



LED Driver with iW3623

(AC Input 90-264 V_{AC}, Output 40V 700mA)

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EBC962

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1.0 Introduction

This reference design describes a 12 LEDs output, universal input (90–264V_{AC}) power supply for non-dimmable LED applications. For this design the iW3623 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

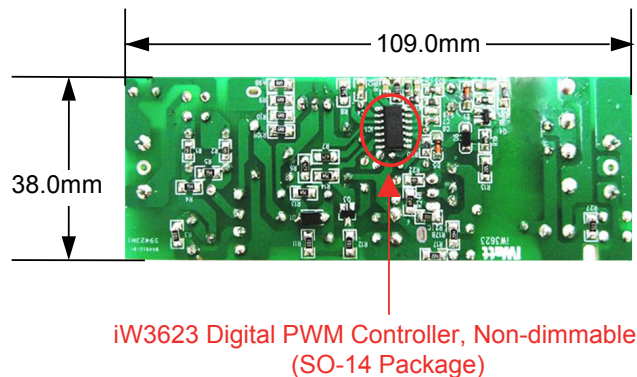


Figure 1.2 PCB Bottom View

2.0 Design Features

- AC input range 90-264V_{AC}, isolated AC/DC offline. 12 LEDs, output 700mA
- For isolated applications
- High efficiency and small BOM solution
- High PF: >0.95
- Low THD: <10%
- Flickerless™ LED technology: no visible flicker
- 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		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	0.9				
Efficiency	η		86		%	Measured at end of PCB $V_{IN}=230V_{AC}$
Environmental						
THD	THD			15	%	$V_{IN} = 230V_{AC}$
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

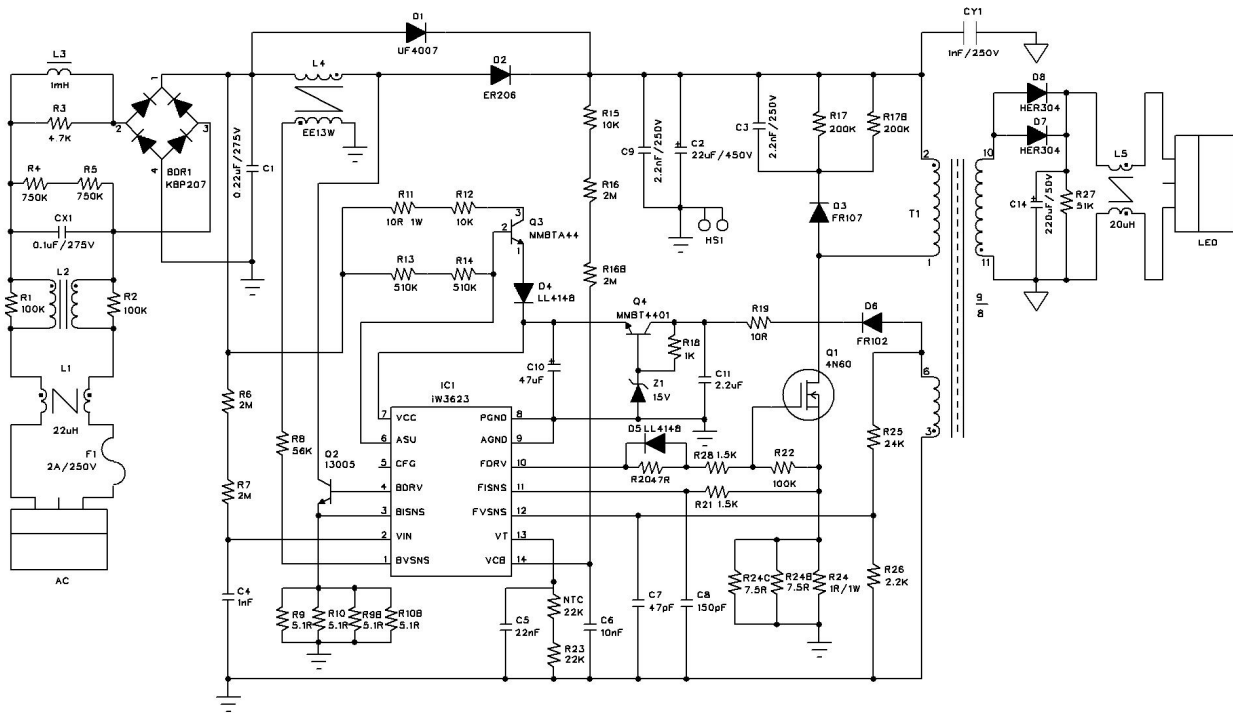
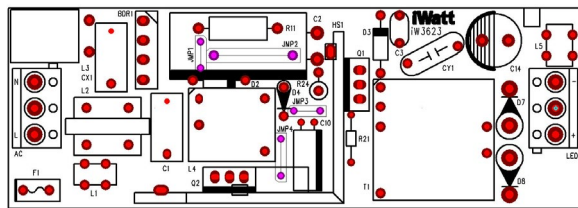
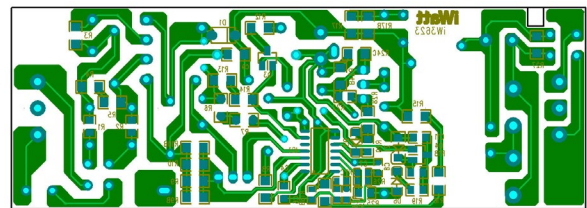


