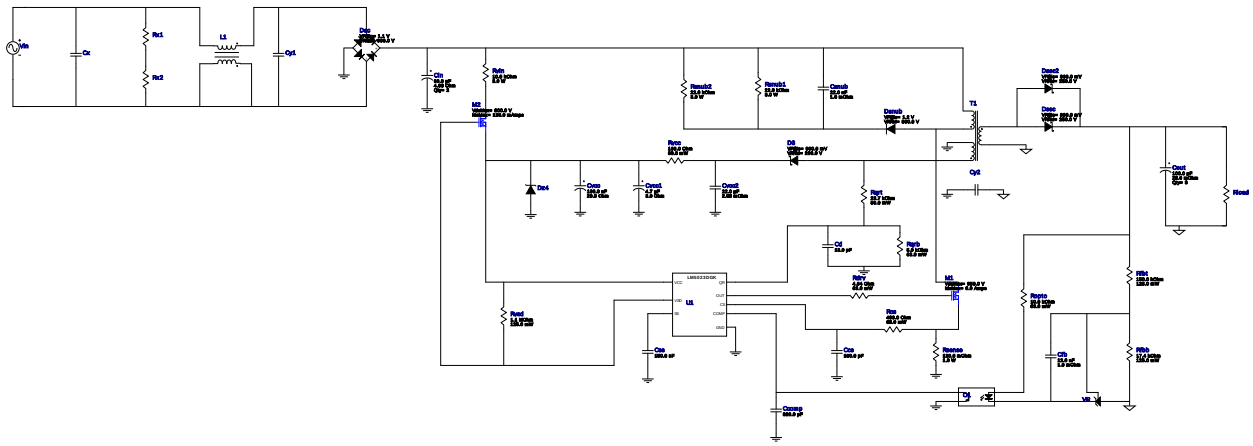
WEBENCH® Design Report

VinMin = 85.0V
VinMax = 265.0V
Vout = 24.0V
Iout = 2.7A

Device = LM5023MM-2/NOPB
Topology = Flyback
Created = 2018-07-27 15:35:36.907
BOM Cost = $13.02
BOM Count = 39
Total Pd = 9.1W

Design : LM5023MM-2/NOPB
LM5023MM-2/NOPB 85.0V-265.0V to 24.00V @ 2.7A

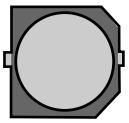


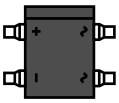
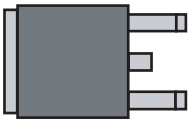
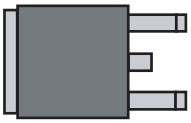
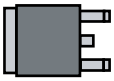
1. The EMI filter shown in the schematic is a placeholder. It has not yet been designed for the application.

