

General Description

This demonstration board utilizes the AL1696 Buck LED driver 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 >0.87
- High efficiency >85%
- THD<40%

Applications

- Retrofit Par, A lamps

Specifications

Parameter	Value
AC Input Voltage	108V-132V
Output Power	8.45W
LED Current	130mA
LED Voltage	65V
Power Factor	>0.87
Efficiency	85%
XYZ Dimension	38x29x15mm
ROHS Compliance	Yes

Evaluation Board



Figure 1: Top View



Figure 2: Bottom View

Connection Instructions:

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

Board Layouts

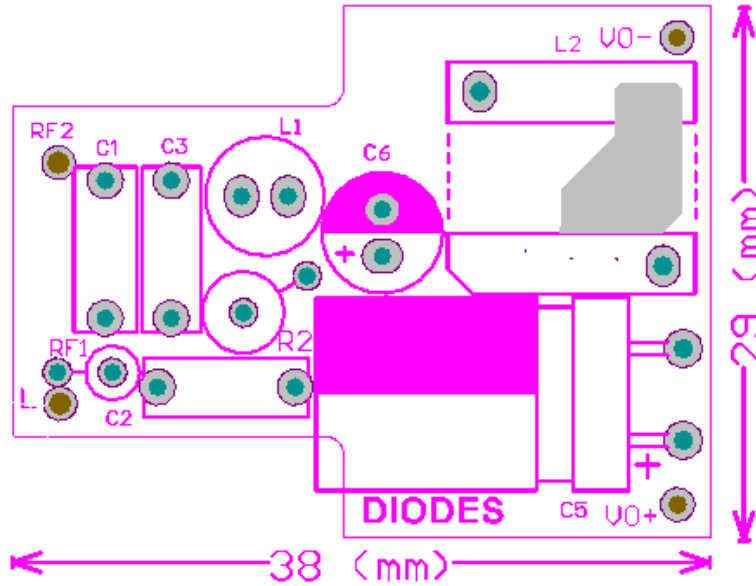


Figure 3: PCB Layout Top View

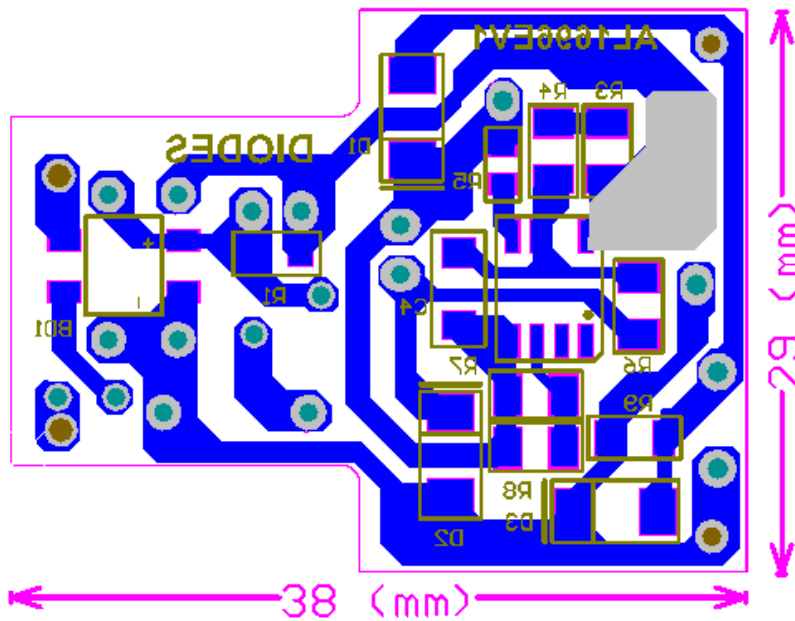


Figure 4: PCB Layout Bottom View

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 AL1696 is a non-isolated design. All terminals carry high voltage during operation!

