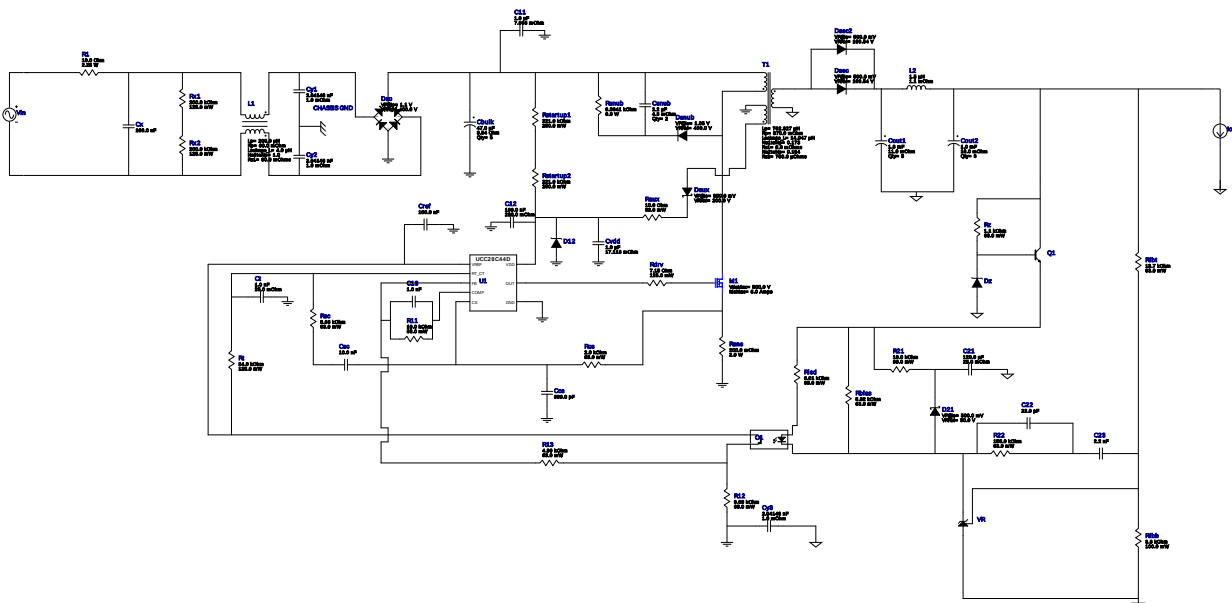


WEBENCH® Design Report

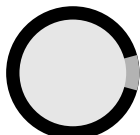
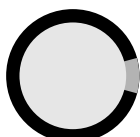
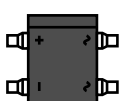
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UCC28C44DR 110.0V-130.0V to 12.00V @ 9.0A

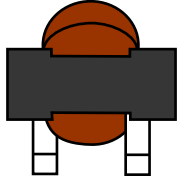
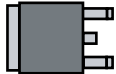
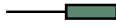


1. The EMI filter selected here contains the estimated values. The real numbers will depend on the attenuation needed at a particular frequency.

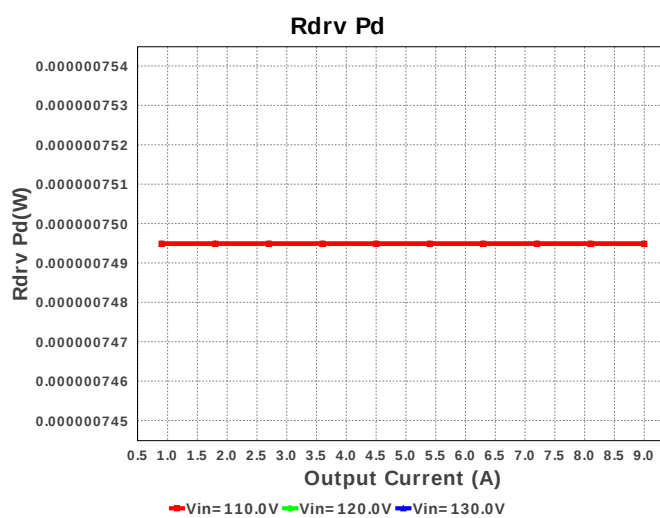
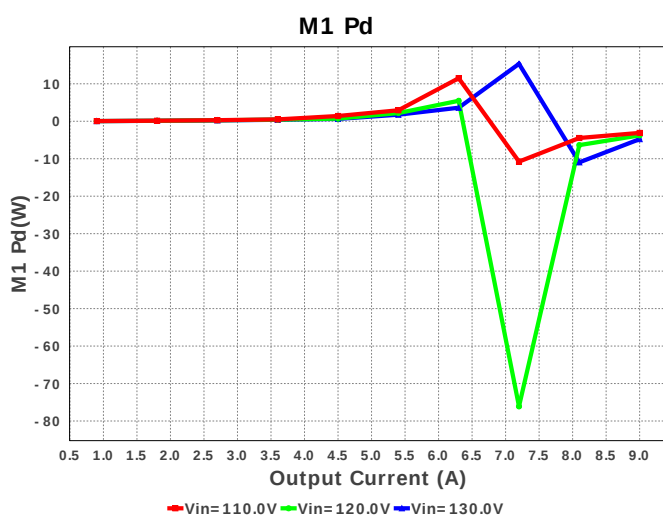
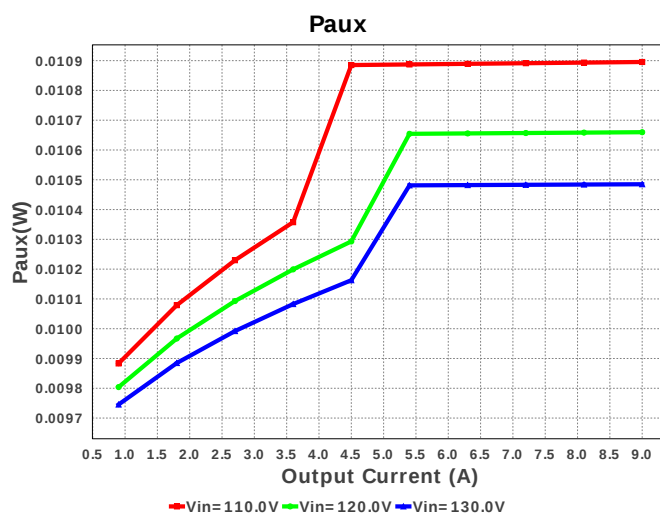
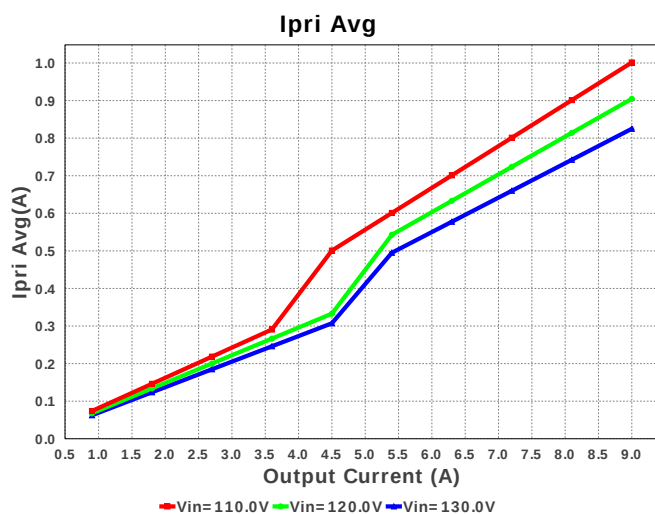
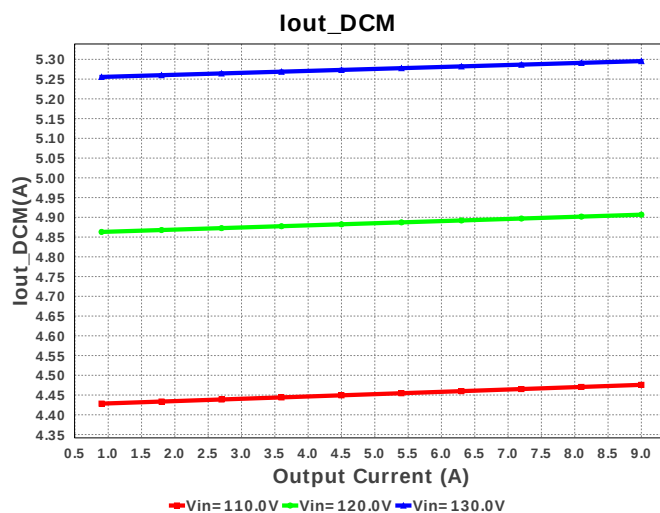
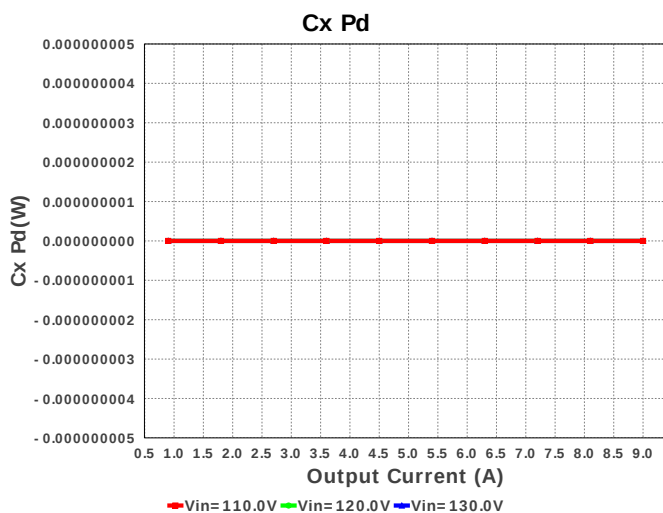
Electrical BOM

