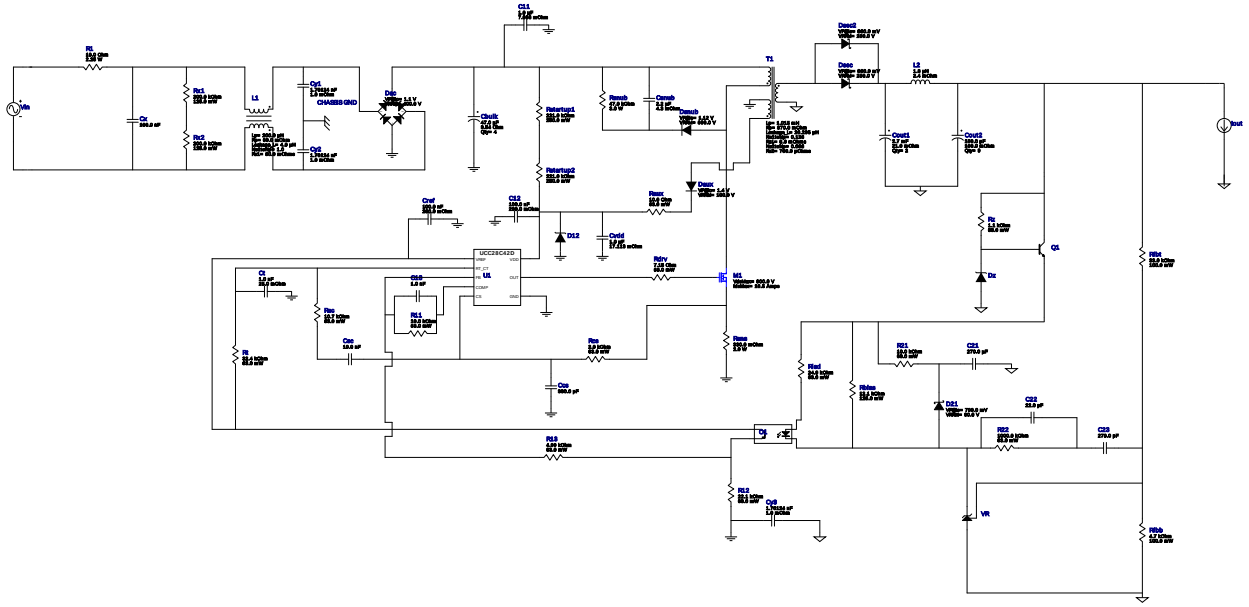
WEBENCH® Design Report

VinMin = 110.0V
VinMax = 130.0V
Vout = 20.0V
Iout = 5.0A

Device = UCC28C42DR
Topology = Flyback
Created = 7/12/16 12:20:26 AM
BOM Cost = $0.00
BOM Count = 69
Total Pd = 12.03W

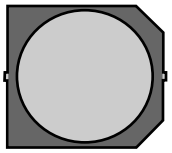
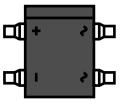
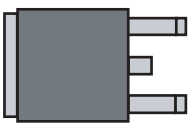
Design : 4737466/18 UCC28C42DR
UCC28C42DR 110.0V-130.0V to 20.00V @ 5.0A

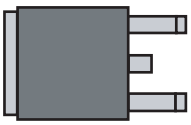


1. The EMI filter selected here contains the estimated values. The real numbers will depend on the attenuation needed at a particular frequency.

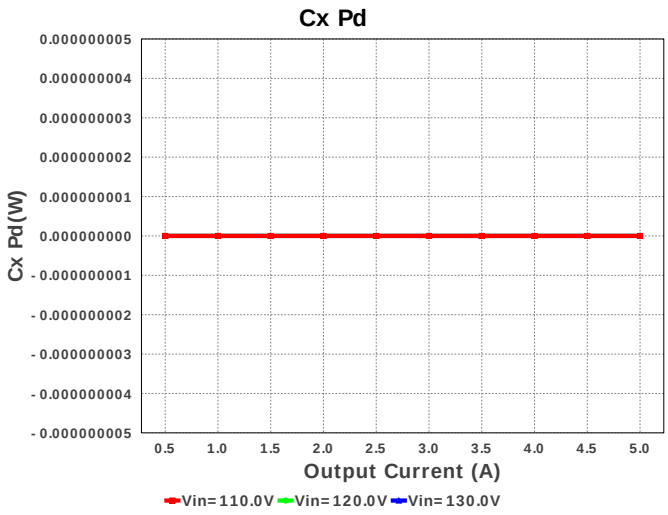
Electrical BOM

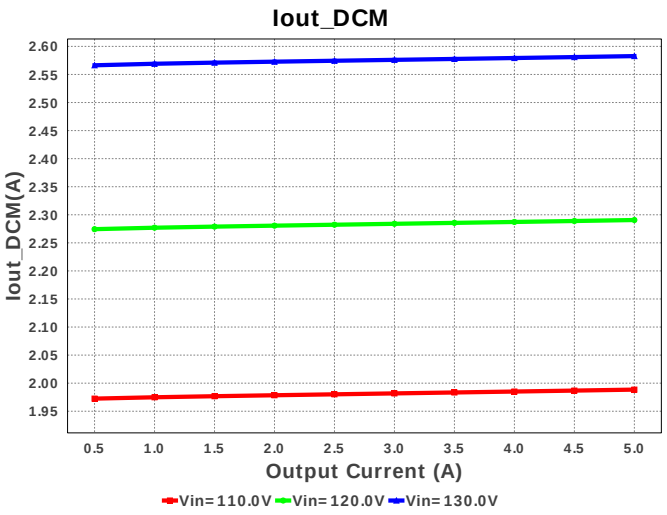
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	C11	MuRata	GRM55DR72E105KW01L Series= X7R	Cap= 1.0 uF ESR= 7.086 mOhm VDC= 250.0 V IRMS= 2.0605 A	1	$0.26	2220_200 54 mm^2
2.	C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
3.	C13	Samsung Electro-Mechanics	CL21C102JBCNFNC Series= C0G/NP0	Cap= 1.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
4.	C21	CUSTOM	CUSTOM Series= ?	Cap= 270.0 uF VDC= 36.0 V IRMS= 0.0 A	1	NA	CUSTOM 0 mm^2
5.	C22	Kemet	C0805C220K3GACTU Series= C0G/NP0	Cap= 22.0 pF VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
6.	C23	Yageo America	CC0805KRX7R9BB271 Series= X7R	Cap= 270.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
7.	Cbulk	Vishay-Bccomponents	MAL215759479E3 Series= 2239	Cap= 47.0 uF ESR= 3.54 Ohm VDC= 500.0 V IRMS= 680.0 mA	4	$2.68	157PUM-SI_2200x2500 576 mm^2
8.	Ccs	Samsung Electro-Mechanics	CL21C331JBANFNC Series= C0G/NP0	Cap= 330.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2

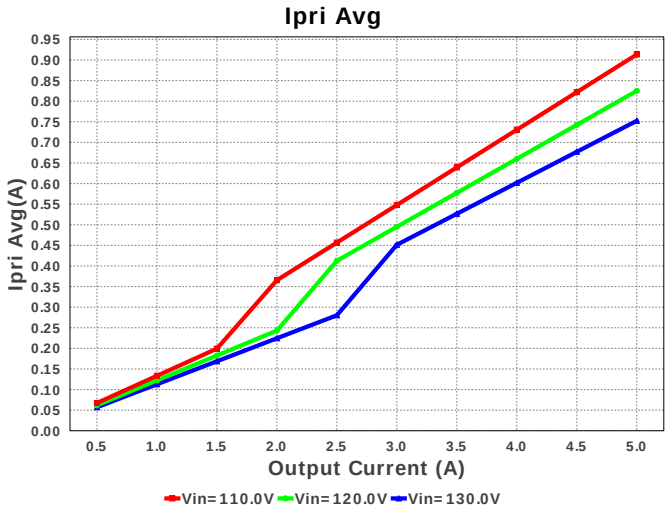
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Cout1	TDK	B41605A8278M009 Series= 2385	Cap= 2.7 mF ESR= 21.0 mOhm VDC= 63.0 V IRMS= 5.3 A	2	$12.37	B41605_2500x4000_9 729 mm^2
10.	Cout2	Panasonic	EEV-FK1J151Q Series= FK	Cap= 150.0 uF ESR= 160.0 mOhm VDC= 63.0 V IRMS= 800.0 mA	9	$0.51	 SM_RADIAL_H13 264 mm^2
11.	Cref	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm^2
12.	Csc	MuRata	GRM216R71H103KA01D Series= X7R	Cap= 10.0 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm^2
13.	Csnub	TDK	C5750X6S2W225K Series= X6S	Cap= 2.2 uF ESR= 4.3 mOhm VDC= 400.0 V IRMS= 0.0 A	1	NA	 2220 54 mm^2
14.	Ct	Kemet	C0805C102J5GACTU Series= C0G/NP0	Cap= 1.0 nF ESR= 25.0 mOhm VDC= 50.0 V IRMS= 1.71 A	1	$0.01	 0805 7 mm^2
15.	Cvdd	MuRata	GRM188R61E105KA12D Series= X5R	Cap= 1.0 uF ESR= 17.113 mOhm VDC= 25.0 V IRMS= 979.39 mA	1	$0.01	 0603 5 mm^2
16.	Cx	TDK	B32913A5104M000 Series= 2231	Cap= 100.0 nF VDC= 1000.0 V IRMS= 0.0 A	1	$0.46	 B32913_2650x600x1500 228 mm^2
17.	Cy1	CUSTOM	CUSTOM Series= ?	Cap= 1.70124 nF ESR= 1.0 mOhm VDC= 220.62 V IRMS= 500.0 uA	1	NA	CUSTOM 0 mm^2
18.	Cy2	CUSTOM	CUSTOM Series= ?	Cap= 1.70124 nF ESR= 1.0 mOhm VDC= 220.62 V IRMS= 500.0 uA	1	NA	CUSTOM 0 mm^2
19.	Cy3	CUSTOM	CUSTOM Series= ?	Cap= 1.70124 nF ESR= 1.0 mOhm VDC= 220.62 V IRMS= 500.0 uA	1	NA	CUSTOM 0 mm^2
20.	D12	Diodes Inc.	MMSZ5248B-7-F	Zener	1	$0.04	 SOD-123 13 mm^2
21.	D21	Diodes Inc.	B260A-13-F	VF@Io= 700.0 mV VRRM= 60.0 V	1	$0.09	 SMA 37 mm^2
22.	Dac	Diodes Inc.	DF1504S-T	VF@Io= 1.1 V VRRM= 400.0 V	1	$0.20	 DF-S 99 mm^2
23.	Daux	NXP Semiconductor	BAS316,115	VF@Io= 1.4 V VRRM= 100.0 V	1	$0.02	 SOD-323 9 mm^2
24.	Dsec	ON Semiconductor	MBRB40250TG	VF@Io= 860.0 mV VRRM= 250.0 V	1	$0.94	 DDPAK 210 mm^2

