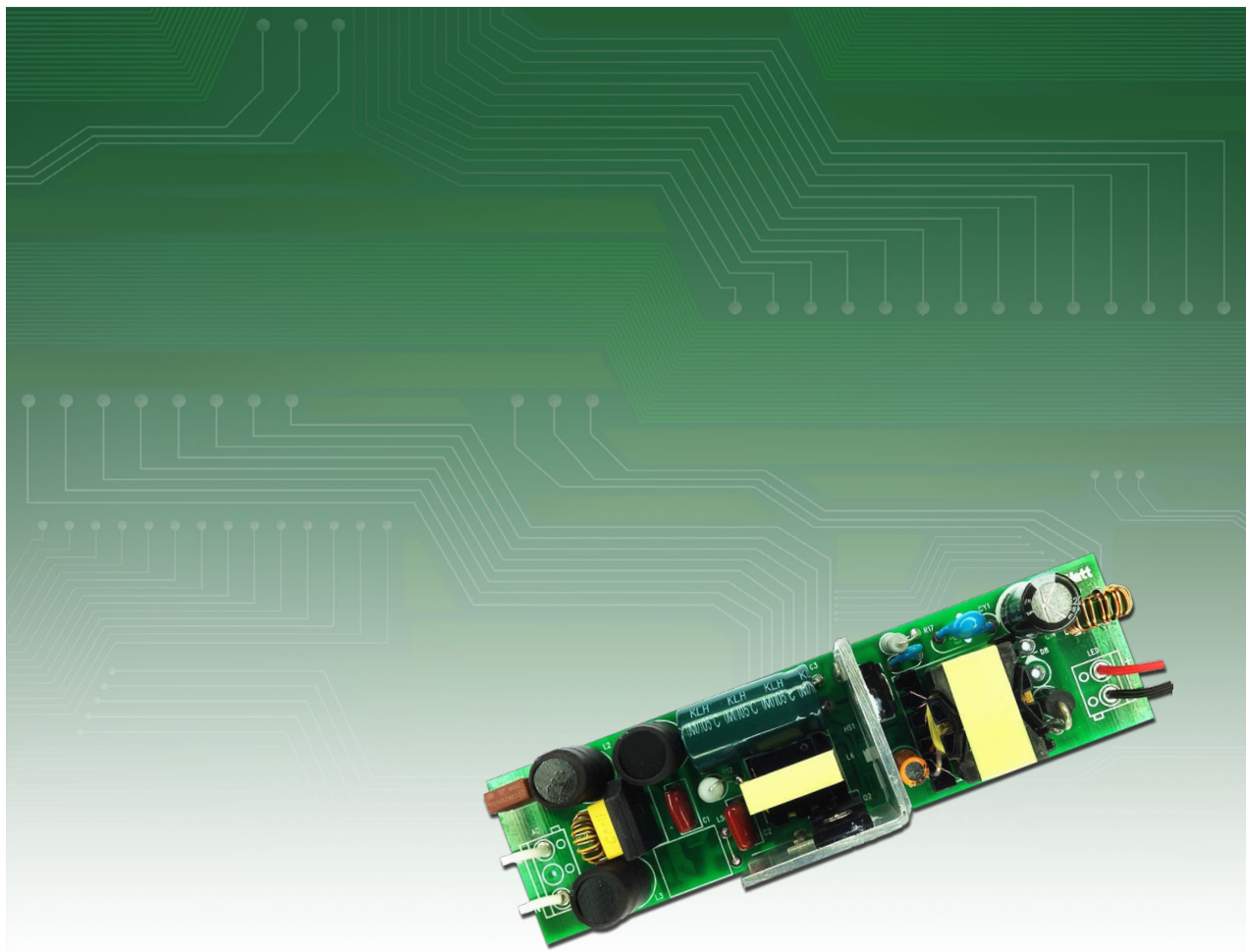




Dimmable LED Driver with iW3617-01

(AC input 180-264V_{AC}, Output 40V 700mA)

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EBC951

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1.0 Introduction

This reference design describes a 12 LEDs output at 700mA current, high line input (180–264V_{AC}) power supply for phase-cut dimmable LED applications. For this design the iW3617-01 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.

