5W Charger Module Design with FT832A

Index

1 INTRODUCTION

This document presents performance characteristics of an isolated flyback charger module designed with FT832A. The module features:

- Charge display is controlled by FT832A internal.
- Simple circuit, low cost.

This document contains sessions on power supply specification, schematic/PCB Gerber/BOM, transformer design and performance data.

2 CHARGER MODULE SPECIFICATION

2.1 Input Characteristics

AC Input Voltage Rating	100Vac to 240Vac
AC Input Voltage Range	90Vac to 264Vac
AC Input Frequency	47Hz to 63Hz
Input Current	0.25A (rms) Max. @ full load, 90Vac~264Vac
Leakage Current	0.35mA Max.

Table 1

2.2 Output Characteristics

Output Voltage	+5.0V
Output Tolerance	+/-0.25V
Min. Load Current	0A
Max. Load Current	1A
Line Regulation	1%
Load Regulation	5%
Ripple & Noise	50 mV

Table 2

Note: Ripple & Noise is measured with 20MHz bandwidth limited (peak to peak value) at the end of a 12-inch twisted wire terminated with a 10uF capacitor in parallel with a 0.1uF ceramic capacitor.

2.3 Performance Specification

Total Output Power	5W Typical
Standby Power	< 0.3W @ 90Vac/63Hz~265Vac/47Hz, no load
Efficiency	73% min. @ 90Vac/60Hz with full load
Turn on Delay Time	≤3.0 sec. max. @ 100Vac/60Hz with full load
Switching Frequency	65K Hz ±3%

Table 3

2.4 Protection Features

Short Circuit Protection	Output shut down (Auto Recovery)
Over Current Protection	Output shut down (Auto Restart) when output current 1.1~1.5X

Table 4

2.5 Environmental

Operating Temperature	0℃to + 40℃
Operating Humidity	20 % to 90 % R. H.
Storage Temperature	-40℃ to 85℃
Storage Humidity	0 % to + 90 % R. H.

Table 5

2.6 Dielectric Withstand (Hi-pot) Test

Input to Output	3000Vac 1 min.

