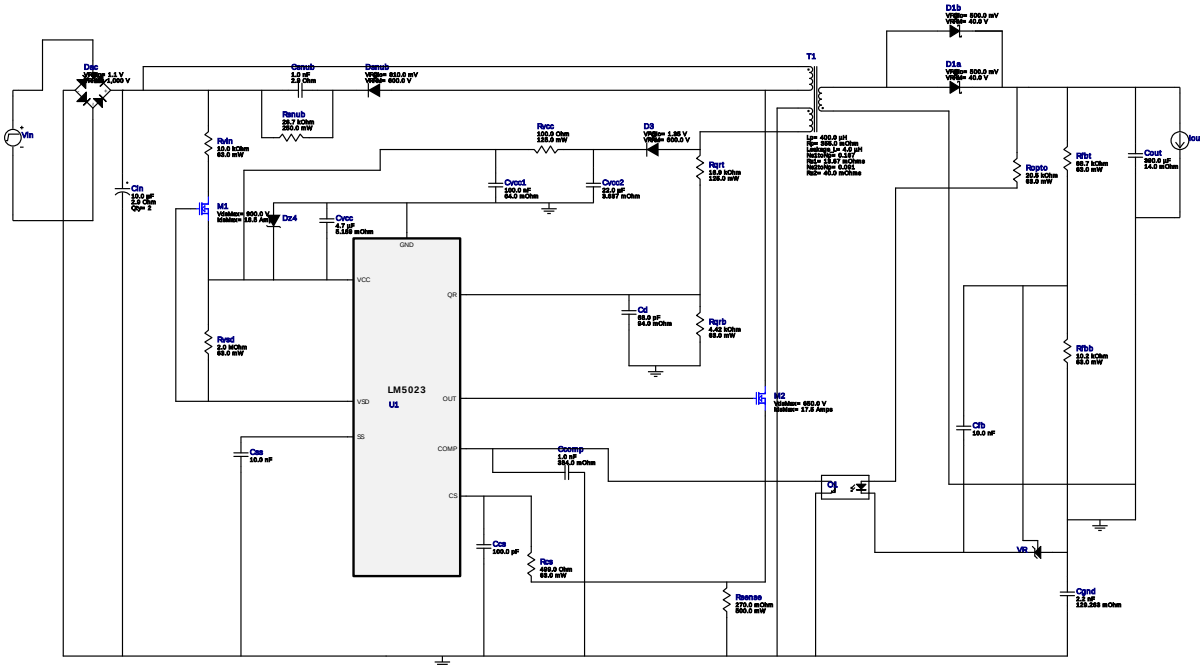


WEBENCH® Design Report

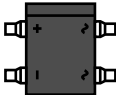
Design : 4108001/7 LM5023MM-2/NOPB
LM5023MM-2/NOPB 220.0V-230.0V to 24.19V @ 2.0A

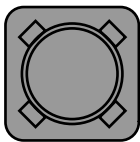


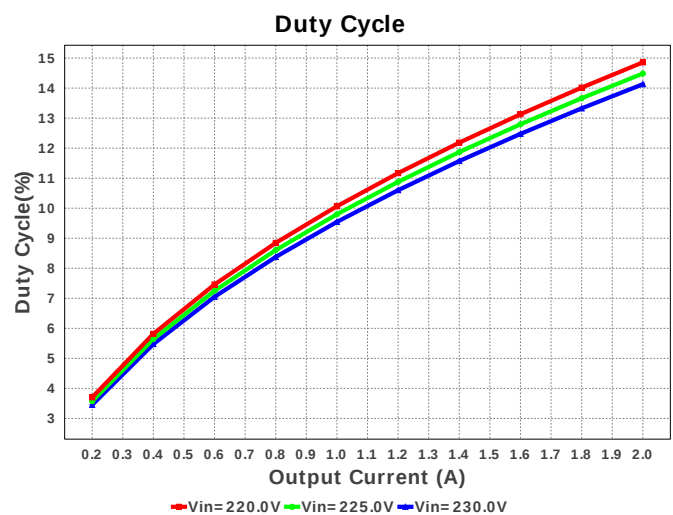
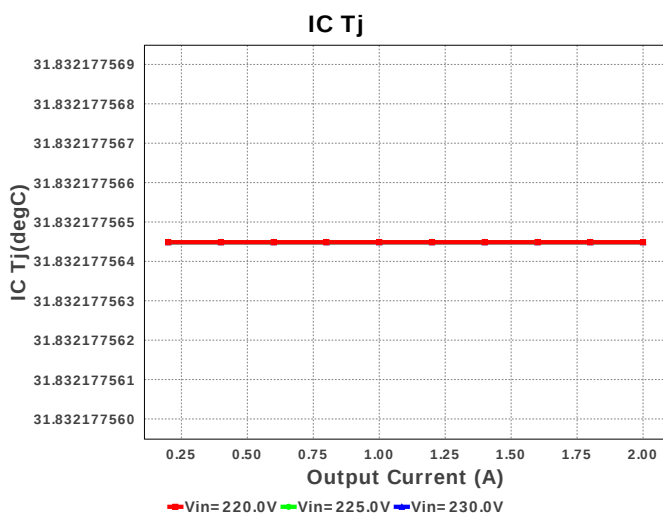
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

