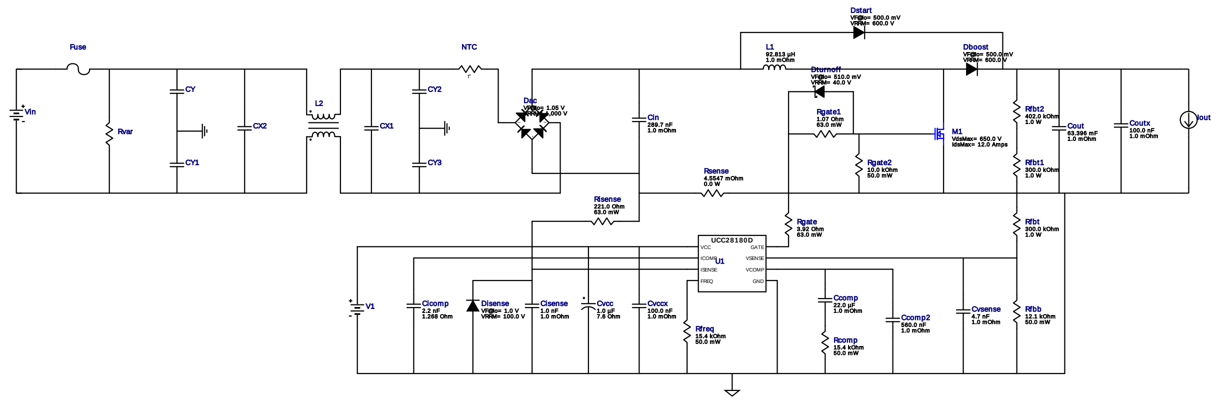
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 210.0V
VinMax = 255.0V
Vout = 400.0V
Iout = 7.0A

Device = UCC28180DR
Topology = PFC-BOOST
Created = 2020-05-23 14:12:34.574
BOM Cost = NA
BOM Count = 32
Total Pd =

Design : 16 UCC28180DR
UCC28180DR 210V-255V to 400.00V @ 7A



1. Mosfet gate resistances are a starting point and need to be modified according to Mosfet selected. Protection circuit is designed for standard input conditions and should be redesigned for unconventional input conditions.

Design Alerts

UCC28180 Design

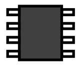
With the current design condition, suitable FET could not be found in the current database. Hence, this design is created using an ideal FET. Please note that the resulting FET parameters are ideal, so the efficiency/loss values have been disabled. Also, the schematic/PCB export and Thermal simulations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

Electrical BOM

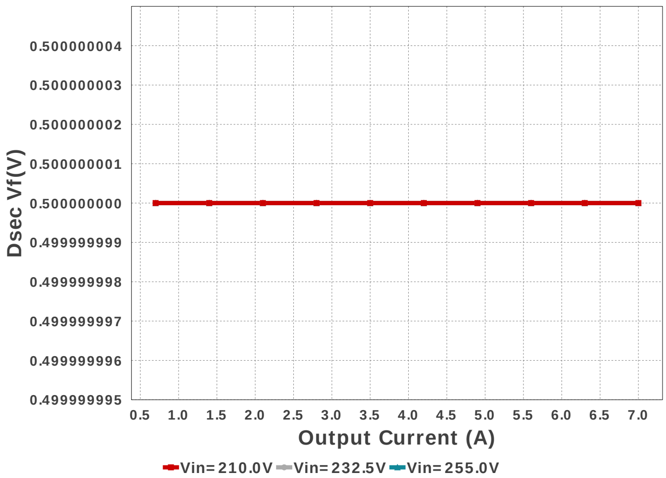
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ccomp	Taiyo Yuden	LMK212BJ226MG-T Series= X5R	Cap= 22.0 uF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.10	0805 7 mm^2
Ccomp2	MuRata	GRM155R61A564KE15D Series= X5R	Cap= 560.0 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 6.0 A	1	$0.03	0402 3 mm^2
Cicomp	TDK	CGA1A2X7R1E222K030BA Series= X7R	Cap= 2.2 nF ESR= 1.26834 Ohm VDC= 25.0 V IRMS= 201.468 mA	1	$0.01	0201_033 2 mm^2
Cin	CUSTOM	CUSTOM Series= ?	Cap= 289.7 nF ESR= 1.0 mOhm VDC= 540.94 V IRMS= 19.849 A	1	NA	CUSTOM 0 mm^2
Cisense	MuRata	GRM033R71C102KA01D Series= X7R	Cap= 1.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
Cout	CUSTOM	CUSTOM Series= ?	Cap= 63.396 mF ESR= 1.0 mOhm VDC= 600.0 V IRMS= 15.8776 A	1	NA	CUSTOM 0 mm^2
Coutx	CUSTOM	CUSTOM Series= ?	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 600.0 V IRMS= 15.8776 A	1	NA	CUSTOM 0 mm^2

