AL1666+AL8116+AL5822: 25~50V/1.2A
0-10V Dimmable Design for External LED Drivers

General Description

This document describes a 0-10V dimmable high PFC single-stage Flyback LED driver utilizing the AL1666 primary-side controller, the AL8116 secondary-side dimming interface IC and the AL5822 LED current ripple suppressor. The LED driver provides a constant output current of 1200mA over a voltage range of 25V to 50V. It works from an universal voltage of 90V_{AC} to 305V_{AC}. The demonstration board can support 0-10V dimming mode. It works at 0-10V dimming mode when a 0-10V analog signal is connected to 0-10V input.

A bill of materials is included that describes the parts used on this demonstration board. A schematic has also been included along with measured performance characteristics. These materials can be used as a reference design for your products.

Key Features

- Universal input: 90~305V_{AC}
- 0-10V dimmable
- Deep dimming to 1% and light off
- Wide output voltage range: 25V to 50V
- Single-Stage topology: Flyback
- Accurate constant current(CC) regulation
- PF>0.96 at 90~300V_{AC} input voltage with full load
- THD<10% at 90~300V_{AC} input voltage with full load
- Peak efficiency up to 89% at 230Vac input, 50V/1.2A output
- Low output LED current ripple(<5%)
- LED open protection
- LED short protection
- Secondary diode short protection
- Primary winding short protection
- Secondary winding short protection
- Built-in over temperature protection

Applications

- 0-10V Dimmable LED Driver

Evaluation Board

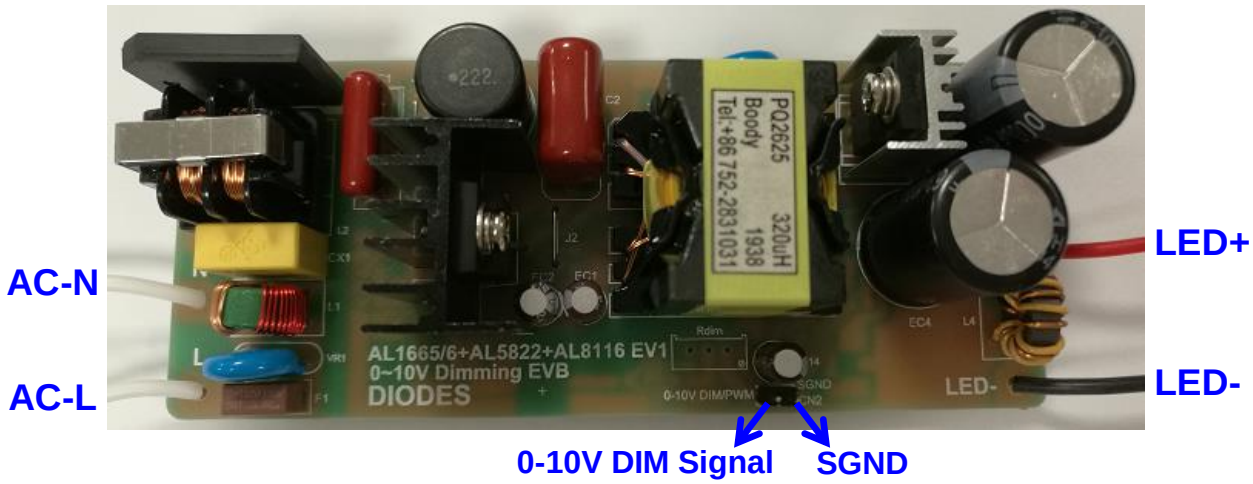


Figure 1. EVB Top View

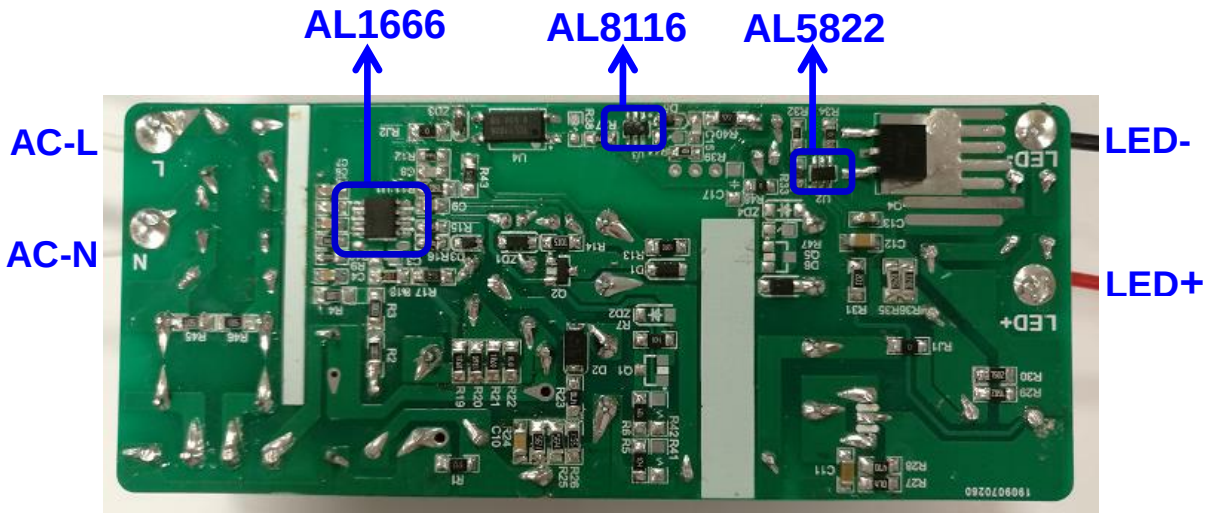


Figure 2. EVB Bottom View

Connection Instructions:

AC Input: AC-L
AC Input: AC-N
DC LED+ Output: LED+
DC LED- Output: LED-
0-10V Signal Input: 0-10V DIM
SGND: Secondary side GND

Quick Start Guide

1. Preset the isolated AC source to 120Vac/230Vac.
2. Ensure that the AC source is switched OFF or disconnected.
3. Connect the anode wire of the LED string to the LED+ of the evaluation board.
4. Connect the cathode wire of the LED string to the LED- terminal of the evaluation board.
5. Connect two AC line wires to the AC-L and AC-N terminals on the evaluation board.
6. Connect your 0-10V analog signal wire to the 0-10V input terminal if you want to make the evaluation board work at 0-10V dimming mode.
7. Ensure that the area around the board is clear and safe, and preferably that the board and LEDs are enclosed in a transparent safety cover.
8. Turn on the main switch. LED string should light up.
   DO NOT TOUCH THE BOARD, LEDs OR BARE WIRING.

Evaluation Board Specifications

The table below represents the minimum acceptable performance of Design

Description	Symbol	Min	Typ	Max	Units	Comment
Input						
Input voltage range	V_{IN}	90		305	Vac	
Line frequency range	f_{LINE}	47		63	Hz	
Power factor		0.96				Full load@90~300VAC
THD				10	%	Full load@90~300VAC
Output						
Output current	Io		1200		mA	
Maximum power				60	W	
Output voltage	Vo	25		50	V	
Output voltage(LED open)			63		V	
Line regulation				±2	%	
Load regulation				±2	%	
Current ripple				5	%	Peak-to-peak
Startup time(AC to 90% Io)				500	ms	Full load @120~277Vac
Efficiency						
Active mode efficiency		87			%	Full load @120~277Vac
Standby						
Input power				500	mW	LED open @120~277Vac
EMI Conduction Test						
EMI Conduction Test	Pass EN55022 with 12dB margin @120Vac, 5dB margin @230Vac					