My Comments

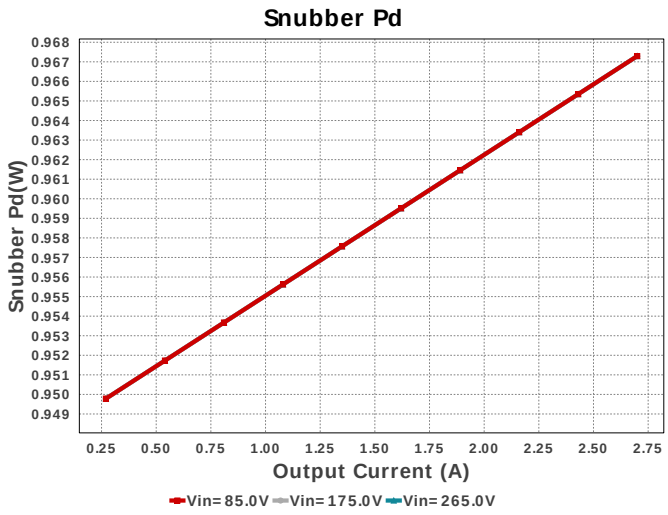
No comments

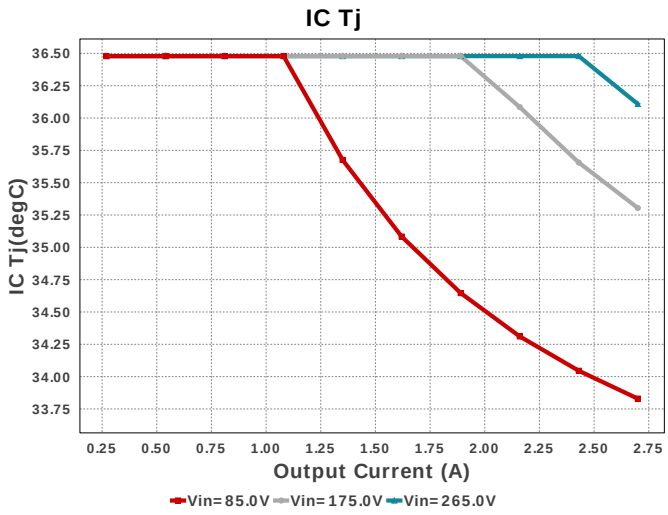
Electrical BOM

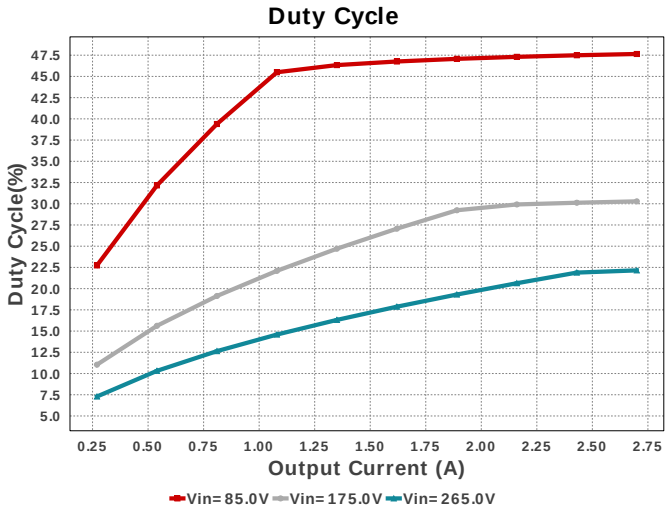
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	Ccomp	Samsung Electro-Mechanics	CL05C821JB5NNNC Series= C0G/NP0	Cap= 820.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0402 3 mm^2
2.	Ccs	Samsung Electro-Mechanics	CL21C101JBANNNC Series= C0G/NP0	Cap= 100.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
3.	Cd	Samsung Electro-Mechanics	CL21C130JBANNNC Series= C0G/NP0	Cap= 13.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
4.	Cfb	MuRata	GRM033C80J123KE01D Series= X6S	Cap= 12.0 nF ESR= 1.0 mOhm VDC= 6.3 V IRMS= 0.0 A	1	$0.01	0201 2 mm^2
5.	Cin	Chemi-Con	EKXG401ELL680MM25S Series= KXG	Cap= 68.0 uF ESR= 4.68 Ohm VDC= 400.0 V IRMS= 1.4625 A	2	$0.97	KXG_1800x2500 400 mm^2
6.	Cout	Panasonic	EEHZA1H101P Series= ZA	Cap= 100.0 uF ESR= 28.0 mOhm VDC= 50.0 V IRMS= 2.0 A	3	$1.08	 SM_RADIAL_10BMM 160 mm^2
7.	Csnub	Vishay-Vitramon	VJ1206Y223KBEAT4X Series= X7R	Cap= 22.0 nF ESR= 1.0 mOhm VDC= 500.0 V IRMS= 0.0 A	1	$0.25	 1206 11 mm^2
8.	Css	TDK	C4532C0G1H154J250KA Series= C0G/NP0	Cap= 150.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.46	 1812 23 mm^2

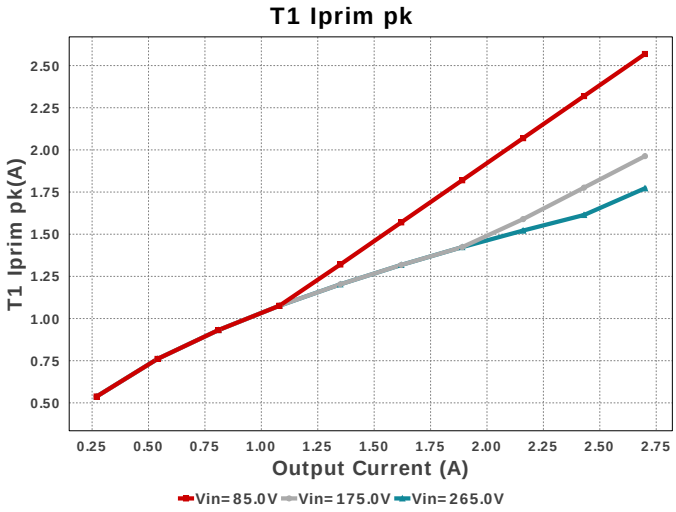
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Cvcc	Vishay-Sprague	293D104X9035A2TE3 Series= 293D	Cap= 100.0 nF ESR= 20.0 Ohm VDC= 35.0 V IRMS= 60.0 mA	1	$0.08	 3216-18 11 mm²
10.	Cvcc1	Panasonic	EEE-FC1V4R7R Series= FC	Cap= 4.7 uF ESR= 3.0 Ohm VDC= 35.0 V IRMS= 50.0 mA	1	$0.08	 SM_RADIAL_B 47 mm²
11.	Cvcc2	TDK	C2012X5R1V226M125AC Series= X5R	Cap= 22.0 uF ESR= 2.05 mOhm VDC= 35.0 V IRMS= 4.5559 A	1	$0.38	 0805 7 mm²
12.	D3	SMC Diode Solutions	SK220ATR	VF@Io= 900.0 mV VRRM= 200.0 V	1	$0.04	 SMA 37 mm²
13.	Dac	Diodes Inc.	DF1506S-T	VF@Io= 1.1 V VRRM= 600.0 V	1	$0.23	 DF-S 99 mm²
14.	Dsec	ON Semiconductor	MBRB40250TG	VF@Io= 860.0 mV VRRM= 250.0 V	1	$0.99	 DDPAK 210 mm²
15.	Dsec2	ON Semiconductor	MBRB40250TG	VF@Io= 860.0 mV VRRM= 250.0 V	1	$0.99	 DDPAK 210 mm²
16.	Dsnub	Microsemi	UFS180JE3/TR13	VF@Io= 1.2 V VRRM= 800.0 V	1	$0.71	 DO-214BA 42 mm²
17.	Dz4	ON Semiconductor	MMBZ5244BLT1G	Zener	1	$0.03	 SOT-23 14 mm²
18.	M1	STMicroelectronics	STD12N65M2	VdsMax= 650.0 V IdsMax= 8.0 Amps	1	$0.75	 DPAK 102 mm²
19.	M2	Infineon Technologies	BSP135H6327XTSA1	VdsMax= 600.0 V IdsMax= 120.0 mAmps	1	$0.62	 SOT-223 76 mm²
20.	O1	Fairchild Semiconductor	FOD817A	Optocoupler	1	$0.13	 DIP-4 71 mm²
21.	Rcs	Vishay-Dale	CRCW0402499RFKED Series= CRCW..e3	Res= 499.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
22.	Rdrv	Vishay-Dale	CRCW04024R64FKED Series= CRCW..e3	Res= 4.64 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
23.	Rfbb	Vishay-Dale	CRCW080517K4FKEA Series= CRCW..e3	Res= 17.4 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
24.	Rfbt	Vishay-Dale	CRCW0805150KFKEA Series= CRCW..e3	Res= 150.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
25.	Ropto	Stackpole Electronics Inc	RMCF0402FT10K0 Series= ?	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²

