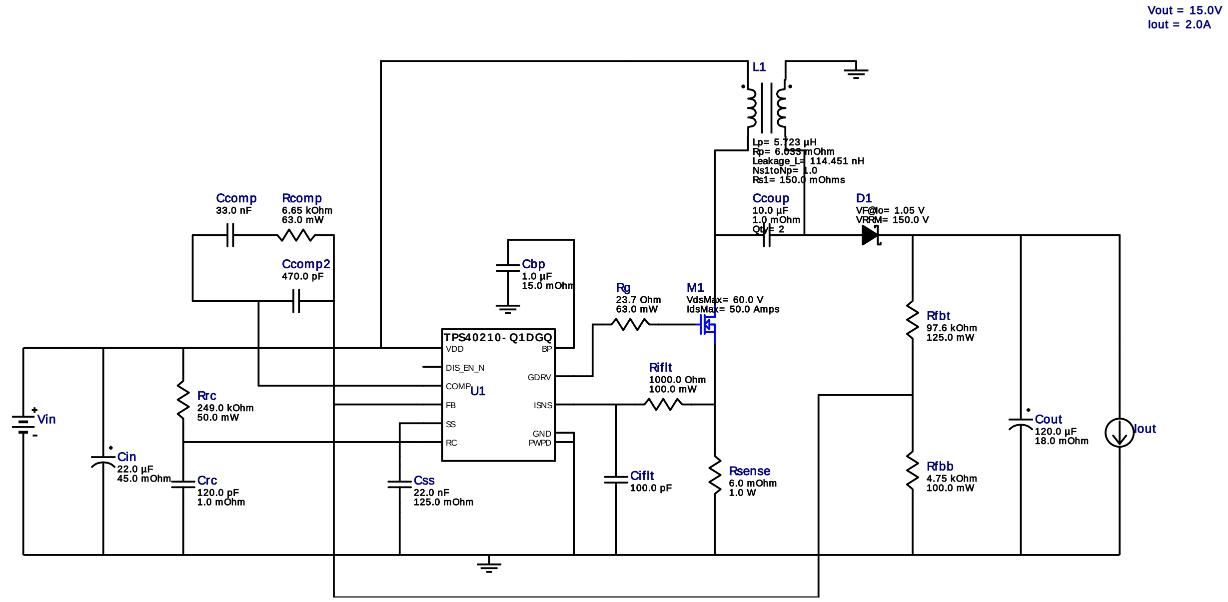
Device = TPS40210QDGQRQ1
Topology = SEPIC
Created = 2019-06-07 03:08:38.072
BOM Cost = NA
BOM Count = 21
Total Pd = 4.69W

WEBENCH ® Design Report

Design : 6582 TPS40210QDGQRQ1
TPS40210QDGQRQ1 5V-20V to 15.00V @ 2A



1. This regulator device is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.View WEBENCH(R) Disclaimer.

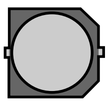
Design Alerts

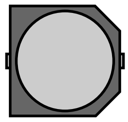
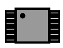
Component Selection Information

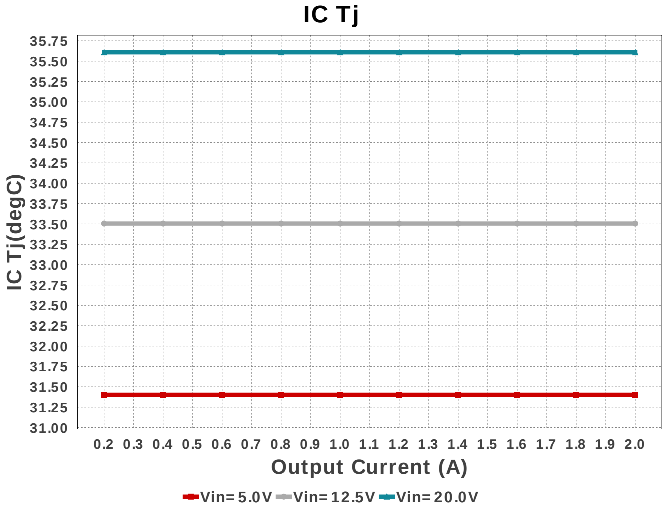
The TPS40210-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. View WEBENCH(R) Disclaimer

