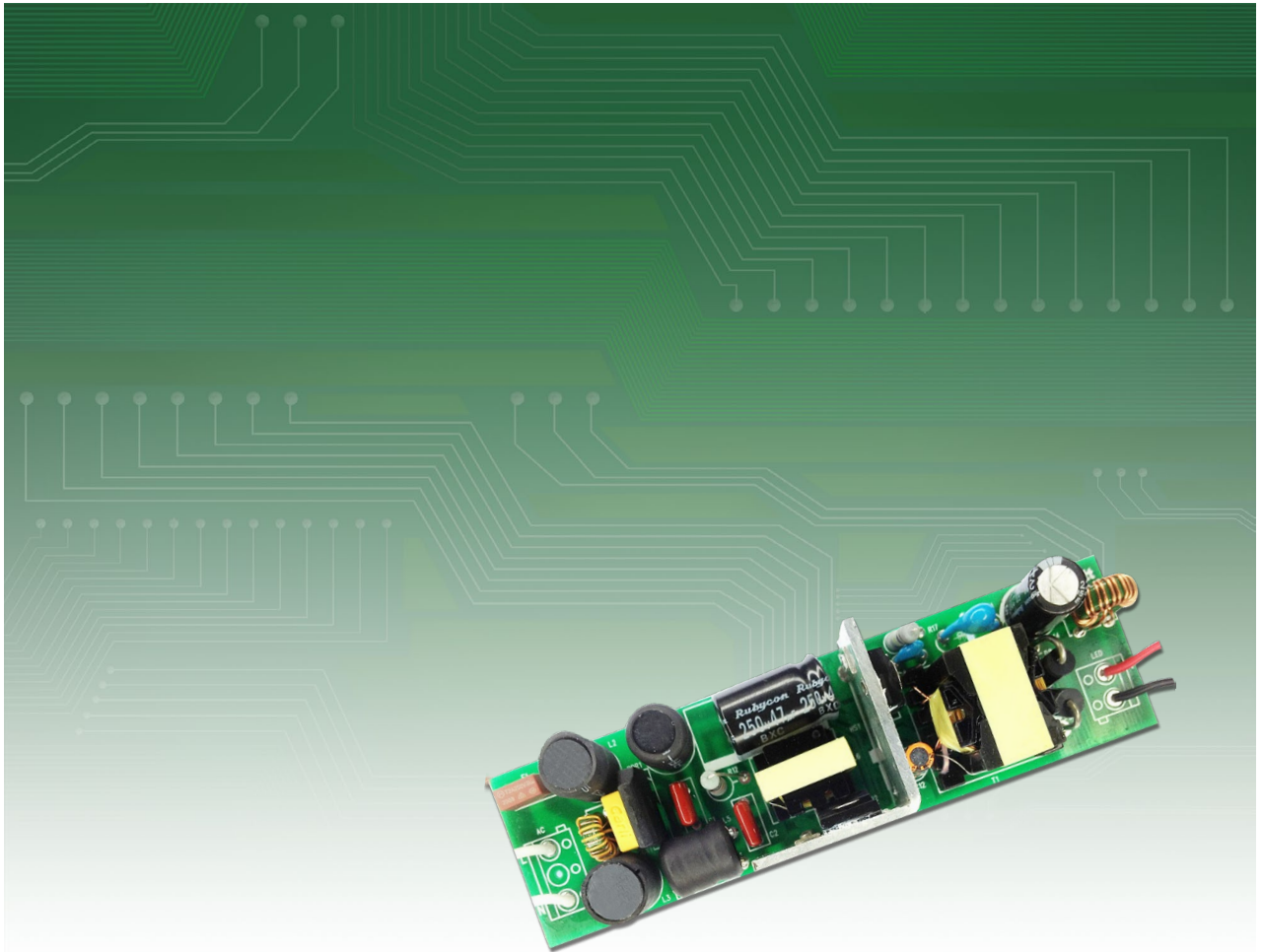




Dimmable LED Driver with iW3617-00

(AC input 90-135V_{AC}, Output 40V 700mA)

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EBC950

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1.0 Introduction

This reference design describes a 12 LEDs output at 700mA current, low line input (90–132V_{AC}) power supply for phase-cut dimmable LED applications. For this design the iW3617-00 is used. This document contains the design features of the phase-cut dimmable LED driver, a detailed circuit diagram, an entire bill of materials required to build the LED driver, a drawing of the power transformer, and test data of the most important performance.