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cvcc	Vishay-Sprague	293D105X9025A2TE3 Series= 293D	Cap= 1.0 uF ESR= 7.6 Ohm VDC= 25.0 V IRMS= 100.0 mA	1	$0.09	3216-18 11 mm²
Cvccx	MuRata	GRM155R71C104KA88D Series= X7R	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
Cvsense	MuRata	GRM033R71A472KA01D Series= X7R	Cap= 4.7 nF ESR= 1.0 mOhm VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
Dac	Diodes Inc.	GBJ2510-F	VF@Io= 1.05 V VRRM= 1,000.0 V	1	$1.09	GBJ 211 mm²
Dboost	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 600.0 V	1	NA	CUSTOM 0 mm²
Disense	ON Semiconductor	1N4148	VF@Io= 1.0 V VRRM= 100.0 V	1	NA	DO-35 40 mm²
Dstart	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 600.0 V	1	NA	CUSTOM 0 mm²
Dturnoff	Comchip Technology	CDBK0540	VF@Io= 510.0 mV VRRM= 40.0 V	1	$0.08	SOD-123F 12 mm²
L1	CUSTOM	CUSTOM	L= 92.813 µH 1.0 mOhm	1	NA	CUSTOM 0 mm²
M1	NA	IdealFET	VdsMax= 650.0 V IdsMax= 12.0 Amps	1	NA	NA 0 mm²
M1	NA	IdealFET	VdsMax= 650.0 V IdsMax= 12.0 Amps	1	NA	NA 0 mm²
NTC	GE Sensing	CL-101 Series= CL	Thermistor	1	$2.30	CL-101 194 mm²
Rcomp	Yageo	RC0201FR-0715K4L Series= ?	Res= 15.4 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rfbb	Yageo	RC0201FR-0712K1L Series= ?	Res= 12.1 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rfbt	Vishay-Dale	CRCW2512300KJNEG Series= CRCW..e3	Res= 300.0 kOhm Power= 1.0 W Tolerance= 5.0%	1	$0.04	2512 43 mm²
Rfbt1	Vishay-Dale	CRCW2512300KJNEG Series= CRCW..e3	Res= 300.0 kOhm Power= 1.0 W Tolerance= 5.0%	1	$0.04	2512 43 mm²
Rfbt2	Vishay-Dale	CRCW2512402KFKEG Series= CRCW..e3	Res= 402.0 kOhm Power= 1.0 W Tolerance= 1.0%	1	$0.05	2512 43 mm²
Rfreq	Yageo	RC0201FR-0715K4L Series= ?	Res= 15.4 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rgate	Vishay-Dale	CRCW04023R92FKED Series= CRCW..e3	Res= 3.92 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rgate1	Vishay-Dale	CRCW04021R07FKED Series= CRCW..e3	Res= 1.07 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rgate2	Yageo	RC0201FR-0710KL Series= ?	Res= 10.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Risense	Vishay-Dale	CRCW0402221RFKED Series= CRCW..e3	Res= 221.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

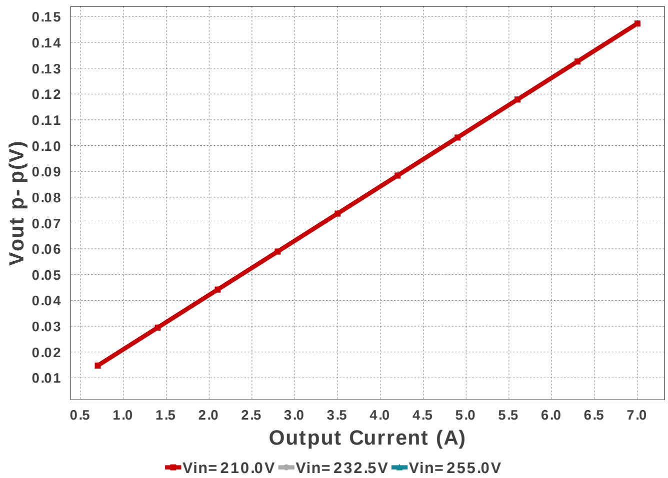
Copyright © 2020, Texas Instruments Incorporated

Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rsense	CUSTOM	CUSTOM Series= ?	Res= 4.5547 mOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rvar	TDK	S10K275E2		0	$0.15	 VAR_S10K275E2 104 mm²
U1	Texas Instruments	UCC28180DR	Switcher	1	$0.40	 D0008A 57 mm²

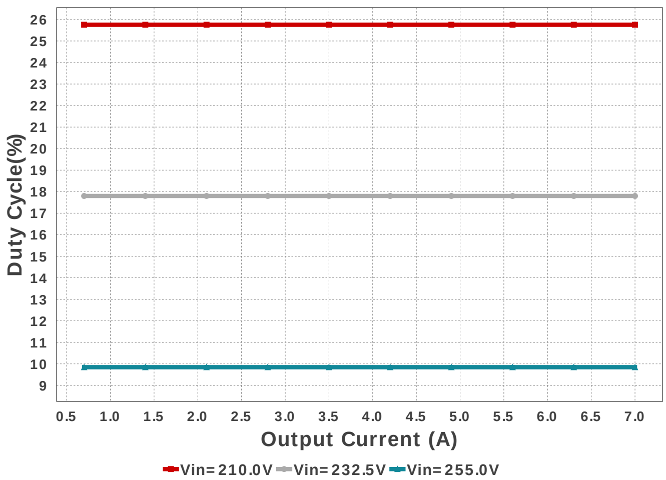
Dsec Vf



