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# AP3772 For 5V 1A Smart Phone Charger Solution

## General Design Specification:

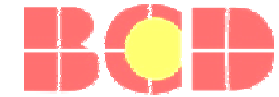
Ø AC Input Range 90-264Vac

Ø DC Output 5V, 1A

Ø Meet “<100mW” No-Load standby Power Consumption Requirement

Ø Meet “EPS2.0” Requirement

# Key Performance



Item	Spec	Test Conditions	Test Data	Result
Output Voltage	4.75~5.25V	90~264Vac @ 0~1A	<b>4.811~5.108</b>	<b>Pass</b>
Ripple	<200mVp-p	90~264Vac @ 0~1A	<b>129mV</b>	<b>Pass</b>
Standby Power	<100mW	230Vac @ 0A	<b>60mW</b>	<b>Pass</b>
Dynamic	4.5~5.5V	90~264Vac @ 0.1~0.85~0.1A 5mS 0.5A/uS	<b>4.78~5.18V</b>	<b>Pass</b>
Common Mode Noise	<2Vp-p	90~264Vac @ 0.5A 30k~500kHz	<b>1.7Vp-p</b>	<b>Pass</b>
EMC	EN55022B -6dB	115Vac 230Vac@ 1A	<b>-10dB</b>	<b>Pass</b>
ESD	15kV	230Vac @ 1A	<b>19kV</b>	<b>Pass</b>

# Specification



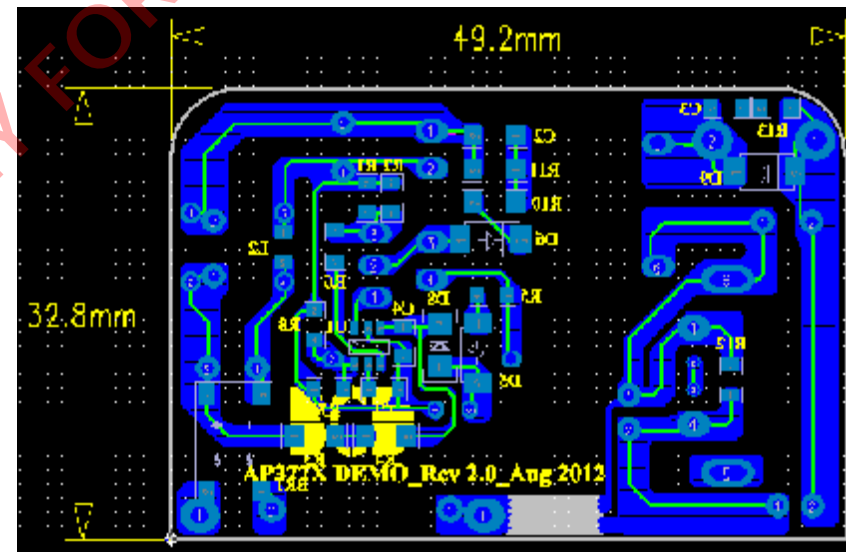
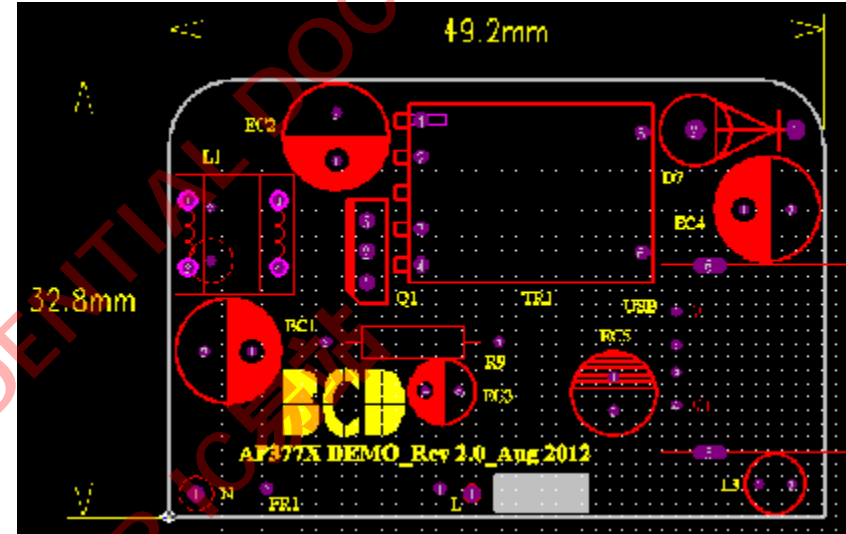
Description	Min	Type	Max	Units	Conditions
<b>Input</b>					
Voltage	90		264	VAC	
Frequency	47	50/60	63	Hz	
No-Load Input Power (230Vac)			30	mW	
<b>Output</b>					
Output Voltage	4.75	5	5.25	V	
Output Current	0		1	A	
Output Power		5		W	
Output Ripple Voltage			200	mVp-p	I <sub>out</sub> = 1A @ 25°C, 20MHz bandwidth
Common Mode Noise			2	Vp-p	30k~500kHz, Load with 10ohm Resistor
Output Over Current Protection	1		1.2		Hiccup, Auto Restart
Ambient Temperature			45	°C	
<b>Efficiency</b>					
Average Efficiency (EPS2.0)	68.2			%	Measured at end of output DC-Cable, 115Vac & 230Vac @ 25°C
<b>EMI</b>	Pass EN55022 Class B with 6dB Margin				