Table 6

2.7 Insulation

Input to Output	DC 500V 10M ohm min

Table 7

3 CHARGER MODULE INFORMATION

3.1 Schematic

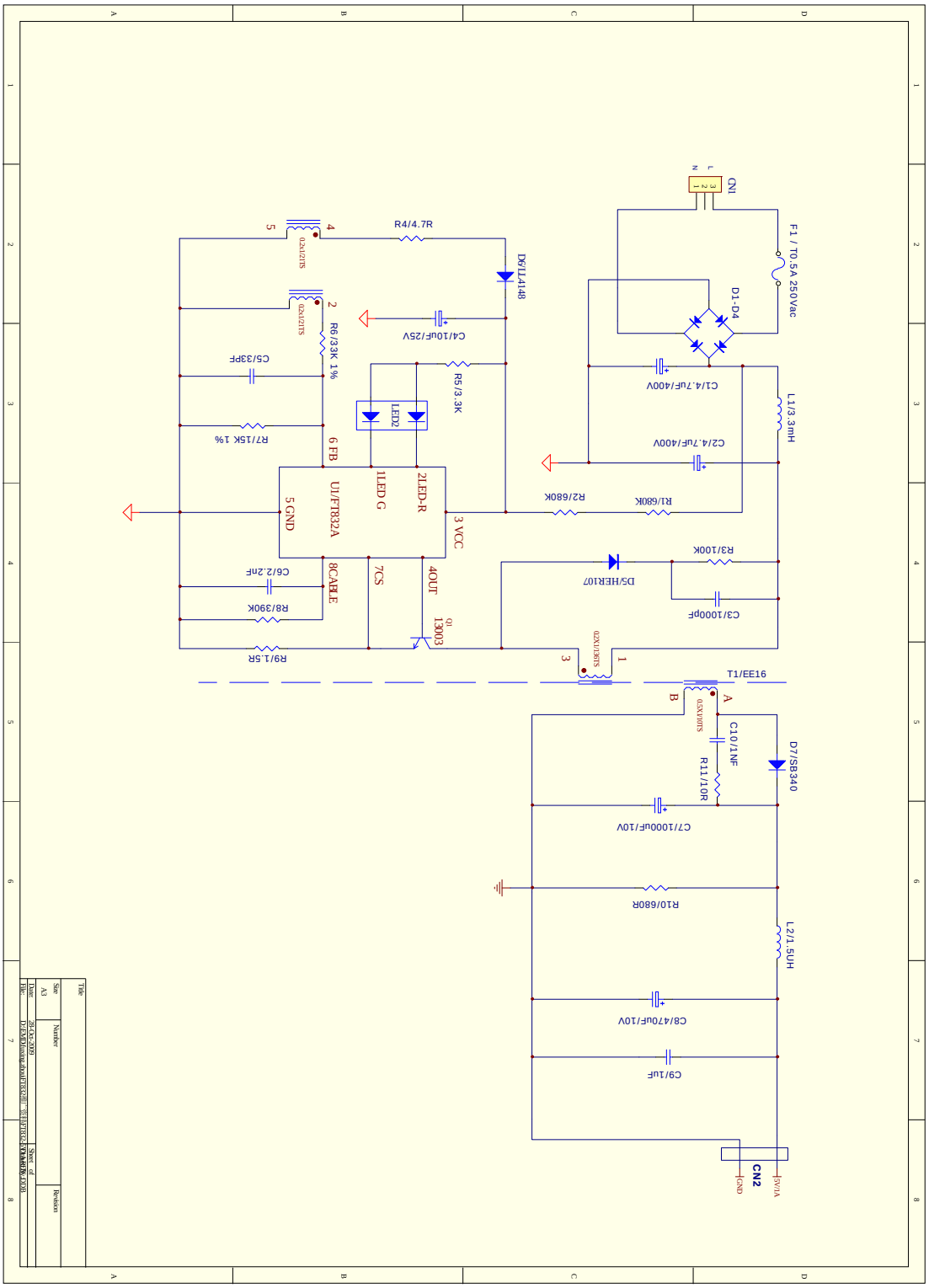

Figure 1: Schematic

3.2 PCB Gerber

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Figure 2: Top View

Figure 3: Bottom view

3.3 Bill of Materials

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Table 8

3.4 Transformer Design

1) Transformer Specification

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2) Structure/Material

Table 9

Figure 4

3.5 Charge Module Snapshot

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Figure 5

4 PERFORMANCE EVALUATION

This session presents the test results of 5W module up to date. Results on inrush current, leakage current and ESD are not included and will be added when they become available.

Overall, the module meets design specifications.

Performance Highlights:

The efficiency over 90Vac ~264Vac is ≥73%

The standby power is < 0.3W at 230Vac/50Hz with no load

OCP value over 90Vac - 264Vac is ------ of rated output current

Characterization Results Summary

Test	Specification	Test
1. Input Characteristics		
Input current (90Vac~132Vac/50Hz)	0.25A Max.	0.124A
Input current (180Vac~264Vac/50Hz)	0.1A Max.	0.067A
Standby power	<0.3W	0.22W
Efficiency（Average）	>73%	73.75%
2. Output Characteristics		
Line regulation	1%	0.8%
Load regulation	5%	4.2%
Ripple & noise	50mV	42.8mV
Over shoot & Under shoot	0.6V	0
3. Time Sequence		
Turn on delay time	<3.0S	1.94S
Hold up time		7.2ms
Rise time		15ms
Fall time		16.4ms
4. Protection		
Over current protection	1.1～1.5A	1.083 A
Short Circuit protection		Pass
5. Brownout/Brownout Recovery		

Table 10

4.1 Input Characteristics

1) Input Normal Characteristics

The module was tested at different input voltages (from 90Vac to 264Vac) and different load conditions (full load and no load). Efficiency and standby power were measured and listed in table 11 and table 12.

Input Voltage	Irms (A)	Pin(W)	Vo(V)	Io(A)	η(%)	Specification	Test Result
90V/50Hz	0.124	7.01	5.17	1.0	73.75	>73%	Pass
115V/50Hz	0.101	6.84	5.20	1.0	76.02		
230V/50Hz	0.067	6.99	5.21	1.0	74.54		
264V/50Hz	0.062	6.97	5.21	1.0	74.75		

Table 11: Input characteristics at full load

Note: 1. All data was measured at DC cord end if not otherwise noted.

2) Standby Power / AVG Efficiency

Input Voltage	Vo(V)	Input Power(W)	Specification	Test Result
90V/50Hz	5.14	0.08	<0.3W	Pass
115V/50Hz	5.17	0.09		
230V/50Hz	5.19	0.17		
264V/50Hz	5.18	0.21		

Table 12: Standby power at no load

Loading(%)	Irms (A)	Pin(W)	Vo(V)	Io(A)	η %	AVG Efficiency	Test Result
100%	0.101	6.84	5.20	1.0	76.02	74.78%	Pass
75%	0.079	5.09	5.14	0.75	75.74		
50%	0.056	3.39	5.08	0.5	74.93		
25%	0.033	1.74	5.04	0.25	72.41		

