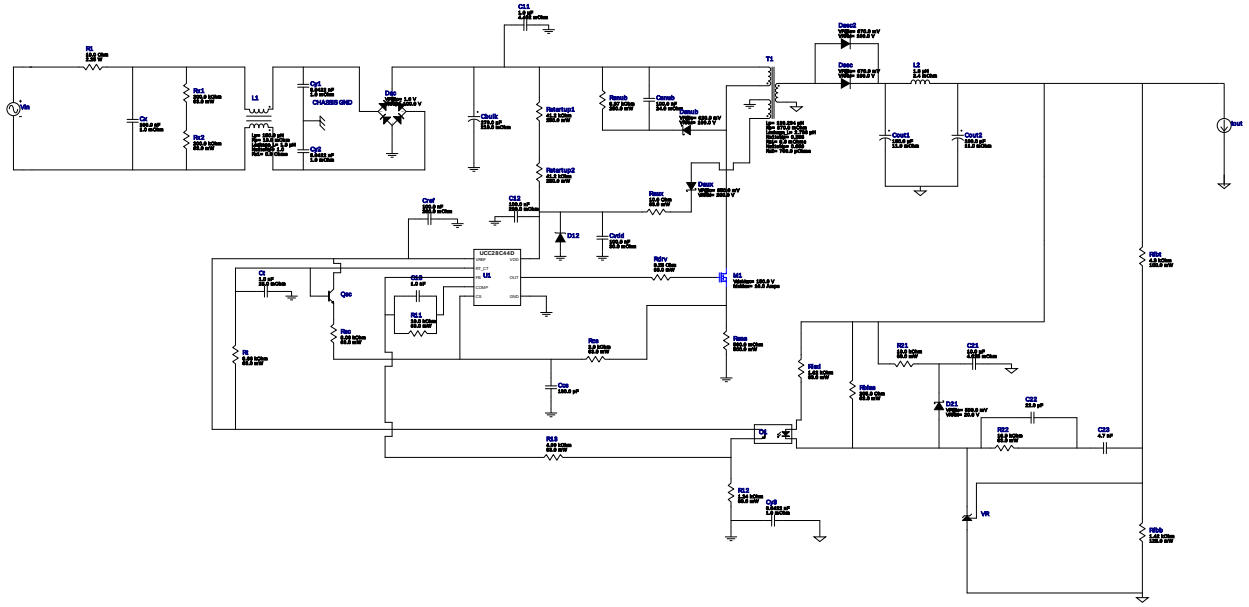
TEXAS INSTRUMENTS

WEBENCH® Design Report

VinMin = 33.0V
VinMax = 33.0V
Vout = 5.0V
Iout = 2.0A

Device = UCC28C44DR
Topology = Flyback
Created = 8/17/16 8:27:55 PM
BOM Cost = $0.00
BOM Count = 54
Total Pd = 2.15W

Design : 4108001/3 UCC28C44DR
UCC28C44DR 33.0V-33.0V to 5.00V @ 2.0A

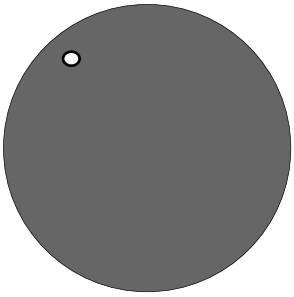


1. The EMI filter selected here contains the estimated values. The real numbers will depend on the attenuation needed at a particular frequency.

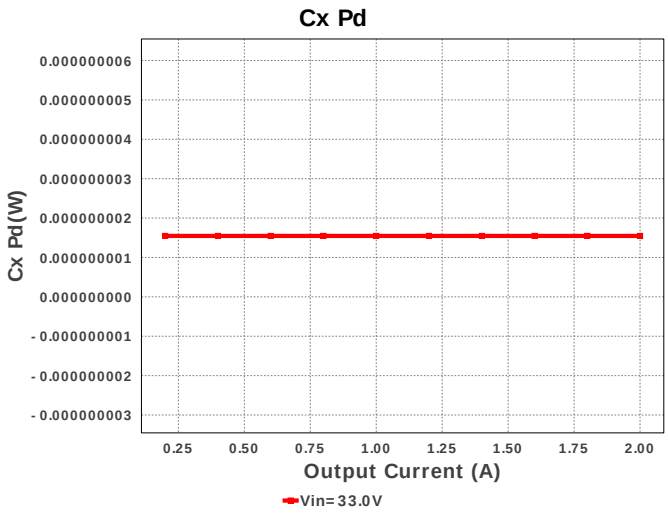
Electrical BOM

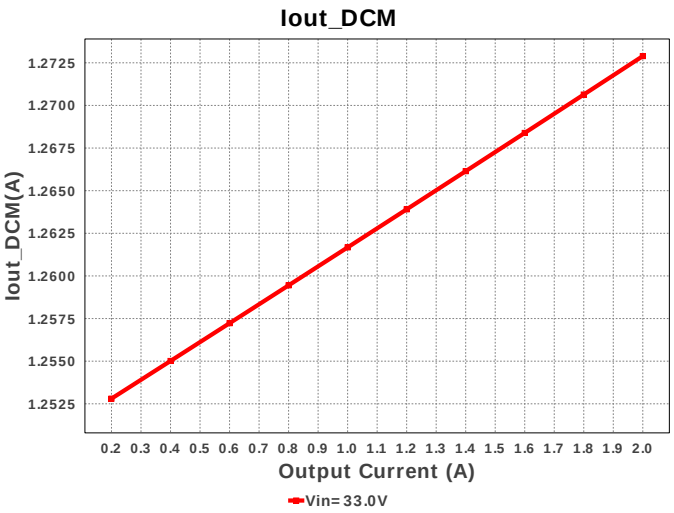
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
1.	C11	MuRata	GRM21BR71H105KA12L Series= X7R	Cap= 1.0 uF ESR= 4.402 mOhm VDC= 50.0 V IRMS= 1.677 A	1	$0.05	0805 7 mm^2
2.	C12	AVX	08053C104KAT2A Series= X7R	Cap= 100.0 nF ESR= 280.0 mOhm VDC= 25.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
3.	C13	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	MuRata	GRM21BR61A106KE19L Series= X5R	Cap= 10.0 uF ESR= 4.025 mOhm VDC= 10.0 V IRMS= 2.445 A	1	$0.03	0805 7 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	CC0805KRX7R9BB472 Series= X7R	Cap= 4.7 nF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2
7.	Cbulk	TDK	B41689K8277Q001 Series= 2358	Cap= 270.0 uF ESR= 218.0 mOhm VDC= 63.0 V IRMS= 1.6 A	1	$2.54	B41689_1600x2500 657 mm^2
8.	Ccs	Kemet	C0805C181K5GACTU Series= C0G/NP0	Cap= 180.0 pF VDC= 50.0 V IRMS= 0.0 A	1	$0.01	0805 7 mm^2

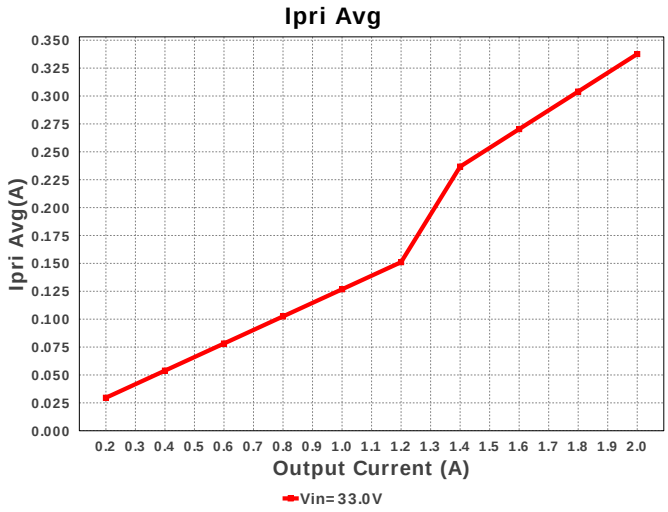
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
9.	Cout1	Panasonic	16SVPE180M Series= SVPE	Cap= 180.0 uF ESR= 11.0 mOhm VDC= 16.0 V IRMS= 4.46 A	1	$0.49	 CAPSMT_62_C10 74 mm^2
10.	Cout2	Panasonic	16SVPE180M Series= SVPE	Cap= 180.0 uF ESR= 11.0 mOhm VDC= 16.0 V IRMS= 4.46 A	1	$0.49	 CAPSMT_62_C10 74 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.	Csnub	AVX	08055C104JAT2A Series= X7R	Cap= 100.0 nF ESR= 24.0 mOhm VDC= 50.0 V IRMS= 0.0 A	1	$0.01	 0805 7 mm^2
13.	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
14.	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
15.	Cx	CUSTOM	CUSTOM Series= ?	Cap= 100.0 nF ESR= 1.0 mOhm VDC= 56.002 V IRMS= 5.1817 mA	1	NA	CUSTOM 0 mm^2
16.	Cy1	CUSTOM	CUSTOM Series= ?	Cap= 8.0422 nF ESR= 1.0 mOhm VDC= 56.002 V IRMS= 500.0 uA	1	NA	CUSTOM 0 mm^2
17.	Cy2	CUSTOM	CUSTOM Series= ?	Cap= 8.0422 nF ESR= 1.0 mOhm VDC= 56.002 V IRMS= 500.0 uA	1	NA	CUSTOM 0 mm^2
18.	Cy3	CUSTOM	CUSTOM Series= ?	Cap= 8.0422 nF ESR= 1.0 mOhm VDC= 56.002 V IRMS= 500.0 uA	1	NA	CUSTOM 0 mm^2
19.	D12	Diodes Inc.	MMSZ5248B-7-F	Zener	1	$0.04	 SOD-123 13 mm^2
20.	D21	Vishay-Semiconductor	SS12-E3/61T	VF@Io= 500.0 mV VRRM= 20.0 V	1	$0.08	 SMA 37 mm^2
21.	Dac	Diodes Inc.	HD01-T	VF@Io= 1.0 V VRRM= 100.0 V	1	$0.12	 MiniDIP 62 mm^2
22.	Daux	Diodes Inc.	DFLS1200-7	VF@Io= 850.0 mV VRRM= 200.0 V	1	$0.21	 PowerDI123 13 mm^2
23.	Dsec	Fairchild Semiconductor	FSV8100V	VF@Io= 670.0 mV VRRM= 100.0 V	1	$0.21	 TO-277A 56 mm^2
24.	Dsec2	Fairchild Semiconductor	FSV8100V	VF@Io= 670.0 mV VRRM= 100.0 V	1	$0.21	 TO-277A 56 mm^2
25.	Dsnub	Vishay-Semiconductor	SS2PH10-M3	VF@Io= 620.0 mV VRRM= 100.0 V	1	$0.14	DO-220AA 14 mm^2

