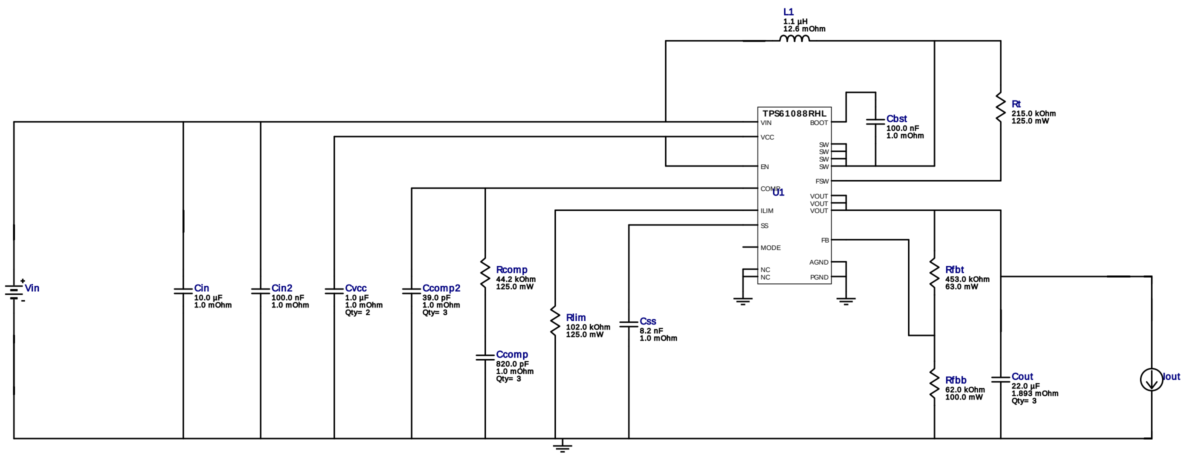
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 3.0V
VinMax = 4.2V
Vout = 10.0V
Iout = 2.5A

Device = TPS61088RHLR
Topology = Boost
Created = 2019-07-23 07:09:14.061
BOM Cost = $5.81
BOM Count = 22
Total Pd = 3.17W

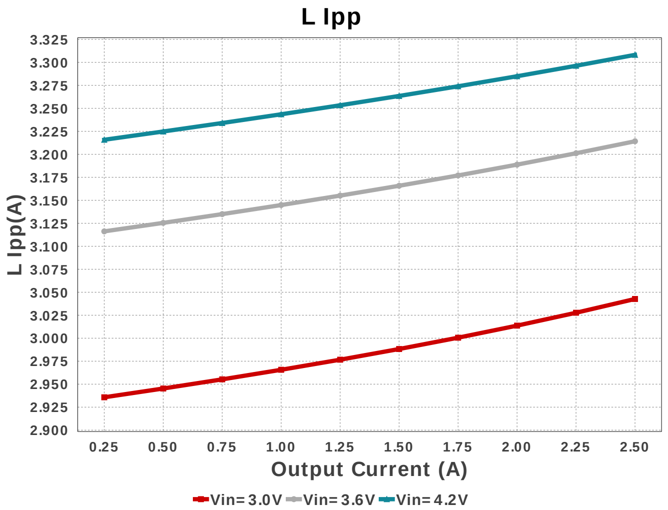
Design : 4 TPS61088RHLR
TPS61088RHLR 3.6V-4.2V to 10.00V @ 2.8A

