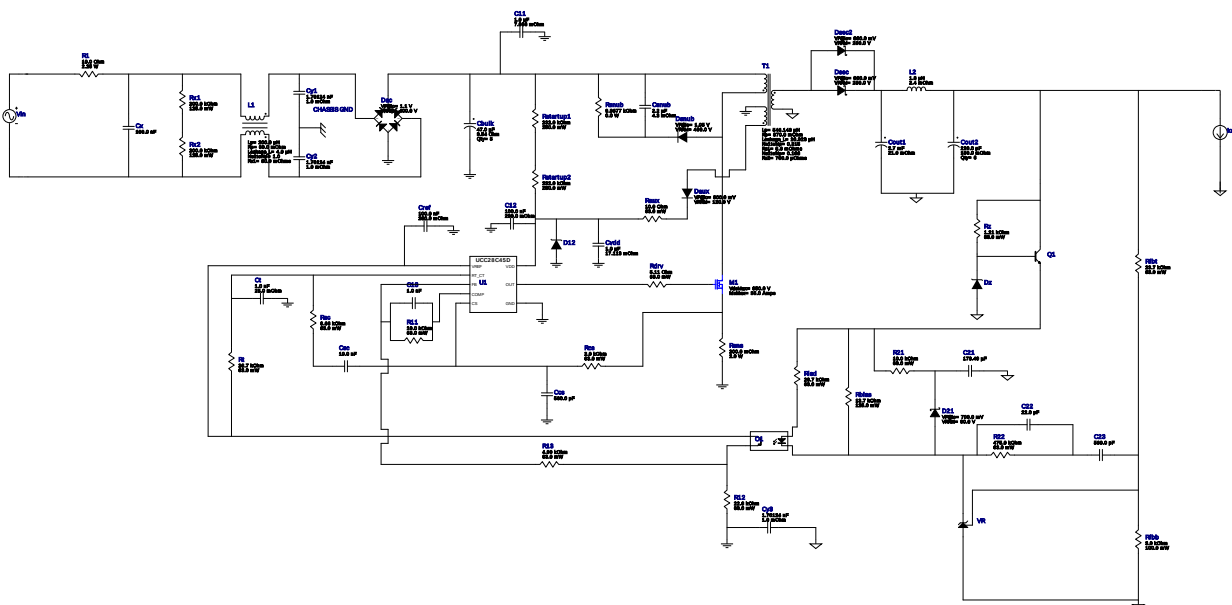


WEBENCH® Design Report

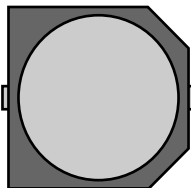
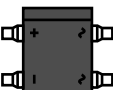
Design : 4737466/31 UCC28C45DR
UCC28C45DR 110.0V-130.0V to 22.20V @ 5.0A

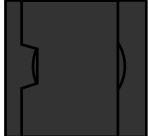


1. The EMI filter selected here contains the estimated values. The real numbers will depend on the attenuation needed at a particular frequency.

Electrical BOM

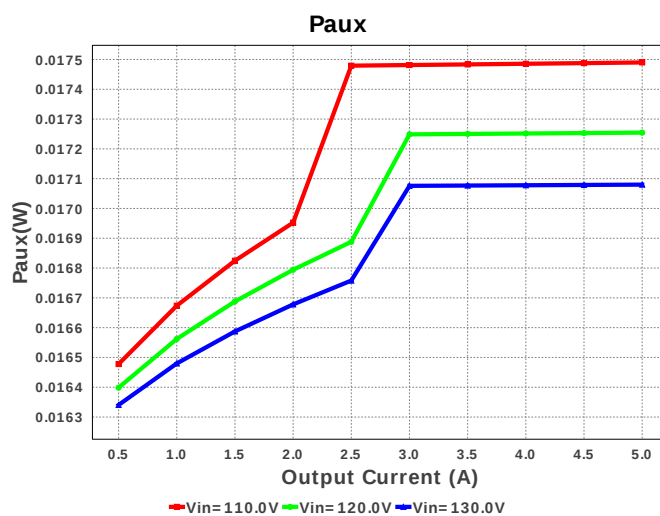
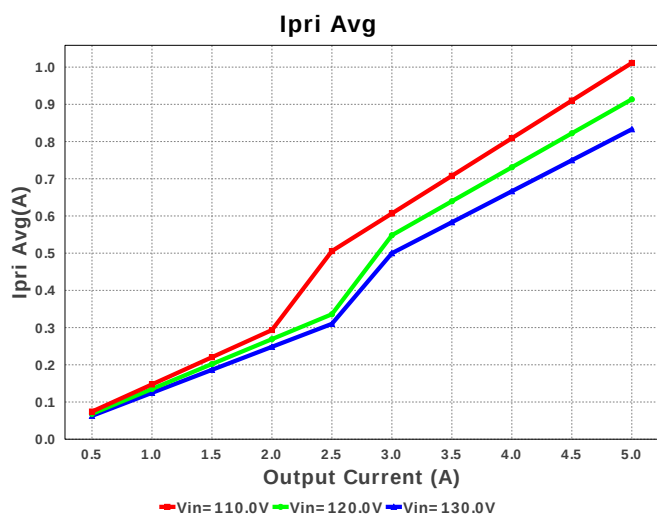
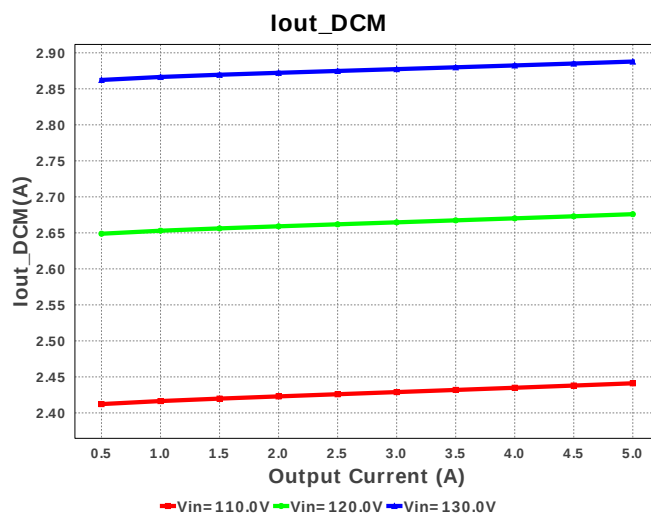
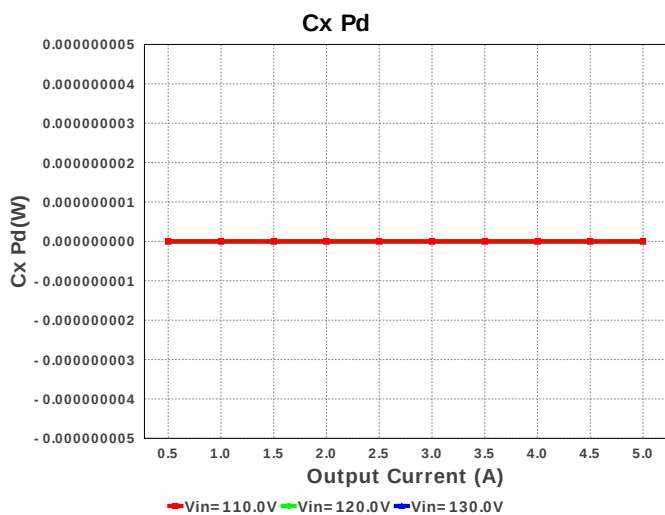
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	C11	MuRata	GRM55DR72E105KW01L Series= X7R	Cap= 1.0 uF ESR= 7.086 mOhm VDC= 250.0 V IRMS= 2.0605 A	1	\$0.26	 2220_200 54 mm ²
2.	C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	 0805 7 mm 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= 178.49 uF VDC= 40.0 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	CC0805KRX7R9BB561 Series= X7R	Cap= 560.0 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	5	\$2.68	157PUM-SI_2200x2500 576 mm ²
8.	Ccs	Yageo America	CC0805KRX7R9BB561 Series= X7R	Cap= 560.0 pF VDC= 50.0 V IRMS= 0.0 A	1	\$0.01	 0805 7 mm ²

