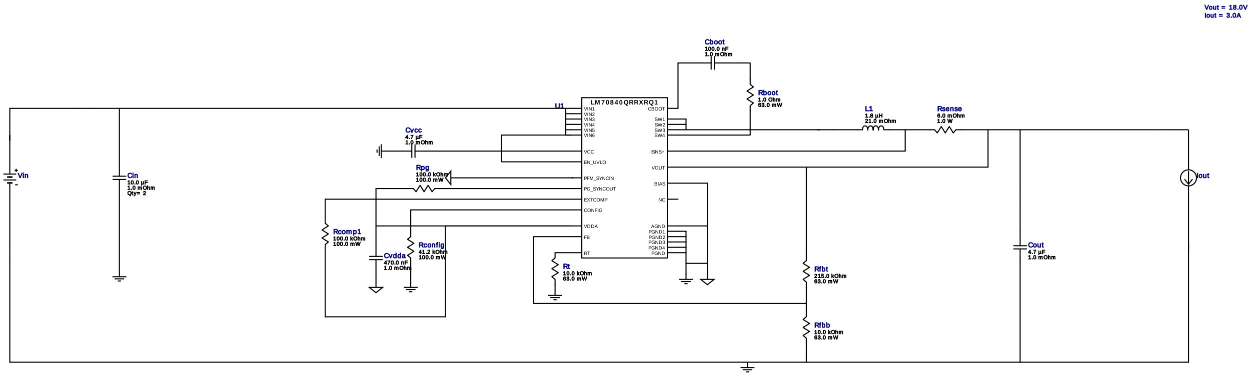
VinMin = 43.0V
VinMax = 58.0V
Vout = 18.0V
Iout = 3.0A

Device = LM70840QRRXRQ1
Topology = Buck
Created = 2024-08-12 16:06:20.360
BOM Cost = $4.89
BOM Count = 16
Total Pd = 3.04W

WEBENCH ® Design Report

Design : 4 LM70840QRRXRQ1
LM70840QRRXRQ1 43V-58V to 18.00V @ 3A



Design Alerts

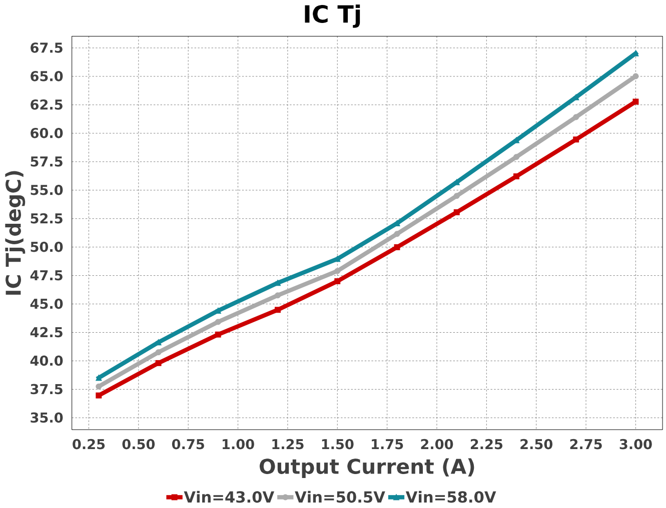
Component Selection Information

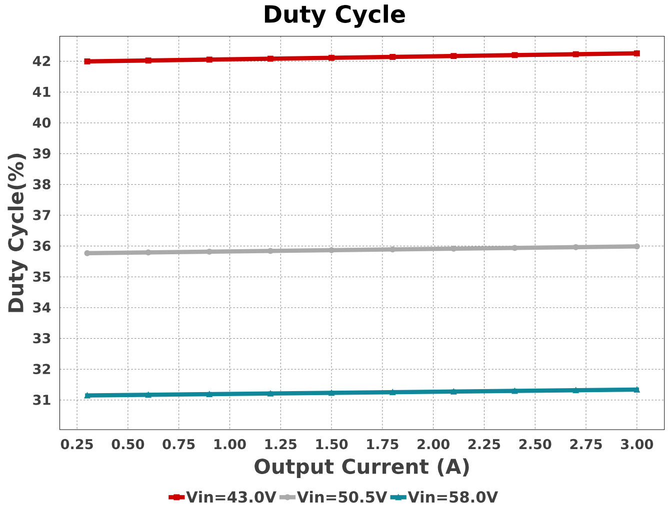
The LM70840-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. Please note :Loop has not been modelled for the design.

