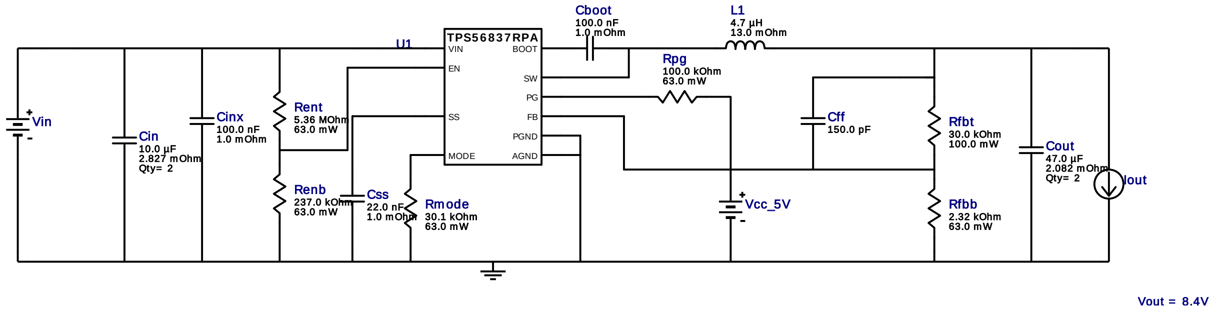
WEBENCH ® Design Report

VinMin = 24.0V
VinMax = 24.0V
Vout = 8.4V
Iout = 6.0A

Device = TPS56837HRPAR
Topology = Buck
Created = 2025-01-23 14:16:48.085
BOM Cost = $3.59
BOM Count = 17
Total Pd = 2.38W

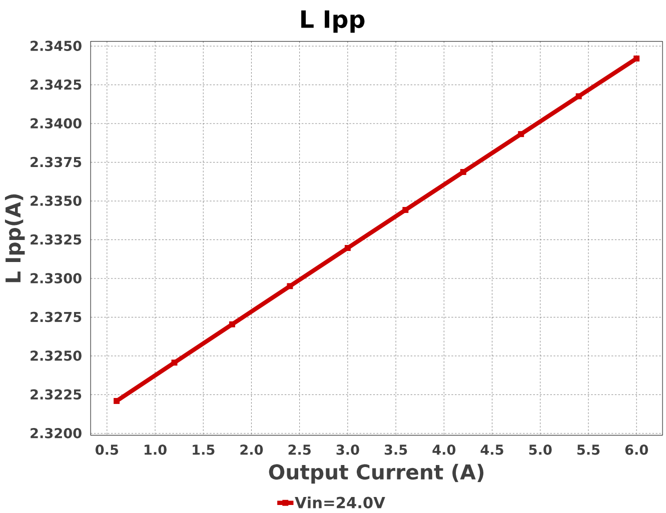
Design : 47 TPS56837HRPAR
TPS56837HRPAR 24V-24V to 8.40V @ 6A

