AL1698EV1 User Guide

230V$_{AC}$ Dimmable LED Driver

General Description

This demonstration board utilizes the AL1698 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 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 that describe 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 >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	>0.9
Efficiency	85%
XYZ Dimension	63.4 x 21 x 18mm
ROHS Compliance	Yes

Evaluation Board

Figure 1: Top View

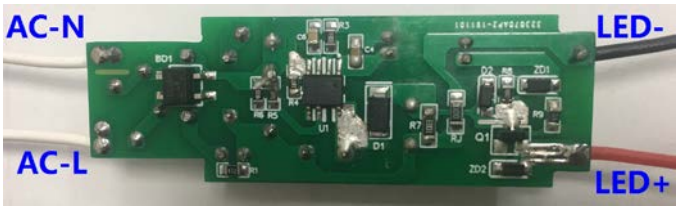


Figure 2: Bottom View

Connection Instructions:

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

Board Layouts

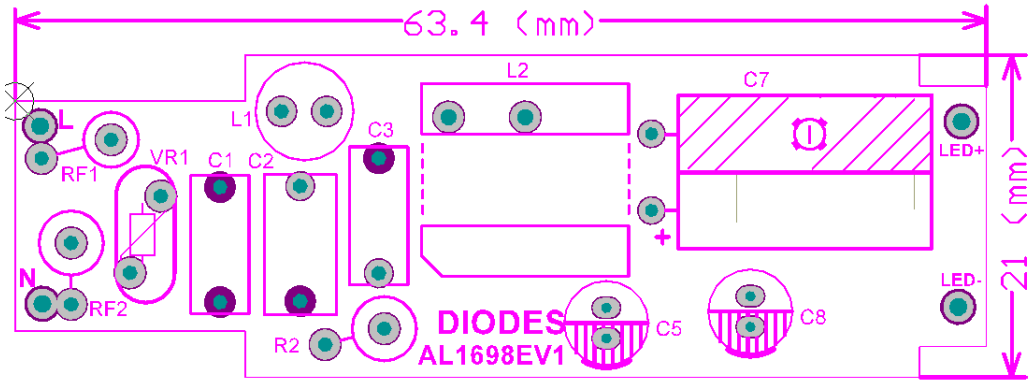


Figure 3: PCB Layout Top View

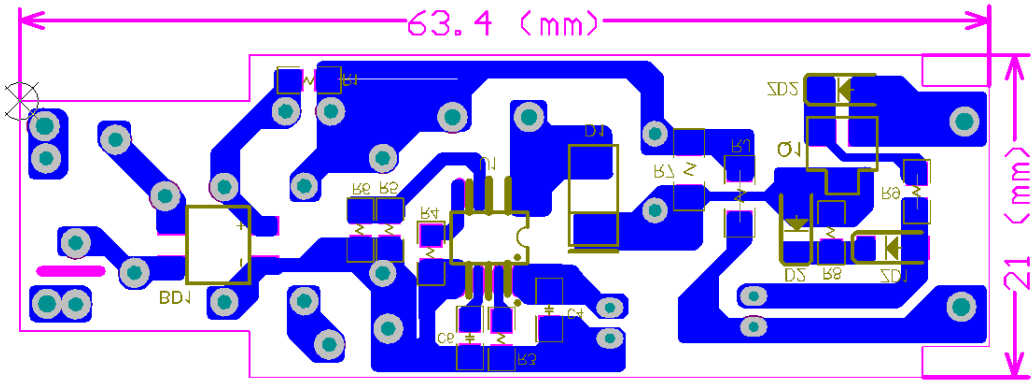


Figure 4: PCB Layout Bottom View

Quick Start Guide

1. Preset the isolated AC source to 230VAC.
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 AL1698 is a non-isolated design. All terminals carry high voltage during operation!

