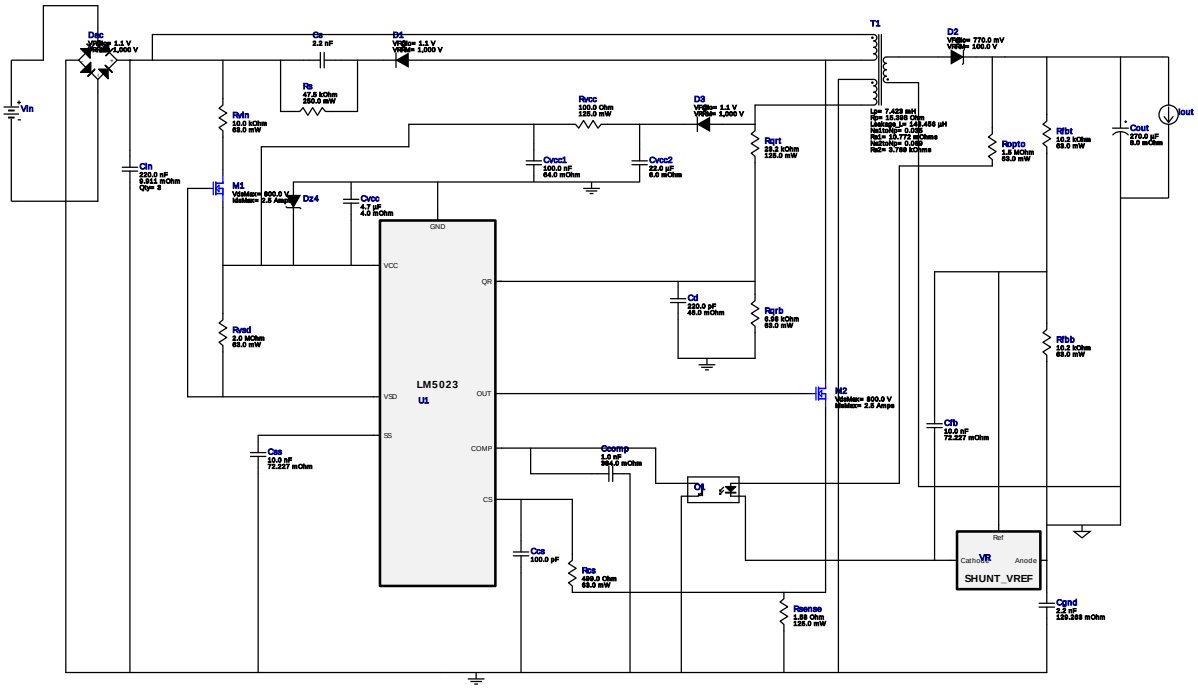
WEBENCH® Design Report

VinMin = 220.0V
VinMax = 240.0V
Vout = 5.0V
Iout = 2.0A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 6/3/15 3:06:57 AM
BOM Cost = $0.00
Footprint = 902.0 mm^2
BOM Count = 36
Total Pd = 2.76W

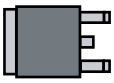
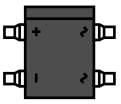
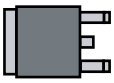
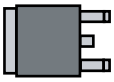
Design : 3922675/2 LM5023MM-2/NOPB
LM5023MM-2/NOPB 220.0V-240.0V to 4.99V @ 2.0A



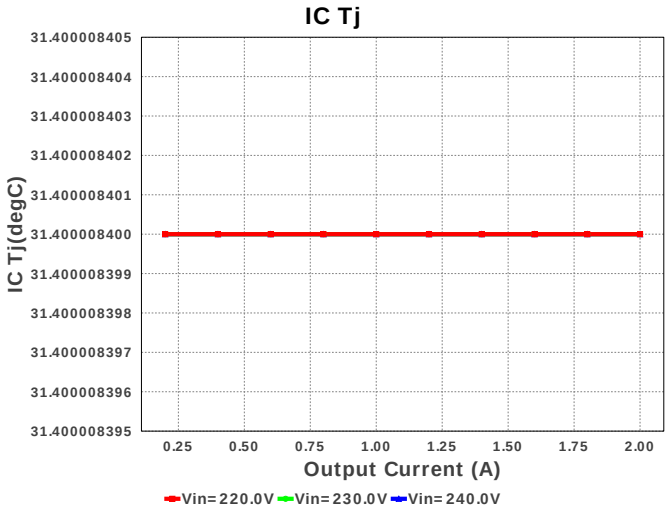
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

