



DEMO BOARD TEST REPORT

120VAC 10.4W Triac-Dimmable LED Driver with PFC Using KP1221

FEATURES

- Low cost Triac Dimmable solution
- HighPF > 0.95 with Constant On Time Control
- Low THD < 15%
- High Efficiency > 86%
- Fast Start-Up Speed < 300ms
- Good line and load regulation < ±2%
- Meet NEMA SSL6 Standard
- Wide range of Dimmer Compatibility
- Build in Protections:
 - LED Short and Open Protection
 - Cycle-by-Cycle Current Limiting (OCP)
 - On-Chip Thermal Shutdown (OTP)
 - Leading Edge Blanking (LEB)
 - VDD UVLO

INTRODUCTION

KP1221 is a highly integrated Constant Current LED power switch with active PFC control for high PF and high efficiency. The IC adopts accurate current sensing and close loop constant current control to achieve high precision CC control with excellent regulation. Additionally KP1221 utilizes a particular dimmable scheme to maintain good triac dimming performance.

The Demo Board of KP1221-D01 is typically designed for the application of 74V/140mA output with 108-132VAC input (60Hz). Besides the multi-protection function, this demo also has very good efficiency, current regulation, PF, THD and meet the EN55015 conducted and radiated EMI requirement.

APPLICATIONS

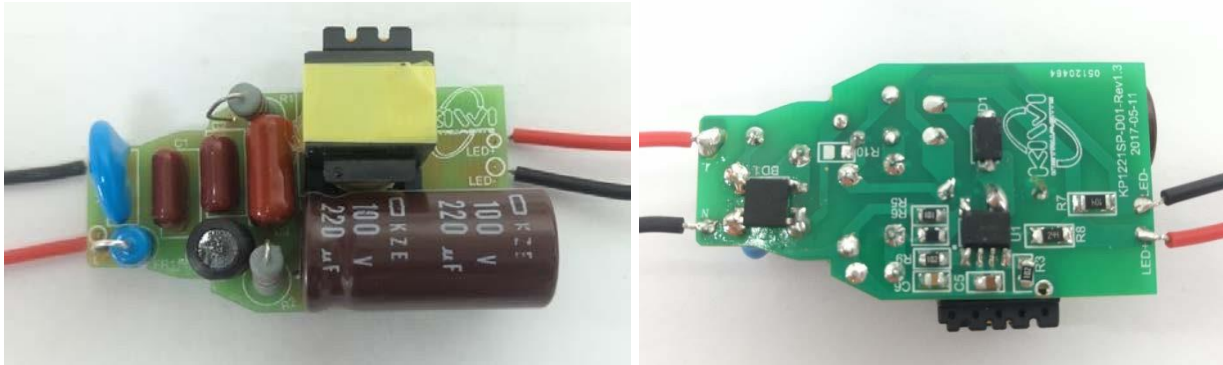
- Solid State Lighting
- Commercial & Residential Lighting

DEMO BOARD SPECIFICATION

Description	Symbol	Min	Type	Max	Unit	Note
Input Voltage	Vin	108		132	Vac	60Hz
Output Voltage	Vout		74		Vdc	
Output Current	Iout		140		mA	
Output Power	Pout		10.4		W	
Efficiency	η		86.5		%	Typical value tested at 120Vac/60Hz
Power Factor	PF	0.95				Tested at 132Vac/60Hz
Startup Time	Tst			300	ms	Tested at 108Vac/60Hz without Dimmer
Surge Test		600			V	Typical Differential Surge value tested at 120V/60Hz
Total Harmonics Distortion	THD			15	%	Tested at 132Vac/60Hz

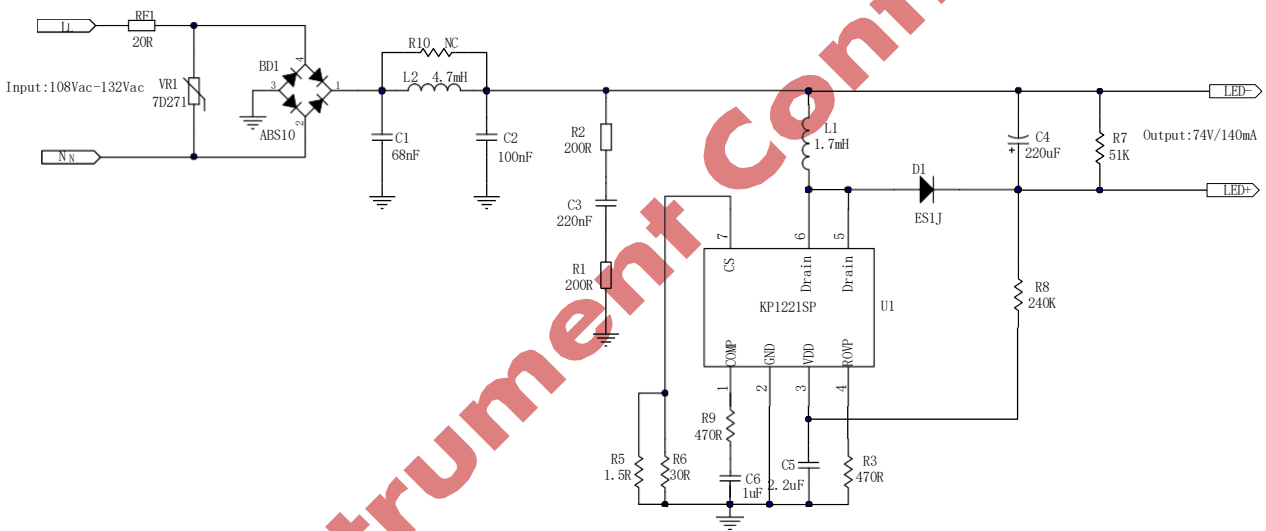
The table above shows the minimum acceptable performance of the design. Actual performance is listed in the results section.