Figure 4.1 Design Schematic

5.0 PCB Layout



PCB Top



PCB Bottom

Figure 5.1 PCB Layout 109.0 mm x 38.0 mm

6.0 Bill of Materials

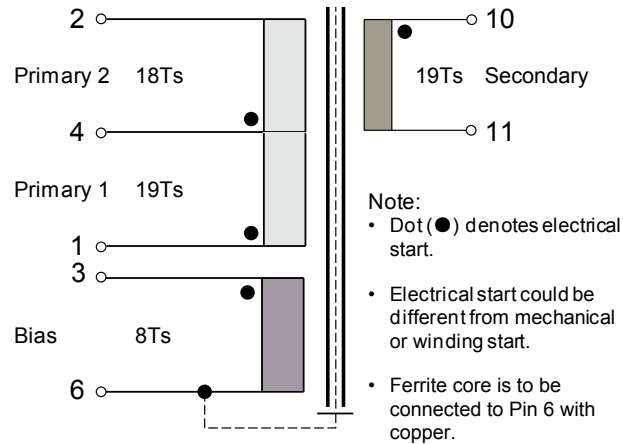
Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
1	1	IC1	iW3623 SO-14	iW3623	iWatt, Inc.
2	1	CX1	100nF, 275V, X2, P=10.5mm	PX104K3IC39H200D9R	Carli
3	1	C1	220nF, 450V, CBB, P=10.5mm	AF224J2G079L250D9R	Carli
4	1	C2	22μF, 450V, E-cap 13X20mm	22uFLK450V	Yongming
5	1	C10	47μF, 25V, E-cap 5X11.5mm	47UFLK25V	Yongming
6	1	C14	220μF, 50V, E-cap 10X16mm	220UFLK50V	Yongming
7	1	C3	2.2NF/250VP=5mm, porcelain capacitor	1NF/1KV	STE
8	1	C7	47pF, 50V, X7R, SMD-0805	CL10B470JB8NNNC	SAMSUNG
9	1	C4	1nF, 50V, X7R, SMD-0805	CL10B102KA8NNNC	SAMSUNG
10	1	C5	22nF, 25v, X7R SMD-0805	CL10B223KA8NNNC	SAMSUNG
11	1	C6	10nF, 25V, X7R, SMD-0805	CL10B103KA8NNNC	SAMSUNG
12	1	C8	150pF, 50V, X7R, SMD-0805	CL10B151JB8NNNC	SAMSUNG
13	1	C11	2.2μF, 25V, X7R, SMD-0805	CL31B225KAHNNNC	SAMSUNG
14	1	C9	10nF, 500V, X7R, SMD-1206	501R18W103KV4E	JOHANSON
15	1	R19	10Ω ±5%, SMD-0805	RC0805JR-0710RL	YAGEO
16	1	R20	47Ω ±5%, SMD-0805	RC0805JR-0747RL	YAGEO
17	1	R18	1KΩ ±5%, SMD-0805	RC0805JR-071KL	YAGEO
18	1	R22	100KΩ±1%, SMD-0805	RC0805JR-07100KL	YAGEO
19	2	R1, R2	100KΩ±5%, SMD-0805	RC0805JR-07100KL	YAGEO
20	2	R22, NTC	22KΩ ±5%, SMD-0805	RC0805JR-0722KL	YAGEO
21	2	R4,R5	750KΩ ±5%, SMD-1206	RC1206JR-07750KL	YAGEO
22	1	R3	4.7KΩ ±5%, SMD-1206	RC1206JR-074K7L	YAGEO
23	1	R24B	7.5Ω ±1%, SMD-1206	RC1206JR-077R5L	YAGEO
24	1	R24C	5.6Ω ±1%, SMD-1206	RC1206JR-075R6L	YAGEO
25	1	R8	56KΩ±5%, SMD-1206	RC1206JR-0756KL	YAGEO
26	2	R13,R14	510KΩ±5%, SMD-1206	RC1206JR-07510KL	YAGEO
27	2	R16 ,R16B	2MΩ±1%, SMD-1206	RC1206JR-072ML	YAGEO
28	1	R6	2MΩ±1%, SMD-1206	RC1206JR-072ML	YAGEO
29	1	R7	2MΩ,±1%, SMD-1206	RC1206JR-072ML	YAGEO
30	1	R25	24KΩ ±1%, SMD-0805	RC0805JR-0724KL	YAGEO
31	1	R26	2.2KΩ ±1%, SMD-0805	RC0805JR-072K2L	YAGEO
32	1	R27	30KΩ ±1%, SMD-1206	RC1206JR-0730KL	YAGEO
33	4	R9,R9B,R10,R10B	4.3Ω ±1%, SMD-1206	RC1206JR-074R3L	YAGEO
34	2	R12, R15	10KΩ ±1%, SMD-1206	RC1206JR-0710KL	YAGEO
35	1	R11	20KΩ ±5%, MOF1/4W	MOF20K 1/4W	YAGEO
36	1	R24	1Ω ±5%, MOF 1W	MOF1R 1W	YAGEO
37	1	R21	1.5KΩ ±5%, MOF 1/8W	MOF1K5 1/8W	YAGEO
38	1	R17, R17B	200KΩ,±1%, SMD-1206	RC1206JR-07200KL	YAGEO
39	1	R28	0Ω,±1%, SMD-1206	RC1206JR-070RL	YAGEO