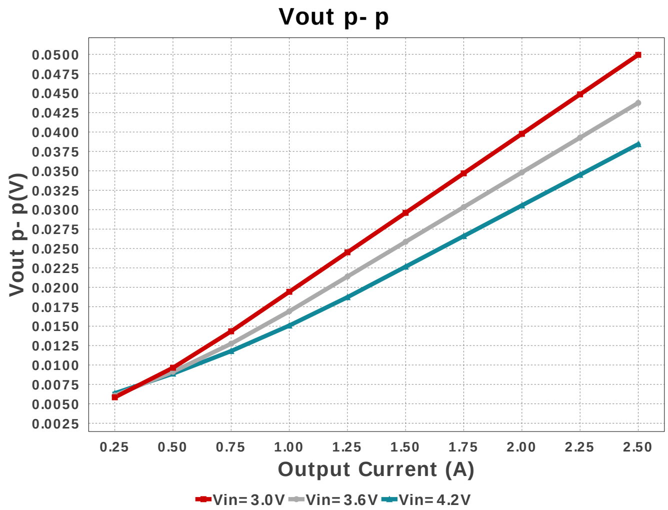


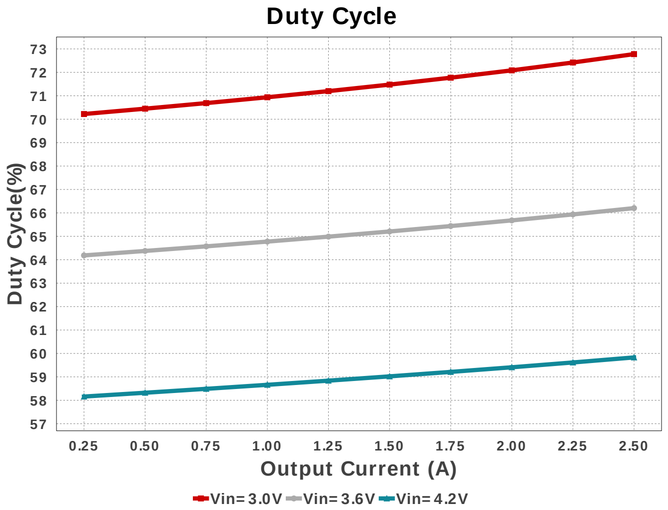
Electrical BOM

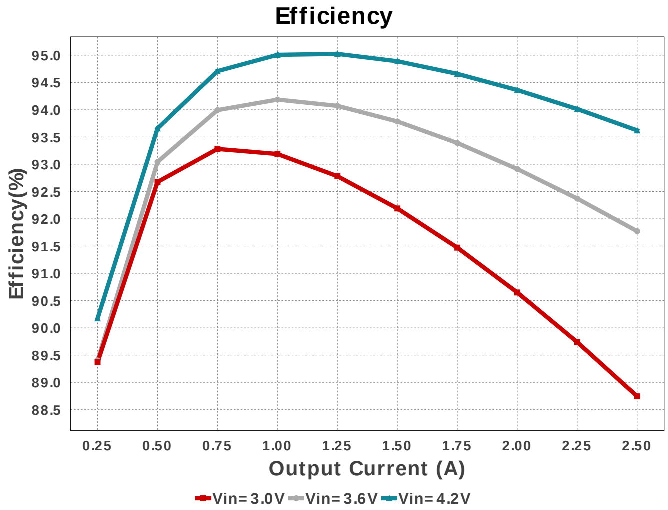
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cbst	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp	MuRata	GRM155R71H821KA01D Series= X7R	Cap= 820.0 pF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	3	$0.01	0402 3 mm²
Ccomp2	MuRata	GRM1555C1E390JA01D Series= C0G/NP0	Cap= 39.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	3	$0.01	0402 3 mm²
Cin	TDK	C3216X5R1H106K160AB Series= X5R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.9 A	1	$0.30	1206_180 11 mm²
Cin2	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
Cout	TDK	CGA9P2X7R1E226M250KA Series= X7R	Cap= 22.0 uF ESR= 1.893 mOhm VDC= 25.0 V IRMS= 6.635 A	3	$0.99	2220_280 54 mm²
Css	MuRata	GRM155R71C822KA01D Series= X7R	Cap= 8.2 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cvcc	Taiyo Yuden	EMK107B7105KA-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	2	$0.02	0603 5 mm²
L1	Coilcraft	XAL6020-112MEB	L= 1.1 µH 12.6 mOhm	1	$0.76	XAL6020 75 mm²

