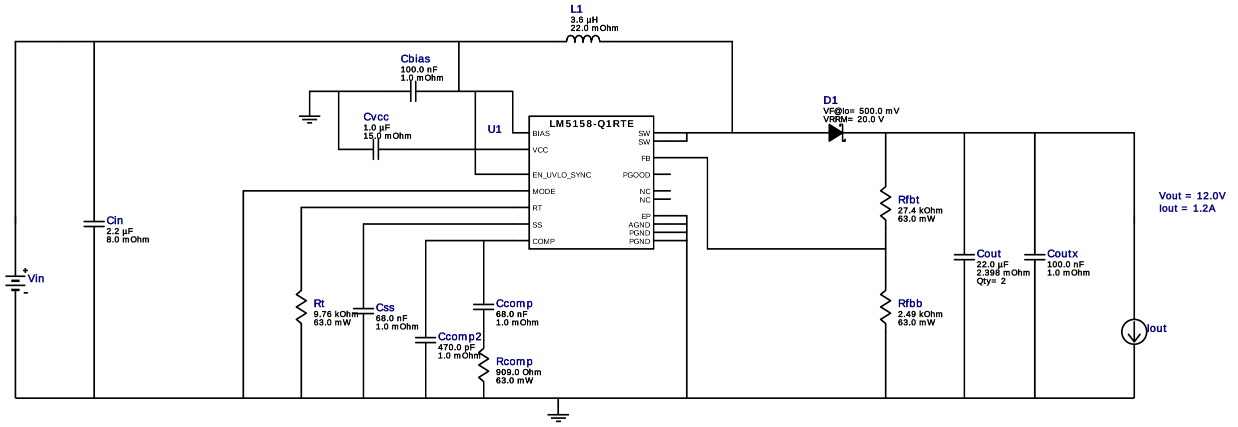
VinMin = 6.0V
VinMax = 6.0V
Vout = 12.0V
Iout = 1.2A

Device = LM5158QRTERQ1
Topology = Boost
Created = 2021-11-08 23:35:14.206
BOM Cost = $3.06
BOM Count = 16
Total Pd = 1.95W

WEBENCH ® Design Report

Design : 88 LM5158QRTERQ1
LM5158QRTERQ1 6V-6V to 12.00V @ 1.2A



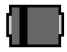
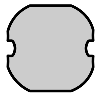
Design Alerts

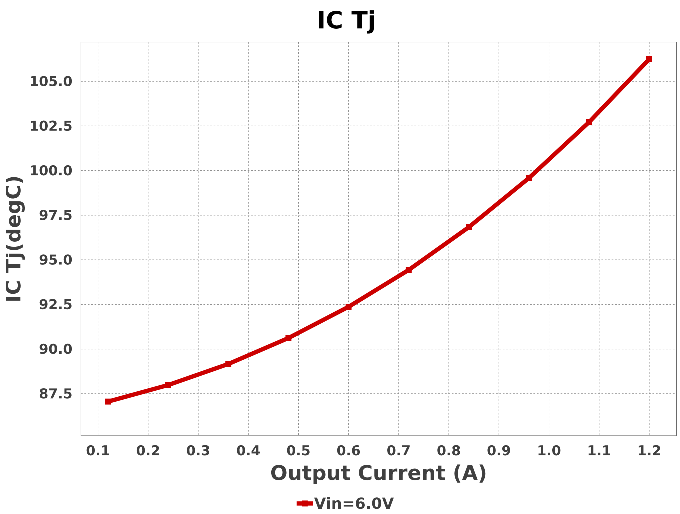
Component Selection Information

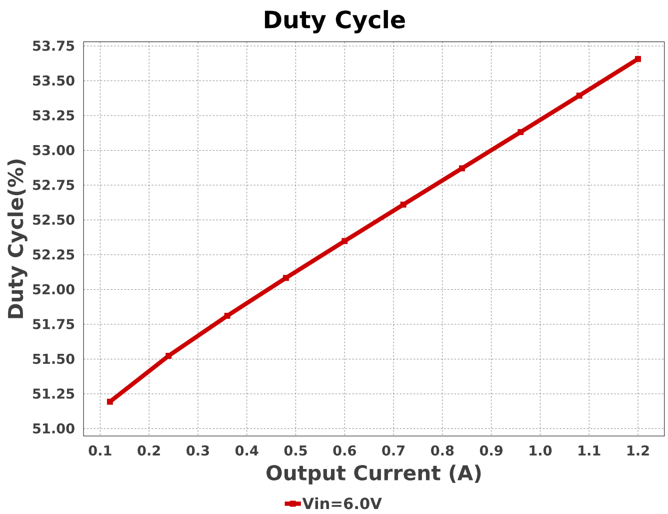
The LM5158-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.

