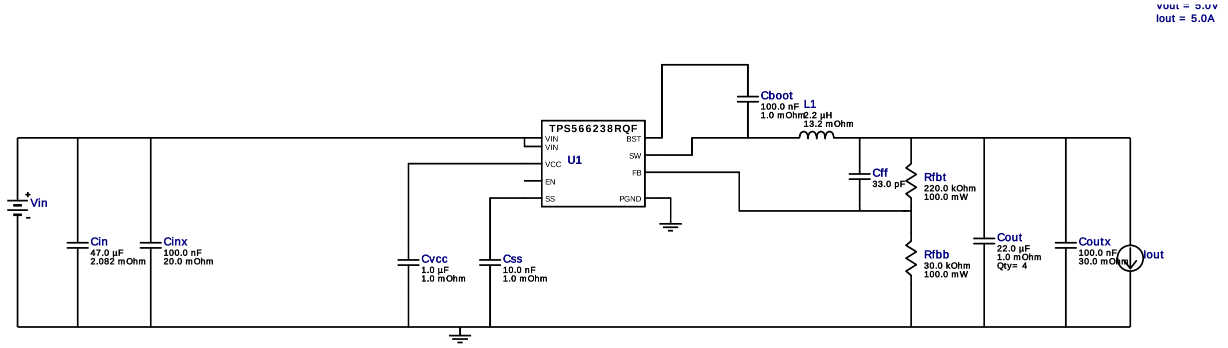
VinMin = 12.0V
VinMax = 12.0V
Vout = 5.0V
Iout = 5.0A

Device = TPS566238RQFR
Topology = Buck
Created = 2024-01-31 18:29:55.005
BOM Cost = $1.71
BOM Count = 15
Total Pd = 1.15W

WEBENCH ® Design Report

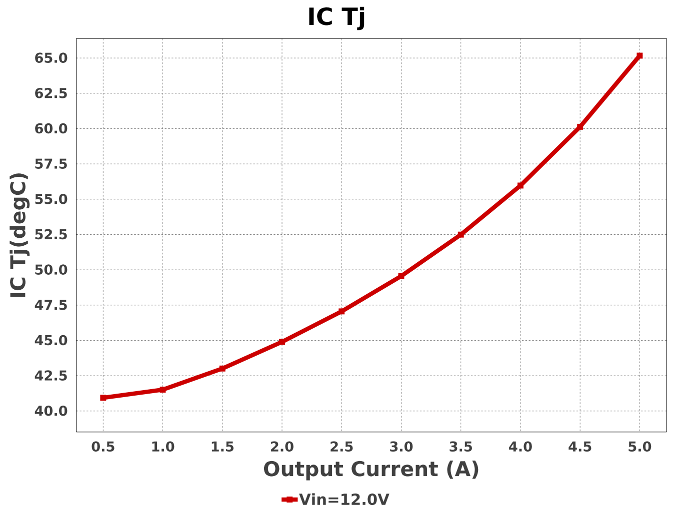
Design : 2 TPS566238RQFR
TPS566238RQFR 12V-12V to 5.00V @ 5A

