DEMO BOARD TEST REPORT

Universal Input High Performance Dual Output 5W Buck-boost Regulator Using KP3210

FEATURES

- High Precision -12V& -5V Dual Output
- Integrated with 650V MOSFET and High Voltage Startup Circuit
- Ultra-Low BOM Cost BuckBoost 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)

APPLICATIONS

- **Pressure Cooker, Electric Cooker**

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-D02 is designed for the application of -12V/200mA & -5V/100mA 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-ClassB conducted and radiated EMI requirement.

DEMO BOARD SEPCIFICATION

Description	Symbol	Min	Type	Max	Unit	Note
Input Voltage	Vin	90		265	Vac	50/60Hz
Output Voltage1	Vout1	11.7	12	12.3	Vdc	
Output Voltage2	Vout2		5		Vdc	5V LDO Regulator
Output Current1	Iout1		200	230	mA	Output1 OCP Current >230mA
Output Current2	Iout2		100		mA	
Total Output Power	Pout		2.9		W	
System Efficiency	η		>58		%	@Full Load
Standby Power Consumption	Pst			70	mW	@265Vac
Startup Time	Tst			25	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.

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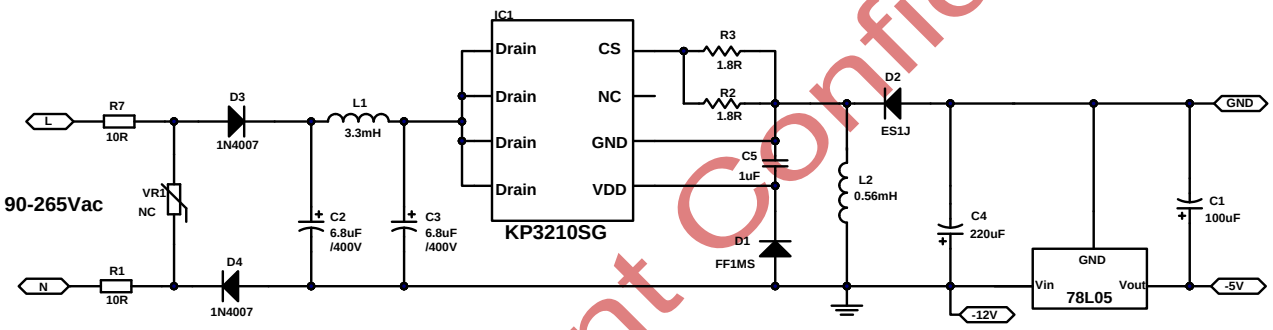
Tel: +86-18681585060 E-mail: wyq@cokinic.com
www.cokinsemi.com

Demo Board of KP3210SG_D02_R1.0

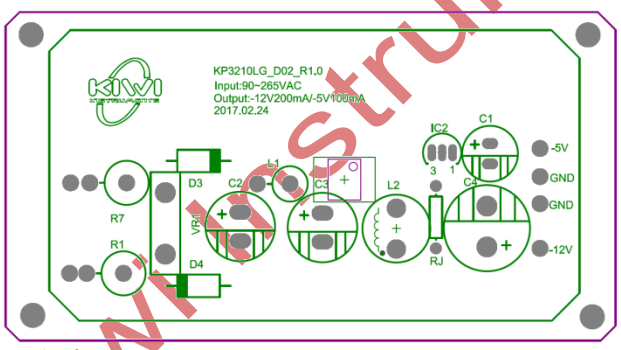
Board Size(in mm): L x W x H=31X18X16

Schematic

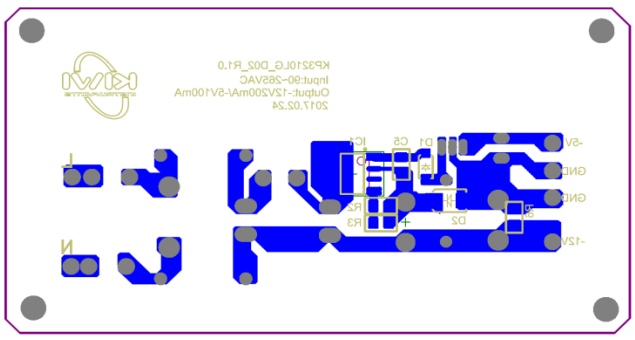


Printed Circuit Board Layout

Top Layer



Bottom Layer



Circuit Description

The demo board of KP3210-D02 is designed with Non-isolated BuckBoost topology, 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 by the components of R1, R7, D3, D4, 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. D3 and D4 rectify 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 BuckBoost applications for small home appliances and linear regulator replacement. The IC utilizes the ON/OFF current 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 R3. 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 70mW.

