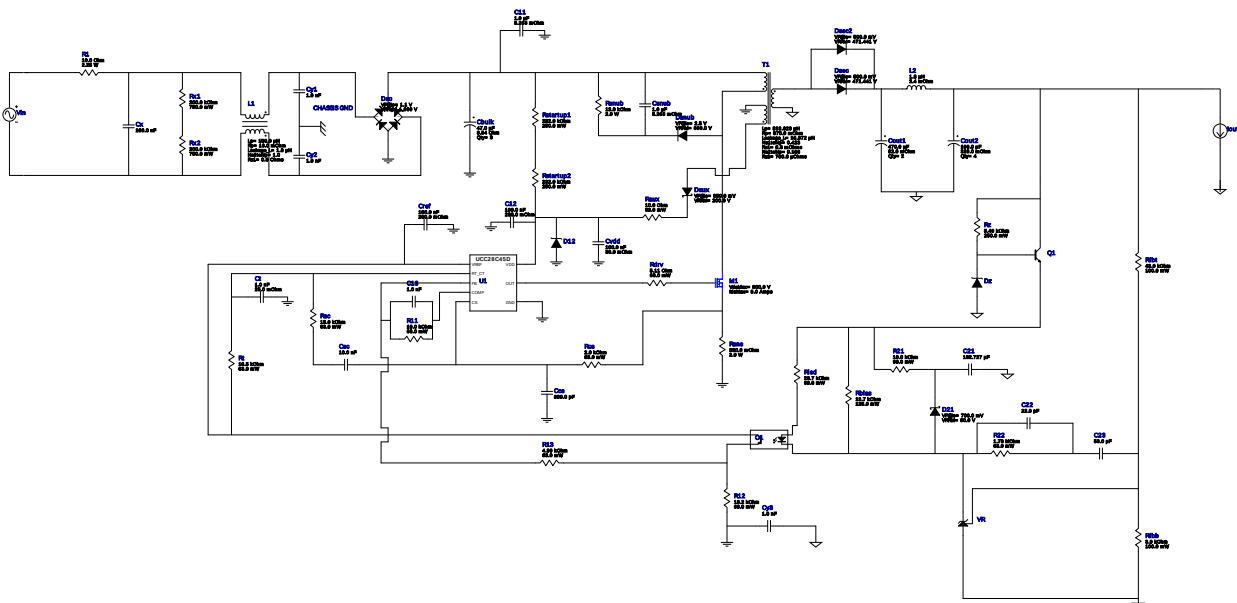


WEBENCH® Design Report

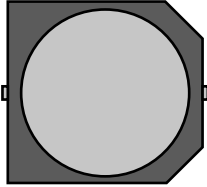
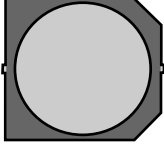
Design : 4178018/29 UCC28C45DR
UCC28C45DR 110.0V-265.0V to 30.00V @ 2.2A

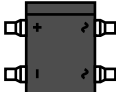
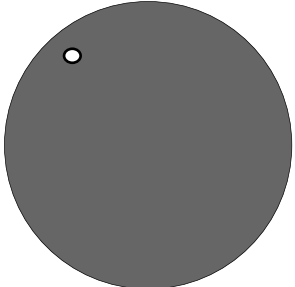


1. The EMI filter selected here contains the estimated values. The real numbers will depend on the attenuation needed at a particular frequency.

Electrical BOM

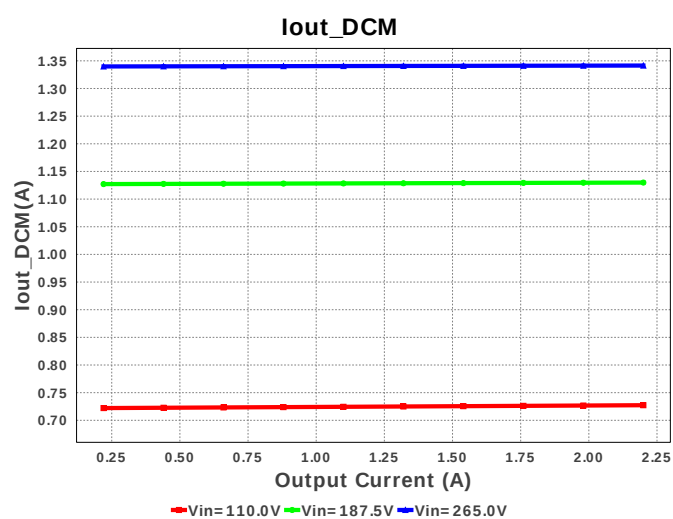
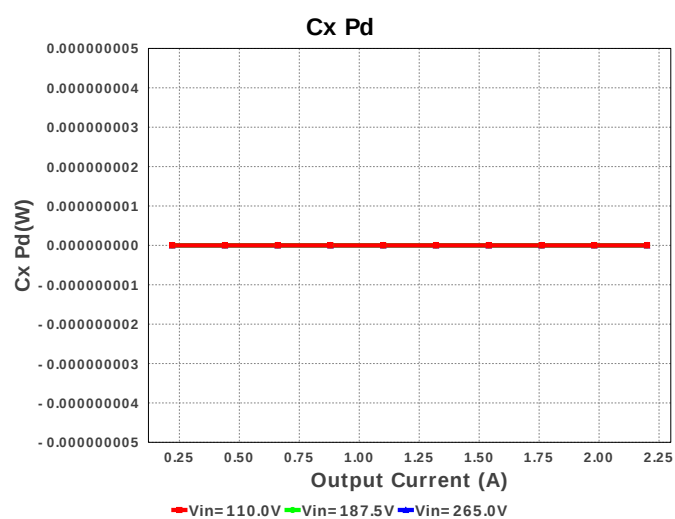
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	C11	TDK	C5750X6S2W105K Series= X6S	Cap= 1.0 uF ESR= 5.263 mOhm VDC= 400.0 V IRMS= 0.0 A	1	\$1.19	 2220 54 mm ²
2.	C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	\$0.01	 0805 7 mm ²
3.	C13	Samsung 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= 182.727 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	CC0805JRNPO9BN560 Series= C0G/NP0	Cap= 56.0 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	3	\$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

