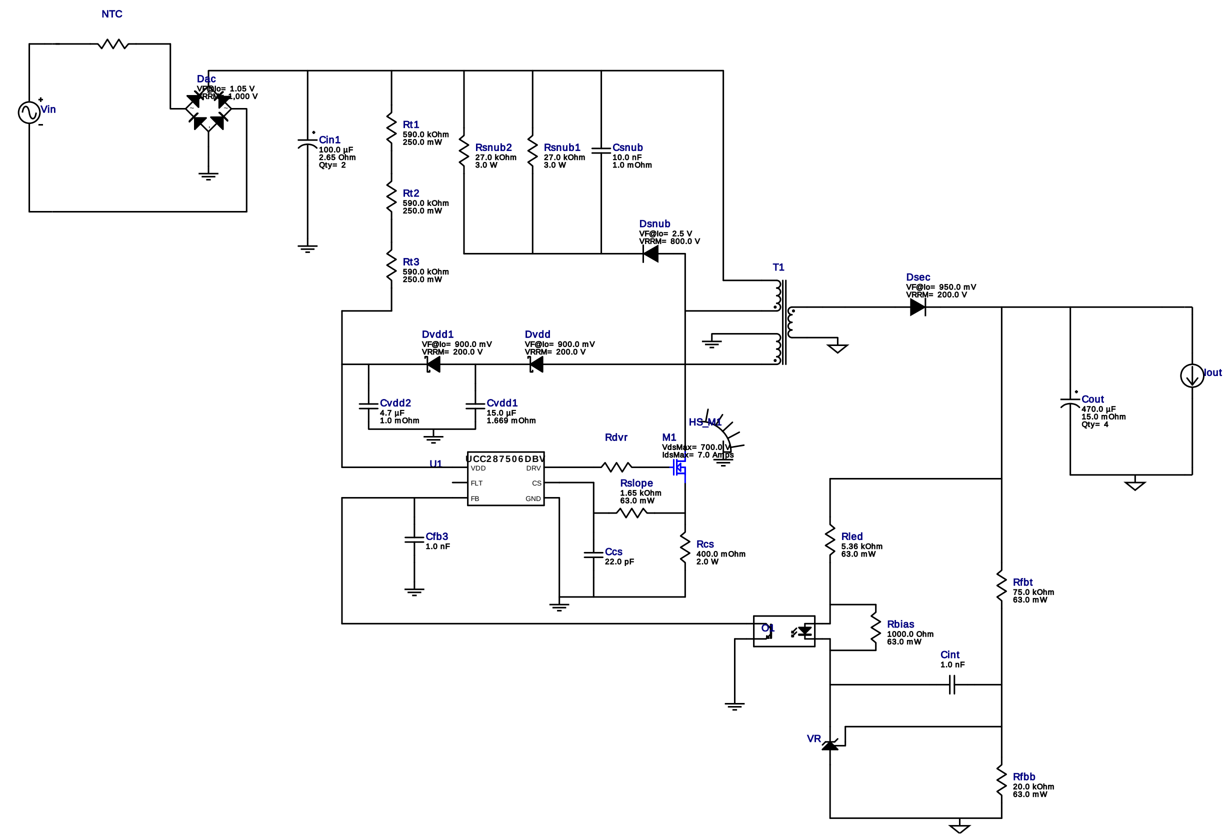
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 85.0V
VinMax = 270.0V
Vout = 12.0V
Iout = 5.0A

Device = UCC287506DBV
Topology = Flyback
Created = 2025-02-12 03:26:26.338
BOM Cost = $11.94
BOM Count = 34
Total Pd = 14.29W

Design : 18 UCC287506DBV
UCC287506DBV 85V-270V to 12.00V @ 5A



1. Click on the transformer symbol and select 'Design Transformer' to design using specific transformer cores and bobbin

2. .UCC287506 is modelled for Auto-Restart protection response.

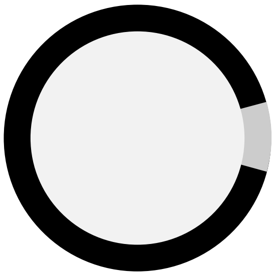
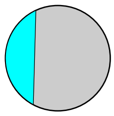
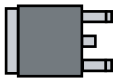
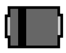
Design Alerts

Component Selection Information

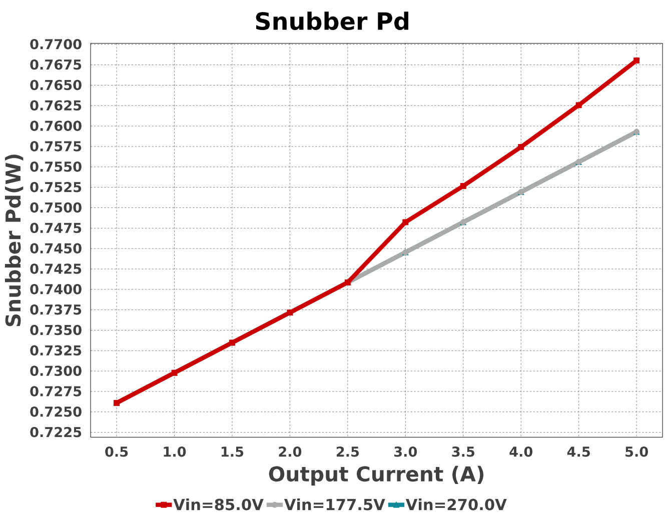
Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

