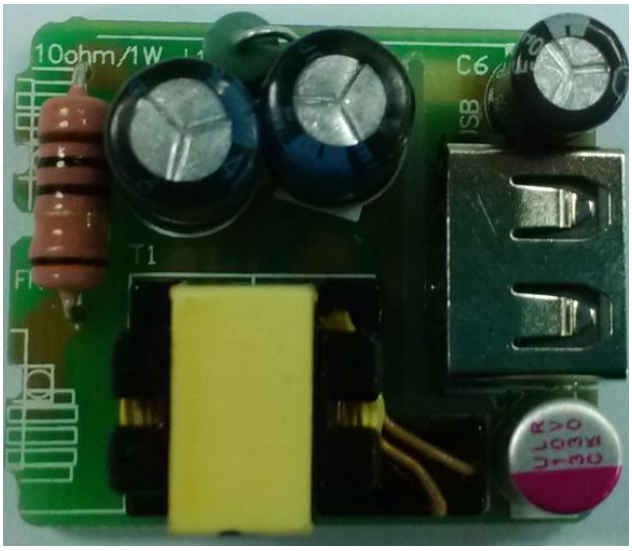
Subject **OB2500NCP Demo Board Manual**	Board Model: CH5V1A2500NCP Doc. No.: OB_DOC_DBM_2500N01
	**Key features:** • Standby power less than 75mW@264Vac • Precise CV/CC regulation • Primary-side sensing and regulation without TL431 and opto-coupler • Cost effective and simplified system design • Average efficiency meet DOE/COC • Intergrated Power MOSFET Switch • No X & Y design • Audio noised free operation • Frequency shuffling technology to improve EMI performance • Meet EN55022 EMI

Revision History

Revise Date	Version	Reason/Issue
2014-12-8	00	First issue
2014-2-5	01	Add COC

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Tables Index

1. Charger Module Specification

1.1. Input Characteristics

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

1.2. Output Characteristics

- Output Voltage 5V
- Output Tolerance ±5%
- Min. load current 0A
- Max. load current 1.0A

1.3. Performance Specifications

- Max. Output Power 5.0W
- Standby Power <75mW @ 230V/50Hz, no load, 25°C
- Efficiency Meet DOE Level 6/COC
- Line Regulation <±2% Max
- Load Regulation <±5%
- Ripple & Noise 80 mV Max
- Turn on Delay Time 2s. Max. @100V with full load

1.4. Protection Function

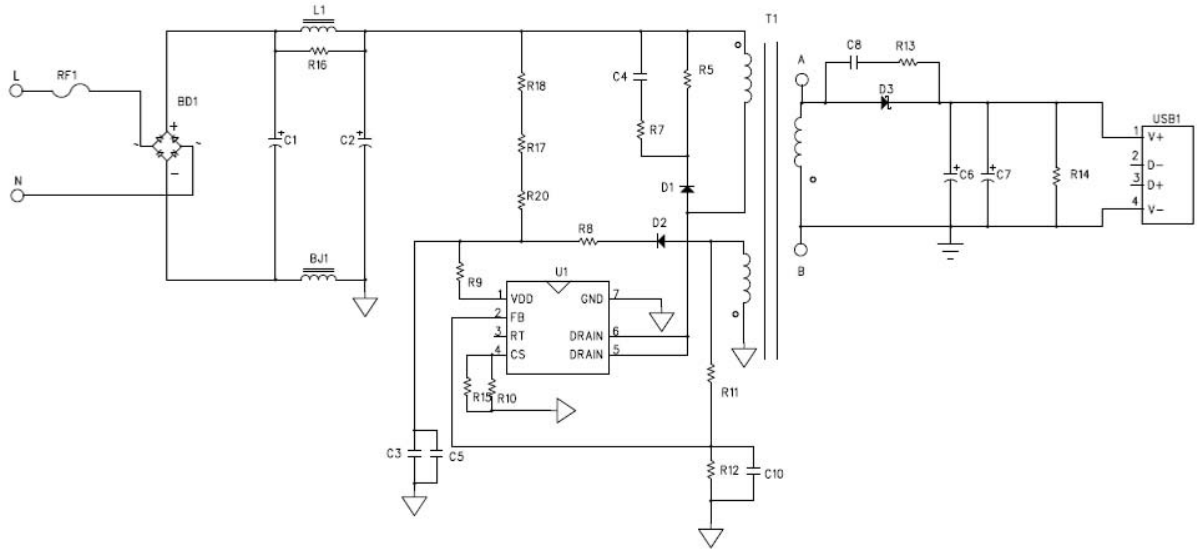
- Short Circuit Protection Output shut down with automatic recovery
- Over Voltage Protection Output shut down with automatic recovery
- Open Loop Protection Output shut down with automatic recovery

1.5. Environments

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

2. Charger Module Information

2.1. Schematic

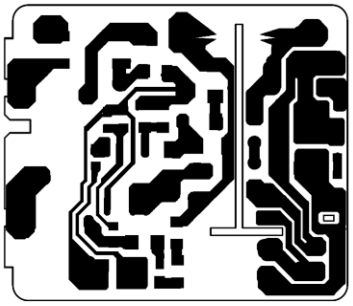


2.2. Bill of material

No.	Position	Description	Quantity
1	RF1	Fuse 10Ω/1W	1
2	R5	RES SMD 1206 270kΩ 5%	1
3	R7	RES SMD 1206 330Ω 5%	1
4	R8	RES SMD 0603 10Ω 5%	1
5	R9	RES SMD 0603 10Ω 5%	1
6	R10	RES SMD 0805 3.6Ω 1%	1
7	R11	RES SMD 0603 24kΩ 1%	1
8	R12	RES SMD 0603 6.8kΩ//150kΩ 1%	1
9	R13	RES SMD 0603 68Ω 5%	1
10	R14	RES SMD 1206 2.4kΩ 5%	1
11	R15	RES SMD 0805 3.9Ω 1%	1
12	R16	RES SMD 0805 2.7kΩ 5%	1
13	R17,R18	RES SMD 0805 1MΩ 5%	2
14	R20	RES SMD 0805 3MΩ 5%	1
15	C1,C2	EC 4.7μF/400V Φ8*12.5mm	2
16	C5	Cap SMD 0805 2.2μF/50V	1
17	C4	Cap SMD 1206 470pF/250V	1
18	C8	Cap SMD 0805 1nF/50V	1
19	C6	EC 330μF/10V Φ7*12.5mm	1
20	C7	EC 330μF/10V Φ6.3*8.5mm Low ESR	1
21	BD1	Bridge Rectifer MB10F SMD 1000V/0.5A	1
22	D1	Diode 1N4007W 1000V/1A SOD-123	1
23	D2	Diode BAV21W SOD-123 250V/0.2A	1

24	D3	Schottky Diode SS54LR 40V/5A SMB	1
25	T1	EE12 Lm:2.2mH Np：Na：Ns=132:17:8 Ae:19.2mm^2	1
26	L1	Choke 1mH/1W Φ4*7mm	1
27	BJ1	Choke 6.8μH SMD 0805	1
28	U1	OB2500NCP SOP7	1
29	USB	Horizontal USB connector	1

2.3 PCB Gerber File



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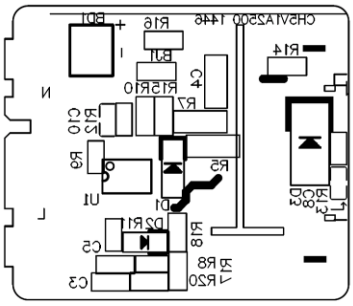

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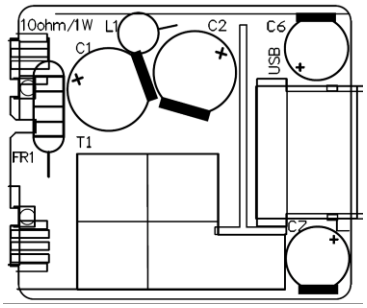
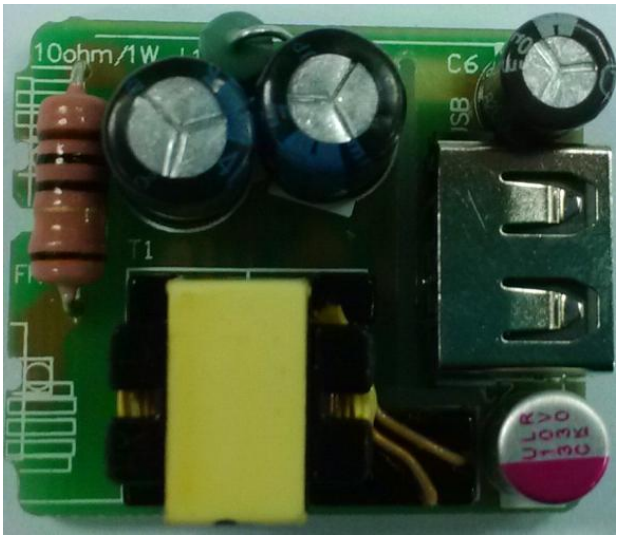
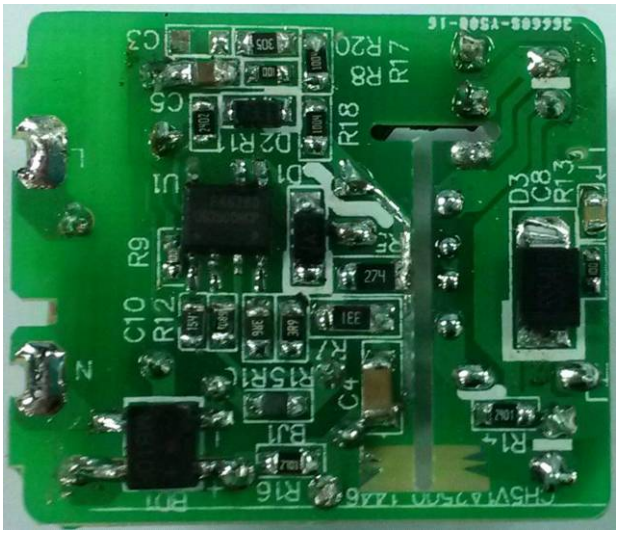