Schematic

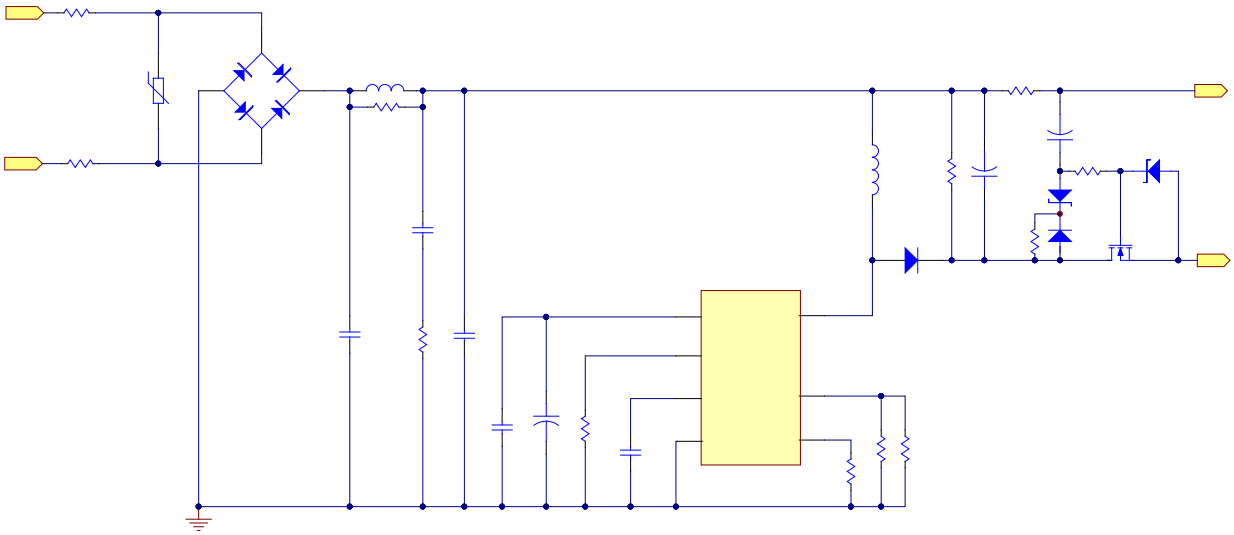


Figure 5: Schematic Circuit

Transformer Design

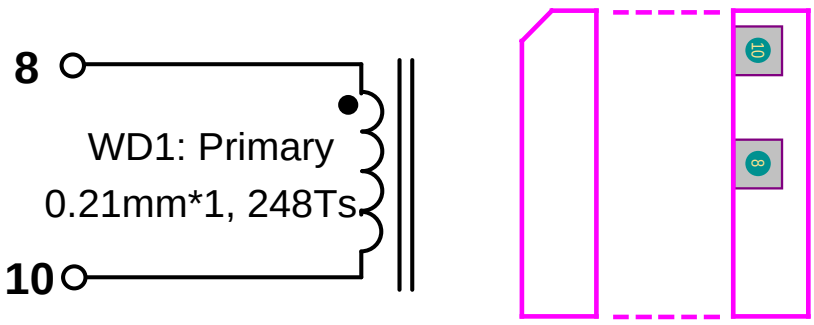
Bobbin and Core

EE13 Vertical 5+5 pin

Transformer Parameters

1. Primary Inductance (Pin8-Pin10, all other windings open)： Lp=2.4mH, ±5%@1kHz
2. Primary Winding Turns (Pin8-Pin10): NP=248Ts
3. Varnish the complete assembly

