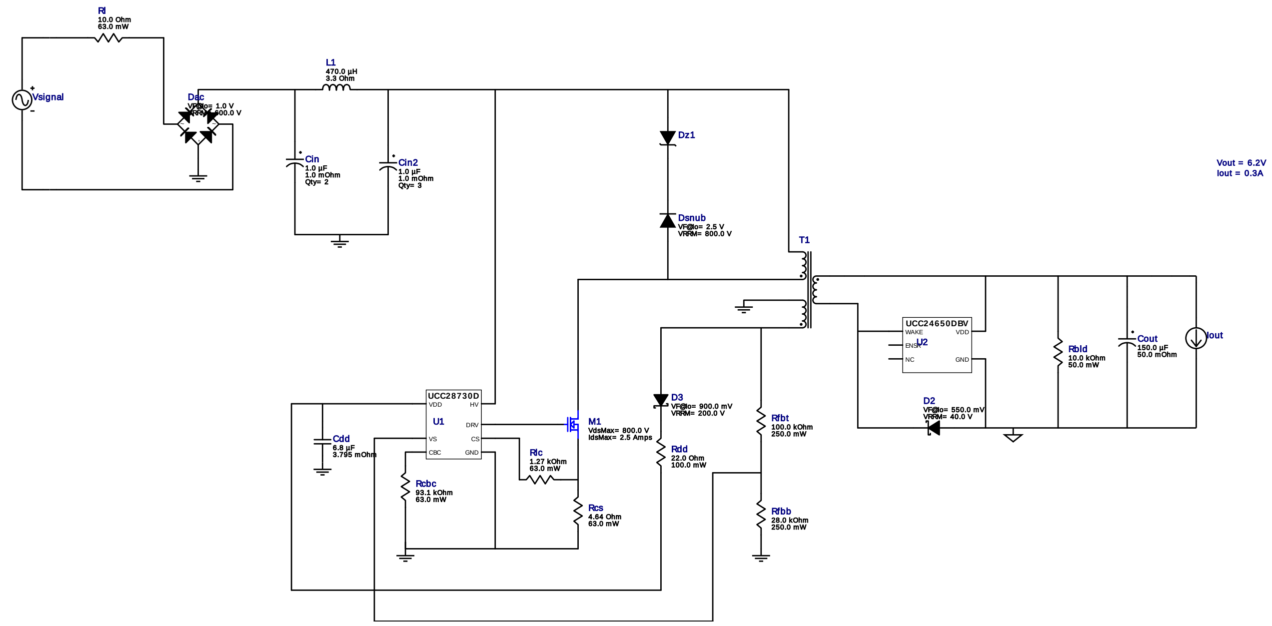
VinMin = 85.0V
VinMax = 265.0V
Vout = 6.2V
Iout = 0.3A

Device = UCC28730DR
Topology = Flyback
Created = 2021-05-06 15:40:13.512
BOM Cost = $6.44
BOM Count = 25
Total Pd = 0.29W

WEBENCH ® Design Report

Design : 24 UCC28730DR
UCC28730DR 85V-265V to 6.20V @ 0.3A



1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. It is recommended to start this device at light load condition. There is an internal series resistance of 28 kOhms to the CBC pin which sets a maximum cable compensation of a 5V output to 400 mV when CBC is shorted to ground. For more information please click the design assistance button.

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

Design Alerts

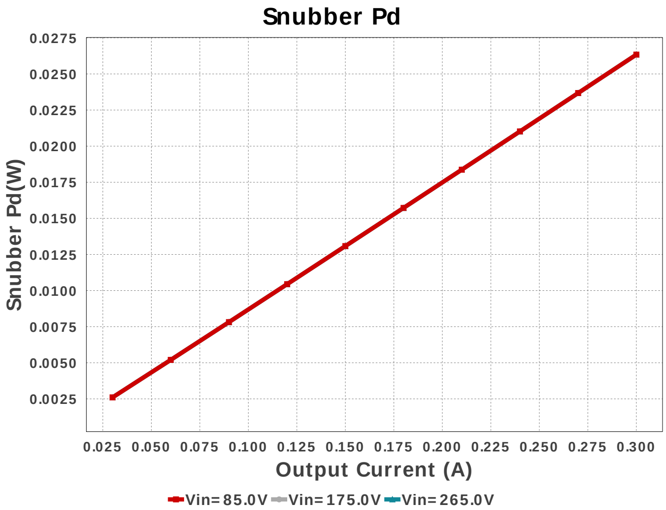
Component Selection Information

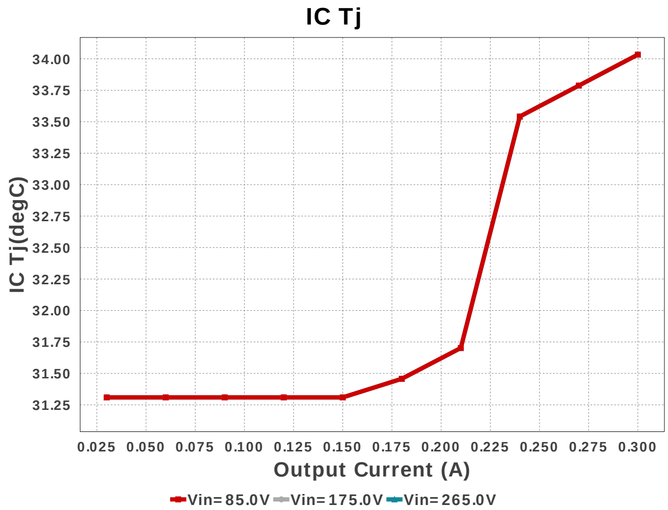
Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

