



**Texas Instruments**

**PMP4378A Test Procedure**

**China Power Reference Design**

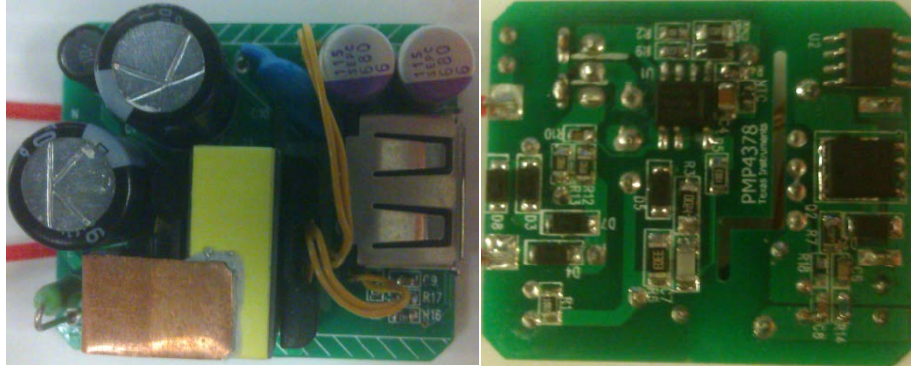
**REV A**

**9/27/2013**

# **1 GENERAL**

## **1.1 PURPOSE**

To provide detailed data for evaluating and verifying the PMP4378A, which uses TI new Primary Side Controller UCC28713 and synchronous rectified controller UCC24610 for 5V2.4A adapter with size 37mmx31mmx15mm. The below photo shows this demo board.



## **1.2 REFERENCE DOCUMENTATION**

Schematic PMP4378A\_SCH.PDF

Assembly PMP4378A\_PCB.PDF

BOM

Promotion tools

## **1.3 TEST EQUIPMENTS**

Power-meter: YOKOGAWA WT210

Multi-meter(current): Fluke 8845A

Multi-meter(voltage): Fluke 187

AC Source: Chroma 61530

Electronic load: Chroma 63105A module

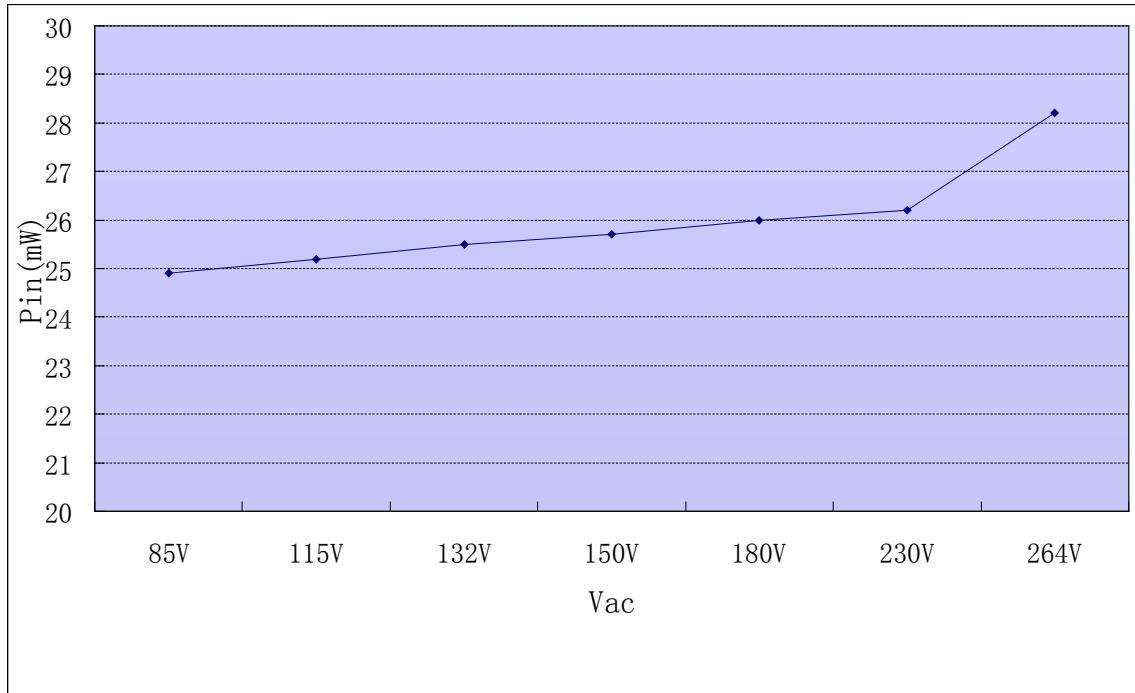
Testing demoboard

# **2 INPUT CHARACTERISTICS**

Efficiency is tested on USB-end

**Otherwise Specified, the test is under the condition with 100cm cable**

## 2.1 STANDBY POWER



## 2.2 EFFICIENCY DATA

Notes: efficiency test is based USB port

85v			
Pi (w)	Io (A)	Vo (V)	efficiency
0.765	0.12	5.089	0.798
1.455	0.24	5.1	0.841
1.793	0.3	5.1	0.853
3.542	0.6	5.133	0.87
5.345	0.9	5.16	0.869
7.224	1.2	5.191	0.862
9.1	1.5	5.228	0.862
11.03	1.8	5.278	0.861
13.02	2.1	5.328	0.859
15.02	2.4	5.358	0.856
132v			
Pi (w)	Io (A)	Vo (V)	efficiency
0.786	0.12	5.086	0.776
1.477	0.24	5.099	0.829
1.804	0.3	5.099	0.848
3.522	0.6	5.131	0.874
5.284	0.9	5.164	0.88
7.089	1.2	5.193	0.879
8.92	1.5	5.226	0.879

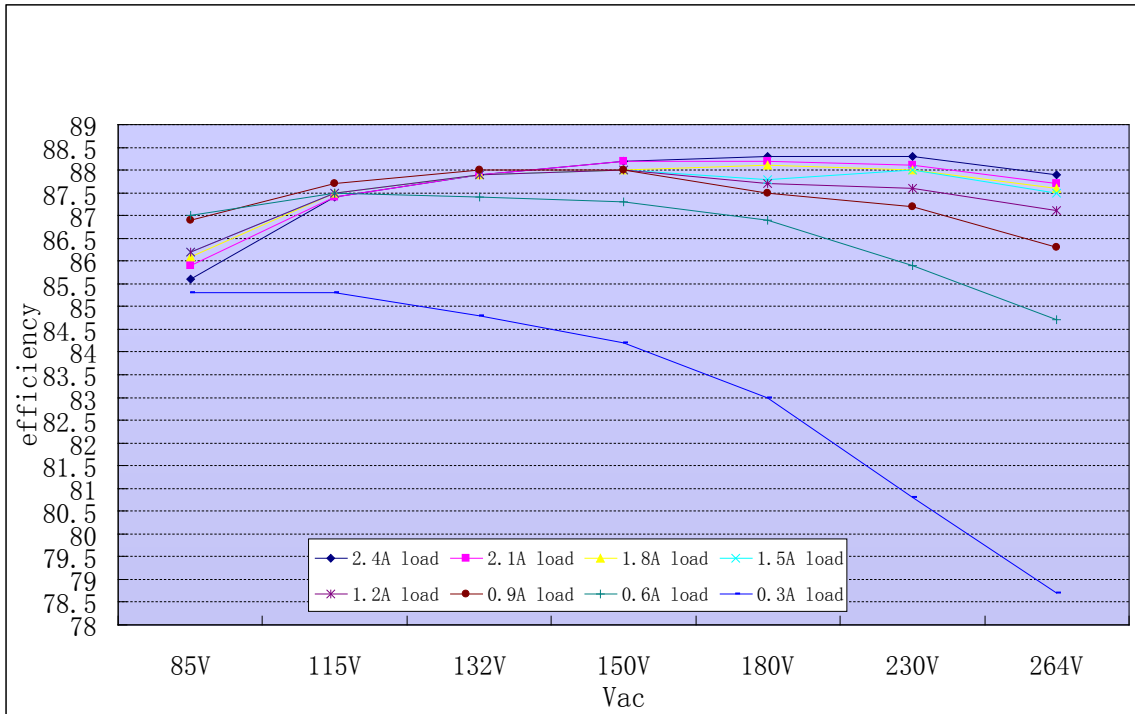
115v			
Pi (w)	Io (A)	Vo (V)	efficiency
0.779	0.12	5.086	0.783
1.469	0.24	5.101	0.833
1.796	0.3	5.104	0.853
3.522	0.6	5.135	0.875
5.303	0.9	5.167	0.877
7.12	1.2	5.194	0.875
8.97	1.5	5.231	0.875
10.86	1.8	5.277	0.875
12.77	2.1	5.312	0.874
14.69	2.4	5.351	0.874
150v			
Pi (w)	Io (A)	Vo (V)	efficiency
0.793	0.12	5.086	0.77
1.489	0.24	5.098	0.822
1.816	0.3	5.098	0.842
3.525	0.6	5.129	0.873
5.28	0.9	5.164	0.88
7.083	1.2	5.194	0.88
8.905	1.5	5.224	0.88

10.8	1.8	5.275	0.879
12.71	2.1	5.321	0.879
14.61	2.4	5.349	0.879
180v			
Pi (w)	Io(A)	Vo(V)	efficiency
0.771	0.12	5.09	0.792
1.517	0.24	5.098	0.807
1.842	0.3	5.098	0.83
3.542	0.6	5.128	0.869
5.312	0.9	5.164	0.875
7.103	1.2	5.194	0.877
8.925	1.5	5.222	0.878
10.78	1.8	5.274	0.881
12.65	2.1	5.315	0.882
14.55	2.4	5.354	0.883
230v			
Pi (w)	Io(A)	Vo(V)	efficiency
0.829	0.12	5.082	0.736
1.569	0.24	5.099	0.78
1.893	0.3	5.099	0.808
3.58	0.6	5.124	0.859
5.323	0.9	5.159	0.872
7.112	1.2	5.193	0.876
8.9	1.5	5.223	0.88
10.77	1.8	5.263	0.88
12.66	2.1	5.314	0.881
14.56	2.4	5.354	0.883

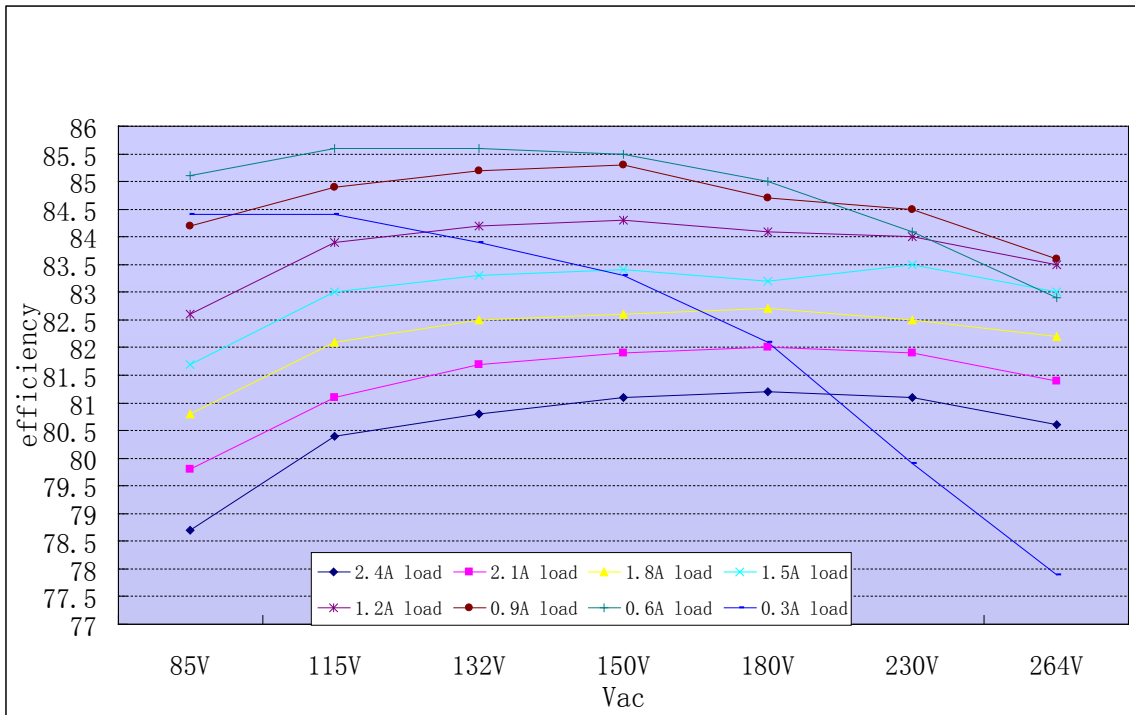
10.79	1.8	5.274	0.88
12.66	2.1	5.318	0.882
14.56	2.4	5.35	0.882

