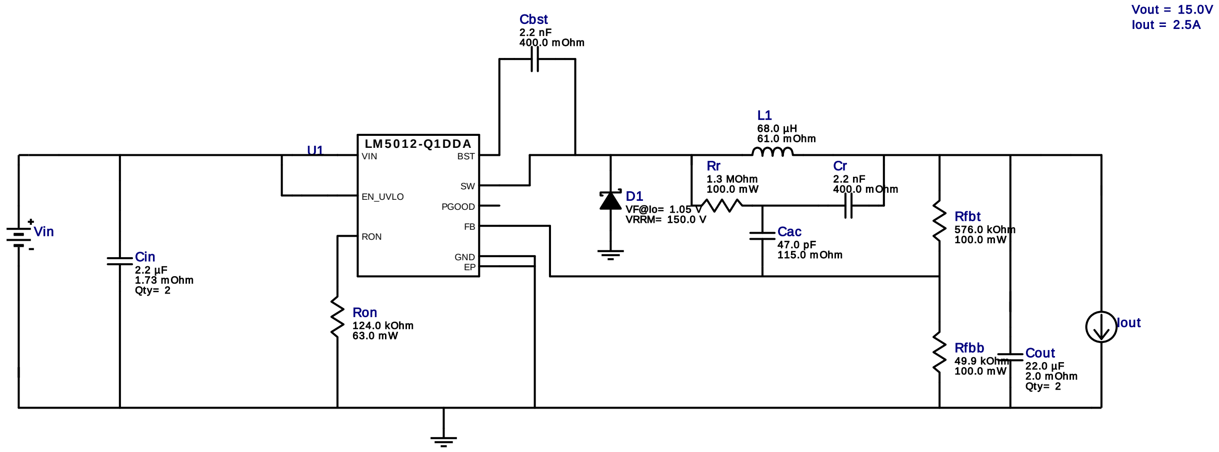
VinMin = 50.0V
VinMax = 85.0V
Vout = 15.0V
Iout = 2.5A

Device = LM5012QDDARQ1
Topology = Buck
Created = 2025-03-02 23:20:27.654
BOM Cost = $3.58
BOM Count = 14
Total Pd = 4.09W

WEBENCH ® Design Report

Design : 3 LM5012QDDARQ1
LM5012QDDARQ1 50V-85V to 15.00V @ 2.5A

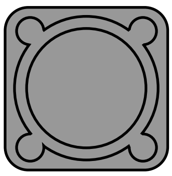


Design Alerts

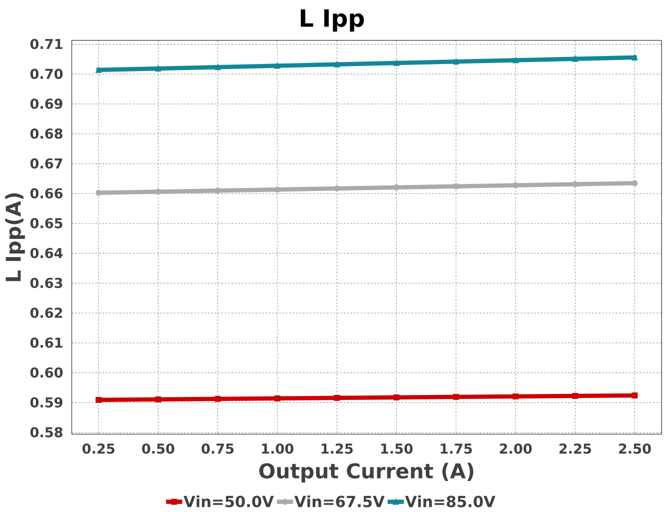
Component Selection Information

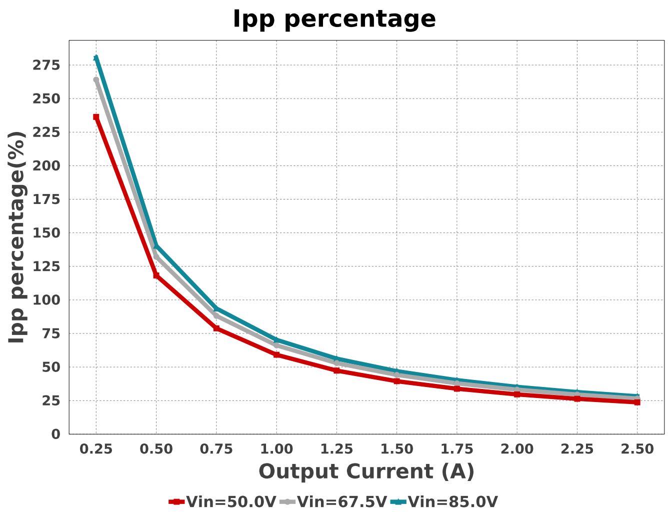
The LM5012-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application.

