



## DEMO BOARD TEST REPORT

# Universal Input High Performance Low Cost 5W Off-line Switching Regulator Using KP3210

## FEATURES

- High Precision 12V & 5V Output
- Integrated with 650V MOSFET and High Voltage Startup Circuit
- Ultra-Low System BOM Cost Buck Solution
- Multi-Mode Control with Audio Noise Free Operation
- Less than 70mW Standby Power
- Green Mode Operation for High Efficiency
- Good Line and Load Regulation
- Built-in Soft Start
- Build in Protections:
  - Over Load Protection (OLP)
  - Cycle-by-Cycle Current Limiting (OCP)
  - Output OVP
  - VDD OVP,UVLO & Clamp
  - On-Chip Thermal Shutdown (OTP)

## INTRODUCTION

KP3210 is a high performance Switch Mode Power Supply Switcher for low power off-line application with minimum components in typical buck solution. The multi-mode PWM control is integrated to simplify circuit design and achieve good line & load regulation without audio noise generated. The peak current limit changes according to the real load condition for low standby power in no load.

The Demo Board of KP3210-D01 is typically designed for the application of 12V/400mA with universal input (90-265Vac, 60/50Hz). Besides the multi-protection function, this demo also has very good efficiency, line & load regulation, low standby power loss and meets the EN55022 Class B conducted and radiated EMI requirement.

## APPLICATIONS

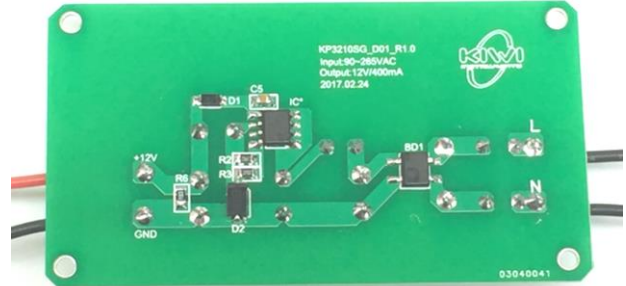
- Electric Cooker, Fan, Hair Straightener.

## DEMO BOARD SEPCIFICATION

Description	Symbol	Min	Type	Max	Unit	Note
Input Voltage	Vin	90		265	Vac	50/60Hz
Output Voltage	Vout	11.8	12	12.5	Vdc	
Output Current	Iout		400	450	mA	System OCP Current >450mA
Output Power	Pout		4.8		W	
Efficiency	$\eta$		82.6		%	Typical value tested at 230Vac/50Hz
Standby Power Consumption	Pst			50	mW	@265Vac
Startup Time	Tst			50	ms	Tested at 90Vac/60Hz
Surge Test		2			kV	Typical differential surge value tested at 230Vac/50Hz

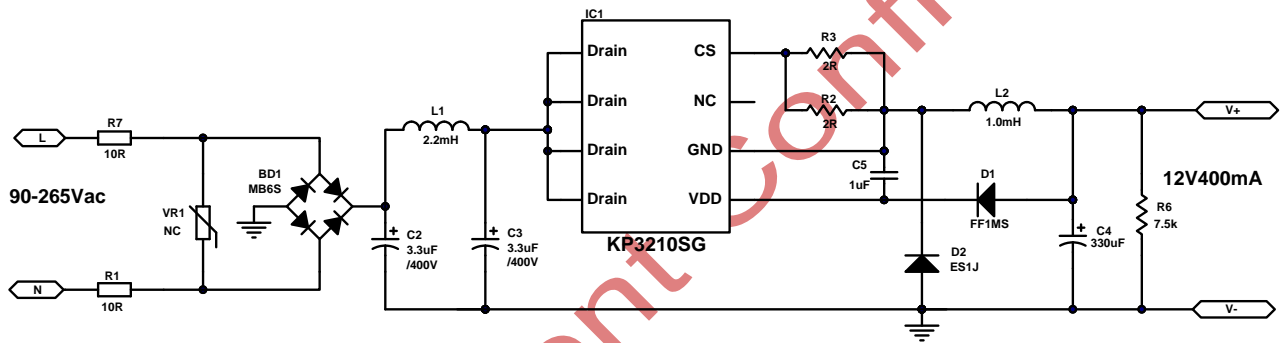
The table above shows the minimum acceptable performance of the design. Actual performance is listed in the results section.

**Demo Board of KP3210-D01-R1.0**



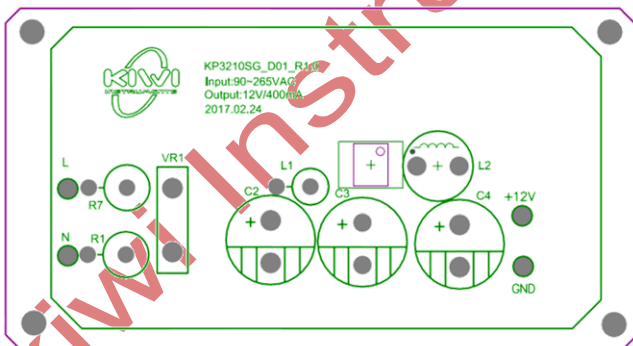
Board Size(in mm): L x W x H=74 x 40 x 16

**Schematic**

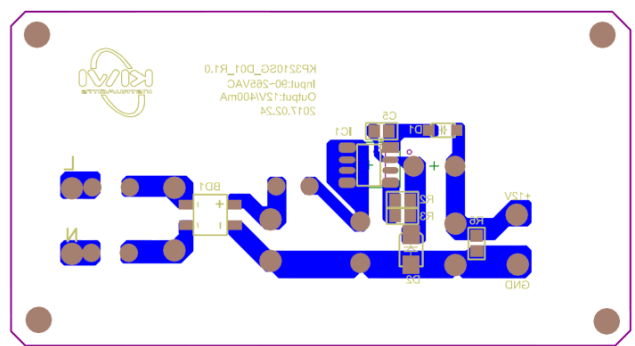


**Printed Circuit Board Layout**

Top Layer



Bottom Layer





## **Circuit Description**

The demo board of KP3210-D01 is designed with Non-isolated Buck, which simplifies the circuit and saves BOM cost. Additionally the demo board can achieve high efficiency, low standby power loss and good Line & Load regulation.

### **1. Input Rectification and EMI filtering**

The circuit input stage is composed of the components of R1, R7, BD1, L1, C2 and C3. R1 and R7 provide the inrush current limitation in the event of component failure or a short circuit. L1, C2 and C3 together provide the differential and common mode EMI filtering. The value of C2 and C3 also determine the Surge Test performance. The bridge diode of BD1 rectifies the AC input to DC output, which is followed by an EMI Filter Circuit.

