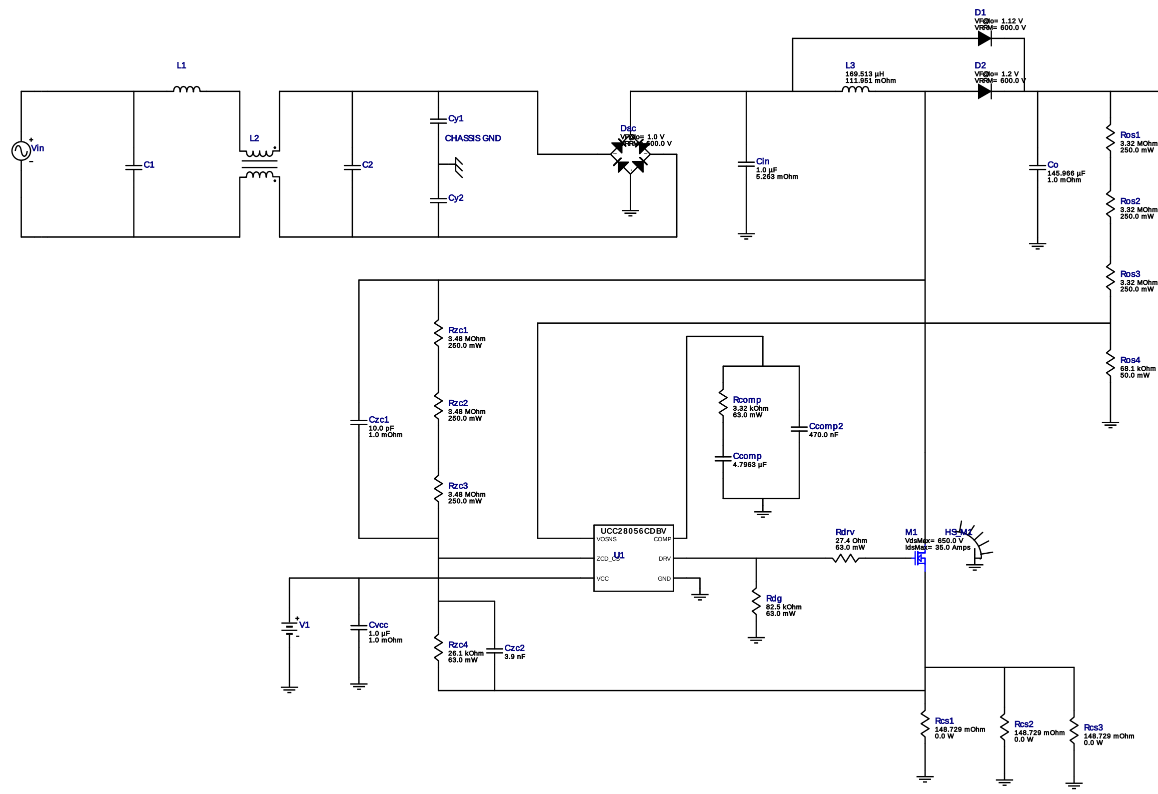
VinMin = 85.0V
VinMax = 265.0V
Vout = 400.0V
Iout = 0.5A

Device = UCC28056CDBVR
Topology = PFC-BOOST
Created = 2020-06-27 01:18:26.887
BOM Cost = NA
BOM Count = 28
Total Pd = 9.45W

WEBENCH ® Design Report

Design : 3 UCC28056CDBVR
UCC28056CDBVR 85V-265V to 400.00V @ 0.5A



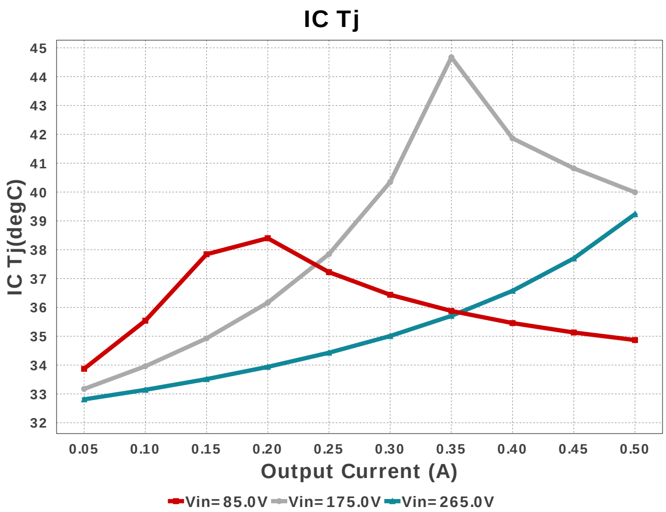
1. The EMI filter shown in the schematic is a placeholder. It has not yet been designed for the application.