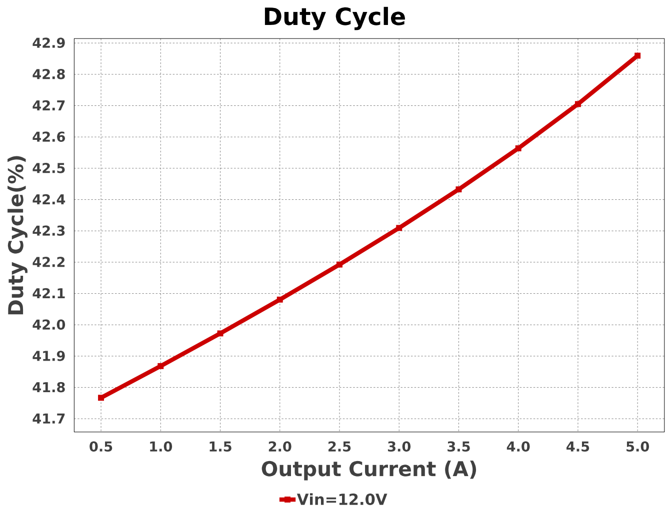


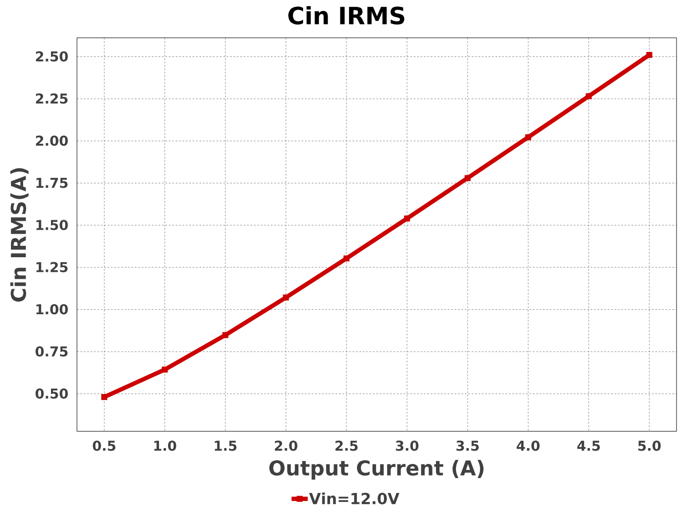
Electrical BOM

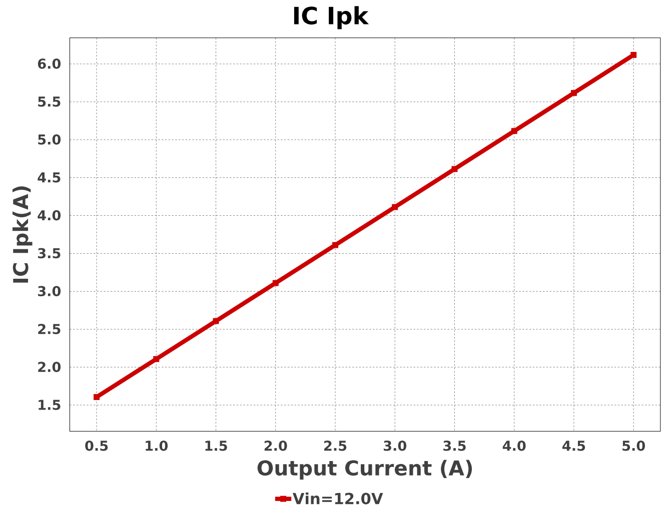
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cff	TDK	CGA1A2C0G1E330J030BA Series= C0G/NP0	Cap= 33.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cin	TDK	C3216X5R1E476M160AC Series= X5R	Cap= 47.0 uF ESR= 2.082 mOhm VDC= 25.0 V IRMS= 5.0279 A	1	$0.35	1206 11 mm²
Cinx	MuRata	GRM188R71H104KA93D Series= X7R	Cap= 100.0 nF ESR= 20.0 mOhm VDC= 50.0 V IRMS= 3.8 A	1	$0.02	0603 5 mm²
Cout	Taiyo Yuden	LMK212BJ226MG-T Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 1.6 A	4	$0.09	0805 7 mm²
Coutx	MuRata	GRM188R71E104KA01D Series= X7R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 25.0 V IRMS= 1.51 A	1	$0.01	0603 5 mm²
Css	MuRata	GRM155R71C103KA01D Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
L1	Coilcraft	XAL5030-222MEB	L= 2.2 µH 13.2 mOhm	1	$0.63	XAL5030 54 mm²
Rfbb	Yageo	RC0603FR-0730KL Series= ?	Res= 30.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbt	Yageo	RC0603FR-07220KL Series= ?	Res= 220.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²

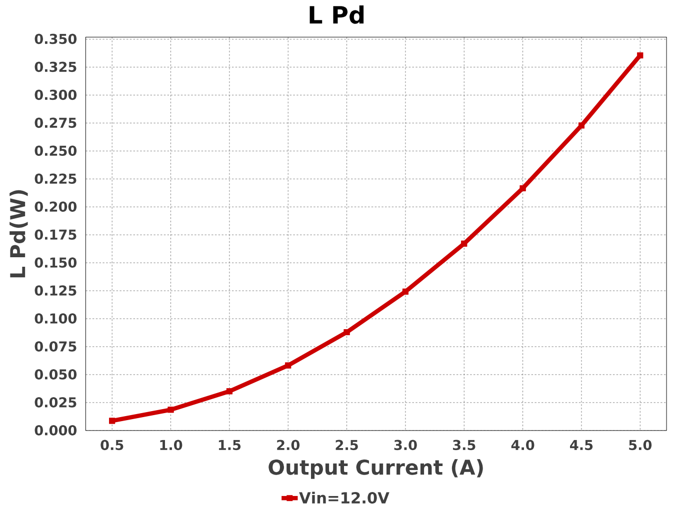
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	TPS566238RQFR	Switcher	1	$0.28	RQF0009A 8 mm^2

