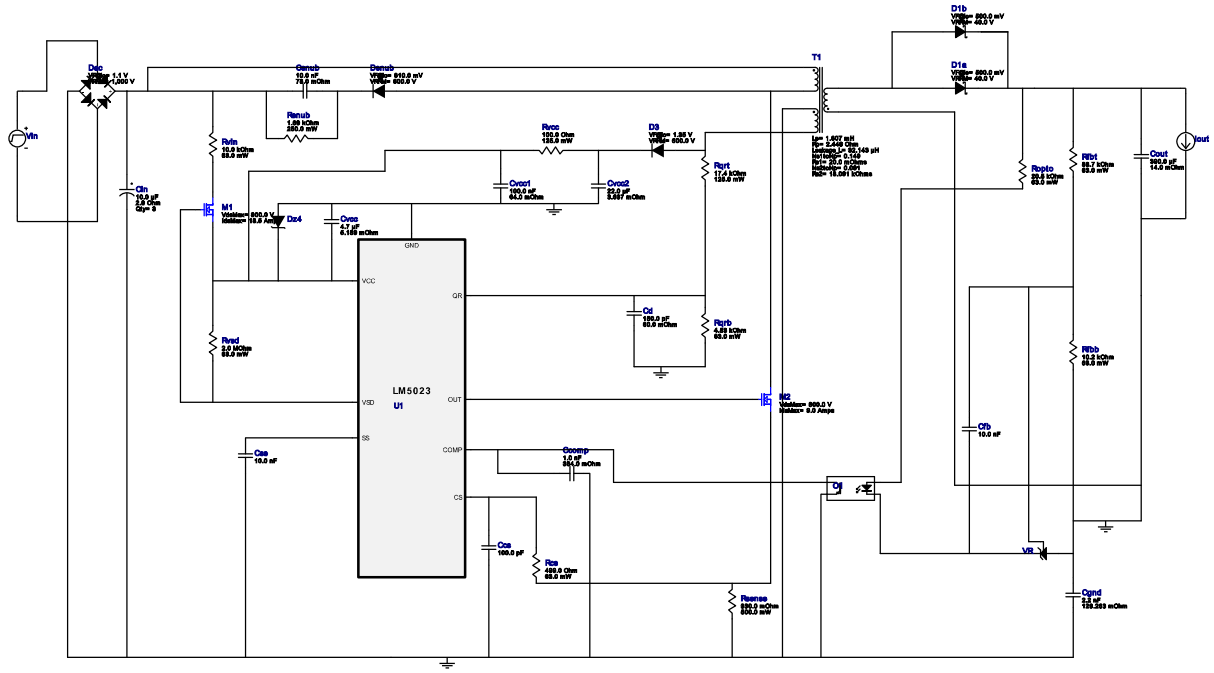
WEBENCH® Design Report

VinMin = 180.0V
VinMax = 240.0V
Vout = 24.0V
Iout = 2.0A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 9/22/16 9:11:00 PM
BOM Cost = $0.00
BOM Count = 37
Total Pd = 1.75W

Design : 4105594/26 LM5023MM-2/NOPB
LM5023MM-2/NOPB 180.0V-240.0V to 24.19V @ 2.0A



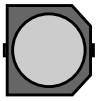
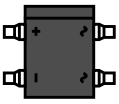
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

