DEMO BOARD TEST REPORT

Universal Input Power Factor Corrected 6.5W LED Driver Using KP1061

FEATURES

- **High PF and Low THD LED Driver Solution**
- **Quasi-Resonant (QR) Operation Mode with High Efficiency and Good EMI performance**
- **Universal Input Range with High PF>0.95**
- **Universal Input Range with Low THD<15%**
- **Fast Start-Up Speed <100ms**
- **Excellent Line and Load regulation <+-1%**
- **Built-in HV startup and IC Power supply circuit**
- **Leading Edge Blanking (LEB)**
- **LED Short and Open Protection**
- **Cycle-by-cycle Current Limiting**
- **Over Temperature Protection (OTP)**

APPLICATIONS

- **Commercial & Residential Lighting**

INTRODUCTION

KP1061 is a highly integrated power switch with constant current (CC) control. The IC can achieve very high Power Factor, low THD and accurate output current regulation. At the same time, the adopted QR operation mode minimized the switching loss and lead to good EMI performance.

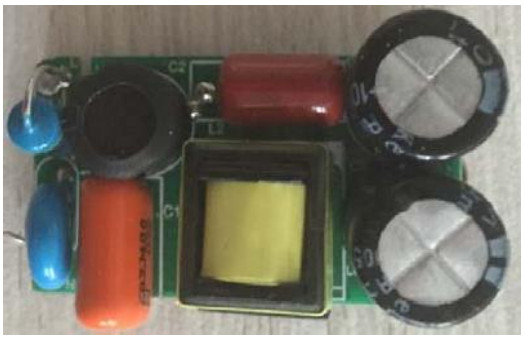
The Demo Board of KP1061-D01-R1.1 is typically designed for the application of 36V/180mA with universal input (90-265Vac, 60/50Hz). Besides the multi-protection function, this demo also has very good efficiency, current regulation, Power Factor, THD and meet the EN55015 conducted and radiated EMI requirement.

DEMO BOARD SEPCIFICATION

Description	Symbol	Min	Type	Max	Unit	Note
Input Voltage	Vin	90		265	Vac	50/60Hz
Output Voltage	Vout		36	70	Vdc	OVP point is 70V
Output Current	Iout		180		mA	
Output Power	Pout			6.5	W	
Efficiency	η		87.4	87.7	%	Typically value tested at 230Vac/50Hz
Startup Time	Tst			100	ms	Tested at 90Vac/60Hz
Power Factor	PF	0.95				
Total Harmonics Distortion	THD			15	%	
EMI	CE/RE	Pass				EN55015
Surge		Pass				1kV Level

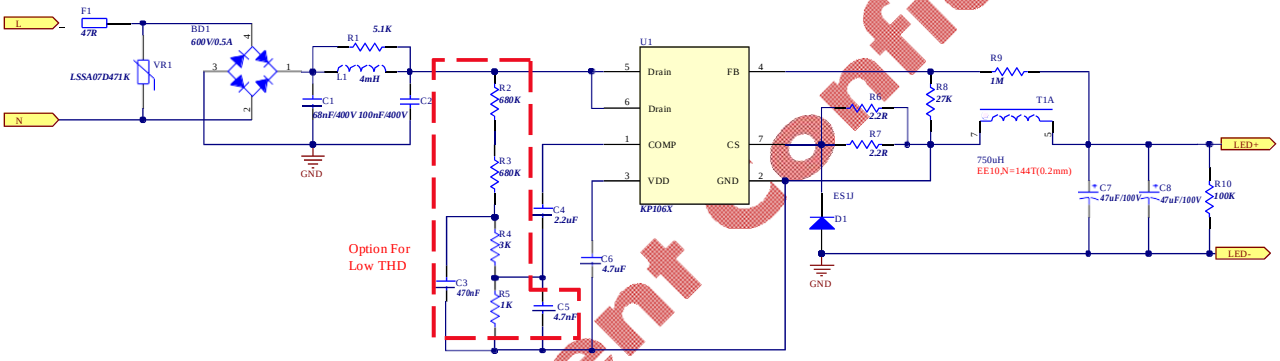
The table above shows the minimum acceptable performance of the design. Actual performance is listed in the results section.

