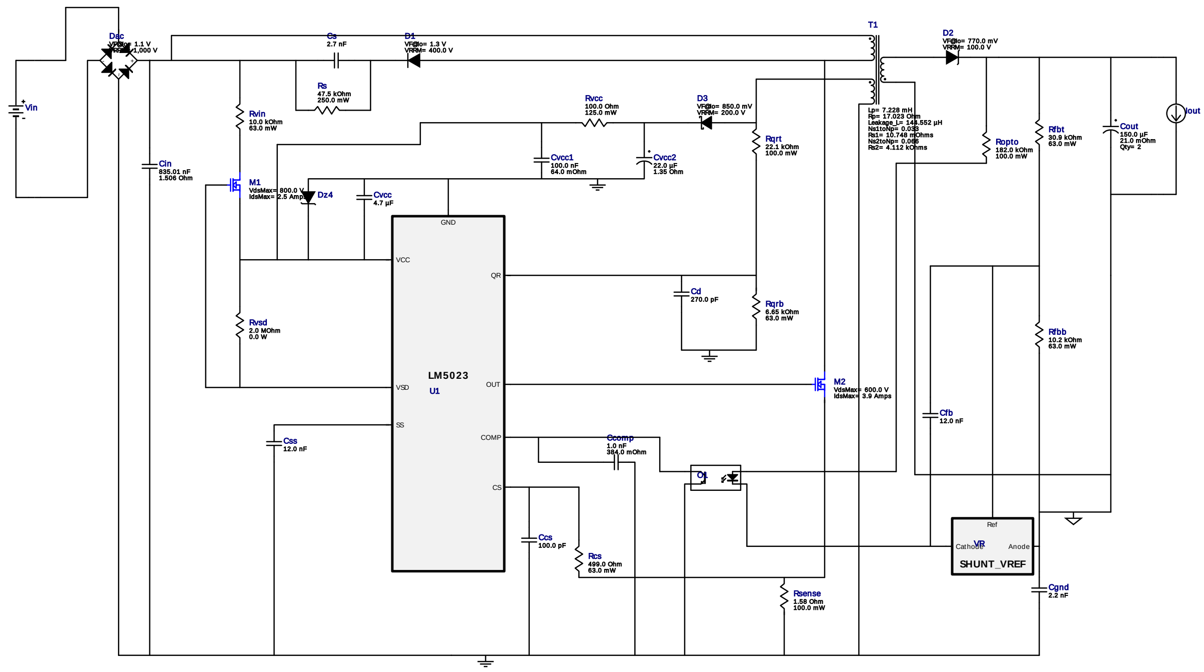
TEXAS INSTRUMENTS

VinMin = 195.0V
VinMax = 235.0V
Vout = 5.0V
Iout = 2.0A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 7/8/13 11:29:52 PM
BOM Cost = $0.00
BOM Count = 35
Total Pd = 3.35W

WEBENCH ® Design Report

Design : 906020/17 LM5023MM-2/NOPB
LM5023MM-2/NOPB 195.0V-235.0V to 5.036764705882353V @ 2.0A



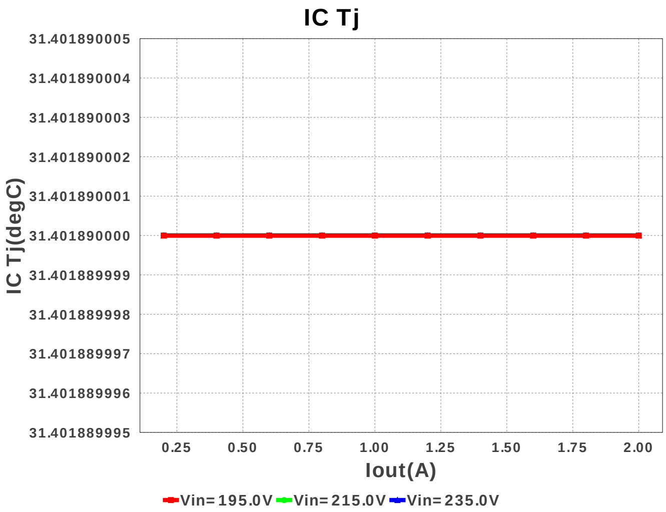
1. Rbld is a starting point, but may need to be experimented with in order to get minimum current needed to hold Vout at no load. Rlc and the feedback resistors may also need adjustment based on the actual transformer used. For more information please click the design assistance button.

