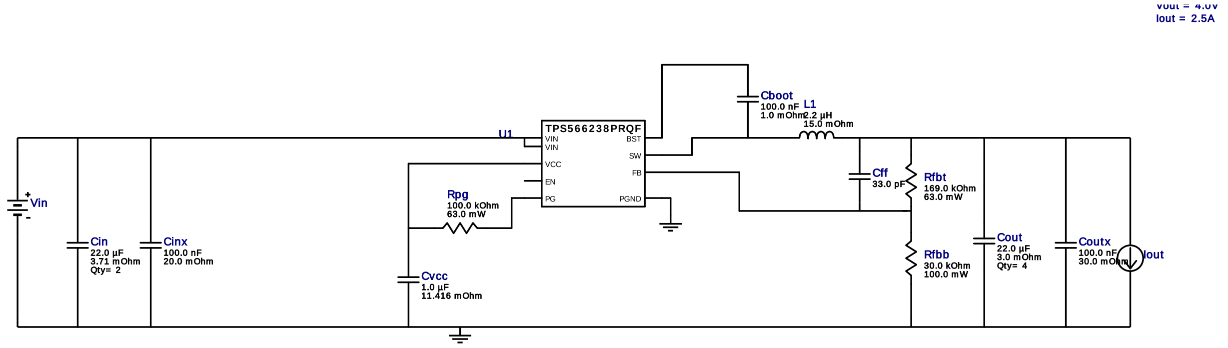
VinMin = 4.6V
VinMax = 5.5V
Vout = 4.0V
Iout = 2.5A

Device = TPS566238PRQFR
Topology = Buck
Created = 2021-12-20 21:08:15.149
BOM Cost = $2.12
BOM Count = 16
Total Pd = 0.34W

WEBENCH ® Design Report

Design : 298 TPS566238PRQFR
TPS566238PRQFR 4.6V-4.6V to 4.00V @ 2.5A

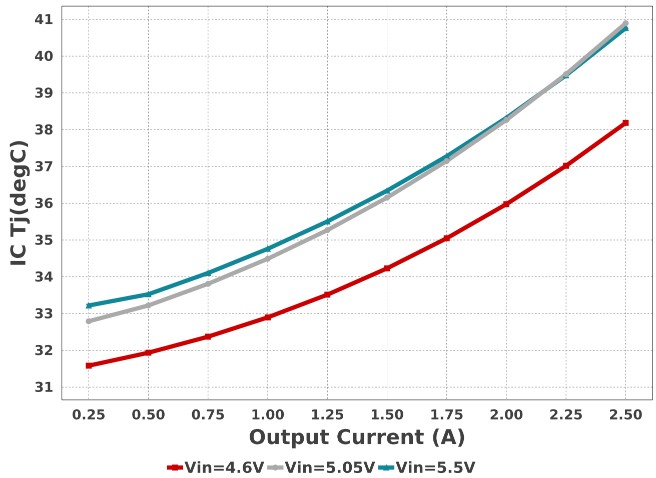


Electrical BOM

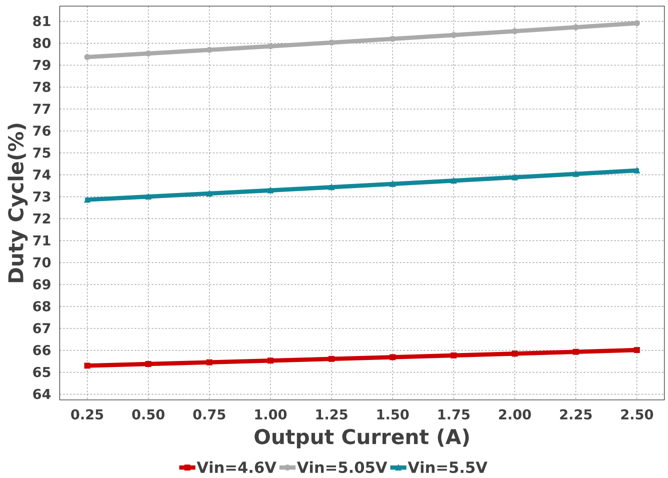
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cff	MuRata	GJM0335C0J330JB01D Series= C0G/NP0	Cap= 33.0 pF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Cin	TDK	C1608X5R1A226M080AC Series= X5R	Cap= 22.0 uF ESR= 3.71 mOhm VDC= 10.0 V IRMS= 2.69936 A	2	$0.12	0603 5 mm^2
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 mm^2
Cout	MuRata	GRM21BR61A226ME44L Series= X5R	Cap= 22.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 3.84 A	4	$0.13	0805 7 mm^2
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 mm^2
Cvcc	TDK	C1005X6S1C105K050BC Series= X6S	Cap= 1.0 uF ESR= 11.416 mOhm VDC= 16.0 V IRMS= 1.483 A	1	$0.02	0402 3 mm^2
L1	TDK	VLP8040T-2R2N	L= 2.2 µH 15.0 mOhm	1	$0.22	VLP8040 113 mm^2
Rfbb	Yageo	RC0603FR-0730KL Series= ?	Res= 30.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfbt	Vishay-Dale	CRCW0402169KFKED Series= CRCW..e3	Res= 169.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
U1	Texas Instruments	TPS566238PRQFR	Switcher	1	$1.04	RQF0009A 8 mm^2