Demo Board of KP1221SP_D01_REV1.3

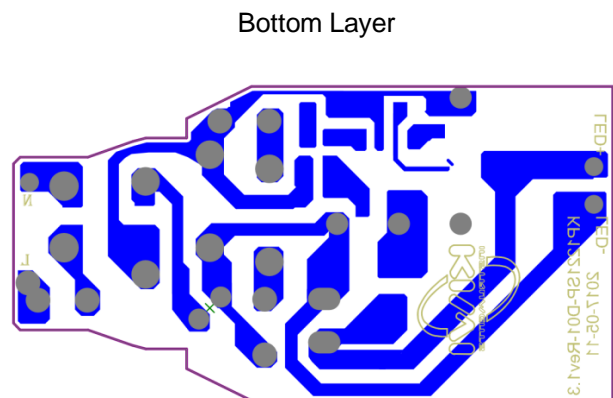
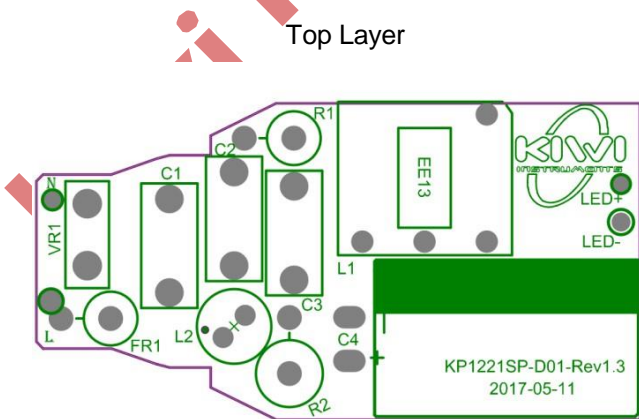


Board Size (in mm): L x W x H=48.6X25.4X20

Schematic



Printed Circuit Board Layout





Circuit Description

The demo board of KP1221-D01 is designed with Non-isolated Buck-Boost topology with Triac Dimming function, which simplifies the circuit and saves BOM cost. Additionally the demo board can achieve good performance for high efficiency, high power factor and accurate output current.

1. Input Rectification and EMI filtering

The circuit input stage is composed by the components of RF1, VR1, BD1, L2, C1, R10 and C2. RF1 provides the inrush current limitation in the event of component failure or a short circuit. VR1 is used for surge test. L2, C1, R10 and C2 together provide the differential and common mode EMI filtering. The value of RF1, C1 and C2 also determine the Surge Test performance. The bridge diode of BD1 rectifies the AC input to DC output.

2. KP1221 Operation

KP1221 is a highly integrated Constant Current LED power switch with active PFC control for high PF and high efficiency. The IC adopts accurate current sensing and close loop constant current control to achieve high precision CC control with excellent line and load regulation. Additionally KP1221 utilizes a particular dimmable control scheme to maintain good triac dimming performance.

R1,R2,C3 compose the damping and bleeder circuit, which can reduce the input current ringing when the dimmer fire on, and also help to maintain a minimum holding current ,thus Triac Dimmer won't turn off.

KP1221 samples the peak inductor current in each switching cycle, which is then multiplied with the duty cycle information to be as the CC loop feedback, and the high accurate output current can be realized with a high accurate reference. R5 and R6 are used as the sensing resistor. With changing the OCP threshold, dimming system will work two different intervals: Constant On Time Control Zone (COT) and Constant Peak Current Zone (CPC). With the peak inductor current tracking with the input voltage basically, the KP1221 realizes high PF input. OCP threshold can be changed by R9, to maintain good dimming performance. KP1221 is integrated with proprietary OVP control scheme, and R3 is used to program the output over voltage.

3. Output Current Regulation

U1, D1, C4 and L1 compose the typical Buck-Boost converter. R7 is the dummy resistor and output capacitor is discharged after system is shut down.



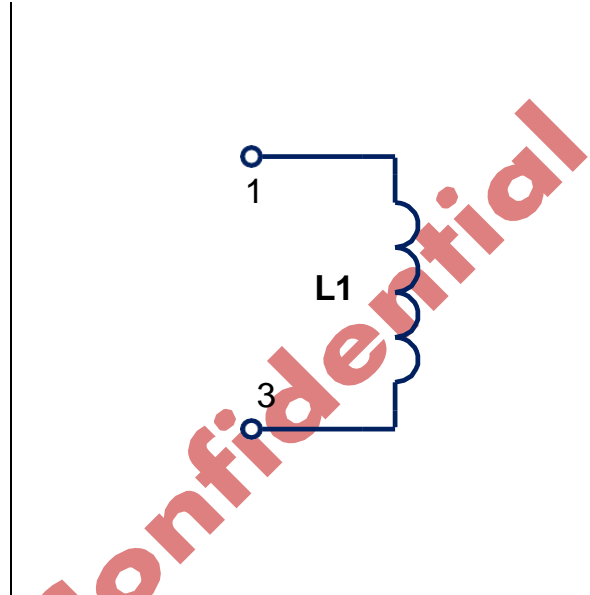
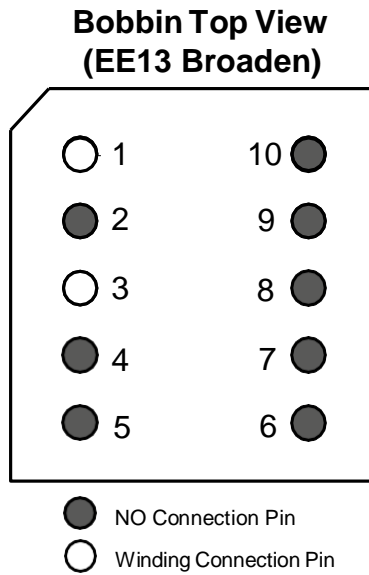
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with PFC Using KP1221**

