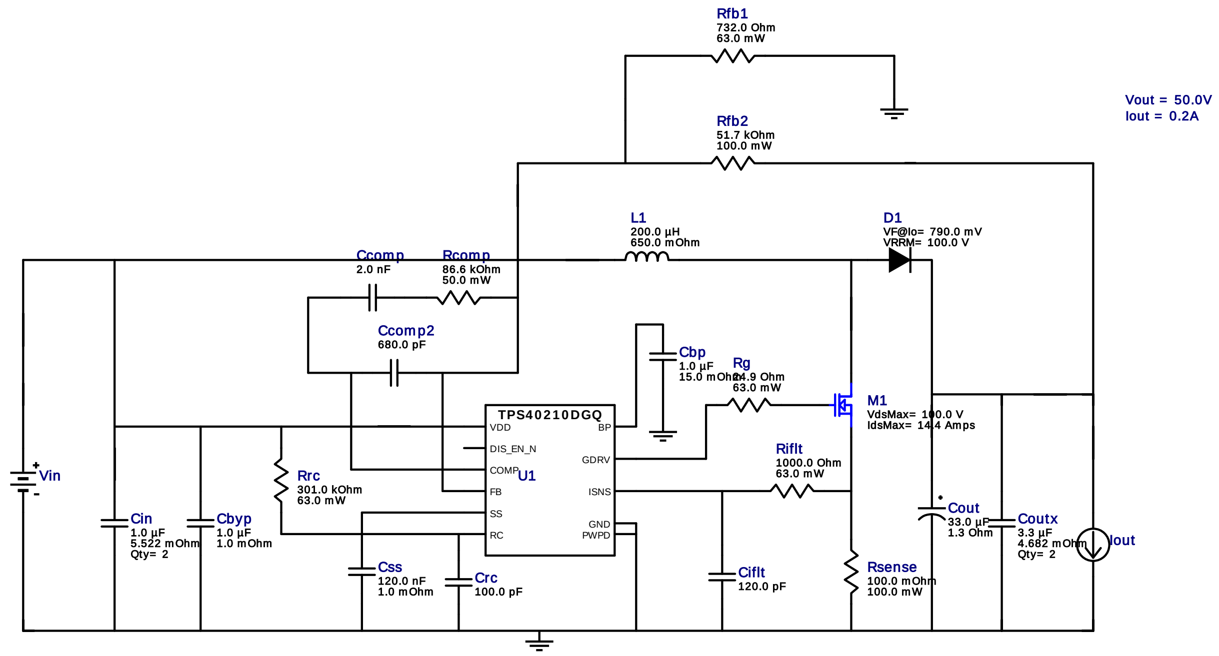
VinMin = 23.0V
VinMax = 25.0V
Vout = 50.0V
Iout = 0.2A

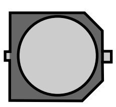
Device = TPS40210DGQR
Topology = Boost
Created = 2021-02-12 07:18:22.104
BOM Cost = $2.51
BOM Count = 23
Total Pd = 0.8W

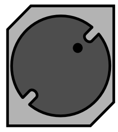
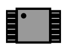
WEBENCH ® Design Report

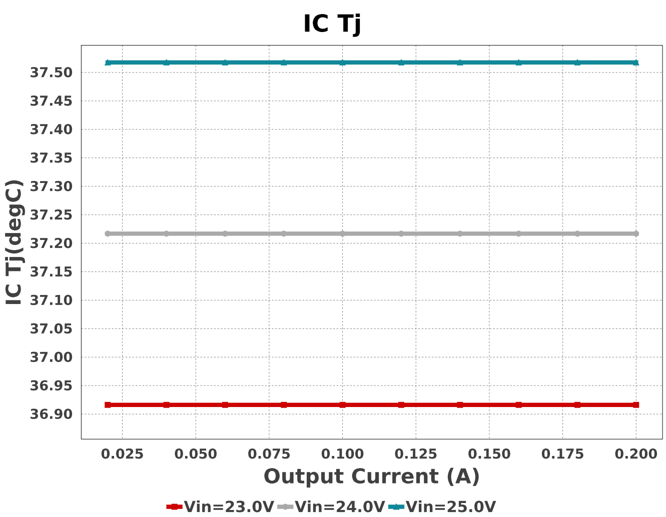
Design : 132 TPS40210DGQR
TPS40210DGQR 23V-25V to 50.00V @ 0.2A

