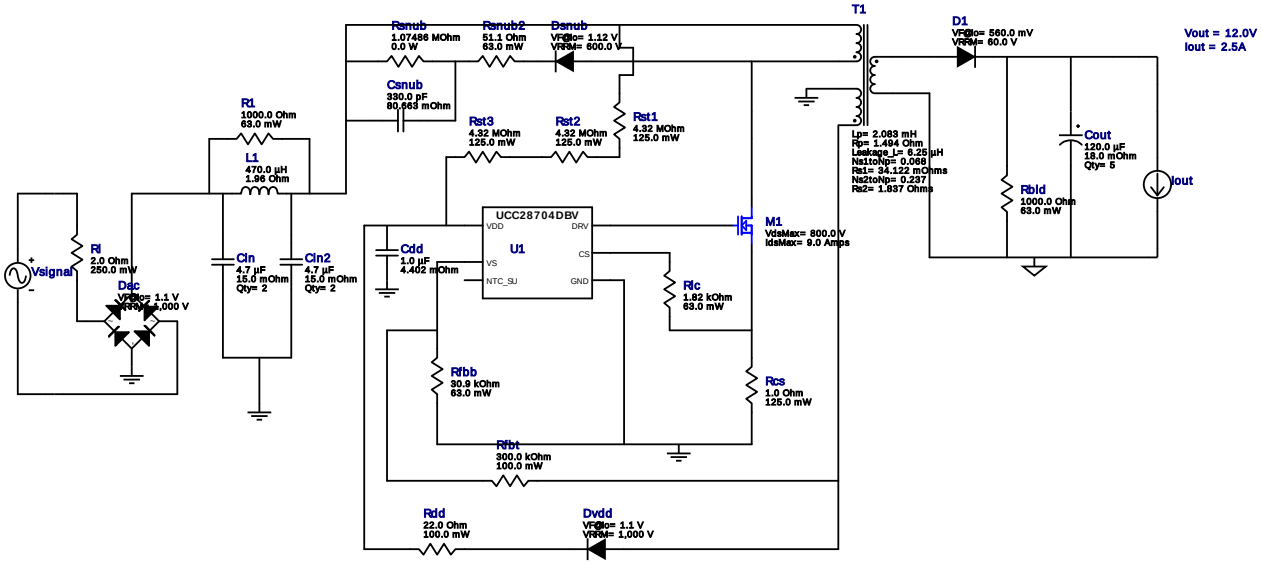
WEBENCH® Design Report

VinMin = 210.0V
VinMax = 230.0V
Vout = 12.0V
Iout = 2.5A

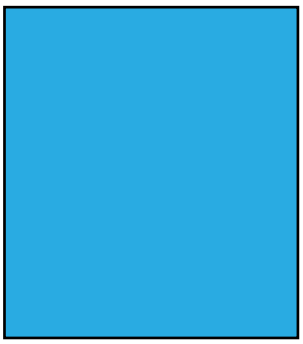
Device = UCC28704DBVR-1
Topology = Flyback
Created = 8/14/16 5:17:59 AM
BOM Cost = $0.00
BOM Count = 32
Total Pd = 4.2W

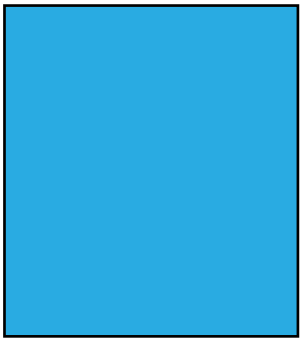
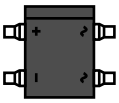
Design : 4009018/105 UCC28704DBVR-1
UCC28704DBVR-1 210.0V-230.0V to 13.09V @ 2.5A



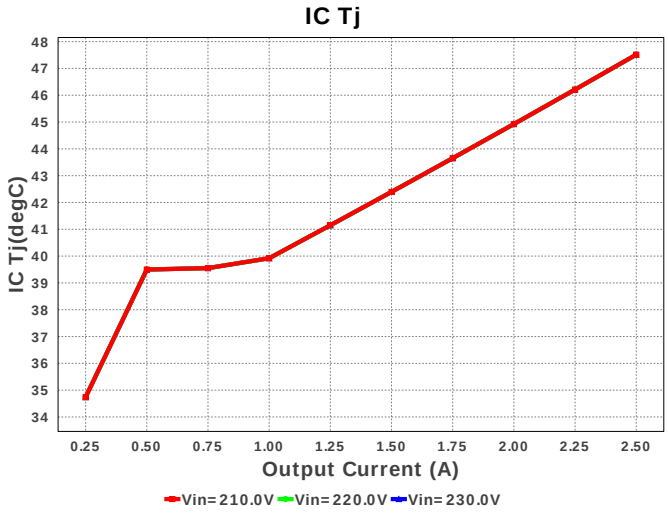
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

