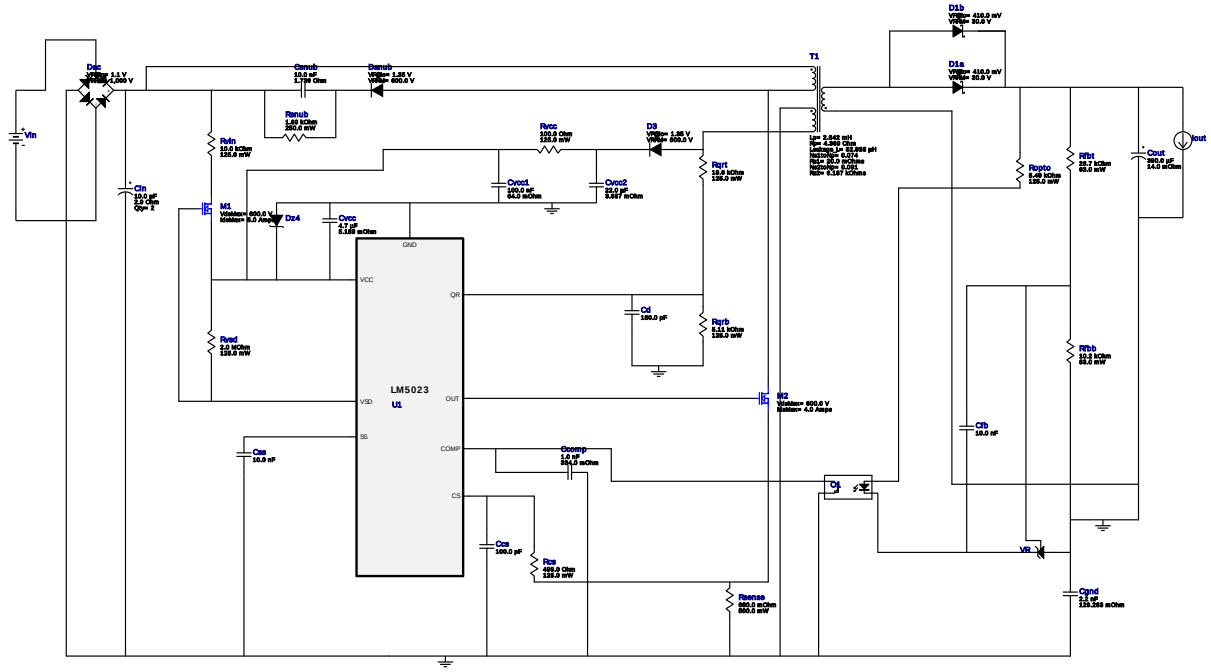
WEBENCH® Design Report

VinMin = 150.0V
VinMax = 265.0V
Vout = 9.0V
Iout = 2.0A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 3/13/16 7:32:40 PM
BOM Cost = $0.00
BOM Count = 36
Total Pd = 1.52W

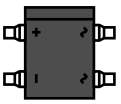
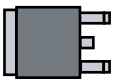
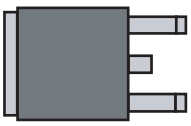
Design : 4161985/1 LM5023MM-2/NOPB
LM5023MM-2/NOPB 150.0V-265.0V to 9.03V @ 2.0A



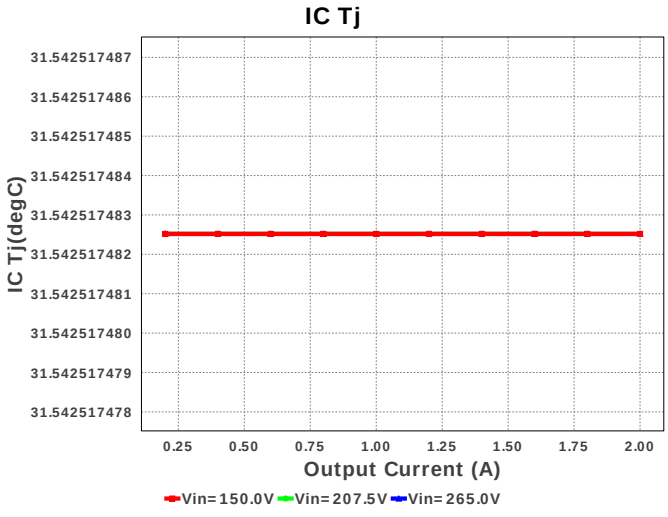
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

