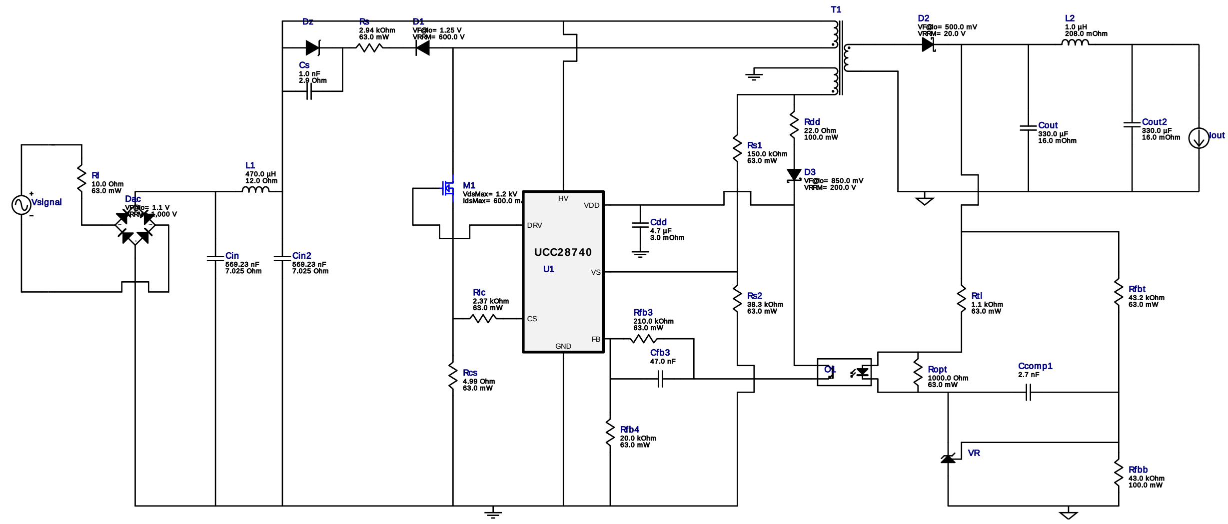
TEXAS INSTRUMENTS

WEBENCH ® Design Report

VinMin = 220.0V
VinMax = 330.0V
Vout = 5.0V
Iout = 1.0A

Device = UCC28740DR
Topology = Flyback
Created = 8/9/16 2:09:52 AM
BOM Cost = $0.00
BOM Count = 33
Total Pd = 1.18W

Design : 4352199/80 UCC28740DR
UCC28740DR 220.0V-330.0V to 5.00V @ 1.0A

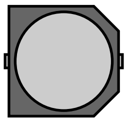


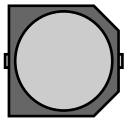
1. Rlc, Rtl and the feedback resistors for this design are a starting point, but may need adjustment based on the actual transformer used. For more information please click the design assistance button.

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

Electrical BOM

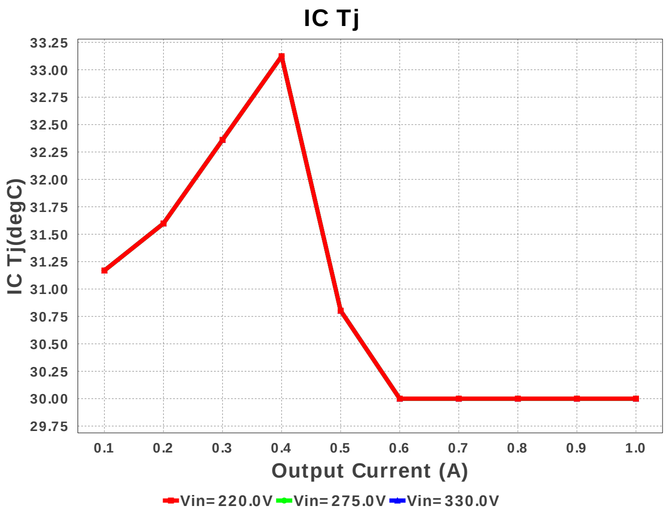
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp1	MuRata	GRM033R61A272KA01D Series= X5R	Cap= 2.7 nF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
2.	Cdd	MuRata	GRM31CR71H475KA12L Series= X7R	Cap= 4.7 uF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 4.98 A	1	$0.07	1206 11 mm^2
3.	Cfb3	MuRata	GRM033C80J473KE19D Series= X6S	Cap= 47.0 nF VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
4.	Cin	CUSTOM	CUSTOM Series= ?	Cap= 569.23 nF ESR= 7.0253 Ohm VDC= 700.03 V IRMS= 36.8155 mA	1	NA	CUSTOM 0 mm^2
5.	Cin2	CUSTOM	CUSTOM Series= ?	Cap= 569.23 nF ESR= 7.0253 Ohm VDC= 700.03 V IRMS= 36.8155 mA	1	NA	CUSTOM 0 mm^2
6.	Cout	Panasonic	16SVP330M Series= SVP	Cap= 330.0 uF ESR= 16.0 mOhm VDC= 16.0 V IRMS= 4.72 A	1	$0.39	SM_RADIAL_10AMM 160 mm^2
7.	Cout2	Panasonic	16SVP330M Series= SVP	Cap= 330.0 uF ESR= 16.0 mOhm VDC= 16.0 V IRMS= 4.72 A	1	$0.39	SM_RADIAL_10AMM 160 mm^2