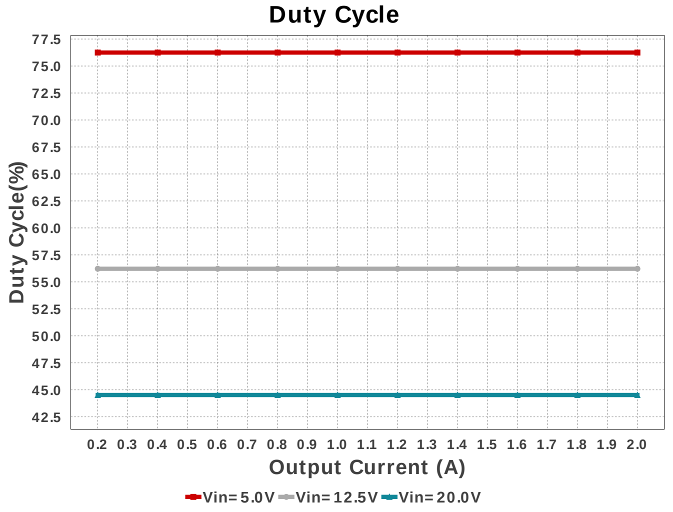
Electrical BOM

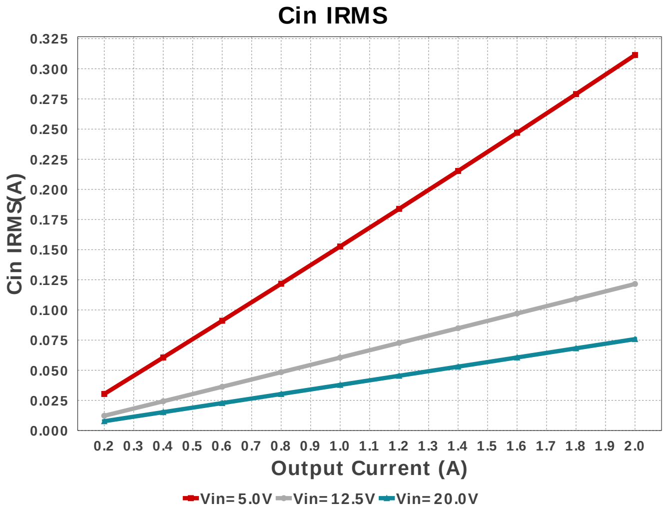
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbp	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm^2
Ccomp	TDK	C2012C0G1H333K125AA Series= C0G/NP0	Cap= 33.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.10	0805 7 mm^2
Ccomp2	AVX	04025A471JAT2A Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccoup	MuRata	GRM32ER71J106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 63.0 V IRMS= 6.0 A	2	$0.30	1210_280 15 mm^2
Ciflt	Samsung Electro-Mechanics	CL21C101JBANNNC Series= C0G/NP0	Cap= 100.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
Cin	Panasonic	EEHZA1K220P Series= ZA	Cap= 22.0 uF ESR= 45.0 mOhm VDC= 80.0 V IRMS= 1.55 A	1	$0.92	SM_RADIAL_8MM 113 mm^2

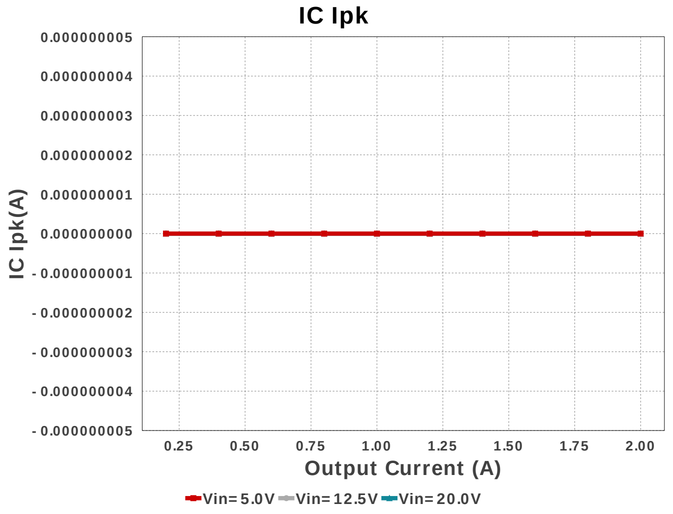


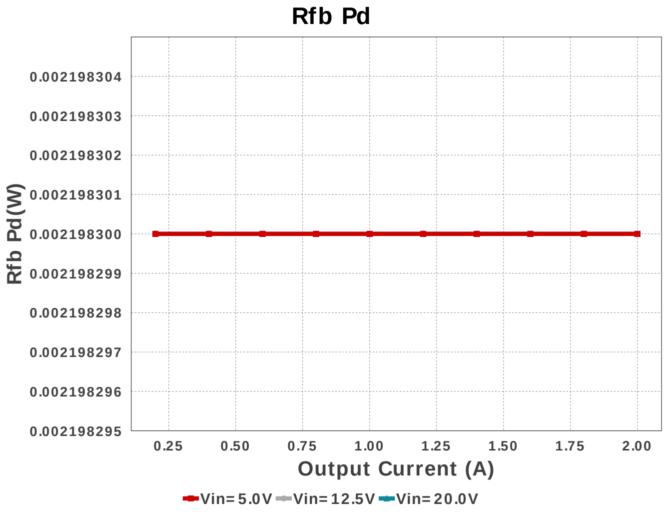
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cout	Panasonic	35SVPF120M Series= SVPF	Cap= 120.0 uF ESR= 18.0 mOhm VDC= 35.0 V IRMS= 4.4 A	1	$0.73	 CAPSMT_62_F12 151 mm^2
Crc	MuRata	GRM033R71E121KA01D Series= X7R	Cap= 120.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Css	Kemet	C0805C223K5RACTU Series= X7R	Cap= 22.0 nF ESR= 125.0 mOhm VDC= 50.0 V IRMS= 645.0 mA	1	$0.01	0805 7 mm^2
D1	SMC Diode Solutions	SB10150TA	VF@Io= 1.05 V VRRM= 150.0 V	1	$0.22	 DO-201AD 166 mm^2
L1	CUSTOM	CUSTOM	Lp= 5.723 µH Rp= 6.033 mOhm Leakage_L= 114.451 nH Ns1toNp= 1.0 Rs1= 150.0 mOhms	1	NA	CUSTOM 0 mm^2
M1	ON Semiconductor	NVTFS5C673NLTAG	VdsMax= 60.0 V IdsMax= 50.0 Amps	1	$0.36	FP-NVTFS5C673NLTAG_WDFN8-Recommended_Land_Pattern 0 mm^2
Rcomp	Vishay-Dale	CRCW04026K65FKED Series= CRCW..e3	Res= 6.65 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Susumu Co Ltd	RR1220P-4751-D-M Series= RR12	Res= 4.75 kOhm Power= 100.0 mW Tolerance= 0.5%	1	$0.01	0805 7 mm^2
Rfbt	Yageo	RT0805BRD0797K6L Series= ?	Res= 97.6 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.04	0805 7 mm^2
Rg	Vishay-Dale	CRCW040223R7FKED Series= CRCW..e3	Res= 23.7 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Riflt	Yageo	RC0603FR-071KL Series= ?	Res= 1000.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rrc	Yageo	RC0201FR-07249KL Series= ?	Res= 249.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rsense	Susumu Co Ltd	PRL1632-R006-F-T1 Series= PRL1632	Res= 6.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.20	 0612 11 mm^2
U1	Texas Instruments	TPS40210QDGQRQ1	Switcher	1	$0.89	 DGQ0010D_NV_N 24 mm^2