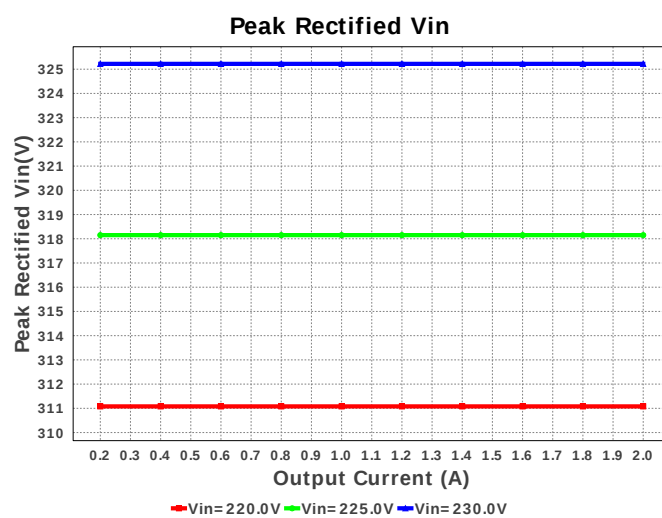
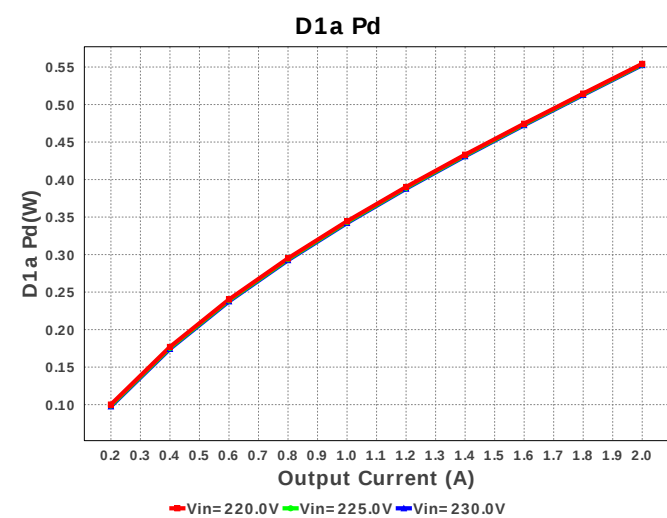
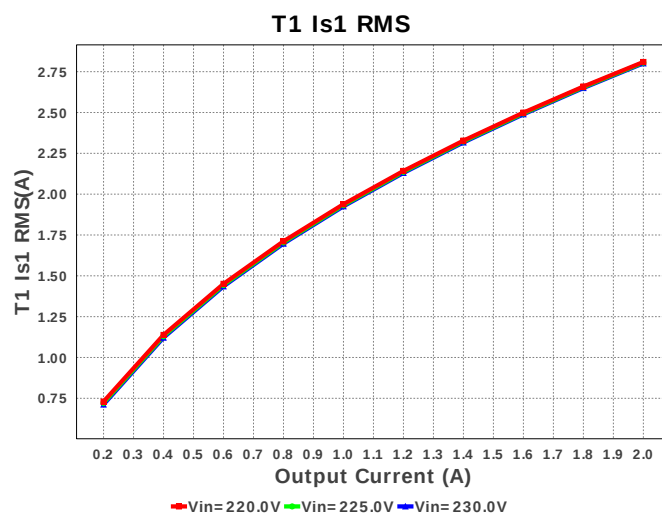
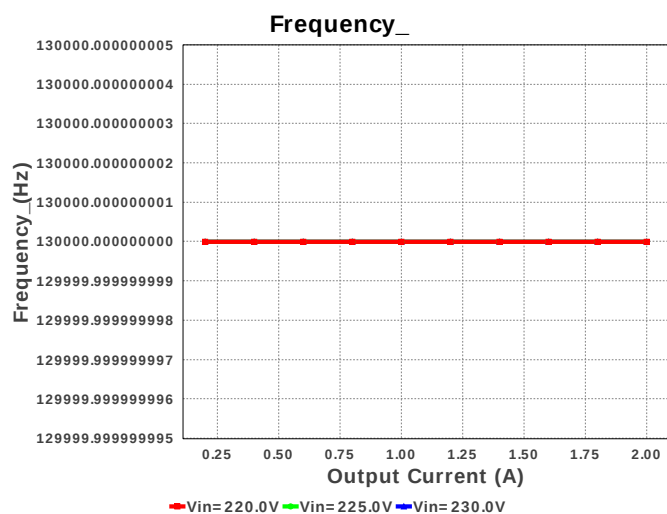
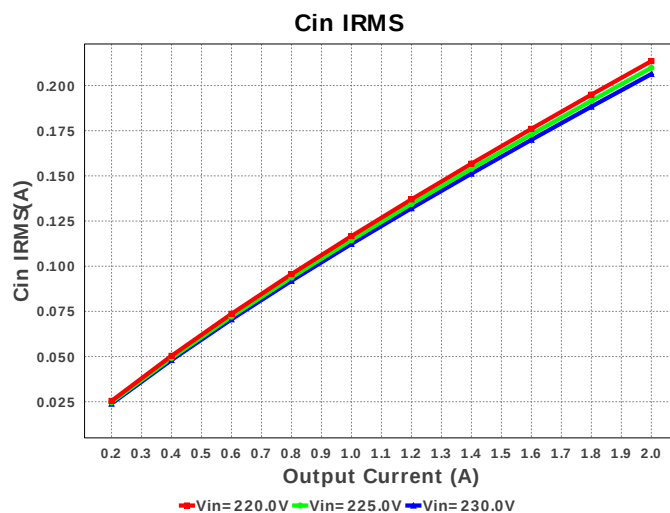
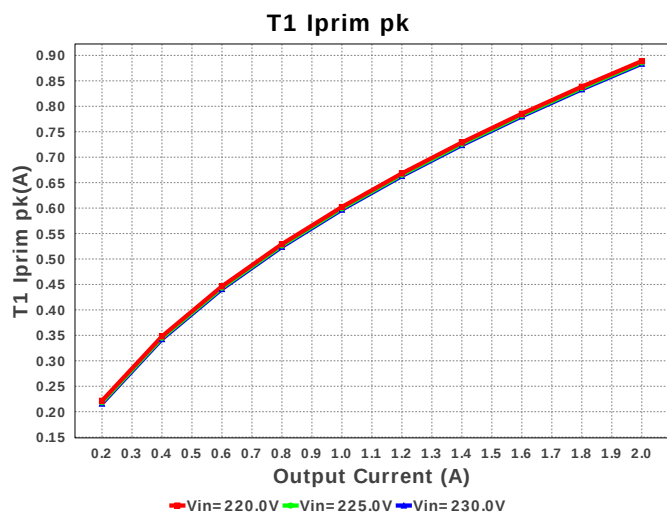
Electrical BOM

