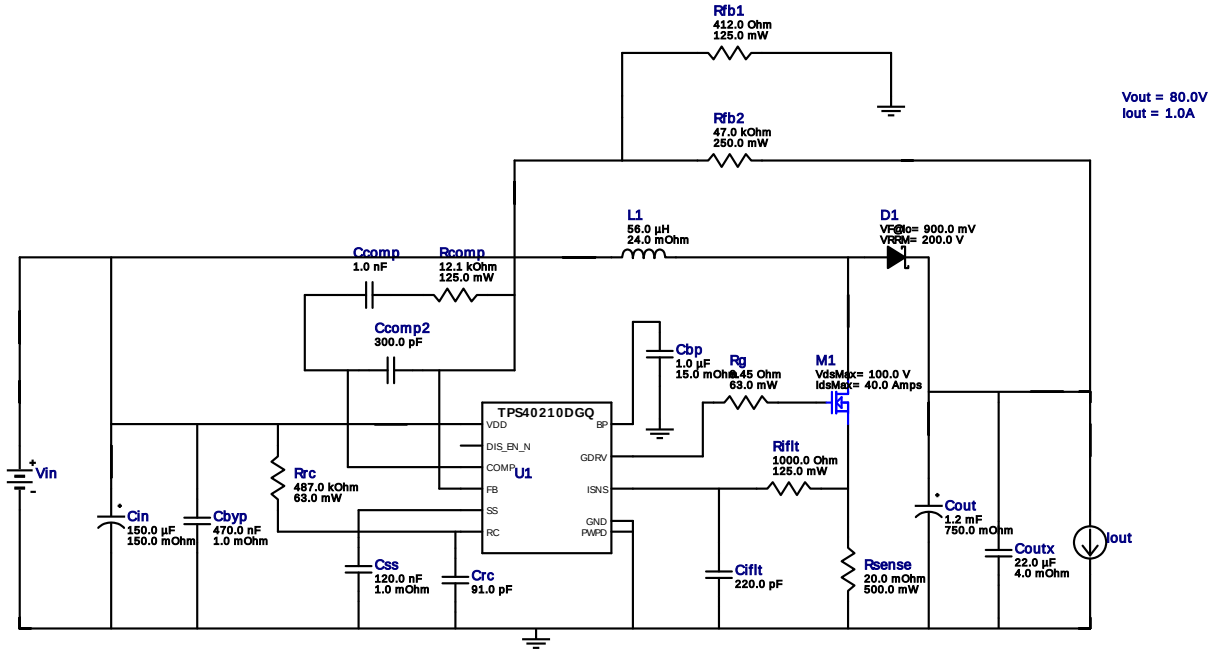
WEBENCH® Design Report

VinMin = 23.0V
VinMax = 24.0V
Vout = 80.0V
Iout = 1.0A

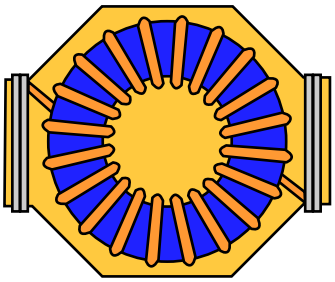
Device = TPS40210DGQR
Topology = Boost
Created = 2018-12-25 12:36:06.920
BOM Cost = NA
BOM Count = 21
Total Pd = 3.72W

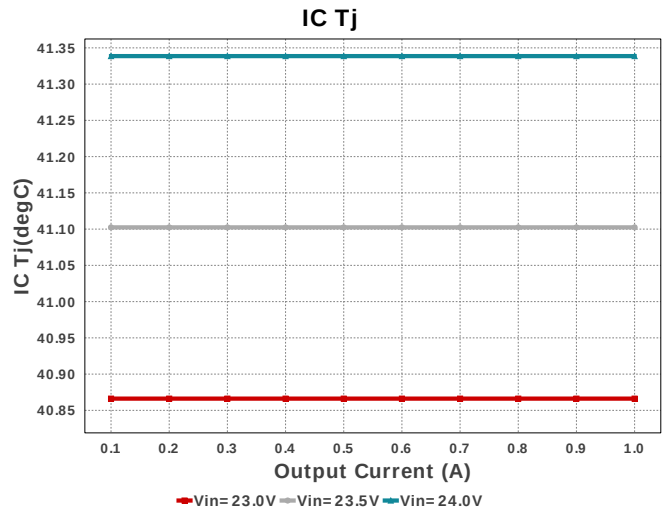
Design : 22 TPS40210DGQR
TPS40210DGQR 23V-24V to 80.55V @ 1A

