DEMO BOARD TEST REPORT

176-265VAC 200W Boost PFC LED Driver Using KP123SP

FEATURES

- Low Cost Boost APFC Solution
- Support Single Windings Design
- PF>0.98 and THD<10% with 176~265Vac Input
- Fast Startup < 300ms
- ±1% CC Regulation
- Suitable for 200W High Power Applications
- Quasi-Resonant for High Efficiency
- Excellent Line and Load Regulation
- Low Ripple with Output Current and No Stroboscopic
- Built-in Protections:
  - Output Over Voltage Protection (OVP)
  - Cycle-by-Cycle Current Limiting (OCP)
  - Leading Edge Blanking (LEB)
  - On-Chip Thermal Fold back (OTP)

APPLICATIONS

- **High Power Lighting**

INTRODUCTION

KP123 is a highly integrated LED Controller for LED lighting application. The IC utilizes Quasi-Resonant (QR) Boost topology with active PFC control for high PF, low THD, and high efficiency. Additionally, KP123 integrates with demagnetization signal detection technology, high voltage startup and IC power supply circuit, which eliminates auxiliary windings for demagnetization detection and power supply, simplifies system design and lower cost.

The Demo Board of KP123SP-D02 is typically designed for the application of 410V/470mA output with 176-265VAC input. And this demo adds a current ripple removing circuit, which can remove 100Hz/120Hz current ripple and achieve no stroboscopic. Besides the multi-protection function, this demo also has very good efficiency, current regulation, and meet the EN55015 conducted and radiated EMI requirement.

DEMO BOARD SEPCIFICATION

Description	Symbol	Min	Type	Max	Unit	Note
Input Voltage	Vin	176		265	Vac	50Hz
Output Voltage	Vout		410		Vdc	
Output Current	Iout		470		mA	
Output Power	Pout		192.7		W	
Efficiency	η		95		%	Typical value tested at 220Vac/50Hz
Power Factor	PF	0.98				Tested at 220Vac/50Hz
Input Current Distortion	THD		9.3		%	Tested at 230Vac/50Hz, IEC6100-3-2 Class C Passed
Startup Time	Tst			160	ms	Tested at 176Vac/50Hz
Surge Test		1000			V	Typical Differential Surge value tested at 220V/50Hz

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

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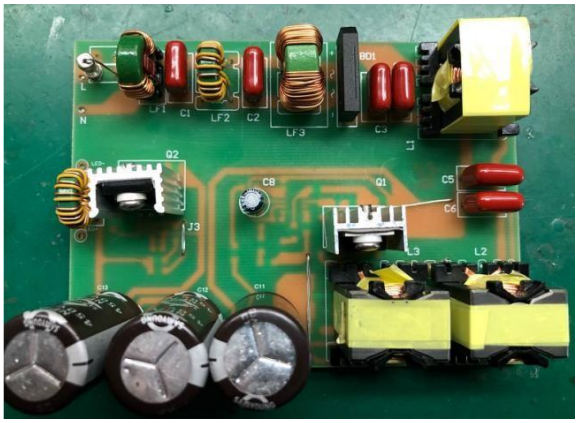
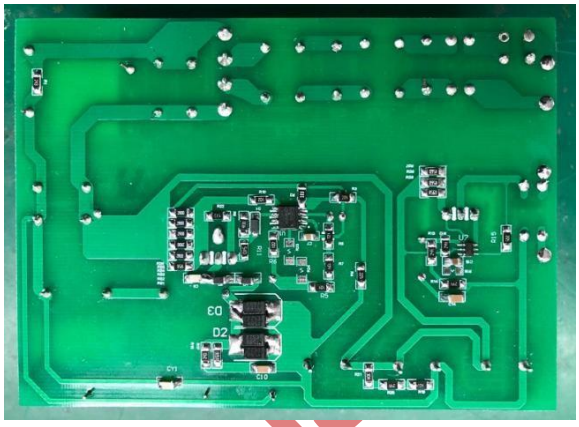
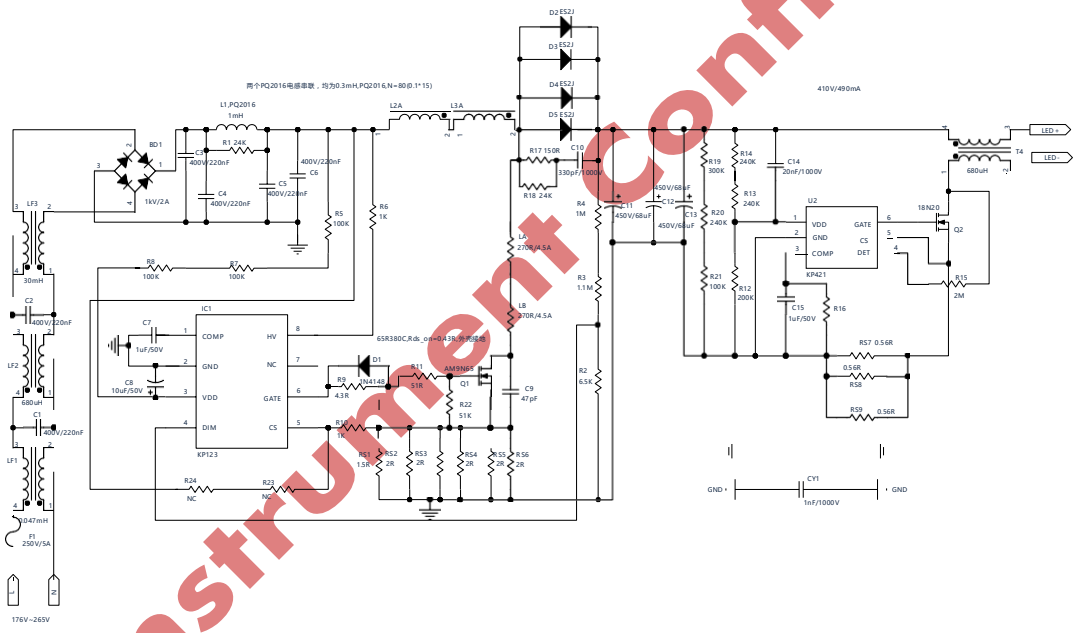
Demo Board of KP123SP_D02_REV1.0





