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AP3772 For 12V 0.5A Smart Phone Charger Solution

General Design Specification:

Ø AC Input Range 90-264Vac

Ø DC Output 12V, 0.5A

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

Ø Meet “5-Star” Requirement

Key Performance



Item	Spec	Test Conditions	Test Data	Result
Output Voltage	11.4~12.6V	90~264Vac @ 0~0.5A	11.755 ~12.003V	Pass
Ripple	<120mVp-p	90~264Vac @ 0~0.5A	102mV	Pass
Standby Power	<100mW	230Vac @ 0A	76mW	Pass
Dynamic	10.8~13.2V	90~264Vac @ 0.1~0.85~0.1A 5mS 0.5A/uS	11.72~11.96V	Pass
EMC	EN55022B -6dB	115Vac 230Vac@ 1A	-6dB	Pass
ESD	15kV	230Vac @ 1A	19kV	Pass

Specification



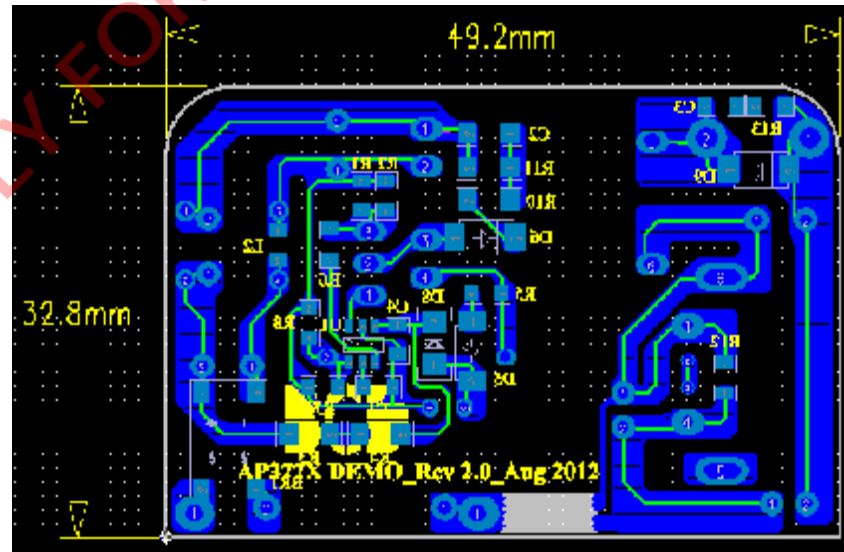
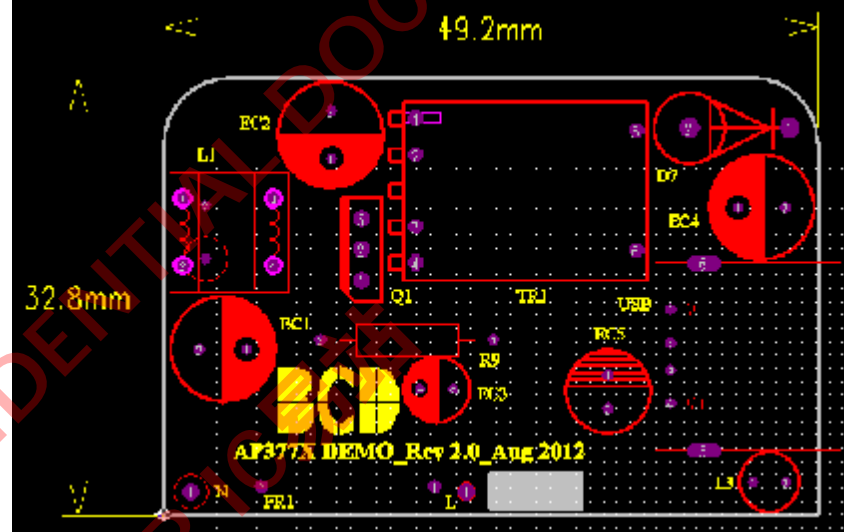
Description	Min	Type	Max	Units	Conditions
Input					
Voltage	90		264	VAC	
Frequency	47	50/60	63	Hz	
No-Load Input Power (230Vac)			100	mW	
Output					
Output Voltage	11.4	12	12.6	V	
Output Current	0		0.5	A	
Output Power	0		5	W	
Output Ripple Voltage			120	mVp-p	I _{out} =0.5A @ 25°C, 20MHzbandwidth
Output Over Current Protection	0.5		0.8	A	Hiccup, Auto Restart
Ambient Temperature			45	°C	
Efficiency					
Average Efficiency (5-Star)	73.4			%	Measured at end of output DC-Cable, 115Vac &230Vac @ 25°C
EMI	Pass EN55022 Class B with 6dB Margin				

Test Equipment

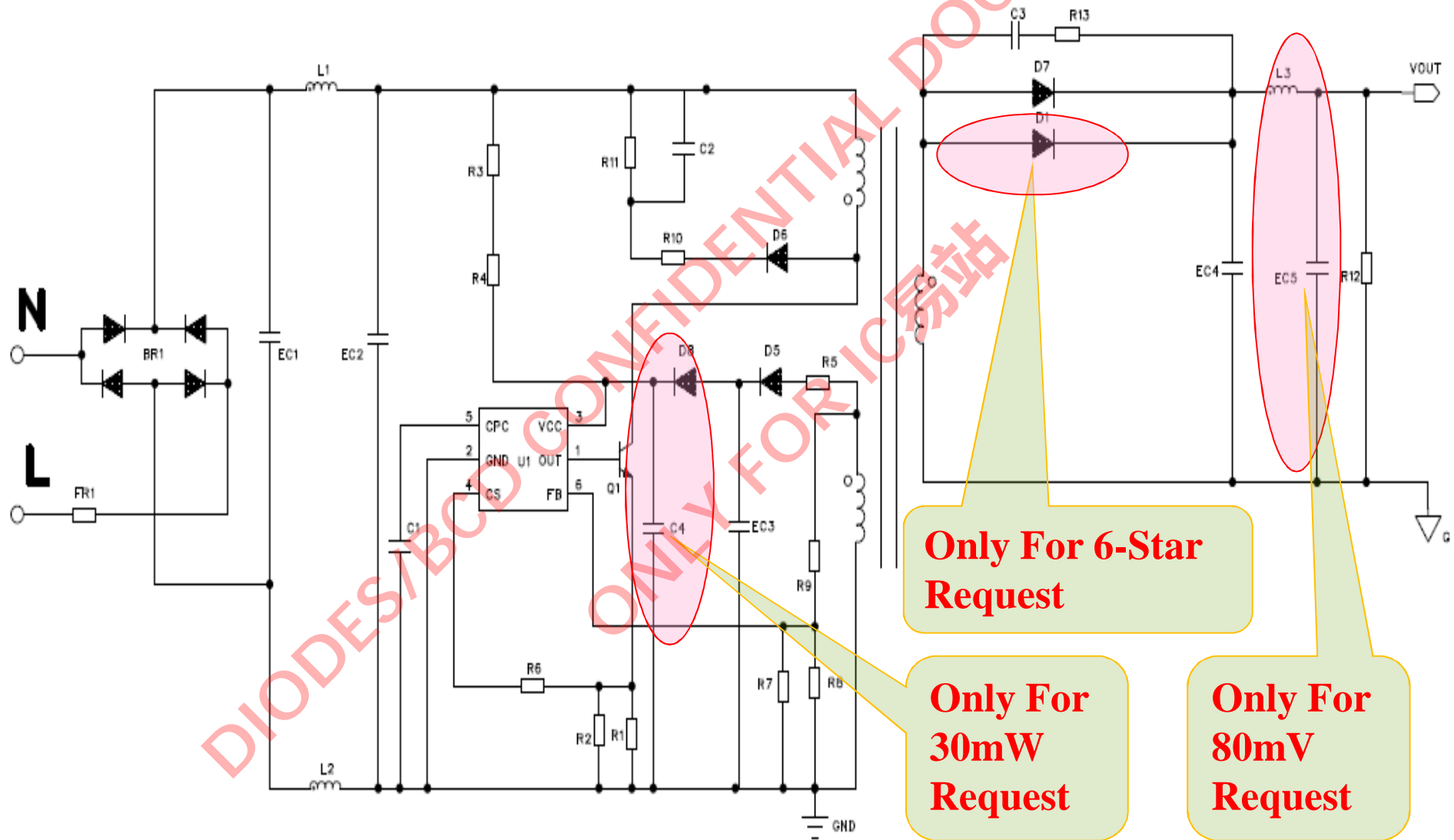
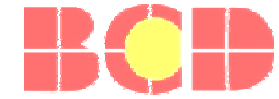


