DEMO BOARD TEST REPORT

Universal Input Power Factor Corrected 12W LED Driver Using KP1062

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<20%**
- **Fast Start-Up Speed <100ms**
- **Excellent Line regulation <+-2%**
- **Built-in HV startup and IC Power supply circuit**
- **Leading Edge Blanking (LEB)**
- **LED Short and Open Protection**
- **Cycle-by-cycle Current Limiting**
- **Over Voltage Protection (OVP) on VDD**
- **Over Temperature Protection (OTP)**

APPLICATIONS

- **Commercial & Residential Lighting**

INTRODUCTION

KP1062 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.

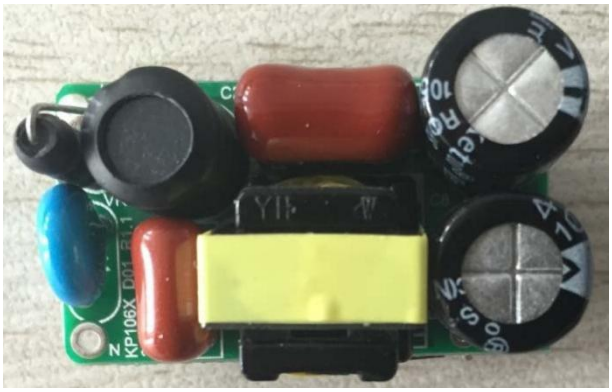
The Demo Board of KP1062-D01-R1.1 is typically designed for the application of 49V/240mA with universal input (90-265Vac, 60/50Hz). Besides the multi-protection function, this demo also has very good efficiency, current regulation, Power Factor, THD and meet the EN55015 conducted and radiated EMI requirement.

DEMO BOARD SEPCIFICATION

Description	Symbol	Min	Type	Max	Unit	Note
Input Voltage	Vin	90		265	Vac	50/60Hz
Output Voltage	Vout		49	70	Vdc	OVP point is 70V
Output Current	Iout		240		mA	
Output Power	Pout			12	W	
Efficiency	η		88.4	89	%	Typically value tested at 230Vac/50Hz
Startup Time	Tst			100	ms	Tested at 90Vac/60Hz
Power Factor	PF	0.95				
Total Harmonics Distortion	THD			20	%	
EMI	CE/RE	Pass				EN55015
Surge		Pass				1kV Level

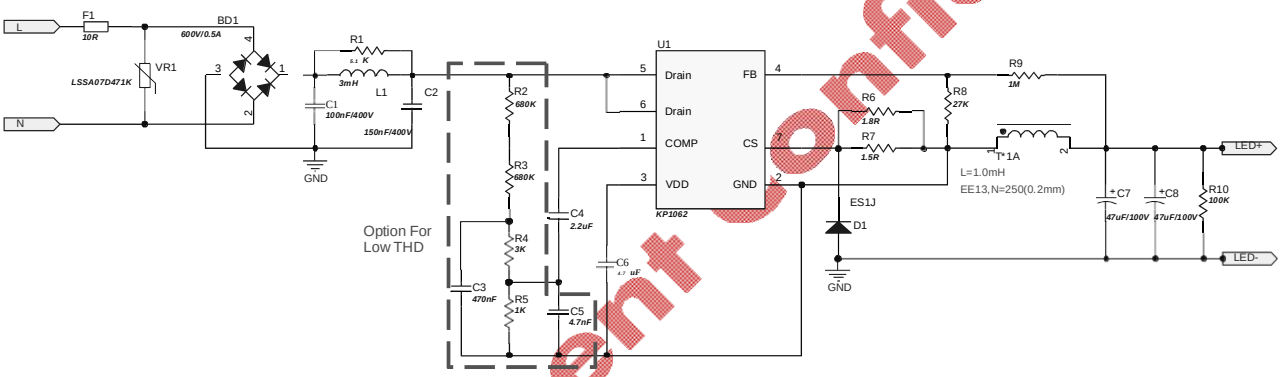
The table above shows the minimum acceptable performance of the design. Actual performance is listed in the results section.