### **2. KP3210 Operation**

KP3210 combines a high voltage power MOSFET switch with power controller in one chip. It is optimized for off-line non-isolated buck or buck-boost applications in small home appliances. The IC utilizes the multi-mode PWM control to regulate a 12V default output with high precision, lowest components count and no audio noise generated.

The current limit circuit samples the voltage on R2 and R4. When the sampled differential voltage exceeds the internal threshold, the power MOSFET is turned off for the remainder of that cycle. An internal leading edge blanking circuit is built in. During this blanking period (300ns, typical), the cycle-by-cycle current limiting comparator is disabled and cannot switch off the GATE driver.

To meet the tight requirement of averaged system efficiency and no load power consumption, a hybrid of frequency modulation (FM) and amplitude modulation (AM) is adopted in KP3210. Around the full load, the system operates in FM mode. When normal to light load conditions, the IC operates in FM+AM mode to achieve excellent regulation and high efficiency. When the system is near zero loading, the IC operates in FM again for standby power reduction. In this way, the no-load consumption can be less than 50mW.

### **3. Output Voltage Regulation**

IC1, L2, C4 and D2 compose the typical Buck converter. D1 and C5 are used as the Output Voltage Detection Circuit when L2 is in demagnetization stage. The IC utilizes the multi-mode PWM control to regulate a 12V default output with high precision, lowest components count and no audio noise generated.



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**Bill of Material**

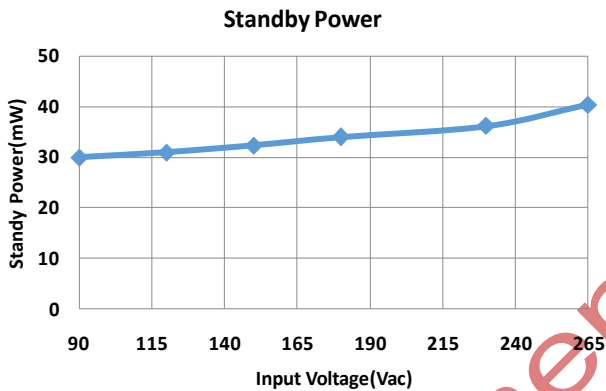
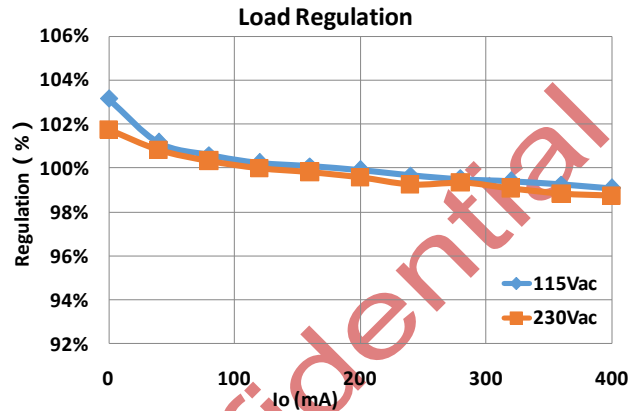
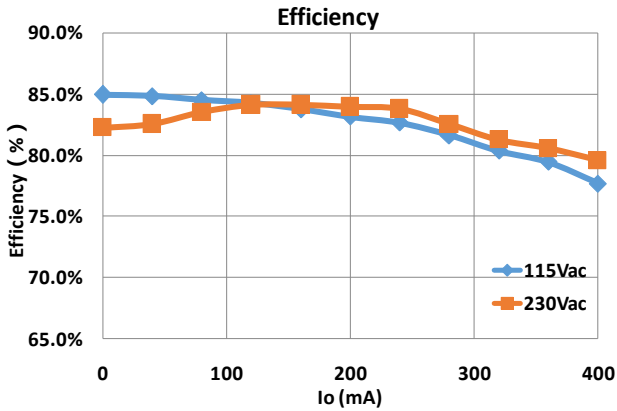
No.	Designator	Value	Description	Package	Manufacturer	Part Number
1	BD1	600V/0.5A	SINGLE PHASE SILICON BRIDGE,600V/0.5A	SMD	Any	MB6S
2	C2	3.3uF	Electrolytic Cap, 400V,6*12	TH	SAMYOUNG	
3	C3	3.3uF	Electrolytic Cap, 400V,6*12	TH	SAMYOUNG	
4	C4	330uF	Electrolytic Cap, 16V,6*12	TH	jianghai	
5	C5	1uF	Ceramic Cap,25V X7R	0805	TDK	C2012X7R1E105K
6	D1	1KV/1A	Fast Recovery Rectifiers	SOD123	YEA SHIN	FF1MS
7	D2	600V/2A	2.0 AMP Surface Mount Super-Fast Recovery Rectifiers	SMA	Lision Tech	ES2J
8	L1	2.2mH	Color Ring Inductor, Isat=0.26A,0410	TH	Any	
9	L2	1mH	WE-TI Inductor,Isat=0.9A,Rdc=1Ω,10*14	TH	Würth Elektronik	7447480102
10	R1	10R	Fuse Resistor,1W	TH	Any	
11	R2	2R	Film Resistor, 1%	0805	Yageo	RC0805JR-072RL
12	R3	2R	Film Resistor, 1%	0805	Yageo	RC0805JR-072RL
13	R6	7.5k	Film Resistor, 5%	0805	Yageo	RC0805JR-077K5L
14	R7	10R	Fuse Resistor,1W	TH	Any	
15	VR1	NC	NC	NC	NC	NC
16	IC1	KP3210	High Performance Low Cost Off-line PWM Power Switch	SOP8	Kiwi instruments	KP3210SG