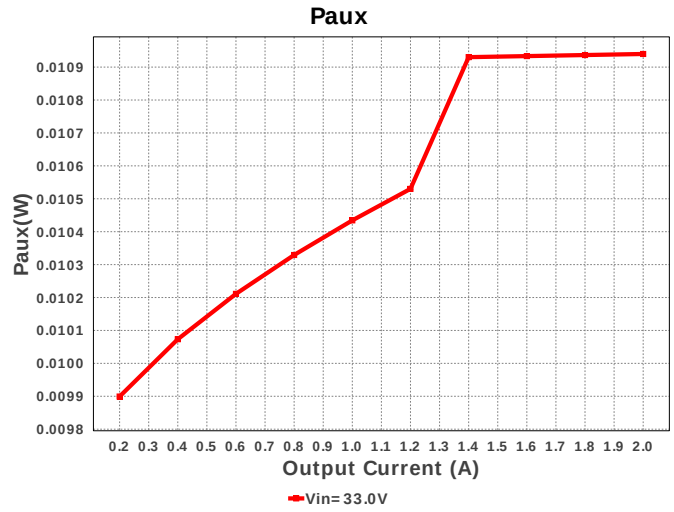
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
26.	L1	API Delevan	CM6296R-154	Lp= 150.0 µH Rp= 16.0 mOhm Leakage_L= 1.8 µH Ns1toNp= 1.0 Rs1= 0.0 Ohms	1	$5.95	 CM6296 833 mm^2
27.	L2	Coilcraft	SER1360-182KLB	L= 1.8 µH DCR= 2.4 mOhm	1	$0.72	 SER1360 225 mm^2
28.	M1	Fairchild Semiconductor	FDMC86240	VdsMax= 150.0 V IdsMax= 16.0 Amps	1	$0.93	 TRANS_Fairchild_MLP08S 18 mm^2
29.	O1	Vishay-Semiconductor	TCMT1109	Optocoupler	1	$0.21	 SOP-4 44 mm^2
30.	Qsc	STMicroelectronics	2N2222A	Bipolar Transistor	1	NA	 TO-18 57 mm^2
31.	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
32.	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
33.	R12	Vishay-Dale	CRCW04021K24FKED Series= CRCW..e3	Res= 1.24 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
34.	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
35.	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
36.	R22	Vishay-Dale	CRCW040216K9FKED Series= CRCW..e3	Res= 16.9 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
37.	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
38.	Rbias	Vishay-Dale	CRCW0402205RFKED Series= CRCW..e3	Res= 205.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
39.	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
40.	Rdrv	Vishay-Dale	CRCW04028R25FKED Series= CRCW..e3	Res= 8.25 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm^2
41.	Rfbb	Yageo America	RT0805BRD071K42L Series= RT0805	Res= 1.42 kOhm Power= 125.0 mW Tolerance= 0.1%	1	$0.05	 0805 7 mm^2

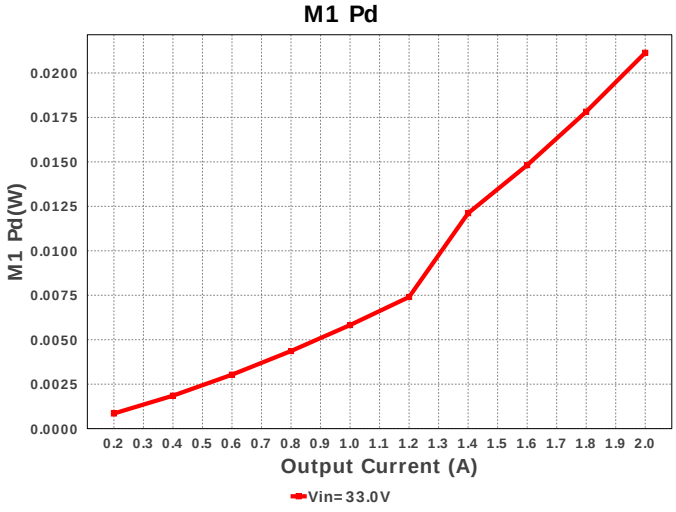
#	Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
42.	Rfbt	Yageo America	RC0603FR-074K3L Series= ?	Res= 4.3 kOhm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	 0603 5 mm²
43.	Rled	Vishay-Dale	CRCW04021K62FKED Series= CRCW..e3	Res= 1.62 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
44.	Rsc	Vishay-Dale	CRCW04028K06FKED Series= CRCW..e3	Res= 8.06 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
45.	Rsns	Rohm	MCR25JZHFLR560 Series= MCR25	Res= 560.0 mOhm Power= 500.0 mW Tolerance= 1.0%	1	$0.03	 1210 15 mm²
46.	Rsnub	Panasonic	ERJ-8ENF8871V Series= ERJ-8E	Res= 8.87 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm²
47.	Rstartup1	Panasonic	ERJ-8ENF4122V Series= ERJ-8E	Res= 41.2 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm²
48.	Rstartup2	Panasonic	ERJ-8ENF4122V Series= ERJ-8E	Res= 41.2 kOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	 1206 11 mm²
49.	Rt	Vishay-Dale	CRCW04028K66FKED Series= CRCW..e3	Res= 8.66 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
50.	Rx1	Vishay-Dale	CRCW0402200KFKED Series= CRCW..e3	Res= 200.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
51.	Rx2	Vishay-Dale	CRCW0402200KFKED Series= CRCW..e3	Res= 200.0 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	 0402 3 mm²
52.	T1	CUSTOM	CUSTOM	Lp= 139.294 µH Rp= 870.0 mOhm Leakage_L= 2.786 µH Ns1toNp= 0.258 Rs1= 8.6 mOhms Ns2toNp= 0.659 Rs2= 700.0 µOhms	1	NA	CUSTOM 0 mm²
53.	U1	Texas Instruments	UCC28C44DR	Switcher	1	$0.60	 D0008A 57 mm²
54.	VR	Texas Instruments	LMV431CM5/NOPB	Voltage References	1	$0.16	 R-PDSO-G3 16 mm²