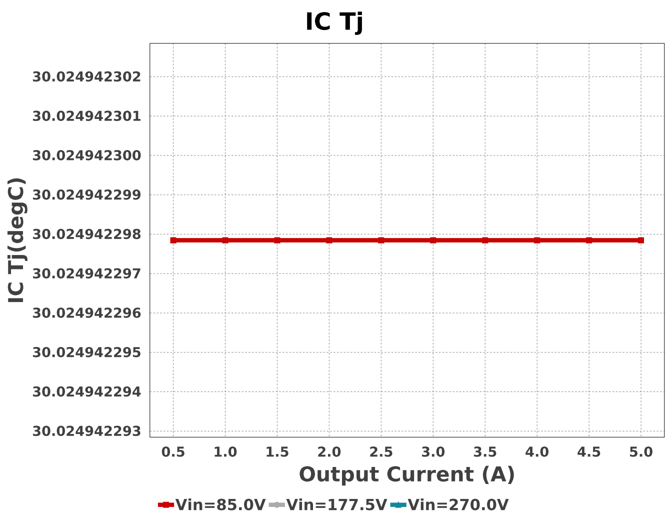
Electrical BOM

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ccs	Samsung Electro-Mechanics	CL21C220JBANNNC Series= C0G/NP0	Cap= 22.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm²
Cfb3	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²

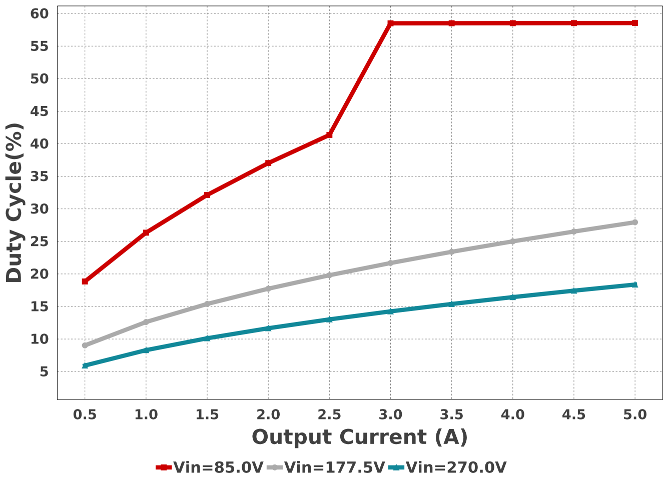
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin1	Rubycon	450HXG100MEFCSN25X25 Series= HXG	Cap= 100.0 uF ESR= 2.65 Ohm VDC= 450.0 V IRMS= 1.2 A	2	$2.09	 HXG_2500x2500 729 mm^2
Cint	MuRata	GRM1555C1H102JA01J Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm^2
Cout	Kemet	A750MS477M1EAAE015 Series= 3273	Cap= 470.0 uF ESR= 15.0 mOhm VDC= 25.0 V IRMS= 4.9 A	4	$0.36	 A750_MS 144 mm^2
Csnub	MuRata	GRM21BR72E103KW03L Series= X7R	Cap= 10.0 nF ESR= 1.0 mOhm VDC= 250.0 V IRMS= 0.0 A	1	$0.08	 0805 7 mm^2
Cvdd1	TDK	C2012X5R1V156M125AC Series= X5R	Cap= 15.0 uF ESR= 1.669 mOhm VDC= 35.0 V IRMS= 5.0498 A	1	$0.20	 0805 7 mm^2
Cvdd2	TDK	C2012X5R1H475K125AB Series= X5R	Cap= 4.7 uF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 4.3 A	1	$0.12	 0805 7 mm^2
Dac	Diodes Inc.	GBJ2510-F	VF@Io= 1.05 V VRRM= 1,000.0 V	1	$1.18	GBJ 211 mm^2
Dsec	SMC Diode Solutions	SBRD10200TR	VF@Io= 950.0 mV VRRM= 200.0 V	1	$0.18	 DPAK 102 mm^2
Dsnub	Bourns	CD1408-FU1800	VF@Io= 2.5 V VRRM= 800.0 V	1	$0.14	 Diode_1408 13 mm^2
Dvdd	Fairchild Semiconductor	S320	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.33	 SMB 44 mm^2
Dvdd1	Fairchild Semiconductor	S320	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.33	 SMB 44 mm^2
M1	AOS	AOTF7N70	VdsMax= 700.0 V IdsMax= 7.0 Amps	1	$0.63	 TO-220FP 79 mm^2
O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$1.17	 SSOP-4 111 mm^2
Rbias	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
Rcs	Stackpole Electronics Inc	CSRN2512FKR400 Series= ?	Res= 400.0 mOhm Power= 2.0 W Tolerance= 1.0%	1	$0.13	 2512 43 mm^2
Rfbb	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rfbt	Vishay-Dale	CRCW040275K0FKED Series= CRCW..e3	Res= 75.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rled	Vishay-Dale	CRCW04025K36FKED Series= CRCW..e3	Res= 5.36 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rslope	Vishay-Dale	CRCW04021K65FKED Series= CRCW..e3	Res= 1.65 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rsnub1	Yageo	FMP300JR-73-27K Series= ?	Res= 27.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.05	FMP300 181 mm²
Rsnub2	Yageo	FMP300JR-73-27K Series= ?	Res= 27.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.05	FMP300 181 mm²
Rt1	Panasonic	ERJ-8ENF5903V Series= ERJ-8E	Res= 590.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.02	1206 11 mm²
Rt2	Panasonic	ERJ-8ENF5903V Series= ERJ-8E	Res= 590.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.02	1206 11 mm²
Rt3	Panasonic	ERJ-8ENF5903V Series= ERJ-8E	Res= 590.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.02	1206 11 mm²
T1	Core=TDK , CoilFormer=TDK	Core=B66421G0000X197 , CoilFormer=B66422W1010D001	Lp= 378.0 µH Turns Ratio(Nas)= 12:7 Turns Ratio(Nps)= 64:7 Npri= 64.0 Naux= 12.0 Nsec= 7.0	1	$0.49	TDK_B66305 756 mm²
U1	Texas Instruments	UCC287506DBV	Switcher	1	$0.12	R-PDSO-G6 10 mm²
VR	Texas Instruments	TL431IDBVR	Voltage References	1	$0.05	R-PDSO-G3 16 mm²

