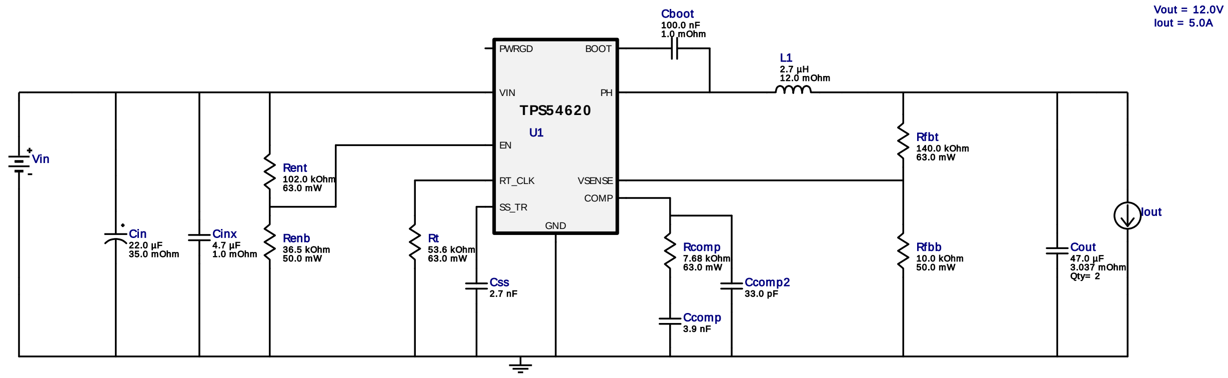
TEXAS INSTRUMENTS

WEBENCH ® Design Report

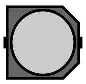
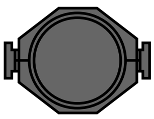
VinMin = 12.8V
VinMax = 16.8V
Vout = 12.0V
Iout = 5.0A

Device = TPS54620RHLR
Topology = Buck
Created = 2020-03-15 16:40:42.623
BOM Cost = $3.62
BOM Count = 16
Total Pd = 2.62W

