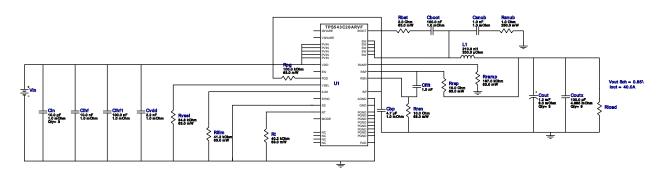VinMin = 10.8V
VinMax = 13.2V
Vout = 0.85V
Vout Sch = 0.85V
Iout = 40.0A

Device = TPS543C20ARVFR
Topology = Buck
Created = 2022-04-12 09:21:12.177
BOM Cost = $10.46
BOM Count = 35
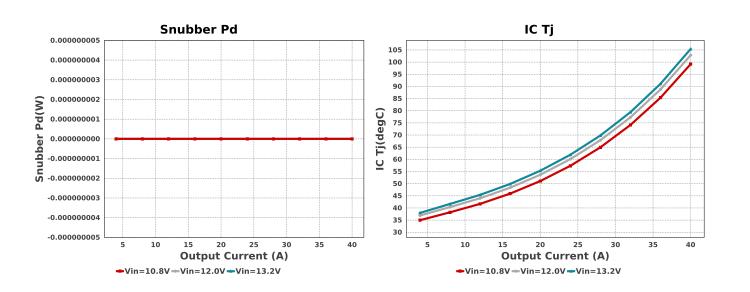Total Pd = 5.72W

WEBENCH ® Design Report

Design : 58 TPS543C20ARVFR
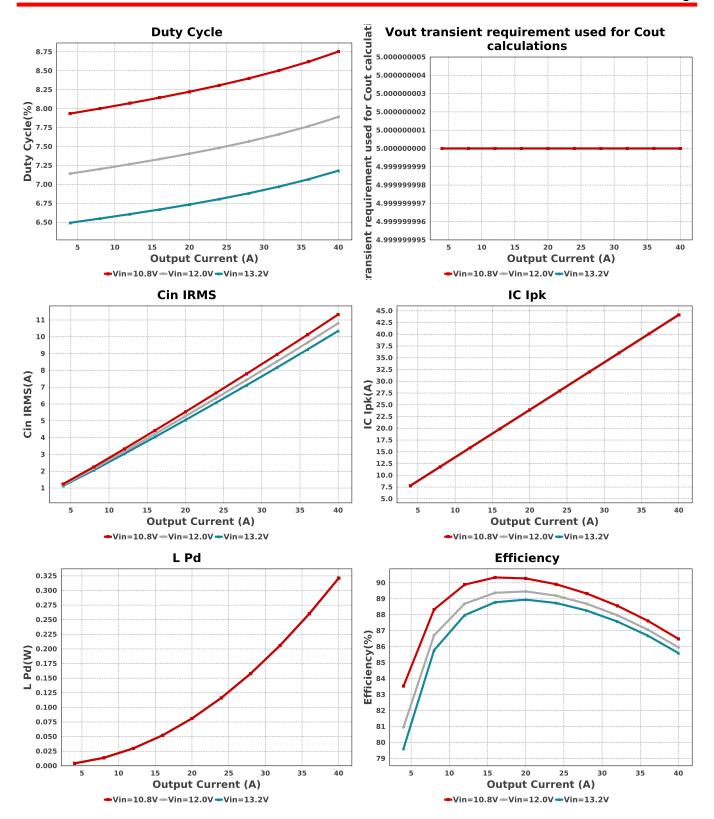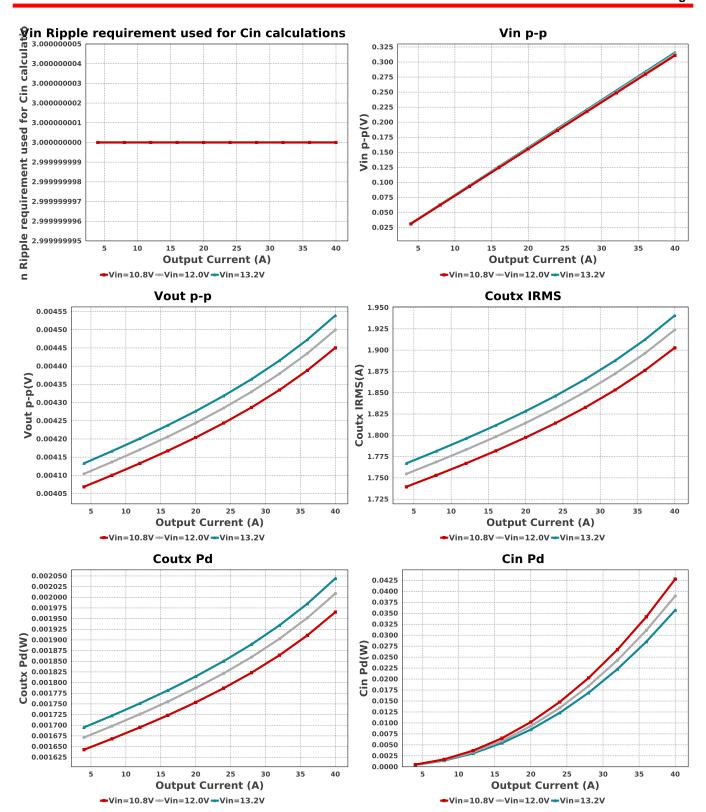TPS543C20ARVFR 10.8V-13.2V to 5.00V @ 20A