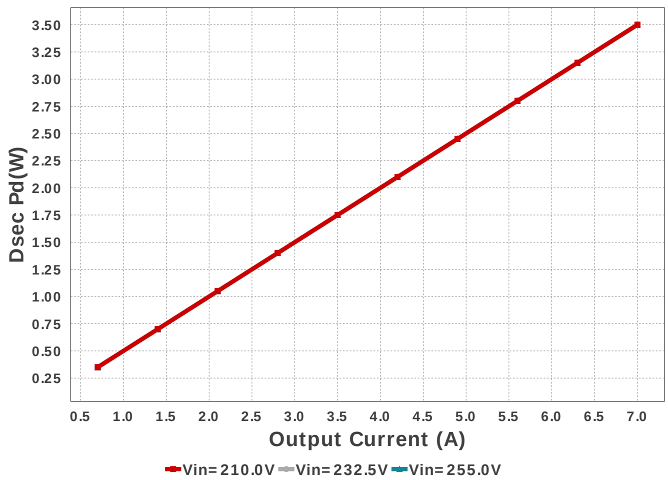
Vout p- p



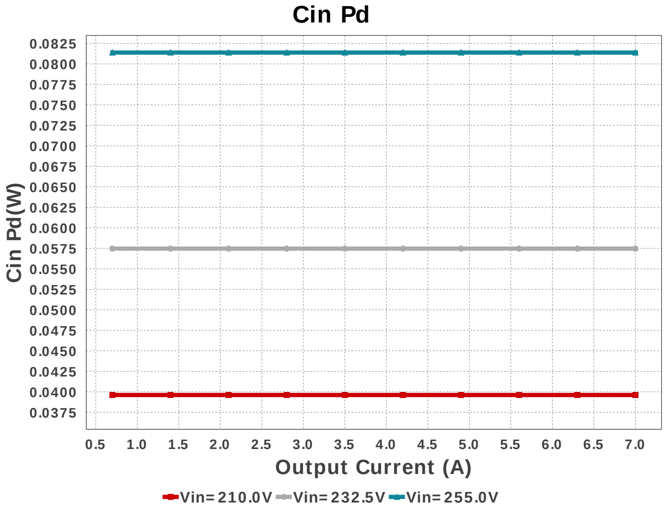
Duty Cycle

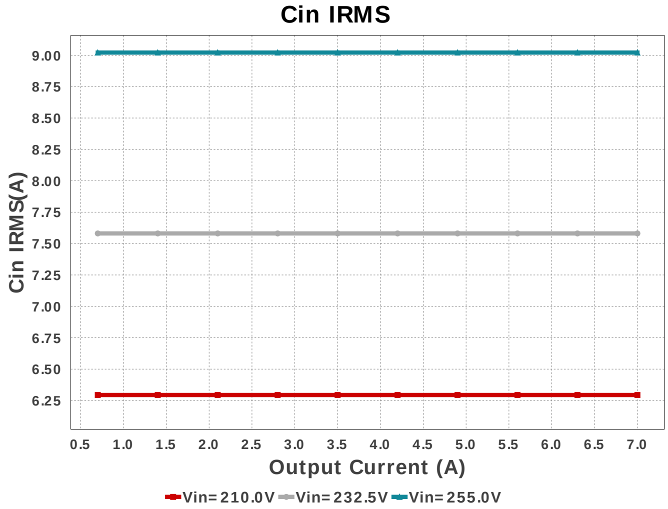


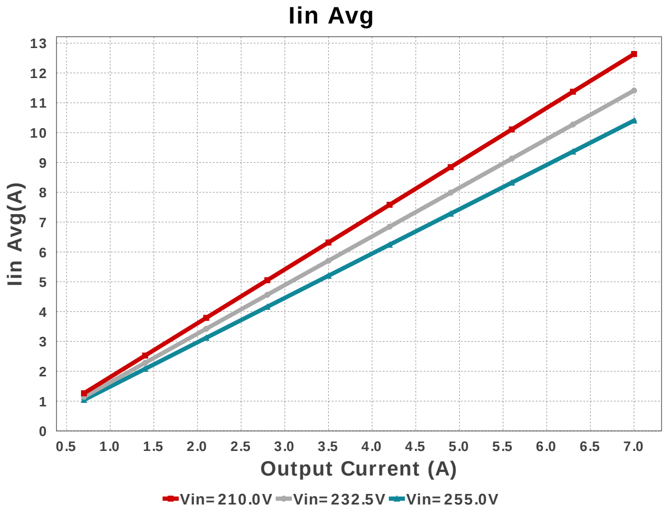
Dsec Pd

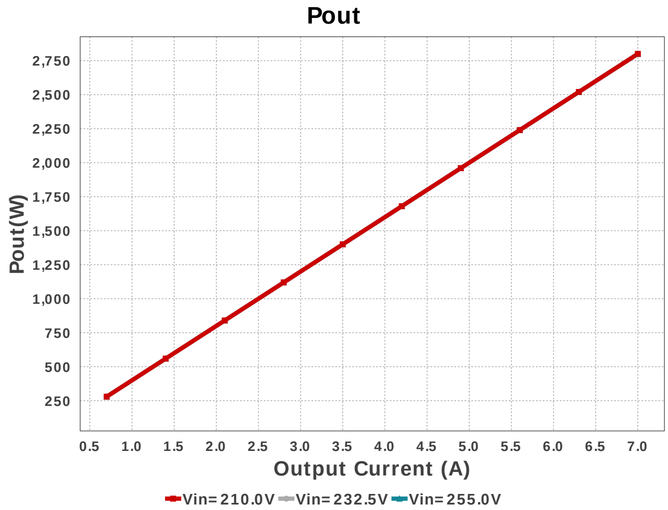


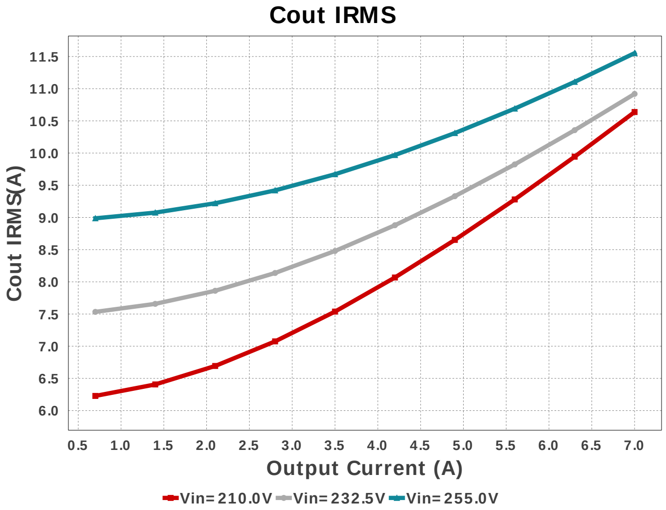
Copyright © 2020, Texas Instruments Incorporated