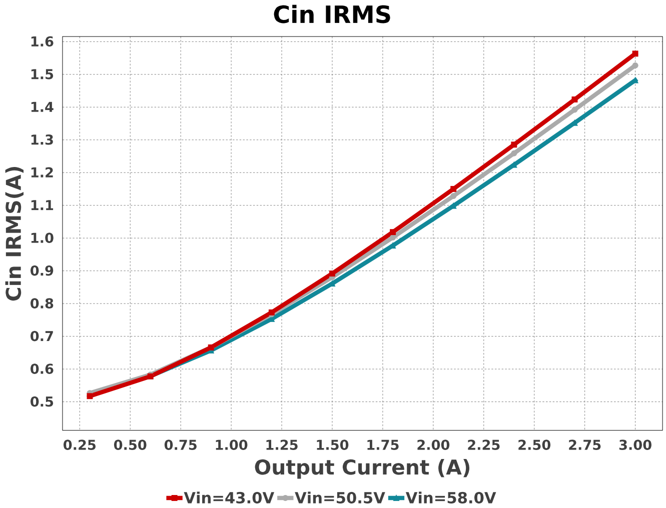
Electrical BOM

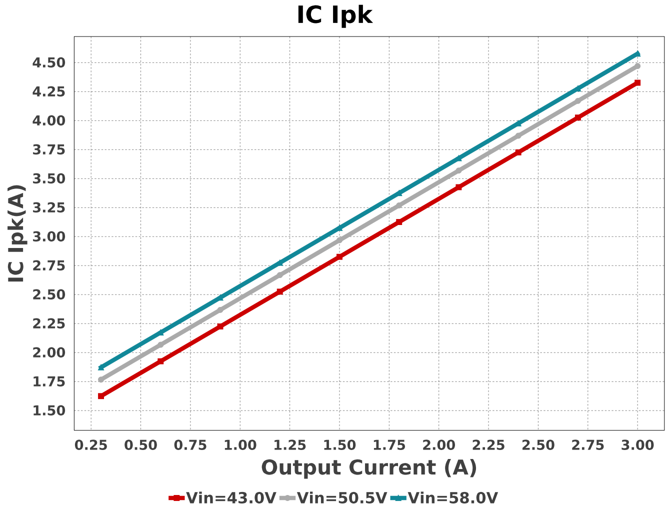
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	MuRata	GRM32ER71J106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 63.0 V IRMS= 6.0 A	2	$0.30	1210_280 15 mm²
Cout	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	1	$0.12	0805 7 mm²
Cvcc	MuRata	GRM155R61A475MEAAD Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0402_065 3 mm²
Cvdda	MuRata	GRM155R61A474KE15D Series= X5R	Cap= 470.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.02	0402 3 mm²
L1	Wurth Elektronik	74438357018	L= 1.8 µH 21.0 mOhm	1	$1.22	WE-MAPI_4030 26 mm²
Rboot	Vishay-Dale	CRCW04021R00FKED Series= CRCW..e3	Res= 1.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rcomp1	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rconfig	Vishay-Dale	CRCW060341K2FKEA Series= CRCW..e3	Res= 41.2 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²