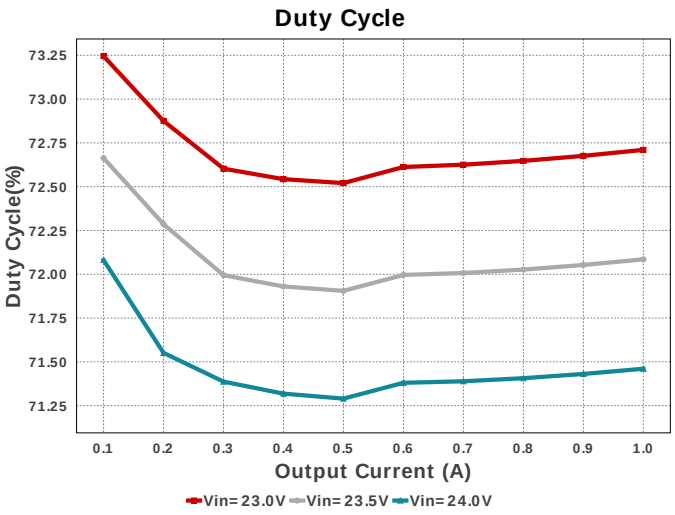


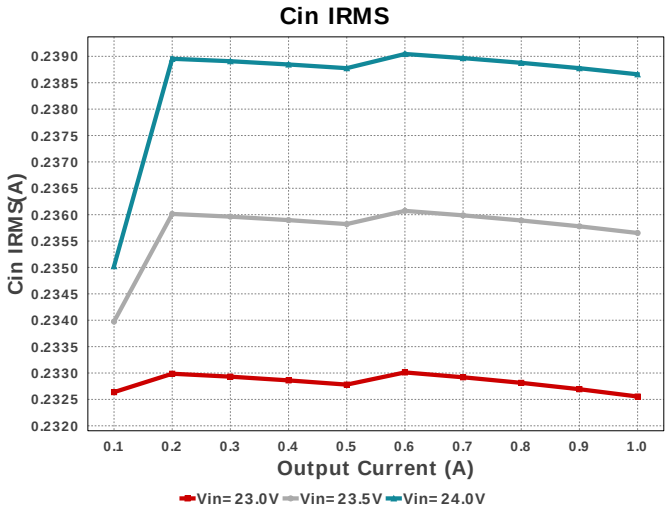
Electrical BOM

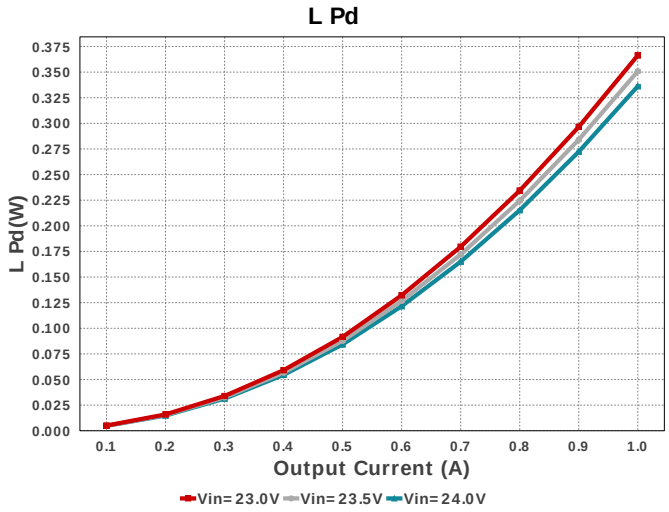
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbp	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm²
Cbyp	Taiyo Yuden	GMK212BJ474KG-T Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 35.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm²
Ccomp	CUSTOM	CUSTOM Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	NA	0805 0 mm²
Ccomp2	Samsung Electro-Mechanics	CL10C301JB8NNNC Series= C0G/NP0	Cap= 300.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Ciflt	Samsung Electro-Mechanics	CL21C221KBANNNC Series= C0G/NP0	Cap= 220.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cin	CUSTOM	CUSTOM Series= FK	Cap= 150.0 uF ESR= 150.0 mOhm VDC= 35.0 V IRMS= 90.0 mA	1	NA	SM_RADIAL_B 0 mm²
Cout	CUSTOM	CUSTOM Series= SXV	Cap= 1.2 mF ESR= 750.0 mOhm VDC= 100.0 V IRMS= 2.35 A	1	NA	CAPSMT_62_E12 0 mm²
Coutx	CUSTOM	CUSTOM Series= X5R	Cap= 22.0 uF ESR= 4.0 mOhm VDC= 100.0 V IRMS= 3.39639 A	1	NA	1206_180 0 mm²

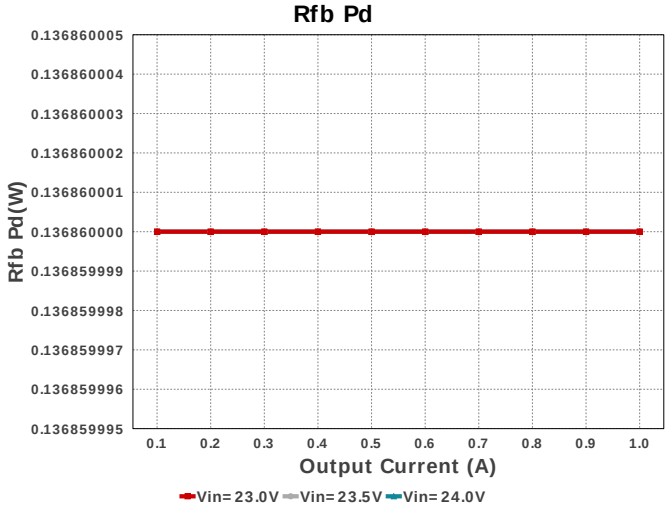
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Crc	Samsung Electro-Mechanics	CL21C910JBANNNC Series= C0G/NP0	Cap= 91.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm²
Css	MuRata	GRM188R71A124KA01D Series= X7R	Cap= 120.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	 0603 5 mm²
D1	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.04	 SMA 37 mm²
L1	Bourns	PM2110-560K-RC	L= 56.0 µH DCR= 24.0 mOhm	1	$1.37	 PM2110 890 mm²
M1	Infineon Technologies	BSC252N10NSF G	VdsMax= 100.0 V IdsMax= 40.0 Amps	1	NA	 PG-TDSON-8 55 mm²
Rcomp	Panasonic	ERJ-6ENF1212V Series= ERJ-6E	Res= 12.1 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rfb1	Vishay-Dale	CRCW0805412RFKEA Series= CRCW..e3	Res= 412.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rfb2	Yageo	RC1206FR-0747KL Series= ?	Res= 47.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm²
Rg	Vishay-Dale	CRCW04028R45FKED Series= CRCW..e3	Res= 8.45 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Riflt	Panasonic	ERJ-6ENF1001V Series= ERJ-6E	Res= 1000.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rrc	Vishay-Dale	CRCW0402487KFKED Series= CRCW..e3	Res= 487.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rsense	Stackpole Electronics Inc	CSR1206FK20L0 Series= ?	Res= 20.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.10	 1206 11 mm²
U1	Texas Instruments	TPS40210DGQR	Switcher	1	$0.75	 S-PDSO-G10 24 mm²

