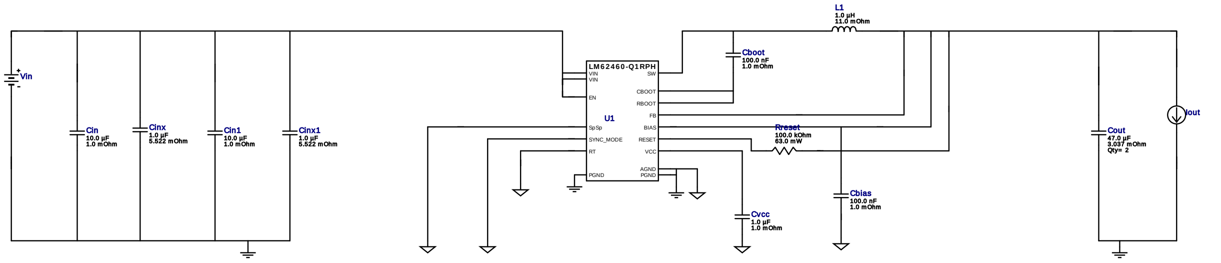
VinMin = 15.0V
VinMax = 24.0V
Vout = 5.0V
Iout = 6.0A

Device = LM62460QRPHRQ1
Topology = Buck
Created = 2021-12-12 05:55:30.243
BOM Cost = $3.99
BOM Count = 12
Total Pd = 2.54W

WEBENCH ® Design Report

Design : 30 LM62460QRPHRQ1
LM62460QRPHRQ1 6V-24V to 5.00V @ 6A



Design Alerts

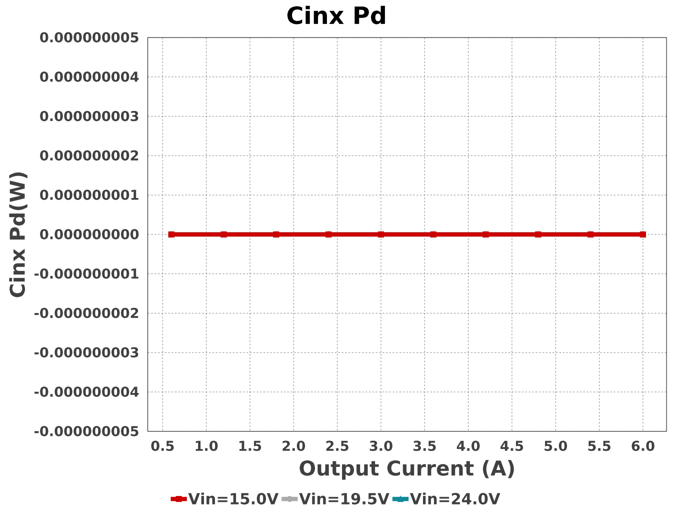
Component Selection Information

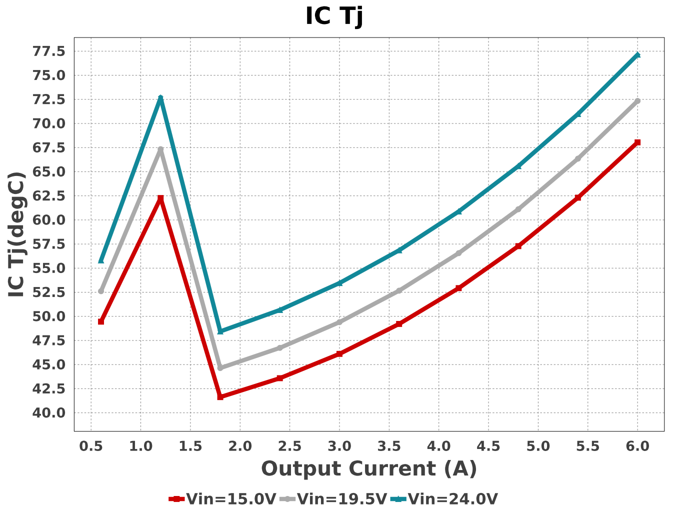
The LM62460-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. The user is required to verify that all components in the design meet the qualification and safety requirements for their specific application. This device can work in steady state at Vin = 3V. However, needs a minimum of 3.6V during start up. See datasheet for details.