My Comments

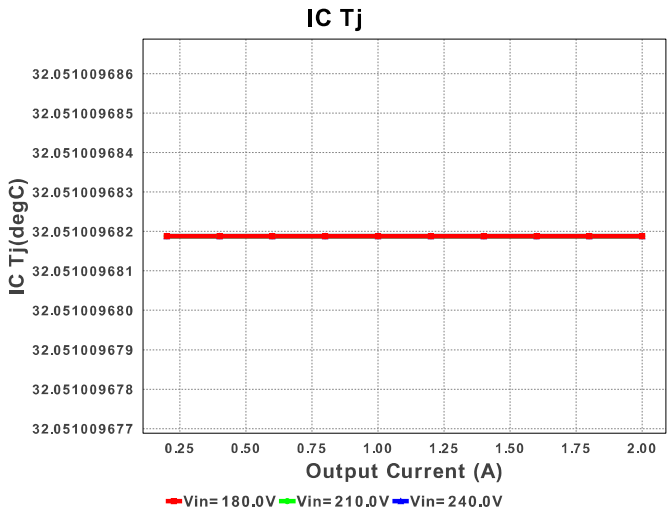
No comments

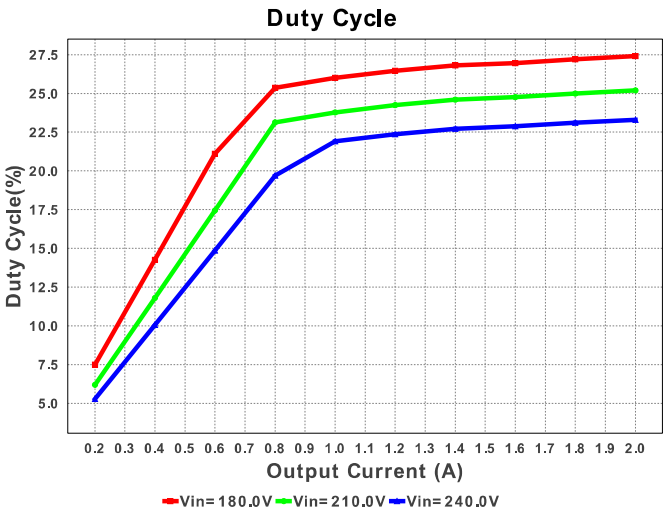
Electrical BOM

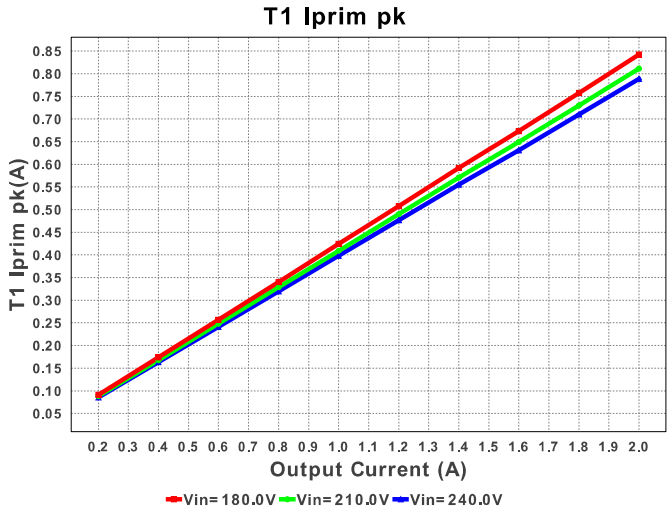
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	$0.01	0805 7 mm²
2.	Ccs	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm²
3.	Cd	Kemet	C0805C151J5GACTU Series= C0G/NP0	Cap= 150.0 pF ESR= 60.0 mOhm VDC= 50.0 V IRMS= 676.0 mA	1	$0.01	0805 7 mm²
4.	Cfb	MuRata	GRM155R71E103KA01D Series= X7R	Cap= 10.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm²
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 mm²
6.	Cin	Kemet	ESG106M400AH4AA Series= 2334	Cap= 10.0 uF ESR= 2.9 Ohm VDC= 400.0 V IRMS= 100.0 mA	3	$0.19	ESG106 144 mm²

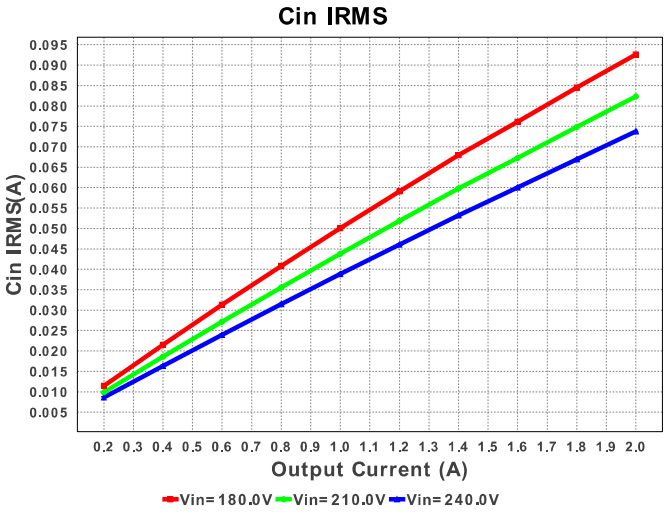
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
7.	Cout	Panasonic	20SVPF390M Series= ?	Cap= 390.0 uF ESR= 14.0 mOhm VDC= 20.0 V IRMS= 4.95 A	1	$0.63	 CAPSMT_62_E12 106 mm²
8.	Csnub	AVX	08051C103KAT2A Series= X7R	Cap= 10.0 nF ESR= 78.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm²
9.	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	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	CRCW040288K7FKED Series= CRCW..e3	Res= 88.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²

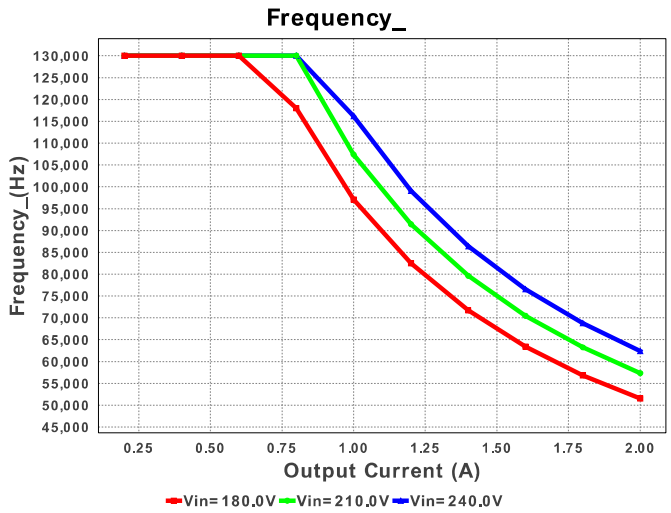
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
25.	Ropto	Vishay-Dale	CRCW040220K5FKED Series= CRCW..e3	Res= 20.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
26.	Rqrb	Vishay-Dale	CRCW04024K53FKED Series= CRCW..e3	Res= 4.53 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
27.	Rqrt	Panasonic	ERJ-6ENF1742V Series= ERJ-6E	Res= 17.4 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
28.	Rsense	Rohm	MCR25JZHFLR330 Series= MCR25	Res= 330.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.03	 1210 15 mm²
29.	Rsnub	Panasonic	ERJ-8ENF1691V Series= ERJ-8E	Res= 1.69 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= 1.607 mH Rp= 2.446 Ohm Leakage_L= 32.143 µH Ns1toNp= 0.149 Rs1= 20.0 mOhms Ns2toNp= 0.091 Rs2= 18.091 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