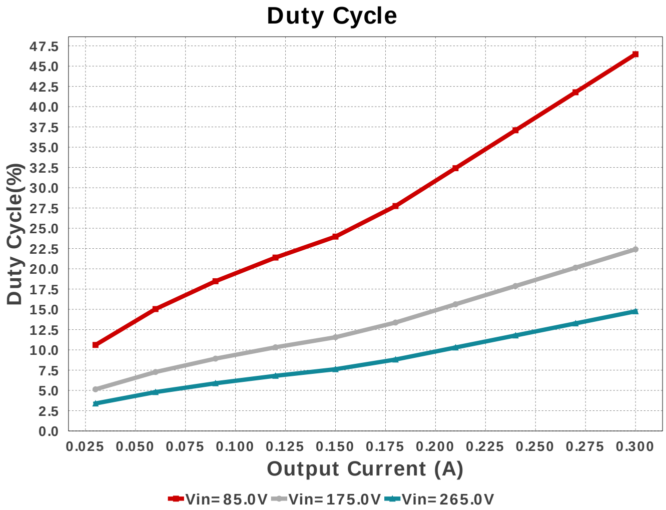
Electrical BOM

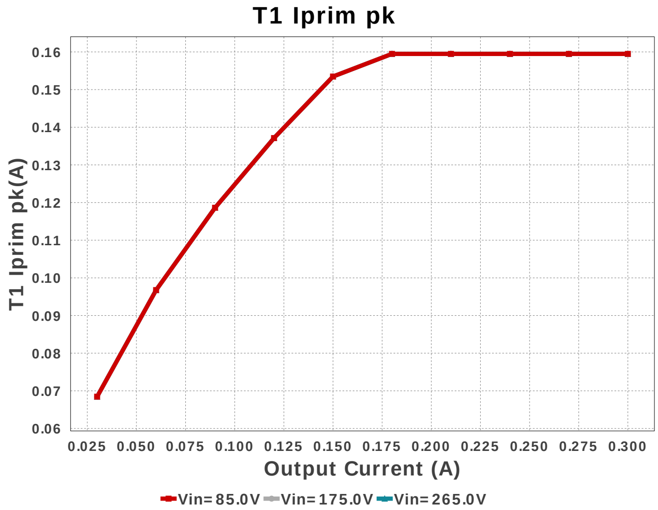
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cdd	TDK	C2012X5R1V685K125AC Series= X5R	Cap= 6.8 uF ESR= 3.795 mOhm VDC= 35.0 V IRMS= 3.3493 A	1	$0.18	0805 7 mm^2
Cin	Chemi-Con	EKMG401ELL1R0MF11D Series= 2200	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 400.0 V IRMS= 15.0 mA	2	$0.18	KMG_630X1100 69 mm^2
Cin2	Chemi-Con	EKMG401ELL1R0MF11D Series= 2200	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 400.0 V IRMS= 15.0 mA	3	$0.18	KMG_630X1100 69 mm^2
Cout	Panasonic	16TQC150MYF Series= TQC	Cap= 150.0 uF ESR= 50.0 mOhm VDC= 16.0 V IRMS= 1.8 A	1	$2.45	7343-31 59 mm^2
D2	Fairchild Semiconductor	SS14FL	VF@Io= 550.0 mV VRRM= 40.0 V	1	$0.04	SOD-123F 12 mm^2

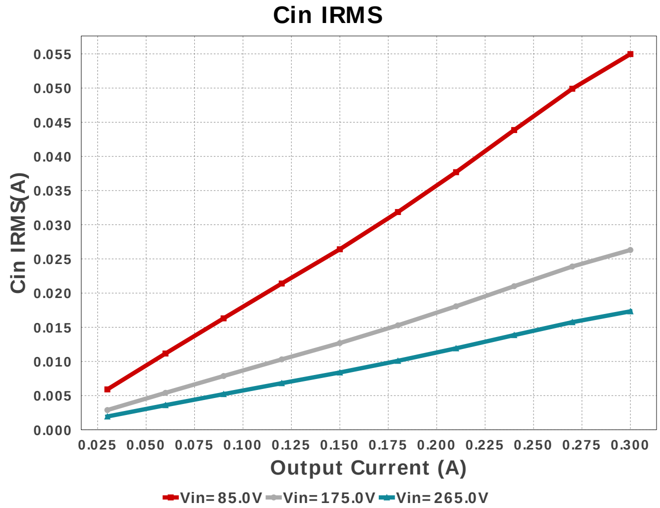
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
D3	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.04	SMA 37 mm²
Dac	Diodes Inc.	HD06-T	VF@Io= 1.0 V VRRM= 600.0 V	1	$0.13	MiniDIP 62 mm²
Dsnub	Bourns	CD1408-FU1800	VF@Io= 2.5 V VRRM= 800.0 V	1	$0.13	Diode_1408 13 mm²
Dz1	Taiwan Semiconductor	BZD27C150P RHG	Zener	1	$0.09	SubSMA 13 mm²
L1	Bourns	SDR0604-471KL	L= 470.0 µH 3.3 Ohm	1	$0.22	SDR0604 61 mm²
M1	STMicroelectronics	STD3NK80Z-1	VdsMax= 800.0 V IdsMax= 2.5 Amps	1	$0.70	IPAK 37 mm²
Rbld	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rcs	Vishay-Dale	CRCW04024R64FKED Series= CRCW..e3	Res= 4.64 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rdd	Yageo	RC0603FR-0722RL Series= ?	Res= 22.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfbb	Vishay-Dale	CMF5028K000FHEB Series= CMF50	Res= 28.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.20	CMF50 46 mm²
Rfbt	Vishay-Dale	CRCW1206100KFKEA Series= CRCW..e3	Res= 100.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rl	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rlc	Vishay-Dale	CRCW04021K27FKED Series= CRCW..e3	Res= 1.27 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
T1	Core=TDK , CoilFormer=TDK	Core=B66311G0000X127 , CoilFormer=B66206C1012T001	Lp= 3.967 mH Turns Ratio(Nas)= 14:5 Turns Ratio(Nps)= 60:5 Npri= 60.0 Naux= 14.0 Nsec= 5.0	1	$0.71	TDK_B66305 245 mm²
U1	Texas Instruments	UCC28730DR	Switcher	1	$0.42	D0007A 55 mm²
U2	Texas Instruments	UCC24650DBVR	Switcher	0	$0.16	DBV0005A 15 mm²

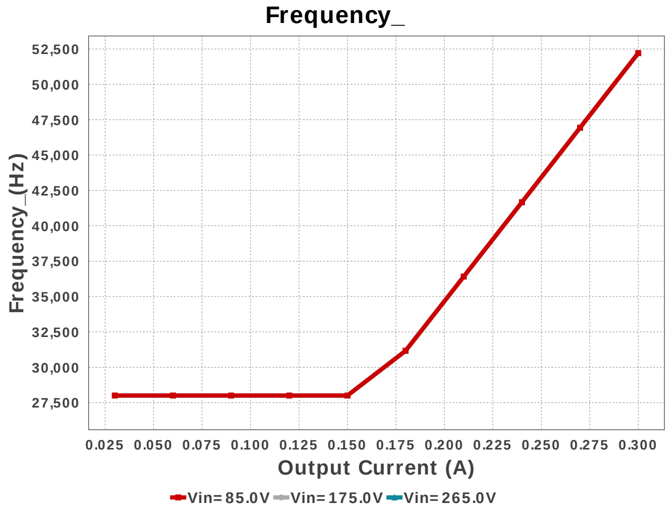

Snubber Pd
Snubber Pd(W)
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250 0.275 0.300
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

