User Guide for

FEBFAN7688SJXA_CP14U306 Evaluation Board

306 W/12 V PC Application with 12 V_{SB} Module Evaluation Board

Featured Fairchild Product: FAN7688

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This user guide supports the 306 W evaluation board for the 80Plus Platinum solution based on a Continuous Conduction Mode (CCM) PFC and LLC convertor using the FAN6982 with the FAN7688. It should be used in conjunction with the FAN7688 datasheet as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at www.fairchildsemi.com.

1. Introduction

The LLC converter in this Evaluation Board (EVB) is controlled by the FAN7688; it's a 16-pin controller and locates in secondary side. The FAN7688 includes PFM and PWM controls to optimization efficiency for all loading, its combine advantage SR control improves efficiency. It employs a current mode control technique based on charge control; this provides a better control-to-output and line-to-output transfer function of the power stage, simplifying the feedback loop design while allowing true input power limit capability. The PFC is controlled by the FAN6982, based on Continuous Conduction Mode (CCM), which employs leading edge modulation for average current control and has a number of advanced features for better performance and reliability.

1.1. Features

LLC:

- Secondary Side PFM Controller with Synchronous Rectifier Control
- Charge Current Control for better Transient Response and Simplified Feedback Loop Design
- Adaptive Synchronous Rectification Control with Dual Edge Tracking
- Closed Loop Soft-Start
- Green Functions to Improve Light Load Efficiency
  - Symmetric PWM Control at Light Load to Limit the Switching Frequency while Reducing Switching Losses
  - Disabling SR During Light Load Operation
- Complete Protection Functions with Auto-Restart

PFC:

- Continuous Conduction Mode and Average-Current-Mode Control
- Power-On Sequence Control
- Brownout Protection
- Fulfills Class-D Requirements of IEC 61000-3-2
- Universal AC Input Voltage
- Efficiency Optimization by External Output Voltage Adjustable Circuit

2. Evaluation Board Specifications

All data for this table was measured at an ambient temperature of 25°C.

Table 1. Summary of Features and Performance

Description	Symbol	Value	Comments
Output Power	P_O	306 W	
Efficiency	Eff, η	Meet 80PLUS Platinum	
Input Voltage	V_{AC}	90~264 V	
Input Frequency		47~63 Hz	
PFC Output Voltage	V_{PFC}	356 V / 392 V	
Output Voltage	V_{OUT}	12 V	100% Load = 300 W
12 V Standby Output	V_{12VSB}	12 V	100% Load = 6 W
Brown-In / Out Voltage	V_{AC}	85 V / 73 V	
PFC Frequency	f_{SW}	65 kHz	
LLC Frequency	f_{LLC}	39 k~150 kHz	
EVB Size	L * W * H	145 mm*122 mm*48 mm	Does not include the metal case

3. Photograph

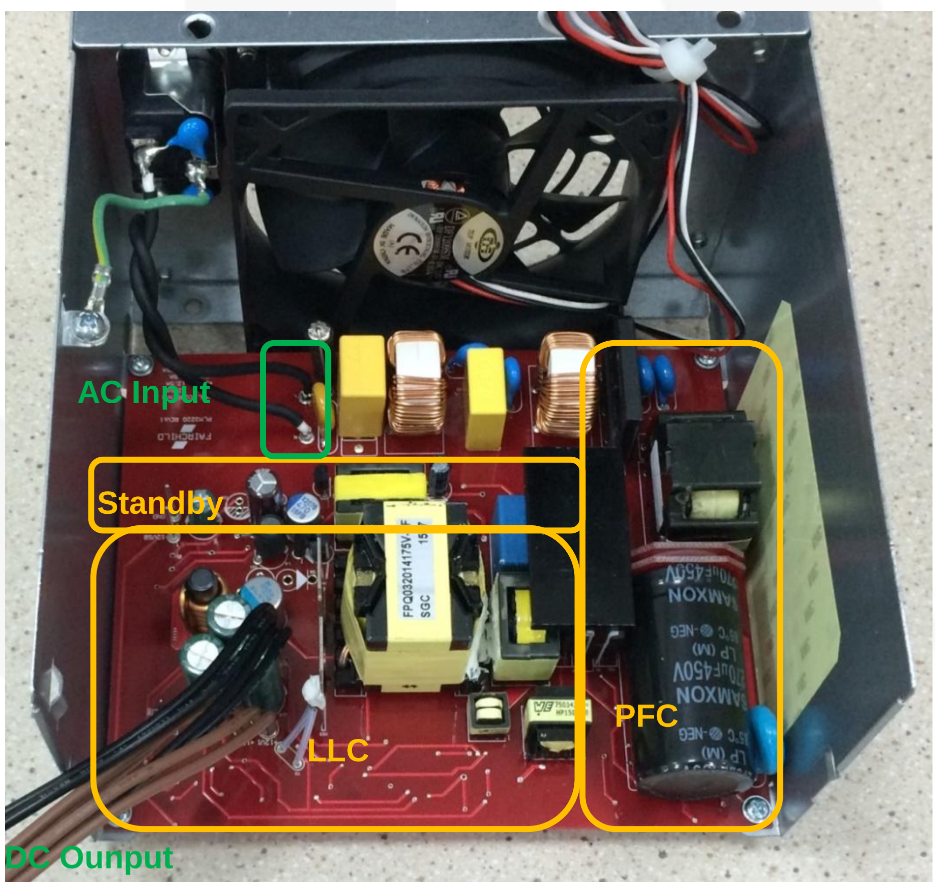


Figure 1. Top View of Evaluation Board (EVB does not include the metal case)

