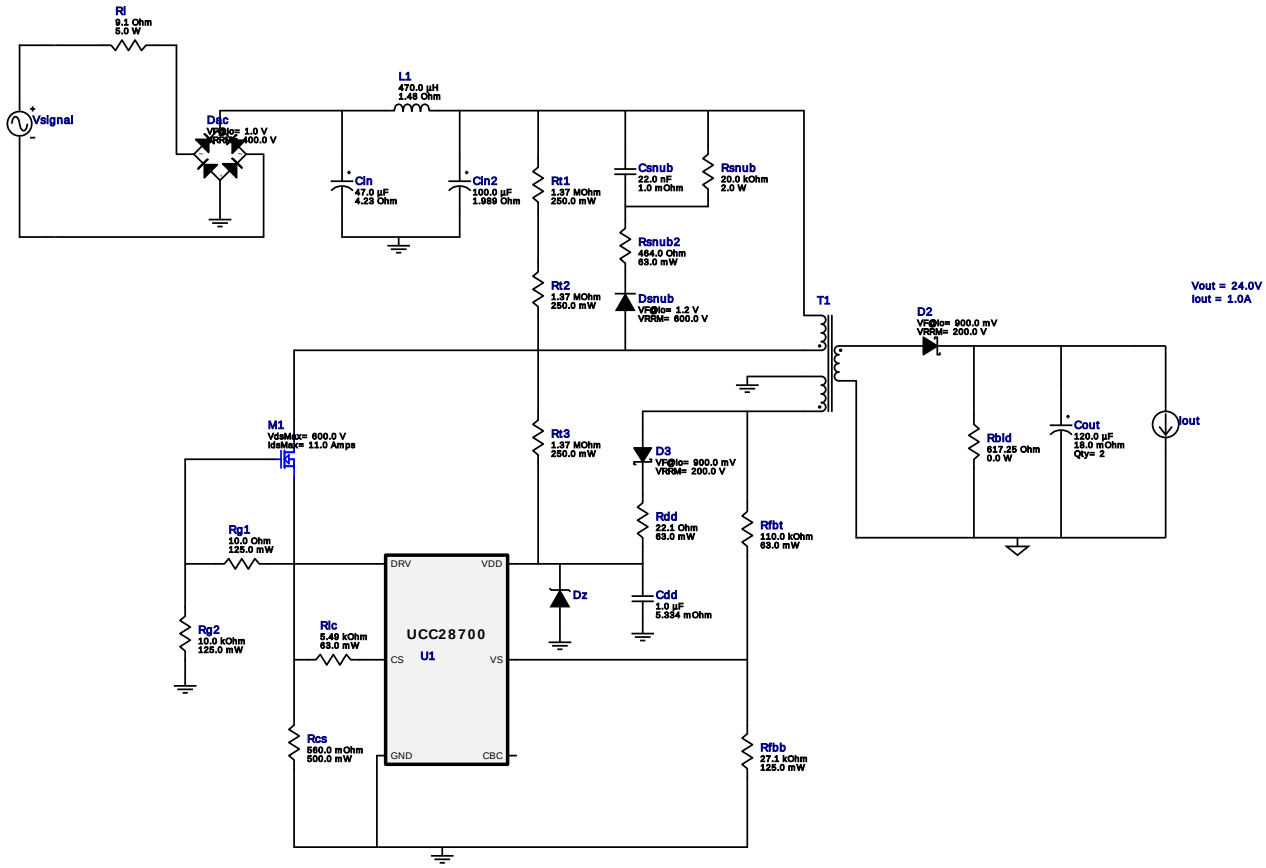
VinMin = 90.0V
VinMax = 140.0V
Vout = 24.0V
Iout = 1.0A

Device = UCC28700DBVR
Topology = Flyback
Created = 2024-08-21 07:19:04.294
BOM Cost = NA
BOM Count = 29
Total Pd = 7.35W

WEBENCH® Design Report

Design : 11 UCC28700DBVR
UCC28700DBVR 90V-140V to 25.69V @ 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	GRM31CR72A105KA01L Series= X7R	Cap= 1.0 uF ESR= 5.334 mOhm VDC= 100.0 V IRMS= 1.55432 A	1	$0.11	1206_190 11 mm^2
Cin	Panasonic	EEU-EB2E470 Series= EB	Cap= 47.0 uF ESR= 4.23 Ohm VDC= 250.0 V IRMS= 390.0 mA	1	$0.54	CAPPRD500W60D1250H2500 210 mm^2

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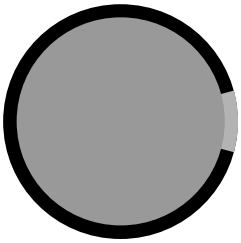
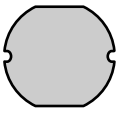
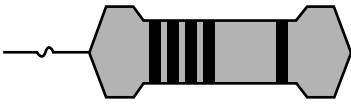
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin2	Nichicon	LLS2G101MELZ Series= 2387	Cap= 100.0 uF ESR= 1.989 Ohm VDC= 400.0 V IRMS= 950.0 mA	1	$1.09	 Nichicon_2200x2500_Snap 576 mm²
Cout	Panasonic	35SEPF120M Series= SEPF	Cap= 120.0 uF ESR= 18.0 mOhm VDC= 35.0 V IRMS= 4.4 A	2	$0.96	 SEPF_F13 144 mm²
D2	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.06	 SMA 37 mm²
D3	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.06	 SMA 37 mm²
Dac	Diodes Inc.	HD04-T	VF@Io= 1.0 V VRRM= 400.0 V	1	$0.13	 MiniDIP 62 mm²
Dz	Diodes Inc.	SMBJ22A-13-F	Zener	1	$0.10	 SMB 44 mm²
L1	NIC Components	NPI105C471MTRF	L= 470.0 µH 1.48 Ohm	1	$0.14	 IND_NPI105C 141 mm²
M1	Infineon Technologies	SPI11N60C3XKSA1	VdsMax= 600.0 V IdsMax= 11.0 Amps	1	$2.08	 TO-262 77 mm²
Rbld	CUSTOM	CUSTOM Series= ?	Res= 617.25 Ohm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rcs	Rohm	MCR25JZHFLR560 Series= MCR25	Res= 560.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.03	 1210 15 mm²
Rdd	Vishay-Dale	CRCW040222R1FKED Series= CRCW..e3	Res= 22.1 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rfbb	Yageo	RT0805BRD0727K1L Series= ?	Res= 27.1 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.05	 0805 7 mm²
Rfbt	Vishay-Dale	CRCW0402110KFKED Series= CRCW..e3	Res= 110.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
Rg1	Vishay-Dale	CRCW080510R0FKEA Series= CRCW..e3	Res= 10.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rg2	Vishay-Dale	CRCW080510K0FKEA Series= CRCW..e3	Res= 10.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
Rl	Yageo	FKN500JR-91-9R1 Series= F_RES	Res= 9.1 Ohm Power= 5.0 W Tolerance= 5.0%	1	$0.17	 FKN500_7WS 278 mm²

