

General Description

This demonstration board utilizes the AL1698K Boost LED driver-converter with a 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 >0.9
- High efficiency >93%
- 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	8.4W
LED Current	20mA
LED Voltage	420V
Power Factor	>0.9
Efficiency	94.4%
XYZ Dimension	57x 28 x 20mm
ROHS Compliance	Yes

Evaluation Board



Figure 1. Top View

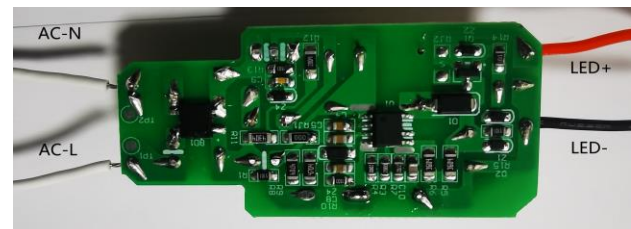


Figure 2. Bottom View

Connection Instructions:

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

Board Layouts

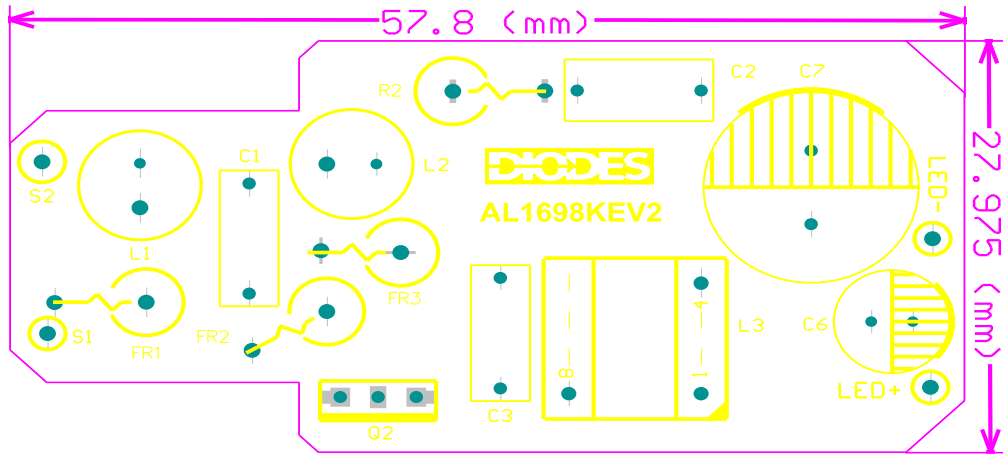


Figure 3. PCB Layout Top View

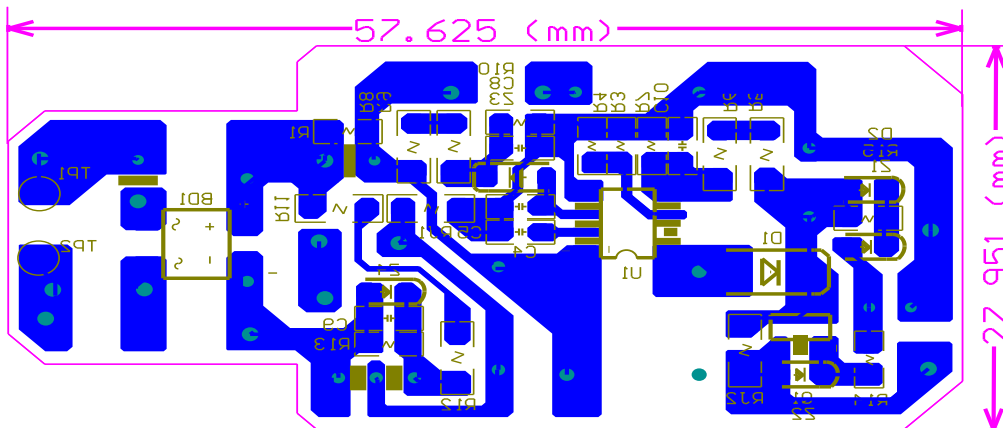


Figure 4. PCB Layout Bottom View