264v			
Pi (w)	Io(A)	Vo(V)	efficiency
0.862	0.12	5.073	0.706
1.612	0.24	5.098	0.759
1.942	0.3	5.098	0.788
3.63	0.6	5.122	0.847
5.377	0.9	5.157	0.863
7.15	1.2	5.19	0.871
8.95	1.5	5.22	0.875
10.81	1.8	5.258	0.876
12.718	2.1	5.309	0.877
14.6	2.4	5.35	0.879

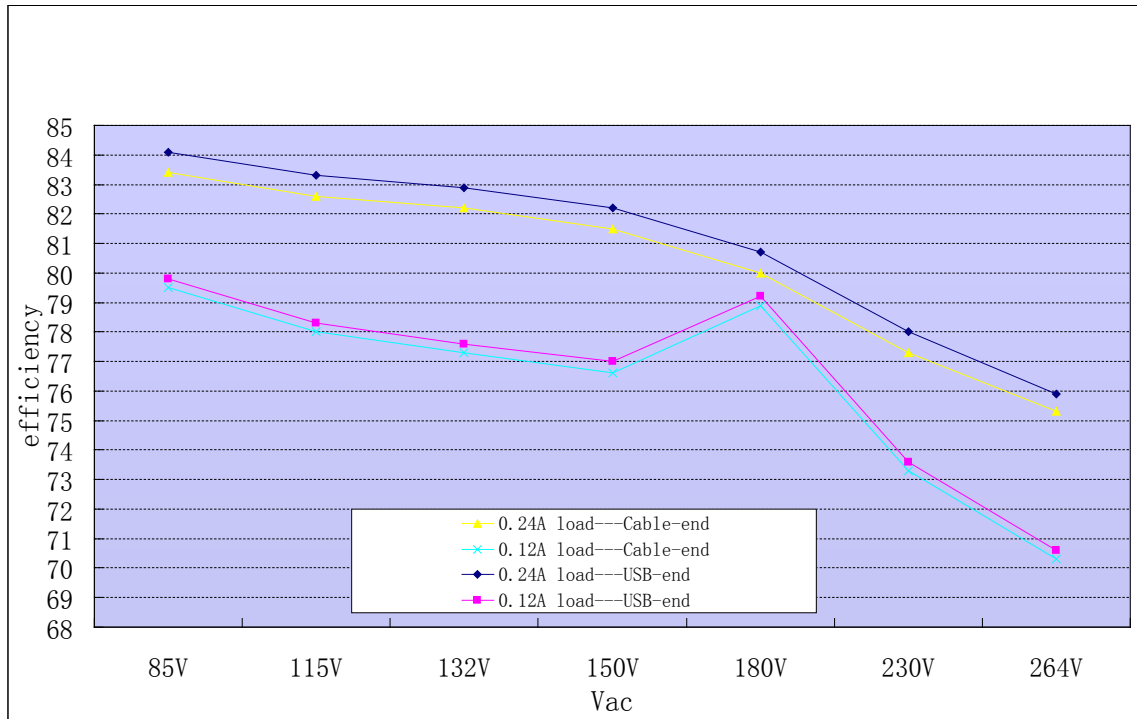
### 2.2.1 Load and input voltage Vs efficiency curve tested at USB-end



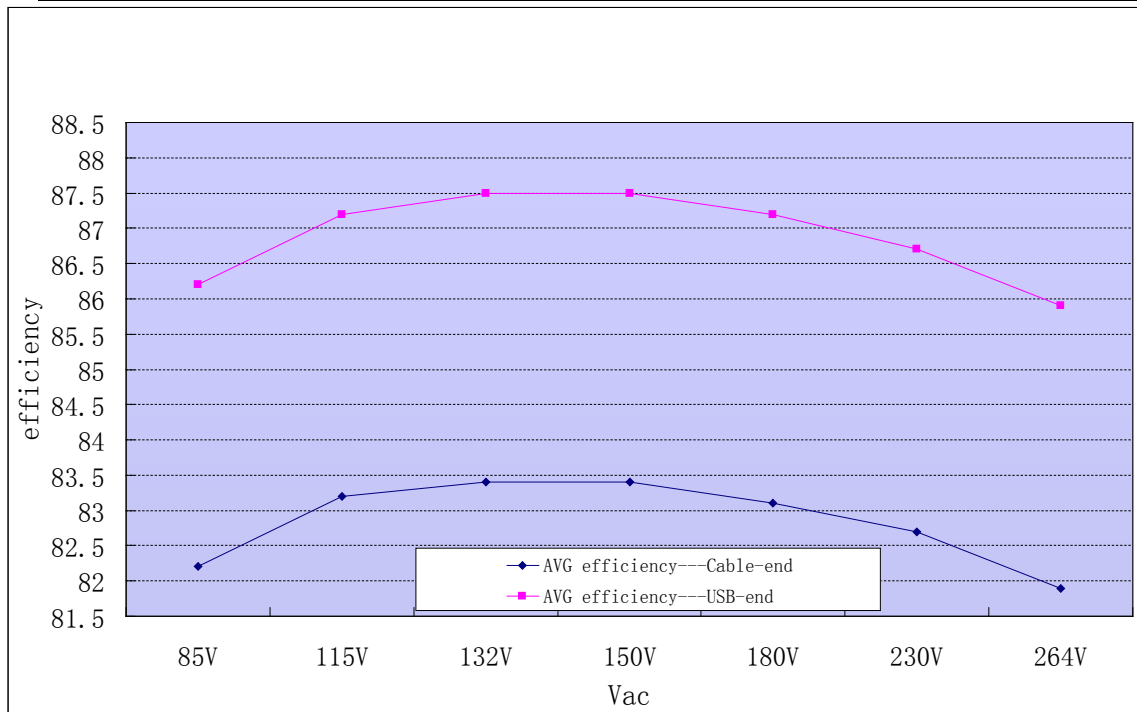
### 2.2.2 Load and input voltage Vs efficiency curve tested at cable-end



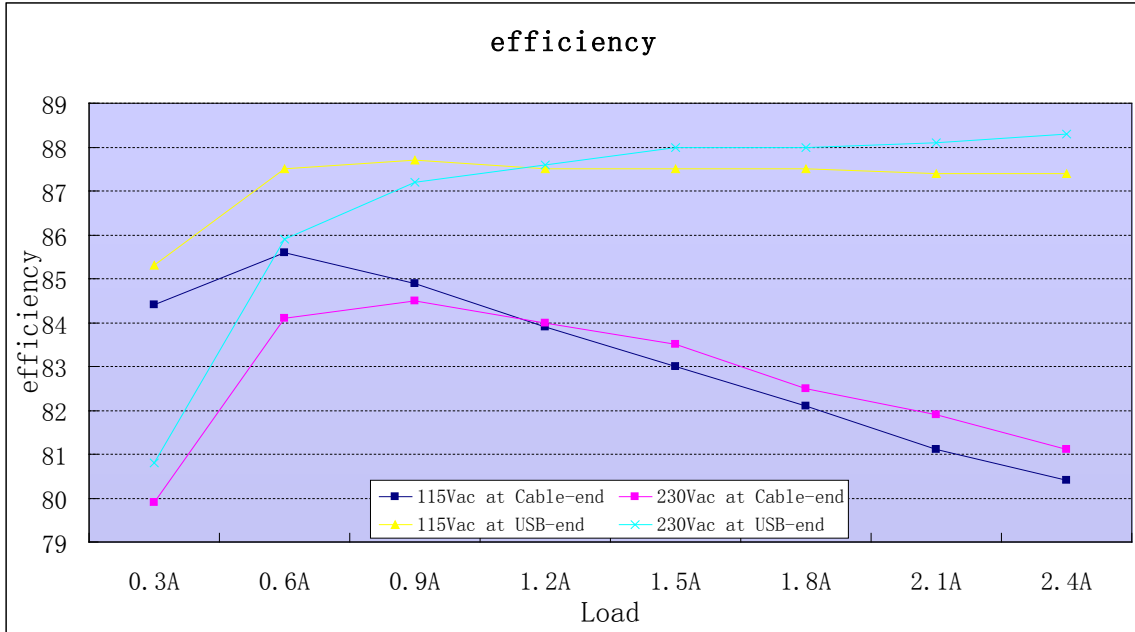
### 2.2.3 efficiency curve at 5% and 10% of full load