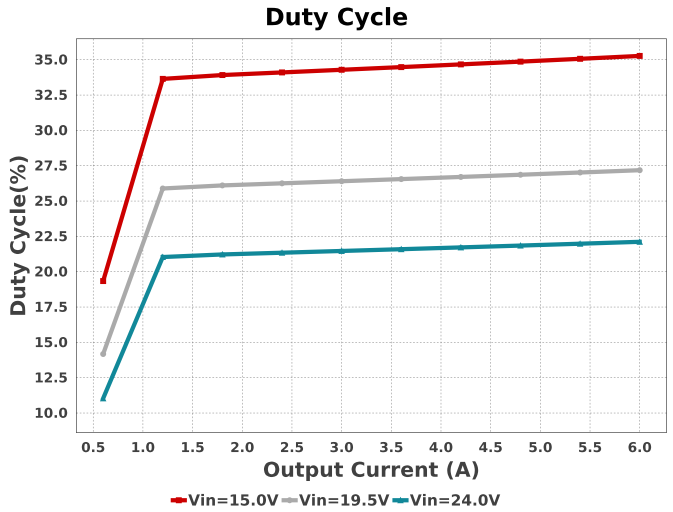
Electrical BOM

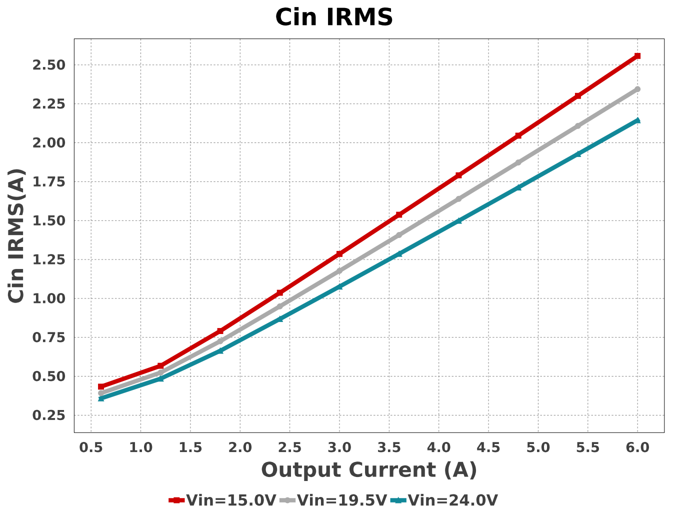
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbias	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Cin	MuRata	GRM32ER71H106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 6.0 A	1	$0.43	1210_270 15 mm^2
Cin1	MuRata	GRM32ER71H106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 6.0 A	1	$0.43	1210_270 15 mm^2
Cinx	TDK	C1608X6S1H105K080AC Series= X6S	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	1	$0.05	0603 5 mm^2
Cinx1	TDK	C1608X6S1H105K080AC Series= X6S	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	1	$0.05	0603 5 mm^2
Cout	MuRata	GRM32ER61C476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	2	$0.38	1210_280 15 mm^2
Cvcc	Kemet	C0603C105Z8VACTU Series= Y5V	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm^2
L1	TDK	VLP8040T-1R0N	L= 1.0 µH 11.0 mOhm	1	$0.22	VLP8040 113 mm^2

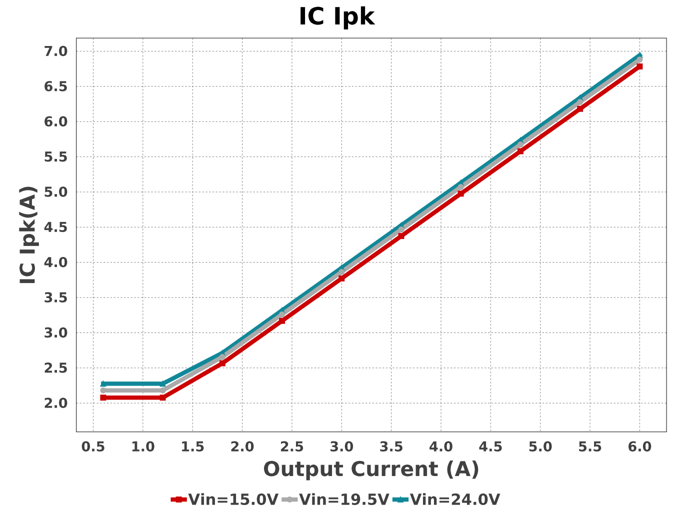
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rreset	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	LM62460QRPHRQ1	Switcher	1	$2.01	RPH0016A 25 mm^2