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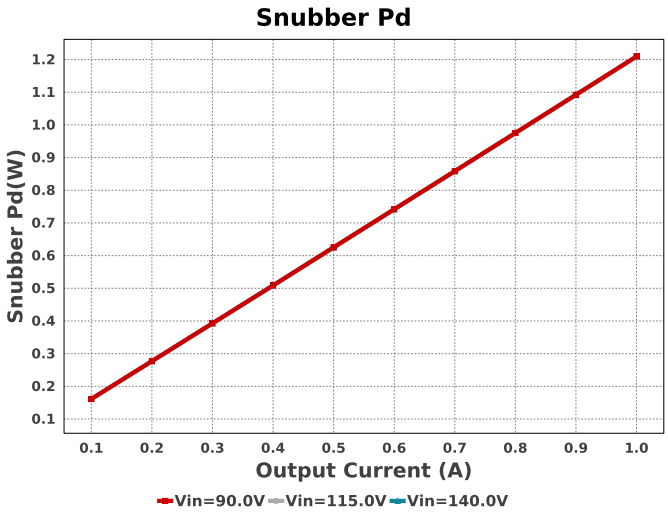
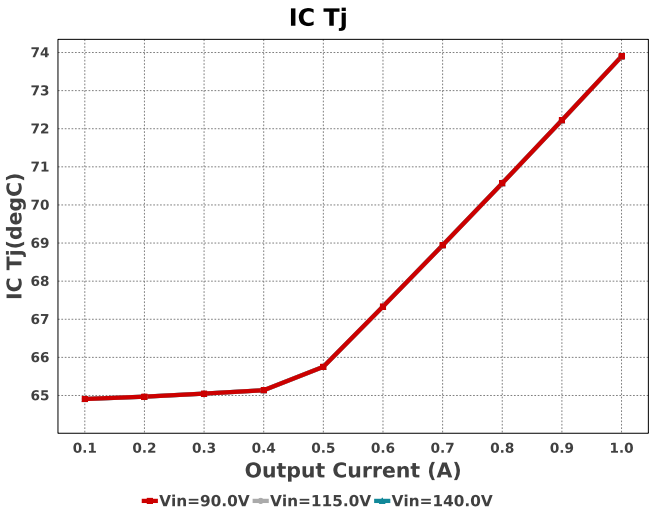
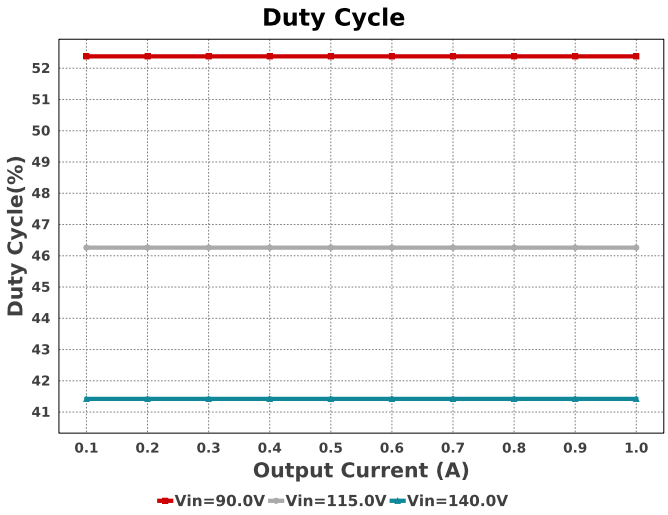
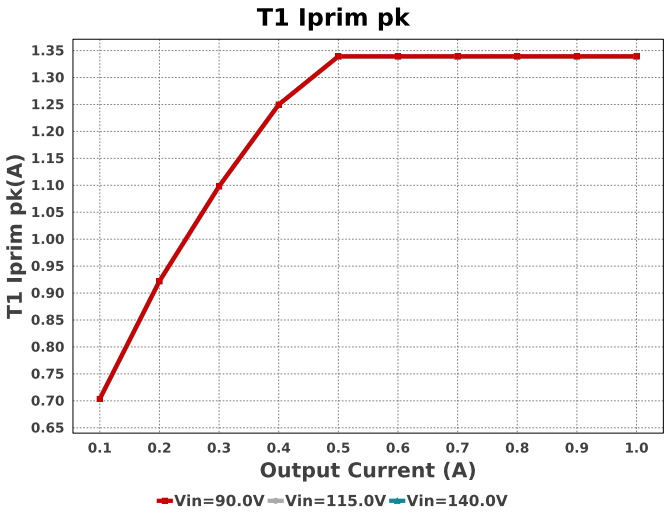
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rlc	Vishay-Dale	CRCW04025K49FKED Series= CRCW..e3	Res= 5.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rt1	Vishay-Dale	CRCW12061M37FKEA Series= CRCW..e3	Res= 1.37 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rt2	Vishay-Dale	CRCW12061M37FKEA Series= CRCW..e3	Res= 1.37 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rt3	Vishay-Dale	CRCW12061M37FKEA Series= CRCW..e3	Res= 1.37 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
T1	Core=TDK , CoilFormer=TDK	Core=B66317G0000X187 , CoilFormer=B66208X1110T001	Lp= 370.0 µH Turns Ratio(Nas)= 10:12 Turns Ratio(Nps)= 49:12 Npri= 49.0 Naux= 10.0 Nsec= 12.0	1	$0.30	TDK_B66305 569 mm²
U1	Texas Instruments	UCC28700DBVR	Switcher	1	$0.38	SOT-23-6 15 mm²