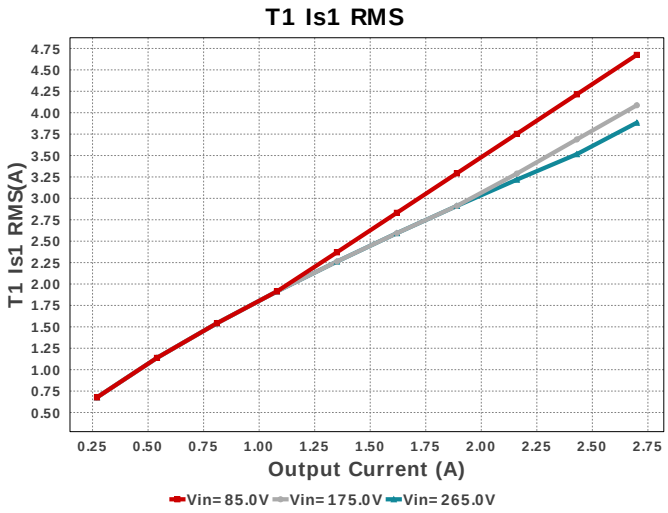
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
26.	Rqrb	Vishay-Dale	CRCW04025K90FKED Series= CRCW..e3	Res= 5.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
27.	Rqrt	Yageo	RC0201FR-0723K7L Series= ?	Res= 23.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	 0201 2 mm²
28.	Rsense	Vishay-Dale	WSLT2010R1200FEB18 Series= WSL...18	Res= 120.0 mOhm Power= 1.0 W Tolerance= 1.0%	1	$0.35	 2010 32 mm²
29.	Rsnub1	Yageo	FMP300JR-73-22K Series= ?	Res= 22.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.03	 FMP300 181 mm²
30.	Rsnub2	Yageo	FMP300JR-73-22K Series= ?	Res= 22.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.03	 FMP300 181 mm²
31.	Rvcc	Vishay-Dale	CRCW0402169RFKED Series= CRCW..e3	Res= 169.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
32.	Rvin	Vishay-Bccomponents	PR03000201002JAC00 Series= ?	Res= 10.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.17	 PR03 197 mm²
33.	Rvsd	Vishay-Dale	CRCW08051M10FKEA Series= CRCW..e3	Res= 1.1 MOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
34.	T1	Core=TDK , CoilFormer=TDK	Core=B65847A0000R087 , CoilFormer=B65848D1010D001	Lp= 391.0 µH Turns Ratio(Nas)= 6:11 Turns Ratio(Nps)= 52:11 Npri= 52.0 Naux= 6.0 Nsec= 11.0	1	$0.88	 TDK_B65839 612 mm²
35.	U1	Texas Instruments	LM5023MM-2/NOPB	Switcher	1	$0.43	 DGK0008A 24 mm²
36.	VR	Texas Instruments	TL431AIDBZR	Voltage References	1	$0.08	 DBZ0003A 14 mm²

