DEMO BOARD TEST REPORT

Universal Input Power Factor Corrected 30W LED Driver with PWM Dimming Using KP112

FEATURES

- Low Cost PSR LED Driver Solution
- Quasi-Resonant (QR) Operation Mode with Up to 90% Efficiency
- Universal Input Range with High PF>0.95
- Fast Start-Up Speed <600ms
- Good Line and Load regulation <+-2%
- Flicker-Free Operation with PWM Dimmers
- Valley Switching Technical for Good EMI
- LED Short and Open Protection
- Current Sense Resistor Short and Open Protection
- Over Voltage Protection (OVP) on VDD
- Cycle-by-cycle Current Limiting
- Line Voltage Absent Protection
- Over Temperature Protection (OTP)
- Internal Soft Start

INTRODUCTION

KP112 is an off-line Primary Side Regulation (PSR) LED controller with PWM Dimming function, which can achieve very high Power Factor 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 KP112-D001 is typically designed for the application of 48V/600mA 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.

APPLICATIONS

- **Commercial & Residential Lighting**

DEMO BOARD SEPCIFICATION

Description	Symbol	Min	Type	Max	Unit	Note
Input Voltage	Vin	90		265	Vac	
Output Voltage	Vout	36		48	Vdc	
Output Current	Iout		600		mA	No Dimming and PWM Dimming Duty Cycle>99%
Output Power	Pout			30	W	
Efficiency	η		88.6	89	%	Typically value tested at 230Vac/50Hz
Standby Power Consumption	Pst		242		mW	Output Current is disabled by closing switch S1
Startup Time	Tst			600	ms	Tested at 90Vac/60Hz
Power Factor	PF	0.95				
Total Harmonics Distortion	THD			16	%	

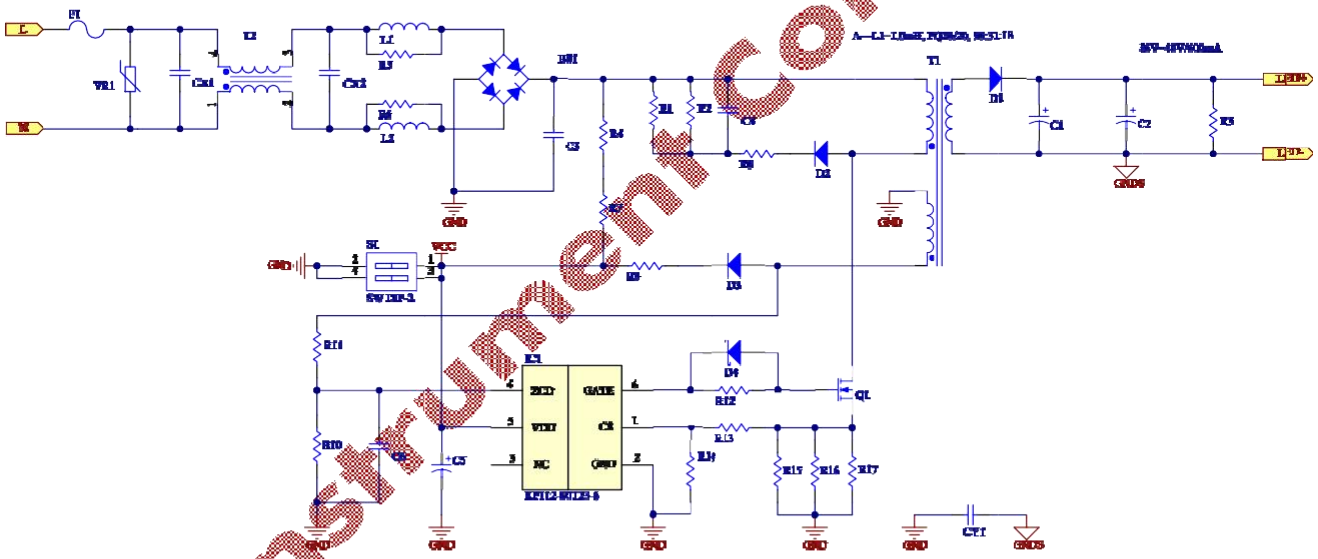
The table above shows the minimum acceptable performance of the design. Actual performance is listed in the results section.

