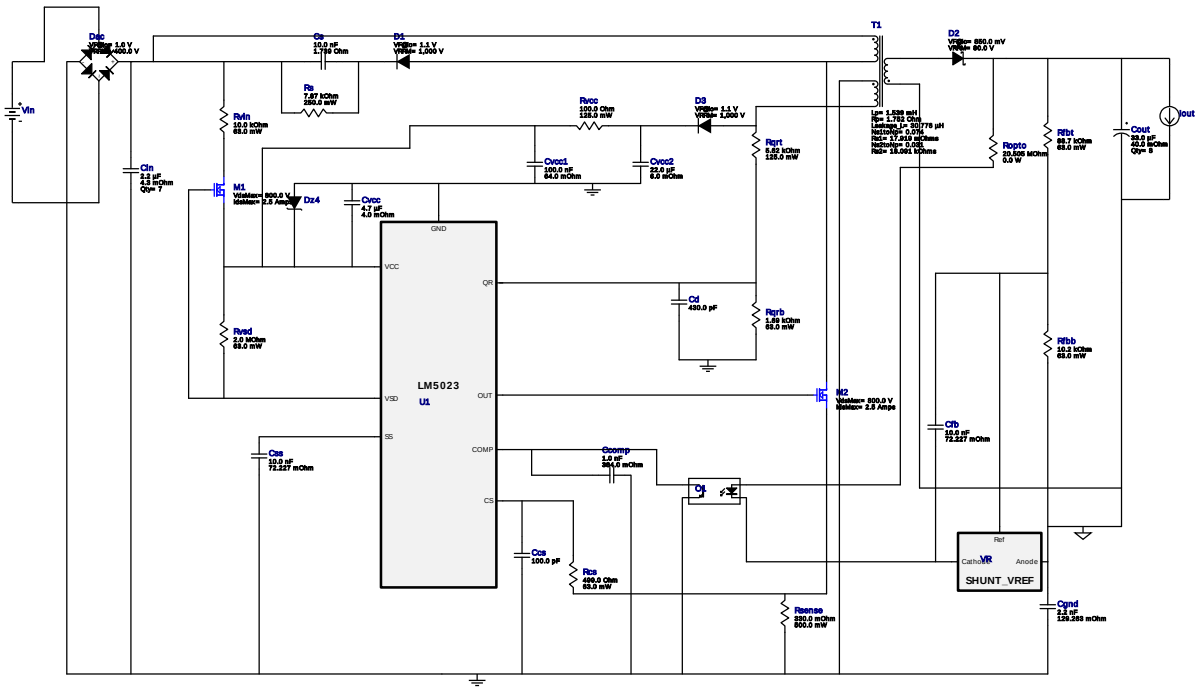
WEBENCH® Design Report

VinMin = 110.0V
VinMax = 130.0V
Vout = 24.0V
Iout = 2.0A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 7/13/15 3:27:23 AM
BOM Cost = $0.00
Footprint = 1,760.0 mm^2
BOM Count = 47
Total Pd = 7.34W

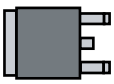
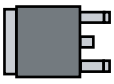
Design : 3778301/10 LM5023MM-2/NOPB
LM5023MM-2/NOPB 110.0V-130.0V to 24.19V @ 2.0A



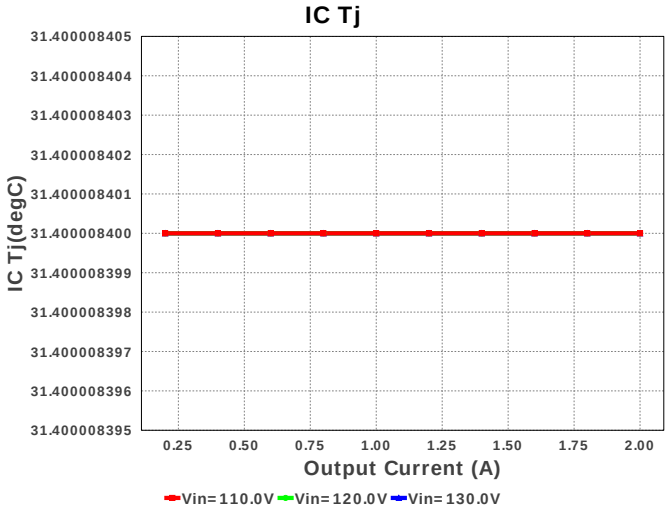
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