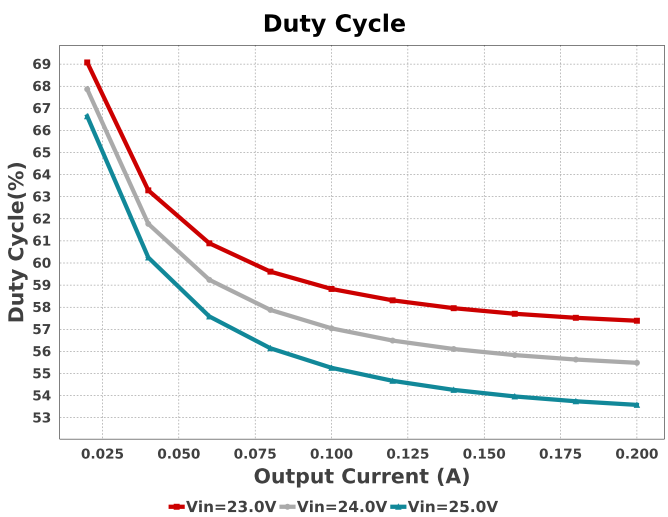


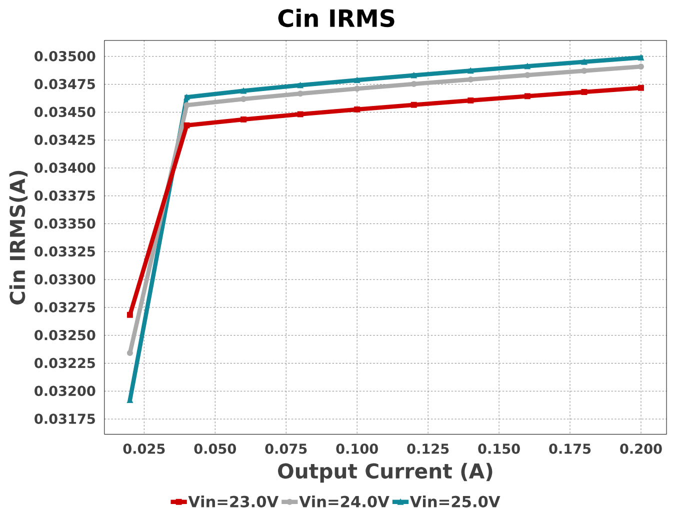
Electrical BOM

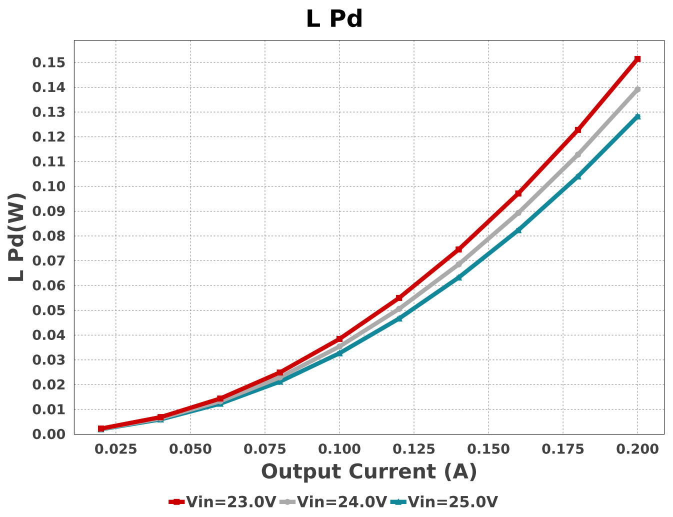
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbp	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm²
Cbyp	Taiyo Yuden	TMK212B7105KG-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Ccomp	Kemet	C0805C202J3GACTU Series= C0G/NP0	Cap= 2.0 nF VDC= 5.0 V IRMS= 0.0 A	1	$0.13	0805 7 mm²
Ccomp2	Samsung Electro-Mechanics	CL05C681JB5NNNC Series= C0G/NP0	Cap= 680.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ciflt	Samsung Electro-Mechanics	CL21C121JBANNNC Series= C0G/NP0	Cap= 120.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cin	TDK	C1608X7R1V105K080AC Series= X7R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 35.0 V IRMS= 2.2162 A	2	$0.05	0603 5 mm²
Cout	Panasonic	EEE-FK1K330P Series= FK	Cap= 33.0 uF ESR= 1.3 Ohm VDC= 80.0 V IRMS= 130.0 mA	1	$0.21	 SM_RADIAL_F 124 mm²
Coutx	TDK	C3225X7S2A335K200AB Series= X7S	Cap= 3.3 uF ESR= 4.682 mOhm VDC= 100.0 V IRMS= 3.39944 A	2	$0.29	1210 15 mm²

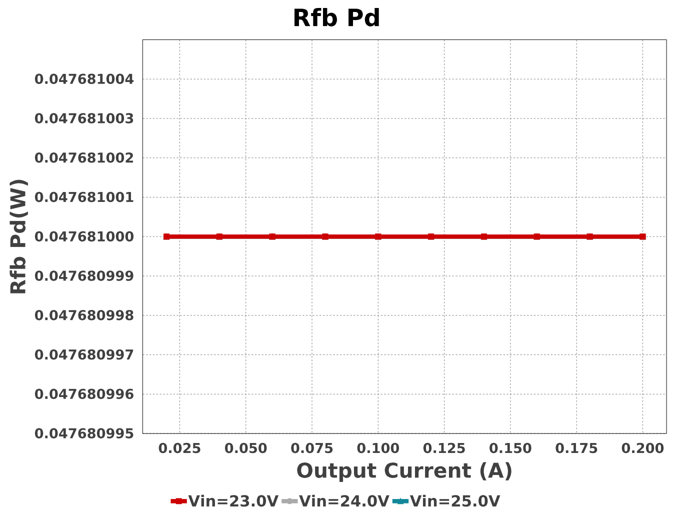
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Crc	Samsung Electro-Mechanics	CL21C101JBANNNC Series= C0G/NP0	Cap= 100.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Css	MuRata	GRM155R61A124KE19D Series= X5R	Cap= 120.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0402 3 mm²
D1	Diodes Inc.	B2100-13-F	VF@Io= 790.0 mV VRRM= 100.0 V	1	$0.13	 SMB 44 mm²
L1	Bourns	SDR1105-201KL	L= 200.0 µH 650.0 mOhm	1	$0.36	 SDR1105 157 mm²
M1	Texas Instruments	CSD19538Q2	VdsMax= 100.0 V IdsMax= 14.4 Amps	1	$0.15	DQK0006C 9 mm²
Rcomp	Yageo	RC0201FR-0786K6L Series= ?	Res= 86.6 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rfb1	Vishay-Dale	CRCW0402732RFKED Series= CRCW..e3	Res= 732.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfb2	Yageo	RT0603DRE0751K7L Series= RT0603	Res= 51.7 kOhm Power= 100.0 mW Tolerance= 0.5%	1	$0.02	0603 5 mm²
Rg	Vishay-Dale	CRCW040224R9FKED Series= CRCW..e3	Res= 24.9 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Riflt	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rrc	Vishay-Dale	CRCW0402301KFKED Series= CRCW..e3	Res= 301.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsense	Panasonic	ERJ-3RSFR10V Series= ERJ-3R	Res= 100.0 mOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.03	0603 5 mm²
U1	Texas Instruments	TPS40210DGQR	Switcher	1	$0.66	 S-PDSO-G10 24 mm²

