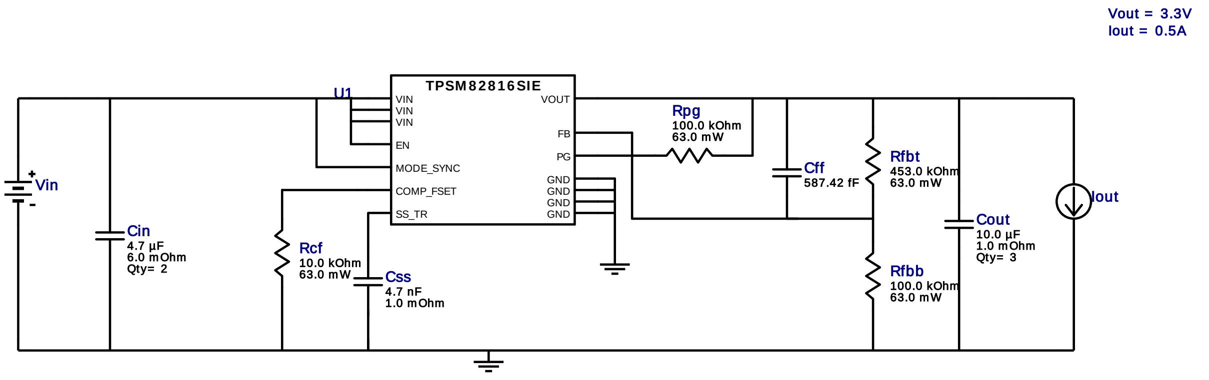
WEBENCH® Design Report

VinMin = 3.4V
VinMax = 6.0V
Vout = 3.3V
Iout = 0.5A

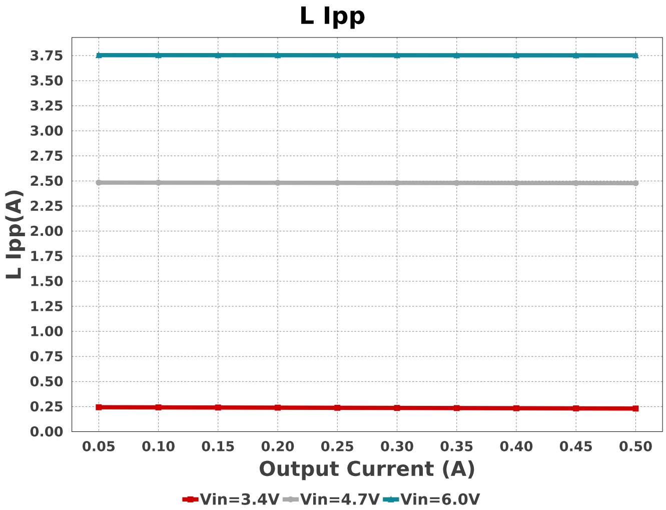
Device = TPSM82816SIER
Topology = Buck
Created = 2023-09-12 10:55:44.902
BOM Cost = NA
BOM Count = 12
Total Pd = 0.39W

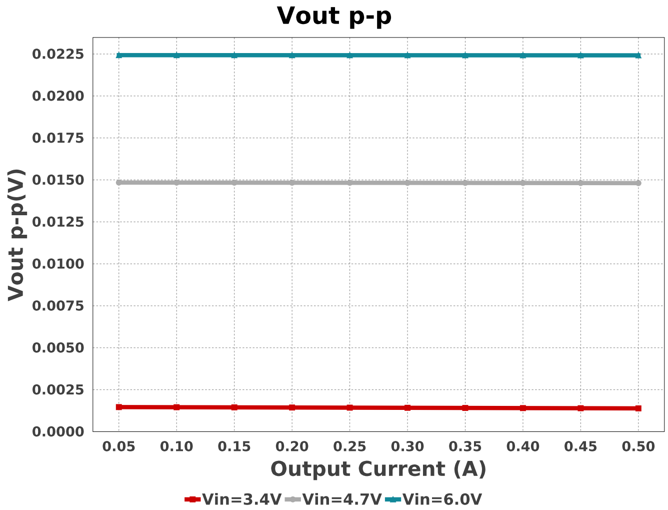
Design : 935 TPSM82816SIER
TPSM82816SIER 5V-6V to 3.30V @ 0.5A