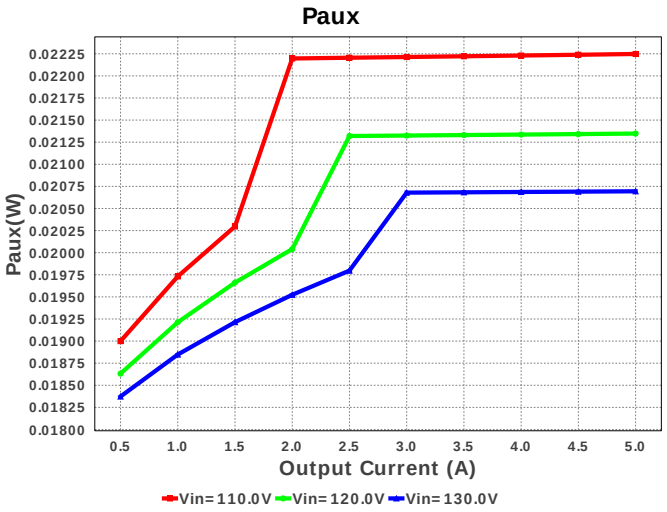
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
25.	Dsec2	ON Semiconductor	MBRB40250TG	VF@Io= 860.0 mV VRRM= 250.0 V	1	$0.94	 DDPAK 210 mm^2
26.	Dsnub	Bourns	CD214C-F3600	VF@Io= 1.12 V VRRM= 600.0 V	1	$0.18	 SMC 83 mm^2
27.	Dz	Diodes Inc.	MMSZ5248B-7-F	Zener	1	$0.04	 SOD-123 13 mm^2
28.	L1	CUSTOM	CUSTOM	Lp= 200.0 µH Rp= 60.0 mOhm Leakage_L= 4.0 µH Ns1toNp= 1.0 Rs1= 60.0 mOhms	1	NA	CUSTOM 0 mm^2
29.	L2	Coilcraft	SER1360-182KLB	L= 1.8 µH DCR= 2.4 mOhm	1	$0.72	 SER1360 225 mm^2
30.	M1	STMicroelectronics	STW21N90K5	VdsMax= 900.0 V IdsMax= 18.5 Amps	1	$3.94	 TO-247 123 mm^2
31.	O1	Vishay-Semiconductor	TCMT1107	Optocoupler	1	$0.21	 SOP-4 44 mm^2
32.	Q1	ON Semiconductor	BC846BLT1G	Bipolar Transistor	1	$0.02	 SOT-23 14 mm^2
33.	R1	Vishay-Dale	AC03000001009JACCS Series= F_RES	Res= 10.0 Ohm Power= 2.25 W Tolerance= 5.0%	1	$0.30	 AC03 158 mm^2
34.	R11	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
35.	R12	Vishay-Dale	CRCW040222K1FKED Series= CRCW..e3	Res= 22.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
36.	R13	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
37.	R21	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
38.	R22	Vishay-Dale	CRCW04021M00FKED Series= CRCW..e3	Res= 1000.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
39.	Raux	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
40.	Rbias	Panasonic	ERJ-6ENF1212V Series= ERJ-6E	Res= 12.1 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm^2
41.	Rcs	Vishay-Dale	CRCW04022K00FKED Series= CRCW..e3	Res= 2.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
42.	Rdrv	Vishay-Dale	CRCW04027R15FKED Series= CRCW..e3	Res= 7.15 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2

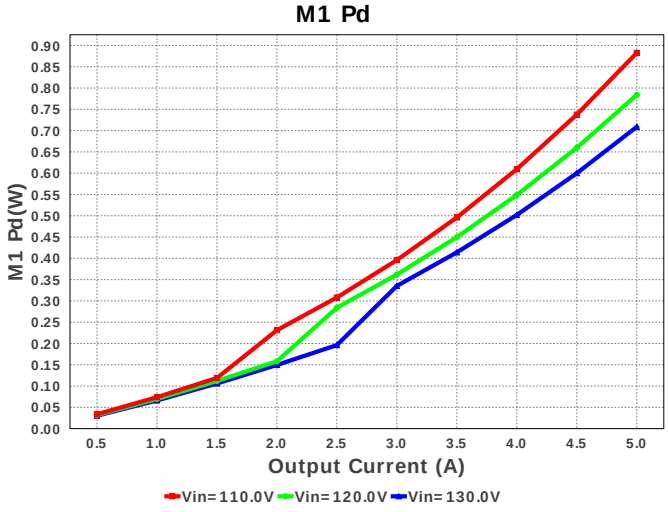
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
43.	Rfbb	Yageo America	RC0603FR-074K7L Series= ?	Res= 4.7 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
44.	Rfbt	Yageo America	RC0603FR-0733KL Series= ?	Res= 33.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
45.	Rled	Vishay-Dale	CRCW040224K9FKED Series= CRCW..e3	Res= 24.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
46.	Rsc	Vishay-Dale	CRCW040210K7FKED Series= CRCW..e3	Res= 10.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
47.	Rsns	Stackpole Electronics Inc	CSRN2512FKR330 Series= ?	Res= 330.0 mOhm Power= 2.0 W Tolerance= 1.0%	1	$0.13	 2512 43 mm²
48.	Rsnub	TE Connectivity	SMF347KJT Series= ?	Res= 47.0 kOhm Power= 3.0 W Tolerance= 5.0%	1	$0.15	SM_3 0 mm²
49.	Rstartup1	Panasonic	ERJ-8ENF2213V Series= ERJ-8E	Res= 221.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm²
50.	Rstartup2	Panasonic	ERJ-8ENF2213V Series= ERJ-8E	Res= 221.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm²
51.	Rt	Vishay-Dale	CRCW040232K4FKED Series= CRCW..e3	Res= 32.4 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
52.	Rx1	Panasonic	ERJ-6ENF2003V Series= ERJ-6E	Res= 200.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
53.	Rx2	Panasonic	ERJ-6ENF2003V Series= ERJ-6E	Res= 200.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	 0805 7 mm²
54.	Rz	Vishay-Dale	CRCW04021K10FKED Series= CRCW..e3	Res= 1.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
55.	T1	CUSTOM	CUSTOM	Lp= 1.015 mH Rp= 870.0 mOhm Leakage_L= 20.295 µH Ns1toNp= 0.126 Rs1= 8.6 mOhms Ns2toNp= 0.086 Rs2= 700.0 µOhms	1	NA	CUSTOM 0 mm²
56.	U1	Texas Instruments	UCC28C42DR	Switcher	1	$0.60	 D0008A 57 mm²
57.	VR	Texas Instruments	TL431AIDBVR	Voltage References	1	$0.07	 R-PDSO-G3 16 mm²

