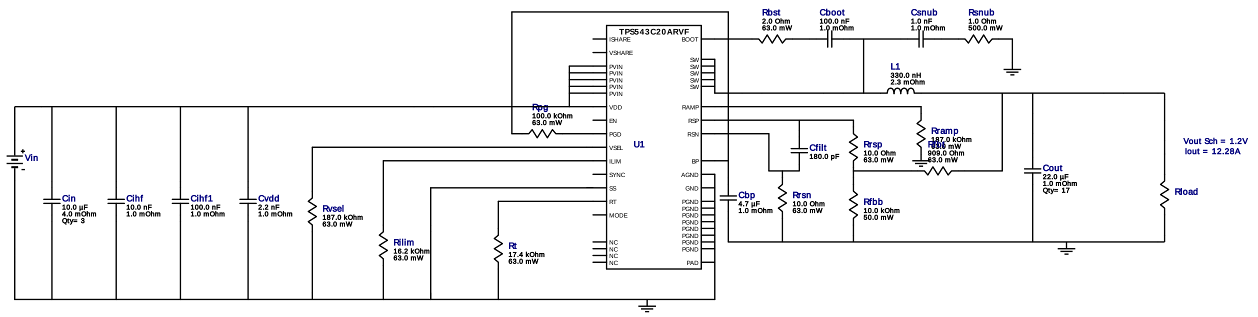
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 11.64V
VinMax = 12.6V
Vout = 1.2V
Vout Sch = 1.2V
Iout = 12.28A

Device = TPS543C20ARVFR
Topology = Buck
Created = 2021-05-19 22:23:00.215
BOM Cost = $5.69
BOM Count = 42
Total Pd = 2.9W

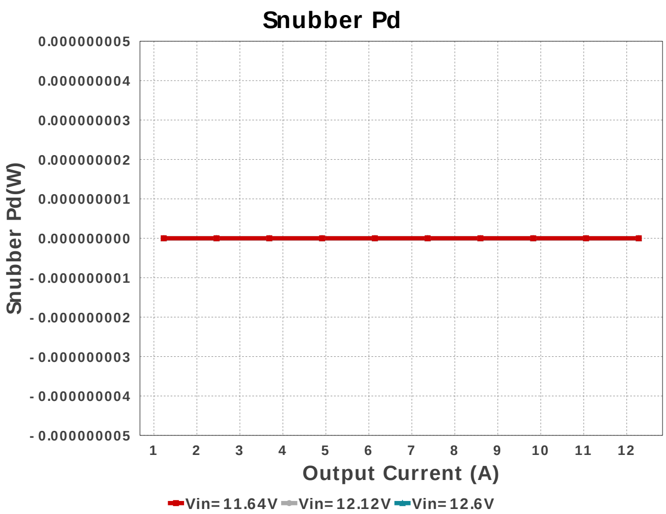
Design : 771 TPS543C20ARVFR
TPS543C20ARVFR 11.64V-12.6V to 1.20V @ 12.28A

