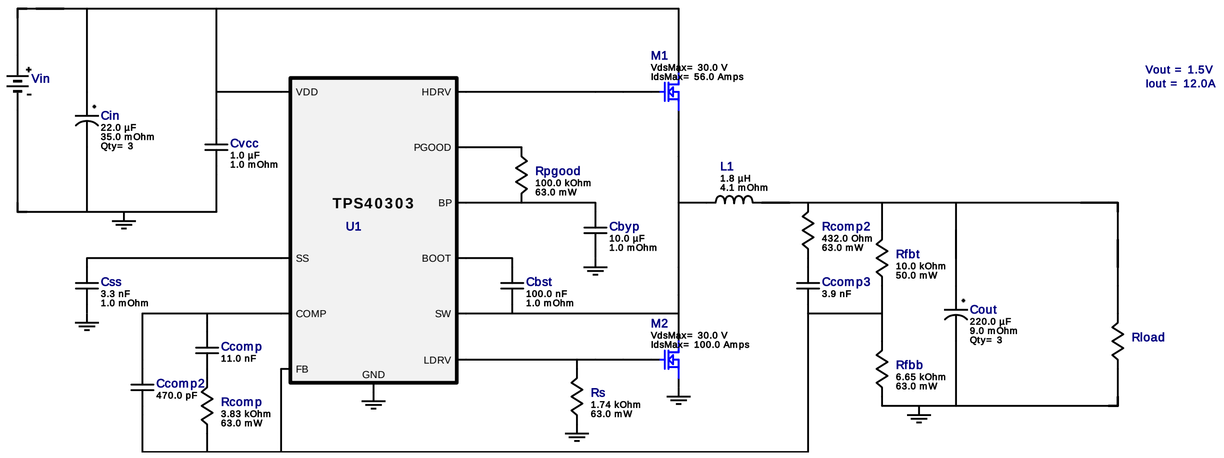
VinMin = 5.0V
VinMax = 20.0V
Vout = 1.5V
Iout = 12.0A

Device = TPS40303DRCR
Topology = Buck
Created = 2023-12-28 14:55:26.920
BOM Cost = $7.59
BOM Count = 23
Total Pd = 1.47W

WEBENCH ® Design Report

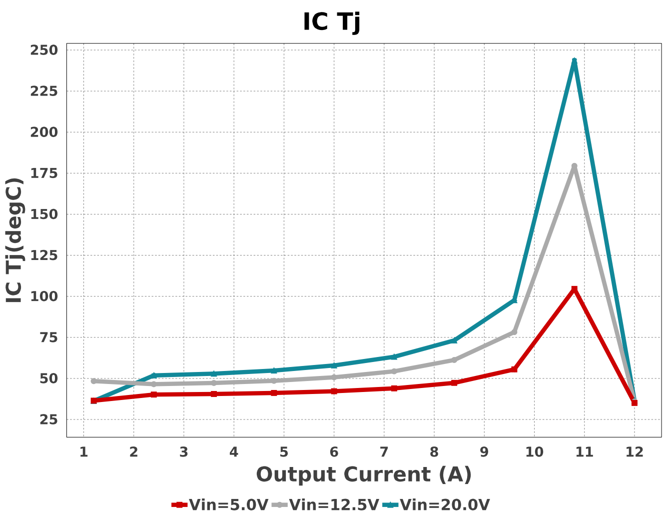
Design : 22 TPS40303DRCR
TPS40303DRCR 5V-20V to 1.50V @ 12A