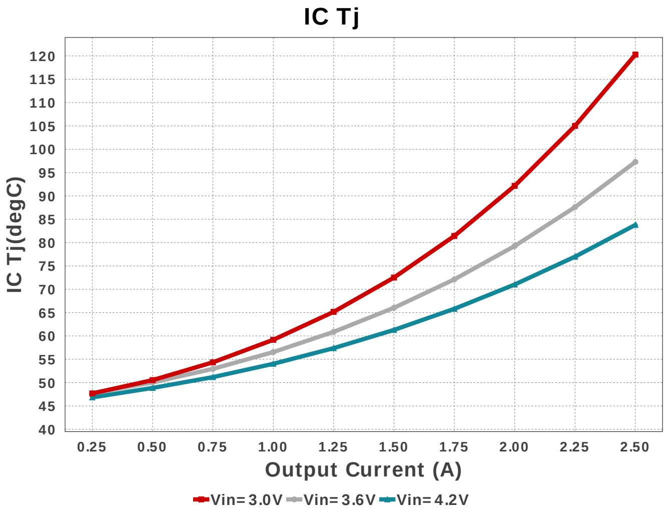
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rcomp	Vishay-Dale	CRCW080544K2FKEA Series= CRCW..e3	Res= 44.2 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rfbb	Yageo	RC0603FR-0762KL Series= ?	Res= 62.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rfbt	Vishay-Dale	CRCW0402453KFKED Series= CRCW..e3	Res= 453.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rlim	Vishay-Dale	CRCW0805102KFKEA Series= CRCW..e3	Res= 102.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rt	Panasonic	ERJ-6ENF2153V Series= ERJ-6E	Res= 215.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
U1	Texas Instruments	TPS61088RHLR	Switcher	1	$1.60	RHL0020A 25 mm^2