Schematic

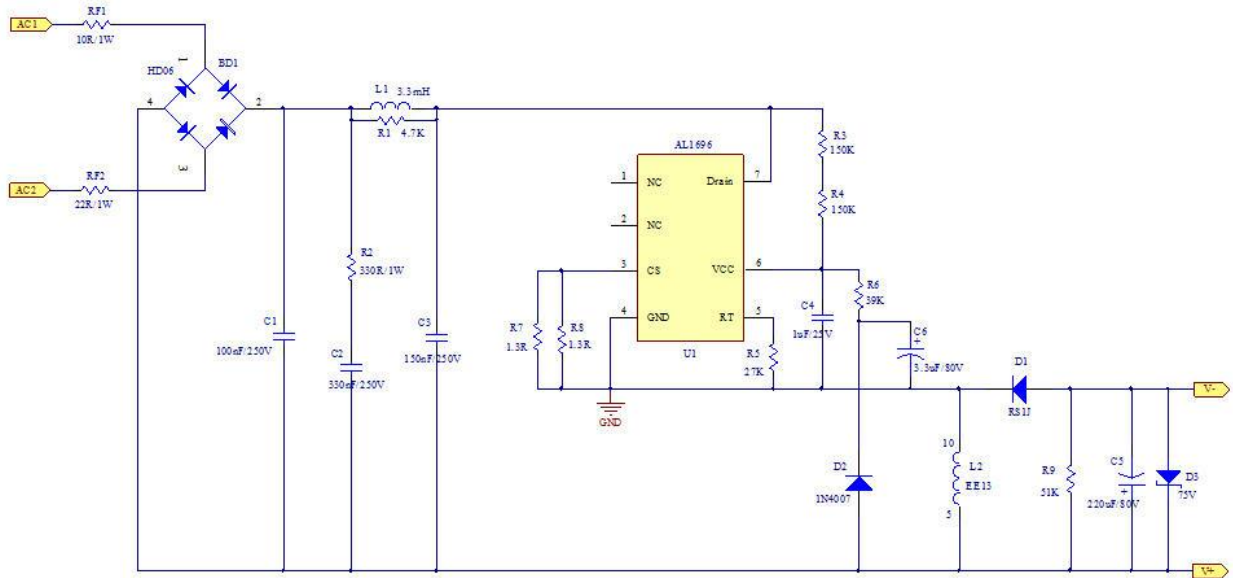
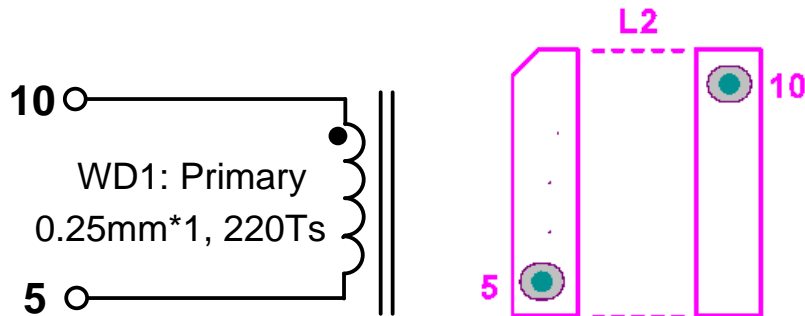


Figure 5: Schematic Circuit

Transformer Design

Bobbin and Core

EE13 Vertical 5+5 pin



Transformer Parameters

- Primary Inductance (Pin 10-Pin5, all other windings open): $L_p=1.45\text{mH}$, $\pm 5\%$ @10kHz
- Primary Winding Turns (Pin 10-Pin 5): $N_p=220\text{Ts}$