Item	Model
AC Source	Chroma 61602
Power Meter	YOKOGAWA WT210
Electronic Load	Chroma 63100
Oscilloscope	YOKOGAWA DLM2024 2.5GS/s 200MHz
Digit Multimeter	Agilent 34410A
Data Acquisition	Agilent 34970A

PCB Layout



Schematic Circuit

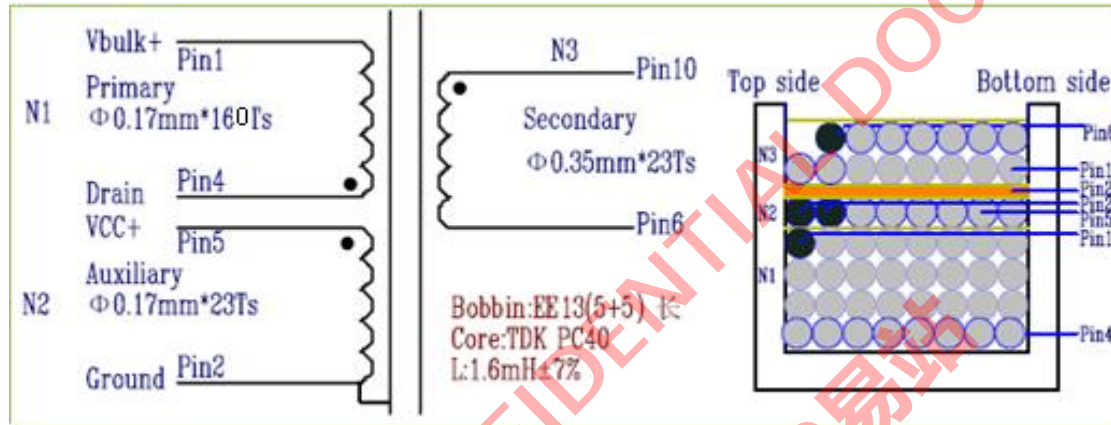
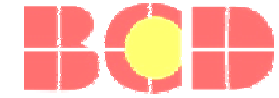


Bill Of Material



NO.	Spec.	position	NO.	Spec.	position
1	0.22UF/50V ±15% 0805 X7R Ceramic	C1	18	0Ω ±1% 1206 1/4W	D8
2	100PF/50V ±15% 0805 X7R Ceramic	C3	19	39KΩ ±1% DIP 1/6W	R9
3	1uF/50V ±15% 0805 X7R Ceramic(Optional)	C4	20	APD3100 3A 100V DO-15	D7
4	1000PF/500V ±15% 1206 X7R Ceramic	C2	21	Transistor NPN APT13003D To-126	Q1
5	0.68Ω ±1% 0805 1/6W	R5	22	AP3772K6TR-G1 SOT23-6	U1
6	2.4Ω ±1% 0805 1/6W	R1, R2	23	6.8uF 400V 8*14mm Electrolytic	EC2
7	1.5MΩ ±5% 1206 1/4W	R3	24	4.7uF 400V 8*12mm Electrolytic	EC1
8	1.2MΩ ±5% 1206 1/4W	R4	25	4.7uF 50V 5*10mm Electrolytic	EC3
9	2.7K ±1% 0805 1/6W	R6	26	680uF 16V 8*14mm Electrolytic(ESR@40K:27mohm)	EC4
10	24KΩ ±1% 0805 1/6W	R7	27	220uF 16V 6*11mm Electrolytic(ESR@40K:70mohm)	EC5
11	120KΩ ±1% 0805 1/6W	R8	28	EE-13 卧式加长型	T1
12	330Ω ±5% 1206 1/4W	R10	29	38mH +/-20% EE-8共模电感	L1
13	200KΩ ±5% 12061/6W	R11	30	3uH工字电感	L3
14	9.1KΩ±5% 0805 1/6W	R12	31	10Ω 1W	F1
15	22Ω ±5% 0805 1/6W	R13	32	USB A母4+2Pin	X1
16	ABS10 SO-4	BR1	33		
17	1N4007 1A 1000V SMA	D5、D6	34		

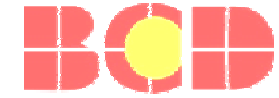
Transformer Specification



Electrical Specifications

Winding	Process Specification	Pin configuration		Cylinder number(Ts)	Direction
		start	finish		
N1	2UEW 0.17mm * 1	4	1	160	RIGHT
N2	2UEW 0.17mm * 1	5	2	23	RIGHT
屏蔽绕组	2UEW 0.17mm * 1	2		4	RIGHT
2 layers of Polyester Yellow tape, T=0.05 mm					
N3	TEX-E 0.35mm * 1	10	6	23	RIGHT
2 layers of Polyester Yellow tape, T=0.05 mm					
磁芯接2PIN					
Assembling the core and curing					
Cut Pin					

