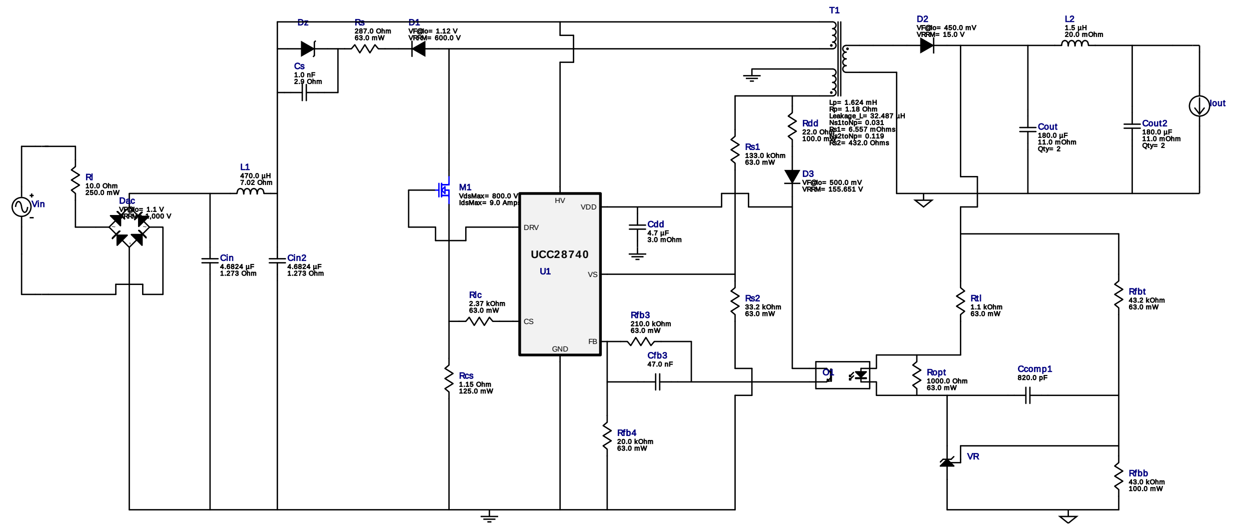
TEXAS INSTRUMENTS

VinMin = 180.0V
VinMax = 250.0V
Vout = 5.0V
Iout = 4.0A

Device = UCC28740DR
Topology = Flyback
Created = 8/12/16 6:32:36 PM
BOM Cost = $0.00
BOM Count = 35
Total Pd = 3.21W

WEBENCH ® Design Report

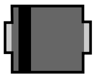
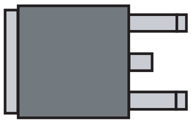
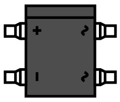
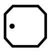
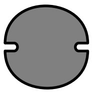
Design : 4766773/4 UCC28740DR
UCC28740DR 180.0V-250.0V to 5.00V @ 4.0A



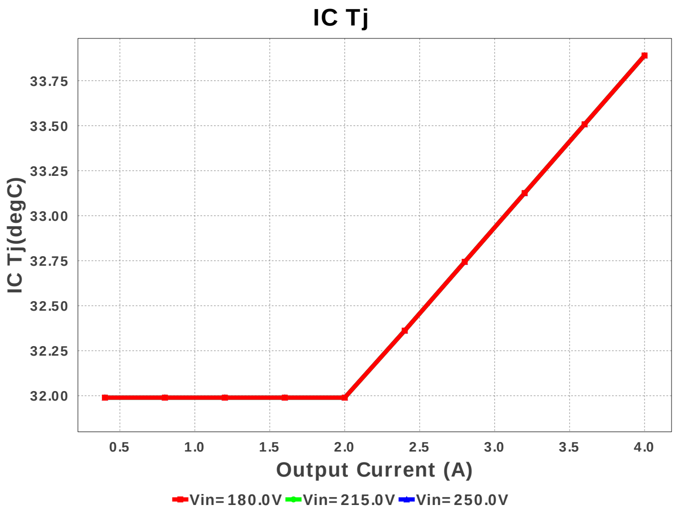
1. Rlc, Rtl and the feedback resistors for this design are a starting point, but may need adjustment based on the actual transformer used. For more information please click the design assistance button.