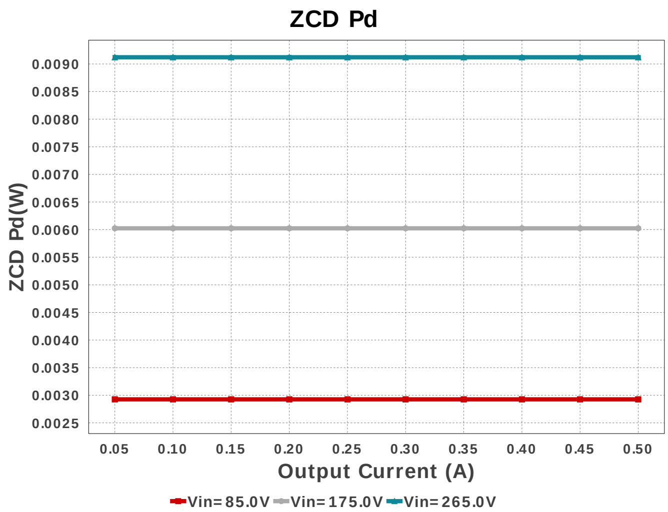
Electrical BOM

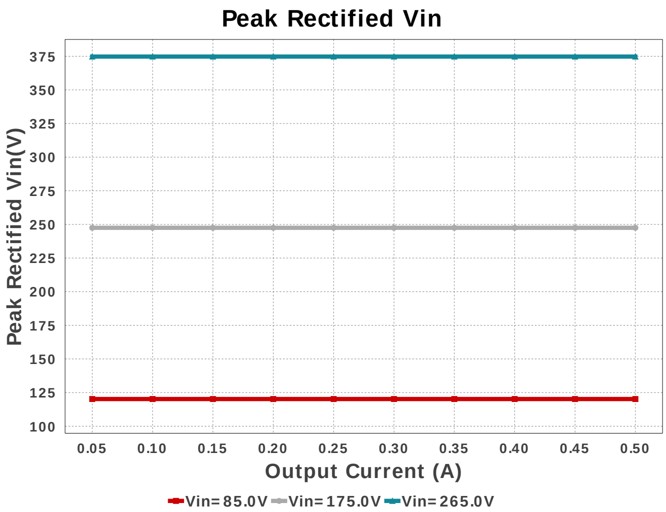
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ccomp	CUSTOM	CUSTOM Series= ?	Cap= 4.7963 uF VDC= 0.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm^2
Ccomp2	Kemet	C2220X474J5GACTU Series= C0G/NP0	Cap= 470.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$3.19	2220 54 mm^2
Cin	TDK	C5750X6S2W105K Series= X6S	Cap= 1.0 uF ESR= 5.263 mOhm VDC= 400.0 V IRMS= 0.0 A	1	$1.31	2220 54 mm^2
Co	CUSTOM	CUSTOM Series= ?	Cap= 145.966 uF ESR= 1.0 mOhm VDC= 432.0 V IRMS= 1.70751 A	1	NA	CUSTOM 0 mm^2
Cvcc	Taiyo Yuden	TMK212B7105KG-T Series= X7R	Cap= 1.0 uF ESR= 1.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0805 7 mm^2
Czc1	Vishay-Vitramon	VJ0805A100JXGAT5Z Series= C0G/NP0	Cap= 10.0 pF ESR= 1.0 mOhm VDC= 1000.0 V IRMS= 0.0 A	1	$0.24	0805 7 mm^2