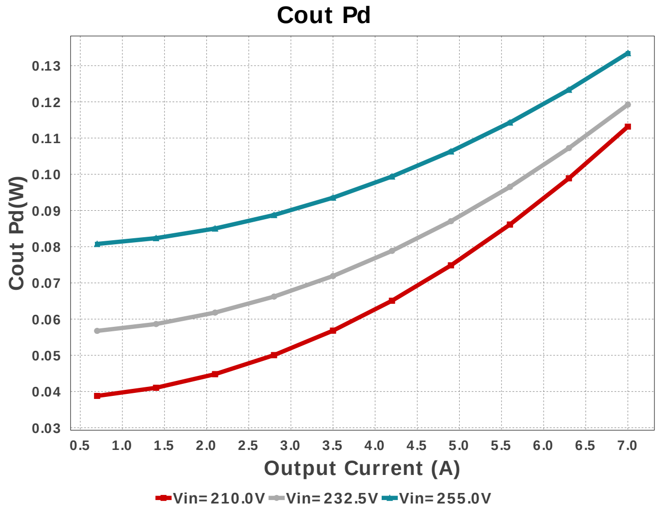

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=210.0V
Vin=232.5V
Vin=255.0V

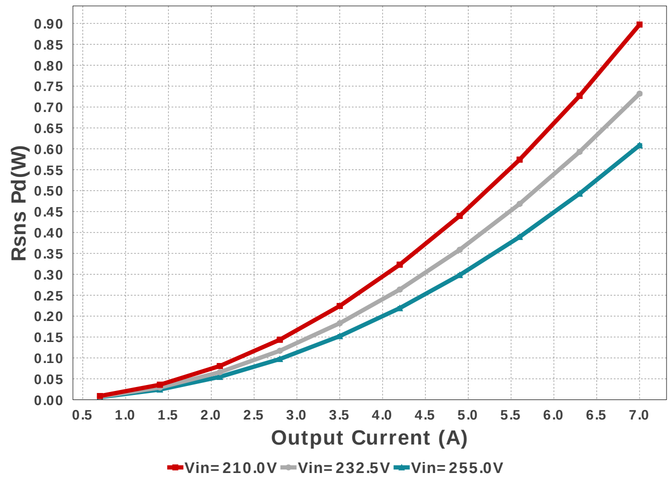

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=210.0V
Vin=232.5V
Vin=255.0V

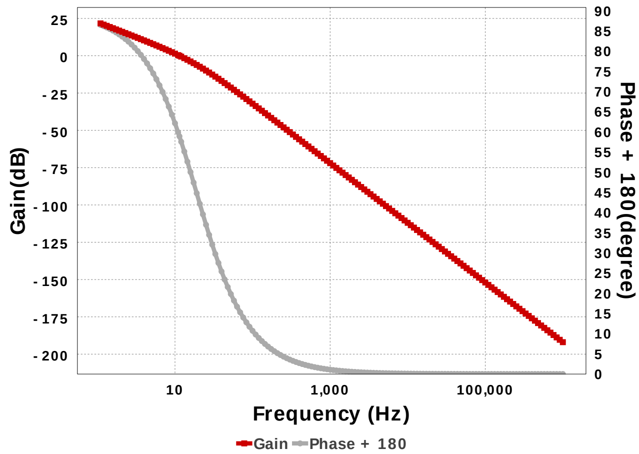

Iin Avg
Iin Avg(A)
Output Current (A)
Vin=210.0V
Vin=232.5V
Vin=255.0V


Pout
Pout(W)
Output Current (A)
Vin=210.0V
Vin=232.5V
Vin=255.0V


Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=210.0V
Vin=232.5V
Vin=255.0V