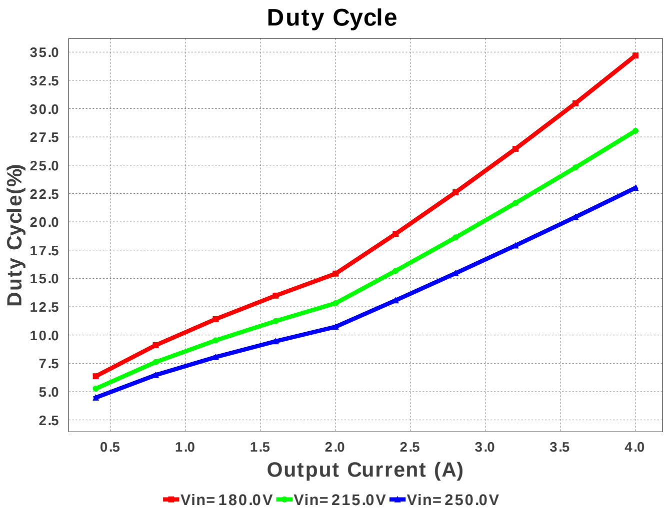
Electrical BOM

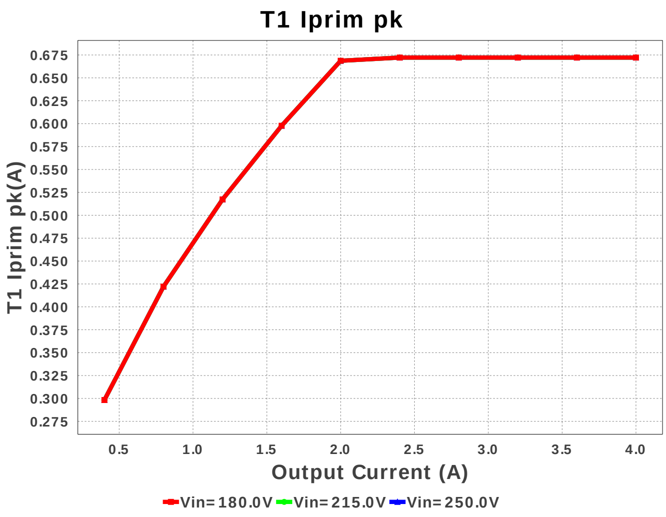
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp1	Yageo America	CC0805KRX7R9BB821 Series= X7R	Cap= 820.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
2.	Cdd	MuRata	GRM31CR71H475KA12L Series= X7R	Cap= 4.7 uF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 4.98 A	1	$0.07	1206 11 mm^2
3.	Cfb3	Taiyo 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= 4.6824 uF ESR= 1.2731 Ohm VDC= 530.32 V IRMS= 172.966 mA	1	NA	CUSTOM 0 mm^2
5.	Cin2	CUSTOM	CUSTOM Series= ?	Cap= 4.6824 uF ESR= 1.2731 Ohm VDC= 530.32 V IRMS= 172.966 mA	1	NA	CUSTOM 0 mm^2
6.	Cout	Panasonic	16SVPE180M Series= SVPE	Cap= 180.0 uF ESR= 11.0 mOhm VDC= 16.0 V IRMS= 4.46 A	2	$0.49	CAPSMT_62_C10 74 mm^2
7.	Cout2	Panasonic	16SVPE180M Series= SVPE	Cap= 180.0 uF ESR= 11.0 mOhm VDC= 16.0 V IRMS= 4.46 A	2	$0.49	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

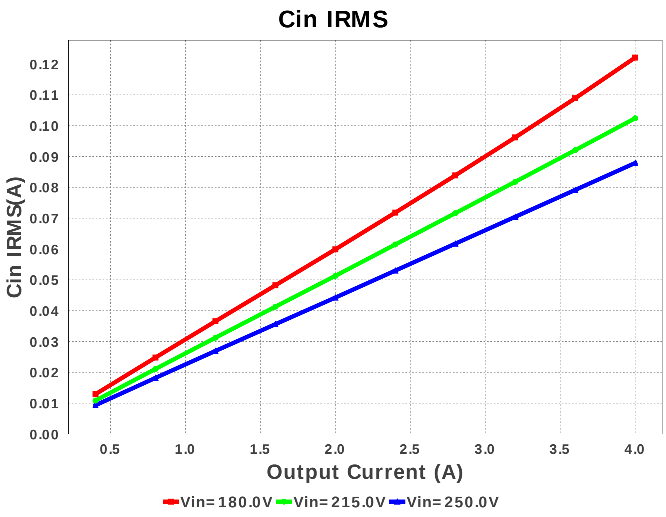
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	D1	Bourns	CD214C-F3600	VF@Io= 1.12 V VRRM= 600.0 V	1	$0.18	 SMC 83 mm²
10.	D2	ON Semiconductor	MBRB2515LT4G	VF@Io= 450.0 mV VRRM= 15.0 V	1	$1.00	 DDPAK 210 mm²
11.	D3	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 155.651 V	1	NA	CUSTOM 0 mm²
12.	Dac	Vishay-Semiconductor	DF10SA	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.24	 DF-S 99 mm²
13.	Dz	ON Semiconductor	1SMB5955BT3G	Zener	1	$0.10	 SMB 44 mm²
14.	L1	Coilcraft	LPS4018-474MRB	L= 470.0 µH DCR= 7.02 Ohm	1	$0.35	 LPS4018 24 mm²
15.	L2	Bourns	SDR0805-1R5ML	L= 1.5 µH DCR= 20.0 mOhm	1	$0.22	 SDR0805 96 mm²
16.	M1	STMicroelectronics	STF10N80K5	VdsMax= 800.0 V IdsMax= 9.0 Amps	1	$2.52	 TO-220FP 79 mm²
17.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$0.38	 SSOP-4 111 mm²
18.	Rcs	Vishay-Dale	CRCW08051R15FKEA Series= CRCW..e3	Res= 1.15 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
19.	Rdd	Yageo America	RC0603FR-0722RL Series= ?	Res= 22.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
20.	Rfb3	Vishay-Dale	CRCW0402210KFKED Series= CRCW..e3	Res= 210.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
21.	Rfb4	Vishay-Dale	CRCW040220K0FKED Series= CRCW..e3	Res= 20.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
22.	Rfbb	Yageo America	RC0603FR-0743KL Series= ?	Res= 43.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
23.	Rfbt	Vishay-Dale	CRCW040243K2FKED Series= CRCW..e3	Res= 43.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
24.	Rl	Panasonic	ERJ-8ENF10R0V Series= ERJ-8E	Res= 10.0 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm²
25.	Rlc	Vishay-Dale	CRCW04022K37FKED Series= CRCW..e3	Res= 2.37 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
26.	Ropt	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