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

Demo Board of KP112-D001

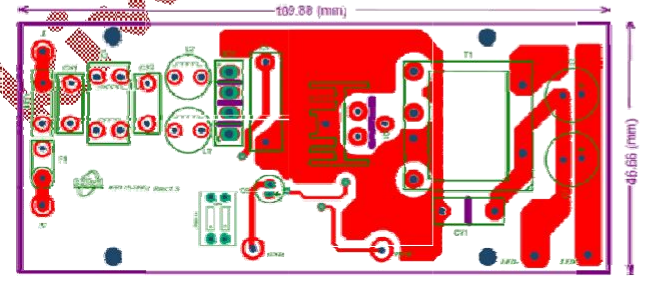
Board Size(in mm): L x W x H=110X47X26

Schematic

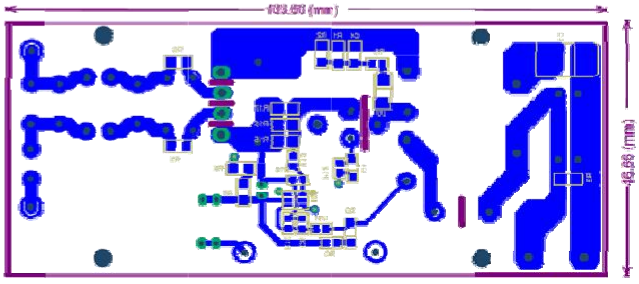


Printed Circuit Board Layout

Top Layer



Bottom Layer



Circuit Description

The demo board of KP112-D001 is designed with the single stage flyback topology, which uses the primary side regulation technology to simply the circuit and save cost of BOM. Additionally the demo board can achieve good performance for high efficiency, high power factor and accurate output current.

1. Input Rectification and EMI filtering

The circuit input stage is composed by the components of F1, CX1, CX2, T2, L1, L2, C3, R5 and R6. F1 provides the inrush current limitation in the event of component failure or a short circuit. CX1, CX2, T2, L1, L2, R5 and R6 together provide the differential and common mode EMI filtering. The bridge diode of BD1 rectifies the AC input to DC output which is followed by a high frequency noise filter capacitor C3. The value of C3 needs to be fine-tuned according to the EMI and PF requirement.

2. KP112 Operation

KP112 is an off-line Primary Side Regulation (PSR) LED controller with PWM Dimming function, which operates in the QR Mode to achieve high efficiency and good EMI performance. Due to the constant on time control function, high PF and low THD result can be maintained. When PWM pulse dimming signal is applied, the output current can be automatically changed.

C5 is the DC voltage power supply for the IC, which is charged from the rectified voltage through R4 and R7 during the startup period and charged by the auxiliary winding from D3 after the output voltage is ready. When the voltage of C5 is higher than the internal OVP threshold, the IC stops switching immediately and enters quiescent operation mode.

R10, R11 and C6 are used to detect zero current cross point for QR operation mode. When the falling edge of the C6 voltage signal is found, the GATE is turned on with some internal dely. In each switching cycle, the high voltage level of C6 is monitored and then is used to configure the OCP level on CS Pin. When LED is shorted, the output and high voltage level of C6 become nearly zero, which makes the OCP level to the minimum value.

R12 and D4 compose the GATE driver circuit. R12 is used to slow down the MOSFET turn on speed. D4 is used to help discharge the MOSFET GATE capacitor to minimize the turn off loss. R13, R14, R15, R16 and R17 are used as the sensing resistor. The averaged voltage on CS pin is regulated by the IC which helps to achieve accurate output current.

3. Output Current Regulation

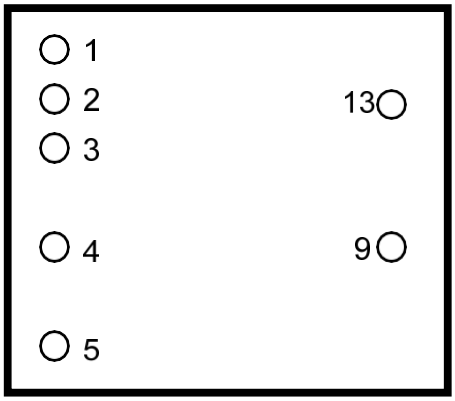
T1, Q1, D1, C1 and C3 compose the typical Flyback converter. R1, R2, D2, C4 and R8 are used as the primary side snubber circuit, which helps to avoid too high voltage spike on the MOSFET after GATE is turned off. R3 is the dummy resistor, and output capacitor is discharged after system is shut down.