# Test Equipment

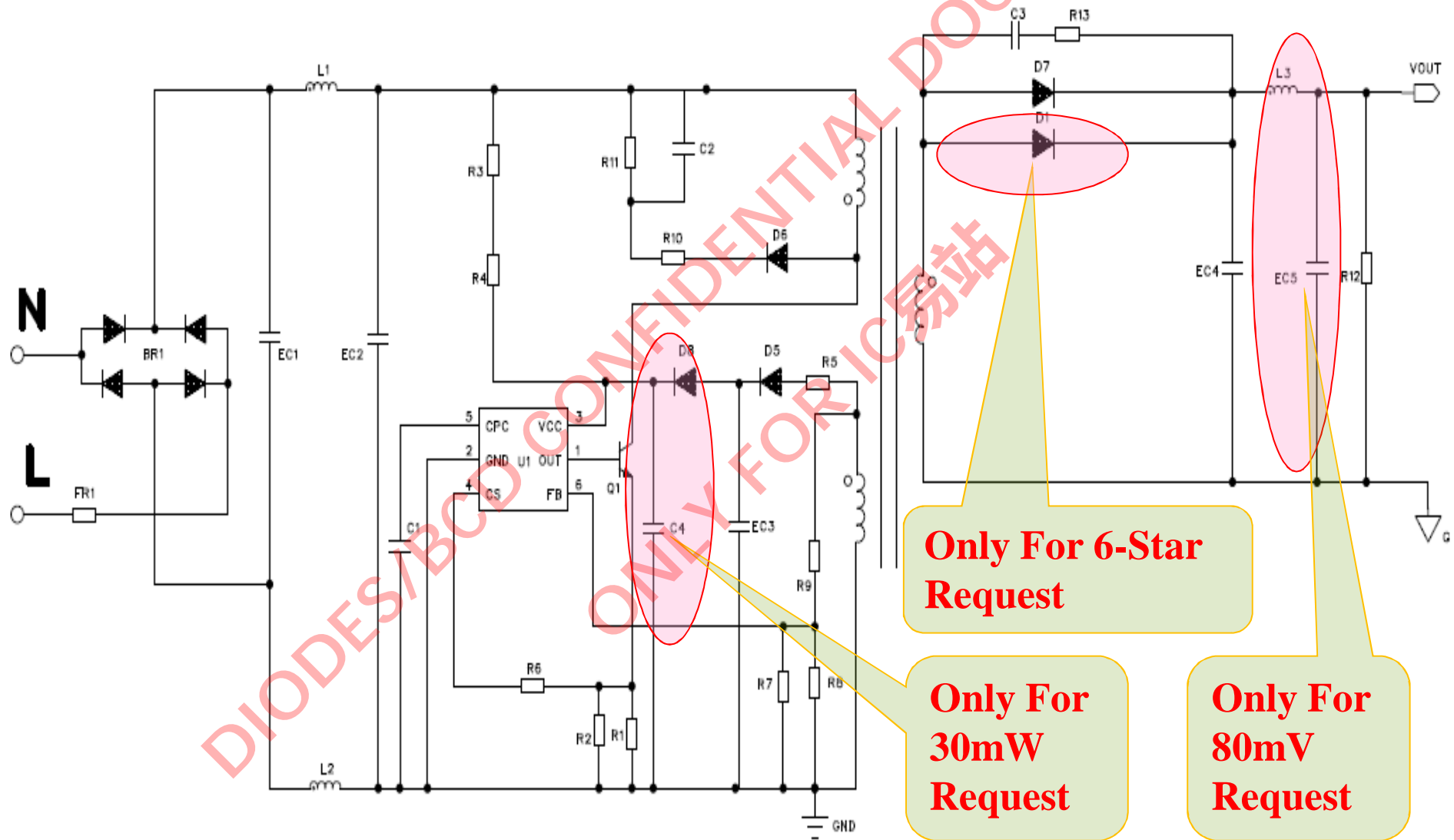


Item	Model
AC Source	Chroma 61602
Power Meter	YOKOGAWA WT210
Electronic Load	Chroma 63100
Oscilloscope	YOKOGAWA DLM2024 2.5GS/s 200MHz
Digit Multimeter	Agilent 34410A
Data Acquisition	Agilent 34970A

# PCB Layout



# Schematic Circuit

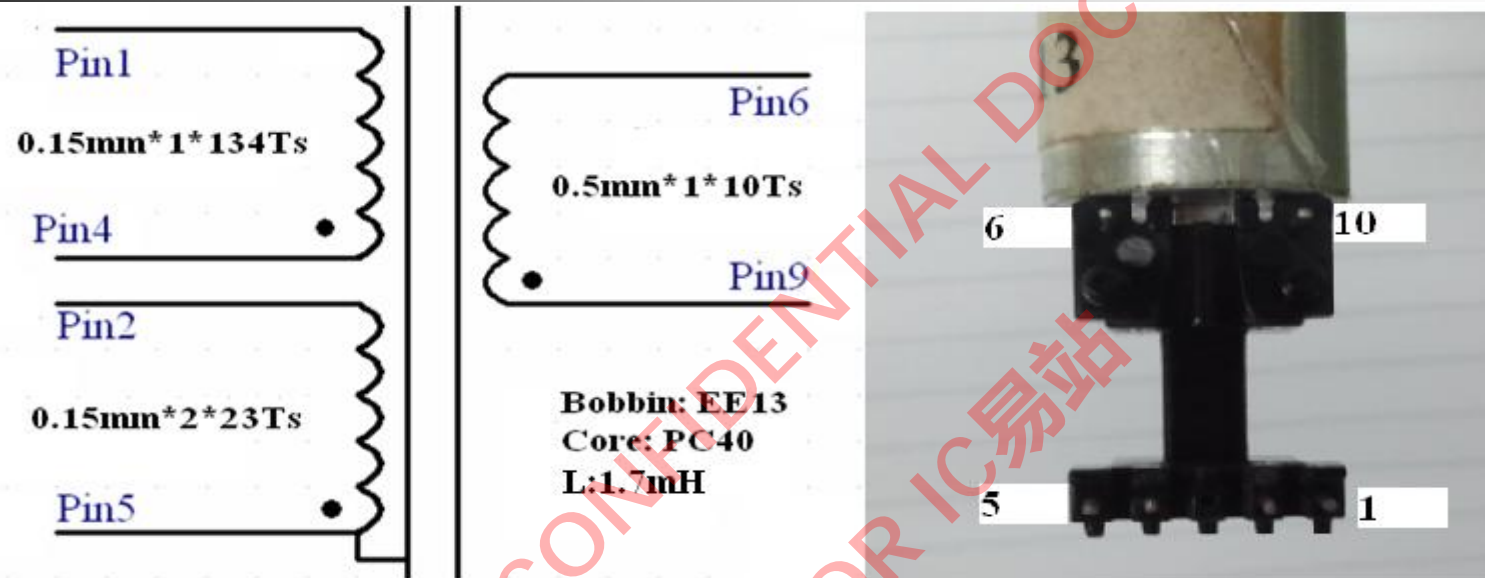


# Bill Of Material



NO.	Spec.	Position	NO.	Spec.	Position
1	0.22UF/50V $\pm$ 15% 0805 X7R Ceramic	C1	16	0 $\Omega$ $\pm$ 5% 1206 1/4W	D8
2	100PF/50V $\pm$ 15% 0805 X7R Ceramic	C3	17	Rectifier Diode M7 1A 1000V SMA	D5 D6
3	1000PF/250V $\pm$ 15% 1206 X7R Ceramic	C2	18	APD340 3A 40V DO-27	D7
4	1.5 $\Omega$ $\pm$ 1% 0805 1/6W	R5	19	Transistor NPN APT13003D TO-92	Q1
5	2.7 $\Omega$ $\pm$ 1% 0805 1/6W	R1, R2	20	AP3772K6TR-G1 SOT23-6	U1
6	1.2M $\Omega$ $\pm$ 5% 1206 1/4W	R3	21	4.7uF 400V 8*12mm Electrolytic	EC1, EC2
7	1.5M $\Omega$ $\pm$ 5% 1206 1/4W	R4	22	4.7uF 50V 5*10mm Electrolytic	EC3
8	2.7K $\pm$ 1% 0805 1/6W	R6	23	1000uF 10V 8*12mm Electrolytic(ESR@40K:27mohm)	EC4
9	470K $\Omega$ $\pm$ 1% 0805 1/6W	R7	24	ABS10	BR1
10	20K $\Omega$ $\pm$ 1% 0805 1/6W	R8	25	EE-13 卧式加长型	T1
11	39K $\Omega$ $\pm$ 1% 1/4W	R9	26	1mH 1W	L1
12	330 $\Omega$ $\pm$ 5% 1206 1/4W	R10	27	Bead 2.2uH 0805	L2
13	200K $\Omega$ $\pm$ 5% 0805 1/6W	R11	28	0 $\Omega$ $\pm$ 5% 1206 1/4W	L3
14	3.3k $\Omega$ $\pm$ 5% 0805 1/6W	R12	29	10 $\Omega$ 1W	F1
15	22 $\Omega$ $\pm$ 5% 0805 1/6W	R13	30	USB A母4+2Pin	USB

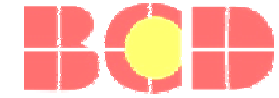
# Transformer Specification



Wdg.No	Start 起线	Finish 收线	Tums 圈数	Wire Dia. 线径	Wdg Type Spread / Even 绕线方法 疏绕/密绕	Wdg Direction 绕线方向	Tums/Layer No. Of Layers
W1	4	1	134T	φ0.15mm*1	单线三层一次绕完	RIGHT	3 Layer
W2	5	2	23T	φ0.15mm*1	单线靠原边密绕	RIGHT	1 Layers
W3	2	Floating	12T	0.15mm*1	单线靠原边密绕	RIGHT	1 Layer
<b>2 layers of Polyester Yellow tape, T=0.05 mm</b>							
W4	10	6	10T	φ0.5mm*1	单线折返回初级压线绕	RIGHT	1 Layer
<b>3 layer of Polyester Yellow tape, T=0.05mm</b>							
磁芯 0.15mm 露铜线接 2脚							
Assembling the core and curing							



