DEMO BOARD TEST REPORT

90-265VAC 80W Boost PFC LED Driver Using KP123SP

FEATURES

- Low Cost Boost APFC Solution
- Support Single Windings Design
- PF>0.95 and THD<10% with Universal Input
- Fast Startup < 300ms
- ±2% CC Regulation
- Built-in 650V Startup and Power Supply Circuit
- Quasi-Resonant for High Efficiency
- Very Low VDD Operation Current
- Excellent Line and Load Regulation
- Built-in Protections:
  - Output Over Voltage Protection (OVP)
  - Cycle-by-Cycle Current Limiting (OCP)
  - Leading Edge Blanking (LEB)
  - On-Chip Thermal Fold back (OTP)
- Available in SOP-8 Package

APPLICATIONS

- **LED Filament Lamp**

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-D01 is typically designed for the application of 420V/180mA output with 90-265VAC input. 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	90		265	Vac	50Hz/60Hz
Output Voltage	Vout		420		Vdc	
Output Current	Iout		180		mA	
Output Power	Pout		75.6		W	
Efficiency	η		94		%	Typical value tested at 220Vac/50Hz
Power Factor	PF	0.97				Tested at 265Vac/50Hz
Input Current Distortion	THD		5.8		%	Tested at 230Vac/50Hz and 115Vac/60Hz，IEC6100-3-2 Class C Passed
Startup Time	Tst			240	ms	Tested at90Vac/60Hz
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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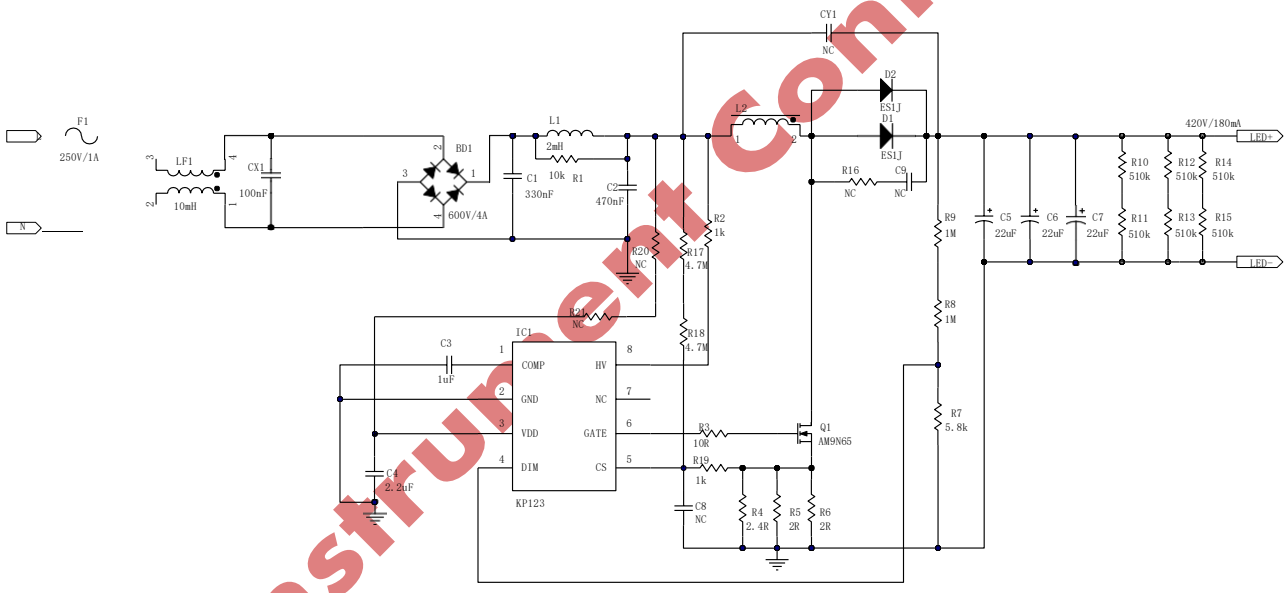
Demo Board of KP123SP_D01_REV1.0

