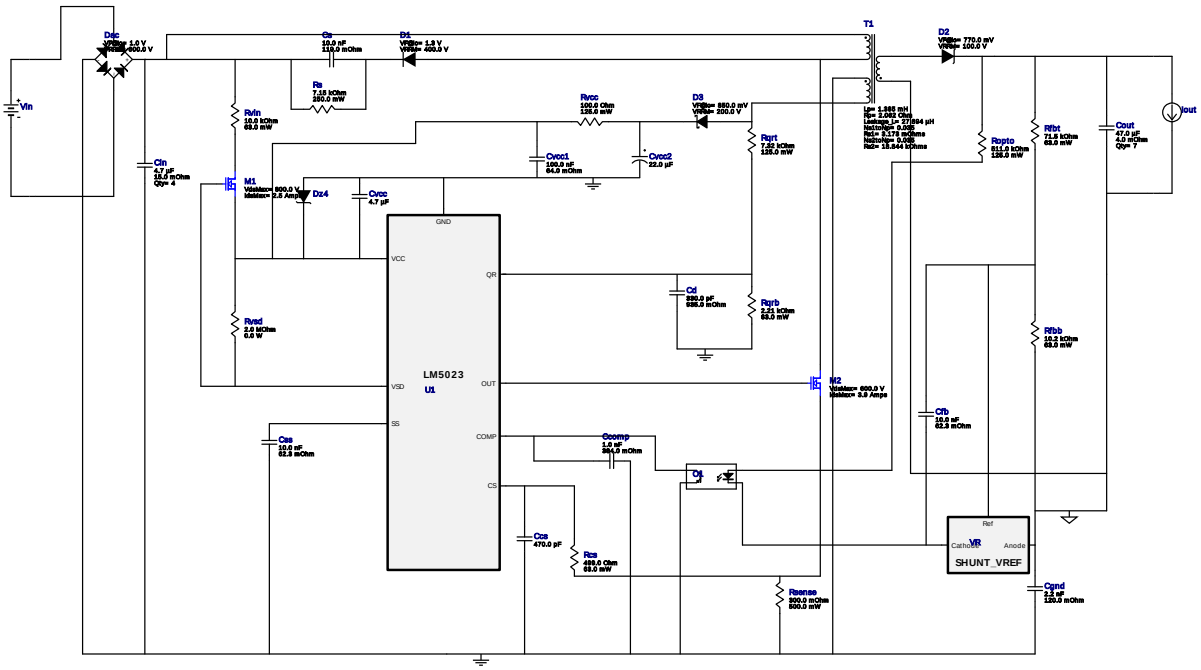
TEXAS INSTRUMENTS

WEBENCH® Design Report

VinMin = 110.0V
VinMax = 150.0V
Vout = 10.0V
Iout = 5.0A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 3/11/14 8:18:24 PM
BOM Cost = $0.00
Footprint = 3,765.0mm2
BOM Count = 2
Total Pd = 11.05W

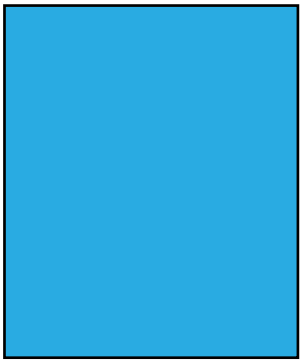
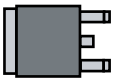
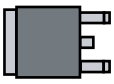
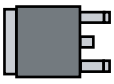
Design : 1823515/14 LM5023MM-2/NOPB
LM5023MM-2/NOPB 110.0V-150.0V to 10.012254901960784V @ 5.0A



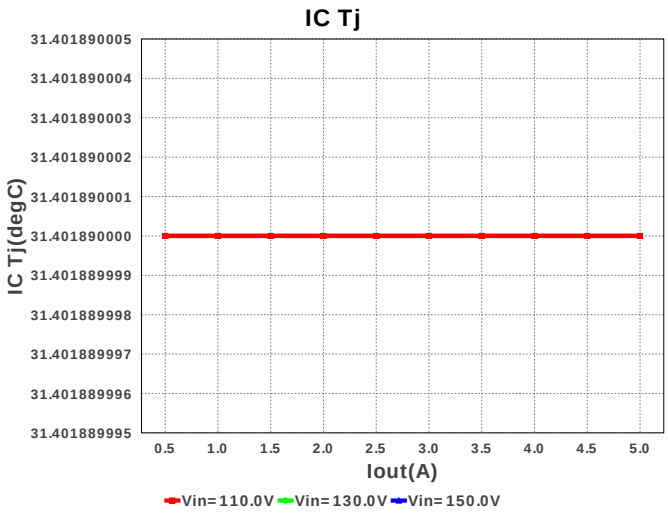
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