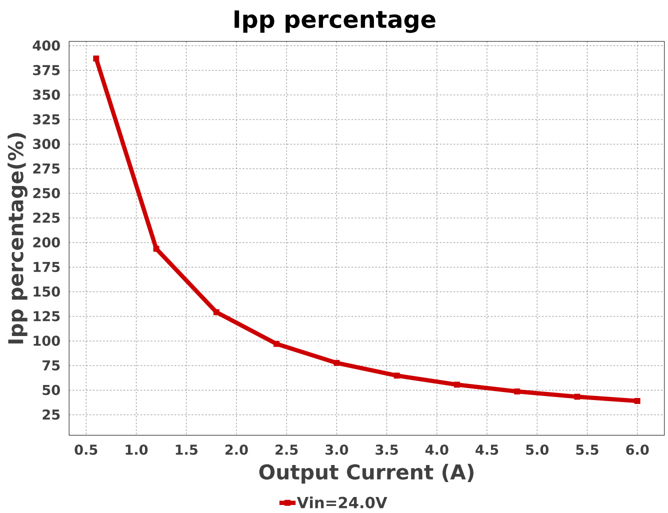


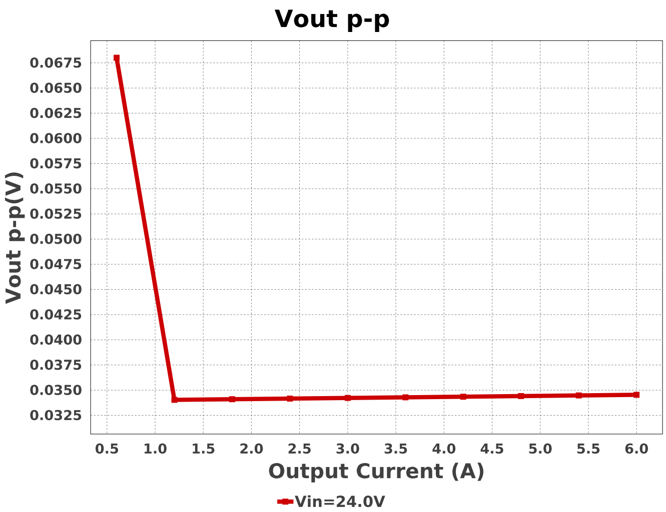
Electrical BOM

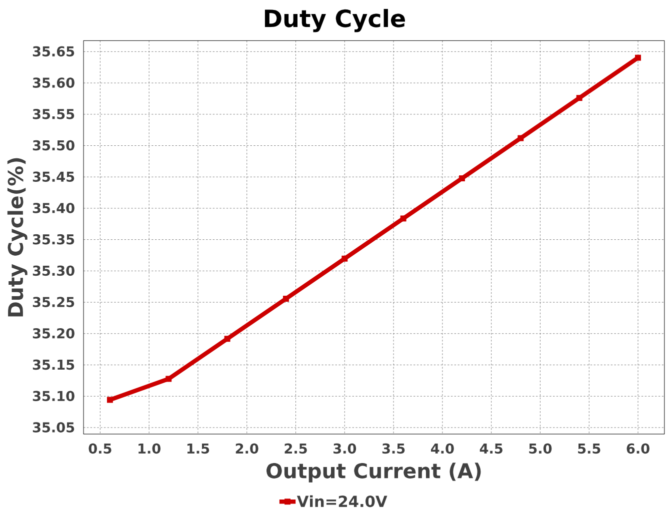
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cboot	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cff	Kemet	C0603C151K3GACTU Series= C0G/NP0	Cap= 150.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0603 5 mm²
Cin	TDK	CGA6P3X7S1H106K250AB Series= X7S	Cap= 10.0 uF ESR= 2.827 mOhm VDC= 50.0 V IRMS= 4.3729 A	2	$0.31	1210_280 15 mm²
Cinx	MuRata	GRM21BR71H104KA01L Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 3.85 A	1	$0.03	0805 7 mm²
Cout	TDK	C3216X5R1E476M160AC Series= X5R	Cap= 47.0 uF ESR= 2.082 mOhm VDC= 25.0 V IRMS= 5.0279 A	2	$0.35	1206 11 mm²
Css	MuRata	GRM155R71C223KA01D Series= X7R	Cap= 22.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
L1	Coilcraft	XAL7070-472MEB	L= 4.7 µH 13.0 mOhm	1	$1.19	XAL7070 87 mm²
Renb	Vishay-Dale	CRCW0402237KFKED Series= CRCW..e3	Res= 237.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rent	Vishay-Dale	CRCW04025M36FKED Series= CRCW..e3	Res= 5.36 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Vishay-Dale	CRCW04022K32FKED Series= CRCW..e3	Res= 2.32 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

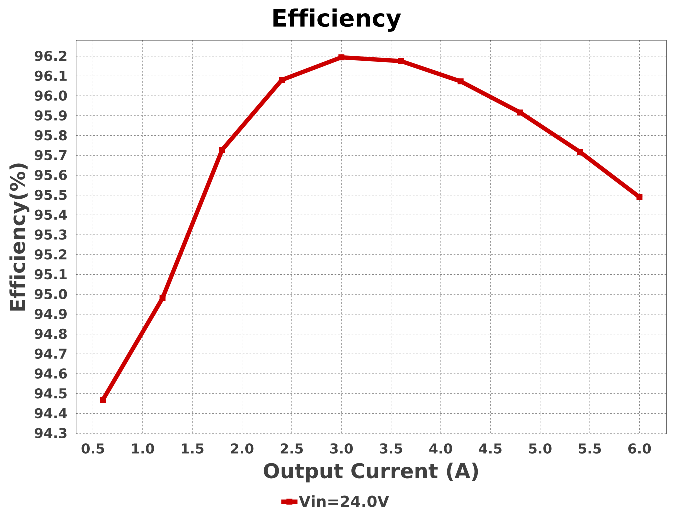
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbt	Yageo	RC0603FR-0730KL Series= ?	Res= 30.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
Rmode	Vishay-Dale	CRCW040230K1FKED Series= CRCW..e3	Res= 30.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	TPS56837HRPAR	Switcher	1	$0.92	RPA0010A 16 mm^2