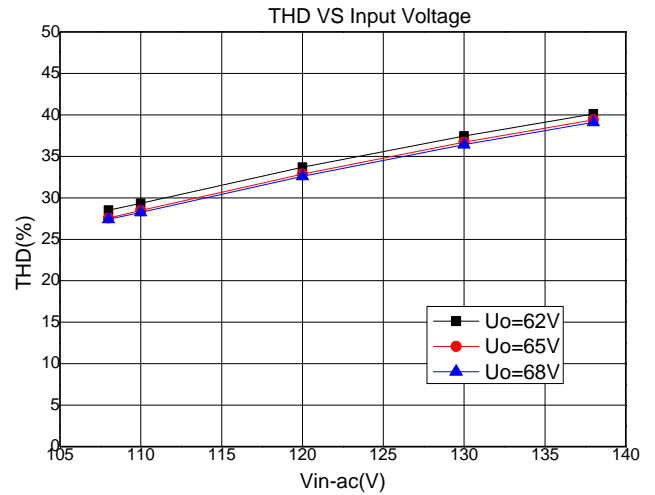
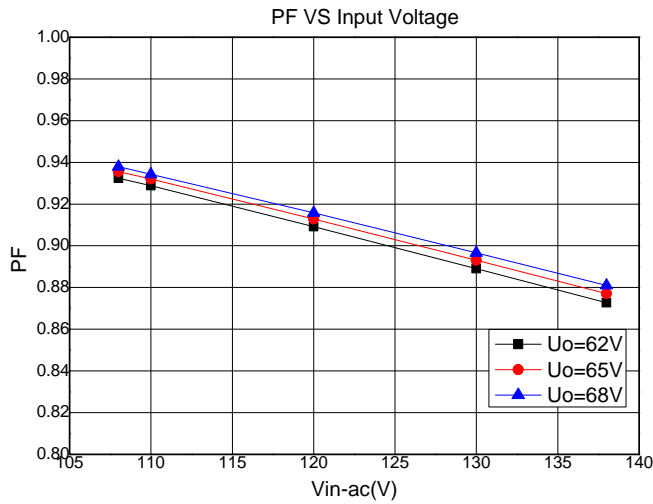
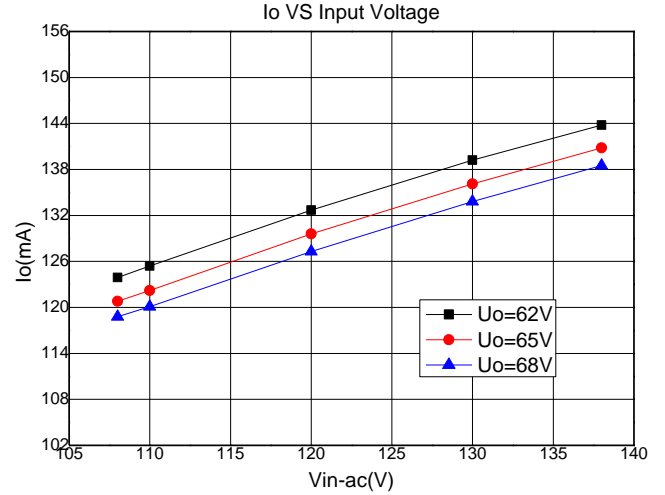
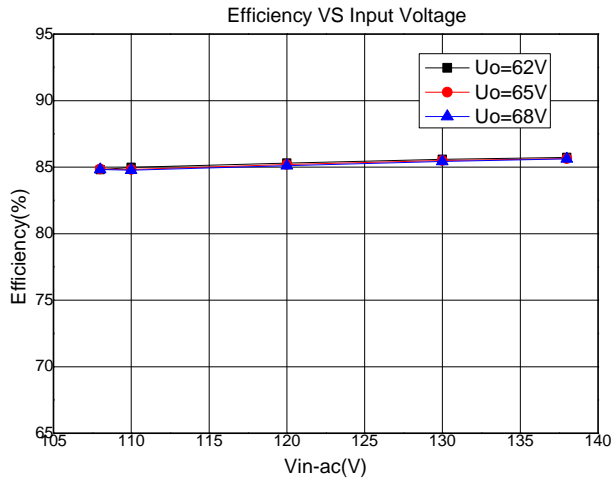
Transformer Winding Construction Diagram

Item	Winding name	Description
1	WD1-Primary Winding	Start at Pin10, Wind 220 turns of $\Phi 0.25\text{mm}$ wire and finish on Pin5.
2	Insulation	3 Layers of insulation tape