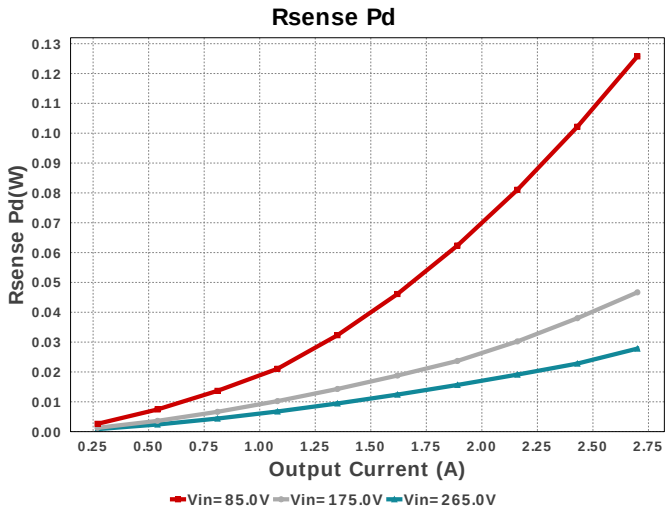


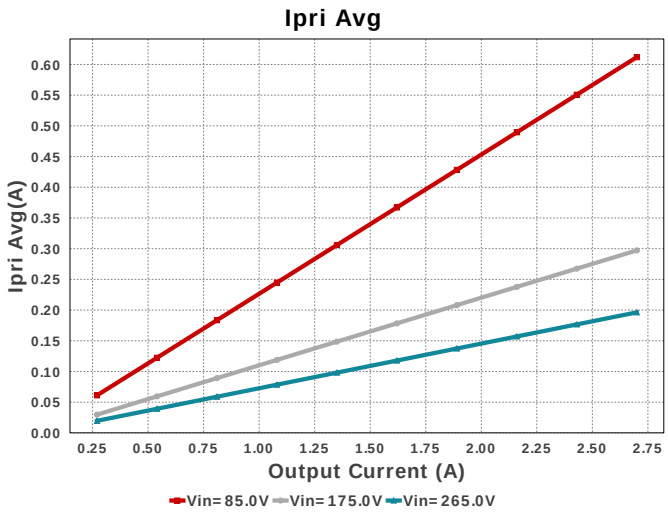


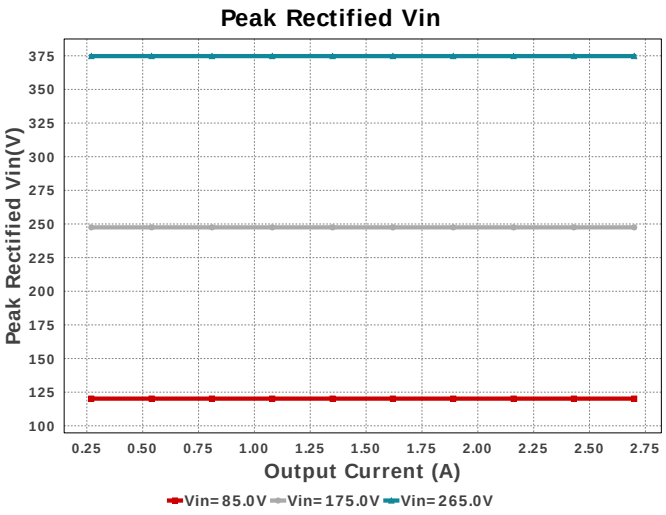


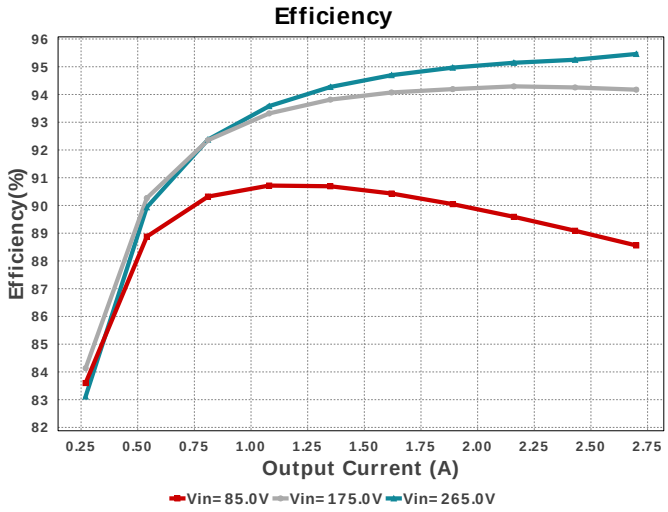


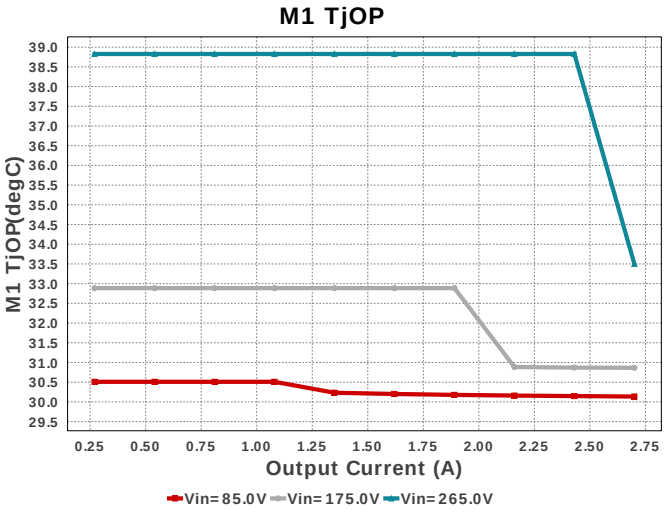


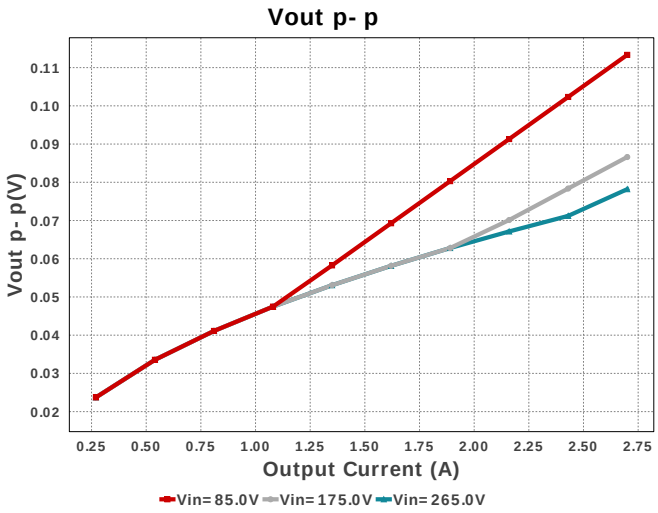


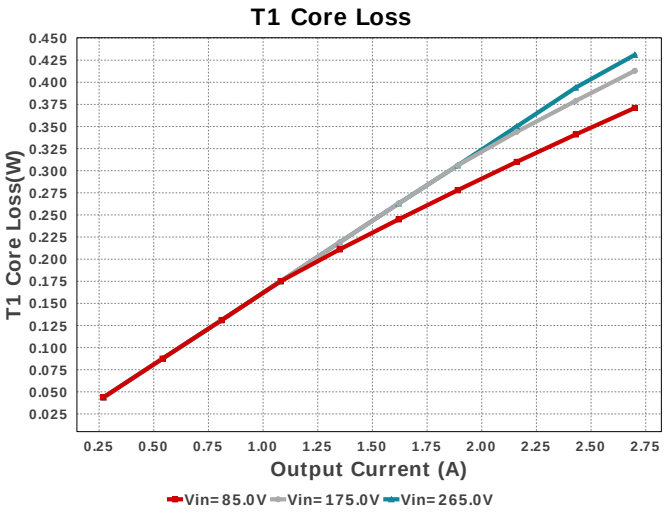


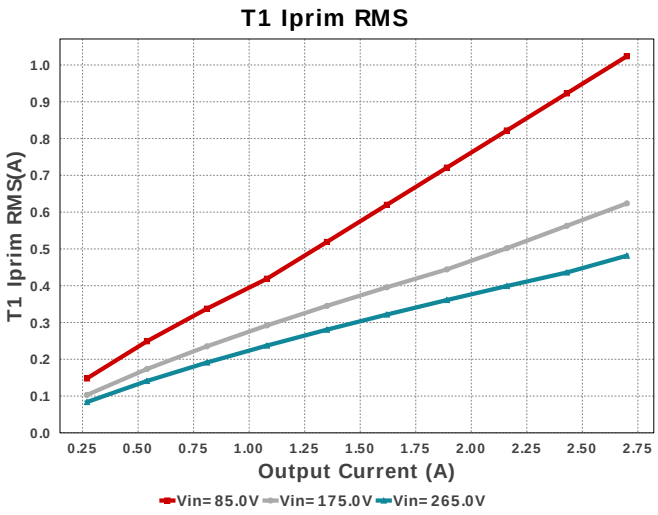


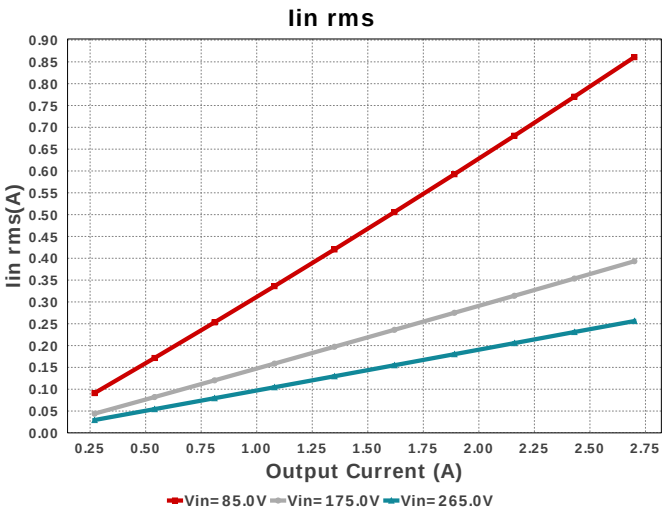


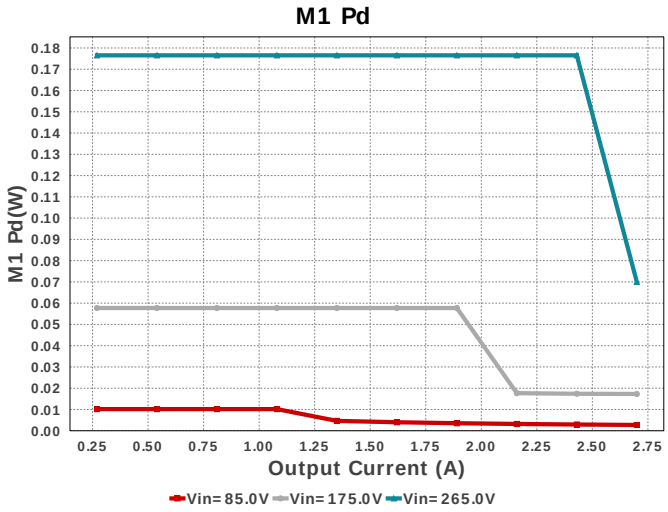


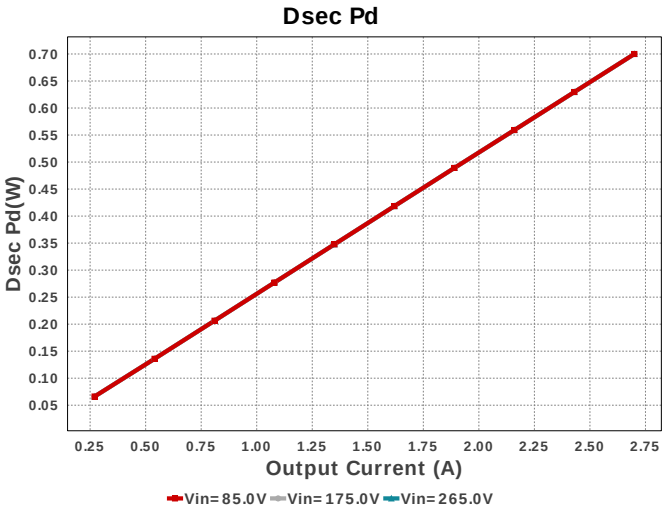


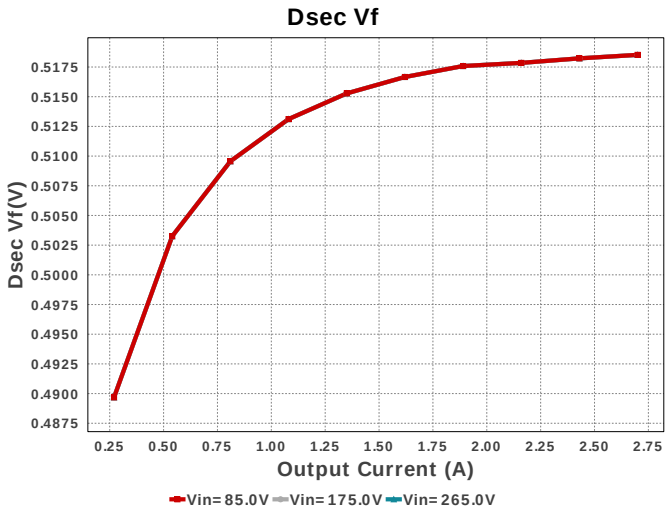


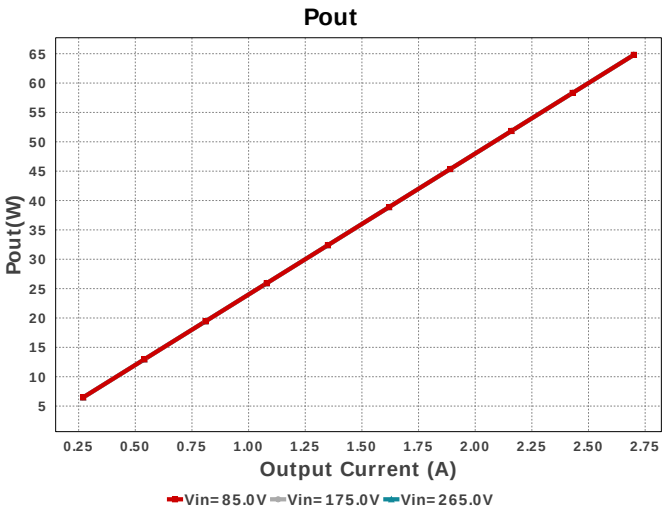


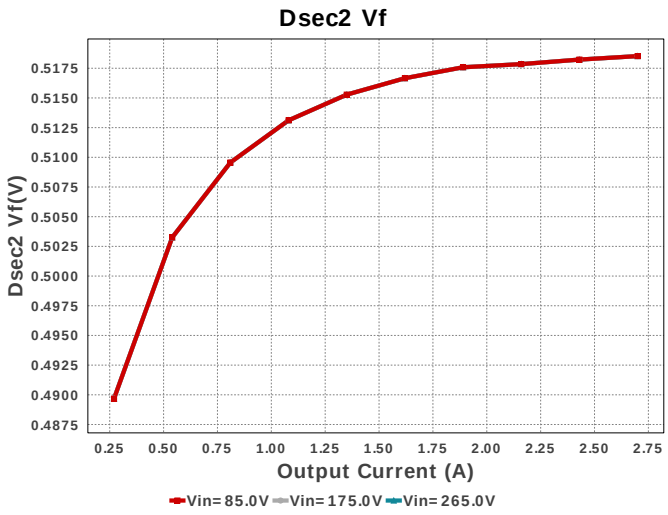


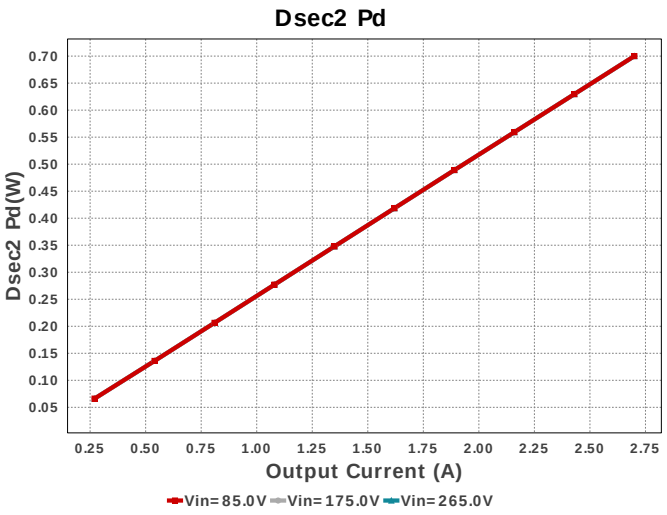


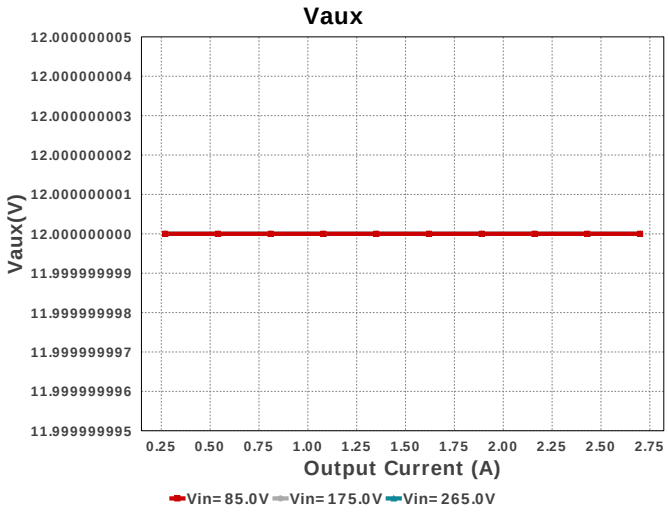


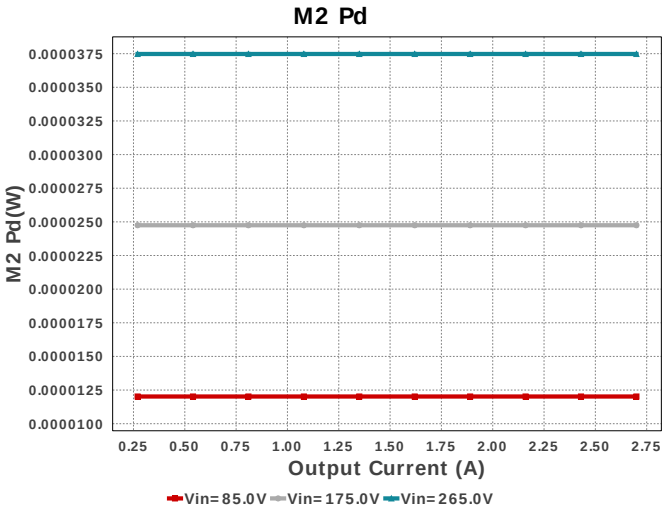


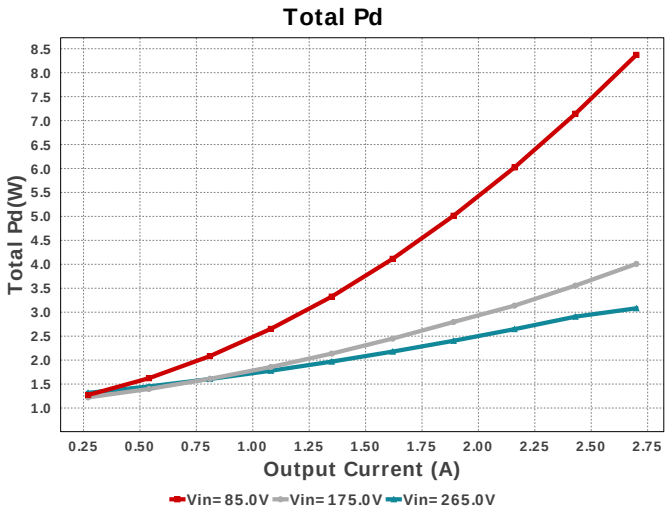


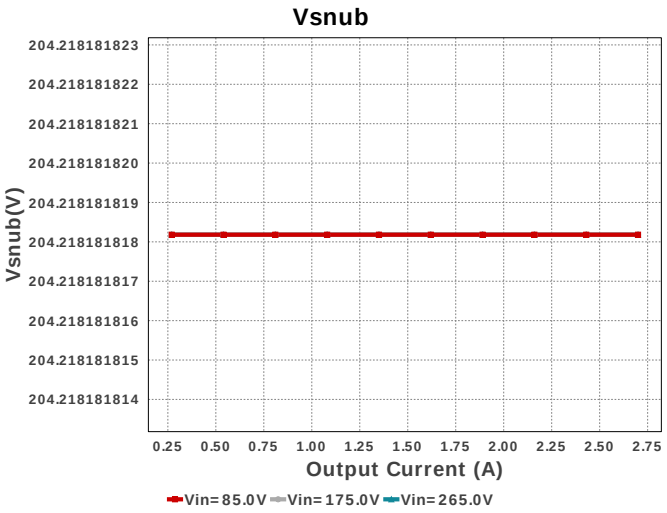


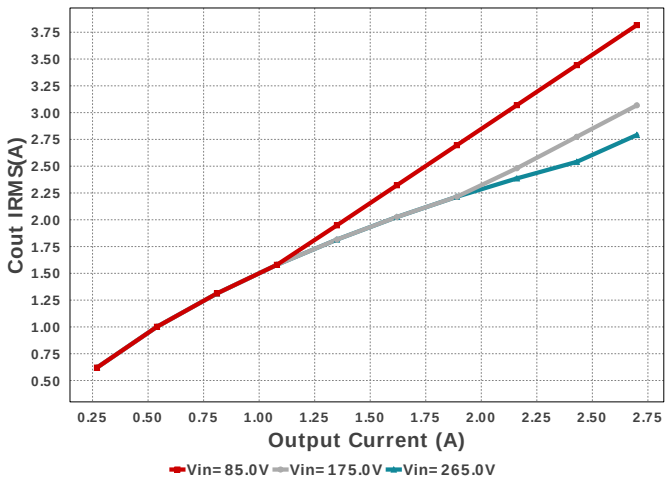


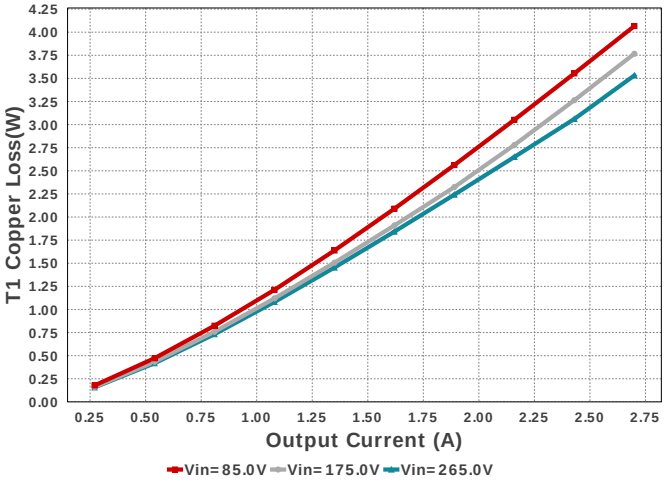