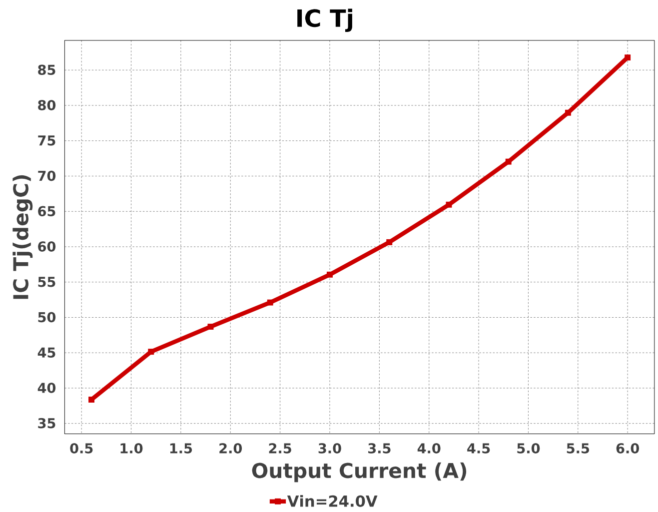


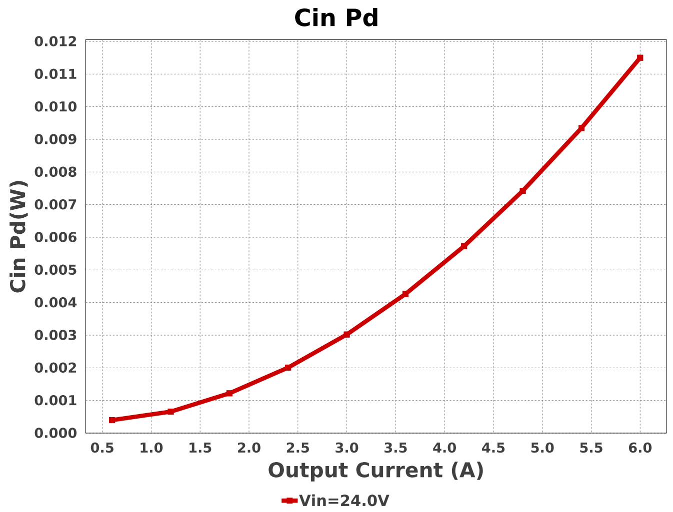


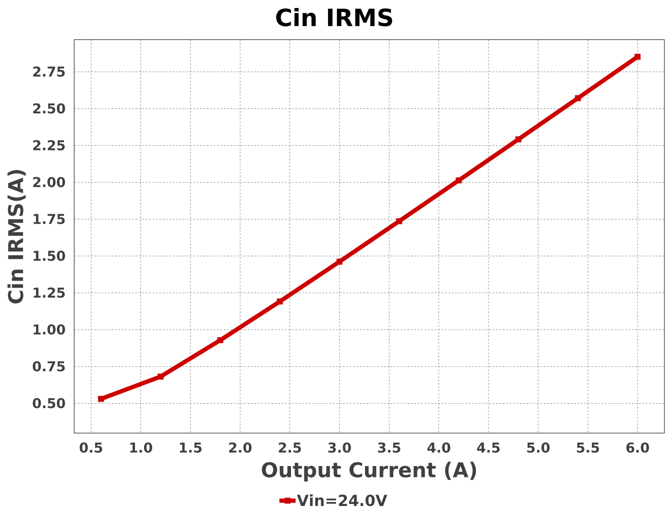


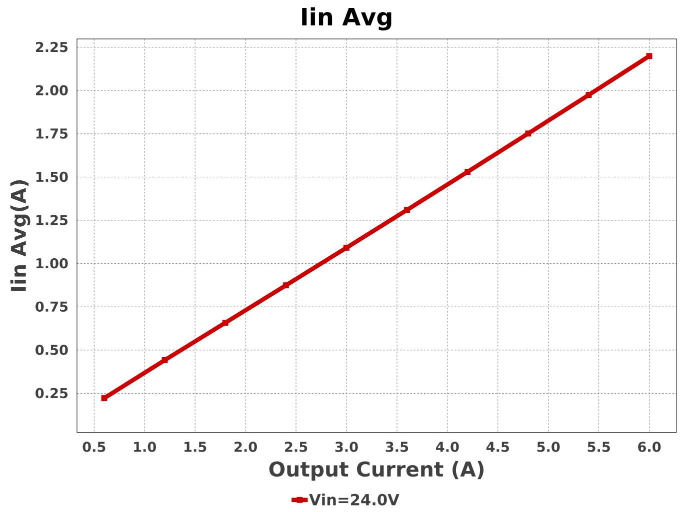


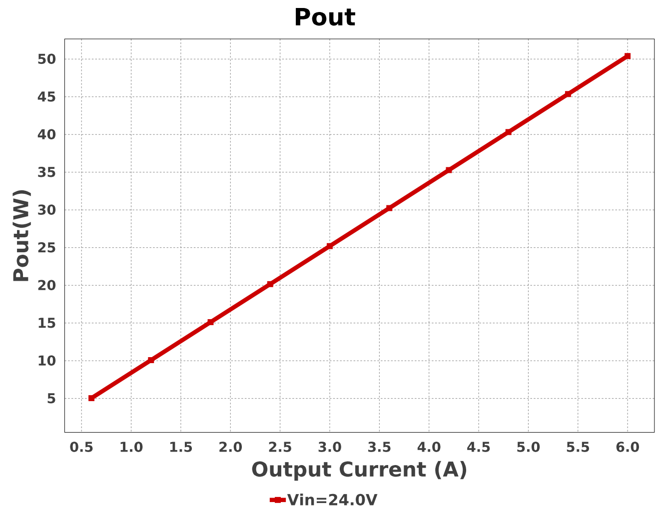

Efficiency
Efficiency(%)
96.2
96.1
96.0
95.9
95.8
95.7
95.6