Quick Start Guide

1. Preset the isolated AC source to 230V_{AC}.
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

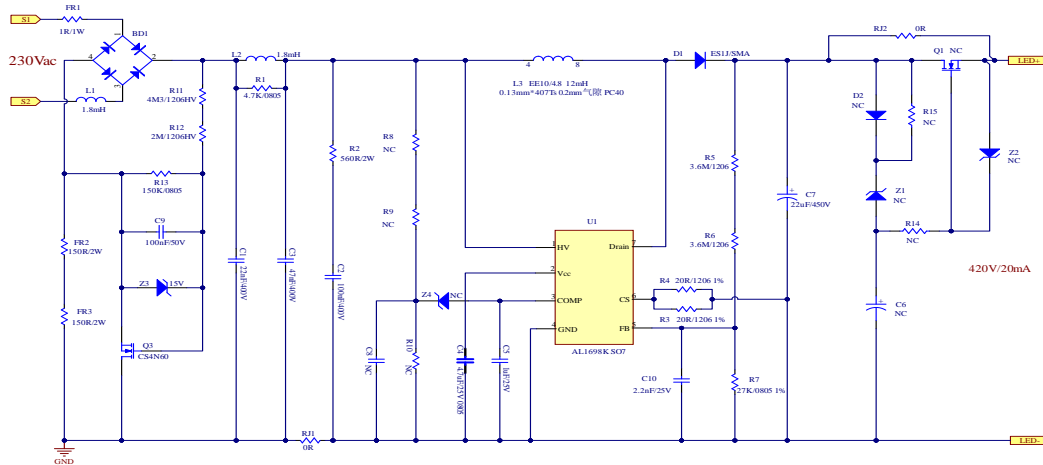


Figure 5. Schematic Circuit

Transformer Design

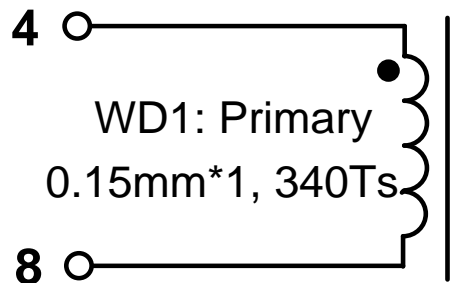
Bobbin and Core

EE10 Vertical 4+4 pin

Transformer Parameters

1. Primary Inductance (Pin4-Pin8, all other windings open): $L_p=12.0\text{mH}$, $\pm 5\% @ 1\text{kHz}$
2. Primary Winding Turns (Pin4-Pin8): $N_p=340\text{T}$ s
3. Varnish the complete assembly

Transformer Winding Construction Diagram

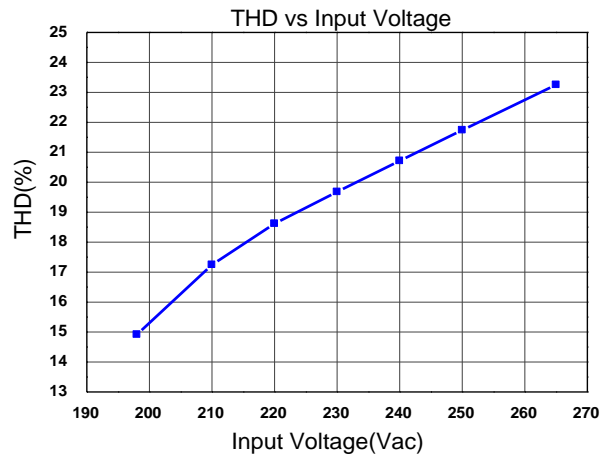
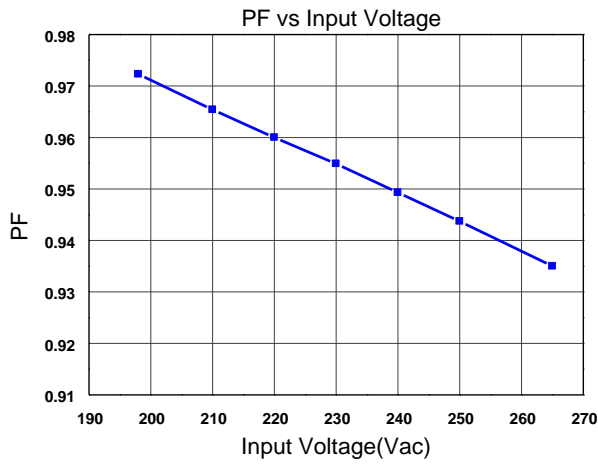
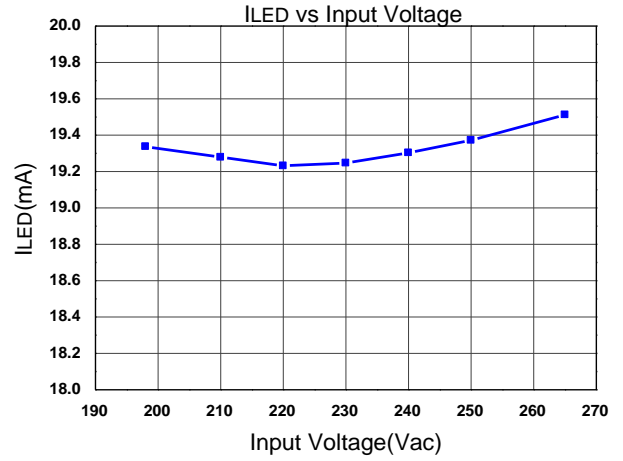
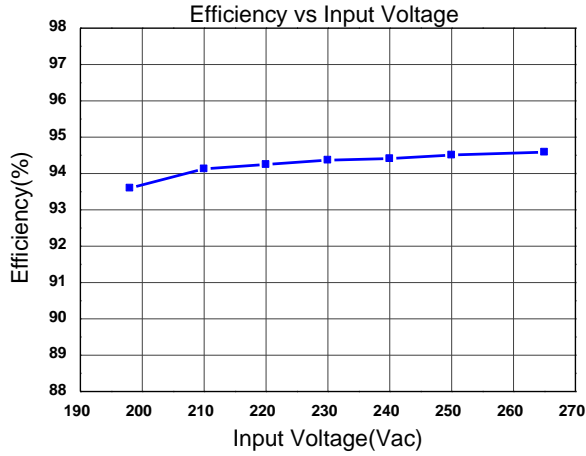


