

### General Description

This demonstration board utilizes the AL1697 Buck-boost LED driver-converter 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 >0.91
- High efficiency >85%
- Single winding
- Low THD
- Good dimmer compatibility
- Low BOM cost

### Applications

- Retrofit Bulb, Par Lamps

### Specifications

Parameter	Value
AC Input Voltage	198~264V
Output Power	8.1W
LED Current	100mA
LED Voltage	81V
Power Factor	>0.91
Efficiency	85%
XYZ Dimension	66.5 x 23.6 x 18mm
ROHS Compliance	Yes

### Evaluation Board

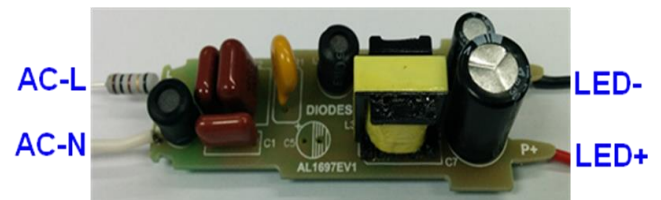


Figure 1: Top View

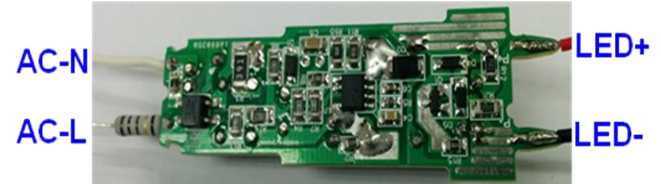


Figure 2: Bottom View

### Connection Instructions:

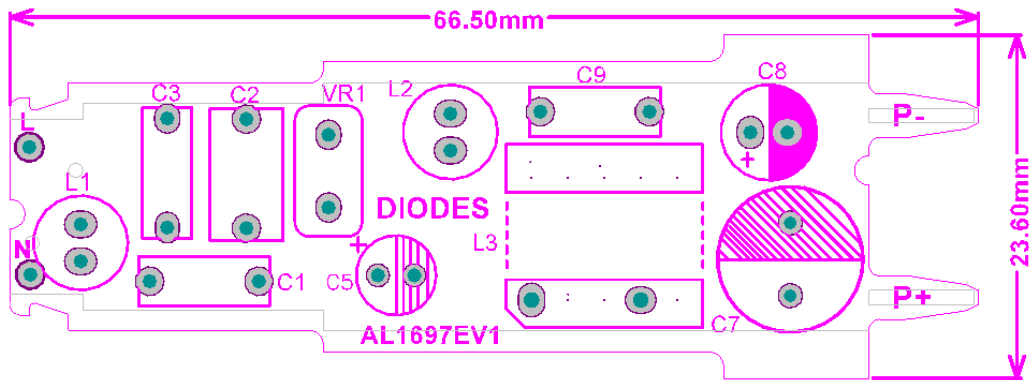
AC-L Input: Fuse resistor-Hot

AC- Input: White-Neutral

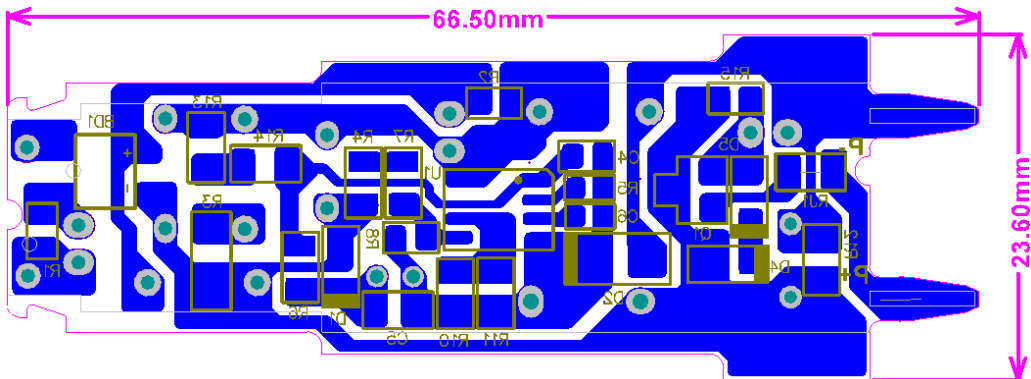
DC LED+ Output: LED+ (Red)

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 230V<sub>AC</sub>.
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 AL1697 is a non-isolated design. All terminals carry high voltage during operation!**