### 2.2.4 Average efficiency curve at 0.3A,0.6A,0.9A,1.2A,1.5A,1.8A,2.1A,2.4A



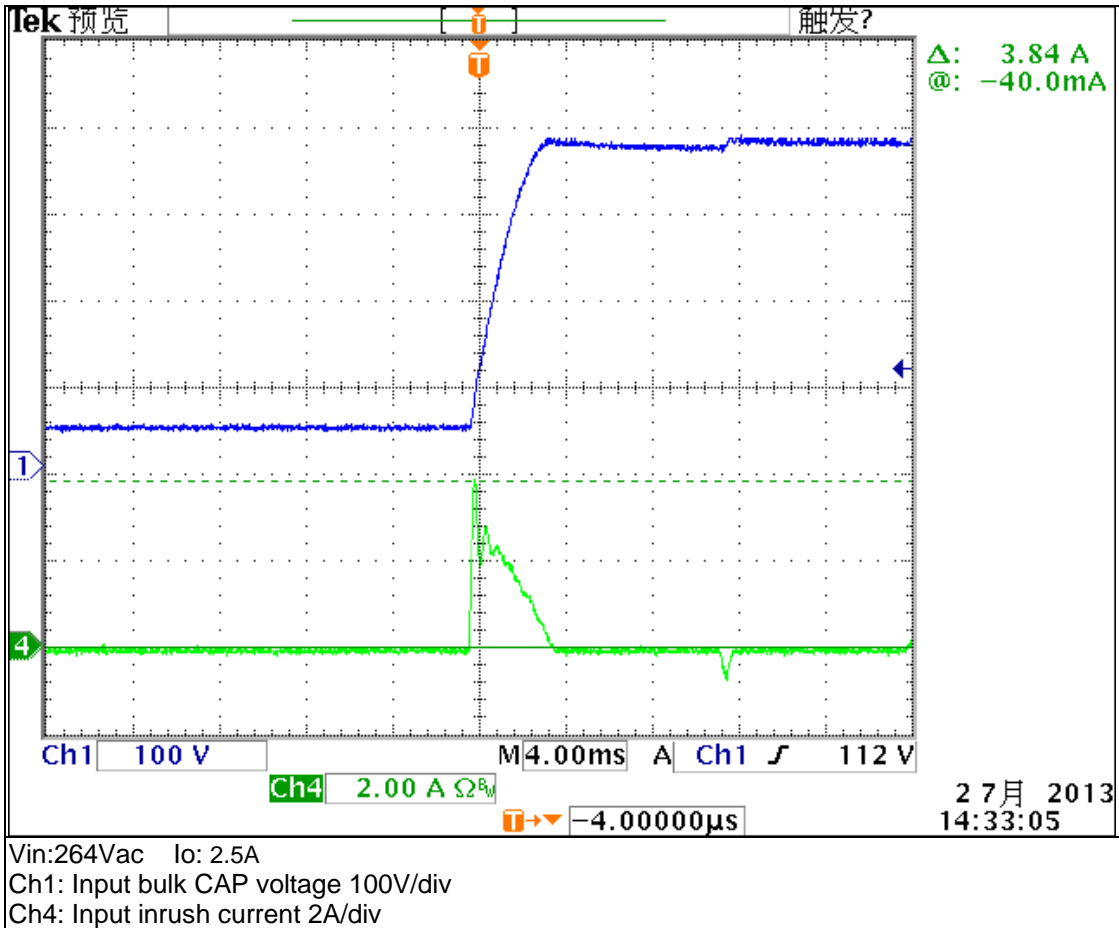
### 2.2.5 Efficiency Vs load curve



### 2.3 INPUT CURRENT

Vin(Vac)	Freq(Hz)	Iin(Arms)	Pass/Fail
85	60	<b>0.317</b>	

### 2.4 INPUT INRUSH CURRENT

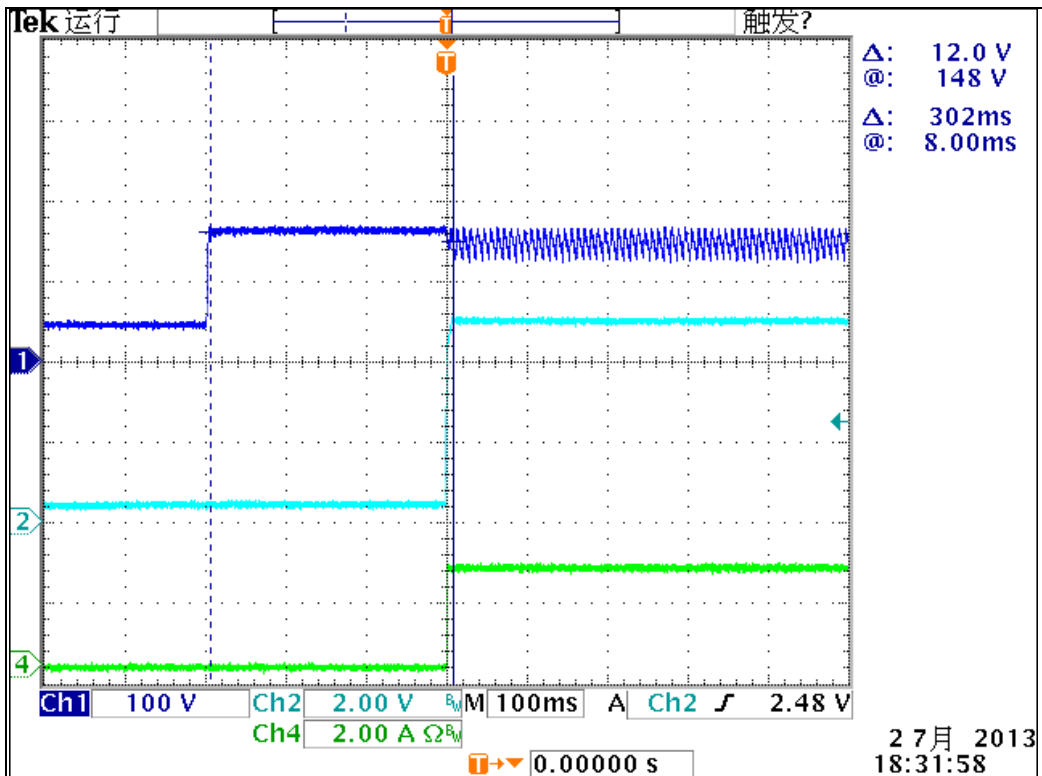


### 3 OUTPUT CHARACTERISTICS

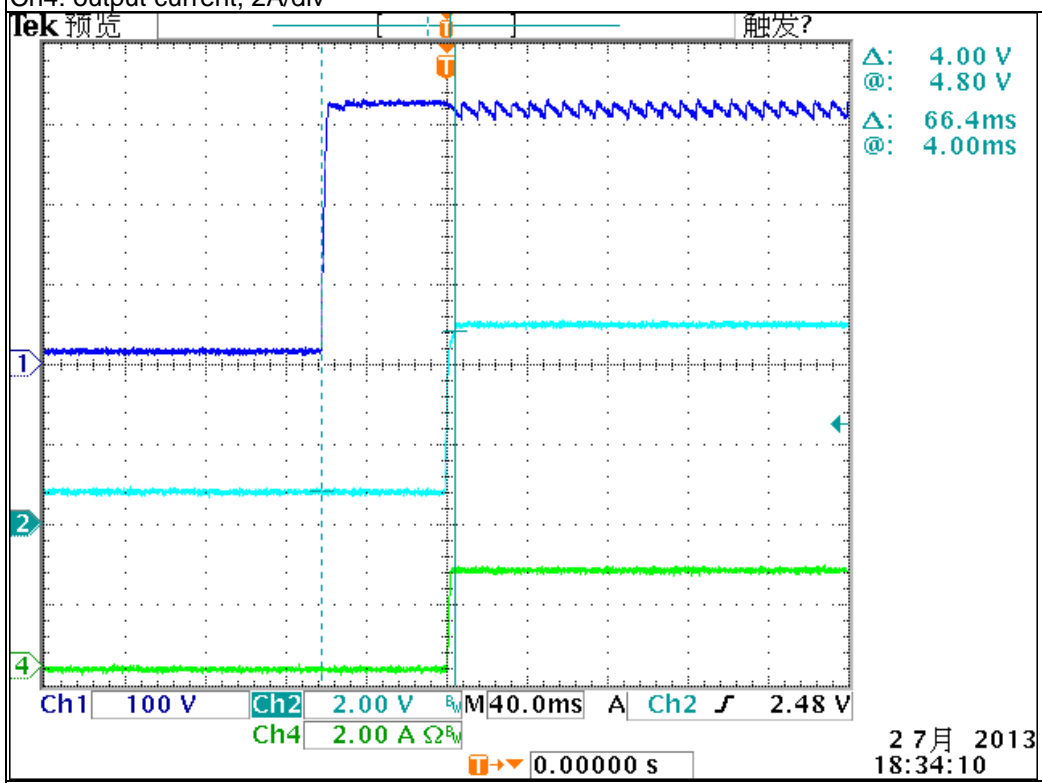
#### 3.1 STARTUP TIME

Input voltage	Output current	Startup time	Pass/Fail
115Vac	2.4A	<b>302mS</b>	
230Vac	2.4A	<b>66.4mS</b>	





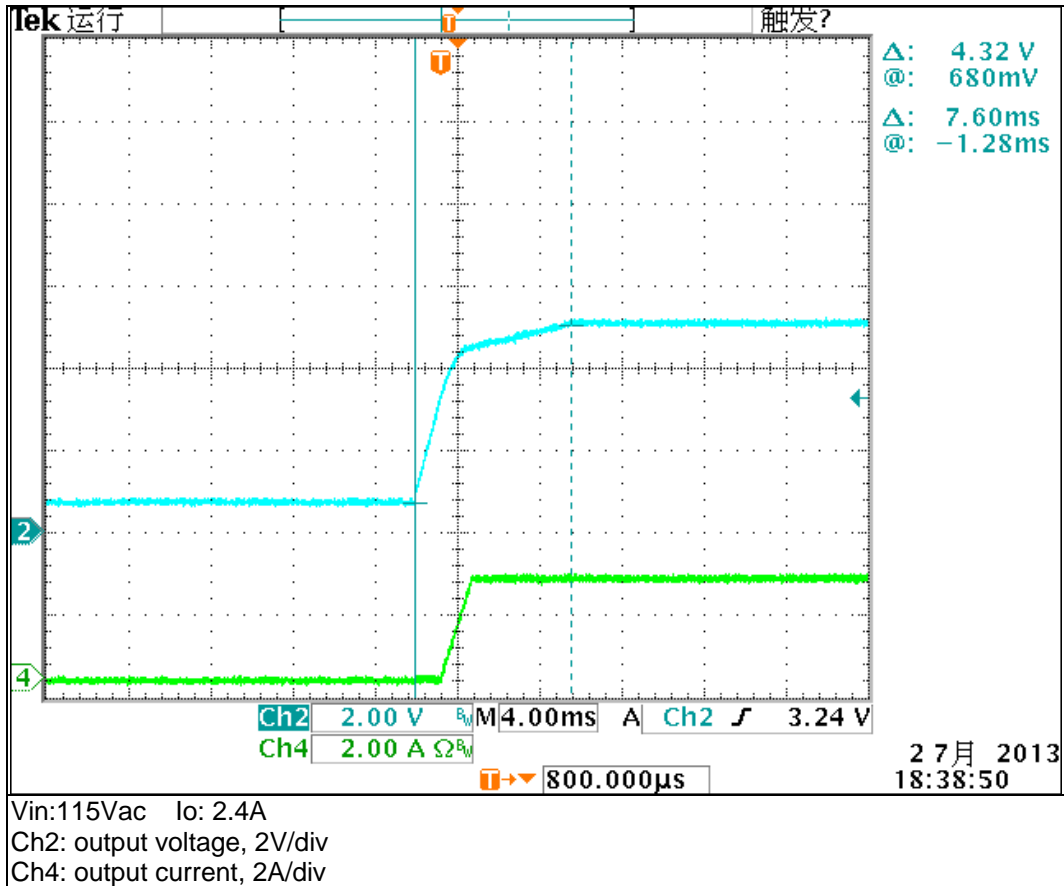
Vin:115Vac Io:2.4A  
Ch1: MOSFET's drain voltage, 100V/div Ch2: output voltage, 2V/div  
Ch4: output current, 2A/div

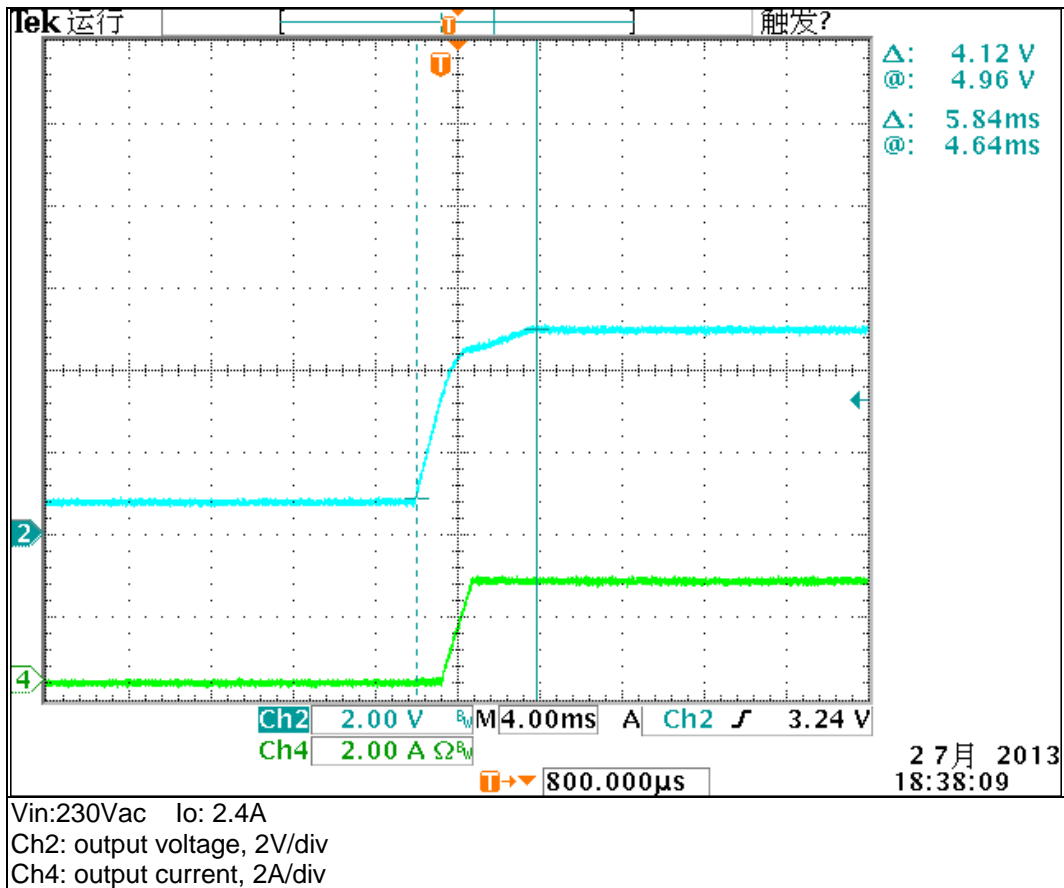


Vin:230Vac Io:2.4A  
Ch1: MOSFET's drain voltage, 100V/div Ch2: output voltage, 2V/div  
Ch4: output current, 2A/div