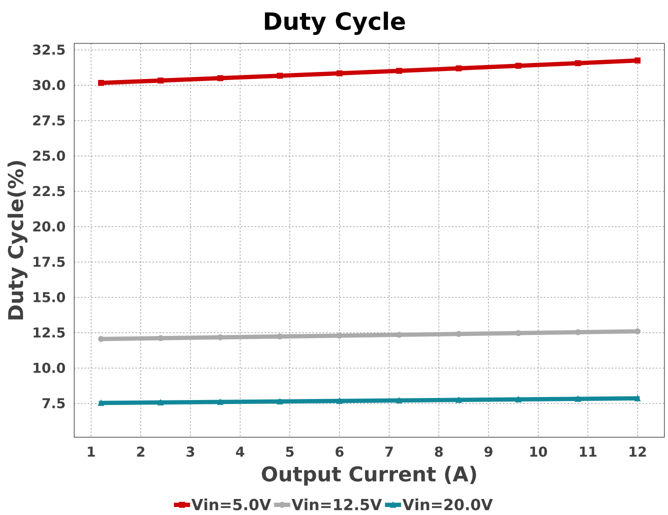


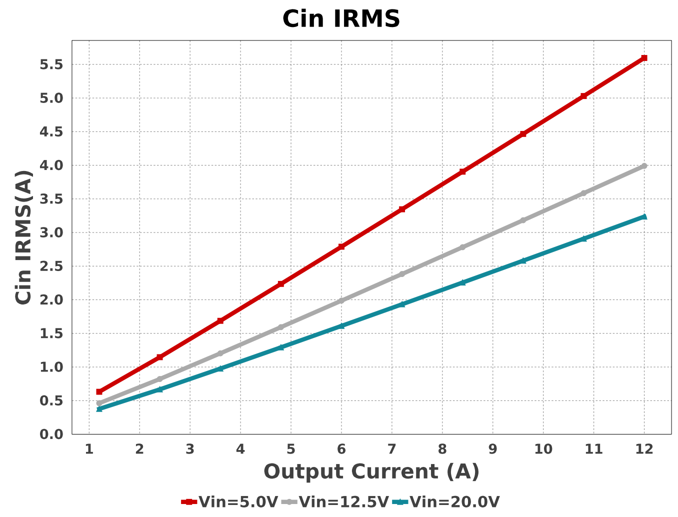
Electrical BOM

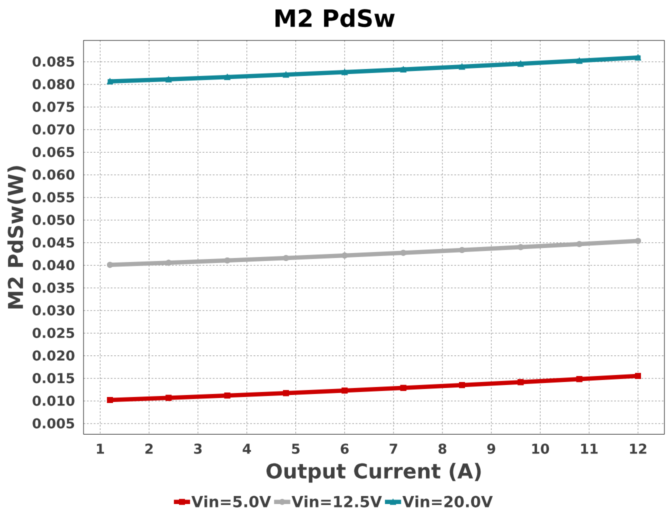
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cbyp	Taiyo Yuden	LMK212BJ106KG-T Series= X5R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm²
Ccomp	Samsung Electro-Mechanics	CL32C113JBHNNNE Series= C0G/NP0	Cap= 11.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.42	1210 15 mm²
Ccomp2	Samsung Electro-Mechanics	CL21C471JBANNNC Series= C0G/NP0	Cap= 470.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Ccomp3	TDK	CGA4C2C0G1H392J060AA Series= C0G/NP0	Cap= 3.9 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm²
Cin	Panasonic	35SVPF22M Series= SVPF	Cap= 22.0 uF ESR= 35.0 mOhm VDC= 35.0 V IRMS= 2.6 A	3	$0.57	CAPSMT_62_F61 74 mm²
Cout	Kemet	T520D227M006ATE009 Series= T520	Cap= 220.0 uF ESR= 9.0 mOhm VDC= 6.3 V IRMS= 0.0 A	3	$0.88	7343-31 59 mm²
Css	MuRata	GRM033R71A332KA01D Series= X7R	Cap= 3.3 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cvcc	Taiyo Yuden	TMK212BJ105KG-T Series= X5R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm²

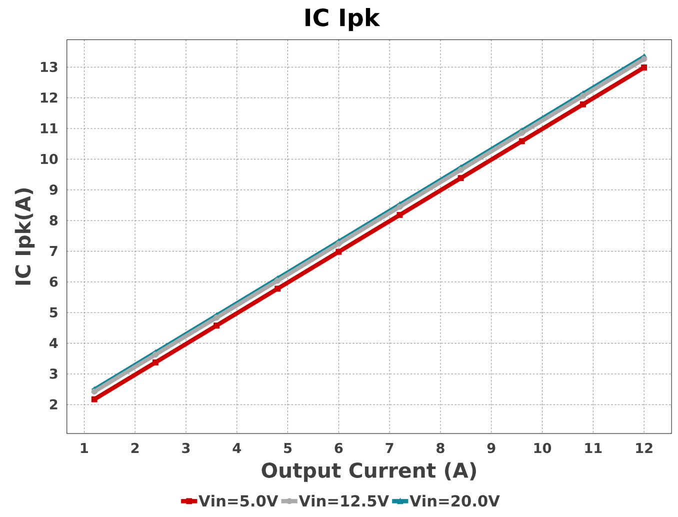
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Coilcraft	XAL7070-182MEB	L= 1.8 µH 4.1 mOhm	1	$1.19	XAL7070 87 mm^2
M1	Texas Instruments	CSD17304Q3	VdsMax= 30.0 V IdsMax= 56.0 Amps	1	$0.25	DQG0008A 18 mm^2
M2	Texas Instruments	CSD17573Q5B	VdsMax= 30.0 V IdsMax= 100.0 Amps	1	$0.52	DNK0008A 56 mm^2
Rcomp	Vishay-Dale	CRCW04023K83FKED Series= CRCW..e3	Res= 3.83 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcomp2	Vishay-Dale	CRCW0402432RFKED Series= CRCW..e3	Res= 432.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW04026K65FKED Series= CRCW..e3	Res= 6.65 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rpgood	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rs	Vishay-Dale	CRCW04021K74FKED Series= CRCW..e3	Res= 1.74 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS40303DRCR	Switcher	1	$0.68	S-PVSON-N10 17 mm^2