Item	Winding name	Description
1	WD1-Primary Winding	Start at Pin 4, Wind 340 turns of $\Phi 0.15\text{mm}$ wire and finish on Pin 8
2	Insulation	2 Layers of insulation tape

Bill of Material

#	Item	Description	Package	Quantity
1	C1	22nF/400V, CL21, Pitch=7.5mm	DIP	1
2	C2	47nF/400V, CL21, Pitch=7.5mm	DIP	1
3	C3	120nF/400V, CL21, Pitch=7.5mm	DIP	1
4	C4	Ceramic Cap,4.7μF/25V,X7R	0805	1
5	C5	Ceramic Cap,1μF/25V,X7R	0805	1
6	C6	E-Cap,130°C,1μF/450V,6.3*11mm	DIP	1
7	C7	E-Cap,130°C,15μF/450V,12.5*16mm	DIP	1
8	C8	Ceramic Cap,4.7μF/25V,X7R	0805	1
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	Switching diode, 1N4148ws,Diodes	SOD-323	1
14	Z1,Z2	BZT52C4V7S,4.7V Zener, Diodes	SOD-323	2
15	Z3	BZT52HC24WF,24V Zener, Diodes	SOD-123	1
15	Z4	BZT52C15S,15V Zener, Diodes	SOD-323	1
16	RF1	Fuse Resistor,4R7, 5%, 1W	DIP	1
17	RF2, RF3	Fuse Resistor,150R, 5%, 1W	DIP	1
18	R1	Resistor, 5.1K, 5%, 1/8W	0805	1
19	R2	SMD Resistor,470R, 5%, 2W	DIP	1
20	R3	SMD Resistor,20R, 1%, 1/8W	0805	1
21	R4	SMD Resistor,20R, 1%, 1/8W	0805	1
22	R5,R6	SMD Resistor,3.6M, 5%, 1/4W	1206	2
23	R7	SMD Resistor,27K, 5%, 1/8W	0805	1
24	R8,R9	SMD Resistor,4.7M, 1%, 1/4W	1206	2
25	R10	Resistor, 130K, 5%, 1/8W	0805	1
26	R11	SMD Resistor,4.3M, 1%, 1/4W	1206	1
27	R12	SMD Resistor,2.0M, 1%, 1/4W	1206	1
28	R13	SMD Resistor,150K, 5%, 1/8W	0805	1
29	R14,R15	SMD Resistor,5.1K, 5%, 1/8W	0805	0
25	RJ1	SMD Resistor,0R, 5%, 1/4W	1206	1
25	RJ2	NC	1206	0
26	L1,L2	4.7mH, 6*8mm,WURTH Elektronik	DIP	2
27	L3	EE10, Vertical, 4+4pin,Single Winding,12mH	DIP	1
28	Q1	N-MOS,DMG3420U, 20V/4A,Diodes	SOT-23	1
28	Q2	CS4N60 4A/600V	TO-251	1
29	U1	AL1698K-20C,Diodes Dimmable IC	SOP-7	1
Total				39