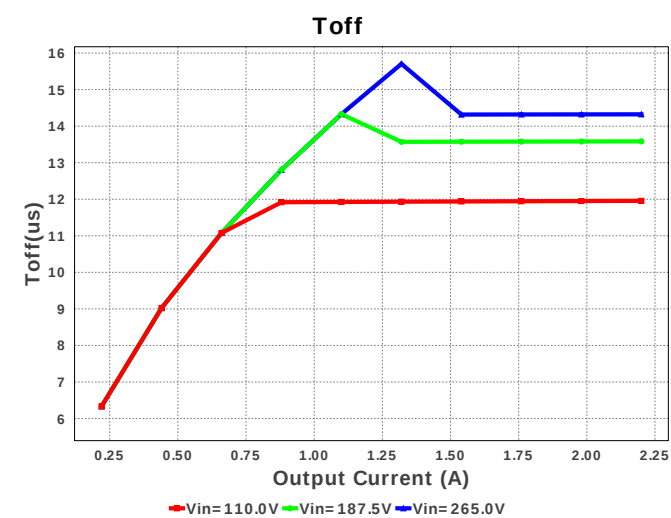
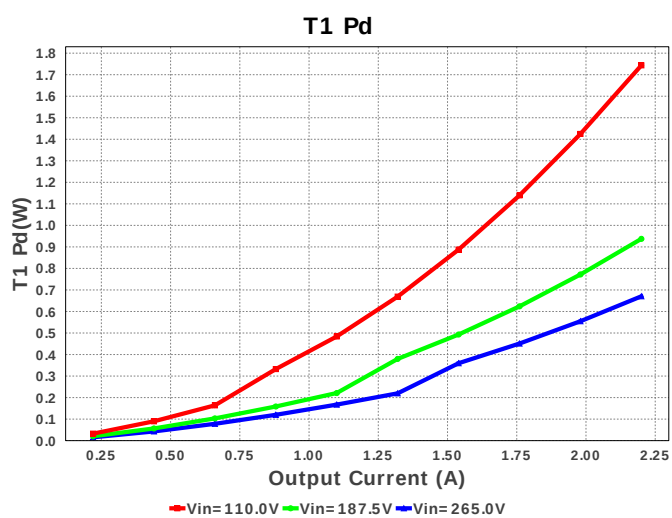
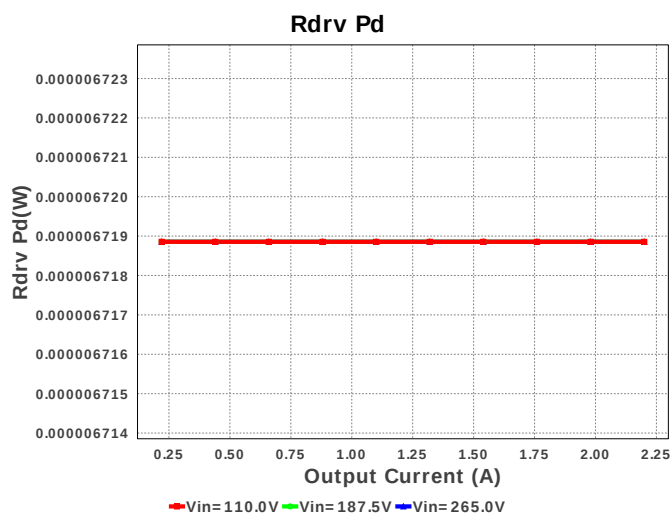
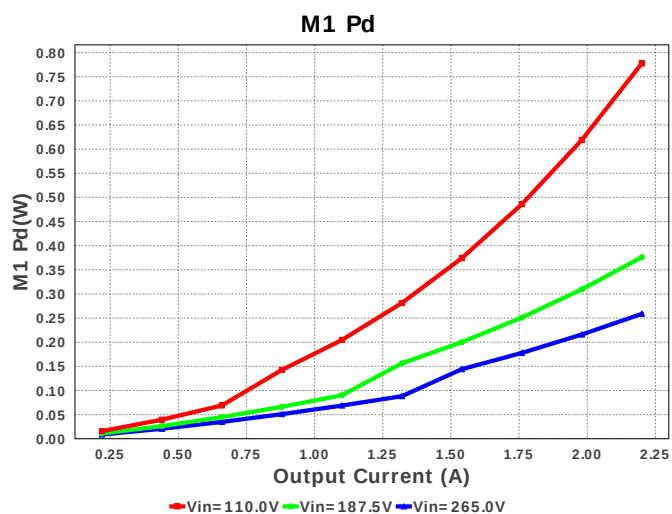
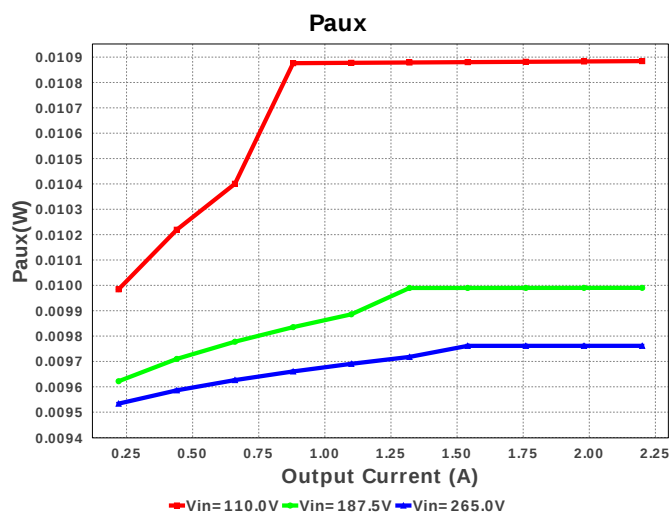
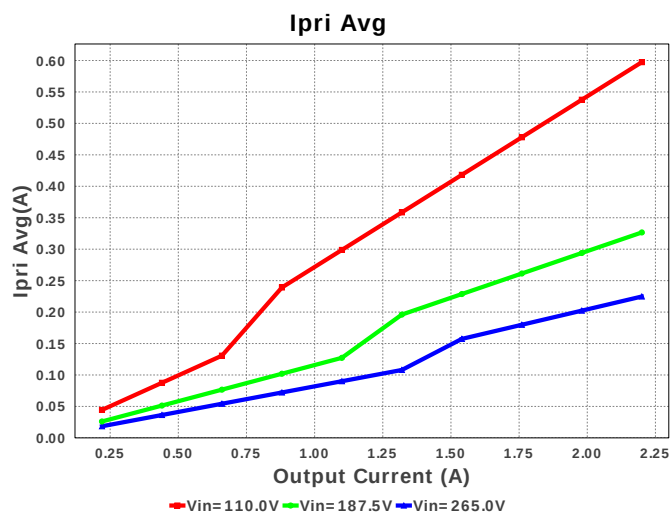
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9.	Cout1	Panasonic	EEV-FK1J471M Series= FK	Cap= 470.0 uF ESR= 82.0 mOhm VDC= 63.0 V IRMS= 1.41 A	2	\$0.78	 SM_RADIAL_J16 399 mm ²
10.	Cout2	Panasonic	EEV-FK1K101Q Series= FK	Cap= 100.0 uF ESR= 320.0 mOhm VDC= 80.0 V IRMS= 500.0 mA	4	\$0.45	 SM_RADIAL_H13 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	C5750X6S2W105K Series= X6S	Cap= 1.0 uF ESR= 5.263 mOhm VDC= 400.0 V IRMS= 0.0 A	1	\$1.19	 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	GRM188R71E104KA01D Series= X7R	Cap= 100.0 nF ESR= 30.0 mOhm VDC= 25.0 V IRMS= 1.51 A	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	TDK	B81123C1102M Series= B81123	Cap= 1.0 nF VDC= 3.0 kV IRMS= 0.0 A	1	\$0.22	 B81123_1800x500x1050 140 mm ²
18.	Cy2	TDK	B81123C1102M Series= B81123	Cap= 1.0 nF VDC= 3.0 kV IRMS= 0.0 A	1	\$0.22	 B81123_1800x500x1050 140 mm ²