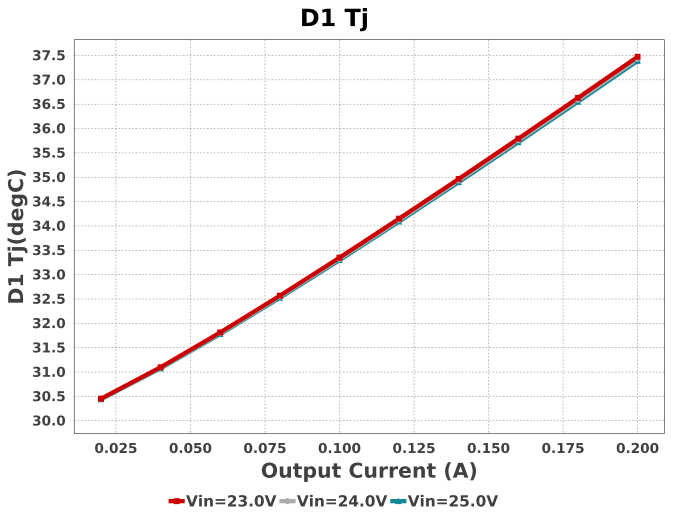


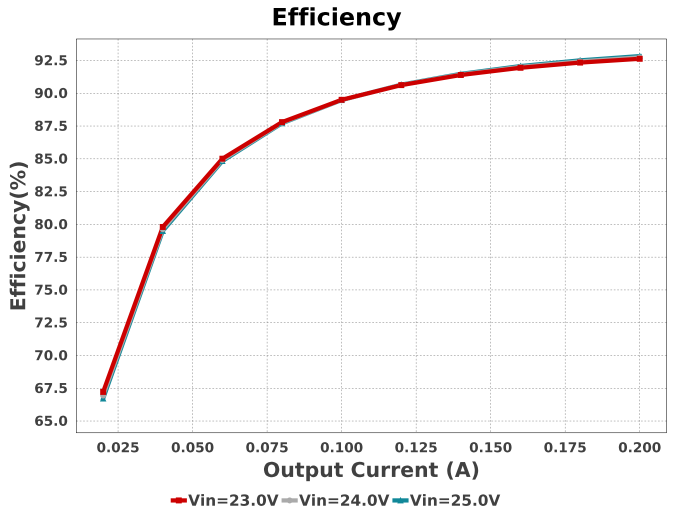


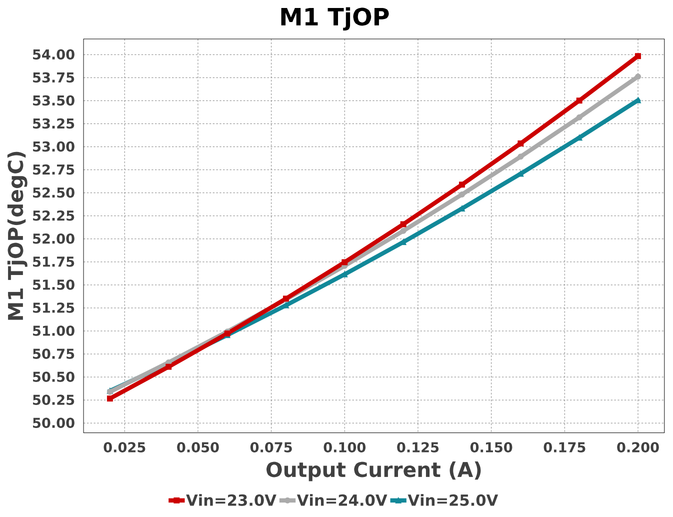

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V


L Pd
L Pd(W)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

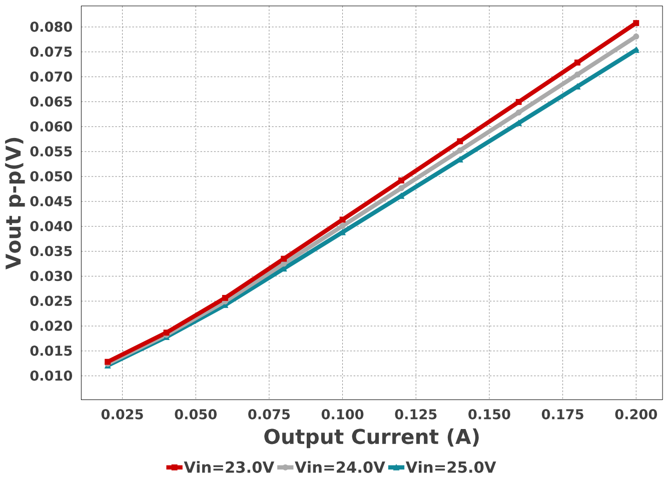

Rfb Pd
Rfb Pd(W)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V


D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

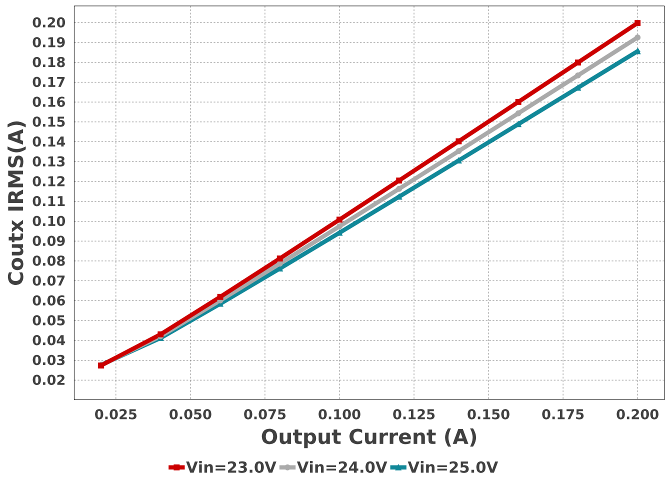

Efficiency
Efficiency(%)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V