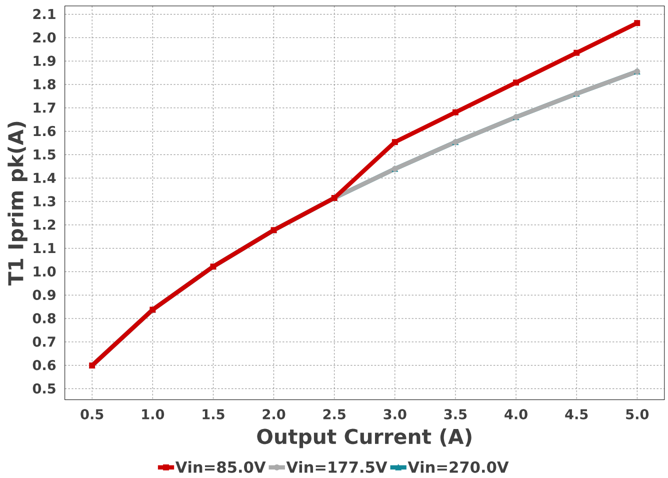




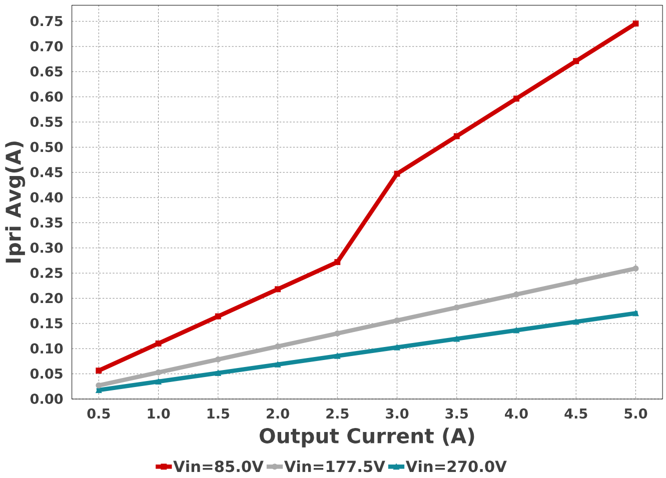
Duty Cycle



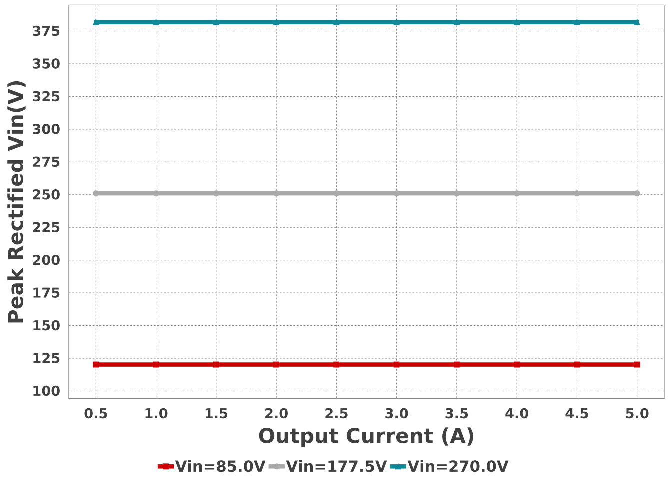
T1 Iprim pk



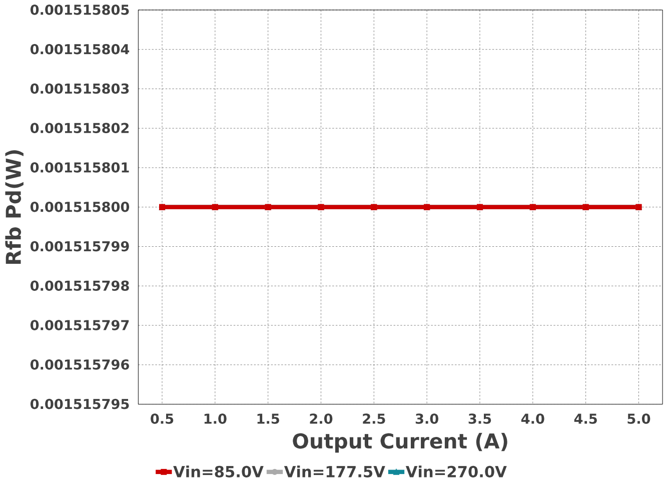
Ipri Avg



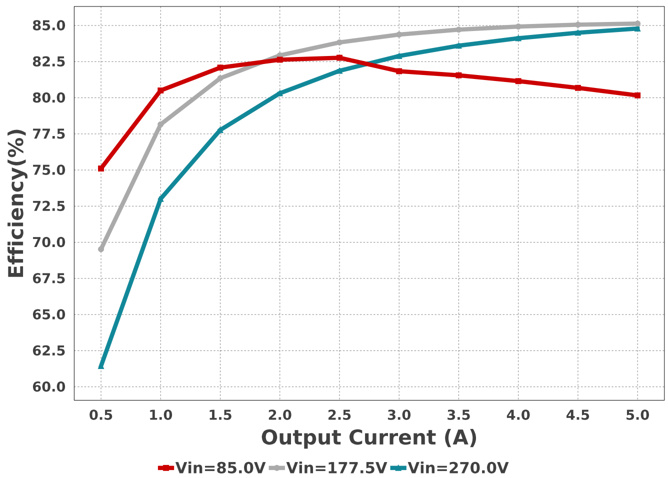
Peak Rectified Vin

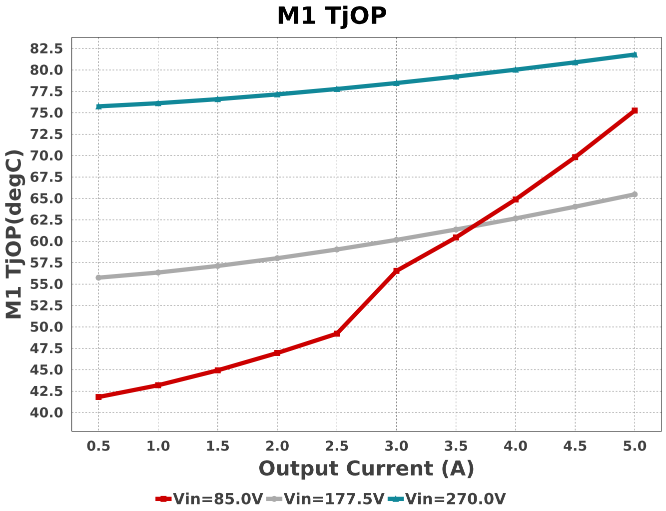


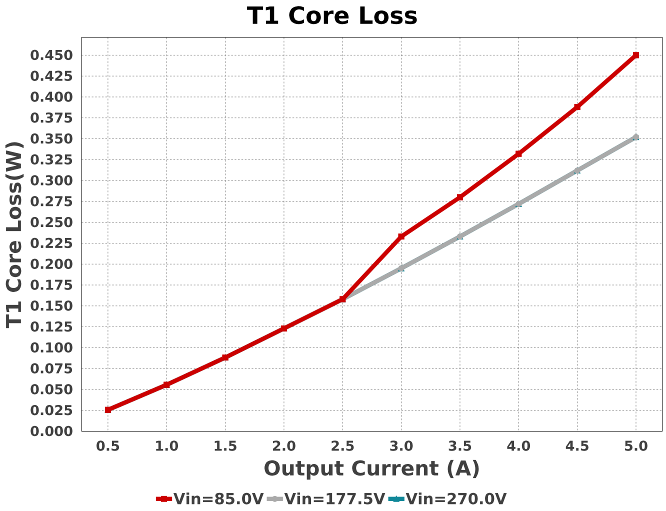