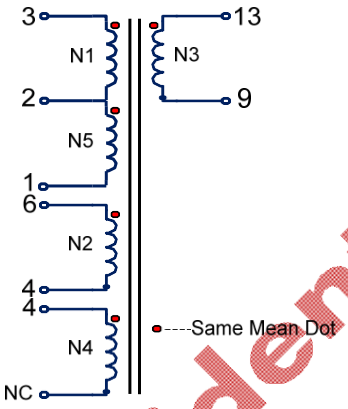
Bill of Material

Number	Designator	Value	Description	Package	Manufacturer	Part Number
1	F1	250V/1A	Fuse 250V/1A	DIP	Any	
2	VR1	10D471K	Varistor, 10D	TH	Lision Tech	LSSA10D471K
3	BD1	1000V/2A	100V/2.0A BRIDGE RECTIFIERS	KBP	Any	KBP210
4	R1	300K	Film Resistor, 5%	1206	Yageo	RC1206JR-07300KL
5	R2	300K	Film Resistor, 5%	1206	Yageo	RC1206JR-07300KL
6	R3	51K	Film Resistor, 5%	1206	Yageo	RC1206JR-0751KL
7	R4	240K	Film Resistor, 5%	1206	Yageo	RC1206JR-07240KL
8	R5	5.1K	Film Resistor, 5%	1206	Yageo	RC1206JR-075K1L
9	R6	5.1K	Film Resistor, 5%	1206	Yageo	RC1206JR-075K1L
10	R7	240K	Film Resistor, 5%	1206	Yageo	RC1206JR-07240KL
11	R8	100R	Film Resistor, 5%	0805	Yageo	RC0805JR-07100RL
12	R9	10R	Film Resistor, 5%	0805	Yageo	RC0805JR-0710RL
13	R10	10k	Film Resistor, 5%	0805	Yageo	RC0805JR-0710KL
14	R11	100k	Film Resistor, 5%	0805	Yageo	RC0805JR-07100KL
15	R12	150R	Film Resistor, 5%	0805	Yageo	RC0805JR-07150RL
16	R13	0R	Film Resistor, 5%	0805	Yageo	RC0805JR-070RL
17	R14	NC		0805		
18	R15	0.56R	Film Resistor, 1%	1206	Yageo	RL1206FR-070R56L
19	R16	0.56R	Film Resistor, 1%	1206	Yageo	RL1206FR-070R56L
20	R17	NC		1206		
21	C1	330uF	Electrolytic Cap, 63V	12*20	jianghai	CD263-63V330uF
22	C2	330uF	Electrolytic Cap, 63V	12*20	jianghai	CD263-63V330uF
23	C3	220nF	CL21-400V, P=15mm	TH	Fala	C.21.2G.334.K6A.C000
24	C4	10nF	Ceramic Cap, 1kV X7R	1206	Murata	GRM31CR73A103KW03L
25	C5	4.7uF	Electrolytic Cap, 50V, 5*11mm	TH	jianghai	CD263-50V4.7uF
26	C6	33pF	Ceramic Cap, 50V NPO	0603	Murata	GRM1885C1H330JA01D
27	CX1	47nF	X1 Cap-275VAC, P=7.5mm	TH	Fala	C.42.P2.473.K3S.C000
28	CX2	47nF	X1 Cap-275VAC, P=7.5mm	TH	Fala	C.42.P2.473.K3S.C000
29	CY1	2.2nF	Y1 Cap-250VAC, P=10mm	TH	Any	CD222M
30	D1	EK3D	200V/3A Schottky Diode	SMC	Lision Tech	EK3D
31	D2	1N4007	1.0 AMP SILICON RECTIFIERS	SMA	Any	1N4007
32	D3	1kV/1A	GENERAL RECTIFIERS	SOD123	Any	A7
33	D4	100V/150mA	FAST SWITCHING DIODES	SOD123	Any	1N4148
34	L1	2.2mH/0.4A	WE-TI Radial Leaded Wire Wound Inductor, 8*10mm	TH	Wurth Elektronik	7447452222
35	L2	2.2mH/0.4A	WE-TI Radial Leaded Wire Wound Inductor, 8*10mm	TH	Wurth Elektronik	7447452222
36	T1	1mH	L1=1.0mH,Core=PQ2020, Np:Ns:Naux=98:31:18	PQ2020	Any	Self Winding
37	T2	20mH	COMMON MODE CHOKE WE-CMB, 15*7.5mm	TH	Wurth Elektronik	744821120
38	Q1	AM8N80P	N Mosfet, 800V/8A, Rdson=1.5ohm	TO-220	Analog Power	AM8N80P
39	IC1	KP112	Single Stage PSR LED Driver with PFC	SOT23-6L	Kiwi	KP112LGA

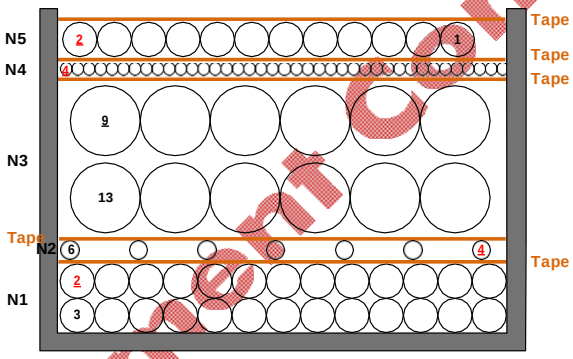
Transformer Manufacture Guide

1. Electrical Diagram





2. Winding Diagram



3. Winding Order

Winding Number	Layer	Start	End	Wire Size	Turns
N1	Primary	3	2	0.3d*1P	71Ts
N2	Auxiliary	6	4	0.15d * 1P	19Ts
N3	Secondary	13	9	0.5d * 1P	31Ts
N4	Shielding	4	NC	0.1d*2P	
N5	Primary	2	1	0.3d*1P	27Ts

