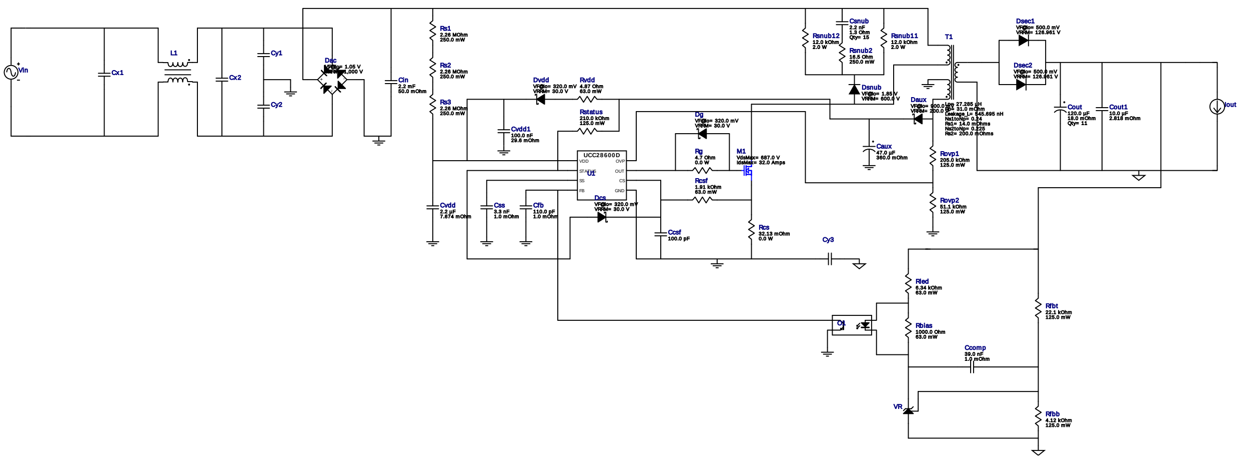
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 85.0V
VinMax = 265.0V
Vout = 16.0V
Iout = 25.0A

Device = UCC28600DR
Topology = Flyback
Created = 2018-11-25 06:33:51.330
BOM Cost = NA
BOM Count = 65
Total Pd =

Design : 908 UCC28600DR
UCC28600DR 85V-265V to 16.00V @ 25A



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

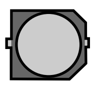
Design Alerts

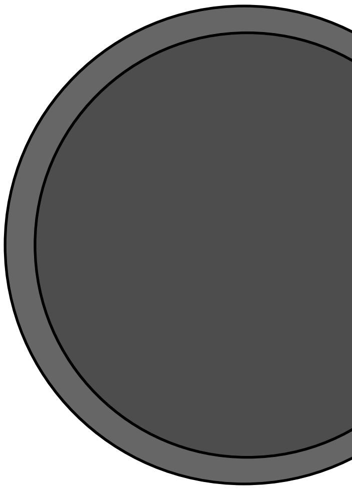
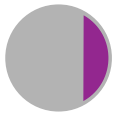
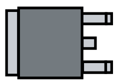
U1 Junction temperature is too high
U1 Tj:125.00 degC Specification: <105.00 degC
Suggested:<105.00 degC
U1 Tj:125.00 degC Specification: <105.00 degC
This may lead to a device malfunction or breakdown.
Some possible solutions are below:
Decrease Switching Frequency to decrease MOSFET or Diode switching losses
Decrease ambient temperature
Decrease thermal resistance by adding a heat sink if feasible
Increase the copper area and thickness of the board

Component Selection Information

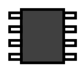
With the current design condition, suitable FET could not be found in the current database. Hence, this design is created using an ideal FET. Please note that the resulting FET parameters are ideal, so the efficiency/loss values have been disabled. Also, the schematic/PCB export and Thermal simulations will not work with the ideal FET.