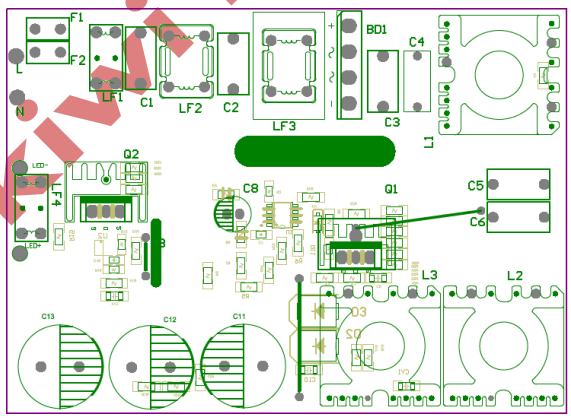
Board Size (in mm): L x W x H=109.5X79.4X33

Schematic

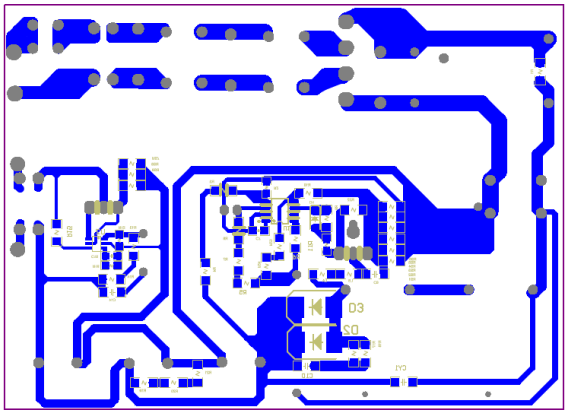


Printed Circuit Board Layout

Top Layer



Bottom Layer



Circuit Description

The demo board of KP123SP_D02 is designed with Non-isolated Boost PFC topology, which simplifies the circuit and saves BOM cost. The demo board can achieve good performance for high efficiency, high PF, low THD, good current regulation and EMC. Additionally, the demo board has a ripple removal circuit to remove the output current ripple and no stroboscopic can be achieved.

1. Input Rectification and EMI filtering

The circuit input stage is composed by the components of F1, BD1, C3, C4, L1, R1, C5 and C6. F1 provides the inrush current limitation in the event of component failure or a short circuit. LF1, LF2, LF3, LF4, C1, C2, C3, C4, C5, C6, L1 together provide the differential and common mode EMI filtering. The value of F1, C3, C4, C5 and C6 also determine the Surge Test performance. The bridge diode of BD1 rectifies the AC input to DC output.

2. KP123 and KP421 Operation

KP123 is a highly integrated Constant Current LED Controller with active PFC control for high PF and high efficiency. The IC adopts accurate current sensing and closed loop constant current control to achieve high precision CC control with excellent line regulation.

In KP123, the inductor demagnetization is detected by monitoring the falling edge of the negative voltage on the gate of power MOSFET. So, no auxiliary winding is needed. KP123 samples the peak inductor current in each switching cycle, which is used as the CC loop feedback, and the high accurate output current can be realized with a high accurate reference. R4, R5 and R6 are used as the sensing resistor. KP123 is integrated with OCP control scheme. When the inductor peak current is over the setting limit, MOSFET will shut down immediately. Additionally, KP123 is integrated with output short protect and output over voltage protect. SCP and OVP is detecting by monitoring the voltage of FB pin. MOSFET will stops switching immediately when FB voltage is lower than FB Low Voltage Threshold voltage or is higher than FB High Voltage Threshold voltage. R7, R8 and R9 are used program the output over voltage.