### 3.2 OUTPUT VOLTAGE RISE TIME

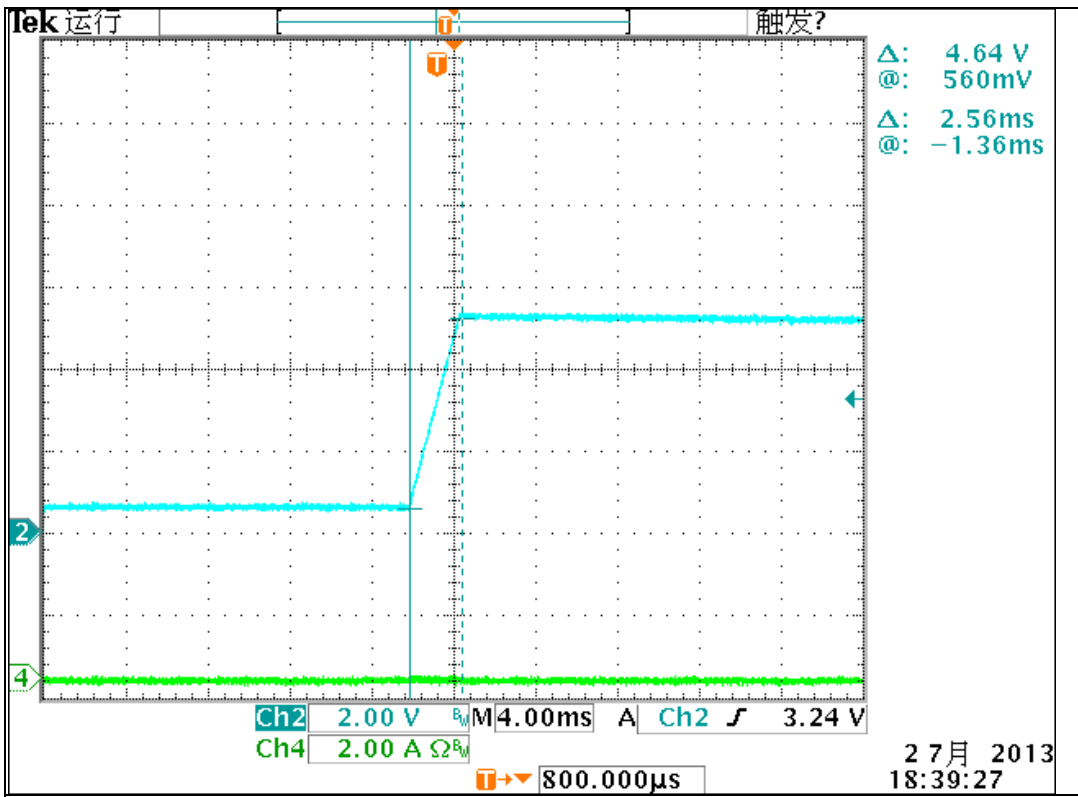
Input voltage	Output current	Startup time	Pass/Fail
115Vac	2.4A	<b>7.6mS</b>	
230Vac	2.4A	<b>5.84mS</b>	



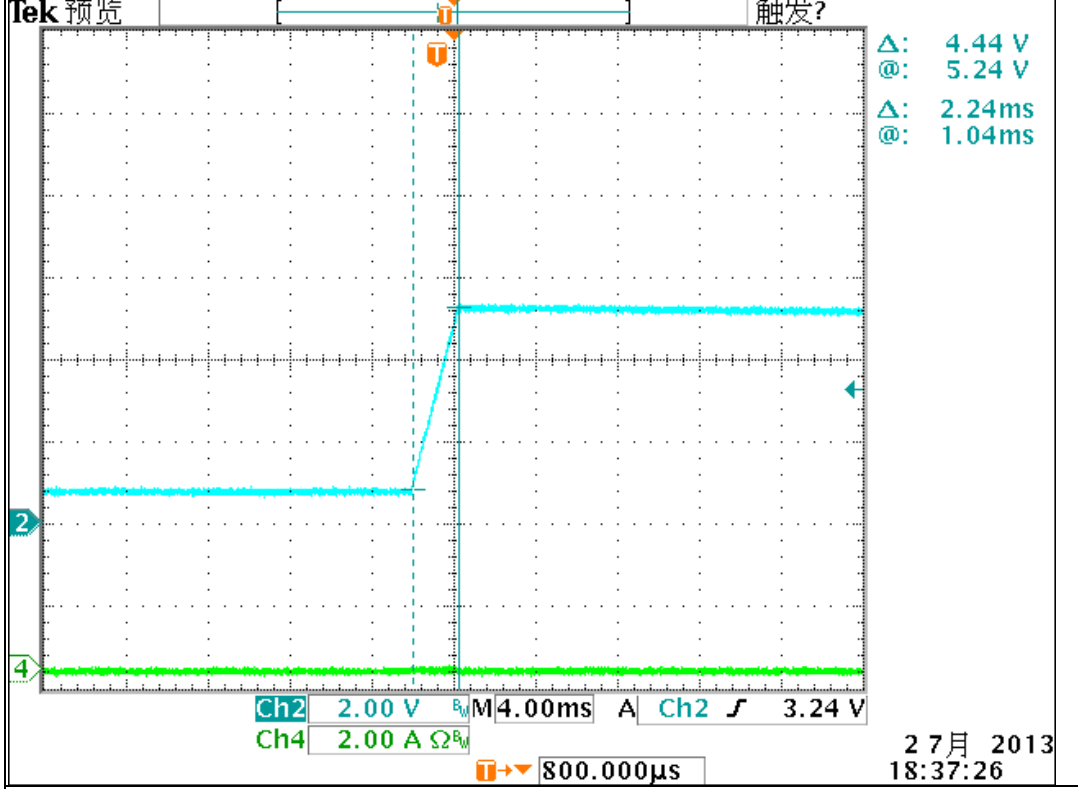


### 3.3 OUTPUT VOLTAGE OVERSHOOT

Input voltage	Output current	overshoot voltage	Pass/Fail
115Vac	0A	<1%	
230Vac	0A	<1%	



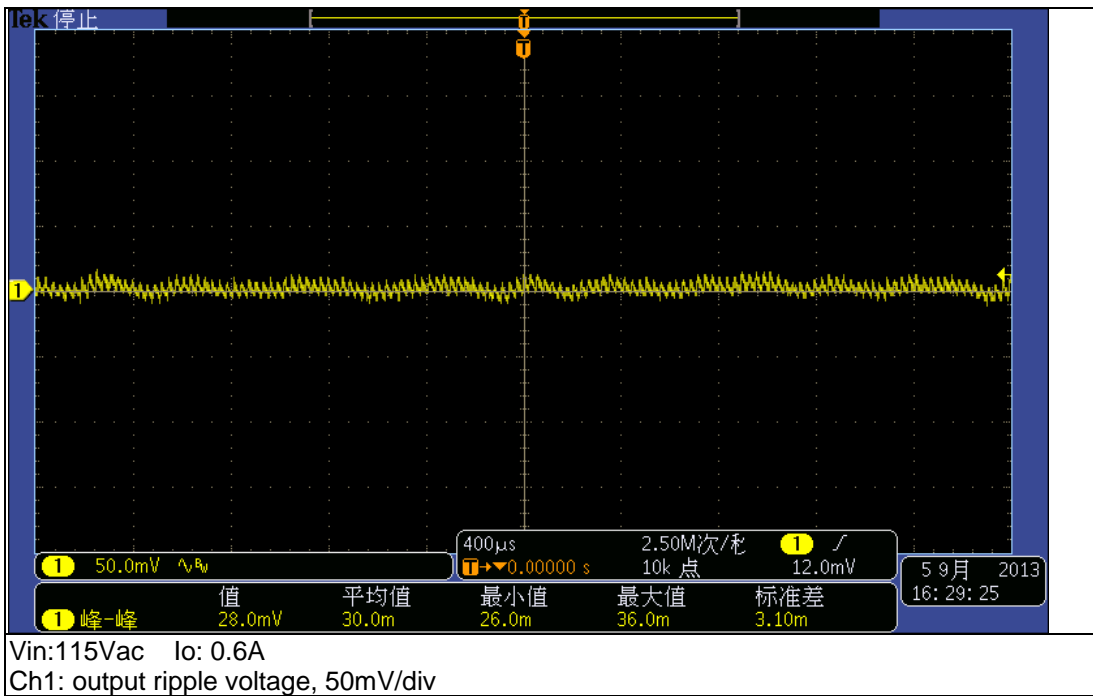
Vin:115Vac Io: 0A  
Ch2: voltage, 2V/div