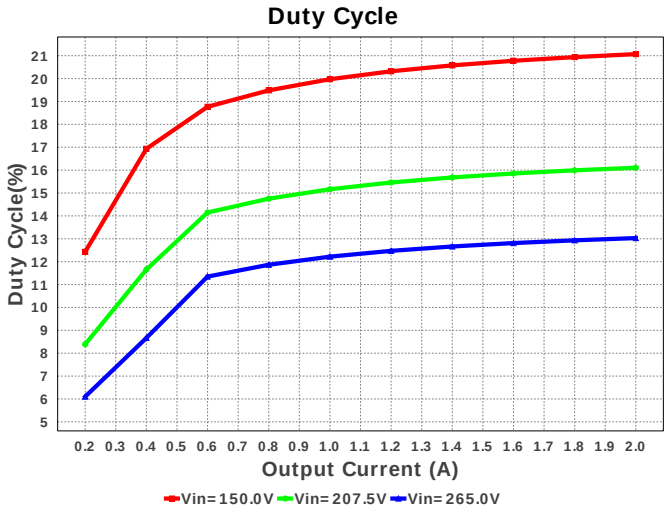
Electrical BOM

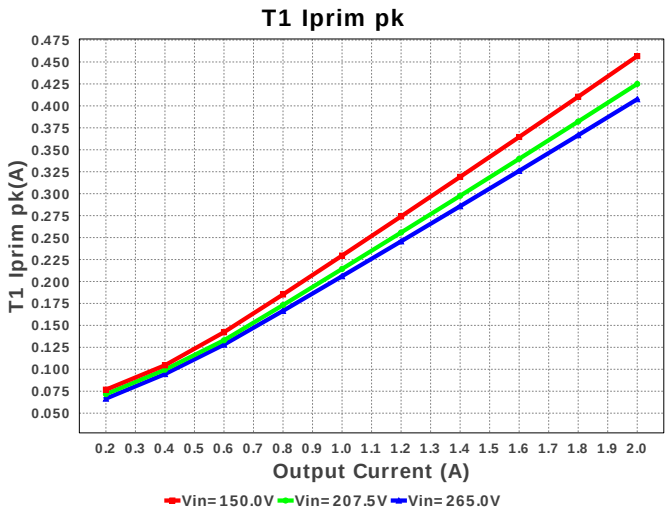
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	$0.01	0805 7 mm^2
2.	Ccs	Kemet	C0201C101K3GACTU Series= C0G/NP0	Cap= 100.0 pF VDC= 10.0 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
3.	Cd	Kemet	C0805C181K5GACTU Series= C0G/NP0	Cap= 180.0 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	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	ESG_10x21 0 mm^2
7.	Cout	Panasonic	20SVPF390M Series= SVPF	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

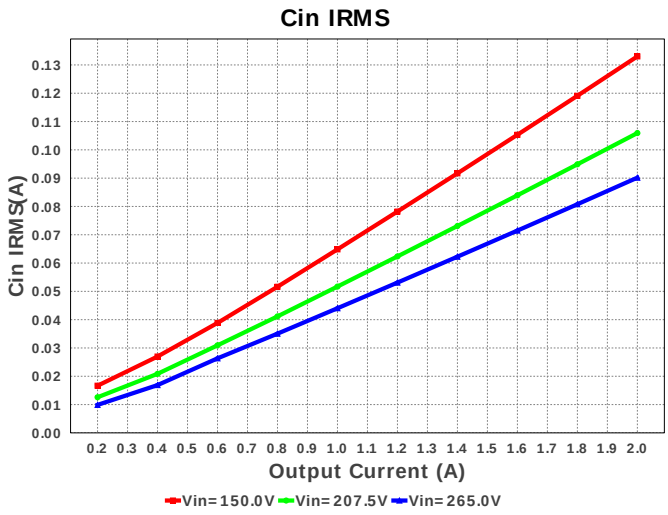
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
8.	Csnub	Kemet	C0805C103K1RACTU Series= X7R	Cap= 10.0 nF ESR= 1.739 Ohm VDC= 100.0 V IRMS= 411.0 mA	1	$0.01	 0805 7 mm²
9.	Css	MuRata	GRM155R71E103KA01D Series= X7R	Cap= 10.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0402 3 mm²
10.	Cvcc	MuRata	GRM21BR61E475KA12L Series= X5R	Cap= 4.7 uF ESR= 5.189 mOhm VDC= 25.0 V IRMS= 2.03531 A	1	$0.03	 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= 3.637 mOhm VDC= 16.0 V IRMS= 3.4771 A	1	$0.13	 1206_190 11 mm²
13.	D1a	ON Semiconductor	MBRA130LT3G	VF@Io= 410.0 mV VRRM= 30.0 V	1	$0.09	 SMA 37 mm²
14.	D1b	ON Semiconductor	MBRA130LT3G	VF@Io= 410.0 mV VRRM= 30.0 V	1	$0.09	 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	Micro Commercial Components	ES1J-TP	VF@Io= 1.35 V VRRM= 600.0 V	1	$0.08	 SMA 37 mm²
18.	Dz4	Diodes Inc.	MMSZ5246B-7-F	Zener	1	$0.03	 SOD-123 13 mm²
19.	M1	STMicroelectronics	STU7NM60N	VdsMax= 600.0 V IdsMax= 5.0 Amps	1	NA	 DPAK 102 mm²
20.	M2	STMicroelectronics	STB4NK60ZT4	VdsMax= 600.0 V IdsMax= 4.0 Amps	1	$0.53	 DDPAK 210 mm²
21.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$0.38	 SSOP-4 111 mm²
22.	Rcs	Vishay-Dale	CRCW0805499RFKEA Series= CRCW..e3	Res= 499.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 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	CRCW040226K7FKED Series= CRCW..e3	Res= 26.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
25.	Ropto	Panasonic	ERJ-6ENF5491V Series= ERJ-6E	Res= 5.49 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²