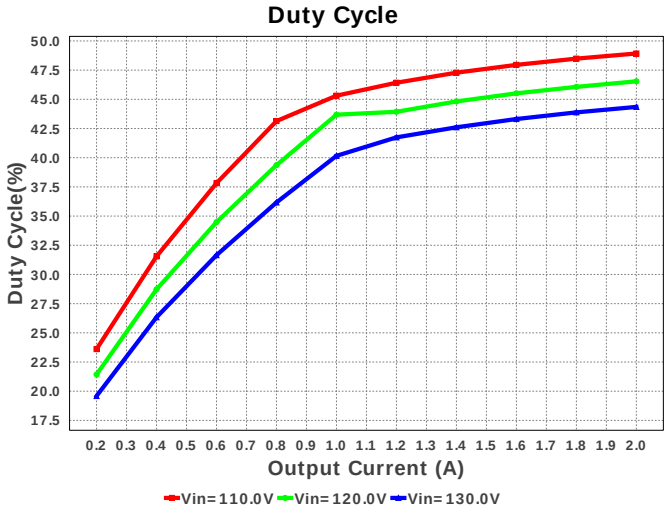
Electrical BOM

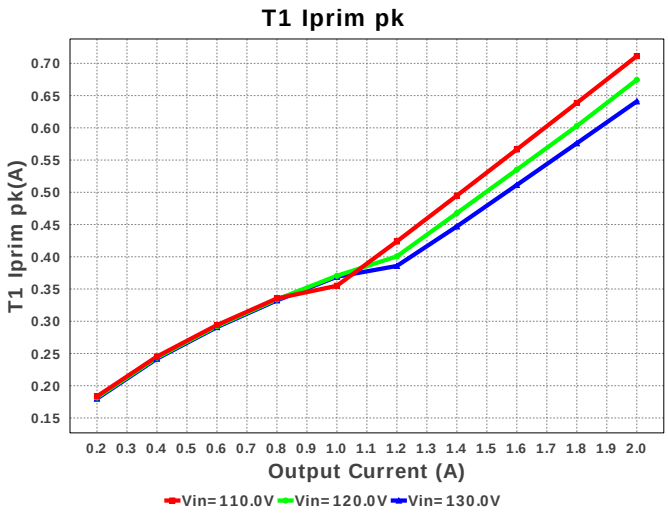
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	$0.01	0805 7 mm^2
2.	Ccs	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
3.	Cd	Samsung Electro-Mechanics	CL21C431JBANNNC Series= C0G/NP0	Cap= 430.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
4.	Cfb	TDK	C1005X7R1E103K Series= X7R	Cap= 10.0 nF ESR= 72.227 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
5.	Cgnd	TDK	C4532JB3D222K Series= JB	Cap= 2.2 nF ESR= 129.263 mOhm VDC= 2.0 kV IRMS= 0.0 A	1	$0.21	1812 23 mm^2
6.	Cin	TDK	C5750X6S2W225K Series= X6S	Cap= 2.2 uF ESR= 4.3 mOhm VDC= 400.0 V IRMS= 0.0 A	7	$1.26	2220 54 mm^2

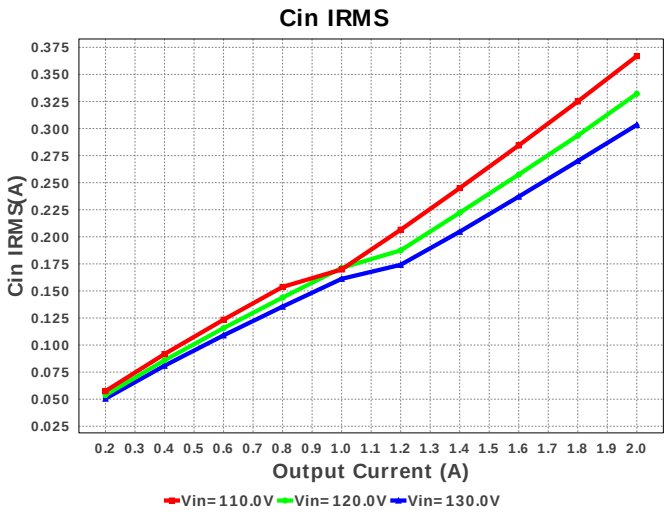
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
7.	Cout	Panasonic	EEHZA1H330XP Series= ZA	Cap= 33.0 uF ESR= 40.0 mOhm VDC= 50.0 V IRMS= 1.6 A	8	$0.70	 SM_RADIAL_6.3BMM 80 mm^2
8.	Cs	Kemet	C0805C103K1RACTU Series= X7R	Cap= 10.0 nF ESR= 1.739 Ohm VDC= 100.0 V IRMS= 411.0 mA	1	$0.01	 0805 7 mm^2
9.	Css	TDK	C1005X7R1E103K Series= X7R	Cap= 10.0 nF ESR= 72.227 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm^2
10.	Cvcc	MuRata	GRM21BR61E475KA12L Series= X5R	Cap= 4.7 uF ESR= 4.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.03	 0805 7 mm^2
11.	Cvcc1	Kemet	C0805C104K5RACTU Series= X7R	Cap= 100.0 nF ESR= 64.0 mOhm VDC= 50.0 V IRMS= 1.64 A	1	$0.01	 0805 7 mm^2
12.	Cvcc2	MuRata	GRM31CR61C226ME15L Series= X5R	Cap= 22.0 uF ESR= 6.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.13	 1206 11 mm^2
13.	D1	Fairchild Semiconductor	1N4007	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.02	 DO-41 43 mm^2
14.	D2	Comchip Technology	CDBC580-G	VF@Io= 850.0 mV VRRM= 80.0 V	1	$0.26	 SMC 83 mm^2
15.	D3	Fairchild Semiconductor	1N4007	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.02	 DO-41 43 mm^2
16.	Dac	Diodes Inc.	HD04-T	VF@Io= 1.0 V VRRM= 400.0 V	1	$0.12	 MiniDIP 62 mm^2
17.	Dz4	Diodes Inc.	MMSZ5246B-7-F	Zener	1	$0.03	 SOD-123 13 mm^2
18.	M1	STMicroelectronics	STD3NK80ZT4	VdsMax= 800.0 V IdsMax= 2.5 Amps	1	$0.46	 DPAK 102 mm^2
19.	M2	STMicroelectronics	STD3NK80ZT4	VdsMax= 800.0 V IdsMax= 2.5 Amps	1	$0.46	 DPAK 102 mm^2
20.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$0.35	 SSOP-4 111 mm^2
21.	Rcs	Vishay-Dale	CRCW0402499RFKED Series= CRCW..e3	Res= 499.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
22.	Rfbb	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
23.	Rfbt	Vishay-Dale	CRCW040288K7FKED Series= CRCW..e3	Res= 88.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
24.	Ropto	CUSTOM	CUSTOM Series= ?	Res= 20.505 MOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2