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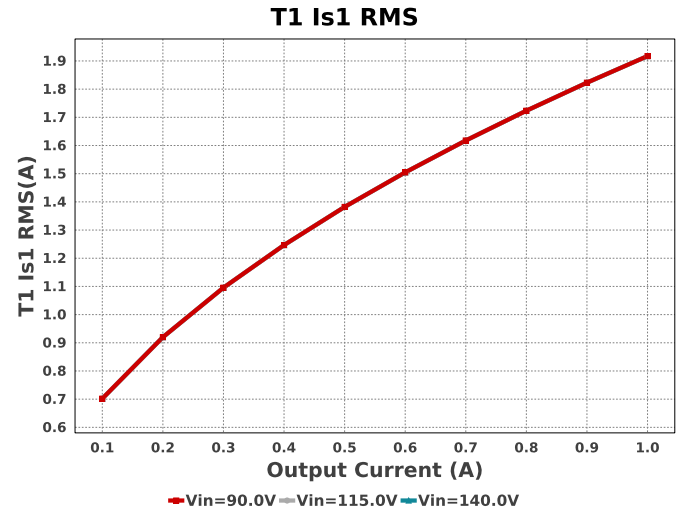

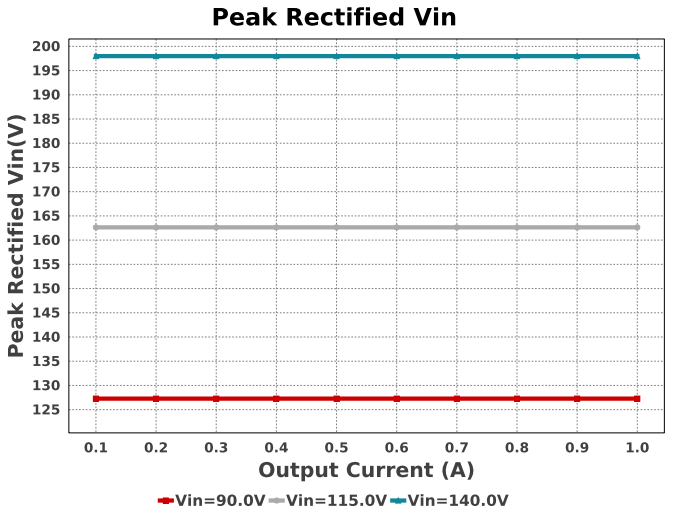

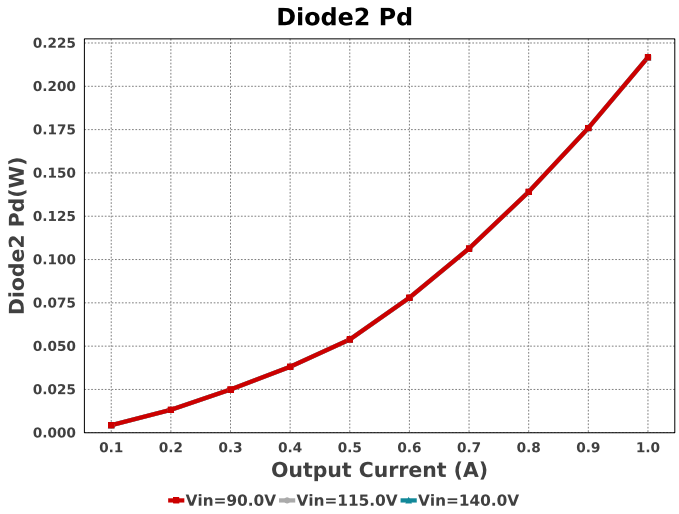

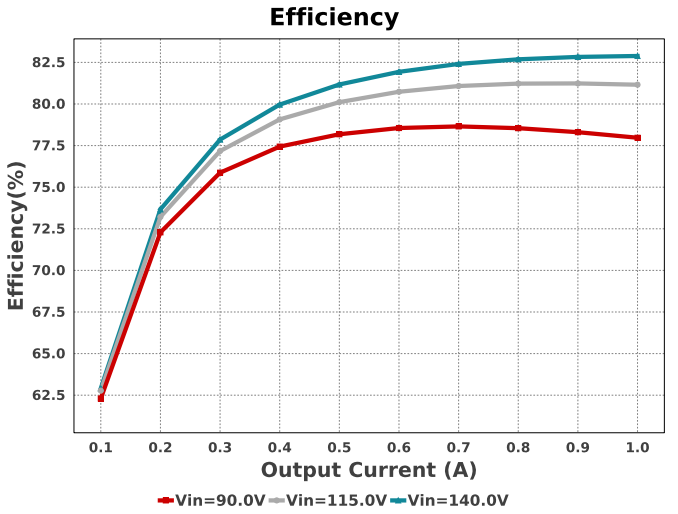

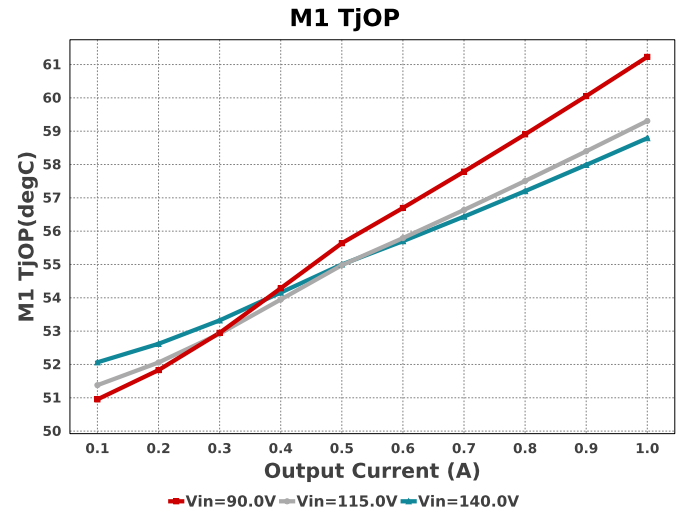

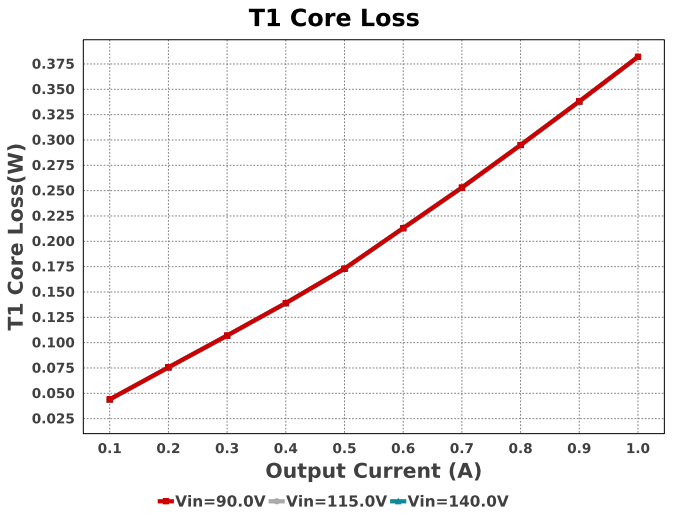

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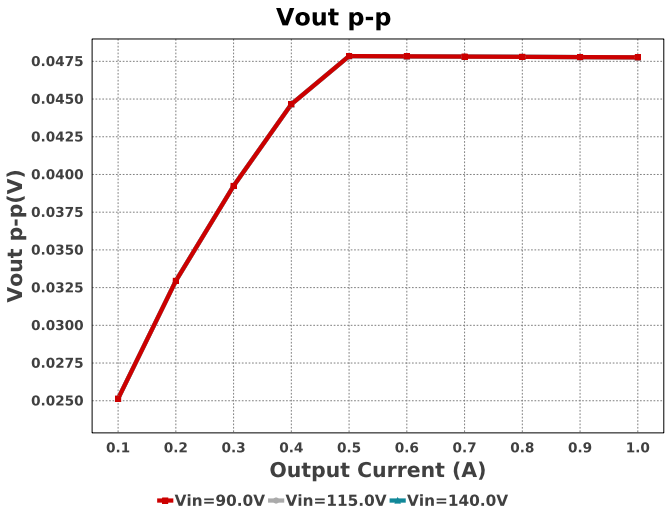

