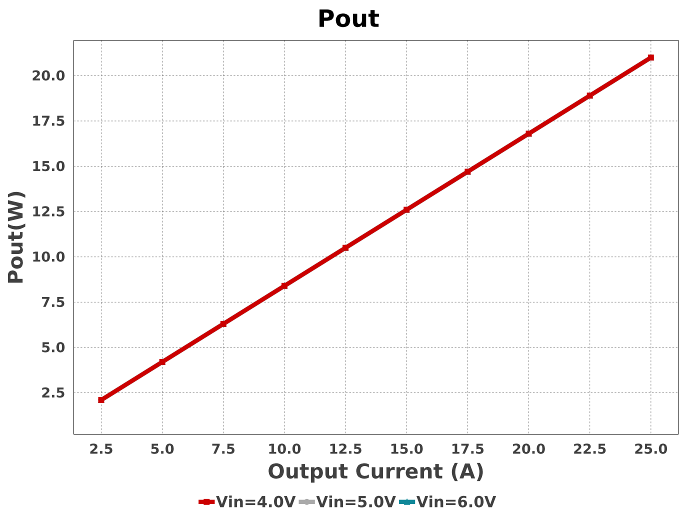

Vout p-p
Vout p-p(V)
0.000950
0.000925
0.000900
0.000875
0.000850
0.000825
0.000800
0.000775
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

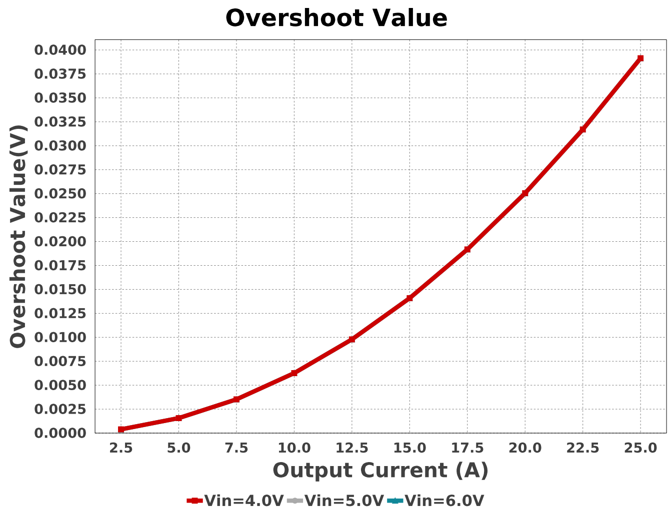

Cin Pd
Cin Pd(W)
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

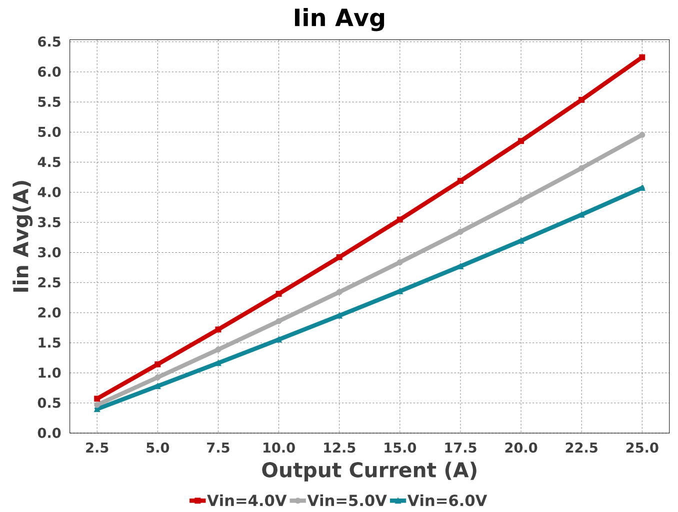

Load overcurrent Iocp (typical)
Load overcurrent Iocp (typical)(A)
29.475
29.450
29.425
29.400
29.375
29.350
29.325
29.300
29.275
29.250
29.225
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

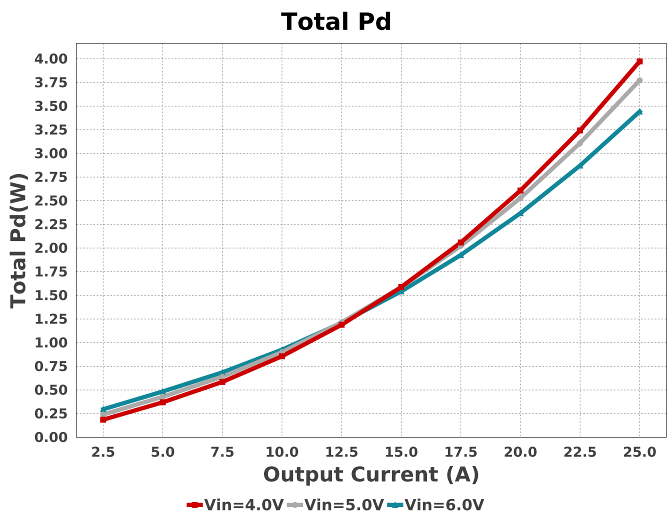

Cout Pd
Cout Pd(W)
0.000270
0.000265
0.000260
0.000255
0.000250
0.000245
0.000240
0.000235
0.000230
0.000225
0.000220
0.000215
0.000210
0.000205
0.000200
0.000195
0.000190
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