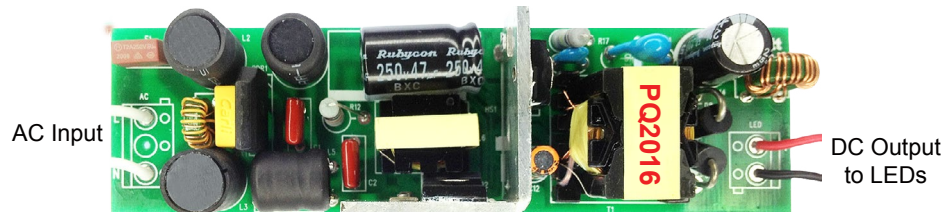


Figure 1.1 PCB Top View

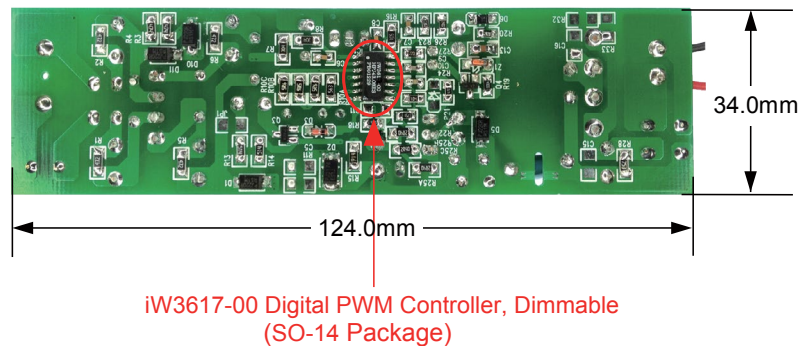


Figure 1.2 PCB Bottom View

2.0 Design Features

- Isolated AC/DC offline, input 120V_{AC}
- Output 12 LEDs at 700mA
- Intelligent wall dimmer detection
 - » Leading-edge dimmer
 - » Trailing-edge dimmer
 - » No dimmer
- Multiple dimming control scheme
 - » Hybrid dimming scheme
 - » PWM dimming scheme, 630Hz
 - » Amplitude dimming scheme
- Wide dimming range from 1% up to 100%
- No visible flicker
- Resonant control to achieve high efficiency
- High power factor, 0.9 without dimmer
- Temperature degrade control to adjust the LED
- Primary-only sensing eliminates opto-isolator feedback and simplifies design

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3.0 Design Specification

The table below represents the minimum acceptable performance of the design.

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Voltage	V_{IN}	90		135	V _{AC}	2 wire
Frequency	f_{LINE}	47	50/60	63	Hz	
Output						
Output voltage	V_{OUT}		40		V	Measured at the end of PCB
Output current	I_{OUT}		0.7		A	
Output ripple current	I_{RIPPLE}		35		mA _{P-P}	Set oscilloscope at 20MHz bandwidth
Total Output Power						
Continuous output power	P_{OUT}		28		W	
Power factor	PF		0.98			V _{IN} = 115V _{AC}
Efficiency	η		86		%	Measured at end of PCB V _{IN} =115V _{AC} (T _{AMB} =25°C)
Environmental						
THD	THD			10	%	V _{IN} = 115V _{AC}
Conducted EMI		Meets CISPR22B/EN55022B				
Safety		Designed to meet IEC950, UL1950 Class II				
Ambient temperature	T_{AMB}	0		40	°C	Free convection, sea level