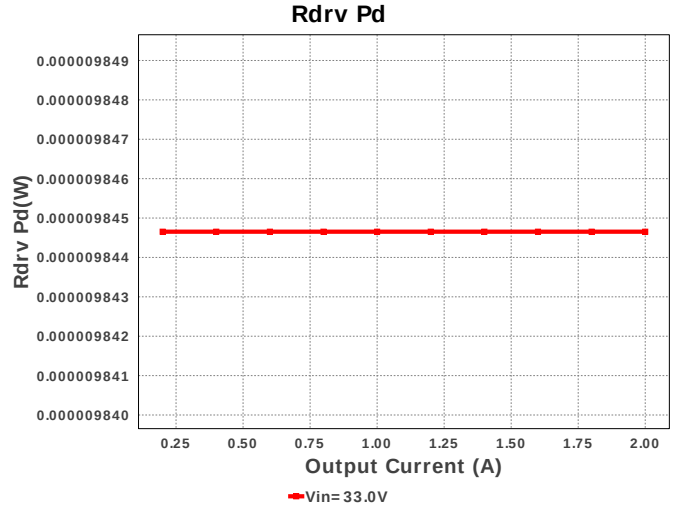


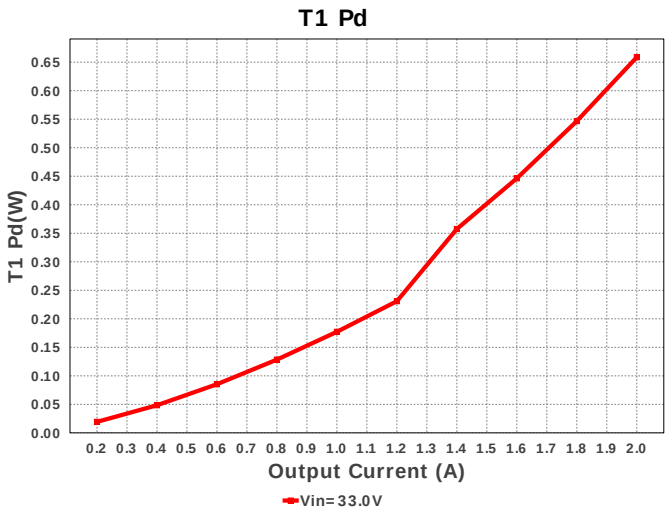


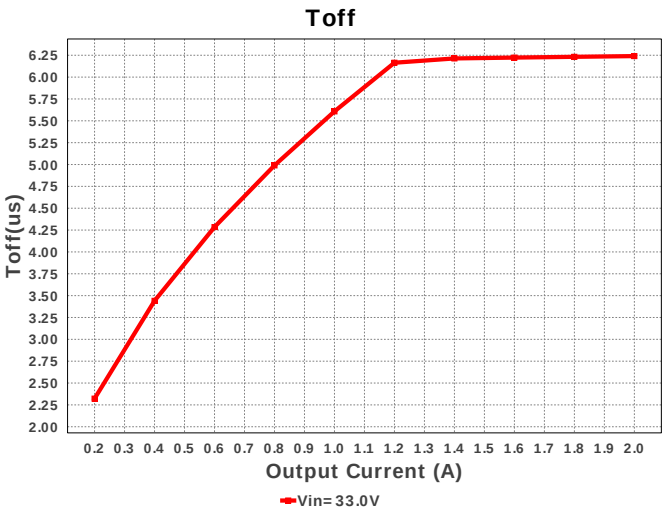


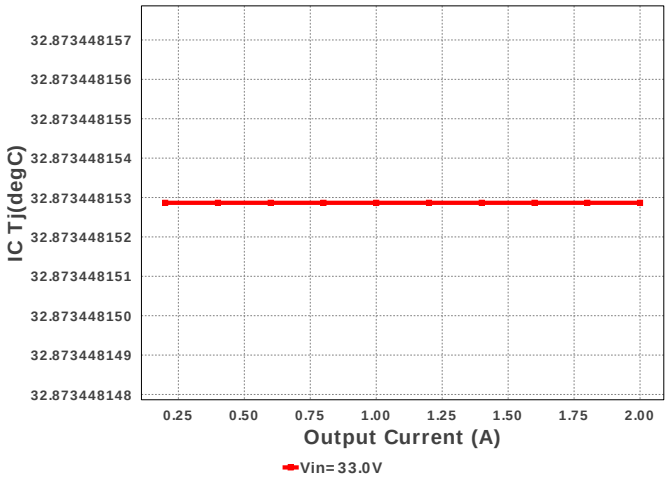


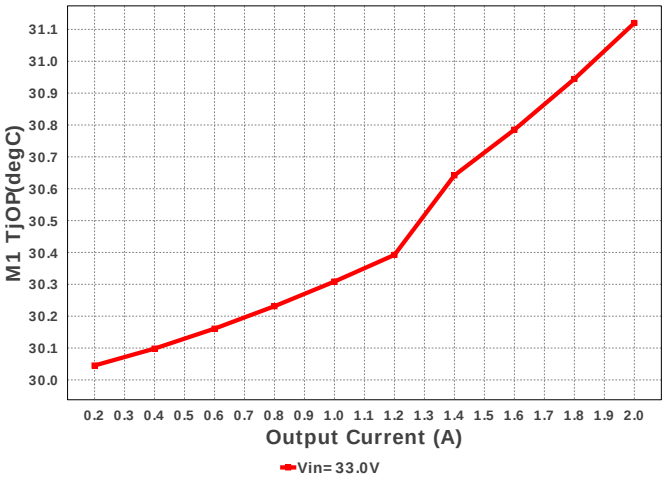


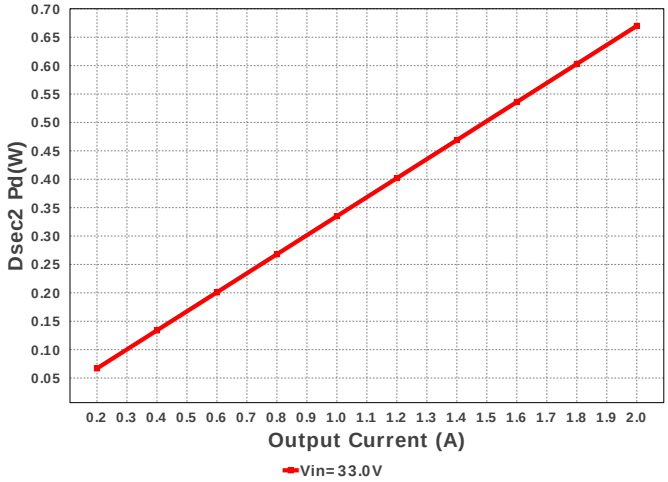


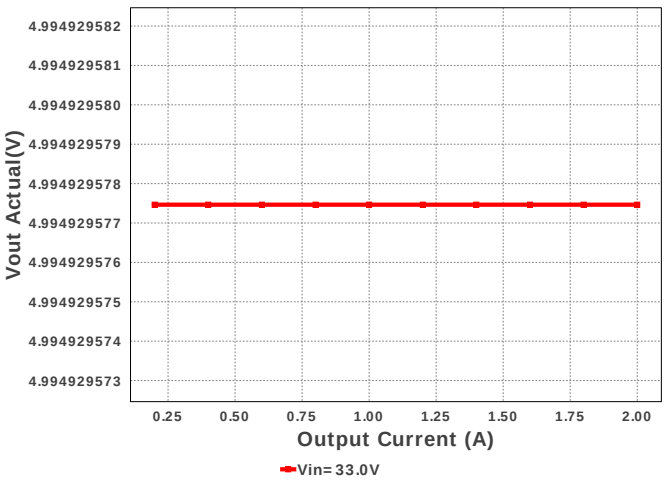


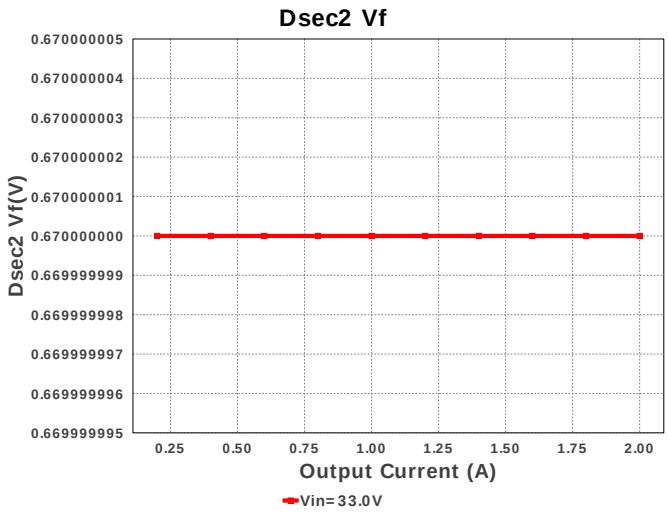


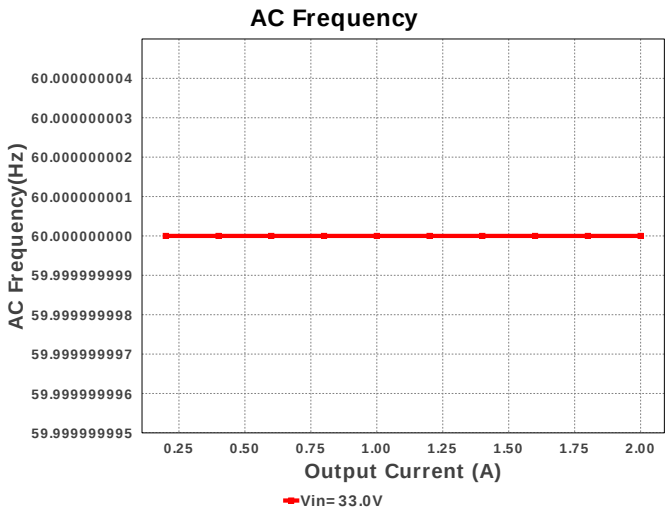


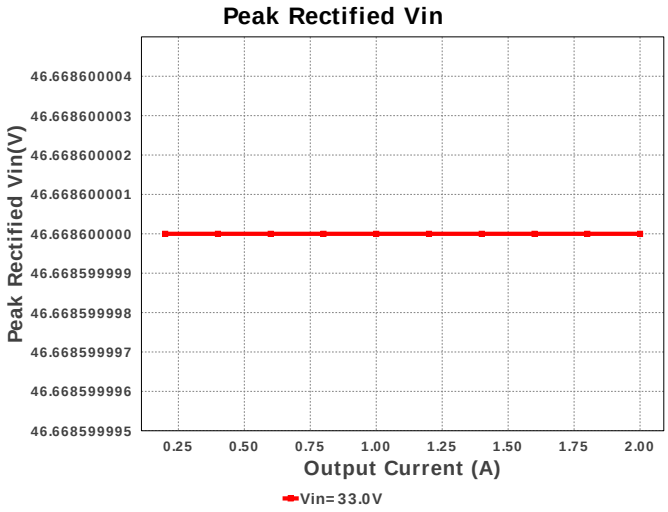


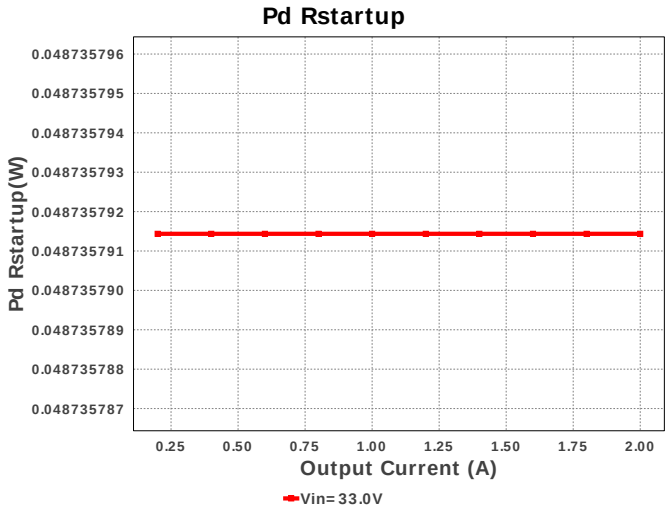


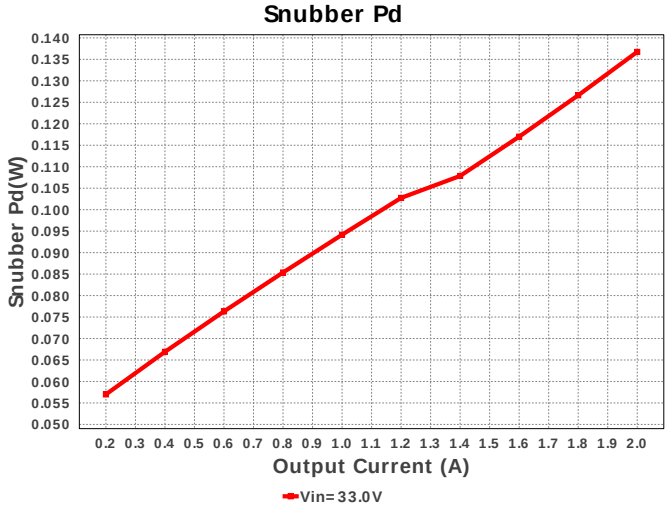


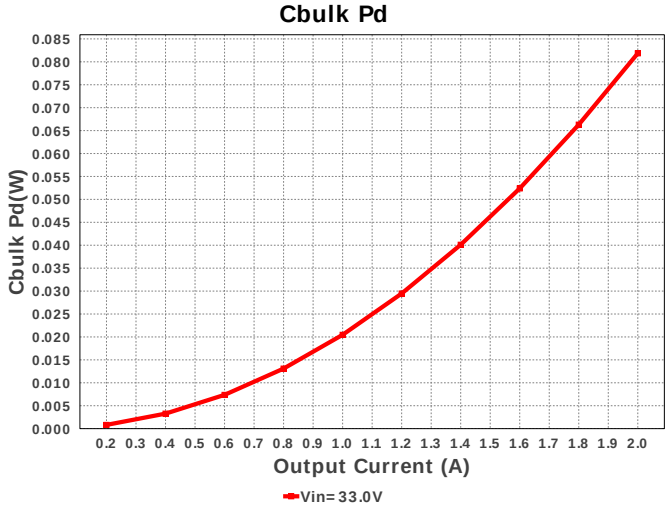


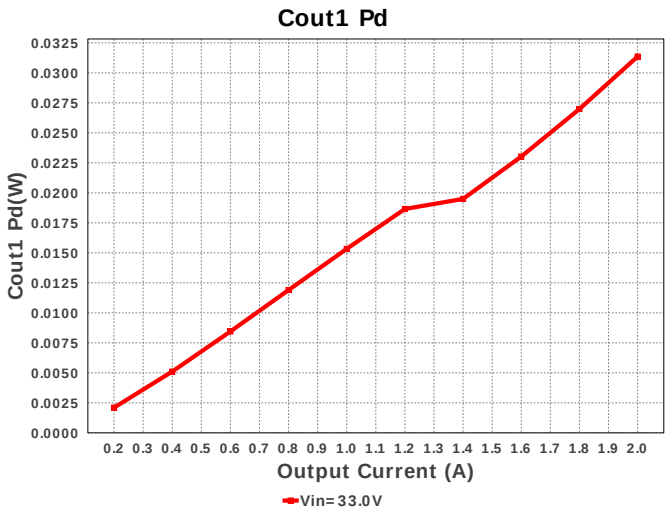


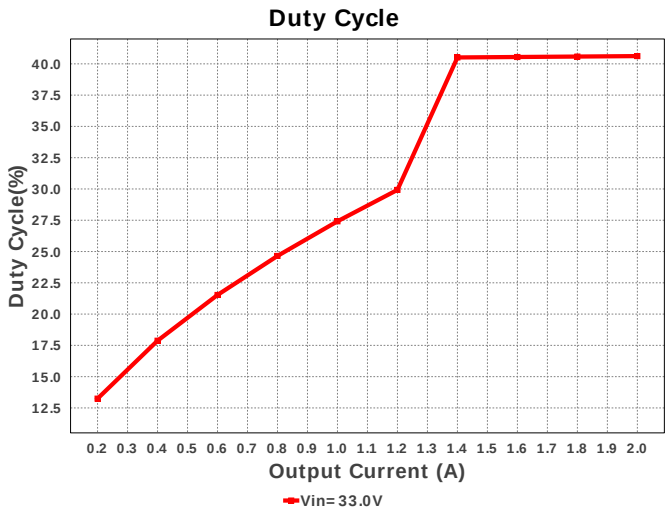


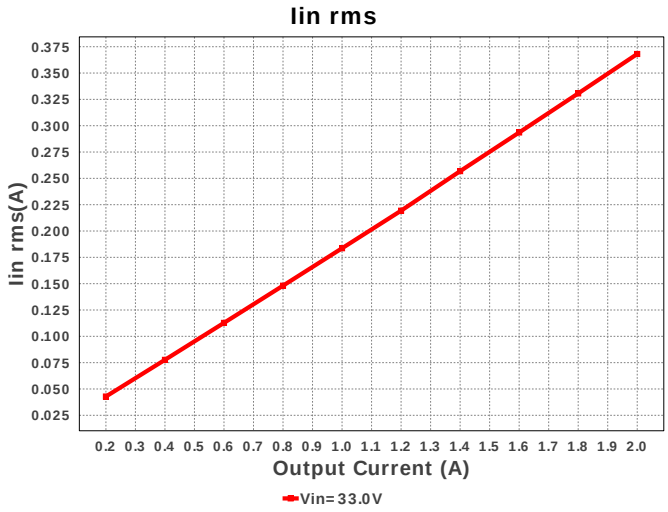


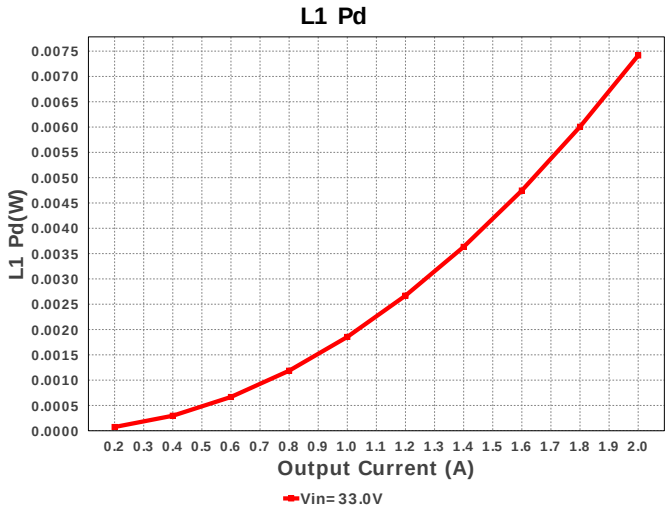


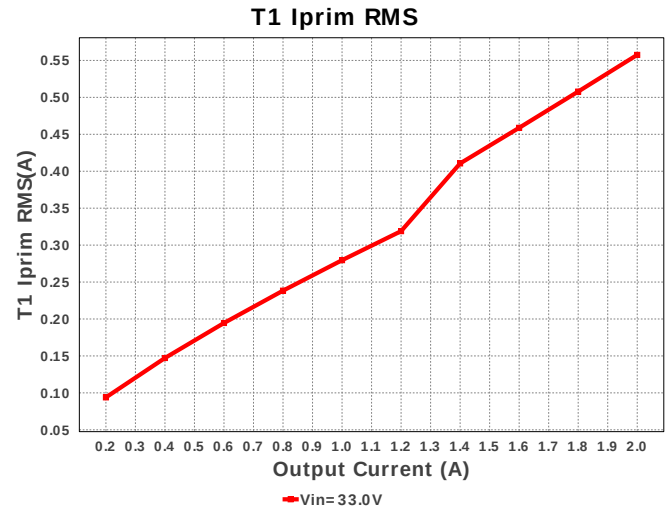


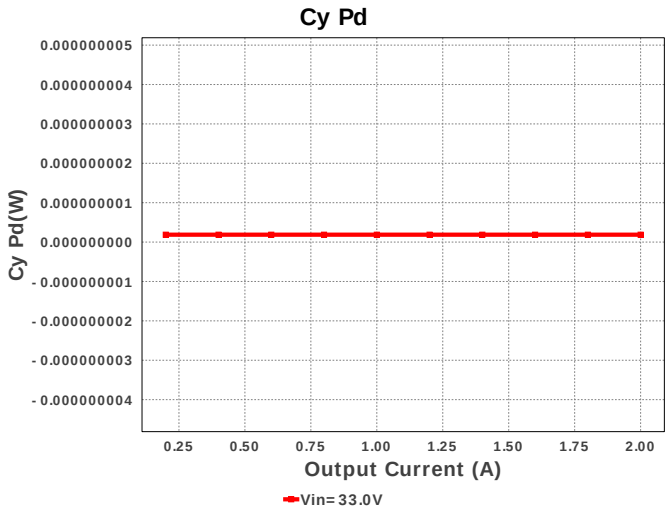


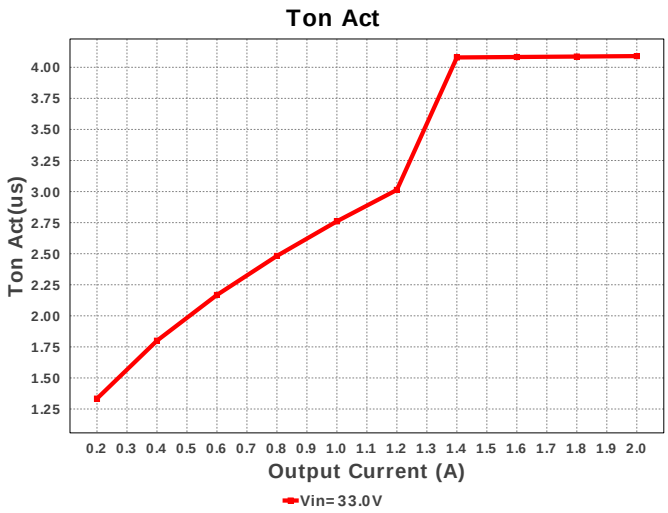


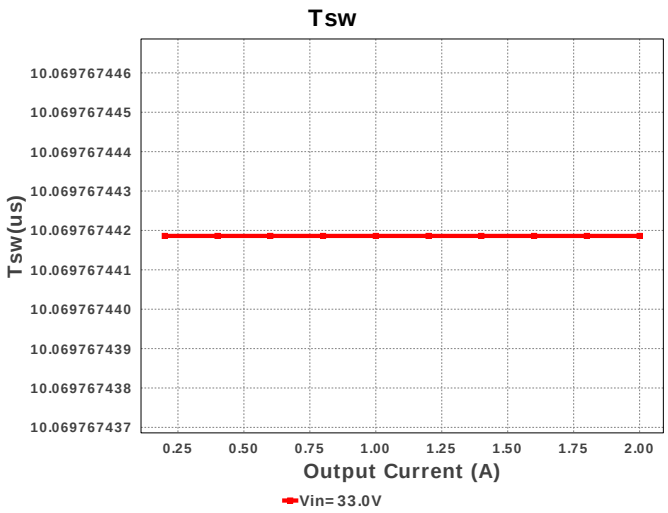


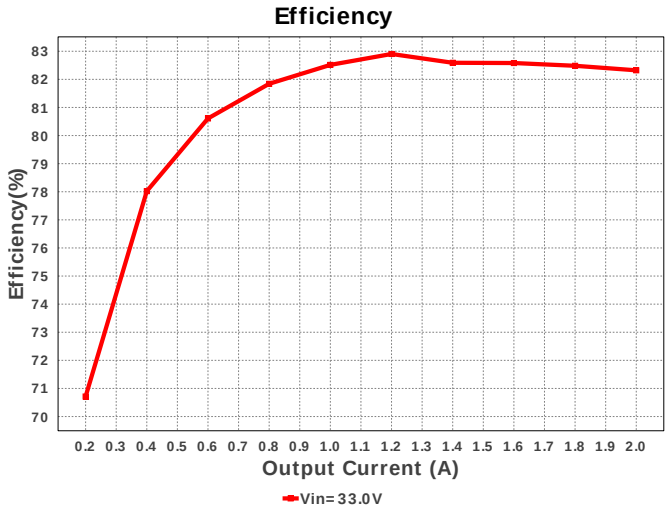


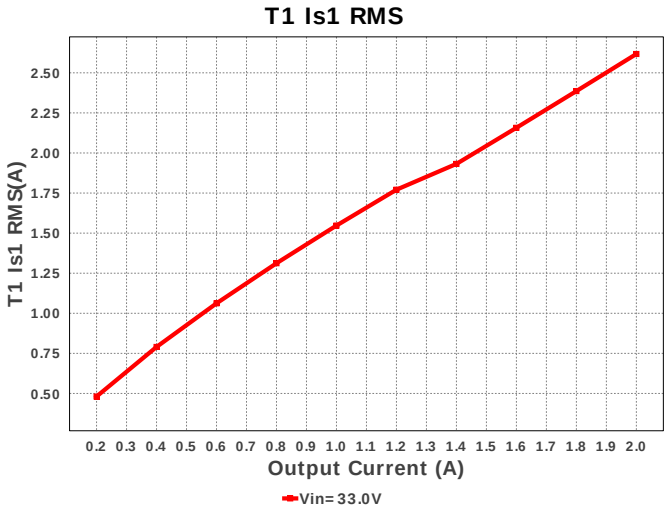


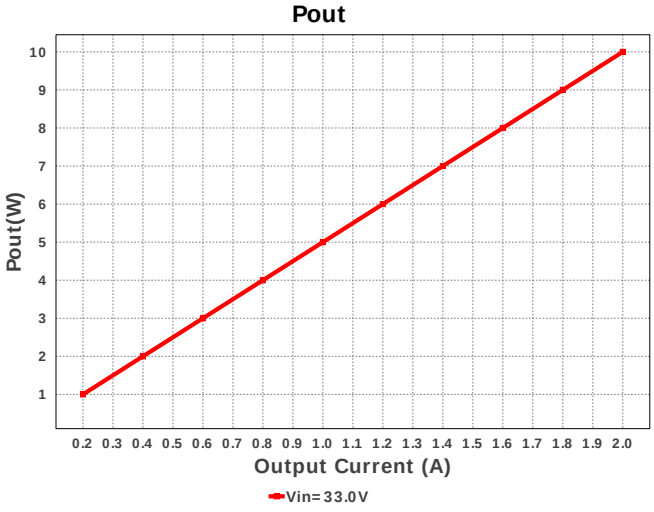


