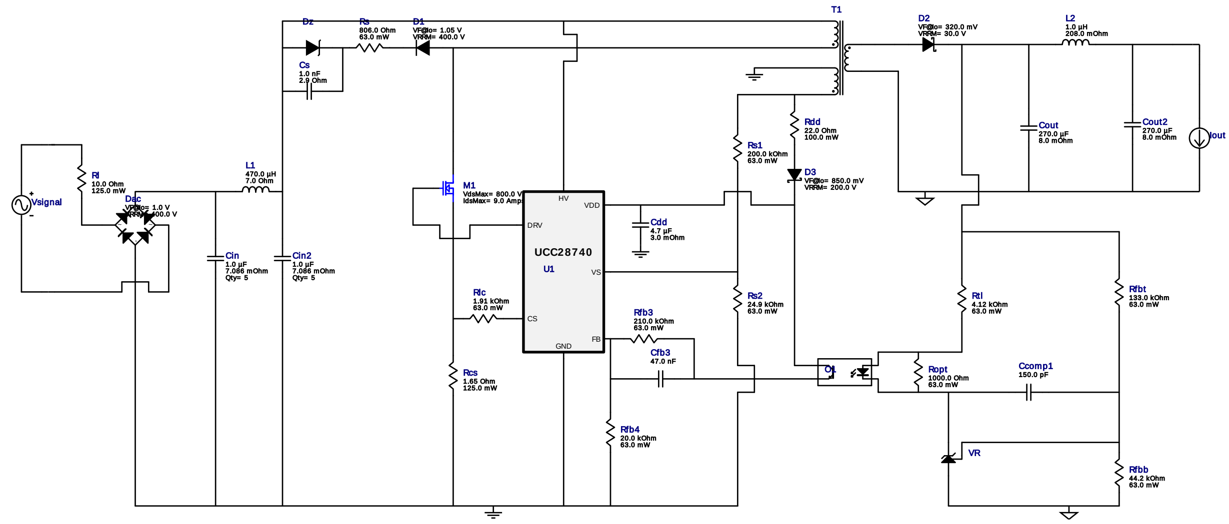
![Texas Instruments]

WEBENCH® Design Report

VinMin = 110.0V
VinMax = 130.0V
Vout = 10.0V
Iout = 1.0A

Device = UCC28740DR
Topology = Flyback
Created = 7/13/16 2:11:35 AM
BOM Cost = $10.25
BOM Count = 41
Total Pd = 1.74W

Design : 4738744/41 UCC28740DR
UCC28740DR 110.0V-130.0V to 10.00V @ 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	MuRata	GRM55DR72E105KW01L Series= X7R	Cap= 1.0 uF ESR= 7.086 mOhm VDC= 250.0 V IRMS= 2.0605 A	5	$0.26	2220_200 54 mm^2
5.	Cin2	MuRata	GRM55DR72E105KW01L Series= X7R	Cap= 1.0 uF ESR= 7.086 mOhm VDC= 250.0 V IRMS= 2.0605 A	5	$0.26	2220_200 54 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

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#	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	Toshiba	CMS06	VF@Io= 320.0 mV VRRM= 30.0 V	1	$0.19	M-FLAT 19 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	Diodes Inc.	HD04-T	VF@Io= 1.0 V VRRM= 400.0 V	1	$0.12	MiniDIP 62 mm^2
13.	Dz	ON Semiconductor	1SMB5953BT3G	Zener	1	$0.10	SMB 44 mm^2
14.	L1	Bourns	SDR0403-471KL	L= 470.0 µH DCR= 7.0 Ohm	1	$0.18	SDR0403 28 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	CRCW08051R65FKEA Series= CRCW..e3	Res= 1.65 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	CRCW040244K2FKED Series= CRCW..e3	Res= 44.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
23.	Rfbt	Vishay-Dale	CRCW0402133KFKED Series= CRCW..e3	Res= 133.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
24.	Rl	Vishay-Dale	CRCW080510R0FKEA Series= CRCW..e3	Res= 10.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
25.	Rlc	Vishay-Dale	CRCW04021K91FKED Series= CRCW..e3	Res= 1.91 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	CRCW0402806RFKED Series= CRCW..e3	Res= 806.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
28.	Rs1	Vishay-Dale	CRCW0402200KFKED Series= CRCW..e3	Res= 200.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
29.	Rs2	Vishay-Dale	CRCW040224K9FKED Series= CRCW..e3	Res= 24.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2