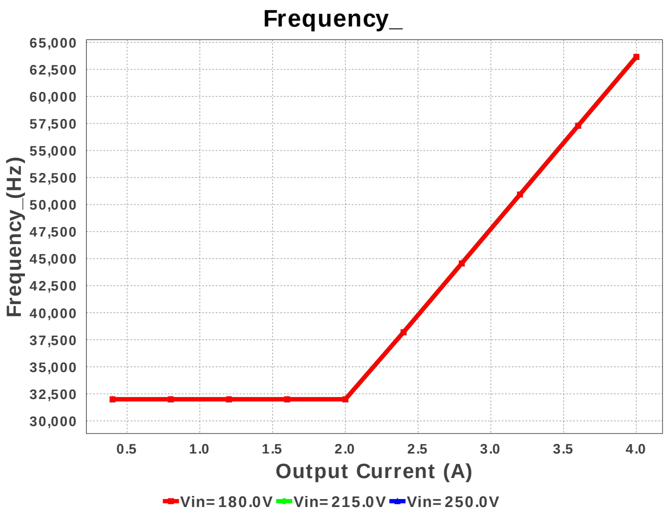
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
27.	Rs	Vishay-Dale	CRCW0402287RFKED Series= CRCW..e3	Res= 287.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
28.	Rs1	Vishay-Dale	CRCW0402133KFKED Series= CRCW..e3	Res= 133.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
29.	Rs2	Vishay-Dale	CRCW040233K2FKED Series= CRCW..e3	Res= 33.2 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	CUSTOM	CUSTOM	Lp= 1.624 mH Rp= 1.18 Ohm Leakage_L= 32.487 µH Ns1toNp= 0.031 Rs1= 6.557 mOhms Ns2toNp= 0.119 Rs2= 432.0 Ohms	1	NA	CUSTOM 0 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