4.0 Schematic

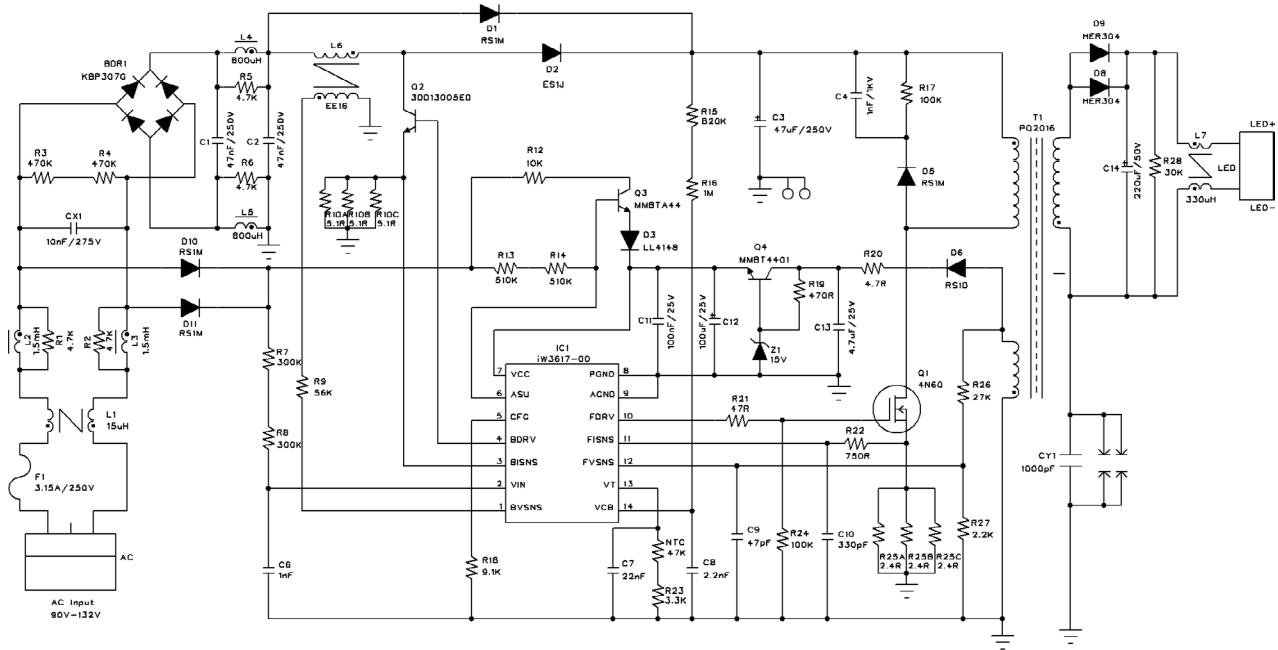
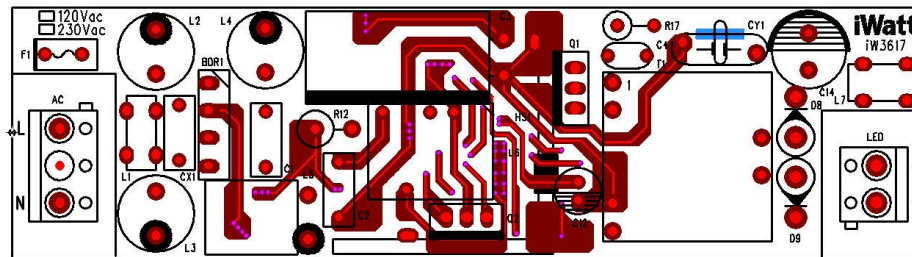
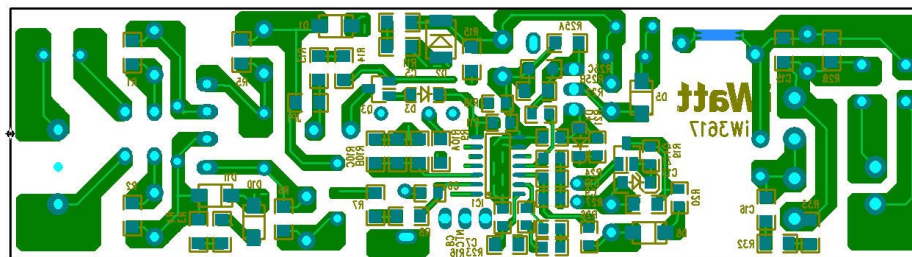