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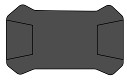
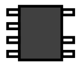
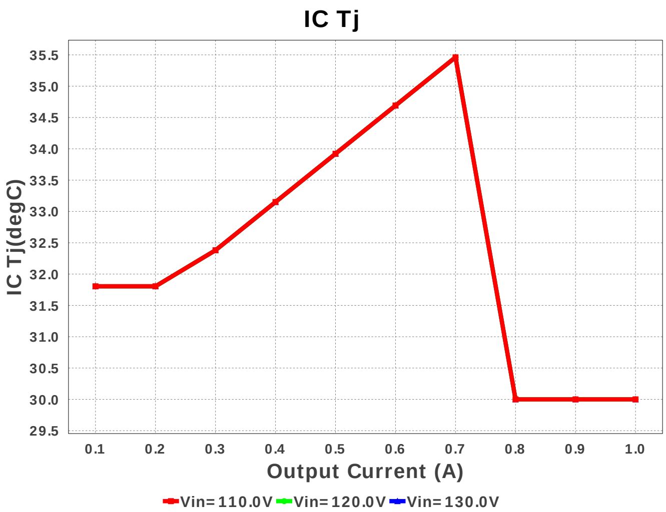
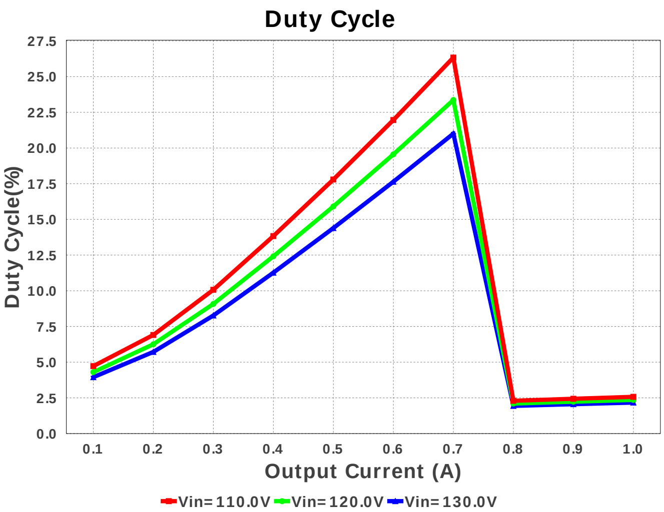
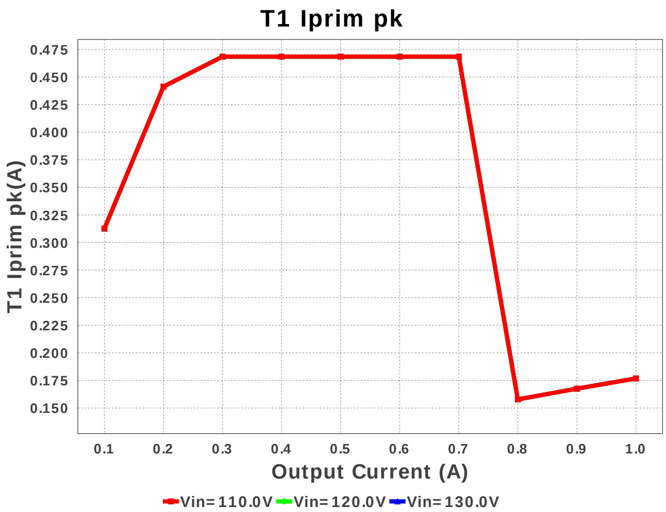
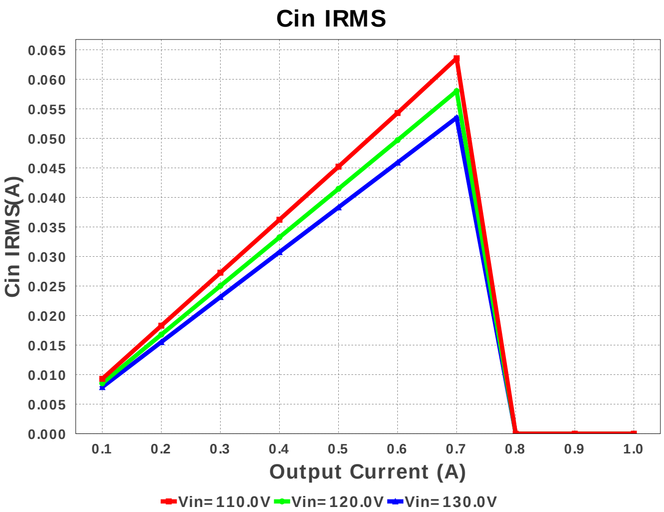
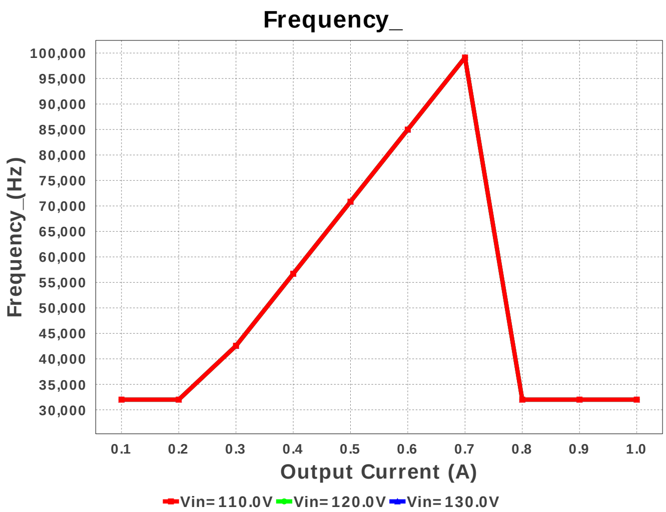
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
30.	Rtl	Vishay-Dale	CRCW04024K12FKED Series= CRCW..e3	Res= 4.12 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
31.	T1	Core=TDK , CoilFormer=TDK	Core=B65805P0000R087 , CoilFormer=B65822J1008T001	Lp= 697.0 µH Turns Ratio(Nas)= 7:4 Turns Ratio(Nps)= 30:4 Npri= 30.0 Naux= 7.0 Nsec= 4.0	1	$1.58	 TDK_B65803 165 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