Board Layouts

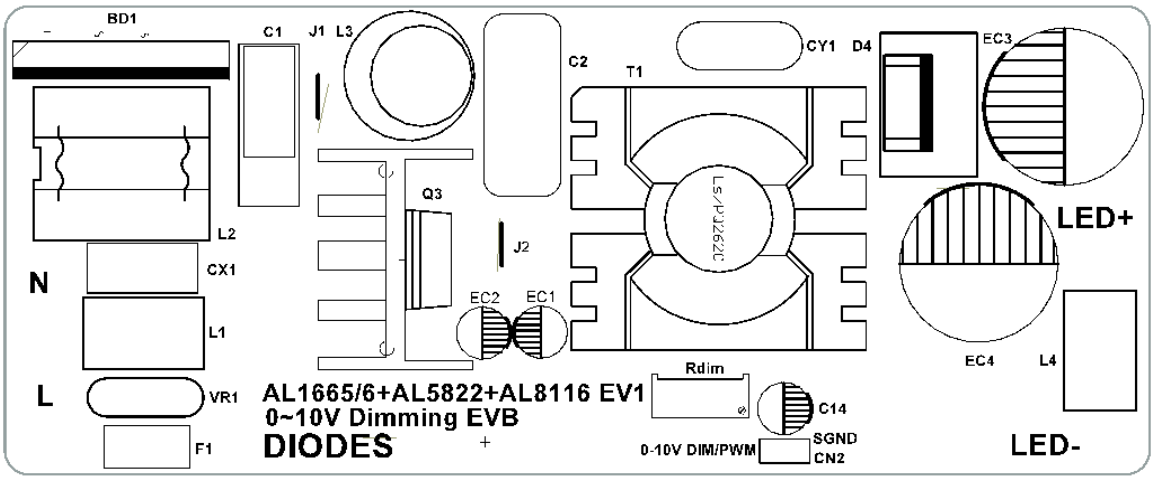


Figure 3. Top Overlay

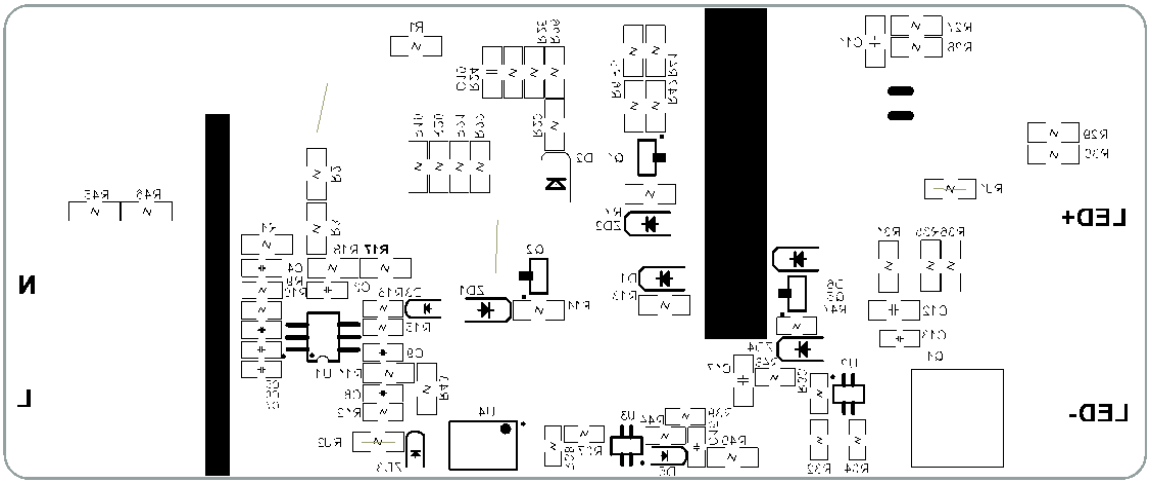


Figure 4. Bottom Overlay

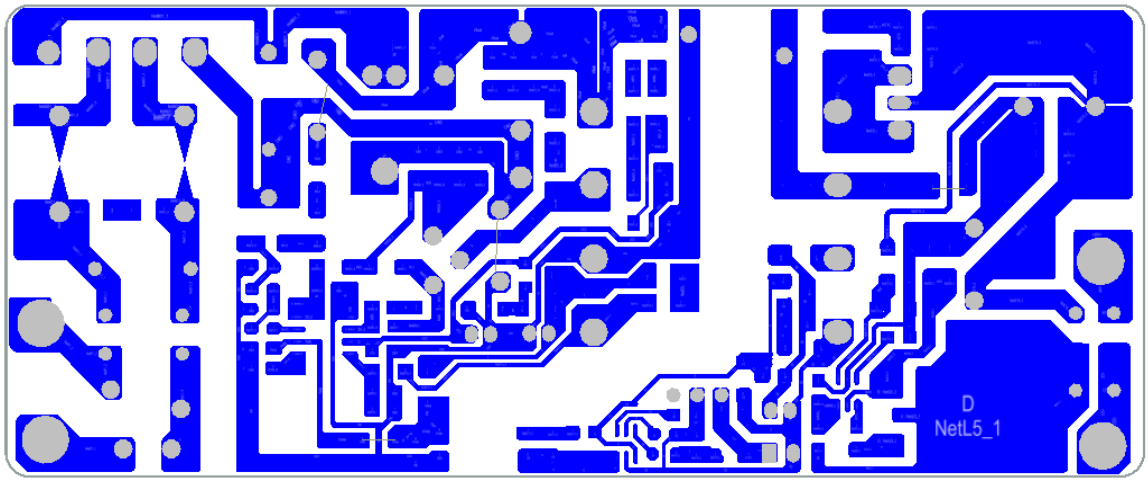


Figure 5. Bottom Layer

Schematic

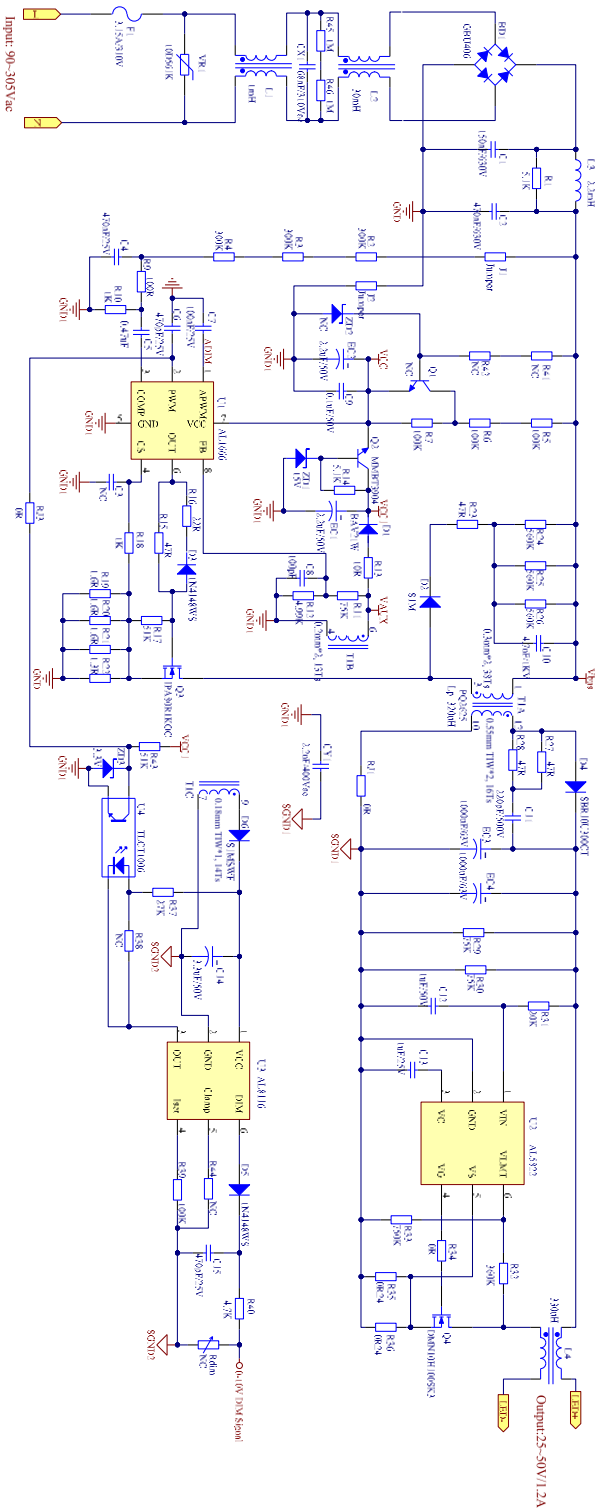


Figure 6. Schematic Circuit

Bill of Material

No	Item	Description	Manufactor	Package	QTY
1	C1	Film Cap, 150nF/630V, CL21,Pitch=15mm	Faratronic	DIP	1
2	C2	Film Cap, 470nF/630V, CL21,Pitch=15mm	Faratronic	DIP	1
3	CX1	X-Cap, X2, 68nF, 310VAC, Pitch=10mm	STE	DIP	1
4	C3	NC	Yageo	0805	0
5	C4	Ceramic Cap, 470nF/25V,X7R	Yageo	0805	1
6	C5	Ceramic Cap, 470nF/25V,X7R	Yageo	0805	1
7	C6	Ceramic Cap, 470pF/25V,X7R	Yageo	0805	1
8	C7	Ceramic Cap, 100nF/25V,X7R	Yageo	0805	1
9	C8	Ceramic Cap, 100pF/25V,X7R	Yageo	0805	1
10	C9	Ceramic Cap, 0.1uF/50V,X7R	Yageo	0805	1
11	C10	Ceramic Cap, 4.7nF/1KV,X7R	Yageo	1206	1
12	C11	Ceramic Cap, 220pF/1KV,X7R	Yageo	1206	1
13	C12	Ceramic Cap, 1uF/50V,X7R	Yageo	1206	1
14	C13	Ceramic Cap, 1uF/25V,X7R	Yageo	0805	1
15	C14	E-Cap, 105℃,3.3uF/50V, 5*9mm	Aishi	DIP	1
16	C15	Ceramic Cap, 470pF/25V,X7R	Yageo	0805	1
17	EC1, EC2	E-Cap, 105℃,2.2uF/50V, 5*9mm	Aishi	DIP	2
18	EC3, EC4	E-Cap, 105℃,1000uF/63V,13*25mm	Aishi	DIP	2
19	CY1	Y-Cap, Y1, 2.2nF/400VAC, Pitch=10mm	TKS	DIP	1
20	BD1	Rectifier Bridge,GBU406, 600V/4A	Diodes Inc	DIP	1
21	D1	Rectifier Diode, BAV21W,0.2A/200V	Diodes Inc	SOD-123	1
22	D2	Rectifier Diode, S1M,1A/1KV	Diodes Inc	SMA	1
23	D3	Switching Diode, 1N4148WS,100V/0.3A	Diodes Inc	SOD-323	1
24	D4	Super Barrier Rectifier,SBR10U300CT, 300V/10A	Diodes Inc	TO-220	1
25	D5	Switching Diode, 1N4148WS,100V/0.3A	Diodes Inc	SOD-323	1
26	D6	Rectifier Diode, S1MSWF, 1A/1KV	Diodes Inc	SOD-123	1
27	ZD1	Zener Diode, DDZ9702, 15V Zener	Diodes Inc	SOD-123	1
28	ZD2	NC	-	-	0
29	ZD3	Zener Diode, BZT52C3V3S, 3.3V Zener	Diodes Inc	SOD-323	1
30	VR1	Varistor, 10D561K	Thinking	DIP	1
31	F1	Fuse, 3.15A/310V	Conquer	DIP	1
32	R1	SMD Resistor, 5.1K, 5%, 1/4W	Yageo	1206	1
33	R2, R3, R4	SMD Resistor, 300K, 5%, 1/4W	Yageo	1206	3
34	R5, R6, R7	SMD Resistor, 100K, 5%, 1/4W	Yageo	1206	3
35	R9	SMD Resistor, 100R, 5%, 1/8W	Yageo	0805	1
36	R10	SMD Resistor, 1K, 5%, 1/8W	Yageo	0805	1
37	R11	SMD Resistor,75K, 1%, 1/4W	Yageo	1206	1
38	R12	SMD Resistor, 4.99K, 1%, 1/8W	Yageo	0805	1

No	Item	Description	Manufactor	Package	QTY
