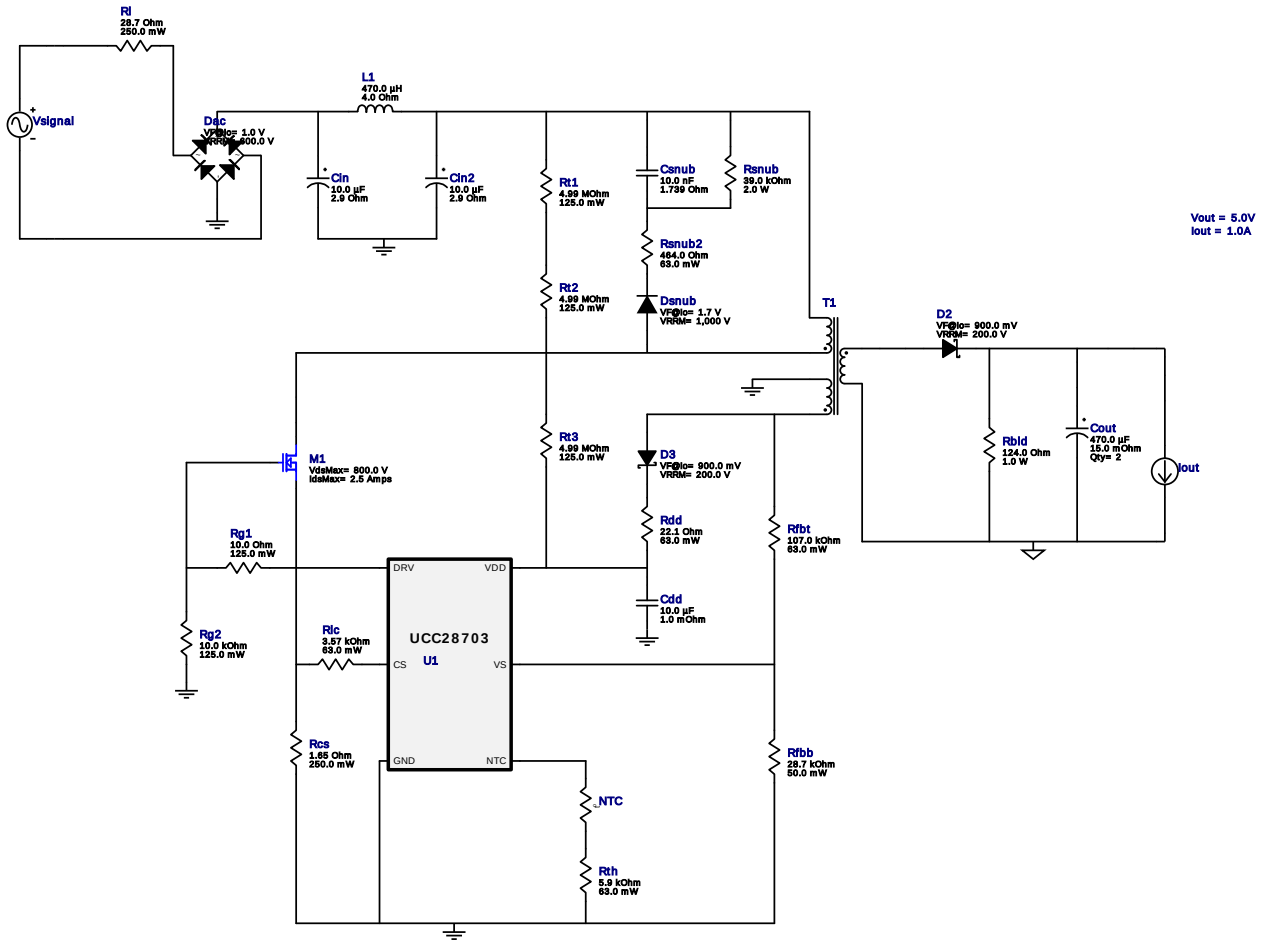
VinMin = 85.0V
VinMax = 265.0V
Vout = 5.0V
Iout = 1.0A

Device = UCC28703DBVR
Topology = Flyback
Created = 2023-03-25 12:37:23.838
BOM Cost = $4.97
BOM Count = 30
Total Pd = 1.63W

WEBENCH® Design Report

Design : 59 UCC28703DBVR
UCC28703DBVR 85V-265V to 5.22V @ 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.

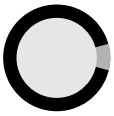
2. Click on the transformer symbol and select 'Design Transformer' to design using specific transformer cores and bobbin

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	MuRata	GRM32ER71J106MA12L Series= X7R	Cap= 10.0 uF ESR= 1.0 mOhm VDC= 63.0 V IRMS= 0.0 A	1	$0.30	 1210_270 15 mm²
Cin	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

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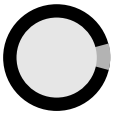
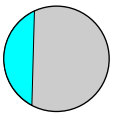
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin2	Kemet	ESG106M400AH4AA Series= 2334	Cap= 10.0 uF ESR= 2.9 Ohm VDC= 400.0 V IRMS= 100.0 mA	1	$0.29	 ESG106 144 mm^2
Cout	Kemet	A750MS477M1EAAE015 Series= 3273	Cap= 470.0 uF ESR= 15.0 mOhm VDC= 25.0 V IRMS= 4.9 A	2	$0.36	 A750_MS 144 mm^2
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	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.06	 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
L1	NIC Components	NPI54C471KTRF	L= 470.0 µH 4.0 Ohm	1	$0.09	 IND_NPI54C 61 mm^2
M1	STMicroelectronics	STD3NK80Z-1	VdsMax= 800.0 V IdsMax= 2.5 Amps	1	$1.11	 IPAK 37 mm^2
NTC	MuRata	NCP15WD683J03RC Series= NCP15	Thermistor	1	$0.05	 0402 3 mm^2
Rbld	Rohm	MCR100JZHF1240 Series= MCR10	Res= 124.0 Ohm Power= 1.0 W Tolerance= 1.0%	1	$0.04	 2512 43 mm^2
Rcs	Vishay-Dale	CRCW12061R65FKEA Series= CRCW..e3	Res= 1.65 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 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	Yageo	RC0201FR-0728K7L Series= ?	Res= 28.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm^2
Rfbt	Vishay-Dale	CRCW0402107KFKED Series= CRCW..e3	Res= 107.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 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	CRCW120628R7FKEA Series= CRCW..e3	Res= 28.7 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 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
Rt1	Vishay-Dale	CRCW08054M99FKEA Series= CRCW..e3	Res= 4.99 MOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm^2
Rt2	Vishay-Dale	CRCW08054M99FKEA Series= CRCW..e3	Res= 4.99 MOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm^2

