

Subject

OB2216 Demo Board Manual

Board Model: AD12V1A2216.02

Doc. No.: OB_DOC_DBM_A_2216A0



Key features:

- Primary-side sensing and regulation without TL431 and opto-coupler
- Cost effective and simplified system design
- Standby power less than 200mW
- Full load efficiency greater than 80%
- No X & Y design
- Audio noised free operation
- Auto-restart in short circuit
- Frequency shuffling technology to improve EMI performance
- Meet EN55022 EMI

Revision History

Revise Date	Version	Reason/Issue
2007-11-12	00	First issue
2008-2-13	01	Update Protection Function
2009-09-03	A0	Improve performance

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1. Adapter Module Specification

1.1. Input Characteristics

- AC input voltage rating 100Vac ~ 240Vac
- AC input voltage range 90Vac ~ 264Vac
- AC input frequency range 47Hz ~ 63Hz

1.2. Output Characteristics

- Output Voltage 12V
- Output Tolerance <20%
- Min. load current 0A
- Max. load current 1A

1.3. Performance Specifications

- Max. Output Power 12W
- Standby Power <0.2W @ 264V/50Hz, no load, 25°C
- Efficiency >77.75% @Ave. 25/50/75/100%Load, normal line, 25°C
- Line Regulation 2% Max
- Load Regulation <20% Max
- Ripple & Noise 100 mV Max
- Hold up Time 10m Sec. Min. @100Vac with full load
- Turn on Delay Time 2 Sec. Max. @100Vac with full load

1.4. Protection Features

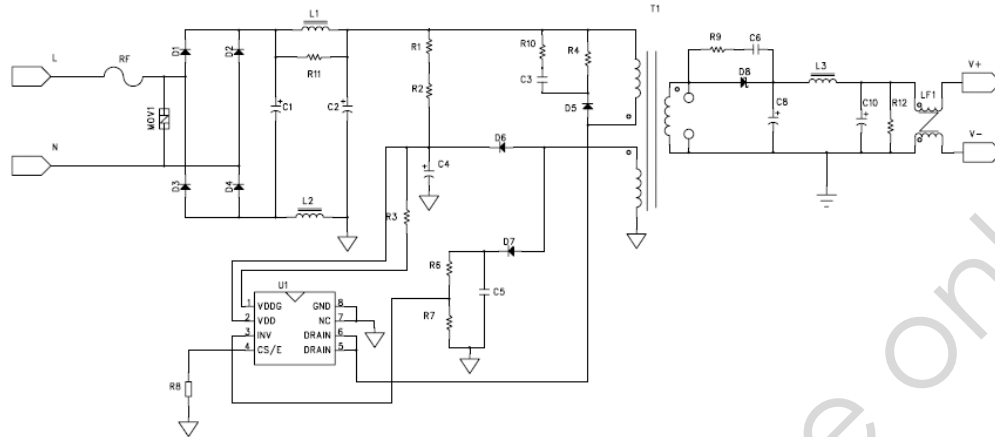
- Short Circuit Protection Output shut down with automatic recovery
- Over Voltage Protection Output shut down with automatic recovery
- Over Current Protection Output shut down with automatic recovery

1.5. Environments

- Operating Temperature 0°C to +40°C
- Operating Humidity 20% to 90% R.H.
- Storage Temperature -40°C to +60°C
- Storage Humidity 0% to 95% R.H.

2. Adapter Module Information

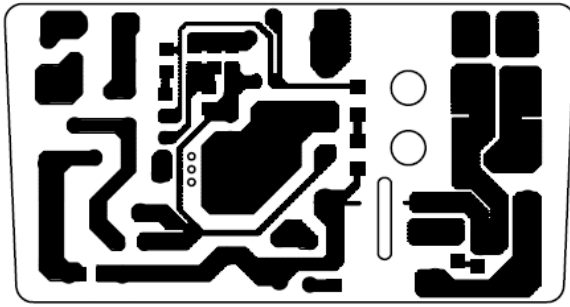
2.1. Schematic



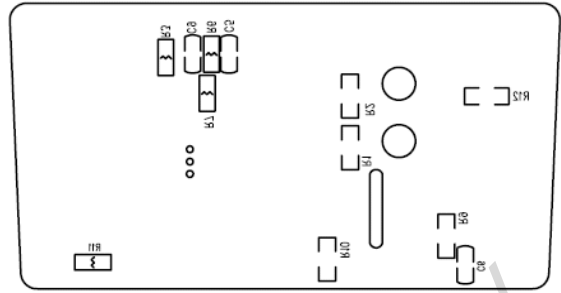
2.2. Bill of material

No.	Position	Description	Quantity	Remark
1	RF	Slow Fuse, 1.5A 250V	1	
2	R1,R2	RES SMD 1206 1.5M $\pm 5\%$	2	
3	R3	RES SMD 0805 1K $\pm 5\%$	1	
4	R4	RES DIP 1W 150K $\pm 5\%$	1	
5	R6	RES SMD 0805 51K $\pm 1\%$	1	
6	R7	RES SMD 0805 5.1K//100k $\pm 1\%$	2	
7	R8	RES DIP 1W 1.3R $\pm 1\%$	1	
8	R9	RES SMD 0805 47R $\pm 5\%$	1	
9	R10	RES SMD 1206 20R $\pm 5\%$	1	
10	R12	RES SMD 1206 2.7K $\pm 5\%$	1	
11	C1	EC10UF/400V 105°C	1	
12	C2	EC22UF/400V 105°C	1	
13	C3	CC 222P 1KV	1	
14	C4	EC 4.7UF/50V 105°C	1	
15	C5	CAP SMD 0805 470nF	1	
16	C6	CAP SMD 0805 1.8nF	1	
17	C8	EC 680UF 16V Low ESR	1	
18	C10	EC 470UF 16V Low ESR	1	
19	D1-D6	IN4007 1A 1000V	7	
20	D7	FR107	1	
21	D8	SCHOTTKY SB3100	1	
22	L1	Choke, $\Phi 6\text{mm} \times 8\text{mm}$ 500uH	1	
23	L2	Choke, 4.7uH 1W	1	
24	L3	Choke, $\Phi 4\text{mm} \times 10\text{mm}$ 1.75 uH	1	
25	LF1	Common choke $\Phi 8\text{mm} \times 3.5\text{mm}$ 150uH		
26	U1	OB2216	1	
27	T1	Transformer EF20	1	
28	MOV1	7D471	1	

