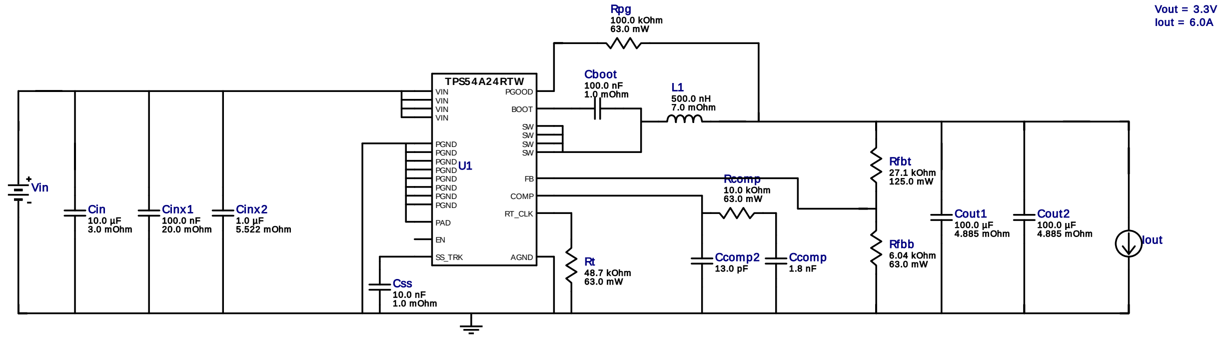
TEXAS INSTRUMENTS

WEBENCH ® Design Report

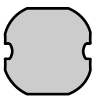
VinMin = 5.0V
VinMax = 5.0V
Vout = 3.3V
Iout = 6.0A

Device = TPS54A24RTWR
Topology = Buck
Created = 2020-10-28 07:45:19.760
BOM Cost = $2.72
BOM Count = 16
Total Pd = 1.41W

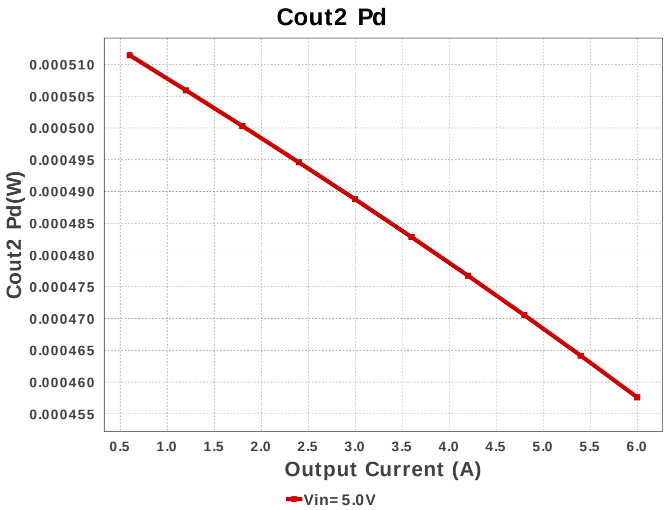
Design : 22 TPS54A24RTWR
TPS54A24RTWR 5V-5V to 3.30V @ 6A

