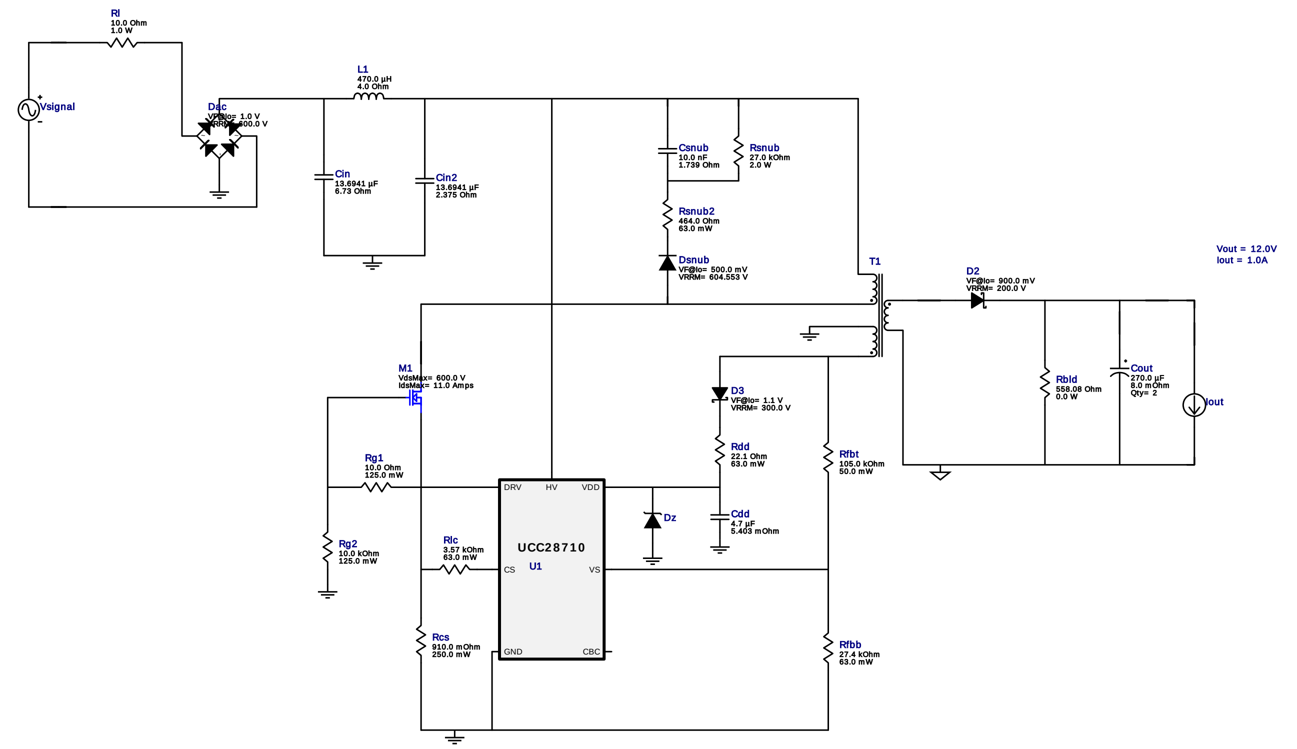
Texas Instruments

WEBENCH® Design Report

VinMin = 85.0V
VinMax = 265.0V
Vout = 12.0V
Iout = 1.0A

Device = UCC28710DR.B
Topology = Flyback
Created = 2025-12-25 23:39:36.527
BOM Cost = NA
BOM Count = 26
Total Pd = 3.79W

Design : 12 UCC28710DR.B
UCC28710DR.B 85V-265V to 12.90V @ 1A



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.

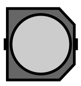
2. Click on the transformer symbol and select 'Design Transformer' to design using specific transformer cores and bobbin

Design Alerts

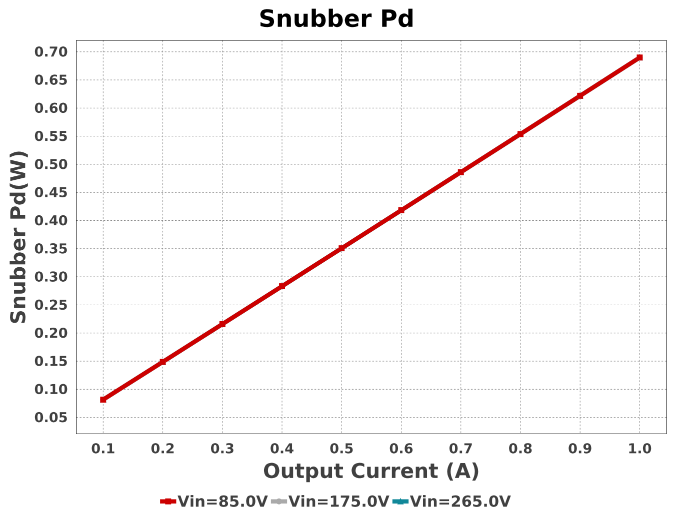
Component Selection Information

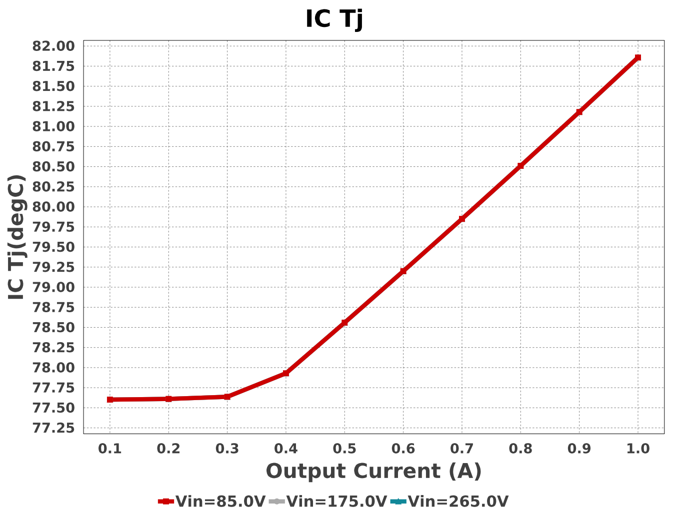
Click on the transformer symbol in the schematic and select "Explore Transformer Core/Bobbin Selection" to design using specific transformer cores and bobbin.

