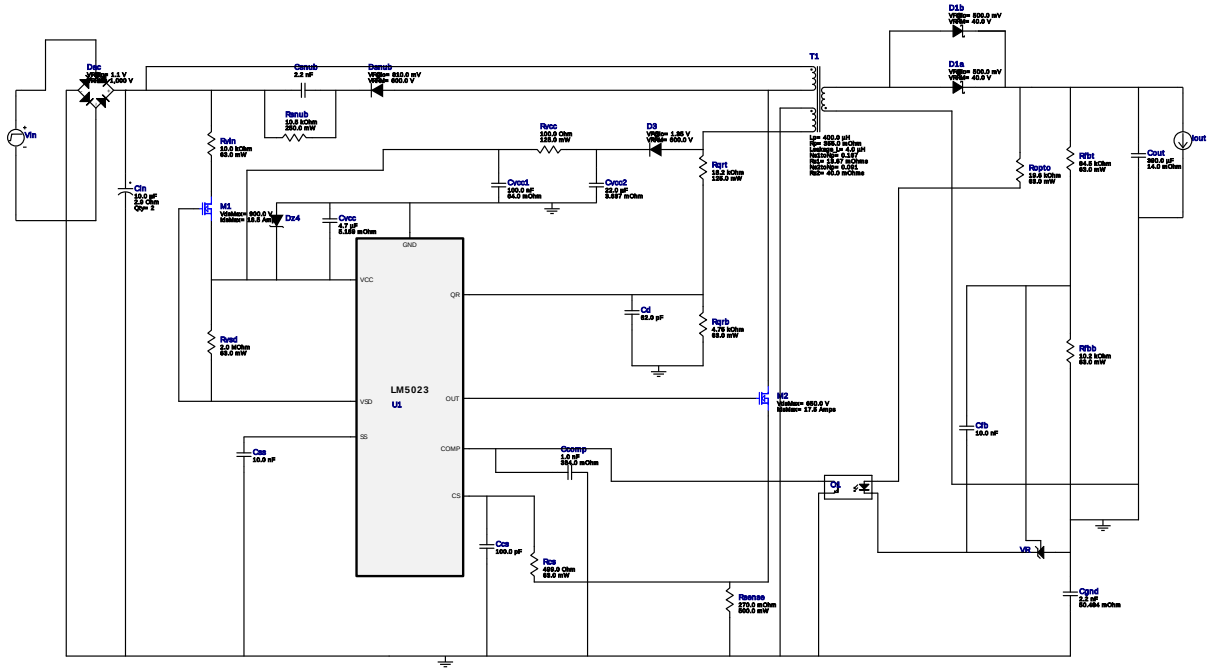
TEXAS INSTRUMENTS

WEBENCH® Design Report

VinMin = 220.0V
VinMax = 250.0V
Vout = 23.0V
Iout = 2.0A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 7/13/16 1:12:17 AM
BOM Cost = $0.00
BOM Count = 36
Total Pd = 3.1W

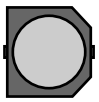
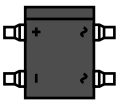
Design : 4738744/11 LM5023MM-2/NOPB
LM5023MM-2/NOPB 220.0V-250.0V to 23.16V @ 2.0A



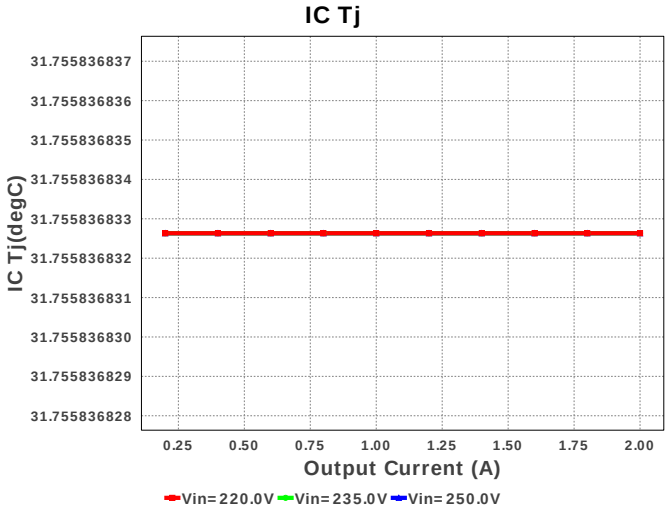
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