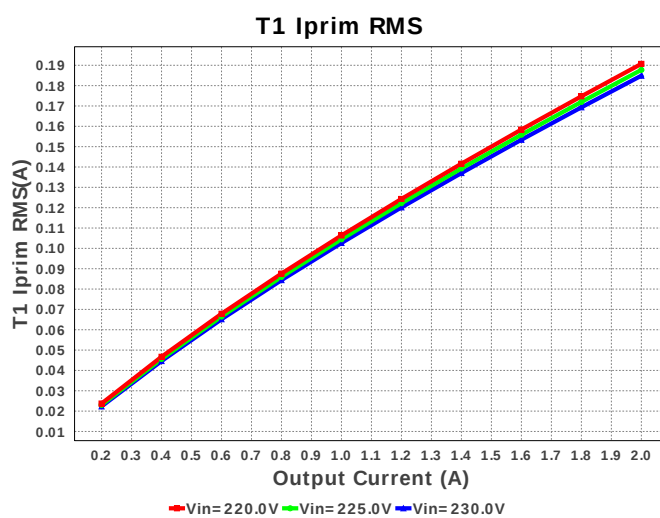
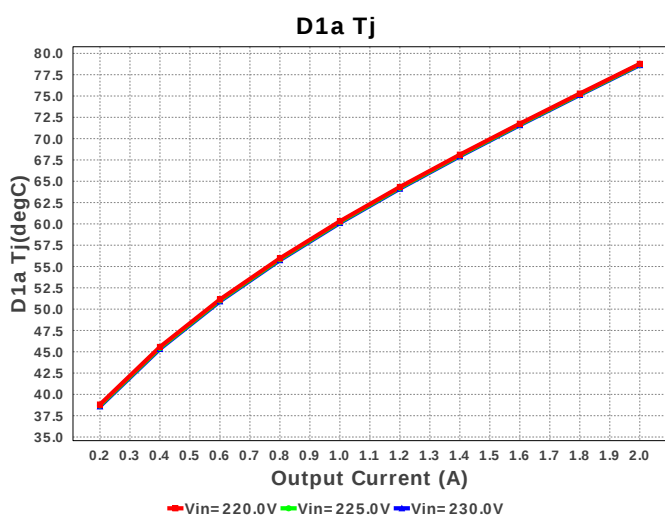
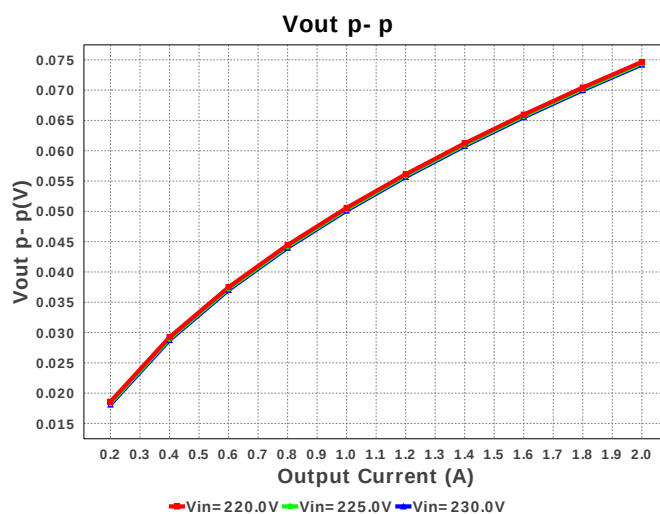
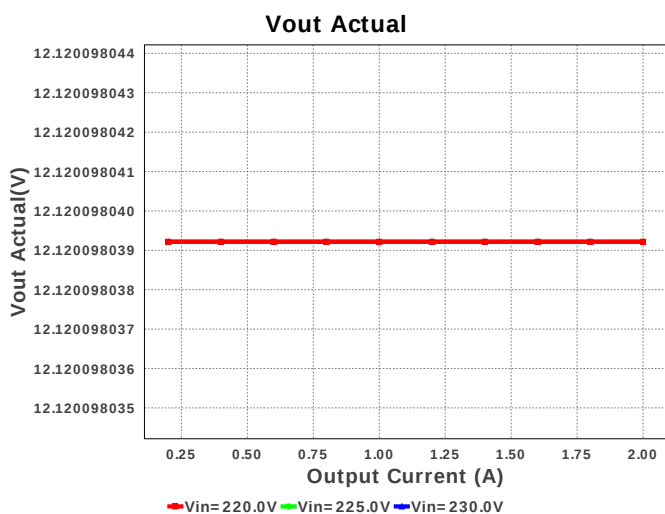
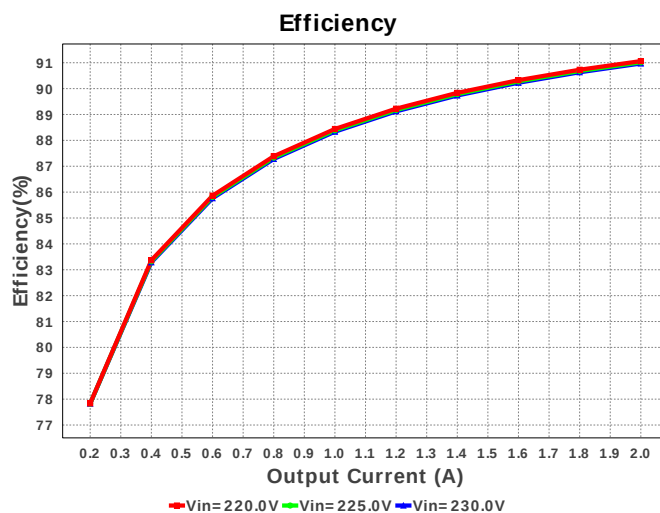
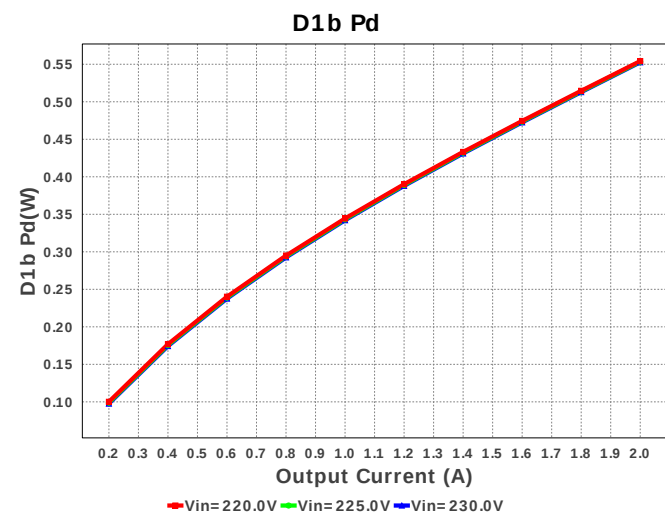
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	\$0.01	0805 7 mm ²
2.	Ccs	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	\$0.01	0201 2 mm ²
3.	Cd	Kemet	C0805C680J5GACTU Series= C0G/NP0	Cap= 68.0 pF ESR= 94.0 mOhm VDC= 50.0 V IRMS= 603.0 mA	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	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	20SPVF390M Series= ?	Cap= 390.0 uF ESR= 14.0 mOhm VDC= 20.0 V IRMS= 4.95 A	1	\$0.63	 CAPSMT_62_E12 106 mm ²
8.	Csnub	MuRata	GRM188R72E102KW07D Series= X7R	Cap= 1.0 nF ESR= 2.9 Ohm VDC= 250.0 V IRMS= 90.0 mA	1	\$0.01	 0603 5 mm ²
9.	Css	MuRata	GRM155R71E103KA01D Series= X7R	Cap= 10.0 nF 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= 5.189 mOhm VDC= 25.0 V IRMS= 2.03531 A	1	\$0.02	 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= 3.637 mOhm VDC= 16.0 V IRMS= 3.4771 A	1	\$0.13	 1206_190 11 mm ²
