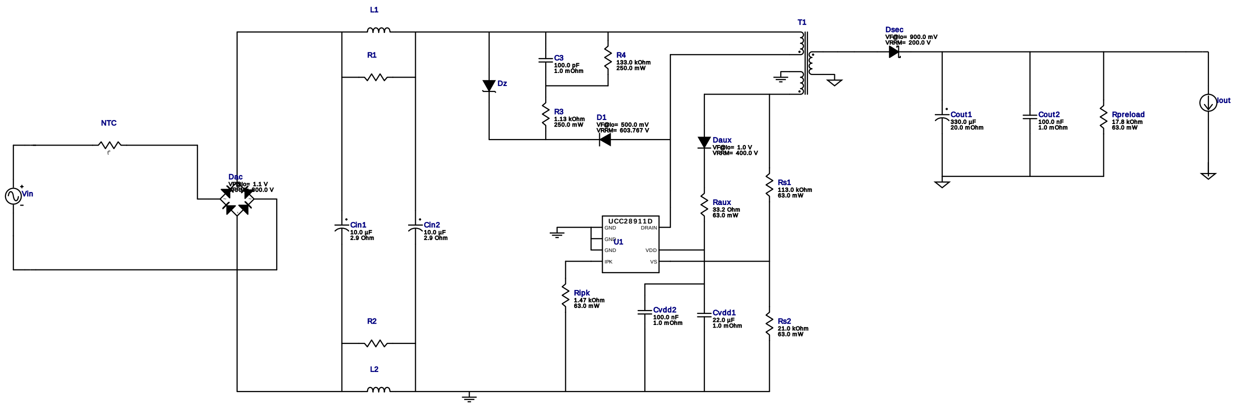
VinMin = 85.0V
VinMax = 265.0V
Vout = 12.0V
Iout = 0.5A

Device = UCC28911D
Topology = Flyback
Created = 2024-08-24 12:16:38.979
BOM Cost = NA
BOM Count = 22
Total Pd = 1.85W

WEBENCH ® Design Report

Design : 2 UCC28911D
UCC28911D 85V-265V to 12.00V @ 0.5A



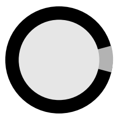
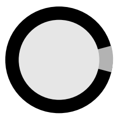
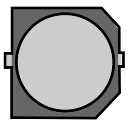
1. The EMI filter shown in the schematic is a placeholder. It has not yet been designed for the application.

Design Alerts

Component Selection Information

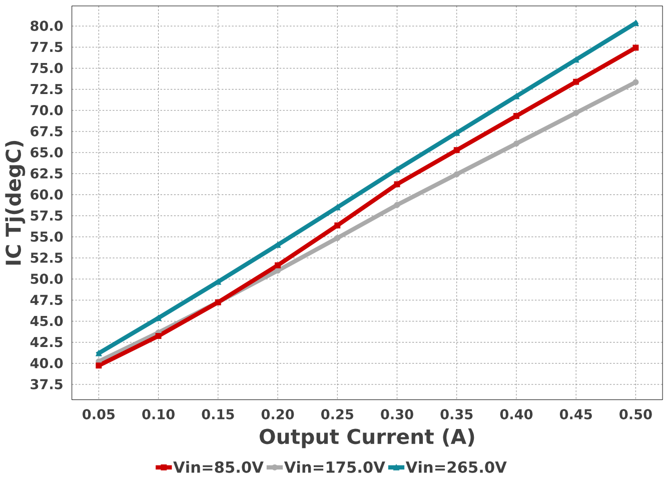
Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

Electrical BOM

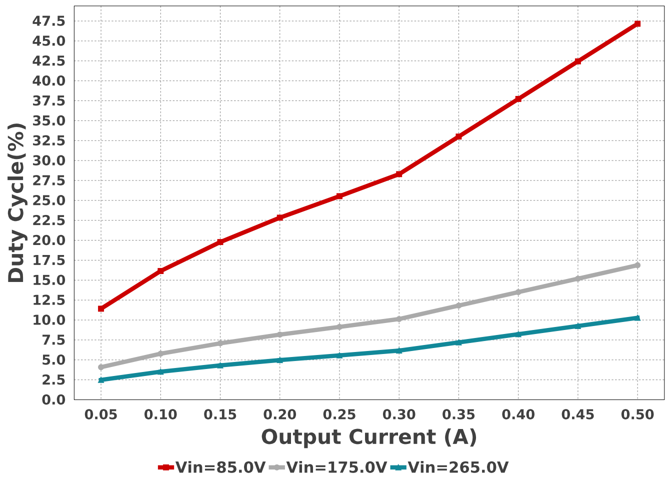
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
C3	MuRata	GRM21A5C2E101JW01D Series= C0G/NP0	Cap= 100.0 pF ESR= 1.0 mOhm VDC= 250.0 V IRMS= 0.0 A	1	$0.07	0805 7 mm²
Cin1	Kemet	ESG106M400AH4AA Series= 2334	Cap= 10.0 uF ESR= 2.9 Ohm VDC= 400.0 V IRMS= 100.0 mA	1	$0.29	 ESG106 144 mm²
Cin2	Kemet	ESG106M400AH4AA Series= 2334	Cap= 10.0 uF ESR= 2.9 Ohm VDC= 400.0 V IRMS= 100.0 mA	1	$0.29	 ESG106 144 mm²
Cout1	Panasonic	EEHZC1E331P Series= ZC	Cap= 330.0 uF ESR= 20.0 mOhm VDC= 25.0 V IRMS= 2.0 A	1	$1.01	 SM_RADIAL_10BMM 160 mm²
Cout2	Kemet	C0603C104M3VACTU Series= Y5V	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0603 5 mm²