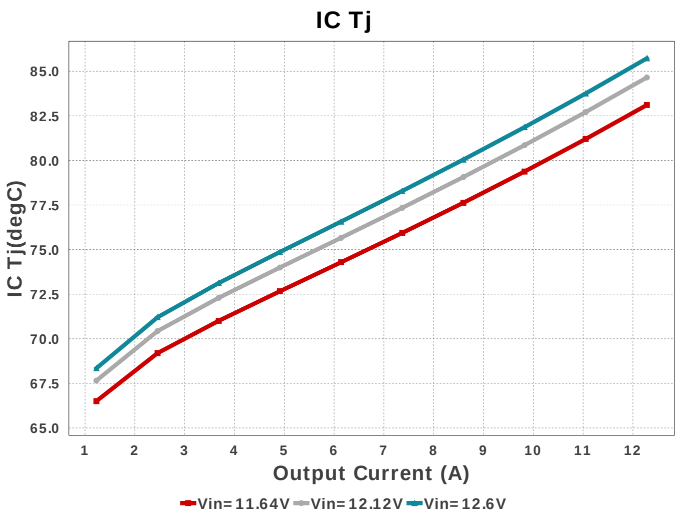


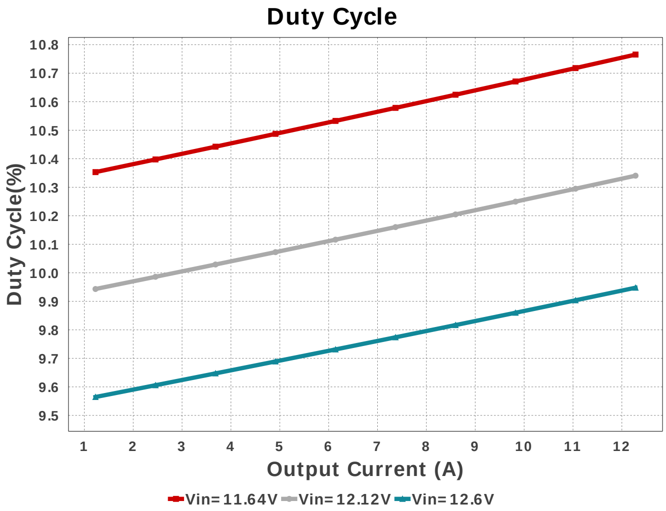
Electrical BOM

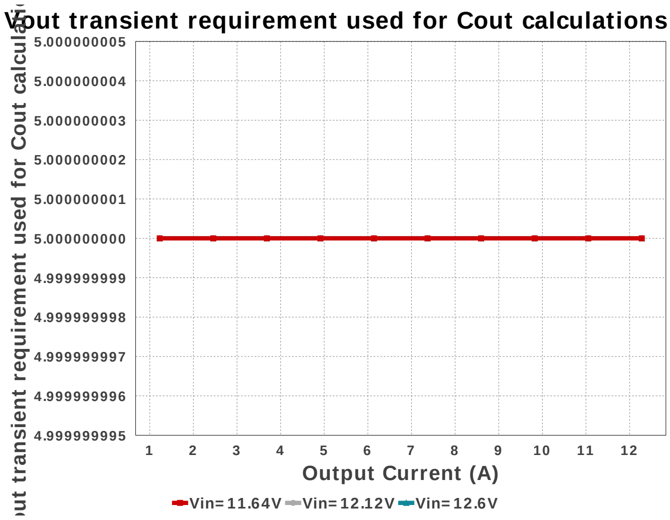
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	Kemet	C0603C104K3RACTU Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm^2
Cbp	Taiyo Yuden	EMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.05	0805 7 mm^2
Cfilt	Taiyo Yuden	UMK105CG181JV-F Series= C0G/NP0	Cap= 180.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
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 mm^2
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 mm^2
Cin	MuRata	GRM21BR61E106MA73L Series= X5R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 2.8 A	3	$0.05	0805 7 mm^2
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 mm^2
Cout	MuRata	GRM188R60J226MEA0D Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 6.0 A	17	$0.05	0603 5 mm^2
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 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

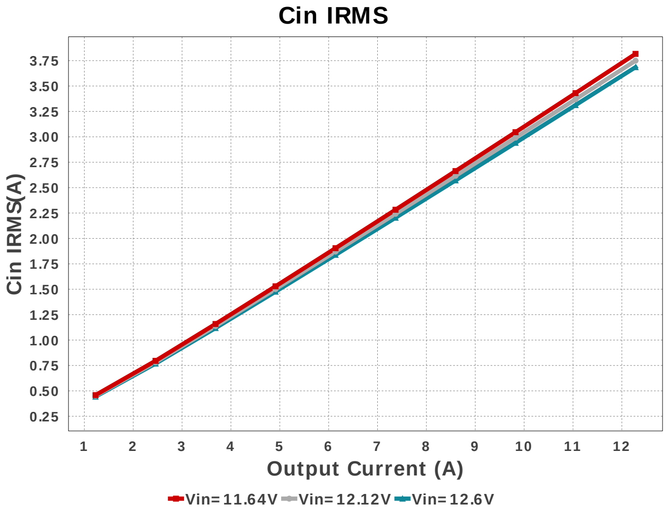
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Coilcraft	XAL6030-331MEB	L= 330.0 nH 2.3 mOhm	1	$0.65	XAL6030 72 mm^2
Rbst	Vishay-Dale	CRCW04022R00FKED Series= CRCW..e3	Res= 2.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbt	Vishay-Dale	CRCW0402909RFKED Series= CRCW..e3	Res= 909.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rilim	Vishay-Dale	CRCW040216K2FKED Series= CRCW..e3	Res= 16.2 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	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	CRCW040217K4FKED Series= CRCW..e3	Res= 17.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rvsel	Vishay-Dale	CRCW0402187KFKED Series= CRCW..e3	Res= 187.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS543C20ARVFR	Switcher	1	$3.76	RVF0040A 63 mm^2

