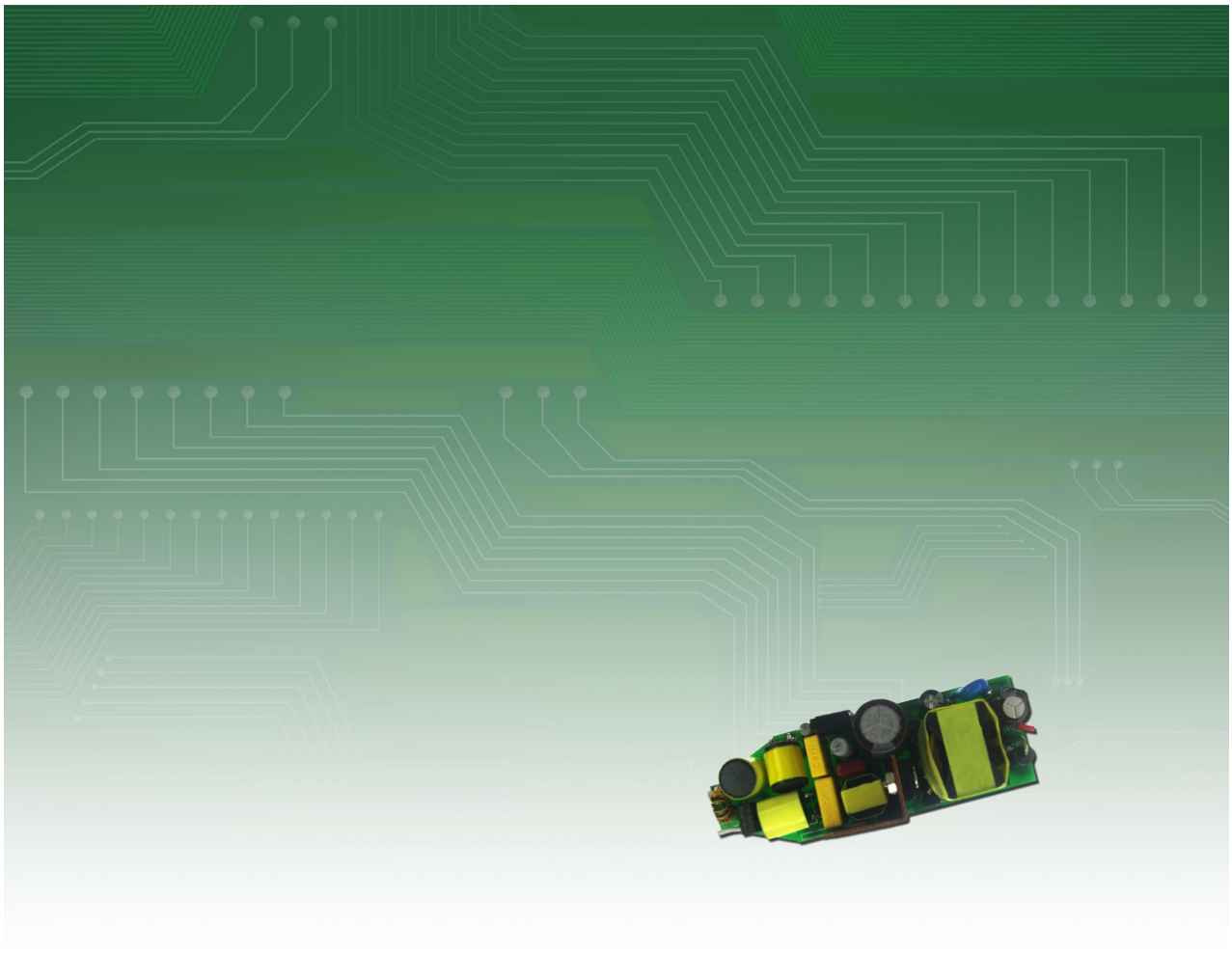
Reference Design

EBC904

iWatt
Power Management Simplified Digitally™



Dimmable LED Driver with iW3614-00

(AC Input 180-264V_{AC}, Output 21V 700mA)

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1.0 Introduction

This reference design describes a 6 LEDs output, high line input (180–264V_{AC}) power supply for dimmable LED applications. For this design the iW3614-00 is used. This document contains the complete specification of the 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