Demo Board of KP1062-D01-R1.1



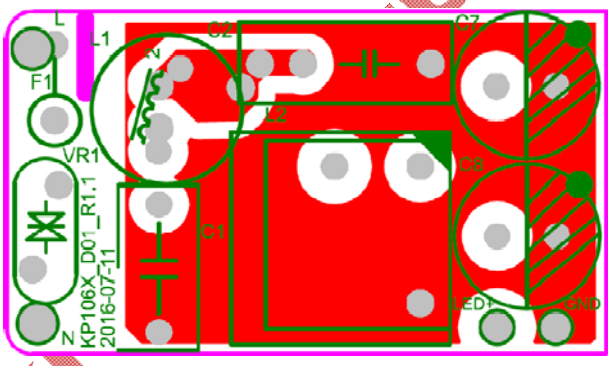
Board Size(in mm): L x W x H=35X20X15

Schematic

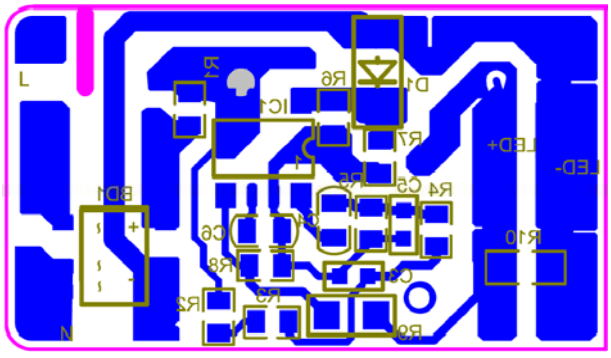


Printed Circuit Board Layout

Top Layer



Bottom Layer



Circuit Description

The demo board of KP1062-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. KP1062 Operation

KP1062 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

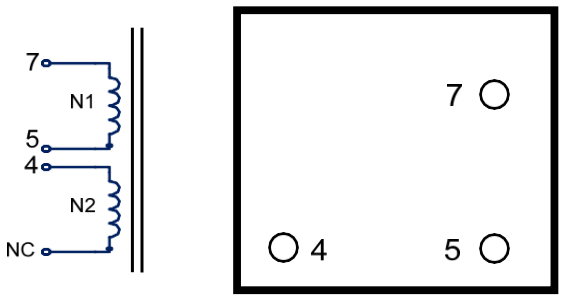
T1, C7 and C8 compose the output filtering circuit. R3 is the dummy resistor, and output capacitor is discharged after system is shut down.

Bill of Material

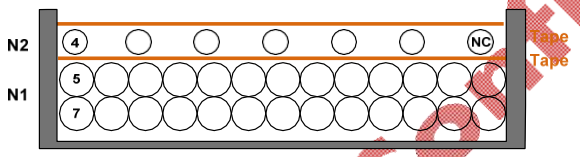
Num.	Designator	Value	Description	Package	Manufacturer
1	BD1	MB6S	SINGLE PHASE SILICON BRIDGE,600V/0.5A	SMD	Any
2	C1	100nF/400V	C21,400Vdc(200Vac),P=7.5mm,T=5.0mm	TH	STE
3	C2	150nF/400V	C21,400Vdc(200Vac),P=10mm,T=6.5mm	TH	STE
4	C3	470nF	Ceramic Cap, 25V X7R	0603	Murata
5	C4	2.2uF	Ceramic Cap, 25V X7R	0805	TDK
6	C5	4.7nF	Ceramic Cap, 50V NPO	0603	Murata
7	C6	4.7uF	Ceramic Cap, 25V X7R	0805	TDK
8	C7	47uF/100V	Electrolytic Cap, 100V,10*13.5	TH	Ketuo
9	C8	47uF/100V	Electrolytic Cap, 100V,10*13.5	TH	Ketuo
10	D1	ES1J	1.0 AMP Surface Mount Super Fast Recovery Rectifiers	SMA	Lision Tech
11	F1	10R	Metal Film Power Resistor,1W	TH	Any
12	L1	3mH	‘Rdc=3.6Ω,DR8*10	TH	鸿富邦科技
13	R1	5.1K	Film Resistor, 5%	0805	Yageo
14	R10	100K	Film Resistor, 5%	1206	Yageo
15	R4	3K	Film Resistor, 5%	0805	Yageo
16	R5	1K	Film Resistor, 5%	0805	Yageo
17	R6	1.8R	Film Resistor, 1%	0805	Yageo
18	R7	1.5R	Film Resistor, 1%	0805	Yageo
19	R8	27K	Film Resistor, 5%	0805	Yageo
20	R9	1M	Film Resistor, 5%	0805	Yageo
21	T*1	1.0mH	EE13,N=250(0.2mm)		
22	U1	KP1062SPA	‘Non-Isolated Buck APFC Offline LED Power Switch	SOP7	Kiwi Instrument
23	VR1	LSSA07D471K	VARISTOR,P=5.0mm,T=4.0mm	07D	Lision Tech
24	R2, R3	680K	Film Resistor, 5%	0805	Yageo