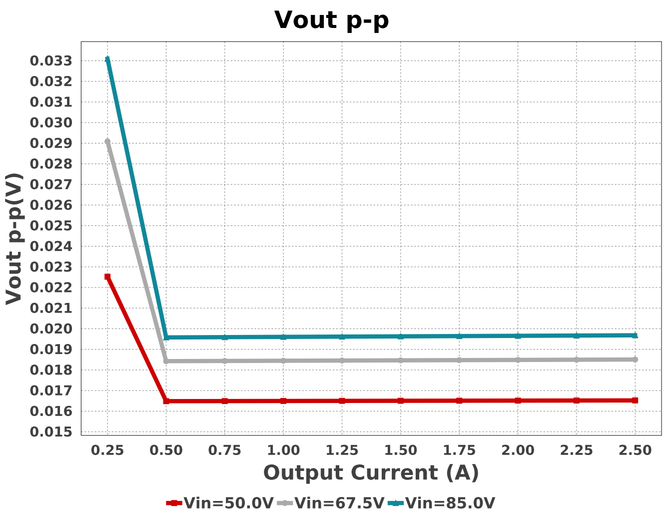
Electrical BOM

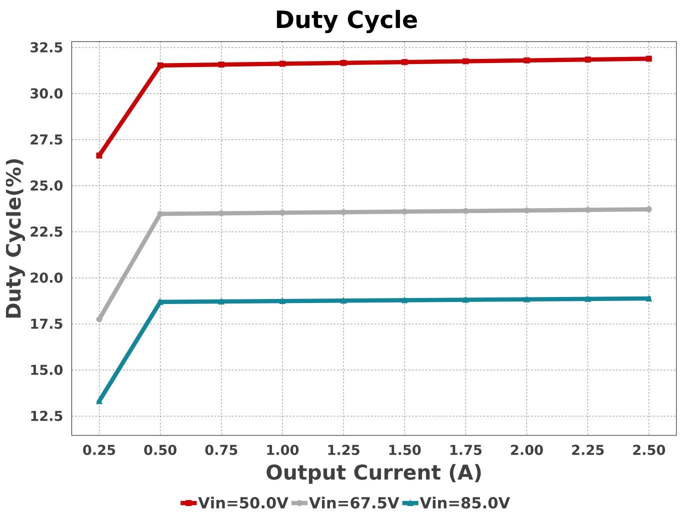
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cac	Kemet	C0805C470J5GACTU Series= C0G/NP0	Cap= 47.0 pF ESR= 115.0 mOhm VDC= 50.0 V IRMS= 505.0 mA	1	$0.01	0805 7 mm²
Cbst	Kemet	C0805C222K5RACTU Series= X7R	Cap= 2.2 nF ESR= 400.0 mOhm VDC= 50.0 V IRMS= 251.0 mA	1	$0.01	0805 7 mm²
Cin	TDK	C3225X7R2A225K230AB Series= X7R	Cap= 2.2 uF ESR= 1.73 mOhm VDC= 100.0 V IRMS= 5.5932 A	2	$0.21	1210_250 15 mm²
Cout	MuRata	GRM32ER61E226KE15L Series= X5R	Cap= 22.0 uF ESR= 2.0 mOhm VDC= 25.0 V IRMS= 3.67 A	2	$0.23	1210 15 mm²
Cr	Kemet	C0805C222K5RACTU Series= X7R	Cap= 2.2 nF ESR= 400.0 mOhm VDC= 50.0 V IRMS= 251.0 mA	1	$0.01	0805 7 mm²
D1	SMC Diode Solutions	SB10150TA	VF@Io= 1.05 V VRRM= 150.0 V	1	$0.26	 DO-201AD 166 mm²
L1	Coilcraft	MSS1583-683MEB	L= 68.0 µH 61.0 mOhm	1	$0.87	 MSS1583 292 mm²