4. Printed Circuit Board (PCB)

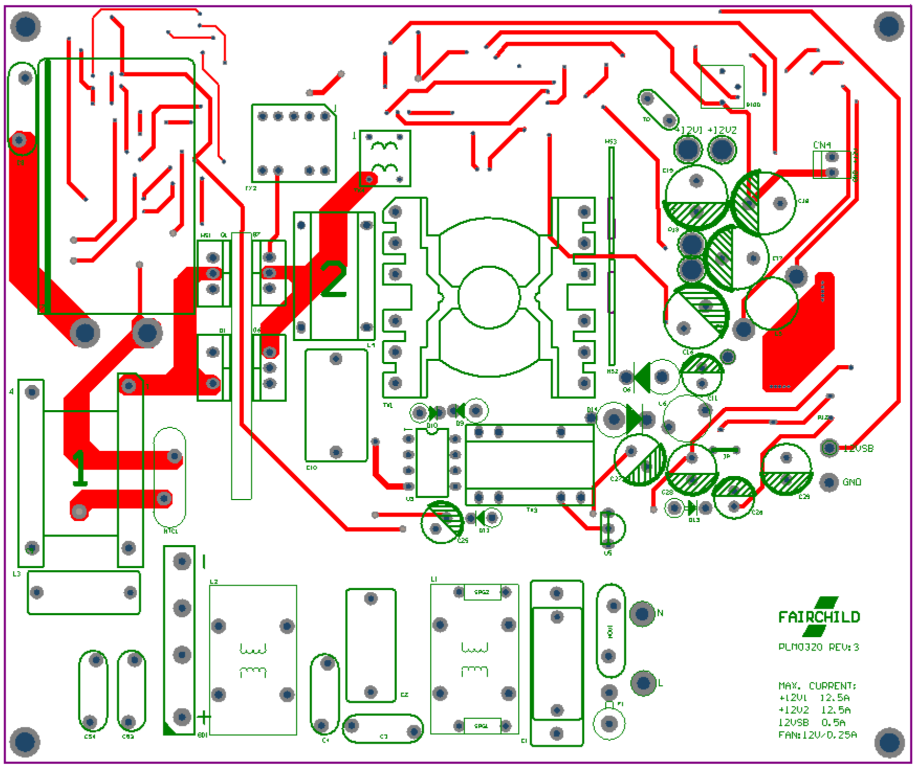


Figure 2. Top Side of Evaluation Board

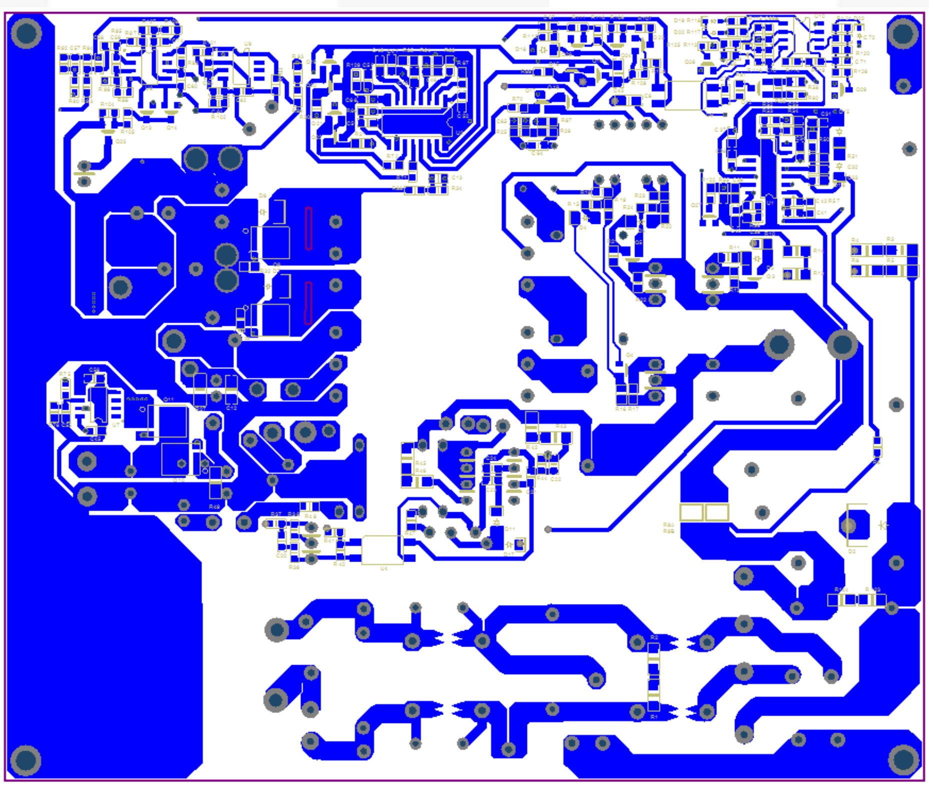


Figure 3. Bottom Side of Evaluation Board

5. Schematic

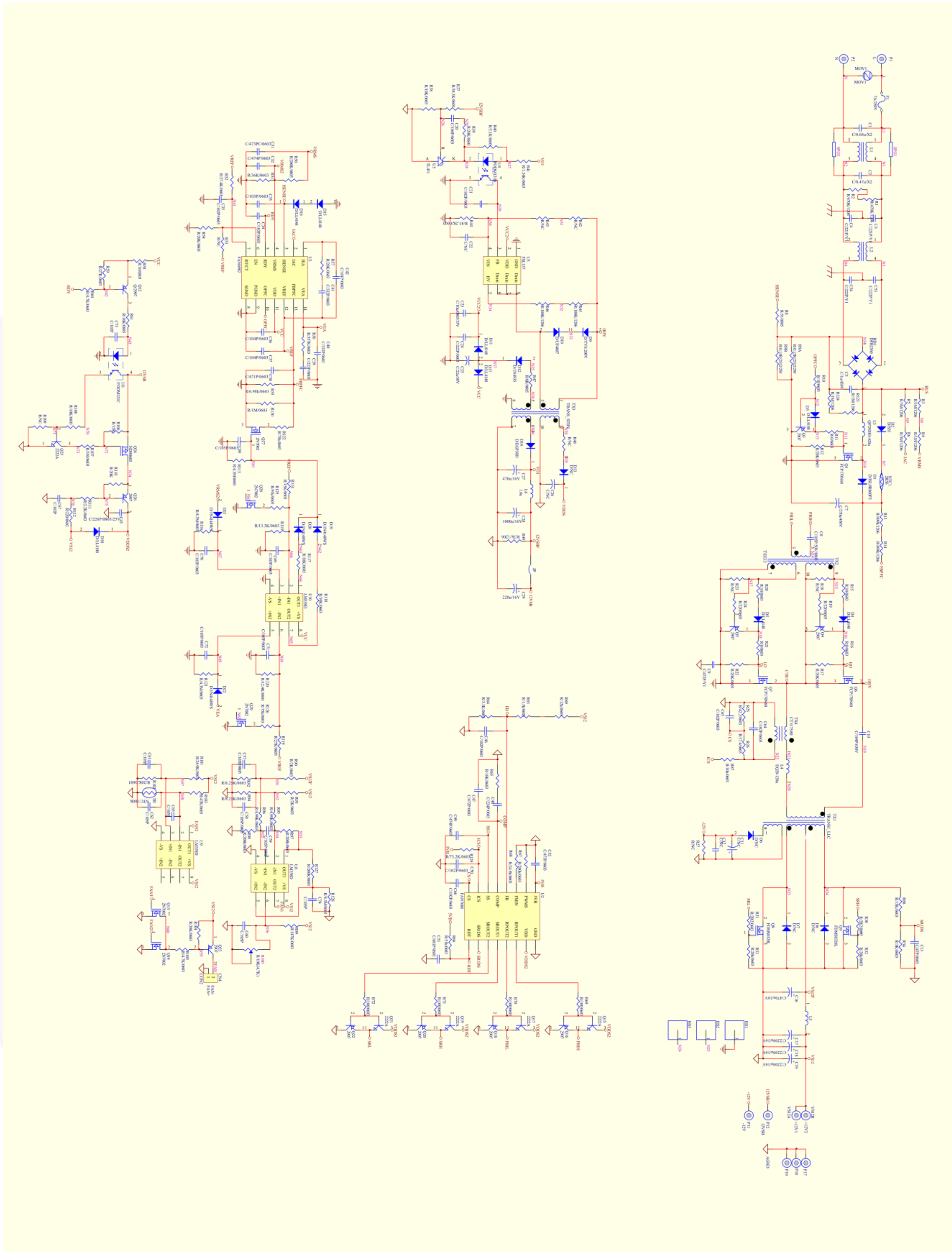


Figure 4. Evaluation Board Schematic

6. Bill of Materials

FEBFAN7688SJXA_CP14U306 BOM (PLM0320 REV.3)						
Item	**Reference**	**Qty.**	**Part No.**	**Value**	**Description**	**Manufacturer**
1	JP	1			JUMPER WIRE 0.6ψ	
2	C13	1		47 pF	C0603 X7R ±10% 50 V	
3	C42	1		100 pF	C0603 X7R ±10% 50 V	
4	C38	1		470 pF	C0603 X7R ±10% 50 V	
5	C51	1		680 pF	C0603 X7R ±10% 50 V	
6	C21, C35, C46, C50, C64, C65, C66, C67, C73	9		1 nF	C0603 X7R ±10% 50 V	
7	C24	1		2.2 nF	C0603 X7R ±10% 50 V	
8	C40, C41	2		3.3 nF	C0603 X7R ±10% 50 V	
9	C47	1		4.7 nF	C0603 X7R ±10% 50 V	
10	C31, C52	2		47 nF	C0603 X7R ±10% 50 V	
11	C33, C34	2		10 nF	C0603 X7R ±10% 50 V	
12	C39	1		22 nF	C0603 X7R ±10% 50 V	
13	C20, C36, C37	3		100 nF	C0603 X7R ±10% 50 V	
14	C48	1		220 nF	C0603 X7R ±10% 50 V	
15	C32, C49	2		470 nF	C0603 X7R ±10% 16 V	
16	C57, C58, C59, C60, C61, C62, C63, C68, C69, C70, C71, C72, C74	13		1 µF	C0603 X7R ±10% 50 V	
17	C8	1		1 µF	C0805 X7R ±10% 50 V	
18	C23	1		10 µF	C0805 X7R ±10% 25 V	
19	C43	1		22 µF	C0805 X7R ±10% 25 V	
20	R11, R16, R21	3		0 Ω	R0603 ±1%	
21	R30, R31	2		2.2 Ω	R0603 ±1%	
22	R10, R15, R20, R58	4		10 Ω	R0603 ±1%	
23	R26	1		17.4 Ω	R0603 ±1%	
24	R25	1		42.2 Ω	R0603 ±1%	
25	R8	1		51 Ω	R0805 ±1%	
26	R69, R70, R71, R72	4		100 Ω	R0603 ±1%	
27	R19, R24, R112	3		220 Ω	R0603 ±1%	
28	R107	1		330 Ω	R0603 ±1%	
29	R41	1		1.24 KΩ	R0603 ±1%	
30	R63	1		1.5 KΩ	R0603 ±1%	
31	R90, R93	2		2 KΩ	R0603 ±1%	
32	R111	1		2.2 KΩ	R0603 ±1%	
33	R34	1		3 KΩ	R0603 ±1%	