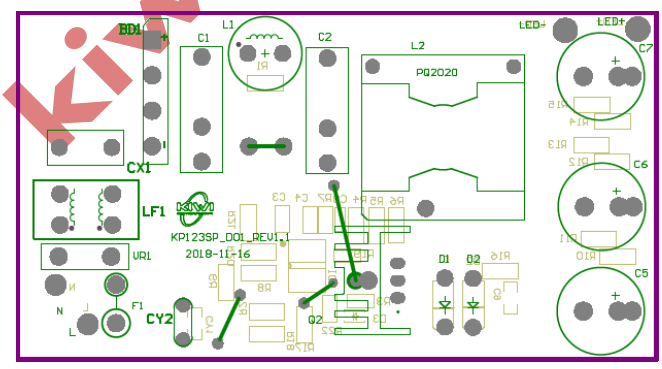
Board Size (in mm): L x W x H=91.5X50X23

Schematic

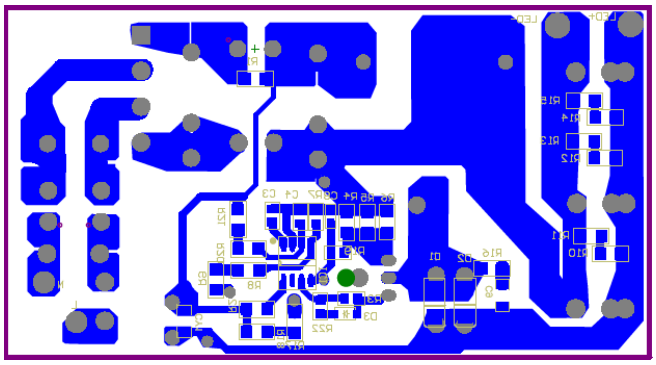


Printed Circuit Board Layout

Top Layer



Bottom Layer



Circuit Description

The demo board of KP123SP_D01 is designed with Non-isolated Boost PFC topology, which simplifies the circuit and saves BOM cost. Additionally the demo board can achieve good performance for high efficiency, high PF, low THD, good current regulation and EMC.

1. Input Rectification and EMI filtering

The circuit input stage is composed by the components of F1, LF1, CX1, BD1, C1, L1, R1 and C2. F1 provides the inrush current limitation in the event of component failure or a short circuit. LF1, CX1, C1, L1, R1 and C2 together provide the differential and common mode EMI filtering. The value of F1, C1 and C2 also determine the Surge Test performance. The bridge diode of BD1 rectifies the AC input to DC output.

2. KP123 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.

3. Output Current Regulation

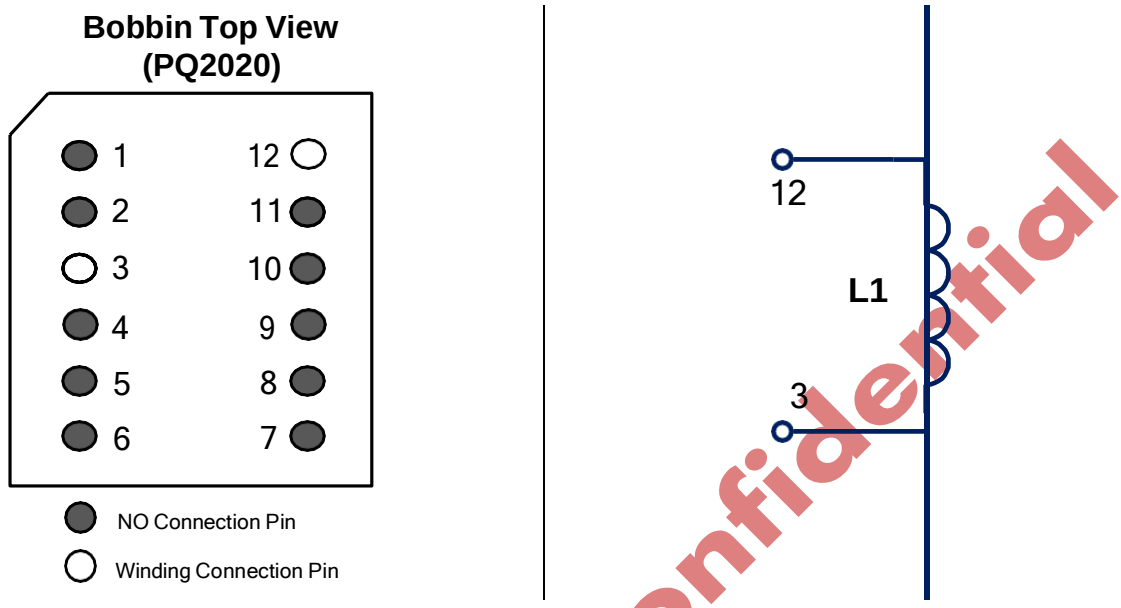
U1, L2, D1, D2and Q2 compose the typical Boost PFC converter. R10~R15 is the dummy resistor and output capacitor C5 and C6 is discharged after system is shut down.