Design : 129 TPS54620RHLR
TPS54620RHLR 12.8V-16.8V to 12.00V @ 5A

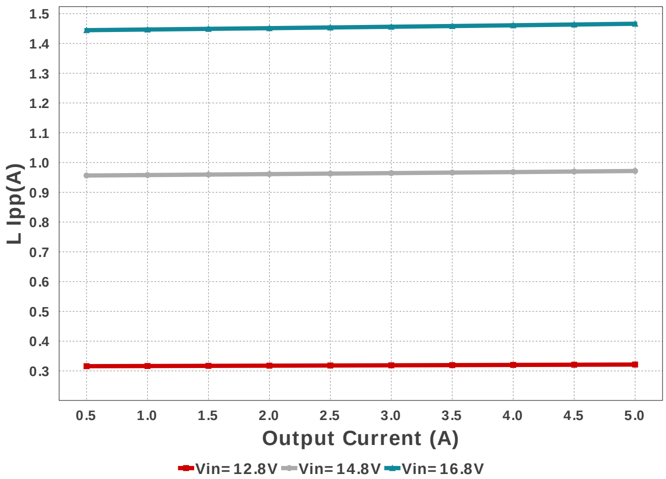


Electrical BOM

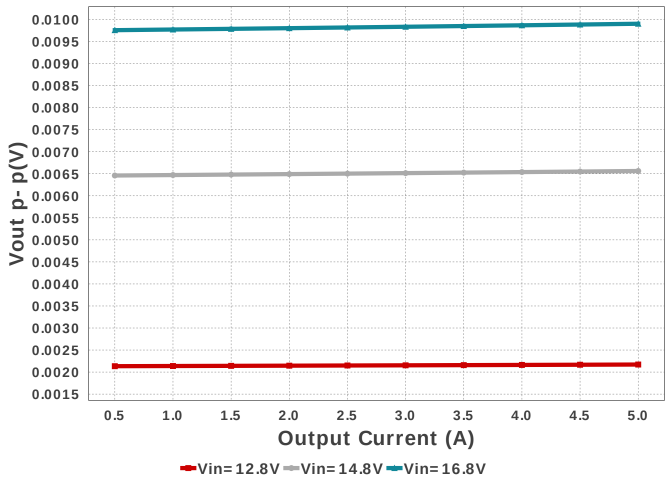
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	Kemet	C0603C104Z3VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Ccomp	TDK	CGA4C2C0G1H392J060AA Series= C0G/NP0	Cap= 3.9 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm²
Ccomp2	Samsung Electro-Mechanics	CL21C330JBANNNC Series= C0G/NP0	Cap= 33.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cin	Panasonic	35SVPF22M Series= SVPF	Cap= 22.0 uF ESR= 35.0 mOhm VDC= 35.0 V IRMS= 2.6 A	1	$0.44	 CAPSMT_62_F61 74 mm²
Cinx	Taiyo Yuden	TMK212BJ475KG-T Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.06	0805 7 mm²
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 mm²
Css	TDK	C2012C0G1H272J060AA Series= C0G/NP0	Cap= 2.7 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.03	0805 7 mm²
L1	NIC Components	NPI31P2R7MTRF	L= 2.7 µH 12.0 mOhm	1	$0.29	 IND_NPI31P 185 mm²
Rcomp	Vishay-Dale	CRCW04027K68FKED Series= CRCW..e3	Res= 7.68 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Renb	Yageo	RC0201FR-0736K5L Series= ?	Res= 36.5 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rent	Vishay-Dale	CRCW0402102KFKED Series= CRCW..e3	Res= 102.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rfbt	Vishay-Dale	CRCW0402140KFKED Series= CRCW..e3	Res= 140.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rt	Vishay-Dale	CRCW040253K6FKED Series= CRCW..e3	Res= 53.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS54620RHLR	Switcher	1	$1.92	S-PVQFN-N14 22 mm^2