3. Output Voltage Regulation

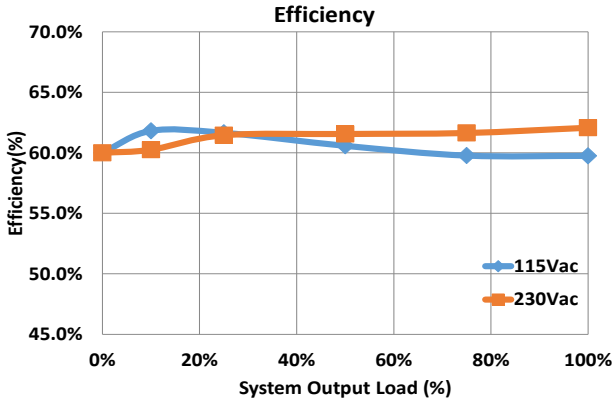
IC1, D2, C4 and L2 compose the typical BuckBoost converter. D1 and C5 are used as the Output Voltage Detection Circuit when L in demagnetization stage. The IC utilizes the ON/OFF current mode PWM control to regulate a 12V default output with high precision, lowest components count and no audio noise generated. In addition, the main12V output channel also supplies a 5V LDO Output.

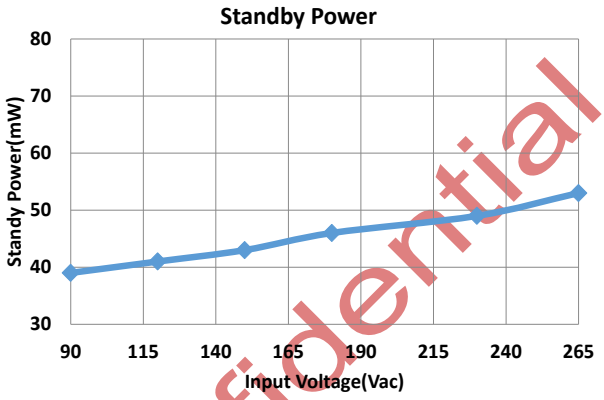
Bill of Material

No.	Designator	Value	Description	Package	Manufacturer	Part Number
1	C1	100uF	Electrolytic Cap, 10V,6.3*11.5	TH	凯泽电子	
2	C2	6.8uF	Electrolytic Cap, 400V,8*12	TH	(Chongx)云辉	
3	C3	6.8uF	Electrolytic Cap, 400V,8*12	TH	(Chongx)云辉	
4	C4	220uF	Electrolytic Cap, 35V,10*20	TH	jianghai	
5	C5	1uF	Ceramic Cap, 25V X7R	0805	TDK	
6	D1	1KV/1A	Fast Recovery Rectifiers	SOD123	YEA SHIN	FF1MS
7	D2	600V/1A	1.0 AMP Surface Mount Super-Fast Recovery Rectifiers	SMA	Lision Tech	ES1J
8	D3	1KV/1A	1.0 AMP SILICON RECTIFIERS	DO41	Any	1N4007
9	D4	1KV/1A	1.0 AMP SILICON RECTIFIERS	DO41	Any	1N4007
10	L1	3.3mH	Color Ring Inductor, Isat=0.16A,0510	TH	Any	
11	L2	560uH	DR Inductor, Isat=0.80A,Rdc=0.7Ω,10*12	TH	Any	
12	R1	10R	Metal Film Power Resistor,1W	TH	Any	
13	R2	1.8R	Film Resistor, 1%	0805	Yageo	
14	R3	1.8R	Film Resistor, 1%	0805	Yageo	
15	R7	10R	Metal Film Power Resistor,1W	TH	Any	
16	IC2	78L05	LOD, 5V,100mA	TO-92	Any	
17	IC1	KP3210SG	High Performance Low Cost Off-line PWM Power Switch	SOP8	Kiwi instruments	KP3210SG

Test Result

1. Test Data--- Efficiency, System Standby Power Loss and Cross Load Regulation



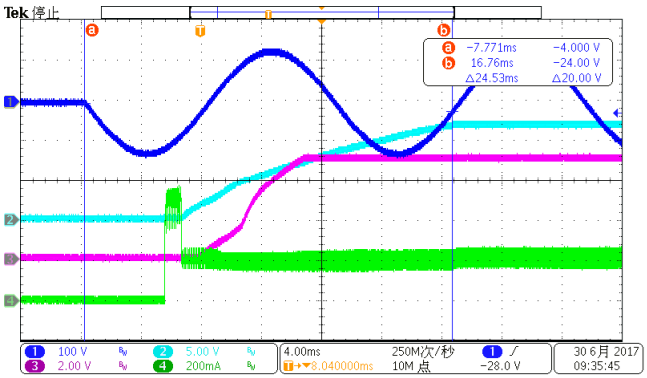


12V Load Regulation													
5V Load	Vin (Vac)	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	Load Reg.
0%	115	12.13	11.93	11.85	11.81	11.77	11.75	11.74	11.73	11.73	11.72	11.73	2.33%
	230	11.95	11.83	11.79	11.76	11.74	11.73	11.71	11.7	11.7	11.7	11.7	2.50%
100%	115	11.71	11.69	11.68	11.67	11.66	11.65	11.65	11.64	11.66	11.67	11.67	3.00%
	230	11.68	11.67	11.65	11.64	11.63	11.62	11.61	11.61	11.6	11.6	11.6	3.33%
5V Load Regulation													
12V Load	Vin (Vac)	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%	Load Reg.
0%	115	5.05	5.05	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.03	5.03	0.4%
	230	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.03	5.03	0.2%
100%	115	5.04	5.04	5.04	5.04	5.04	5.04	5.04	5.03	5.03	5.03	5.03	0.2%
	230	5.05	5.05	5.05	5.05	5.05	5.05	5.04	5.04	5.04	5.04	5.03	0.4%