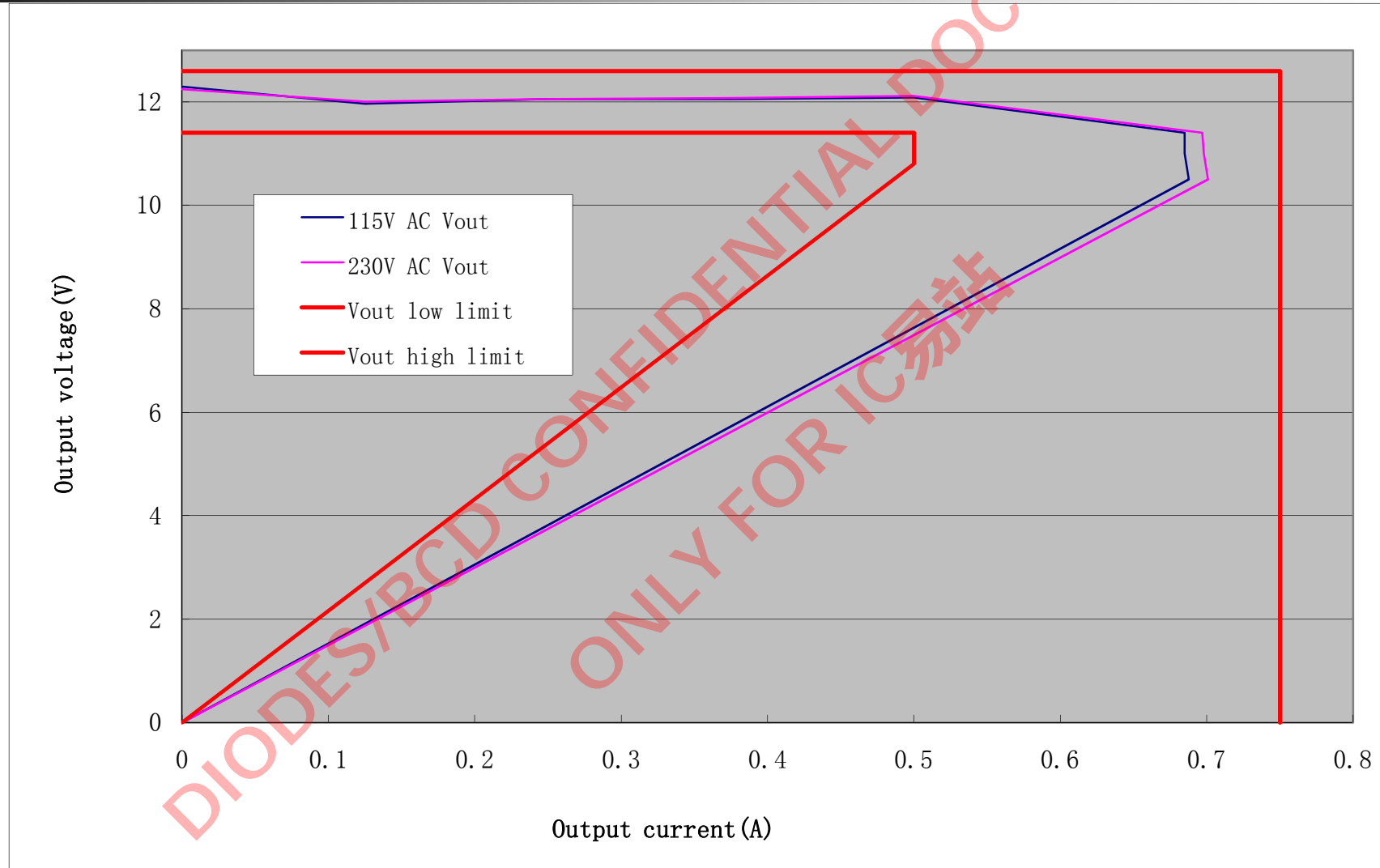
Regulation, Ripple, OCP and Efficiency



V _{IN} (V)	P _{IN} (W)	V _{OUT} (V)	I _O (A)	Ripple (mV)	P _{OUT} (W)	η	OCP	Average η	SPEC.
90V/60Hz	2	11.778	0.126	23	1.484028	74.20%	0.618	76.68%	5 Star 73.4%
	3.845	11.89	0.25	88	2.9725	77.31%			
	5.743	11.882	0.375	102	4.45575	77.59%			
	7.686	11.91	0.501	92	5.96691	77.63%			
115V/60Hz	1.957	11.755	0.126	23.5	1.48113	75.68%	0.635	78.25%	
	3.794	11.943	0.25	31.6	2.98575	78.70%			
	5.628	11.887	0.375	29	4.457625	79.20%			
	7.518	11.919	0.501	33	5.971419	79.43%			
230V/50Hz	1.972	11.849	0.126	24.1	1.492974	75.71%	0.645	79.26%	
	3.759	11.963	0.25	29.4	2.99075	79.56%			
	5.537	11.925	0.375	29	4.471875	80.76%			
	7.413	11.988	0.501	24	6.005988	81.02%			
264V/50Hz	2.016	11.901	0.126	21.1	1.499526	74.38%	0.643	78.54%	
	3.787	11.969	0.25	27.7	2.99225	79.01%			
	5.5730	11.937	0.375	27	4.476375	80.32%			
	7.476	12.003	0.501	27	6.013503	80.44%			

