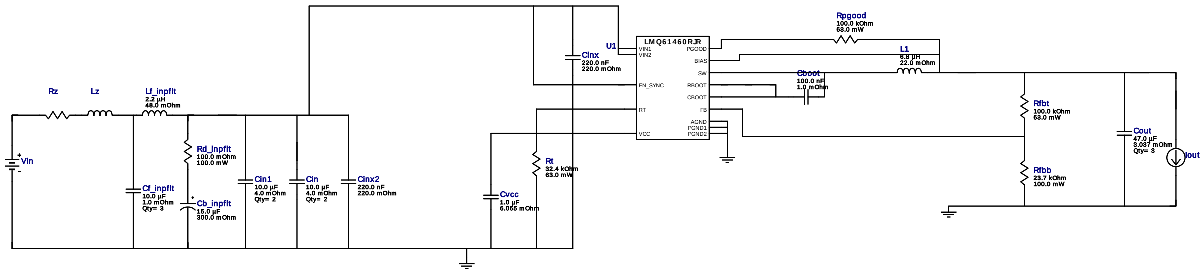
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 9.0V
VinMax = 18.0V
Vout = 5.2V
Iout = 5.0A

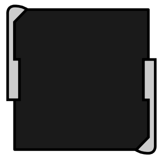
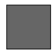
Device = LMQ61460AASRJRR
Topology = Buck
Created = 2024-07-09 10:17:29.885
BOM Cost = $4.67
BOM Count = 23
Total Pd = 2.23W

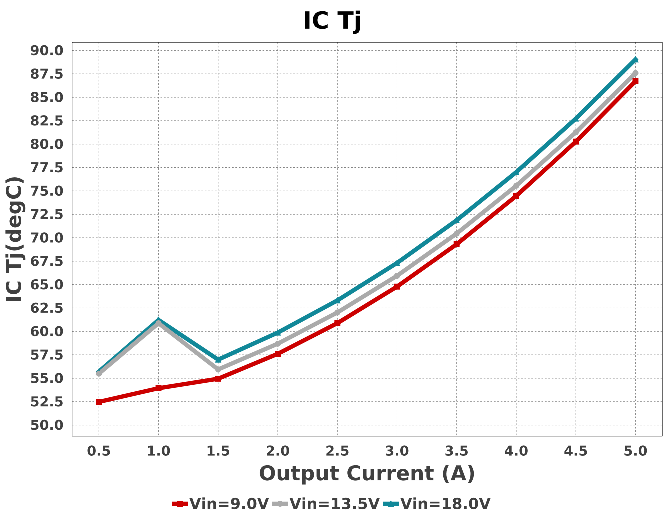
Design : 8 LMQ61460AASRJRR
LMQ61460AASRJRR 9V-30V to 5.00V @ 5A

