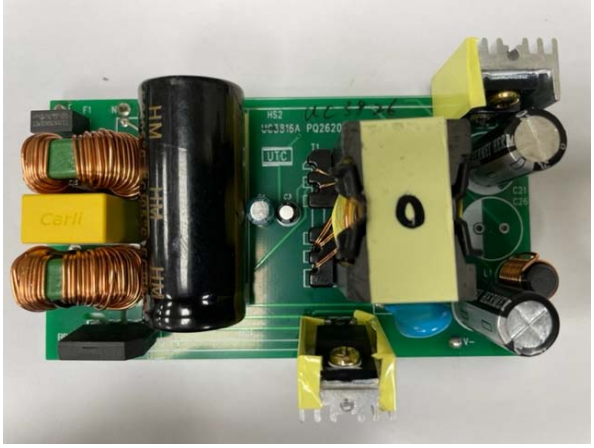
UNISONIC TECHNOLOGIES CO., LTD

60W Openframe Module Using UC3826

UC3826 60W /12V_ 5A Demo Board Manual



Key features:

- AC Input Full Range 90Vac~264Vac
- DC Output 12Vdc 5A
- Average Efficiency
  >88.0% (meet DOE Level VI)
- No load Power
  <100mW @230Vac
- OCP/OVP/OLP/SCP Protection

Revision History

Revise Date	Version	Reason/Issue
2021/10/12	A	R247

Contents Index

1. Openframe Module Specification

1.1. Input Characteristics

● AC input voltage rating	100Vac ~ 240Vac
● AC input voltage range(MAX.)	90Vac ~ 264Vac
● AC input frequency range	47Hz ~ 63Hz
● Input current	2A (rms)max. @ 90Vac/60Hz

1.2. Output Characteristics

● Output Voltage	12V
● Output Tolerance	< ±5%
● Min. load current	0A
● Max. load current	5A

1.3. Performance Specifications

● Maximum Output Power	60W
● Standby Power	<100mW @230Vac
● Average Efficiency	>88.0% (meet DOE Level VI)
● Line Regulation	<0.01%
● Ripple & Noise	< 1%

1.4. Protection Function

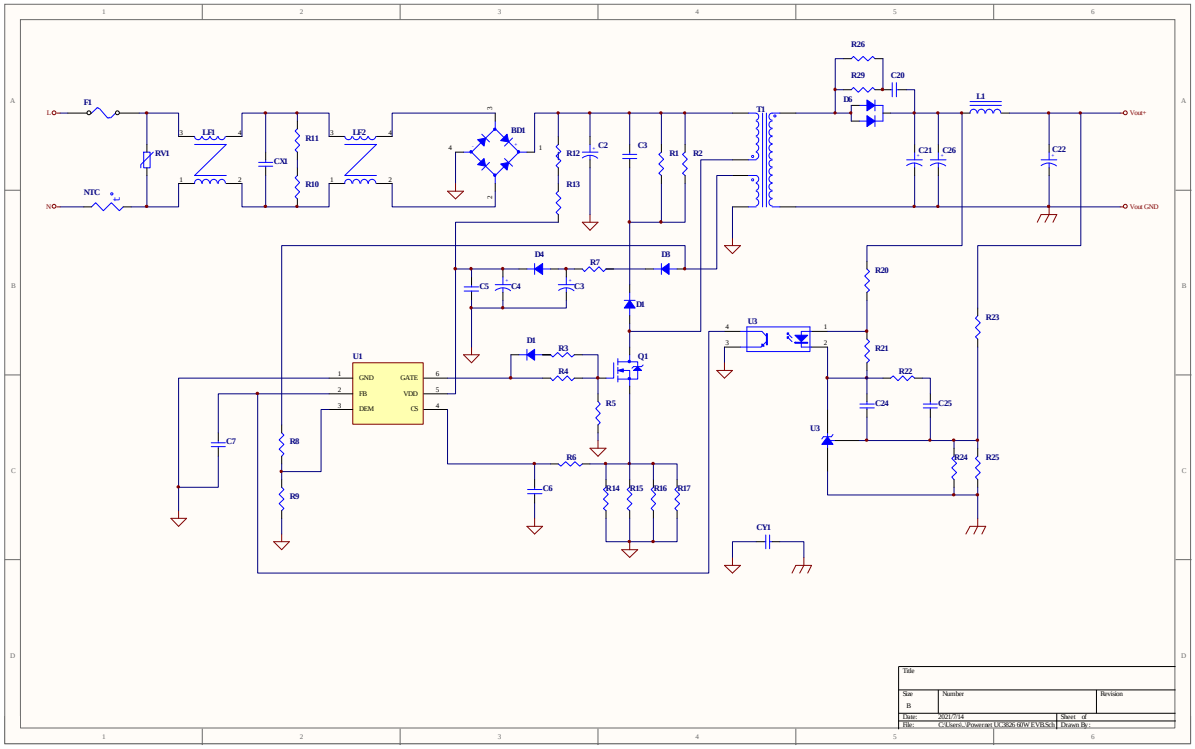
● Short Circuit Protection	Shut down and auto recovery
● Over Voltage Protection	Shut down and auto recovery
● Over Load Protection	Shut down and auto recovery

1.5. Environment

● Operation Temperature	0℃ to 40 ℃
● Operation Humidity	20% to 90% R.H
● Storage Temperature	-40℃ to 60 ℃
● Storage Humidity	0% to 90% R.H