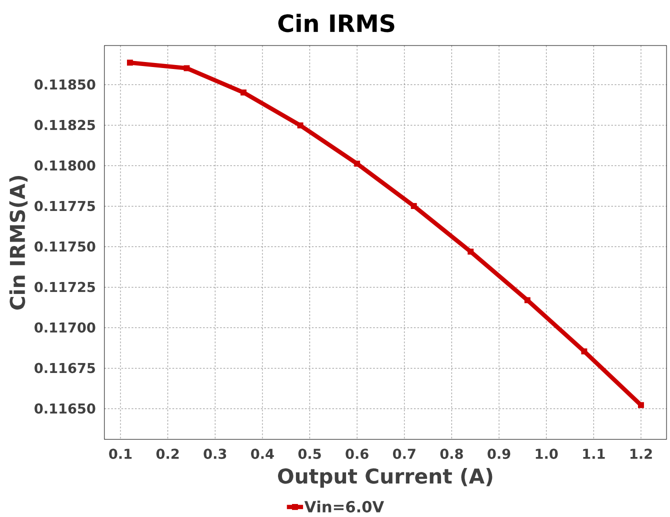
Electrical BOM

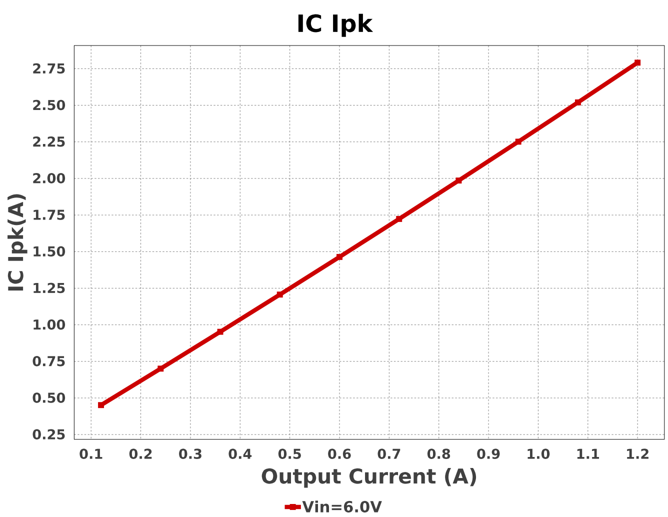
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp	MuRata	GRM155R61A683KA01D Series= X5R	Cap= 68.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccomp2	MuRata	GRM1555C1E471JA01D Series= C0G/NP0	Cap= 470.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	Kemet	C0805C225K8RACTU Series= X7R	Cap= 2.2 uF ESR= 8.0 mOhm VDC= 10.0 V IRMS= 15.55 A	1	$0.04	0805 7 mm^2
Cout	TDK	C3216X5R1V226M160AC Series= X5R	Cap= 22.0 uF ESR= 2.398 mOhm VDC= 35.0 V IRMS= 4.6851 A	2	$0.35	1206_180 11 mm^2
Coutx	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
Css	MuRata	GRM155R61A683KA01D Series= X5R	Cap= 68.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2