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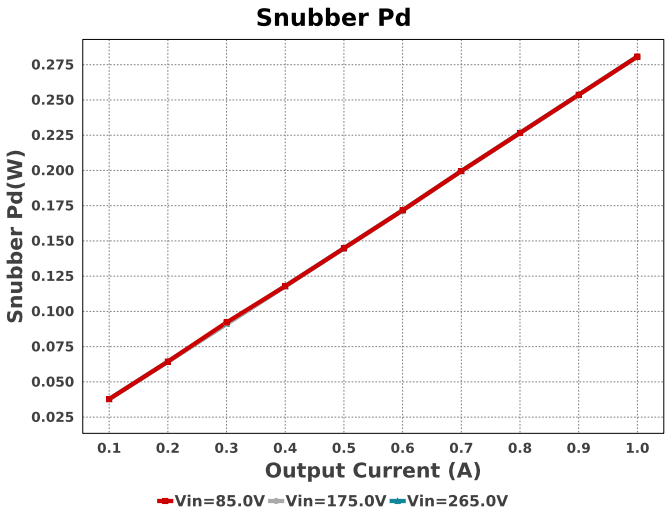
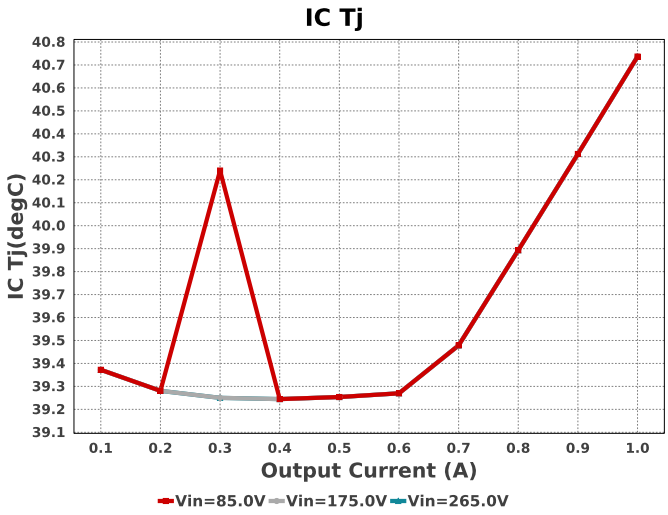
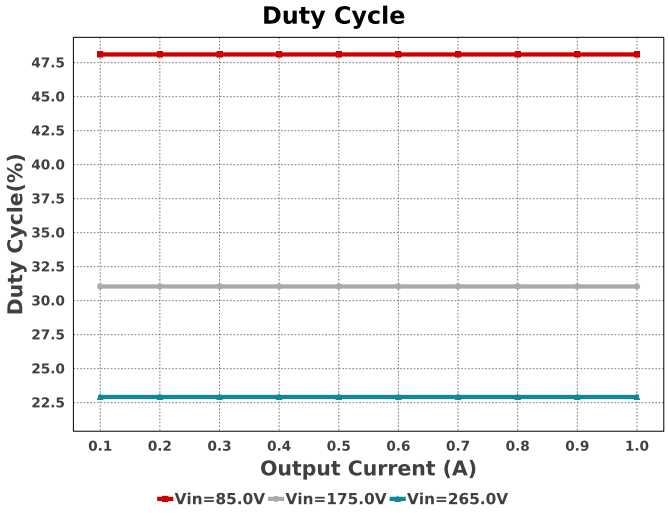
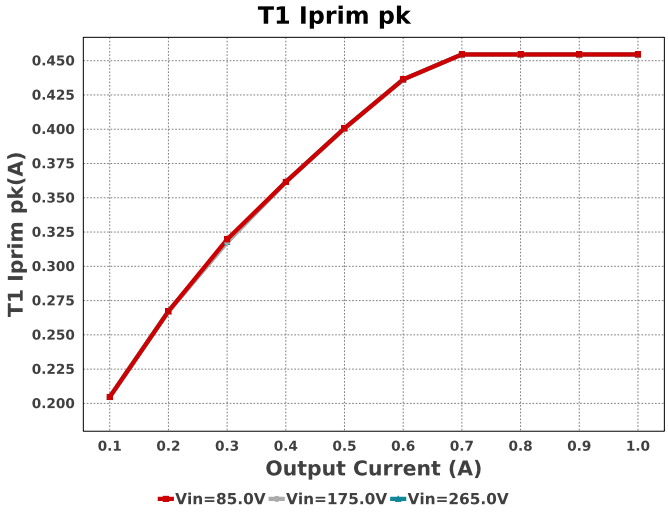
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rt3	Vishay-Dale	CRCW08054M99FKEA Series= CRCW..e3	Res= 4.99 MOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rth	Vishay-Dale	CRCW04025K90FKED Series= CRCW..e3	Res= 5.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
T1	Core=TDK , CoilFormer=TDK	Core=B66417G0000X149 , CoilFormer=B66418W1008D001	Lp= 1.025 mH Turns Ratio(Nas)= 17:5 Turns Ratio(Nps)= 78:5 Npri= 78.0 Naux= 17.0 Nsec= 5.0	1	$1.02	TDK_B66305 491 mm²
U1	Texas Instruments	UCC28703DBVR	Switcher	1	$0.38	SOT-23-6 15 mm²









