



DEMO BOARD TEST REPORT

220~265VAC/50HZ, PF>0.7, CW 260V/27.5mA and RGB 260V/6mA Five-Channel Linear Solution for Smart LED with KP18068

FEATURES

- Meet the Latest Harmonic Current Requirements of IEC-61000-3-2:2019
- PF > 0.7
- Fast Startup Time <0.3S Even at Minimum Dimming
- 0.1% Dimming Depth
- No Flicker
- No Audible Noise
- Constant Input Power with Line Compensation Function
- PWM Dimming for RGB Channels
- Analog Dimming for CW Channels
- Thermal Protection
- Single Layer PCB at a Low Cost

GENERAL DESCRIPTION

The Demo Board is designed to demonstrate the high performance of KP18068. KP18068 is a PF>0.7, high-precision five-channel LED linear constant current dimming controller. It can independently set the output current of five channels by I2C (Inter-Integrated-Circuit Bus) to support various scenes. KP18068 integrates line compensation function, which can easily meet the requirements of constant input power without additional components. And it integrates OTP functions which will automatically reduce the output current to ensure the safety and reliability of the system. And it meets the EN55015B conducted and radiated EMI requirement.

The Demo Board is typically designed for 9W application with 220-265Vac input, 260V/27.5mA output of the CW channels and 260V/6mA output of the RGB channels within A60 LED Bulb.

APPLICATIONS

- LED Smart Lighting with Wireless Control

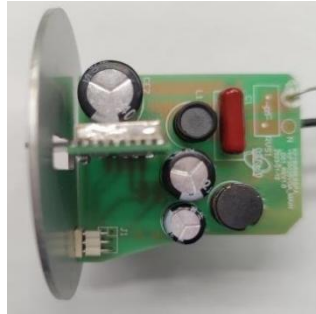
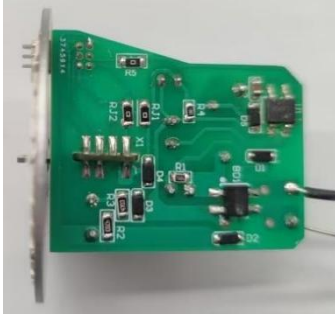
DEMO BOARD SEPCIFICATION

Description	Symbol	Min	Type	Max	Unit	Note	
Input Voltage	Vin	220		265	Vac	50Hz	
Output	Vout/Iout	CW: 260V/27.5mA; RGB: 260V/6mA					
System Efficiency	η	80			%	230Vac/50Hz	
Power Factor	PF	0.7				230Vac/50Hz	
Total Harmonic Distortion	THD	IEC-61000-3-2:2019					
Startup Time	Tst			300	ms	230Vac/50Hz	
Standby Power				0.5	W	230Vac/50Hz	
Conducted EMI Margin		6			dB		
Radiated EMI Margin		6			dB		
Surge Test		1			kV		

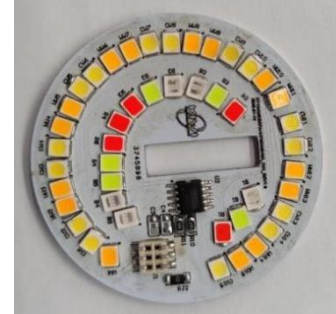
Note: The table above shows the minimum acceptable performance of the design. Actual performance is listed in the results section.