Demo Board of KP1061-D01-R1.1



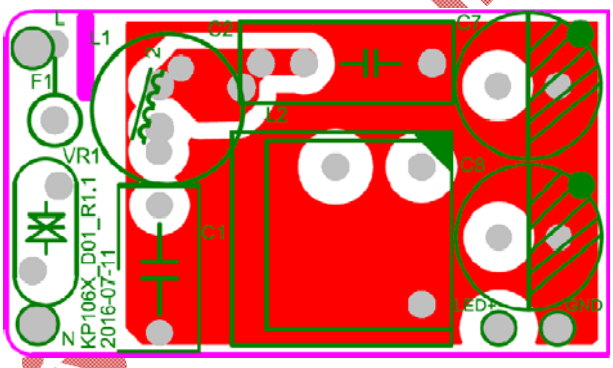
Board Size(in mm): L x W x H=35X20X15

Schematic

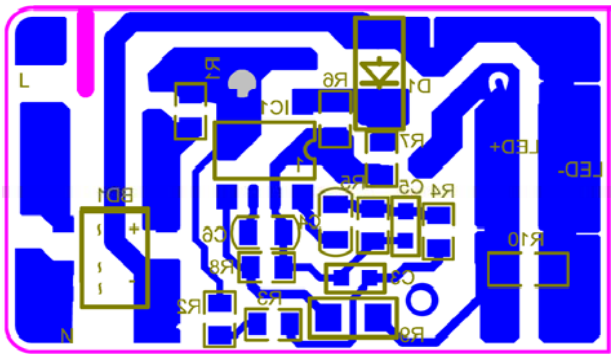


Printed Circuit Board Layout

Top Layer



Bottom Layer



Circuit Description

The demo board of KP1061-D01-R1.1 is designed with Buck topology, which adopts QR operation mode to minimize the switching loss and lead to good EMI performance. The demo board can achieve good performance for high efficiency, high power factor and accurate output current. A THD optimized circuit is adopted to achieve low THD.

1. Input Rectification and EMI filtering

The circuit input stage is composed by the components of F1, VR1, BD1, L1, C1, C2 and R1. F1 provides the inrush current limitation in the event of component failure or a short circuit. VR1 absorbs transient energy to protect the circuit during surge. The bridge diode of BD1 rectifies the AC input to DC output. The value of C1, C2 and L1 needs to be fine-tuned according to the EMI and THD requirement.

2. KP1061 Operation

KP1061 is a highly integrated power switch with constant current (CC) control for LED lighting applications. The IC utilizes Quasi-Resonant (QR) Buck topology with active PFC control for high PF, low THD, high efficiency and good EMI performance.

The VDD hold-up capacitor C6 is charged to 11V by an internal 11V regulator. When the internal power MOSFET is off, a current is drawn to the VDD capacitor from Drain pin.

C4 is compensation capacitor. Larger capacitance of C_{COMP} can provide bigger phase margin for the control loop which may make the system response slowly at the same time. R2, R3, R4, R5, C3 and C5 compose THD optimized circuit, which senses the bus voltage and offsets the compensation voltage for low THD and high PF.

R8 and R9 are used to detect zero current cross point for QR operation mode and achieve OVP. When FB pin voltage drops below 0.2V, an internal DEM comparator is triggered and a new switching cycle is initiated following the DEM triggering. The output voltage is monitored in the PWM OFF state. If the sampled voltage exceeds the OVP threshold for successive 3 cycles, the controller assumes a true OVP and it stops all switching operations. OVP is auto-recovery mode protection. In the event of LED open loop condition / OVP protection, VDD oscillation mode begins. When 8 VDD oscillation cycles had been counted, the IC will reset and start up the system again. However, if the fault still exists, the system will experience the above process.If the fault has gone, the system will resume normal operation.

R6 and R7 are used as the sensing resistor. The averaged voltage on CS pin is regulated by the IC which helps to achieve accurate output current.

D1 is freewheeling diode. When the internal power MOSFET is off, D1 turns on.

3. Output Filtering

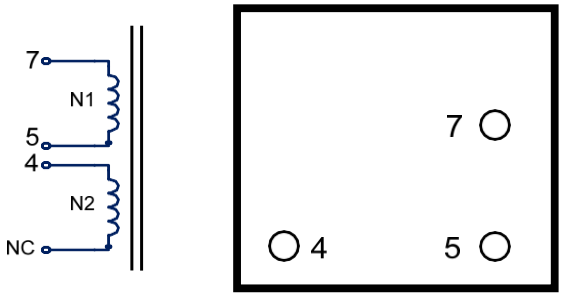
T1, C7 and C8 compose the output filtering circuit. R10 is the dummy resistor, and output capacitor is discharged after system is shut down.