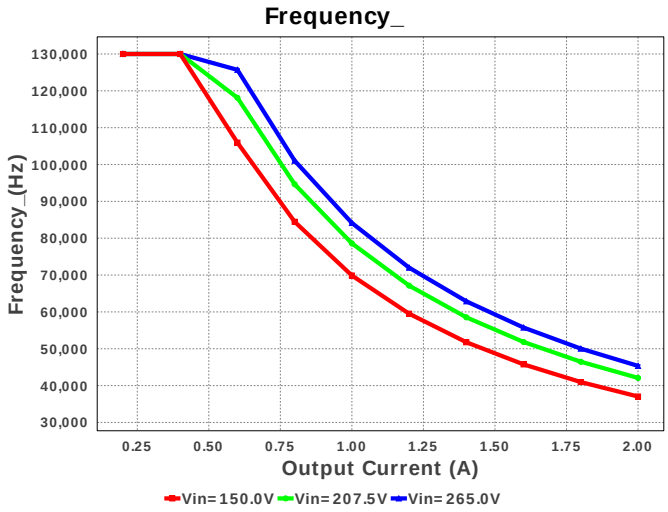
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
26.	Rqrb	Panasonic	ERJ-6ENF5111V Series= ERJ-6E	Res= 5.11 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
27.	Rqrt	Panasonic	ERJ-6ENF1962V Series= ERJ-6E	Res= 19.6 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
28.	Rsense	Rohm	MCR25JZHFLR680 Series= MCR25	Res= 680.0 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	Panasonic	ERJ-6ENF1002V Series= ERJ-6E	Res= 10.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
32.	Rvsd	Vishay-Dale	CRCW08052M00FKEA Series= CRCW..e3	Res= 2.0 MOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
33.	T1	CUSTOM	CUSTOM	Lp= 2.642 mH Rp= 4.369 Ohm Leakage_L= 52.838 µH Ns1toNp= 0.074 Rs1= 20.0 mOhms Ns2toNp= 0.091 Rs2= 6.167 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