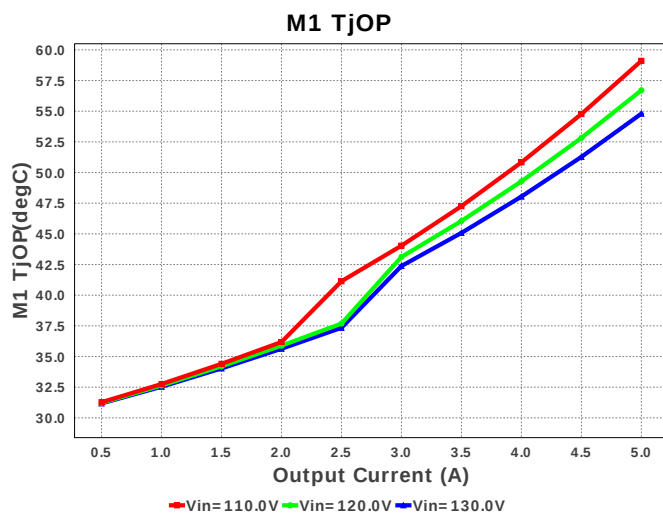
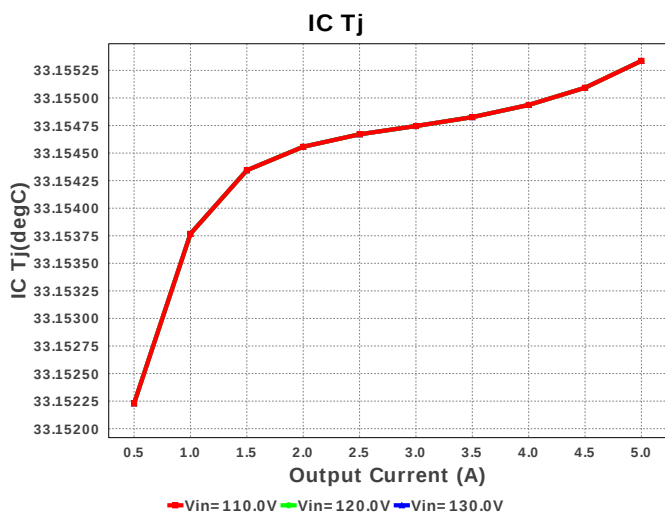
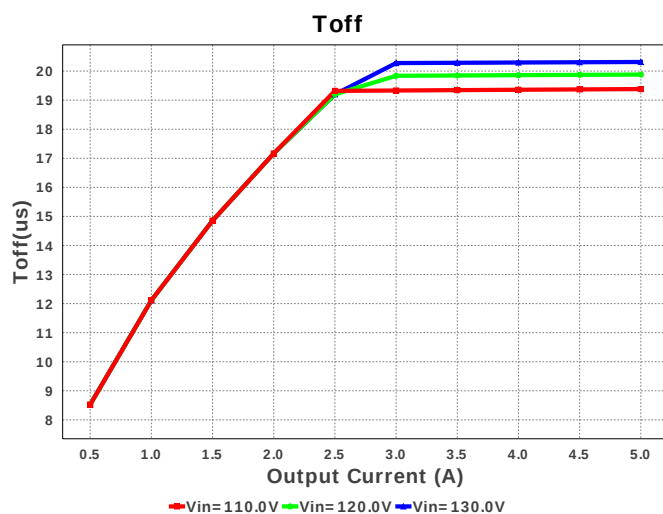
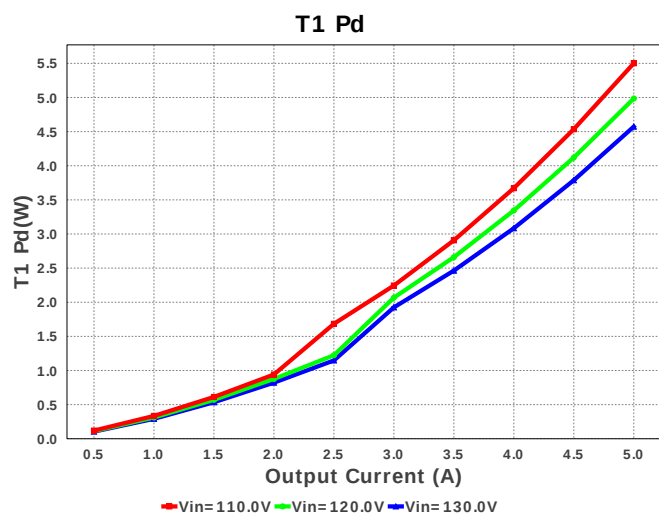
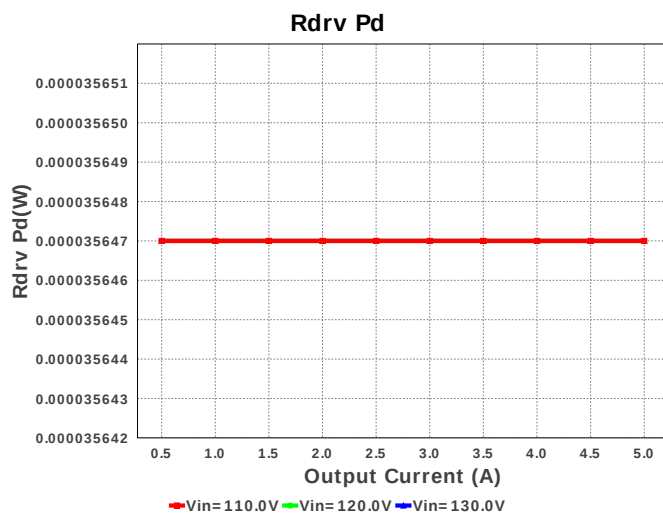
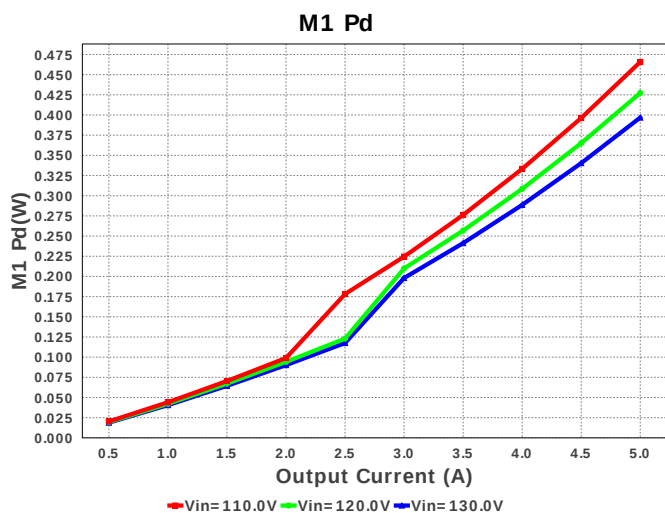
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9.	Cout1	TDK	B41605A8278M009 Series= 2385	Cap= 2.7 mF ESR= 21.0 mOhm VDC= 63.0 V IRMS= 5.3 A	1	\$12.37	B41605_2500x4000_9 729 mm ²
10.	Cout2	Chemi-Con	EMVH500GDA221MLH0S Series= MVH	Cap= 220.0 uF ESR= 150.0 mOhm VDC= 50.0 V IRMS= 850.0 mA	6	\$1.55	 CAPSMT_62_LH0 361 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	Vishay-Semiconductor	V12P12-M3/86A	VF@Io= 800.0 mV VRRM= 120.0 V	1	\$0.40	 TO-277A 56 mm ²