M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

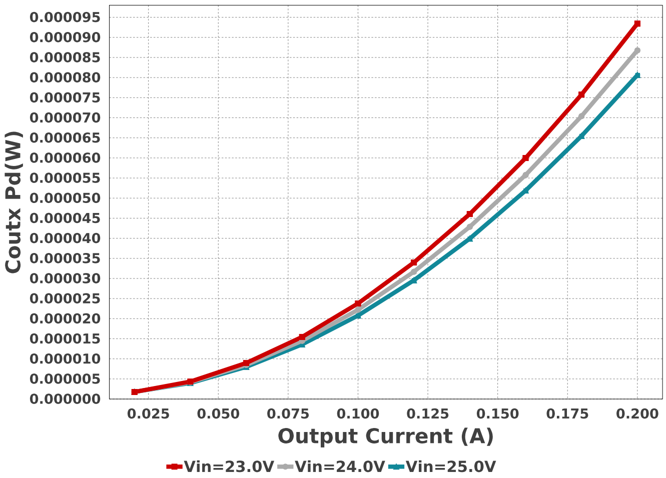
Vout p-p



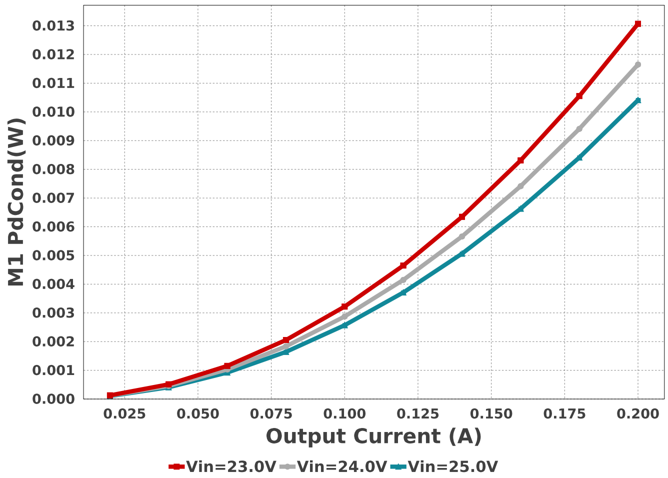
Coutx IRMS



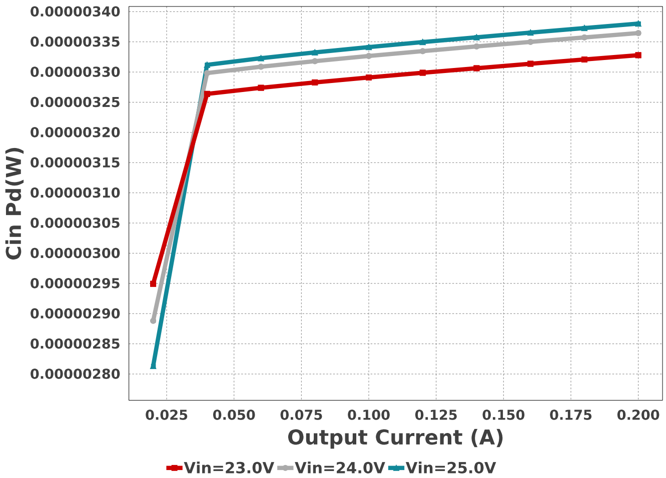
Coutx Pd



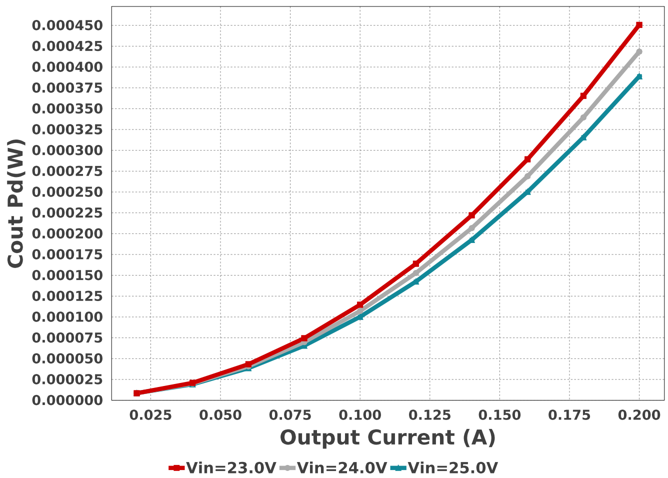
M1 PdCond

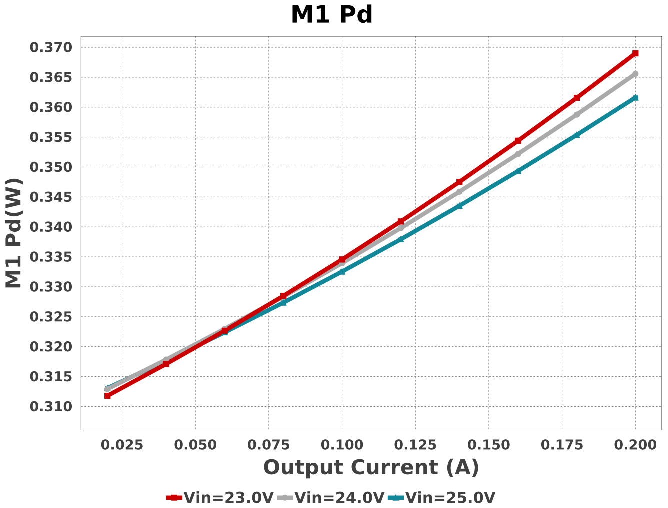


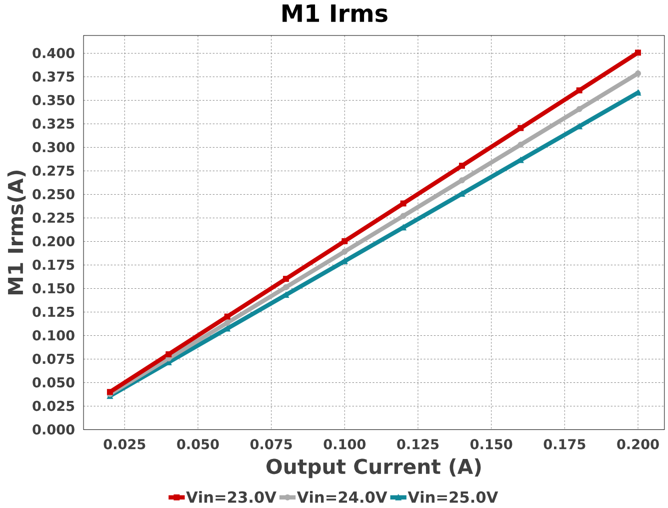
Cin Pd

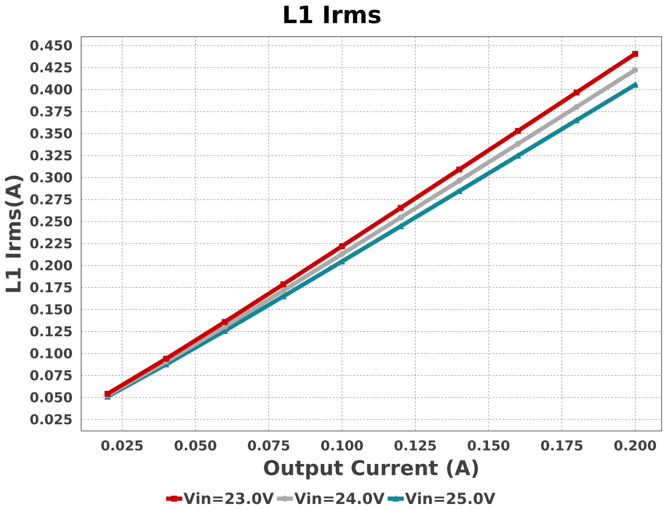


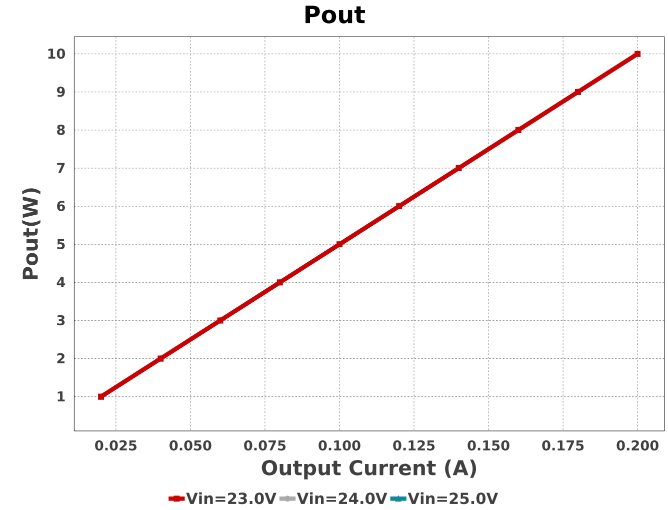
Cout Pd

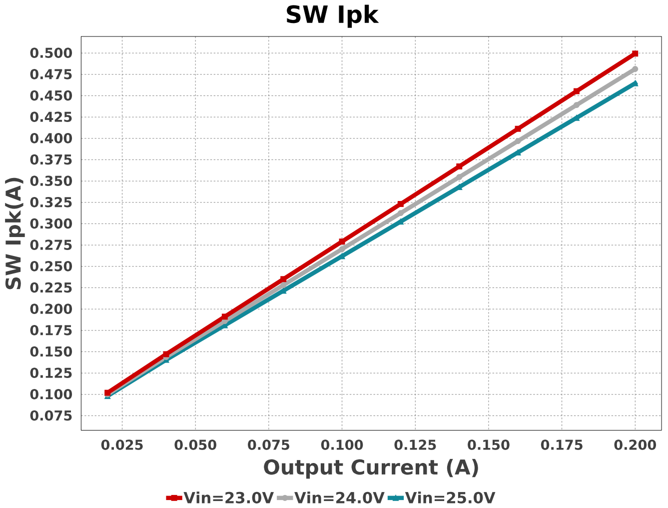


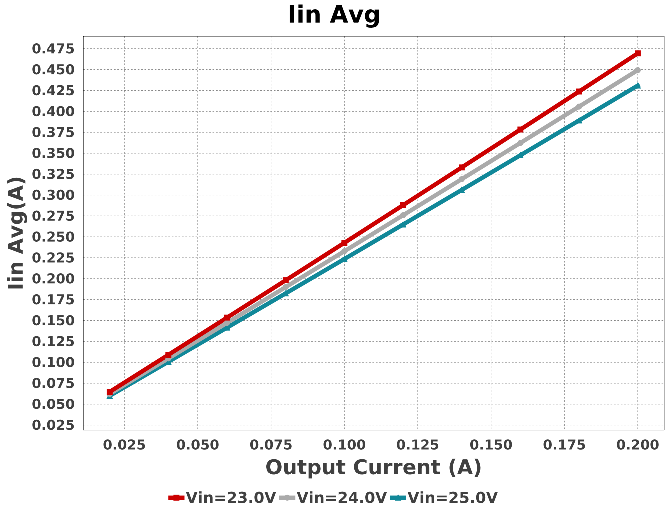

