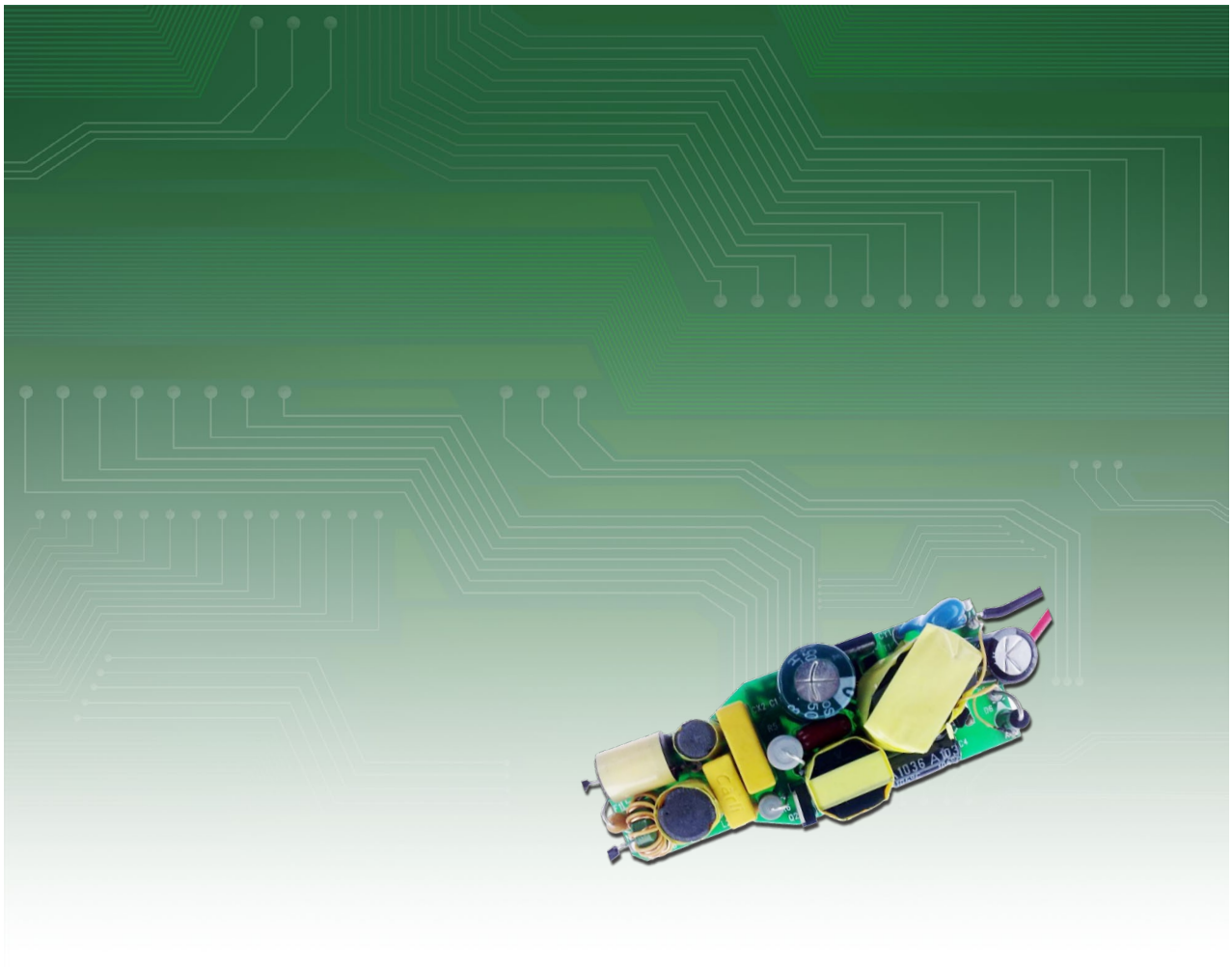
Reference Design

EBC899

iWatt
Power Management Simplified Digitally™



Dimmable LED Driver with iW3614

(AC Input 90-135V_{AC}, Output 30V 350mA)

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1.0 Introduction

This reference design describes a 9 LEDs output at 350mA current, low line input (90–135V_{AC}) power supply for phase-cut dimmable LED applications. For this design the iW3614 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.