Top

2.4 Charger Module Snapshot





2.5 Transformer design

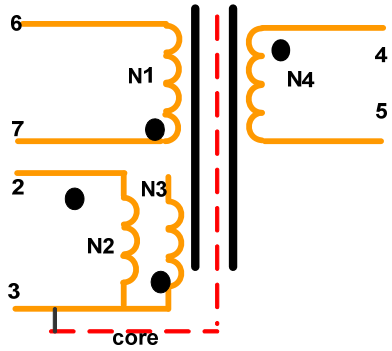
2.5.1 Transformer Specification

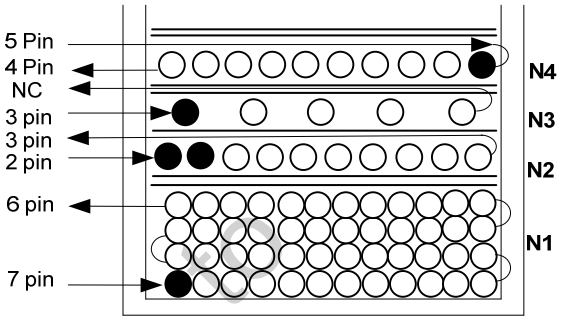
1）Bobbin: EE12（7Pin） Vertical Ae:19.2mm^2

2）Core : ACP40(equals to PC40 of TDK)

3）Lm（7-6）=2.2mH±7%. (at: 10kHz/1V)

2.5.2 Structure/Material





Winging	Material	Start	Turns	Finish	Remark
N1	Φ0.13mm *1 2UEW	7	132	6	Four-layer with tight tension
TAPE	TAPE W=5.5mm (Y)		2		
N2	Φ0.13mm *2 2UEW	2	17	3	
TAPE	TAPE W=5.5mm (Y)		1		
N3	Φ0.13mm *1 2UEW	3	7	NC	Sparse Rolling
TAPE	TAPE W=5.5mm (Y)		2		
N4	Φ0.4mm *1 triple insulated wire	5	8	4	Reverse Rolling
TAPE	TAPE W=5.5mm (Y)		2		
Note:Core connect to Pin 6.					

3. Performance Evaluation

This session presents the test results of OB2500NCP 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 the end of 1.5m, 24 AWG output cable.

Performance Highlights

- Standby power less than 75mW@264V
- Precise CV/CC regulation
- The average efficiency meet DOE Level 6/COC
- EMI passed EN55022 and FCC15 Class B test with more than 6dB margin

System Electrical Specification

Description		Symbol	Min	Typ	Max	Units	Comment
Input Section							
Input Voltage		V_{IN}	90		264	V	2 Wire
Line Frequency		f_{LINE}	47	50/60	63	Hz	
Standby Power					75	mW	230V
Output characteristics							
CV Section	Output Voltage	$V_{OUT\ CV}$	4.75		5.25	V	
	Output Current	$I_{OUT\ CV}$	0		1.0	A	
CC Section	Output Voltage	$V_{OUT\ CC}$	3.0			V	
	Output Current	$I_{OUT\ CC}$	1.1		1.3	A	
Ripple & Noise		V_{RIPPLE}			80	mV_{P-P}	
Continuous Output Power		P_{OUT}		5W			
Over Current Protection		$I_{OUT\ MAX}$			1.30	A	
Active Mode Efficiency		η	73.77/ 64.59			%	Measured at Line End, V_{IN}=115V/230V
Time sequence							
Turn on delay time					2	s	
Environmental							
Conducted/Radiation EMI		Meets EN55022B\FCC 15					
Safety		Meets IEC950,UL1950,Class II					
ESD			18			kV	

Test Equipments

Item	Vender	Module
AC Source	WEST	WEW1010
Digital Power Meter	YOKOGAWA	WT210
Electrical Load	Chroma	63030
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
90V/60HZ	34.4	5.022	<75mW	Pass
115V/60HZ	36.8	5.002		
230V/50HZ	54.5	4.959		
264V/50HZ	61.3	4.952		

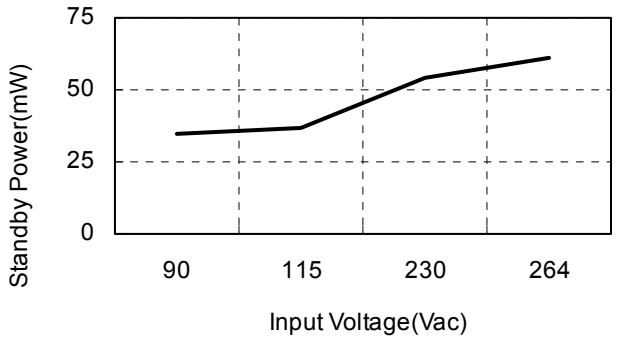


Fig. 1 Standby Power vs. Input Voltage

3.1.2. Efficiency

Table. 2 Efficiency Line end with 24AWG,1.5m（268mΩ） output line.

Input voltage	10%	25%	50%	75%	100%	25%~100 % Load Aver. Eff.	Standards DOE	Standards COC	Test Result
115V/60Hz	73.29%	76.64%	76.02%	74.90%	73.73%	75.32%	73.62%	64.59% (10%Load)	Pass
230V/50Hz	68.49%	74.55%	75.70%	75.35%	74.53%	75.03%		73.77%	

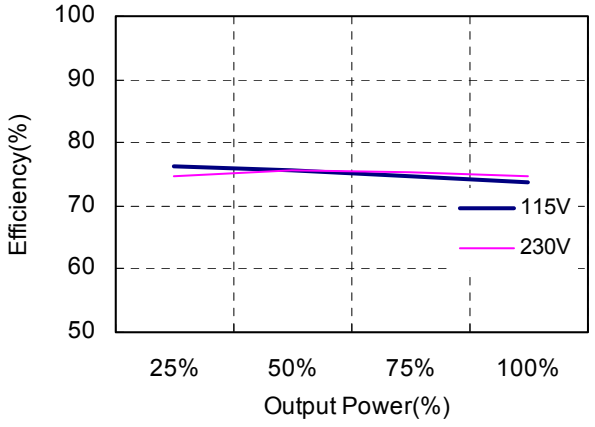


Fig. 2 Efficiency vs. Percent of Rated Output Power

3.1.3. I-V Curve

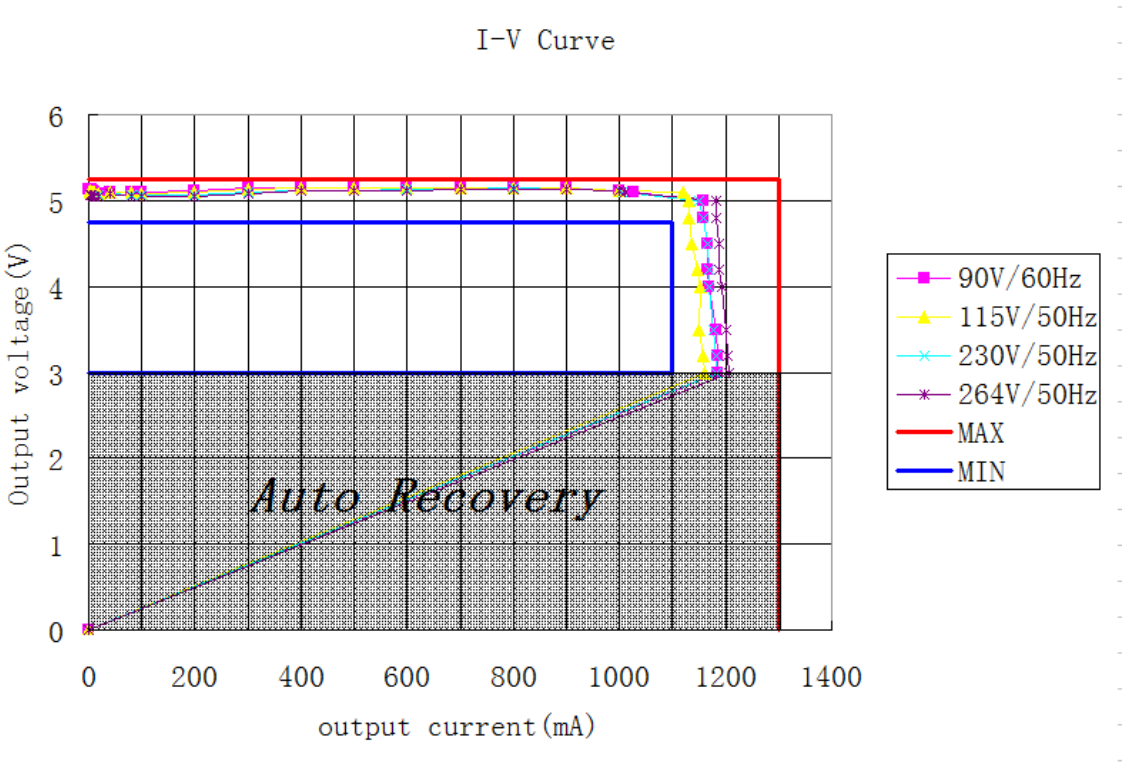


Fig. 3 I-V Curve

3.2. Output Characteristics

3.2.1. Line Regulation & Load Regulation

Table. 3 Line Regulation & Load Regulation

Input voltage	No load(V)	Half load(V)	Full load(V)	Specification(V)	Test result
90V/60Hz	5.022	5.003	4.965	4.75-5.25	Pass
115V/60Hz	5.002	5.000	4.970	4.75-5.25	
230V/50Hz	4.959	4.982	4.968	4.75-5.25	
264V/50Hz	4.952	4.976	4.965	4.75-5.25	
Line Regulation	±0.70%			<±2%	Pass
Load Regulation	±0.57%			<±5%	Pass