39	R13	SMD Resistor, 10R, 5%, 1/4W	Yageo	1206	1
40	R14	SMD Resistor, 5.1K, 5%, 1/4W	Yageo	1206	1
41	R15	SMD Resistor, 47R, 5%, 1/8W	Yageo	0805	1
42	R16	SMD Resistor, 22R, 5%, 1/8W	Yageo	0805	1
43	R17	SMD Resistor, 51K, 5%, 1/4W	Yageo	1206	1
44	R18	SMD Resistor, 1K, 5%, 1/4W	Yageo	1206	1
45	R19, R20, R21	SMD Resistor, 1.6R, 1%, 1/4W	Yageo	1206	3
46	R22	SMD Resistor, 1.3R, 1%, 1/4W	Yageo	1206	1
47	R23	SMD Resistor, 47R, 5%, 1/4W	Yageo	1206	1
48	R24, R25, R26	SMD Resistor, 560K, 5%, 1/4W	Yageo	1206	3
49	R27, R28	SMD Resistor, 47R, 5%, 1/4W	Yageo	1206	2
50	R29, R30	SMD Resistor, 75K, 5%, 1/4W	Yageo	1206	2
51	R31	SMD Resistor, 20K, 5%, 1/4W	Yageo	1206	1
52	R32	SMD Resistor, 360K, 5%, 1/8W	Yageo	0805	1
53	R33	SMD Resistor, 750K, 5%, 1/8W	Yageo	0805	1
54	R34	SMD Resistor, 0R, 5%, 1/8W	Yageo	0805	1
55	R35, R36	SMD Resistor, 0.24R, 1%, 1/4W	Yageo	1206	2
56	R37	SMD Resistor, 27K, 5%, 1/8W	Yageo	0805	1
57	R38	NC	Yageo	0805	1
58	R39	SMD Resistor, 100K, 5%, 1/8W	Yageo	0805	1
59	R40	SMD Resistor, 4.7K, 5%, 1/4W	Yageo	1206	1
60	R41, R42, R44	NC	-	-	0
61	R43	SMD Resistor, 51K, 5%, 1/4W	Yageo	1206	1
62	R45, R46	SMD Resistor, 1M, 5%, 1/4W	Yageo	1206	2
63	RJ1, RJ2	SMD Resistor, 0R, 5%, 1/4W	Yageo	1206	2
64	L1	Common Choke, 1mH	Gaoya Coil	DIP	1
65	L2	Common Inductor, UU10.5, 30mH	Gaoya Coil	DIP	1
66	L3	Drum Inductor, 2.2mH, 14*16mm	Gaoya Coil	DIP	1
67	L4	Common Choke, 330uH	Gaoya Coil	DIP	1
68	T1	Flyback Transformer, PQ2625, 6+6Pin, 0.32mH	Boody	DIP	1
69	Q1, Q5	NC	-	-	0
70	Q2	NPN-BJT, MMBT3904, 40V/0.2A	Diodes Inc	SOT-23	1
71	Q3	N-Mos, IPA80R1KOC, 800V, Rdson=1ohm	Infineon	TO-220	1
72	Q4	N-Mos, DMN10H100SK3-13, 100V	Diodes Inc	TO252	1
73	U1	AL1666, High performance dimmable LED controller	Diodes Inc	SOIC-8	1
74	U2	AL5822, 100/120Hz LED current ripple suppressor	Diodes Inc	SOT23-6	1
75	U3	AL8116, Flexible dimming interface IC	Diodes Inc	SOT23-6	1
76	U4	TCLT1006, Opto-coupler	Vishay	SOP-4L	1
77	J1, J2	Jumper			2

78	CN2	Connector, 2Pin			1
79	PCB	FR4 Single layer, 118*49mm			1
Total					**91**

Transformer Design

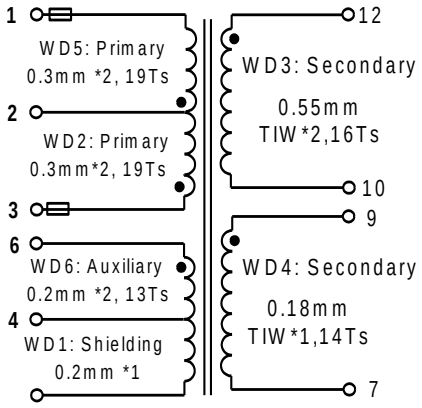
Materials

1. Core: PQ2625(Ferrite Material PC40 or equivalent)
2. Bobbin: PQ2625, Vertical, Primary=6 Pin, Secondary=6 Pin
3. Magnet Wires(Primary): Type 2-UEW
4. Magnet Wire(Secondary): Triple Insulated Wires
5. Layer Insulation Tape: 3M1298 or equivalent