Transformer Winding Construction Diagram

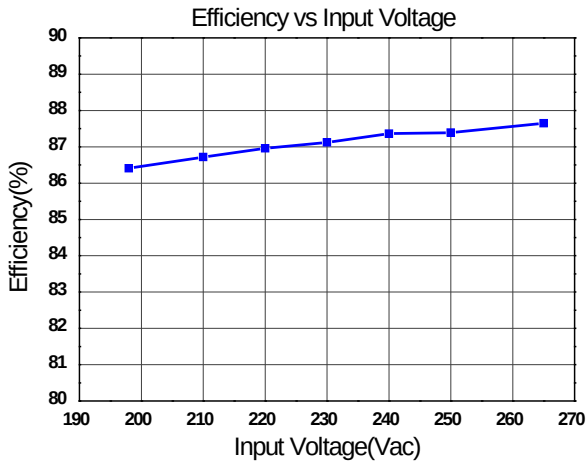


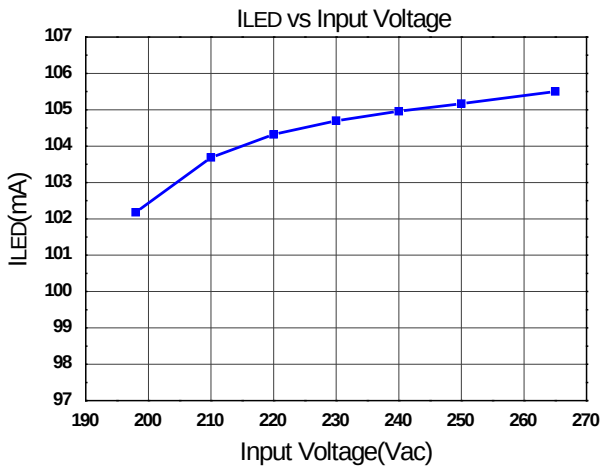
Item	Winding name	Description
1	WD1-Primary Winding	Start at Pin 8, Wind 248 turns of Φ0.21mm wire and finish on Pin 10
2	Insulation	2 Layers of insulation tape