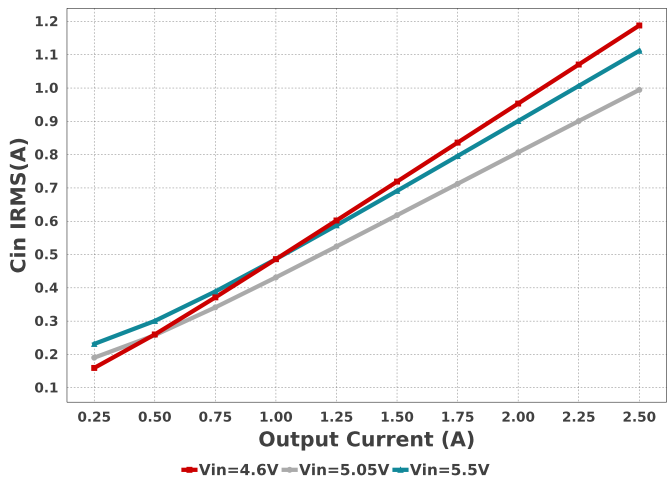
IC Tj



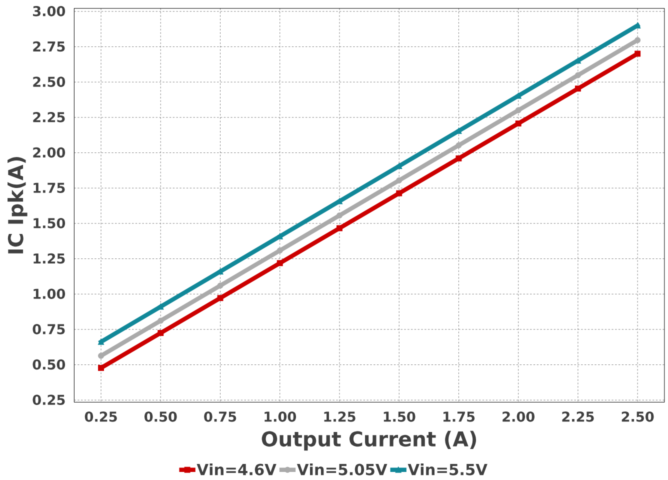
Duty Cycle



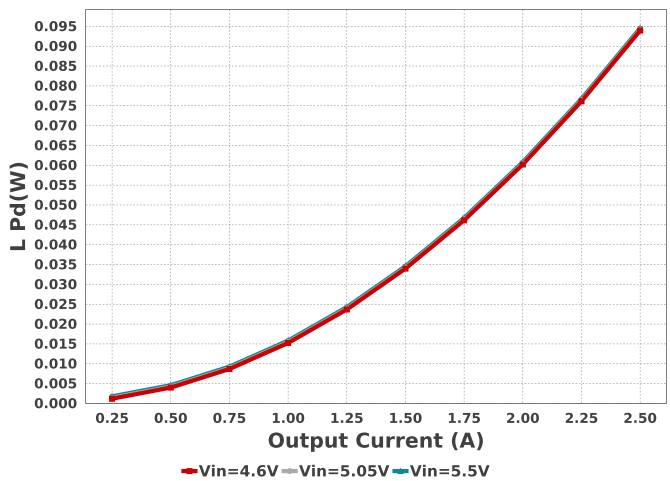
Cin IRMS



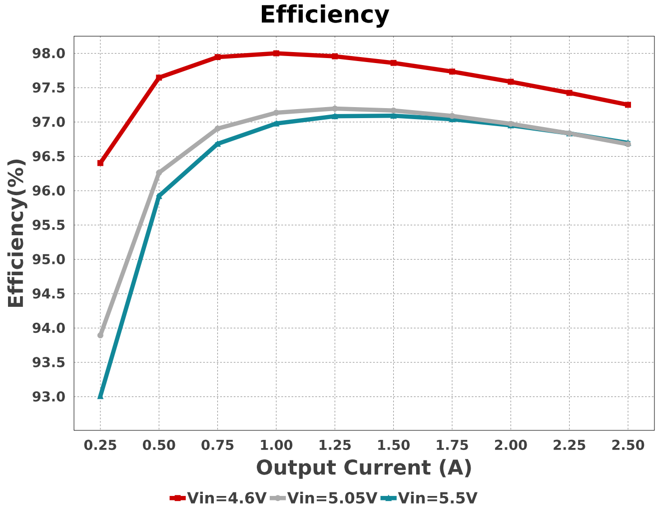
IC Ipk

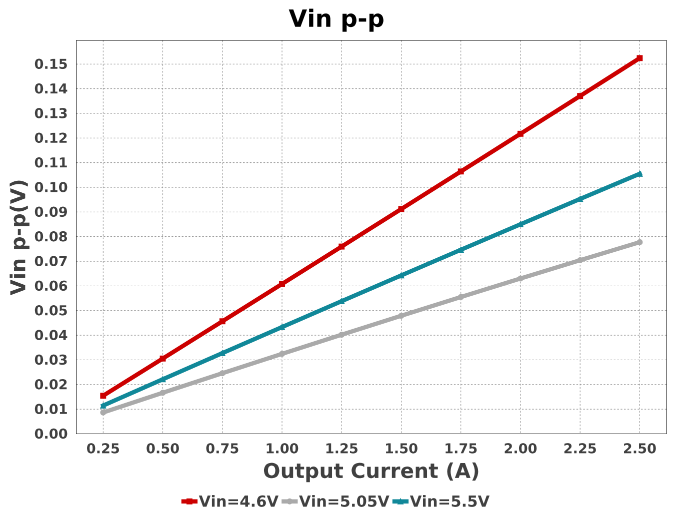


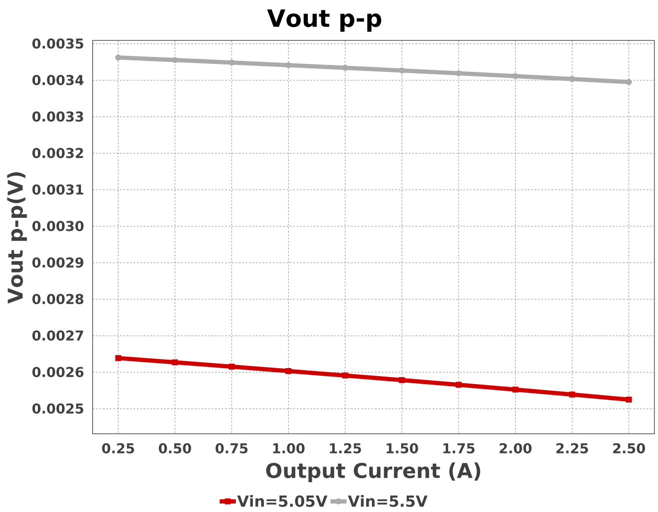
L Pd

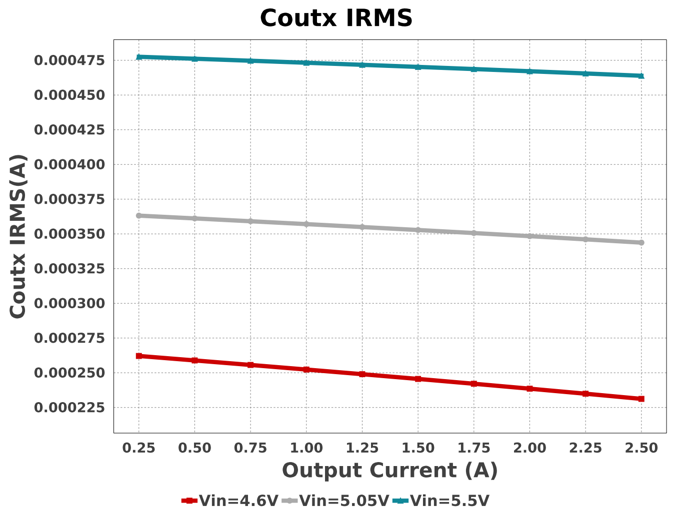


