



ON Semiconductor®

User Guide for
FEBFAN6982MY_CP20U350
Evaluation Board

350 W CCM PFC
with 5 V_{SB} Module
Evaluation Board

Featured ON Products:

FAN6982

FSL117MRIN

*Direct questions or comments
about this evaluation board to:
“Worldwide Direct Support”*

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This user guide supports the 350 W evaluation board for single stage CCM PFC using FAN6982. It should be used in conjunction with the FAN6982 datasheet as well as Fairchild's application notes and technical support team. Please visit Fairchild's website at www.fairchildsemi.com.

1. Overview

The FAN6982 is a 14-pin, Continuous Conduction Mode (CCM) PFC controller IC intended for Power Factor Correction (PFC) pre-regulators. The FAN6982 includes circuits for the implementation of leading edge, average current, “boost”-type power factor correction, and results in a power supply that fully complies with IEC1000-3-2 specification. A TriFault Detect™ function helps reduce external components and provides full protection for feedback loops such as open, short, and over voltage. An over-voltage comparator shuts down the PFC stage in the event of a sudden load decrease. The RDY signal can be used for power-on sequence control. The EN function can choose to enable or disable the range function. FAN6982 also includes PFC soft-start, peak current limiting, and input voltage brownout protection.

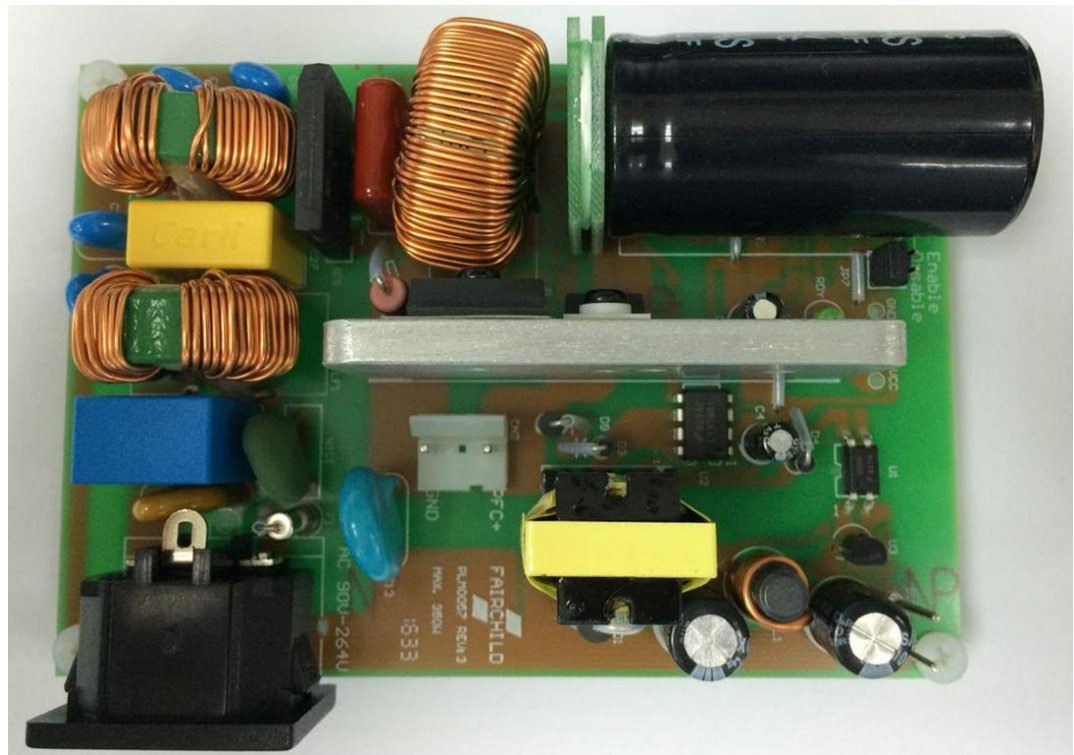


Figure 1. Photo of FEBFAN6982MY_CP20U350

2. Board Configuration

- Input Voltage: 90 V_{AC} ~ 264 V_{AC}
- Output Voltage: 387 V_{DC}
- Output Power: 0 ~ 350 W
- Operation Frequency: 65 kHz