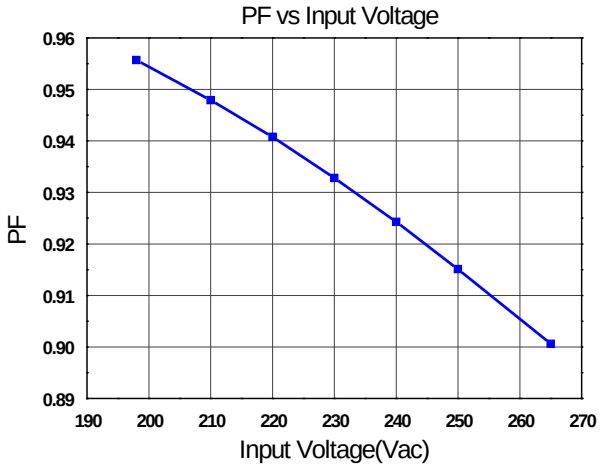
Bill of Material

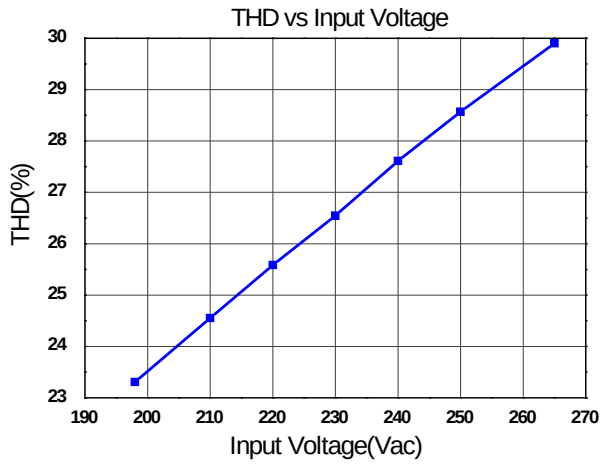
#	Item	Description	Package	Quantity
1	C1	33nF/400V, CL21, Pitch=7.5mm	Through-hole	1
2	C2	100nF/400V, CL21, Pitch=7.5mm	Through-hole	1
3	C3	47nF/400V, CL21, Pitch=7.5mm	Through-hole	1
4	C4	Ceramic Cap, 0.1uF/25V,X7R	0805	1
5	C5	E-Cap,130℃,3.3uF/50V,5*9mm	Through-hole	1
6	C6	Ceramic Cap, 0.47uF/25V,X7R	0805	1
7	C7	E-Cap,130℃,100uF/100V,10*16mm	Through-hole	1
8	C8	E-Cap,130℃,4.7uF/100V, 5*9mm	Through-hole	1
9	BD1	Rectifier Bridge,MB10S,0.8A/1KV,Diodes Inc	MBS	1
10	D1	Fast Recovery Diode,US1J,1A/600V,Diodes Inc	SMA	1
11	D2	Switching diode, 1N4148,Diodes Inc	SOD-123	1
12	ZD1, ZD2	DDZ9688,4.7V Zener, Diodes Inc	SOD-123	2
13	VR1	Varistor, 07D431	Through-hole	1
14	RF1	Fuse Resistor,51R, 5%, 1W	Through-hole	1
15	RF2	Fuse Resistor,51R, 5%, 1W	Through-hole	1
16	R1	Resistor, 4.7K, 5%, 1/8W	0805	1
17	R2	SMD Resistor,390R, 5%, 1W	DIP	1
18	R3	SMD Resistor,130K, 5%, 1/8W	0805	1
19	R4	SMD Resistor,11K, 5%, 1/8W	0805	1
20	R5	SMD Resistor,3.9R, 1%, 1/8W	0805	1
21	R6	SMD Resistor,4.3R, 1%, 1/8W	0805	1
22	R7	SMD Resistor,100K, 5%, 1/4W	1206	1
23	R8	SMD Resistor,10K, 5%, 1/8W	0805	1
24	R9	SMD Resistor,4.7K, 5%, 1/8W	0805	1
25	RJ	SMD Resistor,0R, 5%, 1/4W	1206	1
26	L1	Drum Inductor 4.7mH, 6*8mm	Through-hole	1
27	L2	EE13, Vertical, 5+5pin,Single Winding,2.4mH	Through-hole	1
28	Q1	N-MOS,DMG3420U, 20V/4A,Diodes Inc	SOT-23	1
29	U1	AL1698-20C,Diodes Dimmable IC	SOP-7	1
Total				**30**