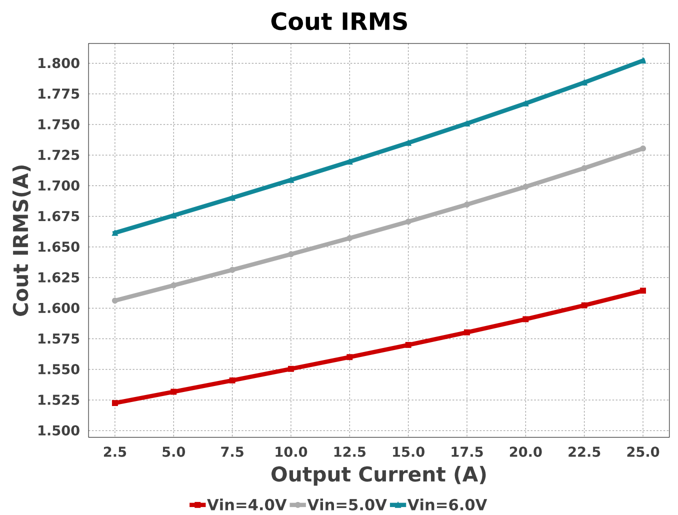

Iout transient step used for Cout calculations
Iout transient step used for Cout calculation
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

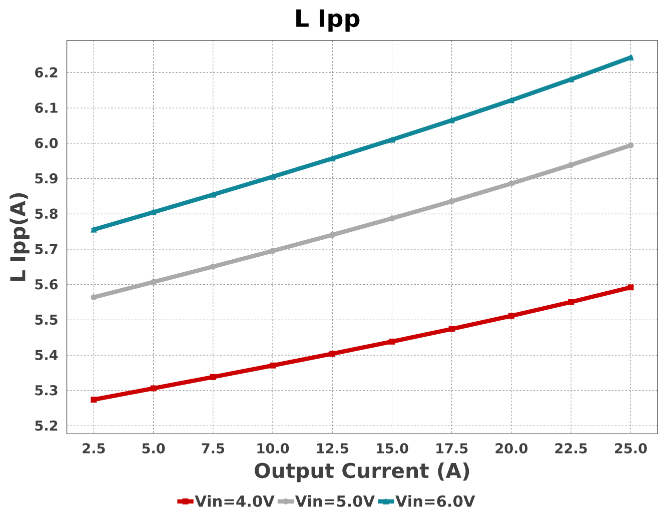

Pout
Pout(W)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

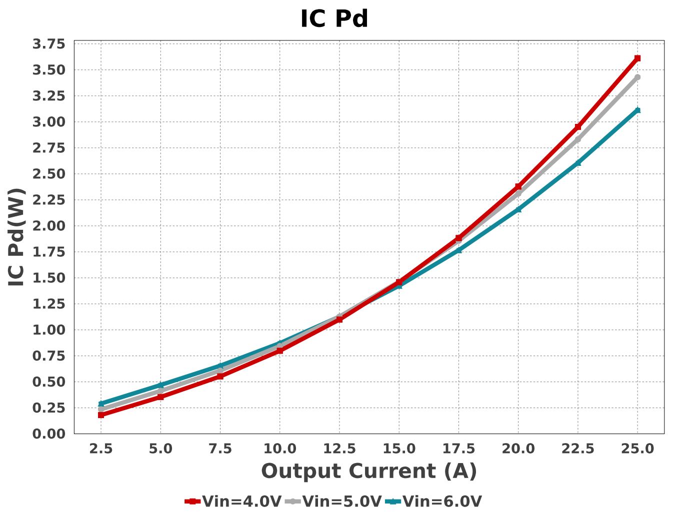

Overshoot Value
Overshoot Value(V)
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