2. Operation Curves

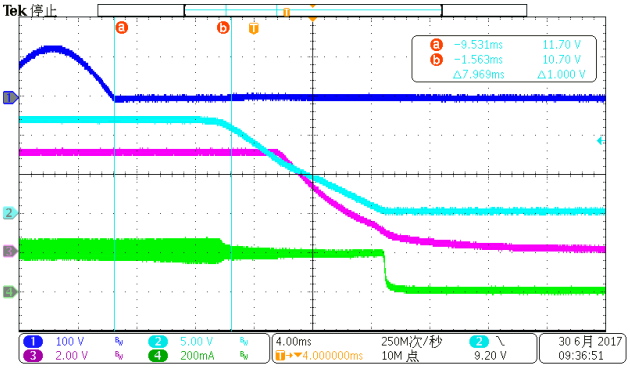
1) Startup and Shutdown Test

Test Condition: 90Vac/60Hz Input, 12V/0.2A 5V/0.1A Output



(CH1-VINAC, CH2-Vo1,CH3-Vo2,CH4-Io1)

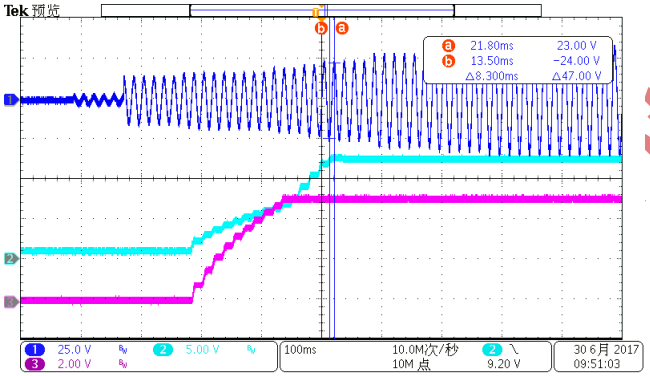
Comments: Startup Time=25ms and No Output Voltage Overshoot



(CH1-VINAC, CH2-Vo1,CH3-Vo2,CH4-Io1)

Comments: Holdup Time=~8ms

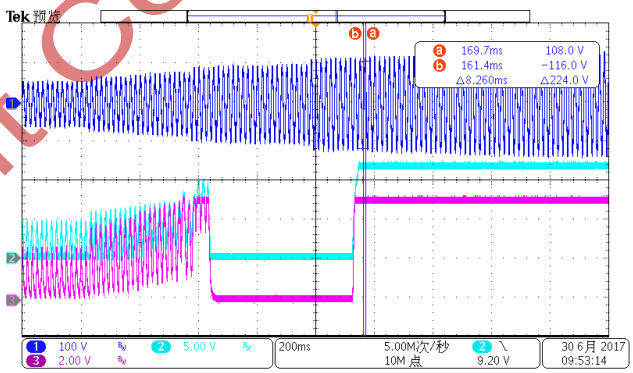
Test Condition: No Load



(CH1-VINAC,CH2-Vo1,CH3-Vo2)

Comments: Vinac Turn Up Voltage=16Vac

Test Condition: Full Load

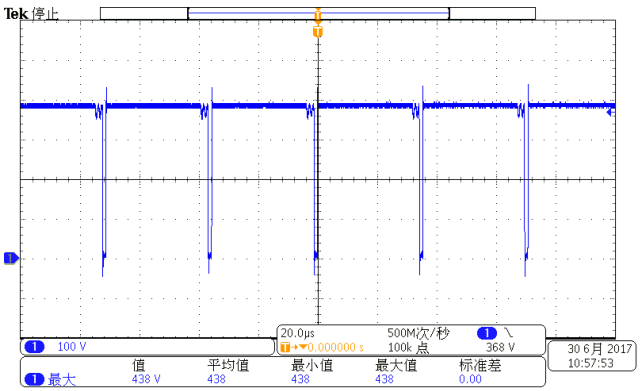


(CH1-VINAC, CH2-Vo1,CH3-Vo2)

Comments: Vinac Turn Up Voltage=76Vac

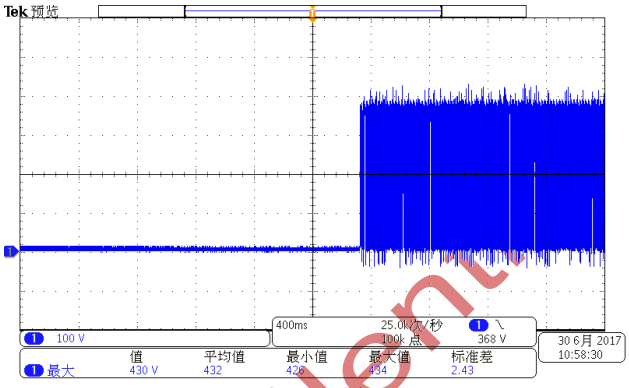
2) Device Maximum Rating Test

Test Condition: 265Vac/50Hz Input, 12V/0.2A 5V/0.1A Output



(CH1-Vds)