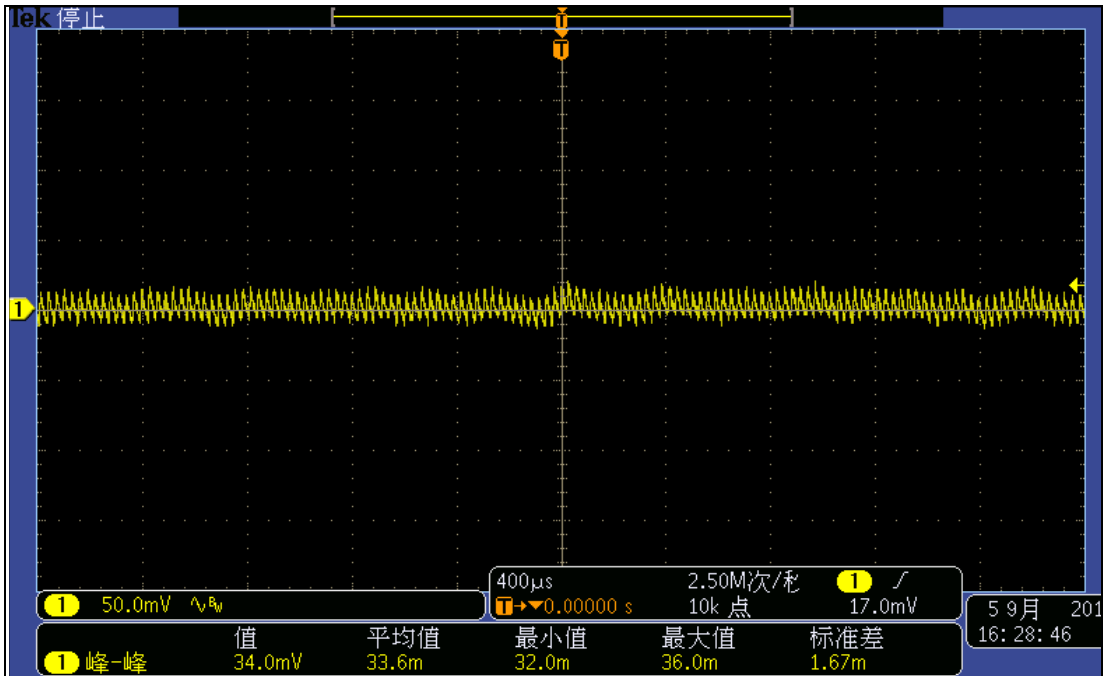


Vin:230Vac Io: 0A  
Ch2: output voltage, 2V/div

### 3.4 RIPPLE VOLTAGE

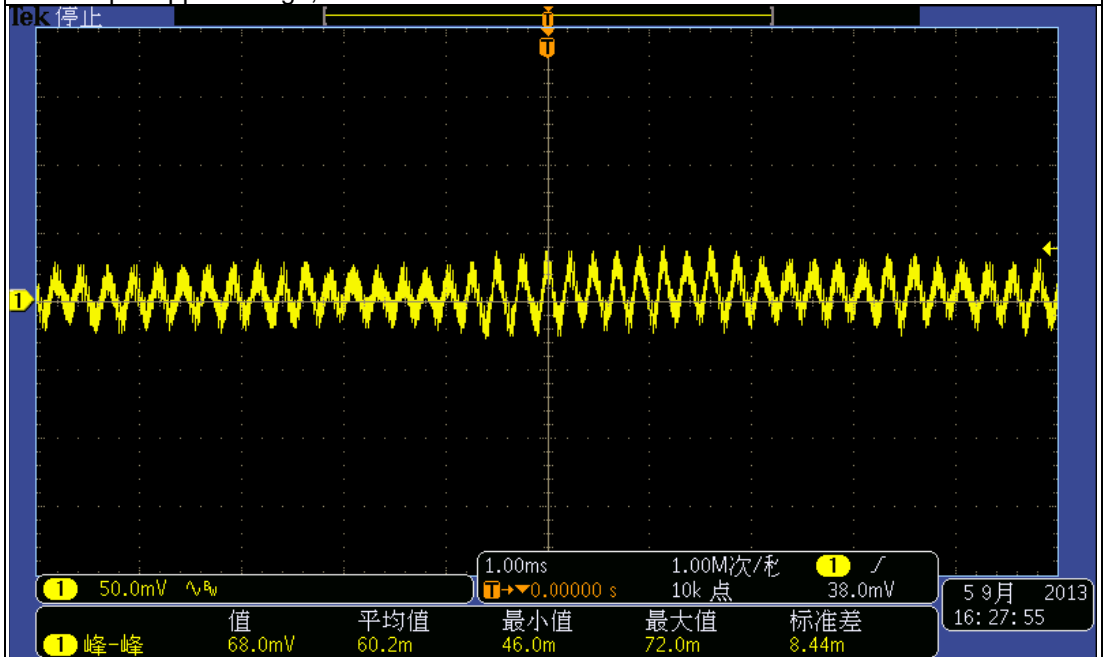
Input voltage	Output current	Ripple voltage	Pass/Fail
115Vac	0.6A	<b>28mV</b>	
115Vac	1.2A	<b>34mV</b>	
115Vac	1.8A	<b>68mV</b>	
115Vac	2.4A	<b>56mV</b>	
230Vac	0.6A	<b>30mV</b>	
230Vac	1.2A	<b>32mV</b>	
230Vac	1.8A	<b>48mV</b>	
230Vac	2.4A	<b>66mV</b>	





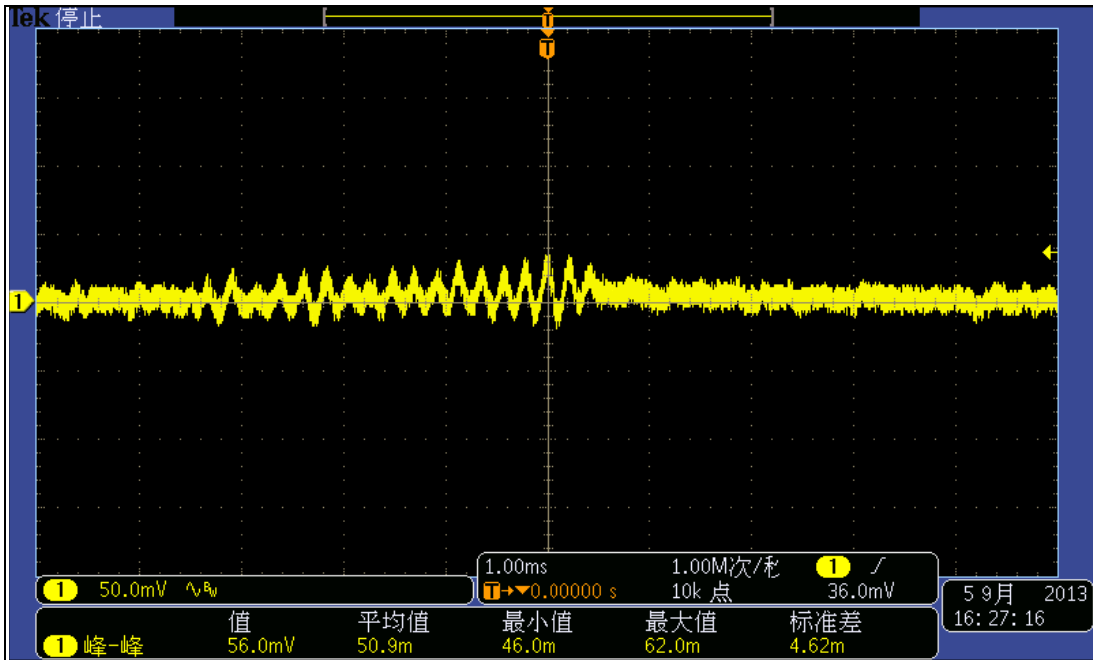
Vin:115Vac Io: 1.2A

Ch1: output ripple voltage, 50mV/div

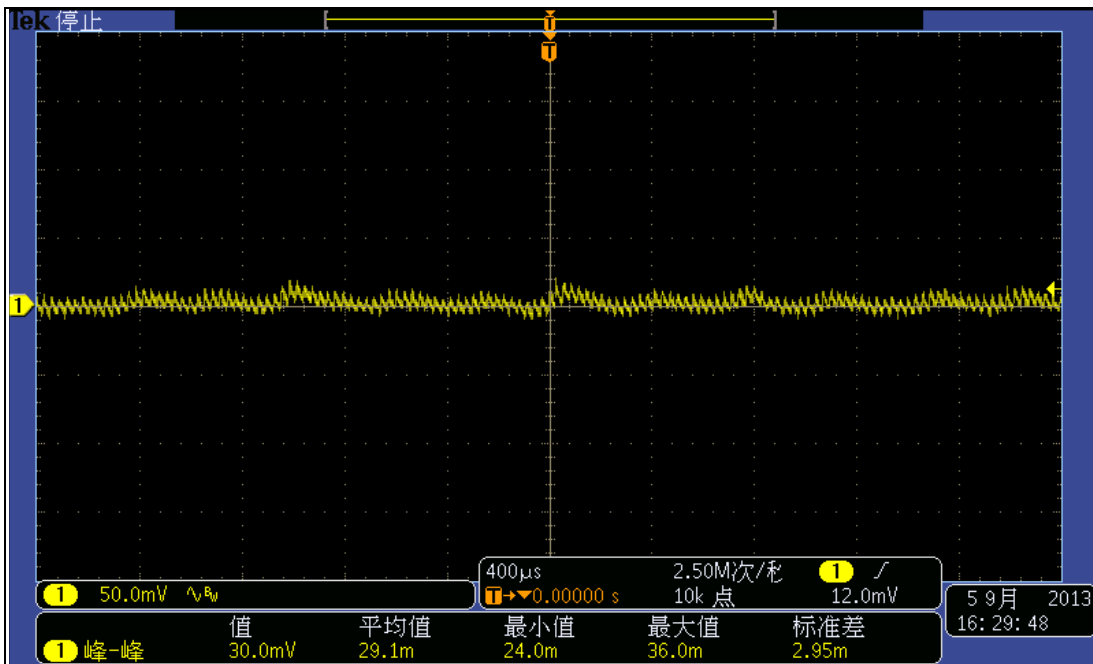


Vin:115Vac Io: 1.8A

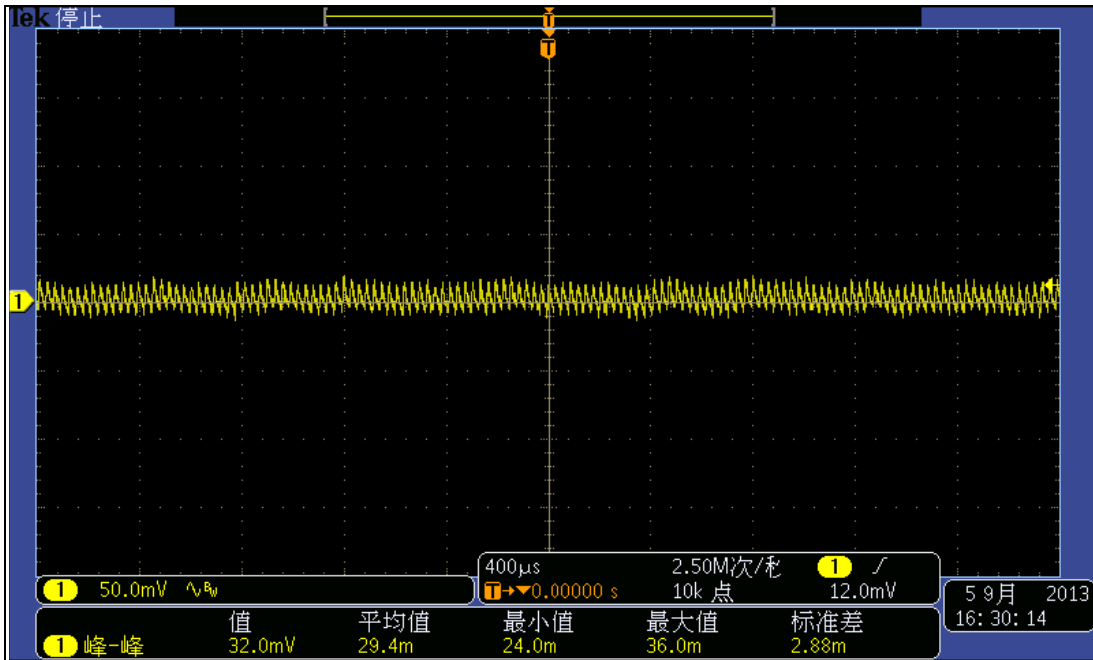
Ch1: output ripple voltage, 50mV/div



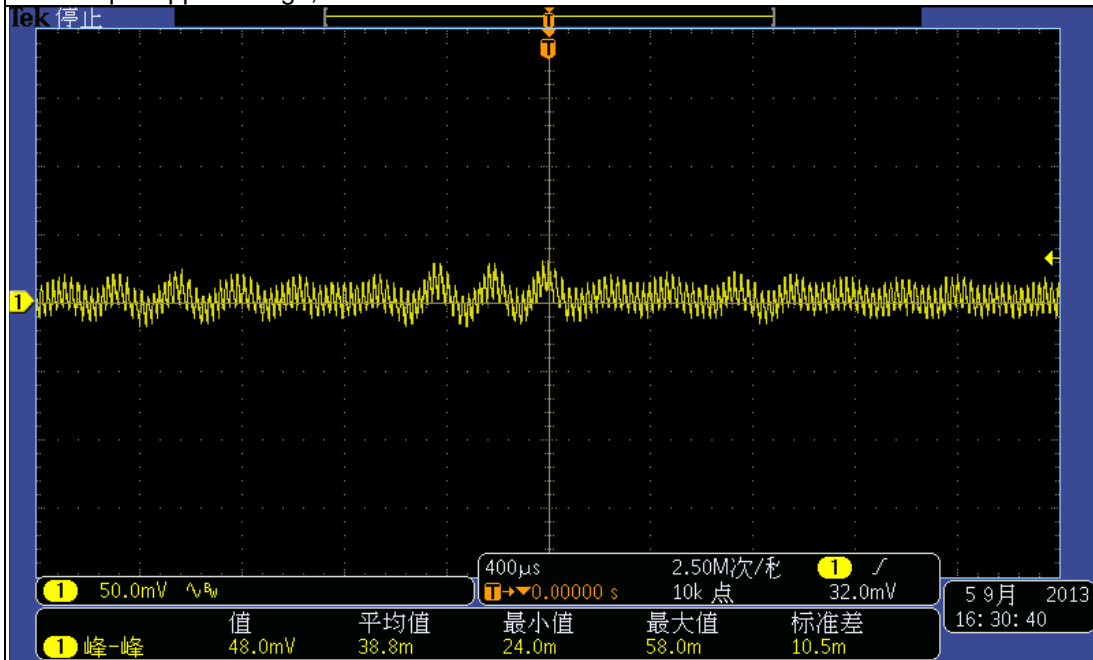
Vin:115Vac Io: 2.4A  
 Ch1: output ripple voltage, 50mV/div