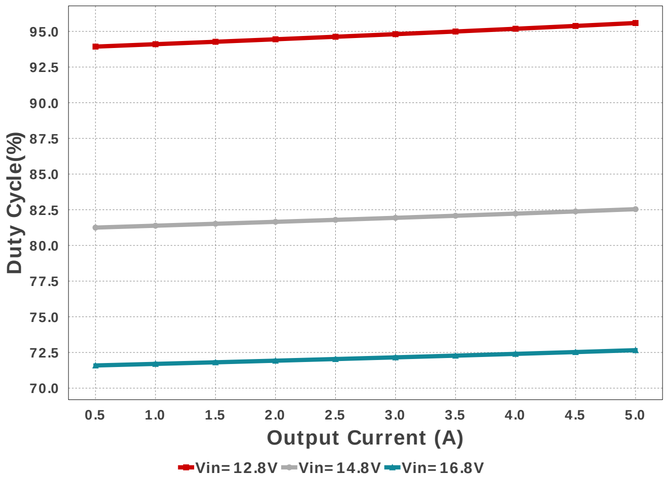
L Ipp



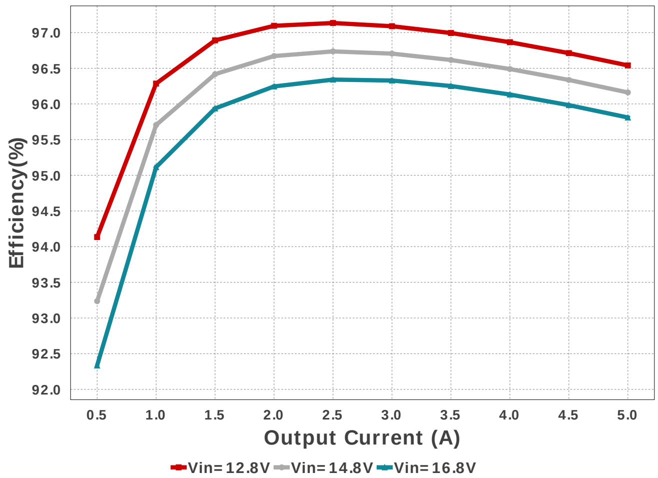
Vout p- p



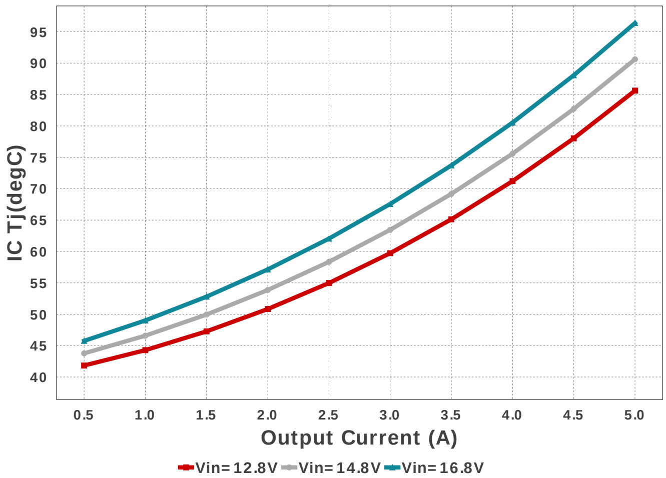
Duty Cycle



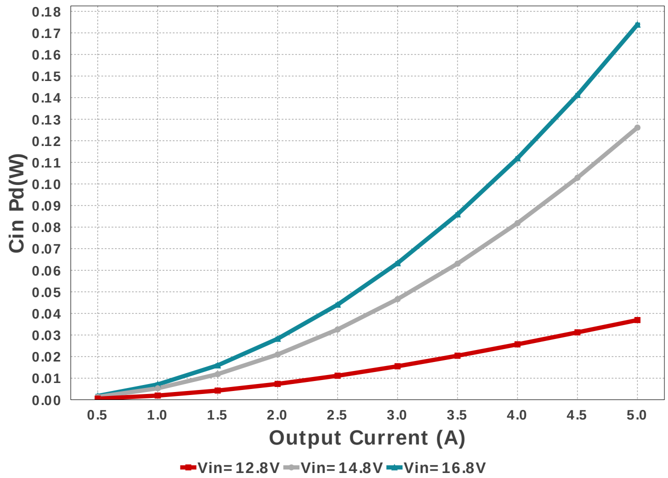
Efficiency



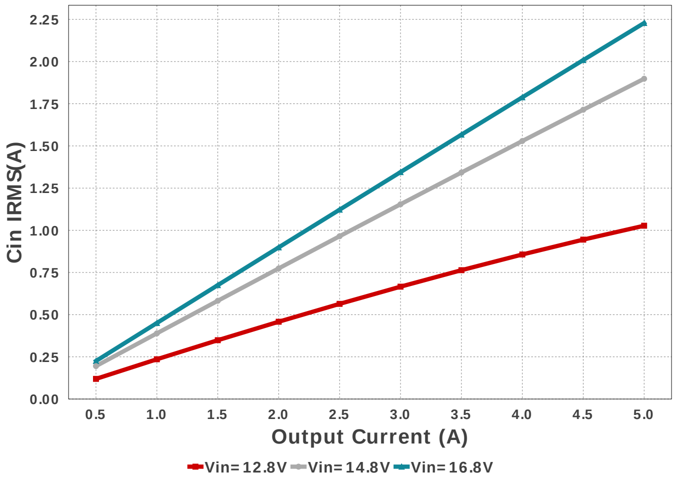
IC Tj



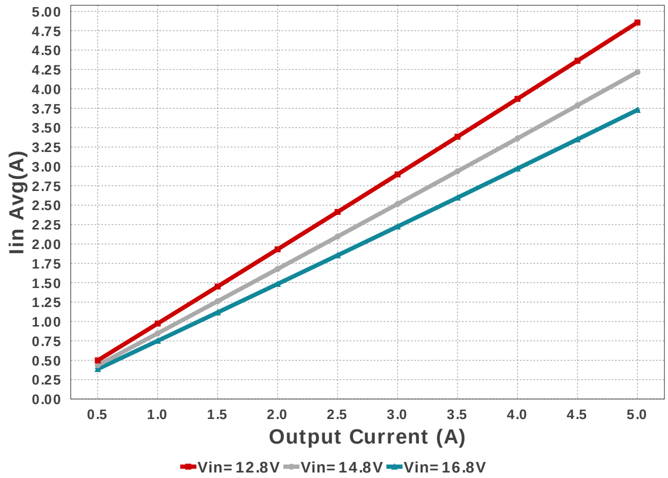
Cin Pd



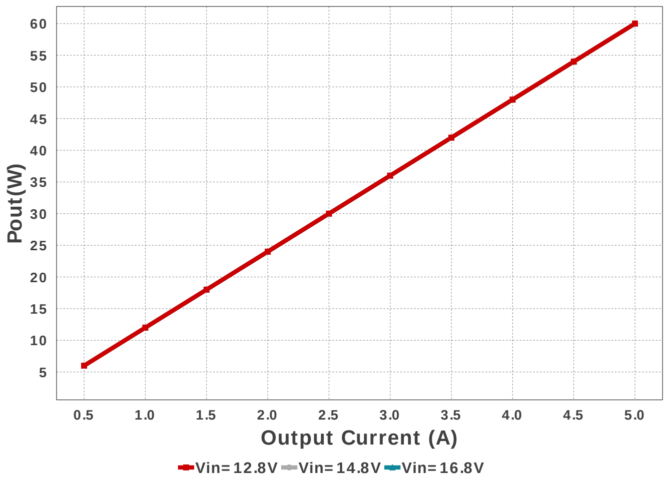
Cin IRMS



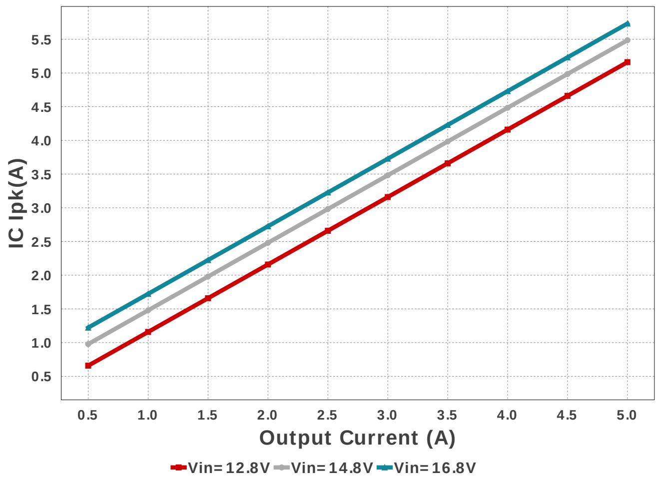
Iin Avg

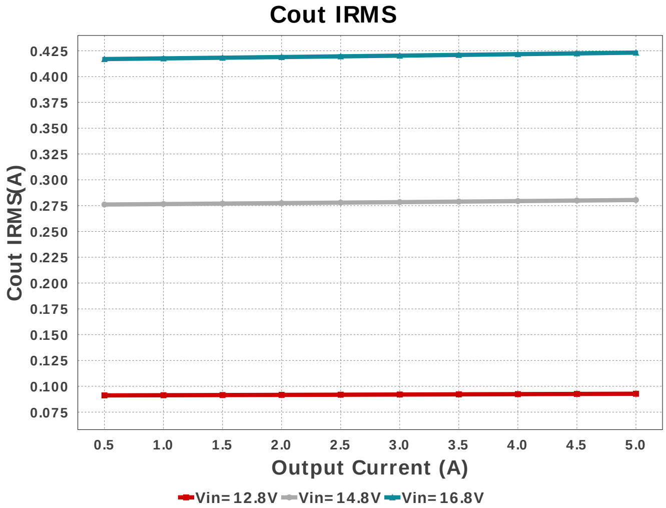


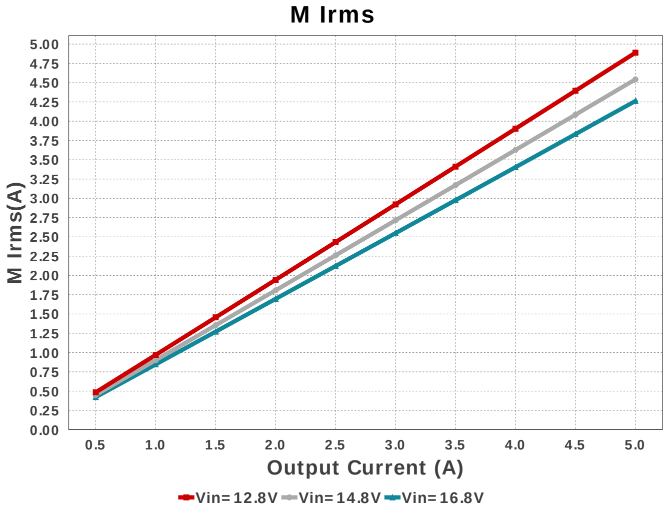
Pout

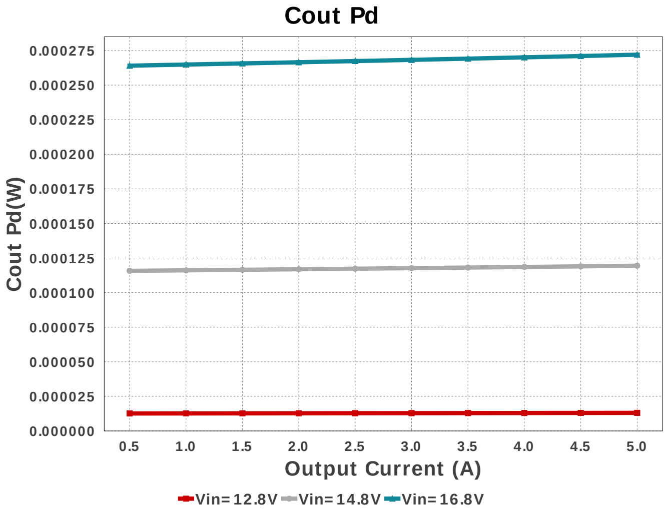


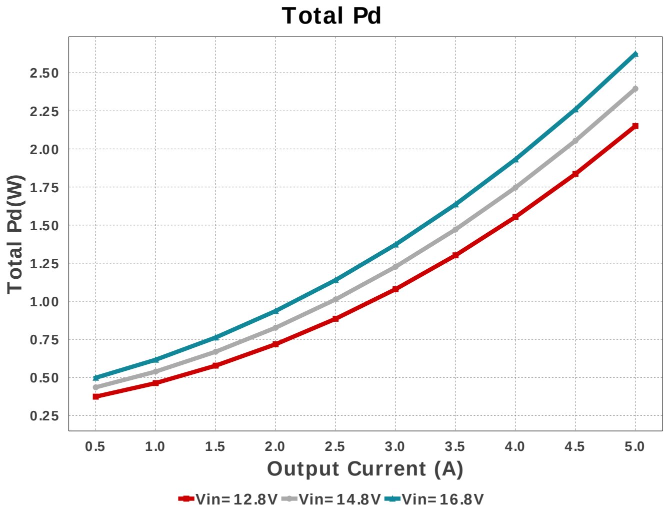
IC Ipk

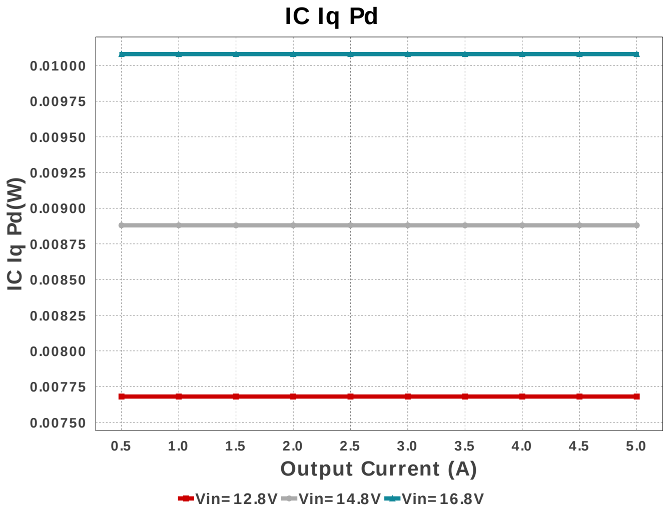


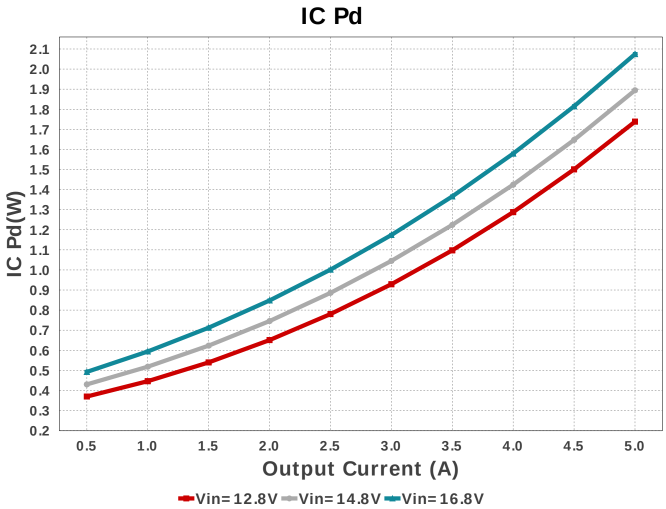

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=12.8V Vin=14.8V Vin=16.8V

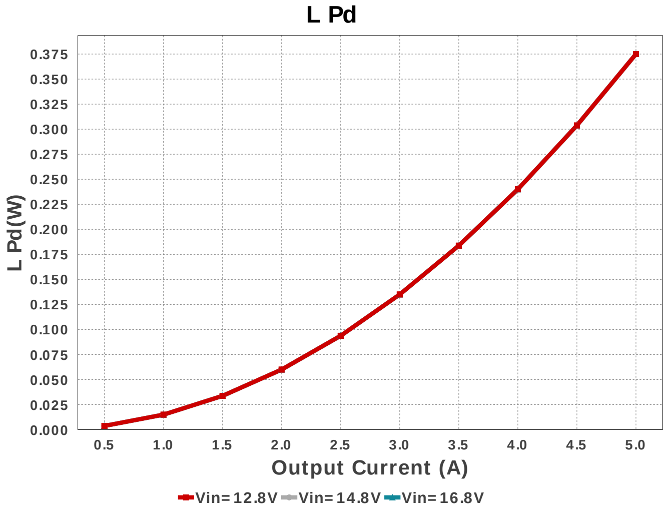

