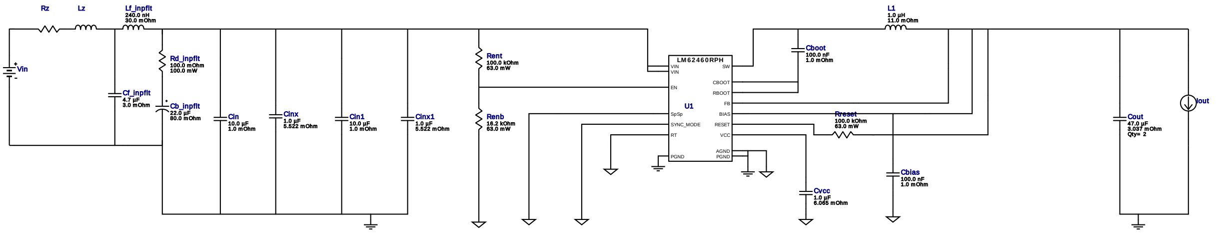
VinMin = 10.0V
VinMax = 24.0V
Vout = 5.0V
Iout = 6.0A

Device = LM62460RPHR
Topology = Buck
Created = 2023-03-14 07:31:28.450
BOM Cost = $4.12
BOM Count = 18
Total Pd = 1.84W

WEBENCH ® Design Report

Design : 17 LM62460RPHR
LM62460RPHR 6V-24V to 5.00V @ 6A



Design Alerts

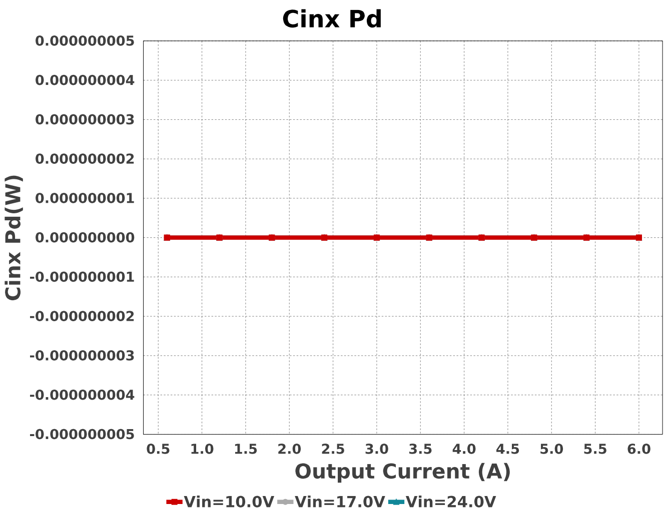
Component Selection Information

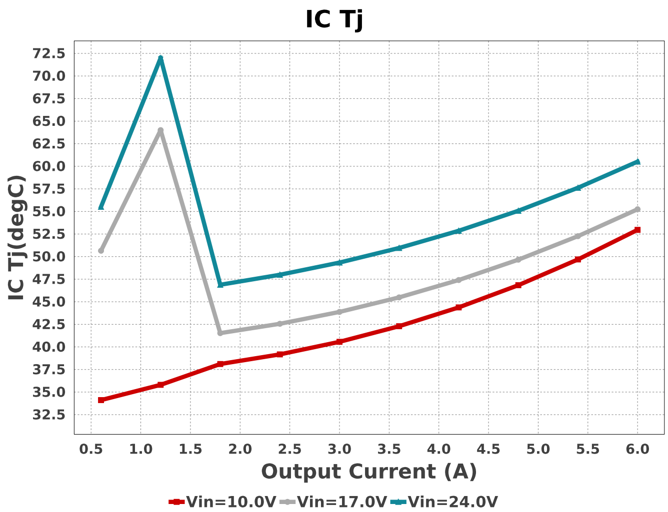
This device can work in steady state at Vin = 3V. However, needs a minimum of 3.6V during start up. See datasheet for details.

