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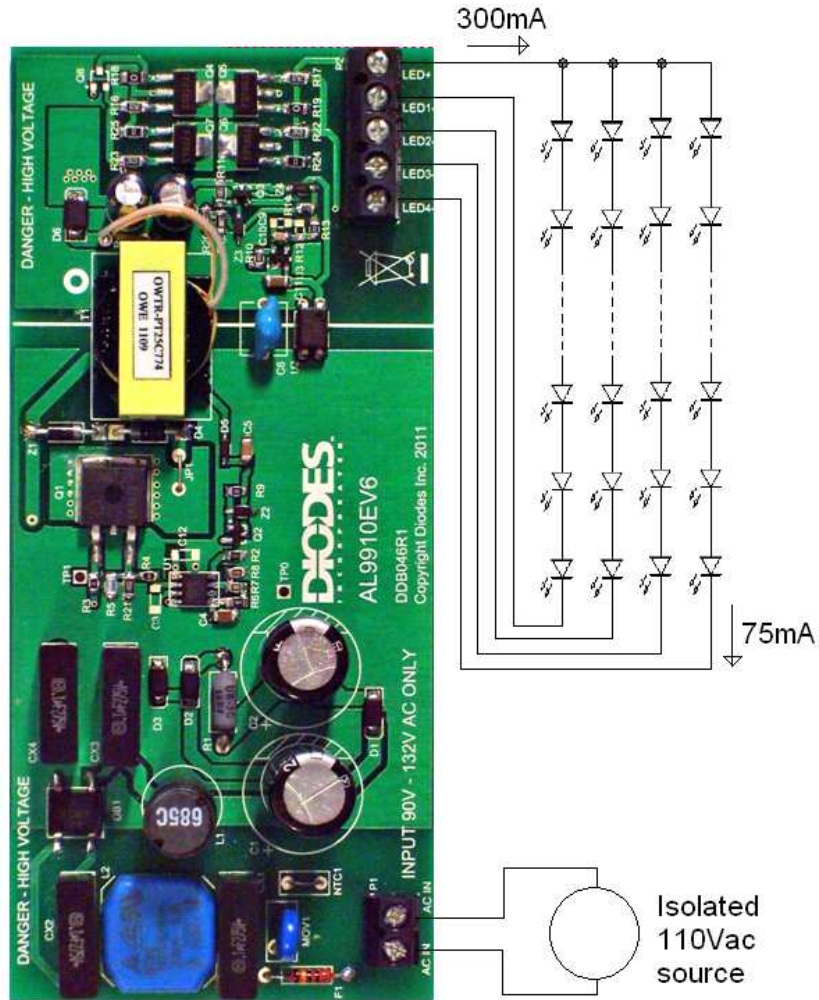
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# AL9910EV6 ISOLATED LED DRIVER USER GUIDE



**WARNING: DANGER – HIGH VOLTAGES ARE PRESENT ON THIS EVALUATION BOARD**

Fig. 1 AL9910EV6 evaluation board connection diagram

## DESCRIPTION

The AL9910EV6 is an offline isolated LED driver evaluation board designed to work on 110V AC line voltage. It provides four constant LED current outputs which drive four separate strings of between 8 and 14 LEDs, with a LED current of 75mA per string.

It will provide a total LED power ranging from 8W to 15W.

## AL9910EV6 SETUP AND TESTING PROCEDURE

### Prerequisite

1. AL9910EV6 evaluation board.
2. Four sets of LEDs strings with 8 to 14 series-connected LEDs. Please note that the number of LEDs in each string must be equal. The LEDs should be mounted on a heatsink capable of a power dissipation of 8 to 15W.
3. For safety reasons during testing, please use an isolated 110V AC source from the output of an isolation transformer. For public demonstration, the evaluation board and LEDs should be fitted into a transparent case with sufficient insulation to meet the local safety requirements.