95.5
95.4
95.3
95.2
95.1
95.0
94.9
94.8
94.7
94.6
94.5
94.4
94.3
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V

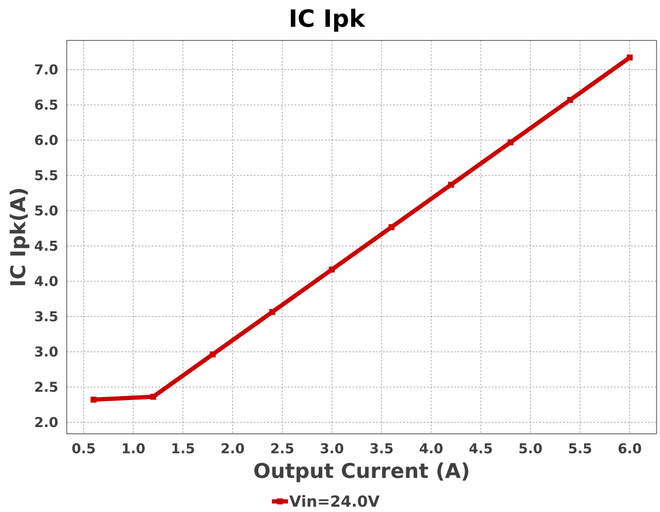

IC Tj
IC Tj(degC)
85
80
75
70
65
60
55
50
45
40
35
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V