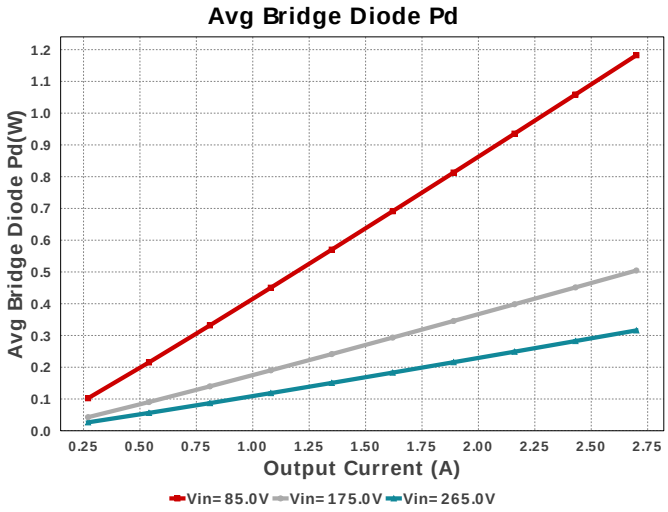


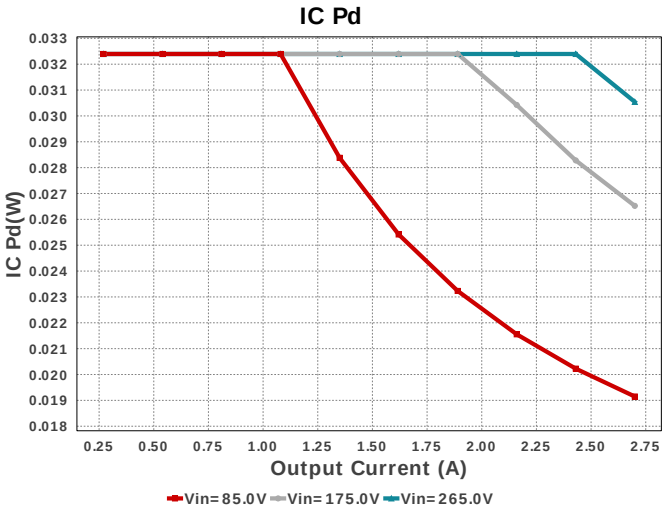


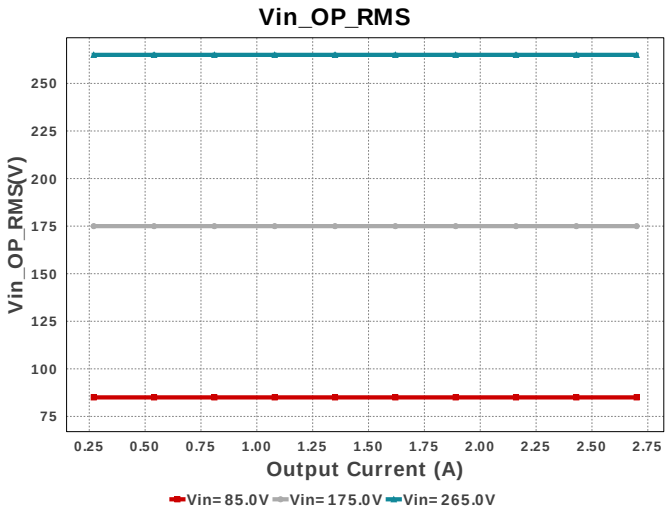


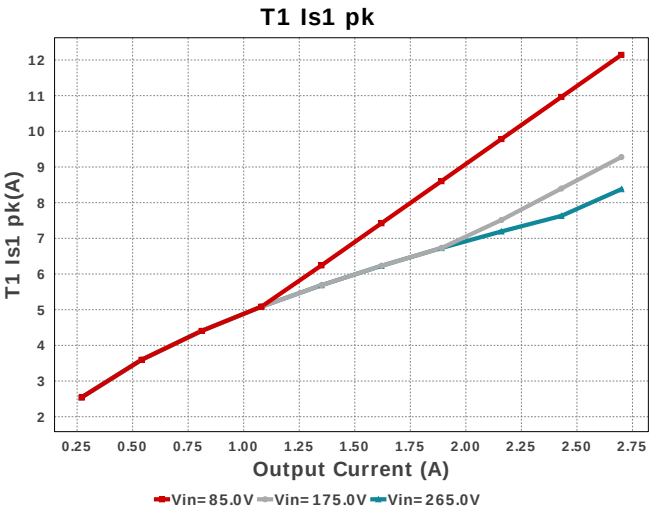


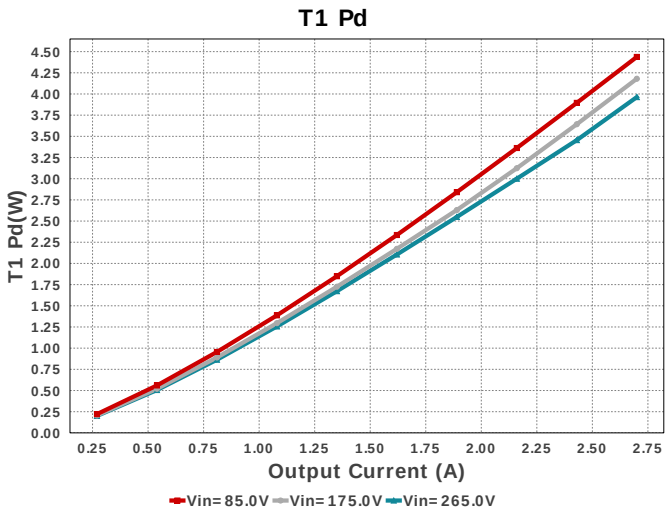


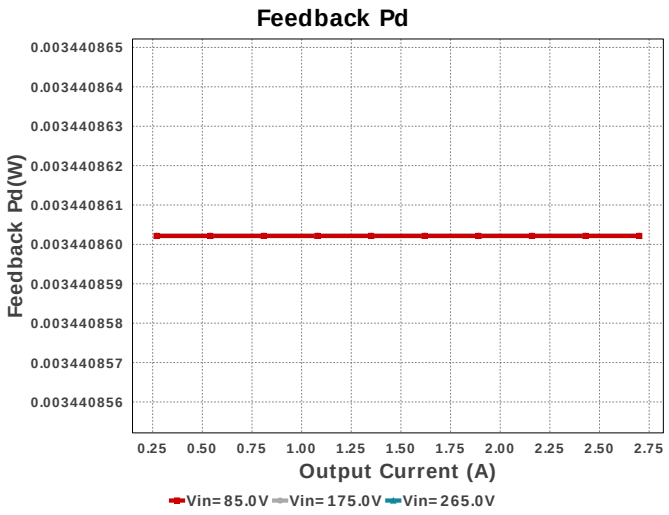












Operating Values

#	Name	Value	Category	Description
1.	Cout IRMS	3.817 A	Current	Output capacitor RMS ripple current
2.	Iin rms	869.37 mA	Current	RMS Input Current
3.	Ipri Avg	611.908 mA	Current	Average Current in Primary Winding over the complete Switching Period
4.	T1 Iprim RMS	1.024 A	Current	Transformer Primary RMS Current
5.	T1 Iprim pk	2.569 A	Current	Transformer Primary Peak Current
6.	T1 Is1 RMS	4.675 A	Current	Transformer Secondary1 RMS Current
7.	T1 Is1 pk	12.143 A	Current	Transformer Secondary1 Peak Current
8.	BOM Count	39	General	Total Design BOM count
9.	Daux trr	0.0 ns	General	Auxiliary Diode Reverse Recovery Time