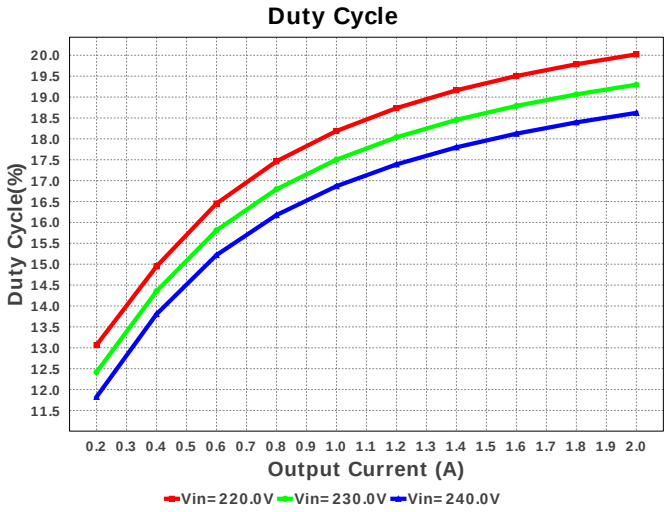
Electrical BOM

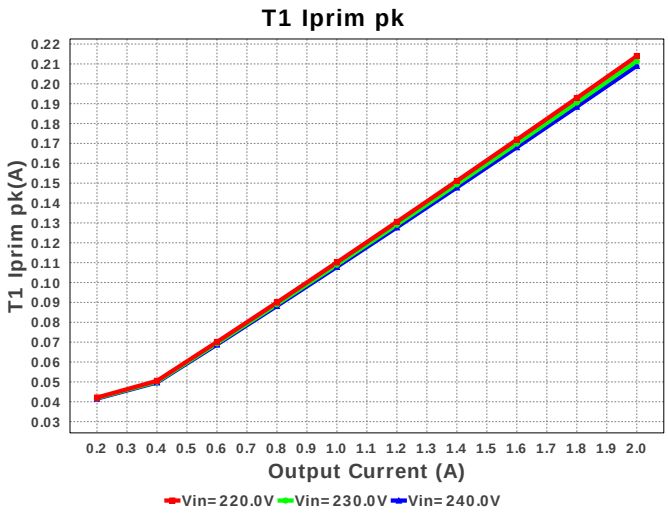
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	$0.01	0805 7 mm^2
2.	Ccs	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
3.	Cd	Kemet	C0805C221J5GACTU Series= C0G/NP0	Cap= 220.0 pF ESR= 46.0 mOhm VDC= 50.0 V IRMS= 888.0 mA	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= 274	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	C3225X7T2W224M Series= 480	Cap= 220.0 nF ESR= 9.911 mOhm VDC= 400.0 V IRMS= 0.0 A	3	$0.18	1210 15 mm^2

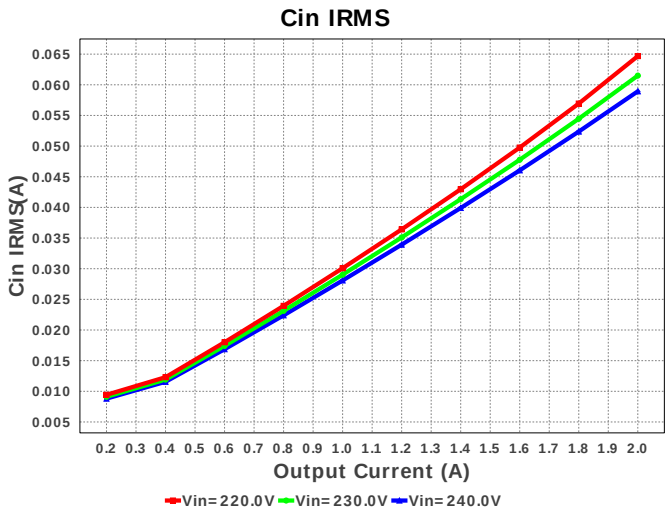
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
7.	Cout	Panasonic	16SVPG270M Series= 2136	Cap= 270.0 uF ESR= 8.0 mOhm VDC= 16.0 V IRMS= 5.8 A	1	$0.70	 CAPSMT_62_C10 74 mm²
8.	Cs	MuRata	GRM155R72A222KA01D Series= X7R	Cap= 2.2 nF VDC= 100.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
9.	Css	TDK	C1005X7R1E103K Series= X7R	Cap= 10.0 nF ESR= 72.227 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
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 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= 6.0 mOhm VDC= 16.0 V IRMS= 0.0 A	1	$0.13	 1206 11 mm²
13.	D1	Fairchild Semiconductor	1N4007	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.02	 DO-41 43 mm²
14.	D2	Vishay-Semiconductor	50WQ10FNPBF	VF@Io= 770.0 mV VRRM= 100.0 V	1	$0.41	 DPAK 102 mm²
15.	D3	Fairchild Semiconductor	1N4007	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.02	 DO-41 43 mm²
16.	Dac	Vishay-Semiconductor	DF10SA	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.24	 DF-S 99 mm²
17.	Dz4	Diodes Inc.	MMSZ5246B-7-F	Zener	1	$0.03	 SOD-123 13 mm²
18.	M1	STMicroelectronics	STD3NK80ZT4	VdsMax= 800.0 V IdsMax= 2.5 Amps	1	$0.46	 DPAK 102 mm²
19.	M2	STMicroelectronics	STD3NK80ZT4	VdsMax= 800.0 V IdsMax= 2.5 Amps	1	$0.46	 DPAK 102 mm²
20.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$0.35	 SSOP-4 111 mm²
21.	Rcs	Vishay-Dale	CRCW0402499RFKED Series= CRCW..e3	Res= 499.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
22.	Rfbb	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
23.	Rfbt	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
24.	Ropto	Vishay-Dale	CRCW04021M50FKED Series= CRCW..e3	Res= 1.5 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²