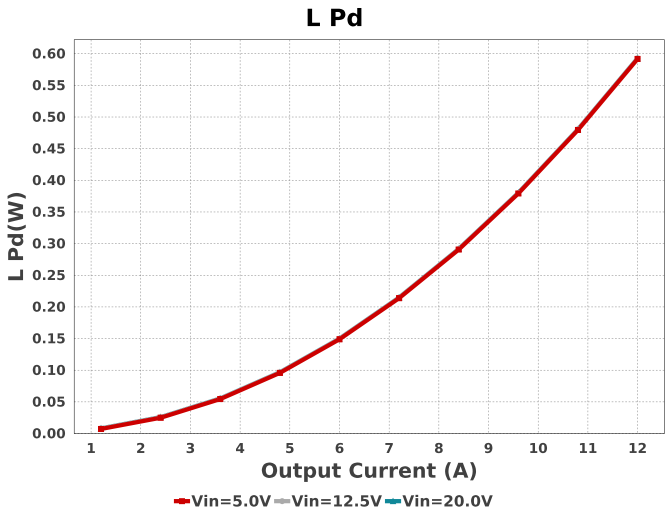


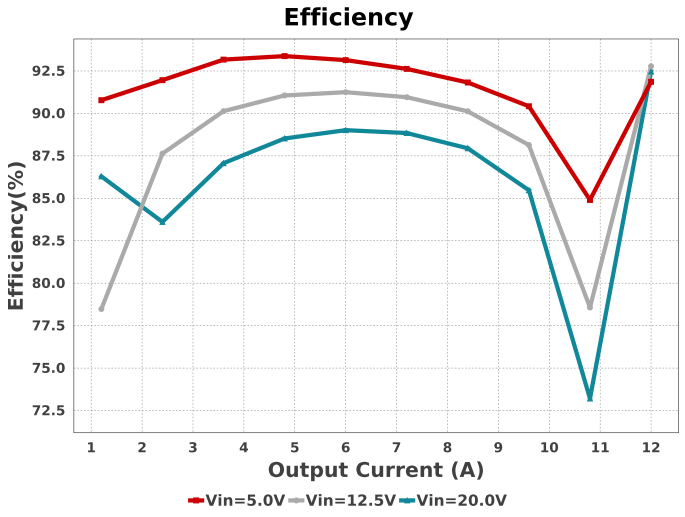


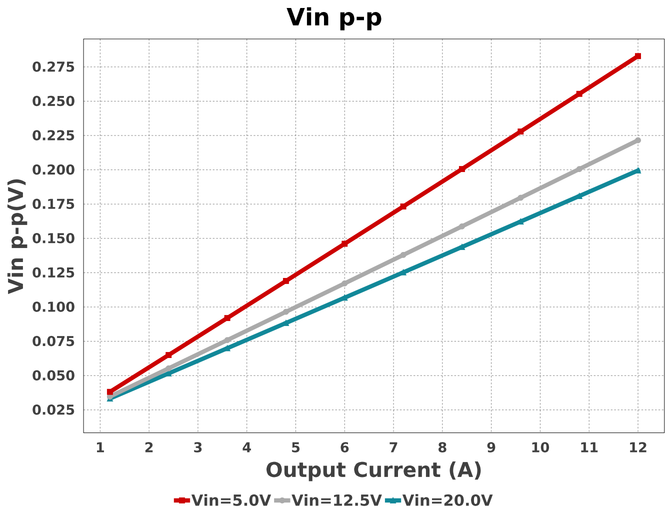

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=5.0V
Vin=12.5V
Vin=20.0V


M2 PdSw
M2 PdSw(W)
Output Current (A)
Vin=5.0V
Vin=12.5V
Vin=20.0V

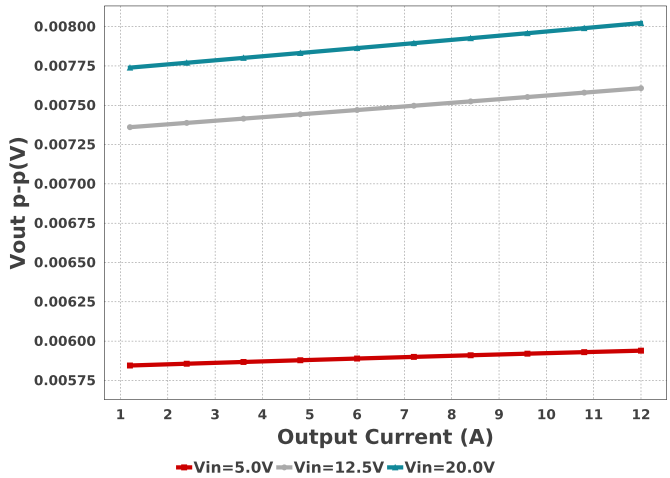

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=5.0V
Vin=12.5V
Vin=20.0V


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

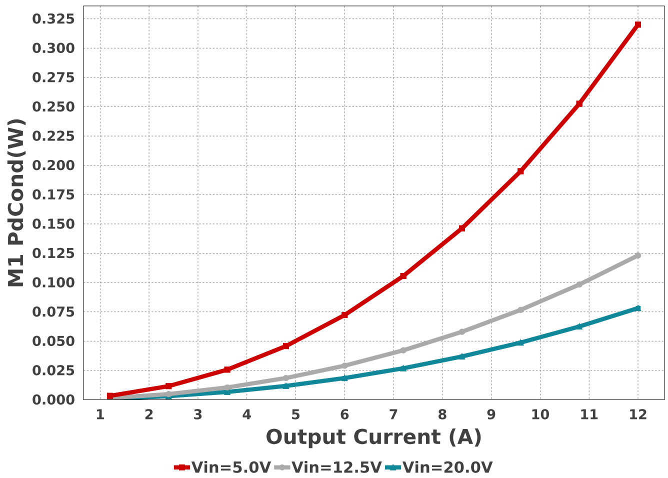

