

### General Description

This demonstration board utilizes the AL1663 Flyback LED driver-controller providing a cost effective solution for 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 also support pwm dimming mode. It works at PWM dimming mode when a digital signal is applied on APWM pin.

A bill of materials is included that describes the parts used on this demonstration board. A schematic have also been included along with measured performance characteristics. These materials can be used as a reference design for your products improving your product's time to market.

### Key Features

- Active PFC with power factor >0.9
- High efficiency >84%
- Low THD
- PWM dimming mode

### Applications

- LED Lighting
- PWM dimming

### AL1663 Flyback Specifications

| Parameter        | Value          |
|------------------|----------------|
| AC Input Voltage | 230V/120V      |
| Output Power     | 19.5W          |
| LED Current      | 650mA          |
| LED Voltage      | 30V            |
| Power Factor     | >0.9           |
| Efficiency       | 84%            |
| XYZ Dimension    | 95 x 30 x 25mm |
| ROHS Compliance  | Yes            |

### Evaluation Board

Figure 1: Top View

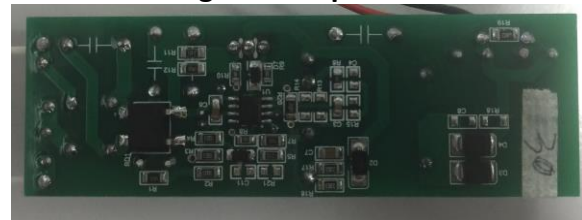
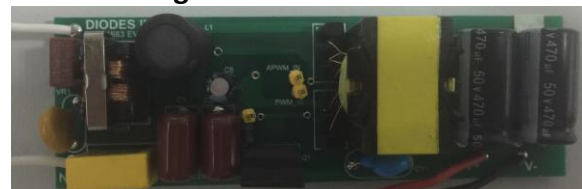


Figure 2: Bottom View



### Connection Instructions:

AC+ Input: AC\_L

AC- Input: AC\_N

DC LED+ Output: LED+

DC LED- Output: LED-

Dimming Signal Input: APWM and PWM  
Input

GND: GND

### Board Layouts

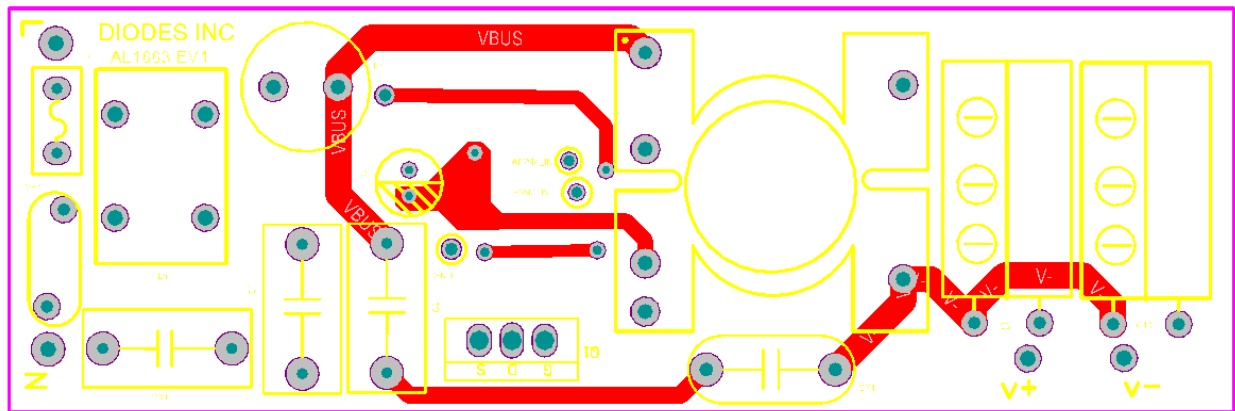


Figure 3: PCB Layout Top View

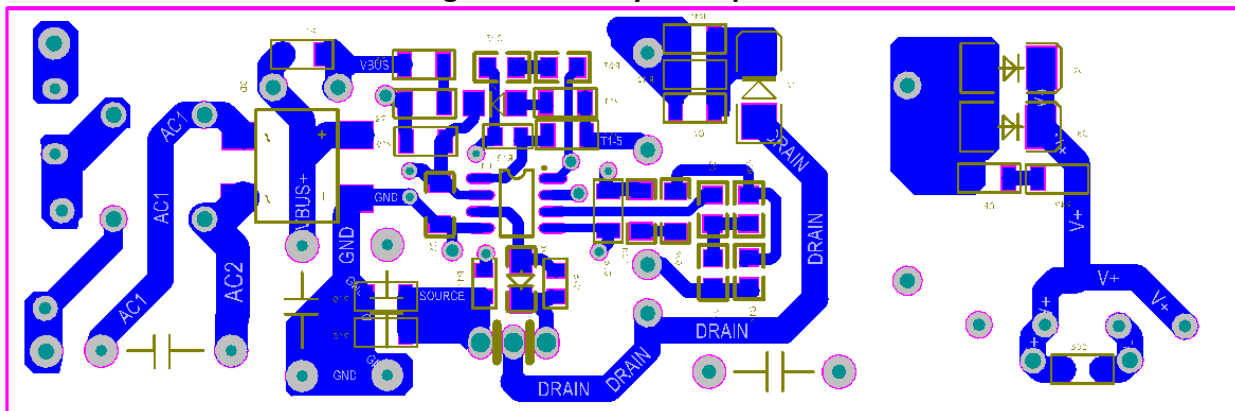


Figure 4: PCB Layout Bottom View

### Quick Start Guide

1. Preset the isolated AC source to 230VAC.
2. Ensure that the AC source is switched OFF or disconnected.
3. Connect the anode wire of the LED string to the LED+ 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. Connect your digital signal wire to the pwm input terminal if you wanna make the evaluation board work at pwm dimming mode.
7. 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.
8. Turn on the main switch. LED string should light up.  
DO NOT TOUCH THE BOARD, LEDs OR BARE WIRING.