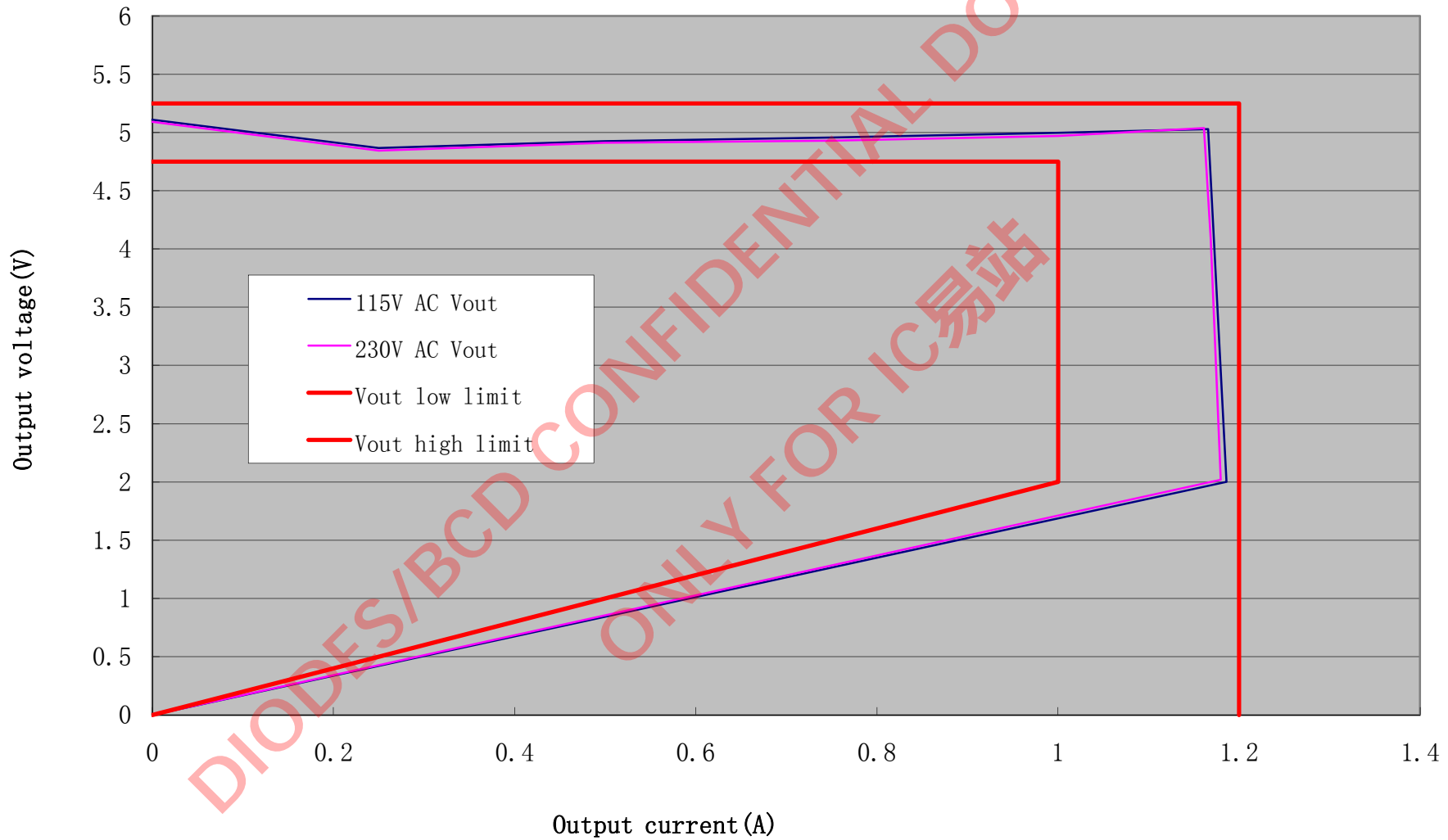
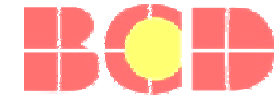
# Regulation, Ripple, OCP and Efficiency



V <sub>IN</sub> (V)	P <sub>IN</sub> (W)	V <sub>OUT</sub> (V)	I <sub>O</sub> (A)	Ripple (mV)	P <sub>OUT</sub> (W)	η	OCP	Average η	SPEC.
90V/60Hz	1.594	4.811	0.25	71	1.20275	75.45%	1.151	75.20%	68.2%
	3.238	4.888	0.5	103	2.444	75.48%			
	4.888	4.902	0.75	129	3.6765	75.21%			
	6.642	4.958	1	110	4.958	74.65%			
115V/60Hz	1.586	4.842	0.25	73	1.2105	76.32%	1.163	76.48%	
	3.208	4.909	0.5	127	2.4545	76.51%			
	4.836	4.939	0.75	112	3.70425	76.60%			
	6.513	4.981	1	112	4.981	76.48%			
230V/50Hz	1.661	4.926	0.25	73	1.2315	74.14%	1.162	76.47%	
	3.221	4.937	0.5	108	2.4685	76.64%			
	4.795	4.948	0.75	108	3.711	77.39%			
	6.426	4.994	1	109	4.994	77.72%			
264V/50Hz	1.699	4.922	0.25	73	1.2305	72.42%	1.158	75.60%	
	3.254	4.941	0.5	109	2.4705	75.92%			
	4.832	4.953	0.75	111	3.71475	76.88%			
	6.477	4.999	1	111	4.999	77.18%			