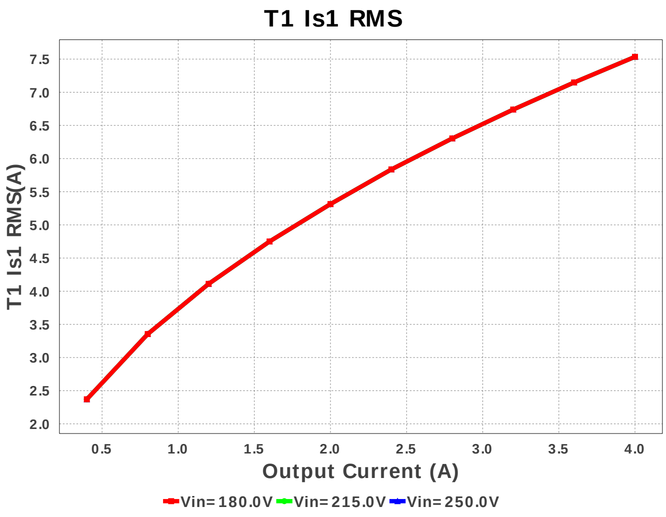


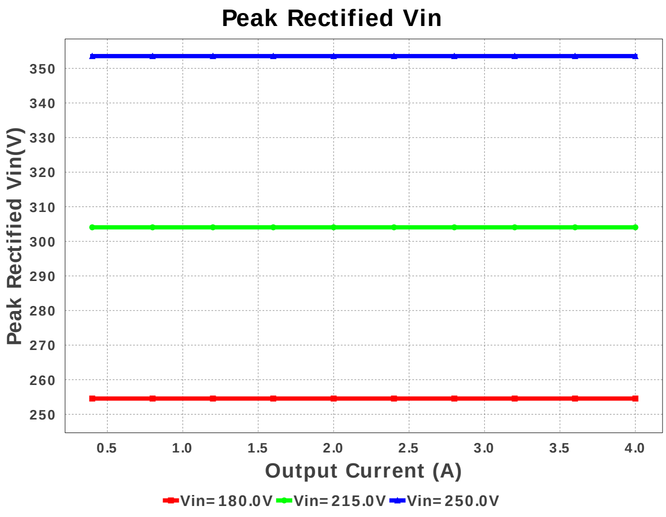


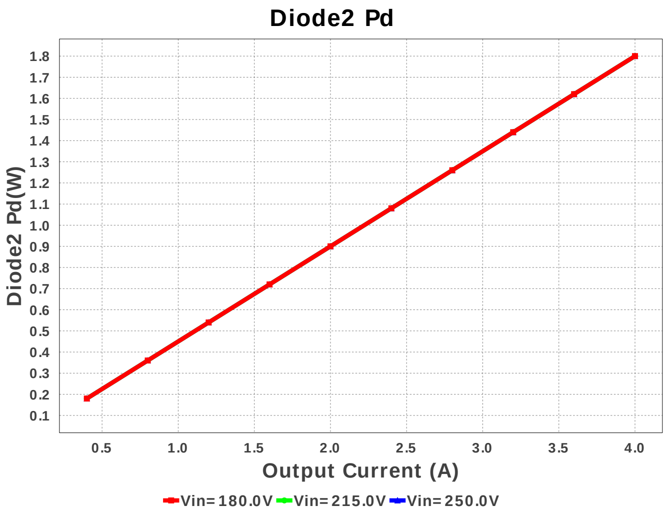

T1 Iprim pk
T1 Iprim pk(A)
Output Current (A)
Vin=180.0V Vin=215.0V Vin=250.0V

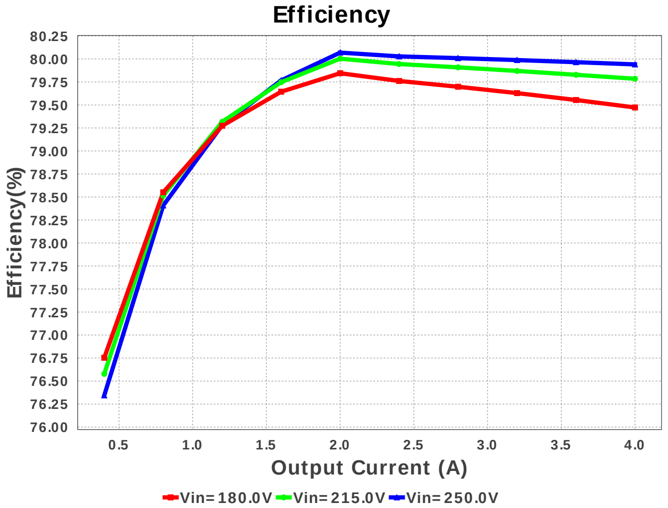

Cin IRMS
Cin IRMS(A)
Output Current (A)
Vin=180.0V Vin=215.0V Vin=250.0V


Frequency_
Frequency_(Hz)
Output Current (A)
Vin=180.0V Vin=215.0V Vin=250.0V

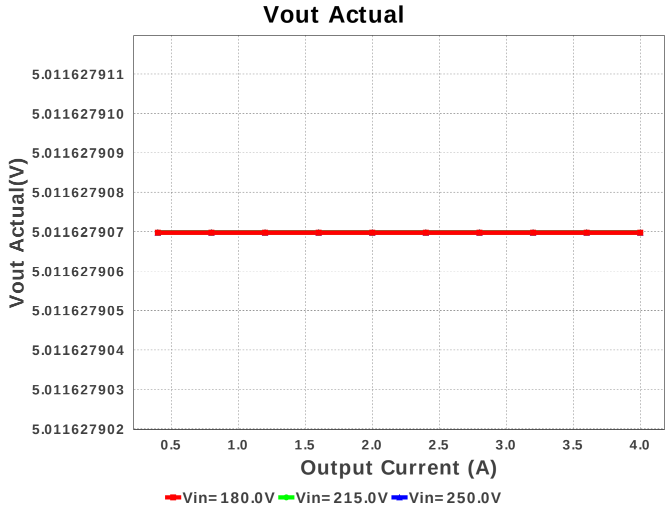

T1 Is1 RMS
T1 Is1 RMS(A)
Output Current (A)
Vin=180.0V Vin=215.0V Vin=250.0V


Peak Rectified Vin
Peak Rectified Vin(V)
Output Current (A)
Vin=180.0V Vin=215.0V Vin=250.0V

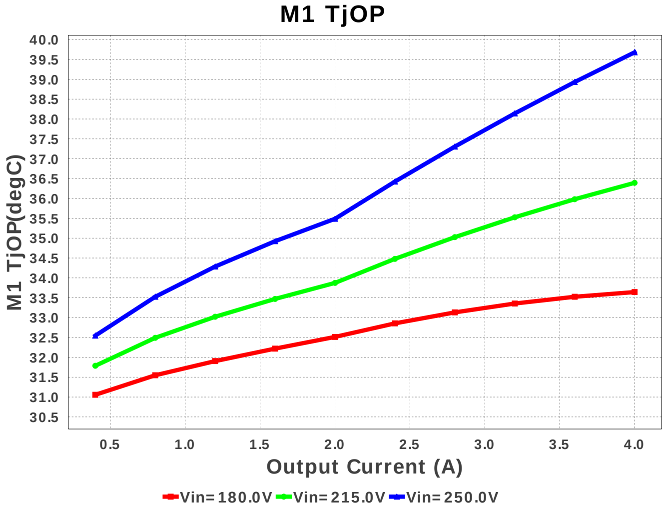

Diode2 Pd
Diode2 Pd(W)
Output Current (A)
Vin=180.0V Vin=215.0V Vin=250.0V



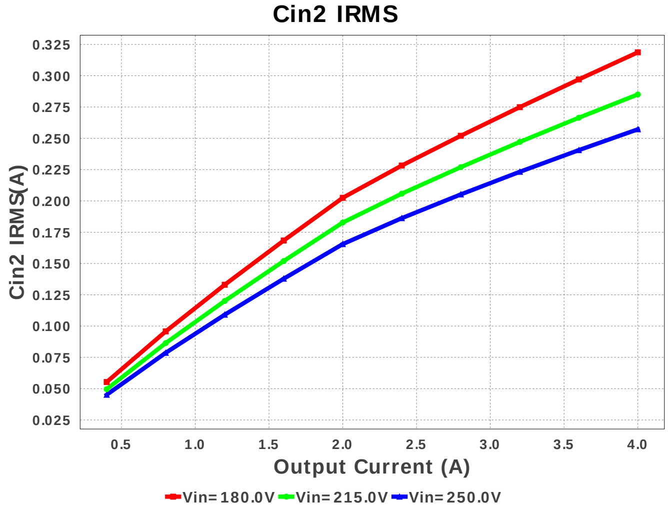
Efficiency
Efficiency(%)
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V