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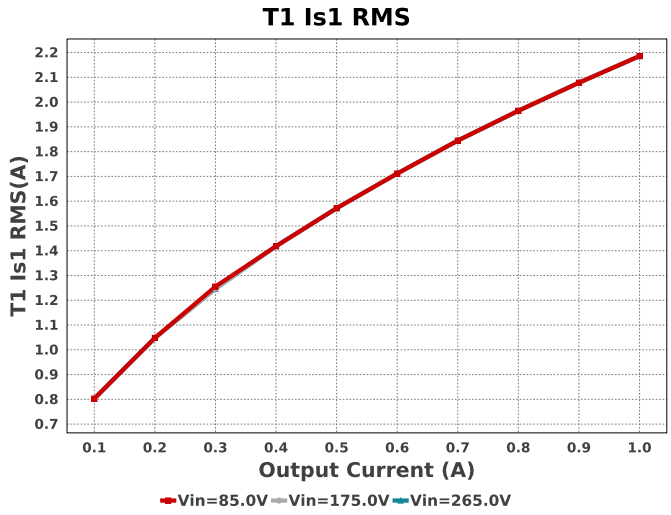

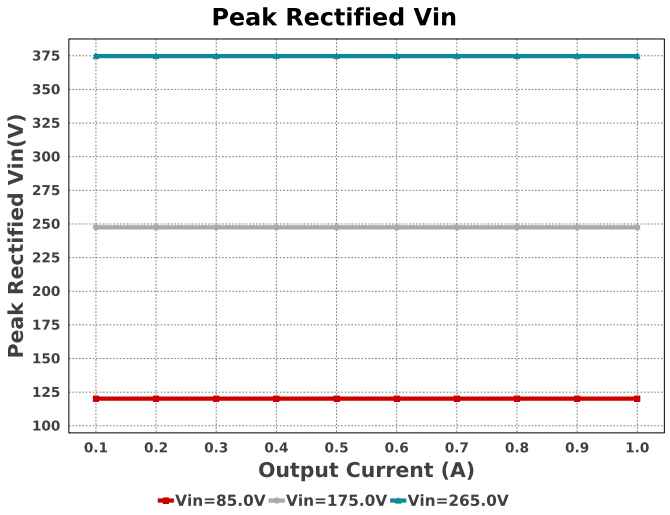

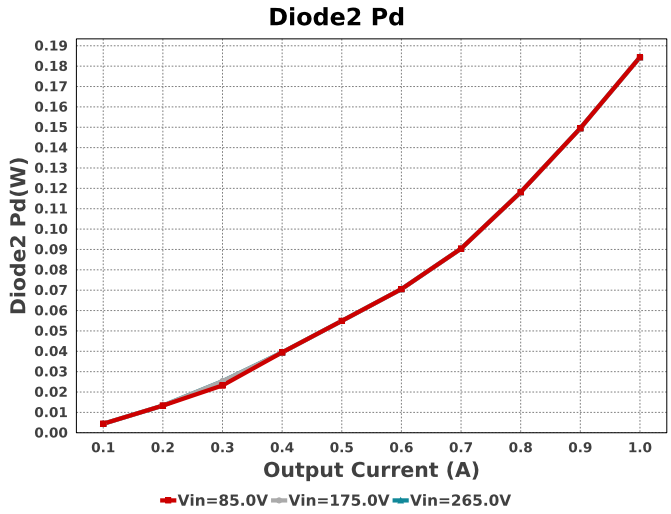