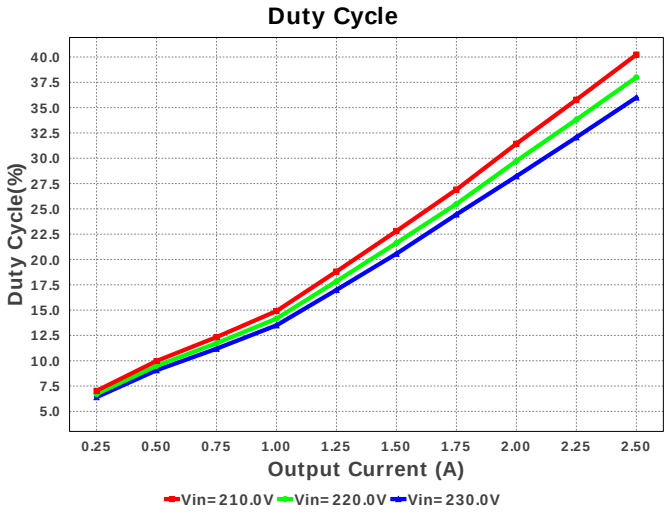
Electrical BOM

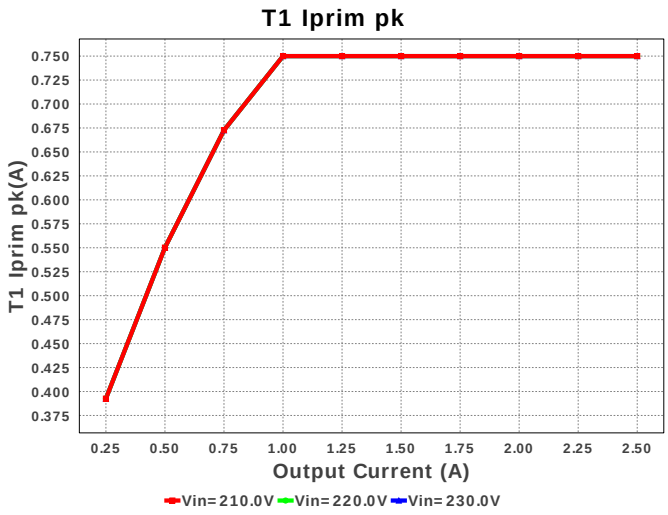
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Cdd	MuRata	GRM21BR71H105KA12L Series= X7R	Cap= 1.0 uF ESR= 4.402 mOhm VDC= 50.0 V IRMS= 1.677 A	1	$0.05	 0805 7 mm^2
2.	Cin	TDK	B32924D3475K Series= B32924	Cap= 4.7 uF ESR= 15.0 mOhm VDC= 630.0 V IRMS= 457.0 mA	2	$1.24	 B32924_31mm 770 mm^2

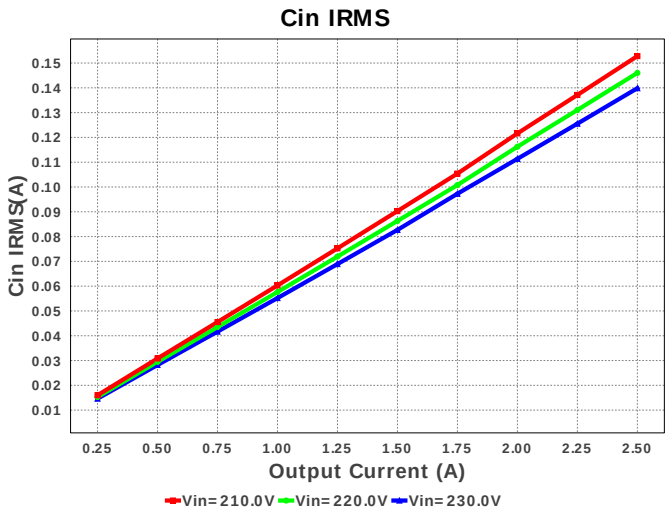
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
3.	Cin2	TDK	B32924D3475K Series= B32924	Cap= 4.7 uF ESR= 15.0 mOhm VDC= 630.0 V IRMS= 457.0 mA	2	$1.24	 B32924_31mm 770 mm^2
4.	Cout	Panasonic	35SEPF120M Series= ?	Cap= 120.0 uF ESR= 18.0 mOhm VDC= 35.0 V IRMS= 4.4 A	5	$0.69	SEPF_F13 0 mm^2
5.	Csnub	TDK	C3216CH2J331J Series= CH	Cap= 330.0 pF ESR= 80.663 mOhm VDC= 630.0 V IRMS= 0.0 A	1	$0.03	 1206 11 mm^2
6.	D1	Diodes Inc.	PDS760-13	VF@Io= 560.0 mV VRRM= 60.0 V	1	$0.60	 PowerDI5 50 mm^2
7.	Dac	Vishay-Semiconductor	DF10SA	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.24	 DF-S 99 mm^2
8.	Dsnub	Bourns	CD214C-F3600	VF@Io= 1.12 V VRRM= 600.0 V	1	$0.18	 SMC 83 mm^2
9.	Dvdd	Fairchild Semiconductor	1N4007	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.03	 DO-41 43 mm^2
10.	L1	Bourns	SDR0805-471KL	L= 470.0 µH DCR= 1.96 Ohm	1	$0.22	 SDR0805 96 mm^2
11.	M1	STMicroelectronics	STF10N80K5	VdsMax= 800.0 V IdsMax= 9.0 Amps	1	$2.52	 TO-220FP 79 mm^2
12.	R1	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
13.	Rbld	Vishay-Dale	CRCW04021K00FKED Series= CRCW..e3	Res= 1000.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
14.	Rcs	Vishay-Dale	CRCW08051R00FKEA Series= CRCW..e3	Res= 1.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm^2
15.	Rdd	Yageo America	RC0603FR-0722RL Series= ?	Res= 22.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm^2
16.	Rfbb	Vishay-Dale	CRCW040230K9FKED Series= CRCW..e3	Res= 30.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
17.	Rfbt	Yageo America	RC0603FR-07300KL Series= ?	Res= 300.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm^2