Electrical Performance







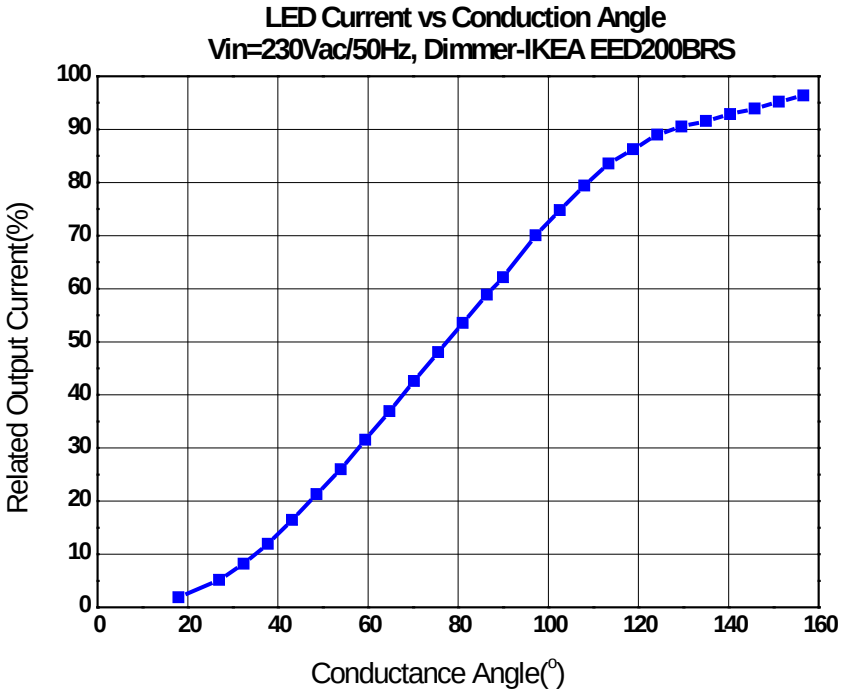


Dimming Test

Dimmer compatibility and dimming range

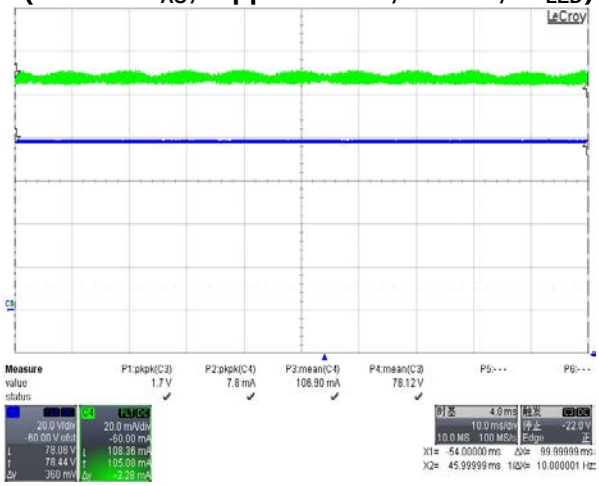
Num	Dimmer Type	ILED(mA)		Dimming Percentage(%)		Flicker or not
		Min	Max	Min	Max	
1	Gira 030700 T 20-525W	23.33	100.89	22.24	96.18	No
2	PEHA D 80 433VL60-300W	27.58	102.26	26.29	97.48	No
3	Merten 5771-99 T 20-315W	31.39	100.28	29.92	95.60	No
4	ABB STD 50-3 L 60-500W	27.25	102.73	25.98	97.93	No
5	Busch Jaeger 6513U-102 T 40-420W	27.00	103.16	25.74	98.34	No
6	Busch Jaeger 6523U-LED L 2-100W	11.98	99.46	11.42	94.81	No
7	Berker 2875 L 60-600W	16.16	101.89	15.41	97.13	No
8	Legrand 775903 T 420W	44.12	101.45	42.06	96.71	No
9	Siemens 5TCB 284 T 20-525W	23.15	103.81	22.07	98.96	No
10	Gira 117600 U 50-420W	33.68	101.10	32.11	96.38	No
11	Busch-Jae 2247U L 500W	3.96	102.65	3.78	97.86	No
12	He T46 T 20-315W	31.91	102.49	30.42	97.70	No
13	Berker 2861 10 U50-420W	32.99	102.04	31.45	97.27	No
14	Jung 254 UDIE1 U50-420W	33.48	100.98	31.92	96.26	No
15	Everflourish EFM700DC T 25-150W	30.18	98.78	28.77	94.17	No
16	IKEA E0902-DIM L25-150W	10.45	102.67	9.96	97.87	No
17	Busch-Jaeger 2200 L60-400W	26.40	99.59	25.17	94.94	No
18	Jung 1254 UDE U50-420W	0.00	100.46	0.00	95.77	No
19	Gira 030200/I01 L60-600W	0.00	100.69	0.00	95.99	No
20	ELSO ATD315 T40-315W	27.44	102.82	26.16	98.02	No
21	IKEA EED100PRS	0.00	100.46	0.00	95.77	No
22	IKEA EED200LRS(W)	0.00	100.69	0.00	95.99	No
23	IKEA EED200BRS	2.00	101.12	1.91	96.40	No
24	IKEA EED200LRS(B)	0.00	97.63	0.00	93.07	No