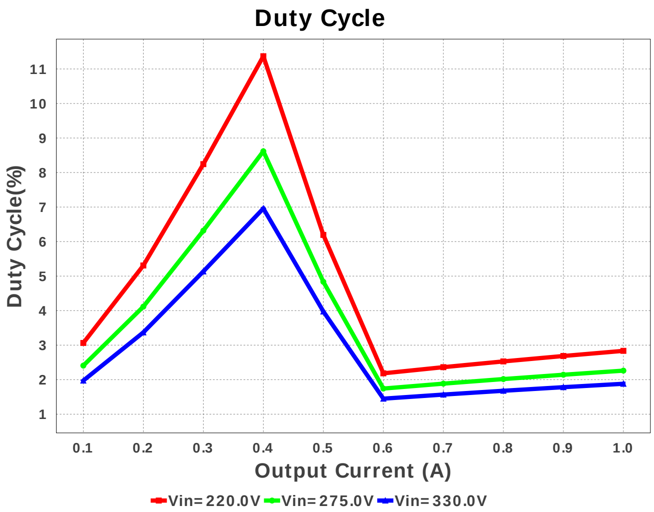


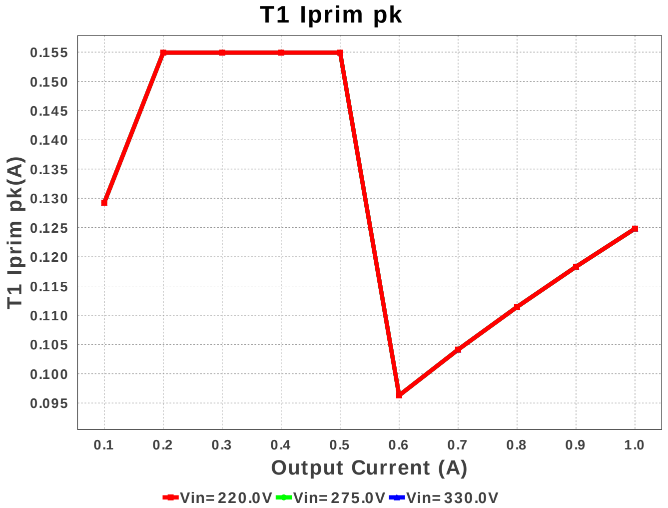


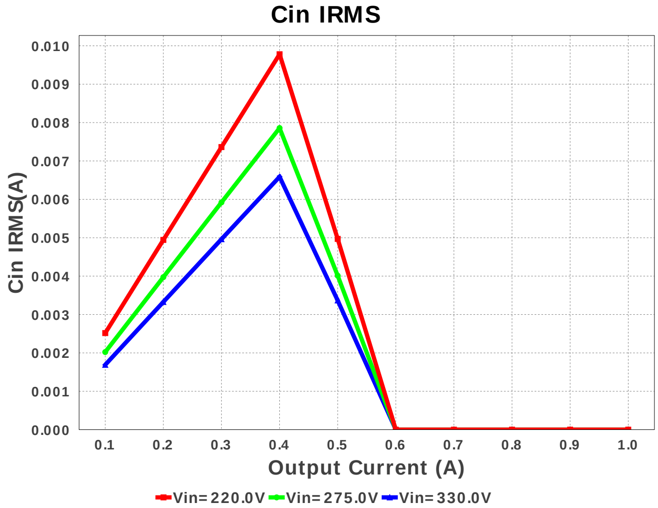
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
8.	Cs	MuRata	GRM188R72E102KW07D Series= X7R	Cap= 1.0 nF ESR= 2.9 Ohm VDC= 250.0 V IRMS= 90.0 mA	1	$0.01	0603 5 mm^2
9.	D1	Diodes Inc.	MURS160-13-F	VF@Io= 1.25 V VRRM= 600.0 V	1	$0.11	SMB 44 mm^2
10.	D2	Diodes Inc.	B220-13-F	VF@Io= 500.0 mV VRRM= 20.0 V	1	$0.08	SMB 44 mm^2
11.	D3	Diodes Inc.	DFLS1200-7	VF@Io= 850.0 mV VRRM= 200.0 V	1	$0.21	PowerDI123 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	1SMB5955BT3G	Zener	1	$0.10	SMB 44 mm^2
14.	L1	NIC Components	NPI32C471MTRF	L= 470.0 µH DCR= 12.0 Ohm	1	$0.08	IND_NPI32C 21 mm^2
15.	L2	TDK	MLP2012S1R0MT0S1	L= 1.0 µH DCR= 208.0 mOhm	1	$0.12	MLP2012S-M 8 mm^2
16.	M1	IXYS	IXTA06N120P	VdsMax= 1.2 kV IdsMax= 600.0 mAmps	1	$1.43	DDPAK 210 mm^2
17.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$0.38	SSOP-4 111 mm^2
18.	Rcs	Vishay-Dale	CRCW04024R99FKED Series= CRCW..e3	Res= 4.99 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 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	Yageo America	RC0603FR-0743KL Series= ?	Res= 43.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm^2
23.	Rfbt	Vishay-Dale	CRCW040243K2FKED Series= CRCW..e3	Res= 43.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
24.	Rl	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
25.	Rlc	Vishay-Dale	CRCW04022K37FKED Series= CRCW..e3	Res= 2.37 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