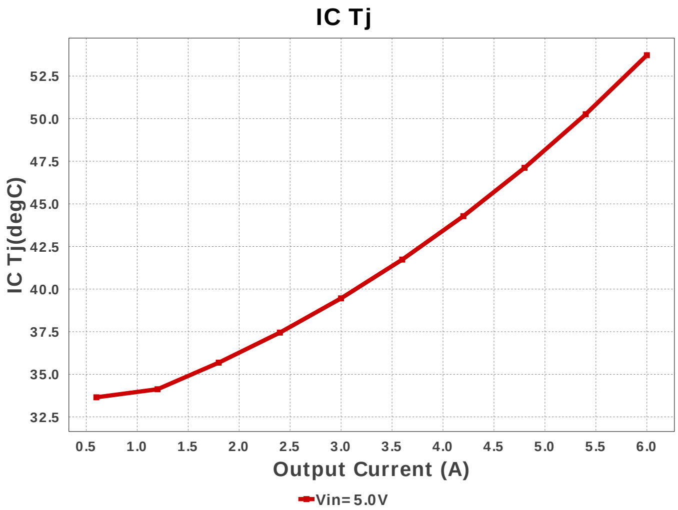


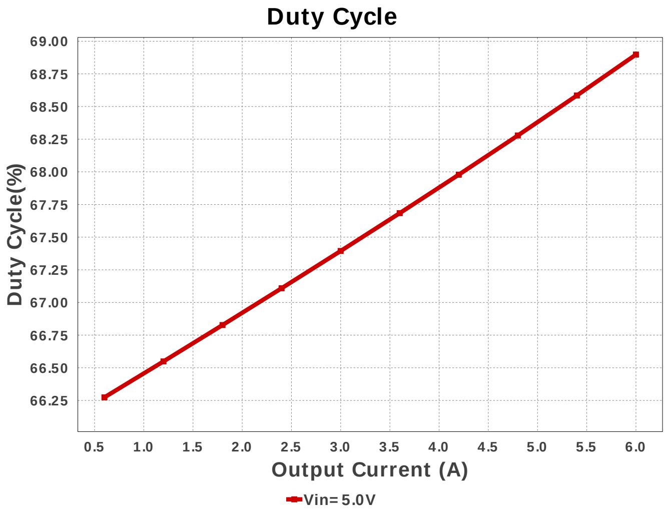
Electrical BOM

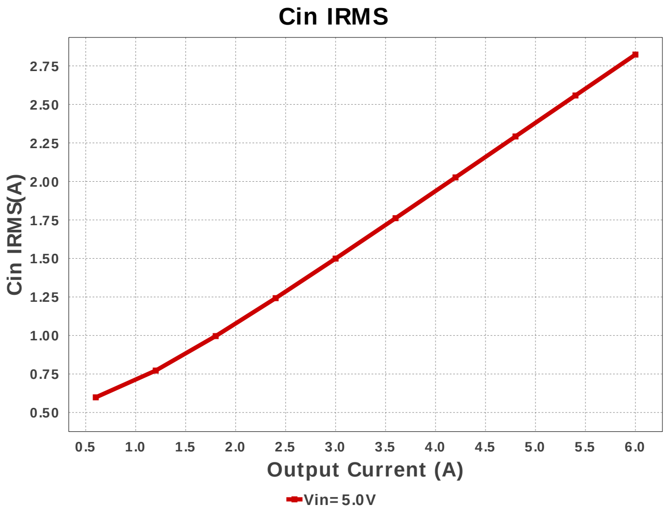
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Ccomp	MuRata	GRM1885C1H182JA01J Series= C0G/NP0	Cap= 1.8 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm²
Ccomp2	Samsung Electro-Mechanics	CL05C130JB5NNNC Series= C0G/NP0	Cap= 13.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cin	Kemet	C0805C106K8PACTU Series= X5R	Cap= 10.0 uF ESR= 3.0 mOhm VDC= 10.0 V IRMS= 11.43 A	1	$0.03	0805 7 mm²
Cinx1	MuRata	GRM188R71H104KA93D Series= X7R	Cap= 100.0 nF ESR= 20.0 mOhm VDC= 50.0 V IRMS= 3.8 A	1	$0.02	0603 5 mm²
Cinx2	TDK	C1608X7R1V105K080AC Series= X7R	Cap= 1.0 uF ESR= 5.522 mOhm VDC= 35.0 V IRMS= 2.2162 A	1	$0.05	0603 5 mm²
Cout1	MuRata	GRM31CR60J107ME39L Series= X5R	Cap= 100.0 uF ESR= 4.885 mOhm VDC= 6.3 V IRMS= 4.4118 A	1	$0.34	1206_190 11 mm²
Cout2	MuRata	GRM31CR60J107ME39L Series= X5R	Cap= 100.0 uF ESR= 4.885 mOhm VDC= 6.3 V IRMS= 4.4118 A	1	$0.34	1206_190 11 mm²
Css	MuRata	GRM155R61A103KA01D Series= X5R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
L1	Bourns	SRN8040-R50Y	L= 500.0 nH 7.0 mOhm	1	$0.27	 SRN8040 100 mm²