Electrical Performance

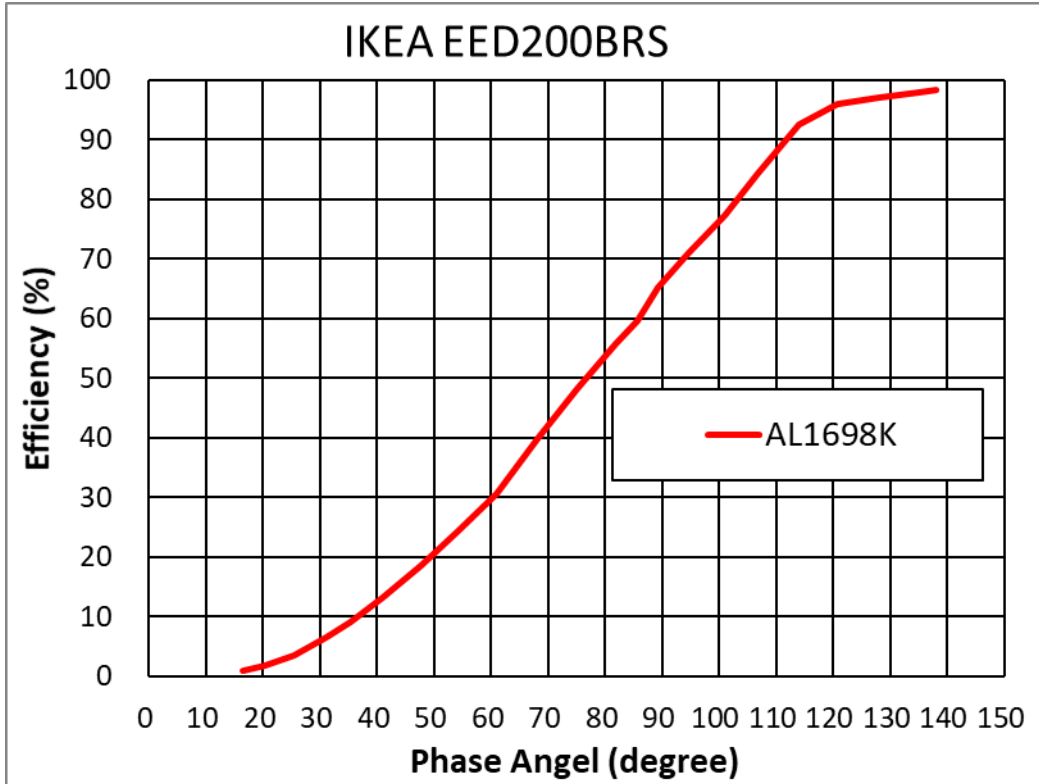


Dimming Test

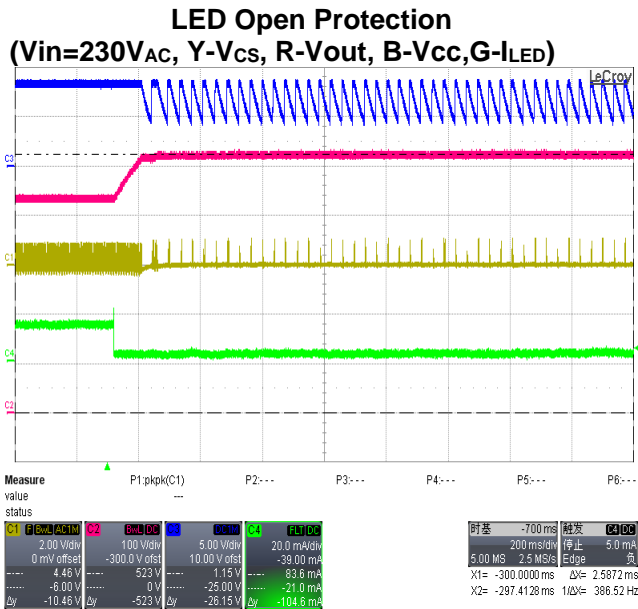
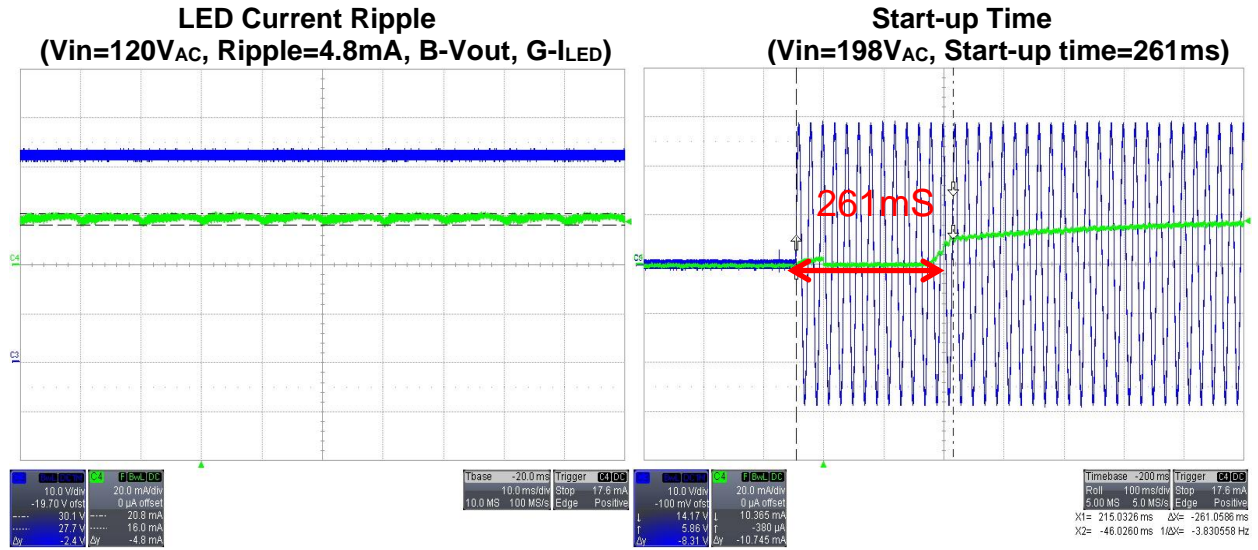
Dimmer compatibility and dimming range

Number	Dimmer Type	ILED(mA)		Dimming Percentage(%)		Flicker or not
		Min	Max	Min	Max	
1	Gira 030700 T 20-525W	4.3751	18.888	23	99	No
2	PEHA D 80 433VL60-300W	1.5739	18.085	8	95	No
3	Merten 5771-99 T 20-315W	6.5815	19.045	34	100	No
4	ABB STD 50-3 L 60-500W	1.1555	18.406	6	96	No
5	Busch Jaeger 6517U-101	1.7499	18.076	9	94	No
6	Busch Jaeger 6513U-102 T 40-420W	4.6418	18.564	24	97	No
7	Busch Jaeger 6523U-LED L 2-100W	0.0004	18.319	0	95	No
9	Berker 2875 L 60-600W	0.284	18.489	1.5	96	No
10	Legrand 775903 T 420W	3.0453	18.344	1	95	No
11	Jung 225 NVDE	1.7059	18.234	9	95	No
12	Siemens 5TCB 284 T 20-525W	3.9711	18.733	21	97	No
13	Busch-Jae 2247U L 500W	1.6594	18.244	9	95	No
15	IKEA E0902-DIM L25-150W	1.5005	18.404	8	96	No
16	Busch-Jaeger 2200 L60-400W	0.351	18.392	2	96	No