Bill of Material

No.	Item	Description	Package	QTY
1	C1	100nF/250V, CL21, Pitch=7.5mm	DIP	1
2	C2	330nF/250V, CL21, Pitch=7.5mm	DIP	1
3	C3	150nF/250V, CL21, Pitch=7.5mm	DIP	1
4	C4	Ceramic Cap, 1uF/25V	0805	1
5	C5	E-Cap, 105°C, 220uF/80V, 10*20mm	DIP	1
6	C6	E-Cap, 105°C, 3.3uF/80V, 5*11mm	DIP	1
7	BD1	Rectifier Bridge, HD06, 0.8A/1000V	SOPA-4	1
8	D1	Fast Recovery Diode, US1J, 1A/600V	SMA	1
9	D2	1N4007, 1A/1000V, Diodes Inc	SOD-123	1
10	D3	75V Zener Diode, 1W Diodes Inc	SOD-80	1
11	RF1	Resistor, 10R, 5%, 1W	DIP	1
12	RF2	Resistor, 22R, 5%, 1W	DIP	1
13	R1	Resistor, 4.7K, 5%, 1/8W	0805	1
14	R2	Power Resistor, 330R, 5%, 1W	DIP	1
15	R3, R4	Resistor, 150K, 5%, 1/4W	1206	2
16	R5	Resistor, 27K, 5%, 1/8W	0805	1
17	R6	Resistor, 39K, 5%, 1/4W	1206	1
18	R7	Resistor, 1.3R, 1%, 1/4W	1206	1
19	R8	Resistor, 1.3R, 1%, 1/4W	1206	1
20	R9	Resistor, 51K, 5%, 1/4W	1206	1
21	L1	Inductor 3.3mH, 6*8mm	DIP	1
22	L2	EE13, Vertical, 5+5 pin, Single Winding, 1.45mH	DIP	1
23	U1	AL1696-20B Diodes Dimmable IC	SOIC-7	1
24	PCB	FR4 Single layer, 38*29mm		
25	Input Wire	L, N white color, 4cm length, 5mm to be stripped		
26	Output Wire	LED+: red color, LED-: black color, 4cm length, 5mm to be stripped		
Total BOM				24