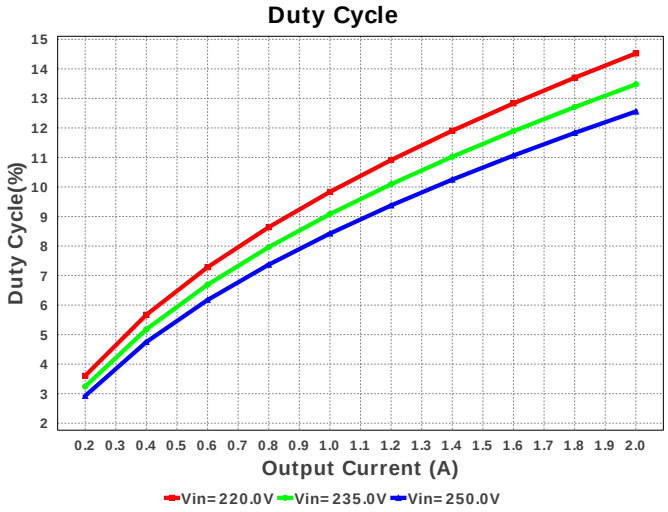
Electrical BOM

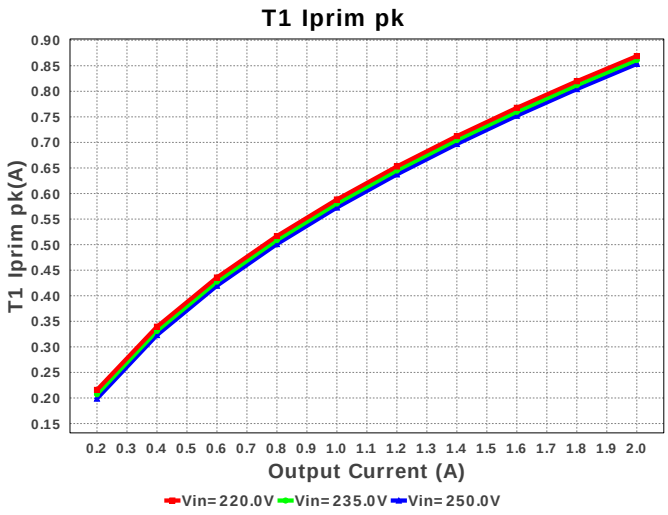
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	$0.01	0805 7 mm^2
2.	Ccs	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
3.	Cd	Samsung Electro-Mechanics	CL21C620JBANNNC Series= C0G/NP0	Cap= 62.0 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	C3225X7S3D222K Series= X7S	Cap= 2.2 nF ESR= 50.484 mOhm VDC= 2.0 kV IRMS= 0.0 A	1	$0.22	1210 15 mm^2
6.	Cin	Kemet	ESG106M400AH4AA Series= 2334	Cap= 10.0 uF ESR= 2.9 Ohm VDC= 400.0 V IRMS= 100.0 mA	2	$0.19	ESG106 144 mm^2

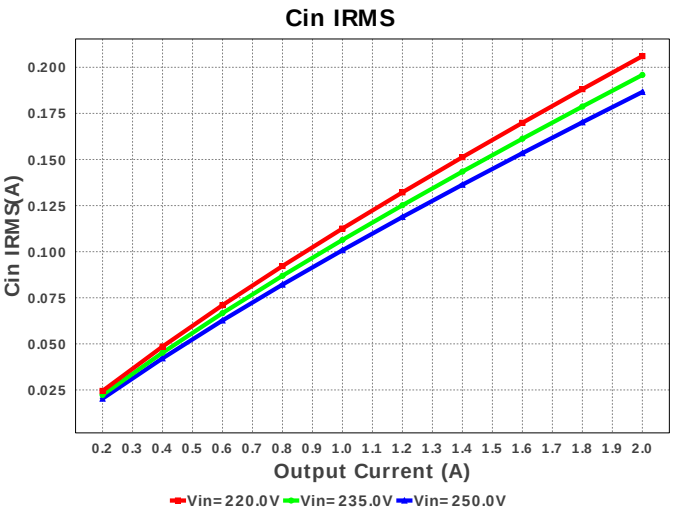
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
7.	Cout	Panasonic	20SVPF390M Series= ?	Cap= 390.0 uF ESR= 14.0 mOhm VDC= 20.0 V IRMS= 4.95 A	1	$0.63	 CAPSMT_62_E12 106 mm²
8.	Csnub	MuRata	GRM155R72A222KA01D Series= X7R	Cap= 2.2 nF VDC= 100.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
9.	Css	MuRata	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	Vishay-Semiconductor	SS14-E3/61T	VF@Io= 500.0 mV VRRM= 40.0 V	1	$0.08	 SMA 37 mm²
14.	D1b	Vishay-Semiconductor	SS14-E3/61T	VF@Io= 500.0 mV VRRM= 40.0 V	1	$0.08	 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	Vishay-Semiconductor	DF10SA	VF@Io= 1.1 V VRRM= 1,000.0 V	1	$0.24	 DF-S 99 mm²
17.	Dsnub	ON Semiconductor	MURS360T3	VF@Io= 810.0 mV VRRM= 600.0 V	1	$1.12	 SMC 83 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	Infineon Technologies	IPP65R190CFD	VdsMax= 650.0 V IdsMax= 17.5 Amps	1	$2.34	TO-220 0 mm²
21.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$0.38	 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	CRCW040284K5FKED Series= CRCW..e3	Res= 84.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
25.	Ropto	Vishay-Dale	CRCW040219K6FKED Series= CRCW..e3	Res= 19.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²