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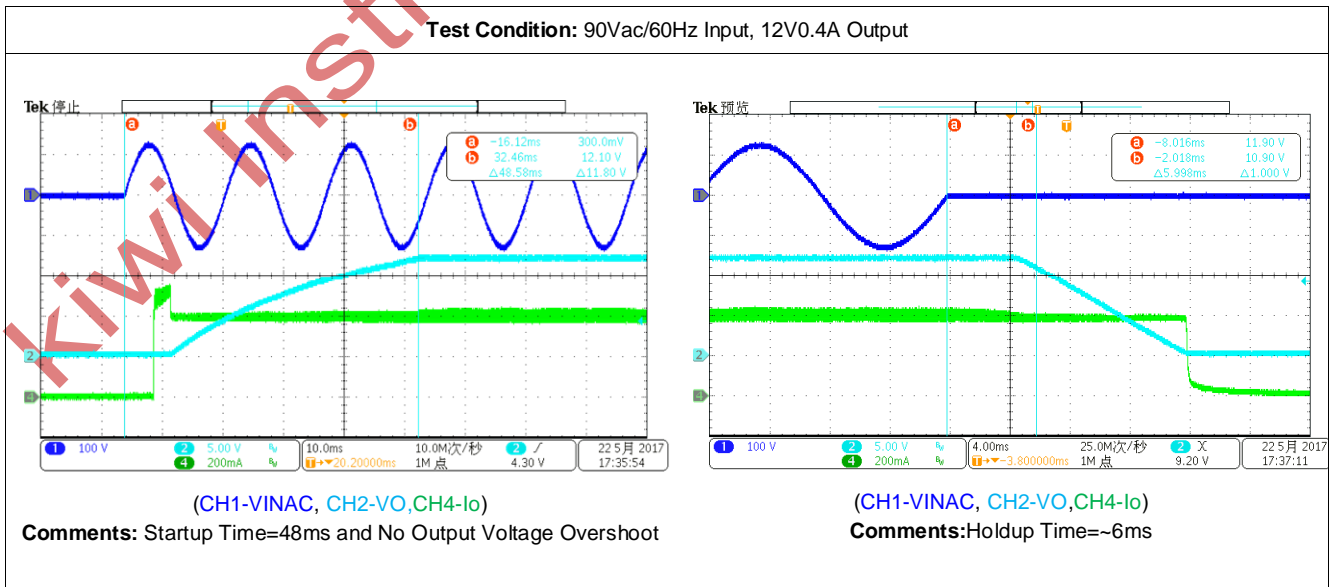
## Test Result