10.	Dsec Vf	518.524 mV	General	Effective Forward Voltage Drop at the Operating Current
11.	Dsec trr	0.0 ns	General	Output Diode Reverse Recovery Time
12.	Dsec2 Vf	518.524 mV	General	Effective Forward Voltage Drop at the Operating Current
13.	Dsnub trr	60.0 ns	General	Snubber Diode Reverse Recovery Time
14.	FootPrint	3.535 k mm^2	General	Total Foot Print Area of BOM components
15.	Frequency	57.021 kHz	General	Switching frequency
16.	Mode	TM	General	Conduction Mode
17.	Pout	64.8 W	General	Total output power
18.	Total BOM	$13.02	General	Total BOM Cost
19.	Vaux	12.0 V	General	Auxiliary Voltage
20.	Vsnub	204.218 V	General	Voltage Across the Snubber
21.	Duty Cycle	47.643 %	Op Point	Duty cycle
22.	Efficiency	87.691 %	Op Point	Steady state efficiency
23.	IC Tj	33.83 degC	Op Point	IC junction temperature
24.	ICThetaJA	200.0 degC/W	Op Point	IC junction-to-ambient thermal resistance
25.	IOUT_OP	2.7 A	Op Point	Iout operating point
26.	M1 TjOP	94.753 degC	Op Point	M1 MOSFET junction temperature
27.	Peak Rectified Vin	120.207 V	Op Point	Peak voltage seen at rectified input
28.	Vin_OP_RMS	85.0 V	Op Point	AC Input RMS Voltage
29.	Vout Actual	24.004 V	Op Point	Vout Actual calculated based on selected voltage divider resistors
30.	Vout OP	24.0 V	Op Point	Operational Output Voltage
31.	Vout Tolerance	2.137 %	Op Point	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
32.	Vout p-p	113.335 mV	Op Point	Peak-to-peak output ripple voltage
33.	Avg Bridge Diode Pd	1.182 W	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
34.	Dsec Pd	700.007 mW	Power	Secondary Diode Power Dissipation
35.	Dsec2 Pd	700.007 mW	Power	Secondary Diode Power Dissipation
36.	Feedback Pd	3.441 mW	Power	Power Dissipation in Feedback Resistors
37.	IC Pd	19.149 mW	Power	IC power dissipation
38.	M1 Pd	725.987 mW	Power	M1 MOSFET total power dissipation
39.	M2 Pd	12.021 µW	Power	M2 MOSFET total power dissipation
40.	Rsense Pd	125.746 mW	Power	LED Current Rsns Power Dissipation
41.	Snubber Pd	967.292 mW	Power	Snubber Power Dissipation
42.	T1 Pd	4.378 W	Power	Estimated Losses in Transformer
43.	Total Pd	9.096 W	Power	Total Power Dissipation
44.	T1 Copper Loss	4.017 W		
45.	T1 Core Loss	361.0 mW		

Design Inputs

#	Name	Value	Description
1.	Iout	2.7	Maximum Output Current

#	Name	Value	Description
2.	VinMax	265.0	Maximum input voltage
3.	VinMin	85.0	Minimum input voltage
4.	Vout	24.0	Output Voltage
5.	acFrequency	60.0	AC Frequency
6.	base_pn	LM5023	Base Product Number
7.	source	AC	Input Source Type
8.	Ta	30.0	Ambient temperature

Design Assistance

1. **LM5023** Product Folder : http://www.ti.com/product/LM5023 : contains the data sheet and other resources.