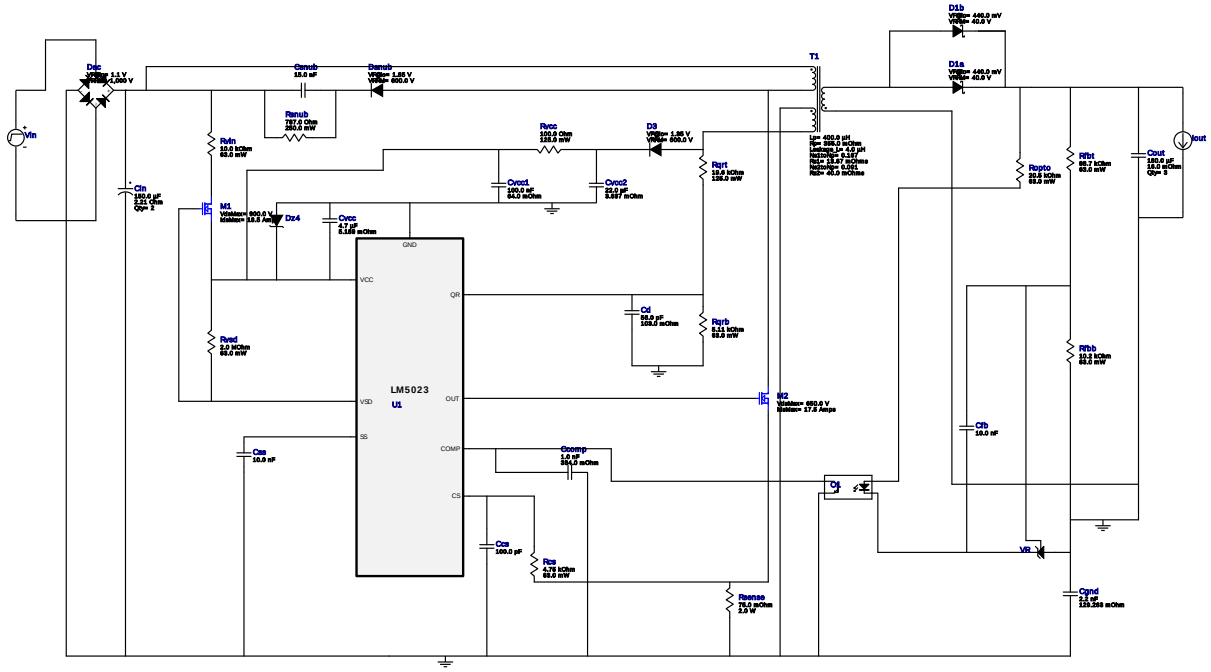
TEXAS INSTRUMENTS

WEBENCH® Design Report

VinMin = 85.0V
VinMax = 265.0V
Vout = 24.0V
Iout = 5.0A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 9/18/16 3:19:42 AM
BOM Cost = $0.00
BOM Count = 38
Total Pd = 3.85W

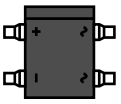
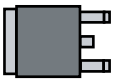
Design : 4790845/24 LM5023MM-2/NOPB
LM5023MM-2/NOPB 85.0V-265.0V to 24.19V @ 5.0A



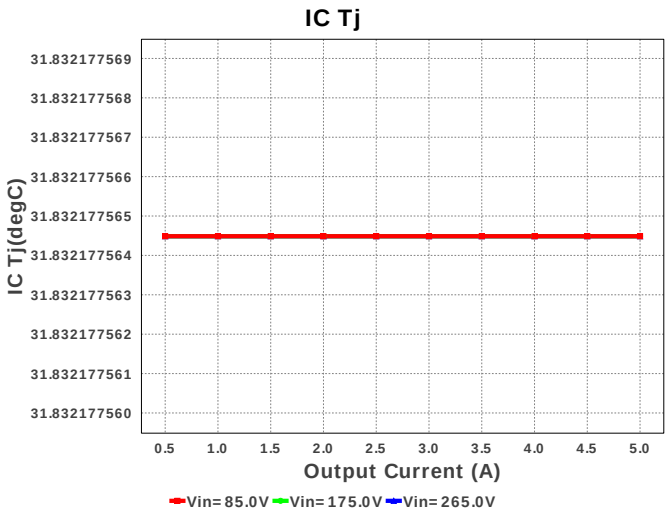
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