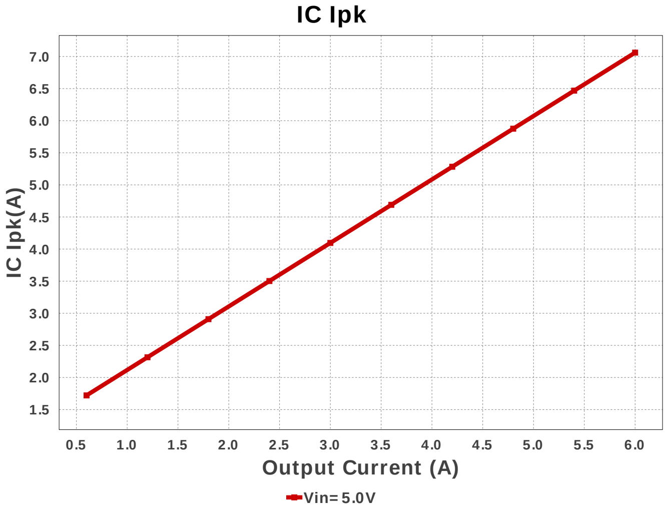
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rcomp	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW04026K04FKED Series= CRCW..e3	Res= 6.04 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Yageo	RT0805BRD0727K1L Series= ?	Res= 27.1 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.06	0805 7 mm^2
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rt	Vishay-Dale	CRCW040248K7FKED Series= CRCW..e3	Res= 48.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS54A24RTWR	Switcher	1	$1.52	RTW0024B 25 mm^2