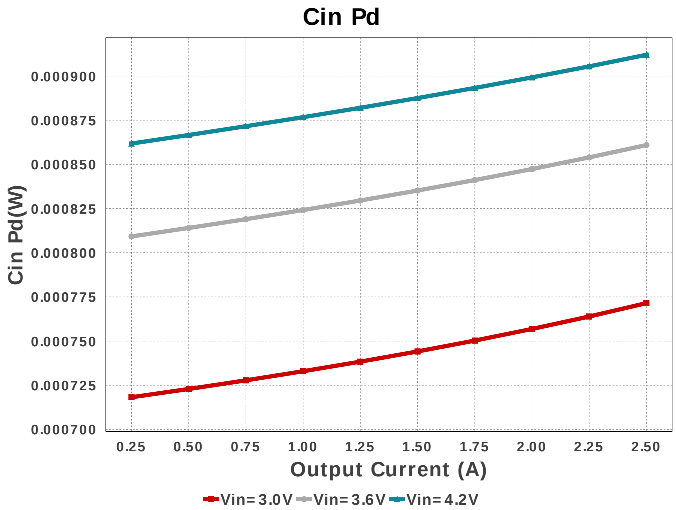


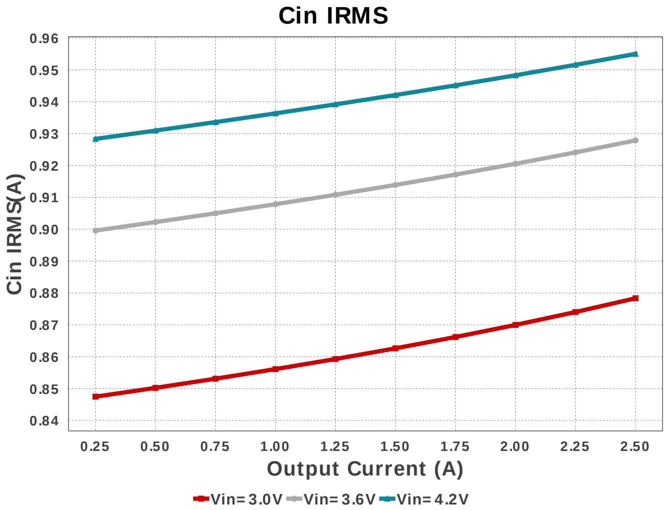


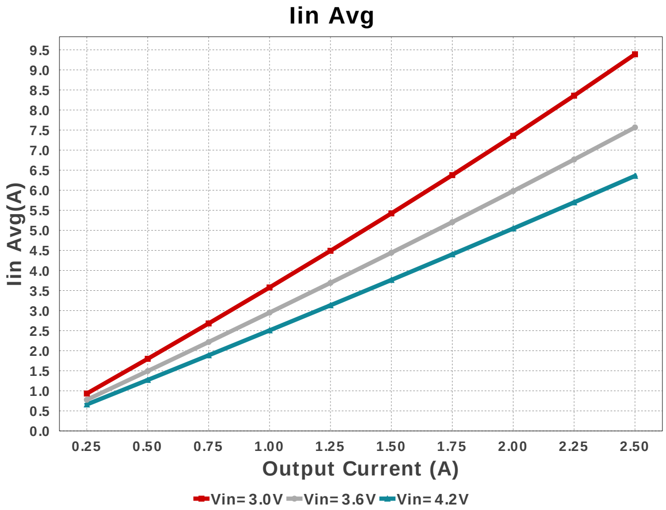


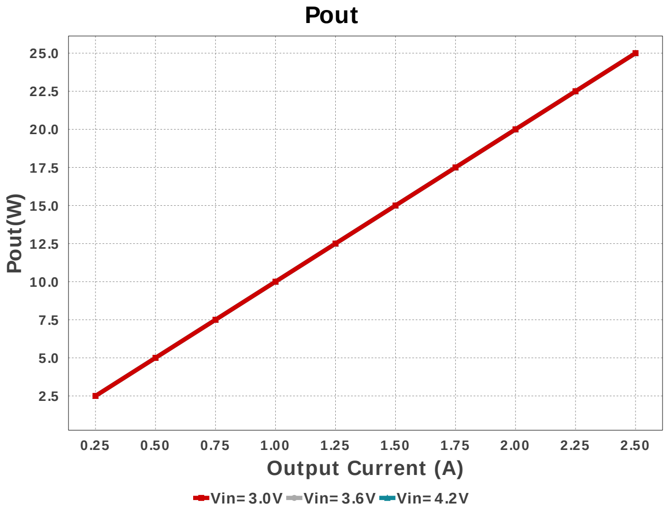


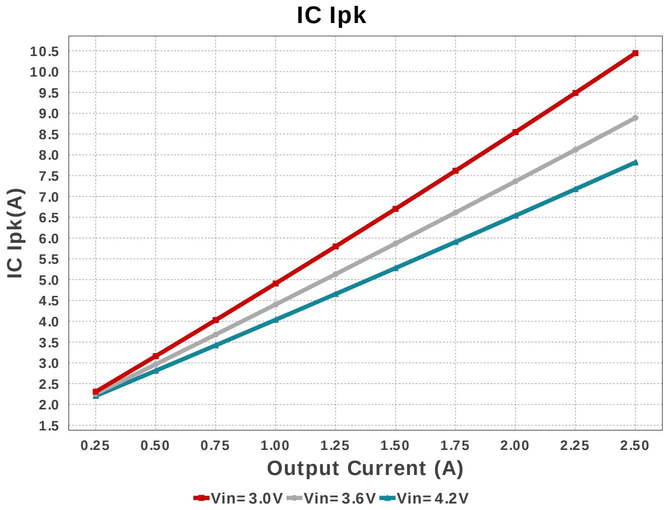

IC Tj
IC Tj(degC)
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V

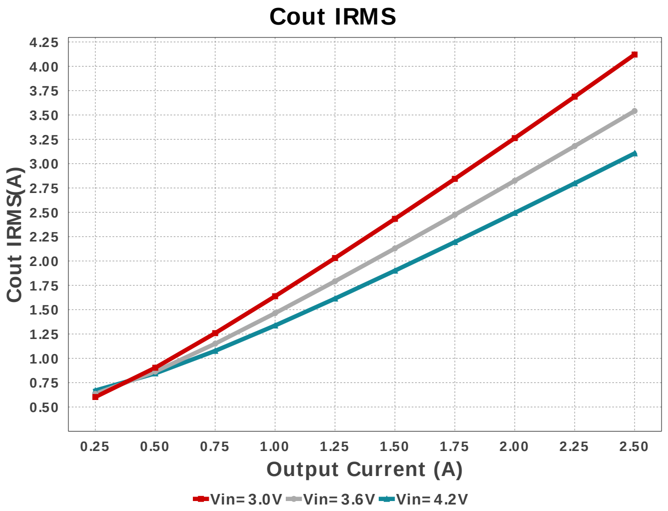

Cin Pd
Cin Pd(W)
0.000900
0.000875
0.000850
0.000825
0.000800
0.000775
0.000750
0.000725
0.000700
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V

