AL1698KEV1 User Guide

120VAC Dimmable LED Driver

General Description

This demonstration board utilizes the AL1698K 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 LED strings. 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. The layout 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 >0.9
- High efficiency >94%
- Single winding
- Low THD
- Good dimmer compatibility
- Low BOM cost

Applications

- Retrofit Bulb, Par Lamps

Specifications

Parameter	Value
AC Input Voltage	108~132V
Output Power	8.1W
LED Current	37mA
LED Voltage	220V
Power Factor	>0.9
Efficiency	94%
XYZ Dimension	57x 28 x 20mm
ROHS Compliance	Yes

Evaluation Board

Figure 1. Top View

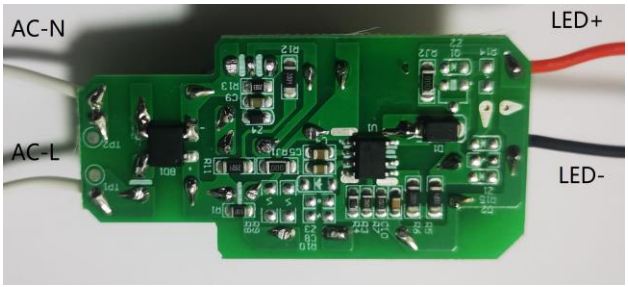


Figure 2. Bottom View

Connection Instructions:

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

Board Layouts

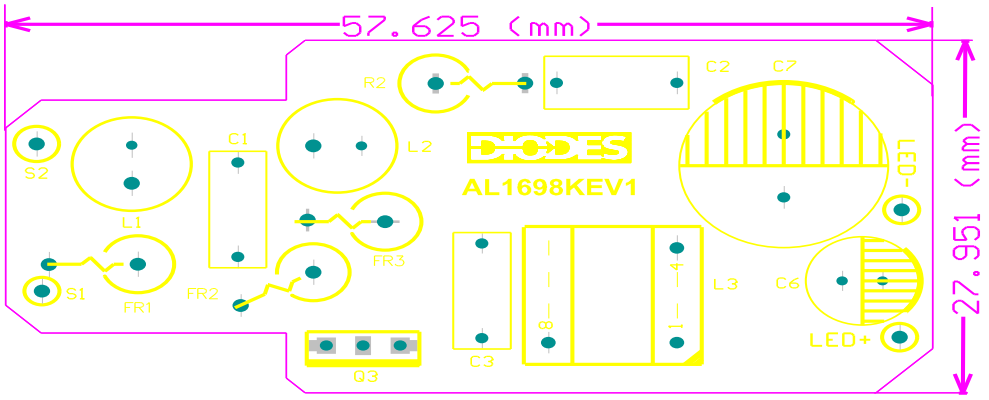


Figure 3. PCB Layout Top View

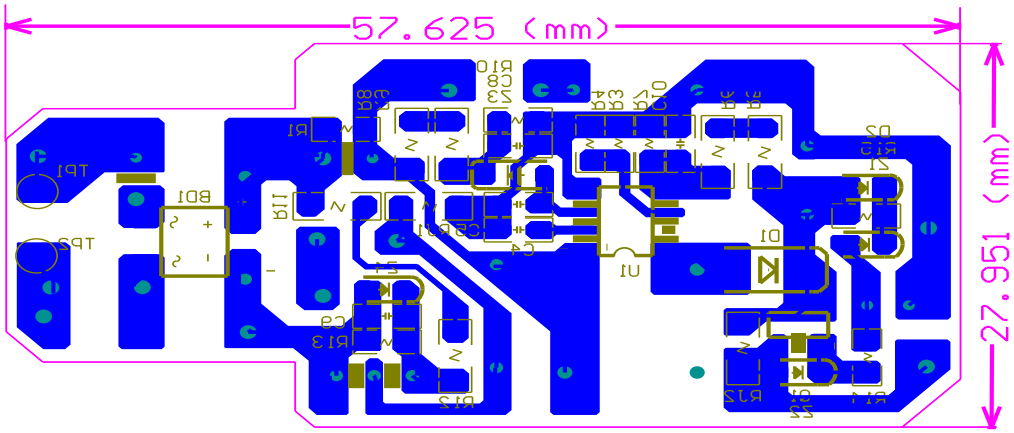


Figure 4. PCB Layout Bottom View

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 AL1698K is a non-isolated design. All terminals carry high voltage during operation!