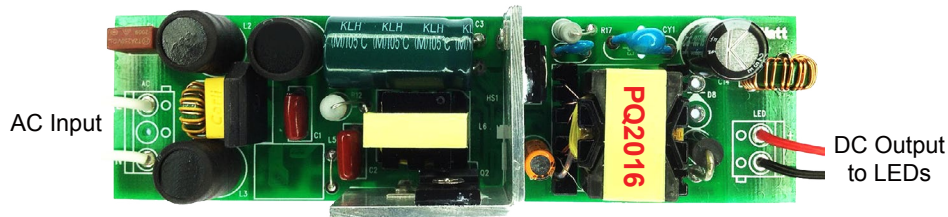


Figure 1.1 PCB Top View

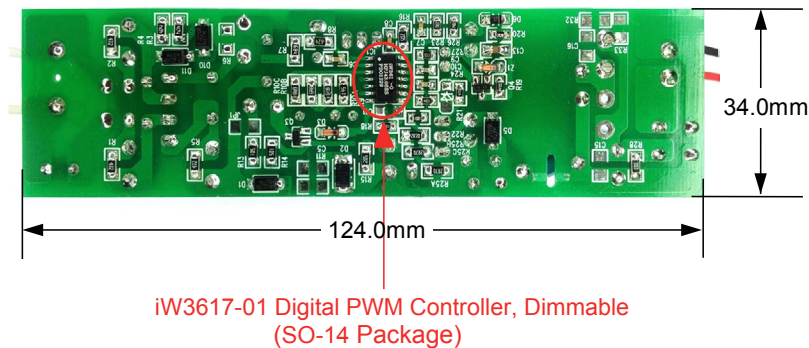


Figure 1.2 PCB Bottom View

2.0 Design Features

- Isolated AC/DC offline, input 230V_{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

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}	180		264	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			$V_{IN} = 230V_{AC}$
Efficiency	η		88		%	Measured at end of PCB $V_{IN} = 230V_{AC}$ ($T_{AMB} = 25^{\circ}C$)
Environmental						
THD	THD			10	%	$V_{IN} = 230V_{AC}$
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