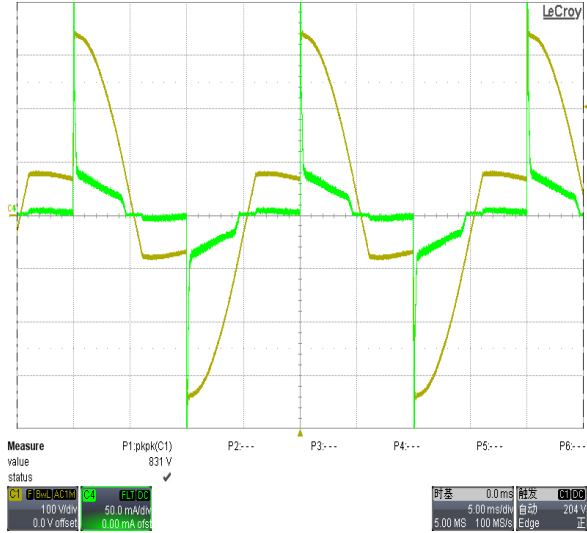
Dimming Curve



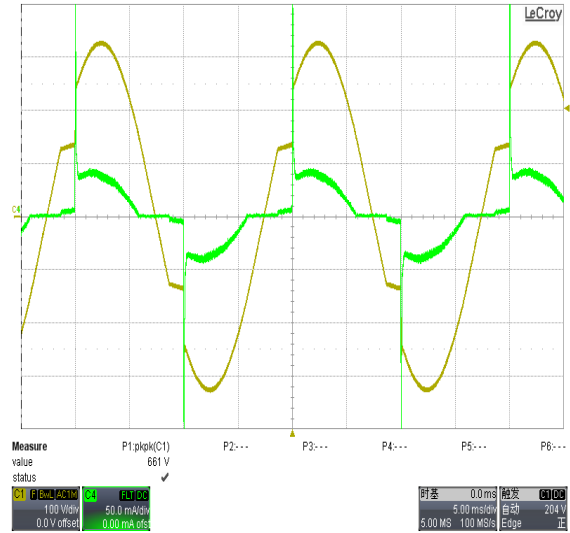
Functional Waveform



Input AC Current vs Dimmer Phase
(Vin=230V_{AC}/50Hz, Conduction Angle 90deg)



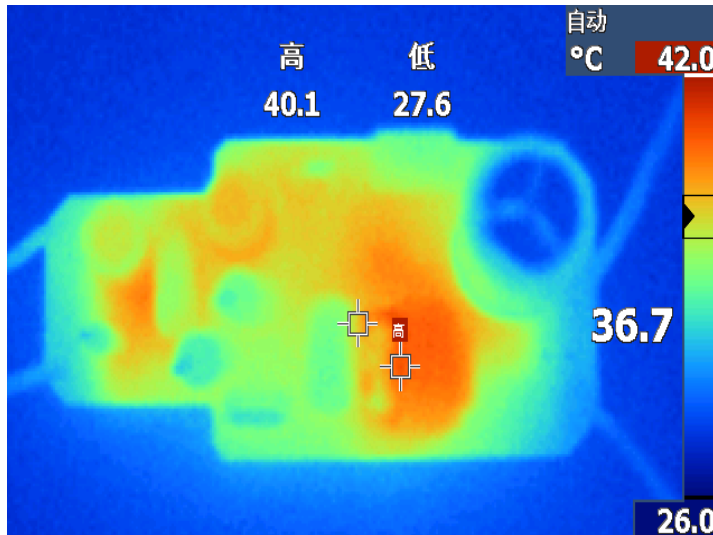
Input AC Current vs Dimmer Phase
(Vin=230V_{AC}/50Hz, Conduction Angle 150deg)