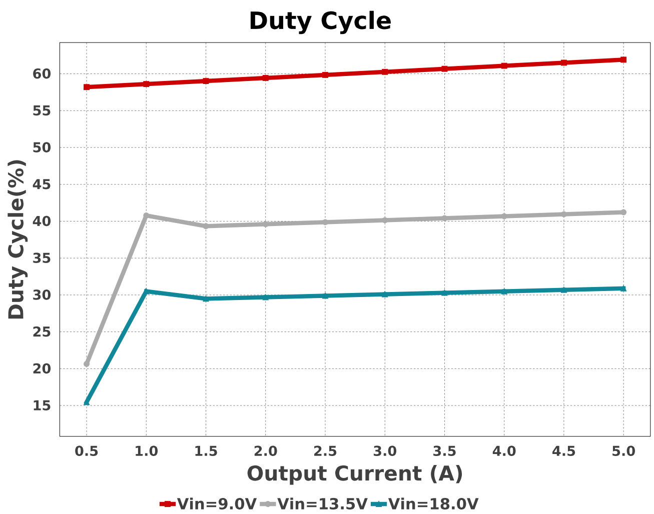


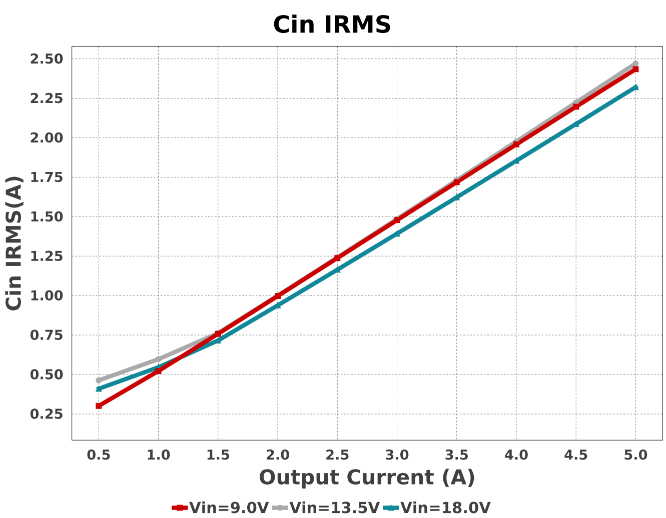
Electrical BOM

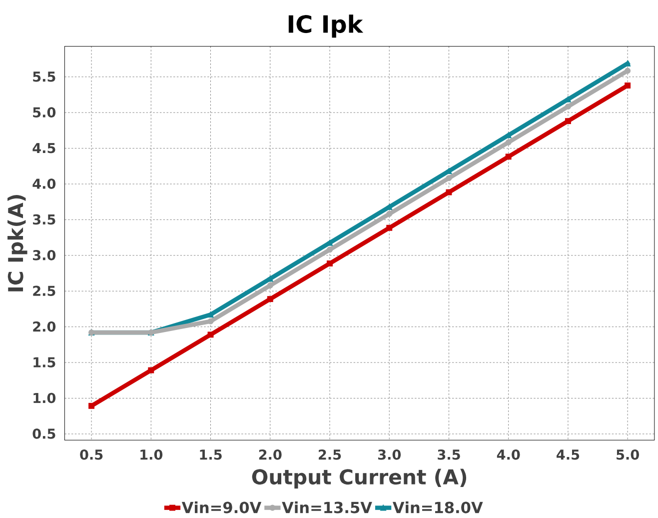
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cb_inpflt	Vishay-Sprague	593D156X9035D2TE3 Series= 593D	Cap= 15.0 uF ESR= 300.0 mOhm VDC= 35.0 V IRMS= 710.0 mA	1	$0.37	7343-31 59 mm²
Cboot	MuRata	GRM155R71A104KA01D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cf_inpflt	TDK	C3225X7R1H106M250AC Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 5.0 A	3	$0.27	1210 15 mm²
Cin	MuRata	GRM31CR71E106KA12L Series= X7R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 6.0 A	2	$0.06	1206_180 11 mm²
Cin1	MuRata	GRM31CR71E106KA12L Series= X7R	Cap= 10.0 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 6.0 A	2	$0.06	1206_180 11 mm²
Cinx	MuRata	GRM188R71E224KA88D Series= X7R	Cap= 220.0 nF ESR= 220.0 mOhm VDC= 25.0 V IRMS= 2.24 A	1	$0.03	0603 5 mm²
Cinx2	MuRata	GRM188R71E224KA88D Series= X7R	Cap= 220.0 nF ESR= 220.0 mOhm VDC= 25.0 V IRMS= 2.24 A	1	$0.03	0603 5 mm²
Cout	MuRata	GRM32ER61C476KE15L Series= X5R	Cap= 47.0 uF ESR= 3.037 mOhm VDC= 16.0 V IRMS= 4.59346 A	3	$0.17	1210_280 15 mm²
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

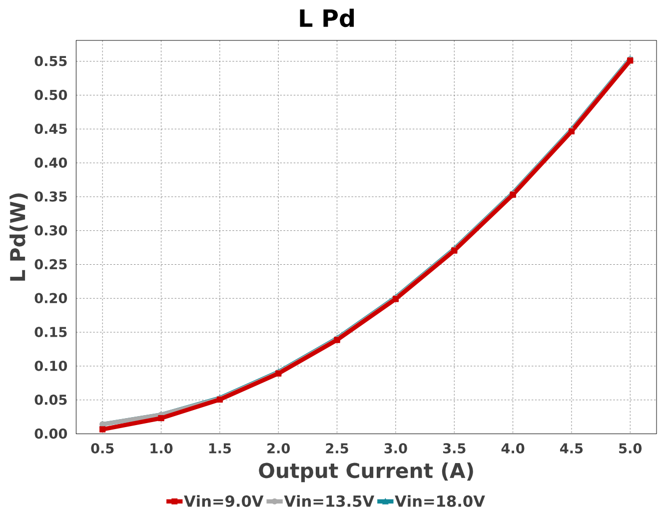
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
L1	Bourns	SRP1235-6R8M	L= 6.8 µH 22.0 mOhm	1	$0.72	 SRP1235 253 mm²
Lf_inpflt	Pulse Engineering	PA4332.222NLT	L= 2.2 µH 48.0 mOhm	1	$0.26	 PA4332 27 mm²
Rd_inpflt	Panasonic	ERJ-3RSFR10V Series= ERJ-3R	Res= 100.0 mOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.03	0603 5 mm²
Rfbb	Panasonic	ERJ-2RKF2372X Series= ?	Res= 23.7 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rpgood	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rt	Vishay-Dale	CRCW040232K4FKED Series= CRCW..e3	Res= 32.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	LMQ61460AASRJRR	Switcher	1	$1.61	RJR0014A-MFG 22 mm²