### Schematic

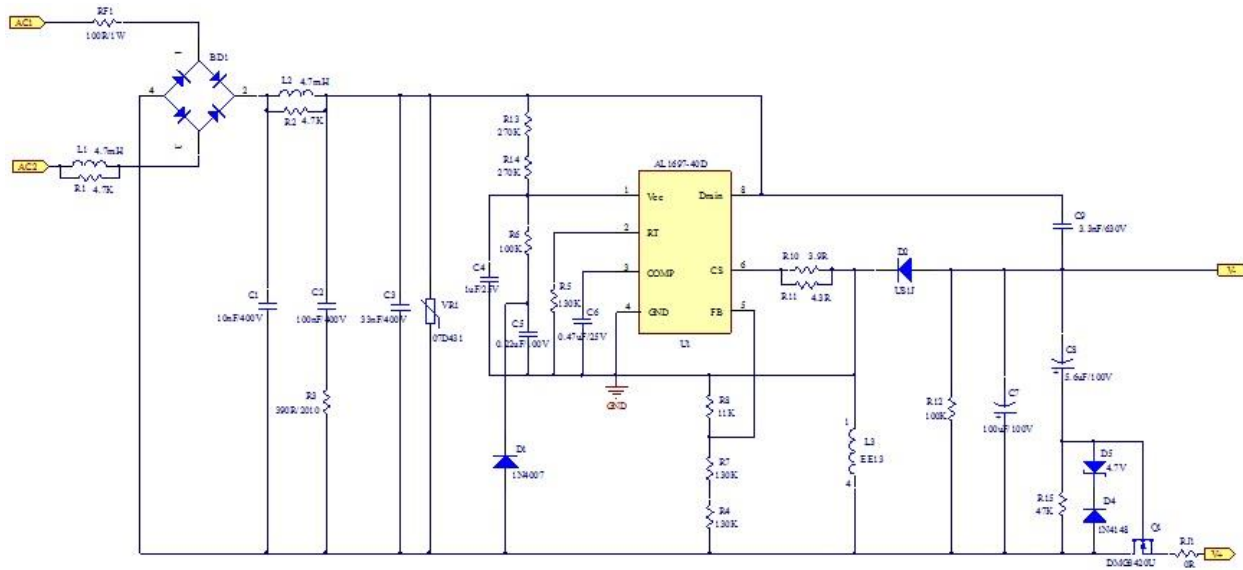


Figure 5: Schematic Circuit

### Transformer Design

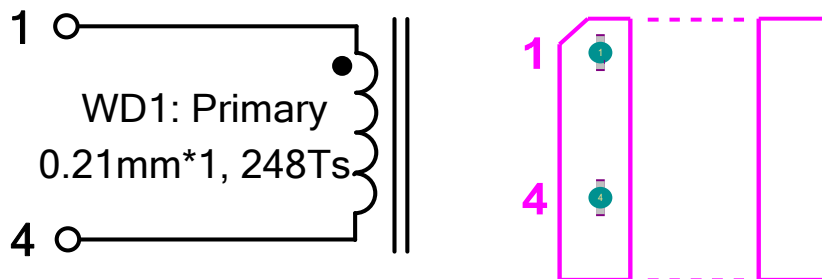
#### Bobbin and Core

EE13 Vertical 5+5 pin

#### Transformer Parameters

1. Primary Inductance (Pin1-Pin4):  $L_p=2.4\text{mH}$ ,  $\pm 5\% @ 1\text{kHz}$
2. Primary Winding Turns(Pin1-Pin4):  $N_p=248\text{Ts}$

