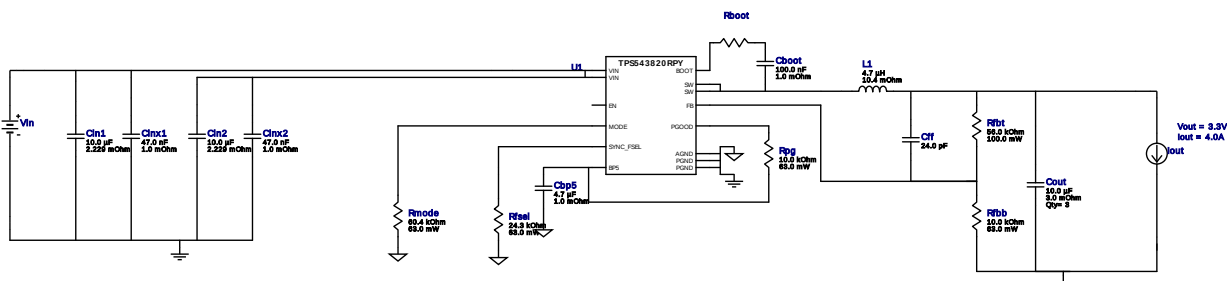


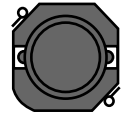
WEBENCH® Design Report

Design : 7 TPS543820RPYR
TPS543820RPYR 11V-13V to 3.30V @ 4A

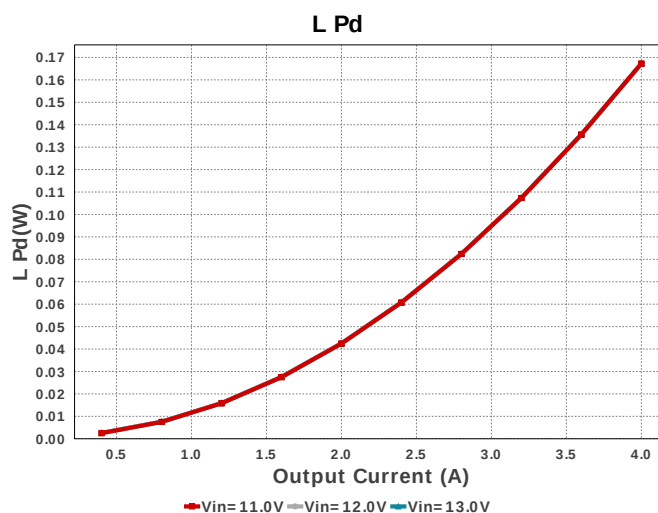
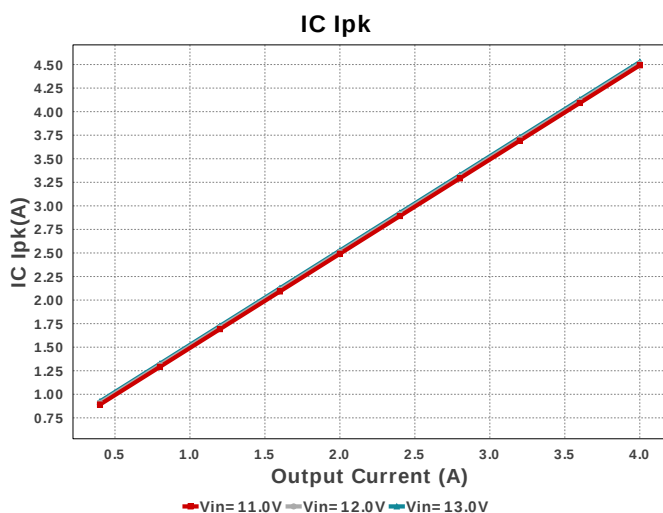
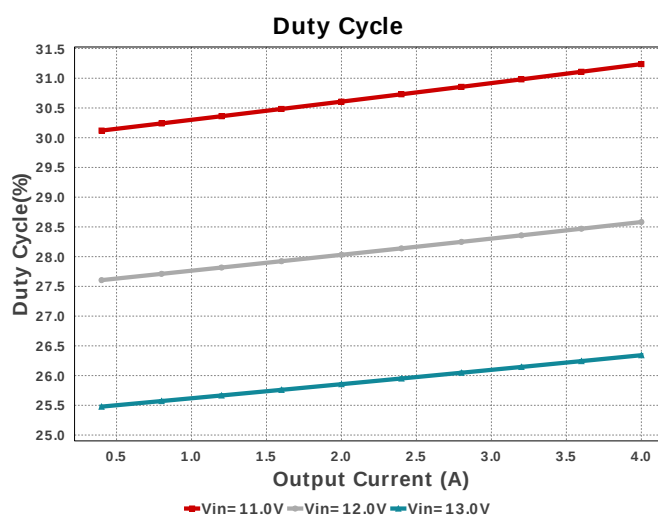
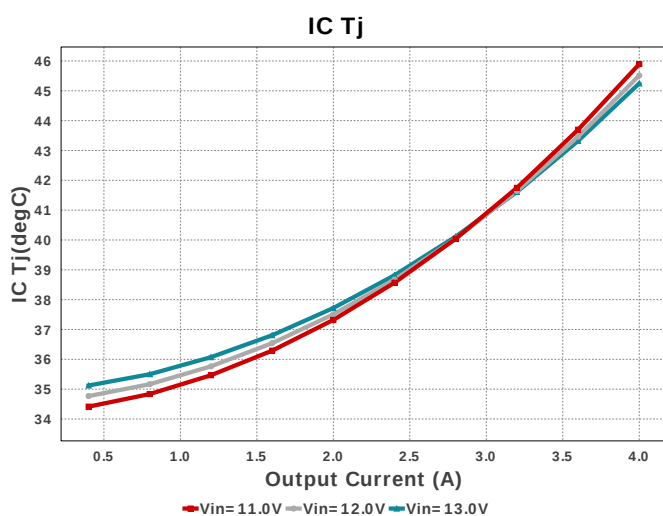


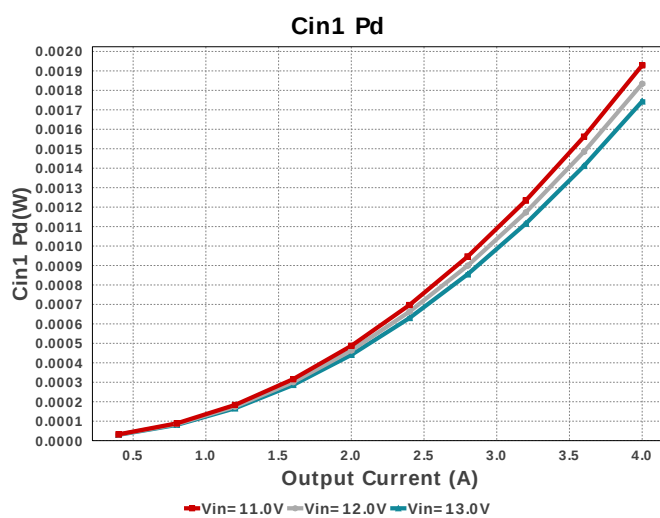
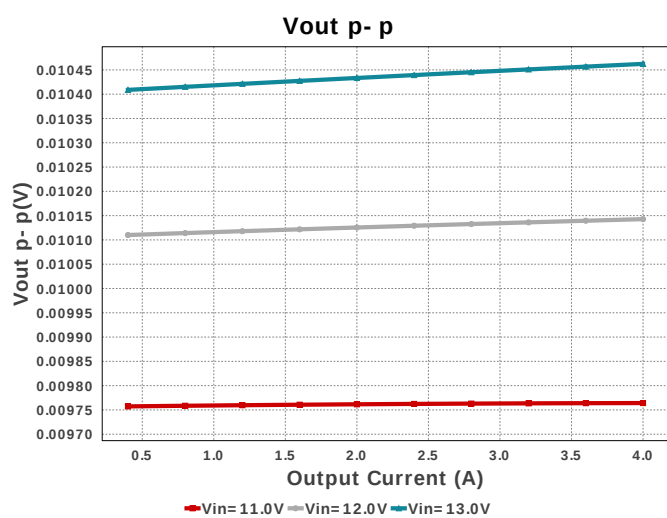
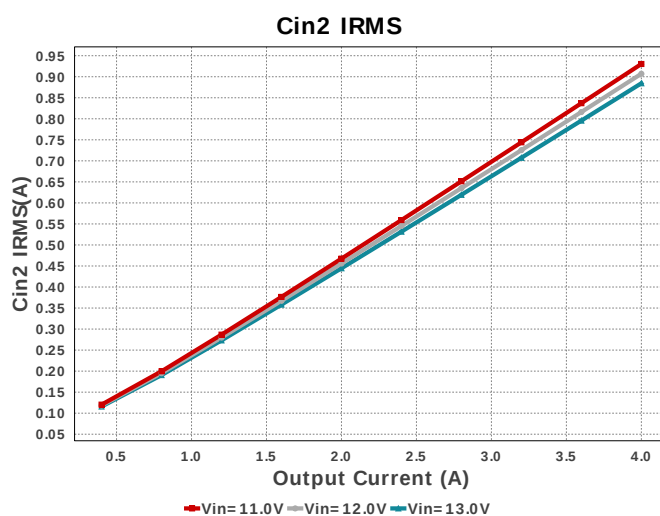
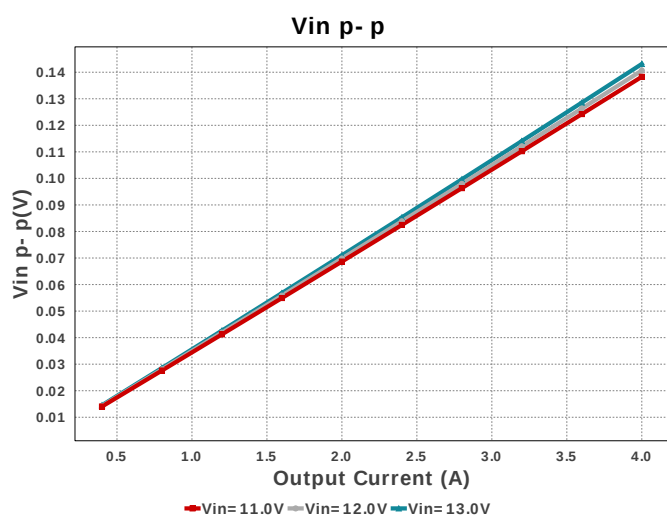
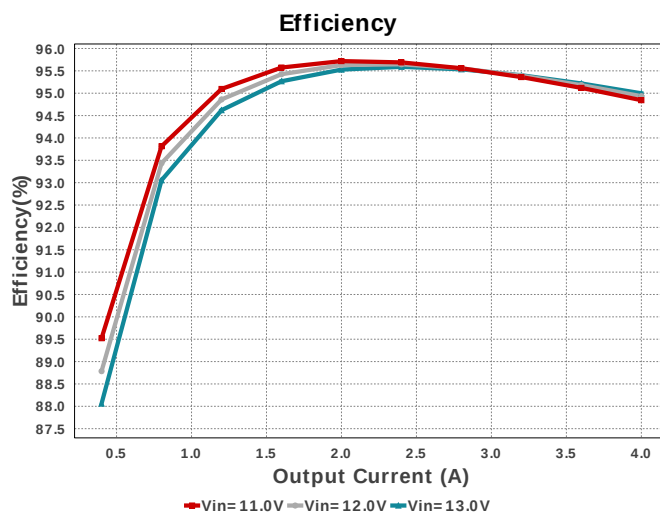
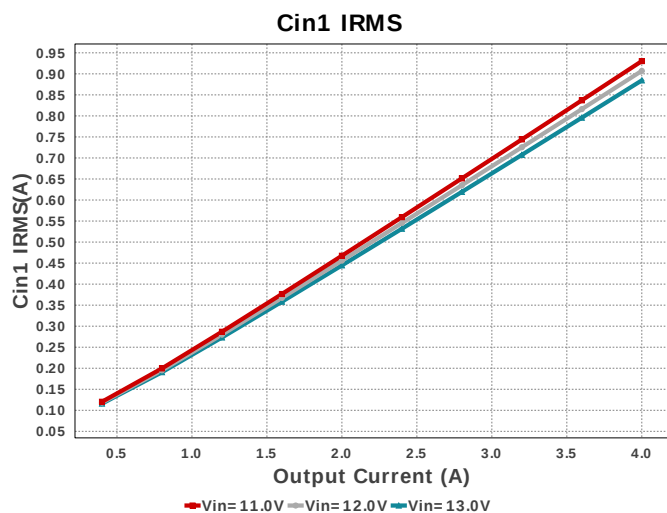
1. Place 0 Ohm resistor for Rboot.

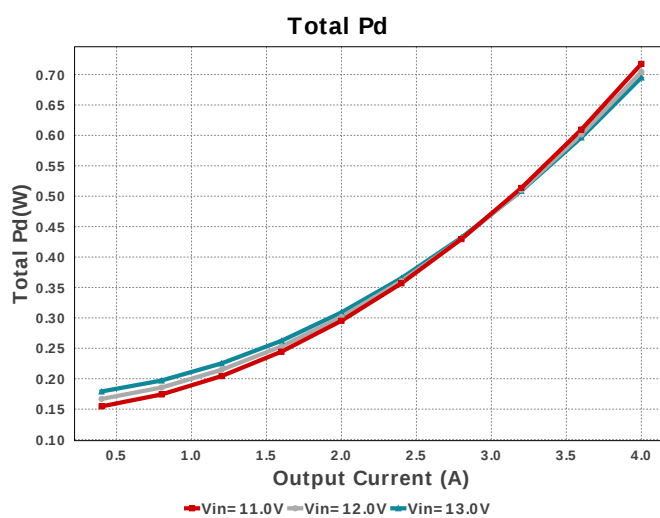
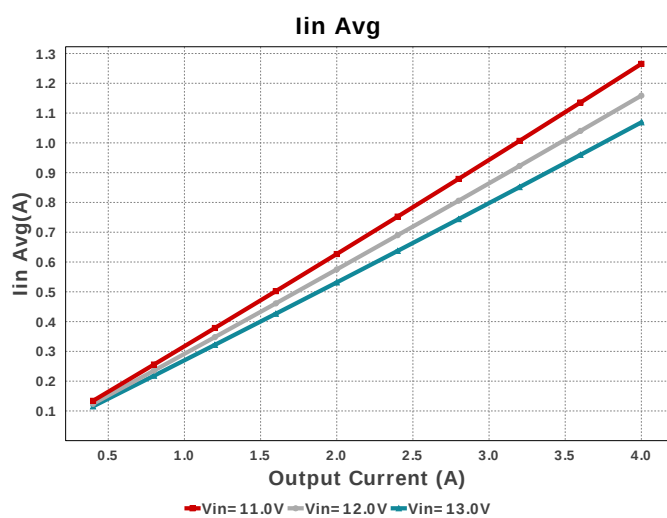
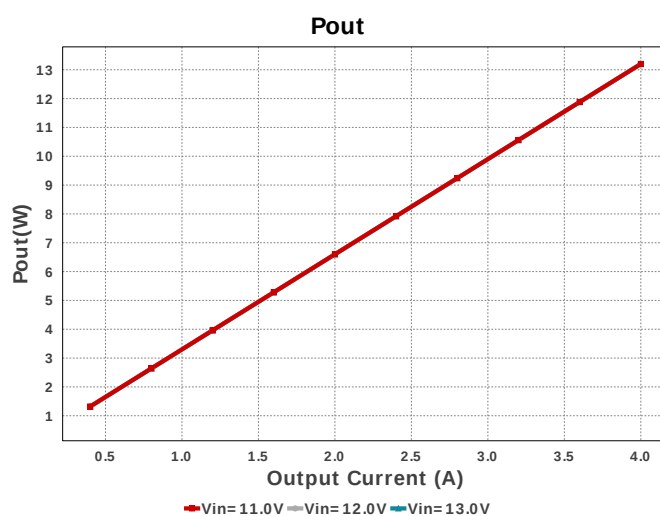
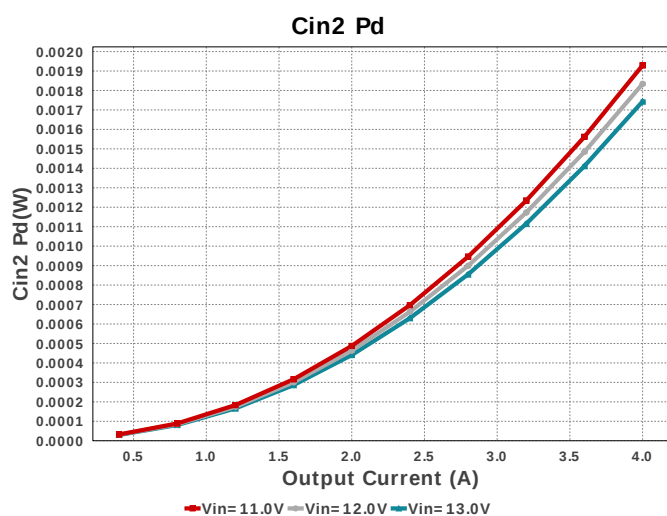
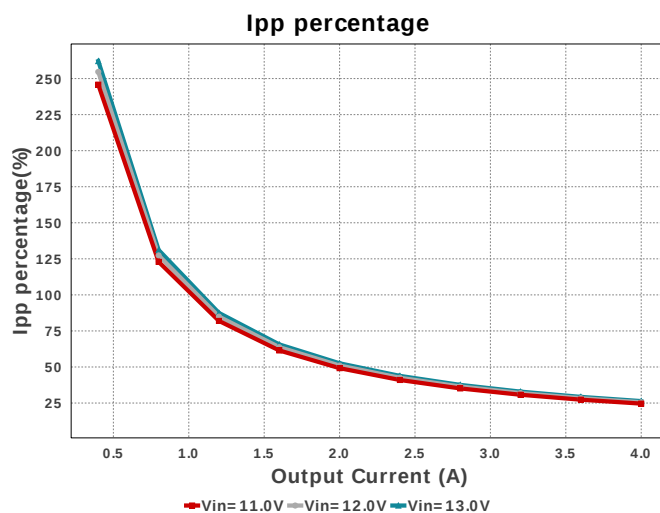
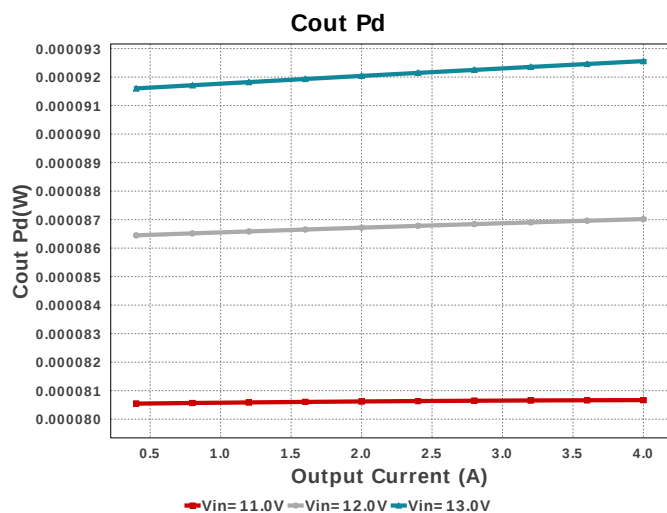