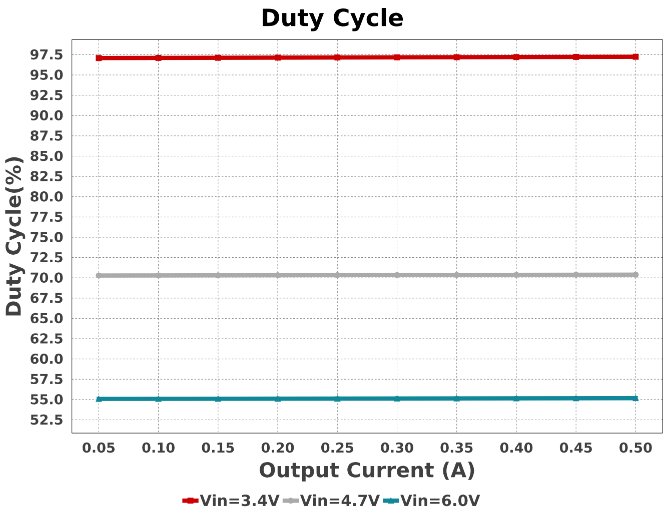


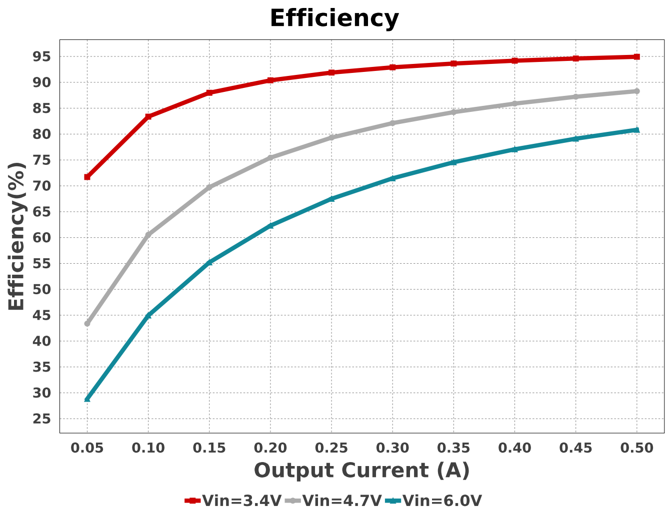
Electrical BOM

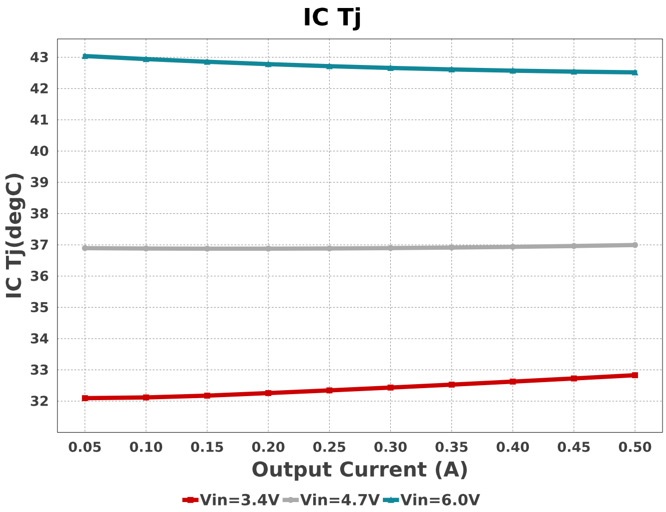
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cff	CUSTOM	CUSTOM Series= ?	Cap= 587.42 fF VDC= 10.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm²
Cin	Kemet	C0603C475K8PACTU Series= X5R	Cap= 4.7 uF ESR= 6.0 mOhm VDC= 10.0 V IRMS= 7.24 A	2	$0.07	0603 5 mm²
Cout	MuRata	GRM155R60J106ME15D Series= X5R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 3.52 A	3	$0.03	0402 3 mm²
Css	Kemet	C0603C472K5RACTU Series= X7R	Cap= 4.7 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²
Rcf	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	Vishay-Dale	CRCW0402453KFKED Series= CRCW..e3	Res= 453.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rpg	Vishay-Dale	CRCW0402100KFKED Series= CRCW..e3	Res= 100.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
U1	Texas Instruments	TPSM82816SIER	Switcher	1	$2.05	SIE0014A 20 mm²