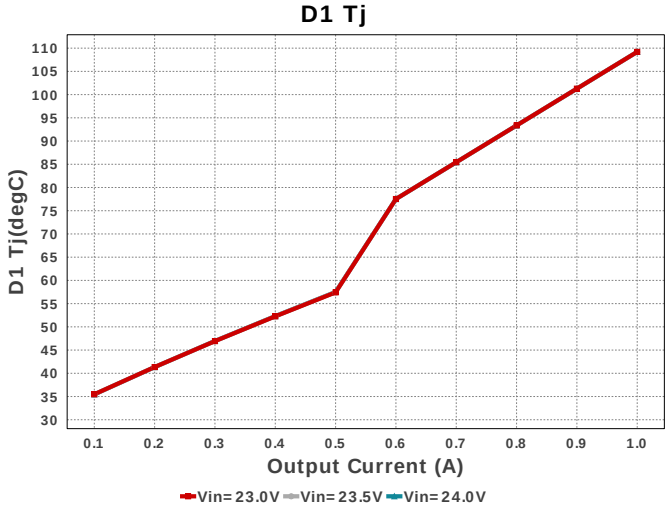




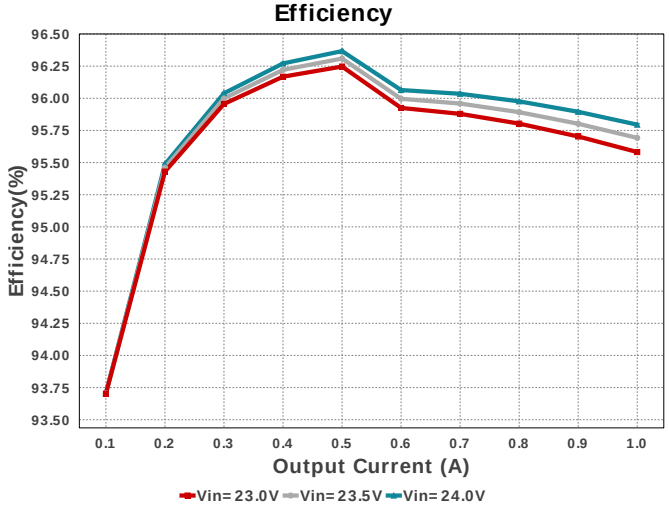




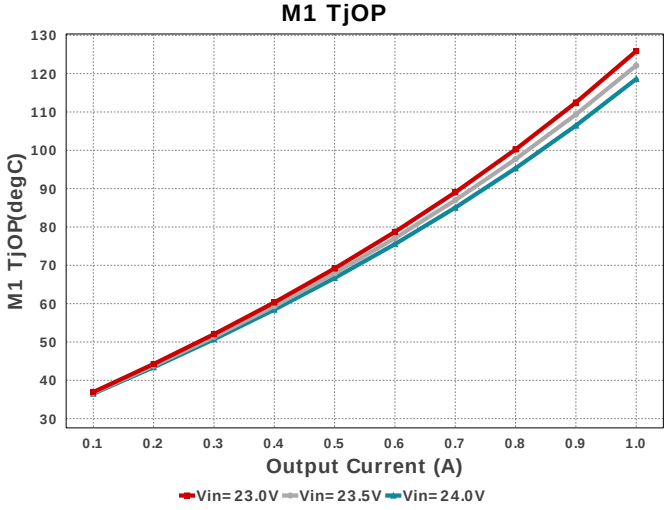




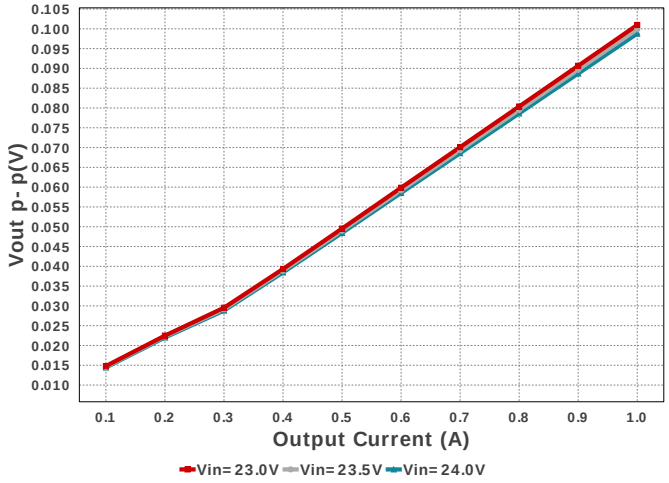
Efficiency



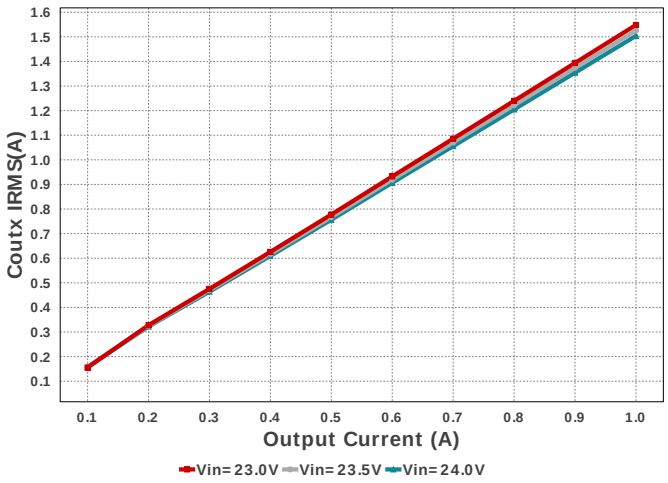
M1 TjOP



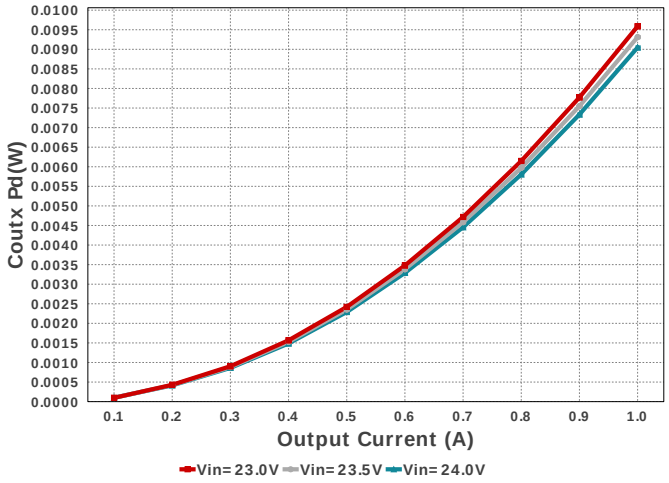
Vout p- p



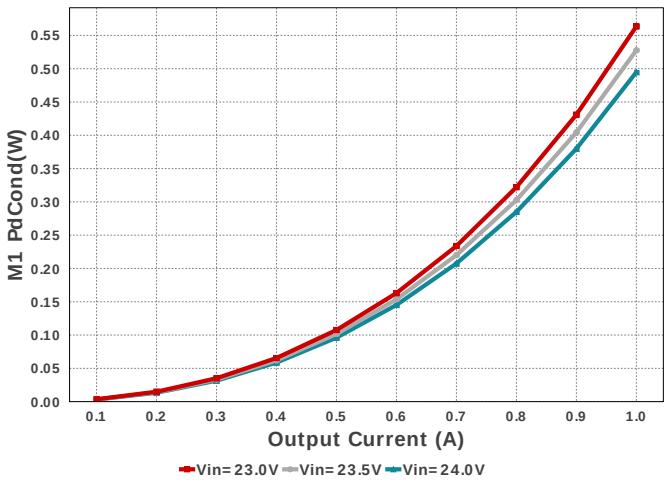
Coutx IRMS

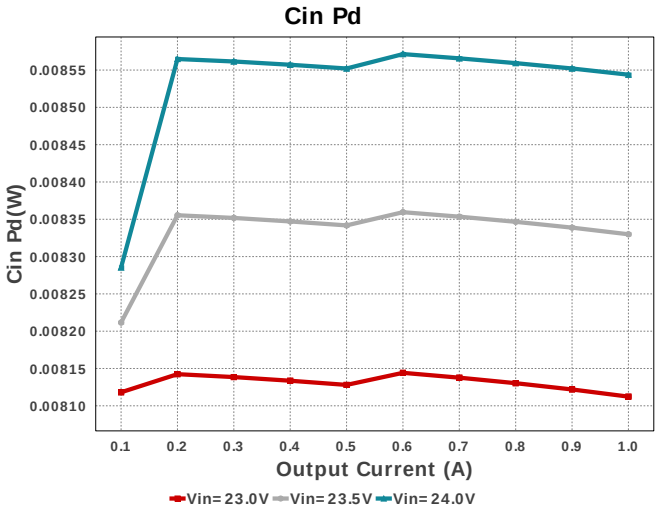


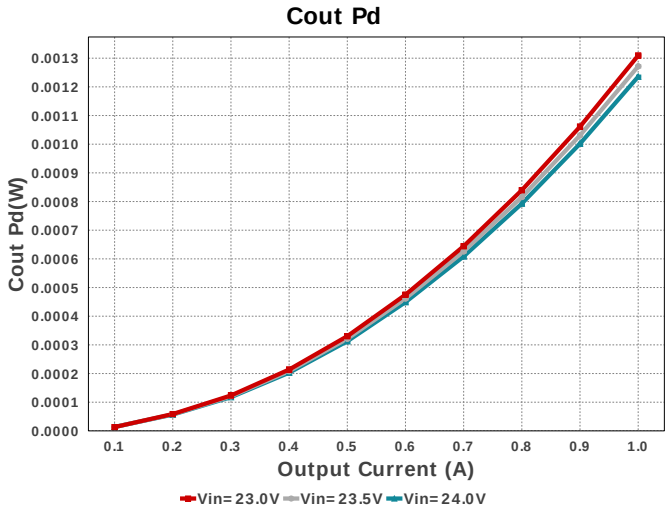