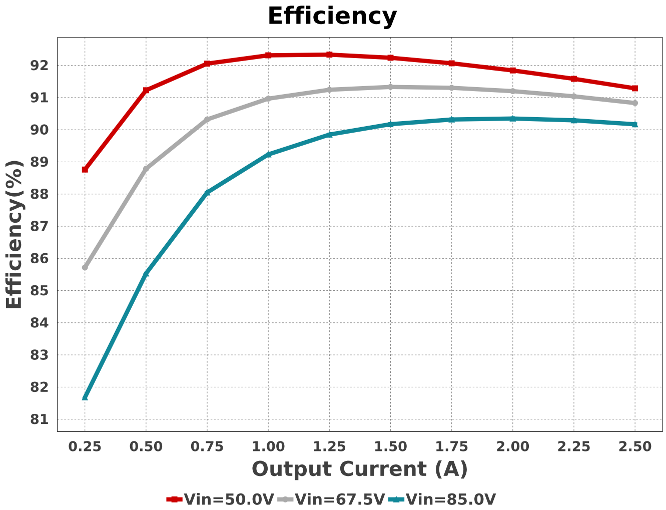
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbb	Yageo	RC0603FR-0749K9L Series= ?	Res= 49.9 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfbt	Yageo	RC0603FR-07576KL Series= ?	Res= 576.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Ron	Vishay-Dale	CRCW0402124KFKED Series= CRCW..e3	Res= 124.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rr	Vishay-Dale	CRCW06031M30FKEA Series= CRCW..e3	Res= 1.3 MOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
U1	Texas Instruments	LM5012QDDARQ1	Switcher	1	$1.50	DDA0008E-MFG 55 mm^2