Cout Pd
Cout Pd(W)
Output Current (A)
Vin=210.0V
Vin=232.5V
Vin=255.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	6.47 A	Capacitor	Input capacitor RMS ripple current
2.	Cin Pd	41.858 mW	Capacitor	Input capacitor power dissipation
3.	Cout IRMS	10.739 A	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	115.32 mW	Capacitor	Output capacitor power dissipation
5.	Dsec Pd	3.5 W	Diode	Secondary Diode Power Dissipation
6.	Dsec Vf	500.0 mV	Diode	Effective Forward Voltage Drop at the Operating Current
7.	ICThetaJA	116.1 degC/W	IC	IC junction-to-ambient thermal resistance
8.	Iin Avg	12.634 A	IC	Average input current
9.	Cin Pd	41.858 mW	Power	Input capacitor power dissipation
10.	Cout Pd	115.32 mW	Power	Output capacitor power dissipation
11.	Dsec Pd	3.5 W	Power	Secondary Diode Power Dissipation
12.	Rsns Pd	897.2 mW	Power	Current Limit Sense Resistor Power Dissipation
13.	Rsns Pd	897.2 mW	Resistor	Current Limit Sense Resistor Power Dissipation
14.	BOM Count	32	System Information	Total Design BOM count
15.	Cross Freq	11.99 Hz	System Information	Bode plot crossover frequency
16.	Duty Cycle	25.754 %	System Information	Duty cycle
17.	FootPrint	1.806 k mm^2	System Information	Total Foot Print Area of BOM components
18.	Frequency	135.707 kHz	System Information	Switching frequency
19.	Gain Marg	-202.678 dB	System Information	Bode Plot Gain Margin
20.	Iout	7.0 A	System Information	Iout operating point
21.	Low Freq Gain	22.247 dB	System Information	Gain at 1Hz
22.	Mode	CCM	System Information	Conduction Mode
23.	Phase Marg	57.609 deg	System Information	Bode Plot Phase Margin
24.	Pout	2.8 kW	System Information	Total output power
25.	Total BOM	NA	System Information	Total BOM Cost
26.	Vin	210.0 V	System Information	Vin operating point
27.	Vout	400.0 V	System Information	Operational Output Voltage
28.	Vout Actual	128.967 V	System Information	Vout Actual calculated based on selected voltage divider resistors
29.	Vout Tolerance	5.826 %	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
30.	Vout p-p	146.426 mV	System Information	Peak-to-peak output ripple voltage

Design Inputs

Name	Value	Description
Iout	7.0	Maximum Output Current

Name	Value	Description
VinMax	255.0	Maximum input voltage
VinMin	210.0	Minimum input voltage
Vout	400.0	Output Voltage
acFrequency	60.0	AC Frequency
base_pn	UCC28180	Base Product Number
source	AC	Input Source Type
Ta	50.0	Ambient temperature

Copyright © 2020, Texas Instruments Incorporated

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

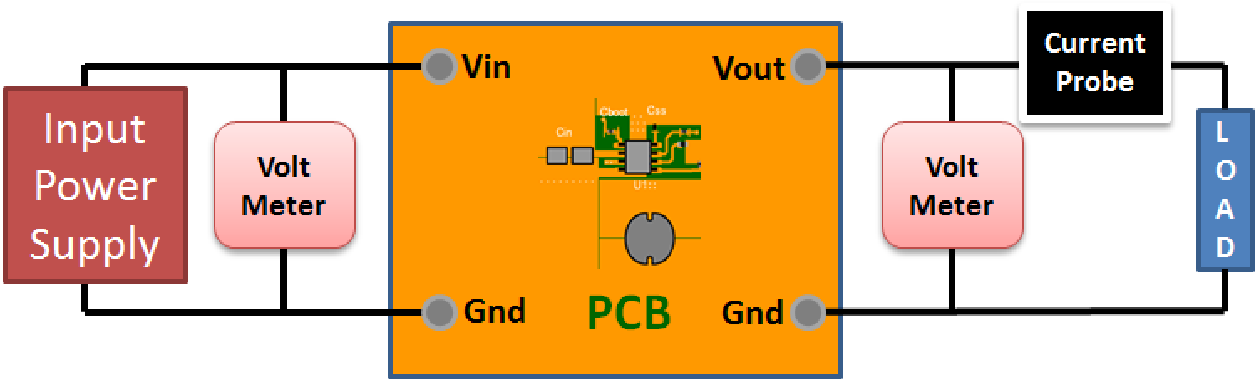
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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 210.0V 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. Feature Highlights: Output Current up to 23A, 85 to 265 V Input Voltage Range, Integrated Thermal Protection,Ideal for High power applications.

2. Master key : 78760316E94F2B0C[v1]

3. **UCC28180** Product Folder : http://www.ti.com/product/UCC28180 : contains the data sheet and other resources.

Important Notice and Disclaimer

TI provides technical and reliability data (including datasheets), design resources (including reference designs), application or other design advice, web tools, safety information, and other resources AS IS and with all faults, and disclaims all warranties. These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

Providing these resources does not expand or otherwise alter TI's applicable Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with TI products.