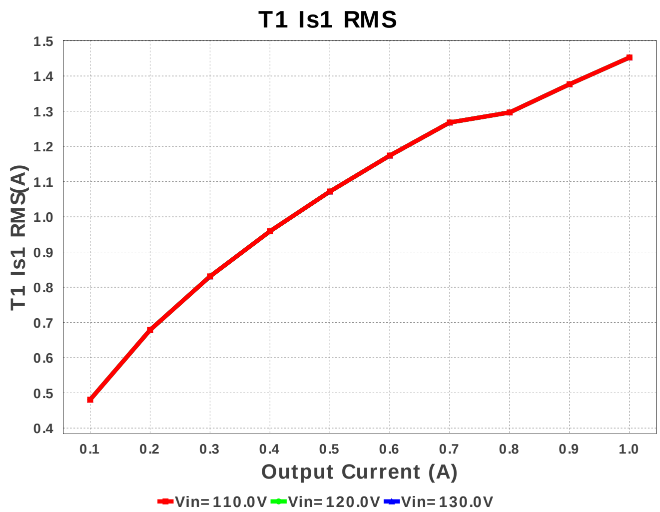


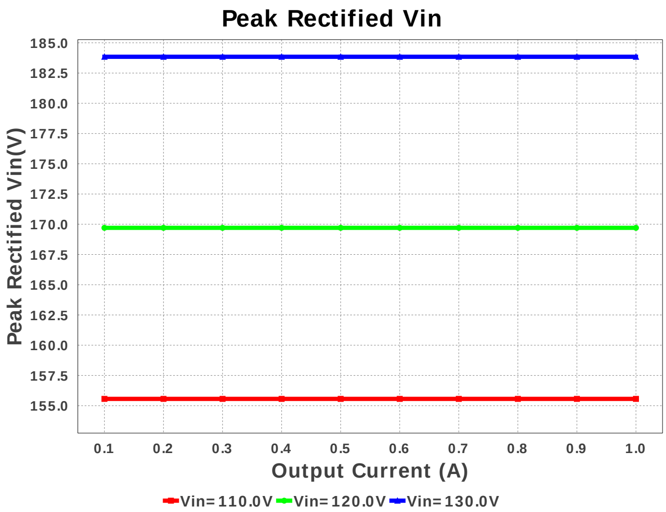


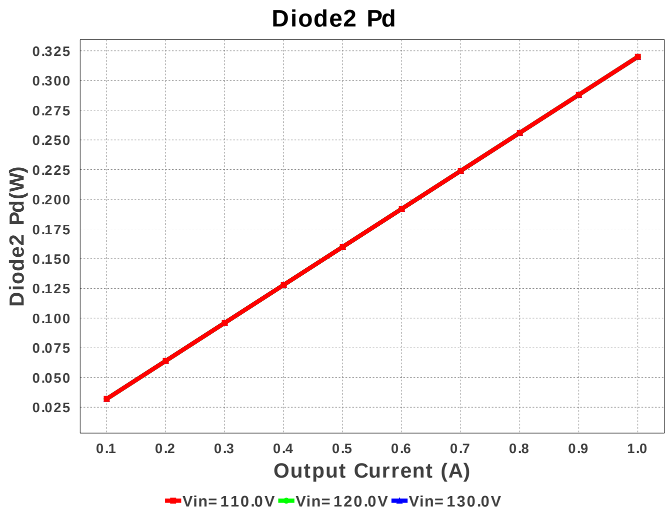


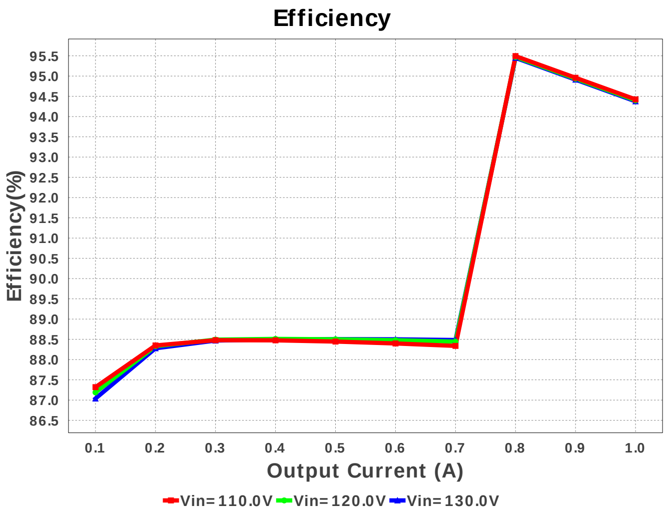


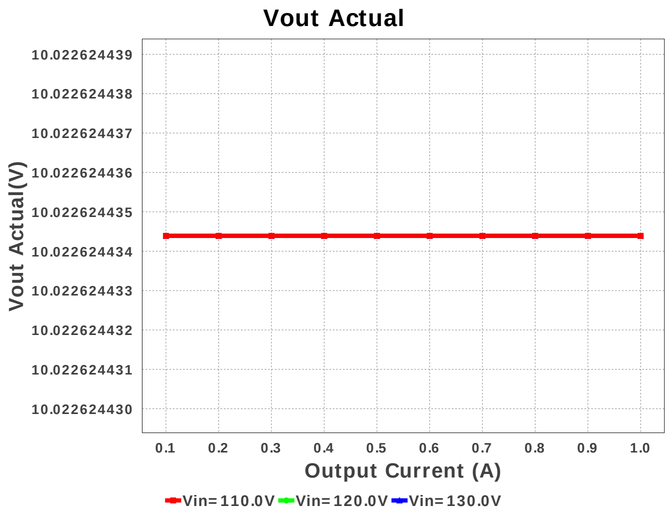

Frequency_
Frequency_(Hz)
100,000
95,000
90,000
85,000
80,000
75,000
70,000
65,000
60,000
55,000
50,000
45,000
40,000
35,000
30,000
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 110.0V Vin= 120.0V Vin= 130.0V