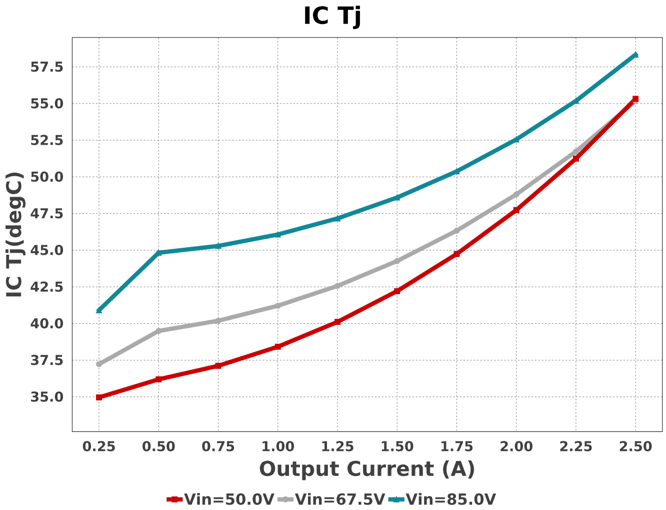


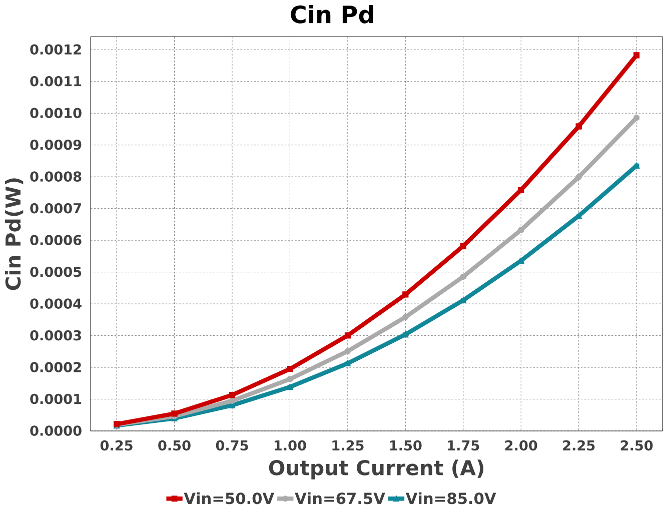


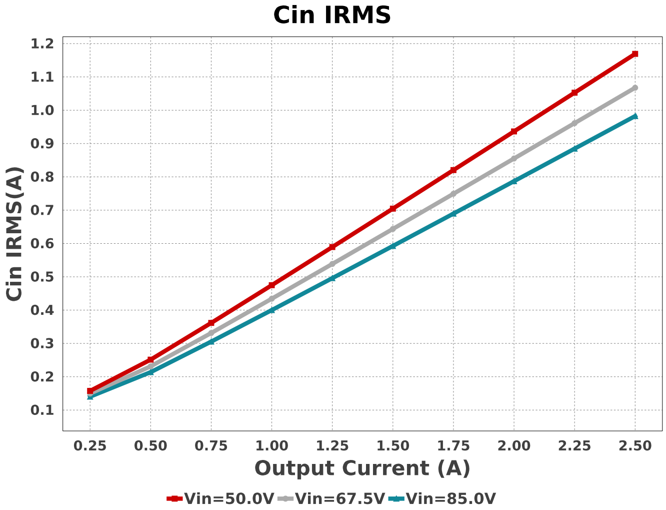


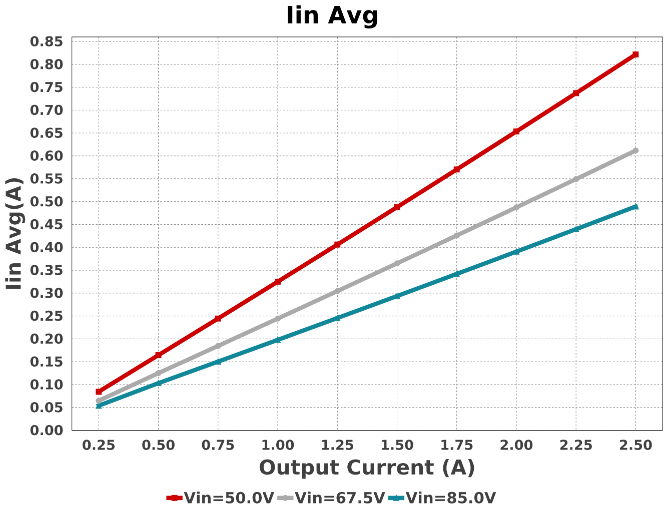


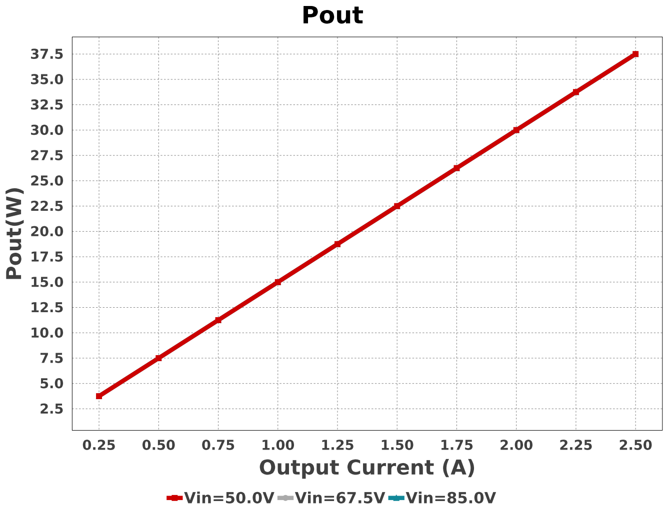

Efficiency
Efficiency(%)
92
91
90
89
88
87
86
85
84
83
82
81
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=50.0V
Vin=67.5V
Vin=85.0V

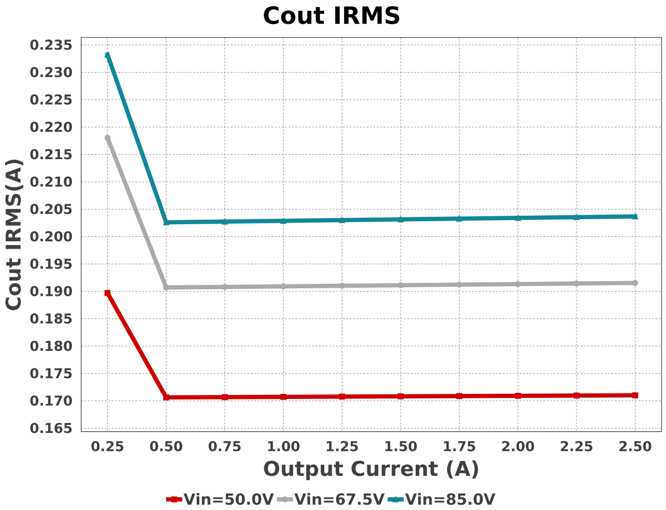

IC Tj
IC Tj(degC)
57.5
55.0
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=50.0V
Vin=67.5V
Vin=85.0V