Transformer Parameters

1. Primary Inductance (Pin3-Pin1)：L_P=320uH, ±5%@1kHz
2. Primary Leakage Inductance (Short other Windings, test the inductance of Pin3-Pin1): L_K<20uH, ±5%@1kHz
3. Primary Winding Turns (Pin3-Pin1): N_P=38Ts
4. Secondary Winding 1 Turns (Pin12-Pin10): N_S=16Ts
5. Secondary Winding 2 Turns (Pin9-Pin7): N_S=14Ts
6. Auxiliary Winding Turns (Pin6-Pin4): N_{AUX}=13Ts

Transformer Winding Construction Diagram



Item	Winding name	Description
1	Wd1 shielding	Start at Pin 4, Wind a full layer of Φ0.2mm*1 wire and left the end
2	Insulation	2 Layer of insulation tape
3	Wd2 Primary	Start at Pin 3, Wind 19 turns of Φ0.3mm*2 wire and finish on Pin 2

4	Insulation	2 Layer of insulation tape
5	Wd3 Secondary-1	Start at Pin 12, Wind 16 turns of Φ0.55mm*2 triple insulation wire and finish on Pin 10
6	Insulation	2 Layers of insulation tape
7	Wd4 Secondary-2	Start at Pin 9, Wind 14 turns of Φ0.18mm*1 triple insulation wire and finish on Pin7
8	Insulation	2 Layers of insulation tape
9	Wd5 Primary	Start at Pin 2, Wind 19 turns of Φ0.3mm*2 wire and finish on Pin 1
10	Insulation	2 Layer of insulation tape
11	Wd6 Auxiliary	Start at Pin 6, Wind 13 turns of Φ0.2mm*2 wire and finish on Pin 4
12	Insulation	2 Layers of insulation tape

Electrical Performance

Figure 7. Efficiency vs. Input Voltage

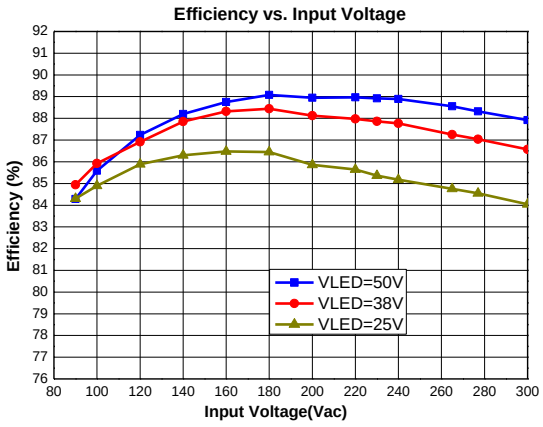


Figure 8. PF vs. Input Voltage

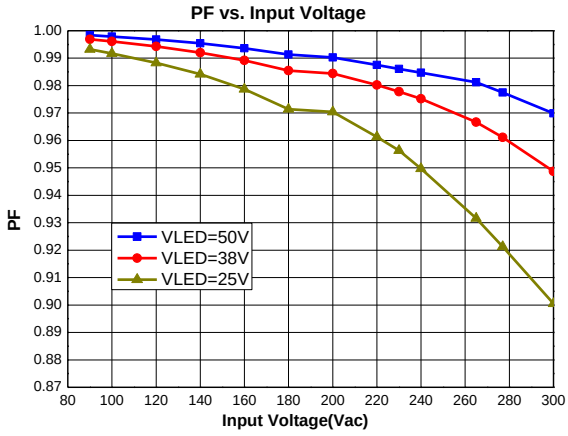


Figure 9. THD vs. Input Voltage

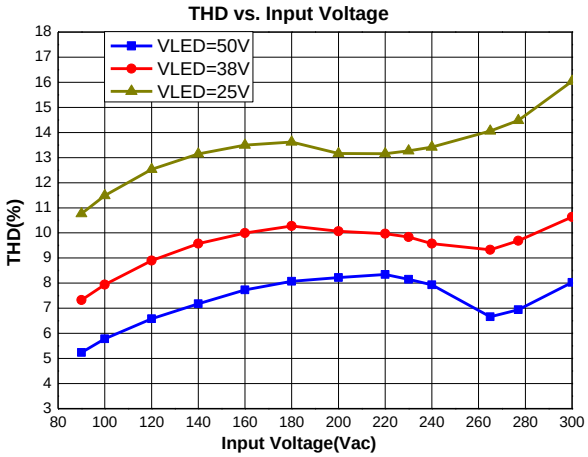


Figure 10. LED Current vs. Input Voltage

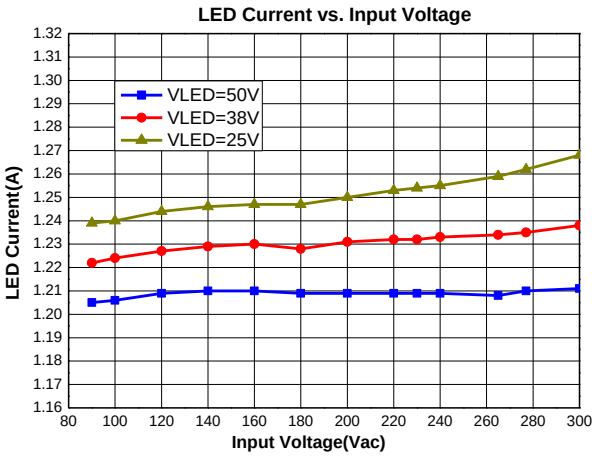


Figure 11. 0-10V Dimming Curve(V_{LED}=50V)

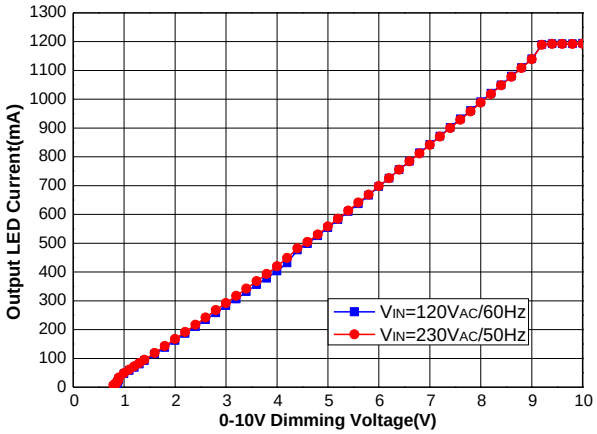
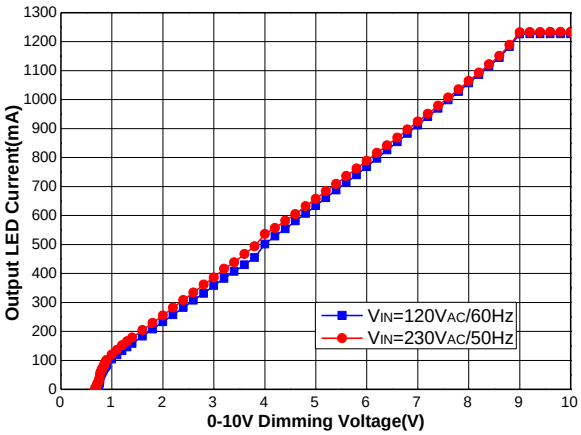


Figure 12. 0-10V Dimming Curve(V_{LED}=25V)



Functional Waveform

This section shows the system basic operating waveforms, start-up characteristics, output LED voltage and current ripple, Flyback Mosfet & output diode voltage stress and circuit protection waveforms. The system has rich protections including LED open/short protection, primary winding/secondary winding short protection, output diode short protection etc.