Bill of Material

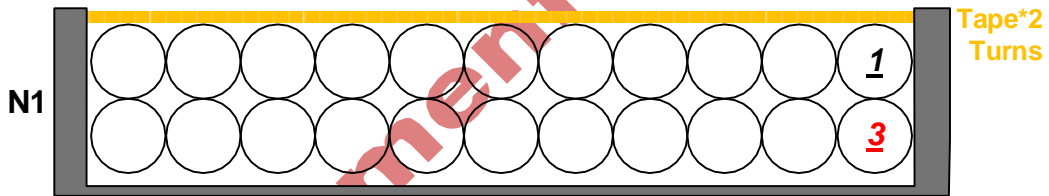
No.	Designator	Value	Description	Package	Manufacturer	Part Number
1	BD1	1KV/1A	Single Phase Silicon Bridge,1KV/1A	SMD	Any	ABS10
2	C1	68nF	250Vdc(160Vac),P=10mm,T=4.8mm	TH	Fala	C212G683K4AC000
3	C2	100nF	250Vdc(160Vac),P=10mm,T=4.8mm	TH	Fala	C212G104K4AC000
4	C3	220nF	250Vdc(160Vac),P=10mm,T=4.8mm	TH	Fala	C212G224K4AC000
5	C4	220uF	Electrolytic Cap, 100V,12.5*20	TH	NCC	
6	C5	2.2uF	Ceramic Cap, 25V X7R	0805	TDK	C2012X7R1E225K
7	C6	1uF	Ceramic Cap, 25V X7R	0805	TDK	C2012X7R1E105K
8	D1	600V/1A	1.0 AMP Surface Mount Super Fast Recovery Rectifiers	SMA	Lision Tech	ES1J
9	RF1	20R	Metal Film Power Resistor,1W	TH	Any	-
10	L1	1.7mH	Single Winding Inductor, Bobbin= EE13 Broaden,Turn=150T	TH	-	-
11	L2	4.7mH	TI Inductor 4.7mH 6*8	TH	-	-
12	R1	200R	Metal Film Power Resistor,1W	TH	Any	-
13	R2	200R	Metal Film Power Resistor,1W	TH	Any	-
14	R3	470R	Film Resistor, 5%	0805	Yageo	RC0805JR-07470RL
15	R5	1.5R	Film Resistor, 5%	0805	Yageo	RC0805JR-071R5L
16	R6	30R	Film Resistor, 5%	0805	Yageo	RC0805JR-0730RL
17	R7	51K	Film Resistor, 5%	1206	Yageo	RC1206JR-0751KL
18	R8	240K	Film Resistor, 5%	1206	Yageo	RC1206JR-07240KL
19	R9	470R	Film Resistor, 5%	0805	Yageo	RC0805JR-07470RL
20	R10	NC	-	-	-	-
21	U1	KP1221SPA	TRIAC Dimmable Primary Side Regulation LED Power Switch With PFC	SOP7	Kiwi Instrument	KP1221SPA
22	VR1	270V	VARISTOR,P=5.0mm,T=4.0mm	07D	Lision Tech	LSSA07D271K
23	PCB	-	PCB_KP1221SP_D01,48.6*25.4	-	Any	-

Inductor Manufacture Guide

1. Electrical Diagram



2. Winding Diagram



3. Winding Order

Number	Winding	Layer	Start	End	Wire Size	Turns	Note
1	N1	Primary	3	1	0.27d*1P	150Ts	
2	Tape					2T	

4. Electrical Specification

Items	Test Condition	Test Pin	Standard
Primary Inductance	measured at 40kHz, 1.0 VRMS	Pins 1 – 3; other windings open	1.7mH±5%



5. BOM

Items	Spec
Core	EE13 Broaden, PC40 or equivalent
Bobbin	EE13 Broaden, 5+5 vertical transformer bobbin
Wire	0.27mm Φ , 130°C
Tape	3M 1350# Polyester Film