Functional Performance



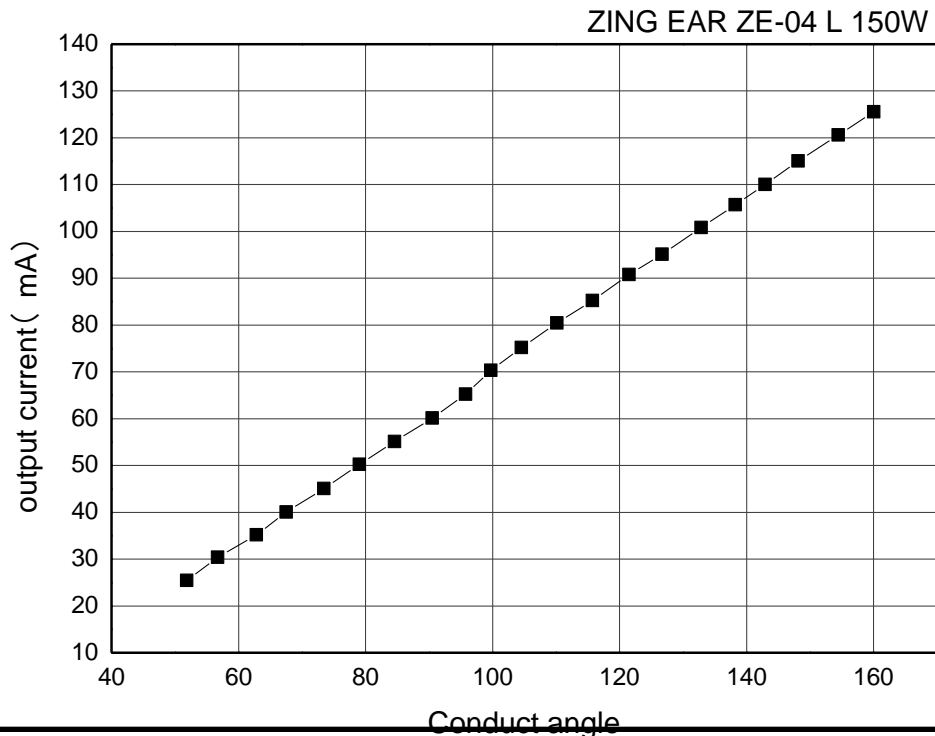
Dimming Test

Dimmer compatibility and dimming range

BoxType	Dimmer Type	Io(mA)		Dimming percentage (%)		Flicker or not?
		min	max	min	max	
Box3	Cooper 9538 L 600W	0.00	118.91	0.00	91.47	N
	Cooper 9539 L 600W	7.23	91.67	5.56	70.52	N
	Cooper 5106P L 600W	0.00	105.79	0.00	81.37	N
	Cooper 51061P L 600W	0.00	116.88	0.00	89.91	N
	Cooper TAL06P L 600W	10.93	112.38	8.40	86.45	N
	Cooper DCL03P L 600W	9.02	112.13	6.94	86.25	N
	Lutron TT-300P L 300W	0.00	104.21	0.00	80.16	N
	Lutron TBL03 L 300W	0.00	110.00	0.00	84.62	N
	ZING EAR ZE-04 L 150W	0.00	114.40	0.00	88.00	N
	Westek 4010 L 300W	0.00	109.54	0.00	84.26	N
Box4	Levlton 6681 L 600 W	0	118.91	0	91.47	N
	Levlton 6602 L 600 W	7.23	91.67	5.56	70.52	N
	Levlton 6631 L 600 W	0	105.79	0	81.37	N
	Levlton 6633-P L 600 W	0	116.88	0	89.91	N
	Levlton 6615-P T 300 W	10.93	112.38	8.4	86.45	N
	Levlton IPE04 T 400 W	9.02	112.13	6.94	86.25	N
	Levlton VPE04 T 400 W	0	104.21	0	80.16	N
	Levlton IPE06 T 600 W	0	110	0	84.62	N
	Levlton TD06-1 Digital 600 W	0	114.4	0	88	N
	Levlton 6681 L 600 W	0	118.91	0	91.47	N

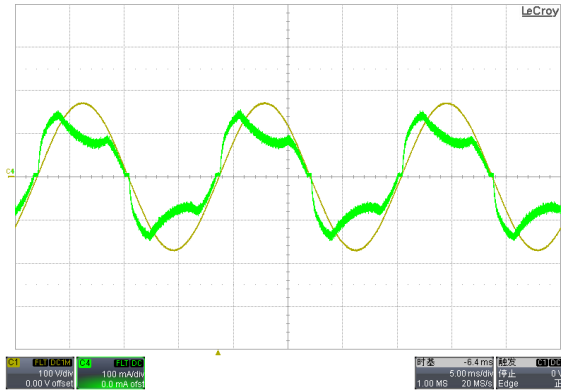
Box5	Lutron DV-10P L 1000W	5.81	117.49	4.47	90.38	N
	Lutron DVLV-10P L 100	2.71	110.81	2.08	85.24	N
	Lutron DV-603P L 600W	0	112.08	0	86.22	N
	Lutron DVCV-153P L 150W	0	108.34	0	83.34	N
	Lutron N-600L 600W	1.79	121.91	1.38	93.78	N
	Lutron NT-600L 600W	4.51	121.84	3.47	93.72	N
	Lutron VT-600 Digital 600W	0	109.24	0	84.03	N
	Lutron CT-603PG L 600W	0	91.41	0	70.32	N
	Lutron CTCL-153P L 150W	0	109.01	0	83.85	N
	Lutron CT-603PG L 600W	0	91.41	0	70.32	N

