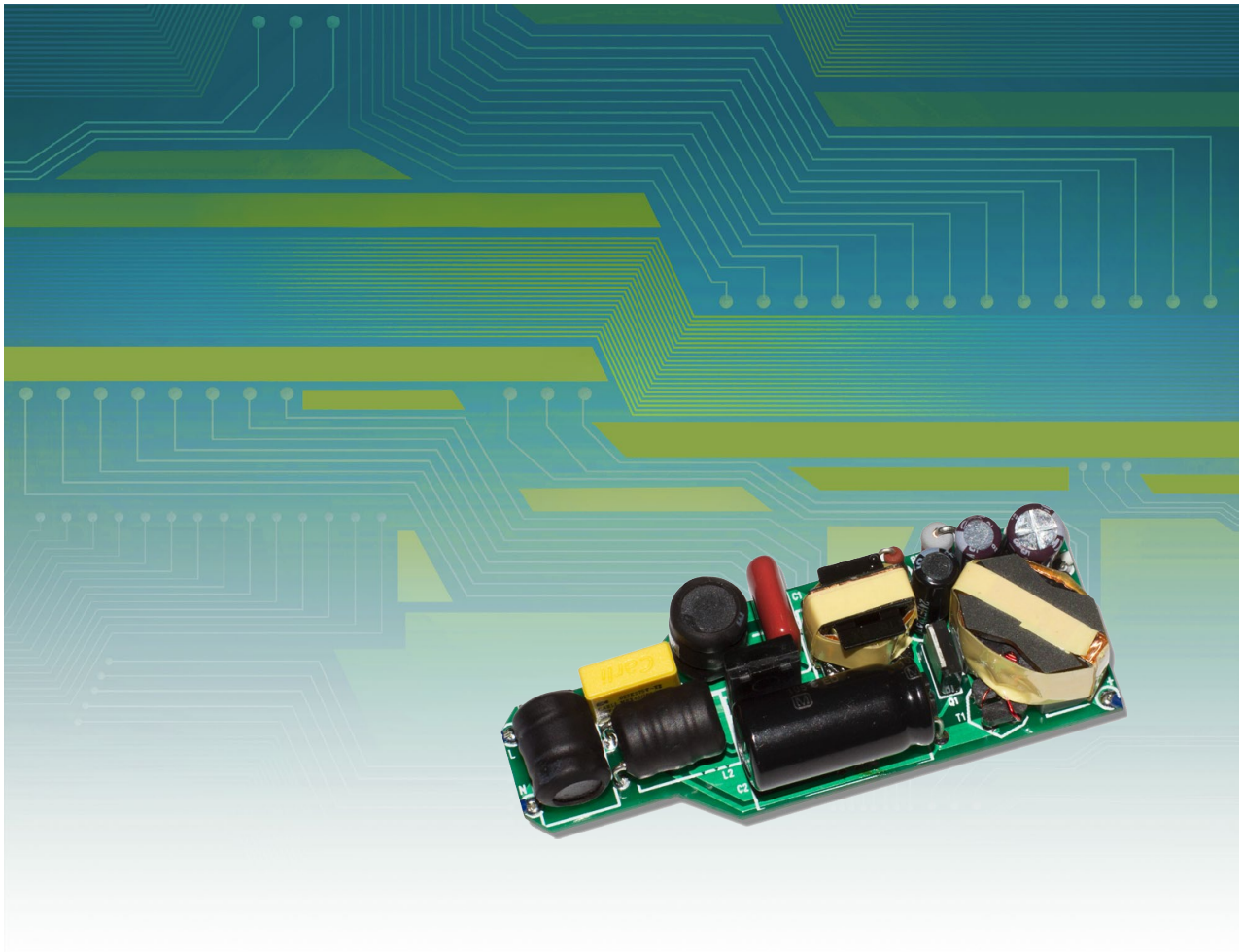
Reference Design

EBC20002



iW3640-00 2-Channel Color Temperature Control Dimmable LED Driver for Warm Sunset Dimming

(AC Input 108-132V_{AC}, Output White 32V 375mA, Amber 18V 1.2W)

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(AC Input 108-132V_{AC}, Output: White 32V 375mA, Amber 18V 1.2W)
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1.0 Introduction

This reference design describes a 10 LEDs output at 375mA current, low line input (108–132V_{AC}) power supply for warm sunset dimming LED applications. For this design the iW3640-00 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.