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Test Result

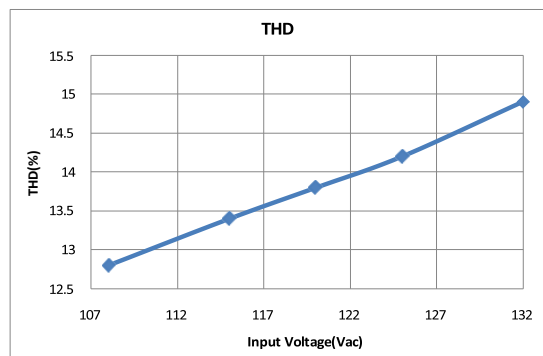
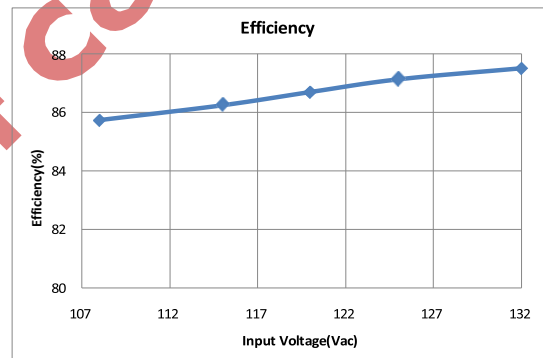
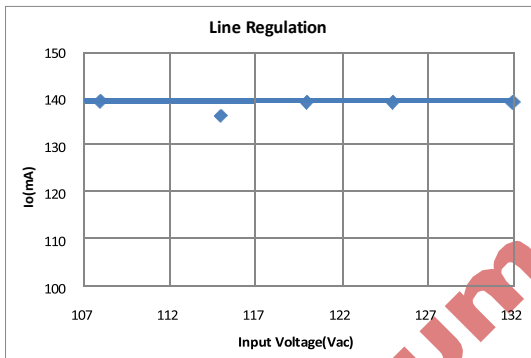
1. Test Data

1) Line Regulation, Efficiency ,PF and THD

VIN (VAC)	Fline (Hz)	Pin (W)	PF	THD(%)	Io (mA)	Vo (V)	Eff (%)
108	60	12	0.982	12.8	139.6	73.7	85.7
115		11.92	0.978	13.4	139.5	73.7	86.3
120		11.85	0.974	13.8	139.4	73.7	86.7
125		11.79	0.971	14.2	139.4	73.7	87.1
132		11.74	0.966	14.9	139.4	73.7	87.5

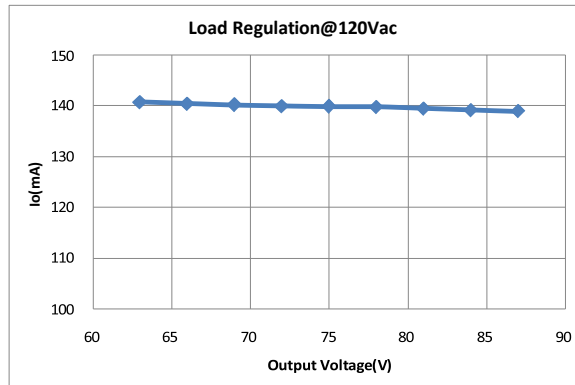
2) Load Regulation(@120Vac)

Vo(V)	63	66	69	72	75	78	81	84	87
Io(mA)	140.8	140.5	140.2	140	139.9	139.8	139.5	139.2	139



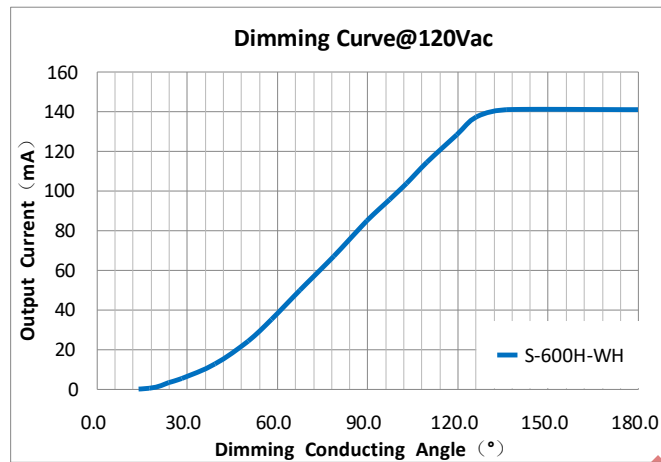


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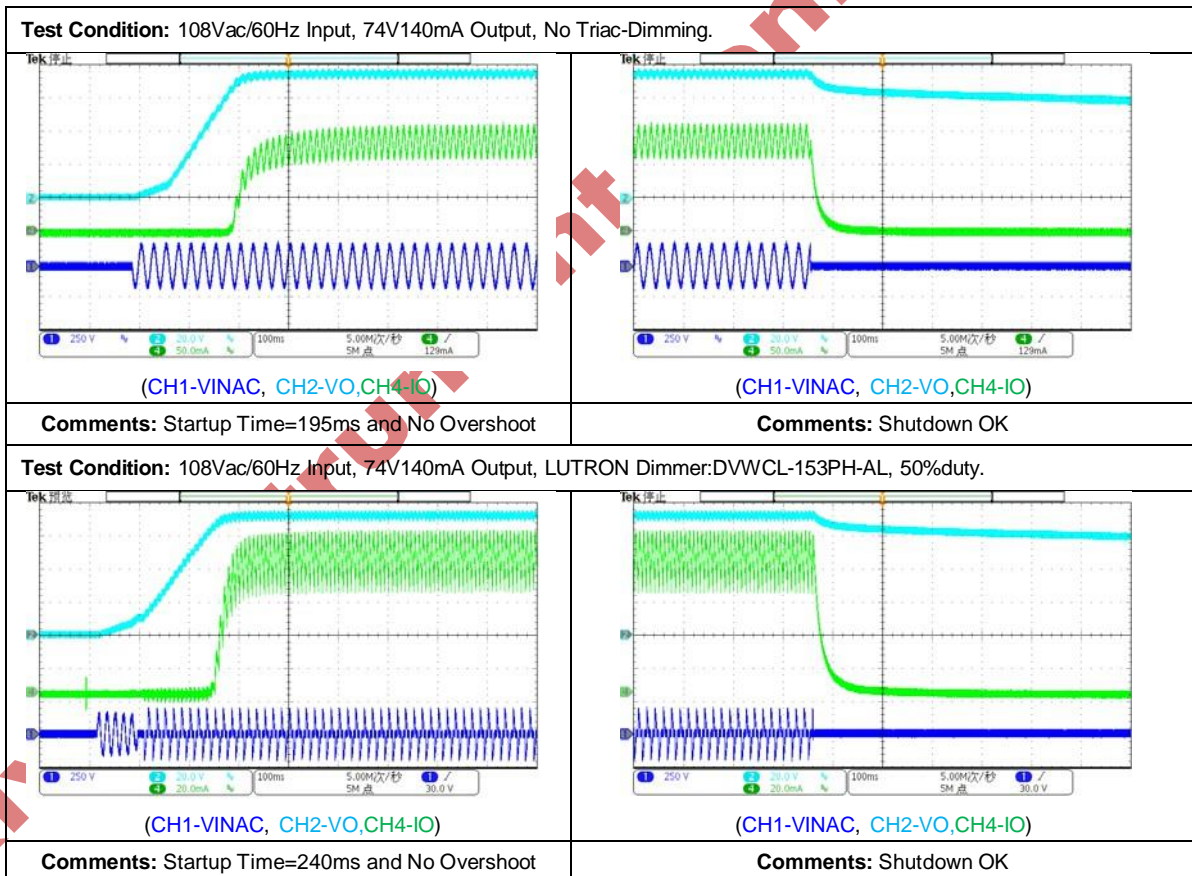
2. Dimming Compatibility Test (No Flicker with these 20 Dimmers @120VAC)