#### Transformer Winding Construction Diagram

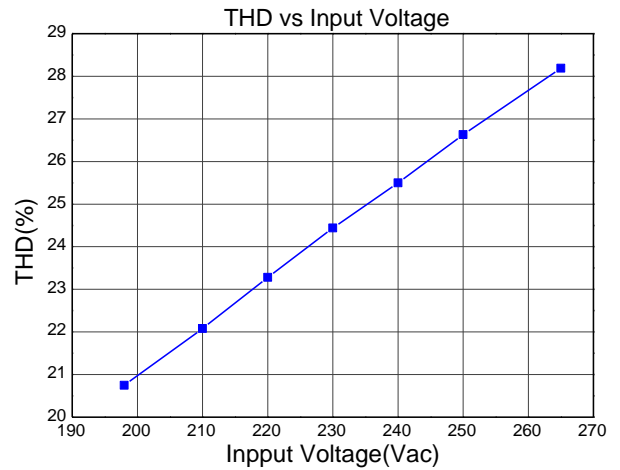
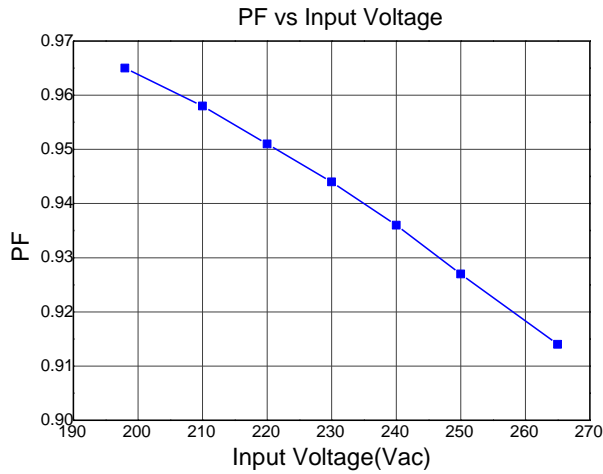
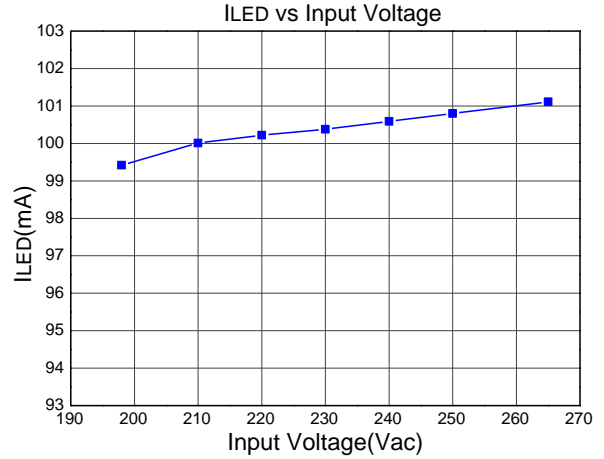
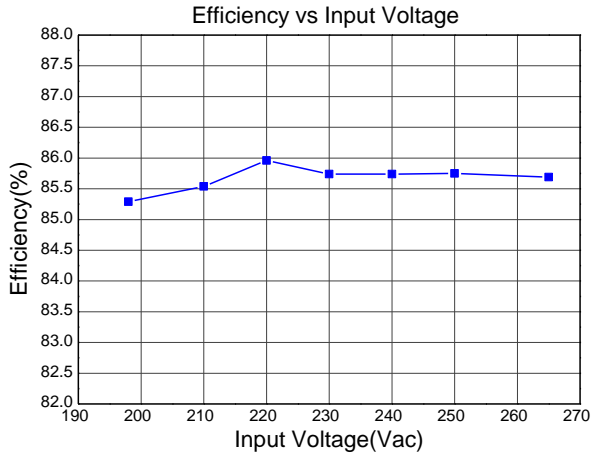


Item	Winding name	Description
1	WD1-Primary Winding	Start at Pin 1, Wind 248 turns of $\Phi 0.21\text{mm}$ wire and finish on Pin 4
2	Insulation	2Layers of insulation tape