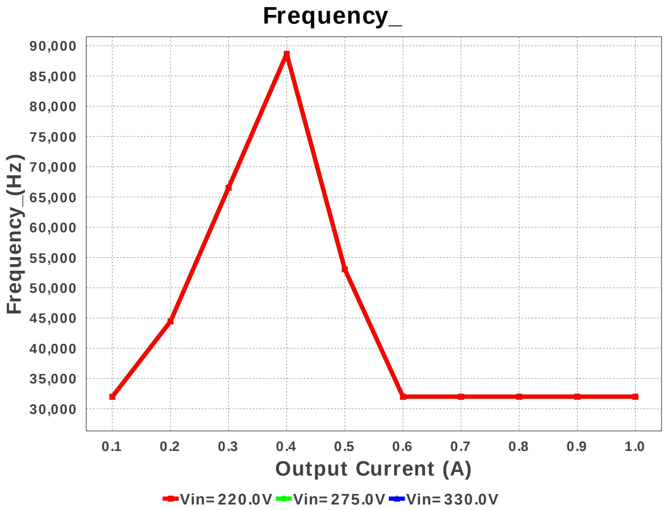
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
27.	Rs	Vishay-Dale	CRCW04022K94FKED Series= CRCW..e3	Res= 2.94 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
28.	Rs1	Vishay-Dale	CRCW0402150KFKED Series= CRCW..e3	Res= 150.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
29.	Rs2	Vishay-Dale	CRCW040238K3FKED Series= CRCW..e3	Res= 38.3 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
30.	Rtl	Vishay-Dale	CRCW04021K10FKED Series= CRCW..e3	Res= 1.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
31.	T1	Core=TDK , CoilFormer=TDK	Core=B66311G0000X127 , CoilFormer=B66206C1014T001	Lp= 2.177 mH Turns Ratio(Nas)= 22:6 Turns Ratio(Nps)= 91:6 Npri= 91.0 Naux= 22.0 Nsec= 6.0	1	$1.06	TDK_B66305 186 mm^2
32.	U1	Texas Instruments	UCC28740DR	Switcher	1	$0.42	R-PDSO-G7 55 mm^2
33.	VR	Texas Instruments	TL431AIDBZR	Voltage References	1	$0.08	DBZ0003A 14 mm^2