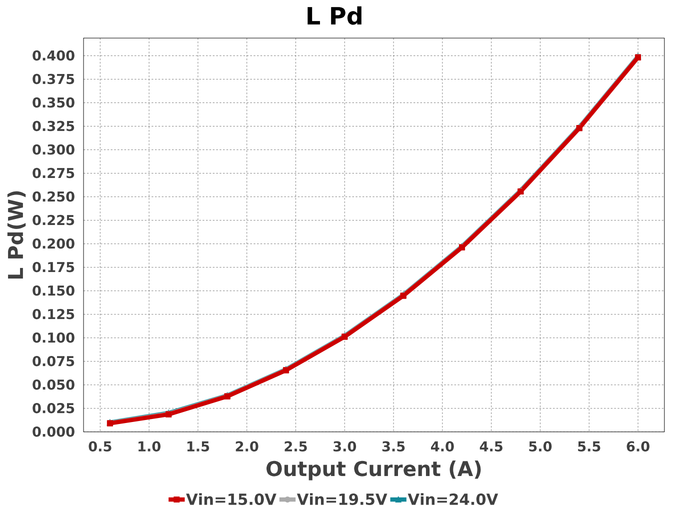


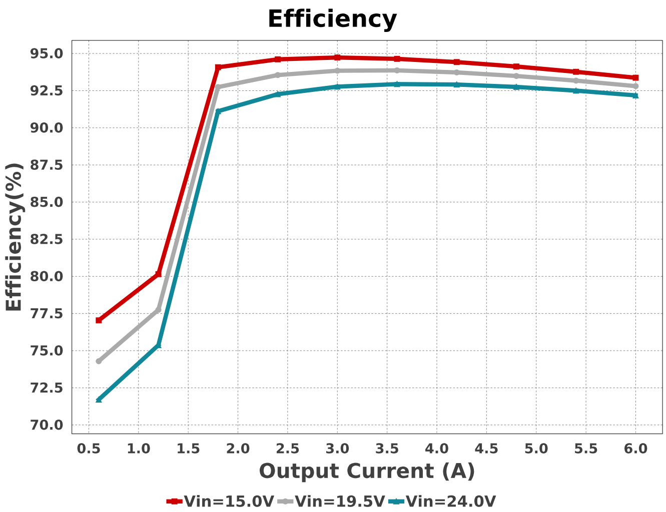


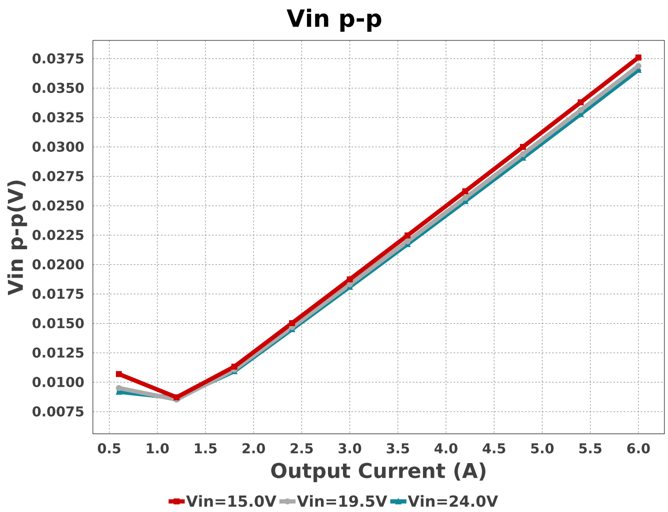


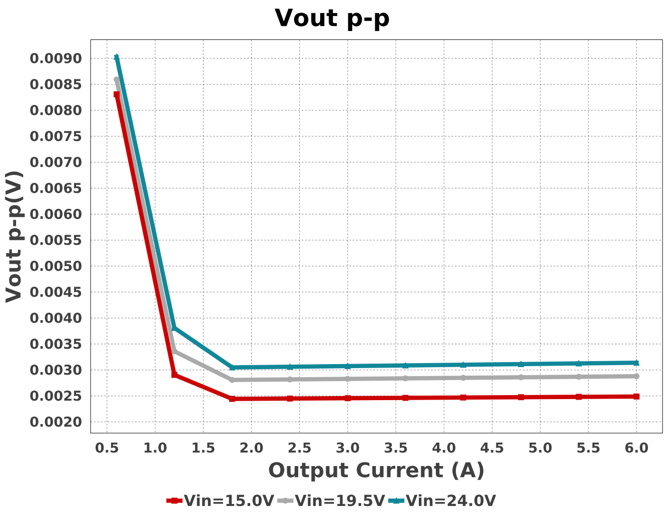


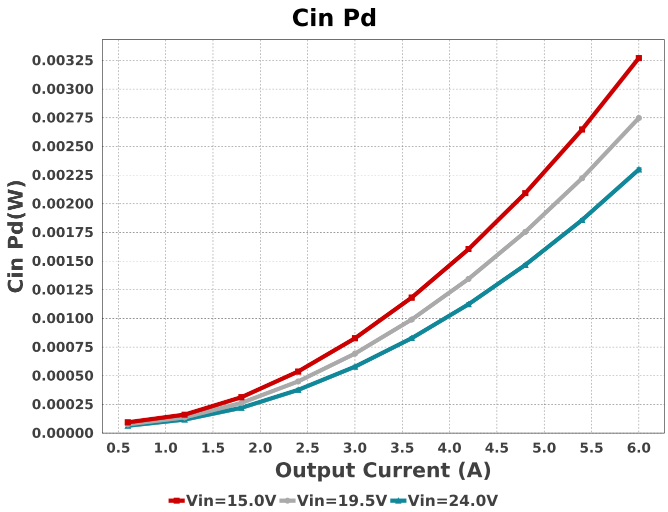


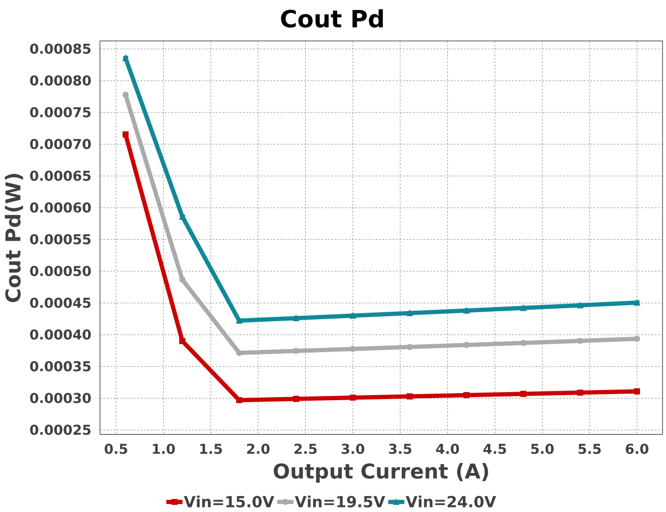


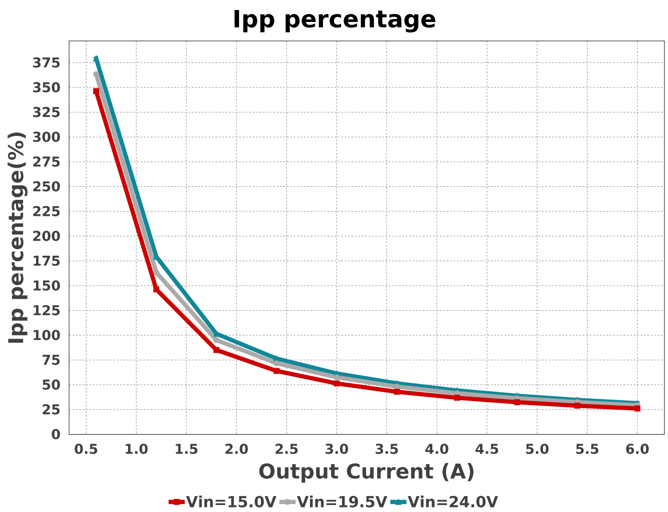

Efficiency
Efficiency(%)
95.0
92.5
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
70.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=15.0V Vin=19.5V Vin=24.0V


Vin p-p
Vin p-p(V)
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=15.0V Vin=19.5V Vin=24.0V

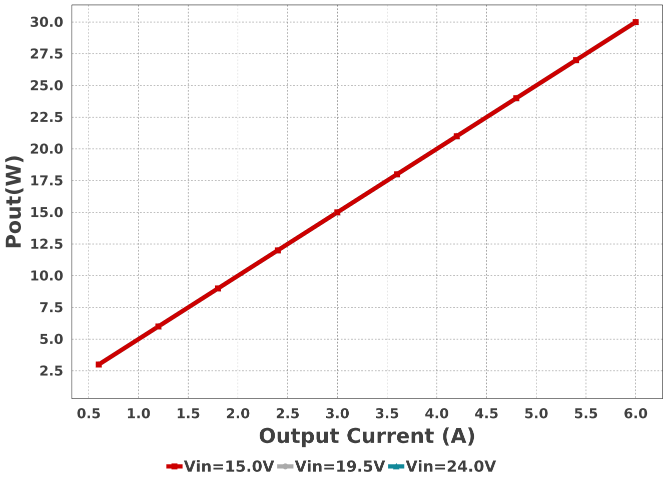

Vout p-p
Vout p-p(V)