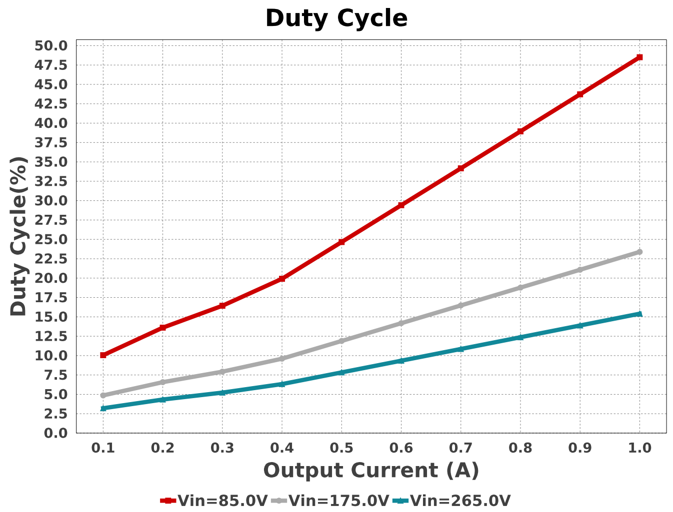
Electrical BOM

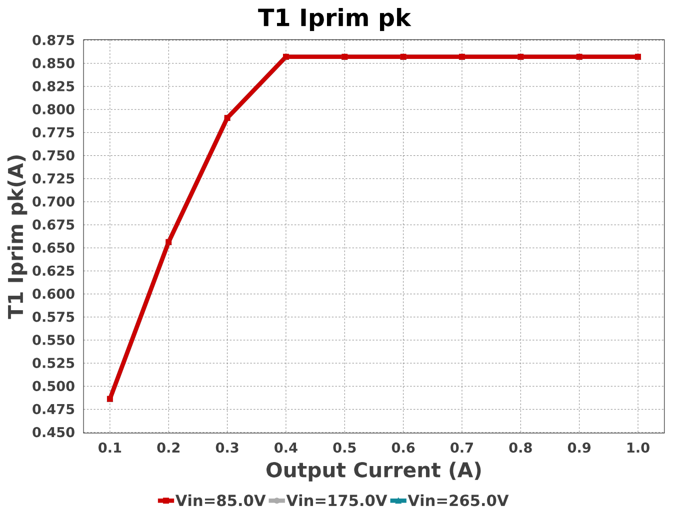
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cdd	TDK	C2012X5R1V475K125AC Series= X5R	Cap= 4.7 uF ESR= 5.403 mOhm VDC= 35.0 V IRMS= 0.0 A	1	$0.08	0805 7 mm^2
Cin	CUSTOM	CUSTOM Series= ?	Cap= 13.6941 uF ESR= 6.7302 Ohm VDC= 562.14 V IRMS= 130.3 mA	1	NA	CUSTOM 0 mm^2
Cin2	CUSTOM	CUSTOM Series= ?	Cap= 13.6941 uF ESR= 2.3751 Ohm VDC= 562.14 V IRMS= 200.263 mA	1	NA	CUSTOM 0 mm^2
Cout	Panasonic	16SVPG270M Series= SVPG	Cap= 270.0 uF ESR= 8.0 mOhm VDC= 16.0 V IRMS= 5.8 A	2	$0.97	 CAPSMT_62_C10 74 mm^2

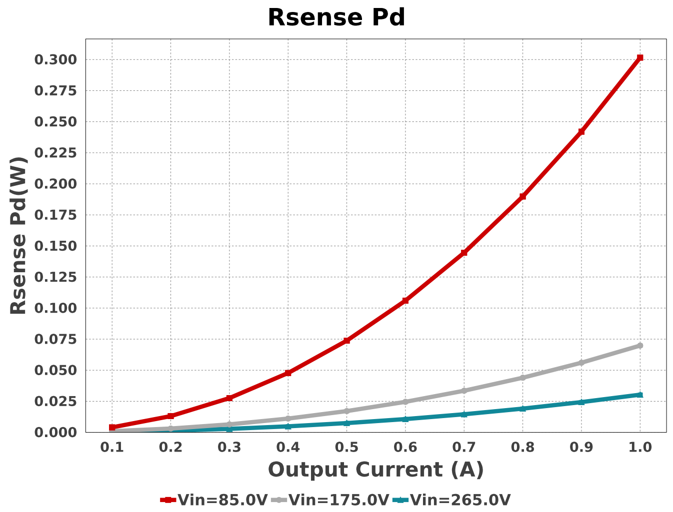
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
D2	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.06	SMA 37 mm^2
D3	SMC Diode Solutions	ST1300ATR	VF@Io= 1.1 V VRRM= 300.0 V	1	$0.12	SMA 37 mm^2
Dac	Diodes Inc.	HD06-T	VF@Io= 1.0 V VRRM= 600.0 V	1	$0.15	MiniDIP 62 mm^2
Dz	Diodes Inc.	SMBJ22A-13-F	Zener	1	$0.10	SMB 44 mm^2
L1	NIC Components	NPI54C471KTRF	L= 470.0 µH 4.0 Ohm	1	$0.15	IND_NPI54C 61 mm^2
M1	STMicroelectronics	STF13NM60ND	VdsMax= 600.0 V IdsMax= 11.0 Amps	1	$2.73	TO-220FP 79 mm^2
Rbld	CUSTOM	CUSTOM Series= ?	Res= 558.08 Ohm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rcs	Bourns	CRM0805-FX-R910ELF Series= ?	Res= 910.0 mOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.04	0805 7 mm^2
Rdd	Vishay-Dale	CRCW040222R1FKED Series= CRCW..e3	Res= 22.1 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Vishay-Dale	CRCW040227K4FKED Series= CRCW..e3	Res= 27.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbt	Yageo	RC0201FR-07105KL Series= ?	Res= 105.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2
Rg1	Vishay-Dale	CRCW080510R0FKEA Series= CRCW..e3	Res= 10.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rg2	Vishay-Dale	CRCW080510K0FKEA Series= CRCW..e3	Res= 10.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rl	Vishay-Dale	CRCW121810R0FKEK Series= CRCW..e3	Res= 10.0 Ohm Power= 1.0 W Tolerance= 1.0%	1	$0.13	1218 24 mm^2
Rlc	Vishay-Dale	CRCW04023K57FKED Series= CRCW..e3	Res= 3.57 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
T1	Core=Wurth Elektronik , CoilFormer=Wurth Elektronik	Core=150-1945 , CoilFormer=070-6372	Lp= 523.0 µH Turns Ratio(Nas)= 14:9 Turns Ratio(Nps)= 66:9 Npri= 66.0 Naux= 14.0 Nsec= 9.0	1	NA	TDK_B66305 410 mm^2
U1	Texas Instruments	UCC28710DR.B	Switcher	1	$0.53	SOIC-7 0 mm^2