Electrical BOM

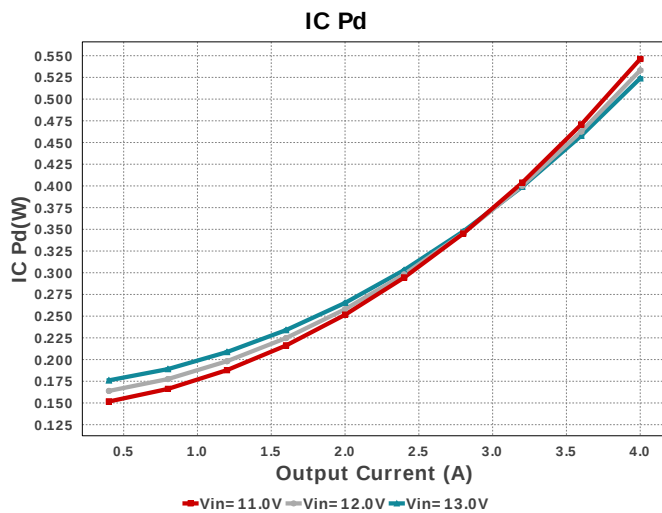
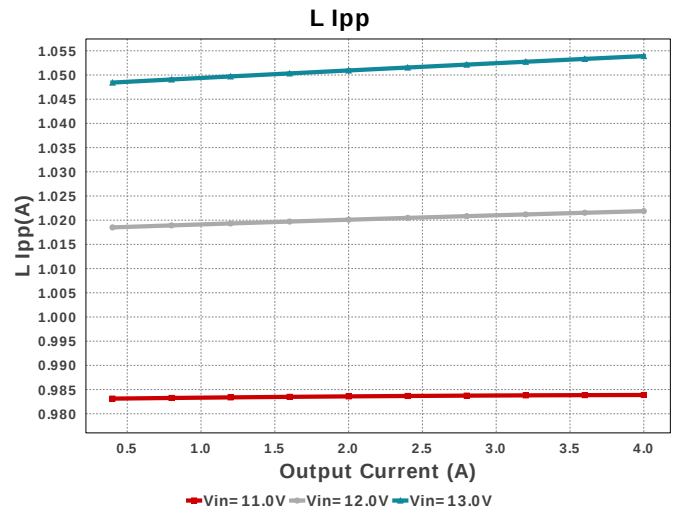
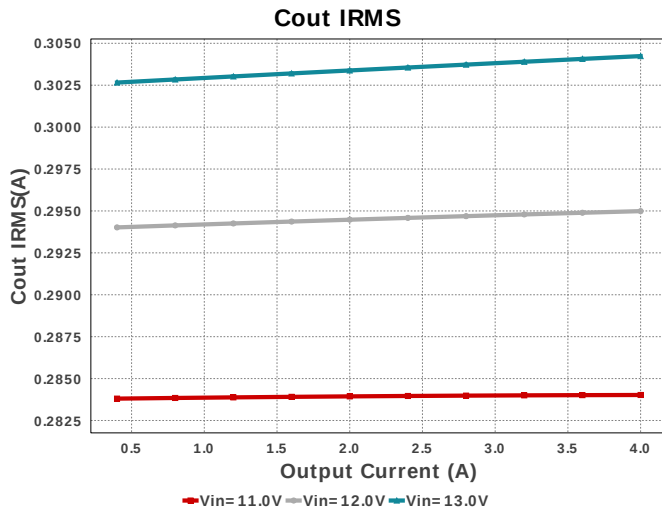
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
Cbp5	Taiyo Yuden	LMK212BJ475KD-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	\$0.03	0805 7 mm ²
Cff	Kemet	C0402C240J3GACTU Series= C0G/NP0	Cap= 24.0 pF VDC= 25.0 V IRMS= 0.0 A	1	\$0.08	0402 3 mm ²
Cin1	TDK	C3216X7R1V106K160AC Series= X7R	Cap= 10.0 uF ESR= 2.229 mOhm VDC= 35.0 V IRMS= 4.8593 A	1	\$0.19	1206_180 11 mm ²
Cin2	TDK	C3216X7R1V106K160AC Series= X7R	Cap= 10.0 uF ESR= 2.229 mOhm VDC= 35.0 V IRMS= 4.8593 A	1	\$0.19	1206_180 11 mm ²
Cinx1	MuRata	GRM155R71E473KA88D Series= X7R	Cap= 47.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
Cinx2	MuRata	GRM155R71E473KA88D Series= X7R	Cap= 47.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	0402 3 mm ²