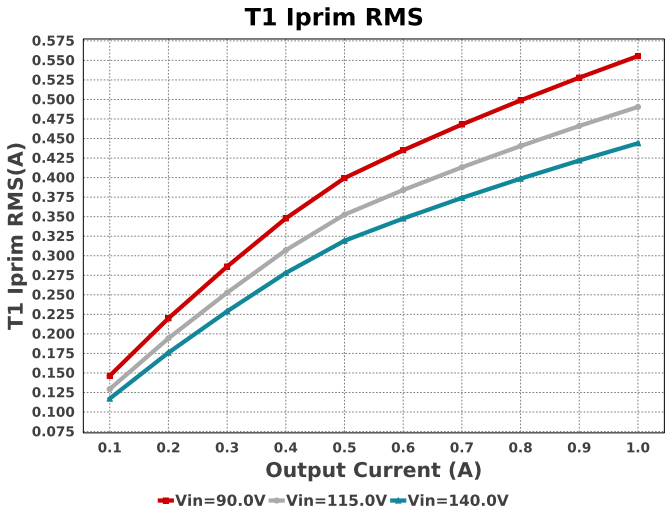

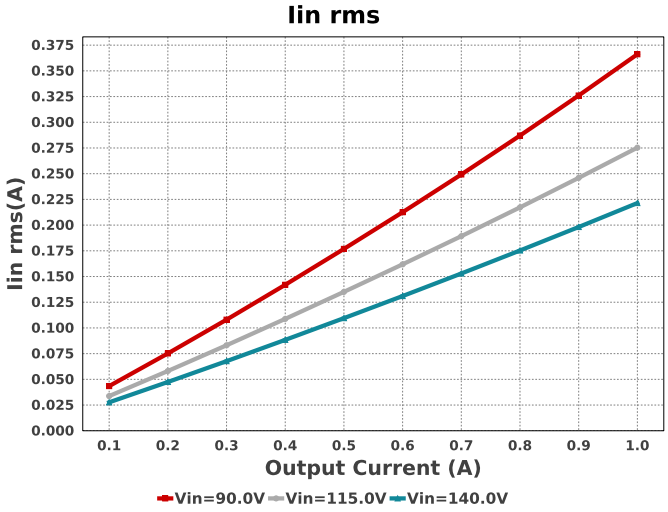

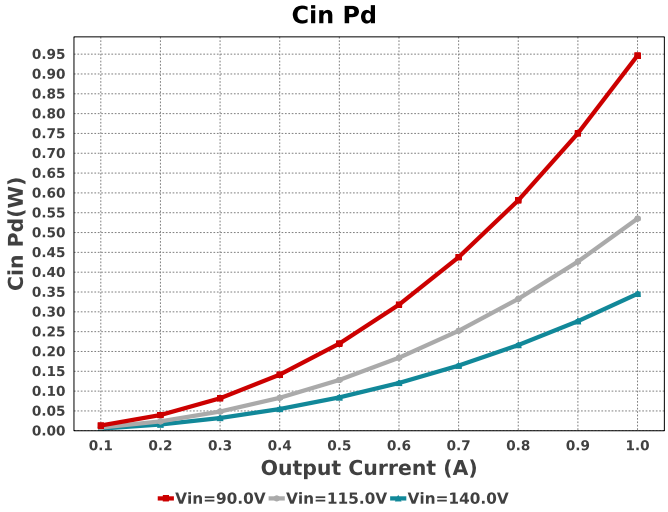

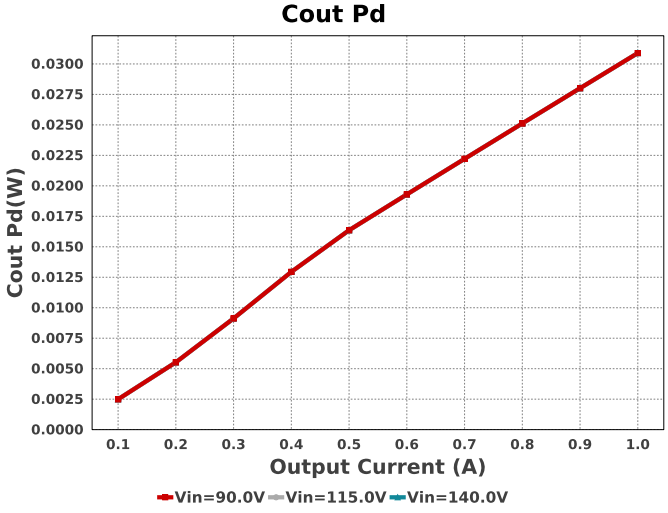

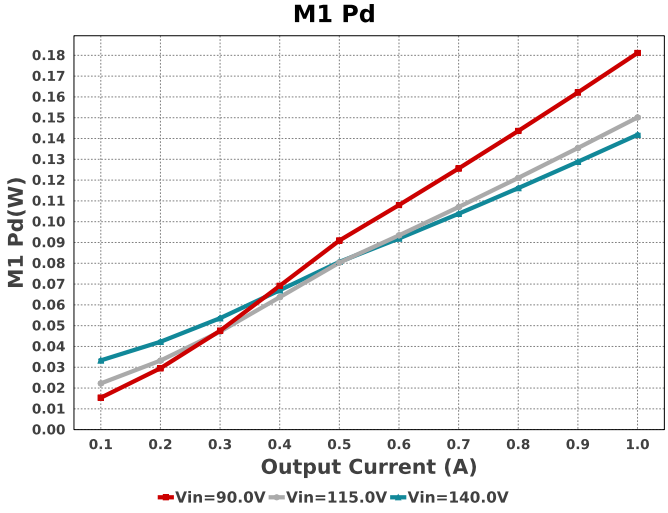

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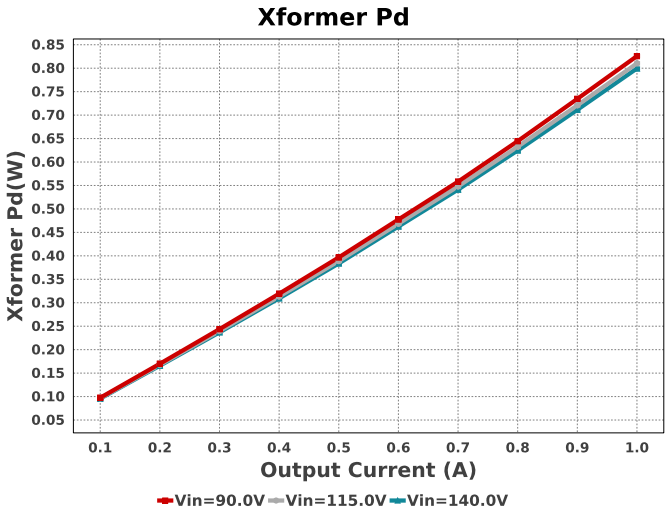