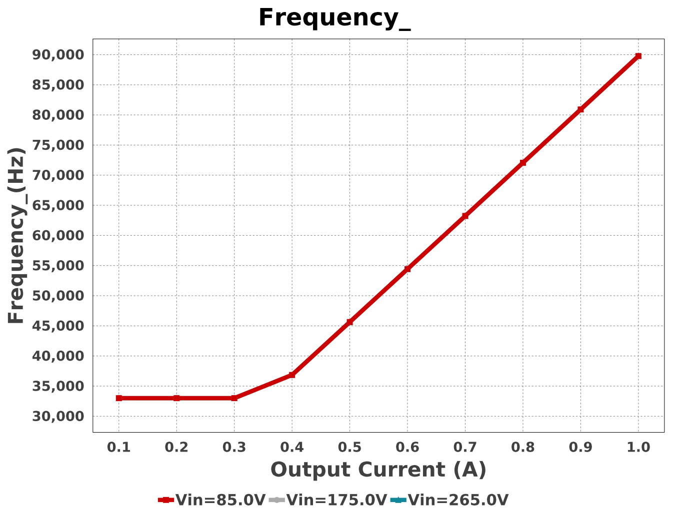

Snubber Pd
Snubber Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

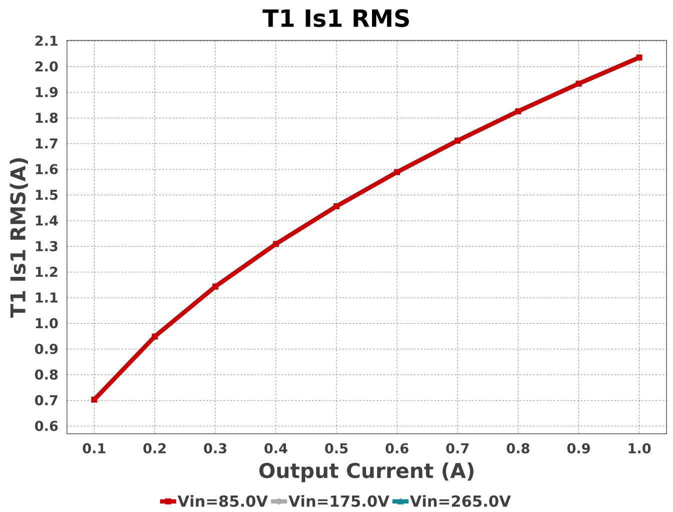

IC Tj
IC Tj(degC)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

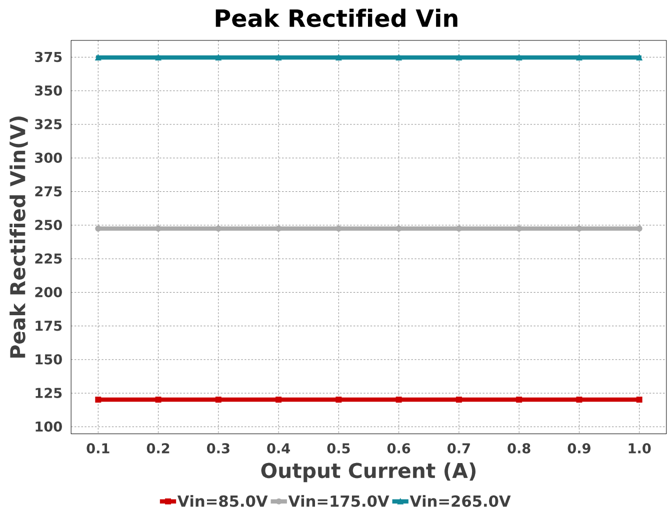

Duty Cycle
Duty Cycle(%)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

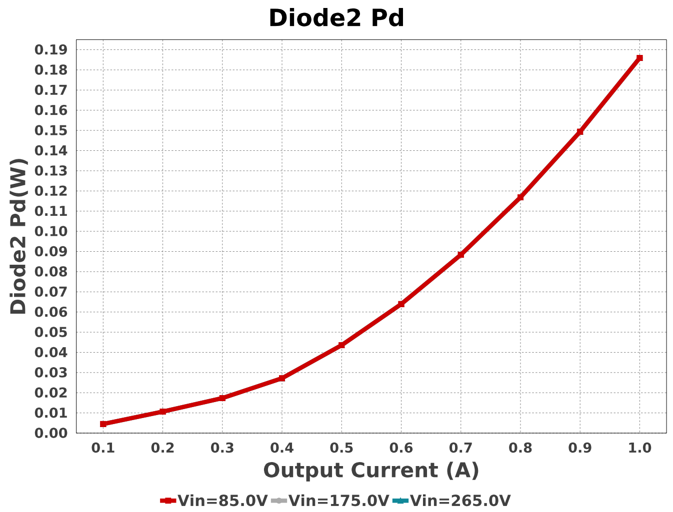

T1 Iprim pk
T1 Iprim pk(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