### 1. Test Data---Load/Line Regulation, Efficiency and Standby Power Loss



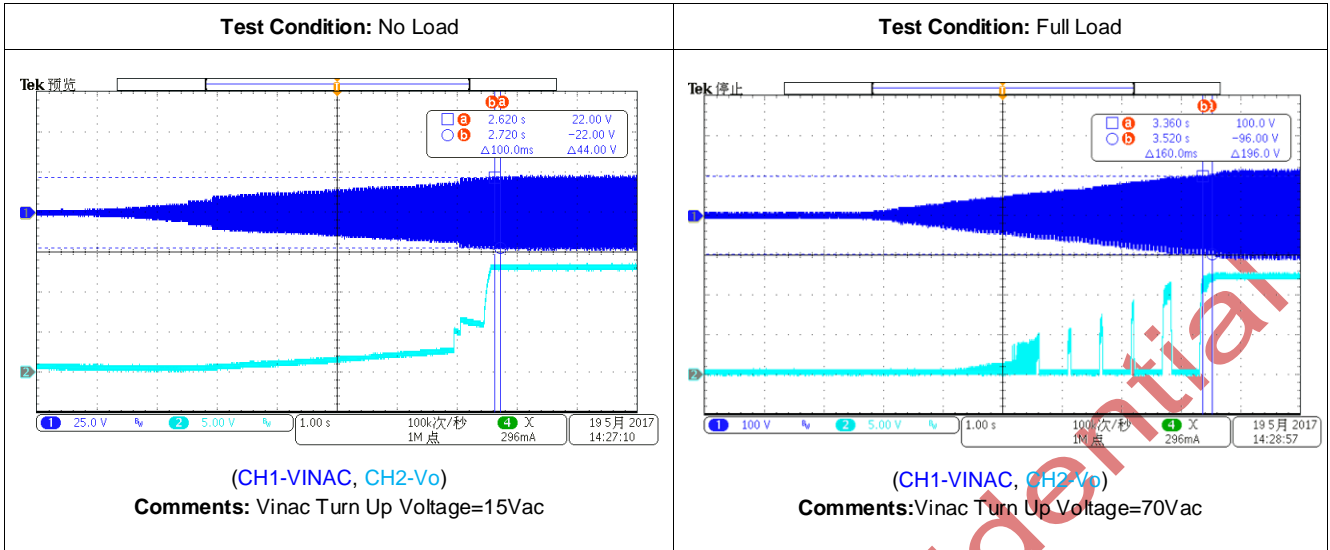
### 2. Operation Curves

#### 1) Startup and Shutdown Test

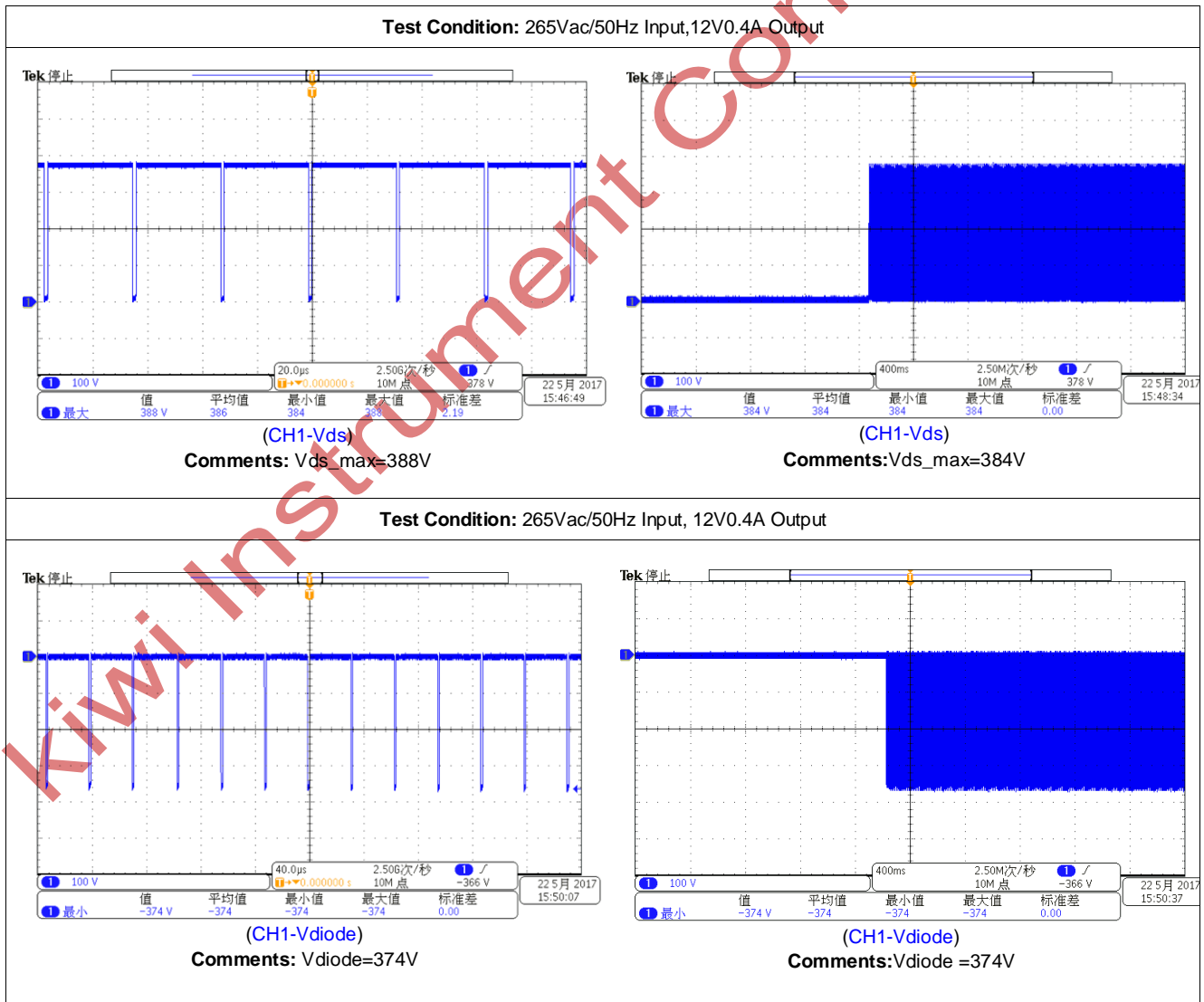




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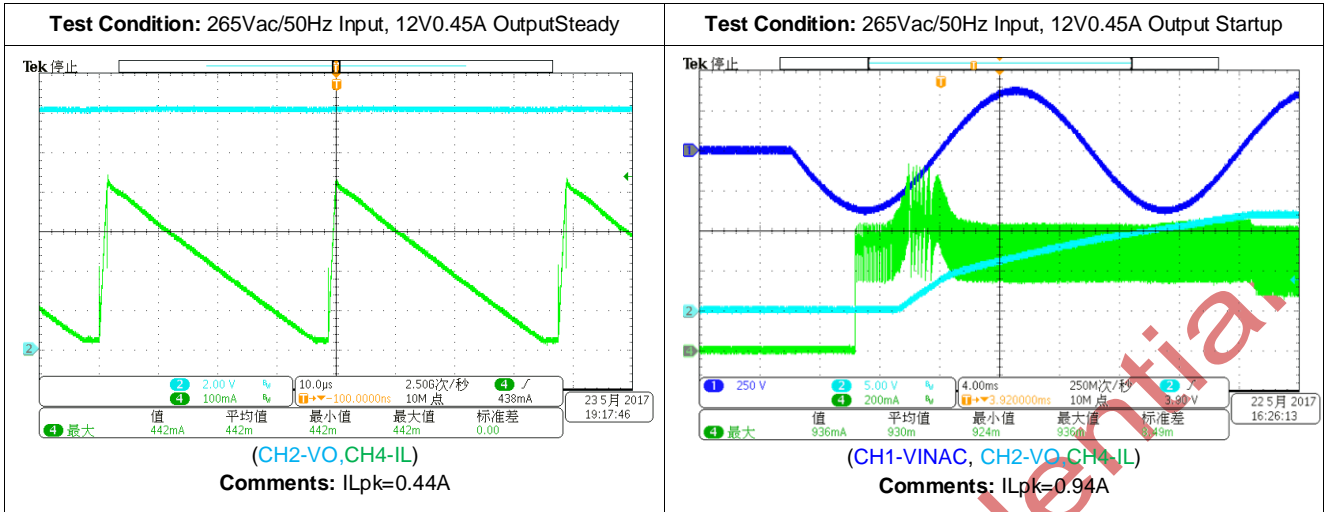


