

### 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

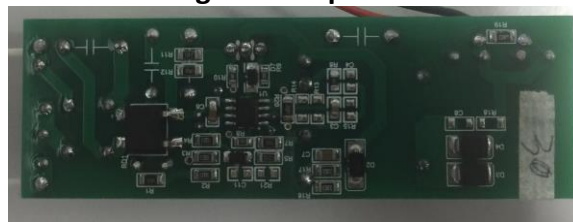
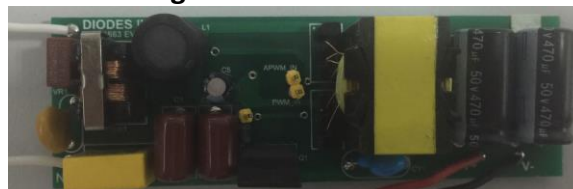


Figure 2: Bottom View



### 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

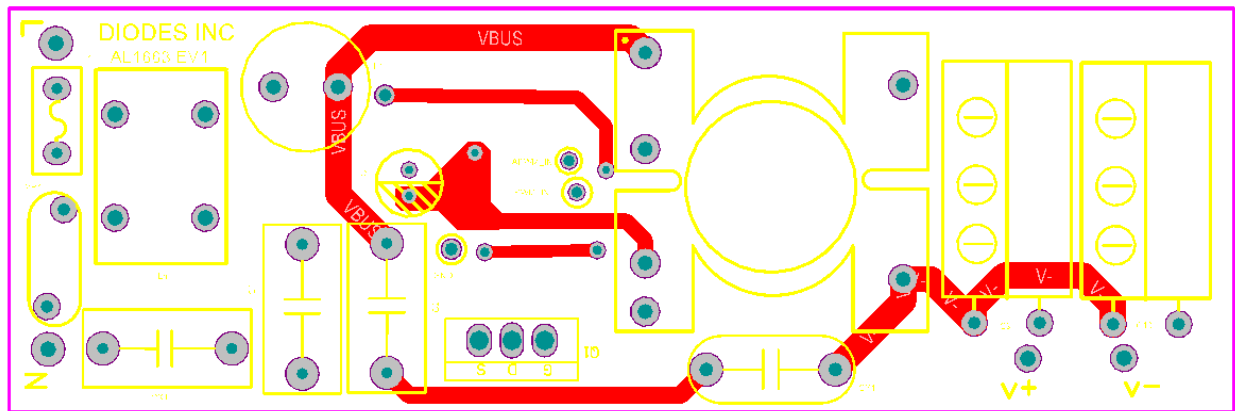


Figure 3: PCB Layout Top View

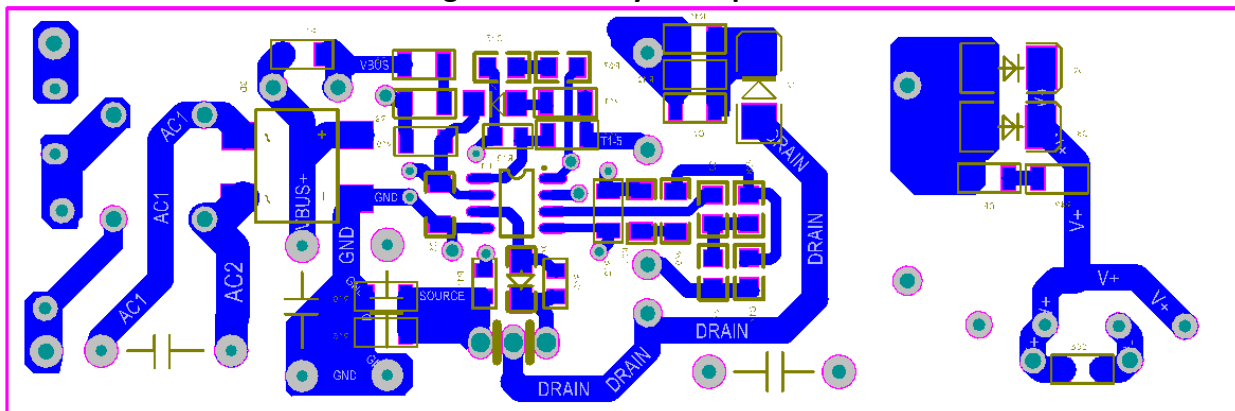


Figure 4: PCB Layout Bottom View

### 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

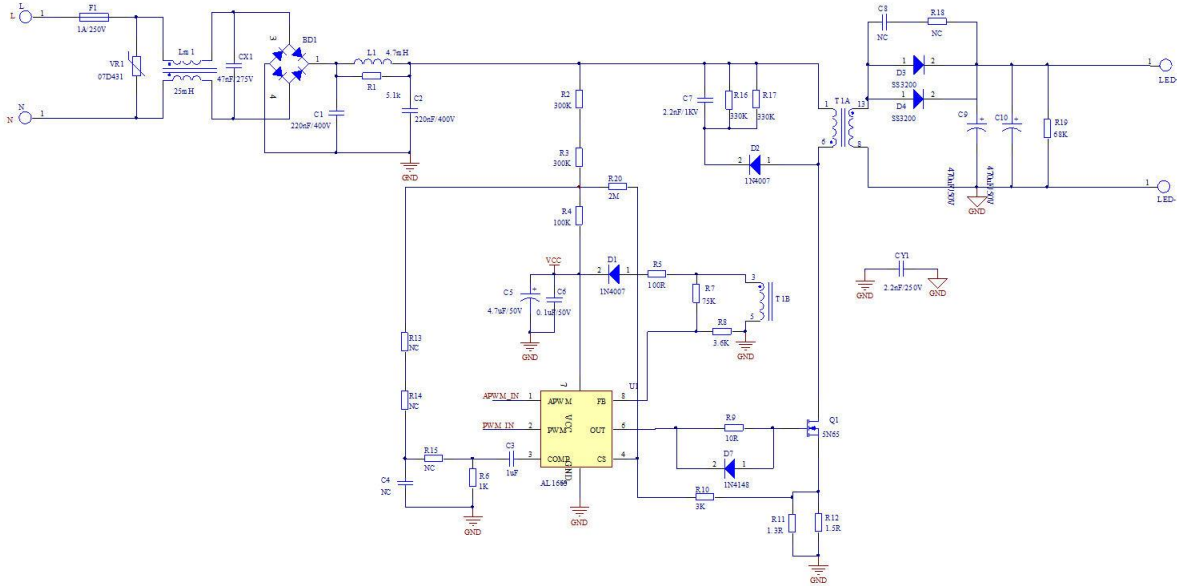


Figure 5: Schematic Circuit

### Transformer Design

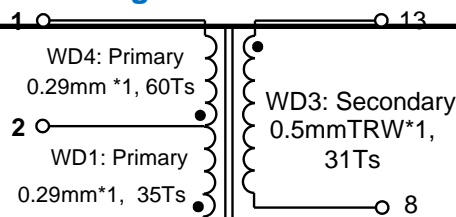
#### Bobbin and Core

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

#### Transformer parameters

1. Primary Inductance (Pin6-Pin1, all other windings open):  
 $L_p = 0.75\text{mH}, \pm 5\% @ 1\text{kHz}$
2. Primary Winding Turns (Pin6-Pin1):  $N_p = 95\text{Ts}$
3. Secondary Winding Turns (Pin13-Pin8):  $N_s = 31\text{Ts}$
4. Auxiliary Winding Turns (Pin3-Pin5):  $N_A = 20\text{Ts}$