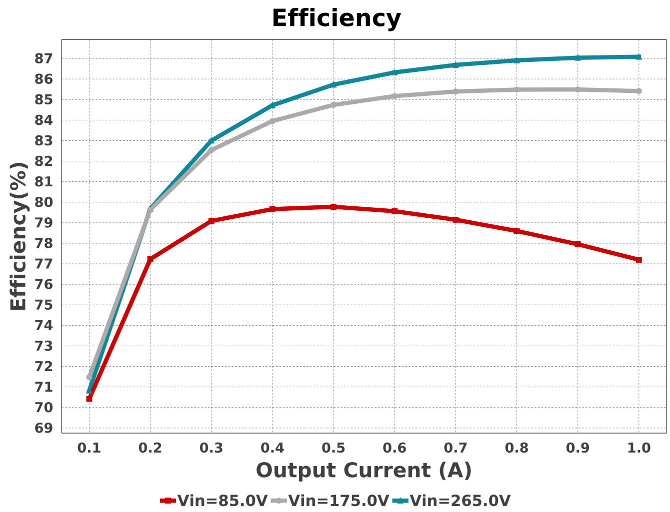

Rsense Pd
Rsense Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

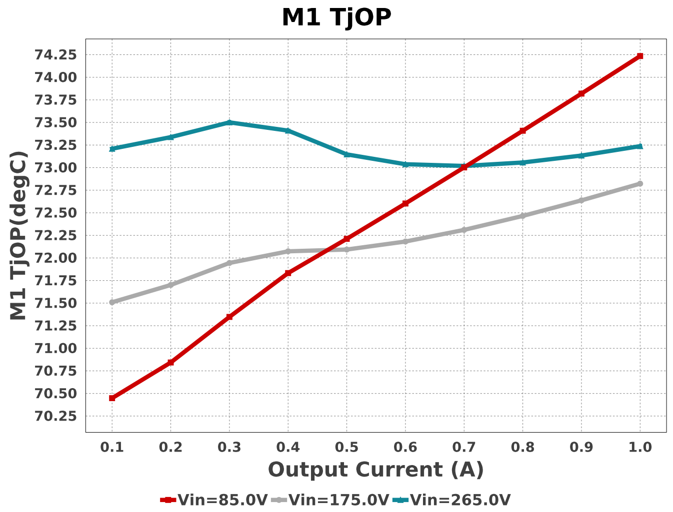

Frequency_
Frequency_(Hz)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

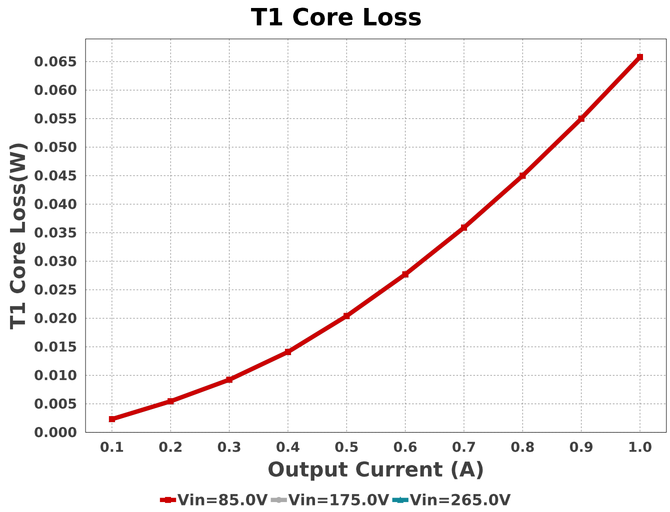

T1 Is1 RMS
T1 Is1 RMS(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

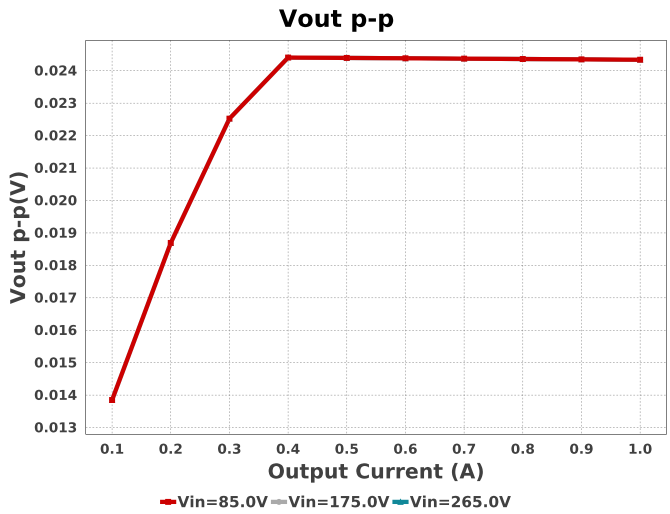

Peak Rectified Vin
Peak Rectified Vin(V)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