Vin:230Vac Io: 0.6A  
 Ch1: output ripple voltage, 50mV/div

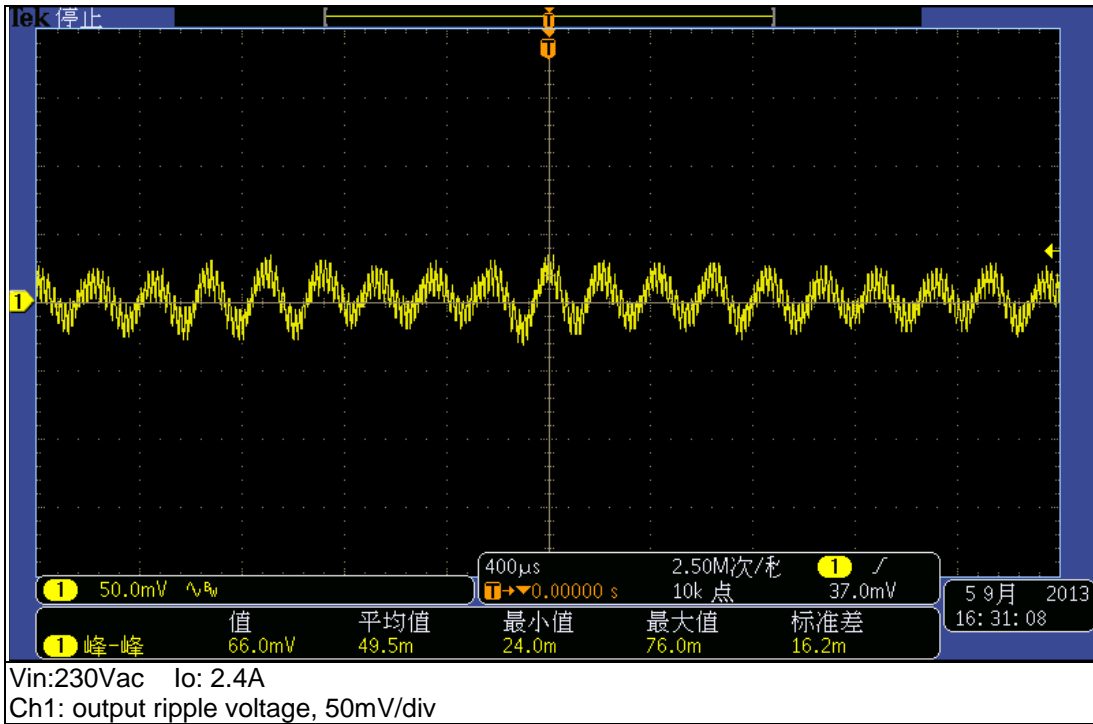


Vin:230Vac Io: 1.2A  
Ch1: output ripple voltage, 50mV/div



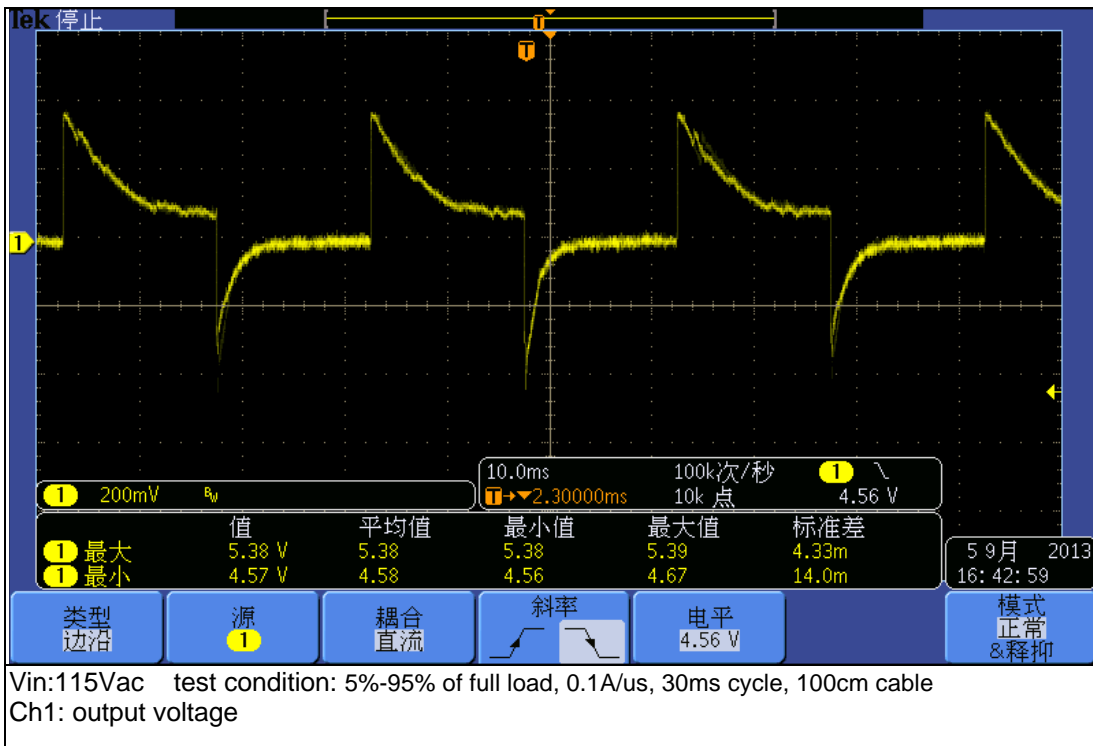
Vin:230Vac Io: 1.8A  
Ch1: output ripple voltage, 50mV/div

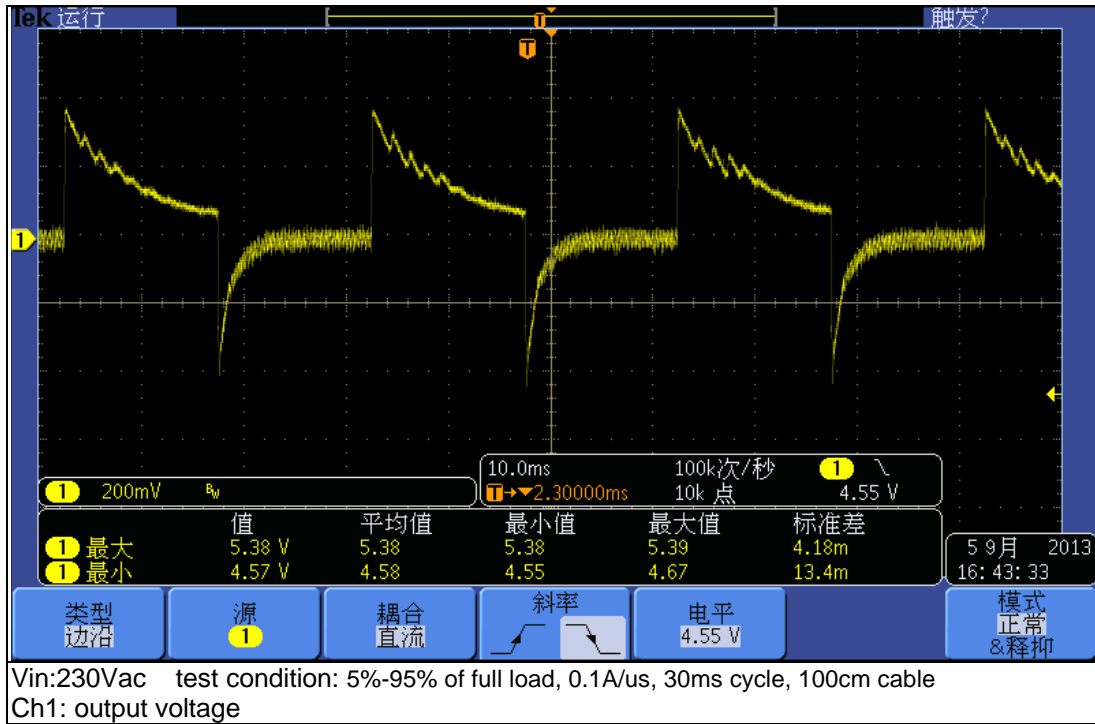




### 3.5 DYNAMIC RESPONSE

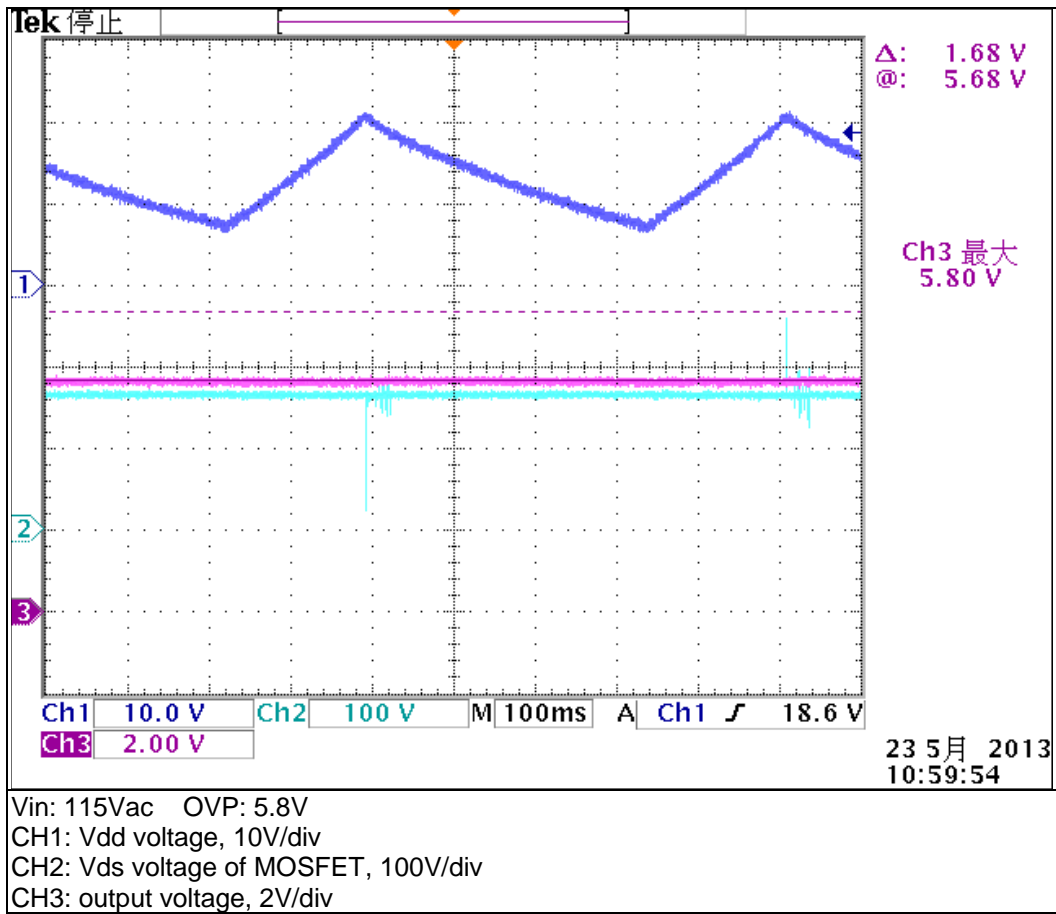
Input voltage	Output current	Max voltage	Min voltage
115Vac	5%-95% of full load	<b>5.38V</b>	<b>4.57V</b>
230Vac	5%-95% of full load	<b>5.46V</b>	<b>4.56V</b>