**2) Device Maximum Rating Test**

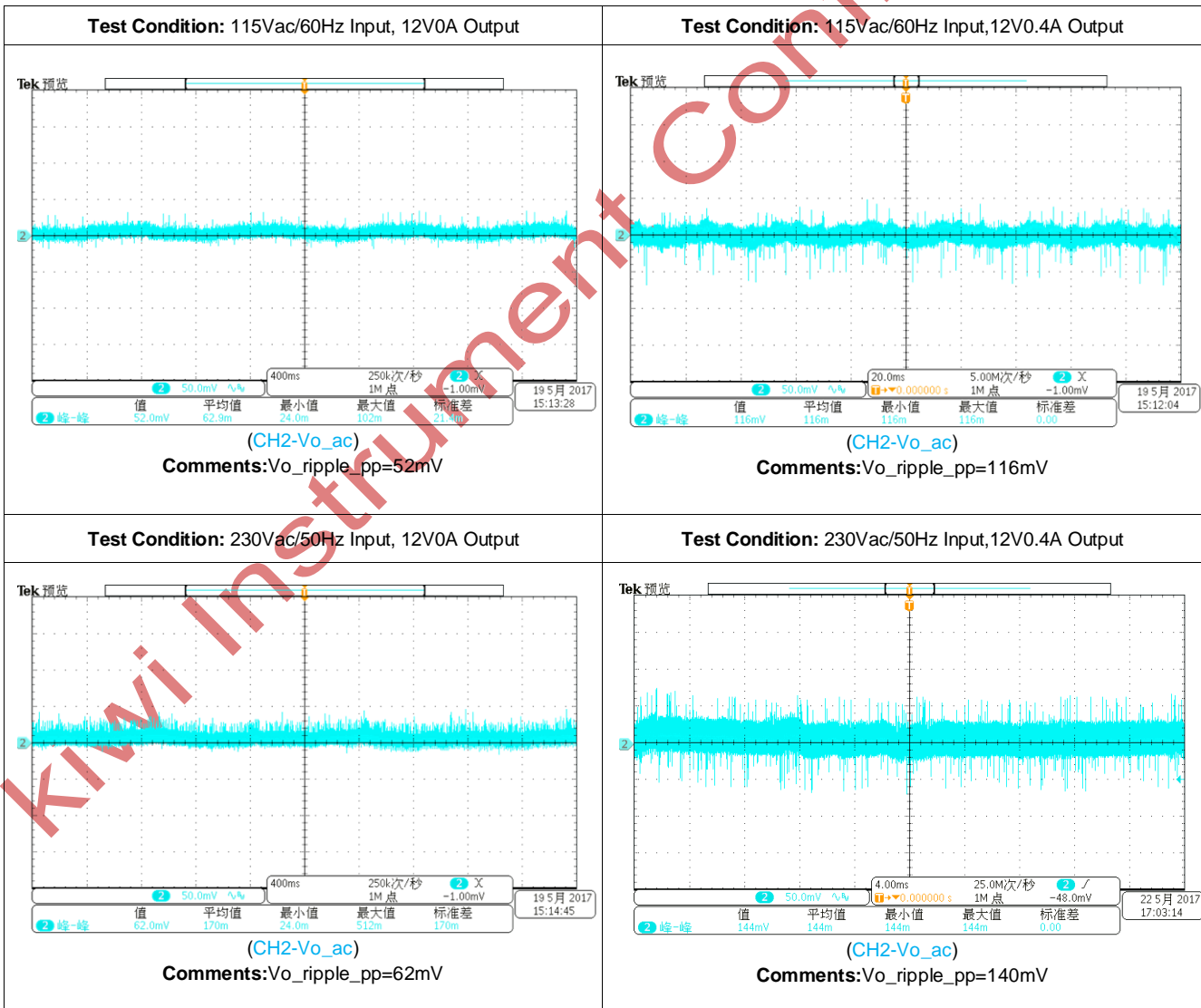




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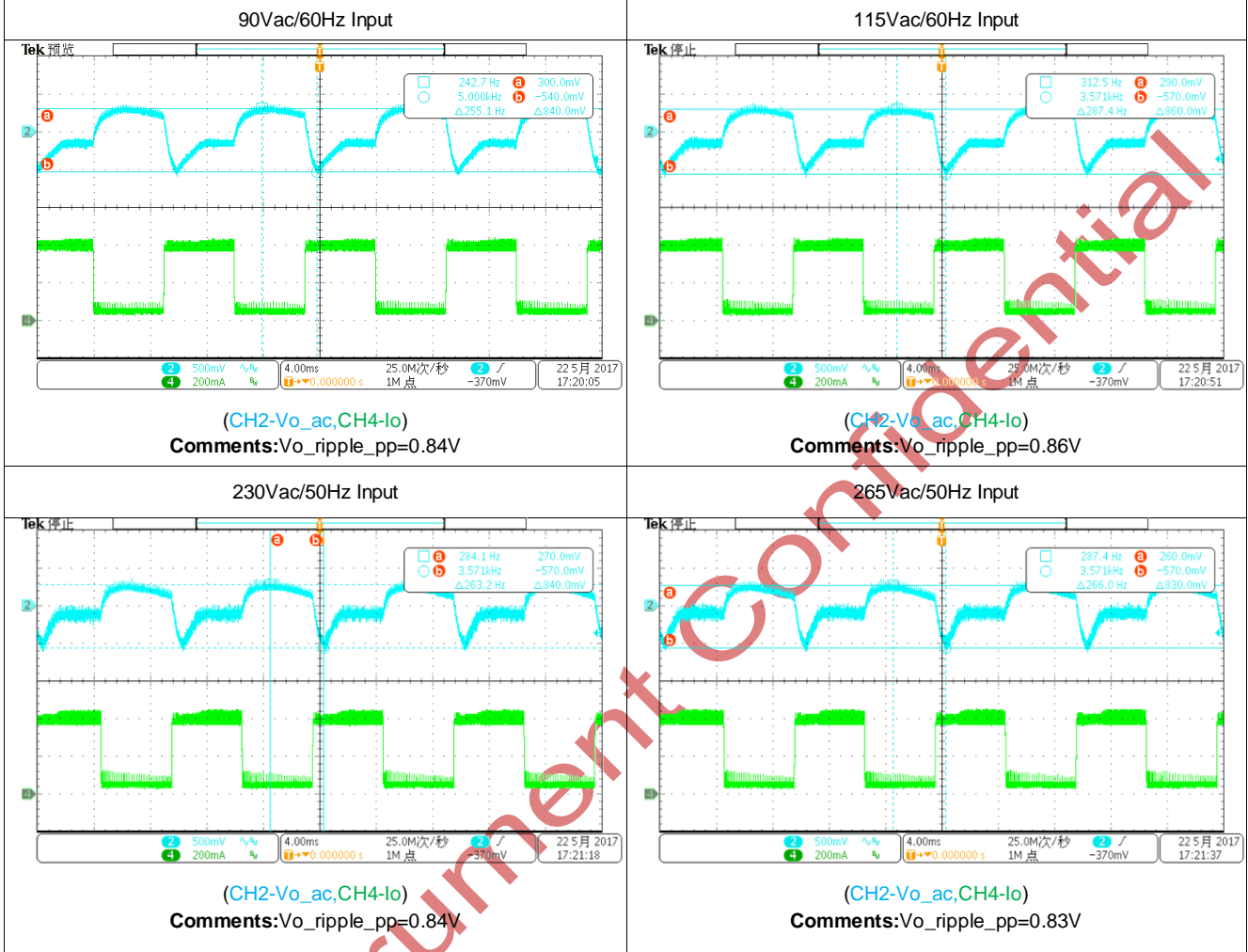