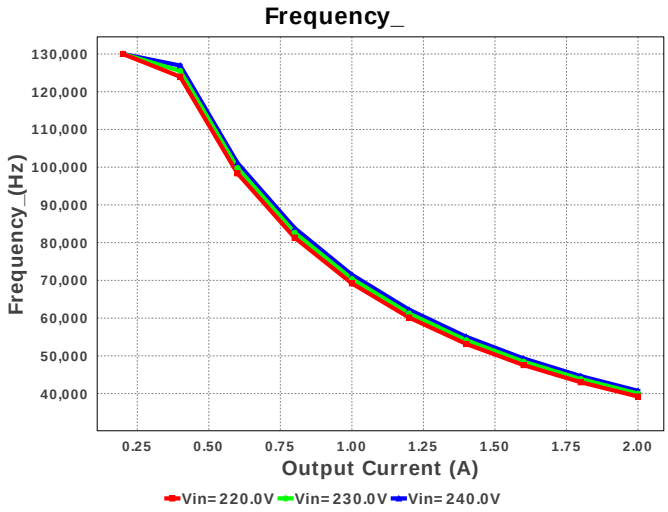
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
25.	Rqrb	Vishay-Dale	CRCW04026K98FKED Series= CRCW..e3	Res= 6.98 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
26.	Rqrt	Panasonic	ERJ-6ENF2322V Series= 225	Res= 23.2 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
27.	Rs	Panasonic	ERJ-8ENF4752V Series= ERJ-8E	Res= 47.5 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
28.	Rsense	Vishay-Dale	CRCW08051R58FKEA Series= CRCW..e3	Res= 1.58 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
29.	Rvcc	Vishay-Dale	CRCW0805100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
30.	Rvin	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
31.	Rvsd	Vishay-Dale	CRCW04022M00FKED Series= CRCW..e3	Res= 2.0 MOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
32.	T1	CUSTOM	CUSTOM	Lp= 7.423 mH Rp= 15.398 Ohm Leakage_L= 148.456 µH Ns1toNp= 0.035 Rs1= 10.772 mOhms Ns2toNp= 0.069 Rs2= 3.769 kOhms	1	NA	CUSTOM 0 mm²
33.	U1	Texas Instruments	LM5023MM-2/NOPB	Switcher	1	$0.38	MUA08A 24 mm²
34.	VR	Texas Instruments	TL431AIDBVR	Voltage References	1	$0.09	R-PDSO-G3 16 mm²