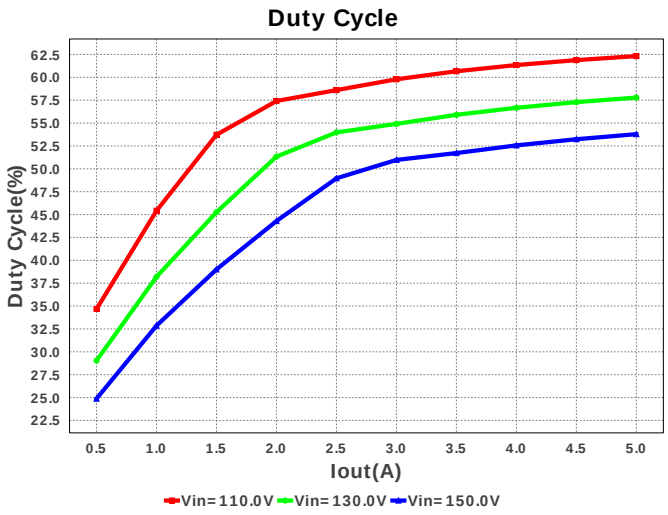
Electrical BOM

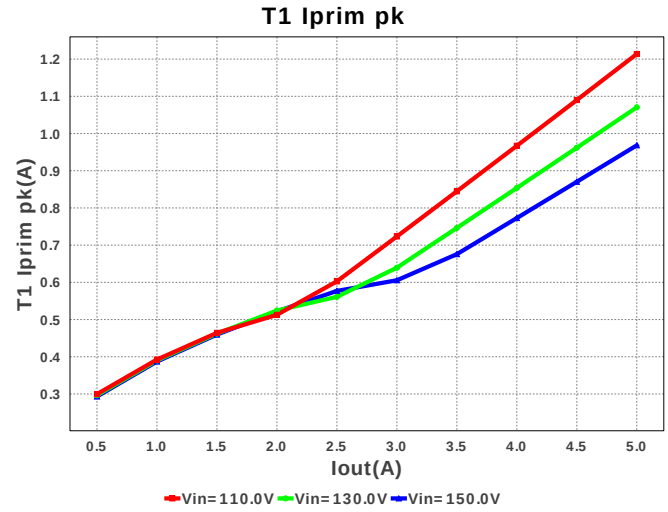
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	$0.01	0805 7mm2
2.	Ccs	MuRata	GRM216R71E471KA01D Series= X7R	Cap= 470.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.02	0805 7mm2
3.	Cd	Kemet	C0805C331K5RACTU Series= X7R	Cap= 330.0 pF ESR= 935.0 mOhm VDC= 50.0 V IRMS= 167.0 mA	1	$0.01	0805 7mm2
4.	Cfb	TDK	C1005X7R1E103K Series= X7R	Cap= 10.0 nF ESR= 62.3 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 3mm2
5.	Cgnd	TDK	C4532X7R3D222K Series= X7R	Cap= 2.2 nF ESR= 120.0 mOhm VDC= 2.0 kV IRMS= 0.0 A	1	$0.21	1812 27mm2

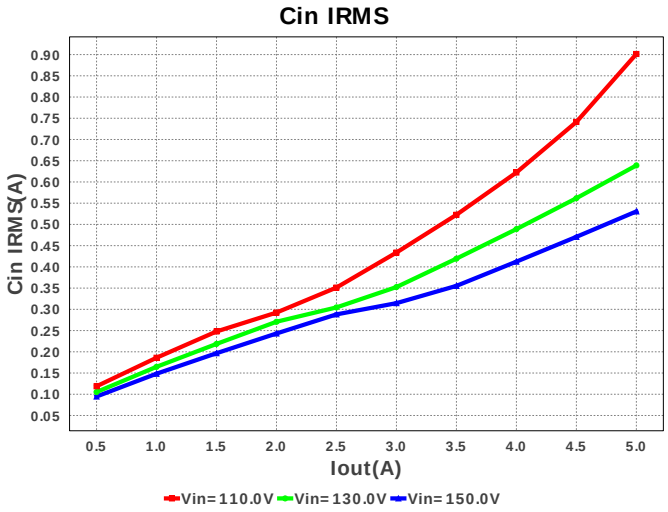
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
6.	Cin	EPCOS Inc	B32924C3475M Series= 303	Cap= 4.7 µF ESR= 15.0 mOhm VDC= 630.0 V IRMS= 457.0 mA	4	$1.83	 B32924_33mm 670mm2
7.	Cout	TDK	C5750X5R1C476M Series= X5R	Cap= 47.0 µF ESR= 4.0 mOhm VDC= 16.0 V IRMS= 2.1 A	7	$0.84	 2220 60mm2
8.	Cs	AVX	12061C103KAT2A Series= X7R	Cap= 10.0 nF ESR= 119.0 mOhm VDC= 100.0 V IRMS= 0.0 A	1	$0.05	 1206 11mm2
9.	Css	TDK	C1005X7R1E103K Series= X7R	Cap= 10.0 nF ESR= 62.3 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0402 3mm2
10.	Cvcc	MuRata	GRM21BC81E475KA12L Series= 379	Cap= 4.7 µF VDC= 25.0 V IRMS= 0.0 A	1	$0.04	 0805 7mm2
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 7mm2
12.	Cvcc2	Nippon Chemi-Con	EMVA160ADA220MD55G Series= MVA	Cap= 22.0 µF VDC= 16.0 V IRMS= 26.0 mA	1	$0.07	 CAPSMT_62_D55 28mm2
13.	D1	Diodes Inc.	RS1G-13-F	VF@Io= 1.3 V VRRM= 400.0 V	1	$0.07	 SMA 37mm2
14.	D2	Vishay-Semiconductor	50WQ10FNPBF	VF@Io= 770.0 mV VRRM= 100.0 V	1	$0.41	 DPAK 102mm2
15.	D3	Diodes Inc.	DFLS1200-7	VF@Io= 850.0 mV VRRM= 200.0 V	1	$0.21	 PowerDI123 13mm2
16.	Dac	Diodes Inc.	HD06-T	VF@Io= 1.0 V VRRM= 600.0 V	1	$0.13	 MiniDIP 62mm2
17.	Dz4	ON Semiconductor	BZX84C16LT1G	Zener	1	$0.02	 SOT-23 14mm2
18.	M1	ST Microelectronics	STD3NK80ZT4	VdsMax= 800.0 V IdsMax= 2.5 Amps	1	$0.68	 DPAK 102mm2
19.	M2	Fairchild Semiconductor	FCD4N60TM	VdsMax= 600.0 V IdsMax= 3.9 Amps	1	$0.49	 DPAK 102mm2
20.	O1	CUSTOM	Custom	Optocoupler	1	NA	CUSTOM 0mm2