Dimming Cure

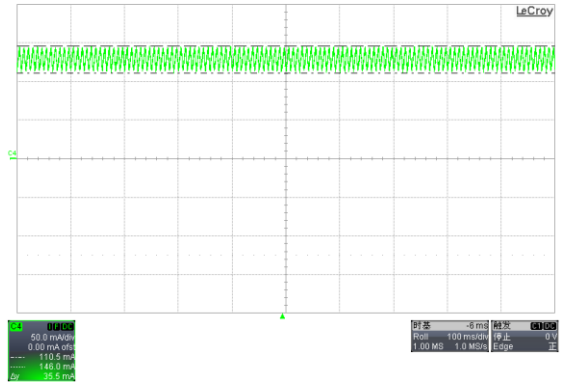


Functional Waveform

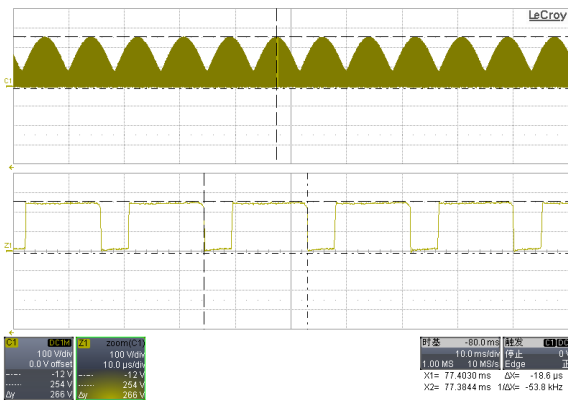
Input Voltage & Input Current
($V_{in}=120V/60Hz$)



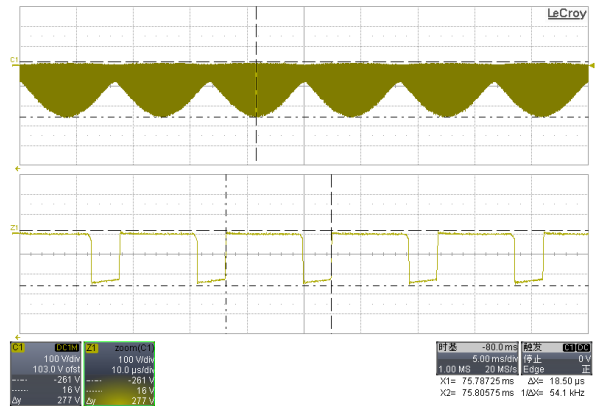
LED Current Ripple
($V_{in}=120VAC/60Hz$ Ripple=35.5mA)



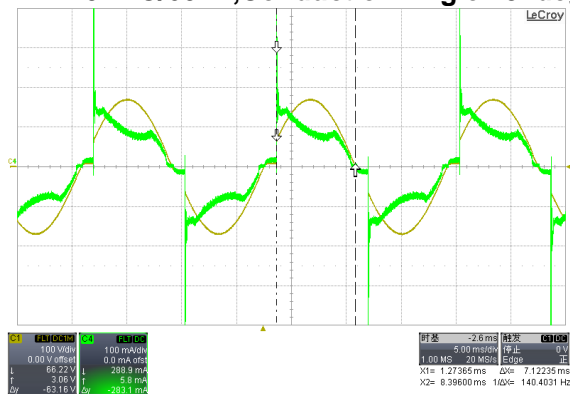
IC VDRAIN Waveform
($V_{in}=132VAC/60Hz$, $V_{DRAIN}=266V$)



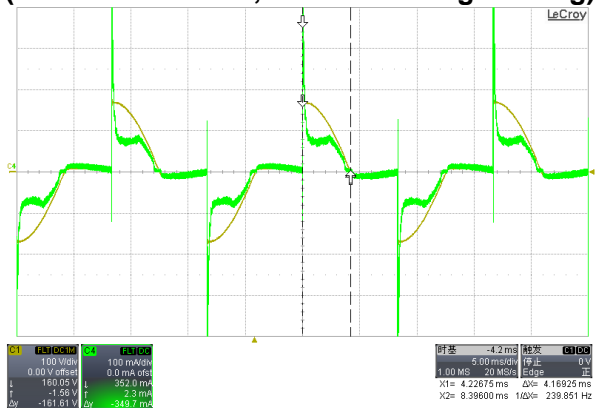
Output Diode VR Waveform
($V_{in}=132VAC/60Hz$, $V_R=277V$)