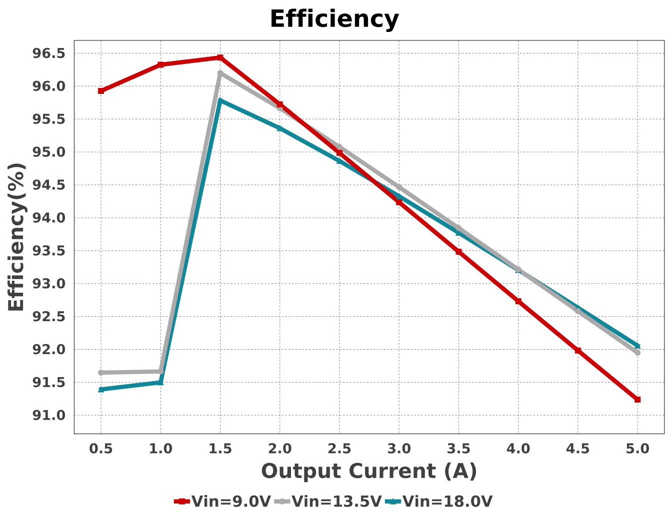


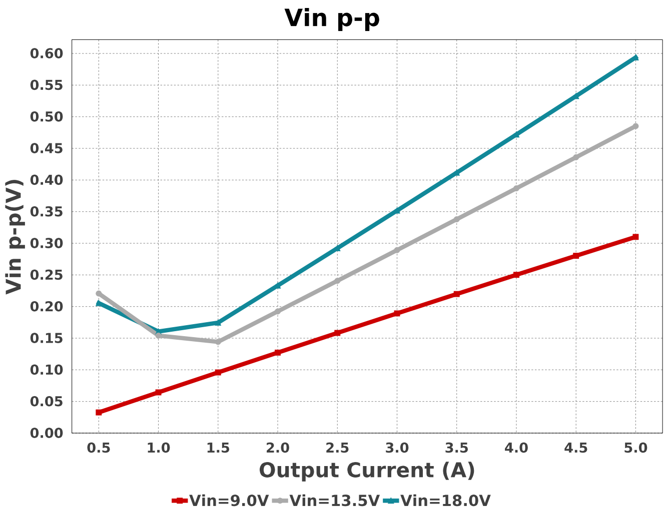


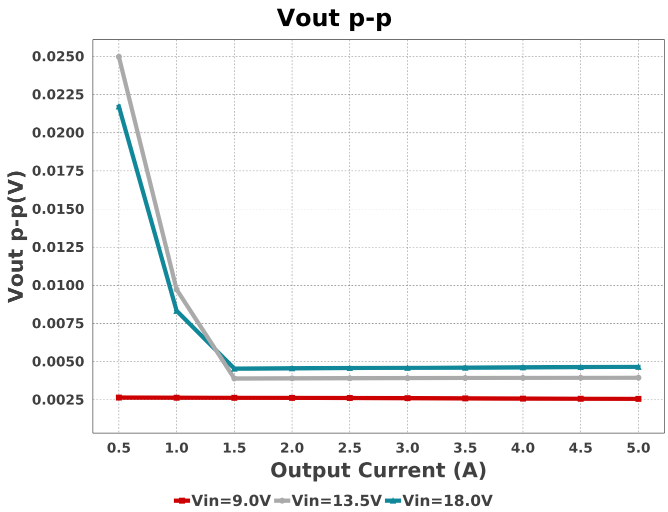


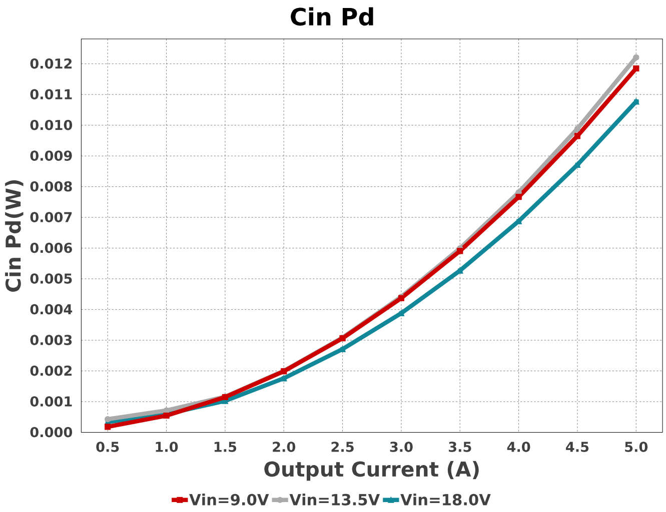


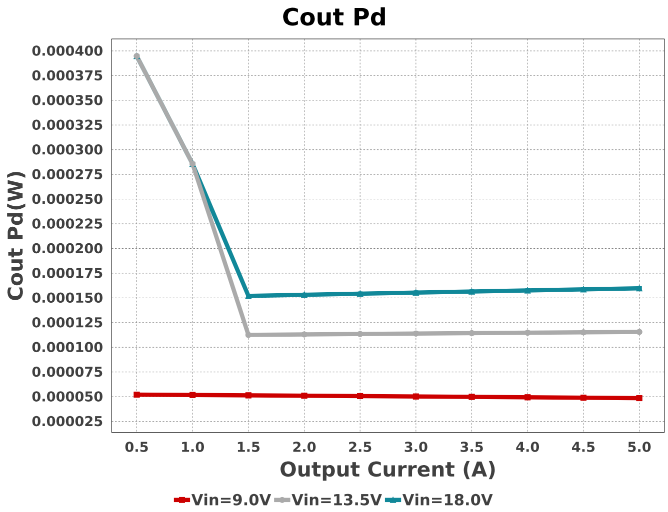

L Pd
L Pd(W)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

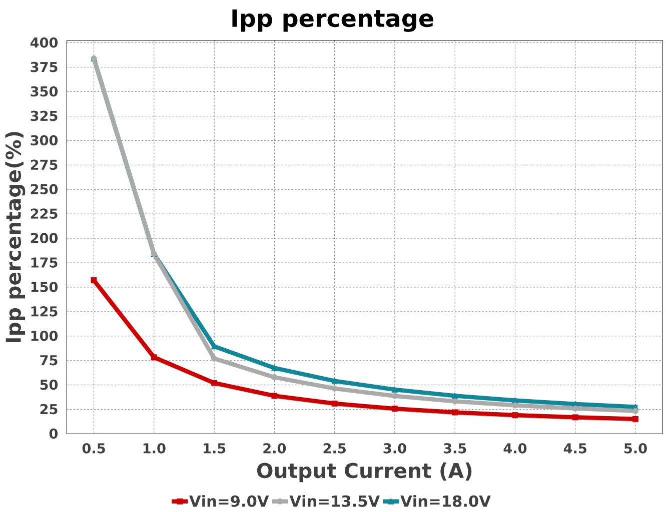

Efficiency
Efficiency(%)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

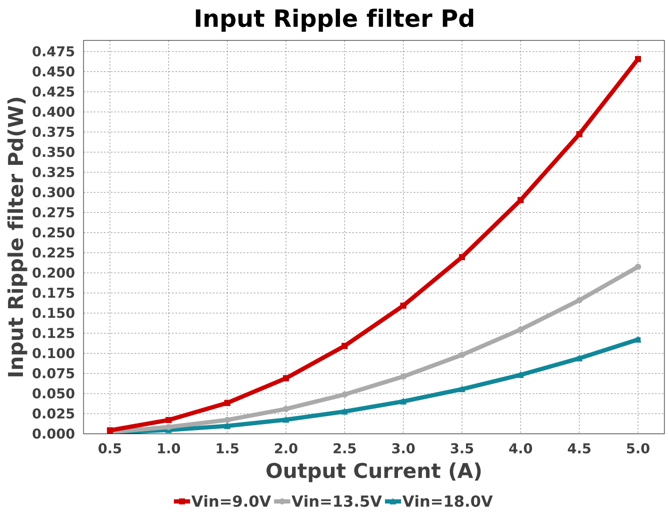