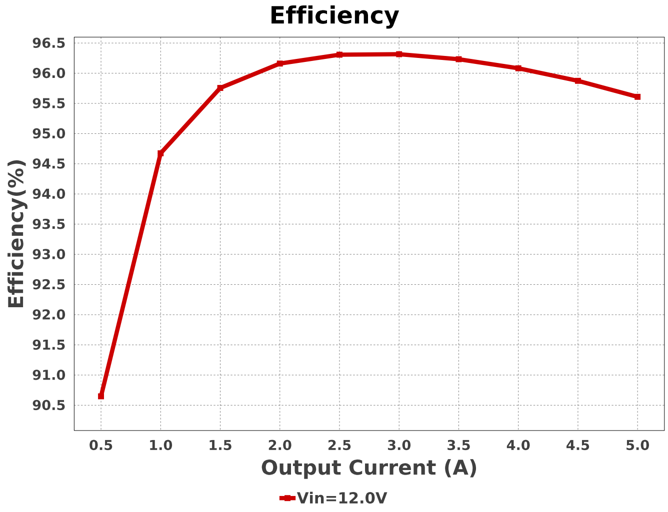




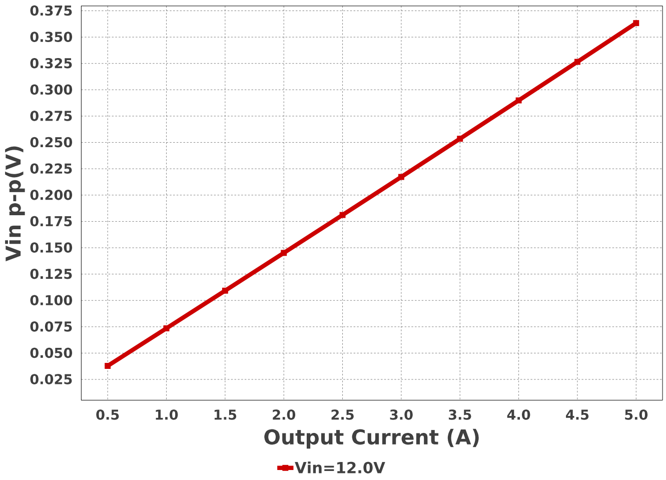




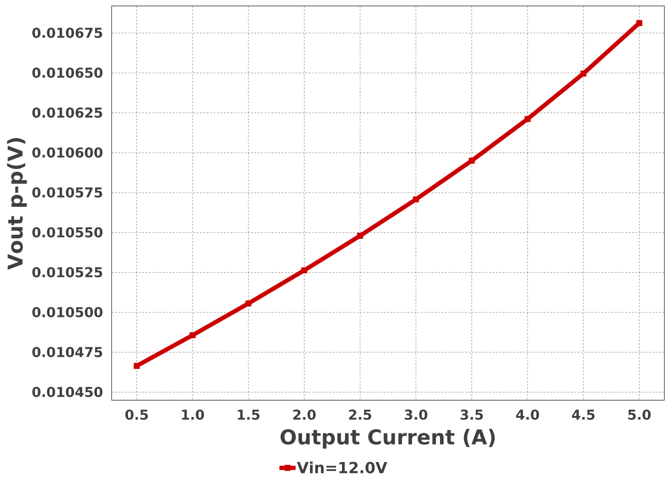




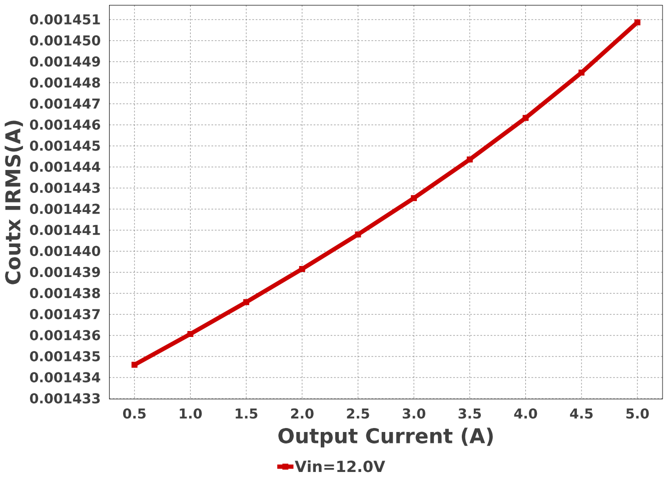
Vin p-p



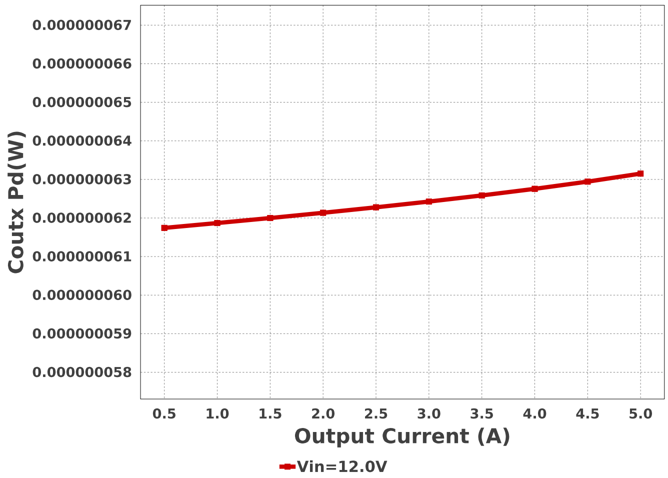
Vout p-p



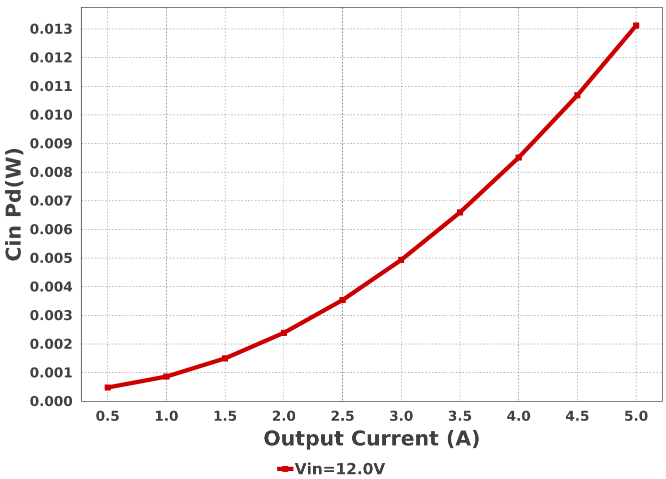
Coutx IRMS



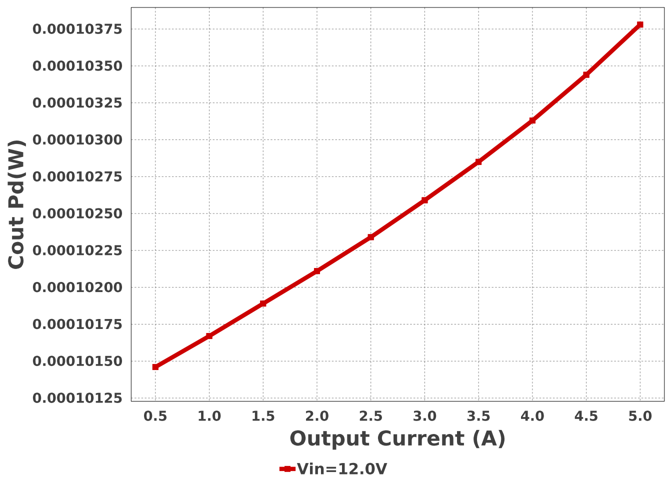