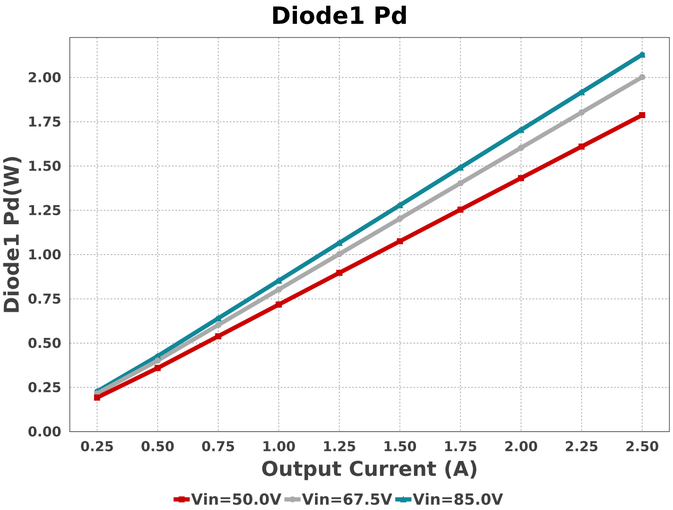

Cin Pd
Cin Pd(W)
0.0012
0.0011
0.0010
0.0009
0.0008
0.0007
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=50.0V
Vin=67.5V
Vin=85.0V

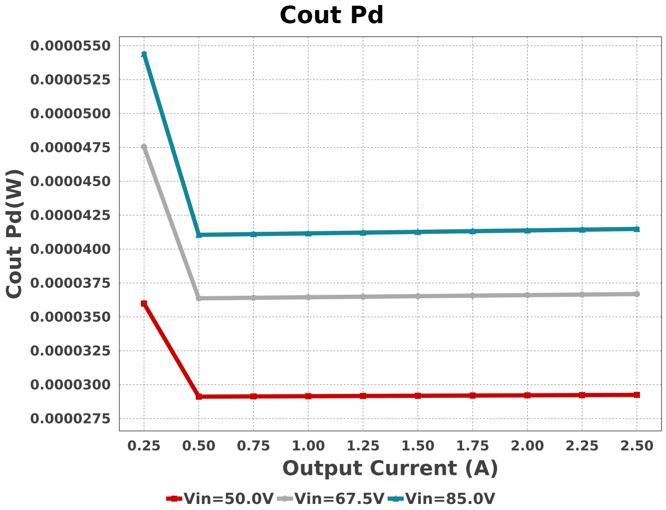

Cin IRMS
Cin IRMS(A)
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=50.0V
Vin=67.5V
Vin=85.0V

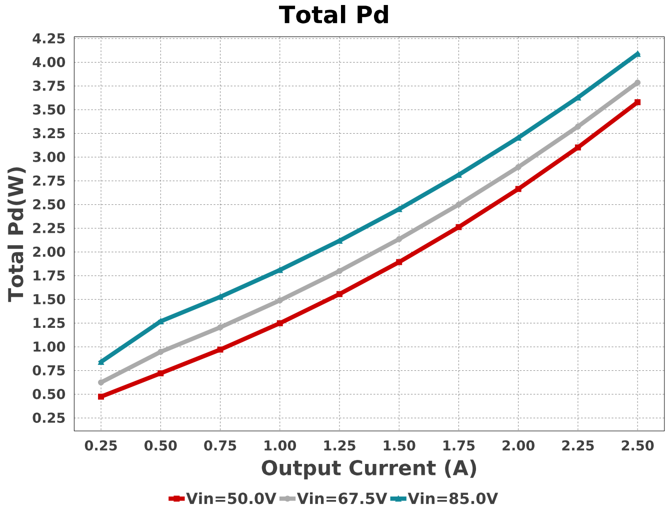

Iin Avg
Iin Avg(A)
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=50.0V
Vin=67.5V
Vin=85.0V