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

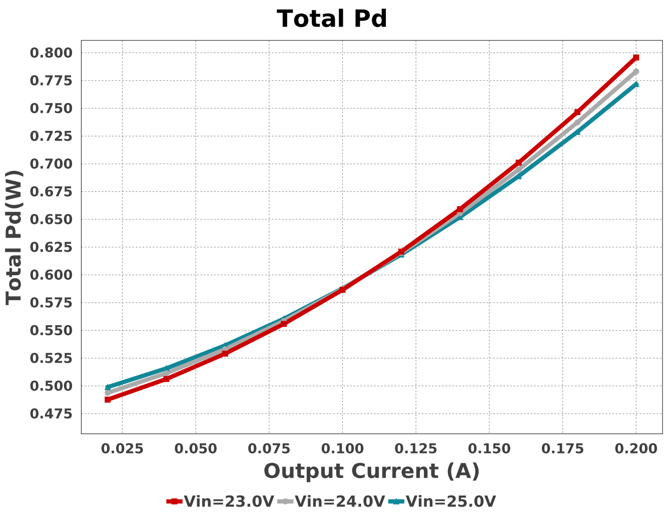

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

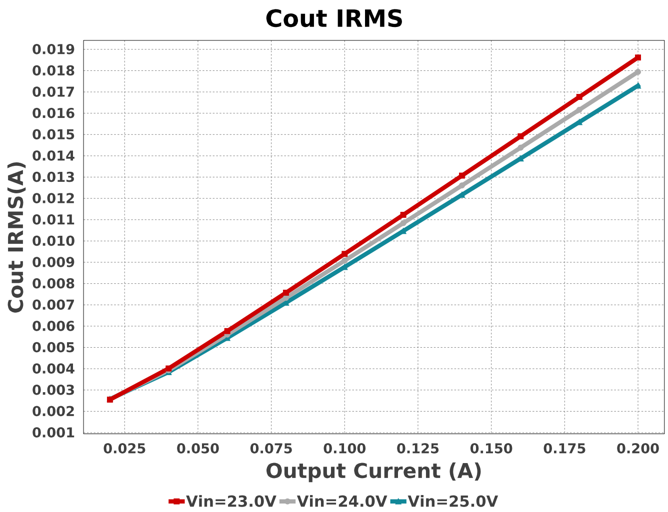

L1 Irms
L1 Irms(A)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

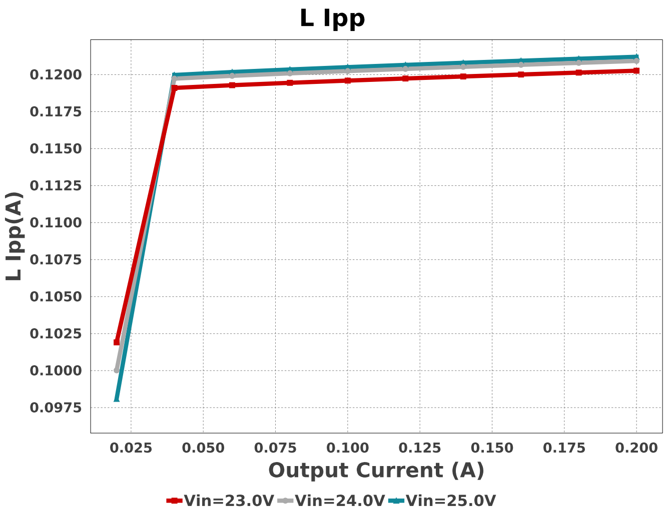

Pout
Pout(W)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

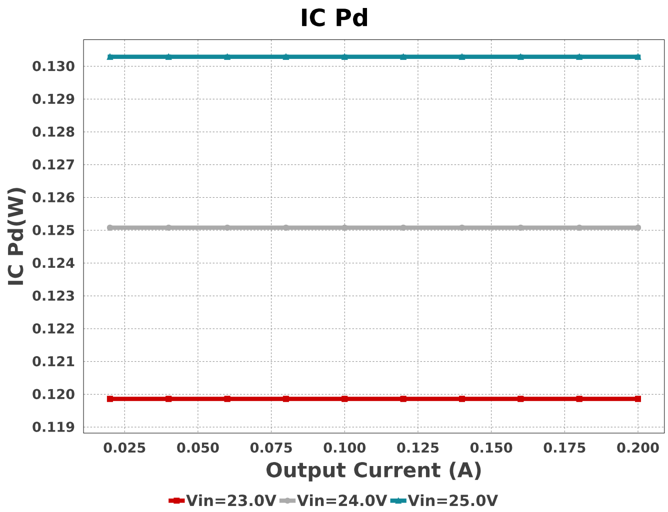

SW Ipk
SW Ipk(A)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

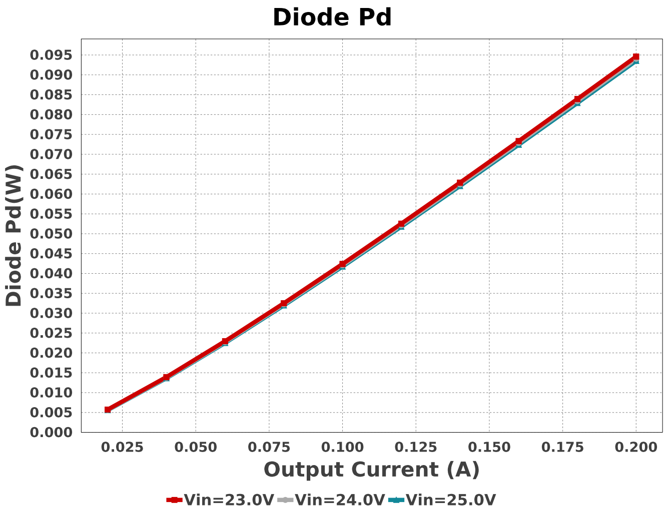

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