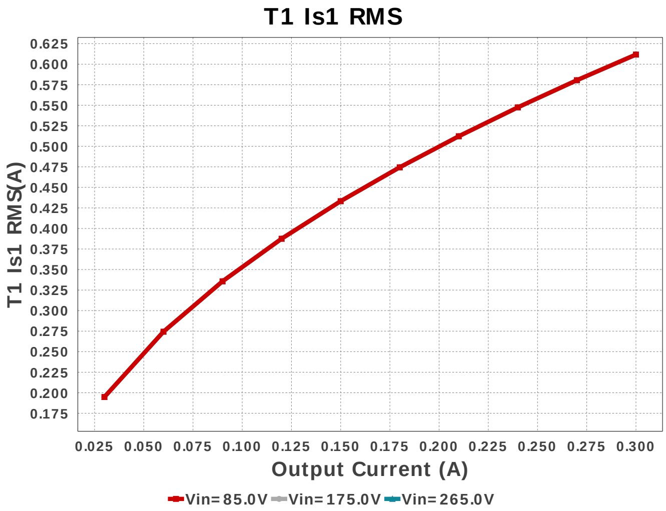

IC Tj
IC Tj(degC)
34.00
33.75
33.50
33.25
33.00
32.75
32.50
32.25
32.00
31.75
31.50
31.25
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250 0.275 0.300
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

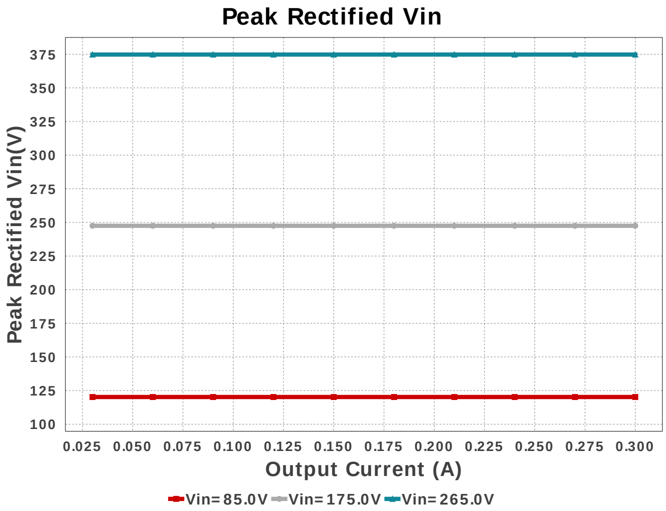

Duty Cycle
Duty Cycle(%)
47.5
45.0
42.5
40.0
37.5
35.0
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250 0.275 0.300
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

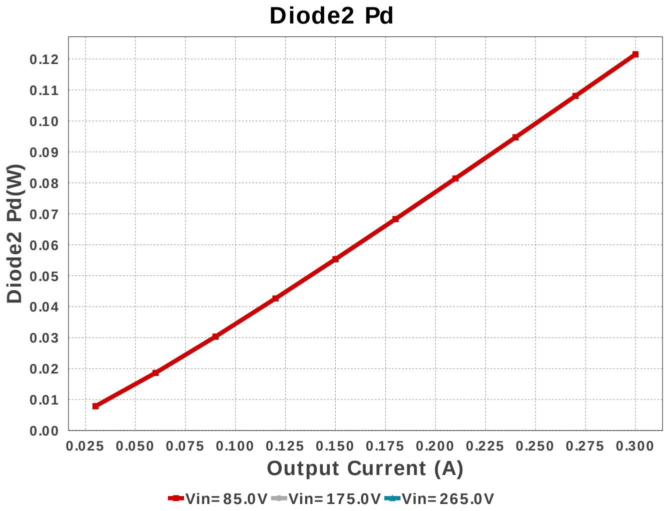

T1 Iprim pk
T1 Iprim pk(A)
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250 0.275 0.300
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

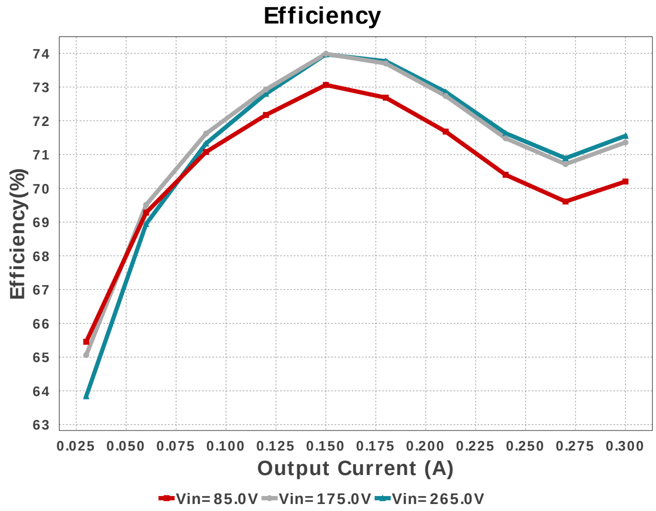

Cin IRMS
Cin IRMS(A)
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250 0.275 0.300
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

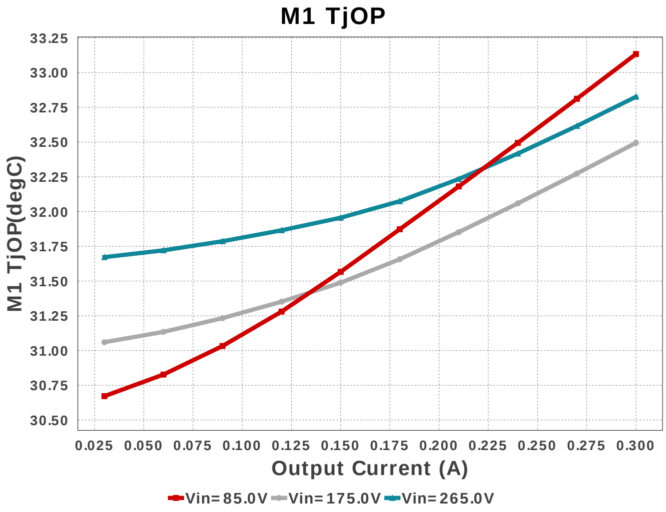

Frequency_
Frequency_(Hz)
52,500
50,000
47,500
45,000
42,500
40,000
37,500
35,000
32,500
30,000
27,500
0.025 0.050 0.075 0.100 0.125 0.150 0.175 0.200 0.225 0.250 0.275 0.300
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