13.	D1a	Vishay-Semiconductor	SS14-E3/61T	VF@Io= 500.0 mV VRRM= 40.0 V	1	\$0.08	 SMA 37 mm ²
14.	D1b	Vishay-Semiconductor	SS14-E3/61T	VF@Io= 500.0 mV VRRM= 40.0 V	1	\$0.08	 SMA 37 mm ²
15.	D3	Micro Commercial Components	ES1J-TP	VF@Io= 1.35 V VRRM= 600.0 V	1	\$0.08	 SMA 37 mm ²
16.	Dac	Vishay-Semiconductor	DF10SA	VF@Io= 1.1 V VRRM= 1,000.0 V	1	\$0.24	 DF-S 99 mm ²
17.	Dsnub	ON Semiconductor	MURS360T3	VF@Io= 810.0 mV VRRM= 600.0 V	1	\$1.12	 SMC 83 mm ²
18.	Dz4	NXP Semiconductor	BZX585-C22,115	Zener	1	\$0.02	 SOD-523 5 mm ²
19.	M1	STMicroelectronics	STW21N90K5	VdsMax= 900.0 V IdsMax= 18.5 Amps	1	\$3.94	 TO-247 123 mm ²
20.	M2	Infineon Technologies	IPP65R190CFD	VdsMax= 650.0 V IdsMax= 17.5 Amps	1	\$2.34	TO-220 0 mm ²
21.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	\$0.38	 SSOP-4 111 mm ²
22.	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
23.	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
24.	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