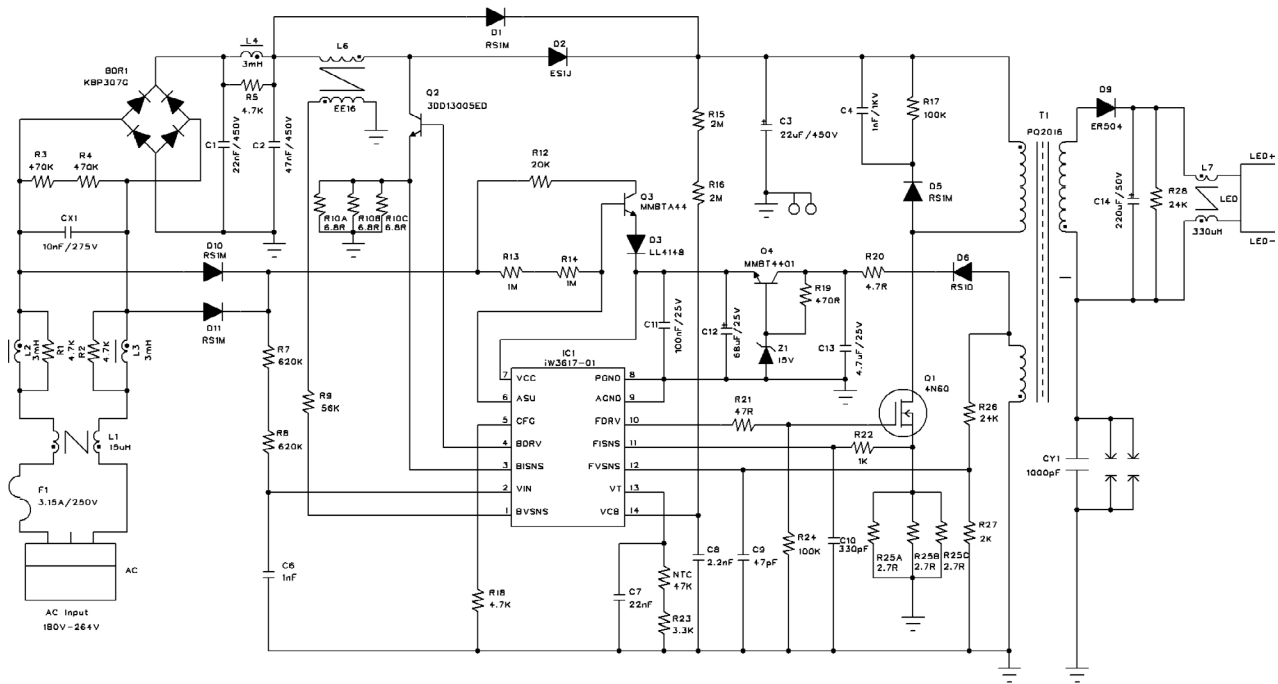
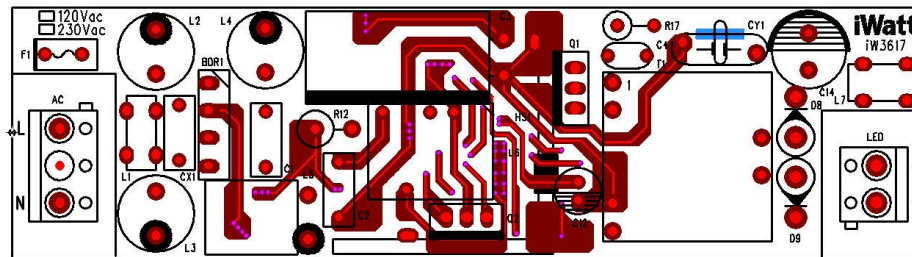
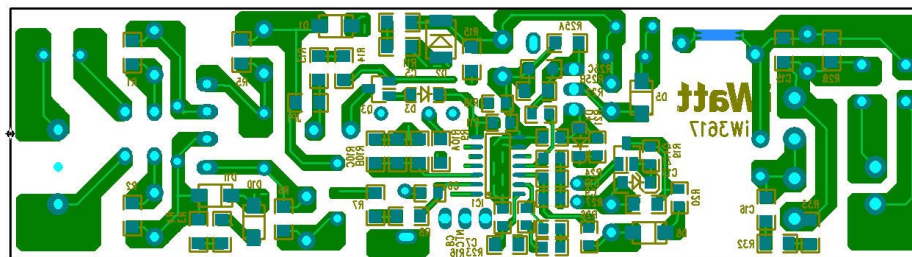