\* Note: Output Voltage measured at end of PCB

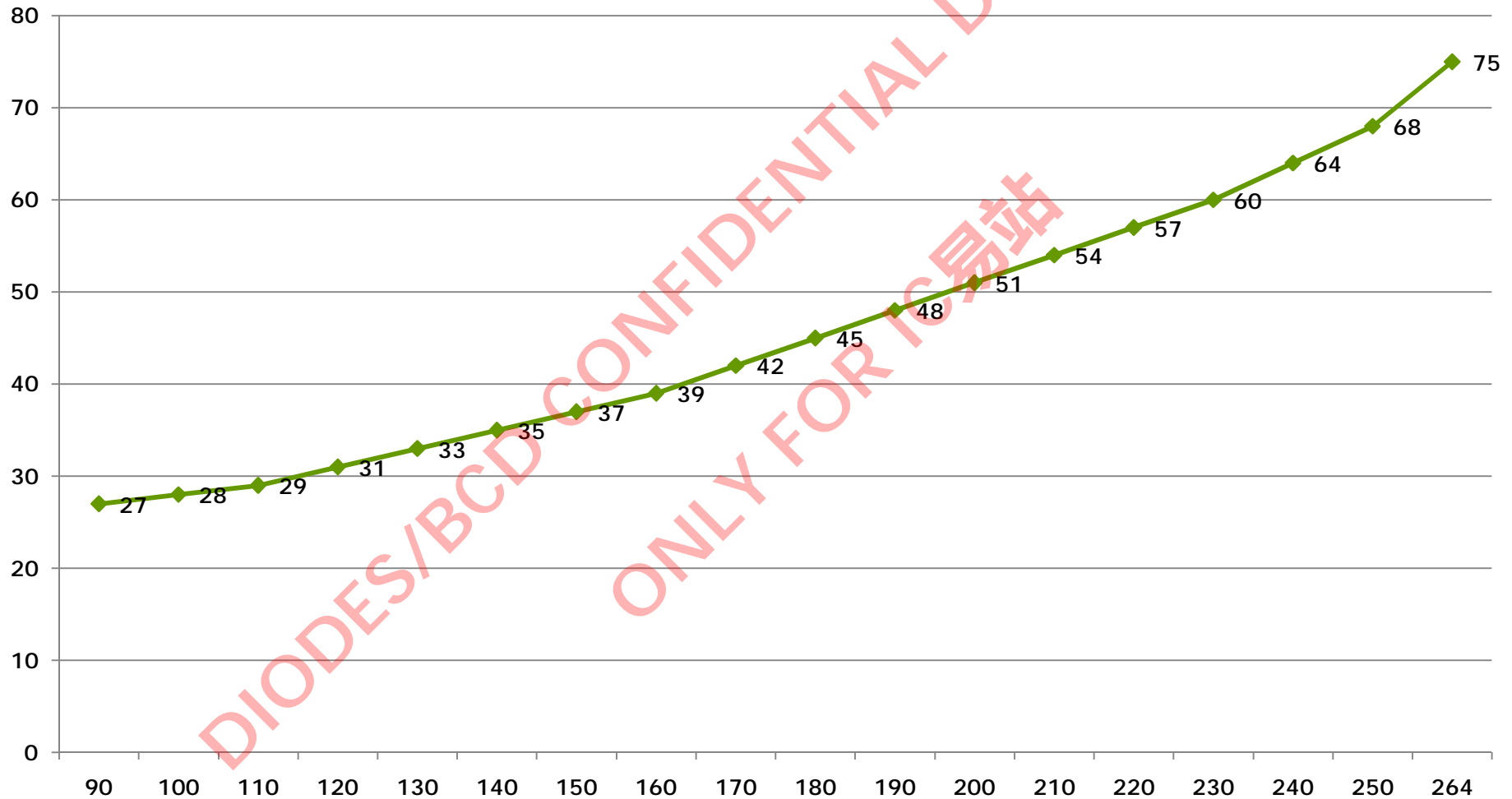
# Output V-I Characteristics



# Standby Power



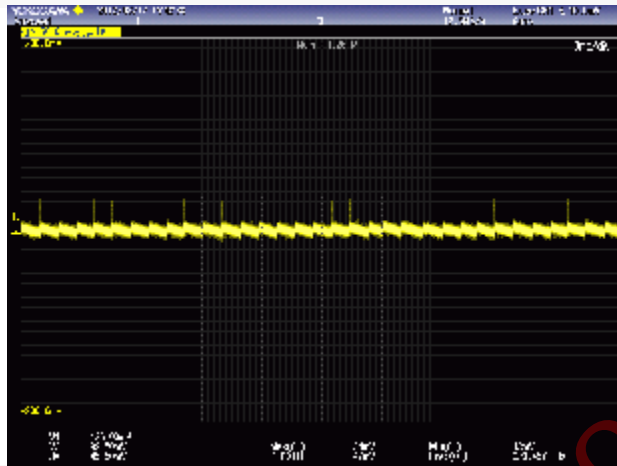
## Stb Power



# Output Ripple & Noise

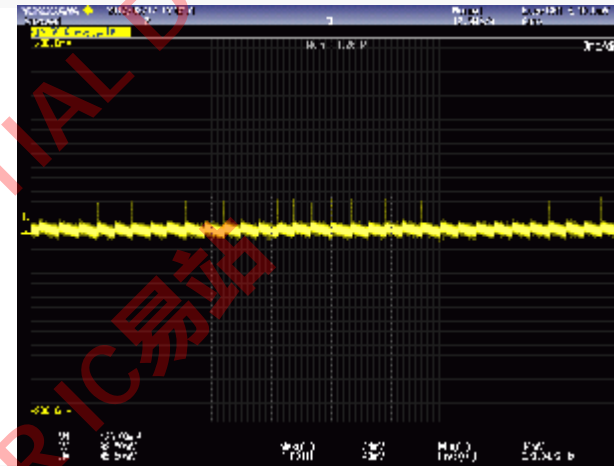


90Vac No Load



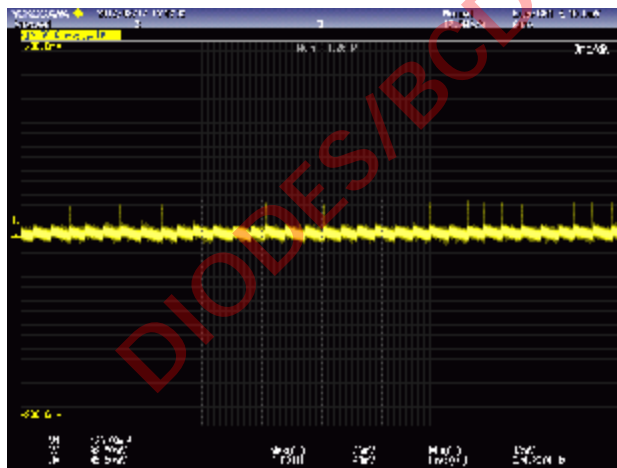
47mV

115Vac No Load



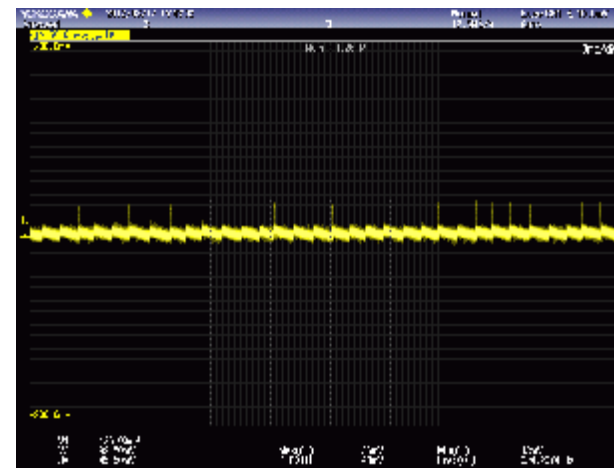
48mV

230Vac No Load



49mV

264Vac No Load

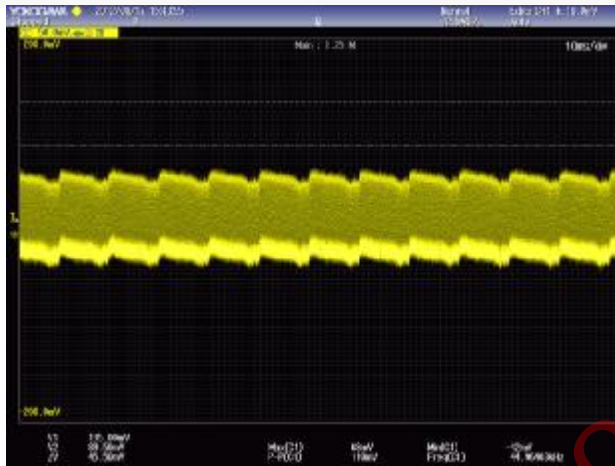


49mV

# Output Ripple & Noise



90Vac Full Load



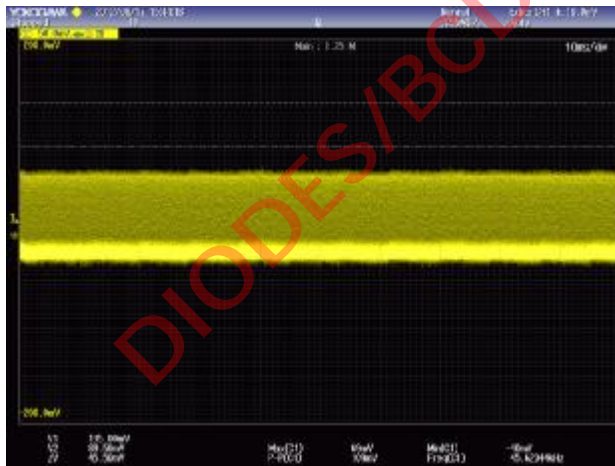
110mV

115Vac Full Load



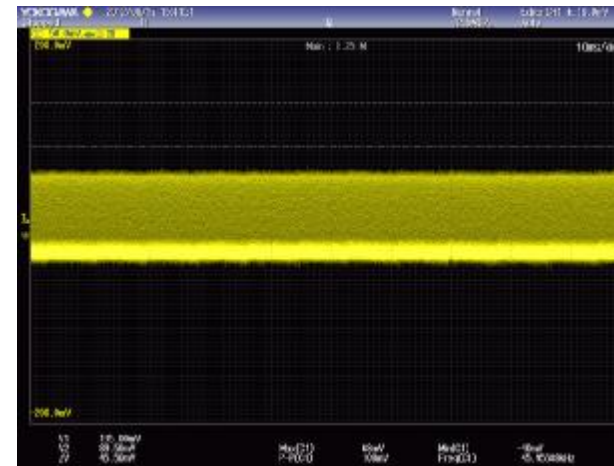
114mV

230Vac Full Load



109mV

264Vac Full Load

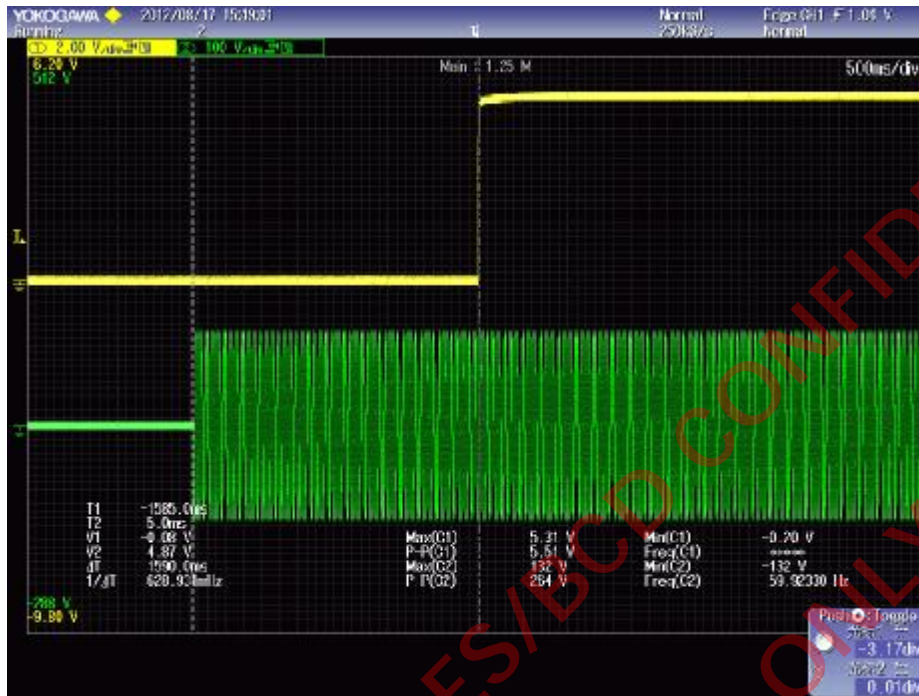


108mV