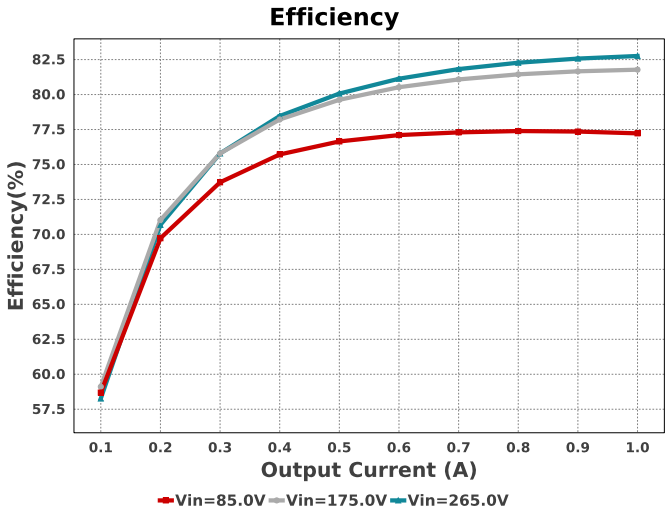

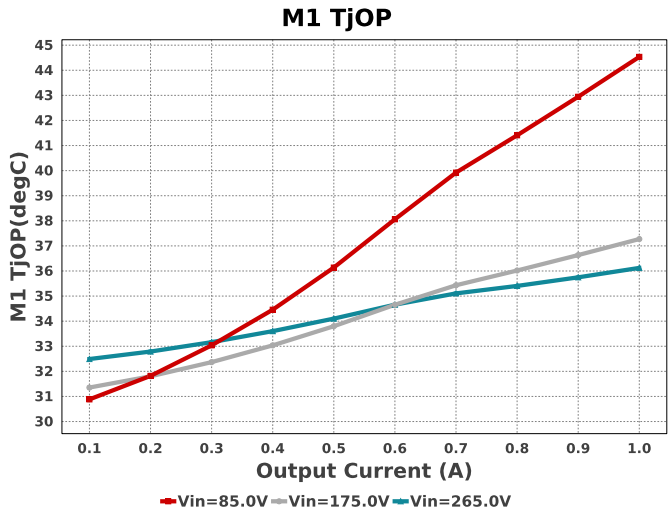

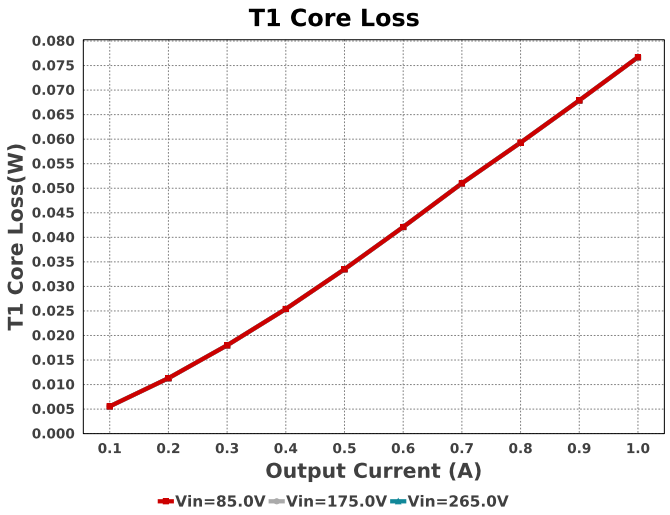

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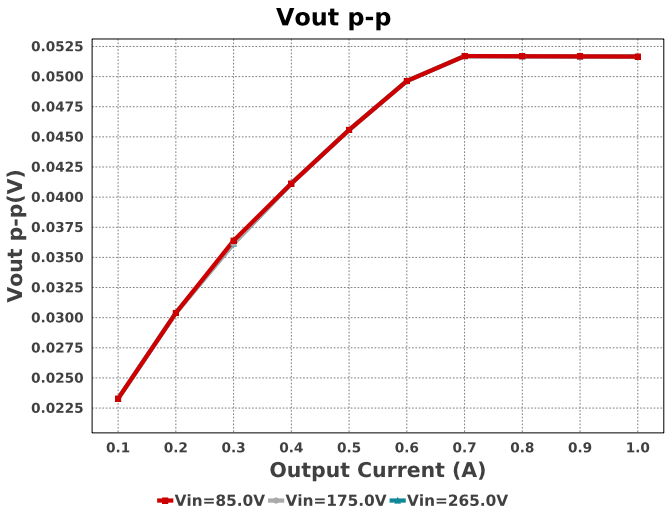