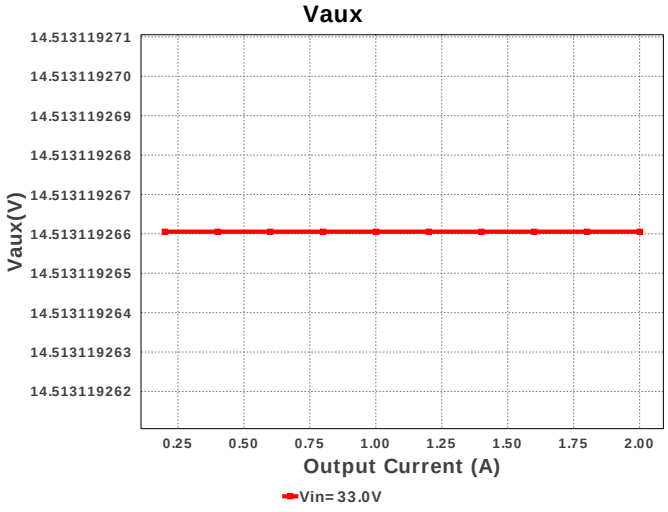


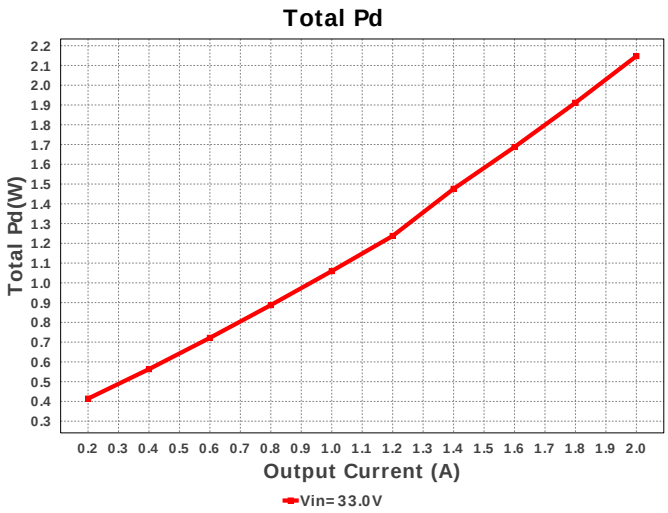


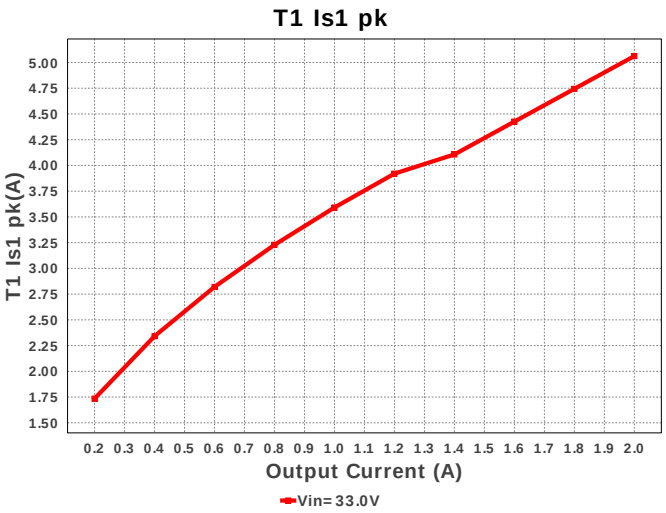


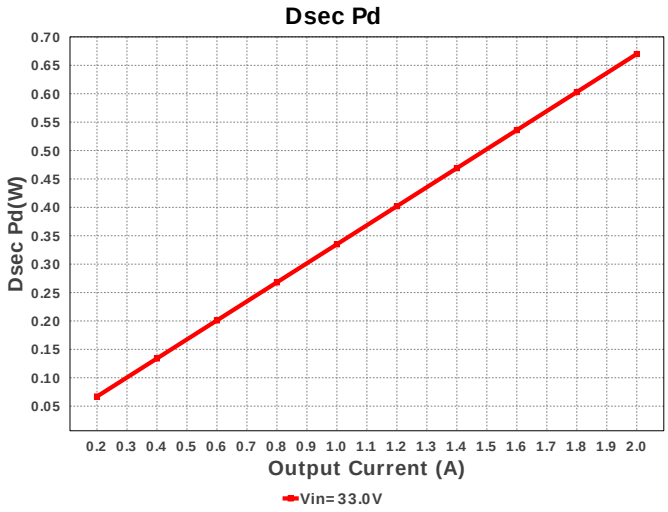


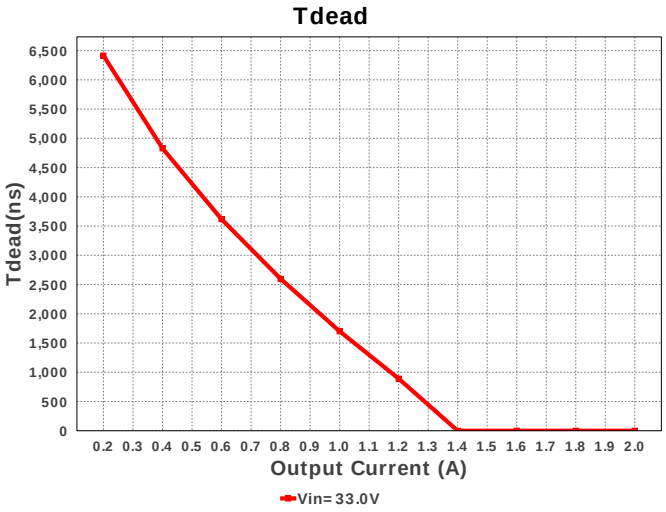


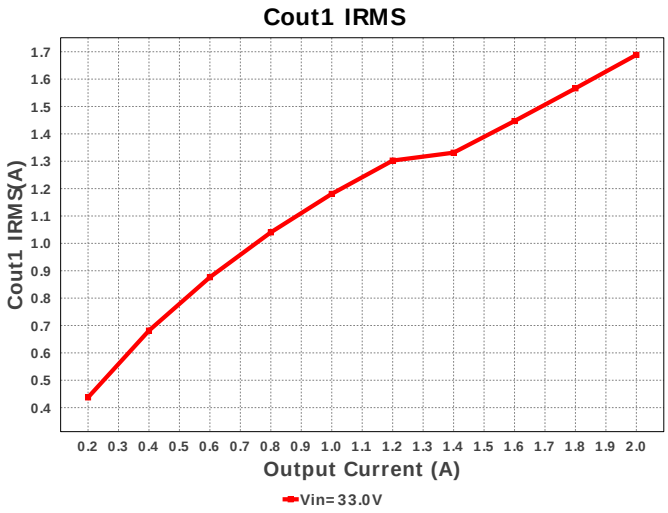


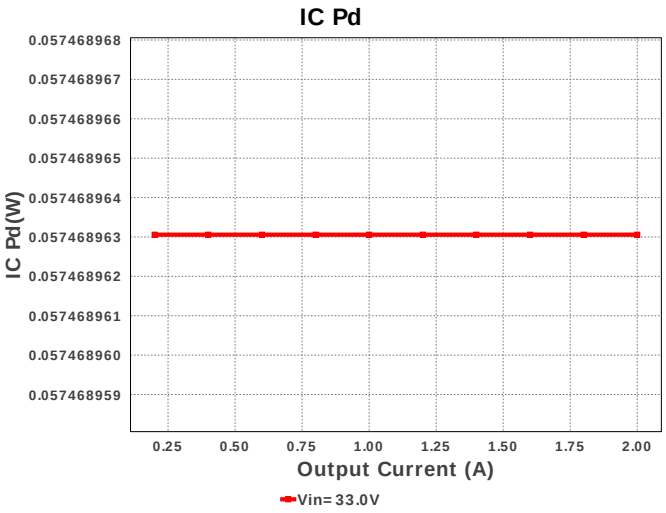


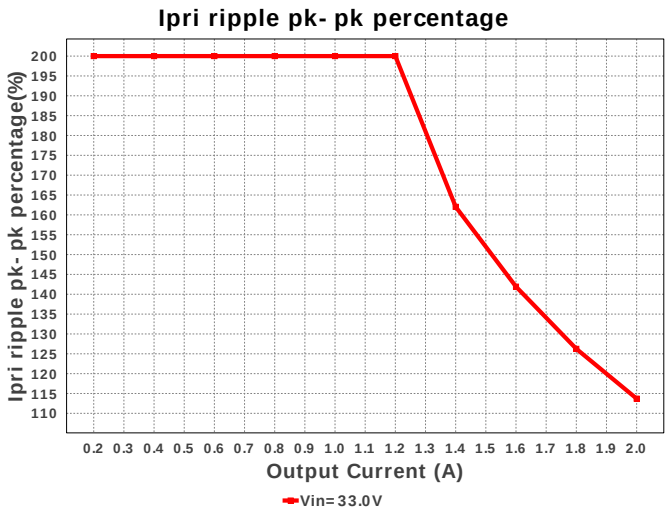


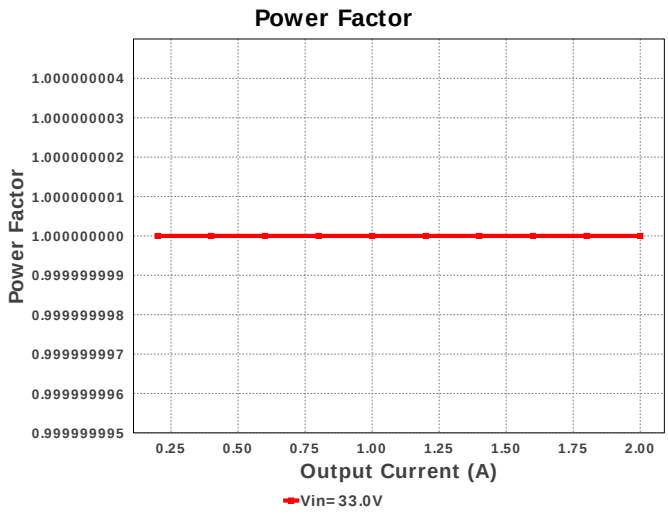


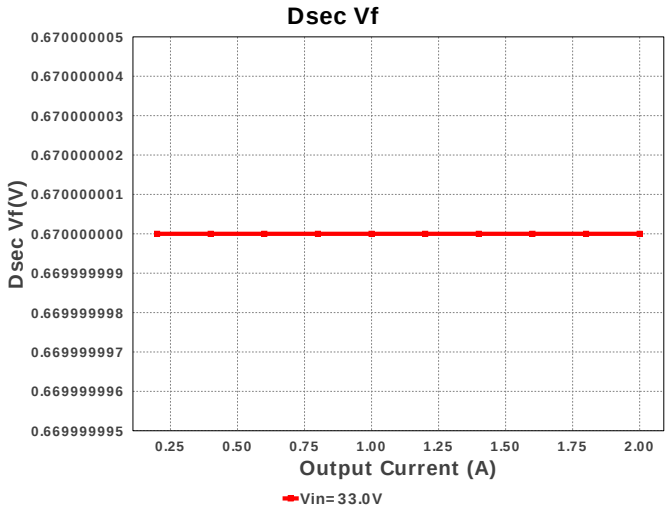


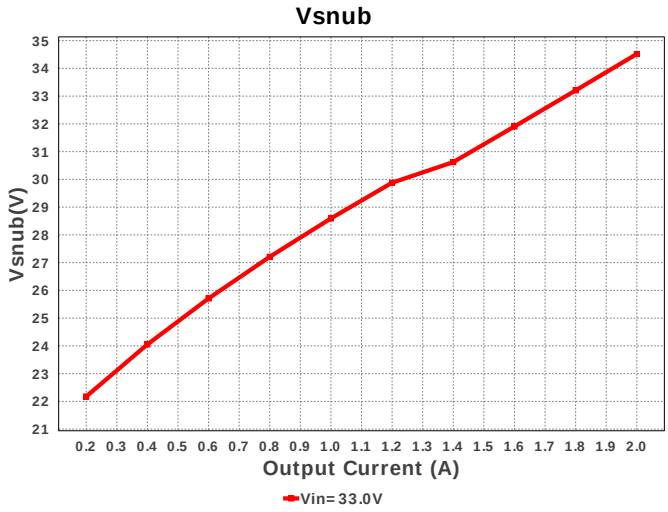


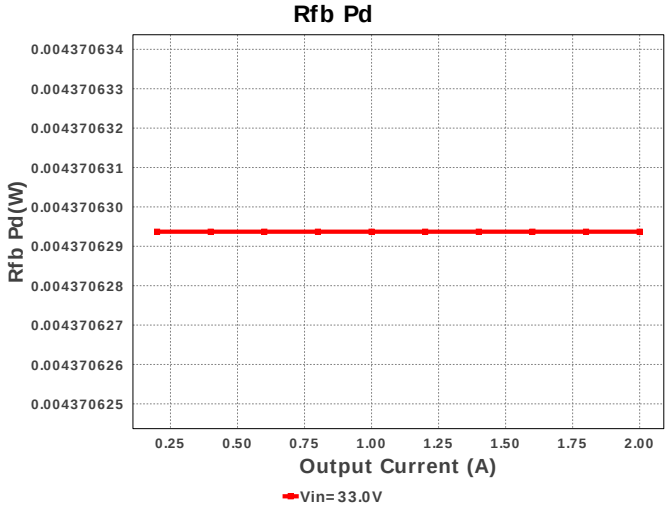


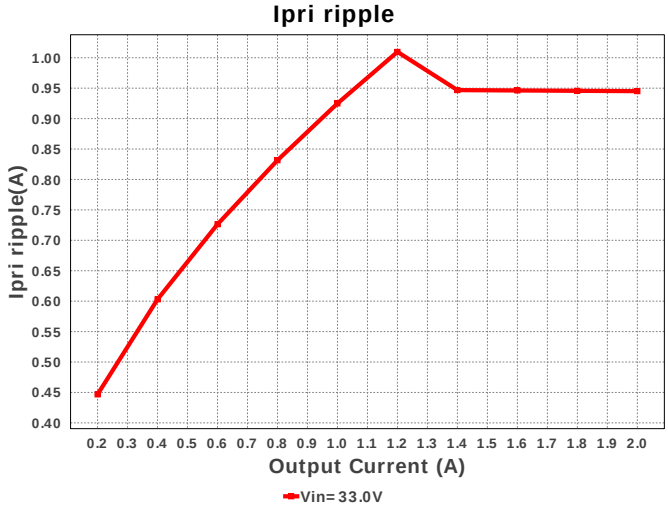


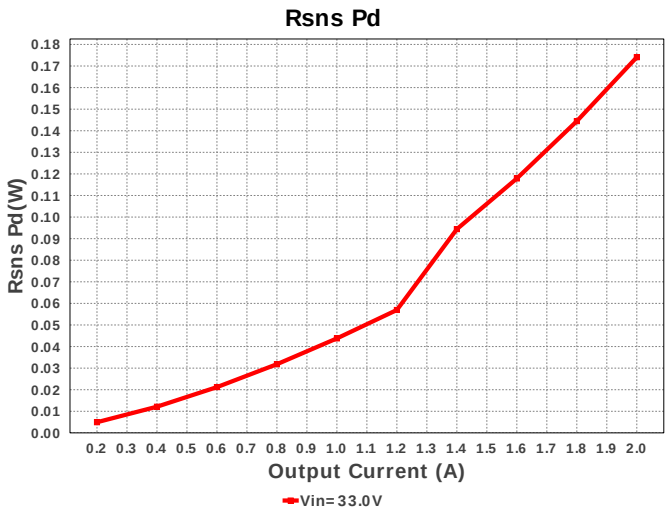


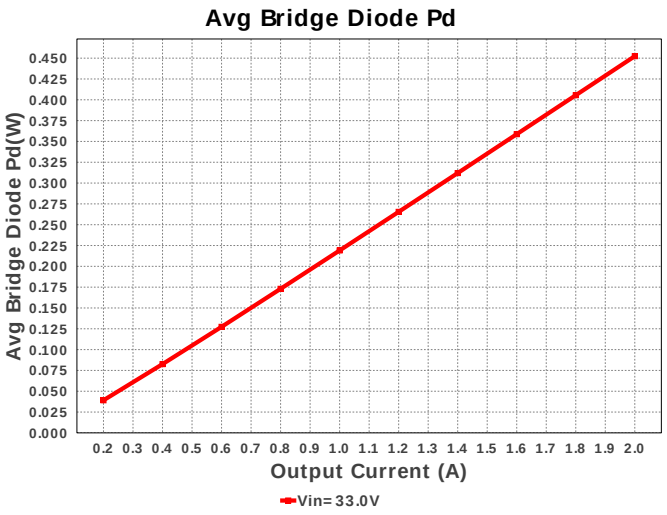


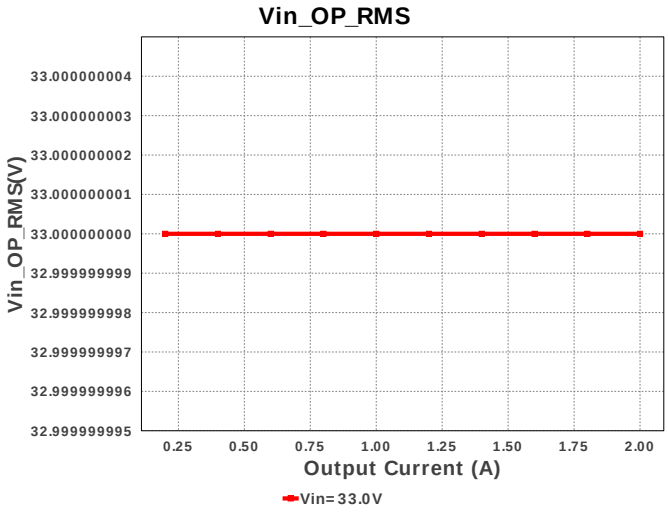


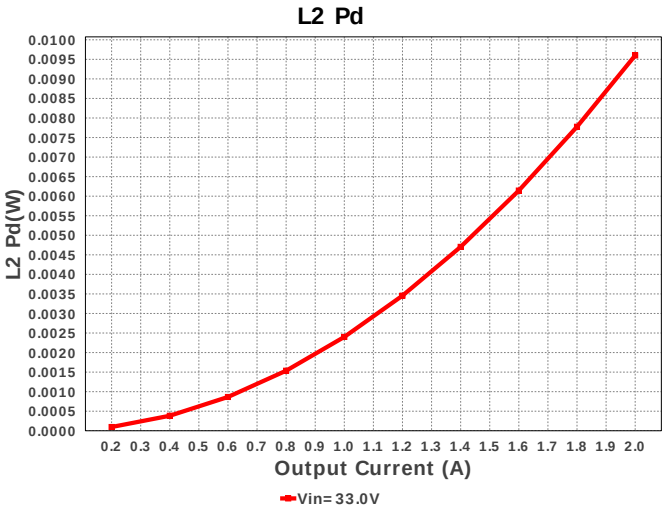


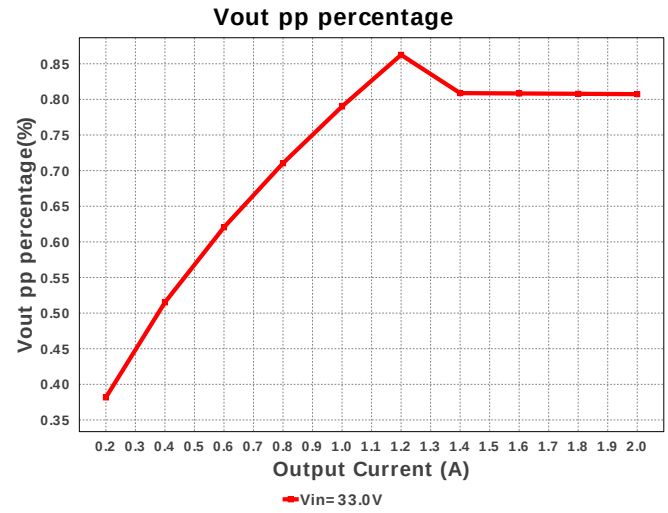


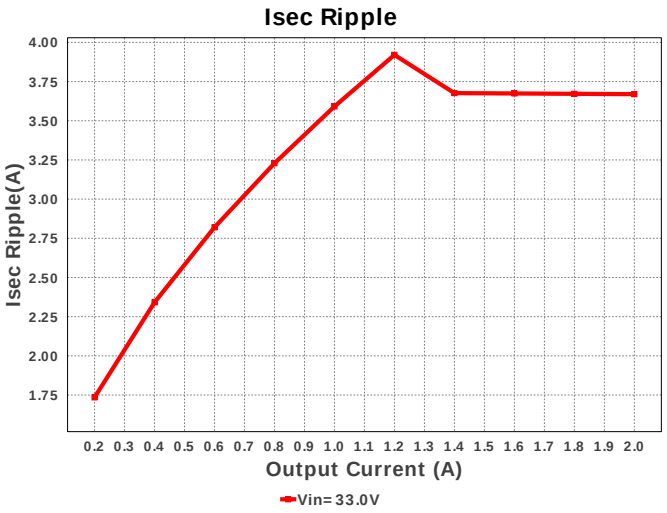


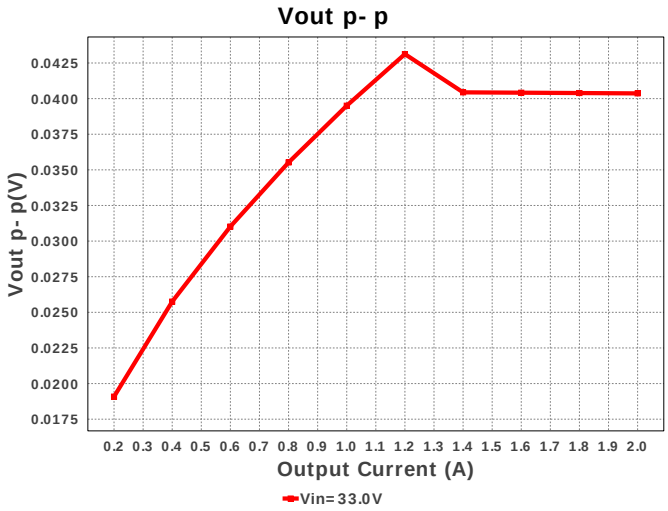


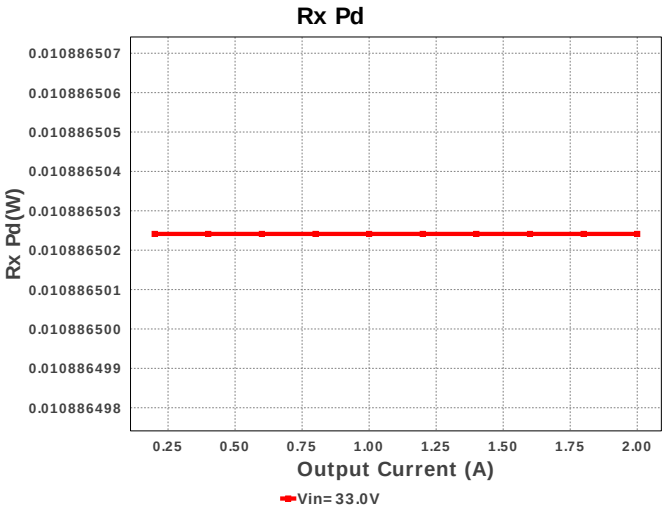


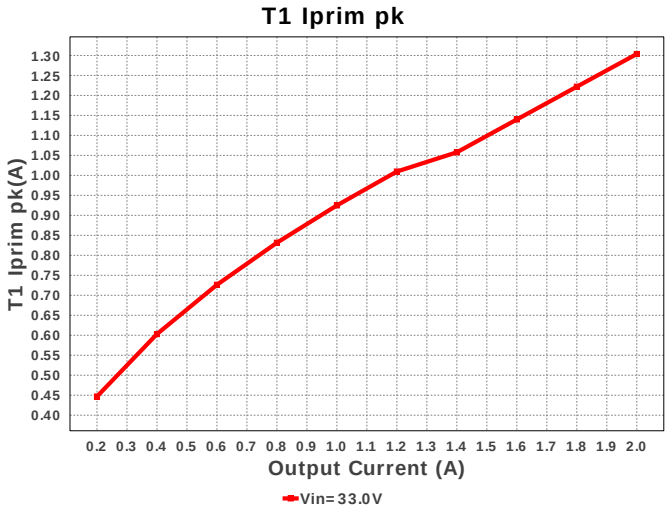












Operating Values

#	Name	Value	Category	Description
1.	Cout1 IRMS	1.689 A	Current	Output capacitor1 RMS ripple current