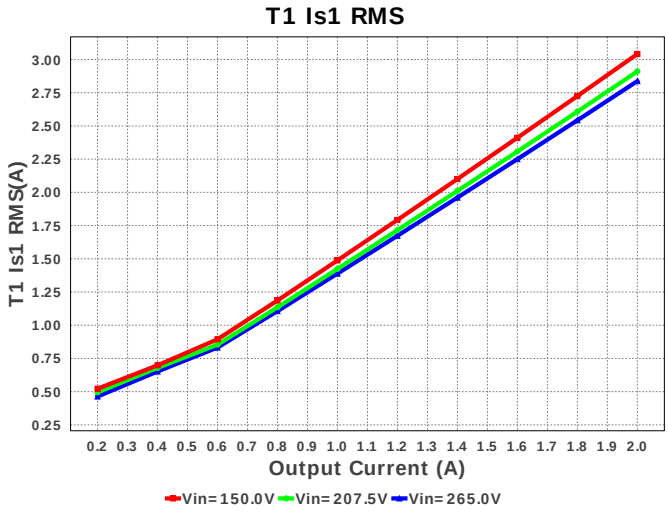


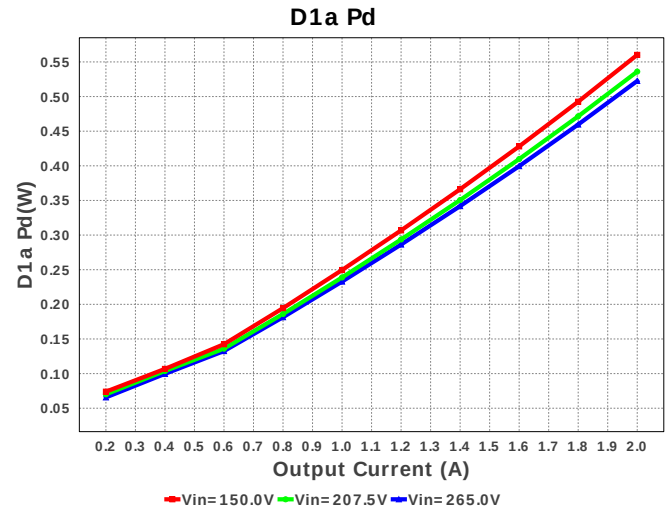


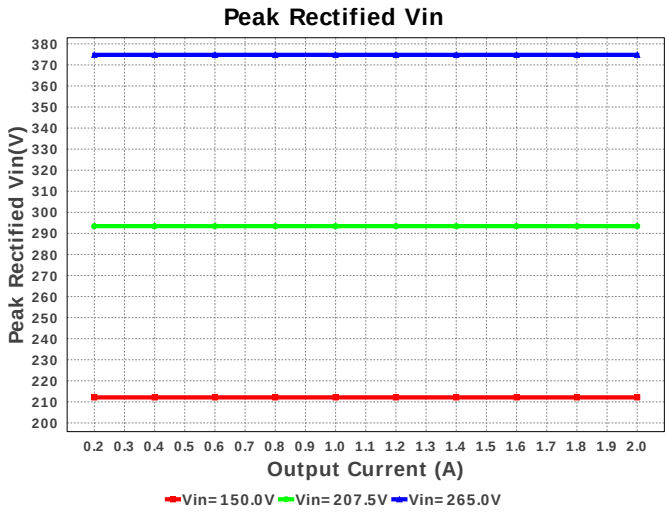


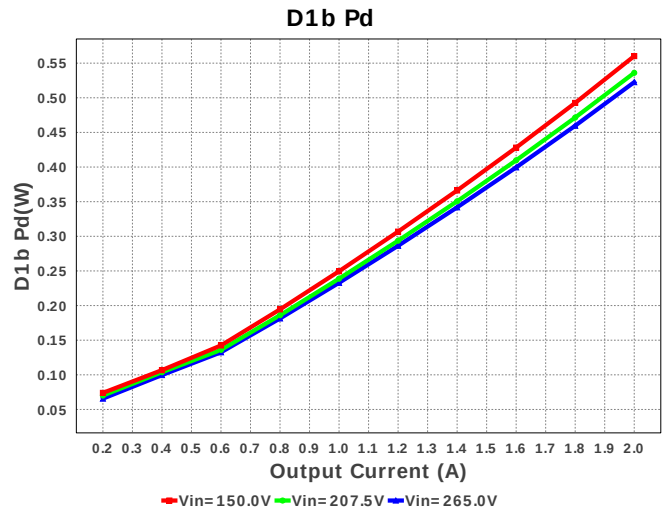


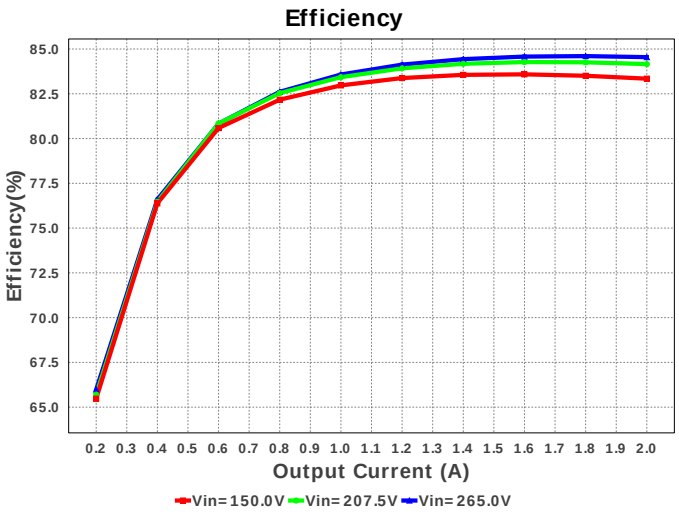


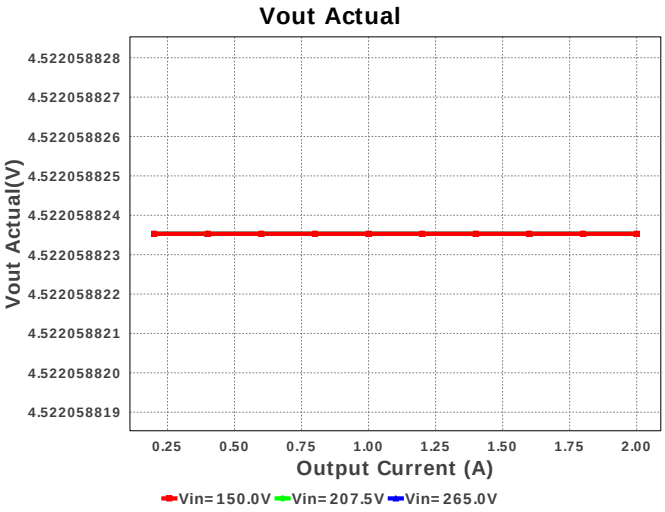


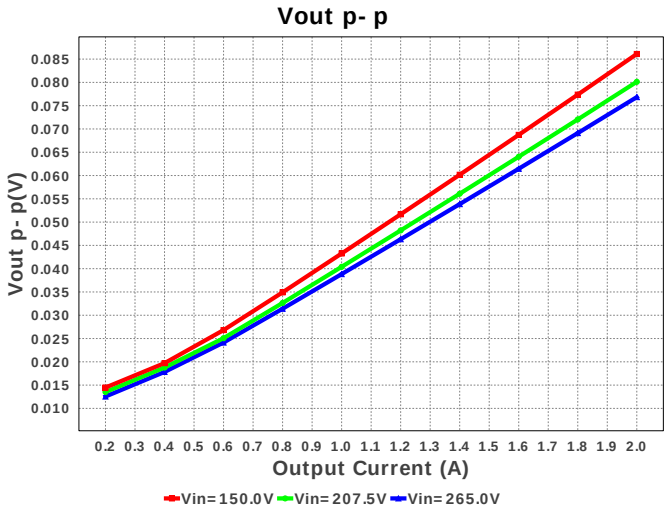


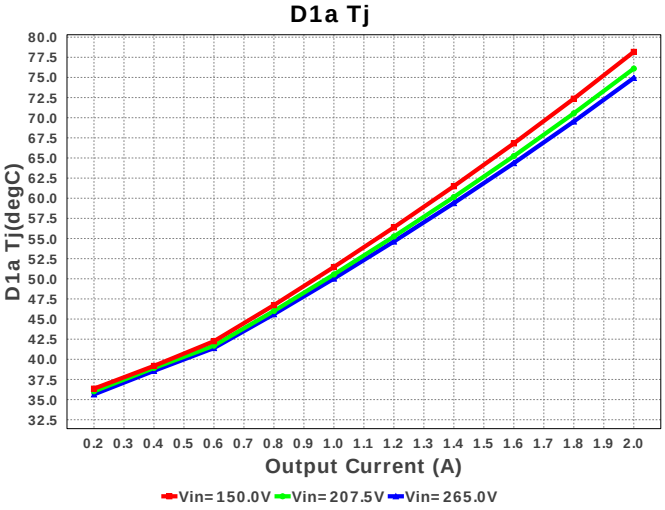


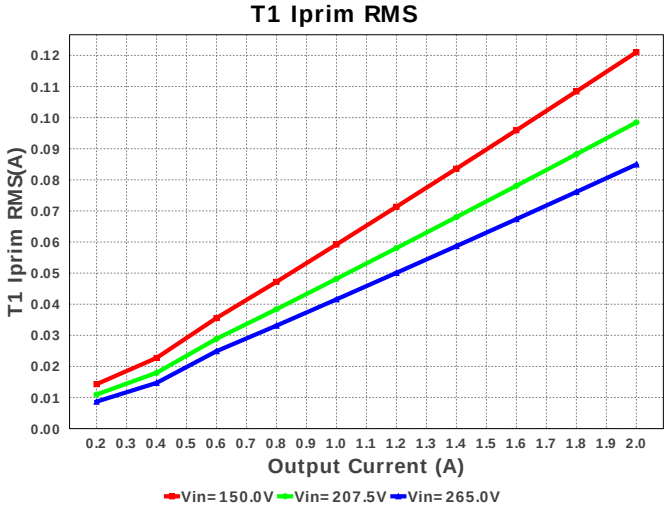


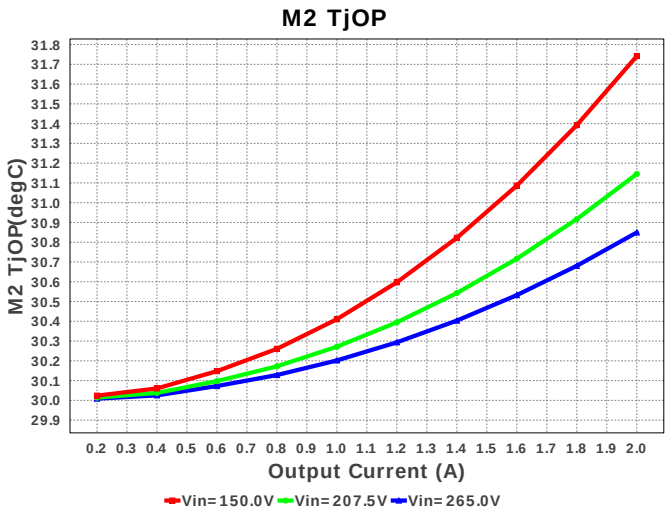


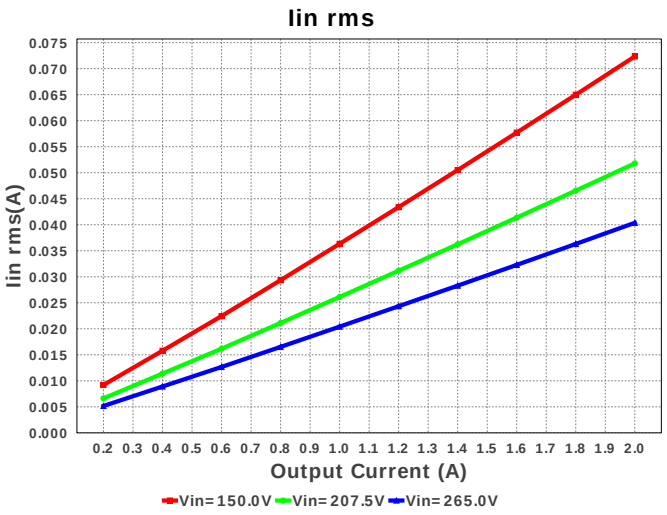


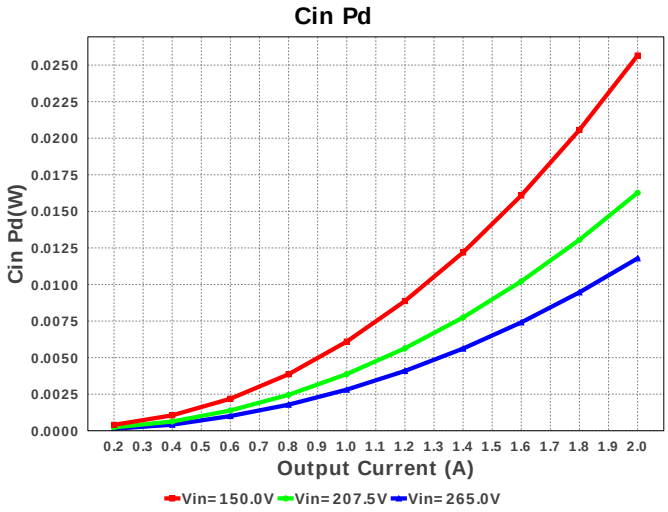


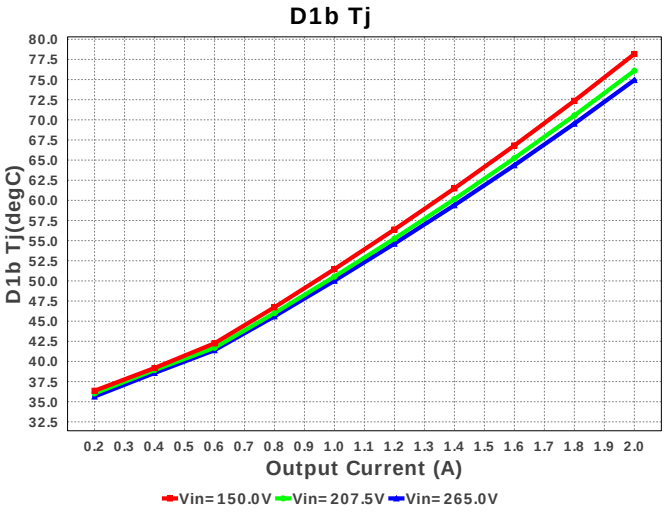


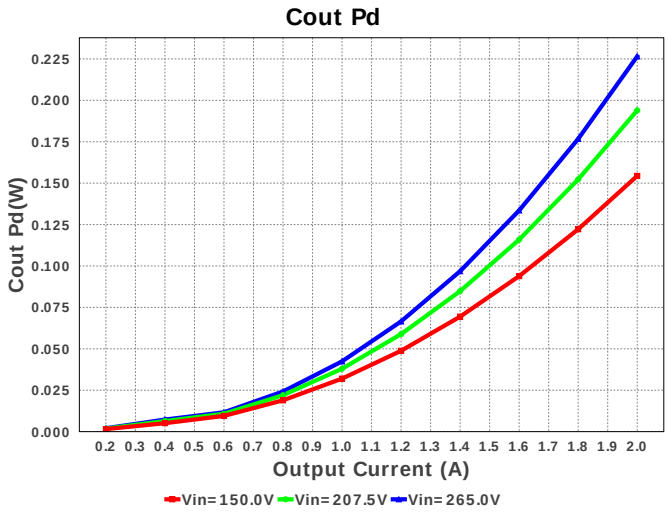


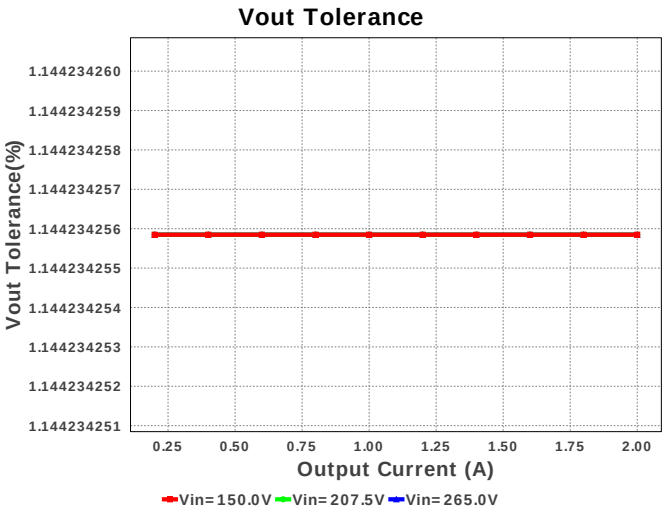


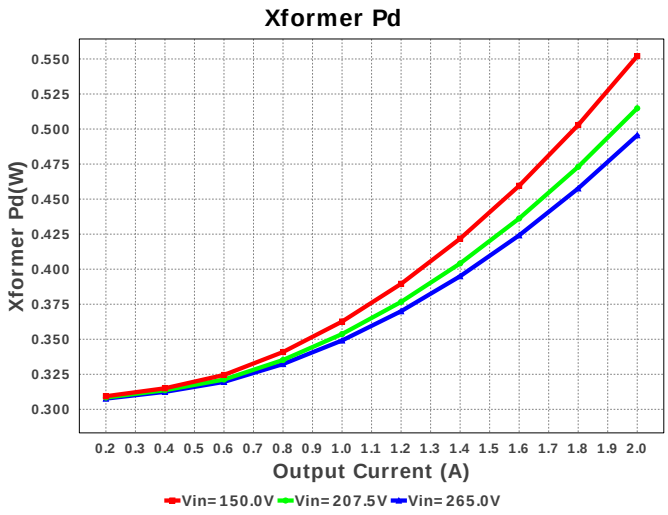


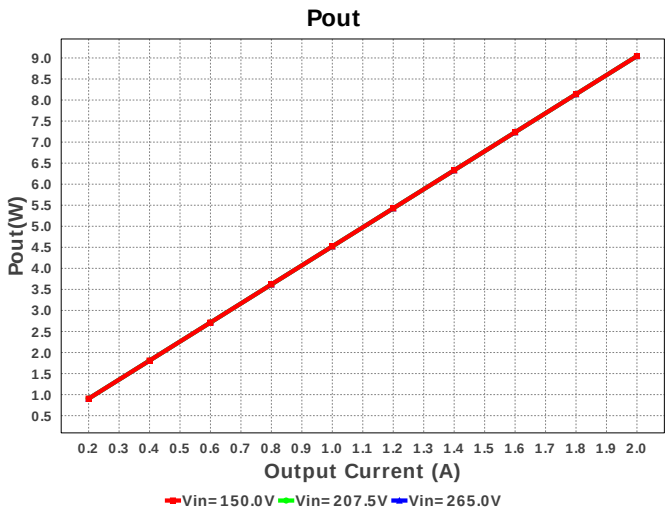