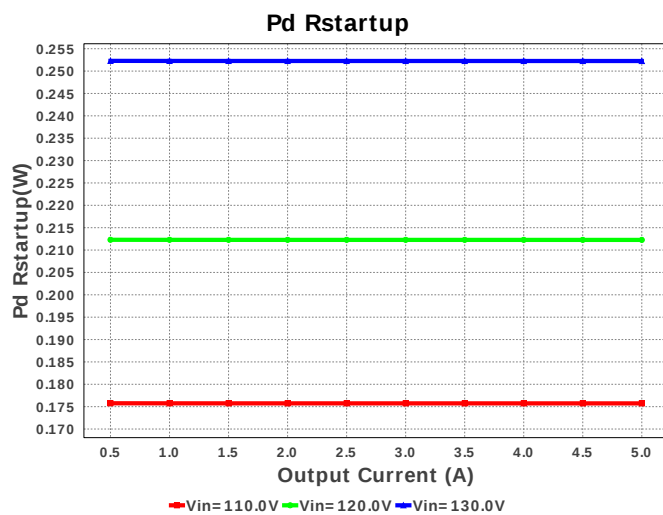
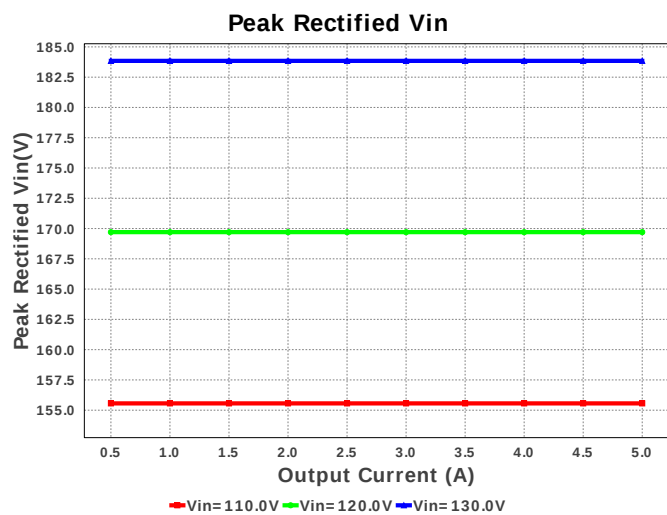
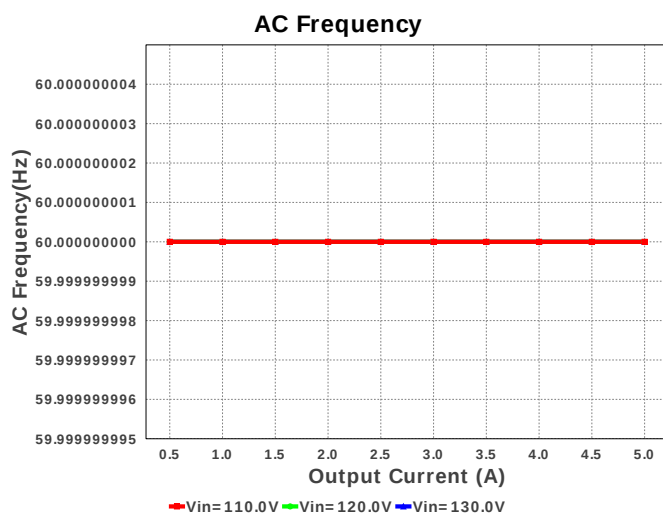
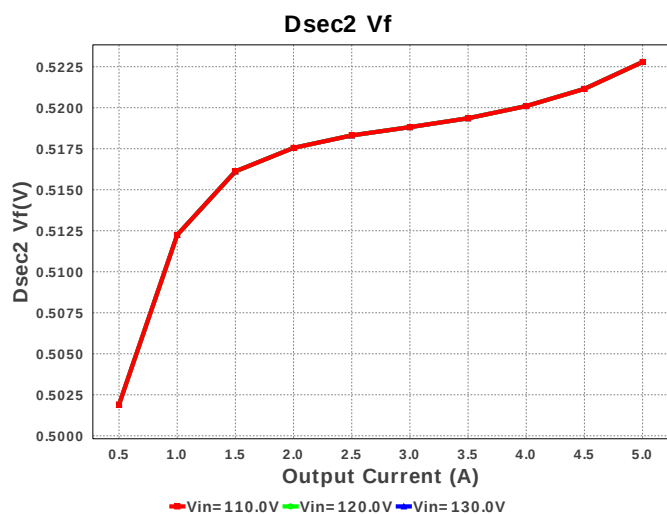
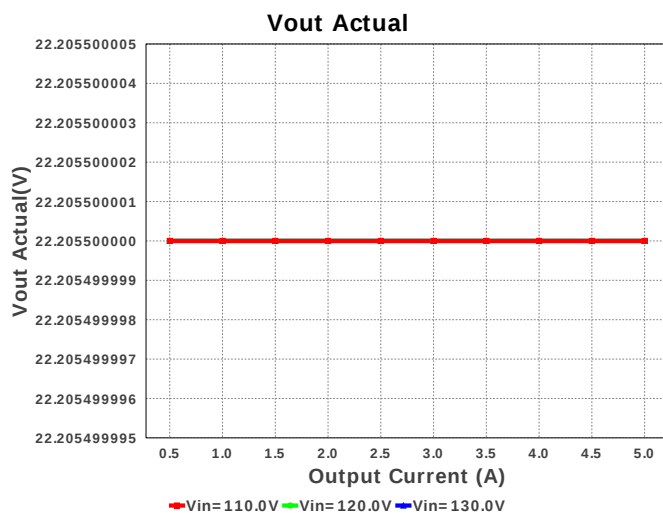
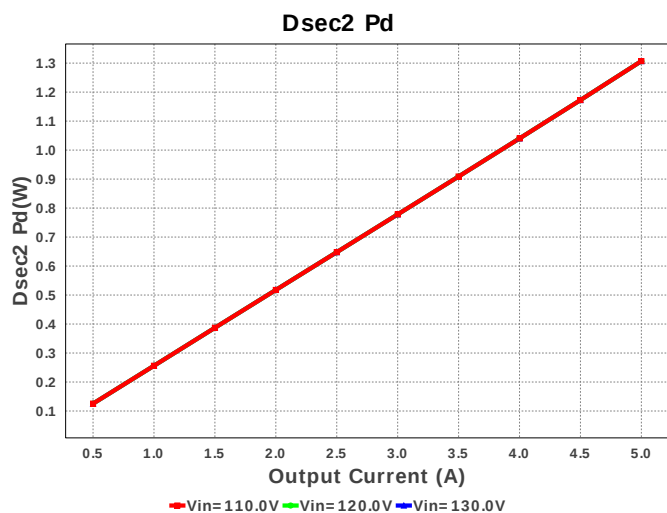
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24.	Dsec	ON Semiconductor	MBRB40250TG	VF@Io= 860.0 mV VRRM= 250.0 V	1	\$0.94	 DDPAK 210 mm²
25.	Dsec2	ON Semiconductor	MBRB40250TG	VF@Io= 860.0 mV VRRM= 250.0 V	1	\$0.94	 DDPAK 210 mm²
26.	Dsnub	Bourns	CD1408-FU1400	VF@Io= 1.05 V VRRM= 400.0 V	1	\$0.13	 Diode_1408 13 mm²
27.	Dz	Diodes Inc.	MMSZ5250B-7-F	Zener	1	\$0.03	 SOD-123 13 mm²
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 mm²
29.	L2	Coilcraft	SER1360-182KLB	L= 1.8 µH DCR= 2.4 mOhm	1	\$0.72	 SER1360 225 mm²
30.	M1	STMicroelectronics	STP45N65M5	VdsMax= 650.0 V IdsMax= 35.0 Amps	1	\$3.85	 TO-220AB 397 mm²
31.	O1	Vishay-Semiconductor	TCMT1107	Optocoupler	1	\$0.21	 SOP-4 44 mm²
32.	Q1	ON Semiconductor	BC846BLT1G	Bipolar Transistor	1	\$0.02	 SOT-23 14 mm²
33.	R1	Vishay-Dale	AC03000001009JACCS Series= F_RES	Res= 10.0 Ohm Power= 2.25 W Tolerance= 5.0%	1	\$0.30	 AC03 158 mm²
34.	R11	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
35.	R12	Vishay-Dale	CRCW040222K6FKED Series= CRCW..e3	Res= 22.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
36.	R13	Vishay-Dale	CRCW04024K99FKED Series= CRCW..e3	Res= 4.99 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
37.	R21	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
38.	R22	Vishay-Dale	CRCW0402475KFKED Series= CRCW..e3	Res= 475.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
39.	Raux	Vishay-Dale	CRCW040210R0FKED Series= CRCW..e3	Res= 10.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
40.	Rbias	Panasonic	ERJ-6ENF1372V Series= ERJ-6E	Res= 13.7 kOhm Power= 125.0 mW Tolerance= 1.0%	1	\$0.01	 0805 7 mm²