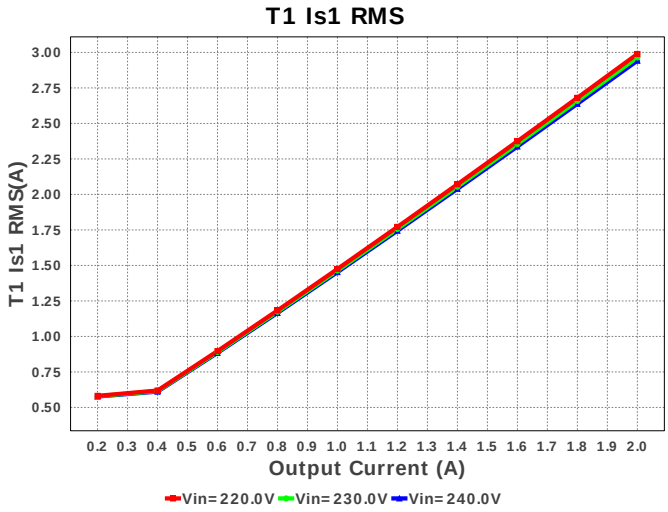


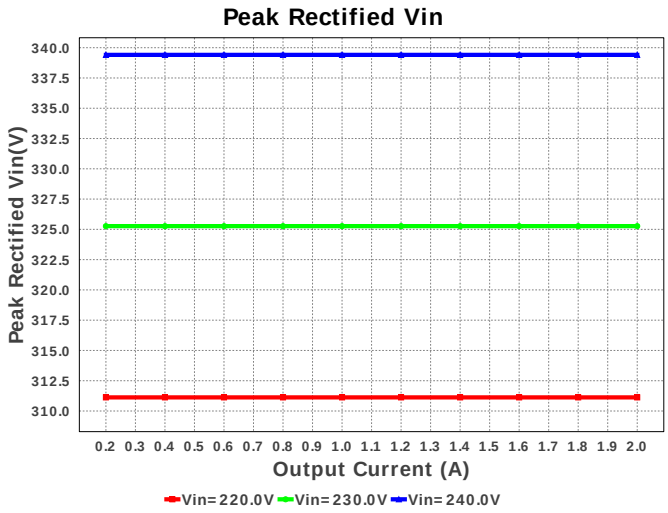


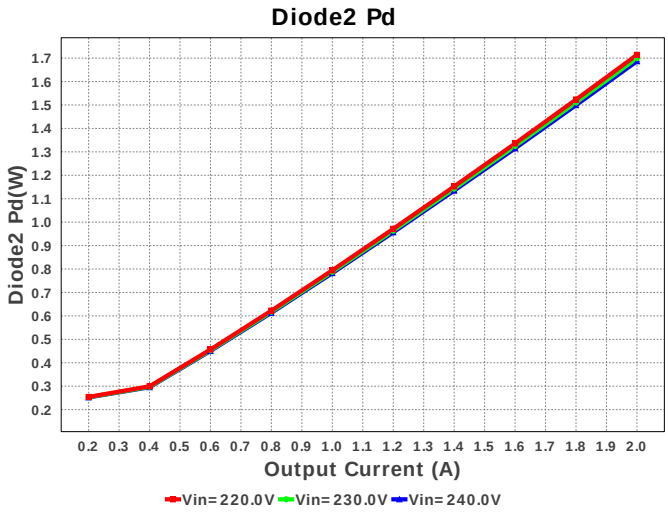


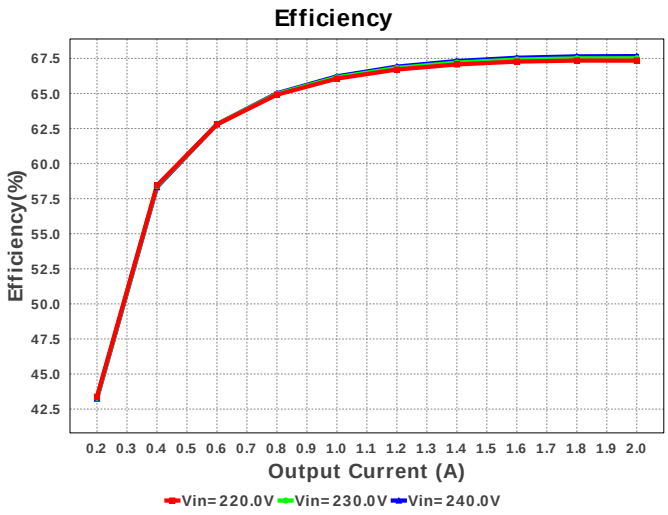


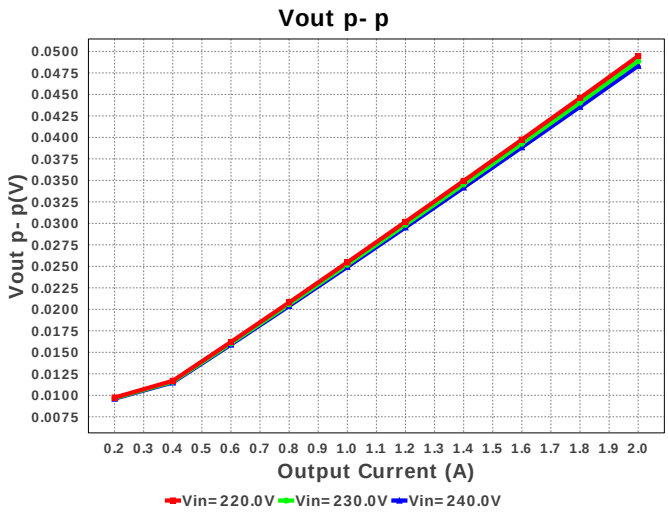


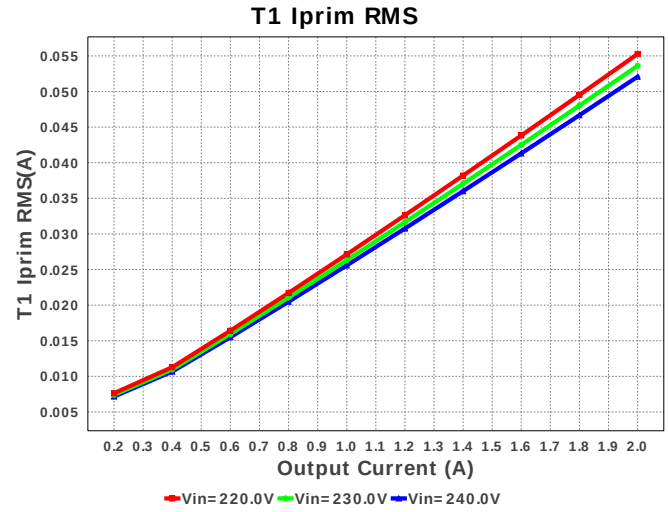


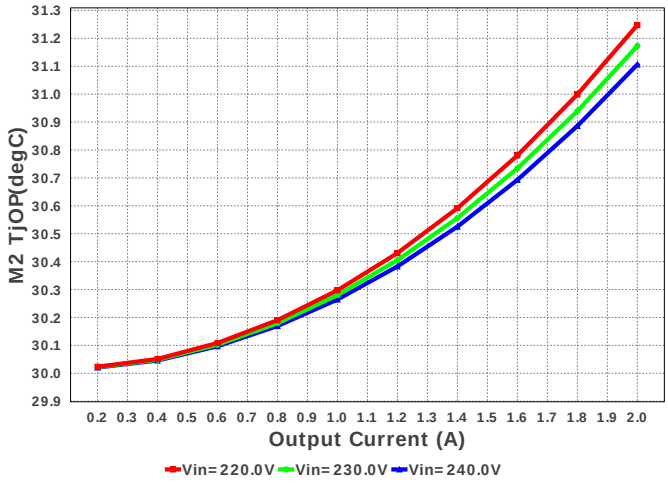


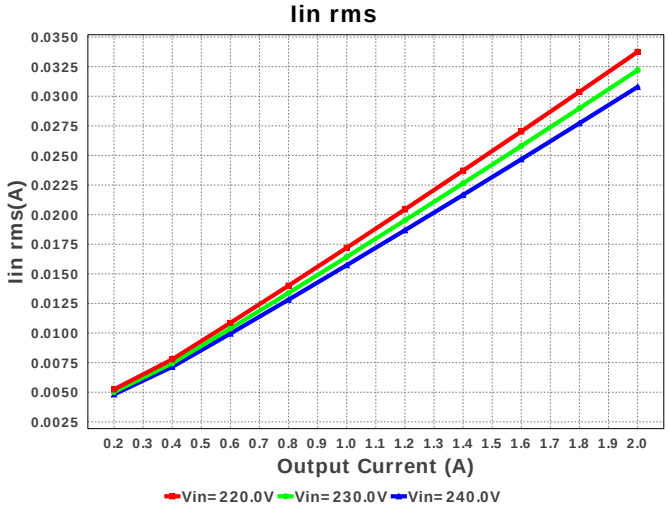


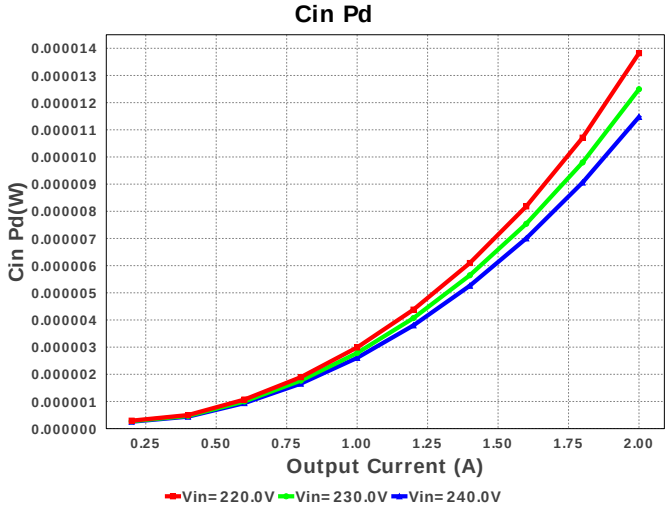


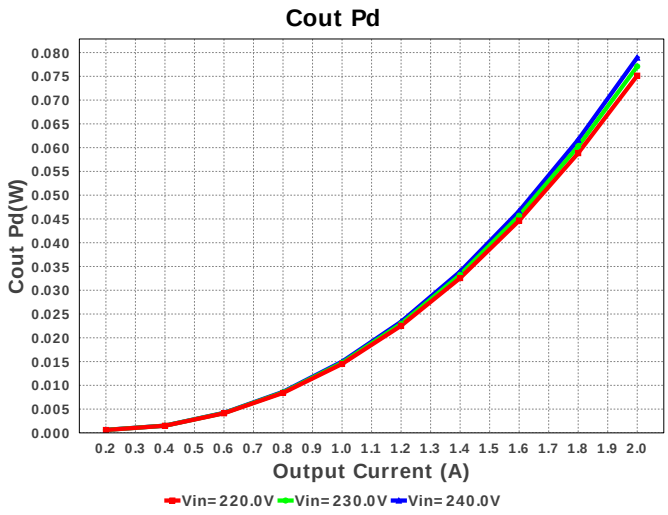


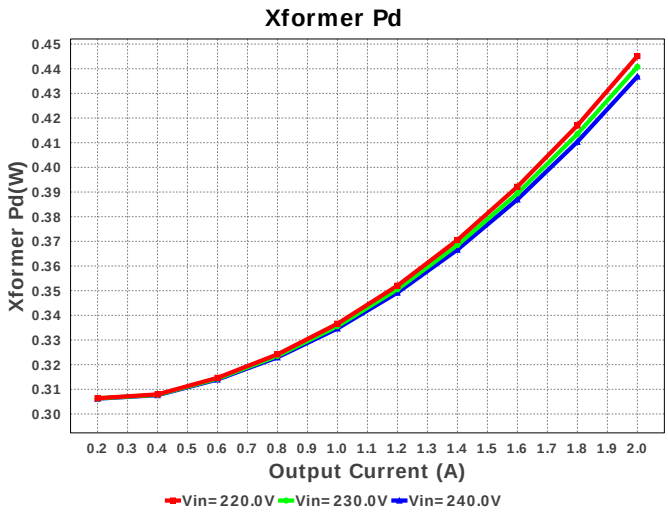


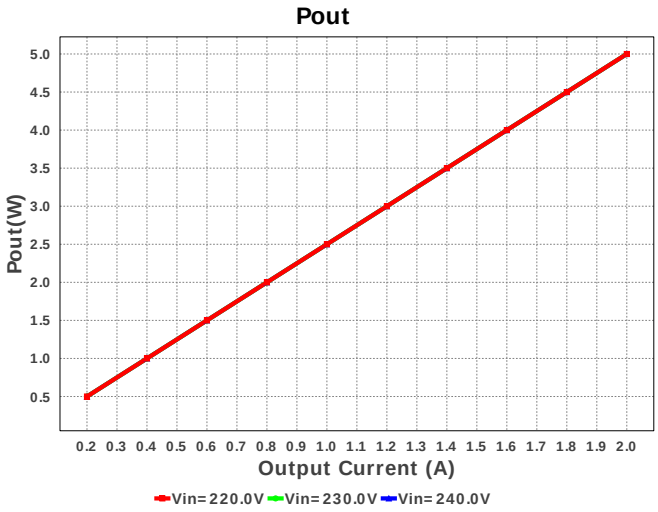


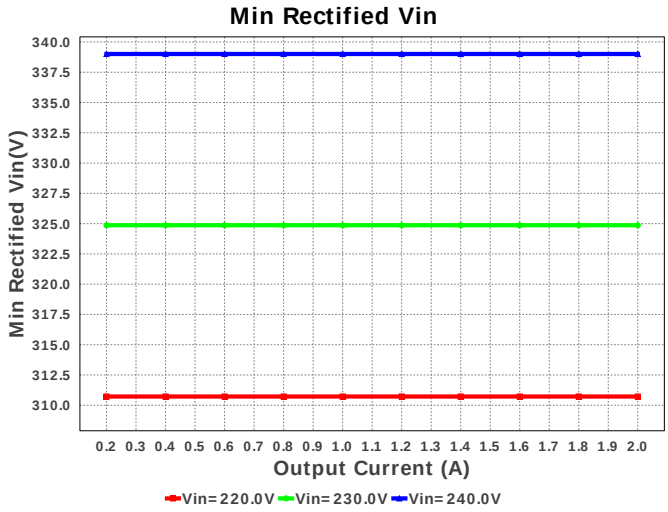


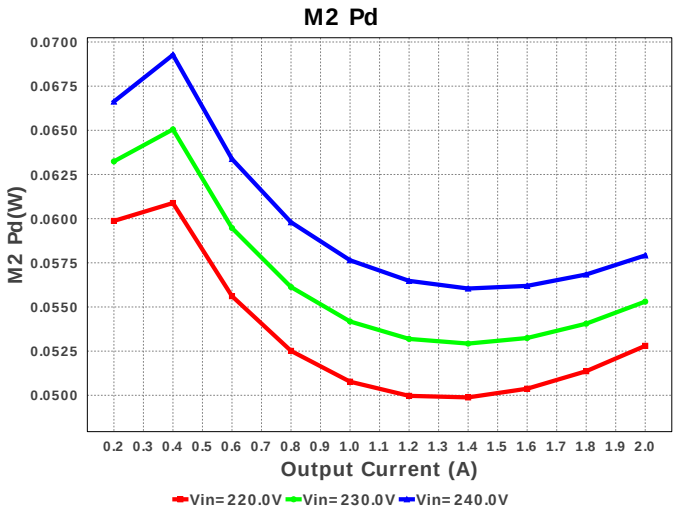