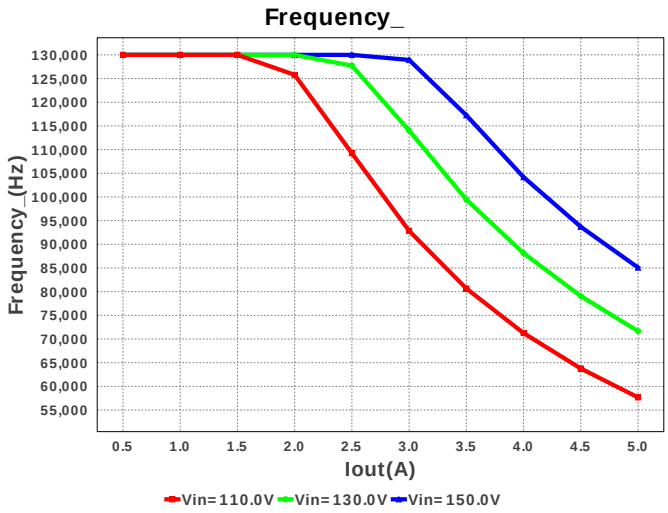
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
21.	Rcs	Vishay-Dale	CRCW0402499RFKED Series= CRCW..e3	Res= 499.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3mm2
22.	Rfbb	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3mm2
23.	Rfbt	Vishay-Dale	CRCW040271K5FKED Series= CRCW..e3	Res= 71.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3mm2
24.	Ropto	Panasonic	ERJ-6ENF5113V Series= 225	Res= 511.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7mm2
25.	Rqrb	Vishay-Dale	CRCW04022K21FKED Series= CRCW..e3	Res= 2.21 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3mm2
26.	Rqrt	Panasonic	ERJ-6ENF7321V Series= 225	Res= 7.32 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7mm2
27.	Rs	Panasonic	ERJ-8ENF7151V Series= ERJ-8E	Res= 7.15 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11mm2
28.	Rsense	Rohm	MCR25JZHFLR300 Series= 298	Res= 300.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.04	 1210 15mm2
29.	Rvcc	Vishay-Dale	CRCW0805100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7mm2
30.	Rvin	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3mm2
31.	Rvsd	CUSTOM	CUSTOM Series= ?	Res= 2.0 MOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0mm2
32.	T1	CUSTOM	CUSTOM	Lp= 1.385 mH Rp= 2.062 Ohm Leakage_L= 27.694 µH Ns1toNp= 0.035 Rs1= 3.173 mOhms Ns2toNp= 0.035 Rs2= 18.844 kOhms	1	NA	CUSTOM 0mm2
33.	U1	Texas Instruments	LM5023MM-2/NOPB	Switcher	1	$0.38	 S-PDSO-G8 36mm2
34.	VR	Texas Instruments	LMV431	Voltage References	1	$0.21	 R-PDSO-G3 16mm2