Figure 13. Input Voltage and Current (V_{IN}=120V_{AC}/60Hz, C3-V_{IN}, C4-I_{IN})

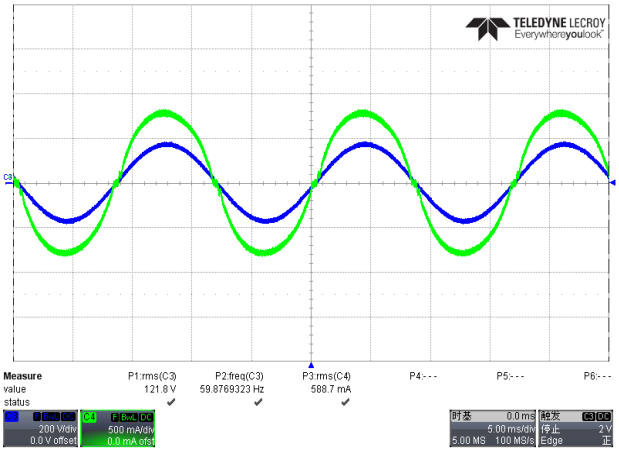


Figure 14. Input Voltage and Current (V_{IN}=230V_{AC}/50Hz, C3-V_{IN}, C4-I_{IN})

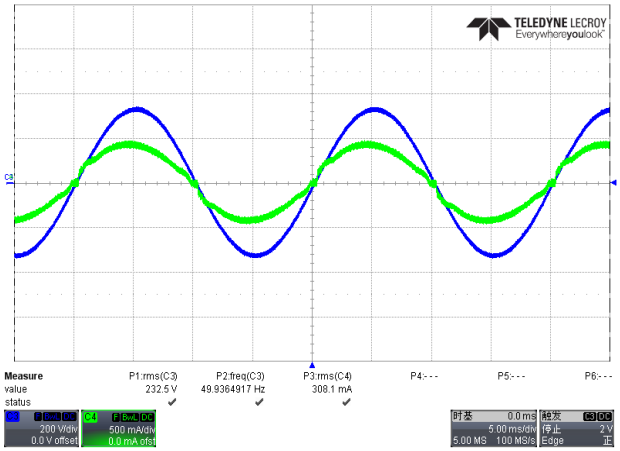


Figure 15. Start-up Time (V_{IN}=120V_{AC}/60Hz, C2-V_{IN}, C3-V_{E-Cap},C4-I_{LED}) Start-up Time=320mS

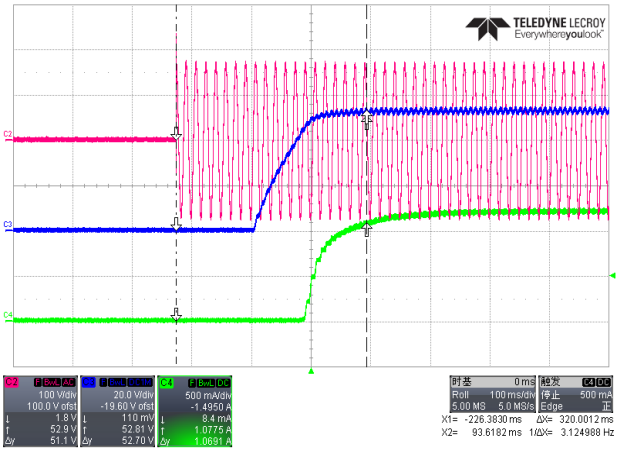


Figure 16. Start-up Time (V_{IN}=230V_{AC}/50Hz, C2-V_{IN}, C3-V_{E-Cap},C4-I_{LED}) Start-up Time=190mS

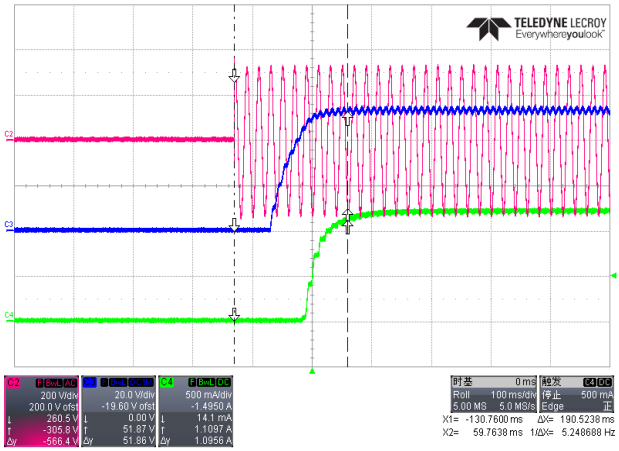


Figure 17. LED Voltage & LED Current (V_{IN}=120V_{AC}/60Hz, C3-V_{LED},C4-I_{LED}) LED Current Ripple=47mA

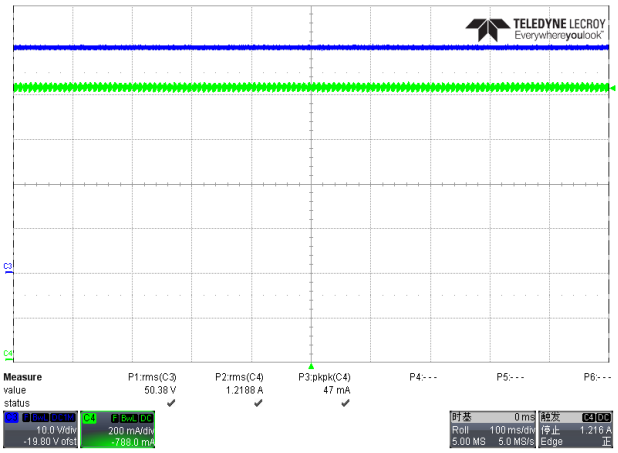


Figure 18. LED Voltage & LED Current (V_{IN}=230V_{AC}/50Hz, C3-V_{LED},C4-I_{LED}) LED Current Ripple=42mA

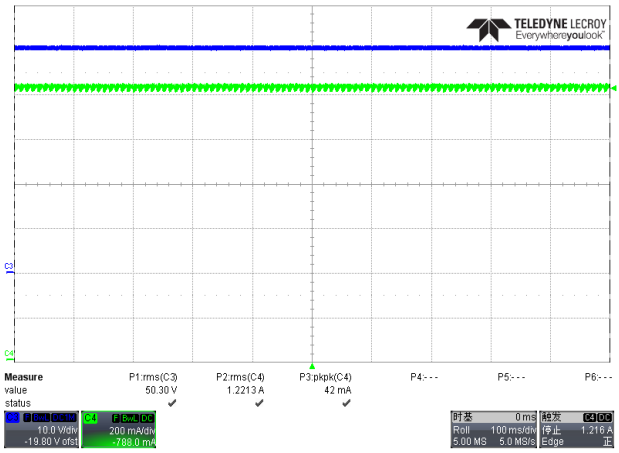


Figure 19. Flyback Mosfet Voltage (V_{IN}=300V_{AC}/50Hz, C3-V_{DS}) V_{DS-MAX}=668V

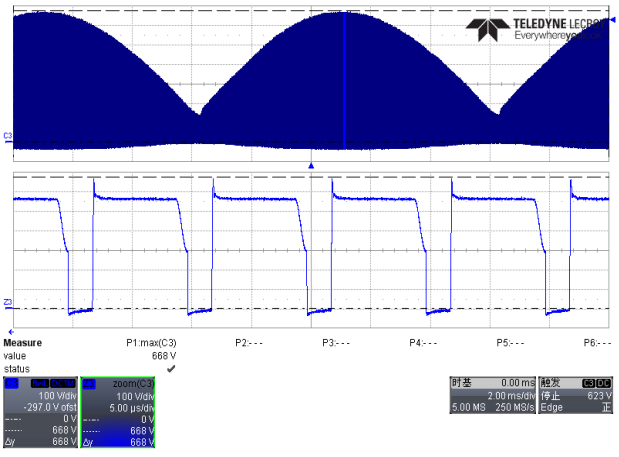


Figure 20. Output Diode Voltage (V_{IN}=300V_{AC}/50Hz, C3-V_{DIODE}) $V_{DIODE-PK}$=284V