Manufacturer	Dimmer Type	Power Stage	Max. Dimming Angle (°)	Io_max (mA)	Min. Dimming Angle (°)	Io_min (mA)	Io-Dimming Range	Flicker or not
LUTRON	S-600H-WH	600W	135.7	141.4	0.0	0	0%-100%	no
	S-600PH-WH	600W	137.4	141.6	17.7	0.54	0%-100%	no
	TG-600PH-AL	600W	140.9	141.6	30.3	6.3	4%-100%	no
	D-603PGH-DK	600W	117.6	126.8	0.0	0	0%-90%	no
	TTCL-100H-WH	100W	136.6	141.4	44.9	19.14	14%-100%	no
	DV-600PH-WH	600W	138.3	140.9	24.2	3.28	2%-100%	no
	MACL-153MLH-WH	150W	127.9	140.2	38.5	11.92	8%-99%	no
	CT-603PGH-WH	600W	116.7	126.9	32.0	10.26	7%-90%	no
	SCL-153PR-WH	150W	134.8	141.4	53.6	28.27	20%-100%	no
	DVCL-153P-IV	600W	133.5	141.5	25.5	2.78	2%-100%	no
	MRF2-600MHW	600W	135.3	141.6	23.8	3.35	2%-100%	no
	DVWCL-153PH-AL	150W	136.6	141.3	39.8	12.71	9%-100%	no
	CTCL-153PDH-WH	150W	134.8	141.4	0.0	0	0%-100%	no
	TGCL-153PH-WH	150W	135.3	141.5	31.1	5.81	4%-100%	no
COPPER	DAL06P-CHK-L	300W	157.3	141.2	21.2	1.58	1%-100%	no
	TAL06P-C1-K-L	300W	154.7	141.1	21.6	6.3	4%-100%	no
LEVITON	IPL06-10Z	150W	143.5	141.4	40.6	12.3	9%-100%	no
	IPI06-1LZ	600W	144.3	141.5	44.3	16.25	11%-100%	no
	R62-6674-POW	150W	140.5	141.4	68.3	52.5	37%-100%	no
	WHTGQ2014040913	600W	141.3	141.5	0.0	0	0%-100%	no