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvdd1	Taiyo Yuden	TMK325B7226KMHP Series= X7R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.31	1210_270 15 mm^2
Cvdd2	Yageo	CC0805KRX7R9BB104 Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm^2
D1	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 603.767 V	1	NA	CUSTOM 0 mm^2
Dac	Vishay-Semiconductor	DF08SA	VF@Io= 1.1 V VRRM= 800.0 V	1	$0.28	DF-S 99 mm^2
Daux	SMC Diode Solutions	UF4004TA	VF@Io= 1.0 V VRRM= 400.0 V	1	$0.04	DO-41 43 mm^2
Dsec	Fairchild Semiconductor	S320	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.33	SMB 44 mm^2
Dz	ON Semiconductor	1SMB5953BT3G	Zener	1	$0.12	SMB 44 mm^2
NTC	Ametherm	SL0310001 Series= miniAMP	Thermistor	1	$0.26	SL03 16 mm^2
R3	Vishay-Dale	CRCW12061K13FKEA Series= CRCW..e3	Res= 1.13 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
R4	Vishay-Dale	CRCW1206133KFKEA Series= CRCW..e3	Res= 133.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Raux	Vishay-Dale	CRCW040233R2FKED Series= CRCW..e3	Res= 33.2 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ripk	Vishay-Dale	CRCW04021K47FKED Series= CRCW..e3	Res= 1.47 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rpreload	Vishay-Dale	CRCW040217K8FKED Series= CRCW..e3	Res= 17.8 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rs1	Vishay-Dale	CRCW0402113KFKED Series= CRCW..e3	Res= 113.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rs2	Vishay-Dale	CRCW040221K0FKED Series= CRCW..e3	Res= 21.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
T1	Core=TDK , CoilFormer=TDK	Core=B66417G0000X149 , CoilFormer=B66418W1008D001	Lp= 1.051 mH Turns Ratio(Nas)= 20:12 Turns Ratio(Nps)= 73:12 Npri= 73.0 Naux= 20.0 Nsec= 12.0	1	$1.02	TDK_B66305 491 mm^2
U1	Texas Instruments	UCC28911D	Switcher	1	$0.58	D0007A 55 mm^2