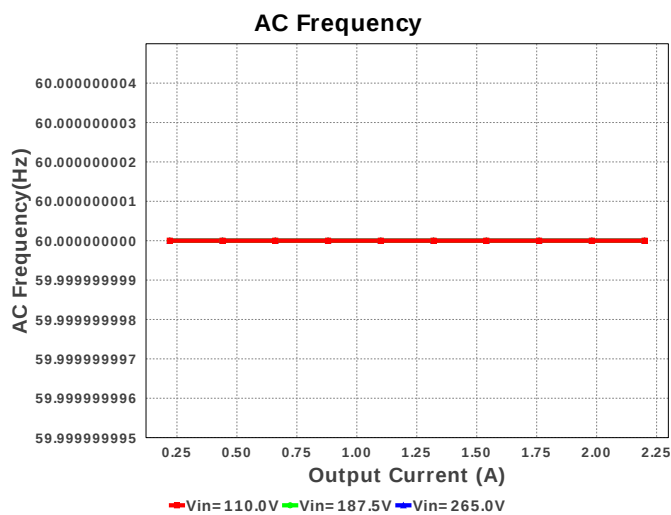
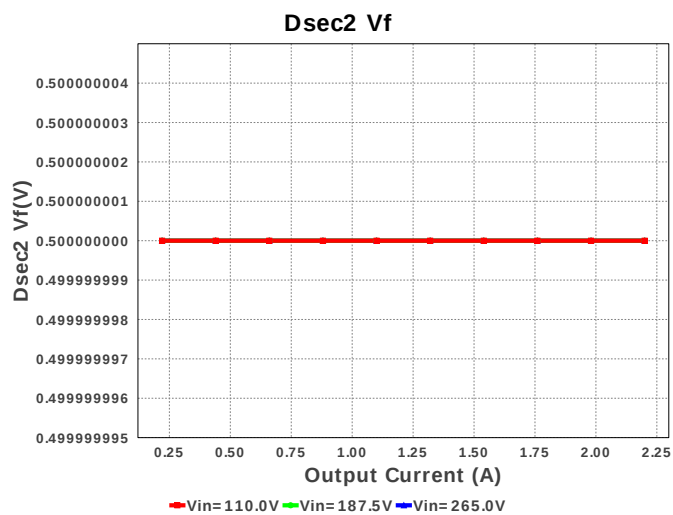
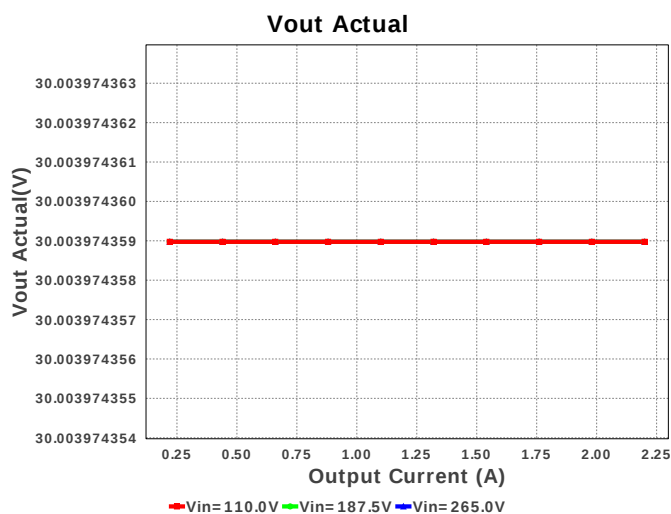
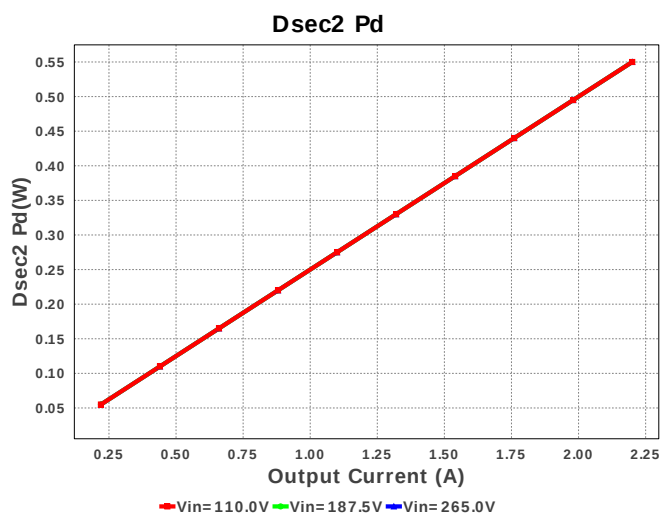
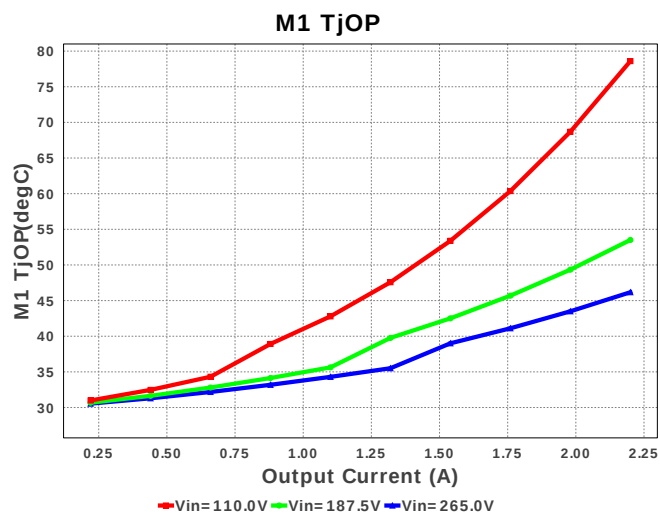
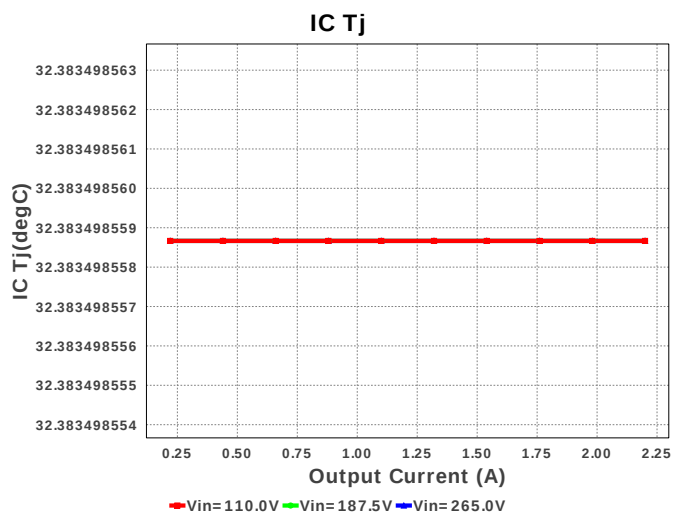
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
19.	Cy3	TDK	B81123C1102M Series= B81123	Cap= 1.0 nF VDC= 3.0 kV IRMS= 0.0 A	1	\$0.22	 B81123_1800x500x1050 140 mm ²
20.	D12	Diodes Inc.	MMSZ5248B-7-F	Zener	1	\$0.04	 SOD-123 13 mm ²
21.	D21	Diodes Inc.	B260A-13-F	VF@Io= 700.0 mV VRRM= 60.0 V	1	\$0.09	 SMA 37 mm ²
22.	Dac	Vishay-Semiconductor	DF10SA	VF@Io= 1.1 V VRRM= 1,000.0 V	1	\$0.24	 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= 471.441 V	1	NA	CUSTOM 0 mm ²
25.	Dsec2	CUSTOM	CUSTOM	VF@Io= 500.0 mV VRRM= 471.441 V	1	NA	CUSTOM 0 mm ²
26.	Dsnub	Bourns	CD1408-FU1800	VF@Io= 2.5 V VRRM= 800.0 V	1	\$0.13	 Diode_1408 13 mm ²
27.	Dz	Diodes Inc.	MMSZ5250B-7-F	Zener	1	\$0.03	 SOD-123 13 mm ²
28.	L1	API Delevan	CM6296R-154	Lp= 150.0 µH Rp= 16.0 mOhm Leakage_L= 1.8 µH Ns1toNp= 1.0 Rs1= 0.0 Ohms	1	\$5.95	 CM6296 833 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	STF10N80K5	VdsMax= 800.0 V IdsMax= 9.0 Amps	1	\$2.52	 TO-220FP 79 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