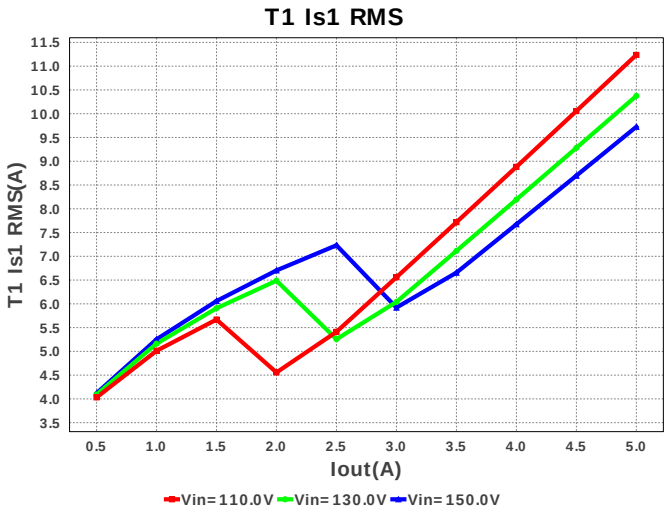


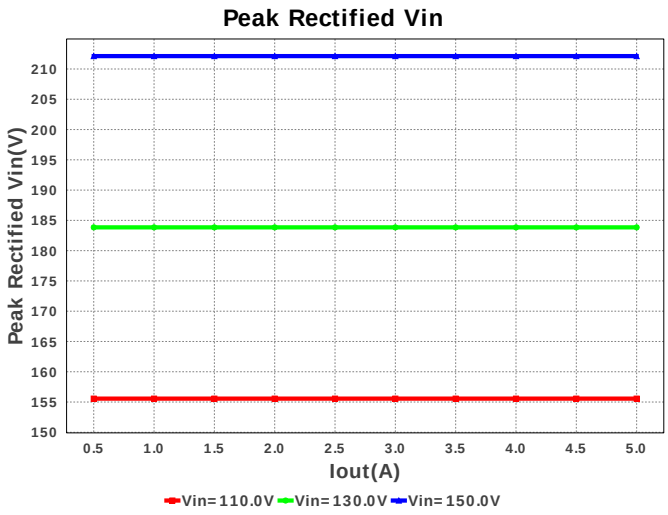


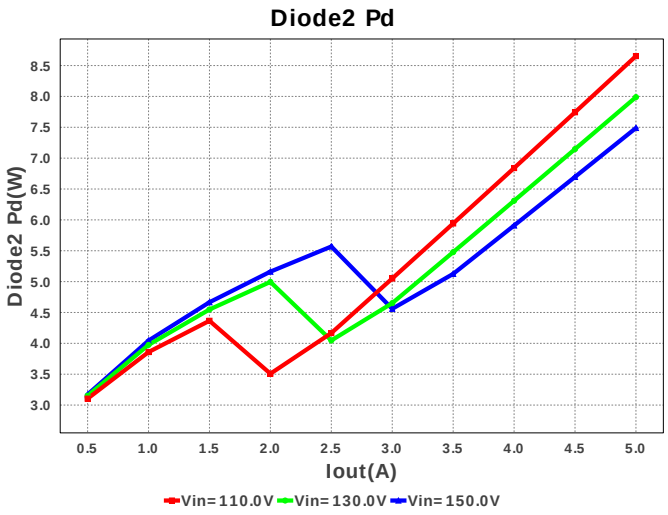


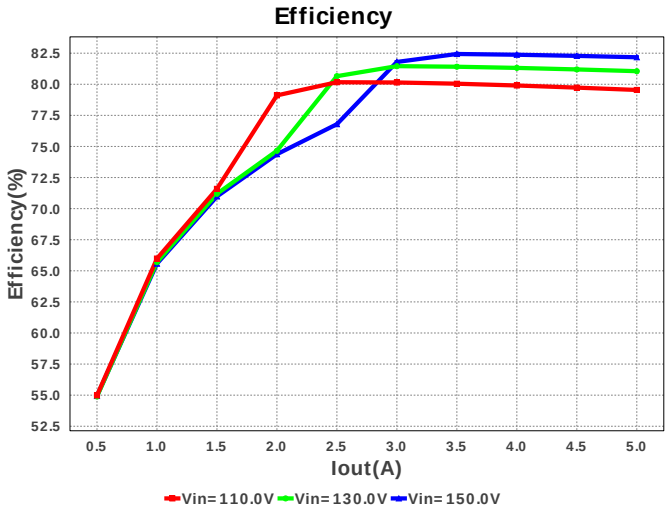


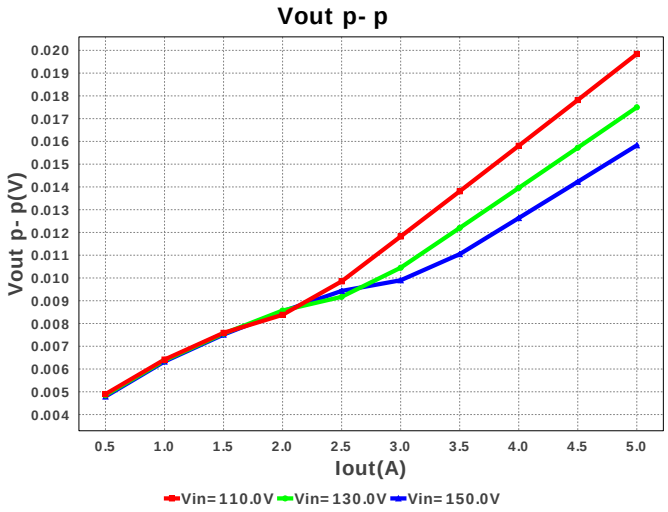


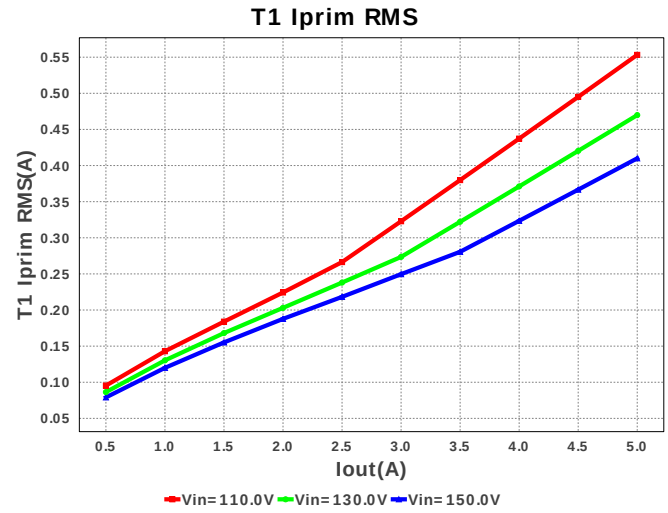


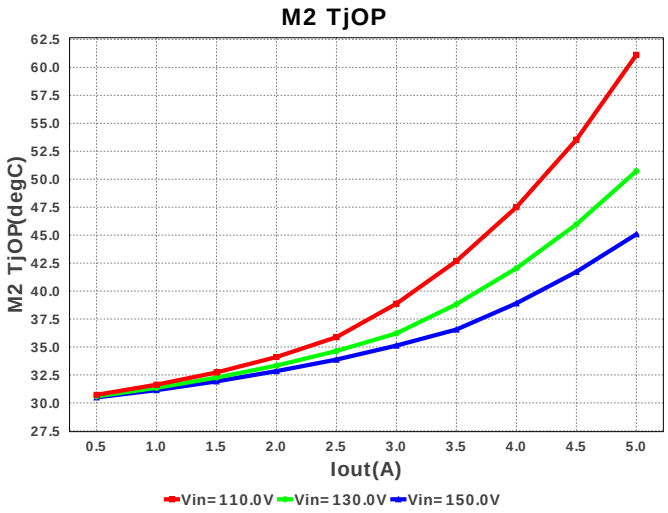


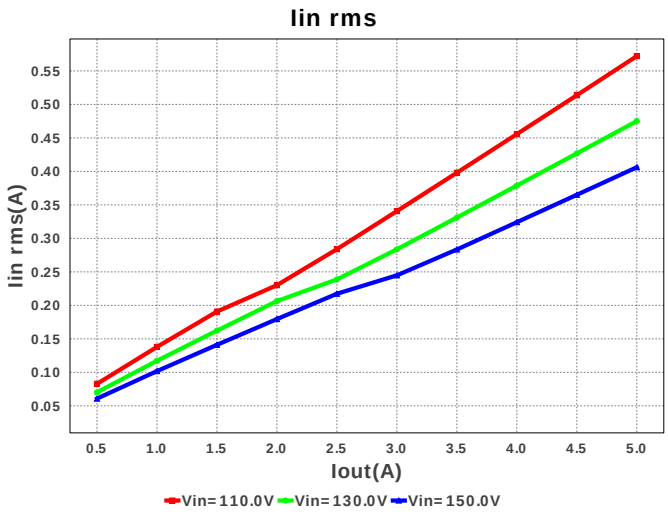


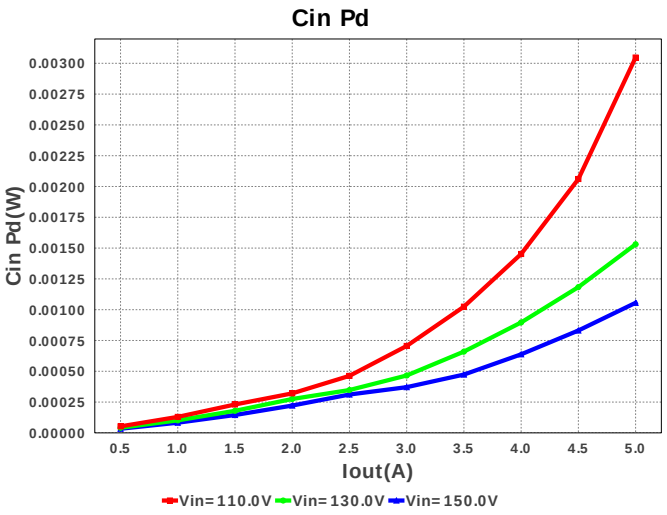


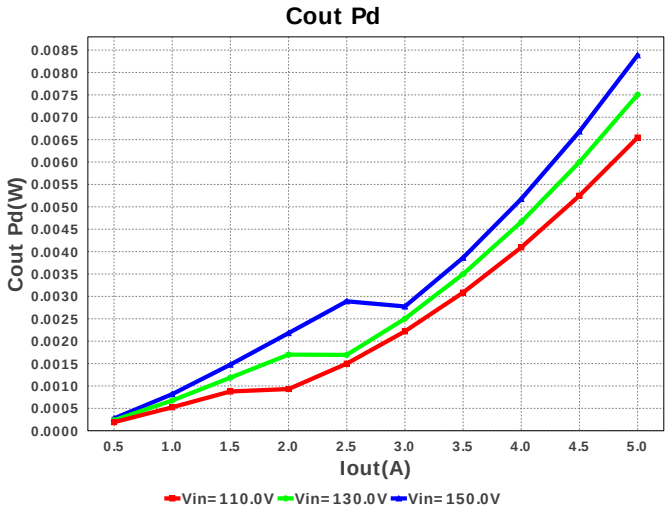


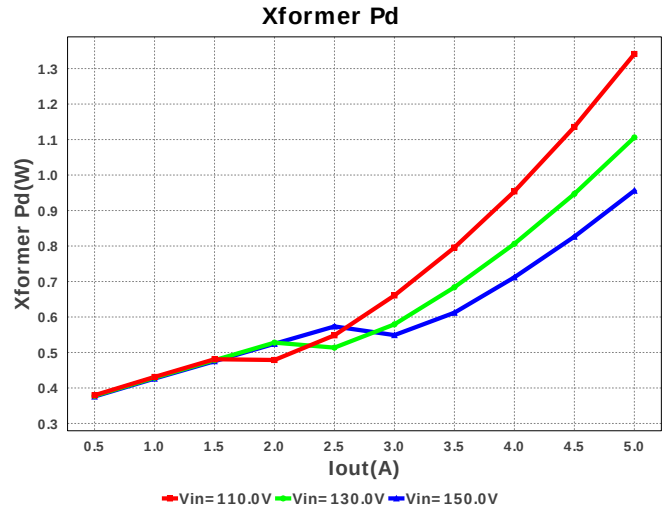


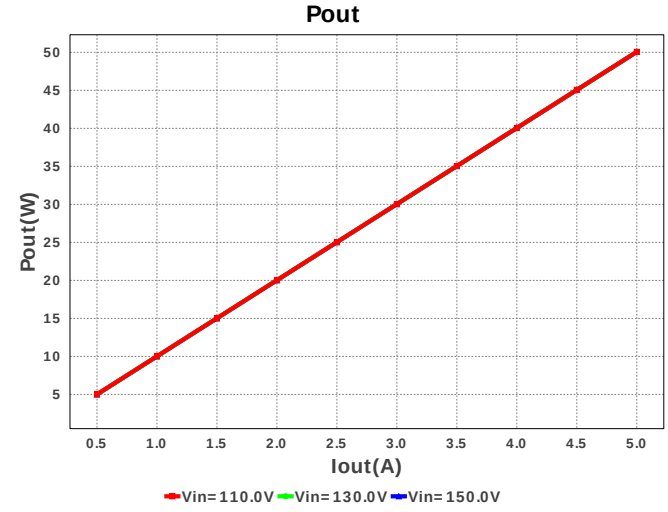


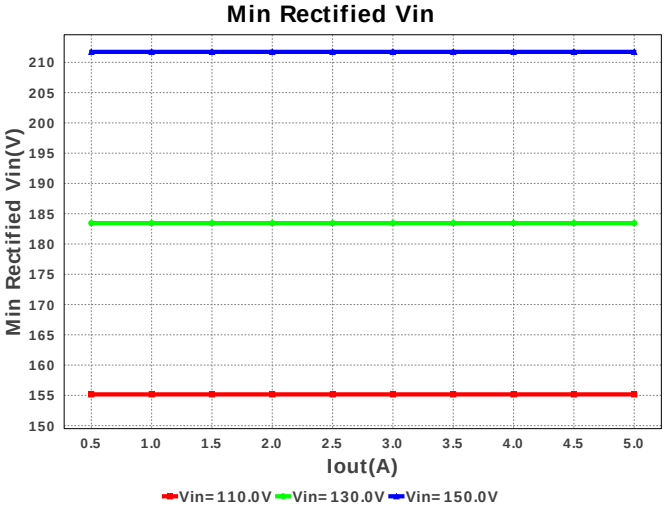


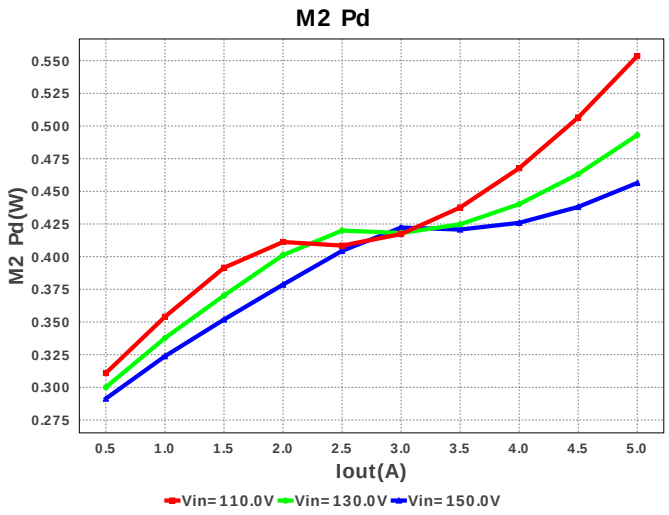


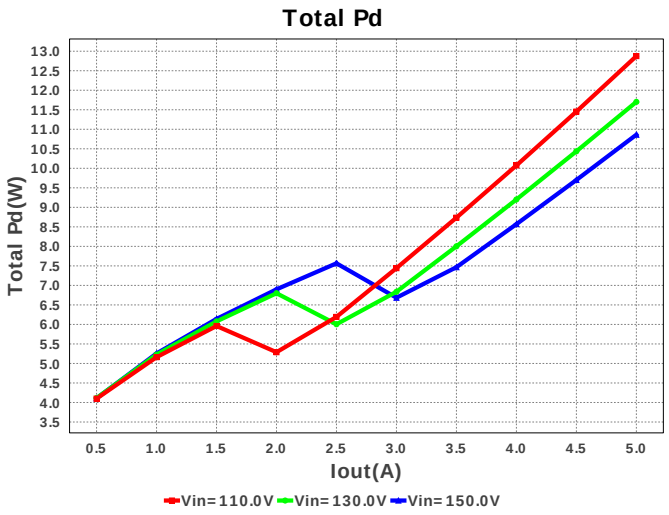


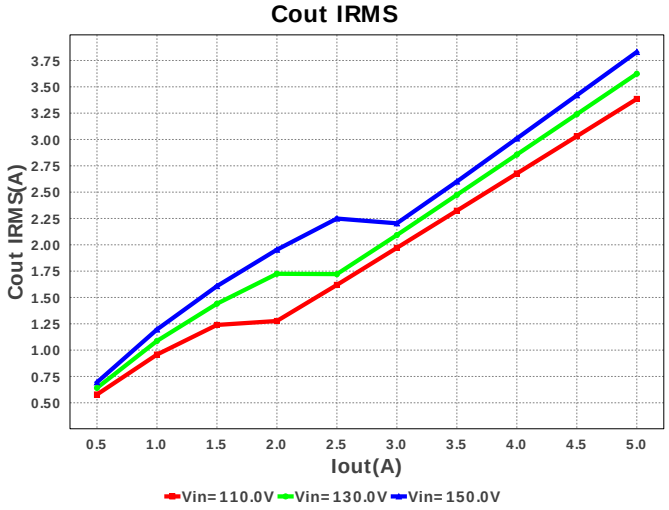


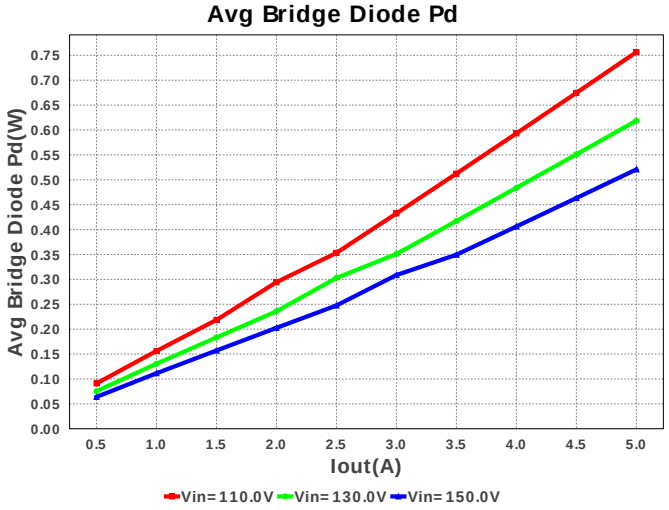


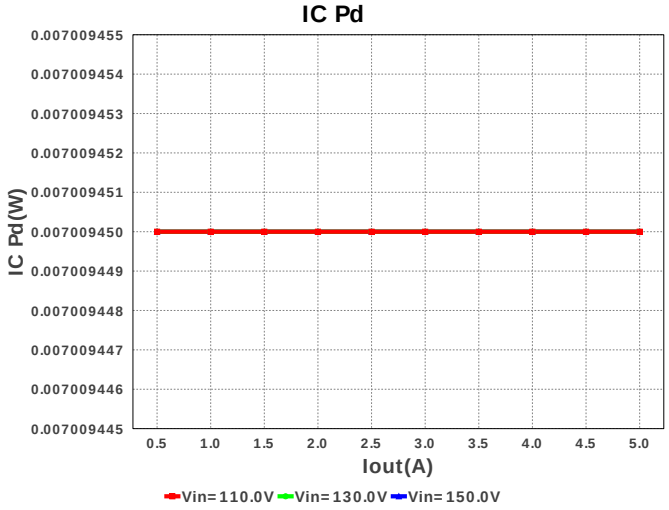


