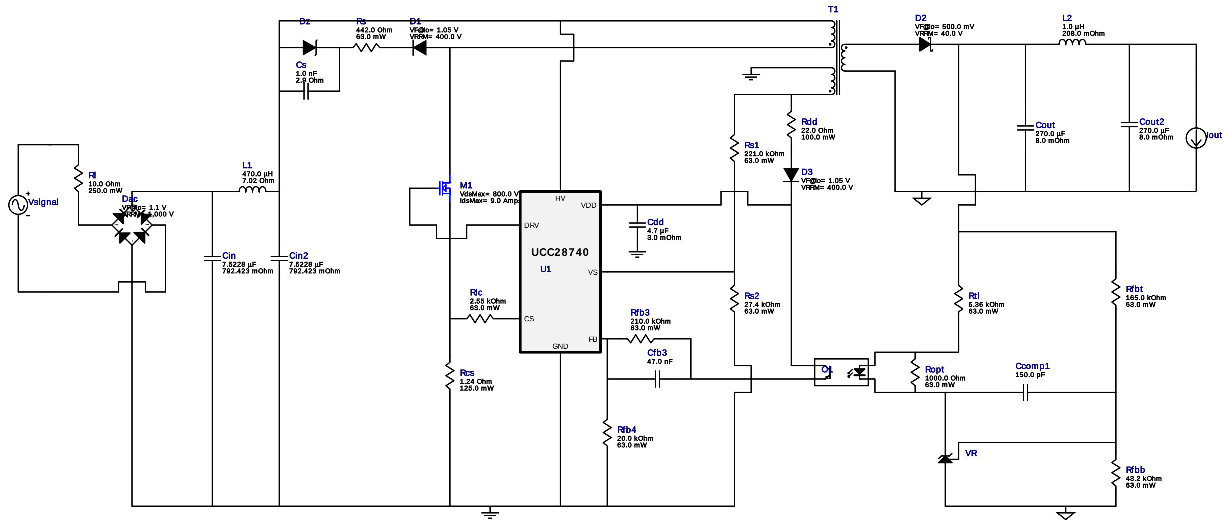
![Texas Instruments]

WEBENCH® Design Report

VinMin = 110.0V
VinMax = 220.0V
Vout = 12.0V
Iout = 1.0A

Device = UCC28740DR
Topology = Flyback
Created = 7/19/16 2:43:03 AM
BOM Cost = $0.00
BOM Count = 33
Total Pd = 2.19W

Design : 3496425/72 UCC28740DR
UCC28740DR 110.0V-220.0V to 12.00V @ 1.0A



1. Rlc, Rtl and the feedback resistors for this design are a starting point, but may need adjustment based on the actual transformer used. For more information please click the design assistance button.

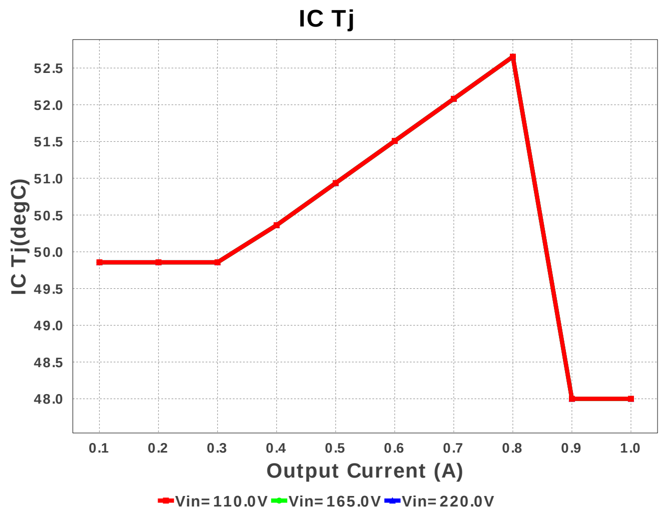
2. Click on the transformer symbol and select 'Design Transformer' to design using specific transformer cores and bobbin