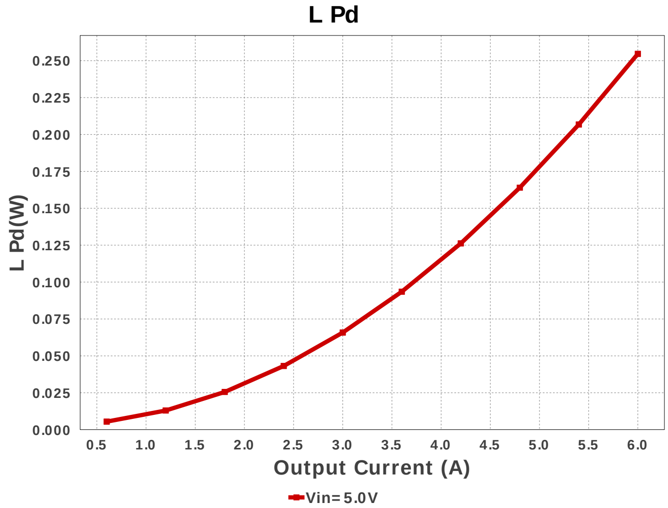


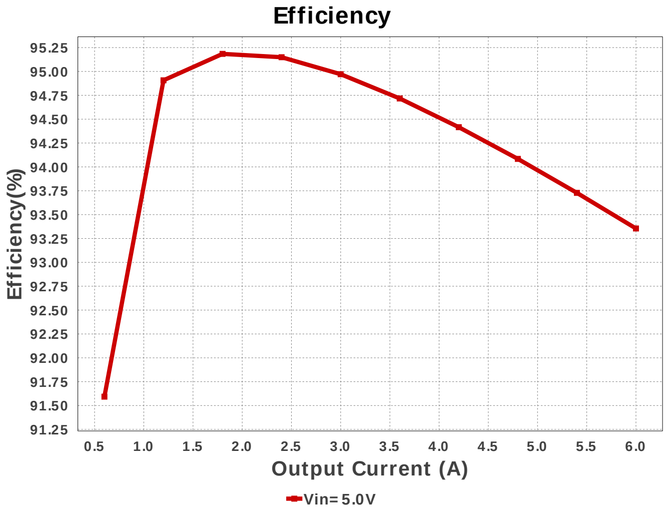


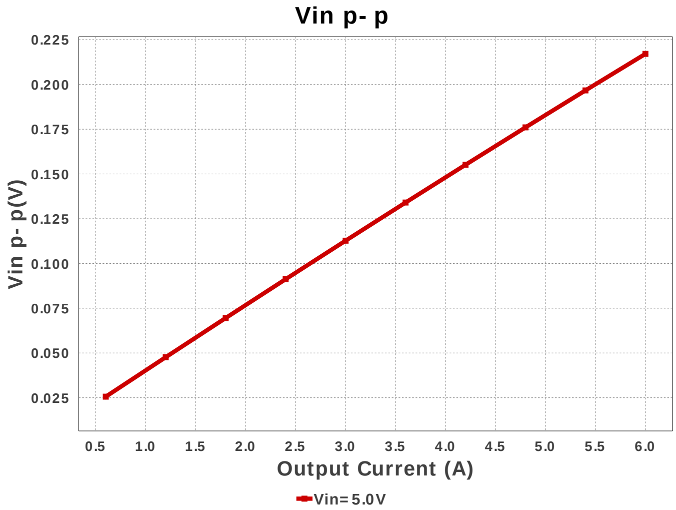


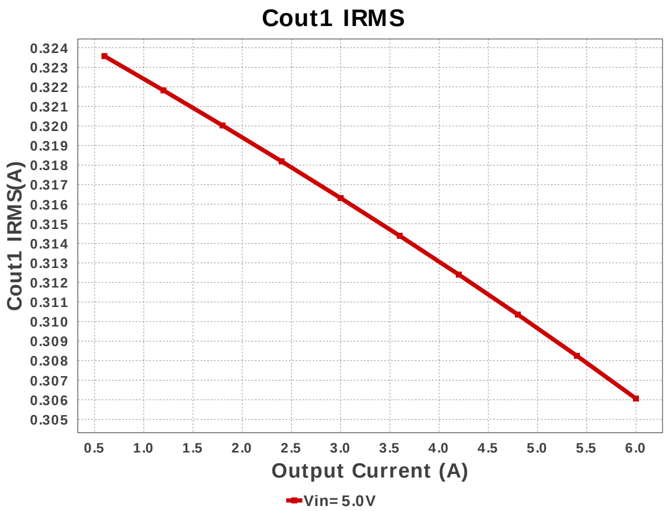


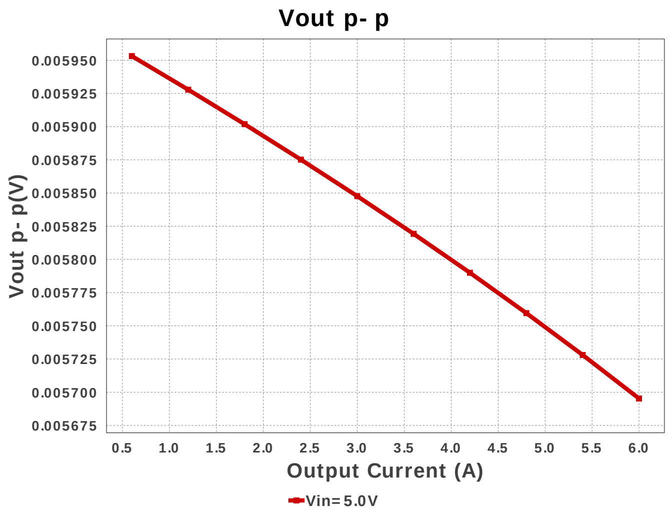

IC Ipk
IC Ipk(A)
Output Current (A)
Vin= 5.0V

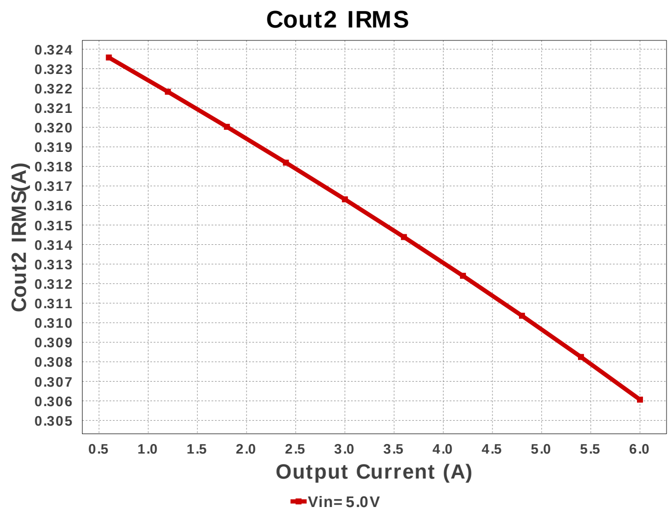

L Pd
L Pd(W)
Output Current (A)
Vin= 5.0V

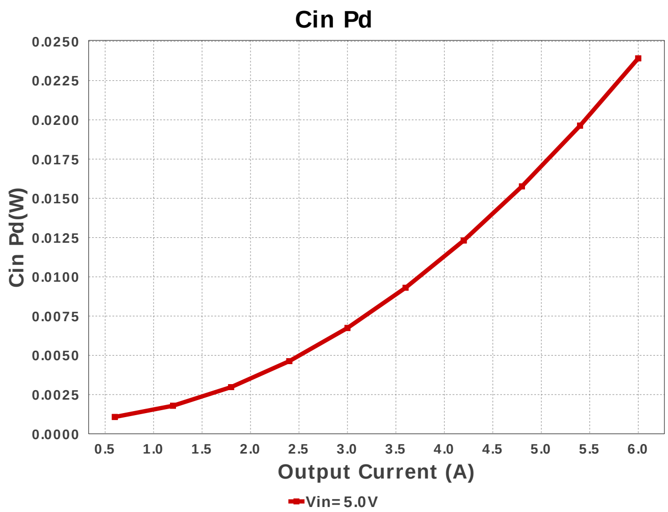

Efficiency
Efficiency(%)
Output Current (A)
Vin= 5.0V

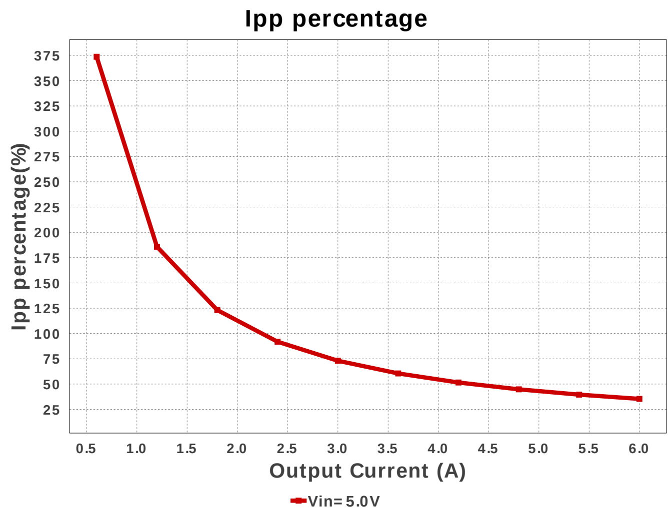

Vin p- p
Vin p- p(V)
Output Current (A)
Vin= 5.0V

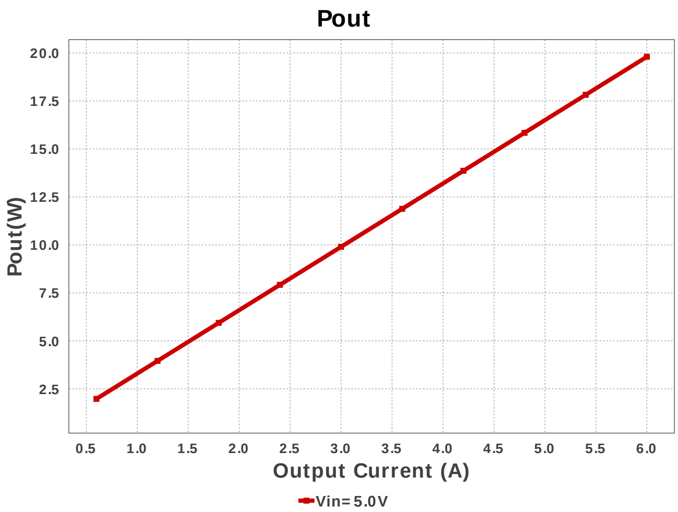

Cout1 IRMS
Cout1 IRMS(A)
Output Current (A)
Vin= 5.0V

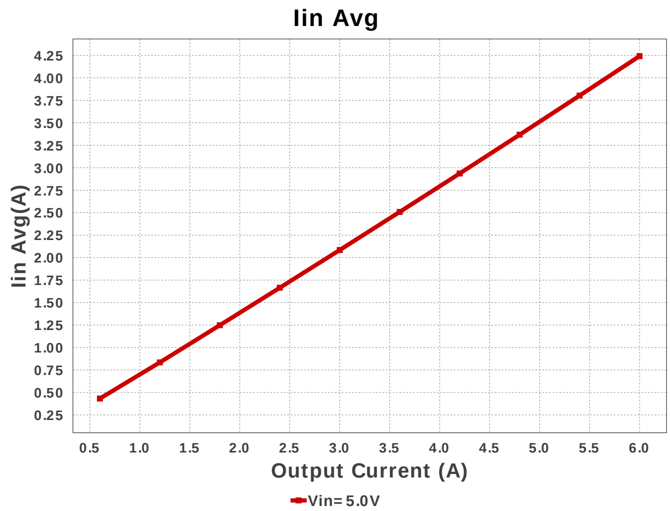

Vout p- p
Vout p- p(V)
Output Current (A)
Vin= 5.0V

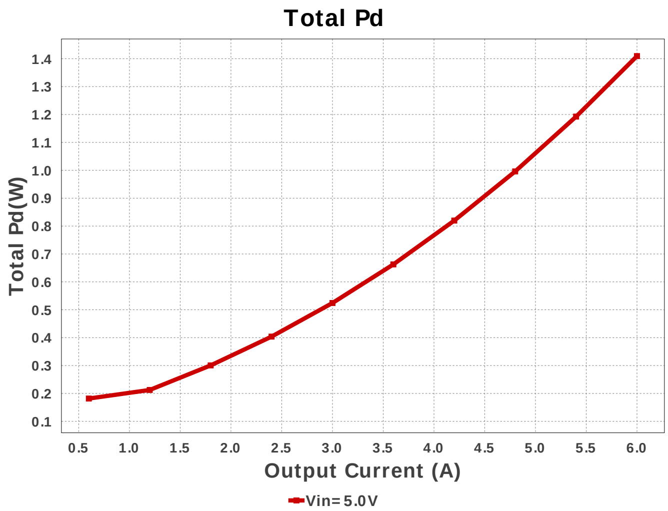

Cout2 IRMS
Cout2 IRMS(A)
Output Current (A)
Vin= 5.0V

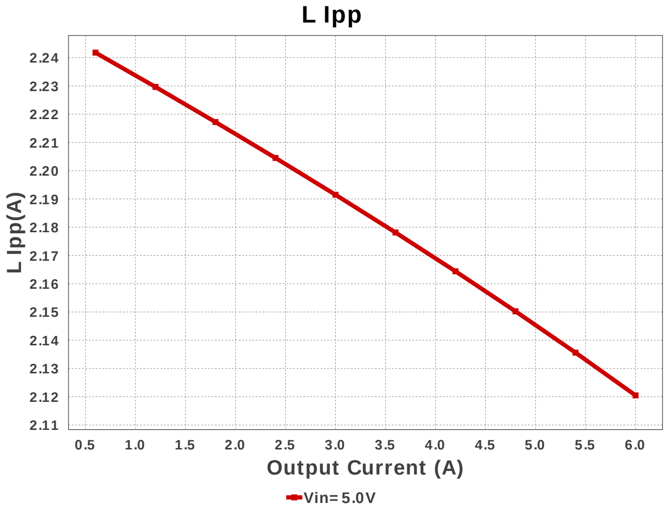