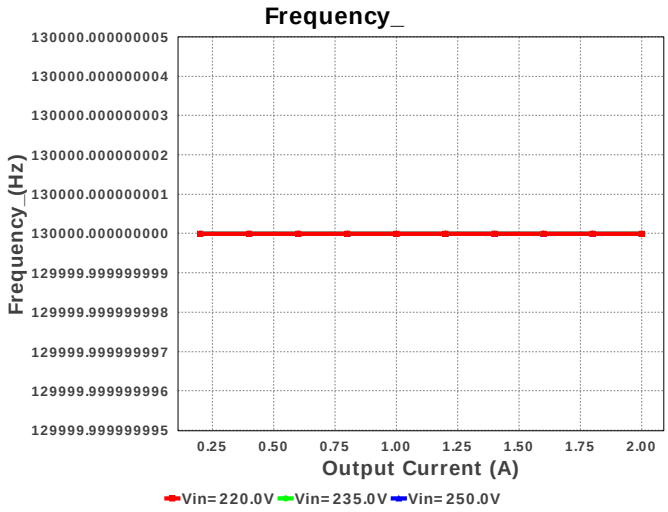
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
26.	Rqrb	Vishay-Dale	CRCW04024K75FKED Series= CRCW..e3	Res= 4.75 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm^2
27.	Rqrt	Panasonic	ERJ-6ENF1822V Series= ERJ-6E	Res= 18.2 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm^2
28.	Rsense	Rohm	MCR25JZHFLR270 Series= MCR25	Res= 270.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.03	1210 15 mm^2
29.	Rsnub	Panasonic	ERJ-8ENF1052V Series= ERJ-8E	Res= 10.5 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm^2
30.	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
31.	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
32.	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
33.	T1	Wurth Elektronik	750313417	Lp= 400.0 µH Rp= 355.0 mOhm Leakage_L= 4.0 µH Ns1toNp= 0.167 Rs1= 13.67 mOhms Ns2toNp= 0.091 Rs2= 40.0 mOhms	1	NA	WE-DD-L 210 mm^2
34.	U1	Texas Instruments	LM5023MM-2/NOPB	Switcher	1	$0.38	MUA08A 24 mm^2
35.	VR	Texas Instruments	TL431AIDBVR	Voltage References	1	$0.07	R-PDSO-G3 16 mm^2