### Connections and Power up

1. Preset the isolated AC source to either 110VAC.
2. **ENSURE THAT THE AC SOURCE IS SWITCHED OFF OR DISCONNECTED.**
3. Solder the anode wires of all LED strings to the LED+ terminal.
4. Solder the cathode wires of the four LED strings individually to the LED1-, LED2-, LED3- and LED4- terminals. Connect ammeters in series with the cathode wires if LED current measurements are required.
5. Connect the two AC line wires to the AC1 and AC2 terminals which are located at the bottom left hand corner of the evaluation board.
6. Ensure that the area around the board is clear and safe, and preferably that the board and LEDs are enclosed in a transparent safety cover.
7. Turn on the mains switch. LED string should light up. **DO NOT TOUCH THE BOARD, LEDs OR BARE WIRING.**

**Caution: The input terminals carry high voltage during operation!**

## **OPERATION**

The AL9910A device is a PWM high-efficiency LED driver control IC. It allows efficient operation of High Brightness (HB) LEDs from voltage sources ranging from 85VAC up to 265VAC. The AL9910A can be configured to work in either fixed frequency or constant OFF-time mode. In fixed frequency mode, the AL9910A controls an external MOSFET at a fixed switching frequency up to 300kHz, which can be programmed using a single resistor. The LED string is driven at a constant current rather than at a constant voltage, thus providing constant light output and enhanced reliability. The output current can be programmed between a few milliamps and more than 1.0A.

### **Input filter and Rectifier section**

In order to meet the EMI requirement, CX1, CX2, CX3, CX4, L1 and L2 are used to provide sufficient filtering for both differential-mode and common-mode noise generated from the switching converter circuit after the bridge rectifier.

The rectified line voltage from the bridge rectifier DB1 is fed into a valley-filled passive power factor correction stage to provide a high power factor for the AC line input. The passive PFC stage comprises of C1, C2, D1, D2, D3 and R1. This design gives power factors of greater than 0.9.

### **Constant Current Flyback Converter section**

The isolated Flyback converter section consists of LED controller AL9910A (U1), ultra-fast free-wheeling rectifier ES2G (D6), transformer (T8) and a high voltage MOSFET switch (Q1). On this evaluation board, the AL9910A is configured to operate in the constant frequency mode to provide the best LED current regulation. The switching frequency of the AL9910A is set to 100kHz using resistor R2. Please refer to the product datasheet for more details on how to configure the constant frequency mode.

The Flyback converter have been designed to provide an total output current of 300mA. The LED current is regulated with an isolated secondary side feedback, consisting of an opto coupler (U2), sense resistors (R1, R2) and voltage reference (U3). The LED current level is set by resistors R1 and R2.

The voltage regulator network consisting of Q2, R9 and Z2 provides stable voltage to the AL9910A from the transformer auxillary winding. Zener diode Z4 and resistor R13 provides protection to the power stage under open LED condition.

### **Multi-channel LED Current Balancing section**

In this section of the evaluation board, bipolar transistors Q4-Q7 are connected as current mirror to provide an effective LED current balancing function to drive up to 4 strings of LEDs with minimal losses. The transistors are mounted as close to one another on the PCB to achieve the best possible thermal coupling. R16, R17, R22 and R23 are the transistor's emitter resistors added to improve the LED current balancing.