Cin Pd
Cin Pd(W)
Output Current (A)
Vin= 5.0V

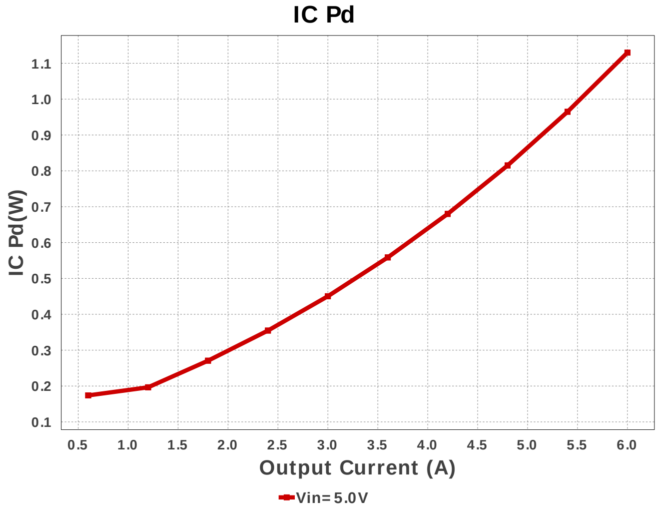

Ipp percentage
Ipp percentage(%)
Output Current (A)
Vin= 5.0V

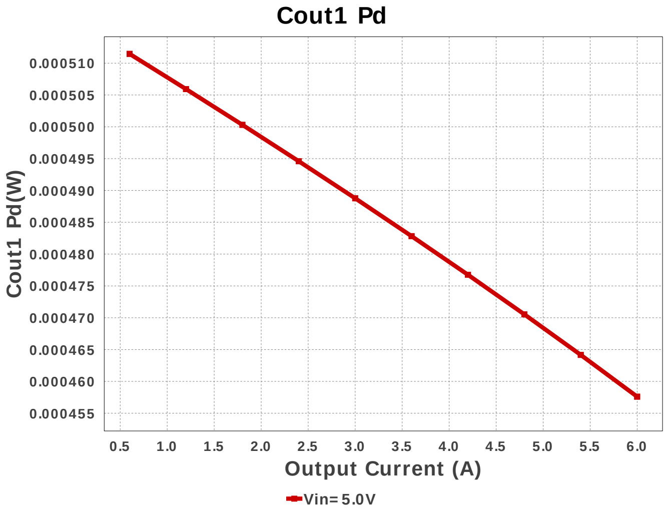

Pout
Pout(W)
Output Current (A)
Vin= 5.0V

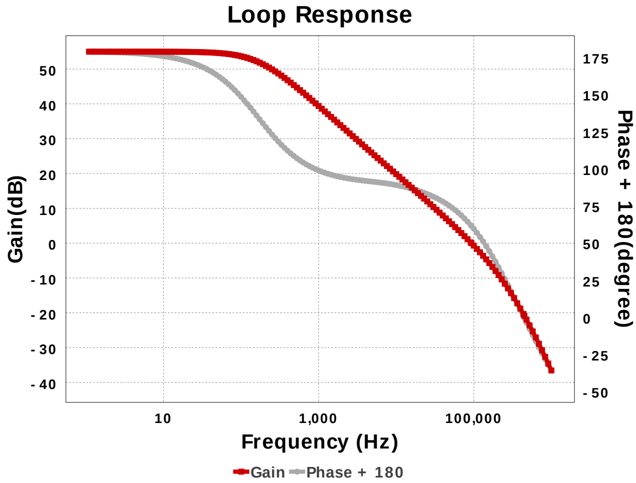

Iin Avg
Iin Avg(A)
Output Current (A)
Vin= 5.0V


Total Pd
Total Pd(W)
Output Current (A)
Vin= 5.0V









Operating Values

#	Name	Value	Category	Description
1.	BOM Count	16		Total Design BOM count
2.	Total BOM	$2.72		Total BOM Cost
3.	Cin IRMS	2.824 A	Capacitor	Input capacitor RMS ripple current
4.	Cin Pd	23.918 mW	Capacitor	Input capacitor power dissipation
5.	Cout1 IRMS	306.065 mA	Capacitor	Output capacitor RMS ripple current
6.	Cout1 Pd	457.6 µW	Capacitor	Output capacitor power dissipation
7.	Cout2 IRMS	306.065 mA	Capacitor	Output capacitor RMS ripple current