FEBFAN7688SJXA_CP14U306 BOM (PLM0320 REV.3)						
Item	**Reference**	**Qty.**	**Part No.**	**Value**	**Description**	**Manufacturer**
34	R64	1		3.3 KΩ	R0603 ±1%	
35	R60, R105	2		4.7 KΩ	R0603 ±1%	
36	R95, R96	2		4.99 KΩ	R0603 ±1%	
37	R40	1		5.1 KΩ	R0603 ±1%	
38	R55	1		6.98 KΩ	R0603 ±1%	
39	R92, R94	2		8.25 KΩ	R0603 ±1%	
40	R38, R65, R87, R108, R117, R118	6		10 KΩ	R0603 ±1%	
41	R89	1		12 KΩ	R0603 ±1%	
42	R120	1		12.4 KΩ	R0603 ±1%	
43	R115	1		13.3 KΩ	R0603 ±1%	
44	R88, R106, R114	3		15 KΩ	R0603 ±1%	
45	R12, R17, R22, R32, R33, R39, R54, R57, R102, R104, R110	11		20 KΩ	R0603 ±1%	
46	R68, R101	2		24.9 KΩ	R0603 ±1%	
47	R59, R119	2		27 KΩ	R0603 ±1%	
48	R52	1		27.4 KΩ	R0603 ±1%	
49	R51	1		36 KΩ	R0603 ±1%	
50	R37	1		38.3 KΩ	R0603 ±1%	
51	R44	1		43.2 KΩ	R0603 ±1%	
52	R103	1		47 KΩ	R0603 ±1%	
53	R66	1		51 KΩ	R0603 ±1%	
54	R129	1		73.2 KΩ	R0603 ±1%	
55	R122, R126	2		75 KΩ	R0603 ±1%	
56	R125	1		91 KΩ	R0603 ±1%	
57	R99	1		147 KΩ	R0603 ±1%	
58	R67, R97, R98, R127	4		200 KΩ	R0603 ±1%	
59	R56	1		357 KΩ	R0603 ±1%	
60	R130 (Parallel with R55)	1		1 MΩ	R0603 ±5%	
61	R113, R116, R121, R128	4		4.3 MΩ	R0603 ±5%	
62	R47	1		0 Ω	R0805 ±1%	
63	R61	1		10 KΩ	R0805 ±1%	
64	R50	1		200 KΩ	R0805 ±1%	
65	R49	1		3 KΩ	R1206 ±1%	
66	R45, R46	2		100 KΩ	R1206 ±1%	
67	R1, R2	2		470 KΩ	R1206 ±1%	

FEBFAN7688SJXA_CP14U306 BOM (PLM0320 REV.3)						
Item	**Reference**	**Qty.**	**Part No.**	**Value**	**Description**	**Manufacturer**
68	R13, R14	2		499 KΩ	R1206 ±1%	
69	R3, R4, R123, R124	4		1 MΩ	R1206 ±5%	
70	R5, R6	2		3 MΩ	R1206 ±5%	
71	R9A, R9B	2		0.15 Ω	R2512 ±1% 2 W	
72	R100	1		10 KΩ	VR	
73	C1	1		0.68 µF	X2 Capacitor 275 V ±10% (11.5*19.5*17.5 mm Pitch=15 mm)	
74	C2	1		0.47 µF	X2 Capacitor 275 V ±10% (18*8.5*16.5 mm, Pitch=15 mm)	
75	C53, C54	2	CD12-E2GA222MYASA	2.2 pF	Y1 Capacitor 250 V ±20%	UNIVERSE CONDENSER
76	C3, C4	2		0.22 pF	Y1 Capacitor 250 V ±20%	
77	C9	1		4.7 pF	Y1 Capacitor 250 V ±20% (19x8x10 mm)	
78	C10	1	MP3S104J0630DB1151H	0.1 µF	MP3S Capacitor DC630V	FUH BANG
79	C25	1		22 µF	Electrolytic Capacitor 50 V 105°C 5*11 mm LHK	HONJU
80	C29	1		220 µF	Electrolytic Capacitor 16 V 105°C 6.3*11 mm GF	SAMXON
81	C7	1		270 µF	Electrolytic Capacitor 450 V 105°C 25*45 mm LP	SAMXON
82	C27	1		470 µF	Solid Capacitor 16 V 8*11.5 mm ULR	HE SHEN TANG
83	C28	1		1000 µF	Electrolytic Capacitor 16 V 105°C 8*18 mm	
84	C17, C18, C19	3		2200 µF	Electrolytic Capacitor 16 V 105°C 10*25 mm	
85	C16	1		470 µF	Solid Capacitor 16 V 10*11.5 mm PSF	HE SHEN TANG
86	C5	1	TF105K2Y159L270D9R	1 µF	MTF Capacitor 450 V ±10%	KENJET TECHNOLOGY
87	BD1	1	DFB2560		Bridge 25 A/600 V TS-6P	Fairchild
88	D1	1	ISL9R860P2		Diode 8 A/600 V TO-220	Fairchild
89	D10	1	UF4007		Diode 1 A/1000 V DO-41	Fairchild
90	D12	1	1N4935		Diode 1 A/200 V DO-41	Fairchild
91	D14	1	EGP30D		Diode 3 A/200 V	Fairchild
92	D19, D20, D21, D22	4	1N4148WS		Diode SOD-32F	Fairchild
93	D2	1	S3J		Diode 3 A/600 V SMC	Fairchild
94	D3, D4, D5, D11, D15, D16, D17, D18	8	LL4148		Diode 200 mA/100 V SOD80	Fairchild

FEBFAN7688SJXA_CP14U306 BOM (PLM0320 REV.3)						
Item	**Reference**	**Qty.**	**Part No.**	**Value**	**Description**	**Manufacturer**
95	D9	1	P6KE200A		TVS	Fairchild
96	Q1, Q6, Q7	3	FCP170N60		MOS 22 A/ 600 V TO-220	Fairchild
97	Q13, Q14, Q27, Q28, Q29	5	2N7002		SOT-23	Fairchild
98	Q15, Q17, Q19, Q21, Q25	5	MMBT2222A		SOT-23	Fairchild
99	Q24	1	NDS0605		-0.18 A/ -60 V SOT-23	Fairchild
100	Q3, Q4, Q5, Q12, Q16, Q18, Q20, Q22, Q23, Q26	10	MMBT2907A		SOT-23	Fairchild
101	Q8, Q9	2	FDMS8320L		100 A /40 V, Power56	Fairchild
102	U1	1	FAN6982MY		IC SO-14L	Fairchild
103	U2	1	FAN7688SJX		IC	Fairchild
104	U3	1	FSL137MRIN		MDIP 8L	Fairchild
105	U4, U6	2	FODM121C		MFP 4L	Fairchild
106	U5	1	KA431LZTA		TO-92R	Fairchild
107	U8, U9, U10	3	LM358M		SO-8L	Fairchild
108	L1, L2	2	SN20128A		EMI Choke	FORMOSA SHING GA
109	L3	1			Inductor QP2920H 420 µH	YUJING
110	L4	1	102Q553		Inductor EQ20 120 µH	SUMIDA
111	L5	1			Inductor 0.75 µH	SHOWWELL
112	TX1	1	FPQ032014175V-PF		Transformer PQ3230 (PC44)	SHOWWELL
113	TX2	1	750342754		Transformer EE13	Würth Elektronik
114	TX3	1	078Q561		Transformer EQ20	SUMIDA
115	TX4	1	750342753		Transformer EE8.3	Würth Elektronik
116	L6	1			TRN-00199	
117	TR	1	TTC104	100 KΩ	NTC 5ψ	
118	FAN	1			Connect WAFER (2530HHS) 2P 2.5 mm 180°	
119	F1	1			FUSE GLASS 7 A/250 V QUICK 5*20 mm	
120	MOV1	1	TVR10471KSY		Varistor ATOM MOV	
121	NTC1	1	SCK132R56MYS		NTC 13ψ SCK2R56	
122	HS1	1	MCH0146		Heat Sink	
123	HS2, HS3	2			Heat Sink	
124		2			Power Cable 1007#16AWG +3.2ψ HOOK	YIYI
125	12VSB, GND	2			Test Pin	