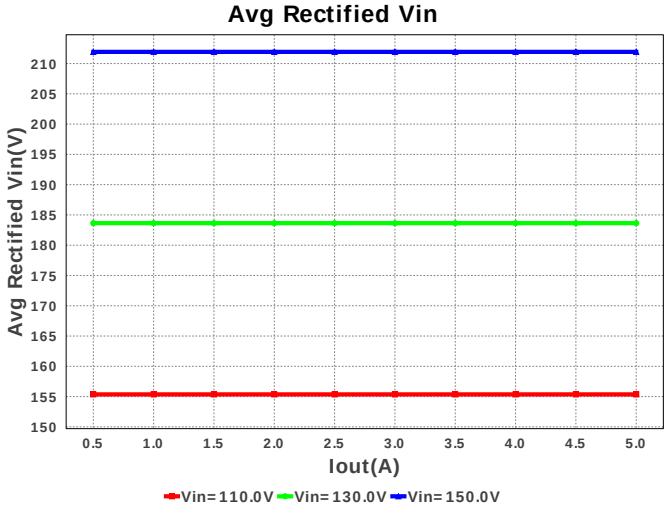


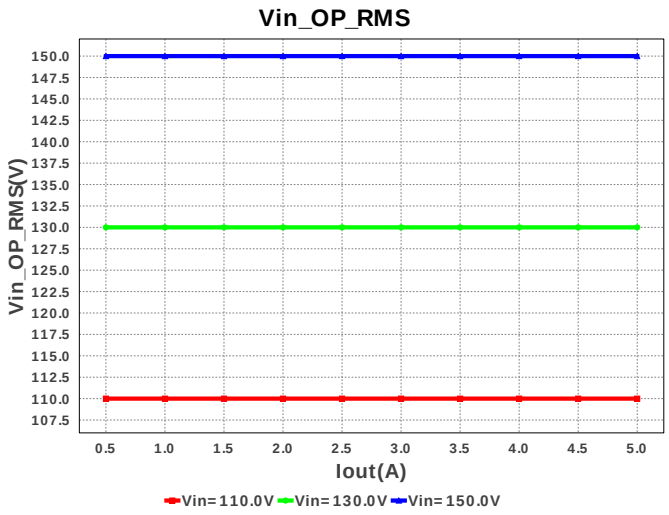


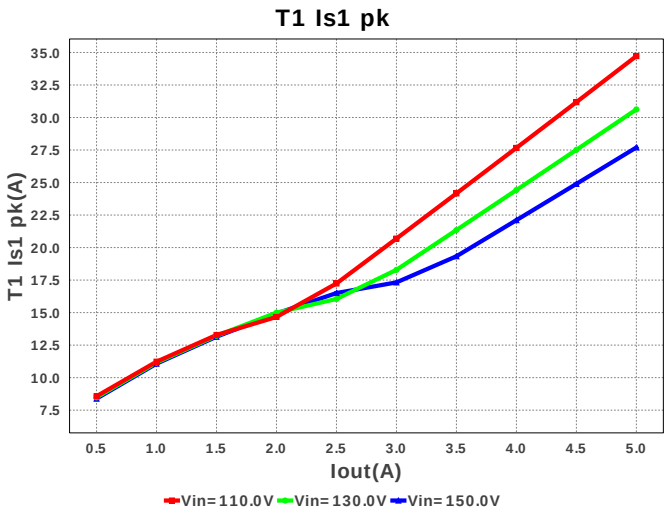












Operating Values

#	Name	Value	Category	Description
1.	Total BOM	$0.0		Total BOM Cost
2.	Cin IRMS	635.241 mA	Current	Input capacitor RMS ripple current
3.	Cout IRMS	3.347 A	Current	Output capacitor RMS ripple current
4.	Iin rms	407.38 mA	Current	RMS Input Current
5.	T1 Iprim RMS	439.163 mA	Current	Transformer Primary RMS Current
6.	T1 Iprim pk	971.045 mA	Current	Transformer Primary Peak Current
7.	T1 Is1 RMS	9.755 A	Current	Transformer Secondary1 RMS Current
8.	T1 Is1 pk	27.778 A	Current	Transformer Secondary1 Peak Current
9.	Avg Rectified Vin	211.93 V	General	Average Rectified Voltage for the AC Line Period
10.	BOM Count	2	General	Total Design BOM count
