# AL1692EV1 User Guide

## 120VAC Dimmable LED Driver

## General Description

This demonstration board utilizes the AL1692 Buck-boost LED driver with single winding inductor providing a cost effective triac dimmable solution for offline high brightness LED applications. This user-friendly evaluation board provides users with quick connection to their different types of LEDs string. The demonstration board can be modified easily to adjust the LED output current and the number of series connected LEDs that are driven.

A BOM, schematic and layout are included that describes the parts used on this demonstration board, along with measured performance characteristics. These materials can be used as a reference design.

## Key Features

- Triac Dimmable
- Active PFC with power factor >0.96
- Low THD
- High efficiency >84%
- Single winding
- Good dimmer compatibility
- Low BOM cost

## Applications

- Retrofit Bulb, Par lamps

## Specifications

| Parameter | Value |
|---|---|
| AC Input Voltage | 108~132V |
| Output Power | 14.08W |
| LED Current | 220mA |
| LED Voltage | 64V |
| Power Factor | >0.96 |
| Efficiency | 84% |
| XYZ Dimension | 54.5x37x18mm |
| ROHS Compliance | Yes |

## Evaluation Board

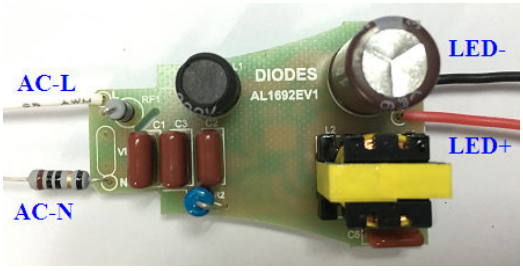



**Figure 1: Top View**

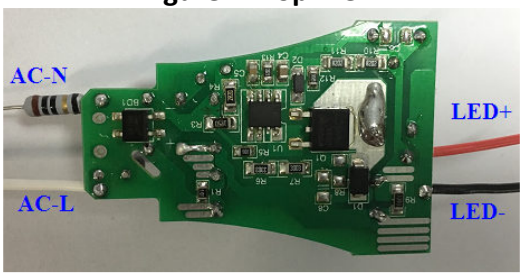



**Figure 2: Bottom View**

**Connection Instructions:**

AC-L Input: White – Hot
AC-N Input: White– Neutral
DC LED+ Output: LED+ (Red)
DC LED- Output: LED- (Black)