Cout	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	3	\$0.03	0805 7 mm ²
L1	Coilcraft	MSS1048-472NLB	L= 4.7 uH 10.4 mOhm	1	\$0.56	 MSS1048 146 mm ²
Rfbb	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbt	Susumu Co Ltd	RR1220P-563-D Series= RR12	Res= 56.0 kOhm Power= 100.0 mW Tolerance= 0.5%	1	\$0.01	0805 7 mm ²
Rfsel	Vishay-Dale	CRCW040224K3FKED Series= CRCW..e3	Res= 24.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
Rmode	Vishay-Dale	CRCW040260K4FKED Series= CRCW..e3	Res= 60.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
Rpg	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	0402 3 mm ²
U1	Texas Instruments	TPS543820RPYR	Switcher	1	\$1.40	RPY0014A-MFG 14 mm ²









Operating Values

#	Name	Value	Category	Description
1.	Cin1 IRMS	884.434 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin1 Pd	1.744 mW	Capacitor	Input capacitor power dissipation
3.	Cin2 IRMS	884.434 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin2 Pd	1.744 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	304.237 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	92.56 μ W	Capacitor	Output capacitor power dissipation
7.	Total Cin ESR	2.229 mOhm	Capacitor	Cin Capacitor ESR
8.	Total Cout ESR	1.0 mOhm	Capacitor	Cout Capacitor ESR
9.	Cramp	2.0 pF	IC	Selected Cramp for setting Ramp amplitude
10.	IC Ipk	4.527 A	IC	Peak switch current in IC
11.	IC Pd	523.98 mW	IC	IC power dissipation
12.	IC Tj	45.248 degC	IC	IC junction temperature
13.	IC Tolerance	2.5 mV	IC	IC Feedback Tolerance
14.	ICThetaJA Effective	29.1 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
15.	Iin Avg	1.069 A	IC	Average input current
16.	Ipp percentage	26.348 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