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	250Ts
N4	Shielding	4	NC	0.1d*1P	

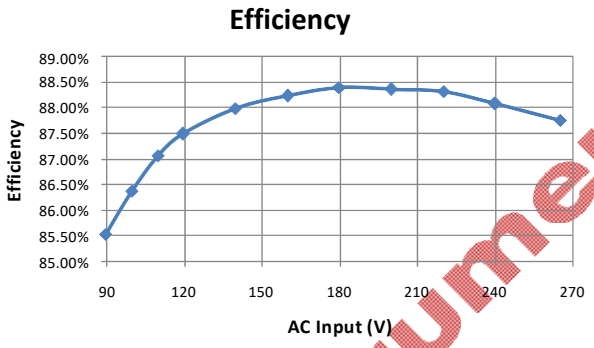
4. Electrical Specification

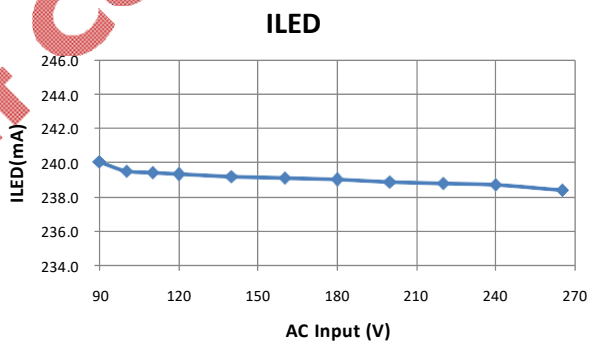
Inductance	1mH±5% Test condition: Pins 5 - 7, measured at 40kHz,1.0 VRMS

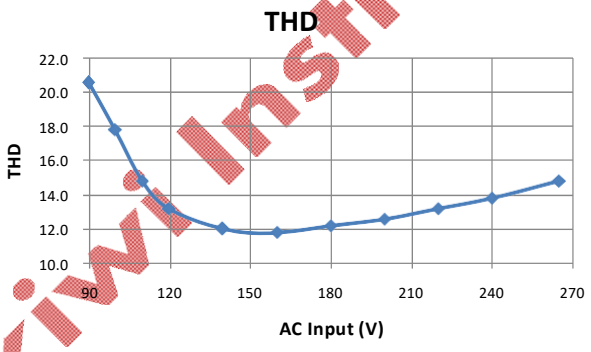
Test Result

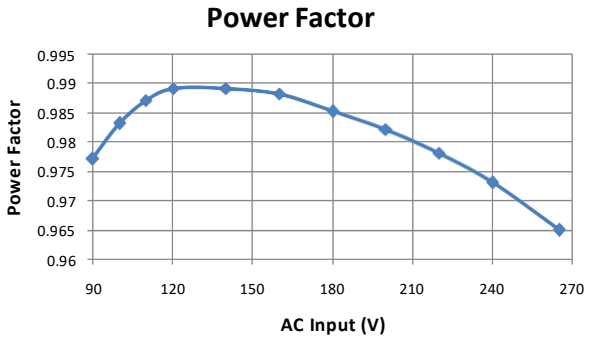
1. Efficiency, PF, THD and Line Regulation