4. Electrical Specification

Primary Inductance	1.00mH±5% Test condition: Pins 1 - 3,all other windings open, measured at 40kHz,1.0 VRMS
Primary Leakage Inductance	40uH±10% Test condition: Pins 1 - 3 with all other pins shorted, measured at 40kHz,1.0 VRMS

Test Result

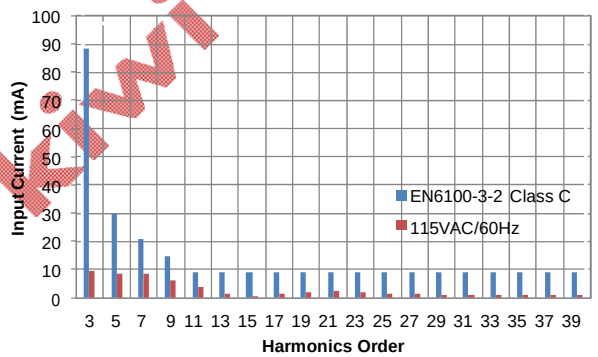
1. Efficiency, PF and THD

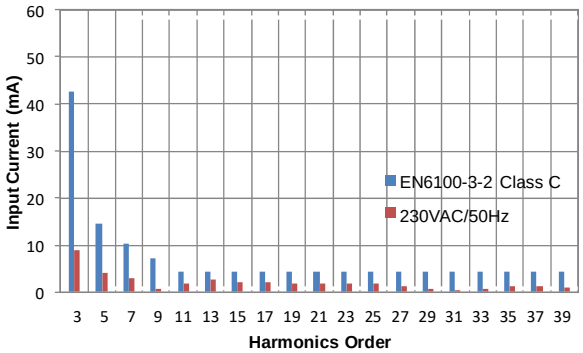
f (Hz)	Vin (VAC)	Pin (W)	Vout (V)	Iout (mA)	Pout (W)	Efficiency (%)	PF	THD (%)
60	90	35.328	48.1	621	29.870	84.55	0.9956	5.21
	100	34.768	48.1	619	29.774	85.64	0.9956	5.52
	110	34.282	48.1	617	29.678	86.57	0.9949	5.95
	120	33.990	48.1	616	29.630	87.17	0.9939	6.29
	130	33.721	48.1	615	29.582	87.72	0.9925	6.53
	140	33.530	48.1	613	29.485	87.94	0.9907	6.96
50	190	33.093	48.1	609	29.293	88.52	0.9817	12.93
	200	33.060	48.1	609	29.293	88.61	0.9784	12.97
	210	33.150	48.1	611	29.389	88.65	0.9753	13.52
	220	33.195	48.1	612	29.437	88.68	0.9715	14.1
	230	33.230	48.1	612	29.437	88.59	0.968	14
	240	33.272	48.1	612	29.437	88.47	0.9626	15.34
	250	33.298	48.1	612	29.437	88.41	0.9578	15.6
	260	33.421	48.1	615	29.582	88.51	0.9511	15.38
	265	33.540	48.1	616	29.630	88.34	0.9505	15

2. LED Current Load Regulation

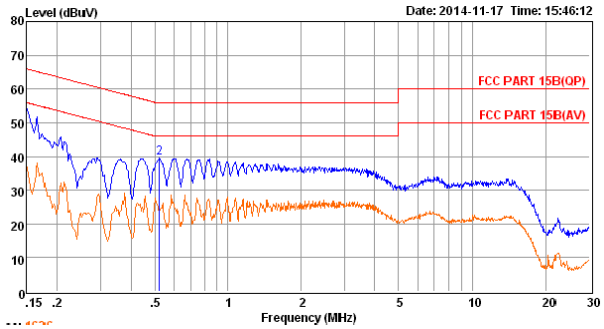
	Vout (V)	36	37	38	39	40	41	42	43	44	45	46	47	48
120Vac /60Hz	Iout (mA)	608	608	609	610	610	612	613	614	615	616	617	618	618
230Vac /50Hz	Iout (mA)	609	609	609	609	610	610	611	612	612	613	613	614	614