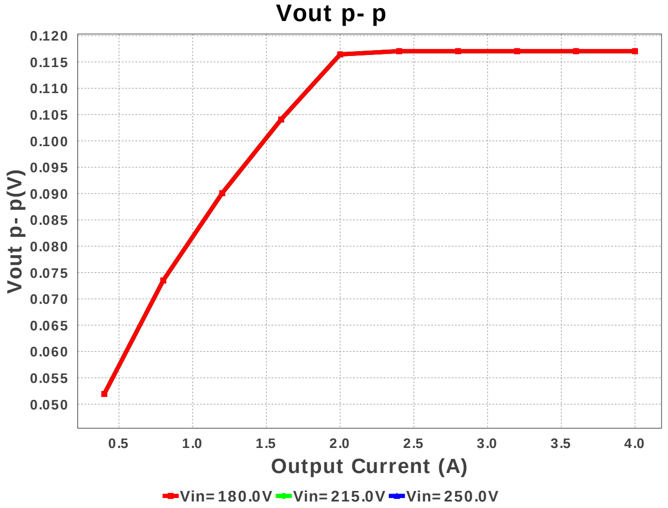
Vout Actual
Vout Actual(V)
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V



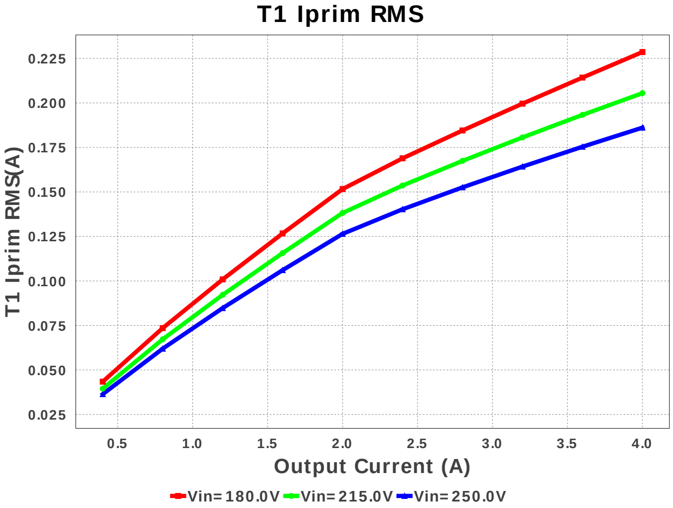
M1 TjOP
M1 TjOP(degC)
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V



Cin2 IRMS
Cin2 IRMS(A)
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V

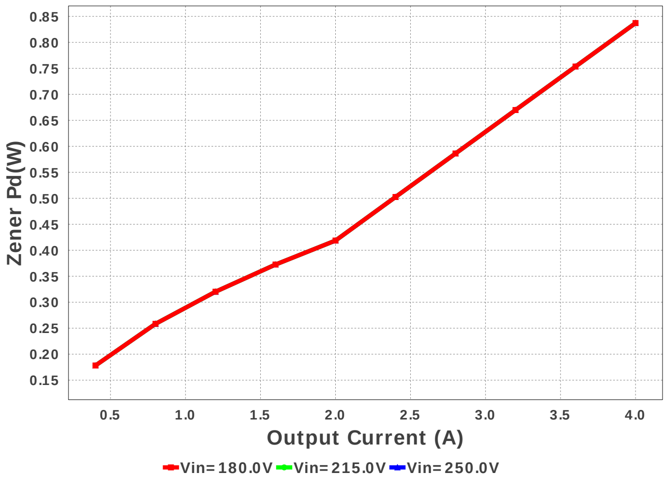


Vout p- p
Vout p- p(V)
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V

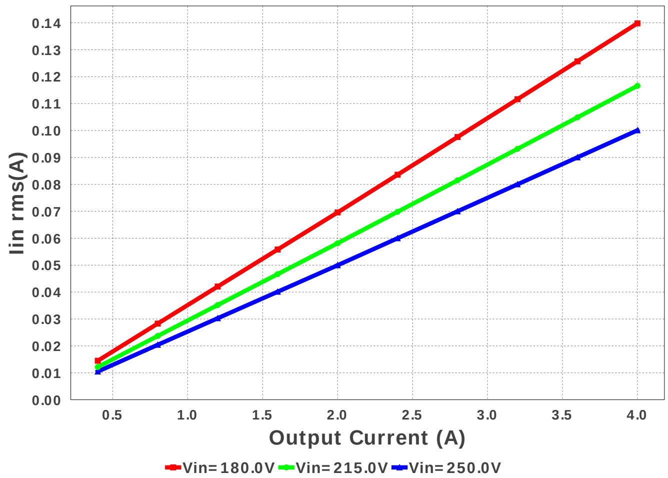


T1 Iprim RMS
T1 Iprim RMS(A)
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V