2.	Iin rms	368.1 mA	Current	RMS Input Current
3.	Iout_DCM	1.273 A	Current	Approximate Current below which DCM mode of operation will begin
4.	Ipri Avg	337.61 mA	Current	Average Current in Primary Winding over the complete Switching Period
5.	Ipri ripple	945.09 mA	Current	Ripple Current in the Primary Winding
6.	Ipri ripple pk-pk percentage	113.707 %	Current	Primary Current pk-pk ripple percentage(of Ipri avg during ton only)
7.	Isec Ripple	3.67 A	Current	Ripple Current in the Secondary Winding
8.	T1 Iprim RMS	557.532 mA	Current	Transformer Primary RMS Current
9.	T1 Iprim pk	1.304 A	Current	Transformer Primary Peak Current
10.	T1 Is1 RMS	2.617 A	Current	Transformer Secondary1 RMS Current
11.	T1 Is1 pk	5.062 A	Current	Transformer Secondary1 Peak Current
12.	AC Frequency	50.0 Hz	General	Input AC frequency
13.	BOM Count	54	General	Total Design BOM count
14.	Daux trr	0.0 ns	General	Auxiliary Diode Reverse Recovery Time
15.	Dsec Vf	670.0 mV	General	Effective Forward Voltage Drop at the Operating Current
16.	Dsec trr	19.64 ns	General	Output Diode Reverse Recovery Time