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	$0.02	0603 5 mm²
Cbp	Taiyo Yuden	EMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.05	0805 7 mm²
Cfilt	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cihf	MuRata	GRM155R71E103KA01D Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cihf1	Kemet	C0603C104Z3VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Cin	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	3	$0.28	1210 15 mm²
Cinx	Kemet	C0603C104Z3VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	2	$0.01	0603 5 mm²
Cout	Panasonic	2SVPE1200M Series= SVPE	Cap= 1.2 mF ESR= 8.0 mOhm VDC= 2.0 V IRMS= 5.23 A	3	$0.49	CAPSMT_62_C10 74 mm²
Coutx	MuRata	GRM31CR60J107ME39L Series= X5R	Cap= 100.0 uF ESR= 4.885 mOhm VDC= 6.3 V IRMS= 4.4118 A	9	$0.34	1206_190 11 mm²
Csnub	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 mm²

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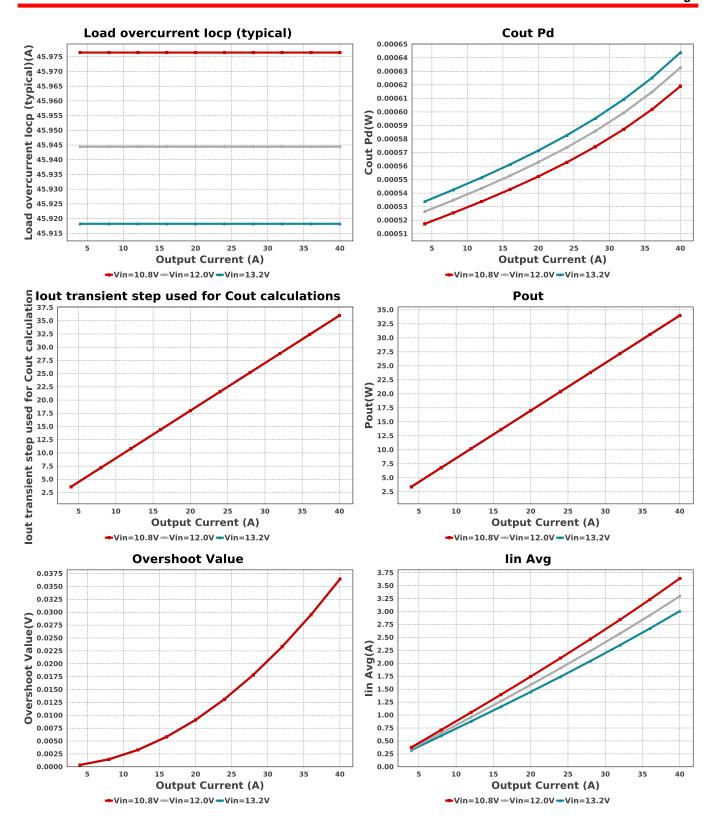
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvdd	MuRata	GRM155R71E222KA01D Series= X7R	Cap= 2.2 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
L1	Coiltronics	FP1308-R21-R	L= 210.0 nH 200.0 µOhm	1	$0.91	IND_FP1308 232 mm²
Rbst	Vishay-Dale	CRCW04022R00FKED Series= CRCW..e3	Res= 2.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rilim	Vishay-Dale	CRCW040241K2FKED Series= CRCW..e3	Res= 41.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rramp	Vishay-Dale	CRCW0402187KFKED Series= CRCW..e3	Res= 187.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rrsn	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rrsp	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsnub	Vishay-Dale	CRCW12061R00FKEA Series= CRCW..e3	Res= 1.0 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rt	Vishay-Dale	CRCW040240K2FKED Series= CRCW..e3	Res= 40.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rvsel	Vishay-Dale	CRCW040234K8FKED Series= CRCW..e3	Res= 34.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	TPS543C20ARVFR	Switcher	1	$3.95	RVF0040A 63 mm²

Snubber Pd

IC Tj

Duty Cycle

Vin=10.8V Vin=12.0V Vin=13.2V

Vout transient requirement used for Cout calculations

Vin=10.8V Vin=12.0V Vin=13.2V

Cin IRMS

Vin=10.8V Vin=12.0V Vin=13.2V

IC Ipk

Vin=10.8V Vin=12.0V Vin=13.2V

L Pd

Vin=10.8V Vin=12.0V Vin=13.2V

Efficiency

Vin=10.8V Vin=12.0V Vin=13.2V

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Vin Ripple requirement used for Cin calculations

Vin p-p

Vout p-p

Coutx IRMS

Coutx Pd

Cin Pd

Load overcurrent Iocp (typical)