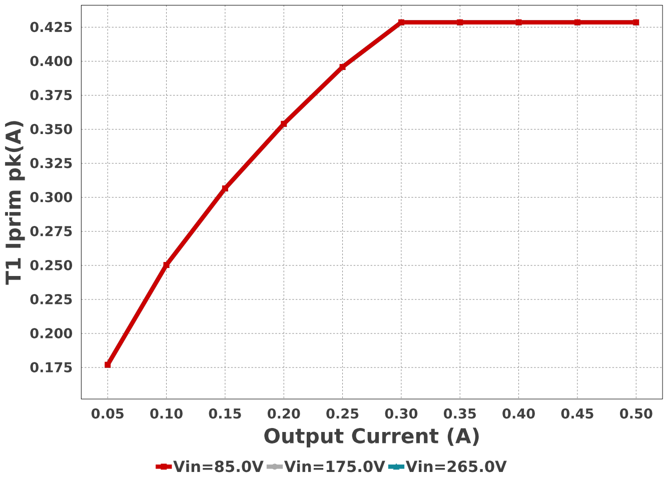
IC Tj



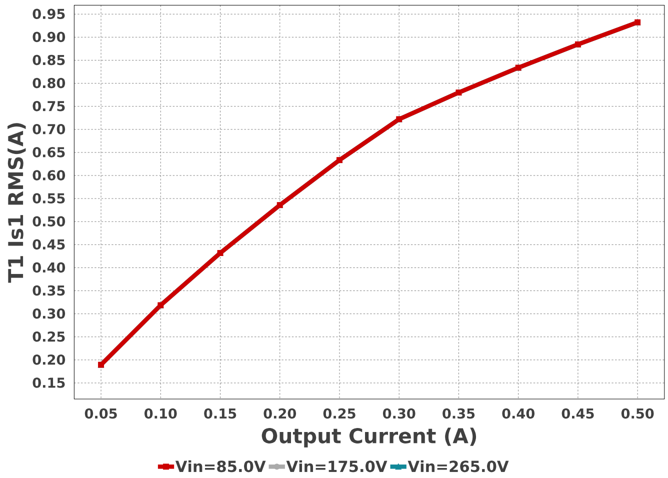
Duty Cycle



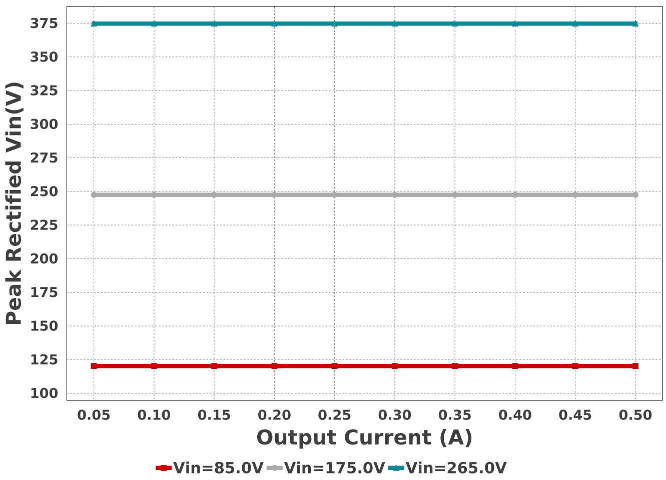
T1 Iprim pk



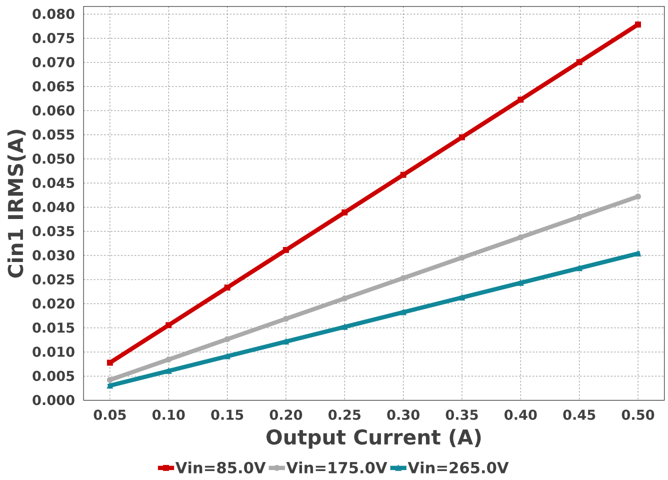
T1 Is1 RMS

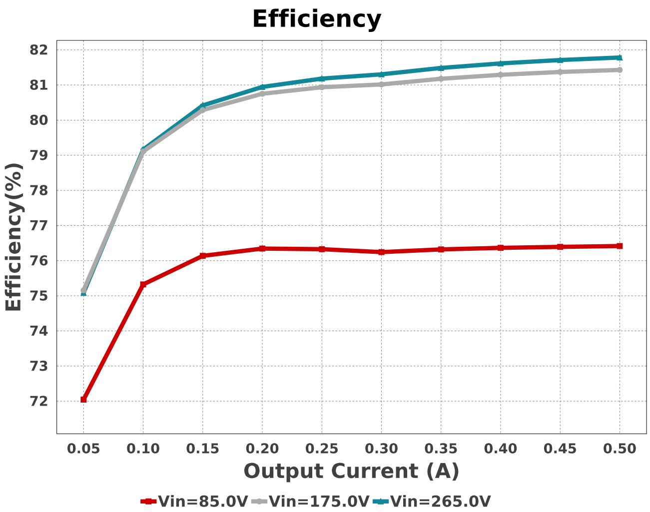


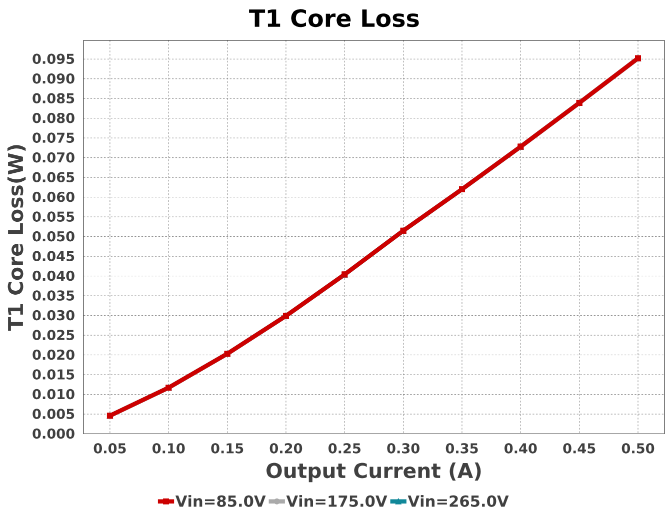
Peak Rectified Vin

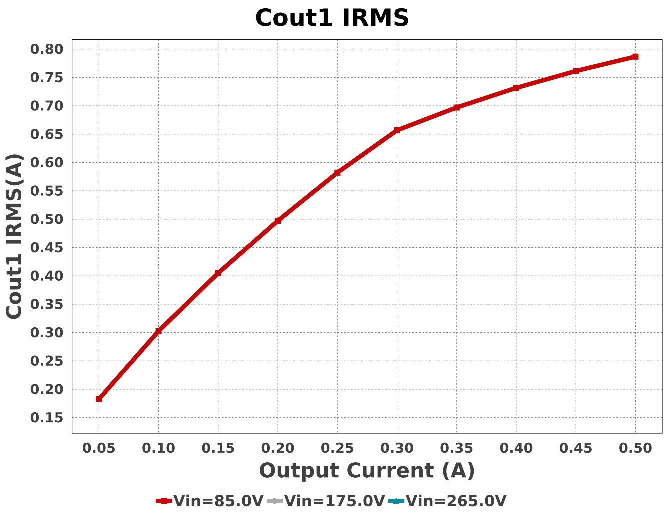


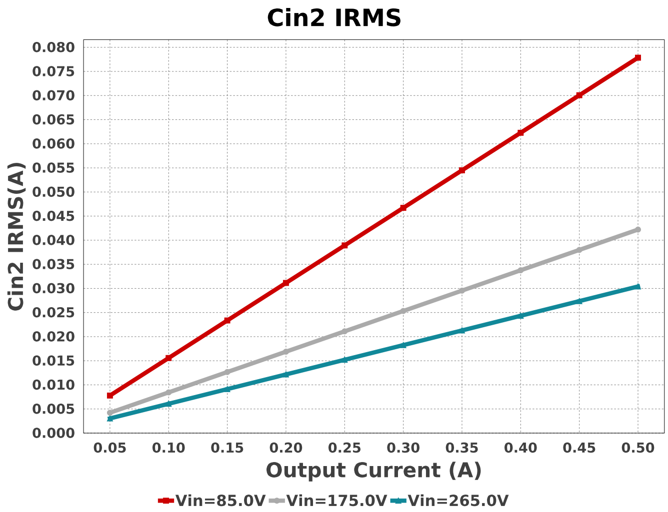
Cin1 IRMS

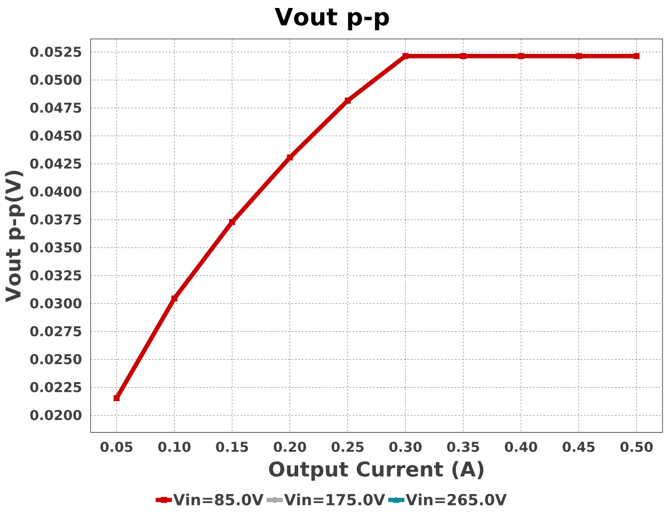


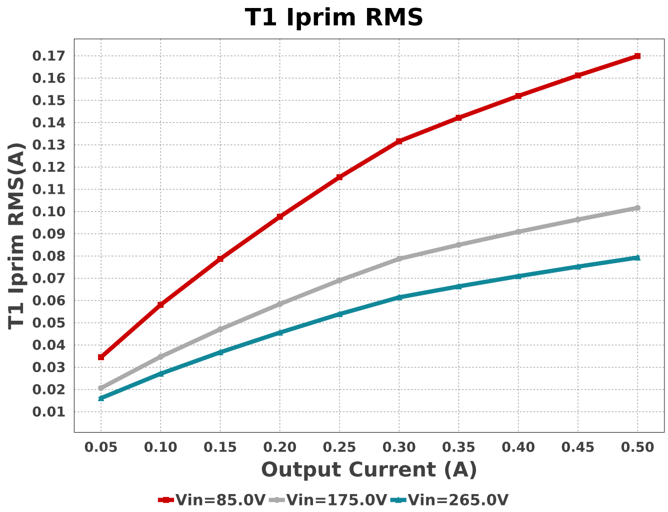

Efficiency
Efficiency(%)
82
81