KP421 is a current ripple removing controller, which can remove 100Hz/120Hz current ripple produced by front stage LED driver with external NMOSFET. And the power loss can be minimized. KP421 can suppress or basically eliminate LED current ripple by detecting front stage output voltage ripple to adjust MOSFET impedance in series in the LED current Loop. When preceding stage LED current increases, DET voltage and MOSFET impedance will increase. When preceding stage LED current decreases, DET voltage and MOSFET impedance will decrease.

3. Output Current Regulation

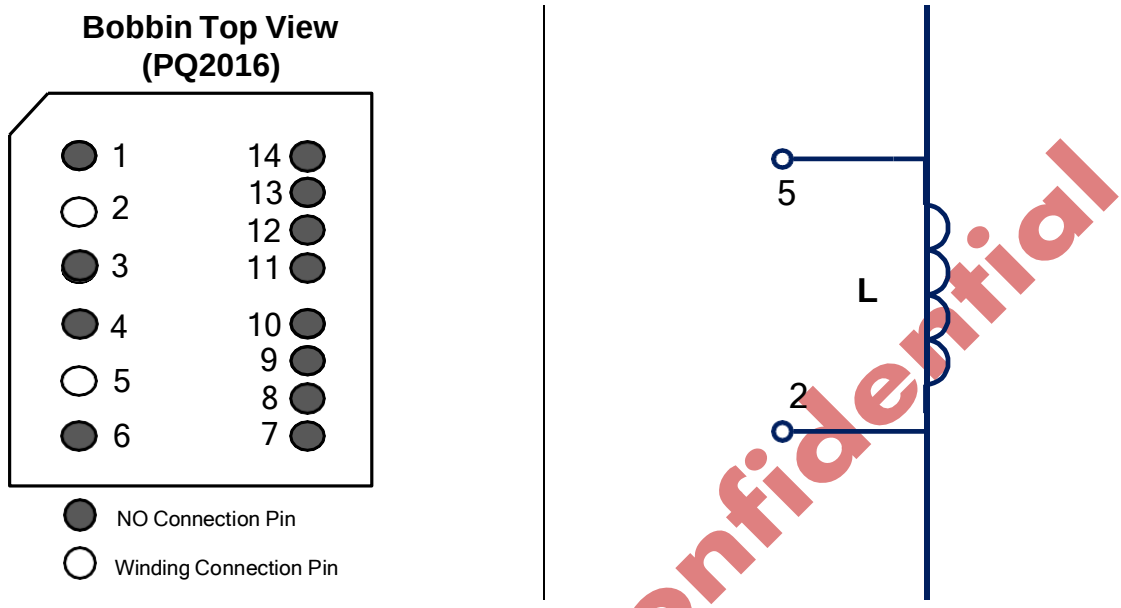
IC1, L2, L3, D2~D5 and Q1 compose the typical Boost PFC converter. R19~R21 is the dummy resistor and output capacitor C11, C12 and C13 is discharged after system is shut down.

