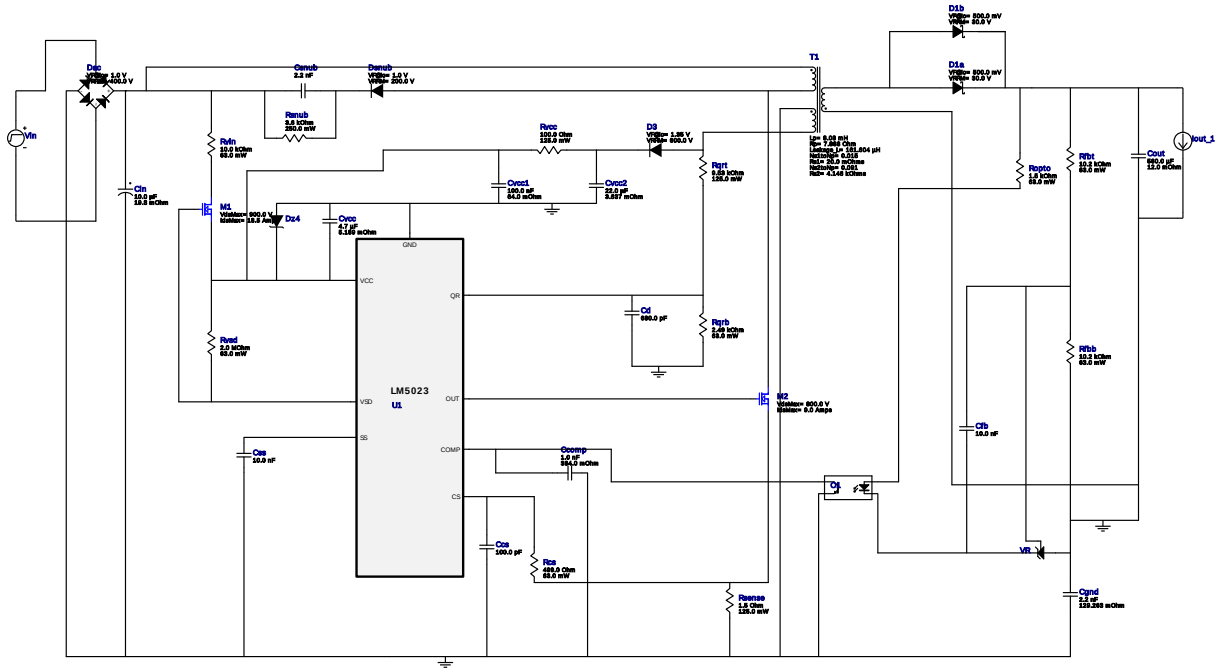
WEBENCH® Design Report

VinMin = 110.0V
VinMax = 130.0V
Vout = 5.0V
Iout = 2.2A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 9/27/16 6:48:05 AM
BOM Cost = $0.00
BOM Count = 35
Total Pd = 1.6W

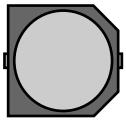
Design : 4652143/4 LM5023MM-2/NOPB
LM5023MM-2/NOPB 110.0V-130.0V to 4.99V @ 2.2A



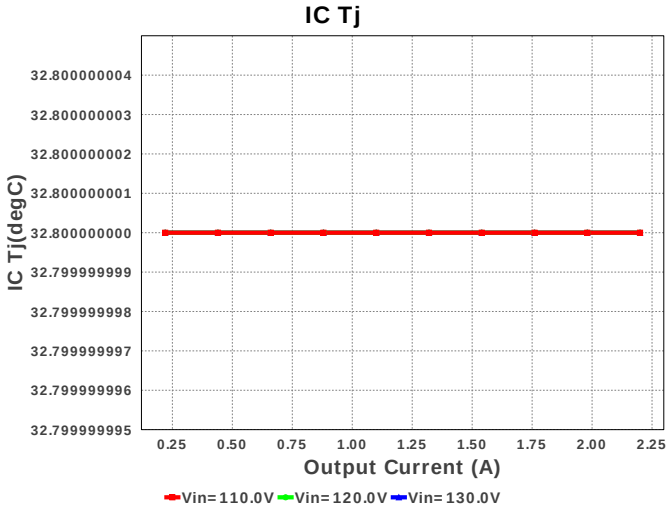
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