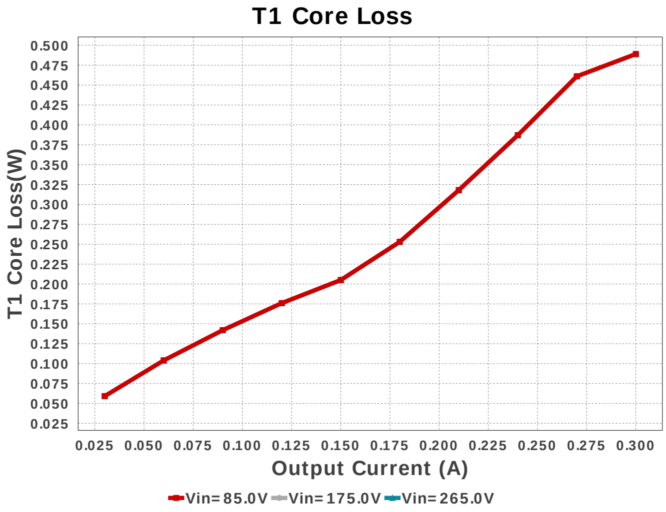

T1 Is1 RMS
T1 Is1 RMS(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

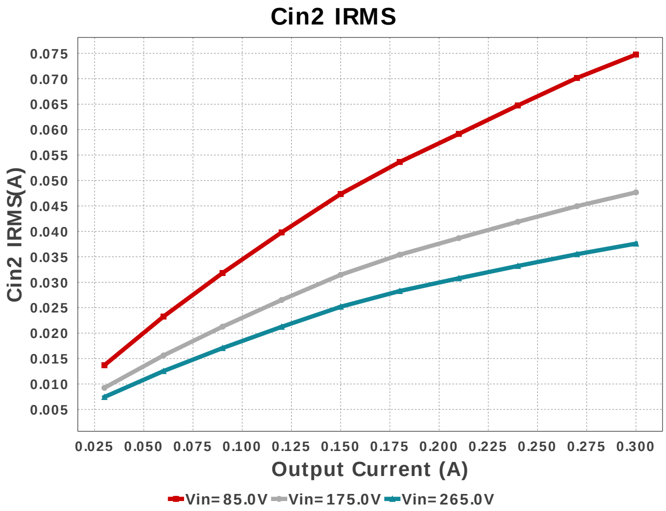

Peak Rectified Vin
Peak Rectified Vin(V)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