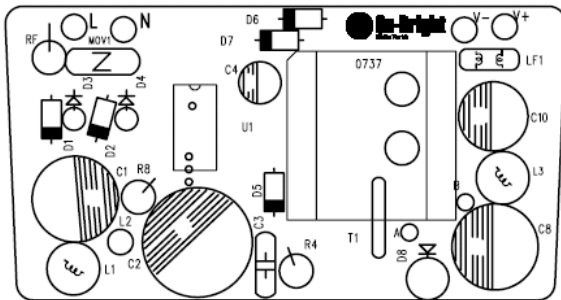
2.3. PCB Gerber File



Bottom



Bottom



TOP

2.4. Adapter Module Snapshot

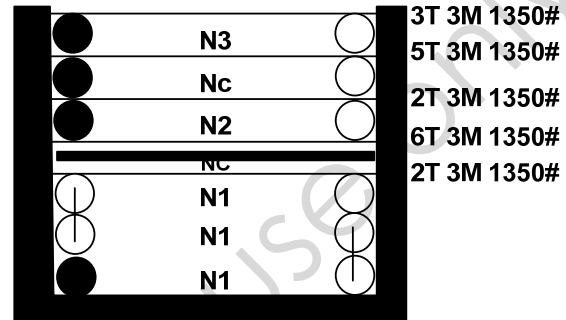
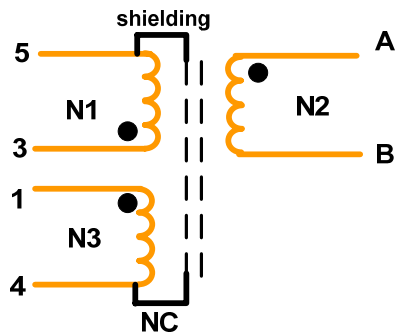


2.5. Transformer design

2.5.1. Transformer Specification

- 1) Bobbin: EF20 (10Pin) HOR
- 2) Core material: PC40 (TDK).
- 3) $L(5-3) = 1.9\text{mH} \pm 10\%$ (10KHz, 1V, 25°C)

2.5.2. Structure/Material



Bottom

Tape

Winding	Material	Start	Turns	Finish
N1	0.27Φ*1 2UEW	5	40	C
N1	0.27Φ*1 2UEW	C	40	D
N1	0.27Φ*1 2UEW	D	40	3
TAPE	TAPE W=13mm (Y)		2	
Shielding	Copper W=13mm	5	1.1	
TAPE	TAPE W=13mm (Y)		6	
N2	0.45 Φ*1 triple insulated wire	B	18	A
TAPE	TAPE W=13mm (Y)		2	
NC	0.15Φ*4 2UEW	4	18	NC
TAPE	TAPE W=13mm (Y)		5	
N3	0.18Φ*3 2UEW	4	20	1
TAPE	TAPE W=9mm (Y)		3	

3. Performance Evaluation

This session presents the test results of OBPD12W module up to date. Results on inrush current and safety test are not included and will be added when they become available.

Overall, the module meets design specifications. All data was measured at #22 AWG Line end.

Performance Highlights

- The standby power is about 0.168W @ 264Vac/50HZ no load.
- The average efficiency more than 77.75% @25/50/75/100% load, normal line.
- EMI passed EN55022 and FCC15 Class B test with more than 6dB margin

Characterization Results Summary

Test Item	Test result
1. Input characteristics	
Input current (90V/60Hz, full load)	300mA Max
Standby power at no load (264Vac)	0.168W
Average Efficiency (230Vac, 25%/50%/75%/100%)	79.66%
2. Output characteristics	
Line regulation	2%
Load regulation	20%
Ripple & noise	100mV Max
Over shoot	5% Max
Under shoot	
Dynamic test	750mVp-p
3. Time sequence (100Vac with Full load)	
Turn on delay time	1.73S
Hold up time	19.04mS
Rise time	10.16mS
Fall time	11.70mS

Test Equipments

Item	Vender	Module
AC Source	WEST	WEW1010
Digital Power Meter	YOKOGAWA	WT210
Electrical Load	Prodigit	3315C
Oscilloscope	LeCroy	WS424
Multimeter	VICTORY	VC9807A

3.1. Input Characteristics

3.1.1. Standby power

Table. 1 Standby power

Input voltage	Pin(mW)	Vo(V)	Specification	Test result
90Vac/60HZ	112	13.35	<200mW	Pass
115Vac/60HZ	115	13.35		
230Vac/50HZ	147	13.40		
264Vac/50HZ	168	13.42		

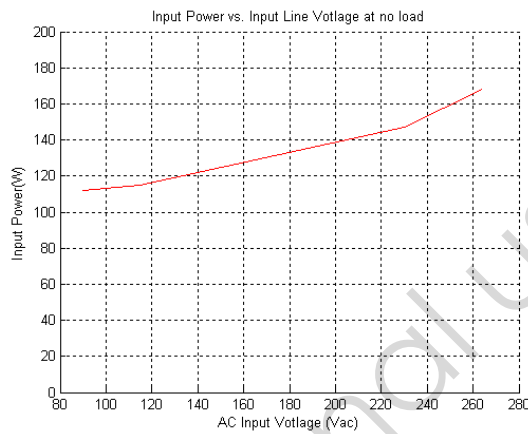


Fig. 1 No-load Input Power vs. Input Line Voltage

3.1.2. Efficiency

Table. 2 Efficiency

Input voltage	25%	50%	75%	100%	Aver. Eff.	CEC/CoC
115Vac/60HZ	80.06	82.32	82.12	82.02	81.63	>77.75%
230Vac/50HZ	77.00	79.81	80.40	81.46	79.66	