Coutx Pd

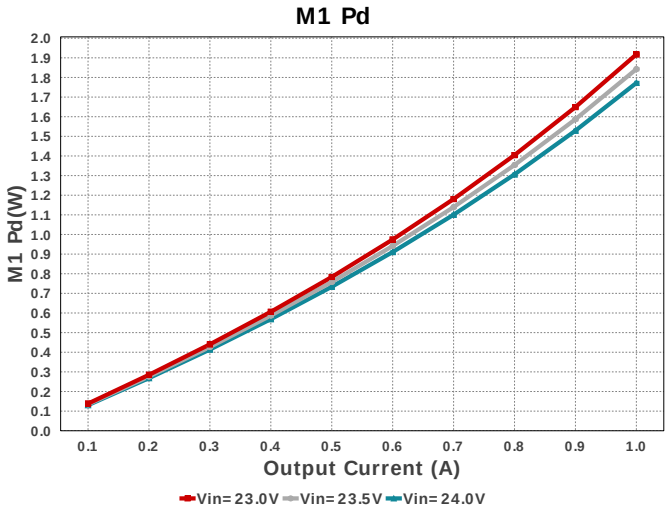


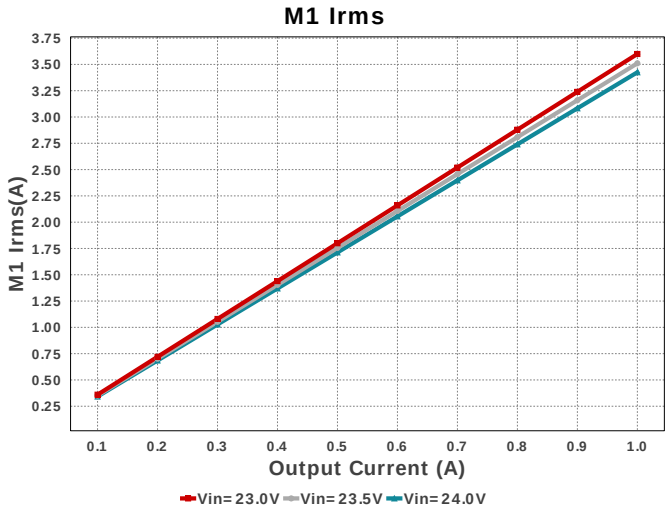
M1 PdCond

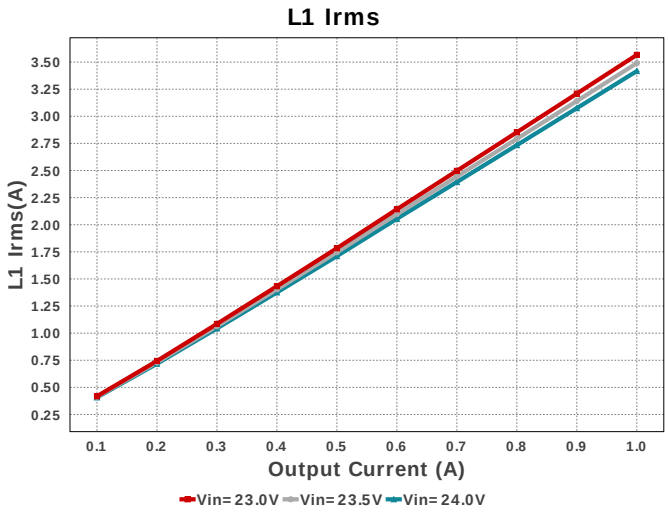


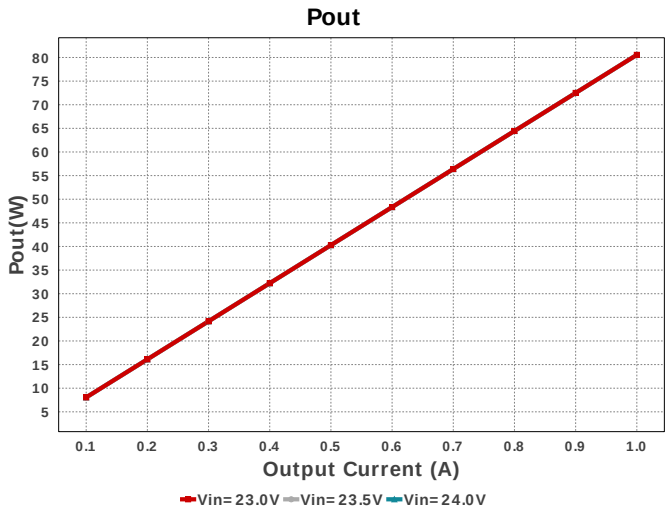


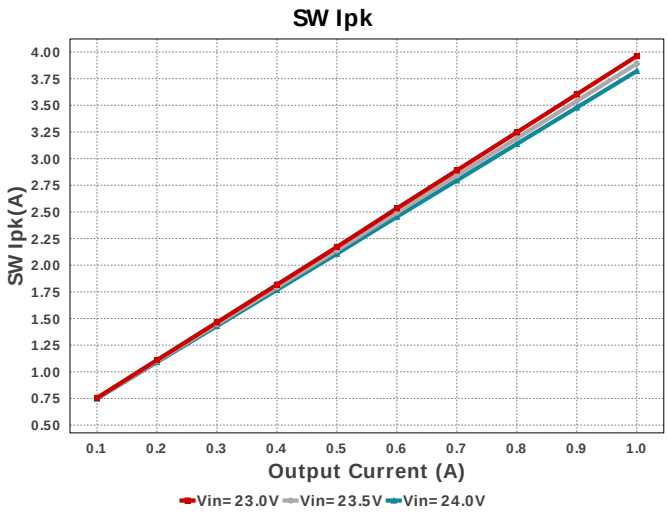


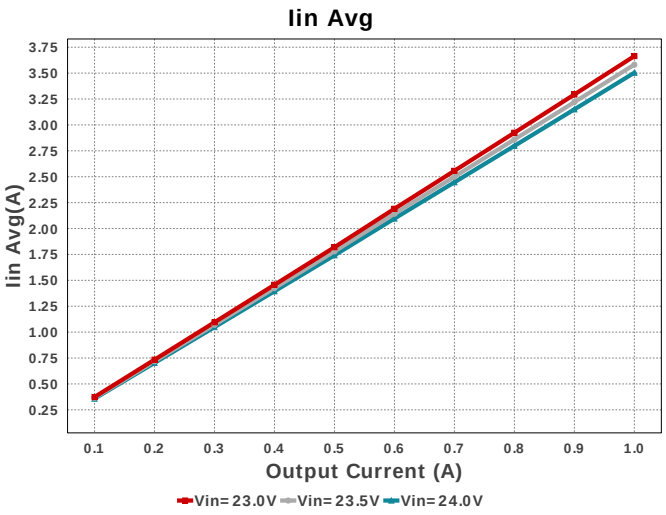


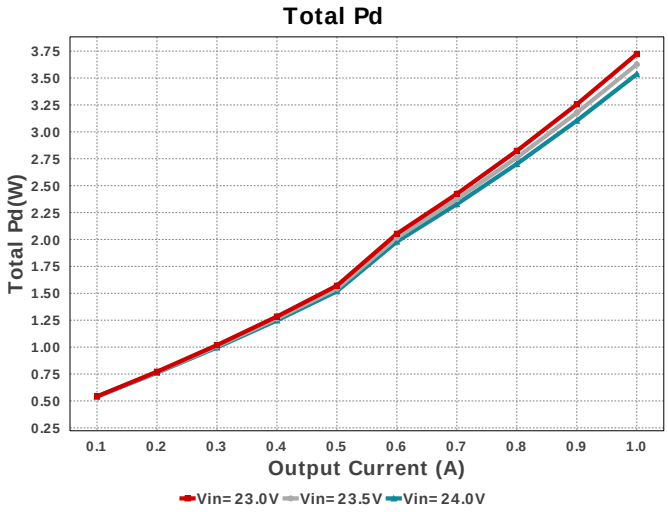


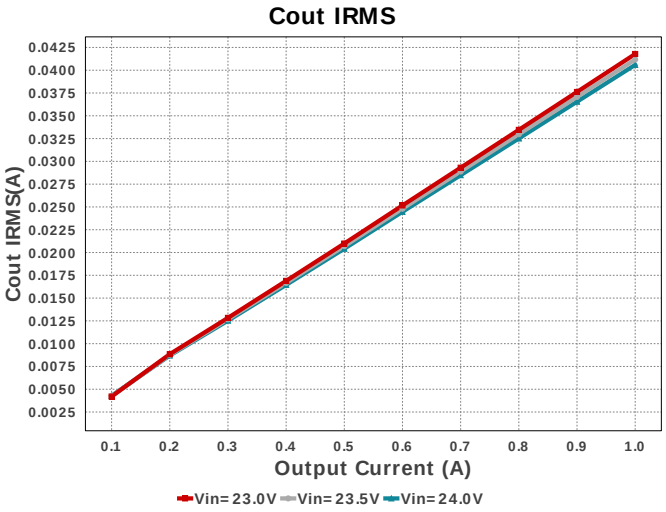


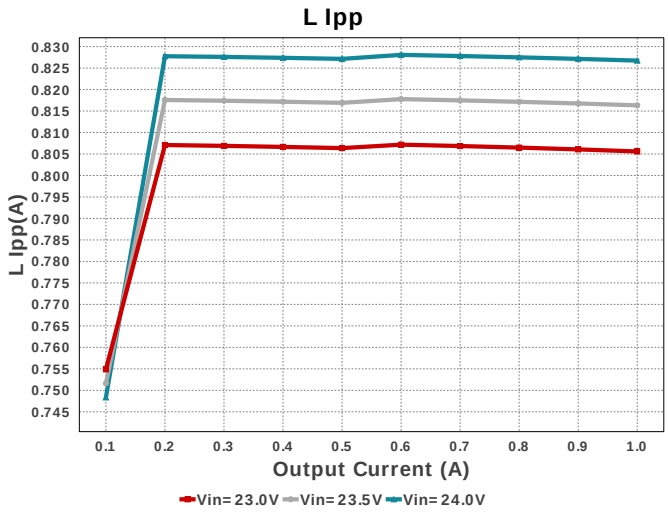


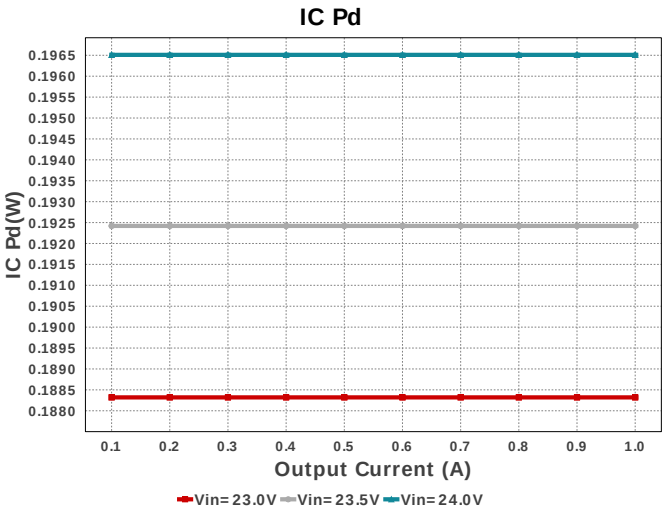