Vin p-p
Vin p-p(V)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

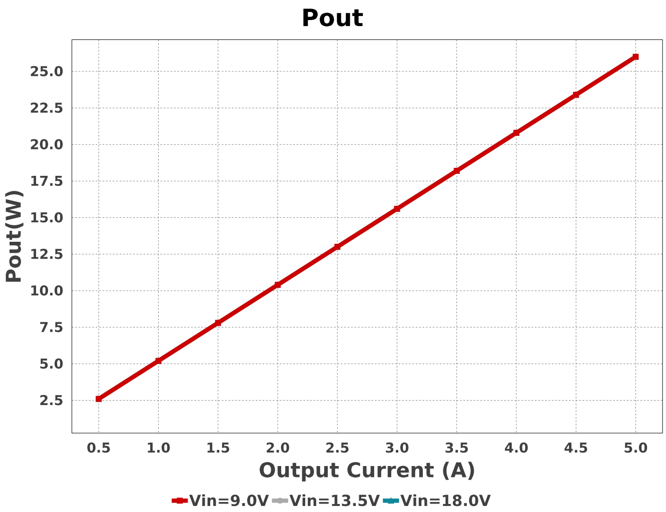

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

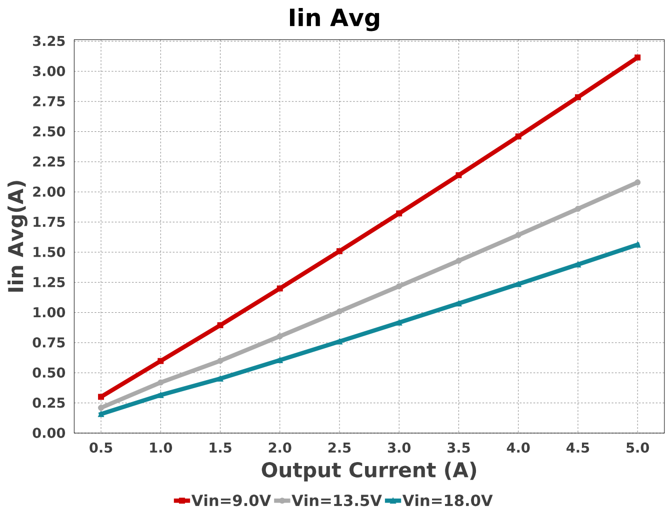

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

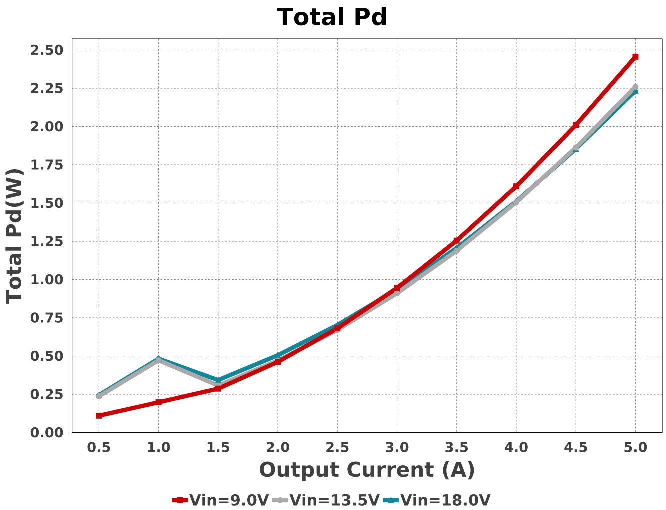

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

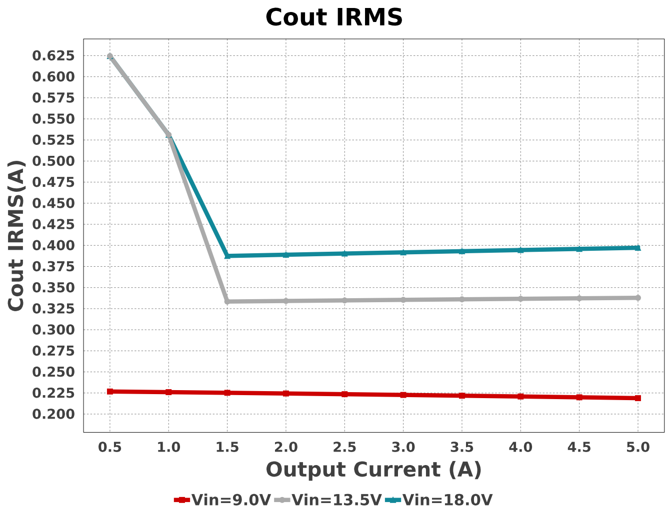

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V