* Note: Output Voltage measured at end of PCB

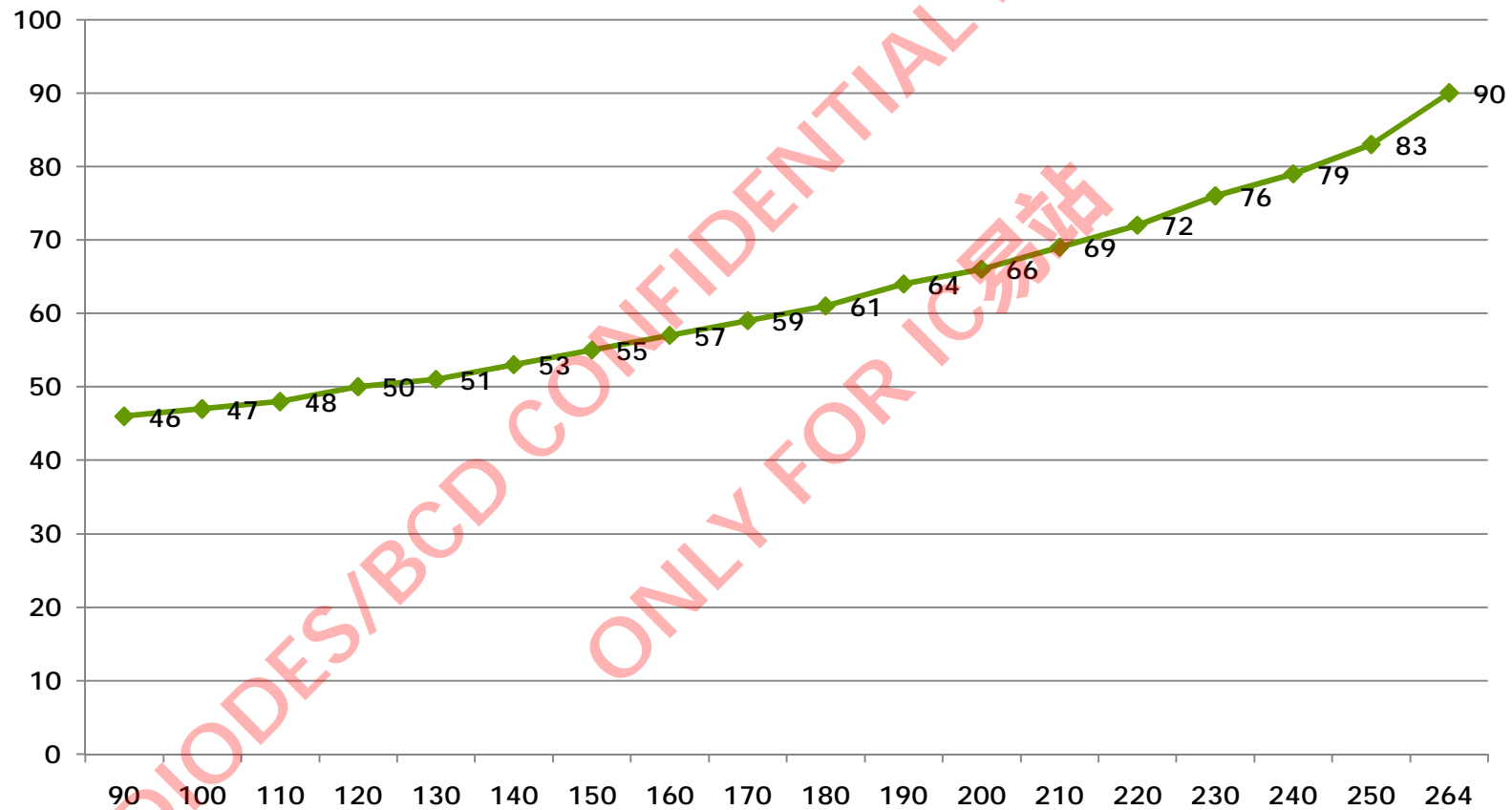
Output V-I Characteristics



Standby Power



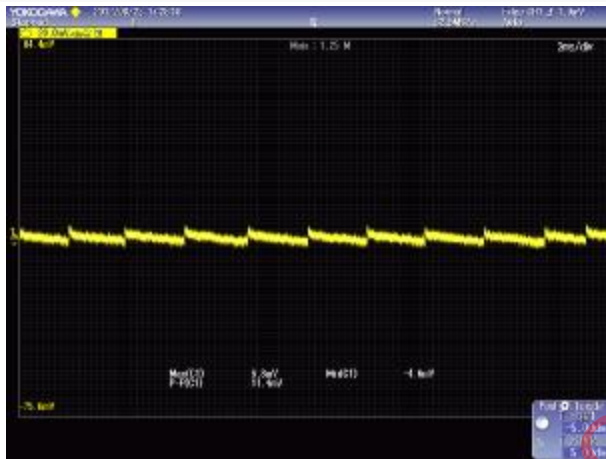
Stb Power



Output Ripple & Noise



90Vac No Load



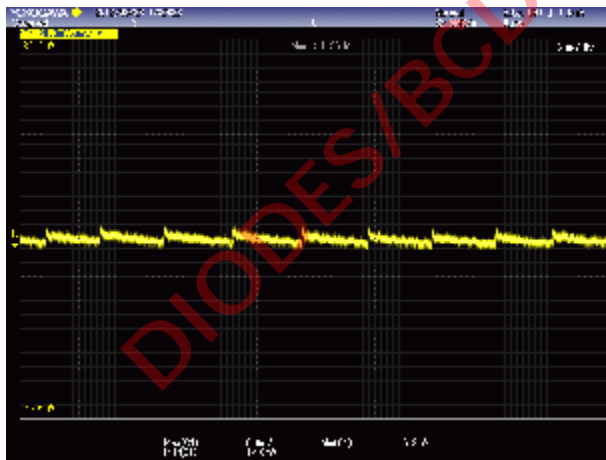
11.4mV

115Vac No Load



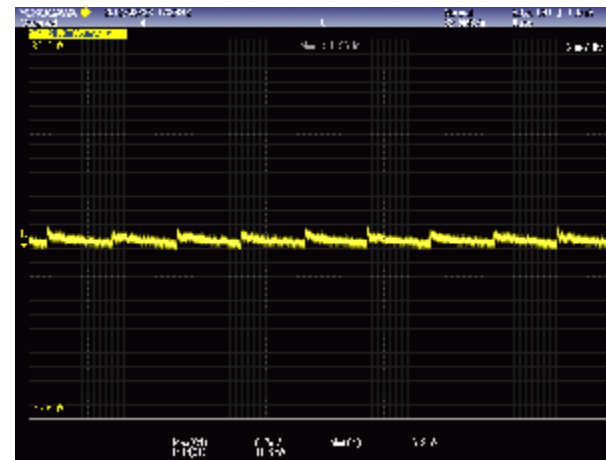
12.6mV

230Vac No Load



12.0mV

264Vac No Load

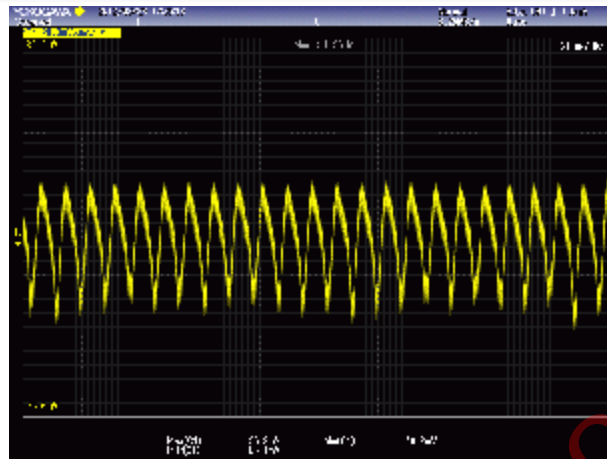


11.9mV

Output Ripple & Noise

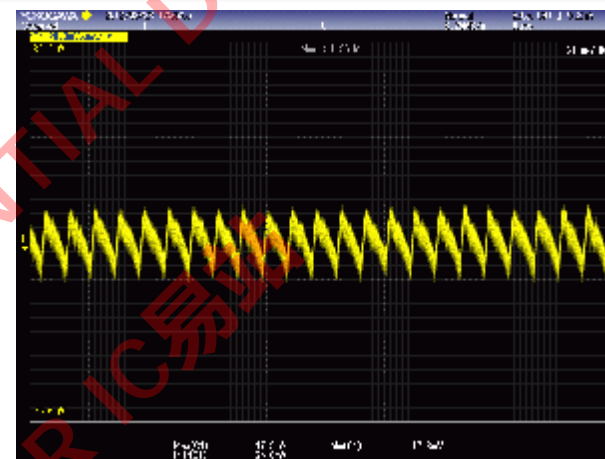


90Vac Full Load