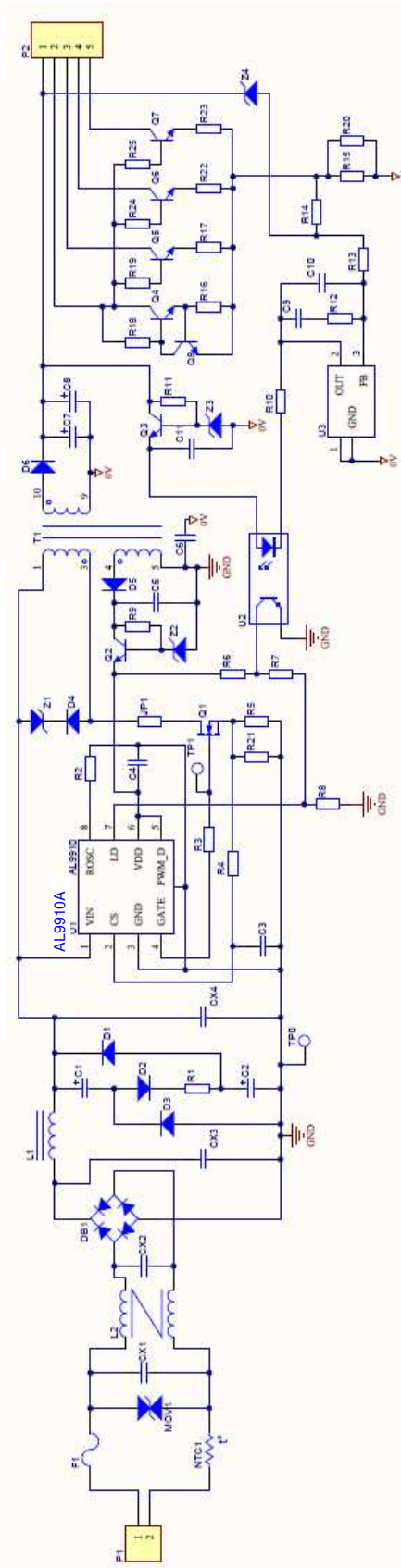
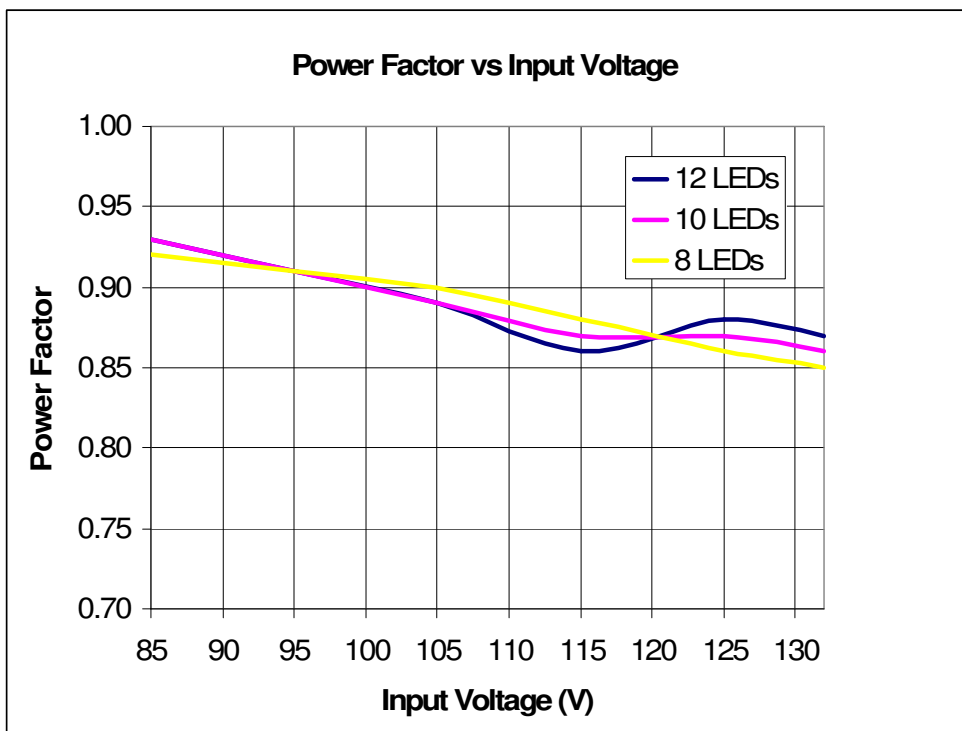