Dimming Curve

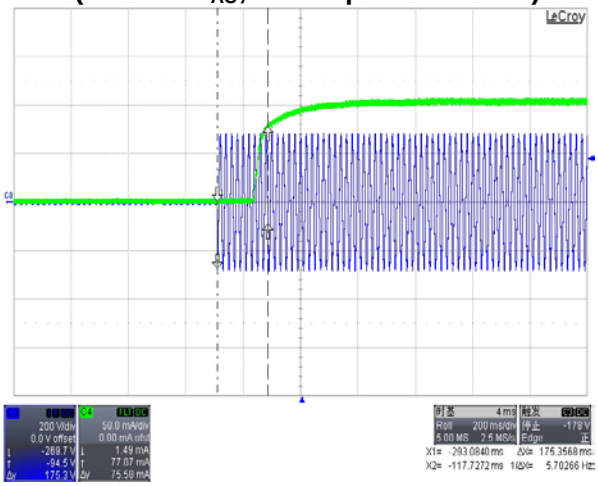


Functional Waveform

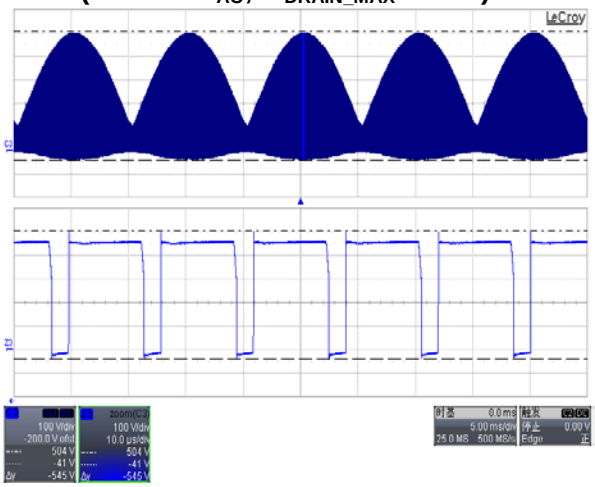
LED Current Ripple
(Vin=230V$_{AC}$, Ripple=7.8mA, B-Vout,G-I$_{LED}$)



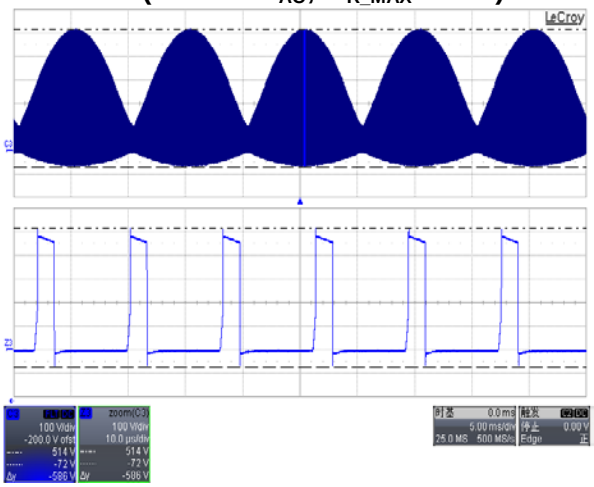
Start-up Time
(Vin=198V$_{AC}$, Start-up time=175ms)



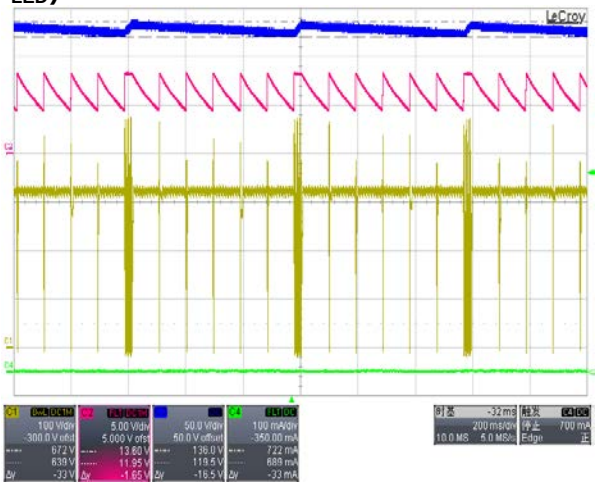
IC V_{DRAIN} Waveform
(Vin=264V_{AC}, V_{DRAIN_MAX}=504V)



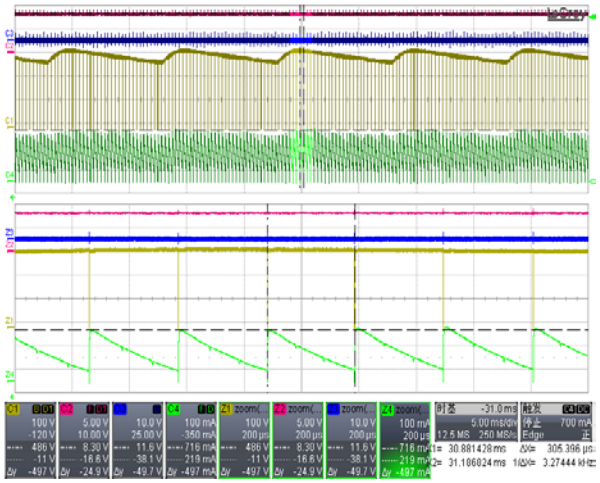
Output Diode V_R Waveform
(Vin=264V_{AC}, V_{R_MAX}=514V)



