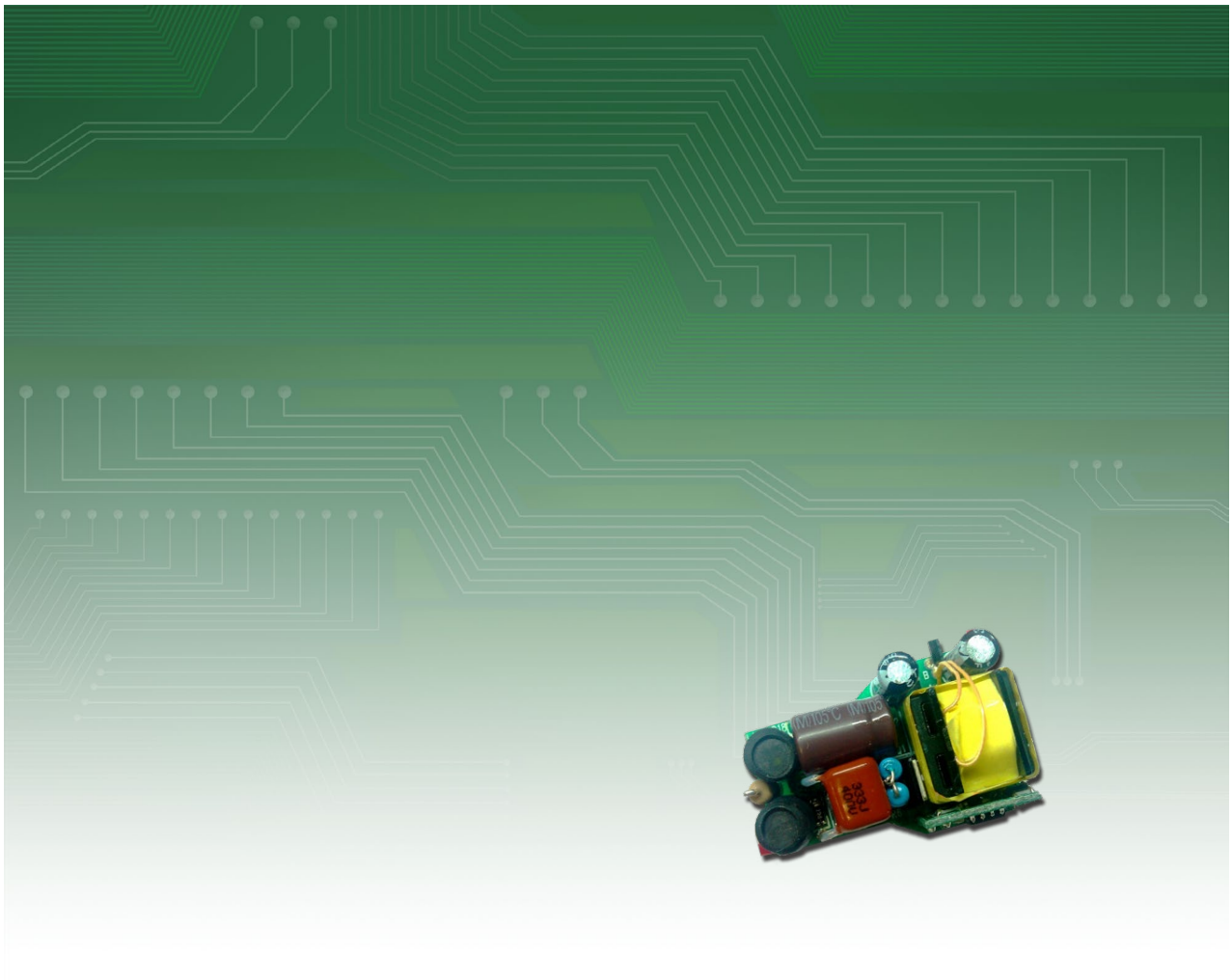
Reference Design

EBC895

iWatt
Power Management Simplified Digitally™



Dimmable LED Driver with iW3602-01

(AC Input 90-135V_{AC}, Output 12V 400mA)

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1.0 Introduction

This reference design describes a 4 LEDs output at 400mA current, low line input (90–135V_{AC}) power supply for dimmable LED applications. For this design the iW3602-01 is used. This document contains the design features and complete specification 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.