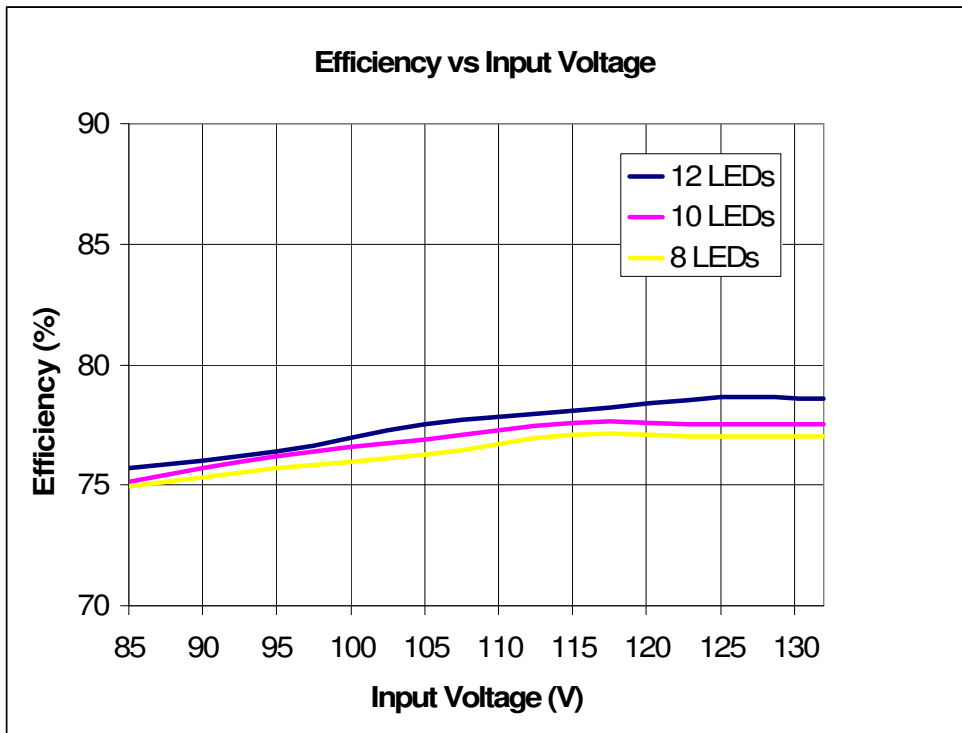