Vin(VAC)	Frequency (HZ)	Pin(W)	Vout(V)	Iout(mA)	Pout(W)	Efficiency	PF	THD (%)
90	50	13.47	48.0	240.0	11.520	85.52%	0.977	20.5
100		13.31	48.0	239.5	11.496	86.37%	0.983	17.8
110		13.2	48.0	239.4	11.496	87.05%	0.987	14.8
120		13.13	48.0	239.3	11.486	87.48%	0.989	13.2
140		13.05	48.0	239.2	11.482	87.98%	0.989	12.0
160		13.01	48.0	239.1	11.477	88.22%	0.988	11.8
180		12.98	48.0	239.0	11.472	88.38%	0.985	12.2
200		12.98	48.0	238.9	11.467	88.35%	0.982	12.6
220		12.98	48.0	238.8	11.462	88.31%	0.978	13.2
240		13.01	48.0	238.7	11.458	88.07%	0.973	13.8
265		13.04	48.0	238.4	11.443	87.75%	0.965	14.8





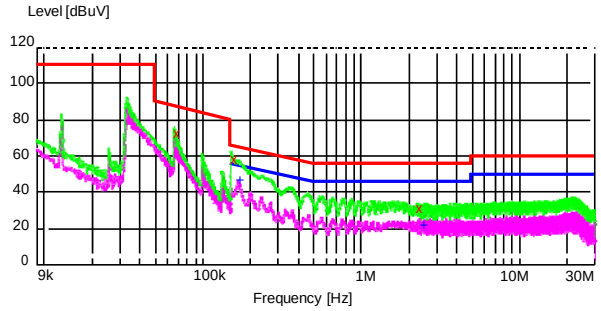




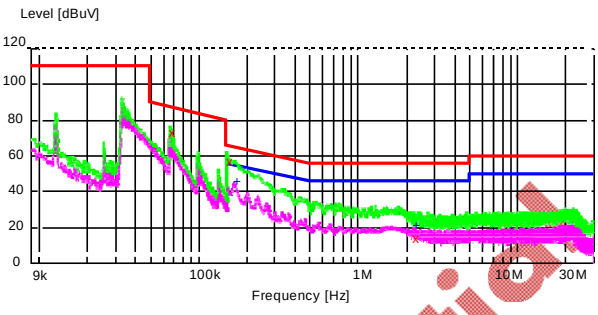
2. Load Regulation

	Vout (V)	39.3	42.3	45.3	48.2	51.2	54.0	56.9
120Vac/60Hz	Iout (mA)	238.9	238.8	238.7	238.5	238.3	238.1	238.1
230Vac/50Hz	Iout (mA)	239.0	238.9	238.9	238.7	238.7	238.5	238.4

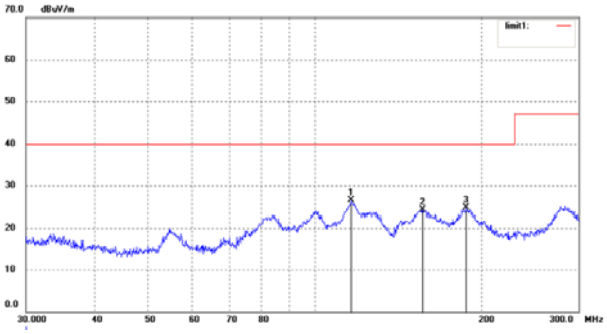
3. EMC Test Result (Test Condition: Vin=110VAC/60Hz, Vout=49V, Io=240mA)