Demo Board of KP18068+KP35026_D01_REV1.0

Part A

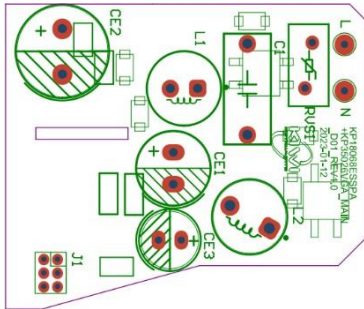


Part B

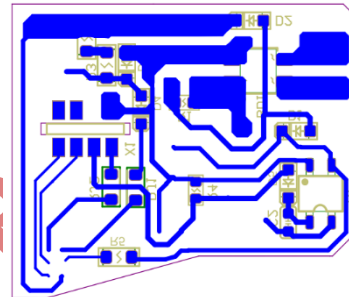


Printed Circuit Board Layout

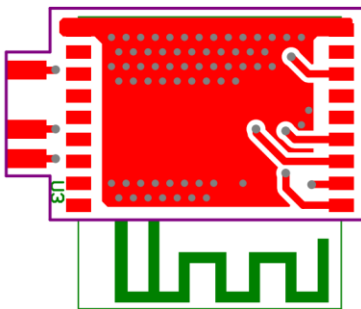
Part A (MAIN) Top Layer



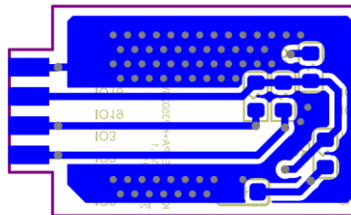
Part A (MAIN) Bottom Layer



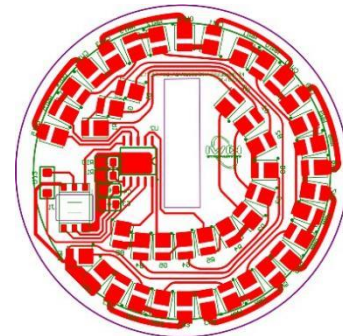
Part A (WIFI) Top Layer



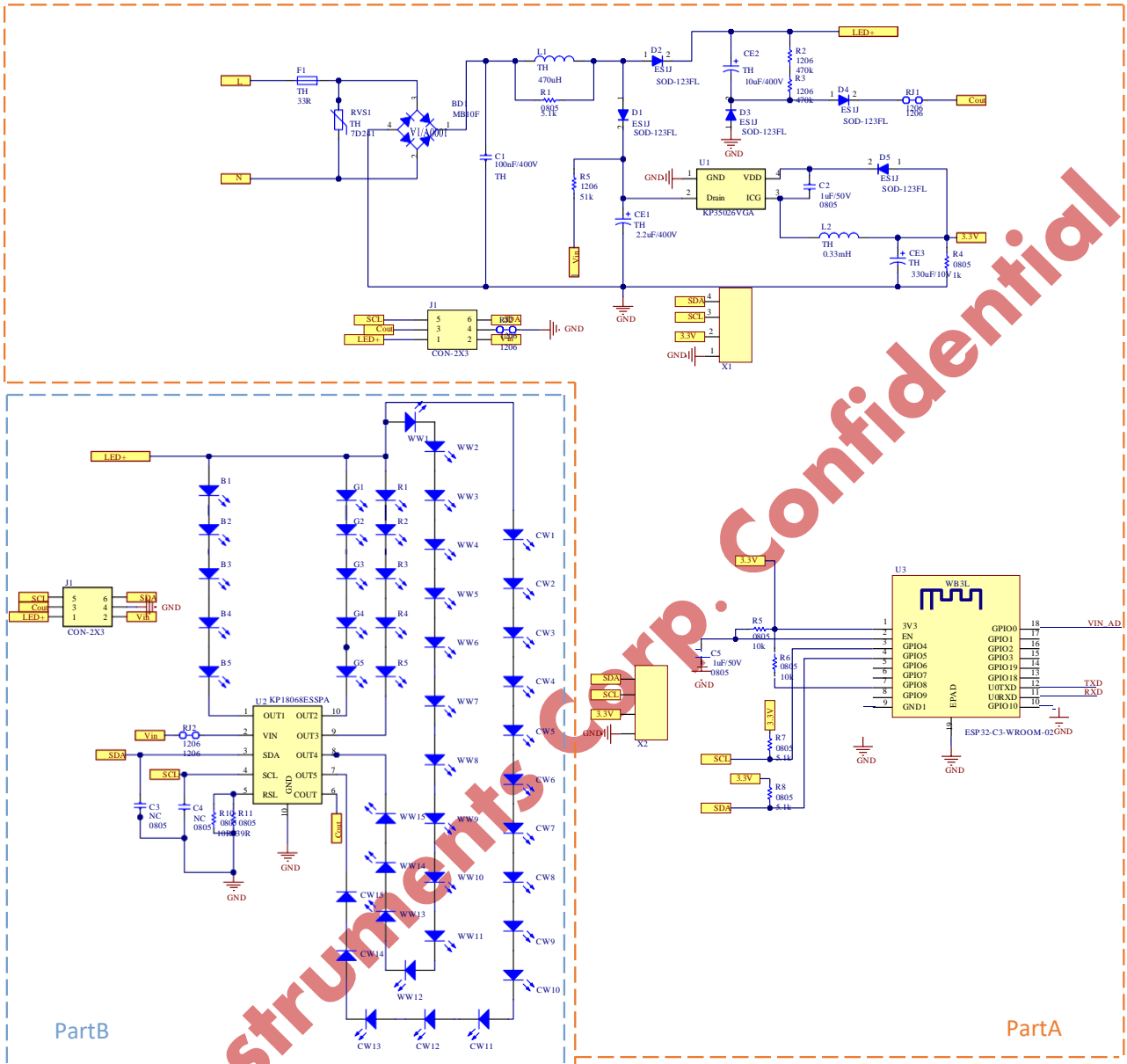
Part A (WIFI) Bottom Layer



Part B (LED) Top Layer



Schematic



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**220~265VAC/50HZ, PF>0.7, CW 260V/27.5mA and RGB 260V/6mA
Five-Channel Linear Solution for Smart LED with KP18068**

Bill of Material

Part A (MAIN)

No.	Designator	Value	Description	Package	Manufacturer	Part Number
1	BD1	1000V/1A	BRD 1A 1000V 1.1V	MBF	World	MB10F
2	C1	100nF/400V	CBB 400Vdc 12*5*9 P10	TH	STE	B22G104JN1B01 20090050EOZ
3	C2	1µF/50V	Ceramic Cap 50V ±10% X7R	0805	WE	885012207103
4	CE1	2.2µF/400V	Electrolytic Cap 400V 8*12 P3.5	TH	AISHI	EW2H2GM2R2F1 20T
5	CE2	10µF/400V	Electrolytic Cap 400V 10*16 P5.0	TH	AISHI	EGM2GM150G1 60T3
6	CE3	330µF/10V	Electrolytic Cap 10V 6.3*11 P2.5	TH	AISHI	EW2H1AM331E11 0T
7	D1, D2, D3, D4, D5	1000V/1A	DIO FRD 1A 1000V 1.1V	SOD-123FL	ST	1N4007W
8	F1	33R	Fuse Resistor ±5% 2W	TH	SY	RFB02J20R0A64 0NC
9	L1	470µH	Inductor Isat 0.31A Rdc 1.68Ω 6*8	TH	FH	VLU0608-471KB
10	L2	330µH	Inductor Isat 0.88A Rdc 0.70Ω 8*9.5	TH	WE	7447720331
11	R1	5.1k	Chip Resistor ±1% 1/8W	0805	FH	RS-05K5101FT
12	R2, R3	470k	Chip Resistor ±1% 1/4W	1206	FH	RS-06K4703FT
13	R4	1k	Chip Resistor ±1% 1/8W	0805	FH	RS-05K3900FT
14	R5	51k	Chip Resistor ±1% 1/4W	1206	FH	RS-06K4703FT
15	RJ1, RJ2	1206	1206 WIRE JUMPER	1206	NO	NOT HAVE
16	RVS1	7D241	VARISTOR 150VAC 21J 1750A	TH	WE	820471511
17	U1	-	Low Cost Fast Dynamic Response Non-isolated PWM Power Switch	SOP-4	KIWI	KP35026VGA

Part A (WIFI)

No.	Designator	Value	Description	Package	Manufacturer	Part Number
18	C5	1µF/50V	Ceramic Cap 50V ±10% X7R	0805	WE	885012207103
19	R5, R6	10k	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1002FT
20	R7, R8	5.1k	Chip Resistor ±1% 1/8W	0805	FH	RS-05K5101FT
21	U3	-	ESP32-C3-WROOM-02	WB3L	ESPRESSIF	/

Part B (LED)

No.	Designator	Value	Description	Package	Manufacturer	Part Number
22	J1	0R	2*3 2.54mm Right angle Pin Header	TH	HRS	A2-6PA-2.54DS
23	U2	-	PF>0.7, Five-Channel High-Voltage Linear LED Dimming Driver	ESSOP-10	KIWI	KP18068ESSPA
24	R10	10R	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1100FT
25	R11	39R	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1100FT
26	B1~B5	Blue LED	LED Voltage 54V	2835	Any	B1~B5
27	G1~G5	Green LED	LED Voltage 54V	2835	Any	G1~G5
28	R1~R5	Red LED	LED Voltage 54V	2835	Any	R1~R5
29	WW1~WW15	Warm LED	LED Voltage 18V	2835	Any	WW1~WW15
30	CW1~CW15	Cool LED	LED Voltage 18V	2835	Any	CW1~CW15

Test Result

1. Steady characteristics

1.1 System Efficiency

Standard: PF>0.7, η >80%. @ 230Vac input & full load

Result: Pass

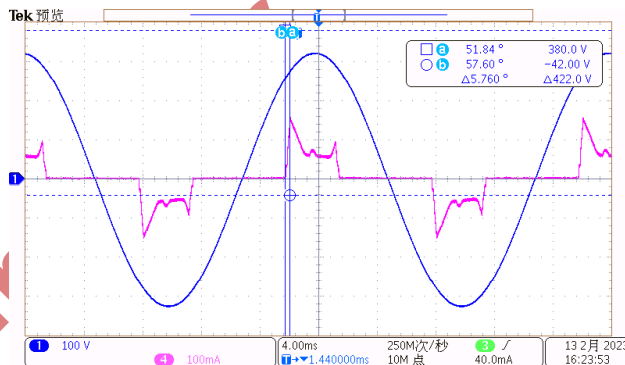
Vin(Vac)	Fline(Hz)	Pin(W)	Vo(V)	Io(mA)	PF	Eff(%)
220	50	8.46	257.5	27.14	0.69	82.6
230		8.57	257.5	27.17	0.75	81.64
240		8.81	257.2	26.73	0.75	78.04
250		8.81	256.3	25.43	0.74	73.98
265		8.95	255.1	23.54	0.65	67.1

1.2 Total Harmonic current

Standard: requirements of IEC-61000-3-2:2019 (the start phase of input current must be less than 60°and the peak phase of input current must be less than 65°,and the subharmonic should be meet 3rd subharmonic < 86%, 5th subharmonic <61%) .