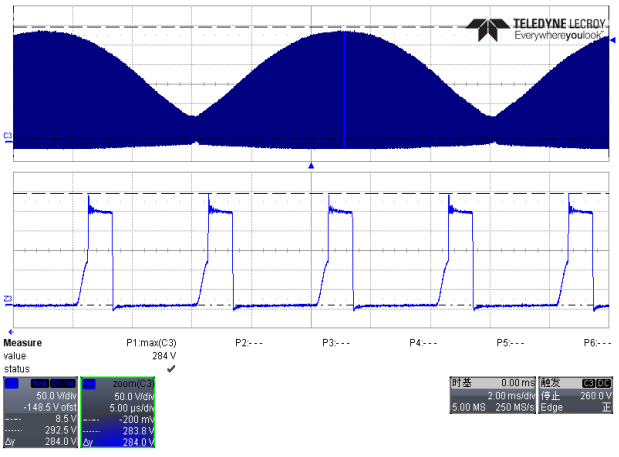


Figure 21. Peak Primary-side Current (V_{IN}=90V_{AC}/60Hz, C4-I_L) I_{L_PK}=4.28A

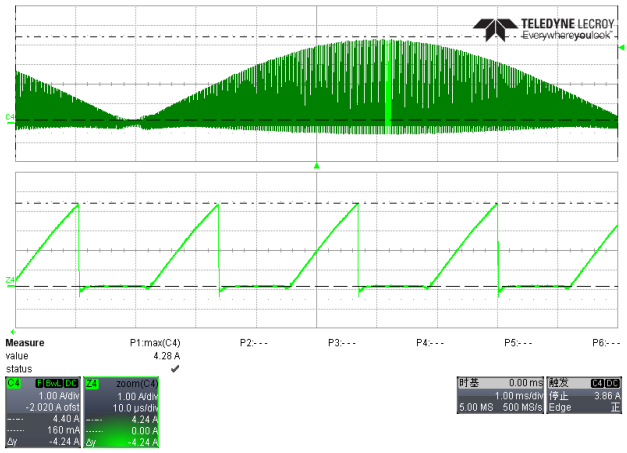
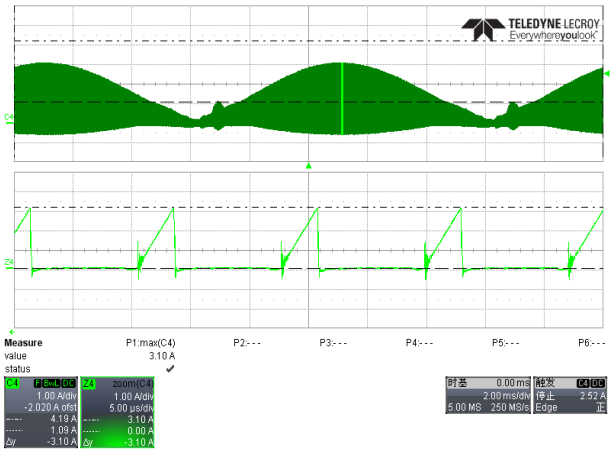


Figure 22. Peak Primary-side Current (V_{IN}=230V_{AC}/50Hz, C4-I_L) I_{L_PK}=3.1A



$$B_{MAX} = \frac{L_P \cdot I_{PK}}{N_P \cdot A_e} = \frac{0.32 * 10^{-3} * 4.28}{38 * 119 * 10^{-6}} = 0.302(T)$$

$$B_{MAX} = \frac{L_P \cdot I_{PK}}{N_P \cdot A_e} = \frac{0.32 * 10^{-3} * 3.1}{38 * 119 * 10^{-6}} = 0.219(T)$$

Figure 23. LED Open Protection (V_{IN}=120V_{AC}/60Hz, C1-V_{CC}, C2-V_{FB}, C3-V_{OUT},C4-I_{LED}) V_{OUT_PK}=62.7V

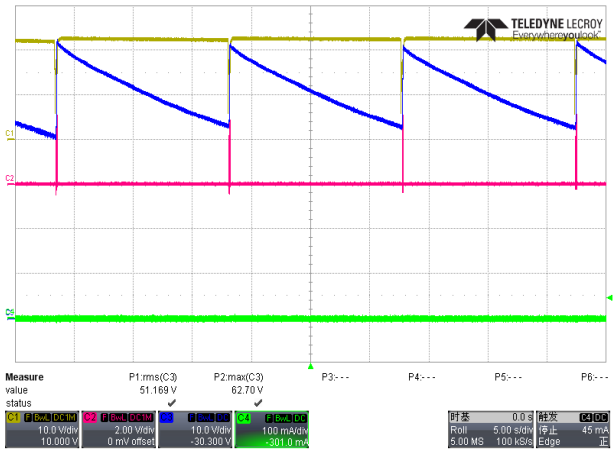


Figure 24. LED Open Protection (V_{IN}=230V_{AC}/50Hz, C1-V_{CC}, C2-V_{FB}, C3-V_{OUT},C4-I_{LED}) V_{OUT_PK}=63.1V

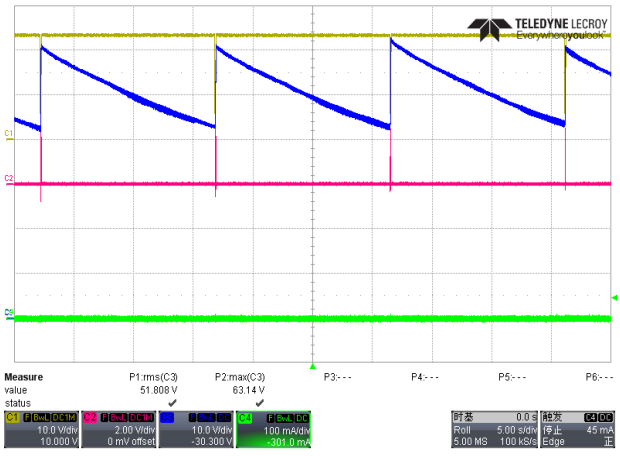


Figure 25. LED Short Protection

(V_{IN}=120V_{AC}/60Hz, C1-V_{E-Cap}, C2-V_{DS-Q4}, C3-V_{OUT},C4-I_{LED})

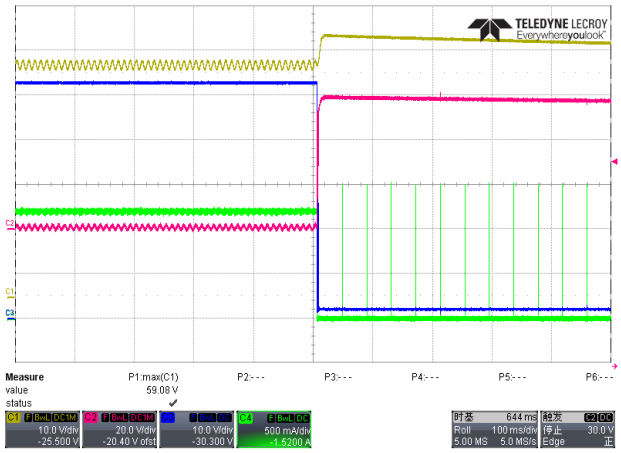


Figure 26. LED Short Protection

(V_{IN}=230V_{AC}/50Hz, C1-V_{E-Cap}, C2-V_{DS-Q4}, C3-V_{OUT},C4-I_{LED})

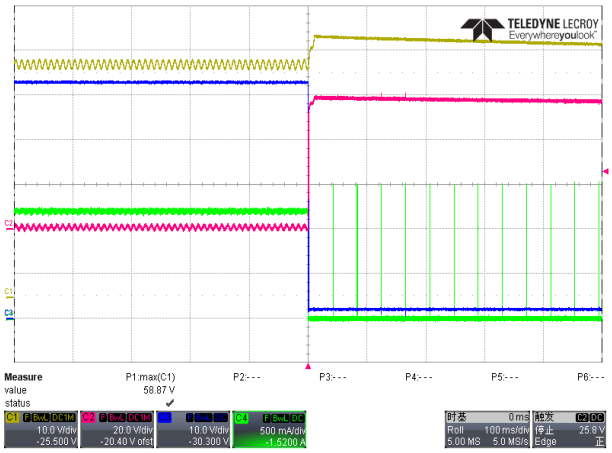


Figure 27. LED Short Recovery

(V_{IN}=120V_{AC}/60Hz, C1-V_{E-Cap}, C2-V_{DS-Q4}, C3-V_{OUT},C4-I_{LED})