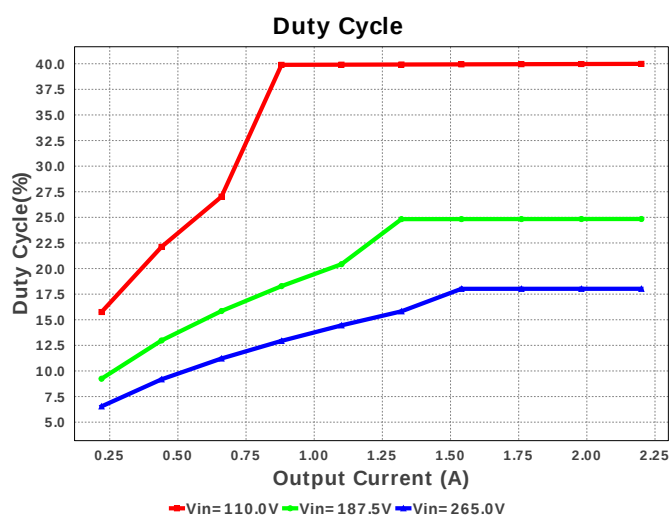
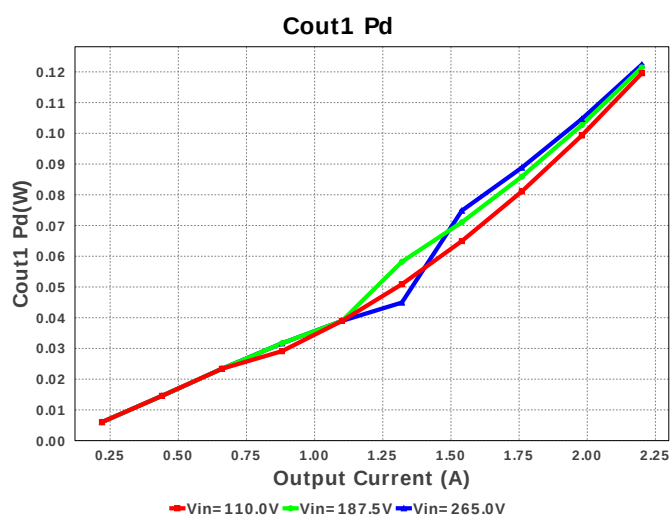
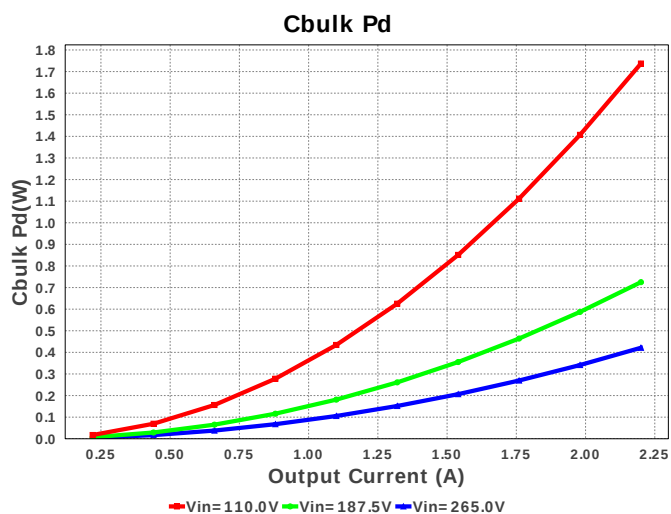
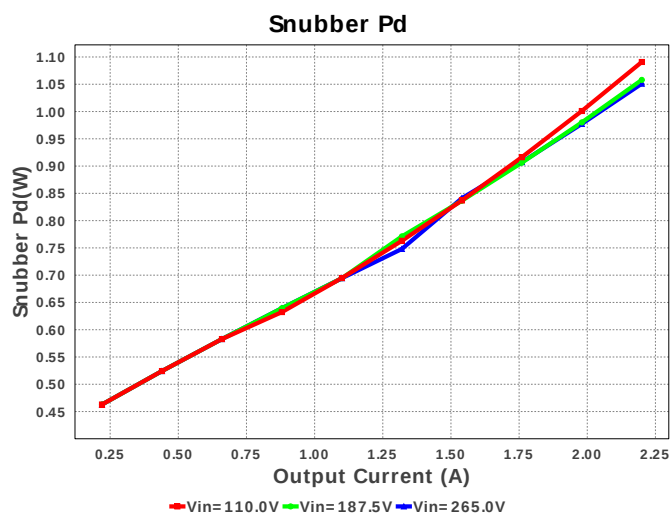
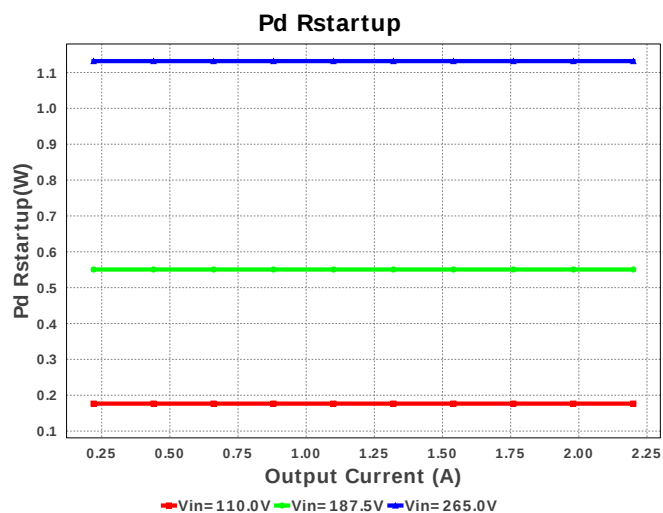
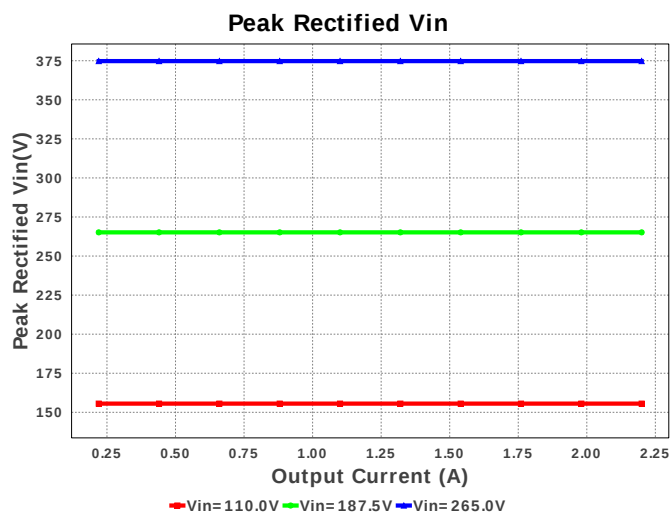
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34.	R11	Vishay-Dale	CRCW040210K0FKED Series= CRCW..e3	Res= 10.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
35.	R12	Vishay-Dale	CRCW040218K2FKED Series= CRCW..e3	Res= 18.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
36.	R13	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	CRCW04021M78FKED Series= CRCW..e3	Res= 1.78 MOhm 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
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-073K9L Series= ?	Res= 3.9 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm²
44.	Rfbt	Yageo America	RC0603FR-0743KL Series= ?	Res= 43.0 kOhm Power= 100.0 mW Tolerance= 1.0%	1	\$0.01	 0603 5 mm²
45.	Rled	Vishay-Dale	CRCW040226K7FKED Series= CRCW..e3	Res= 26.7 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
46.	Rsc	Vishay-Dale	CRCW040213K0FKED Series= CRCW..e3	Res= 13.0 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.	Rsnu	Vishay-Bcomponents	PR02000201302JR500 Series= ?	Res= 13.0 kOhm Power= 2.0 W Tolerance= 5.0%	1	\$0.05	PR02 113 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	CRCW040216K5FKED Series= CRCW..e3	Res= 16.5 kOhm Power= 63.0 mW Tolerance= 1.0%	1	\$0.01	 0402 3 mm²
52.	Rx1	Vishay-Semiconductor	CRCW2010200KFKEF Series= ?	Res= 200.0 kOhm Power= 750.0 mW Tolerance= 1.0%	1	\$0.03	 2010 32 mm²
53.	Rx2	Vishay-Semiconductor	CRCW2010200KFKEF Series= ?	Res= 200.0 kOhm Power= 750.0 mW Tolerance= 1.0%	1	\$0.03	 2010 32 mm²

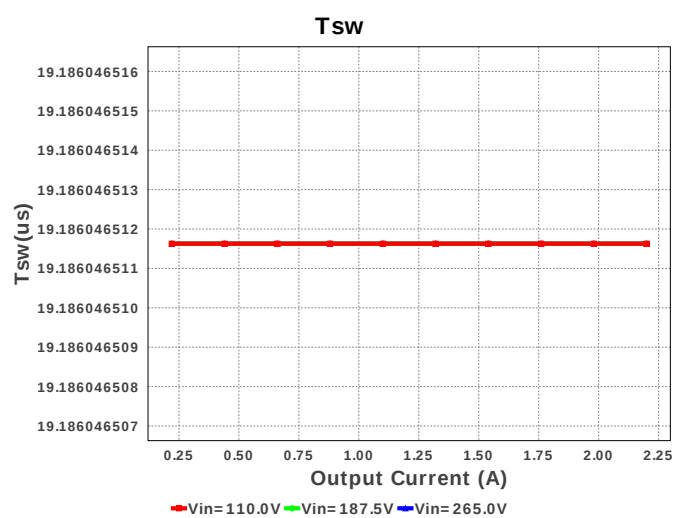
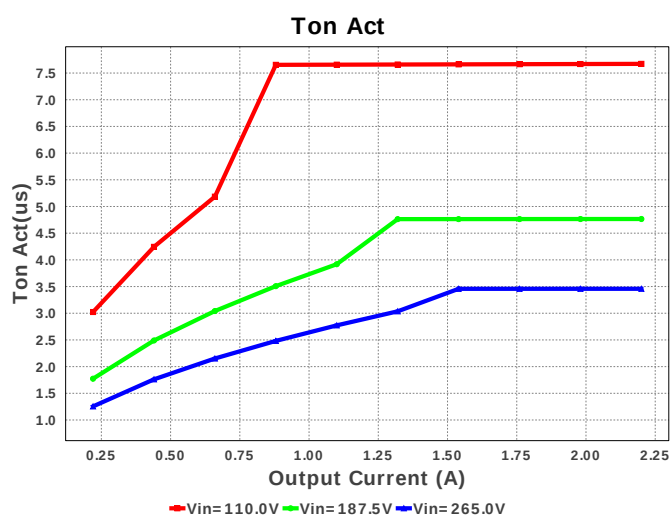
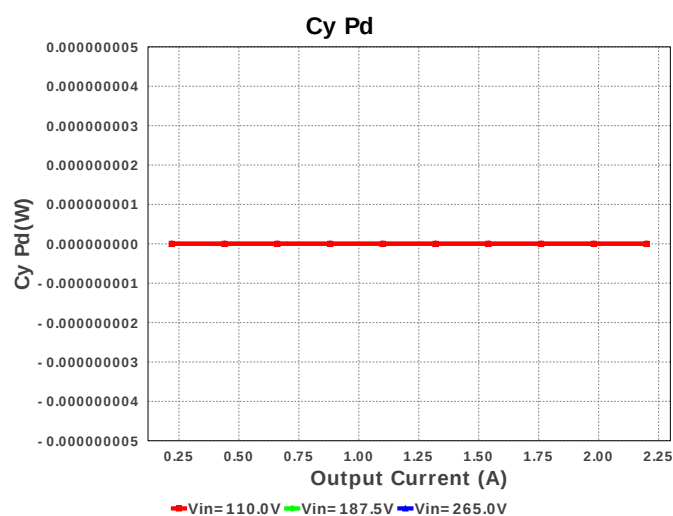
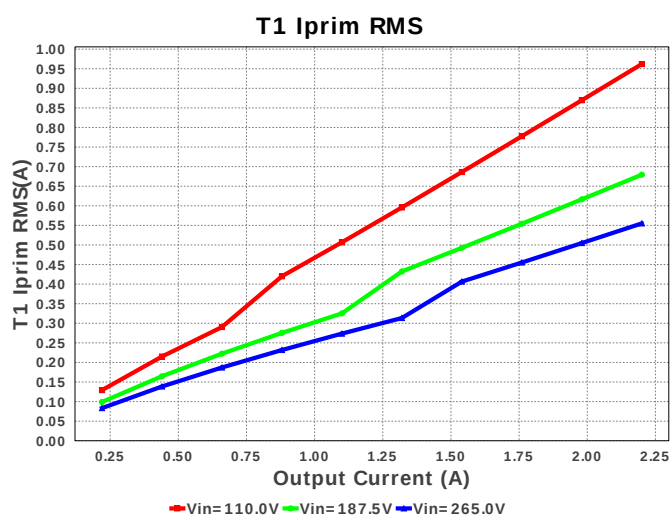
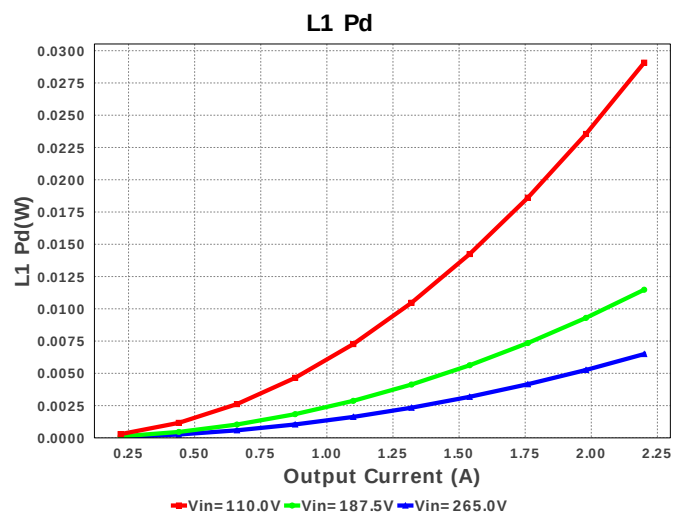
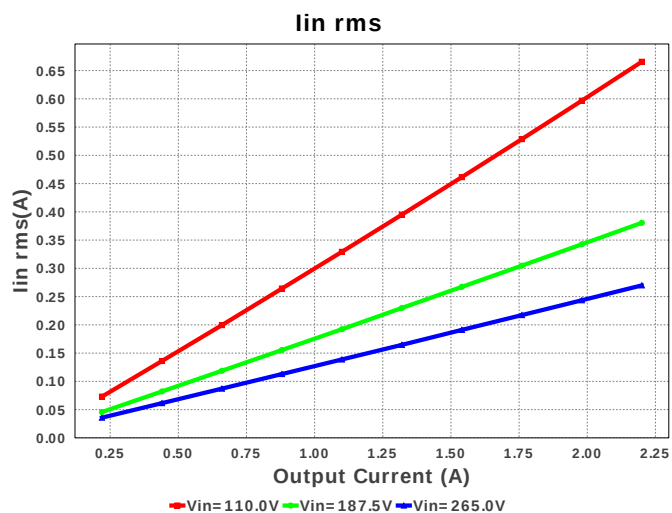
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
54.	Rz	Panasonic	ERJ-8ENF5491V Series= ERJ-8E	Res= 5.49 kOhm Power= 250.0 mW Tolerance= 1.0%	1	\$0.01	 1206 11 mm ²
55.	T1	CUSTOM	CUSTOM	Lp= 833.623 μH Rp= 870.0 mOhm Leakage_L= 16.672 μH Ns1toNp= 0.423 Rs1= 8.6 mOhms Ns2toNp= 0.166 Rs2= 700.0 μOhms	1	NA	CUSTOM 0 mm ²
56.	U1	Texas Instruments	UCC28C45DR	Switcher	1	\$0.60	
57.	VR	Texas Instruments	TL431AIDBZR	Voltage References	1	\$0.08	 D0008A 57 mm ² DBZ0003A 14 mm ²