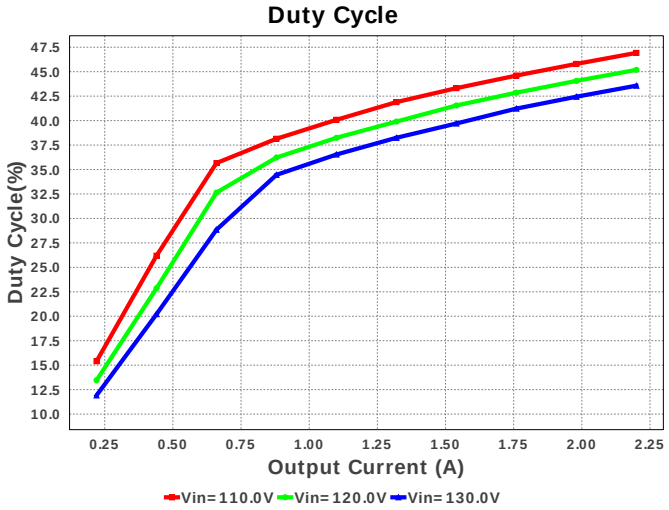
Electrical BOM

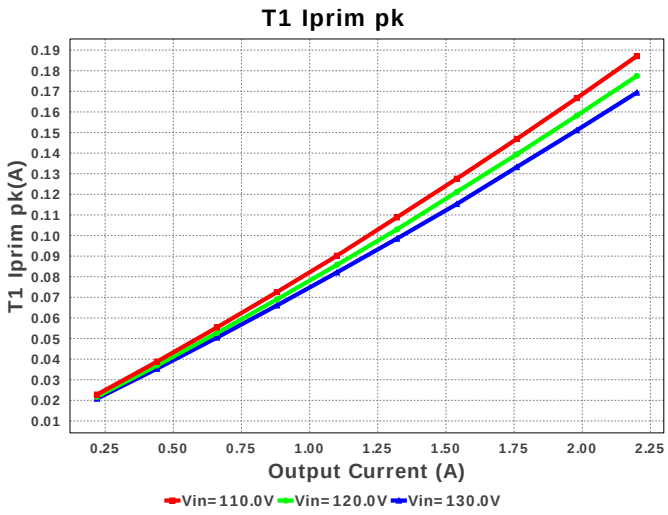
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	$0.01	0805 7 mm^2
2.	Ccs	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
3.	Cd	Yageo America	CC0805KRX7R9BB681 Series= X7R	Cap= 680.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
4.	Cfb	MuRata	GRM155R71E103KA01D Series= X7R	Cap= 10.0 nF 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	$0.16	1812 23 mm^2
6.	Cin	Rubycon	200RX3010M8X16 Series= ?	Cap= 10.0 uF ESR= 19.8 mOhm VDC= 200.0 V IRMS= 200.0 mA	1	$0.18	RX30_800x1600 100 mm^2

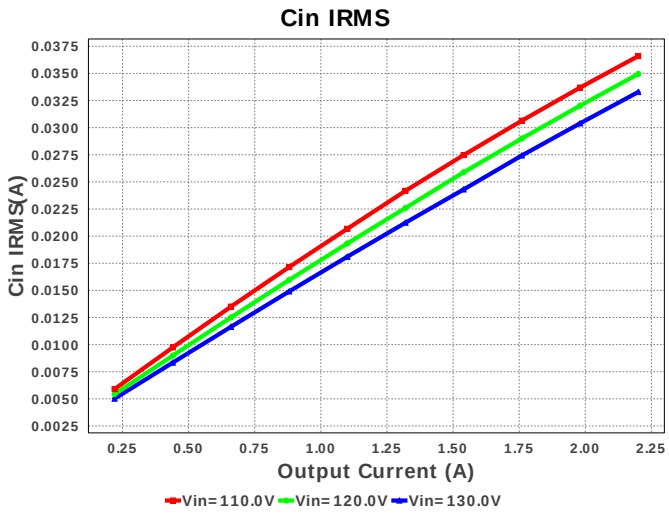
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
7.	Cout	Panasonic	20SVPF560M Series= ?	Cap= 560.0 uF ESR= 12.0 mOhm VDC= 20.0 V IRMS= 5.4 A	1	$0.70	 CAPSMT_62_F12 151 mm²
8.	Csnub	MuRata	GRM155R72A222KA01D Series= X7R	Cap= 2.2 nF VDC= 100.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
9.	Css	MuRata	GRM155R71E103KA01D Series= X7R	Cap= 10.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
10.	Cvcc	MuRata	GRM21BR61E475KA12L Series= X5R	Cap= 4.7 uF ESR= 5.189 mOhm VDC= 25.0 V IRMS= 2.03531 A	1	$0.02	 0805 7 mm²
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 mm²
12.	Cvcc2	MuRata	GRM31CR61C226ME15L Series= X5R	Cap= 22.0 uF ESR= 3.637 mOhm VDC= 16.0 V IRMS= 3.4771 A	1	$0.13	 1206_190 11 mm²
13.	D1a	Diodes Inc.	B230A-13-F	VF@Io= 500.0 mV VRRM= 30.0 V	1	$0.09	 SMA 37 mm²
14.	D1b	Diodes Inc.	B230A-13-F	VF@Io= 500.0 mV VRRM= 30.0 V	1	$0.09	 SMA 37 mm²
15.	D3	Micro Commercial Components	ES1J-TP	VF@Io= 1.35 V VRRM= 600.0 V	1	$0.08	 SMA 37 mm²
16.	Dac	Diodes Inc.	HD04-T	VF@Io= 1.0 V VRRM= 400.0 V	1	$0.12	 MiniDIP 62 mm²
17.	Dsnub	Central Semiconductor	CMR1U-02M	VF@Io= 1.0 V VRRM= 200.0 V	1	$0.38	 SMA 37 mm²
18.	Dz4	NXP Semiconductor	BZX585-C22,115	Zener	1	$0.02	 SOD-523 5 mm²
19.	M1	STMicroelectronics	STW21N90K5	VdsMax= 900.0 V IdsMax= 18.5 Amps	1	$3.94	 TO-247 123 mm²
20.	M2	STMicroelectronics	STF10N80K5	VdsMax= 800.0 V IdsMax= 9.0 Amps	1	$2.52	 TO-220FP 79 mm²
21.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$0.36	 SSOP-4 111 mm²
22.	Rcs	Vishay-Dale	CRCW0402499RFKED Series= CRCW..e3	Res= 499.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
23.	Rfbb	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
24.	Rfbt	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
25.	Ropto	Vishay-Dale	CRCW04021K50FKED Series= CRCW..e3	Res= 1.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²