**Caution: This AL1663 evaluation board is a non-isolated design. All terminals carry high voltage during operation!**

### Schematic

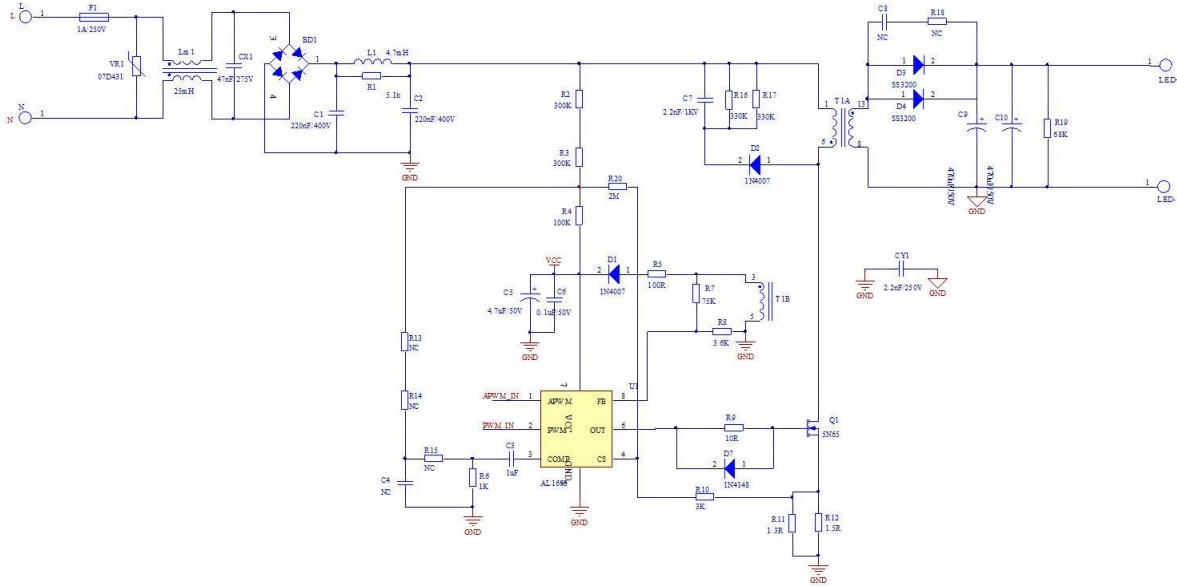


Figure 5: Schematic Circuit

### Transformer Design

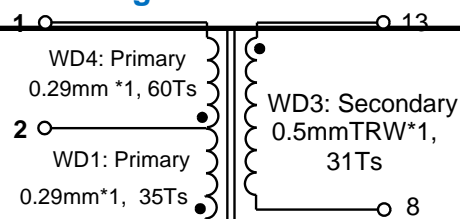
#### Bobbin and Core

- Bobbin: PQ2620, 6+8Pin
- Core: PC40

#### Transformer parameters

1. Primary Inductance (Pin6-Pin1, all other windings open):  
Lp=0.75mH, ±5%@1kHz
2. Primary Winding Turns (Pin6-Pin1): N<sub>P</sub>=95Ts
3. Secondary Winding Turns(Pin13-Pin8):N<sub>S</sub>=31Ts
4. Auxiliary Winding Turns (Pin3-Pin5): N<sub>A</sub>=20Ts