0.0090
0.0085
0.0080
0.0075
0.0070
0.0065
0.0060
0.0055
0.0050
0.0045
0.0040
0.0035
0.0030
0.0025
0.0020
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=15.0V Vin=19.5V Vin=24.0V


Cin Pd
Cin Pd(W)
0.00325
0.00300
0.00275
0.00250
0.00225
0.00200
0.00175
0.00150
0.00125
0.00100
0.00075
0.00050
0.00025
0.00000
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=15.0V Vin=19.5V Vin=24.0V

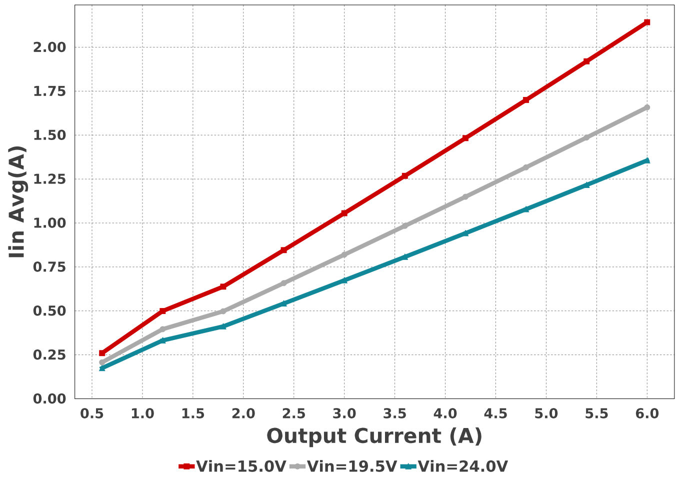

Cout Pd
Cout Pd(W)
0.00085
0.00080
0.00075
0.00070
0.00065
0.00060
0.00055
0.00050
0.00045
0.00040
0.00035
0.00030
0.00025
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=15.0V Vin=19.5V Vin=24.0V