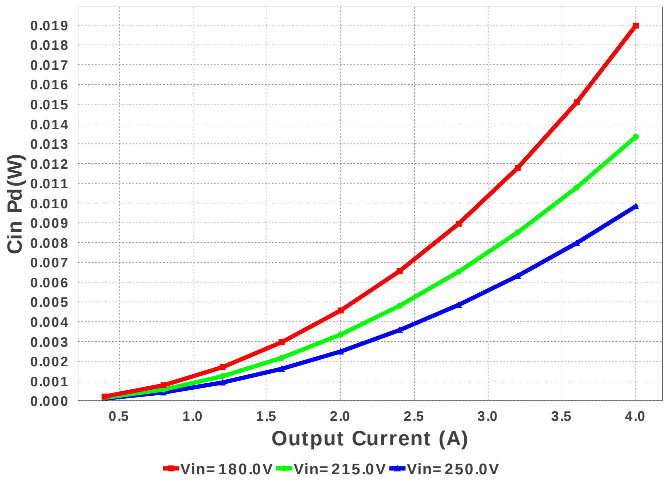
Zener Pd



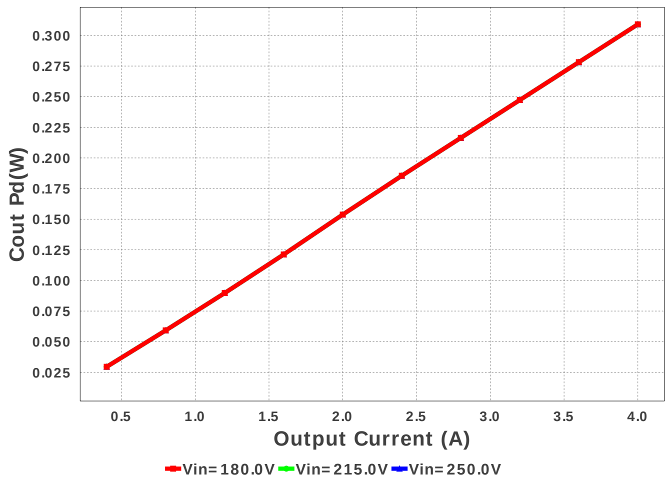
Iin rms



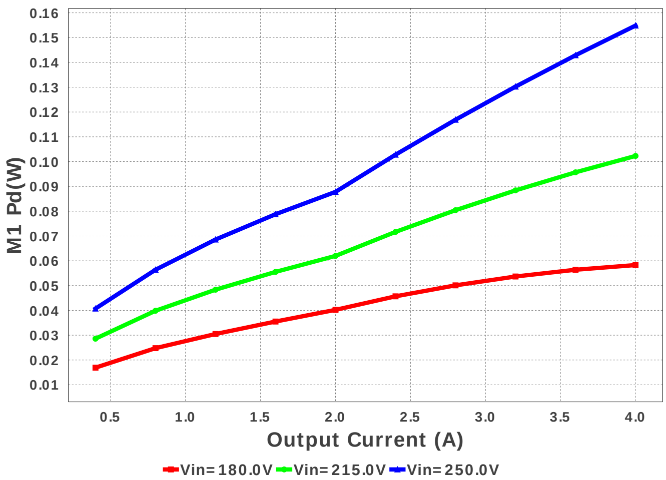
Cin Pd



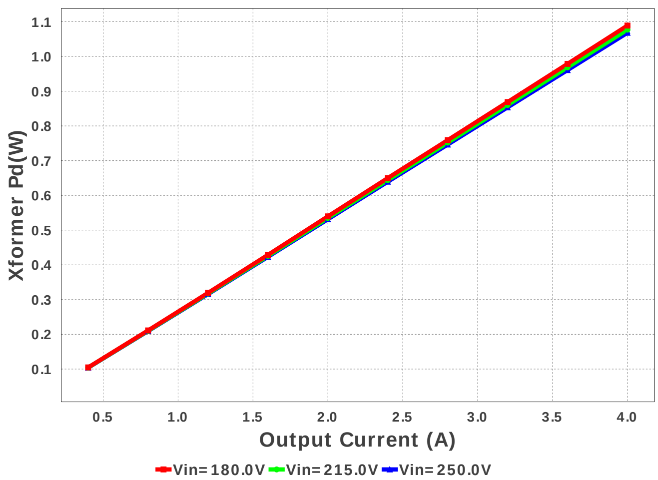
Cout Pd

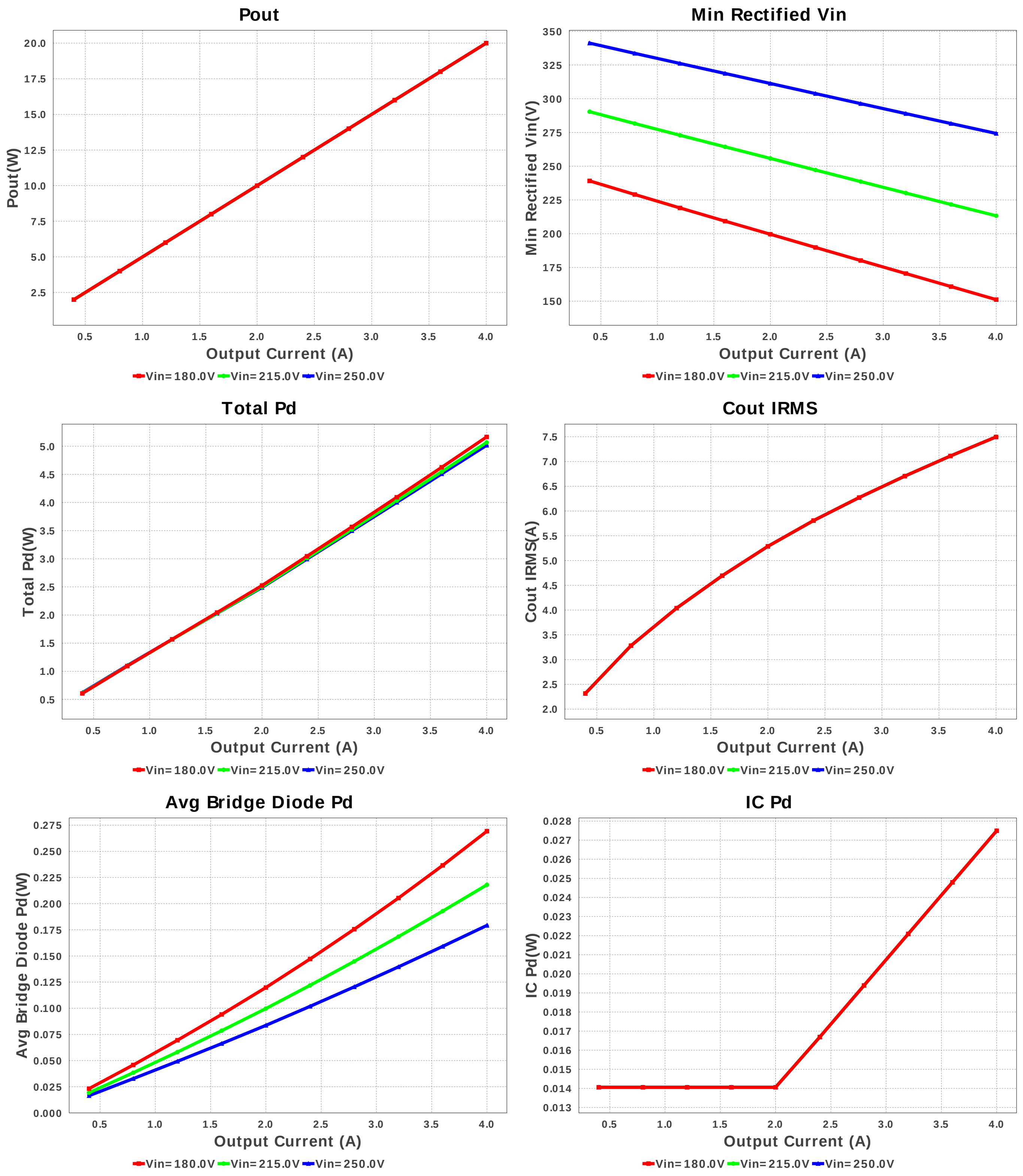


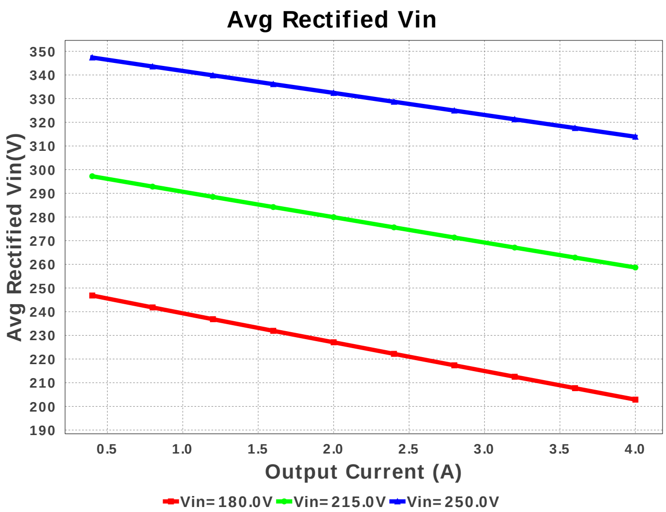
M1 Pd

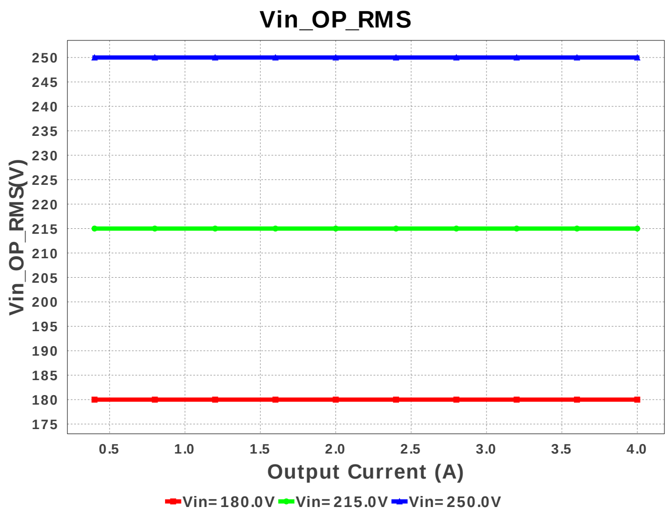


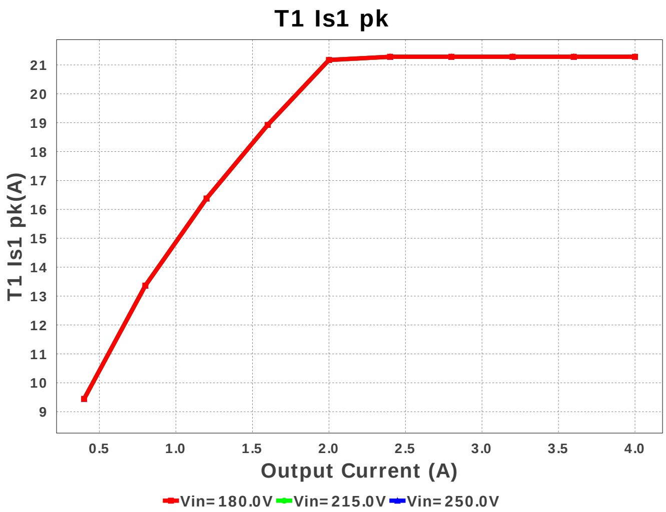
Xformer Pd




Pout
Pout(W)
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V
Min Rectified Vin
Min Rectified Vin(V)
350
325
300
275
250
225
200
175
150
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V
Total Pd
Total Pd(W)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V
Cout IRMS
Cout IRMS(A)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V
Avg Bridge Diode Pd
Avg Bridge Diode Pd(W)
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V
IC Pd
IC Pd(W)
0.028
0.027
0.026
0.025
0.024
0.023
0.022
0.021
0.020
0.019
0.018
0.017
0.016
0.015
0.014
0.013
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Output Current (A)
Vin= 180.0V Vin= 215.0V Vin= 250.0V







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	81.918 mA	Current	Input capacitor RMS ripple current
2.	Cin2 IRMS	247.625 mA	Current	Input Capacitor Cin2 RMS Ripple Current