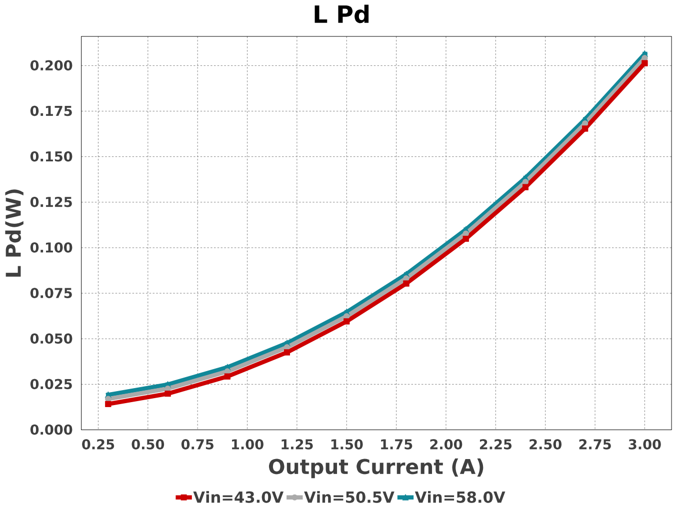
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbb	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW0402215KFKED Series= CRCW..e3	Res= 215.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rpg	Vishay-Dale	CRCW0603100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
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 mm²
Rt	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LM70840QRRXRQ1	Switcher	1	$2.63	RRX0029B 64 mm²