Bill of Material

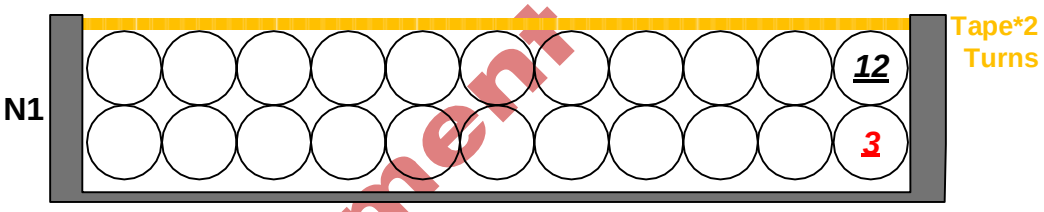
No.	Designator	Value	Description	Package	Manufacturer	Part Number
1	F1	250V/1A	FUSE,250V/1A	TH	Any	
2	LF1	10mH/1A	WE-CMBNC Common Mode Power Line Choke,TYPES	TH	WE	
3	CX1	100nF	MKP62,275Vac~X2,P=7.5mm,T=5mm	TH	Fala	
4	BD1	600V/4A	SINGLE PHASE SILICON BRIDGE,600V/4A	SMD	Any	
5	C1	330nF/450V	450V,P=12mm,T=4.8mm	TH	Any	
6	C2	470nF/450V	450V,P=15mm,T=6.4mm	TH	Any	
7	C3	1uF	Ceramic Cap, 25V X7R	0805	TDK	C2012X7R1E105K
8	C4	2.2uF	Ceramic Cap, 25V X7R	0805	TDK	C2012X7R1E225K
9	C5	22uF	Electrolytic Cap, 450V,12.5*20	TH	JiangHai	
10	C6	22uF	Electrolytic Cap, 450V,12.5*20	TH	JiangHai	
11	C7	22uF	Electrolytic Cap, 450V,12.5*20	TH	JiangHai	
12	L1	2mH	TI Inductor 2mH 10*16	TH	WE	
13	L2	1mH	Single Winding Inductor, Bobbin= PQ2020,Turn=143T,0.5mm	PQ2020	Any	
14	R1	10K	Film Resistor, 5%	1206	Yageo	
15	R2	1K	Film Resistor, 5%	0805	Yageo	
16	R3	10R	Film Resistor, 5%	0805	Yageo	
17	R4	2.4R	Film Resistor, 5%	1206	Yageo	
18	R5	2R	Film Resistor, 5%	1206	Yageo	
19	R6	2R	Film Resistor, 5%	1206	Yageo	
20	R7	5.8K	Film Resistor, 5%	0805	Yageo	
21	R8,R9	1M	Film Resistor, 5%	1206	Yageo	
22	R10	510K	Film Resistor, 5%	1206	Yageo	
23	R11	510K	Film Resistor, 5%	1206	Yageo	
24	R12	510K	Film Resistor, 5%	1206	Yageo	
25	R13	510K	Film Resistor, 5%	1206	Yageo	
26	R14	510K	Film Resistor, 5%	1206	Yageo	
27	R15	510K	Film Resistor, 5%	1206	Yageo	
28	R17,R18	4.7M	Film Resistor, 5%	1206	Yageo	
29	R19	1K	Film Resistor, 5%	0805	Yageo	
30	D1	600V/1A	1.0 AMP Surface Mount Super Fast Recovery Rectifiers	SMA	Lision Tech	ES1J
31	D2	600V/1A	1.0 AMP Surface Mount Super Fast Recovery Rectifiers	SMA	Lision Tech	ES1J
32	Q1	AM9N65	N MOSFET AM9N65	TO-220	Analog	AM9N65
33	IC	KP123SP	KP123SP,SOP-8	SMD	Kiwi Instrument	KP123SP
34	Heatsink	-	Al, L x W x H=14.4X9.3X26.4(mm)		Any	
35	Wire	-	Four		Any	
36	PCB		PCB_KP123SP_REV1.1，Board Size (in mm): L x W x H=91.5X50X23		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	12	0.5d*1P	143Ts	
2	Tape					2T	