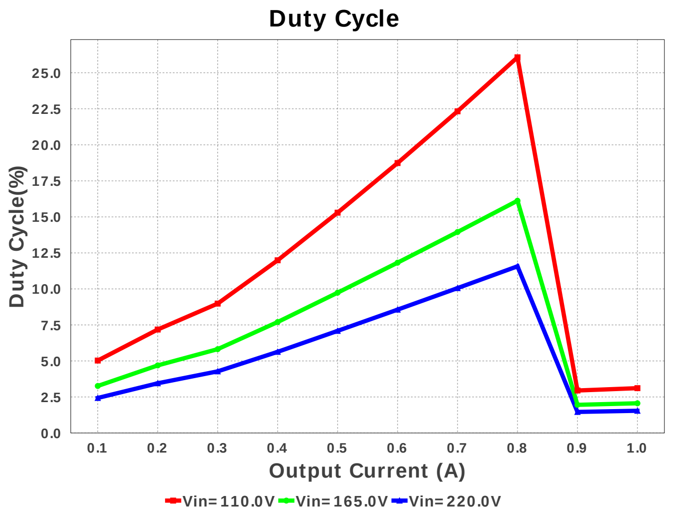
Electrical BOM

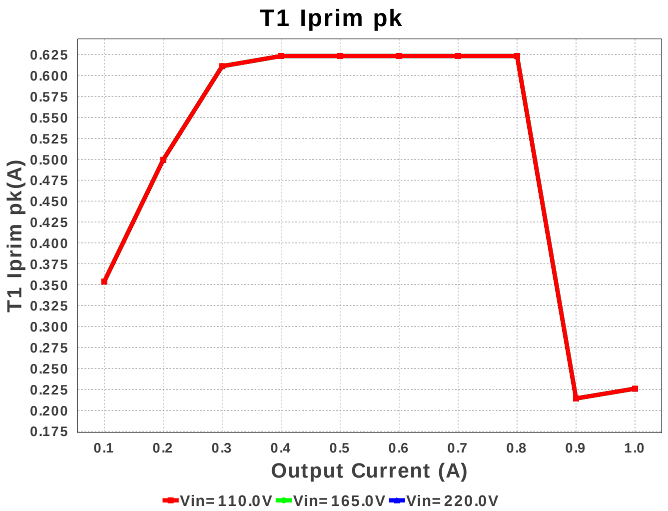
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp1	TDK	C2012C0G1H151J Series= C0G/NP0	Cap= 150.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
2.	Cdd	MuRata	GRM31CR71H475KA12L Series= X7R	Cap= 4.7 uF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 4.98 A	1	$0.07	1206 11 mm^2
3.	Cfb3	Taiyo Yuden	TMK212B7473KD-T Series= X7R	Cap= 47.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
4.	Cin	CUSTOM	CUSTOM Series= ?	Cap= 7.5228 uF ESR= 792.42 mOhm VDC= 466.69 V IRMS= 169.821 mA	1	NA	CUSTOM 0 mm^2
5.	Cin2	CUSTOM	CUSTOM Series= ?	Cap= 7.5228 uF ESR= 792.42 mOhm VDC= 466.69 V IRMS= 169.821 mA	1	NA	CUSTOM 0 mm^2
6.	Cout	Panasonic	16SVPG270M Series= ?	Cap= 270.0 uF ESR= 8.0 mOhm VDC= 16.0 V IRMS= 5.8 A	1	$0.70	CAPSMT_62_C10 74 mm^2
7.	Cout2	Panasonic	16SVPG270M Series= ?	Cap= 270.0 uF ESR= 8.0 mOhm VDC= 16.0 V IRMS= 5.8 A	1	$0.70	CAPSMT_62_C10 74 mm^2
8.	Cs	MuRata	GRM188R72E102KW07D Series= X7R	Cap= 1.0 nF ESR= 2.9 Ohm VDC= 250.0 V IRMS= 90.0 mA	1	$0.01	0603 5 mm^2

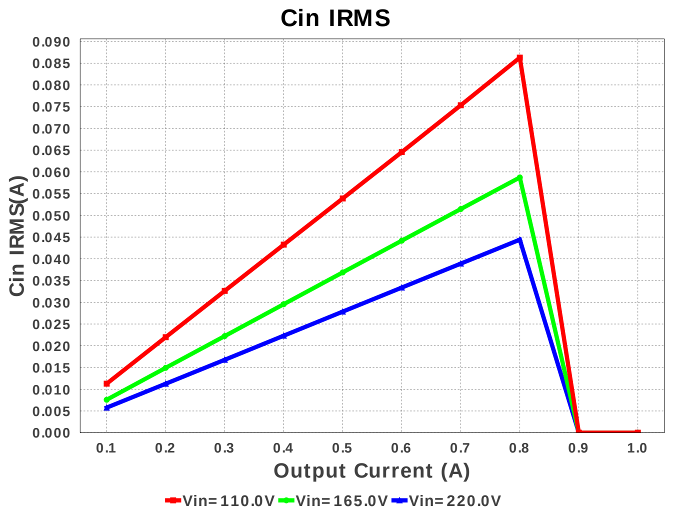
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	D1	Bourns	CD1408-FU1400	VF@Io= 1.05 V VRRM= 400.0 V	1	$0.13	Diode_1408 13 mm^2
10.	D2	Diodes Inc.	B240A-13-F	VF@Io= 500.0 mV VRRM= 40.0 V	1	$0.09	SMA 37 mm^2
11.	D3	Bourns	CD1408-FU1400	VF@Io= 1.05 V VRRM= 400.0 V	1	$0.13	Diode_1408 13 mm^2
12.	Dac	Vishay-Semiconductor	DF10SA	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.24	DF-S 99 mm^2
13.	Dz	ON Semiconductor	1SMB5952BT3G	Zener	1	$0.10	SMB 44 mm^2
14.	L1	Coilcraft	LPS4018-474MRB	L= 470.0 µH DCR= 7.02 Ohm	1	$0.35	LPS4018 24 mm^2
15.	L2	TDK	MLP2012S1R0MT0S1	L= 1.0 µH DCR= 208.0 mOhm	1	$0.12	MLP2012S-M 8 mm^2
16.	M1	STMicroelectronics	STF10N80K5	VdsMax= 800.0 V IdsMax= 9.0 Amps	1	$2.52	TO-220FP 79 mm^2
17.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$0.38	SSOP-4 111 mm^2
18.	Rcs	Vishay-Dale	CRCW08051R24FKEA Series= CRCW..e3	Res= 1.24 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
19.	Rdd	Yageo America	RC0603FR-0722RL Series= ?	Res= 22.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
20.	Rfb3	Vishay-Dale	CRCW0402210KFKED Series= CRCW..e3	Res= 210.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
21.	Rfb4	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
22.	Rfbb	Vishay-Dale	CRCW040243K2FKED Series= CRCW..e3	Res= 43.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
23.	Rfbt	Vishay-Dale	CRCW0402165KFKED Series= CRCW..e3	Res= 165.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
24.	Rl	Panasonic	ERJ-8ENF10R0V Series= ERJ-8E	Res= 10.0 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
25.	Rlc	Vishay-Dale	CRCW04022K55FKED Series= CRCW..e3	Res= 2.55 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
26.	Ropt	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
27.	Rs	Vishay-Dale	CRCW0402442RFKED Series= CRCW..e3	Res= 442.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
28.	Rs1	Vishay-Dale	CRCW0402221KFKED Series= CRCW..e3	Res= 221.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