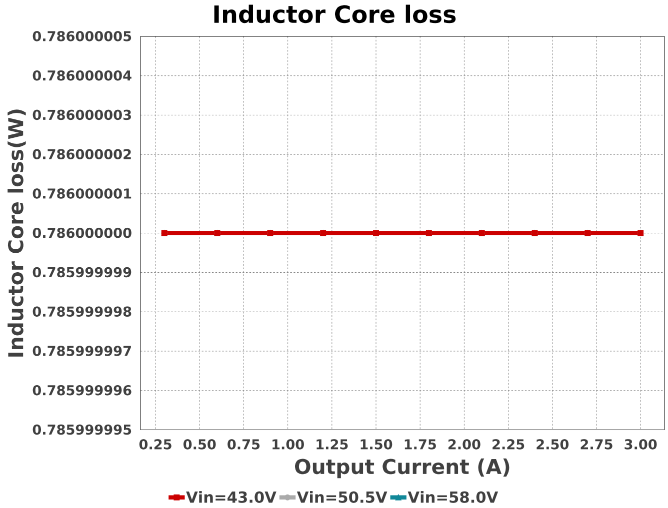


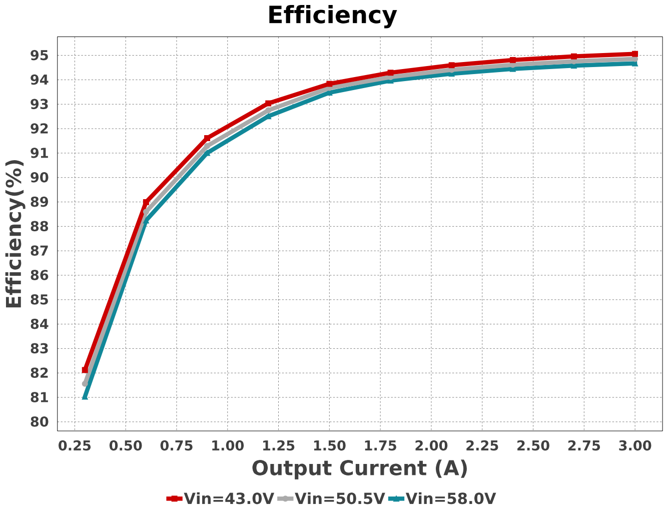


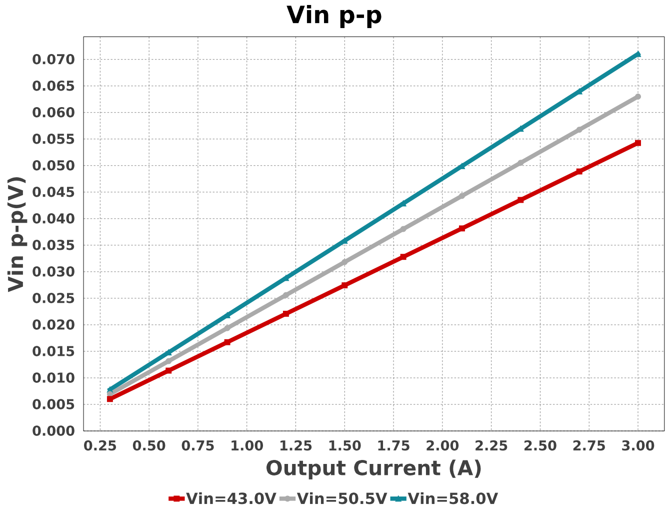


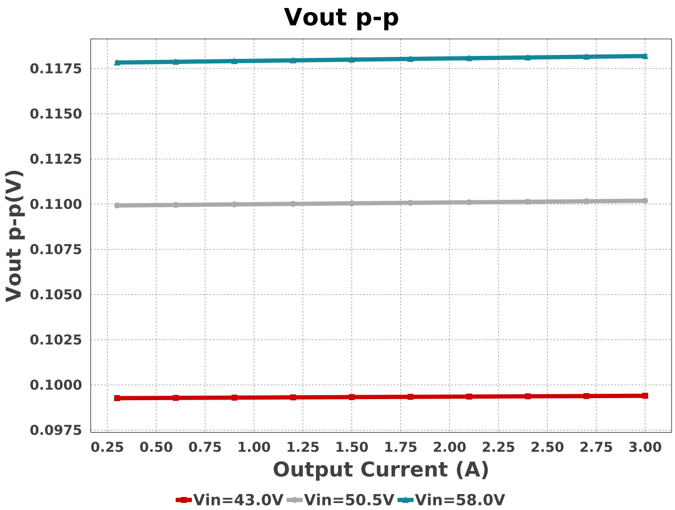


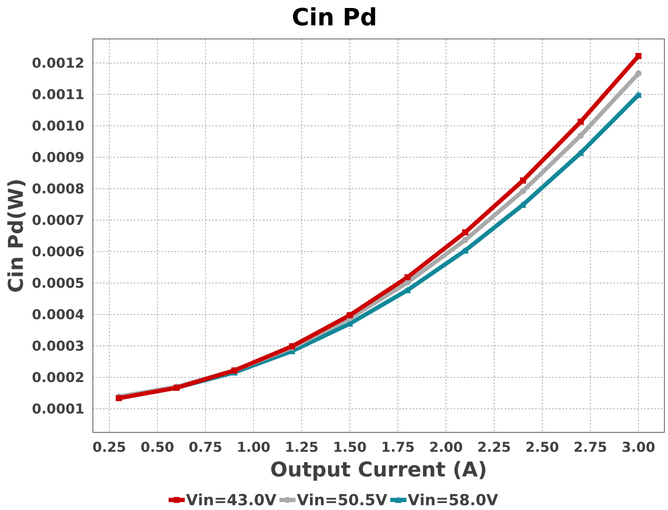

L Pd
L Pd(W)
Output Current (A)
Vin=43.0V
Vin=50.5V
Vin=58.0V

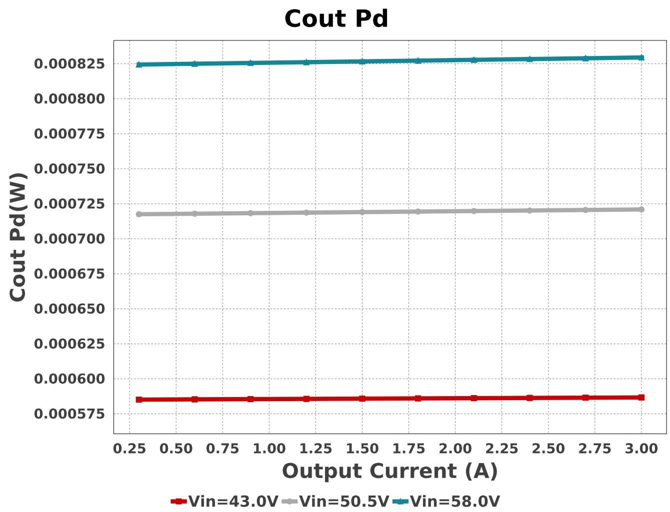

Inductor Core loss
Inductor Core loss(W)
Output Current (A)
Vin=43.0V
Vin=50.5V
Vin=58.0V