Figure 4.1 Design Schematic

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

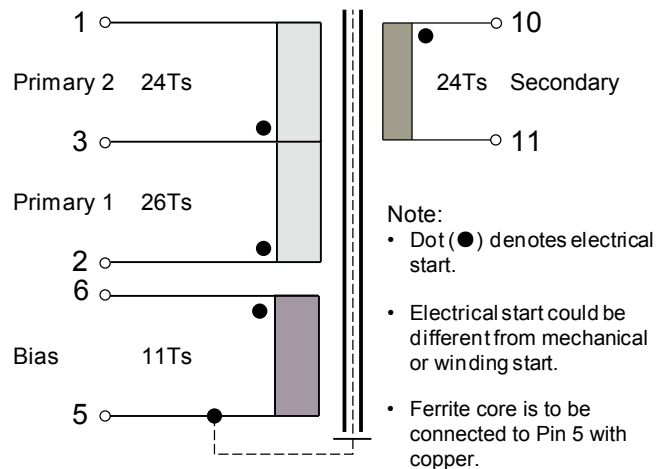
Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
1	1	IC1	iW3617-01, digital PWM controller, dimmable, SO-14	iW3617-01	iWatt, Inc
2	1	CX1	10nF, 275V, X2, P=7.5mm	PX103K31F29H200D9R	Carli
3	1	C1	22nF, 400V, CL21, P=7.5mm	AF223J2G079L250D9R	Carli
4	1	C2	47nF, 400V, CL21, P=7.5mm	AF473J2G079L250D9R	Carli
5	1	C3	22μF, 450V, E-Cap	22μFLK450V	Yongming
6	1	C12	68μF, 25V, E-Cap	68MFLK25V	Yongming
7	1	C14	220μF, 50V, E-Cap	220MFLK50V	Yongming
8	1	C4	1nF, 1KV, Ceramic capacitor, P=5mm	1NF/1KV	STE
9	1	C9	47pF, 25V, X7R, SMD-0805	CL10B470JB8NNNC	SAMSUNG
10	1	C10	330pF, 25V, X7R, SMD-0805	CL10B331JB8NNNC	SAMSUNG
11	1	C6	1nF, 25V, X7R, SMD-0805	CL10B102KA8NNNC	SAMSUNG
12	1	C8	2.2nF, 25V, X7R, SMD-0805	CL10B222KB8NNNC	SAMSUNG
13	1	C7	22nF, 25V, X7R, SMD-0805	CL10B223KA8NNNC	SAMSUNG
14	1	C11	100nF, 25V, X7R, SMD-0805	CL10B104KB8NNNC	SAMSUNG
15	1	C13	4.7μF, 25V, X7R, SMD-0805	CL31B475KAHNNNC	SAMSUNG
16	1	R21	47Ω ±5%, SMD-0805	RC0805JR-0747RL	YAGEO
17	1	R20	4.7Ω ±5%, SMD-0805	RC0805JR-074R7L	YAGEO
18	1	R19	470Ω ±5%, SMD-0805	RC0805JR-07470RL	YAGEO
19	1	R18	4.7kΩ ±5%, SMD-0805	RC0805JR-074K7L	YAGEO
20	1	R23	3.3kΩ ±1%, SMD-0805	RC0805JR-073K3L	YAGEO
21	1	R24	100kΩ ±5%, SMD-0805	RC0805JR-07100KL	YAGEO
22	1	R28	16kΩ ±5%, SMD-1206	RC1206JR-0716KL	YAGEO
23	2	R13, R14	1MΩ ±5%, SMD-1206	RC1206JR-071ML	YAGEO
24	3	R1, R2, R5	4.7kΩ ±5%, SMD-1206	RC1206JR-074K7L	YAGEO
25	1	R9	56kΩ ±5%, SMD-1206	RC1206JR-0756KL	YAGEO
26	2	R3, R4	470kΩ ±5%, SMD-1206	RC1206JR-07470KL	YAGEO
27	1	R16	2MΩ ±1%, SMD-1206	RC1206JR-072ML	YAGEO
28	1	R15	2MΩ ±1%, SMD-1206	RC1206JR-072ML	YAGEO
29	1	R8	620kΩ ±1%, SMD-1206	RC1206JR-07620KL	YAGEO
30	1	R7	620kΩ ±1%, SMD-1206	RC0805JR-07620KL	YAGEO
31	1	R22	1kΩ ±1%, SMD-0805	RC0805JR-071KL	YAGEO
32	1	R27	2kΩ ±1%, SMD-0805	RC0805JR-072KL	YAGEO
33	1	R26	24kΩ ±1%, SMD-0805	RC0603JR-0724KL	YAGEO
34	3	R25A, R25B, R25C	2.7Ω ±1%, SMD-1206	RC0805JR-072R7L	YAGEO
35	3	R10A, R10B, R10C	6.8Ω ±1%, SMD-1206	RC0805JR-076R8L	YAGEO
36	1	R12	20kΩ ±5%, MOF	MOF20K1W	YAGEO
37	1	R17	100kΩ ±5%, MOF	MOF100K1W	YAGEO
38	1	NTC	SDNT2012X473, NTC, 47K	SDNT2012X473	YAGEO
39	1	L5	Jumper, φ0.6mm, P=6.1mm		
40	1	F1	T3.15A, 250V	CRUPMP3.15A250V	GONGDE
41	1	BDR1	KBP307G, 3A, 1000V, KBP	KBP307G	PANJIT Semiconductor