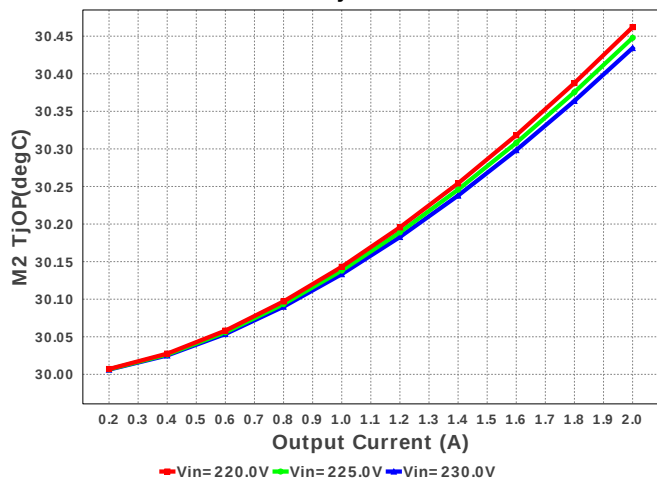
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
25.	Ropto	Vishay-Dale	CRCW040220K5FKED Series= CRCW..e3	Res= 20.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
26.	Rqrb	Vishay-Dale	CRCW04024K42FKED Series= CRCW..e3	Res= 4.42 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
27.	Rqrt	Panasonic	ERJ-6ENF1692V Series= ERJ-6E	Res= 16.9 kOhm Power= 125.0 mW Tolerance= 1.0%	1	\$0.01	 0805 7 mm²
28.	Rsense	Rohm	MCR25JZHFLR270 Series= MCR25	Res= 270.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	\$0.03	 1210 15 mm²
29.	Rsnu	Panasonic	ERJ-8ENF2672V Series= ERJ-8E	Res= 26.7 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.	Rvsn	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	Würth 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 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