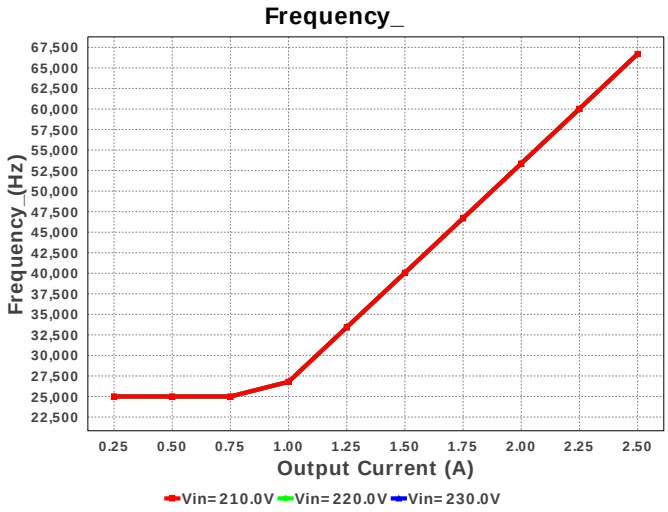
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
18.	Rl	Vishay-Dale	CRCW12062R00FKEA Series= CRCW..e3	Res= 2.0 Ohm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
19.	Rlc	Vishay-Dale	CRCW04021K82FKED Series= CRCW..e3	Res= 1.82 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
20.	Rsnub	CUSTOM	CUSTOM Series= ?	Res= 1.07486 MOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
21.	Rsnub2	Vishay-Dale	CRCW040251R1FKED Series= CRCW..e3	Res= 51.1 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
22.	Rst1	Vishay-Dale	CRCW08054M32FKEA Series= CRCW..e3	Res= 4.32 MOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
23.	Rst2	Vishay-Dale	CRCW08054M32FKEA Series= CRCW..e3	Res= 4.32 MOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
24.	Rst3	Vishay-Dale	CRCW08054M32FKEA Series= CRCW..e3	Res= 4.32 MOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
25.	T1	CUSTOM	CUSTOM	Lp= 2.083 mH Rp= 1.494 Ohm Leakage_L= 6.25 µH Ns1toNp= 0.068 Rs1= 34.122 mOhms Ns2toNp= 0.237 Rs2= 1.837 Ohms	1	NA	CUSTOM 0 mm^2
26.	U1	Texas Instruments	UCC28704DBVR-1	Switcher	1	$0.30	SOT-23-6 15 mm^2