### Bill of Material

#	Item	Description	Package	Quantity
1	C1	10nF/400V, CL21, Pitch=7.5mm	DIP	1
2	C2	100nF/400V, CL21, Pitch=7.5mm	DIP	1
3	C3	33nF/400V, CL21, Pitch=7.5mm	DIP	1
4	C4	Ceramic Cap, 1uF/25V,X7R	0805	1
5	C5	Ceramic Cap, 0.22uF/100V,X7R	1206	1
6	C6	Ceramic Cap, 0.47uF/25V,X7R	0603	1
7	C7	E-Cap,130°C,100uF/100V,10*16mm	DIP	1
8	C8	E-Cap,130°C,5.6uF/100V, 5*9mm	DIP	1
9	C9	3.3nF/630V, CL21, Pitch=7.5mm	DIP	1
10	BD1	Rectifier Bridge,HD06,0.8A/600V,Diodes Inc	MiniDIP	1
11	D1	1N4007, 1A/1000V,Diodes Inc	SOD-123	1
12	D2	Fast Recovery Diode,US1J,1A/600V,Diodes Inc	SMA	1
13	D4	Switching diode, 1N4148,Diodes Inc	SOD-123	1
14	D5	DDZ9688,4.7V Zener, Diodes Inc	SOD-123	1
15	VR1	Varistor, 07D431	DIP	1
16	RF1	Fuse Resistor,100R, 5%, 1W	DIP	1
17	R1, R2	Resistor, 4.7K, 5%, 1/8W	0805	2
18	R3	SMD Resistor,390R, 5%, 1W	2010	1
19	R5	SMD Resistor,130K, 5%, 1/8W	0603	1
20	R6	SMD Resistor,100K, 5%, 1/8W	1206	1
21	R4,R7	SMD Resistor,130K, 5%, 1/4W	1206	2
22	R8	SMD Resistor,11K, 5%, 1/8W	0805	1
23	R10	SMD Resistor,3.9R, 1%, 1/4W	1206	1
24	R11	SMD Resistor,4.3R, 1%, 1/4W	1206	1
25	R12	SMD Resistor,100K, 5%, 1/4W	1206	1
26	R13,R14	SMD Resistor,270K, 5%, 1/4W	1206	2
27	RJ1	SMD Resistor,0R, 5%, 1/4W	1206	1
28	R15	SMD Resistor,47K, 5%, 1/8W	0805	1
29	L1, L2	Drum Inductor 4.7mH, 6*8mm	DIP	2
30	L3	EE13, Vertical, 5+5pin,Single Winding,2.4mH	DIP	1
31	Q1	N-MOS,DMG3420U, 20V/4A,Diodes Inc	SOT-23	1
32	U1	AL1697-40D,Diodes Dimmable IC	SOIC-7	1
<b>Total</b>				<b>36</b>