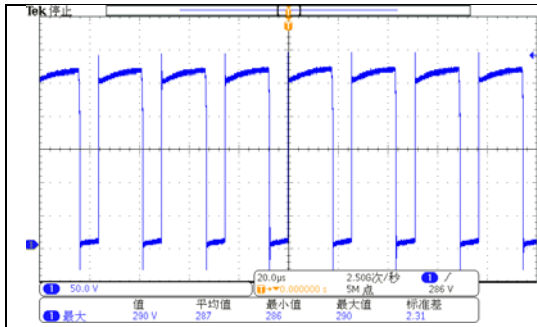
3. Operation Curves

1) Startup and Shutdown Test

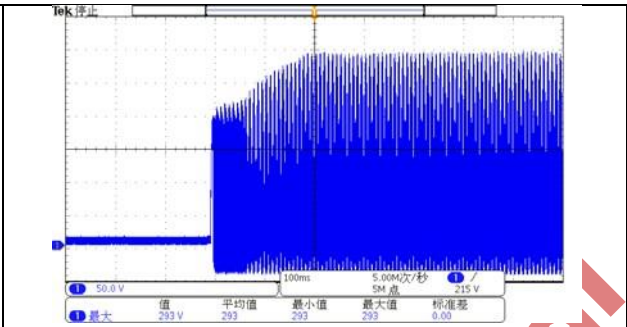


2) Device Maximum Rating Test



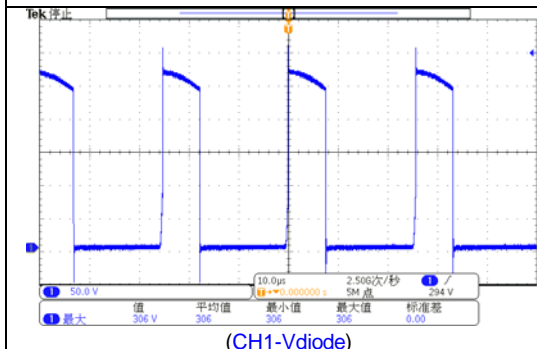


Comments: Vds_max=290V

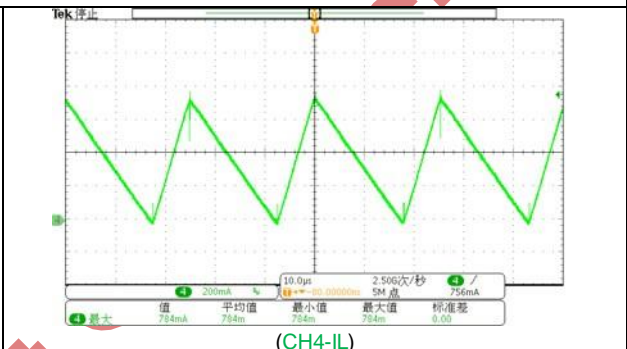


Comments: Vds_max=293V

Test Condition: 132Vac/60Hz Input, 74V140mA Output



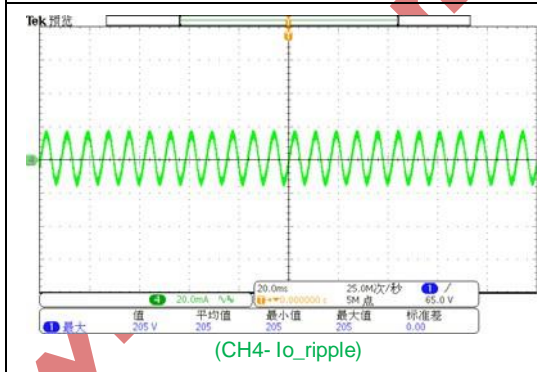
Comments: Vdiode=306V



Comments: IL =784mA,B=0.28T

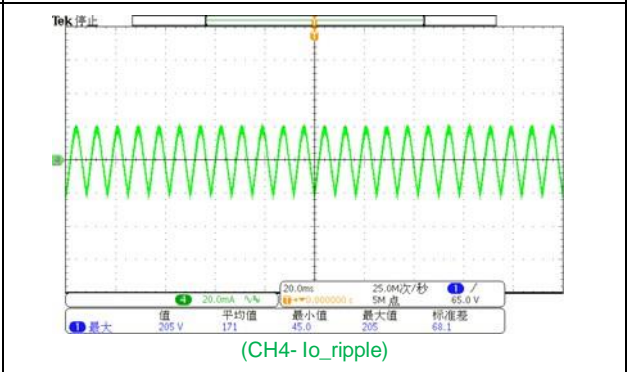
3) Output Ripple Test

Test Condition: 120Vac/60Hz Input, 74V140mA Output
No Triac-Dimming.



Comments: Io_ripple_pp=36mA

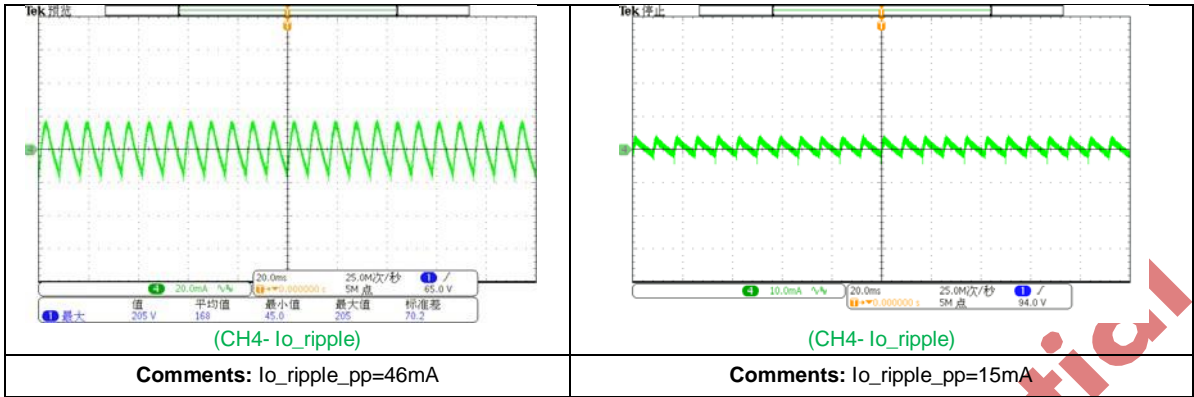
Test Condition: 120Vac/60Hz Input, 74V140mA Output
LUTRON Dimmer:DVWCL-153PH-AL, 75% duty.