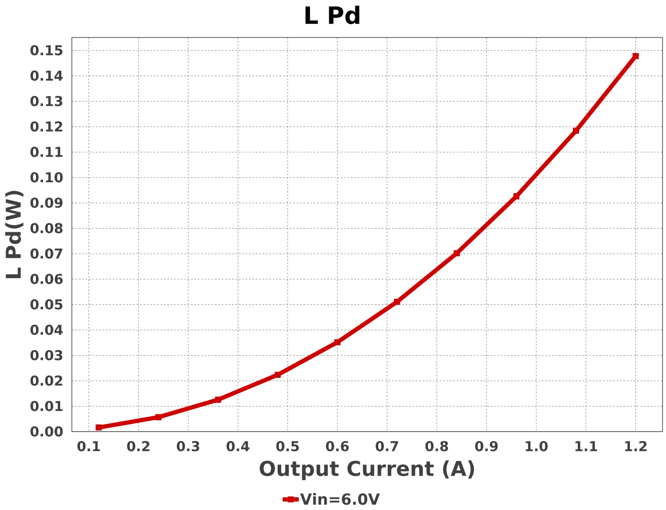
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvcc	Kemet	C0805C105K4RACTU Series= X7R	Cap= 1.0 uF ESR= 15.0 mOhm VDC= 16.0 V IRMS= 8.19 A	1	$0.02	0805 7 mm^2
D1	Diodes Inc.	B220-13-F	VF@Io= 500.0 mV VRRM= 20.0 V	1	$0.08	 SMB 44 mm^2
L1	Bourns	SRN8040-3R6Y	L= 3.6 µH 22.0 mOhm	1	$0.27	 SRN8040 100 mm^2
Rcomp	Vishay-Dale	CRCW0402909RFKED Series= CRCW..e3	Res= 909.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Vishay-Dale	CRCW040227K4FKED Series= CRCW..e3	Res= 27.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rt	Vishay-Dale	CRCW04029K76FKED Series= CRCW..e3	Res= 9.76 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	LM5158QRTERQ1	Switcher	1	$1.86	RTE0016K-IPC_A 16 mm^2