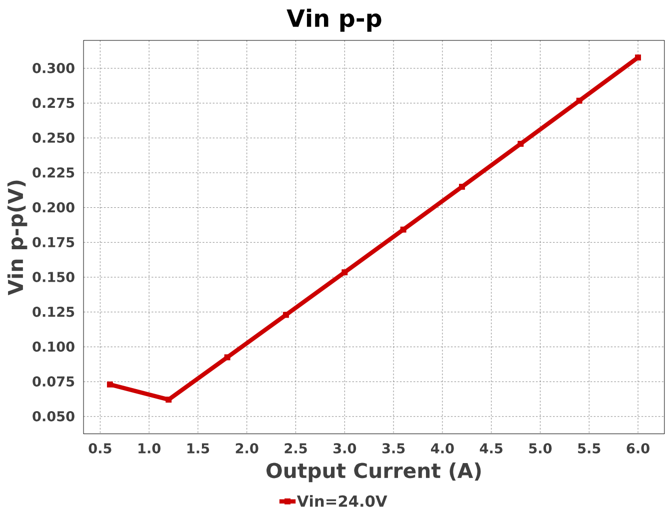

Cin Pd
Cin Pd(W)
0.012
0.011
0.010
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V

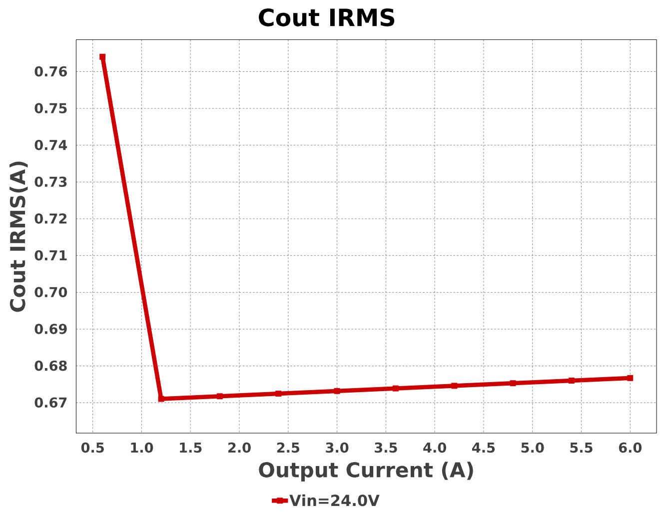

Cin IRMS
Cin IRMS(A)
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V

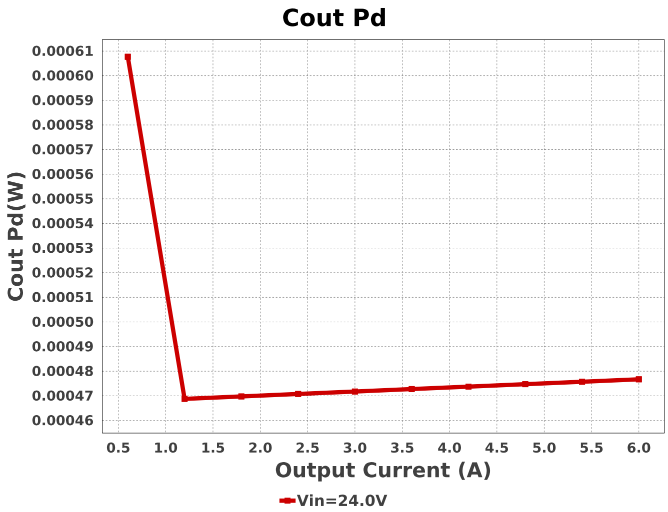

Iin Avg
Iin Avg(A)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V

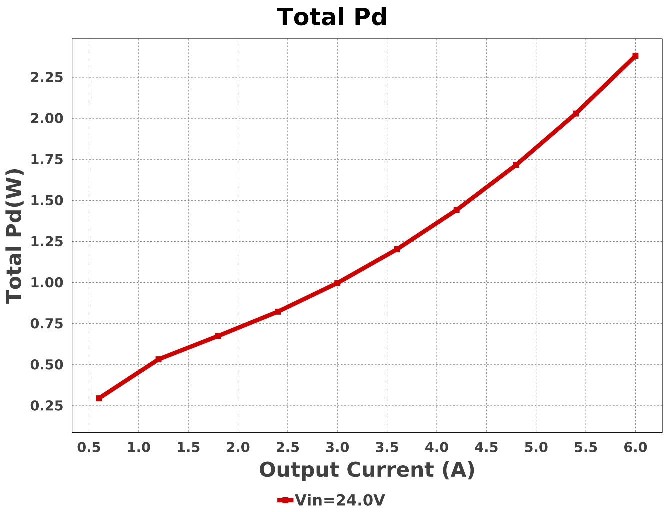

Pout
Pout(W)
50
45
40
35
30
25
20
15
10
5
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V