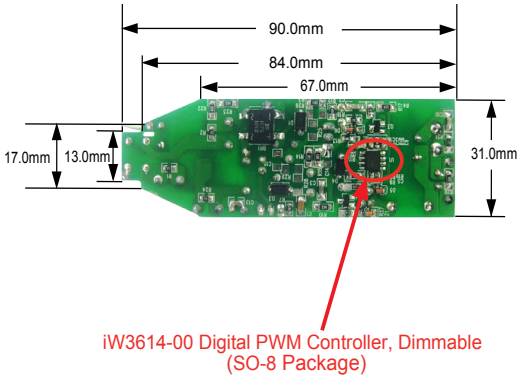


Figure 1.2 PCB Bottom View

2.0 Design Features

- Isolated AC/DC offline, input 230V_{AC}
- Output 6 LEDs at 700mA
- Intelligent wall dimmer detection:
  - » Leading-edge dimmer
  - » Trailing-edge dimmer
  - » No-dimmer
- Multiple dimming control schemes
  - » Hybrid dimming
  - » PWM dimming: 900Hz
  - » Amplitude dimming
- Wide dimming range from 1% to 100%
- Flickerless™ LED dimming technology: no visible flicker
- Resonant control to achieve high efficiency
- High power factor, 0.9-0.98 without dimmer
- Over-temperature protection and de-rating
- PrimAccurate™ 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	63	Hz	
Output						
Output voltage	V_{OUT}		21		V	Measured at the end of PCB
Output current	I_{OUT}		0.7		A	
Output ripple current	I_{RIPPLE}				mA_{P_P}	Set oscilloscope at 20MHz bandwidth
Total Output Power						
Continuous output power	P_{OUT}		14.7		W	
Power factor	*PF*	0.9				
Efficiency	η		83		%	Measured at end of PCB V_{IN}=230V_{AC}
Environmental						
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

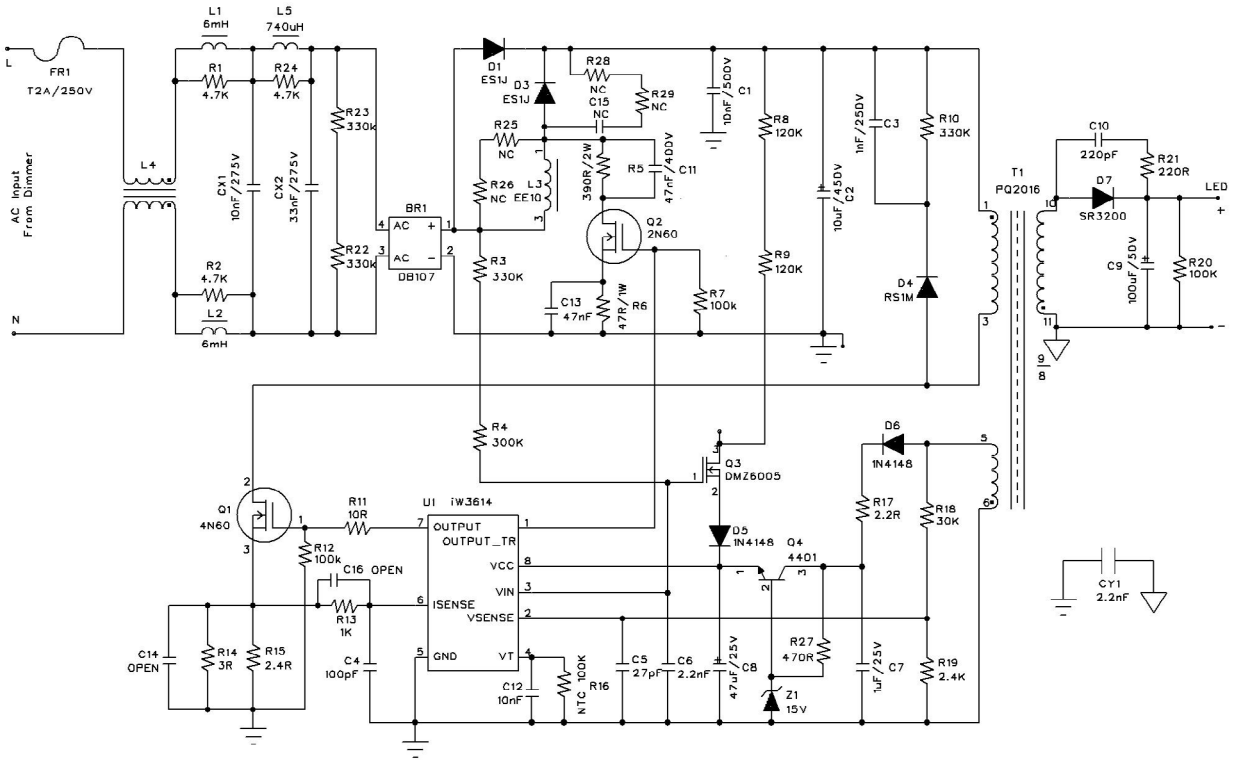
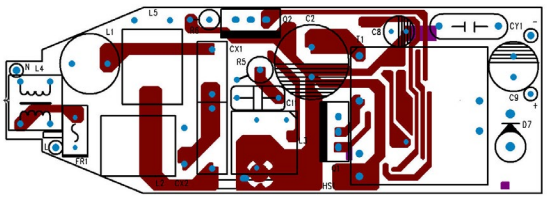
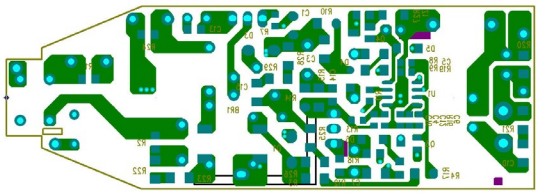