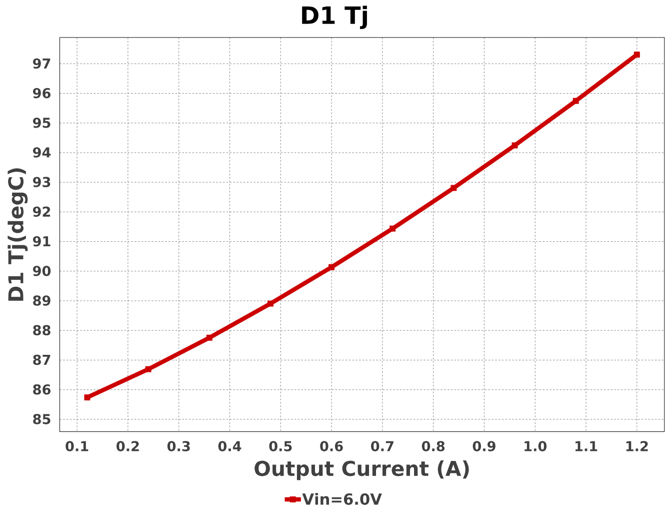


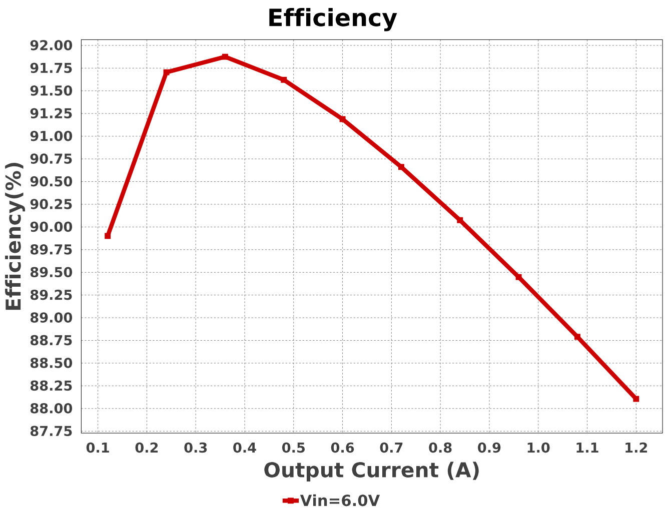


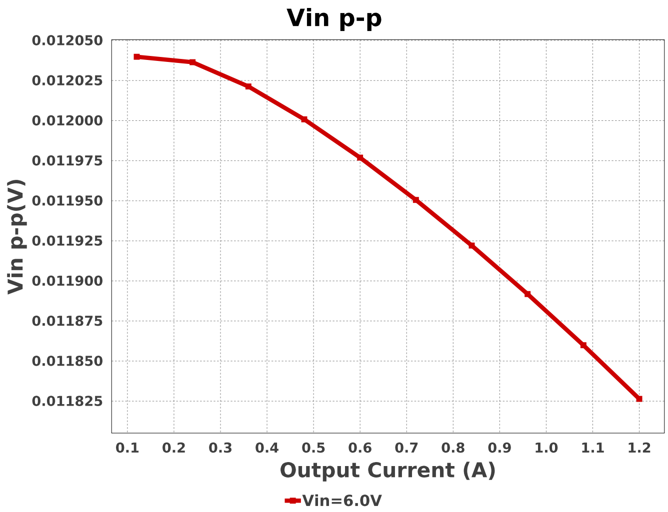


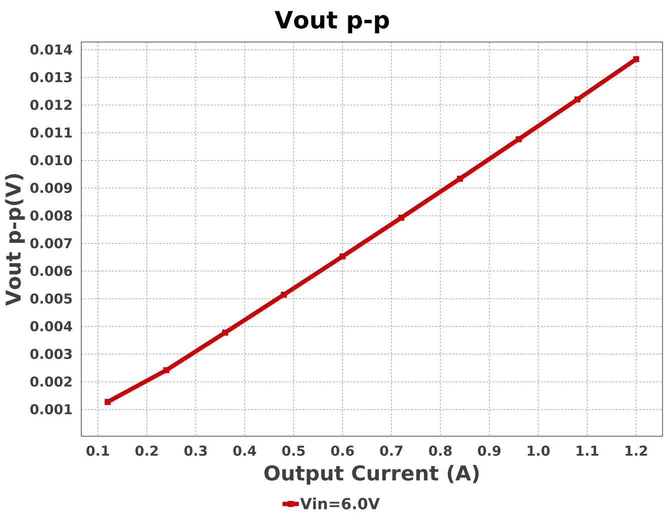


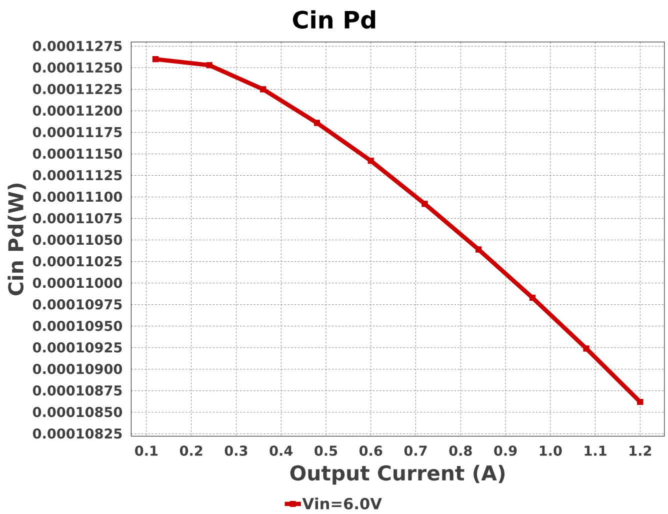

L Pd
L Pd(W)
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

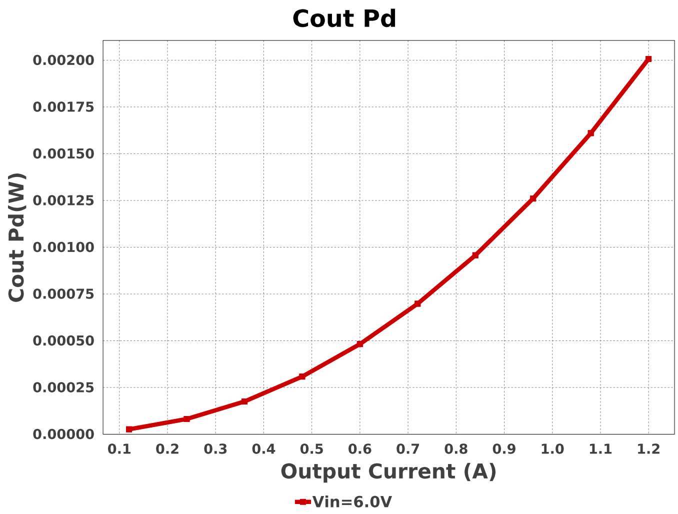

D1 Tj
D1 Tj(degC)
97
96
95
94
93
92
91
90
89
88
87
86
85
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