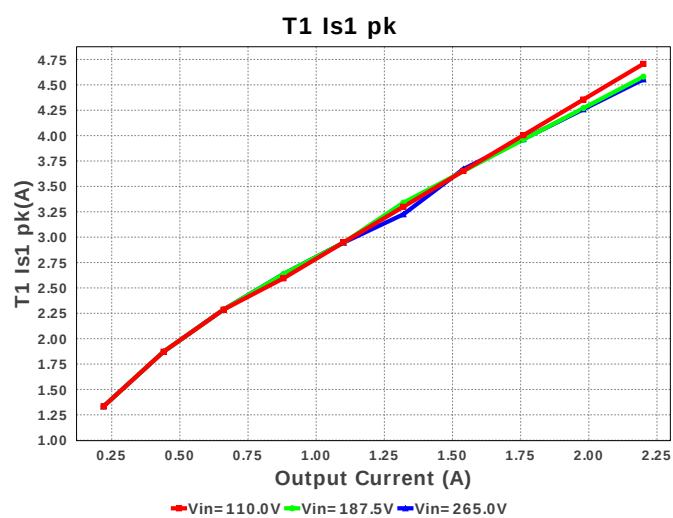
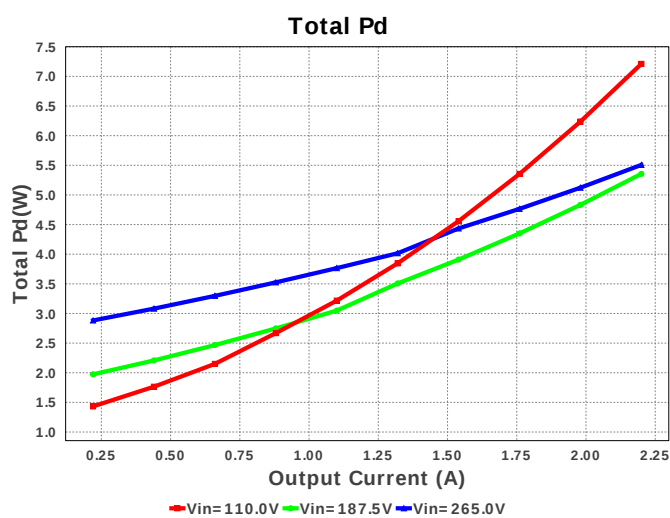
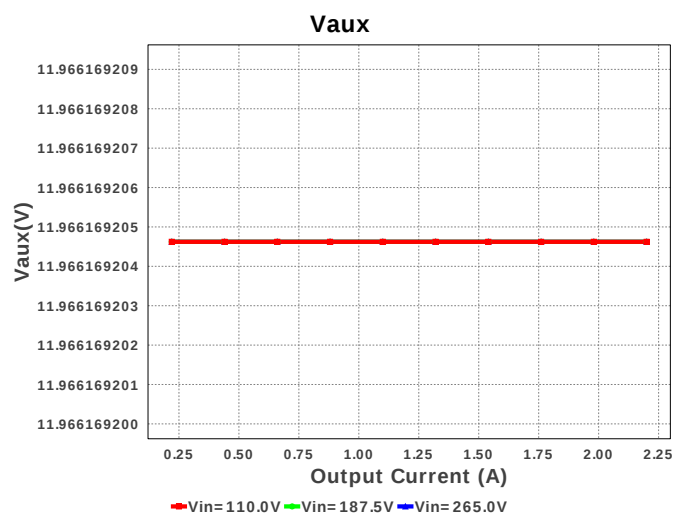
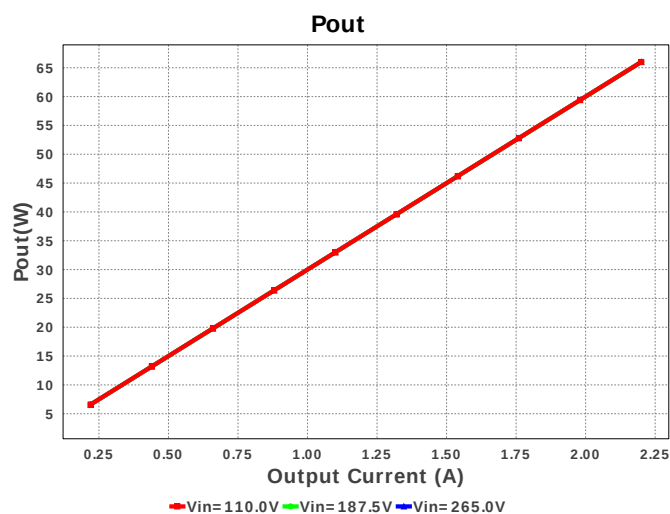
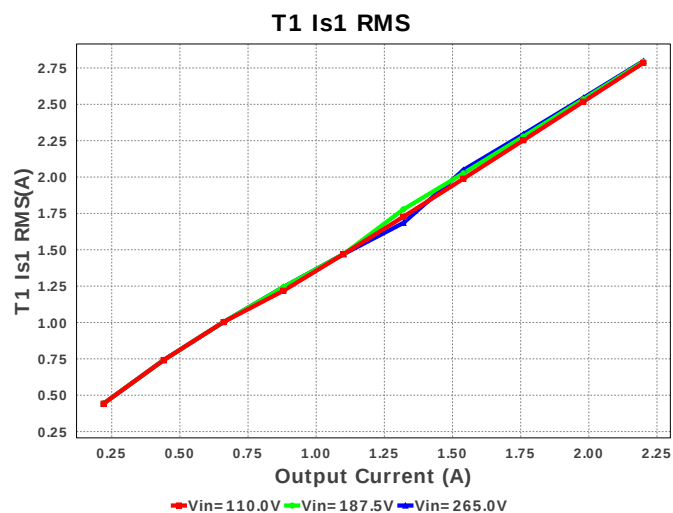
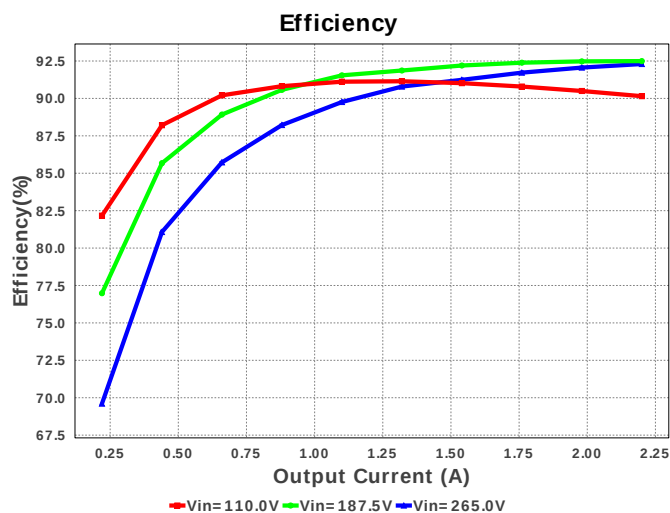