Input Ripple filter Pd
Input Ripple filter Pd(W)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

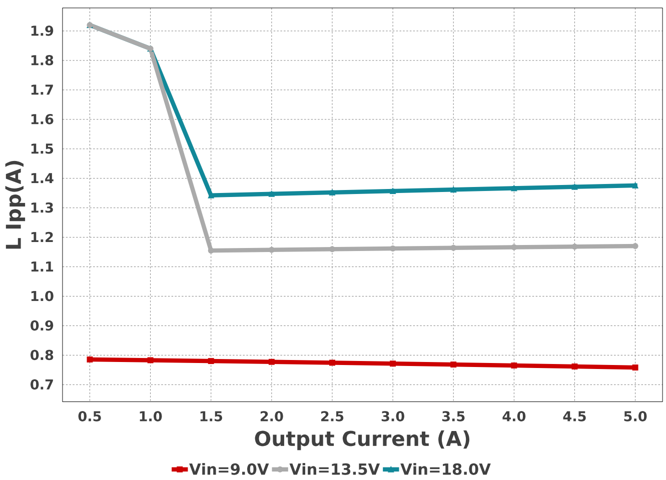

Pout
Pout(W)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V


Iin Avg
Iin Avg(A)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

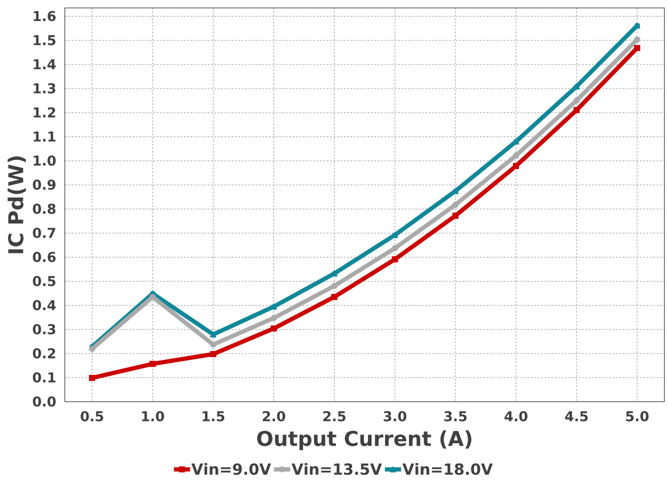

Total Pd
Total Pd(W)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=9.0V Vin=13.5V Vin=18.0V