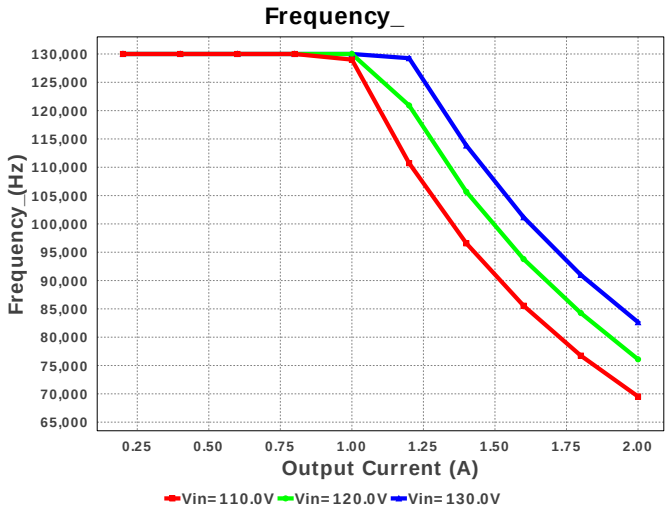
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
25.	Rqrb	Vishay-Dale	CRCW04021K69FKED Series= CRCW..e3	Res= 1.69 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
26.	Rqrt	Panasonic	ERJ-6ENF5621V Series= ERJ-6E	Res= 5.62 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
27.	Rs	Panasonic	ERJ-8ENF7871V Series= ERJ-8E	Res= 7.87 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
28.	Rsense	Rohm	MCR25JZHFLR330 Series= MCR25	Res= 330.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.03	1210 15 mm^2
29.	Rvcc	Vishay-Dale	CRCW0805100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
30.	Rvin	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
31.	Rvsd	Vishay-Dale	CRCW04022M00FKED Series= CRCW..e3	Res= 2.0 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
32.	T1	CUSTOM	CUSTOM	Lp= 1.539 mH Rp= 1.752 Ohm Leakage_L= 30.776 µH Ns1toNp= 0.074 Rs1= 17.919 mOhms Ns2toNp= 0.031 Rs2= 18.091 kOhms	1	NA	CUSTOM 0 mm^2
33.	U1	Texas Instruments	LM5023MM-2/NOPB	Switcher	1	$0.38	MUA08A 24 mm^2
34.	VR	Texas Instruments	TL431AIDBVR	Voltage References	1	$0.09	R-PDSO-G3 16 mm^2