17.	Dsec2 Vf	670.0 mV	General	Effective Forward Voltage Drop at the Operating Current
18.	Dsnub trr	0.0 ns	General	Snubber Diode Reverse Recovery Time
19.	FootPrint	2.664 k mm^2	General	Total Foot Print Area of BOM components
20.	Frequency	99.307 kHz	General	Switching frequency
21.	Mode	CCM	General	Conduction Mode
22.	Pout	10.0 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	6.24 us	General	Approximate Converter Off Time
26.	Ton Act	4.09 us	General	Approximate Converter On Time
27.	Total BOM	$0.0	General	Total BOM Cost
28.	Tsw	10.07 us	General	Switching Time Period
29.	Vaux	14.513 V	General	Auxiliary Voltage

#	Name	Value	Category	Description
30.	Vsnub	34.518 V	General	Voltage Across the Snubber
31.	Vout Actual	4.995 V	Op_Point	Vout Actual calculated based on selected voltage divider resistors
32.	Vout OP	5.0 V	Op_Point	Operational Output Voltage
33.	Duty Cycle	40.619 %	Op_point	Duty cycle
34.	Efficiency	82.322 %	Op_point	Steady state efficiency
35.	IC Tj	32.873 degC	Op_point	IC junction temperature
36.	ICThetaJA	50.0 degC/W	Op_point	IC junction-to-ambient thermal resistance
37.	IOUT_OP	2.0 A	Op_point	Iout operating point
38.	M1 TjOP	31.12 degC	Op_point	M1 MOSFET junction temperature
39.	Peak Rectified Vin	46.669 V	Op_point	Peak voltage seen at rectified input
40.	Vin_OP_RMS	33.0 V	Op_point	AC Input RMS Voltage
41.	Vout p-p	40.367 mV	Op_point	Peak-to-peak output ripple voltage
42.	Avg Bridge Diode Pd	452.38 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
43.	Cbulk Pd	81.855 mW	Power	Bulk capacitor power dissipation
44.	Cout1 Pd	31.364 mW	Power	Output capacitor1 power dissipation
45.	Cx Pd	1.074 nW	Power	X-cap Power Dissipation
46.	Cy Pd	187.5 pW	Power	Y-caps Power Dissipation
47.	Dsec Pd	670.0 mW	Power	Secondary Diode Power Dissipation
48.	Dsec2 Pd	670.0 mW	Power	Secondary Diode Power Dissipation
49.	IC Pd	57.469 mW	Power	IC power dissipation
50.	L1 Pd	7.415 mW	Power	Power Dissipation in the Inductor
51.	L2 Pd	9.6 mW	Power	Average Power Dissipation in the Inductor Over the AC Line Period
52.	M1 Pd	21.135 mW	Power	M1 MOSFET total power dissipation