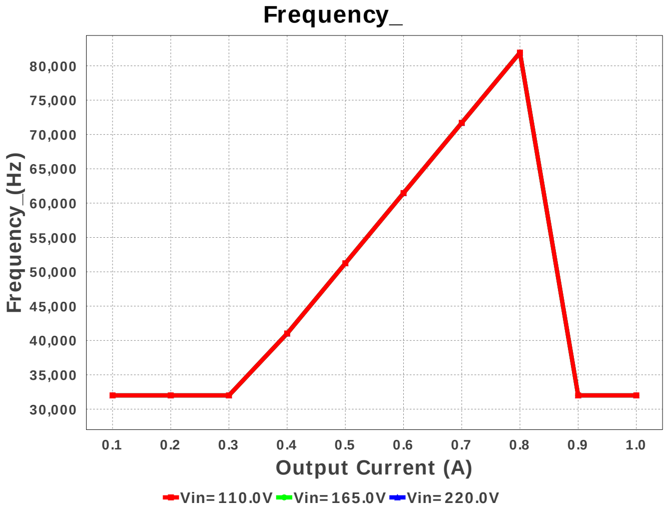
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
29.	Rs2	Vishay-Dale	CRCW040227K4FKED Series= CRCW..e3	Res= 27.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
30.	Rtl	Vishay-Dale	CRCW04025K36FKED Series= CRCW..e3	Res= 5.36 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
31.	T1	Core=TDK , CoilFormer=TDK	Core=B66307G0000X127 , CoilFormer=B66308B1108T001	Lp= 659.0 µH Turns Ratio(Nas)= 9:6 Turns Ratio(Nps)= 38:6 Npri= 38.0 Naux= 9.0 Nsec= 6.0	1	$0.66	TDK_B66305 199 mm²
32.	U1	Texas Instruments	UCC28740DR	Switcher	1	$0.42	R-PDSO-G7 55 mm²
33.	VR	Texas Instruments	TL431AIDBVR	Voltage References	1	$0.07	R-PDSO-G3 16 mm²