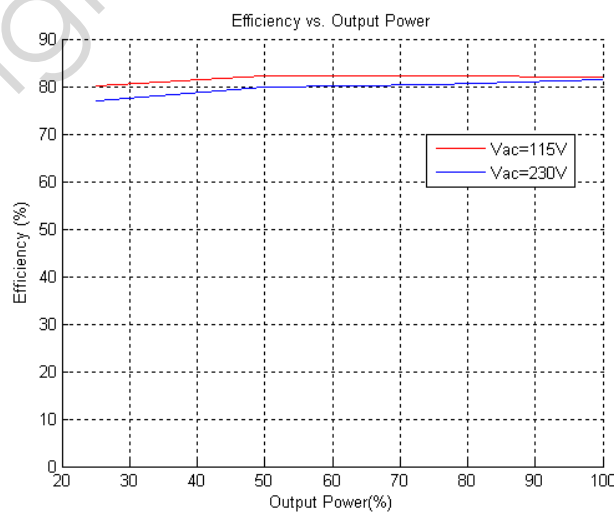


Fig. 2 Efficiency vs. Percent of Rated Output Power

3.2. Output Characteristics

3.2.1. Line Regulation & Load Regulation

Table. 3 Line Regulation & Load Regulation

Input voltage	No load	Half load	Full load	Specification	Test result
90Vac/60HZ	13.35	12.12	11.76		
115Vac/60HZ	13.35	12.12	11.80		
230Vac/50HZ	13.40	12.14	11.87		
264Vac/50HZ	13.42	12.15	11.87		
Line Regulation	2%			<2%	Pass
Load Regulation	12.91%			<20%	Pass

3.2.2. Ripple & Noise

Table. 4 Ripple & Noise

Input voltage	R&N (mV)			Remark
	No load	Full load		
90Vac/60HZ	34mV	42mV		Fig. 4,5
115Vac/60HZ	41mV	91mV		
230Vac/50HZ	34mV	105mV		
264Vac/50HZ	38mV	89mV		Fig. 6,7

Note: Ripple & noise was measured at board end without probe cap and ground clip. Measurement bandwidth was limited to 20MHz.

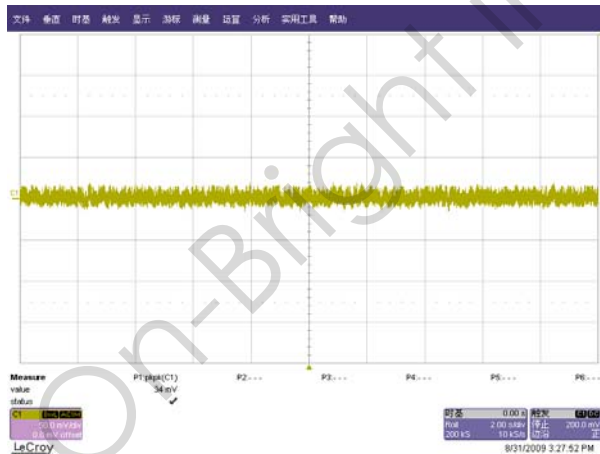


Fig. 3 Measured ripple & noise waveform @90Vac/60HZ, no load.

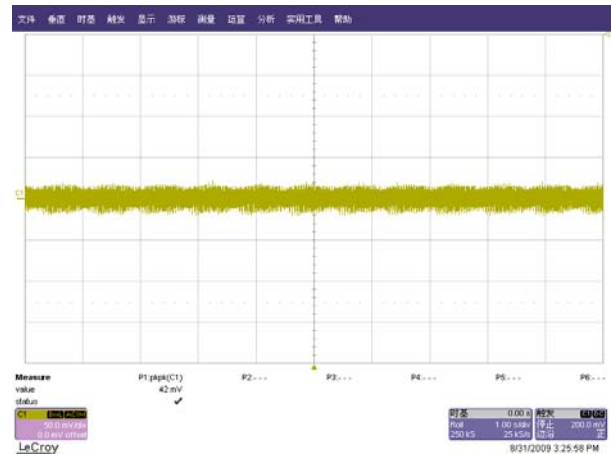


Fig. 4 Measured ripple & noise waveform @90Vac/60HZ, full load.

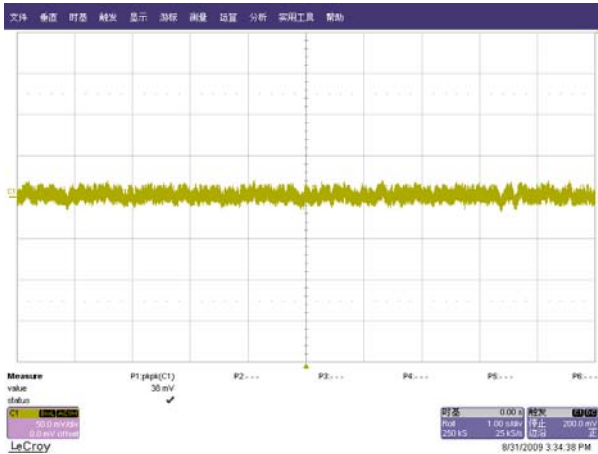


Fig. 5 Measured ripple& noise waveform@264Vac/50HZ, no load

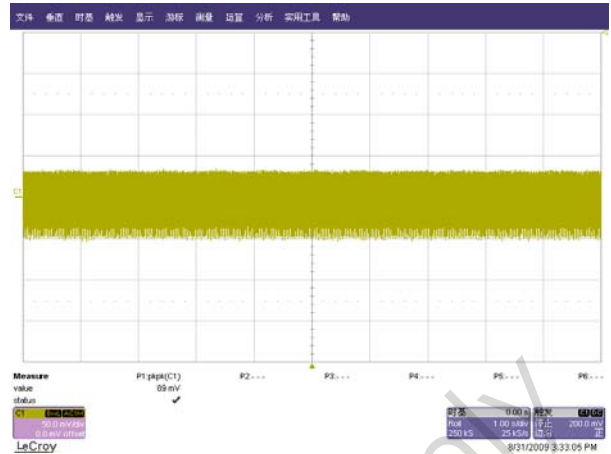


Fig. 6 Measured ripple& noise waveform@264Vac/50HZ, full load

3.2.3.Over shoot & Under shoot

Over shoot and under shoot were measured under below conditions.

- AC input switch on for over shoot and off for under shoot.
- Input voltage ranges from 90Vac/60HZ~264Vac/50HZ.