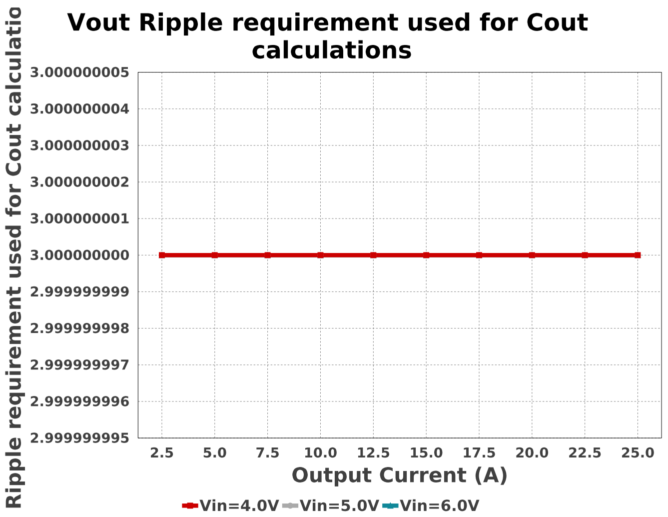

Iin Avg
Iin Avg(A)
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

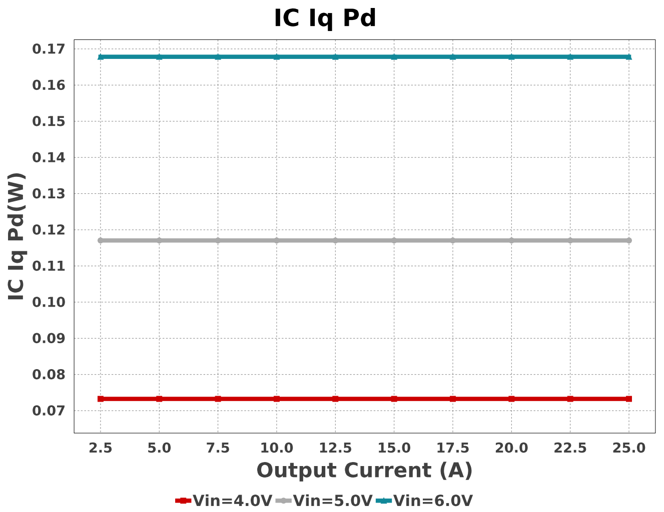

Total Pd
Total Pd(W)
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

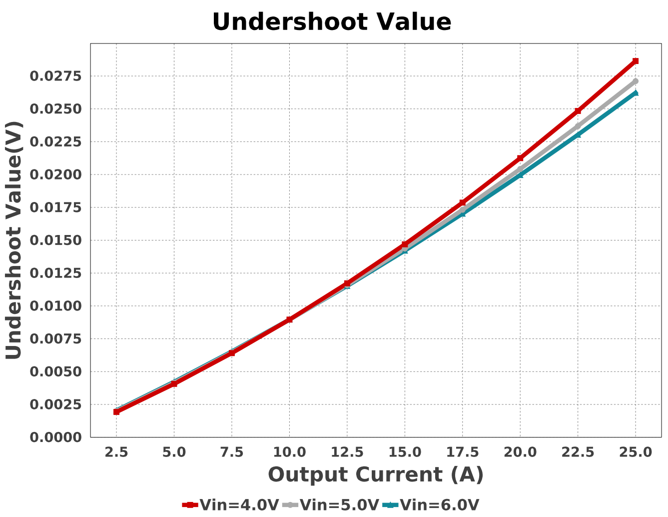

Cout IRMS
Cout IRMS(A)
1.800
1.775
1.750
1.725
1.700
1.675
1.650
1.625
1.600
1.575
1.550
1.525
1.500
2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
Output Current (A)
Vin=4.0V Vin=5.0V Vin=6.0V

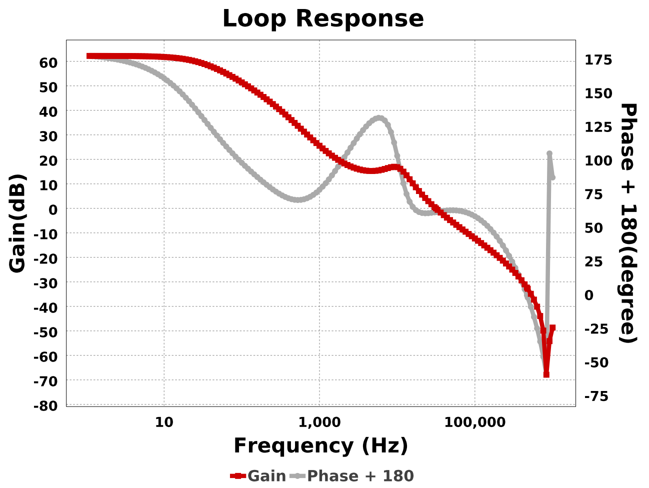












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	9.242 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	86.477 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	1.247 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	129.62 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	27.16 A	IC	Peak switch current in IC
6.	IC Iq Pd	167.825 mW	IC	IC Iq Pd
7.	IC Pd	3.108 W	IC	IC power dissipation
8.	IC Tj	76.616 degC	IC	IC junction temperature
9.	ICThetaJA Effective	15.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	4.252 A	IC	Average input current
11.	L Ipp	4.32 A	Inductor	Peak-to-peak inductor ripple current