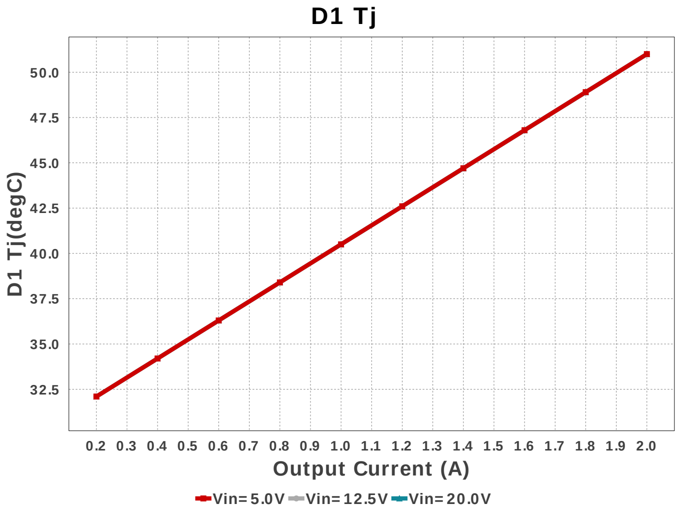

IC Tj
IC Tj(degC)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

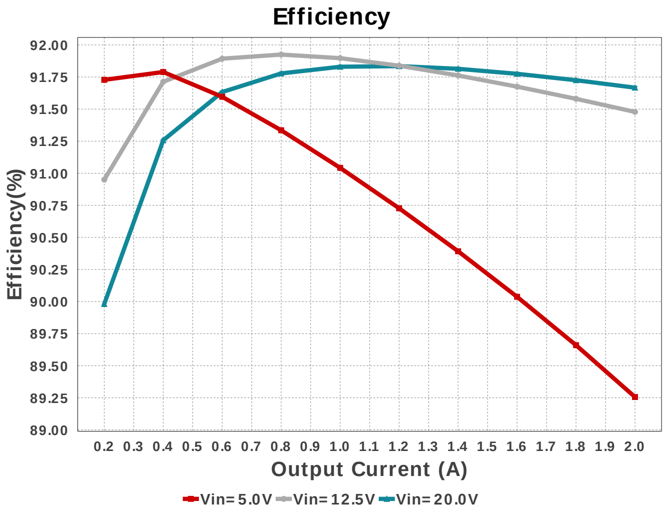

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

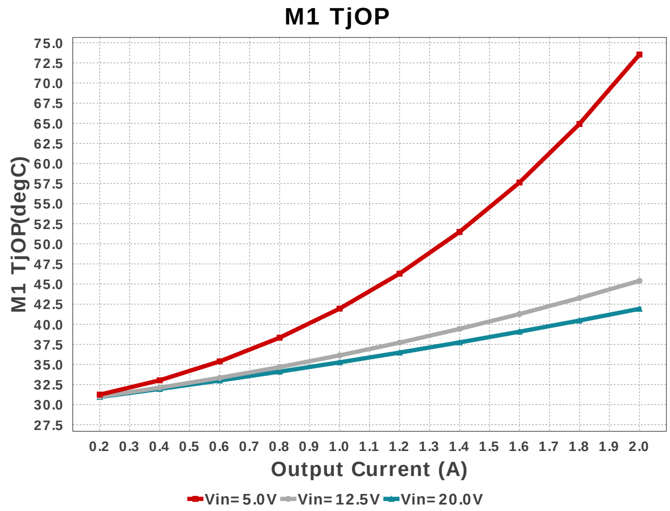

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

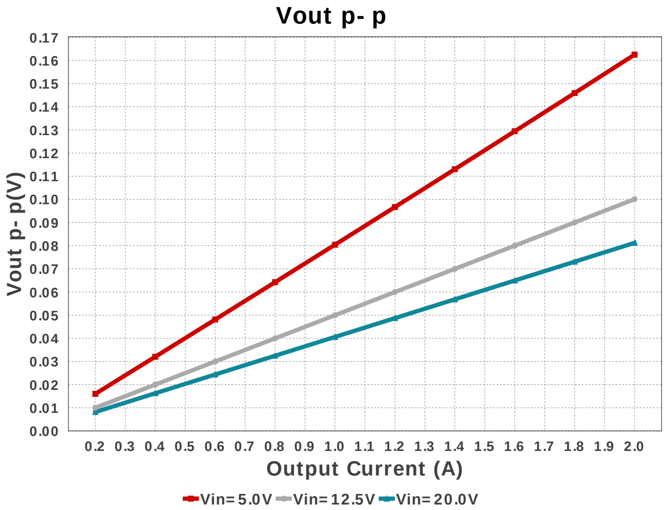

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

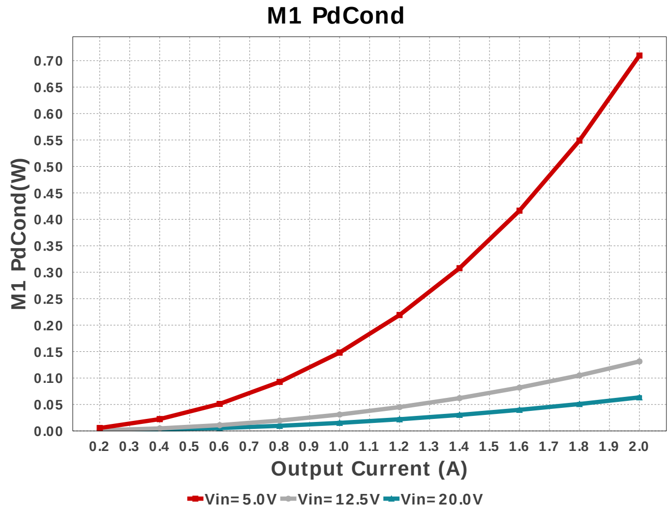

Rfb Pd
Rfb Pd(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

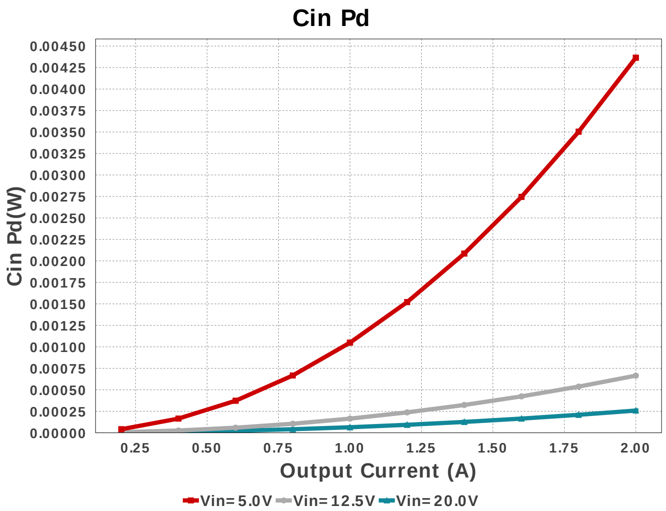

D1 Tj
D1 Tj(degC)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