3.2.2. Ripple & Noise

Table. 4 Ripple & Noise

Input voltage	R&N (mV)		
	No load	Full load	Remark
90V/60Hz	13	71	Fig. 4,5
115V/60Hz	13	66	
230V/50Hz	15	56	
264V/50Hz	15	55	Fig. 6,7

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

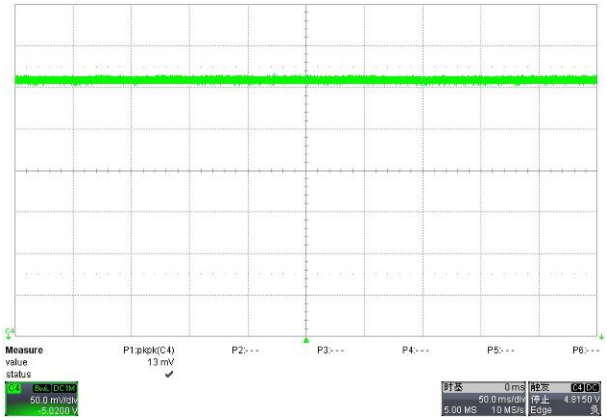


Fig. 4 Measured ripple& noise waveform@90V/60Hz, no load

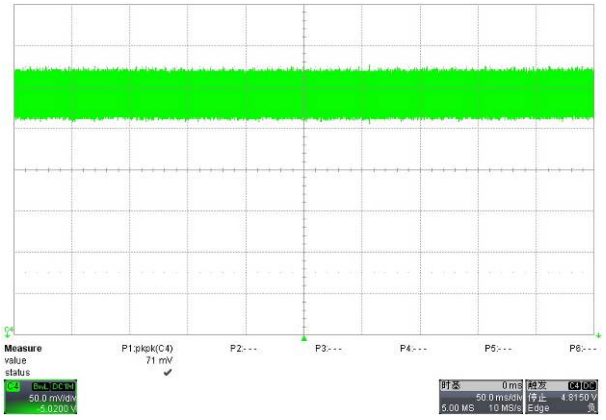


Fig. 5 Measured ripple& noise waveform@90V/60Hz, full load

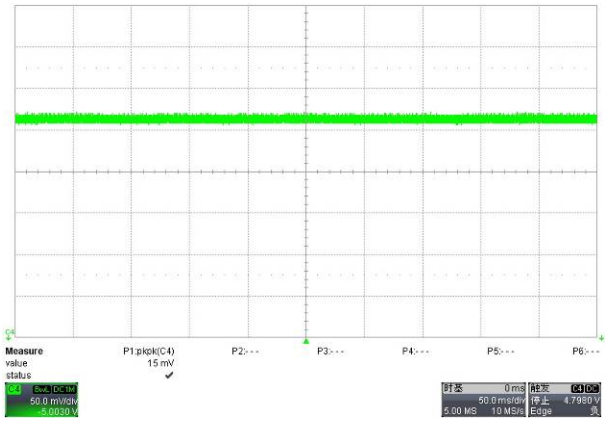


Fig. 6 Measured ripple& noise waveform@264V/50Hz, no load

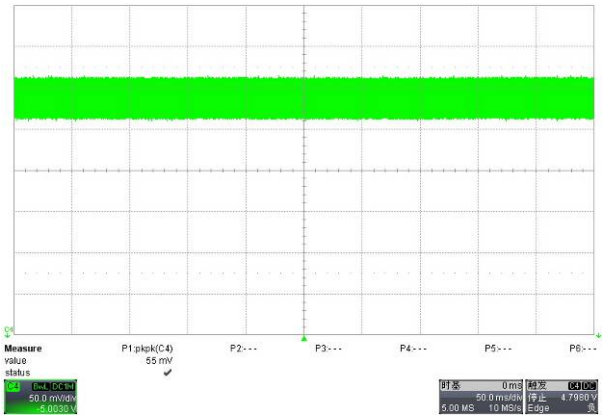


Fig. 7 Measured ripple& noise waveform@264V/50Hz, full load

3.2.3. Over Shoot & Under Shoot

Over shoot and under shoot were measured under below conditions.

a. AC input switch on for over shoot and off for under shoot.

b. Input voltage ranges from 90V/60Hz~264V/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	

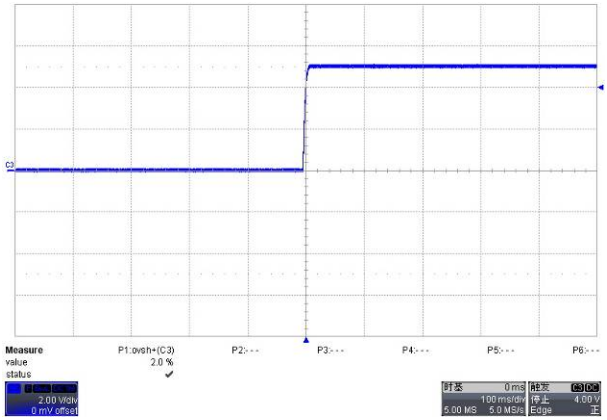


Fig. 8 Measured overshoot waveform@90V/60Hz, full load

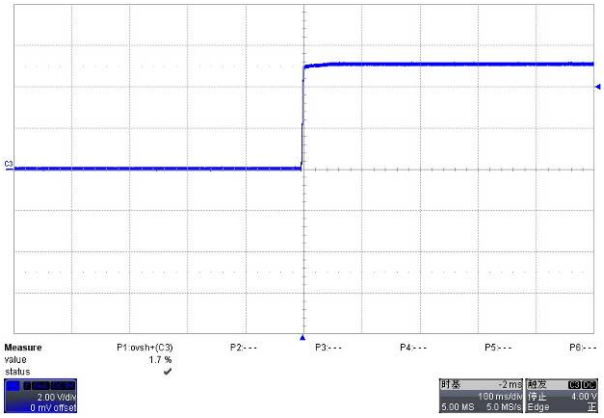


Fig. 9 Measured overshoot waveform@90V/60Hz, no load

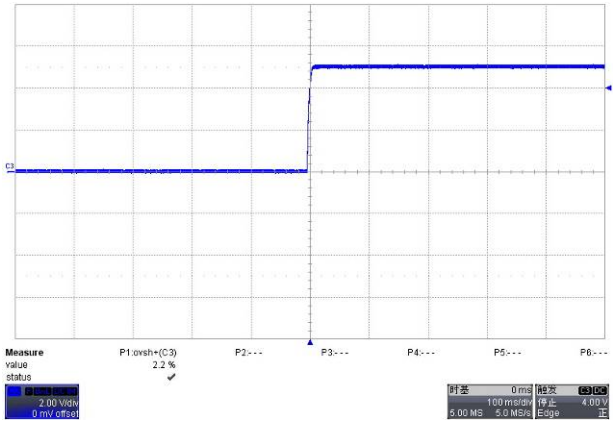


Fig. 10 Measured overshoot waveform@264V/50Hz, full load

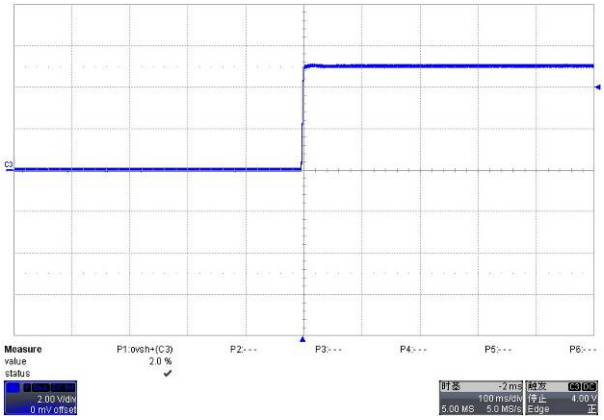


Fig. 11 Measured overshoot waveform@264V/50Hz, no load

3.2.4. Dynamic Test

A dynamic loading with low load lasting for 50ms/20ms and high load lasting for 50ms/20ms is added to output. The high load is 0.5A and the low load is 0A.The ramp is set at 0.125A/μs at transient. Measurement was taken at line end(Same as R&N measurement)