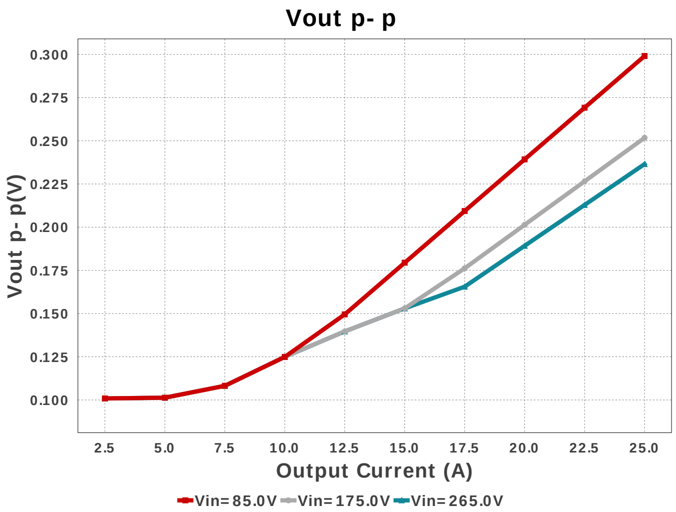
Electrical BOM

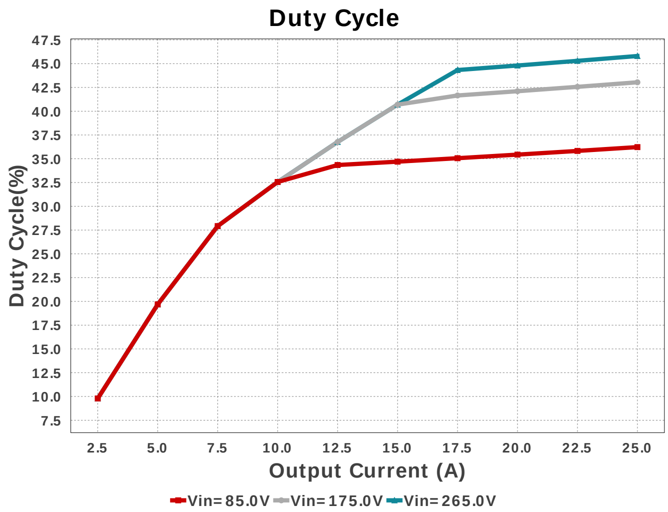
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Caux	Panasonic	EEE-FK1V470P Series= FK	Cap= 47.0 uF ESR= 360.0 mOhm VDC= 35.0 V IRMS= 240.0 mA	1	$0.12	 SM_RADIAL_D 84 mm^2
Ccomp	MuRata	GRM155R71A393KA01D Series= X7R	Cap= 39.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
Ccsf	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Cfb	MuRata	GRM1555C1E111JA01D Series= C0G/NP0	Cap= 110.0 pF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0402 3 mm^2