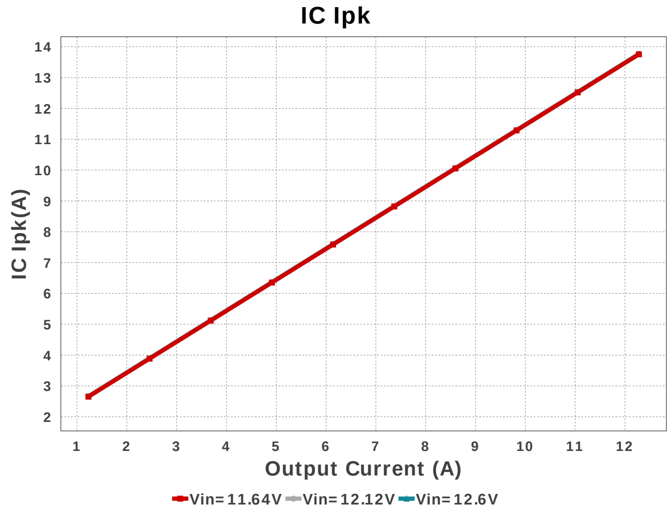


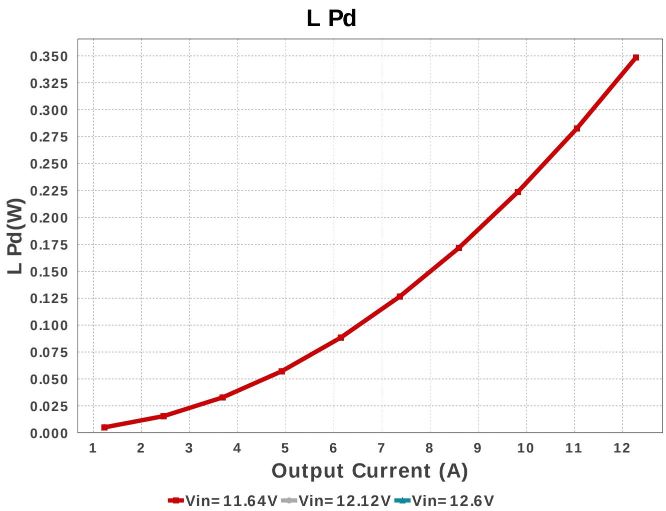


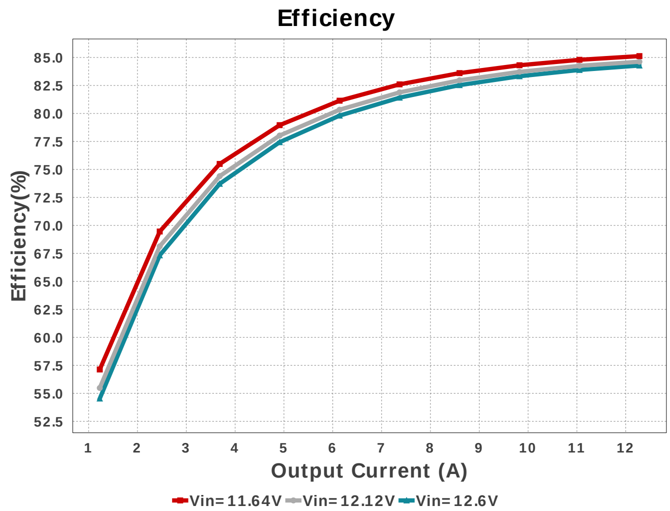

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

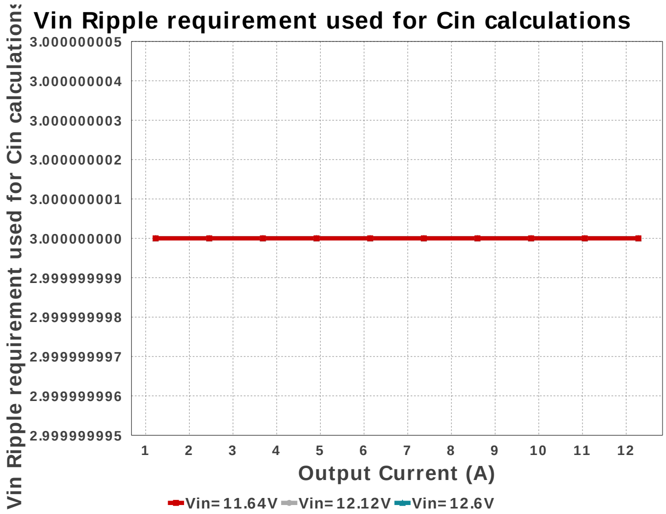

Vout transient requirement used for Cout calculations
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