### Transformer Winding Construction Diagram



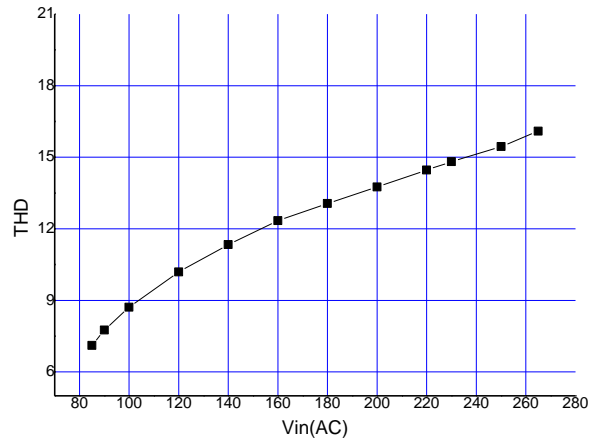
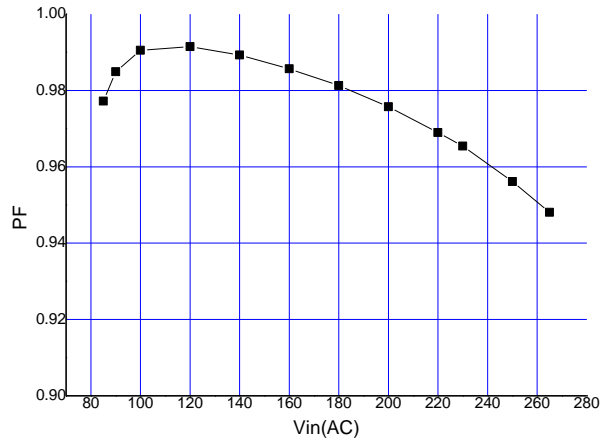
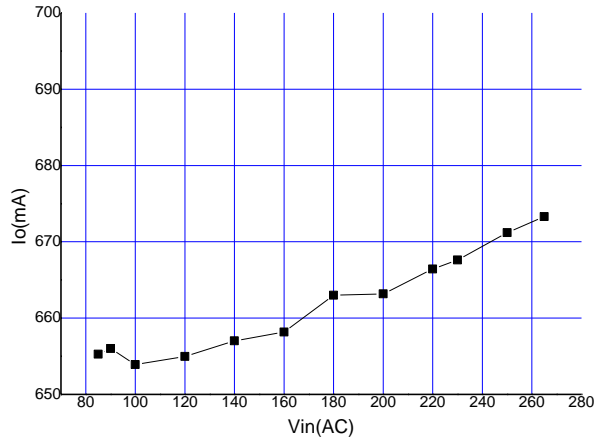
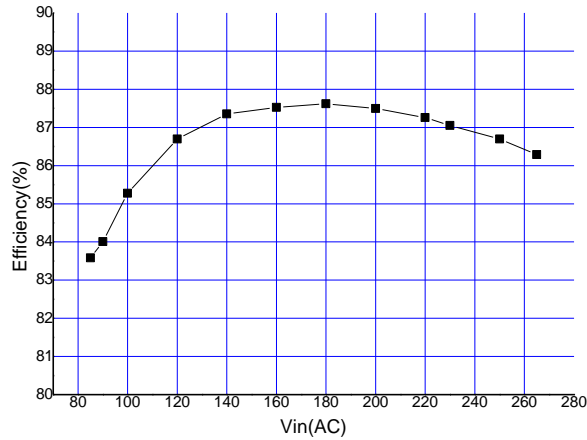
Wdg Num	Winding name	Description
1	WD1 primary winding	Start from Pin6, $\Phi 0.29\text{mm}^*1$ , 35Ts, one layer, end at pin2.
2	Insulation tape	1layer insulation tape
3	WD2 shielding winding	Start from Pin5, $\Phi 0.13\text{mm}^*1$ , full one layer, end with floating.
4	Insulation tape	1layer insulation 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**