8.	Cout2 Pd	457.6 µW	Capacitor	Output capacitor power dissipation
9.	IC Ipk	7.06 A	IC	Peak switch current in IC
10.	IC Pd	1.13 W	IC	IC power dissipation
11.	IC Tj	53.724 degC	IC	IC junction temperature
12.	ICThetaJA Effective	21.0 degC/W	IC	Effective IC Junction-to-Ambient Thermal Resistance
13.	Iin Avg	4.242 A	IC	Average input current
14.	Ipp percentage	35.341 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
15.	L Ipp	2.12 A	Inductor	Peak-to-peak inductor ripple current
16.	L Pd	254.62 mW	Inductor	Inductor power dissipation
17.	Cin Pd	23.918 mW	Power	Input capacitor power dissipation
18.	Cout1 Pd	457.6 µW	Power	Output capacitor power dissipation
19.	Cout2 Pd	457.6 µW	Power	Output capacitor power dissipation
20.	IC Pd	1.13 W	Power	IC power dissipation
21.	L Pd	254.62 mW	Power	Inductor power dissipation
22.	Total Pd	1.409 W	Power	Total Power Dissipation
23.	Cross Freq	93.313 kHz	System Information	Bode plot crossover frequency
24.	Duty Cycle	68.898 %	System Information	Duty cycle
25.	Efficiency	93.355 %	System Information	Steady state efficiency
26.	FootPrint	195.0 mm^2	System Information	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
27.	Frequency	995.676 kHz	System Information	Switching frequency
28.	Gain Marg	-20.868 dB	System Information	Bode Plot Gain Margin
29.	Iout	6.0 A	System Information	Iout operating point
30.	Low Freq Gain	54.999 dB	System Information	Gain at 1Hz
31.	Mode	CCM	System Information	Conduction Mode
32.	Phase Marg	62.241 deg	System Information	Bode Plot Phase Margin
33.	Pout	19.8 W	System Information	Total output power
34.	Vin	5.0 V	System Information	Vin operating point
35.	Vin p-p	217.073 mV	System Information	Peak-to-peak input voltage