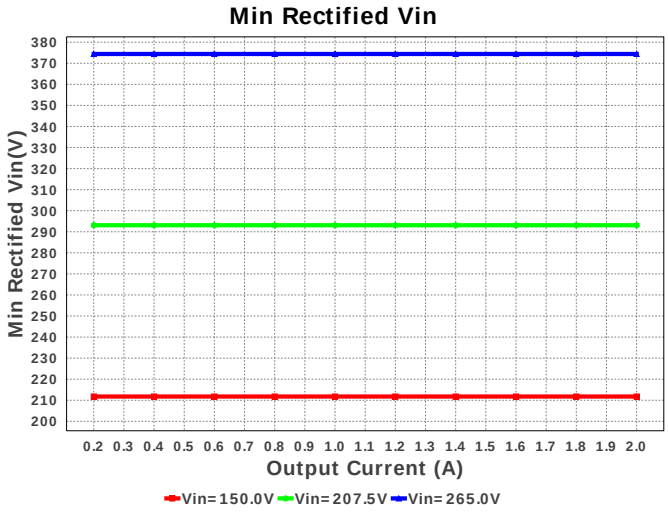


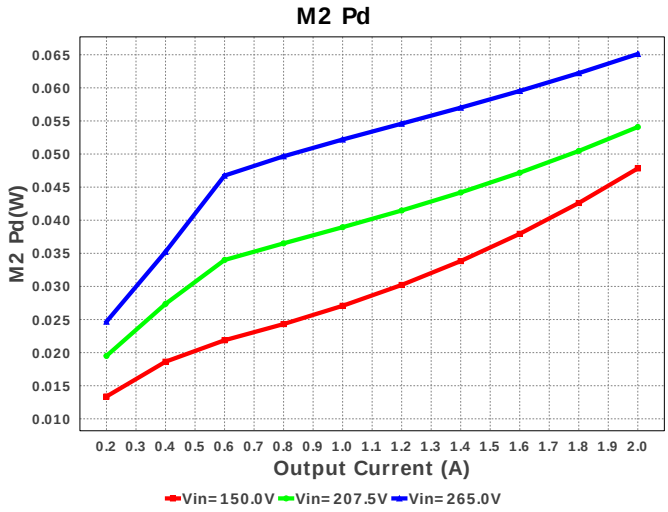


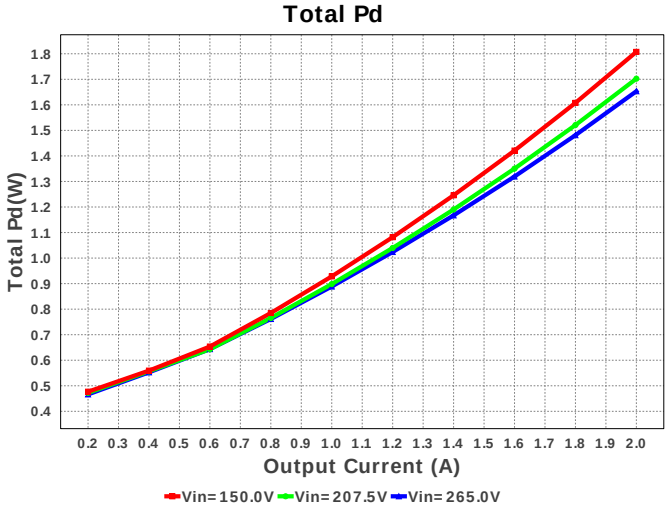


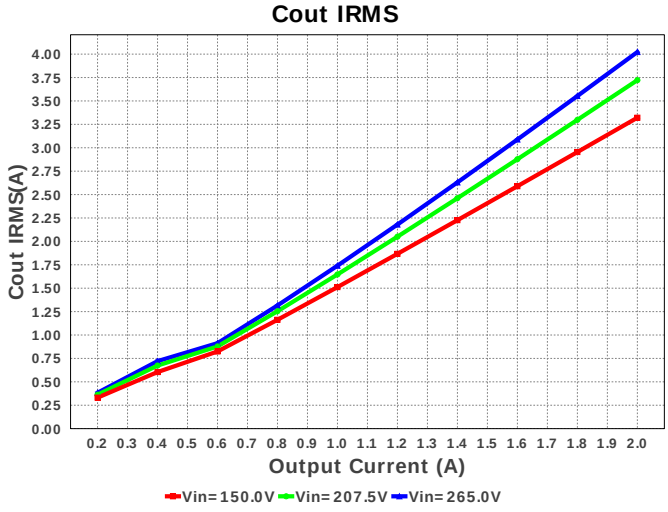


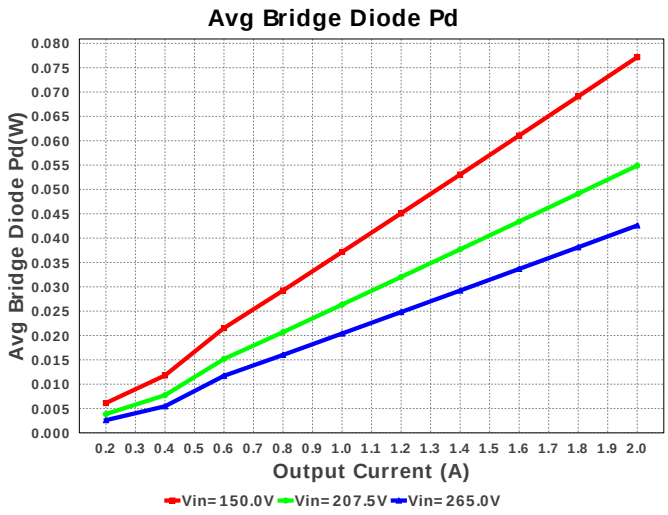


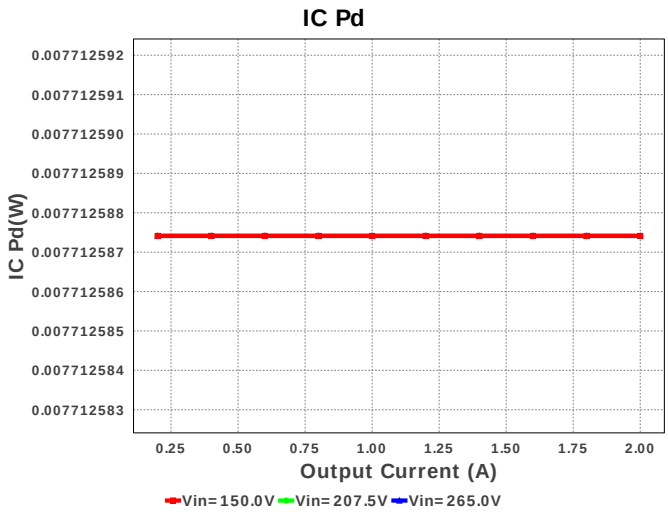


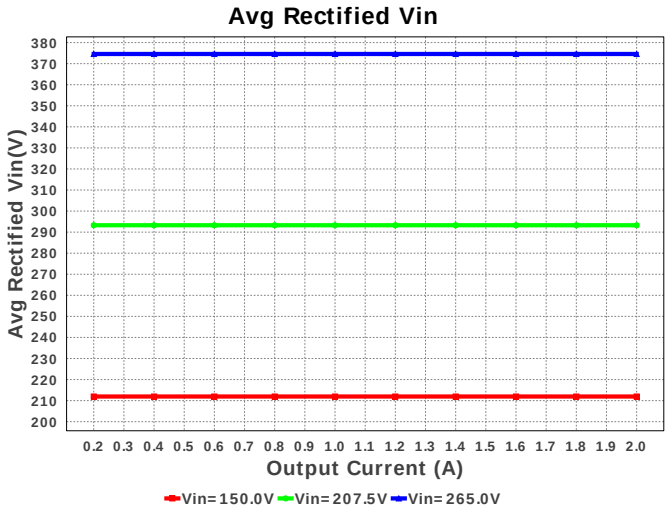


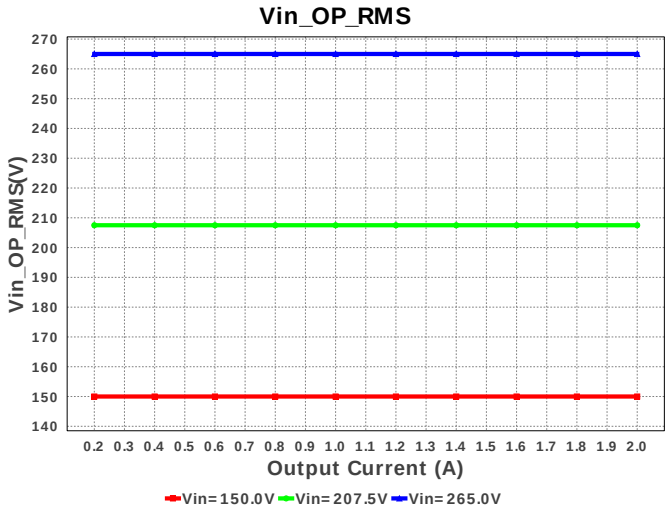


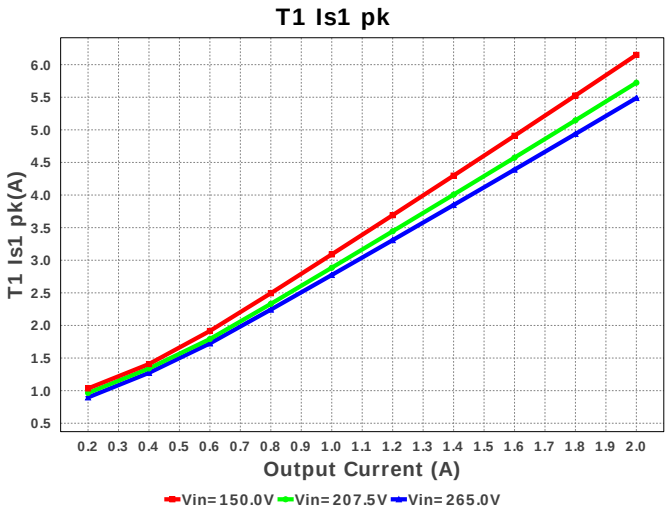












Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	124.423 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	2.758 A	Current	Output capacitor RMS ripple current
3.	Iin rms	73.846 mA	Current	RMS Input Current
4.	T1 Iprim RMS	112.252 mA	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	408.332 mA	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	