6.0 Bill of Materials (Cont.)

Item	Qty.	Ref.	Description	Manufacturer P/N	Manufacturer
40	1	F1	T3.15A, 250V	MST3.15A250V	Conquer
41	1	BDR1	KBP307G, 3A, 1000V, KBP	KBP307G	PANJIT Semiconductor
42	1	D6	RS1D, 1A, 200V, SMA	RS1D	PANJIT Semiconductor
43	1	D3	FR107, DO-15	FR107	PANJIT Semiconductor
44	1	D1	RS1M, 1A, 1000V, SMA	RS1M	PANJIT Semiconductor
45	1	D2	ER206, 2A, 600V, DO-15	ER206	PANJIT Semiconductor
46	2	D7, D8	HER304, 3A, 300V, DO-201AD	HER304	PANJIT Semiconductor
47	1	D5	LL4148, 0.15A, 100V, LL-34	LL4148	PANJIT Semiconductor
48	1	D4	LL4148, 0.15A, 100V, package	LL4148	PANJIT Semiconductor
49	1	Z1	Zener, ZMM15B, 15V, LL-34	ZMM15B	ST
50	1	Q1	7N60.7A, 600V, TO-220F	FTA07N60	ARK
51	1	Q4	MMBT4401, NPN, SOT-23	MMBT4401	NXP
52	1	Q3	MMBT444, NPN, 0.3A, 500V, SOT-23	MMBT444	NXP
53	1	Q2	3DD13005ED, NPN, 4A 700V, TO-220HF	3DD13005ED	Huangjing
54	1	L3	Drum choke, I-shaped 10X12mm, 1mH	10X12MM1MH	XIN YUAN YANG
55	1	L2	UU9.5	UU9.5	XIN YUAN YANG
56	1	L1	Common Mode Inductor T8*4*3 15μH	T8*4*3 15UH	XIN YUAN YANG
57	1	L5	Common Mode Inductor T10*4*6 330μH	T10*4*6 330UH	XIN YUAN YANG
58	1	L4	EF16	EF16	XIN YUAN YANG
59	1	T1	Transformer PQ2016 L=0.85mH(Vcc=11Ts)	PQ2016	XIN YUAN YANG
60	1	CY1	Y1, 1000pF, 400V	1000PF/400V	STE
61	1	JUMP1	Jumper φ 0.6mm P=5mm		
62	1	JUMP1	Jumper φ 0.6mm P=15mm		
63	1	JUMP1	Jumper φ 0.6mm P=5mm		
64	1	JUMP1	Jumper φ 0.6mm P=7mm		
65	1	PCB	FR-4		