Table. 5 Over shoot & Under shoot measurement results

Input	load		Remark
90V/60HZ	Full load	over shoot	Fig. 8
		under shoot	
	No load	over shoot	Fig. 9
		under shoot	
264V/50HZ	Full load	over shoot	Fig. 10
		under shoot	
	No load	over shoot	Fig. 11
		under shoot	



Fig. 7 Measured overshoot waveform@90Vac/60HZ, full load



Fig. 8 Measured overshoot waveform@90Vac/60HZ, no load

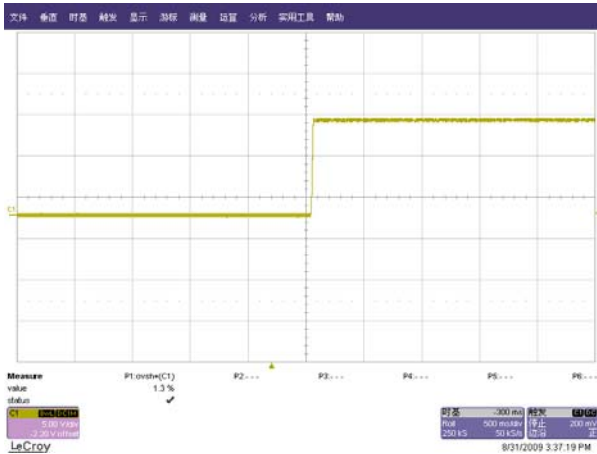


Fig. 9 Measured overshoot waveform @264Vac/50HZ, full load

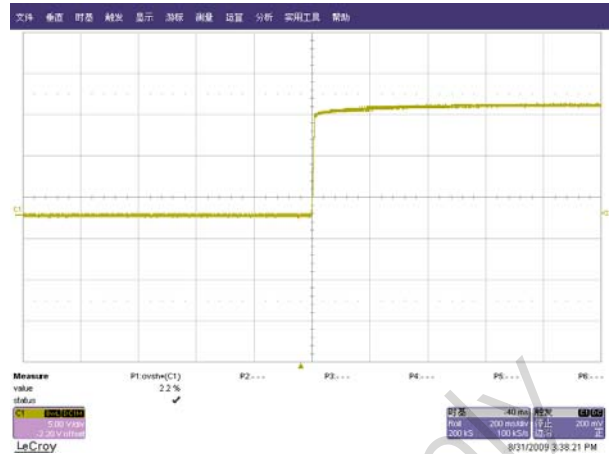


Fig. 10 Measured overshoot waveform @264Vac/50HZ, no load

3.2.4. Dynamic Test

A dynamic loading with low set at 20% load lasting for 50ms and high set at 80% load lasting for 50ms is added to output. The ramp is set at 0.25A/us at transient. Measurement was taken at Board end (Same as R&N measurement)

Table. 6 Output voltage under dynamic test

Input	Output (mV)	Remark
264V/50HZ	488mVp-p	Fig. 12
180V/50HZ	688mVp-p	
115V/60HZ	750mVp-p	
90V/60HZ	750mVp-p	Fig.13

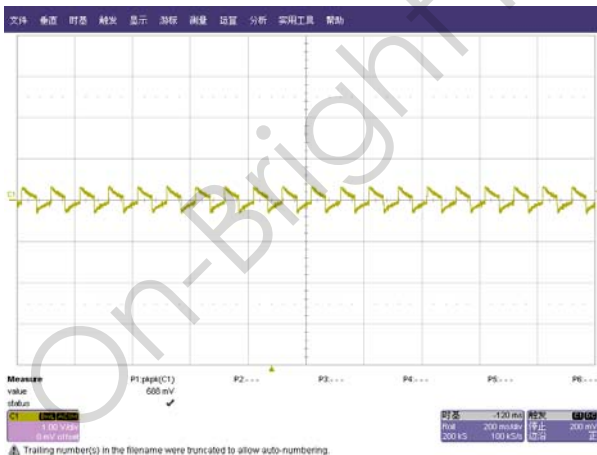


Fig. 11 Output voltage waveform under Dynamic test @264Vac/50HZ

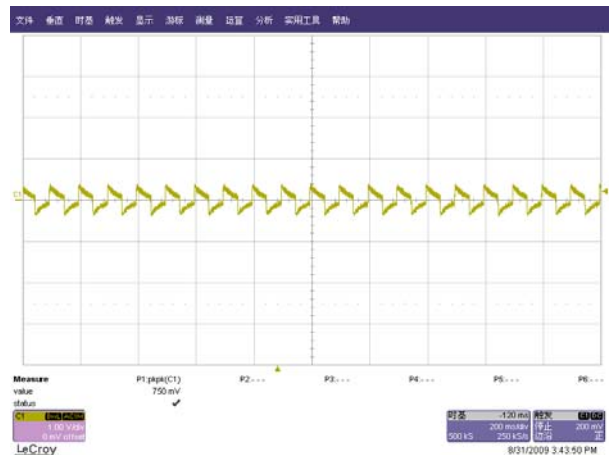


Fig. 12 Output voltage waveform under Dynamic test @90Vac/60HZ

3.2.5. Time Sequence (Full load)

Table. 7 Turn-on delay/hold-up/rise/fall time measurement results

Item	Input voltage	Meas. Data	Test spec.	Test results	Remark
Turn-on delay time	100V/60HZ	1.73s	<2S	Pass	Fig. 14
	240V/50HZ	0.663s		Pass	Fig. 15
Hold-up time	100V/60HZ	19.04ms	>10mS	Pass	Fig. 16
	240V/50HZ	N.A.			
Rise Time	100V/60HZ	11.27ms		Pass	Fig. 17
	240V/50HZ	10.16ms		Pass	Fig. 18
Fall Time	100V/60HZ	11.70ms		Pass	Fig. 19
	240V/50HZ	12.18ms		Pass	Fig. 20