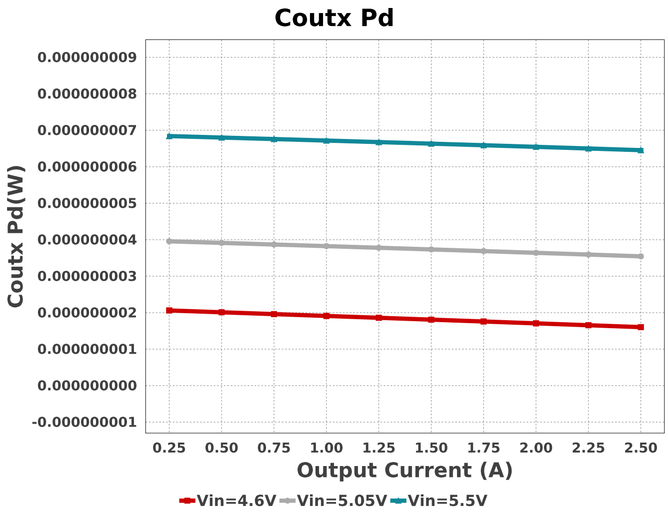
Efficiency

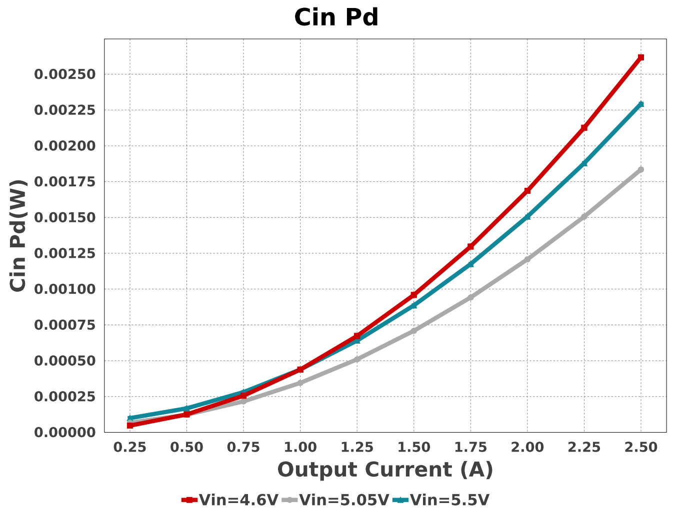


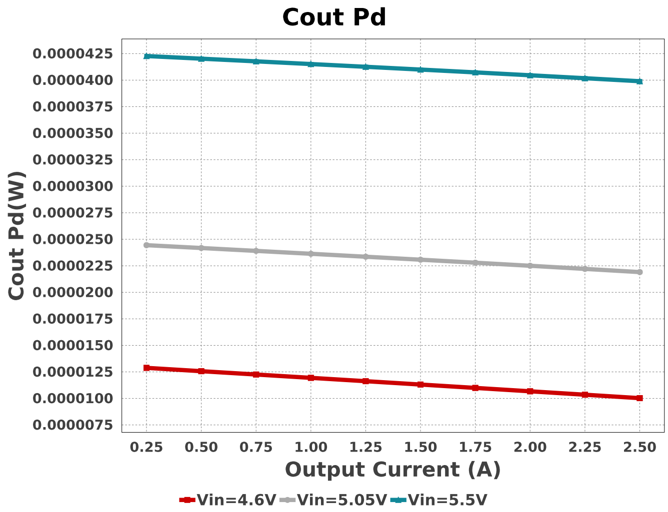

Vin p-p
Vin p-p(V)
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V

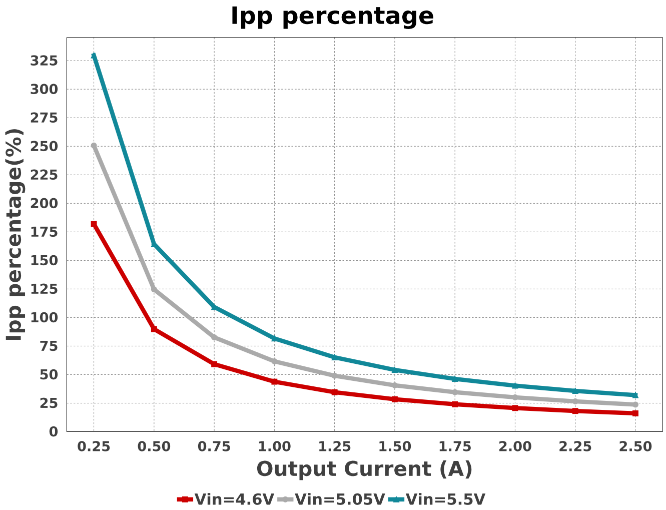

Vout p-p
Vout p-p(V)
0.0035
0.0034
0.0033
0.0032
0.0031
0.0030
0.0029
0.0028
0.0027
0.0026