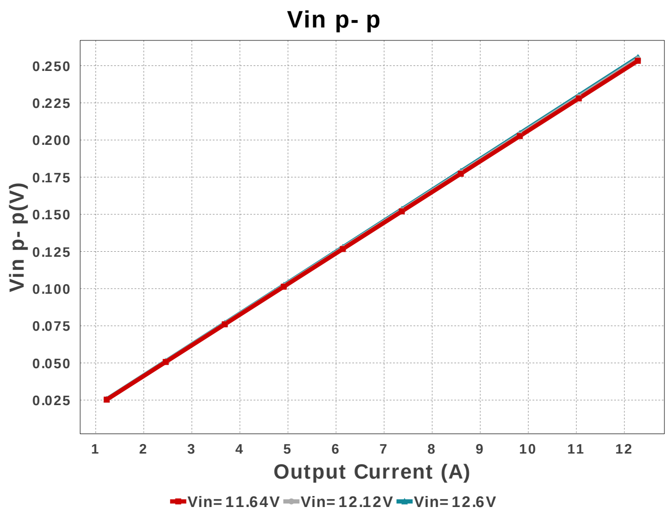

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

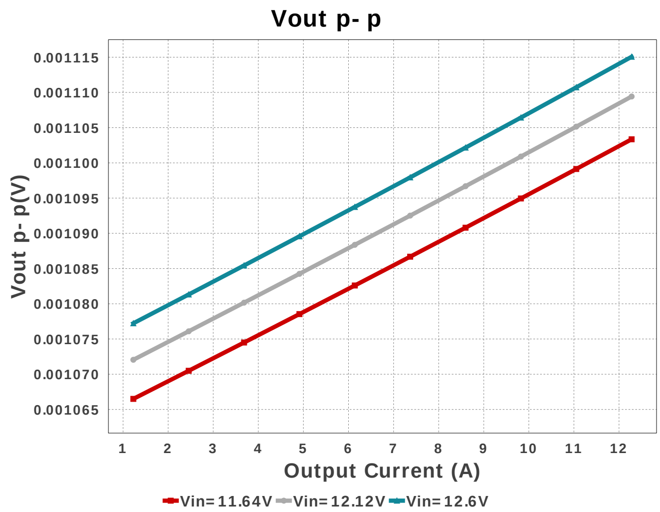

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

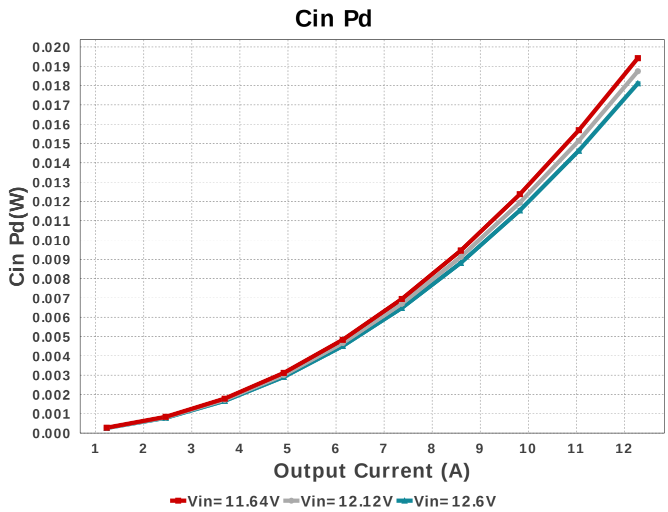

L Pd
L Pd(W)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

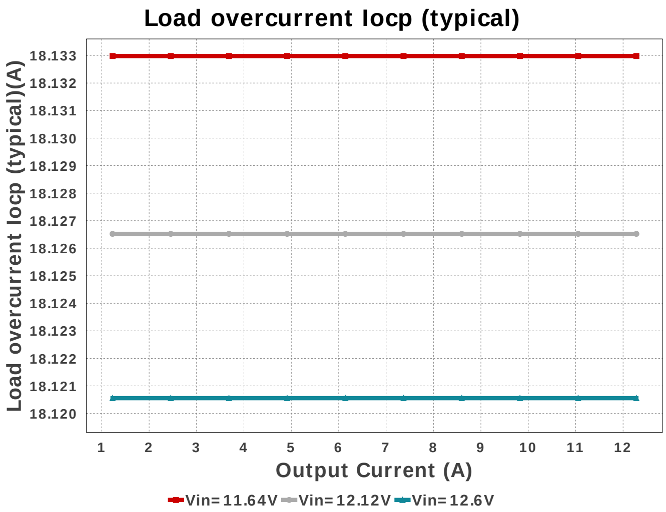

Efficiency
Efficiency(%)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

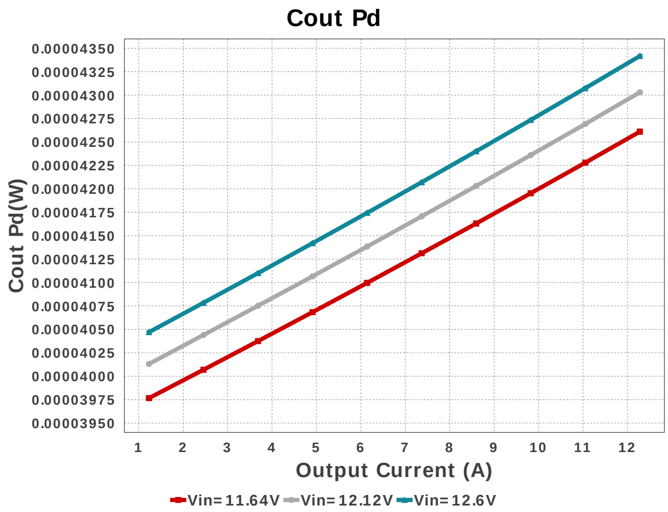

Vin Ripple requirement used for Cin calculations
Vin Ripple requirement used for Cin calculations
Output Current (A)
Vin=11.64V
Vin=12.12V
Vin=12.6V