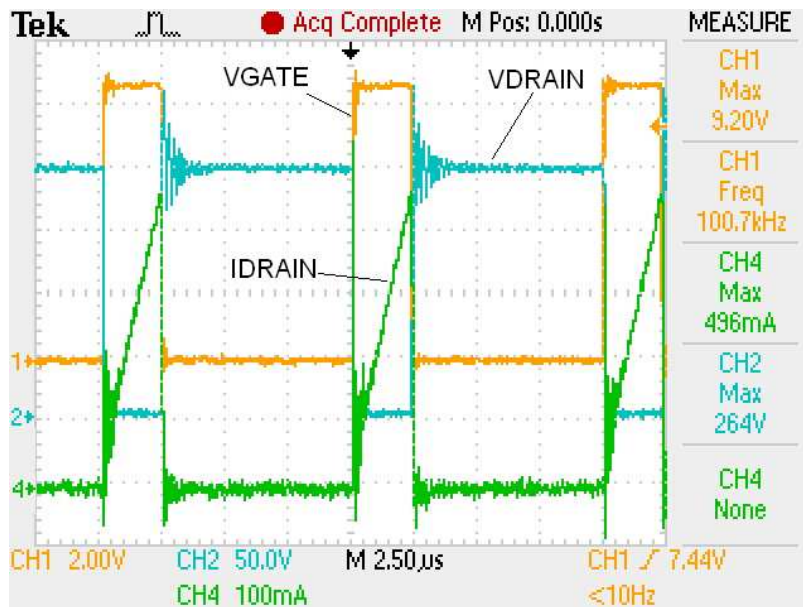
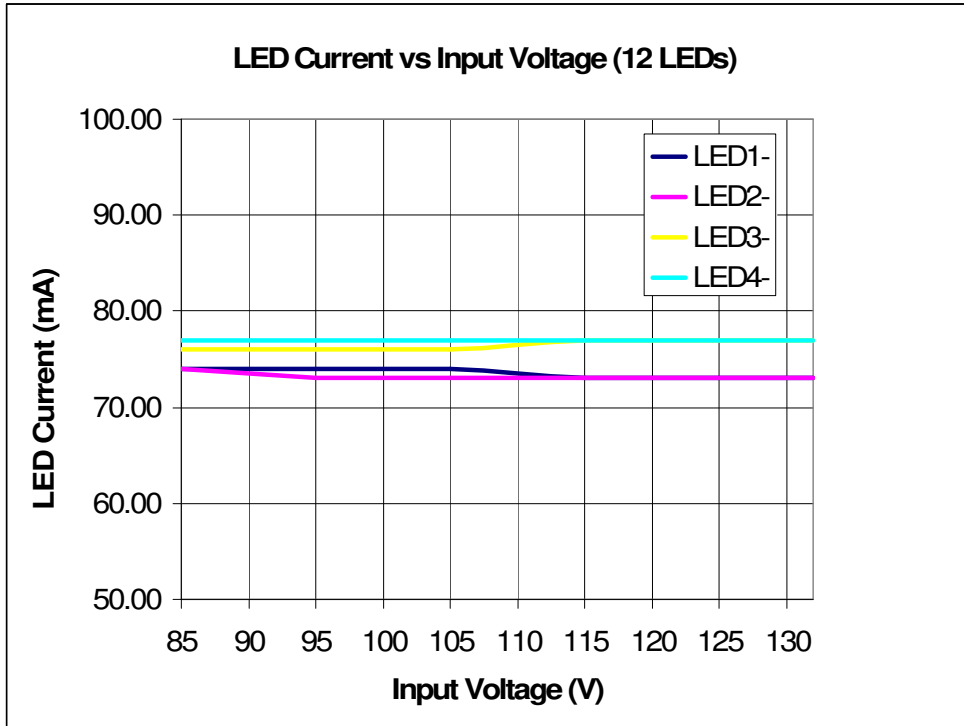
Fig. 2 AL9910EV6 Schematic Diagram