Vin=10.8V Vin=12.0V Vin=13.2V

Cout Pd

Vin=10.8V Vin=12.0V Vin=13.2V

Iout transient step used for Cout calculations

Vin=10.8V Vin=12.0V Vin=13.2V

Pout

Vin=10.8V Vin=12.0V Vin=13.2V

Overshoot Value

Vin=10.8V Vin=12.0V Vin=13.2V

Iin Avg

Vin=10.8V Vin=12.0V Vin=13.2V

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Total Pd

Vin=10.8V — Vin=12.0V — Vin=13.2V

Cout IRMS

Vin=10.8V — Vin=12.0V — Vin=13.2V

L Ipp

Vin=10.8V — Vin=12.0V — Vin=13.2V

Vout Ripple requirement used for Cout calculations

Vin=10.8V — Vin=12.0V — Vin=13.2V

IC Pd

Vin=10.8V — Vin=12.0V — Vin=13.2V

IC Iq Pd

Vin=10.8V — Vin=12.0V — Vin=13.2V

Undershoot Value

Vin=10.8V — Vin=12.0V — Vin=13.2V

Loop Response

— Gain — Phase + 180

Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	10.348 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	38.375 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	491.374 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	891.46 µW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	1.941 A	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	2.83 mW	Capacitor	Output capacitor_x power loss
7.	IC Ipk	44.212 A	IC	Peak switch current in IC
8.	IC Iq Pd	711.618 mW	IC	IC Iq Pd
9.	IC Pd	5.362 W	IC	IC power dissipation
10.	IC Tj	105.407 degC	IC	IC junction temperature
11.	ICThetaJA Effective	15.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
12.	Iin Avg	3.009 A	IC	Average input current
13.	L Ipp	8.425 A	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	3.377 W	Inductor	Inductor power dissipation
15.	Cin Pd	35.693 mW	Power	Input capacitor power dissipation
16.	Cout Pd	643.86 µW	Power	Output capacitor power dissipation
17.	Coutx Pd	2.044 mW	Power	Output capacitor_x power loss
18.	IC Pd	5.36 W	Power	IC power dissipation
19.	L Pd	321.18 mW	Power	Inductor power dissipation
20.	Snubber Pd	0.0 W	Power	Snubber Power Dissipation
21.	Total Pd	5.72 W	Power	Total Power Dissipation
22.	BOM Count	35	System Information	Total Design BOM count
23.	Cross Freq	67.663 kHz	System Information	Bode plot crossover frequency
24.	Duty Cycle	7.182 %	System Information	Duty cycle
25.	Efficiency	85.599 %	System Information	Steady state efficiency
26.	FootPrint	733.0 mm^2	System Information	Total Foot Print Area of BOM components
27.	Frequency	497.512 kHz	System Information	Switching frequency
28.	Gain Marg	-23.626 dB	System Information	Bode Plot Gain Margin
29.	Iout	40.0 A	System Information	Iout operating point
30.	Iout transient step used for Cout calculations	36.0 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
31.	Load overcurrent Iocp (typical)	45.918 A	System Information	Over current protection threshold
32.	Low Freq Gain	67.008 dB	System Information	Gain at 1Hz
33.	Mode	CCM	System Information	Conduction Mode
34.	Overshoot Value	36.424 mV	System Information	Theoretical Vout Overshoot Value
35.	Phase Marg	99.286 deg	System Information	Bode Plot Phase Margin
36.	Pout	34.0 W	System Information	Total output power

#	Name	Value	Category	Description
37.	Total BOM	$10.458	System Information	Total BOM Cost
38.	Undershoot Value	17.91 mV	System Information	Theoretical Vout Undershoot Value
39.	Vin	13.2 V	System Information	Vin operating point
40.	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).
41.	Vin p-p	315.75 mV	System Information	Peak-to-peak input voltage
42.	Vout	850.0 mV	System Information	Operational Output Voltage
43.	Vout Ripple requirement used for Cout calculations	3.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
44.	Vout Tolerance	500.0 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
45.	Vout p-p	4.539 mV	System Information	Peak-to-peak output ripple voltage
46.	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	40.0	Maximum Output Current
	VinMax	13.2	Maximum input voltage
	VinMin	10.8	Minimum input voltage
	Vout	850.0 m	Output Voltage
	base_pn	TPS543C20A	Base Product Number
	source	DC	Input Source Type
	Ta	25.0	Ambient temperature
	UserFsw	500.0 k	Customer Selected Frequency
1.	Vout Sch	850.0 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.
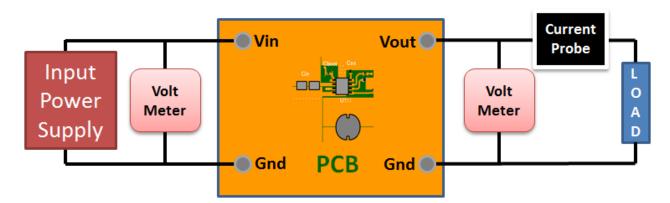
Soldering Component to Board

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 10.8V 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 : DB536B516A0BDA5D[v1]

2. **TPS543C20A** Product Folder : http://www.ti.com/product/TPS543C20A : contains the data sheet and other resources.

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