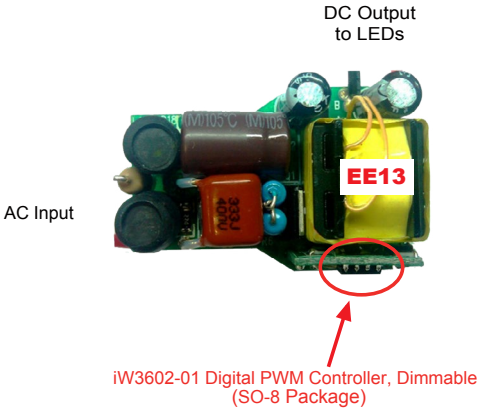


Figure 1.1 PCB Top View

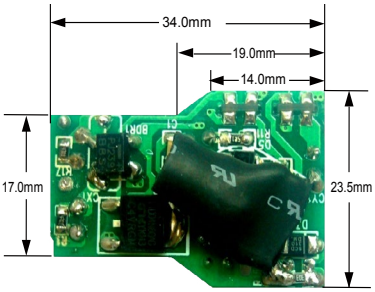


Figure 1.2 PCB Bottom View

2.0 Design Features

- Isolated AC/DC offline, input 230V_{AC}
- Output 4 LEDs at 400mA
- 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 technology: no visible flicker
- Resonant control to achieve high efficiency
- High power factor, 0.7-0.9 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}		12		V	Measured at the end of PCB
Output current	I_{OUT}		0.4		A	
Output ripple current	I_{RIPPLE}				mA_{P_P}	Set oscilloscope at 20MHz bandwidth
Total Output Power						
Continuous output power	P_{OUT}		4.8		W	
Power factor	*PF*	0.7				
Efficiency	η		73		%	Measured at end of PCB V_{IN}=115V_{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

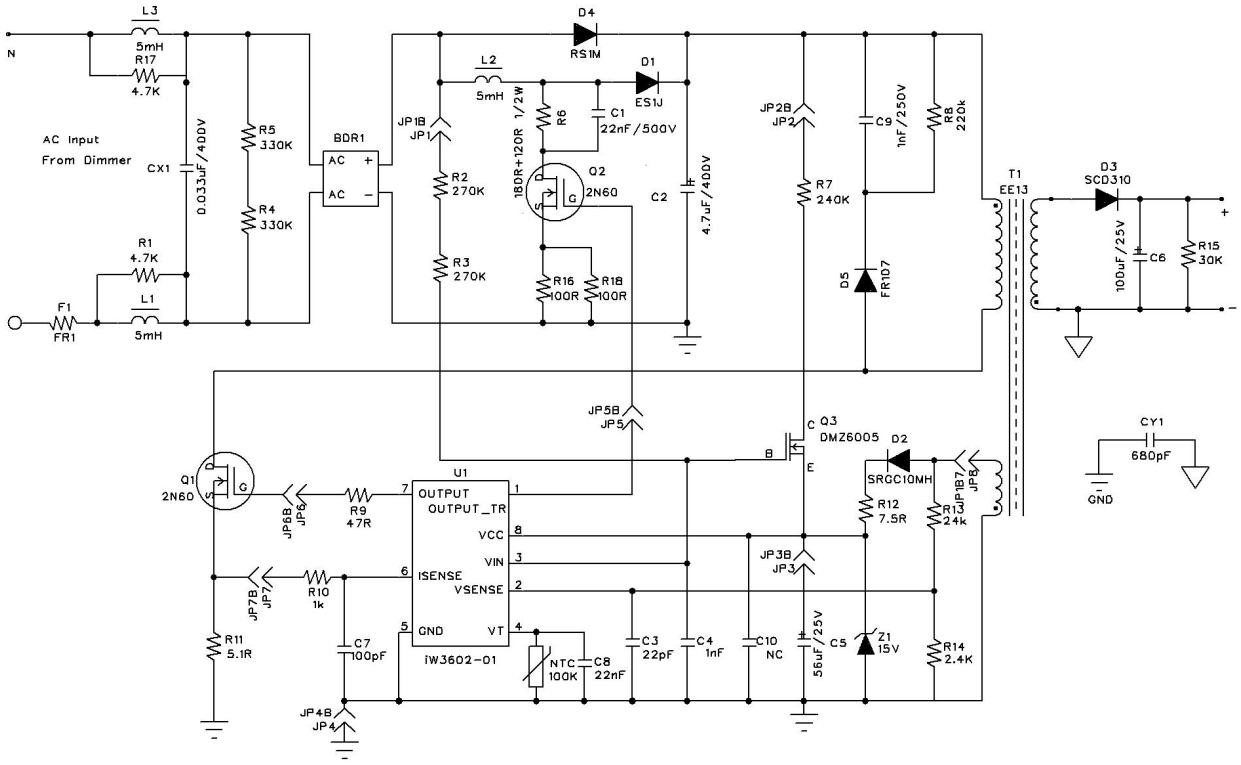
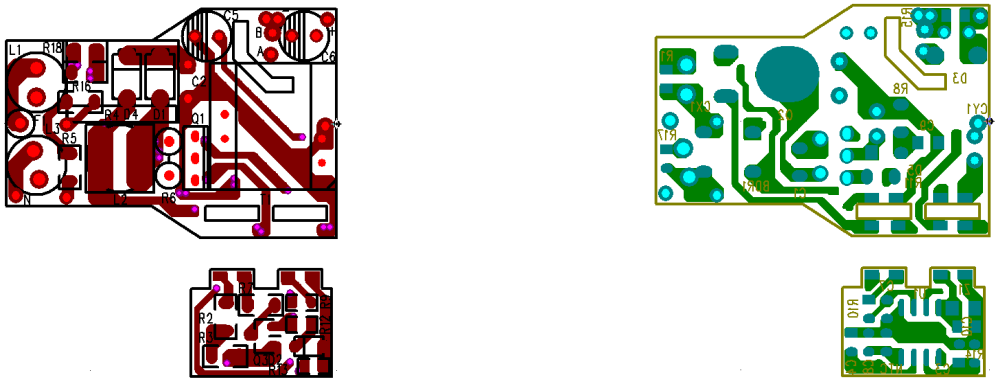