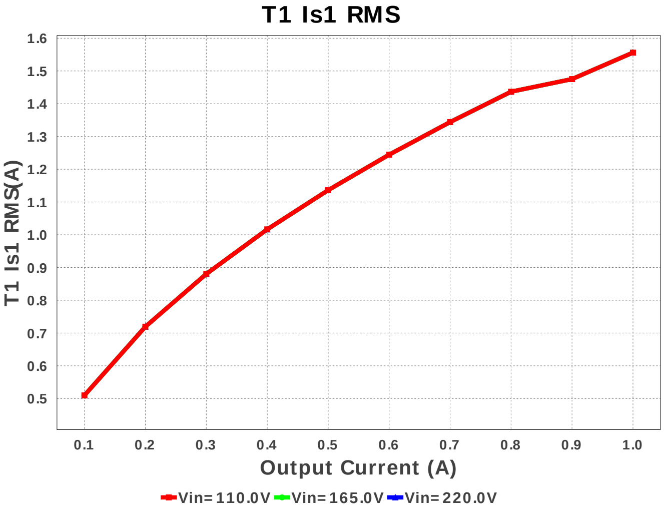


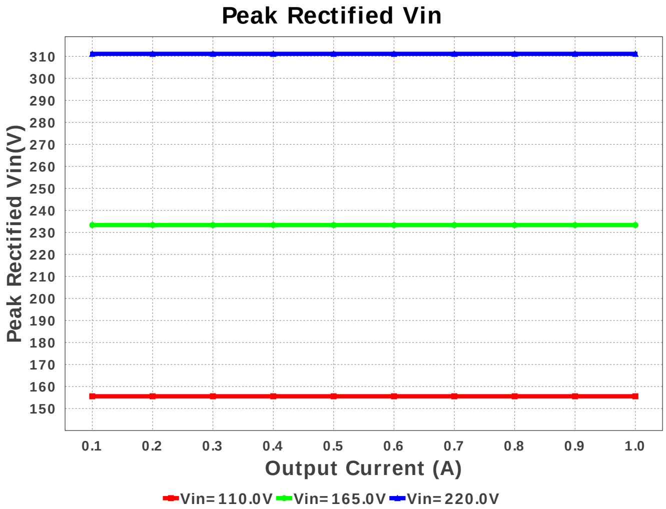


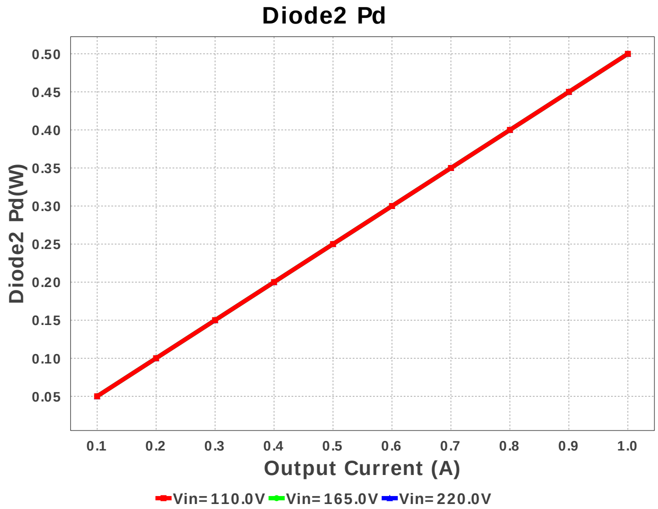


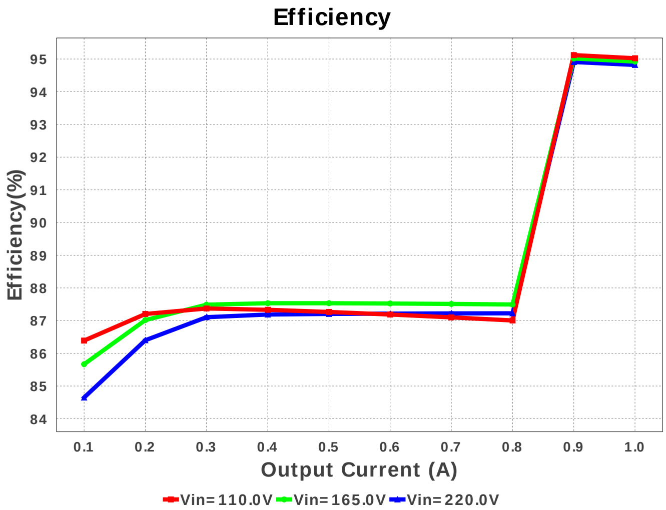


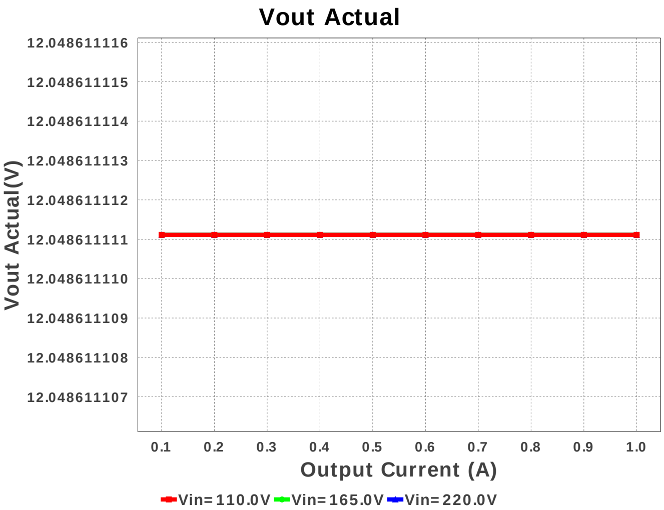

Frequency_
Frequency_(Hz)
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

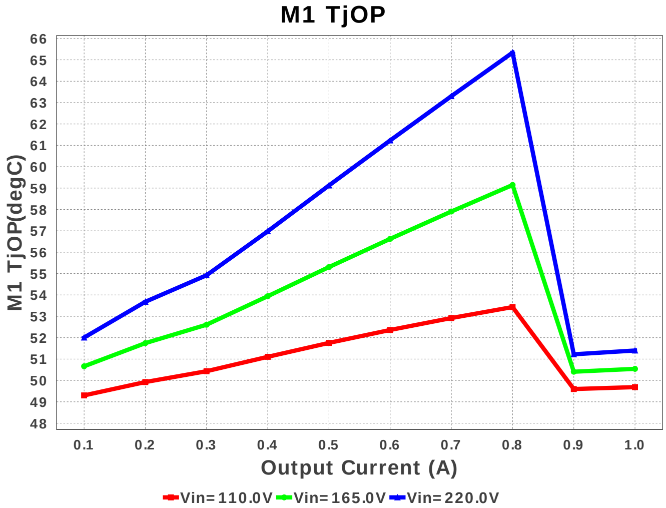

T1 Is1 RMS
T1 Is1 RMS(A)
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