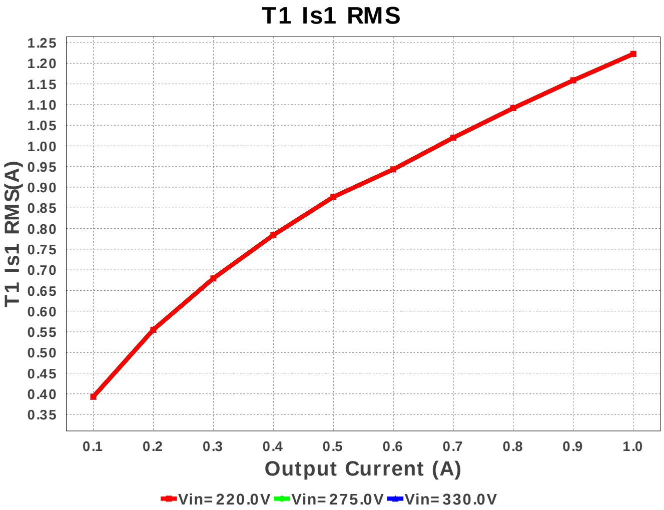


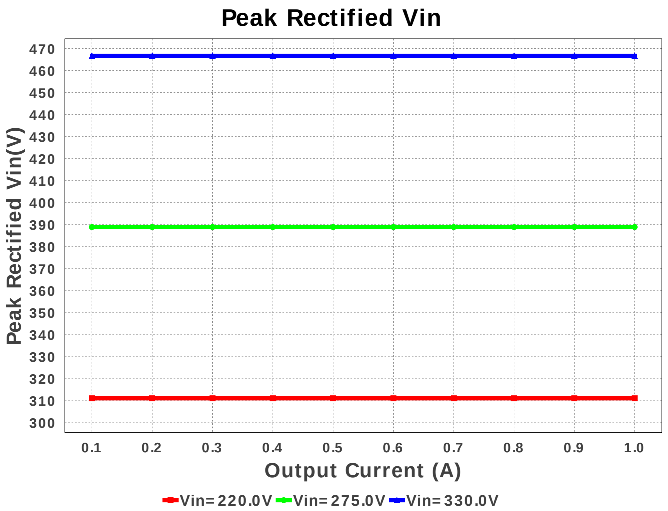


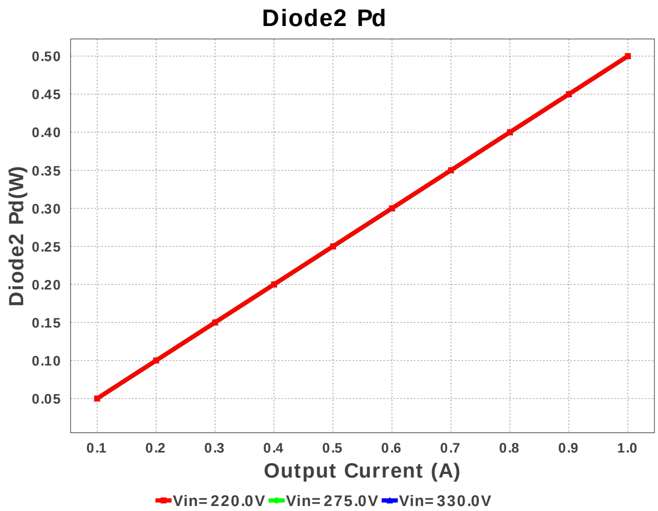

T1 Iprim pk
T1 Iprim pk(A)
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

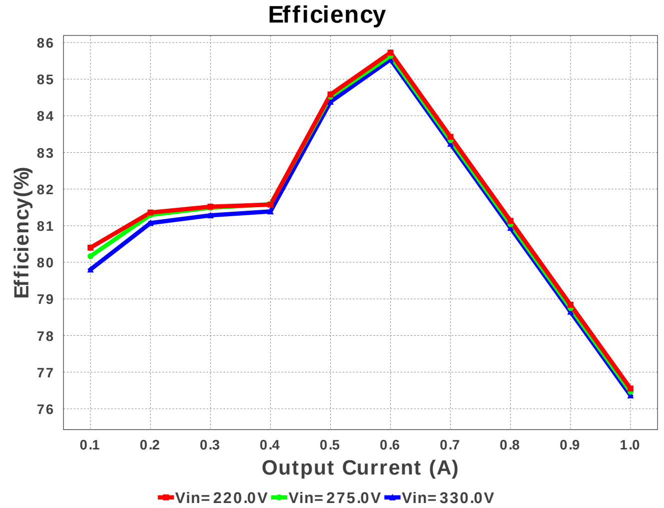

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

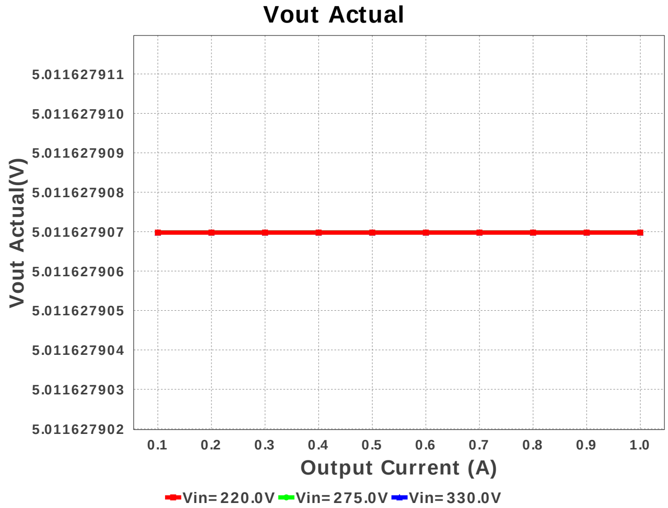

Frequency_
Frequency_(Hz)
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

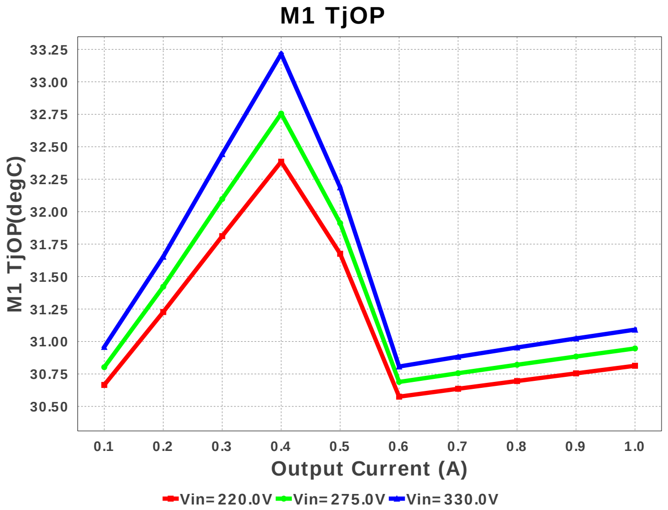

T1 Is1 RMS
T1 Is1 RMS(A)
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

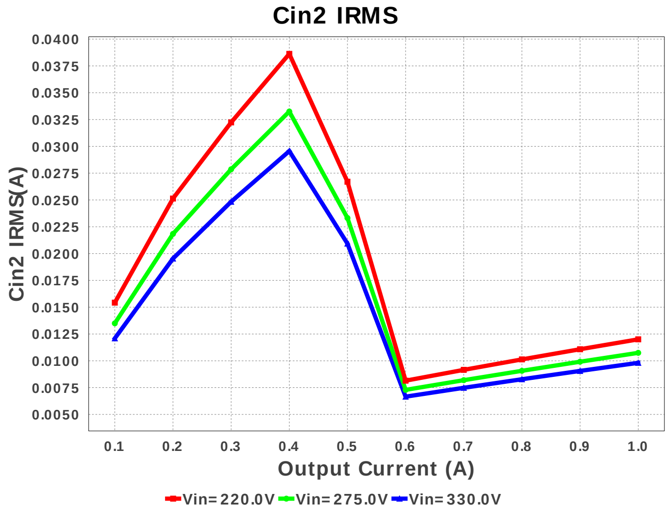

Peak Rectified Vin
Peak Rectified Vin(V)
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