**3) Output Ripple Test**



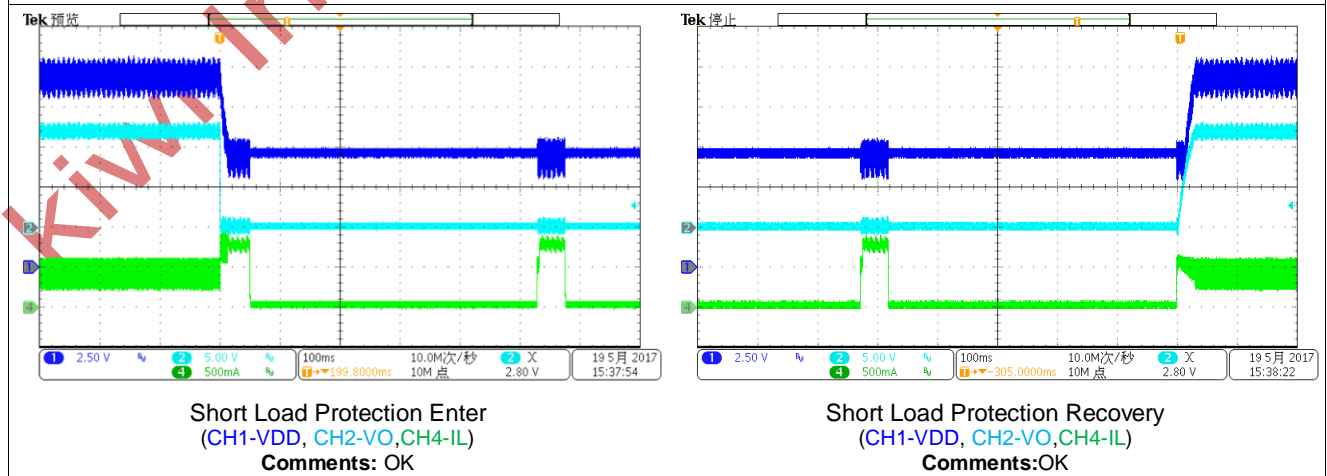
**4) Load Transient Test**

**Test condition: Load 50-400mA, frequency 100Hz, duty Cycle=50%, slew rate=500mA/us**

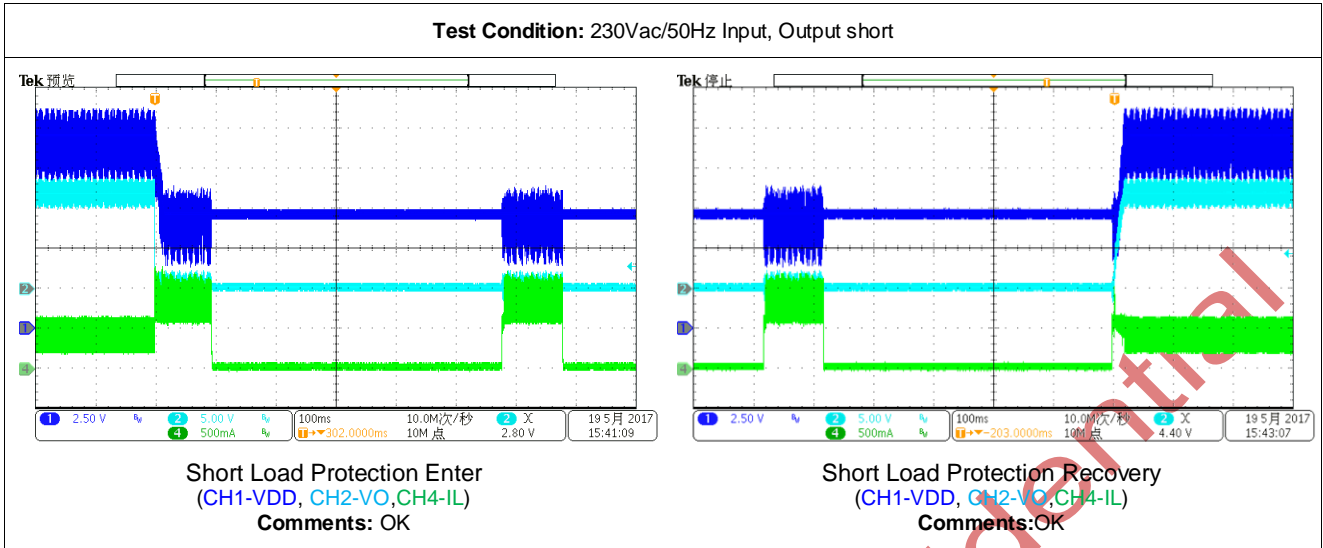


**5) Over Load Protection Test**

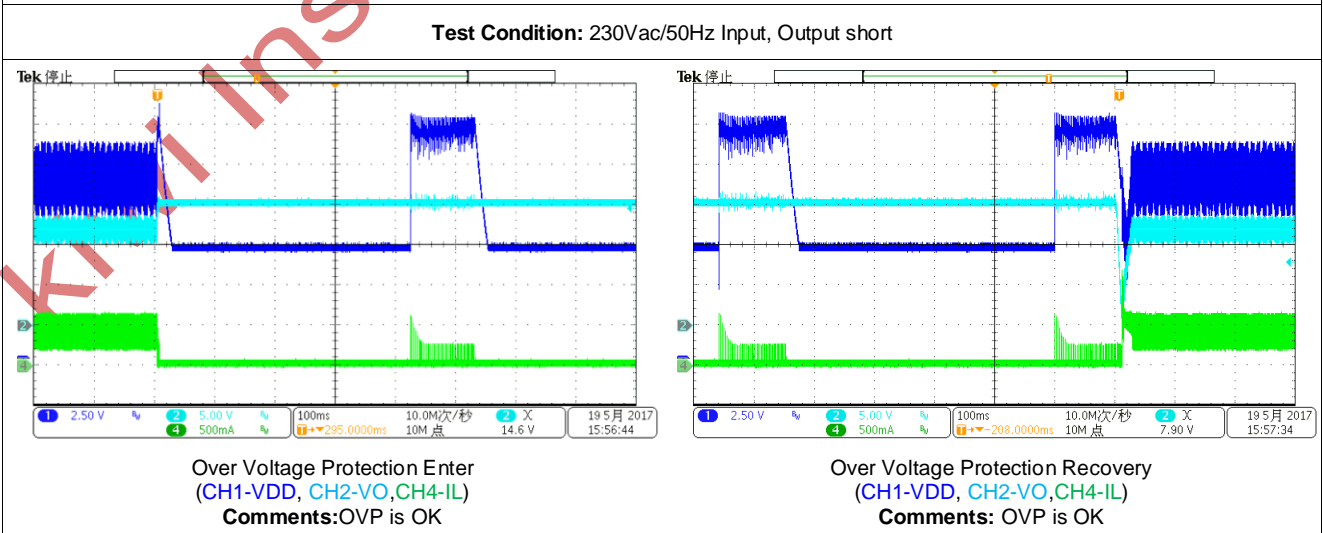
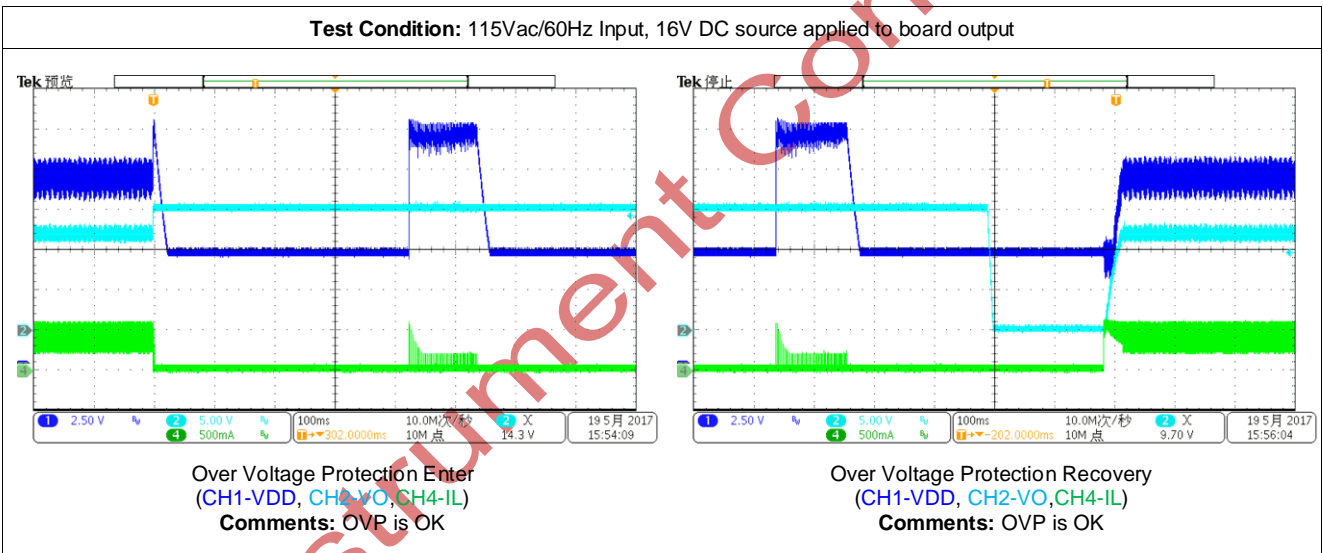
**Test Condition: 115Vac/60Hz Input, Output short**