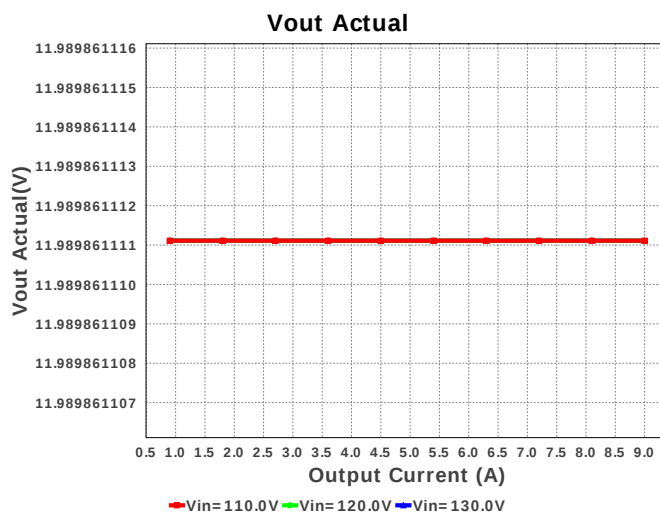
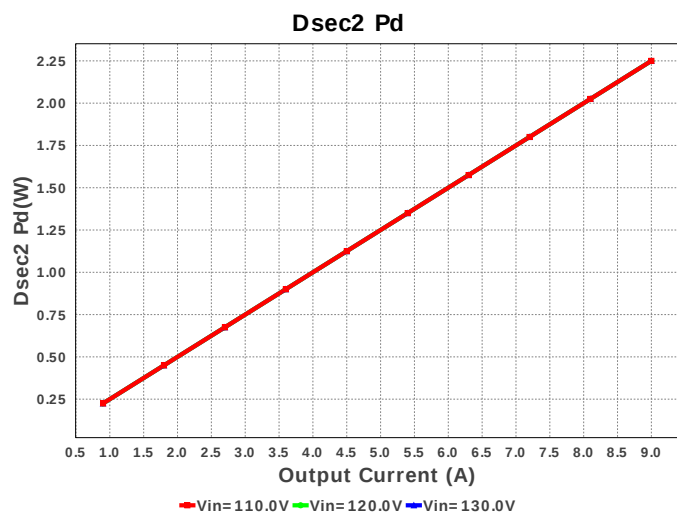
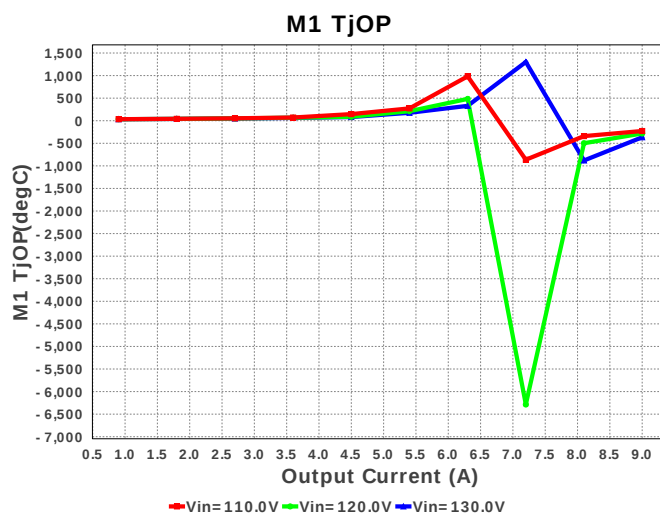
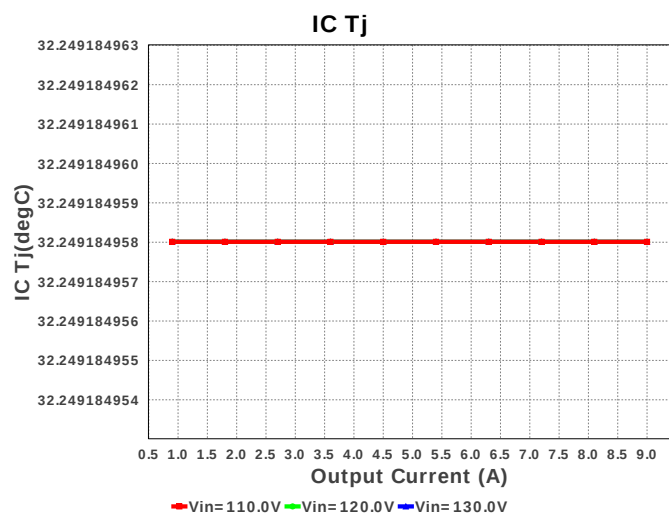
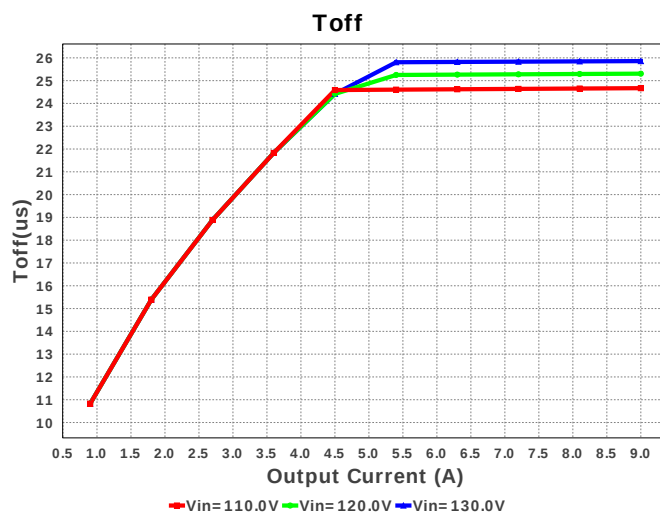
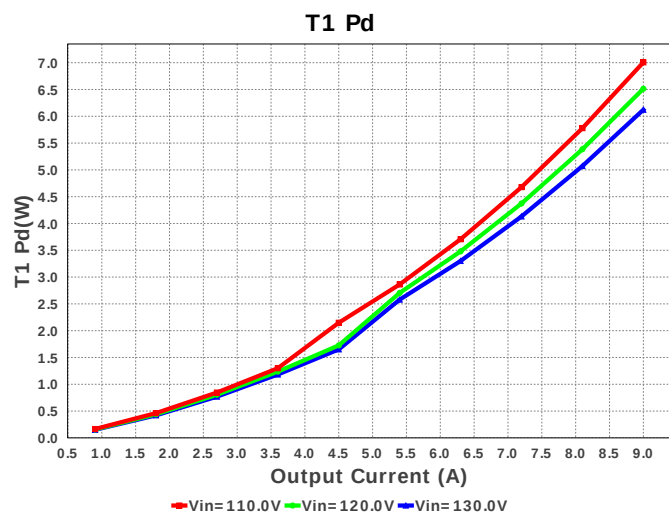
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1.	C11	MuRata	GRM55DR72E105KW01L Series= X7R	Cap= 1.0 uF ESR= 7.086 mOhm VDC= 250.0 V IRMS= 2.0605 A	1	\$0.26	 2220_200 54 mm ²
2.	C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	 0805 7 mm ²
3.	C13	MuRata	GRM033R71C102KA01D Series= X7R	Cap= 1.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	 0201 2 mm ²
4.	C21	Panasonic	20SVPF120M Series= ?	Cap= 120.0 uF ESR= 25.0 mOhm VDC= 20.0 V IRMS= 3.2 A	1	\$0.43	 CAPSMT_62_F61 74 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	CC0805KRX7R9BB222 Series= X7R	Cap= 2.2 nF 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	MuRata	GRM033R71C681KA01D Series= X7R	Cap= 680.0 pF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	 0201 2 mm ²