3. Schematics

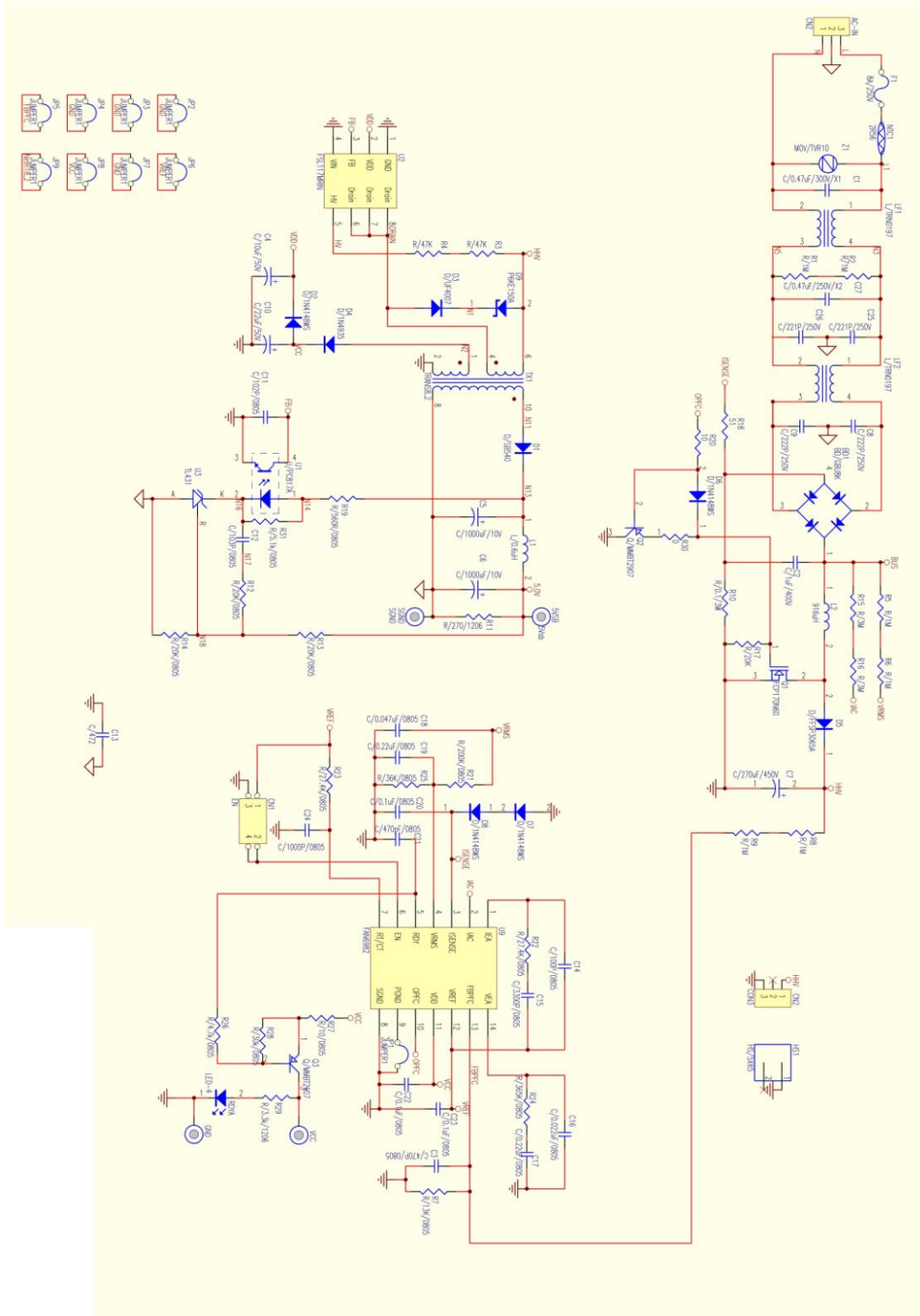


Figure 2. FAN6982 Evaluation Board Schematic



4. PCB Layout

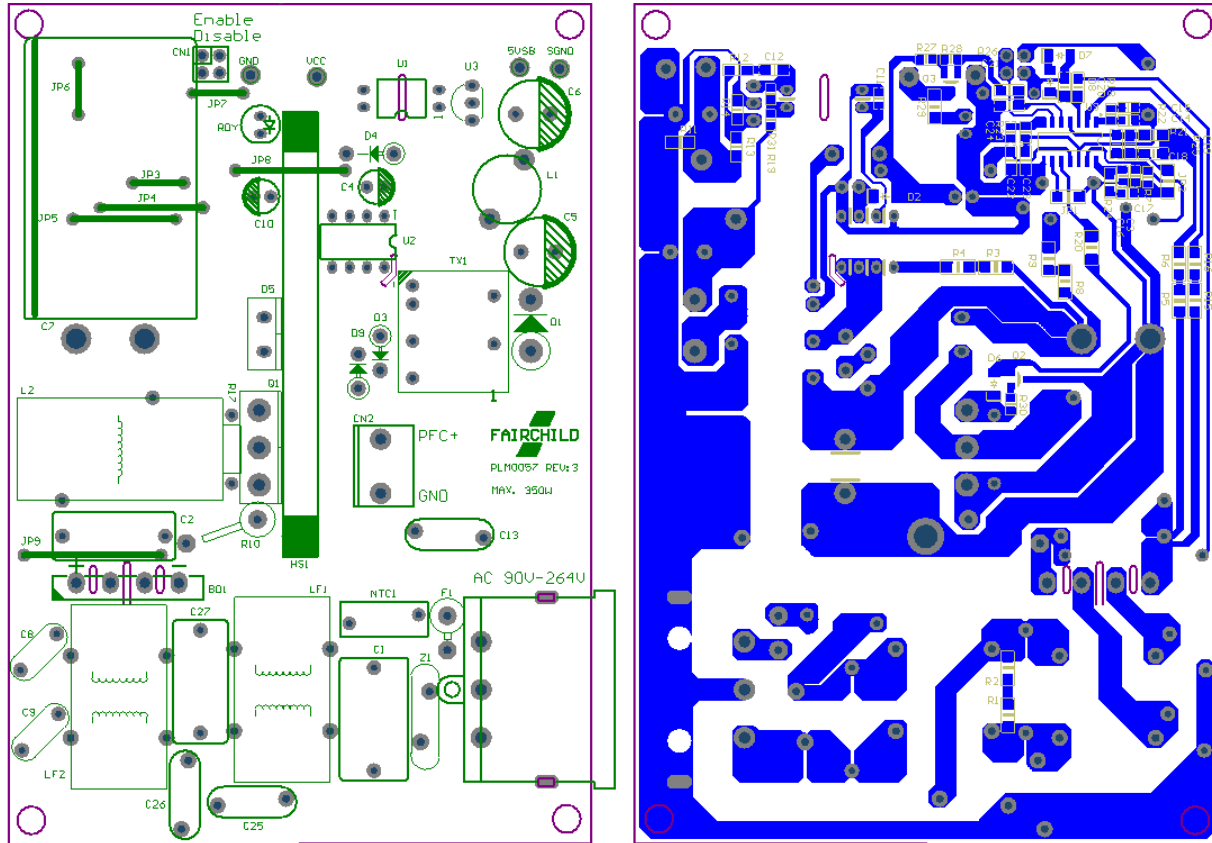


Figure 3. FAN6982 Evaluation Board PCB Layout



5. Test Results

5.1 Test Equipment

Test Mode	FEBFAN6982MY_CP20U350
Test Date	Aug. 20, 2016
Test Temperature	Ambient
Test Equipment	AC Source: EXTECH 6800 AC/DC Electronic load: PRODIGIT 3360+3253 Oscilloscope: Lecroy wavesurfer 24Xs DC source: ABM 9303D
Test Items	1. Brown In/Out 2. AC Trim Up & Trim Down 3. PFC ON/OFF & RDY 4. Ripple & Noise 5. Efficiency 6. Current Harmonic

5.2 Test Procedure

Before testing the board; AC voltage supply for line input, and AC/DC electric load for output should be connected to the board properly.

1. When AC voltage ($90\sim 264 V_{AC}$) is supplied, $5 V_{SB}$ output is turned on by FSL117MRIN. Then the auxiliary winding will supply the VDD voltage for FAN6982 to start PFC stage.
2. PFC startup is controlled by VEA level. Before FBPFC voltage reaches 2.4 V, the VEA level is around 2.8 V.
3. During the bulk voltage of the PFC rising to 387 V, the AC/DC electric load is advised to set in light-load.
4. After the bulk voltage is established in steady state 387 V, then electric load can be changed the load setting to test the other performance.
5. External cooling fans must be enabled.



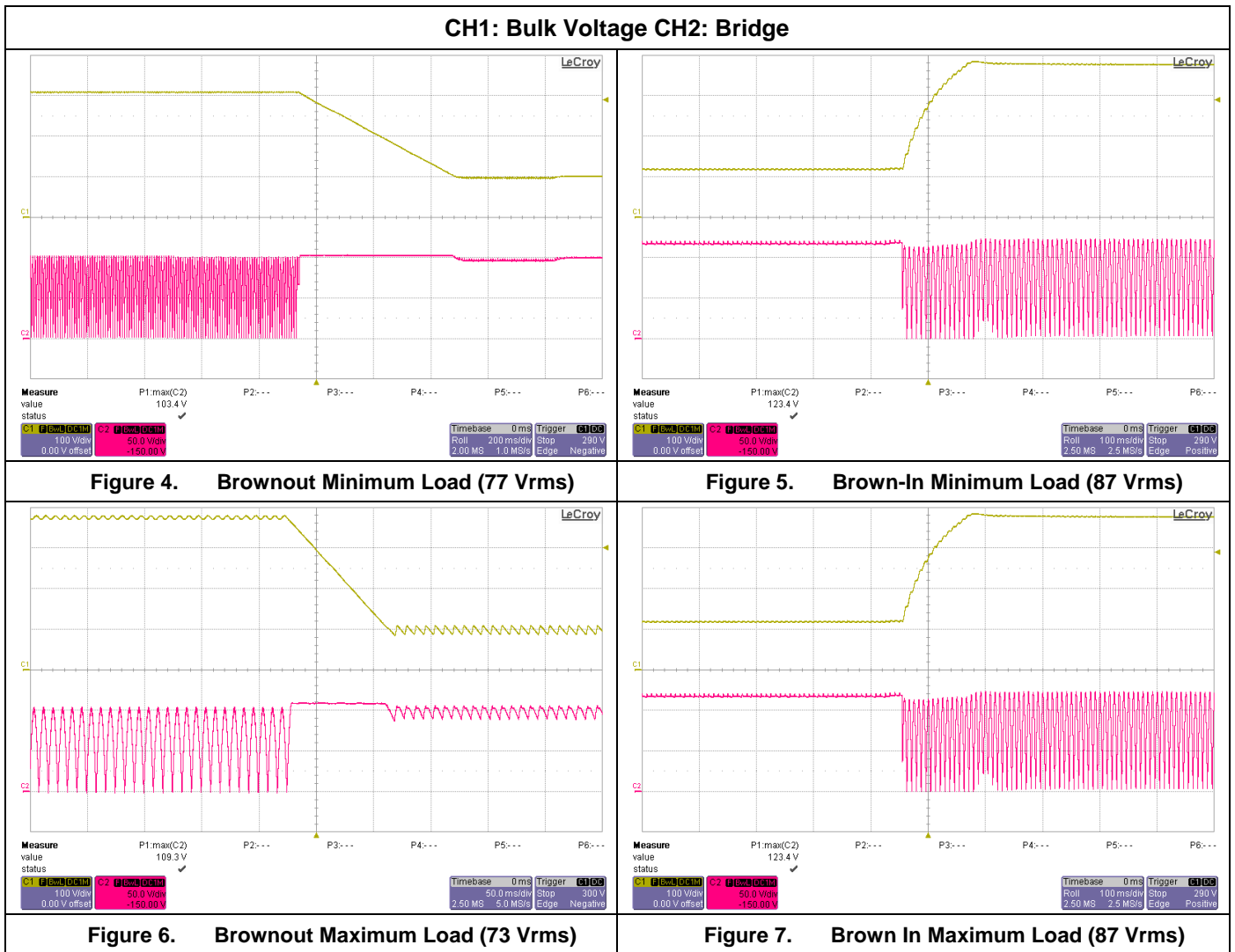
5.3 Brown In/Out

Test Condition

Decrease input AC voltage gradually and measure the turn-off threshold.