3. Harmonics Test Data (Test Condition: Vout=48V, Io=600mA)

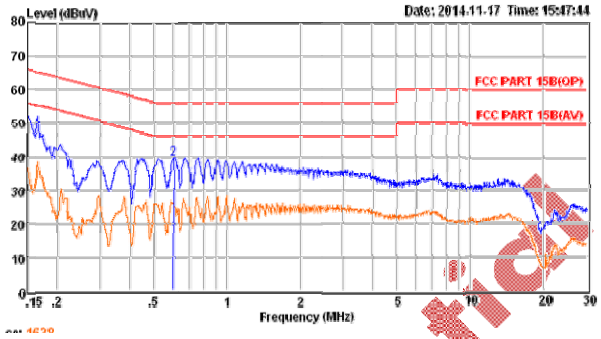




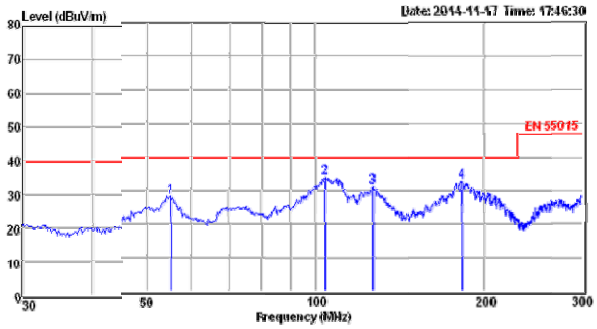
4. EMC Test Result (Test Condition: Vin=120VAC/60Hz, Vout=48V, Io=600mA)



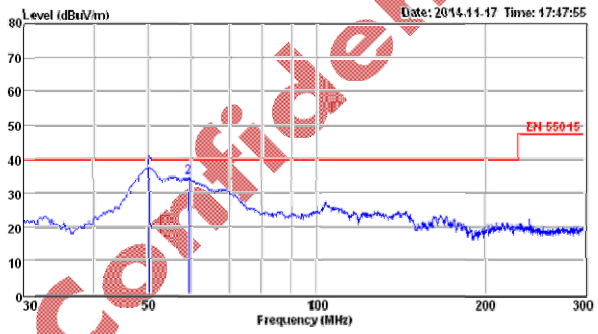
Conduction EMI---LINE



Conduction EMI---NEUTRAL

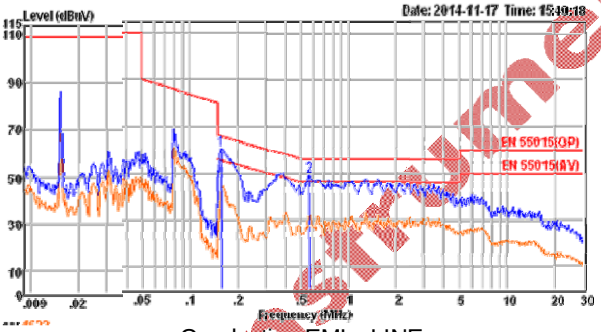


Radiation EMI---HORIZONTAL

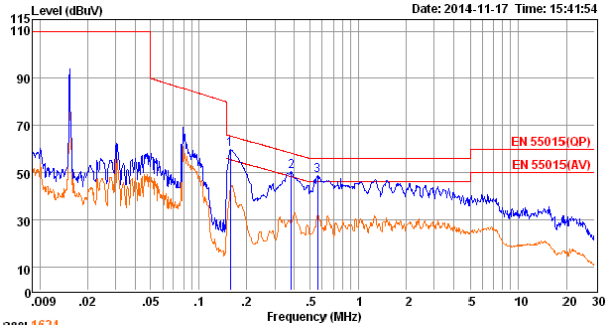


Radiation EMI---VERTICAL

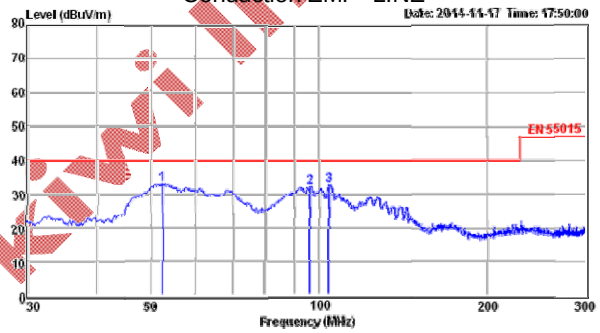
5. EMC Test Result (Test Condition: Vin=230VAC/50Hz, Vout=48V, Io=600mA)