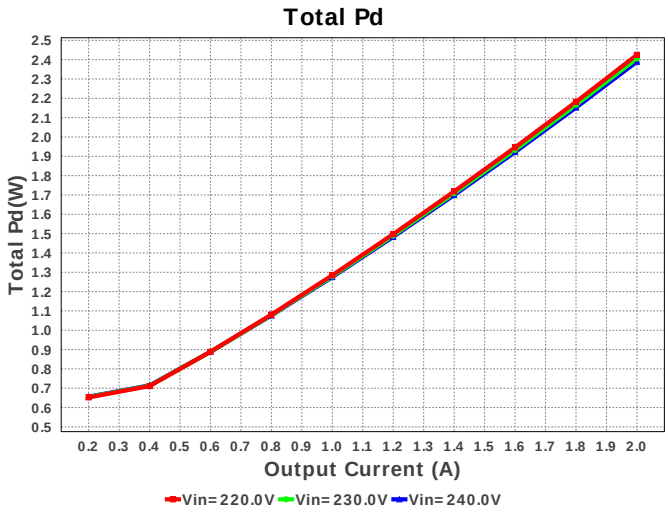


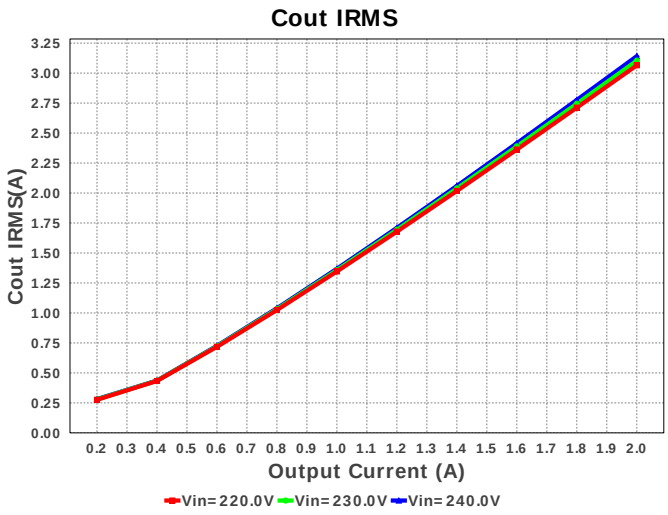


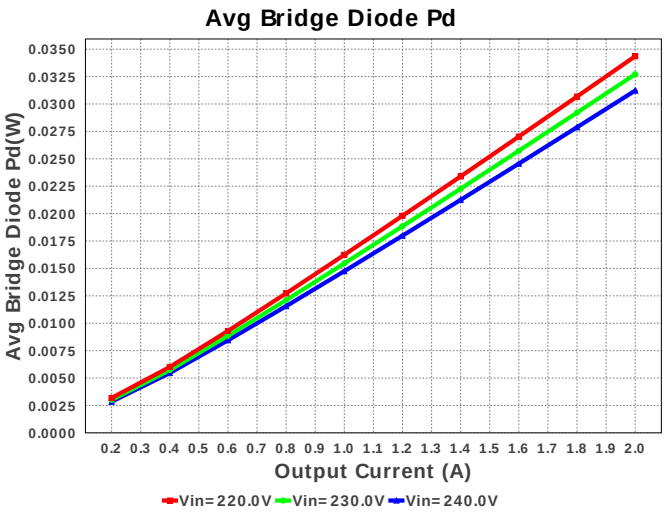


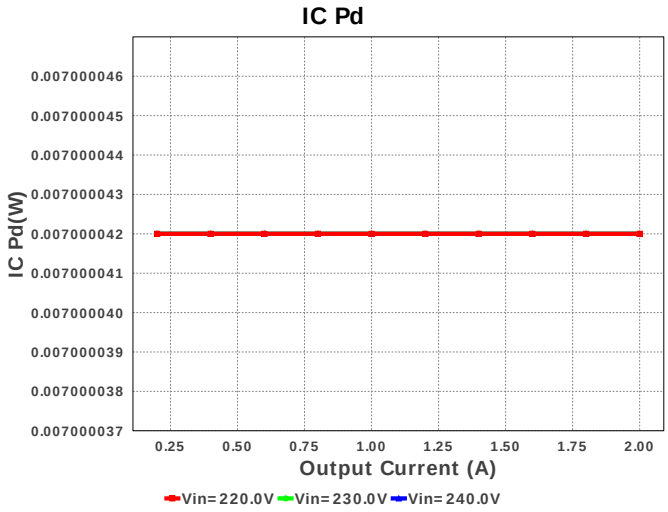


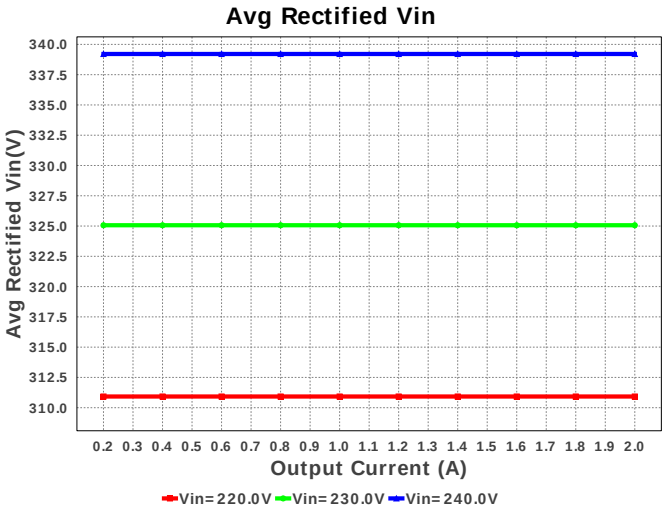


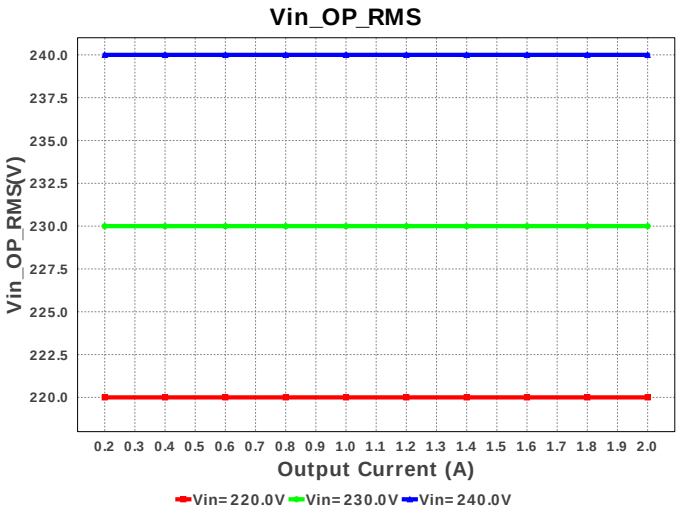


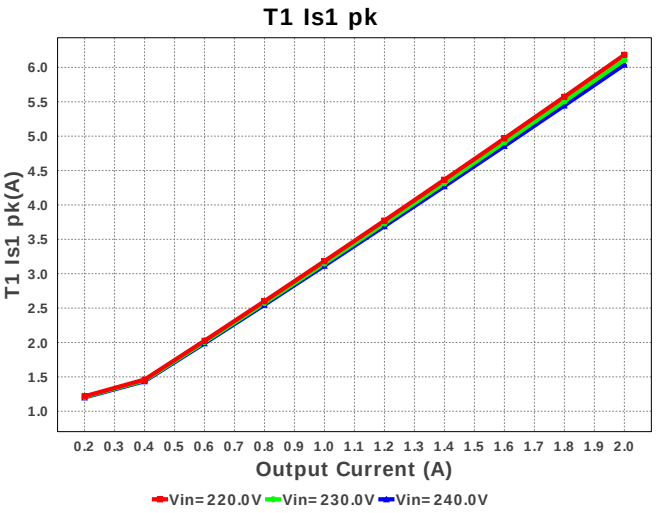












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	155.147 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	2.293 A	Current	Output capacitor RMS ripple current
3.	Iin rms	53.101 mA	Current	RMS Input Current
4.	T1 Iprim RMS	72.697 mA	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	231.093 mA	