**Electrical Performance**

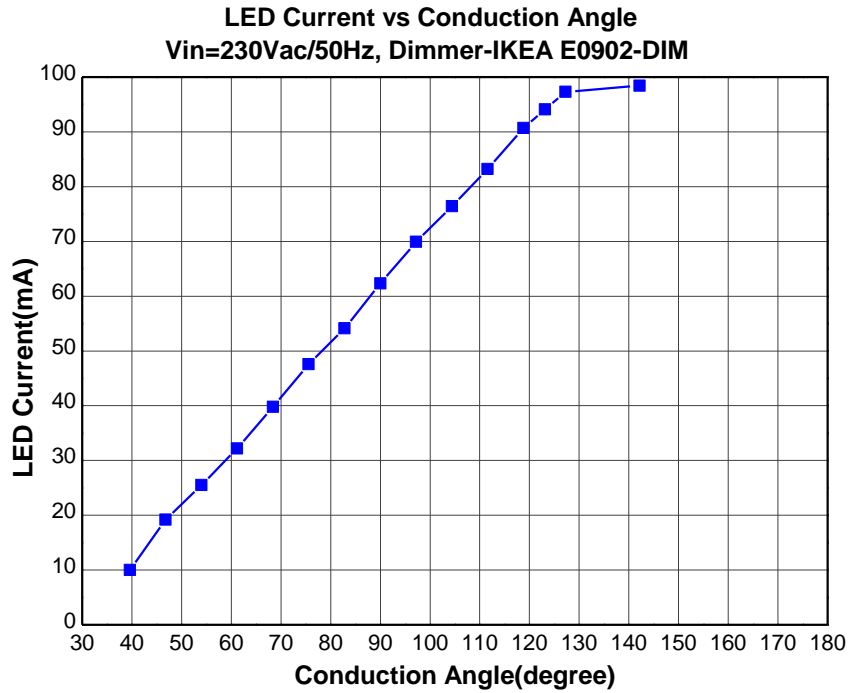


### Dimming Test

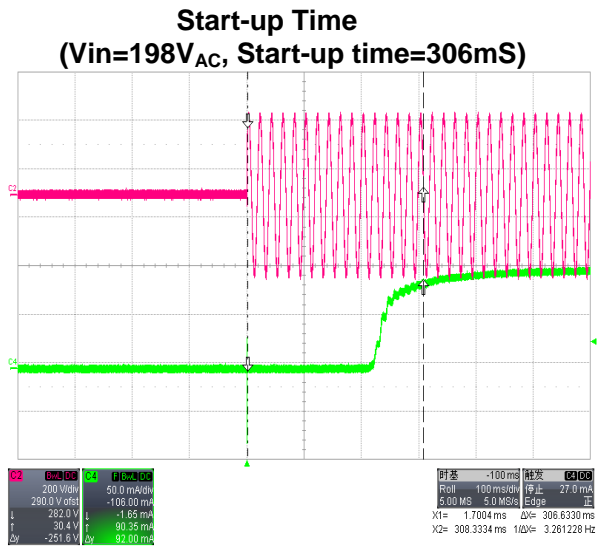
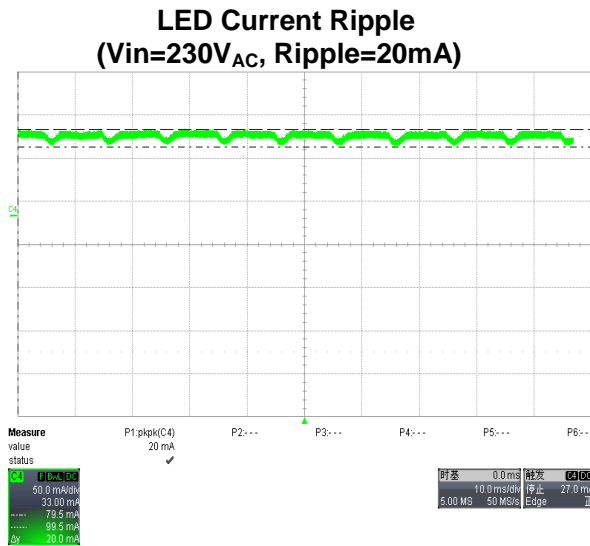
#### Dimmer compatibility and dimming range

Num	Dimmer Type	ILED(mA)		Dimming Percentage(%)		Flicker or not
		Min	Max	Min	Max	
1	Gira 030700 T 20-525W	21.62	100.37	20.99	97.45	No
2	Busch Jaeger 6519U T 40-550W	18.73	100.44	18.18	97.51	No
3	Busch Jaeger 6517 U-101 L, 60-400W	3.73	101.65	3.621	98.69	No
4	PEHA D 80 433 V L 60-300W	3.14	101.46	3.049	98.5	No
5	Berker 281902 L 20-315W	0.00	100.27	0	97.35	No
6	Gira 030000 I01 L60-400W	0.00	100.39	0	97.47	No
7	Merten 5771-99 T 20-315W	32.61	101.60	31.66	98.64	No
8	PEHA 433HAB T 20-315W	24.34	100.81	23.63	97.87	No
9	ABB STD 50-3 L 60-500W	20.22	100.75	19.63	97.82	No
10	Berker 2874 T 20-250W	23.35	100.42	22.67	97.5	No
11	Busch Jaeger 6513U-102 T 40-420W	31.08	100.31	30.17	97.39	No
12	Busch Jaeger 6523U-LED L 2-100W	5.42	100.48	5.262	97.55	No
13	Berker 2875 L 60-600W	31.38	101.94	30.47	98.97	No
14	Legrand 775903 T 420W	25.42	100.01	24.68	97.1	No
15	Merten 5771-99 T 20-315W	14.12	100.78	13.71	97.84	No
16	Siamens 5TCB 284 T 20-525W	32.41	101.22	31.47	98.27	No
17	Gira 117600 U 50-420W	4.67	100.86	4.534	97.92	No
18	Busch-Jae 2247U L 500W	22.90	100.72	22.23	97.79	No
19	KOPP/Sicherung 8033 L 40-400W	24.70	100.46	23.98	97.53	No
20	He T46 T 20-315W	16.78	101.65	16.29	98.69	No
21	Berker 2861 10 U50-420W	30.61	100.41	29.72	97.49	No
22	Busch-Jaeger 2250U L 60-600W	11.59	101.47	11.25	98.51	No
23	Jung 254 UDIE1 U50-420W	12.08	100.58	11.73	97.65	No
24	Jung 1254 UDE U50-420W	39.95	101.21	38.79	98.26	No
25	Gira 030200/I01 L60-600W	5.36	100.97	5.204	98.03	No
26	Everflourish EFM700DC T 25-150W	27.92	100.74	27.11	97.81	No
27	IKEA E0902-DIM L25-150W	31.52	101.15	30.6	98.2	No
28	Busch-Jaeger 2200 L60-400W	3.9	101.06	3.786	98.12	No
29	ELSO ATD315 T40-315W	8.73	100.01	8.476	97.1	No
30	CLIPSAL 32E450LM L 20-450W	25.08	100.07	24.35	97.16	No