Coutx Pd

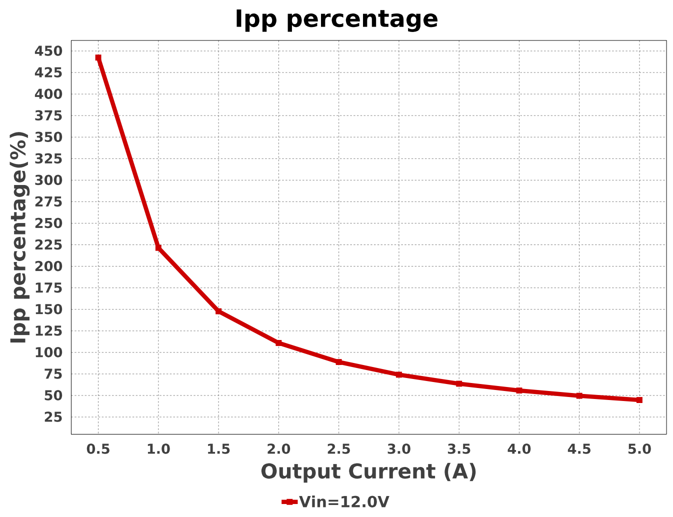


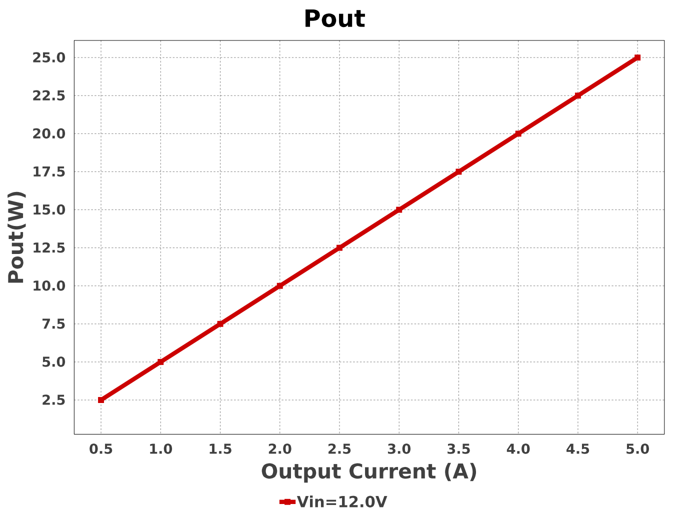
Cin Pd

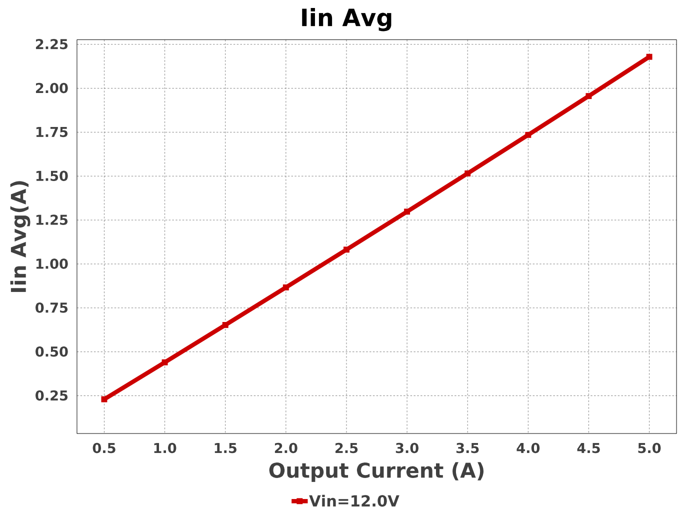


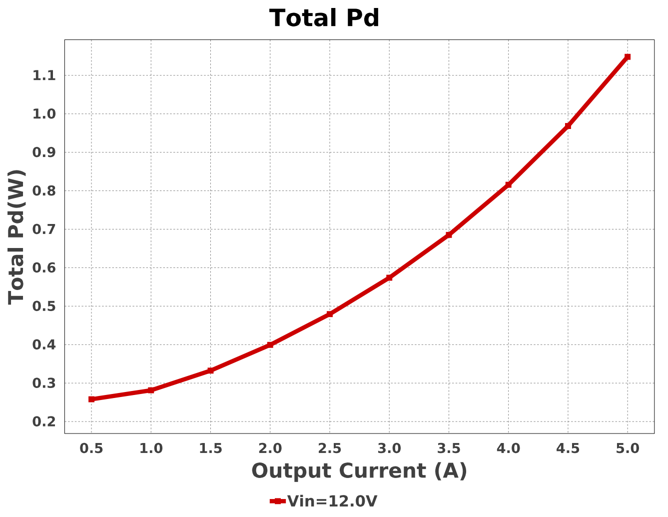
Cout Pd

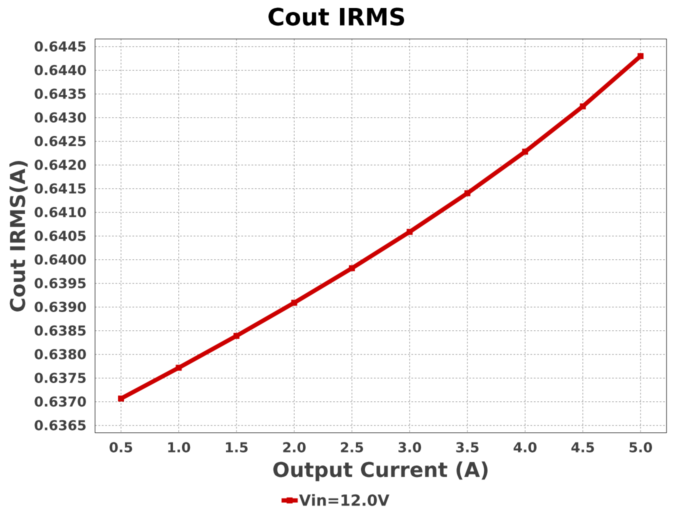


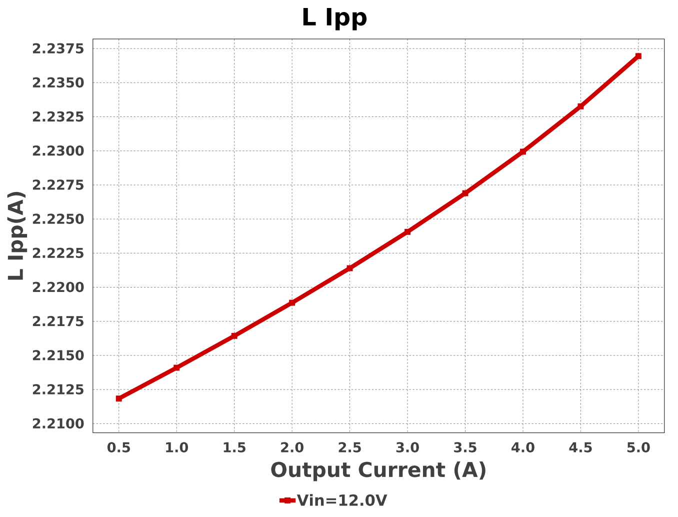

Ipp percentage
Ipp percentage(%)