Figure 4.1 Design Schematic

5.0 PCB Layout



a) PCB Top

b) PCB Bottom

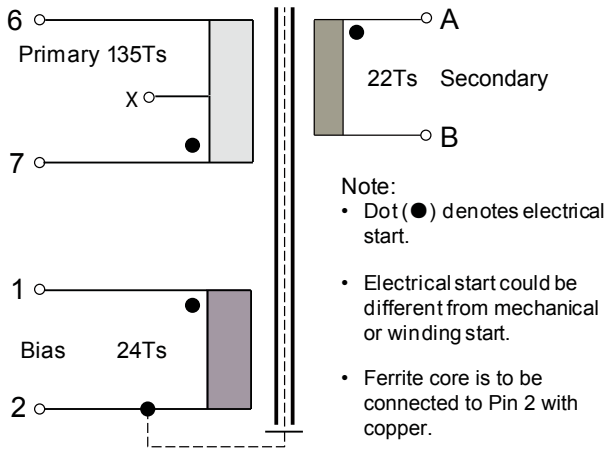
Figure 5.1 PCB Layout

6.0 Bill of Materials

Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
1	1	U1	iW3602-01, digital PWM controller, dimmable, SO-8	iW3602-01	iWatt, Inc.
2	1	CX1	0.047μF, 250V, CL21, pin=7.5mm	AF473J2E079L250D9R	Carli
3	1	C2	22nF, 500V, SMD-1206	501R18W223KV4E	Johanson
4	1	C3	22pF, 50V, SMD-0603	C1608X7R1H220J	TDK Corp.
5	1	C7	150pF, 50V, SMD-0603	C1608X7R1H151J	TDK Corp.
6	1	C4	1nF, 50V, SMD-0603	C1608X7R1H102J	TDK Corp.
7	1	C8	22nF, 50V, SMD-0603	C1608X7R1H223J	TDK Corp.
8	1	C9	1nF, 250V, SMD-0805	C2012X7R2E102J	TDK Corp.
9	1	C2	6.8μF, 200V, E-cap,105°C, 6.3X11.5mm	PKLH-6.8UF200V	Koshin
10	1	C5	47μF, 25V, E-cap, 105°C, 5X11.5mm	PKLH-47UF25V	Koshin
11	1	C6	100μF, 25V, E-cap, 105°C, 5X11.5mm	PKLH-100UF25V	Koshin
12	1	BR1	1A, 1000V, B10S	B10S	PANJIT Semiconductor
13	1	D1	1A, 600V, ES1J, SMD	ES1J	PANJIT Semiconductor
14	2	D4, D5	1A, 1000V, RS1M, SMD	WRS1M	PANJIT Semiconductor
15	1	D2	1A, 200V, FR102, SMD	RS1D	PANJIT Semiconductor
16	1	D3	3A, 60V, SR36, SMD	SR36	PANJIT Semiconductor
17	2	Q1, Q2	2A, 600V, FTU2N60B, TO-251	FTU2N60B	ARK
18	1	Q3	F501/DMZ6005, SOD-23	F501/DMZ6005	huajing/ARK
19	4	R2, R3, R4, R5	150kΩ, ±5%, SMD-1206	RC1206JR-07150KL	YAGEO
20	1	R6	300Ω, 1W, MOF	300R1WMOF	YAGEO
21	2	R16, R18	100Ω, ±5%, SMD-1206	RC1206JR-07100RL	YAGEO
22	1	R7	130kΩ, ±5%, SMD-1206	RC1206JR-07130KL	YAGEO
23	1	R8	220kΩ, ±5%, SMD-1206	RC1206JR-07220KL	YAGEO
24	1	R9	47Ω, ±5%, SMD-0603	RC0603JR-0747RL	YAGEO
25	1	R10	1KΩ, ±5%, SMD-0603	RC0603JR-071KL	YAGEO
26	1	R15	30KΩ, ±5%, SMD-0805	RC0805JR-0730KL	YAGEO
27	2	R1, R2	4.7KΩ, ±5%, SMD-0805	RC0805FR-074K7L	YAGEO
28	1	R11	4.7Ω, ±5%, SMD-0805	RC0805FR-074R7L	YAGEO
29	1	NTC	100kΩ, ±5%, SMD-0603	RC0603JR-07100KL	YAGEO
30	1	R12	10Ω, ±5%, SMD-0805	RC0805FR-0710RL	YAGEO
31	1	R14	2.4kΩ, ±5%, SMD-0603	RC0603JR-072K4L	YAGEO
32	1	R13	24kΩ, ±5%, SMD-0805	RC0805FR-0724KL	YAGEO
33	1	FR1	10Ω, 1W	KNP1WST-52-J-10R	Shunchi
34	1	CY1	680pF, 250V	Y1680PF250V	STF
35	1	Z1	15V, LL34		ST
36	2	L1, L3	5mH, 6X8mm		TDK Corp
37	1	L2	5mH, SMD	SFD6D65T-502M-R-S-LF	FENFA
38	1	T1	Transformer, EE13		