Thermal Test

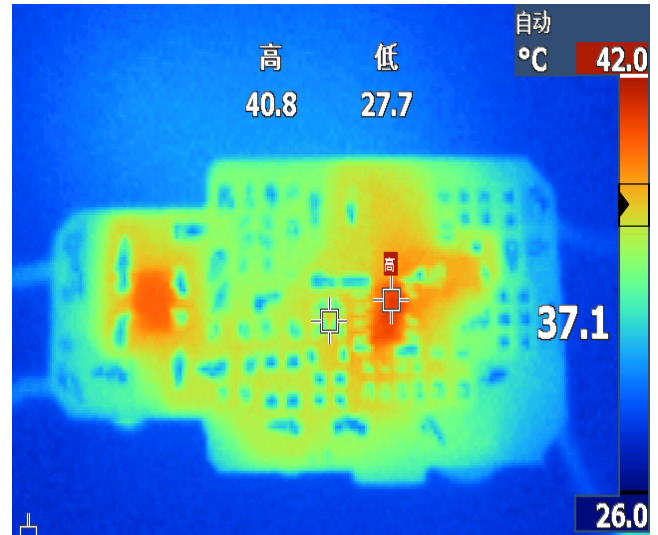
Top

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



Bottom

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



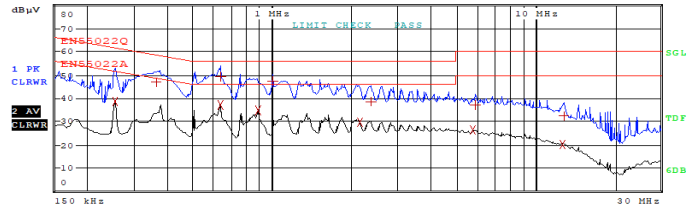
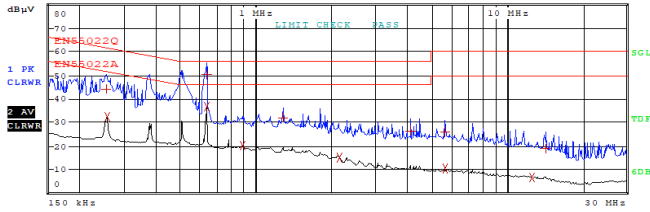
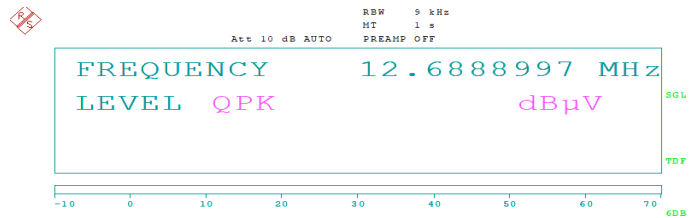
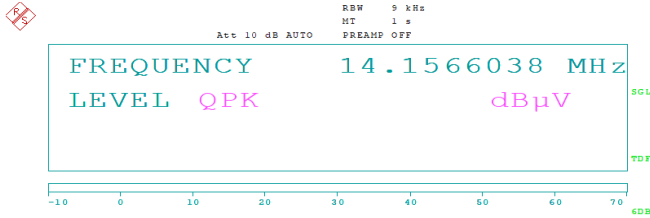
EMI Conduction Test

Line Terminal

V_{in}=230V_{AC}/50Hz, Margin>5dB

Neutral Terminal

V_{in}=230V_{AC}/50Hz, Margin>6dB



EDIT PEAK LIST (Final Measurement Results)

TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
Trace1:	EN55022Q		
Trace2:	EN55022A		
Trace3:	---		
1 Quasi Peak	251.659338219 kHz	44.26	-17.44
2 Average	254.169071602 kHz	32.38	-19.23
1 Quasi Peak	634.878262431 kHz	50.46	-5.54
2 Average	634.878262431 kHz	36.73	-9.26
2 Average	881.64914842 kHz	20.38	-25.61
1 Quasi Peak	1.27405044044 MHz	32.23	-23.76
2 Average	2.1374603093 MHz	15.37	-30.62
1 Quasi Peak	4.08119508439 MHz	26.59	-29.40
1 Quasi Peak	5.61140113855 MHz	25.94	-34.05
2 Average	5.61140113855 MHz	10.59	-39.40
2 Average	12.4388782936 MHz	6.61	-43.38
1 Quasi Peak	14.1566038021 MHz	18.93	-41.06

EDIT PEAK LIST (Final Measurement Results)

TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
Trace1:	EN55022Q		
Trace2:	EN55022A		
Trace3:	---		
2 Average	251.659338219 kHz	38.58	-13.11
1 Quasi Peak	360.057740611 kHz	46.80	-11.92
1 Quasi Peak	634.878262431 kHz	49.41	-6.58
2 Average	634.878262431 kHz	37.15	-8.84
2 Average	881.64914842 kHz	35.05	-10.94
1 Quasi Peak	1.00339897152 MHz	47.68	-8.31
2 Average	2.1374603093 MHz	29.67	-16.12
1 Quasi Peak	2.36108594985 MHz	36.80	-17.19
2 Average	5.72419030143 MHz	26.39	-23.60
1 Quasi Peak	5.89763899176 MHz	37.00	-23.00
2 Average	12.5632670765 MHz	20.40	-29.59
1 Quasi Peak	12.6888997473 MHz	32.31	-27.68

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