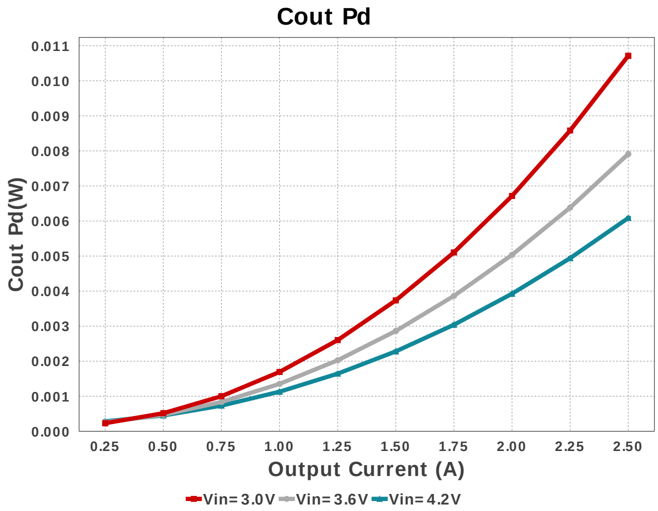

Cin IRMS
Cin IRMS(A)
0.96
0.95
0.94
0.93
0.92
0.91
0.90
0.89
0.88
0.87
0.86
0.85
0.84
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V