Result: Pass

Test Condition: 230Vac/50Hz Input, 260V/27.5mA Output



(CH1-Vin, CH4-Iin)

Comments: Start Phase:51.84°(Limit 60°),
Peak Phase:57.6°(Limit 65°)

Sub-harmonic	Value	Limit
3 rd	63.89%	86%
5 th	19.55%	61%

1.3 Standby Power

Standard: the standby power should be no more than 0.5W at input 230Vac and remote dim off.

Result: Pass



220~265VAC/50HZ, PF>0.7, CW 260V/27.5mA and RGB 260V/6mA
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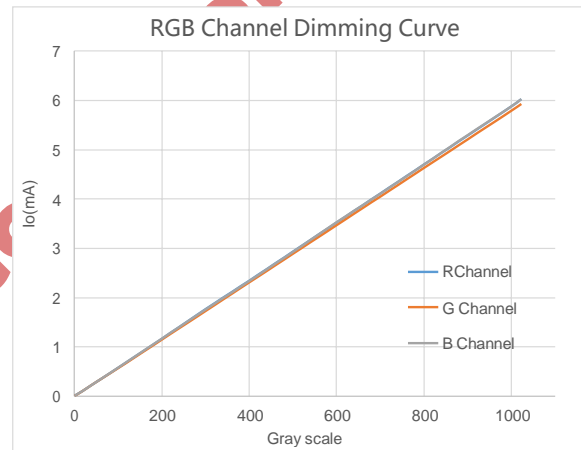
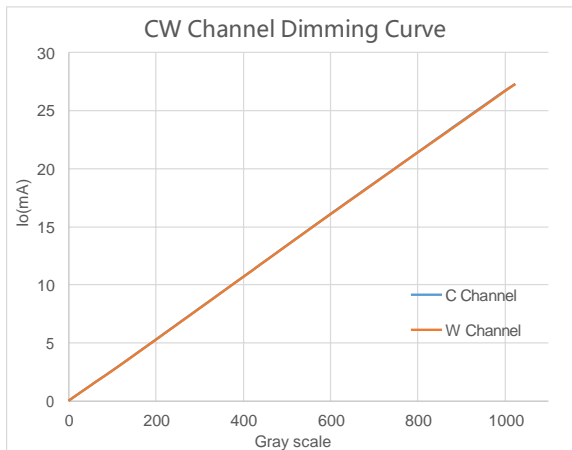
Vin(Vac)	Fin (Hz)	Pstb (mW)
220	50	219.68
230	50	227.99
240	50	238.54

1.4 Dimming Curve

Standard:

1. the degree of dimming linearity should be as small as possible.
2. C and W channel dimming curves should keep as consistent as possible; R, G and B channel dimming curves should keep as consistent as possible.

Result: Pass



2. Dynamic characteristics

2.1 Power On

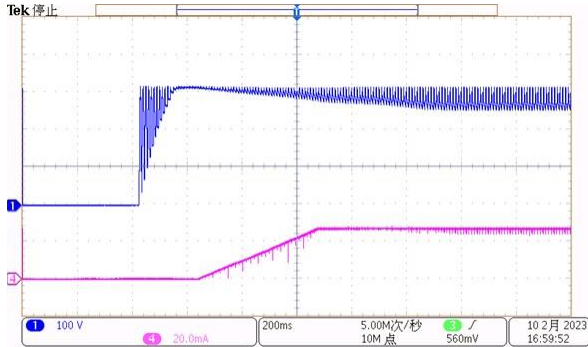
Standard:

1. the startup time should no more than 300ms;
2. the rising process of output current should be smooth with different duty under CW mode and RGB mode.

Result: Pass

Waveforms (CW Mode):

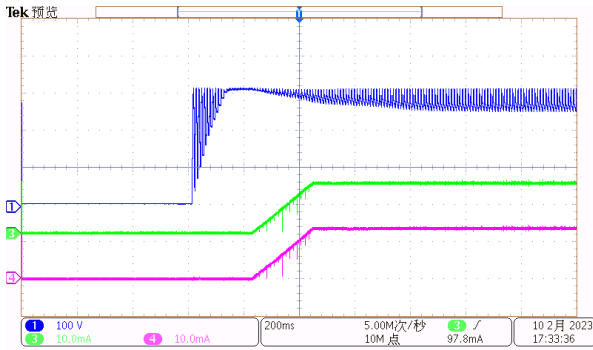
Test Condition: 230Vac/50Hz Input,
Duty: (C: 100%, W: 0%)



(CH1-Vbus, CH4-Io_C)

Comments: Startup time = 216ms

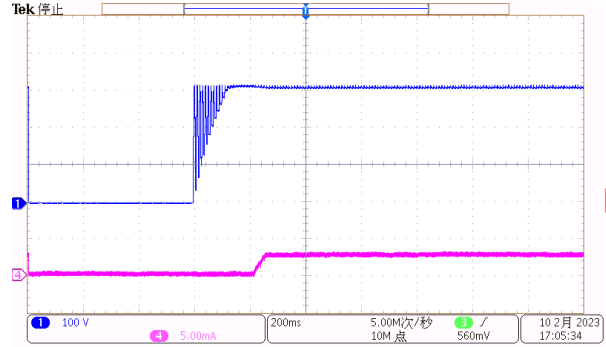
Test Condition: 230Vac/50Hz Input,
Duty: (C: 50%, W: 50%)



(CH1-Vbus, CH3-Io_W, CH4-Io_C)

Comments: CW Channel Start at the same time

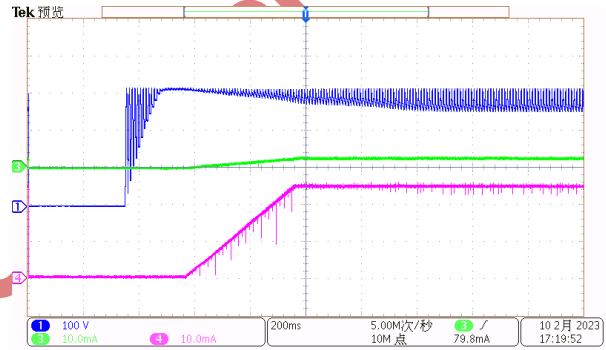
Test Condition: 230Vac/50Hz Input,
Duty: (C: 10%, W: 0%)



(CH1-Vbus, CH4-Io_C)

Comments: Startup time = 216ms

Test Condition: 230Vac/50Hz Input,
Duty: (C: 90%, W: 10%)



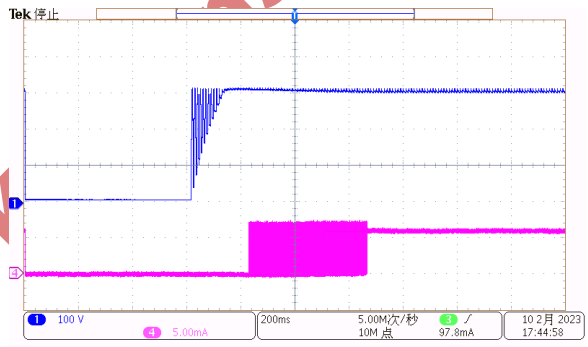
(CH1-Vbus, CH3-Io_W, CH4-Io_C)

Comments: CW Channel Start at the same time

Note: There exist some burrs in the current waveforms due to the changing duty cycle and the burrs do not affect the smoothness of the dimming process. Similar situations also appear in part of results below and no more detailed description.