## Board Layouts

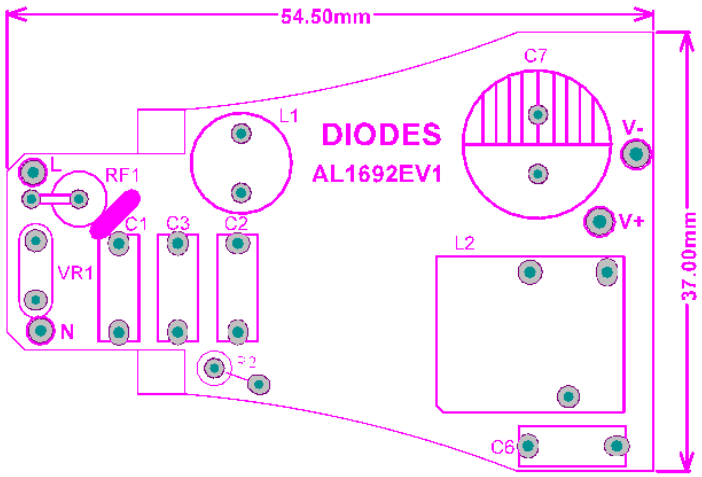



**Figure 3: PCB Layout Top View**

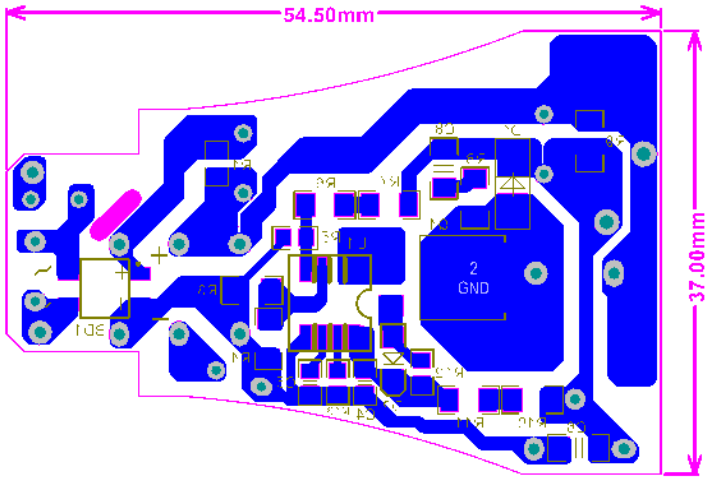



**Figure 4: PCB Layout Bottom View**

## Quick Start Guide

1. Preset the isolated AC source to 120VAC.
2. Ensure that the AC source is switched OFF or disconnected.
3. Connect the anode wire of the LED string to the LED+ terminal of the evaluation board.
4. Connect the cathode wire of the LED string to the LED- terminal of the evaluation board.
5. Connect two AC line wires to the AC-L and AC-N terminals on 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 main switch. LED string should light up with LED.
   DO NOT TOUCH THE BOARD, LEDs OR BARE WIRING.