Table13: Vin: 115Vac

Loading (%)	Irms (A)	Pin(W)	Vo(V)	Io(A)	η %	AVG Efficiency	Test Result
100%	0.067	6.99	5.21	0.995	74.54	73.21%	Pass
75%	0.053	5.22	5.18	0.75	74.43		
50%	0.038	3.47	5.09	0.5	73.34		
25%	0.021	1.79	5.05	0.25	70.53		

Table14: Vin: 230Vac

4.2 Output Characteristics

1) Line Regulation & Load Regulation

Input Voltage	No Load	Half Load	Full Load	Specification	Test Result
90Vac/50Hz	5.14	5.07	5.17	4.75~5.25	pass
115Vac/50Hz	5.17	5.08	5.20	4.75~5.25	
230Vac/50Hz	5.19	5.11	5.21	4.75~5.25	
264Vac/50Hz	5.18	5.11	5.21	4.75~5.25	
Line Regulation	0.8%			<1%	Pass
Load	4.2%			<5%	Pass

Table15: Regulation

Note: All data is measured at DC cord end

2) Ripple & Noise

Ripple& Noise Input voltage	No Load	Full Load	Spec.	Test Result	Remark
90Vac/50Hz	35mV	42.8mV	50mV	Pass	Figure 6
264Vac/50Hz	30mV	36.8mV		Pass	Figure 7

Table16: ripple & noise

Note: Ripple& noise was measured at DC cord end(1.2M/18AWG) with a 0.1uF/100v ceramic cap connected in parallel with a 10uF/50V Electrolytic cap. Bandwidth was limited to 20MHz.

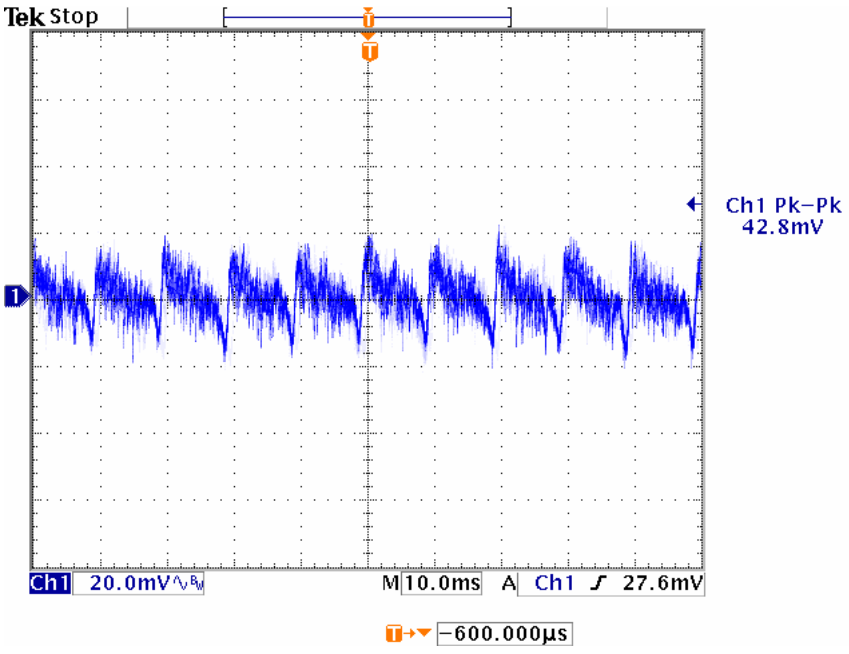


Figure 6: Measured ripple& noise waveform@90Vac/50Hz,Full load.