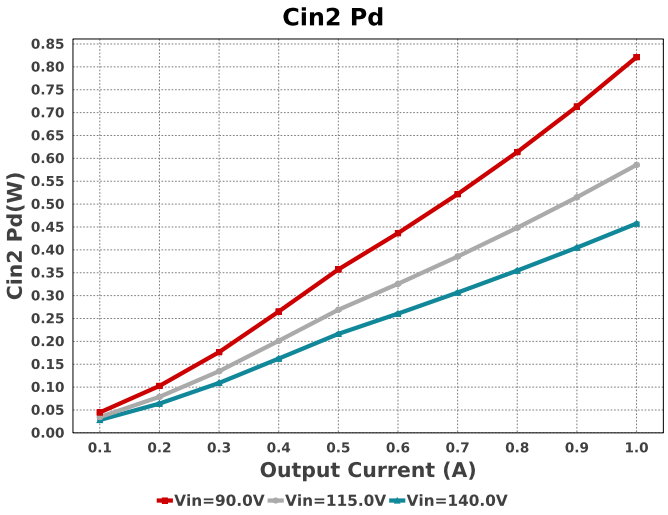

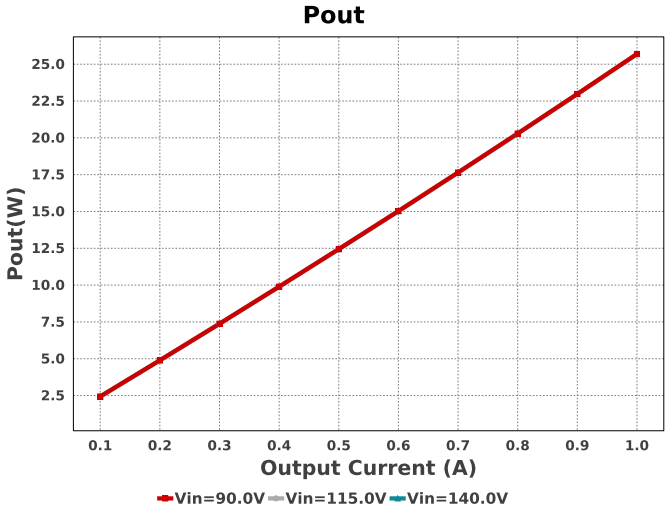

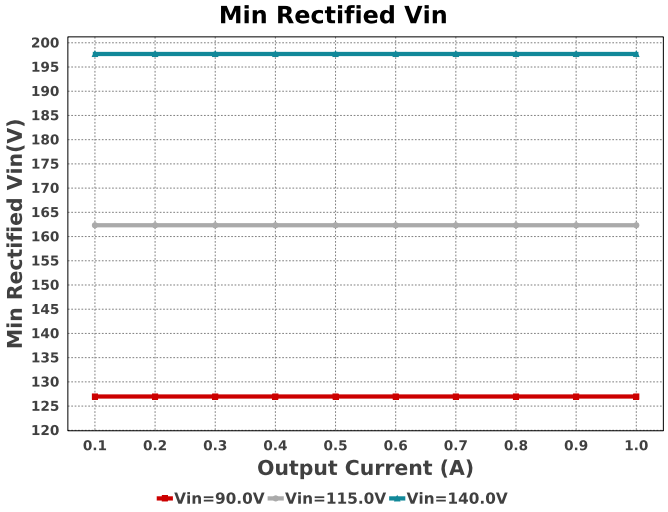

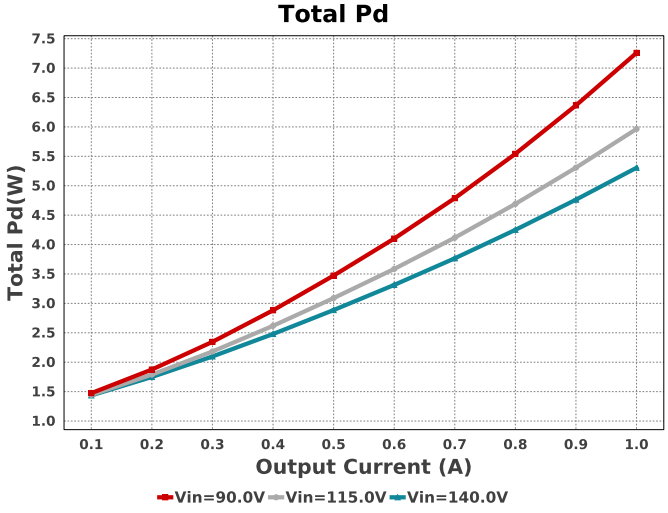

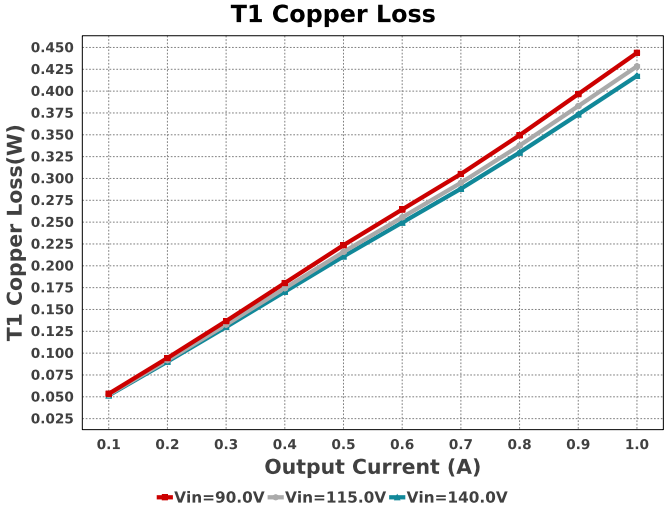

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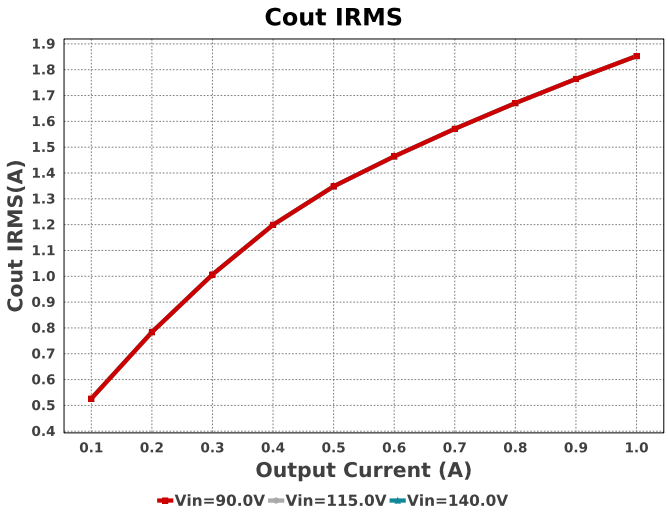