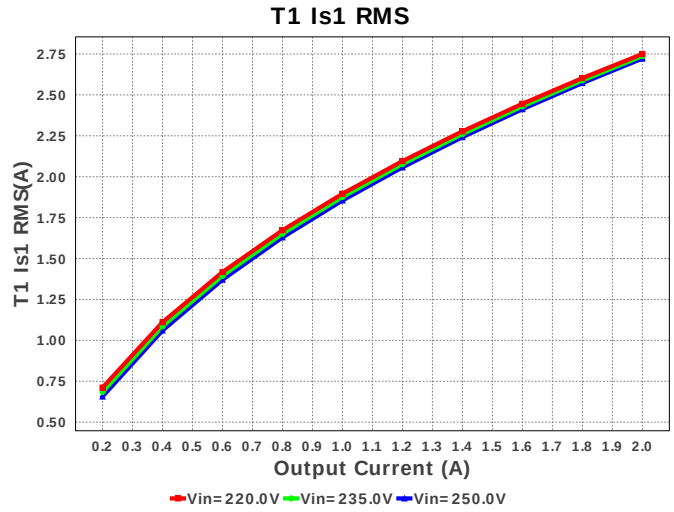


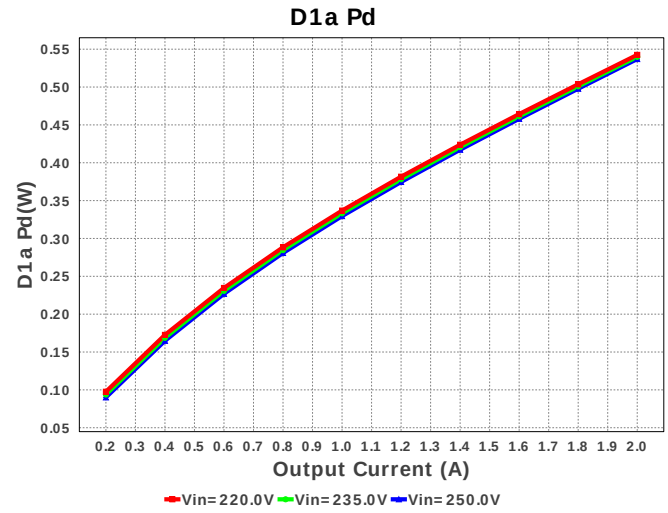


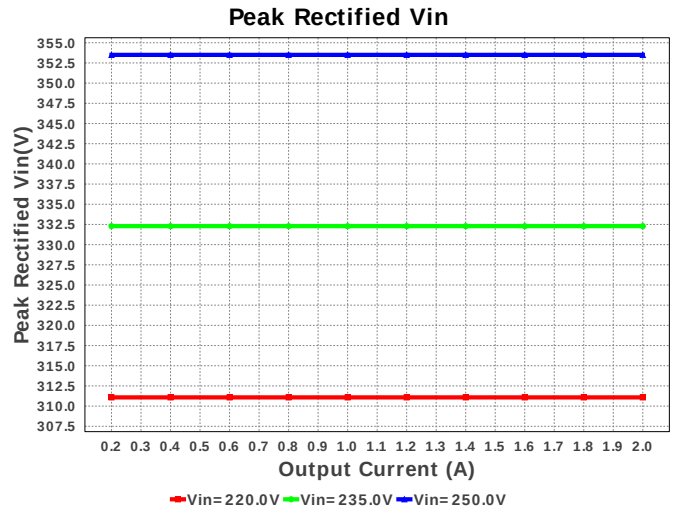


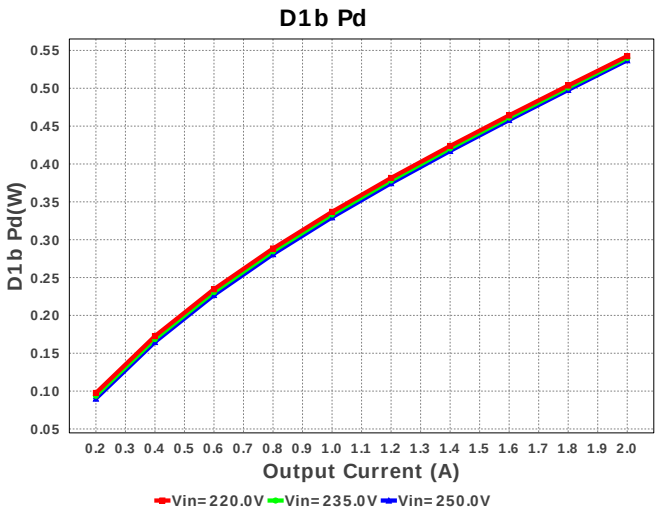


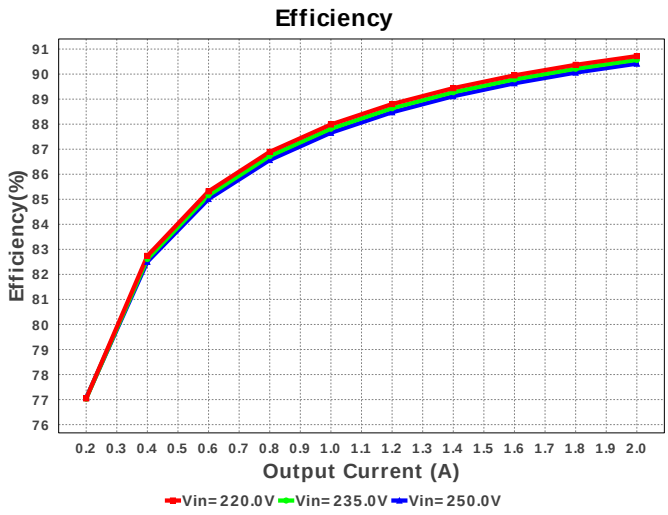


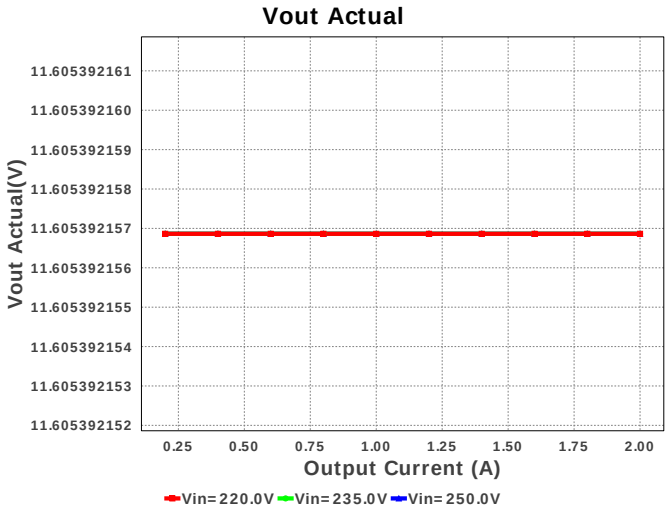


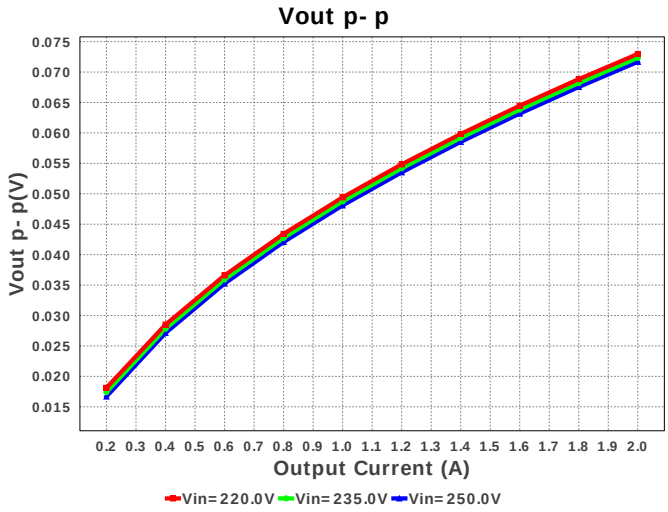


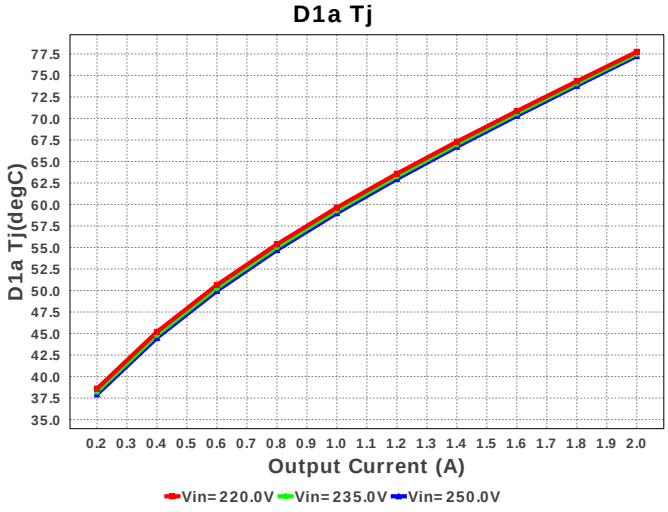


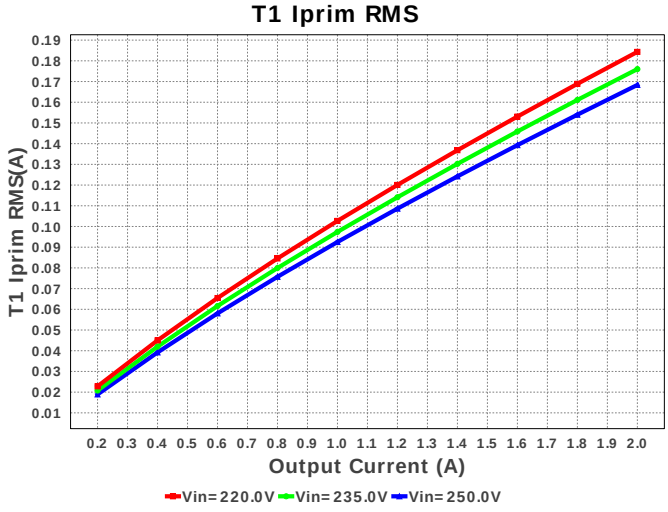


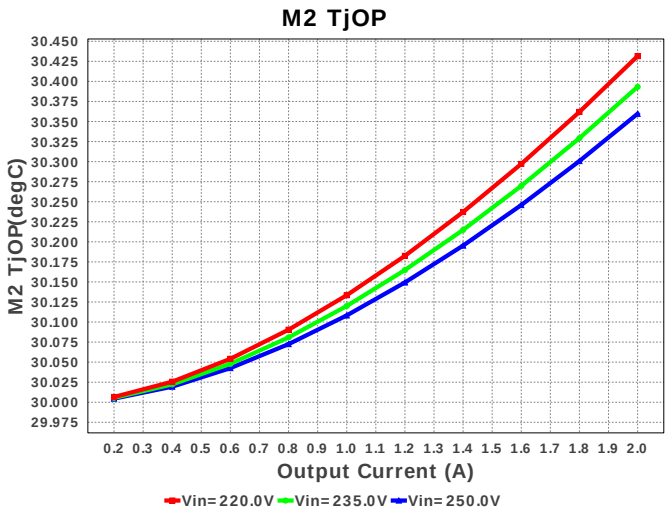


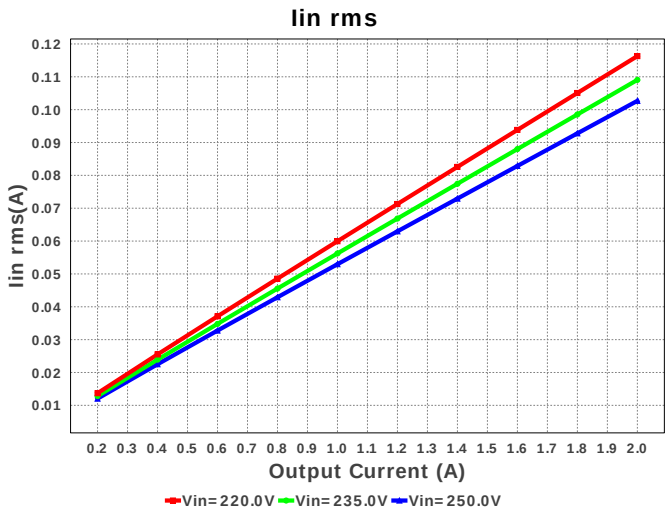


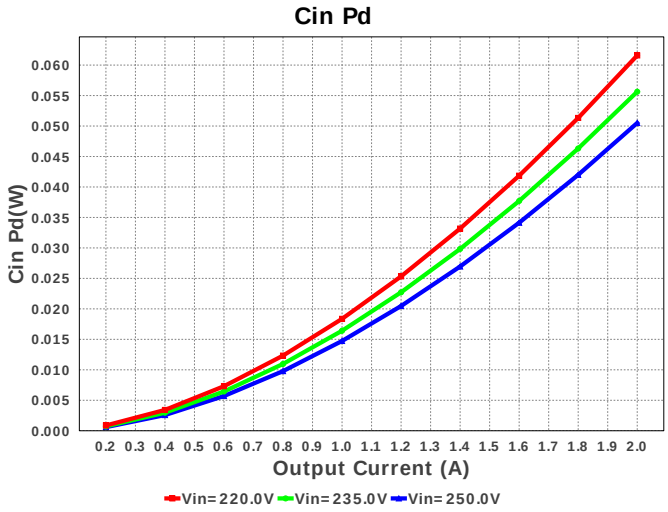


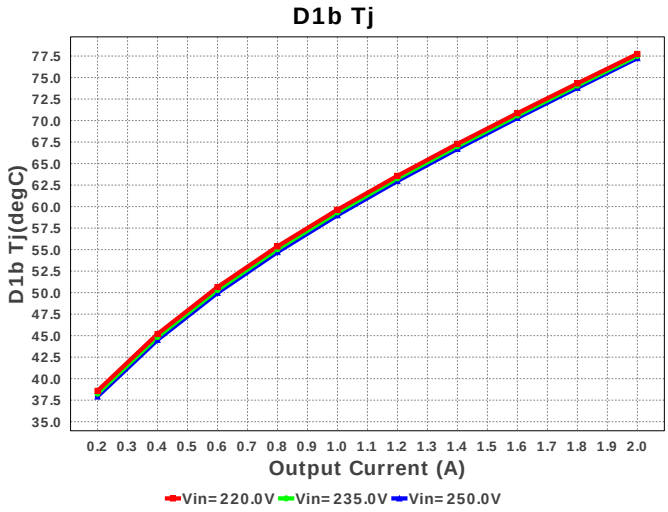


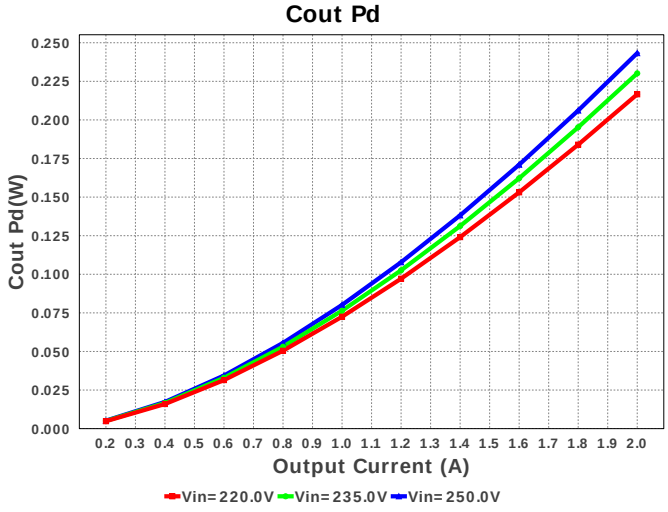


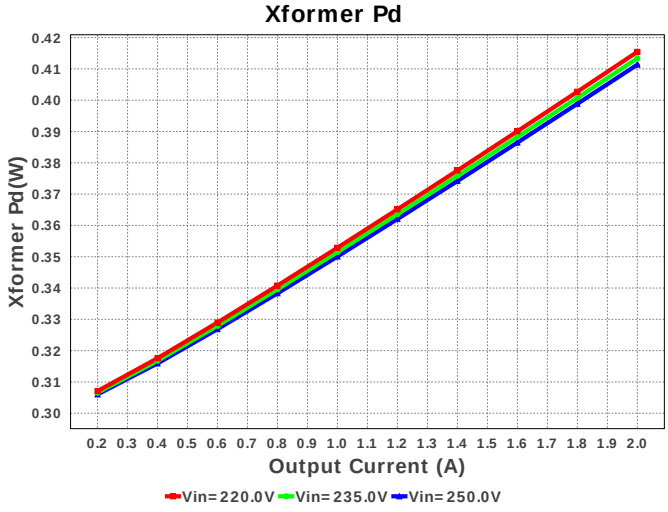


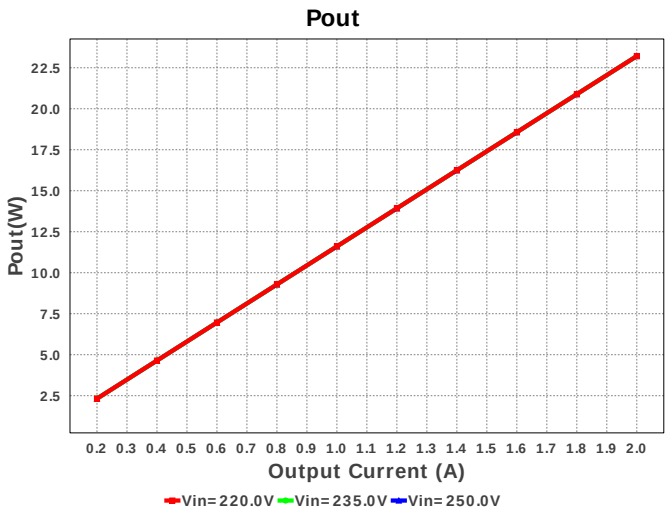


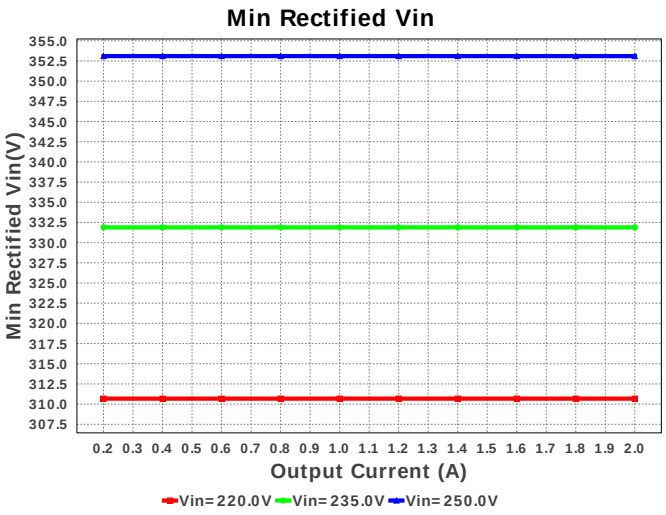


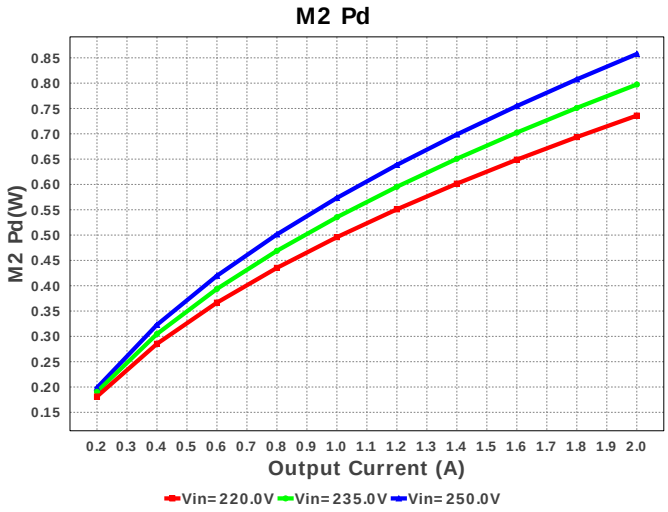