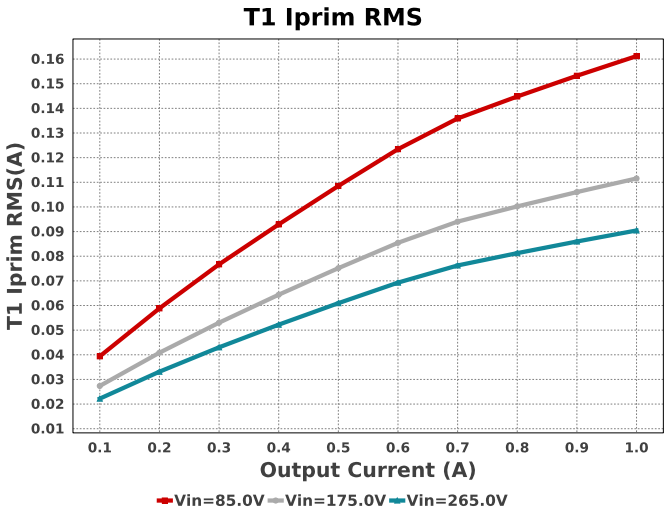

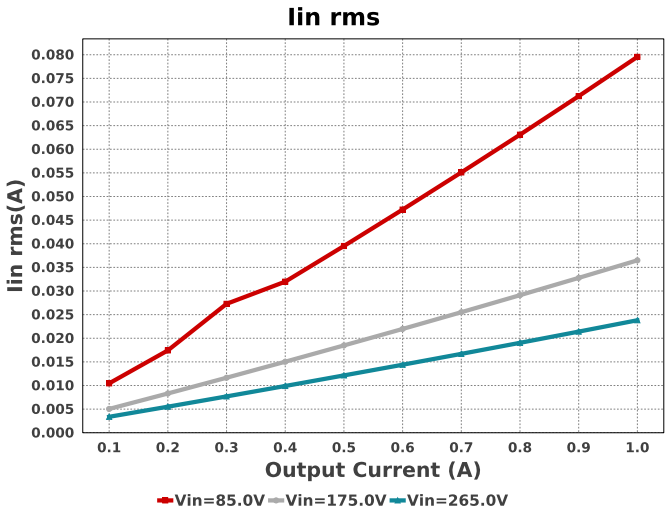

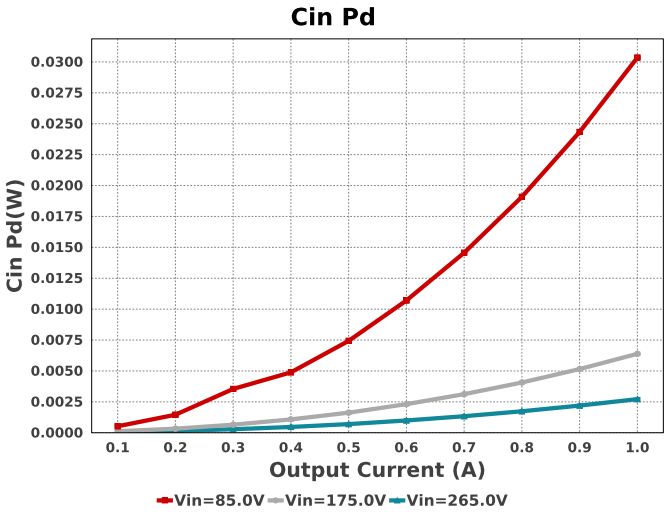

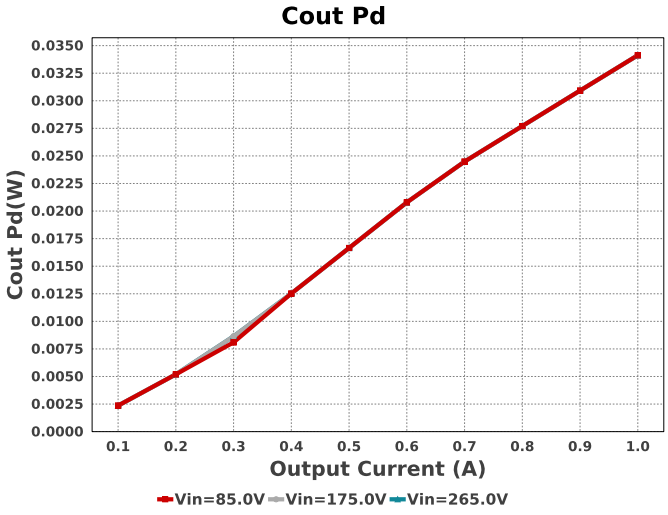

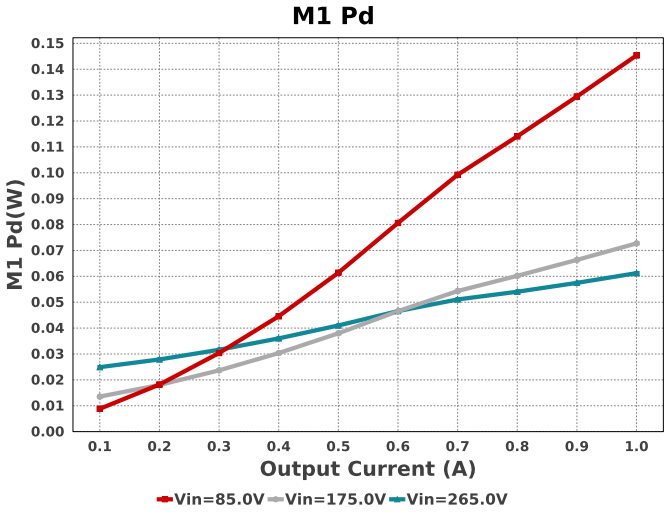

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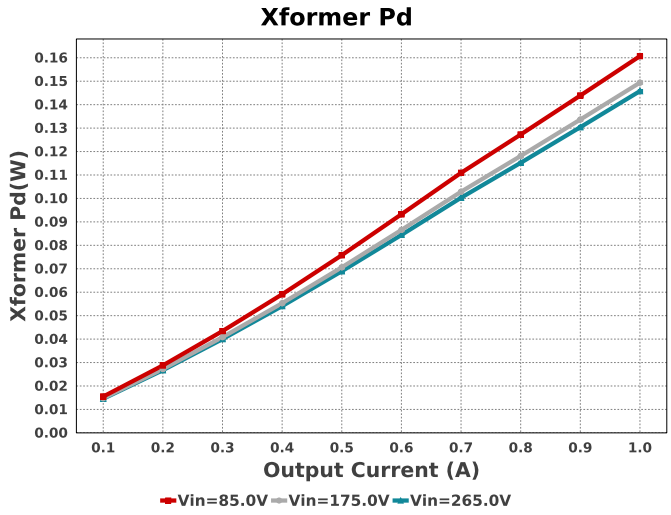