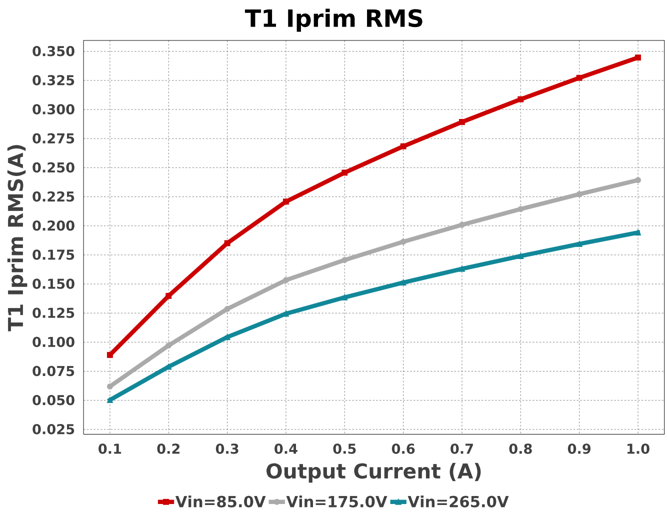

Diode2 Pd
Diode2 Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

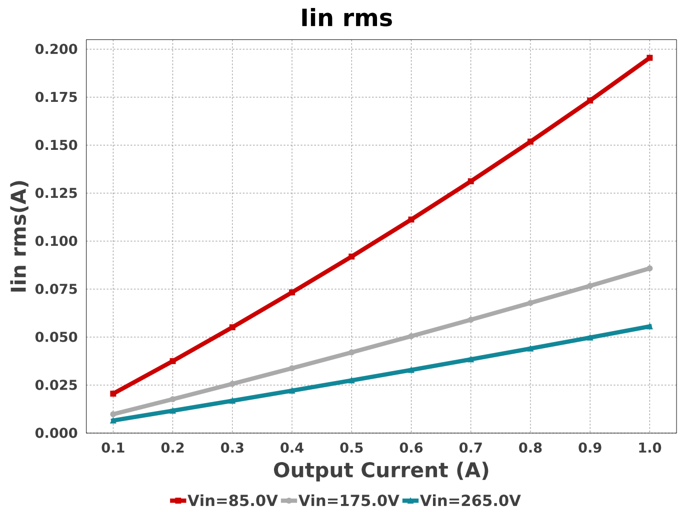

Efficiency
Efficiency(%)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

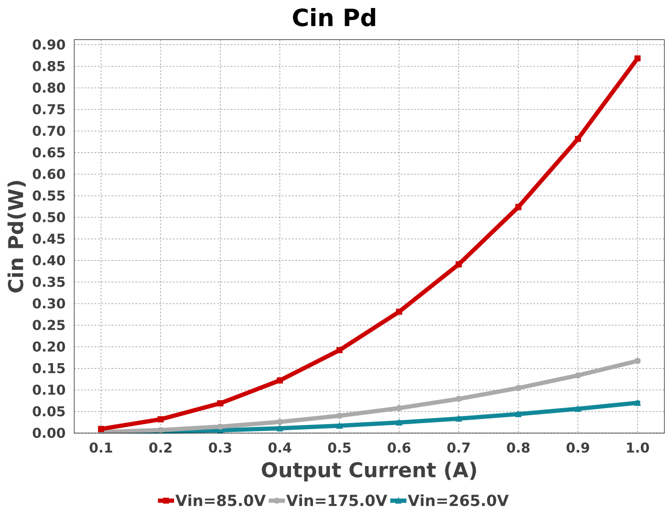

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

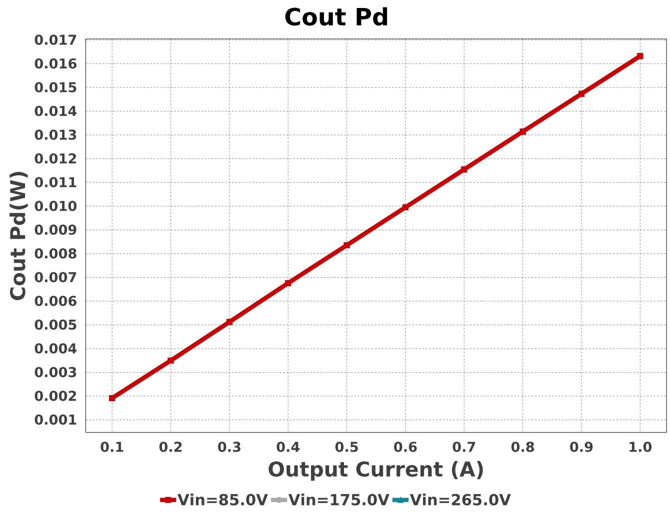

T1 Core Loss
T1 Core Loss(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

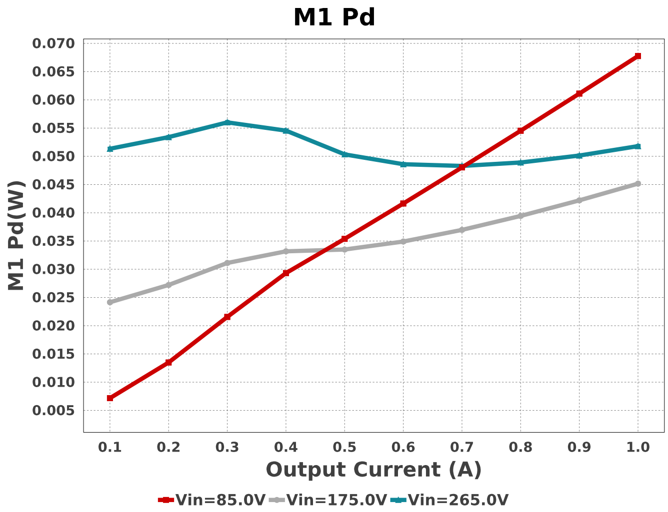

Vout p-p
Vout p-p(V)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


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