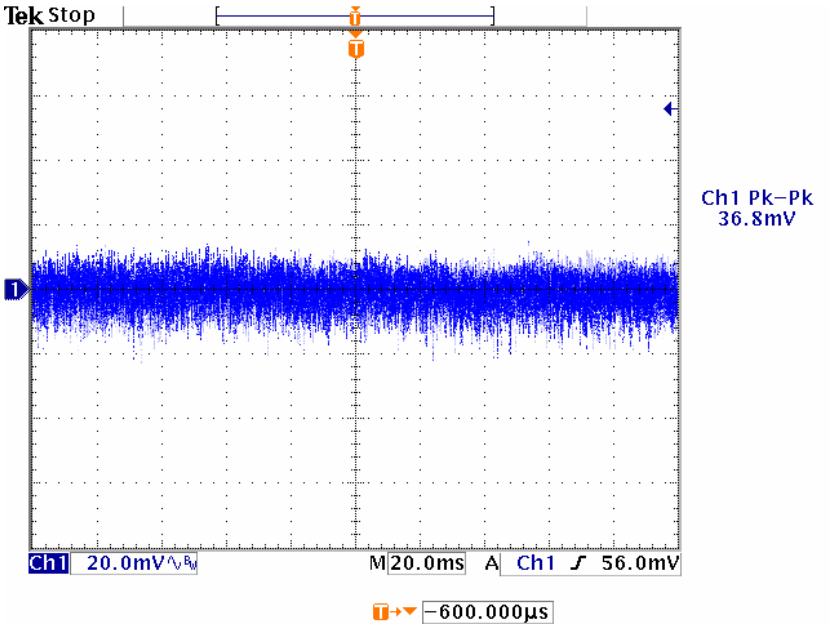


Figure 7: Measured ripple& noise waveform@264Vac/50Hz, full load

3) Over Shoot &Under Shoot

Over shoot/under shoot were measured under below conditions.

1. AC input switches ON for over shoot and OFF for under shoot.
2. Input voltage ranges from 90Vac/50Hz~264Vac/50Hz.

Input	Load		Meas. Data	Spec.	Test Result	Remark
90V/50Hz	Full load	over shoot	0	600mV	Pass	
		under shoot	0		Pass	
	No load	over shoot	0		Pass	
		under shoot	0		Pass	
264V/50Hz	Full load	over shoot	0		Pass	Figure 8
		under shoot	0		Pass	
	No load	over shoot	0		Pass	
		under shoot	0		Pass	

Table 17: Over shoot/under shoot measurement results

Note: All data is from measurement taken at PCB end.

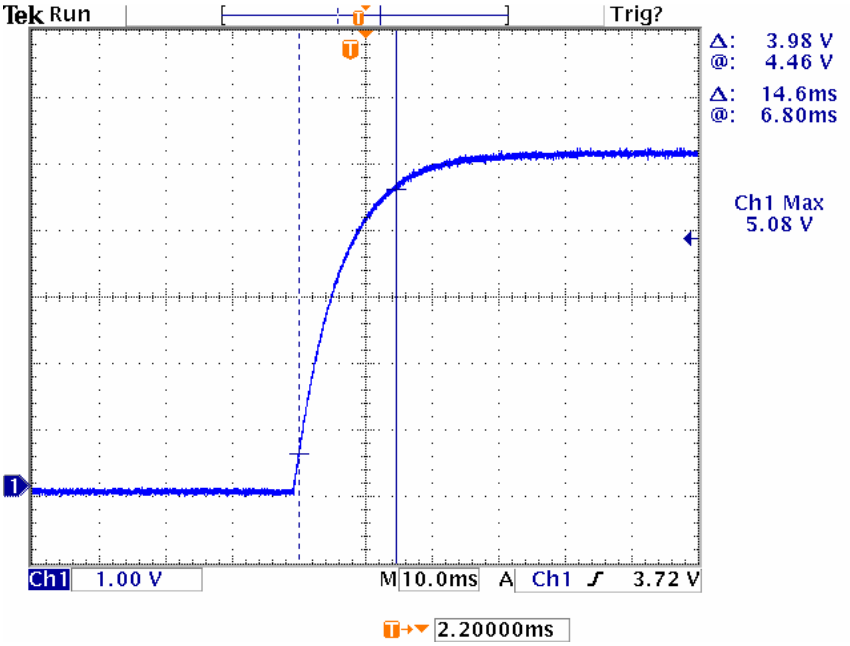


Figure 8: Measured overshoot waveform@264Vac/50Hz, full load

4) Time Sequence

Time sequence parameters were measured with DSO.

Item	Input Voltage	Meas. Data	Test spec.	Test Result	Remark
Turn-on delay time	90V/50Hz	1.94 S	<3.0S	Pass	Figure 9
	264V/50Hz	0.482S		Pass	
Hold-up time	90V/50Hz	7.2mS			Figure 10
	264V/50Hz	N.A.			
Rise Time	90V/50Hz	15ms		Pass	Figure 11
	264V/50Hz	N.A.			
Fall Time	90V/50Hz	16.4mS		Pass	Figure 12
	264V/50Hz	N.A.			