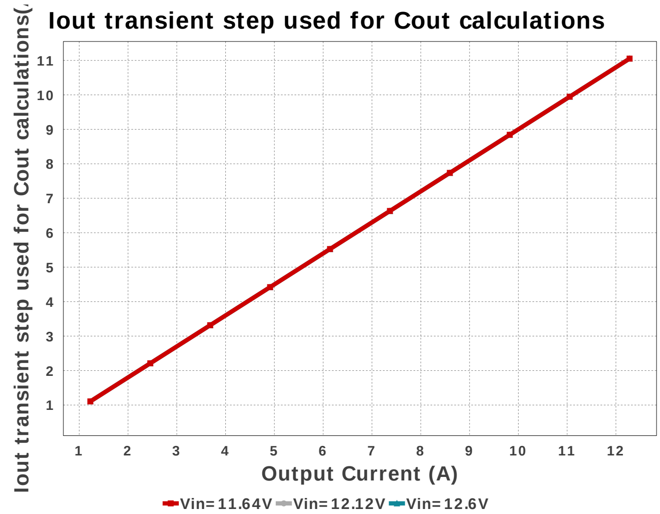

Vin p- p
Vin p- p(V)
Output Current (A)
Vin=11.64V
Vin=12.12V
Vin=12.6V

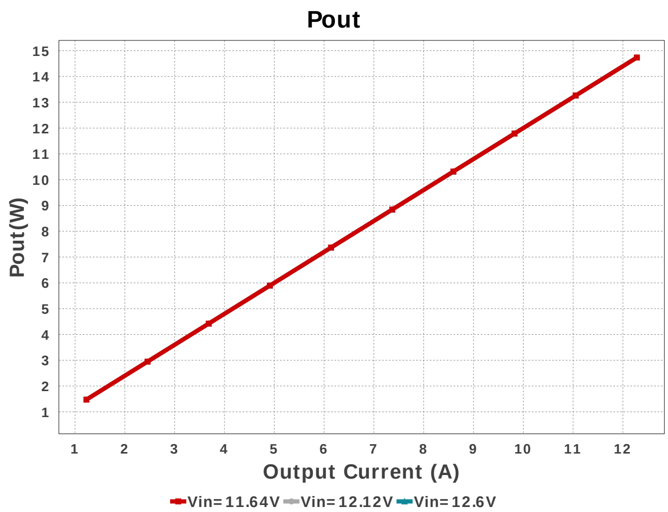

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=11.64V
Vin=12.12V
Vin=12.6V

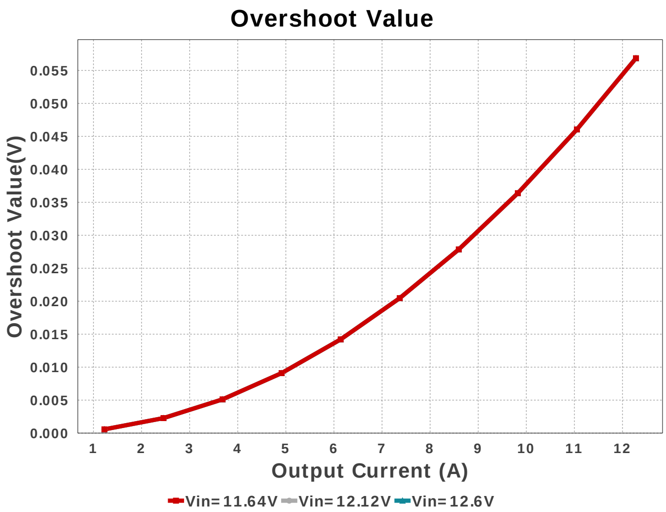

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=11.64V
Vin=12.12V
Vin=12.6V

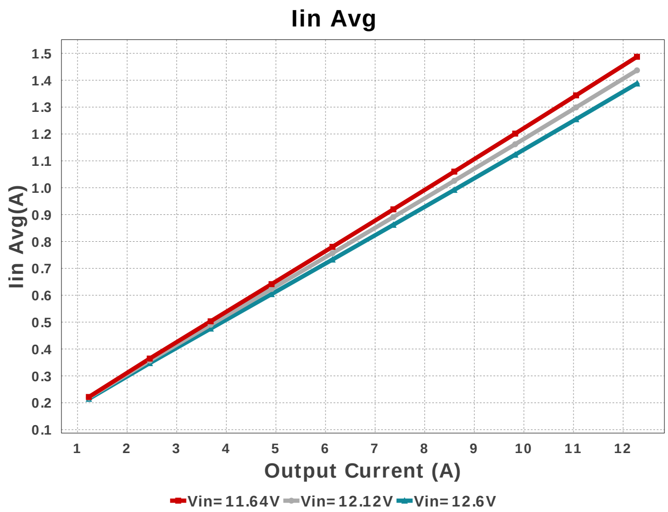

Load overcurrent Iocp (typical)
Load overcurrent Iocp (typical)(A)
Output Current (A)
Vin=11.64V
Vin=12.12V
Vin=12.6V

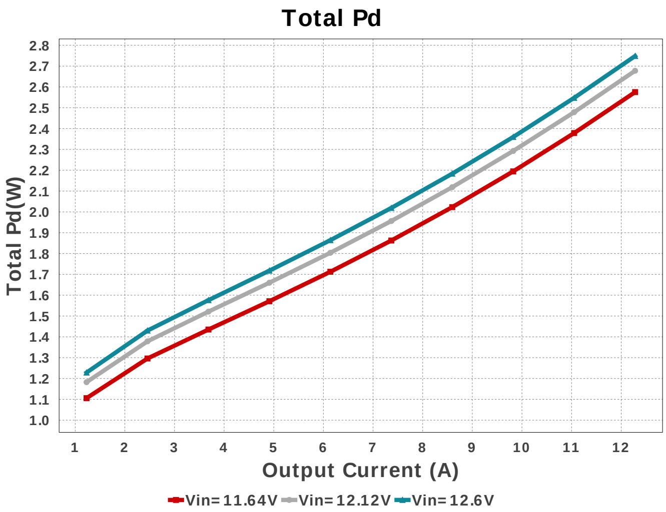

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=11.64V
Vin=12.12V
Vin=12.6V