2. Open Frame Module Information

2.1. Schematic

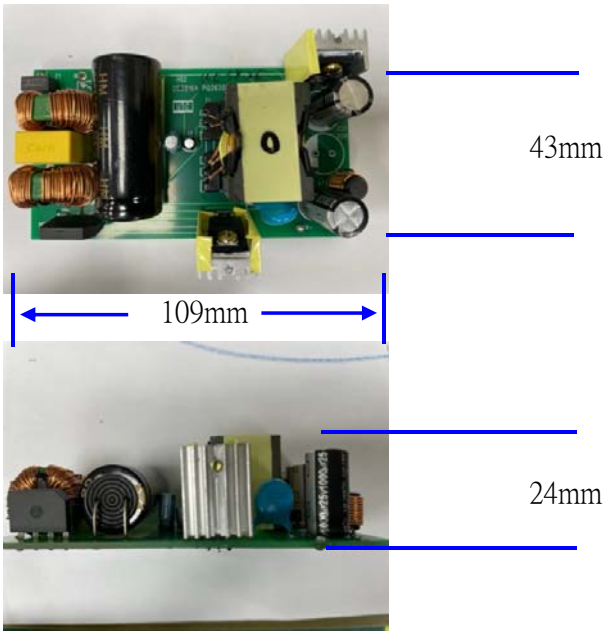


2.2. BOM

1	BD1	BRIDGE-RECT(橋式二極體) | GBP408 4A 800V	1
2	C1	Capacitor, aluminum electrolytic,120uF/450V, 105℃	1
3	C2	Capacitor, ceramic, 680pF/1KV, NPO, SMD 1206	1
4	C3	Capacitor, aluminum electrolytic,4.7uF/50V; 105℃,HER-MEI LH Series	1
5	C4	Capacitor, aluminum electrolytic,2.2uF/50V; 105℃,HER-MEI LH Series	1
6	C5	Capacitor, ceramic, 0.1uF/50V, X7R, SMD 0805	1
7	C6	Capacitor, ceramic, 100pF/50V, X7R, SMD 0805	1
8	C7	Capacitor, ceramic, 1nF/50V, X7R, SMD 0805	1
9	C20	Capacitor, ceramic, 1nF/1KV, NPO, SMD 1206	1
10	C21,C22	Capacitor, aluminum electrolytic, 1000uF/25V, 105℃ HER-MEI LS Series	2
11	C23	Capacitor, ceramic, 0.1uF/50V, X7R, SMD 0805	1
12	C24	Capacitor, ceramic, 47n/50V, X7R, SMD 0805	1
13	C25	Capacitor, ceramic, 10n/50V, X7R, SMD 0805	1
14	CX1	Capacitor, X2, 0.33uF/275VAC, 105℃ ,±20%	1
15	CY1	Capacitor, Y1, 1000pF/400V, 105℃,±20%	1
16	D1	HIGH-SPEED SWITCHING DIODE, UTC 1N4148, SOD-123	1
17	D2,D3,D4	Standard Recovery Diode RS1M 1A/1000V SMA	3
18	F1	Fuse, 3.15A / 250V MST 方型	1
19	LF1	L=24mH	1
20	LF2	L=24mH	1

21	L1	L=2uH	1
22	R1	Resistor, chip,750K, ±5%, SMD 1206	1
23	R2	Resistor, chip,750K, ±5%, SMD 1206	1
24	R3	Resistor, chip, 4.7R, ±5%, SMD 0805	1
25	R4	Resistor, chip,10R, ±5%, SMD 0805	1
26	R6	Resistor, chip,464R, ±5%, SMD 1206	1
27	R7	Resistor, chip,0R, ±5%, SMD 0805	1
28	R8	Resistor, chip,470K, ±5%, SMD 0805	1
29	R9	Resistor, chip,72K, ±5%, SMD 0805	1
30	R12,R13	Resistor, chip,2.2M, ±5%, SMD 1206	2
31	R14,R15,R16,R1	Resistor, chip, 1R, ±5%, SMD 1206	4
33	R20	Resistor, chip, 470R, ±5%, SMD 0805	1
34	R21,R22	Resistor, chip, 1K, ±5%, SMD 0805	2
35	R23	Resistor, chip,39K, ±1%, SMD 0805	1
36	R24	Resistor, chip,10K, ±1%, SMD 0805	1
37	R26	Resistor, chip,51R, ±5%, SMD 1206	1
38	U3	IC, Opto-Coupler, UPC817, SMD	1
39	T1	Transformer, PQ-2625 Lp=460uH 34:5:7Ts	1
40	U1	LOW COST POWER-SAVING MODE PWM CONTROLLER FOR FLYBACK CONVERTERS, UTC UC3862G, SC59-6	1
41	U2	PROGRAMMABLE PRECISION REFERENCE, UTC TL431, SOT-23	1
42	D6	DUAL TRENCH MOS SCHOTTKY BARRIER RECTIFIER, UTC TGBR40U100CG, 40A/100V, TO-220F	1
43	Q1	10A, 650V N-CHANNEL POWER MOSFET, UTC 10N65-TC, TO-220F1	1
		: **The Yellow color block means the parts that UTC can provide.**	

2.3. Open frame Module Snapshot



2.4. Transformer Design

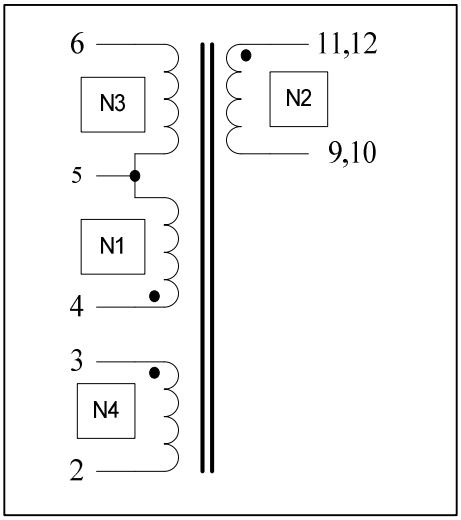
2.4.1. Transformer Specification

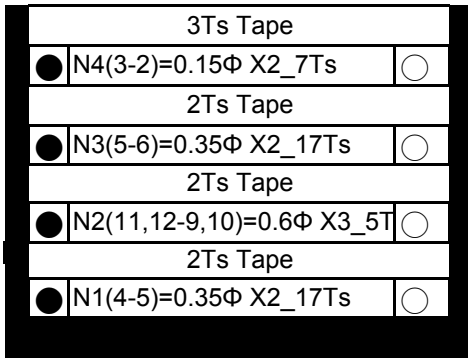
1) Bobbin：PQ2625

2) Core material：PC40 (TDK) or equivalent.

3) Lm：460uH,±10% (65KHz)

2.4.2. Transformer Diagram





Bottom

Transformer Winding Data

Layer No.	Winding	Material	Start	Turns	Finish
1	N1	0.4ΦX1 2 UEW	4	17	5
2	Tape	Tape		2	
3	N2	Triple Insulated Wire 0.6ΦX2	11,12	5	9,10
4	Tape	Tape		2	
5	N3	Triple Insulated Wire 0.4ΦX1	5	17	6
6	Tape	Tape		2	
7	N4	0.21ΦX2 2UEW	3	7	2 中間密繞
8	Tape	Tape		3	

3. Performance Evaluation

This document presented here is to describe the open frame Module performance.