Bill of Material

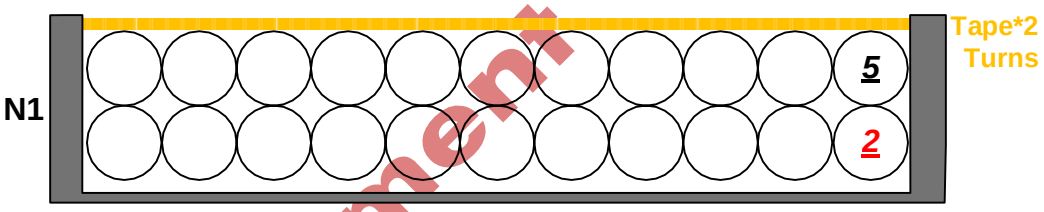
No.	Designator	Value	Description	Package	Manufacturer	Part Number
1	BD1	600V/4A	SINGLE PHASE SILICON BRIDGE	TH	Any	
2	C1, C2, C3,C4, C5, C6	220nF	CL21,400Vdc,P=12mm,T=5mm	TH	Any	
3	C7	1uF	Ceramic Cap, 50V X7R	0805	TDK	C2012X7R1E105K
4	C8	10uF	Electrolytic Cap, 50V,6.3*12	TH	jianghai	
5	C9	47pF	Ceramic Cap, 1000V X7R	1206	Any	
6	C10	330pF	Ceramic Cap, 1000V X7R	1206	Any	
7	C11, C12, C13	68uF	Electrolytic Cap, 450V,16*20	TH	SAMYOUNG	
8	C14	20nF	Ceramic Cap, 1000V X7R	1206	Any	
9	C15	1uF	Ceramic Cap, 50V X7R'	0805	TDK	C2012X7R1E105K
10	F1	250V/5A	Fuse 250V/5A	TH	Any	
11	D1	75V/200mA	Surface Mount Diode	SOD123	Any	1N4148
12	D2,D3,D4,D5	600V/1.5A	1.5 AMP Surface Mount Super Fast Recovery Diode	SMA	Lision Tech	ES2J
13	R1,R18	24K	Film Resistor, 5%	1206	Yageo	
14	R2	6.7K	Film Resistor, 5%	1206	Yageo	
15	R3	1.1M	Film Resistor, 5%	1206	Yageo	
16	R4	1M	Film Resistor, 5%	1206	Yageo	
17	R5,R7,R8,R21	100K	Film Resistor, 5%	1206	Yageo	
18	R6,R10	1K	Film Resistor, 5%	1206	Yageo	
19	R9	4.3R	Film Resistor, 5%	1206	Yageo	
20	R11	51R	Film Resistor, 5%	1206	Yageo	
21	R12,R13,R14,R20	240K	Film Resistor, 5%	1206	Yageo	
22	R15	2M	Film Resistor, 5%	1206	Yageo	
23	R17	150R	Film Resistor, 5%	1206	Yageo	
24	R19	300K	Film Resistor, 5%	1206	Yageo	
25	R22	51K	Film Resistor, 5%	1206	Yageo	
26	R16,R23,R24	NC				
27	LF1	470uH	WE-CMBNiZn Common Mode Power Line Choke,TYPE XS	XS	Wurth Elektronik	
28	LF2,LF4	680uH	Common Mode Power Line Choke	TH	Any	
29	LF3	30mH	Common Mode Power Line Choke	TH	Any	
30	L1	1mH	Single Winding Inductor, Bobbin= PQ2016	PQ2016	Any	
31	L2,L3	0.3mH	Single Winding Inductor, Bobbin= PQ2016,Turn=80T,0.1*15mm	PQ2016	Any	
32	Q1	65R380C	N Mosfet, 650V, Rdson=0.38ohm	TO-220	WUXI UNIGROUP MICRO	65R380C
33	LA,LB	270R/4.5A	Magnetic beads,270R±25%,4.5A@100Mhz	1206	Any	BLM31KN271SN1
34	Q2	SFF18N20	N Mosfet, 200V, Rdson=0.15ohm	TO-220	HISEMICON	SFF18N20
35	IC1	KP123	Boost PFC LED Driver	SOP-8	Kiwi instrument	
36	IC2	KP421	Adaptive Current Ripple Removing Controller	SOT-23-6	Kiwi instrument	
37	Heatsink	-	Al, L x W x H=14.4X9.3X26.4(mm)	-	Any	
38	Wire	-	Three	-	Any	
39	PCB	-	PCB_KP123SP_D02_REV1.0，Board Size (in mm): L x W x H=109.5X79.4X33	-	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	2	5	0.1d*15P	80Ts	
2	Tape					2T	

4. Electrical Specification

Items	Test Condition	Test Pin	Standard
Primary Inductance	measured at 40kHz,1.0 VRMS	Pins 2-5; other windings open	0.3mH±5%
DC Resistance	-	Pins 2-5	1.2ohm MAX

5. BOM

Items	Spec
Core	PQ2016, PC40 or equivalent
Bobbin	PQ2016, 6+8 vertical transformer bobbin
Wire	Φ 0.1 mm *15,130℃
Tape	3M 1350# Polyester Film

Test Result

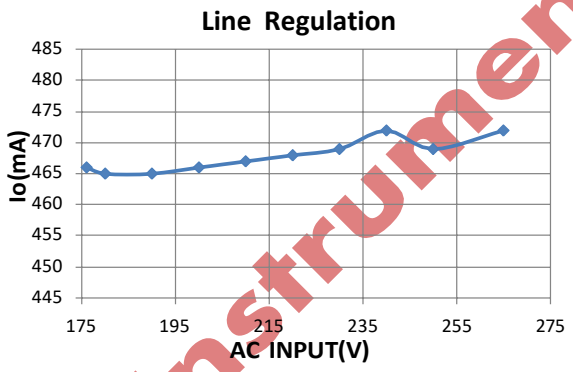
1. Test Data

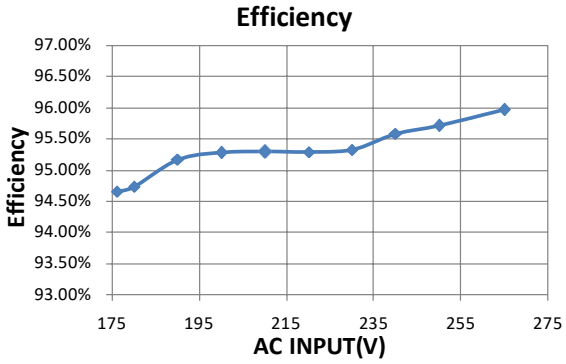
1) Line Regulation, Efficiency, PF and THD