After DC power off, increase input voltage and measure the recovery threshold.

Table 1. Test Results



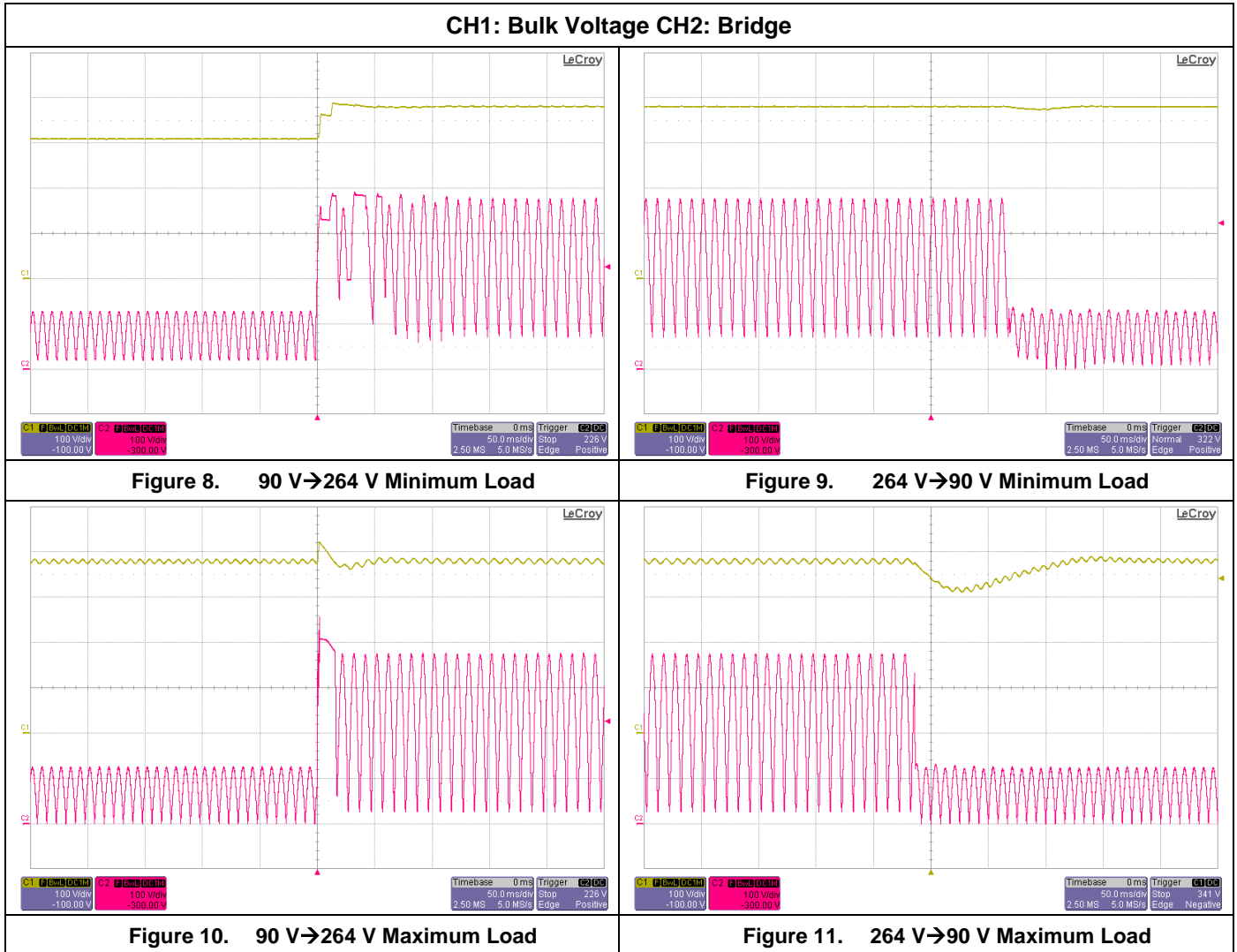


5.4 AC Trim Up & Trim Down

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.