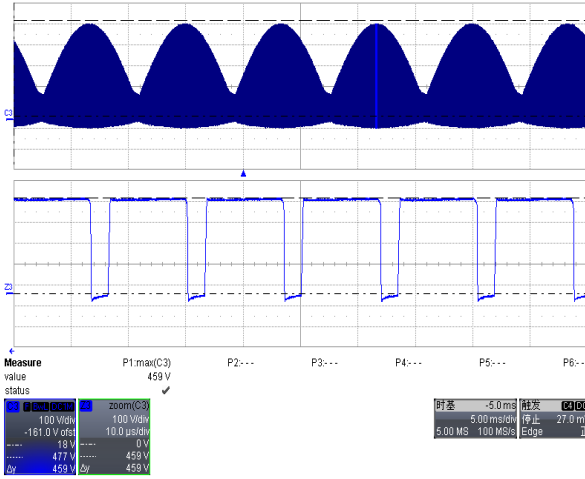
**Dimming Curve**



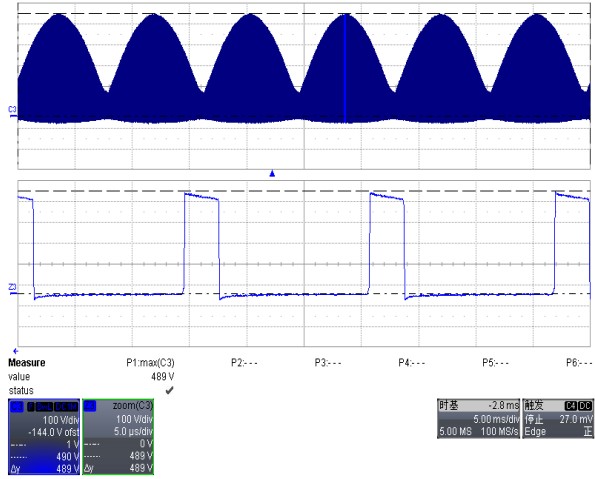
**Functional Waveform**



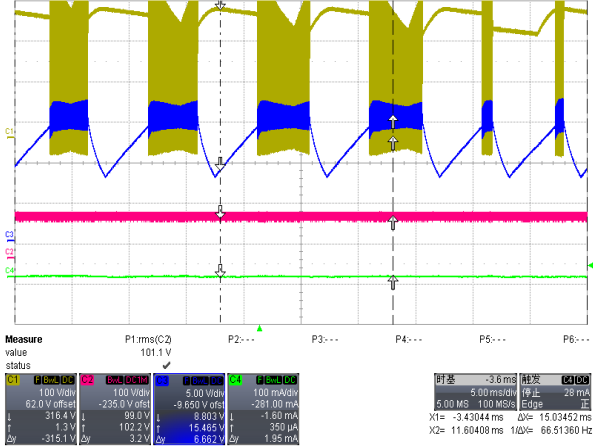
**IC V<sub>DRAIN</sub> Waveform**  
(Vin=264V<sub>AC</sub>, V<sub>DRAIN\_MAX</sub>=459V)



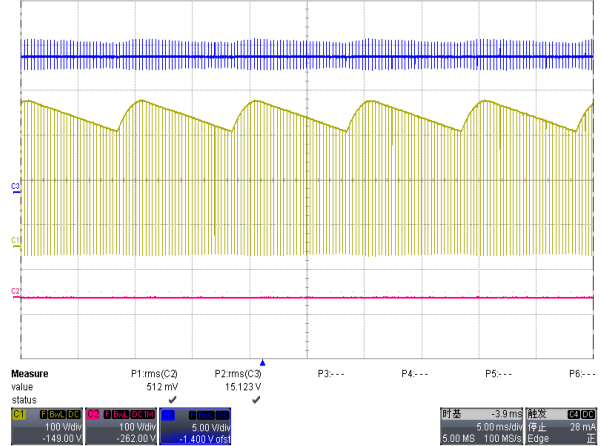
**Output Diode V<sub>R</sub> Waveform**  
(Vin=264V<sub>AC</sub>, V<sub>R\_MAX</sub>=489V)



**LED Open Protection**  
(Vin=230V<sub>AC</sub>, Y-V<sub>DRAIN</sub>, R-V<sub>out</sub>, B-V<sub>CC</sub>, G-I<sub>LED</sub>)