Waveforms (RGB Mode):

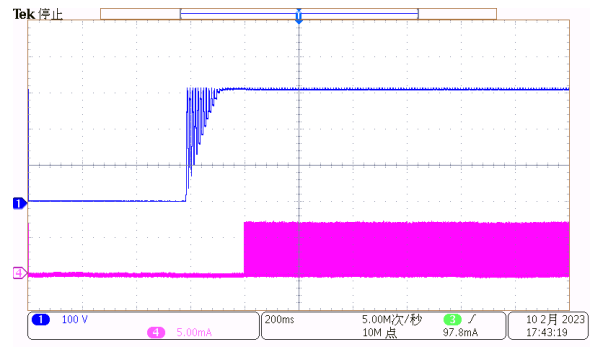
Test Condition: 230Vac/50Hz Input,
Duty: (R: 100%, G: 0%, B: 0%)



(CH1-Vbus, CH4-Io_R)

Comments: Startup Time=216ms

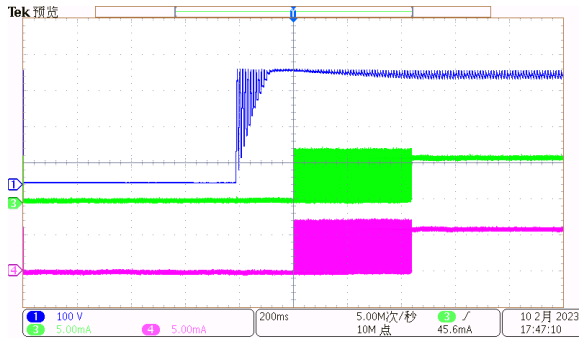
Test Condition: 230Vac/50Hz Input,
Duty: (R: 10%, G: 0%, B: 0%)



(CH1-Vbus, CH4-Io_R)

Comments: Startup Time=216ms

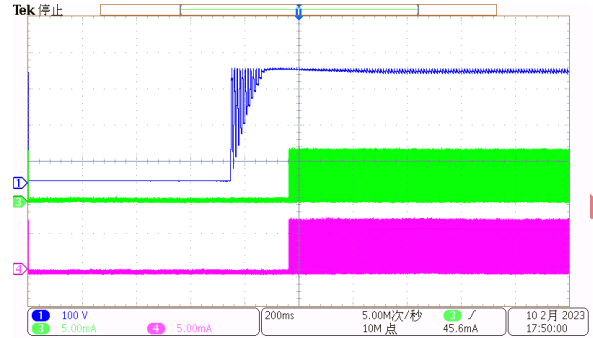
Test Condition: 230Vac/50Hz Input,
Duty: (R: 33%, G: 33%, B: 33%)



(CH1- Vbus, CH3-Io_G, CH4-Io_R)

Comments: RGB Channel Start at the same time

Test Condition: 230Vac/50Hz Input,
Duty: (R: 80%, G: 50%, B: 20%)



(CH1- Vbus, CH3-Io_G, CH4-Io_R)

Comments: RGB Channel Start at the same time

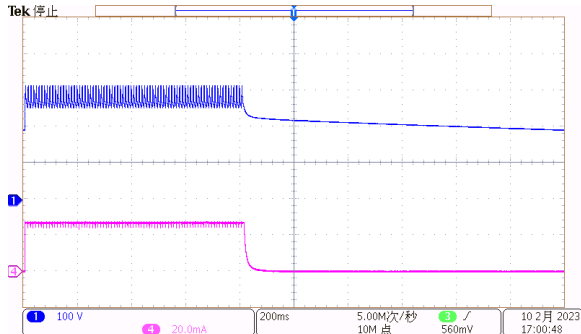
2.2 Power Off

Standard: the falling process of output current should be smooth and have no noticeable upwarp with different duty under CW mode and RGB mode.

Result: Pass

Waveforms (CW Mode):

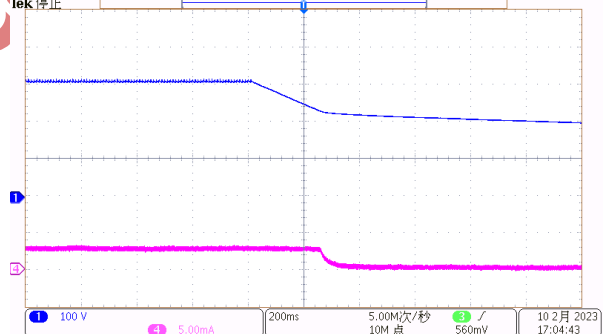
Test Condition: 230Vac/50Hz Input,
Duty: (C: 100%, W: 0%)



(CH1-Vbus, CH4-Io_C)

Comments: Power Off OK

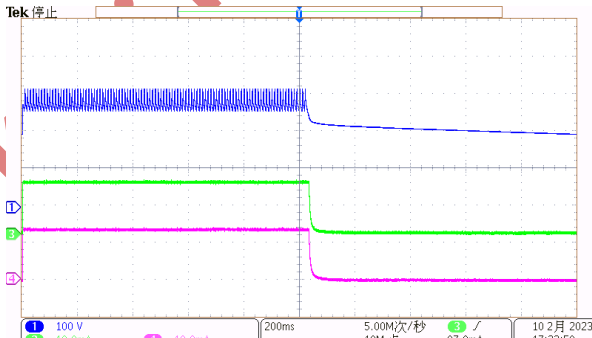
Test Condition: 230Vac/50Hz Input,
Duty: (C: 10%, W: 0%)



(CH1-Vbus, CH4-Io_C)

Comments: Power Off OK

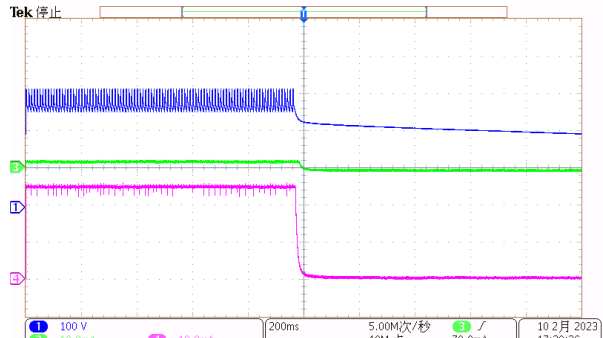
Test Condition: 230Vac/50Hz Input,
Duty: (C: 50%, W: 50%)