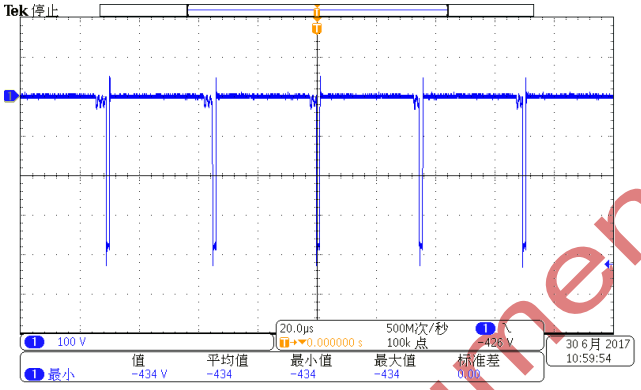
Comments: Vds_max=438V



(CH1-Vds)

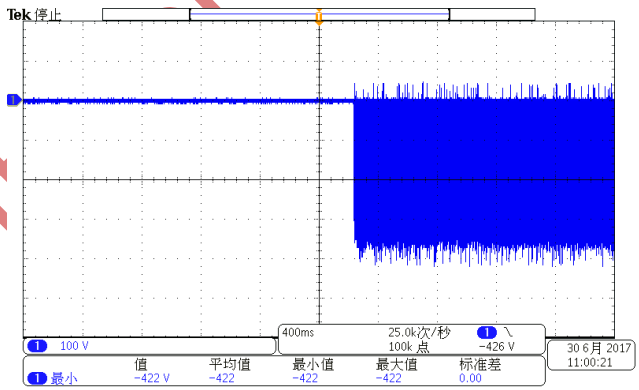
Comments: Vds_max=434V

Test Condition: 265Vac/50Hz Input, 12V/0.2A 5V/0.1A Output



(CH1-Vdiode)

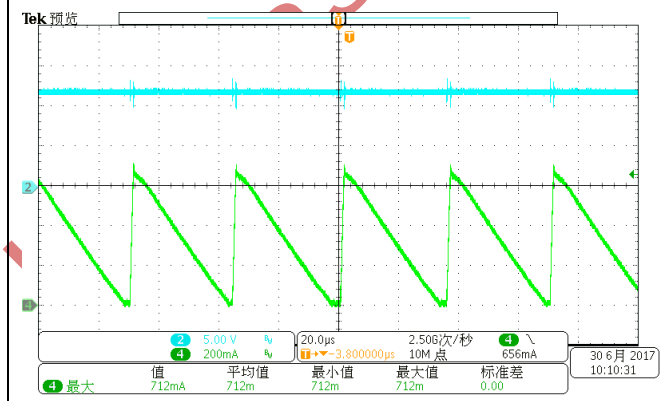
Comments: Vdiode=434V



(CH1-Vdiode)

Comments: Vdiode =422V

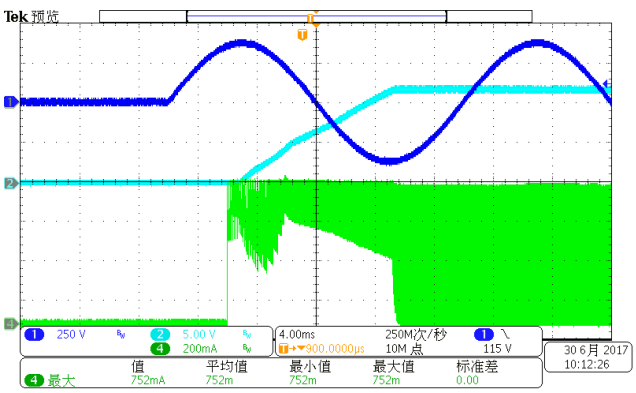
Test Condition: 265Vac/50Hz Input, 12V/0.2A 5V/0.1A Steady



(CH2-Vo1,CH4-IL)

Comments: ILpk=0.71A

Test Condition: 265Vac/50Hz Input, 12V/0.2A 5V/0.1A Startup

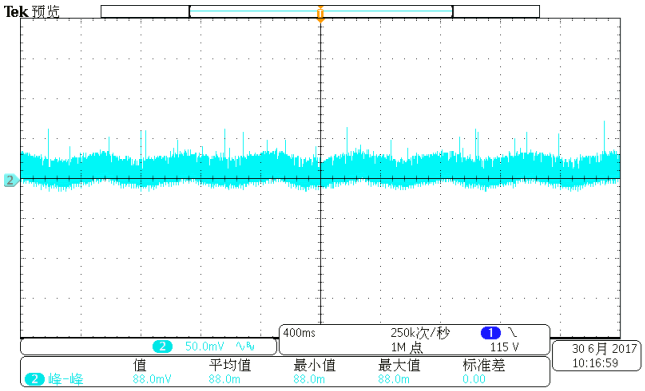


(CH1-VINAC, CH2-Vo1,CH4-IL)