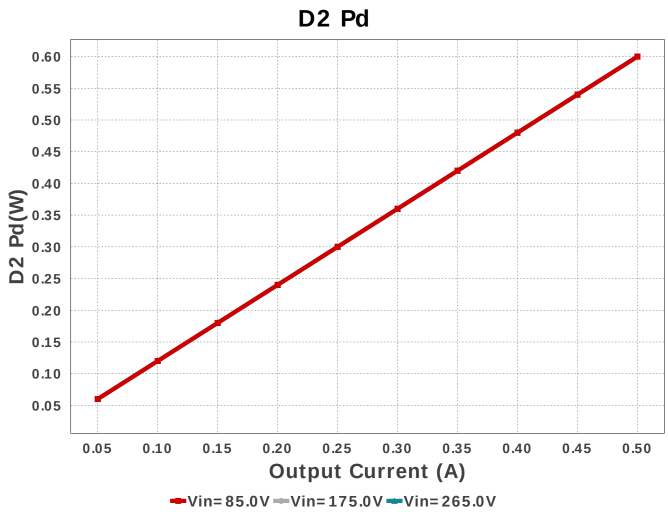
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Czc2	TDK	CGA4C2C0G1H392J060AA Series= C0G/NP0	Cap= 3.9 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.04	0805 7 mm^2
D1	Bourns	CD214C-F3600	VF@Io= 1.12 V VRRM= 600.0 V	1	$0.23	SMC 83 mm^2
D2	Bourns	CD214B-F3600	VF@Io= 1.2 V VRRM= 600.0 V	1	$0.14	SMB 44 mm^2
Dac	Fairchild Semiconductor	GBU6J	VF@Io= 1.0 V VRRM= 600.0 V	1	$0.43	GBU 131 mm^2
HS_M1	Aavid	576602B00000G	Heatsink	1	$0.59	576602 403 mm^2
L3	CUSTOM	CUSTOM	L= 169.513 µH 111.951 mOhm	1	NA	CUSTOM 0 mm^2
M1	STMicroelectronics	STP45N65M5	VdsMax= 650.0 V IdsMax= 35.0 Amps	1	$3.79	TO-220AB 79 mm^2
Rcomp	Vishay-Dale	CRCW04023K32FKED Series= CRCW..e3	Res= 3.32 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rcs1	CUSTOM	CUSTOM Series= ?	Res= 148.729 mOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rcs2	CUSTOM	CUSTOM Series= ?	Res= 148.729 mOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rcs3	CUSTOM	CUSTOM Series= ?	Res= 148.729 mOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
Rdg	Vishay-Dale	CRCW040282K5FKED Series= CRCW..e3	Res= 82.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Rdrv	Vishay-Dale	CRCW040227R4FKED Series= CRCW..e3	Res= 27.4 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
Ros1	Vishay-Dale	CRCW12063M32FKEA Series= CRCW..e3	Res= 3.32 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Ros2	Vishay-Dale	CRCW12063M32FKEA Series= CRCW..e3	Res= 3.32 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Ros3	Vishay-Dale	CRCW12063M32FKEA Series= CRCW..e3	Res= 3.32 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Ros4	Yageo	RC0201FR-0768K1L Series= ?	Res= 68.1 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm^2

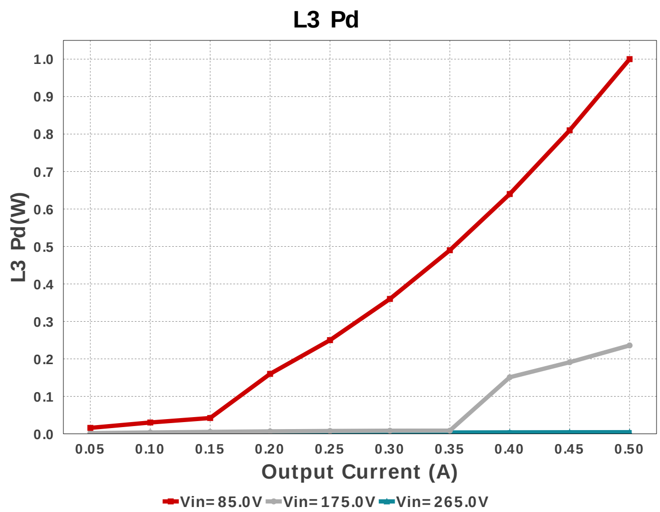
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Rzc1	Vishay-Dale	CRCW12063M48FKEA Series= CRCW..e3	Res= 3.48 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rzc2	Vishay-Dale	CRCW12063M48FKEA Series= CRCW..e3	Res= 3.48 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rzc3	Vishay-Dale	CRCW12063M48FKEA Series= CRCW..e3	Res= 3.48 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
Rzc4	Vishay-Dale	CRCW040226K1FKED Series= CRCW..e3	Res= 26.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
U1	Texas Instruments	UCC28056CDBVR	Switcher	1	$0.22	DBV0006A 15 mm^2