(CH1-Vbus, CH3-Io_W, CH4-Io_C)

Comments: CW Channel Stop at the same time

Test Condition: 230Vac/50Hz Input,
Duty: (C: 90%, W: 10%)

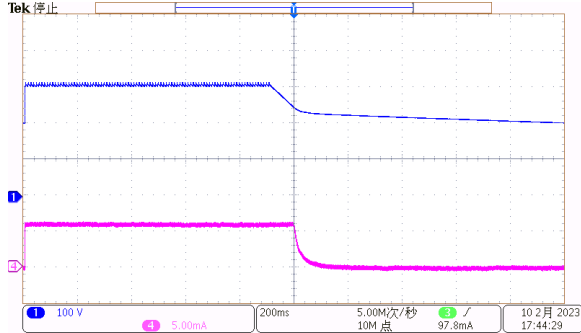


(CH1-Vbus, CH3-Io_W, CH4-Io_C)

Comments: CW Channel Stop at the same time

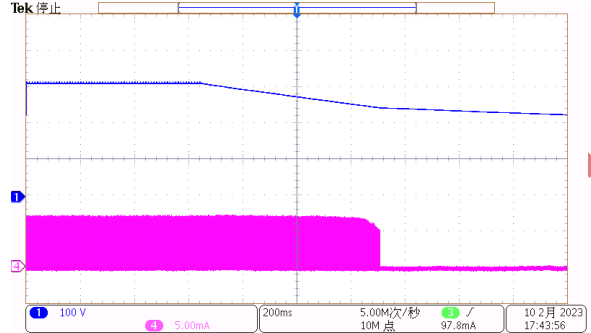
Waveforms (RGB Mode):

Test Condition: 230Vac/50Hz Input,
Duty: (R: 100%, G: 0%, B: 0%)



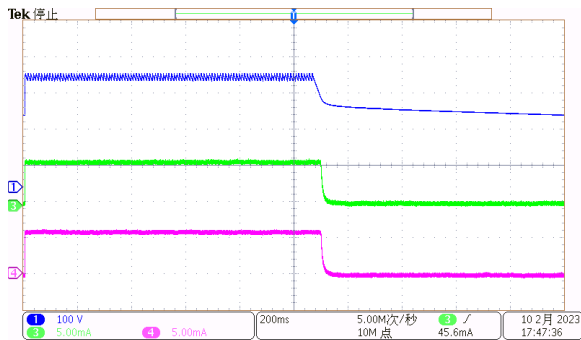
(CH1-Vbus, CH4-Io_R)
Comments: Power Off OK

Test Condition: 230Vac/50Hz Input,
Duty: (R: 10%, G: 0%, B: 0%)



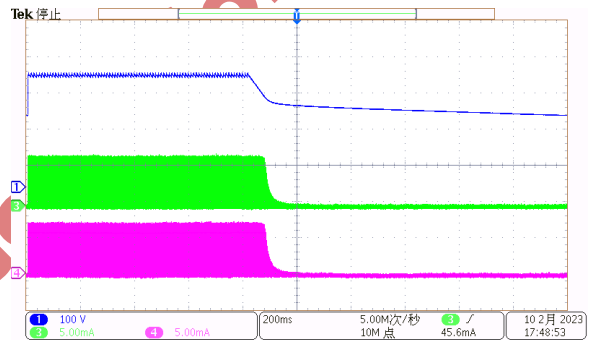
(CH1-Vbus, CH4-Io_R)
Comments: Power Off OK

Test Condition: 230Vac/50Hz Input,
Duty: (R: 33%, G: 33%, B: 33%)



(CH1- Vbus, CH3-Io_G, CH4-Io_R)
Comments: RGB Channel Stop at the same time

Test Condition: 230Vac/50Hz Input,
Duty: (R: 80%, G: 50%, B: 20%)



(CH1- Vbus, CH3-Io_G, CH4-Io_R)
Comments: RGB Channel Stop at the same time

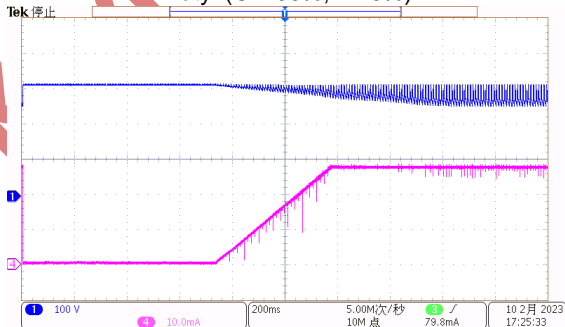
2.3 Dimming On

Standard: the rising process of output current should be smooth with different duty under CW mode and RGB mode.

Result: Pass

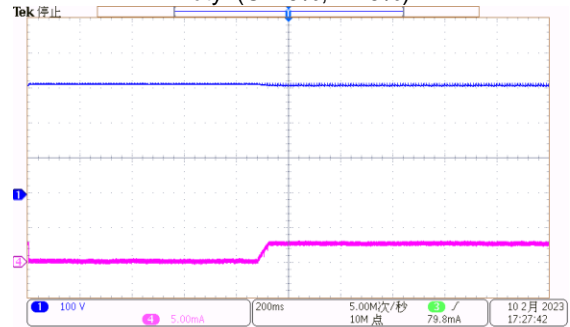
Waveforms (CW Mode):

Test Condition: 230Vac/50Hz Input,
Duty: (C: 100%, W: 0%)



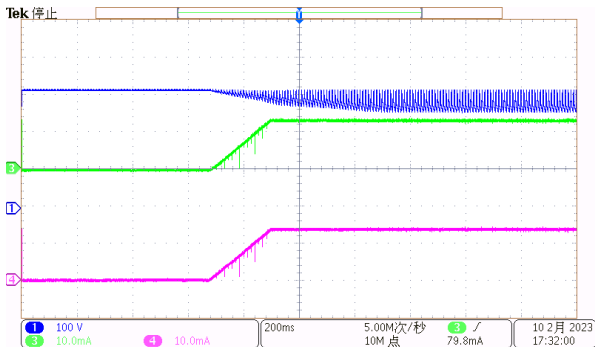
(CH1-Vbus, CH4-Io_C)
Comments: DIM ON OK

Test Condition: 230Vac/50Hz Input,
Duty: (C: 10%, W: 0%)



(CH1-Vbus, CH4-Io_C)
Comments: DIM ON OK

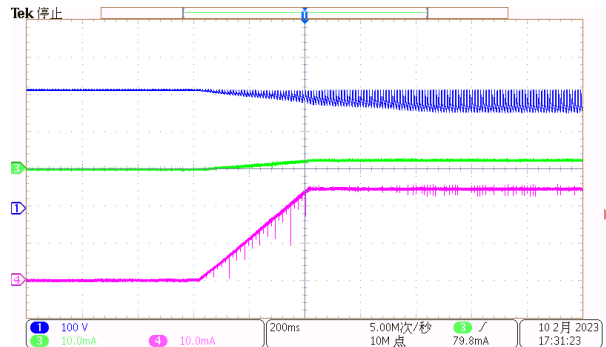
Test Condition: 230Vac/50Hz Input,
Duty: (C: 50%, W: 50%)