Table 18: turn-on delay /hold-up/Rise/Fall time measurement results

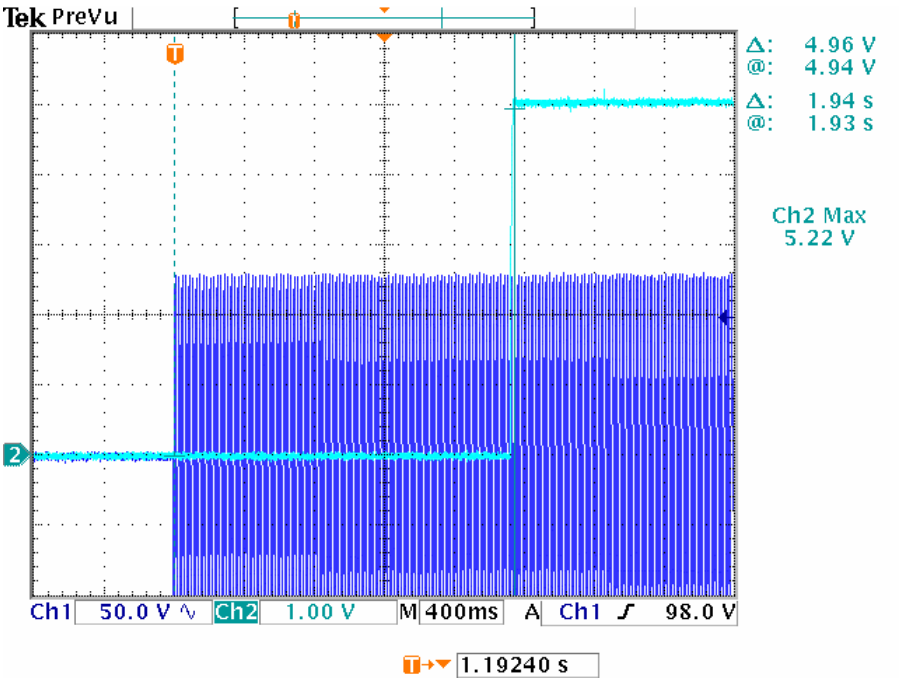


Figure 9: Turn on delay time measured waveform@90Vac/50Hz,full load

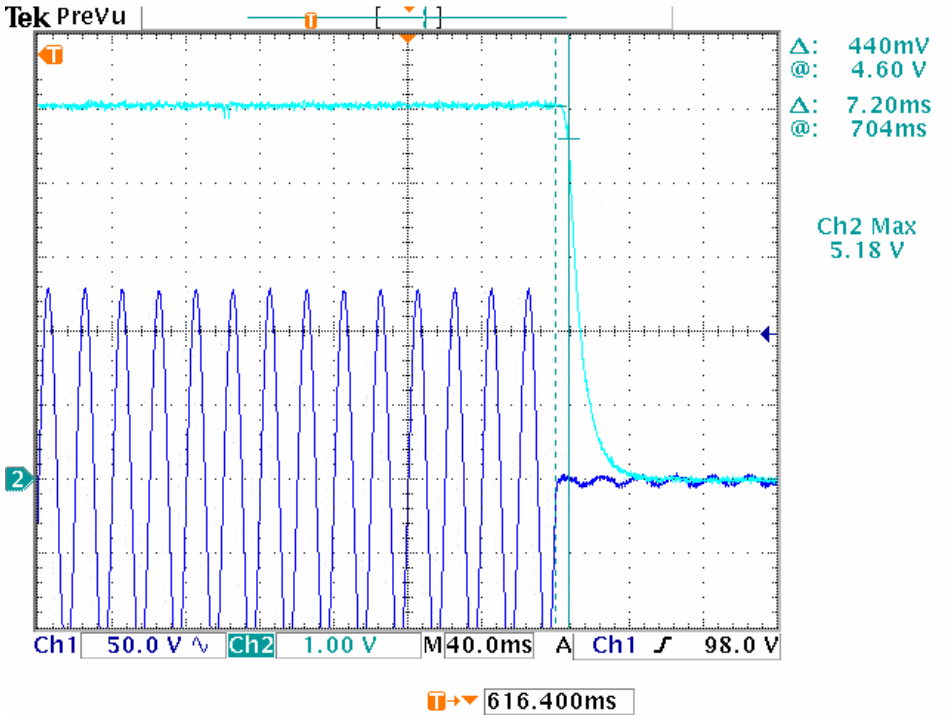


Figure 10: Hold on delay time measured waveform@90Vac/50Hz,full load

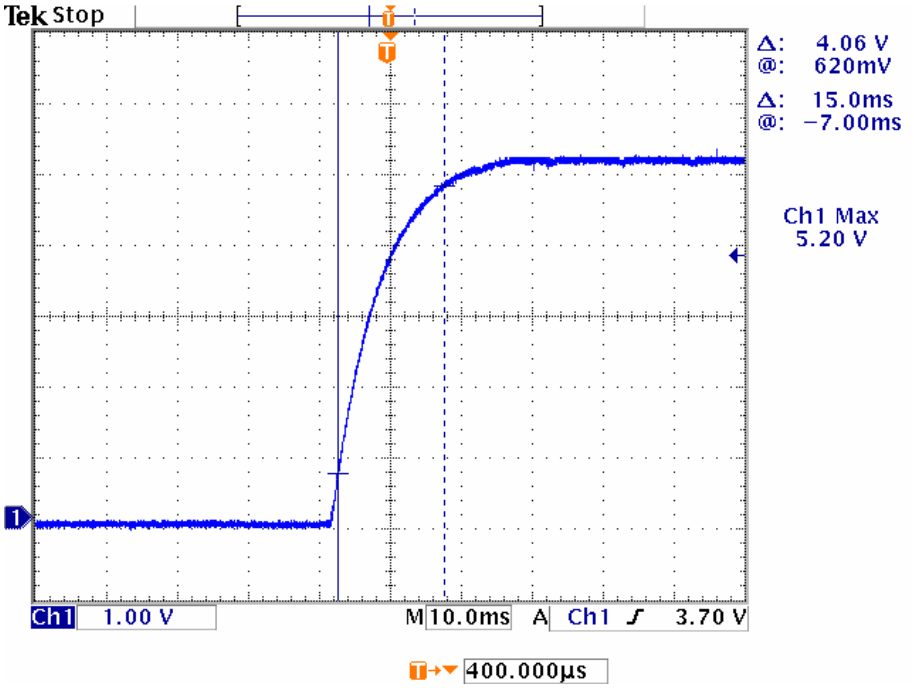


Figure 11: Rise time measured waveform@90Vac/50Hz,full load

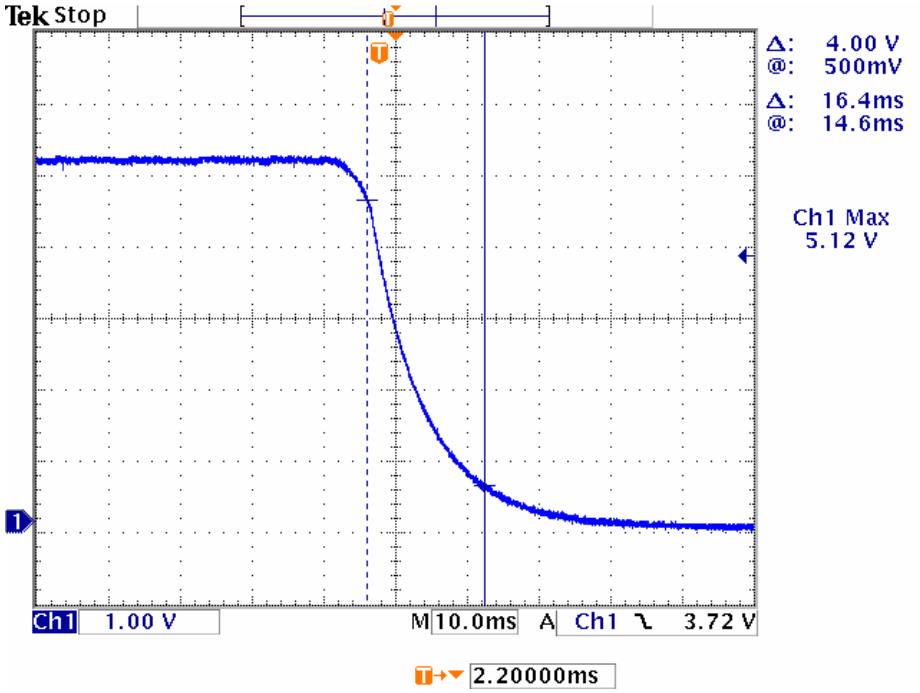


Figure 12: Fall time measured waveform@90Vac/50Hz,full load