450 425 400 375 350 325 300 275 250 225 200 175 150 125 100 75 50 25
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V

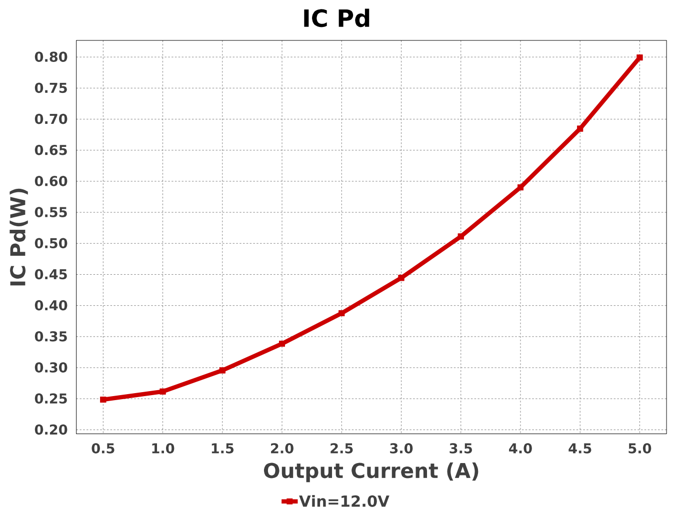

Pout
Pout(W)
25.0 22.5 20.0 17.5 15.0 12.5 10.0 7.5 5.0 2.5
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V


Iin Avg
Iin Avg(A)
2.25 2.00 1.75 1.50 1.25 1.00 0.75 0.50 0.25
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V


Total Pd
Total Pd(W)
1.1 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V


Cout IRMS
Cout IRMS(A)
0.6445 0.6440 0.6435 0.6430 0.6425 0.6420 0.6415 0.6410 0.6405 0.6400 0.6395 0.6390 0.6385 0.6380 0.6375 0.6370 0.6365
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V