Ipp percentage
Ipp percentage(%)
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=15.0V Vin=19.5V Vin=24.0V

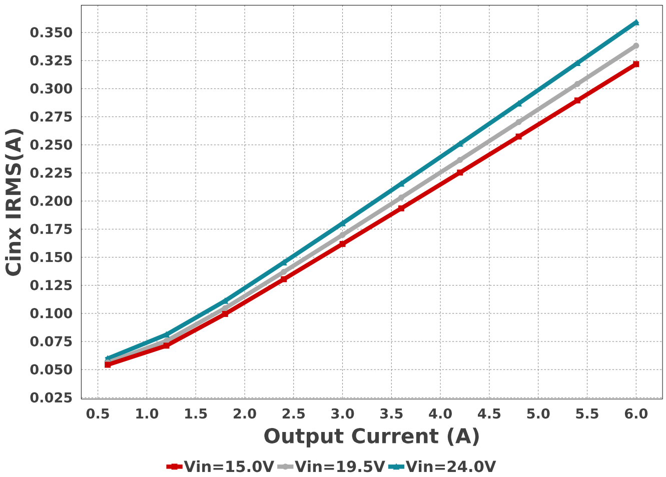
Pout



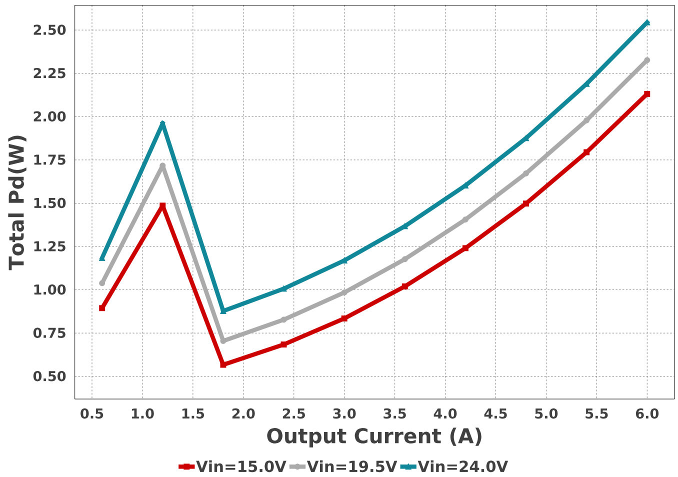
Iin Avg



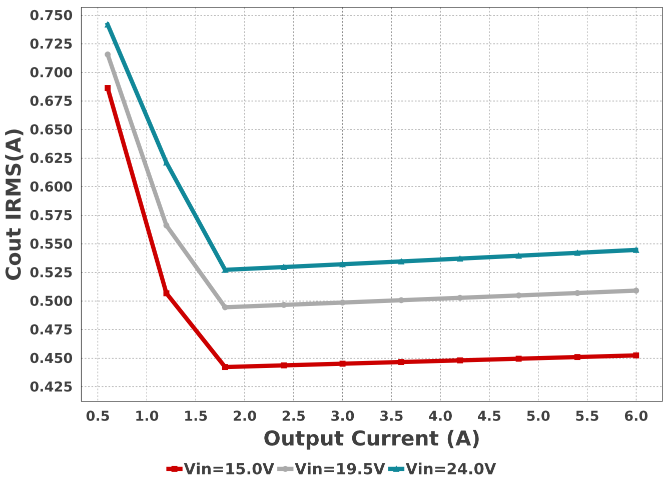
Cinx IRMS



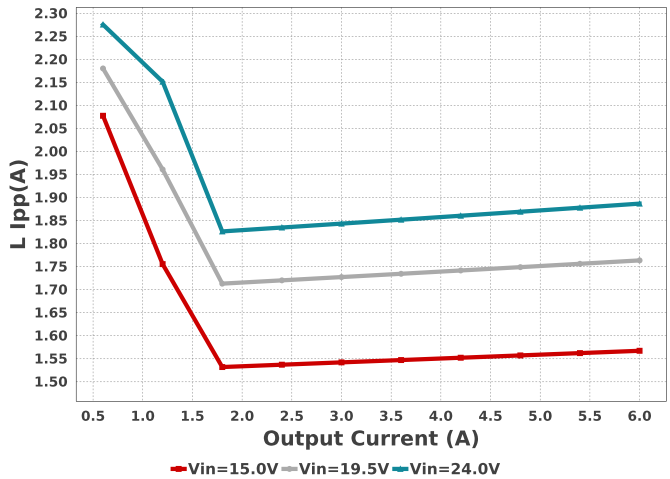
Total Pd

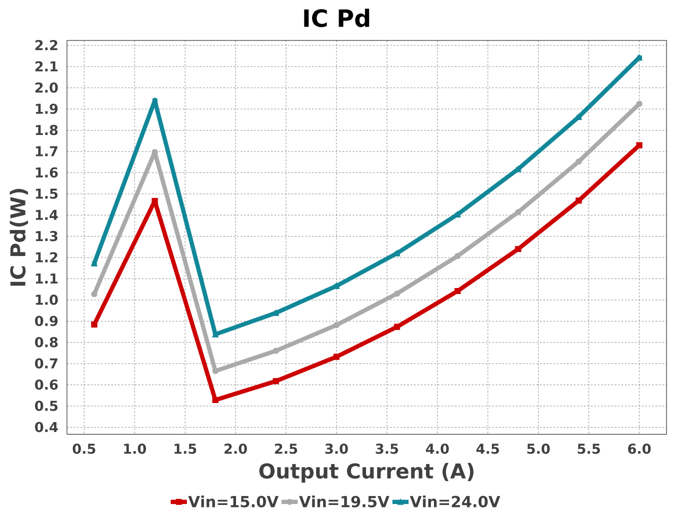


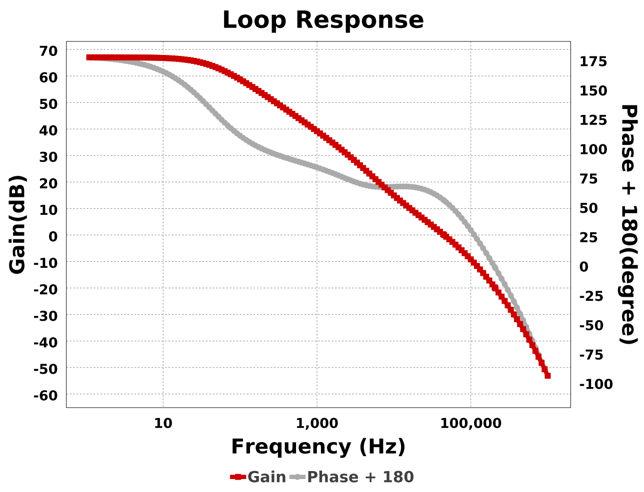
Cout IRMS

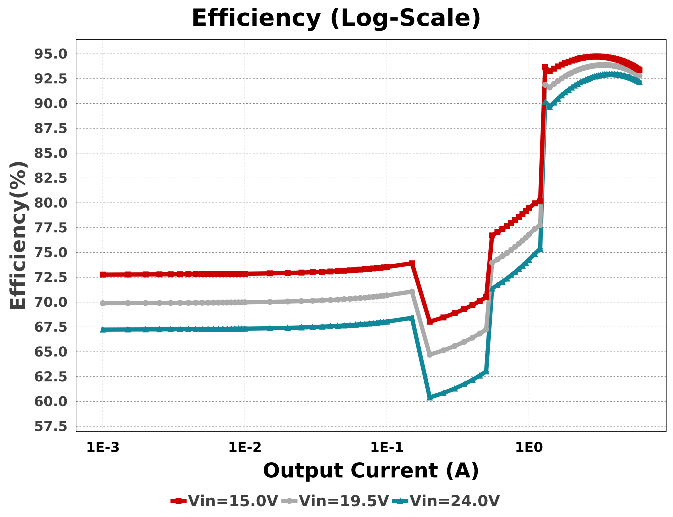


L Ipp









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	2.144 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	2.299 mW	Capacitor	Input capacitor power dissipation
3.	Cinx IRMS	359.054 mA	Capacitor	Bulk capacitor RMS ripple current
4.	Cinx Pd	0.0 W	Capacitor	Bulk capacitor power dissipation
5.	Cout IRMS	544.736 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	450.6 µW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	6.944 A	IC	Peak switch current in IC
8.	IC Pd	2.143 W	IC	IC power dissipation
9.	IC Tj	77.137 degC	IC	IC junction temperature
10.	ICThetaJA Effective	22.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
11.	Iin Avg	1.356 A	IC	Average input current
12.	Ipp percentage	31.45 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
13.	L Ipp	1.887 A	Inductor	Peak-to-peak inductor ripple current
14.	L Pd	399.26 mW	Inductor	Inductor power dissipation
15.	Cin Pd	2.299 mW	Power	Input capacitor power dissipation
16.	Cinx Pd	0.0 W	Power	Bulk capacitor power dissipation
17.	Cout Pd	450.6 µW	Power	Output capacitor power dissipation