Table 2. Test Results

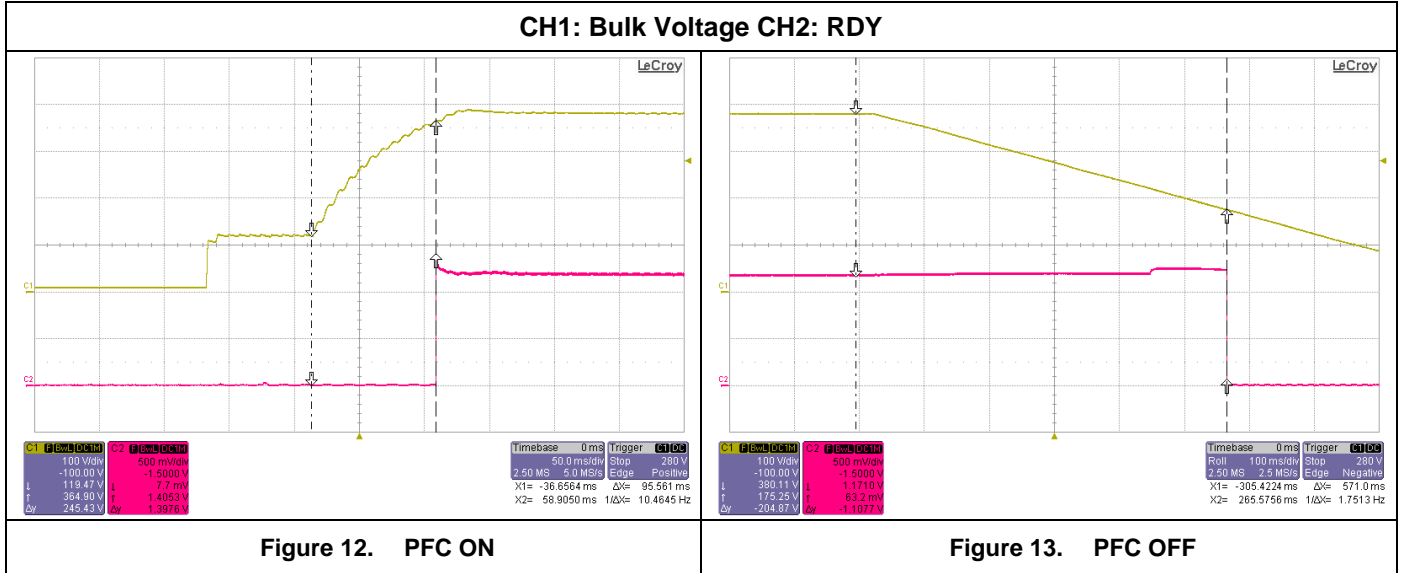




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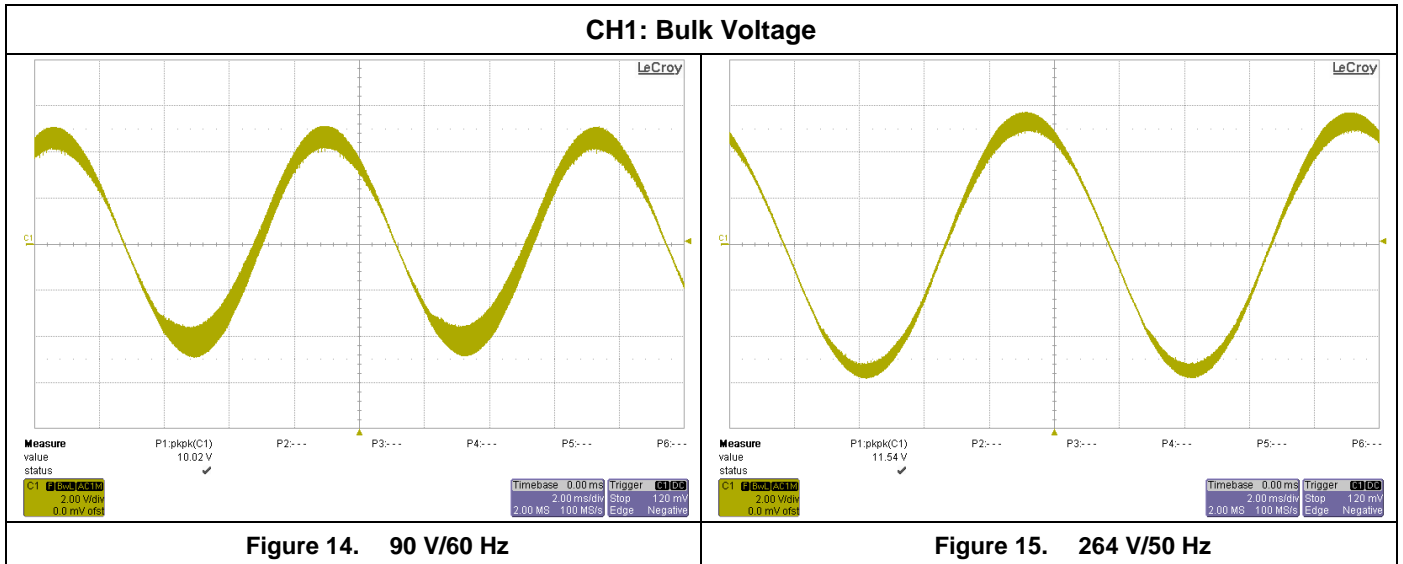
5.5 PFC ON/OFF & RDY

Table 3. Test Results



5.6 Ripple & Noise

Table 4. Test Results





5.7 Efficiency

Test Condition:

Measure efficiency at Min., Mid. and Max. loading.

Table 5. Test Results

FAN6982		Input Watts	Output Watts	Efficiency
A.	$V_{IN}= 115\text{ V}$, at 100% Load	369.2 W	350 W	94.79%
B.	$V_{IN}= 115\text{ V}$, at 50% Load	186.7 W	175 W	93.73%
C.	$V_{IN}= 115\text{ V}$, at 20% Load	76.5 W	70 W	91.50%
D.	$V_{IN}= 230\text{ V}$, at 100% Load	359.1 W	350 W	97.46%
E.	$V_{IN}= 230\text{ V}$, at 50% Load	182.4 W	175 W	95.94%
F.	$V_{IN}= 230\text{ V}$, at 20% Load	74.5 W	70 W	93.95%

5.8 Current Harmonic

Test Condition

Tested by DC loading side parallel with a 10 $\mu\text{F}/\text{EC}$ and 0.1 $\mu\text{F}/\text{CC}$ capacitor and Measured Band-width with DC-20 MHz

Table 6. Test Results

FAN6982			
Input Voltage	Condition	PF	THD(%)
115 V/60 Hz	75 W Load	0.969	13.06
	Mid Load	0.993	7.82
	Max. Load	0.998	5.09
230 V/50 Hz	75 W Load	0.906	16.88
	Mid Load	0.968	12.55
	Max. Load	0.980	8.34



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5.8. 115 V/60 Hz Input Current Waveform & Harmonic