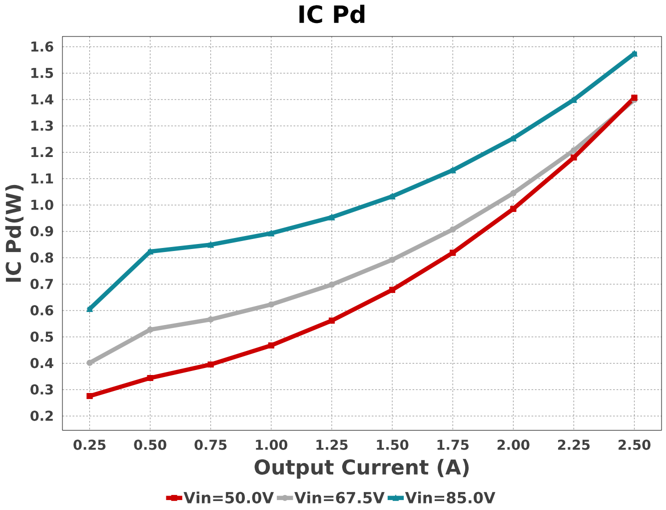

Pout
Pout(W)
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
Output Current (A)
Vin=50.0V
Vin=67.5V
Vin=85.0V

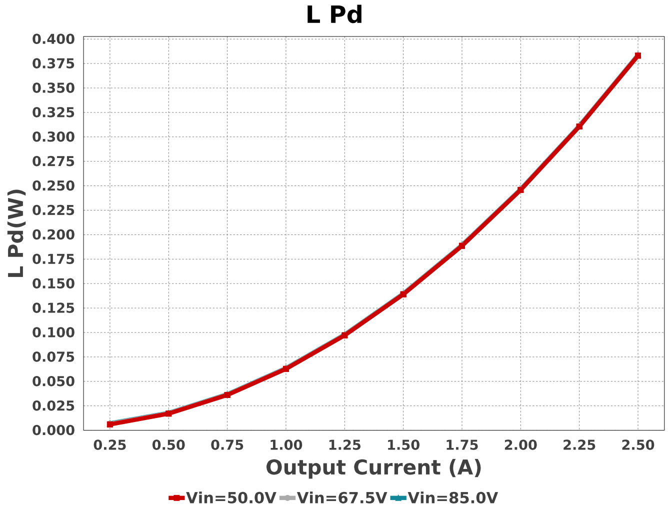

Cout IRMS
Cout IRMS(A)
0.235
0.230
0.225
0.220
0.215
0.210
0.205
0.200
0.195
0.190
0.185
0.180
0.175
0.170
0.165
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=50.0V Vin=67.5V Vin=85.0V

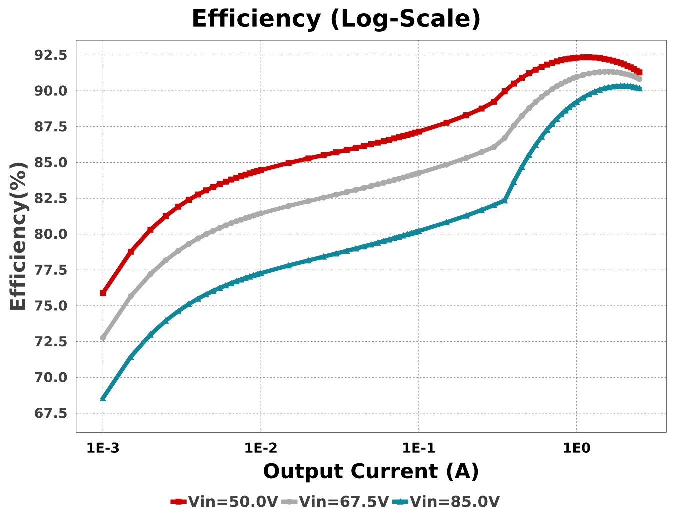

Diode1 Pd
Diode1 Pd(W)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=50.0V Vin=67.5V Vin=85.0V


Cout Pd
Cout Pd(W)
0.0000550
0.0000525
0.0000500
0.0000475
0.0000450
0.0000425
0.0000400
0.0000375
0.0000350
0.0000325
0.0000300
0.0000275
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=50.0V Vin=67.5V Vin=85.0V