0.0025
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=5.05V Vin=5.5V

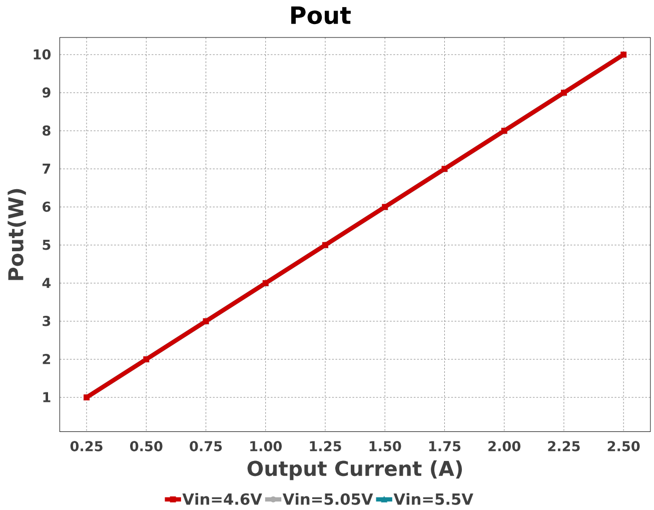

Coutx IRMS
Coutx IRMS(A)
0.000475
0.000450
0.000425
0.000400
0.000375
0.000350
0.000325
0.000300
0.000275
0.000250
0.000225
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V

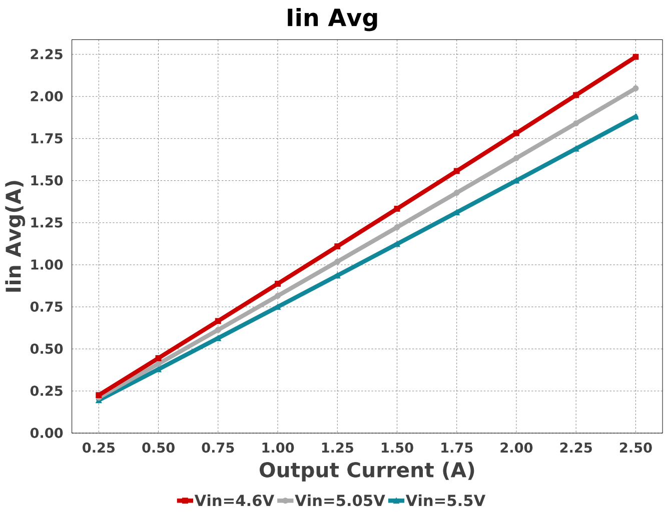