18.	IC Pd	2.143 W	Power	IC power dissipation
19.	L Pd	399.26 mW	Power	Inductor power dissipation
20.	Total Pd	2.545 W	Power	Total Power Dissipation
21.	BOM Count	12	System Information	Total Design BOM count
22.	Cross Freq	44.954 kHz	System Information	Bode plot crossover frequency
23.	Duty Cycle	22.116 %	System Information	Duty cycle
24.	Efficiency	92.181 %	System Information	Steady state efficiency
25.	FootPrint	220.0 mm^2	System Information	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
26.	Frequency	2.2 MHz	System Information	Switching frequency
27.	Gain Marg	-19.739 dB	System Information	Bode Plot Gain Margin
28.	Iout	6.0 A	System Information	Iout operating point
29.	Low Freq Gain	67.034 dB	System Information	Gain at 1Hz
30.	Mode	CCM	System Information	Conduction Mode
31.	Phase Marg	56.53 deg	System Information	Bode Plot Phase Margin
32.	Pout	30.0 W	System Information	Total output power
33.	Total BOM	$3.992	System Information	Total BOM Cost
34.	Vin	24.0 V	System Information	Vin operating point
35.	Vin p-p	36.549 mV	System Information	Peak-to-peak input voltage
36.	Vout	5.0 V	System Information	Operational Output Voltage
37.	Vout Tolerance	1.25 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
38.	Vout p-p	3.14 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	6.0	Maximum Output Current
VinMax	24.0	Maximum input voltage
VinMin	15.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM62460-Q1	Base Product Number
source	DC	Input Source Type
Ta	30.0	Ambient temperature
UserFsw	2.2 M	Customer Selected Frequency