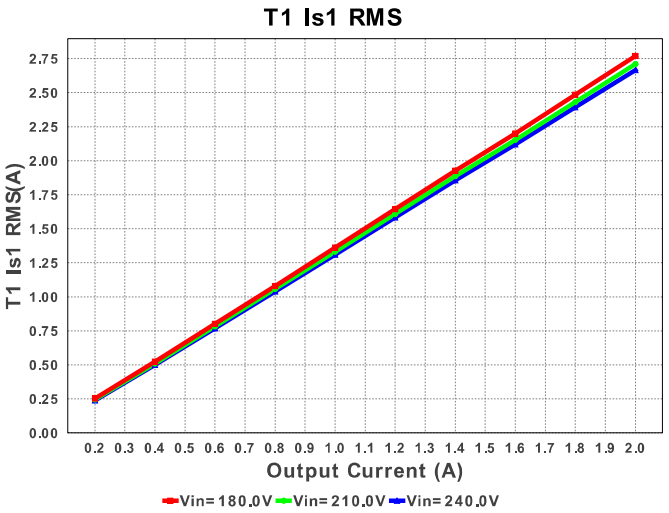




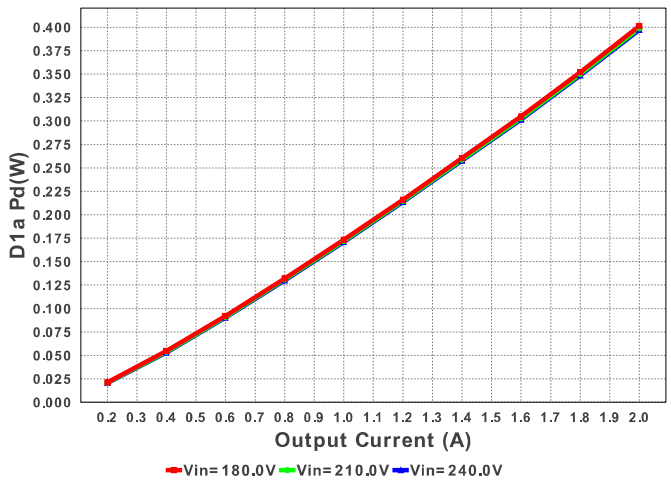




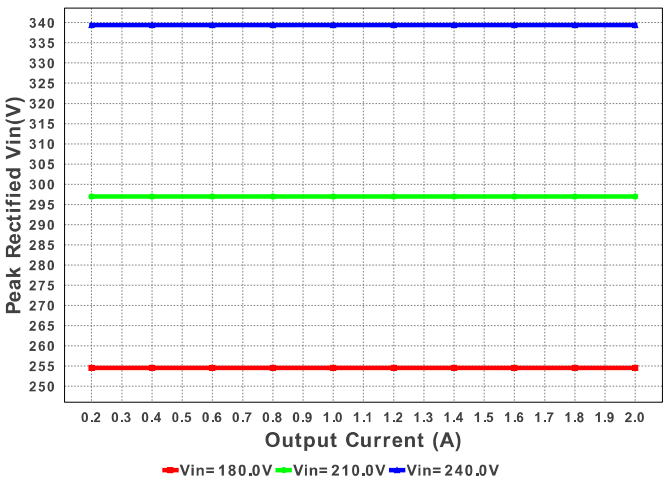




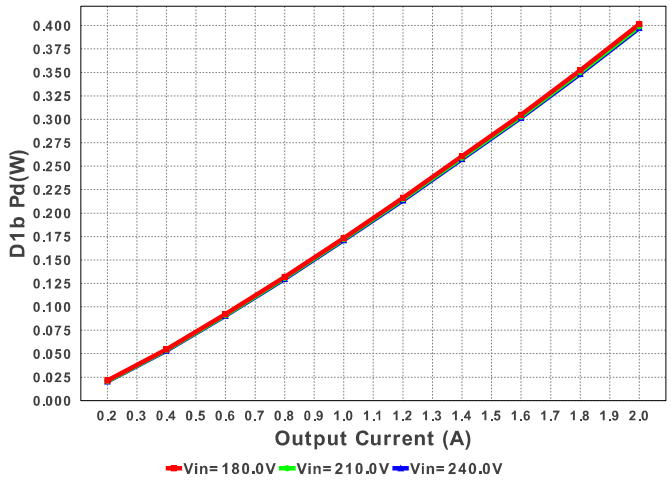
D1a Pd



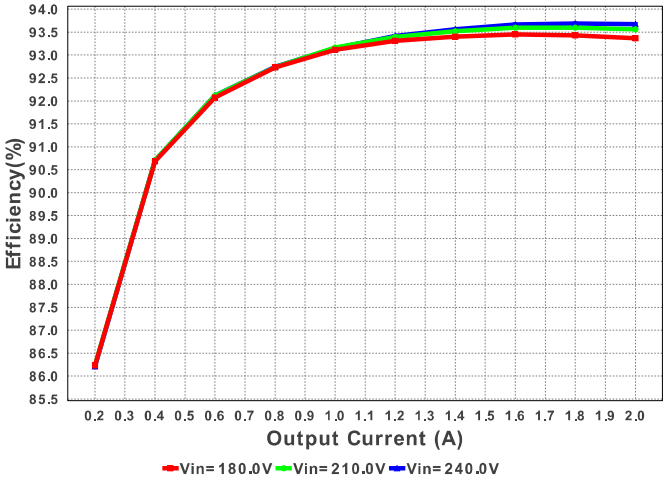
Peak Rectified Vin



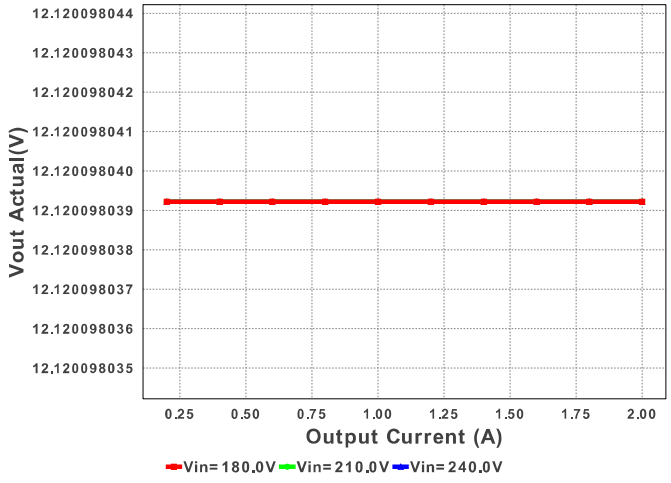
D1b Pd



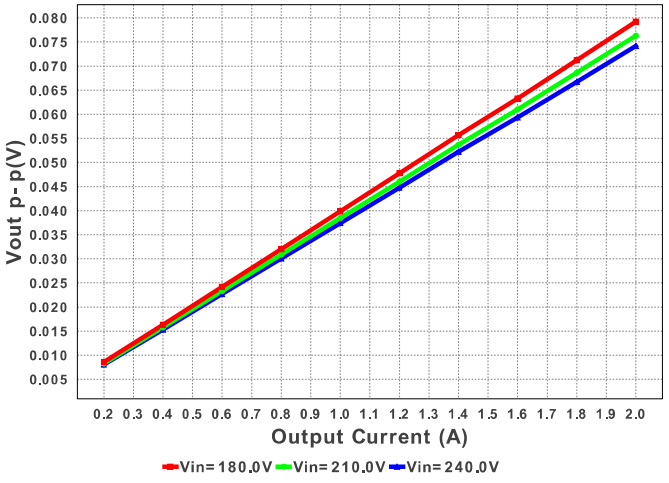
Efficiency

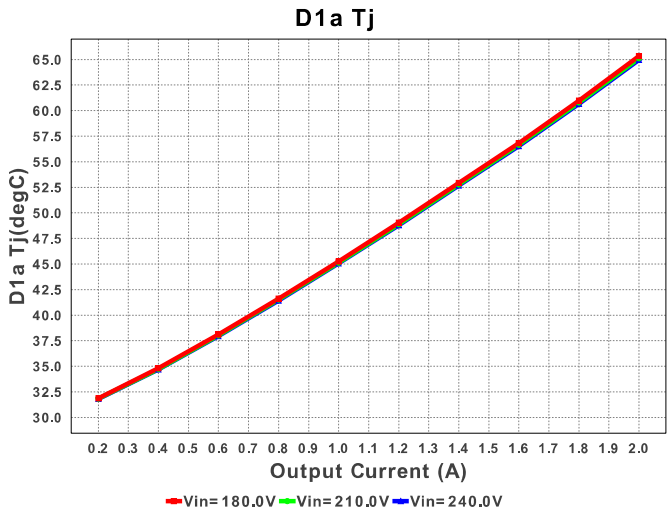


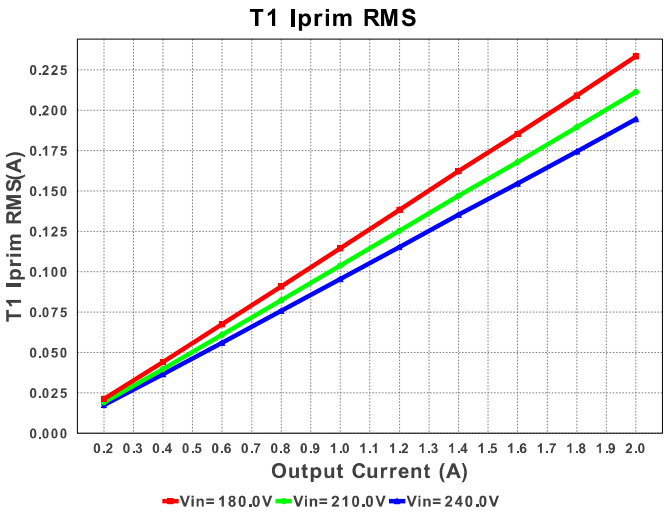
Vout Actual

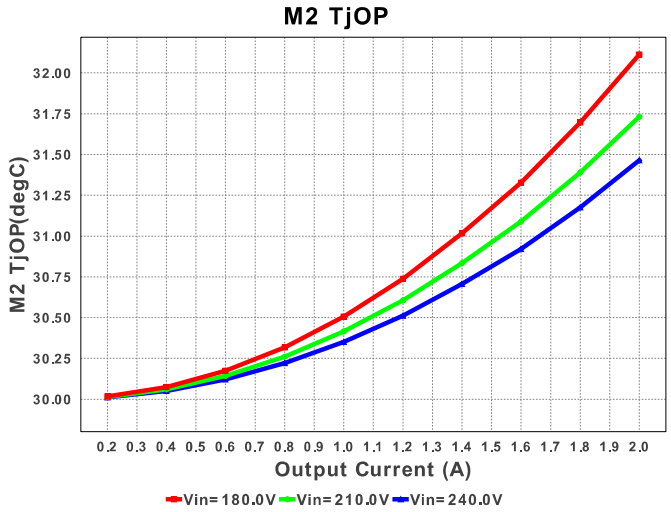


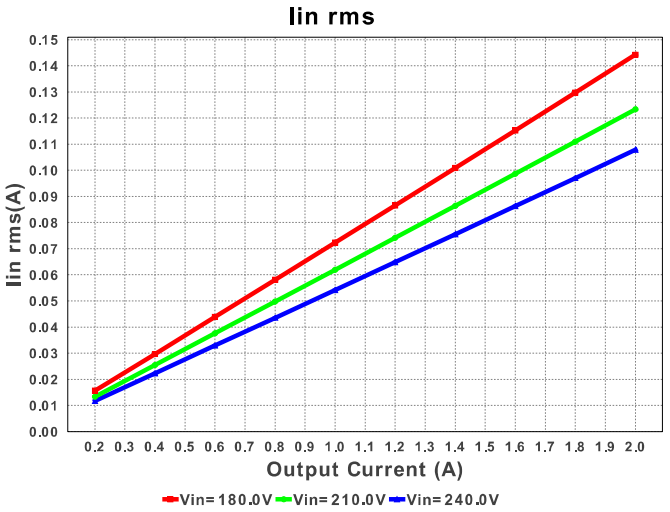
Vout p-p

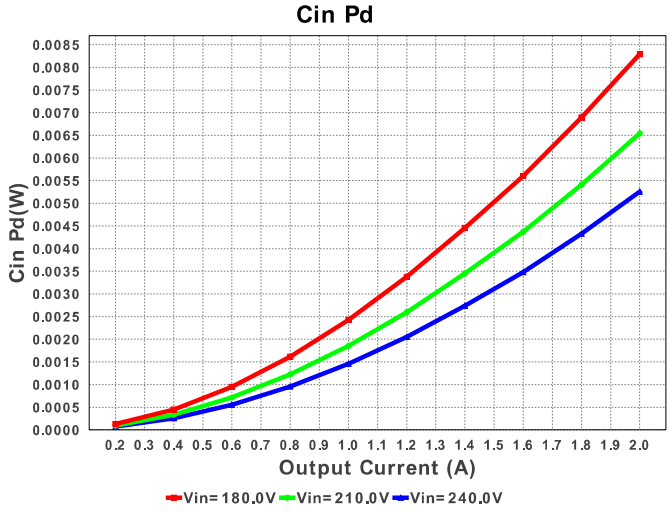