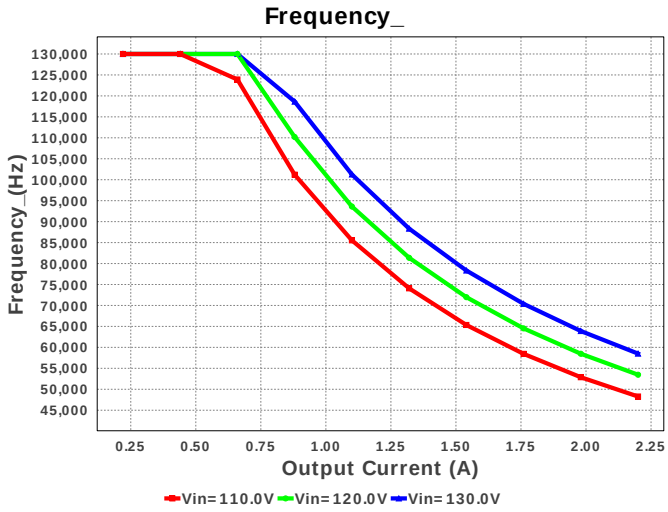
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
26.	Rqrb	Vishay-Dale	CRCW04022K49FKED Series= CRCW..e3	Res= 2.49 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
27.	Rqrt	Panasonic	ERJ-6ENF9531V Series= ERJ-6E	Res= 9.53 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
28.	Rsense	Vishay-Dale	CRCW08051R50FKEA Series= CRCW..e3	Res= 1.5 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
29.	Rsnub	Yageo America	RC1206FR-073K6L Series= ?	Res= 3.6 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
30.	Rvcc	Vishay-Dale	CRCW0805100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
31.	Rvin	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
32.	Rvsd	Vishay-Dale	CRCW04022M00FKED Series= CRCW..e3	Res= 2.0 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
33.	T1	CUSTOM	CUSTOM	Lp= 8.08 mH Rp= 7.888 Ohm Leakage_L= 161.604 µH Ns1toNp= 0.015 Rs1= 20.0 mOhms Ns2toNp= 0.091 Rs2= 4.146 kOhms	1	NA	CUSTOM 0 mm²
34.	U1	Texas Instruments	LM5023MM-2/NOPB	Switcher	1	$0.38	MUA08A 24 mm²
35.	VR	Texas Instruments	TL431AIDBZR	Voltage References	1	$0.08	DBZ0003A 14 mm²