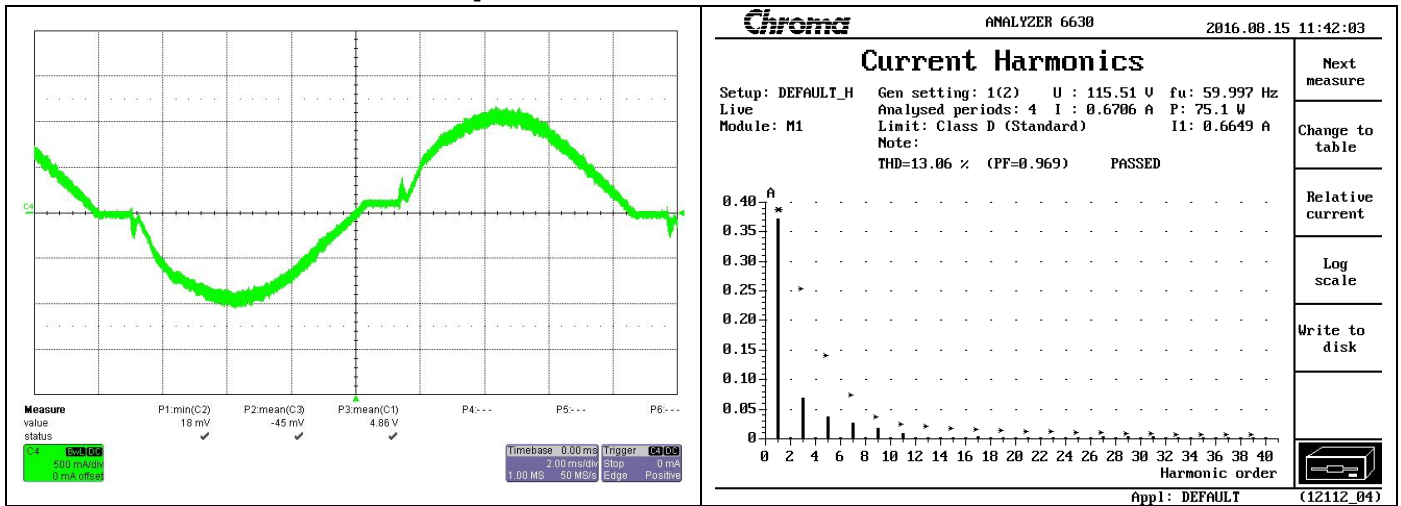


Figure 16. 75 W Load

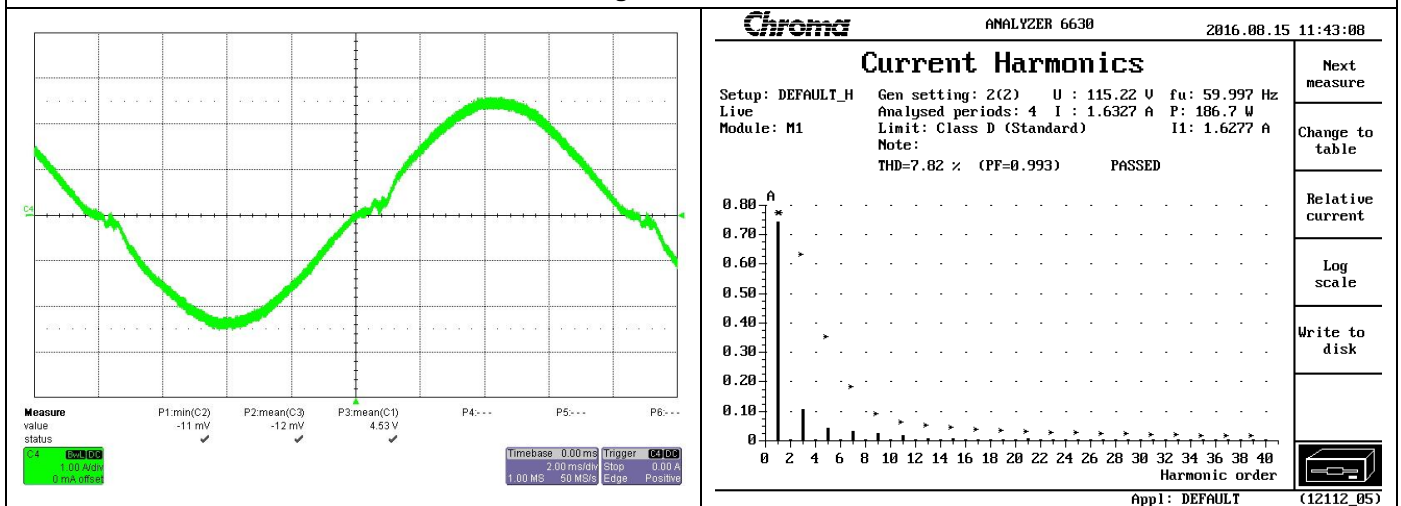


Figure 17. Mid Load

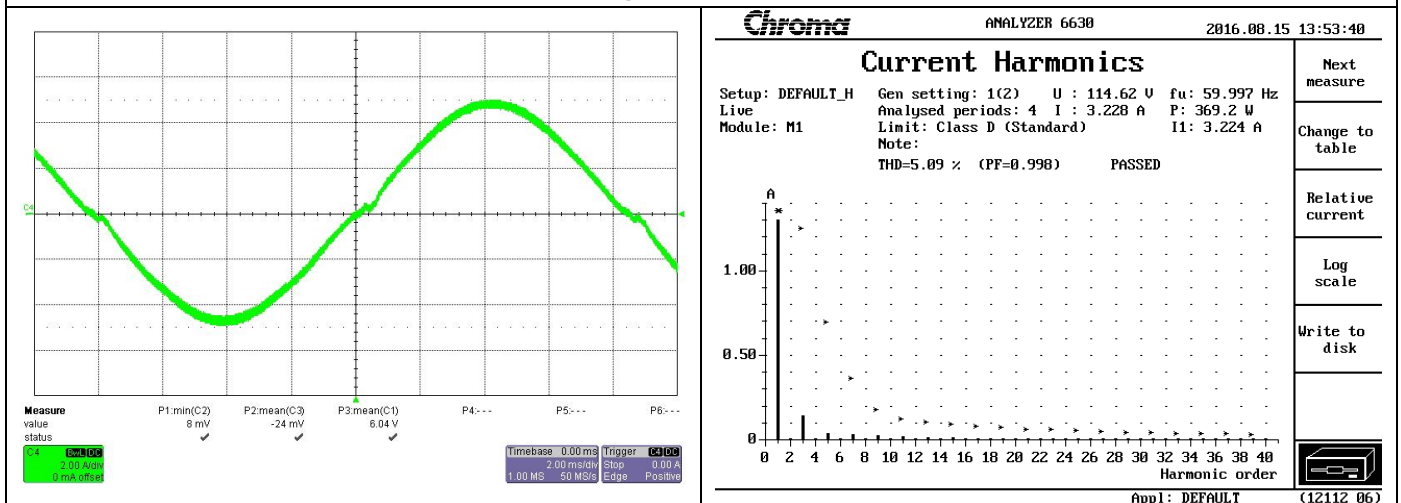


Figure 18. Max. Load



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5.9. 230 V/50 Hz Input Current Waveform & Harmonic