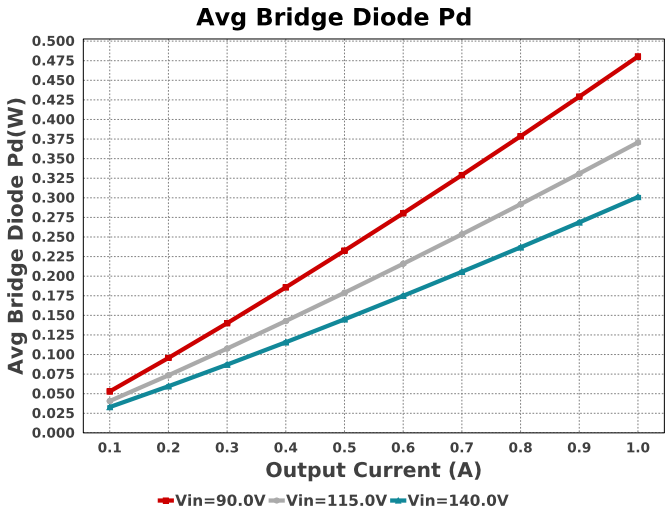

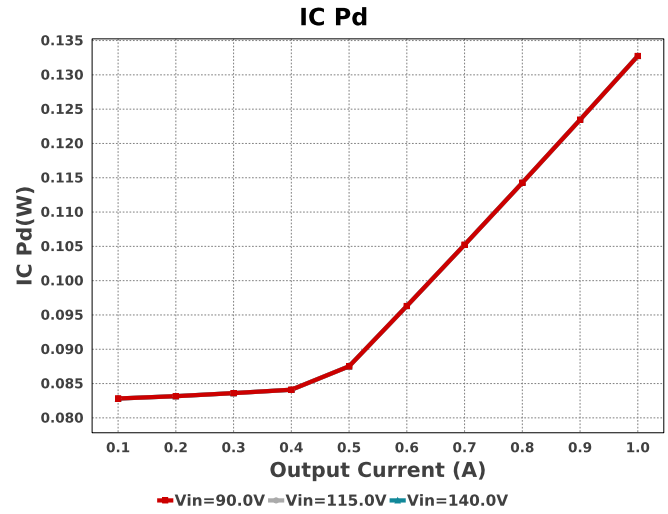

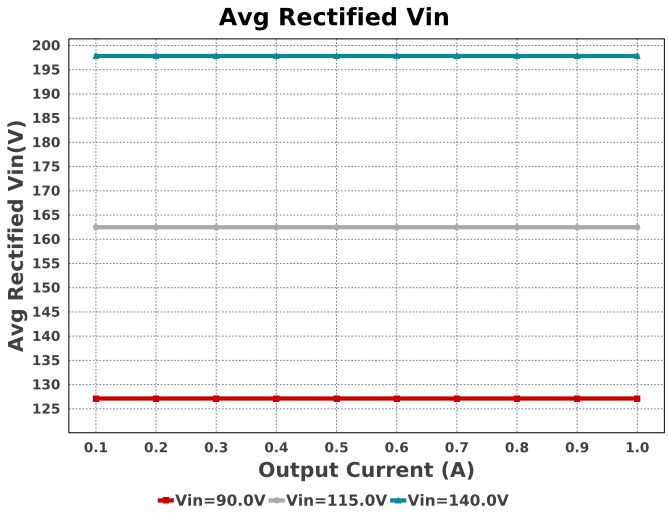

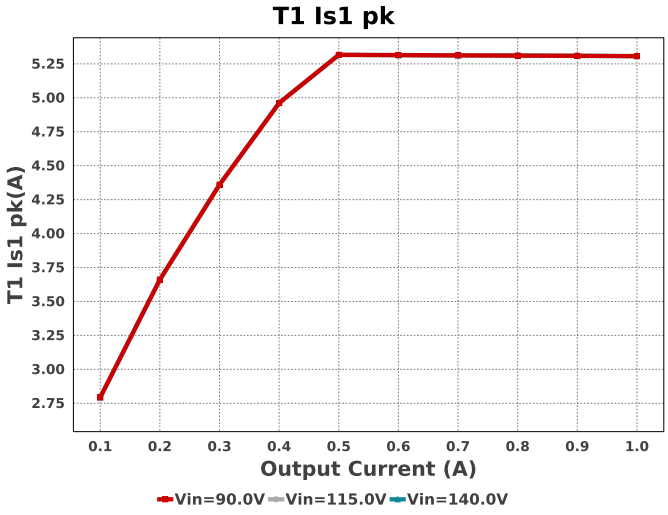

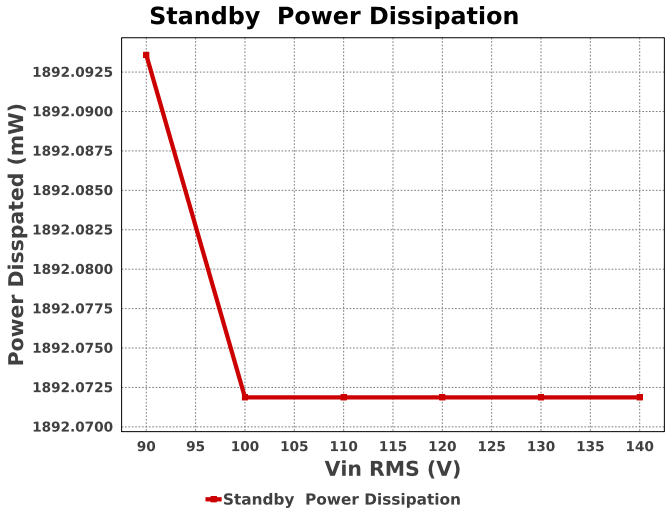

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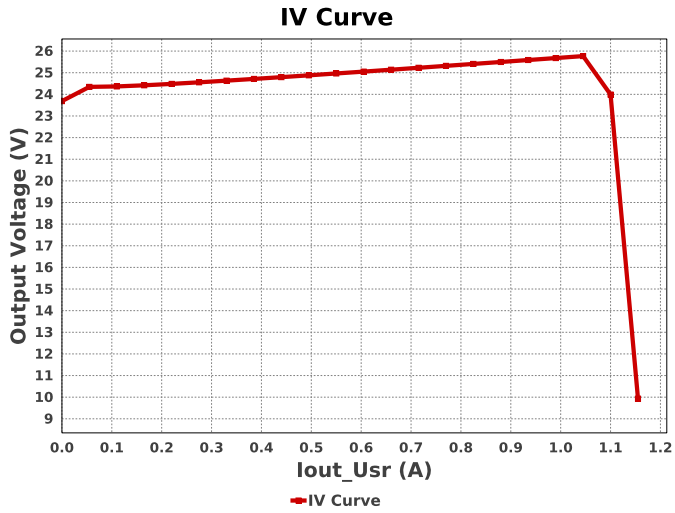

Operating Values

#	Name	Value	Category	Description
1.	Cin Pd	950.91 mW	Capacitors	Input capacitor power dissipation
2.	Cin2 Pd	823.32 mW	Capacitors	Average Power Dissipation in the Input Capacitor Cin2
3.	Cout IRMS	1.853 A	Capacitors	Output capacitor RMS ripple current
4.	Cout Pd	30.893 mW	Capacitors	Output capacitor power dissipation
5.	Avg Bridge Diode Pd	481.67 mW	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
6.	Diode2 Pd	216.76 mW	Diodes	Diode2 power dissipation
7.	IC Pd	132.75 mW	IC	IC power dissipation
8.	IC Tj	73.896 degC	IC	IC junction temperature
9.	ICThetaJA	180.0 degC/W	IC	IC junction-to-ambient thermal resistance
10.	M1 Pd	181.12 mW	Mosfet	M1 MOSFET total power dissipation
11.	M1 TjOP	61.23 degC	Mosfet	M1 MOSFET junction temperature
12.	Avg Bridge Diode Pd	481.67 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
13.	Cin Pd	950.91 mW	Power	Input capacitor power dissipation
14.	Cin2 Pd	823.32 mW	Power	Average Power Dissipation in the Input Capacitor Cin2
15.	Cout Pd	30.893 mW	Power	Output capacitor power dissipation
16.	Diode2 Pd	216.76 mW	Power	Diode2 power dissipation