(CH1-Vbus, CH3-Io_W, CH4-Io_C)

Comments: CW Channel DIM ON at the same time

Test Condition: 230Vac/50Hz Input,
Duty: (C: 90%, W: 10%)

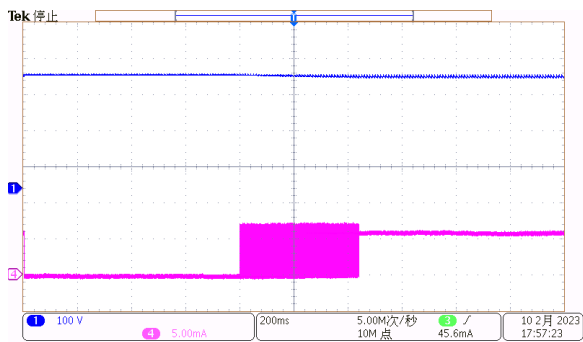


(CH1-Vbus, CH3-Io_W, CH4-Io_C)

Comments: CW Channel DIM ON at the same time

Waveforms (RGB Mode):

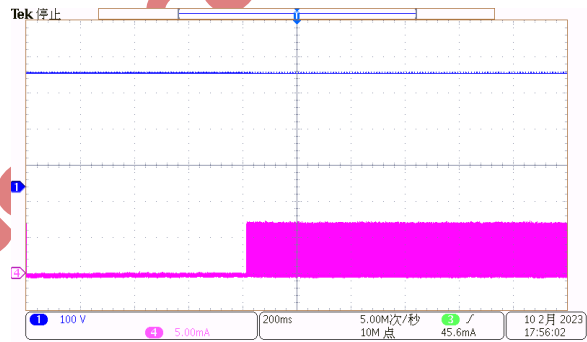
Test Condition: 230Vac/50Hz Input,
Duty: (R: 100%, G: 0%, B: 0%)



(CH1-Vbus, CH4-Io_R)

Comments: DIM ON OK

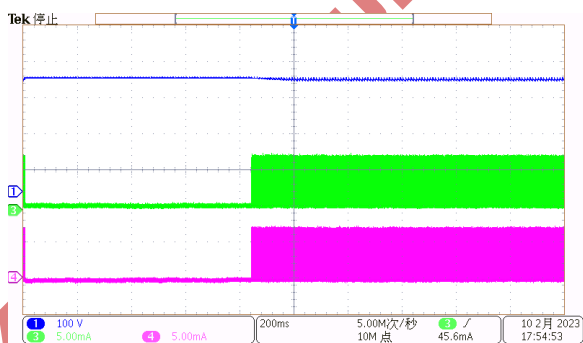
Test Condition: 230Vac/50Hz Input,
Duty: (R: 10%, G: 0%, B: 0%)



(CH1-Vbus, CH4-Io_R)

Comments: DIM ON OK

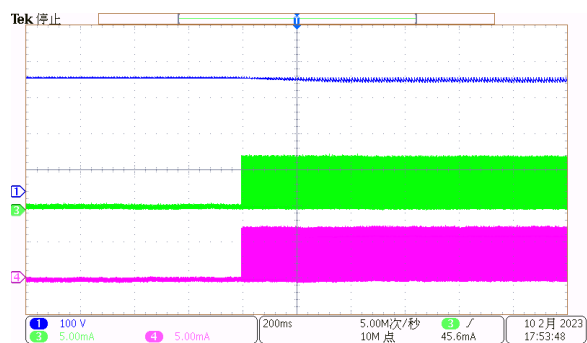
Test Condition: 230Vac/50Hz Input,
Duty: (R: 33%, G: 33%, B: 33%)



(CH1-Vbus, CH3-Io_G, CH4-Io_R)

Comments: RGB Channel DIM ON at the same time

Test Condition: 230Vac/50Hz Input,
Duty: (R: 80%, G: 50%, B: 20%)



(CH1-Vbus, CH3-Io_G, CH4-Io_R)

Comments: RGB Channel DIM ON at the same time

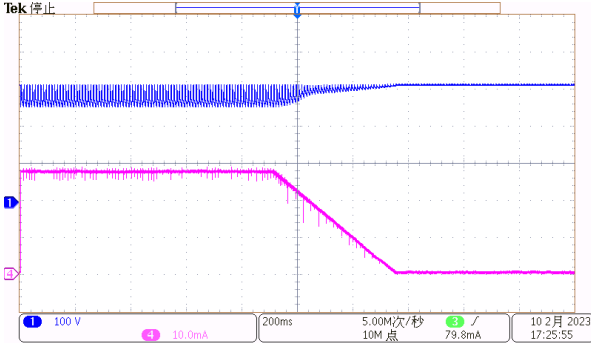
2.4 Dimming Off

Standard: the falling process of output current should be smooth with different duty under CW mode and RGB mode.

Result: Pass

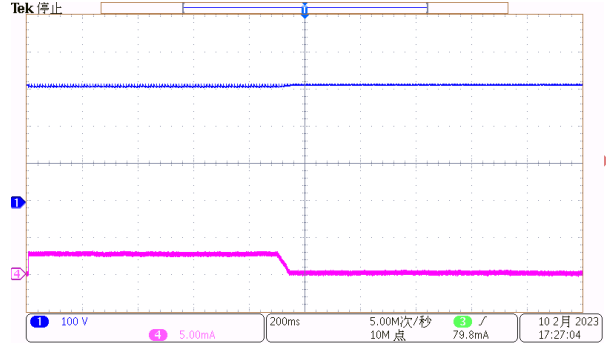
Waveforms (CW Mode):

Test Condition: 230Vac/50Hz Input,
Duty: (C: 100%, W: 0%)



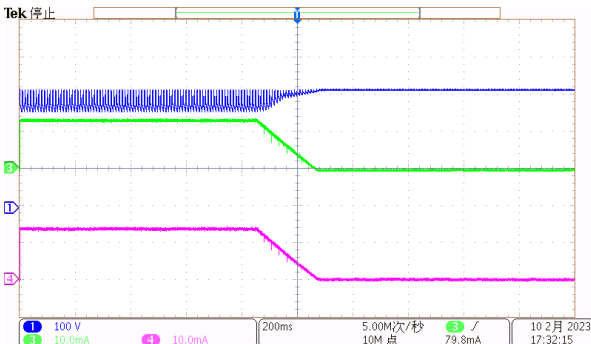
(CH1-Vbus, CH4-Io_C)
Comments: DIM OFF OK

Test Condition: 230Vac/50Hz Input,
Duty: (C: 10%, W: 0%)



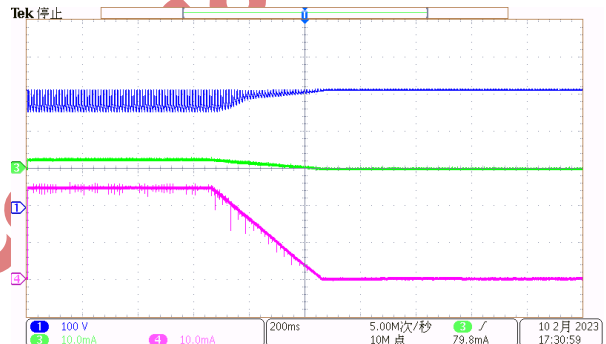
(CH1-Vbus, CH4-Io_C)
Comments: DIM OFF OK