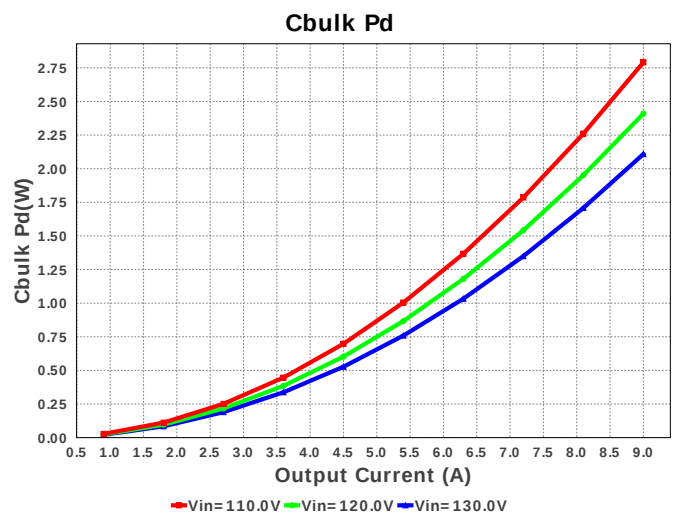
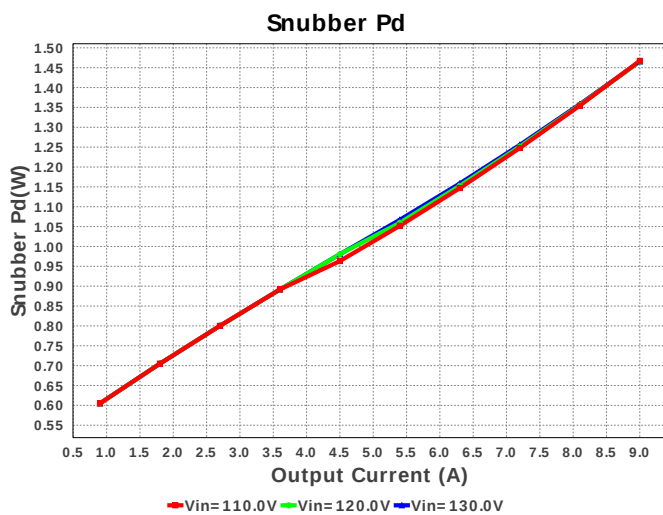
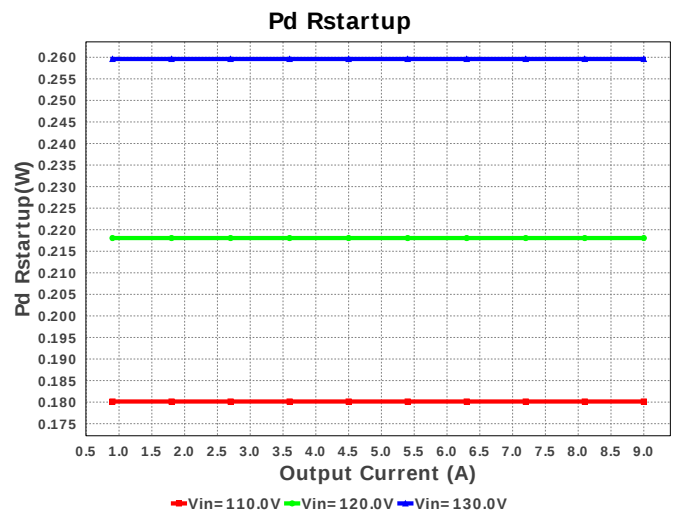
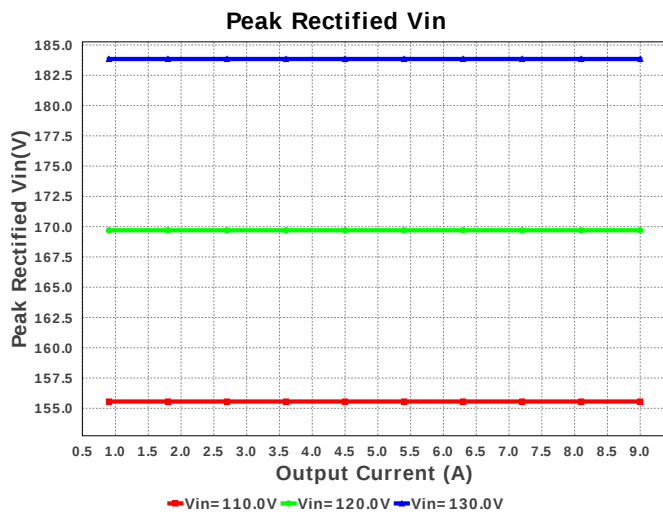
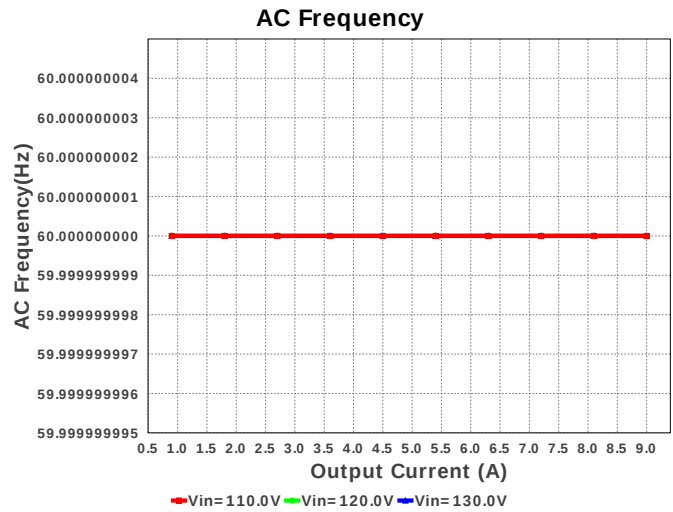
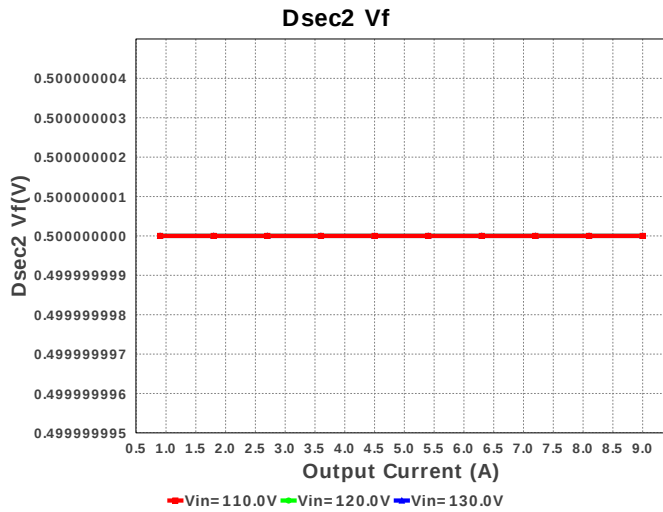
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9.	Cout1	Nichicon	UHV1V182MHD Series= HV	Cap= 1.8 mF ESR= 11.0 mOhm VDC= 35.0 V IRMS= 3.925 A	3	NA	 CAPPR5-12.5X25 210 mm ²
10.	Cout2	Nichicon	UHV1V102MHD Series= HV	Cap= 1.0 mF ESR= 16.0 mOhm VDC= 35.0 V IRMS= 2.92 A	3	NA	 CAPPR5-12.5X25 210 mm ²
11.	Cref	MuRata	GRM155R61C104KA88D Series= X5R	Cap= 100.0 nF VDC= 16.0 V IRMS= 0.0 A	1	\$0.01	 0402 3 mm ²
12.	Csc	MuRata	GRM033R60J103KA01D Series= X5R	Cap= 10.0 nF VDC= 6.3 V IRMS= 0.0 A	1	\$0.01	 0201 2 mm ²
13.	Csnub	TDK	C5750X6S2W225K Series= X6S	Cap= 2.2 uF ESR= 4.3 mOhm VDC= 400.0 V IRMS= 0.0 A	2	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= 2.04148 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= 2.04148 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= 2.04148 nF ESR= 1.0 mOhm VDC= 220.62 V IRMS= 500.0 uA	1	NA	CUSTOM 0 mm ²
20.	D12	Diodes Inc.	DFLZ18-7	Zener	1	\$0.13	 PowerDI123 13 mm ²
21.	D21	Diodes Inc.	B230A-13-F	VF@Io= 500.0 mV VRRM= 30.0 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	Diodes Inc.	DFLS1200-7	VF@Io= 850.0 mV VRRM= 200.0 V	1	\$0.21	 PowerDI123 13 mm ²
24.	Dsec	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 109.54 V	1	NA	CUSTOM 0 mm ²
25.	Dsec2	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 109.54 V	1	NA	CUSTOM 0 mm ²