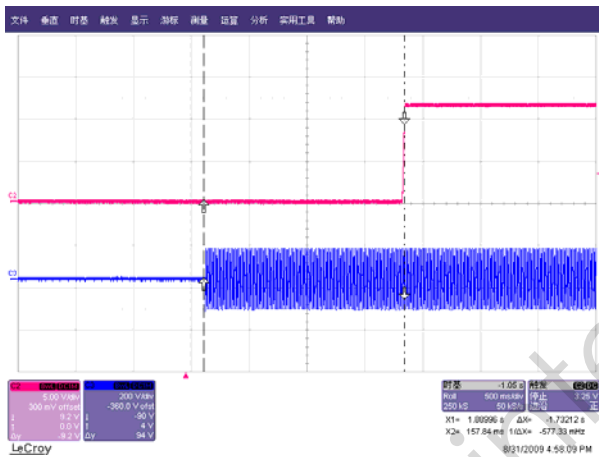


Fig. 13 Turn on delay time measured waveform @100Vac/60HZ,full load



Fig. 14 Turn on delay time measured waveform @240Vac/50HZ,full load

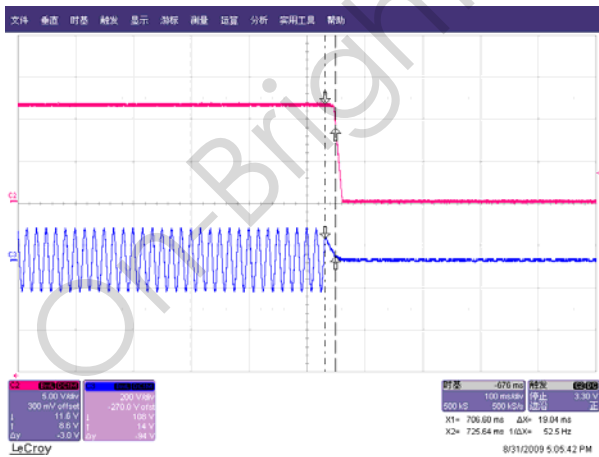


Fig. 15 Hold-up time measured waveform@100Vac/60HZ,full load



Fig. 16 Rise time measured waveform@100Vac/60HZ,full load

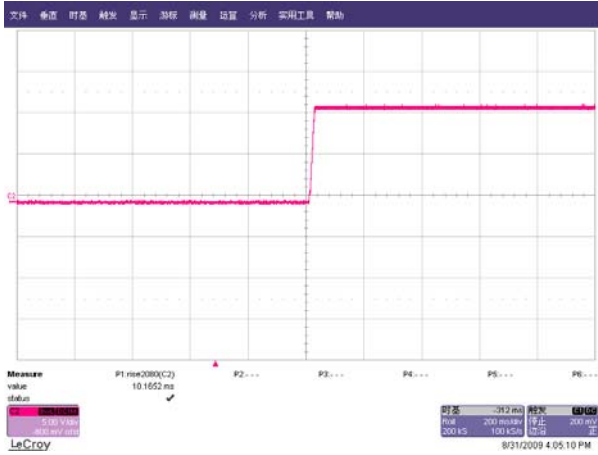


Fig. 17 Rise time measured waveform@240Vac/50HZ,full load

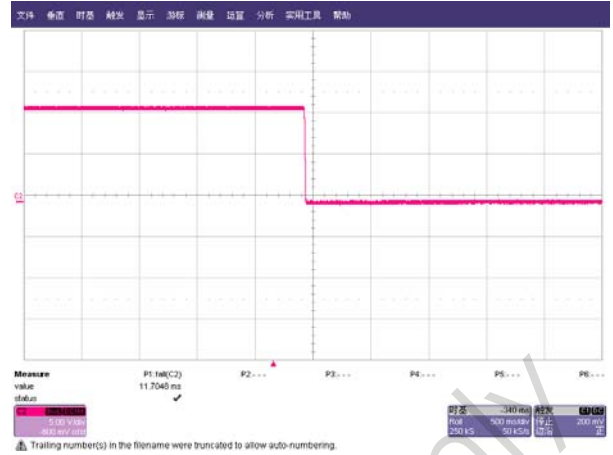


Fig. 18 Fall time measured waveform@100Vac/60HZ,full load

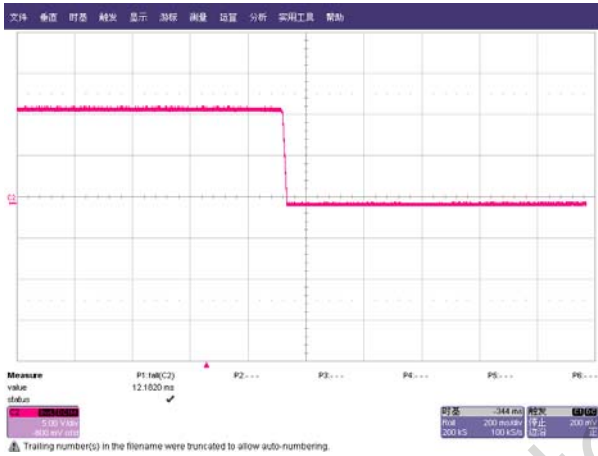


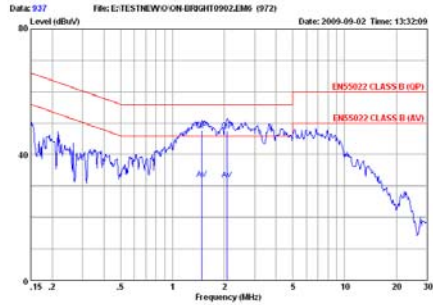
Fig. 19 Fall time measured waveform@240Vac/50HZ,full load

3.3. EMI Test

The Power supply passed EN55022 Class B EMI requirement with more than 6dB margin

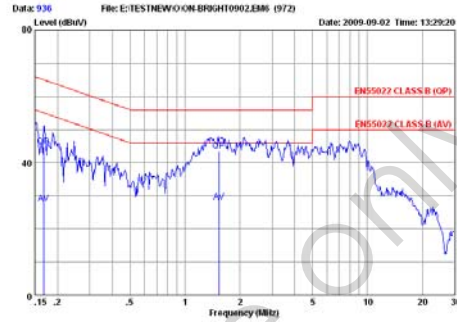
3.3.1. Conducted EMI Test

3.3.1.1 EN55022 CLASS B @ full load report



Site : Audix ACI(Conducted Emission)
 Condition : EN55022 CLASS B (QP) ESR2-25-09.04.02(2) NEUTRAL
 Project No. :
 Applicant :
 EUT :
 M/N : OB2216
 S/N :
 Power Supply : 12V 1A
 Ambient : 230V/50Hz
 Test line : 20°C 53dB
 Test Mode : Full Load
 Test Engineer : Hugh
 Memo :

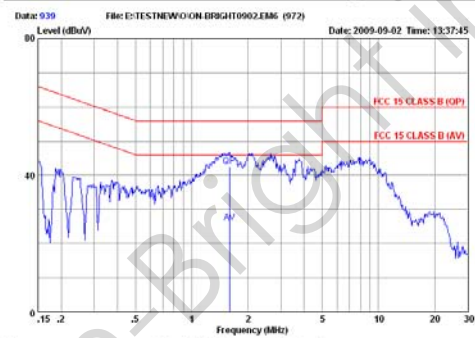
	Freq	Level	Read Level	Cable Loss	LISN Factor	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dB	dBuV	dB	
1	1.480	47.67	47.33	0.07	0.27	0.34	56.00	-8.33	QP
2	1.480	32.03	31.69	0.07	0.27	0.34	46.00	-13.97	Average
3	2.079	47.46	47.10	0.08	0.28	0.36	56.00	-8.54	QP
4	2.079	31.76	31.40	0.08	0.28	0.36	46.00	-14.24	Average