Test Condition: 230Vac/50Hz Input,
Duty: (C: 50%, W: 50%)



(CH1-Vbus, CH3-Io_W, CH4-Io_C)
Comments: CW Channel DIM OFF at the same time

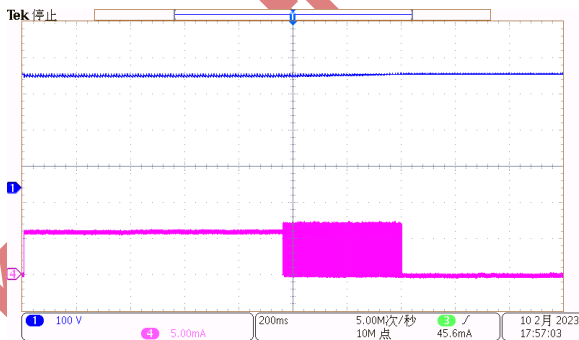
Test Condition: 230Vac/50Hz Input,
Duty: (C: 90%, W: 10%)



(CH1-Vbus, CH3-Io_W, CH4-Io_C)
Comments: CW Channel DIM OFF at the same time

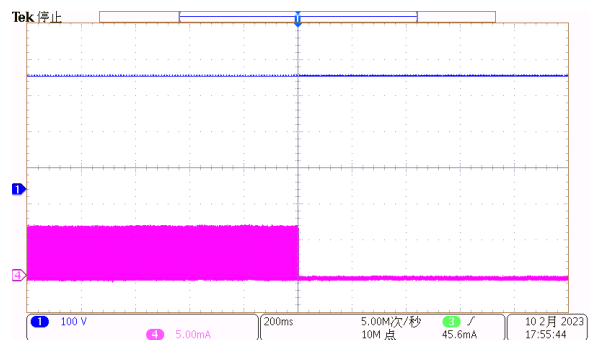
Waveforms (RGB Mode):

Test Condition: 230Vac/50Hz Input,
Duty: (R: 100%, G: 0%, B: 0%)



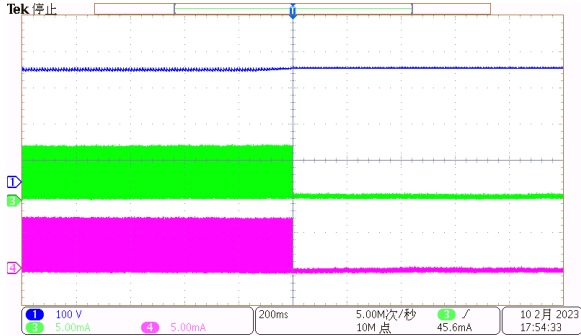
(CH1-Vbus, CH4-Io_R)
Comments: DIM OFF OK

Test Condition: 230Vac/50Hz Input,
Duty: (R: 10%, G: 0%, B: 0%)



(CH1-Vbus, CH4-Io_R)
Comments: DIM OFF OK

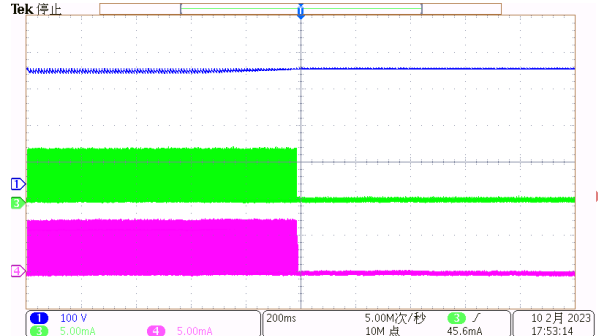
Test Condition: 230Vac/50Hz Input,
Duty: (R: 33%, G: 33%, B: 33%)



(CH1- Vbus, CH3-Io_G, CH4-Io_R)

Comments: RGB Channel DIM OFF at the same time

Test Condition: 230Vac/50Hz Input,
Duty: (R: 80%, G: 50%, B: 20%)



(CH1- Vbus, CH3-Io_G, CH4-Io_R)

Comments: RGB Channel DIM OFF at the same time

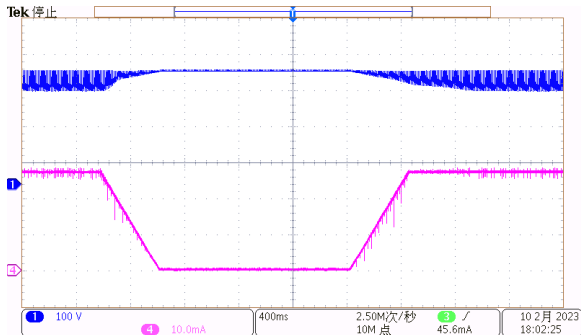
2.5 Dimming Dynamic

Standard: the color transitions of LEDs should be smooth, and the brightness of LEDs has no noticeable change when the duty changes.

Result: Pass

Waveforms (CW Mode):

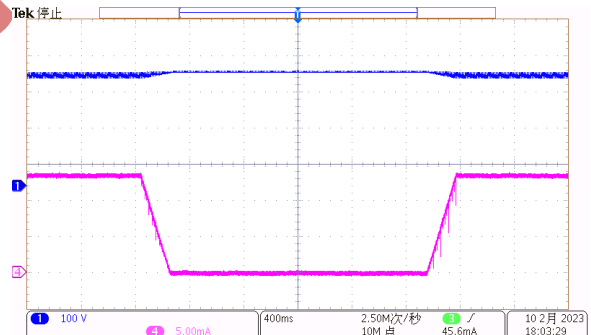
Test Condition: 230Vac/50Hz Input,
Duty: (C: 100%)→ (C: 1%)→ (C: 100%)



(CH1-Vbus, CH4-Io_C)

Comments: Dimming OK

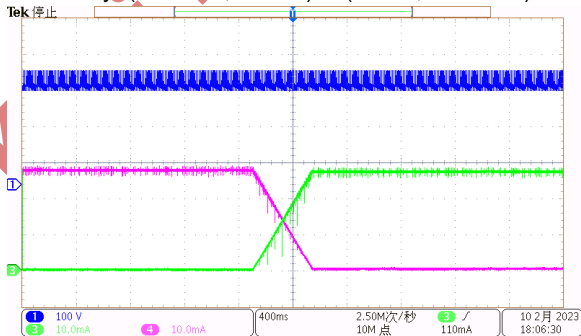
Test Condition: 230Vac/50Hz Input,
Duty: (C: 50%)→ (C: 10%)→ (C: 50%)



(CH1-Vbus, CH4-Io_C)