3.	Cout IRMS	7.524 A	Current	Output capacitor RMS ripple current
4.	Iin rms	92.837 mA	Current	RMS Input Current
5.	T1 Iprim RMS	181.175 mA	Current	Transformer Primary RMS Current
6.	T1 Iprim pk	672.174 mA	Current	Transformer Primary Peak Current
7.	T1 Is1 RMS	7.562 A	Current	Transformer Secondary1 RMS Current
8.	T1 Is1 pk	21.438 A	Current	Transformer Secondary1 Peak Current
9.	Avg Rectified Vin	314.964 V	General	Average Rectified Voltage for the AC Line Period
10.	BOM Count	35	General	Total Design BOM count
11.	FootPrint	1.367 k mm^2	General	Total Foot Print Area of BOM components
12.	Mode	DCM	General	Conduction Mode
13.	Pout	20.0 W	General	Total output power
14.	Total BOM	$0.0	General	Total BOM Cost
15.	Vout Actual	5.012 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
16.	Vout OP	5.0 V	Op_Point	Operational Output Voltage
17.	Duty Cycle	21.795 %	Op_point	Duty cycle
18.	Efficiency	86.172 %	Op_point	Steady state efficiency
19.	Frequency	60.524 kHz	Op_point	Switching frequency
20.	IC Tj	33.702 degC	Op_point	IC junction temperature
21.	ICThetaJA	141.5 degC/W	Op_point	IC junction-to-ambient thermal resistance
22.	IOUT_OP	4.0 A	Op_point	Iout operating point