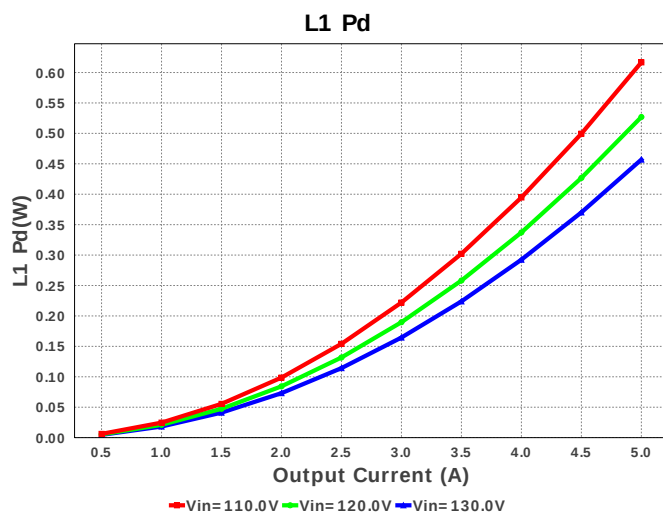
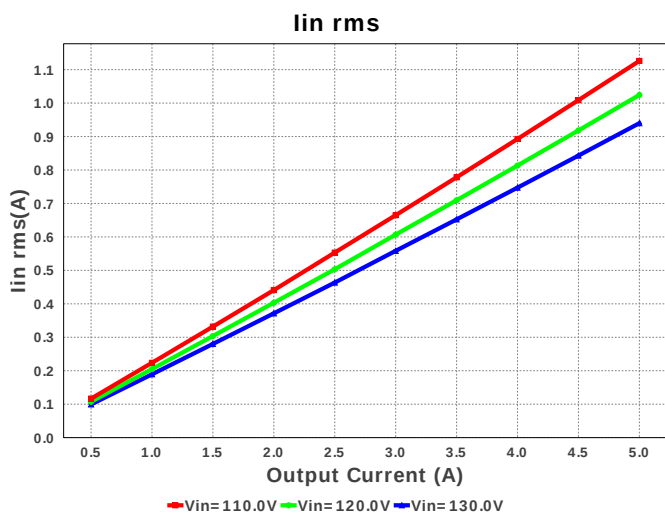
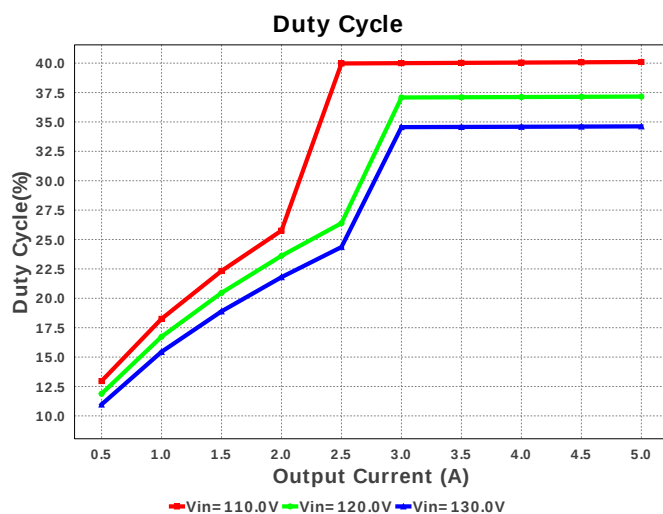
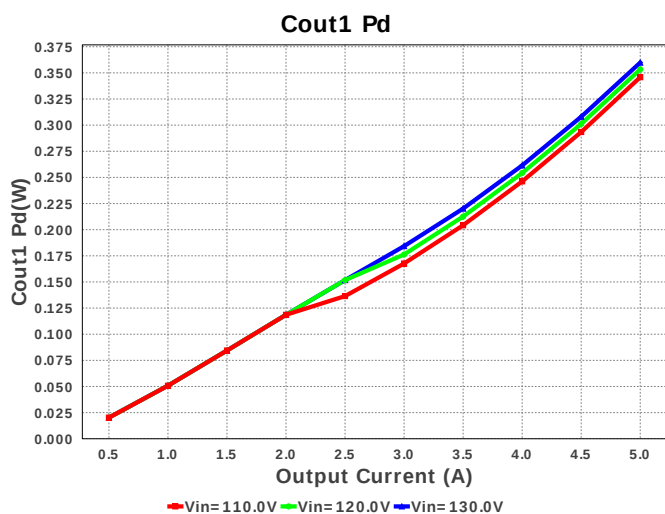
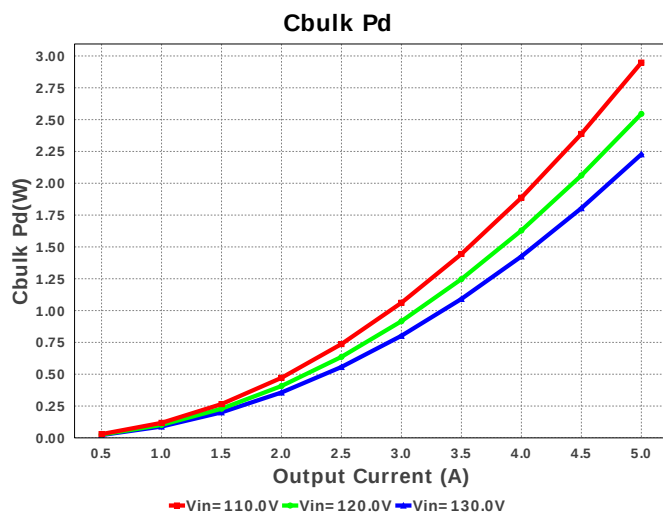
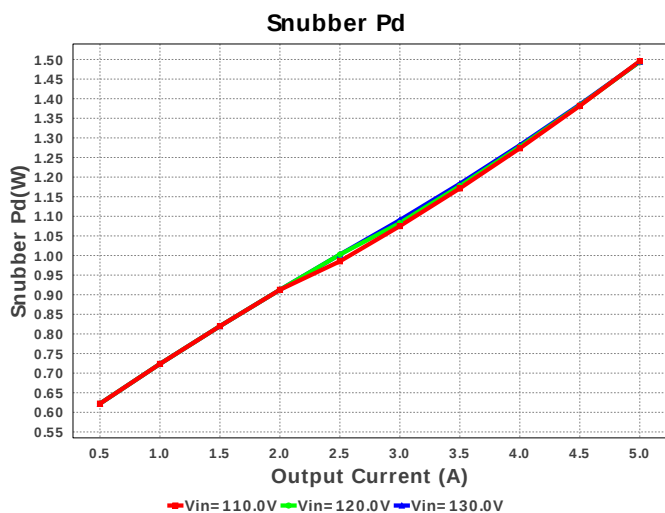
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
41.	Rcs	Vishay-Dale	CRCW04022K00FKED Series= CRCW..e3	Res= 2.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
42.	Rdrv	Vishay-Dale	CRCW04025R11FKED Series= CRCW..e3	Res= 5.11 Ohm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
43.	Rfbb	Yageo America	RC0603FR-073KL Series= ?	Res= 3.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm²
44.	Rfbt	Vishay-Dale	CRCW040223K7FKED Series= CRCW..e3	Res= 23.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
45.	Rled	Vishay-Dale	CRCW040228K7FKED Series= CRCW..e3	Res= 28.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
46.	Rsc	Vishay-Dale	CRCW04028K66FKED Series= CRCW..e3	Res= 8.66 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
47.	Rsns	Stackpole Electronics Inc	CSRN2512FKR200 Series= ?	Res= 200.0 mOhm Power= 2.0 W Tolerance= 1.0%	1	\$0.13	 2512 43 mm²
48.	Rsns	CUSTOM	CUSTOM Series= ?	Res= 9.8677 kOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
49.	Rstartup1	Panasonic	ERJ-8ENF2323V Series= ERJ-8E	Res= 232.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	 1206 11 mm²
50.	Rstartup2	Panasonic	ERJ-8ENF2323V Series= ERJ-8E	Res= 232.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	 1206 11 mm²
51.	Rt	Vishay-Dale	CRCW040226K7FKED Series= CRCW..e3	Res= 26.7 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	CRCW04021K21FKED Series= CRCW..e3	Res= 1.21 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
55.	T1	CUSTOM	CUSTOM	Lp= 546.148 µH Rp= 870.0 mOhm Leakage_L= 10.923 µH Ns1toNp= 0.315 Rs1= 8.6 mOhms Ns2toNp= 0.166 Rs2= 700.0 µOhms	1	NA	CUSTOM 0 mm²
56.	U1	Texas Instruments	UCC28C45DR	Switcher	1	\$0.60	 D0008A 57 mm²