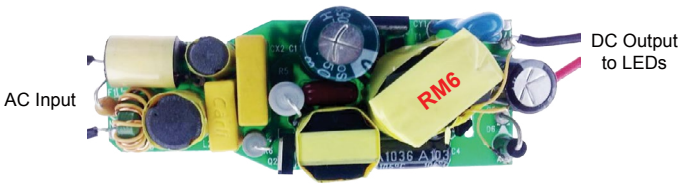


Figure 1.1 PCB Top View

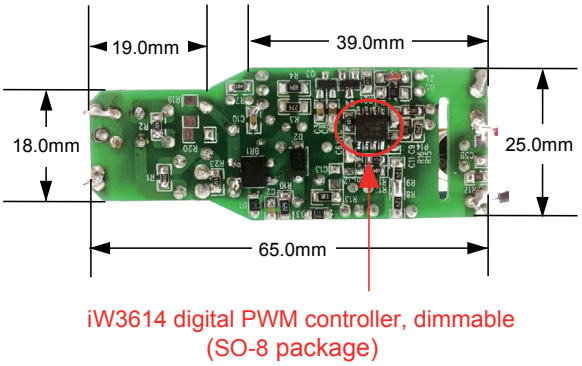


Figure 1.2 PCB Bottom View

2.0 Design Features

- Isolated AC/DC offline, input 120V_{AC}
- Output 9 LEDs at 350mA
- 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 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}	90		135	V_{AC}	2 wire
Frequency	f_{LINE}	57	60	63	Hz	
Output						
Output voltage	V_{OUT}		30		V	Measured at the end of PCB
Output current	I_{OUT}		0.35		A	
Output ripple current	I_{RIPPLE}		70		mA_{P_P}	Set oscilloscope at 20MHz bandwidth
Total Output Power						
Continuous output power	P_{OUT}		12		W	
Power factor	*PF*		0.90			Harmonic meet IEC61000-3-2
Efficiency	η		80		%	Measured at end of PCB V_{IN}=115V_{AC} (T_{AMB}=25°C)
Environmental						
Conducted EMI		Meets EN55015B				
Safety		Designed to meet IEC950, UL1950 Class II				
Ambient temperature	T_{AMB}		40		°C	Free convection, sea level

4.0 Schematic

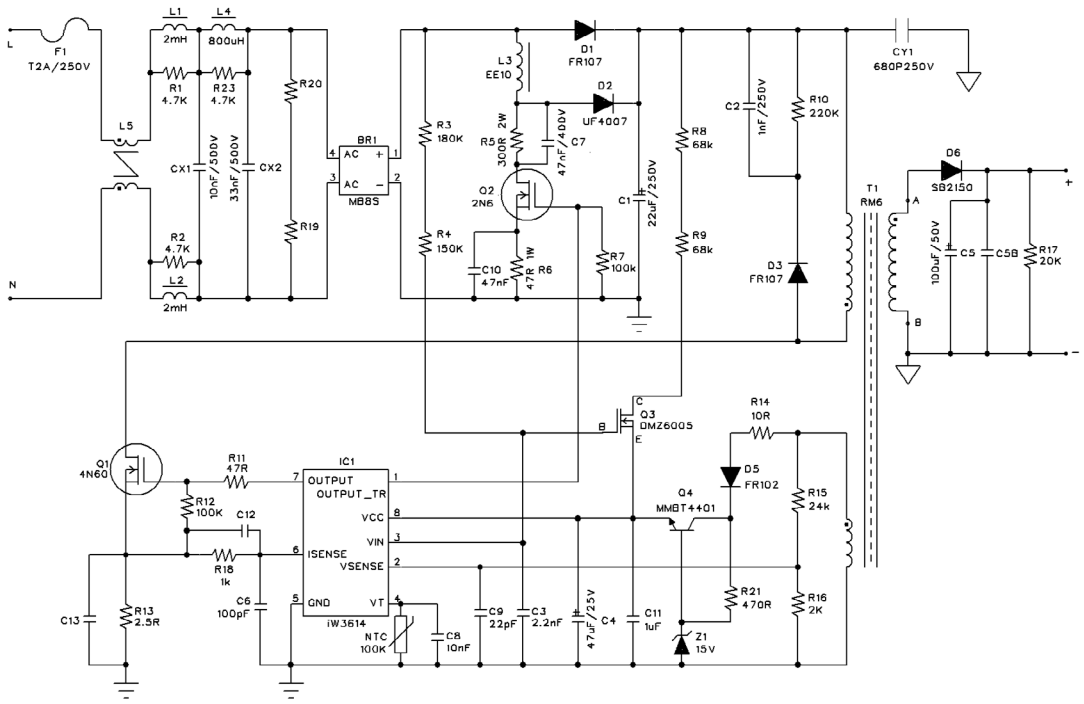
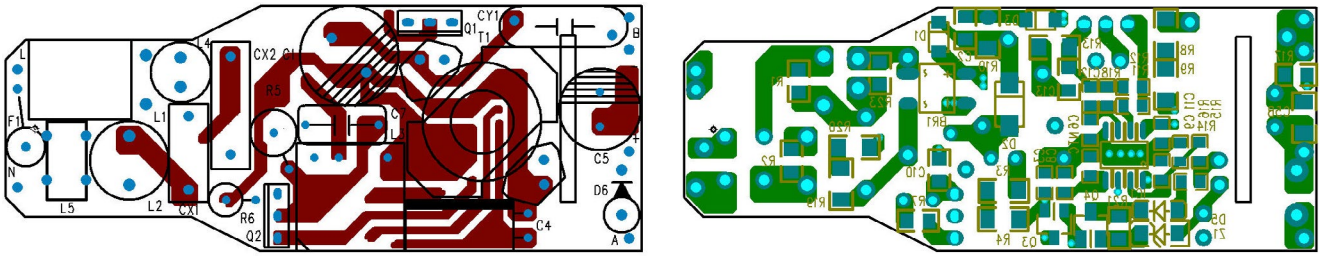