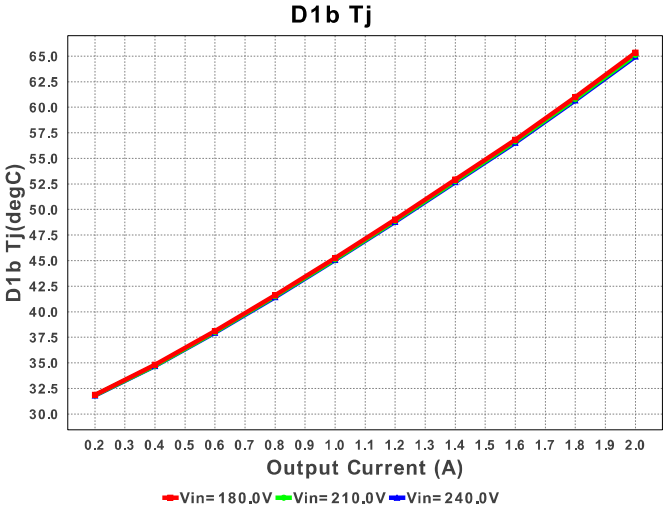


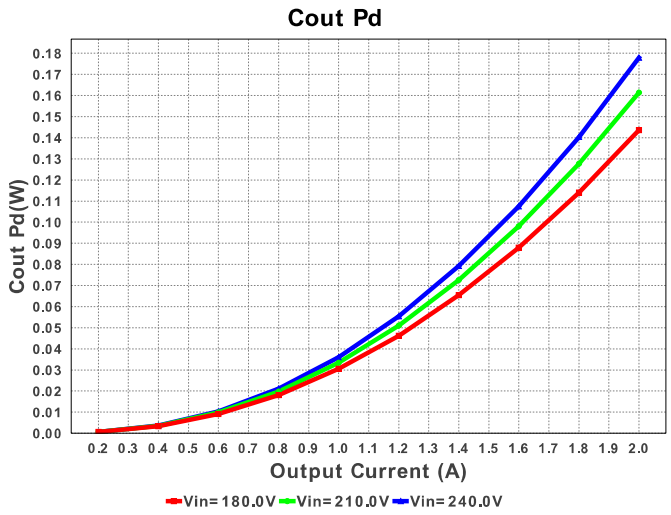


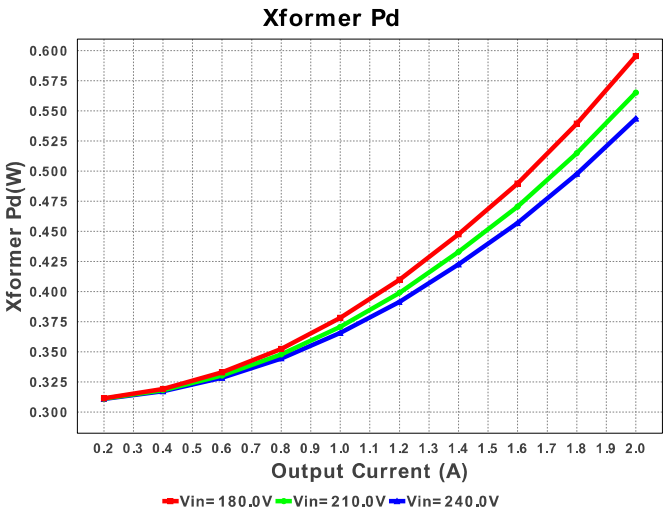


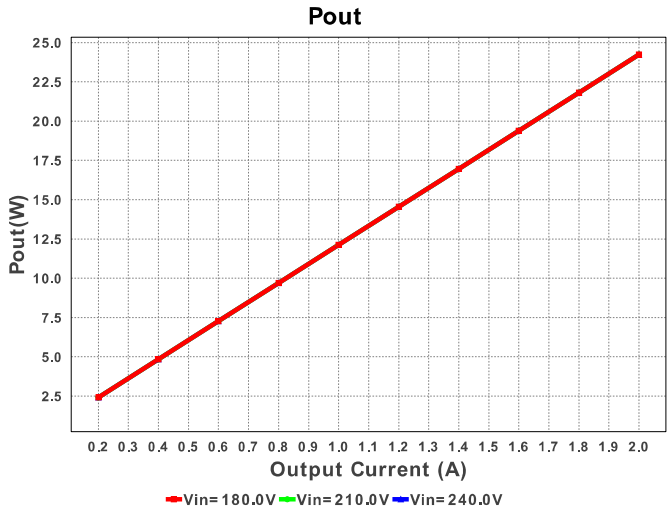


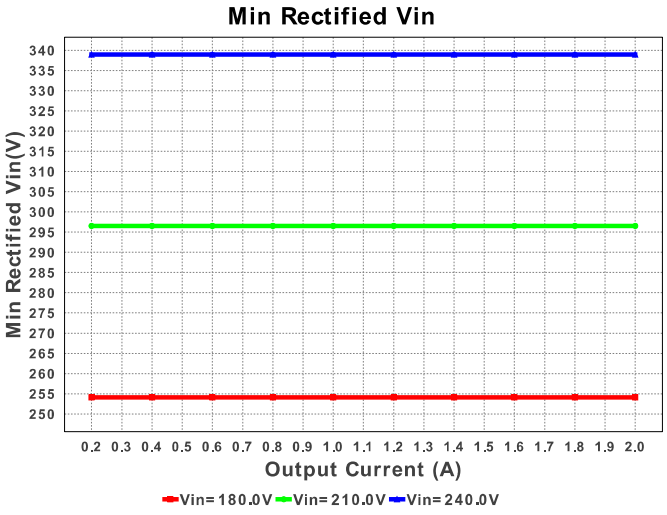


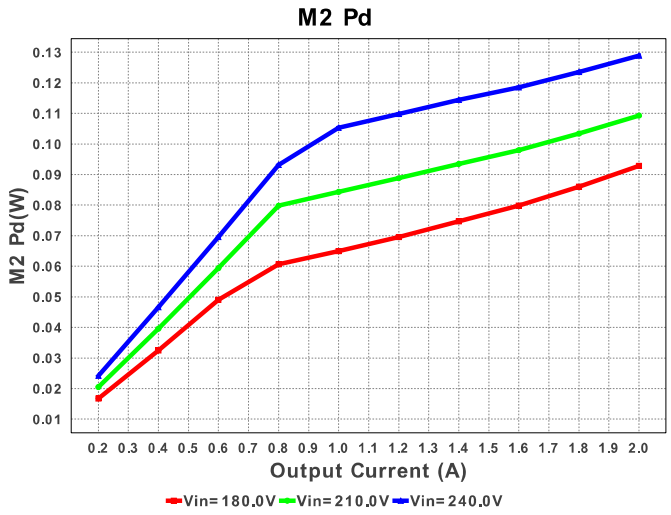


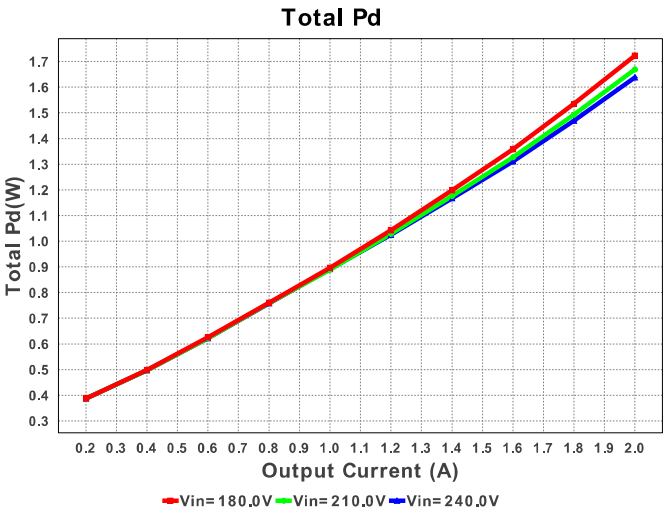


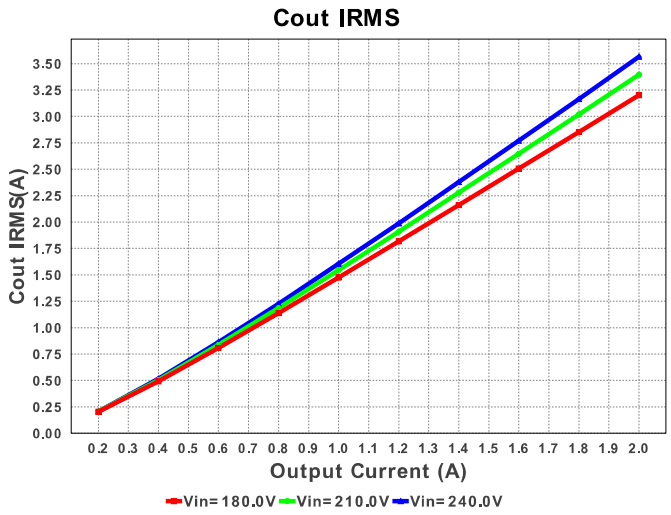


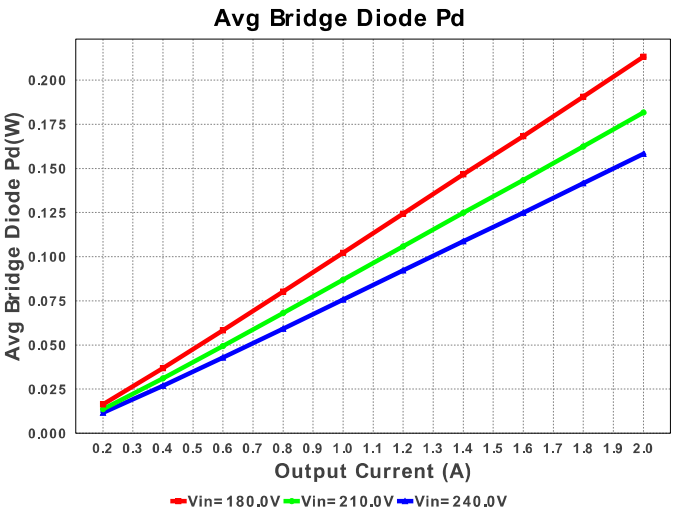


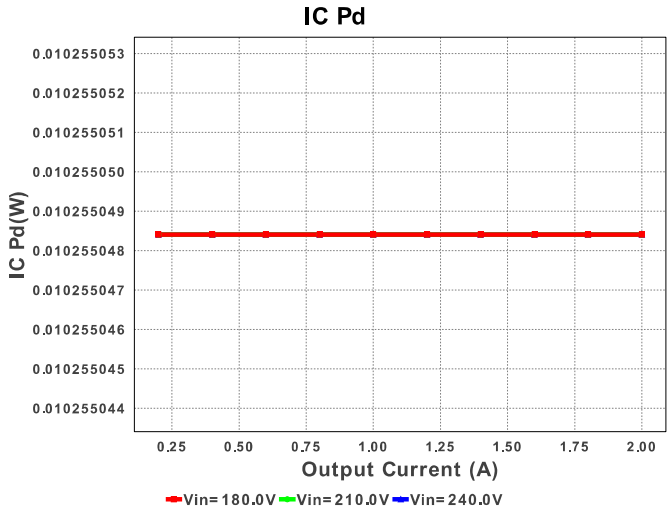


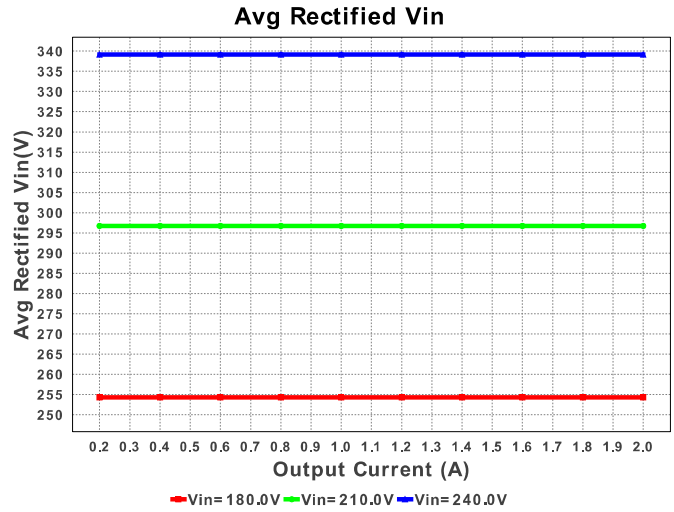


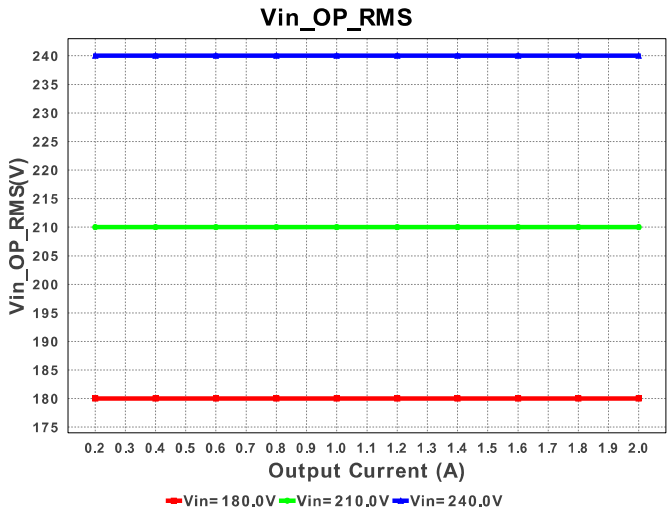


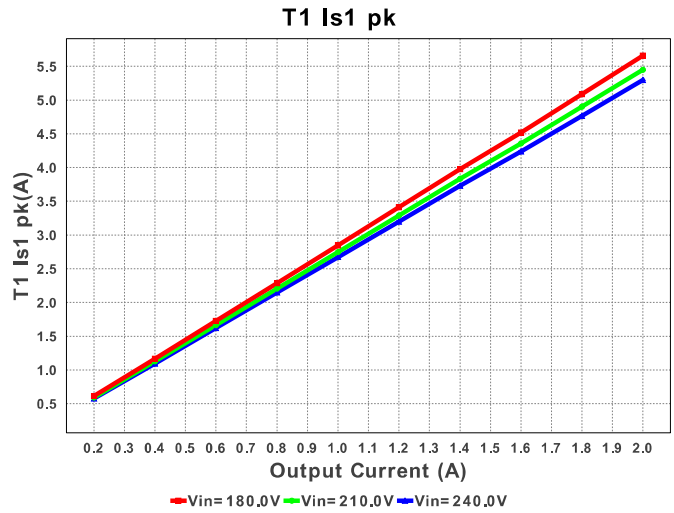