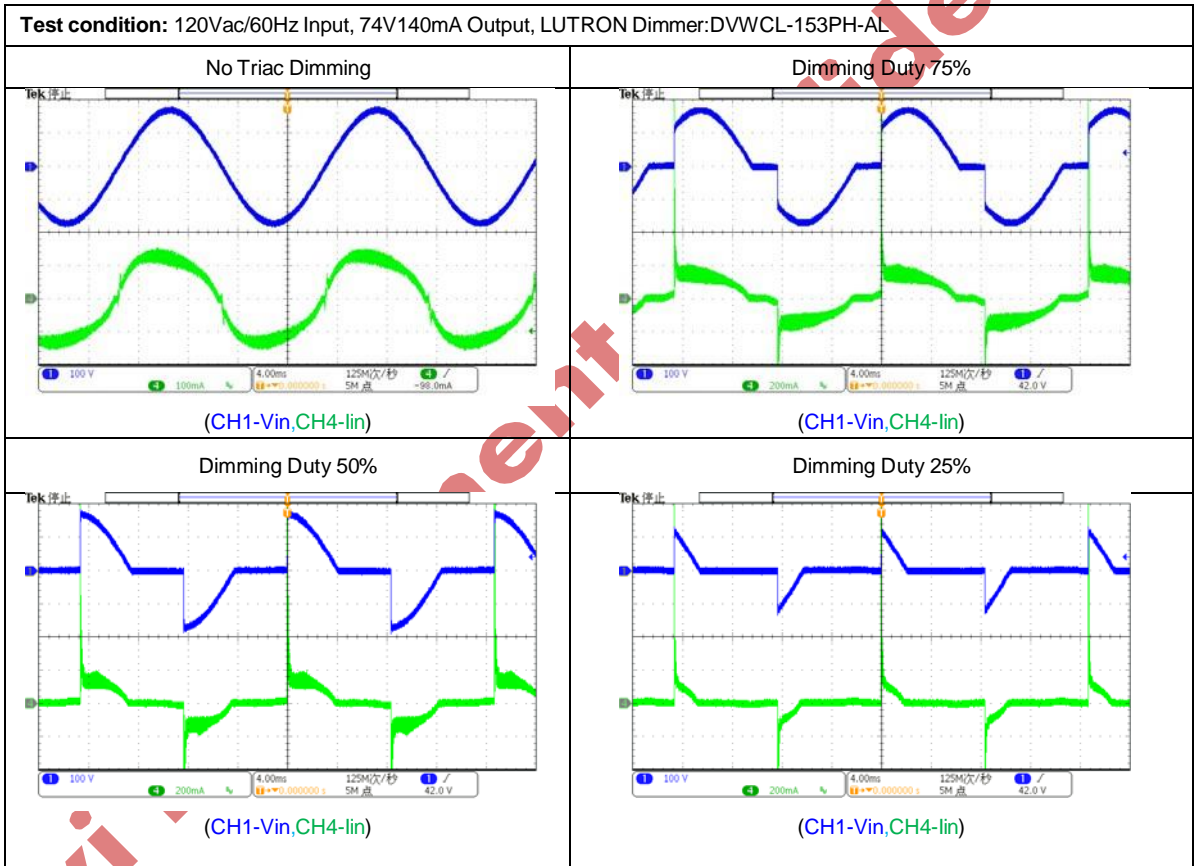
Comments: Io_ripple_pp=44mA

Test Condition: 120Vac/60Hz Input, 74V140mA Output
LUTRON Dimmer:DVWCL-153PH-AL, 50% duty.

Test Condition: 120Vac/60Hz Input, 74V140mA Output
LUTRON Dimmer:DVWCL-153PH-AL, 25% duty.