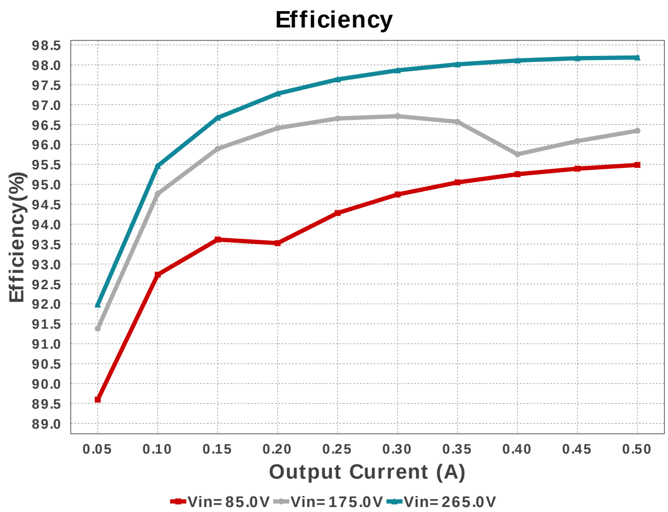


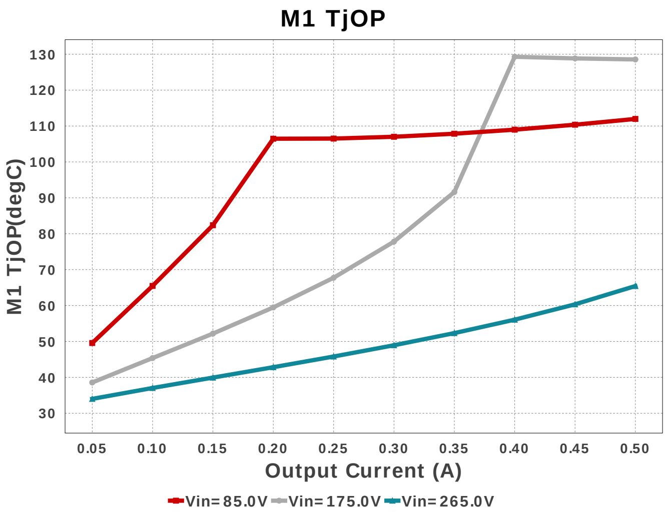


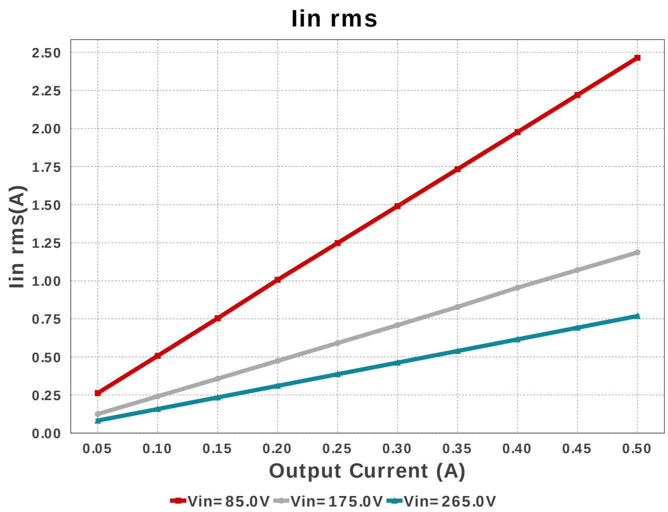


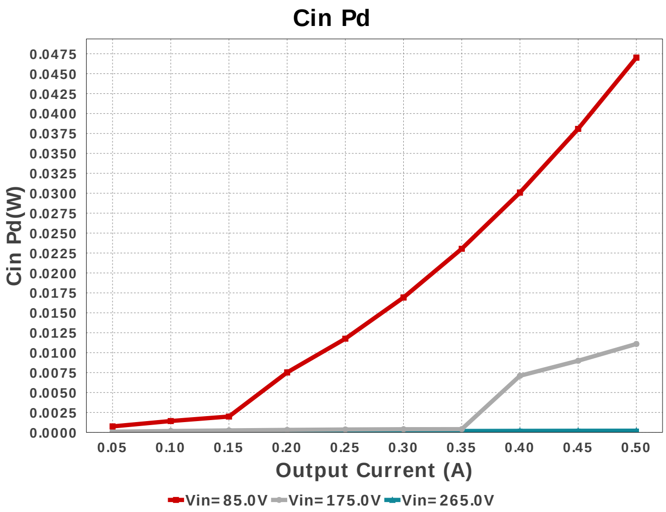


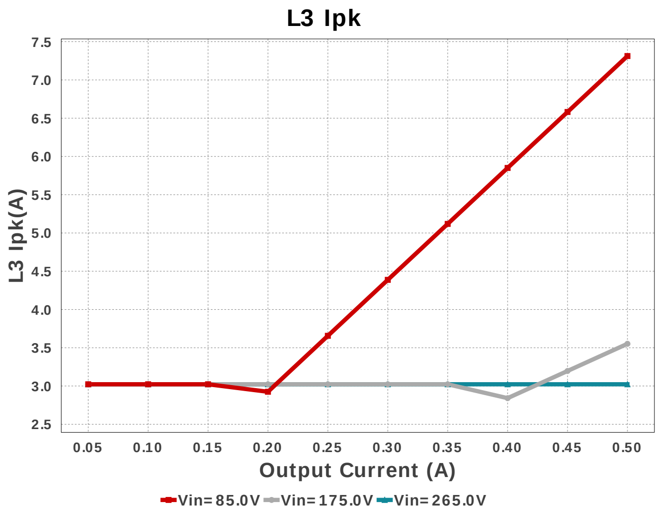

L3 Pd
L3 Pd(W)
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

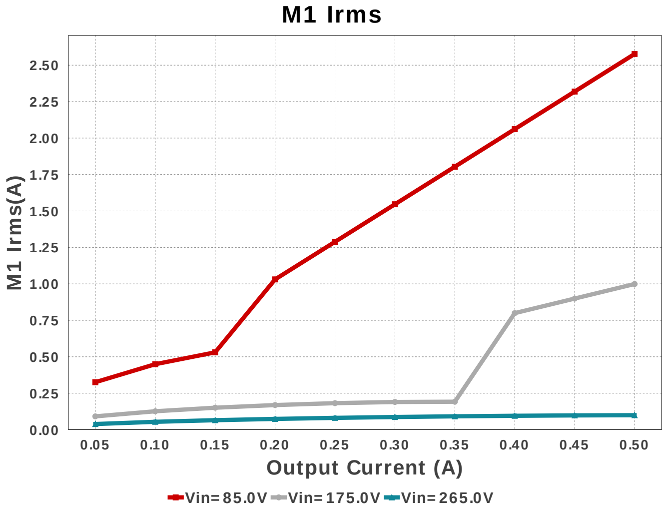

Efficiency
Efficiency(%)
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

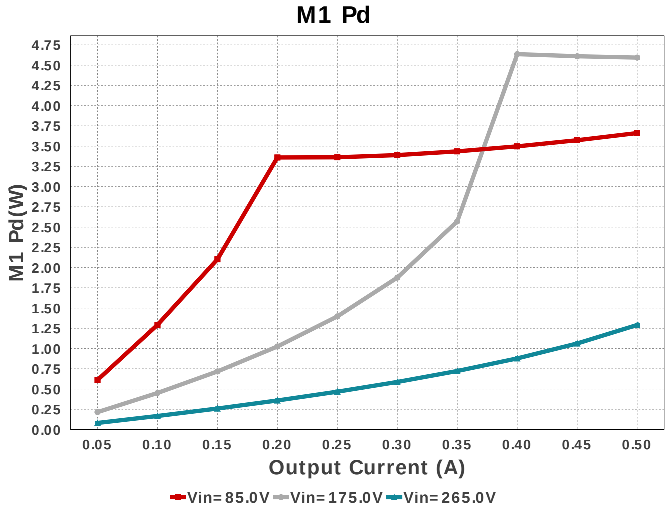

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

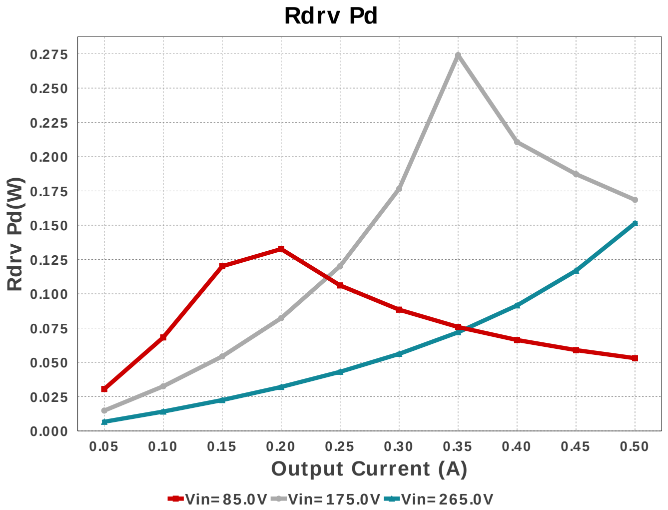

Iin rms
Iin rms(A)