Rfb Pd

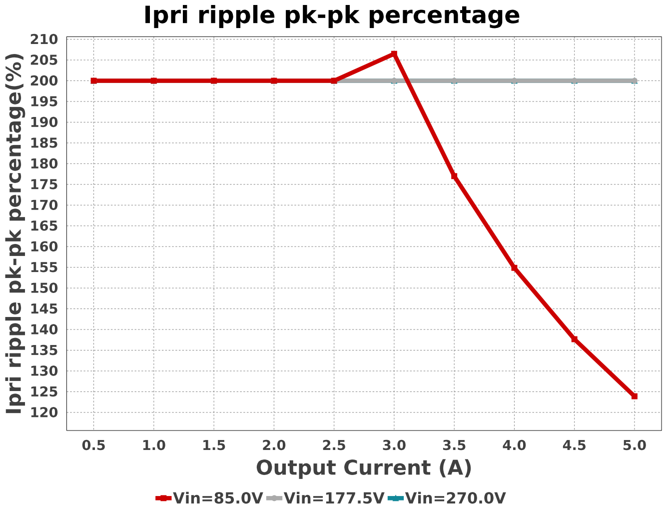


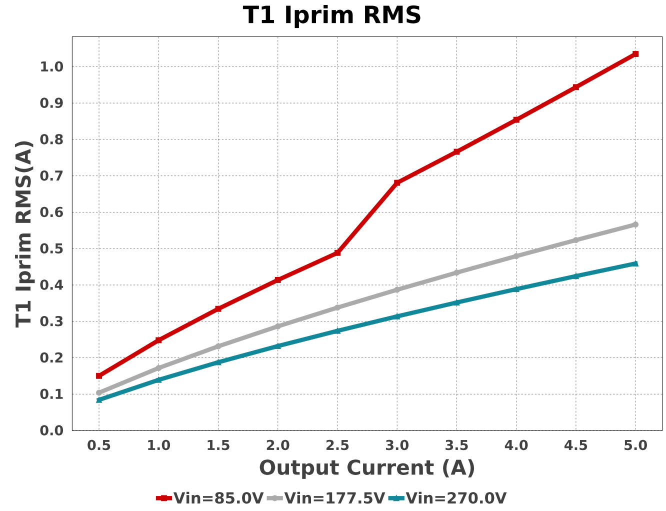
Efficiency

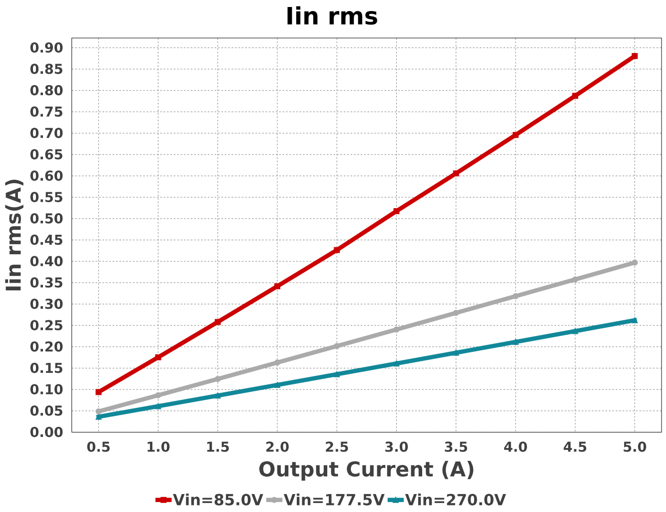


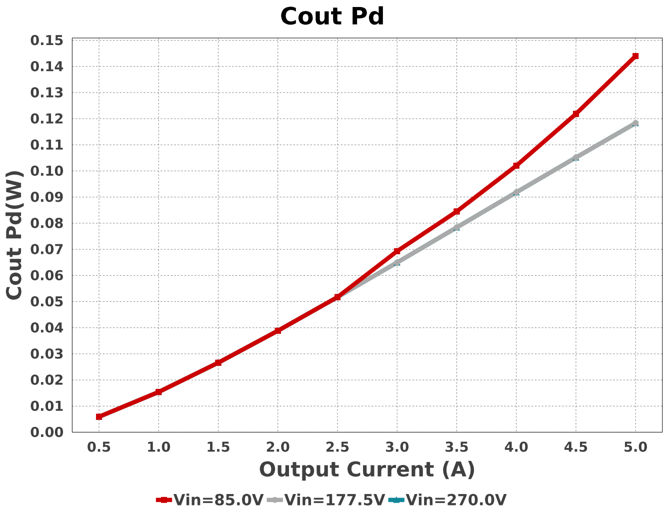

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

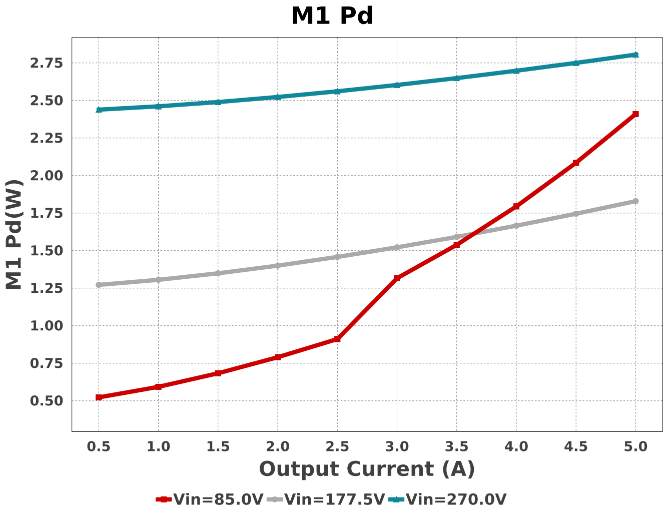

T1 Core Loss