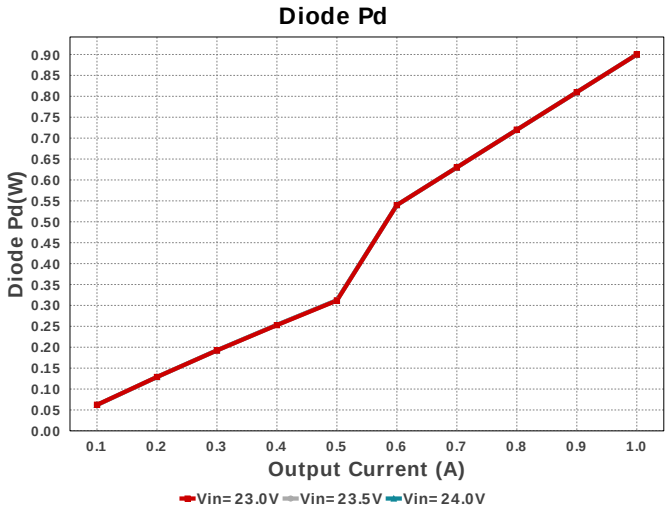


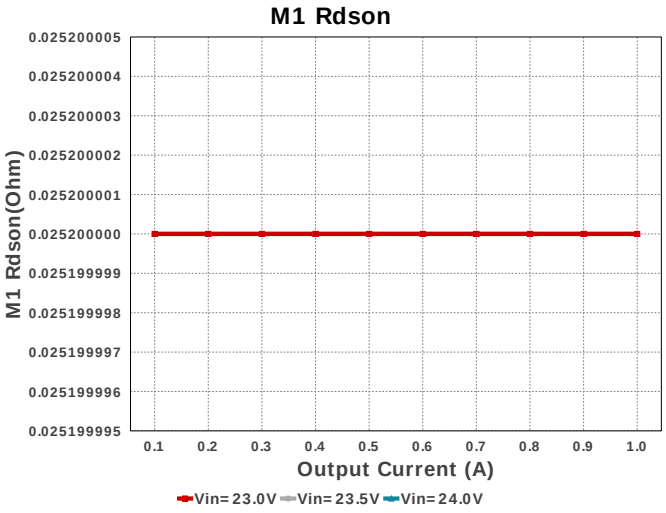


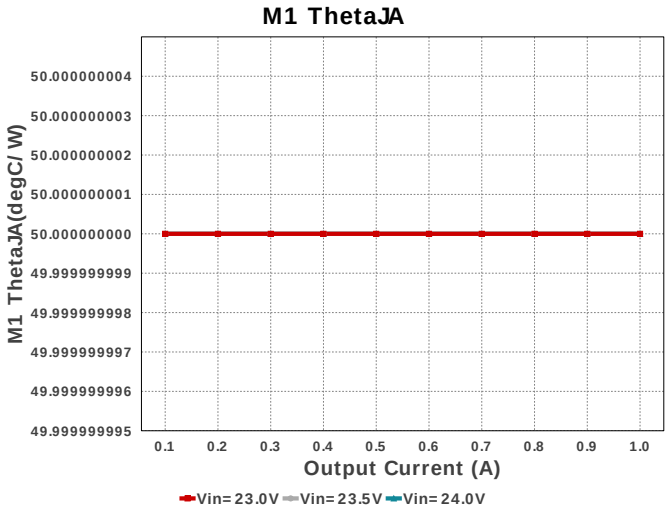


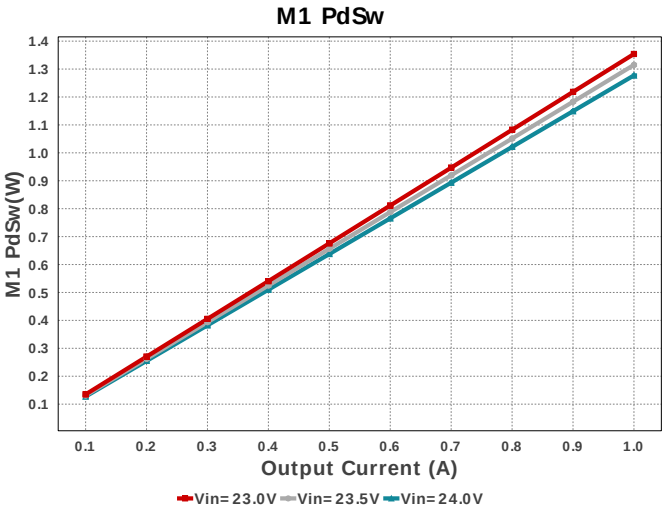


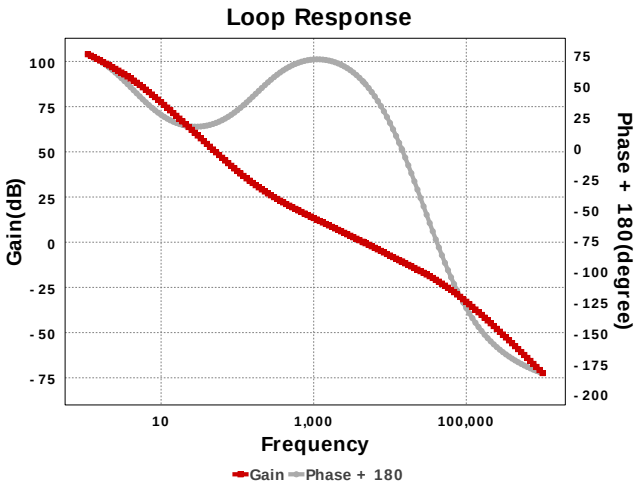












Operating Values

#	Name	Value	Category	Description
1.	BOM Count	21		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin IRMS	232.555 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	8.112 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	41.781 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	1.309 mW	Capacitor	Output capacitor power dissipation
7.	Coutx IRMS	1.548 A	Capacitor	Output capacitor_x RMS ripple current
8.	Coutx Pd	9.588 mW	Capacitor	Output capacitor_x power loss
9.	D1 Tj	109.2 degC	Diode	D1 junction temperature
10.	Diode Pd	900.0 mW	Diode	Diode power dissipation
11.	IC Pd	188.32 mW	IC	IC power dissipation