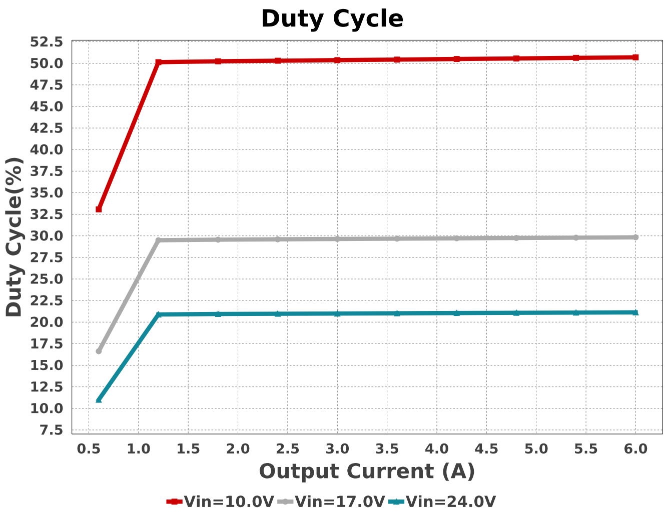
Electrical BOM

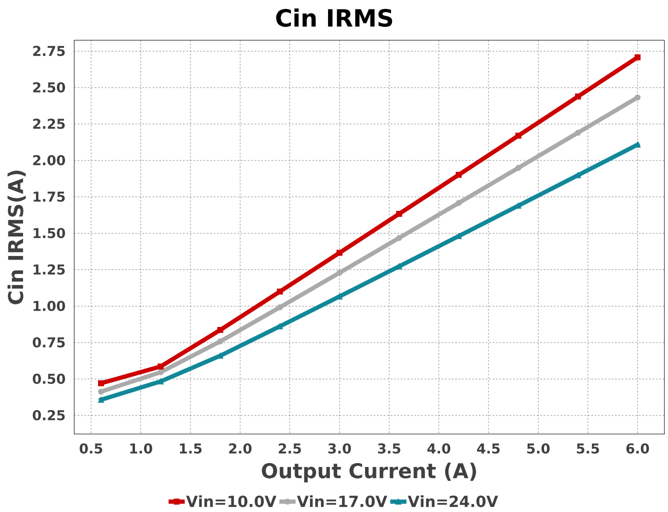
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cb_inpflt	Panasonic	EEHZA1H220P Series= ZA	Cap= 22.0 uF ESR= 80.0 mOhm VDC= 50.0 V IRMS= 1.1 A	1	$0.50	SM_RADIAL_6.3AMM 80 mm^2
Cbias	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
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
Cf_inpflt	MuRata	GRM31CR71H475KA12L Series= X7R	Cap= 4.7 uF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 4.98 A	1	$0.10	1206 11 mm^2
Cin	MuRata	GRM32ER71H106KA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 6.0 A	1	$0.47	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	$0.47	1210_270 15 mm^2
Cinx	TDK	C1608X5R1H105K080AB Series= X5R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	1	$0.03	0603 5 mm^2
Cinx1	TDK	C1608X5R1H105K080AB Series= X5R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 50.0 V IRMS= 2.2162 A	1	$0.03	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	$0.17	1210_280 15 mm^2

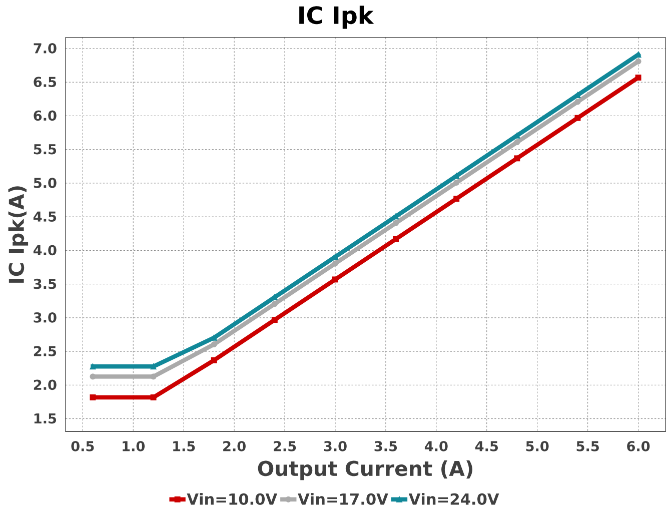
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvcc	MuRata	GRM188R60J105KA01D Series= X5R	Cap= 1.0 uF ESR= 6.065 mOhm VDC= 6.3 V IRMS= 1.36934 A	1	$0.01	0603 5 mm²
L1	TDK	VLP8040T-1R0N	L= 1.0 µH 11.0 mOhm	1	$0.22	VLP8040 113 mm²
Lf_inpflt	MuRata	DFE18SANR24MG0L	L= 240.0 nH 30.0 mOhm	1	$0.17	DFE18_G 5 mm²
Rd_inpflt	Panasonic	ERJ-3RSFR10V Series= ERJ-3R	Res= 100.0 mOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.03	0603 5 mm²
Renb	Vishay-Dale	CRCW040216K2FKED Series= CRCW..e3	Res= 16.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rent	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rreset	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LM62460RPHR	Switcher	1	$1.70	RPH0016A 25 mm²