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

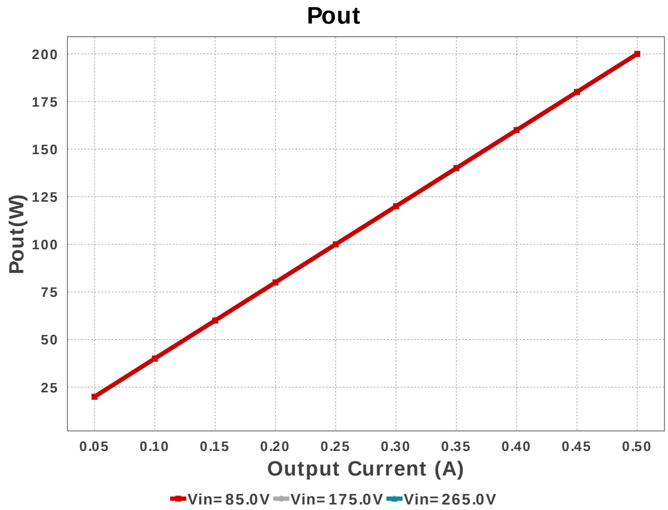

Cin Pd
Cin Pd(W)
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

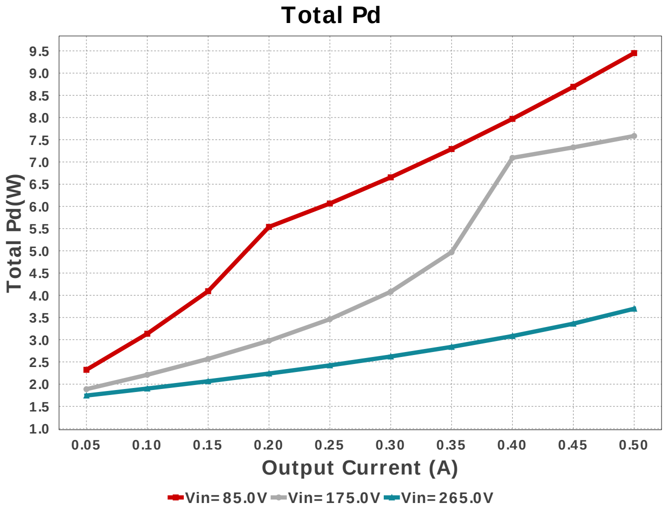

L3 Ipk
L3 Ipk(A)
Output Current (A)
Vin= 85.0V Vin= 175.0V Vin= 265.0V

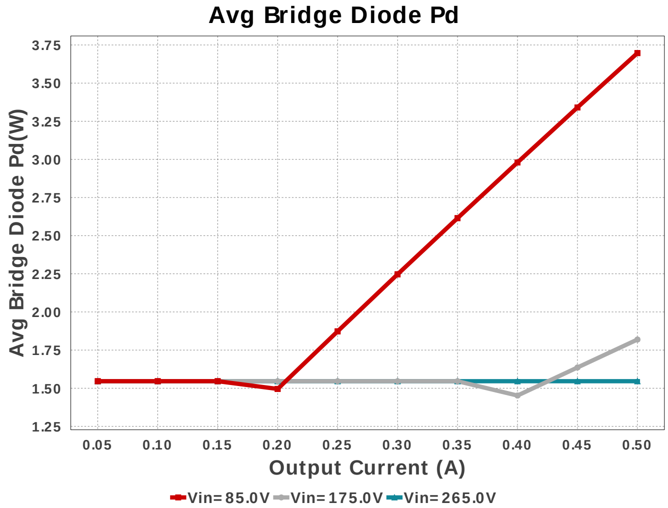

M1 Irms
M1 Irms(A)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

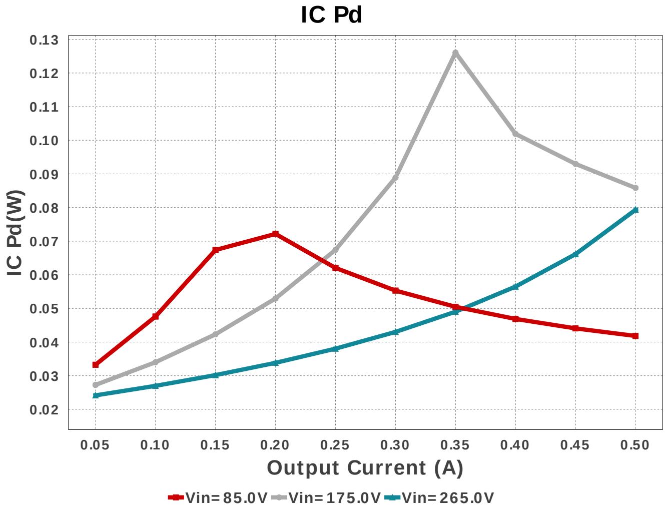

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

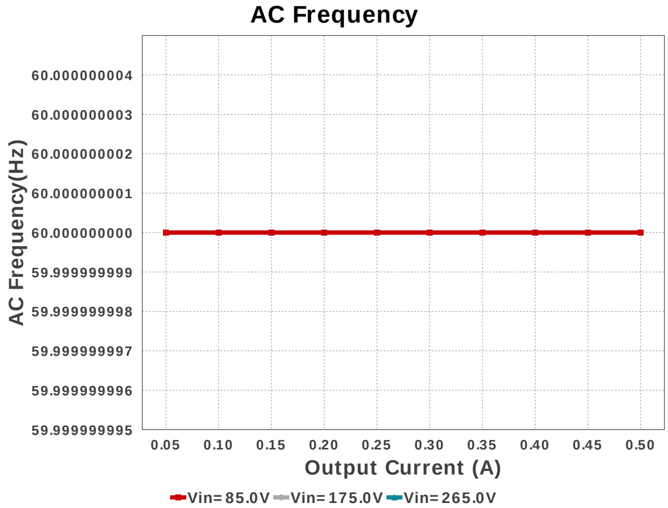

Rdrv Pd