T1 Core Loss(W)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

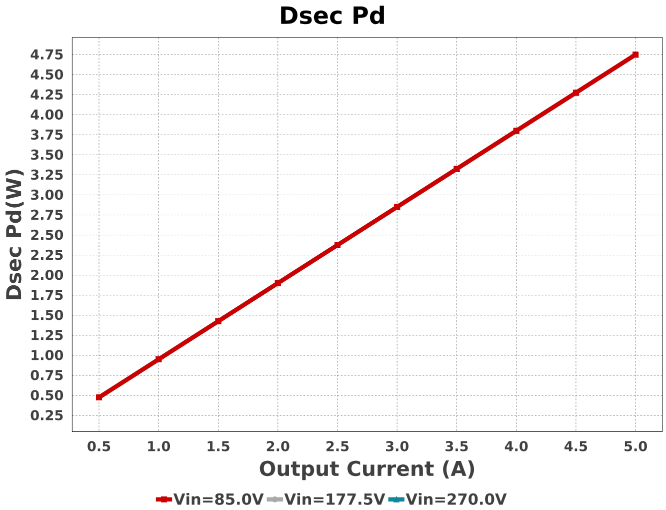

Ipri ripple pk-pk percentage
Ipri ripple pk-pk percentage(%)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

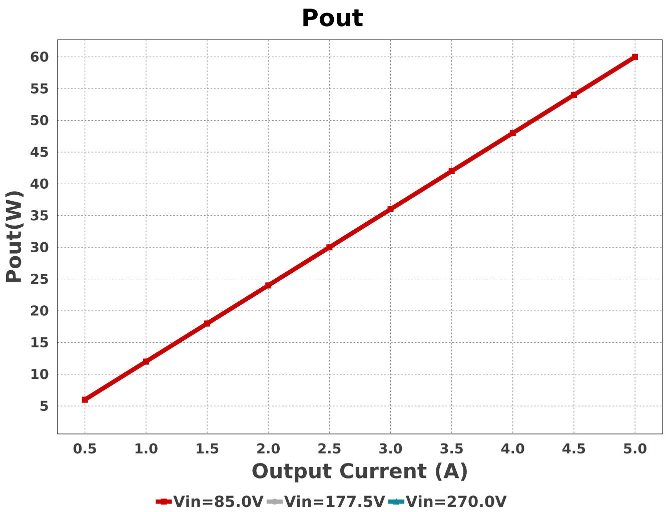

T1 Iprim RMS
T1 Iprim RMS(A)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