4.3 Protection

1) Over Current Protection (OCP)

The OCP was tested at 90Vac/50Hz and 264Vac/50Hz input voltage. The results are listed in Table19.

Input Voltage	OCP	Remark
90Vac/50Hz	1.083 A	
115Vac/50Hz	N.A.	
230Vac/50Hz	N.A.	
264Vac/50Hz	1.062 A	

Table 19: OCP value vs. input voltage

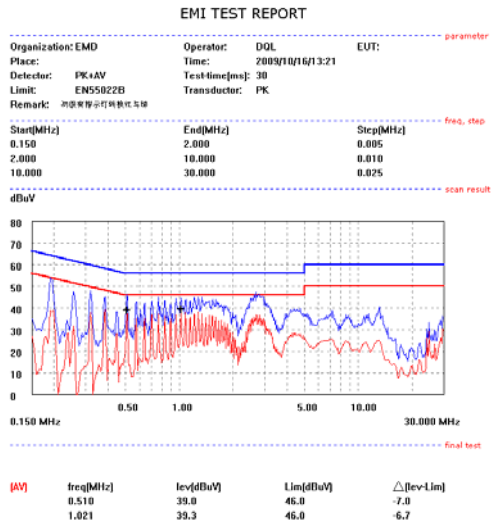
2) Short Circuit Protection

The system is protected during output short circuit condition and recovered when short circuit condition is removed. The module passed SCP test.