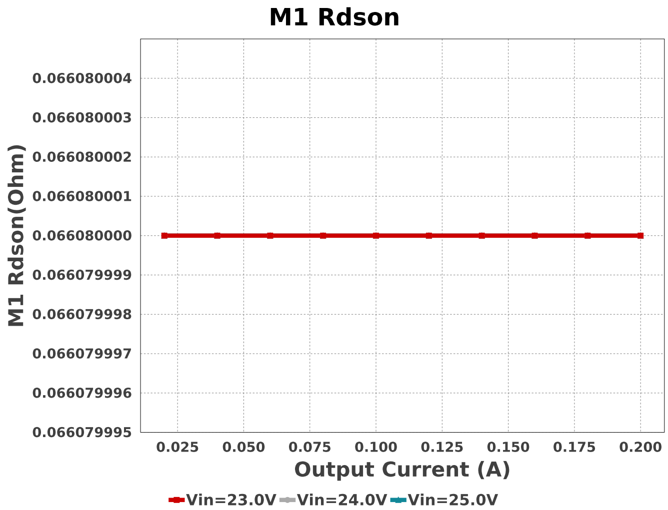

Total Pd
Total Pd(W)
0.800
0.775
0.750
0.725
0.700
0.675
0.650
0.625
0.600
0.575
0.550
0.525
0.500
0.475
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

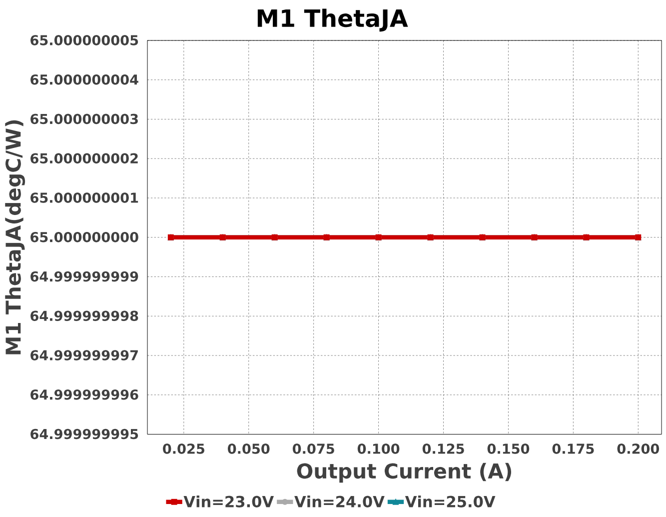

Cout IRMS
Cout IRMS(A)
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

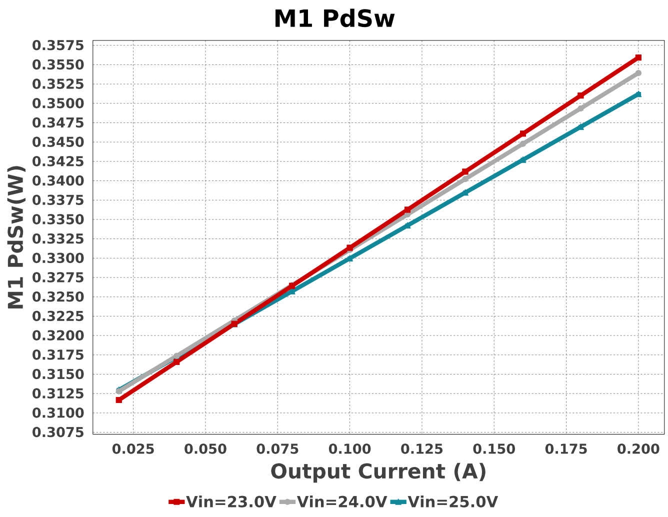

L Ipp
L Ipp(A)
0.1200
0.1175
0.1150
0.1125
0.1100
0.1075
0.1050
0.1025
0.1000
0.0975
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V

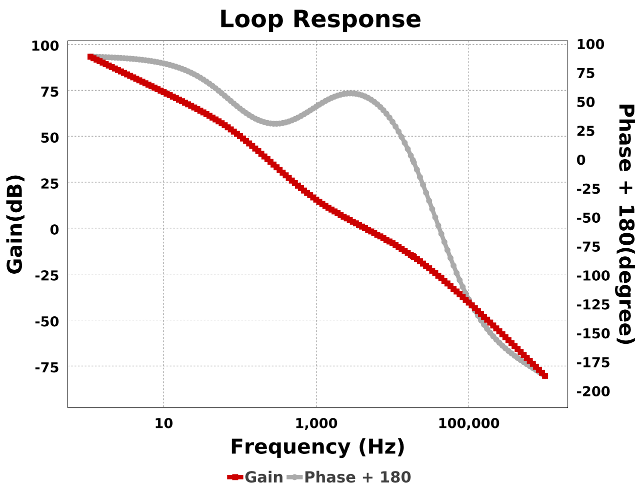

IC Pd
IC Pd(W)
0.130
0.129
0.128
0.127
0.126
0.125
0.124
0.123
0.122
0.121
0.120
0.119
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V


Diode Pd
Diode Pd(W)
0.095
0.090
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
0.000
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V


M1 Rdson
M1 Rdson(Ohm)
0.066080004
0.066080003
0.066080002
0.066080001
0.066080000
0.066079999
0.066079998
0.066079997
0.066079996
0.066079995
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200
Output Current (A)
Vin=23.0V Vin=24.0V Vin=25.0V