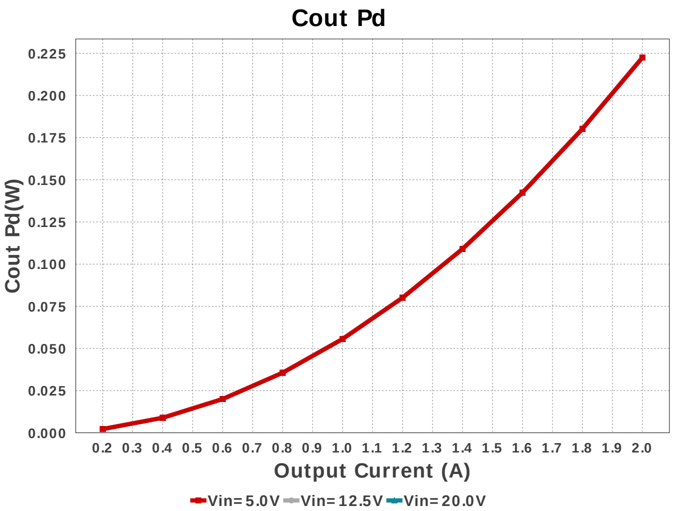

Efficiency
Efficiency(%)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

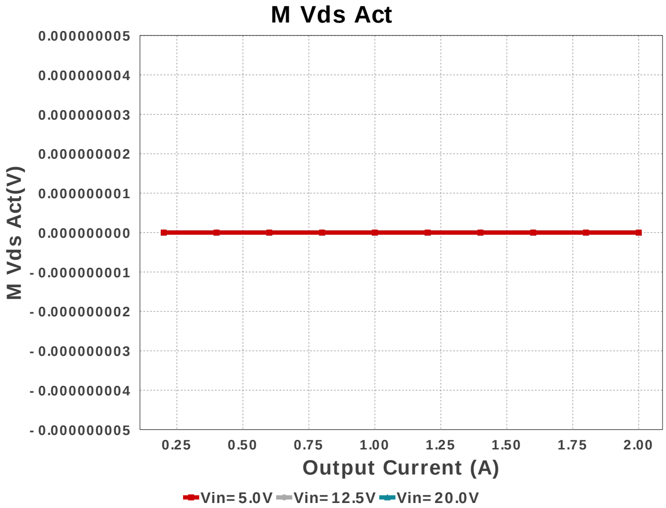

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

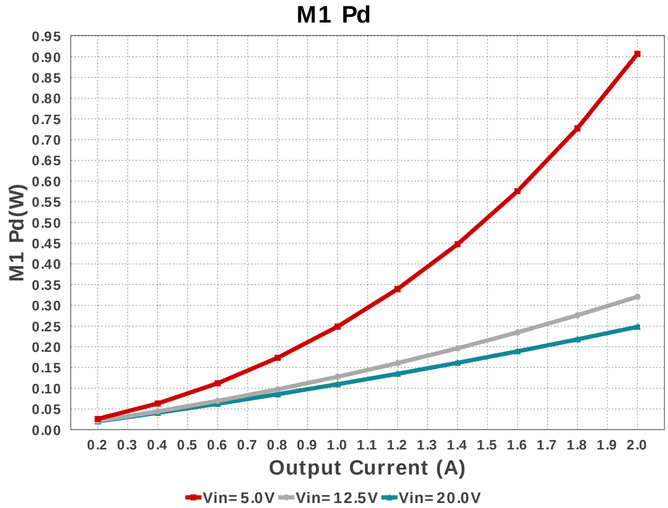

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

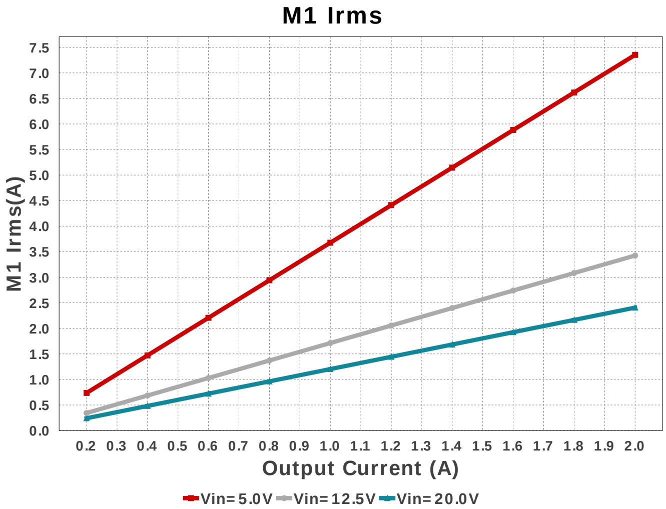

M1 PdCond
M1 PdCond(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

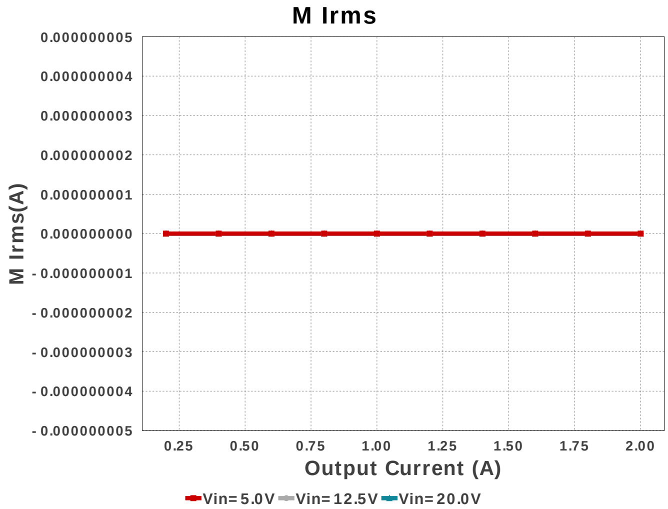

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

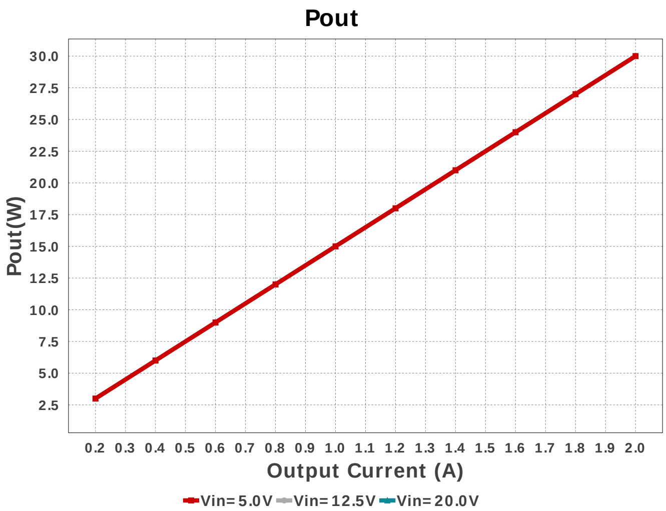

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

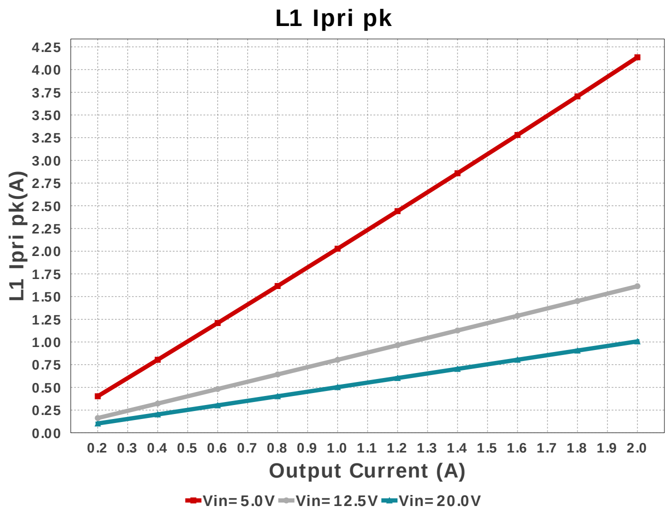