### Transformer Winding Construction Diagram



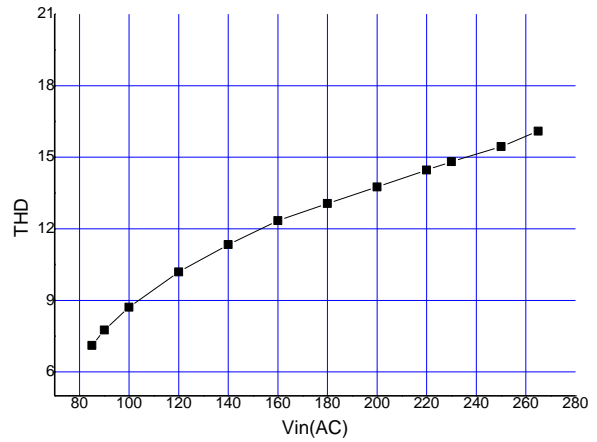
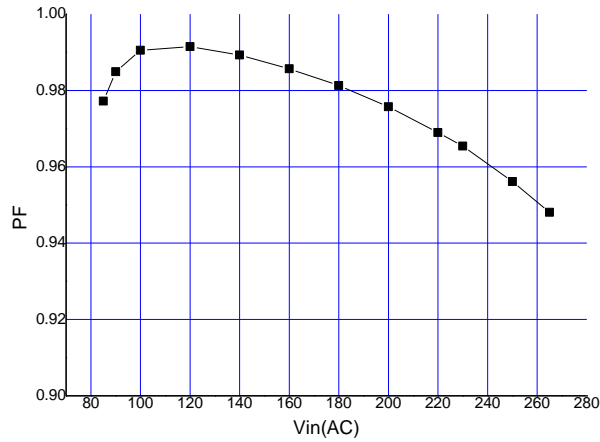
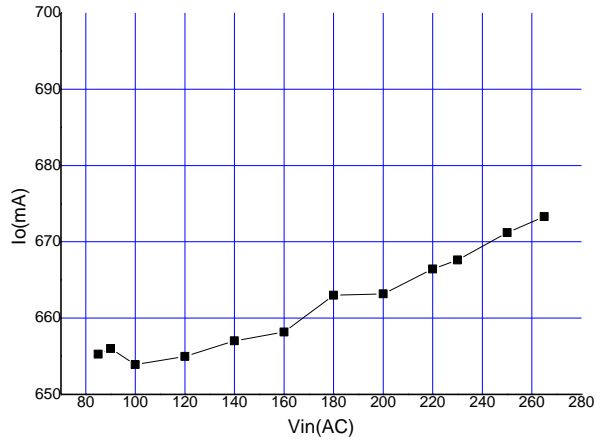
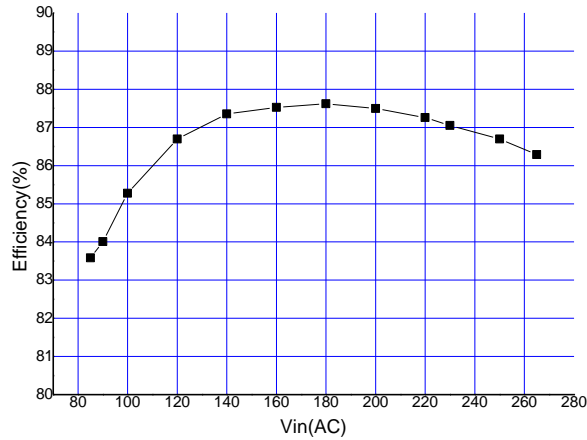
| Wdg Num | Winding name          | Description  |
|---------|-----------------------|--|
| 1       | WD1 primary winding   | Start from Pin6, $\Phi 0.29\text{mm}^*1$ , 35Ts, one layer, end at pin2.                       |
| 2       | Insulation tape       | 1layer insulation tape   |
| 3       | WD2 shielding winding | Start from Pin5, $\Phi 0.13\text{mm}^*1$ , full one layer, end with floating.                  |
| 4       | Insulation tape       | 1layer insulation tape   |
| 5       | WD3 secondary winding | Start from Pin13, triple insulation wire $\Phi 0.5\text{mm}^*1$ , 31Ts, 3 layers, end at Pin8. |
| 6       | Insulation tape       | 2layer insulation tape   |
| 7       | WD4 primary winding   | Start from Pin2, $\Phi 0.29\text{mm}^*1$ , 60Ts, 2 layers, end at Pin1.                        |
| 8       | Insulation tape       | 2 layer insulation tape  |
| 9       | WD5 auxiliary winding | Start from Pin3, $\Phi 0.15\text{mm}^*1$ , 20Ts, 1 layer, end at Pin5.                         |
| 10      | Insulation tape       | 1 layer Insulation tape  |

### Bill of Material

| #  | Item            | Quantity | Package | Description                    |
|----|-----------------|----------|---------|--------------------------------|
| 1  | CX1             | 1        | DIP     | X-Cap, 47nF/275VAC, Pitch=10mm |
| 2  | C1              | 1        | DIP     | 220nF/400V, CL21, Pitch=10mm   |
| 3  | C2              | 1        | DIP     | 220nF/400V, CL21, Pitch=10mm   |
| 4  | C3              | 1        | 0805    | Ceramic Cap, 1uF/16V,X7R       |
| 5  | C5              | 1        | DIP     | E-Cap, 130°C,4.7uF/50V,5*9mm   |
| 6  | C6              | 1        | 0805    | Ceramic Cap, 0.1uF/50V,X7R     |
| 7  | C7              | 1        | 1206    | Ceramic Cap, 2.2nF/1KV,X7R     |
| 8  | C4,C8           | 0        |         | NC                             |
| 9  | C9,C10          | 2        | DIP     | E-Cap, 130°C,470uF/50V,10*20mm |