Bill of Material

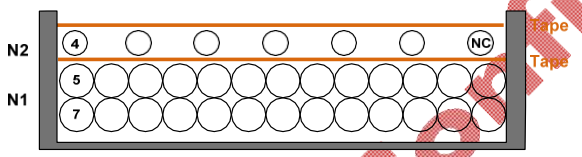
Num.	Designator	Value	Description	Package	Manufacturer
1	BD1	MB6S	SINGLE PHASE SILICON BRIDGE,600V/0.5A	SMD	Any
2	C1	68nF/400V	C21,400Vdc(200Vac), P=10mm,T=4.7mm	TH	STE
3	C2	100nF/400V	C21,400Vdc(200Vac), P=7.5mm,T=5.0mm	TH	STE
4	C3	470nF	Ceramic Cap, 25V X7R	0603	Murata
5	C4	2.2uF	Ceramic Cap, 25V X7R	0805	TDK
6	C5	4.7nF	Ceramic Cap, 50V NPO	0603	Murata
7	C6	4.7uF	Ceramic Cap, 25V X7R	0805	TDK
8	C7, C8	47uF/100V	Electrolytic Cap, 100V,10*16	TH	Ketuo
9	D1	ES1J	1.0 AMP Surface Mount Super Fast Recovery Rectifiers	SMA	Lision Tech
10	F1	47R	Metal Film Power Resistor,1W	TH	Any
11	L1	4mH	DR8*10,Isat=0.25A	TH	湘越电子
12	R1	5.1K	Film Resistor, 5%	0805	Yageo
13	R2, R3	680K	Film Resistor, 5%	0805	Yageo
14	R4	3K	Film Resistor, 5%	0805	Yageo
15	R5	1K	Film Resistor, 5%	0805	Yageo
16	R6, R7	2.2R	Film Resistor, 1%	0805	Yageo
17	R8	27K	Film Resistor, 5%	0805	Yageo
18	R9	1M	Film Resistor, 5%	0805	Yageo
19	R10	100K	Film Resistor, 5%	1206	Yageo
20	T1	750uH	EE10,N=144T(0.2mm)		
21	U1	KP1061SPA	Non-Isolated Buck APFC Offline LED Power Switch	SOP7	Kiwi Instrument
22	VR1	LSSA07D471K	VARISTOR,P=5.0mm,T=4.0mm	07D	Lision Tech

Inductor Manufacture Guide

1. Electrical Diagram



2. Winding Diagram



3. Winding Order

Winding Number	Layer	Start	End	Wire Size	Turns
N1	Primary	7	5	0.2d*1P	144Ts
N2	Shielding	4	NC	0.1d*1P	