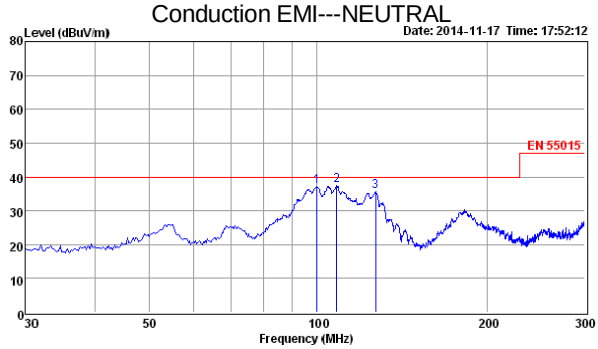
Conduction EMI---LINE



Conduction EMI---NEUTRAL

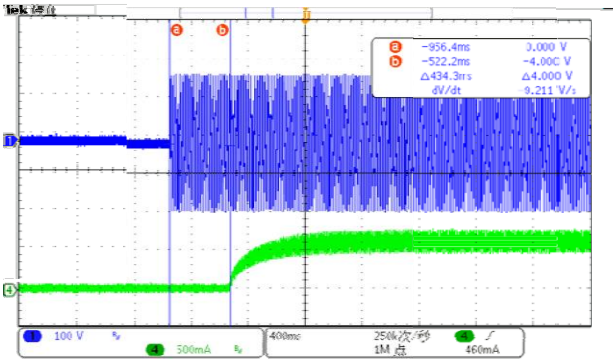


Radiation EMI---HORIZONTAL

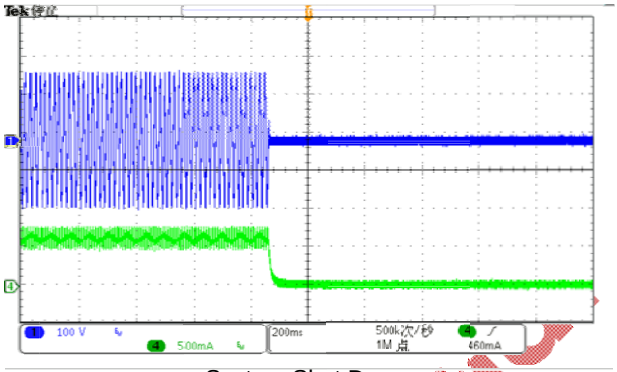


Radiation EMI---VERTICAL

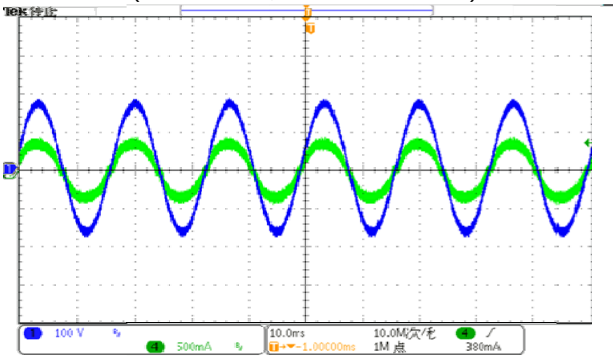
6. Operation Curves (Test Condition: Vin=120VAC/60Hz, Vout=48V, Io=600mA)



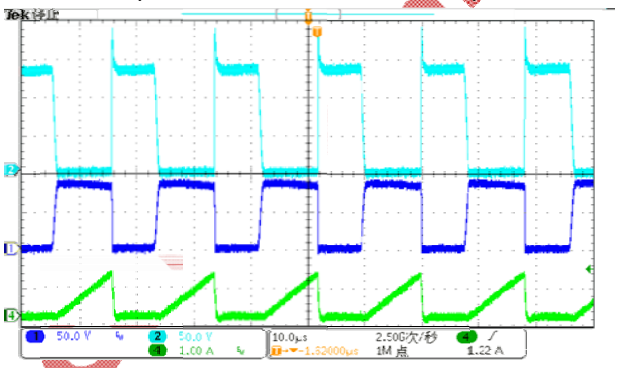
System Startup Time
(CH1-VINAC, CH4-LED Current)



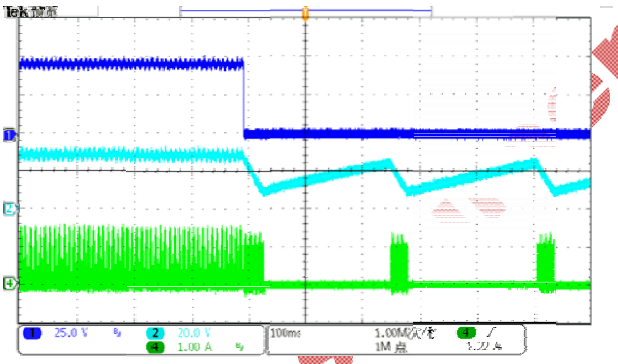
System Shut Down
(CH1-VINAC, CH4-LED Current)



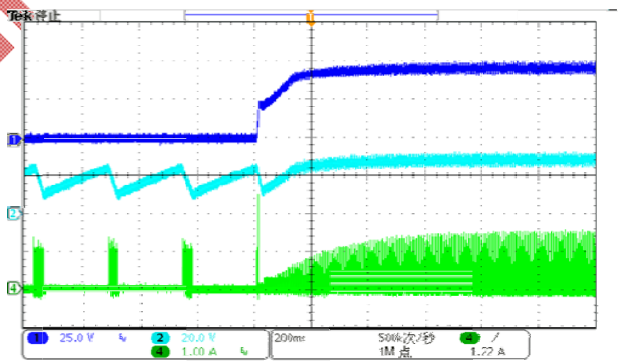
System Steady State
(CH1-VINAC, CH4-AC Current)