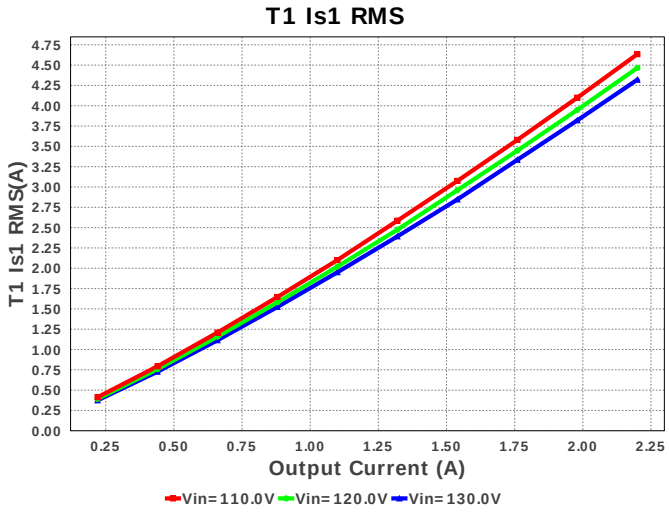


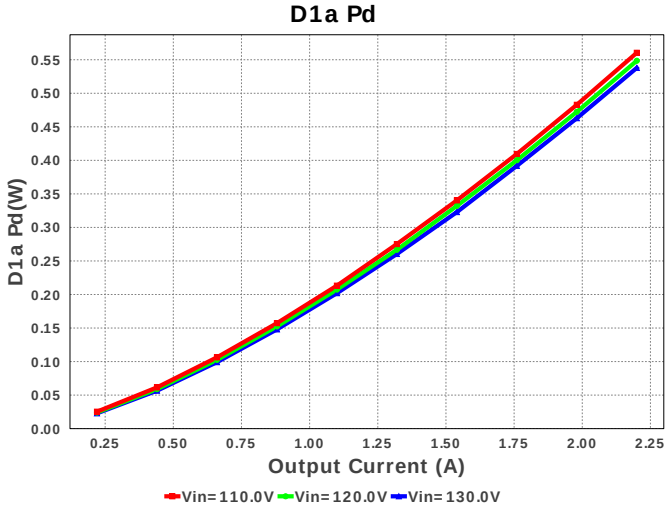


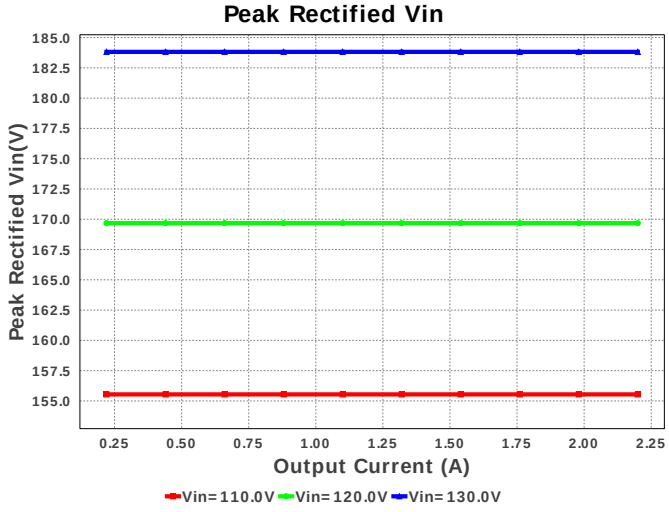


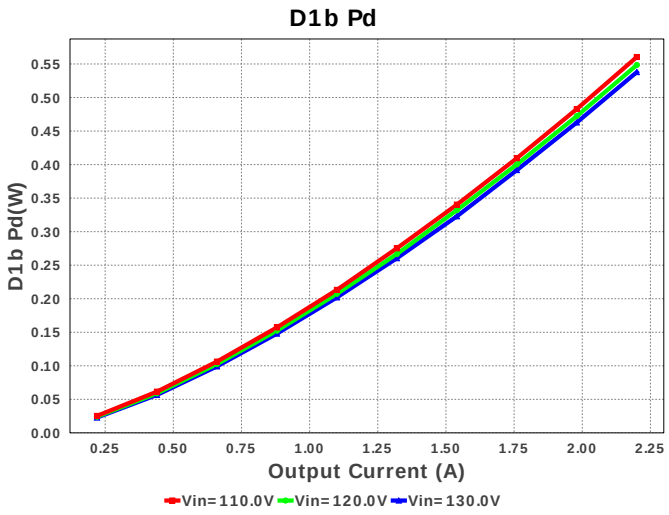


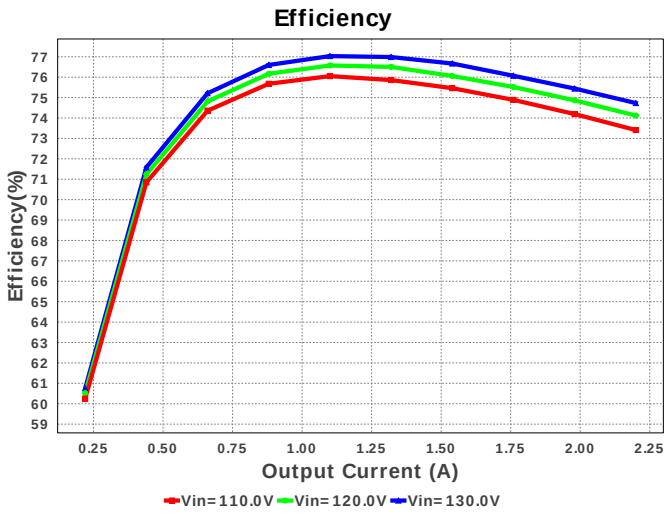


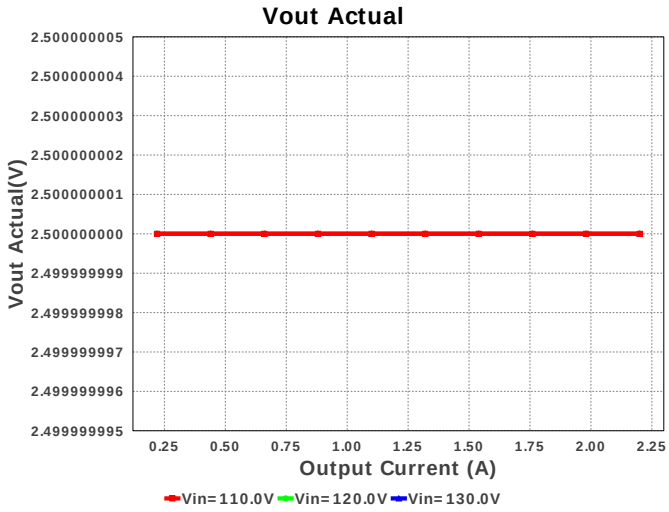


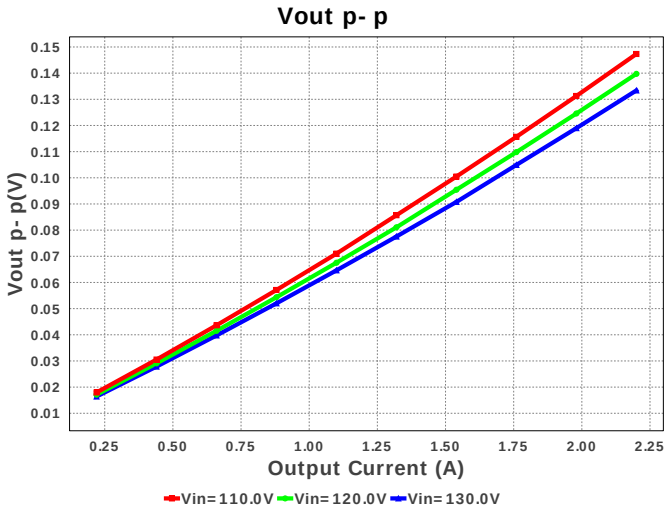


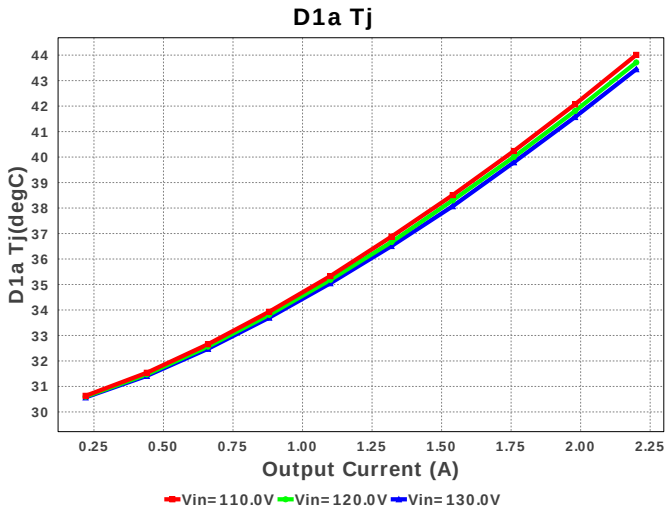


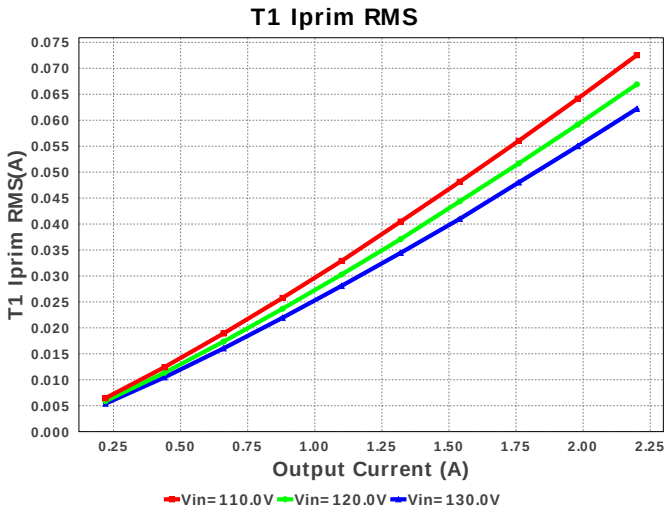


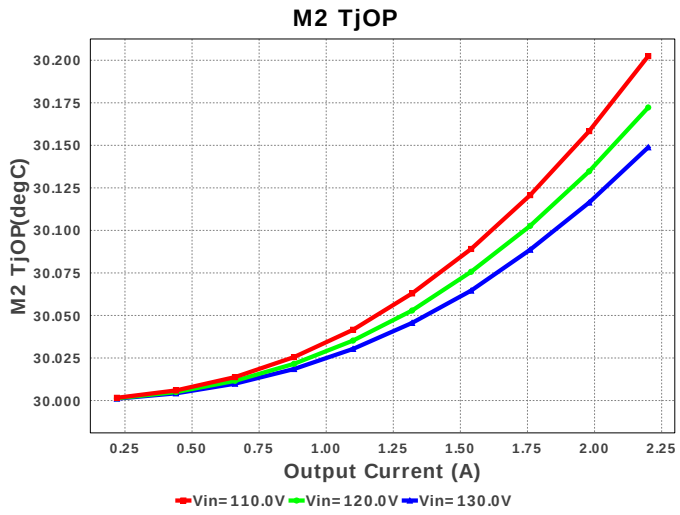


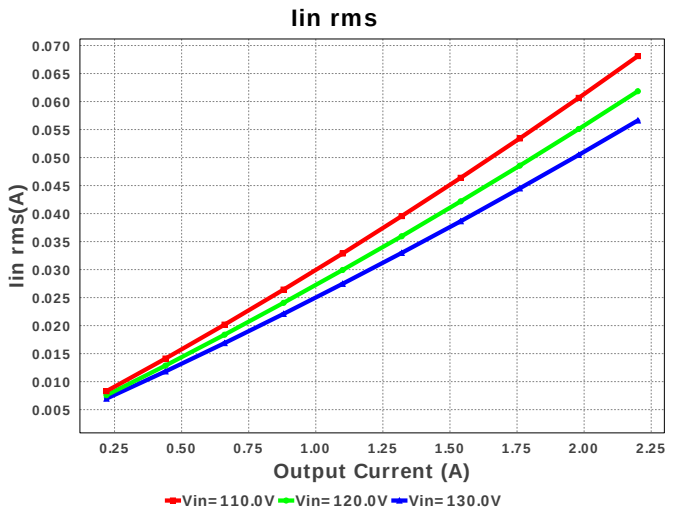


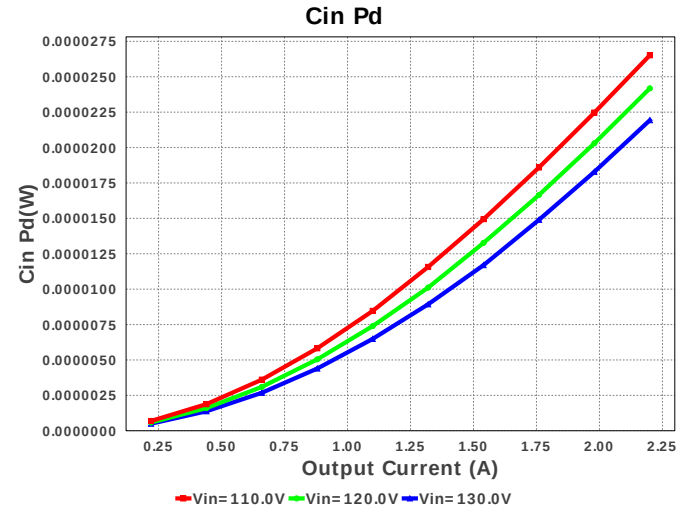


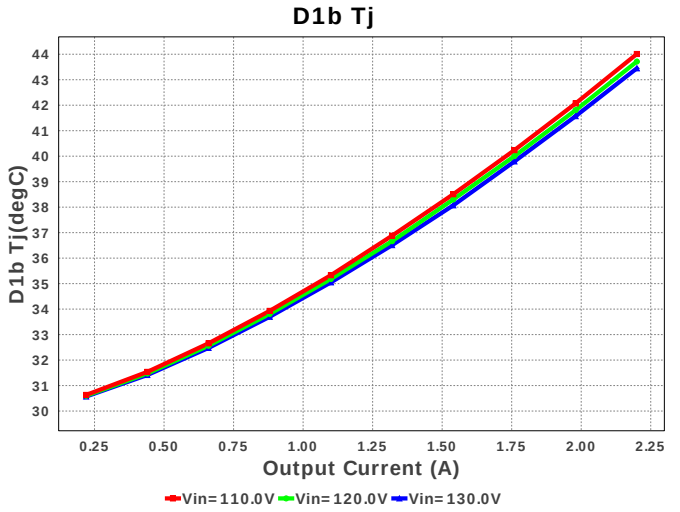


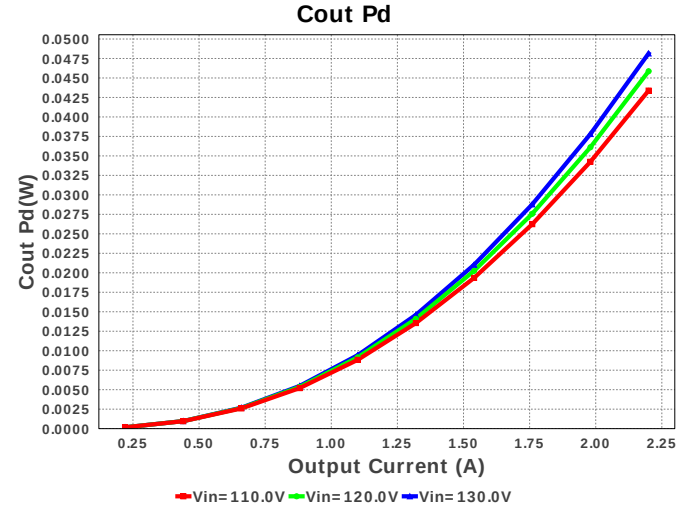


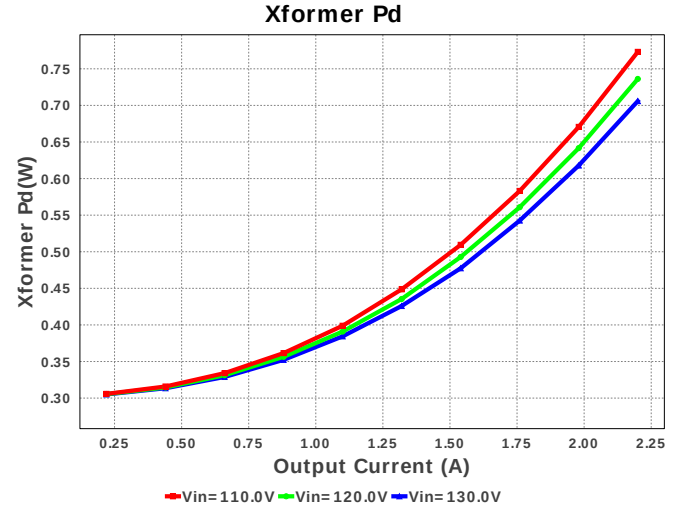


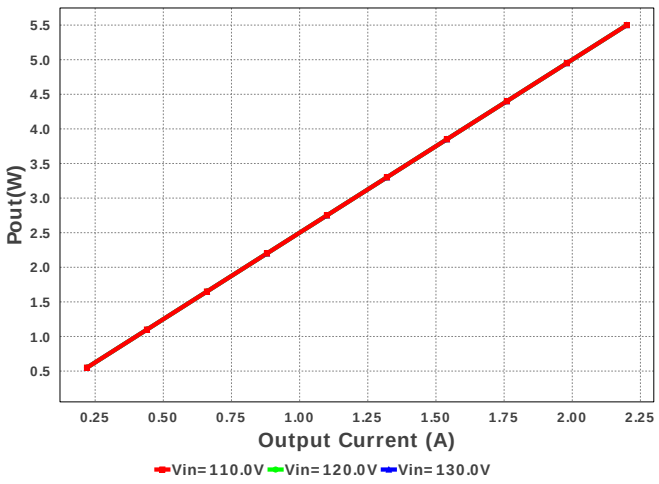


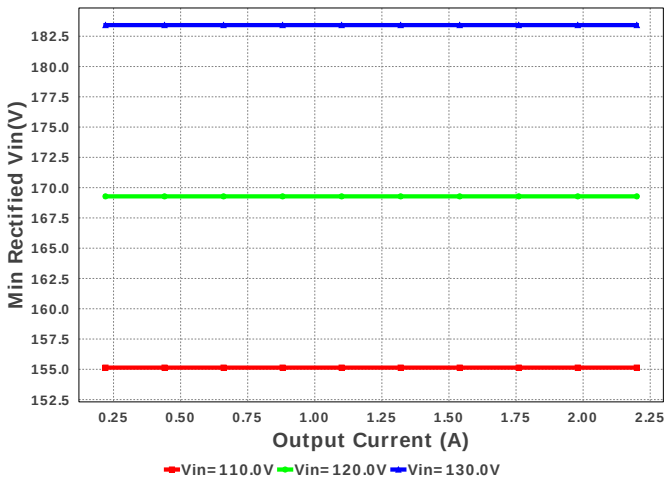