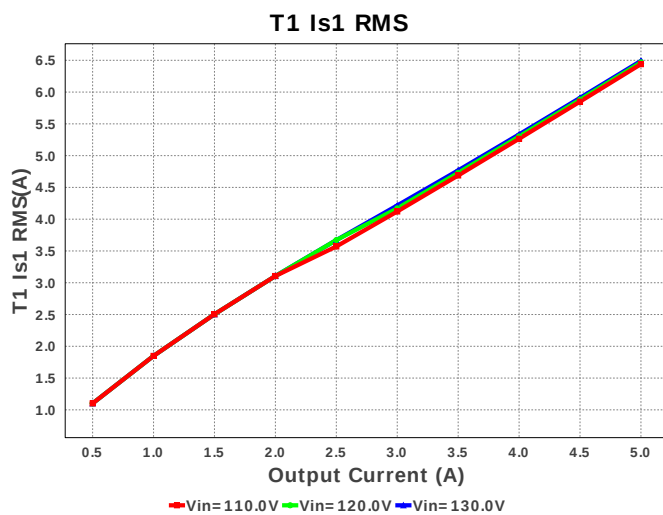
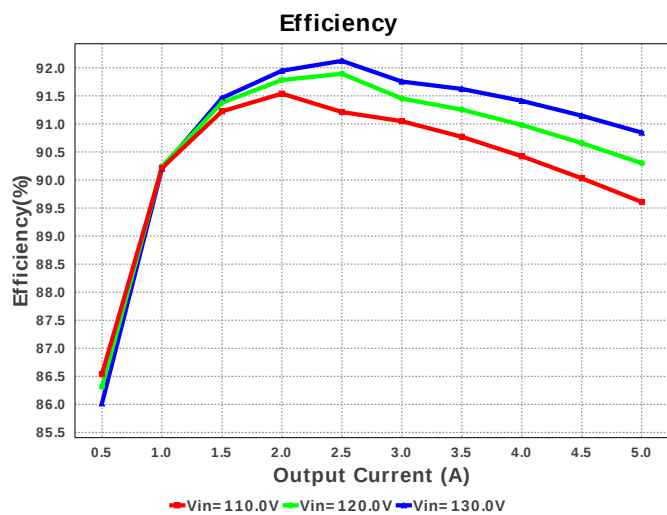
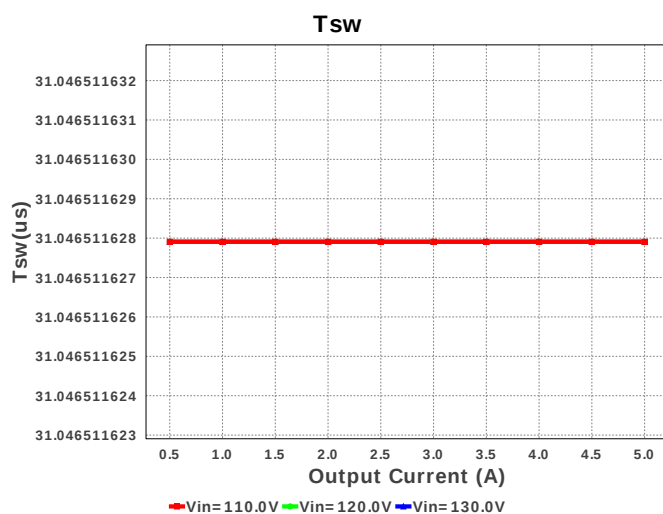
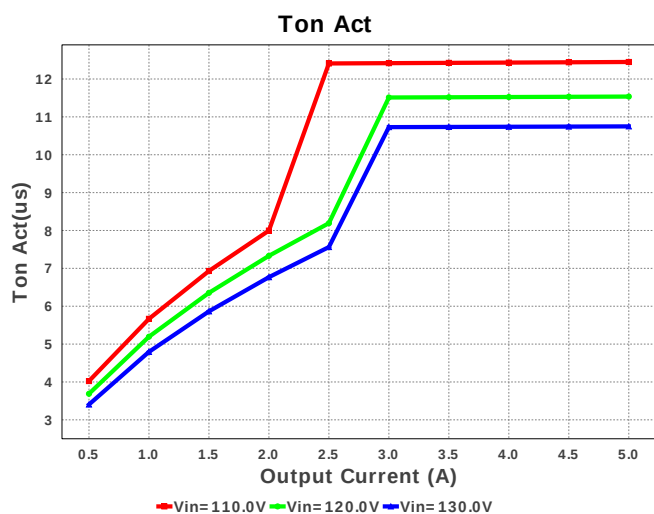
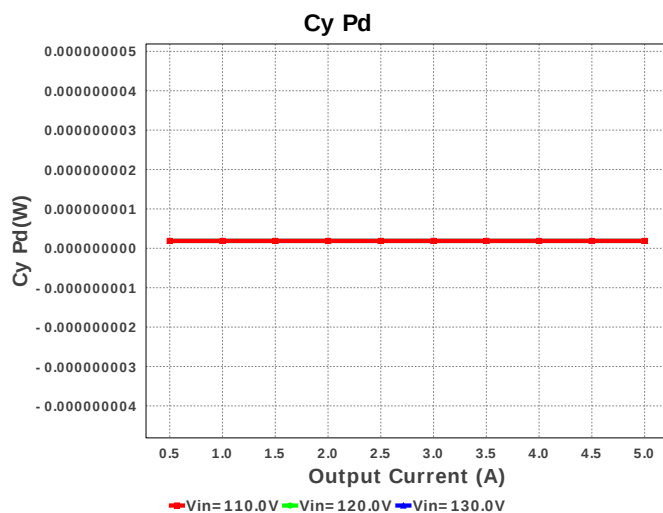
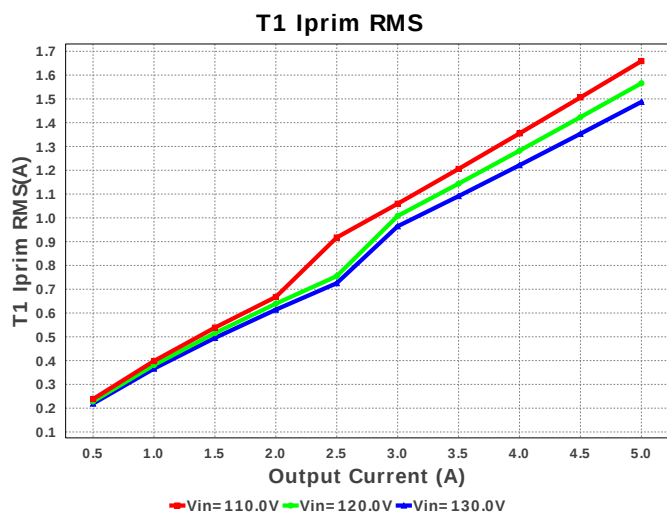
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
57.	VR	Texas Instruments	TL431AIDBVR	Voltage References	1	\$0.07	 R-PDSO-G3 16 mm ²