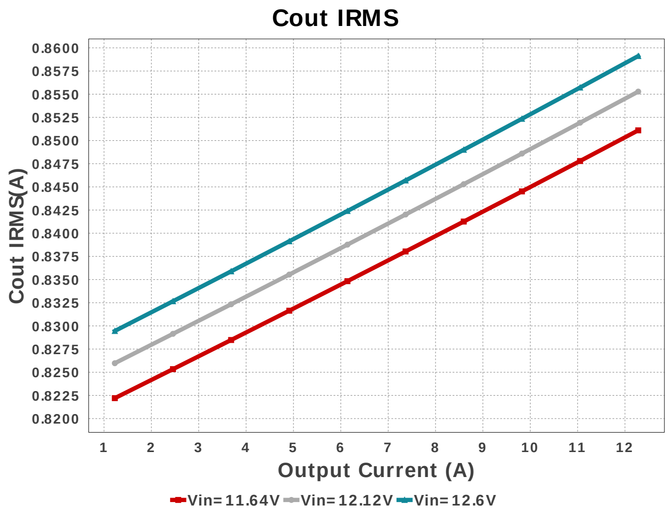

Iout transient step used for Cout calculations
Iout transient step used for Cout calculations(
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

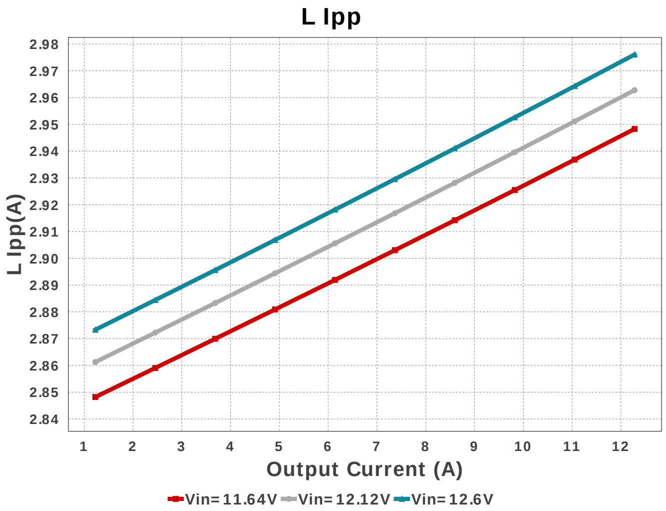

Pout
Pout(W)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

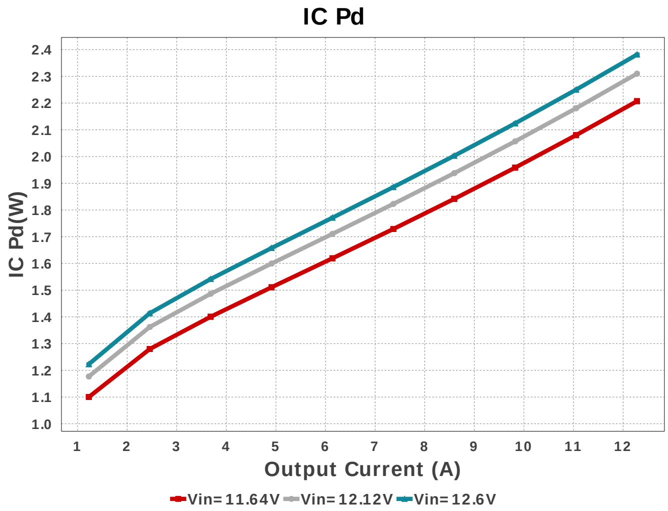

Overshoot Value
Overshoot Value(V)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