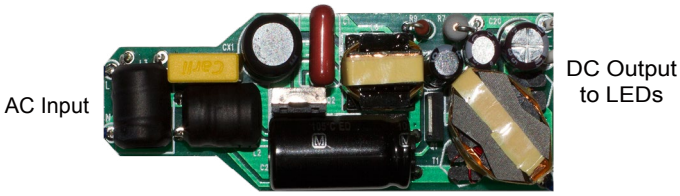


Figure 1.1 PCB Top View

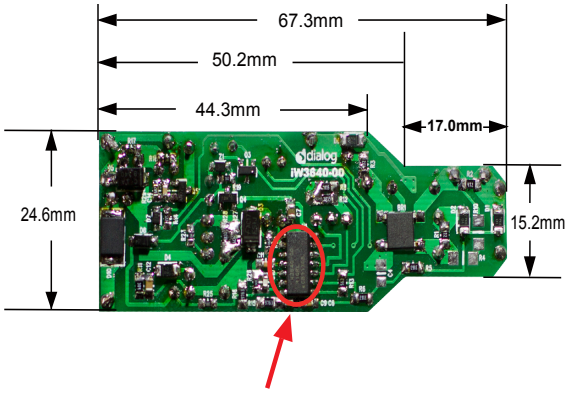


Figure 1.2 PCB Bottom View

2.0 Design Features

- AC input range 108-132V_{AC}, non-isolated
- 2-channel output
  - White: 32V, 375mA
  - Amber: 18V, 1.2W
- Wide dimmer compatibility, automatic detection of dimmer type
  - Leading-edge, trailing-edge, digital, no dimmer
- Wide dimming range: 3%-100%
- Flickerless™: no visible flicker across entire dimming range
- High power factor (PF) > 0.95
- Low total harmonic distortion (THD) < 15%
- PrimAccurate™ primary-only sensing eliminates opto-isolator feedback and simplifies design
- Full protection suite
  - Input over-voltage protection
  - Transformer primary winding over-current protection
  - LED open/short protection
  - Single fault protection
  - Over-temperature protection and de-rating

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}	108		132	V_{AC}	2 wire
Frequency	f_{LINE}	57	60	63	Hz	
Output						
Output voltage	V_{OUT}		32		V	Measured at the end of PCB
Output current	I_{OUT}		375		mA	
Amber			18V 1.2W			
Output ripple current	I_{RIPPLE}				mA_{P_P}	Set oscilloscope at 20MHz bandwidth
Total Output Power						
Continuous output power	P_{OUT}		13.2		W	
Power factor	*PF*	0.99				
Efficiency	η		80		%	Measured at end of PCB V_{IN}=120V_{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