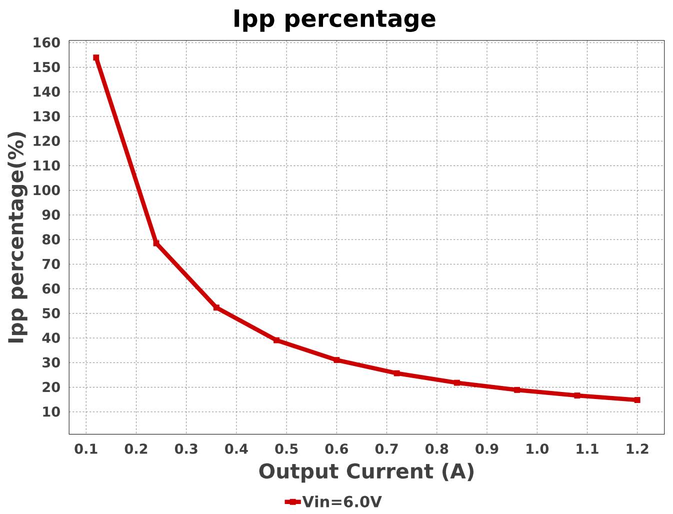

Efficiency
Efficiency(%)
92.00
91.75
91.50
91.25
91.00
90.75
90.50
90.25
90.00
89.75
89.50
89.25
89.00
88.75
88.50
88.25
88.00
87.75
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

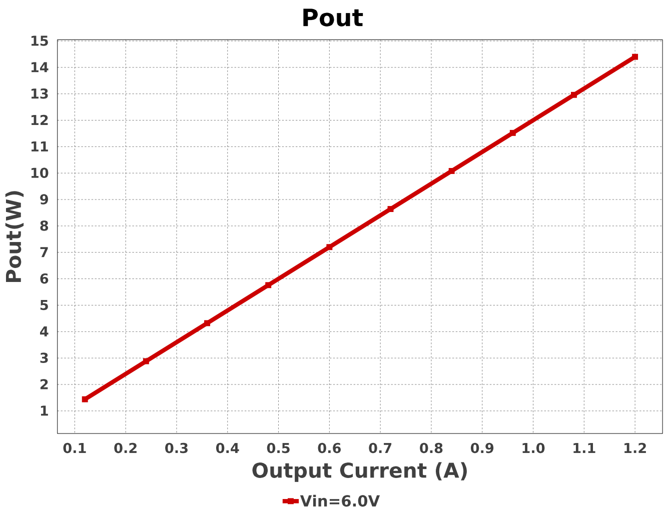

Vin p-p
Vin p-p(V)
0.012050
0.012025
0.012000
0.011975
0.011950
0.011925
0.011900
0.011875
0.011850
0.011825
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

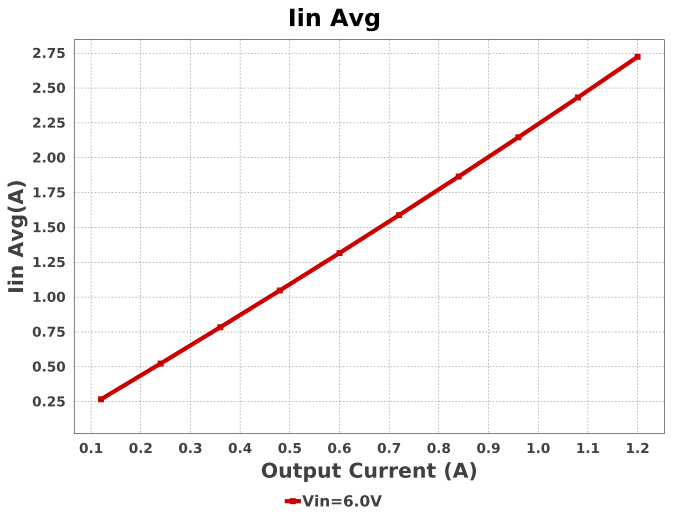

Vout p-p
Vout p-p(V)
0.014
0.013
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