M Vds Act
M Vds Act(V)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

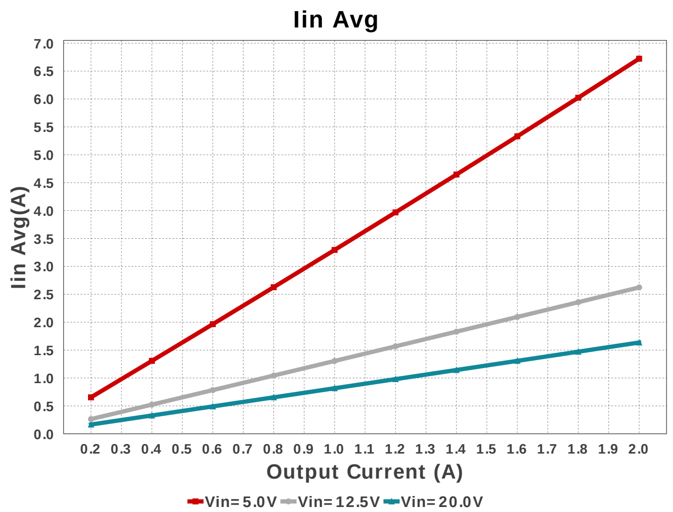

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

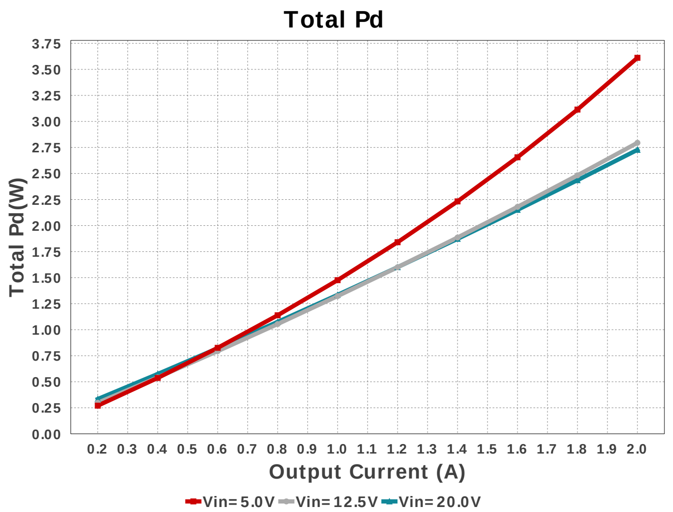

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

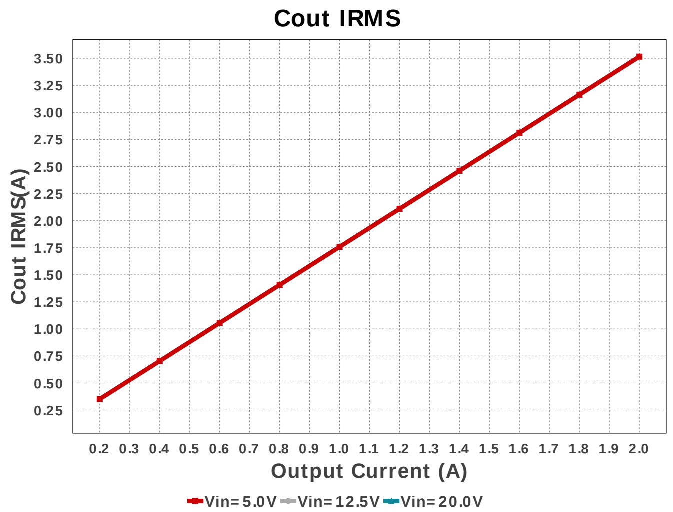

M Irms
M Irms(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

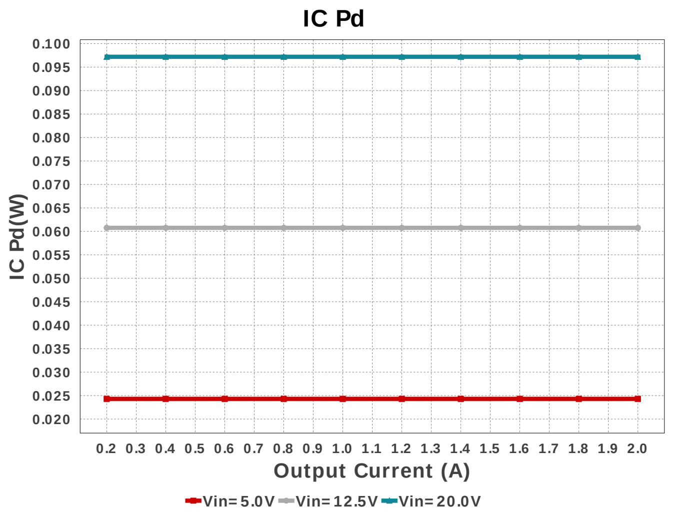

Pout
Pout(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

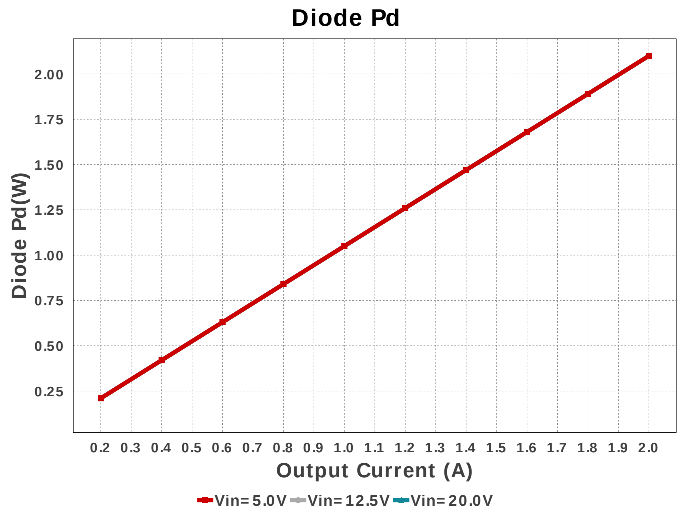

L1 Ipri pk
L1 Ipri pk(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