| 10 | CY1             | 1        | DIP     | Y-Cap, 2.2nF/250VAC, 10mm      |
| 11 | BD1             | 1        | SOPA-4  | Rectifier Bridge,DB107S,1A/1KV |
| 12 | D1              | 1        | SOD-123 | Diode, 1N4007,1A/1KV           |
| 13 | D2              | 1        | SMA     | Diode, 1N4007,1A/1KV           |
| 14 | D3,D4           | 2        | SMB     | Schottky, SS3200, 3A/200V      |
| 15 | D7              | 1        | SOD-123 | Switching Diode, 1N4148        |
| 16 | VR1             | 1        | DIP     | Varistor, 07D431               |
| 17 | F1              | 1        | DIP     | Fuse,1A/250V                   |
| 18 | R1              | 1        | 1206    | SMD Resistor,5.1K, 5%, 1/4W    |
| 19 | R2,R3           | 2        | 1206    | SMD Resistor,300K, 5%, 1/4W    |
| 20 | R4              | 1        | 1206    | SMD Resistor,100K, 5%, 1/4W    |
| 21 | R5              | 1        | 1206    | SMD Resistor,100R, 5%, 1/4W    |
| 22 | R6              | 1        | 0805    | SMD Resistor,1K, 5%, 1/4W      |
| 23 | R7              | 1        | 1206    | SMD Resistor,75K, 5%, 1/4W     |
| 24 | R8              | 1        | 1206    | SMD Resistor,3.6K, 5%, 1/4W    |
| 25 | R9              | 1        | 0805    | SMD Resistor, 10R, 5%, 1/4W    |
| 26 | R10             | 1        | 0805    | SMD Resistor, 3K, 5%, 1/4W     |
| 27 | R11             | 1        | 1206    | SMD Resistor, 1.3R, 1%, 1/4W   |
| 28 | R12             | 1        | 1206    | SMD Resistor, 1.5R, 1%, 1/4W   |
| 29 | R13,R14,R15,R18 | 0        |         | NC                             |
| 30 | R16,R17         | 2        | 1206    | SMD Resistor,330K, 5%, 1/4W    |
| 31 | R19             | 1        | 1206    | SMD Resistor,68K, 5%, 1/4W     |
| 32 | R20             | 1        | 1206    | SMD Resistor,2M, 5%, 1/4W      |
| 33 | L1              | 1        | DIP     | Inductor 4.7mH, 10*12mm        |
| 34 | Lm1             | 1        | DIP     | Common Inductor, 25mH          |
| 35 | T1              | 1        | DIP     | Transformer,PQ2620,0.75mH      |
| 36 | Q1              | 1        | TO-220  | Mosfet, 5N65, 5A/650V          |