Figure 4.1 Design Schematic

5.0 PCB Layout



a) PCB Top



b) PCB Bottom

Figure 5.1 PCB Layout 90mm X 31mm

6.0 Bill of Materials

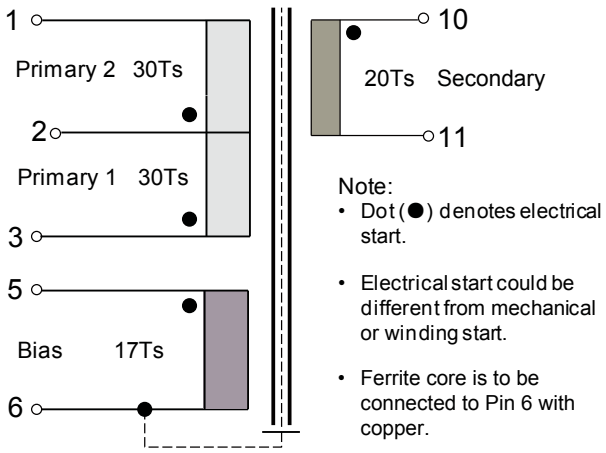
Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
1	1	U1	iW3614-00, Digital PWM Controller Dimmable, SO-8	iW3614-00	iWatt, Inc.
2	1	CX1	0.01µF, 275V, X2	PX103K3IB19H200D9R	CARLI
3	1	CX2	0.033µF, 275V, X2	PX333K3IC29H200D9R	CARLI
4	1	C11	47nF/400V, CL21 pin=7.5mm	AF473J2G079L250D9R	CARLI
5	1	C2	10µF, 450V, E-cap, 105°C	10µFLK450V	Yongming
6	1	C3	1nF, 250V, X7R, SMD1206	251R15W102KV4E	Johanson
7	1	C4	100pF, 50V, X7R, SMD 0805	CL10C101KB8NNNC	Samsung
8	1	C5	27pF, 50V, X7R, SMD 0805	CL10C27KB8NNNC	Samsung
9	1	C6	2.2nF, 50V, X7R, SMD 0805	CL10C222KB8NNNC	Samsung
10	1	C7	1µF, 50V, X7R, SMD 1206	CL10C105KB8NNNC	Samsung
11	1	C13	47nF, 50V, X7R, SMD 0805	CL10C473KB8NNNC	Samsung
12	1	C10	220pF, 250V, X7R, SMD1206	251R15W221KV4E	Johanson
13	1	C12	10nF, 50V, X7R, SMD 0805	CL10C103KB8NNNC	Samsung
14	1	C8	47µF, 25V, E-cap	47µFLK25V	Samsung
15	1	C9	100µF, 50V, E-cap	100µFLK50V	Samsung
16	3	R1, R2, R24	4.7KΩ, ±5%, SMD-1206	R1206JR-074K7L	Yongming
17	1	R3	330KΩ, ±1%, SMD-1206	RC1206JR-07330KL	Yongming
18	1	R4	300KΩ, ±1%, SMD-1206	RC1206JR-07300KL	YAGEO
19	1	R5	390Ω, ±5%, 2W	390R2W MOF	YAGEO
20	1	R6	47Ω , ±5%, 1W	47R1W MOF	YAGEO
21	1	R10	330KΩ, ±5%, SMD-1206	RC1206JR-07330KL	YAGEO
22	2	R7,R12	100KΩ, ±5%, SMD-0805	RC0805JR-07100KL	YAGEO
23	2	R8,R9	120KΩ, ±5%, SMD-1206	RC1206JR-07120KL	YAGEO
24	1	R13	1KΩ, ±1%, SMD-0603	RC0603JR-071KL	YAGEO
25	1	R14	3Ω, ±1%, SMD-1206	RC1206JR-073RL	YAGEO
26	1	R15	2.4Ω, ±1%, SMD-1206	RC1206JR-072R4L	YAGEO
27	2	R22,R23	330kΩ, ±5%, SMD-1206	RC1206JR-07330KL	YAGEO
28	1	R27	470Ω, ±5%, SMD-0805	RC0805JR-07470RL	YAGEO
29	1	R16	100KΩ, ±5%, SMD-0603 (100K NTC)	RC0603JR-07100KL	YAGEO
30	1	R11	10Ω, ±5%, SMD-0805	RC0805JR-0710RL	YAGEO
31	1	R18	30KΩ, ±1%, SMD-0805	RC0805JR-0730KL	YAGEO
32	1	R19	2.4KΩ, ±1%, SMD-0603	RC0603JR-072K4L	YAGEO
33	1	R20	100KΩ, ±5%, SMD-1206	RC1206JR-07100KL	YAGEO
34	1	R21	220Ω, ±5%, SMD-1206	RC1206JR-07150RL	YAGEO
35	1	F1	T2A250V	MST2A250V	Conquer
36	1	BR1	DB107S, SMD	KBP1010S	PANJIT
37	1	D4	RS1M, SMD	SRGC10MH	ZOWEI
38	2	D3,D1	ES1J, SMD	ES1J	PANJIT
39	2	D5,D6	1N4148 0.1A/100V, SMD	1N4148	PANJIT