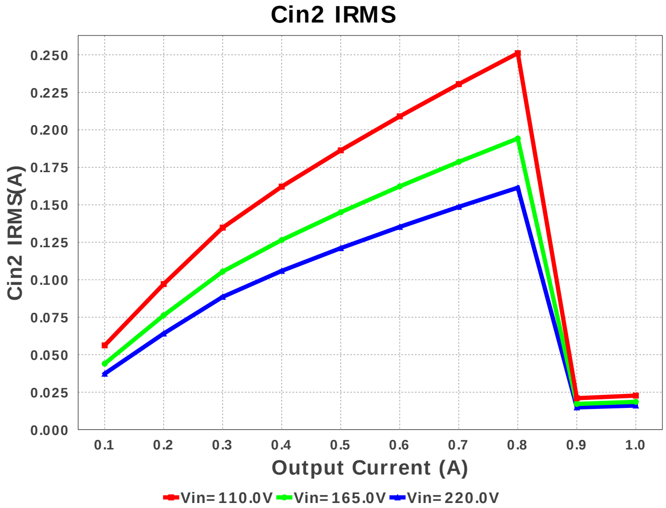

Peak Rectified Vin
Peak Rectified Vin(V)
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

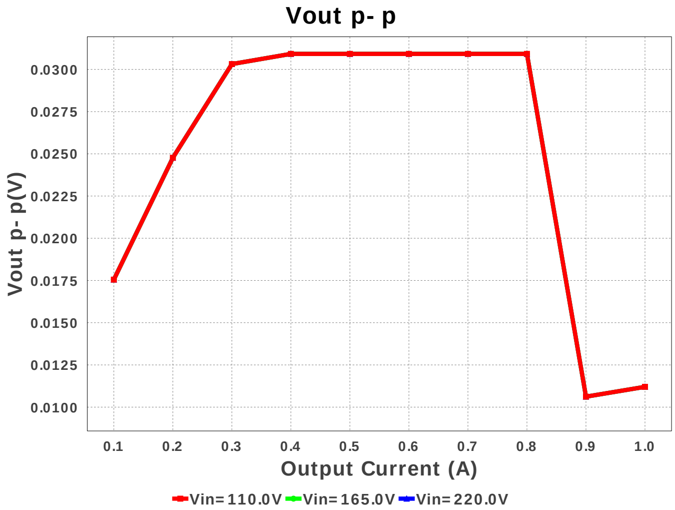

Diode2 Pd
Diode2 Pd(W)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

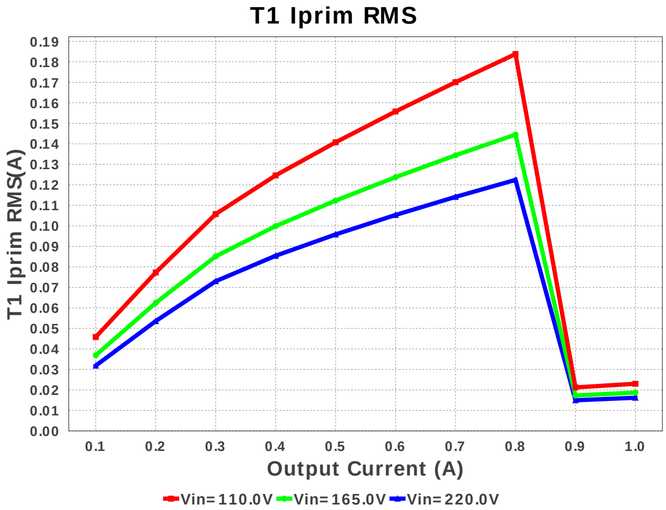

Efficiency
Efficiency(%)
95
94
93
92
91
90
89
88
87
86
85
84
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