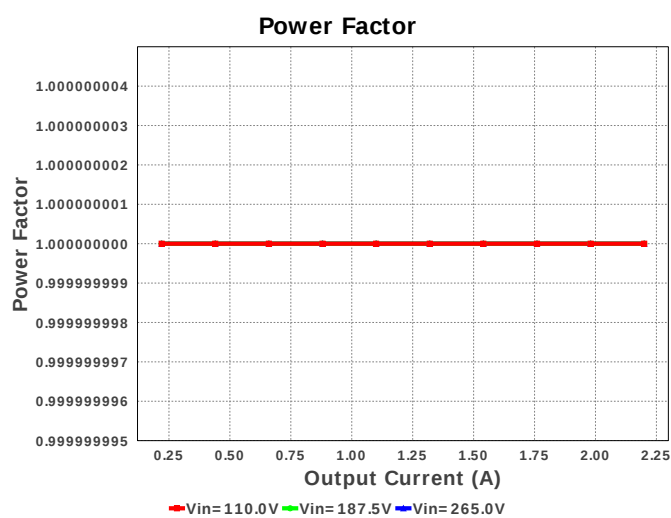
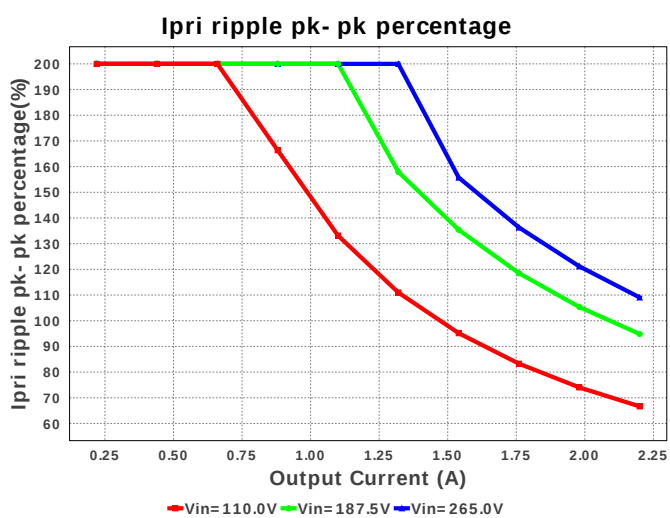
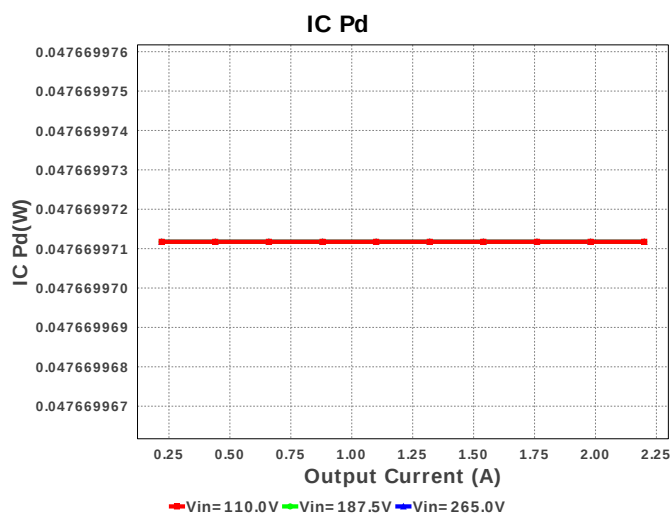
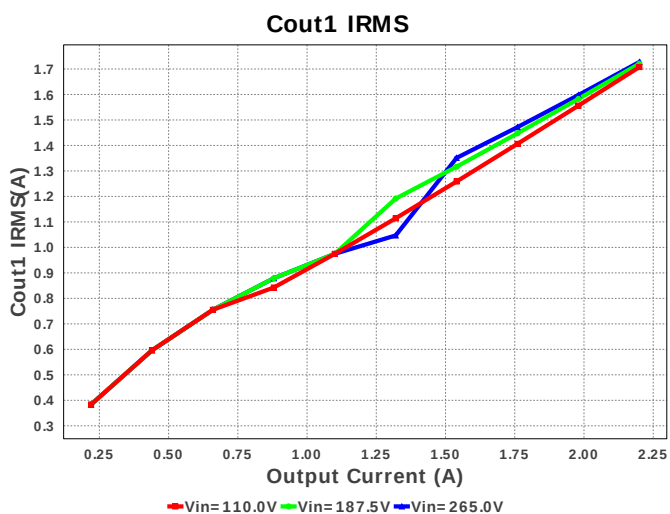
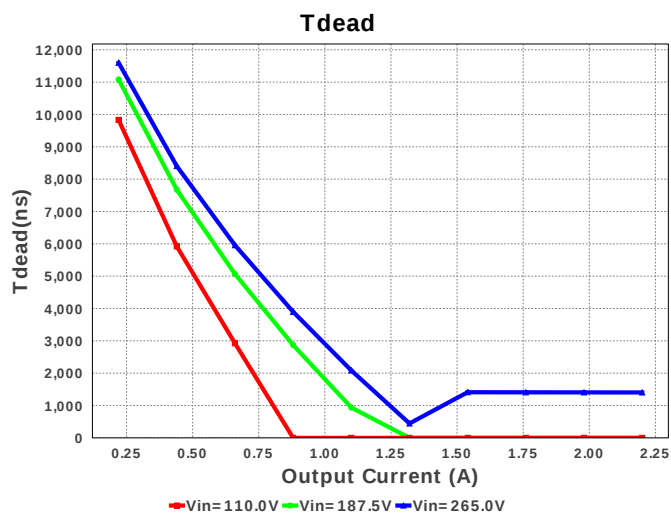
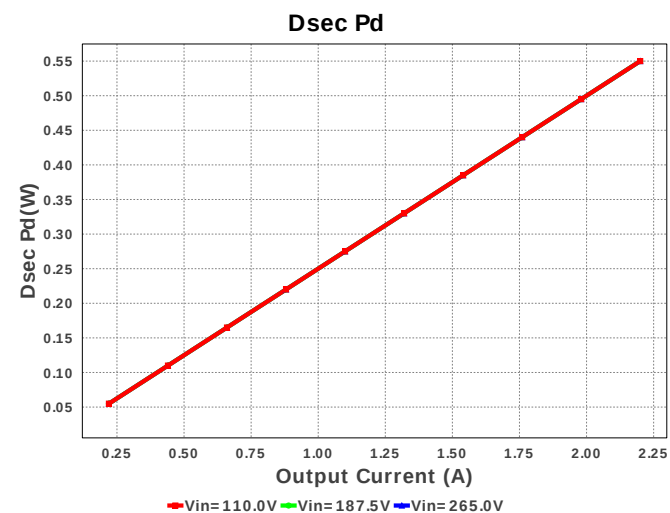