Figure 4.1 Design Schematic

5.0 PCB Layout



a) PCB Top



b) PCB Bottom

Figure 5.1 PCB Layout 124.0 mm x 34.0 mm

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6.0 Bill of Materials

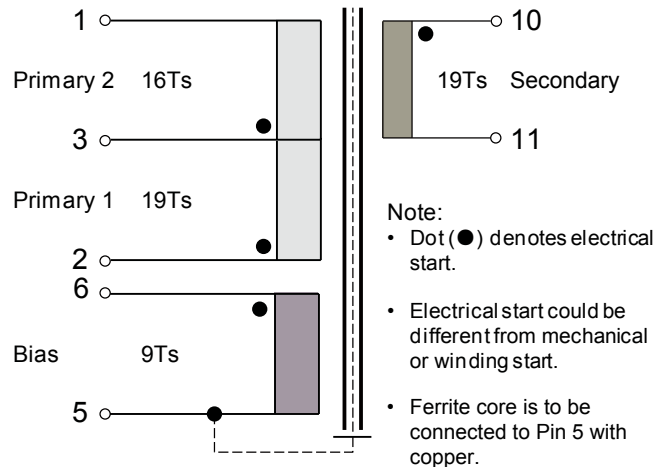
Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
1	1	IC1	iW3617-00, digital PWM controller, dimmable, SO-14	iW3617-00	iWatt, Inc
2	1	CX1	10nF, 275V, X2, P=7.5mm	PX103K31F29H200D9R	Carli
3	2	C1, C2	47nf, 250V, CBB21	AF473J2G079L400D9R	Carli
4	1	C3	47μF, 250V, E-Cap	47uFLK250V	Yongming
5	1	C12	100μF, 25V, E-Cap	100UFLK25V	Yongming
6	1	C14	220μF, 50V, E-Cap	220UFLK50V	Yongming
7	1	C4	1nF/1kV, ceramic capacitor, P=5mm	1NF/1KV	STE
8	1	C9	47pF, 25V, X7R, SMD-0805	CL10B470JB8NNNC	SAMSUNG
9	1	C10	330pF, 25V, X7R, SMD-0805	CL10B331JB8NNNC	SAMSUNG
10	1	C6	1nF, 25V, X7R, SMD-0805	CL10B102KA8NNNC	SAMSUNG
11	1	C8	2.2nF, 25V, X7R, SMD-0805	CL10B222KB8NNNC	SAMSUNG
12	1	C7	22nF, 25V, X7R, SMD-0805	CL10B223KA8NNNC	SAMSUNG
13	1	C11	100nF, 25V, X7R, SMD-0805	CL10B104KB8NNNC	SAMSUNG
14	1	C13	4.7μF, 25V, X7R, SMD-0805	CL31B475KAHNNNC	SAMSUNG
15	1	R21	47Ω ±5%, SMD-0805	RC0805JR-0747RL	YAGEO
16	1	R20	4.7Ω ±5%, SMD-0805	RC0805JR-074R7L	YAGEO
17	1	R19	470Ω ±5%, SMD-0805	RC0805JR-07470RL	YAGEO
18	1	R18	9.1kΩ ±5%, SMD-0805	RC0805JR-079K1L	YAGEO
19	1	R23	3.3kΩ ±1%, SMD-0805	RC0805JR-073K3L	YAGEO
20	1	R24	100kΩ ±5%, SMD-0805	RC0805JR-07100KL	YAGEO
21	1	R28	30kΩ ±5%, SMD-1206	RC1206JR-0730KL	YAGEO
22	2	R13, R14	510kΩ ±5%, SMD-1206	RC1206JR-07510KL	YAGEO
23	4	R1, R2, R5, R6	4.7kΩ ±5%, SMD-1206	RC1206JR-074K7L	YAGEO
24	1	R9	56kΩ ±5%, SMD-1206	RC1206JR-0756KL	YAGEO
25	2	R3,R4	470kΩ ±5%, SMD-1206	RC1206JR-07470KL	YAGEO
26	1	R15	820kΩ ±1%, SMD-1206	RC1206JR-07820KL	YAGEO
27	1	R16	1MΩ ±1%, SMD-1206	RC1206JR-071ML	YAGEO
28	2	R7,R8	300kΩ ±1%, SMD-1206	RC1206JR-07300KL	YAGEO
29	1	R22	750Ω ±1%, SMD-0805	RC0805JR-07750RL	YAGEO
30	1	R27	2.2kΩ ±1%, SMD-0805	RC0805JR-072K2L	YAGEO
31	1	R26	27kΩ ±1%, SMD-0805	RC0805JR-0727KL	YAGEO
32	3	R25A, R25B, R25C	2.4Ω ±1%, SMD-1206	RC0603JR-072R4L	YAGEO
33	1	R10A	5.1Ω ±1%, SMD-1206	RC0805JR-075R1L	YAGEO
34	2	R10B, R10C	5.1Ω ±1%, SMD-1206	RC0805JR-075R1L	YAGEO
35	1	R12	10kΩ ±5%, MOF 1W	MOF10K1W	YAGEO
36	1	R17	100kΩ ±5%, MOF 1W	MOF100K1W	YAGEO
37	1	NTC	SDNT2012X473, NTC, 47k	SDNT2012X473	YAGEO
38	1	F1	T3.15A, 250V	CRUPMP3.15A250V	GONGDE
39	1	BDR1	KBP307G, 3A, 1000V, KBP	KBP307G	PANJIT Semiconductor
40	1	D6	RS1D, 1A, 200V, SMA	RS1D	PANJIT Semiconductor
41	4	D1, D5, D10, D11	RS1M, 1A, 1000V, SMA	RS1M	PANJIT Semiconductor