Operating Values

#	Name	Value	Category	Description
1.	BOM Count	23		Total Design BOM count
2.	Total BOM	$2.505		Total BOM Cost
3.	Cin IRMS	34.718 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	3.328 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	18.617 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	450.57 µW	Capacitor	Output capacitor power dissipation
7.	Coutx IRMS	199.769 mA	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	93.424 µW	Capacitor	Output capacitor_x power loss
9.	D1 Tj	37.472 degC	Diode	D1 junction temperature
10.	Diode Pd	94.587 mW	Diode	Diode power dissipation
11.	IC Pd	119.86 mW	IC	IC power dissipation
12.	IC Tj	36.916 degC	IC	IC junction temperature
13.	IC Tolerance	14.0 mV	IC	IC Feedback Tolerance
14.	ICThetaJA	57.7 degC/W	IC	IC junction-to-ambient thermal resistance
15.	Iin Avg	469.38 mA	IC	Average input current
16.	L Ipp	120.266 mA	Inductor	Peak-to-peak inductor ripple current
17.	L Pd	151.42 mW	Inductor	Inductor power dissipation
18.	L1 Irms	440.604 mA	Inductor	Inductor ripple current
19.	M1 Irms	400.668 mA	Mosfet	M1 MOSFET Irms
20.	M1 Pd	368.99 mW	Mosfet	M1 MOSFET total power dissipation
21.	M1 PdCond	13.068 mW	Mosfet	M1 MOSFET conduction losses
22.	M1 PdSw	355.92 mW	Mosfet	M1 MOSFET switching losses
23.	M1 Rdson	66.08 mOhm	Mosfet	Drain-Source On-resistance
24.	M1 ThetaJA	65.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
25.	M1 TjOP	53.984 degC	Mosfet	M1 MOSFET junction temperature
26.	Cin Pd	3.328 µW	Power	Input capacitor power dissipation
27.	Cout Pd	450.57 µW	Power	Output capacitor power dissipation
28.	Coutx Pd	93.424 µW	Power	Output capacitor_x power loss
29.	Diode Pd	94.587 mW	Power	Diode power dissipation
30.	IC Pd	119.86 mW	Power	IC power dissipation
31.	L Pd	151.42 mW	Power	Inductor power dissipation
32.	M1 Pd	368.99 mW	Power	M1 MOSFET total power dissipation

#	Name	Value	Category	Description
33.	M1 PdCond	13.068 mW	Power	M1 MOSFET conduction losses
34.	M1 PdSw	355.92 mW	Power	M1 MOSFET switching losses
35.	Rfb Pd	47.681 mW	Power	Rfb Power Dissipation
36.	Total Pd	795.754 mW	Power	Total Power Dissipation
37.	Rfb Pd	47.681 mW	Resistor	Rfb Power Dissipation
38.	Cross Freq	4.051 kHz	System Information	Bode plot crossover frequency
39.	Duty Cycle	57.387 %	System Information	Duty cycle
40.	Efficiency	92.629 %	System Information	Steady state efficiency
41.	FootPrint	460.0 mm^2	System Information	Total Foot Print Area of BOM components
42.	Frequency	525.481 kHz	System Information	Switching frequency
43.	Gain Marg	-15.139 dB	System Information	Bode Plot Gain Margin
44.	Iout	200.0 mA	System Information	Iout operating point
45.	Low Freq Gain	93.693 dB	System Information	Gain at 1Hz
46.	Mode	CCM	System Information	Conduction Mode
47.	Phase Marg	55.681 deg	System Information	Bode Plot Phase Margin
48.	Pout	10.0 W	System Information	Total output power
49.	SW Ipk	499.367 mA	System Information	Peak switch current
50.	Vin	23.0 V	System Information	Vin operating point
51.	Vout	50.0 V	System Information	Operational Output Voltage
52.	Vout Actual	50.14 V	System Information	Vout Actual calculated based on selected voltage divider resistors
53.	Vout Tolerance	3.524 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
54.	Vout p-p	80.783 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	200.0 m	Maximum Output Current
VinMax	25.0	Maximum input voltage
VinMin	23.0	Minimum input voltage
Vout	50.0	Output Voltage
base_pn	TPS40210	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 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

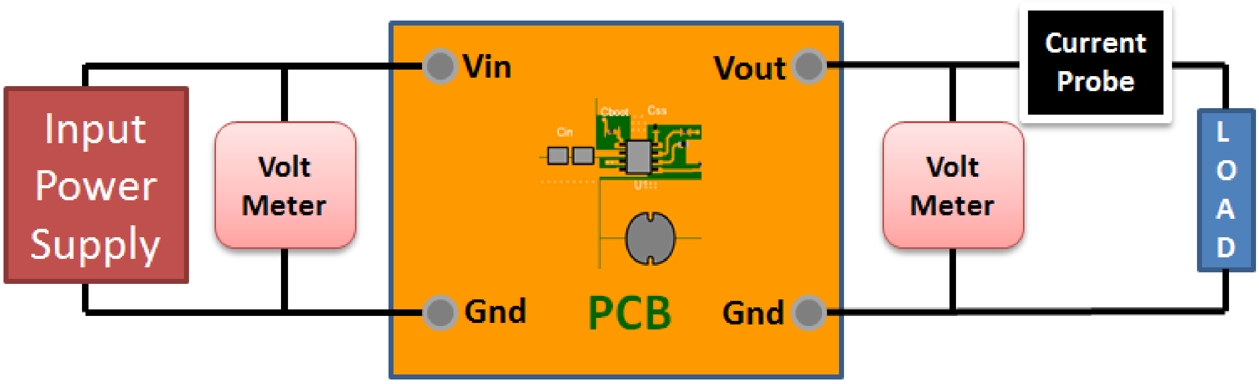
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 23.0V 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 : 41C90AB6DFF26FB4[v1]

2. **TPS40210** Product Folder : http://www.ti.com/product/TPS40210 : contains the data sheet and other resources.

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