Figure 4.1 Design Schematic

5.0 PCB Layout



a) PCB Top b) PCB Bottom

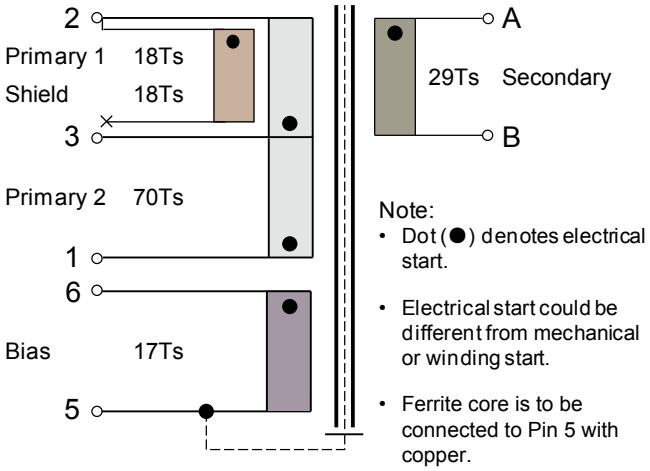
Figure 5.1 PCB Layout 65.0 mm x 25.0 mm

6.0 Bill of Materials

Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
1	1	IC1	iW3614-00, digital PWM controller, dimmable, SO-8	iW3614-00	iWatt, Inc
2	1	CX1	0.01µF, 275V, X2, Pin=7.5mm	PX103K3IB19H200D9R	CARLI
3	1	CX2	0.033µF, 275V, X2, Pin=10mm	PX333K3IC29H200D9	CARLI
4	1	C7	47nF/400V, CL21, Pin=7.5mm	AF473J2G079L250D9R	CARLI
5	1	C1	22µF, 250V, E-CAP, 105'C	22UFLK250V	Yongming
6	1	C2	1nF, 250V, X7R, SMD 0805	251R15W102KV4E	Johanson
7	1	C3	2.2nF, 50V, X7R, SMD 0805	CL10C222KB8NNNC	Samsung
8	1	C6	100pF, 50V, X7R, SMD 0603	CL10C101KB8NNNC	Samsung
9	1	C8	1nF, 50V, X7R, SMD 0603	CL10C102KB8NNNC	Samsung
10	1	C9	22pF, 50V, X7R, SMD 0603	CL10C220KB8NNNC	Samsung
11	1	C11	1µF, 50V, X7R, SMD 0805	CL10C105KB8NNNC	Samsung
12	1	C10	47nF, 50V, X7R, SMD 0805	CL10C473KB8NNNC	Samsung
13	1	C4	47µF, 25V, E-Cap	47UFLK25V	Yongming
14	1	C5	100µF, 50V, E-Cap	100UFLK50V	Yongming
15	3	R1, R2, R23	4.7kΩ ±5%, SMD-0805	RC0805JR-074K7L	YAGEO
16	1	R3	150kΩ ±1%, SMD-1206	RC1206JR-07150KL	YAGEO
17	1	R4	180kΩ ±1%, SMD-1206	RC1206JR-07180KL	YAGEO
18	1	R5	300Ω ±5%, 2W	300R2W MOF	YAGEO
19	1	R6	47Ω ±5%, 1W	47R1W MOF	YAGEO
20	1	R10	220kΩ ±5%, SMD-1206	RC1206JR-07220KL	YAGEO
21	2	R7, R12	100kΩ ±5%, SMD-0805	RC0805JR-07100KL	YAGEO
22	2	R8, R9	68kΩ ±5%, SMD-1206	RC1206JR-0768KL	YAGEO
23	1	R18	1kΩ ±1%, SMD-0603	RC0603JR-071KL	YAGEO
24	1	R13	2.5Ω ±1%, SMD-1206	RC1206JR-072R5L	YAGEO
25	1	R21	470Ω ±1%, SMD-0805	RC0805JR-07470RL	YAGEO
26	1	R11	47Ω ±5%, SMD-0805	RC0805JR-0747RL	YAGEO
27	1	R14	10Ω ±5%, SMD-0805	RC0805JR-0710RL	YAGEO
28	1	R15	24kΩ ±1%, SMD-0805	RC0805JR-0724KL	YAGEO
29	1	R16	2kΩ ±1%, SMD-0603	RC0603JR-072KL	YAGEO
30	1	NTC	100kΩ ±5%, SMD-0603	RC0603JR-07100KL	YAGEO