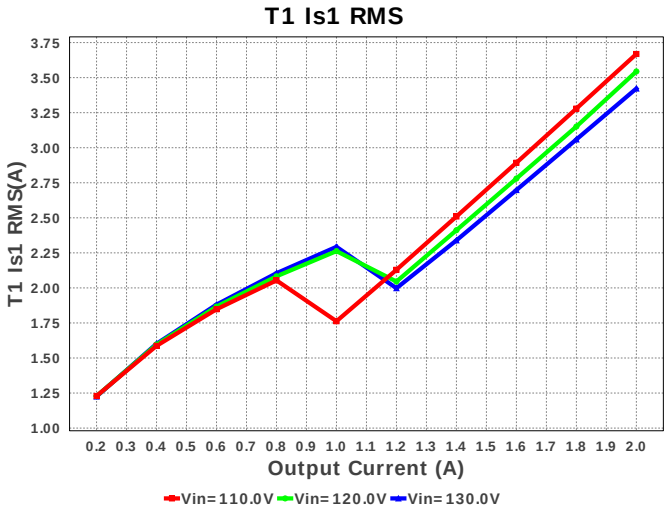


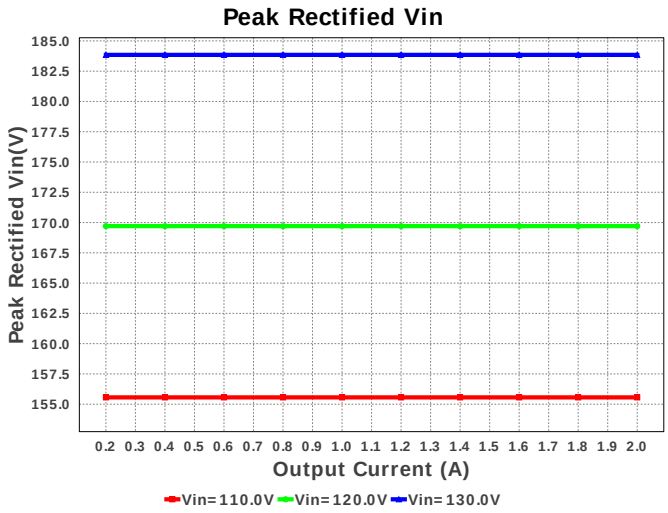


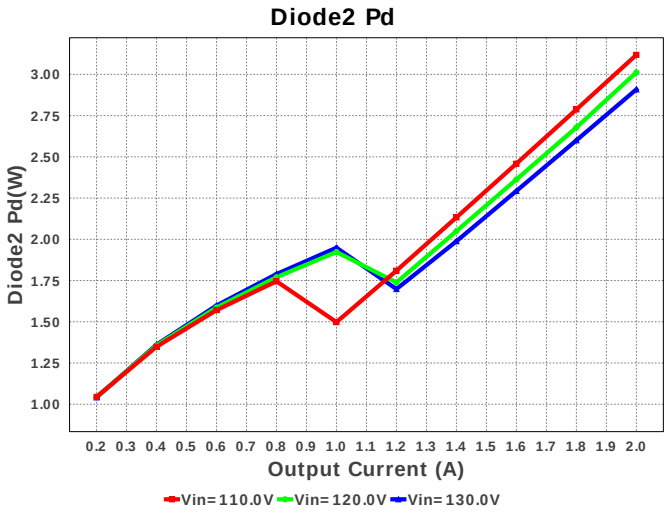


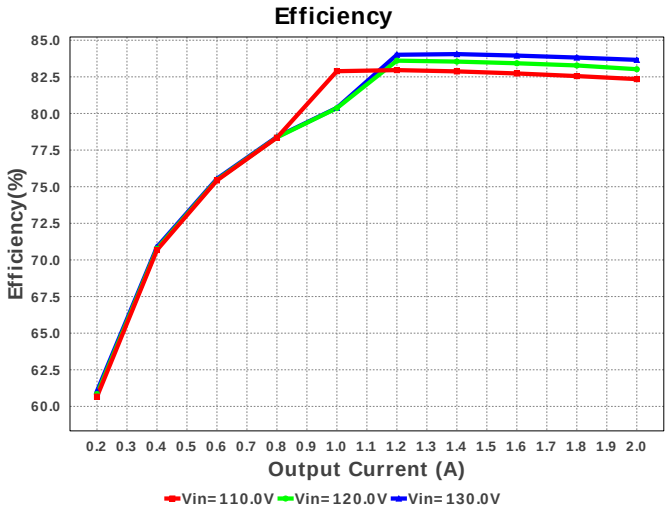


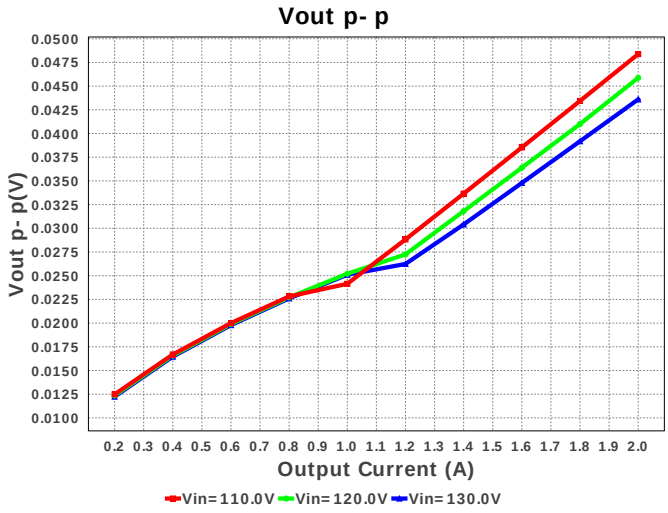


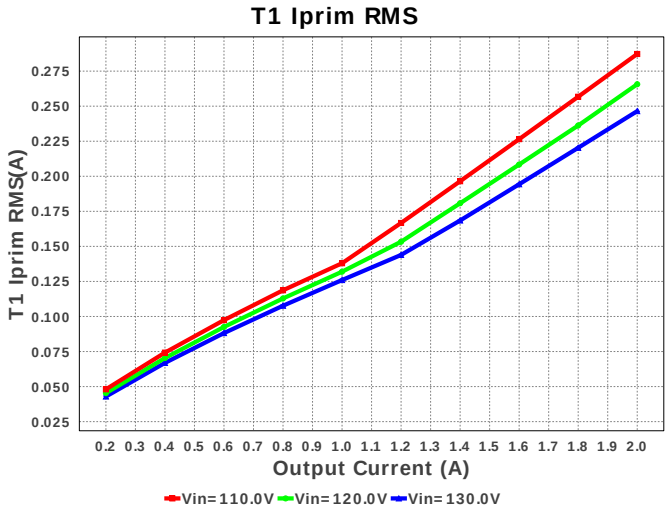


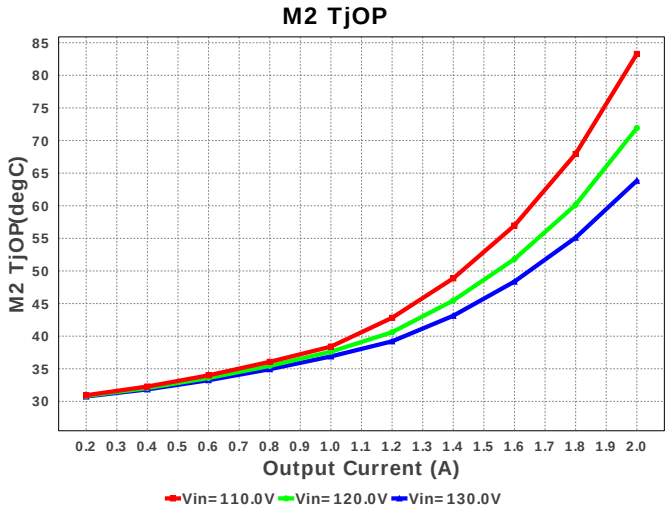


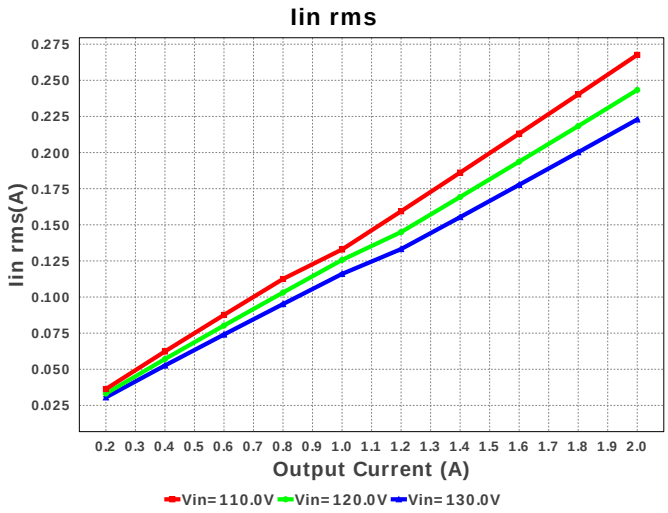


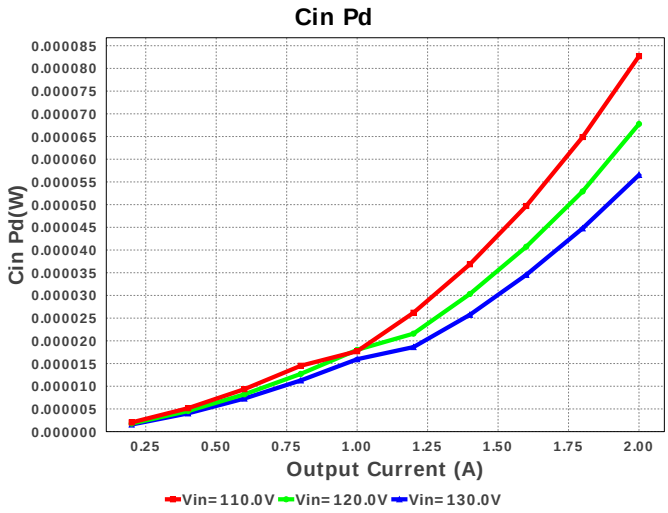


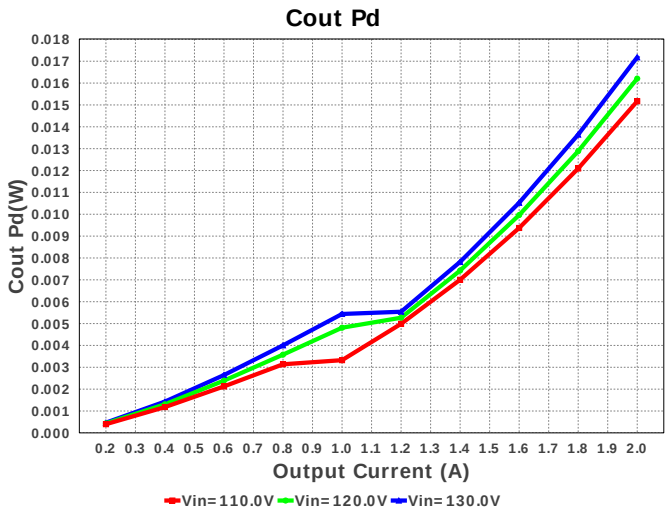


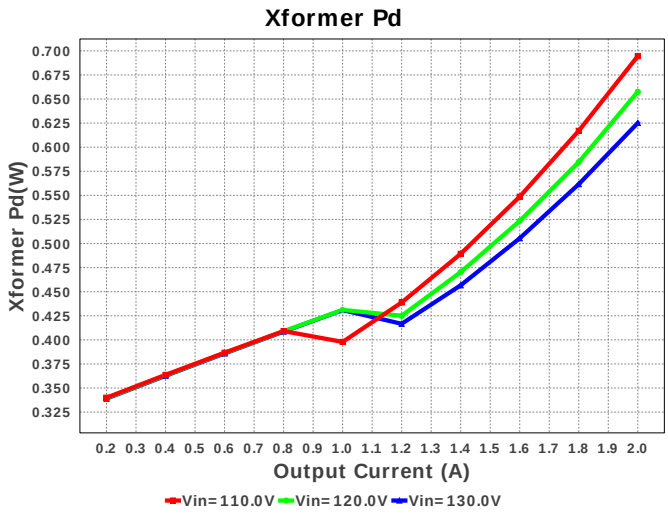


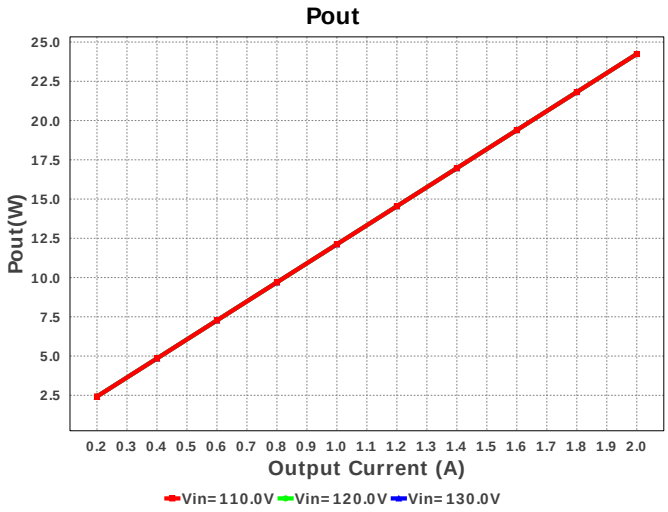


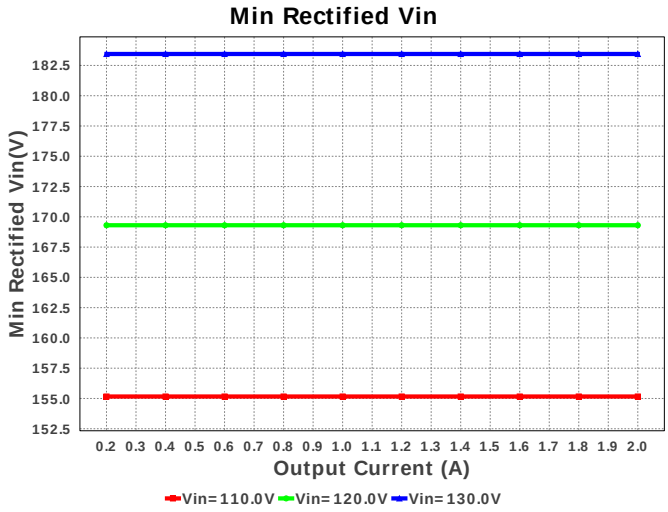


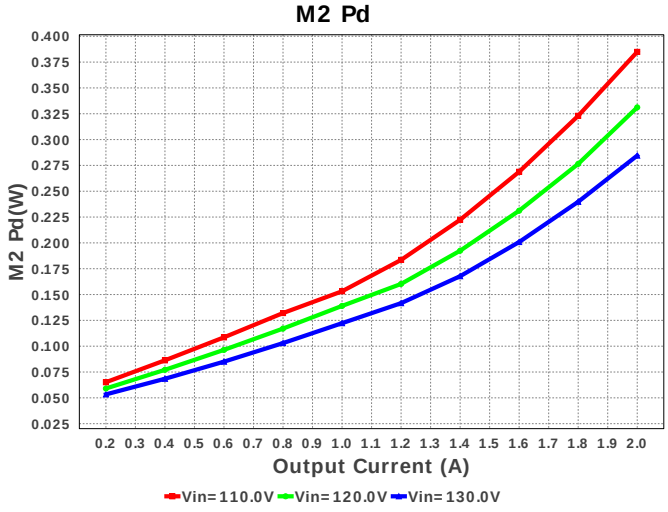


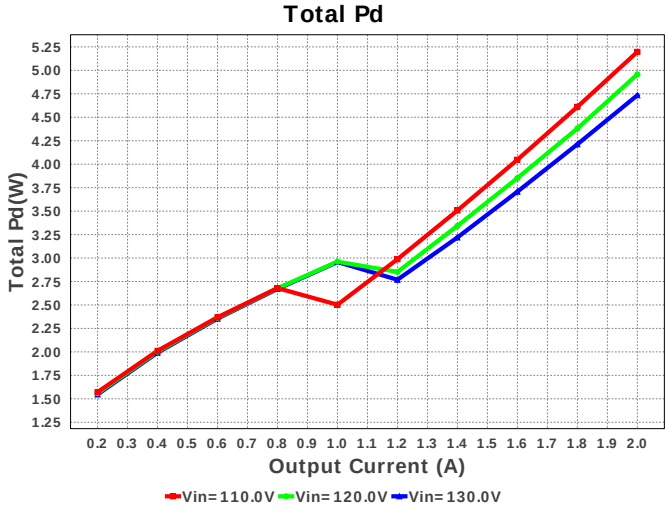


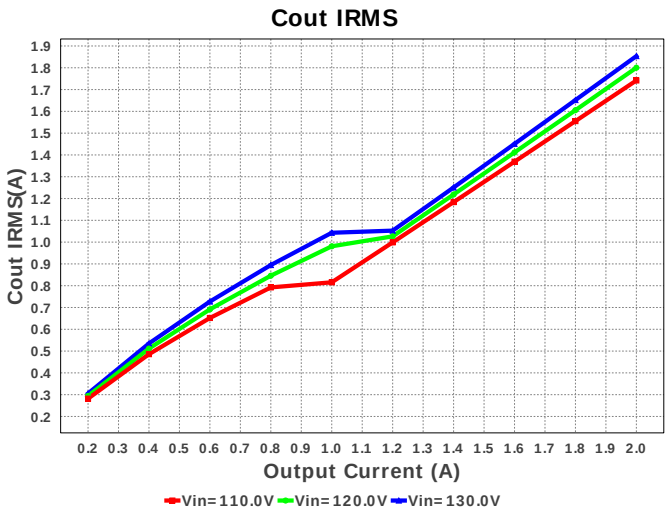


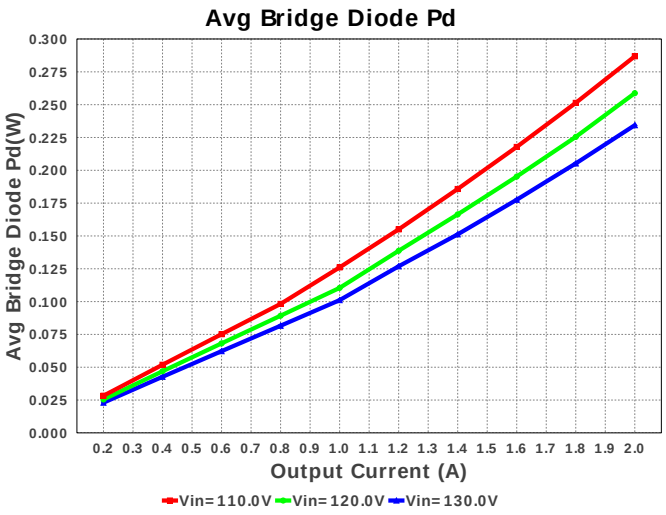


