1	ACDC_TinySwitch-4_060321; Rev.1.3; Copyright Power Integrations 2021	INPUT	INFO	OUTPUT	UNIT	ACDC_TinySwitch-4_060321_Rev1-3.xls; TinySwitch-4 Continuous/Discontinuous Flyback Transformer Design Spreadsheet
2	**ENTER APPLICATION VARIABLES**					**Customer**
3	VACMIN			85	Volts	Minimum AC Input Voltage
4	VACMAX			265	Volts	Maximum AC Input Voltage
5	fL			50	Hertz	AC Mains Frequency
6	VO	20.00		20.00	Volts	Output Voltage (at continuous power)
7	IO	0.50		0.50	Amps	Power Supply Output Current (corresponding to peak power)
8	Power			10.00	Watts	Continuous Output Power
9	n			0.85		Efficiency Estimate at output terminals. Under 0.7 if no better data available
10	Z			0.50		Z Factor. Ratio of secondary side losses to the total losses in the power supply. Use 0.5 if no better data available
11	tC			3.00	mSeconds	Bridge Rectifier Conduction Time Estimate
12	CIN	24.00		24.00	uFarads	Input Capacitance
13						
14						
15	**ENTER TinySwitch-4 VARIABLES**					
16	**TinySwitch-4**	**TNY288D**		**TNY288D**		User-defined TinySwitch-4
17						
18	Chose Configuration	**INC**		Increased Current Limit		Enter "RED" for reduced current limit (sealed adapters), "STD" for standard current limit or "INC" for increased current limit (peak or higher power applications)
19	ILIMITMIN			0.605	Amps	Minimum Current Limit
20	ILIMITTYP			0.650	Amps	Typical Current Limit
21	ILIMITMAX			0.721	Amps	Maximum Current Limit
22	fSmin			124000	Hertz	Minimum Device Switching Frequency
23	I^2fmin			50.193	A^2kHz	I^2f (product of current limit squared and frequency is trimmed for tighter tolerance)
24	VOR	104.0		104.0	Volts	Reflected Output Voltage (VOR < 135 V Recommended)
25	VDS			10.0	Volts	TinySwitch-4 on-state Drain to Source Voltage
26	VD			0.70	Volts	Output Winding Diode Forward Voltage Drop
27	KP			1.48		Ripple to Peak Current Ratio (KP < 6)
28	KP_TRANSIENT			1.05		Transient Ripple to Peak Current Ratio. Ensure KP_TRANSIENT > 0.25
29						
30						
31	**ENTER BIAS WINDING VARIABLES**					
32	VB			22.00	Volts	Bias Winding Voltage
33	VDB			0.70	Volts	Bias Winding Diode Forward Voltage Drop
34	NB			13.82		Bias Winding Number of Turns
35	VZOV			28.00	Volts	Over Voltage Protection zener diode voltage.
36						
37						
38	**UVLO VARIABLES**					
39	V_UV_TARGET			95.82	Volts	Target DC under-voltage threshold, above which the power supply with start
40	V_UV_ACTUAL			92.20	Volts	Typical DC start-up voltage based on standard value of RUV_ACTUAL
41	RUV_IDEAL			3.74	Mohms	Calculated value for UV Lockout resistor
42	RUV_ACTUAL			3.60	Mohms	Closest standard value of resistor to RUV_IDEAL
43						
44						
45	**ENTER TRANSFORMER CORE/CONSTRUCTION VARIABLES**					
46	**Core Type**	**EE16**		**EE16**		Enter Transformer Core
47	Core		EE16		P/N:	PC40EE16-Z
48	Custom core				P/N:	EE16_BOBBIN
49	AE			0.19	cm^2	Core Effective Cross Sectional Area
50	LE			3.50	cm	Core Effective Path Length
51	AL			1140	nH/T^2	Ungapped Core Effective Inductance
52	BW			8.6	mm	Bobbin Physical Winding Width
53	M			0.00	mm	Safety Margin Width (Half the Primary to Secondary Creepage Distance)
54	L			3		Number of Primary Layers
55	NS	13		13		Number of Secondary Turns
56						
57						
58	**DC INPUT VOLTAGE PARAMETERS**					
59	VMIN			87.1	Volts	Minimum DC Input Voltage
60	VMAX			374.8	Volts	Maximum DC Input Voltage
61						
62						
63	**CURRENT WAVEFORM SHAPE PARAMETERS**					
64	DMAX			0.45		Duty Ratio at full load, minimum primary inductance and minimum input voltage
65	IAVG			0.15	Amps	Average Primary Current

66	IP			0.61	Amps	Minimum Peak Primary Current
67	IR			0.61	Amps	Primary Ripple Current
68	IRMS			0.28	Amps	Primary RMS Current
69						
70						
71	**TRANSFORMER PRIMARY DESIGN PARAMETERS**					
72	LP			471	uHenries	Typical Primary Inductance. +/- 10% to ensure a minimum primary inductance of 424 uH
73	LP_TOLERANCE			10	%	Primary inductance tolerance
74	NP			65		Primary Winding Number of Turns
75	ALG			110	nH/T^2	Gapped Core Effective Inductance