Table. 6 Output voltage under dynamic test(0.5A lasting for 50ms,0A lasting for 50ms)

Input	Vomin-Vomax(v)	Remark
90V/60Hz	5.42~4.06	Fig. 12
115V/60Hz	5.45~4.07	
230V/50Hz	5.53~4.22	
264V/50Hz	5.55~4.26	Fig. 13

(0.5A lasting for 20ms,0A lasting for 20ms)

Input	Vomin-Vomax(v)	Remark
90V/60Hz	5.42~4.73	Fig. 14
115V/60Hz	5.43~4.75	
230V/50Hz	5.47~4.80	
264V/50Hz	5.49~4.76	Fig. 15

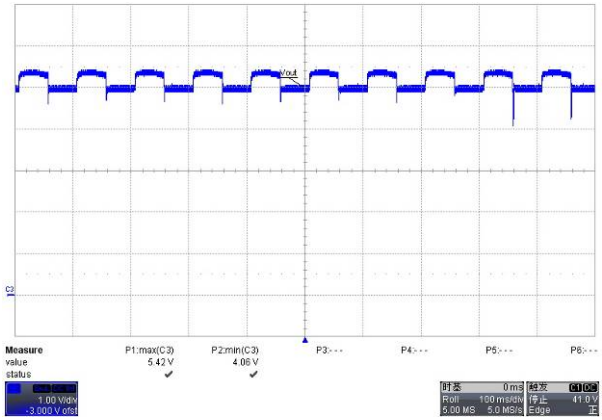


Fig. 12 Output voltage waveform under Dynamic test @90V/60Hz 0-0.5A,50ms

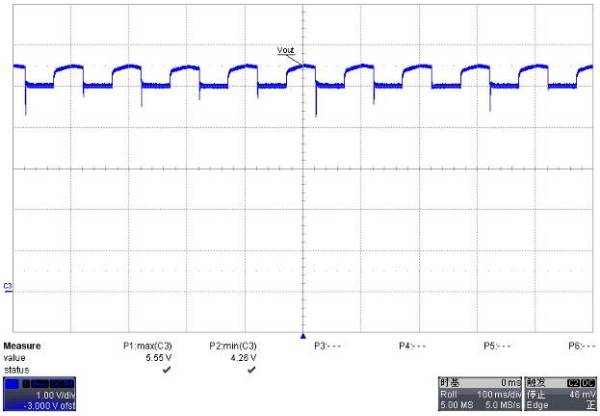


Fig. 13 Output voltage waveform under Dynamic test @264V/50Hz 0-0.5A,50ms

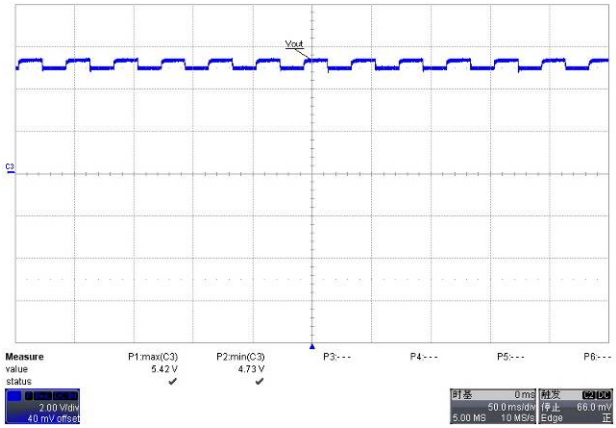


Fig. 14 Output voltage waveform under Dynamic test @90V/60Hz 0-0.5A,20ms

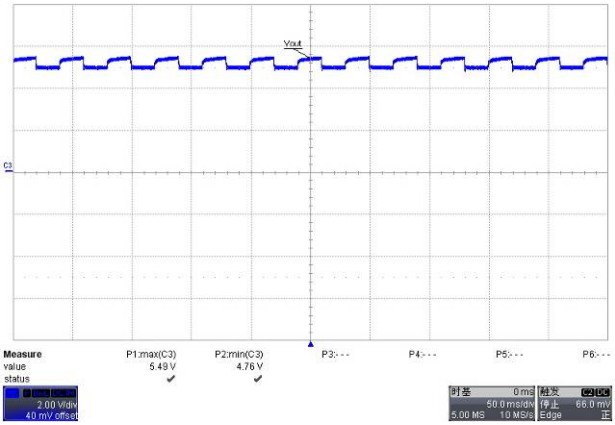


Fig. 15 Output voltage waveform under Dynamic test @264V/50Hz 0-0.5A,20ms

3.2.5. Time Sequence (Full load)

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

Item	Input voltage	Meas. Data	Test spec.	Test results	Remark
Turn-on delay time	100V/60Hz	1.26s	<2s	**Pass**	Fig. 16
	240V/50Hz	0.46s		**Pass**	Fig. 17
Rise Time	100V/60Hz	9.96ms		**Pass**	Fig. 18
	240V/50Hz	9.26ms		**Pass**	Fig. 19
Fall Time	100V/60Hz	5.56ms		**Pass**	Fig. 20
	240V/50Hz	5.82ms		**Pass**	Fig. 21