4. Electrical Specification

Items	Test Condition	Test Pin	Standard
Primary Inductance	measured at 40kHz,1.0 VRMS	Pins 3-12; other windings open	1mH±5%
DC Resistance	-	Pins 3-12	1.5ohm MAX

5. BOM

Items	Spec
Core	PQ2020, PC40 or equivalent
Bobbin	PQ2020 , 6+6 vertical transformer bobbin
Wire	0.5mmΦ ,130℃
Tape	3M 1350# Polyester Film

Test Result

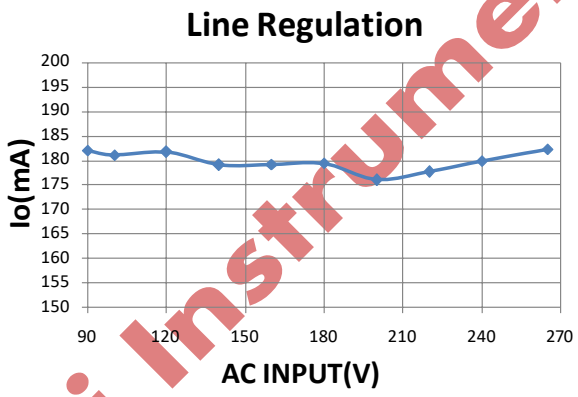
1. Test Data

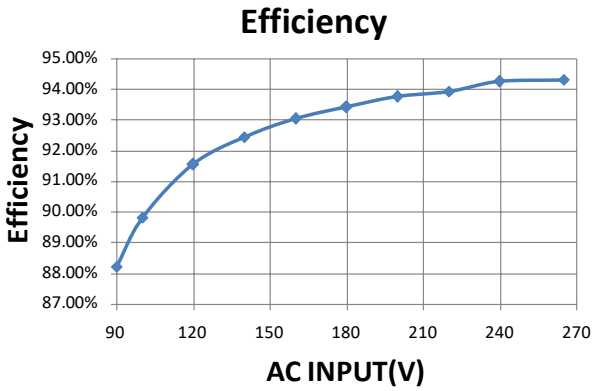
1) Line Regulation, Efficiency, PF and THD

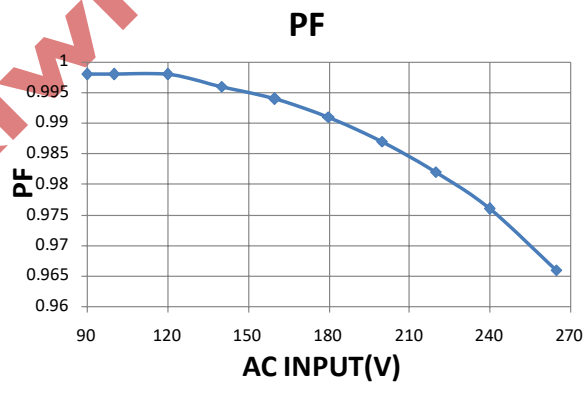
VIN (VAC)	Fline (Hz)	Pin (W)	PF	THD	Io (mA)	Vo (V)	Eff (%)
90	50	84.45	0.998	4.3%	182.1	421.4	88.2
100		82.84	0.998	4.1%	181.2	420.3	89.83
120		81.52	0.998	3.3%	181.7	420.3	91.56
140		79.9	0.996	3.1%	179.1	419	92.45
160		79.61	0.994	3.7%	179.2	418.5	93.05
180		79.92	0.991	3.5%	179.4	418.1	93.43
200		78.57	0.987	4.2%	176	417	93.78
220		79.83	0.982	5.1%	177.7	417.2	93.95
240		81.39	0.976	6.5%	179.9	417.4	94.28
265		82.98	0.966	8.0%	182.4	418	94.34

