1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
2	**Enter Application Variables**					**Design Title**
3	Input Voltage Range	Higl		**High Line**		Input voltage range
4	VACMIN			185	VAC	Minimum AC input voltage. Spreadsheet simulation is performed at this voltage. To examine operation at other votlages, enter here, but enter fixed value for LPFC_ACTUAL.
5	VACMAX			265	VAC	Maximum AC input voltage
6	VBROWNIN			167	VAC	Expected Typical Brown-in Voltage per IC specifications; Line impedance not accounted.
7	VBROWNOUT			156	VAC	Expected Typical Brown-out voltage per IC specifications; Line impedance not accounted.
8	VO			385	VDC	Nominal load voltage
9	PO	**900**		900	W	Nominal Output power
10	fL			50	Hz	Line frequency
11	TA Max			40	°C	Maximum ambient temperature
12	n			0.96		Enter the efficiency estimate for the boost converter at VACMIN. Should approximately

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						match calculated efficiency in Loss Budget section
13	VO_MIN			366	VDC	Minimum Output voltage
14	VO_RIPPLE_MAX			20	VDC	Maximum Output voltage ripple
15	tHOLDUP			20	ms	Holdup time
16	VHOLDUP_MIN			310	VDC	Minimum Voltage Output can drop to during holdup
17	I_INRUSH			40	A	Maximum allowable inrush current
18	Forced Air Cooling	Yes		**Yes**		Enter "Yes" for Forced air cooling. Otherwise enter "No". Forced air reduces acceptable choke current density and core autopick core size
19						
20	**KP and INDUCTANCE**					
21	KP_TARGET	**0.300**		0.300		Target ripple to peak inductor current ratio at the peak of VACMIN. Affects inductance value
22	LPFC_TARGET (0 bias)			324	uH	PFC inductance required to hit KP_TARGET at peak of VACMIN and full load
23	LPFC_DESIRED (0 bias)			324	uH	LPFC value used for calculations. Leave blank to

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						use LPFC_TARGET. Enter value to hold constant (also enter core selection) while changing VACMIN to examine brownout operation. Calculated inductance with rounded (integral) turns for powder core.
24	KP_ACTUAL			0.282		Actual KP calculated from LPFC_ACTUAL
25	LPFC_PEAK			324	uH	Inductance at VACMIN, 90°. For Ferrite, same as LPFC_DESIRED (0 bias)
26						
27	**Basic current parameters**					
28	IAC_RMS			5.07	A	AC input RMS current at VACMIN and Full Power load
29	IO_DC			2.34	A	Output average current/Average diode current
30						
31						
32	**PFS Parameters**					
33	PFS Part Number	PFS		**PFS7539H**		If examining brownout operation, over-ride autopick with desired device size
34	Operating Mode	Full		**Full Power**		Mode of operation of PFS. For Full

1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
						Power mode enter "Full Power" otherwise enter "EFFICIENCY" to indicate efficiency mode
35	IOCP min			10.0	A	Minimum Current limit
36	IOCP typ			10.5	A	Typical current limit
37	IOCP max			11.0	A	Maximum current limit
38	IP			8.07	A	MOSFET peak current
39	IRMS			3.20	A	PFS MOSFET RMS current
40	RDSON			0.40	Ohms	Typical RDSon at 100 'C
41	FS_PK			102	kHz	Estimated frequency of operation at crest of input voltage (at VACMIN)
42	FS_AVG			96	kHz	Estimated average frequency of operation over line cycle (at VACMIN)
43	PCOND_LOSS_PFS			4.1	W	Estimated PFS conduction losses
44	PSW_LOSS_PFS			7.9	W	Estimated PFS switching losses
45	PFS_TOTAL			12.0	W	Total Estimated PFS losses
46	TJ Max			100	deg C	Maximum steady-state junction temperature
47	Rth-JS			2.80	°C/W	Maximum thermal resistance (Junction to heatsink)

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48	HEATSINK Theta-CA		Info	0.87	°C/W	Big heatsink; Consider changing Rth or TJ
49						
50						
51	INDUCTOR DESIGN					
52	**Basic Inductor Parameters**					
53	LPFC (0 Bias)			324	uH	Value of PFC inductor at zero current. This is the value measured with LCR meter. For powder, it will be different than LPFC.
54	LP_TOL			10.0	%	Tolerance of PFC Inductor Value (ferrite only)
55	IL_RMS			4.89	A	Inductor RMS current (calculated at VACMIN and Full Power Load)
56	**Material and Dimensions**					
57	Core Type	Ferı		**Ferrite**		Enter "Sendust", "Pow Iron" or "Ferrite"
58	Core Material	Aut		**PC44/PC95**		Select from 60u, 75u, 90u or 125 u for Sendust cores. Fixed at PC44/PC95 for Ferrite cores. Fixed at -52 material for Pow Iron cores.
59	Core Geometry	Aut		**PQ**		Toroid only for Sendust and Powdered Iron; EE or PQ for Ferrite cores.