FEBFAN7688SJXA_CP14U306 BOM (PLM0320 REV.3)						
Item	**Reference**	**Qty.**	**Part No.**	**Value**	**Description**	**Manufacturer**
126		1			Heat Shrinkable Tubing 3*15 mm	
127		1			Heat Shrinkable Tubing 6*20 mm	
128		3			MCH0040 Bead Core C8B 3.5*3.2*1.0	
129		4			Bushing TO220 602M	
130		4			Silicone Sheet TO-220	
131		2			Screws 3ψ12 mm	
132		6			Nut 3ψ	
133		4			Copper Tube M3 6.5*6 mm	
134		1			CANADA Silicone ES2482W 333 ml	
135		2			Heat Shrinkable Tubing 3*7.5 mm (for YS-201M)	
136	SPG1, SPG2	2			Surge Absorber YS-201M	

7. Transformer and Winding Specifications

7.1. Main Transformer (TX1)

- Core: PQ3230 (PC44)
- Bobbin: 12 Pins

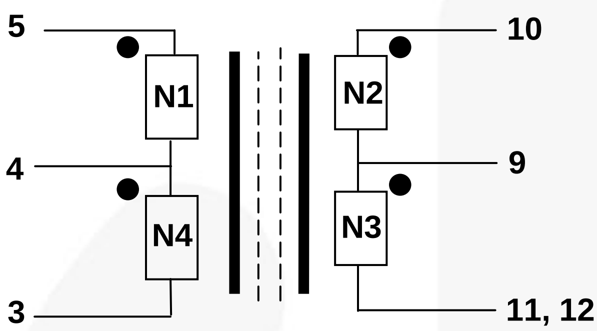


Figure 5. Transformer Specifications of TX1

Table 2. Winding Specifications

No.	Winding	Pin (S → F)	Wire	Turns	Winding Method
1	N1	5 → 4	0.7φ×1	20	Solenoid Winding
2	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
3	N2	10 → 9	Copper foil 0.3 mm (3T), W=15 mm Copper Foil to Pin, 0.7φ*2	3	N2, N3 are the same copper foil
4	N3	9 → 11, 12		3	
5	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
6	N4	4 → 3	0.7φ×1	20	Solenoid Winding
7	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
8	0.8T Open loop shielding to PIN2				
9	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
10	1.2T Close loop shielding on outside to PIN2				
11	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				

Table 3. Electrical Characteristics

	Pins	Specifications
Inductance	3 - 5	1.75 mH ±5%

7.2. Resonant Inductor (L4)

- Core: EQ20 (TP5)
- Bobbin: 10 Pins

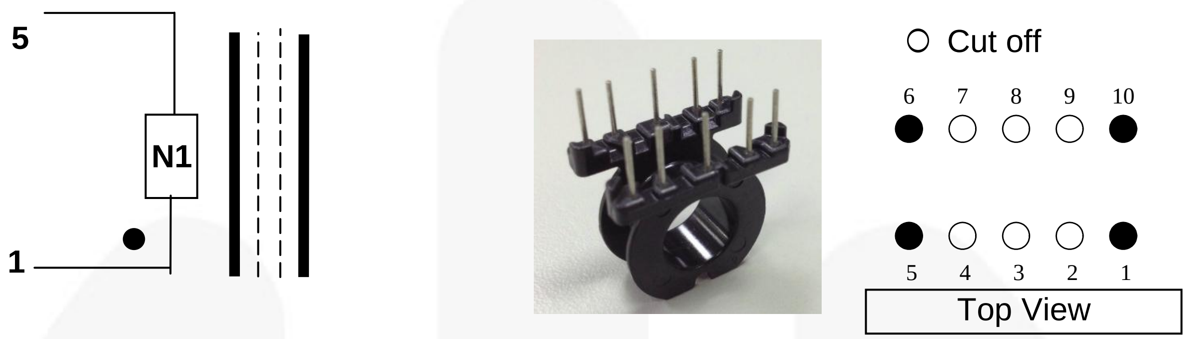


Figure 6. Transformer Specifications of L4

Table 4. Winding Specifications

No.	Winding	Pin (S → F)	Wire	Turns	Winding Method
1	N1	1 → 5	0.1φ×40	24	Solenoid Winding

Table 5. Electrical Characteristics

	Pins	Specifications
Inductance	1 - 5	120 µH ±5%

7.3. Pulse Transformer (TX2)

- Core: EE13 (3C90)
- Bobbin: 10 Pins

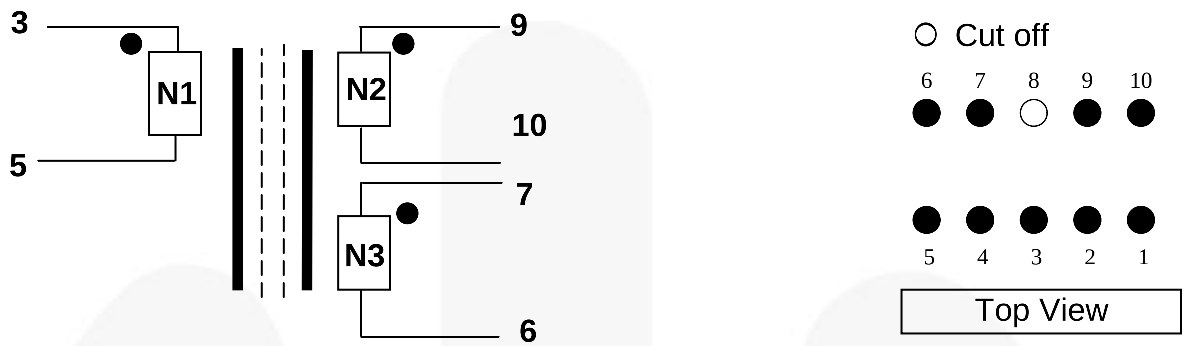


Figure 7. Transformer Specifications of TX2

Table 6. Winding Specifications

No.	Winding	Pin (S → F)	Wire	Turns	Winding Method
1	N1	3 → 5	0.2φ×1	15	Solenoid Winding
2	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
3	N2	9 → 10	0.15φ×1	18	Solenoid Winding Transformer Triple Wire
4	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
5	N2	7 → 6	0.2φ×1	18	Solenoid Winding
6	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				

Table 7. Electrical Characteristics

	Pins	Specifications
Inductance	3 – 5	>200 μH

7.4. Current Transformer (TX4)

- Core: EE8.3 (3C90)
- Bobbin: 4 Pins

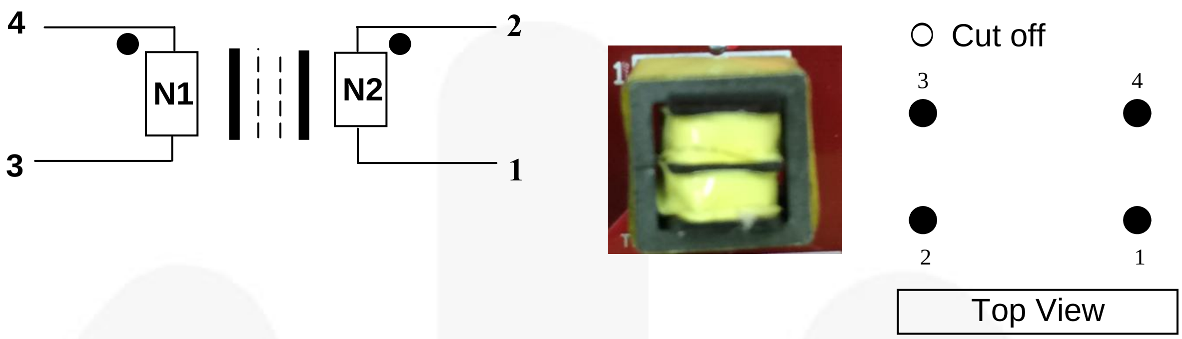


Figure 8. Transformer Specifications of TX4

Table 8. Winding Specifications

No.	Winding	Pin (S → F)	Wire	Turns	Winding Method
1	N1	4 → 3	0.1φ×50	0.75	Solenoid Winding
2	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				
3	N2	2 → 1	0.15φ×1	80	Solenoid Winding
4	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				

Table 9. Electrical Characteristics

	Pins	Specifications
Inductance	1 – 2	> 4 mH

7.5. PFC Inductor (L3)

- Core: QP2920H (3C94)
- Bobbin: 4 Pins

Figure 9. Transformer Specifications of L3

Table 10. Winding Specifications

No.	Winding	Pin (S → F)	Wire	Turns	Winding Method
1	N1	1 → 3	0.1φ×50	40	Solenoid Winding
2	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				

Table 11. Electrical Characteristics

	Pins	Specifications
Inductance	1 – 2	420 μH ± 5%

7.6. 12 V Standby Transformer (TX3)