**Caution: The AL1692 is a non-isolated design. All terminals carry high voltage during operation!**

## Schematic

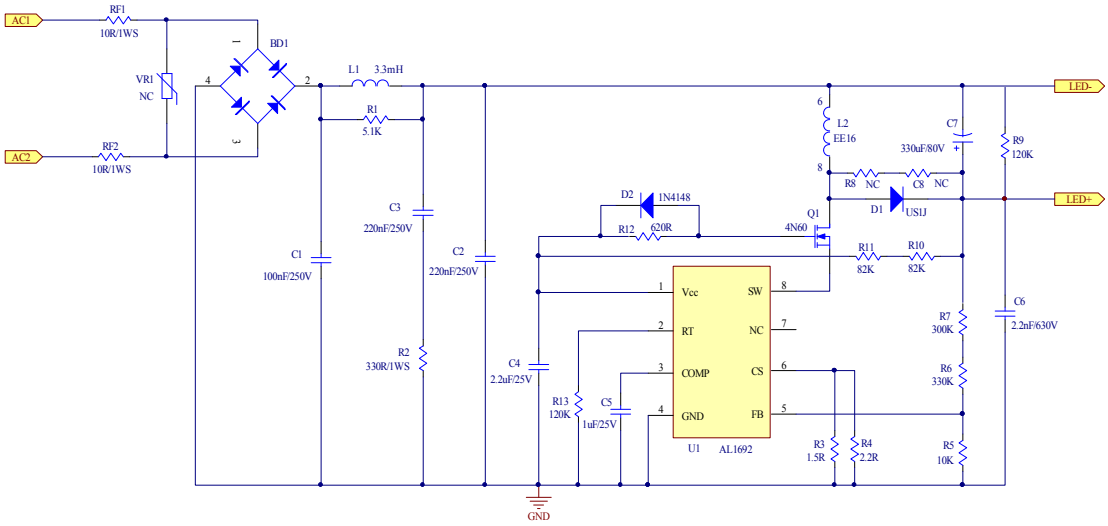



**Figure 5: Schematic Circuit**

## Transformer Design

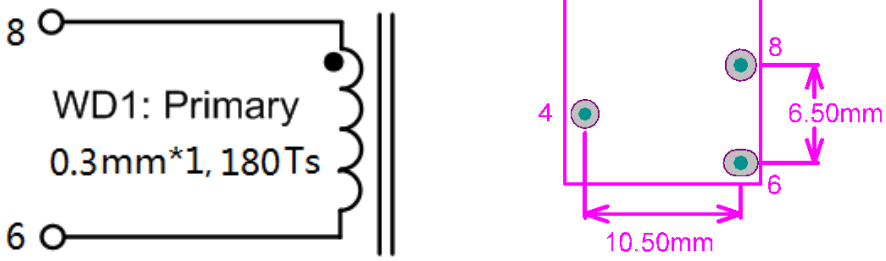
### Bobbin and Core

EE16 Vertical 5+5 pin

### Transformer Parameters

1. Primary Inductance (Pin8-Pin6)：Lp=0.68mH, ±5%@10kHz
2. Primary Winding Turns (Pin 8-Pin 6): $N_P$=180Ts

### Transformer Winding Construction Diagram

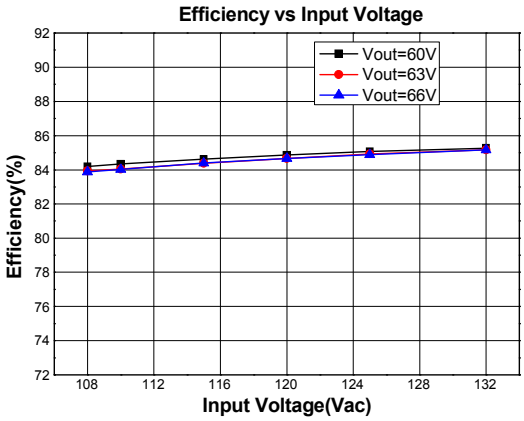


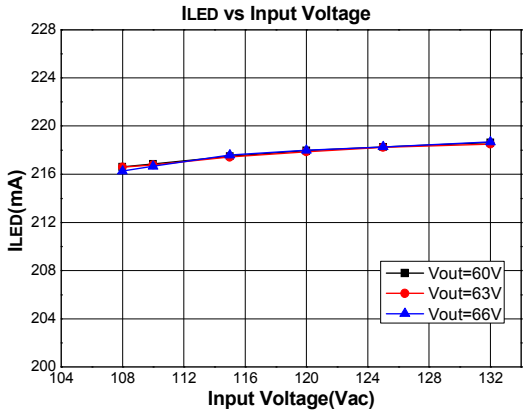

| Item | Winding name | Description |
|---|---|---|
| 1 | WD1-Primary Winding | Start at Pin8, Wind 180 turns of Φ0.3mm wire and finish on Pin6. |
| 2 | Insulation | 2 Layers of insulation tape |

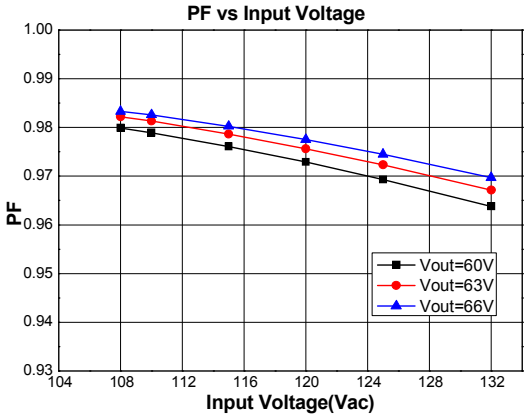
## Bill of Material

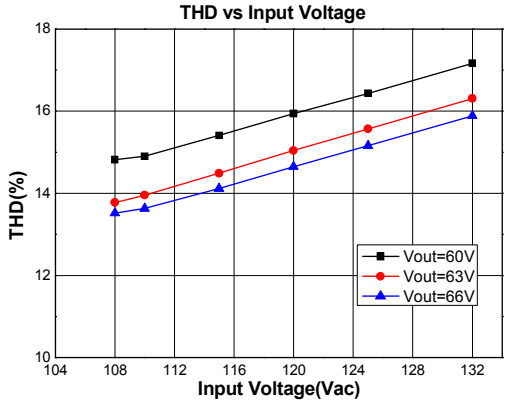
| No | Item | Description | Package | Quantity |
|---|---|---|---|---|
| 1 | C1 | 100nF/250V, CL21, Pitch=7.5mm | DIP | 1 |
| 2 | C2 | 220nF/250V, CL21, Pitch=7.5mm | DIP | 1 |
| 3 | C3 | 220nF/250V, CL21, Pitch=7.5mm | DIP | 1 |
| 4 | C4 | Ceramic Cap, 2.2uF/25V,X7R | 0805 | 1 |
| 5 | C5 | Ceramic Cap, 1uF/25V,X7R | 0805 | 1 |
| 6 | C6 | 2.2nF/630V, CL21, Pitch=7.5mm | DIP | 1 |