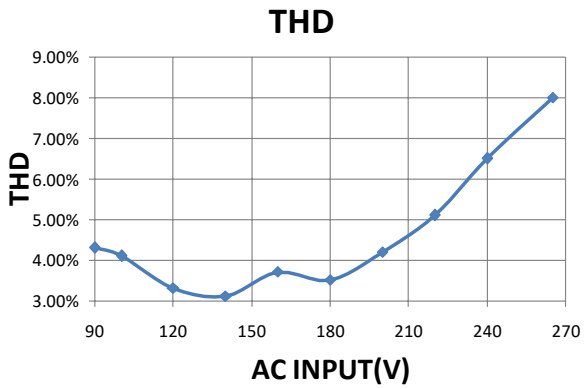
2) High Order Harmonic

Vin	THD	3	5	7	9	11	13	15
127Vin/60Hz	3.3	2.7	1.3	0.3	0.3	0.2	0.3	0.4
220Vin/50Hz	5.1	3.5	1.3	1.3	1.5	1.2	1.1	0.9



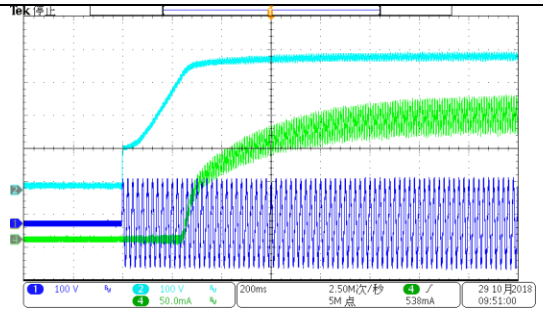
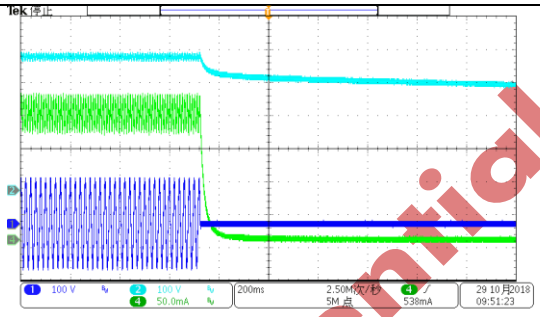
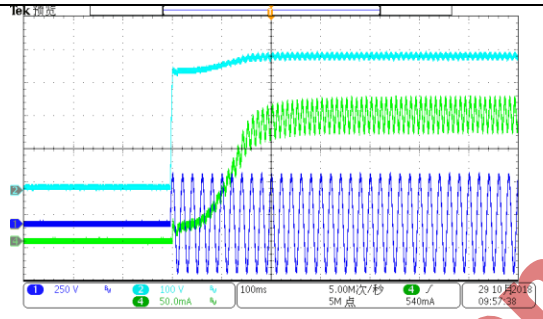
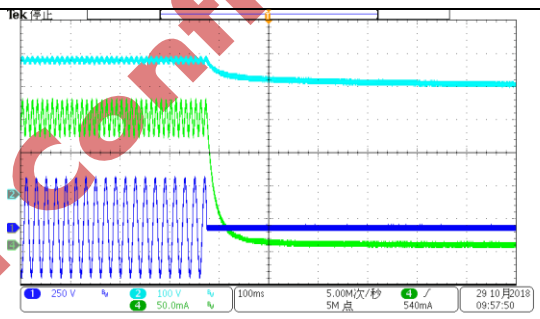




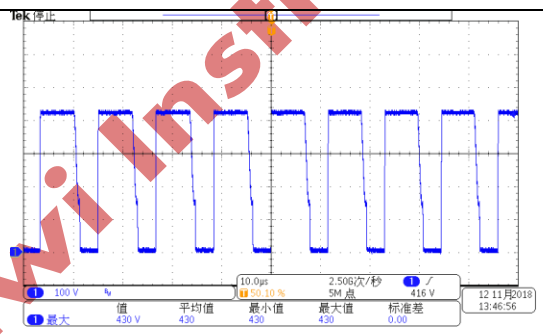
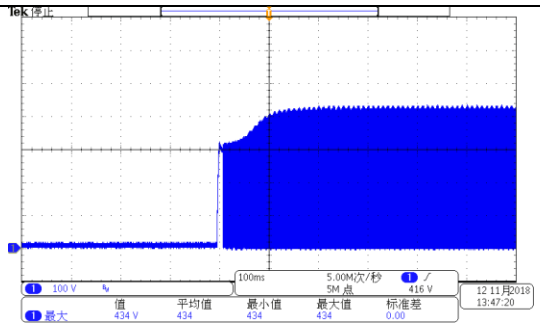