Schematic

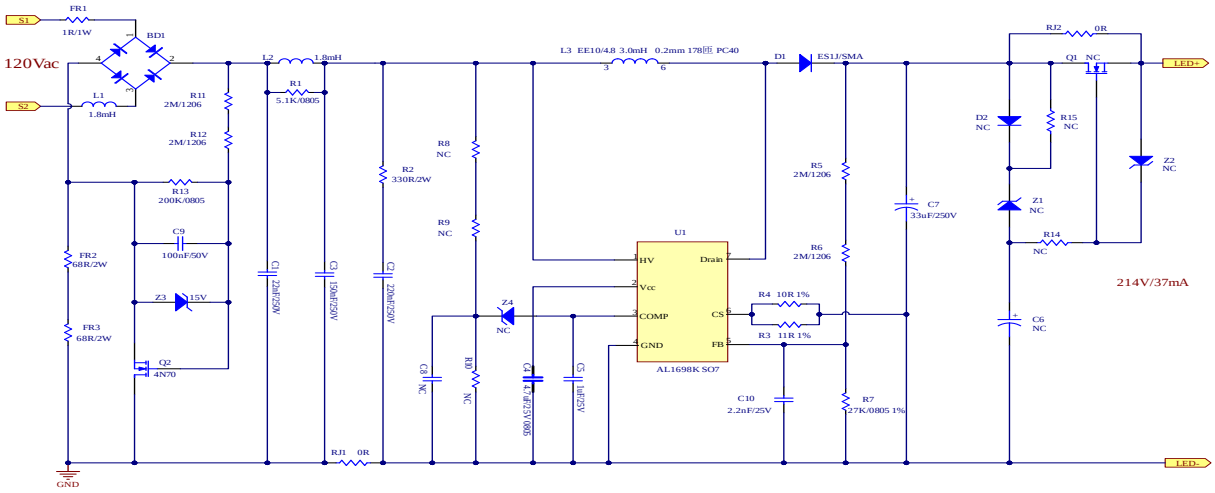


Figure 5. Schematic Circuit

Transformer Design

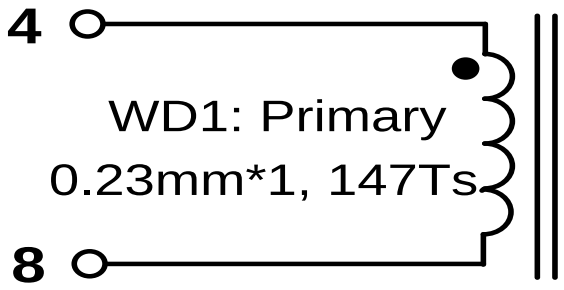
Bobbin and Core

EE10 Vertical 4+4 pin

Transformer Parameters

1. Primary Inductance (Pin8-Pin10, all other windings open)： Lp=3.0mH, ±5%@1kHz
2. Primary Winding Turns (Pin4-Pin8): NP=147Ts
3. Varnish the complete assembly