#	Name	Value	Category	Description
12.	L Pd	1.316 W	Inductor	Inductor power dissipation
13.	Cin Pd	86.477 mW	Power	Input capacitor power dissipation
14.	Cout Pd	129.62 µW	Power	Output capacitor power dissipation
15.	IC Pd	3.108 W	Power	IC power dissipation
16.	L Pd	1.316 W	Power	Inductor power dissipation
17.	Snubber Pd	30.38 mW	Power	Snubber Power Dissipation
18.	Total Pd	4.536 W	Power	Total Power Dissipation
19.	BOM Count	37	System Information	Total Design BOM count
20.	Cross Freq	31.53 kHz	System Information	Bode plot crossover frequency
21.	Duty Cycle	16.276 %	System Information	Duty cycle
22.	Efficiency	82.218 %	System Information	Steady state efficiency
23.	FootPrint	465.0 mm^2	System Information	Total Foot Print Area of BOM components
24.	Frequency	843.882 kHz	System Information	Switching frequency
25.	Gain Marg	-32.316 dB	System Information	Bode Plot Gain Margin
26.	Iout	25.0 A	System Information	Iout operating point
27.	Iout transient step used for Cout calculations	22.5 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
28.	Load overcurrent Iocp (typical)	30.197 A	System Information	Over current protection threshold
29.	Low Freq Gain	62.21 dB	System Information	Gain at 1Hz
30.	Mode	CCM	System Information	Conduction Mode
31.	Overshoot Value	58.636 mV	System Information	Theoretical Vout Overshoot Value
32.	Phase Marg	61.859 deg	System Information	Bode Plot Phase Margin
33.	Pout	21.0 W	System Information	Total output power
34.	Total BOM	$7.06	System Information	Total BOM Cost
35.	Undershoot Value	29.399 mV	System Information	Theoretical Vout Undershoot Value
36.	Vin	6.0 V	System Information	Vin operating point
37.	Vin Ripple requirement used for Cin calculations	3.0 %	System Information	Custom maximum input ripple requirement that was used for Cin selection(% of Minimum Vin).
38.	Vin p-p	85.518 mV	System Information	Peak-to-peak input voltage
39.	Vout	840.0 mV	System Information	Operational Output Voltage
40.	Vout Ripple requirement used for Cout calculations	3.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
41.	Vout Tolerance	750.65 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Vout p-p	661.391 µV	System Information	Peak-to-peak output ripple voltage
43.	Vout transient requirement used for Cout calculations	5.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

#	Name	Value	Description
	Iout	25.0	Maximum Output Current
	VinMax	6.0	Maximum input voltage
	VinMin	4.0	Minimum input voltage
	Vout	840.0 m	Output Voltage
	base_pn	TPS543B20	Base Product Number
	source	DC	Input Source Type
	Ta	30.0	Ambient temperature
	UserFsw	844.0 k	Customer Selected Frequency
1.	Vout Sch	840.0 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

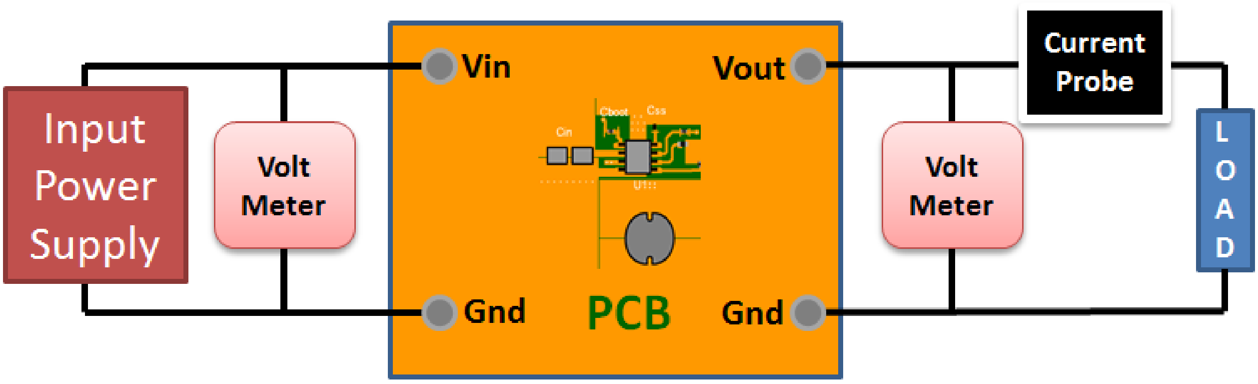
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.0V 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 : 87FAD8896240A6BB[v1]

2. **TPS543B20** Product Folder : http://www.ti.com/product/TPS543B20 : contains the data sheet and other resources.