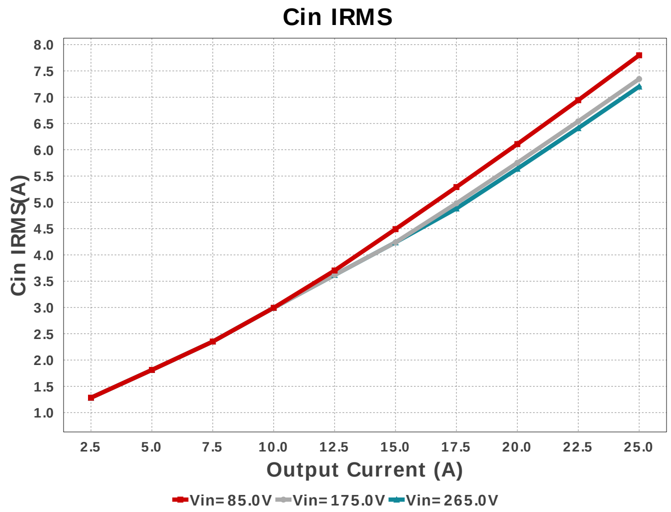
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin	TDK	B43510A5228M000 Series= 2384	Cap= 2.2 mF ESR= 50.0 mOhm VDC= 450.0 V IRMS= 16.9 A	1	$41.51	 B43510_4500x10000_00 2209 mm²
Cout	Panasonic	35SEPF120M Series= SEPF	Cap= 120.0 uF ESR= 18.0 mOhm VDC= 35.0 V IRMS= 4.4 A	11	$0.69	 SEPF_F13 144 mm²
Cout1	TDK	C2012X5R1V106K085AC Series= X5R	Cap= 10.0 uF ESR= 2.818 mOhm VDC= 35.0 V IRMS= 3.8868 A	1	$0.19	0805 7 mm²
Csnub	MuRata	GRM188R72E222KW07D Series= X7R	Cap= 2.2 nF ESR= 1.3 Ohm VDC= 250.0 V IRMS= 120.0 mA	15	$0.35	0603 5 mm²
Css	MuRata	GRM033R70J332KA01D Series= X7R	Cap= 3.3 nF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Cvdd	TDK	C1608X5R1V225K080AC Series= X5R	Cap= 2.2 uF ESR= 7.674 mOhm VDC= 35.0 V IRMS= 1.87823 A	1	$0.06	0603 5 mm²
Cvdd1	TDK	C1608X5R1H104K080AA Series= X5R	Cap= 100.0 nF ESR= 29.6 mOhm VDC= 50.0 V IRMS= 971.99 mA	1	$0.01	0603 5 mm²
Dac	Diodes Inc.	GBJ2510-F	VF@Io= 1.05 V VRRM= 1,000.0 V	1	$1.20	GBJ 211 mm²
Daux	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.04	 SMA 37 mm²
Dcs	Toshiba	CMS06	VF@Io= 320.0 mV VRRM= 30.0 V	1	$0.20	 M-FLAT 19 mm²
Dg	Toshiba	CMS06	VF@Io= 320.0 mV VRRM= 30.0 V	1	$0.20	 M-FLAT 19 mm²
Dsec1	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 126.961 V	1	NA	CUSTOM 0 mm²
Dsec2	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 126.961 V	1	NA	CUSTOM 0 mm²
Dsnub	STMicroelectronics	STTH506B-TR	VF@Io= 1.85 V VRRM= 600.0 V	1	$0.66	 DPAK 102 mm²