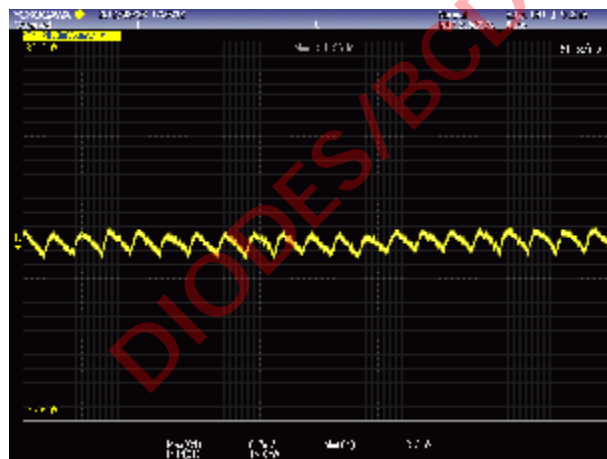
66.1mV

115Vac Full Load



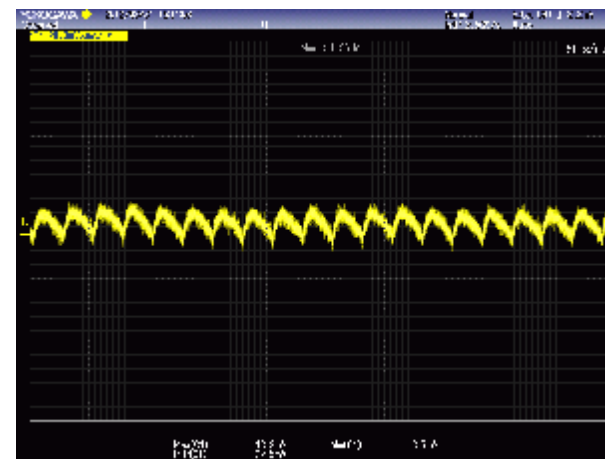
35.0mV

230Vac Full Load



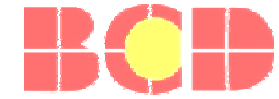
15.0mV

264Vac Full Load



22.5mV

Turn On Delay Time

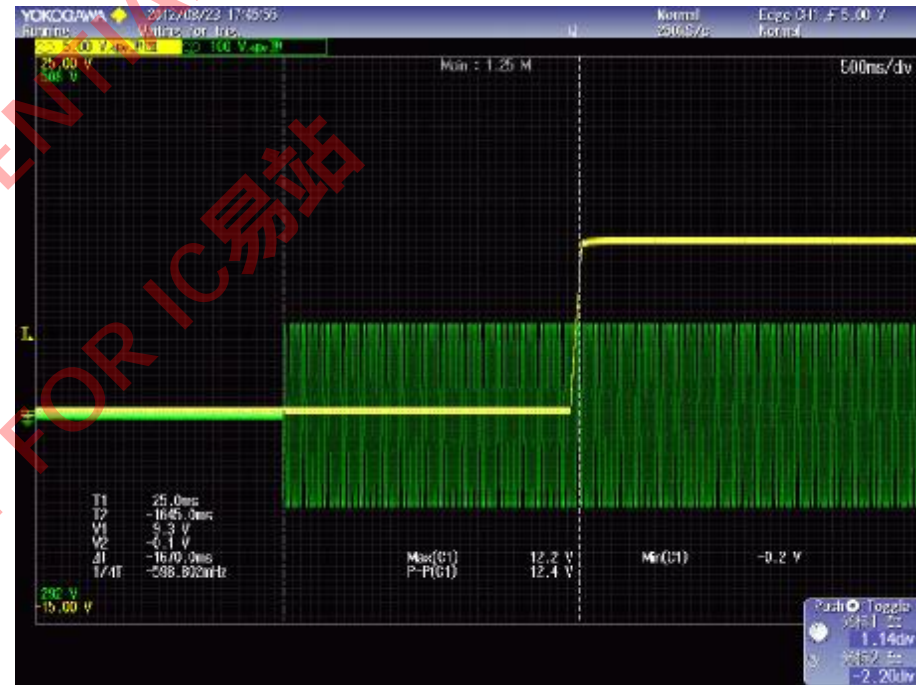


90Vac No Load



$T_{\text{DELAY}}: 1.65\text{S}$

90Vac Full Load

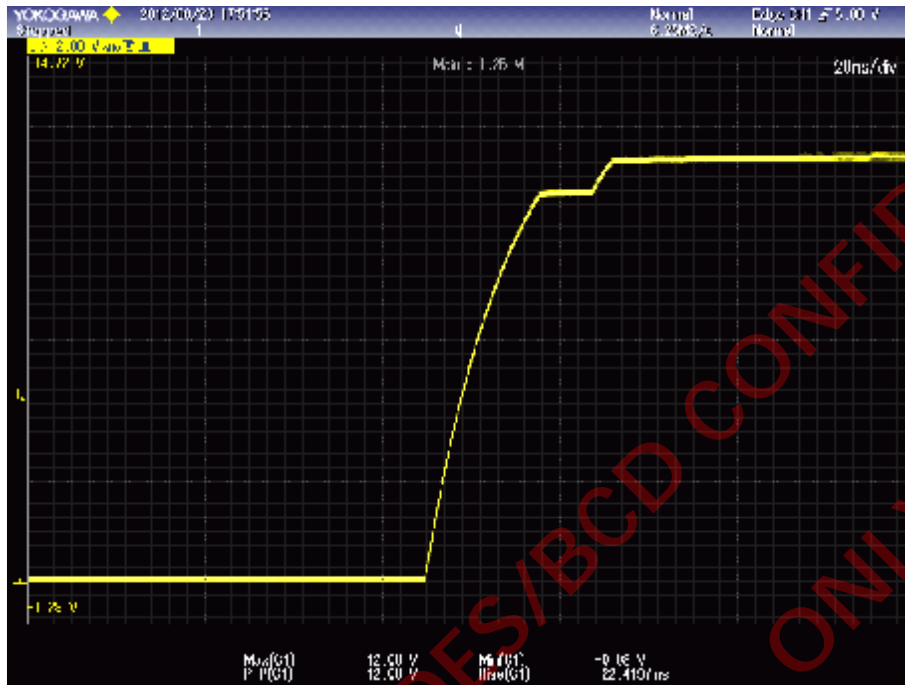


$T_{\text{DELAY}}: 1.67\text{S}$

Output Rise Time

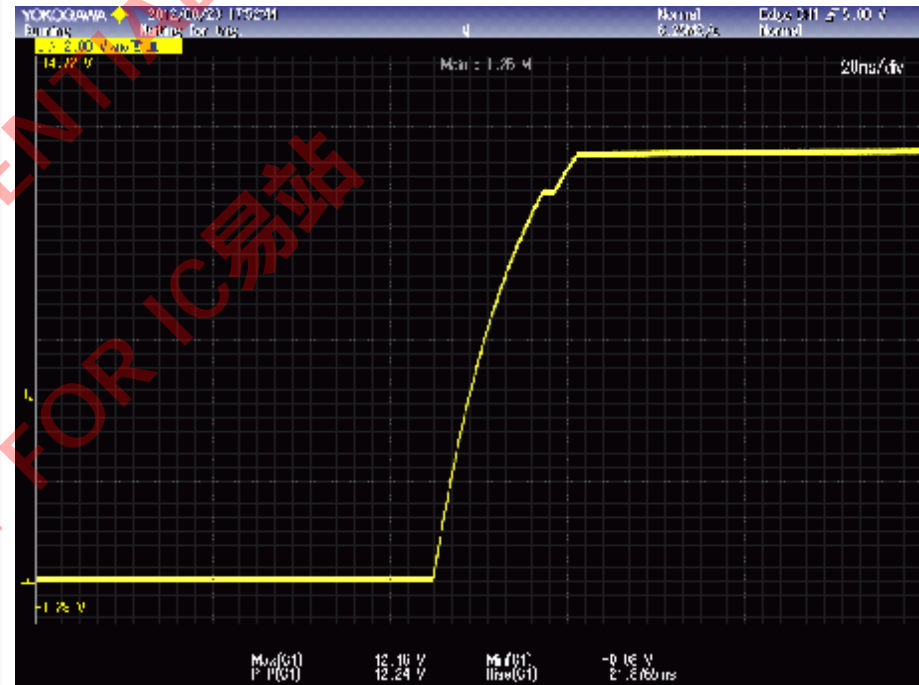


115Vac CR Mode Full Load



T_{RISE} : 22.4mS