Site : Audix ACI(Conducted Emission)
 Condition : EN55022 CLASS B (QP) ESR2-25-09.04.02(2) LINE
 Project No. :
 Applicant :
 EUT :
 M/N : OB2216
 S/N :
 Power Supply : 12V 1A
 Ambient : 230V/50Hz
 Test line : 20°C 53dB
 Test Mode : Full Load
 Test Engineer : Hugh
 Memo :

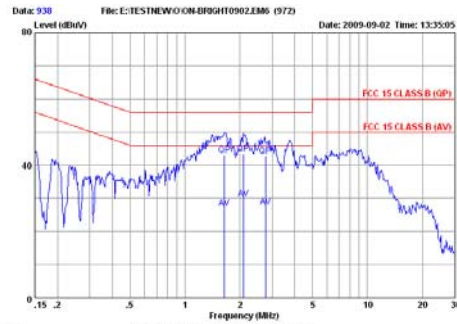
	Freq	Level	Read Level	Cable Loss	LISN Factor	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dB	dBuV	dB	
1	0.167	44.73	44.51	0.02	0.20	0.22	65.10	-20.37	QP
2	0.167	27.69	27.47	0.02	0.20	0.22	55.10	-27.41	Average
3	1.532	43.45	43.11	0.07	0.27	0.34	56.00	-12.55	QP
4	1.532	28.08	27.74	0.07	0.27	0.34	46.00	-17.92	Average

3.3.1.2 FCC CLASS B @ full load report



Site : Audix ACI(Conducted Emission)
 Condition : FCC 15 CLASS B (QP) ESR2-25-09.04.02(2) LINE
 Project No. :
 Applicant :
 EUT :
 M/N : OB2216
 S/N :
 Power Supply : 12V 1A
 Ambient : 120V/60Hz
 Test line : 20°C 53dB
 Test Mode : Full Load
 Test Engineer : Hugh
 Memo :

	Freq	Level	Read Level	Cable Loss	LISN Factor	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dB	dBuV	dB	
1	1.595	42.63	42.29	0.07	0.27	0.34	56.00	-13.37	QP
2	1.595	26.00	25.66	0.07	0.27	0.34	46.00	-20.00	Average

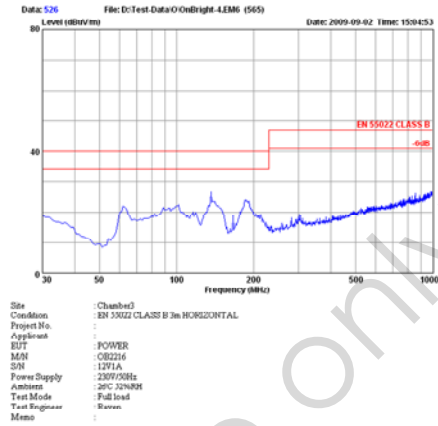
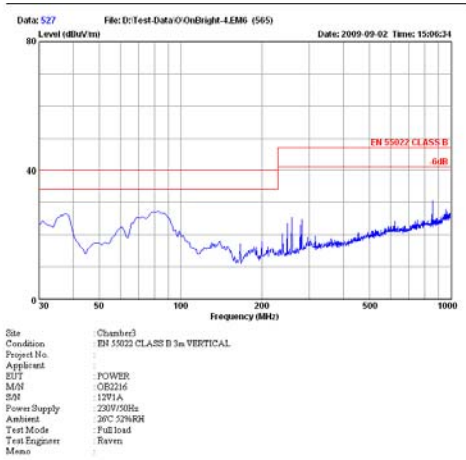


Site : Audix ACI(Conducted Emission)
 Condition : FCC 15 CLASS B (QP) ESR2-25-09.04.02(2) NEUTRAL
 Project No. :
 Applicant :
 EUT :
 M/N : OB2216
 S/N :
 Power Supply : 12V 1A
 Ambient : 120V/60Hz
 Test line : 20°C 53dB
 Test Mode : Full Load
 Test Engineer : Hugh
 Memo :

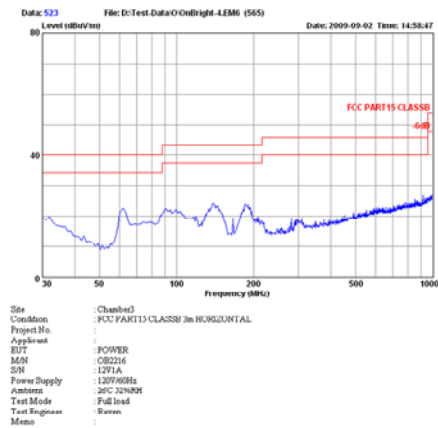
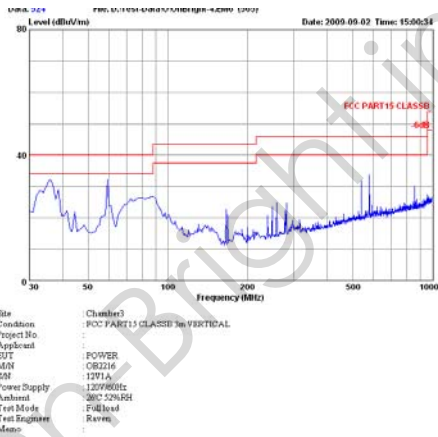
	Freq	Level	Read Level	Cable Loss	LISN Factor	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dB	dBuV	dB	
1	1.644	43.09	42.75	0.07	0.27	0.34	56.00	-12.91	QP
2	1.644	26.89	26.55	0.07	0.27	0.34	46.00	-19.11	Average
3	2.088	43.55	43.19	0.08	0.28	0.36	56.00	-12.45	QP
4	2.088	29.87	29.51	0.08	0.28	0.36	46.00	-16.13	Average
5	2.758	42.75	42.36	0.10	0.29	0.39	56.00	-13.25	QP
6	2.758	27.44	27.05	0.10	0.29	0.39	46.00	-18.56	Average

3.3.2. Radiation EMI Test

3.3.2.1. EN55022 CLASS B @ full load report



3.3.2.2. FCC CLASS B @ full load report



4. Protection

4.1. Over voltage protection

Table. 8 OVP @ no load

Input	OVP Protection
115Vac/60Hz	OK
230Vac/50Hz	OK

4.2. Short circuit protection

The system is protected during output short circuit condition and recovered when short circuit condition is removed.