# Turn On Delay Time

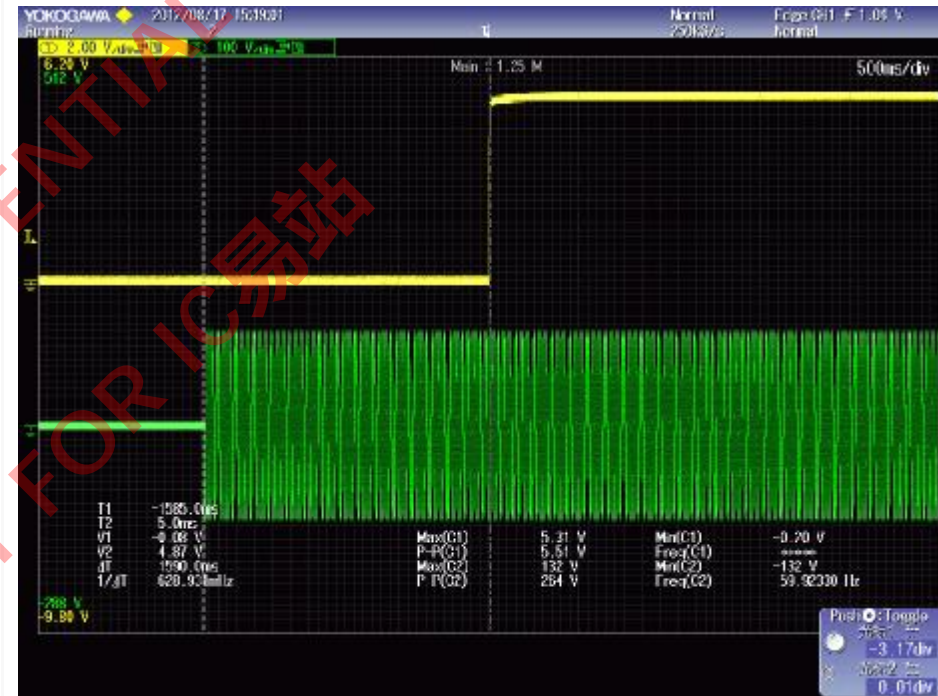


90Vac No Load



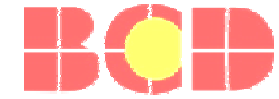
$T_{DELAY}: 1.59S$

90Vac Full Load

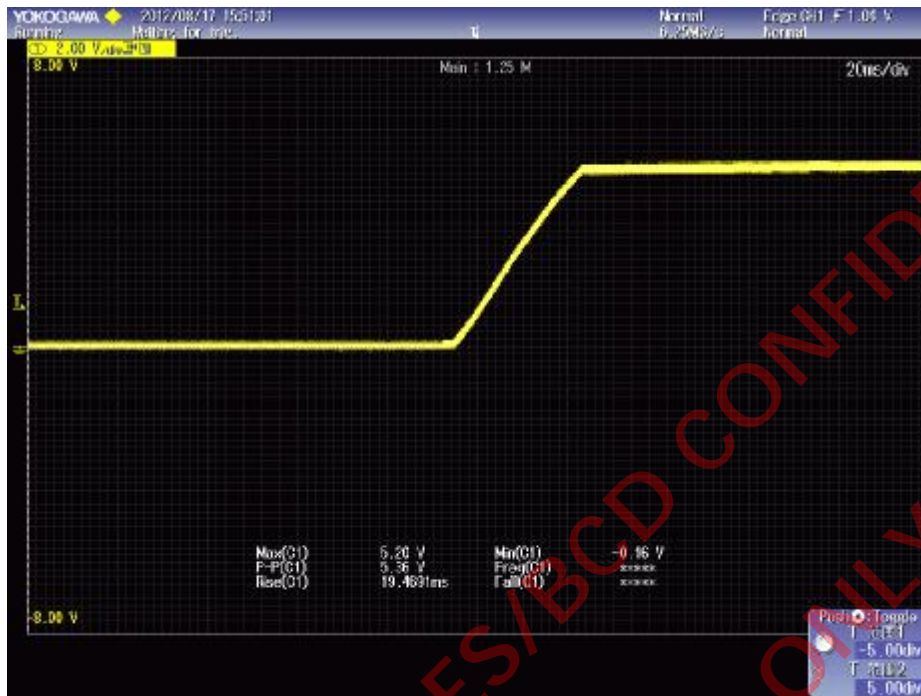


$T_{DELAY}: 1.615S$

# Output Rise Time



## 115Vac Full Load



$T_{RISE}: 19.47\text{ms}$

## 230Vac Full Load



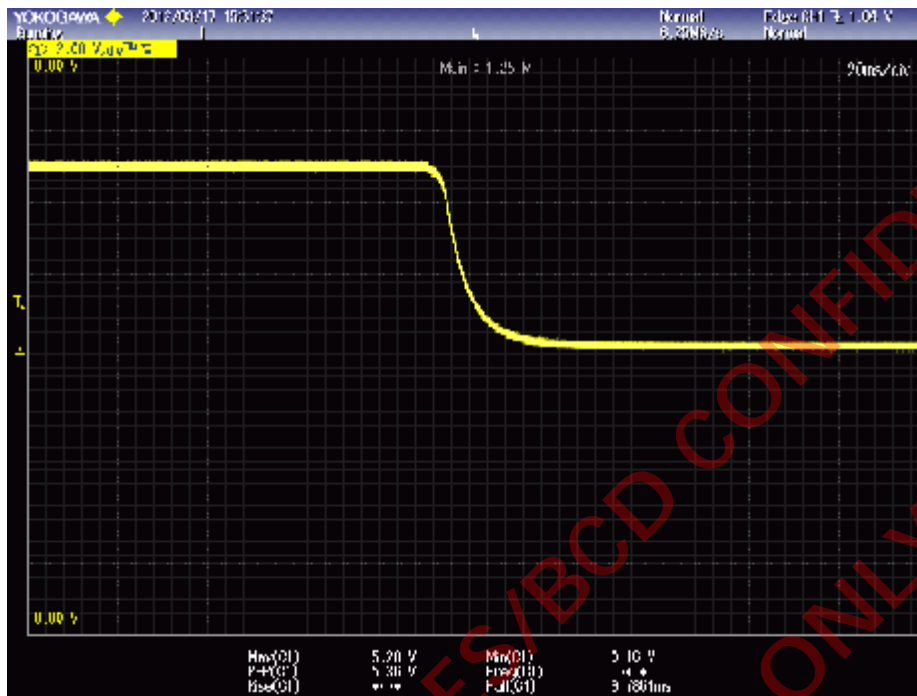
$T_{RISE}: 19.67\text{ms}$



# Output Fall Time



## 115Vac CR Mode Full Load



$T_{FALL}: 9.78\text{ms}$

## 230Vac CR Mode Full Load



$T_{FALL}: 9.69\text{ms}$



# Capacitor Load

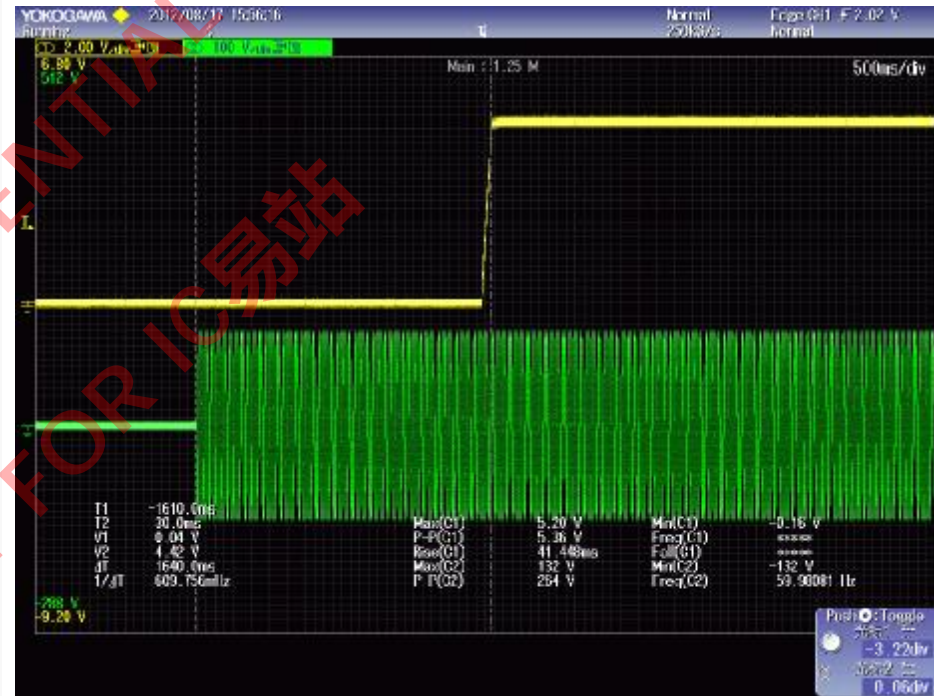


90Vac No Load With 1000uF



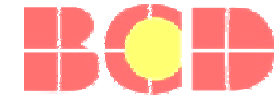
$T_{FALL}: 1.55S$

90Vac Full Load With 1000uF

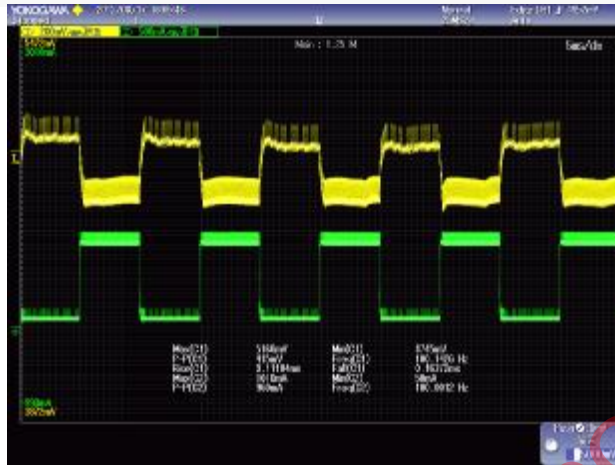