Rdrv Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

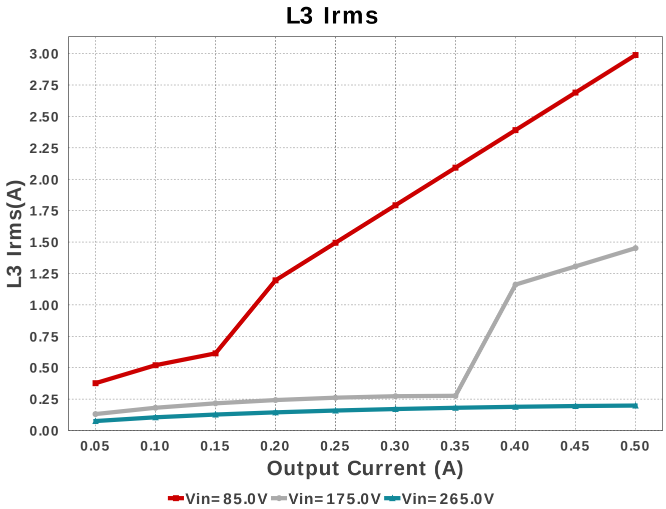

Pout
Pout(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

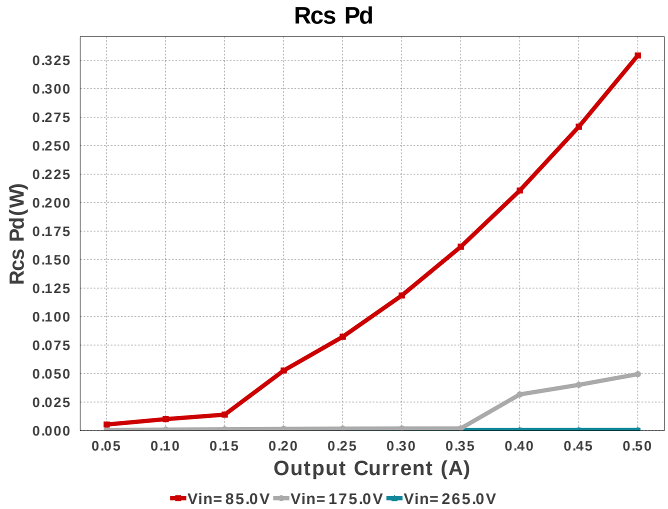

Total Pd
Total Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

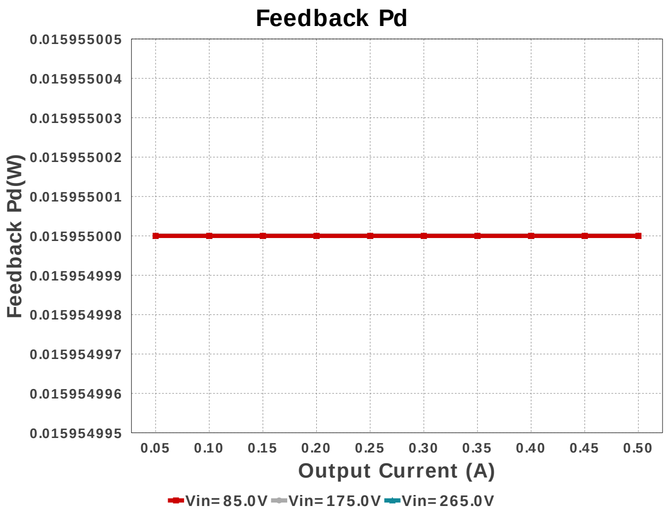

Avg Bridge Diode Pd
Avg Bridge Diode Pd(W)
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

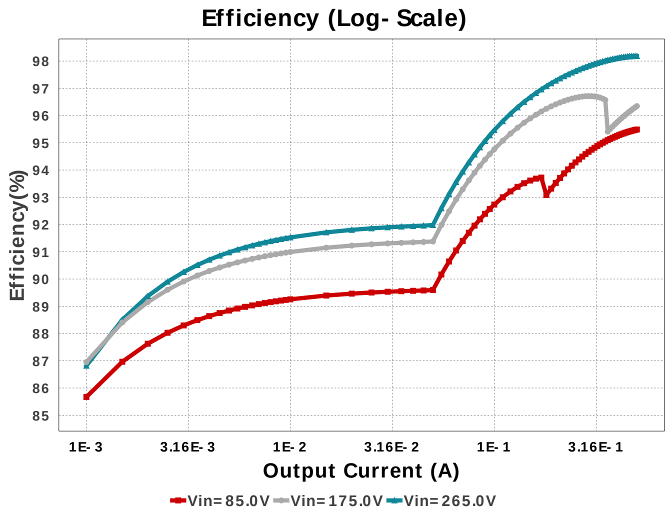












Operating Values

#	Name	Value	Category	Description
1.	Cin Pd	47.012 mW	Capacitor	Input capacitor power dissipation
2.	Avg Bridge Diode Pd	3.657 W	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
3.	D2 Pd	600.0 mW	Diode	D2 diode power dissipation
4.	IC Pd	41.822 mW	IC	IC power dissipation
5.	IC Tj	34.868 degC	IC	IC junction temperature
6.	ICThetaJA	116.4 degC/W	IC	IC junction-to-ambient thermal resistance
7.	L3 Ipk	7.312 A	Inductor	Peak Inductor Current in L3
8.	L3 Irms	2.989 A	Inductor	Inductor RMS Current Over one line cycle
9.	M1 Irms	2.577 A	MOSFETs	Q Iavg
10.	M1 Pd	3.661 W	Mosfet	M1 MOSFET total power dissipation
11.	M1 TjOP	111.971 degC	Mosfet	M1 MOSFET junction temperature