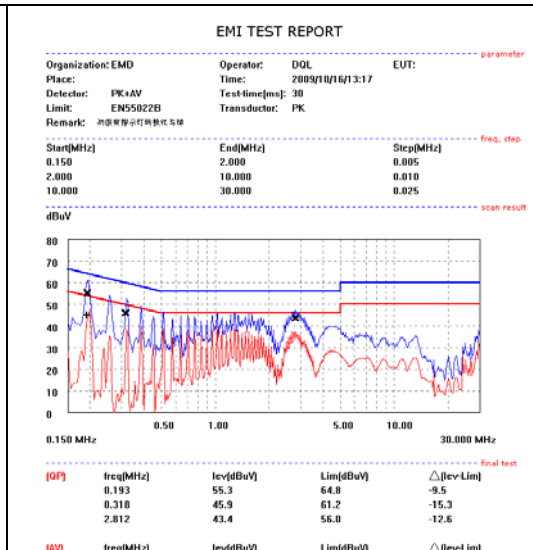
4.4 EMI Test

The Power supply passed EN55022 Class B EMI requirement with more than 5dB margin.

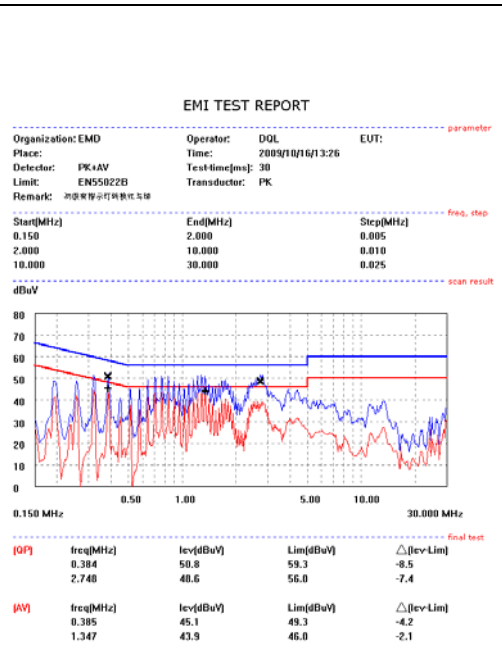
Conducted EMI Test Result



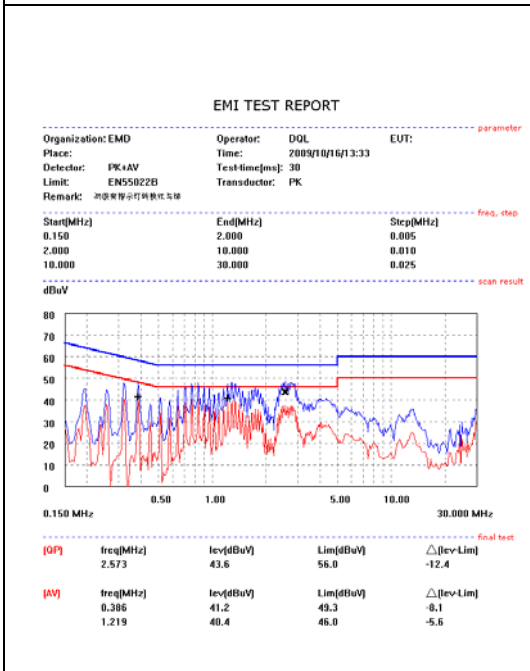
Vin=120Vac,Full load Floated L



Vin=120Vac,Full load Floated N



Vin=230Vac,Full load Floated L

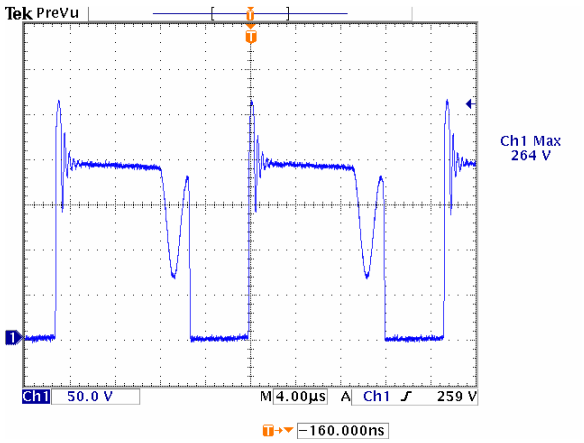


Vin=230Vac,Full load Floated N

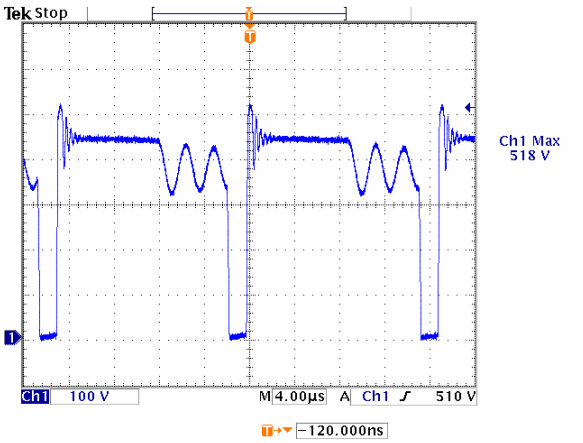
Figure 13

5 SYSTEM OTHER IMPORTANT WAVEFORM

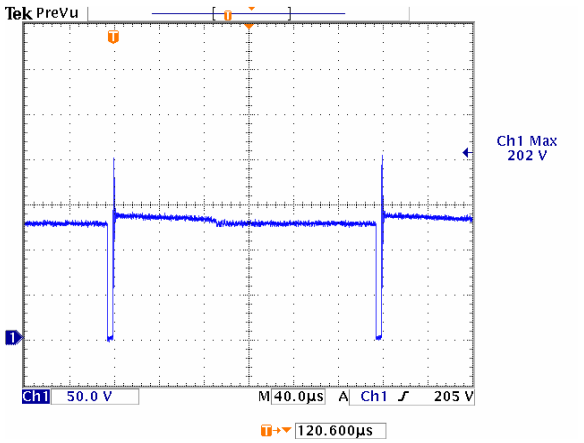