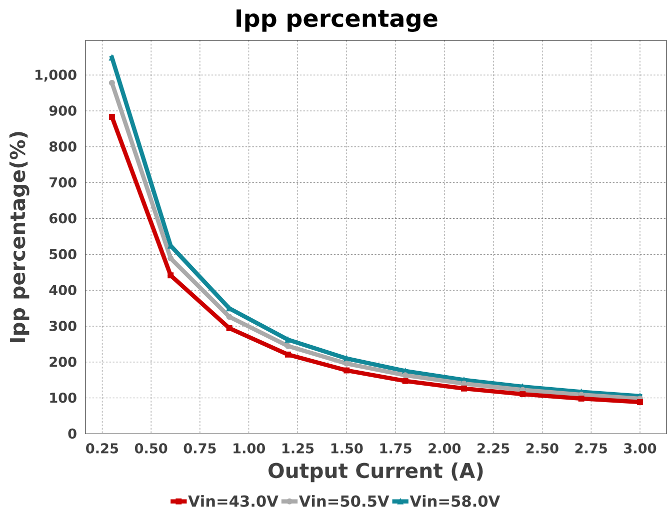

Efficiency
Efficiency(%)
Output Current (A)
Vin=43.0V
Vin=50.5V
Vin=58.0V

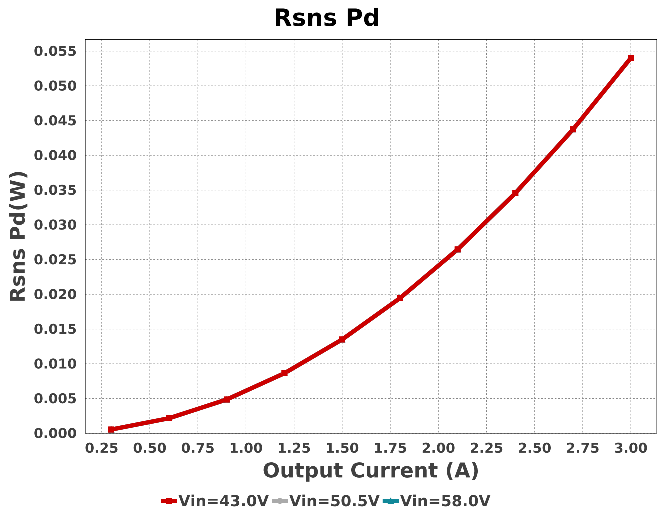

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=43.0V
Vin=50.5V
Vin=58.0V

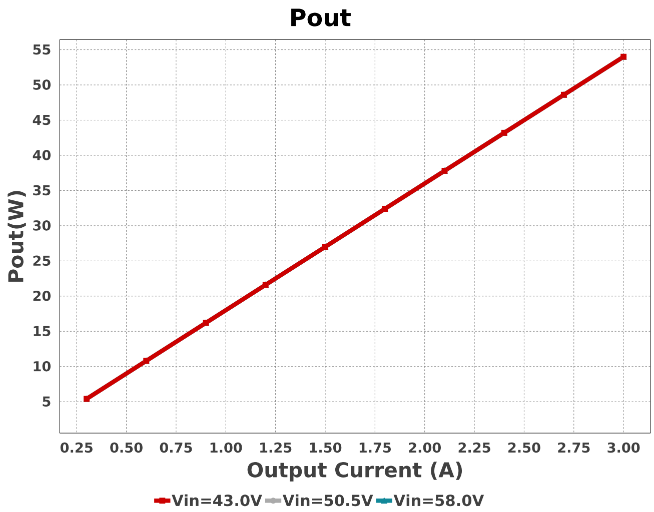

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=43.0V
Vin=50.5V
Vin=58.0V

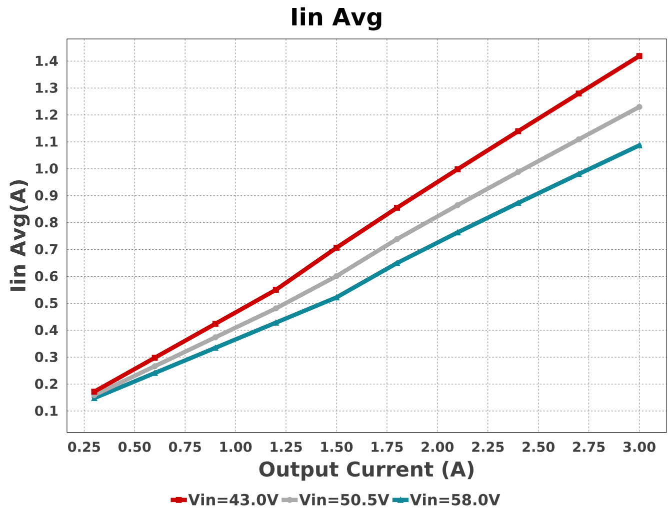

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=43.0V