6.0 Bill of Materials (Cont.)

Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
42	1	D6	RS1D, 1A, 200V, SMA	RS1D	PANJIT Semiconductor
43	4	D1, D5, D10, D11	RS1M, 1A, 1000V, SMA	RS1M	PANJIT Semiconductor
44	1	D2	ES1J, 1A, 600V, SMA	ES1J	PANJIT Semiconductor
45	1	D9	ER504, 5A, 300V, DO-201AD	ER504	PANJIT Semiconductor
46	1	D3	LL4148, 0.15A, 100V, LL-34	LL4148	PANJIT Semiconductor
47	1	Z1	Zener, ZMM15B, 15V, LL-34	ZMM15B	ST
48	1	Q1	4N60.4A, 600V, TO-220F	FTA04N60B	ARK
49	1	Q4	MMBT4401, NPN, SOT-23	MMBT4401	NXP
50	1	Q3	MMBT444, NPN, 0.3A, 500V, SOT-23	MMBT444	NXP
51	1	Q2	3DD13005ED, NPN, 4A, 700V, TO-220HF	BTR13005GD	IPS
52	3	L2, L3, L4	Drum choke, I-shaped, 10X12mm, 3mH	10X12MM3MH	XINyuanyang
53	1	L1	Common mode inductor, T8*4*3, 15μH	B29 T8*4*3 15uH	XINyuanyang
54	1	L7	Common mode inductor, T10*4*6, 330μH	B29 T10*4*6 60uH	XINyuanyang
55	1	L6	EE16, L=0.8mH	EE16	XINyuanyang
56	1	T1	Transformer, PQ2016 L=0.85mH(Vcc=11Ts)	PQ2016	XINyuanyang
57	1	CY1	Y1, 1000pF, 400V	1000PF/400V	STE
58	2	"L,N"	Terminal		
59	2	"+, -"	Terminal		
60	2	"L,N"	UL3239/24AWG, L=60mm, striped and tin plated 3mm of two ends, white color		
61	1	"+"	UL3239/24AWG, L=60mm, striped and tin plated 3mm of two ends, red color		
62	1	"-"	UL3239/24AWG, L=60mm, striped and tin plated 3mm of two ends, black color		
63	1	Housing	Plastic housing		
64	1	HS1	heatsink		
65	2	FOR HS1	screw		

7.0 Transformer Drawing

Schematic:



Electrical Specifications:

1. Primary inductance (L_p) = 0.85mH @10kHz
2. Primary leakage inductance (L_k) $\leq$ 15 μ H @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: $V_{IN}=180V_{AC}-264V_{AC}/50Hz$; 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)
180	31.71	39.52	708	26.0	88.24%	0.999	264
190	31.66	39.51	708	26.0	88.35%	0.998	278
200	31.56	39.50	708	25.2	88.61%	0.998	310
210	31.56	39.48	708	25.2	88.57%	0.998	325
220	31.56	39.46	708	25.2	88.52%	0.997	336
230	31.57	39.45	708	25.2	88.47%	0.997	364
240	31.57	39.43	709	24.4	88.55%	0.997	374
250	31.53	39.42	709	24.4	88.64%	0.996	387
264	31.49	39.41	709	24.0	88.73%	0.991	387