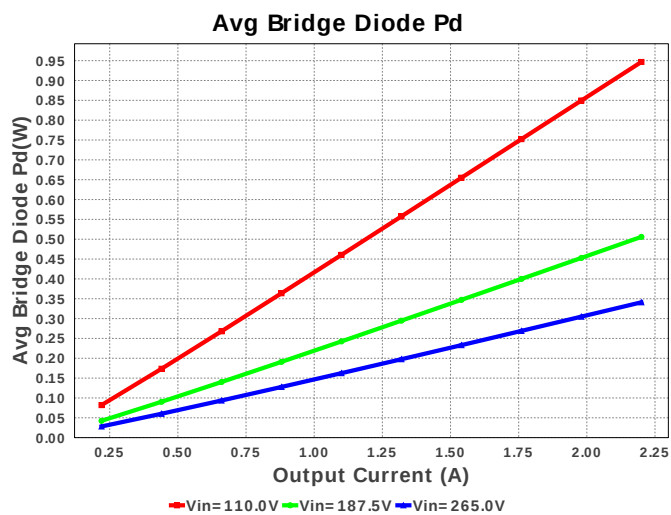
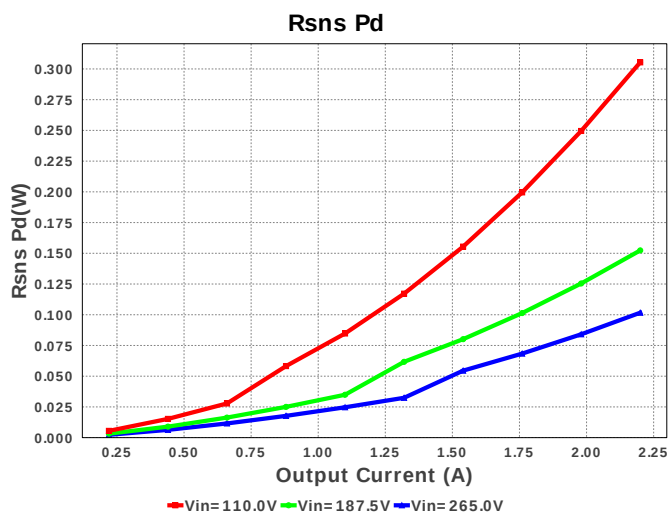
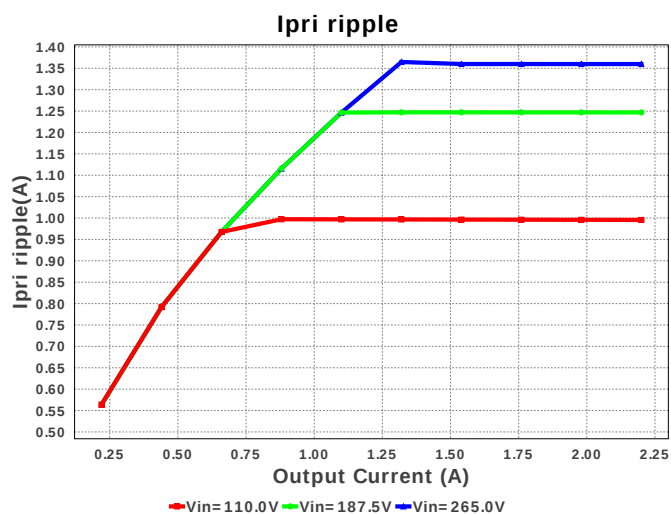
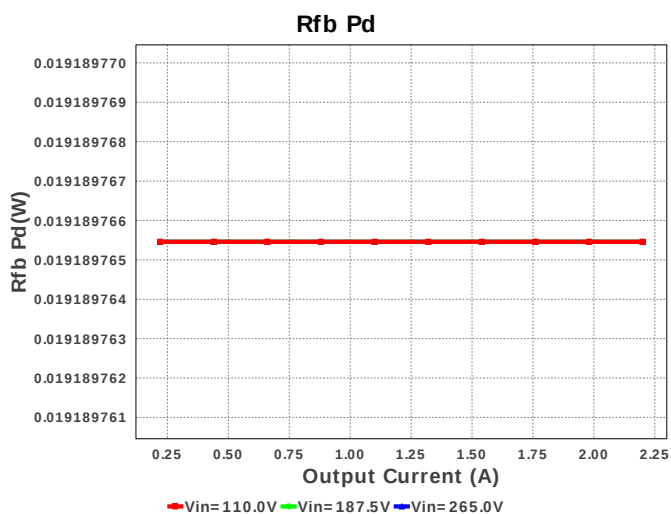
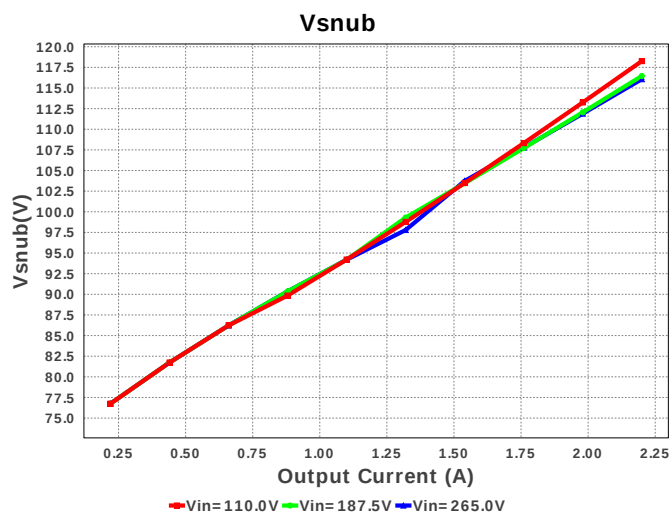
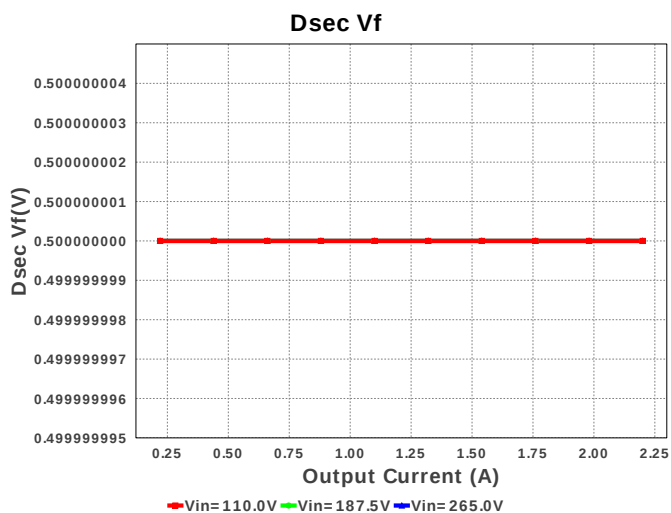