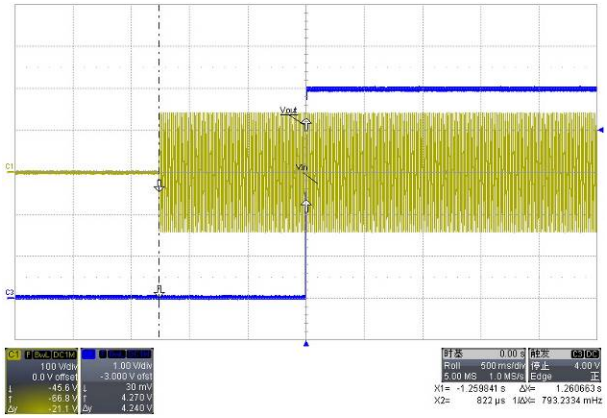


Fig. 16 Turn on delay time measured waveform @100V/60Hz,full load

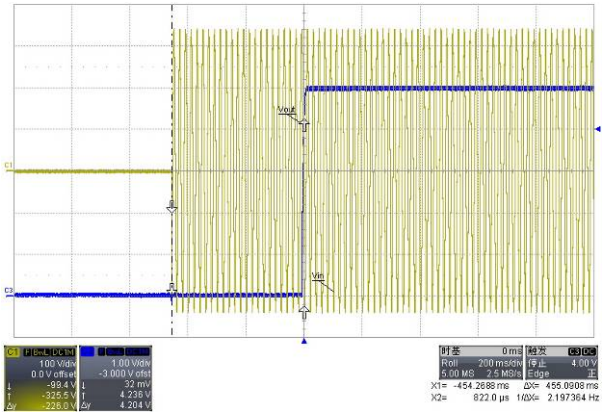


Fig. 17 Turn on delay time measured waveform @240V/50Hz,full load

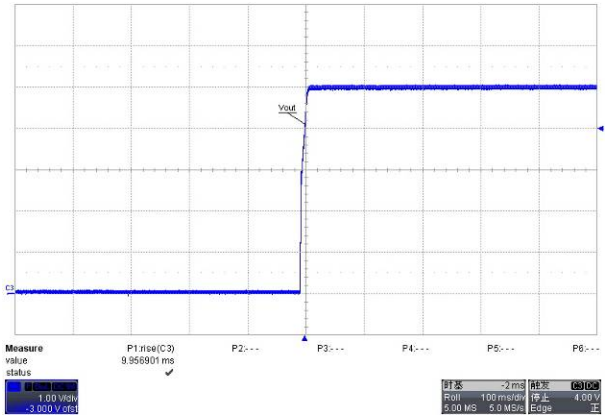


Fig. 18 Rise time measured waveform@100V/60HZ,full load

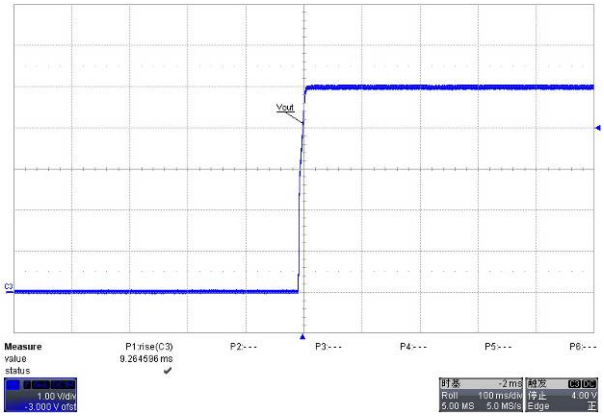


Fig. 19 Rise time measured waveform@240V/50HZ,full load

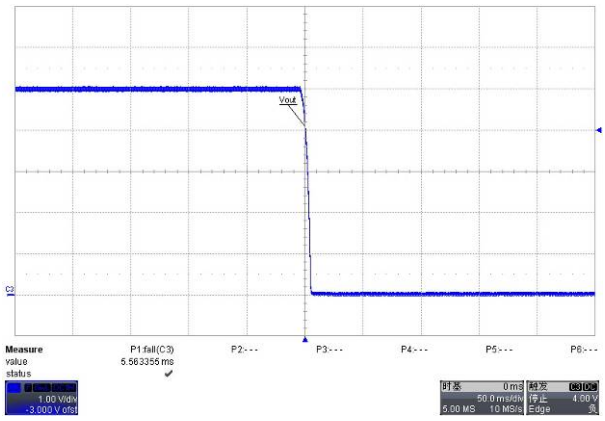


Fig. 20 Fall time measured waveform@100V/60Hz,full load

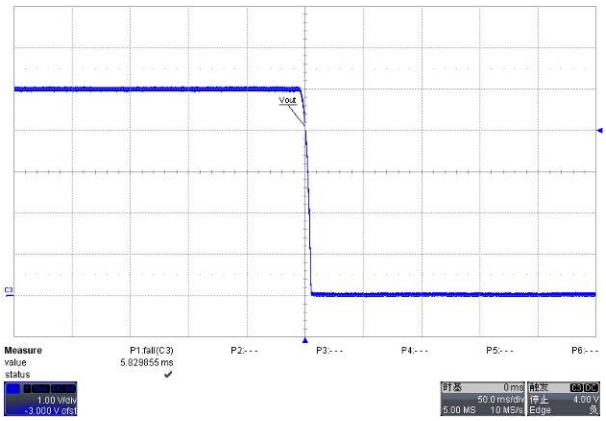


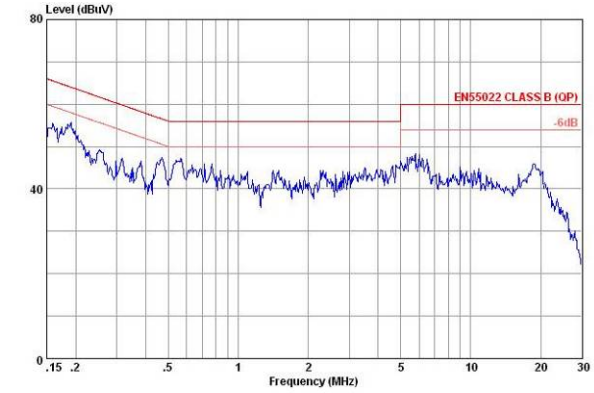
Fig. 21 Fall time measured waveform@240V/50Hz,full load

3.3. EMI Test

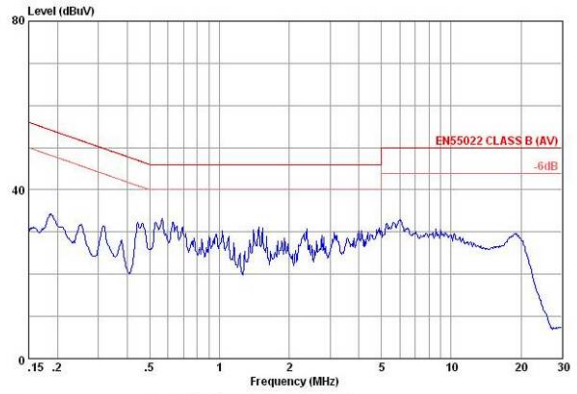
The Power supply passed EN55022 Class B EMI requirement with more than 6dB margin

3.3.1. Conducted EMI Test

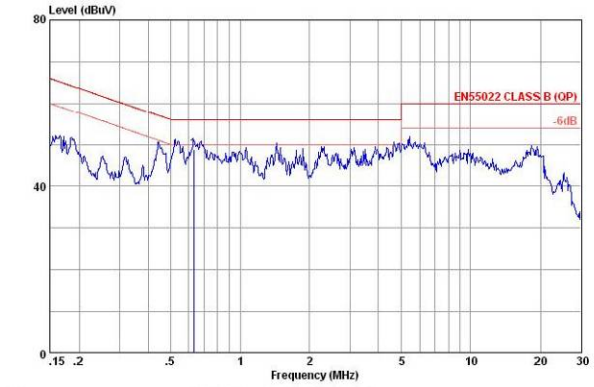
3.3.1.1. EN55022 CLASS B @ full load report



Site : Audix(Shanghai) Shielded1
Condition : EN55022 CLASS B (QP) ESH2-Z5-2014 LINE
Project No. :
Applicant :
EUT : OB2500N
M/N : 5V 1A
S/N :
Power Supply : 230V/50Hz
Ambient : 22'C 48%RH
Test line : L
Test Mode :
Test Engineer : Eric
Memo :

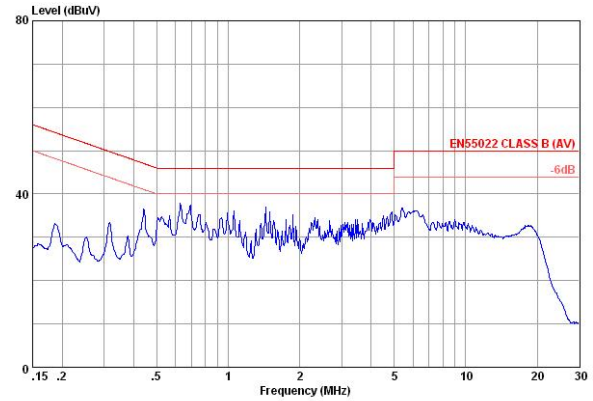


Site : Audix(Shanghai) Shielded1
Condition : EN55022 CLASS B (AV) ESH2-Z5-2014 LINE
Project No. :
Applicant :
EUT : OB2500N
M/N : 5V 1A
S/N :
Power Supply : 230V/50Hz
Ambient : 22'C 48%RH
Test line : L
Test Mode :
Test Engineer : Eric
Memo :



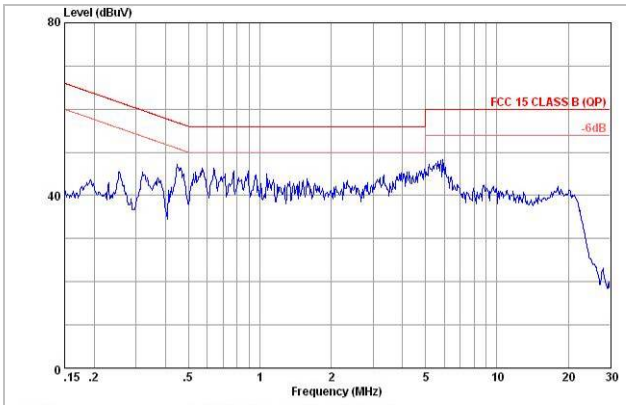
Site : Audix(Shanghai) Shielded1
Condition : EN55022 CLASS B (QP) ESH2-Z5-2014 NEUTRAL
Project No. :
Applicant :
EUT : OB2500N
M/N : 5V 1A
S/N :
Power Supply : 230V/50Hz
Ambient : 22'C 48%RH
Test line : N
Test Mode :
Test Engineer : Eric
Memo :

	Freq	Level	Read Level	Cable Loss	LISN Factor	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dB	dBuV	dB	
1	0.630400	48.71	48.51	0.04	0.16	0.20	56.00	-7.29	QP

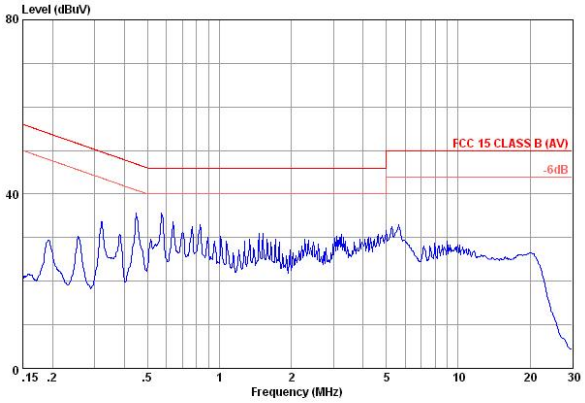


Site : Audix(Shanghai) Shielded1
Condition : EN55022 CLASS B (AV) ESH2-Z5-2014 NEUTRAL
Project No. :
Applicant :
EUT : OB2500N
M/N : 5V 1A
S/N :
Power Supply : 230V/50Hz
Ambient : 22'C 48%RH
Test line : N
Test Mode :
Test Engineer : Eric
Memo :

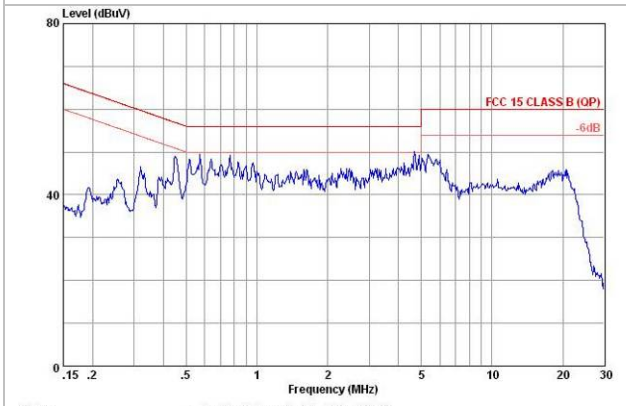
3.3.1.2. FCC CLASS B @ full load report



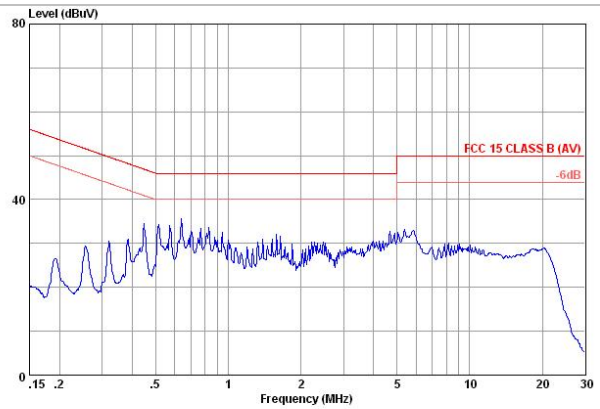
Site	: Audix(Shanghai) Shielded1
Condition	: FCC 15 CLASS B (QP) ESH2-Z5-2014 LINE
Project No.	:
Applicant	:
EUT	: OB2500N
M/N	: 5V 1A
S/N	:
Power Supply	: 120V/60Hz
Ambient	: 22'C 48%RH
Test line	: L
Test Mode	:
Test Engineer	: Eric
Memo	:



Site	: Audix(Shanghai) Shielded1
Condition	: FCC 15 CLASS B (AV) ESH2-Z5-2014 LINE
Project No.	:
Applicant	:
EUT	: OB2500N
M/N	: 5V 1A
S/N	:
Power Supply	: 120V/60Hz
Ambient	: 22'C 48%RH
Test line	: L
Test Mode	:
Test Engineer	: Eric



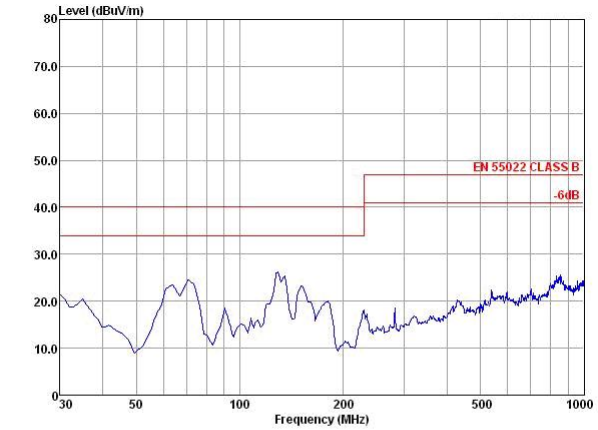
Site	: Audix(Shanghai) Shielded1
Condition	: FCC 15 CLASS B (QP) ESH2-Z5-2014 NEUTRAL
Project No.	:
Applicant	:
EUT	: OB2500N
M/N	: 5V 1A
S/N	:
Power Supply	: 120V/60Hz
Ambient	: 22'C 48%RH
Test line	: N
Test Mode	:
Test Engineer	: Eric
Memo	:



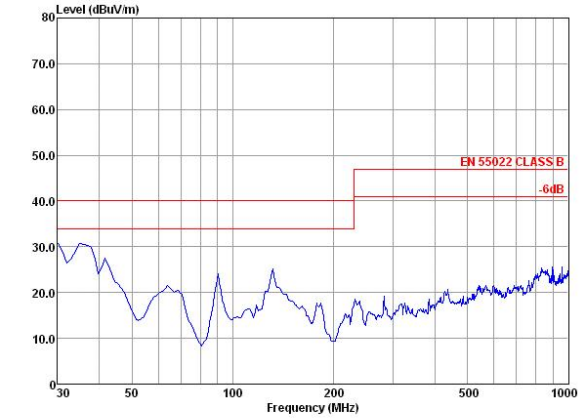
Site	: Audix(Shanghai) Shielded1
Condition	: FCC 15 CLASS B (AV) ESH2-Z5-2014 NEUTRAL
Project No.	:
Applicant	:
EUT	: OB2500N
M/N	: 5V 1A
S/N	:
Power Supply	: 120V/60Hz
Ambient	: 22'C 48%RH
Test line	: N
Test Mode	:
Test Engineer	: Eric
Memo	:

3.3.2. Radiation EMI Test

3.3.2.1. EN55022 CLASS B @ full load report

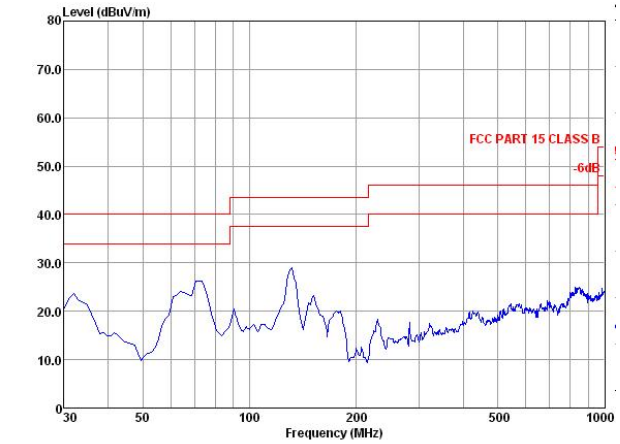



```
Site          : Audix(Shanghai) Chamber3
Condition     : EN 55022 CLASS B HORIZONTAL
Project No.   :
Applicant     :
EUT           : OB2500N
M/N           : 5V 1A
S/N           :
Power Supply  : 230V/50Hz
Ambient       : 22'C  60%RH
Test Mode     :
Test Engineer: Bill
Memo          :
```

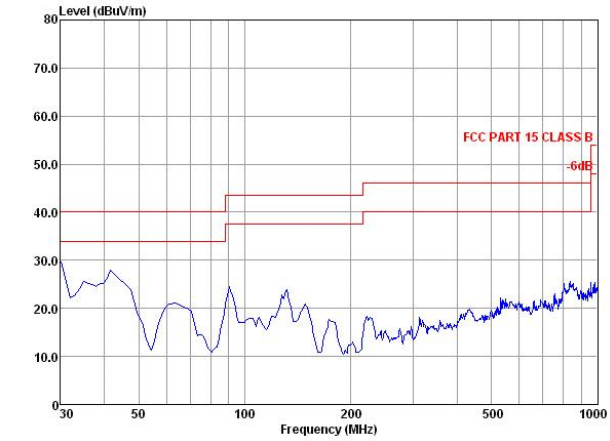



```
Site          : Audix(Shanghai) Chamber3
Condition     : EN 55022 CLASS B VERTICAL
Project No.   :
Applicant     :
EUT           : OB2500N
M/N           : 5V 1A
S/N           :
Power Supply  : 230V/50Hz
Ambient       : 22'C  60%RH
Test Mode     :
Test Engineer: Bill
Memo          :
```

3.3.2.2. FCC CLASS B @ full load report




```
Site          : Audix(Shanghai) Chamber3
Condition     : FCC PART 15 CLASS B HORIZONTAL
Project No.   :
Applicant     :
EUT           : OB2500N
M/N           : 5V 1A
S/N           :
Power Supply  : 120V/60Hz
Ambient       : 22'C  60%RH
Test Mode     :
Test Engineer: Bill
Memo          :
```




```
Site          : Audix(Shanghai) Chamber3
Condition     : FCC PART 15 CLASS B VERTICAL
Project No.   :
Applicant     :
EUT           : OB2500N
M/N           : 5V 1A
S/N           :
Power Supply  : 120V/60Hz
Ambient       : 22'C  60%RH
Test Mode     :
Test Engineer: Bill
Memo          :
```