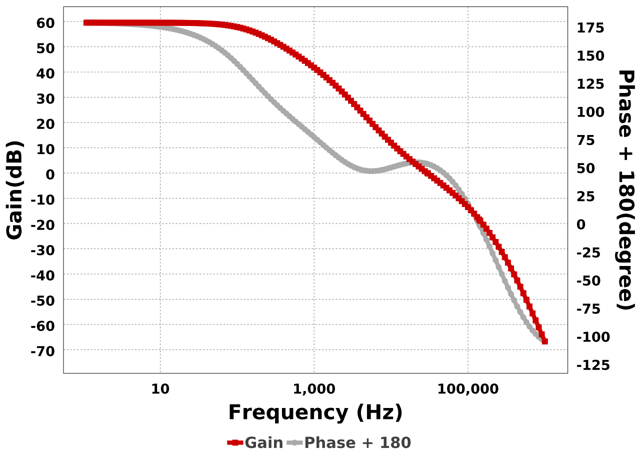
L Ipp



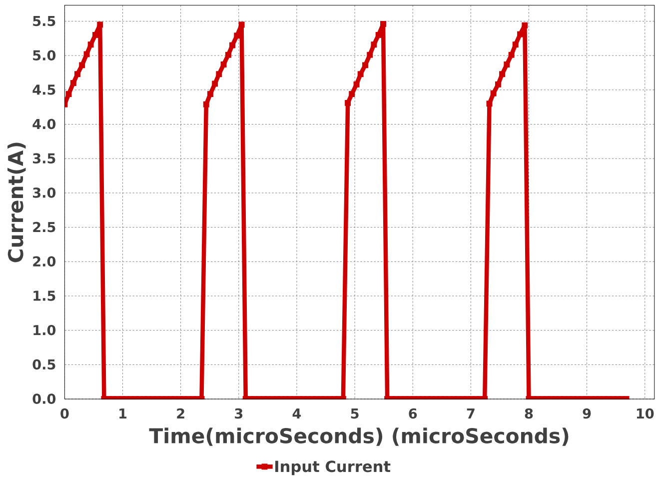
IC Pd



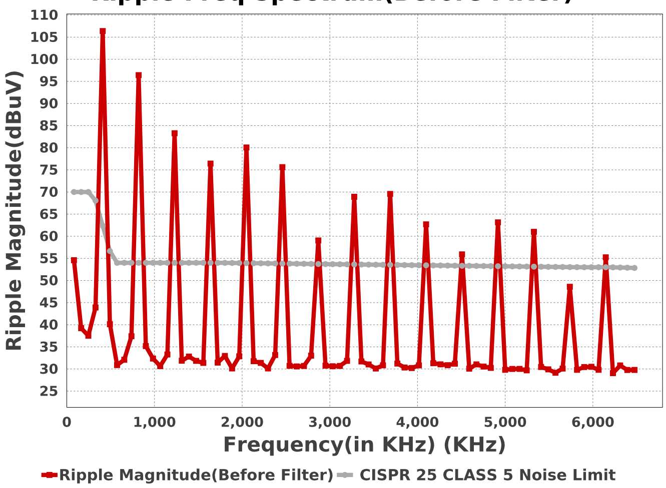
Loop Response



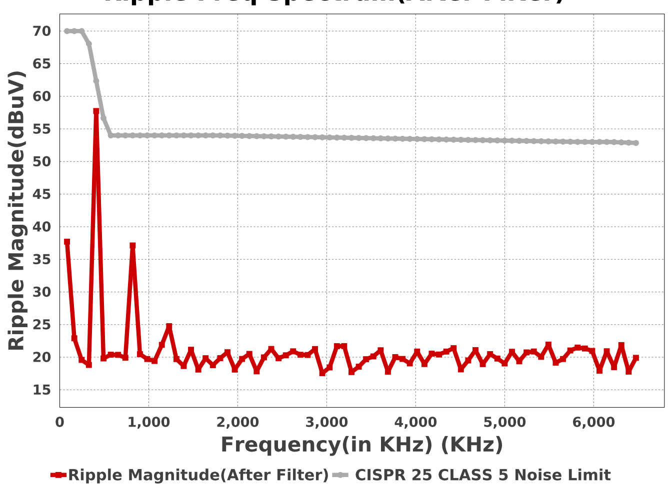
Input Current