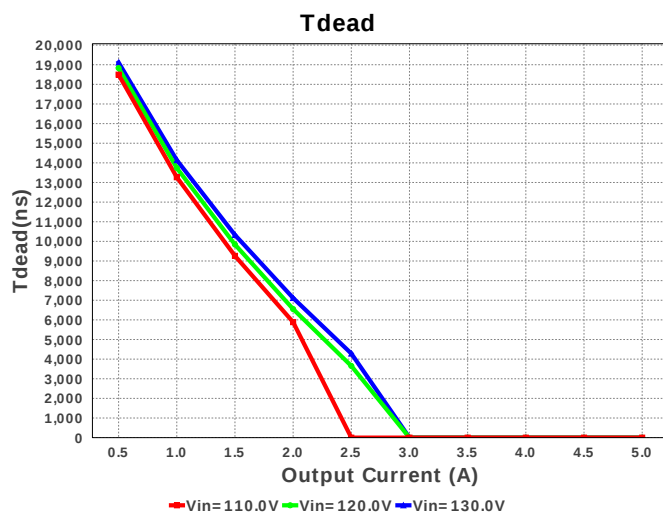
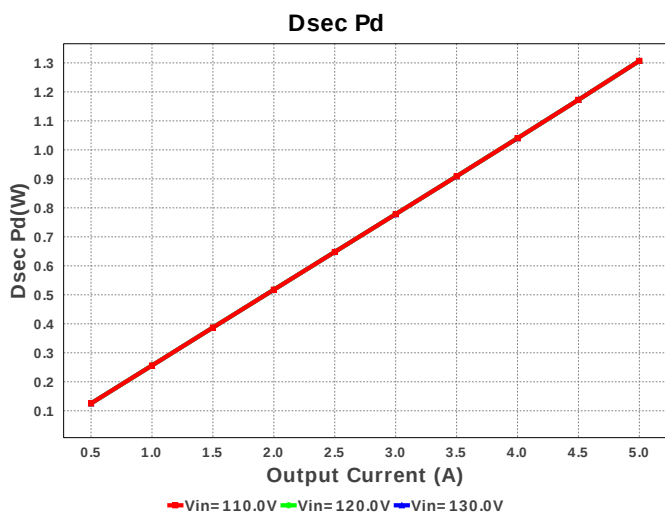
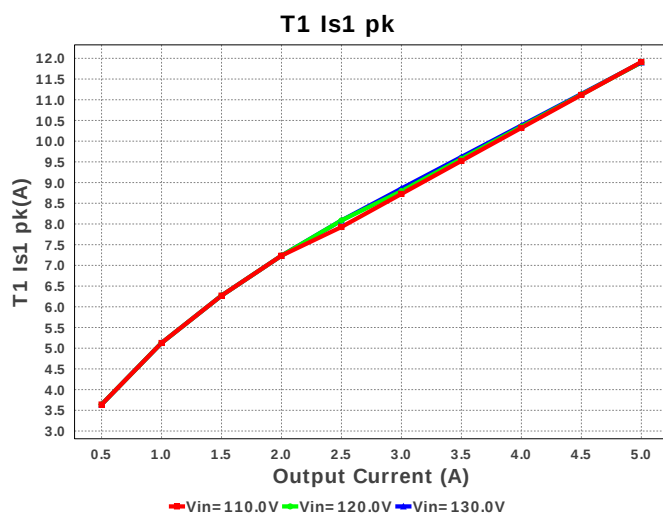
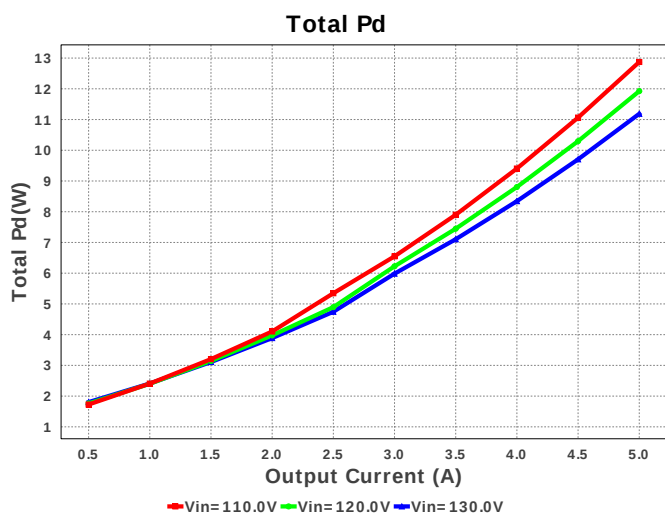
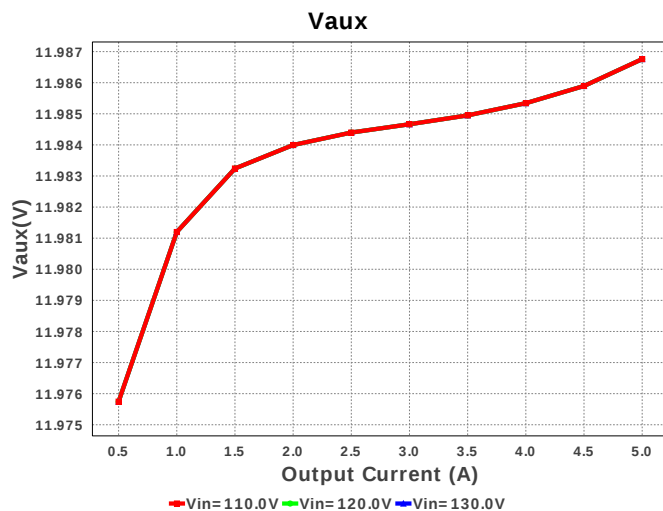
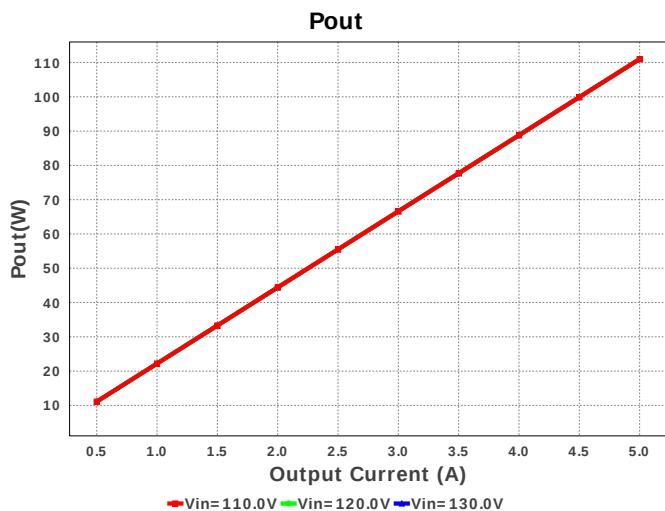