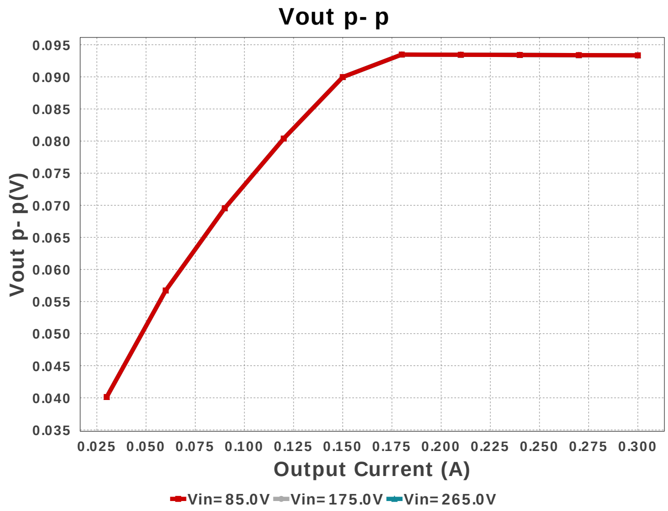

Diode2 Pd
Diode2 Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

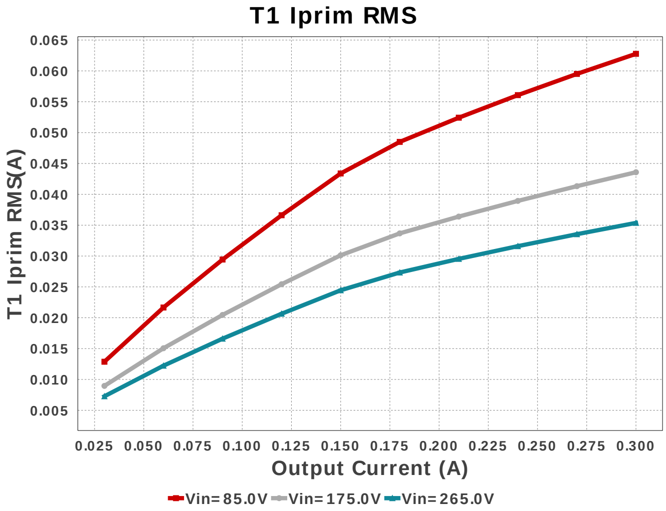

Efficiency
Efficiency(%)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

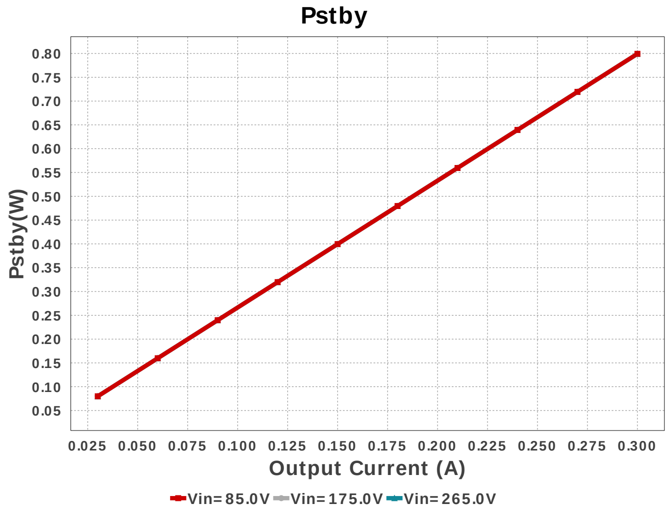

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

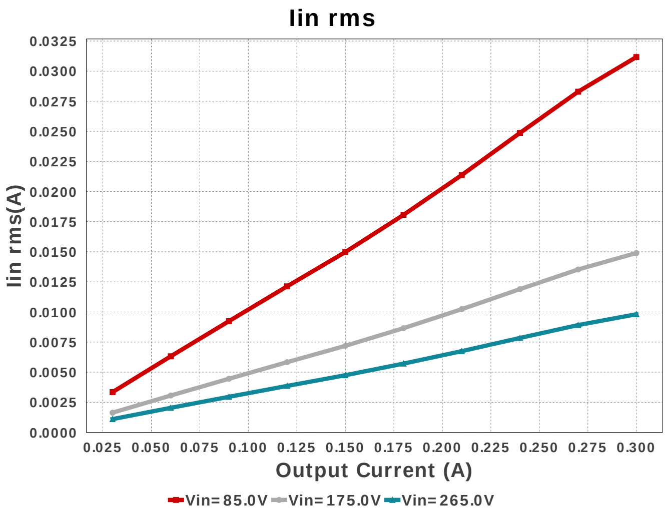

T1 Core Loss
T1 Core Loss(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

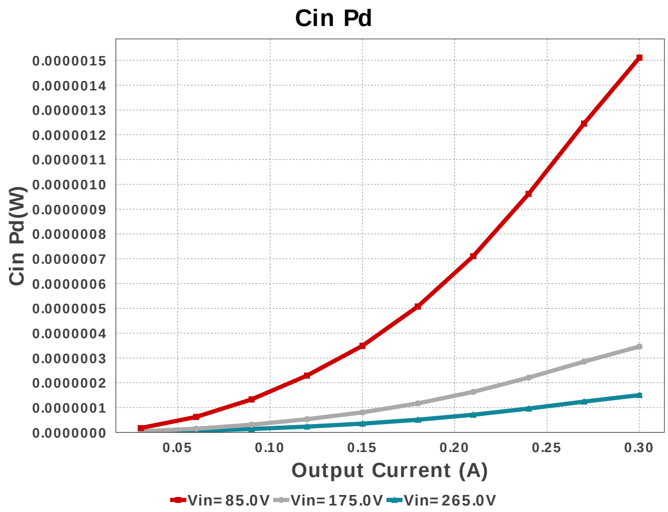

Cin2 IRMS
Cin2 IRMS(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Vout p-p
Vout p-p(V)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

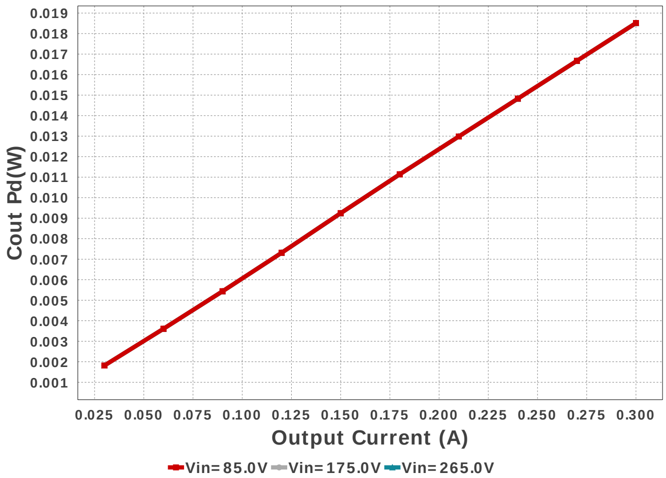

T1 Iprim RMS
T1 Iprim RMS(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Pstby
Pstby(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

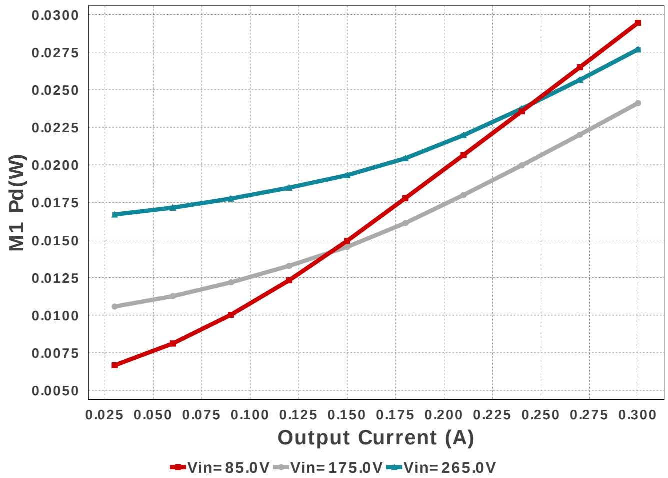

Iin rms
Iin rms(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Cin Pd
Cin Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