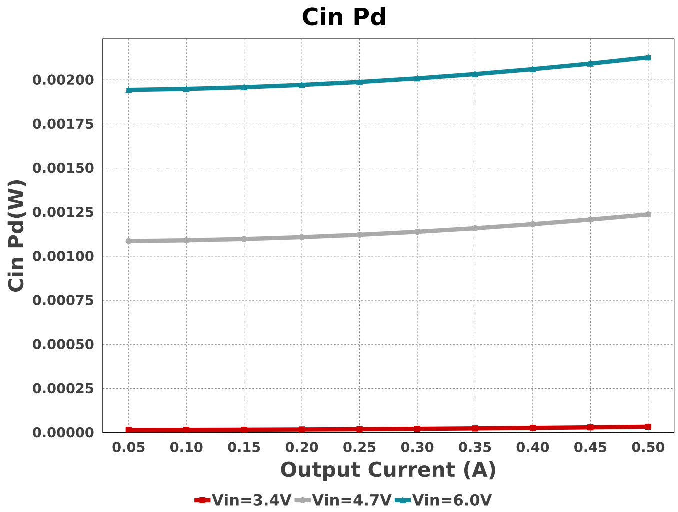

L Ipp
L Ipp(A)
Output Current (A)
Vin=3.4V
Vin=4.7V
Vin=6.0V

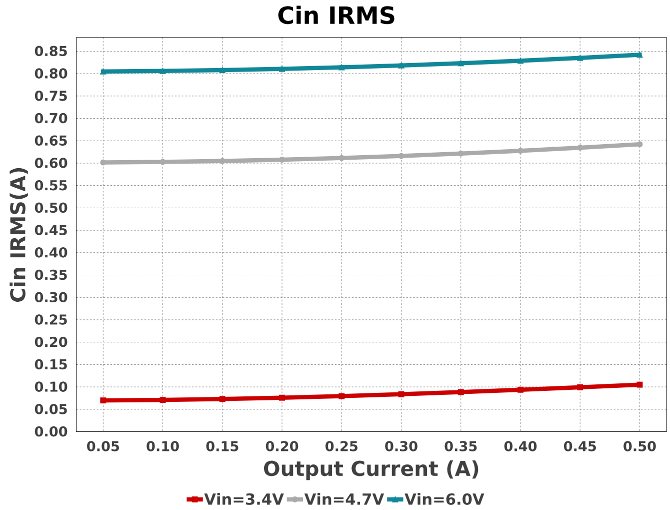

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=3.4V
Vin=4.7V
Vin=6.0V

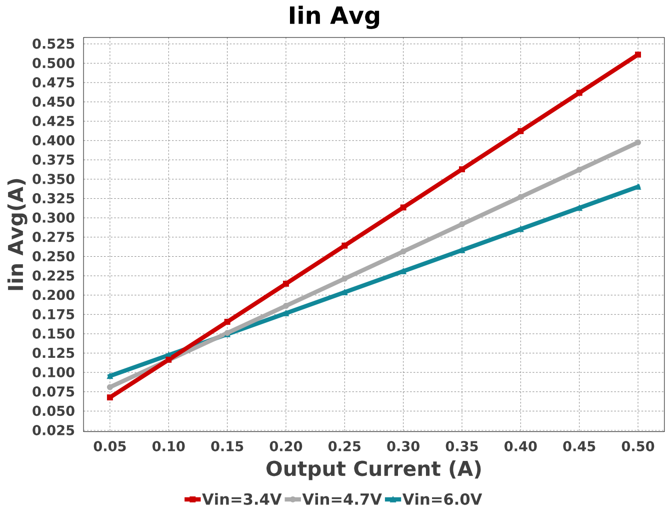

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=3.4V
Vin=4.7V
Vin=6.0V

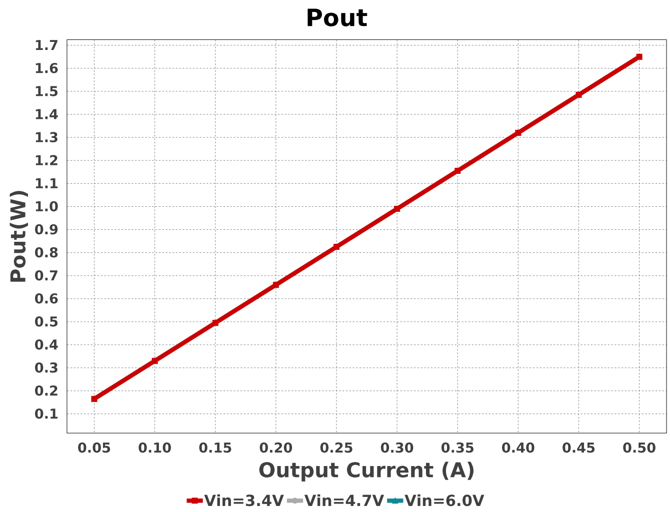

Efficiency