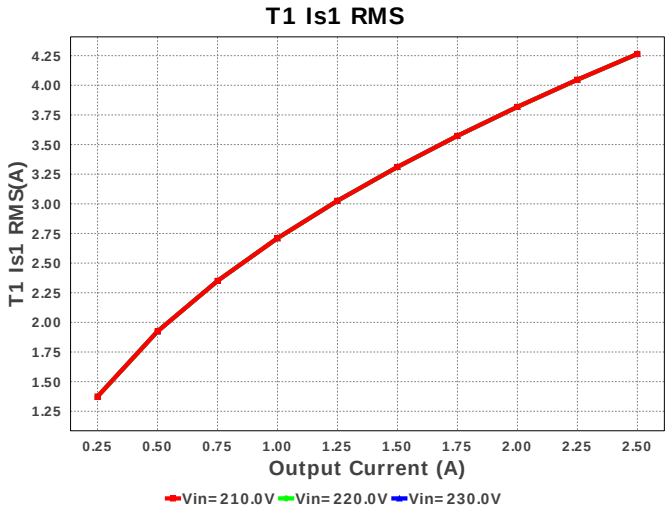


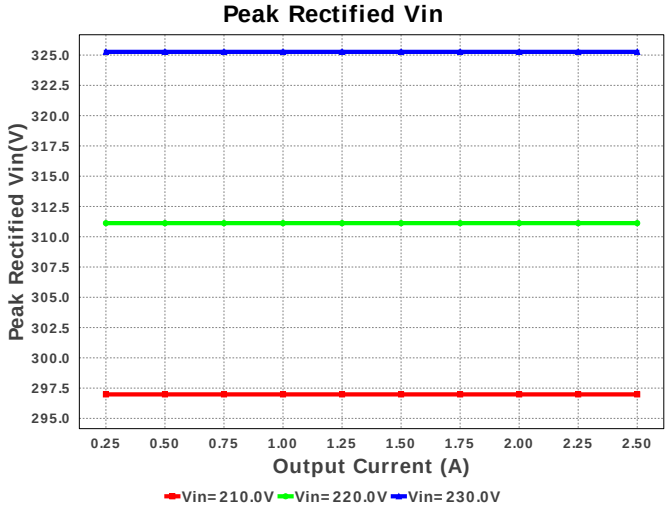


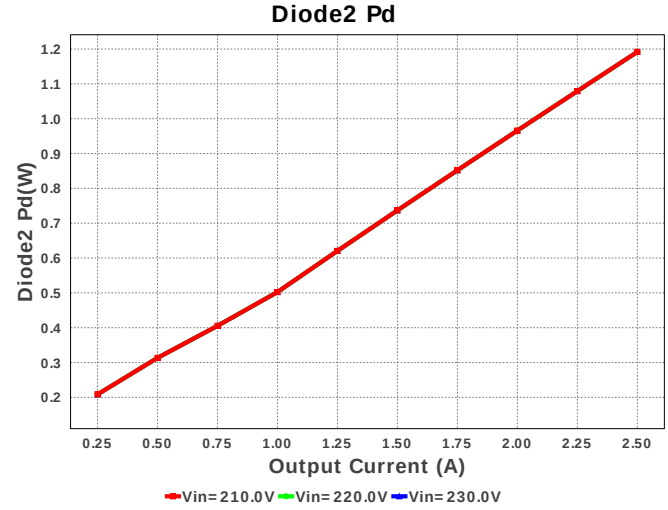


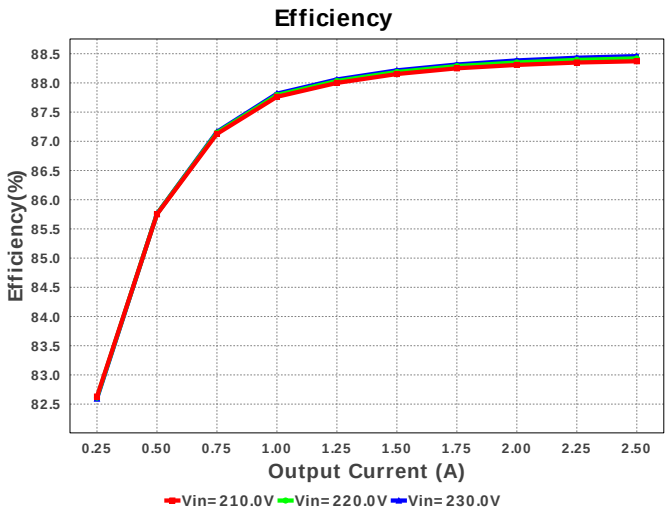


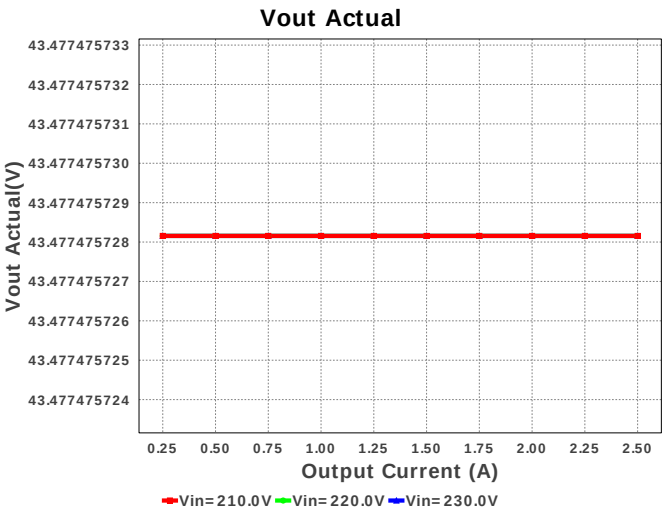


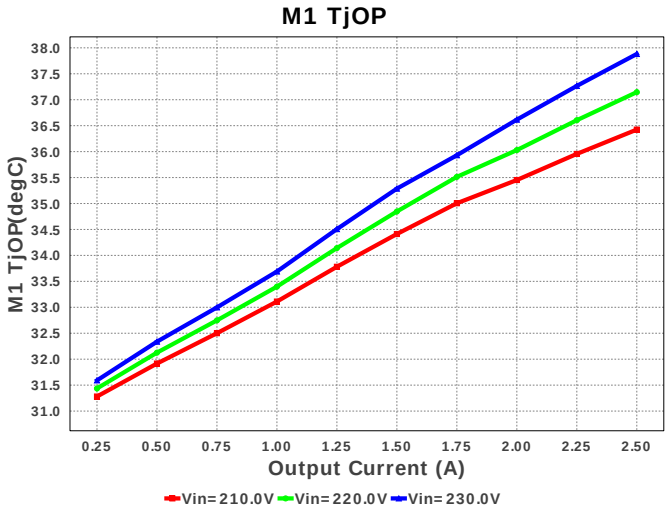


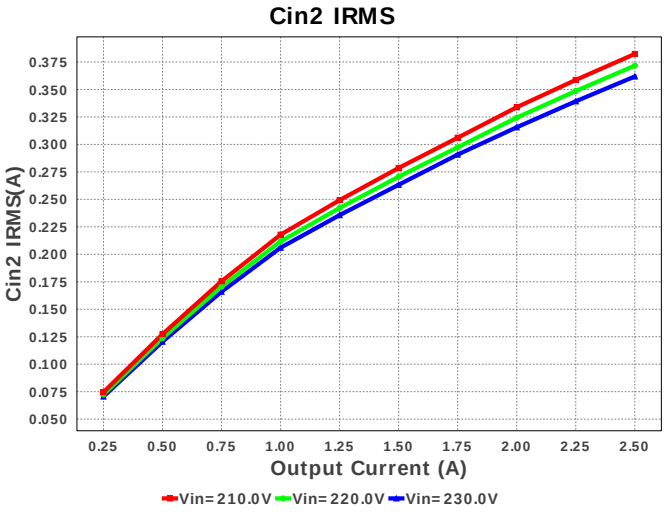


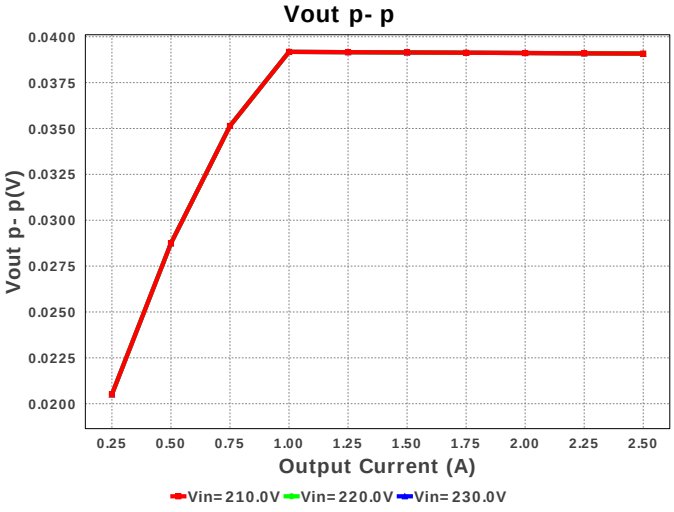


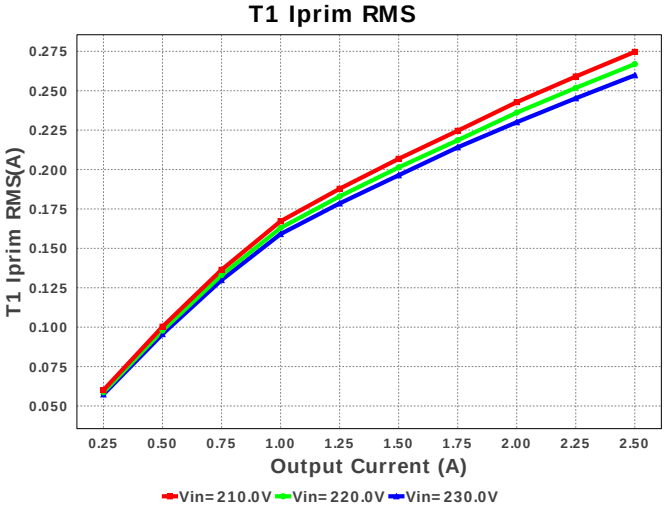


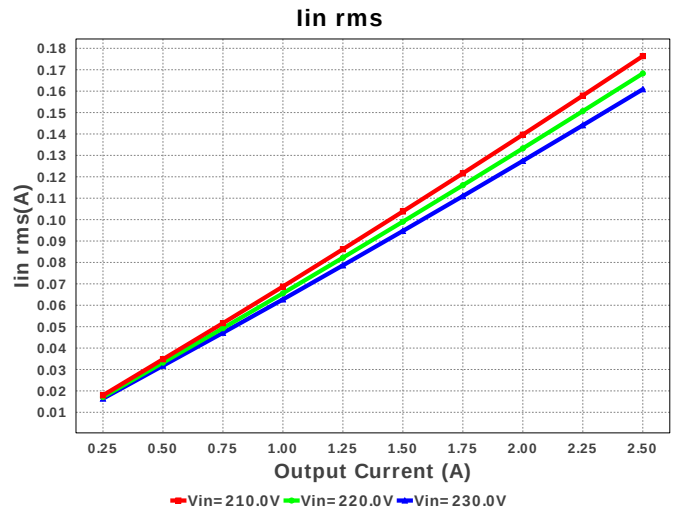


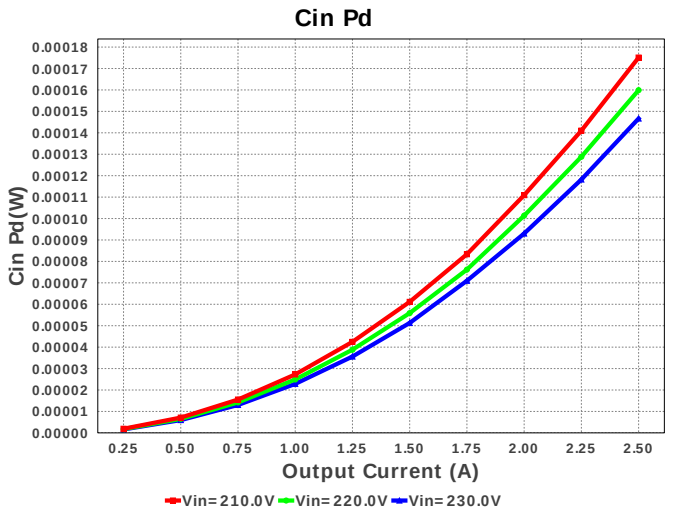


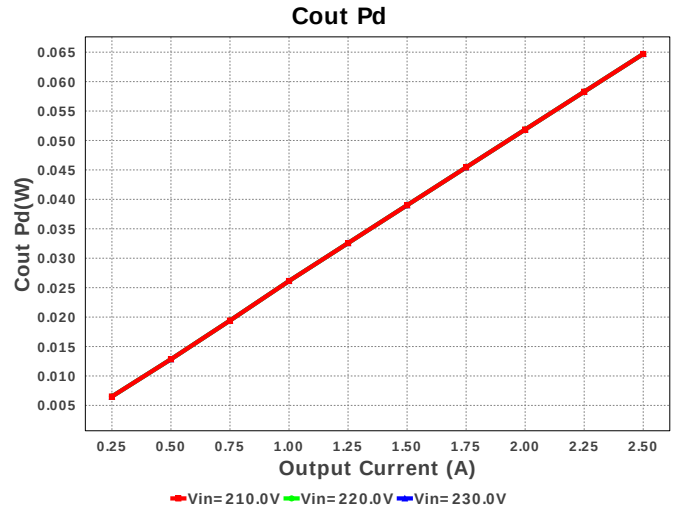


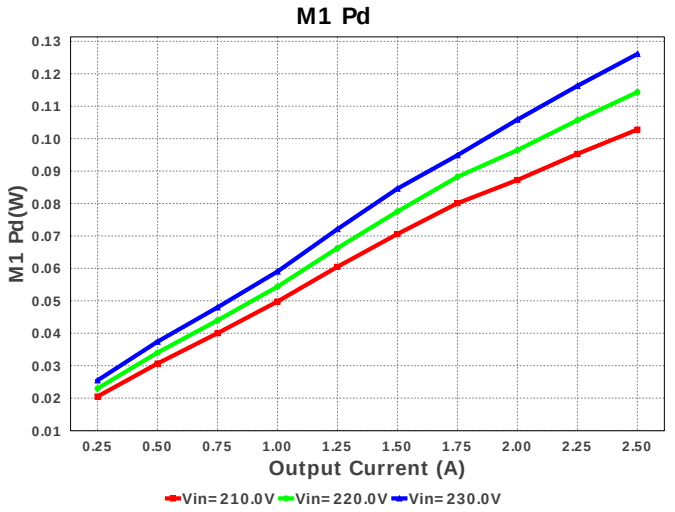


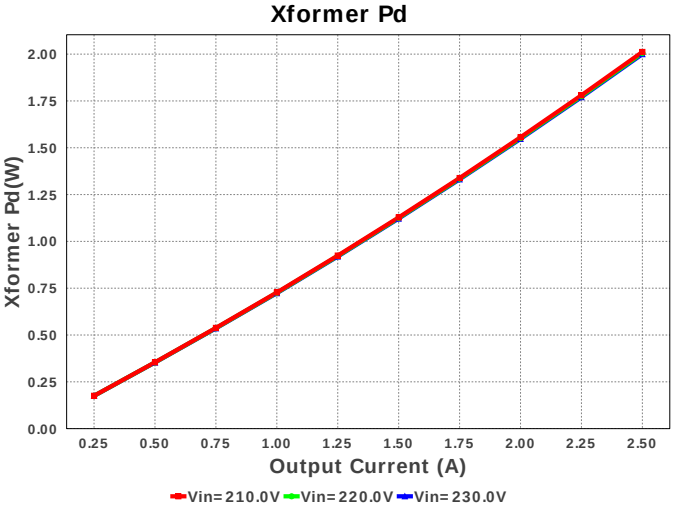


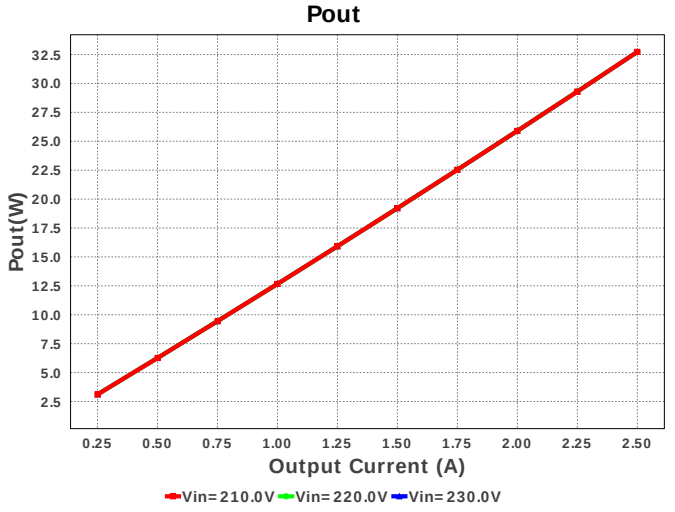


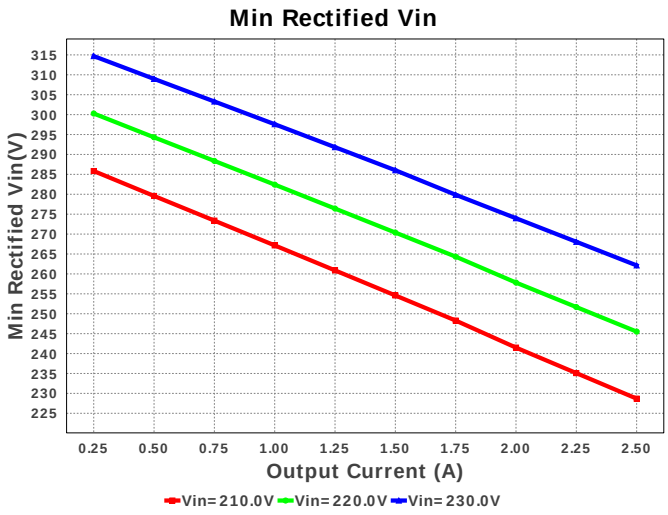


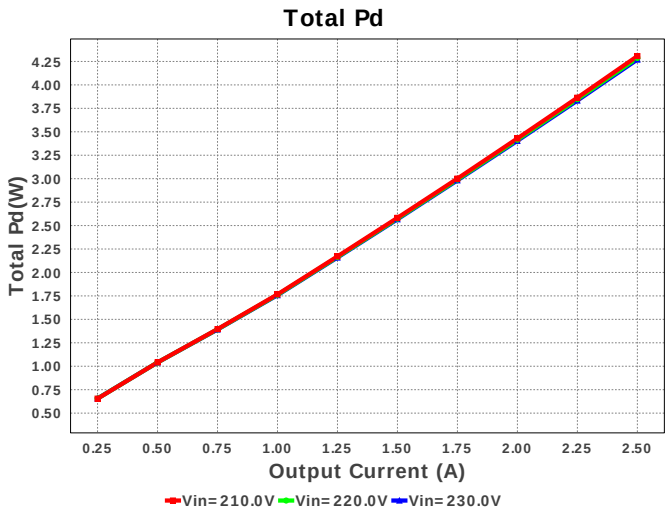


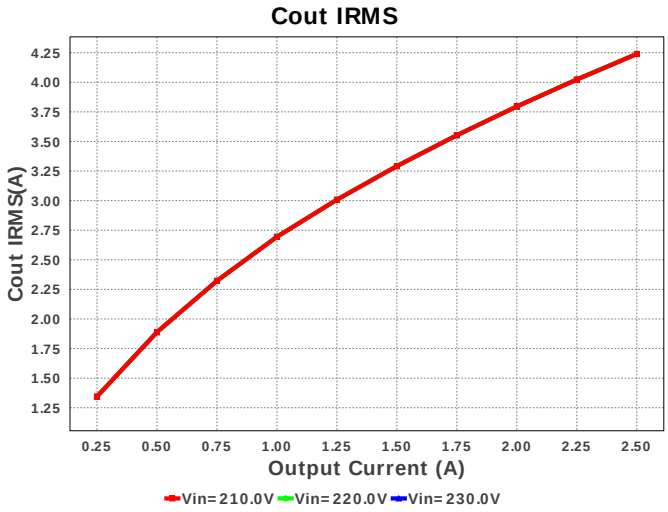


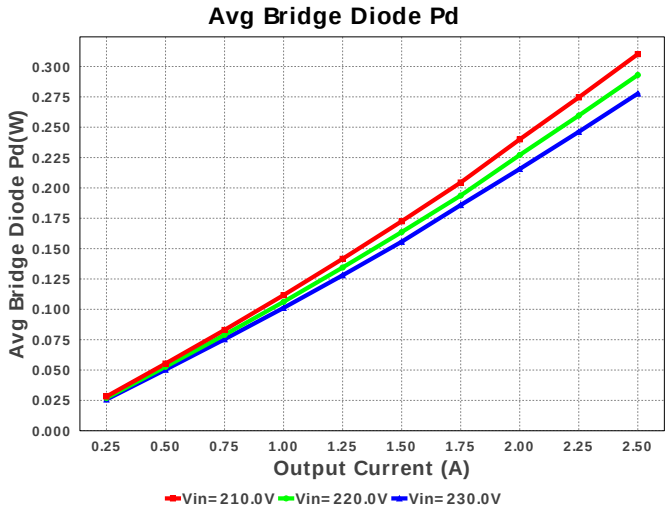


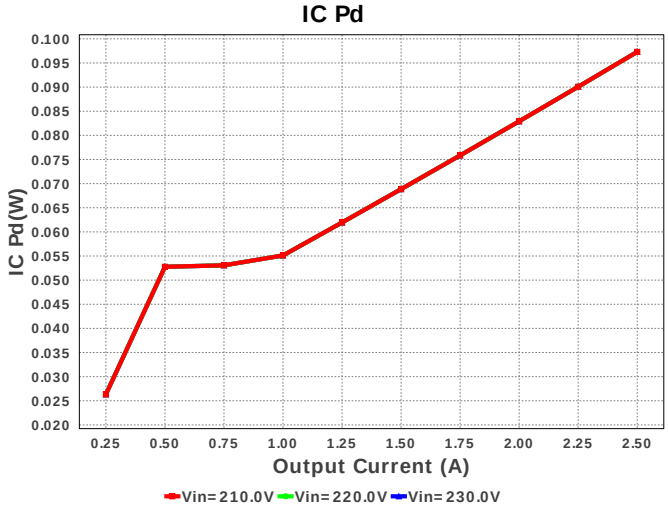


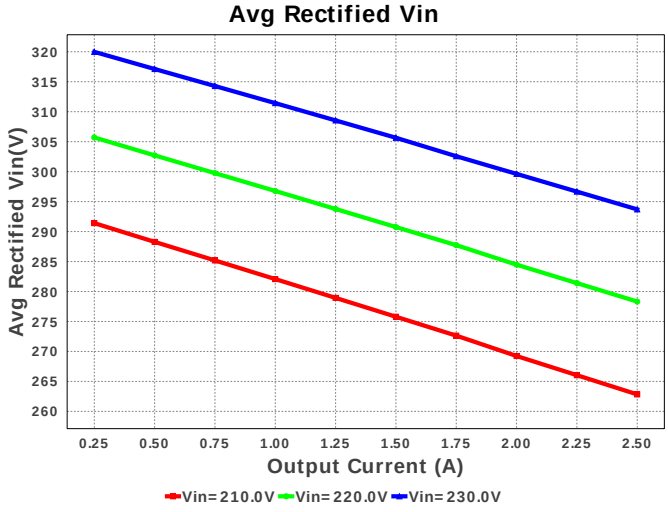


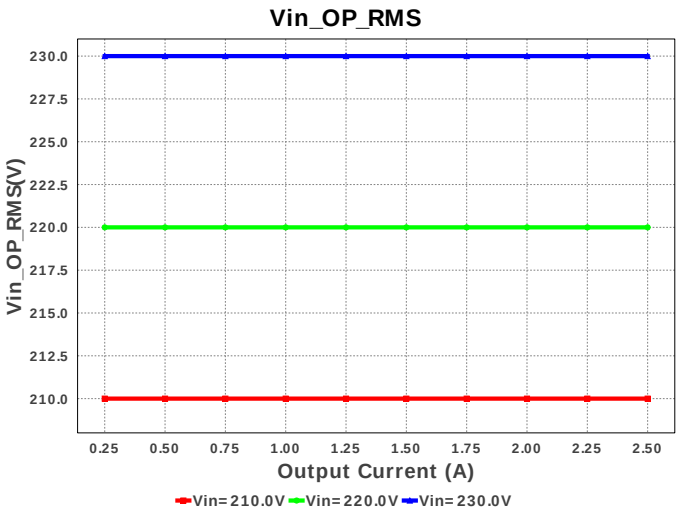


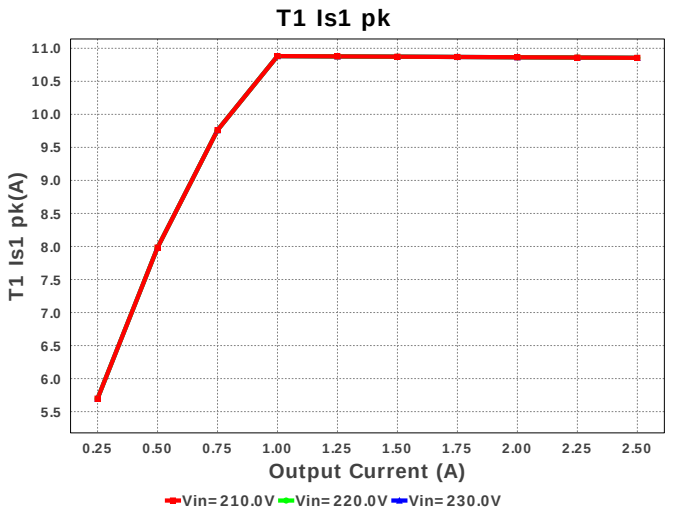