M Irms
M Irms(A)
Output Current (A)
Vin=12.8V Vin=14.8V Vin=16.8V

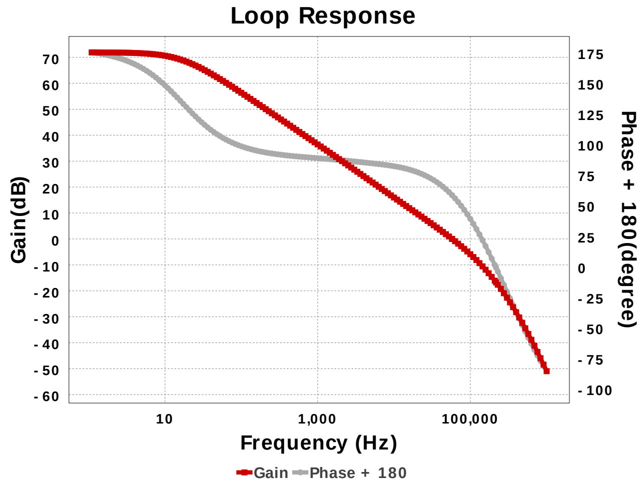

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=12.8V Vin=14.8V Vin=16.8V


Total Pd
Total Pd(W)
Output Current (A)
Vin=12.8V Vin=14.8V Vin=16.8V


IC Iq Pd
IC Iq Pd(W)
Output Current (A)
Vin=12.8V Vin=14.8V Vin=16.8V


IC Pd
IC Pd(W)
Output Current (A)
Vin=12.8V Vin=14.8V Vin=16.8V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	2.229 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	173.82 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	423.234 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	272.0 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	5.733 A	IC	Peak switch current in IC
6.	IC Iq Pd	10.08 mW	IC	IC Iq Pd
7.	IC Pd	2.075 W	IC	IC power dissipation