7.0 Transformer Drawing

Schematic:



Electrical Specifications:

1. Primary inductance (L_p) = 0.5mH @10KHz
2. Primary leakage inductance (L_k) ≤ 40uH@10KHz

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. Remove pins 4, 5, 7, 8, 9, 12, 13 from the bobbin
2. Core is connected to PRI-GND pin6.
3. Varnish the complete assembly

8.0 Performance

8.1 Constant Current and Efficiency

* Note: $V_{IN}=90V_{AC}-264V_{AC}/50Hz$; Loading with 12 LEDs 700mA

V_{IN} (V _{AC})	P_{IN} (W)	V_{OUT} (V)	I_{OUT} (mA)	Ripple(PK) (mA)	η (%)	Power Factor	V_{bulk} (V)	THD (%)
90	32.90	40.26	686.00	35.00	83.94%	0.987	202.0	12.80
100	32.19	40.26	683.00	35.00	85.42%	0.994	207.0	2.710
110	31.65	40.26	682.00	35.00	86.75%	0.998	213.0	2.910
115	31.49	40.26	682.00	35.00	87.19%	0.997	218.0	3.080
120	31.38	40.26	682.00	35.00	87.49%	0.997	223.0	3.190
130	31.23	40.26	682.00	33.00	87.91%	0.996	228.0	4.100
140	31.14	40.26	680.00	33.00	87.91%	0.995	232.0	3.800
150	31.08	40.26	680.00	33.00	88.08%	0.993	245.0	3.770
160	30.99	40.26	680.00	33.00	88.33%	0.993	257.0	4.190
170	30.90	40.26	680.00	33.00	88.59%	0.992	269.0	4.260
180	30.94	40.26	678.00	31.00	88.22%	0.990	282.0	5.150
190	30.96	40.26	678.00	31.00	88.16%	0.990	294.0	5.400
200	31.00	40.26	679.00	31.00	88.18%	0.985	306.0	5.340
210	31.19	40.26	682.00	31.00	88.03%	0.983	331.0	5.800
220	31.20	40.26	684.00	31.00	88.26%	0.981	345.0	5.660
230	31.18	40.26	685.00	31.00	88.44%	0.977	357.0	5.680
240	31.32	40.26	686.00	31.00	88.17%	0.974	369.0	6.030
250	31.36	40.26	686.00	31.00	88.06%	0.970	379.0	7.340
264	31.42	40.26	688.00	31.00	88.15%	0.930	390.0	23.54