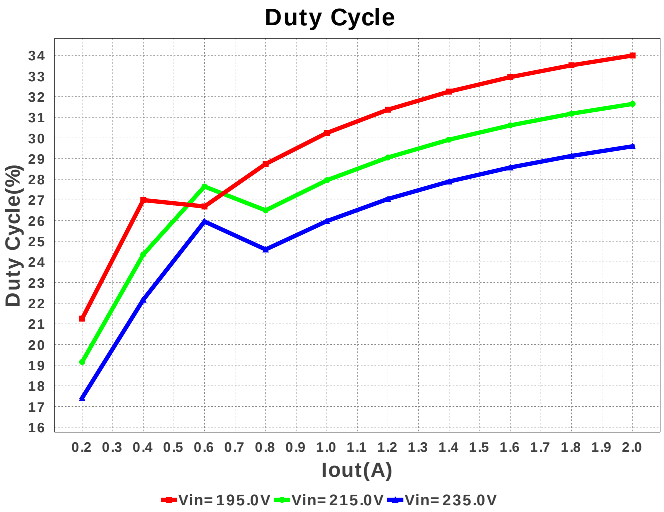
Electrical BOM

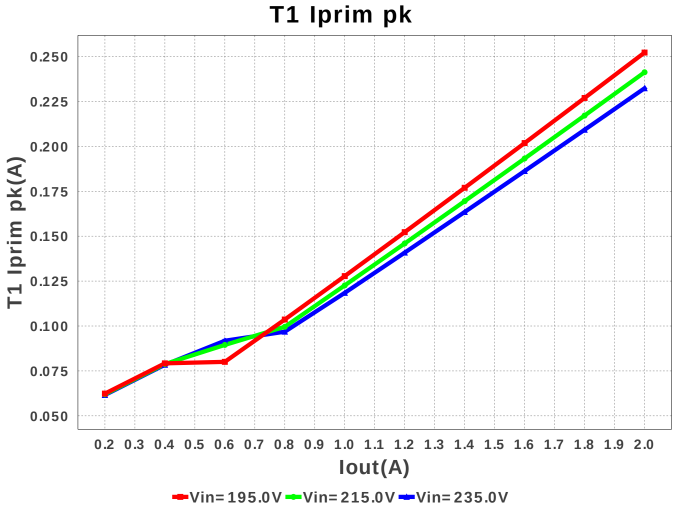
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Kemet	C0805C102K5RACTU Series= X7R	Cap= 1.0 nF ESR= 384.0 mOhm VDC= 50.0 V IRMS= 214.0 mA	1	$0.01	0805 13 mm^2
2.	Ccs	MuRata	GRM033R71C101KA01D Series= X7R	Cap= 100.0 pF VDC= 16.0 V IRMS= 0.0 A	1	$0.01	0201 6 mm^2
3.	Cd	Yageo America	CC0805KRX7R9BB271 Series= X7R	Cap= 270.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 13 mm^2
4.	Cfb	MuRata	GRM155R71E123KA61D Series= X7R	Cap= 12.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 8 mm^2
5.	Cgnd	TDK	C4532X7R3D222K Series= X7R	Cap= 2.2 nF VDC= 2.0 kV IRMS= 0.0 A	1	$0.21	1812 39 mm^2
6.	Cin	CUSTOM	CUSTOM Series= ?	Cap= 835.01 nF ESR= 1.50627 Ohm VDC= 498.51 V IRMS= 155.021 mA	1	NA	CUSTOM 0 mm^2
7.	Cout	Nippon Chemi-Con	APXE100ARA151MF80G Series= PXE	Cap= 150.0 uF ESR= 21.0 mOhm VDC= 10.0 V IRMS= 2.88 A	2	$0.75	CAPSMT_62_F80 74 mm^2

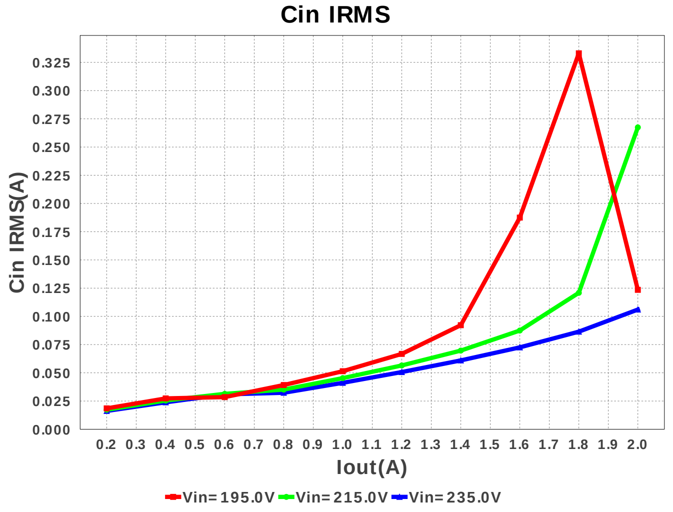
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
8.	Cs	MuRata	GRM155R72A272KA01D Series= X7R	Cap= 2.7 nF VDC= 100.0 V IRMS= 0.0 A	1	$0.01	0402 8 mm^2
9.	Css	MuRata	GRM155R71E123KA61D Series= X7R	Cap= 12.0 nF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0402 8 mm^2
10.	Cvcc	MuRata	GRM219R61C475KE15D Series= X5R	Cap= 4.7 uF VDC= 16.0 V IRMS= 0.0 A	1	$0.04	0805 13 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 13 mm^2
12.	Cvcc2	Panasonic	EEE-FK1C220UR Series= FK	Cap= 22.0 uF ESR= 1.35 Ohm VDC= 16.0 V IRMS= 90.0 mA	1	$0.09	SM_RADIAL_B 47 mm^2
13.	D1	Diodes Inc.	RS1G-13-F	VF@Io= 1.3 V VRRM= 400.0 V	1	$0.07	SMA 37 mm^2
14.	D2	Vishay-Semiconductor	50WQ10FNPBF	VF@Io= 770.0 mV VRRM= 100.0 V	1	$0.41	DPAK 102 mm^2
15.	D3	Diodes Inc.	DFLS1200-7	VF@Io= 850.0 mV VRRM= 200.0 V	1	$0.21	PowerDI123 22 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.	Dz4	ON Semiconductor	BZX84C15LT1G	Zener	1	$0.02	SOT-23 22 mm^2
18.	M1	ST Microelectronics	STD3NK80ZT4	VdsMax= 800.0 V IdsMax= 2.5 Amps	1	$0.62	DPAK 102 mm^2
19.	M2	Fairchild Semiconductor	FCD4N60TM	VdsMax= 600.0 V IdsMax= 3.9 Amps	1	$0.49	DPAK 102 mm^2
20.	O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$0.39	SSOP-4 111 mm^2
21.	Rcs	Vishay-Dale	CRCW0402499RFKED Series= CRCW..e3	Res= 499.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 8 mm^2
22.	Rfbb	Vishay-Dale	CRCW040210K2FKED Series= CRCW..e3	Res= 10.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 8 mm^2
23.	Rfbt	Vishay-Dale	CRCW040230K9FKED Series= CRCW..e3	Res= 30.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 8 mm^2
24.	Ropto	Vishay-Dale	CRCW0603182KFKEA Series= CRCW..e3	Res= 182.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 10 mm^2
25.	Rqrb	Vishay-Dale	CRCW04026K65FKED Series= CRCW..e3	Res= 6.65 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 8 mm^2
26.	Rqrt	Vishay-Dale	CRCW060322K1FKEA Series= CRCW..e3	Res= 22.1 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 10 mm^2