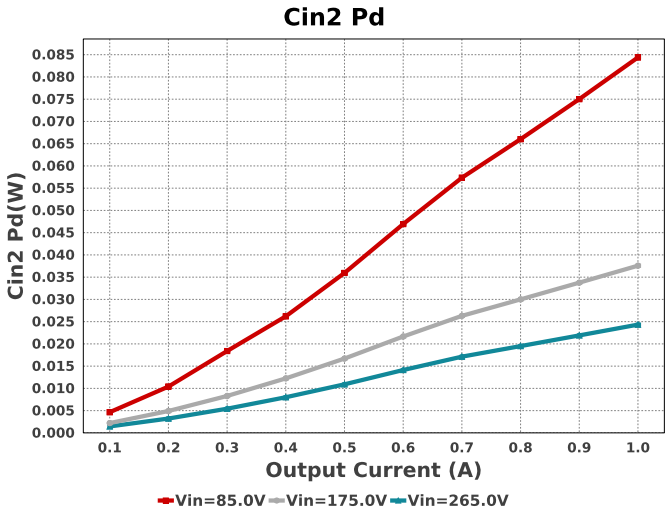

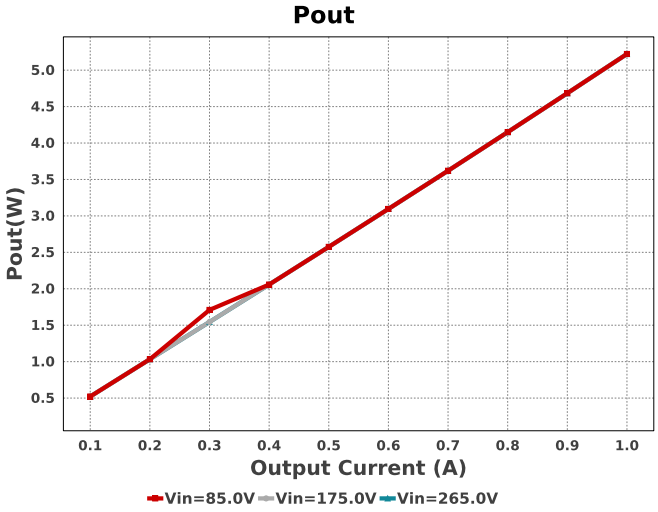

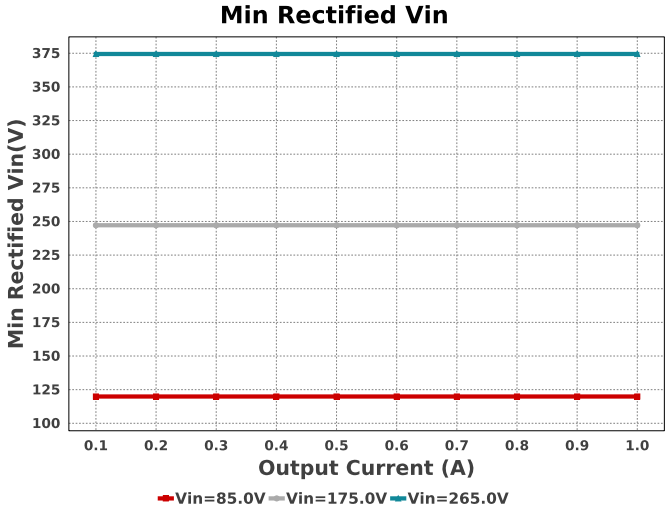

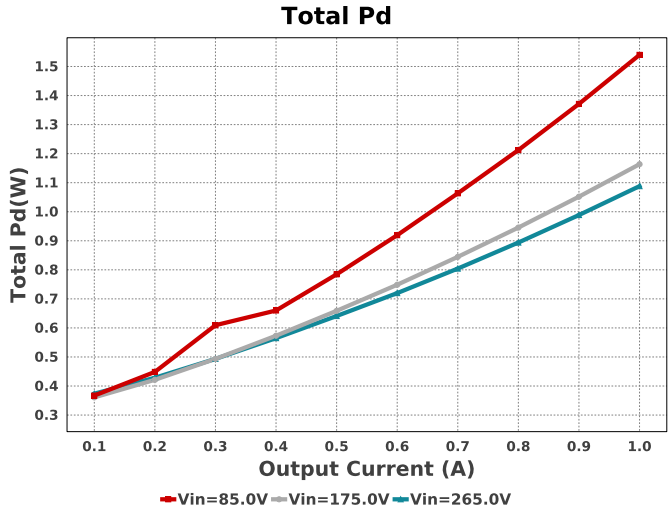

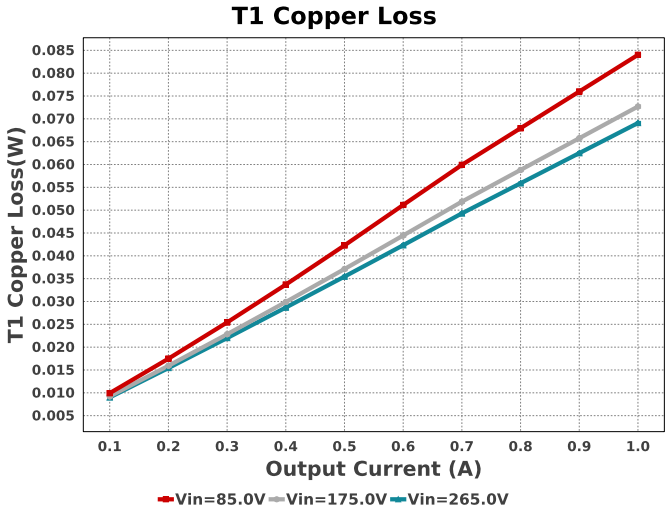

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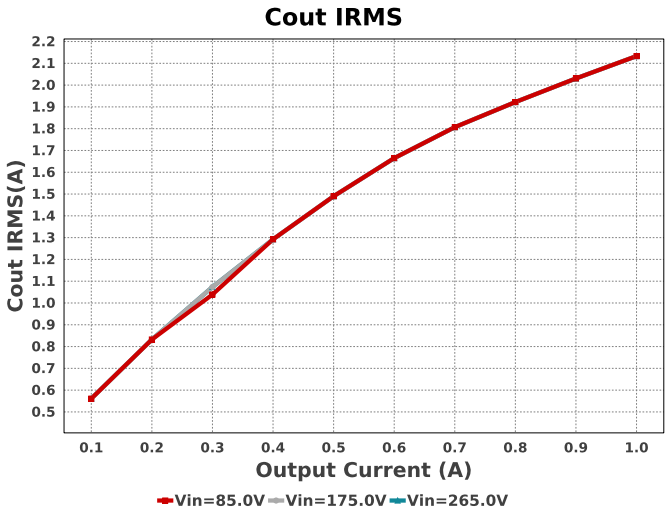