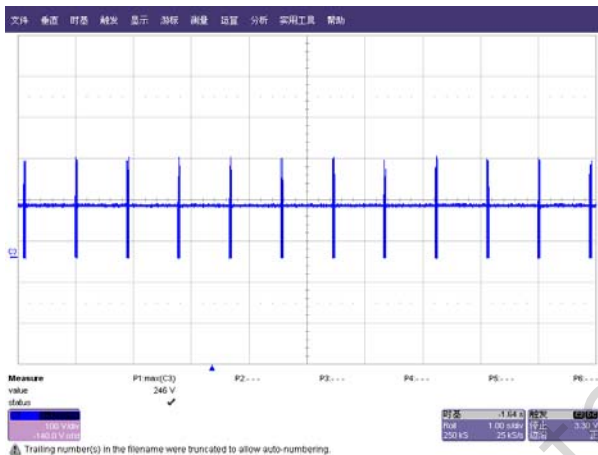


Fig. 20 Output short, Vds waveform @90 Vac/60Hz, full load

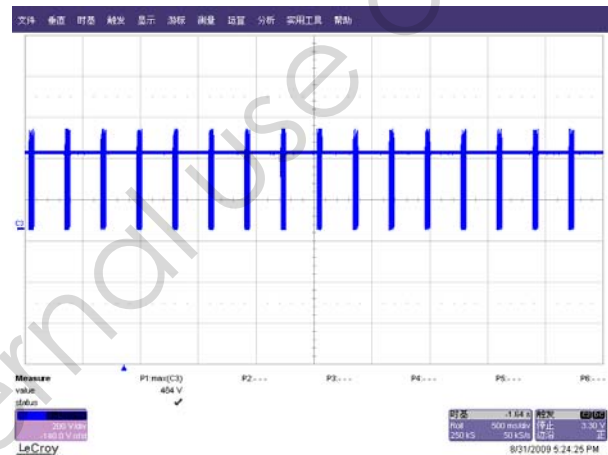


Fig. 21 Output short, Vds waveform @264 Vac/50Hz, full load

4.3. Open Loop Protection

Table. 9 OLP @ Full load

Input	OLP Protection
115Vac/60Hz	OK
230Vac/50Hz	OK

4.4 Over Current Protection

Table. 10 Over current Protection

Input	OCP Current	OCP Recovery
90Vac/60Hz	1.45	1.32
115 Vac/60Hz	1.50	1.35
230Vac/50Hz	1.58	1.44
264Vac/50Hz	1.62	1.46

5. Thermal Testing

Vin	Po(line end)	Environment	IC	Transformer (winding)
85Vac	12W	40°C	89.8°C	87.4°C