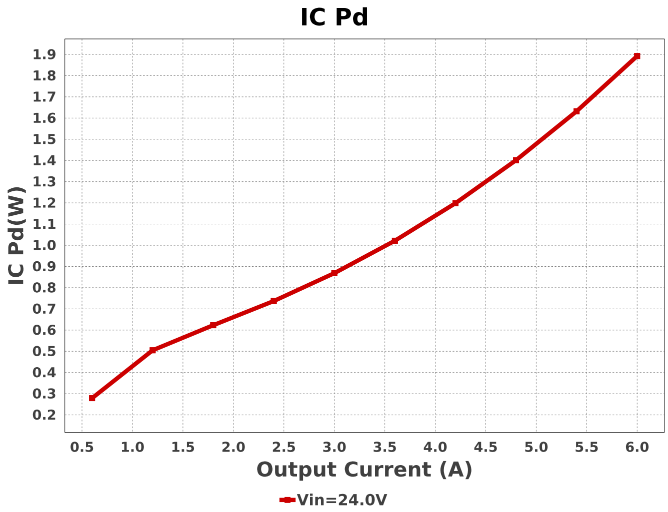

IC Ipk
IC Ipk(A)
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V

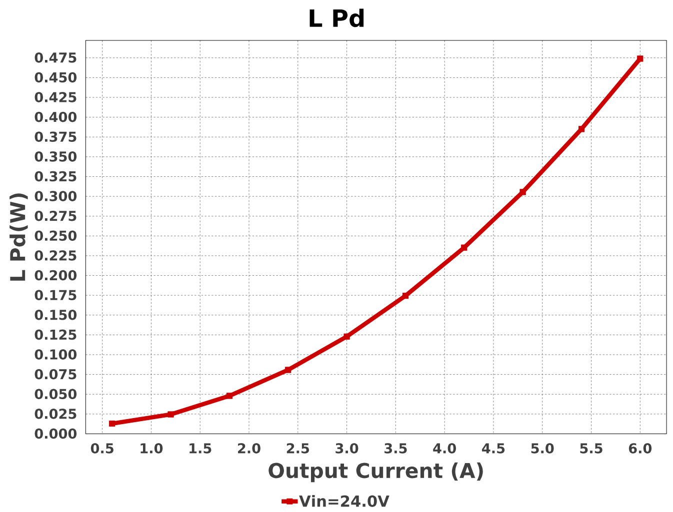

Vin p-p
Vin p-p(V)
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V

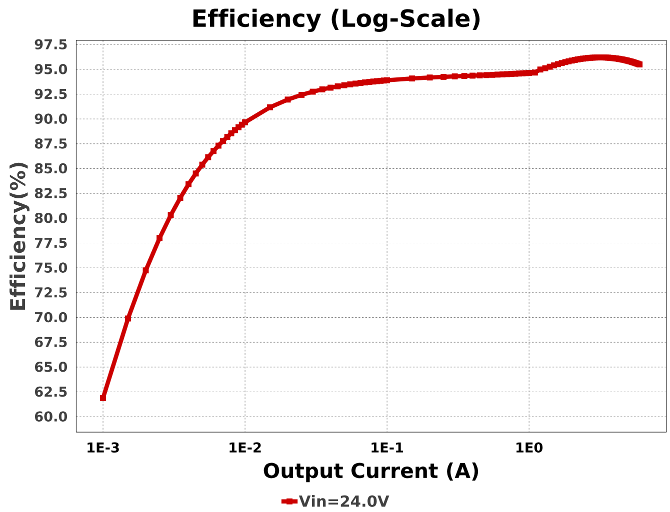

Cout IRMS
Cout IRMS(A)
0.76
0.75
0.74
0.73
0.72
0.71
0.70
0.69
0.68
0.67
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V


Cout Pd
Cout Pd(W)
0.00061
0.00060
0.00059
0.00058
0.00057
0.00056
0.00055
0.00054
0.00053
0.00052
0.00051
0.00050
0.00049
0.00048
0.00047
0.00046
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V