- Core: EQ20 (TP5)
- Bobbin: 10 Pins

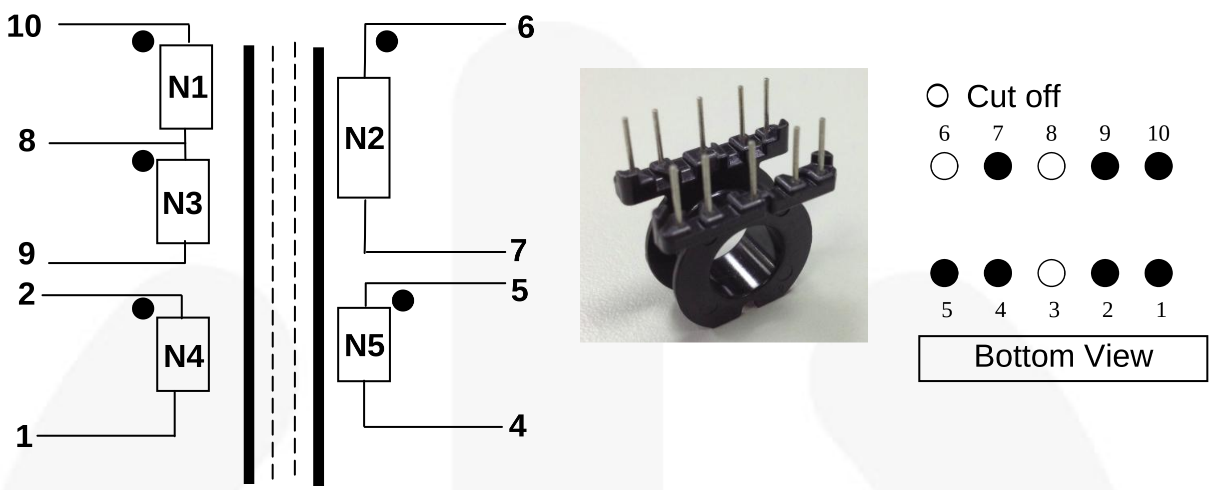


Figure 10. Transformer Specifications of TX3

Table 12. Winding Specifications

No.	Winding	Pin (S → F)	Wire	Turns	Winding Method
1	N1	10 → 8	0.2φ×1	49	Solenoid Winding
2	Insulation: Polyester Tape t = 0.025 mm, 2-Layer				
3	N2	6 → 7	0.25φ×2	11	Solenoid Winding Transformer Triple Wire
4	Insulation: Polyester Tape t = 0.025 mm, 2-Layer				
5	N2	8 → 9	0.2φ×1	22	Solenoid Winding
6	Insulation: Polyester Tape t = 0.025 mm, 2-Layer				
7	N2	2 → 1	0.15φ×1	15	Solenoid Winding
8	Insulation: Polyester Tape t = 0.025 mm, 2-Layer				
9	N2	5 → 4	0.2φ×1	16	Solenoid Winding
10	Insulation: Polyester Tape t = 0.025 mm, 2-Layer				
11	1.2T Close loop shielding on outside to PIN1				
12	Insulation: Polyester Tape t = 0.025 mm, 3-Layer				

Table 13. Electrical Characteristics

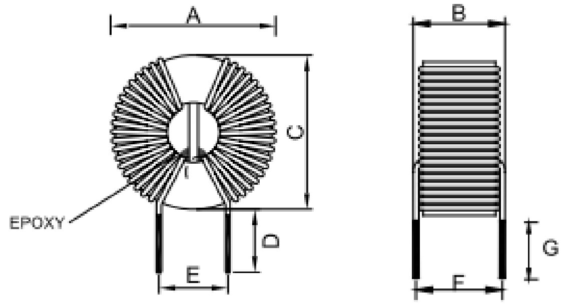
	Pins	Specifications
Inductance	10 – 9	820 μH ± 5%

7.7. EMI Choke (L1, L2)

FORMOSA SHING GA ENTERPRISE CO., LTD.

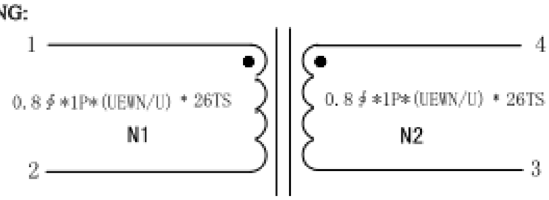
CUSTOMER	FAIRCHILD	CUSTOMER P/N		CORE TYPE	SN-20128-A

1. DIMENSION (Unit:mm) & SCHEMATIC



A = 25.2 MAX
B = 15.0 MAX
C = 23.5 MAX
D = 10.0 ± 1.0
E = 13.0 REF
F = 16.0 REF
G = 8.0 ± 1.0 (mm)

2. WINDING:



3. ELECTRICAL SPECIFICATION:

3.1 INDUCTANCE: HP-4284A AT :10KHz/0.1V
L(1--2):20.0mH(MIN) L(4--3):20.0mH(MIN)

3.2 DCR : HK-502BC at 25℃
R(1--2): 45mΩ MAX / R(4--3): 45mΩ MAX

3.3 HI-POT : HY-7110COIL-COIL
500V AC 5mA 60Hz , 3SEC

4. MATERLAL LIST:

NO	ITEM	MATERIAL	MANUFACTURER	UL NUMBER
1	CORE	SN-20128-A	SHING GA	
2	WIRE	UEWN/U 130℃	PACIFIC	E201757
3	PCB	FR-4 1.6㎜/t	KINGBOARD	E123995
4	EPOXY	3300/3300A/B-1	EATTO	E218090
		G-9007	TIANLONG(GUDAK)	

APPROVE	REVIEWED	PREPARED	SHING GA P/N	SN20128A08226
Pin Chen	Steven Chang	Henry Tsai	DATE	2015-03-26
			REV.	A
			PAGE	1 OF 1

Figure 11. Transformer Specifications of L1 and L2

8. Test Conditions & Test Equipment

8.1. Features

Table 14. Test Conditions & Test Equipment

Test Mode	FEBFAN7688SJXA_CP14U306			
Test Date	May 29, 2015			
Test Temperature	Ambient 25ºC			
Test Equipment	AC Source: EXTECH 6800 AC/DC Electronic Load: Chroma 63030 Power Meter: Chroma 6630 Oscilloscope: Lecroy 24MXs-B			
Test Items	1. Current Harmonic 2. AC Trim up & Trim down 3. Efficiency 4. Output Transient Response 5. 392 V to 354 V && 354 V to 392 V @Loading 6. 392 V to 354 V && 354 V to 392 V @Vrms 7. Hold-up time 8. AC Cycle Drop 9. AC Transient 10. SURGE & ESD 11. EMI			
Test Loading	306 W (Loading shown in Amps)			
	Loading	12V1	12V2	12Vsb
	100%	12.5	12.5	0.5
	50%	6.25	6.25	0.25
	20%	2.5	2.5	0.1
	Min.	1.25	1.25	0.05

9. Performance of Evaluation Board

9.1. Current Harmonic Test:

Test Condition:

Measure input current power factor (PF) and total harmonic distortion (THD, IEC61000-3-2, Class D) at various line and output loading.

A PF less than 0.95 in 230 V/50 Hz can cause a fast response of PFC voltage loop in some test requirement; it can be fine tuned to meet PF > 0.95 when it is needed.