Efficiency
Efficiency(%)
Output Current (A)
Vin=5.0V
Vin=12.5V
Vin=20.0V


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

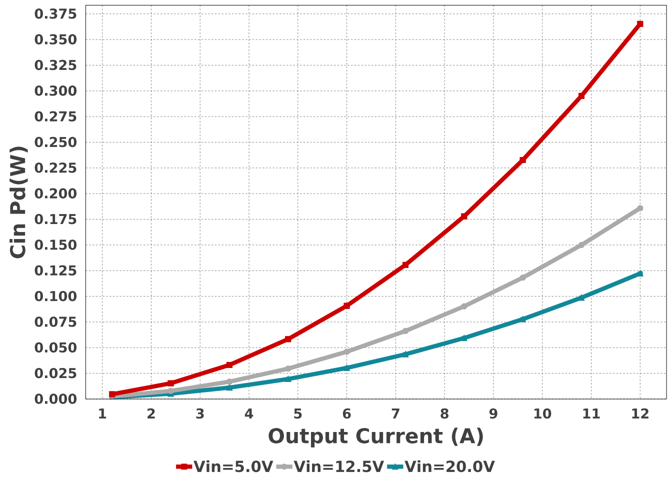
Vout p-p



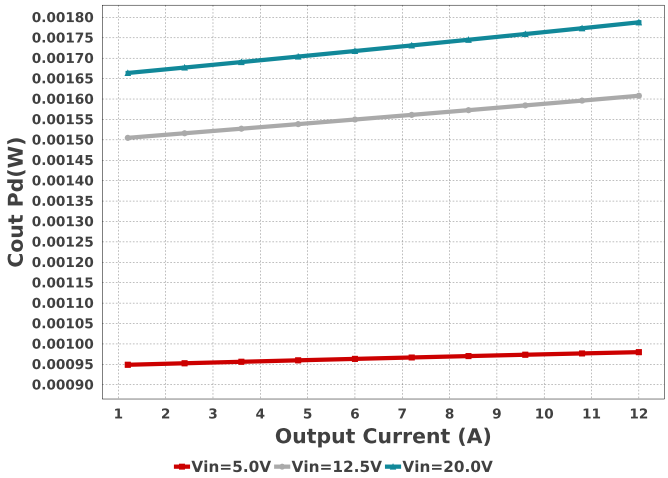
M1 PdCond



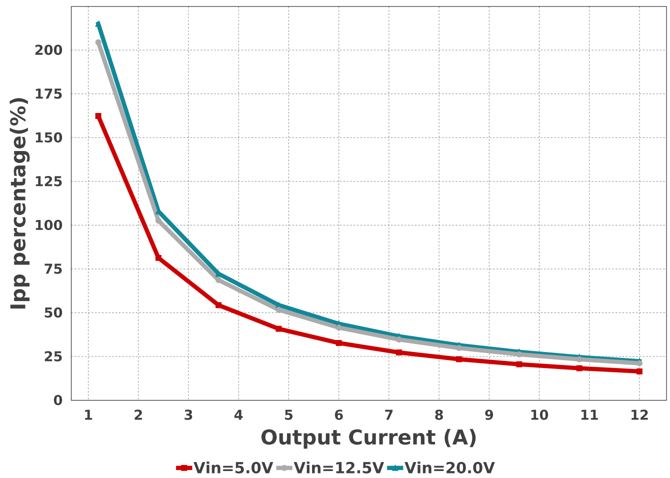
Cin Pd



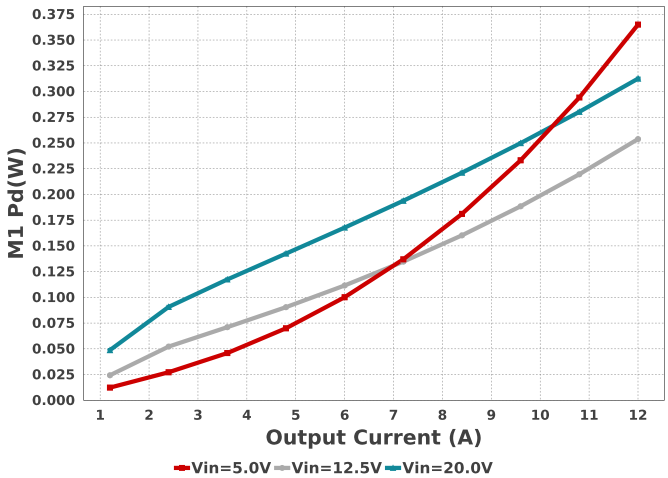
Cout Pd

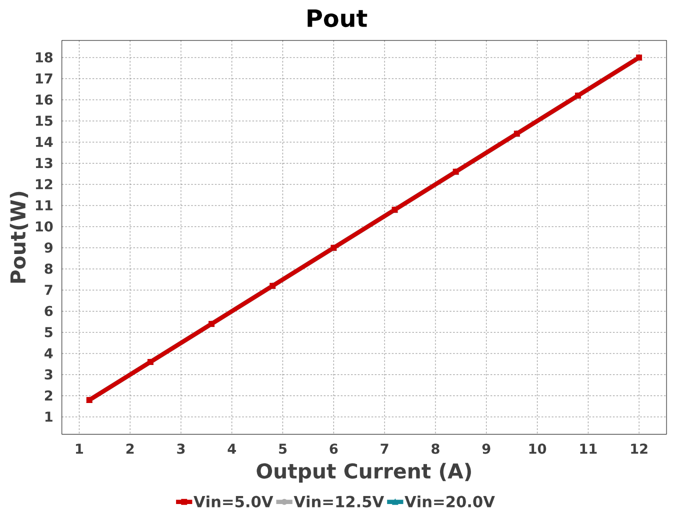


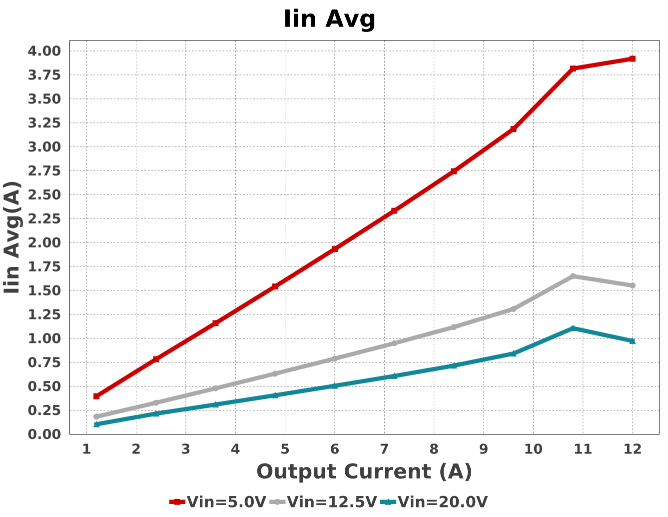
Ipp percentage

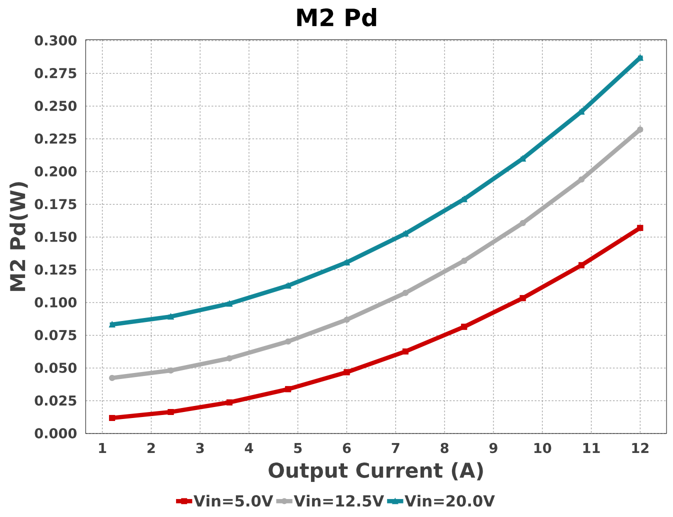