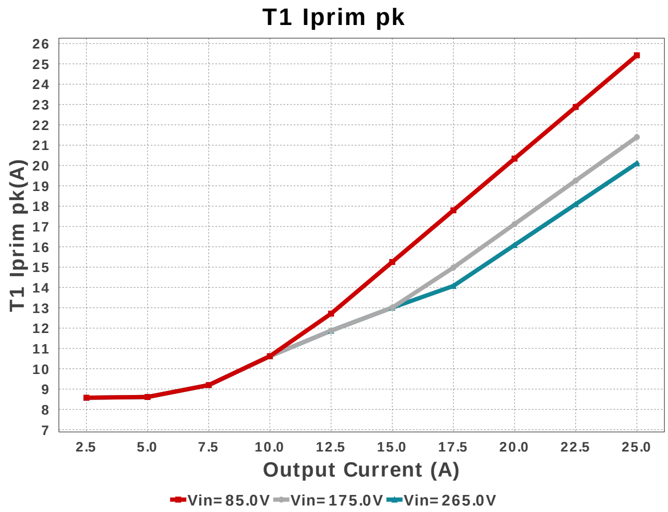
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Dvdd	Toshiba	CMS06	VF@Io= 320.0 mV VRRM= 30.0 V	1	$0.20	M-FLAT 19 mm^2
M1	NA	IdealFET	VdsMax= 687.0 V IdsMax= 32.0 Amps	1	NA	NA 0 mm^2
O1	Fairchild Semiconductor	FOD817A	Optocoupler	1	$0.13	DIP-4 71 mm^2
Rbias	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcs	CUSTOM	CUSTOM Series= ?	Res= 32.13 mOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rcsf	Vishay-Dale	CRCW04021K91FKED Series= CRCW..e3	Res= 1.91 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rfbb	Panasonic	ERJ-6ENF4121V Series= ERJ-6E	Res= 4.12 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rfbt	Panasonic	ERJ-6ENF2212V Series= ERJ-6E	Res= 22.1 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rg	CUSTOM	CUSTOM Series= ?	Res= 4.7 Ohm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rled	Vishay-Dale	CRCW04026K34FKED Series= CRCW..e3	Res= 6.34 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rovp1	Vishay-Dale	CRCW0805205KFKEA Series= CRCW..e3	Res= 205.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rovp2	Panasonic	ERJ-6ENF5112V Series= ERJ-6E	Res= 51.1 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rs1	Vishay-Dale	CRCW12062M26FKEA Series= CRCW..e3	Res= 2.26 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rs2	Vishay-Dale	CRCW12062M26FKEA Series= CRCW..e3	Res= 2.26 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rs3	Vishay-Dale	CRCW12062M26FKEA Series= CRCW..e3	Res= 2.26 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rsnub11	Vishay-Bccomponents	PR02000201202JR500 Series= ?	Res= 12.0 kOhm Power= 2.0 W Tolerance= 5.0%	1	$0.05	PR02 117 mm^2
Rsnub12	Vishay-Bccomponents	PR02000201202JR500 Series= ?	Res= 12.0 kOhm Power= 2.0 W Tolerance= 5.0%	1	$0.05	PR02 117 mm^2
Rsnub2	Vishay-Dale	CRCW120616R5FKEA Series= CRCW..e3	Res= 16.5 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rstatus	Panasonic	ERJ-6ENF2103V Series= ERJ-6E	Res= 210.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
Rvdd	Vishay-Dale	CRCW04024R87FKED Series= CRCW..e3	Res= 4.87 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

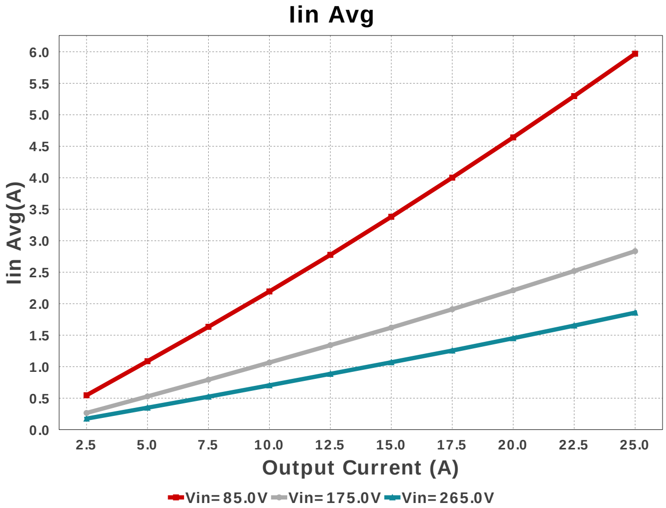
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
T1	CUSTOM	CUSTOM	Lp= 27.285 µH Rp= 31.0 mOhm Leakage_L= 545.695 nH Ns1toNp= 0.24 Rs1= 14.0 mOhms Ns2toNp= 0.225 Rs2= 200.0 mOhms	1	NA	CUSTOM 0 mm^2
U1	Texas Instruments	UCC28600DR	Switcher	1	$0.46	 D0008A 57 mm^2
VR	Texas Instruments	TL431AIDBZR	Voltage References	1	$0.08	 DBZ0003A 14 mm^2