$T_{FALL}: 1.64S$

# Dynamic



90Vac 10%~85%~10% 5mS 0.5A/uS



**Vomin**  
**4.75V**  
**Vomax**  
**5.16V**

115Vac 10%~85%~10% 5mS 0.5A/uS



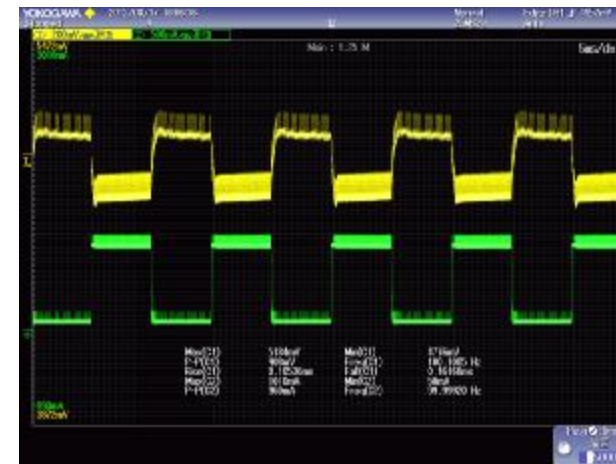
**Vomin**  
**4.76V**  
**Vomax**  
**5.21V**

230Vac 10%~85%~10% 5mS 0.5A/uS



**Vomin**  
**4.78V**  
**Vomax**  
**5.18V**

264Vac 10%~85%~10% 5mS 0.5A/uS



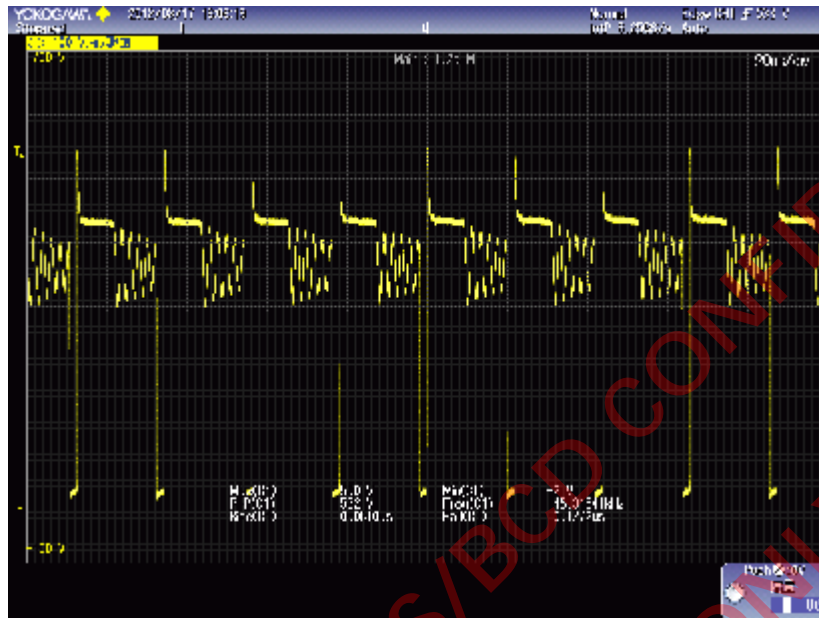
**Vomin**  
**4.78V**  
**Vomax**  
**5.18V**

# BJT Voltage Stress



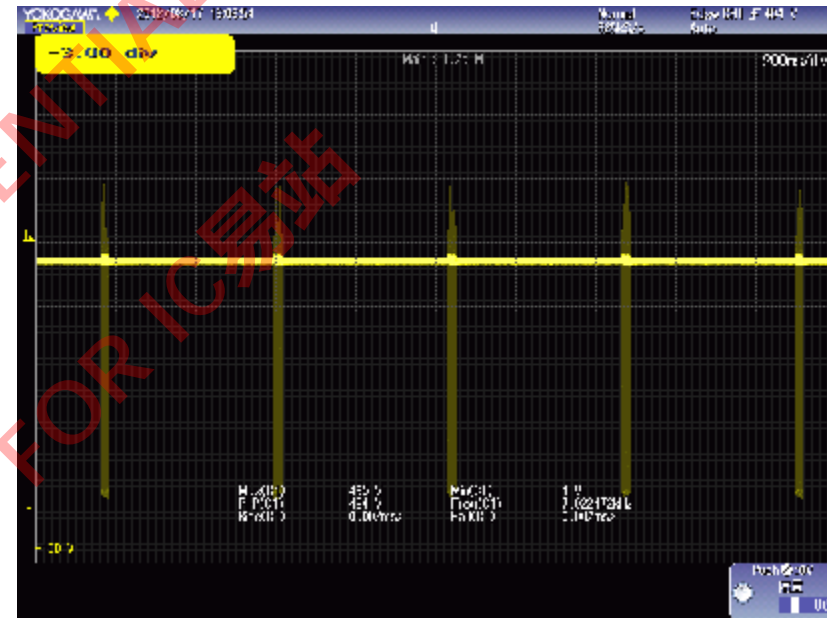
264Vac Full Load

$V_{MAX}: 550V$



264Vac Short

$V_{MAX}: 495V$



## Absolute Maximum Ratings (Note 1)

Parameter	Symbol	Value	Unit
Collector-Emitter Voltage ( $V_{BE}=0$ )	$V_{CES}$	700	V
Collector-Emitter Voltage ( $I_B=0$ )	$V_{CEO}$	465	V