17.	IC Pd	132.75 mW	Power	IC power dissipation
18.	M1 Pd	181.12 mW	Power	M1 MOSFET total power dissipation
19.	Snubber Pd	1.209 W	Power	Snubber Power Dissipation
20.	T1 Copper Loss	518.55 mW	Power	Transformer Copper Loss Power Dissipation
21.	T1 Core Loss	388.0 mW	Power	Transformer Core Loss Power Dissipation
22.	Total Pd	7.353 W	Power	Total Power Dissipation
23.	Xformer Pd	906.55 mW	Power	Transformer power dissipation
24.	Avg Rectified Vin	127.128 V	System Information	Average Rectified Voltage for the AC Line Period
25.	BOM Count	29	System Information	Total Design BOM count
26.	Duty Cycle	52.38 %	System Information	Duty cycle
27.	Efficiency	77.749 %	System Information	Steady state efficiency
28.	FootPrint	2.6 k mm^2	System Information	Total Foot Print Area of BOM components
29.	Frequency	91.112 kHz	System Information	Switching frequency
30.	Frequency	91.112 kHz	System Information	Switching frequency
31.	Iin rms	367.19 mA	System Information	RMS Input Current
32.	Iout	1.0 A	System Information	Iout operating point
33.	Min Rectified Vin	126.978 V	System Information	Minimum voltage seen at rectified input
34.	Mode	DCM	System Information	Conduction Mode
35.	Peak Rectified Vin	127.278 V	System Information	Peak voltage seen at rectified input
36.	Pout	25.694 W	System Information	Total output power
37.	Total BOM	NA	System Information	Total BOM Cost