The Summarized Result :

Item	Test result
1. Input Characteristics	
Input Current (90V/60Hz, full load)	1431 mA
Standby Power at No Load	<100mW (meet DOE Level VI)
Averaged Efficiency (@115/230Vac, 25%~100% Load ,On PCB End)	90.23% Meet DOE Level VI >88.0% @115VAC 91.24% Meet DOE Level VI >88.0% @230VAC
2. Output characteristics	
Output Tolerance	<5%
Line Regulation	≒0%
Ripple & Noise	<1%
Overshoot	≦3%
Ripple of DynamicTest	<1%

3. Protection	
Short Circuit Protection	Shut Down and Auto Recovery
Over Voltage Protection	Shut Down and Auto Recovery
Over Load Protection	Shut Down and Auto Recovery

Test Equipment:

Item	Vendor	Model No:
1.AC Source	Chroma	61602
2.Digital Power meter	Chroma	66202
3.Electronic Load	Chroma	63102
4.Digital Oscilloscope	Tektronics	DPO3014
5.Multi-meter	Keithley	2000
6.Thermal meter	Opex	PT-3S

3.1. Input Characteristics

3.1.1 Full Load Efficiency :

Table 1 Full Load Efficiency :

Input	Irms(mA)	Pin(W)	Vo(V)	Io(A)	Eff(%)
90Vac/60Hz	1431	69.48	12.12	5	87.22
115Vac/60Hz	1266	68.37	12.12		88.64
230Vac/50Hz	710	66.83	12.14		90.83
264Vac/50Hz	636	66.85	12.14		90.80

3.1.2 Efficiency:

B.Vo : PCB side measured 12V output. B.Eff :PCB side measured Efficiency.

*Table 3 Efficiency(**Test On PCB END**) :*

Input Voltage	10%(0.5A)					
	Pi(W)	B.Vo(V)	B.Eff(%)			
115Vac/60Hz	6.64	12.19	91.79			
230Vac/50Hz	6.71	12.19	90.83			
Input Voltage	25%(1.25A)			50%(2.5A)		
	Pi(W)	B.Vo(V)	B.Eff(%)	Pi(W)	B.Vo(V)	B.Eff(%)
115Vac/60Hz	16.63	12.18	91.55	33.42	12.16	90.96
230Vac/50Hz	16.66	12.18	91.39	33.28	12.17	91.42
Input Voltage	75%(3.75A)			100%(5.0A)		
	Pi(W)	B.Vo(V)	B.Eff(%)	Pi(W)	B.Vo(V)	B.Eff(%)
115Vac/60Hz	50.71	12.14	89.78	68.37	12.12	88.64
230Vac/50Hz	49.89	12.15	91.33	66.83	12.14	90.83

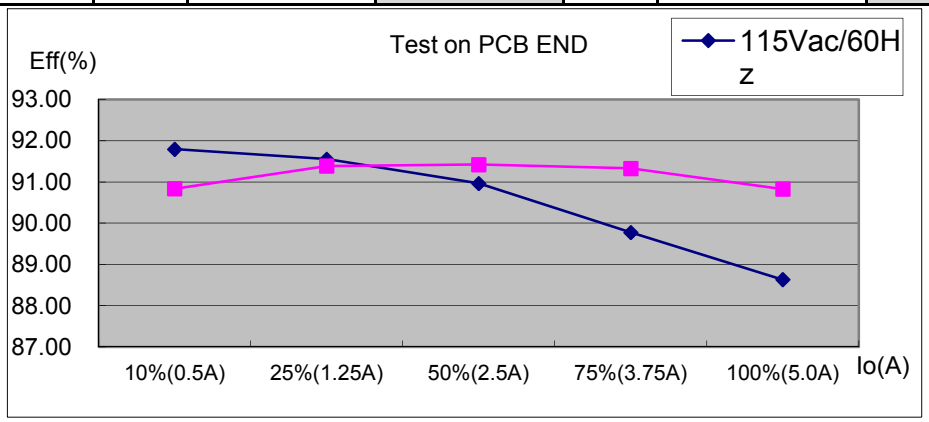


Fig.1 Efficiency VS Load

Table 4 Average Efficiency (PCB End) :

Input Voltage	Average	Remark	Result
	B.Aver. Eff.(%)		
115Vac/60Hz	90.23	DOE Level VI >	**PASS**
230Vac/50Hz	91.24	88.00%	

3.1.3 Standby power

3.1.3.1

Table 5 Standby PowerTest Data

Input Voltage	Stand by power			
	Pin(mW)	Vo(V)	Remark	Result
90Vac/60Hz	26	12.19	DOE Level VI <100mW	—
115Vac/60Hz	28	12.19		
230Vac/50Hz	55	12.19		
264Vac/50Hz	64	12.19		

Input Voltage	Light Load		
	Pin(mW)	Io(mA)	Remark
90Vac/60Hz	154	10	For Reference
90Vac/60Hz	290	20	
90Vac/60Hz	428	30	
90Vac/60Hz	563	40	
90Vac/60Hz	699	50	
115Vac/60Hz	152	10	
115Vac/60Hz	287	20	
115Vac/60Hz	425	30	
115Vac/60Hz	560	40	
115Vac/60Hz	697	50	
230Vac/50Hz	178	10	
230Vac/50Hz	313	20	
230Vac/50Hz	450	30	
230Vac/50Hz	588	40	
230Vac/50Hz	724	50	
264Vac/50Hz	193	10	
264Vac/50Hz	328	20	
264Vac/50Hz	464	30	
264Vac/50Hz	602	40	
264Vac/50Hz	740	50	