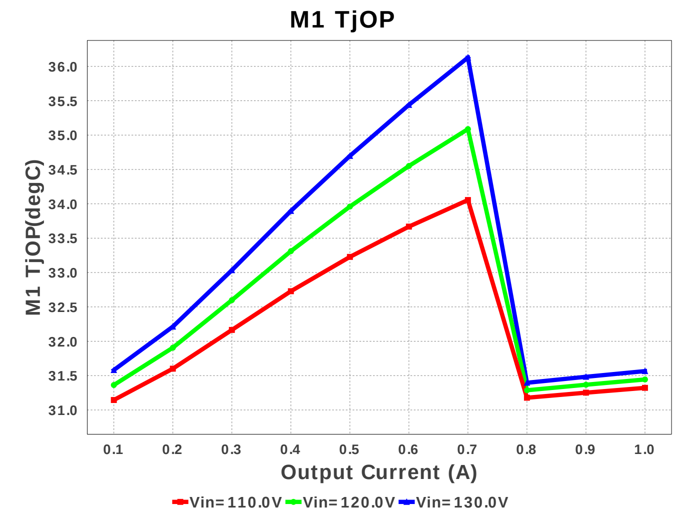

T1 Is1 RMS
T1 Is1 RMS(A)
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 110.0V Vin= 120.0V Vin= 130.0V

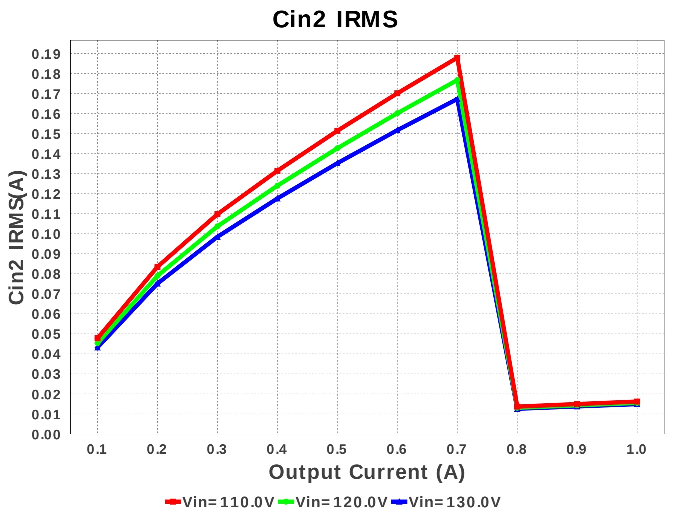

Peak Rectified Vin
Peak Rectified Vin(V)
185.0
182.5
180.0
177.5
175.0
172.5
170.0
167.5
165.0
162.5
160.0
157.5
155.0
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 110.0V Vin= 120.0V Vin= 130.0V

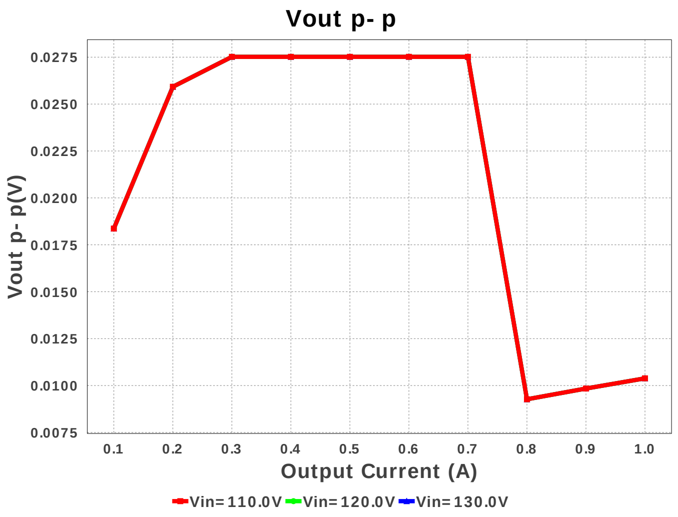

Diode2 Pd
Diode2 Pd(W)
0.325
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 110.0V Vin= 120.0V Vin= 130.0V

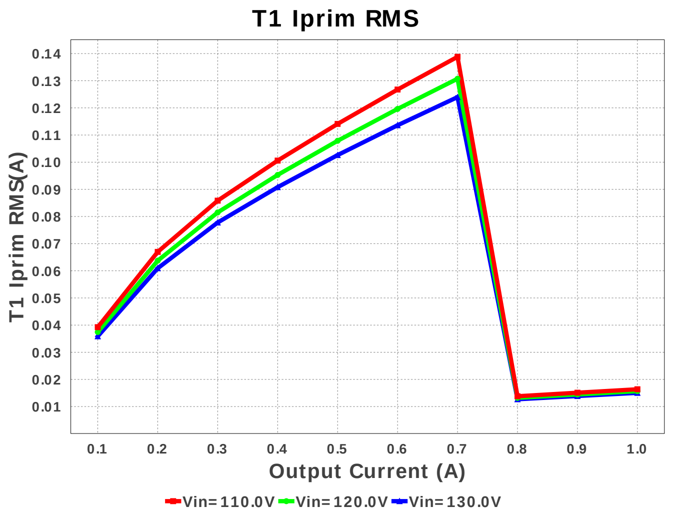

Efficiency
Efficiency(%)
95.5
95.0
94.5
94.0
93.5
93.0
92.5
92.0
91.5
91.0
90.5
90.0
89.5
89.0
88.5
88.0
87.5
87.0
86.5
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 110.0V Vin= 120.0V Vin= 130.0V