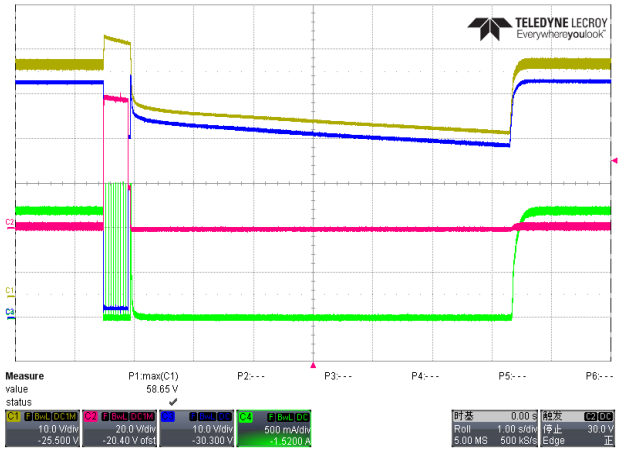


Figure 28. LED Short Recovery

(V_{IN}=230V_{AC}/50Hz, C1-V_{E-Cap}, C2-V_{DS-Q4}, C3-V_{OUT},C4-I_{LED})

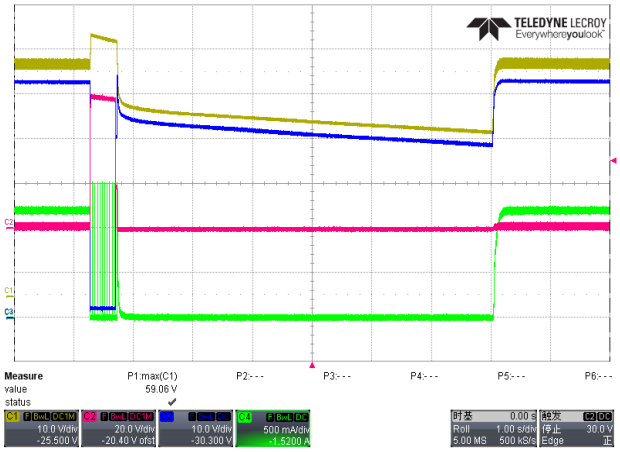


Figure 29. Primary Winding Short Protection

(V_{IN}=120V_{AC}/60Hz, C1-V_{CC}, C2-V_{CS}, C3-V_{DS-Q3},C4-I_{LED})

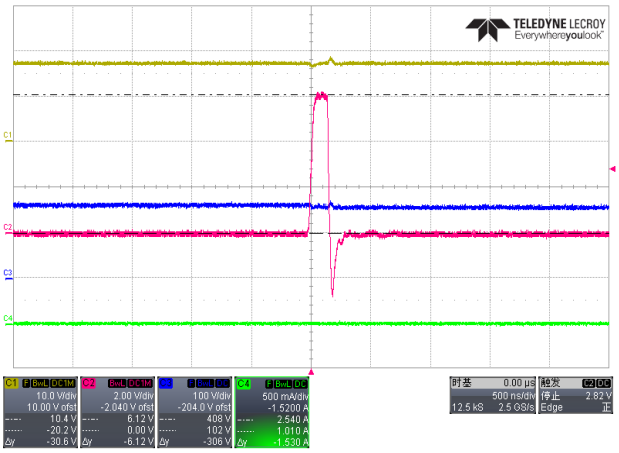


Figure 30. Primary Winding Short Protection

(V_{IN}=230V_{AC}/50Hz, C1-V_{CC}, C2-V_{CS}, C3-V_{DS-Q3},C4-I_{LED})

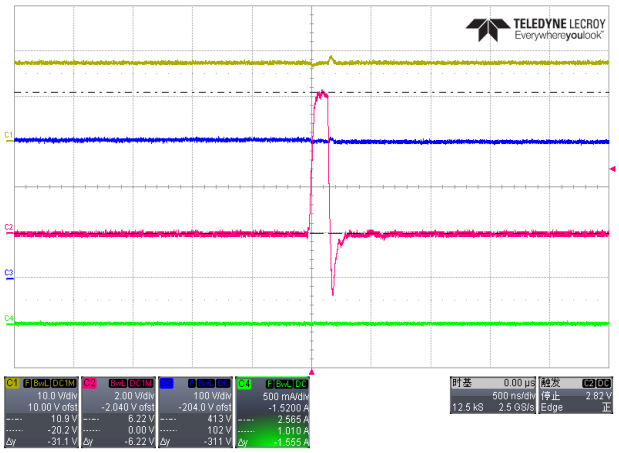


Figure 31. Secondary Winding Short Protection

(V_{IN}=120V_{AC}/60Hz, C1-V_{CC}, C2-V_{CS}, C3-V_{DS-Q3},C4-I_{LED})

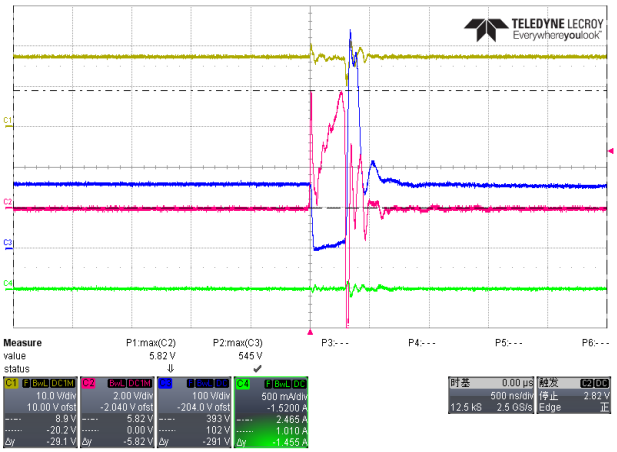


Figure 32. Secondary Winding Short Protection

(V_{IN}=230V_{AC}/50Hz, C1-V_{CC}, C2-V_{CS}, C3-V_{DS-Q3},C4-I_{LED})

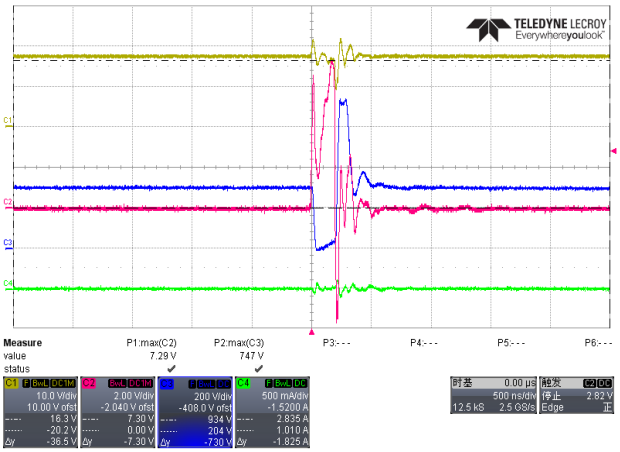


Figure 33. Output Diode Short Protection

(V_{IN}=120V_{AC}/60Hz, C1-V_{CC}, C2-V_{CS}, C3-V_{DS-Q3},C4-I_{LED})

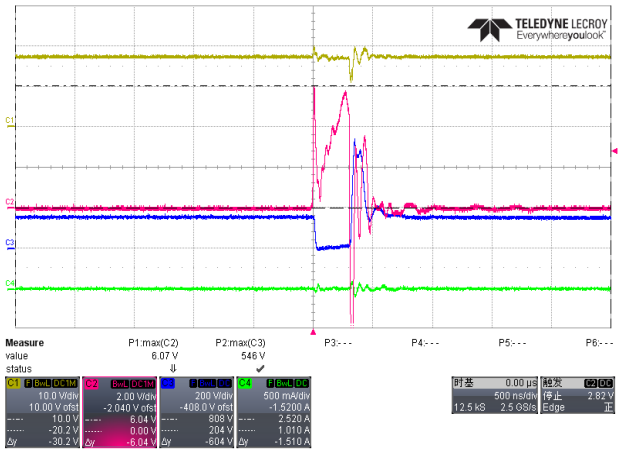
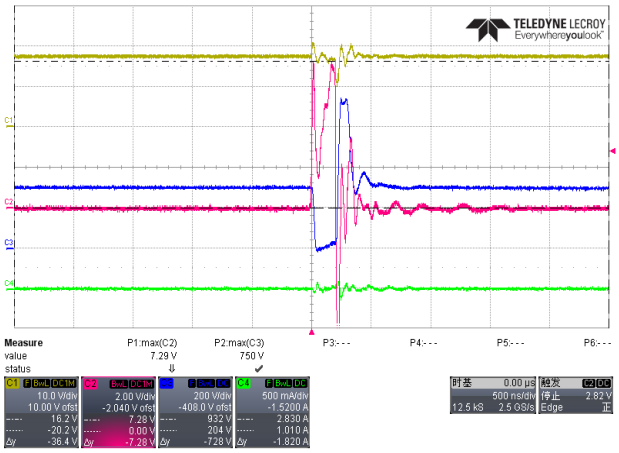