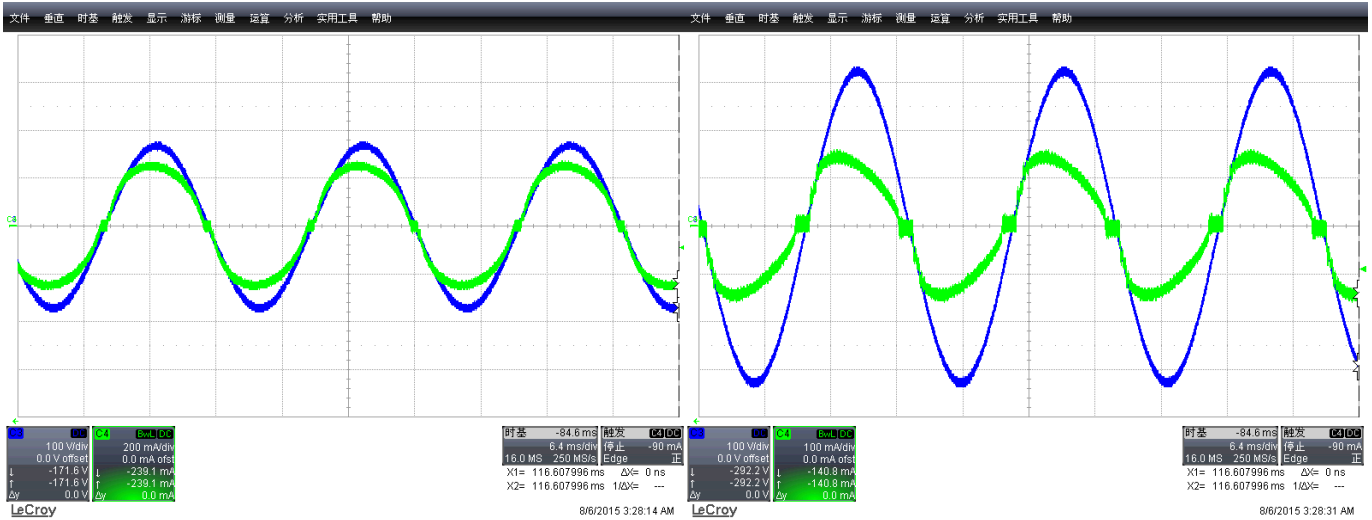
**Vin=120V**

**Input Voltage Input Current**

**Input Voltage & Input Current**

**Vin=230V**

**Input Voltage Input Current**



**Output Voltage & Output Current**

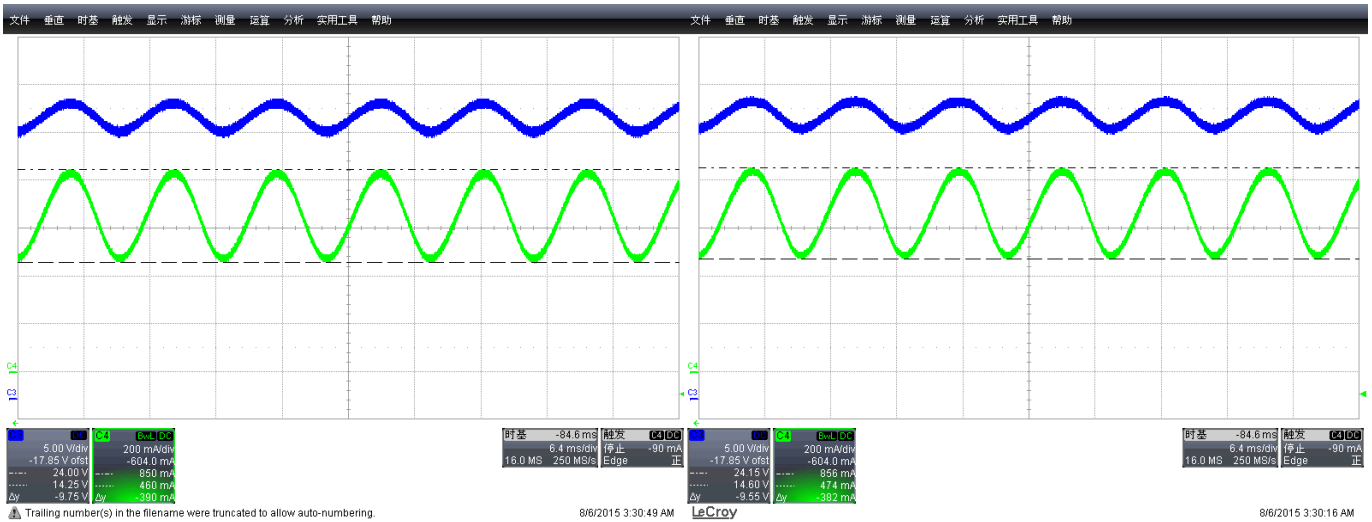
**Vin=120V**

**Output Voltage Output Current**

**Output Voltage & Output Current**

**Vin=230V**

**Output Voltage Output Current**