Coutx Pd
Coutx Pd(W)
0.000000009
0.000000008
0.000000007
0.000000006
0.000000005
0.000000004
0.000000003
0.000000002
0.000000001
0.000000000
-0.000000001
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V

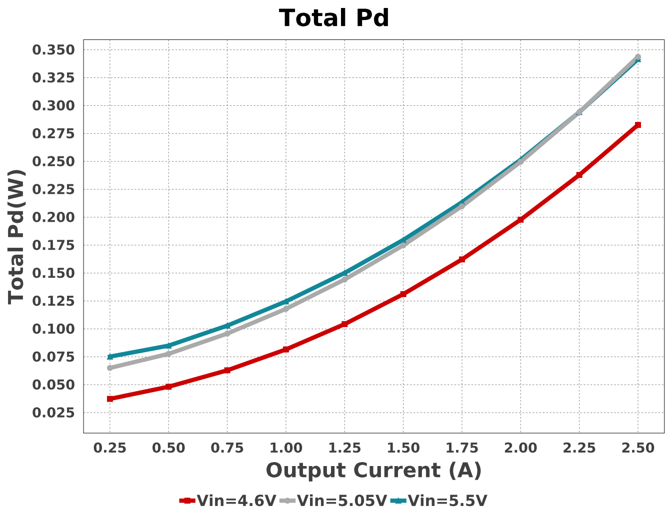

Cin Pd
Cin Pd(W)
0.00250
0.00225
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V