Transformer Winding Construction Diagram

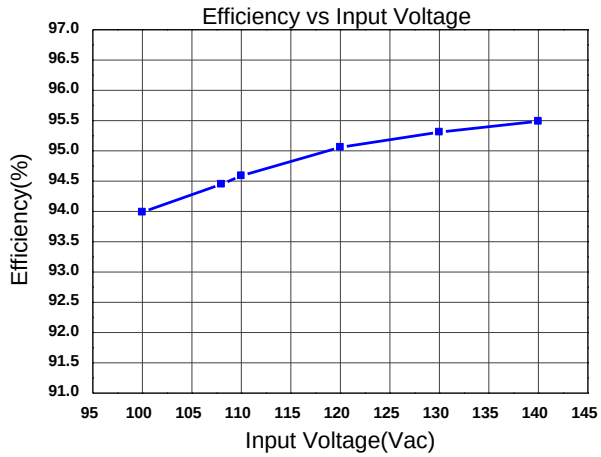


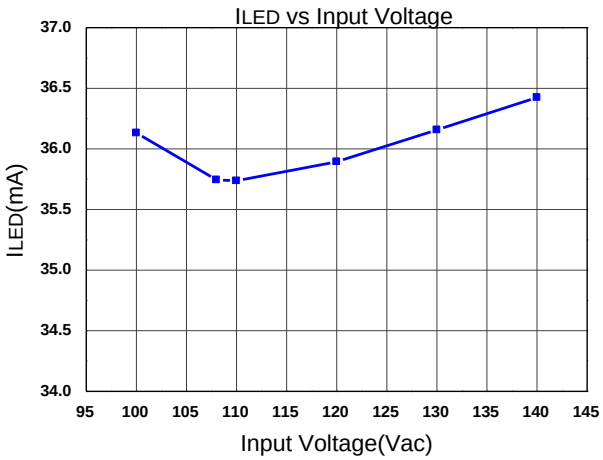
Item	Winding name	Description
1	WD1-Primary Winding	Start at Pin 4, Wind 147 turns of Φ0.23mm wire and finish on Pin 8
2	Insulation	2 Layers of insulation tape

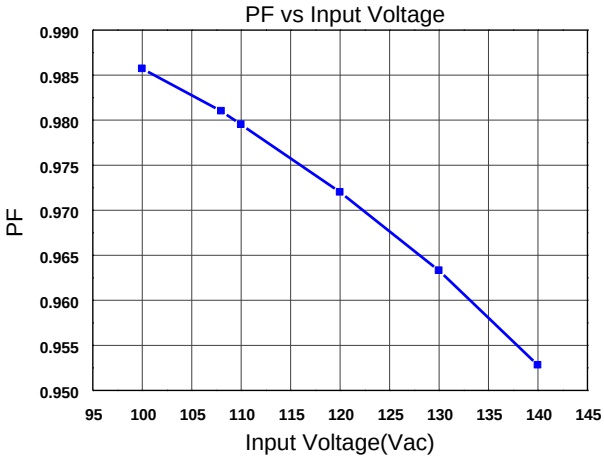
Bill of Material

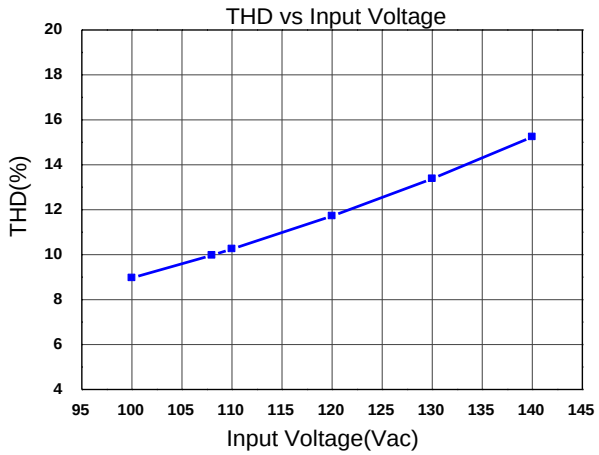
#	Item	Description	Package	Quantity
1	C1	22nF/250V, CL21, Pitch=7.5mm	DIP	1
2	C2	220nF/250V, CL21, Pitch=7.5mm	DIP	1
3	C3	150nF/250V, CL21, Pitch=7.5mm	DIP	1
4	C4	Ceramic Cap,4.7μF/25V,X7R	0805	1
5	C5	Ceramic Cap,1.0μF/25V,X7R	0805	1
6	C6	NC	DIP	0
7	C7	E-Cap,130°C,33μF/250V,12.5*16mm	DIP	1
8	C8	NC	805	0
9	C9	Ceramic Cap,100nF/25V,X7R	0805	1
10	C10	Ceramic Cap,2.2nF/25V,X7R	805	1
11	BD1	Rectifier Bridge,HDS10M,1A/1KV, Diodes Incorporated (Diodes)	HDS	1
12	D1	Fast Recovery Diode,ES1J,1A/600V, Diodes	SMA	1
13	D2	NC	SOD-323	0
14	Z1	NC	SOD-323	0
15	Z2	NC	SOD-323	0
16	Z3	BZT52C15S,15V Zener, Diodes	SOD-323	1
17	FR1	Fuse Resistor,1R, 5%, 1W	DIP	1
18	FR2，FR3	Fuse Resistor,68R, 5%, 2W	DIP	2
16	R1	Resistor, 5.1K, 5%, 1/8W	0805	1
17	R2	SMD Resistor,330R, 5%, 2W	DIP	1
18	R3	SMD Resistor,10R, 1%, 1/8W	0805	1
19	R4	SMD Resistor,11R, 1%, 1/8W	0805	1
20	R5,R6,R11,R12	SMD Resistor,2M, 5%, 1/4W	1206	4
21	R7	SMD Resistor,27K, 5%, 1/8W	0805	1
22	R8,R9	NC	1206	0
23	R10	NC	0805	0
24	R13	SMD Resistor,200K, 5%, 1/8W	0805	1
24	R14,R15	NC	0805	0
25	RJ1,RJ2	SMD Resistor,0R, 5%, 1/4W	1206	2
26	L1,L2	1.8mH, 6*8mm,WURTH Elektronic	DIP	2
27	L3	EE10, Vertical, 4+4pin,Single Winding,3.0mH	DIP	1
28	Q2	CS4N60 4A/600V	TO-251	1
29	U1	AL1698K-20C, Diodes Dimmable IC	SOP-7	1