2. Operation Curves

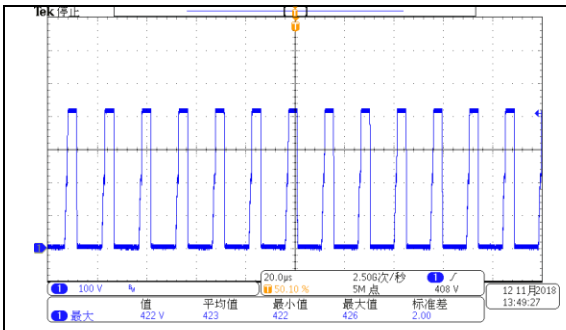
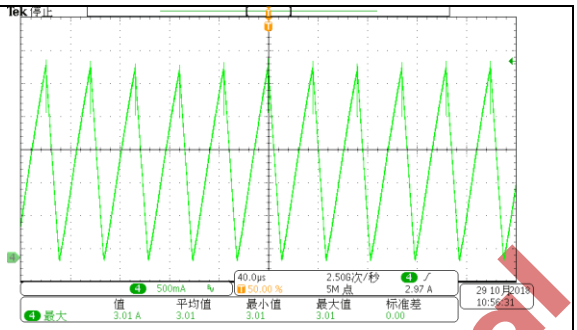
1) Startup and Shutdown Test

Test Condition: 90Vac/50Hz Input, 420V180mA Output.	
	
(CH1-VINAC, CH2-VO,CH4-IO)	(CH1-VINAC, CH2-VO,CH4-IO)
Comments: Startup Time=240ms and No Overshoot	**Comments:**Shutdown OK
Test Condition: 265Vac/50Hz Input, 420V180mA Output	
	
(CH1-VINAC, CH2-VO,CH4-IO)	(CH1-VINAC, CH2-VO,CH4-IO)
Comments: Startup Time=4ms and No Overshoot	**Comments:**Shutdown OK

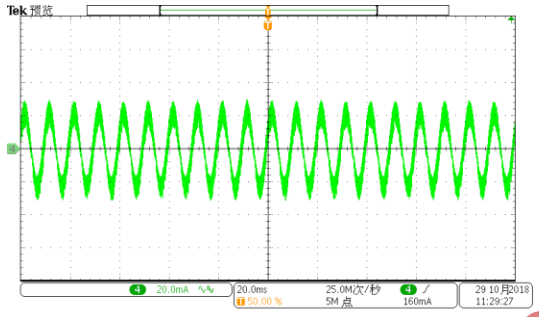
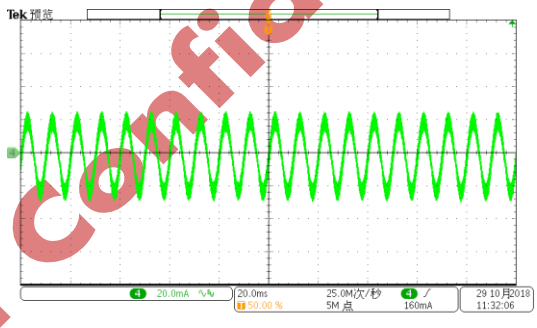
2) DeviceMaximum Rating Test

Test Condition: 220Vac/50Hz Input, 420V180mA Output	
	
(CH1-Vds)	(CH1-Vds)
Comments: Vds_max=430V	**Comments:**Vds_max=434V

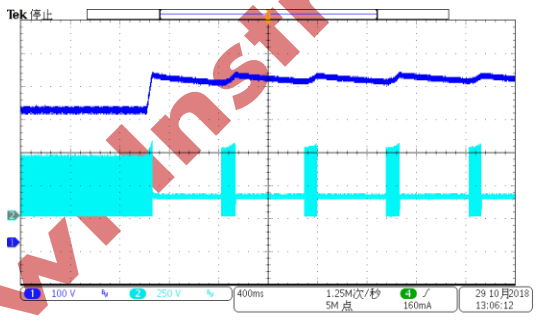
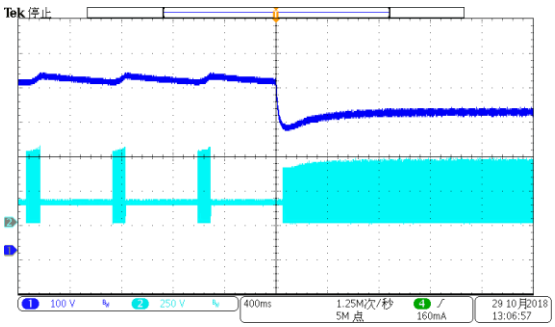
Test Condition: 220Vac/50Hz Input, 420V180mA Output