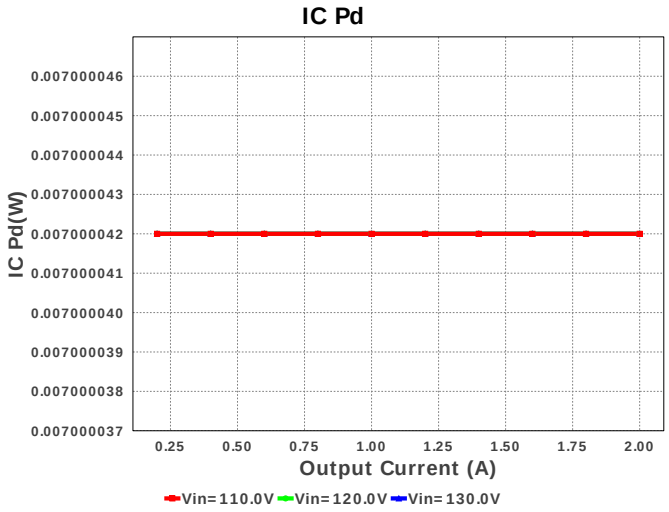


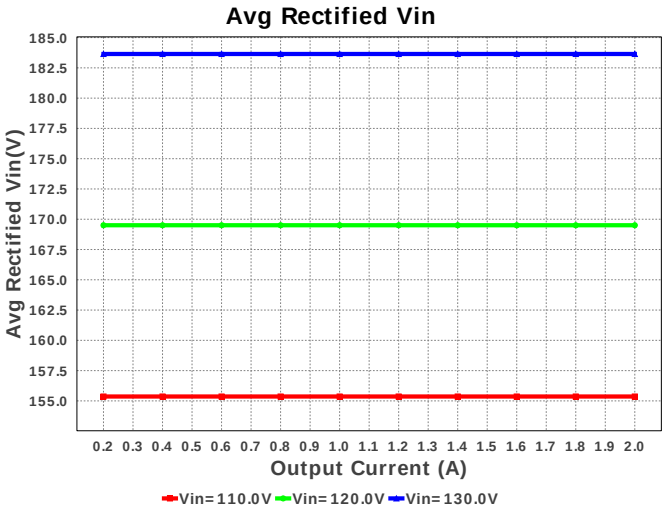


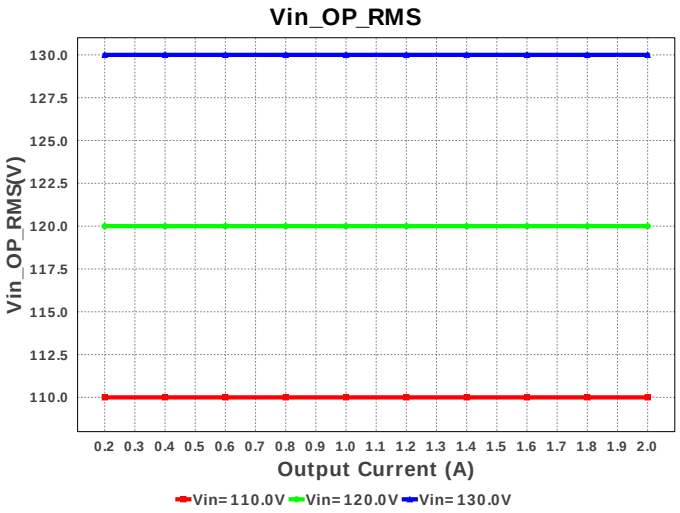


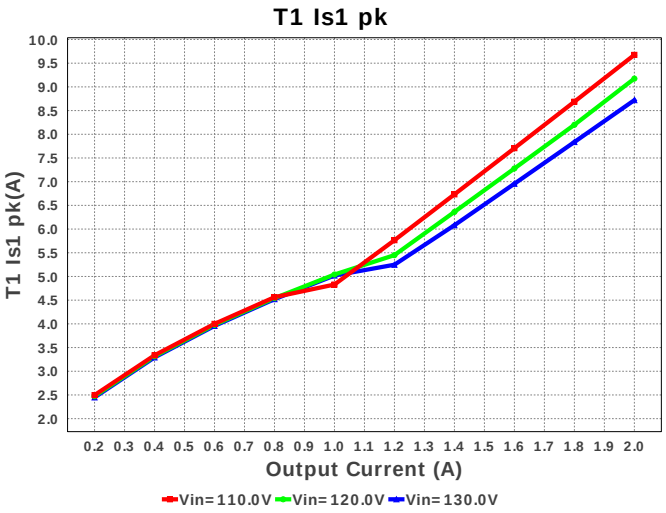












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	634.556 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	1.275 A	Current	Output capacitor RMS ripple current
3.	Iin rms	428.65 mA	Current	RMS Input Current
4.	T1 Iprim RMS	429.268 mA	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	934.638 mA	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	4.153 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	12.714 A	Current	Transformer Secondary1 Peak Current
8.	Avg Rectified Vin	183.646 V	General	Average Rectified Voltage for the AC Line Period