80
79
78
77
76
75
74
73
72
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


T1 Core Loss
T1 Core Loss(W)
0.095
0.090
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

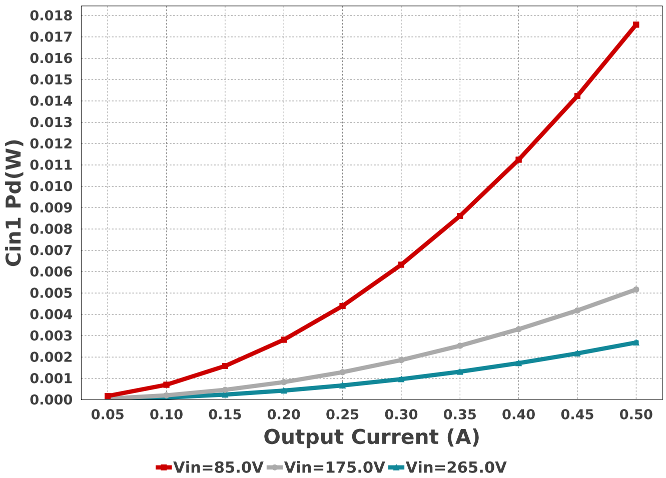

Cout1 IRMS
Cout1 IRMS(A)
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Cin2 IRMS
Cin2 IRMS(A)
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

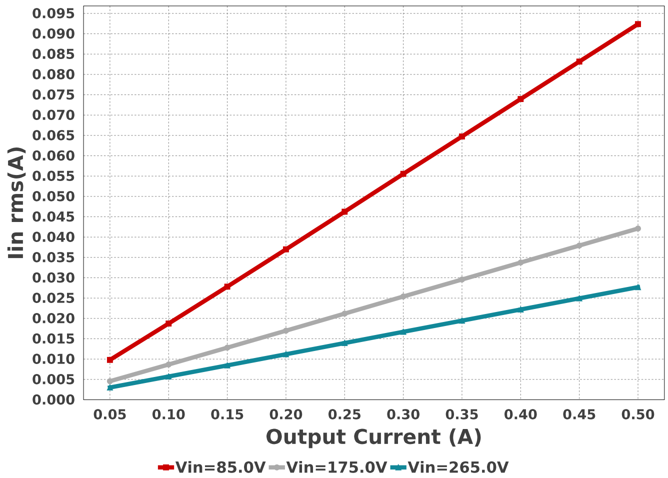

Vout p-p
Vout p-p(V)
0.0525
0.0500
0.0475
0.0450
0.0425
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