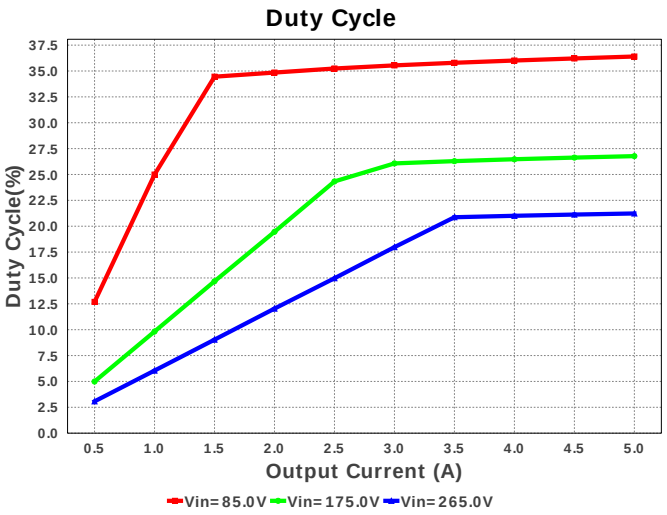
Electrical BOM

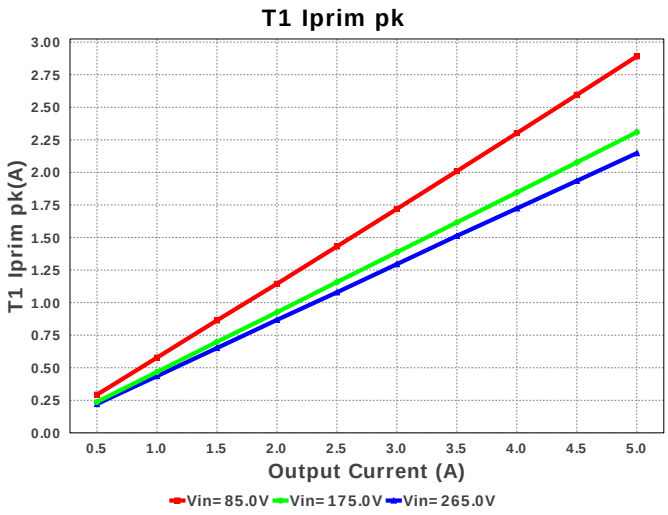
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	$0.01	0805 7 mm^2
2.	Ccs	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
3.	Cd	Kemet	C0805C560J5GACTU Series= C0G/NP0	Cap= 56.0 pF ESR= 103.0 mOhm VDC= 50.0 V IRMS= 541.0 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	Rubycon	450BXW150MEFC18X45 Series= BXW	Cap= 150.0 uF ESR= 2.21 Ohm VDC= 450.0 V IRMS= 800.0 mA	2	$1.29	BXW_1800x4500 400 mm^2
7.	Cout	Panasonic	25SVPF180M Series= ?	Cap= 180.0 uF ESR= 16.0 mOhm VDC= 25.0 V IRMS= 4.65 A	3	$0.61	CAPSMT_62_E12 106 mm^2

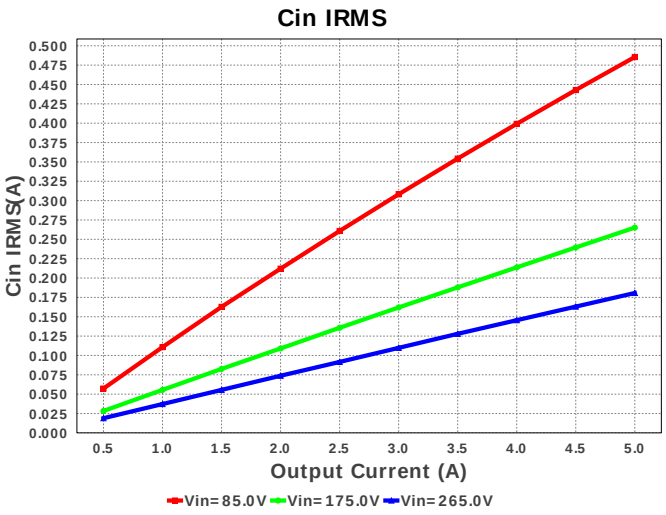
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
8.	Csnub	MuRata	GRM21BR72A153KA01L Series= X7R	Cap= 15.0 nF VDC= 100.0 V IRMS= 0.0 A	1	$0.02	 0805 7 mm^2
9.	Css	MuRata	GRM155R71E103KA01D Series= X7R	Cap= 10.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm^2
10.	Cvcc	MuRata	GRM21BR61E475KA12L 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	SL44-E3/57T	VF@Io= 440.0 mV VRRM= 40.0 V	1	$0.32	 SMC 83 mm^2
14.	D1b	Vishay-Semiconductor	SL44-E3/57T	VF@Io= 440.0 mV VRRM= 40.0 V	1	$0.32	 SMC 83 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	STMicroelectronics	STTH506B-TR	VF@Io= 1.85 V VRRM= 600.0 V	1	$0.59	 DPAK 102 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	$0.36	 SSOP-4 111 mm^2
22.	Rcs	Vishay-Dale	CRCW04024K75FKED Series= CRCW..e3	Res= 4.75 kOhm 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
25.	Ropto	Vishay-Dale	CRCW040220K5FKED Series= CRCW..e3	Res= 20.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
26.	Rqrb	Vishay-Dale	CRCW04025K11FKED Series= CRCW..e3	Res= 5.11 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2

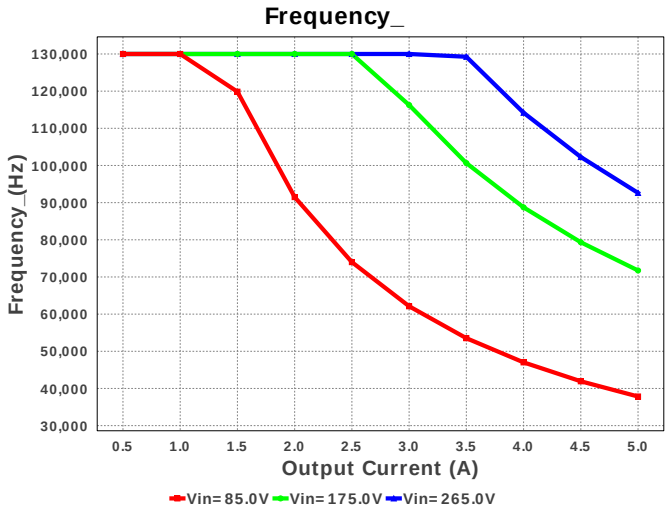
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
27.	Rqrt	Panasonic	ERJ-6ENF1962V Series= ERJ-6E	Res= 19.6 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
28.	Rsense	Stackpole Electronics Inc	CSRN2512FK75L0 Series= ?	Res= 75.0 mOhm Power= 2.0 W Tolerance= 1.0%	1	$0.14	2512 43 mm²
29.	Rsnub	Panasonic	ERJ-8ENF7870V Series= ERJ-8E	Res= 787.0 Ohm 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	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 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