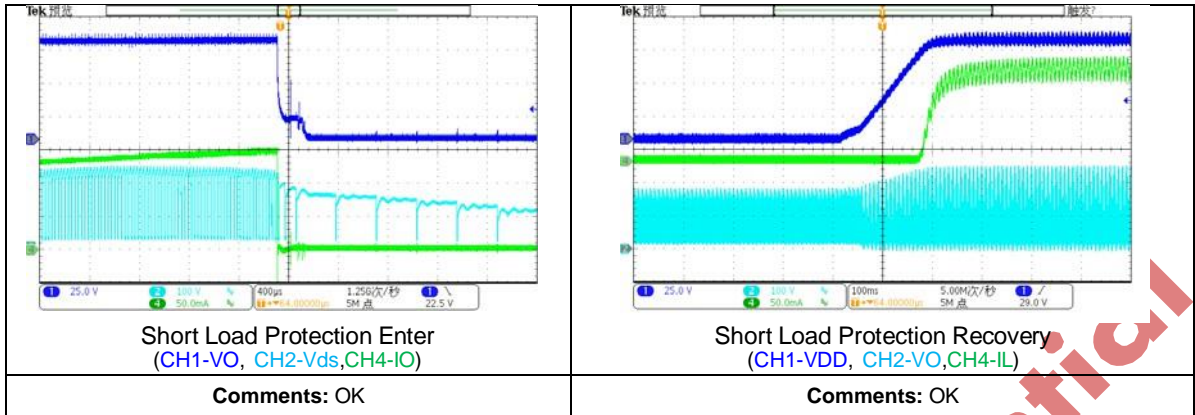


4) Triac Dimming Test

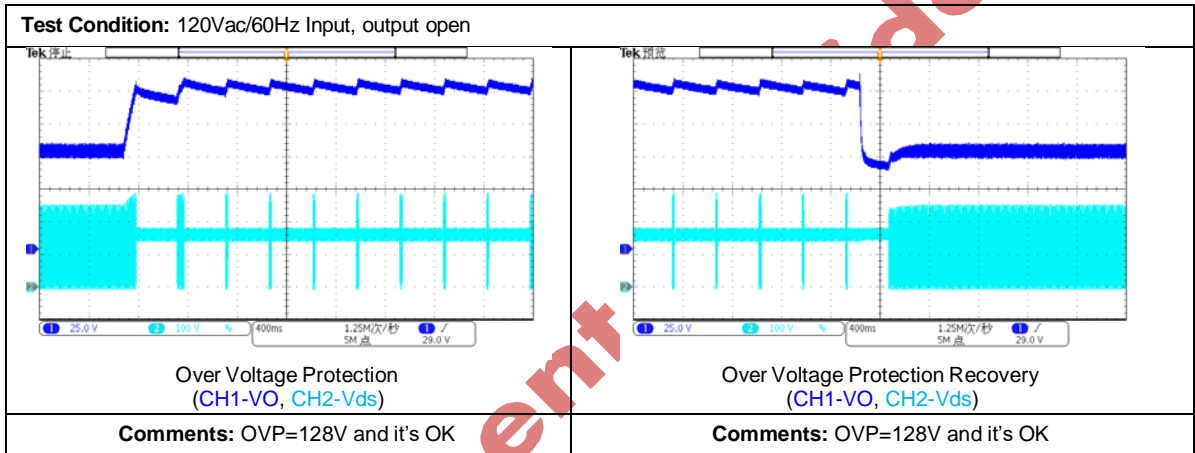


5) LED Short Protection Test

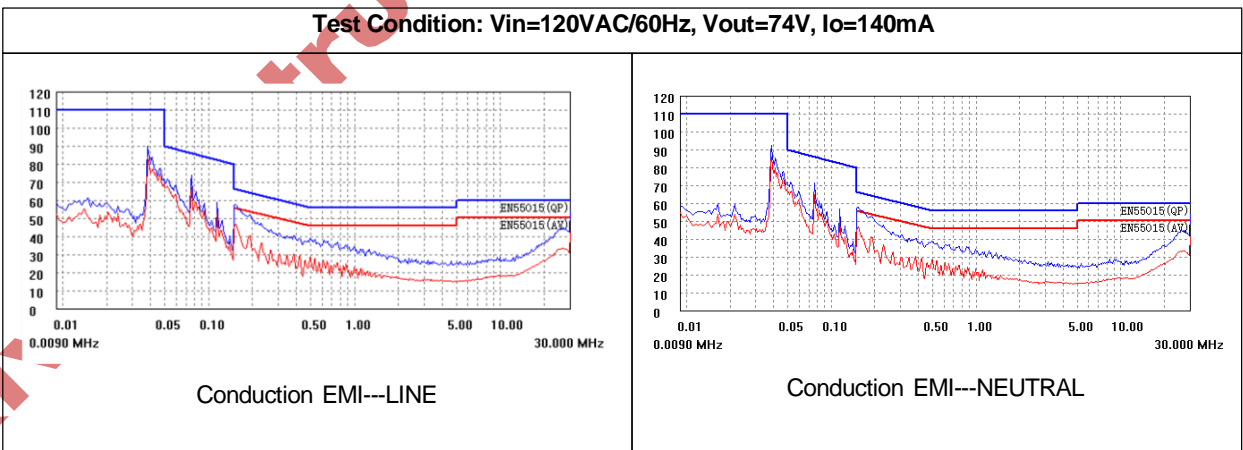
Test Condition: 120Vac/60Hz Input, Output short



6) Over Voltage Protection Test



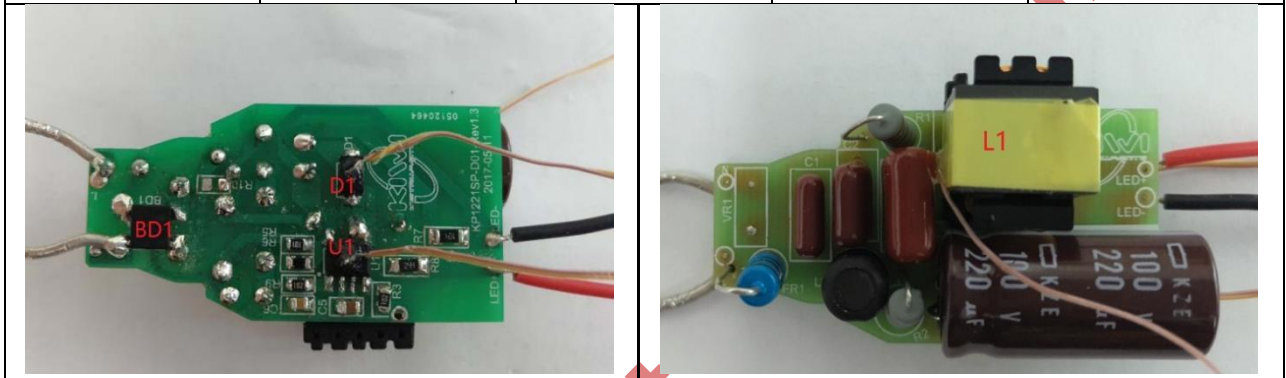
4. EMC Test Result



5. Thermal Test

Test Condition: 100Vac/60Hz, 140Vac/50Hz; 74V/140mA output; Ta=28°C under natural convection

Component	100Vac		140Vac	
	T(°C)	Trise(°C)	T(°C)	Trise(°C)
BD1	65.4	37.4	54	26
U1	88.1	60.1	72.4	44.4
D1	71.4	43.4	66.2	38.2
L1 Core	60.5	32.5	58.2	30.2



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Test Setup Guide

1. Connect the “LED+” terminal to the anode of LED string and the “LED-” terminal to the cathode of LED string.
2. Set the AC Power Supply to between 108VAC and 132VAC.
3. Connect the AC Power Source terminal to the “L” and “N” terminals on the Demo Board
4. Turn on the AC Power Source to make system startup; and Turn off the AC Power Source to make system shutdown.

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Revision History

DATE	REV	DESCRIPTION
2017/07/14	1.0	First Release

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