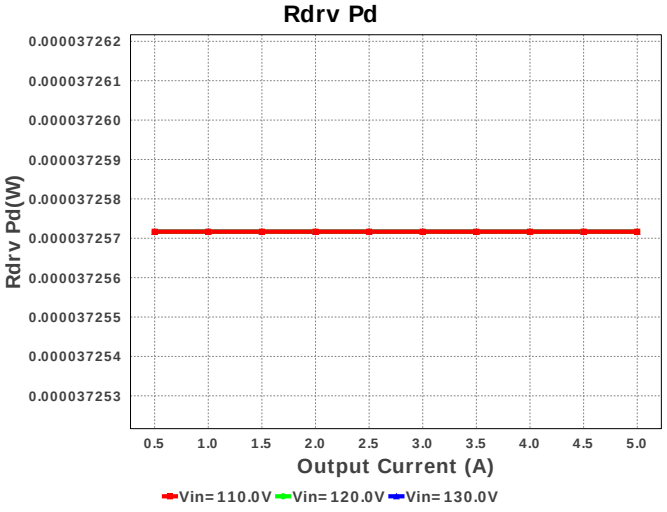


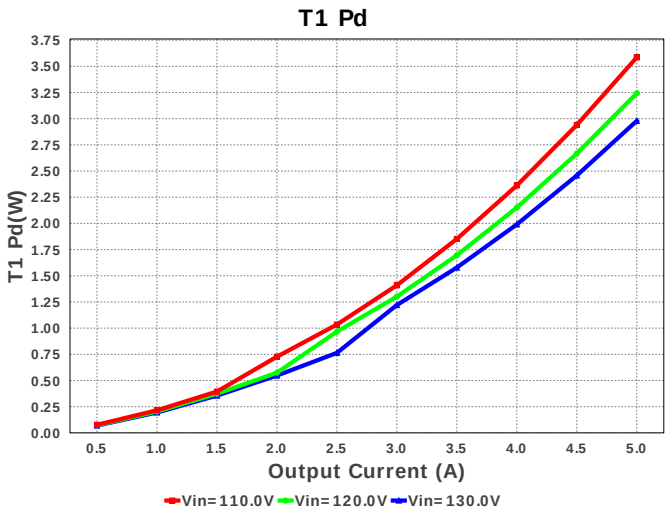


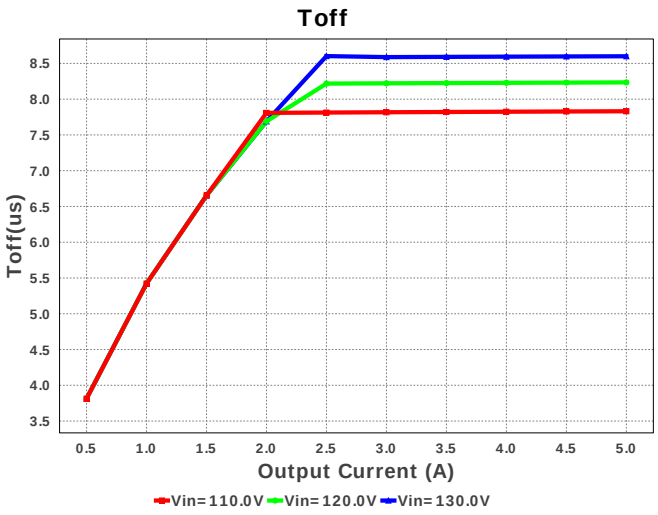


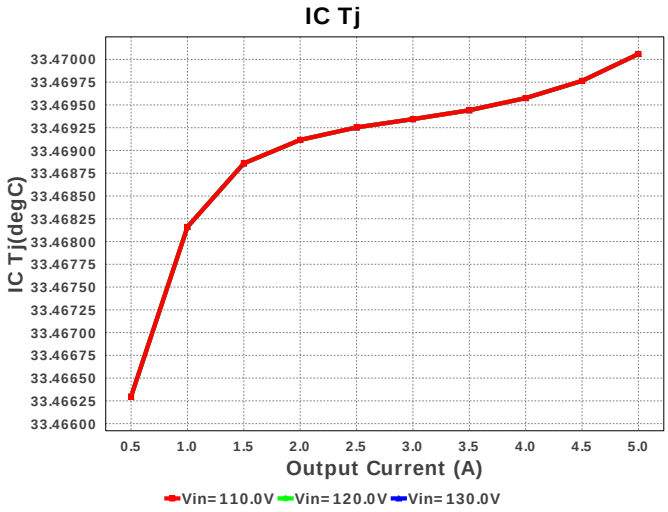


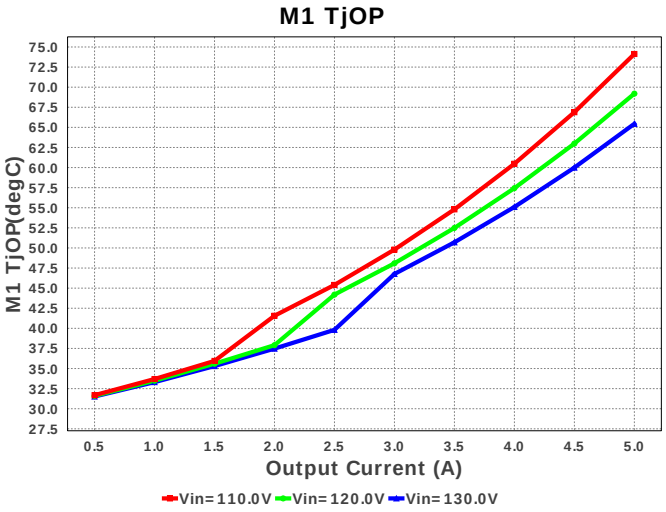


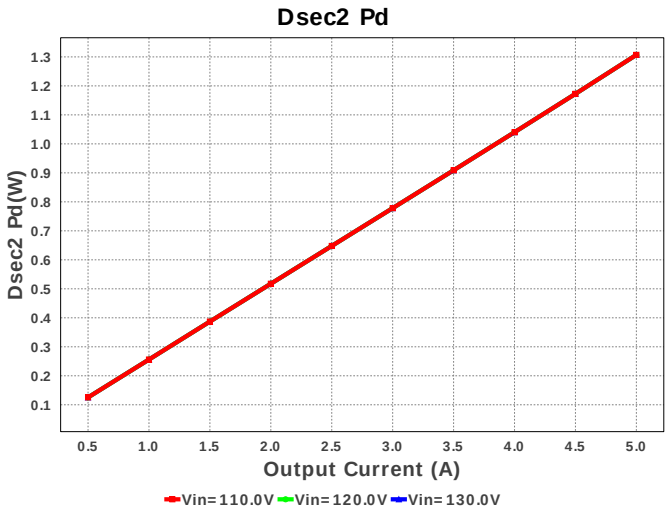


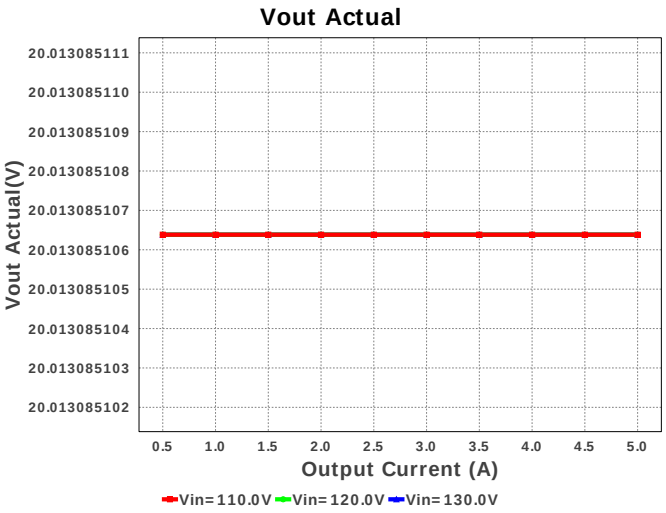


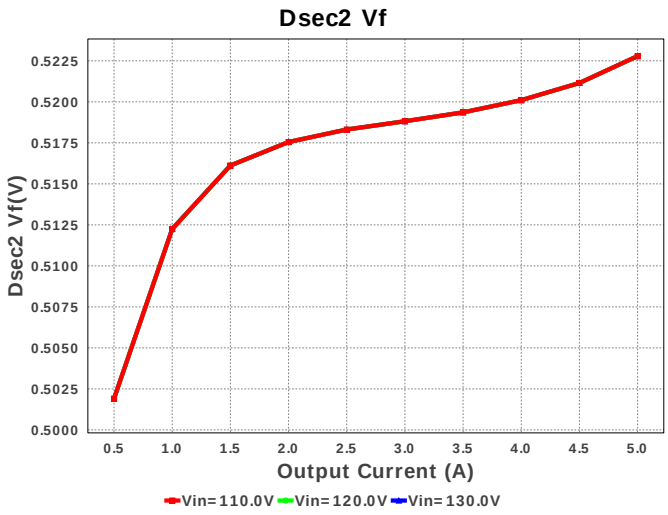


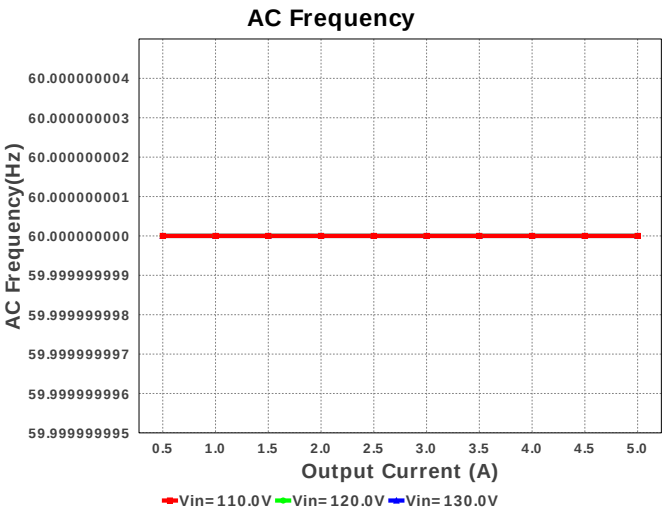


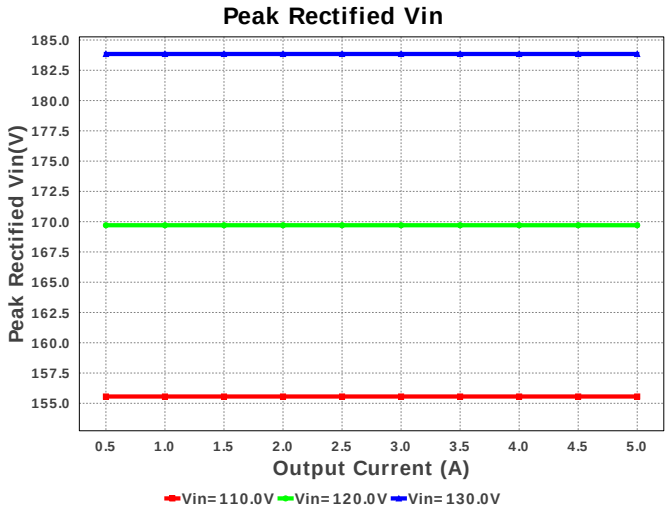


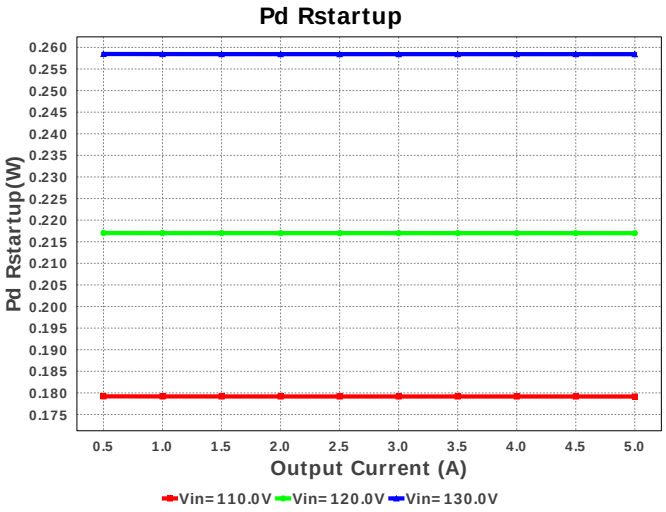


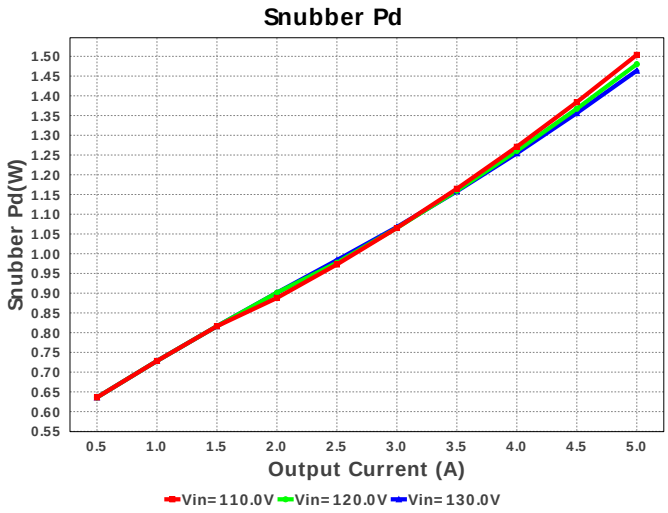


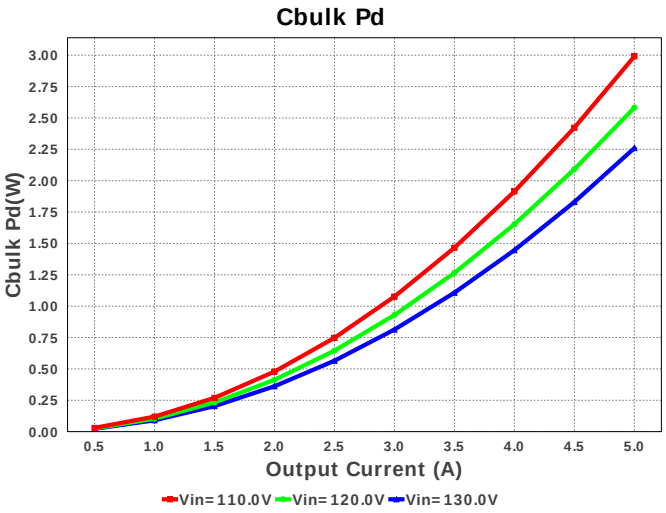

Dsec2 Vf
Dsec2 Vf(V)
0.5225
0.5200
0.5175
0.5150
0.5125
0.5100
0.5075
0.5050
0.5025
0.5000
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V

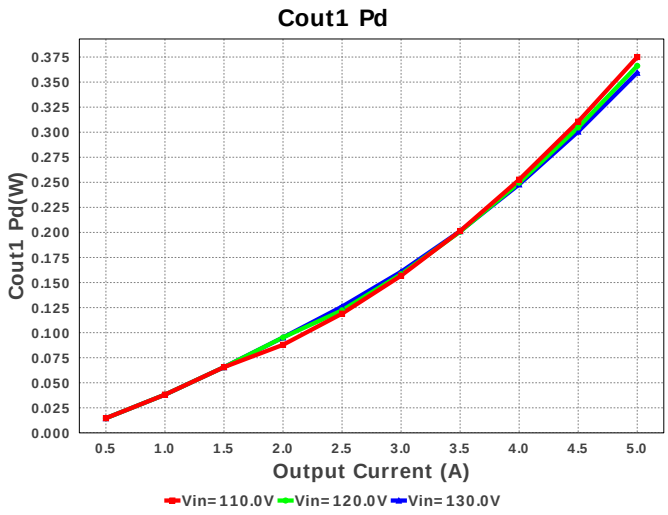

AC Frequency
AC Frequency(Hz)