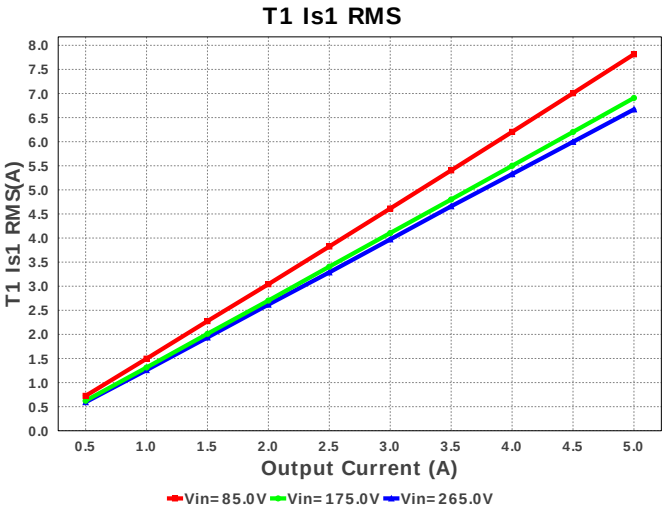


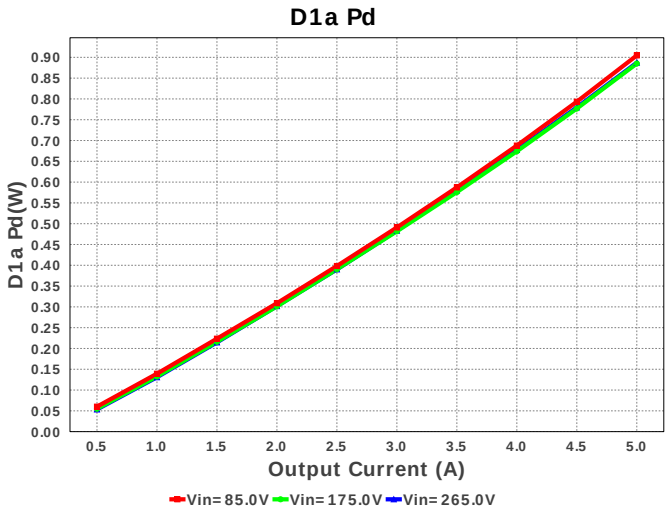


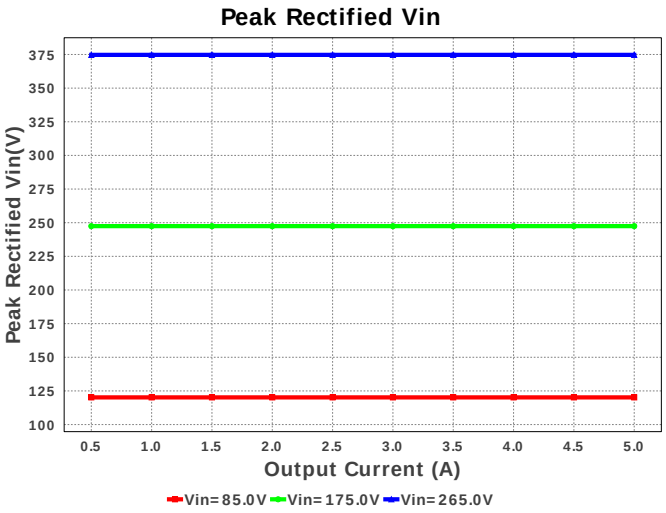


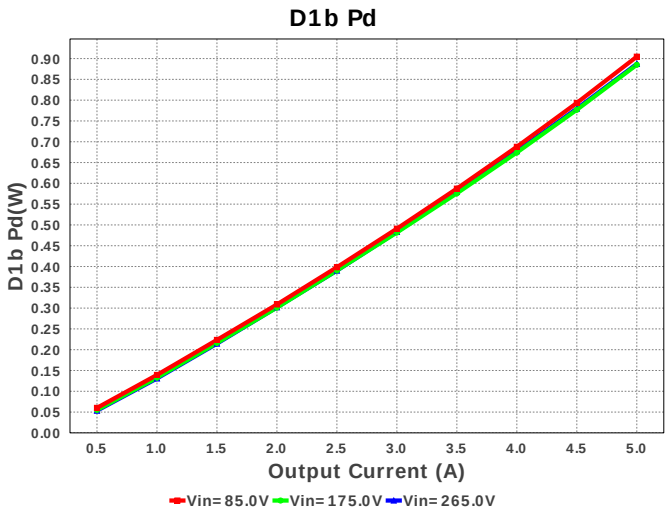


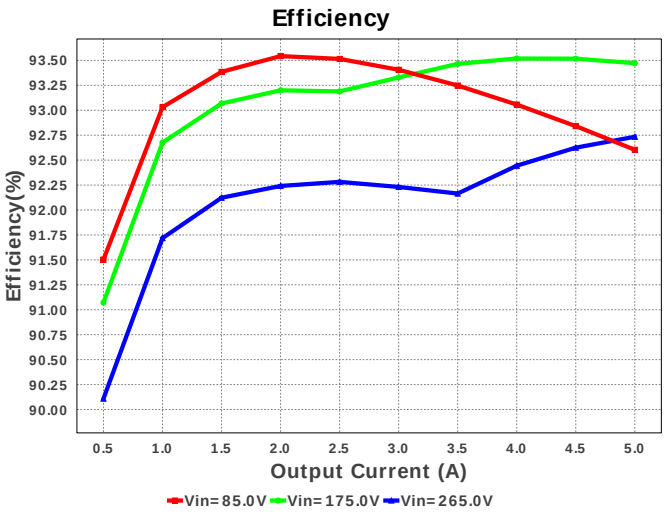


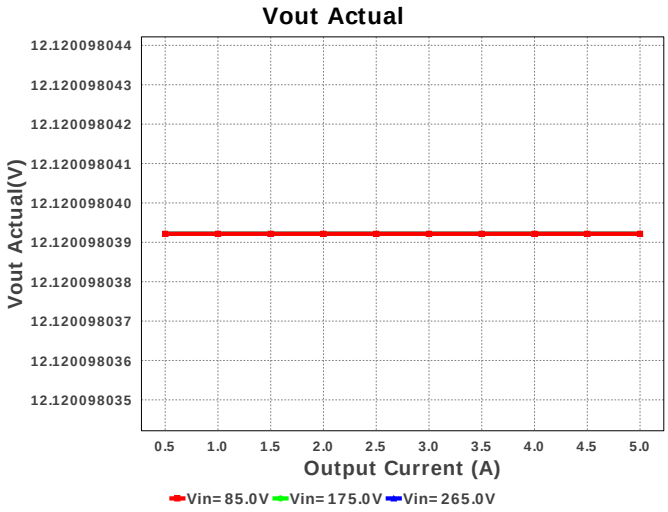


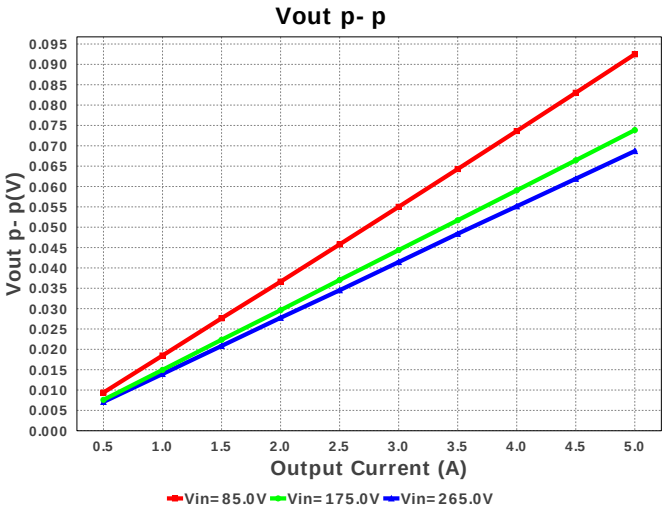


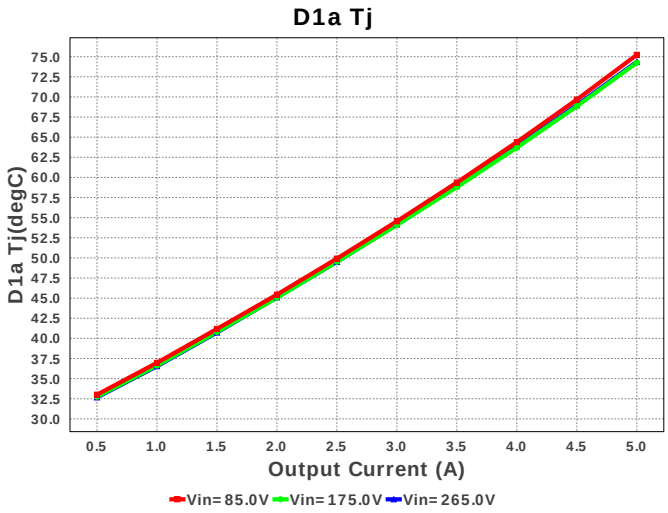


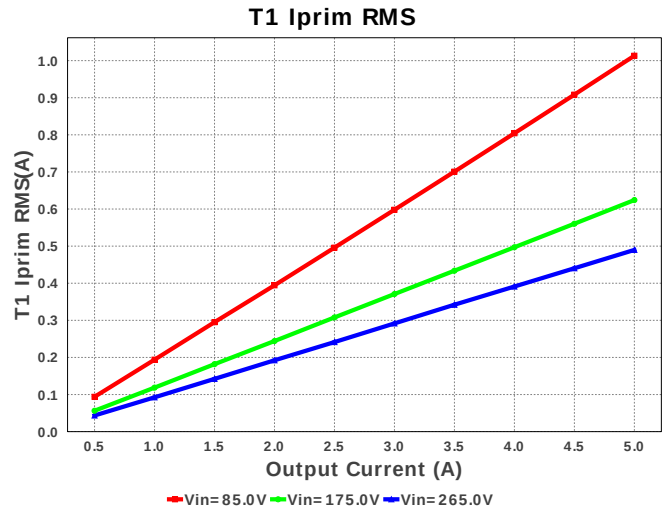


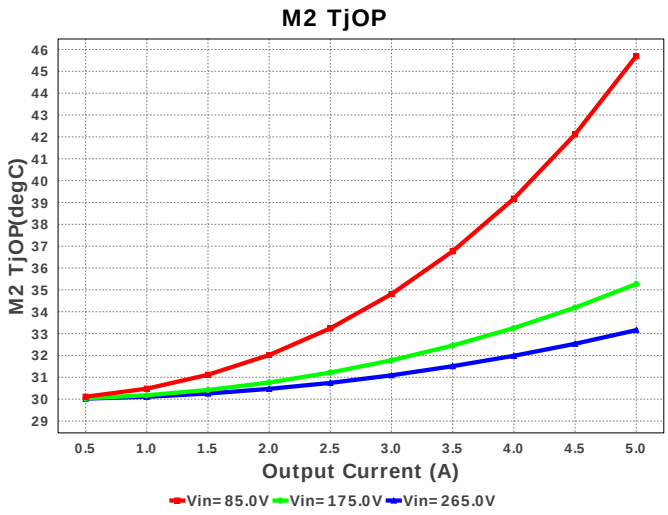


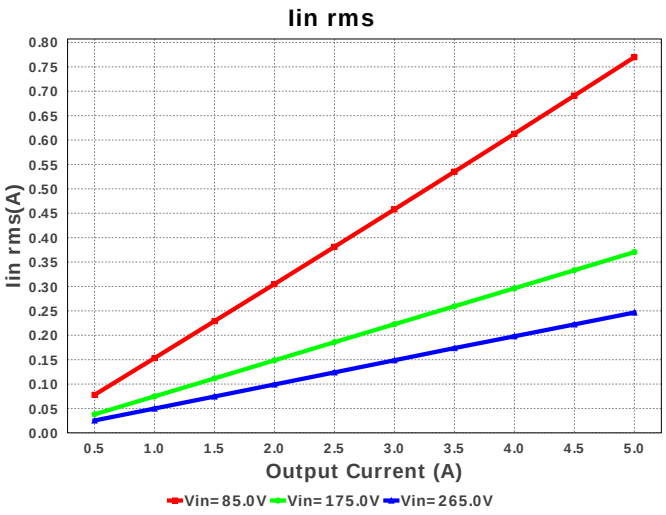


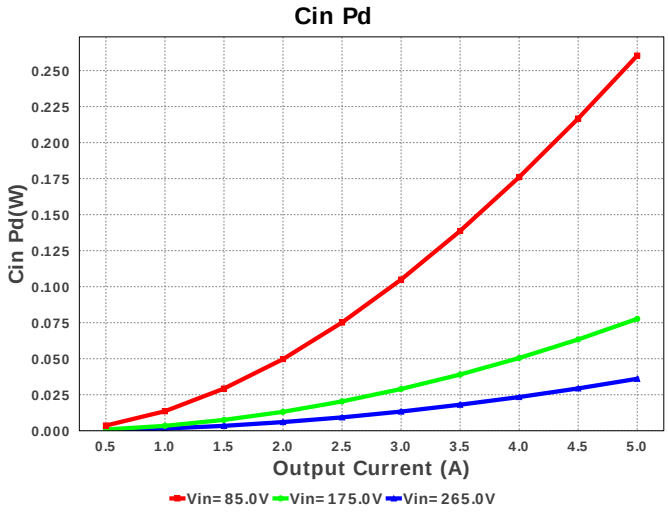


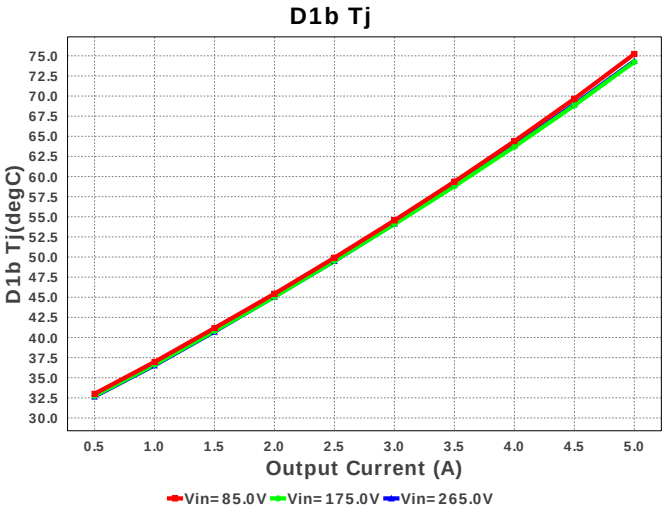


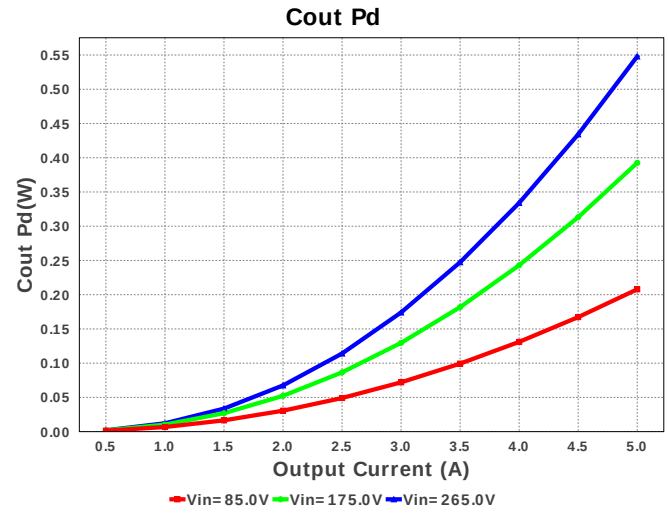