## PARTS LIST

Ref	Description	P/N	Package	Manufacturer
U1	Universal high brightness LED driver	AL9910A	SO8	Diodes Inc
U2	Opto coupler CTR 80-160%	FOD817A300		Fairchild
U3	Shunt regulator	ZTLV431	SOT23	Diodes Inc
Q1	N-ch 600V MOSFET 3.2A, $Q_{G(max)} = 16nC$	SPB03N60S5	TO252	Infineon
Q2	NPN Transistor	MMBT2222A	SOT23	Diodes Inc
Q3	60V NPN Transistor	MMBTA06	SOT23	Diodes Inc
Q4, Q5, Q6, Q7	60V NPN Transistor	FZT853	SOT223	Diodes Inc
D1, D2, D3	1A 1KV diode $t_{RR}=1.8\mu s$	S1M-13-F	SMA	Diodes Inc
D4	400V 1A ultrafast recovery diode	MUR140	DO-41	Diodes Inc
D5	150V 400mA switching diode	BAV20W-7	SOD123	Diodes Inc
D6	400V 2A ultrafast recovery diode	ES2G	SMB	Diodes Inc
DB1	1A, 600V bridge rectifier	DF06S		Diodes Inc
Z1	100V 1W Zener	1N4764ADO41	DO-41	Diodes Inc
Z2	9.1V 50mW Zener	BZT52C9V1-7	SOD123	Diodes Inc
Z3	16V 500mW Zener	DDZ9703	SOD123	Diodes Inc
Z4	56V 500mW Zener	MMSZ5263B	SOD123	Diodes Inc
R1	10R 3W resistor, +/-50ppm/C, +/-1% generic		Wire wound	
R2	226K 0.125W +/-1% generic		0805	
R3,R4	0R 0.125W +/-5% generic		0805	
R5	0R5 0.25W +/-1% generic		1206	
R6	5K6 0.125W +/-5% generic		0805	
R7	100K 0.125W +/-5% generic		0805	
R8, R10	5K1 0.125W +/-5% generic		0805	
R9	1K 0.125W +/-5% generic		0805	
R11	10K 0.25W +/-5% generic		1206	
R13	20K 0.125W +/-5% generic		0805	
R14	470R 0.125W +/-5% generic		0805	
R15, R20	8R2 0.33W +/-1% generic		1206	
R16, R17, R22, R23	2R2 0.25W +/-1% generic		1206	
R18, R19, R24, R25	0R 0.25W +/-1% generic		1206	
R21	1R 0.25W +/-1% generic		1206	
F1	10R 1W fusible resistor +/-200ppm generic			
C1,C2	33 $\mu$ F 450V electrolytic capacitor	EEUED2E330		Panasonic
C4,C11	4.7 $\mu$ F 25V X7R		1206	
C5	1 $\mu$ F 50V X7R		1206	
C7,C8	33 $\mu$ F 63V			
C10	100nF 16V X7R		0805	
CX1,CX2, CX3, CX4	100nF 275VAC, Film, X2, 20%	ECQU2A104ML		Panasonic
MOV1	275V Varistor, 21J	B72207S0271K101	5mm pitch	Epcos
L1	6.8mH 290mA	19R685C		Murata
L2	30mH 300mA common mode choke	B82791G2301N001		Epcos
T1	800 $\mu$ H Flyback transformer turn ratio = 1.76:1	OWTR-PT25C774	EER25	Olewoff

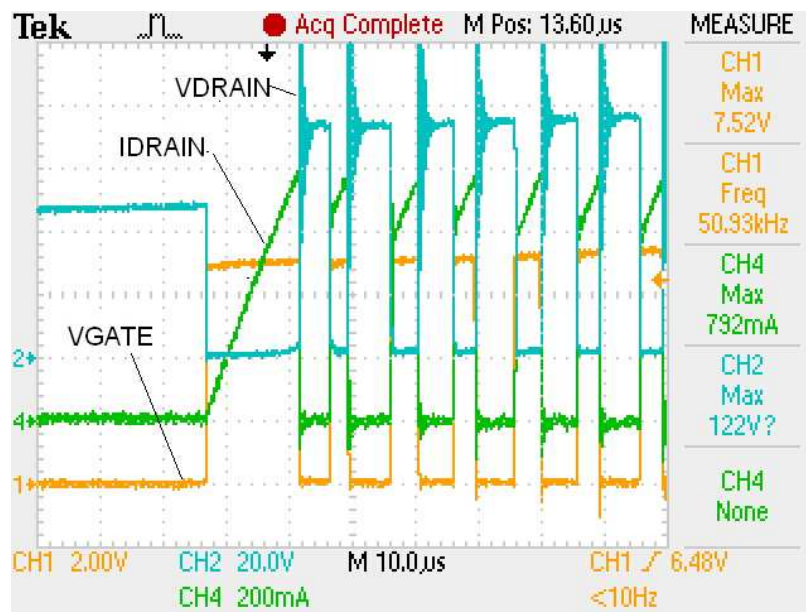
## PERFORMANCE





Operating waveforms during normal operation (Orange: AL9910A's gate output voltage; Green: Q1's Drain current; Blue: Q1's Drain voltage)





Operating waveforms during start up condition (Orange: AL9910A's gate output voltage; Green: Q1's Drain current; Blue: Q1's Drain voltage)

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