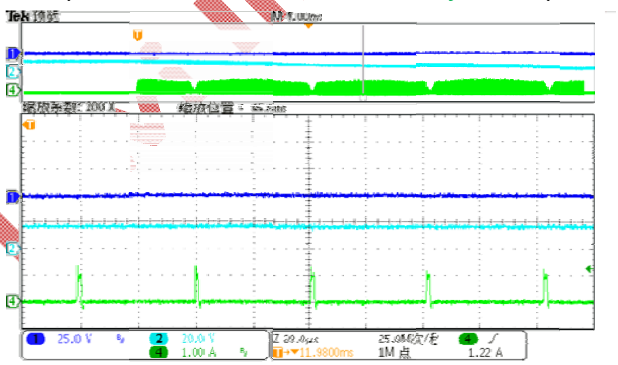
System Steady State
(CH1-V_MOS, CH2-V_Diode, CH4-Primary Current)



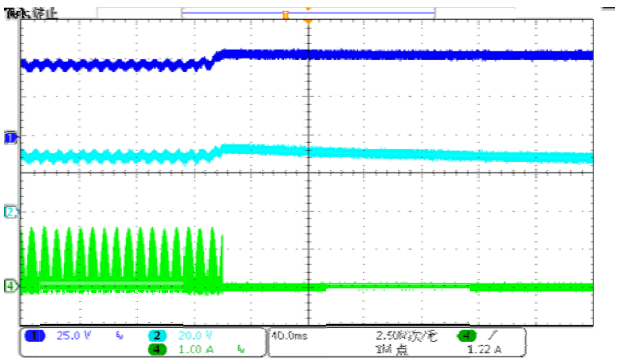
LED Short Fault Happen
(CH1-VLED, CH2-VCC, CH4-Primary Current)



LED Short Fault Recovery
(CH1-VLED, CH2-VCC, CH4-Primary Current)

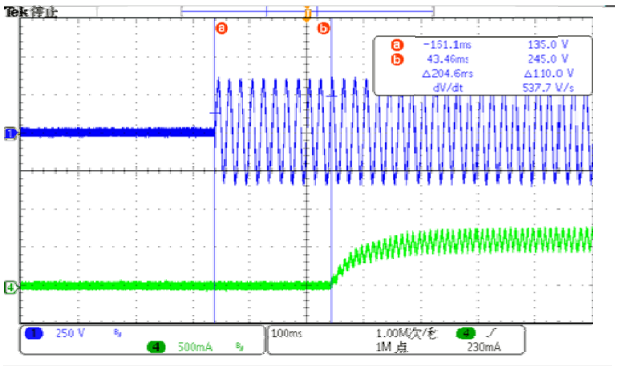


LED Short Fault Steady State
(CH1-VLED, CH2-VCC, CH4-Primary Current)

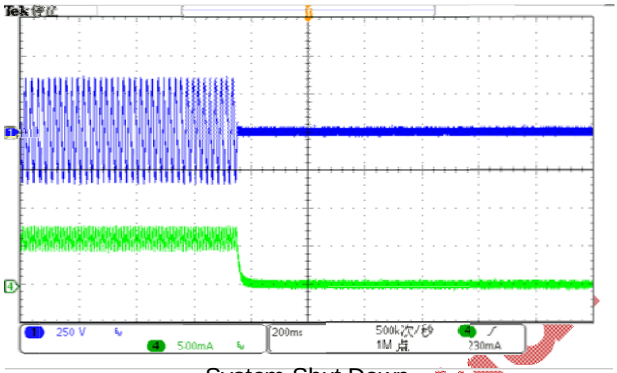


LED Open Fault Happen
(CH1-VLED, CH2-VCC, CH4-Primary Current)

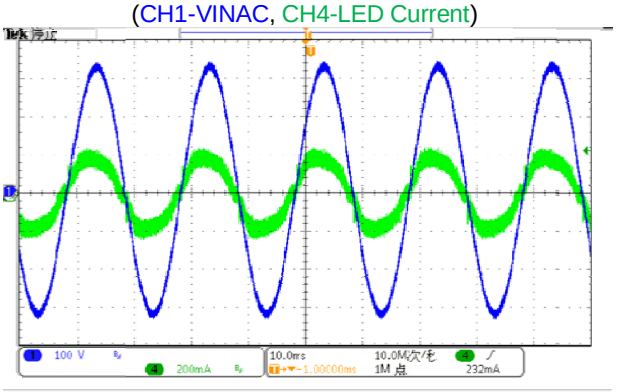
7. Operation Curves (Test Condition: Vin=230VAC/50Hz, Vout=48V, Io=600mA)



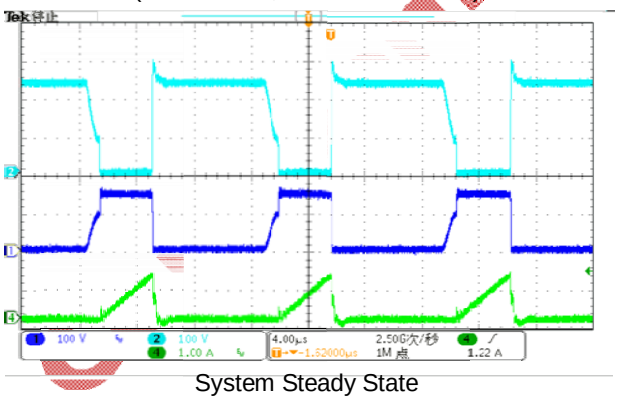
System Startup Time
(CH1-VINAC, CH4-LED Current)