| 7 | C7 | E-Cap,105℃,330uF/80V,13*16mm | DIP | 1 |
| 8 | C8 | NC | 1206 | 0 |
| 9 | BD1 | Rectifier Bridge,HD06,0.8A/600V,Diodes Inc | SOPA-4 | 1 |
| 10 | D1 | Fast Recovery Diode,US1J,1A/600V,Diodes Inc | SMA | 1 |
| 11 | D2 | Switching diode, 1N4148,Diodes Inc | SOD-123 | 1 |
| 12 | RF1 | Fuse Resistor, 10R/1WS | DIP | 1 |
| 13 | RF2 | Fuse Resistor, 10R/1WS | DIP | 1 |
| 14 | R1 | Resistor, 5.1K, 5%, 1/8W | 0805 | 1 |
| 15 | R2 | Power Resistor,330R, 5%, 1WS | DIP | 1 |
| 16 | R3 | SMD Resistor,1.5R, 1%, 1/4W | 1206 | 1 |
| 17 | R4 | SMD Resistor,2.2R, 1%, 1/4W | 1206 | 1 |
| 18 | R5 | SMD Resistor,10K, 5%, 1/8W | 0805 | 1 |
| 19 | R6 | SMD Resistor,330K, 5%, 1/4W | 1206 | 1 |
| 20 | R7 | SMD Resistor,300K, 5%, 1/4W | 1206 | 1 |
| 21 | R8 | NC | 1206 | 0 |
| 22 | R9 | SMD Resistor,120K, 5%, 1/4W | 1206 | 1 |
| 23 | R10,R11 | SMD Resistor,82K, 5%, 1/4W | 1206 | 2 |
| 24 | R12 | Resistor, 620R, 5%, 1/8W | 0805 | 1 |
| 25 | R13 | SMD Resistor,120K, 5%, 1/8W | 0805 | 1 |
| 26 | VR1 | NC | DIP | 0 |
| 27 | L1 | Drum Inductor 3.3mH, 8*10mm | DIP | 1 |
| 28 | L2 | EE16, Vertical, 5+5pin,Single Winding,0.68mH | DIP | 1 |
| 29 | Q1 | N-Mosfet, 4N60, DPAK | DPAK | 1 |
| 30 | U1 | AL1692,Diodes Dimmable IC | SOIC-8 | 1 |
| **Total BOM** | | | | **28** |