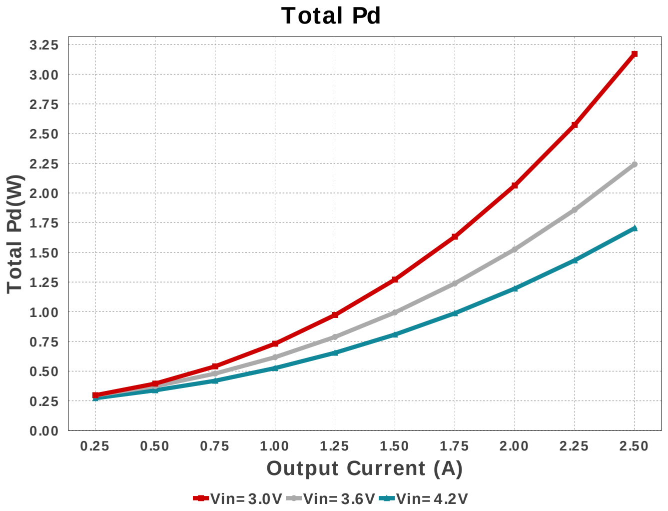

Iin Avg
Iin Avg(A)
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V

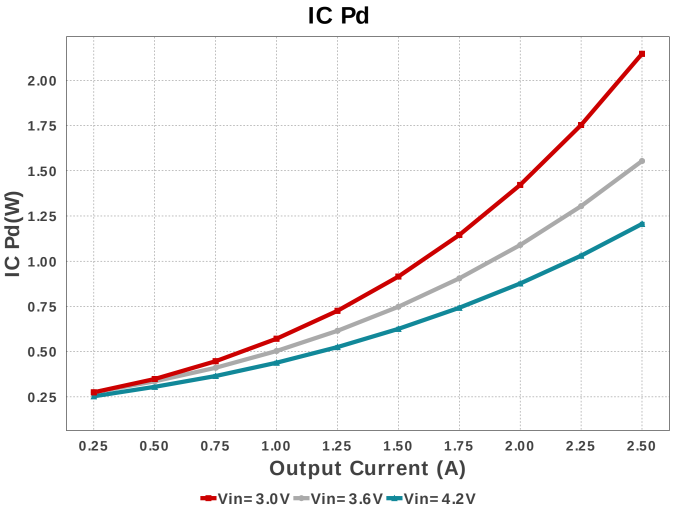

Pout
Pout(W)
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V

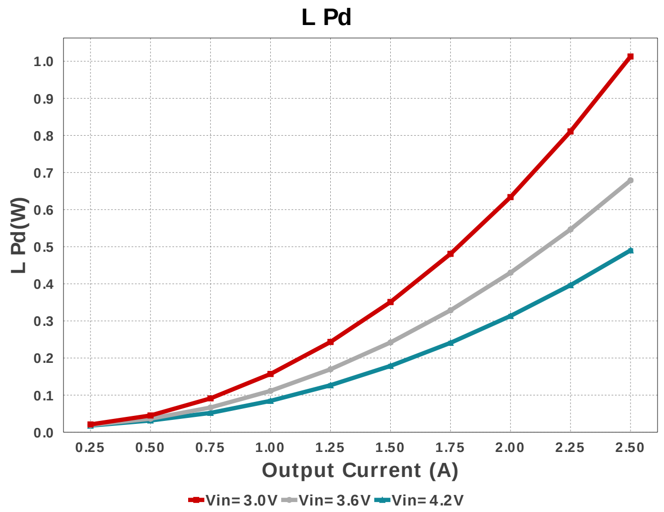

IC Ipk
IC Ipk(A)
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin=3.0V Vin=3.6V Vin=4.2V

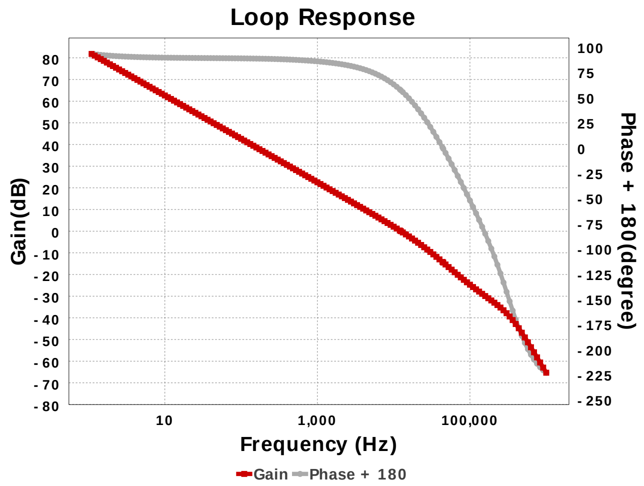

Cout IRMS
Cout IRMS(A)
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V

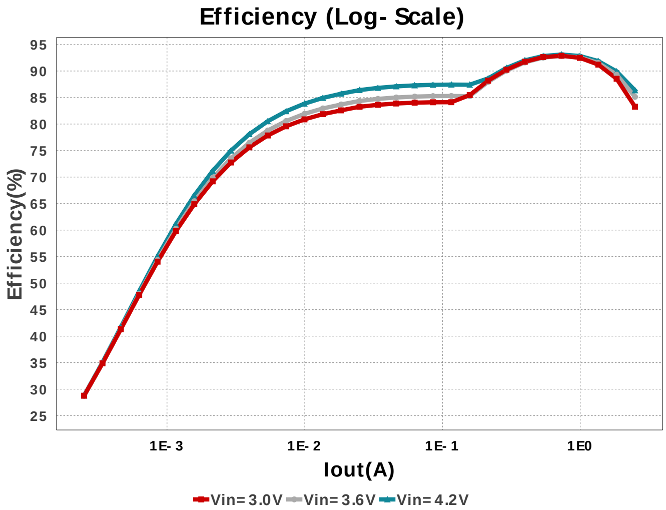

Cout Pd
Cout Pd(W)
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V


Total Pd
Total Pd(W)
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
0.00
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V


IC Pd
IC Pd(W)
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= 3.0V Vin= 3.6V Vin= 4.2V


L Pd
L Pd(W)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.25 0.50 0.75 1.00 1.25 1.50 1.75 2.00 2.25 2.50
Output Current (A)
Vin= 3.0V Vin= 3.6V Vin= 4.2V


Loop Response
Gain(dB)
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
Phase + 180(degree)
100
75
50
25
0
-25
-50
-75
-100
-125
-150
-175
-200
-225
-250
10 1,000 100,000
Frequency (Hz)
Gain Phase + 180