L Ipp
L Ipp(A)
2.2375 2.2350 2.2325 2.2300 2.2275 2.2250 2.2225 2.2200 2.2175 2.2150 2.2125 2.2100
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=12.0V



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	2.51 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	13.119 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	644.3 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	103.78 µW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	1.451 mA	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	63.151 nW	Capacitor	Output capacitor_x power loss
7.	IC Ipk	6.118 A	IC	Peak switch current in IC
8.	IC Pd	799.22 mW	IC	IC power dissipation
9.	IC Tj	65.166 degC	IC	IC junction temperature
10.	IC Tolerance	11.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA Effective	44.0 degC/W	IC	IC junction-to-ambient thermal resistance with TI EVM
12.	Iin Avg	2.179 A	IC	Average input current
13.	Ipp percentage	44.739 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	2.237 A	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	335.5 mW	Inductor	Inductor power dissipation
16.	Cin Pd	13.119 mW	Power	Input capacitor power dissipation
17.	Cout Pd	103.78 µW	Power	Output capacitor power dissipation
18.	Coutx Pd	63.151 nW	Power	Output capacitor_x power loss
19.	IC Pd	799.22 mW	Power	IC power dissipation
20.	L Pd	335.5 mW	Power	Inductor power dissipation
21.	Total Pd	1.148 W	Power	Total Power Dissipation
22.	BOM Count	15	System Information	Total Design BOM count
23.	Duty Cycle	42.86 %	System Information	Duty cycle
24.	Efficiency	95.609 %	System Information	Steady state efficiency
25.	FootPrint	131.0 mm²	System Information	Total Foot Print Area of BOM components
26.	Frequency	594.122 kHz	System Information	Switching frequency
27.	Iout	5.0 A	System Information	Iout operating point
28.	Mode	CCM	System Information	Conduction Mode
29.	Pout	25.0 W	System Information	Total output power
30.	Total BOM	$1.71	System Information	Total BOM Cost
31.	Vin	12.0 V	System Information	Vin operating point
32.	Vin p-p	363.316 mV	System Information	Peak-to-peak input voltage
33.	Vout	5.0 V	System Information	Operational Output Voltage
34.	Vout Actual	5.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
35.	Vout Tolerance	3.644 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
36.	Vout p-p	10.681 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	5.0	Maximum Output Current
VinMax	12.0	Maximum input voltage
VinMin	12.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	TPS566238	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

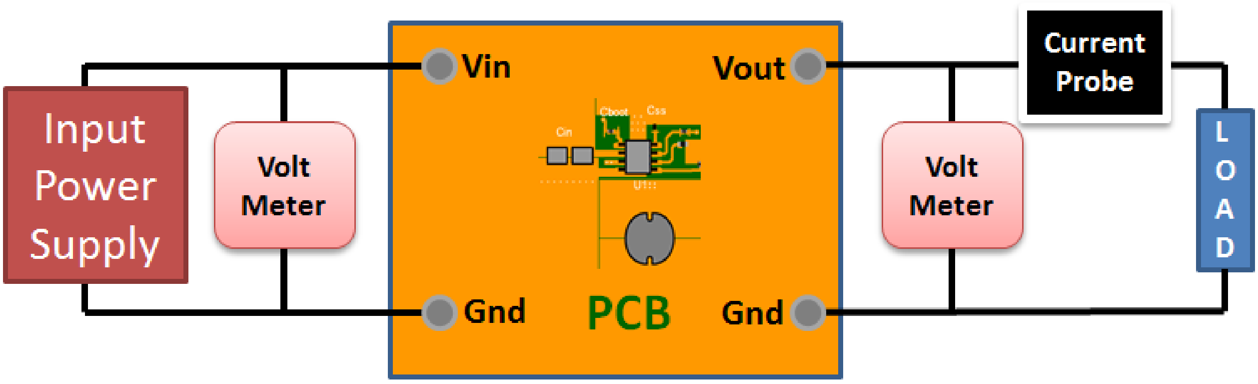
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 12.0V 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 : 93E3EFA480C2186AF56F7FED17BCE730[v1]

2. **TPS566238** Product Folder : http://www.ti.com/product/TPS566238 : contains the data sheet and other resources.

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