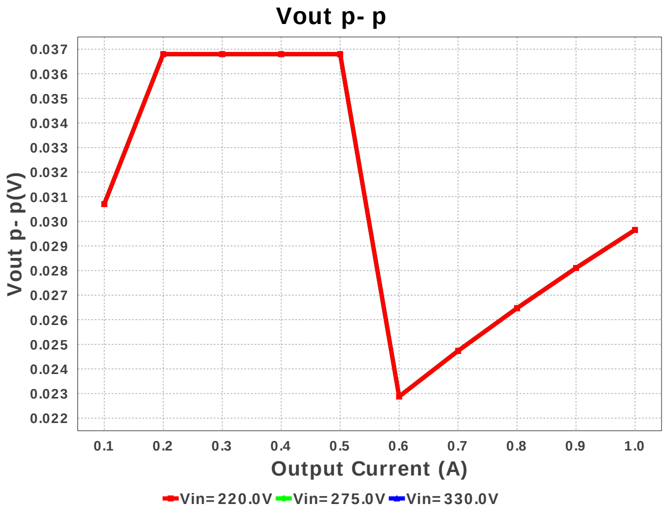

Diode2 Pd
Diode2 Pd(W)
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

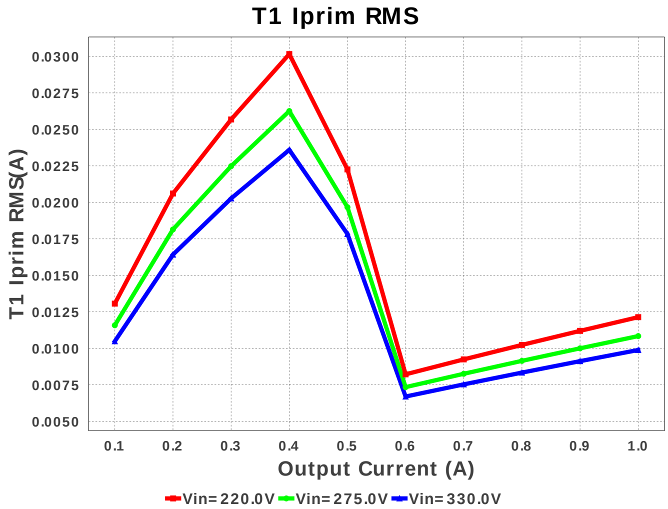

Efficiency
Efficiency(%)
86
85
84
83
82
81
80
79
78
77
76
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

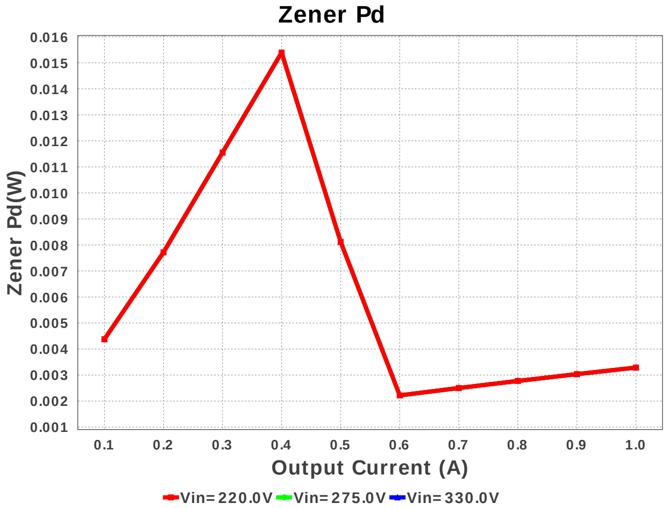

Vout Actual
Vout Actual(V)
5.011627911
5.011627910
5.011627909
5.011627908
5.011627907
5.011627906
5.011627905
5.011627904
5.011627903
5.011627902
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

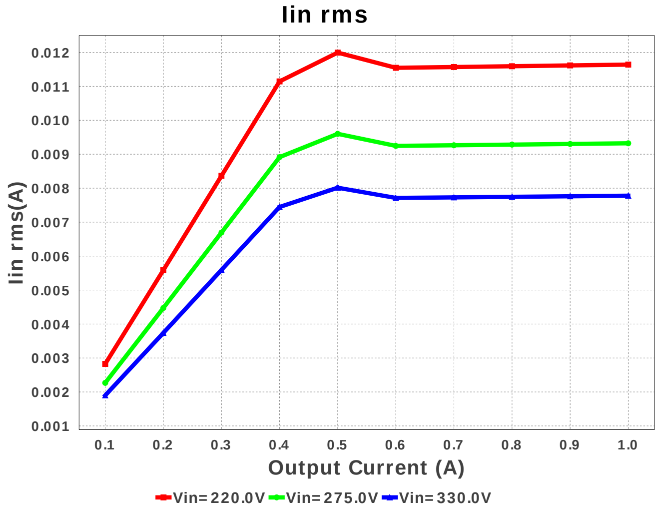

M1 TjOP
M1 TjOP(degC)
33.25
33.00
32.75
32.50
32.25
32.00
31.75
31.50
31.25
31.00
30.75
30.50
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