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60	Core	Auto		**PQ35/35**		Core part number
61	Ae			196.00	mm^2	Core cross sectional area
62	Le			87.90	mm	Core mean path length
63	AL			4750.00	nH/t^2	Core AL value
64	Ve			16.30	cm^3	Core volume
65	HT (EE/PQ) / ID (toroid)			7.00	mm	Core height/Height of window; ID if toroid
66	MLT			75.2	mm	Mean length per turn
67	BW			22.50	mm	Bobbin width
68	LG			1.65	mm	Gap length (Ferrite cores only)
69	**Flux and MMF calculations**					
70	BP_TARGET (ferrite only)			3900	Gauss	Target flux density at worst case: IOCP and maximum tolerance inductance (ferrite only) - drives turns and gap
71	B_OCP (or BP)			3845	Gauss	Target flux density at worst case: IOCP and maximum tolerance inductance (ferrite only) - drives turns and gap
72	B_MAX			2679	Gauss	peak flux density at AC peak, VACMIN and Full Power Load, nominal inductance
73						
74	µ_TARGET (powder only)			N/A	%	%µ at peak current vs. zero current, at VACMIN, Full

1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
						Power Load, divided by permeability at 0 current (powder only)
75	µ_MAX (powder only)			N/A	%	%µ vs. zero current, at VACMIN Full Power LOAD (powder only)
76	µ_OCP (powder only)			N/A	%	%µ vs. zero current, at IOCP_typ (powder only)
77	I_TEST			10.5	A	Current at which B_TEST and H_TEST are calculated, for checking flux at a current other than IOCP or IP; if blank IOCP_typ is used.
78	B_TEST			3671	Gauss	Flux density at I_TEST and maximum tolerance inductance
79	µ_TEST (powder only)			N/A	%	relative permeability at I_TEST and typical inductance (powder only)
80	**Wire**					
81	TURNS			52		Inductor turns. To adjust turns, change BP_TARGET (ferrite) or µ_TARGET (powder)
82	ILRMS			4.89	A	Inductor RMS current
93	**Loss calculations**					
94	BAC-p-p			804	Gauss	Core AC peak-peak flux excursion at

1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
						VACMIN, peak of sine wave
95	LPFC_CORE_LOSS			0.33	W	Estimated Inductor core Loss
96	LPFC_COPPER_LOSS			2.51	W	Estimated Inductor copper losses
97	LPFC_TOTAL_LOSS			2.84	W	Total estimated Inductor Losses
98						
99						
100	**Built-in PFC Diode**					
101	PFC Diode Part Number			INTERNAL2		PFC Diode Part Number
102	Type			SPECIAL		PFD Diode Type
103	Manufacturer			PI		Diode Manufacturer
104	VRRM			530	V	Diode rated reverse voltage
105	IF			6	A	Diode rated forward current
106	Qrr					high temperature
107	VF			1.44	V	Diode rated forward voltage drop
108	PCOND_DIODE			3.37	W	Estimated Diode conduction losses
109	PSW_DIODE			1.00	W	Estimated Diode switching losses
110	P_DIODE			4.37	W	Total estimated Diode losses
111	TJ Max			100	deg C	Maximum steady-state operating temperature
112	Rth-JS			3.00	degC/W	Maximum thermal resistance (Junction to heatsink)
113	HEATSINK Theta-CA			0.87	degC/W	Maximum thermal

1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
						resistance of heatsink
114						
115						
116	**Output Capacitor**					
117	Output Capacitor	**Aut**		820	uF	Minimum value of Output capacitance
118	VO_RIPPLE_EXPECTED			9.5	V	Expected ripple voltage on Output with selected Output capacitor
119	T_HOLDUP_EXPECTED			23.7	ms	Expected holdup time with selected Output capacitor
120	ESR_LF			0.20	ohms	Low Frequency Capacitor ESR
121	ESR_HF			0.07	ohms	High Frequency Capacitor ESR
122	IC_RMS_LF			1.58	A	Low Frequency Capacitor RMS current
123	IC_RMS_HF			1.58	A	High Frequency Capacitor RMS current
124	CO_LF_LOSS			0.50	W	Estimated Low Frequency ESR loss in Output capacitor
125	CO_HF_LOSS			0.18	W	Estimated High frequency ESR loss in Output capacitor
126	Total CO LOSS			0.68	W	Total estimated losses in Output Capacitor
127						
128						
129	**Input Bridge (BR1) and Fuse (F1)**					
130	I^2t Rating			57.58	A^2*s	Minimum I^2t rating for fuse