Comments: ILpk=0.75A

3) Output Ripple Test

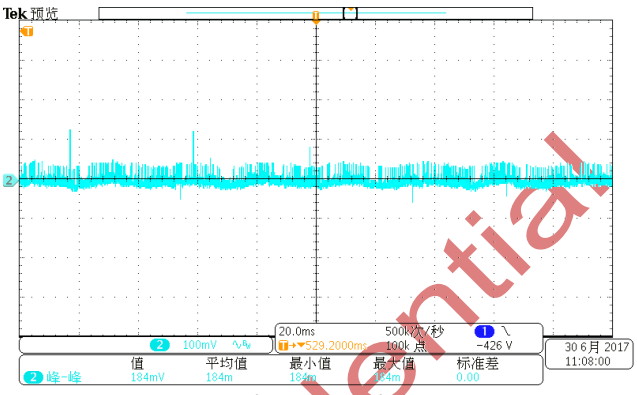
Test Condition: 115Vac/60Hz Input, 12V/0A 5V/0A Output



(CH2-Vo1_ac)

Comments: Vo1_ripple_pp=88mV

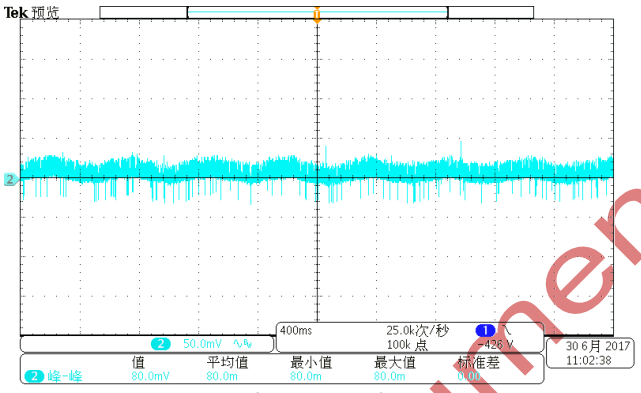
Test Condition: 115Vac/60Hz Input,12V/0.2A 5V/0.1A Output



(CH2-Vo1_ac)

Comments: Vo1_ripple_pp=184mV

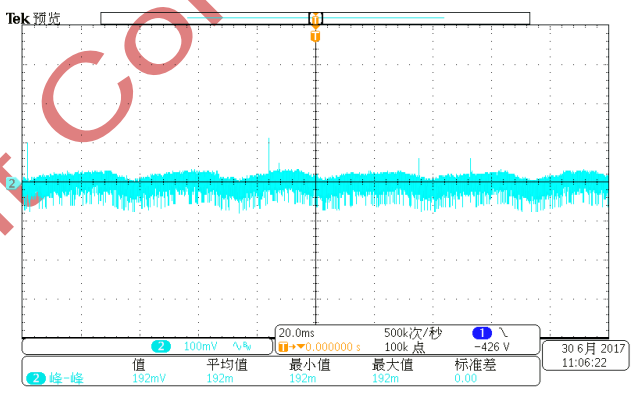
Test Condition: 230Vac/50Hz Input, 12V/0A 5V/0A Output



(CH2-Vo1_ac)

Comments: Vo1_ripple_pp=80mV

Test Condition: 230Vac/50Hz Input, 12V/0.2A 5V/0.1A Output



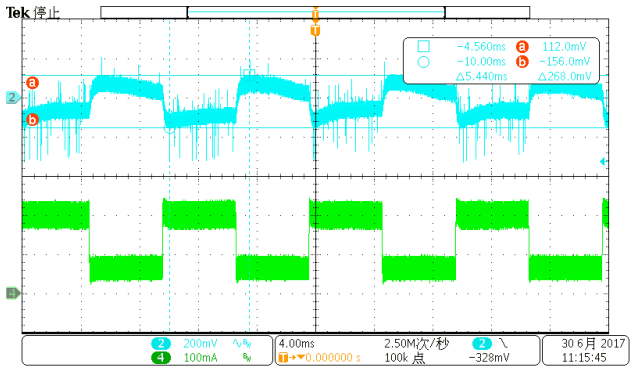
(CH2-Vo1_ac)

Comments: Vo1_ripple_pp=192mV

4) Load Transient Test

Test condition: Load 50-200mA, frequency 100Hz, duty Cycle=50%, slew rate=500mA/us

90Vac/60Hz Input



(CH2-Vo1_ac,CH4-Io1)

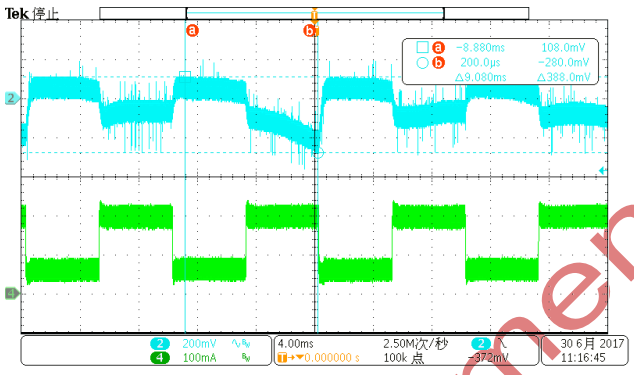
Comments: Vo1_ripple_pp=268mV

115Vac/60Hz Input

(CH2-Vo1_ac,CH4-Io1)