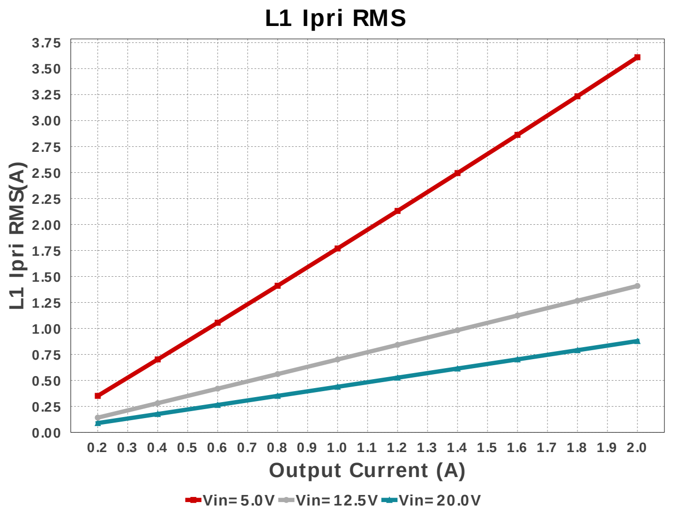

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

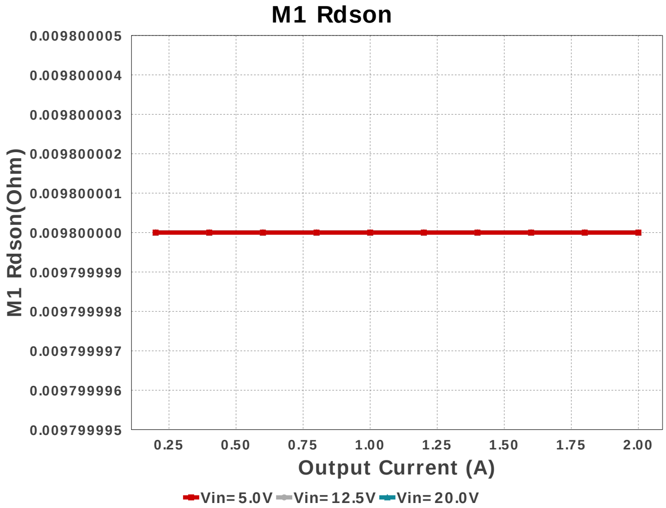

Total Pd
Total Pd(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

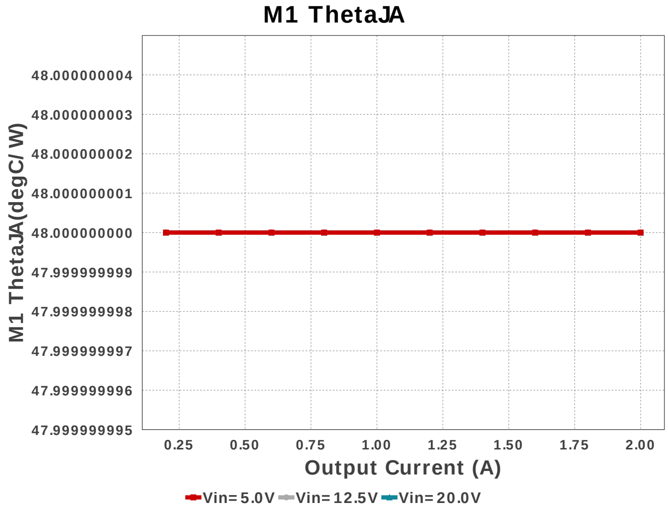

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

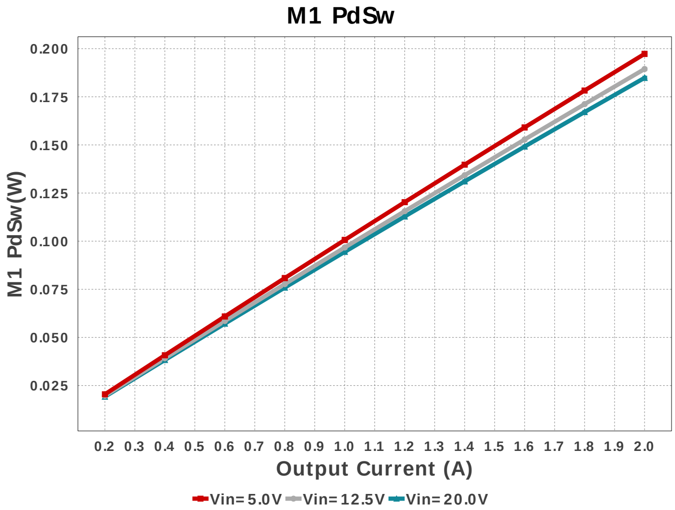

IC Pd
IC Pd(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

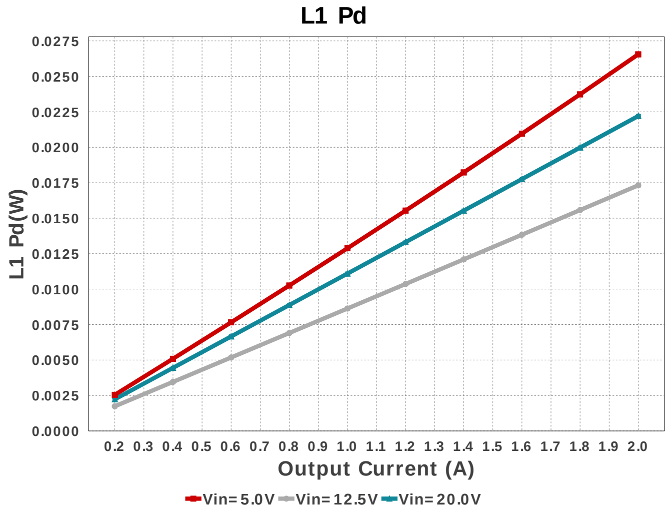

Diode Pd
Diode Pd(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

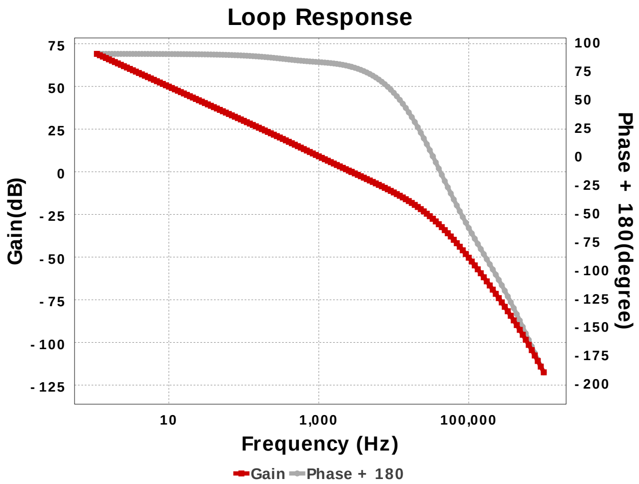

L1 Ipri RMS
L1 Ipri RMS(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V











Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	321.374 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	4.648 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	3.516 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	222.48 mW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	51.0 degC	Diode	D1 junction temperature
6.	Diode Pd	2.1 W	Diode	Diode power dissipation
7.	IC Pd	36.29 mW	IC	IC power dissipation
8.	IC Tj	32.094 degC	IC	IC junction temperature
9.	IC Tolerance	14.0 mV	IC	IC Feedback Tolerance
10.	ICThetaJA	57.7 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	6.937 A	IC	Average input current