1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
131	Fuse Current rating			7.37	A	Minimum Current rating of fuse
132	VF			0.90	V	Input bridge Diode forward Diode drop
133	IAVG			4.58	A	Input average current at 70 VAC.
134	PIV_INPUT BRIDGE			375	V	Peak inverse voltage of input bridge
135	PCOND_LOSS_BRIDGE			8.21	W	Estimated Bridge Diode conduction loss
136	CIN			1.0	uF	Input capacitor. Use metallized polypropylene or film foil type with high ripple current rating
137	RT			9.37	ohms	Input Thermistor value
138	D_Precharge			1N5407		Recommended precharge Diode
139						
140						
141	**PFS3 small signal components**					
142	C_REF			1.0	uF	REF pin capacitor value
143	RV1			4.0	MOhms	Line sense resistor 1
144	RV2			6.0	MOhms	Line sense resistor 2
145	RV3			6.0	MOhms	Typical value of the lower resistor connected to the V-PIN. Use 1% resistor only!
146	RV4			161.6	kOhms	Description pending, could be modified based on

1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
						feedback chain R1-R4
147	C_V			0.495	nF	V pin decoupling capacitor (RV4 and C_V should have a time constant of 80us) Pick the closest available capacitance.
148	C_VCC			1.0	uF	Supply decoupling capacitor
149	C_C			100	nF	Feedback C pin decoupling capacitor
150	Power good Vo lower threshold VPG(L)			333	V	Vo lower threshold voltage at which power good signal will trigger
151	PGT set resistor			333.0	kohm	Power good threshold setting resistor
152						
153						
154	**Feedback Components**					
155	R1			4.0	Mohms	Feedback network, first high voltage divider resistor
156	R2			6.0	Mohms	Feedback network, second high voltage divider resistor
157	R3			6.0	Mohms	Feedback network, third high voltage divider resistor
158	R4			161.6	kohms	Feedback network, lower divider resistor
159	C1			0.495	nF	Feedback network, loop

1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
						speedup capacitor. (R4 and C1 should have a time constant of 80us) Pick the closest available capacitance.
160	R5			35.7	kohms	Feedback network: zero setting resistor
161	C2			1000	nF	Feedback component- noise suppression capacitor
162						
163						
164	**Loss Budget (Estimated at VACMIN)**					
165	PFS Losses			11.98	W	Total estimated losses in PFS
166	Boost diode Losses			4.37	W	Total estimated losses in Output Diode
167	Input Bridge losses			8.21	W	Total estimated losses in input bridge module
168	Inductor losses			2.84	W	Total estimated losses in PFC choke
169	Output Capacitor Loss			0.68	W	Total estimated losses in Output capacitor
170	EMI choke copper loss			0.50	W	Total estimated losses in EMI choke copper
171	Total losses			28.09	W	Overall loss estimate
172	Efficiency			0.97		Estimated efficiency at VACMIN, full load.
173						
174						

1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
175	**CAPZero component selection recommendation**					
176	CAPZero Device			CAP005DG		(Optional) Recommended CAPZero device to discharge X-Capacitor with time constant of 1 second
177	Total Series Resistance (R1+R2)			0.48	k-ohms	Maximum Total Series resistor value to discharge X-Capacitors
178						
179						
180	**EMI filter components recommendation**					
181	CIN_RECOMMENDED			1000	nF	Metallized polyester film capacitor after bridge, ratio with Po
182	CX2			680	nF	X capacitor after differencial mode choke and before bridge, ratio with Po
183	LDM_calc			151	uH	estimated minimum differencial inductance to avoid <10kHz resonance in input current
184	CX1			680	nF	X capacitor before common mode choke, ratio with Po
185	LCM			10	mH	typical common mode choke value
186	LCM_leakage			30	uH	estimated leakage inductance of CM choke,

1	Hiper_PFS-3_Boost_050625; Rev.1.1	INPUT	INFO	OUTPUT	UNITS	Continuous Mode Boost Converter Design Spreadsheet
						typical from 30~60uH
187	CY1 (and CY2)			220	pF	typical Y capacitance for common mode noise suppression
188	LDM_Actual			121	uH	cal_LDM minus LCM_leakage, utilizing CM leakage inductance as DM choke.
189	DCR_LCM	**0.10**		0.10	Ohms	total DCR of CM choke for estimating copper loss
190	DCR_LDM	**0.10**		0.10	Ohms	total DCR of DM choke(or CM #2) for estimating copper loss
191						
192	**Note: CX2 can be placed between CM chock and DM choke depending on EMI design requirement.**					
193						