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#	Name	Value	Category	Description
38.	Vin_RMS	90.0 V	System Information	Vin operating point
39.	Vout	25.694 V	System Information	Operational Output Voltage
40.	Vout Actual	25.694 V	System Information	Vout Actual calculated based on selected voltage divider resistors
41.	Vout Tolerance	863.4 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
42.	Vout p-p	47.764 mV	System Information	Peak-to-peak output ripple voltage
43.	T1 Copper Loss	518.55 mW	Transformer	Transformer Copper Loss Power Dissipation
44.	T1 Core Loss	388.0 mW	Transformer	Transformer Core Loss Power Dissipation
45.	T1 Iprim RMS	555.493 mA	Transformer	Transformer Primary RMS Current
46.	T1 Iprim pk	1.339 A	Transformer	Transformer Primary Peak Current
47.	T1 Is1 RMS	1.917 A	Transformer	Transformer Secondary1 RMS Current
48.	T1 Is1 pk	5.307 A	Transformer	Transformer Secondary1 Peak Current
49.	Xformer Pd	906.55 mW	Transformer	Transformer power dissipation

Design Inputs

Name	Value	Description
Iout	1.0	Maximum Output Current
VinMax	140.0	Maximum input voltage
VinMin	90.0	Minimum input voltage
Vout	24.0	Output Voltage
acFrequency	60.0	AC Frequency
base_pn	UCC28700	Base Product Number
source	AC	Input Source Type
Ta	50.0	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

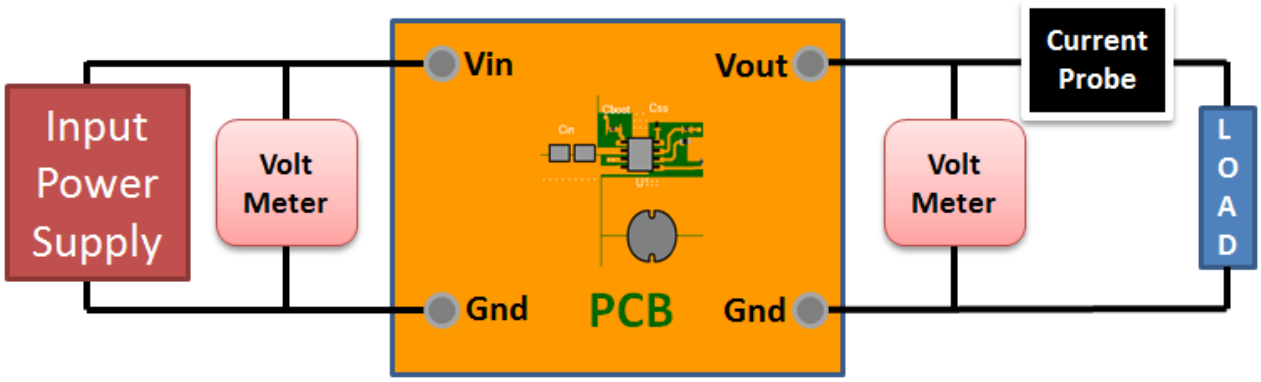
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 90.0V 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	B66317G0000X187
2.	Core Manufacturer	TDK
3.	Coil Former Part Number	B66208X1110T001
4.	Coil Former Manufacturer	TDK

Transformer Electrical Diagram

Primary

Turns	49.0
AWG	28.0
Layers	4.0
Strands	3.0
Insulation Type	Heavy Insulated Magnet Wire

Secondary

Turns	12.0
AWG	30.0
Layers	1.0
Strands	2.0
Insulation Type	Triple Insulated

Auxiliary

Turns	10.0
AWG	28.0
Layers	1.0
Strands	4.0
Insulation Type	Heavy Insulated Magnet Wire

Transformer Construction Diagram

Winding Instruction

Winding	AWG	Turns	Winding Orientation
Primary First 2/4.0	28.0	25	Clockwise
Triple Insulated Secondary	30.0	12.0	Counter Clockwise
Auxiliary	28.0	10.0	Counter Clockwise
Primary Second 2/4.0	28.0	24	Clockwise

Transformer Parameters

#	Name	Value
1.	Lpri	3.7E-4H
2.	Inductance Factor(Al)	155.0nH
3.	Npri	49.0
4.	Nsec	12.0
5.	Naux	10.0
6.	Core Type	E25/13/7
7.	Core Material	N87

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#	Name	Value
8.	Bmax	0.20T
9.	Switching Frequency	87.50kHz
10.	DMax	0.49
11.	Ipk(Primary)	1.38A
12.	Irms(Primary)	0.56A
13.	Ipk(Secondary)	5.65A
14.	Irms(Secondary)	2.13A

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 : A8DAB122B23F44E8[v1]

3. **UCC28700** Product Folder : http://www.ti.com/product/UCC28700 : contains the data sheet and other resources.

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