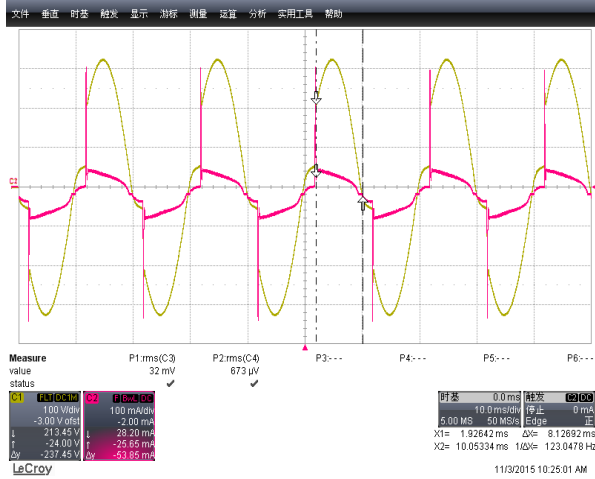


**LED Short Protection**  
(Vin=230V<sub>AC</sub>, Y-V<sub>DRAIN</sub>, R-V<sub>out</sub>, B-V<sub>CC</sub>)

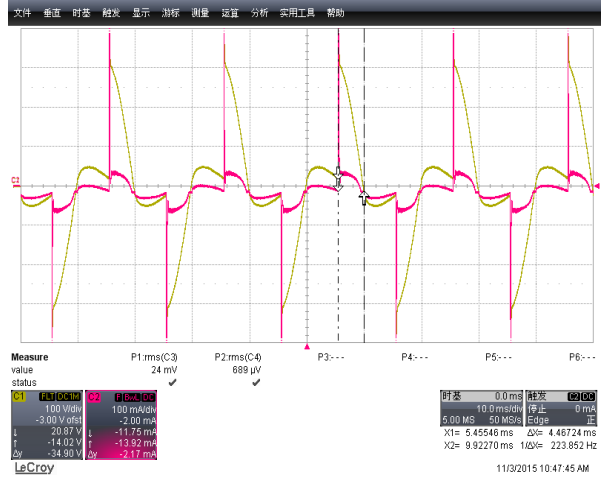




**Input AC Current vs Dimmer Phase**  
( $V_{in}=230V_{AC}/50Hz$ , Conduction Angle 146deg)



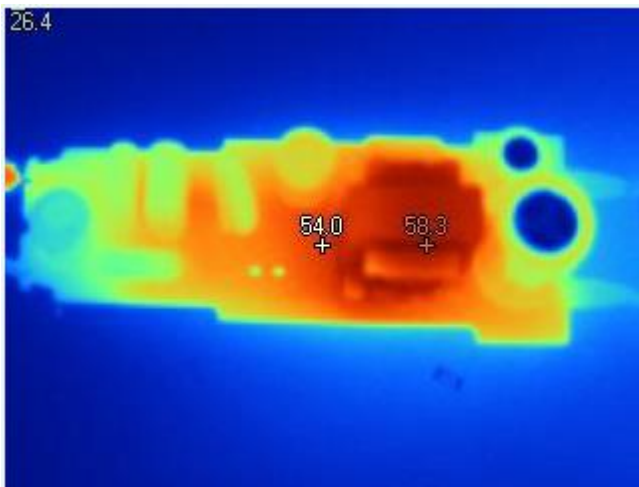
**Input AC Current vs Dimmer Phase**  
( $V_{in}=230V_{AC}/50Hz$ , Conduction Angle 80deg)