**Startup Overshoot**

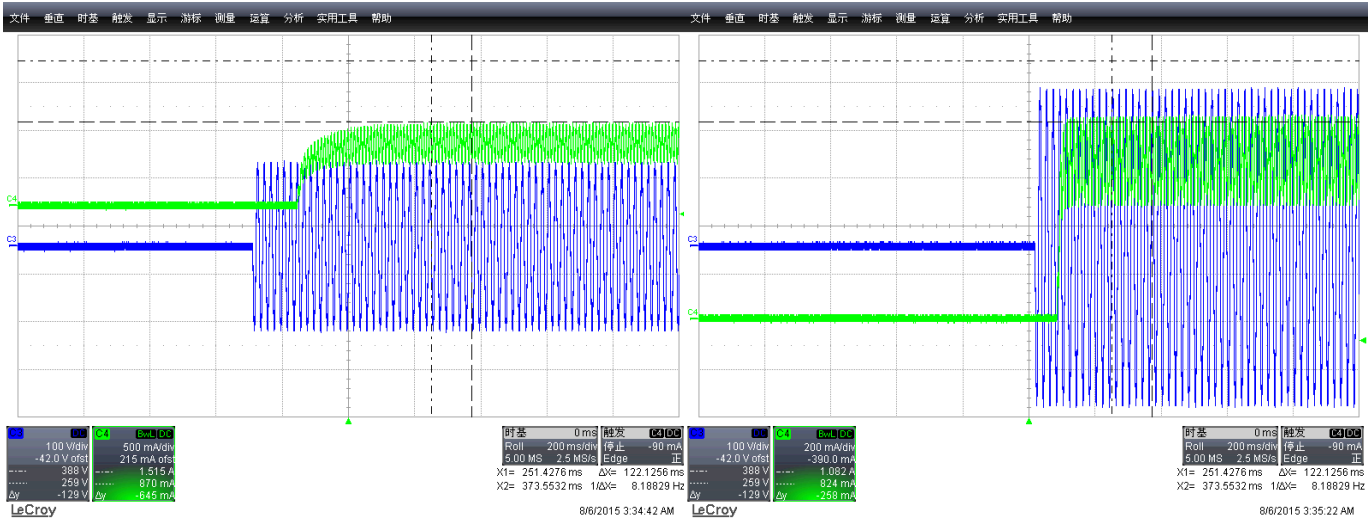
**Vin=120VAC (No overshoot current)**

**Input Voltage Output Current**

**Startup Overshoot**

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

**Input Voltage Output Current**



**Startup time**

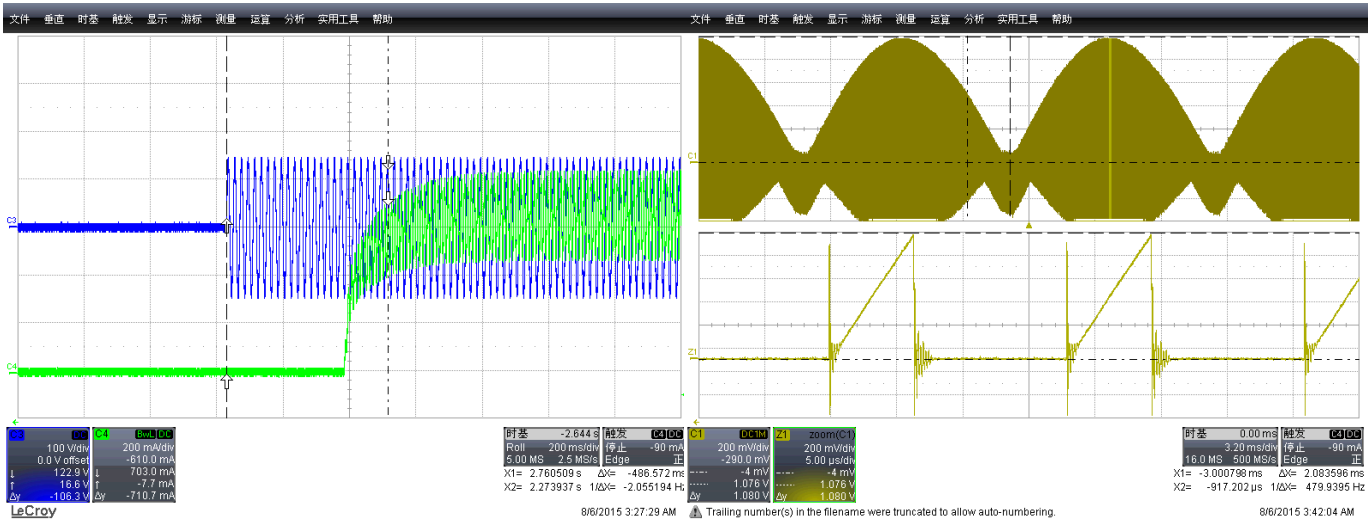
**Vin=120VAC Start time=482ms**

**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**

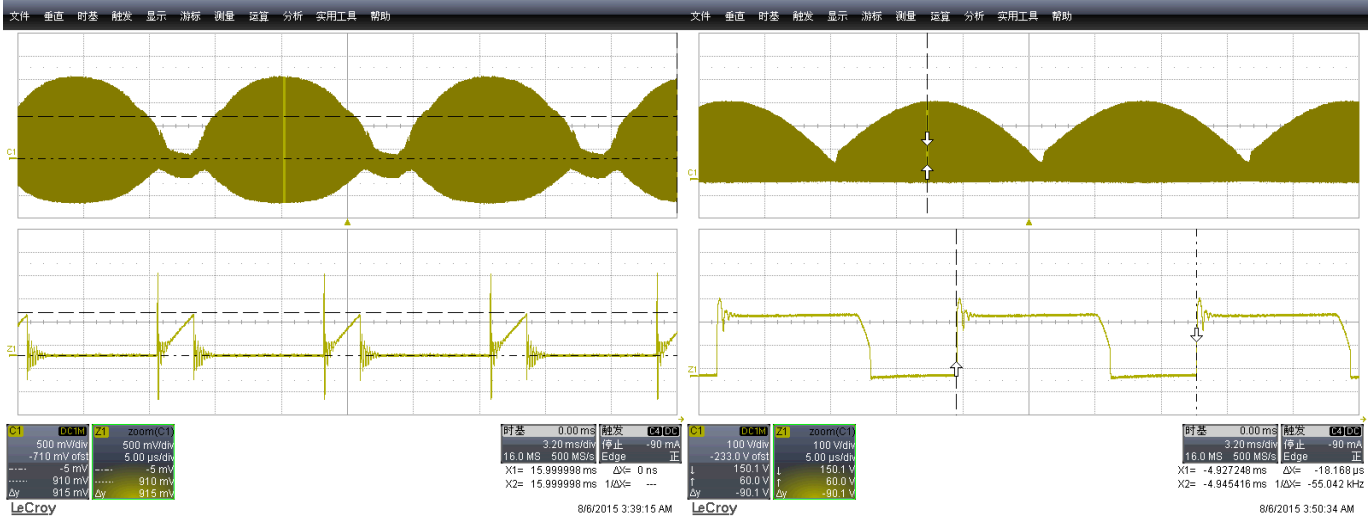