60.000000004
60.000000003
60.000000002
60.000000001
60.000000000
59.999999999
59.999999998
59.999999997
59.999999996
59.999999995
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V

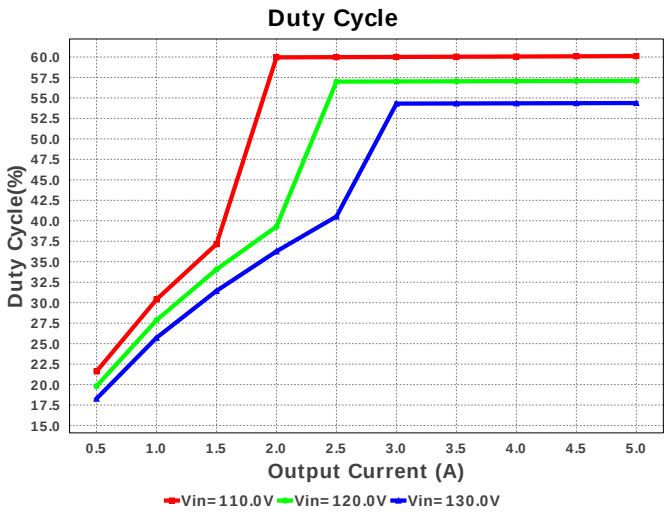

Peak Rectified Vin
Peak Rectified Vin(V)
185.0
182.5
180.0
177.5
175.0
172.5
170.0
167.5
165.0
162.5
160.0
157.5
155.0
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V

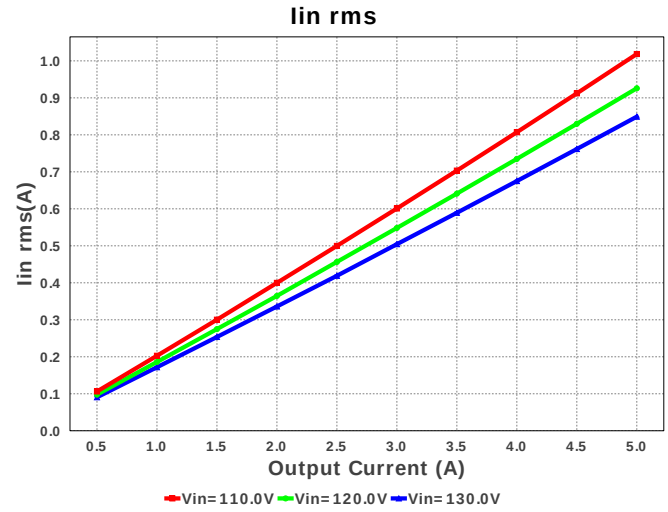

Pd Rstartup
Pd Rstartup(W)
0.260
0.255
0.250
0.245
0.240
0.235
0.230
0.225
0.220
0.215
0.210
0.205
0.200
0.195
0.190
0.185
0.180
0.175
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V

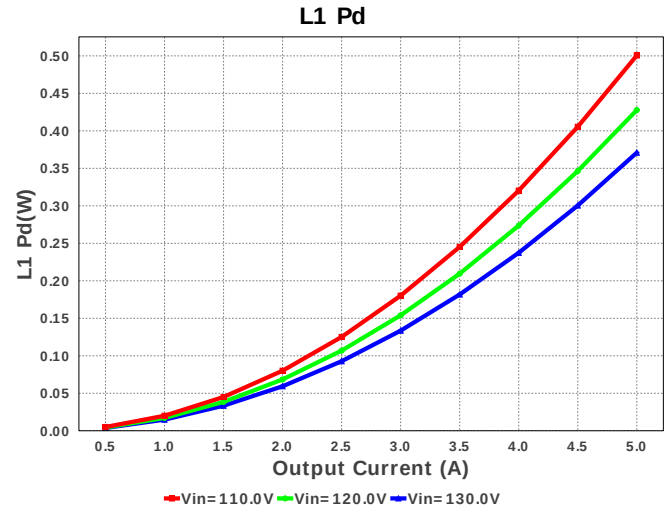

Snubber Pd
Snubber Pd(W)
1.50
1.45
1.40
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V