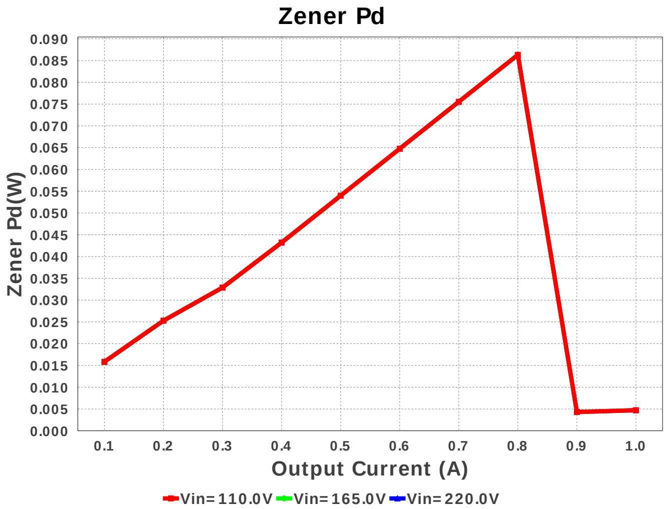

Vout Actual
Vout Actual(V)
12.048611116
12.048611115
12.048611114
12.048611113
12.048611112
12.048611111
12.048611110
12.048611109
12.048611108
12.048611107
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

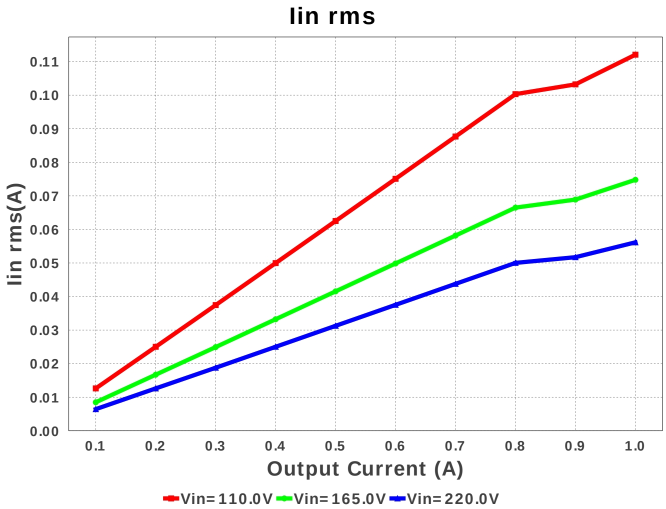

M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

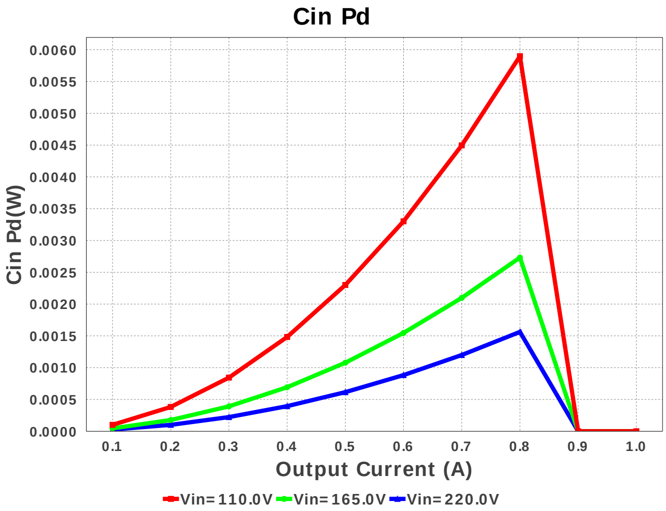

Cin2 IRMS
Cin2 IRMS(A)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

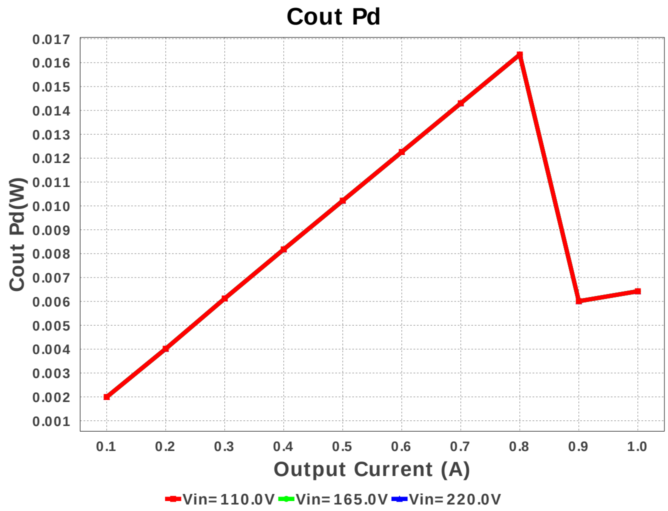

Vout p- p
Vout p- p(V)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

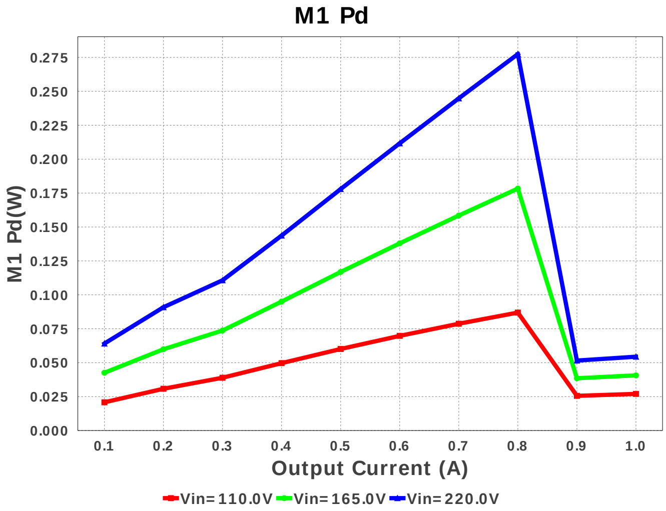

T1 Iprim RMS
T1 Iprim RMS(A)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