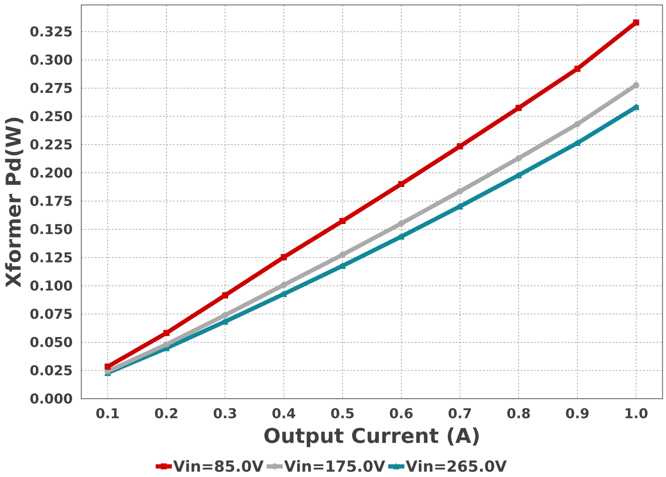

Iin rms
Iin rms(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


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

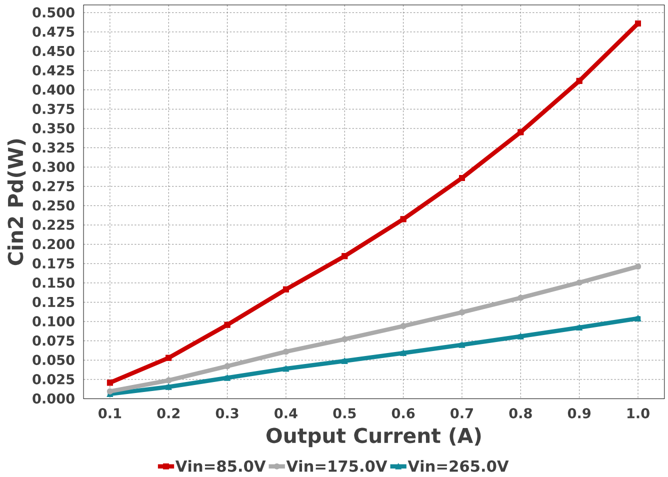

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


M1 Pd
M1 Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

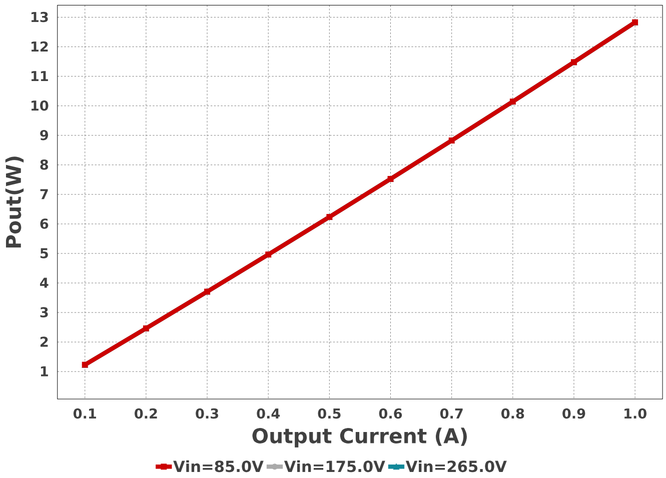
Xformer Pd



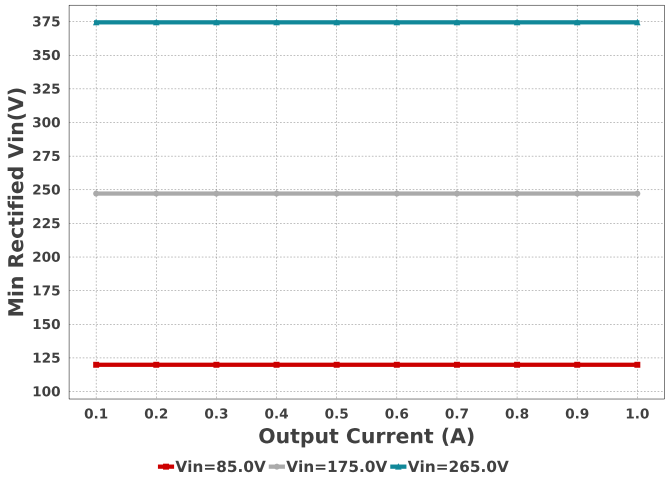
Cin2 Pd



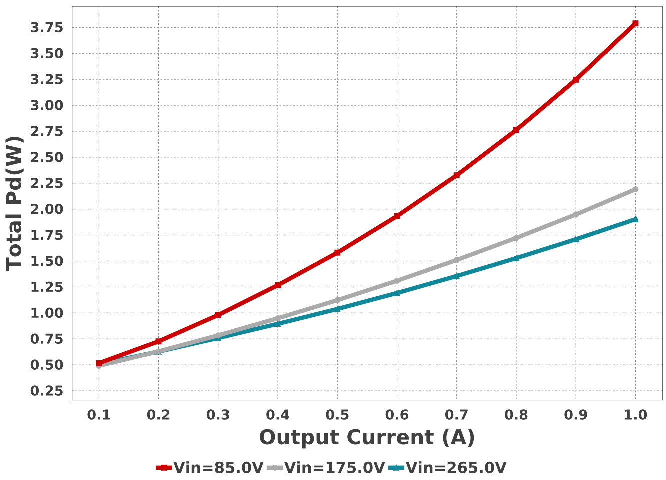
Pout



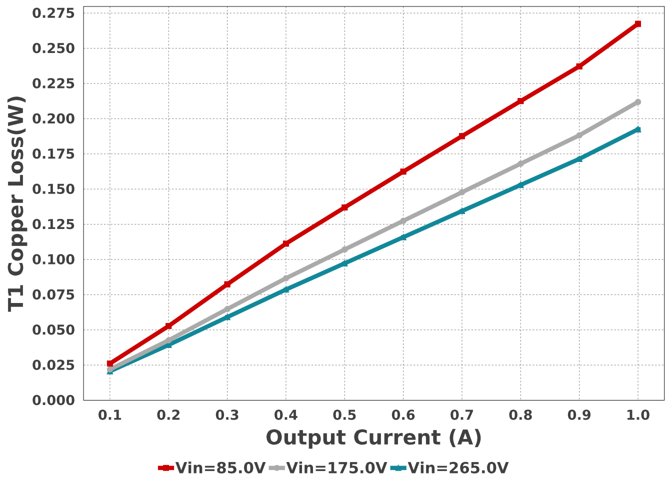
Min Rectified Vin

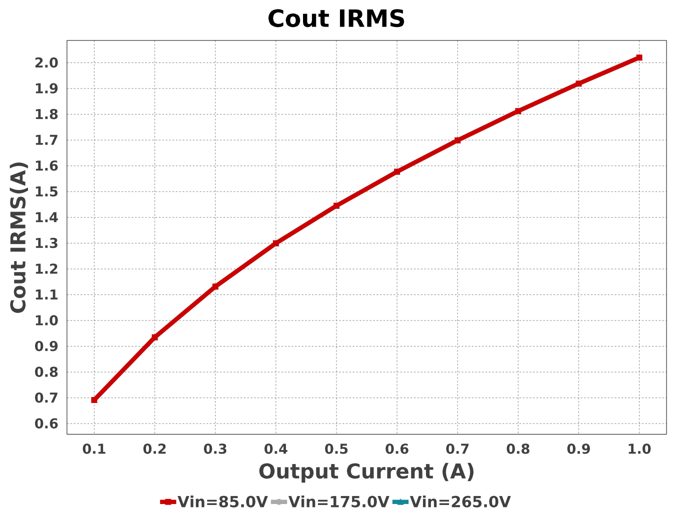


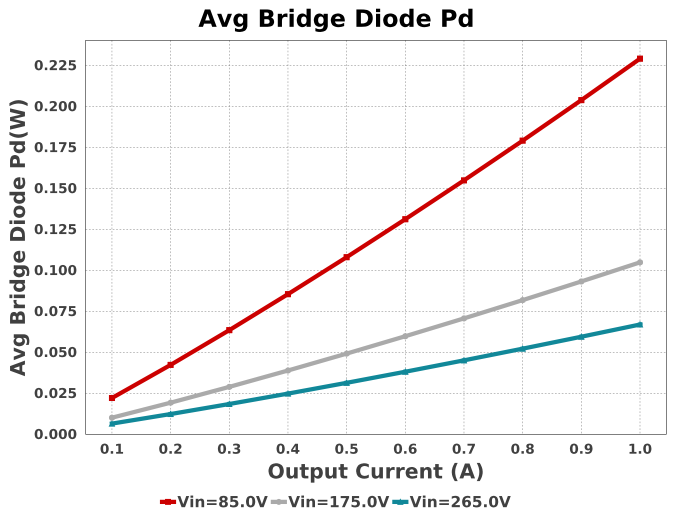
Total Pd