23.	M1 TjOP	39.656 degC	Op_point	M1 MOSFET junction temperature
24.	Min Rectified Vin	276.378 V	Op_point	Minimum voltage seen at rectified input
25.	Peak Rectified Vin	353.55 V	Op_point	Peak voltage seen at rectified input
26.	Vin_OP_RMS	250.0 V	Op_point	AC Input RMS Voltage
27.	Vout p-p	117.911 mV	Op_point	Peak-to-peak output ripple voltage
28.	Avg Bridge Diode Pd	108.533 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
29.	Cin Pd	8.543 mW	Power	Input capacitor power dissipation
30.	Cout Pd	311.342 mW	Power	Output capacitor power dissipation
31.	Diode2 Pd	1.016 W	Power	Diode2 power dissipation

#	Name	Value	Category	Description
32.	IC Pd	26.162 mW	Power	IC power dissipation
33.	M1 Pd	154.495 mW	Power	M1 MOSFET total power dissipation
34.	Total Pd	3.209 W	Power	Total Power Dissipation
35.	Xformer Pd	1.045 W	Power	Transformer power dissipation
36.	Zener Pd	205.84 mW	Power	Zener power dissipation
37.	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	4.0	Maximum Output Current
2.	VinMax	250.0	Maximum input voltage
3.	VinMin	180.0	Minimum input voltage
4.	Vout	5.0	Output Voltage
5.	base_pn	UCC28740	Base Product Number
6.	source	DC	Input Source Type
7.	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.