230Vac CR Mode Full Load

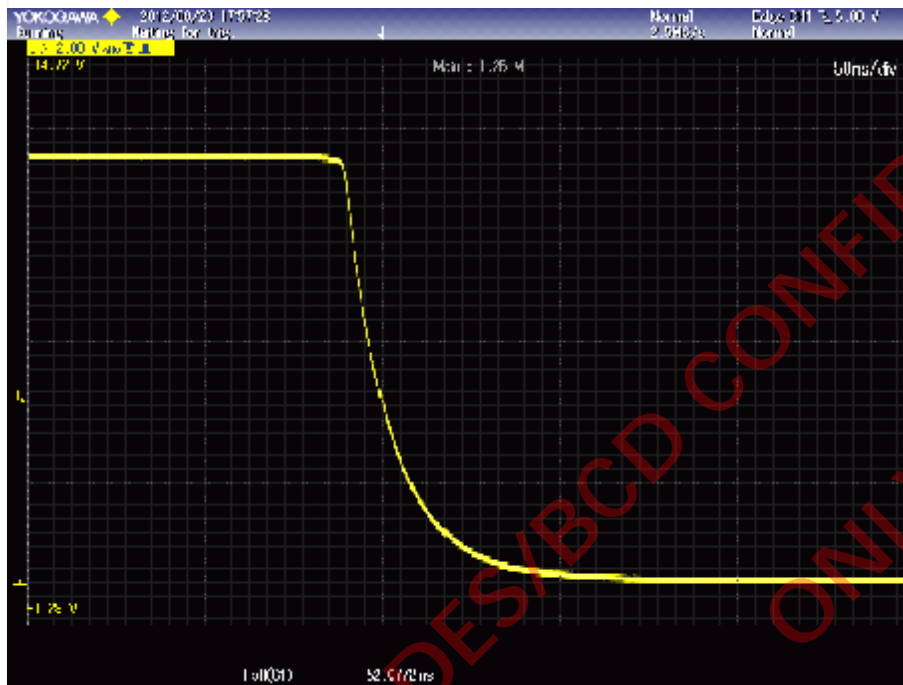


T_{RISE} : 21.9mS

Output Fall Time

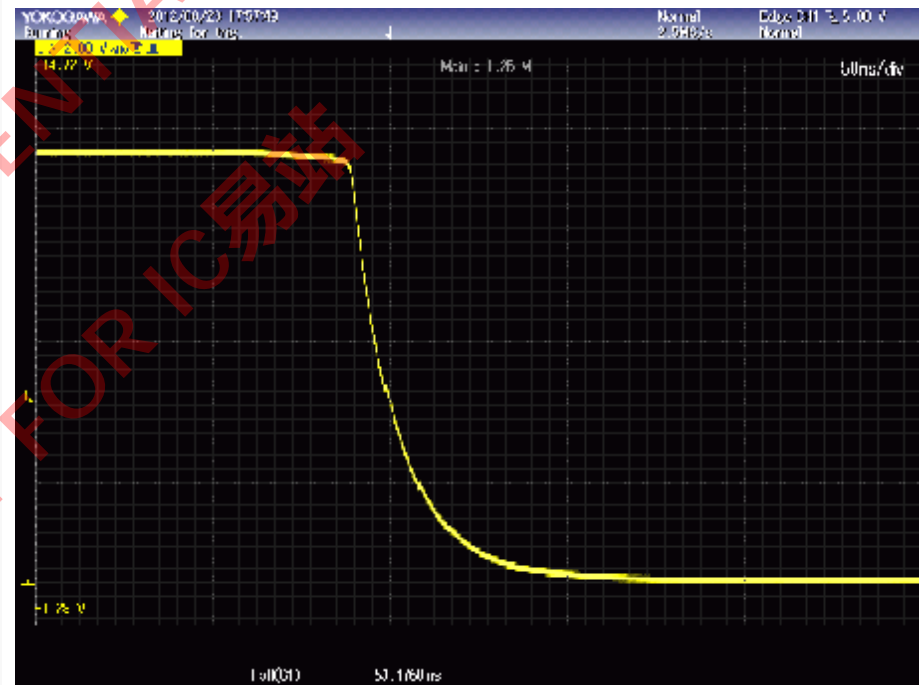


115Vac CR Mode Full Load



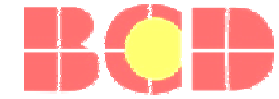
T_{FALL} : 52mS

230Vac CR Mode Full Load

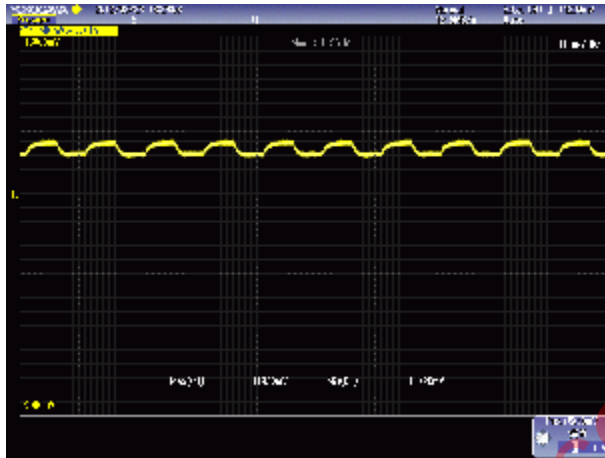


T_{FALL} : 53.1mS

Dynamic

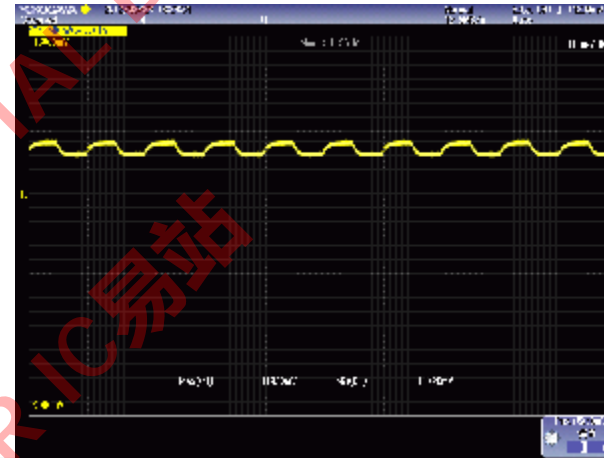


90Vac 25%~50%~25% 5mS 0.1A/uS



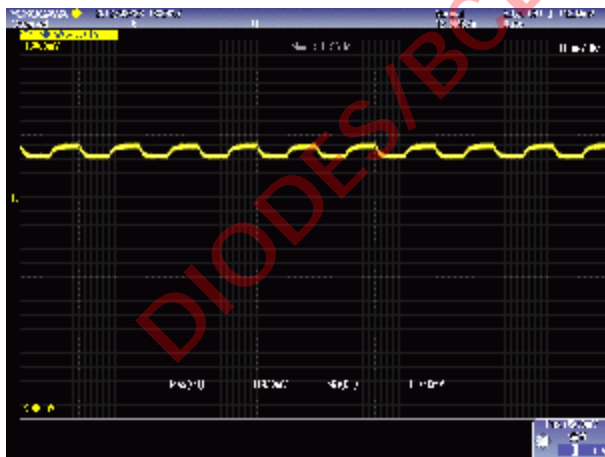
Vomin
11.92V
Vomax
11.72V

115Vac 25%~50%~25% 5mS 0.1A/uS