6.0 Bill of Materials (Cont.)

Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
42	1	D2	ES1J, 1A, 600V, SMA	ES1J	PANJIT Semiconductor
43	2	D8,D9	UF304, 3A, 400V, DO-201AD	UF304	PANJIT Semiconductor
44	1	D3	LL4148, 0.15A, 100V, LL-34	LL4148	PANJIT Semiconductor
45	1	Z1	Zener, ZMM15B, 15V, LL-34	ZMM15B	ST Semiconductor
46	1	Q1	4N60, 4A, 600V, TO-220F	FTA04N60B	ARK
47	1	Q4	MMBT4401, NPN, SOT-23	MMBT4401	NXP
48	1	Q3	MMBT444, NPN, 0.3A, 500V, SOT-23	MMBT444	NXP
49	1	Q2	NPN transistor, 4A, 700V, TO-220HF	BTR13005GD	IPS
50	2	L2,L3	Drum choke, I-shaped 10X12mm, 1.5mH	10X12MM1.5MH	XINyuanyang
51	2	L4,L5	Drum choke, I-shaped 10X12mm, 800μH	10X12MM800uH	XINyuanyang
52	1	L1	Common mode inductor, T8*4*3, 15μH	B29 T8*4*3 15uH	XINyuanyang
53	1	L7	Common mode inductor, T10*4*6, 60μH	B29 T10*4*6 60uH	XINyuanyang
54	1	L6	EE16, L=0.55mH	EE16	XINyuanyang
55	1	T1	Transformer, PQ2016, L=0.4mH (Vcc=9Ts)	PQ2016	XINyuanyang
56	1	CY1	Y1, 1000pF, 400V	1000PF/400V	STE
57	2	"L,N"	Terminal		
58	2	"+, -"	Terminal		
59	2	"L,N"	UL3239/24AWG, L=60mm, striped and tin plated 3mm of two ends, white color		
60	1	"+"	UL3239/24AWG, L=60mm, striped and tin plated 3mm of two ends, red color		
61	1	"-"	UL3239/24AWG, L=60mm, striped and tin plated 3mm of two ends, black color		
62	1	Housing	Plastic housing		
63	1	HS1	heatsink		
64	2	FOR HS1	screw		

7.0 Transformer Drawing

Schematic:



Electrical Specifications:

1. Primary inductance (L_p) = 0.4mH @10kHz
2. Primary leakage inductance (L_k) < = 10uH @60kHz
3. Electrical strength = 3KV, 50/60Hz, 1Min

Materials:

1. Core : PQ2016 (Ferrite Material TDK PC40 or equivalent)
2. Bobbin : PQ2016, vertical, primary=6, secondary=8
3. Magnet wires (Pri) : type 2-UEW
4. Magnet wire (Sec) : triple insulated wires
5. Layer insulation tape : 3M1298 or equivalent

Finished:

1. Cut remained of Pin3, 4, 7, 8, 9, 12, 13, 14 after wires termination
2. Core is connected to PRI-GND Pin5
3. Varnish the complete assembly

8.0 Performance

8.1 Constant Current and Efficiency

* Note: V_{IN}=90V_{AC}-132V_{AC}/60Hz; Loading with 12LEDS 700mA

V _{IN} (V _{AC})	P _{IN} (W)	V _{OUT} (V)	I _{OUT} (mA)	Ripple(PK) (mA)	η (%)	Power Factor	V _{bulk} (V)
90	32.81	39.36	703	32.8	84.33%	0.997	152
100	32.40	39.30	698	32.4	84.66%	0.999	163
110	31.91	39.28	698	31.9	85.92%	0.999	174
115	31.81	39.27	697	31.8	86.05%	0.999	185
120	31.66	39.25	697	31.7	86.41%	0.999	197
132	31.40	39.23	697	31.5	87.08%	0.995	207