4. Electrical Specification

Inductance	0.75mH±5% Test condition: Pins 5 - 7, measured at 40kHz,1.0 VRMS

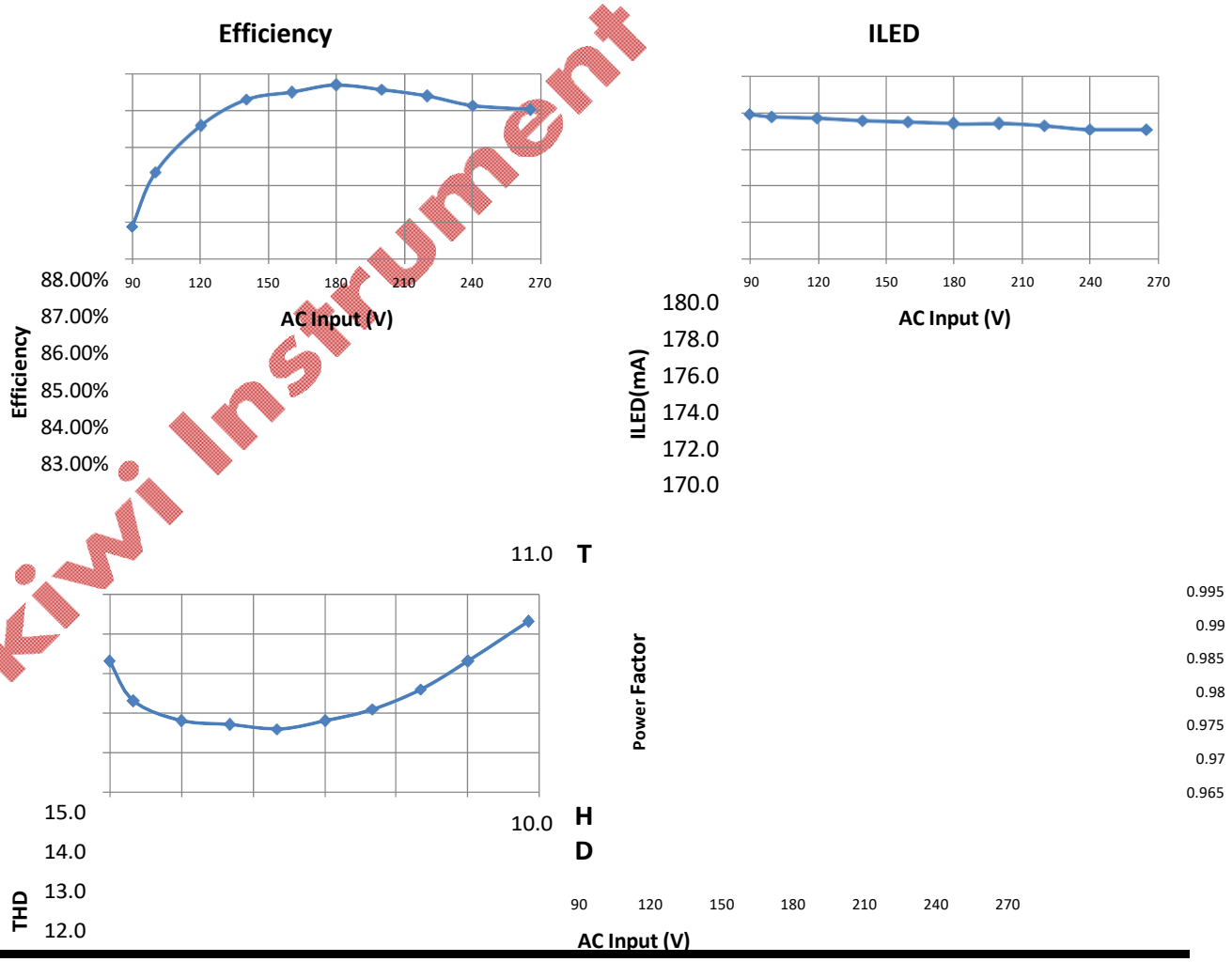
5. Materials

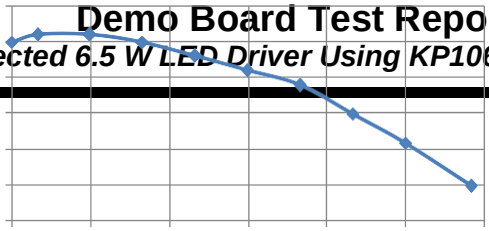
Item	Description	Remark
1	Core: EE10, PC40	
2	Bobbin: EE10, Horizontal, 8 pins, 4/4	
3	Wire: 0.20 Φ 2UEW, 130℃	
4	Tape: 3M 1350# Polyester Film	

Test Result

1. Efficiency, PF, THD and Line Regulation

Vin(VAC)	Frequency (HZ)	Pin(W)	Vout(V)	Iout(mA)	Pout(W)	Efficiency	PF	THD (%)
90	50	7.44	35.09	177.9	6.243	83.90%	0.99	13.3
100		7.31	35.09	177.8	6.239	85.35%	0.991	12.3
120		7.2	35.09	177.7	6.235	86.60%	0.991	11.8
140		7.14	35.10	177.6	6.234	87.31%	0.99	11.7
160		7.12	35.10	177.5	6.230	87.50%	0.988	11.6
180		7.1	35.10	177.4	6.227	87.70%	0.986	11.8
200		7.11	35.10	177.4	6.227	87.58%	0.984	12.1
220		7.12	35.10	177.3	6.223	87.40%	0.98	12.6
240		7.13	35.09	177.1	6.214	87.16%	0.976	13.3
265		7.14	35.09	177.1	6.214	87.04%	0.97	14.3