Note: All data were be measured at #22 AWG Line end

Case: $\Phi 60\text{mm} \times 25\text{mm} \times 42\text{mm}$



6. Other Important Waveform

6.1. Vdd, Sense & Vds wave form @ no load /full load

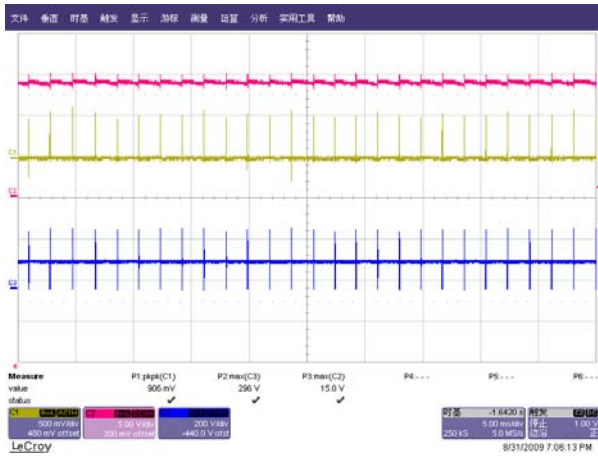


Fig. 22 Vdd, Sense & Vds waveform @90Vac/60Hz, no load

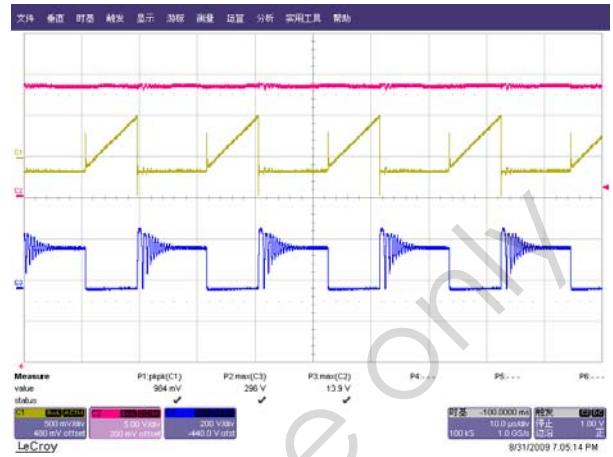


Fig. 23 Vdd, Sense & Vds waveform @90Vac/60Hz, full load

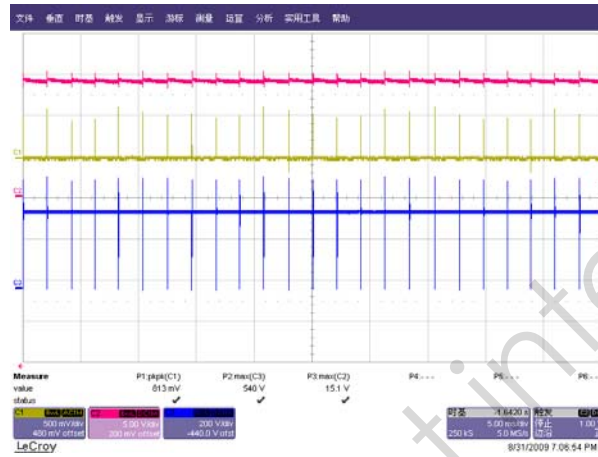


Fig. 24 Vdd, Sense & Vds waveform @264Vac/50Hz, no load



Fig. 25 Vdd, Sense & Vds waveform @264Vac/50Hz, full load

6.2. MOSFET Vds waveform @ start/normal/output short



Fig. 26 Start, Vds waveform @90 Vac/60Hz, full load

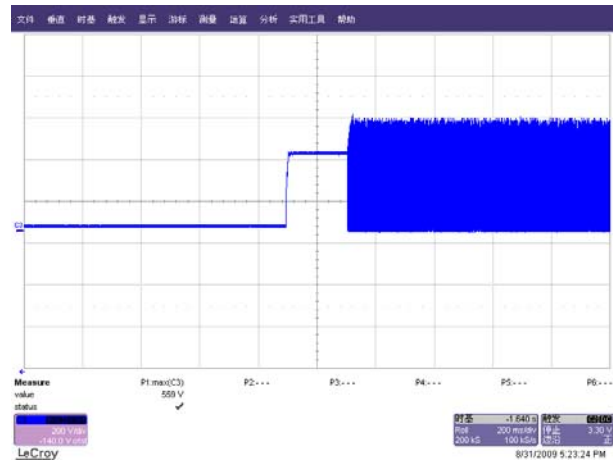


Fig. 27 Start, Vds waveform @264 Vac/50Hz, full load

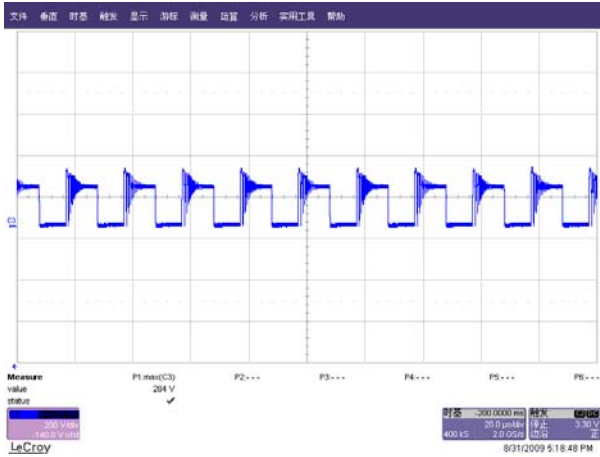


Fig. 28 Normal, Vds waveform@90 Vac/60Hz, full load

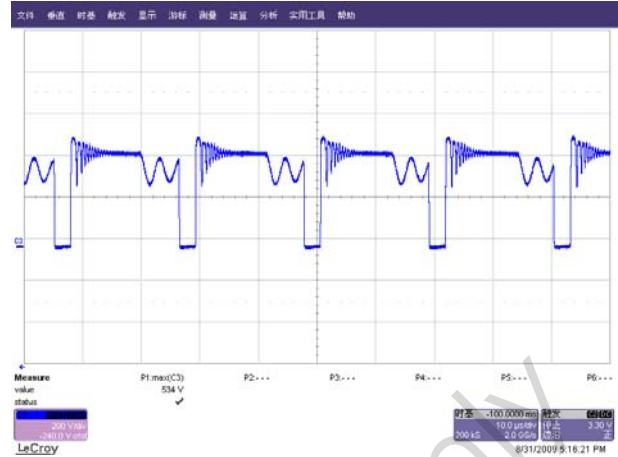


Fig. 29 Normal, Vds waveform@264 Vac/50Hz, full load

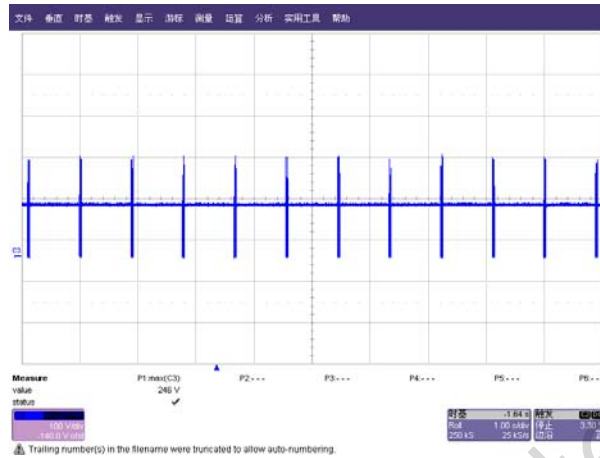


Fig. 30 Output short, Vds waveform@90 Vac/60Hz,

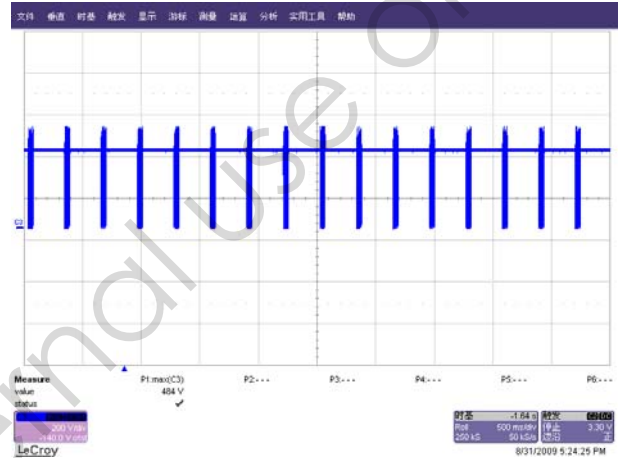


Fig. 31 Output short, Vds waveform@264 Vac/50Hz,

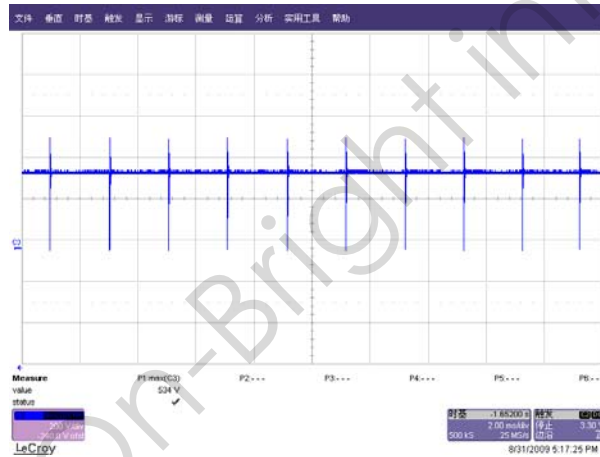


Fig. 32 Vds waveform@264 Vac/50Hz, no load

Table. 11 Vds_max @ Full load / Output short

Input	Vds_max(V)
264Vac/50Hz @No load	534
264Vac/50Hz @ Full load	534
264Vac/50Hz @ Output short	484

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