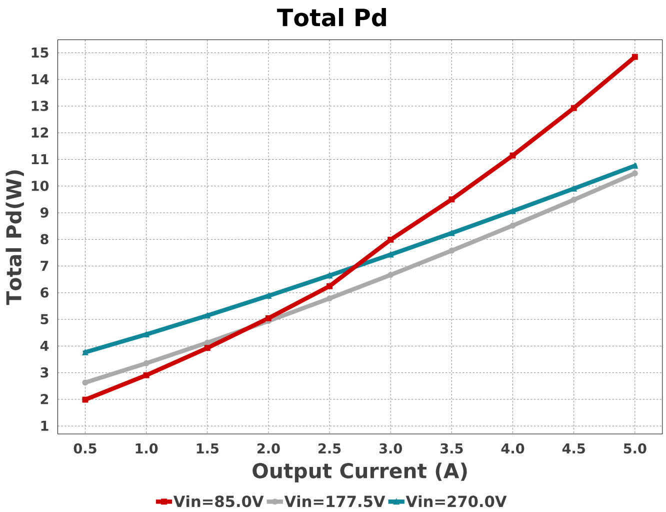

Iin rms
Iin rms(A)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

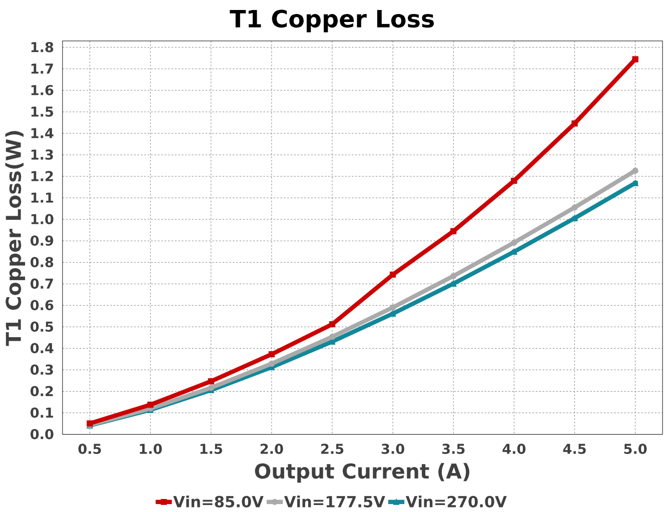

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

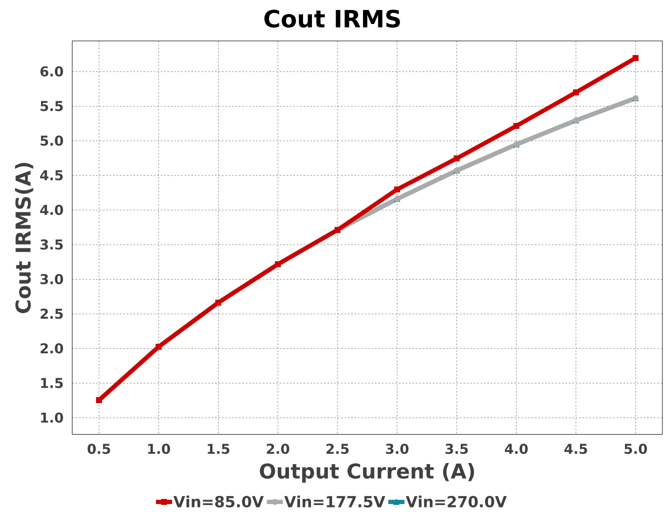

M1 Pd
M1 Pd(W)
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

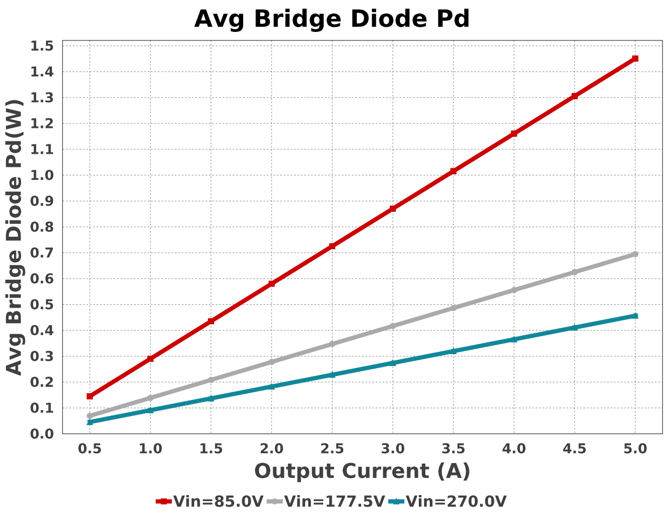

Dsec Pd
Dsec Pd(W)
4.75
4.50
4.25
4.00
3.75
3.50
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

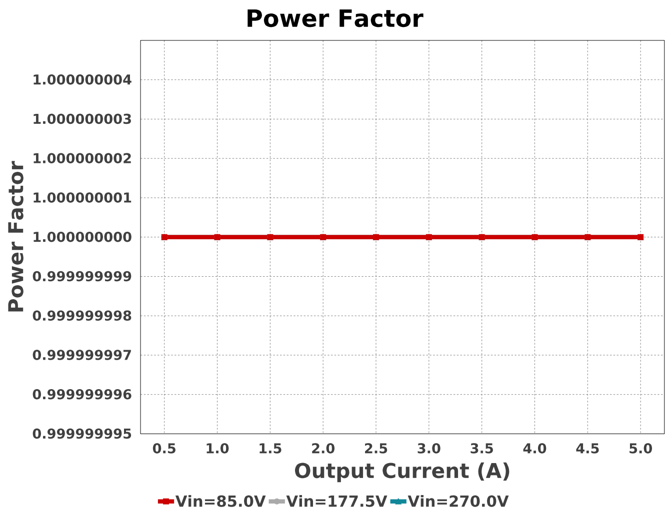

Pout
Pout(W)
60
55
50
45
40
35
30
25
20
15
10
5
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

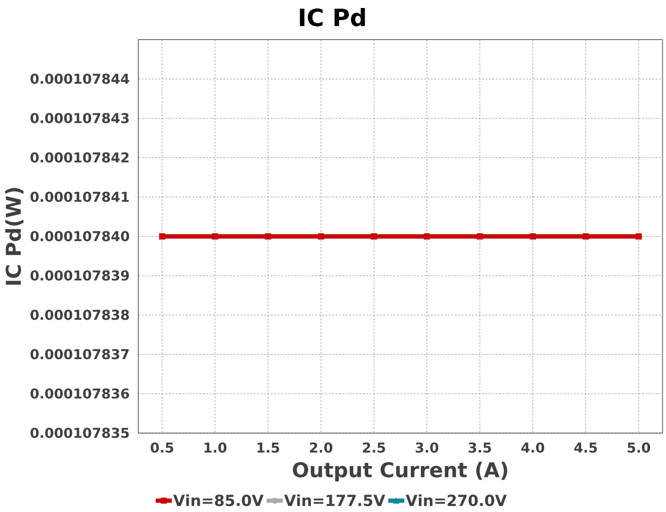

Total Pd
Total Pd(W)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

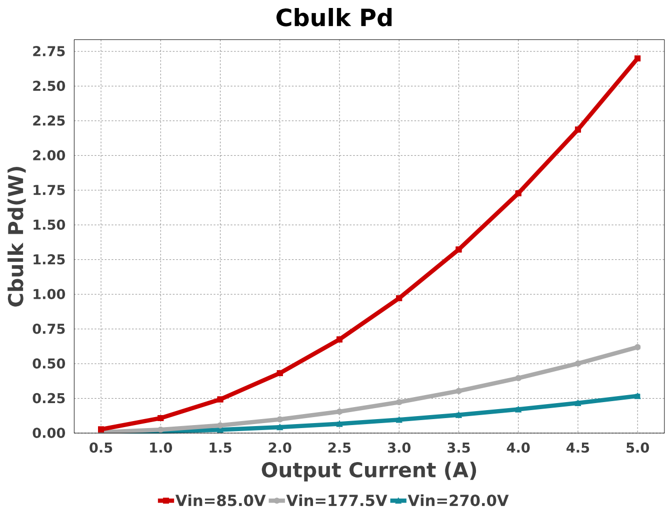

T1 Copper Loss
T1 Copper Loss(W)
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