Figure 34. Output Diode Short Protection

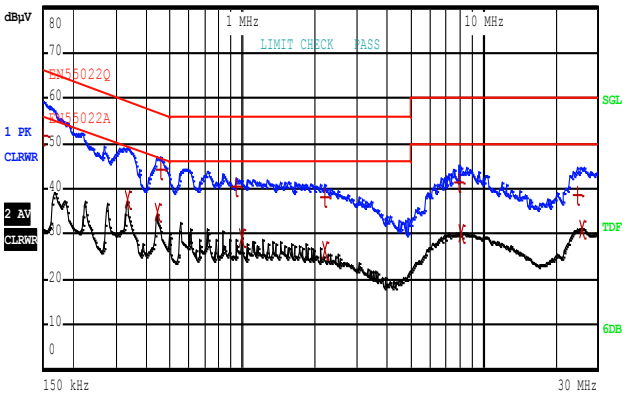
(V_{IN}=230V_{AC}/50Hz, C1-V_{CC}, C2-V_{CS}, C3-V_{DS-Q3},C4-I_{LED})



EMI Conduction Test

Below shows the EMC conduction test results, the data is taken at maximum output current (1.2A) and full load voltage (50V) condition.

Figure 35. Live Terminal
V_{IN}=120V_{AC}, Margin>11.8dB

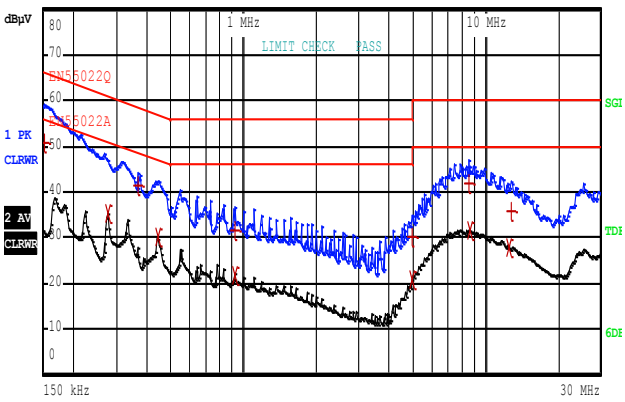


EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	150 kHz	51.55	-14.44
2	Average	332.507282579 kHz	37.56	-11.82
2	Average	443.732257589 kHz	34.72	-12.27
1	Quasi Peak	457.177788726 kHz	44.04	-12.70
1	Quasi Peak	935.888336808 kHz	40.40	-15.59
2	Average	993.464328234 kHz	29.19	-16.80
1	Quasi Peak	2.20222749414 MHz	38.04	-17.95
2	Average	2.20222749414 MHz	26.39	-19.60
1	Quasi Peak	7.87042209709 MHz	41.47	-18.52
2	Average	8.10890375706 MHz	30.13	-19.86
1	Quasi Peak	24.4700375488 MHz	38.69	-21.30
2	Average	25.7182553901 MHz	31.12	-18.87

Figure 36. Neutral Terminal
V_{IN}=120V_{AC}, Margin>15dB

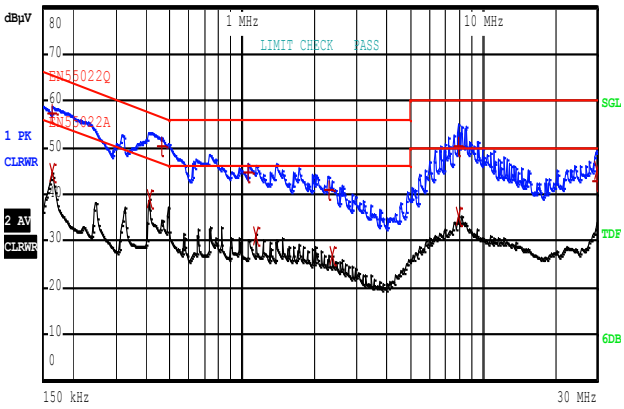


EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

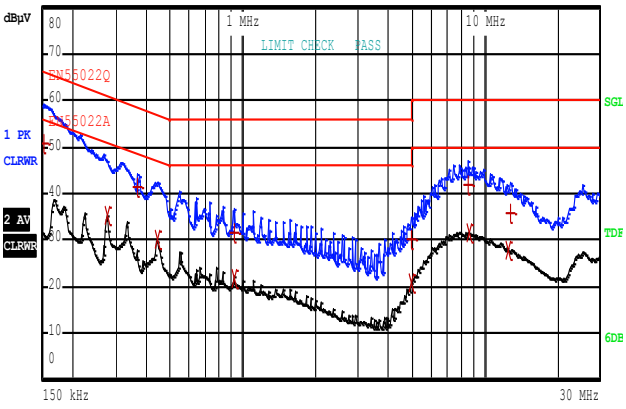
TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	151.5 kHz	50.92	-14.99
2	Average	275.229549832 kHz	35.47	-15.48
1	Quasi Peak	367.294901197 kHz	41.63	-16.92
2	Average	443.732257589 kHz	30.09	-16.89
1	Quasi Peak	917.447639259 kHz	31.76	-24.23
2	Average	917.447639259 kHz	21.72	-24.28
1	Quasi Peak	4.97983359306 MHz	30.20	-25.79
2	Average	4.97983359306 MHz	20.58	-25.41
1	Quasi Peak	8.52253934396 MHz	41.65	-18.34
2	Average	8.6077647374 MHz	31.38	-18.62
2	Average	12.4388782936 MHz	27.60	-22.39
1	Quasi Peak	12.6888997473 MHz	35.75	-24.24

Figure 37. Live Terminal
V_{IN}=230V_{AC}, Margin>4.7dB



EDIT PEAK LIST (Final Measurement Results)				
Trace1:	EN55022Q			
Trace2:	EN55022A			
Trace3:	---			
TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	162.428505844 kHz	57.21	-8.12
2	Average	162.428505844 kHz	44.52	-10.81
2	Average	409.779295157 kHz	39.01	-8.63
1	Quasi Peak	461.749566613 kHz	50.31	-6.34
1	Quasi Peak	1.05458240332 MHz	44.54	-11.45
2	Average	1.14196162708 MHz	31.12	-14.88
1	Quasi Peak	2.29164676133 MHz	41.00	-14.99
2	Average	2.36108594985 MHz	26.89	-19.10
1	Quasi Peak	7.87042209709 MHz	50.40	-9.59
2	Average	7.87042209709 MHz	35.29	-14.70
1	Quasi Peak	29.8580960942 MHz	42.90	-17.09
2	Average	30 MHz	45.32	-4.67

Figure 38. Neutral Terminal
V_{IN}=230V_{AC}, Margin>6dB



EDIT PEAK LIST (Final Measurement Results)				
Trace1:	EN55022Q			
Trace2:	EN55022A			
Trace3:	---			
TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
2	Average	167.350252 kHz	46.75	-8.34
1	Quasi Peak	174.145343305 kHz	55.73	-9.02
2	Average	418.01585899 kHz	34.23	-13.25
1	Quasi Peak	485.30343514 kHz	44.68	-11.56
1	Quasi Peak	1.14196162708 MHz	35.18	-20.81
2	Average	1.16491505578 MHz	23.84	-22.15
1	Quasi Peak	4.78552220172 MHz	40.53	-15.46
2	Average	4.83337742374 MHz	26.85	-19.15
1	Quasi Peak	8.10890375706 MHz	48.91	-11.08
2	Average	8.10890375706 MHz	38.43	-11.56
1	Quasi Peak	12.4388782936 MHz	39.07	-20.92
2	Average	30 MHz	44.00	-5.99

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.
Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or

2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

www.diodes.com