53.	Paux	10.94 mW	Power	Power Dissipation in Raux and Daux
54.	Pd Rstartup	48.736 mW	Power	Power Dissipation in Rstartup1 and Rstartup2
55.	Rdrv Pd	9.845 µW	Power	Power Dissipation in Gate Drive Resistor
56.	Rfb Pd	4.371 mW	Power	Rfb Power Dissipation
57.	Rsns Pd	174.071 mW	Power	Current Limit Sense Resistor Power Dissipation
58.	Rx Pd	10.887 mW	Power	Total Power Dissipation in Rx1 and Rx2
59.	Snubber Pd	136.744 mW	Power	Snubber Power Dissipation
60.	T1 Pd	658.706 mW	Power	Estimated Losses in Transformer
61.	Total Pd	2.147 W	Power	Total Power Dissipation
62.	Vout Tolerance	1.478 %		Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
63.	Vout pp percentage	807.332 m%		Output Voltage ripple percentage

Design Inputs

#	Name	Value	Description
1.	Iout	2.0	Maximum Output Current
2.	VinMax	33.0	Maximum input voltage
3.	VinMin	33.0	Minimum input voltage
4.	Vout	5.0	Output Voltage
5.	acFrequency	50.0	Light Output in Lumen
6.	base_pn	UCC28C44	Texas Instruments Base Part 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.