2.372 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	5.499 A	Current	Transformer Secondary1 Peak Current
8.	Avg Rectified Vin	374.588 V	General	Average Rectified Voltage for the AC Line Period
9.	BOM Count	36	General	Total Design BOM count
10.	FootPrint	1.024 k mm^2	General	Total Foot Print Area of BOM components
11.	Pout	18.052 W	General	Total output power

#	Name	Value	Category	Description
12.	Total BOM	$0.0	General	Total BOM Cost
13.	D1a Tj	67.572 degC	Op_Point	D1 junction temperature
14.	D1b Tj	67.572 degC	Op_Point	D1 junction temperature
15.	Vout Actual	9.026 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
16.	Vout OP	9.026 V	Op_Point	Operational Output Voltage
17.	Duty Cycle	22.672 %	Op_point	Duty cycle
18.	Efficiency	92.247 %	Op_point	Steady state efficiency
19.	Frequency_	78.75 kHz	Op_point	Switching frequency
20.	IC Tj	32.584 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	31.494 degC	Op_point	M2 MOSFET junction temperature
24.	Min Rectified Vin	374.413 V	Op_point	Minimum voltage seen at rectified input
25.	Peak Rectified Vin	374.763 V	Op_point	Peak voltage seen at rectified input
26.	Vin_OP_RMS	265.0 V	Op_point	AC Input RMS Voltage
27.	Vout p-p	76.983 mV	Op_point	Peak-to-peak output ripple voltage
28.	Avg Bridge Diode Pd	63.561 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
29.	Cin Pd	22.448 mW	Power	Input capacitor power dissipation
30.	Cout Pd	106.488 mW	Power	Output capacitor power dissipation
31.	D1a Pd	436.883 mW	Power	Diode1 power dissipation
32.	D1b Pd	436.883 mW	Power	Diode1 power dissipation
33.	IC Pd	12.919 mW	Power	IC power dissipation
34.	M2 Pd	88.132 mW	Power	M2 MOSFET total power dissipation
35.	Total Pd	1.517 W	Power	Total Power Dissipation
36.	Xformer Pd	483.22 mW	Power	Transformer power dissipation
37.	Vout Tolerance	1.031 %		Vout Tolerance based on IC Tolerance and voltage divider resistors if applicable

Design Inputs

#	Name	Value	Description
1.	Iout	2.0	Maximum Output Current
2.	VinMax	265.0	Maximum input voltage
3.	VinMin	150.0	Minimum input voltage
4.	Vout	9.0	Output Voltage
5.	base_pn	LM5023	Texas Instruments Base Part 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.