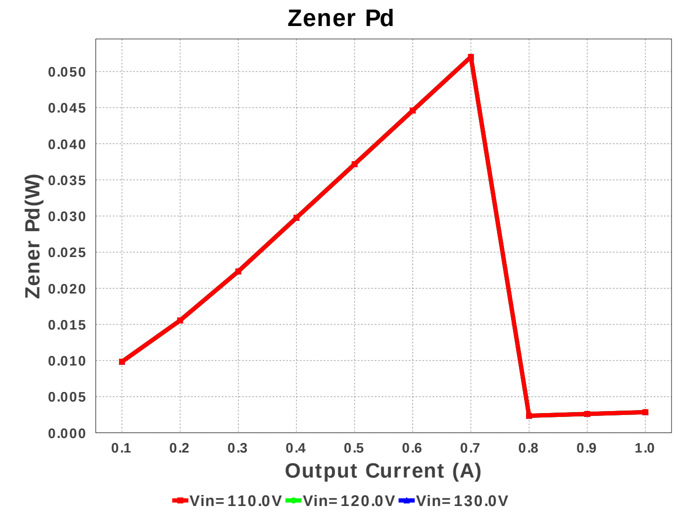

Vout Actual
Vout Actual(V)
10.022624439
10.022624438
10.022624437
10.022624436
10.022624435
10.022624434
10.022624433
10.022624432
10.022624431
10.022624430
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
Output Current (A)
Vin= 110.0V Vin= 120.0V Vin= 130.0V

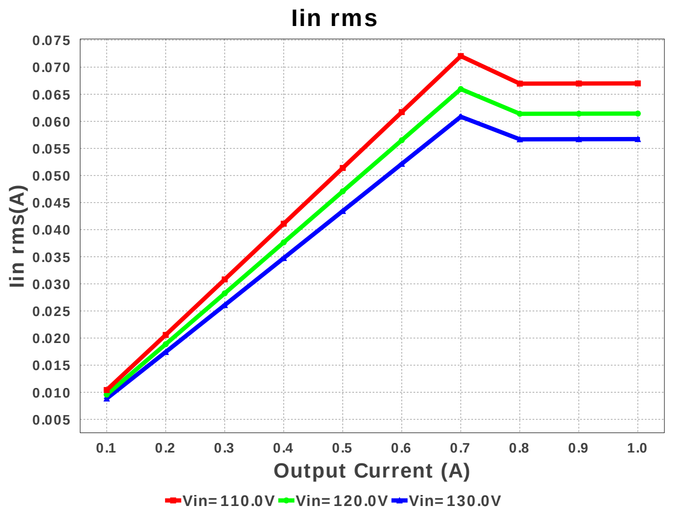












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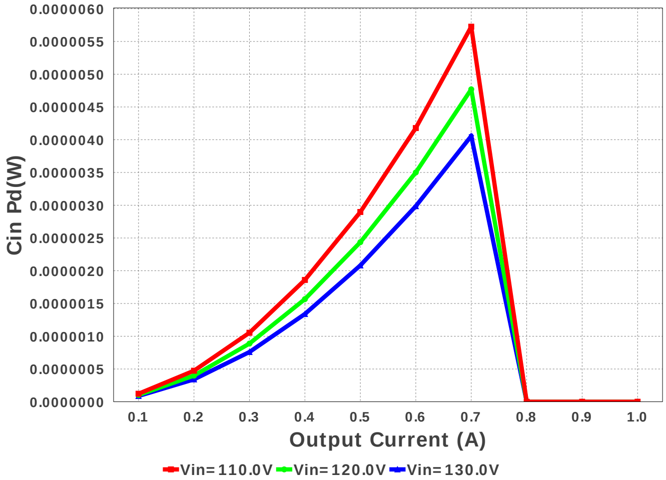
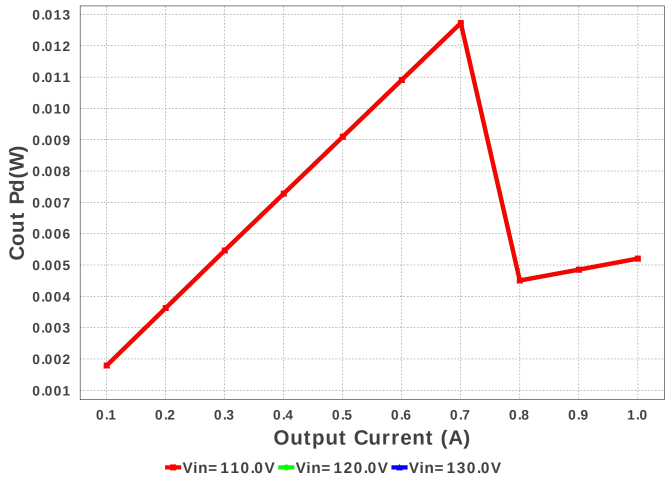
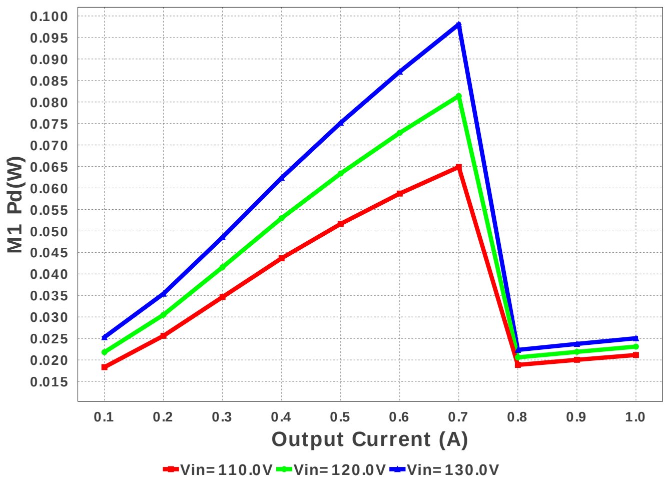
Cin Pd