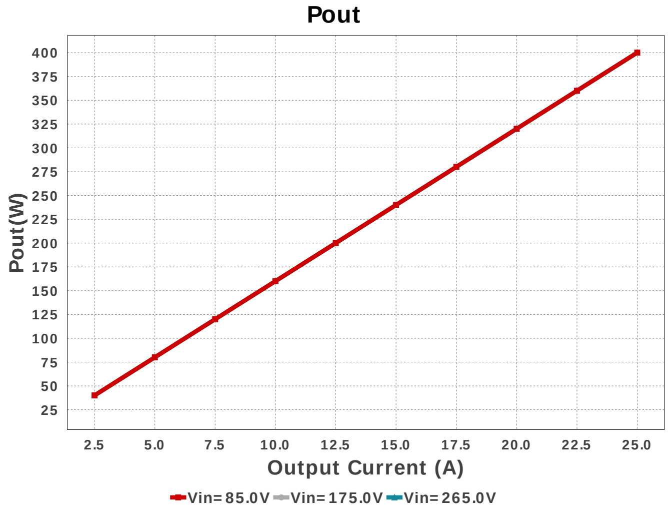


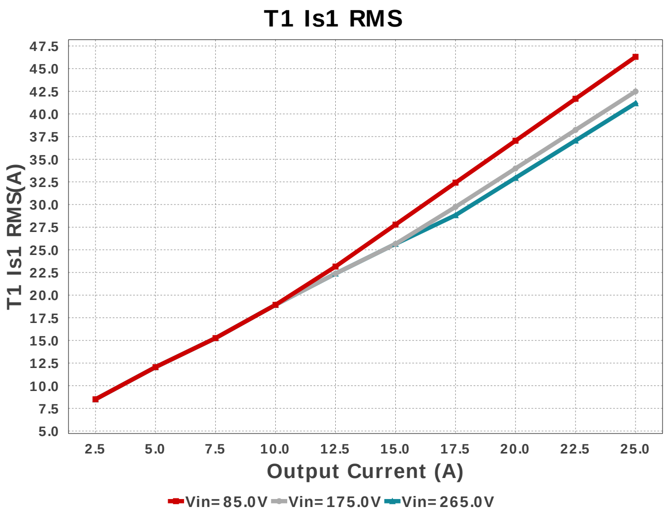


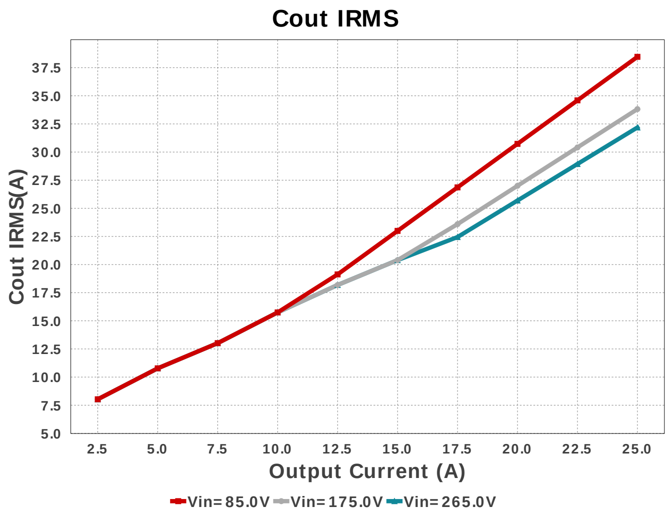


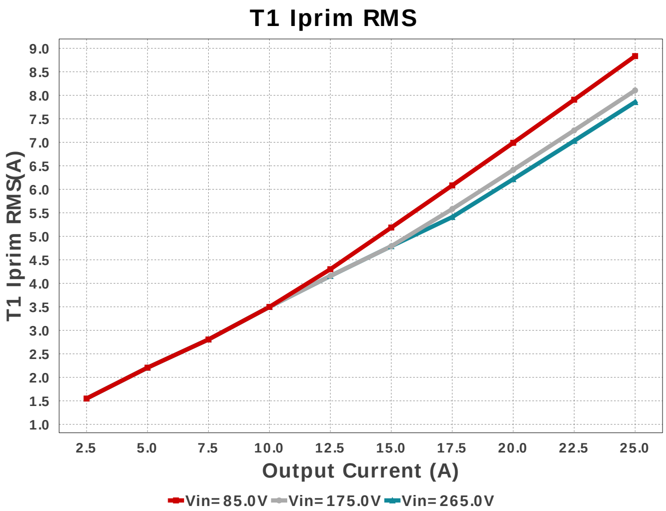












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	7.32 A	Capacitor	Input capacitor RMS ripple current
2.	Cout IRMS	33.485 A	Capacitor	Output capacitor RMS ripple current
3.	ICThetaJA	108.9 degC/W	IC	IC junction-to-ambient thermal resistance
4.	Iin Avg	5.832 A	IC	Average input current
5.	BOM Count	65	System Information	Total Design BOM count
6.	Duty Cycle	43.586 %	System Information	Duty cycle
7.	FootPrint	4.972 k mm^2	System Information	Total Foot Print Area of BOM components

#	Name	Value	Category	Description
8.	Frequency	82.092 kHz	System Information	Switching frequency
9.	Iout	25.0 A	System Information	Iout operating point
10.	Mode	DCM	System Information	Conduction Mode
11.	Pout	400.476 W	System Information	Total output power
12.	Total BOM	NA	System Information	Total BOM Cost
13.	Vin	85.0 V	System Information	Vin operating point