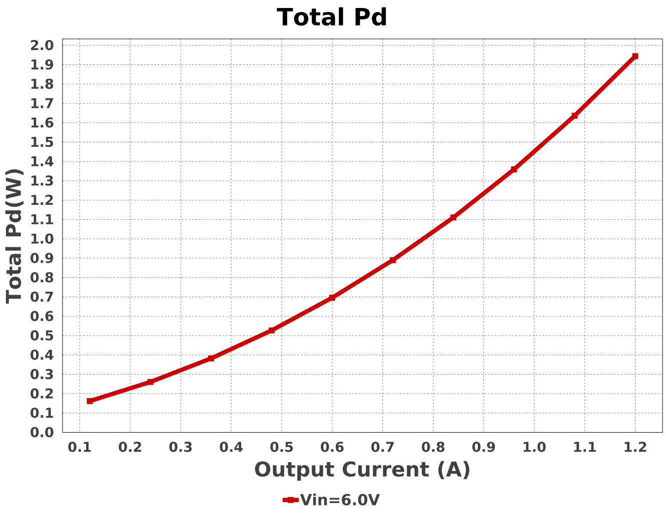

Cin Pd
Cin Pd(W)
0.00011275
0.00011250
0.00011225
0.00011200
0.00011175
0.00011150
0.00011125
0.00011100
0.00011075
0.00011050
0.00011025
0.00011000
0.00010975
0.00010950
0.00010925
0.00010900
0.00010875
0.00010850
0.00010825
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

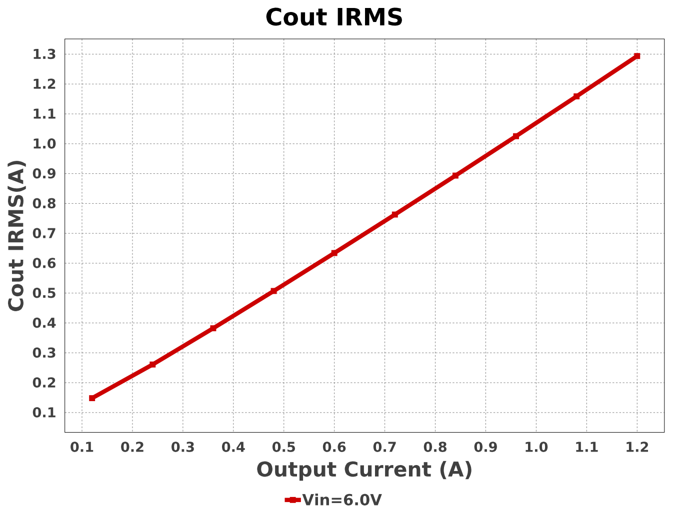

Cout Pd
Cout Pd(W)
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

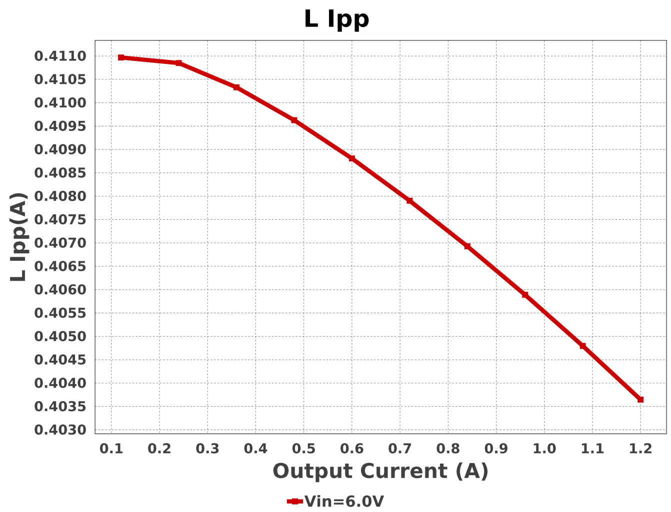

Ipp percentage
Ipp percentage(%)
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