**Vin=230VAC V<sub>R<sub>RM</sub>\_MAX=910mV</sub>**

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

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

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



**Drain Waveform**

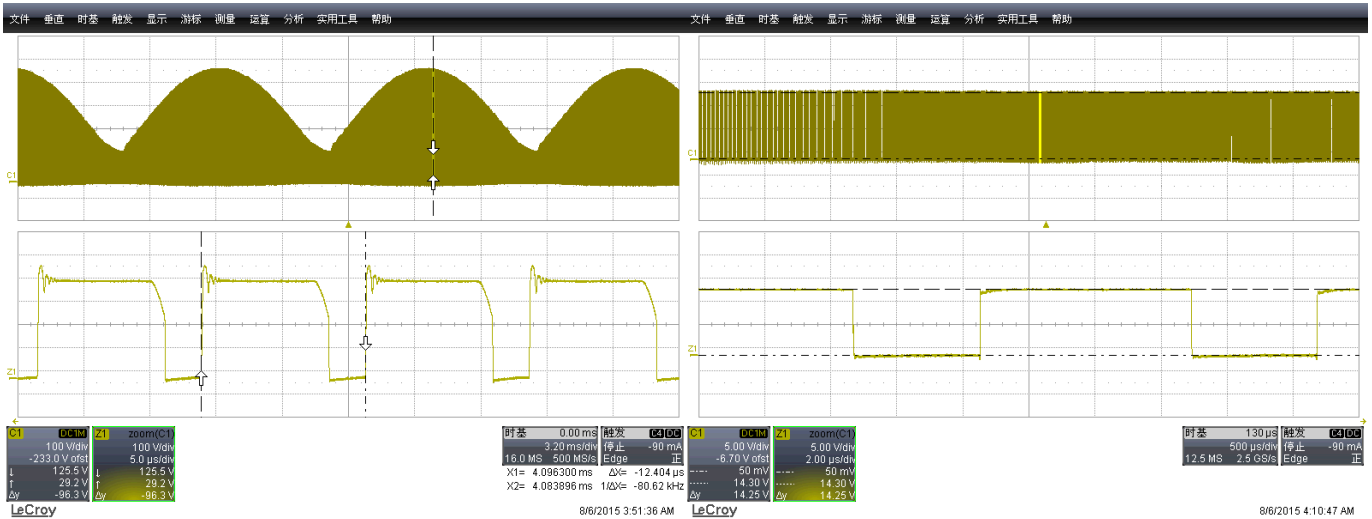
**Vin=230VAC Frequency=80kHz**

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