Efficiency(%)
Output Current (A)
Vin=3.4V
Vin=4.7V
Vin=6.0V

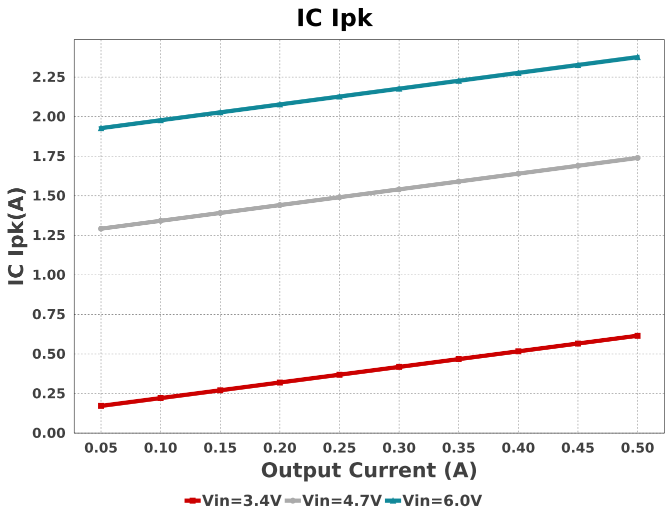

IC Tj
IC Tj(degC)
Output Current (A)
Vin=3.4V
Vin=4.7V
Vin=6.0V

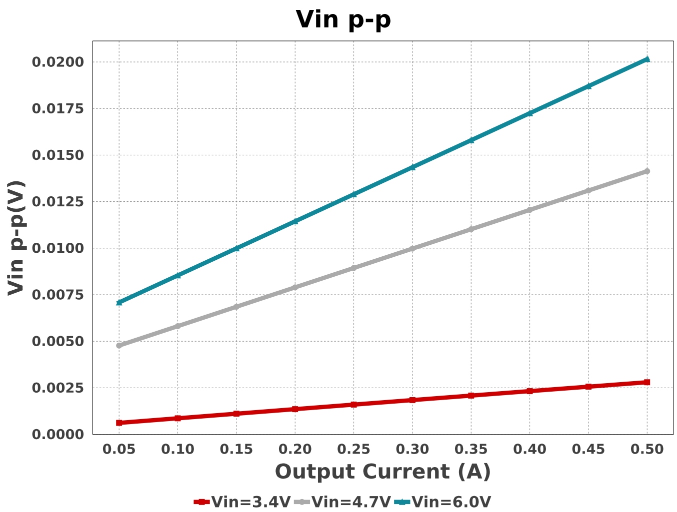

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=3.4V
Vin=4.7V
Vin=6.0V

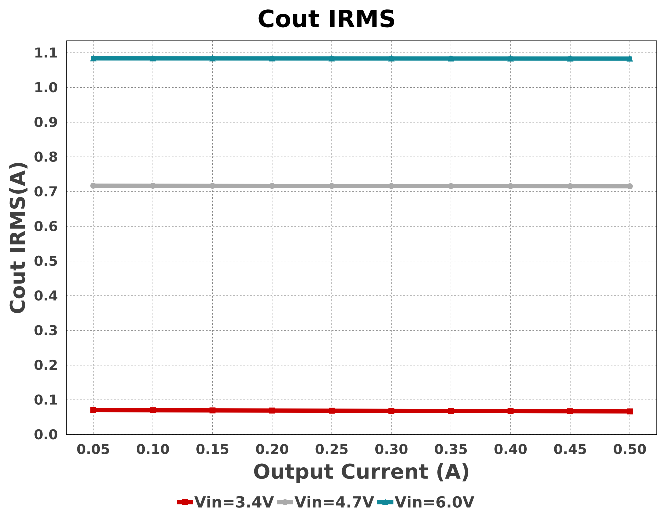

Cin IRMS
Cin IRMS(A)