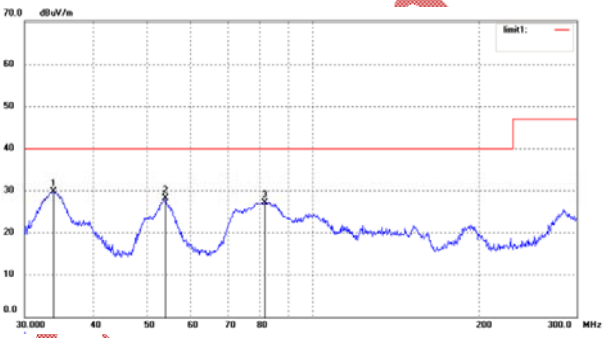
Conduction EMI---LINE



Conduction EMI---NEUTRAL

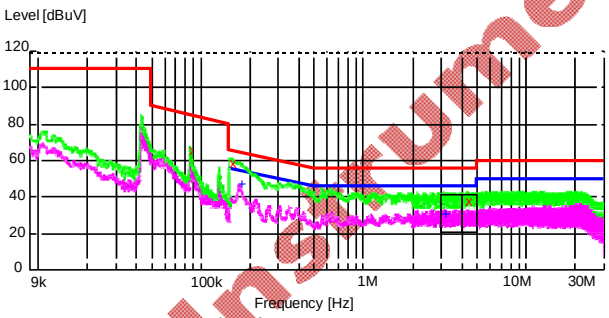


Radiation EMI---HORIZONTAL

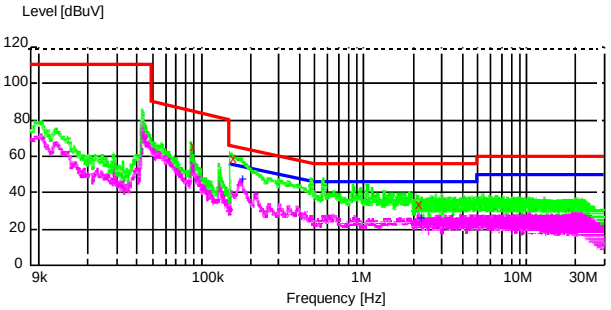


Radiation EMI---VERTICAL

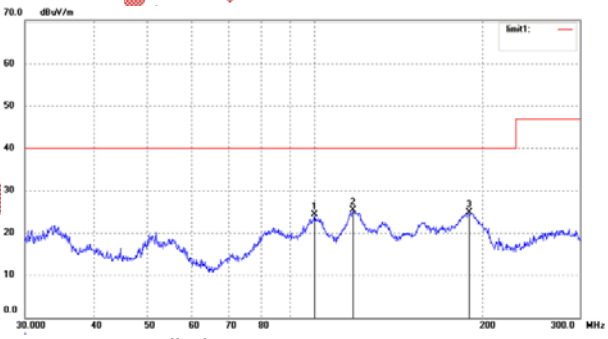
4. EMC Test Result (Test Condition: Vin=230VAC/50Hz, Vout=49V, Io=240mA)