31	1	R17	20kΩ ±5%, SMD-0805	RC0805JR-0720KL	YAGEO
32	1	FR1	T2A, 250V	MST2A250V	Conquer
33	1	BR1	DB107S, SMD	KBP1010S	PANJIT
34	2	D1, D3	FR107, 1A1000V, SMD-1206S	SRGC10MH	ZOWEI
35	1	D2	MF4007/ES1J, SMA	ES1J	PANJIT
36	1	D5	FR102, 1A, 1000V, SMD-1206S	SRGC10DH	ZOWEI
37	1	D6	MBR2150, 2A, 150V, DO-41	MBR2150	PANJIT
38	1	Z1	Zener, 15V, LL34	ZVS15V	ST
39	1	CY1	Y1, 680pF, 250V	Y1680PF250V	STF
40	1	Q1	FTU04N60B, 4A, 600V, TO-251	FTU04N60B	ARK
41	1	Q2	FTU2N60B, 2A, 600V, TO-251	FTU02N60B	ARK
42	1	Q3	DMZ6005, N-Depletion, 600V, SOT-23	DMZ6005	ARK
43	1	Q4	MMBT4401, SOT-23	MMBT4401	NXP
44	2	L1, L2	2mH, Drum choke, 8X10mm, 0.21mm, 240Ts	8X10MM	xingyuangyang
45	1	L4	800µH, Drum choke, 6X8mm, 0.17mm, 175Ts	6X8MM	xingyuangyang
46	1	L3	1.2mH, EE10, 0.19mmX240Ts	EE10	xingyuangyang
47	1	L5	25µH, T8X4X3, B29	Common Mode Choke	Bead & Ferrite
48	1	T1	RM6, Transformer	RM6	xingyuangyang

7.0 Transformer Drawing

Schematic:



Electrical Specifications:

1.	Primary inductance (Lp) = 1.2mH @10kHz
2.	Primary leakage inductance (Lk) ≤ 50μH @10kHz
3.	Electrical strength = 3KV, 50/60Hz,1Min

Materials:

1.	Core : RM6 (Ferrite material TDK PC40 or equivalent)
2.	Bobbin : RM6, vertical, primary=3, secondary=3
3.	Magnet wires (Pri) : type 2-UEW
4.	Magnet wire (Sec) : triple insulated wires
5.	Layer insulation tape : 3M1298 or equivalent

Finished:

1.	Remove pin 4 from the bobbin
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}-135V_{AC}/60Hz; Loading with 9 LEDs 350mA

V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (A)	Ripple(PK) (mA)	η (%)	Power Factor
90	13.72	29.727	0.359	68	77.81%	0.946
100	13.30	29.698	0.358	64	79.96%	0.945
110	13.06	29.676	0.357	64	81.21%	0.936
115	12.96	29.648	0.357	64	81.67%	0.942
120	12.88	29.63	0.357	64	82.06%	0.937
130	12.76	29.613	0.356	64	82.67%	0.912
135	12.72	29.6	0.356	68	82.91%	0.892