4. Protection Function

4.1. Over voltage protection

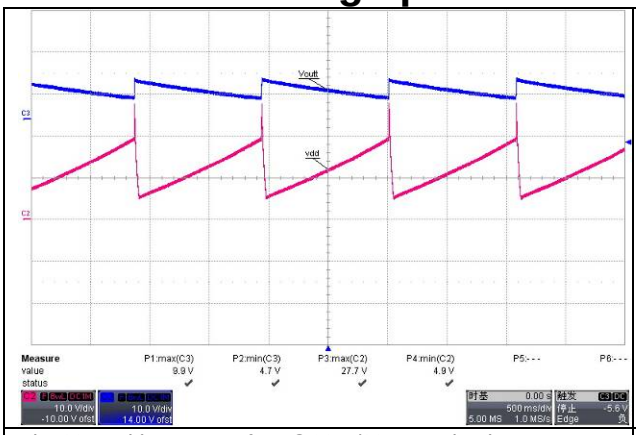


Fig. 22 Vdd、Vo waveform@90 V/60Hz, no load

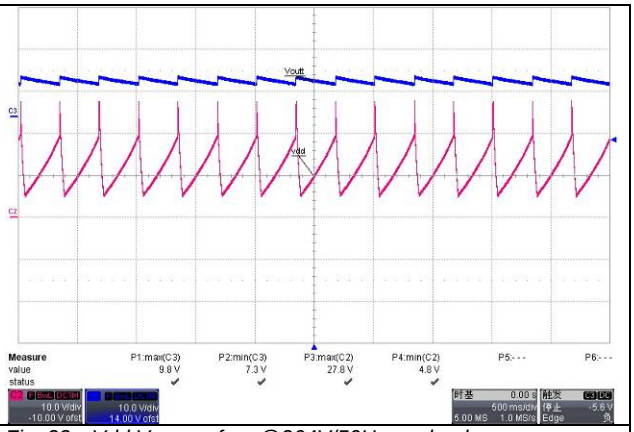


Fig. 23 Vdd Vo waveform@264V/50Hz, no load

4.2. Short circuit protection

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

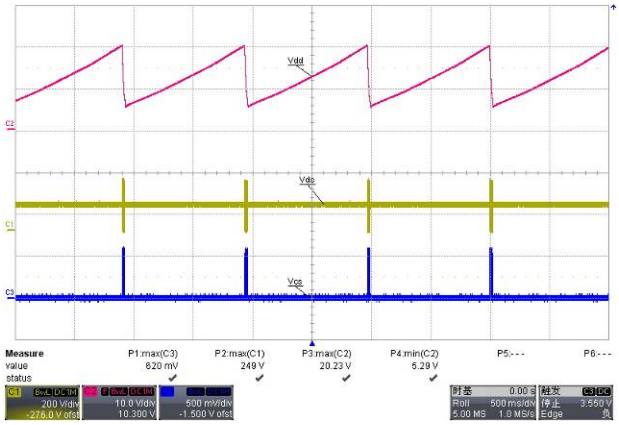


Fig. 24 Output short, Vds、Vcs、Vdd waveform@90 V/60Hz, full load

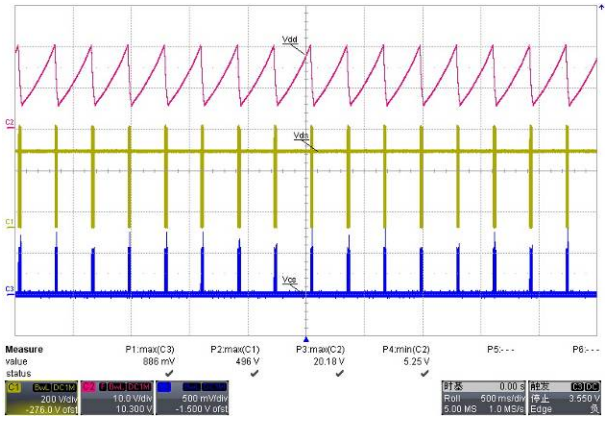


Fig. 25 Output short, Vds、Vcs、Vdd waveform@264 V/50Hz, full load

4.3. Over Current Protection

Table. 8 Over current Protection

Input	OCP Current	Max. startup current
90V/60Hz	1.182A	1.179A
115 V/60Hz	1.154A	1.151A
230V/50Hz	1.167A	1.164A
264V/50Hz	1.188A	1.185A

4.4. Short Current

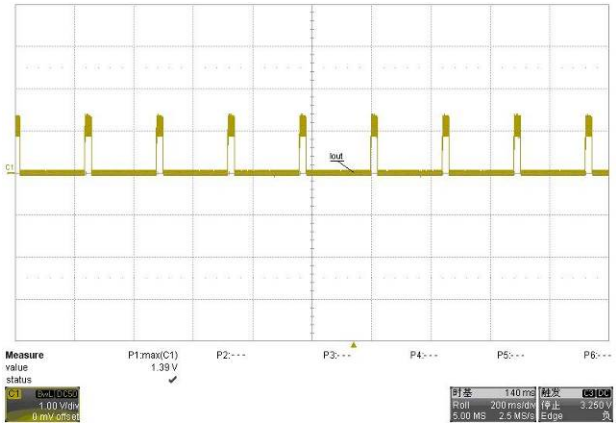


Fig. 26 Output short, output current @264 V/60Hz, full load （1A/V）

4.5. Open Loop Protection

Table.9 OLP @ Full load

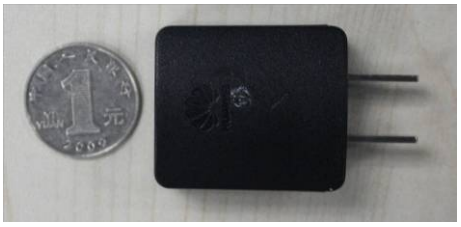
Input	OLP Protection
115V/60Hz	OK
230V/50Hz	OK

5. Thermal Testing

Vin	Po	Ambient	IC	BD	Tr(wire)	Tr(core)	Input EC	Output EC	Output Diode
90V/60Hz	5W	40℃	108.8℃	79.2℃	89.3℃	92.3℃	84.3℃	77.9℃	104.5℃
264V/50Hz	5W	40℃	105.4℃	68.0℃	85.9℃	88.3℃	73.0℃	76.6℃	105.1℃

Note: All data were measured at 24AWG，1.5m Line end.

L×W×H=39mm×34mm×23mm.