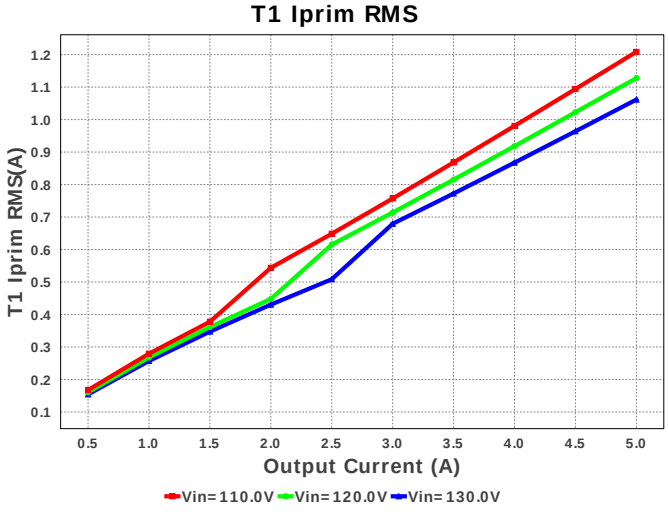

Cbulk Pd
Cbulk Pd(W)
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Output Current (A)
Vin=110.0V Vin=120.0V Vin=130.0V