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	132.978 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	2.531 A	Current	Output capacitor RMS ripple current
3.	Iin rms	208.89 mA	Current	RMS Input Current
4.	T1 Iprim RMS	286.135 mA	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	901.943 mA	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	2.615 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	6.056 A	Current	Transformer Secondary1 Peak Current
8.	Avg Rectified Vin	339.16 V	General	Average Rectified Voltage for the AC Line Period
9.	BOM Count	37	General	Total Design BOM count
10.	FootPrint	1.329 k mm^2	General	Total Foot Print Area of BOM components
11.	Mode	DCM	General	Conduction Mode

#	Name	Value	Category	Description
12.	Pout	48.383 W	General	Total output power
13.	Total BOM	$0.0	General	Total BOM Cost
14.	D1 Tj	62.357 degC	Op_Point	D1 junction temperature
15.	D1 Tj	62.357 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	24.578 %	Op_point	Duty cycle
19.	Efficiency	96.511 %	Op_point	Steady state efficiency
20.	Frequency	57.539 kHz	Op_point	Switching frequency
21.	IC Tj	33.063 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	33.196 degC	Op_point	M2 MOSFET junction temperature
25.	Min Rectified Vin	338.96 V	Op_point	Minimum voltage seen at rectified input
26.	Peak Rectified Vin	339.36 V	Op_point	Peak voltage seen at rectified input
27.	Vin_OP_RMS	240.0 V	Op_point	AC Input RMS Voltage
28.	Vout p-p	84.787 mV	Op_point	Peak-to-peak output ripple voltage
29.	Avg Bridge Diode Pd	203.977 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
30.	Cin Pd	17.094 mW	Power	Input capacitor power dissipation
31.	Cout Pd	89.649 mW	Power	Output capacitor power dissipation
32.	Diode1 Pd	367.692 mW	Power	Diode1 power dissipation
33.	Diode1 Pd	367.692 mW	Power	Diode1 power dissipation
34.	IC Pd	15.313 mW	Power	IC power dissipation
35.	M2 Pd	110.972 mW	Power	M2 MOSFET total power dissipation
36.	Total Pd	1.749 W	Power	Total Power Dissipation
37.	Xformer Pd	671.953 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	240.0	Maximum input voltage
3.	VinMin	180.0	Minimum input voltage
4.	Vout	24.0	Output Voltage
5.	base_pn	LM5023	Base Product Number
6.	source	DC	Input Source Type
7.	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.