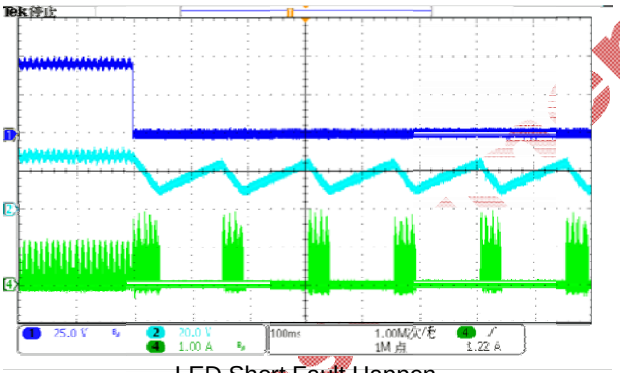
System Shut Down
(CH1-VINAC, CH4-LED Current)



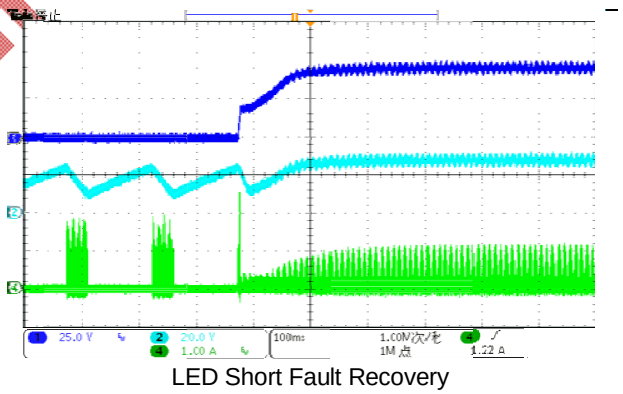
System Steady State
(CH1-VINAC, CH4-AC Current)



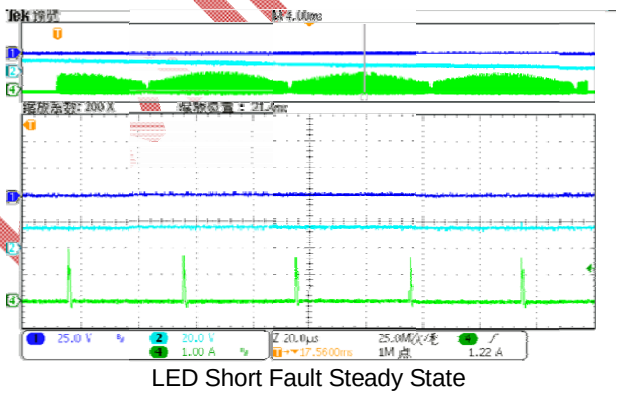
System Steady State
(CH1-V_MOS, CH2-V_Diode, CH4-Primary Current)



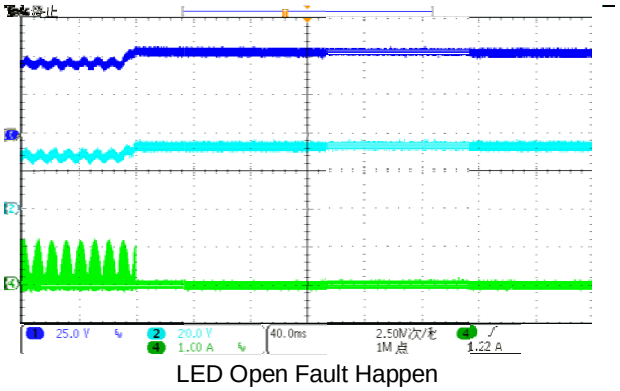
LED Short Fault Happen
(CH1-VLED, CH2-VCC, CH4-Primary Current)



LED Short Fault Recovery
(CH1-VLED, CH2-VCC, CH4-Primary Current)



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



LED Open Fault Happen
(CH1-VLED, CH2-VCC, CH4-Primary 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.
5. For PWM dimming case:
   a) Pre-define the external PWM Dimming Signal to satisfy following condition:
      - Dimming Frequency: 100Hz<PWM<20kHZ
      - Dimming Voltage: 2V<PWM_H<5V; PWM_H<0.5V
   b) Connect the positive terminal of the PWM Dimming signal to the “PWM+” terminal on the Demo Board, and connect the GND terminal of the PWM Dimming signal to the “GND” terminal on the Demo Board.
   c) Repeat the step of 1-4 to enable PWM dimming function.

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