3.2 Output Characteristics

3.2.1 Line Regulation & Load Regulation

Table 6 Line Regulation & Load Regulation

Input Voltage	Load			Load Regulation%	Remark	Result
	No Load (V)	Half Load	Full Load			
90Vac/60Hz	12.19	12.17	12.12	0.58		**PASS**
115Vac/60Hz	12.19	12.17	12.12	0.58		
Line Regulation%	0%	0.00%	0.00%			
Input Voltage	Load			Load Regulation%	Remark	Result
	No Load (V)	Half Load	Full Load			
230Vac/50Hz	12.19	12.17	12.14	0.41		**PASS**
264Vac/50Hz	12.19	12.17	12.14	0.41		
Line Regulation%	0%	0.00%	0.00%			

3.2.2 Ripple & Noise

Table 8 Ripple & Noise

Input Voltage	Ripple & Noise(mV)				Remark	Result
	No. Load		Full Load			
90Vac/60Hz	26.80	Fig 4	68.40	Fig 5		**PASS**
115Vac/60Hz	31.20	—	60.40	—		**PASS**
230Vac/50Hz	51.60	—	62.80	—		**PASS**
264Vac/50Hz	59.60	Fig 6	62.40	Fig 7		**PASS**

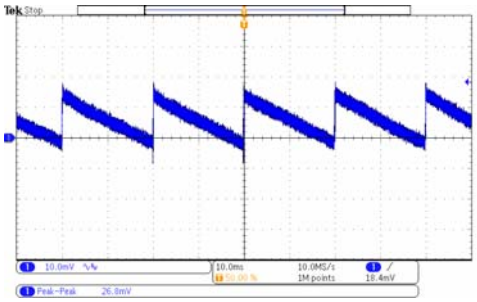


Fig.4 90Vac/60Hz@ No Load

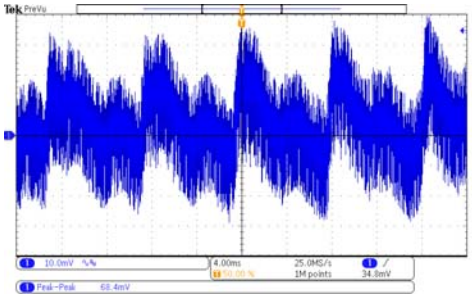


Fig.5 90Vac/60Hz@Full Load

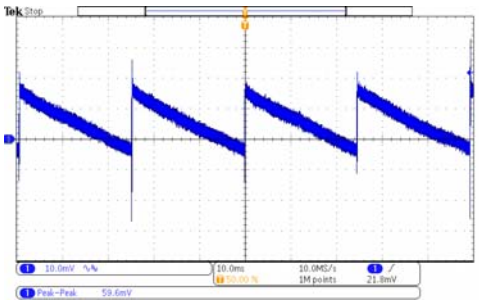


Fig.6 264Vac/50Hz@ No Load

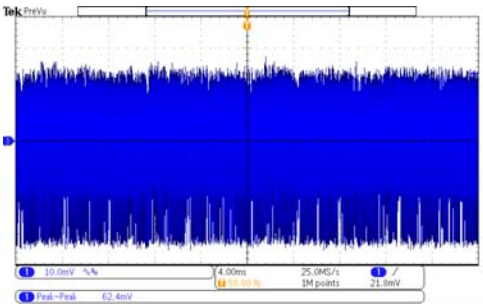


Fig.7 264Vac/50Hz@Full Load

3.2.3 Overshoot

AC Power switch ON for overshoot, and switch OFF for undershoot.

Table 9 Overshoot

Input Voltage	Load Condition	Over shoot / Under shoot	Data (%)	Remark
90Vac/60Hz	Full Load	Overshoot	5.298	Fig.9
		Undershoot	5.96	Fig. 11
	No Load	Overshoot	1.316	Fig. 8
		Undershoot	—	—
264Vac/50Hz	Full Load	OverShoot	1.987	Fig.10
		Undershoot	1.987	Fig.12

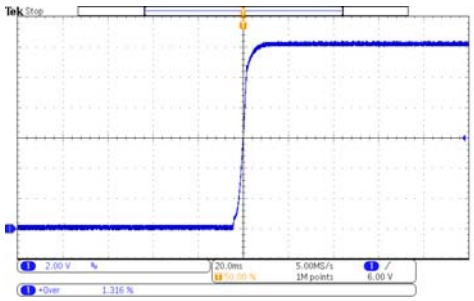


Fig.8 90Vac / 60Hz, Overshoot @ No Load

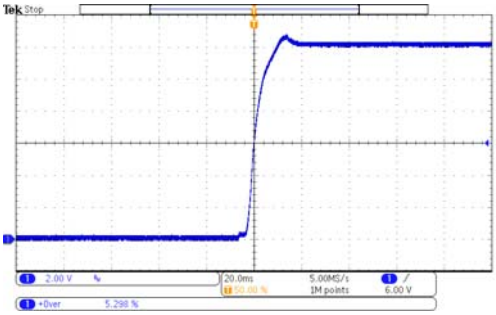


Fig.9 90Vac / 60Hz, Overshoot @ Full Load

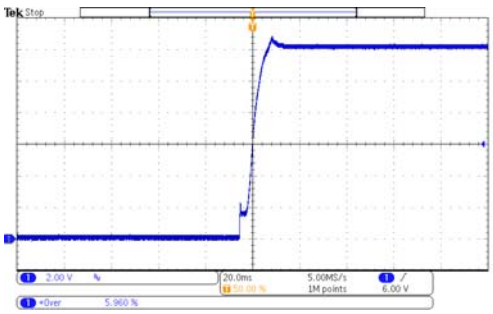


Fig.10 264Vac / 60Hz, Overshoot @ Full Load

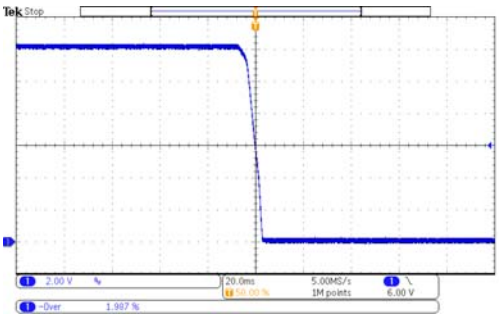


Fig.11 90Vac/60Hz,Under shoot @ Full Load

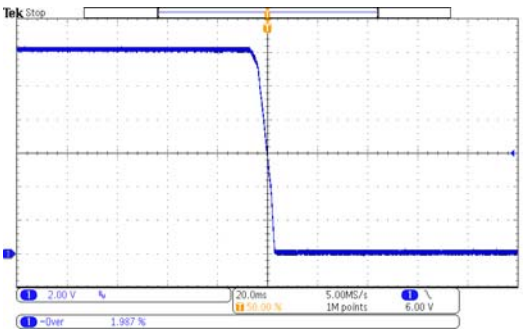


Fig.12 264Vac/60Hz, Undershoot @ Full Load

3.2.4 Dynamic Test

The High Level ;Low level switching time is set to 50ms each.