17.	L Ipp	1.054 A	Inductor	Peak-to-peak inductor ripple current
18.	L Pd	167.36 mW	Inductor	Inductor power dissipation
19.	L1 DCR	10.4 mOhm	Inductor	L1 DCR
20.	Cin1 Pd	1.744 mW	Power	Input capacitor power dissipation
21.	Cin2 Pd	1.744 mW	Power	Input capacitor power dissipation
22.	Cout Pd	92.56 μ W	Power	Output capacitor power dissipation
23.	IC Pd	523.98 mW	Power	IC power dissipation
24.	L Pd	167.36 mW	Power	Inductor power dissipation
25.	Total Pd	695.063 mW	Power	Total Power Dissipation
26.	BOM Count	17	System	Total Design BOM count
27.	Duty Cycle	26.342 %	System	Duty cycle
28.	Efficiency	94.998 %	System	Steady state efficiency

#	Name	Value	Category	Description
29.	FootPrint	240.0 mm ²	System Information	Total Foot Print Area of BOM components
30.	Frequency	500.0 kHz	System Information	Switching frequency
31.	Inductor ripple current requirement used for Inductor selection	30.0 %	System Information	Custom Inductor ripple current (% of average inductor current) requirement used for Inductor selection
32.	Iout	4.0 A	System Information	Iout operating point
33.	Iout transient step used for Cout calculations	1.0 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
34.	Mode	CCM	System Information	Conduction Mode
35.	Overshoot Value	28.185 mV	System Information	Theoretical Vout Overshoot Value
36.	Peak Over current Limit HS FET(Maximum)	9.6 A	System Information	Over current protection threshold
37.	Peak Over current Limit HS FET(Minimum)	8.6 A	System Information	Over current protection threshold
38.	Peak Over current Limit HS FET(typical)	9.0 A	System Information	Over current protection threshold
39.	Pout	13.2 W	System Information	Total output power
40.	Total BOM	\$2.62	System Information	Total BOM Cost