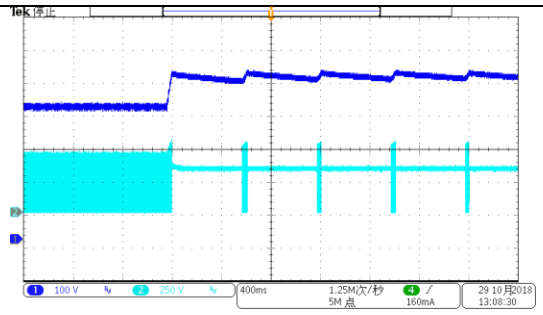
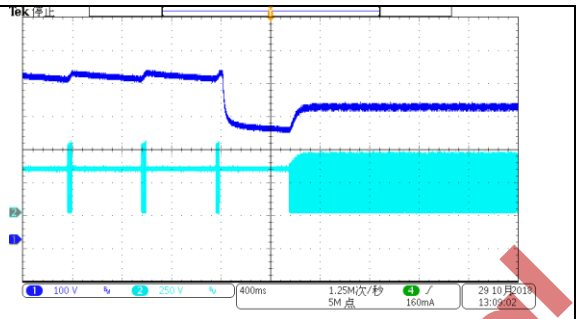
 (CH1-Vdiode)	 (CH4-IL)
Comments: Vdiode=426V	**Comments:**IL=3A,B=0.28T

3) Output Ripple Test

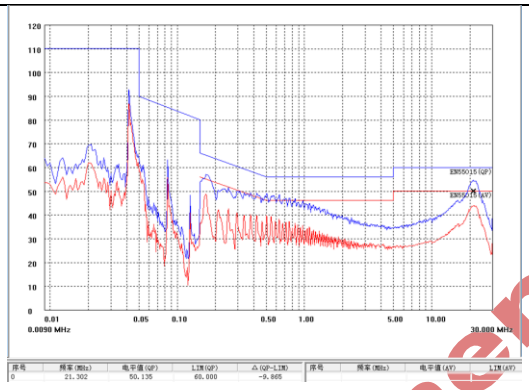
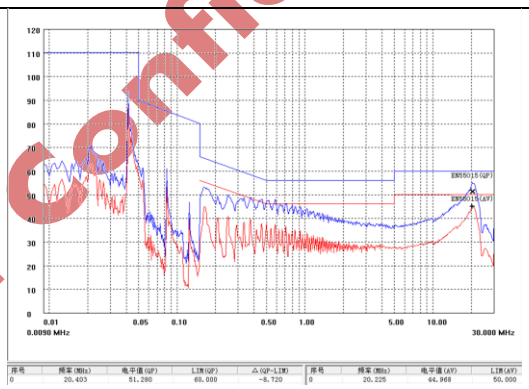
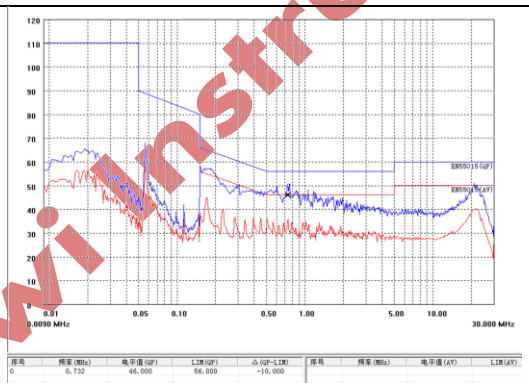
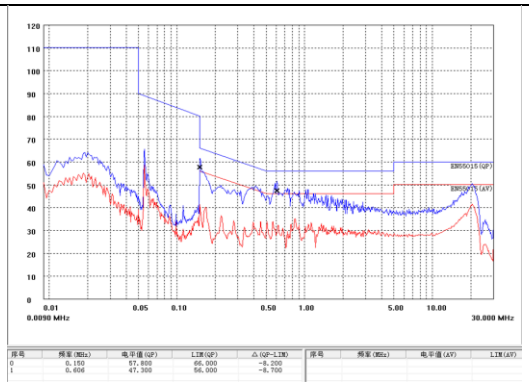
Test Condition: 90Vac/50Hz Input, 420V180mA Output	**Test Condition:** 220Vac/50Hz Input, 420V180mA Output
 (CH4- Io_ripple)	 (CH4- Io_ripple)
Comments: Io_ripple_pp=61mA	**Comments:**Io_ripple_pp=55mA