|    |     |    |        |                             |
|----|-----|----|--------|-----------------------------|
| 37 | U1  | 1  | SOIC-8 | AL1663, high PFC Controller |
| 38 | PCB | 39 |        | FR4 Double layer, 95*31mm   |

**Functional Performance**



**Functional Waveform**

Waveforms:

**Input Voltage & Input Current**

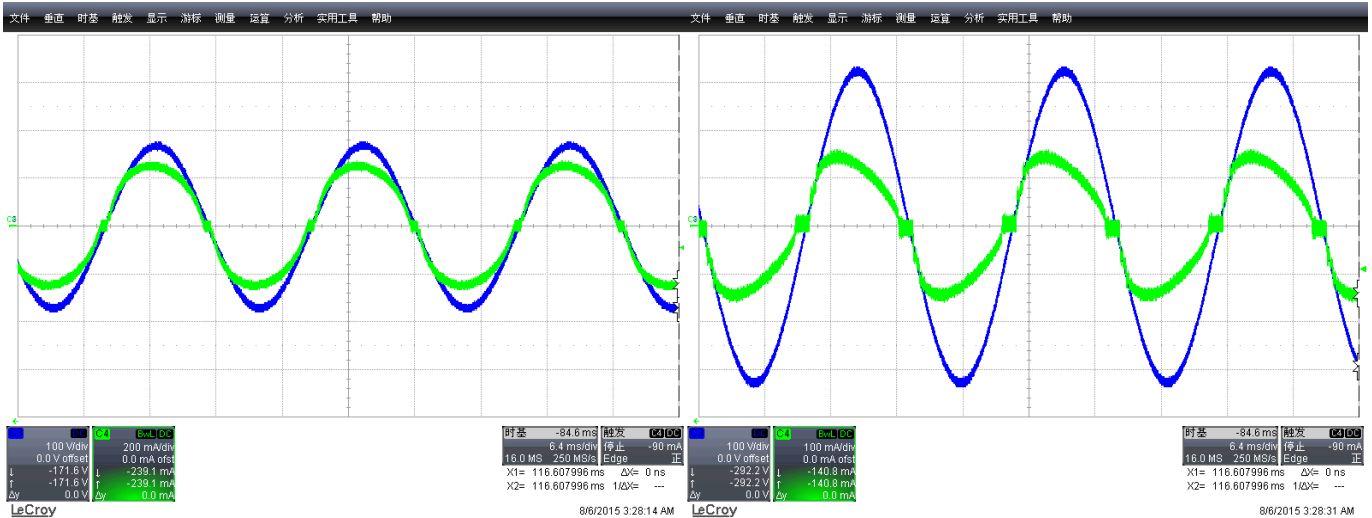
**Vin=120V**

**Input Voltage Input Current**

**Input Voltage & Input Current**

**Vin=230V**

**Input Voltage Input Current**



**Output Voltage & Output Current**

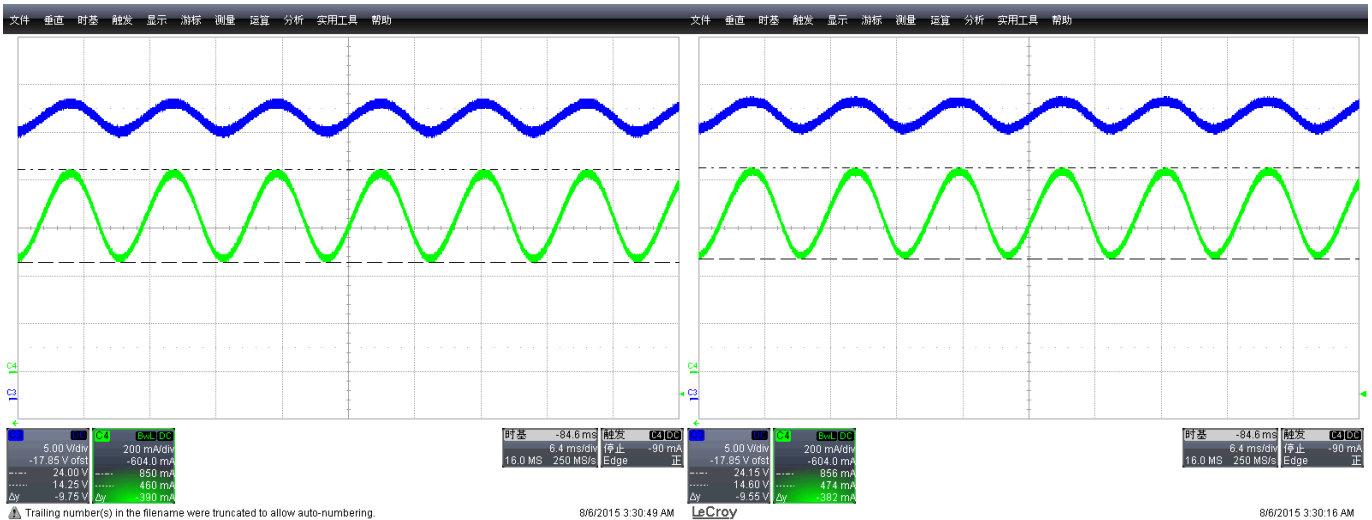