8.	IC Tj	96.388 degC	IC	IC junction temperature
9.	IC Tolerance	8.0 mV	IC	IC Feedback Tolerance
10.	ICThetaJA	32.0 degC/W	IC	IC junction-to-ambient thermal resistance
11.	Iin Avg	3.728 A	IC	Average input current
12.	L Ipp	1.466 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	375.0 mW	Inductor	Inductor power dissipation
14.	M1 Irms	4.262 A	Mosfet	Q Iavg
15.	Cin Pd	173.82 mW	Power	Input capacitor power dissipation
16.	Cout Pd	272.0 µW	Power	Output capacitor power dissipation
17.	IC Pd	2.075 W	Power	IC power dissipation
18.	L Pd	375.0 mW	Power	Inductor power dissipation
19.	Total Pd	2.624 W	Power	Total Power Dissipation
20.	BOM Count	16	System Information	Total Design BOM count
21.	Cross Freq	57.808 kHz	System Information	Bode plot crossover frequency
22.	Duty Cycle	72.66 %	System Information	Duty cycle
23.	Efficiency	95.81 %	System Information	Steady state efficiency
24.	FootPrint	357.0 mm^2	System Information	Total Foot Print Area of BOM components
25.	Frequency	881.052 kHz	System Information	Switching frequency
26.	Gain Marg	-16.777 dB	System Information	Bode Plot Gain Margin
27.	Iout	5.0 A	System Information	Iout operating point
28.	Low Freq Gain	71.907 dB	System Information	Gain at 1Hz
29.	Mode	CCM	System Information	Conduction Mode
30.	Phase Marg	59.358 deg	System Information	Bode Plot Phase Margin
31.	Pout	60.0 W	System Information	Total output power
32.	Total BOM	$3.62	System Information	Total BOM Cost
33.	Vin	16.8 V	System Information	Vin operating point
34.	Vout	12.0 V	System Information	Operational Output Voltage