Test Results:

Input Voltage	Condition	PF	THD (%)	Class D
100 V/50 Hz	Input 75 W	0.983	14.170	Pass
	Mid. Load	0.980	13.390	Pass
	100% Load	0.992	8.310	Pass
230 V/50 Hz	Input 75 W	0.879	17.330	Pass
	Mid. Load	0.939	16.410	Pass
	100% Load	0.976	11.560	Pass

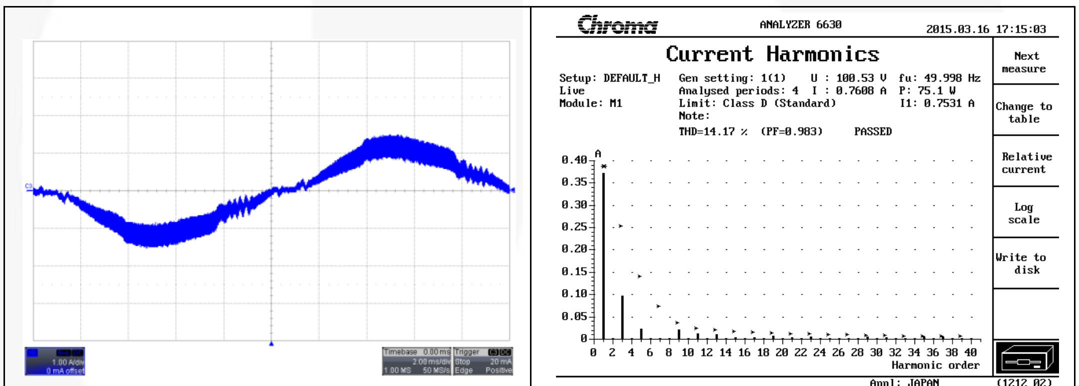


Figure 12. Input Current Waveform and THD Test Result in 115 V_{AC} 75 W Load, 100 V/50 Hz

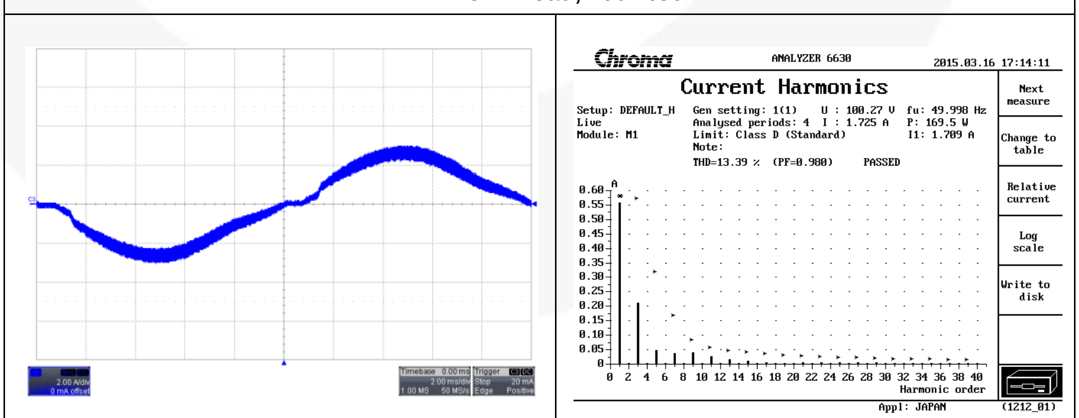


Figure 13. Input Current Waveform and THD Test Result in 115 V_{AC}, Mid. Load

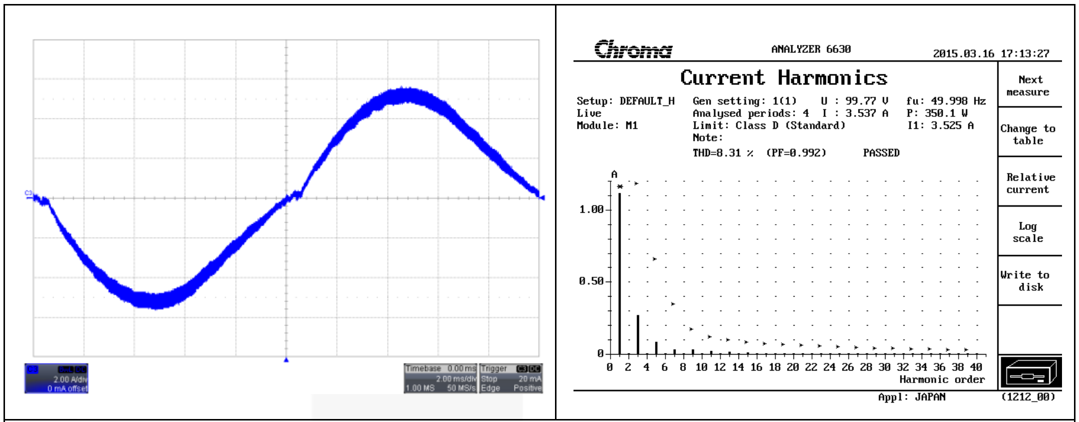


Figure 14. Input Current Waveform and THD Test Result in 115 V_{AC}, 100% Load

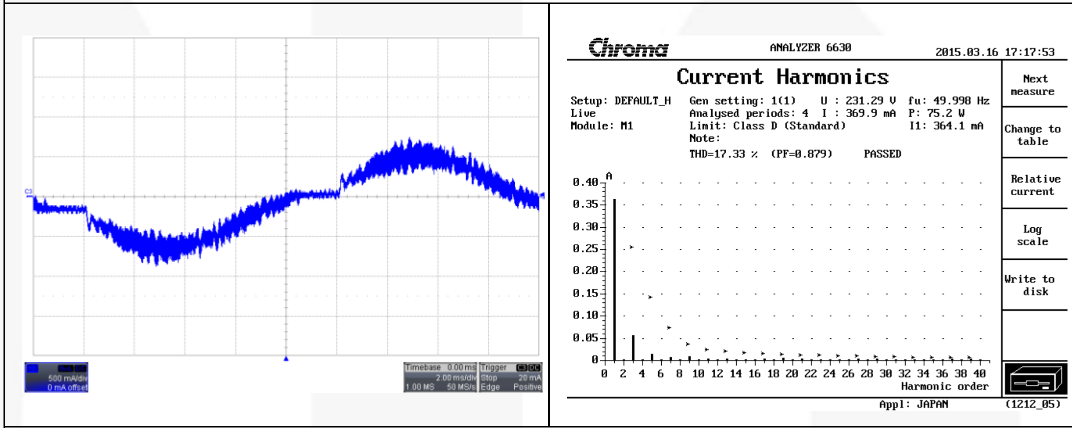


Figure 15. Input Current Waveform and THD Test Result in 230 V_{AC}, 75 W Load, 230 V/50 Hz

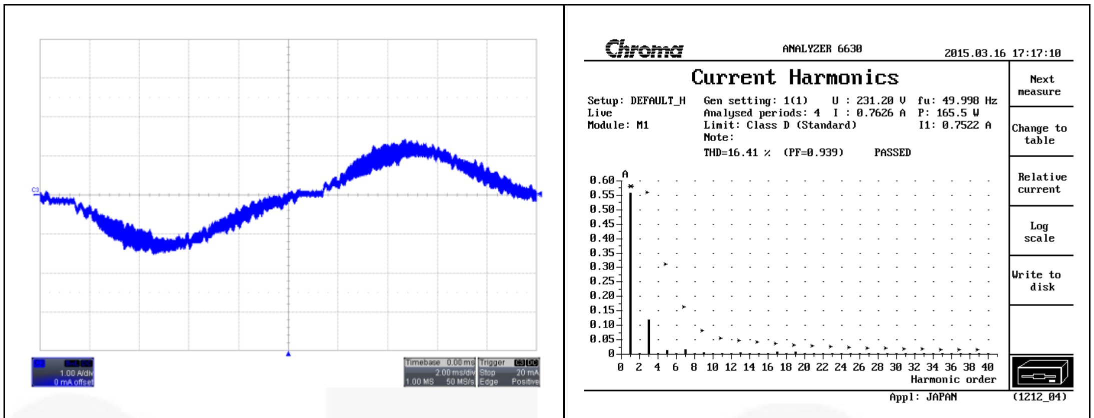


Figure 16. Input Current Waveform and THD Test Result in 230 V_{AC}, Mid. Load

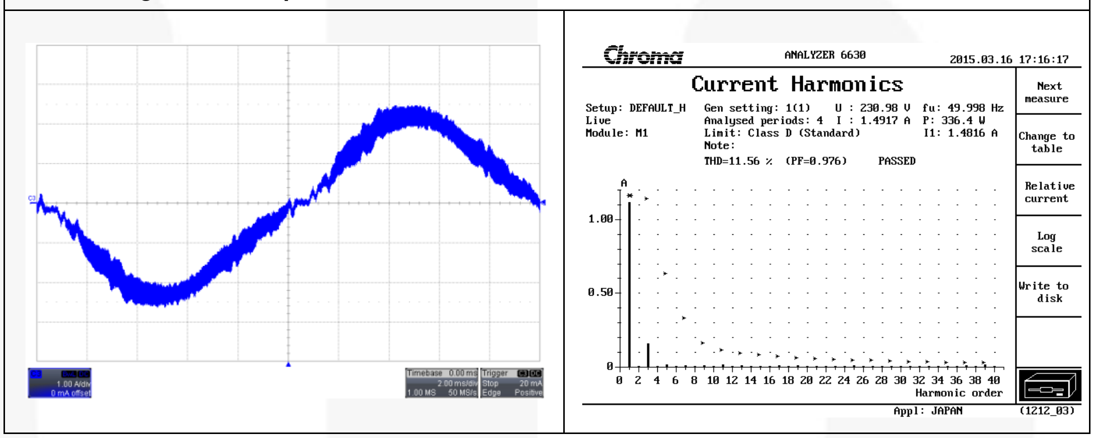


Figure 17. Input Current Waveform and THD Test Result in 230 V_{AC}, 100% Load

9.2. AC Trim Up & Trim Down

Test Condition:

Switch the input voltage from 90 V to 264 V or from 264 V to 90 V. The output voltages should be normal and the output of PFC bus should be less than 450 V.