**Vin=120V**

**Output Voltage Output Current**

**Output Voltage & Output Current**

**Vin=230V**

**Output Voltage Output Current**



**Startup Overshoot**

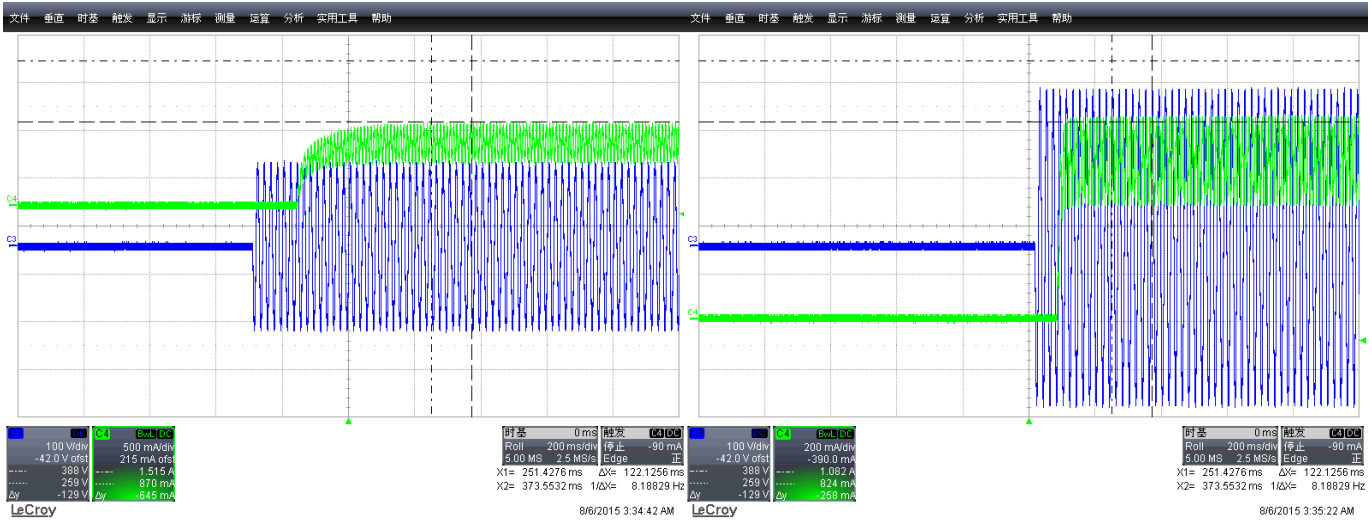
**Vin=120VAC (No overshoot current)**

**Input Voltage Output Current**

**Startup Overshoot**

**Vin=230VAC (No overshoot current)**

**Input Voltage Output Current**



**Startup time**

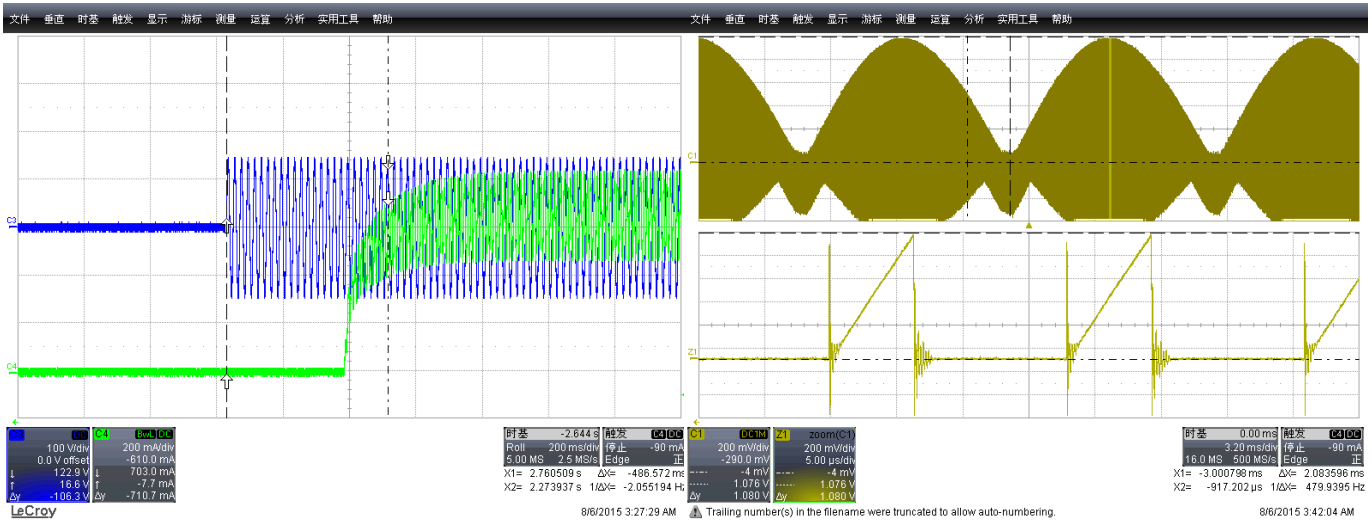
**Vin=120VAC Start time=482ms**

**Input Voltage Output Current**

**CS Vcs Waveform**

**Vin=120VAC V<sub>RRM\_MAX</sub>=1.08V**

**Output V<sub>CS</sub>**



**CS Vcs Waveform**

**Drain V<sub>Drain</sub> Waveform**

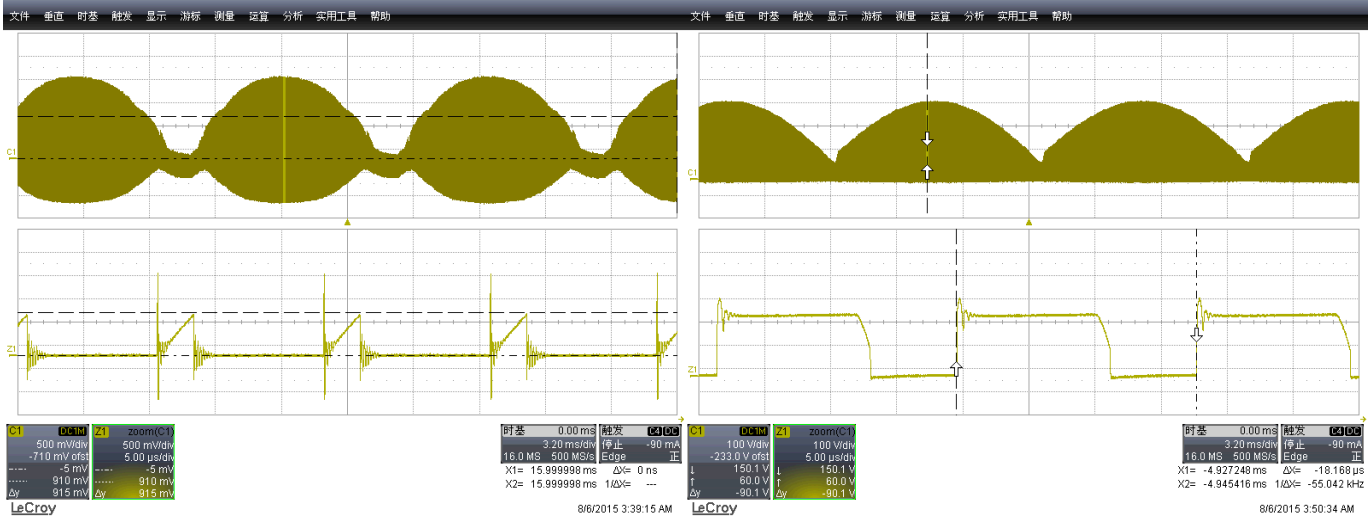