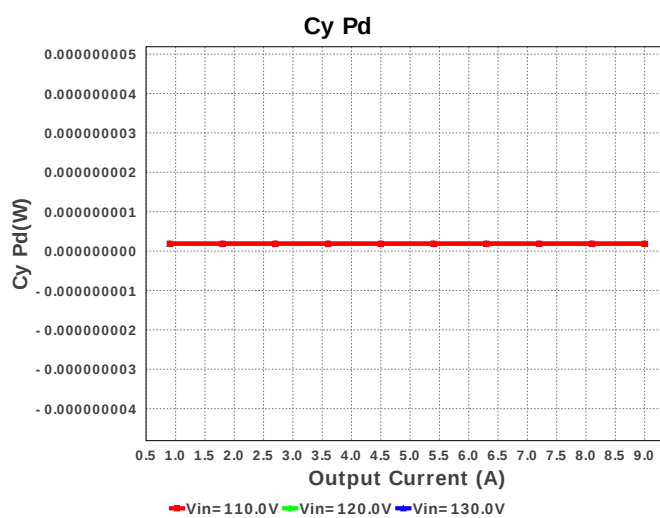
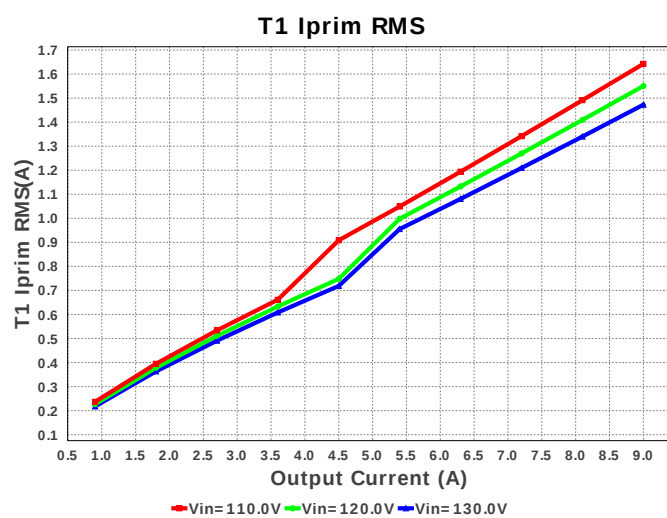
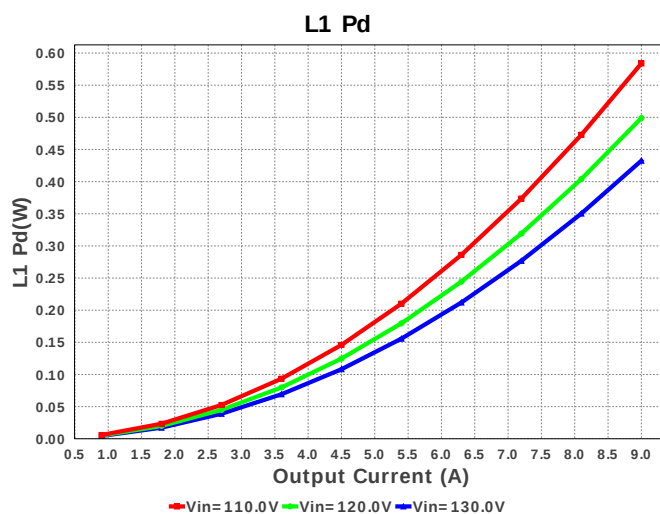
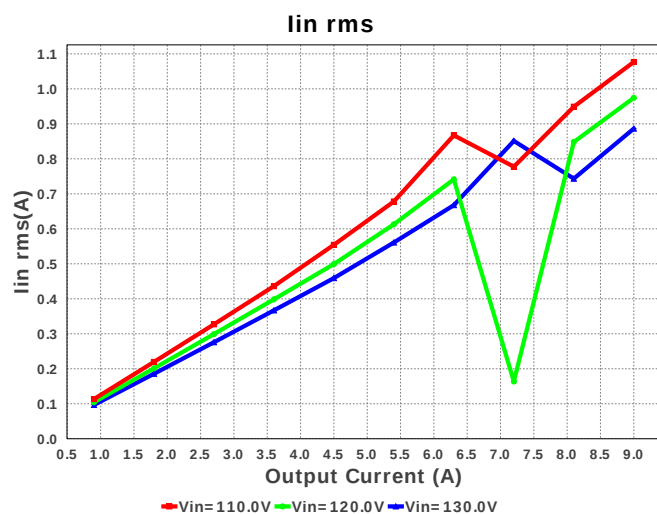
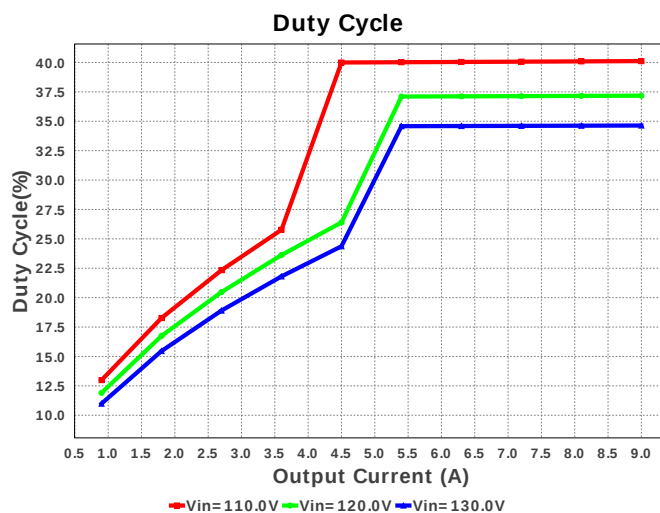
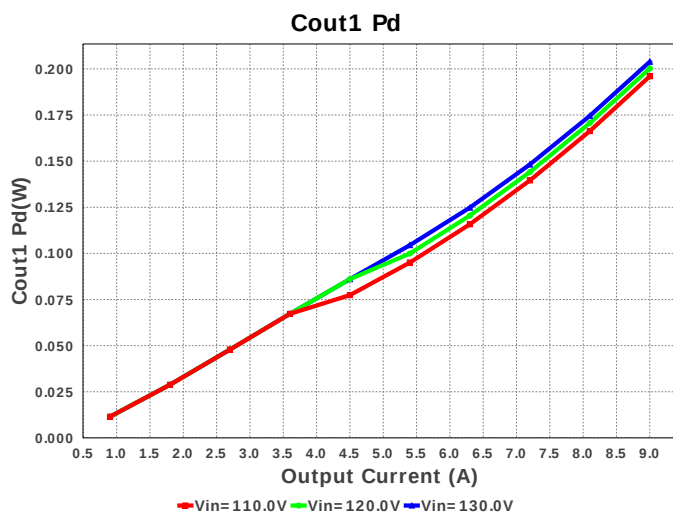
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26.	Dsneb	Bourns	CD1408-FU1400	VF@Io= 1.05 V VRRM= 400.0 V	1	\$0.13	 Diode_1408 13 mm ²
27.	Dz	Diodes Inc.	DFLZ10-7	Zener	1	\$0.13	 PowerDI123 13 mm ²
28.	L1	CUSTOM	CUSTOM	Lp= 200.0 µH Rp= 60.0 mOhm Leakage_L= 4.0 µH Ns1toNp= 1.0 Rs1= 60.0 mOhms	1	NA	CUSTOM 0 mm ²
29.	L2	Coilcraft	SER1590-152MLB	L= 1.5 µH DCR= 1.1 mOhm	1	\$1.12	 SER1590 324 mm ²
30.	M1	Fairchild Semiconductor	FDD6N50TM	VdsMax= 500.0 V IdsMax= 6.0 Amps	1	\$0.47	 DPAK 102 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	CRCW04029K09FKED Series= CRCW..e3	Res= 9.09 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	CRCW0402158KFKED Series= CRCW..e3	Res= 158.0 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	Vishay-Dale	CRCW04025K62FKED Series= CRCW..e3	Res= 5.62 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 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	CRCW08057R15FKEA Series= CRCW..e3	Res= 7.15 Ohm Power= 125.0 mW Tolerance= 1.0%	1	\$0.01	 0805 7 mm ²
43.	Rfbb	Yageo America	RC0603FR-073K6L Series= ?	Res= 3.6 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm ²
44.	Rfbt	Vishay-Dale	CRCW040213K7FKED Series= CRCW..e3	Res= 13.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²