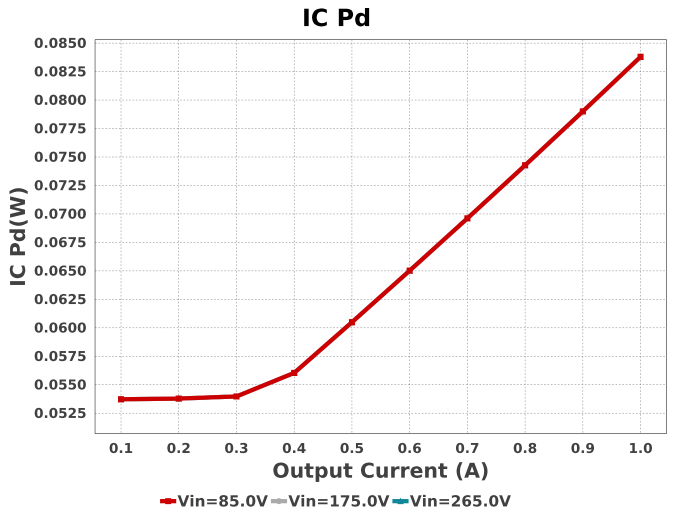


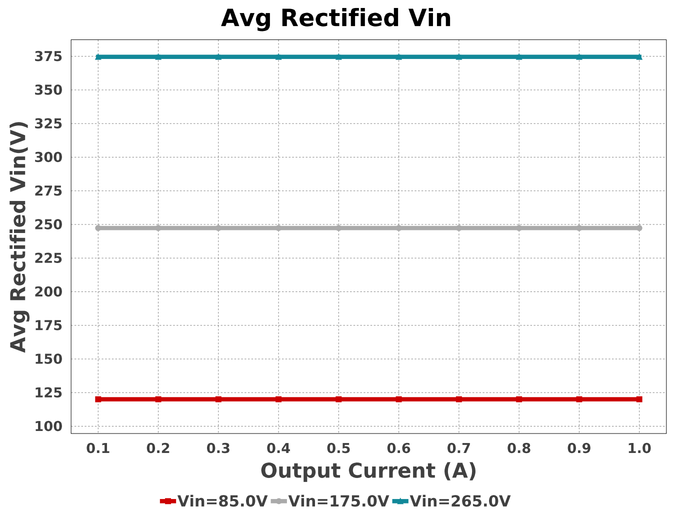
T1 Copper Loss

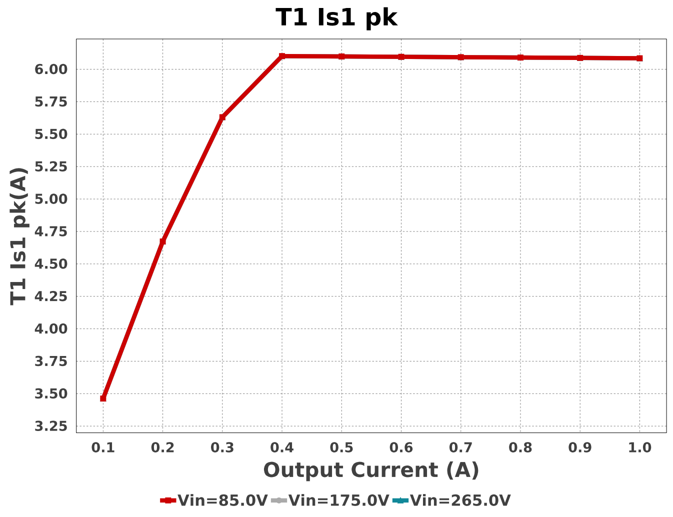


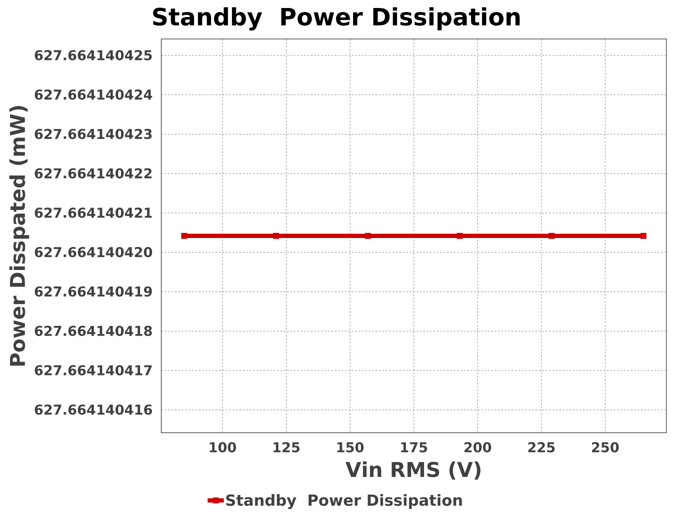

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

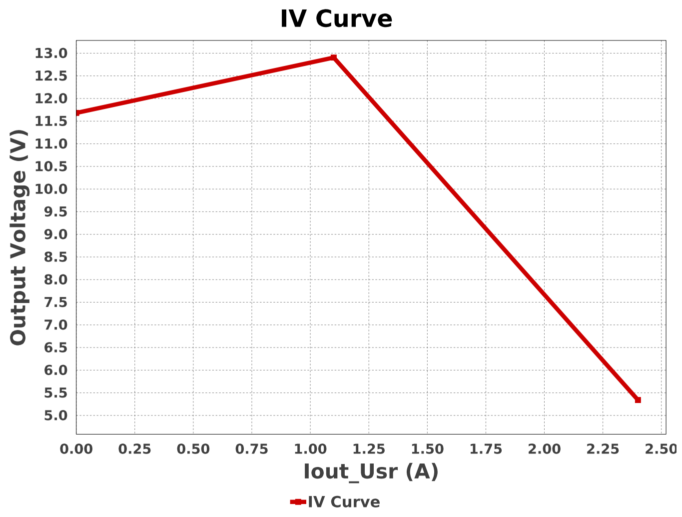

Avg Bridge Diode Pd
Avg Bridge Diode Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


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


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


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


Standby Power Dissipation
Power Disspated (mW)
Vin RMS (V)
Standby Power Dissipation