Total Pd
Total Pd(W)
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V


IC Pd
IC Pd(W)
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0 5.5 6.0
Output Current (A)
Vin=24.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	2.852 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	11.499 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	676.712 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	476.71 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	7.172 A	IC	Peak switch current in IC
6.	IC Pd	1.892 W	IC	IC power dissipation
7.	IC Tj	86.776 degC	IC	IC junction temperature
8.	IC Tolerance	6.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	30.0 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	2.199 A	IC	Average input current
11.	Ipp percentage	39.07 %	Inductor	Inductor ripple current percentage (with respect to average inductor current)
12.	L Ipp	2.344 A	Inductor	Peak-to-peak inductor ripple current
13.	L Pd	473.95 mW	Inductor	Inductor power dissipation
14.	Cin Pd	11.499 mW	Power	Input capacitor power dissipation
15.	Cout Pd	476.71 µW	Power	Output capacitor power dissipation
16.	IC Pd	1.892 W	Power	IC power dissipation
17.	L Pd	473.95 mW	Power	Inductor power dissipation
18.	Total Pd	2.38 W	Power	Total Power Dissipation
19.	BOM Count	17	System Information	Total Design BOM count
20.	Duty Cycle	35.64 %	System Information	Duty cycle
21.	Efficiency	95.49 %	System Information	Steady state efficiency
22.	FootPrint	206.0 mm^2	System Information	Total Foot Print Area of BOM components
23.	Frequency	463.938 kHz	System Information	Switching frequency
24.	Iout	6.0 A	System Information	Iout operating point
25.	Mode	CCM	System Information	Conduction Mode
26.	Pout	50.4 W	System Information	Total output power
27.	Total BOM	$3.59	System Information	Total BOM Cost
28.	Vin	24.0 V	System Information	Vin operating point
29.	Vin p-p	307.752 mV	System Information	Peak-to-peak input voltage
30.	Vout	8.4 V	System Information	Operational Output Voltage
31.	Vout Actual	8.359 V	System Information	Vout Actual calculated based on selected voltage divider resistors
32.	Vout Tolerance	2.894 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
33.	Vout p-p	34.538 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	6.0	Maximum Output Current
SoftStart	2.2 ms	Soft Start Time (ms)
VinMax	24.0	Maximum input voltage
VinMin	24.0	Minimum input voltage
Vout	8.4	Output Voltage
base_pn	TPS56837H	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

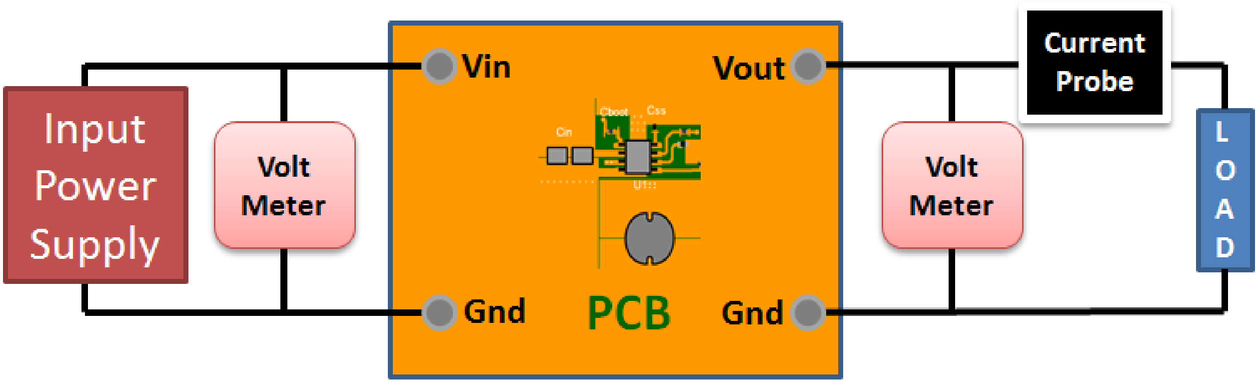
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 24.0V 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 : F99F3073C415E694101A56F6FF7B20CC[v1]

2. **TPS56837H** Product Folder : http://www.ti.com/product/TPS56837H : contains the data sheet and other resources.

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