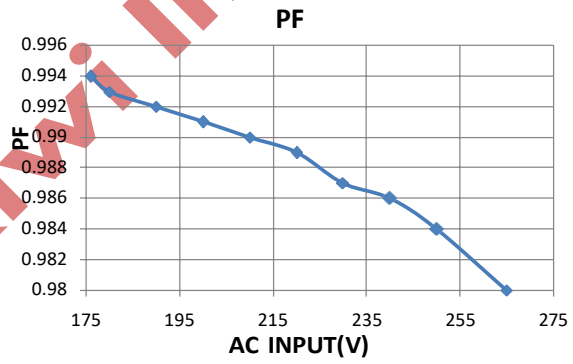
VIN (VAC)	Fline (Hz)	Pin (W)	PF	THD	Io (mA)	Vo (V)	Eff (%)
176	50	204.8	0.994	8.1%	466	416.0	94.66
180		203.2	0.993	8.2%	465	414.0	94.74
190		201.6	0.992	8.5%	465	412.6	95.17
200		201.5	0.991	8.8%	466	412.0	95.28
210		201.6	0.990	9.0%	467	411.4	95.30
220		201.7	0.989	9.2%	468	410.7	95.29
230		201.9	0.987	9.3%	469	410.4	95.33
240		202.5	0.986	9.4%	472	410.1	95.59
250		200.6	0.984	9.7%	469	409.4	95.72
265		201.2	0.980	10%	472	409.1	95.97

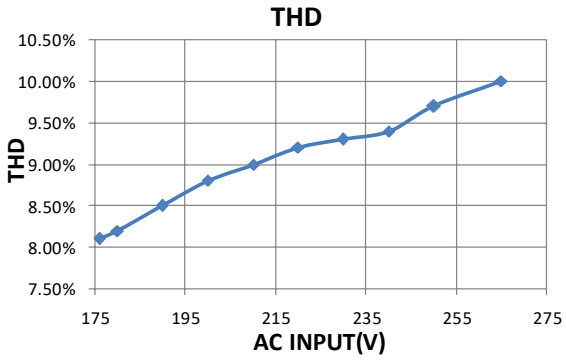
2) High Order Harmonic

Vin	THD	3	5	7	9	11	13	15
220Vin/50Hz	9.2	8.5	2.4	0.5	1.0	0.9	0.6	0.4



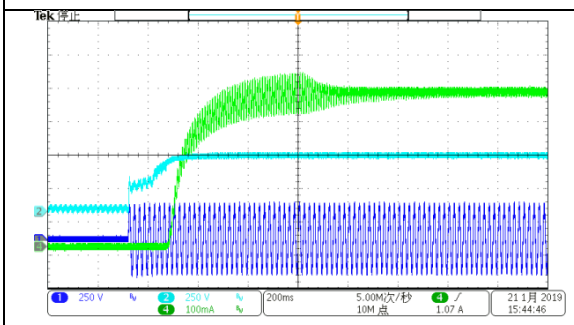
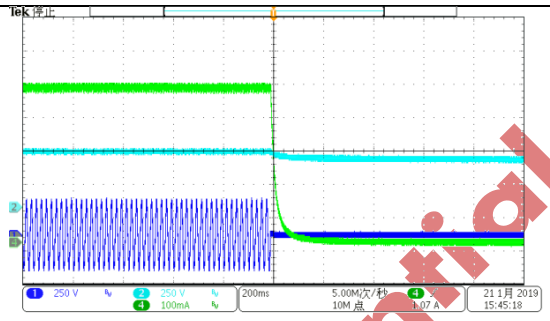
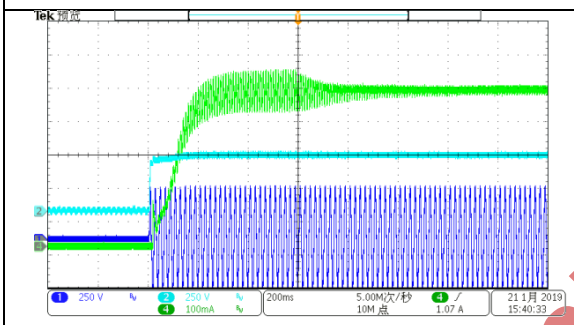
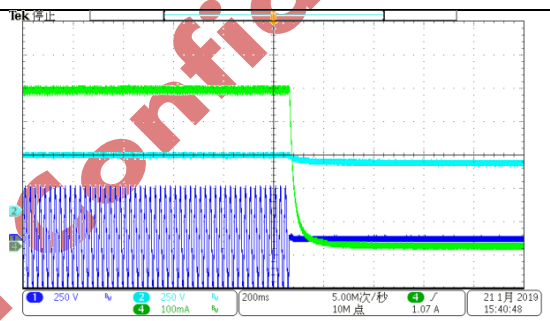