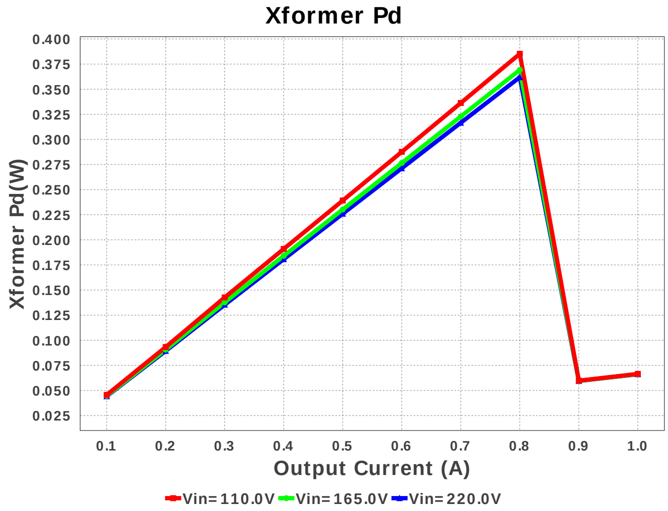

Zener Pd
Zener Pd(W)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

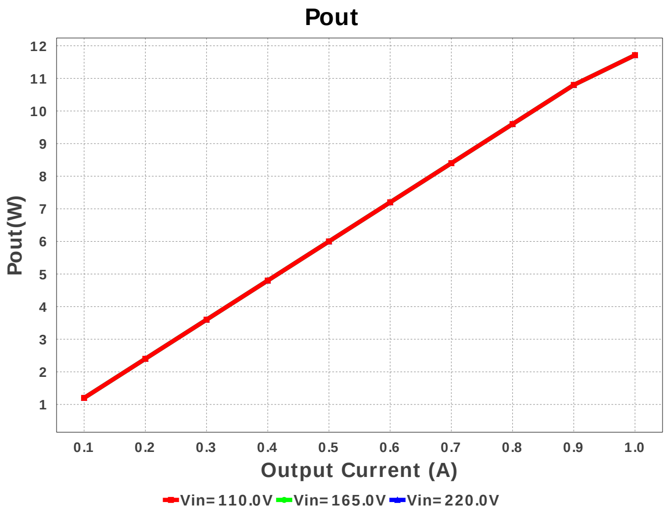

Iin rms
Iin rms(A)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

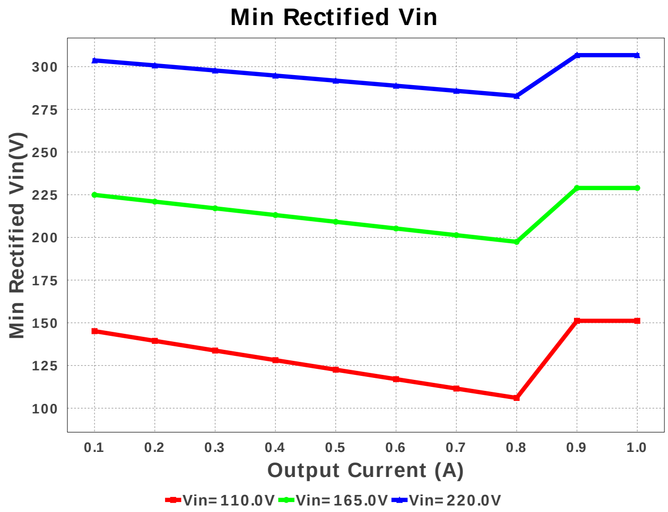

Cin Pd
Cin Pd(W)
Output Current (A)
Vin= 110.0V Vin= 165.0V Vin= 220.0V

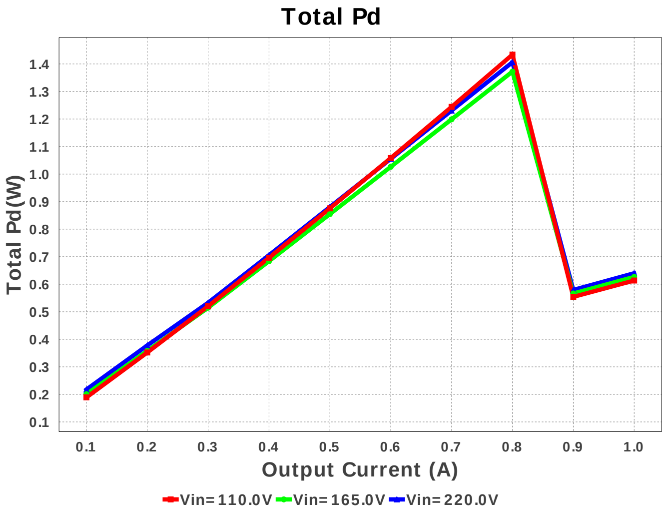

Cout Pd
Cout Pd(W)
Output Current (A)
Vin= 110.0V Vin= 165.0V Vin= 220.0V

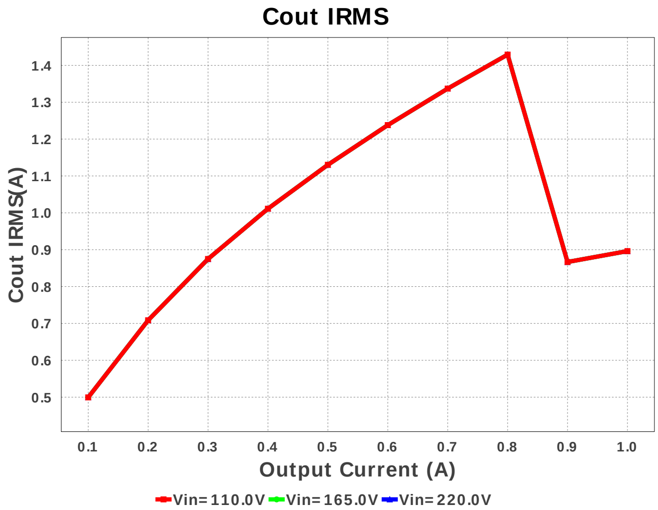

M1 Pd
M1 Pd(W)
Output Current (A)
Vin= 110.0V Vin= 165.0V Vin= 220.0V

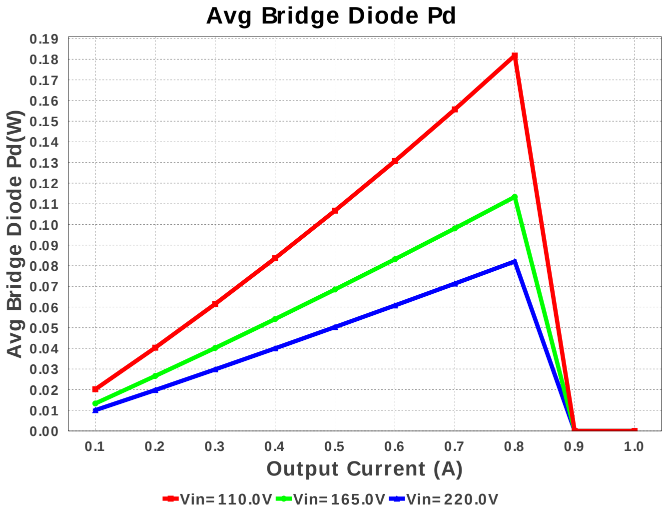

Xformer Pd
Xformer Pd(W)
Output Current (A)
Vin= 110.0V Vin= 165.0V Vin= 220.0V

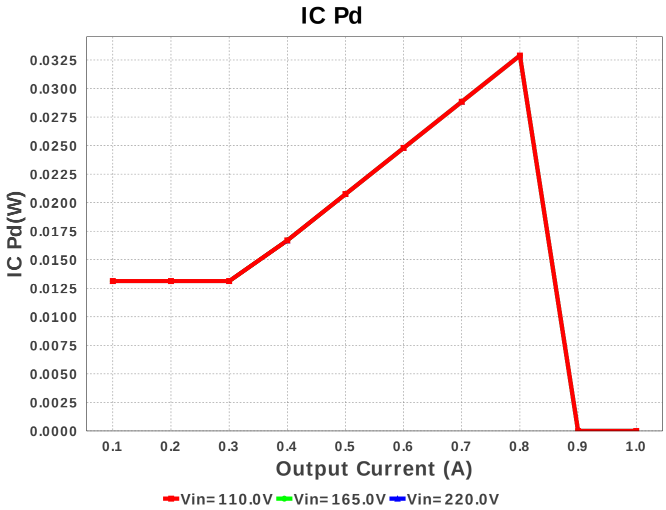

Pout
Pout(W)
Output Current (A)
Vin= 110.0V Vin= 165.0V Vin= 220.0V

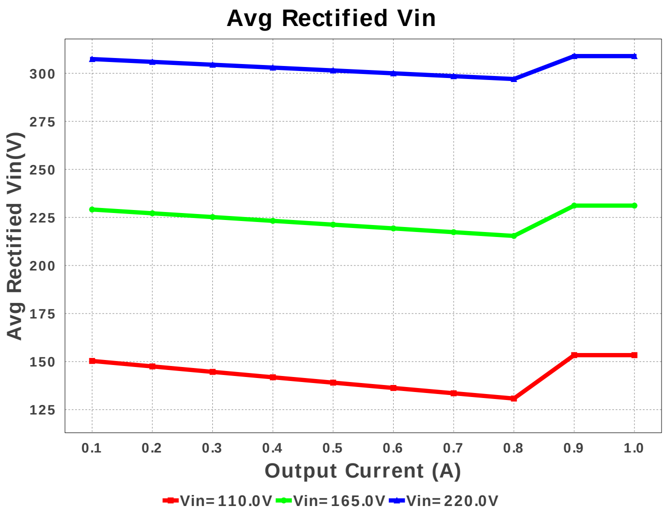

Min Rectified Vin
Min Rectified Vin(V)
Output Current (A)
Vin= 110.0V Vin= 165.0V Vin= 220.0V