Vin=50.5V
Vin=58.0V

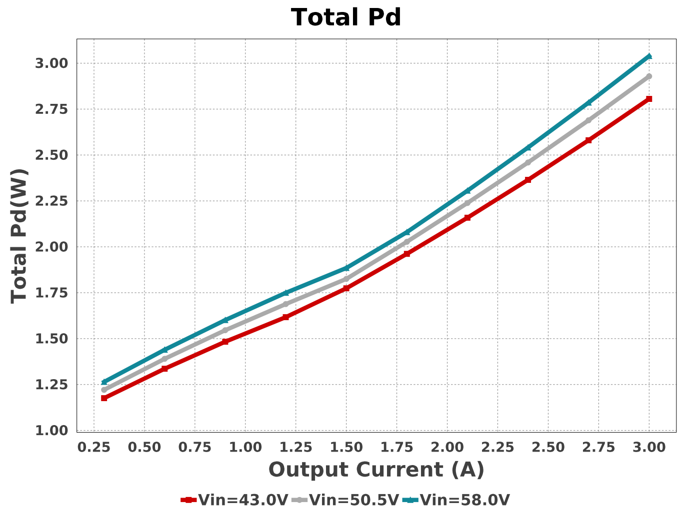

Cout Pd
0.000825
0.000800
0.000775
0.000750
0.000725
0.000700
0.000675
0.000650
0.000625
0.000600
0.000575
Cout Pd(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=43.0V Vin=50.5V Vin=58.0V

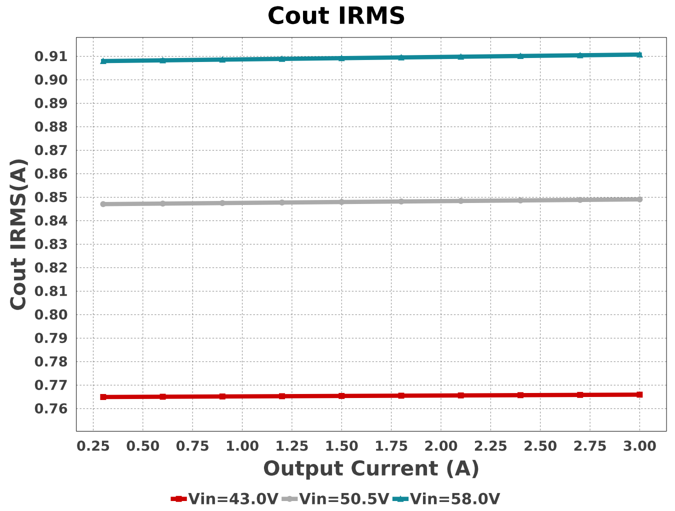

Ipp percentage
1,000
900
800
700
600
500
400
300
200
100
0
Ipp percentage(%)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=43.0V Vin=50.5V Vin=58.0V