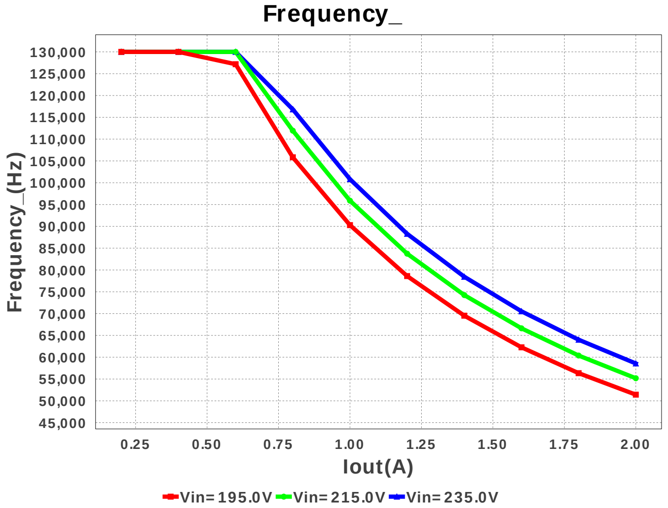
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
27.	Rs	Panasonic	ERJ-8ENF4752V Series= ERJ-8E	Res= 47.5 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 19 mm^2
28.	Rsense	Vishay-Dale	CRCW06031R58FKEA Series= CRCW..e3	Res= 1.58 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 10 mm^2
29.	Rvcc	Vishay-Dale	CRCW0805100RFKEA Series= CRCW..e3	Res= 100.0 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 13 mm^2
30.	Rvin	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 8 mm^2
31.	Rvsd	CUSTOM	CUSTOM Series= ?	Res= 2.0 MOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm^2
32.	T1	CUSTOM	CUSTOM	Lp= 7.228 mH Rp= 17.023 Ohm Leakage_L= 144.552 µH Ns1toNp= 0.033 Rs1= 10.748 mOhms Ns2toNp= 0.066 Rs2= 4.112 kOhms	1	NA	CUSTOM 0 mm^2
33.	U1	Texas Instruments	LM5023MM-2/NOPB	Switcher	1	$2.00	S-PDSO-G8 36 mm^2
34.	VR	Texas Instruments	LMV431	Voltage References	1	NA	R-PDSO-G3 25 mm^2