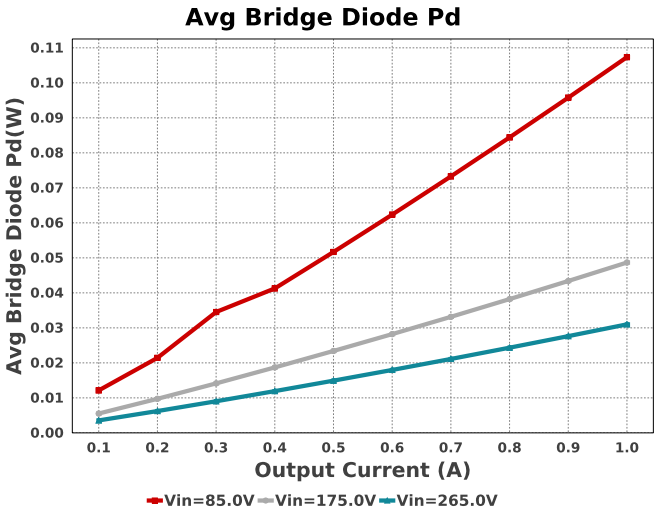

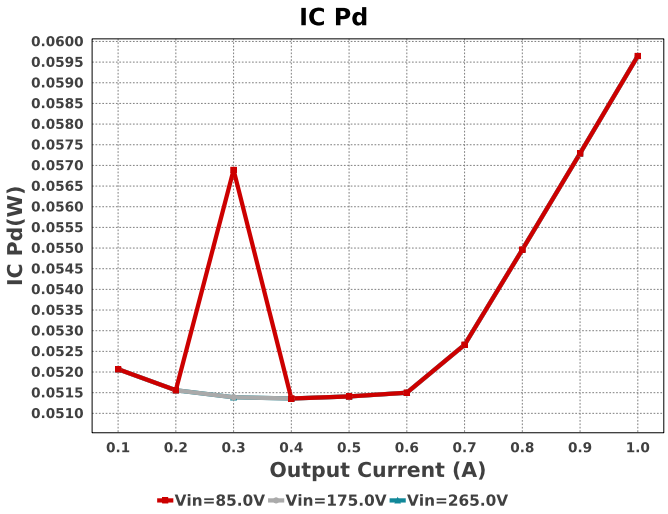

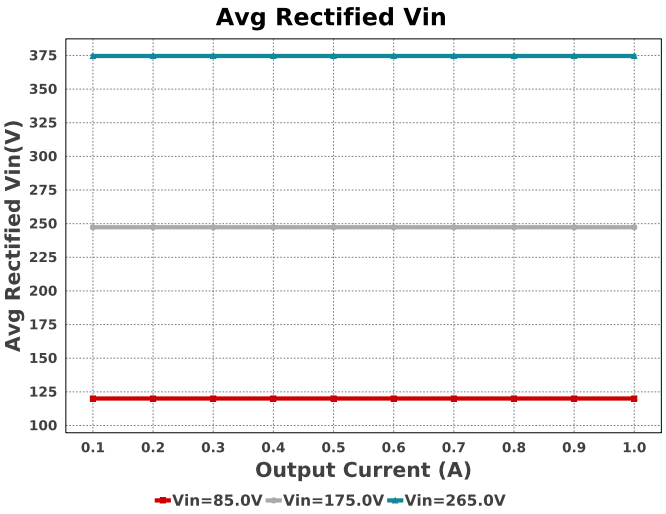

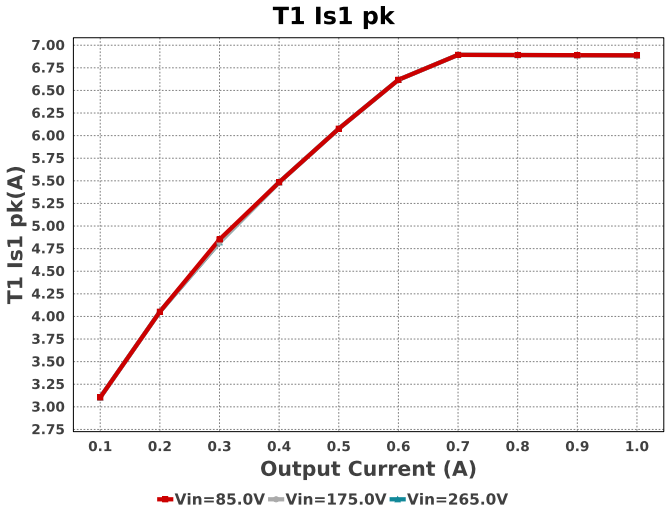

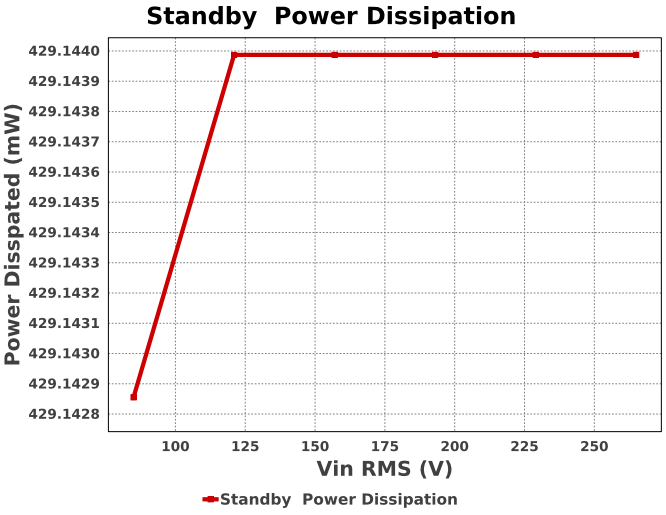

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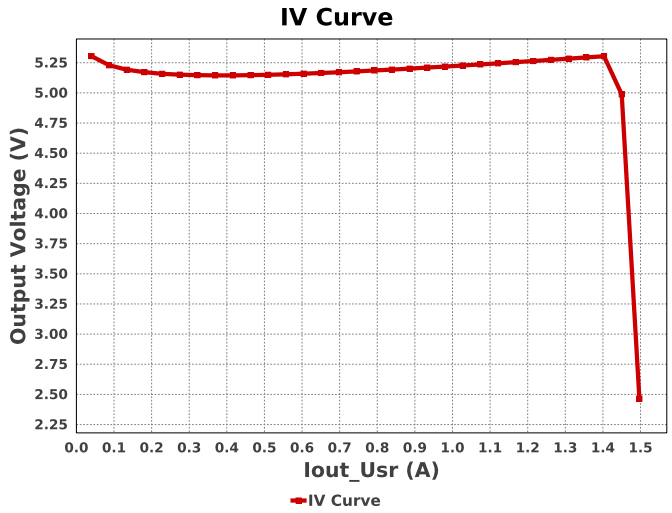