Total Pd
Total Pd(W)
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=50.0V Vin=67.5V Vin=85.0V


IC Pd
IC Pd(W)
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
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=50.0V Vin=67.5V Vin=85.0V


L Pd
L Pd(W)
0.400
0.375
0.350
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=50.0V Vin=67.5V Vin=85.0V



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	982.444 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	834.89 µW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	203.681 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	41.486 µW	Capacitor	Output capacitor power dissipation
5.	Diode1 Pd	2.129 W	Diode	Diode1 power dissipation
6.	IC Pd	1.574 W	IC	IC power dissipation
7.	IC Tj	58.336 degC	IC	IC junction temperature
8.	IC Tolerance	19.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	18.0 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	489.28 mA	IC	Average input current
11.	Ipp percentage	28.223 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	705.57 mA	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	383.78 mW	Inductor	Inductor power dissipation
14.	Cin Pd	834.89 µW	Power	Input capacitor power dissipation
15.	Cout Pd	41.486 µW	Power	Output capacitor power dissipation
16.	Diode1 Pd	2.129 W	Power	Diode1 power dissipation
17.	IC Pd	1.574 W	Power	IC power dissipation
18.	L Pd	383.78 mW	Power	Inductor power dissipation
19.	Total Pd	4.089 W	Power	Total Power Dissipation
20.	BOM Count	14	System Information	Total Design BOM count
21.	Duty Cycle	18.884 %	System Information	Duty cycle
22.	Efficiency	90.169 %	System Information	Steady state efficiency
23.	FootPrint	610.0 mm^2	System Information	Total Foot Print Area of BOM components
24.	Frequency	273.931 kHz	System Information	Switching frequency
25.	Iout	2.5 A	System Information	Iout operating point
26.	Mode	CCM	System Information	Conduction Mode
27.	Pout	37.5 W	System Information	Total output power
28.	Total BOM	$3.58	System Information	Total BOM Cost
29.	Vin	85.0 V	System Information	Vin operating point
30.	Vout	15.0 V	System Information	Operational Output Voltage
31.	Vout Actual	15.052 V	System Information	Vout Actual calculated based on selected voltage divider resistors
32.	Vout Tolerance	3.472 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
33.	Vout p-p	19.682 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.5	Maximum Output Current
VinMax	85.0	Maximum input voltage
VinMin	50.0	Minimum input voltage
Vout	15.0	Output Voltage
base_pn	LM5012-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

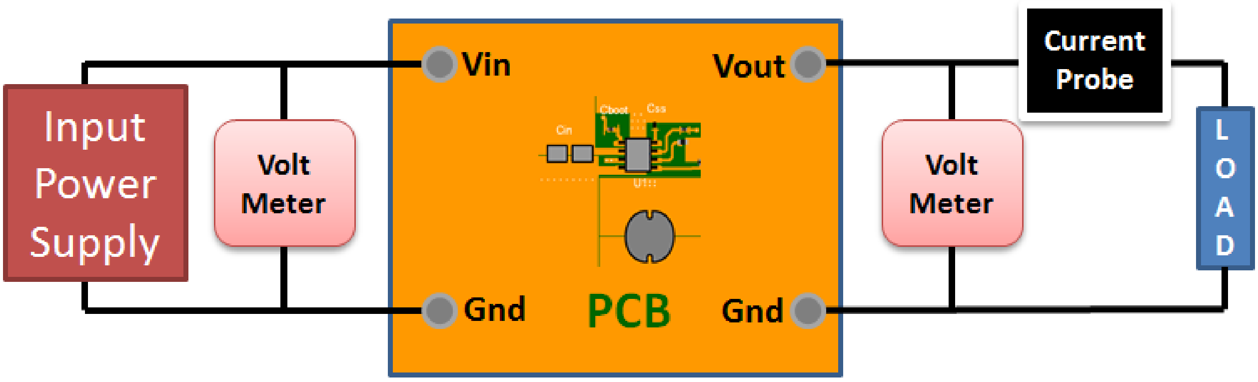
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 50.0V 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. The LM5012-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

2. Master key : 540540835BFE532DA29369383AB8C5E5[v1]

3. **LM5012-Q1** Product Folder : http://www.ti.com/product/LM5012%2DQ1 : contains the data sheet and other resources.