36.	Vout	3.3 V	System Information	Operational Output Voltage
37.	Vout Actual	3.292 V	System Information	Vout Actual calculated based on selected voltage divider resistors
38.	Vout Tolerance	1.75 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
39.	Vout p-p	5.695 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	6.0	Maximum Output Current
VinMax	5.0	Maximum input voltage
VinMin	5.0	Minimum input voltage
VinTyp	5.0	Typical input voltage
Vout	3.3	Output Voltage
base_pn	TPS54A24	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

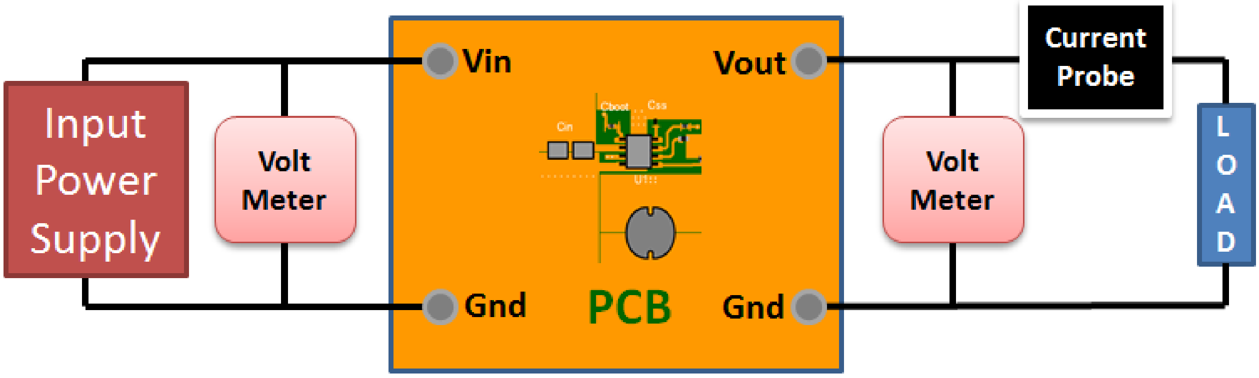
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 5.0V 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 : 24CF39F1B9722FBB[v1]

2. **TPS54A24** Product Folder : http://www.ti.com/product/TPS54A24 : contains the data sheet and other resources.