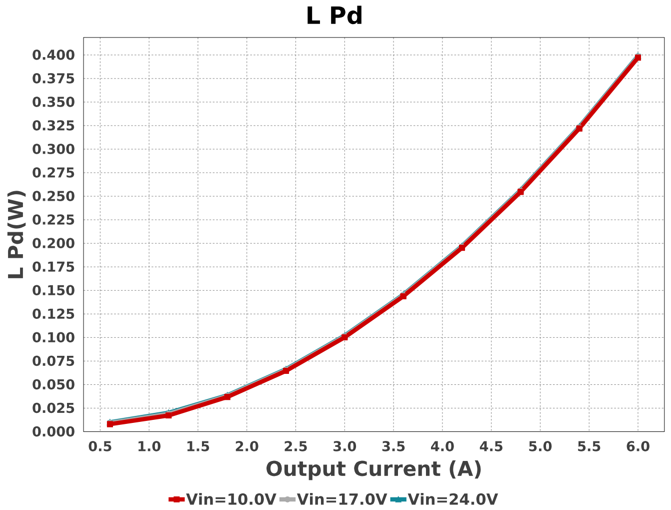


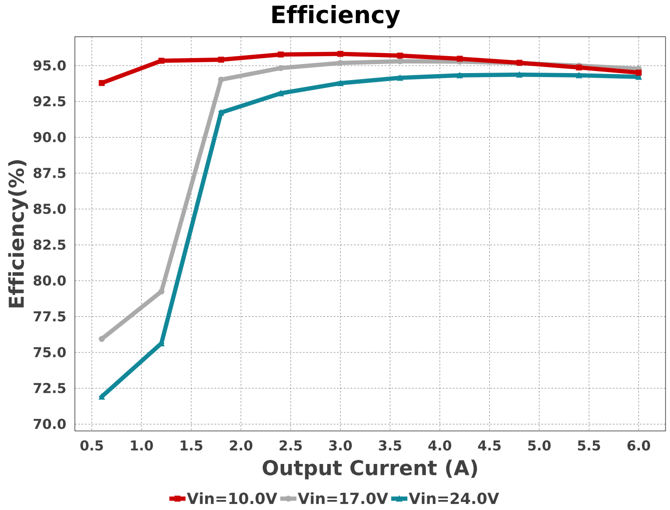


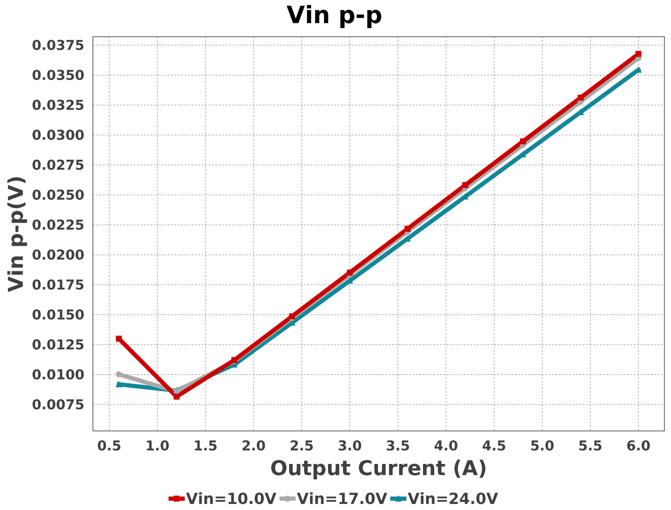


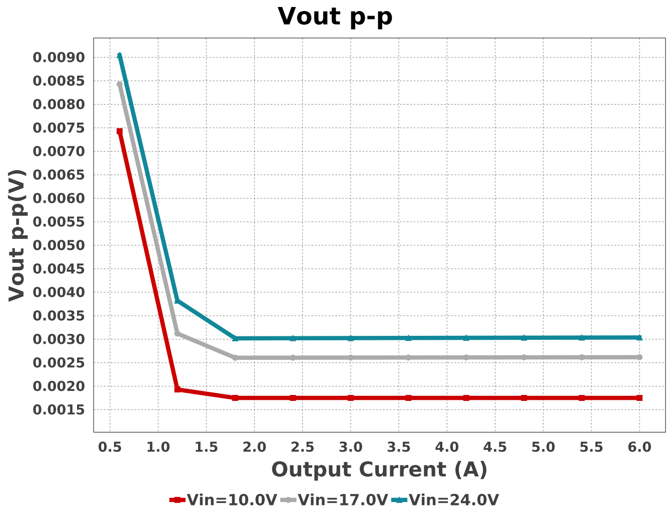


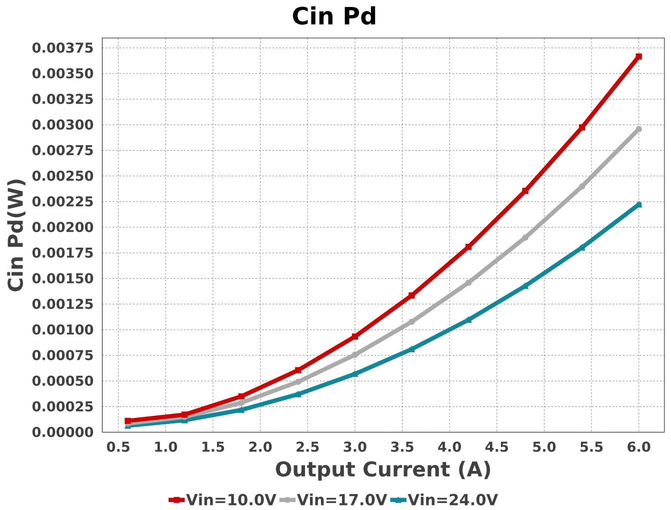

IC Ipk
IC Ipk(A)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

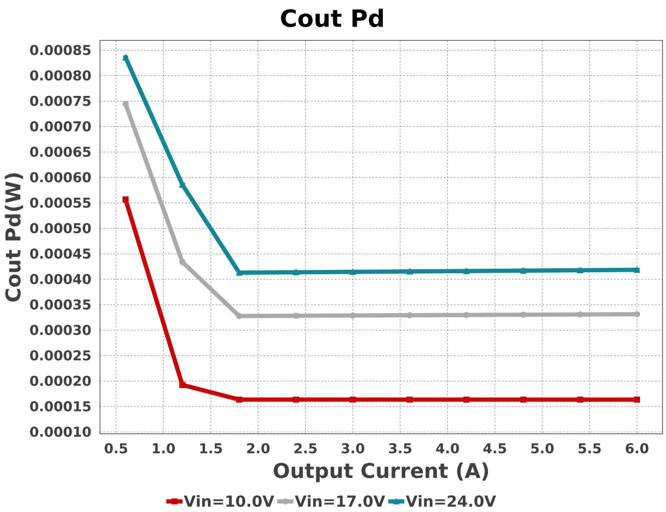

L Pd
L Pd(W)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

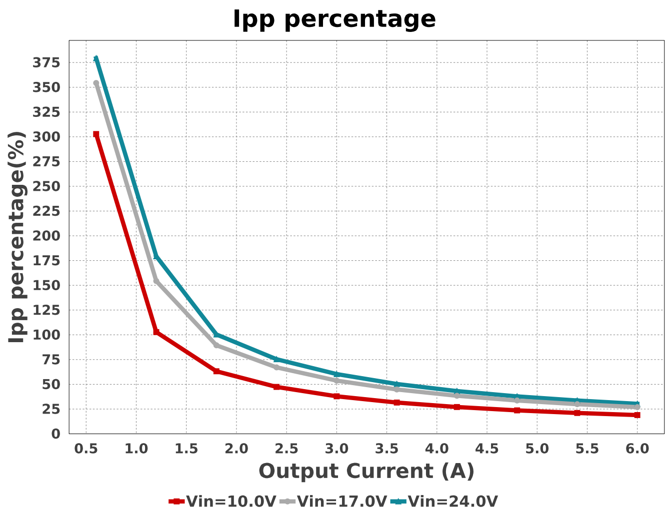

Efficiency
Efficiency(%)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

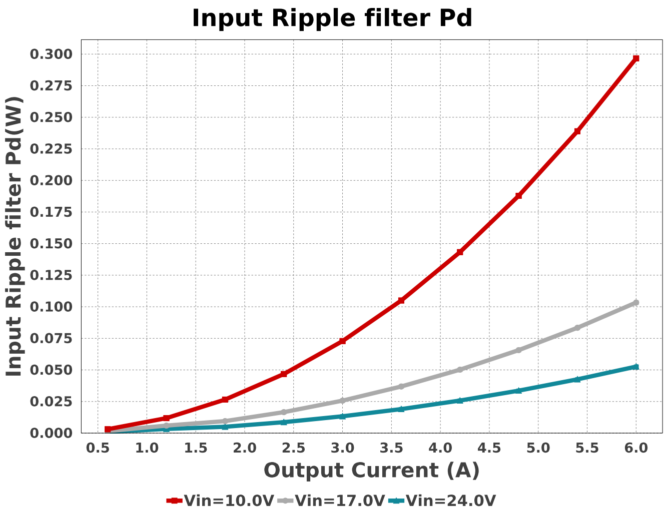