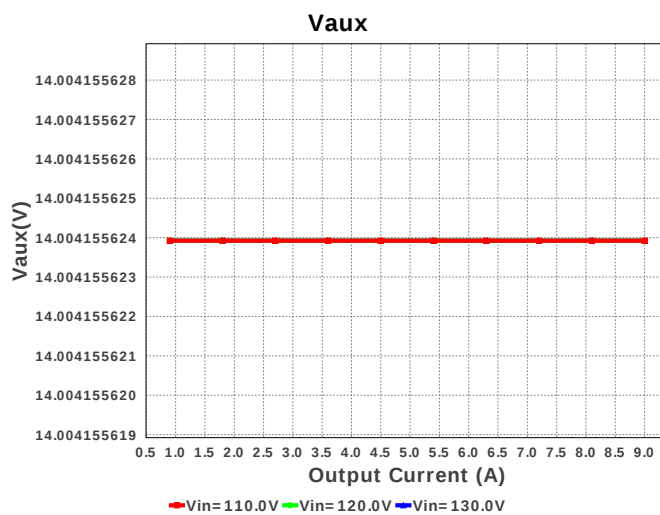
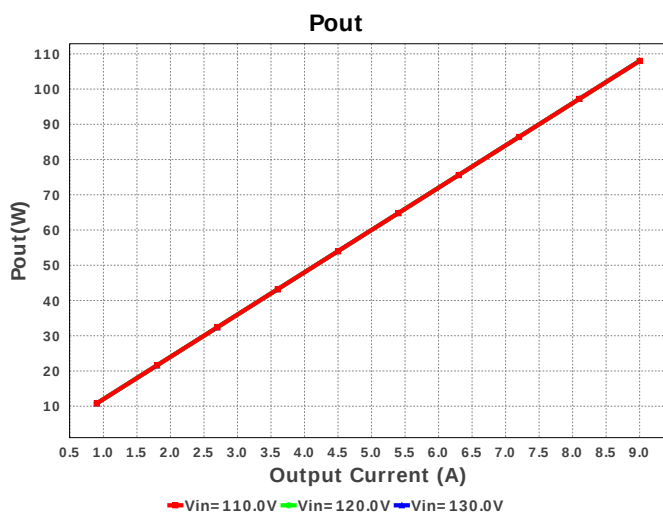
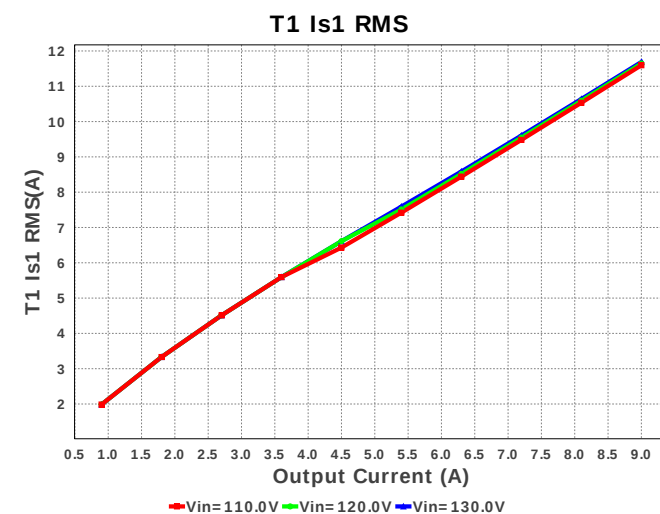
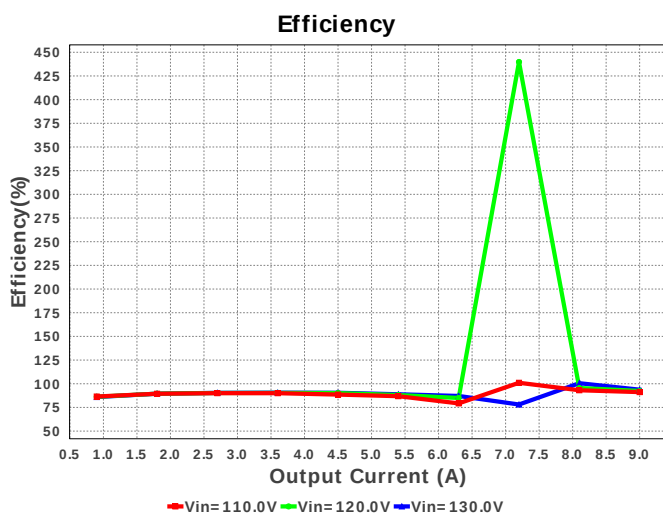
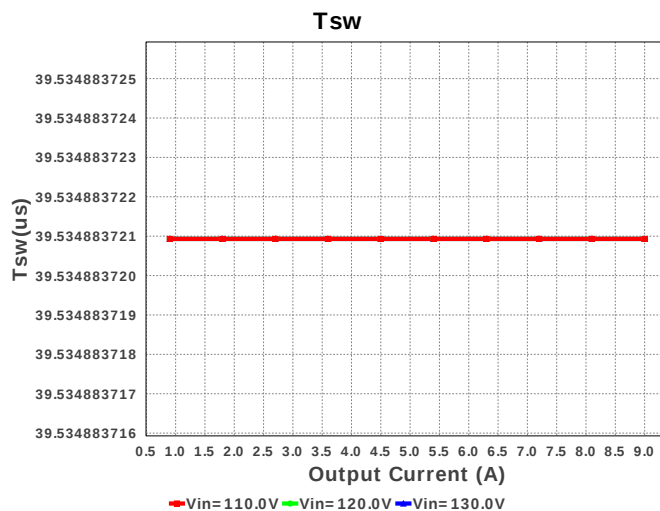
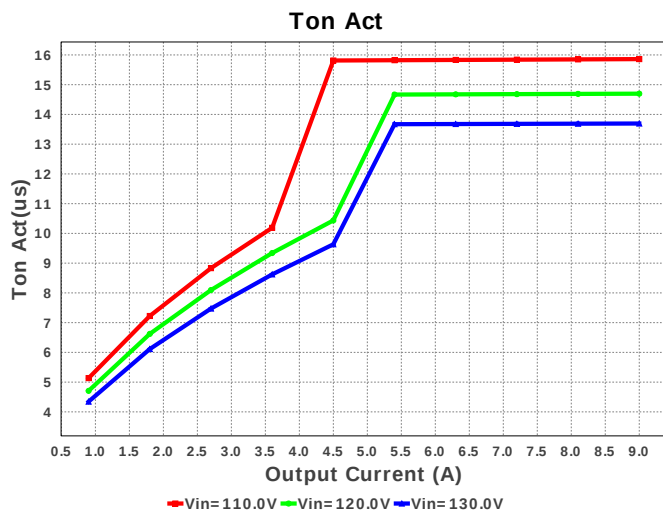
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
45.	Rled	Vishay-Dale	CRCW04026K81FKED Series= CRCW..e3	Res= 6.81 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
46.	Rsc	Vishay-Dale	CRCW04028K66FKED Series= CRCW..e3	Res= 8.66 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
47.	Rsns	Stackpole Electronics Inc	CSRN2512FKR200 Series= ?	Res= 200.0 mOhm Power= 2.0 W Tolerance= 1.0%	1	\$0.13	 2512 43 mm ²
48.	Rsnub	CUSTOM	CUSTOM Series= ?	Res= 9.8641 kOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm ²
49.	Rstartup1	Panasonic	ERJ-8ENF2213V Series= ERJ-8E	Res= 221.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	 1206 11 mm ²
50.	Rstartup2	Panasonic	ERJ-8ENF2213V Series= ERJ-8E	Res= 221.0 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	 1206 11 mm ²
51.	Rt	Panasonic	ERJ-6ENF3402V Series= ERJ-6E	Res= 34.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	\$0.01	 0805 7 mm ²
52.	Rx1	Panasonic	ERJ-6ENF2003V Series= ERJ-6E	Res= 200.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	\$0.01	 0805 7 mm ²
53.	Rx2	Panasonic	ERJ-6ENF2003V Series= ERJ-6E	Res= 200.0 kOhm Power= 125.0 mW Tolerance= 1.0%	1	\$0.01	 0805 7 mm ²
54.	Rz	Vishay-Dale	CRCW04021K10FKED Series= CRCW..e3	Res= 1.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm ²
55.	T1	CUSTOM	CUSTOM	Lp= 702.327 µH Rp= 870.0 mOhm Leakage_L= 14.047 µH Ns1toNp= 0.173 Rs1= 8.6 mOhms Ns2toNp= 0.194 Rs2= 700.0 µOhms	1	NA	CUSTOM 0 mm ²
56.	U1	Texas Instruments	UCC28C44DR	Switcher	1	\$0.60	 D0008A 57 mm ²
57.	VR	Texas Instruments	TL431AIDBZR	Voltage References	1	\$0.08	 DBZ0003A 14 mm ²