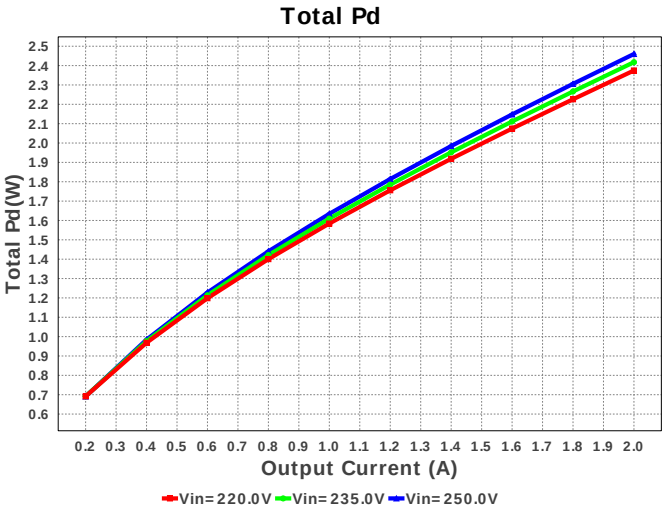


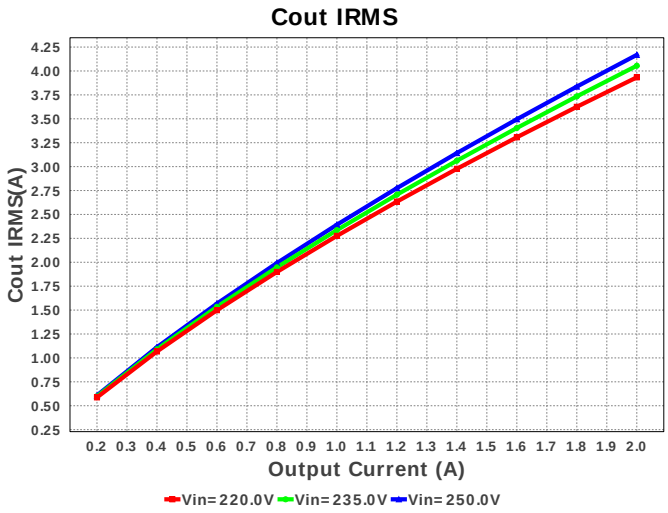


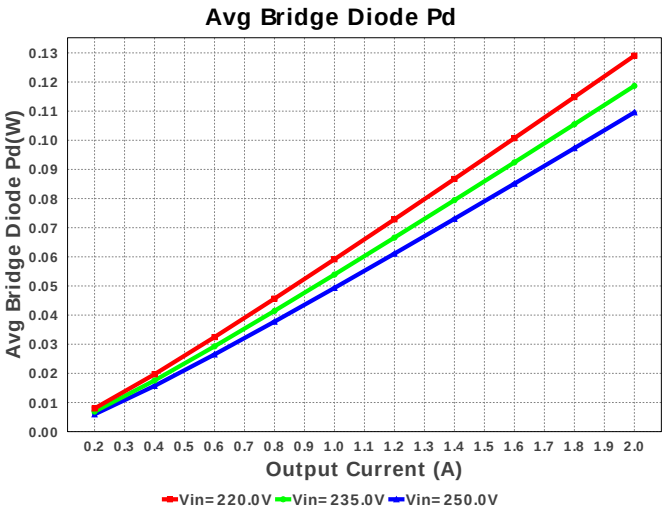


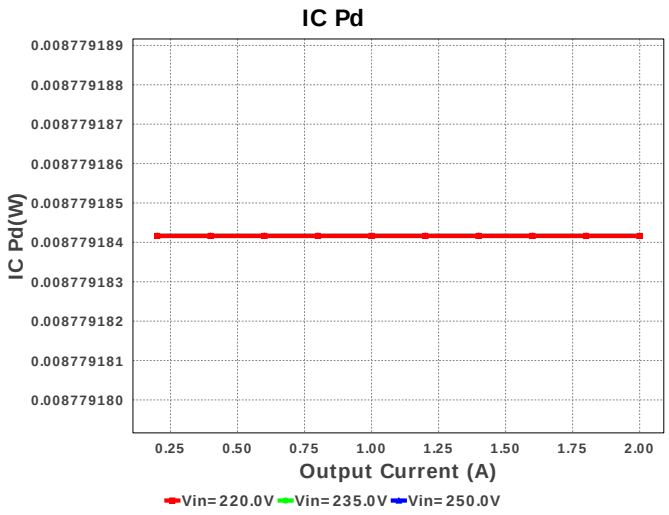


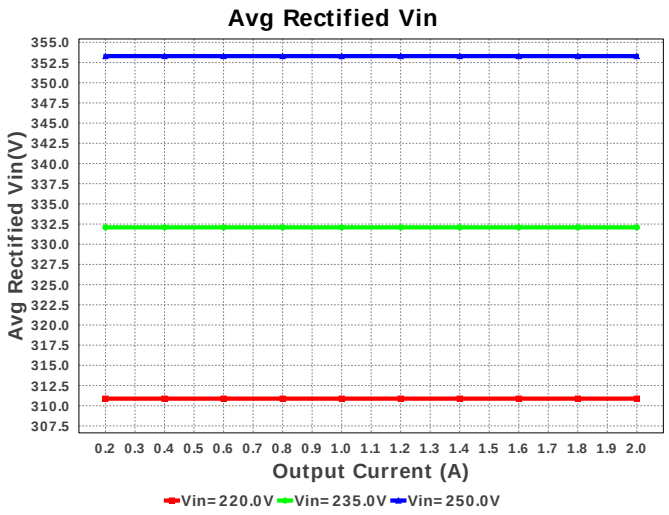


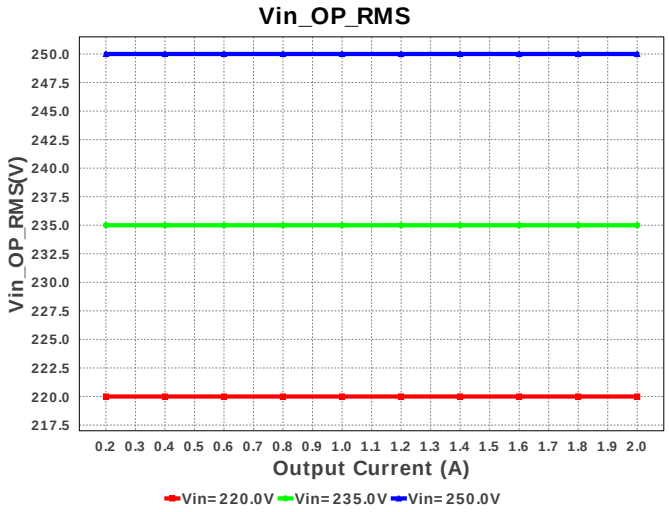


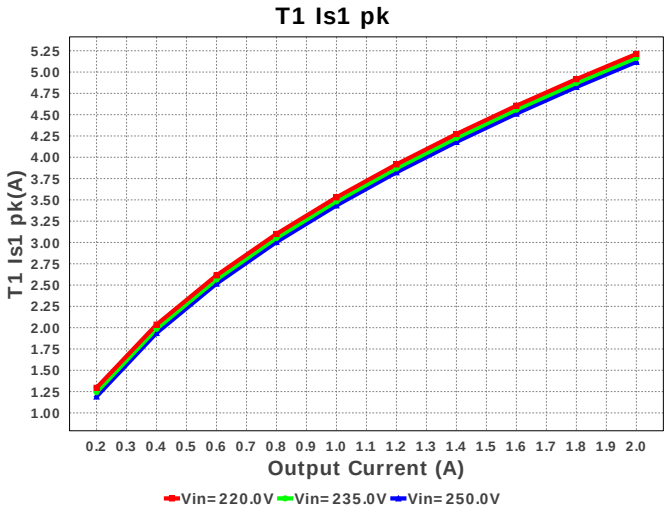












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	358.628 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	3.348 A	Current	Output capacitor RMS ripple current
3.	Iin rms	197.72 mA	Current	RMS Input Current
4.	T1 Iprim RMS	314.085 mA	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	1.24 A	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	3.866 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	7.436 A	Current	Transformer Secondary1 Peak Current