Comments: Vo1_ripple_pp=272mV

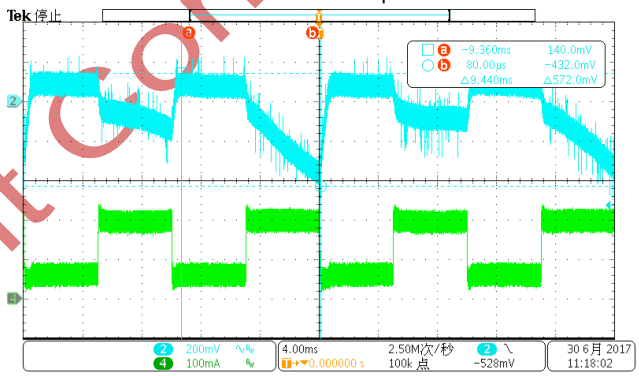
230Vac/50Hz Input



(CH2-Vo1_ac,CH4-Io1)

Comments: Vo1_ripple_pp=388mV

265Vac/50Hz Input

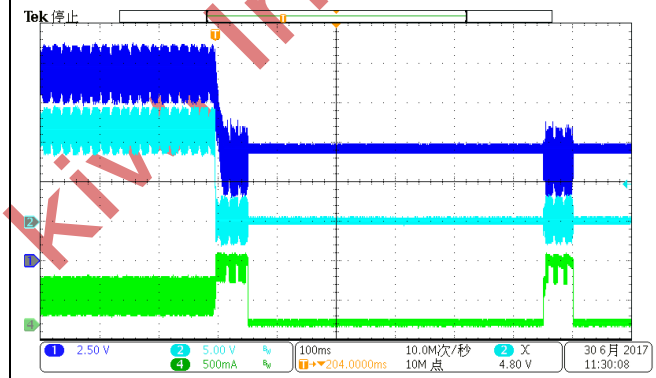


(CH2-Vo1_ac,CH4-Io1)

Comments: Vo1_ripple_pp=572mV

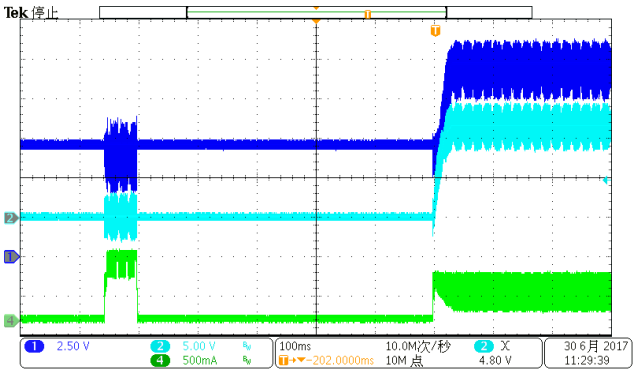
5) Over Load Protection Test

Test Condition: 115Vac/60Hz Input,Vo1 Output short



Short Load Protection Enter
(CH1-VDD, CH2-Vo1,CH4-IL)

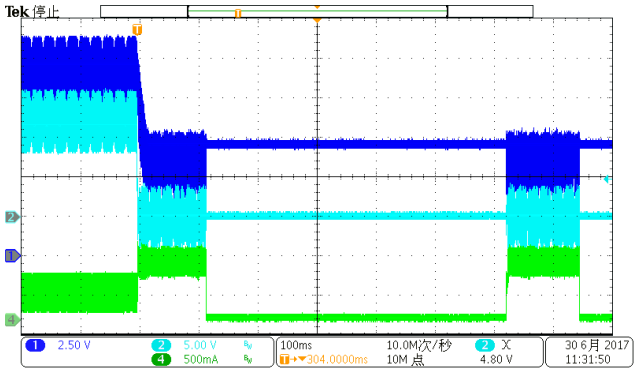
Comments: OK



Short Load Protection Recovery
(CH1-VDD, CH2-Vo1,CH4-IL)

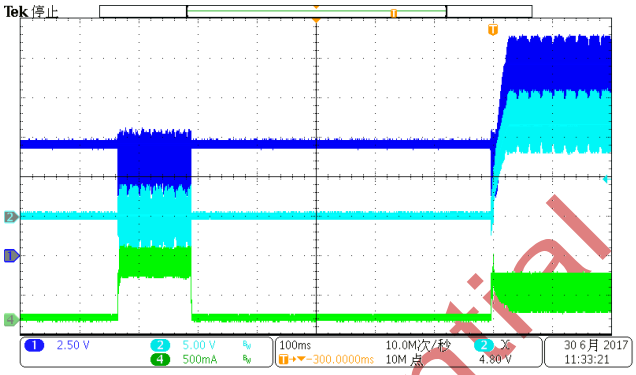
Comments: OK

Test Condition: 230Vac/50Hz Input,Vo1 Output short



Short Load Protection Enter
(CH1-VDD, CH2-Vo1,CH4-IL)