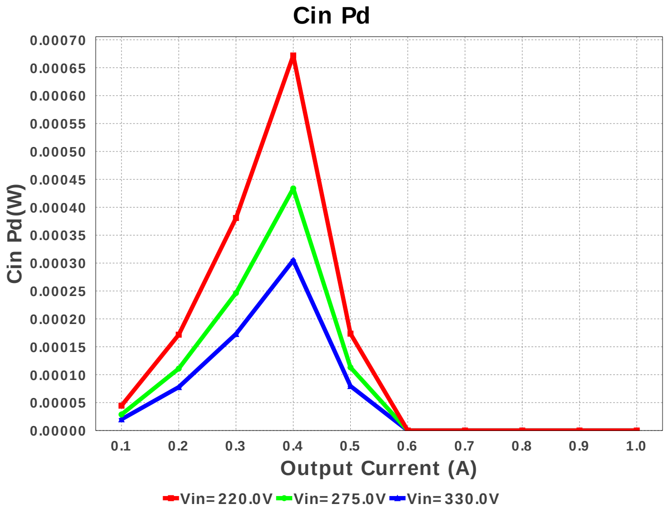

Cin2 IRMS
Cin2 IRMS(A)
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

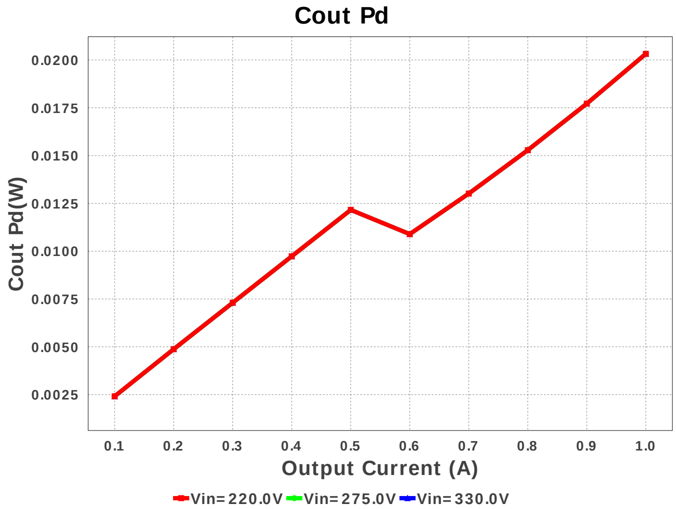

Vout p- p
Vout p- p(V)
0.037
0.036
0.035
0.034
0.033
0.032
0.031
0.030
0.029
0.028
0.027
0.026
0.025
0.024
0.023
0.022
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

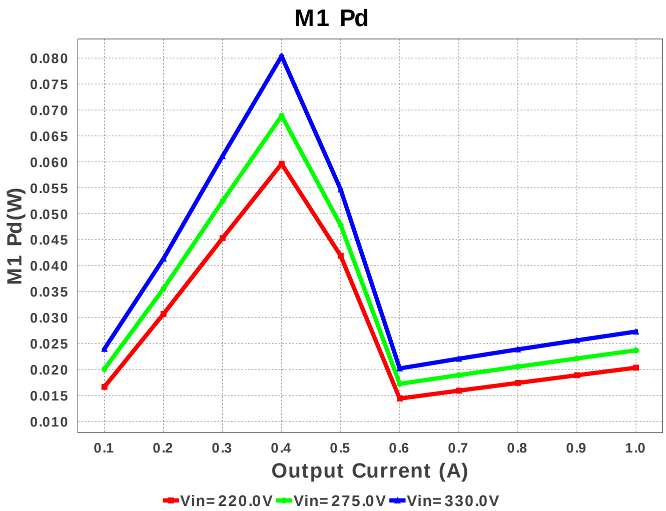

T1 Iprim RMS
T1 Iprim RMS(A)
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Output Current (A)
Vin= 220.0V
Vin= 275.0V
Vin= 330.0V