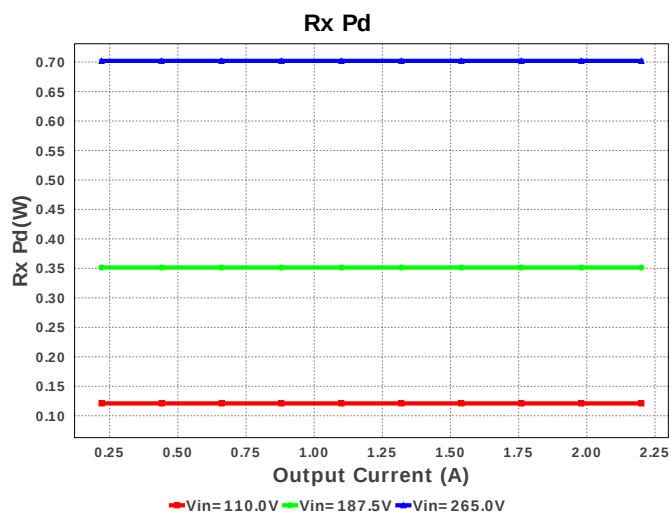
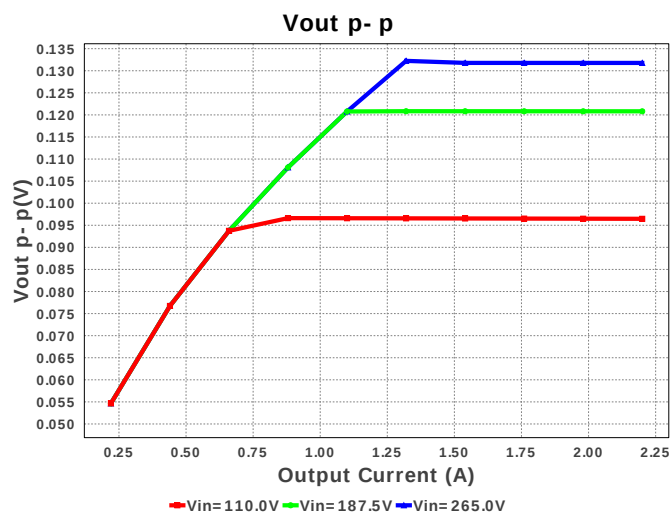
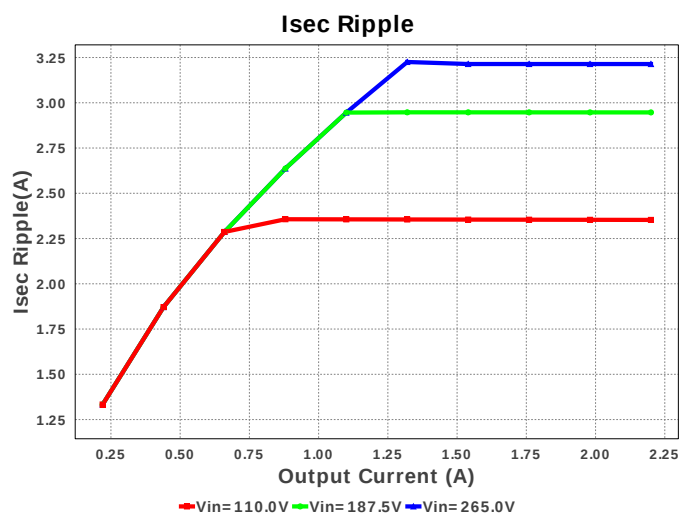
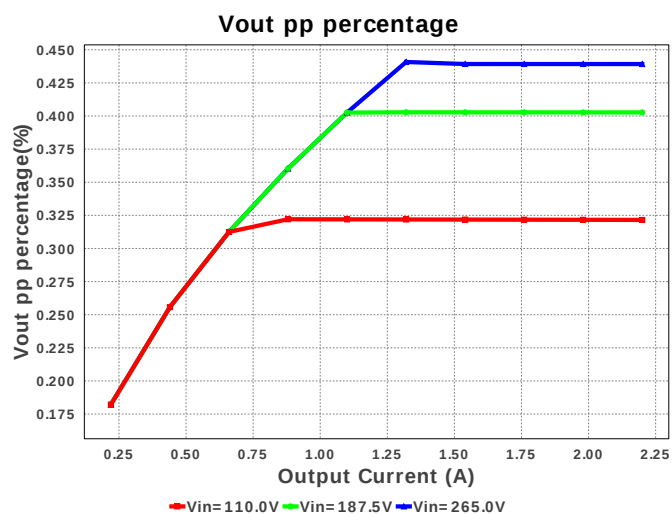
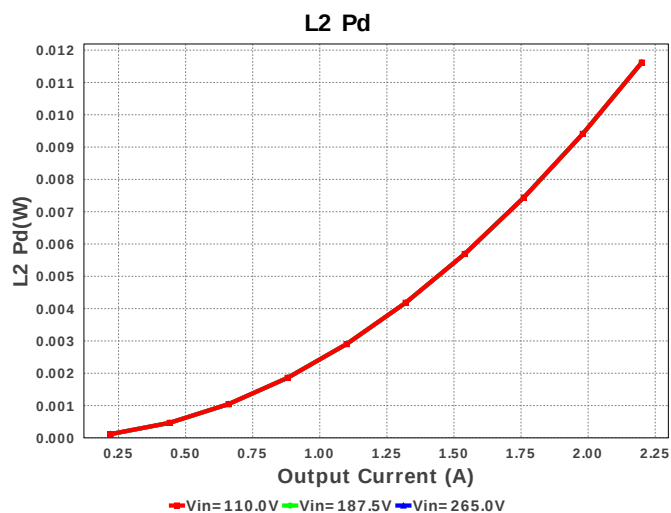
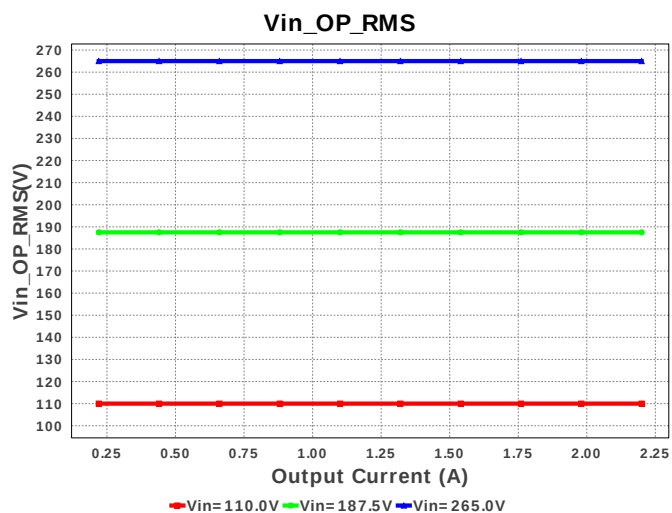


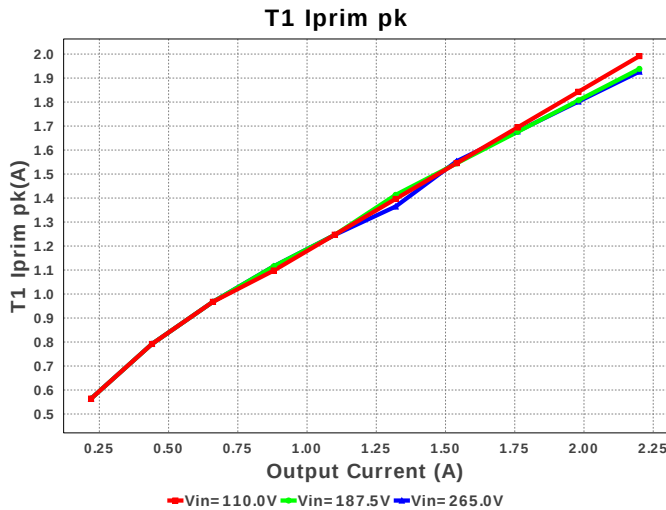












Operating Values

#	Name	Value	Category	Description
1.	Cout1 IRMS	1.708 A	Current	Output capacitor1 RMS ripple current
2.	Iin rms	665.56 mA	Current	RMS Input Current
3.	Iout_DCM	727.307 mA	Current	Approximate Current below which DCM mode of operation will begin
4.	Ipri Avg	597.329 mA	Current	Average Current in Primary Winding over the complete Switching Period
5.	Ipri ripple	995.576 mA	Current	Ripple Current in the Primary Winding
6.	Ipri ripple pk-pk percentage	66.648 %	Current	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
7.	Isec Ripple	2.353 A	Current	Ripple Current in the Secondary Winding
8.	T1 Iprim RMS	961.93 mA	Current	Transformer Primary RMS Current
9.	T1 Iprim pk	1.992 A	Current	Transformer Primary Peak Current
10.	T1 Is1 RMS	2.785 A	Current	Transformer Secondary1 RMS Current
11.	T1 Is1 pk	4.707 A	Current	Transformer Secondary1 Peak Current
12.	AC Frequency	60.0 Hz	General	Input AC frequency
13.	BOM Count	63	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	6.327 k mm ²	General	Total Foot Print Area of BOM components
20.	Frequency	52.121 kHz	General	Switching frequency
21.	Mode	CCM	General	Conduction Mode
22.	Pout	66.0 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	11.956 us	General	Approximate Converter Off Time
26.	Ton Act	7.672 us	General	Approximate Converter On Time
27.	Total BOM	\$0.0	General	Total BOM Cost
28.	Tsw	19.186 us	General	Switching Time Period
29.	Vaux	11.966 V	General	Auxiliary Voltage
30.	Vsnub	118.26 V	General	Voltage Across the Snubber
31.	Vout Actual	30.004 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
32.	Vout OP	30.0 V	Op_Point	Operational Output Voltage
33.	Duty Cycle	39.988 %	Op_point	Duty cycle
34.	Efficiency	90.15 %	Op_point	Steady state efficiency
35.	IC Tj	32.383 degC	Op_point	IC junction temperature
36.	ICThetaJA	50.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
37.	IOUT_OP	2.2 A	Op_point	Iout operating point
38.	M1 TJOP	78.598 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	96.466 mV	Op_point	Peak-to-peak output ripple voltage
42.	Avg Bridge Diode Pd	946.674 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
43.	Cbulk Pd	1.737 W	Power	Bulk capacitor power dissipation
44.	Cout1 Pd	119.556 mW	Power	Output capacitor1 power dissipation
45.	Cx Pd	0.0 W	Power	X-cap Power Dissipation
46.	Cy Pd	0.0 W	Power	Y-caps Power Dissipation
47.	Dsec Pd	550.0 mW	Power	Secondary Diode Power Dissipation
48.	Dsec2 Pd	550.0 mW	Power	Secondary Diode Power Dissipation
49.	IC Pd	47.67 mW	Power	IC power dissipation
50.	L1 Pd	29.07 mW	Power	Power Dissipation in the Inductor

#	Name	Value	Category	Description
51.	L2 Pd	11.616 mW	Power	Average Power Dissipation in the Inductor Over the AC Line Period
52.	M1 Pd	777.561 mW	Power	M1 MOSFET total power dissipation
53.	Paux	10.884 mW	Power	Power Dissipation in Raux and Daux
54.	Pd Rstartup	176.594 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
55.	Rdrv Pd	6.719 μ W	Power	Power Dissipation in Gate Drive Resistor
56.	Rfb Pd	19.19 mW	Power	Rfb Power Dissipation
57.	Rsns Pd	305.352 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	1.091 W	Power	Snubber Power Dissipation
60.	T1 Pd	1.743 W	Power	Estimated Losses in Transformer
61.	Total Pd	7.211 W	Power	Total Power Dissipation
62.	Vout Tolerance	2.179 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
63.	Vout pp percentage	321.555 m%		Output Voltage ripple percentage

Design Inputs

#	Name	Value	Description
1.	Iout	2.2	Maximum Output Current
2.	VinMax	265.0	Maximum input voltage
3.	VinMin	110.0	Minimum input voltage
4.	Vout	30.0	Output Voltage
5.	line_fsw	60.0	Light Output in Lumen
6.	base_pn	UCC28C45	Base Product 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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