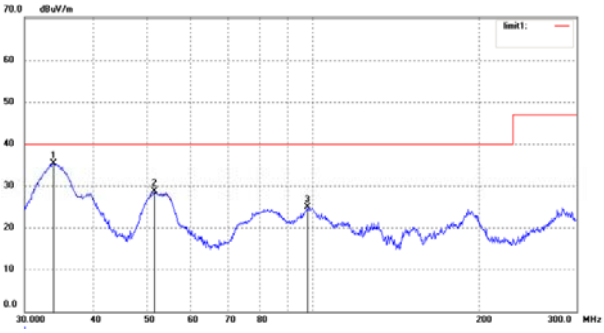
Conduction EMI---LINE



Conduction EMI---NEUTRAL

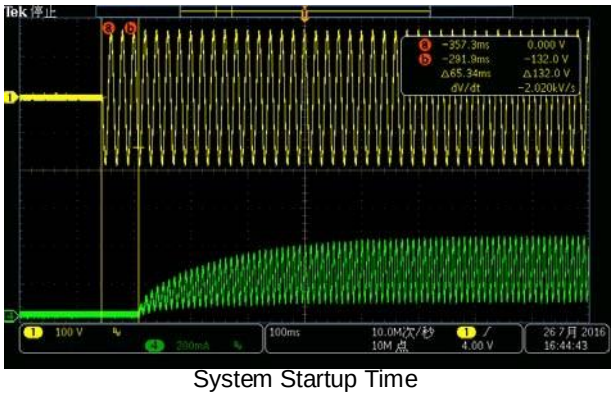


Radiation EMI---HORIZONTAL

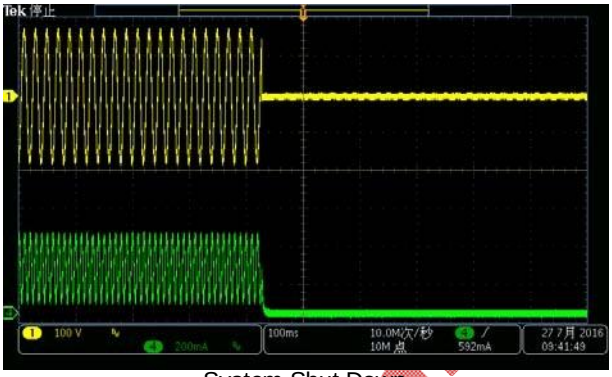


Radiation EMI---VERTICAL

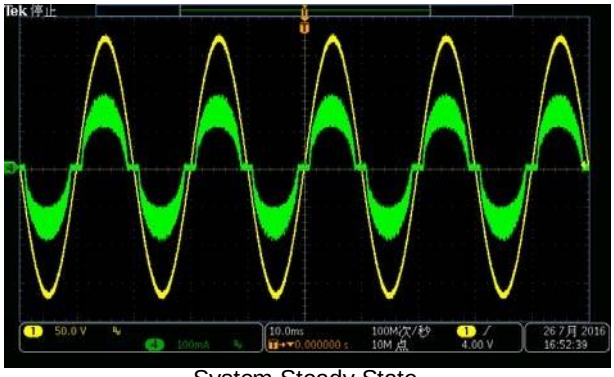
8. Operation Curves (Test Condition: Vin=120VAC/60Hz, Vout=48V, Io=600mA)



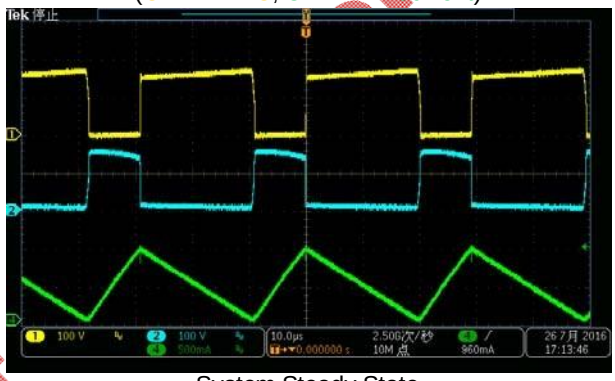
System Startup Time
(CH1-VINAC, CH4-LED Current)



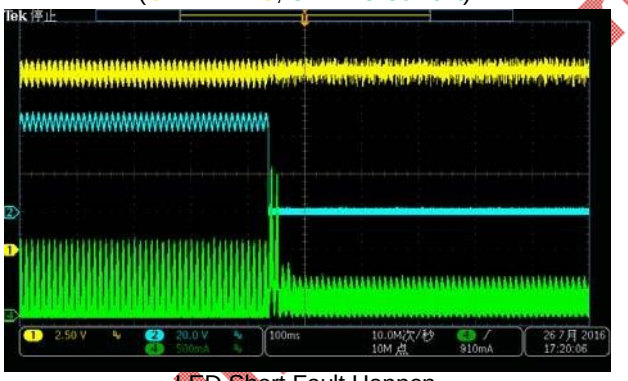
System Shut Down
(CH1-VINAC, CH4-LED Current)



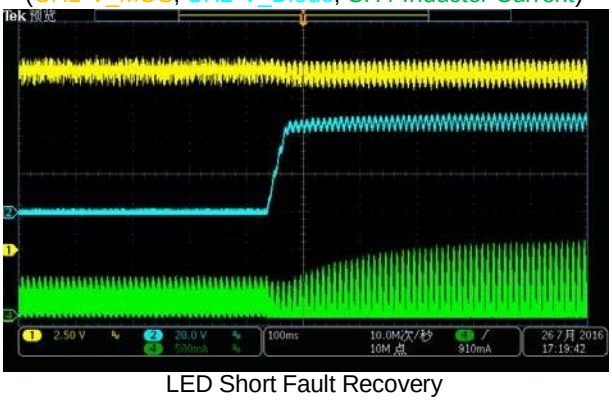
System Steady State
(CH1-VINAC, CH4-AC Current)