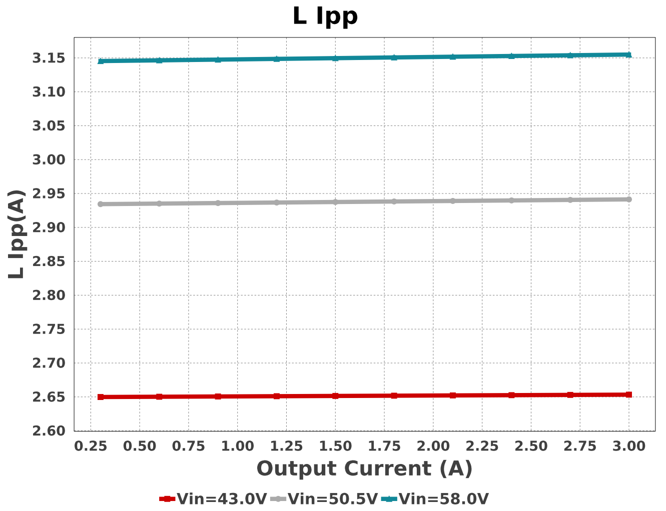

Rsns Pd
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Rsns Pd(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=43.0V Vin=50.5V Vin=58.0V

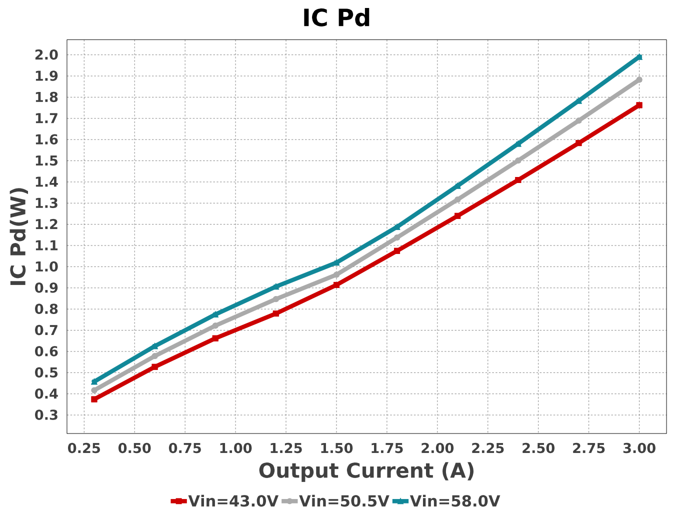

Pout
55
50
45
40
35
30
25
20
15
10
5
Pout(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=43.0V Vin=50.5V Vin=58.0V


Iin Avg
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Iin Avg(A)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=43.0V Vin=50.5V Vin=58.0V


Total Pd
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
Total Pd(W)
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50 2.75 3.00
Output Current (A)
Vin=43.0V Vin=50.5V Vin=58.0V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	1.482 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	1.098 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	910.754 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	829.47 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	4.577 A	IC	Peak switch current in IC
6.	IC Pd	1.99 W	IC	IC power dissipation
7.	IC Tj	67.024 degC	IC	IC junction temperature
8.	IC Tolerance	10.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA Effective	18.6 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
10.	Iin Avg	1.087 A	IC	Average input current
11.	Ipp percentage	105.165 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	3.155 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	206.42 mW	Inductor	Inductor power dissipation
14.	Cin Pd	1.098 mW	Power	Input capacitor power dissipation
15.	Cout Pd	829.47 µW	Power	Output capacitor power dissipation
16.	IC Pd	1.99 W	Power	IC power dissipation
17.	Inductor Core loss	786.0 mW	Power	
18.	L Pd	206.42 mW	Power	Inductor power dissipation
19.	Rsns Pd	54.0 mW	Power	Current Limit Sense Resistor Power Dissipation
20.	Total Pd	3.039 W	Power	Total Power Dissipation
21.	Rsns Pd	54.0 mW	Resistor	Current Limit Sense Resistor Power Dissipation
22.	BOM Count	16	System Information	Total Design BOM count
23.	Duty Cycle	31.34 %	System Information	Duty cycle
24.	Efficiency	94.672 %	System Information	Steady state efficiency
25.	FootPrint	172.0 mm^2	System Information	Total Foot Print Area of BOM components
26.	Frequency	2.2 MHz	System Information	Switching frequency