Electrical Performance







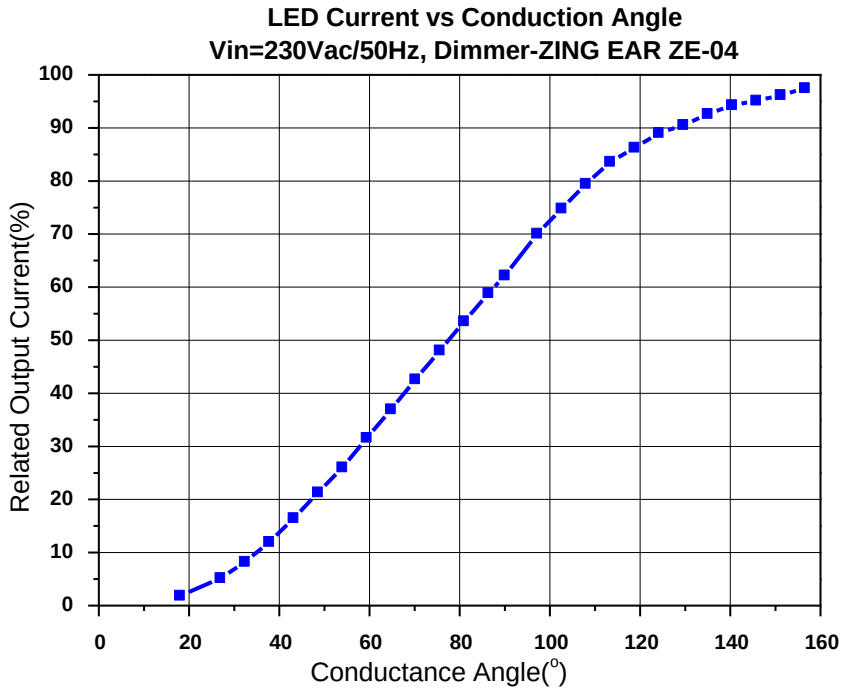


Dimming Test

Dimmer compatibility and dimming range

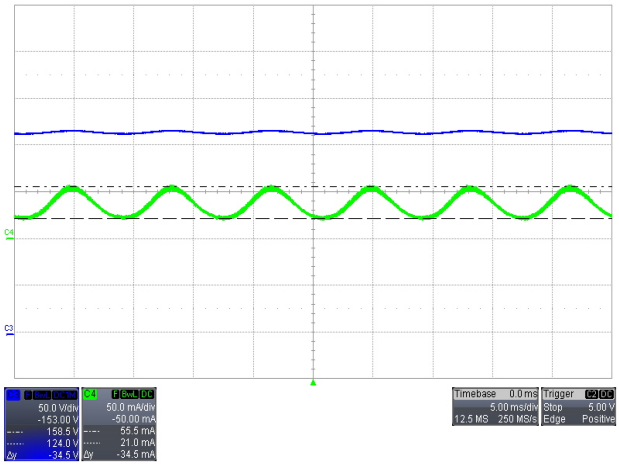
Num	Dimmer Type	ILED(mA)		Dimming Percentage(%)		Flicker or not
		Min	Max	Min	Max	
1	Lutron D600PH-WH	0.199	31.668	**0.556177**	**88.50755**	No
2	Lutron C-600	2.223	33.761	**6.212968**	**94.35718**	No
3	Lutron NLV-600	2.8886	33.855	**8.073225**	**94.6199**	No
4	Lutron NTELV-600	3.937	34.565	**11.00335**	**96.60425**	No
5	Lutron DVELV-300P	2.614	34.119	**7.305757**	**95.35774**	No
6	Lutron DV-600P	1.052	32.216	**2.94019**	**90.03913**	No
7	Lutron SELV-300P	2.584	34.846	**7.221912**	**97.3896**	No
8	Lutron MACL-153M	2.253	31.066	**6.296814**	**86.82504**	No
9	Lutron S600P-L-600W	0.318	32.392	**0.888765**	**90.53102**	No
10	Lutron LXLV-600PL	1.326	32.434	**3.705981**	**90.64841**	No
11	Lutron MAW-603	2.632	33.904	**7.356065**	**94.75685**	No
12	Lutron MIR-600	2.892	35.424	**8.082728**	**99.00503**	No