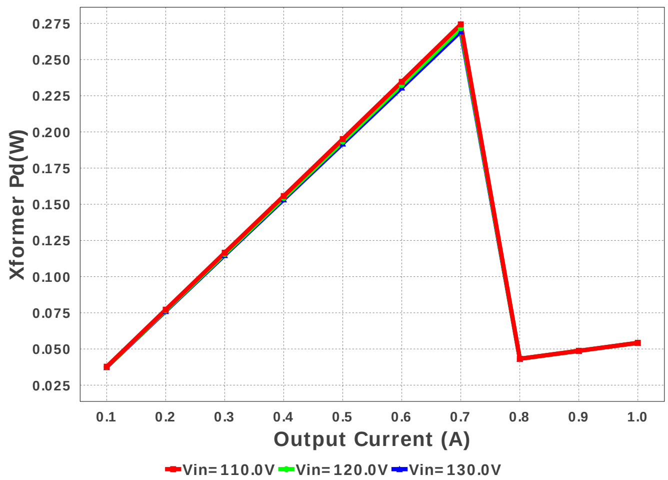
Cout Pd



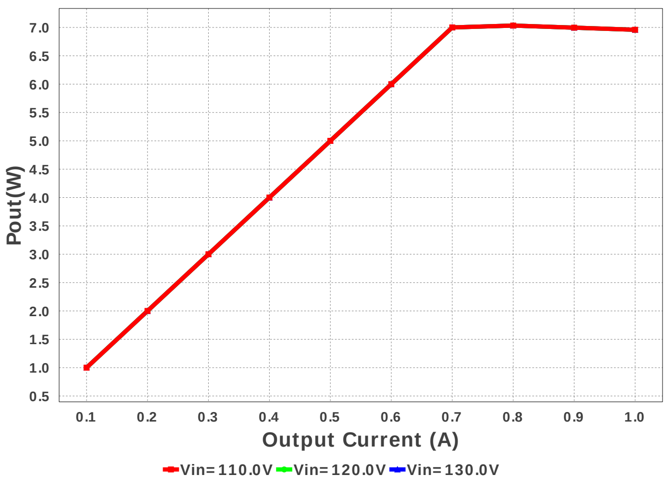
M1 Pd



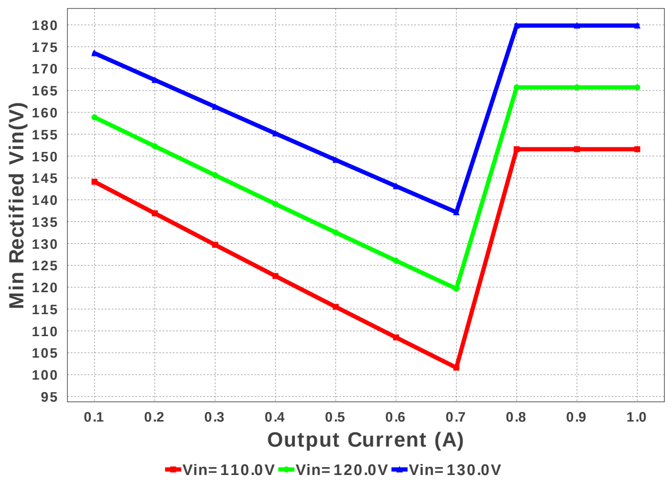
Xformer Pd

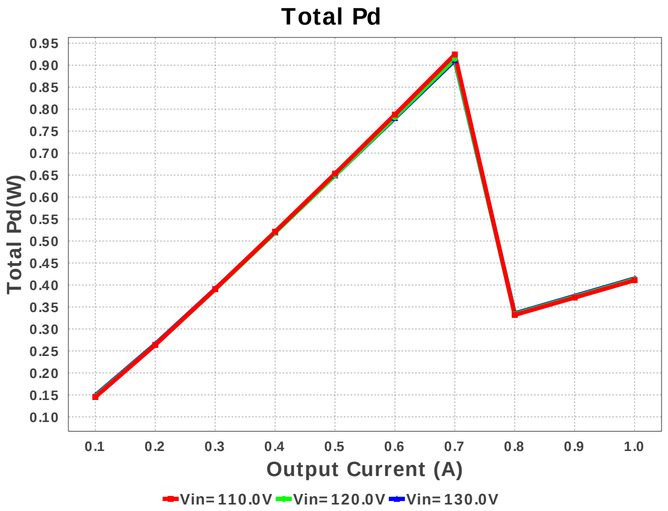


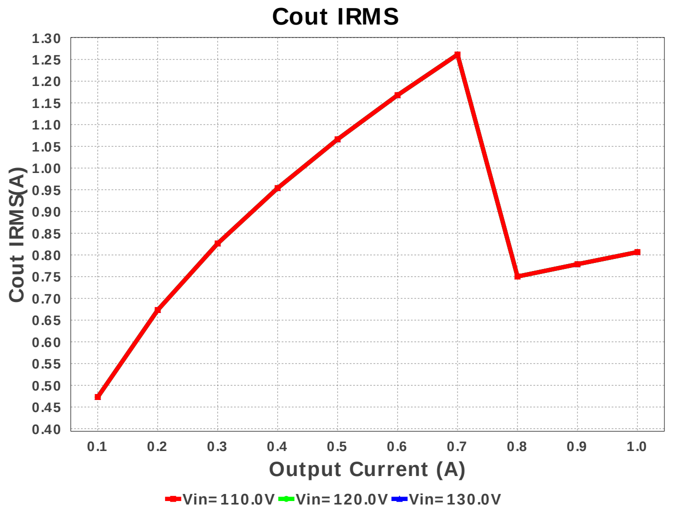
Pout

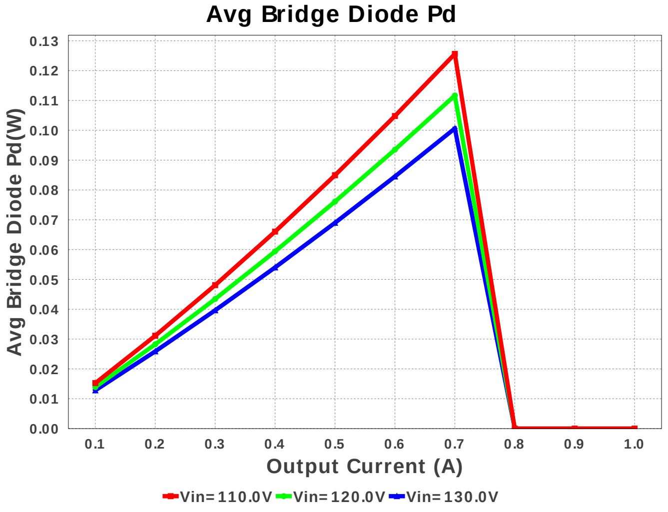


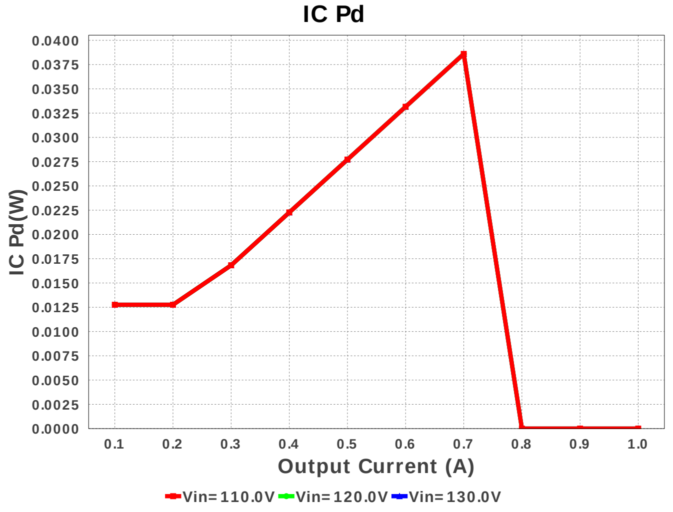
Min Rectified Vin

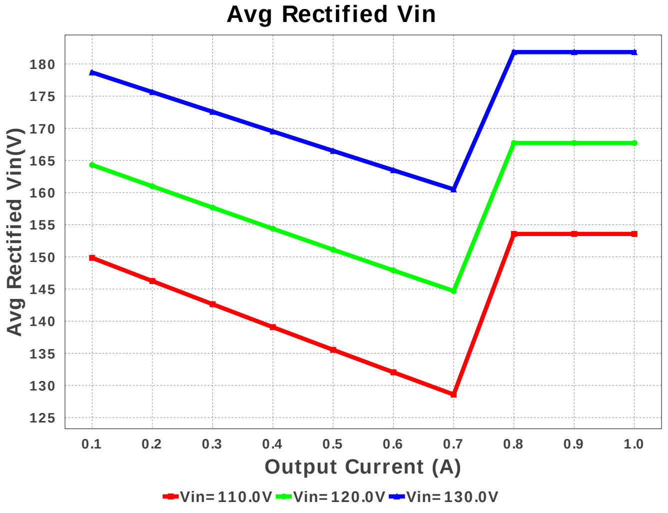


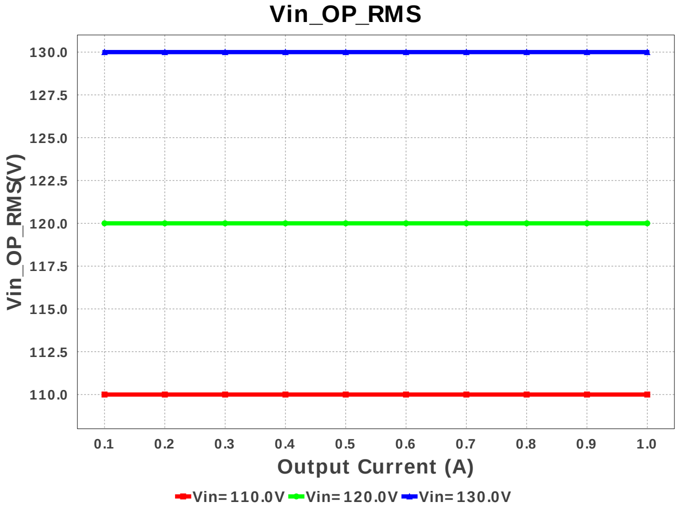

Total Pd
Total Pd(W)
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V

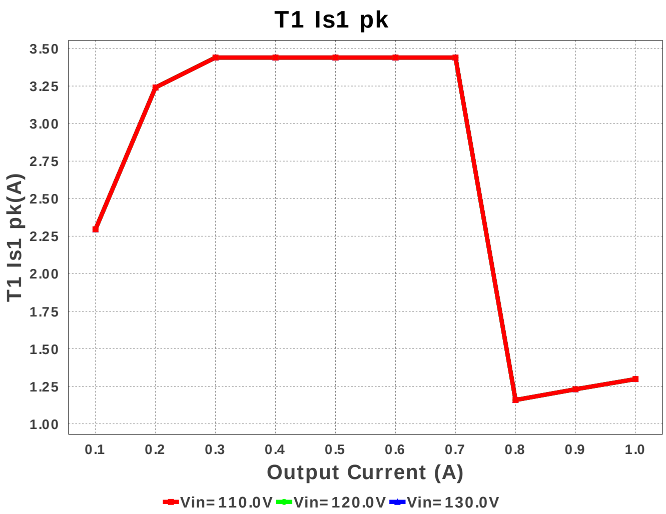

Cout IRMS
Cout IRMS(A)
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V


Avg Bridge Diode Pd
Avg Bridge Diode Pd(W)
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V


IC Pd
IC Pd(W)
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V


Avg Rectified Vin
Avg Rectified Vin(V)
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V


Vin_OP_RMS
Vin_OP_RMS(V)
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	78.207 mA	Current	Input capacitor RMS ripple current
2.	Cin2 IRMS	210.029 mA	Current	Input Capacitor Cin2 RMS Ripple Current
3.	Cout IRMS	1.879 A	Current	Output capacitor RMS ripple current
4.	Iin rms	90.301 mA	Current	RMS Input Current