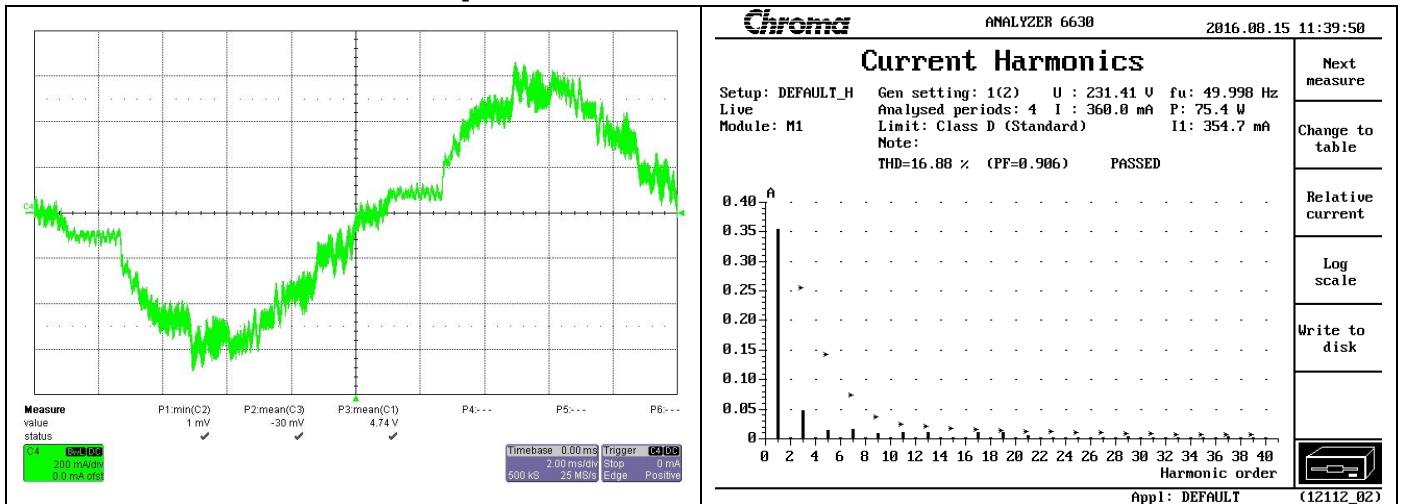


Figure 19. 75 W Load

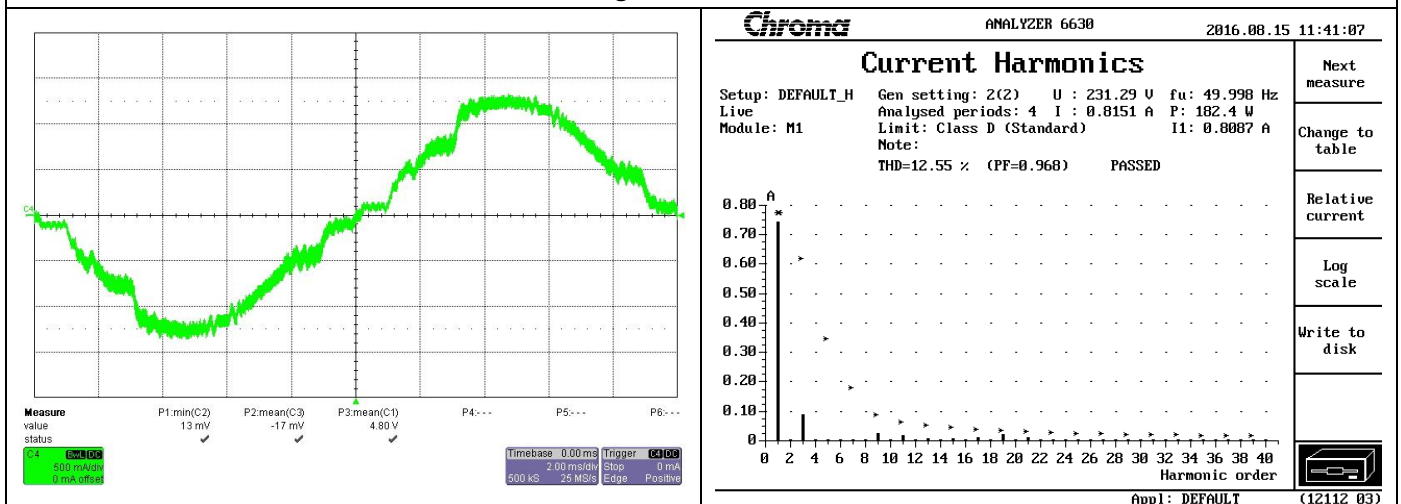


Figure 20. Mid Load

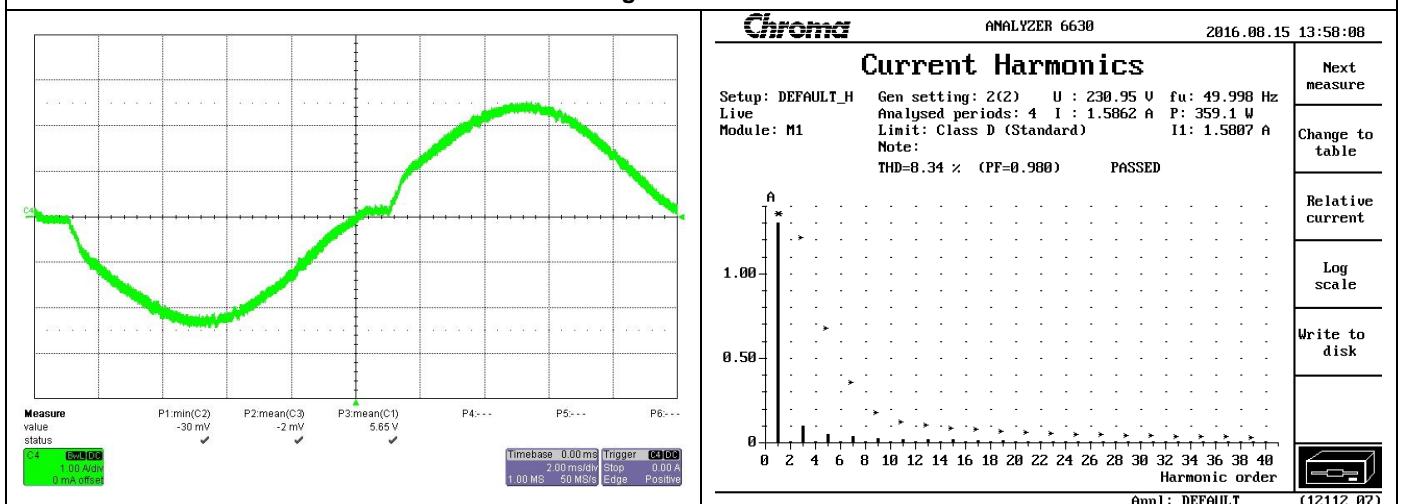


Figure 21. Max. Load



6. Build of Materials (BOM)

Item	Qty.	Reference	Part Number	Value	Description	Manufacturer	Package
1	1	C14		100 pF	CAP, SMD, CERAMIC, 25 V, X7R	STD	805
2	2	C3, C21		470 pF	CAP, SMD, CERAMIC, 25 V, X7R	STD	805
3	2	C11, C24		1 nF	CAP, SMD, CERAMIC, 25 V, X7R	STD	805
4	1	C15		3.3 nF	CAP, SMD, CERAMIC, 25 V, X7R	STD	805
5	1	C12		10 nF	CAP, SMD, CERAMIC, 25 V, X7R	STD	805
6	1	C16		0.022 μF	CAP, SMD, CERAMIC, 25 V, X7R	STD	805
7	1	C18		0.047 μF	CAP, SMD, CERAMIC, 25 V, X7R	STD	805
8	3	C20, C22, C23		0.1 μF	CAP, SMD, CERAMIC, 25 V, X7R	STD	805
9	2	C17, C19		0.22 μF	CAP, SMD, CERAMIC, 25 V, X7R	STD	805
10	2	JP1, JP2		0 Ω	RES, SMD, 1/4W	STD	1206
11	1	R20		10 Ω	RES, SMD, 1/4W	STD	1206
12	1	R11		270 kΩ	RES, SMD, 1/4W	STD	1206
13	1	R29		3.3 kΩ	RES, SMD, 1/4W	STD	1206
14	2	R3, R4		47 kΩ	RES, SMD, 1/4W	STD	1206
15	6	R1, R2, R5, R6, R8, R9		1 MΩ	RES, SMD, 1/4W	STD	1206
16	2	R15, R16		3 MΩ	RES, SMD, 1/4W	STD	1206
17	1	R30		0 Ω	RES, SMD, 1/8W	STD	805
18	1	R27		10 Ω	RES, SMD, 1/8W	STD	805
19	1	R18		51 Ω	RES, SMD, 1/8W	STD	805
20	1	R19		560 Ω	RES, SMD, 1/8W	STD	805
21	1	R26		4.7kΩ	RES, SMD, 1/8W	STD	805
22	1	R31		5.1 kΩ	RES, SMD, 1/8W	STD	805
23	1	R7		13 kΩ	RES, SMD, 1/8W	STD	805
24	3	R12, R13, R14		20 kΩ	RES, SMD, 1/8W	STD	805
25	2	R22, R23		27.4 K	RES, SMD, 1/8W	STD	805
26	1	R28		30 kΩ	RES, SMD, 1/8W	STD	805
27	1	R25		36 kΩ	RES, SMD, 1/8W	STD	805
28	1	R21		200 kΩ	RES, SMD, 1/8W	STD	805
29	1	R24		365 kΩ	RES, SMD, 1/8W	STD	805
30	1	C4		10 μF	LHK series, Cap, Alum, Elect., 105°C, 5*11 mm, 50V	Jackcon	Axial
31	1	C10		22μF	LHK series, Cap, Alum, Elect., 105°C, 5*11 mm, 50V	Jackcon	Axial
32	1	C7	ELXS451VSN271MQ45S	270 μF	Cap, Alum, Elect., 105°C, 25*45 mm, 450V	Nichicom	Thru-Hole
33	2	C5, C6		1000 μF	LHK series, Cap, Alum, Elect., 105°C, 10*12.5 mm, 10V	Jackcon	Thru-Hole
34	1	C2	TF105K2Y159L270D9R	1 μF	Cap, 450 V, 10%, Polypropylene	Kenjet	
35	2	C8, C9	CS11-E2GA222MYAS	222 pF	Cap, Ceramic, 250 V _{AC} , 20%	TDK	

Continued on the following page...