#	Name	Value	Category	Description
27.	Iout	3.0 A	System Information	Iout operating point
28.	Iout transient step used for Cout calculations	1.5 A	System Information	Custom Transient current step requirement that was used for Cout selection (A).
29.	Mode	CCM	System Information	Conduction Mode
30.	Overshoot Value	74.161 mV	System Information	Theoretical Vout Overshoot Value
31.	Pout	54.0 W	System Information	Total output power
32.	Total BOM	$4.89	System Information	Total BOM Cost
33.	Undershoot Value	343.347 mV	System Information	Theoretical Vout Undershoot Value
34.	Vin	58.0 V	System Information	Vin operating point
35.	Vin p-p	71.02 mV	System Information	Peak-to-peak input voltage
36.	Vout	18.0 V	System Information	Operational Output Voltage
37.	Vout Actual	18.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors
38.	Vout Ripple requirement used for Cout calculations	1.0 %	System Information	Custom maximum output ripple requirement that was used for Cout selection(% of Vout).
39.	Vout Tolerance	3.204 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	118.194 mV	System Information	Peak-to-peak output ripple voltage
41.	Vout transient requirement used for Cout calculations	3.0 %	System Information	Custom Transient voltage change requirement that was used for Cout selection (% of Vout).

Design Inputs

Name	Value	Description
Iout	3.0	Maximum Output Current
VinMax	58.0	Maximum input voltage
VinMin	43.0	Minimum input voltage
Vout	18.0	Output Voltage
base_pn	LM70840-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

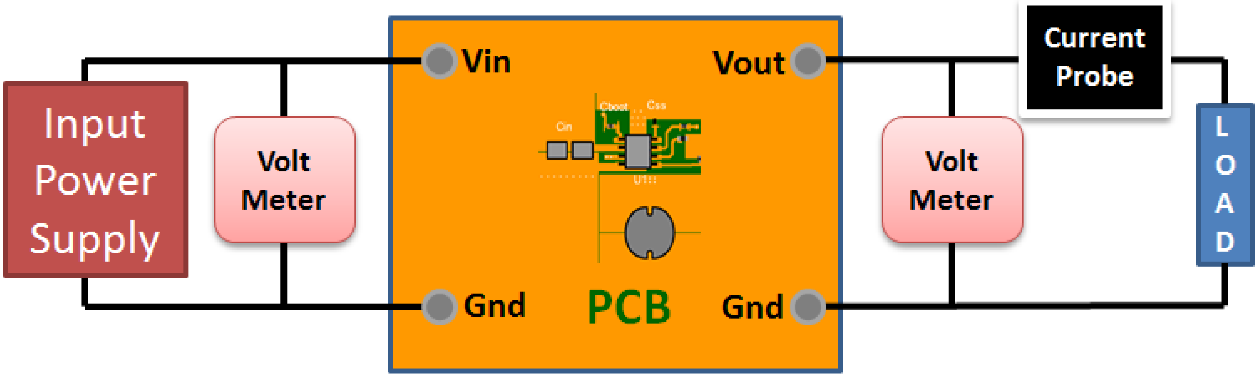
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 43.0V 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 : 71590F7B87C1D65681CB58F7954C2616[v1]

2. **LM70840-Q1** Product Folder : http://www.ti.com/product/LM70840%2DQ1 : contains the data sheet and other resources.