13	Lutron DV-603PG	0.781	32.093	**2.182784**	**89.69536**	No
14	Lutron NTLV-600	3.842	33.706	**10.73784**	**94.20347**	No
15	Lutron AY-600P	1.974	32.966	**5.517049**	**92.13527**	No
16	Lutron TGCL-153P	8.209	32.017	**22.94298**	**89.48295**	No
17	Lutron DVLV-603P	1.911	32.561	**5.340973**	**91.00335**	No
18	Lutron MAELV-600	4.217	34.584	**11.78591**	**96.65735**	No
19	Cooper SI06P	0.293	32.547	**0.818893**	**90.96423**	No
20	Cooper SI061	0.073	35.849	**0.204025**	**100.1928**	No
21	Cooper TAL06P	2.088	34.593	**5.835662**	**96.6825**	No
22	Cooper DLC03P	3.345	34.432	**9.348798**	**96.23253**	No
23	Lutron TT-300	0.152	32.591	**0.424818**	**91.0872**	No
24	Leviton TBL03	1.9836	34.278	**5.543879**	**95.80212**	No
25	ZING EAR ZE-04	0.275	35.157	**0.768586**	**98.2588**	No
26	Westek 4010	0.232	33.812	**0.648407**	**94.49972**	No

Dimming Curve

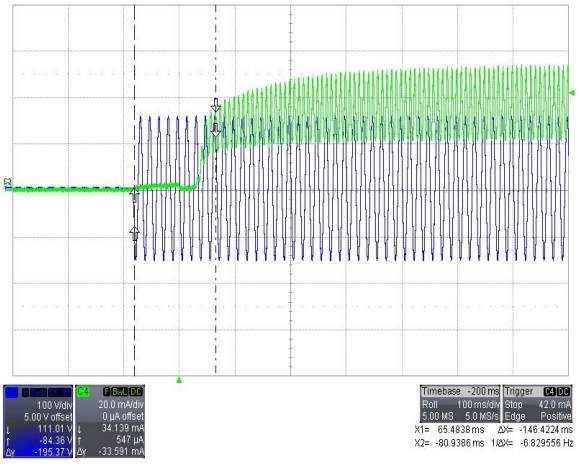


Functional Waveform

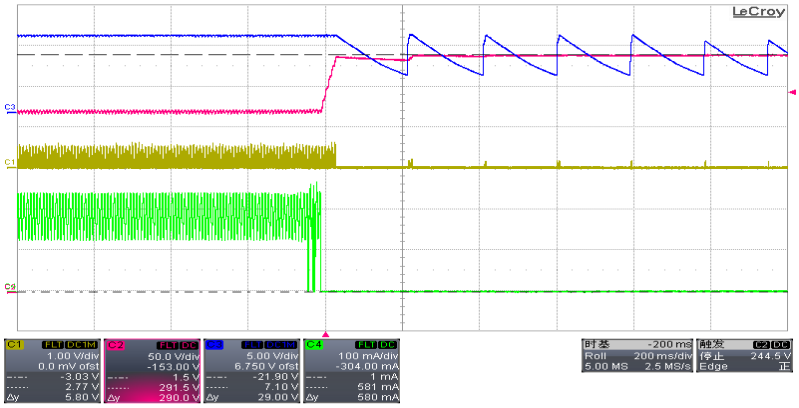
LED Current Ripple
(Vin=120VAC, Ripple=7.8mA, B-Vout, G-ILED)