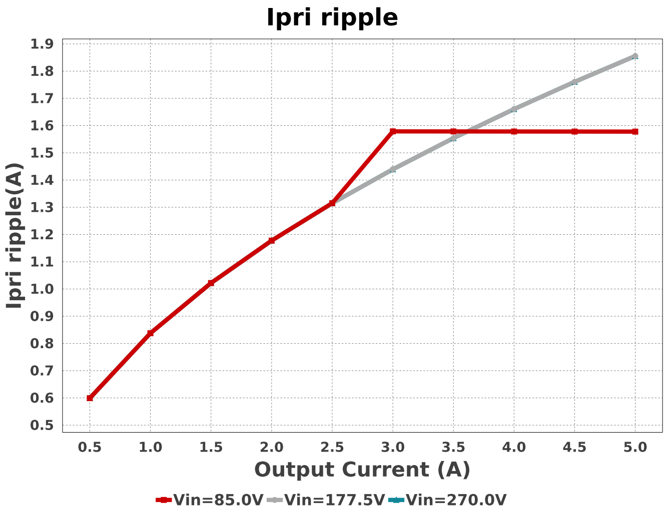

Cout IRMS
Cout IRMS(A)
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

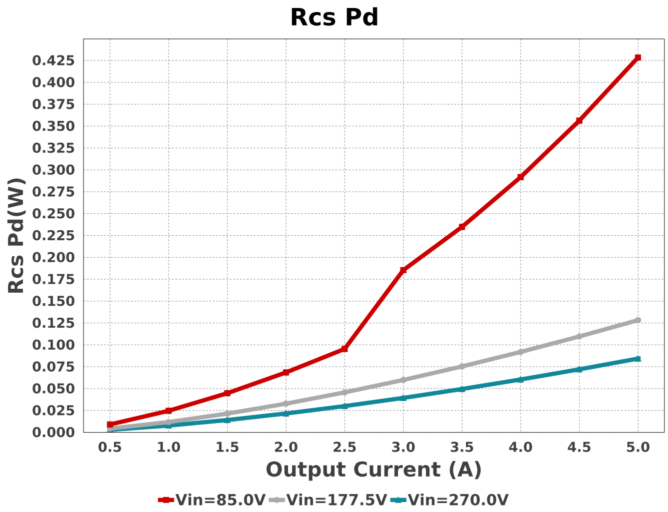

Avg Bridge Diode Pd
Avg Bridge Diode Pd(W)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V

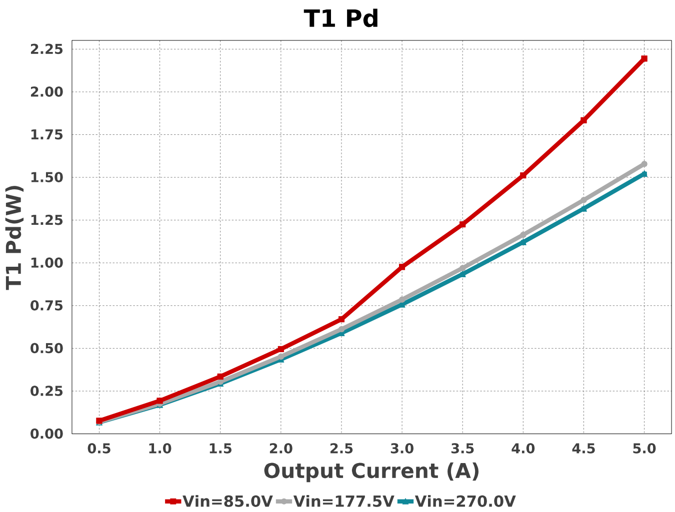

Power Factor
Power Factor
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V


Cbulk Pd
Cbulk Pd(W)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V


Ipri ripple
Ipri ripple(A)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V


Rcs Pd
Rcs Pd(W)
Output Current (A)
Vin=85.0V Vin=177.5V Vin=270.0V



Operating Values

#	Name	Value	Category	Description
1.	Cbulk Pd	2.7 W	Capacitor	Bulk capacitor power dissipation
2.	Cout IRMS	6.196 A	Capacitor	Output capacitor RMS ripple current
3.	Cout Pd	143.98 mW	Capacitor	Output capacitor power dissipation
4.	Avg Bridge Diode Pd	1.451 W	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
5.	Dsec Pd	4.75 W	Diode	Secondary Diode Power Dissipation
6.	IC Pd	107.84 µW	IC	IC power dissipation
7.	IC Tj	30.025 degC	IC	IC junction temperature
8.	ICThetaJA	231.3 degC/W	IC	IC junction-to-ambient thermal resistance
9.	M1 Pd	2.41 W	Mosfet	M1 MOSFET total power dissipation
10.	M1 TjOP	75.265 degC	Mosfet	M1 MOSFET junction temperature
11.	Avg Bridge Diode Pd	1.451 W	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
12.	Cbulk Pd	2.7 W	Power	Bulk capacitor power dissipation
13.	Cout Pd	143.98 mW	Power	Output capacitor power dissipation
14.	Dsec Pd	4.75 W	Power	Secondary Diode Power Dissipation
15.	IC Pd	107.84 µW	Power	IC power dissipation
16.	M1 Pd	2.41 W	Power	M1 MOSFET total power dissipation
17.	Rcs Pd	428.36 mW	Power	Power Dissipation in Current Sense Resistors
18.	Rfb Pd	1.516 mW	Power	Rfb Power Dissipation
19.	Snubber Pd	768.03 mW	Power	Snubber Power Dissipation
20.	T1 Copper Loss	1.238 W	Power	Transformer Copper Loss Power Dissipation
21.	T1 Core Loss	401.0 mW	Power	Transformer Core Loss Power Dissipation
22.	T1 Pd	1.639 W	Power	Estimated Losses in Transformer
23.	Total Pd	14.291 W	Power	Total Power Dissipation
24.	Rcs Pd	428.36 mW	Resistor	Power Dissipation in Current Sense Resistors
25.	Rfb Pd	1.516 mW	Resistor	Rfb Power Dissipation
26.	BOM Count	34	System Information	Total Design BOM count
27.	Duty Cycle	58.542 %	System Information	Duty cycle
28.	Efficiency	80.763 %	System Information	Steady state efficiency
29.	FootPrint	4.45 k mm^2	System Information	Total Foot Print Area of BOM components
30.	Frequency	100.0 kHz	System Information	Switching frequency
31.	Iin rms	874.01 mA	System Information	RMS Input Current
32.	Iout	5.0 A	System Information	Iout operating point
33.	Mode	CCM	System Information	Conduction Mode
34.	Peak Rectified Vin	120.207 V	System Information	Peak voltage seen at rectified input
35.	Pout	60.0 W	System Information	Total output power
36.	Power Factor	1.0	System Information	Assumed Power Factor for the Application
37.	Total BOM	$11.94	System Information	Total BOM Cost
38.	Vin_RMS	85.0 V	System Information	Vin operating point