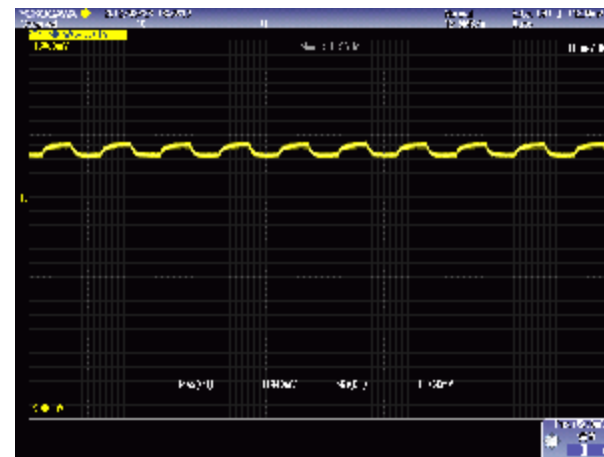
Vomin
11.92V
Vomax
11.72V

230Vac 25%~50%~25% 5mS 0.1A/uS



Vomin
11.92V
Vomax
11.74V

264Vac 25%~50%~25% 5mS 0.1A/uS



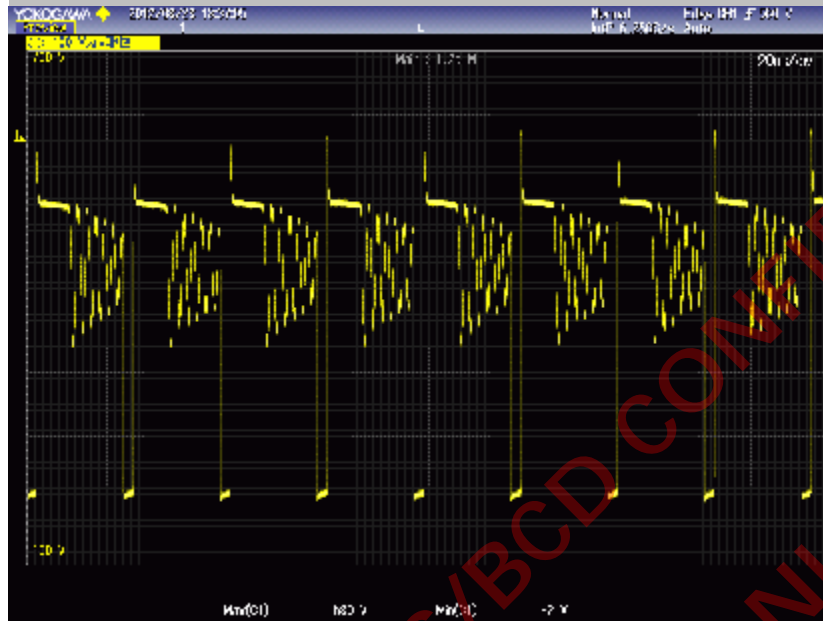
Vomin
11.94V
Vomax
11.76V

BJT Voltage Stress



264Vac Full Load

$V_{MAX}: 580V$



264Vac Short

$V_{MAX}: 505V$



Absolute Maximum Ratings (Note 1)

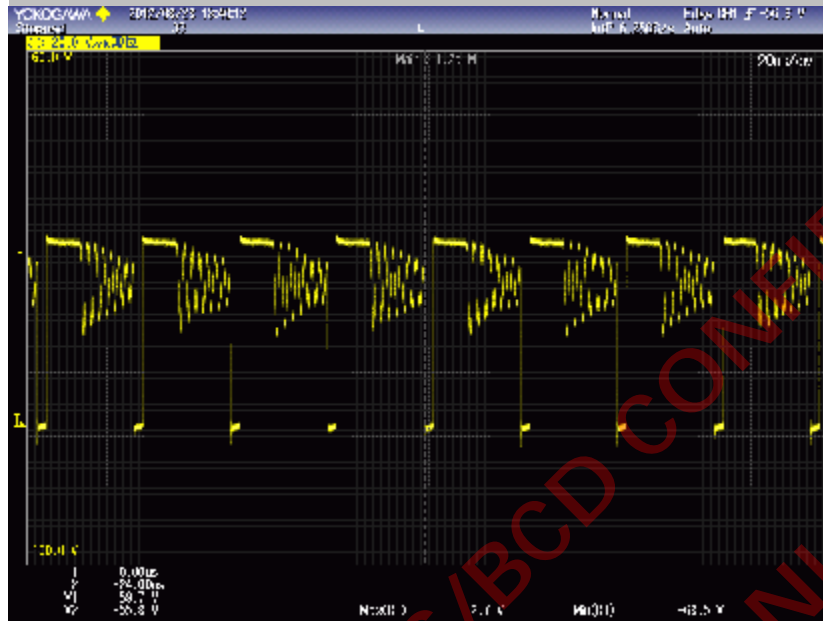
Parameter	Symbol	Value	Unit
Collector-Emitter Voltage ($V_{BE}=0$)	V_{CES}	700	V
Collector-Emitter Voltage ($I_B=0$)	V_{CEO}	465	V