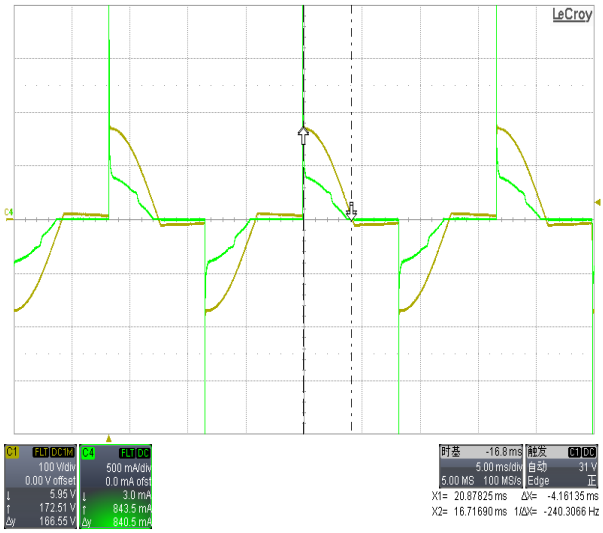
Start-up Time
(Vin=108VAC, Start-up time=146ms)



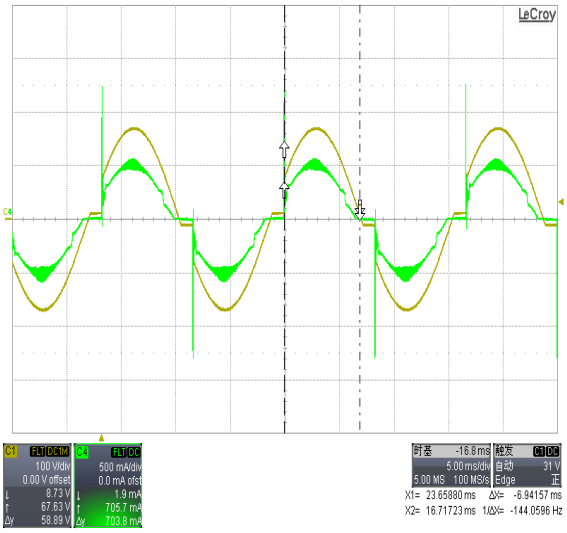
LED Open Protection
(Vin=230V$_{AC}$, Y-V$_{CS}$, R-Vout, B-Vcc,G-I$_{LED}$)



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



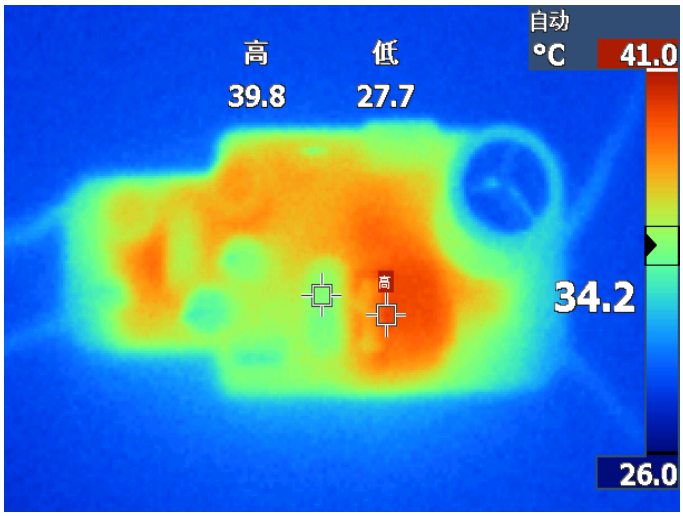
Input AC Current vs Dimmer Phase
(Vin=120V$_{AC}$/60Hz,Conduction Angle 90deg)