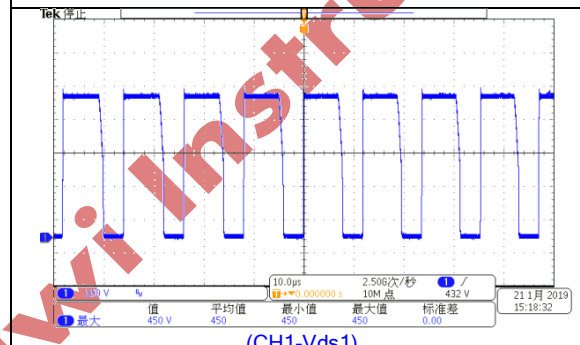
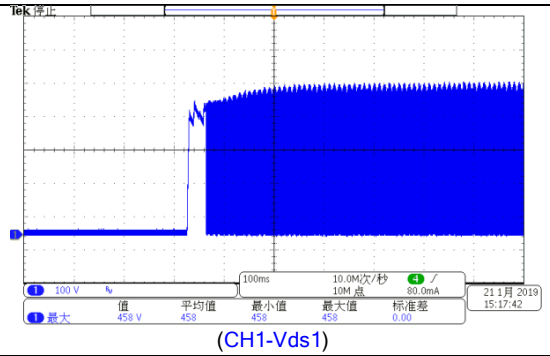


2. Operation Curves

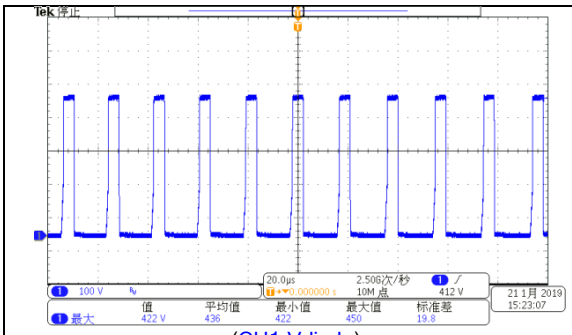
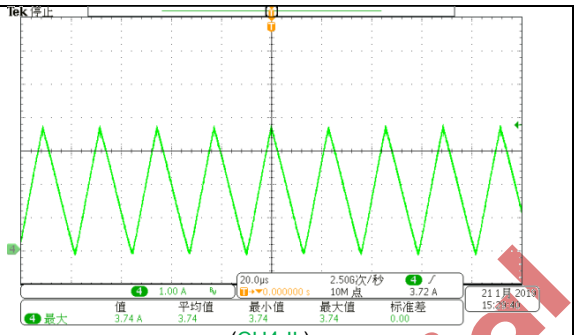
1) Startup and Shutdown Test

Test Condition: 176Vac/50Hz Input, 410V470mA Output	
 (CH1-VINAC, CH2-VO,CH4-IO)	 (CH1-VINAC, CH2-VO,CH4-IO)
Comments: Startup Time=156ms and No Overshoot	**Comments:**Shutdown OK
Test Condition: 265Vac/50Hz Input, 410V470mA Output	
 (CH1-VINAC, CH2-VO,CH4-IO)	 (CH1-VINAC, CH2-VO,CH4-IO)
Comments: Startup Time=14.8ms and No Overshoot	**Comments:**Shutdown OK

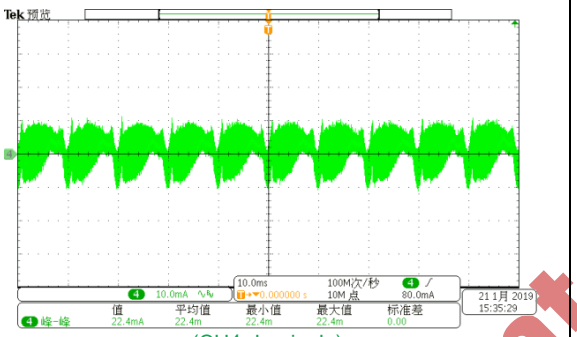
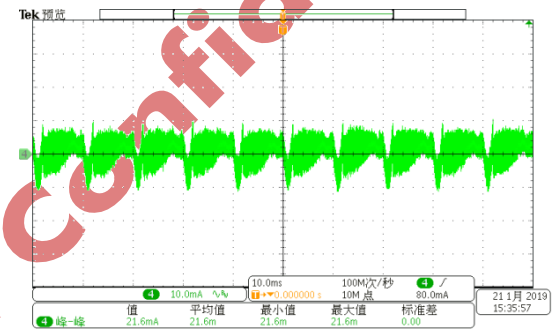
2) Device Maximum Rating Test

Test Condition: 265Vac/50Hz Input, 410V470mA Output	
 (CH1-Vds1)	 (CH1-Vds1)
Comments: Vds_max=450V	**Comments:**Vds_max=458V