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

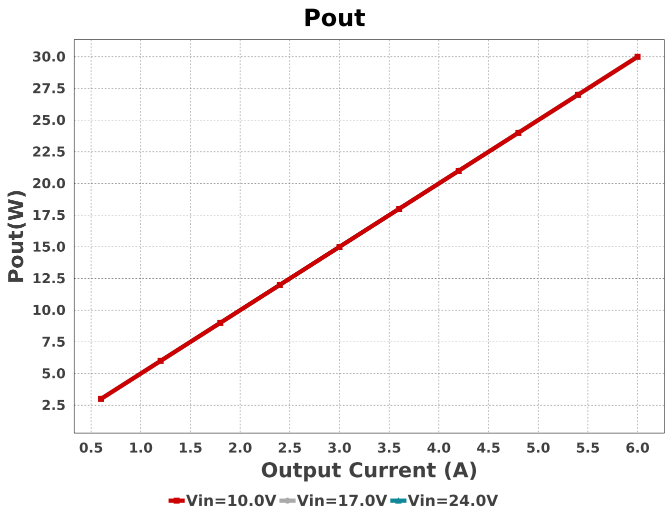

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

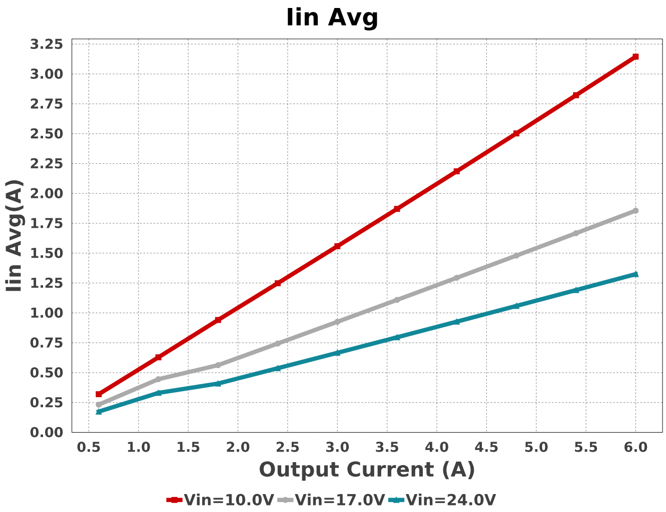

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

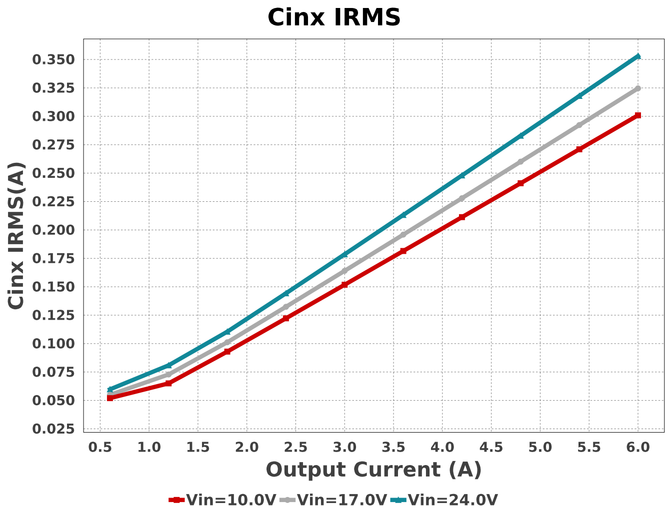

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

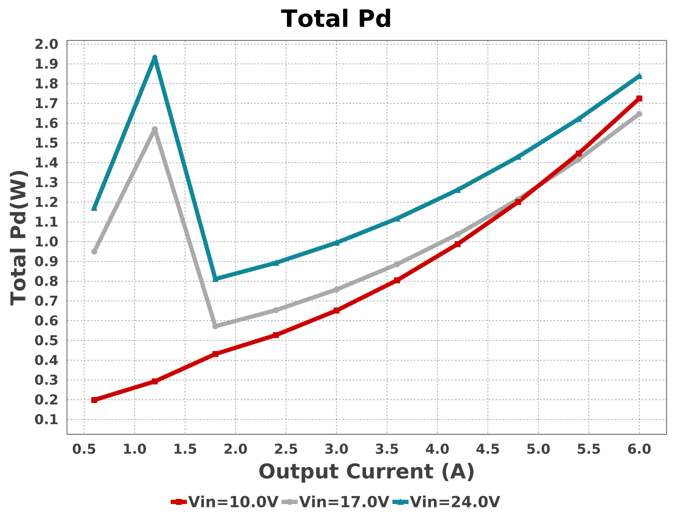

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

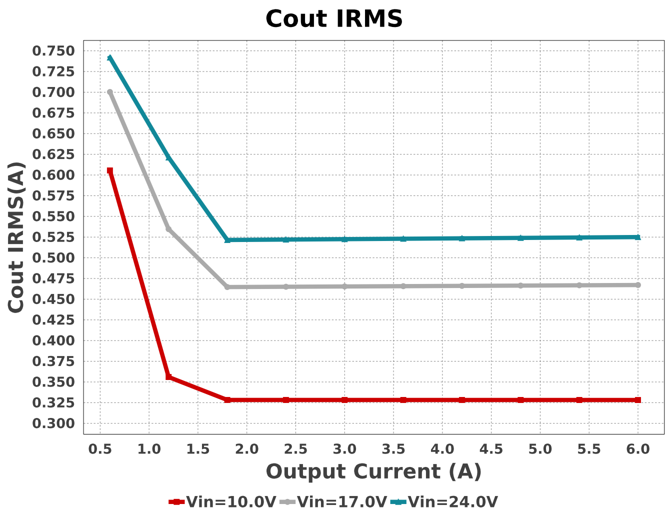

Input Ripple filter Pd
Input Ripple filter Pd(W)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