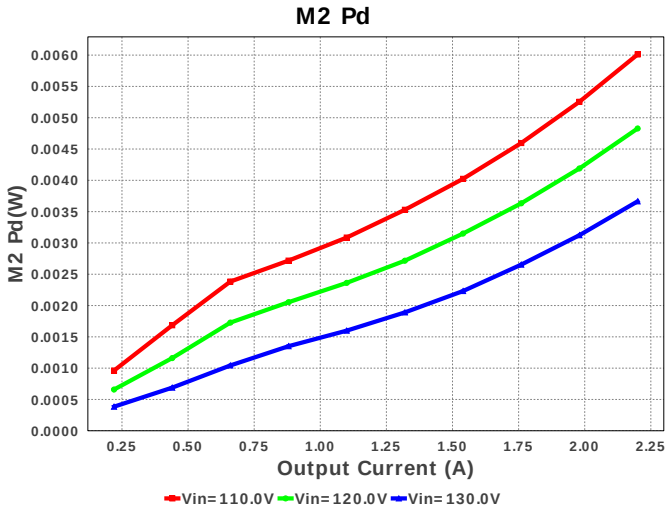


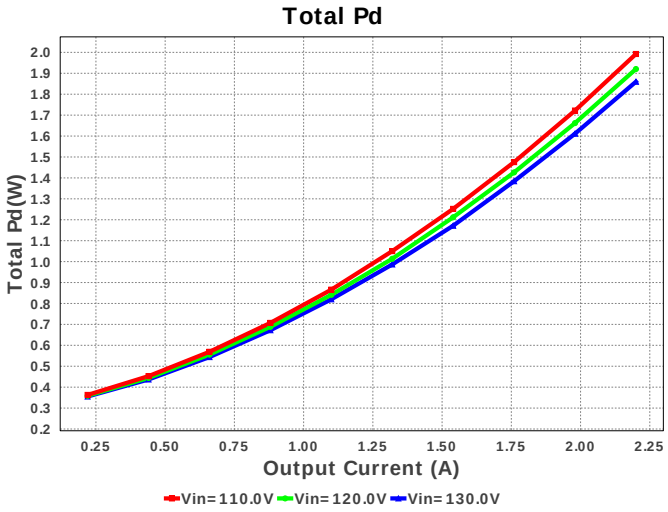


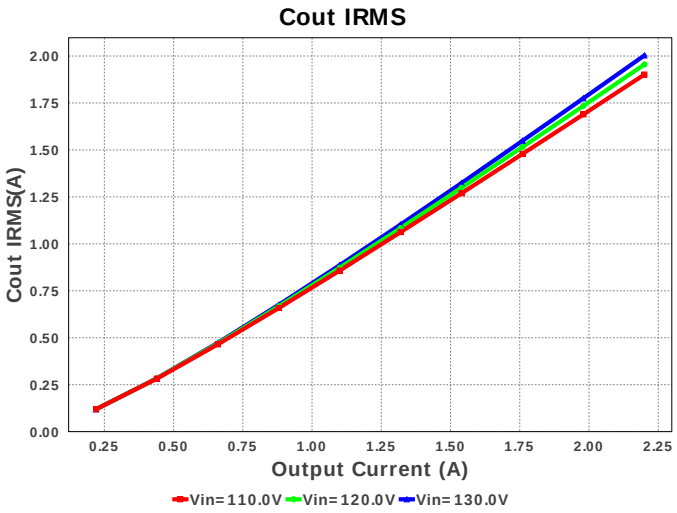


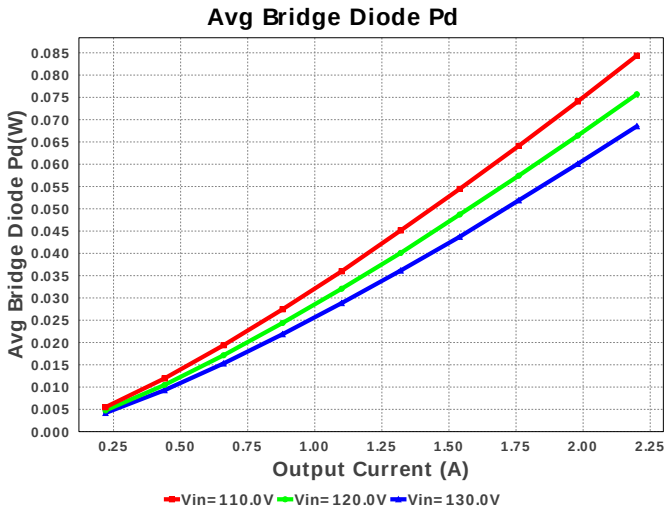


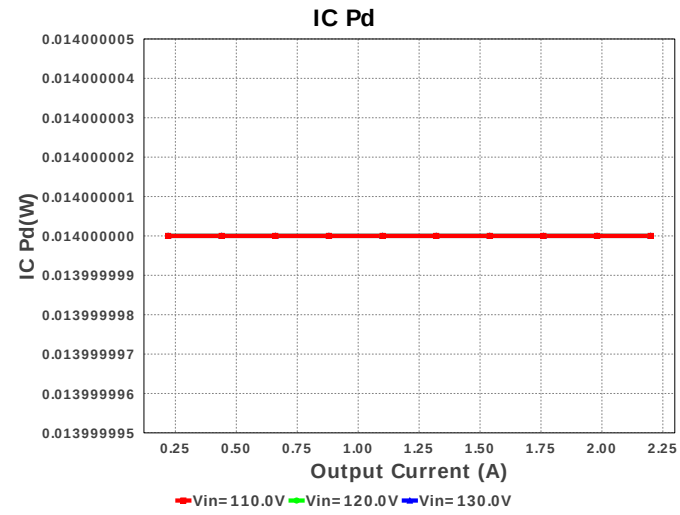


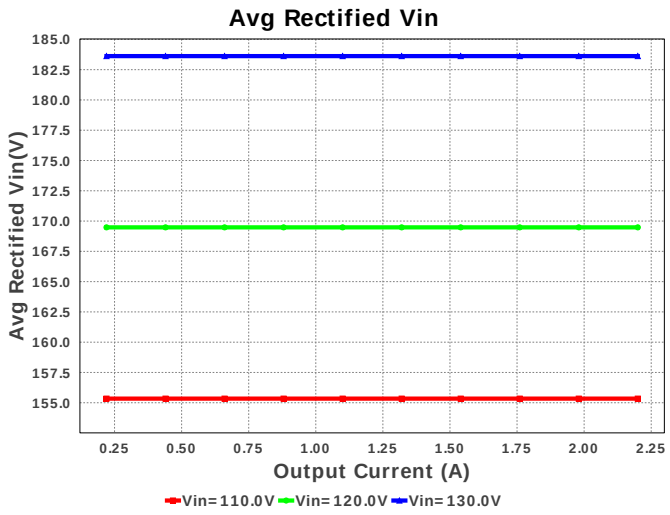


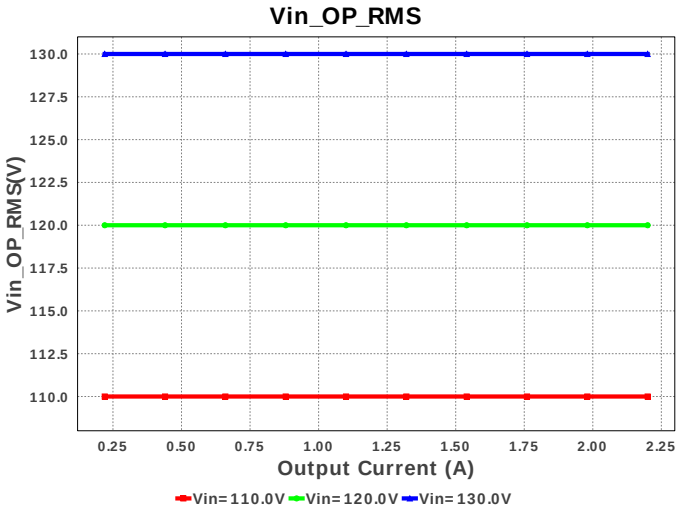


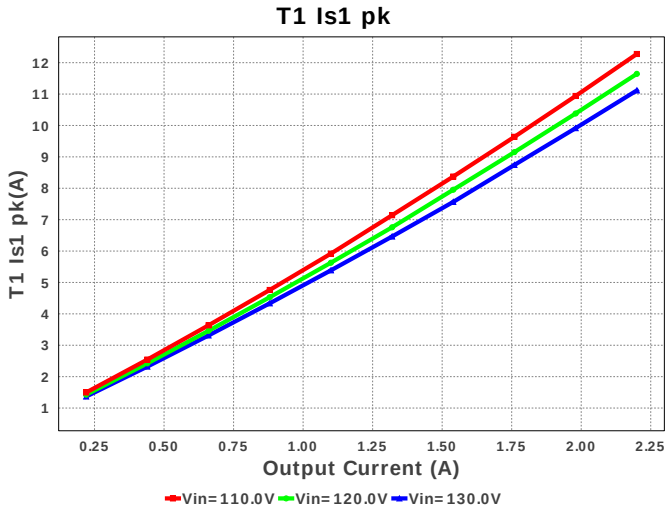












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	49.121 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	1.372 A	Current	Output capacitor RMS ripple current
3.	Iin rms	96.775 mA	Current	RMS Input Current
4.	T1 Iprim RMS	88.827 mA	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	205.872 mA	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	3.931 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	13.509 A	Current	Transformer Secondary1 Peak Current