5.	T1 Iprim RMS	150.415 mA	Current	Transformer Primary RMS Current
6.	T1 Iprim pk	468.485 mA	Current	Transformer Primary Peak Current
7.	T1 Is1 RMS	1.889 A	Current	Transformer Secondary1 RMS Current
8.	T1 Is1 pk	5.348 A	Current	Transformer Secondary1 Peak Current
9.	Avg Rectified Vin	156.224 V	General	Average Rectified Voltage for the AC Line Period
10.	BOM Count	41	General	Total Design BOM count
11.	FootPrint	1.378 k mm^2	General	Total Foot Print Area of BOM components
12.	Pout	10.0 W	General	Total output power
13.	Total BOM	$10.25	General	Total BOM Cost
14.	Vout Actual	10.023 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
15.	Vout OP	10.0 V	Op_Point	Operational Output Voltage
16.	Duty Cycle	30.925 %	Op_point	Duty cycle
17.	Efficiency	85.186 %	Op_point	Steady state efficiency
18.	Frequency_	56.911 kHz	Op_point	Switching frequency
19.	IC Tj	36.069 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	32.364 degC	Op_point	M1 MOSFET junction temperature
23.	Min Rectified Vin	128.602 V	Op_point	Minimum voltage seen at rectified input
24.	Peak Rectified Vin	183.846 V	Op_point	Peak voltage seen at rectified input
25.	Vin_OP_RMS	130.0 V	Op_point	AC Input RMS Voltage
26.	Vout p-p	42.781 mV	Op_point	Peak-to-peak output ripple voltage