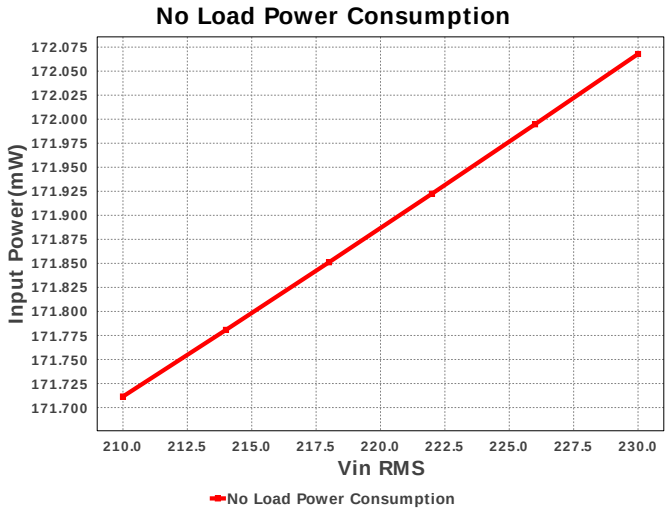


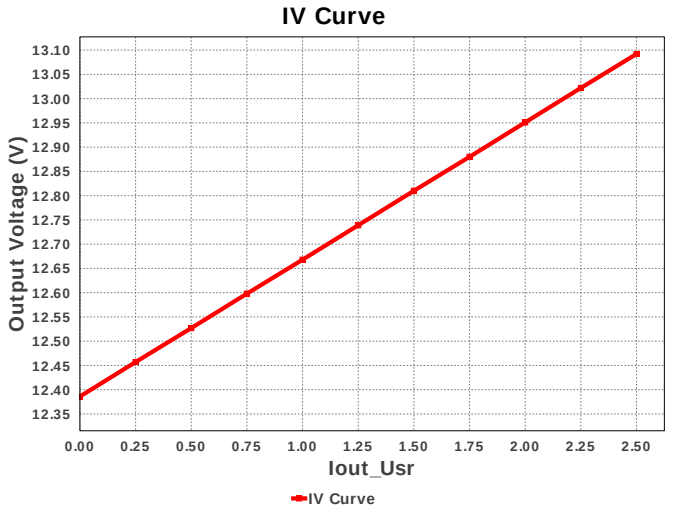












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	140.486 mA	Current	Input capacitor RMS ripple current
2.	Cin2 IRMS	361.0 mA	Current	Input Capacitor Cin2 RMS Ripple Current
3.	Cout IRMS	4.239 A	Current	Output capacitor RMS ripple current
4.	Iin rms	160.58 mA	Current	RMS Input Current
5.	T1 Iprim RMS	257.112 mA	Current	Transformer Primary RMS Current
6.	T1 Iprim pk	750.0 mA	Current	Transformer Primary Peak Current
7.	T1 Is1 RMS	4.264 A	Current	Transformer Secondary1 RMS Current
8.	T1 Is1 pk	10.856 A	Current	Transformer Secondary1 Peak Current
9.	Avg Rectified Vin	299.789 V	General	Average Rectified Voltage for the AC Line Period
10.	BOM Count	32	General	Total Design BOM count
11.	FootPrint	3.677 k mm^2	General	Total Foot Print Area of BOM components
12.	Mode	DCM	General	Conduction Mode
13.	Pout	32.73 W	General	Total output power
14.	Total BOM	$0.0	General	Total BOM Cost