76	BM			2710	Gauss	Maximum Operating Flux Density, BM<3100 is recommended
77	BAC			1355	Gauss	AC Flux Density for Core Loss Curves (0.5 X Peak to Peak)
78	ur			1654		Relative Permeability of Ungapped Core
79	LG			0.20	mm	Gap Length (Lg > 0.1 mm)
80	BWE			25.8	mm	Effective Bobbin Width
81	OD			0.395	mm	Maximum Primary Wire Diameter including insulation
82	INS			0.06	mm	Estimated Total Insulation Thickness (= 2 * film thickness)
83	DIA			0.34	mm	Bare conductor diameter
84	AWG			28	AWG	Primary Wire Gauge (Rounded to next smaller standard AWG value)
85	CM			161	Cmils	Bare conductor effective area in circular mils
86	CMA		Info	580	Cmils/Amp	CAN DECREASE CMA < 500 (decrease L(primary layers),increase NS,use smaller Core)
87						
88						
89	**TRANSFORMER SECONDARY DESIGN PARAMETERS**					
90	**Lumped parameters**					
91	ISP			3.04	Amps	Peak Secondary Current
92	ISRMS			1.28	Amps	Secondary RMS Current
93	IRIPPLE			1.18	Amps	Output Capacitor RMS Ripple Current
94	CMS			256	Cmils	Secondary Bare Conductor minimum circular mils
95	AWGS			26	AWG	Secondary Wire Gauge (Rounded up to next larger standard AWG value)
96						
97						
98	**VOLTAGE STRESS PARAMETERS**					
99	VDRAIN			613	Volts	Maximum Drain Voltage Estimate (Assumes 20% zener clamp tolerance and an additional 10% temperature tolerance)
100	PIVS			95	Volts	Output Rectifier Maximum Peak Inverse Voltage
101						
102						
103	**TRANSFORMER SECONDARY DESIGN PARAMETERS (MULTIPLE OUTPUTS)**					
104						
105	**1st output**					
106	VO1			20.00	Volts	Main Output Voltage (if unused, defaults to single output design)
107	IO1			0.50	Amps	Output DC Current
108	PO1			10.00	Watts	Output Power
109	VD1			0.70	Volts	Output Diode Forward Voltage Drop
110	NS1			13.00		Output Winding Number of Turns
111	ISRMS1			1.279	Amps	Output Winding RMS Current
112	IRIPPLE1			1.18	Amps	Output Capacitor RMS Ripple Current
113	PIVS1			95	Volts	Output Rectifier Maximum Peak Inverse Voltage
114	Recommended Diodes			1N5817, SB120		Recommended Diodes for this output
115	CMS1			256	Cmils	Output Winding Bare Conductor minimum circular mils
116	AWGS1			26	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
117	DIAS1			0.41	mm	Minimum Bare Conductor Diameter
118	ODS1			0.66	mm	Maximum Outside Diameter for Triple Insulated Wire
119						
120						
121	**2nd output**					
122	VO2				Volts	Output Voltage
123	IO2				Amps	Output DC Current
124	PO2			0.00	Watts	Output Power
125	VD2			0.70	Volts	Output Diode Forward Voltage Drop
126	NS2			0.44		Output Winding Number of Turns
127	ISRMS2			0.000	Amps	Output Winding RMS Current
128	IRIPPLE2			0.00	Amps	Output Capacitor RMS Ripple Current
129	PIVS2			3	Volts	Output Rectifier Maximum Peak Inverse Voltage
130	Recommended Diode					Recommended Diodes for this output
131	CMS2			0	Cmils	Output Winding Bare Conductor minimum circular mils
132	AWGS2			N/A	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
133	DIAS2			N/A	mm	Minimum Bare Conductor Diameter

134	ODS2			N/A	mm	Maximum Outside Diameter for Triple Insulated Wire
135						
136						
137	**3rd output**					
138	VO3				Volts	Output Voltage
139	IO3				Amps	Output DC Current
140	PO3			0.00	Watts	Output Power
141	VD3			0.70	Volts	Output Diode Forward Voltage Drop
142	NS3			0.44		Output Winding Number of Turns
143	ISRMS3			0.000	Amps	Output Winding RMS Current
144	IRIPPLE3			0.00	Amps	Output Capacitor RMS Ripple Current
145	PIVS3			3	Volts	Output Rectifier Maximum Peak Inverse Voltage
146	Recommended Diode					Recommended Diodes for this output
147	CMS3			0	Cmils	Output Winding Bare Conductor minimum circular mils
148	AWGS3			N/A	AWG	Wire Gauge (Rounded up to next larger standard AWG value)
149	DIAS3			N/A	mm	Minimum Bare Conductor Diameter
150	ODS3			N/A	mm	Maximum Outside Diameter for Triple Insulated Wire
151						
152						
153						
154	**Total power**			10	Watts	Total Output Power
155						
156	Negative Output	N/A		N/A		If negative output exists enter Output number; eg: If VO2 is negative output, enter 2
157						