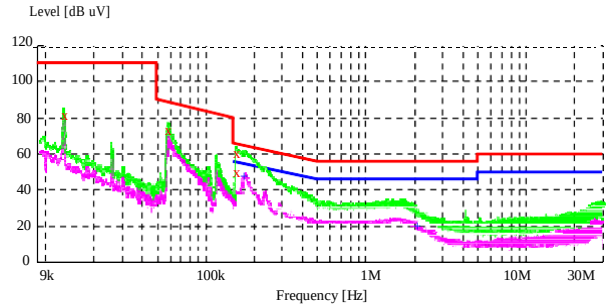


2. Load Regulation

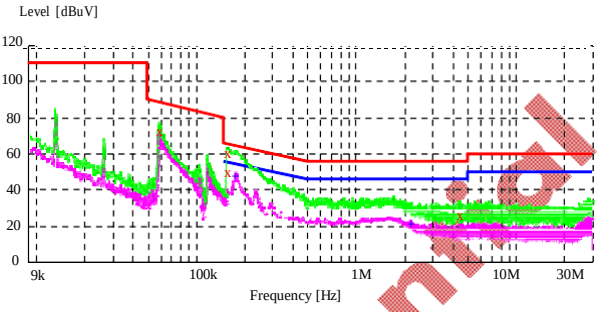
	Vout (V)	26.2	29.1	31.9	34.8	37.7	40.4	43.2
120Vac/60Hz	**Iout (mA)**	178.7	178.5	178.5	178.0	177.8	177.3	177.0

230Vac/50Hz	**Iout (mA)**	178.5	178.1	178.4	177.8	177.5	177.2	177.0

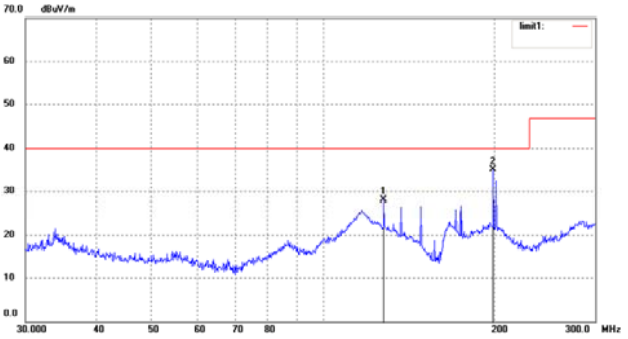
3. EMC Test Result (Test Condition: Vin=110VAC/60Hz, Vout=36V, Io=180mA)