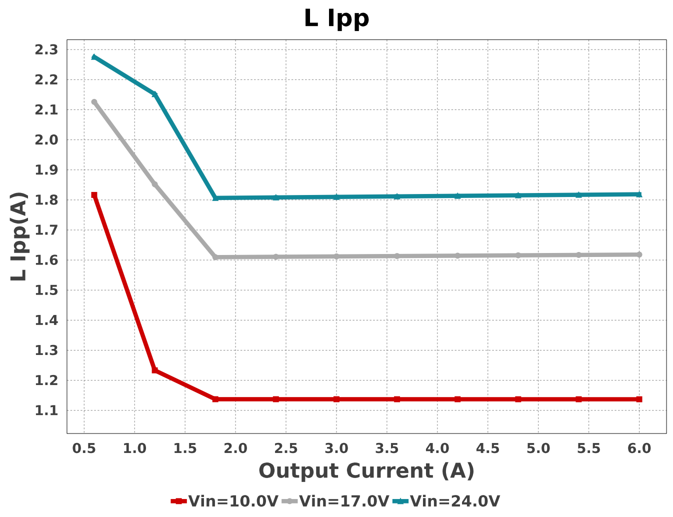

Pout
Pout(W)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

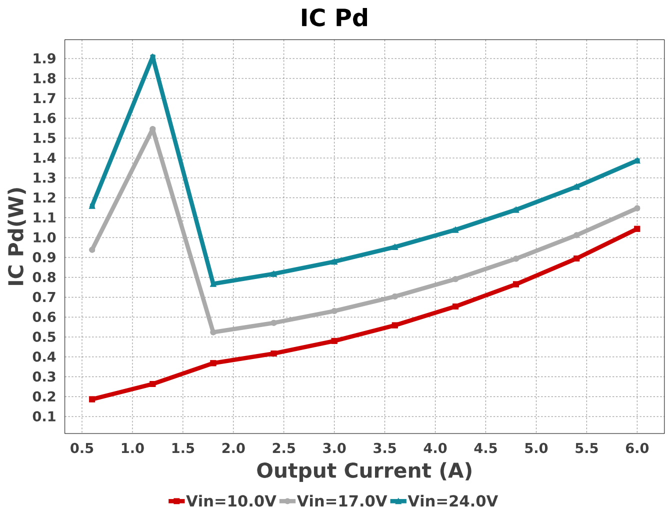

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

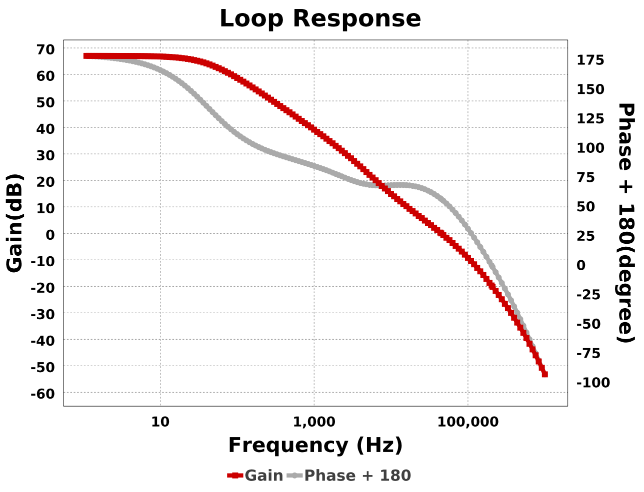

Cinx IRMS
Cinx IRMS(A)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

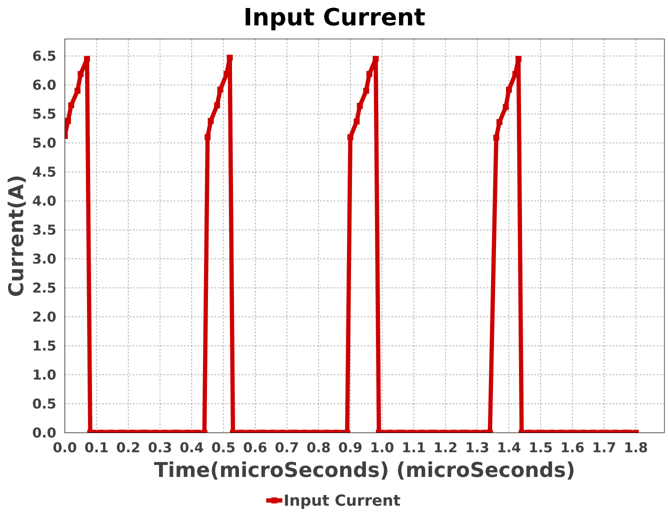

Total Pd
Total Pd(W)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

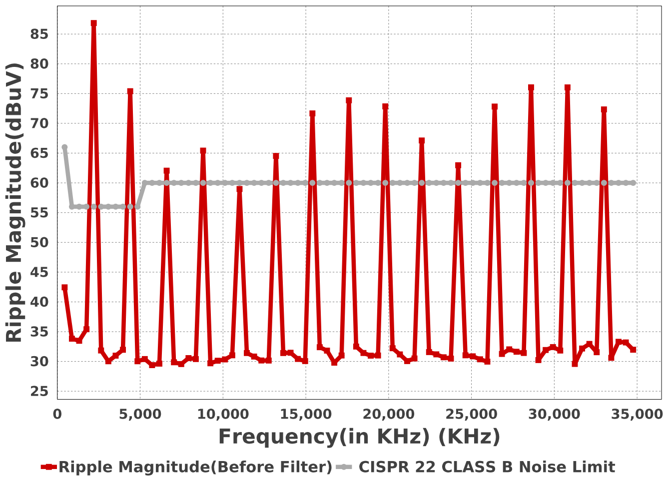

L Ipp
L Ipp(A)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=10.0V Vin=17.0V Vin=24.0V