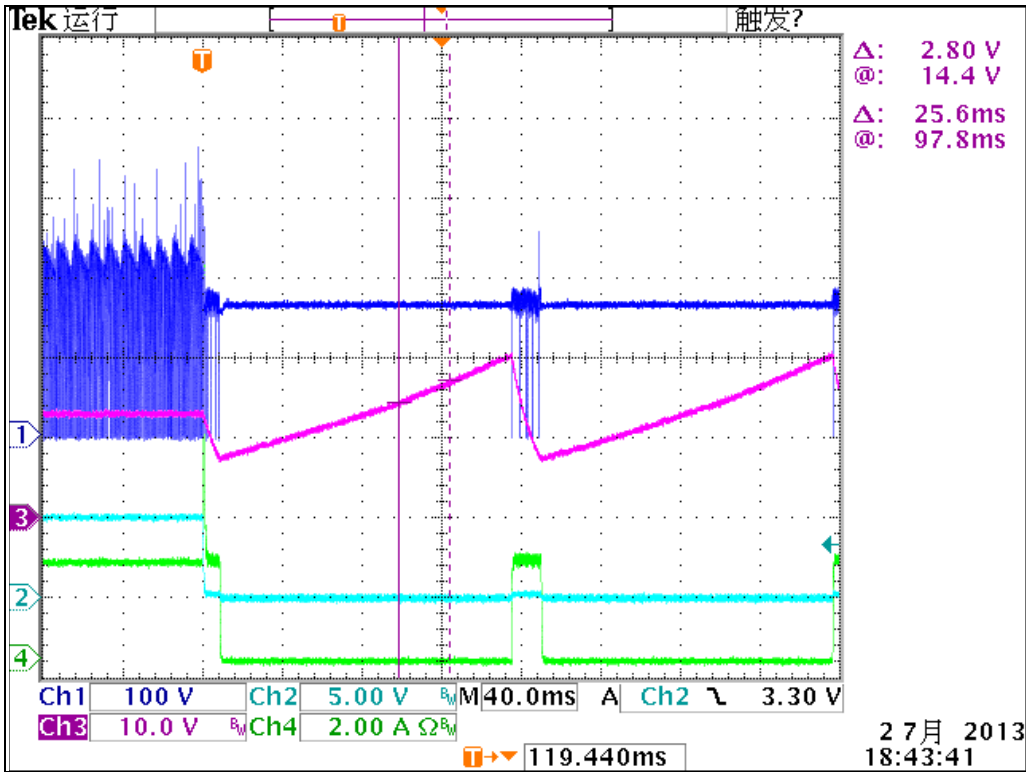
### 3.6 OUTPUT VOLTAGE PROTECTION

CONDITIONS	Protection voltage (V)	Pass/Fail
Vin (Vac)		
115&230	5.8	

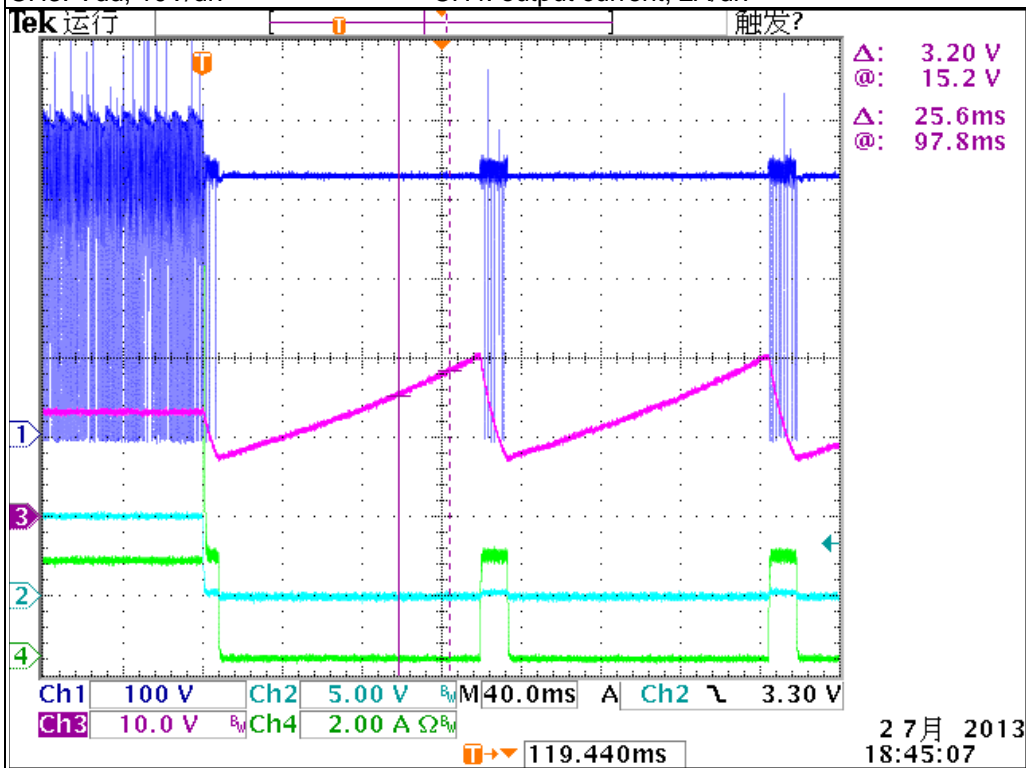


### 3.7 OUTPUT SHORT PROTECTION

Input voltage	Output short protection
115&230Vac	Hiccup up mode

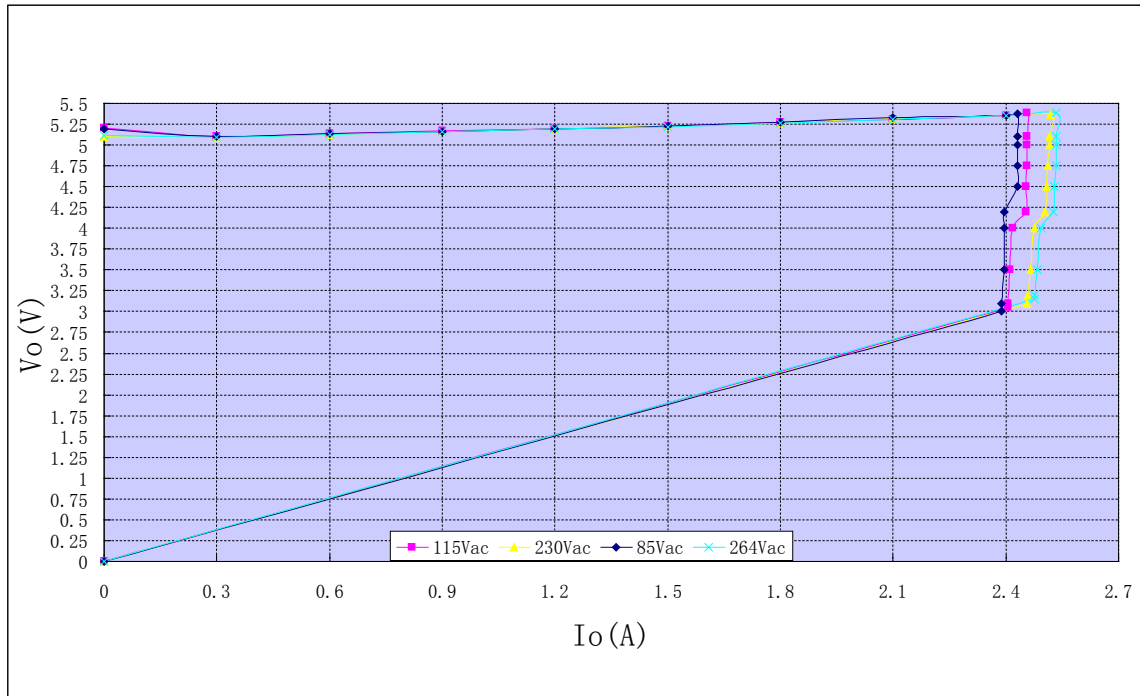


Vin:115Vac  
 CH1: Vds of MOSFET, 100V/div CH2: output voltage, 5V/div  
 CH3: Vdd, 10V/div CH4: output current, 2A/div



Vin:230Vac  
 CH1: Vds of MOSFET, 100V/div CH2: output voltage, 5V/div  
 CH3: Vdd, 10V/div CH4: output current, 2A/div

## 4 IV CURVE



## 5 THERMAL TEST

### 5.1. Thermal test with case at Ta=25° C

Temp record						
Thermal Coupler Channel	Name	Pos	90VAC 50Hz, Ambient:25°C		264VAC 60Hz, Ambient:25°C	
			Record Time	CV5V	Record Time	CV5V
			15:00~16:40	2.4A	16:40~17:40	2.4A
11	Input cap	C1	62.7° C		57.6° C	
15	Input cap	C2	66.7° C		61.6° C	
3	Input inductor	L1	65.9° C		57.8° C	
8	Schonounous MOSFET	Q2	53.1° C		53.1° C	
9	Transformer	T1 Core	72.2° C		70.6° C	
1	Transformer	T1 Winding	79.1° C		76.1° C	
17	Power Switch	Q1	70.9° C		71.1° C	
5	Output cap	C5	56.4° C		55.7° C	
7	Output cap	C3	60.9° C		60.3° C	
13	Output rectifier	D2	58.6° C		58.4° C	
16	Rect. Bridge diode	DB1	68.7° C		59.9° C	
10	UCC28713	U1	67.4° C		66° C	
4	UCC24610	U2	55.8° C		55.3° C	
actual Ta			Ta=25° C		Ta=25° C	

### 5.2. Thermal test with case at Ta=45° C

Temp record						
Thermal Coupler Channel	Name	Pos	90VAC 50Hz, Ambient:45°C		264VAC 60Hz, Ambient:45°C	
			Record Time	CV5V	Record Time	CV5V
			14:00~15:00	2.4A	16:10~17:10	2.4A
11	Input cap	C1	67.5°C		63.2°C	
15	Input cap	C2	71°C		66.3°C	
3	Input inductor	L1	71.9°C		63.5°C	
8	Schonounous MOSFET	Q2	68.4°C		68°C	
9	Transformer	T1 Core	79.4°C		76.7°C	
1	Transformer	T1 Winding	85.1°C		77°C	
17	Power Switch	Q1	73°C		73°C	
5	Output cap	C5	63.9°C		63.7°C	
7	Output cap	C3	67.8°C		67.2°C	
13	Output rectifier	D2	66.4°C		66.2°C	
16	Rect. Bridge diode	DB1	73.1°C		64.9°C	
10	UCC28713	U1	71.9°C		70.2°C	
4	UCC24610	U2	64.7°C		64.3°C	
actual Ta			Ta=45. 5° C		Ta=46. 8° C	