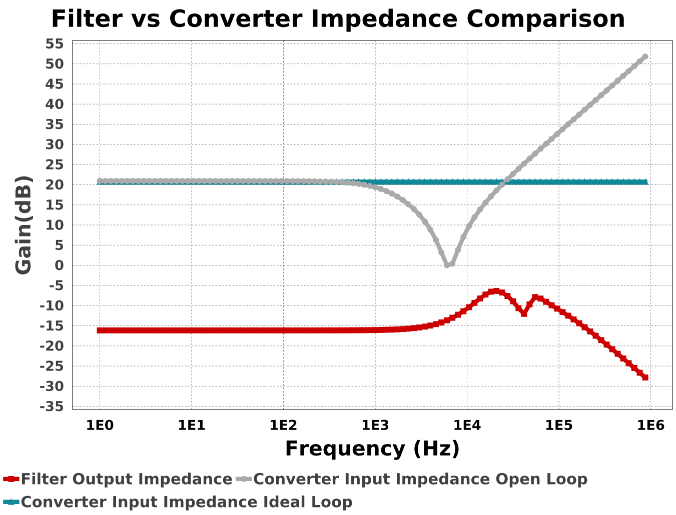


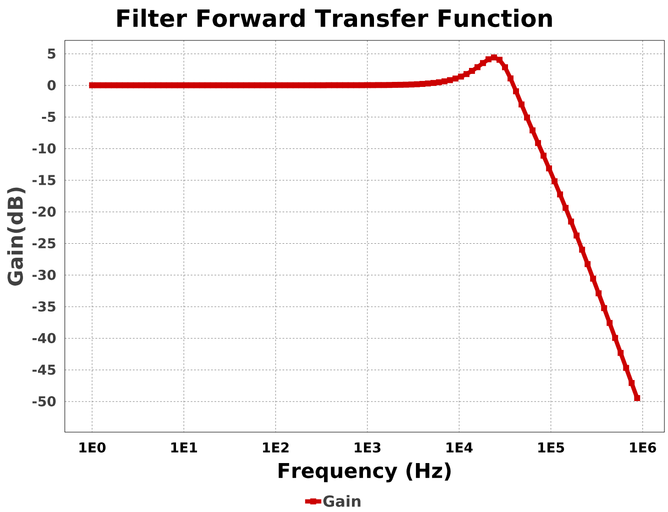
Ripple Freq Spectrum(Before Filter)

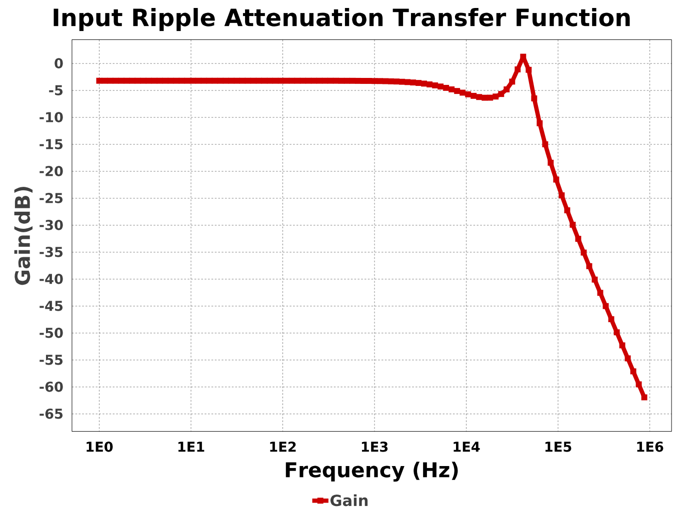


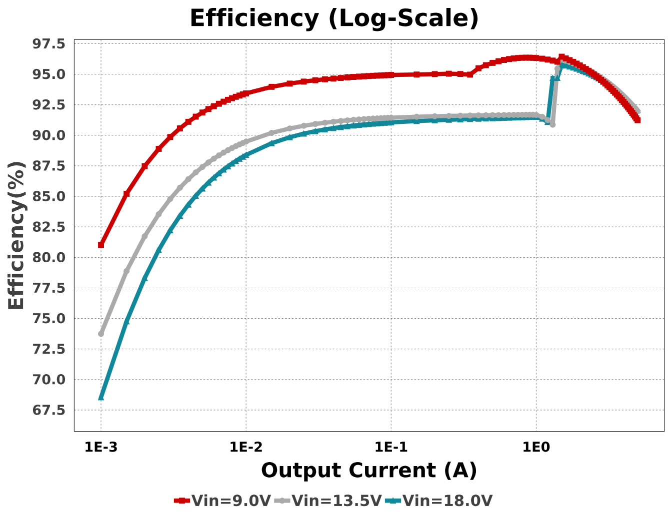
Ripple Freq Spectrum(After Filter)