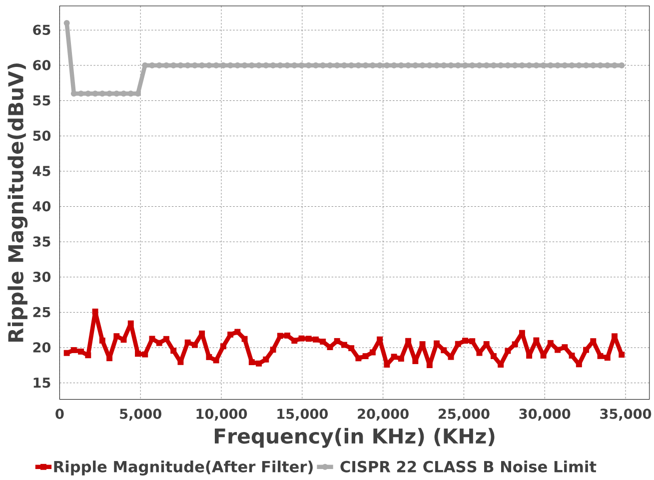

Loop Response
Gain(dB)
Phase + 180(degree)
Frequency (Hz)
Gain Phase + 180


Input Current
Current(A)
Time(microSeconds) (microSeconds)
Input Current

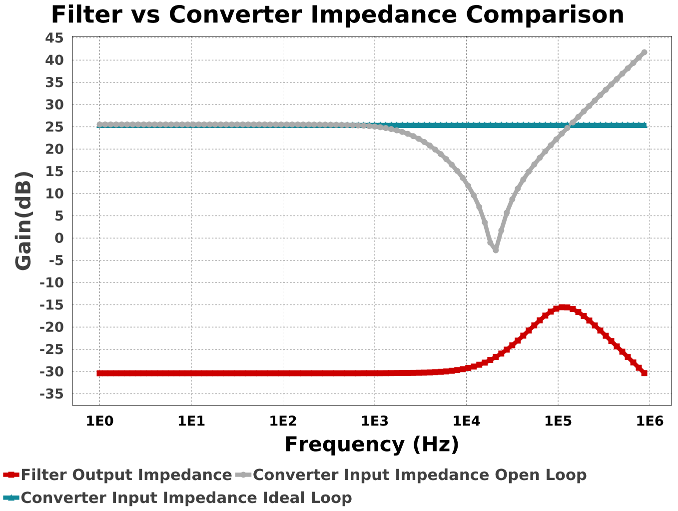
Ripple Freq Spectrum(Before Filter)



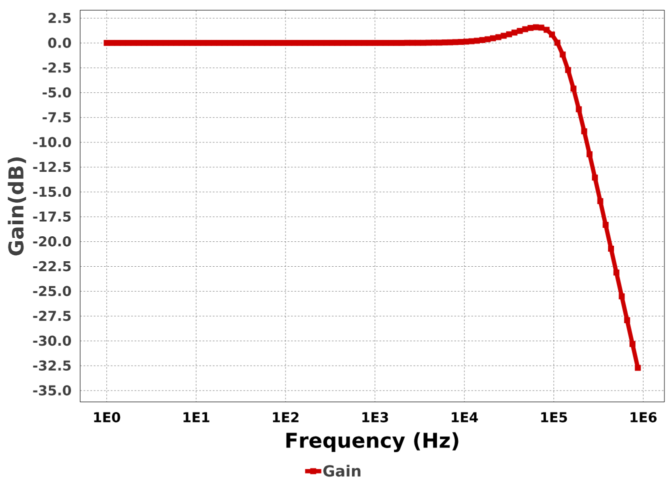
Ripple Freq Spectrum(After Filter)



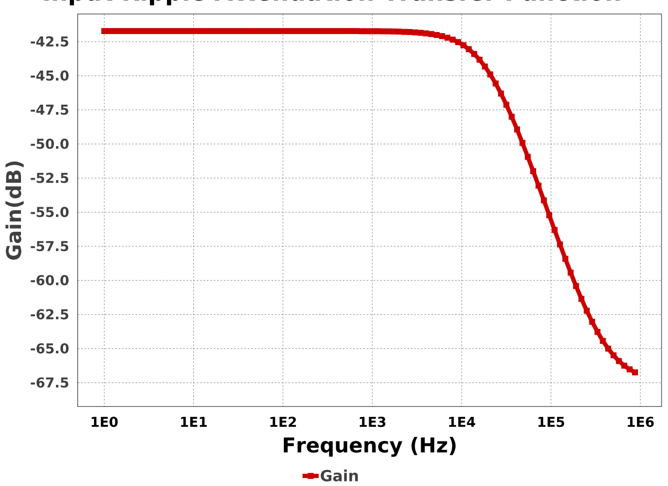
Filter vs Converter Impedance Comparison



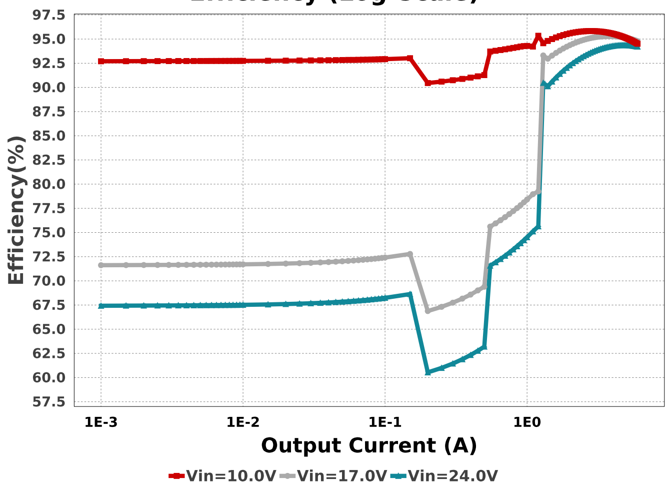
Filter Forward Transfer Function



Input Ripple Attenuation Transfer Function



Efficiency (Log-Scale)