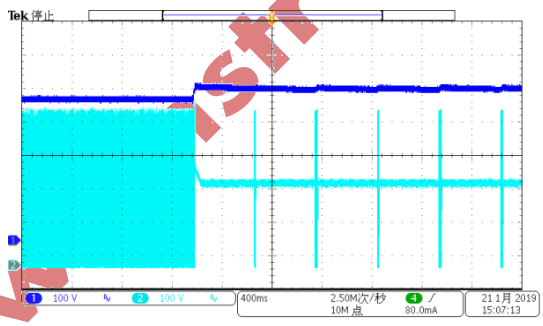
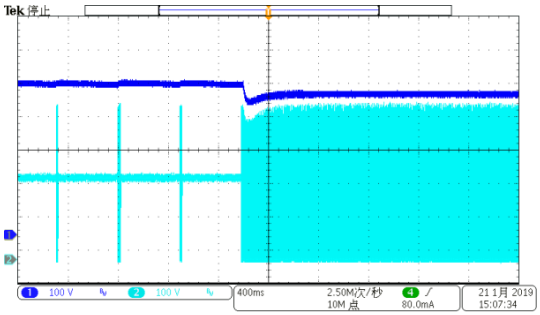
Test Condition: 265Vac/50Hz Input, 410V470mA Output	**Test Condition:** 176Vac/50Hz Input, 410V470mA Output

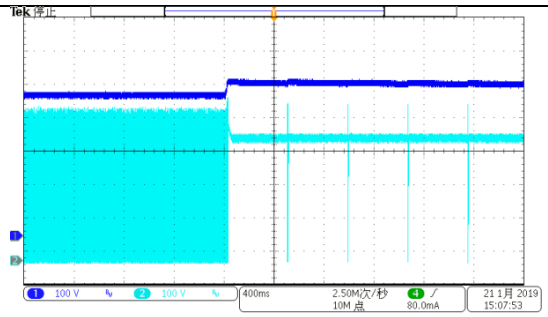
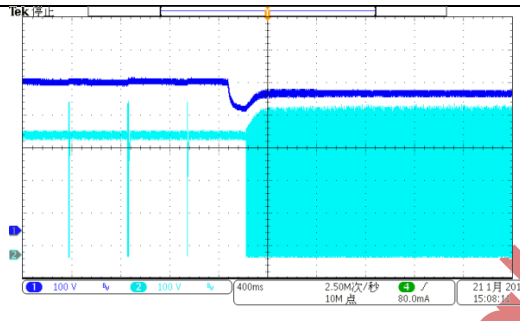
 (CH1-Vdiode)	 (CH4-IL)
Comments: Vdiode=422V	**Comments:**IL=3.74A,B=0.28T

3) Output Ripple Test

Test Condition: 176Vac/50Hz Input, 410V470mA Output	**Test Condition:** 265Vac/50Hz Input, 410V470mA Output
 (CH4- Io_ripple)	 (CH4- Io_ripple)
Comments: Io_ripple_pp=22.4mA	**Comments:**Io_ripple_pp=21.6mA

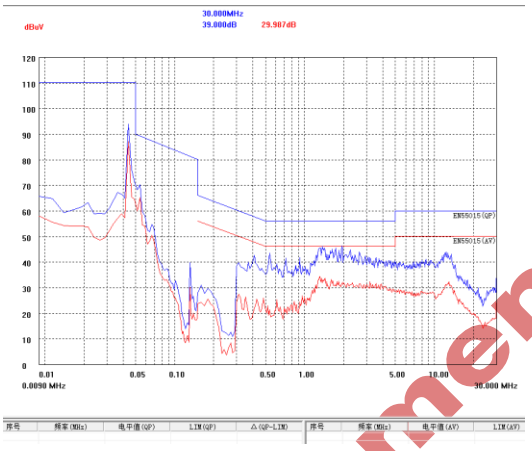
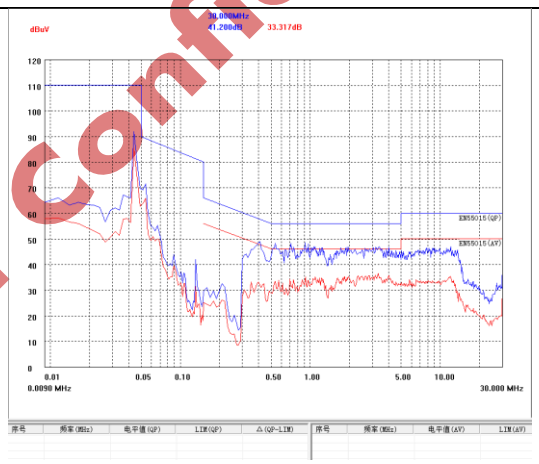
4) Over Voltage Protection Test

Test Condition: 176Vac/50Hz Input, output open	
 Over Voltage Protection (CH1-VO, CH2-Vds1)	 Over Voltage Protection (CH1-VO, CH2-Vds1)
Comments: OVP=470V and it's OK	**Comments:** OVP=470V and it's OK
Test Condition: 265Vac/50Hz Input, output open	