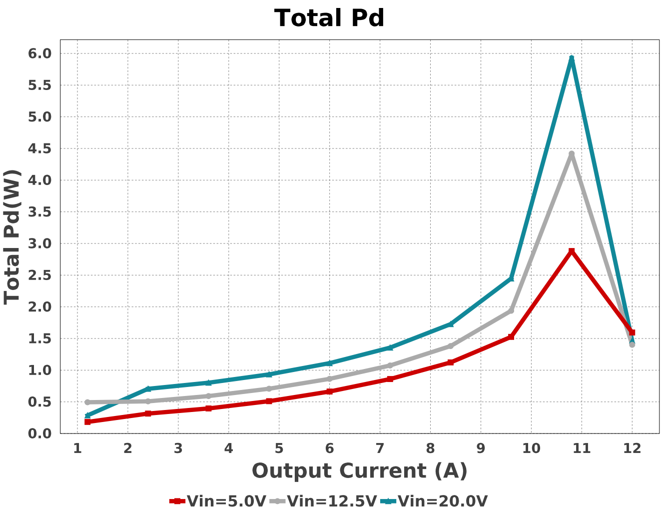
M1 Pd

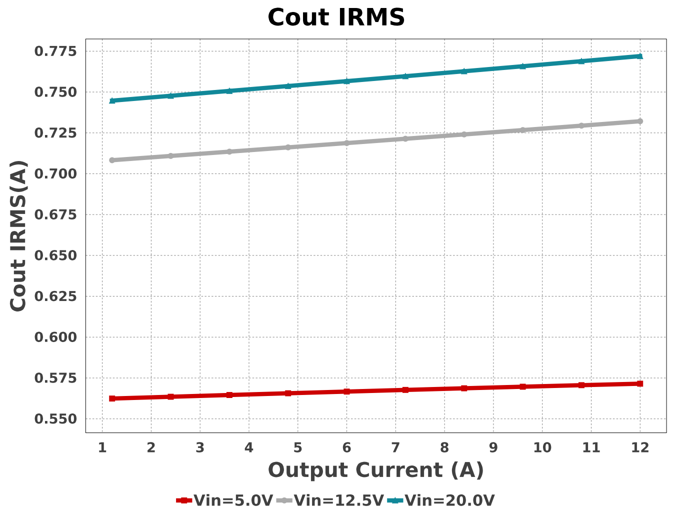


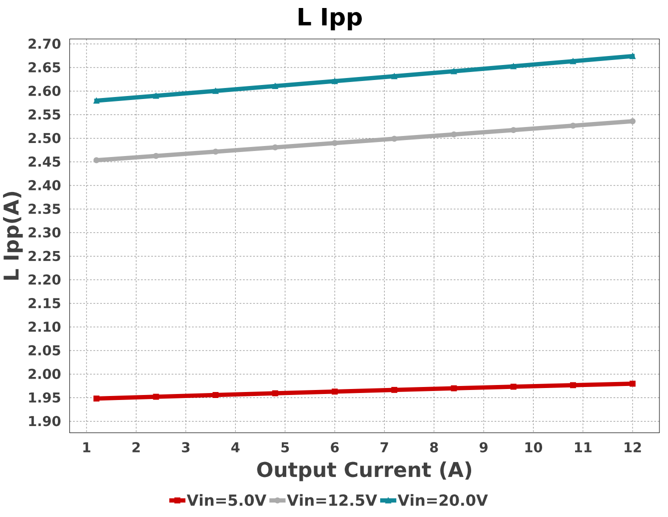

Pout
Pout(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

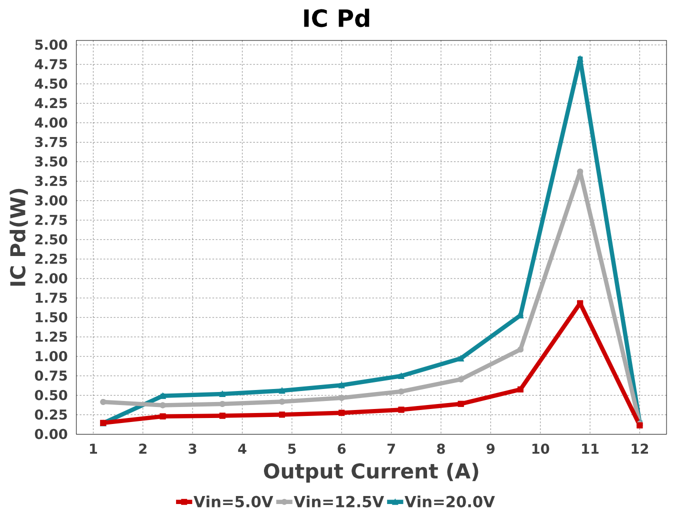

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

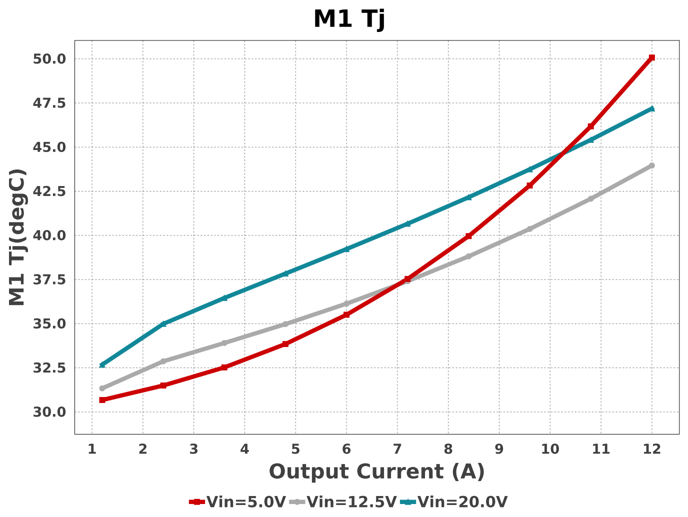

M2 Pd
M2 Pd(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

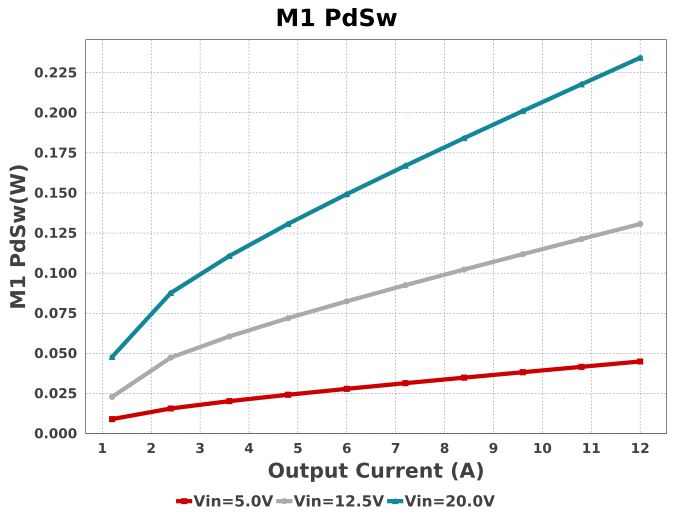

Total Pd