T1 Iprim RMS
T1 Iprim RMS(A)
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

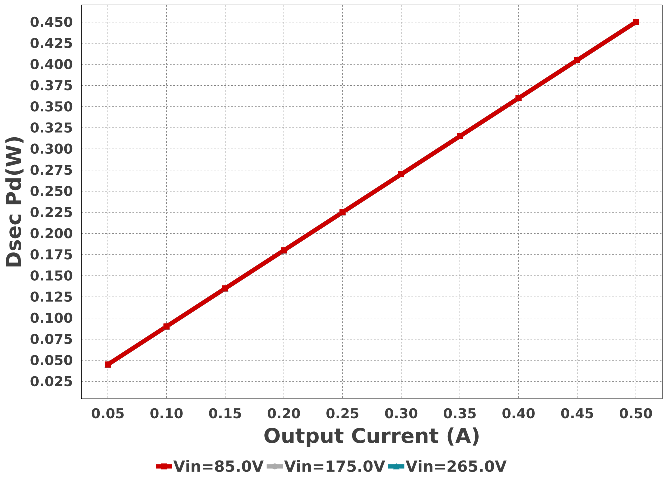
Cin1 Pd



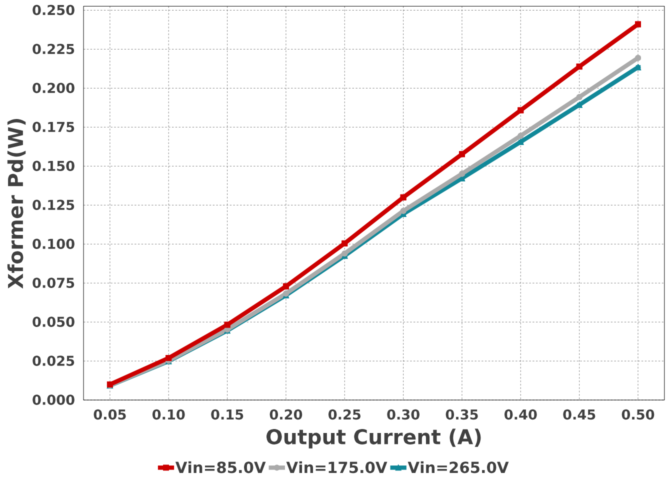
Iin rms



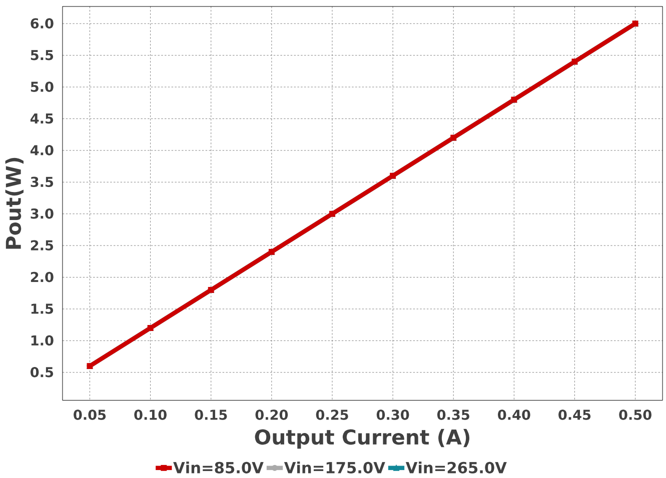
Dsec Pd



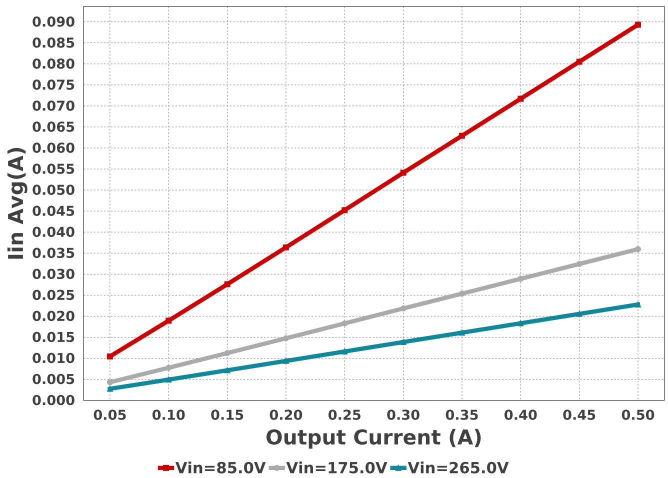
Xformer Pd

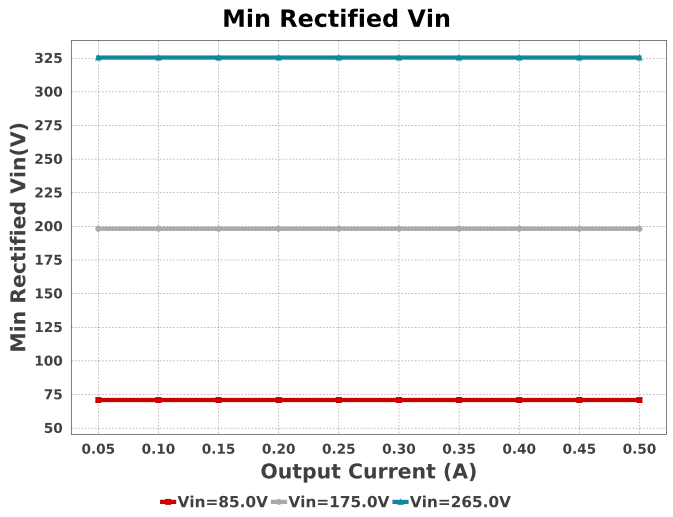


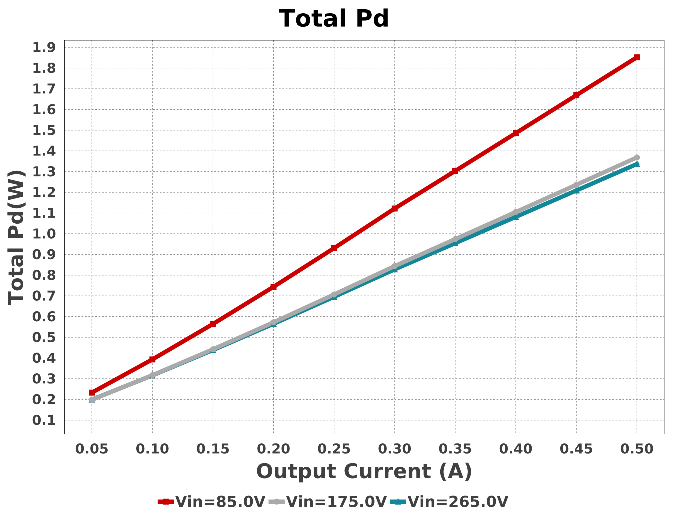
Pout

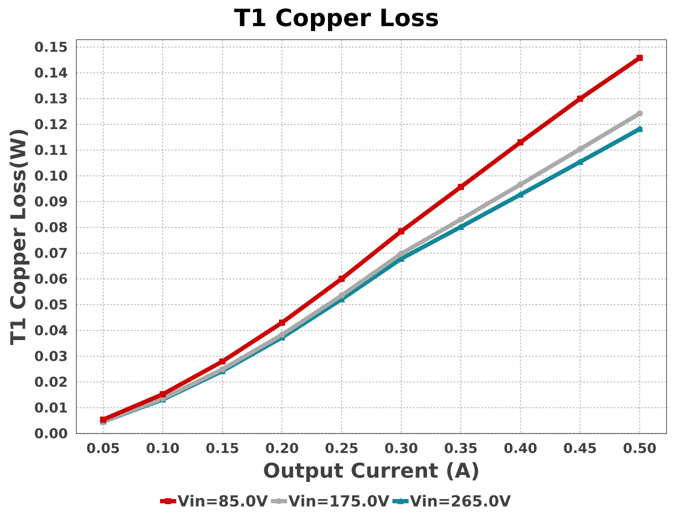


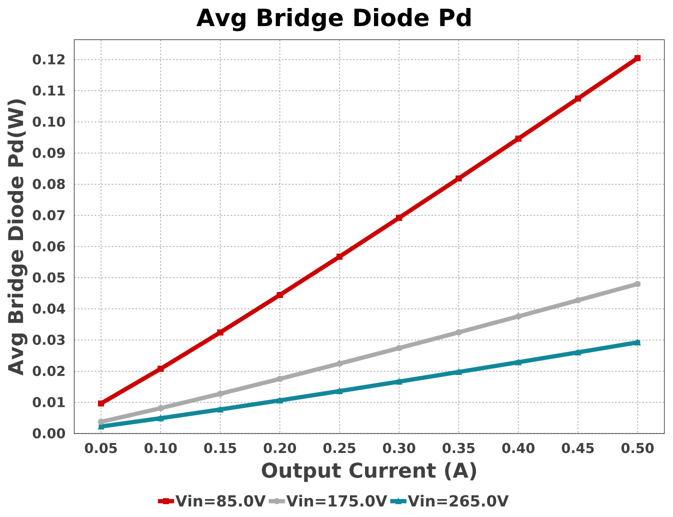
Iin Avg

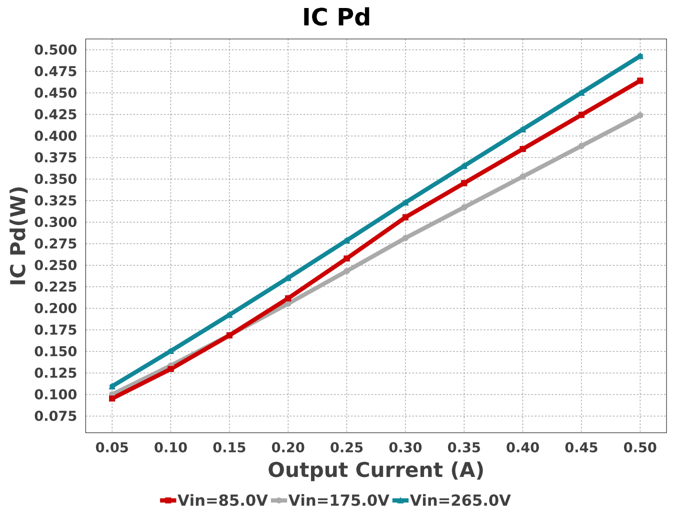


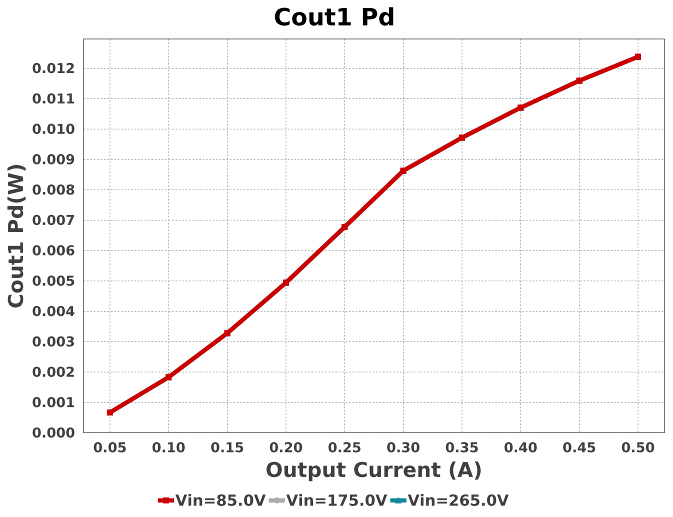

Min Rectified Vin
Min Rectified Vin(V)
325
300
275
250
225
200
175
150
125
100
75
50
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

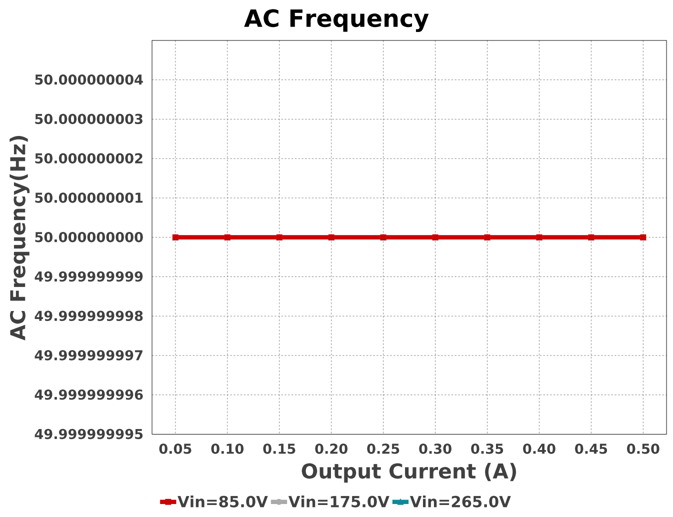

Total Pd
Total Pd(W)
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

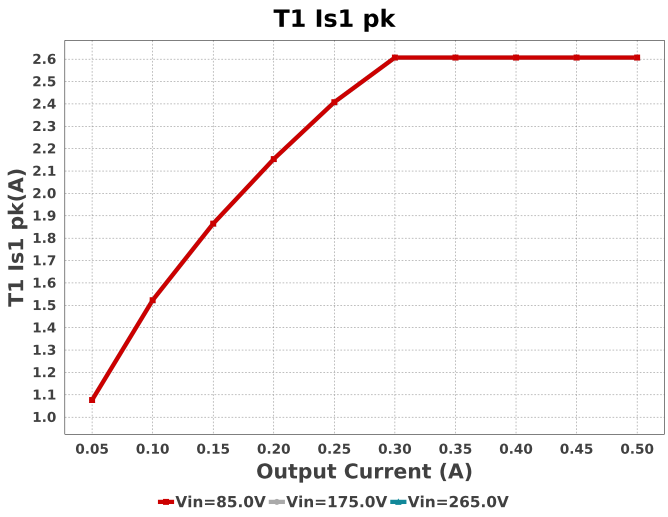

T1 Copper Loss
T1 Copper Loss(W)
0.15
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Avg Bridge Diode Pd
Avg Bridge Diode Pd(W)
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
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=85.0V Vin=175.0V Vin=265.0V


IC Pd
IC Pd(W)
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
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Cout1 Pd
Cout1 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