7.0 Transformer Drawing

Schematic:



Electrical Specifications:

1.	Primary inductance (Lp) = 2.3mH @10kHz
2.	Primary leakage inductance (Lk) ⩽ 100μH @10kHz
3.	Electrical strength = 3KV, 50/60Hz, 1min

Materials:

1.	Core : EE13(Ferrite Material TDK PC40 or equivalent)
2.	Bobbin :EE13 Horizontal. 4+4pin
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 3, 4, 5, 8 from the bobbin
2.	Varnish the complete assembly

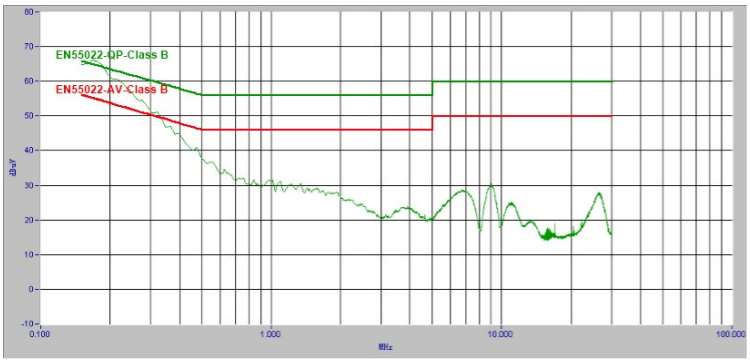
8.0 Performance

8.1 Constant Current and Efficiency

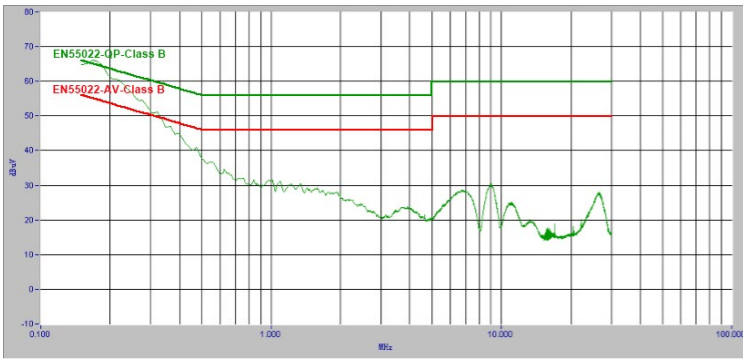
* Note: V_{IN}=90V_{AC}-135V_{AC}/60Hz; Loading with 4 LEDs 400mA

V_{IN} (V_{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	η (%)	Power Factor
90	6.080	11.828	0.381	74.12%	0.781
100	6.005	11.818	0.386	75.95%	0.774
110	6.080	11.815	0.395	76.73%	0.676
120	6.020	11.81	0.395	77.39%	0.739
130	5.960	11.794	0.395	78.32%	0.728
135	5.888	11.818	0.395	79.28%	0.722

8.2 Conducted EMI



a) Peak Scan L



b) Peak Scan N

Figure 8.2.1 EMI Results

Trademark Information

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