Comments: Dimming OK

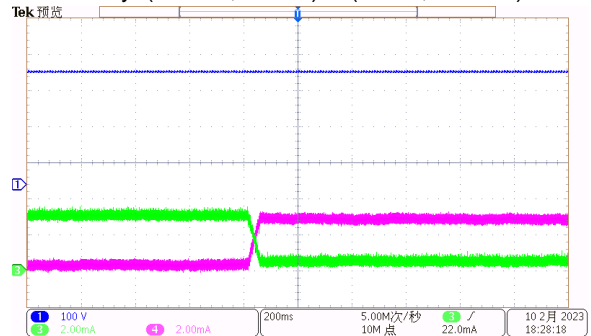
Test Condition: 230Vac/50Hz Input,
Duty: (C: 100%, W: 0%)→ (C: 0%, W: 100%)



(CH1-Vbus, CH3-Io_W, CH4-Io_C)

Comments: Dimming OK

Test Condition: 230Vac/50Hz Input,
Duty: (C: 10%, W: 0%)→ (C: 0%, W: 10%)



(CH1-Vbus, CH3-Io_W, CH4-Io_C)

Comments: Dimming OK



**220~265VAC/50HZ, PF>0.7, CW 260V/27.5mA and RGB 260V/6mA
Five-Channel Linear Solution for Smart LED with KP18068**

3. Thermal Test

Standard: CW mode: $\Delta T < 90^{\circ}\text{C}$ (Limited 115°C); RGB mode: $\Delta T < 70^{\circ}\text{C}$

Result: Pass

Test Condition: Burn in for 1 hour in the A60 lamp cavity @ confined container (30cm*30cm*30cm plastic box) and steady environment with no airflow, T_a is the temperature inside the plastic box.

Component	Test Condition: CW Mode, Full Load		Test Condition: RGB Mode, Full Load	
	230Vac/50Hz		230Vac/50Hz	
	$T_a = 20.3^{\circ}\text{C}$		$T_a = 20.8^{\circ}\text{C}$	
	$T_c(^{\circ}\text{C})$	$T_{rise}(^{\circ}\text{C})$	$T_c(^{\circ}\text{C})$	$T_{rise}(^{\circ}\text{C})$
KP18068ESSPA	106.7	86.4	82.6	61.8
KP35026VGA	59.1	38.8	54.8	34
Light Board	109.6	89.3	83	62.2

4. EMC/EMS Test

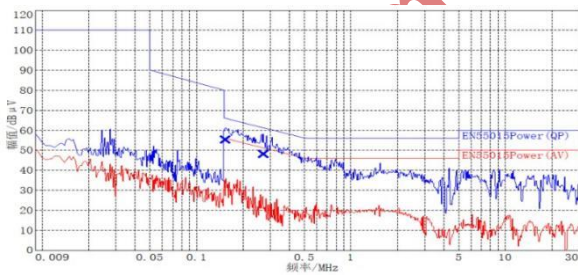
Standard:

Standard	EN55015
Content	CE/RE
Requirement	6 dB Margin

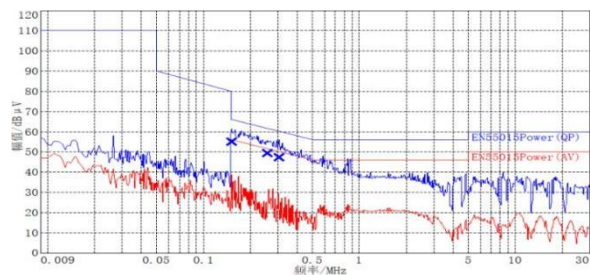
4.1 Conducted Emissions

Result: Pass

Test Condition: $V_{in} = 230\text{VAC}/50\text{Hz}$, CW Mode, Full Load

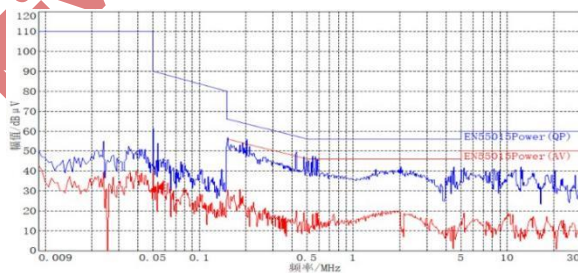


Conduction EMI---LINE

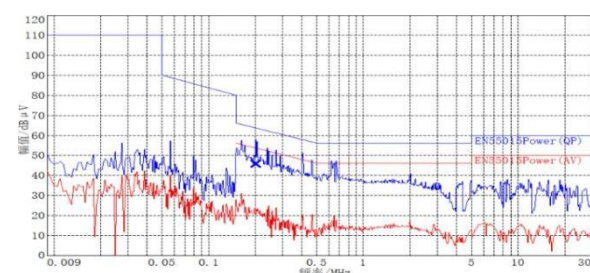


Conduction EMI---NEUTRAL

Test Condition: $V_{in} = 230\text{VAC}/50\text{Hz}$, RGB Mode, Full Load



Conduction EMI---LINE



Conduction EMI---NEUTRAL



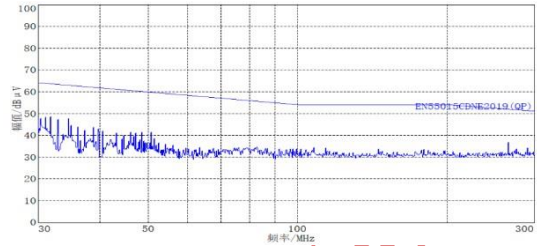
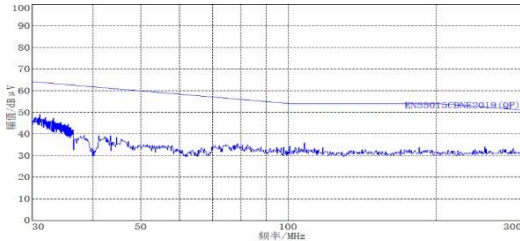
**220~265VAC/50HZ, PF>0.7, CW 260V/27.5mA and RGB 260V/6mA
Five-Channel Linear Solution for Smart LED with KP18068**

4.2 Radiated Emissions

Result: Pass

Test Condition: Vin=230VAC/50Hz, CW Mode, Full Load

Test Condition: Vin=230VAC/50Hz, RGB Mode, Full Load



Surge Test

Line to Line 1kV 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 30 seconds before next one.

Result: Pass

Input Voltage (VAC)	Surge Level (V)	Injection Location	Injection Phase (°)	Test Result (Pass/Fail)
230Vac/50Hz	+1000	L to N	0	Pass
	+1000	L to N	90	Pass
	+1000	L to N	180	Pass
	+1000	L to N	270	Pass
	-1000	L to N	0	Pass
	-1000	L to N	90	Pass
	-1000	L to N	180	Pass
	-1000	L to N	270	Pass

Test Setup Guide

1. Set the AC Power Source between 220VAC and 265VAC.
2. Connect the AC Power Source terminal to the “L” and “N” terminals on the Demo Board
3. Turn on the AC Power Source to make system startup; and Turn off the AC Power Source to make system shutdown.



**220~265VAC/50HZ, PF>0.7, CW 260V/27.5mA and RGB 260V/6mA
Five-Channel Linear Solution for Smart LED with KP18068**

Revision History

DATE	REV	DESCRIPTION
2023/02/14	1.0	First Release

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