#	Name	Value	Category	Description
12.	IC Tj	40.866 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	3.664 A	IC	Average input current
16.	L Ipp	805.594 mA	Inductor	Peak-to-peak inductor ripple current
17.	L Pd	366.33 mW	Inductor	Inductor power dissipation
18.	L1 Irms	3.567 A	Inductor	Inductor ripple current
19.	M1 Irms	3.599 A	Mosfet	M1 MOSFET Irms
20.	M1 Pd	1.918 W	Mosfet	M1 MOSFET total power dissipation
21.	M1 PdCond	563.54 mW	Mosfet	M1 MOSFET conduction losses
22.	M1 PdSw	1.354 W	Mosfet	M1 MOSFET switching losses
23.	M1 Rdson	25.2 mOhm	Mosfet	Drain-Source On-resistance
24.	M1 ThetaJA	50.0 degC/W	Mosfet	MOSFET junction-to-ambient thermal resistance
25.	M1 TjOP	125.877 degC	Mosfet	M1 MOSFET junction temperature
26.	Cin Pd	8.112 mW	Power	Input capacitor power dissipation
27.	Cout Pd	1.309 mW	Power	Output capacitor power dissipation
28.	Coutx Pd	9.588 mW	Power	Output capacitor_x power loss
29.	Diode Pd	900.0 mW	Power	Diode power dissipation
30.	IC Pd	188.32 mW	Power	IC power dissipation
31.	L Pd	366.33 mW	Power	Inductor power dissipation
32.	M1 Pd	1.918 W	Power	M1 MOSFET total power dissipation
33.	M1 PdCond	563.54 mW	Power	M1 MOSFET conduction losses
34.	M1 PdSw	1.354 W	Power	M1 MOSFET switching losses
35.	Rfb Pd	136.86 mW	Power	Rfb Power Dissipation
36.	Total Pd	3.723 W	Power	Total Power Dissipation
37.	Rfb Pd	136.86 mW	Resistor	Rfb Power Dissipation
38.	Cross Freq	4.337 kHz	System Information	Bode plot crossover frequency
39.	Duty Cycle	72.71 %	System Information	Duty cycle
40.	Efficiency	95.582 %	System Information	Steady state efficiency
41.	FootPrint	1.396 k mm^2	System Information	Total Foot Print Area of BOM components
42.	Frequency	364.61 kHz	System Information	Switching frequency
43.	Gain Marg	-10.488 dB	System Information	Bode Plot Gain Margin
44.	Iout	1.0 A	System Information	Iout operating point
45.	Low Freq Gain	103.947 dB	System Information	Gain at 1Hz
46.	Mode	CCM	System Information	Conduction Mode
47.	Phase Marg	54.601 deg	System Information	Bode Plot Phase Margin
48.	Pout	80.554 W	System Information	Total output power
49.	SW Ipk	3.962 A	System Information	Peak switch current
50.	Vin	23.0 V	System Information	Vin operating point
51.	Vout	80.554 V	System Information	Operational Output Voltage
52.	Vout Actual	80.554 V	System Information	Vout Actual calculated based on selected voltage divider resistors
53.	Vout Tolerance	4.043 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
54.	Vout p-p	100.966 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	24.0	Maximum input voltage
VinMin	23.0	Minimum input voltage
Vout	80.0	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

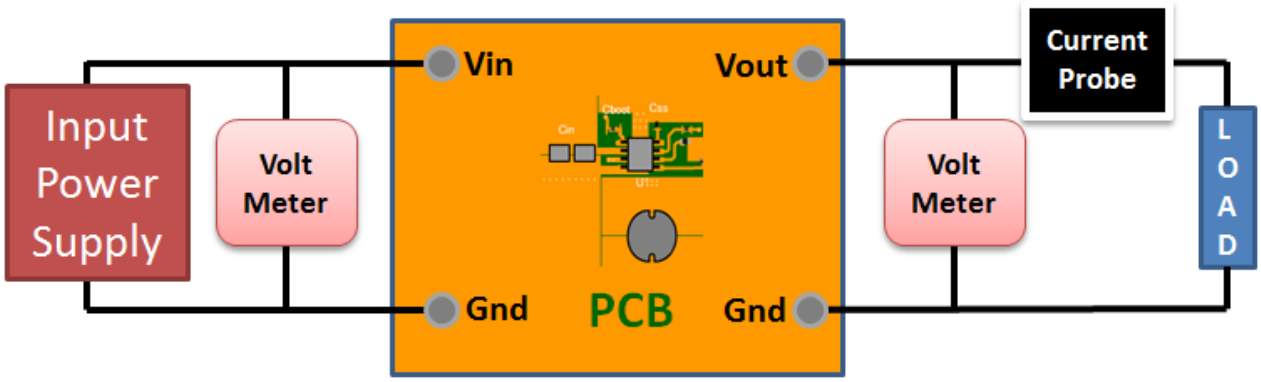
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins.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