0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40 0.45 0.50
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin1 IRMS	77.846 mA	Capacitor	Input Capacitor Cin1 RMS Ripple Current
2.	Cin1 Pd	17.574 mW	Capacitor	Average Power Dissipation in the Input Capacitor Cin1
3.	Cin2 IRMS	77.846 mA	Capacitor	Input Capacitor Cin2 RMS Ripple Current
4.	Cout1 IRMS	786.796 mA	Capacitor	Output capacitor1 RMS ripple current
5.	Cout1 Pd	12.381 mW	Capacitor	Output capacitor1 power dissipation
6.	Avg Bridge Diode Pd	120.47 mW	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
7.	D1 trr	500.0 ns	Diode	D1 Reverse Recovery Time
8.	Daux trr	50.0 ns	Diode	Auxiliary Diode Reverse Recovery Time
9.	Dsec Pd	450.0 mW	Diode	Secondary Diode Power Dissipation
10.	Dsec trr	30.0 ns	Diode	Output Diode Reverse Recovery Time
11.	IC Pd	464.14 mW	IC	IC power dissipation
12.	IC Tj	77.435 degC	IC	IC junction temperature
13.	ICThetaJA	102.2 degC/W	IC	IC junction-to-ambient thermal resistance
14.	Iin Avg	89.325 mA	IC	Average input current
15.	Avg Bridge Diode Pd	120.47 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
16.	Cin1 Pd	17.574 mW	Power	Average Power Dissipation in the Input Capacitor Cin1
17.	Cout1 Pd	12.381 mW	Power	Output capacitor1 power dissipation