## Electrical Performance



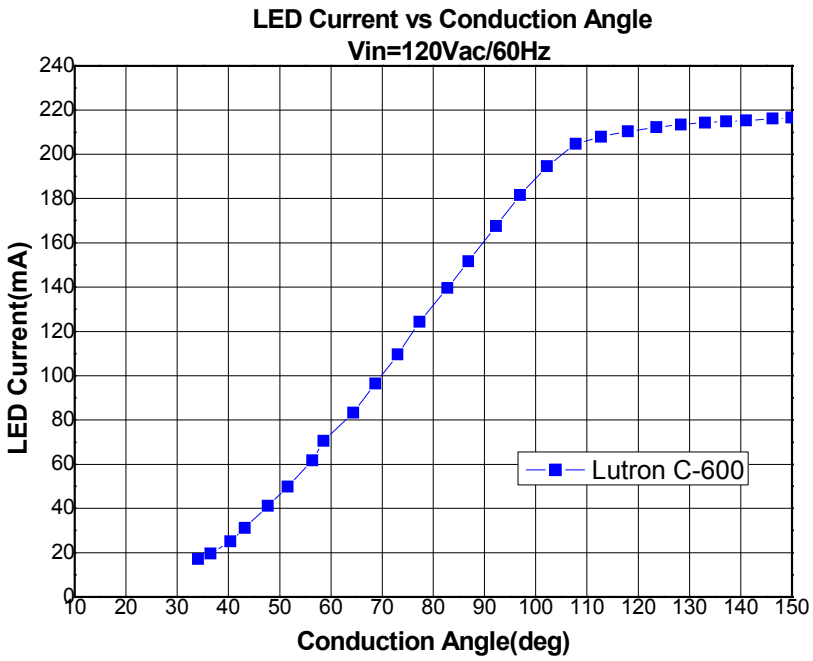



## Dimming Test

### Dimmer compatibility and dimming range

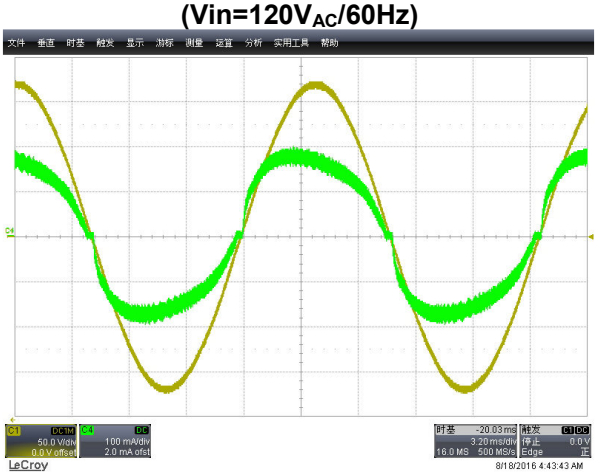
| Num | Dimmer Type | ILED(mA) | | Dimming Percentage(%) | | Flicker or not |
|---|---|---|---|---|---|---|
| | | Min | Max | Min | Max | |
| 1 | Lutron D-600P L 600W | 0 | 214 | 0.00 | 98.21 | Shimmer |
| 2 | Lutron D600PH-WH L 600W | 0 | 213.6 | 0.00 | 98.03 | No |
| 3 | Lutron C-600 L 600W | 16.3 | 216.6 | 7.48 | 99.40 | No |
| 4 | Lutron NLV-600 | 26.8 | 215.7 | 12.30 | 98.99 | No |
| 5 | Lutron NTELV-600 | 37.8 | 216.1 | 17.35 | 99.17 | No |
| 6 | Lutron DVELV-300P | 22.9 | 214.8 | 10.51 | 98.58 | No |
| 7 | Lutron DV-600P | 16.5 | 214.8 | 7.57 | 98.58 | No |
| 8 | Lutron SELV-300P | 22.9 | 216.1 | 10.51 | 99.17 | No |
| 9 | Lutron CTELV-303P | 24.1 | 214.7 | 11.06 | 98.53 | No |
| 10 | Lutron MACL-153M | 25.4 | 212.9 | 11.66 | 97.71 | No |
| 11 | Lutron S-600P | 3.7 | 214.8 | 1.70 | 98.58 | No |
| 12 | Lutron LXLV-600PL | 21.9 | 214.9 | 10.05 | 98.62 | No |
| 13 | Lutron MAW-603 | 13.9 | 215.8 | 6.38 | 99.04 | No |
| 14 | Lutron MIR-600 | 14.4 | 216.1 | 6.61 | 99.17 | No |
| 15 | Lutron DV-603PG | 16.5 | 209.6 | 7.57 | 96.19 | No |
| 16 | Lutron NTLV-600 | 30.3 | 216.7 | 13.91 | 99.45 | No |
| 17 | Lutron AY-600P | 24.1 | 215.5 | 11.06 | 98.90 | No |
| 18 | Lutron TGCL-153P | 64.5 | 214.9 | 29.60 | 98.62 | No |
| 19 | Lutron DVLV-603P | 26.8 | 214.8 | 12.30 | 98.58 | No |
| 20 | Lutron MAELV-600 | 34.9 | 216 | 16.02 | 99.13 | No |
| 21 | Cooper 9538 | 13.2 | 216.6 | 6.06 | 99.40 | No |
| 22 | Cooper 9539 | 30.6 | 212.7 | 14.04 | 97.61 | No |
| 23 | Cooper SI06P | 10.6 | 216.1 | 4.86 | 99.17 | No |
| 24 | Cooper SI061 | 7.6 | 216.4 | 3.49 | 99.31 | No |
| 25 | Cooper TAL06P | 88.3 | 217.5 | 40.52 | 99.82 | No |
| 26 | Cooper DLC03P | 23.5 | 217.2 | 10.78 | 99.68 | No |
| 27 | Lutron TT-300 | 0 | 216.1 | 0.00 | 99.17 | No |
| 28 | Leviton TBL03 | 24.6 | 217.1 | 11.29 | 99.63 | No |