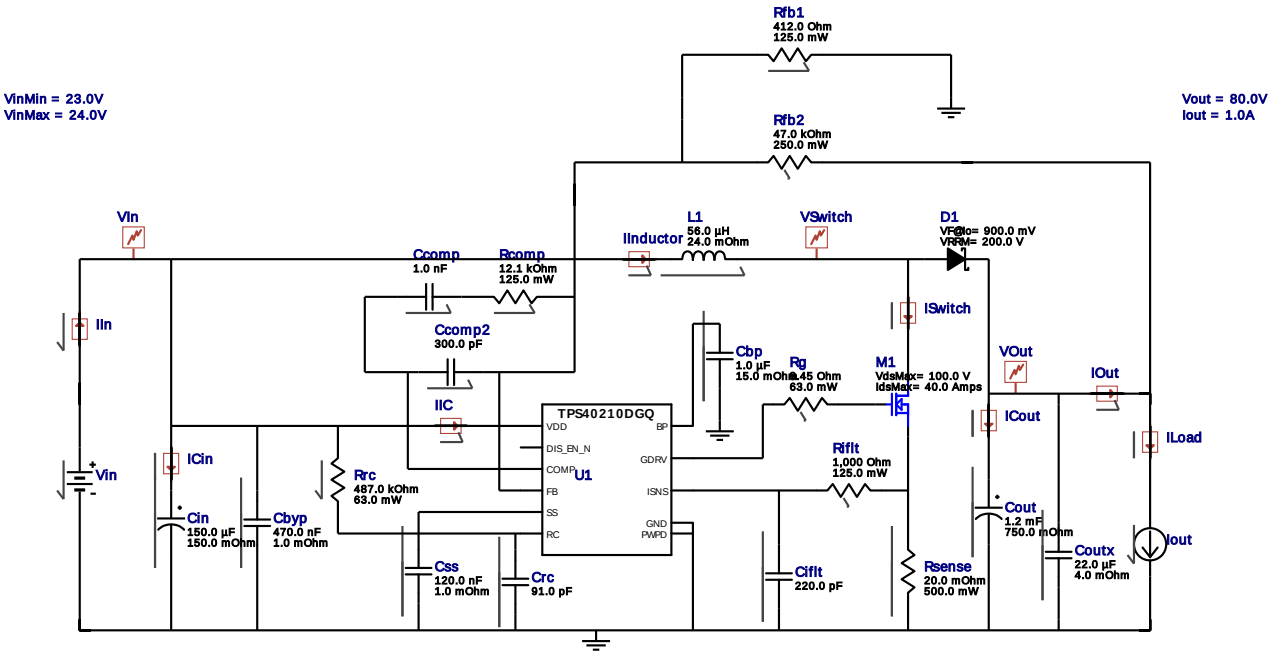


WEBENCH® Electrical Simulation Report

Design Id = 22

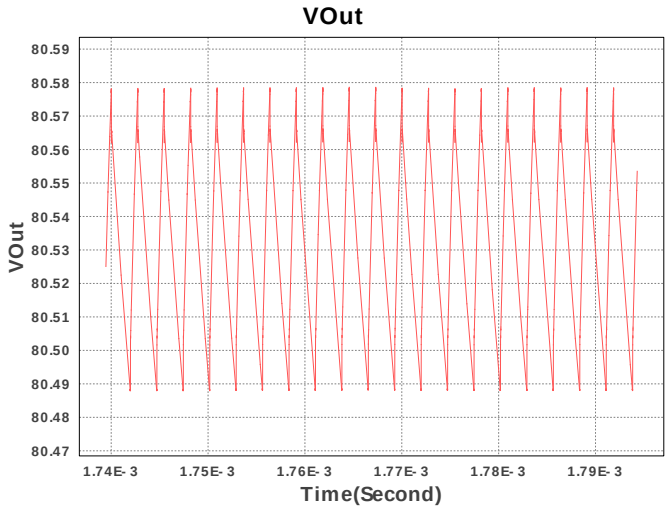
sim_id = 1

Simulation Type = Steady State



Simulation Parameters

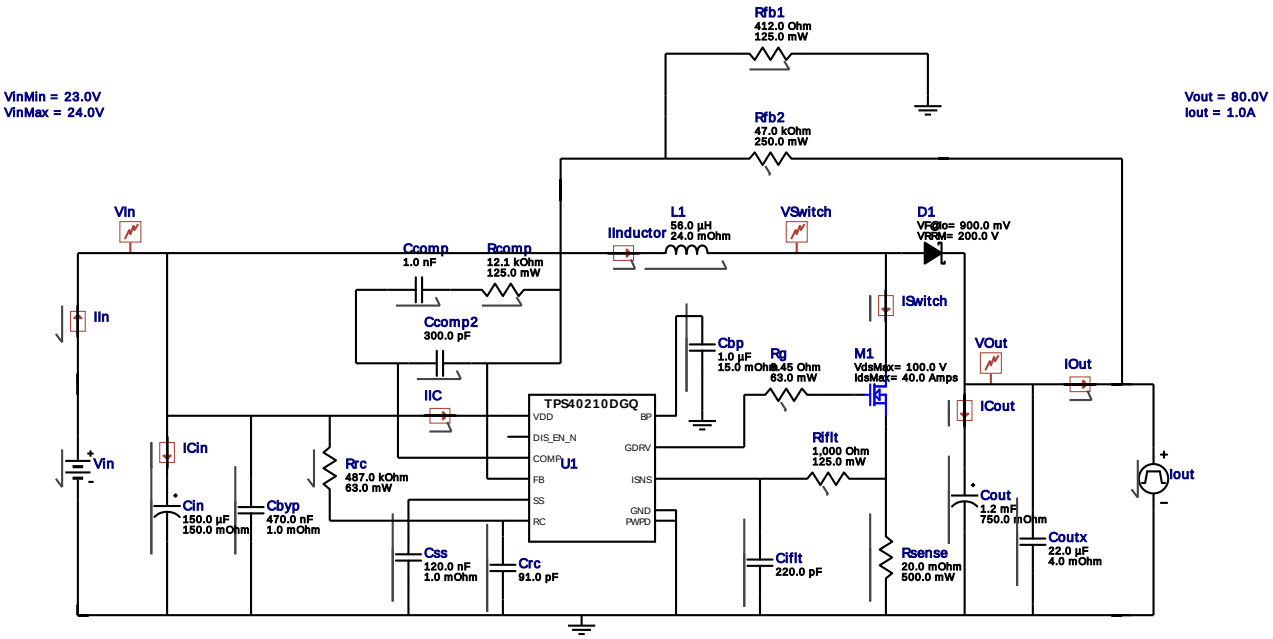
#	Name	Parameter Name	Description	Values
1.	Cout	IC	initial condition	81.1297572815534
2.	Css	IC	initial condition	0.9
3.	Coutx	IC	no description	81.1297572815534
4.	Iout	I	Load Current	1.0 A



Design Id = 22

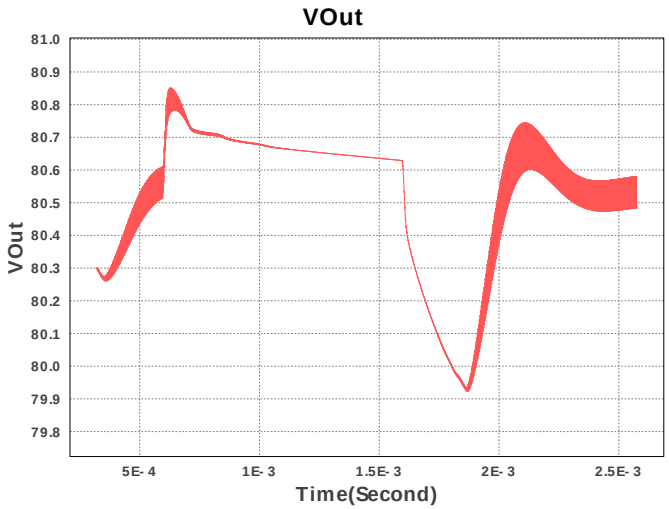
sim_id = 2

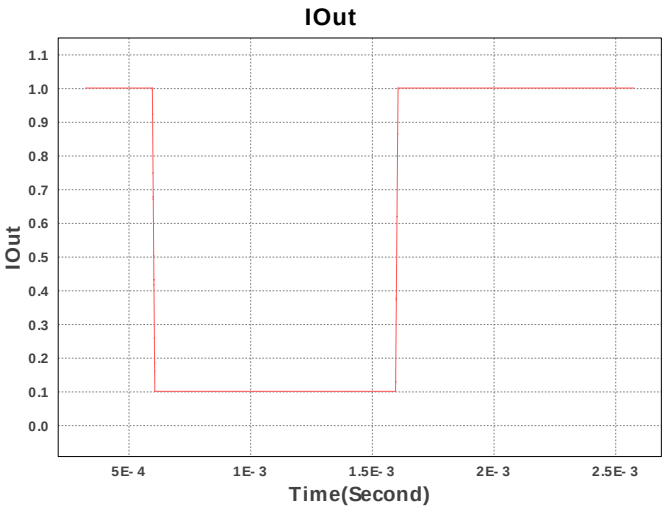
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	Cout	IC	Initial Voltage	81.1297572815534 V
2.	Css	IC	Initial Voltage	0.9 V
3.	Coutx	IC	Initial Voltage	81.1297572815534 V
4.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	1.0 A
		I2	Minimum Load Current	0.1 A
		Td	Initial Time Delay	5.959001589495056E-4 s
		Tf	Fall Time	10u s
		Tr	Rise Time	10u s
		Pw	Pulse Width	9.89476102353011E-4 s





Design Assistance

1. Master key : 4C48893BED716EE5[v1]

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