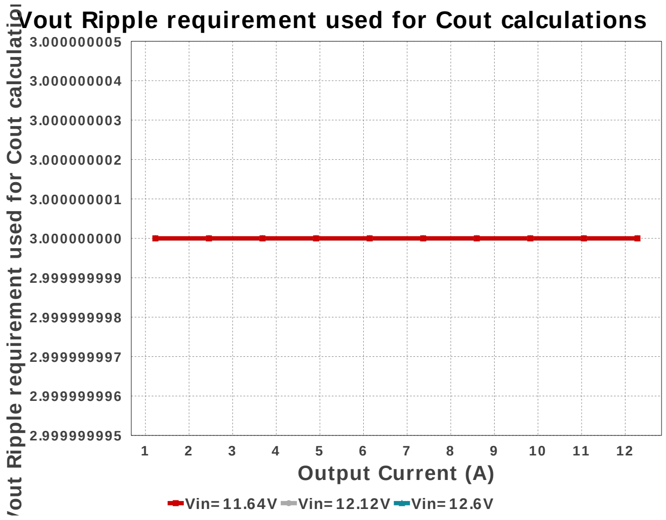

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

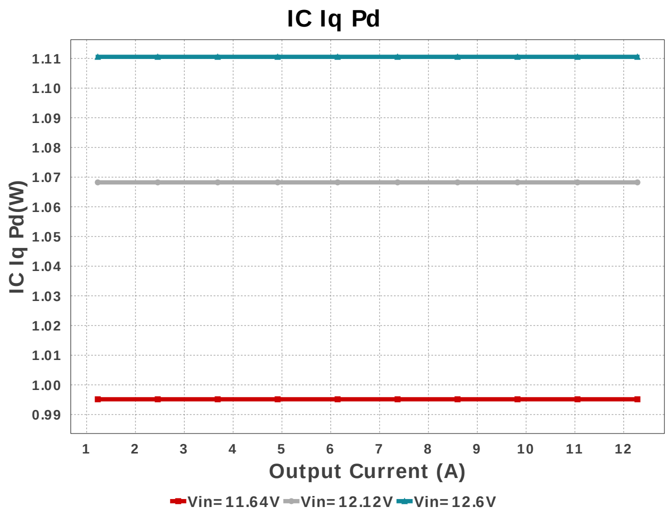

Total Pd
Total Pd(W)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V

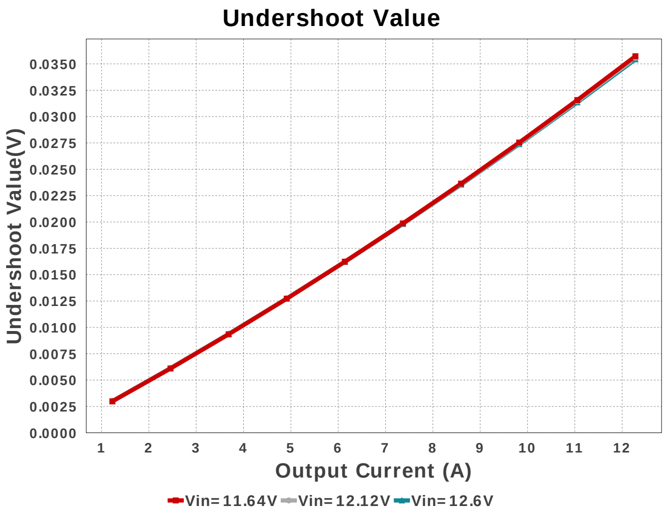

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=11.64V Vin=12.12V Vin=12.6V











Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	3.685 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	18.11 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	859.117 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	43.417 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	13.768 A	IC	Peak switch current in IC
6.	IC Iq Pd	1.111 W	IC	IC Iq Pd
7.	IC Pd	2.382 W	IC	IC power dissipation
8.	IC Tj	85.723 degC	IC	IC junction temperature
9.	ICThetaJA Effective	15.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	1.388 A	IC	Average input current
11.	L Ipp	2.976 A	Inductor	Peak-to-peak inductor ripple current

#	Name	Value	Category	Description
12.	L Pd	348.53 mW	Inductor	Inductor power dissipation
13.	Cin Pd	18.11 mW	Power	Input capacitor power dissipation
14.	Cout Pd	43.417 µW	Power	Output capacitor power dissipation
15.	IC Pd	2.382 W	Power	IC power dissipation
16.	L Pd	348.53 mW	Power	Inductor power dissipation
17.	Snubber Pd	182.483 mW	Power	Snubber Power Dissipation
18.	Total Pd	2.902 W	Power	Total Power Dissipation
19.	BOM Count	42	System Information	Total Design BOM count
20.	Duty Cycle	9.948 %	System Information	Duty cycle
21.	Efficiency	83.404 %	System Information	Steady state efficiency
22.	FootPrint	314.0 mm^2	System Information	Total Foot Print Area of BOM components
23.	Frequency	1.149 MHz	System Information	Switching frequency
24.	Iout	12.28 A	System Information	Iout operating point
25.	Iout transient step used for Cout calculations	11.052 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
26.	Load overcurrent Iocp (typical)	18.121 A	System Information	Over current protection threshold
27.	Mode	CCM	System Information	Conduction Mode
28.	Overshoot Value	56.851 mV	System Information	Theoretical Vout Overshoot Value
29.	Pout	14.736 W	System Information	Total output power
30.	Total BOM	$5.69	System Information	Total BOM Cost
31.	Undershoot Value	35.432 mV	System Information	Theoretical Vout Undershoot Value
32.	Vin	12.6 V	System Information	Vin operating point
33.	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).
34.	Vin p-p	257.039 mV	System Information	Peak-to-peak input voltage
35.	Vout	1.2 V	System Information	Operational Output Voltage
36.	Vout Ripple requirement used for Cout calculations	3.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
37.	Vout Tolerance	546.37 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
38.	Vout p-p	1.115 mV	System Information	Peak-to-peak output ripple voltage
39.	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	12.28	Maximum Output Current
	VinMax	12.6	Maximum input voltage
	VinMin	11.64	Minimum input voltage
	Vout	1.2	Output Voltage
	base_pn	TPS543C20A	Base Product Number
	source	DC	Input Source Type
	Ta	50.0	Ambient temperature
	UserFsw	1.149 M	Customer Selected Frequency
1.	Vout Sch	1.2	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