Thermal Test

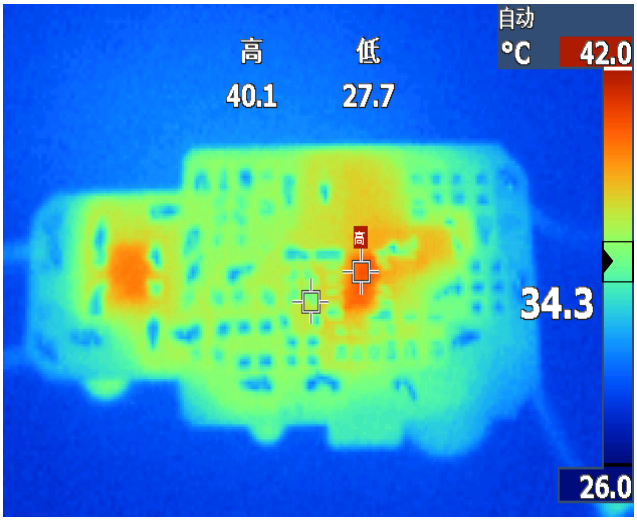
Top

Vin=230VAC/50Hz,Burn-in time=30min



Bottom

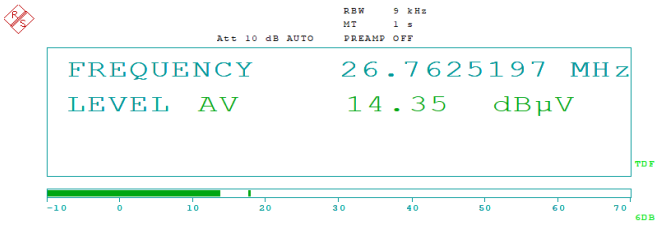
Vin=230VAC/50Hz,Burn-in time=30min

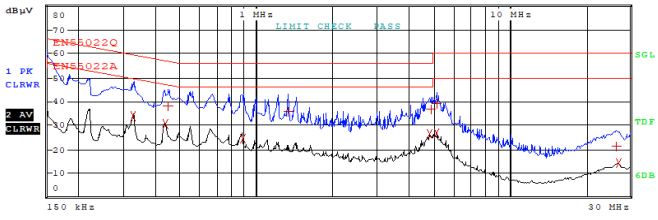


EMI Conduction Test

Line Terminal

Vin=230VAC/50Hz, Margin>9dB

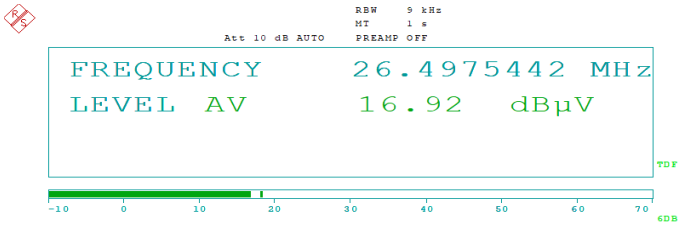


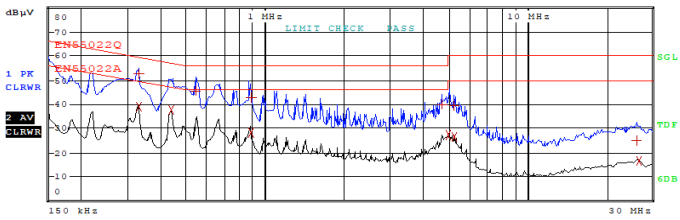


EDIT PEAK LIST (Final Measurement Results)				
Trace1:	EN55022Q			
Trace2:	EN55022A			
Trace3:	---			
	TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	150 kHz	56.50	-9.50
2	Average	325.955575511 kHz	34.11	-15.44
2	Average	439.3388689 kHz	30.65	-16.42
1	Quasi Peak	448.169580165 kHz	38.19	-18.71
2	Average	881.64914842 kHz	24.56	-21.43
1	Quasi Peak	1.32578199726 MHz	36.00	-19.99
2	Average	4.78552220172 MHz	26.47	-19.52
1	Quasi Peak	4.83337742374 MHz	36.56	-19.43
1	Quasi Peak	5.13072753076 MHz	38.83	-21.16
2	Average	5.13072753076 MHz	26.83	-23.16
1	Quasi Peak	26.2351923234 MHz	21.44	-38.55
2	Average	26.7625196891 MHz	14.30	-35.69

Neutral Terminal

Vin=230VAC/50Hz, Margin>6dB





EDIT PEAK LIST (Final Measurement Results)				
Trace1:	EN55022Q			
Trace2:	EN55022A			
Trace3:	---			
	TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	329.215131266 kHz	52.49	-6.97
2	Average	329.215131266 kHz	39.13	-10.33
2	Average	439.3388689 kHz	37.68	-9.39
1	Quasi Peak	541.437681113 kHz	45.62	-10.37
1	Quasi Peak	881.64914842 kHz	42.88	-13.11
2	Average	881.64914842 kHz	28.08	-17.91
1	Quasi Peak	4.6912285087 MHz	40.19	-15.80
2	Average	4.93052830996 MHz	27.25	-18.75
1	Quasi Peak	5.23385515413 MHz	39.58	-20.42
2	Average	5.23385515413 MHz	26.25	-23.74
1	Quasi Peak	25.975437944 MHz	25.12	-34.87
2	Average	26.4975442467 MHz	16.79	-33.20

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