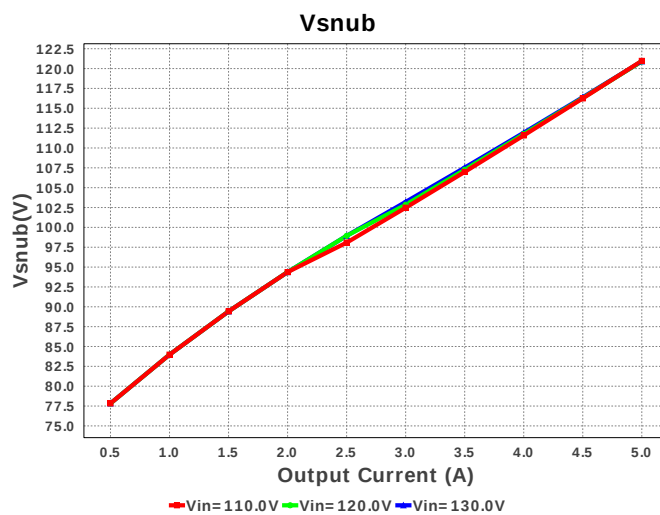
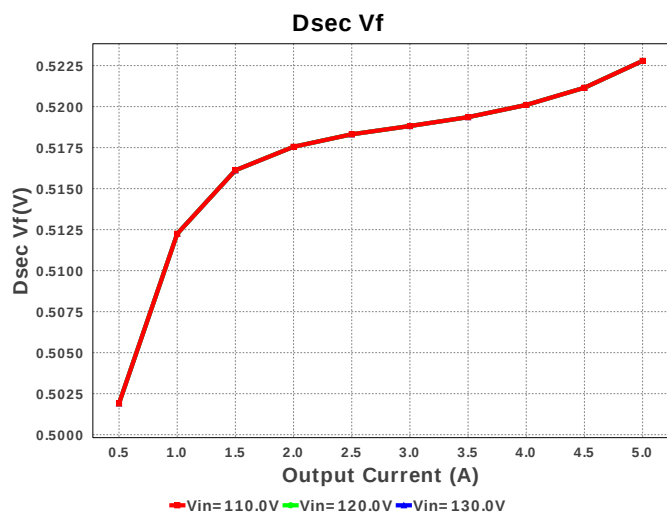
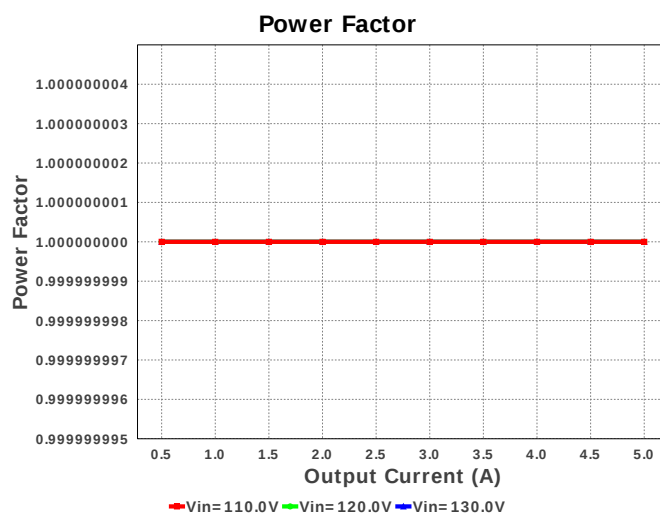
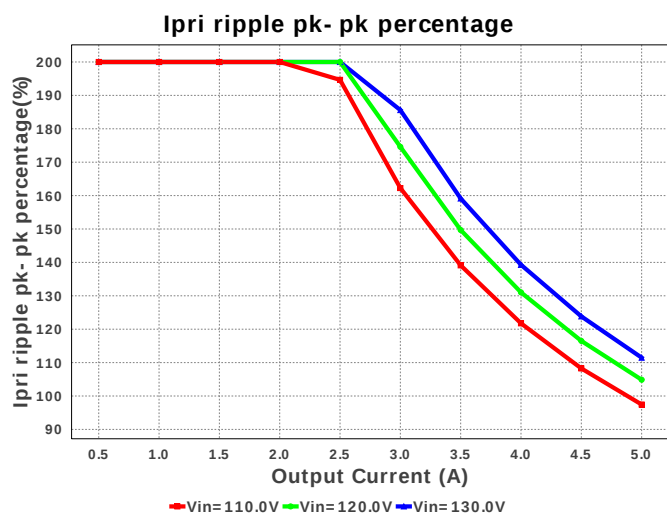
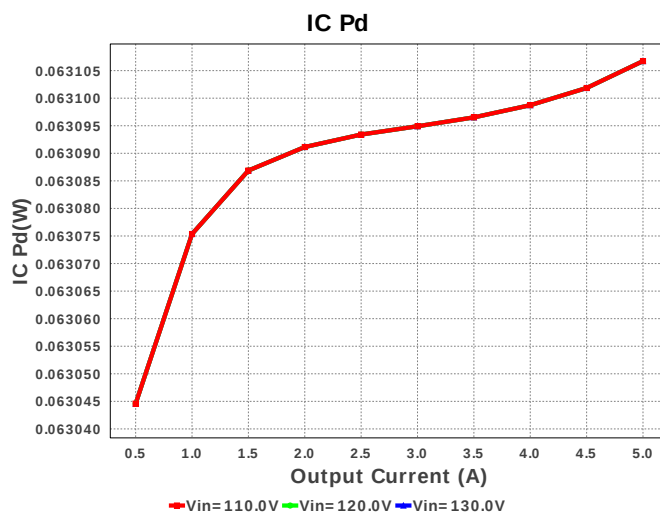
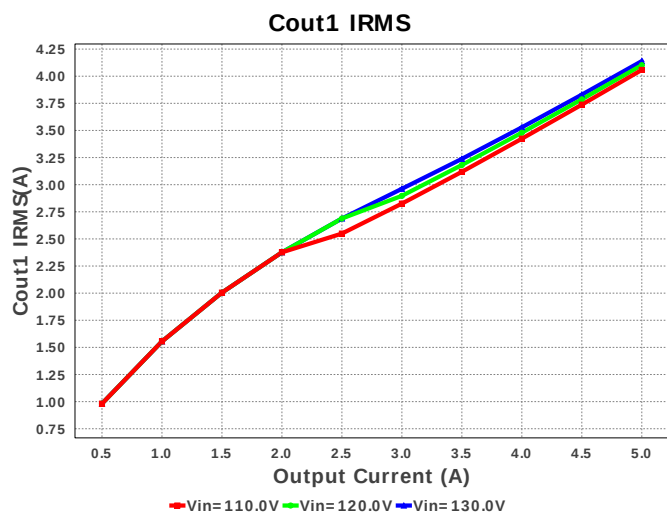