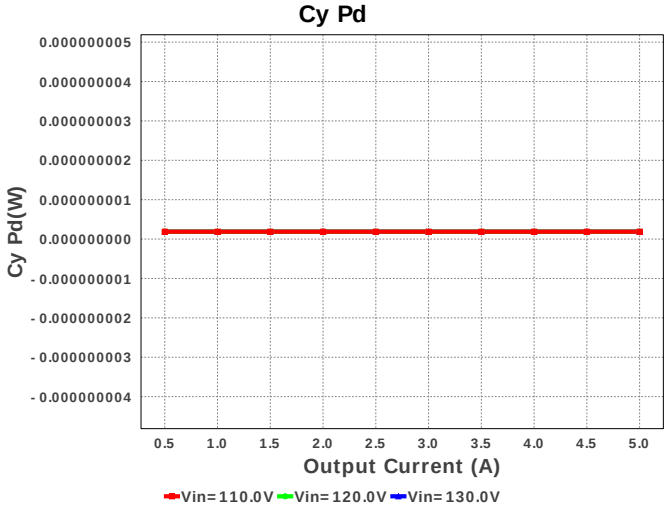


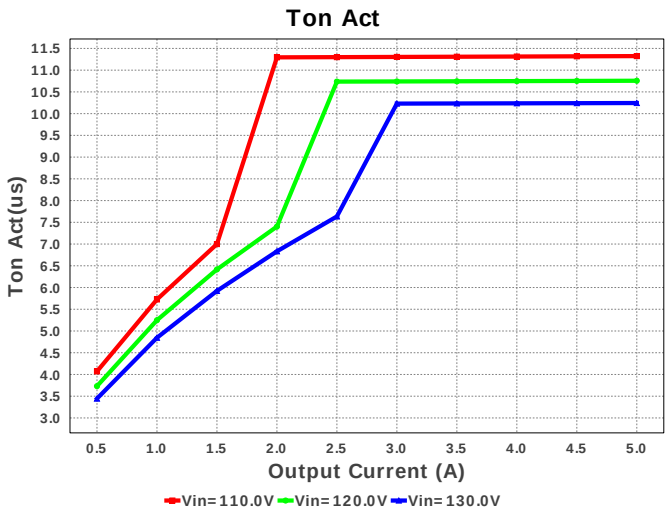


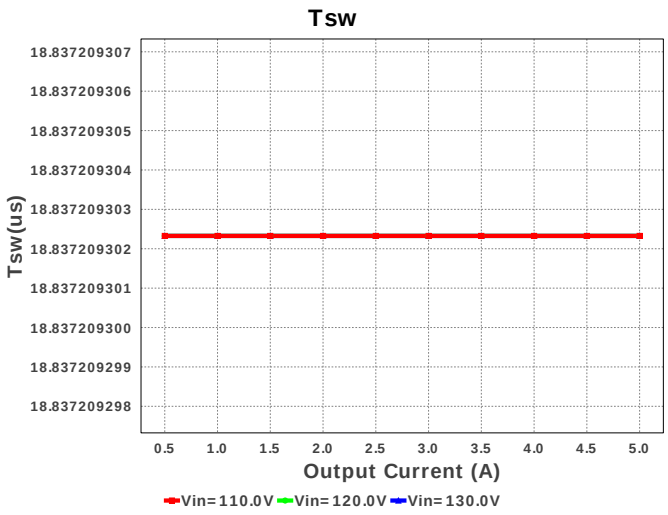


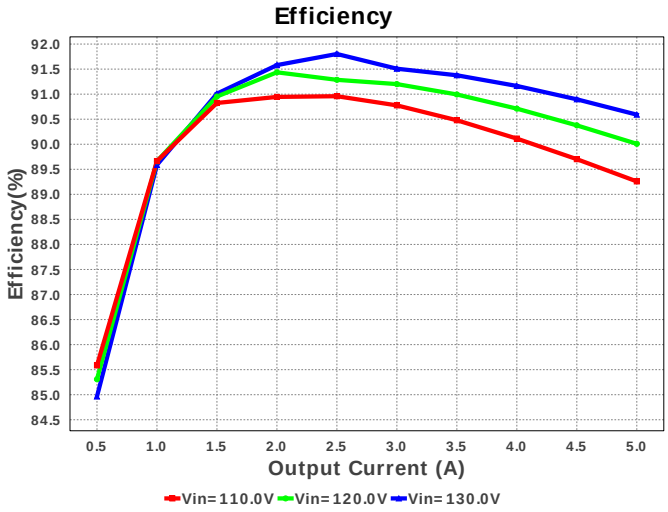


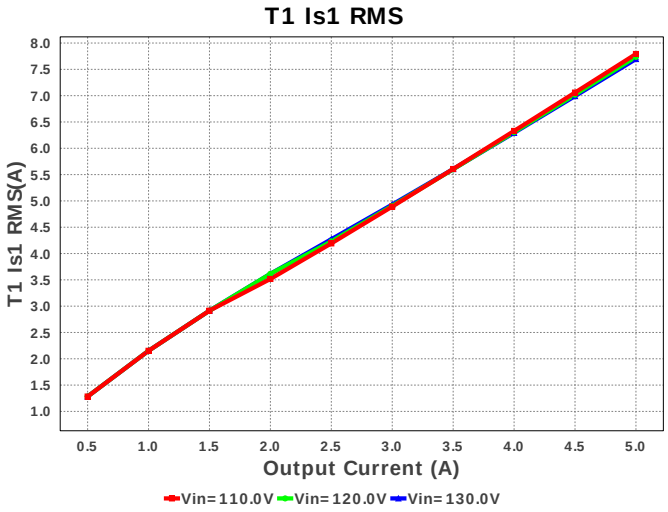


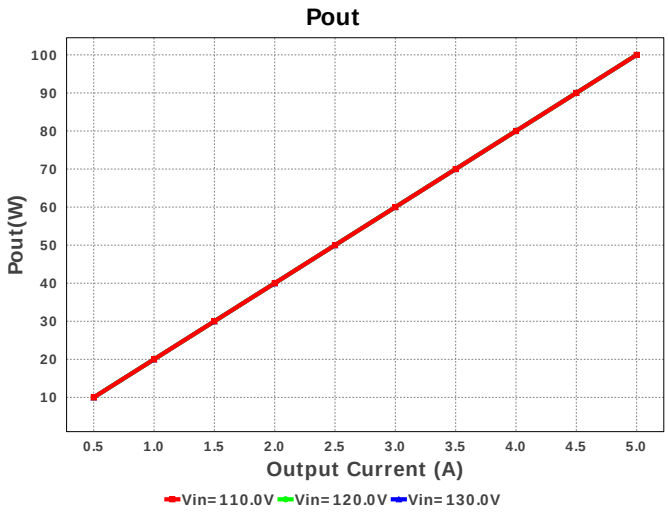


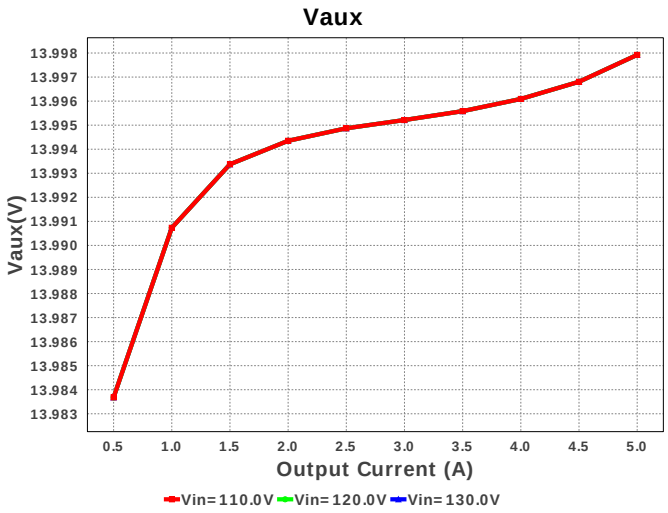


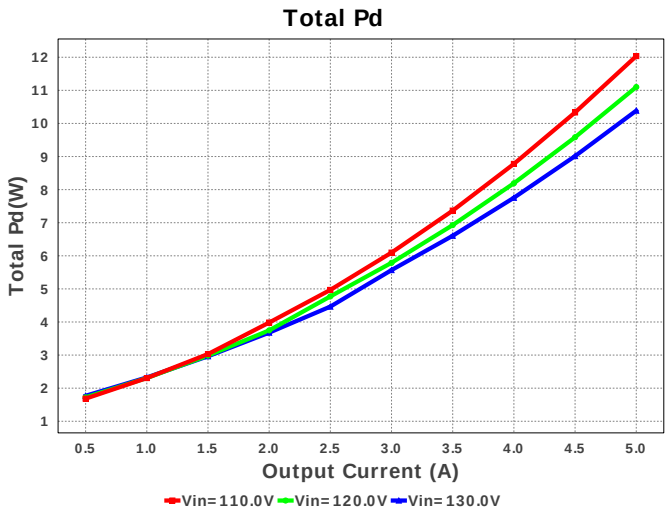


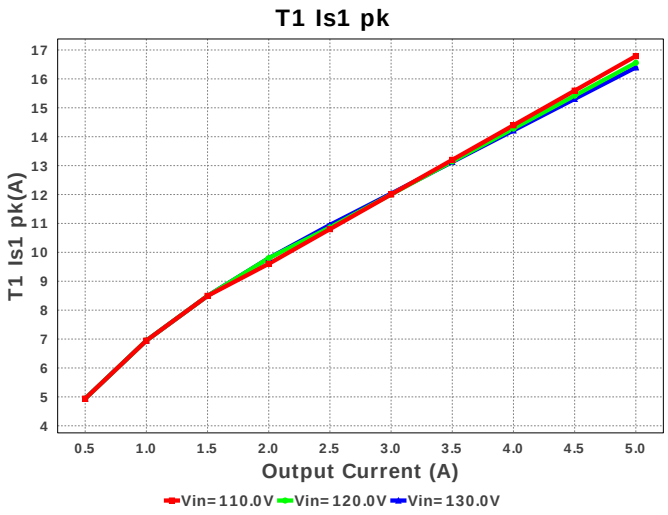


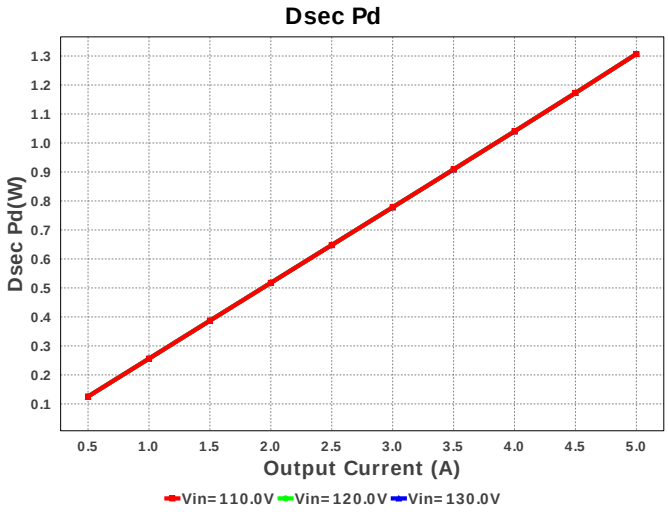


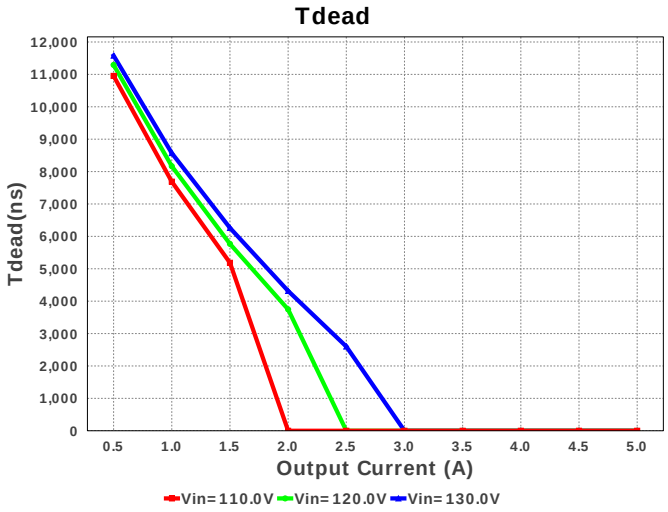


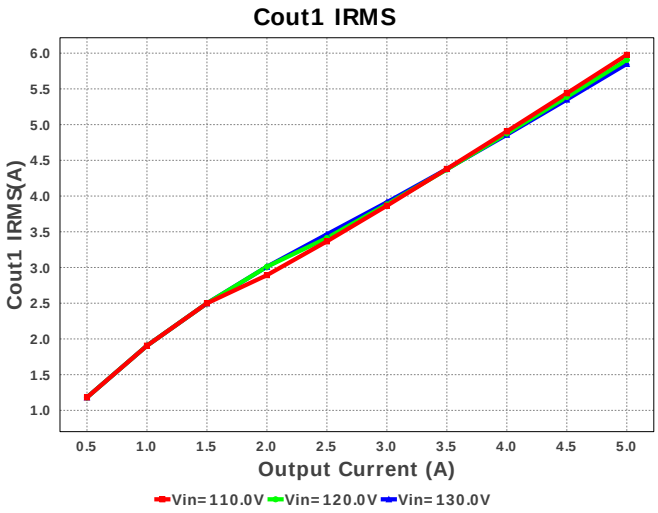


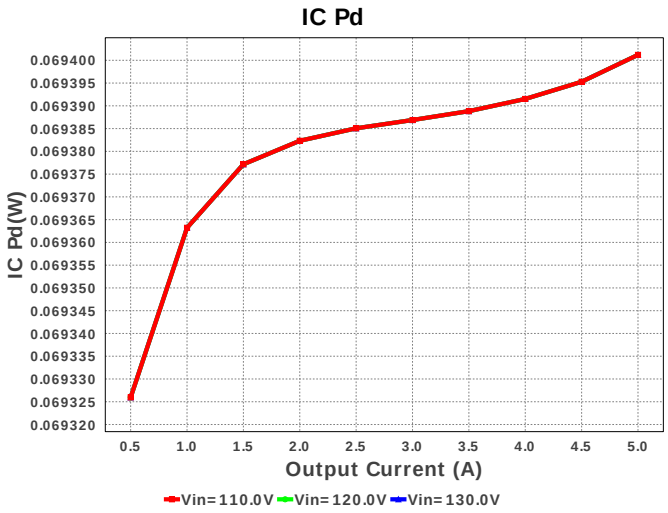


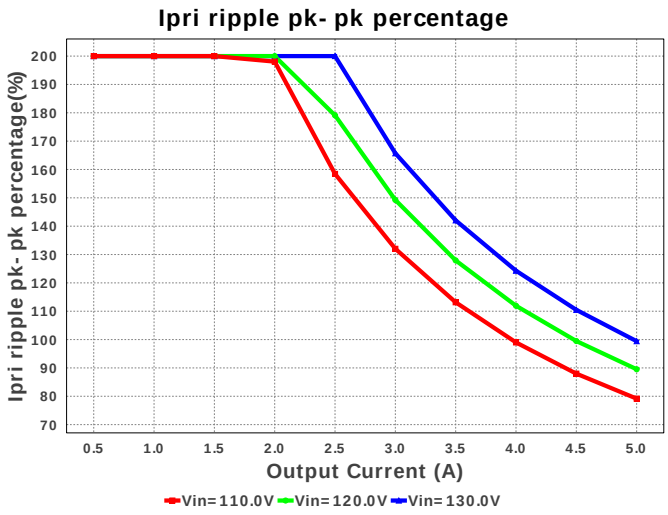


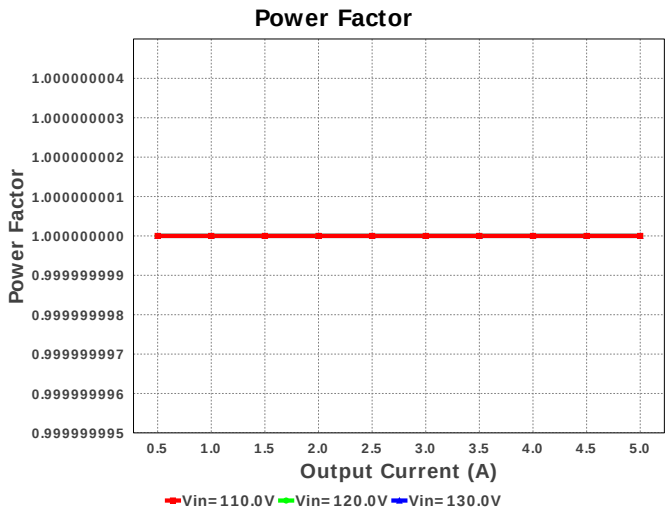


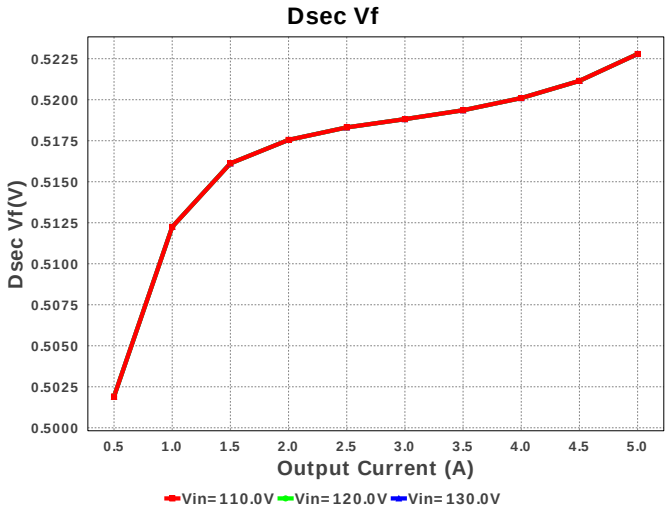


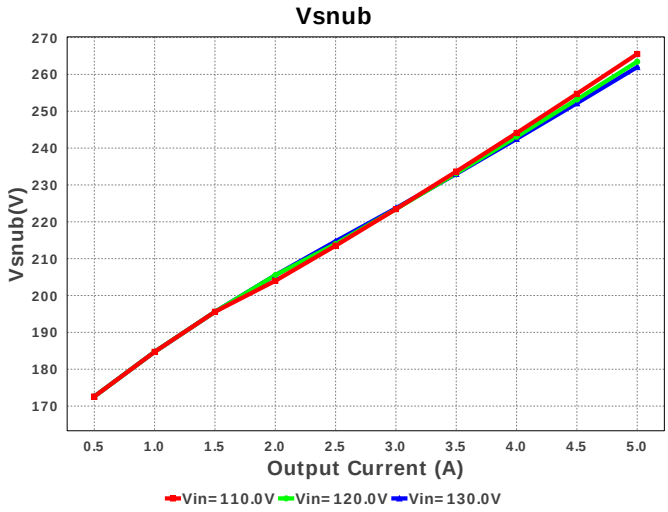


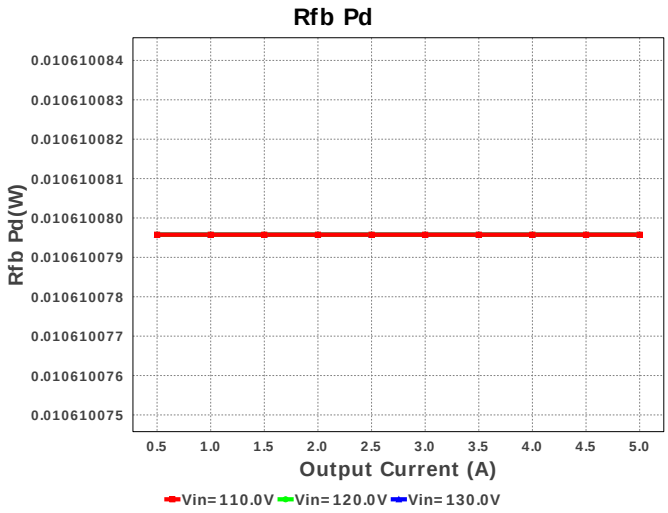


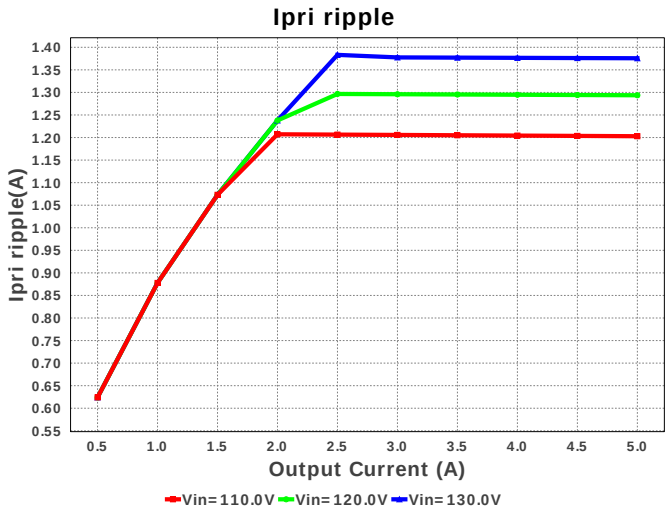


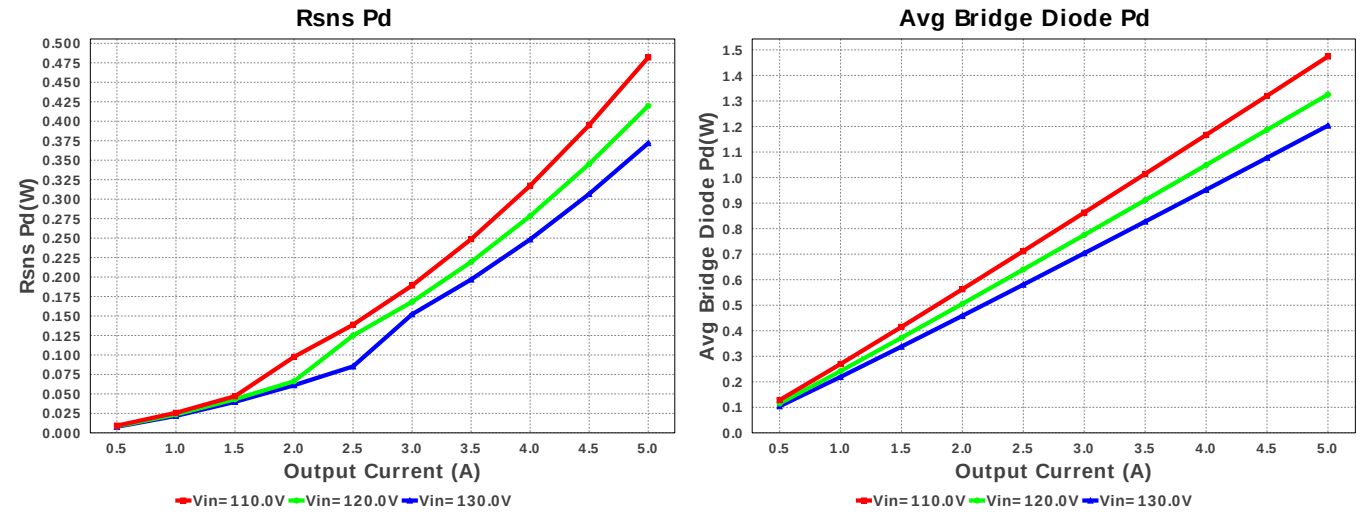


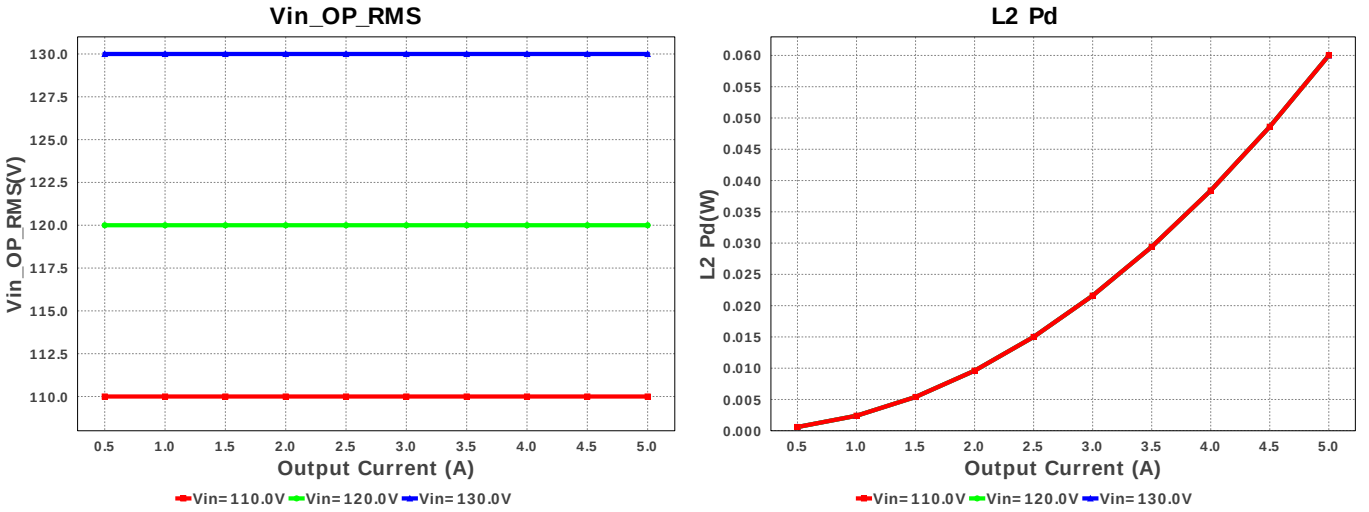


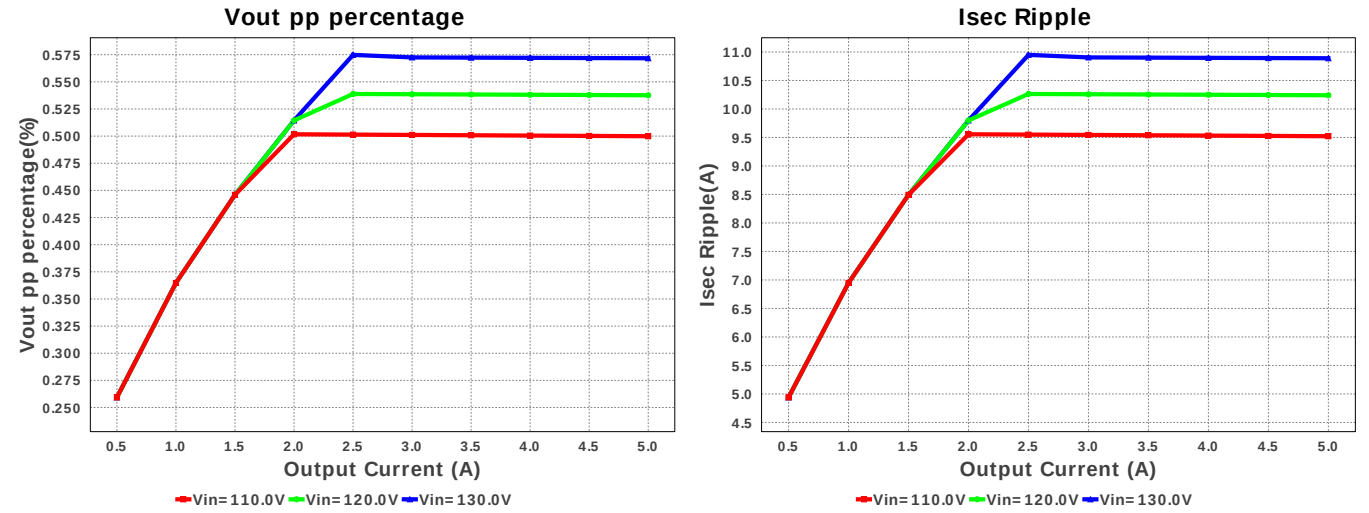


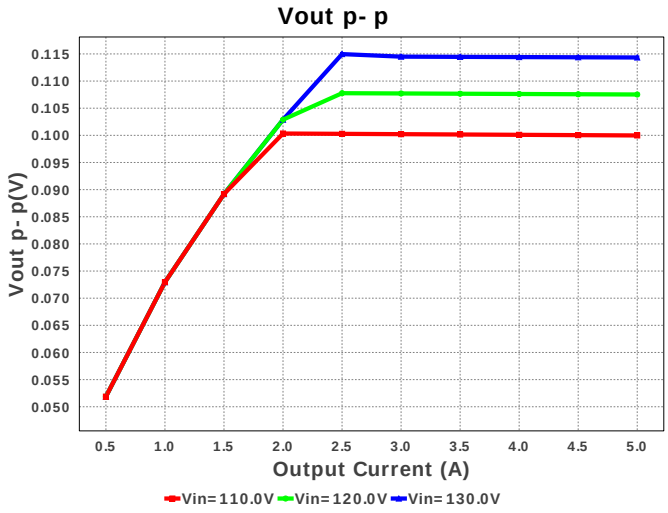


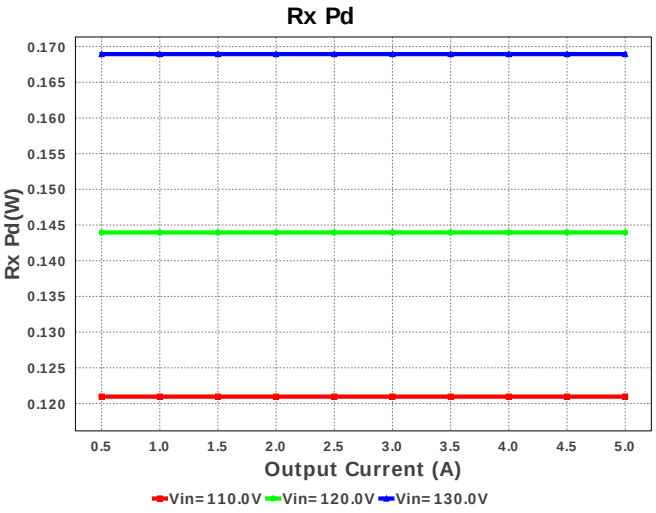


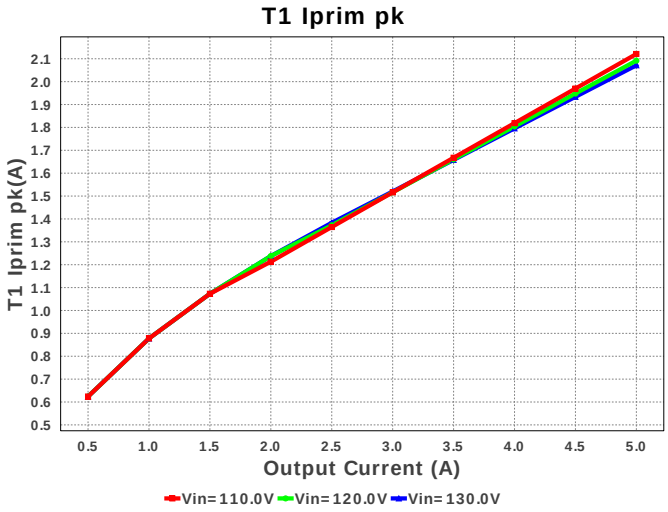












Operating Values

#	Name	Value	Category	Description
1.	Cout1 IRMS	5.976 A	Current	Output capacitor1 RMS ripple current
2.	Iin rms	1.018 A	Current	RMS Input Current
3.	Iout_DCM	1.989 A	Current	Approximate Current below which DCM mode of operation will begin
4.	Ipri Avg	913.361 mA	Current	Average Current in Primary Winding over the complete Switching Period
5.	Ipri ripple	1.203 A	Current	Ripple Current in the Primary Winding
6.	Ipri ripple pk-pk percentage	79.168 %	Current	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
7.	Isec Ripple	9.522 A	Current	Ripple Current in the Secondary Winding
8.	T1 Iprim RMS	1.208 A	Current	Transformer Primary RMS Current
9.	T1 Iprim pk	2.121 A	Current	Transformer Primary Peak Current
10.	T1 Is1 RMS	7.792 A	Current	Transformer Secondary1 RMS Current