Operating Values

#	Name	Value	Category	Description
1.	Cin Pd	31.188 mW	Capacitors	Input capacitor power dissipation
2.	Cin2 Pd	85.223 mW	Capacitors	Average Power Dissipation in the Input Capacitor Cin2
3.	Cout IRMS	2.133 A	Capacitors	Output capacitor RMS ripple current
4.	Cout Pd	34.126 mW	Capacitors	Output capacitor power dissipation
5.	Avg Bridge Diode Pd	108.75 mW	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
6.	Diode2 Pd	184.4 mW	Diodes	Diode2 power dissipation
7.	IC Pd	59.648 mW	IC	IC power dissipation
8.	IC Tj	40.737 degC	IC	IC junction temperature
9.	ICThetaJA	180.0 degC/W	IC	IC junction-to-ambient thermal resistance
10.	M1 Pd	145.34 mW	Mosfet	M1 MOSFET total power dissipation
11.	M1 TjOP	44.534 degC	Mosfet	M1 MOSFET junction temperature
12.	Avg Bridge Diode Pd	108.75 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
13.	Cin Pd	31.188 mW	Power	Input capacitor power dissipation
14.	Cin2 Pd	85.223 mW	Power	Average Power Dissipation in the Input Capacitor Cin2
15.	Cout Pd	34.126 mW	Power	Output capacitor power dissipation
16.	Diode2 Pd	184.4 mW	Power	Diode2 power dissipation
17.	IC Pd	59.648 mW	Power	IC power dissipation
18.	M1 Pd	145.34 mW	Power	M1 MOSFET total power dissipation
19.	Snubber Pd	280.781 mW	Power	Snubber Power Dissipation
20.	T1 Copper Loss	128.43 mW	Power	Transformer Copper Loss Power Dissipation
21.	T1 Core Loss	116.0 mW	Power	Transformer Core Loss Power Dissipation
22.	Total Pd	1.632 W	Power	Total Power Dissipation
23.	Xformer Pd	244.43 mW	Power	Transformer power dissipation
24.	Avg Rectified Vin	120.057 V	System Information	Average Rectified Voltage for the AC Line Period
25.	BOM Count	30	System Information	Total Design BOM count
26.	Duty Cycle	48.105 %	System Information	Duty cycle
27.	Efficiency	76.193 %	System Information	Steady state efficiency
28.	FootPrint	1.542 k mm^2	System Information	Total Foot Print Area of BOM components
29.	Frequency	66.292 kHz	System Information	Switching frequency
30.	Frequency	66.292 kHz	System Information	Switching frequency
31.	Iin rms	80.631 mA	System Information	RMS Input Current
32.	Iout	1.0 A	System Information	Iout operating point
33.	Min Rectified Vin	119.907 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	5.222 W	System Information	Total output power
37.	Total BOM	$4.97	System Information	Total BOM Cost

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#	Name	Value	Category	Description
38.	Vin_RMS	85.0 V	System Information	Vin operating point
39.	Vout	5.222 V	System Information	Operational Output Voltage
40.	Vout Actual	19.149 V	System Information	Vout Actual calculated based on selected voltage divider resistors
41.	Vout Tolerance	1.794 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Vout p-p	51.66 mV	System Information	Peak-to-peak output ripple voltage
43.	T1 Copper Loss	128.43 mW	Transformer	Transformer Copper Loss Power Dissipation
44.	T1 Core Loss	116.0 mW	Transformer	Transformer Core Loss Power Dissipation
45.	T1 Iprim RMS	161.207 mA	Transformer	Transformer Primary RMS Current
46.	T1 Iprim pk	454.545 mA	Transformer	Transformer Primary Peak Current
47.	T1 Is1 RMS	2.186 A	Transformer	Transformer Secondary1 RMS Current
48.	T1 Is1 pk	6.888 A	Transformer	Transformer Secondary1 Peak Current
49.	Xformer Pd	244.43 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	5.0	Output Voltage
acFrequency	50.0	AC Frequency
base_pn	UCC28703	Base Product Number
source	AC	Input Source Type
Ta	30.0	Ambient temperature

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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

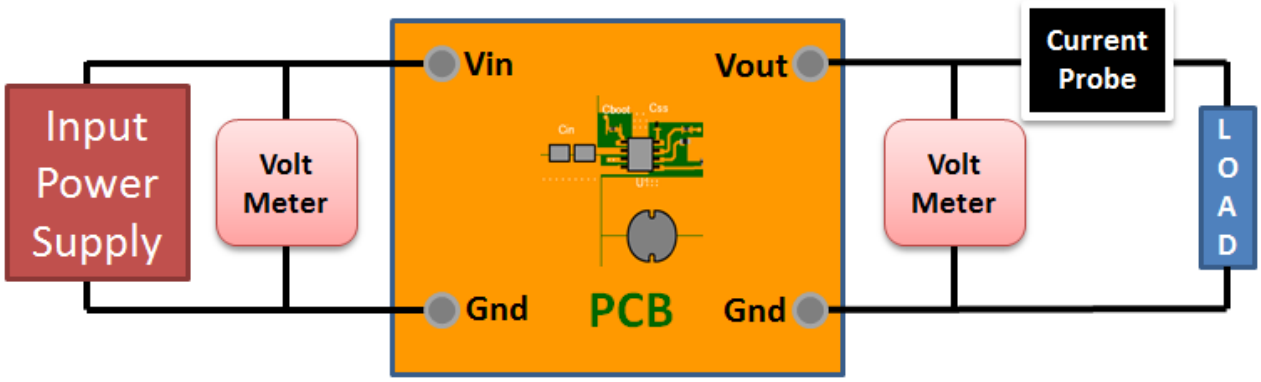
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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	78.0
AWG	34.0
Layers	4.0
Strands	3.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	5.0
AWG	29.0
Layers	1.0
Strands	4.0
Insulation Type	Triple Insulated

Auxiliary

Turns	17.0
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 2/4.0	34.0	39	Clockwise
Triple Insulated Secondary	29.0	5.0	Counter Clockwise
Auxiliary	28.0	17.0	Counter Clockwise
Primary Second 2/4.0	34.0	39	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	0.00102H
2.	Inductance Factor(Al)	169.0nH
3.	Npri	78.0
4.	Nsec	5.0
5.	Naux	17.0
6.	Core Type	EFD20/10/7
7.	Core Material	N49

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#	Name	Value
8.	Bmax	0.20T
9.	Switching Frequency	87.50kHz
10.	DMax	0.49
11.	Ipk(Primary)	0.47A
12.	Irms(Primary)	0.19A
13.	Ipk(Secondary)	7.33A
14.	Irms(Secondary)	2.76A

Design Assistance

1. Application Hints Rbld 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 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 UCC28700 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(For non Q1 parts). http://www.ti.com/lit/ds/symlink/ucc28700.pdfFor non Q1 partshttp://www.ti.com/lit/ds/symlink/ucc28700-q1.pdf

2. Master key : D64FB28942867A44[v1]

3. **UCC28703** Product Folder : http://www.ti.com/product/UCC28703 : contains the data sheet and other resources.

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