Test Results:

90 V→264 V	264 V →90 V
50% Load	50% Load
Pass	Pass

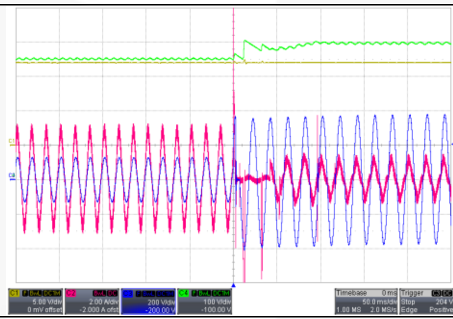
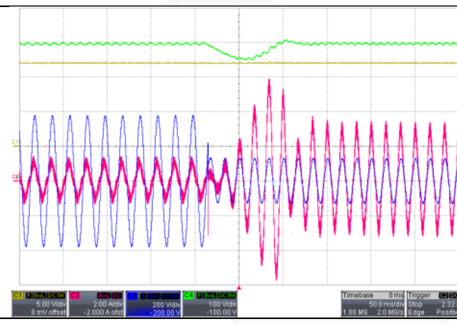
Ch1:12Vo, Ch2: Iin, Ch3: VAC, Ch4:Vbulk	
90 V→264 V	264 V→90 V
	

Figure 18. Test Waveform of AC Trim Up & Trim Down

9.3. Efficiency

Test Condition:

Measure input current Power Factor (PF) and Total Harmonic Distortion (THD, Class D) at various line and output loading.

Test Results:

	Input Watts (W)	Output Watts (W)			12V FAN	Efficiency	Standard
		12V1	12V2	12Vsb			
When V_{IN}= 115 V, at 100% Load	344.00	152.31	152.28	6.00	ON	90.28%	> 89%
When V_{IN}= 115 V, at 50% Load	167.30	76.37	76.39	3.01	OFF	93.10%	> 92%
When V_{IN}= 115 V, at 20% Load	69.00	30.63	30.67	1.21	OFF	90.59%	> 90%
When V_{IN}= 230 V, at 100% Load	336.80	152.31	152.31	6.00	ON	92.22%	> 91%
When V_{IN}= 230 V, at 50% Load	165.30	76.37	76.39	3.01	OFF	94.23%	> 94%
When V_{IN}= 230 V, at 20% Load	68.50	30.63	30.66	1.21	OFF	91.24%	> 90%

9.4. Output Transient Response

Test Condition:

Figure 19 summarizes the expected output transient step sizes for each output. Input =115 V_{AC}; I_O= 0~7.2 A or I_O= 4.8~12 A. The transient load slew rate is = 1.0 A/μS.

Test Result:

V_{IN}=115 V	0~7.2 A (mV)	4.8~12 A (mV)
12V1	**448**	**462**
12V2	**452**	**465**

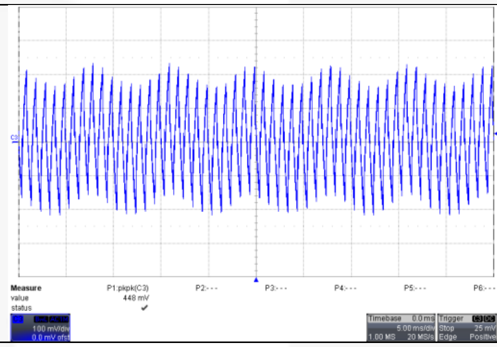
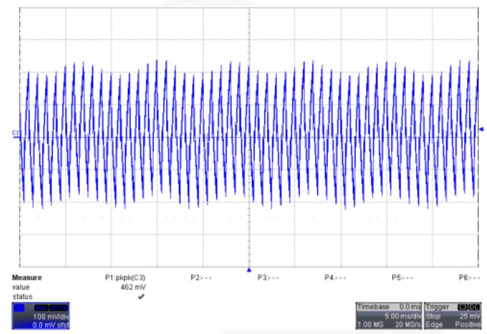
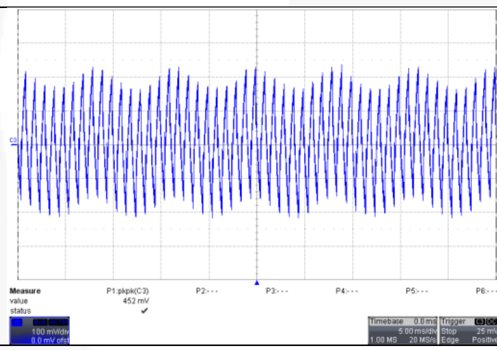
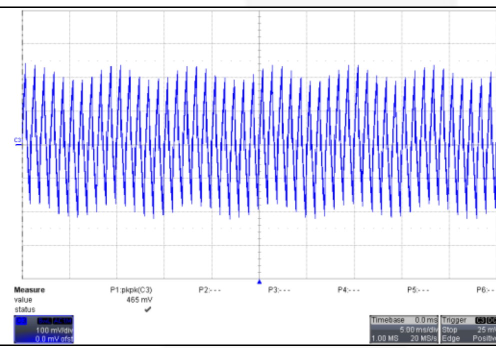
12V1, 0~7.2 A	12V1, 4.8~12 A
	
12V2, 0~7.2 A	**12V2, 4.8~12 A**
	

Figure 19. Test Waveform of Output Transient Response

9.5. 390 V to 358 V && 358 V to 390 V at Loading

Test Condition:

Load: 100% load, during the loading-point to change, the PFC bulk voltage steps up to 390 V from 358 V or steps down to 358 V from 390 V.

Test Results:

Input Voltage	Loading (A)	Loading (%)
115 V / 60 Hz 390 V to 358 V	15.37	61.5
230 V / 60 Hz 390 V to 358 V	16.09	64.4
115 V / 60 Hz 358 V to 390 V	17.9	71.6
230 V / 60 Hz 358 V to 390 V	18.7	74.8

9.6. 390 V to 358 V && 358 V to 390 V at Vrms

Test Condition:

Load: 100%. Load, during the AC input to change, the PFC bulk voltage steps up to 390 V from 358 V or steps down to 358 V from 390 V.

Test Results:

Loading & Bulk Voltage	Input Voltage
Loading = 100% 390 V to 358 V	235 V
Loading = 100% 358 V to 390 V	253 V

9.7. Hold up Time

Test Condition:

After AC power off, the output voltages should stay at nominal value for at least 17 ms.

Test Results:

Hold up Time					
90 V/60 Hz			264 V/50 Hz		
100% Load	50% Load	20% Load	100% Load	50% Load	20% Load
17.09 ms	**23.56 ms**	**66.51 ms**	**17.61 ms**	**68.59 ms**	**134.68 ms**
Vbulk 395 V	Vbulk 352 V	Vbulk 352 V	Vbulk 395 V	Vbulk 395 V	Vbulk 395 V

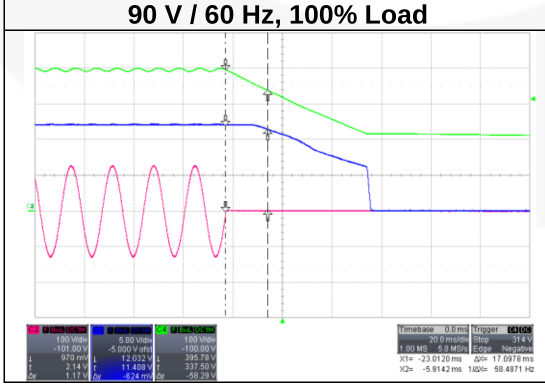
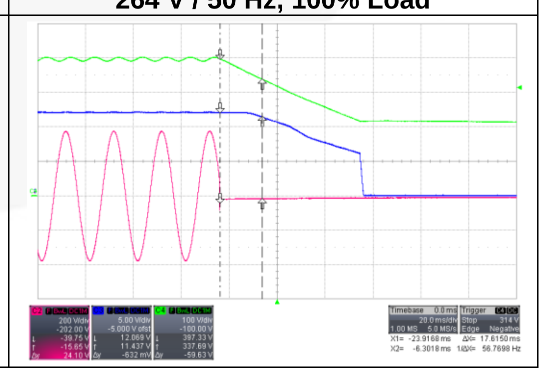
Ch2: V_{AC}, Ch3:12Vo, Ch4:Vbulk	
90 V / 60 Hz, 100% Load	264 V / 50 Hz, 100% Load
	

Figure 20. Test Waveform of Hold up Time

9.8. AC Cycle Drop

Test Condition:

After AC input drop 0.5 cycle, check system to ensure that no damage occurred and behavior is correct. If the AC drop time increases to 1 cycle, the Vbulk will drop too much to make the 12 V V_O also drop. So, it's also about min. frequency of controller.