11.	T1 Is1 pk	16.788 A	Current	Transformer Secondary1 Peak Current
12.	AC Frequency	60.0 Hz	General	Input AC frequency
13.	BOM Count	69	General	Total Design BOM count
14.	Daux trr	4.0 ns	General	Auxiliary Diode Reverse Recovery Time
15.	Dsec Vf	522.788 mV	General	Effective Forward Voltage Drop at the Operating Current
16.	Dsec trr	0.0 ns	General	Output Diode Reverse Recovery Time
17.	Dsec2 Vf	522.788 mV	General	Effective Forward Voltage Drop at the Operating Current
18.	Dsnub trr	30.0 ns	General	Snubber Diode Reverse Recovery Time
19.	FootPrint	8.199 k mm^2	General	Total Foot Print Area of BOM components
20.	Frequency	53.086 kHz	General	Switching frequency
21.	Pout	100.0 W	General	Total output power
22.	Power Factor	1.0	General	Assumed Power Factor for the Application
23.	Tdead	0.0 ns	General	Approximate Dead Time of the Regulator
24.	Toff	7.831 us	General	Approximate Converter Off Time
25.	Ton Act	11.323 us	General	Approximate Converter On Time
26.	Total BOM	$0.0	General	Total BOM Cost
27.	Tsw	18.837 us	General	Switching Time Period
28.	Vaux	13.998 V	General	Auxiliary Voltage
29.	Vsnub	265.537 V	General	Voltage Across the Snubber

#	Name	Value	Category	Description
30.	Vout Actual	20.013 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
31.	Vout OP	20.0 V	Op_Point	Operational Output Voltage
32.	Duty Cycle	60.112 %	Op_point	Duty cycle
33.	Efficiency	89.258 %	Op_point	Steady state efficiency
34.	IC Tj	33.47 degC	Op_point	IC junction temperature
35.	ICThetaJA	50.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
36.	IOUT_OP	5.0 A	Op_point	Iout operating point
37.	M1 TjOP	74.13 degC	Op_point	M1 MOSFET junction temperature
38.	Peak Rectified Vin	155.562 V	Op_point	Peak voltage seen at rectified input
39.	Vin_OP_RMS	110.0 V	Op_point	AC Input RMS Voltage
40.	Vout p-p	99.98 mV	Op_point	Peak-to-peak output ripple voltage