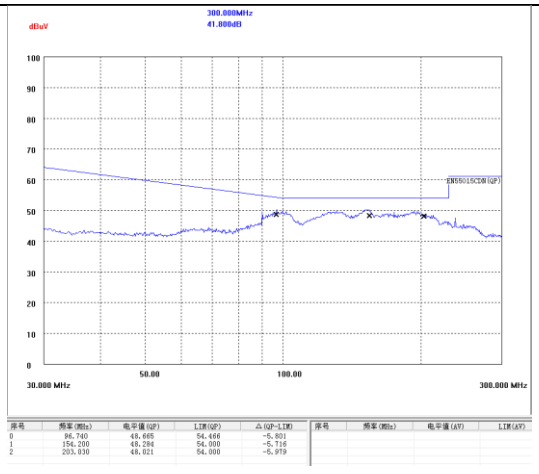
 Over Voltage Protection (CH1-VO, CH2-Vds1)	 Over Voltage Protection Recovery (CH1-VO, CH2-Vds1)
Comments: OVP=470V and it's OK	**Comments:** OVP=470V and it's OK

3. EMC Test Result

Test Condition: Vin=220VAC/50Hz, Vout=410V, Io=470mA

 Conduction EMI---LINE	 Conduction EMI---NEUTRAL

Test Condition: Vin=220VAC/50Hz, Vout=420V, Io=180mA

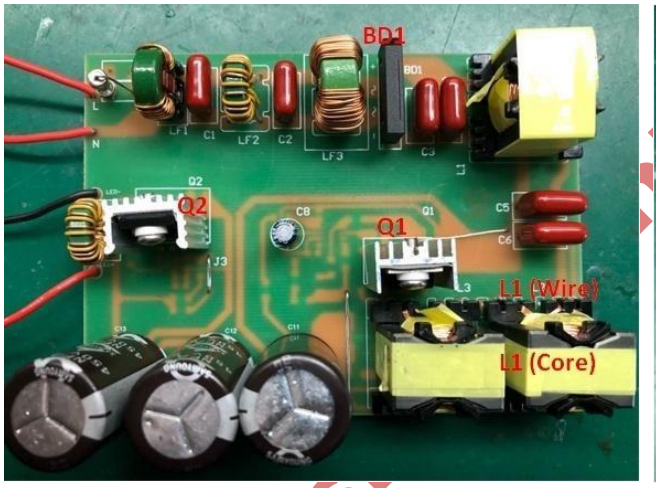


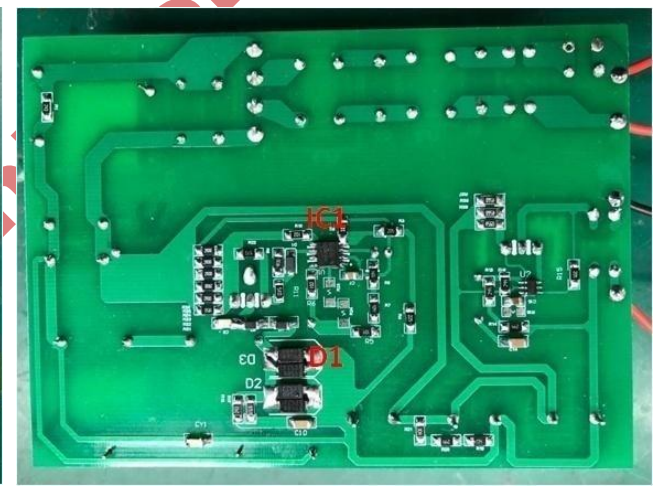
Conduction EMI---CDN

4. Thermal Test

Test Condition: 176Vac/50Hz, 220Vac/50Hz, 265Vac/50Hz; 410V/470mA output; In the non-convective environment.

	176Vac			220Vac			265Vac		
	Tc(ºC)	Ta(ºC)	Trise(ºC)	Tc(ºC)	Ta(ºC)	Trise(ºC)	Tc(ºC)	Ta(ºC)	Trise(ºC)
BD1	**92.0**	**41.3**	**50.7**	**78.9**	**37.4**	**41.5**	**74.5**	**38.2**	**36.3**
L1(Core)	**68.8**	**41.3**	**27.5**	**54.7**	**37.4**	**17.3**	**52.4**	**38.2**	**14.2**
L1(Wire)	**71.9**	**41.3**	**30.6**	**57.1**	**37.4**	**19.7**	**54.5**	**38.2**	**16.3**
Q1	**77.6**	**41.3**	**36.3**	**61.6**	**37.4**	**24.2**	**62.6**	**38.2**	**24.4**
Q2	**89.2**	**41.3**	**47.9**	**87.9**	**37.4**	**50.5**	**92.0**	**38.2**	**53.8**
D1	**95.7**	**41.3**	**54.4**	**91.4**	**37.4**	**54.0**	**92.4**	**38.2**	**54.2**
IC	**69.5**	**41.3**	**28.2**	**64.7**	**37.4**	**27.3**	**66.7**	**38.2**	**28.5**





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 176VAC and 265VAC.
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.

Revision History

DATE	REV	DESCRIPTION
2019/01/31	1.0	First Release

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