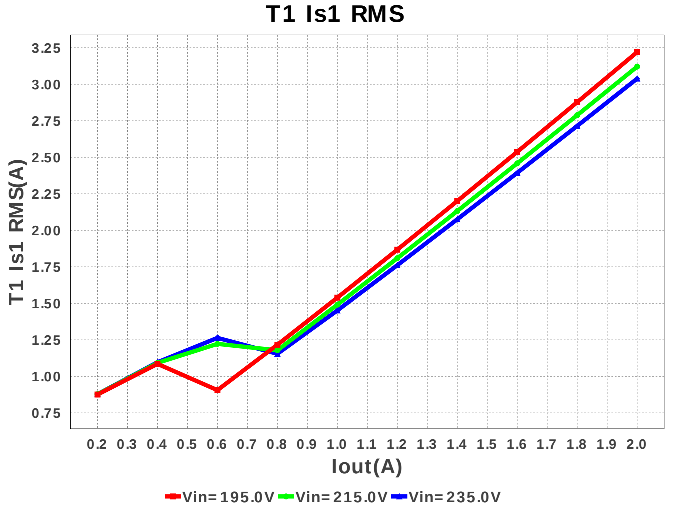


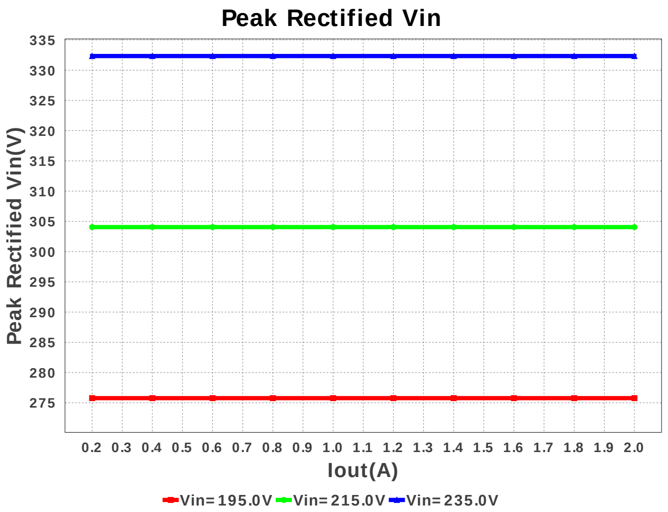


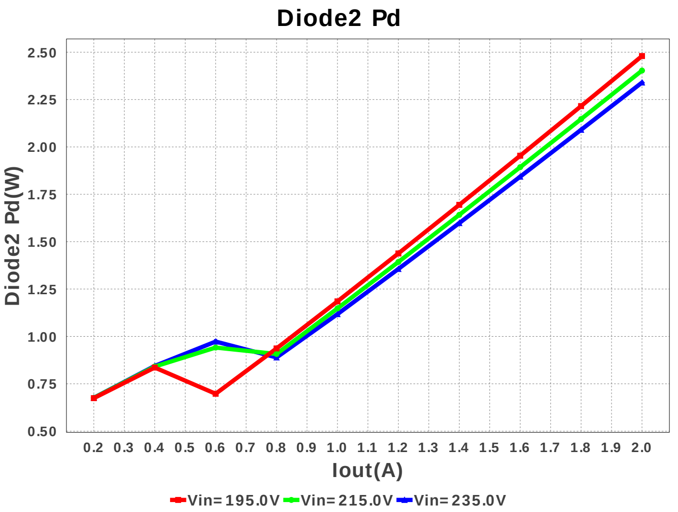

T1 Iprim pk
T1 Iprim pk(A)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V


Cin IRMS
Cin IRMS(A)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V

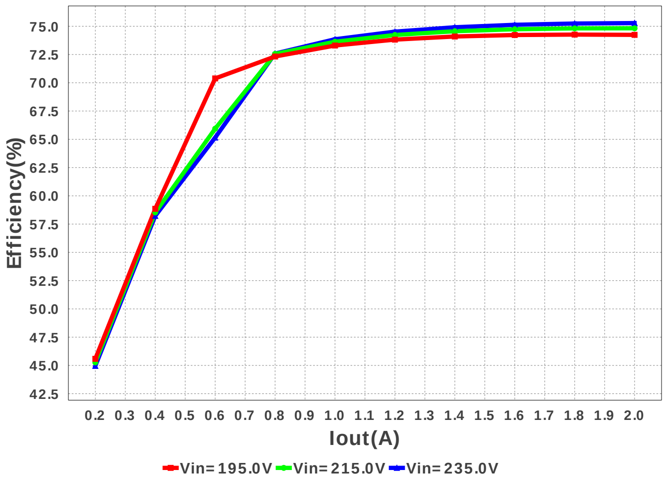

Frequency_
Frequency_(Hz)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V


T1 Is1 RMS
T1 Is1 RMS(A)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V

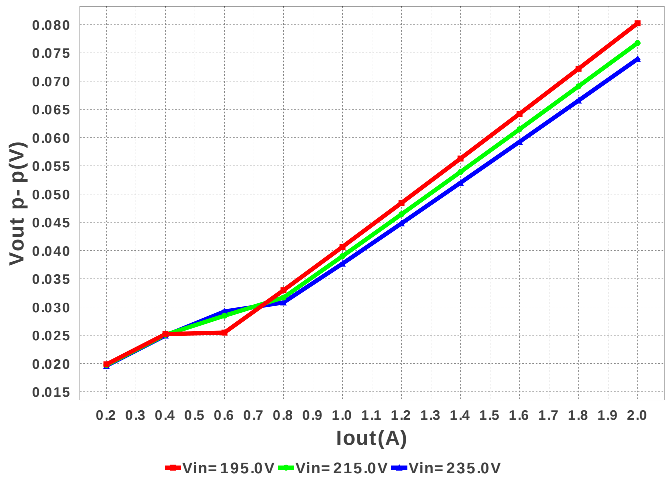

Peak Rectified Vin
Peak Rectified Vin(V)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V