**Vin=230VAC V<sub>R<sub>RM</sub>\_MAX=910mV</sub>**

**Output V<sub>CS</sub>**

**Vin=120VAC Frequency=55kHz**

**Output V<sub>Drain</sub>**



**Drain Waveform**

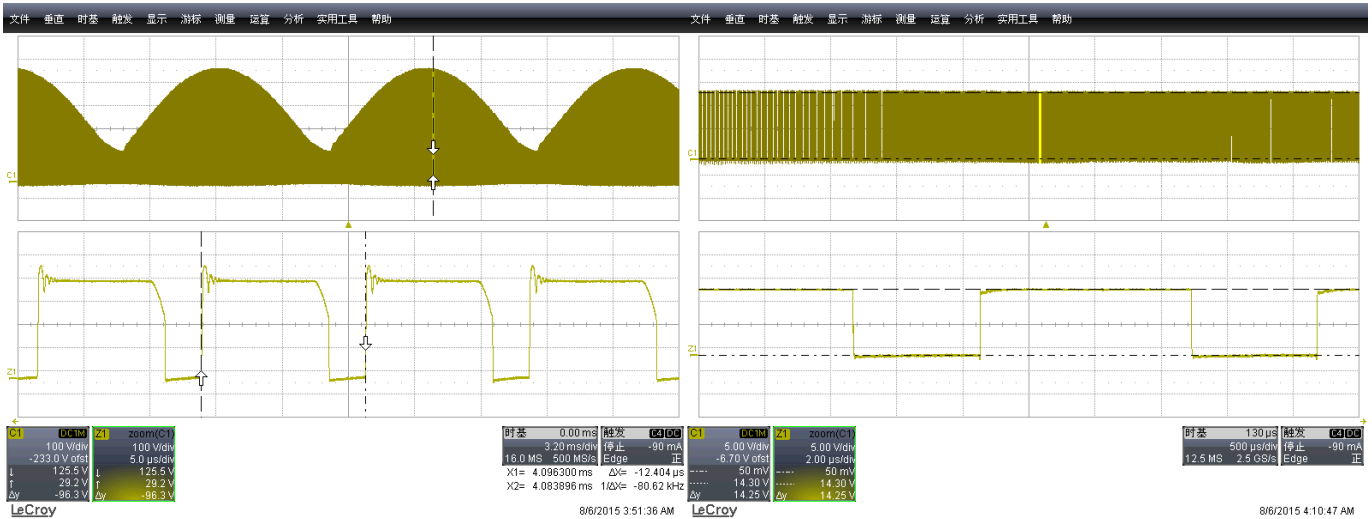
**Vin=230VAC Frequency=80kHz**

**Output V<sub>Drain</sub>**

**Gate V<sub>gate</sub> Waveform**

**Vin=120VAC V<sub>gate</sub>=14.3V**

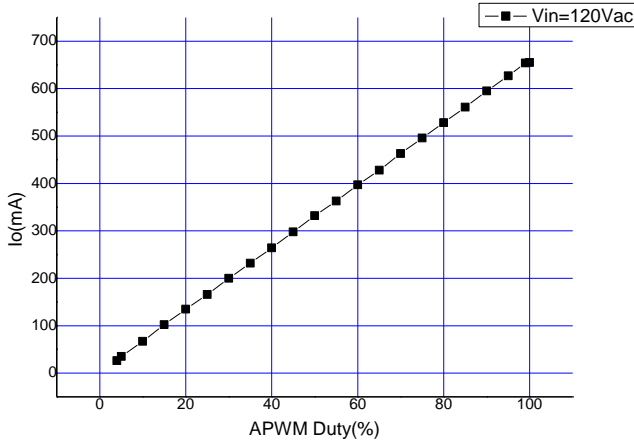
**Output Diode V<sub>CS</sub>**



**PWM Dimming Functional Performance**

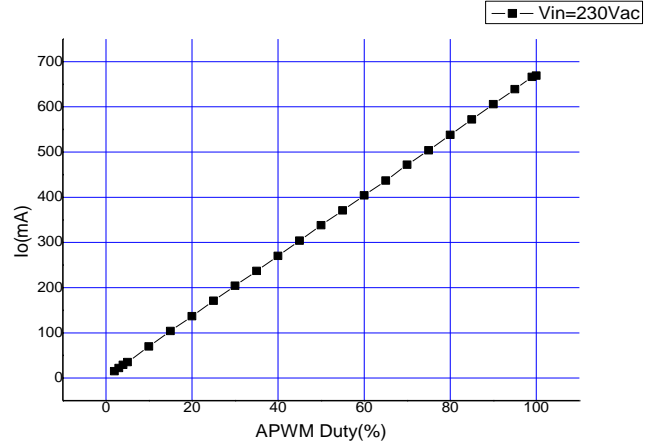
**PWM Frequency:1kHz**

**Vin=120V**



**PWM Frequency:1.01kHz**

**Vin=230V**



**PWM Dimming Functional Waveform**

Waveforms:

**Drain  $V_{Drain}$  & Output Current**

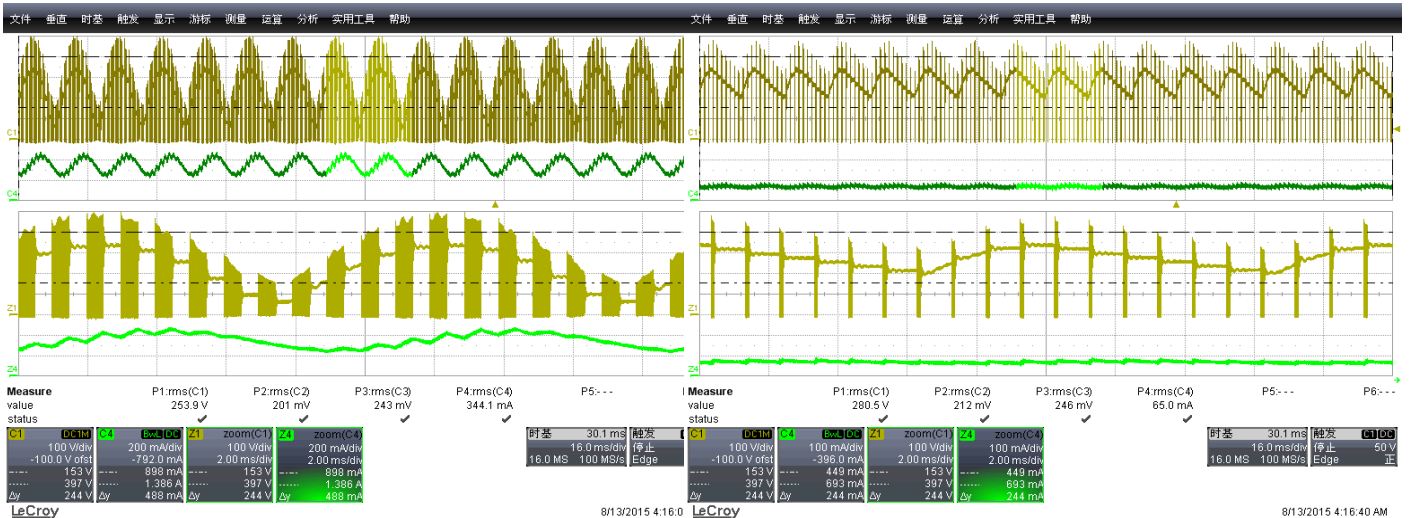
**PWM duty=50%**

**Output  $V_{Drain}$  Output Current**

**Drain  $V_{Drain}$  & Output Current**

**PWM duty=10%**

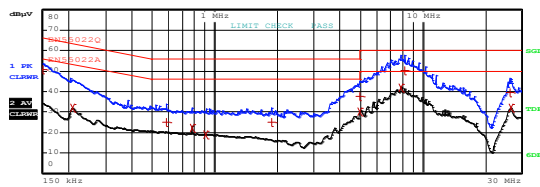
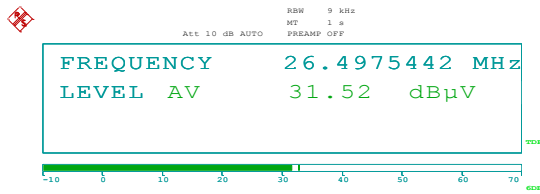
**Output  $V_{Drain}$  Output Current**



**EMI Conduction Test**

**Line Terminal**

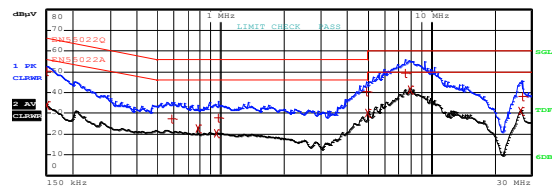
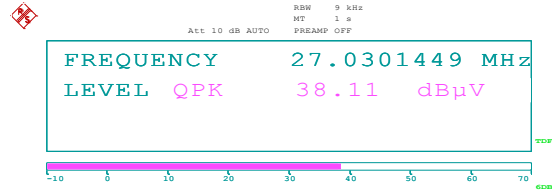
**Vin=230VAC/50Hz LIMIT CHECK PASS**



Date: 6.MAY.2015 15:56:14

**Neutral Terminal**

**Vin=230VAC/50Hz LIMIT CHECK PASS**



Date: 6.MAY.2015 16:00:13

**Line Terminal**

**Vin=230VAC/50Hz Margin>7dB**

EDIT PEAK LIST (Final Measurement Results)

| TRACE        | FREQUENCY          | LEVEL dBµV | DELTA LIMIT dB |
|--------------|--------------------|------------|----------------|
| 1 Quasi Peak | 150 kHz            | 30.92      | -13.07         |
| 2 Average    | 208.24110178 kHz   | 32.13      | -21.20         |
| 1 Quasi Peak | 380.484478884 kHz  | 23.08      | -30.91         |
| 2 Average    | 774.872132397 kHz  | 22.13      | -23.86         |
| 2 Average    | 838.370286303 kHz  | 18.84      | -27.15         |
| 1 Quasi Peak | 1.87810643122 MHz  | 24.81      | -31.18         |
| 1 Quasi Peak | 4.87883359306 MHz  | 37.74      | -18.23         |
| 2 Average    | 4.87883359306 MHz  | 30.18      | -18.81         |
| 2 Average    | 7.78249712393 MHz  | 42.08      | -7.91          |
| 1 Quasi Peak | 8.188998279463 MHz | 30.21      | -9.78          |
| 1 Quasi Peak | 26.2351923234 MHz  | 39.66      | -20.33         |
| 2 Average    | 26.4975442467 MHz  | 31.93      | -18.04         |

**Neutral Terminal**

**Vin=230VAC/50Hz Margin>8dB**

EDIT PEAK LIST (Final Measurement Results)

| TRACE        | FREQUENCY         | LEVEL dBµV | DELTA LIMIT dB |
|--------------|-------------------|------------|----------------|
| 1 Quasi Peak | 150 kHz           | 30.08      | -13.91         |
| 2 Average    | 150 kHz           | 34.06      | -21.93         |
| 1 Quasi Peak | 380.484478884 kHz | 27.46      | -28.53         |
| 2 Average    | 774.872132397 kHz | 22.48      | -23.80         |
| 2 Average    | 845.247220176 kHz | 20.18      | -25.82         |
| 1 Quasi Peak | 973.888158195 kHz | 27.68      | -28.31         |
| 1 Quasi Peak | 4.88171119798 MHz | 40.69      | -18.30         |
| 2 Average    | 4.87883359306 MHz | 30.14      | -18.83         |
| 1 Quasi Peak | 7.48843657237 MHz | 49.19      | -10.81         |
| 2 Average    | 7.87042208709 MHz | 41.58      | -8.41          |
| 2 Average    | 26.4975442467 MHz | 31.33      | -18.66         |
| 1 Quasi Peak | 27.030144886 MHz  | 38.13      | -21.86         |

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