8.2 Harmonic and Current Waveform

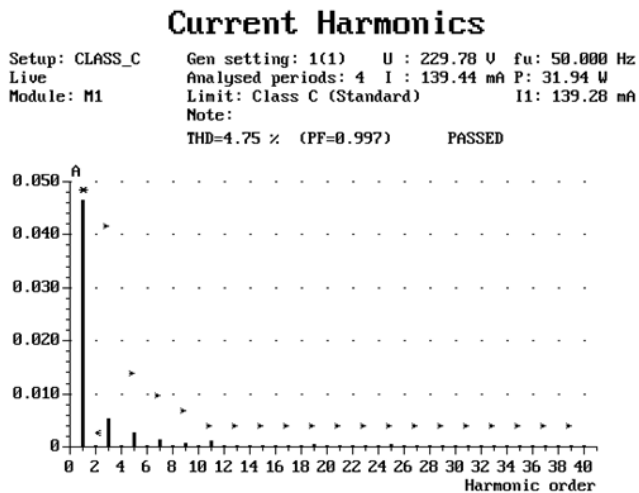


Figure 8.2.1 Current Harmonics @230V_{AC}
THD=4.75%

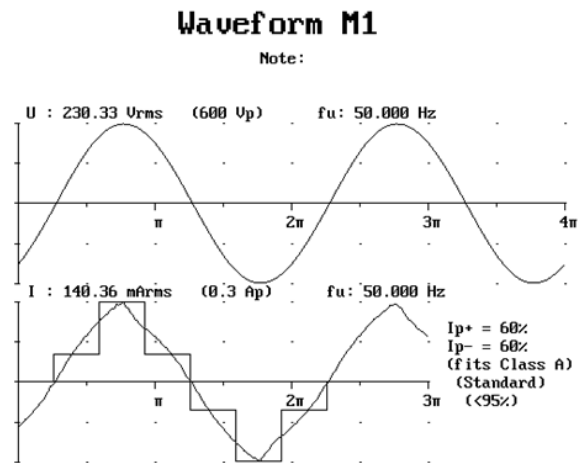
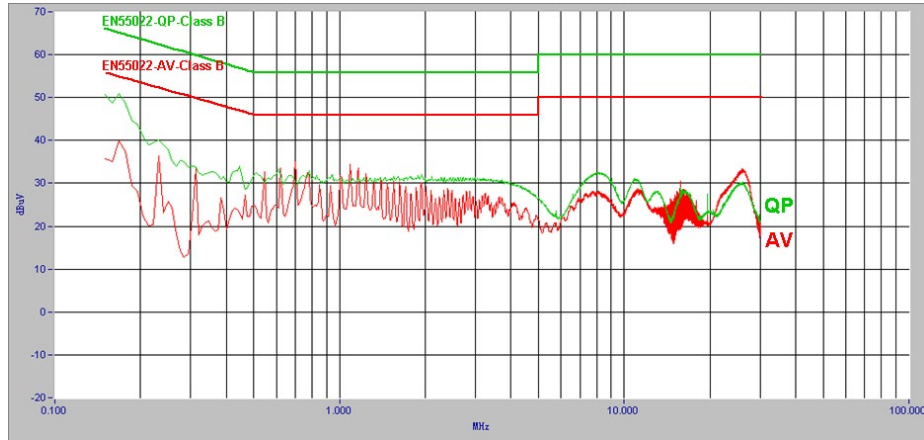


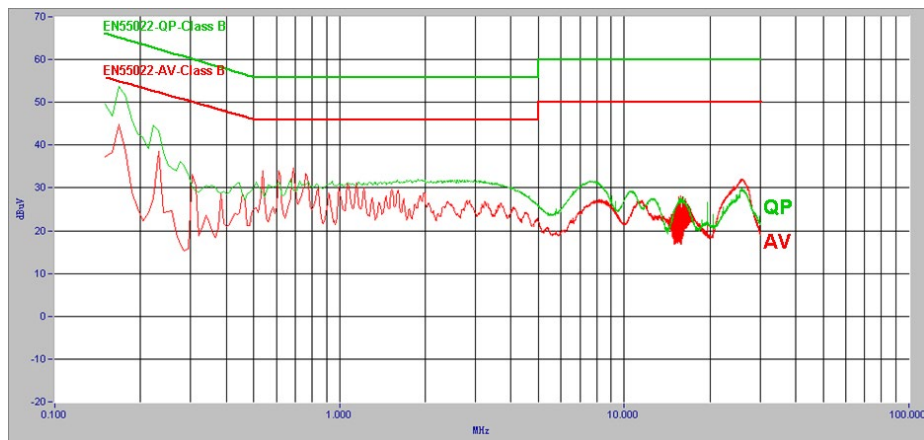
Figure 8.2.2 AC Current Waveform @230V_{AC}
PF=0.997

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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