15.	Vout Actual	43.477 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
16.	Duty Cycle	35.257 %	Op_point	Duty cycle
17.	Efficiency	88.617 %	Op_point	Steady state efficiency
18.	Frequency	66.695 kHz	Op_point	Switching frequency
19.	IC Tj	36.811 degC	Op_point	IC junction temperature
20.	ICThetaJA	70.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
21.	IOUT_OP	2.5 A	Op_point	Iout operating point
22.	M1 TjOP	38.18 degC	Op_point	M1 MOSFET junction temperature
23.	Min Rectified Vin	274.313 V	Op_point	Minimum voltage seen at rectified input
24.	Peak Rectified Vin	325.266 V	Op_point	Peak voltage seen at rectified input
25.	Vin_OP_RMS	230.0 V	Op_point	AC Input RMS Voltage
26.	Vout p-p	39.081 mV	Op_point	Peak-to-peak output ripple voltage
27.	Avg Bridge Diode Pd	181.324 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
28.	Cin Pd	148.022 µW	Power	Input capacitor power dissipation
29.	Cout Pd	64.692 mW	Power	Output capacitor power dissipation
30.	Diode1 Pd	1.192 W	Power	Diode2 power dissipation
31.	IC Pd	97.301 mW	Power	IC power dissipation

#	Name	Value	Category	Description
32.	M1 Pd	130.877 mW	Power	M1 MOSFET total power dissipation
33.	Total Pd	4.204 W	Power	Total Power Dissipation
34.	Xformer Pd	1.998 W	Power	Transformer power dissipation
35.	Vout Tolerance	2.032 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	2.5	Maximum Output Current
2.	VinMax	230.0	Maximum input voltage
3.	VinMin	210.0	Minimum input voltage
4.	Vout	12.0	Output Voltage
5.	line_fsw	60.0	Light Output in Lumen
6.	base_pn	UCC28704	Base Product Number
7.	source	AC	Input Source Type
8.	Ta	30.0	Ambient temperature

Design Assistance

1. Application Hints: T1: The transformer parameters assume that an RM6 core is used, and the DCR values are assumed values used only for efficiency estimates. Rbld: Rbld is used to to set a minimum load for the circuit, so that in standby the output voltage does not float up. The value chosen by WEBENCH should be a good starting point but may need to be adjusted to achieve minimum power dissipation at standby as well. 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. 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. Cdd: Cdd supplies the device operating current until the output of the converter reaches the target minimum operating voltage. The value calculated by WEBENCH for Cdd is a good starting point since it assumes that the output current of the Flyback is available to charge the output capacitance until the minimum output voltage is acheived, but may need to be adjusted. Part Description: The UCC28704 Flyback power supply controller provides Constant-Voltage (CV) and Constant-Current (CC) output regulation. Primary-Side Regulation (PSR) eliminates the use of an Opto-Coupler. Please see the datasheet for further design guidance. http://www.ti.com/lit/ds/symlink/ucc28704.pdf

2. **UCC28704** Product Folder : http://www.ti.com/product/UCC28704 : contains the data sheet and other resources.