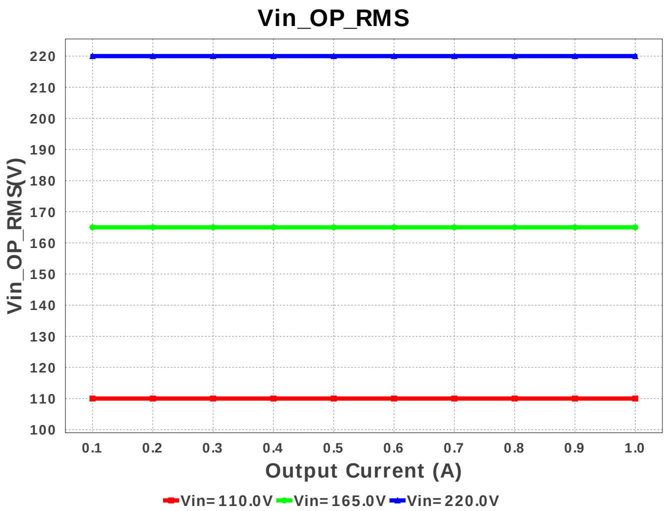

Total Pd
Total Pd(W)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V

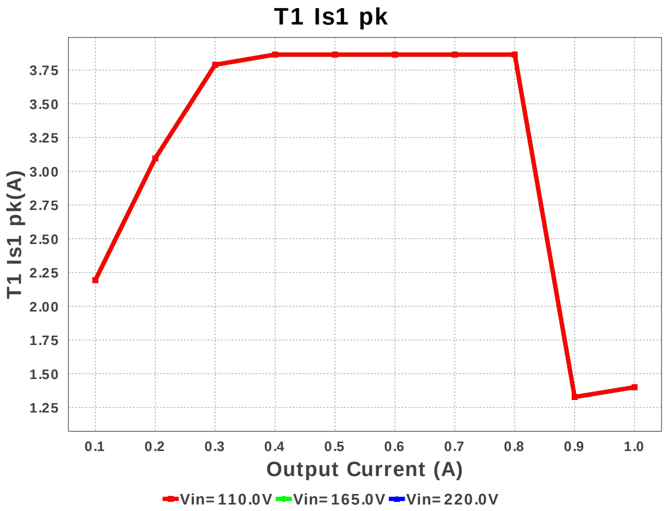

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V


Avg Bridge Diode Pd
Avg Bridge Diode Pd(W)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V


Avg Rectified Vin
Avg Rectified Vin(V)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V


Vin_OP_RMS
Vin_OP_RMS(V)
Output Current (A)
Vin=110.0V Vin=165.0V Vin=220.0V



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	57.387 mA	Current	Input capacitor RMS ripple current
2.	Cin2 IRMS	189.454 mA	Current	Input Capacitor Cin2 RMS Ripple Current
3.	Cout IRMS	1.887 A	Current	Output capacitor RMS ripple current
4.	Iin rms	64.485 mA	Current	RMS Input Current
5.	T1 Iprim RMS	140.305 mA	Current	Transformer Primary RMS Current
6.	T1 Iprim pk	623.387 mA	Current	Transformer Primary Peak Current
7.	T1 Is1 RMS	1.896 A	Current	Transformer Secondary1 RMS Current
8.	T1 Is1 pk	5.389 A	Current	Transformer Secondary1 Peak Current
9.	Avg Rectified Vin	292.636 V	General	Average Rectified Voltage for the AC Line Period
10.	BOM Count	33	General	Total Design BOM count
11.	FootPrint	996.0 mm^2	General	Total Foot Print Area of BOM components
12.	Pout	12.0 W	General	Total output power
13.	Total BOM	$0.0	General	Total BOM Cost
14.	Vout Actual	12.049 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
15.	Vout OP	12.0 V	Op_Point	Operational Output Voltage
16.	Duty Cycle	15.197 %	Op_point	Duty cycle
17.	Efficiency	84.586 %	Op_point	Steady state efficiency
18.	Frequency_	68.748 kHz	Op_point	Switching frequency
19.	IC Tj	55.376 degC	Op_point	IC junction temperature
20.	ICThetaJA	141.5 degC/W	Op_point	IC junction-to-ambient thermal resistance
21.	IOUT_OP	1.0 A	Op_point	Iout operating point
22.	M1 TjOP	60.517 degC	Op_point	M1 MOSFET junction temperature
23.	Min Rectified Vin	274.149 V	Op_point	Minimum voltage seen at rectified input
24.	Peak Rectified Vin	311.124 V	Op_point	Peak voltage seen at rectified input
25.	Vin_OP_RMS	220.0 V	Op_point	AC Input RMS Voltage
26.	Vout p-p	43.113 mV	Op_point	Peak-to-peak output ripple voltage
27.	Avg Bridge Diode Pd	70.649 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
28.	Cin Pd	2.61 mW	Power	Input capacitor power dissipation
29.	Cout Pd	28.475 mW	Power	Output capacitor power dissipation
30.	Diode2 Pd	355.446 mW	Power	Diode2 power dissipation
31.	IC Pd	52.127 mW	Power	IC power dissipation
32.	M1 Pd	200.264 mW	Power	M1 MOSFET total power dissipation
33.	Total Pd	2.187 W	Power	Total Power Dissipation
34.	Xformer Pd	1.248 W	Power	Transformer power dissipation
35.	Zener Pd	60.328 mW	Power	Zener power dissipation
36.	Vout Tolerance	1.926 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	1.0	Maximum Output Current
2.	VinMax	220.0	Maximum input voltage
3.	VinMin	110.0	Minimum input voltage
4.	Vout	12.0	Output Voltage
5.	acFrequency	0.0	Light Output in Lumen
6.	base_pn	UCC28740	Texas Instruments Base Part Number
7.	source	AC	Input Source Type
8.	ta	48.0	Ambient temperature

Design Assistance

1. Application Hints 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. Rtl Rtl is added to prevent excessive diode current and limit Iopt to the maximum value necessary for regulationThe Rtl value may be adjusted for optimal limiting later during the porotype evaluation process. 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. Rfb3 & Cfb3 Rfb3 is necessary to limit the current into FB and to avoid excess draining of Cvdd during this type of transient situation.The value of Rfb3 is chosen to limit the excess Ifb and Rfb4 current to an acceptable level when the optocoupler is saturatedCfb3 helps improve the transient response and is estimated initially by equating the time constant to 1ms. This can later beadjusted for optimal performance during prototype evaluation Rfb4 Rfb4 speeds up the turnoff time of the optocoupler in the case of a heavy load-step transient condition. This value tends to fallwithin the range of 10k and 100k. A tradeoff must be made between a lower value for faster transient response and a higher value forlower standby power. Rfb4 also serves to set a minimum bias current for the optocoupler and to drain dark current Part Description The UCC28740 isolated-flyback controller provides Constant-Voltage (CV) using an optical coupler toimprove transient response. Constant-Current (CC) regulation is accomplished through Primary Side Regulation (PSR) techniques. Please see the datasheet for further design guidance. http://www.ti.com/lit/ds/symlink/ucc28740.pdf

2. UCC28740 Product Folder : http://www.ti.com/product/UCC28740 : contains the data sheet and other resources.