27.	Avg Bridge Diode Pd	104.548 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
28.	Cin Pd	8.668 µW	Power	Input capacitor power dissipation
29.	Cout Pd	28.255 mW	Power	Output capacitor power dissipation
30.	Diode2 Pd	245.64 mW	Power	Diode2 power dissipation
31.	IC Pd	42.889 mW	Power	IC power dissipation
32.	M1 Pd	37.819 mW	Power	M1 MOSFET total power dissipation
33.	Total Pd	1.739 W	Power	Total Power Dissipation
34.	Xformer Pd	1.043 W	Power	Transformer power dissipation
35.	Zener Pd	41.851 mW	Power	Zener power dissipation
36.	Vout Tolerance	1.841 %		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.	Iout1	1.0	Output Current #1
3.	Iout2	1.0	Output Current #2
4.	Iout3	2.0	Output Current #3
5.	VinMax	130.0	Maximum input voltage
6.	VinMin	110.0	Minimum input voltage
7.	Vout	10.0	Output Voltage
8.	Vout1	10.0	Output Voltage #1
9.	Vout2	3.0	Output Voltage #2
10.	Vout3	2.0	Output Voltage #3
11.	acFrequency	60.0	Light Output in Lumen

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#	Name	Value	Description
12.	base_pn	UCC28740	Texas Instruments Base Part Number
13.	source	AC	Input Source Type
14.	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.

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