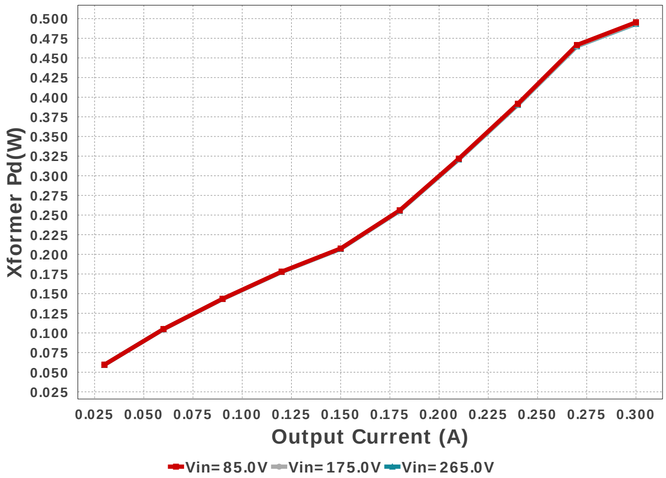
Cout Pd



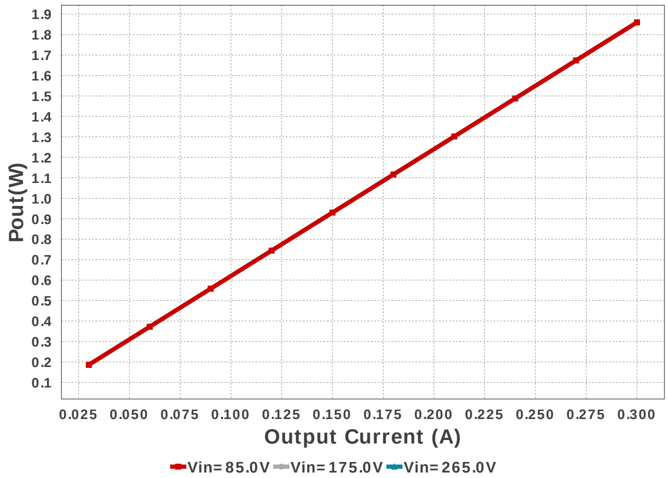
M1 Pd



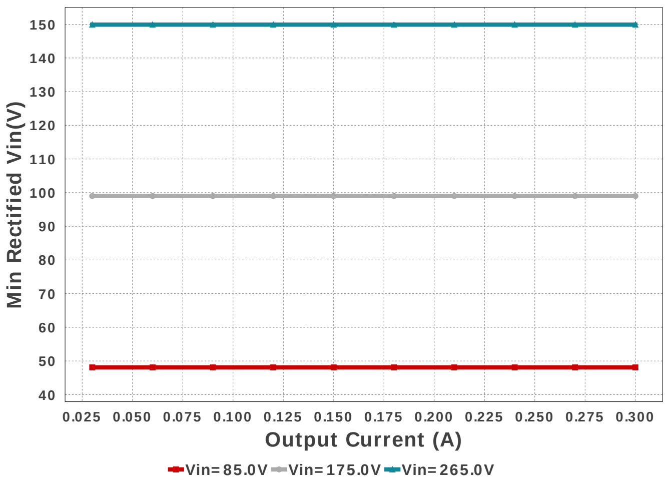
Xformer Pd



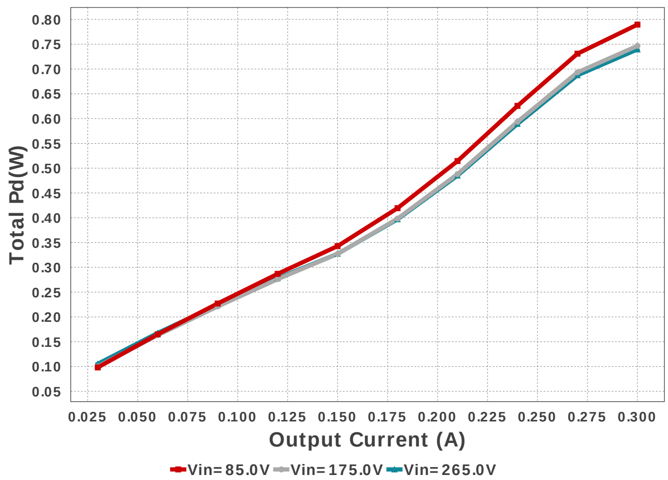
Pout



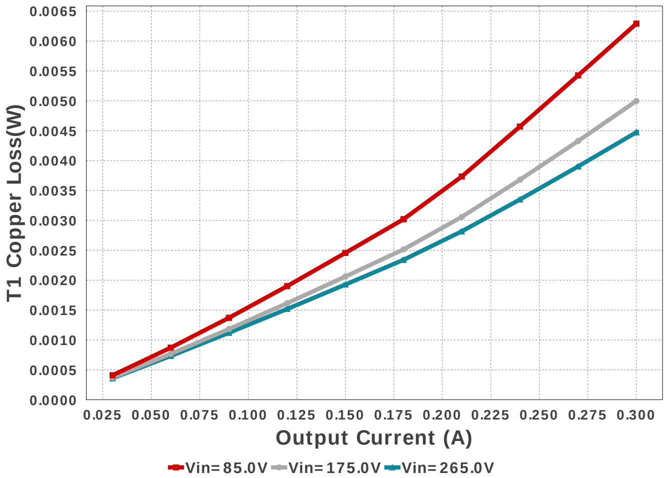
Min Rectified Vin



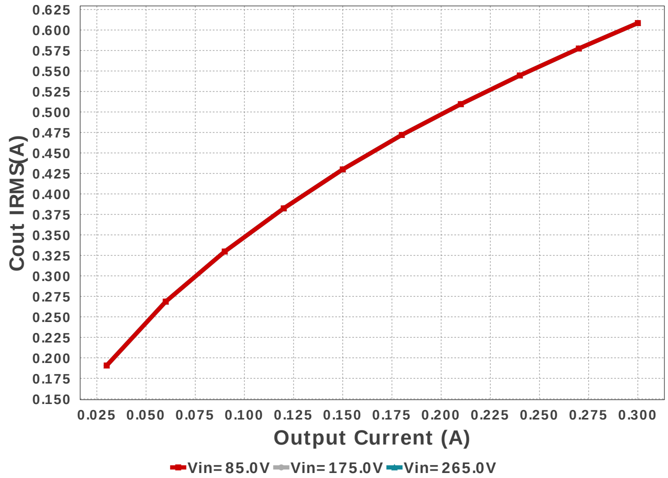
Total Pd



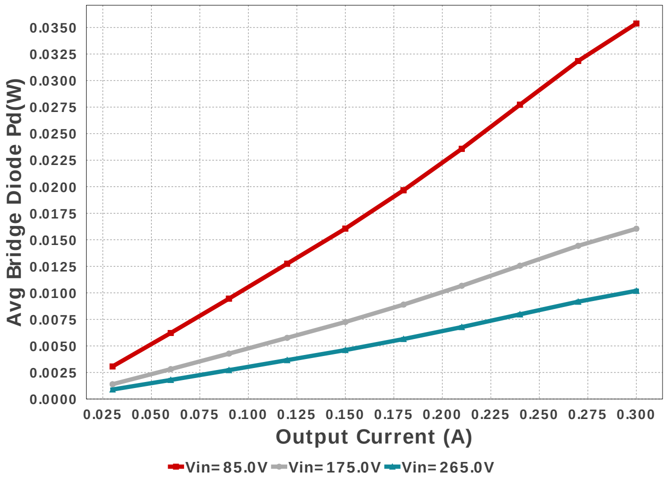
T1 Copper Loss



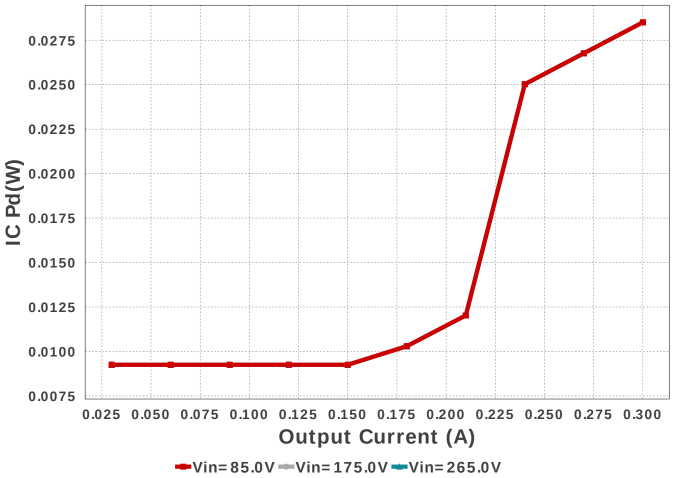
Cout IRMS



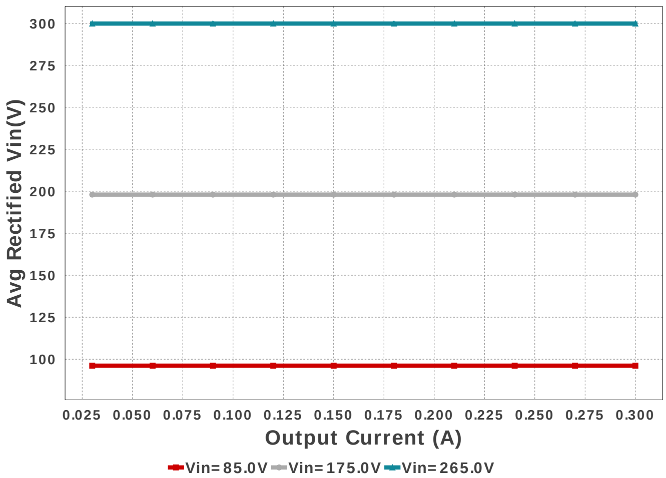
Avg Bridge Diode Pd



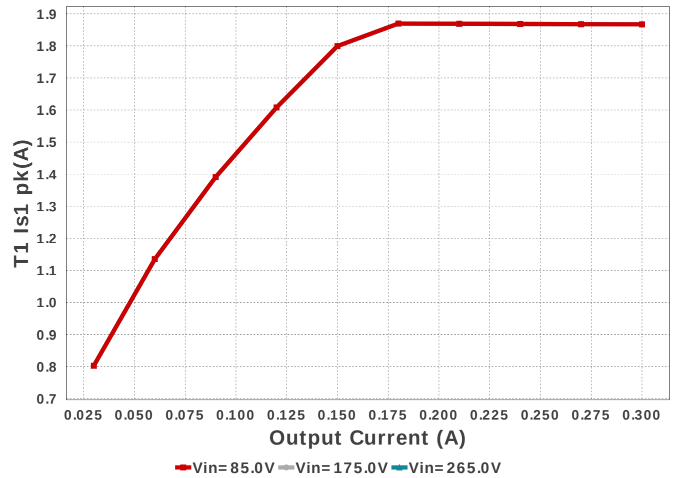
IC Pd



Avg Rectified Vin



T1 Is1 pk



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	44.65 mA	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	996.81 nW	Capacitor	Input capacitor power dissipation
3.	Cin2 IRMS	67.53 mA	Capacitor	Input Capacitor Cin2 RMS Ripple Current
4.	Cout IRMS	608.491 mA	Capacitor	Output capacitor RMS ripple current
5.	Cout Pd	18.513 mW	Capacitor	Output capacitor power dissipation
6.	Avg Bridge Diode Pd	28.773 mW	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
7.	Diode2 Pd	121.53 mW	Diode	Diode2 power dissipation
8.	IC Pd	28.505 mW	IC	IC power dissipation
9.	IC Tj	34.033 degC	IC	IC junction temperature
10.	ICThetaJA	141.5 degC/W	IC	IC junction-to-ambient thermal resistance
11.	M1 Pd	29.449 mW	Mosfet	M1 MOSFET total power dissipation

#	Name	Value	Category	Description
12.	M1 TjOP	33.133 degC	Mosfet	M1 MOSFET junction temperature
13.	Avg Bridge Diode Pd	28.773 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
14.	Cin Pd	996.81 nW	Power	Input capacitor power dissipation
15.	Cout Pd	18.513 mW	Power	Output capacitor power dissipation
16.	Diode2 Pd	121.53 mW	Power	Diode2 power dissipation
17.	IC Pd	28.505 mW	Power	IC power dissipation
18.	M1 Pd	29.449 mW	Power	M1 MOSFET total power dissipation
19.	Snubber Pd	26.34 mW	Power	Snubber Power Dissipation
20.	T1 Copper Loss	4.661 mW	Power	Transformer Copper Loss Power Dissipation
21.	T1 Core Loss	4.661 mW	Power	Transformer Core Loss Power Dissipation