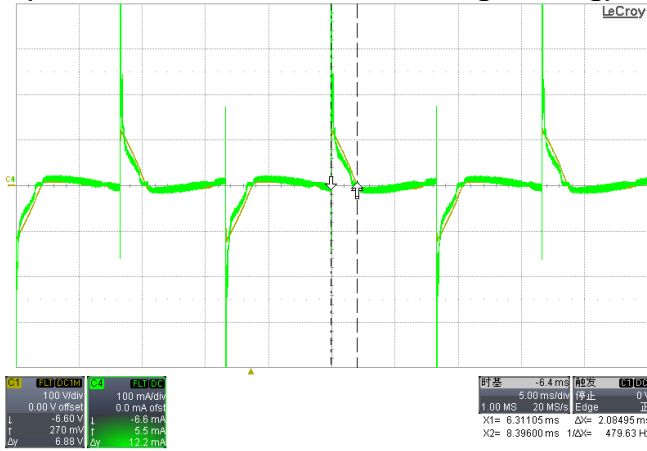
Input AC Current vs Dimmer Phase
($V_{in}=120VAC/60Hz$, Conduction Angle 154deg)



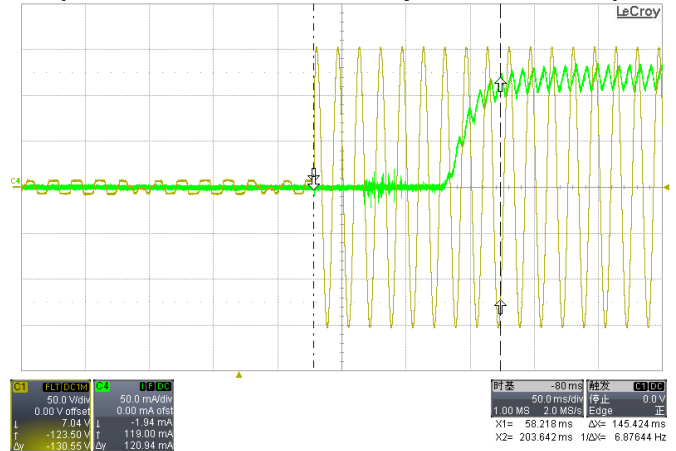
put AC Current vs Dimmer Phase
($V_{in}=120VAC/60Hz$, Conduction angle 90deg)



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

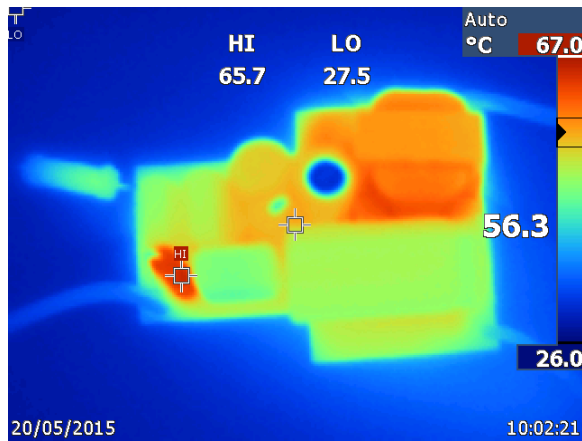


Start-up time
(Vin=108VAC/60Hz, Start-up time=145.4ms)

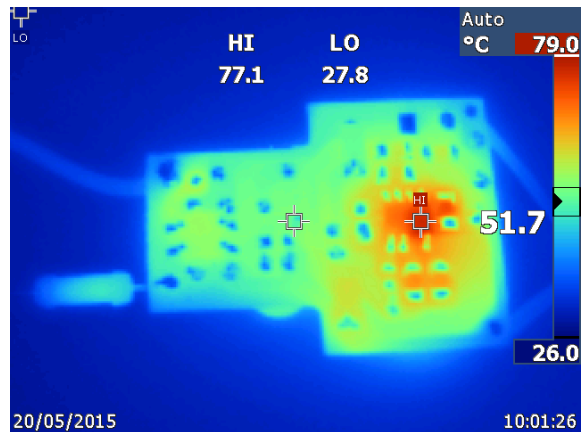


Thermal Test

Top
(Vin=120VAC, Burn-in time=30min)