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	18		Total Design BOM count
2.	Total BOM	$4.124		Total BOM Cost
3.	Cin IRMS	2.108 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	2.222 mW	Capacitor	Input capacitor power dissipation
5.	Cinx IRMS	353.034 mA	Capacitor	Bulk capacitor RMS ripple current
6.	Cinx Pd	0.0 W	Capacitor	Bulk capacitor power dissipation
7.	Cout IRMS	525.021 mA	Capacitor	Output capacitor RMS ripple current
8.	Cout Pd	418.57 µW	Capacitor	Output capacitor power dissipation
9.	Input Ripple Noise After input filter	25.97 dBuV	EMI Noise	Input Ripple Noise after filter at switching frequency

#	Name	Value	Category	Description
10.	Input Ripple Noise before input filter	86.85 dBuV	EMI Noise	Input Ripple Noise before filter at switching frequency
11.	Input Ripple filter Pd	52.632 mW	EMI Noise	Input Ripple Filter Power Dissipation
12.	Noise limits defined by CISPR Standards	56.0 dBuV	EMI Noise	Noise limits for CLASS B of CISPR 22 standard
13.	IC Ipk	6.909 A	IC	Peak switch current in IC
14.	IC Pd	1.387 W	IC	IC power dissipation
15.	IC Tj	60.519 degC	IC	IC junction temperature
16.	ICThetaJA Effective	22.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
17.	Iin Avg	1.324 A	IC	Average input current
18.	Ipp percentage	30.312 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
19.	L Ipp	1.819 A	Inductor	Peak-to-peak inductor ripple current
20.	L Pd	399.03 mW	Inductor	Inductor power dissipation
21.	Cin Pd	2.222 mW	Power	Input capacitor power dissipation
22.	Cinx Pd	0.0 W	Power	Bulk capacitor power dissipation
23.	Cout Pd	418.57 µW	Power	Output capacitor power dissipation
24.	IC Pd	1.387 W	Power	IC power dissipation
25.	Input Ripple filter Pd	52.632 mW	Power	Input Ripple Filter Power Dissipation
26.	L Pd	399.03 mW	Power	Inductor power dissipation
27.	Total Pd	1.838 W	Power	Total Power Dissipation
28.	Cross Freq	44.95 kHz	System Information	Bode plot crossover frequency
29.	Duty Cycle	21.132 %	System Information	Duty cycle
30.	Efficiency	94.217 %	System Information	Steady state efficiency
31.	FootPrint	326.0 mm^2	System Information	Total Foot Print Area of BOM components
32.	Frequency	2.2 MHz	System Information	Switching frequency
33.	Gain Marg	-19.676 dB	System Information	Bode Plot Gain Margin
34.	Iout	6.0 A	System Information	Iout operating point
35.	Low Freq Gain	67.014 dB	System Information	Gain at 1Hz
36.	Mode	CCM	System Information	Conduction Mode
37.	Phase Marg	56.487 deg	System Information	Bode Plot Phase Margin
38.	Pout	30.0 W	System Information	Total output power
39.	Vin	24.0 V	System Information	Vin operating point
40.	Vin p-p	35.446 mV	System Information	Peak-to-peak input voltage
41.	Vout	5.0 V	System Information	Operational Output Voltage
42.	Vout Tolerance	1.25 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
43.	Vout p-p	3.037 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	10.0	Minimum input voltage
Vout	5.0	Output Voltage
base_pn	LM62460	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

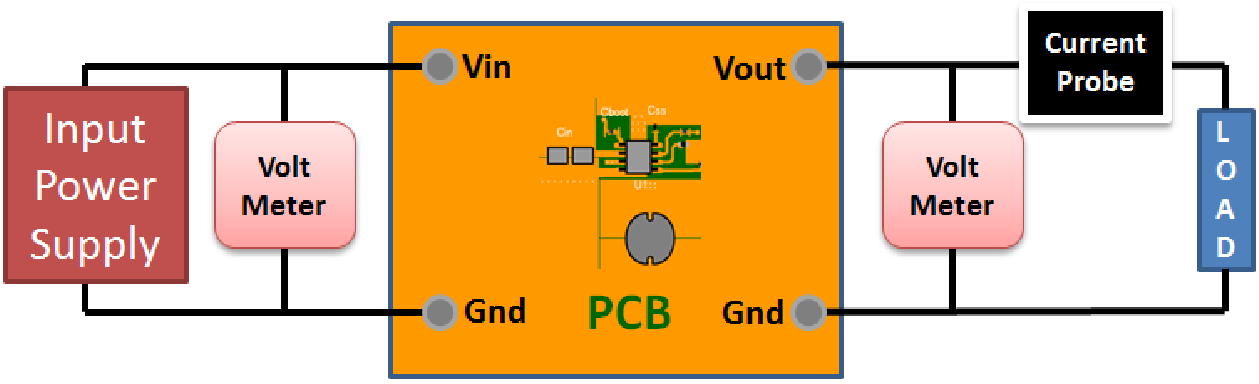
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 10.0V 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.