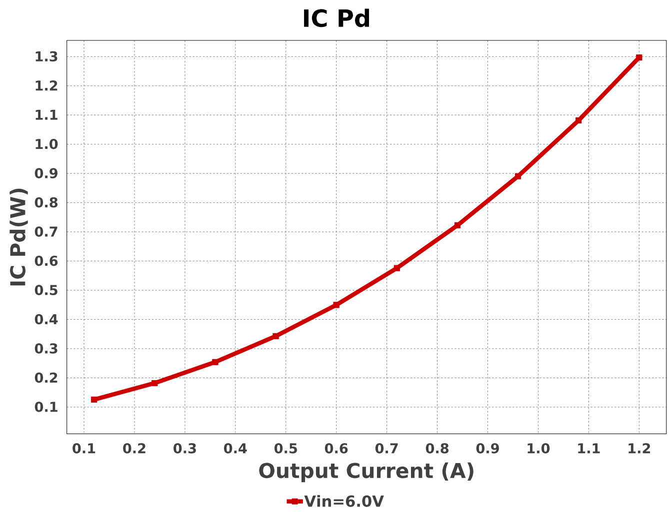

Pout
Pout(W)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

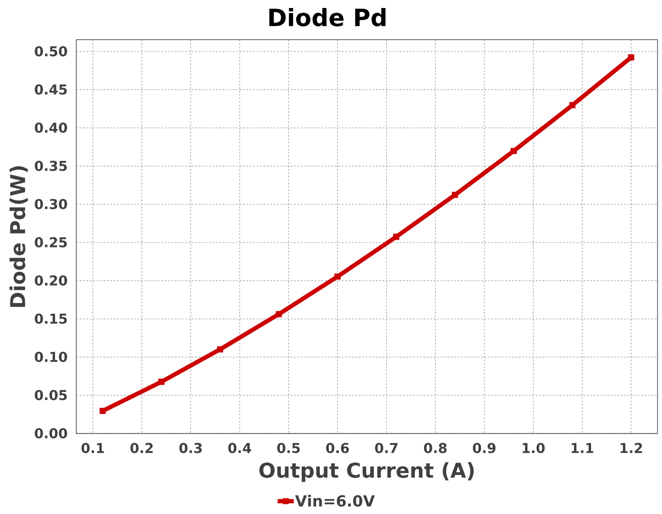

Iin Avg
Iin Avg(A)
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V

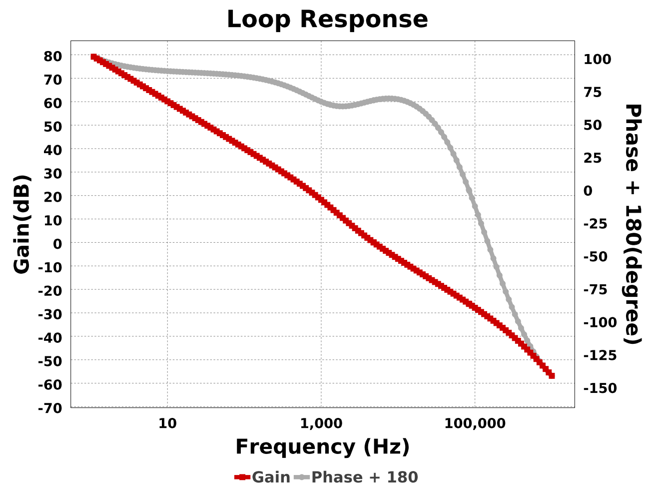

Total Pd
Total Pd(W)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V


Cout IRMS
Cout IRMS(A)
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
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
Output Current (A)
Vin=6.0V