Table 10 Dynamic Test

Input Voltage	Output (V)	Io(A):Low-High	Remark
90Vac/60Hz	11.5~12.7	0.0↔2.5	Fig.13
90Vac/60Hz	11.5~12.9	2.5↔5.0	Fig.14
264Vac/50Hz	11.5~12.9	0.0↔2.5	Fig.15
264Vac/50Hz	11.3~12.9	2.5↔5.0	Fig.16

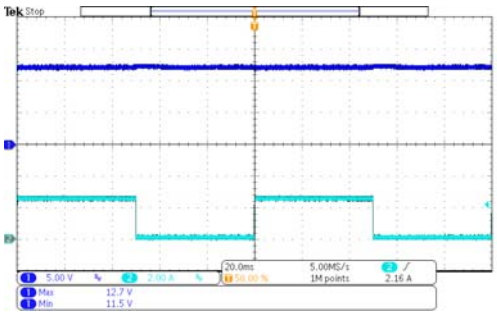


Fig. 13 90Vac / 60Hz Dynamic Test

CH2 Current Probe Waveform (0A-2.5A)

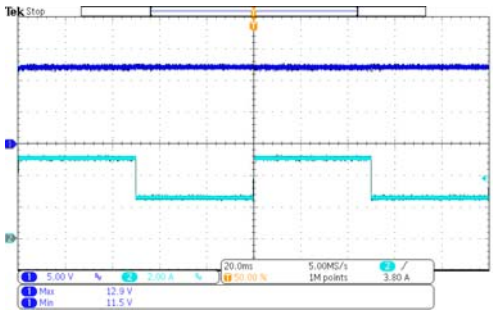


Fig. 14 90Vac / 60Hz Dynamic Test

CH2 Current Probe Waveform(2.5A-5A)

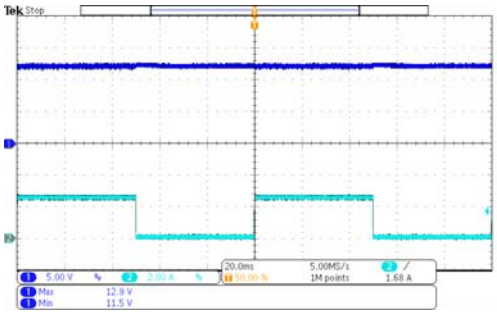


Fig. 15 264Vac / 50Hz Dynamic Test

CH2 Current Probe Waveform(0A-2.5A)

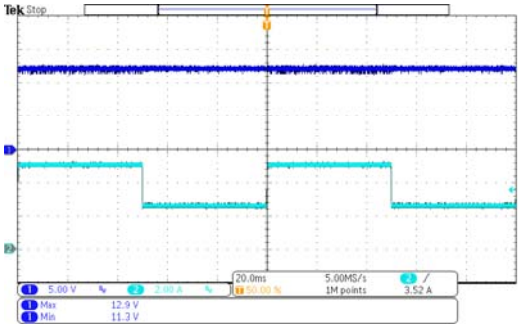


Fig. 16 264Vac / 50Hz Dynamic Test

CH2 Current Probe Waveform(2.5A-5A)

3.2.5 Time Sequence

Table 11 Time Sequence (Test at full load)

Item	Input Voltage	Meas. Data	Remark	Result
Turn on Delay Time	100Vac/60Hz	328ms	Fig. 15	**Ref**
	180Vac/60Hz	17ms	Fig. 16	**Ref**
Hold-UpTime	100Vac/60Hz	8ms	Fig. 17	**Ref**
	240Vac/50Hz	50.2ms	Fig. 18	**Ref**
Rise Time	100Vac/60Hz	7.08ms	Fig. 19	**Ref**
	240Vac/50Hz	6.191ms	Fig. 20	**Ref**
Falling Time	100Vac/60Hz	5.579ms	Fig. 21	**Ref**
	240Vac/50Hz	5.923ms	Fig. 22	**Ref**