## Dimming Curve

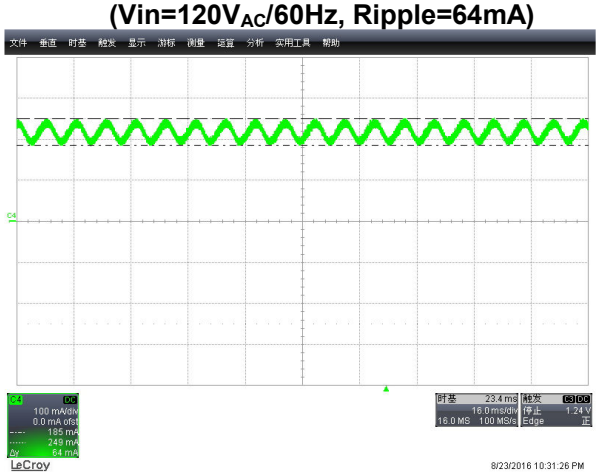



## Functional Waveform

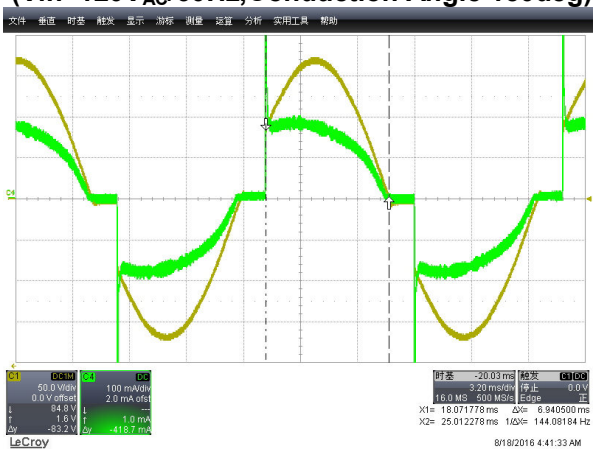
**Input Voltage & Input Current (Vin=120VAC/60Hz)**



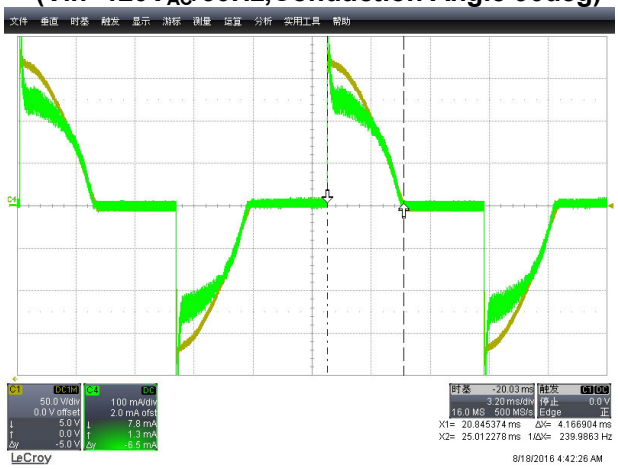
**LED Current Ripple (Vin=120VAC/60Hz, Ripple=64mA)**