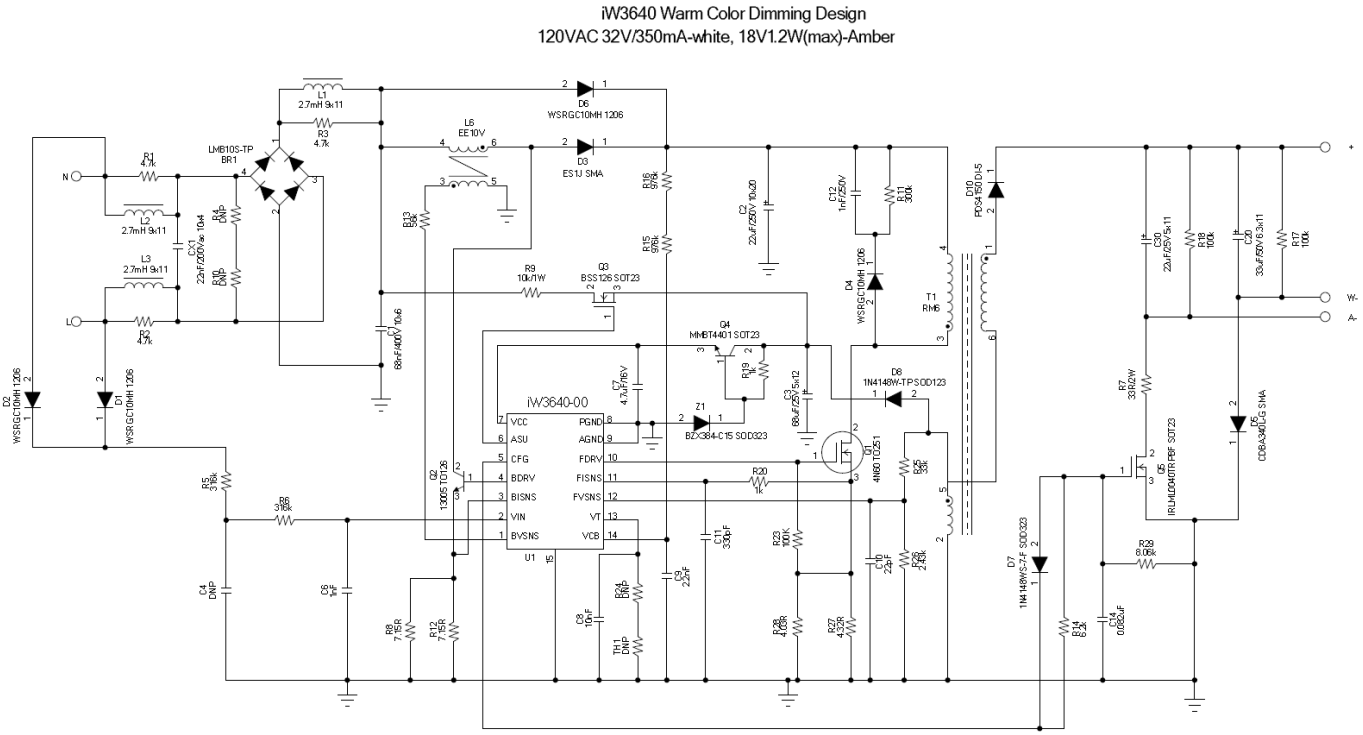
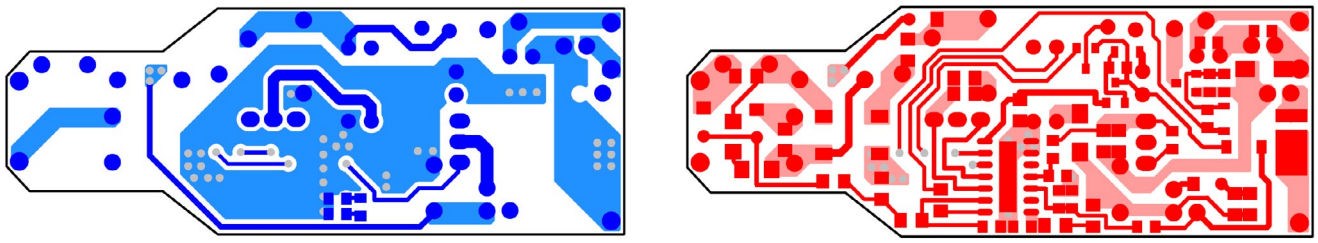