Diode2 Pd
Diode2 Pd(W)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V

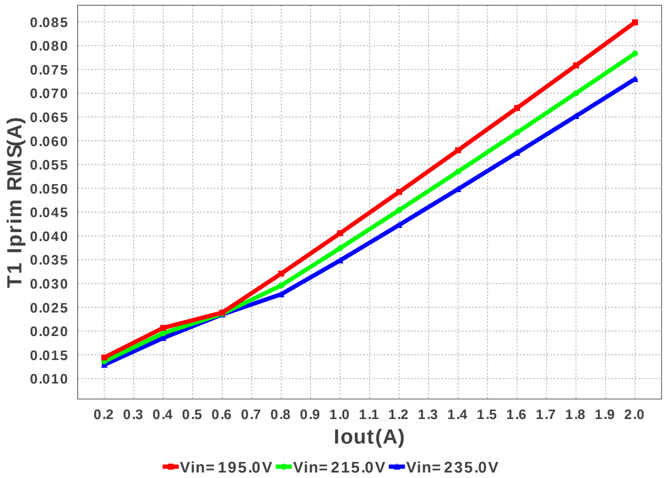
Efficiency



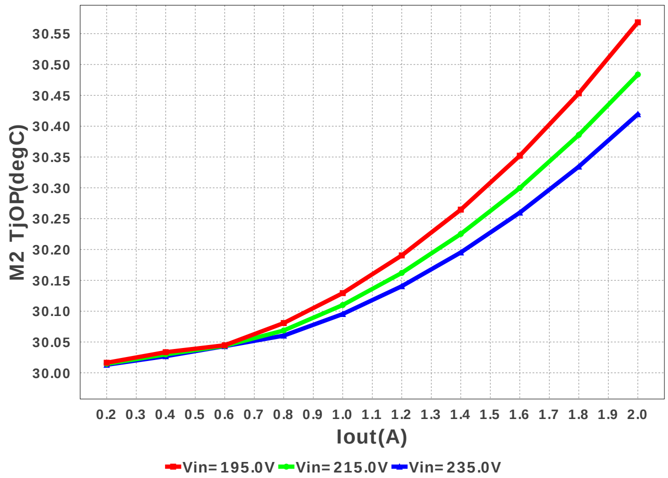
Vout p- p



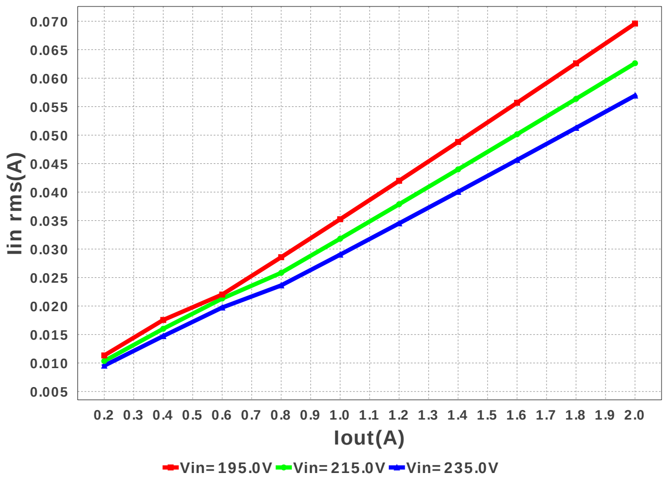
T1 Iprim RMS



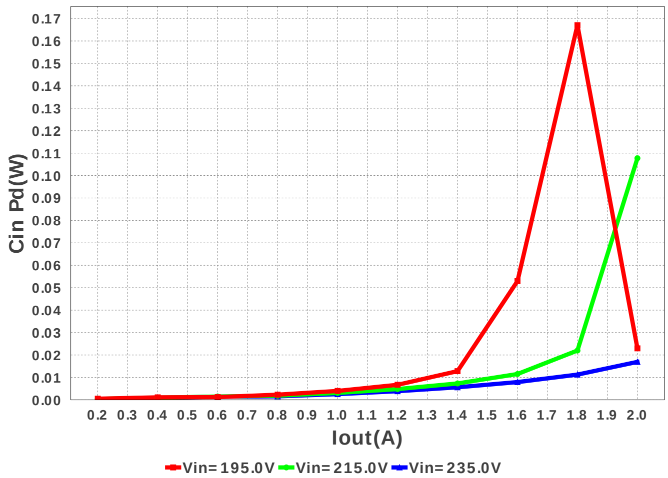
M2 TjOP

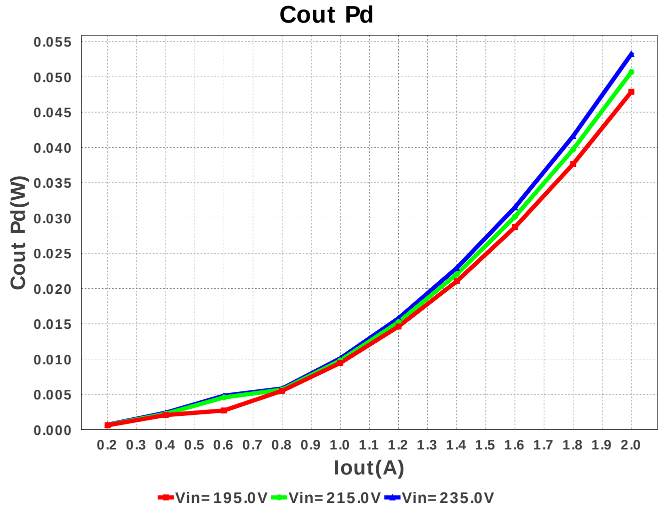


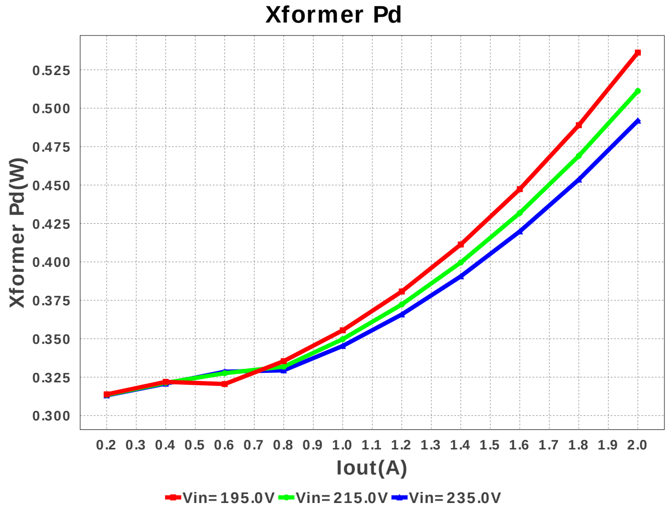
Iin rms

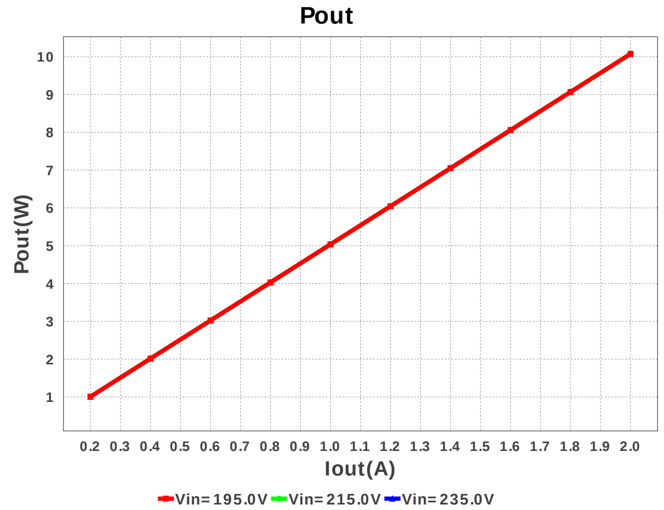


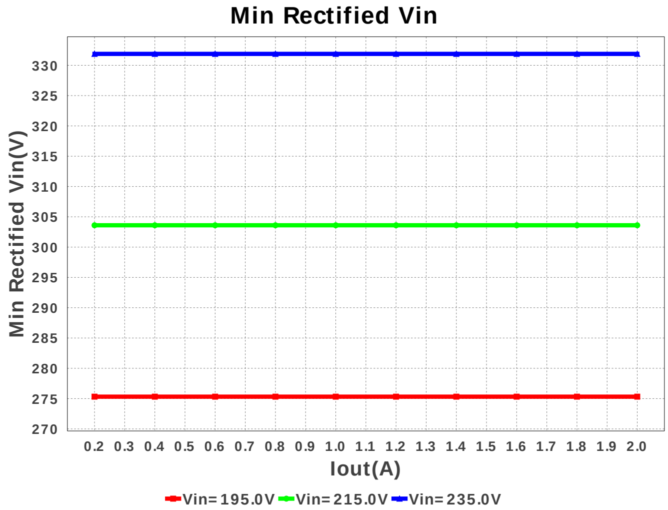