**Input AC Current vs Dimmer Phase (Vin=120$V_{AC}$/60Hz,Conduction Angle 150deg)**

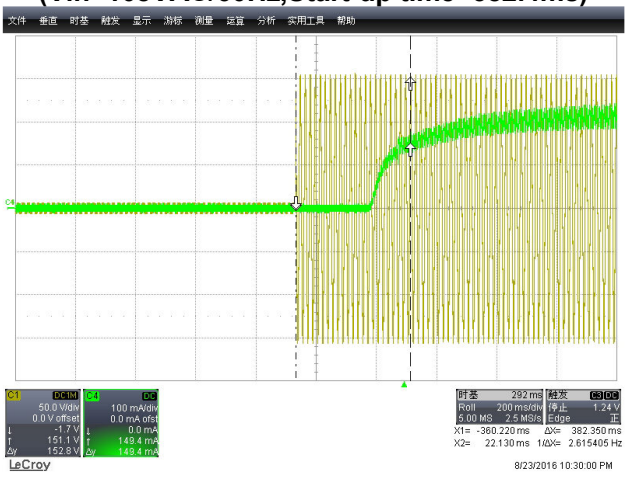



**Input AC Current vs Dimmer Phase (Vin=120$V_{AC}$/60Hz,Conduction Angle 90deg)**

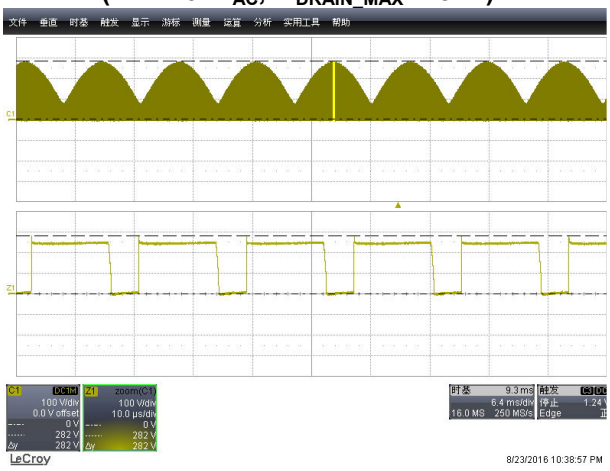



**Input AC Current vs Dimmer Phase (Vin=120VAC/60Hz,Conduction angle 45deg)**


**Start-up time (Vin=108VAC/60Hz,Start-up time=382.4ms)**

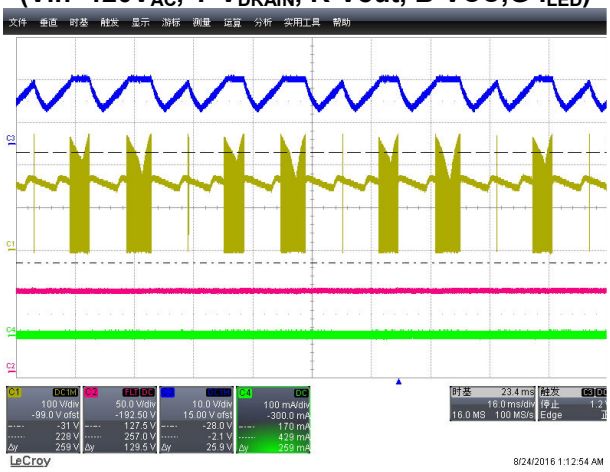


### IC $V_{DRAIN}$ Waveform (Vin=132$V_{AC}$, $V_{DRAIN\_MAX}$=282V)

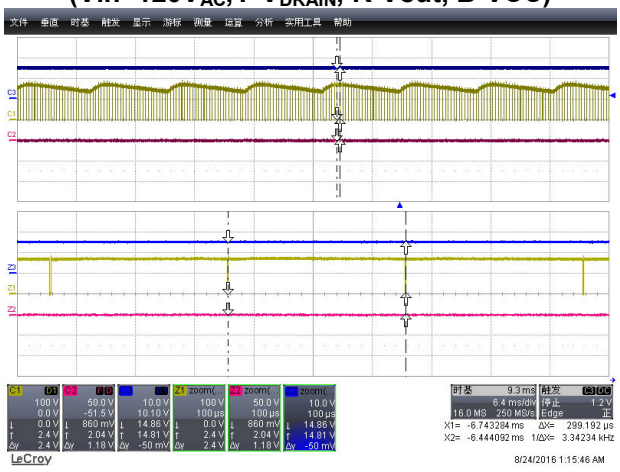



### Output Diode $V_R$ Waveform (Vin=132$V_{AC}$, $V_{R\_MAX}$=297V)


### LED Open Protection (Vin=120$V_{AC}$, Y-$V_{DRAIN}$, R-Vout, B-VCC,G-$I_{LED}$)

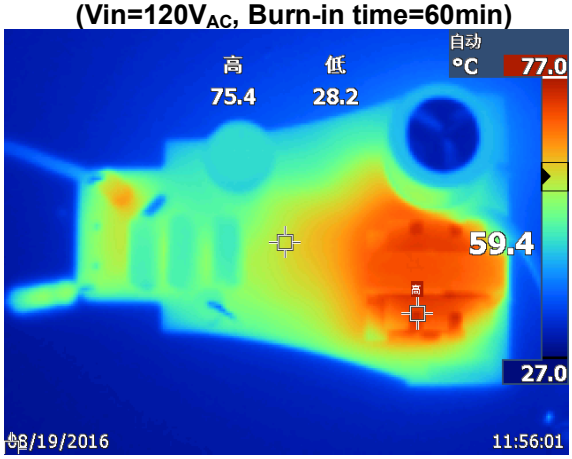



### LED Short Protection (Vin=120$V_{AC}$,Y-$V_{DRAIN}$, R-Vout, B-VCC)

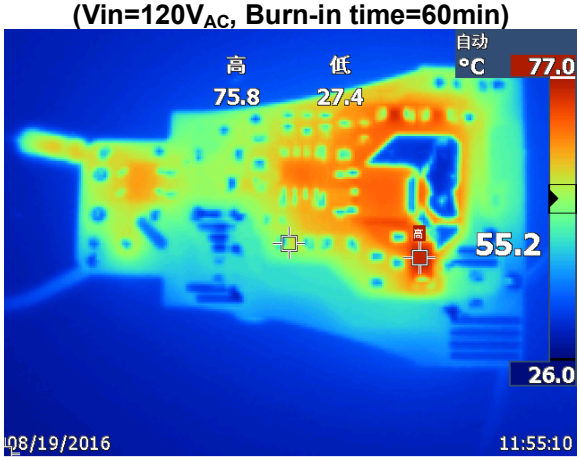


## Thermal Test

**Top**
**(Vin=120V$_{AC}$, Burn-in time=60min)**

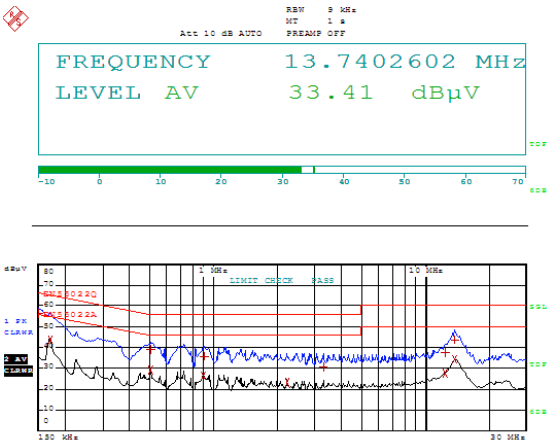



**Bottom**
**(Vin=120V$_{AC}$, Burn-in time=60min)**




## EMI Conduction Test

**Line Terminal**
**(Vin=120VAC, Margin>9dB)**

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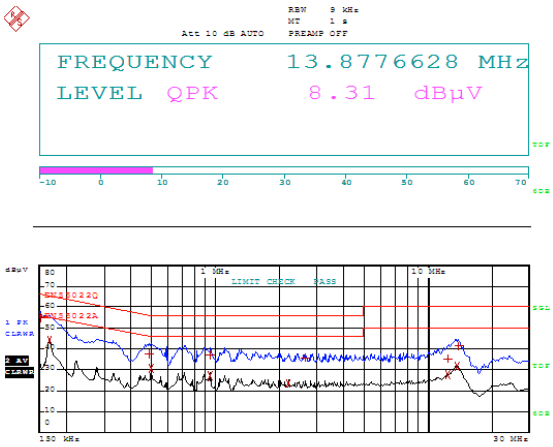
EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

| TRACE | | FREQUENCY | LEVEL dBµV | DELTA LIMIT dB |
|---|---|---|---|---|
| 1 | Quasi Peak | 150 kHz | 56.18 | -9.81 |
| 2 | Average | 169.02375452 kHz | 43.72 | -11.28 |