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

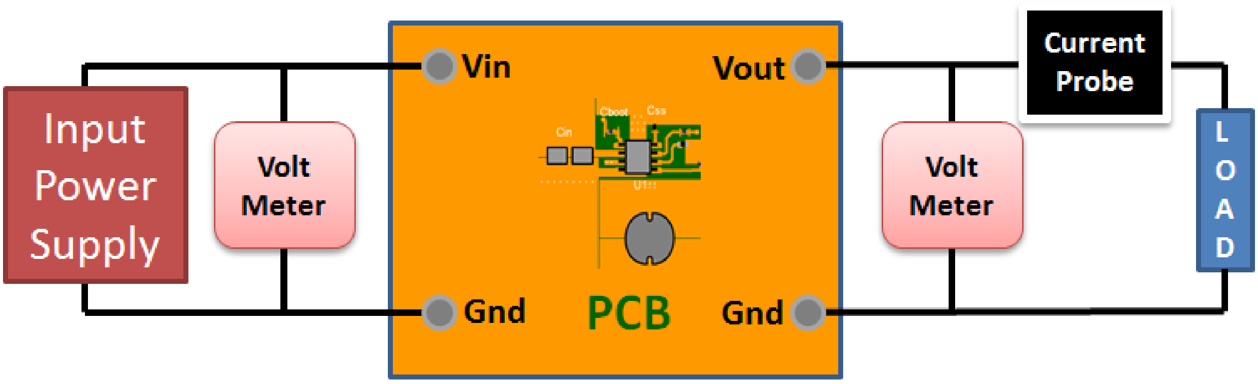
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 15.0V 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.