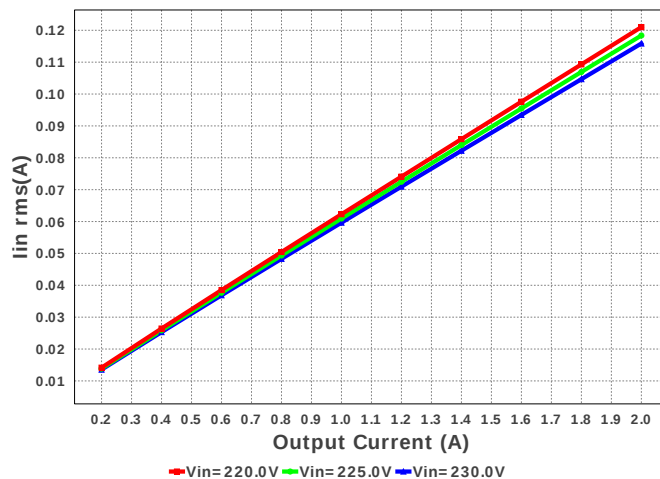




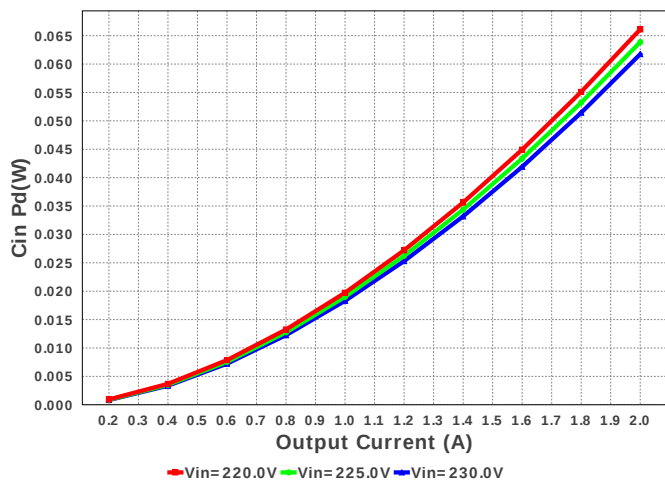
M2 TjOP



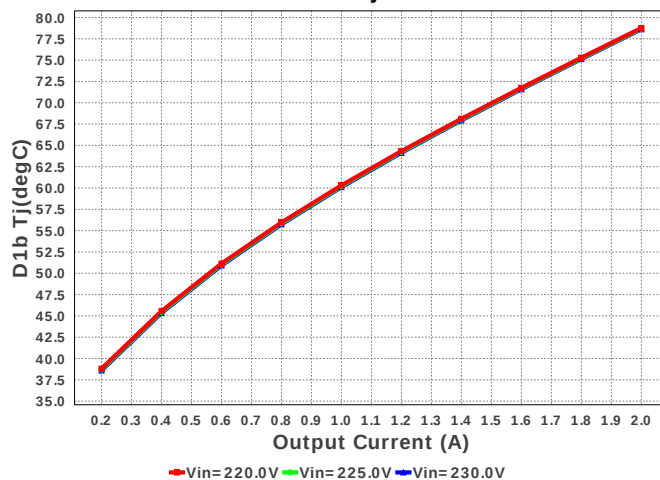
lin rms



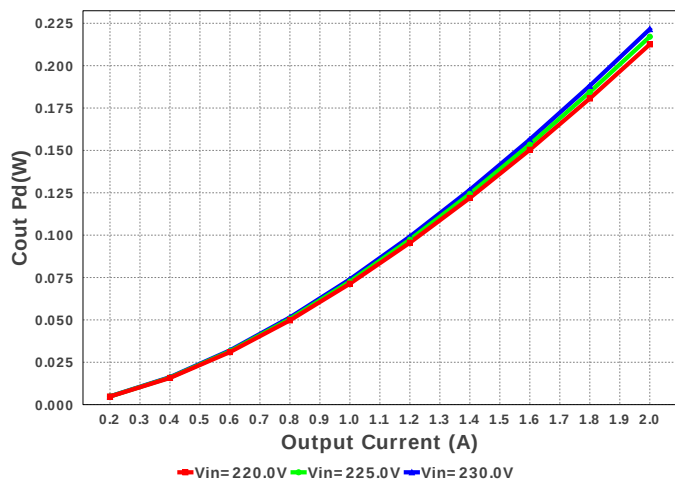
Cin Pd



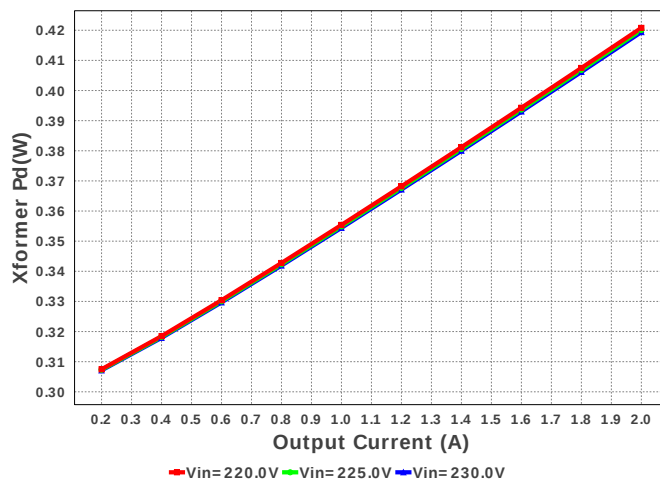
D1b Tj