22.	Total Pd	293.497 mW	Power	Total Power Dissipation
23.	Xformer Pd	9.322 mW	Power	Transformer power dissipation
24.	Avg Rectified Vin	96.166 V	System Information	Average Rectified Voltage for the AC Line Period
25.	BOM Count	25	System Information	Total Design BOM count
26.	Duty Cycle	46.47 %	System Information	Duty cycle
27.	Efficiency	86.371 %	System Information	Steady state efficiency
28.	FootPrint	1.019 k mm^2	System Information	Total Foot Print Area of BOM components
29.	Frequency	52.209 kHz	System Information	Switching frequency
30.	Frequency	52.209 kHz	System Information	Switching frequency
31.	Iin rms	25.335 mA	System Information	RMS Input Current
32.	Iout	300.0 mA	System Information	Iout operating point
33.	Min Rectified Vin	48.083 V	System Information	Minimum voltage seen at rectified input
34.	Mode	DCM	System Information	Conduction Mode
35.	Peak Rectified Vin	120.207 V	System Information	Peak voltage seen at rectified input
36.	Pout	1.86 W	System Information	Total output power
37.	Total BOM	$6.44	System Information	Total BOM Cost
38.	Vin_RMS	85.0 V	System Information	Vin operating point
39.	Vout	6.2 V	System Information	Operational Output Voltage
40.	Vout Actual	18.514 V	System Information	Vout Actual calculated based on selected voltage divider resistors
41.	Vout Tolerance	2.582 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Vout p-p	93.354 mV	System Information	Peak-to-peak output ripple voltage
43.	T1 Copper Loss	4.661 mW	Transformer	Transformer Copper Loss Power Dissipation
44.	T1 Core Loss	4.661 mW	Transformer	Transformer Core Loss Power Dissipation
45.	T1 Iprim RMS	62.768 mA	Transformer	Transformer Primary RMS Current
46.	T1 Iprim pk	159.483 mA	Transformer	Transformer Primary Peak Current
47.	T1 Is1 RMS	611.71 mA	Transformer	Transformer Secondary1 RMS Current
48.	T1 Is1 pk	1.867 A	Transformer	Transformer Secondary1 Peak Current
49.	Xformer Pd	9.322 mW	Transformer	Transformer power dissipation
50.	Pstby	799.237 mW	power	Pstby