8.	Avg Rectified Vin	183.62 V	General	Average Rectified Voltage for the AC Line Period
9.	BOM Count	35	General	Total Design BOM count
10.	FootPrint	948.0 mm^2	General	Total Foot Print Area of BOM components
11.	Mode	DCM	General	Conduction Mode
12.	Pout	10.978 W	General	Total output power
13.	Total BOM	$0.0	General	Total BOM Cost
14.	D1 Tj	40.091 degC	Op_Point	D1 junction temperature
15.	D1 Tj	40.091 degC	Op_Point	D1 junction temperature
16.	Vout Actual	4.99 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
17.	Vout OP	4.99 V	Op_Point	Operational Output Voltage
18.	Duty Cycle	49.668 %	Op_point	Duty cycle
19.	Efficiency	87.26 %	Op_point	Steady state efficiency
20.	Frequency	54.884 kHz	Op_point	Switching frequency
21.	IC Tj	34.117 degC	Op_point	IC junction temperature
22.	ICThetaJA	200.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
23.	IOUT_OP	2.2 A	Op_point	Iout operating point
24.	M2 TjOP	30.304 degC	Op_point	M2 MOSFET junction temperature
25.	Min Rectified Vin	183.42 V	Op_point	Minimum voltage seen at rectified input
26.	Peak Rectified Vin	183.82 V	Op_point	Peak voltage seen at rectified input
27.	Vin_OP_RMS	130.0 V	Op_point	AC Input RMS Voltage
28.	Vout p-p	162.103 mV	Op_point	Peak-to-peak output ripple voltage
29.	Avg Bridge Diode Pd	80.096 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
30.	Cin Pd	47.774 µW	Power	Input capacitor power dissipation
31.	Cout Pd	22.574 mW	Power	Output capacitor power dissipation

#	Name	Value	Category	Description
32.	Diode1 Pd	403.644 mW	Power	Diode1 power dissipation
33.	Diode1 Pd	403.644 mW	Power	Diode1 power dissipation
34.	IC Pd	20.586 mW	Power	IC power dissipation
35.	M2 Pd	24.535 mW	Power	M2 MOSFET total power dissipation
36.	Total Pd	1.603 W	Power	Total Power Dissipation
37.	Xformer Pd	679.001 mW	Power	Transformer power dissipation
38.	Vout Tolerance	1.334 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	2.2	Maximum Output Current
2.	VinMax	130.0	Maximum input voltage
3.	VinMin	110.0	Minimum input voltage
4.	Vout	5.0	Output Voltage
5.	line_fsw	60.0	Light Output in Lumen
6.	base_pn	LM5023	Base Product Number
7.	source	AC	Input Source Type
8.	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.