# Schottky Voltage Stress



264Vac Full Load

$V_{MAX}: 35.9V$



264Vac Short

$V_{MAX}: 30.6V$



## SCHOTTKY BARRIER RECTIFIERS

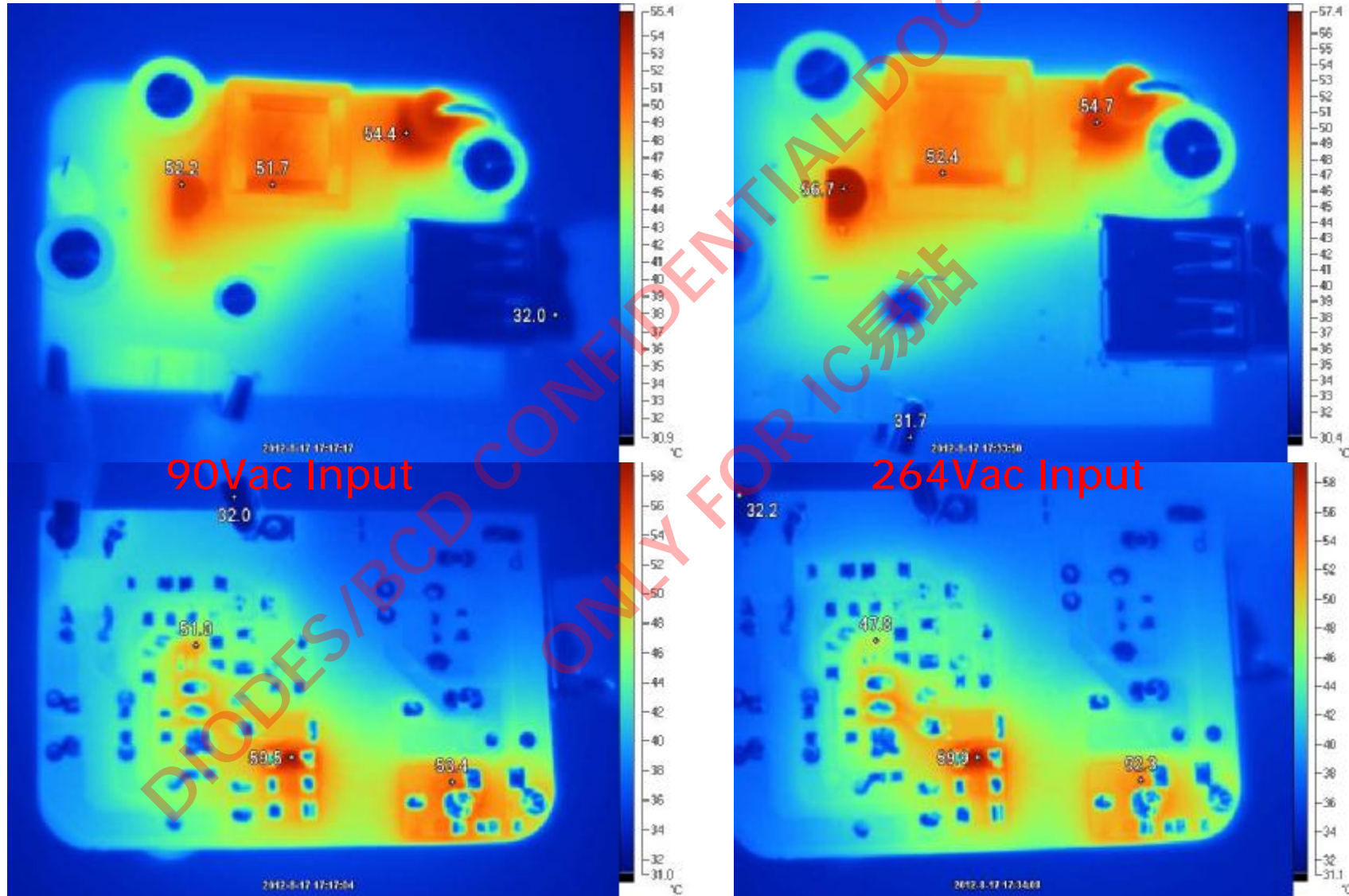
APD340

Absolute Maximum Ratings ( $T_A=25^{\circ}C$ , unless otherwise noted) (Note 1)

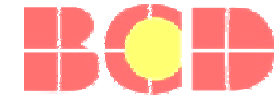
Parameter	Symbol	Value	Unit
Maximum Repetitive Peak Reverse Voltage	$V_{RRM}$	40	V