#	Name	Value	Category	Description
39.	Vout	12.0 V	System Information	Operational Output Voltage
40.	Vout Actual	11.7 V	System Information	Achieved Vout with feedback resistor pair
41.	Vout Tolerance	8.0 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Ipri Avg	745.542 mA	Transformer	Average Current in Primary Winding over the complete Switching Period
43.	Ipri ripple	1.578 A	Transformer	Ripple Current in the Primary Winding
44.	Ipri ripple pk-pk percentage	123.896 %	Transformer	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
45.	T1 Copper Loss	1.238 W	Transformer	Transformer Copper Loss Power Dissipation
46.	T1 Core Loss	401.0 mW	Transformer	Transformer Core Loss Power Dissipation
47.	T1 Iprim RMS	1.035 A	Transformer	Transformer Primary RMS Current
48.	T1 Iprim pk	2.062 A	Transformer	Transformer Primary Peak Current
49.	T1 Pd	1.639 W	Transformer	Estimated Losses in Transformer

Design Inputs

Name	Value	Description
Iout	5.0	Maximum Output Current
VinMax	270.0	Maximum input voltage
VinMin	85.0	Minimum input voltage
Vout	12.0	Output Voltage
acFrequency	50.0	AC Frequency
base_pn	UCC287506	Base Product Number
source	AC	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

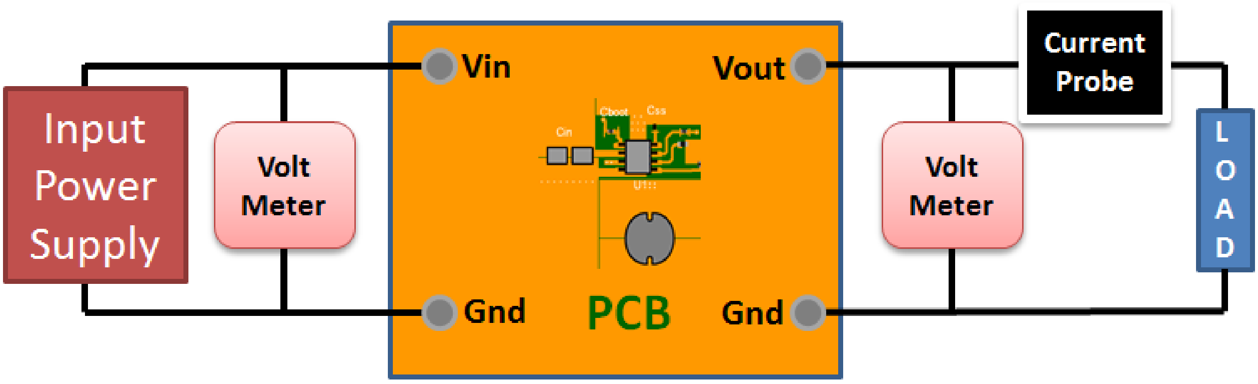
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 85.0V 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.



WEBENCH® Transformer Report

#	Name	Value
1.	Core Part Number	B66421G0000X197
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B66422W1010D001
4.	Coil Former Manufacturer	TDK

Transformer Electrical Diagram

Primary

Turns	64.0
AWG	26.0
Layers	4.0
Strands	2.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	7.0
AWG	26.0
Layers	1.0
Strands	3.0
Insulation Type	Triple Insulated

Auxiliary

Turns	12.0
AWG	28.0
Layers	1.0
Strands	3.0
Insulation Type	Heavy Insulated Magnet Wire

Transformer Construction Diagram

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 2/4.0	26.0	32	Clockwise
Auxiliary	28.0	12.0	Counter Clockwise
Triple Insulated Secondary	26.0	7.0	Counter Clockwise
Primary Second 2/4.0	26.0	32	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	3.78E-4H
2.	Inductance Factor(Al)	93.0nH
3.	Npri	64.0
4.	Nsec	7.0
5.	Naux	12.0
6.	Core Type	EFD25/13/9
7.	Core Material	N97

#	Name	Value
8.	Bmax	0.20T
9.	Switching Frequency	100.00kHz
10.	DMax	0.6
11.	Ipk(Primary)	1.96A
12.	Irms(Primary)	0.96A
13.	Ipk(Secondary)	17.9A
14.	Irms(Secondary)	7.19A

Design Assistance

1. Master key : 659DE37EC66DA0E8[v1]
2. **UCC287506** Product Folder : http://www.ti.com/product/UCC28750 : contains the data sheet and other resources.