| 1 | Quasi Peak | 300.008614528 kHz | 39.27 | -16.72 |
| 2 | Average | 300.008614528 kHz | 29.30 | -16.69 |
| 2 | Average | 890.465639904 kHz | 26.39 | -19.60 |
| 1 | Quasi Peak | 899.370296303 kHz | 35.72 | -20.27 |
| 2 | Average | 2.22424976908 MHz | 23.23 | -22.76 |
| 1 | Quasi Peak | 3.27881664913 MHz | 30.83 | -25.16 |
| 1 | Quasi Peak | 12.3157210828 MHz | 37.44 | -22.55 |
| 2 | Average | 12.3157210828 MHz | 27.73 | -22.26 |
| 1 | Quasi Peak | 13.7402601784 MHz | 43.90 | -16.09 |
| 2 | Average | 13.7402601784 MHz | 34.23 | -15.76 |

**Neutral Terminal**
**(Vin=120VAC, Margin>11dB)**




Date: 26.AUG.2016 14:32:31

EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

| TRACE | | FREQUENCY | LEVEL dBµV | DELTA LIMIT dB |
|---|---|---|---|---|
| 1 | Quasi Peak | 151.5 kHz | 54.86 | -11.05 |
| 2 | Average | 165.693318812 kHz | 43.99 | -11.17 |
| 1 | Quasi Peak | 485.30343514 kHz | 37.44 | -18.80 |
| 2 | Average | 485.058034186 kHz | 30.61 | -15.46 |
| 1 | Quasi Peak | 935.888336808 kHz | 37.37 | -18.62 |
| 2 | Average | 935.888336808 kHz | 27.45 | -18.54 |
| 2 | Average | 2.20222748414 MHz | 23.71 | -22.28 |
| 1 | Quasi Peak | 2.634188838 MHz | 35.75 | -20.24 |
| 1 | Quasi Peak | 12.3157210828 MHz | 35.46 | -24.53 |
| 2 | Average | 12.3157210828 MHz | 27.79 | -22.20 |
| 2 | Average | 13.7402601784 MHz | 31.57 | -18.42 |
| 1 | Quasi Peak | 13.8776627802 MHz | 41.25 | -18.74 |

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