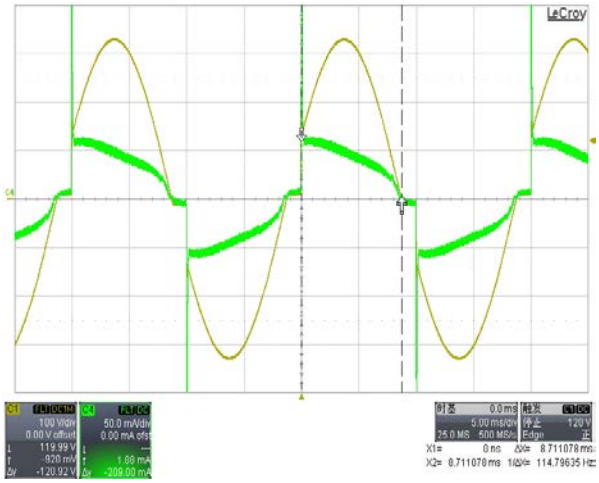
LED Open Protection
(Vin=230V_{AC}, Y-V_{DRAIN}, R-VCC, B-Vout,G-I_{LED})



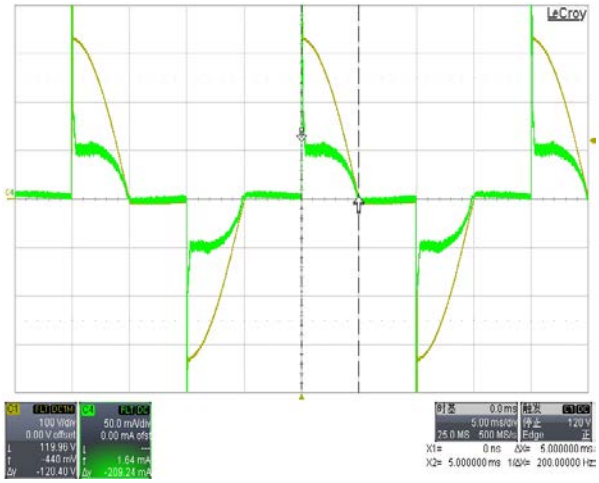
LED Short Protection
(Vin=230V_{AC},Y-V_{DRAIN}, R-VCC, B- Vout, G-I_{LED})



Input AC Current vs Dimmer Phase (Vin=230V$_{AC}$/50Hz,Conduction Angle 157deg)



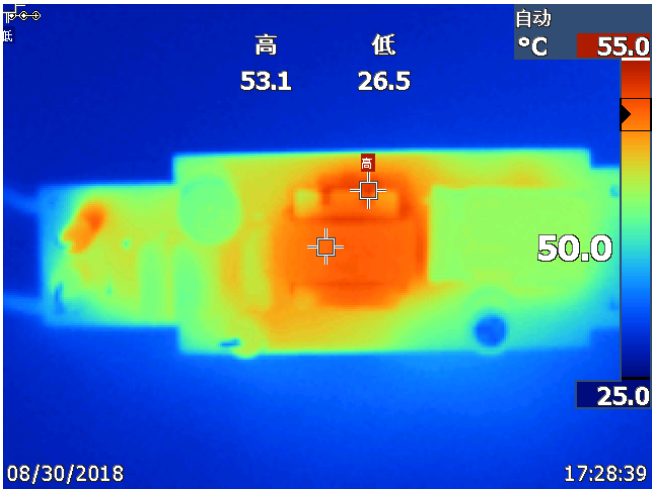
Input AC Current vs Dimmer Phase (Vin=230V$_{AC}$/50Hz,Conduction Angle 90deg)