Cin Pd

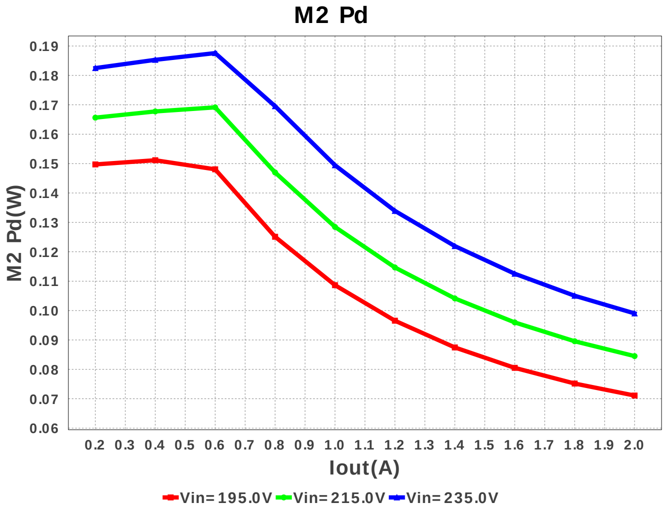


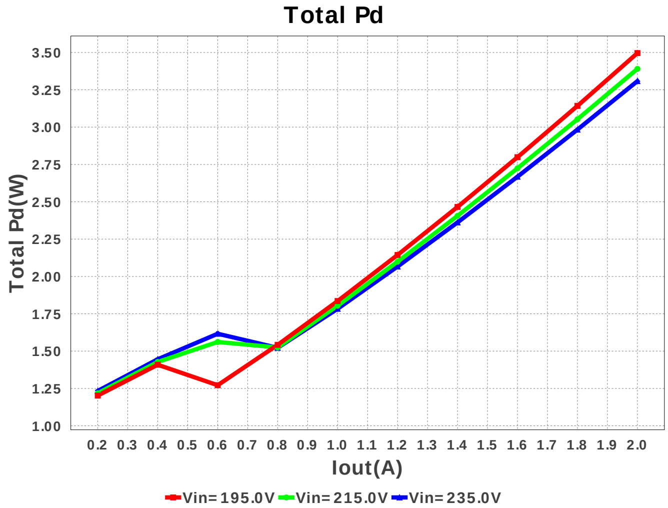

Cout Pd
Cout Pd(W)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V


Xformer Pd
Xformer Pd(W)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V

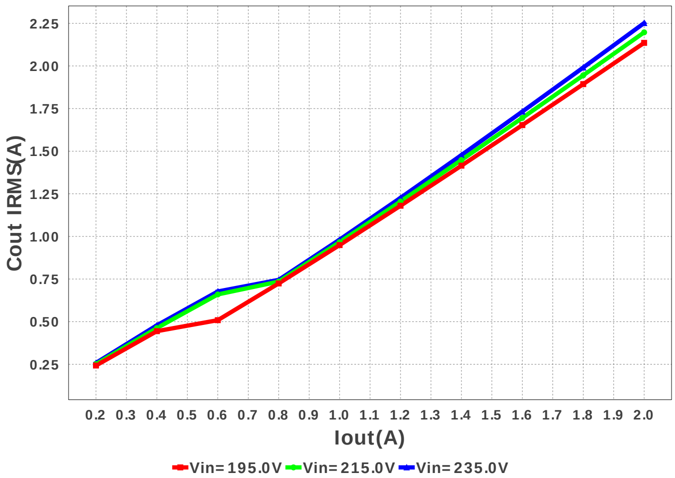

Pout
Pout(W)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V


Min Rectified Vin
Min Rectified Vin(V)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V