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	2.942 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	6.678 A	Current	Transformer Secondary1 Peak Current
8.	Avg Rectified Vin	339.208 V	General	Average Rectified Voltage for the AC Line Period
9.	BOM Count	36	General	Total Design BOM count
10.	FootPrint	902.0 mm^2	General	Total Foot Print Area of BOM components
11.	Pout	9.98 W	General	Total output power

#	Name	Value	Category	Description
12.	Total BOM	$0.0	General	Total BOM Cost
13.	Vout OP	4.99 V	Op_Point	Operational Output Voltage
14.	Duty Cycle	30.441 %	Op_point	Duty cycle
15.	Efficiency	78.309 %	Op_point	Steady state efficiency
16.	Frequency	55.205 kHz	Op_point	Switching frequency
17.	IC Tj	32.062 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	32.181 degC	Op_point	M2 MOSFET junction temperature
21.	Min Rectified Vin	339.008 V	Op_point	Minimum voltage seen at rectified input
22.	Peak Rectified Vin	339.408 V	Op_point	Peak voltage seen at rectified input
23.	Vin_OP_RMS	240.0 V	Op_point	AC Input RMS Voltage
24.	Vout p-p	53.423 mV	Op_point	Peak-to-peak output ripple voltage
25.	Avg Bridge Diode Pd	45.026 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
26.	Cin Pd	79.522 µW	Power	Input capacitor power dissipation
27.	Cout Pd	42.07 mW	Power	Output capacitor power dissipation
28.	Diode2 Pd	1.874 W	Power	Diode2 power dissipation
29.	IC Pd	10.312 mW	Power	IC power dissipation
30.	M2 Pd	70.081 mW	Power	M2 MOSFET total power dissipation
31.	Total Pd	2.764 W	Power	Total Power Dissipation
32.	Xformer Pd	481.718 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	240.0	Maximum input voltage
4.	VinMin	220.0	Minimum input voltage
5.	Vout	5.0	Output Voltage
6.	Vout1	5.0	Output Voltage #1
7.	base_pn	LM5023	Base Product Number
8.	source	DC	Input Source Type
9.	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.