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	116.552 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	108.67 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	1.294 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	2.008 mW	Capacitor	Output capacitor power dissipation
5.	D1 Tj	97.417 degC	Diode	D1 junction temperature
6.	Diode Pd	496.67 mW	Diode	Diode power dissipation
7.	IC Ipk	2.792 A	IC	Peak switch current in IC
8.	IC Pd	1.298 W	IC	IC power dissipation
9.	IC Tj	106.26 degC	IC	IC junction temperature
10.	IC Tolerance	10.0 mV	IC	IC Feedback Tolerance
11.	ICThetaJA Effective	16.38 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
12.	Iin Avg	2.725 A	IC	Average input current
13.	Ipp percentage	14.817 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
14.	L Ipp	403.75 mA	Inductor	Peak-to-peak inductor ripple current
15.	L Pd	147.9 mW	Inductor	Inductor power dissipation
16.	Cin Pd	108.67 µW	Power	Input capacitor power dissipation
17.	Cout Pd	2.008 mW	Power	Output capacitor power dissipation
18.	Diode Pd	496.67 mW	Power	Diode power dissipation
19.	IC Pd	1.298 W	Power	IC power dissipation
20.	L Pd	147.9 mW	Power	Inductor power dissipation
21.	Total Pd	1.949 W	Power	Total Power Dissipation
22.	BOM Count	16	System Information	Total Design BOM count
23.	Cross Freq	4.818 kHz	System Information	Bode plot crossover frequency
24.	Duty Cycle	53.672 %	System Information	Duty cycle
25.	Efficiency	88.077 %	System Information	Steady state efficiency
26.	FootPrint	222.0 mm^2	System Information	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
27.	Frequency	2.063 MHz	System Information	Switching frequency
28.	Gain Marg	-26.213 dB	System Information	Bode Plot Gain Margin
29.	Iout	1.2 A	System Information	Iout operating point
30.	Low Freq Gain	79.176 dB	System Information	Gain at 1Hz
31.	Mode	CCM	System Information	Conduction Mode
32.	Phase Marg	68.844 deg	System Information	Bode Plot Phase Margin
33.	Pout	14.4 W	System Information	Total output power
34.	Total BOM	$3.06	System Information	Total BOM Cost
35.	Vin	6.0 V	System Information	Vin operating point
36.	Vin p-p	11.829 mV	System Information	Input Source ripple voltage
37.	Vout	12.0 V	System Information	Operational Output Voltage
38.	Vout Actual	12.004 V	System Information	Vout Actual calculated based on selected voltage divider resistors
39.	Vout Tolerance	2.87 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	13.663 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	1.2	Maximum Output Current
VinMax	6.0	Maximum input voltage
VinMin	6.0	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	LM5158-Q1	Base Product Number
source	DC	Input Source Type
Ta	85.0	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

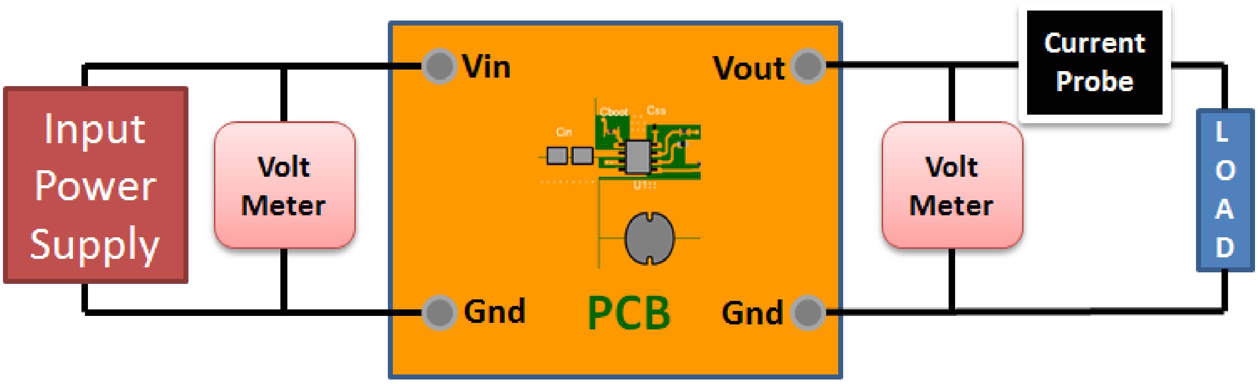
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 6.0V 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 : 71AEBEEDA92F5778[v1]

2. **LM5158-Q1** Product Folder : http://www.ti.com/product/LM5158%2DQ1 : contains the data sheet and other resources.

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