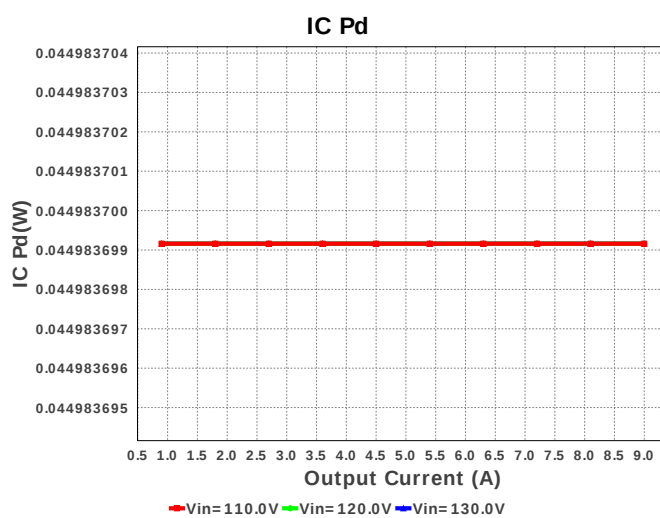
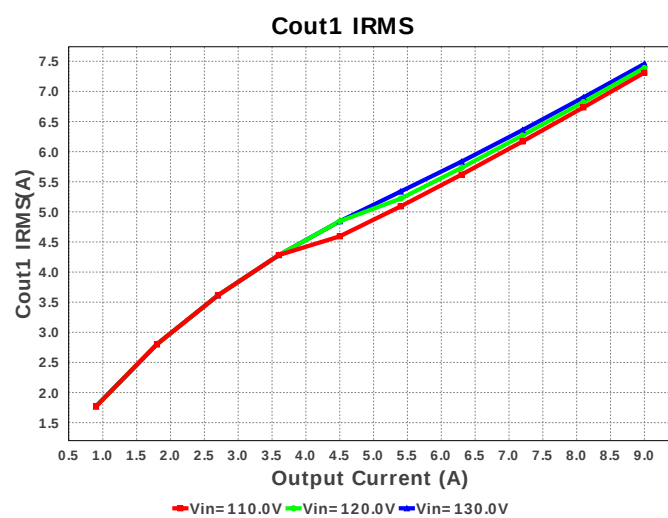
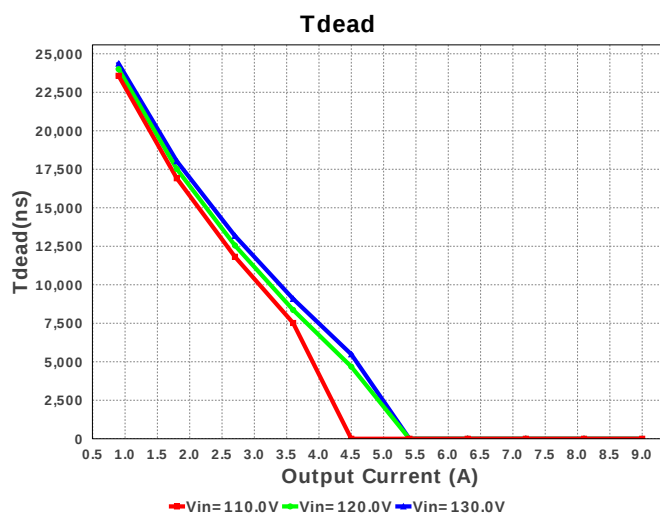
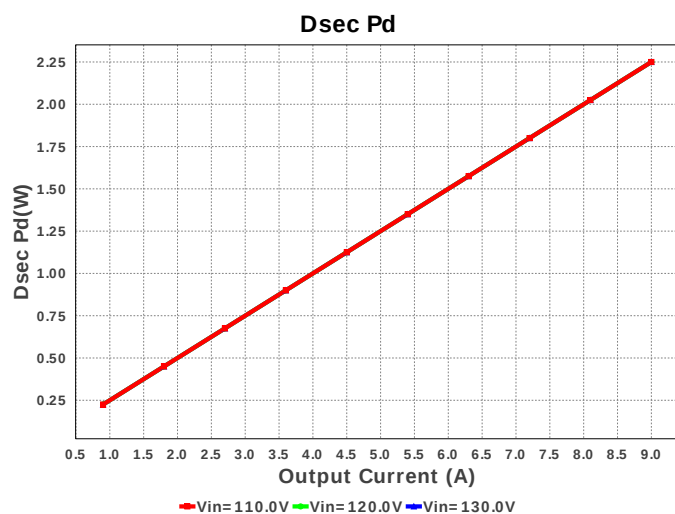
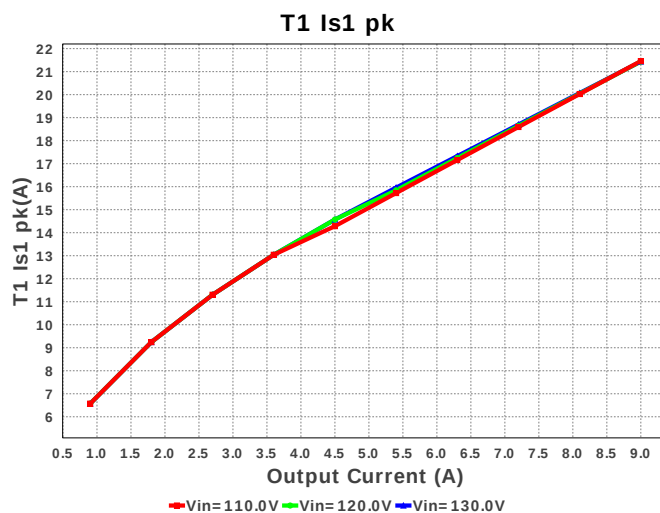
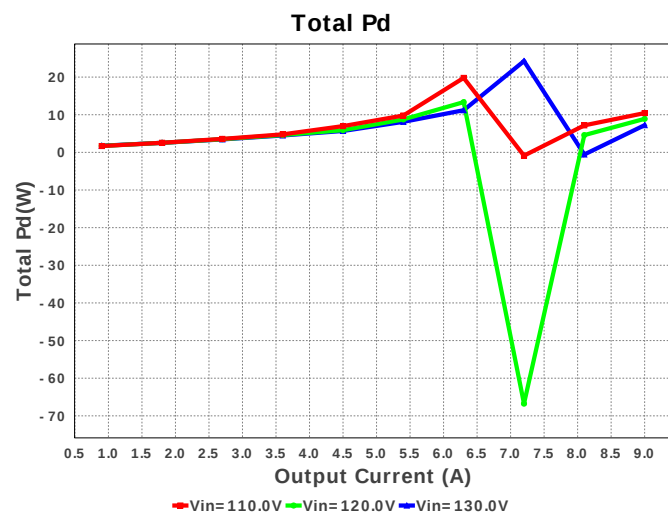