**Thermal Test**

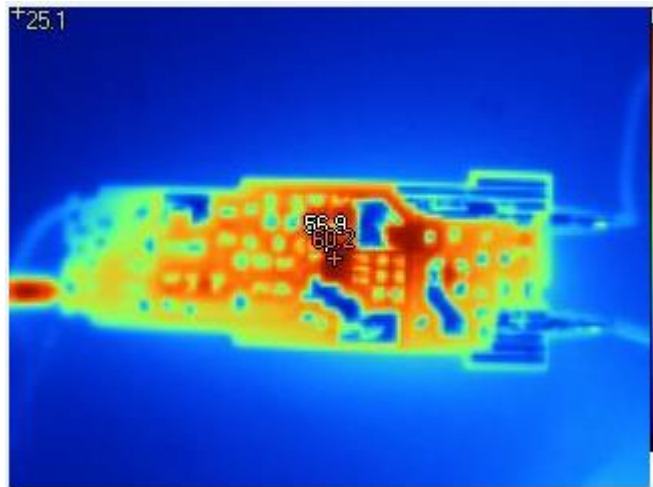
**Top**

$V_{in}=230V_{AC}/50Hz$ , Burn-in time=30min



**Bottom**

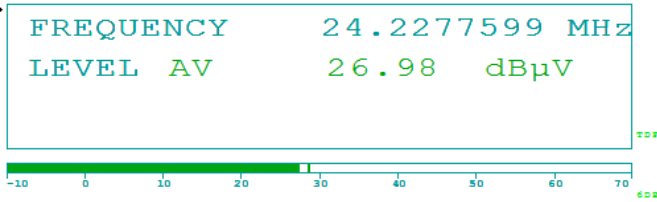
$V_{in}=230V_{AC}/50Hz$ , Burn-in time=30min



### EMI Conduction Test

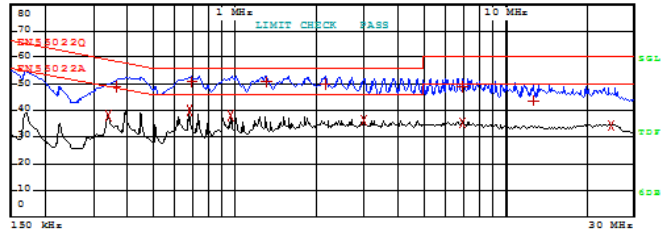
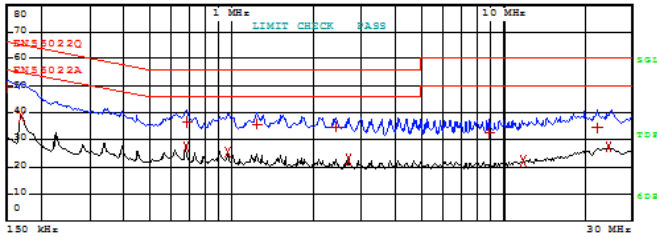
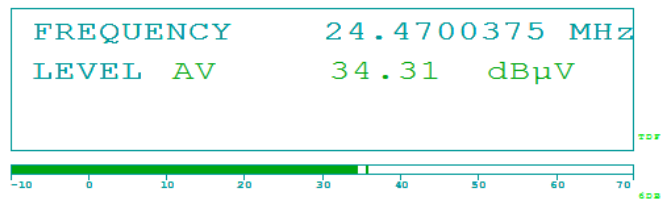
Line Terminal

Vin=230V<sub>AC</sub>/50Hz, Margin>16dB



Neutral Terminal

Vin=230V<sub>AC</sub>/50Hz, Margin>5dB



EDIT PEAK LIST (Final Measurement Results)			
TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
Trace1:	EN55022Q		
Trace2:	EN55022A		
Trace3:	---		
1 Quasi Peak	150 kHz	49.36	-16.63
2 Average	169.02375452 kHz	38.79	-16.21
2 Average	673.936068749 kHz	27.26	-18.73
1 Quasi Peak	680.675429436 kHz	36.58	-19.42
2 Average	954.699692378 kHz	25.49	-20.50
1 Quasi Peak	1.23658090545 MHz	35.90	-20.09
1 Quasi Peak	2.40884377744 MHz	34.90	-21.09
2 Average	2.68713603405 MHz	22.54	-23.45
1 Quasi Peak	8.86858861671 MHz	32.55	-27.44
2 Average	11.8351658887 MHz	22.31	-27.68
1 Quasi Peak	22.1524057738 MHz	34.18	-25.81
2 Average	24.2277599493 MHz	27.14	-22.85

EDIT PEAK LIST (Final Measurement Results)			
TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
Trace1:	EN55022Q		
Trace2:	EN55022A		
Trace3:	---		
2 Average	939.190678959 kHz	38.26	-10.95
1 Quasi Peak	960.037740611 kHz	49.00	-9.71
2 Average	673.936068749 kHz	39.85	-6.14
1 Quasi Peak	687.48218373 kHz	50.65	-5.34
2 Average	954.699692378 kHz	38.34	-7.65
1 Quasi Peak	1.29965885429 MHz	50.63	-5.36
1 Quasi Peak	2.1374603093 MHz	50.01	-5.98
2 Average	2.96826993929 MHz	36.19	-9.80
1 Quasi Peak	6.9154455372 MHz	49.03	-10.96
2 Average	6.9154455372 MHz	35.34	-14.65
1 Quasi Peak	12.5632670765 MHz	43.92	-16.07
2 Average	24.4700375488 MHz	34.41	-15.58

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