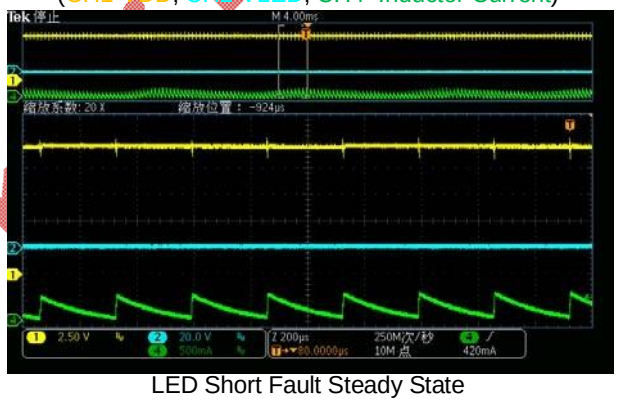
System Steady State
(CH1-V_MOS, CH2-V_Diode, CH4-Inductor Current)



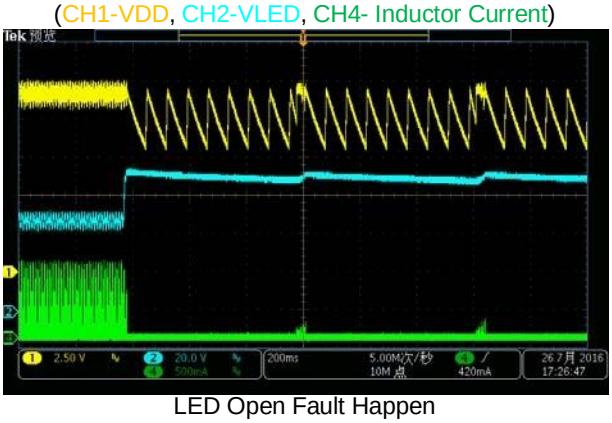
LED Short Fault Happen
(CH1-VDD, CH2-VLED, CH4- Inductor Current)



LED Short Fault Recovery
(CH1-VDD, CH2-VLED, CH4- Inductor Current)

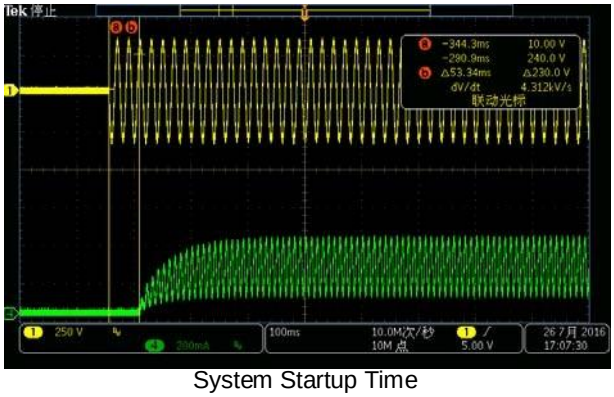


LED Short Fault Steady State
(CH1-VDD, CH2-VLED, CH4-Primary Current)

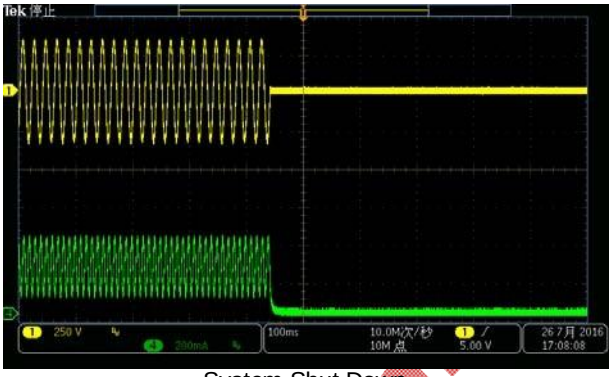


LED Open Fault Happen
(CH1-VDD, CH2-VLED, CH4-Primary Current)

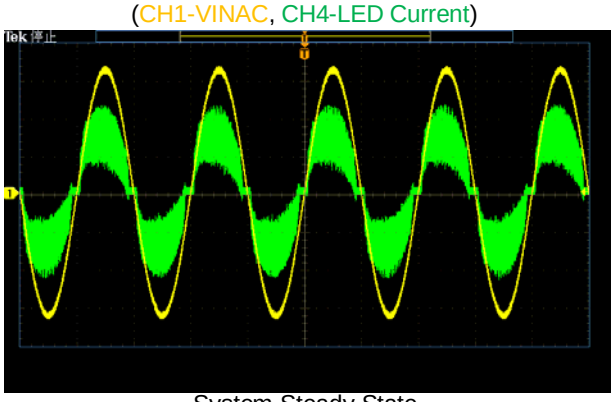
6. Operation Curves (Test Condition: Vin=230VAC/50Hz, Vout=48V, Io=600mA)