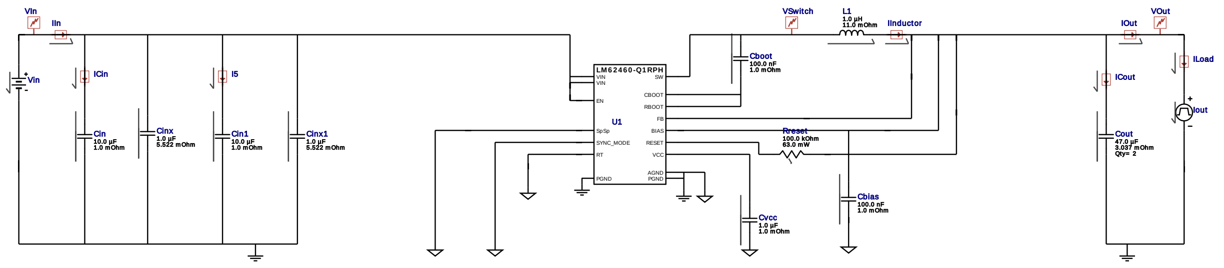


WEBENCH® Electrical Simulation Report

Design Id = 30

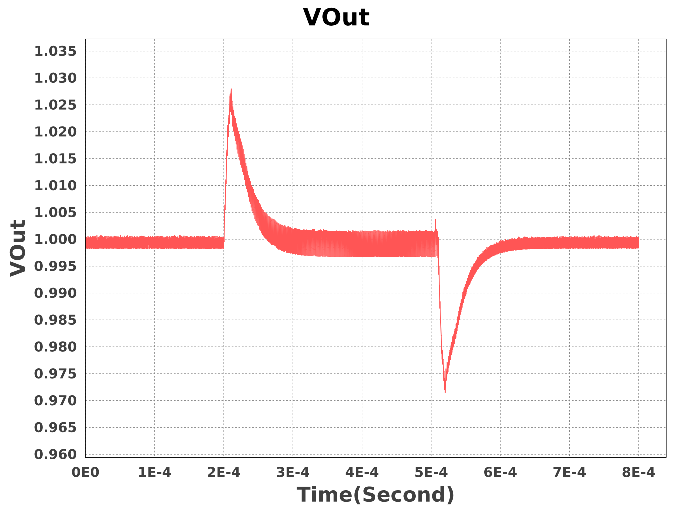
sim_id = 1

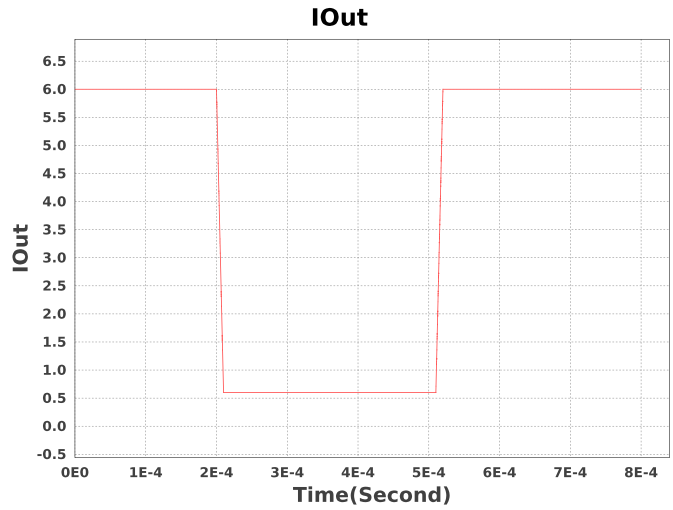
Simulation Type = Load Transient



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	L1	IC	Initial Current	6.0 A
2.	Iout	signal_type	Signal Type	PULSE
		I1	Initial Load Current	6.0 A
		I2	Minimum Load Current	0.6 A
		Td	Initial Time Delay	200u s
		Tf	Fall Time	10u s
		Tr	Rise Time	10u s
		Pw	Pulse Width	300u s

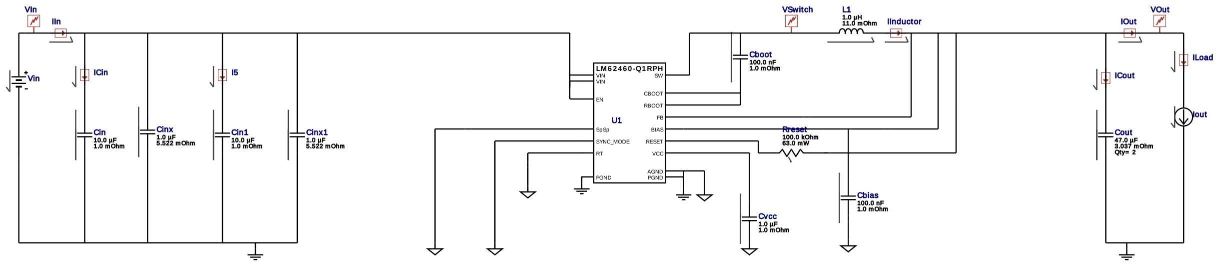




Design Id = 30

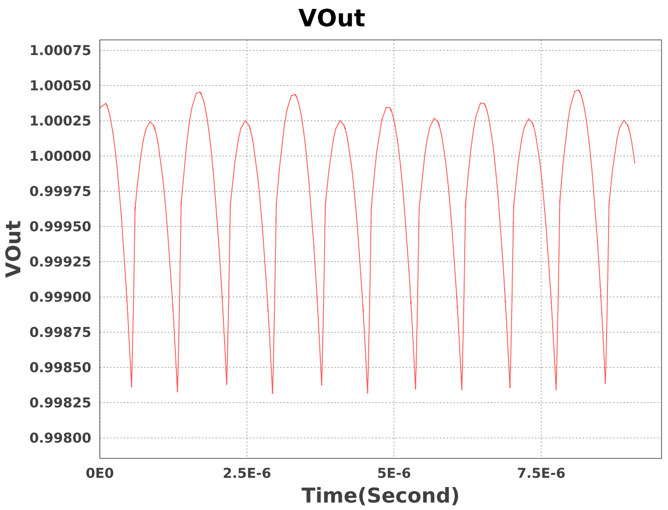
sim_id = 2

Simulation Type = Steady State



Simulation Parameters

#	Name	Parameter Name	Description	Values
1.	L1	IC	Initial Current	6.0 A
2.	Iout	I	Output Current	6.0 A



Design Assistance

1. The LM62460-Q1 is qualified for Automotive applications. All passives and other components selected in this design may not be qualified for Automotive applications. This device can work in steady state at Vin = 3V. However, needs a minimum of 3.6V during start up. See datasheet for details 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 : AFB1D78F0789392D[v1]

3. **LM62460-Q1** Product Folder : http://www.ti.com/product/LM62460%2DQ1 : contains the data sheet and other resources.