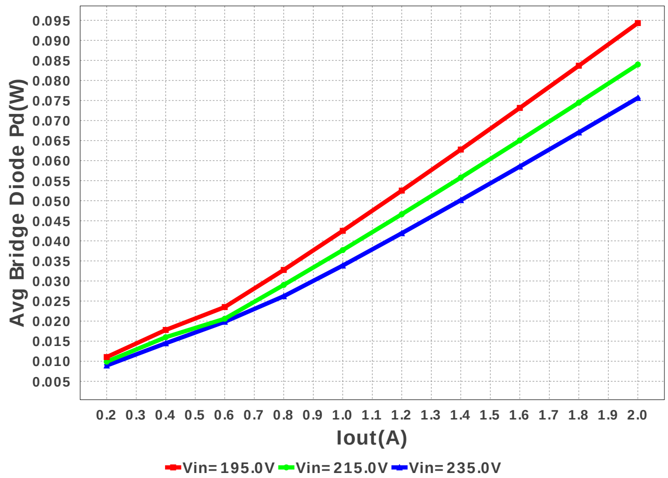

M2 Pd
M2 Pd(W)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V


Total Pd
Total Pd(W)
Iout(A)
Vin=195.0V Vin=215.0V Vin=235.0V

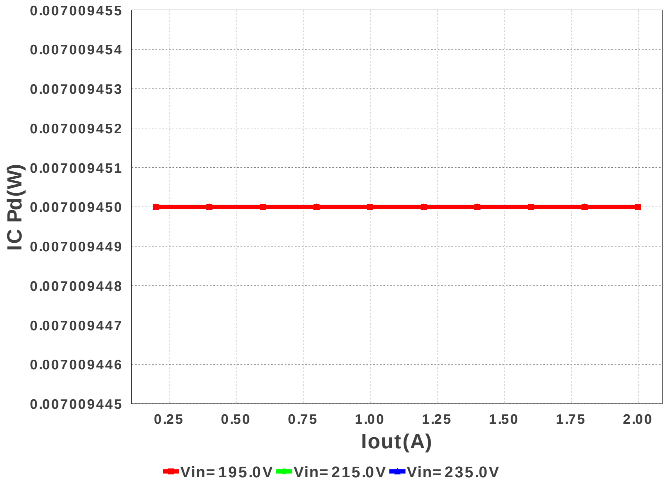
Cout IRMS



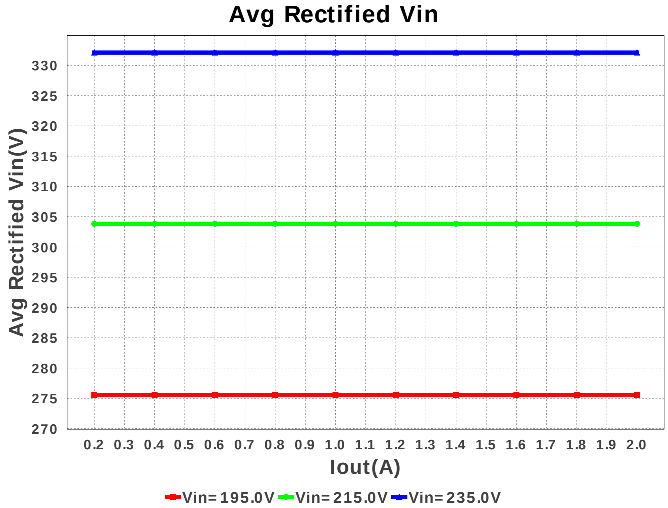
Avg Bridge Diode Pd



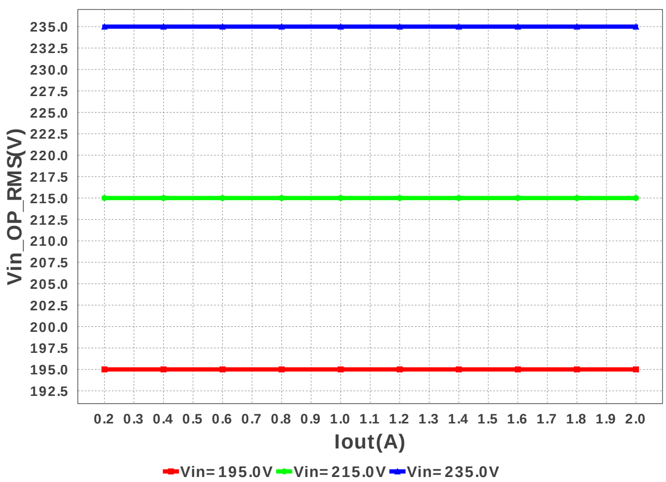
IC Pd



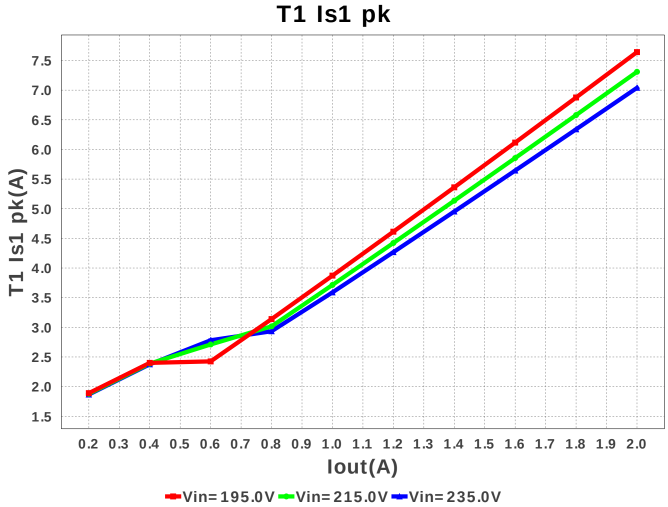
Avg Rectified Vin



Vin_OP_RMS



T1 Is1 pk



Operating Values

#	Name	Value	Category	Description
1.	Cin IRMS	114.272 mA	Current	Input capacitor RMS ripple current
2.	Cout IRMS	2.112 A	Current	Output capacitor RMS ripple current
3.	Iin rms	57.135 mA	Current	RMS Input Current
4.	T1 Iprim RMS	78.059 mA	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	233.102 mA	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	3.049 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	7.063 A	Current	Transformer Secondary1 Peak Current
8.	Avg Rectified Vin	332.112 V	General	Average Rectified Voltage for the AC Line Period
9.	BOM Count	35	General	Total Design BOM count
10.	FootPrint	1.112 k mm^2	General	Total Foot Print Area of BOM components
11.	Pout	10.074 W	General	Total output power

#	Name	Value	Category	Description
12.	Total BOM	$0.0	General	Total BOM Cost
13.	Vout OP	5.037 V	Op_Point	Operational Output Voltage
14.	Duty Cycle	35.685 %	Op_point	Duty cycle
15.	Efficiency	75.026 %	Op_point	Steady state efficiency