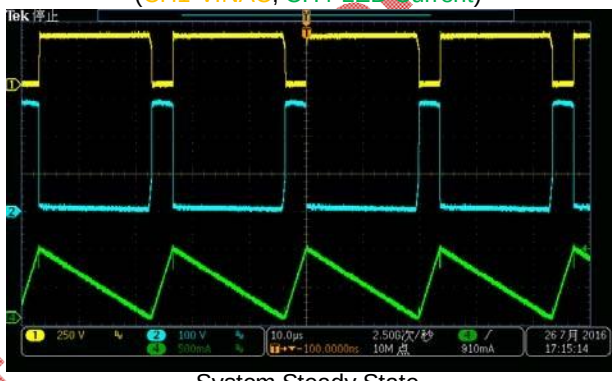
System Startup Time
(CH1-VINAC, CH4-LED Current)



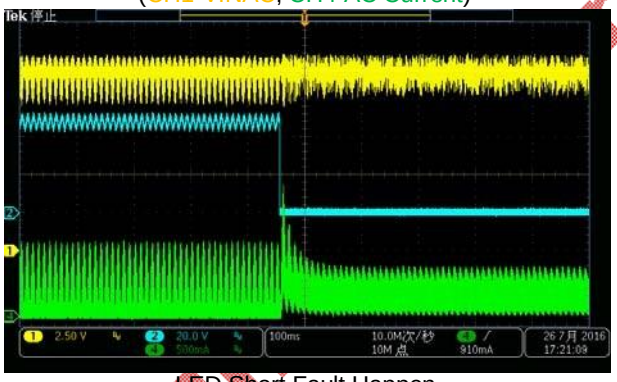
System Shut Down
(CH1-VINAC, CH4-LED Current)



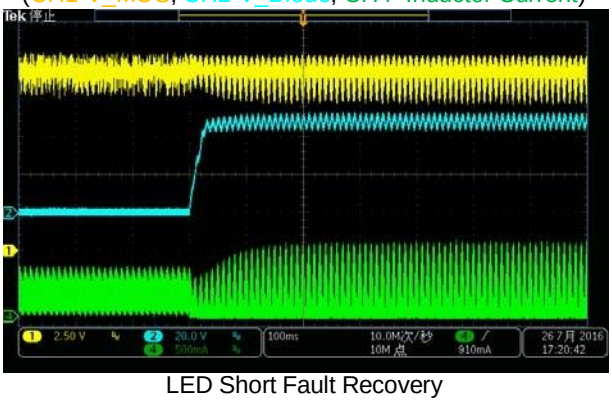
System Steady State
(CH1-VINAC, CH4-AC Current)



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

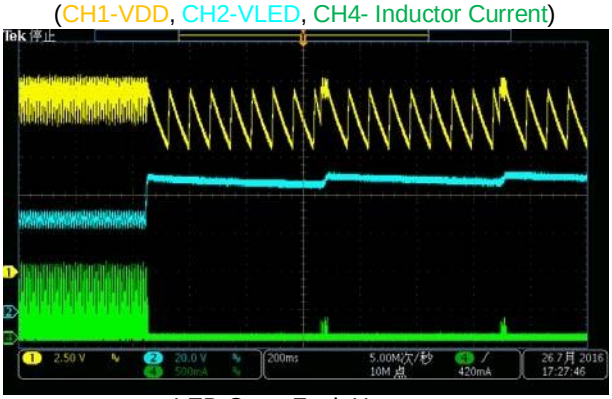


LED Short Fault Happen
(CH1-VDD, CH2-VLED, CH4- Inductor Current)



LED Short Fault Recovery
(CH1-VDD, CH2-VLED, CH4- Inductor Current)

LED Short Fault Steady State
(CH1-VDD, CH2-VLED, CH4- Inductor Current)



LED Open Fault Happen
(CH1-VDD, CH2-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 LED string.
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 system shutdown.

Revision History

DATE	REV.	DESCRIPTION
2016-07-28	1.0	First Release

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