**Gate Vgate Waveform**

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

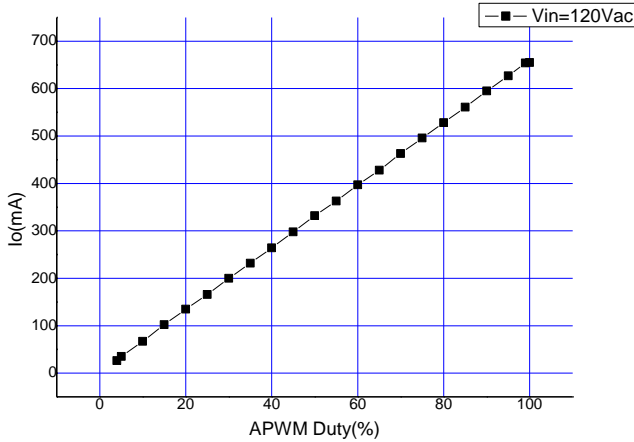
**Output Diode V<sub>CS</sub>**



**PWM Dimming Functional Performance**

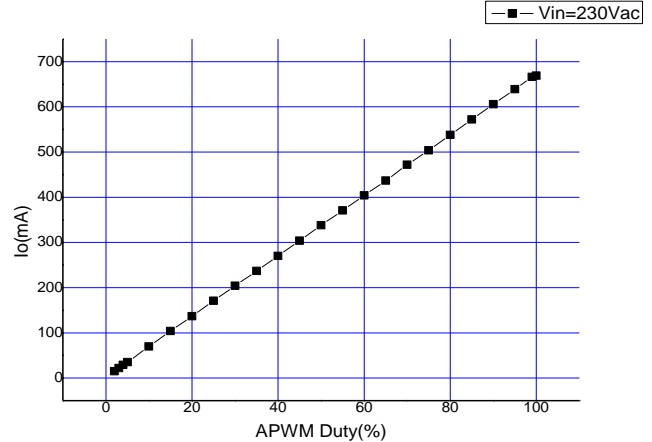
PWM Frequency:1kHz

Vin=120V



PWM Frequency:1.01kHz

Vin=230V



### PWM Dimming Functional Waveform

Waveforms:

Drain  $V_{Drain}$  & Output Current

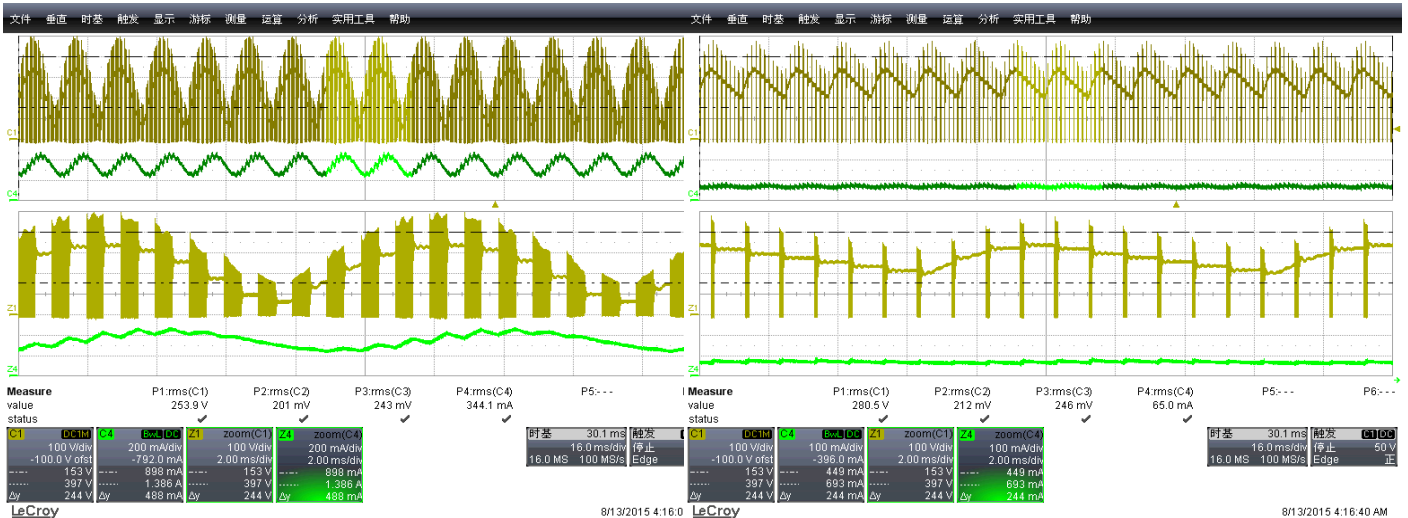
PWM duty=50%

Output  $V_{Drain}$  Output Current

Drain  $V_{Drain}$  & Output Current

PWM duty=10%

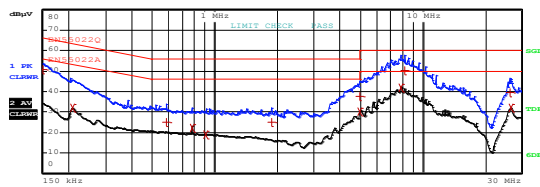
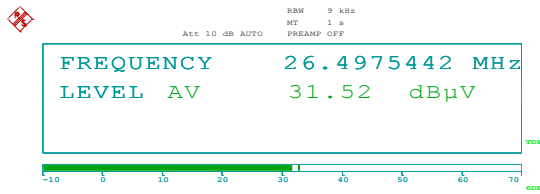
Output  $V_{Drain}$  Output Current



### EMI Conduction Test

**Line Terminal**

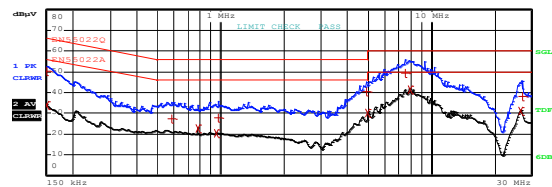
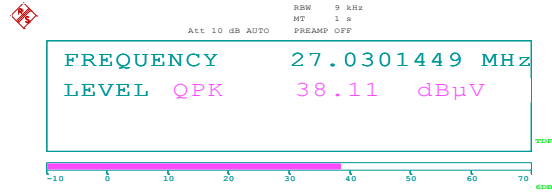
**Vin=230VAC/50Hz LIMIT CHECK PASS**



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	973.88158195 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	41.38	-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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