41.	Avg Bridge Diode Pd	1.474 W	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
42.	Cbulk Pd	2.991 W	Power	Bulk capacitor power dissipation
43.	Cout1 Pd	375.01 mW	Power	Output capacitor1 power dissipation
44.	Cx Pd	0.0 W	Power	X-cap Power Dissipation
45.	Cy Pd	187.5 pW	Power	Y-caps Power Dissipation
46.	Dsec Pd	1.307 W	Power	Secondary Diode Power Dissipation
47.	Dsec2 Pd	1.307 W	Power	Secondary Diode Power Dissipation
48.	IC Pd	69.401 mW	Power	IC power dissipation
49.	L1 Pd	500.515 mW	Power	Power Dissipation in the Inductor
50.	L2 Pd	60.0 mW	Power	Average Power Dissipation in the Inductor Over the AC Line Period
51.	M1 Pd	882.592 mW	Power	M1 MOSFET total power dissipation
52.	Paux	22.248 mW	Power	Power Dissipation in Raux and Daux
53.	Pd Rstartup	179.163 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
54.	Rdrv Pd	37.257 µW	Power	Power Dissipation in Gate Drive Resistor
55.	Rfb Pd	10.61 mW	Power	Rfb Power Dissipation
56.	Rsns Pd	481.891 mW	Power	Current Limit Sense Resistor Power Dissipation
57.	Rx Pd	120.961 mW	Power	Total Power Dissipation in Rx1 and Rx2
58.	Snubber Pd	1.504 W	Power	Snubber Power Dissipation
59.	T1 Pd	3.585 W	Power	Estimated Losses in Transformer
60.	Total Pd	12.035 W	Power	Total Power Dissipation
61.	Vout Tolerance	2.095 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
62.	Vout pp percentage	499.901 m%		Output Voltage ripple percentage

Design Inputs

#	Name	Value	Description
1.	Iout	5.0	Maximum Output Current
2.	VinMax	130.0	Maximum input voltage
3.	VinMin	110.0	Minimum input voltage
4.	Vout	20.0	Output Voltage
5.	acFrequency	60.0	Light Output in Lumen
6.	base_pn	UCC28C42	Texas Instruments Base Part Number
7.	source	AC	Input Source Type
8.	ta	30.0	Ambient temperature

Design Assistance

1. UCC28C42 Product Folder : http://www.ti.com/product/UCC28C42 : contains the data sheet and other resources.