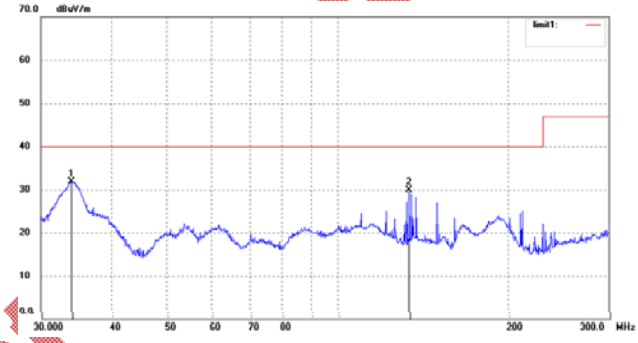
Conduction EMI---LINE



Conduction EMI---NEUTRAL

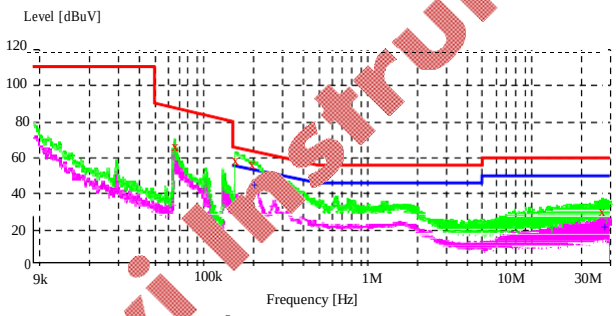


Radiation EMI---HORIZONTAL

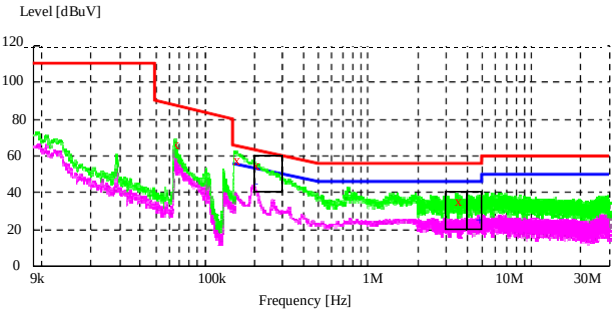


Radiation EMI---VERTICAL

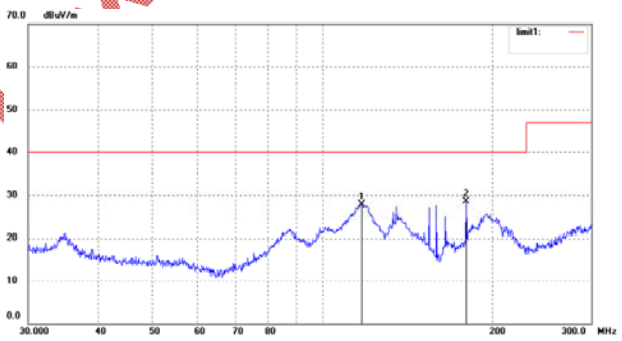
4. EMC Test Result (Test Condition: Vin=230VAC/50Hz, Vout=36V, Io=180mA)



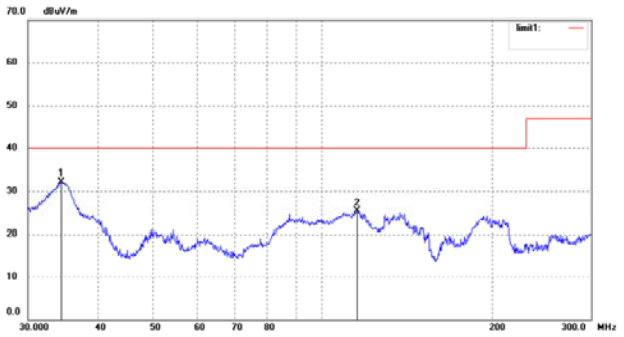
Conduction EMI---LINE



Conduction EMI---NEUTRAL

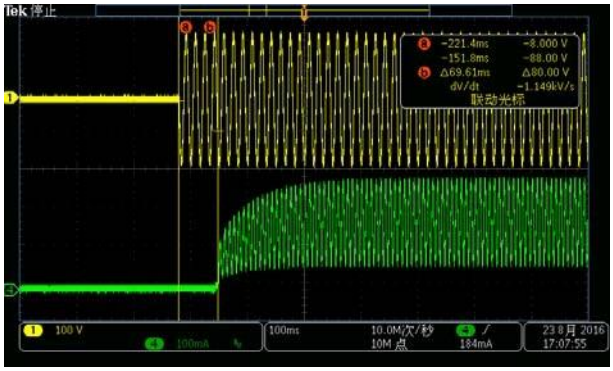


Radiation EMI---HORIZONTAL



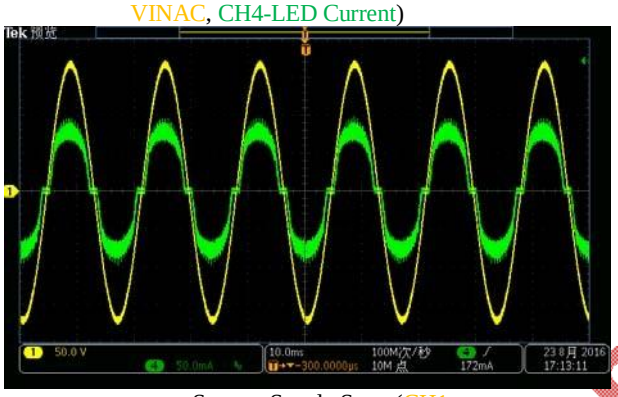
Radiation EMI---VERTICAL

5. Operation Curves (Test Condition: Vin=120VAC/60Hz, Vout=36V, Io=180mA)



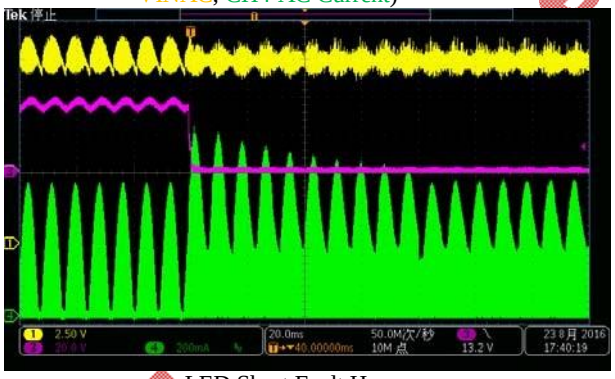
System Startup Time (CH1-VINAC, CH4-LED Current)

System Shut Down (CH1-VINAC, CH4-LED Current)