9.	BOM Count	47	General	Total Design BOM count
10.	FootPrint	1.76 k mm^2	General	Total Foot Print Area of BOM components
11.	Pout	48.383 W	General	Total output power

#	Name	Value	Category	Description
12.	Total BOM	$0.0	General	Total BOM Cost
13.	Vout OP	24.192 V	Op_Point	Operational Output Voltage
14.	Duty Cycle	70.109 %	Op_point	Duty cycle
15.	Efficiency	86.826 %	Op_point	Steady state efficiency
16.	Frequency_	75.822 kHz	Op_point	Switching frequency
17.	IC Tj	32.31 degC	Op_point	IC junction temperature
18.	ICThetaJA	200.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
19.	IOUT_OP	2.0 A	Op_point	Iout operating point
20.	M2 TjOP	494.697 degC	Op_point	M2 MOSFET junction temperature
21.	Min Rectified Vin	183.446 V	Op_point	Minimum voltage seen at rectified input
22.	Peak Rectified Vin	183.846 V	Op_point	Peak voltage seen at rectified input
23.	Vin_OP_RMS	130.0 V	Op_point	AC Input RMS Voltage
24.	Vout p-p	63.571 mV	Op_point	Peak-to-peak output ripple voltage
25.	Avg Bridge Diode Pd	448.976 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
26.	Cin Pd	247.349 µW	Power	Input capacitor power dissipation
27.	Cout Pd	8.127 mW	Power	Output capacitor power dissipation
28.	Diode2 Pd	3.53 W	Power	Diode2 power dissipation
29.	IC Pd	11.549 mW	Power	IC power dissipation
30.	M2 Pd	1.031 W	Power	M2 MOSFET total power dissipation
31.	Total Pd	7.341 W	Power	Total Power Dissipation
32.	Xformer Pd	978.392 mW	Power	Transformer power dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	2.0	Maximum Output Current
2.	Iout1	2.0	Output Current #1
3.	VinMax	130.0	Maximum input voltage
4.	VinMin	110.0	Minimum input voltage
5.	Vout	24.0	Output Voltage
6.	Vout1	24.0	Output Voltage #1
7.	acFrequency	60.0	Light Output in Lumen
8.	base_pn	LM5023	Texas Instruments Base Part Number
9.	source	AC	Input Source Type
10.	ta	30.0	Ambient temperature

Design Assistance

1. 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. Please see the datasheet for further design guidance. http://www.ti.com/lit/ds/symlink/lm5023.pdf

2. LM5023 Product Folder : http://www.ti.com/product/LM5023 : contains the data sheet and other resources.