6.0 Bill of Materials (Cont.)

Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
40	1	D7	MUR3200 3A/200V D0-201AD	MUR3200	PANJIT
41	1	Z1	Zener, 15V, SMD	ZVS15V	ST
42	1	CY1	Y1, 2.2nF250V	Y12.2NF250V	STF
43	1	Q1	FTA04N60B, TO-220F	FTA04N60B	ARK
44	1	Q2	FTA02N60B, TO-220F	FTA02N60B	ARK
45	1	Q4	MMBT4401, SOT-23	MMBT4401	NXP
46	1	Q3	DMZ6005, N-Depletion, 600V, SOT-23	DMZ6005,	ARK
47	2	L1,L2	6mH, Drum choke, 10X12mm, 0.20mm,400Ts	10X12MM	xingyuangyang
48	1	L5	740μH, Drum choke, 10X12mm, 0.35mm 140Ts	10X12MM	xingyuangyang
49	1	L3	3.6mH, EE10	EE10	xingyuangyang
50	1	L4	Common Mode Inductor T8*4*3 30uH	Common Mode Choke	Bead&Ferrite
51	1	T1	PQ2016, Transformer	PQ2016	xingyuangyang

7.0 Transformer Drawing

Schematic:



Note:
- Dot (●) denotes electrical start.
- Electrical start could be different from mechanical or winding start.
- Ferrite core is to be connected to Pin 6 with copper.

Electrical Specifications:

1.	Primary inductance (Lp) = 1.3mH @10KHz
2.	Primary leakage inductance (Lk) ≤70μH @10KHz

Materials:

1.	Core: PQ2016 (ferrite material TDK PC40 or equivalent)
2.	Bobbin: PQ2016
3.	Magnet wires (Pri): type 2-UEW
4.	Magnet wire (Sec): triple insulated wires
5.	Layer insulation tape: 3M1298 or equivalent

Finished:

1.	Remove pins 2, 4, 7, 8, 9, 12, 13, 14 from the bobbin
2.	Varnish the complete assembly
3.	Core is connected to primary pin 6

8.0 Performance

8.1 Constant Current and Efficiency

* Note: V_{IN}=180V_{AC}-264V_{AC}/50Hz; Loading with 6 LEDs 700mA

V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	η (%)	Power Factor
180	18.82	22.36	0.705	83.76%	0.954
190	18.69	22.33	0.703	84.03%	0.962
200	18.61	22.31	0.702	84.19%	0.970
210	18.56	22.30	0.702	84.37%	0.974
220	18.50	22.28	0.700	84.35%	0.976
230	18.41	22.26	0.699	84.47%	0.976
240	18.37	22.24	0.698	84.47%	0.972
250	18.36	22.22	0.697	84.35%	0.965
260	18.32	22.21	0.696	84.40%	0.956
264	18.35	22.20	0.696	84.20%	0.952