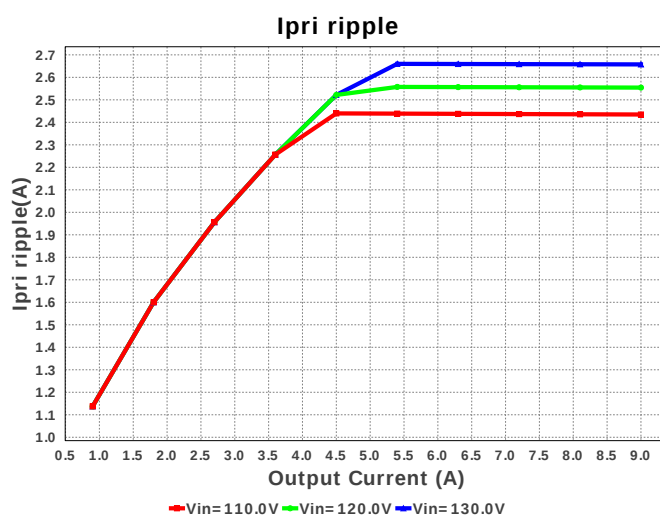
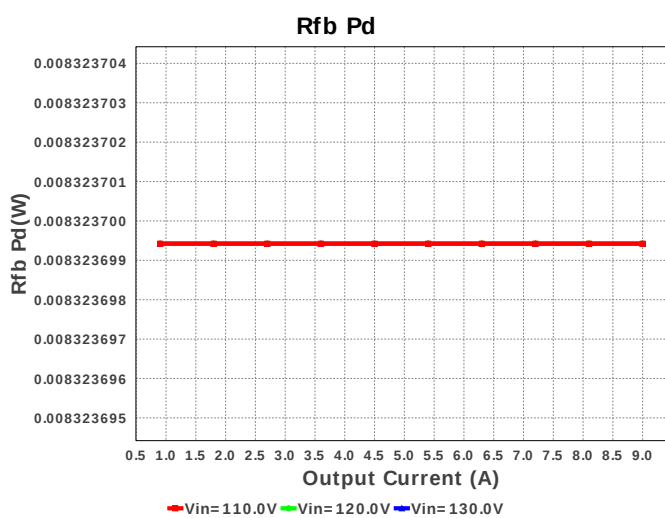
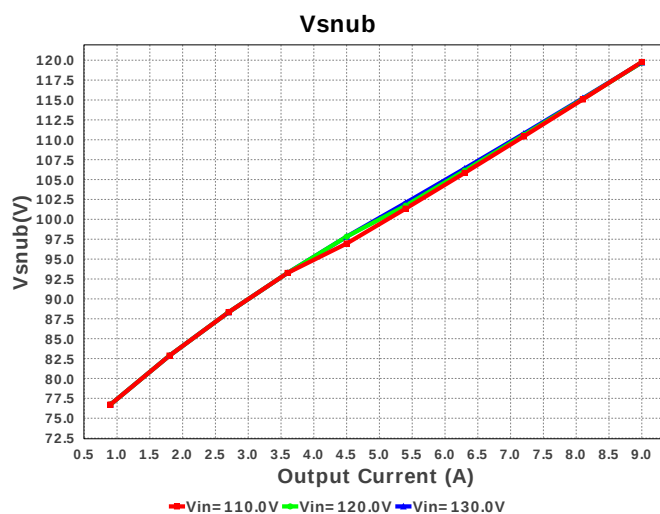
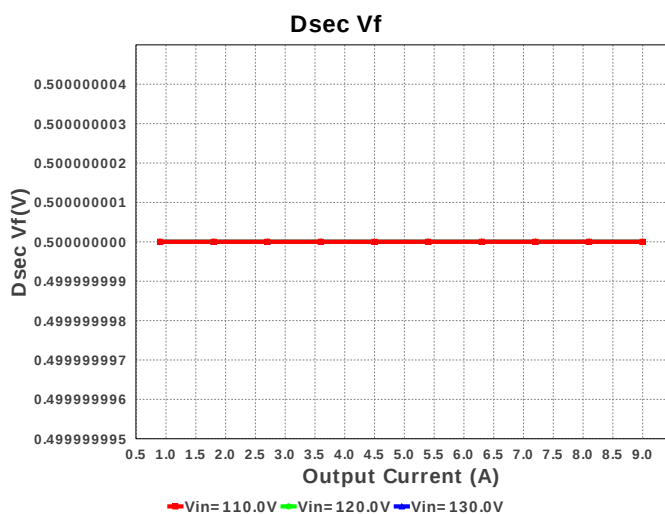
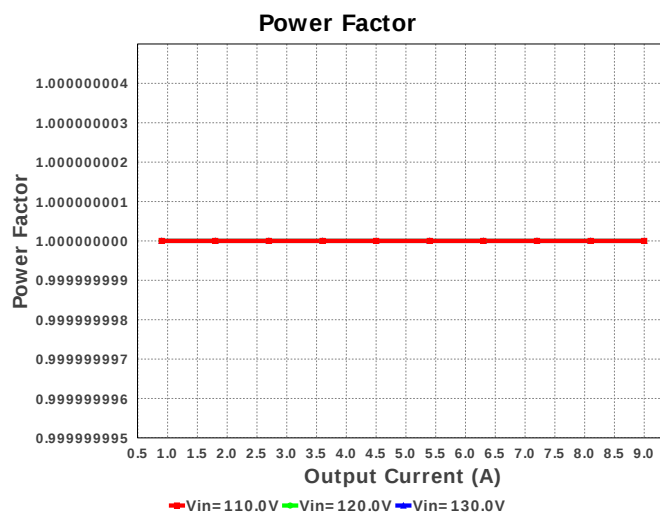
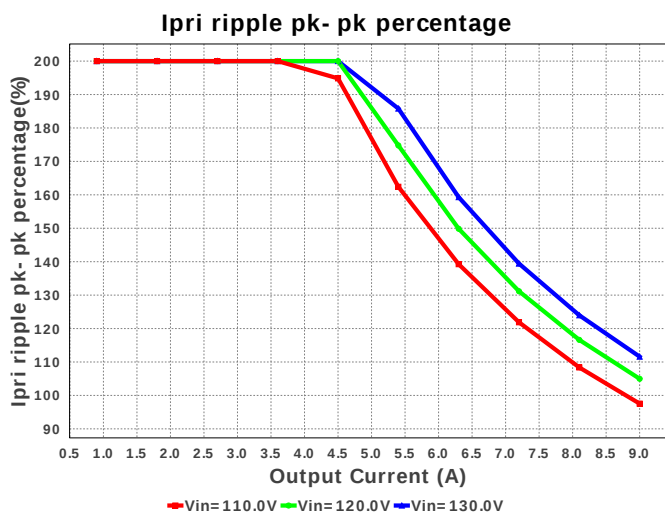