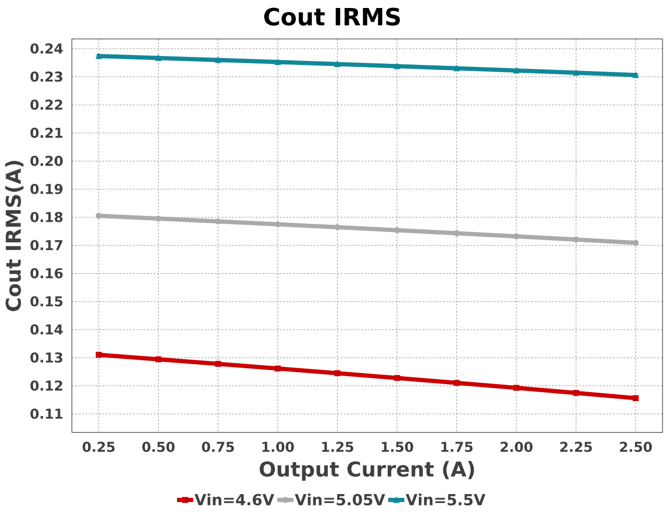

Cout Pd
Cout Pd(W)
0.0000425
0.0000400
0.0000375
0.0000350
0.0000325
0.0000300
0.0000275
0.0000250
0.0000225
0.0000200
0.0000175
0.0000150
0.0000125
0.0000100
0.0000075
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V