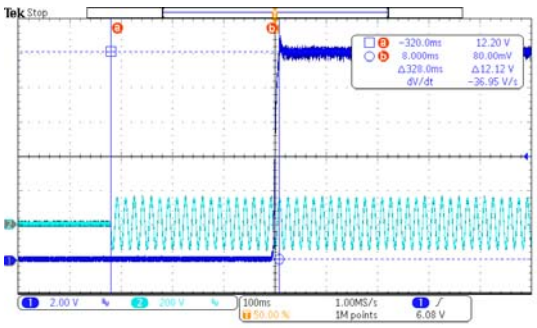


Fig. 15 100Vac/60Hz, Full Load Turn-on Delay Time
CH1=Vout, CH2=AC Input

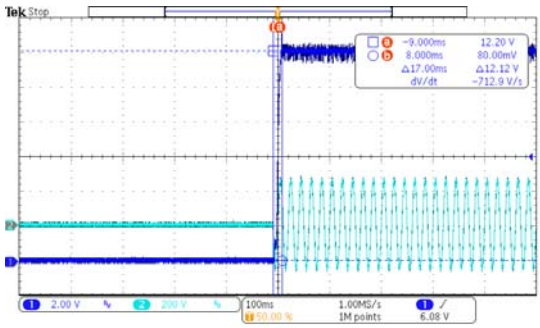


Fig. 16 180Vac/50Hz, Full load Turn-on Delay Time
CH1=Vout, CH2=AC Input

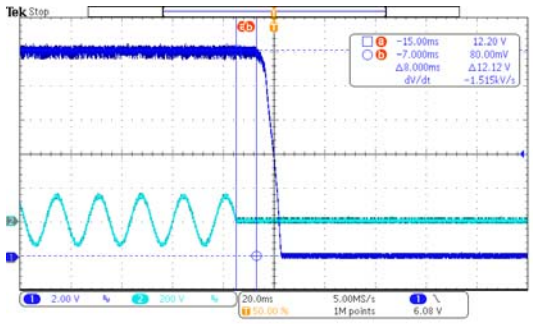


Fig. 17 100Vac / 60Hz, Full Load Hold-UpTime
CH1=Vout, CH2=AC Input

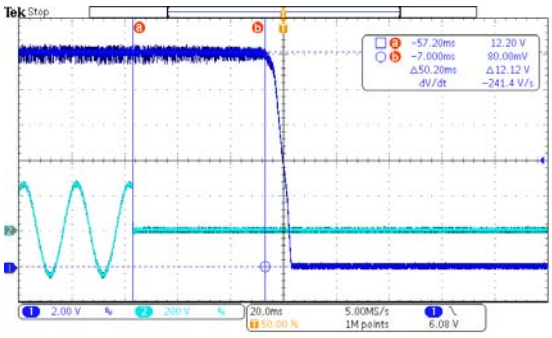


Fig.18 240Vac / 50Hz,Full Load Hold-Up Time
CH1=Vout, CH2=AC Input

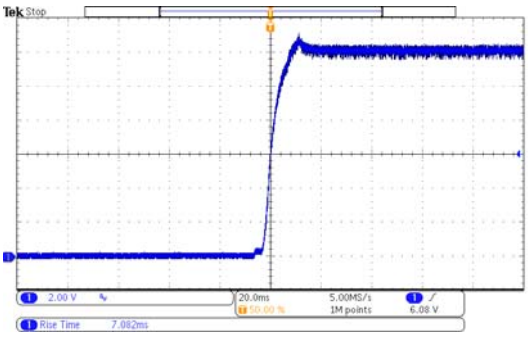


Fig. 19 100Vac/60Hz,Full Load Rising Time

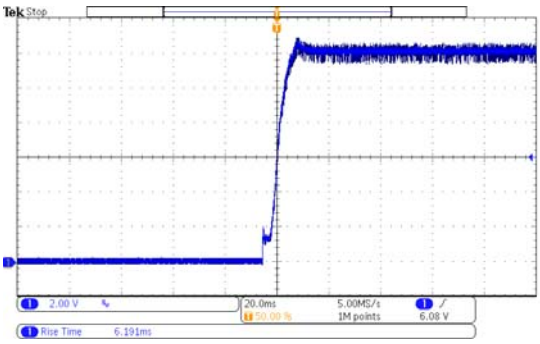


Fig.20 240Vac/50Hz,Full load Rising Time

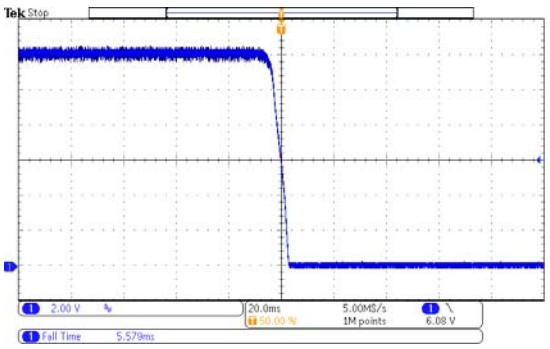


Fig. 21 100Vac/60Hz Full load FallingTime

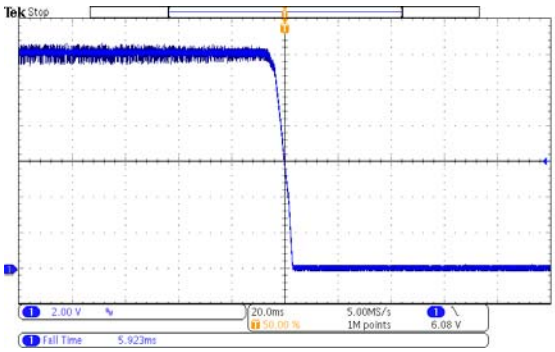


Fig. 22 240Vac/50Hz Full load Falling Time

3.3 Protection

3.3.1 Short Circuit Protection

When short the output voltage ,and no parts are damaged.Once Short Circuit condition is removed and the power should recover automatically .

Table 12 Short Circuit Protection

Input Voltage	Protection Mode	Result
90Vac/60Hz	Auto Recovery	PASS
264Vac/50Hz	Auto Recovery	PASS

3.3.2. Over Voltage Protection (OVP)

When Over Voltage Protectioncondition is removed and the power automatically recover

Table 13 OVP

Input Voltage	Protection Mode	Result	Remark	Test condition
115Vac/60Hz	Auto Recovery	Vo_Max.=13.6V	Fig. 23	U3(Pin1-Pin2) to short
230Vac/50Hz	Auto Recovery	Vo_Max.=13.6V	Fig. 24	

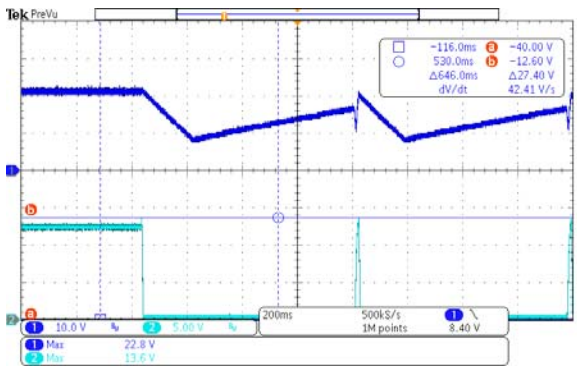


Fig 23. 115Vac/60Hz OVP (Full Load)

CH1: Vcc, CH2: Vo

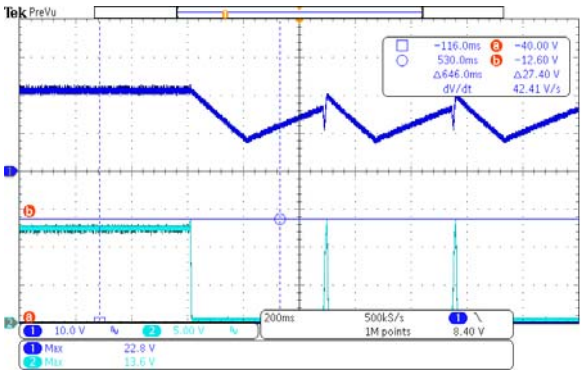


Fig 24 230Vac/50Hz OVP (Full load)

CH1: Vcc, CH2: Vo

3.3.3 Over Load Protection

When over load condition is removed and the power automatically recover.