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	22		Total Design BOM count
2.	Total BOM	$5.81		Total BOM Cost
3.	Cin IRMS	878.336 mA	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	771.47 µW	Capacitor	Input capacitor power dissipation
5.	Cout IRMS	4.121 A	Capacitor	Output capacitor RMS ripple current
6.	Cout Pd	10.714 mW	Capacitor	Output capacitor power dissipation
7.	IC Ipk	10.444 A	IC	Peak switch current in IC
8.	IC Pd	2.146 W	IC	IC power dissipation
9.	IC Tj	120.282 degC	IC	IC junction temperature
10.	ICThetaJA	38.8 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	9.39 A	IC	Average input current
12.	L Ipp	3.043 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	1.013 W	Inductor	Inductor power dissipation
14.	Cin Pd	771.47 µW	Power	Input capacitor power dissipation
15.	Cout Pd	10.714 mW	Power	Output capacitor power dissipation
16.	IC Pd	2.146 W	Power	IC power dissipation
17.	L Pd	1.013 W	Power	Inductor power dissipation
18.	Total Pd	3.171 W	Power	Total Power Dissipation
19.	Cross Freq	12.167 kHz	System Information	Bode plot crossover frequency
20.	Duty Cycle	72.779 %	System Information	Duty cycle
21.	Efficiency	88.744 %	System Information	Steady state efficiency
22.	FootPrint	337.0 mm^2	System Information	Total Foot Print Area of BOM components
23.	Frequency	652.351 kHz	System Information	Switching frequency
24.	Gain Marg	-14.258 dB	System Information	Bode Plot Gain Margin
25.	Iout	2.5 A	System Information	Iout operating point
26.	Low Freq Gain	80.59 dB	System Information	Gain at 1Hz
27.	Mode	BOOST CCM	System Information	PWM/PFM Mode
28.	Phase Marg	58.922 deg	System Information	Bode Plot Phase Margin
29.	Pout	25.0 W	System Information	Total output power
30.	Vin	3.0 V	System Information	Vin operating point
31.	Vout Actual	10.001 V	System Information	Vout Actual calculated based on selected voltage divider resistors
32.	Vout Tolerance	4.44 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
33.	Vout p-p	49.937 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	2.5	Maximum Output Current
VinMax	4.2	Maximum input voltage
VinMin	3.0	Minimum input voltage
Vout	10.0	Output Voltage
base_pn	TPS61088	Base Product Number
source	DC	Input Source Type
Ta	37.0	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

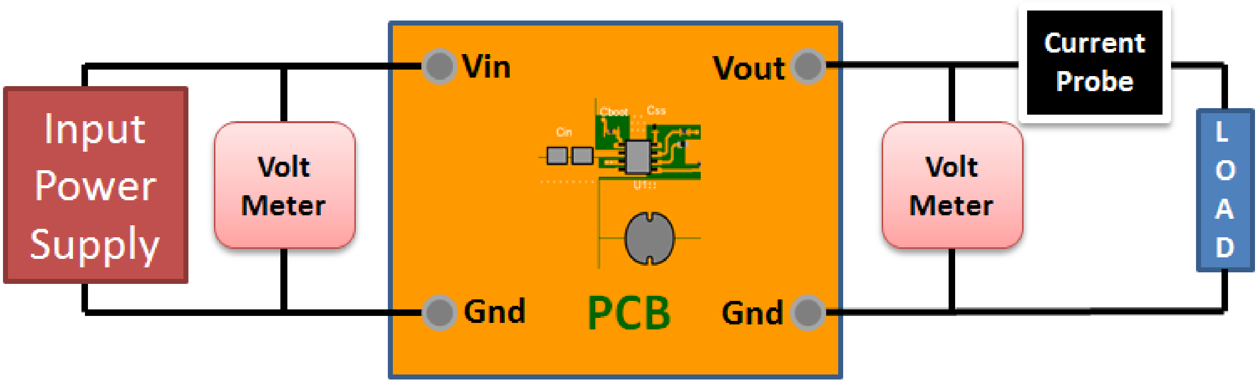
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 3.0V 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 : 84F8F281898B6F10[v1]

2. **TPS61088** Product Folder : http://www.ti.com/product/TPS61088 : contains the data sheet and other resources.

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