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Item	Qty.	Reference	Part Number	Value	Description	Manufacturer	Package
36	2	C25, C26	CD85-B2GA221KYAS	221 pF	Cap, Ceramic, 250 V _{AC} , 20%	TDK	
37	1	C13	CD16-E2GA472MYAS	472 pF	Cap, Ceramic, 400 V _{AC} , 20%	TDK	
38	1	C1	SX1-S474-2K300S1	0.47 μF	Cap, X1 Type, 300 V _{AC} , 10%, Polypropylene	Kenjet	
39	1	C27	PX474K3ID42H200D9R	0.47 μF	Cap, X2 Type, 250 V _{AC} , 20%, Polypropylene	Kenjet	
40	1	R17		20 kΩ	RES, DIP, 1/4 W	STD	Axial
41	1	R10		0.1 Ω	RES, DIP, 3 W	STD	Axial
42	1	CN1	P2S1-116202088111		Connector, Pin HDR 2X2P 2.54 mm 180°	Most Well	
43	1	CN2	3961-WS(3-1)-LF		Connector, WAFER(3960HS)3-1P 3.96 mm 180°	T&A Brother	
44	1	AC-IN	R-301SN(12B)		AC Inlet, INLET 3P 90°	Richbay	
45	1	BD1	GBU8K		Diode Bridge, 8 A, 800 V	ON	GBU
46	1	D1	SB540		Diode, Schottky, 40 V, 5 A	ON	DO-201AD
47	1	D3	UF4007		Diode, 1000 V, 1 A, Fast recovery	ON	DO-41
48	1	D4	1N4935		Diode, 200 V, 1 A, Fast recovery	ON	DO-41
49	1	D5	FFSP3065A		Diode, 650 V, 30 A, SiC Schottky	ON	TO-220
50	4	D2, D6, D7, D8	1N4148WS		Diode, 100 V, 500 mA	ON	SOD-32F
51	1	Q1	FCH170N60		MOSFET, NCH, 600 V, 22 A, 0.17 Ω	ON	TO-247
52	2	Q2, Q3	MMBT2907		Transistor, PNP, 40 V, 0.5 A	ON	SOT-23
53	1	D9	P6KE150A		Transient Voltage Suppressors, 150V	ON	DO-41
54	1	F1			Ceramic Fuse .8 A, 250 V, Slow	Sleetech	
55	1	HS1	MCH0668		Heat Sink	Long Teng Feng	
56	3	JP3, JP6, JP7	JUMPER		Φ0.8 x 7.5 mm	STD	
57	2	JP4, JP5	JUMPER		Φ0.8 x 15 mm	STD	
58	1	JP8	JUMPER		Φ0.8 x 16 mm	STD	
59	1	JP9	JUMPER		Φ0.8 x 20 mm	STD	
60	1	NTC1	SCK132R56MYS		Negative Temperature Coefficient Thermistor, SCK2R56	TKS	
61	1	RDY			LED, 3Φ, Green		
62	1	Z1	TVR10471KSY		Valistor	TKS	
63	1	L1	TRN0201		Filter Inductor, 0.6 μH	Sen Huei	
64	1	L2	TRN0351		PFC Inductor, 916 μH, CH270060	Sen Huei	
65	2	LF1, LF2	TRN0197		Common Mode Choke, 9 mH	Sen Huei	
66	1	TX1	TRN0350		Flyback Transformer	Sen Huei	EEL19
67	1	U1	PC817A		Phototransistor Optocouplers	ON	MDIP-4
68	1	U2	FSL117MRIN		Standby Power Controller	ON	DIP-8
69	1	U3	KA431LTZF		Regulator	ON	TO-92
70	1	U9	FAN6982MY		PFC Controller	ON	SOIC-14
71	4	Nylon	8441B		Hex Standoff, 6-32, Nylon, 3/8"	B&F Fastener	
72	4	Nylon	NY PMS 632 0038 PH		Machine Screw, Nylon, 6-32x3/8"	Keystone Electronics	
73	2	5VSB, SGND	42-0M00405-00		Test Pin SG004-05, φ 2.2*18.2mm	Kang Yang	

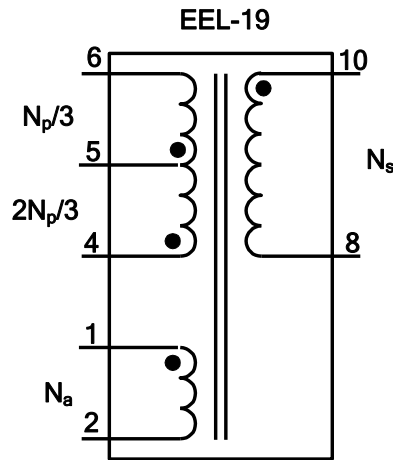


7. Notice Letter

To properly operate the high-power CCM PFC evaluation board, cooling fans must be enabled to remove the heat from switching devices and diodes. (Fans are not provided with the evaluation board. Supply fans for testing).

8. Transformer & Inductor

8.1. TX1 Specification



Core: EEL-19 ($A_e=25\text{mm}^2$)
Bobbin: EEL-19

	Pin (S → F)	Wire	Turns	Winding Method
$2N_p/3$	4 → 5	0.27 ϕ ×1	75	Solenoid Winding
Insulation: Polyester Tape t = 0.025 mm, 3 Layer				
N_s	10 → 8	0.55 ϕ ×2	9	Solenoid Winding
Insulation: Polyester Tape t = 0.025 mm, 3 Layers				
$N_p/3$	5 → 6	0.27 ϕ ×1	33	Solenoid Winding
Insulation: Polyester Tape t = 0.025 mm, 6 Layers				
N_a	1 → 2	0.15 ϕ ×1	33	Solenoid Winding
Insulation: Polyester Tape t = 0.025 mm, 3 Layers				

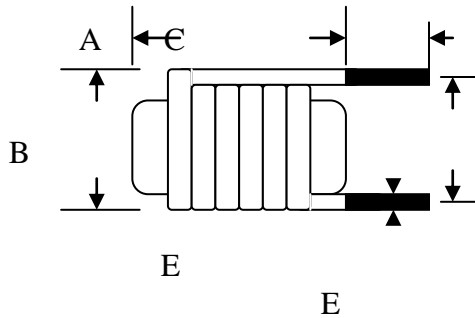
	Pin	Specifications	Remark
Inductance	1–3	950 $\mu\text{H} \pm 10\%$	100 kHz, 1 V
Leakage	4–6	< 30 μH Max.	Short All Other Pins



8.2. L1 Specification

1 DIMENSION :

UNIT : mm



A	17.0 max
B	13.5 max
C	10±1
D	10±1
E	φ1.4±0.1
F	1-2

2 ELECTRICAL SPECIFICATON : at 1 KHz,0.25 V

2.1 INSDUCTANCE : 0.6 μ H \pm 20%

2.2 DC RESISTANCE : 0.003 \square max.

2.3 TURN & WIRE : ϕ 1.4x5.5TS

3 MATERIALS LIST :

COMPONENTM	MAT'L	MANUFACTURE	UL FILE NO.
1.CORE	S6,SGB or equal	Ferrite core R6x15 Jaw Shianq.	
2.WIRE	THFN-216 130°C	Ta ya eiectic wire factory.,	E197768
	UEWN/U 130°C	Pacific eiectic wire & cable co ltd.	E201757
	UEY 130°C	Chuen Yih wire co.,ltd	E174837
3.TUBE	UL TUBE	Shengzhen Changyuan co ltd.	E180908
4.TERMINALS	Tin coated- Copper wire	Will fore special wire corp.	
5.SOLDER	96.5% Su 3% Ag 0.5% Cu	Xin yuan co.,ltd.	



8.3. L2 Specification

1. Surface, Structure:

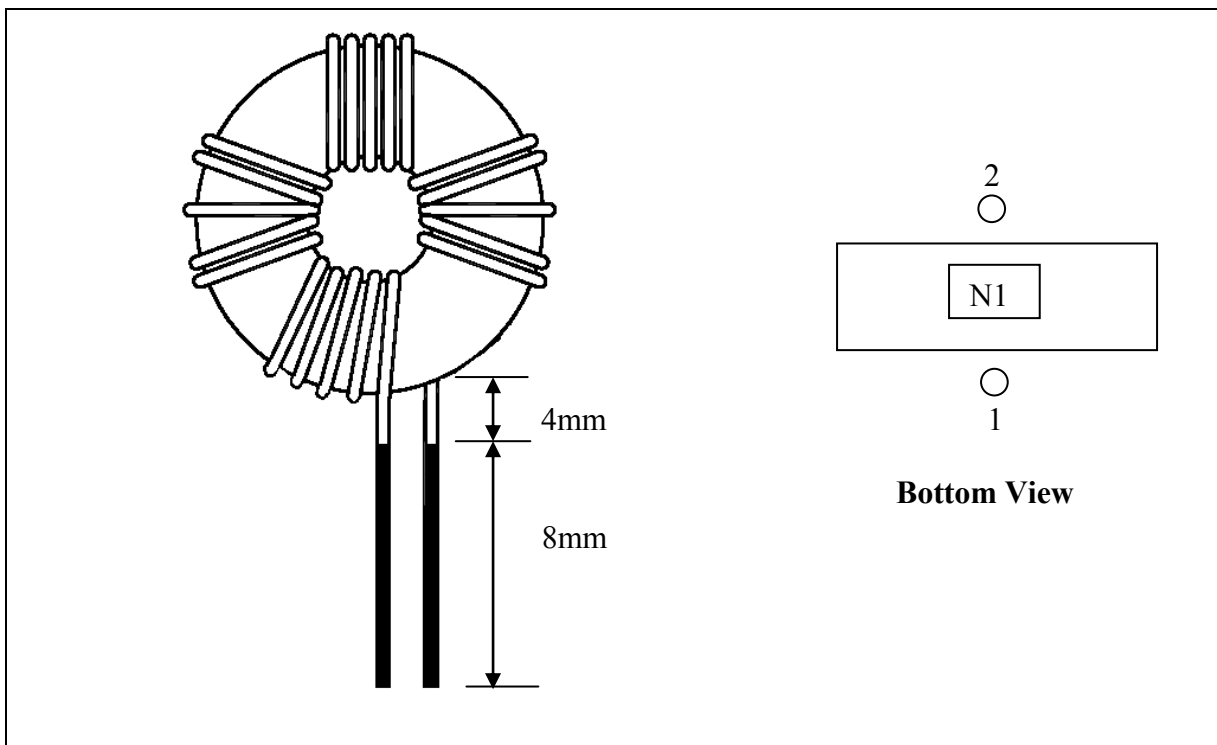
1.1 Surface: damage, rusting, etc. are not permitted.