18.	Dsec Pd	450.0 mW	Power	Secondary Diode Power Dissipation
19.	IC Pd	464.14 mW	Power	IC power dissipation
20.	T1 Copper Loss	145.8 mW	Power	Transformer Copper Loss Power Dissipation
21.	T1 Core Loss	95.2 mW	Power	Transformer Core Loss Power Dissipation
22.	Total Pd	1.852 W	Power	Total Power Dissipation
23.	Xformer Pd	241.0 mW	Power	Transformer power dissipation
24.	AC Frequency	50.0 Hz	System Information	Input AC frequency
25.	BOM Count	22	System Information	Total Design BOM count
26.	Duty Cycle	47.157 %	System Information	Duty cycle at the Minimum voltage seen at the rectified input
27.	Efficiency	76.416 %	System Information	Steady state efficiency
28.	FootPrint	1.41 k mm^2	System Information	Total Foot Print Area of BOM components
29.	Frequency	74.25 kHz	System Information	Approximate switching frequency
30.	Iin rms	92.374 mA	System Information	RMS Input Current
31.	Iout	500.0 mA	System Information	Iout operating point
32.	Min Rectified Vin	70.922 V	System Information	Minimum voltage seen at rectified input
33.	Mode	DCM	System Information	Conduction Mode
34.	Peak Rectified Vin	120.207 V	System Information	Peak voltage seen at rectified input
35.	Pout	6.0 W	System Information	Total output power
36.	Total BOM	NA	System Information	Total BOM Cost
37.	Vin_RMS	85.0 V	System Information	Vin operating point