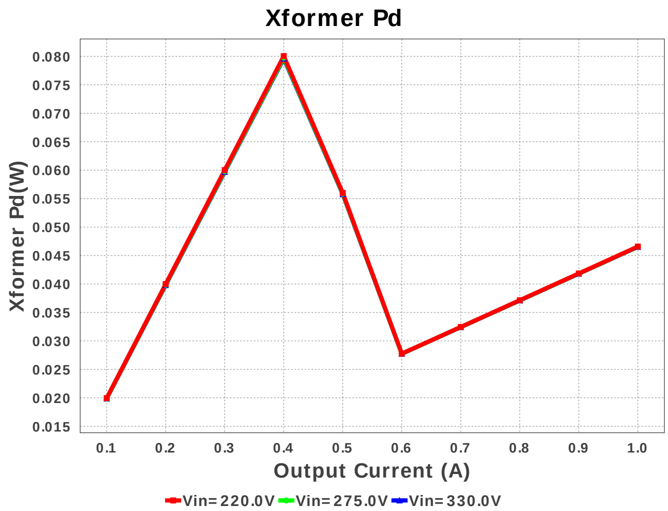

Zener Pd
Zener Pd(W)
Output Current (A)
Vin=220.0V

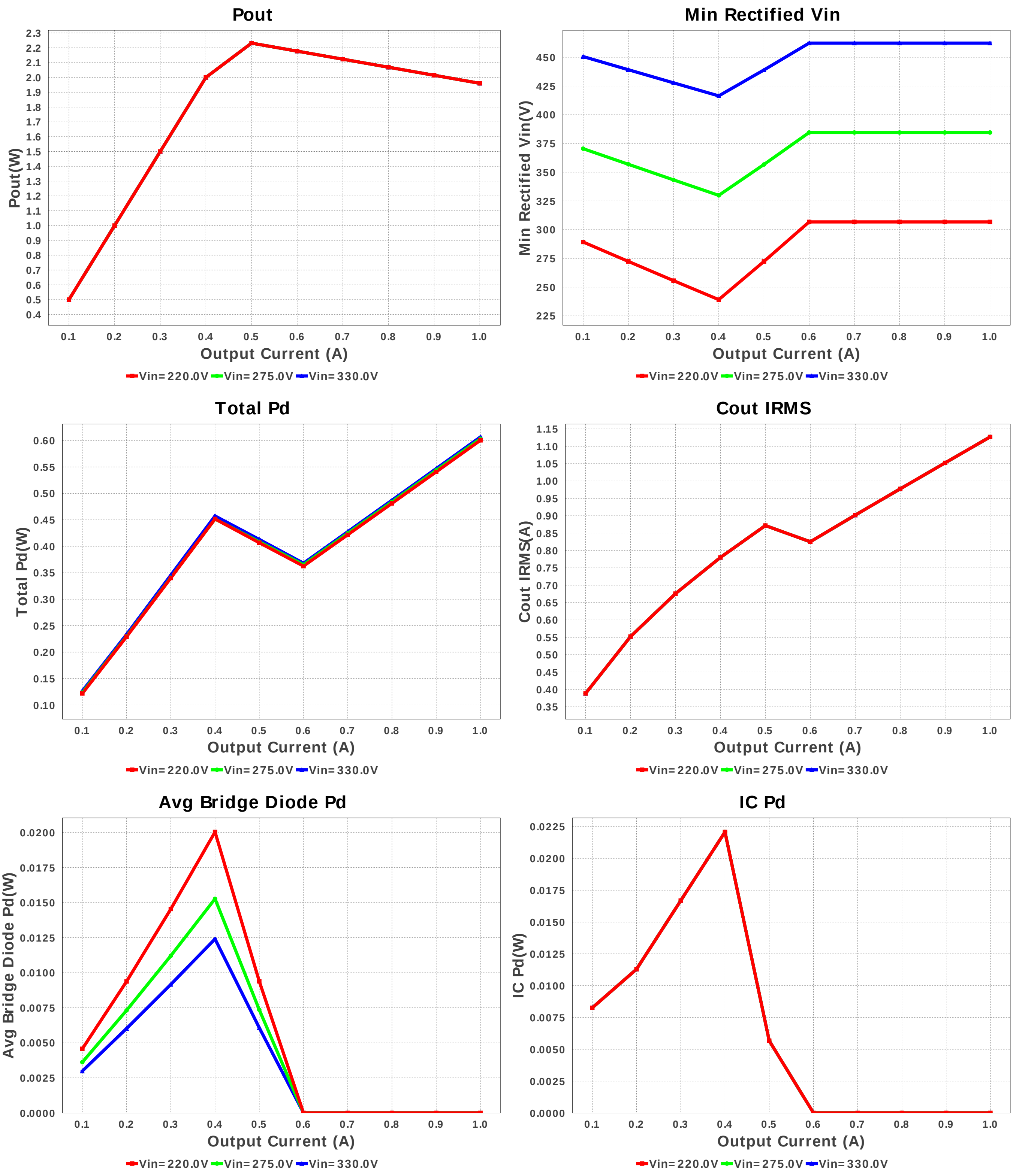

Iin rms
Iin rms(A)
Output Current (A)
Vin=220.0V Vin=275.0V Vin=330.0V

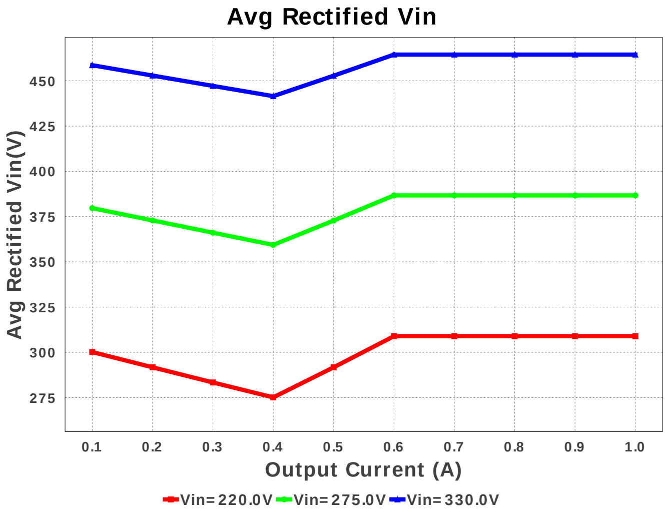

Cin Pd
Cin Pd(W)
Output Current (A)
Vin=220.0V Vin=275.0V Vin=330.0V

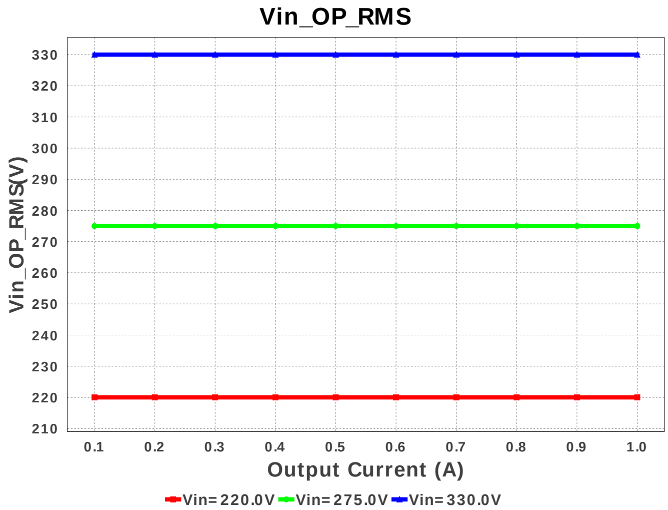

Cout Pd
Cout Pd(W)
Output Current (A)
Vin=220.0V Vin=275.0V Vin=330.0V

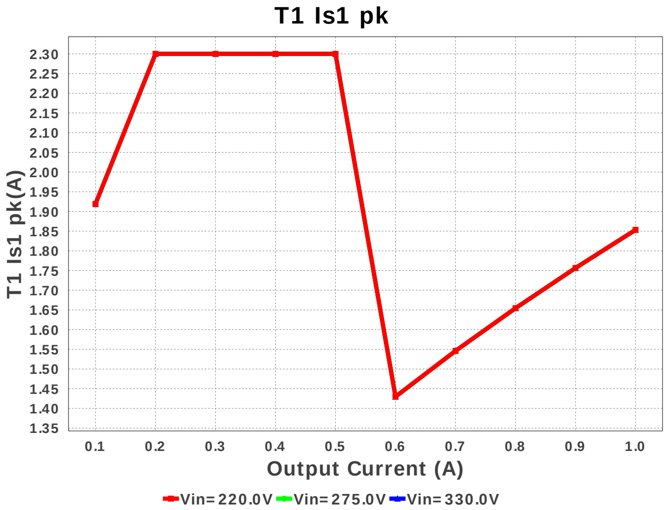

M1 Pd
M1 Pd(W)
Output Current (A)
Vin=220.0V Vin=275.0V Vin=330.0V


Xformer Pd
Xformer Pd(W)
Output Current (A)
Vin=220.0V Vin=275.0V Vin=330.0V


Pout
Pout(W)
Output Current (A)
Min Rectified Vin
Min Rectified Vin(V)
Output Current (A)
Total Pd
Total Pd(W)
Output Current (A)
Cout IRMS
Cout IRMS(A)
Output Current (A)
Avg Bridge Diode Pd
Avg Bridge Diode Pd(W)
Output Current (A)
IC Pd
IC Pd(W)
Output Current (A)
Vin= 220.0V Vin= 275.0V Vin= 330.0V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	16.488 mA	Current	Input capacitor RMS ripple current
2.	Cin2 IRMS	52.459 mA	Current	Input Capacitor Cin2 RMS Ripple Current
3.	Cout IRMS	1.89 A	Current	Output capacitor RMS ripple current
4.	Iin rms	18.735 mA	Current	RMS Input Current
5.	T1 Iprim RMS	38.818 mA	Current	Transformer Primary RMS Current
6.	T1 Iprim pk	154.91 mA	Current	Transformer Primary Peak Current
7.	T1 Is1 RMS	1.9 A	Current	Transformer Secondary1 RMS Current
8.	T1 Is1 pk	5.411 A	Current	Transformer Secondary1 Peak Current
9.	Avg Rectified Vin	420.175 V	General	Average Rectified Voltage for the AC Line Period
10.	BOM Count	33	General	Total Design BOM count
11.	FootPrint	1.292 k mm^2	General	Total Foot Print Area of BOM components