0.85 0.80 0.75 0.70 0.65 0.60 0.55 0.50 0.45 0.40 0.35 0.30 0.25 0.20 0.15 0.10 0.05 0.00
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=3.4V Vin=4.7V Vin=6.0V

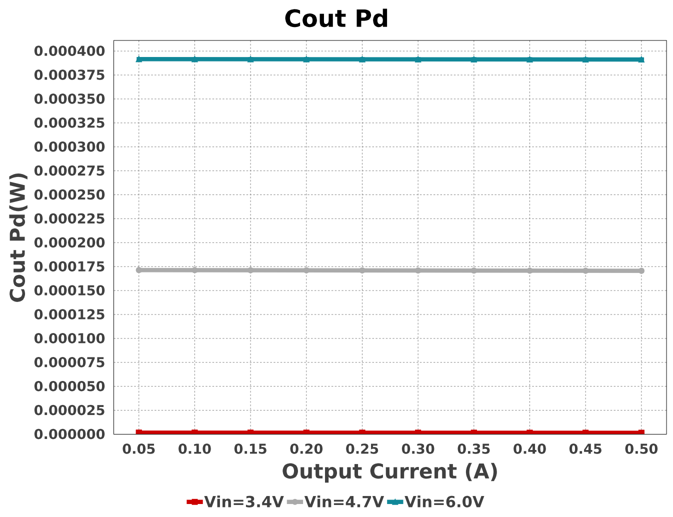

Iin Avg
Iin Avg(A)
0.525 0.500 0.475 0.450 0.425 0.400 0.375 0.350 0.325 0.300 0.275 0.250 0.225 0.200 0.175 0.150 0.125 0.100 0.075 0.050 0.025
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=3.4V Vin=4.7V Vin=6.0V