#	Name	Value	Category	Description
38.	Vout	12.0 V	System Information	Operational Output Voltage
39.	Vout Tolerance	66.667 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
40.	Vout p-p	52.143 mV	System Information	Peak-to-peak output ripple voltage
41.	T1 Copper Loss	167.08 mW	Transformer	Transformer Copper Loss Power Dissipation
42.	T1 Core Loss	120.0 mW	Transformer	Transformer Core Loss Power Dissipation
43.	T1 Iprim RMS	169.916 mA	Transformer	Transformer Primary RMS Current
44.	T1 Iprim pk	428.571 mA	Transformer	Transformer Primary Peak Current
45.	T1 Is1 RMS	932.227 mA	Transformer	Transformer Secondary1 RMS Current
46.	T1 Is1 pk	2.607 A	Transformer	Transformer Secondary1 Peak Current
47.	Xformer Pd	287.08 mW	Transformer	Transformer power dissipation

Design Inputs

Name	Value	Description
Iout	500.0 m	Maximum Output Current
VinMax	265.0	Maximum input voltage
VinMin	85.0	Minimum input voltage
Vout	12.0	Output Voltage
acFrequency	50.0	AC Frequency
base_pn	UCC28911	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

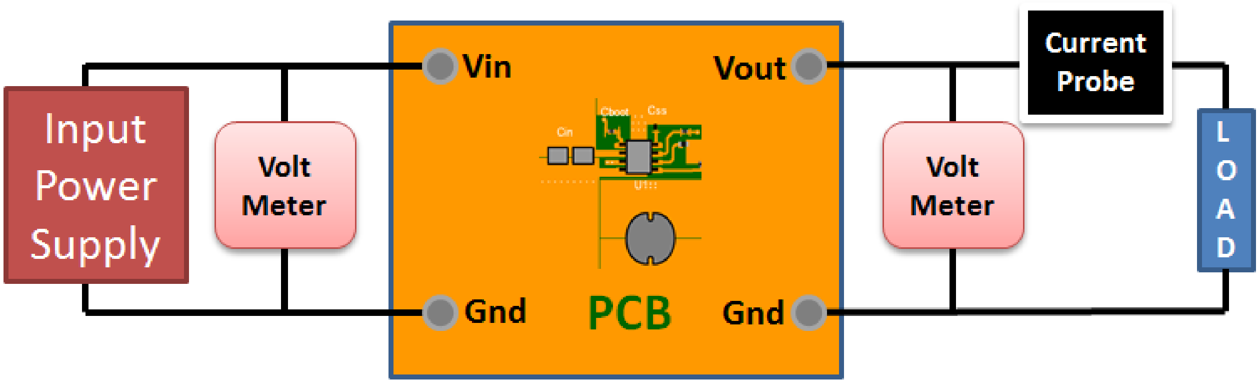
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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	B66417G0000X149
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B66418W1008D001
4.	Coil Former Manufacturer	TDK

Transformer Electrical Diagram

Primary

Turns	73.0
AWG	26.0
Layers	3.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	12.0
AWG	32.0
Layers	1.0
Strands	2.0
Insulation Type	Triple Insulated

Auxiliary

Turns	20.0
AWG	28.0
Layers	1.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire

Transformer Construction Diagram

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 2/3.0	26.0	49	Clockwise
Triple Insulated Secondary	32.0	12.0	Counter Clockwise
Auxiliary	28.0	20.0	Counter Clockwise
Primary Second 1/3.0	26.0	24	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	0.00105H
2.	Inductance Factor(Al)	198.0nH
3.	Npri	73.0
4.	Nsec	12.0
5.	Naux	20.0
6.	Core Type	EFD20/10/7
7.	Core Material	N49

#	Name	Value
8.	Bmax	0.20T
9.	Switching Frequency	90.00kHz
10.	DMax	0.48
11.	Ipk(Primary)	0.43A
12.	Irms(Primary)	0.17A
13.	Ipk(Secondary)	2.61A
14.	Irms(Secondary)	0.97A

Design Assistance

1. Master key : 0E2CCDFB9143C5FFACC9ADCC688F2624[v1]
2. **UCC28911** Product Folder : http://www.ti.com/product/UCC28911 : contains the data sheet and other resources.