8.0 Performance (Cont.)

8.2 Harmonic and Current Waveform

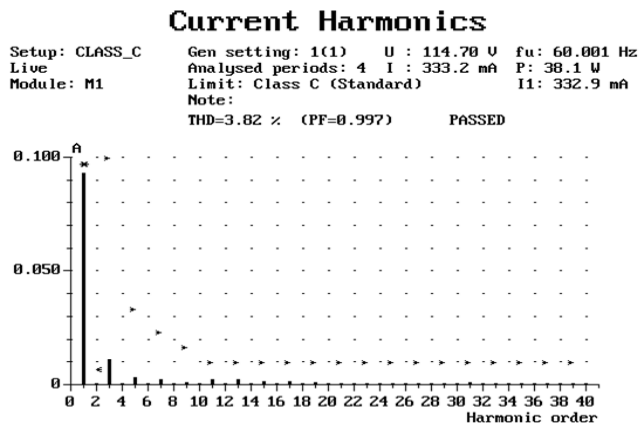


Figure 8.2.1 Current Harmonics

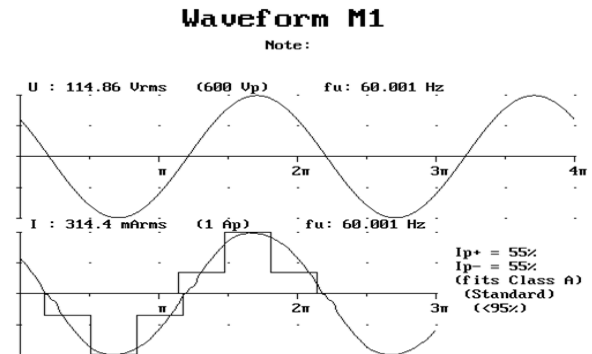


Figure 8.2.2 AC Current Waveform

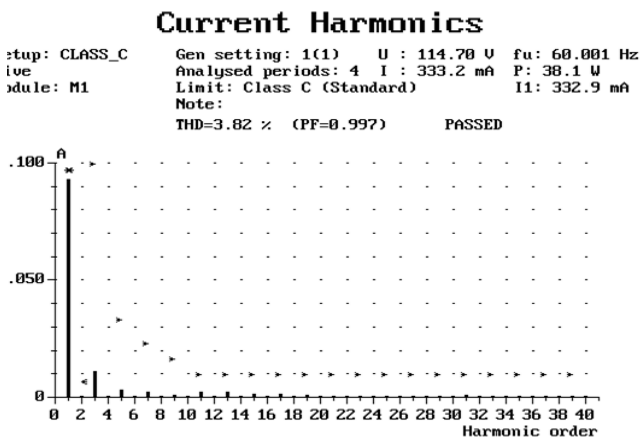


Figure 8.2.3 Current Harmonics

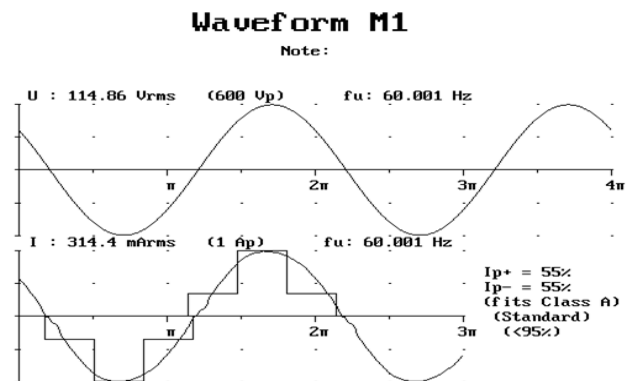
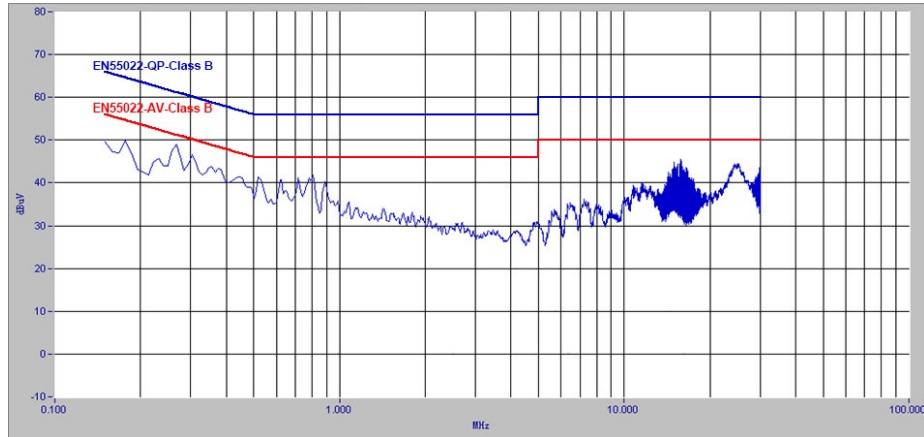


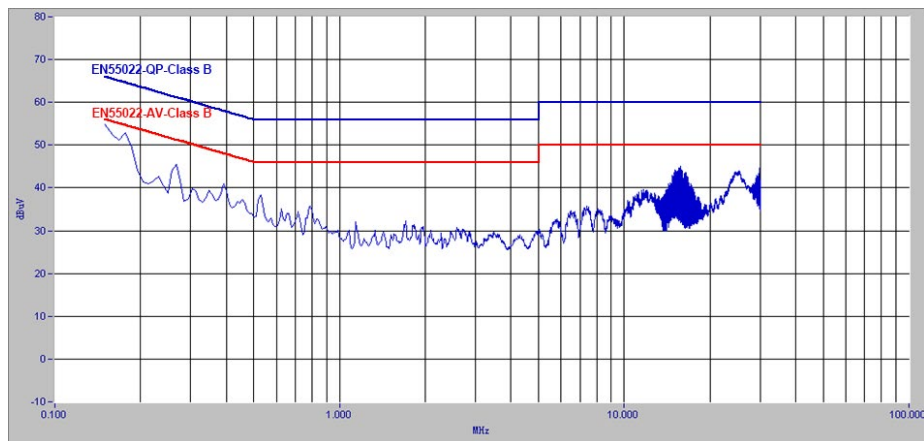
Figure 8.2.4 Current Harmonics

8.0 Performance (Cont.)

8.3 Conducted EMI



a) QP Scan L



b) QP Scan N

Figure 8.3.1 EMI Results



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