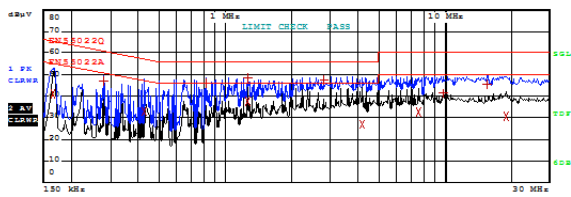
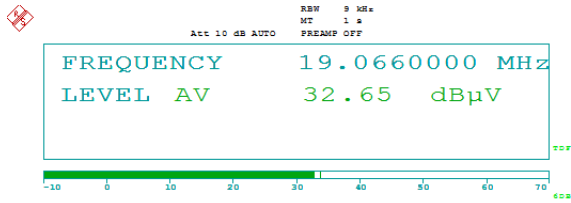


Bottom
(Vin=120VAC, Burn-in time=30min)



EMI Conduction Test

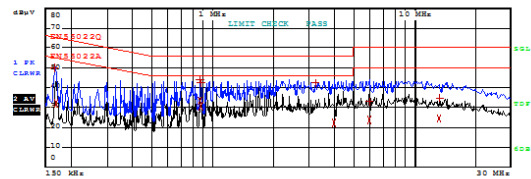
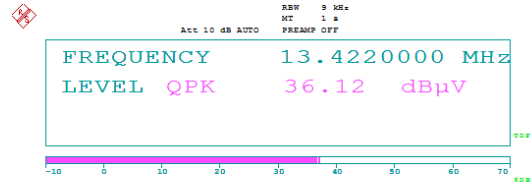
Line Terminal
(Vin=120VAC, Margin>6dB)



Date: 20.MAY.2015 09:27:00

EDIT PEAK LIST (Final Measurement Results)				
TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB	
Trace1:	ENS50220			
Trace2:	ENS5022A			
Trace3:	---			
2 Average	166 kHz	41.02	-14.13	
1 Quasi Peak	276 kHz	47.14	-13.73	
2 Average	426 kHz	32.90	-14.42	
1 Quasi Peak	818 kHz	45.90	-10.10	
1 Quasi Peak	1.266 MHz	48.22	-7.77	
2 Average	1.266 MHz	37.68	-8.31	
1 Quasi Peak	2.81 MHz	47.37	-8.62	
2 Average	4.202 MHz	27.07	-18.92	
2 Average	7.682 MHz	32.34	-17.65	
1 Quasi Peak	9.902 MHz	41.46	-18.53	
1 Quasi Peak	15.534 MHz	45.79	-14.20	
2 Average	19.066 MHz	30.73	-19.26	

Neutral Terminal
(Vin=120VAC, Margin>6dB)



Date: 20.MAY.2015 09:28:13

EDIT PEAK LIST (Final Measurement Results)				
TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB	
Trace1:	ENS50220			
Trace2:	ENS5022A			
Trace3:	---			
1 Quasi Peak	166 kHz	49.69	-15.46	
2 Average	170 kHz	31.96	-22.99	
1 Quasi Peak	874 kHz	44.00	-11.99	
2 Average	874 kHz	33.54	-12.45	
1 Quasi Peak	878 kHz	42.44	-13.55	
2 Average	878 kHz	30.68	-15.31	
1 Quasi Peak	3.23 MHz	42.54	-13.46	
2 Average	4.002 MHz	22.37	-23.62	
1 Quasi Peak	5.978 MHz	32.80	-27.19	
2 Average	5.978 MHz	23.64	-26.35	
2 Average	13.202 MHz	24.56	-25.43	
1 Quasi Peak	13.422 MHz	34.67	-25.33	

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