Operating Values

#	Name	Value	Category	Description
1.	BOM Count	26		Total Design BOM count
2.	Total BOM	NA		Total BOM Cost
3.	Cin Pd	868.38 mW	Capacitors	Input capacitor power dissipation
4.	Cin2 Pd	485.96 mW	Capacitors	Average Power Dissipation in the Input Capacitor Cin2
5.	Cout IRMS	2.02 A	Capacitors	Output capacitor RMS ripple current
6.	Cout Pd	16.324 mW	Capacitors	Output capacitor power dissipation
7.	Avg Bridge Diode Pd	229.11 mW	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
8.	Diode2 Pd	185.9 mW	Diodes	Diode2 power dissipation
9.	IC Pd	83.797 mW	IC	IC power dissipation
10.	IC Tj	81.857 degC	IC	IC junction temperature
11.	ICThetaJA	141.5 degC/W	IC	IC junction-to-ambient thermal resistance
12.	M1 Pd	67.761 mW	Mosfet	M1 MOSFET total power dissipation
13.	M1 TjOP	74.235 degC	Mosfet	M1 MOSFET junction temperature
14.	Avg Bridge Diode Pd	229.11 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
15.	Cin Pd	868.38 mW	Power	Input capacitor power dissipation
16.	Cin2 Pd	485.96 mW	Power	Average Power Dissipation in the Input Capacitor Cin2
17.	Cout Pd	16.324 mW	Power	Output capacitor power dissipation
18.	Diode2 Pd	185.9 mW	Power	Diode2 power dissipation
19.	IC Pd	83.797 mW	Power	IC power dissipation
20.	M1 Pd	67.761 mW	Power	M1 MOSFET total power dissipation
21.	Rsense Pd	301.54 mW	Power	LED Current Rsns Power Dissipation
22.	Snubber Pd	689.879 mW	Power	Snubber Power Dissipation
23.	T1 Copper Loss	267.36 mW	Power	Transformer Copper Loss Power Dissipation
24.	T1 Core Loss	65.8 mW	Power	Transformer Core Loss Power Dissipation
25.	Total Pd	3.789 W	Power	Total Power Dissipation
26.	Xformer Pd	333.16 mW	Power	Transformer power dissipation
27.	Rsense Pd	301.54 mW	Rcs	LED Current Rsns Power Dissipation
28.	Avg Rectified Vin	120.057 V	System Information	Average Rectified Voltage for the AC Line Period
29.	Duty Cycle	48.507 %	System Information	Duty cycle
30.	Efficiency	77.197 %	System Information	Steady state efficiency
31.	FootPrint	1.376 k mm^2	System Information	Total Foot Print Area of BOM components
32.	Frequency	89.771 kHz	System Information	Switching frequency
33.	Frequency	89.771 kHz	System Information	Switching frequency
34.	Iin rms	195.5 mA	System Information	RMS Input Current
35.	Iout	1.0 A	System Information	Iout operating point
36.	Min Rectified Vin	119.907 V	System Information	Minimum voltage seen at rectified input
37.	Mode	DCM	System Information	Conduction Mode
38.	Peak Rectified Vin	120.207 V	System Information	Peak voltage seen at rectified input
39.	Pout	12.828 W	System Information	Total output power

#	Name	Value	Category	Description
40.	Vin_RMS	85.0 V	System Information	Vin operating point
41.	Vout	12.828 V	System Information	Operational Output Voltage
42.	Vout Actual	19.57 V	System Information	Vout Actual calculated based on selected voltage divider resistors
43.	Vout Tolerance	2.606 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
44.	Vout p-p	24.339 mV	System Information	Peak-to-peak output ripple voltage
45.	T1 Copper Loss	267.36 mW	Transformer	Transformer Copper Loss Power Dissipation
46.	T1 Core Loss	65.8 mW	Transformer	Transformer Core Loss Power Dissipation
47.	T1 Iprim RMS	344.664 mA	Transformer	Transformer Primary RMS Current
48.	T1 Iprim pk	857.143 mA	Transformer	Transformer Primary Peak Current
49.	T1 Is1 RMS	2.036 A	Transformer	Transformer Secondary1 RMS Current
50.	T1 Is1 pk	6.085 A	Transformer	Transformer Secondary1 Peak Current
51.	Xformer Pd	333.16 mW	Transformer	Transformer power dissipation

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	265.0	Maximum input voltage
VinMin	85.0	Minimum input voltage
Vout	12.0	Output Voltage
acFrequency	60.0	AC Frequency
base_pn	UCC28710	Base Product Number
source	AC	Input Source Type
Ta	70.0	Ambient temperature
UserFsw	92.0 k	Customer Selected Frequency

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

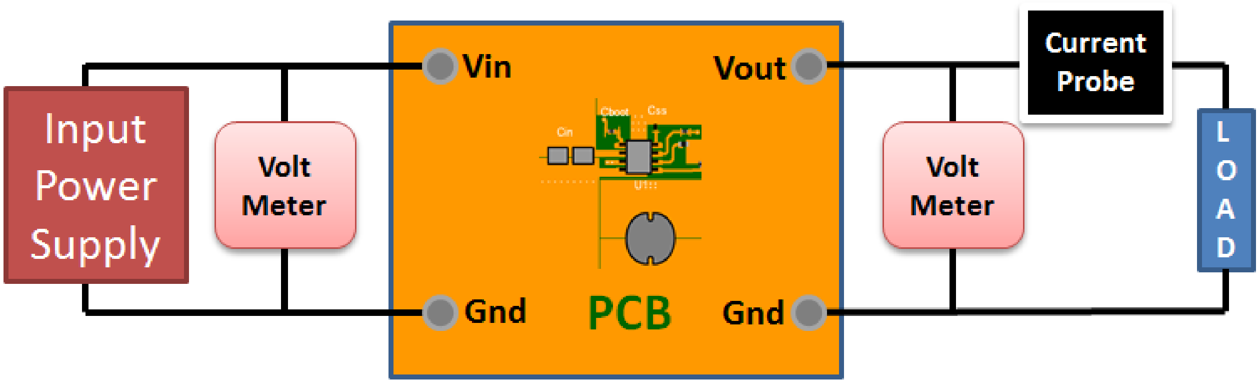
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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	150-1945
2.	Core Manufacturer	Wurth Elektronik
3.	Coil Former Part Number	070-6372
4.	Coil Former Manufacturer	Wurth Elektronik

Transformer Electrical Diagram

Primary

Turns	66.0
AWG	29.0
Layers	2.0
Strands	1.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	9.0
AWG	28.0
Layers	1.0
Strands	2.0
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

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 1/2.0	29.0	33	Clockwise
Triple Insulated Secondary	28.0	9.0	Counter Clockwise
Auxiliary	28.0	14.0	Counter Clockwise
Primary Second 1/2.0	29.0	33	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	5.23E-4H
2.	Inductance Factor(Al)	121.0nH
3.	Npri	66.0
4.	Nsec	9.0
5.	Naux	14.0
6.	Core Type	EE20/10/6
7.	Core Material	TP4A

#	Name	Value
8.	Bmax	0.21T
9.	Switching Frequency	92.00kHz
10.	DMax	0.48
11.	Ipk(Primary)	0.86A
12.	Irms(Primary)	0.34A
13.	Ipk(Secondary)	6.29A
14.	Irms(Secondary)	2.37A

Design Assistance

1. Application Hints Rdd is set to 22 Ohms by default. it can be varied between 1 Ohm to 47 Ohms depending on transformer selected and Vdd expected Rg1 is set to 10 Ohms by default, it can be adjusted according to mosfet selected 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. 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 UCC28710 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. Please see the datasheet for further design guidance. http://www.ti.com/lit/ds/symlink/ucc28710.pdf

2. Master key : DB85EC5F4E363F1C8E9C8FD085227B18[v1]

3. **UCC28710** Product Folder : http://www.ti.com/product/UCC28710 : contains the data sheet and other resources.