1.2 The shape, dimension and marking of the transformer: as below mention.

2. Mechanical Performance:

Terminal strength: Each terminal of the transformer must be withstanding a pull 1.5 Kg for 10 second , without loosening , breaking of other.

3. Electrical:



4. Windings:

Winding	Terminal	Wire Gauge (mm)	T	Note
N1	1 → 2	0.8	111Ts	916 μH+5% · 1 V/1 KHz

5. Core:

Toroids Core TR Type :(CH270060 · High Flux).

OD=26.9 mm; ID=14.7 mm; HT=11.2 mm.



8.4. LF1 & LF2 Specification

1. Surface, Structure:

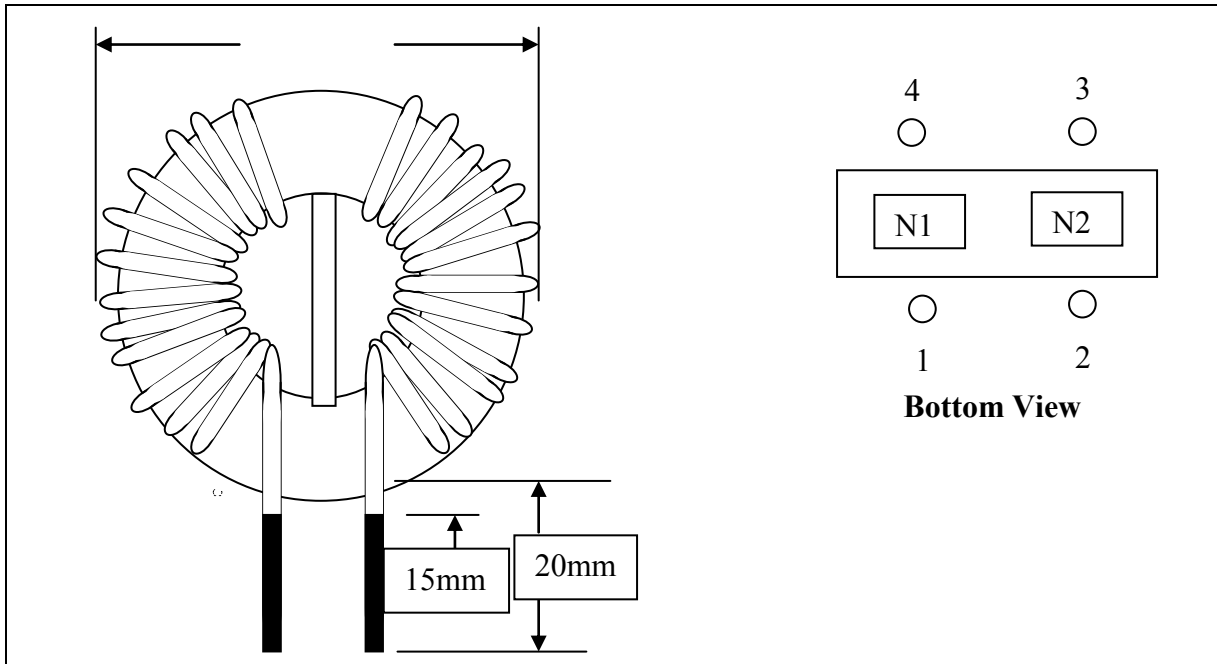
1.1 Surface: damage, rusting, etc. are not permitted.

1.2 The shape, dimension and marking of the transformer: as below mention.

2. Mechanical Performance:

Terminal strength: Each terminal of the transformer must be withstanding a pull 1.5 Kg for 10 second, without loosening , breaking of other.

3. Electrical:



4. Windings:

Winding	Terminal	Wire Gauge (mm)	T	Note
N1	1→4	0.9	30.5	≥ 8 mH, 1 V/1 KHz
N2	2→3	0.9	30.5	≥ 8 mH, 1 V/1 KHz

Notes:

1. Between N1&N2 with isolated slab 2 mm.
2. Each winding draw out with tubing and reserve wire 12 mm.

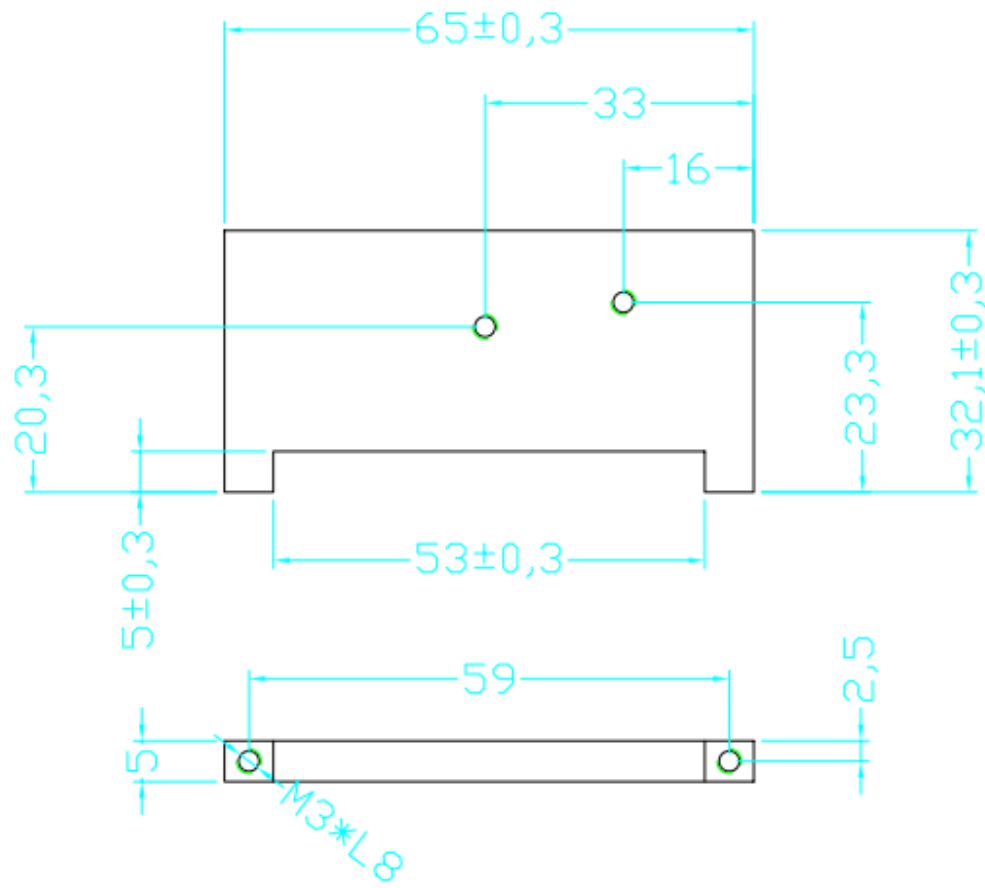
5. Core:

Toroids Core TR Type: RT221408

OD=14 mm ; ID=6.6 mm ; HT=6.3 mm



8.5. Heat Sink



Unit:mm