8.2 Harmonic and Current Waveform

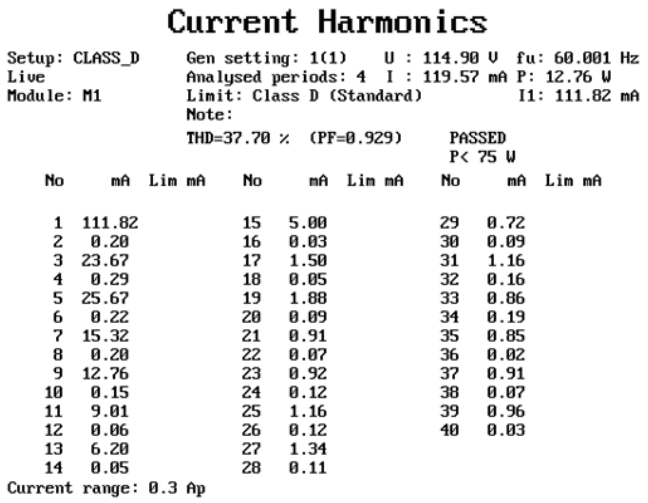


Figure 8.2.1 Current Harmonics @115V_{AC}

Meet IEC61000-3-2 requirement

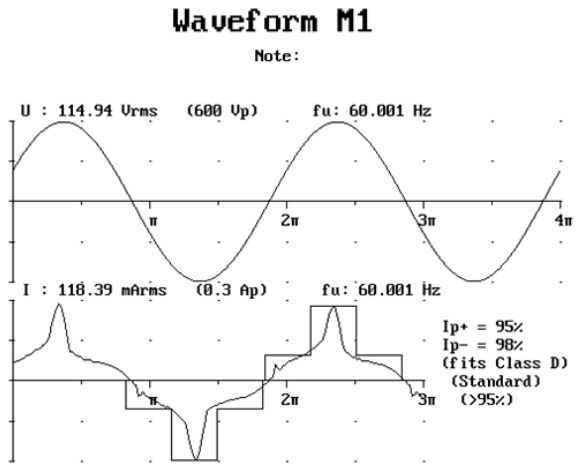
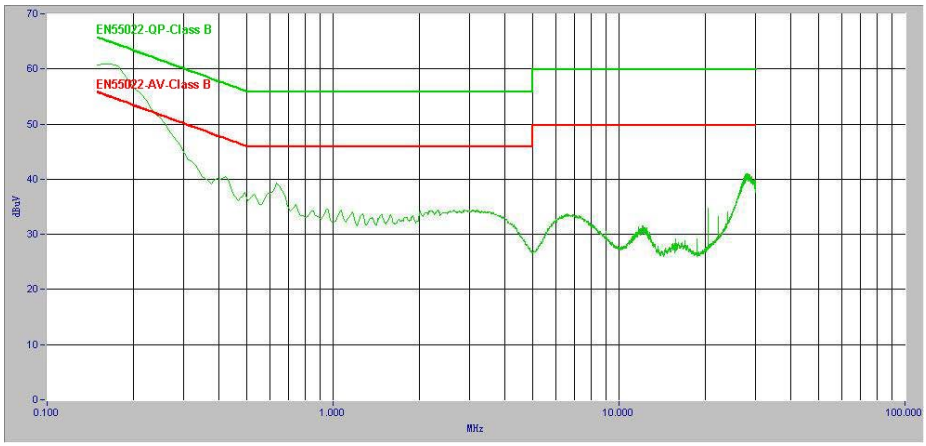


Figure 8.2.2 AC Current Waveform @115V_{AC}

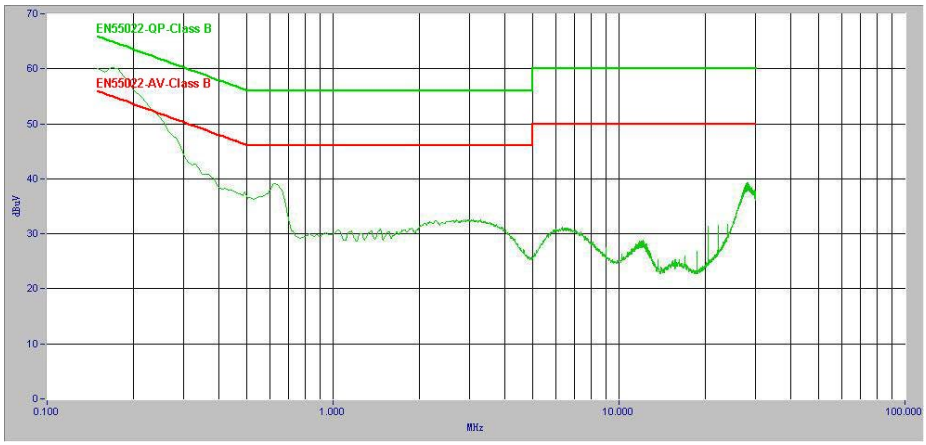
PF=0.929

8.0 Performance (Cont.)

8.3 Conducted EMI



a) QP Scan L



b) QP Scan N

Figure 8.3.1 EMI Results

Trademark Information

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