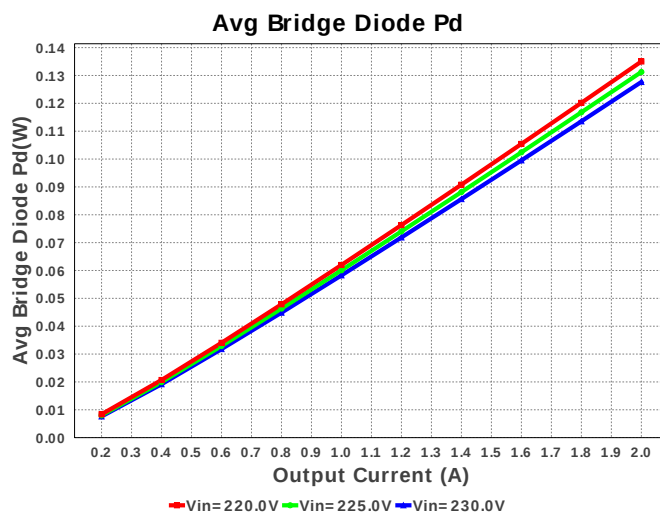
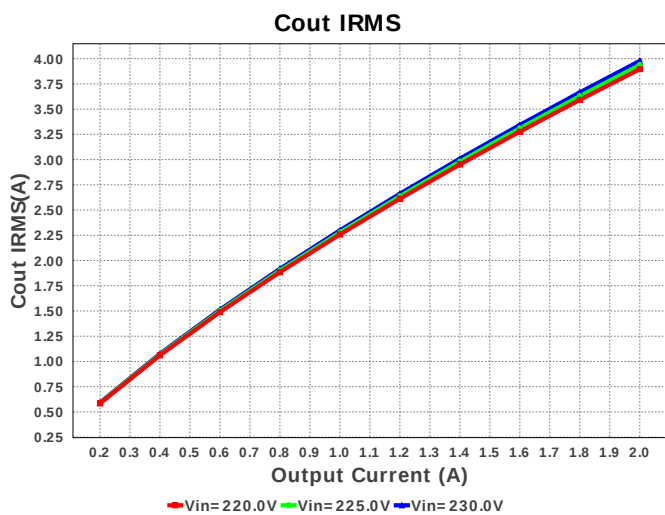
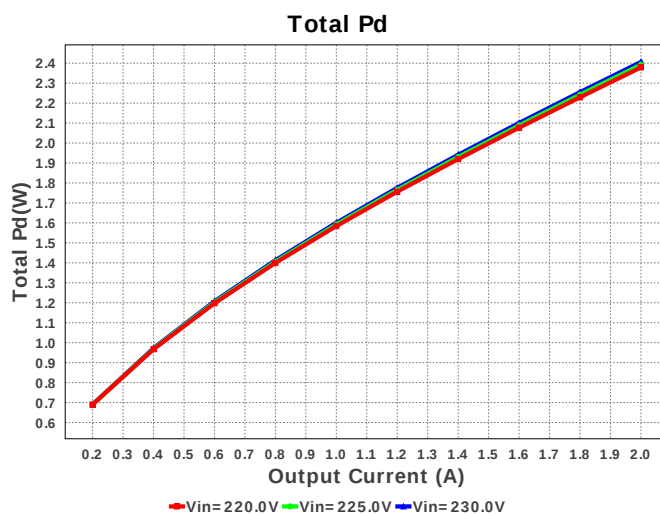
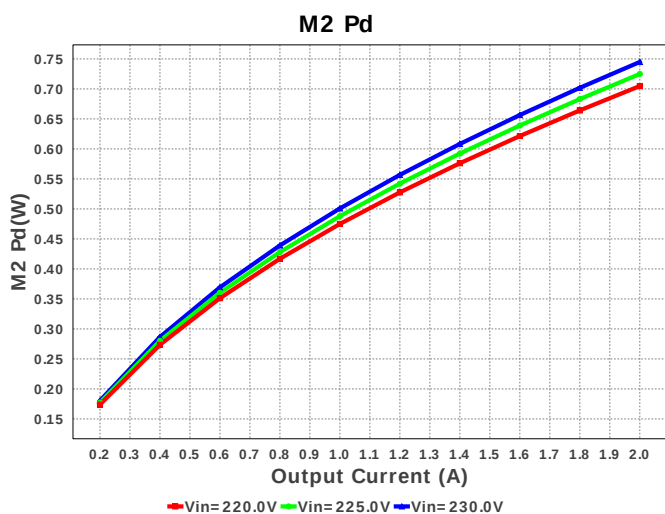
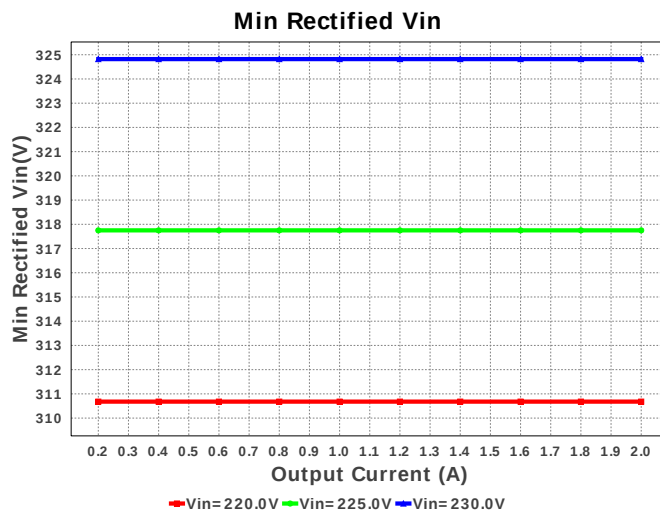
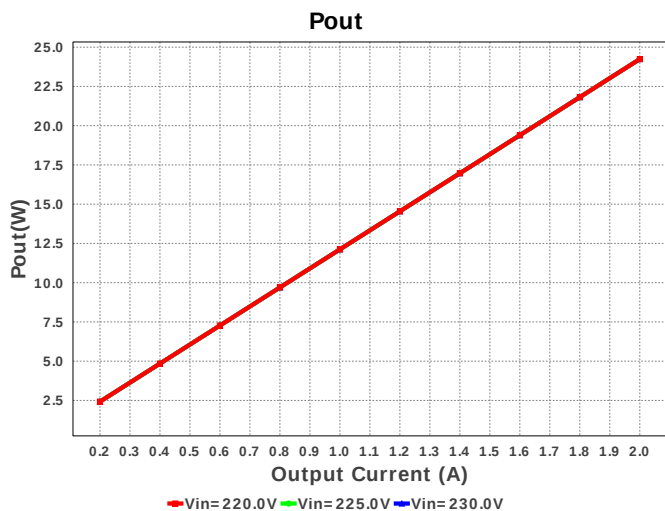