Comments: OK

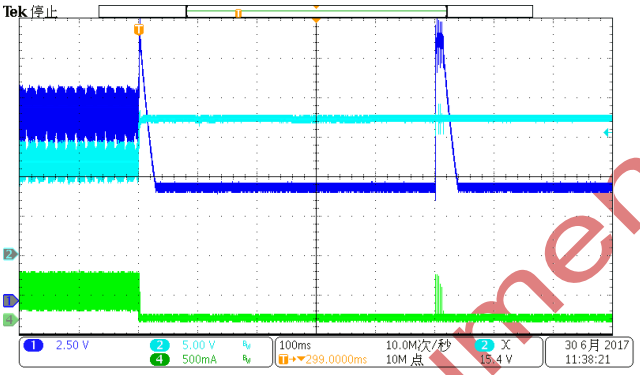


Short Load Protection Recovery
(CH1-VDD, CH2-Vo1,CH4-IL)

Comments: OK

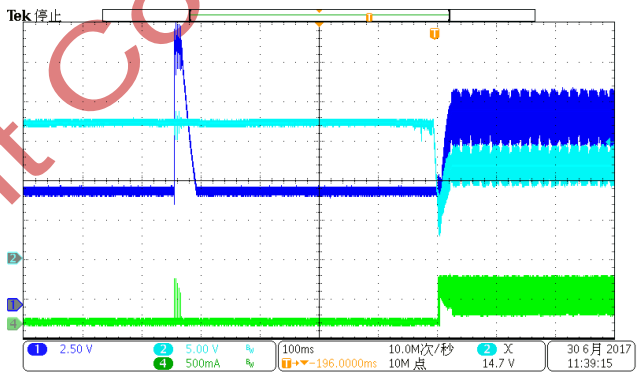
6) Over Voltage Protection Test

Test Condition: 115Vac/60Hz Input, 18V DC source applied to board Vo1 output



Over Voltage Protection Enter
(CH1-VDD, CH2-Vo1,CH4-IL)

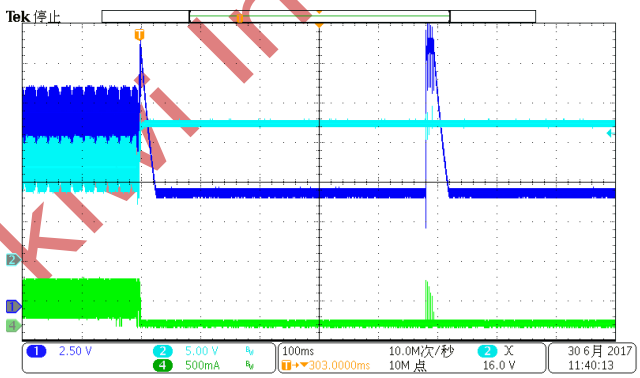
Comments: OVP Enter is OK



Over Voltage Protection Recovery
(CH1-VDD, CH2-Vo1,CH4-IL)

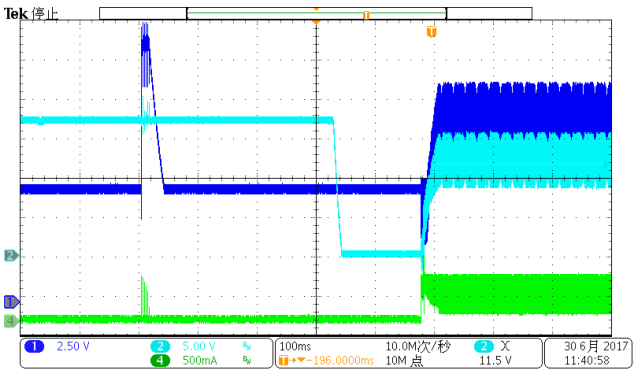
Comments: OVP Recovery is OK

Test Condition: 230Vac/50Hz Input, 18V DC source applied to board Vo1 output



Over Voltage Protection Enter
(CH1-VDD, CH2-Vo1,CH4-IL)

Comments: OVP Enter is OK

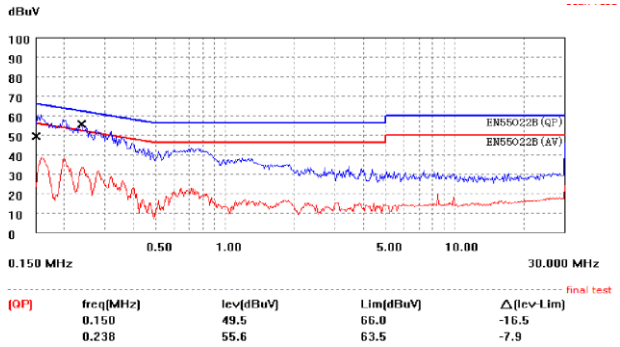


Over Voltage Protection Recovery
(CH1-VDD, CH2-Vo1,CH4-IL)