Operating Values

#	Name	Value	Category	Description
1.	BOM Count	23		Total Design BOM count
2.	Total BOM	$4.67		Total BOM Cost
3.	Cin IRMS	2.321 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	10.771 mW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	397.176 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	159.69 µW	Capacitor	Output capacitor power dissipation
7.	Input Ripple Noise After input filter	57.77 dBuV	EMI Noise	Input Ripple Noise after filter at switching frequency
8.	Input Ripple Noise before input filter	106.38 dBuV	EMI Noise	Input Ripple Noise before filter at switching frequency
9.	Input Ripple filter Pd	117.2 mW	EMI Noise	Input Ripple Filter Power Dissipation
10.	Noise limits defined by CISPR Standards	62.36 dBuV	EMI Noise	Noise limits for CLASS 5 of CISPR 25 standard
11.	IC Ipk	5.688 A	IC	Peak switch current in IC
12.	IC Pd	1.562 W	IC	IC power dissipation
13.	IC Tj	89.041 degC	IC	IC junction temperature
14.	IC Tolerance	10.0 mV	IC	IC Feedback Tolerance
15.	ICThetaJA	25.0 degC/W	IC	IC junction-to-ambient thermal resistance
16.	Iin Avg	1.563 A	IC	Average input current
17.	Ipp percentage	27.517 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
18.	L Ipp	1.376 A	Inductor	Peak-to-peak inductor ripple current
19.	L Pd	553.47 mW	Inductor	Inductor power dissipation
20.	Cin Pd	10.771 mW	Power	Input capacitor power dissipation
21.	Cout Pd	159.69 µW	Power	Output capacitor power dissipation
22.	IC Pd	1.562 W	Power	IC power dissipation
23.	Input Ripple filter Pd	117.2 mW	Power	Input Ripple Filter Power Dissipation
24.	L Pd	553.47 mW	Power	Inductor power dissipation
25.	Total Pd	2.234 W	Power	Total Power Dissipation
26.	Cross Freq	29.622 kHz	System Information	Bode plot crossover frequency

#	Name	Value	Category	Description
27.	Duty Cycle	30.888 %	System Information	Duty cycle
28.	Efficiency	92.057 %	System Information	Steady state efficiency
29.	FootPrint	527.0 mm^2	System Information	Total Foot Print Area of BOM components
30.	Frequency	409.814 kHz	System Information	Switching frequency
31.	Gain Marg	-18.402 dB	System Information	Bode Plot Gain Margin
32.	Iout	5.0 A	System Information	Iout operating point
33.	Low Freq Gain	59.557 dB	System Information	Gain at 1Hz
34.	Mode	CCM	System Information	Conduction Mode
35.	Phase Marg	53.989 deg	System Information	Bode Plot Phase Margin
36.	Pout	26.0 W	System Information	Total output power
37.	Vin	18.0 V	System Information	Vin operating point
38.	Vin p-p	593.747 mV	System Information	Peak-to-peak input voltage
39.	Vout	5.2 V	System Information	Operational Output Voltage
40.	Vout Actual	5.219 V	System Information	Vout Actual calculated based on selected voltage divider resistors
41.	Vout Tolerance	2.649 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Vout p-p	4.655 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	5.0	Maximum Output Current
VinMax	18.0	Maximum input voltage
VinMin	9.0	Minimum input voltage
Vout	5.2	Output Voltage
base_pn	LMQ61460	Base Product Number
source	DC	Input Source Type
Ta	50.0	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

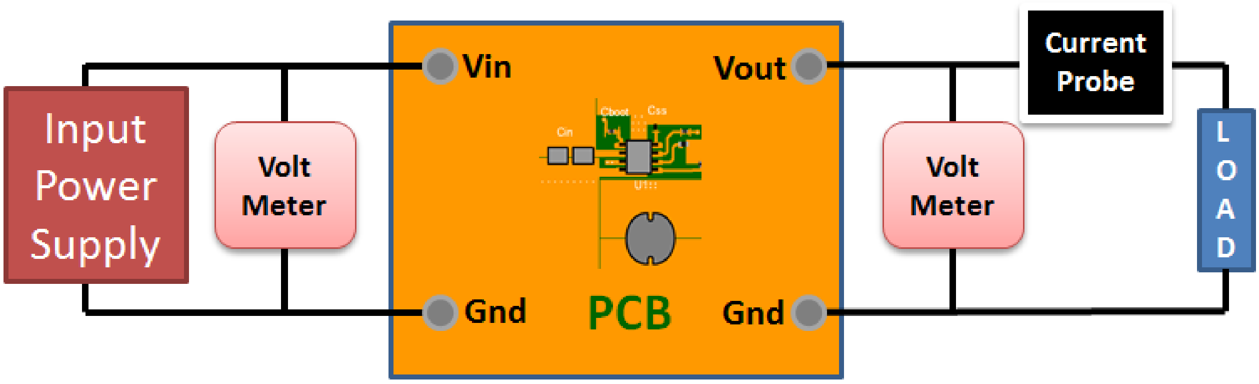
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 9.0V 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 : 25E1641D0EB9446D[v1]

2. **LMQ61460** Product Folder : http://www.ti.com/product/LMQ61460 : contains the data sheet and other resources.

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