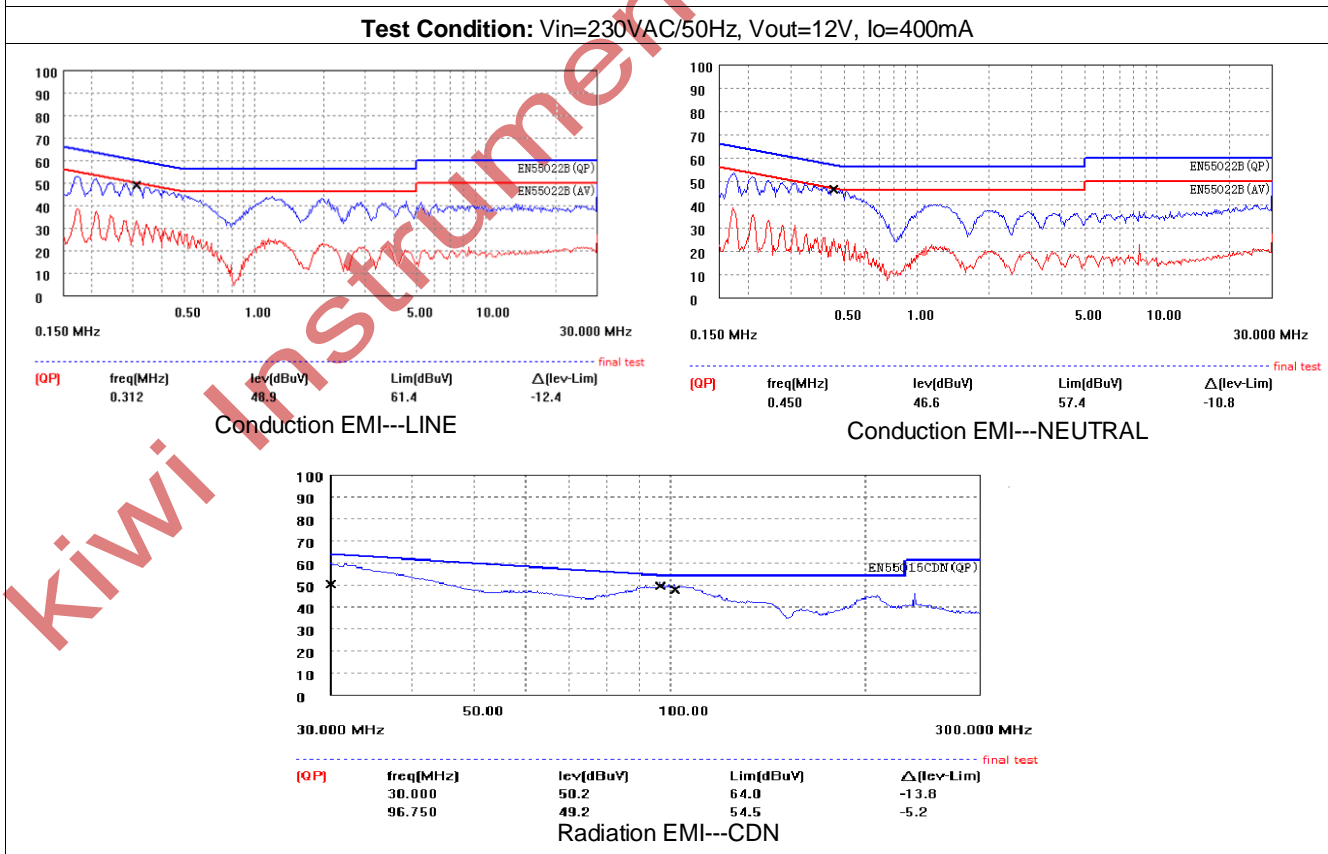
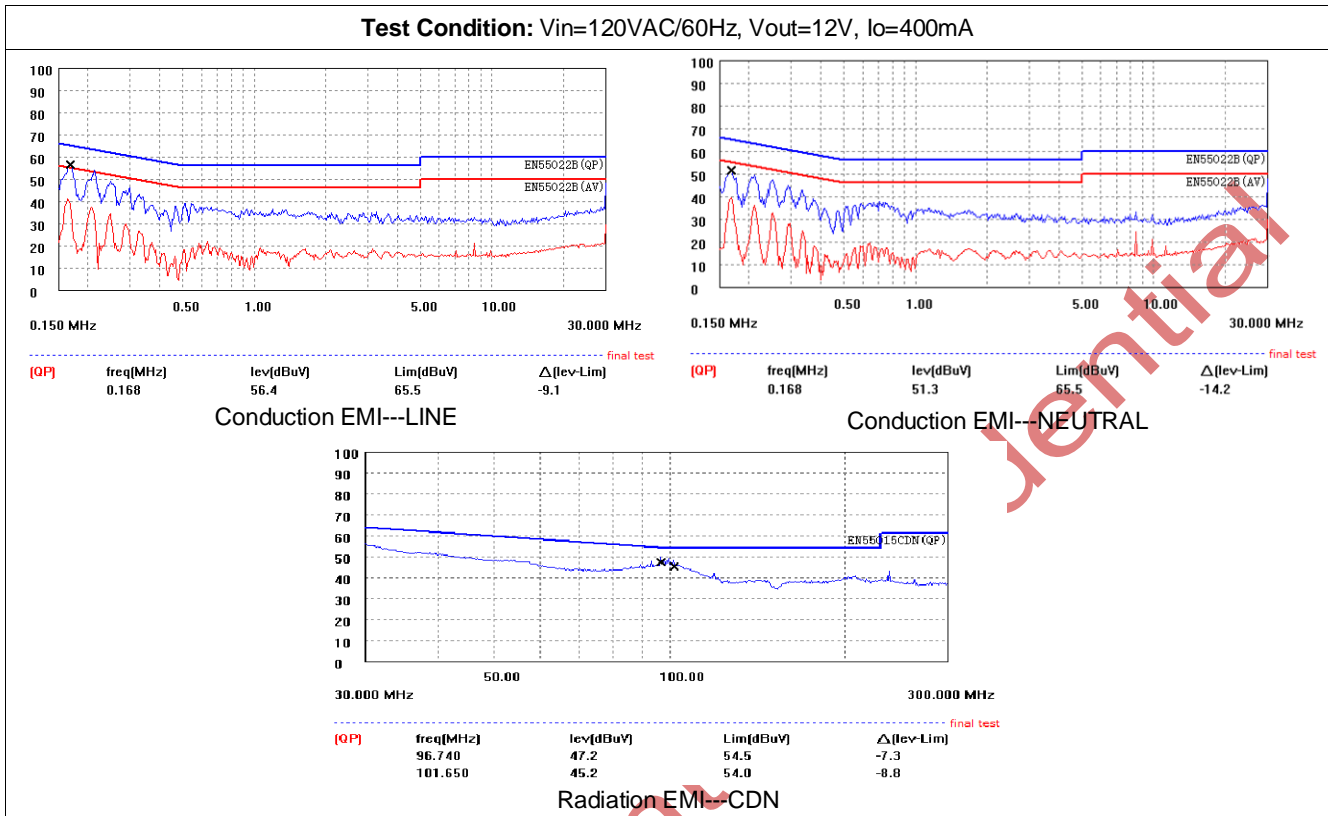