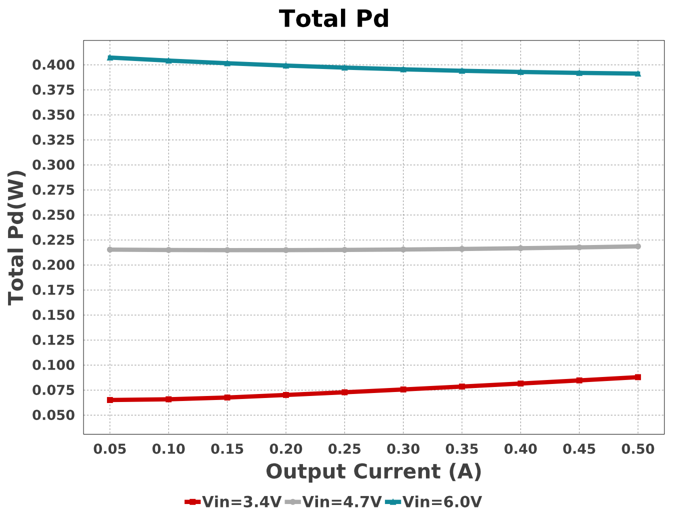

Pout
Pout(W)
1.7 1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=3.4V Vin=4.7V Vin=6.0V

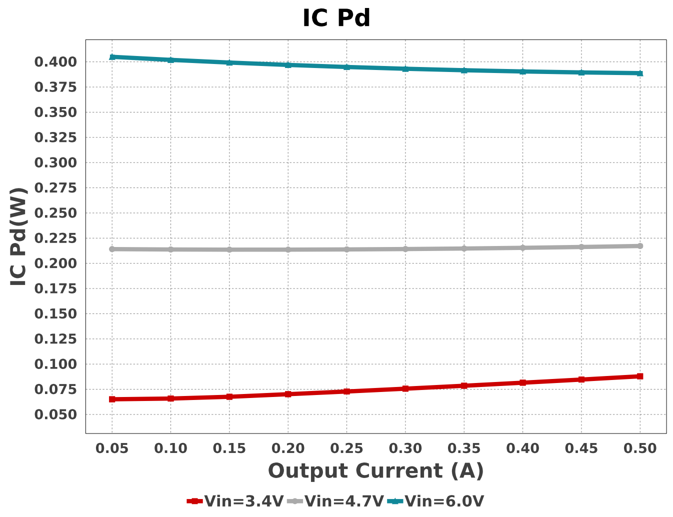

IC Ipk
IC Ipk(A)
2.25 2.00 1.75 1.50 1.25 1.00 0.75 0.50 0.25 0.00
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=3.4V Vin=4.7V Vin=6.0V

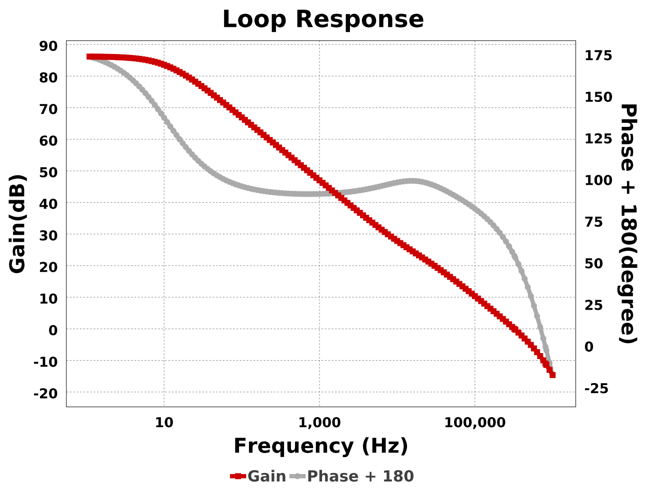

Vin p-p
Vin p-p(V)
0.0200 0.0175 0.0150 0.0125 0.0100 0.0075 0.0050 0.0025 0.0000
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=3.4V Vin=4.7V Vin=6.0V


Cout IRMS
Cout IRMS(A)
1.1 1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1 0.0
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=3.4V Vin=4.7V Vin=6.0V









Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	842.138 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	2.128 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	1.083 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	391.17 µW	Capacitor	Output capacitor power dissipation
5.	IC Ipk	2.376 A	IC	Peak switch current in IC
6.	IC Pd	388.76 mW	IC	IC power dissipation
7.	IC Tj	42.518 degC	IC	IC junction temperature
8.	IC Tolerance	6.0 mV	IC	IC Feedback Tolerance
9.	ICThetaJA	32.2 degC/W	IC	IC junction-to-ambient thermal resistance
10.	Iin Avg	340.22 mA	IC	Average input current
11.	Cin Pd	2.128 mW	Power	Input capacitor power dissipation
12.	Cout Pd	391.17 µW	Power	Output capacitor power dissipation
13.	IC Pd	388.76 mW	Power	IC power dissipation
14.	Total Pd	391.301 mW	Power	Total Power Dissipation
15.	BOM Count	12	System Information	Total Design BOM count
16.	Cross Freq	321.313 kHz	System Information	Bode plot crossover frequency
17.	Duty Cycle	55.164 %	System Information	Duty cycle
18.	Efficiency	80.831 %	System Information	Steady state efficiency
19.	FootPrint	60.0 mm^2	System Information	Total Foot Print Area of BOM components
20.	Frequency	1.8 MHz	System Information	Switching frequency
21.	Gain Marg	-10.999 dB	System Information	Bode Plot Gain Margin
22.	Iout	500.0 mA	System Information	Iout operating point
23.	L Ipp	3.753 A	System Information	Peak-to-peak inductor ripple current

#	Name	Value	Category	Description
24.	Low Freq Gain	86.168 dB	System Information	Gain at 1Hz
25.	Mode	FCCM	System Information	Conduction Mode
26.	Phase Marg	54.645 deg	System Information	Bode Plot Phase Margin
27.	Pout	1.65 W	System Information	Total output power
28.	Total BOM	NA	System Information	Total BOM Cost
29.	Vin	6.0 V	System Information	Vin operating point
30.	Vin p-p	20.153 mV	System Information	Peak-to-peak input voltage
31.	Vout	3.3 V	System Information	Operational Output Voltage
32.	Vout Actual	3.318 V	System Information	Vout Actual calculated based on selected voltage divider resistors
33.	Vout Tolerance	2.671 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
34.	Vout p-p	22.422 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	500.0 m	Maximum Output Current
VinMax	6.0	Maximum input voltage
VinMin	3.4	Minimum input voltage
Vout	3.3	Output Voltage
base_pn	TPSM82816	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

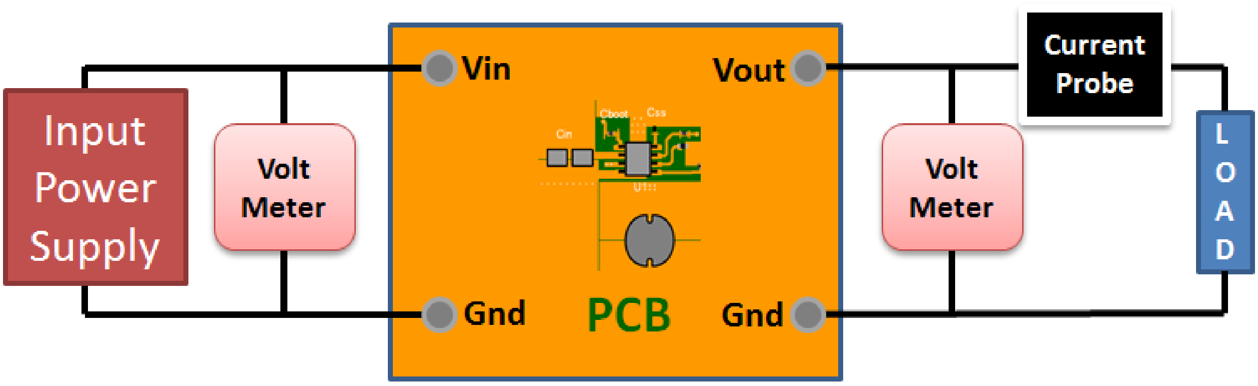
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 3.4V 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 : D2EF7407B055A396[v1]

2. **TPSM82816** Product Folder : https://www.ti.com/product/TPSM82816 : contains the data sheet and other resources.

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