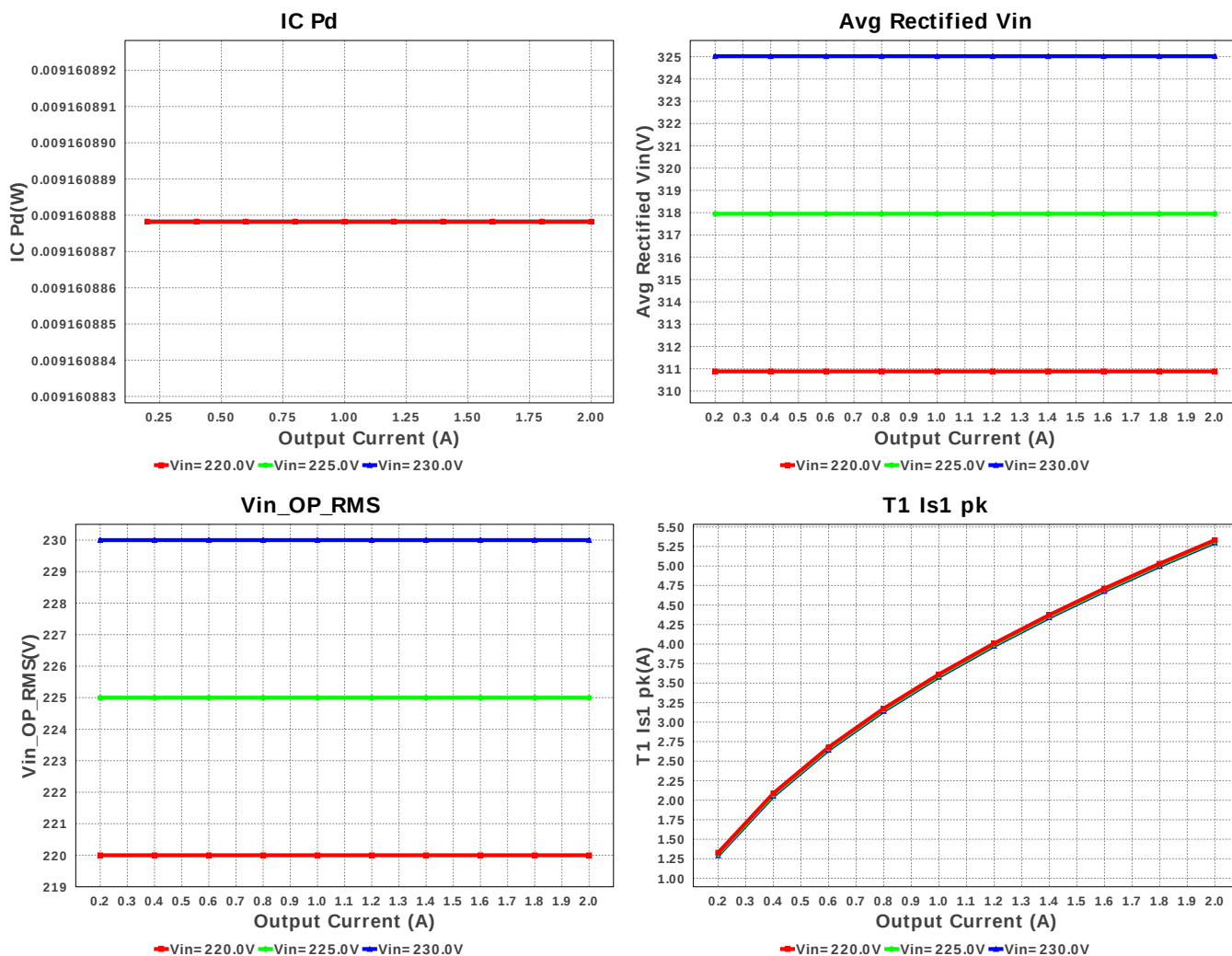
Cout Pd



Xformer Pd







Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	377.932 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	3.297 A	Current	Output capacitor RMS ripple current
3.	Iin rms	223.34 mA	Current	RMS Input Current
4.	T1 Iprim RMS	328.665 mA	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	1.278 A	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	3.95 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	7.664 A	Current	Transformer Secondary1 Peak Current
8.	Avg Rectified Vin	325.02 V	General	Average Rectified Voltage for the AC Line Period
9.	BOM Count	36	General	Total Design BOM count
10.	FootPrint	1.409 k mm ²	General	Total Foot Print Area of BOM components
11.	Mode	DCM	General	Conduction Mode
12.	Pout	48.383 W	General	Total output power
13.	Total BOM	\$0.0	General	Total BOM Cost
14.	D1a Tj	98.565 degC	Op_Point	D1 junction temperature
15.	D1b Tj	98.565 degC	Op_Point	D1 junction temperature
16.	Vout Actual	24.192 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
17.	Vout OP	24.192 V	Op_Point	Operational Output Voltage
18.	Duty Cycle	21.357 %	Op_point	Duty cycle
19.	Efficiency	94.189 %	Op_point	Steady state efficiency
20.	Frequency_	130.0 kHz	Op_point	Switching frequency
21.	IC Tj	33.874 degC	Op_point	IC junction temperature
22.	ICThetaJA	200.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
23.	IOUT_OP	2.0 A	Op_point	Iout operating point
24.	M2 TjOP	31.39 degC	Op_point	M2 MOSFET junction temperature
25.	Min Rectified Vin	324.82 V	Op_point	Minimum voltage seen at rectified input
26.	Peak Rectified Vin	325.22 V	Op_point	Peak voltage seen at rectified input
27.	Vin_OP_RMS	230.0 V	Op_point	AC Input RMS Voltage
28.	Vout p-p	107.299 mV	Op_point	Peak-to-peak output ripple voltage
29.	Avg Bridge Diode Pd	190.554 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
30.	Cin Pd	207.108 mW	Power	Input capacitor power dissipation
31.	Cout Pd	152.222 mW	Power	Output capacitor power dissipation

#	Name	Value	Category	Description
32.	D1a Pd	779.146 mW	Power	Diode1 power dissipation
33.	D1b Pd	779.146 mW	Power	Diode1 power dissipation
34.	IC Pd	19.369 mW	Power	IC power dissipation
35.	M2 Pd	655.242 mW	Power	M2 MOSFET total power dissipation
36.	Total Pd	2.985 W	Power	Total Power Dissipation
37.	Xformer Pd	551.58 mW	Power	Transformer power dissipation
38.	Vout Tolerance	2.138 %		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.	VinMax	230.0	Maximum input voltage
3.	VinMin	220.0	Minimum input voltage
4.	Vout	24.0	Output Voltage
5.	acFrequency	50.0	Light Output in Lumen
6.	base_pn	LM5023	Texas Instruments Base Part 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 fine 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.

Texas Instruments' WEBENCH simulation tools attempt to recreate the performance of a substantially equivalent physical implementation of the design. Simulations are created using Texas Instruments' published specifications as well as the published specifications of other device manufacturers. While Texas Instruments does update this information periodically, this information may not be current at the time the simulation is built. Texas Instruments does not warrant the accuracy or completeness of the specifications or any information contained therein. Texas Instruments does not warrant that any designs or recommended parts will meet the specifications you entered, will be suitable for your application or fit for any particular purpose, or will operate as shown in the simulation in a physical implementation. Texas Instruments does not warrant that the designs are production worthy.

You should completely validate and test your design implementation to confirm the system functionality for your application prior to production.

Use of Texas Instruments' WEBENCH simulation tools is subject to [Texas Instruments' Site Terms and Conditions of Use](#). Prototype boards based on WEBENCH created designs are provided AS IS without warranty of any kind for evaluation and testing purposes and are subject to the terms of the [Evaluation License Agreement](#).