41.	Undershoot Value	68.653 mV	System Information	Theoretical Vout Undershoot Value
42.	Vin	13.0 V	System Information	Vin operating point
43.	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).
44.	Vin p-p	143.107 mV	System Information	Peak-to-peak input voltage
45.	Vout Actual	3.3 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	1.792 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
48.	Vout p-p	10.462 mV	System Information	Peak-to-peak output ripple voltage
49.	Vout transient requirement used for Cout calculations	4.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

Name	Value	Description
Iout	4.0	Maximum Output Current
VinMax	13.0	Maximum input voltage
VinMin	11.0	Minimum input voltage
VinTyp	12.0	Typical input voltage
Vout	3.3	Output Voltage
base_pn	TPS543820	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature

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 C_{in} and C_{out} , 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

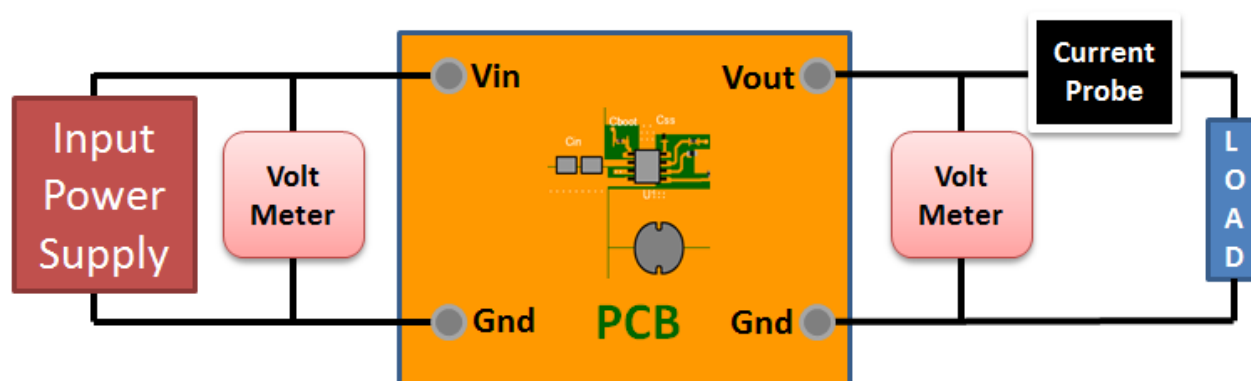
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab down 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 11.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to V_{in} and GND. Connect a digital volt meter and a load if needed to set the minimum load of the design from V_{out} 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 V_{in} and GND, a load is connected between V_{out} and GND and a current meter is connected in series between V_{out} 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 : 52003F2EB9EC5023[v1]
2. **TPS543820** Product Folder : <http://www.ti.com/product/TPS543820> : contains the data sheet and other resources.

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