#	Name	Value	Category	Description
12.	M1 Irms	7.352 A	Mosfet	M1 MOSFET Irms
13.	M1 Pd	1.968 W	Mosfet	M1 MOSFET total power dissipation
14.	M1 PdCond	1.375 W	Mosfet	M1 MOSFET conduction losses
15.	M1 PdSw	592.64 mW	Mosfet	M1 MOSFET switching losses
16.	M1 Rdson	15.0 mOhm	Mosfet	Drain-Source On-resistance
17.	M1 ThetaJA	48.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
18.	M1 TjOP	124.47 degC	Mosfet	M1 MOSFET junction temperature
19.	Cin Pd	4.648 mW	Power	Input capacitor power dissipation
20.	Cout Pd	222.48 mW	Power	Output capacitor power dissipation
21.	Diode Pd	2.1 W	Power	Diode power dissipation
22.	IC Pd	36.29 mW	Power	IC power dissipation
23.	L1 Pd	27.883 mW	Power	Power Dissipation in the Inductor
24.	M1 Pd	1.968 W	Power	M1 MOSFET total power dissipation
25.	M1 PdCond	1.375 W	Power	M1 MOSFET conduction losses
26.	M1 PdSw	592.64 mW	Power	M1 MOSFET switching losses
27.	Rfb Pd	2.198 mW	Power	Rfb Power Dissipation
28.	Total Pd	4.686 W	Power	Total Power Dissipation
29.	Rfb Pd	2.198 mW	Resistor	Rfb Power Dissipation
30.	BOM Count	21	System Information	Total Design BOM count
31.	Cross Freq	886.638 Hz	System Information	Bode plot crossover frequency
32.	Duty Cycle	76.247 %	System Information	Duty cycle
33.	Efficiency	86.491 %	System Information	Steady state efficiency
34.	FootPrint	853.0 mm^2	System Information	Total Foot Print Area of BOM components
35.	Frequency	534.018 kHz	System Information	Switching frequency
36.	Gain Marg	-23.197 dB	System Information	Bode Plot Gain Margin
37.	Iout	2.0 A	System Information	Iout operating point
38.	Low Freq Gain	60.072 dB	System Information	Gain at 1Hz
39.	Mode	CCM	System Information	Conduction Mode
40.	Phase Marg	75.746 deg	System Information	Bode Plot Phase Margin
41.	Pout	30.0 W	System Information	Total output power
42.	Total BOM	NA	System Information	Total BOM Cost
43.	Vin	5.0 V	System Information	Vin operating point
44.	Vout	15.0 V	System Information	Operational Output Voltage
45.	Vout Actual	15.083 V	System Information	Vout Actual calculated based on selected voltage divider resistors
46.	Vout Tolerance	2.586 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
47.	Vout p-p	146.632 mV	System Information	Peak-to-peak output ripple voltage
48.	L1 Ipri RMS	3.725 A	Transformer	RMS current in primary of PFC-Coil L1.
49.	L1 Ipri pk	4.268 A	Transformer	Peak current in primary of PFC-Coil L1.
50.	L1 Pd	27.883 mW	Transformer	Power Dissipation in the Inductor

Design Inputs

Name	Value	Description
Iout	2.0	Maximum Output Current
VinMax	20.0	Maximum input voltage
VinMin	5.0	Minimum input voltage
Vout	15.0	Output Voltage
base_pn	TPS40210-Q1	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

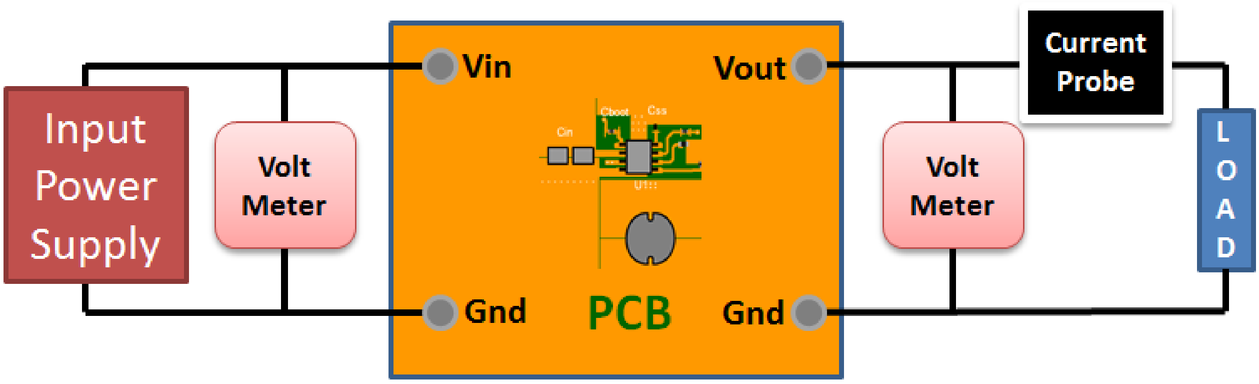
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 5.0V 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. The TPS40210-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application

2. Master key : B9C964572EBB957B[v1]

3. **TPS40210-Q1** Product Folder : http://www.ti.com/product/TPS40210%2DQ1 : contains the data sheet and other resources.

Important Notice and Disclaimer

TI provides technical and reliability data (including datasheets), design resources (including reference designs), application or other design advice, web tools, safety information, and other resources AS IS and with all faults, and disclaims all warranties. These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

Providing these resources does not expand or otherwise alter TI's applicable Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with TI products.