Total Pd(W)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

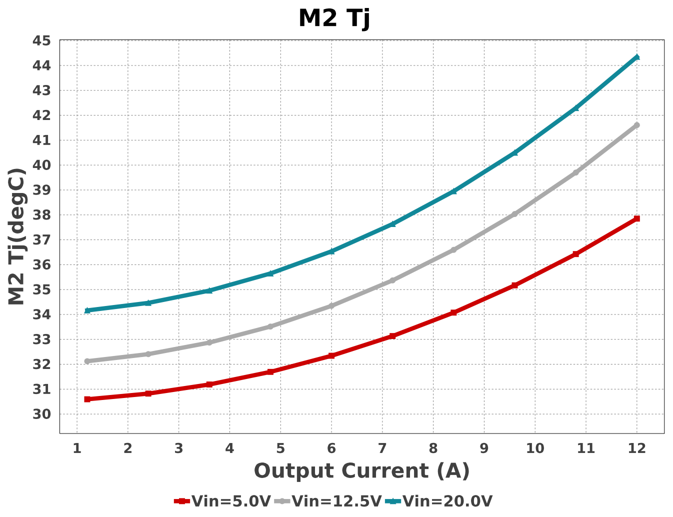

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

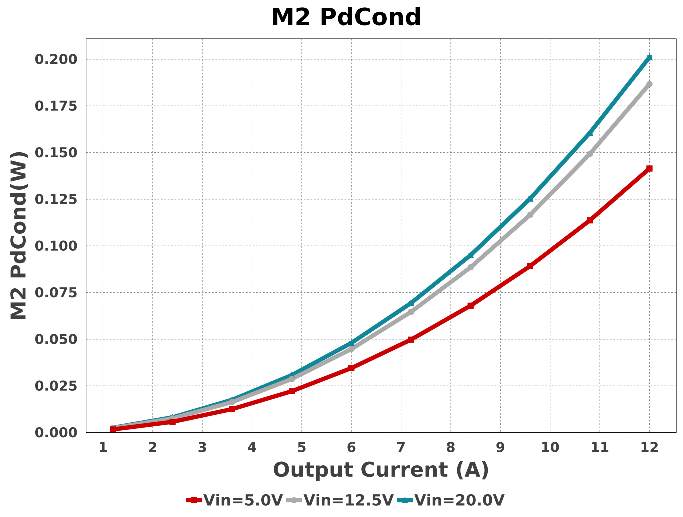

L Ipp
L Ipp(A)
Output Current (A)
Vin=5.0V Vin=12.5V Vin=20.0V

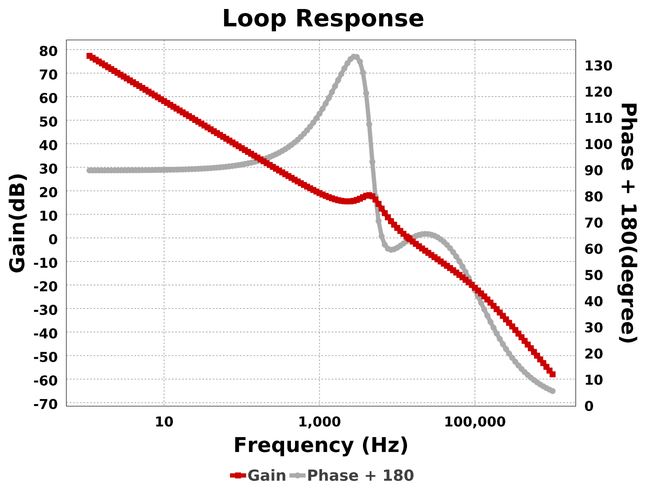












Operating Values

#	Name	Value	Category	Description
1.	BOM Count	23		Total Design BOM count
2.	Total BOM	$7.59		Total BOM Cost
3.	Cin IRMS	3.237 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	122.24 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	771.985 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	1.788 mW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	13.337 A	IC	Peak switch current in IC
8.	IC Pd	149.81 mW	IC	IC power dissipation
9.	IC Tj	36.637 degC	IC	IC junction temperature
10.	IC Tolerance	6.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA	44.3 degC/W	IC	IC junction-to-ambient thermal resistance