**6) Over Voltage Protection Test**



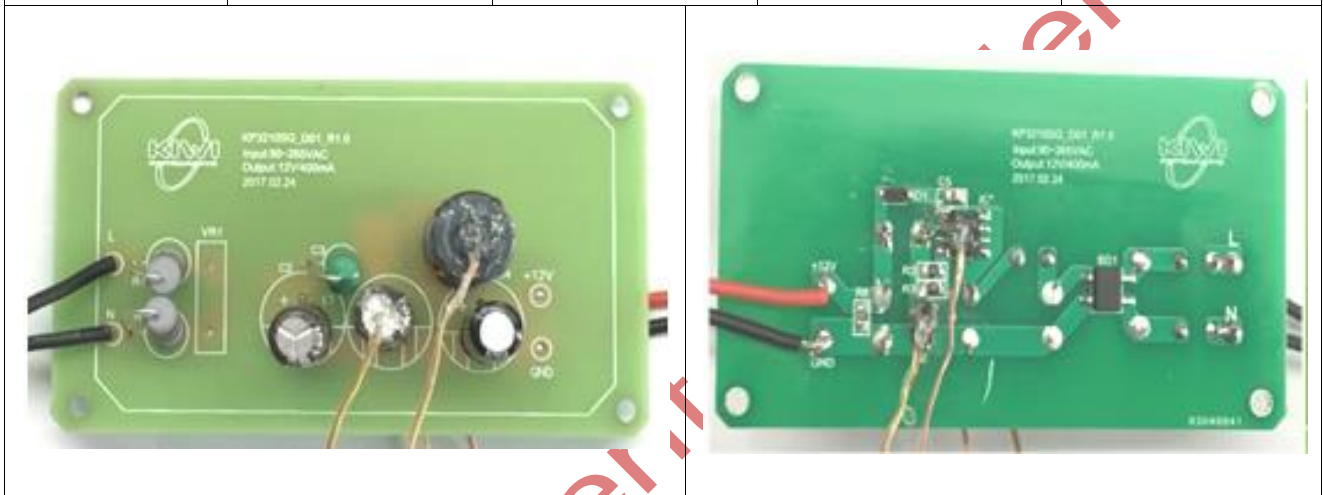
### 3. EMC Test Result



#### 4. Thermal Test

90Vac/60Hz, 265Vac/50Hz; 12V0.4A output; Ta=30°C under nonnatural convection, Burn-in 1Hour.

	90Vac		265Vac	
	Tc(°C)	Trise(°C)	Tc(°C)	Trise(°C)
IC1	95.8	65.8	92	62
L1	63.5	33.5	66.5	36.5
D1	72.5	42.5	72	42
Cin	38.4	8.4	39.9	9.9





## 5. Surge Test

Line to Line 2kV surge testing was completed according to IEC61000-4-5. Input voltage was set at 230VAC/50Hz. Output was loaded at full load and operation was verified following each surge event. Each injection phase below is tested with 5 times and hold for 60 seconds before next one.

Input Voltage (VAC)	Surge Level (V)	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
230Vac/50Hz	+2000	L to N	0	Pass
	+2000	L to N	90	Pass
	+2000	L to N	180	Pass
	+2000	L to N	270	Pass
	-2000	L to N	0	Pass
	-2000	L to N	90	Pass
	-2000	L to N	180	Pass
	-2000	L to N	270	Pass

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## **Test Setup Guide**

1. Connect the "V+" and "V-" terminal to the positive and negative end of the load.
2. Set the AC Power Source 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.

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**Revision History**

DATE	REV	DESCRIPTION
2017/05/23	1.0	First Release

**Contact Us:**

**US  
(Headquarter):**

**Add:**2060 Walsh Ave, Suite 244,  
Santa Clara, CA, 95050  
**Tel:**1-+86-18681585060  
**Fax:** 1-408-905-6912  
**E-mail:**marketing@kiwiinst.com

**Hangzhou  
(R&D Center):**

**Add:**Room 1201,Building C, No.581  
HuoJuRoad,BinjiangDist.Hangzhou,P.R.C  
**Tel:**(86) 571-8795-8612  
**Fax:**(86) 571-8795-5363  
**E-mail:** marketing@kiwiinst.com.cn

**Shenzhen  
(Marketing/Field Support):**

**Add:**B302-B303, University  
Creative Park, Xili Rd., Nanshan  
District, Shenzhen, P.R.C  
**Tel:**(86)755-8204-2689  
**Fax:**(86)755-8204-2192  
**E-mail:**marketing@kiwiinst.com.cn

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