14.	Vout	16.0 V	System Information	Operational Output Voltage
15.	Vout p-p	248.564 mV	System Information	Peak-to-peak output ripple voltage
16.	T1 Iprim RMS	8.054 A	Transformer	Transformer Primary RMS Current
17.	T1 Iprim pk	21.13 A	Transformer	Transformer Primary Peak Current
18.	T1 Is1 RMS	42.213 A	Transformer	Transformer Secondary1 RMS Current

Design Inputs

Name	Value	Description
Iout	25.0	Maximum Output Current
VinMax	265.0	Maximum input voltage
VinMin	85.0	Minimum input voltage
Vout	16.0	Output Voltage
acFrequency	60.0	AC Frequency
base_pn	UCC28600	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

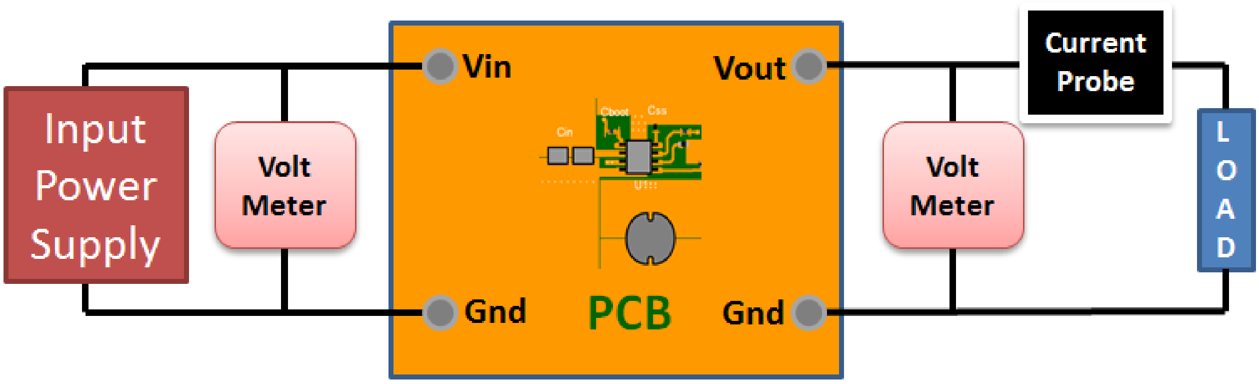
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins.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



Design Assistance

1. Quasi-Resonant Flyback Green-Mode Controller

2. Master key : 6122D9DF1E6F878E[v1]

3. **UCC28600** Product Folder : http://www.ti.com/product/UCC28600 : contains the data sheet and other resources.