3.3.3.1 Over Load Protection

Table 14 OLP

Input Voltage	OLP(A)	Over Rating	Remark
90Vac/60Hz	5.5	110%	
115Vac/60Hz	5.7	114%	
230Vac/50Hz	5.75	115%	
264Vac/50Hz	5.75	115%	

3.3.4 Thermal Testing

Table 15 Thermal Testing

Input Voltage	AMB	U1(℃)	Q1(℃)	D4(℃)	T1_Wire(℃)	T1_Core(℃)
90Vac/60Hz	25℃	54.4	74.5	108	75.5	60.8
264Vac/50Hz		45.5	61.4	132	78.3	77.5

4. Other Important Waveforms

4.1.1. Waveform from Top to Bottom :Vds;Vcc;Vfb@90Vac/60Hz, No Load

Measuring Data:Vds_max=248V;Vcc=20V;Vfb=1.2V; Frequency=22.0KHz(burst mode)

CH1:Vds, CH2:Vcc, CH3:Vfb

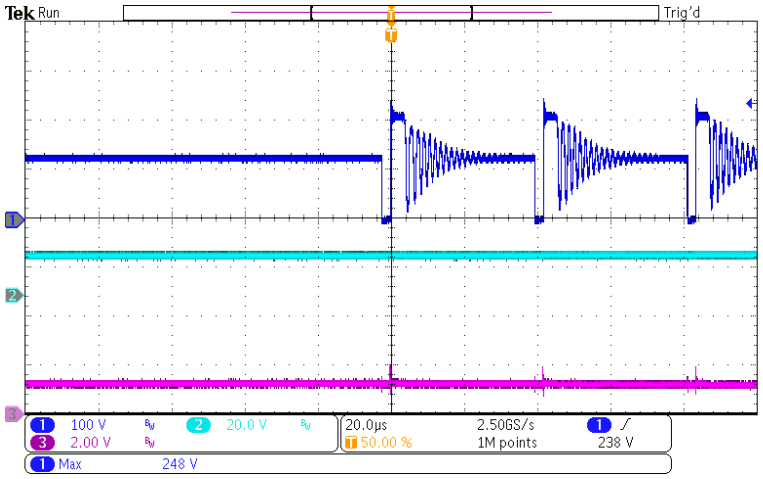


Fig.25 Vds;Vcc;Vfb @90Vac/60Hz, No Load

4.1.2. Waveform from Top to Bottom :Vds;Vcc;Vfb @90Vac/60Hz,Full Load

Measuring Data:Vds_max=304V; Vcc=21V;Vfb=3.4V; Frequency=67.5KHz

CH1:Vds, CH2:Vcc, CH3:Vfb

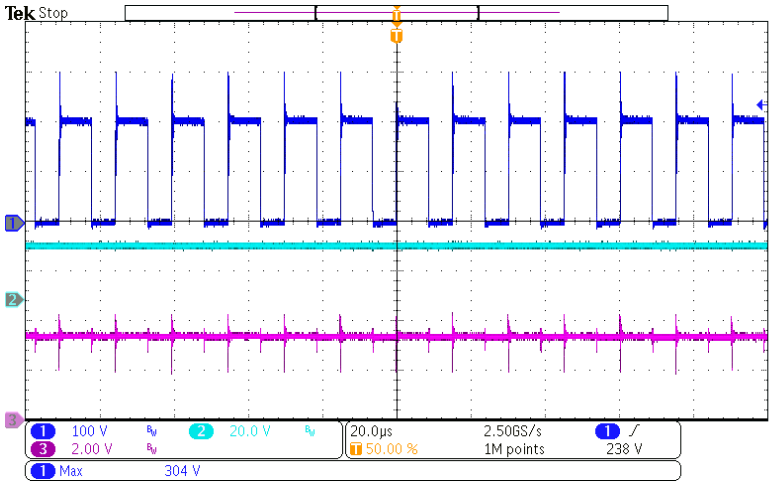
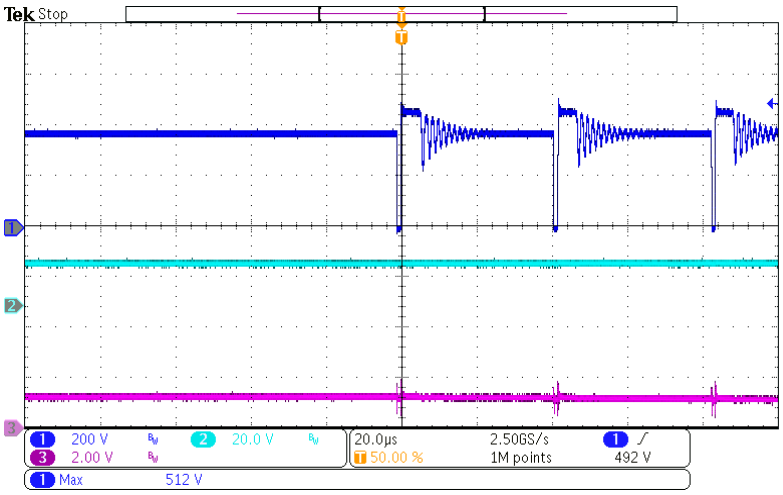


Fig. 26 Vds;Vcc;Vfb @90Vac/50Hz,Full Load

4.1.3. Waveform from Top to Bottom :Vds;Vcc;Vfb@264Vac/50Hz,No Load

Measuring Data:Vds_max=512V;Vcc=20V;Vfb=1.2V; Frequency=24KHz(burst mode)