5.1 MOSFET VDS Wave form at 90Vac/264Vac, Normal/Output Short



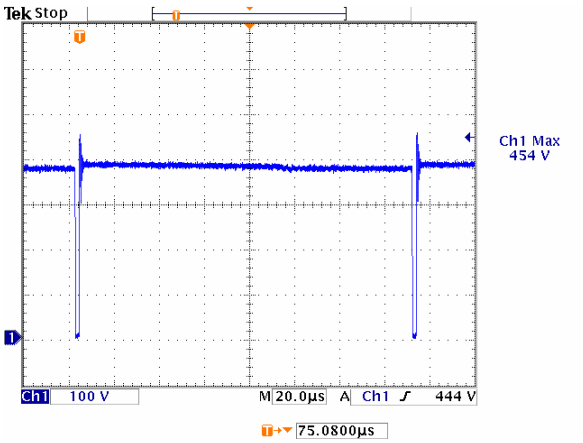
Normal, Vds wave form@90Vac/50Hz, full load



Normal, Vds wave form@264 Vac/50Hz,full load

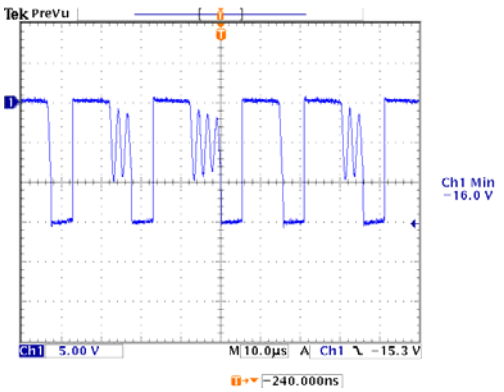


Startup with Output short, Vds wave form@90Vac/50Hz,

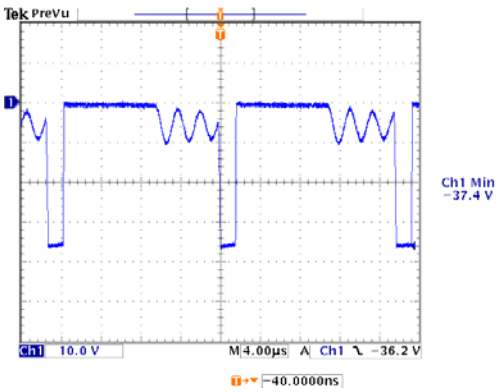


Output short, Vds wave form@264 Vac/50Hz,

5.2 Output Rectifier Diode VAK Waveform at Full Load



V_{AK} wave form@90Vac/50Hz,full load



V_{AK} wave form@264Vac/50Hz,full load