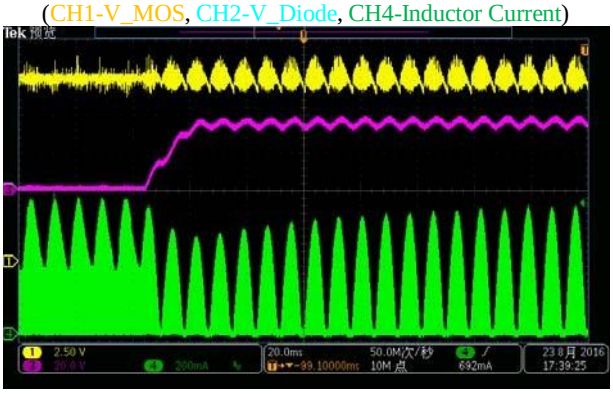


System Steady State (CH1-VINAC, CH4-AC Current)

System Steady State (CH1-V_MOS, CH2-V_Diode, CH4-Inductor Current)

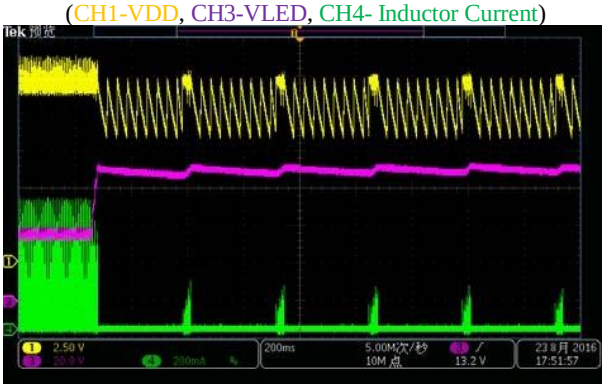


LED Short Fault Happen (CH1-VDD, CH3-VLED, CH4- Inductor Current)



LED Short Fault Recovery (CH1-VDD, CH3-VLED, CH4- Inductor Current)

LED Short Fault Steady State

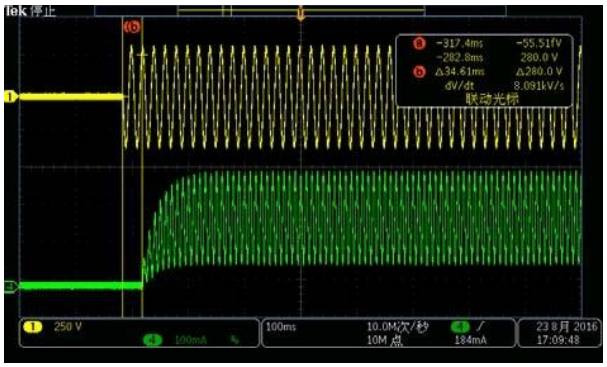


LED Open Fault Happen

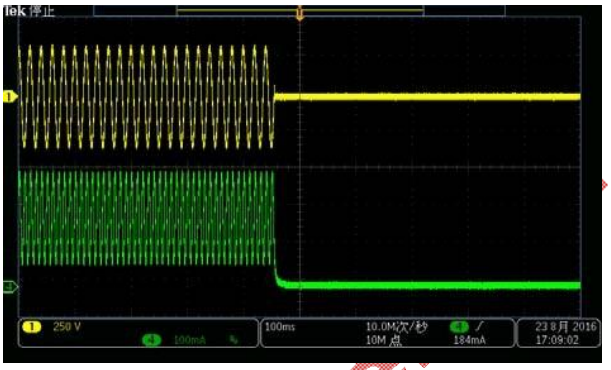
(CH1-VDD, CH3-VLED, CH4-Inductor Current)

(CH1-VDD, CH3-VLED, CH4-Inductor Current)

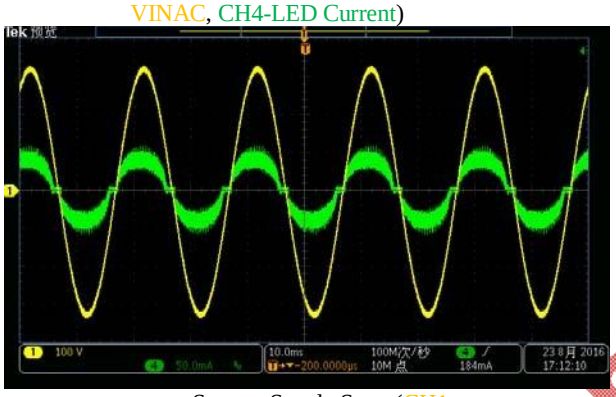
6. Operation Curves (Test Condition: Vin=230VAC/50Hz, Vout=36V, Io=180mA)