4) Over Voltage Protection Test

Test Condition: 90Vac/50Hz Input, output open	
 Over Voltage Protection (CH1-VO, CH2-Vds)	 Over Voltage Protection (CH1-VO, CH2-Vds)
Comments: OVP=510V and it's OK	**Comments:** OVP=510V and it's OK
Test Condition: 220Vac/50Hz Input, output open	

 Over Voltage Protection (CH1-VO, CH2-Vds)	 Over Voltage Protection Recovery (CH1-VO, CH2-Vds)
Comments: OVP=510V and it's OK	**Comments:** OVP=510V and it's OK

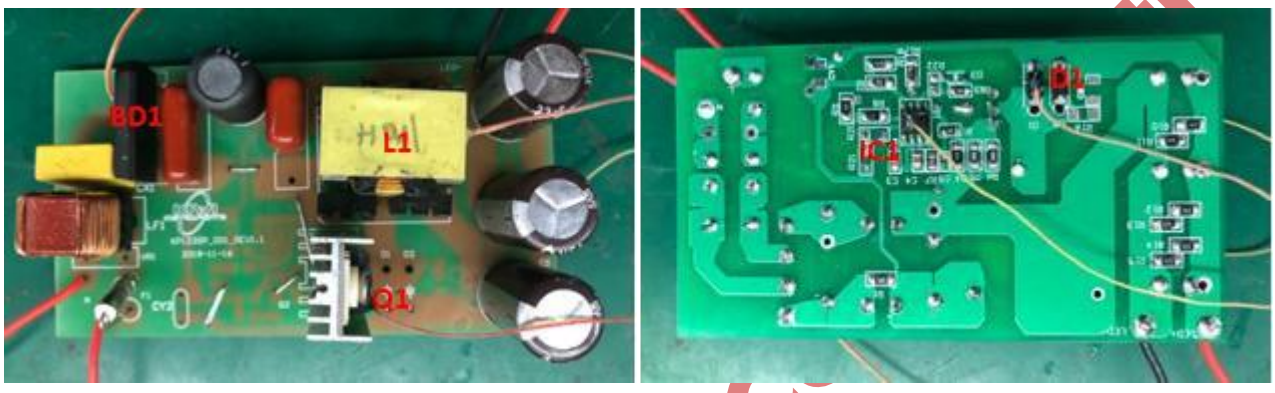
3. EMC Test Result

Test Condition: Vin=110VAC/50Hz, Vout=420V, Io=180mA	
 Conduction EMI---LINE	 Conduction EMI---NEUTRAL
Test Condition: Vin=220VAC/50Hz, Vout=420V, Io=180mA	
 Conduction EMI---LINE	 Conduction EMI---NEUTRAL

4. Thermal Test

Test Condition: 110Vac/50Hz, 220Vac/50Hz; 420V180mA output; In the non-convective environment.

	110Vac			220Vac		
	Tc(°C)	Ta(°C)	Trise(°C)	Tc(°C)	Ta(°C)	Trise(°C)
BD1	**85.2**	**38.2**	**47**	**59.3**	**33.9**	**25.4**
L2(Core)	**92.6**	**38.2**	**54.4**	**74.6**	**33.9**	**40.7**
D1	**78.2**	**38.2**	**40**	**63.3**	**33.9**	**29.4**
Q1	**91.5**	**38.2**	**53.3**	**62.7**	**33.9**	**28.8**
IC	**84.2**	**38.2**	**46**	**100.3**	**33.9**	**66.4**



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 90VAC 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
2018/11/16	1.0	First Release

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