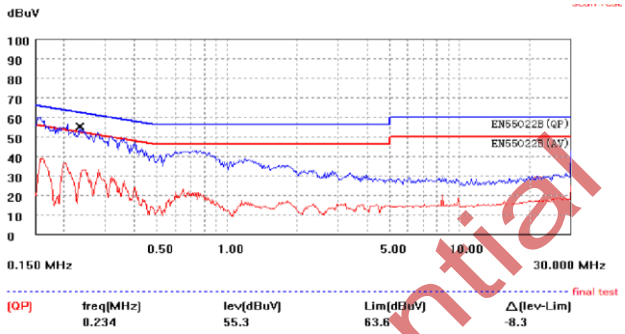
Comments: OVP Recovery is OK

3. EMC Test Result

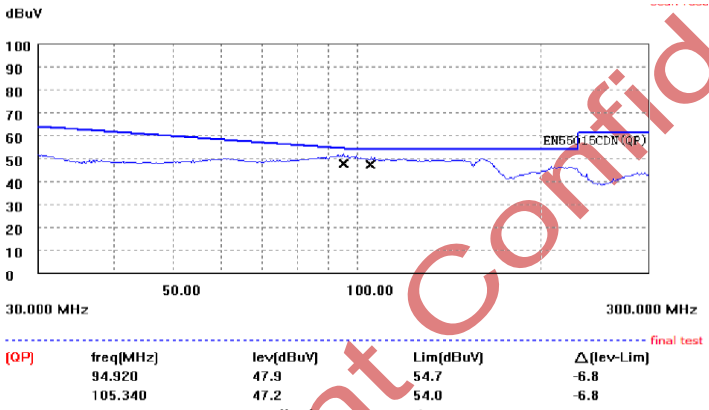
Test Condition: Vin=120VAC/60Hz, Vout1=12V/0.2A ,Vout2=5V/0.1A



Conduction EMI---LINE

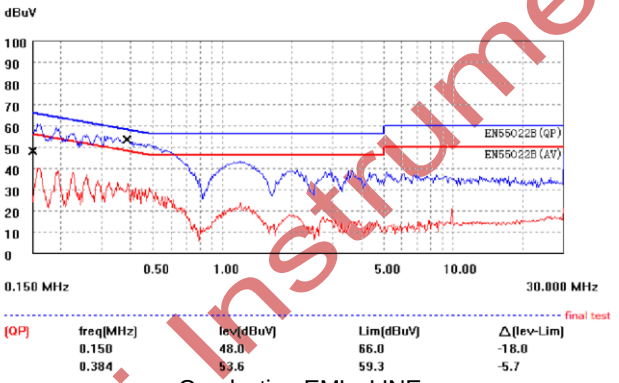


Conduction EMI---NEUTRAL

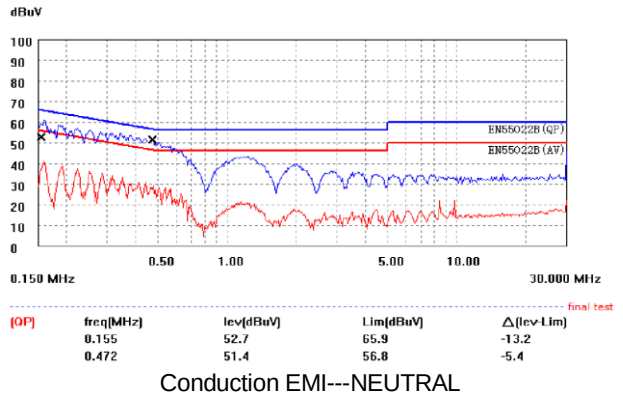


Radiation EMI---CDN

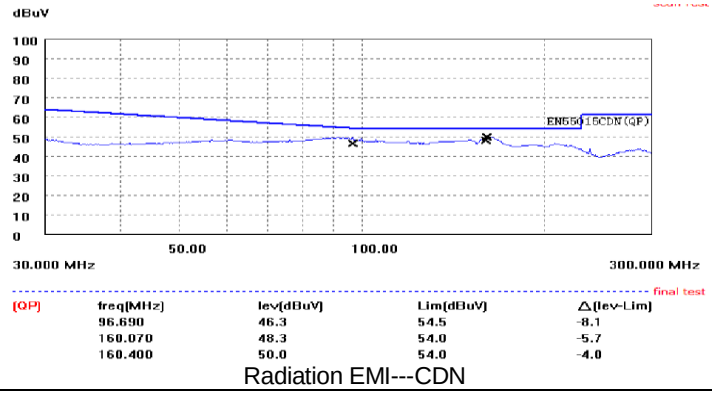
Test Condition: Vin=230VAC/50Hz, Vout1=12V/0.2A ,Vout2=5V/0.1A



Conduction EMI---LINE



Conduction EMI---NEUTRAL



Radiation EMI---CDN

4. Thermal Test

90Vac/60Hz, 265Vac/50Hz; 12V/0.2A & 5V/0.1A output; Ta=30°c under natural convection, Burn-in 1Hour.

Component	90Vac		265Vac	
	Tc(°C)	Trise(°C)	Tc(°C)	Trise(°C)
IC1(KP3210SG)	97.1	67.1	77.2	47.2
C3	70	40	61.1	31.1
D2	78.6	48.6	77	47
L2	79	49	80.6	50.6
IC2(78L05)	99.8	69.8	102	72

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 60seconds 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

Test Setup Guide

1. Connect the '-12V','-5V' and 'GND' 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.

Revision History

DATE	REV	DESCRIPTION
2017/06/30	1.0	First Release

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