Thermal Test

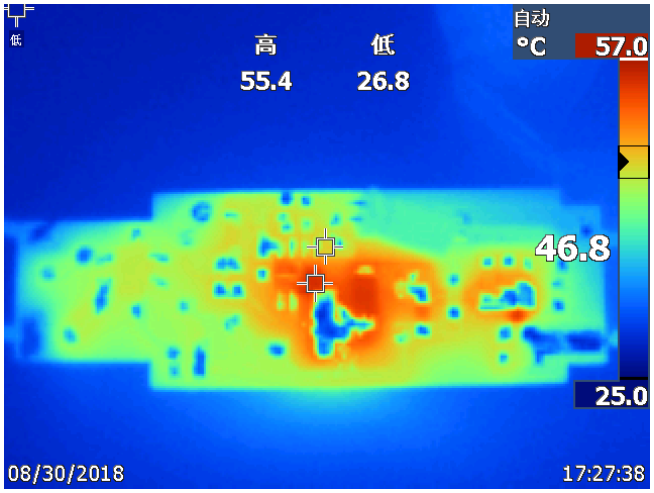
Top

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



Bottom

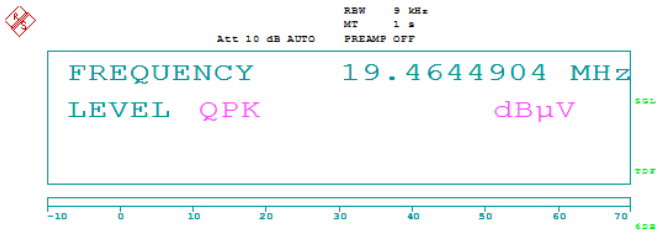
Vin=230V$_{AC}$/50Hz,Burn-in time=30min



EMI Conduction Test

Line Terminal

Vin=230VAC/50Hz, Margin>10dB



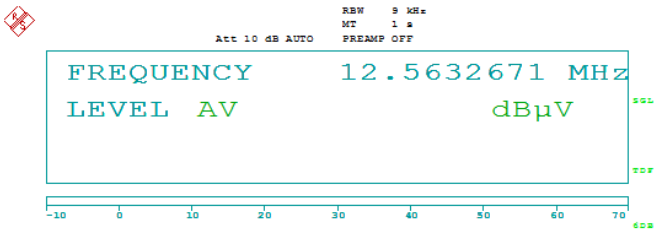
EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	202.1773373 kHz	49.58	-13.93
2	Average	204.199110673 kHz	43.08	-10.35
1	Quasi Peak	409.779295157 kHz	43.31	-14.33
2	Average	409.779295157 kHz	27.09	-20.55
1	Quasi Peak	908.363999266 kHz	30.48	-25.52
2	Average	908.363999266 kHz	21.35	-24.64
1	Quasi Peak	2.1374603093 MHz	32.94	-23.05
2	Average	2.1374603093 MHz	20.08	-25.91
2	Average	5.66751514993 MHz	16.47	-33.52
1	Quasi Peak	8.86858861671 MHz	25.26	-34.73
2	Average	16.4353775277 MHz	15.67	-34.32
1	Quasi Peak	19.4644904373 MHz	23.31	-36.68

Neutral Terminal

Vin=230VAC/50Hz, Margin>7dB



EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	232.397635727 kHz	46.90	-15.45
2	Average	342.582585749 kHz	40.36	-8.78
1	Quasi Peak	687.48218373 kHz	48.76	-7.23
2	Average	687.48218373 kHz	37.48	-8.51
1	Quasi Peak	973.889156195 kHz	47.39	-8.60
2	Average	973.889156195 kHz	34.99	-11.00
1	Quasi Peak	2.45695550736 MHz	45.96	-10.03
2	Average	2.74114748873 MHz	32.98	-13.01
1	Quasi Peak	6.51466251798 MHz	42.95	-17.04
2	Average	7.71534368894 MHz	31.61	-18.38
1	Quasi Peak	12.5632670765 MHz	40.62	-19.37
2	Average	12.5632670765 MHz	29.59	-20.40

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