Test Results:

115 V→0 V→115 V	230 V→0 V→230 V
100% Load	100% Load
Pass	**Pass**

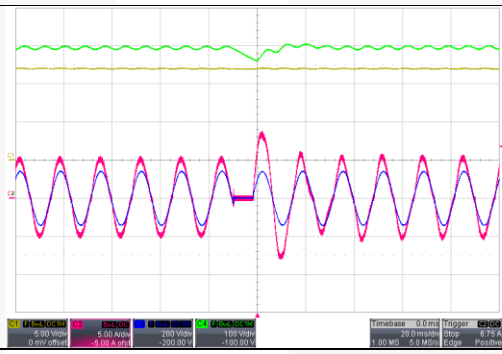
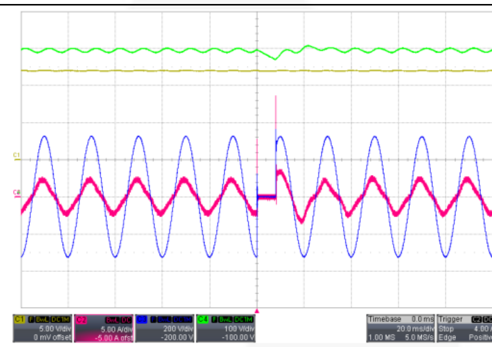
Ch1: 12Vo, Ch2: Iin, Ch3: VAC, Ch4: Vbulk	
115 V→0 V→115 V, Max. Load	**230 V→0 V→230 V, Max. Load**
	

Figure 21. Test Waveform of AC Cycle Drop

9.9. AC Transient

Test Condition:

AC Transient in 115 V→80 V→115 V and 230 V→160 V→230 V conditions, check system to ensure that no damage occurred and behavior is correct.

Test Results:

115 V→80 V→115 V	230 V→160 V→230 V
100% Load	100% Load
Pass	**Pass**

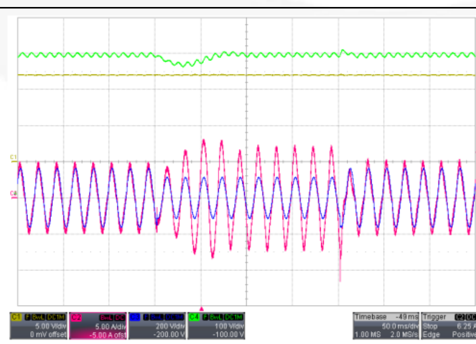
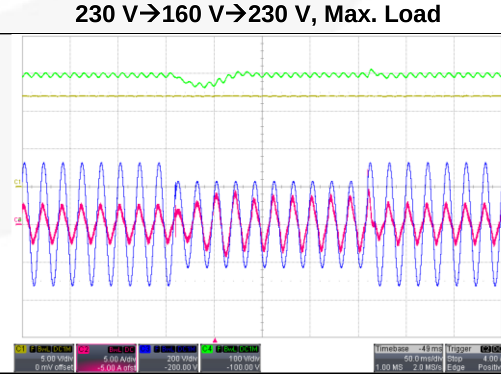
Ch1: $12V_O$, Ch2: Iin, Ch3: VAC, Ch4: Vbulk	
115 V→80V→115 V, Max. Load	**230 V→160 V→230 V, Max. Load**
	

Figure 22. Test Waveform of AC Transient

9.10. Surge & ESD

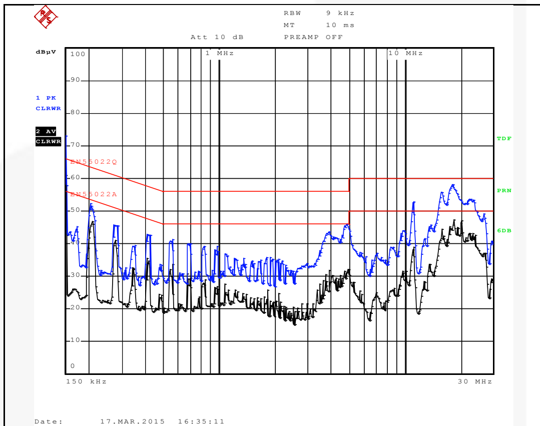
L-PE ±3k V	N-PE ±3k V	L-N ±1k V	AIR ±16k V	Contact ±8k V
Pass	Pass	Pass	Pass	Pass

9.11. EMI Conduction

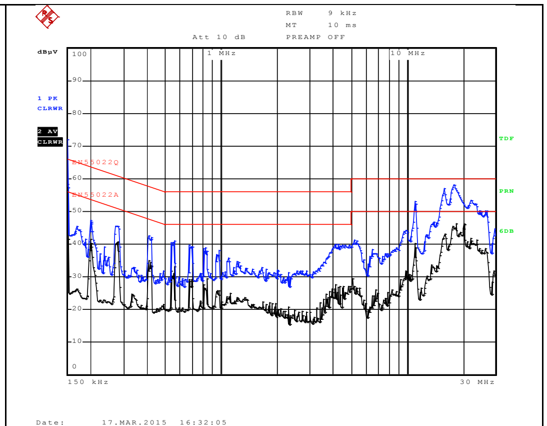
Test Condition:

EMI conduction test in 100% Load.

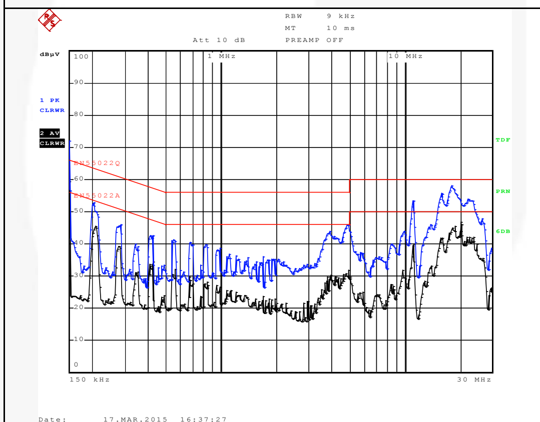
Test Results:



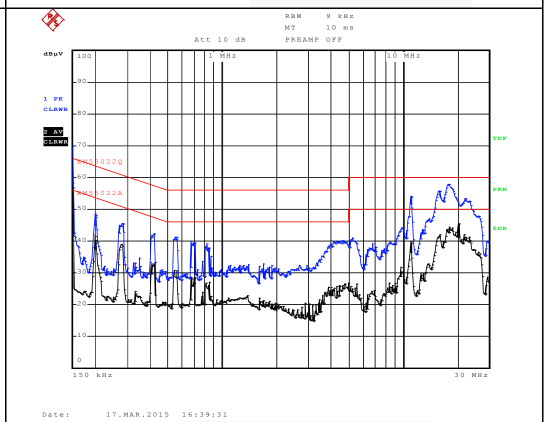
115 V / 60 Hz CONDUCTION-L



115 V / 60 Hz CONDUCTION-N



230 V / 50 Hz CONDUCTION-L



230 V / 50 Hz CONDUCTION-N

Figure 23. Test Waveform of EMI

Figure 24 shows, this EVB is design and test with the metal case. If the user wants to perform an EMI conduction test, connect power earth (PE) to secondary ground point and flowing point of Y-cap C9.

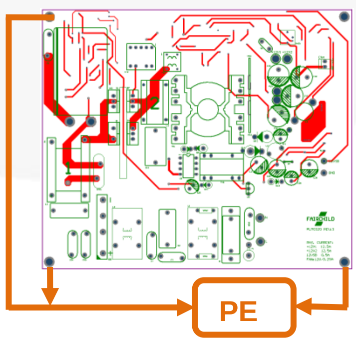


Figure 24. Setting of EMI Test

10. Revision History

Rev.	Date	Description
1.0.0	May 2015	Initial release
1.1	September 2015	Correct Output power, page 4 306 kW to 306 W