Figure 4.1 Design Schematic

5.0 PCB Layout



a) PCB Top

b) PCB Bottom

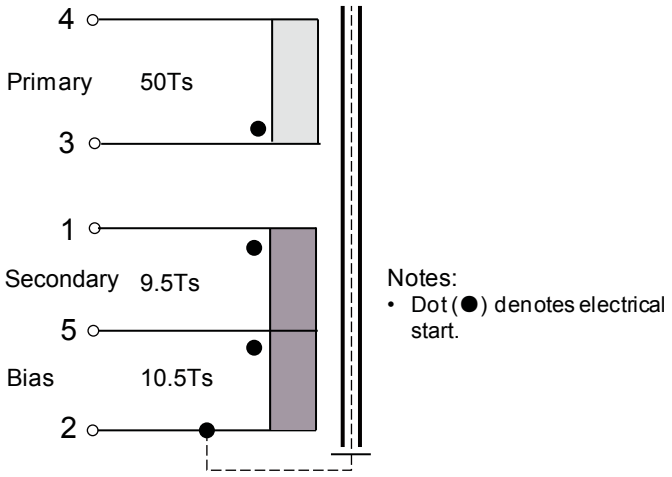
Figure 5.1 PCB Layout

6.0 Bill of Materials

Item	Qty.	Ref.	Description
1	1	U1	Offline LED controller, dual channel
2	3	L1, L2, L3	Drum Inductor, 2.7mH, Isat=0.22A
3	1	L6	EE10V, 8 pin, custom inductor
4	1	T1	RM6, 6 pin, custom transformer
5	1	CX1	0.022uF, 200Vac, X2 cap
6	1	C1	0.068uF, 400Vdc, film cap
7	1	C2	22uF/250V, 8000hr@105c, E-cap
8	1	C3	68uF/25V, 5000hr@105c, E-cap
9	1	C20	33uF/50V, 2000hr@105c, E-cap
10	1	C30	22uF/25V, 2000hr@105c, E-cap
11	1	BR1	Bridge rectifier, 1000V, 1A
12	4	D1, D2, D4, D6	1000V, 1A, fast recovery
13	1	D3	600V, 1A, ultra fast
14	1	D5	40V, 3A, Schottky
15	1	D7	75V, 150mA
16	1	D8	100V, 150mA
17	1	D10	150V, 4A, schottky
18	1	Q1	N-CH, Vds=600V, I=4A
19	1	Q2	NPN, Vceo=700V, I=4A
20	1	Q3	N-CH, depletion, Vds=600V, I=21mA
21	1	Q4	NPN, 40V, 600mA
22	1	Q5	N-CH, 40V, 3.6A
23	1	Z1	15V, 200mW, zener
24	1	F1	Fuse, 125V, 2A, fast
25	1	R7	33R, 2W, 5%
26	1	R9	10k, 1W, 5%
27	1	C6	1000pF, 50V, 10%, X7R
28	1	C7	4.7uF, 16V, 10%, X7R
29	1	C8	10000pF, 50V, 10%, X7R
30	1	C9	2200pF, 50V, 10%, X7R
31	1	C10	22pF, 50V, 10%, C0G
32	1	C11	330pF, 50V, 10%, X7R
33	1	C12	1000pF, 250V, 10%, X7R
34	1	C14	0.082uF, 25V, 10%, X7R
35	3	R1, R2, R3	4.7k, 5%, 1/8W
36	2	R5, R6	316k, 1%, 1/8W
37	2	R8, R12	7.15R, 1%, 1/8W
38	1	R11	300k, 5%, 1/8W
39	1	R13	56k, 5%, 1/8W
40	1	R14	6.2k, 1%, 1/10W
41	1	R29	8.06k, 1%, 1/10W
42	2	R15, R16	976k, 1%, 1/8W
43	3	R17, R18, R23	100k, 5%, 1/10W
44	2	R19, R20	1k, 5%, 1/10W
45	1	R25	33k, 1%, 1/10W
46	1	R26	2.4k, 1%, 1/10W
47	2	R27, R28	4.32R, 1%, 1/8W

7.0 Transformer Drawing

Schematic:



Electrical Specifications:

1.	Primary Inductance (Lp3-4) =1.0mH (±5%) @10kHz
2.	Primary Leakage Inductance (Lk) <5%*Lp Short pin1-pin2

Materials:

1.	Core : RM6 (Ferrite Material TDK PC40 or equivalent)
2.	Bobbin : RM6 6 pins
3.	Magnet Wires (Pri) : Type 2-UEW
4.	Layer Insulation Tape :3M1298 or equivalent
5.	Vanished after finishing
6.	Core connected to pin 2

8.0 Performance

8.1 Efficiency

* Note: V_{IN}=108V_{AC}-132V_{AC}/60Hz; Loading with 4 LEDs 375mA

V_{IN} (V_{AC})	P_{IN} (W)	η (%)	Power Factor	THD%	ILED(mA)
108	13.6	80.7	0.998	4.1	373
114	13.5	80.9	0.997	4.2	374
120	13.5	81.2	0.996	5.1	374
126	13.5	81.5	0.995	6.5	374
132	13.4	81.8	0.991	11.1	374

8.2 Dimming Profile

Phase (degree)	V_white(mA)	P_White(W)	I_Amber(mA)	P_Amber(W)
160	374	11.2	0	0
140	374	11.2	0	0
120	285	8.5	0	0
90	95	2.9	31	0.56
70	22	0.66	26	0.48
50	5	0.15	16	0.28

8.3 Conducted EMI

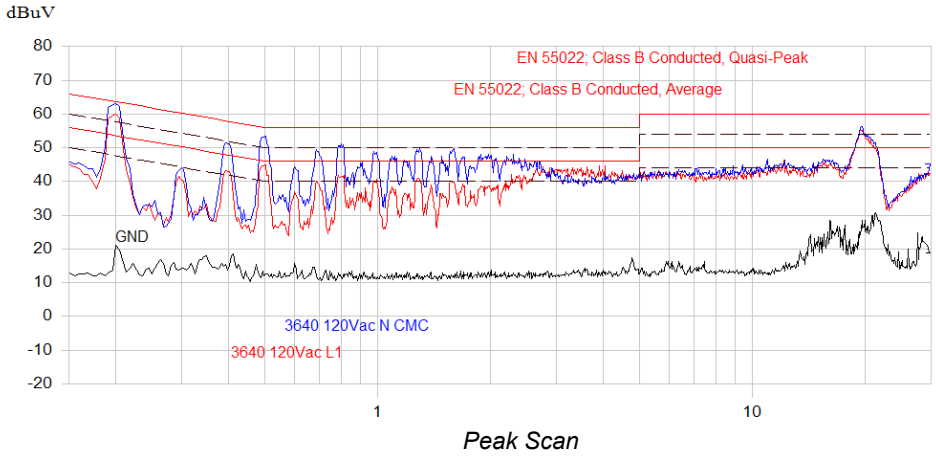


Figure 8.3 EMI Results

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