Design Inputs

Name	Value	Description
Iout	300.0 m	Maximum Output Current
VinMax	265.0	Maximum input voltage
VinMin	85.0	Minimum input voltage
Vout	6.2	Output Voltage
acFrequency	60.0	AC Frequency
base_pn	UCC28730	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

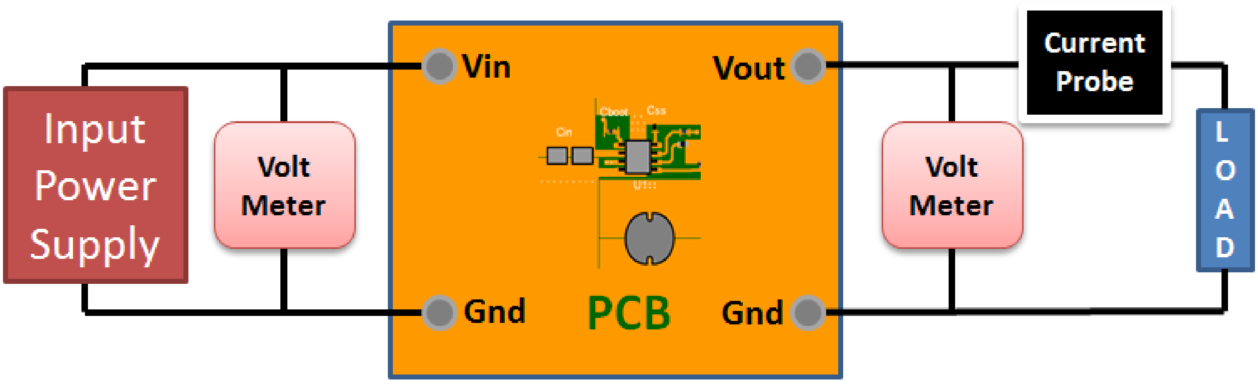
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins.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



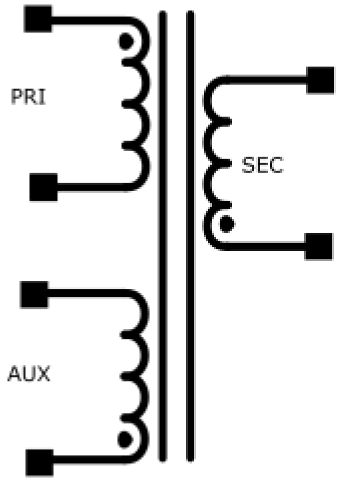
WEBENCH® Transformer Report

#	Name	Value
1.	Core Part Number	B66311G0000X127
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B66206C1012T001
4.	Coil Former Manufacturer	TDK

Transformer Electrical Diagram

Primary

Turns	60.0
AWG	25.0
Layers	3.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire



Secondary

Turns	5.0
AWG	26.0
Layers	1.0
Strands	3.0
Insulation Type	Triple Insulated

Auxiliary

Turns	14.0
AWG	28.0
Layers	1.0
Strands	2.0
Insulation Type	Heavy Insulated Magnet Wire

Transformer Construction Diagram

TRANSFORMER WINDING DIAGRAM – COMING SOON

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 2/3.0	25.0	40	Clockwise
Triple Insulated Secondary	26.0	5.0	Counter Clockwise
Auxiliary	28.0	14.0	Counter Clockwise
Primary Second 1/3.0	25.0	20	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	0.00397H
2.	Inductance Factor(Al)	1102.0nH
3.	Npri	60.0
4.	Nsec	5.0
5.	Naux	14.0
6.	Core Type	E20/10/6
7.	Core Material	N27
8.	Bmax	0.25T
9.	Switching Frequency	61.65kHz
10.	DMax	0.51
11.	Ipk(Primary)	0.12A
12.	Irms(Primary)	0.05A

#	Name	Value
13.	Ipk(Secondary)	1.44A
14.	Irms(Secondary)	0.54A

Design Assistance

1. Application Hints: Rbld: Rbld is used to to set a minimum load for the circuit, so that in standby the output voltage does not float up. The value chosen by WEBENCH should be a good starting point but may need to be adjusted to achieve minimum power dissipation at standby as well. Rlc: Rlc provides the function of feed-forward line compensation to eliminate change in IPP due to change in di/dt and the propagation delay of the internal comparator and MOSFET turn-off time. For best results the chosen value may need to be adjusted based on board, FET and transformer parasitics. Rfbt & Rfbb: The feedback resistors will set the output voltage of the circuit. The values chosen may need to be fined tuned based on the final Transformer turns ratios and the voltage across the output diode at close to zero current. Rwake: To avoid exceeding the maximum source-current rating for WAKE on the UCC24650, a series resistor, Rwake, may be required to limit the WAKE current. For more information regarding Rwake, please refer to the UCC24650 datasheet. Cdd Cdd supplies the device operating current until the output of the converter reaches the target minimum operating voltage. The value calculated by WEBENCH for Cdd is a good starting point since it assumes that the output current of the Flyback is available to charge the output capacitance until the minimum output voltage is acheived, but may need to be adjusted. Part Description: The UCC28730 family of flyback power supply controllers provides Constant-Voltage (CV) and Constant-Current (CC) output regulation. Primary-Side Regulation (PSR) eliminates the use of an Opto-Coupler. The UCC24650 is an easy to use secondary-side voltage monitor that can provided a wake-up alert singal to a primary-side regulation (PSR) controller, such as the UCC28730, to help acheive <5mW Zero-Power standby loss in many applications and provide excellent load transient performance. Please see the datasheet for further design guidance. http://www.ti.com/lit/ds/symlink/ucc28730.pdf http://www.ti.com/lit/ds/symlink/ucc24650.pdf

2. Master key : 8539E8D1B888CCB1[v1]

3. **UCC28730** Product Folder : http://www.ti.com/product/UCC28730 : contains the data sheet and other resources.