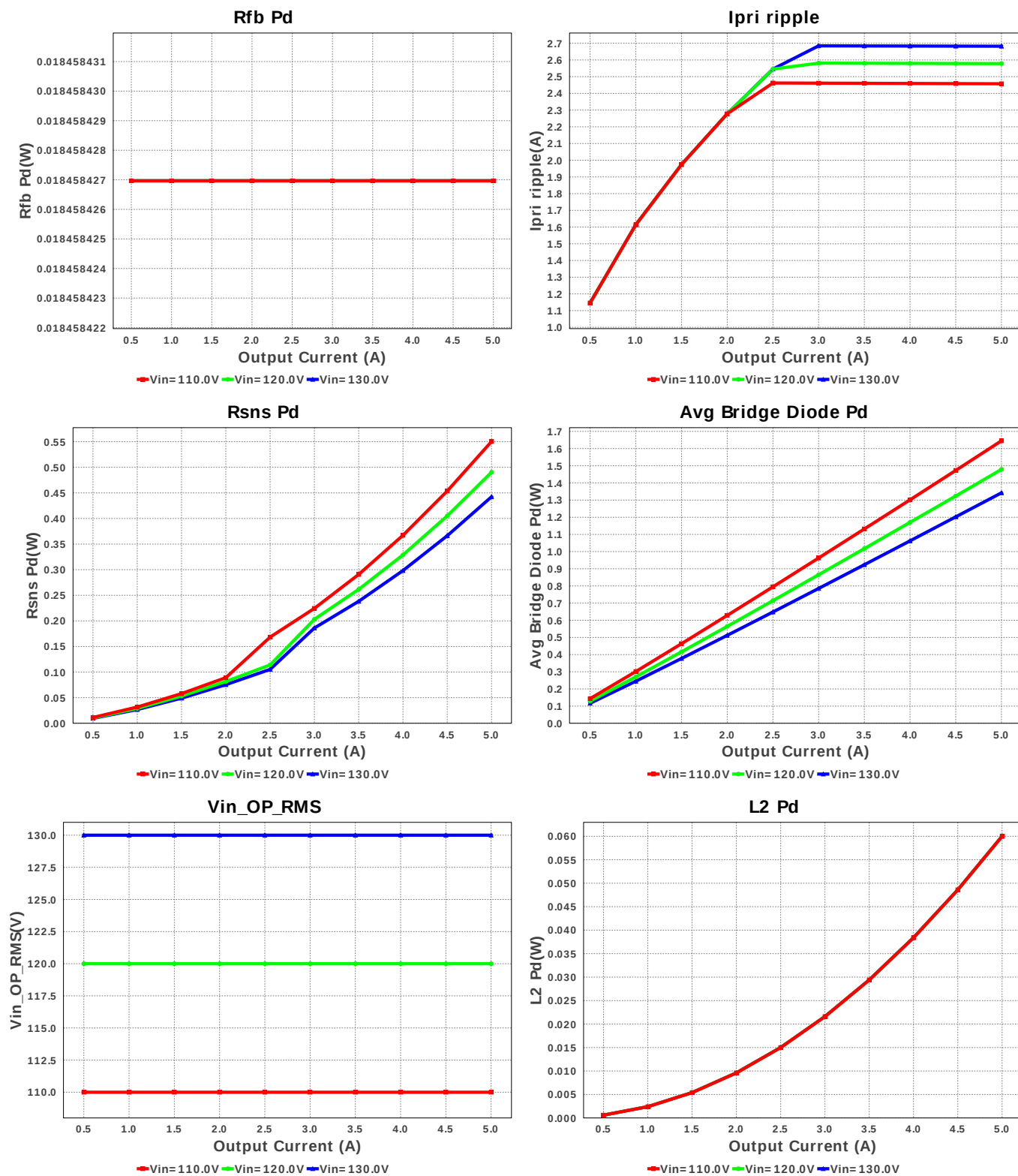


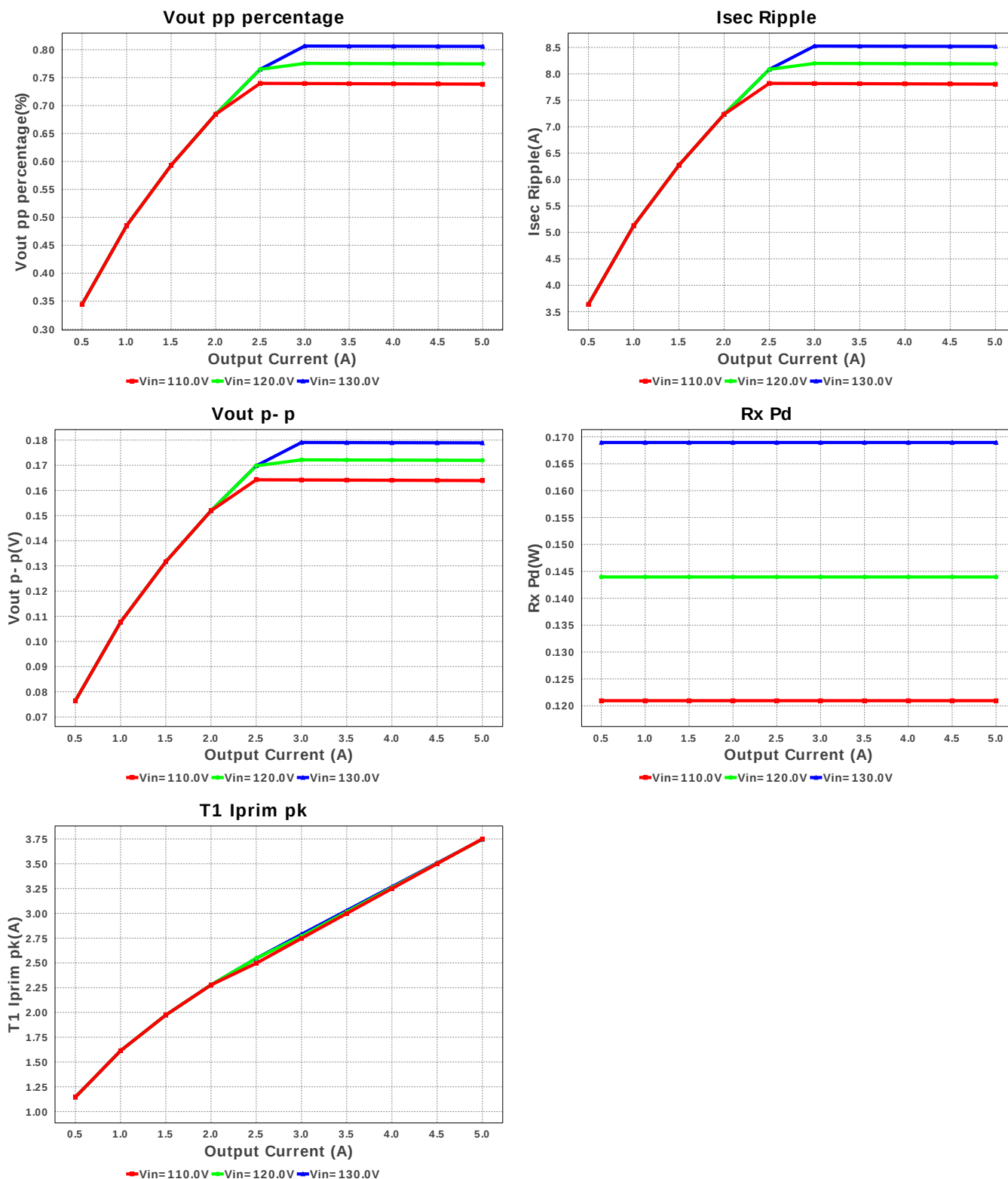












Operating Values

#	Name	Value	Category	Description
1.	Cout1 IRMS	4.058 A	Current	Output capacitor1 RMS ripple current
2.	Iin rms	1.126 A	Current	RMS Input Current
3.	Iout_DCM	2.441 A	Current	Approximate Current below which DCM mode of operation will begin
4.	Ipri Avg	1.011 A	Current	Average Current in Primary Winding over the complete Switching Period
5.	Ipri ripple	2.458 A	Current	Ripple Current in the Primary Winding
6.	Ipri ripple pk-pk percentage	97.455 %	Current	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
7.	Isec Ripple	7.805 A	Current	Ripple Current in the Secondary Winding
8.	T1 Iprim RMS	1.659 A	Current	Transformer Primary RMS Current
9.	T1 Iprim pk	3.75 A	Current	Transformer Primary Peak Current

#	Name	Value	Category	Description
10.	T1 Is1 RMS	6.44 A	Current	Transformer Secondary1 RMS Current
11.	T1 Is1 pk	11.912 A	Current	Transformer Secondary1 Peak Current
12.	AC Frequency	60.0 Hz	General	Input AC frequency
13.	BOM Count	66	General	Total Design BOM count
14.	Daux trr	0.0 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	35.0 ns	General	Snubber Diode Reverse Recovery Time
19.	FootPrint	8.089 k mm ²	General	Total Foot Print Area of BOM components
20.	Frequency	32.21 kHz	General	Switching frequency
21.	Pout	111.0 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	19.381 us	General	Approximate Converter Off Time
25.	Ton Act	12.449 us	General	Approximate Converter On Time
26.	Total BOM	\$0.0	General	Total BOM Cost
27.	Tsw	31.047 us	General	Switching Time Period
28.	Vaux	11.987 V	General	Auxiliary Voltage
29.	Vsnub	120.97 V	General	Voltage Across the Snubber
30.	Vout Actual	22.206 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
31.	Vout OP	22.2 V	Op_Point	Operational Output Voltage
32.	Duty Cycle	40.099 %	Op_point	Duty cycle
33.	Efficiency	89.608 %	Op_point	Steady state efficiency
34.	IC Tj	33.155 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	59.103 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	163.915 mV	Op_point	Peak-to-peak output ripple voltage
41.	Avg Bridge Diode Pd	1.645 W	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
42.	Cbulk Pd	2.948 W	Power	Bulk capacitor power dissipation
43.	Cout1 Pd	345.815 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	63.107 mW	Power	IC power dissipation
49.	L1 Pd	616.684 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	465.653 mW	Power	M1 MOSFET total power dissipation
52.	Paux	17.49 mW	Power	Power Dissipation in Raux and Daux
53.	Pd Rstartup	175.731 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
54.	Rdrv Pd	35.647 μW	Power	Power Dissipation in Gate Drive Resistor
55.	Rfb Pd	18.458 mW	Power	Rfb Power Dissipation
56.	Rsns Pd	550.343 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	1.496 W	Power	Snubber Power Dissipation
59.	T1 Pd	5.501 W	Power	Estimated Losses in Transformer
60.	Total Pd	12.873 W	Power	Total Power Dissipation
61.	Vout Tolerance	2.12 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
62.	Vout pp percentage	738.355 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	22.2	Output Voltage
5.	acFrequency	60.0	Light Output in Lumen
6.	base_pn	UCC28C45	Texas Instruments Base Part Number
7.	source	AC	Input Source Type
8.	ta	30.0	Ambient temperature

Design Assistance

1. UCC28C45 Product Folder : <http://www.ti.com/product/UCC28C45> : contains the data sheet and other resources.

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