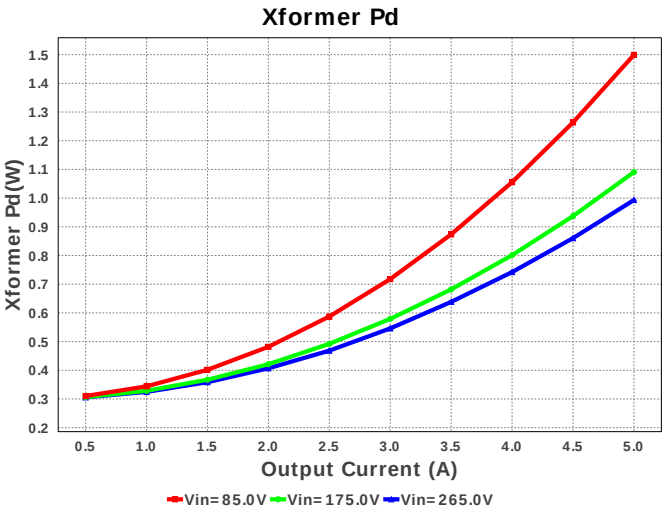


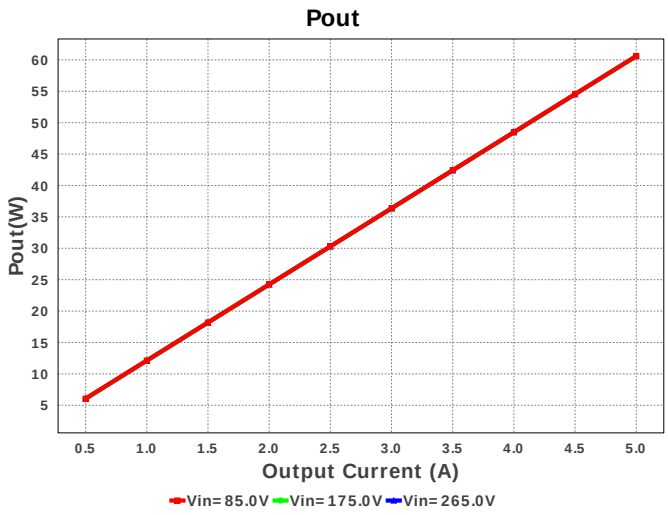


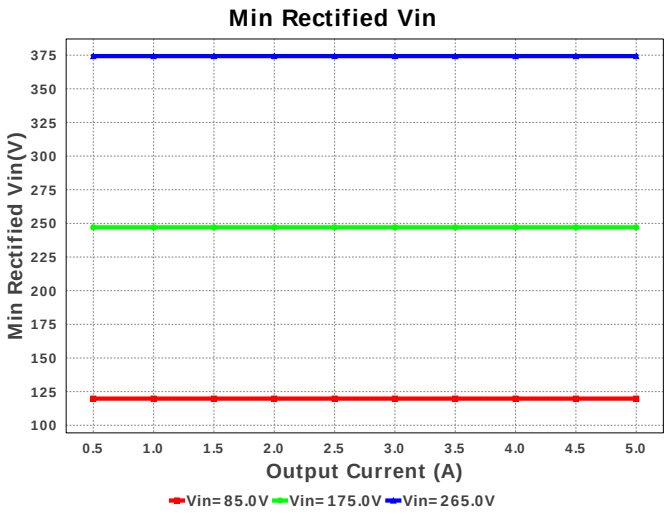


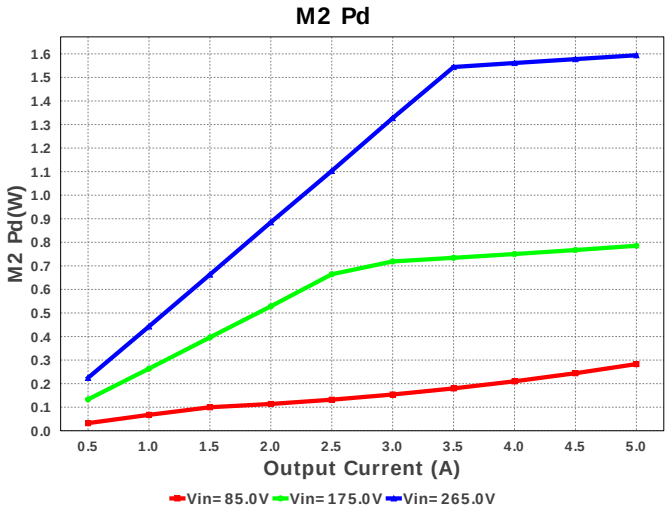


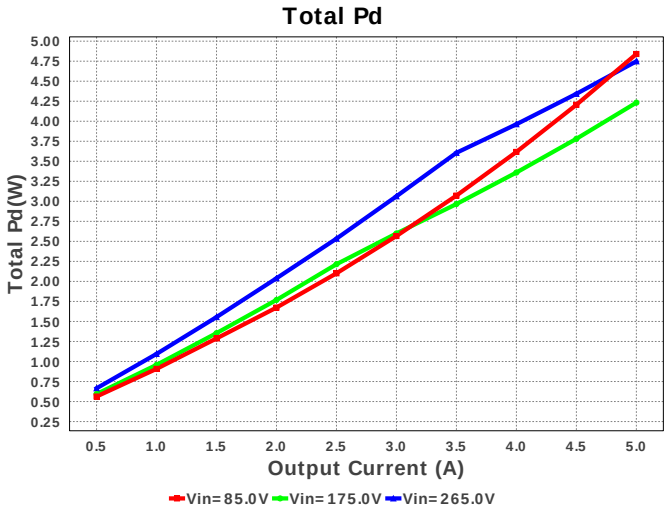


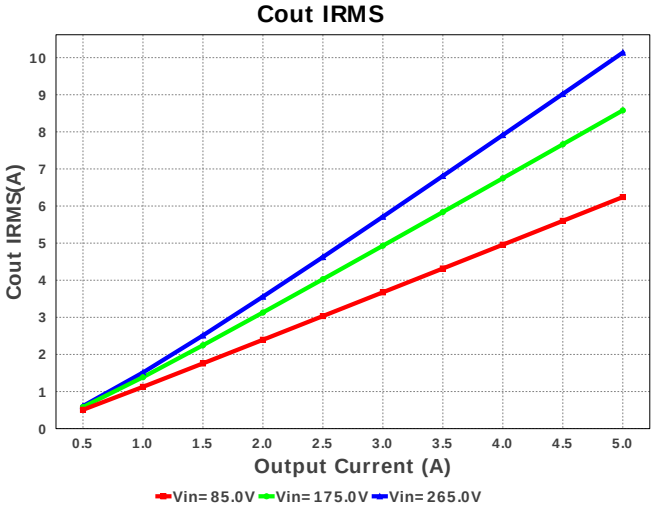


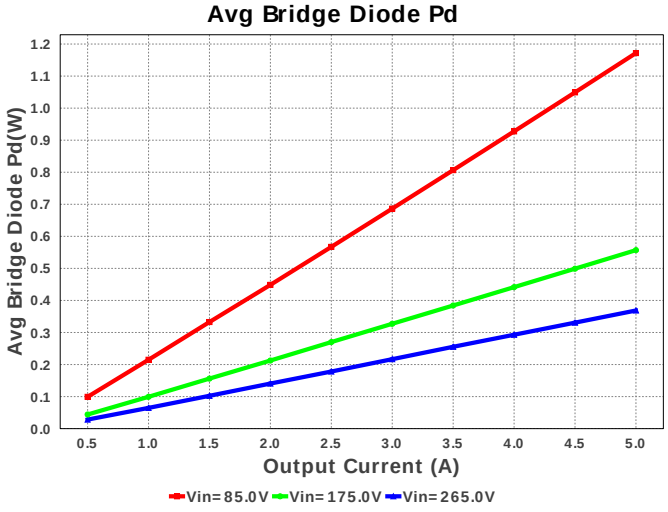


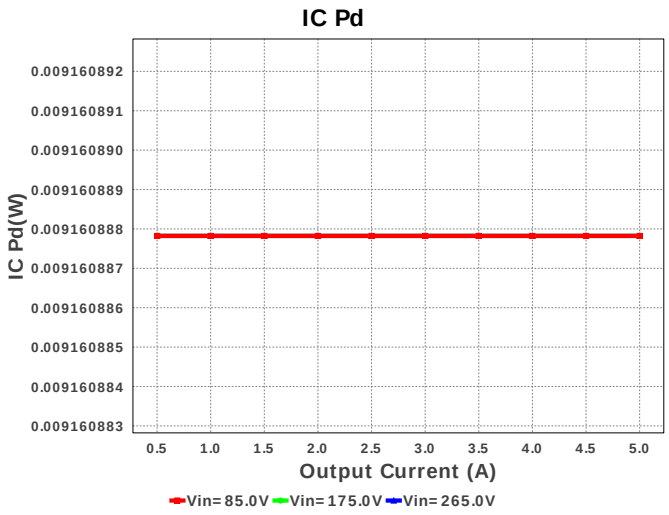


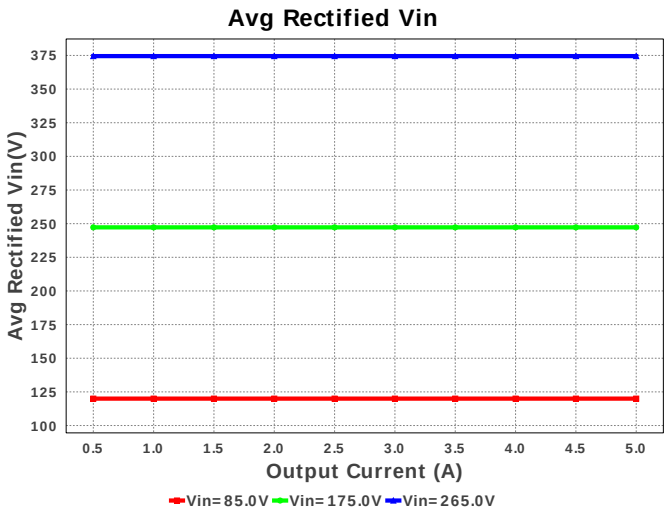


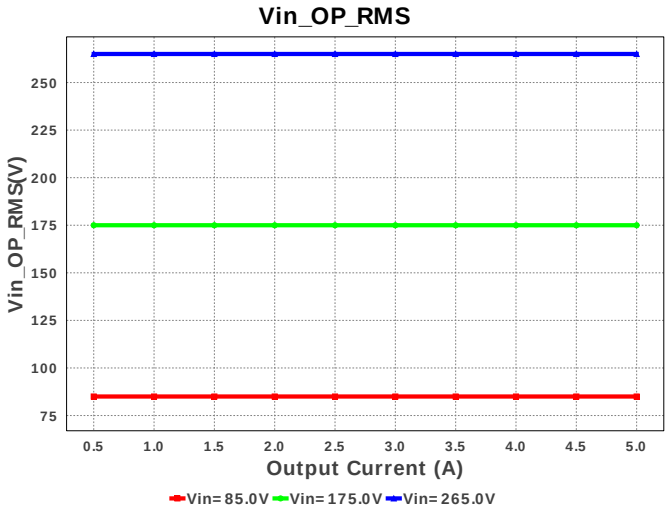


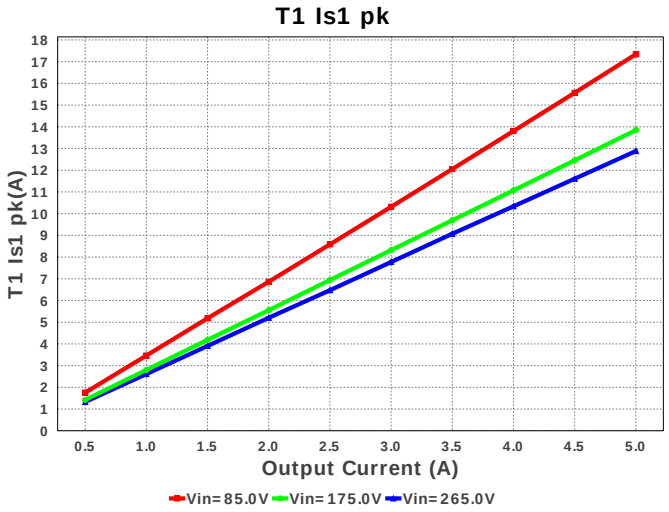












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	340.606 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	7.151 A	Current	Output capacitor RMS ripple current