#	Name	Value	Category	Description
12.	Iin Avg	973.31 mA	IC	Average input current
13.	Ipp percentage	22.285 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	2.674 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	592.84 mW	Inductor	Inductor power dissipation
16.	M1 Pd	312.48 mW	Mosfet	M1 MOSFET total power dissipation
17.	M1 PdCond	78.192 mW	Mosfet	M1 MOSFET conduction losses
18.	M1 PdSw	234.29 mW	Mosfet	M1 MOSFET switching losses
19.	M1 Tj	47.187 degC	Mosfet	M1 MOSFET junction temperature
20.	M2 Pd	286.95 mW	Mosfet	M2 MOSFET total power dissipation
21.	M2 PdCond	201.01 mW	Mosfet	M2 MOSFET conduction losses
22.	M2 PdSw	85.941 mW	Mosfet	M2 MOSFET switching losses
23.	M2 Tj	44.348 degC	Mosfet	M2 MOSFET junction temperature
24.	Cin Pd	122.24 mW	Power	Input capacitor power dissipation
25.	Cout Pd	1.788 mW	Power	Output capacitor power dissipation
26.	IC Pd	149.81 mW	Power	IC power dissipation
27.	L Pd	592.84 mW	Power	Inductor power dissipation
28.	M1 Pd	312.48 mW	Power	M1 MOSFET total power dissipation
29.	M1 PdCond	78.192 mW	Power	M1 MOSFET conduction losses
30.	M1 PdSw	234.29 mW	Power	M1 MOSFET switching losses
31.	M2 Pd	286.95 mW	Power	M2 MOSFET total power dissipation
32.	M2 PdCond	201.01 mW	Power	M2 MOSFET conduction losses
33.	M2 PdSw	85.941 mW	Power	M2 MOSFET switching losses
34.	Total Pd	1.466 W	Power	Total Power Dissipation
35.	Cross Freq	13.867 kHz	System Information	Bode plot crossover frequency
36.	Duty Cycle	7.862 %	System Information	Duty cycle
37.	Efficiency	92.468 %	System Information	Steady state efficiency
38.	FootPrint	640.0 mm^2	System Information	Total Foot Print Area of BOM components
39.	Frequency	300.0 kHz	System Information	Switching frequency
40.	Gain Marg	-69.259 dB	System Information	Bode Plot Gain Margin
41.	Iout	12.0 A	System Information	Iout operating point
42.	Low Freq Gain	77.328 dB	System Information	Gain at 1Hz
43.	Mode	CCM	System Information	Conduction Mode
44.	Phase Marg	63.389 deg	System Information	Bode Plot Phase Margin
45.	Pout	18.0 W	System Information	Total output power
46.	Vin	20.0 V	System Information	Vin operating point
47.	Vin p-p	199.501 mV	System Information	Peak-to-peak input voltage
48.	Vout	1.5 V	System Information	Operational Output Voltage
49.	Vout Actual	1.502 V	System Information	Vout Actual calculated based on selected voltage divider resistors
50.	Vout Tolerance	2.225 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
51.	Vout p-p	8.023 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	12.0	Maximum Output Current
VinMax	20.0	Maximum input voltage
VinMin	5.0	Minimum input voltage
Vout	1.5	Output Voltage
base_pn	TPS40303	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

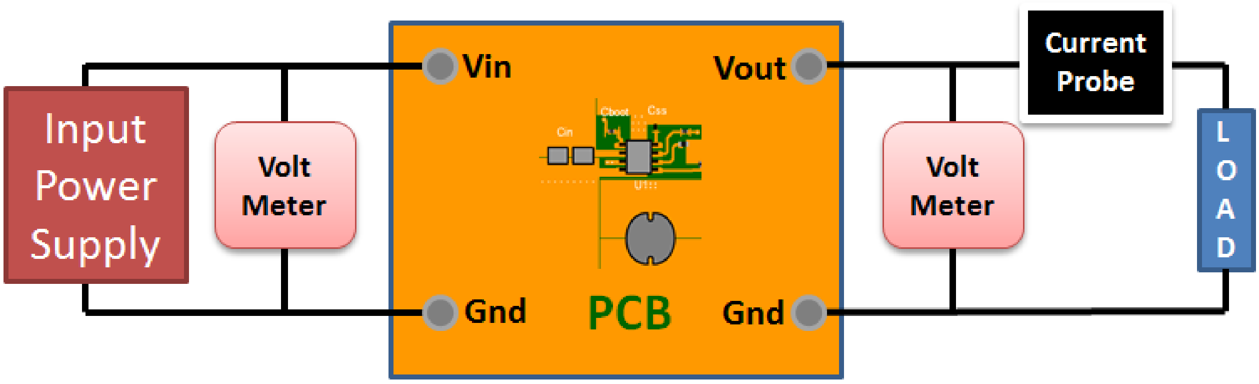
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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. Master key : 26510326DA8560301457A5AC077CA1DF[v1]

2. **TPS40303** Product Folder : http://www.ti.com/product/TPS40303 : contains the data sheet and other resources.

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