#	Name	Value	Category	Description
12.	Avg Bridge Diode Pd	3.697 W	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
13.	Cin Pd	47.012 mW	Power	Input capacitor power dissipation
14.	D2 Pd	600.0 mW	Power	D2 diode power dissipation
15.	Feedback Pd	15.955 mW	Power	Power Dissipation in Feedback Resistors
16.	IC Pd	41.822 mW	Power	IC power dissipation
17.	L3 Pd	1.0 W	Power	L3 power loss
18.	M1 Pd	3.661 W	Power	M1 MOSFET total power dissipation
19.	Rcs Pd	329.16 mW	Power	Power Dissipation in Current Sense Resistors
20.	Rdrv Pd	53.056 mW	Power	Power Dissipation in Gate Drive Resistor
21.	Total Pd	9.45 W	Power	Total Power Dissipation
22.	ZCD Pd	2.926 mW	Power	Power Dissipation in ZCD Resistors
23.	Feedback Pd	15.955 mW	Resistor	Power Dissipation in Feedback Resistors
24.	Rcs Pd	329.16 mW	Resistor	Power Dissipation in Current Sense Resistors
25.	Rdrv Pd	53.056 mW	Resistor	Power Dissipation in Gate Drive Resistor
26.	ZCD Pd	2.926 mW	Resistor	Power Dissipation in ZCD Resistors
27.	AC Frequency	60.0 Hz	System Information	Input AC frequency
28.	BOM Count	28	System Information	Total Design BOM count
29.	Efficiency	95.488 %	System Information	Steady state efficiency
30.	FootPrint	1.267 k mm^2	System Information	Total Foot Print Area of BOM components
31.	Frequency	78.405 kHz	System Information	Switching frequency
32.	Iin rms	2.464 A	System Information	RMS Input Current
33.	Iout	500.0 mA	System Information	Iout operating point
34.	Mode	CRM	System Information	Conduction Mode
35.	Peak Rectified Vin	120.207 V	System Information	Peak voltage seen at rectified input
36.	Pout	200.0 W	System Information	Total output power
37.	Total BOM	NA	System Information	Total BOM Cost
38.	Vin_RMS	85.0 V	System Information	Vin operating point
39.	Vout	400.0 V	System Information	Operational Output Voltage

Design Inputs

Name	Value	Description
Iout	500.0 m	Maximum Output Current
VinMax	265.0	Maximum input voltage
VinMin	85.0	Minimum input voltage
Vout	400.0	Output Voltage
base_pn	UCC28056C	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

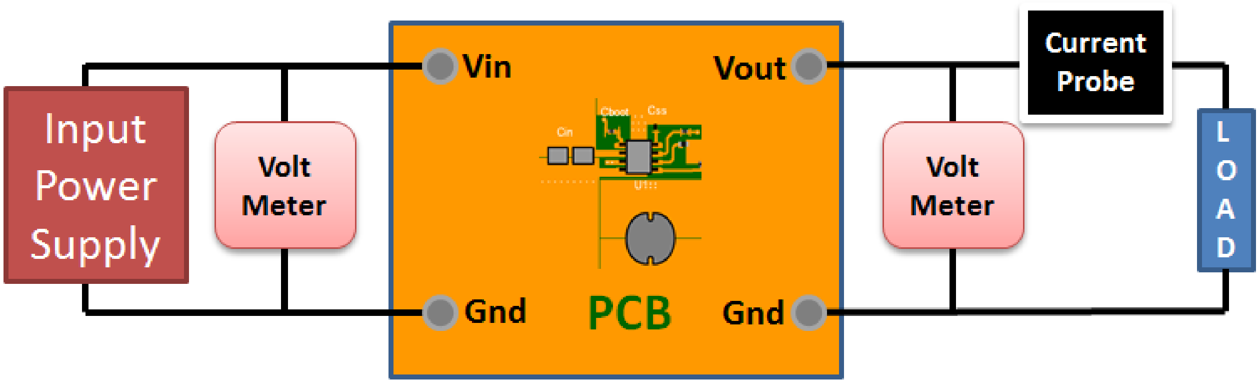
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. 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. Master key : EBF92C32EBD97758[v1]

2. **UCC28056C** Product Folder : http://www.ti.com/product/UCC28056 : contains the data sheet and other resources.

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