16.	Frequency	58.402 kHz	Op_point	Switching frequency
17.	IC Tj	32.103 degC	Op_point	IC junction temperature
18.	ICThetaJA	200.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
19.	IOUT_OP	2.0 A	Op_point	Iout operating point
20.	M2 TjOP	30.48 degC	Op_point	M2 MOSFET junction temperature
21.	Min Rectified Vin	331.887 V	Op_point	Minimum voltage seen at rectified input
22.	Peak Rectified Vin	332.337 V	Op_point	Peak voltage seen at rectified input
23.	Vin_OP_RMS	235.0 V	Op_point	AC Input RMS Voltage
24.	Vout p-p	74.16 mV	Op_point	Peak-to-peak output ripple voltage
25.	Avg Bridge Diode Pd	86.261 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
26.	Cin Pd	19.669 mW	Power	Input capacitor power dissipation
27.	Cout Pd	46.835 mW	Power	Output capacitor power dissipation
28.	Diode2 Pd	2.348 W	Power	Diode2 power dissipation
29.	IC Pd	10.514 mW	Power	IC power dissipation
30.	M2 Pd	99.519 mW	Power	M2 MOSFET total power dissipation
31.	Total Pd	3.353 W	Power	Total Power Dissipation
32.	Xformer Pd	511.783 mW	Power	Transformer power dissipation

Design Inputs

#	Name	Value	Description
1.	Iout	2.0	Maximum Output Current
2.	Iout1	2.0	Output Current #1
3.	VinMax	235.0	Maximum input voltage
4.	VinMin	195.0	Minimum input voltage
5.	Vout	5.0	Output Voltage
6.	Vout1	5.0	Output Voltage #1
7.	base_pn	LM5023	Base Product Number
8.	source	AC	Input Source Type
9.	Ta	30.0	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.