3.	Iin rms	470.97 mA	Current	RMS Input Current
4.	T1 Iprim RMS	701.966 mA	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	2.355 A	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	5.344 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	14.127 A	Current	Transformer Secondary1 Peak Current
8.	Avg Rectified Vin	374.51 V	General	Average Rectified Voltage for the AC Line Period
9.	BOM Count	38	General	Total Design BOM count
10.	FootPrint	2.274 k mm^2	General	Total Foot Print Area of BOM components
11.	Mode	DCM	General	Conduction Mode
12.	Pout	120.959 W	General	Total output power
13.	Total BOM	$0.0	General	Total BOM Cost
14.	D1a Tj	70.62 degC	Op_Point	D1 junction temperature
15.	D1b Tj	70.62 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	15.125 %	Op_point	Duty cycle
19.	Efficiency	96.916 %	Op_point	Steady state efficiency
20.	Frequency_	60.167 kHz	Op_point	Switching frequency
21.	IC Tj	32.777 degC	Op_point	IC junction temperature
22.	ICThetaJA	200.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
23.	IOUT_OP	5.0 A	Op_point	Iout operating point
24.	M2 TjOP	36.79 degC	Op_point	M2 MOSFET junction temperature
25.	Min Rectified Vin	374.31 V	Op_point	Minimum voltage seen at rectified input
26.	Peak Rectified Vin	374.71 V	Op_point	Peak voltage seen at rectified input
27.	Vin_OP_RMS	265.0 V	Op_point	AC Input RMS Voltage
28.	Vout p-p	75.341 mV	Op_point	Peak-to-peak output ripple voltage
29.	Avg Bridge Diode Pd	494.599 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
30.	Cin Pd	128.194 mW	Power	Input capacitor power dissipation
31.	Cout Pd	272.726 mW	Power	Output capacitor power dissipation

#	Name	Value	Category	Description
32.	D1a Pd	812.395 mW	Power	Diode1 power dissipation
33.	D1b Pd	812.395 mW	Power	Diode1 power dissipation
34.	IC Pd	13.885 mW	Power	IC power dissipation
35.	M2 Pd	827.417 mW	Power	M2 MOSFET total power dissipation
36.	Total Pd	3.849 W	Power	Total Power Dissipation
37.	Xformer Pd	865.299 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	5.0	Maximum Output Current
2.	VinMax	265.0	Maximum input voltage
3.	VinMin	85.0	Minimum input voltage
4.	Vout	24.0	Output Voltage
5.	acFrequency	60.0	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 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.