8.2 Current Harmonics

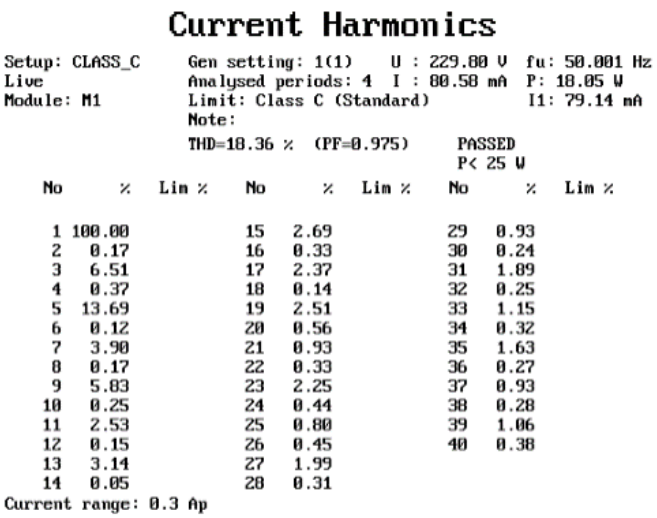


Figure 8.2.1 Current Harmonics

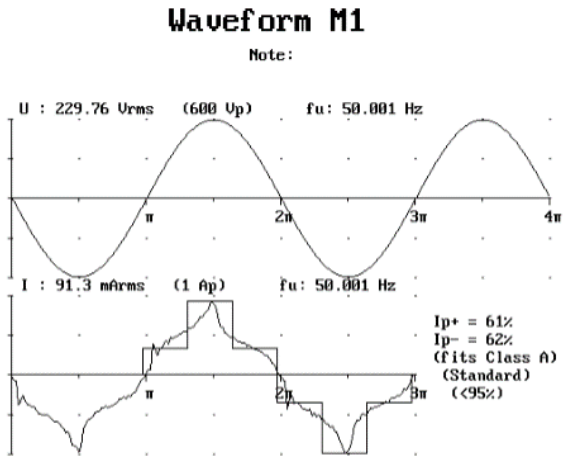
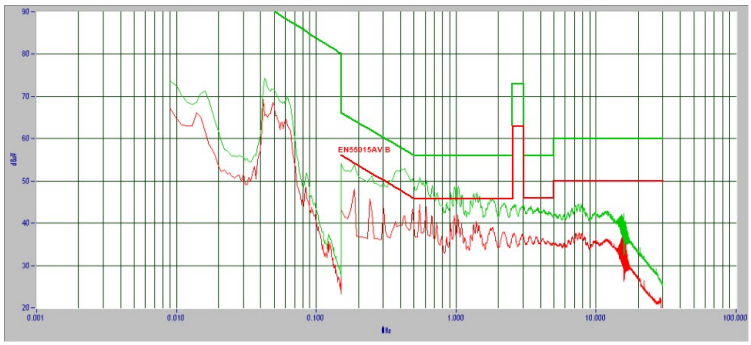


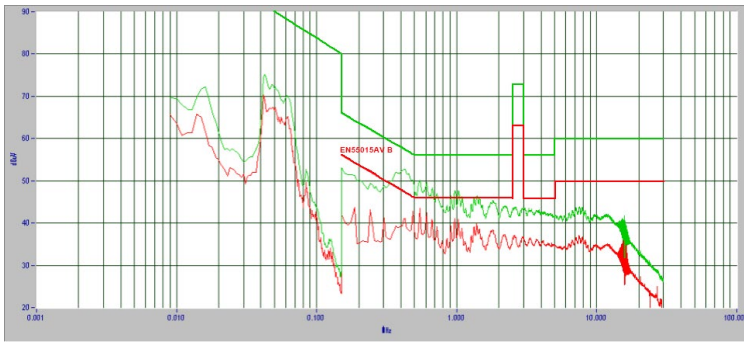
Figure 8.2.2 AC Current Waveform

8.0 Performance (Cont.)

8.3 Conducted EMI



a) QP & AV Scan L



b) QP & AV Scan N

Figure 8.3.1 EMI Results

Trademark Information

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