8.2 Harmonic and Current Waveform

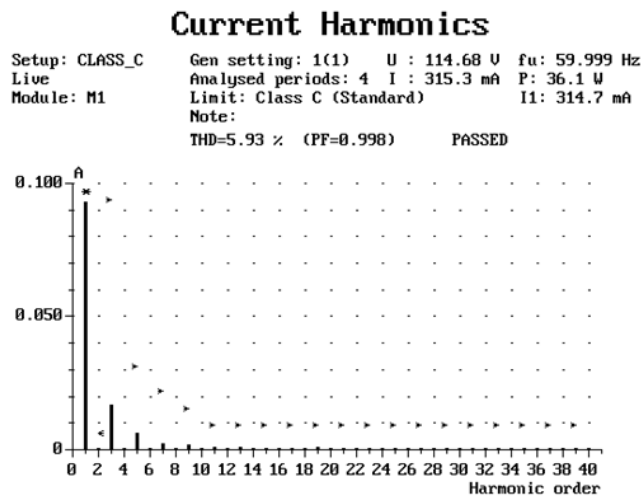


Figure 8.2.1 Current Harmonics @115V_{AC}

THD=5.93%

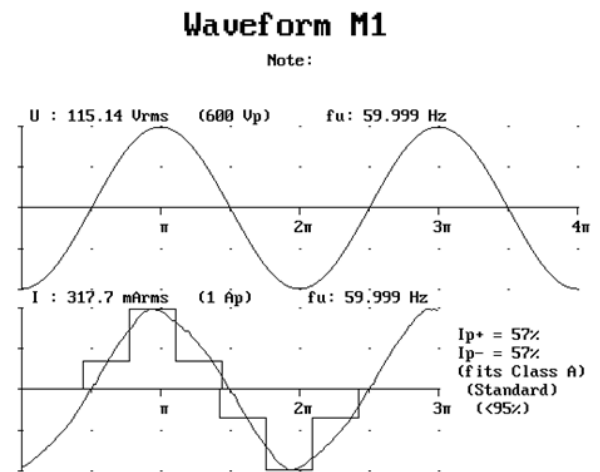
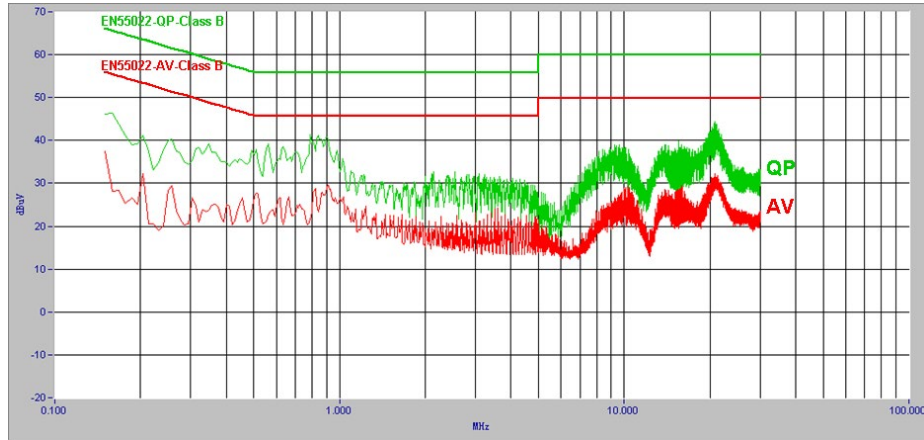


Figure 8.2.2 AC Current Waveform @115V_{AC}

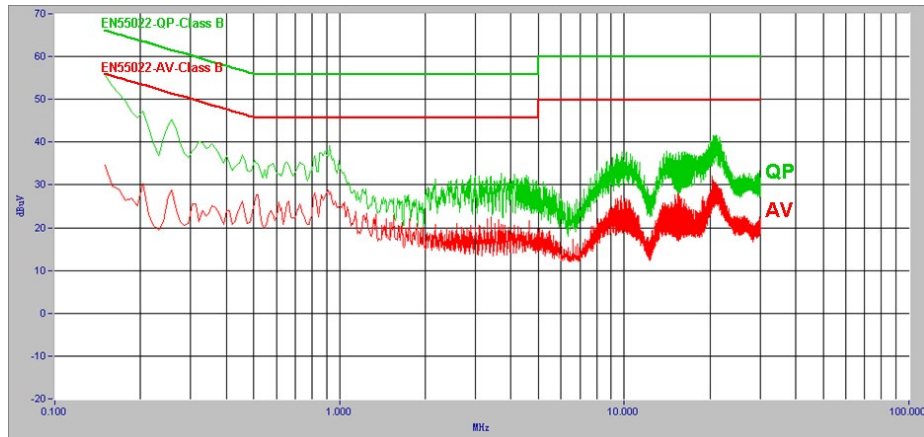
PF=0.998

8.0 Performance (Cont.)

8.3 Conducted EMI



a) QP & AV Scan L



b) QP & AV Scan N

Figure 8.3.1 EMI Results



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