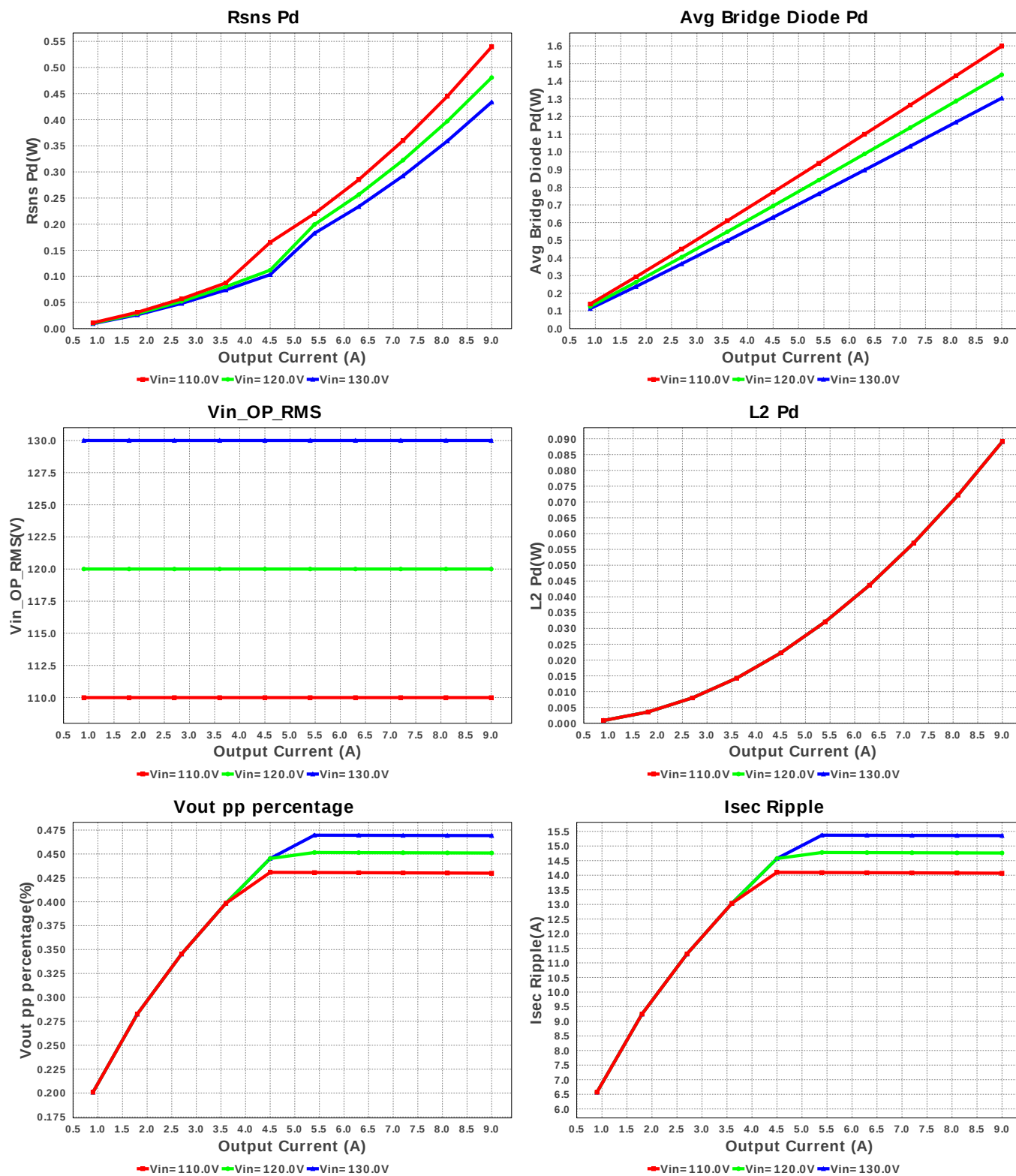


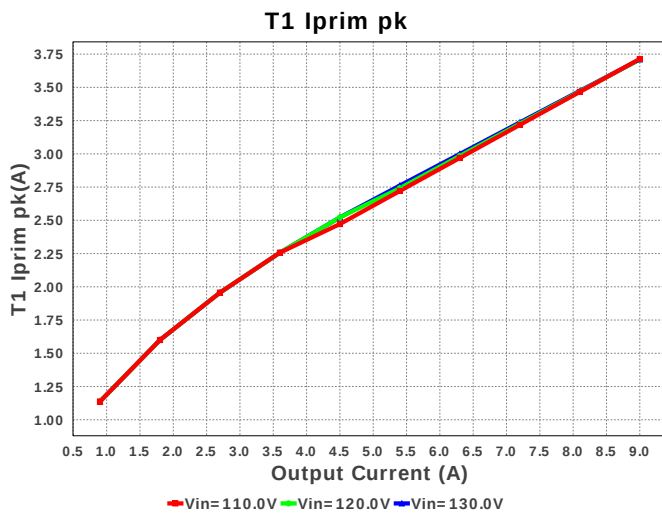
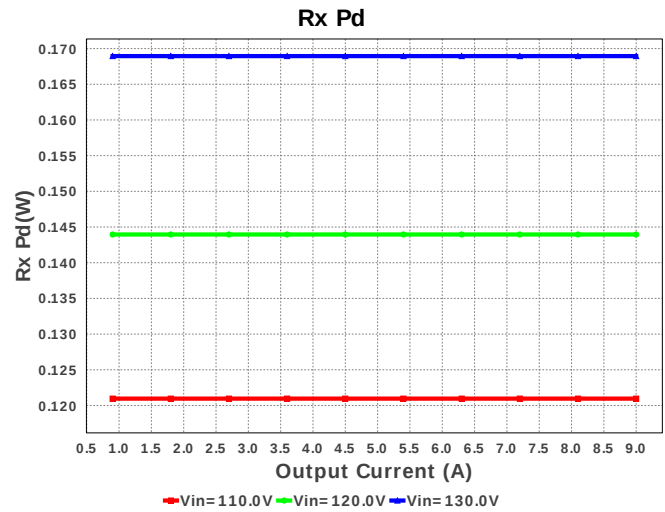
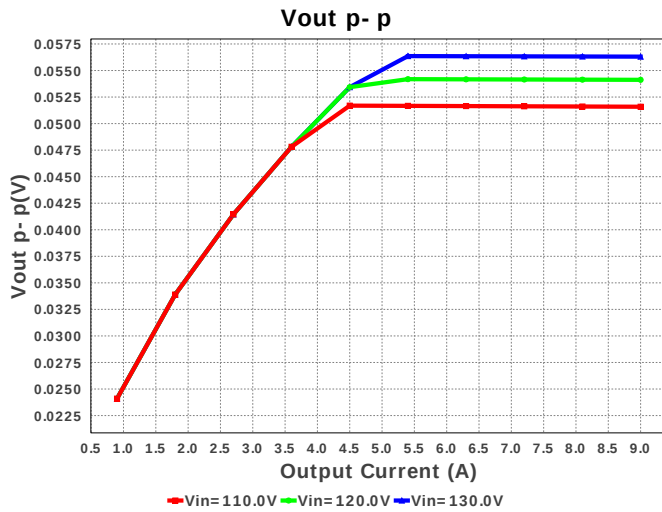












Operating Values

#	Name	Value	Category	Description
1.	Cout1 IRMS	7.311 A	Current	Output capacitor1 RMS ripple current
2.	Iin rms	1.077 A	Current	RMS Input Current
3.	Iout_DCM	4.476 A	Current	Approximate Current below which DCM mode of operation will begin
4.	Ipri Avg	1.001 A	Current	Average Current in Primary Winding over the complete Switching Period
5.	Ipri ripple	2.435 A	Current	Ripple Current in the Primary Winding
6.	Ipri ripple pk-pk percentage	97.547 %	Current	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
7.	Isec Ripple	14.069 A	Current	Ripple Current in the Secondary Winding
8.	T1 Iprim RMS	1.642 A	Current	Transformer Primary RMS Current
9.	T1 Iprim pk	3.713 A	Current	Transformer Primary Peak Current
10.	T1 Is1 RMS	11.595 A	Current	Transformer Secondary1 RMS Current
11.	T1 Is1 pk	21.458 A	Current	Transformer Secondary1 Peak Current
12.	AC Frequency	50.0 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	500.0 mV	General	Effective Forward Voltage Drop at the Operating Current
16.	Dsec trr	60.0 ns	General	Output Diode Reverse Recovery Time
17.	Dsec2 Vf	500.0 mV	General	Effective Forward Voltage Drop at the Operating Current
18.	Dsnub trr	35.0 ns	General	Snubber Diode Reverse Recovery Time
19.	FootPrint	5.913 k mm ²	General	Total Foot Print Area of BOM components
20.	Frequency	25.294 kHz	General	Switching frequency
21.	Mode	CCM	General	Conduction Mode
22.	Pout	108.0 W	General	Total output power
23.	Power Factor	1.0	General	Assumed Power Factor for the Application
24.	Tdead	0.0 ns	General	Approximate Dead Time of the Regulator
25.	Toff	24.67 us	General	Approximate Converter Off Time
26.	Ton Act	15.86 us	General	Approximate Converter On Time
27.	Total BOM	\$0.0	General	Total BOM Cost
28.	Tsw	39.535 us	General	Switching Time Period
29.	Vaux	14.004 V	General	Auxiliary Voltage

#	Name	Value	Category	Description
30.	Vsnub	119.777 V	General	Voltage Across the Snubber
31.	Vout Actual	11.99 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
32.	Vout OP	12.0 V	Op_Point	Operational Output Voltage
33.	Duty Cycle	40.116 %	Op_point	Duty cycle
34.	Efficiency	91.188 %	Op_point	Steady state efficiency
35.	IC Tj	32.249 degC	Op_point	IC junction temperature
36.	ICThetaJA	50.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
37.	IOUT_OP	9.0 A	Op_point	Iout operating point
38.	M1 TJOP	-227.973 degC	Op_point	M1 MOSFET junction temperature
39.	Peak Rectified Vin	155.562 V	Op_point	Peak voltage seen at rectified input
40.	Vin_OP_RMS	110.0 V	Op_point	AC Input RMS Voltage
41.	Vout p-p	51.588 mV	Op_point	Peak-to-peak output ripple voltage
42.	Avg Bridge Diode Pd	1.599 W	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
43.	Cbulk Pd	2.791 W	Power	Bulk capacitor power dissipation
44.	Cout1 Pd	195.996 mW	Power	Output capacitor1 power dissipation
45.	Cx Pd	0.0 W	Power	X-cap Power Dissipation
46.	Cy Pd	187.5 pW	Power	Y-caps Power Dissipation
47.	Dsec Pd	2.25 W	Power	Secondary Diode Power Dissipation
48.	Dsec2 Pd	2.25 W	Power	Secondary Diode Power Dissipation
49.	IC Pd	44.984 mW	Power	IC power dissipation
50.	L1 Pd	583.801 mW	Power	Power Dissipation in the Inductor
51.	L2 Pd	89.1 mW	Power	Average Power Dissipation in the Inductor Over the AC Line Period
52.	M1 Pd	-3.108 W	Power	M1 MOSFET total power dissipation
53.	Paux	10.895 mW	Power	Power Dissipation in Raux and Daux
54.	Pd Rstartup	180.142 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
55.	Rdrv Pd	749.489 nW	Power	Power Dissipation in Gate Drive Resistor
56.	Rfb Pd	8.324 mW	Power	Rfb Power Dissipation
57.	Rsns Pd	539.507 mW	Power	Current Limit Sense Resistor Power Dissipation
58.	Rx Pd	120.961 mW	Power	Total Power Dissipation in Rx1 and Rx2
59.	Snubber Pd	1.467 W	Power	Snubber Power Dissipation
60.	T1 Pd	7.006 W	Power	Estimated Losses in Transformer
61.	Total Pd	10.437 W	Power	Total Power Dissipation
62.	Vout Tolerance	1.926 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
63.	Vout pp percentage	429.899 m%		Output Voltage ripple percentage

Design Inputs

#	Name	Value	Description
1.	Iout	9.0	Maximum Output Current
2.	VinMax	130.0	Maximum input voltage
3.	VinMin	110.0	Minimum input voltage
4.	Vout	12.0	Output Voltage
5.	line_fsw	50.0	Light Output in Lumen
6.	base_pn	UCC28C44	Base Product Number
7.	source	AC	Input Source Type
8.	Ta	30.0	Ambient temperature

Design Assistance

1. **UCC28C44** Product Folder : <http://www.ti.com/product/UCC28C44> : contains the data sheet and other resources.

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