6. Other Important Waveform

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

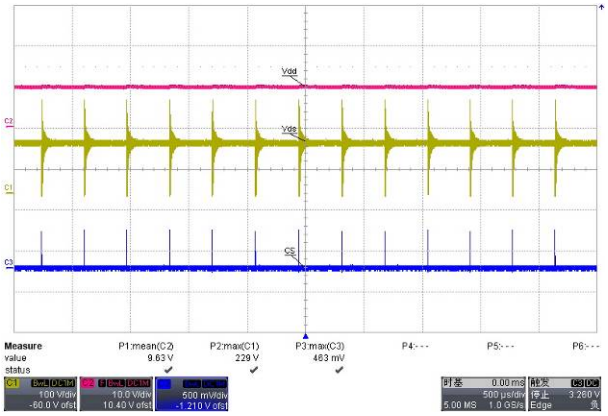


Fig. 27 Vdd, Sense& Vds waveform@90V/60Hz,no load

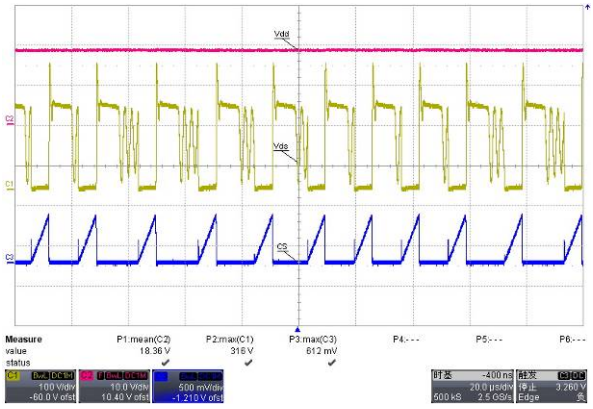


Fig. 28 Vdd, Sense & Vds waveform @90V/60Hz, full load

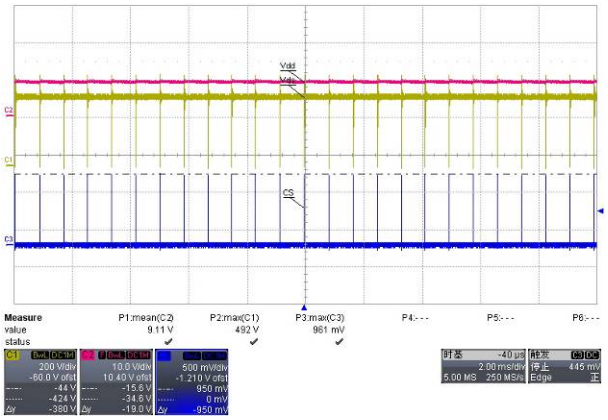


Fig. 29 Vdd, Sense & Vds waveform @264V/50Hz, no load

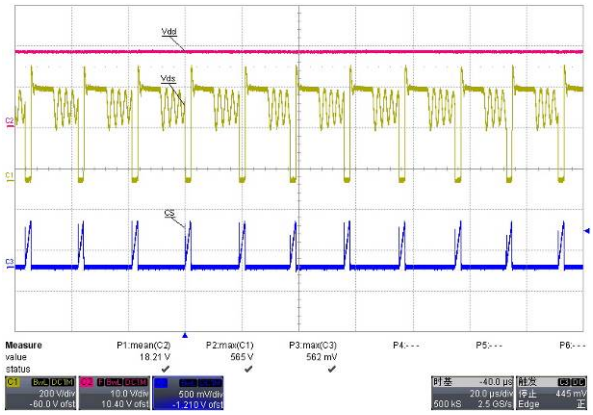


Fig. 30 Vdd, Sense & Vds waveform @264V/50Hz,full load

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

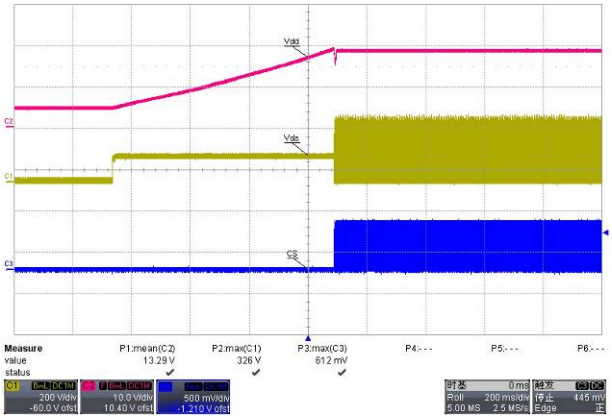


Fig. 31 Start, Vds waveform@90 V/60Hz, full load

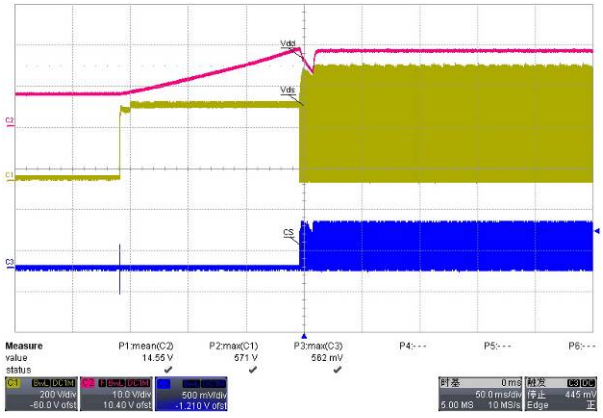


Fig. 32 Start, Vds waveform@264 V/50Hz, full load

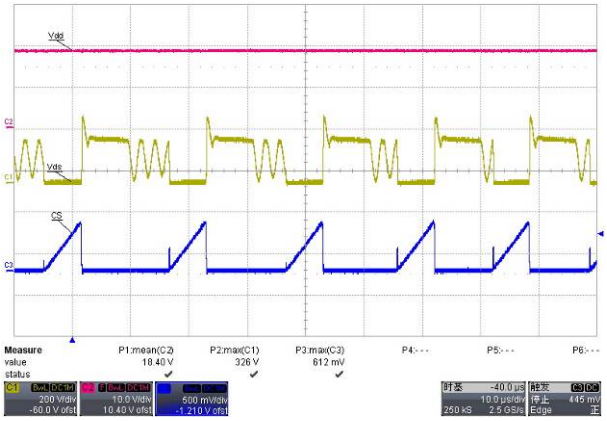


Fig. 33 Normal, Vds waveform@90 V/60Hz, full load

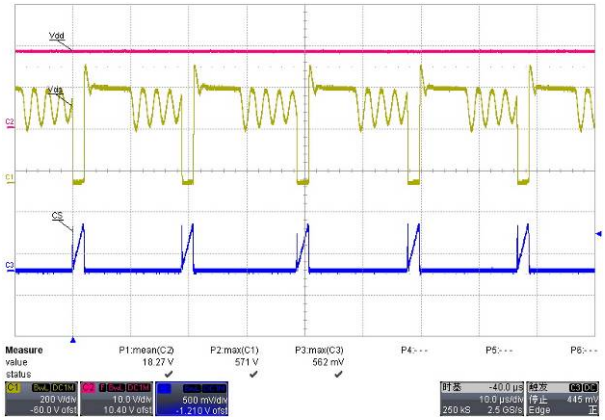


Fig. 34 Normal, Vds waveform@264 V/50Hz, full load

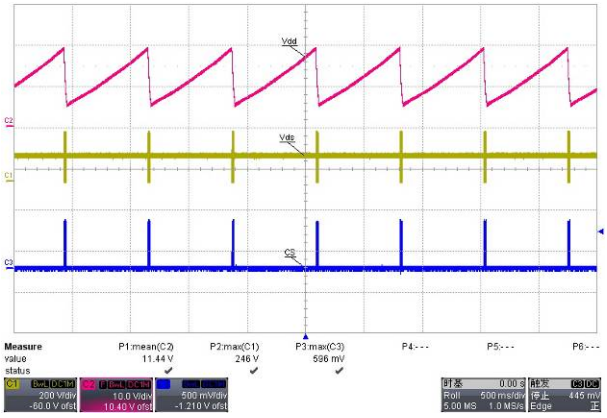


Fig. 35 Output short, Vds waveform@90 V/60Hz

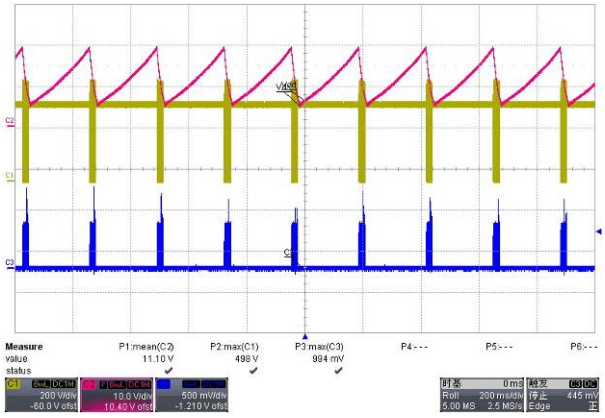


Fig. 36 Output short, Vds waveform@264 V/50Hz

Table. 10 Vds_max @ Full load / Output short

Input	Vds _max(V)
264V/50Hz @Short	498
264V/50Hz @ Full load	571
264V/50Hz @ Start	571

6.3. Output schottky Vak waveform @ start /output short/ normal

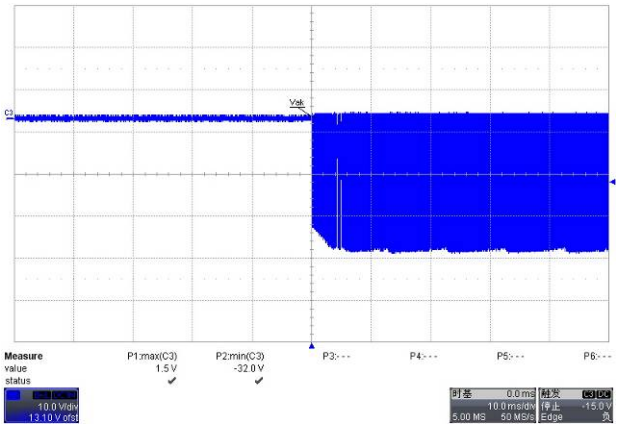


Fig. 37 Start, Vak waveform@264 V/60Hz, full load

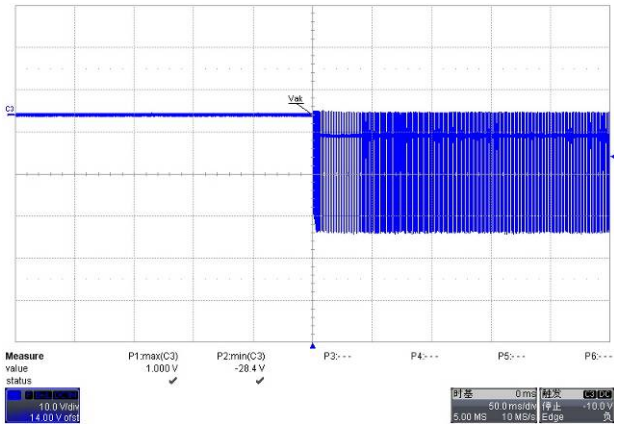


Fig. 38 Start, Vak waveform@264 V/50Hz, no load

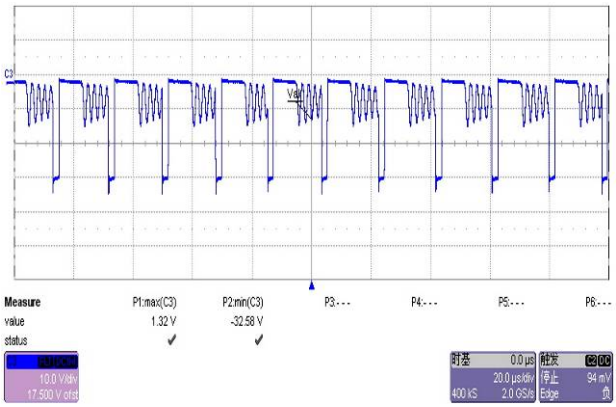


Fig. 39 Normal Vak waveform@264 V/60Hz full load

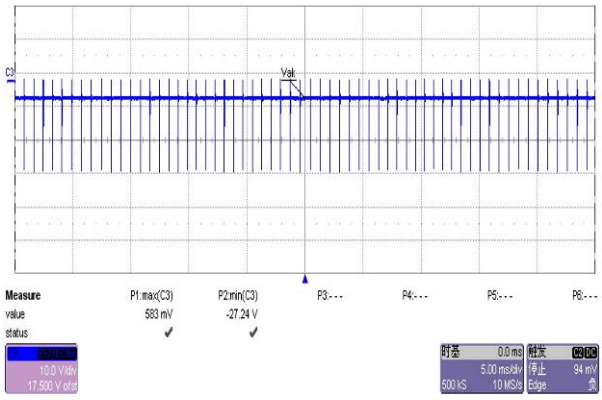


Fig. 40 Normal Vak waveform@264 V/60Hz no load

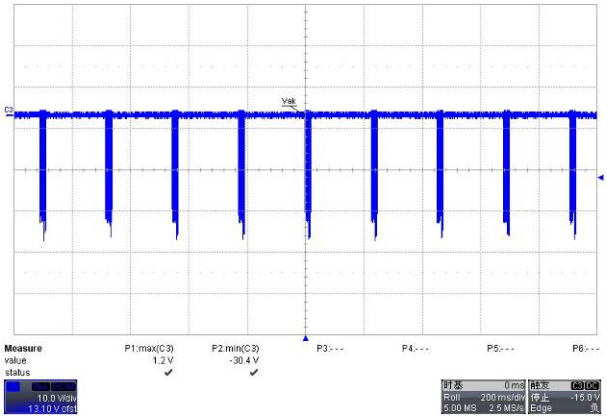


Fig. 41 Short, Vak waveform@264 V/60Hz, full load

Table. 11 Vak_max @ Full load / Output short/Start

Input	Vds_max(V)
264V/50Hz @ Start Full load	32.0
264V/50Hz @ Full load	32.6
264V/50Hz @ Output short	30.4

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