## 6 EMI Test

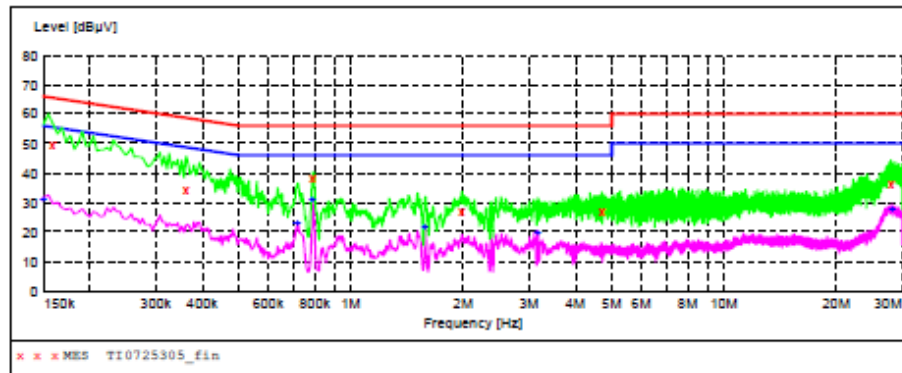
## 6.1 Conduction emission

Shenzhen Huatongwei International Inspection CO.,Ltd

Voltage Mains Test EN 55022 CLASS B

EUT: PMP4378  
 Manufacturer: TI  
 Operating Condition: LOAD  
 Test Site: 3# SHIELDED ROOM  
 Operator: ZHANGBAO.SUN  
 Test Specification: AC 230V/50Hz  
 Comment:  
 Start of Test: 7/25/2013 / 6:41:43PM

SCAN TABLE: "Voltage (9K-30M)FIN"  
 Short Description: 150K-30M Voltage



MEASUREMENT RESULT: "TI0725305\_fin"

7/25/2013 6:44PM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	FE
0.159000	49.60	10.1	66	15.9	QP	L1	GND
0.361800	34.10	10.1	59	24.6	QP	L1	GND
0.789000	38.60	10.1	56	17.4	QP	L1	GND
1.977000	27.20	10.2	56	28.8	QP	L1	GND
4.695000	26.80	10.2	56	29.2	QP	L1	GND
28.018500	36.70	10.9	60	23.3	QP	L1	GND

MEASUREMENT RESULT: "TI0725305\_fin2"

7/25/2013 6:44PM

Frequency MHz	Level dBµV	Transd dB	Limit dBµV	Margin dB	Detector	Line	FE
0.150000	30.70	10.1	56	25.3	AV	L1	GND
0.717000	22.90	10.1	46	23.1	AV	L1	GND
0.789000	30.80	10.1	46	15.2	AV	L1	GND
1.876800	21.50	10.2	46	24.5	AV	L1	GND
3.160800	19.90	10.2	46	26.1	AV	L1	GND
28.122000	28.00	10.9	50	22.0	AV	L1	GND

Page 1/1 7/25/2013 6:44PM TI0725305

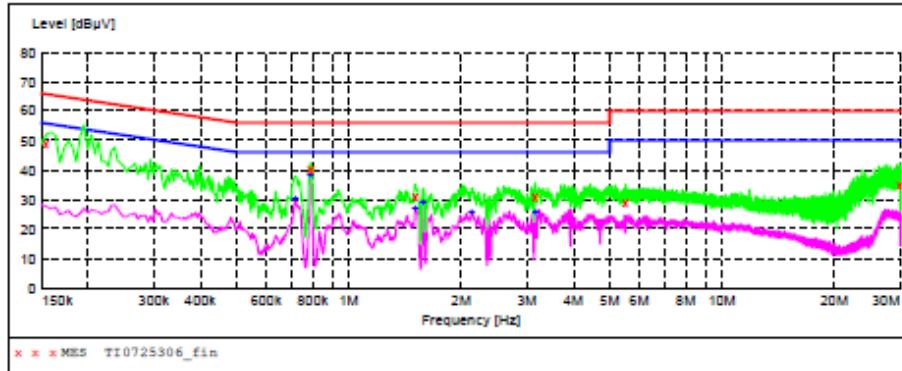
Vin: 230Vac, Line, Io: 2.4A  
 Test condition: 1.5m cable with 2R load resistor

Shenzhen Huatongwei International Inspection CO.,Ltd

Voltage Mains Test EN 55022 CLASS B

EUT: FMP4378  
 Manufacturer: TI  
 Operating Condition: LOAD  
 Test Site: 3# SHIELDED ROOM  
 Operator: ZHANGBAO.SUN  
 Test Specification: AC 230V/50Hz  
 Comment:  
 Start of Test: 7/25/2013 / 6:44:29PM

SCAN TABLE: "Voltage (9K-30M)FIN"  
 Short Description: 150K-30M Voltage



MEASUREMENT RESULT: "TI0725306\_fin"

7/25/2013 6:46PM

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	FE
0.154500	48.80	10.1	66	17.0	QP	N	GND
0.789000	40.30	10.1	56	15.7	QP	N	GND
1.504500	30.90	10.2	56	25.1	QP	N	GND
3.156000	31.20	10.2	56	24.8	QP	N	GND
5.514000	29.30	10.2	60	30.7	QP	N	GND
29.881500	35.00	11.0	60	25.0	QP	N	GND

MEASUREMENT RESULT: "TI0725306\_fin2"

7/25/2013 6:46PM

Frequency MHz	Level dBuV	Transd dB	Limit dBuV	Margin dB	Detector	Line	FE
0.717000	30.10	10.1	46	15.9	AV	N	GND
0.789000	38.60	10.1	46	7.4	AV	N	GND
1.504500	27.10	10.2	46	18.9	AV	N	GND
1.576500	28.70	10.2	46	17.3	AV	N	GND
2.134500	25.80	10.2	46	20.2	AV	N	GND
3.160500	25.90	10.2	46	20.1	AV	N	GND

Vin:230Vac, Neutral, Io: 2.4A  
 Test condition: 1.5m cable with 2R load resistor



## 6.2 Radiated emission

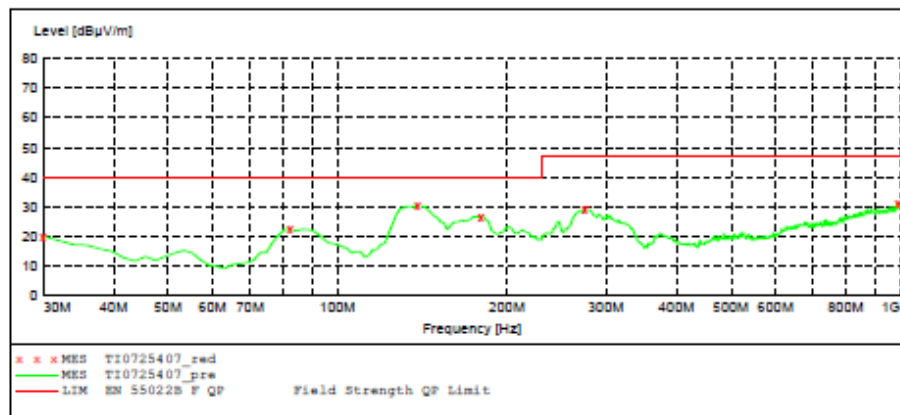
SHENZHEN HUATONGWEI INTERNATIONAL INSPECTION CO.,LTD

RADIATED EMISSION TEST EN 55022 CLASSB

EUT: FMP4378  
 Manufacturer: TI  
 Operating Condition: LOAD  
 Test Site: 3M CHAMBER  
 Operator: MINGHUA.FAN  
 Test Specification: AC 230V/50Hz  
 Comment:  
 Start of Test: 7/25/2013 / 5:13:25PM

SWEEP TABLE: "test (30M-1G)"

Start	Stop	Detector	Meas. Time	IF Bandw.	Transducer
30.0 MHz	1.0 GHz	MaxPeak	Coupled	120 kHz	HL562 201106



MEASUREMENT RESULT: "TI0725407\_red"

7/25/2013 5:15PM

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Asimuth deg	Polarisation
30.000000	19.90	-10.0	40.0	20.1	---	300.0	76.00	HORIZONTAL
82.484970	22.40	-19.9	40.0	17.6	---	300.0	221.00	HORIZONTAL
138.857715	30.20	-19.8	40.0	9.8	---	300.0	197.00	HORIZONTAL
179.679359	26.70	-20.5	40.0	13.3	---	100.0	358.00	HORIZONTAL
274.929860	29.00	-16.3	47.0	18.0	---	100.0	45.00	HORIZONTAL
990.280561	31.10	-3.1	47.0	15.9	---	100.0	316.00	HORIZONTAL

Vin:230Vac, HORIZONTAL, Io: 2.4A  
 Test condition: 1.5m cable with 2R resistor

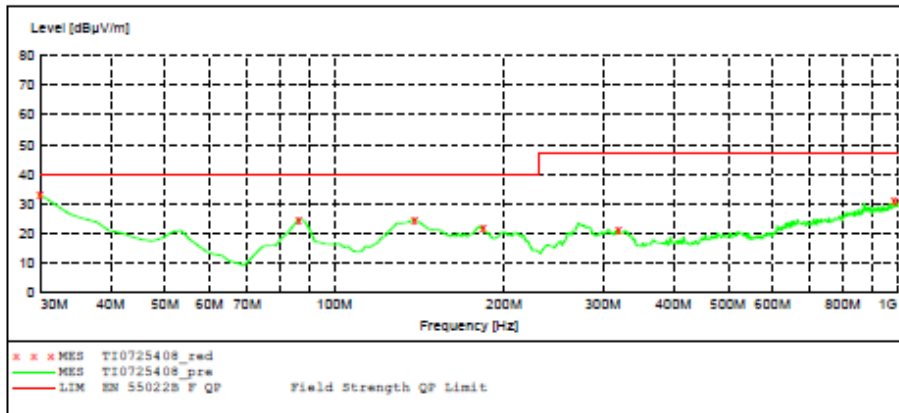
SHENZHEN HUATONGWEI INTERNATIONAL INSPECTION CO.,LTD

RADIATED EMISSION TEST EN 55022 CLASSB

EUT: FMP4378  
 Manufacturer: TI  
 Operating Condition: LOAD  
 Test Site: 3M CHAMBER  
 Operator: MINGHUA.FAN  
 Test Specification: AC 230V/50Hz  
 Comment:  
 Start of Test: 7/25/2013 / 5:15:48PM

SWEEP TABLE: "test (30M-1G)"

Short Description:	Field Strength	Transducer
Start Stop Detector Meas. IF	Time Bandw.	
30.0 MHz 1.0 GHz MaxPeak Coupled 120 kHz		HL562 201106



MEASUREMENT RESULT: "TI0725408\_red"

7/25/2013 5:17PM

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Det.	Height cm	Asimuth deg	Polarisation
30.000000	33.00	-10.0	40.0	7.0	---	100.0	53.00	VERTICAL
86.372745	24.80	-19.4	40.0	15.2	---	100.0	296.00	VERTICAL
138.857715	24.80	-19.8	40.0	15.2	---	100.0	242.00	VERTICAL
182.567134	22.20	-20.5	40.0	17.8	---	100.0	94.00	VERTICAL
319.639279	21.10	-14.6	47.0	25.9	---	100.0	248.00	VERTICAL
988.336673	31.00	-3.1	47.0	16.0	---	100.0	278.00	VERTICAL

Vin:230Vac, VERTICAL, Io: 2.4A  
 Test condition: 1.5m cable with 2R resistor

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