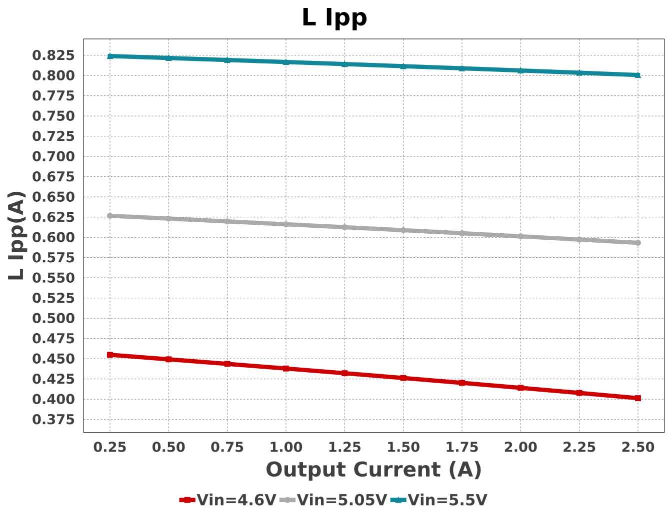

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V

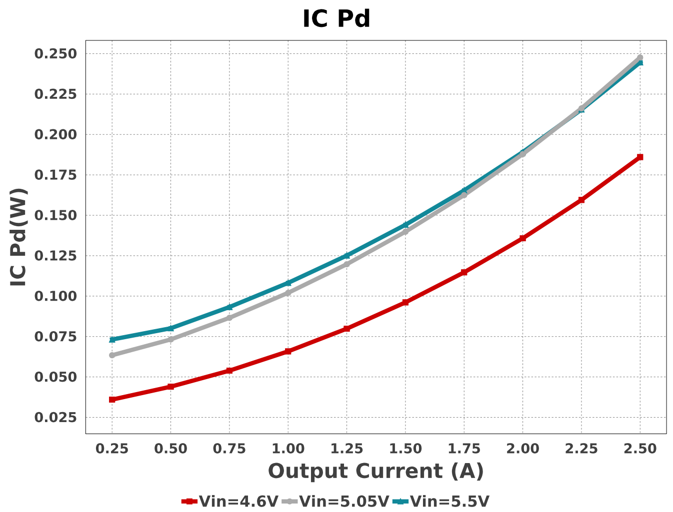

Pout
Pout(W)
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V


Iin Avg
Iin Avg(A)
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V


Total Pd
Total Pd(W)
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V


L Ipp
L Ipp(A)
Output Current (A)
Vin=4.6V Vin=5.05V Vin=5.5V



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.112 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	2.293 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	230.646 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	39.898 µW	Capacitor	Output capacitor power dissipation
5.	Coutx IRMS	463.863 µA	Capacitor	Output capacitor_x RMS ripple current
6.	Coutx Pd	6.455 nW	Capacitor	Output capacitor_x power loss
7.	IC Ipk	2.9 A	IC	Peak switch current in IC
8.	IC Pd	244.6 mW	IC	IC power dissipation
9.	IC Tj	40.762 degC	IC	IC junction temperature
10.	IC Tolerance	9.0 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	1.88 A	IC	Average input current
13.	Ipp percentage	32.024 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	800.59 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	94.551 mW	Inductor	Inductor power dissipation
16.	Cin Pd	2.293 mW	Power	Input capacitor power dissipation
17.	Cout Pd	39.898 µW	Power	Output capacitor power dissipation
18.	Coutx Pd	6.455 nW	Power	Output capacitor_x power loss
19.	IC Pd	244.6 mW	Power	IC power dissipation
20.	L Pd	94.551 mW	Power	Inductor power dissipation
21.	Total Pd	341.585 mW	Power	Total Power Dissipation
22.	BOM Count	16	System Information	Total Design BOM count
23.	Duty Cycle	74.2 %	System Information	Duty cycle
24.	Efficiency	96.697 %	System Information	Steady state efficiency
25.	FootPrint	185.0 mm^2	System Information	Total Foot Print Area of BOM components
26.	Frequency	593.975 kHz	System Information	Switching frequency
27.	Iout	2.5 A	System Information	Iout operating point
28.	Mode	CCM	System Information	Conduction Mode
29.	Pout	10.0 W	System Information	Total output power
30.	Total BOM	$2.12	System Information	Total BOM Cost
31.	Vin	5.5 V	System Information	Vin operating point
32.	Vin p-p	105.495 mV	System Information	Peak-to-peak input voltage
33.	Vout	4.0 V	System Information	Operational Output Voltage
34.	Vout Actual	3.98 V	System Information	Vout Actual calculated based on selected voltage divider resistors
35.	Vout Tolerance	3.241 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
36.	Vout p-p	3.395 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.5	Maximum Output Current
VinMax	5.5	Maximum input voltage
VinMin	4.6	Minimum input voltage
Vout	4.0	Output Voltage
base_pn	TPS566238P	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

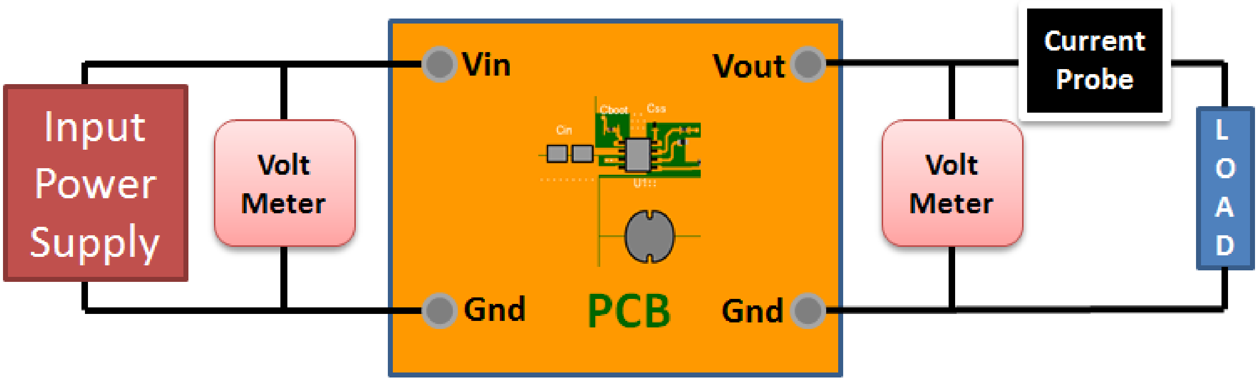
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 4.6V 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 : D6A24BC0319B1695[v1]

2. **TPS566238P** Product Folder : http://www.ti.com/product/TPS566238 : contains the data sheet and other resources.