12.	Pout	5.0 W	General	Total output power
13.	Total BOM	$0.0	General	Total BOM Cost
14.	Vout Actual	5.012 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
15.	Vout OP	5.0 V	Op_Point	Operational Output Voltage
16.	Duty Cycle	18.838 %	Op_point	Duty cycle
17.	Efficiency	80.873 %	Op_point	Steady state efficiency
18.	Frequency_	73.69 kHz	Op_point	Switching frequency
19.	IC Tj	32.743 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	33.051 degC	Op_point	M1 MOSFET junction temperature
23.	Min Rectified Vin	373.663 V	Op_point	Minimum voltage seen at rectified input
24.	Peak Rectified Vin	466.686 V	Op_point	Peak voltage seen at rectified input
25.	Vin_OP_RMS	330.0 V	Op_point	AC Input RMS Voltage
26.	Vout p-p	86.572 mV	Op_point	Peak-to-peak output ripple voltage
27.	Avg Bridge Diode Pd	18.81 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
28.	Cin Pd	1.91 mW	Power	Input capacitor power dissipation
29.	Cout Pd	57.179 mW	Power	Output capacitor power dissipation
30.	Diode2 Pd	375.47 mW	Power	Diode2 power dissipation
31.	IC Pd	19.384 mW	Power	IC power dissipation

#	Name	Value	Category	Description
32.	M1 Pd	76.286 mW	Power	M1 MOSFET total power dissipation
33.	Total Pd	1.183 W	Power	Total Power Dissipation
34.	Xformer Pd	531.844 mW	Power	Transformer power dissipation
35.	Zener Pd	26.8 mW	Power	Zener power dissipation
36.	Vout Tolerance	1.336 %		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	330.0	Maximum input voltage
3.	VinMin	220.0	Minimum input voltage
4.	Vout	5.0	Output Voltage
5.	acFrequency	60.0	Light Output in Lumen
6.	base_pn	UCC28740	Texas Instruments Base Part Number
7.	source	AC	Input Source Type
8.	ta	30.0	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.