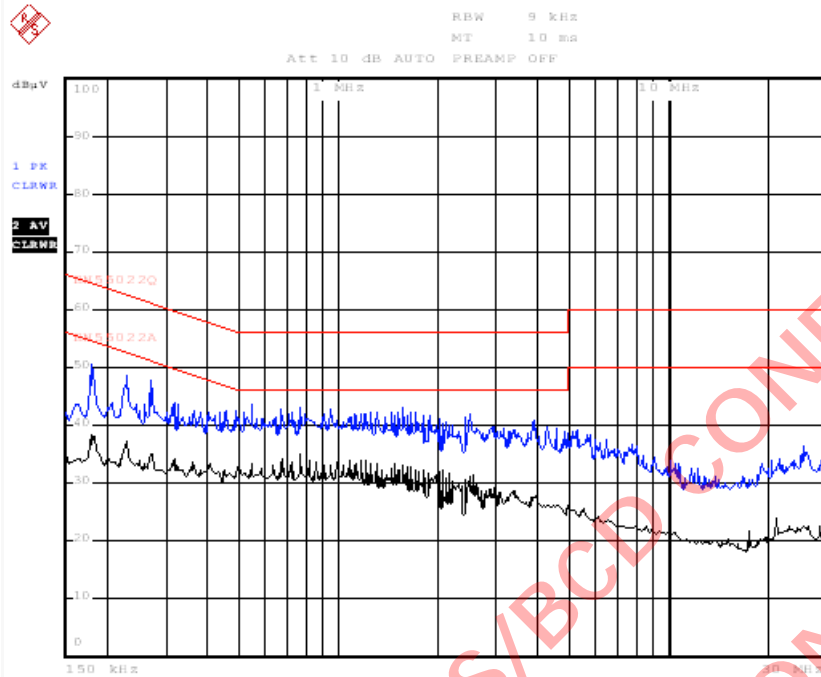
# Temperature Rise



# Conduction



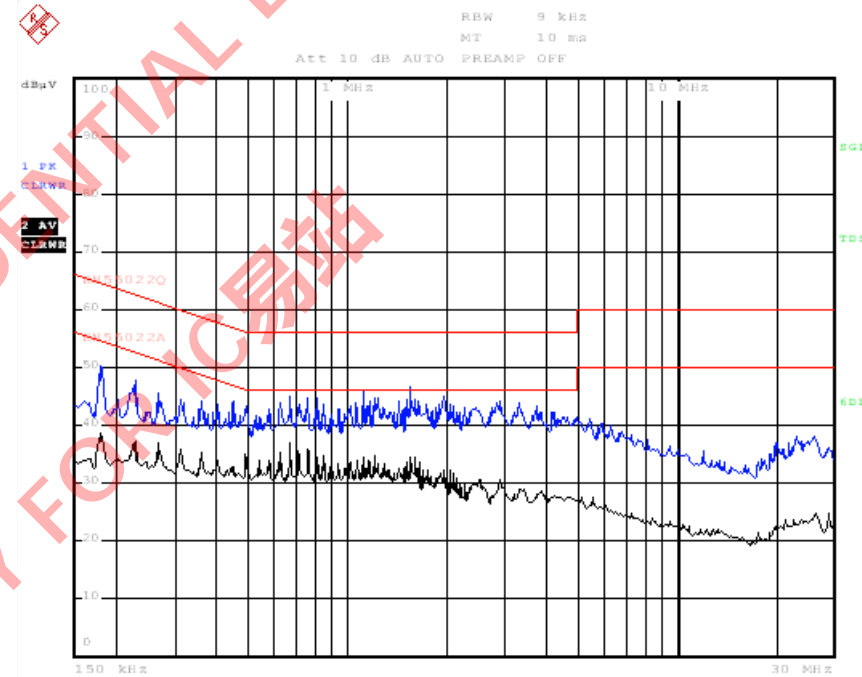
### 230Vac Full Load L



Date: 17.AUG.2012 03:27:02

Margin: >10dB

### 230Vac Full Load N



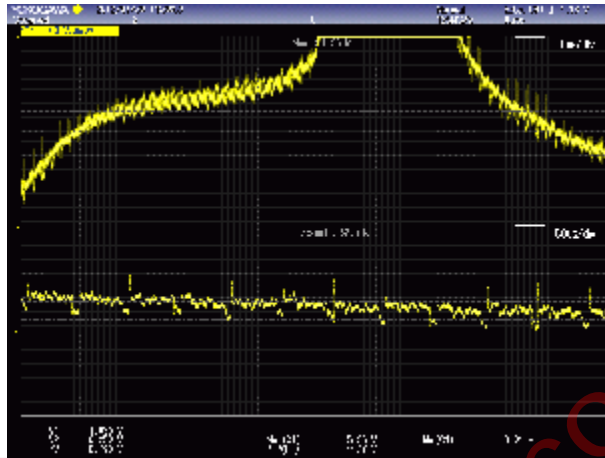
Date: 17.AUG.2012 03:28:40

Margin: >10dB

# Common Mode Noise

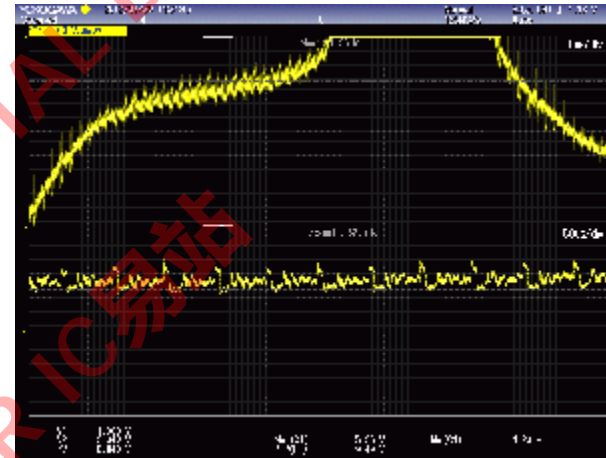


90Vac 10ohm Resistor Load



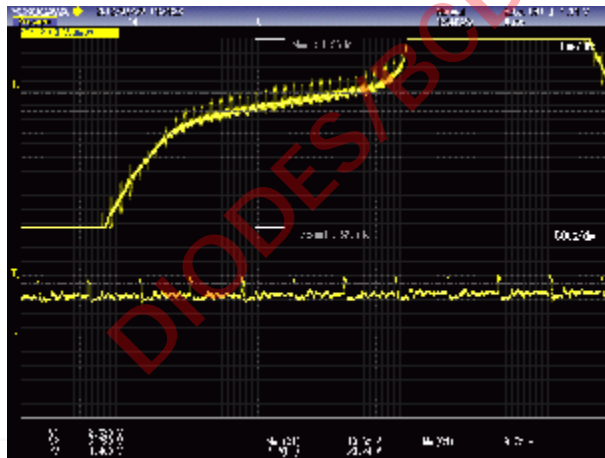
0.78V

115Vac 10ohm Resistor Load



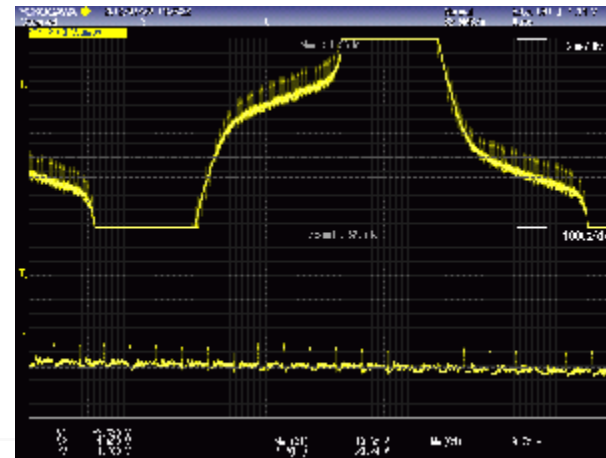
0.84V

230Vac 10ohm Resistor Load



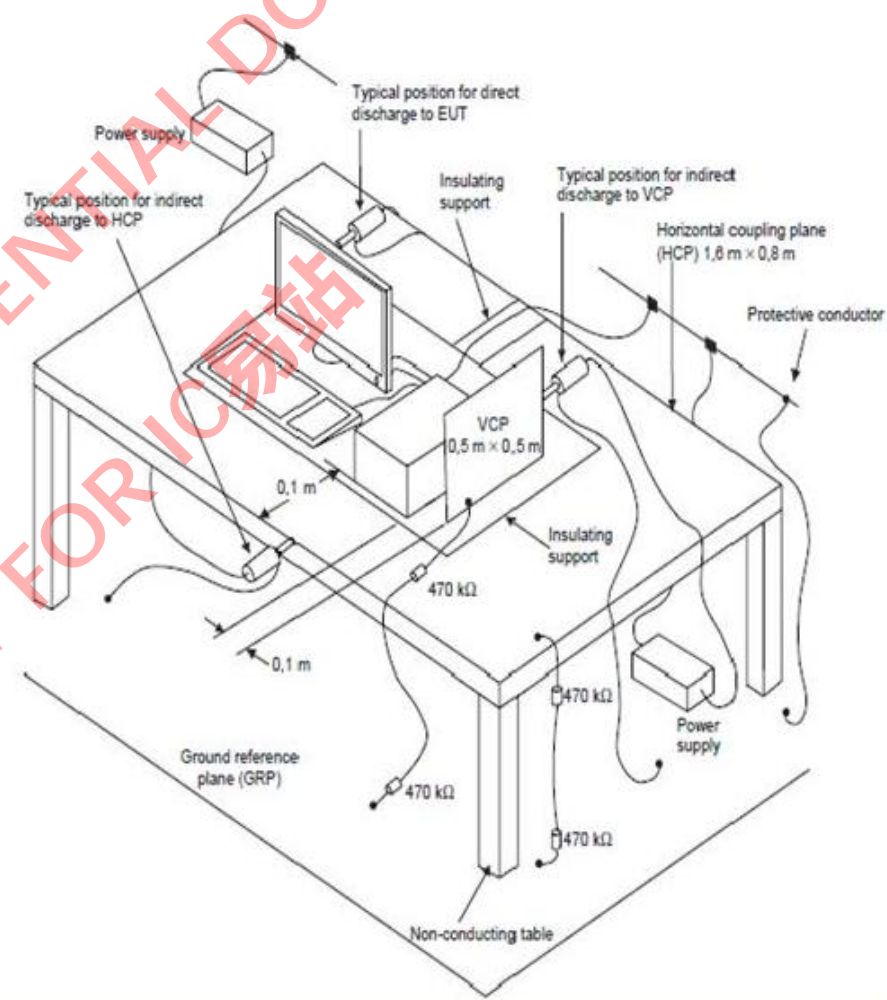
1.46V

264Vac 10ohm Resistor Load



1.7V

Air Discharged		No Load Result	Full Load Result
<b>230Vac No Load and Full Load</b>			
15kV	+	Pass	Pass
	-	Pass	Pass
16kV	+	Pass	Pass
	-	Pass	Pass
17kV	+	Pass	Pass
	-	Pass	Pass
18kV	+	Pass	Pass
	-	Pass	Pass
19kV	+	Pass	Pass
	-	Pass	Pass
20kV	+	Pass	Pass
	-	Fail	Fail







**Thank You!!!**