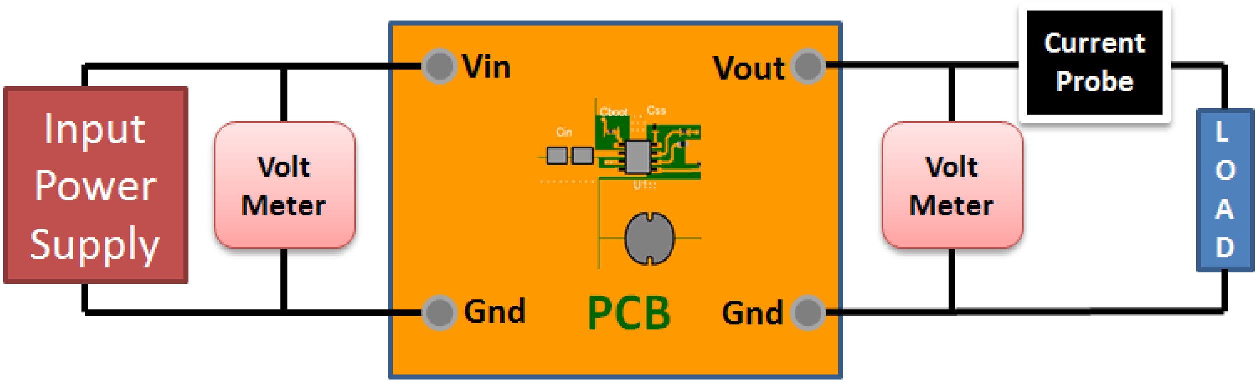
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 11.64V 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.

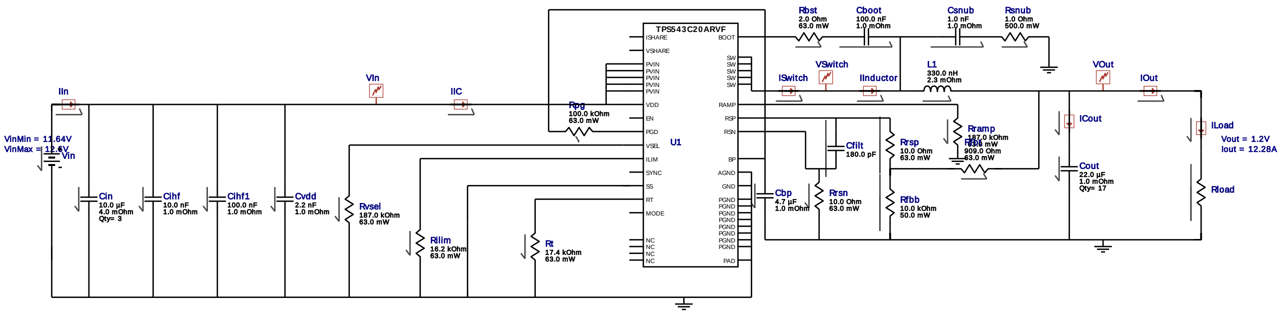


WEBENCH® Electrical Simulation Report

Design Id = 771

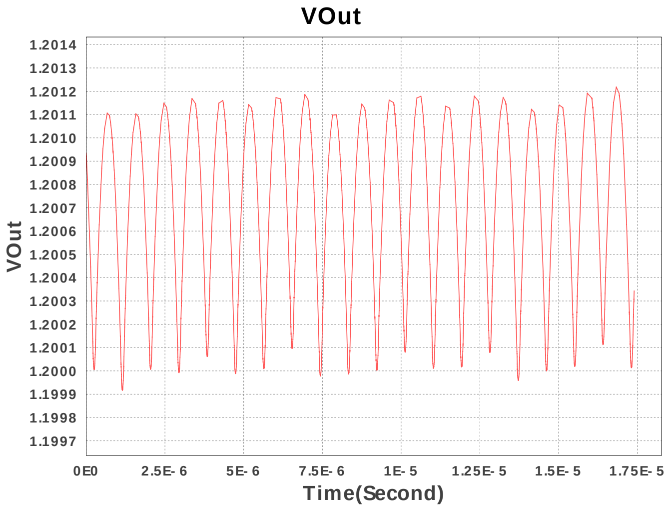
sim_id = 1

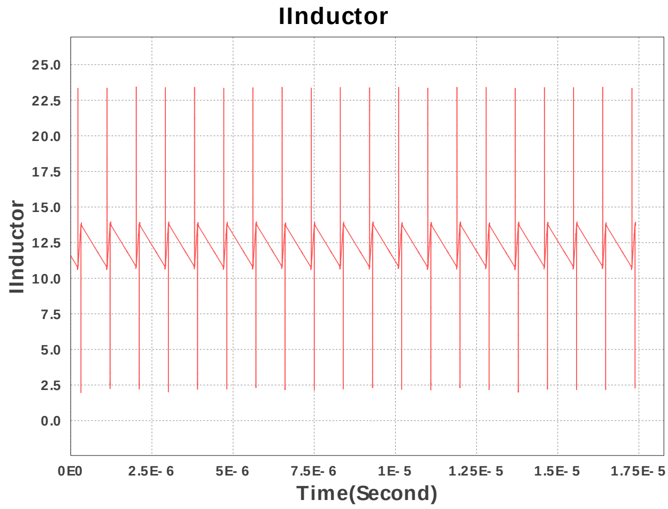
Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	L1	IC	Initial Condition	12.28
2.	Cboot	IC	no description	3.15
3.	Rload	R	Load Resistance	0.09771986970684039 Ohm





Design Assistance

1. Master key : 705BAF3F164BD058[v1]

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

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