8.	Avg Rectified Vin	353.3 V	General	Average Rectified Voltage for the AC Line Period
9.	BOM Count	36	General	Total Design BOM count
10.	FootPrint	1.401 k mm^2	General	Total Foot Print Area of BOM components
11.	Pout	46.329 W	General	Total output power
12.	Total BOM	$0.0	General	Total BOM Cost
13.	D1a Tj	97.115 degC	Op_Point	D1 junction temperature
14.	D1b Tj	97.115 degC	Op_Point	D1 junction temperature
15.	Vout Actual	23.164 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
16.	Vout OP	23.164 V	Op_Point	Operational Output Voltage
17.	Duty Cycle	20.72 %	Op_point	Duty cycle
18.	Efficiency	93.725 %	Op_point	Steady state efficiency
19.	Frequency_	130.0 kHz	Op_point	Switching frequency
20.	IC Tj	33.712 degC	Op_point	IC junction temperature
21.	ICThetaJA	200.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
22.	IOUT_OP	2.0 A	Op_point	Iout operating point
23.	M2 TjOP	31.267 degC	Op_point	M2 MOSFET junction temperature
24.	Min Rectified Vin	353.1 V	Op_point	Minimum voltage seen at rectified input
25.	Peak Rectified Vin	353.5 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	104.102 mV	Op_point	Peak-to-peak output ripple voltage
28.	Avg Bridge Diode Pd	177.771 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
29.	Cin Pd	186.49 mW	Power	Input capacitor power dissipation
30.	Cout Pd	156.905 mW	Power	Output capacitor power dissipation
31.	D1a Pd	762.674 mW	Power	Diode1 power dissipation

#	Name	Value	Category	Description
32.	D1b Pd	762.674 mW	Power	Diode1 power dissipation
33.	IC Pd	18.562 mW	Power	IC power dissipation
34.	M2 Pd	832.934 mW	Power	M2 MOSFET total power dissipation
35.	Total Pd	3.102 W	Power	Total Power Dissipation
36.	Xformer Pd	539.333 mW	Power	Transformer power dissipation
37.	Vout Tolerance	2.129 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	2.0	Maximum Output Current
2.	Iout1	2.0	Output Current #1
3.	Iout2	3.0	Output Current #2
4.	Iout3	2.0	Output Current #3
5.	VinMax	250.0	Maximum input voltage
6.	VinMin	220.0	Minimum input voltage
7.	Vout	23.0	Output Voltage
8.	Vout1	23.0	Output Voltage #1
9.	Vout2	5.0	Output Voltage #2
10.	Vout3	5.0	Output Voltage #3
11.	acFrequency	60.0	Light Output in Lumen
12.	base_pn	LM5023	Texas Instruments Base Part Number
13.	source	AC	Input Source Type
14.	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.