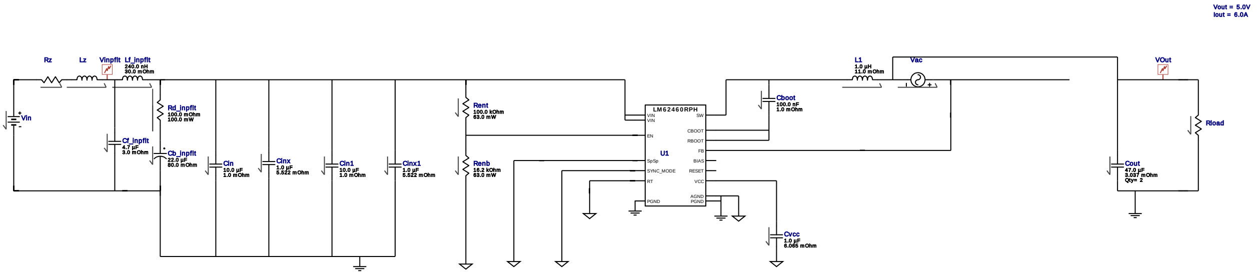


WEBENCH® Electrical Simulation Report

Design Id = 17

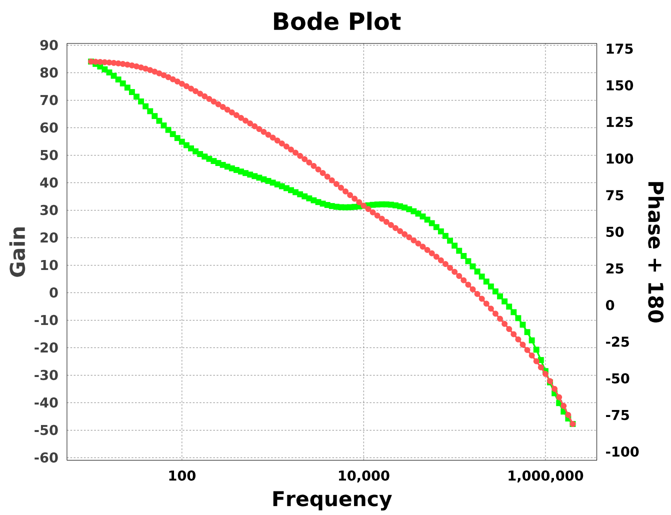
sim_id = 1

Simulation Type = Bode Plot



Simulation Parameters

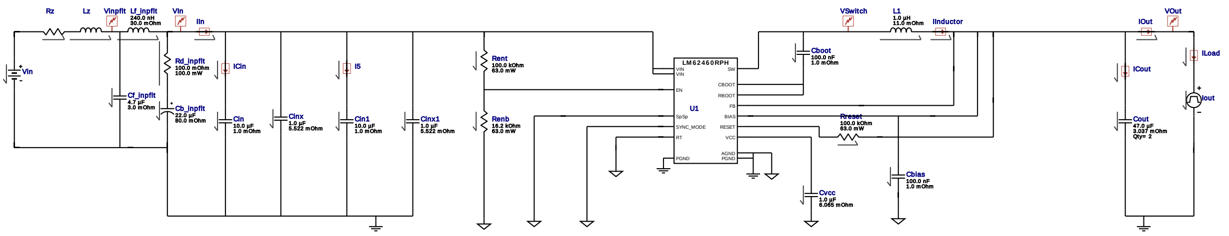
#	Name	Parameter Name	Description	Values
1.	Cinj	C	Injection Capacitance	10000000 F
2.	Linj	L	Injection Inductance	10000000 H
3.	Vinj	AC	AC voltage	1 V
4.	Rload	R	Load Resistance	0.8333333333333334 Ohm
5.	Rz	R	no description	2.48E-4 Ohm
6.	Lz	L	no description	1.0E-10 H



Design Id = 17

sim_id = 2

Simulation Type = Load Transient



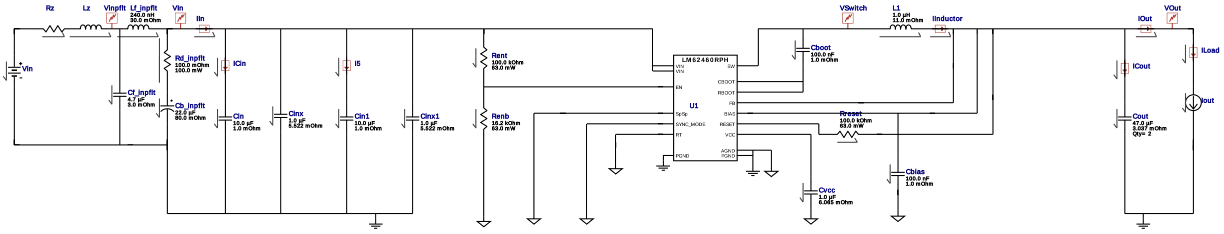
Simulation Parameters

#	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
3.	Rz	R	no description	2.48E-4 Ohm
4.	Lz	L	no description	1.0E-10 H

Design Id = 17

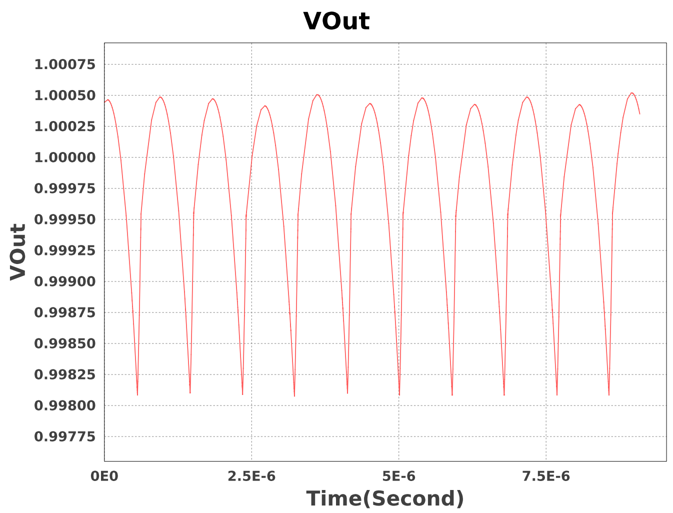
sim_id = 4

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
3.	Rz	R	no description	2.48E-4 Ohm
4.	Lz	L	no description	1.0E-10 H



Design Assistance

1. The LM62460 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 : A19392E5572167559A9A1E772277F17F[v1]

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