11.	FootPrint	3.765 kmm2	General	Total Foot Print Area of BOM components
12.	Pout	50.061 W	General	Total output power
13.	Vout OP	10.012 V	Op_Point	Operational Output Voltage
14.	Duty Cycle	73.366 %	Op_point	Duty cycle
15.	Efficiency	81.924 %	Op_point	Steady state efficiency
16.	Frequency	84.868 kHz	Op_point	Switching frequency
17.	IC Tj	31.402 degC	Op_point	IC junction temperature
18.	ICThetaJA	200.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
19.	IOUT_OP	5.0 A	Op_point	Iout operating point
20.	M2 TjOP	47.674 degC	Op_point	M2 MOSFET junction temperature
21.	Min Rectified Vin	211.73 V	Op_point	Minimum voltage seen at rectified input
22.	Peak Rectified Vin	212.13 V	Op_point	Peak voltage seen at rectified input
23.	Vin_OP_RMS	150.0 V	Op_point	AC Input RMS Voltage
24.	Vout p-p	15.873 mV	Op_point	Peak-to-peak output ripple voltage
25.	Avg Bridge Diode Pd	595.845 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
26.	Cin Pd	1.513 mW	Power	Input capacitor power dissipation
27.	Cout Pd	6.401 mW	Power	Output capacitor power dissipation
28.	Diode2 Pd	7.511 W	Power	Diode2 power dissipation
29.	IC Pd	7.009 mW	Power	IC power dissipation
30.	M2 Pd	478.397 mW	Power	M2 MOSFET total power dissipation
31.	Total Pd	11.046 W	Power	Total Power Dissipation
32.	Xformer Pd	1.009 W	Power	Transformer power dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	5.0 A	Maximum Output Current
2.	Iout1	5.0 Amps	Output Current #1
3.	VinMax	150.0 V	Maximum input voltage
4.	VinMin	110.0 V	Minimum input voltage
5.	Vout	10.0 V	Output Voltage
6.	Vout1	10.0 Volt	Output Voltage #1
7.	base_pn	LM5023	Base Product Number
8.	source	AC	Input Source Type
9.	Ta	30.0 degC	Ambient temperature

Design Assistance

1. Application Hints Rbld The European Standard for offline power supplies reuires that power supplies with an output power greater than 70W need to have a PFC front end. There may be application#s where a PFC front end is not required, so please make a choice based on whatever works for you Rlc provides the function of feed-forward line compensation to eliminate change in IPP due to change in di/dt and the propagation

delay of the internal comparator and MOSFET turn-off time. For best results the chosen value may need to be adjusted based on board, FET and transformer parasitics. Rfbt & Rfbb 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.