CH1:Vds, CH2:Vcc, CH3:Vfb



4.1.4 Waveform fromTop to Bottom :Vds;Vcc;Vfb@ 264Vac/50Hz, Full Load

Measuring Data:Vds_max=560Vmax;Vcc=20V;Vfb=3.2V; Frequency=66KHz

CH1:Vds, CH2:Vcc, CH3:Vfb

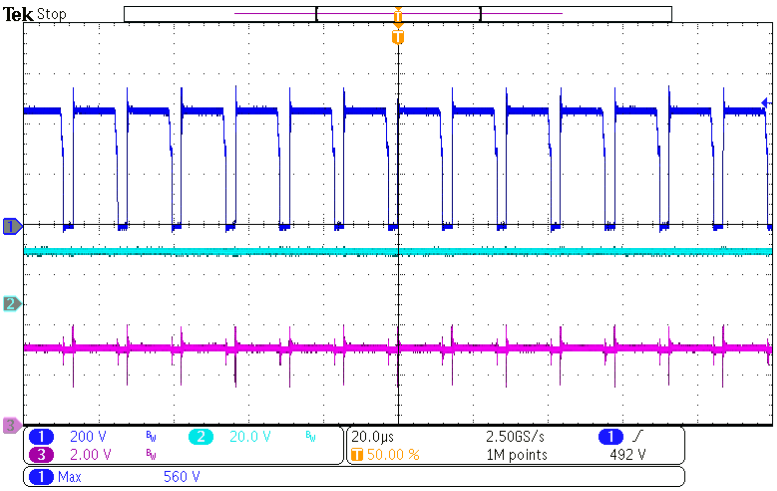


Fig.29 Vds;Vcc;Vfb 264Vac/50Hz, Full Load

4.2. Waveform at Full Load, Operating Start / Normal / Output Short to Ground .

Table 26 Measuring Data at Full Load, Operating Start/ Normal / Output Short Test.

Test Item	Input voltage	Q1,Vds(Max)	D5(Max)	Remark
Start at full load	264V/50HZ	560	67	Fig 30
Normal at full load	264V/50HZ	552	65	Fig 31
Short at full load	264V/50HZ	576	53	Fig 32

4.2.1. Start up at Full Load Waveform from Top to Bottom : CH1:Q1,Vds(Max), CH2:D5(Max)

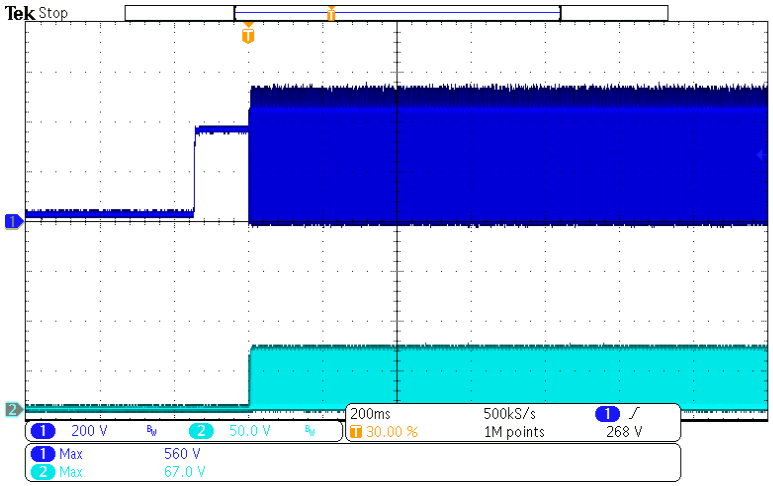


Fig.30 264Vac / 50Hz,Start up at Full load. Q1,Vds(p-p);D5(Vp-p)

4.2.2. Normal Full Load Waveform from Top to Bottom : CH1:Q1,Vds(Max), CH2:D5(Max)

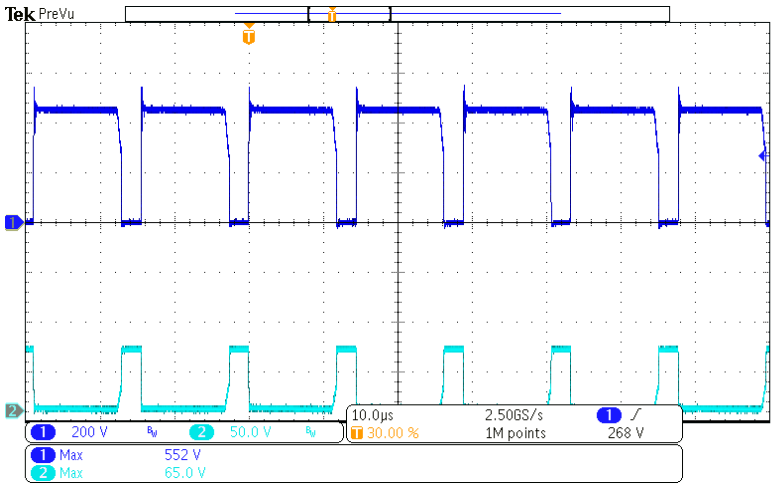


Fig.31 264Vac / 50Hz,Normal Full Load. Q1,Vds(p-p);D5(Vp-p)

4.2.3 Output Short to Ground Waveform from Top to Bottom : CH1:Q1,Vds(Max), CH2:D5(Max)

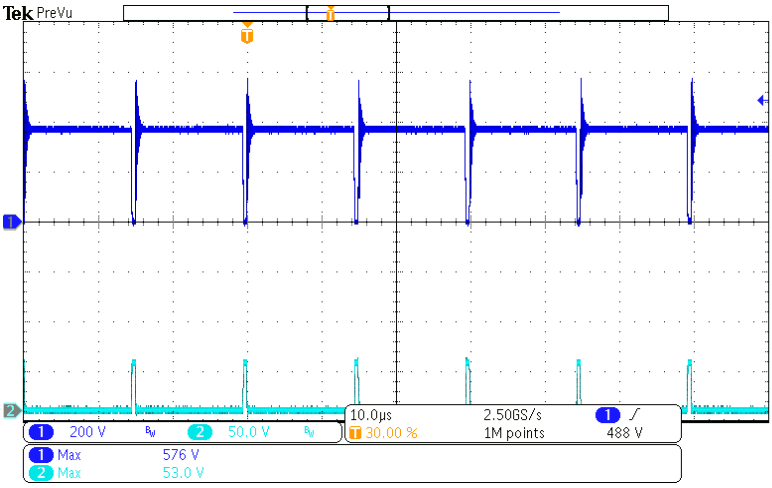


Fig.32 264Vac / 50Hz, Output Short to Ground at Full Load. Q1,Vds(Max);D5,(Max)