35.	Vout Actual	12.0 V	System Information	Vout Actual calculated based on selected voltage divider resistors

#	Name	Value	Category	Description
36.	Vout Tolerance	2.904 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
37.	Vout p-p	9.903 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	5.0	Maximum Output Current
VinMax	16.8	Maximum input voltage
VinMin	12.8	Minimum input voltage
Vout	12.0	Output Voltage
base_pn	TPS54620	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

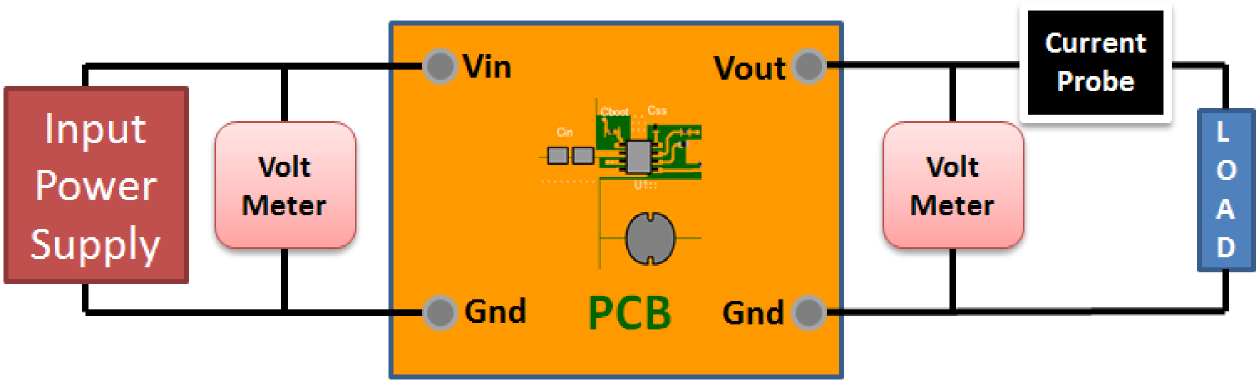
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 12.8V 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 : E86007F5CFD5661C[v1]

2. **TPS54620** Product Folder : http://www.ti.com/product/TPS54620 : contains the data sheet and other resources.

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