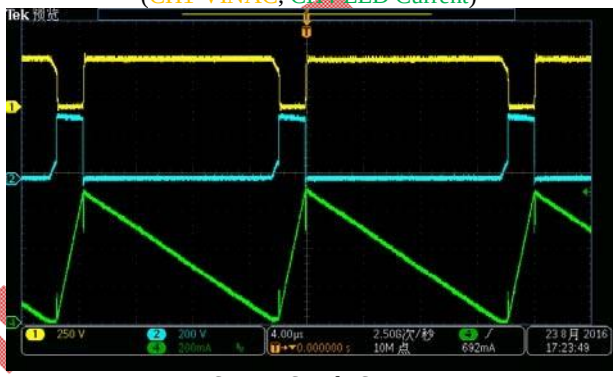
System Startup Time (CH1-VINAC, CH4-LED Current)



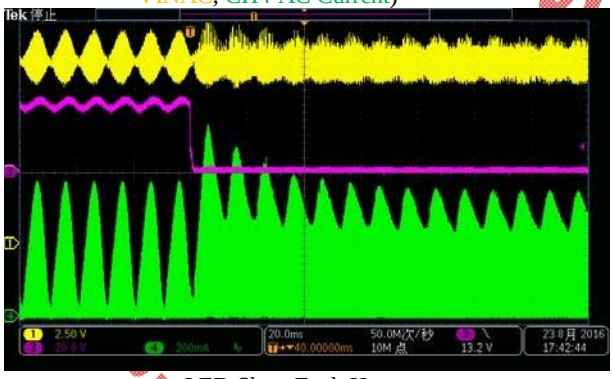
System Shut Down (CH1-VINAC, CH4-LED Current)



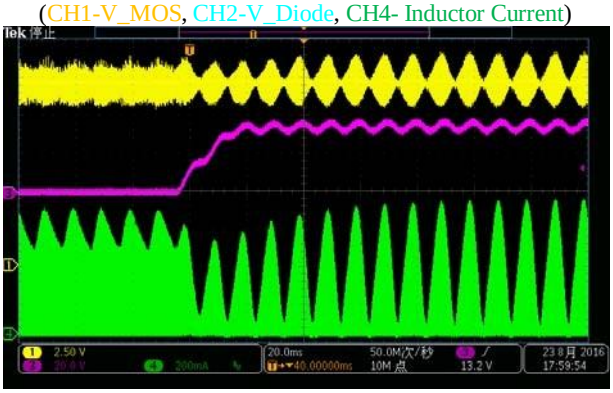
System Steady State (CH1-VINAC, CH4-AC Current)



System Steady State (CH1-V_MOS, CH2-V_Diode, CH4- Inductor Current)

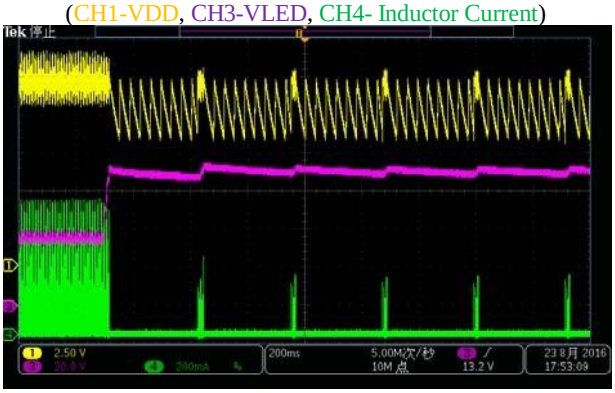


LED Short Fault Happen (CH1-VDD, CH3-VLED, CH4- Inductor Current)



LED Short Fault Recovery (CH1-VDD, CH3-VLED, CH4- Inductor Current)

LED Short Fault Steady State (CH1-VDD, CH3-VLED, CH4- Inductor Current)



LED Open Fault Happen (CH1-VDD, CH3-VLED, CH4- Inductor Current)

Test Setup Guide

1. Connect the “LED+” terminal to the anode of LED string and the “LED-” terminal to the cathode of LEDstring.
2. Set the AC Power Source 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 systemshutdown.

Revision History

DATE	REV.	DESCRIPTION
2016-08-23	1.0	First Release
2016-11-11	1.01	Add Inductor Manufacture Materials

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