Schottky Voltage Stress



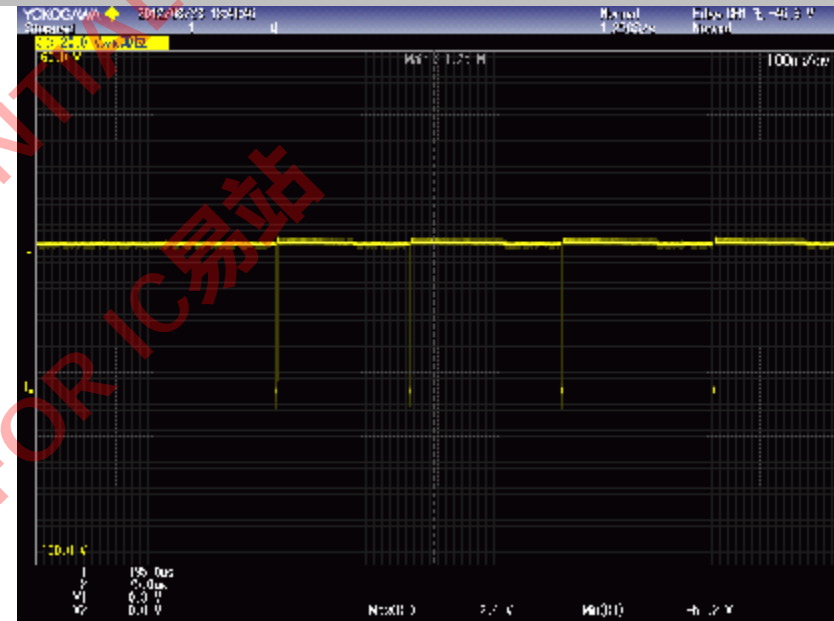
264Vac Full Load

$V_{MAX}: 63.5V$



264Vac Short

$V_{MAX}: 51.2V$



SCHOTTKY BARRIER RECTIFIERS

APD3100

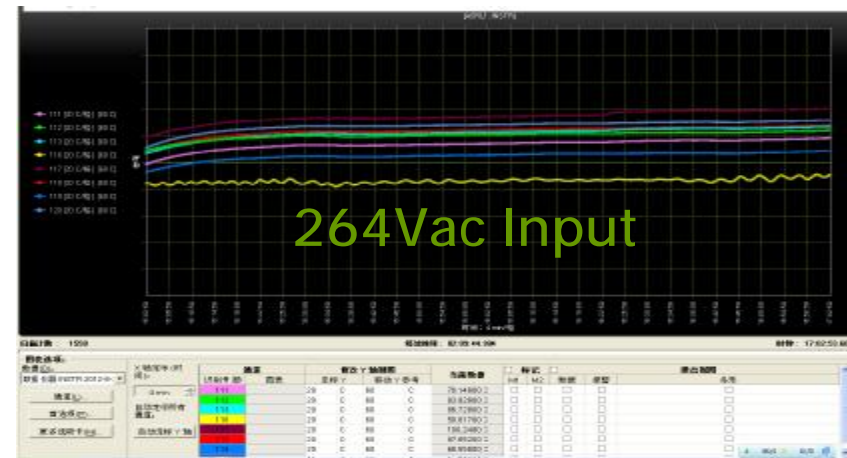
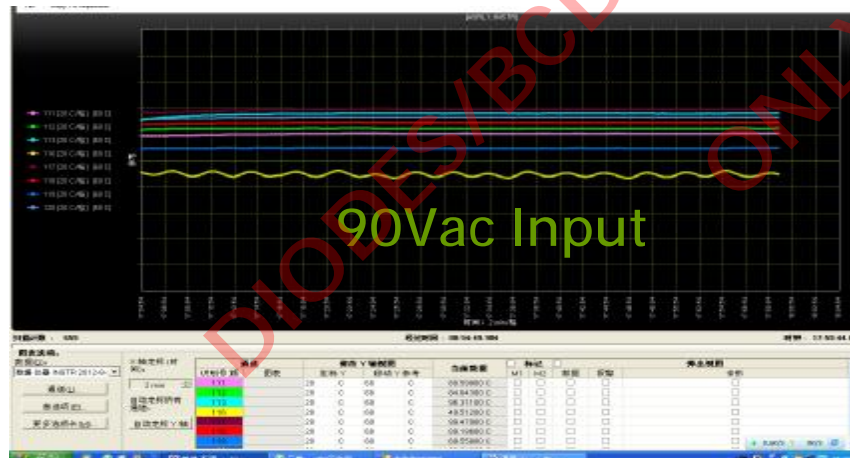
Absolute Maximum Ratings ($T_A=25^{\circ}C$, unless otherwise noted) (Note 1)

Parameter	Symbol	Value	Unit
Maximum Repetitive Peak Reverse Voltage	V_{RRM}	100	V

Temperature Rise



Location	Rated temp (°C)	90V/AC (°C)	264V/AC (°C)	T _{MAX} (°C)	Utilization ratio
EC2(4.7uF/400V)	105	80.5	78	80.5	76.7%
IC(AP3772B)	120	99.5	100	100	83.3%
Q1(APT13003D)	120	89.2	87.5	89.2	74.3%
Coil	120	69.5	68.5	69.5	57.9%
Core	120	93.2	91.4	93.2	77.7%
Schottky (DIP APD3100)	120	84.5	83.7	84.5	70.4%
EC4(680UF/16V)	105	96.3	88.6	96.3	91.7%
Ambient temperature		50.2	50.1	50.2	

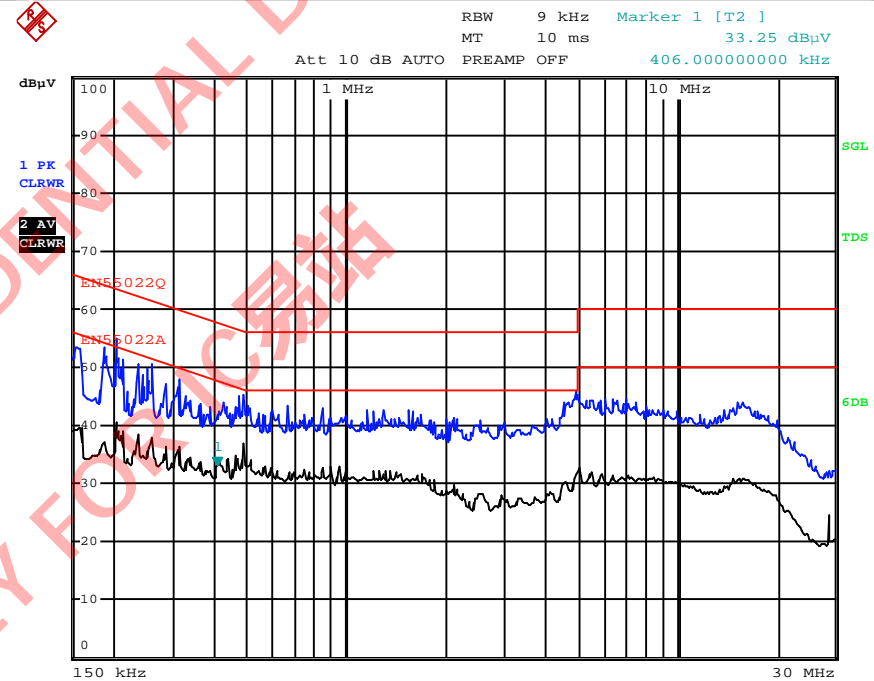
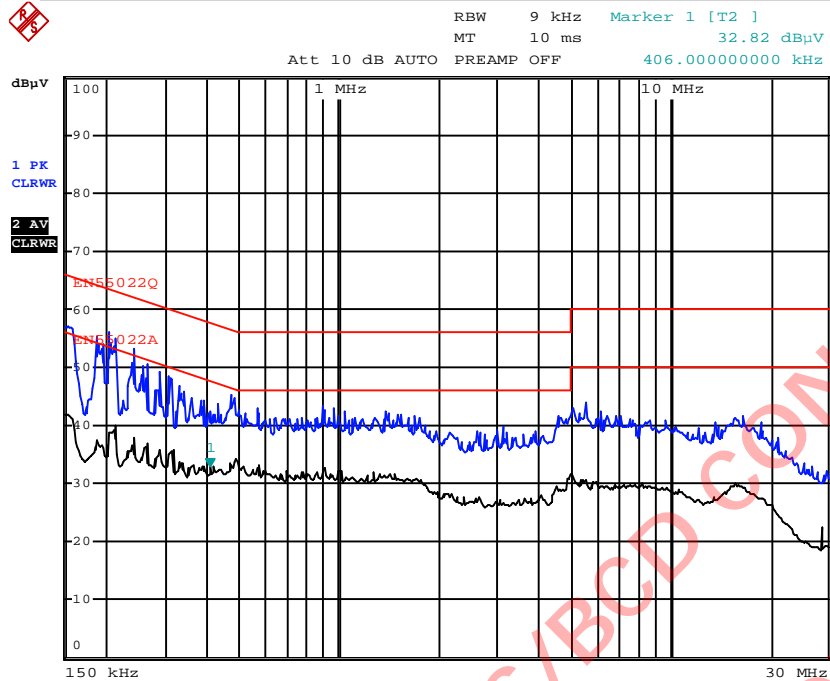


Conduction



230Vac Full Load L

230Vac Full Load N



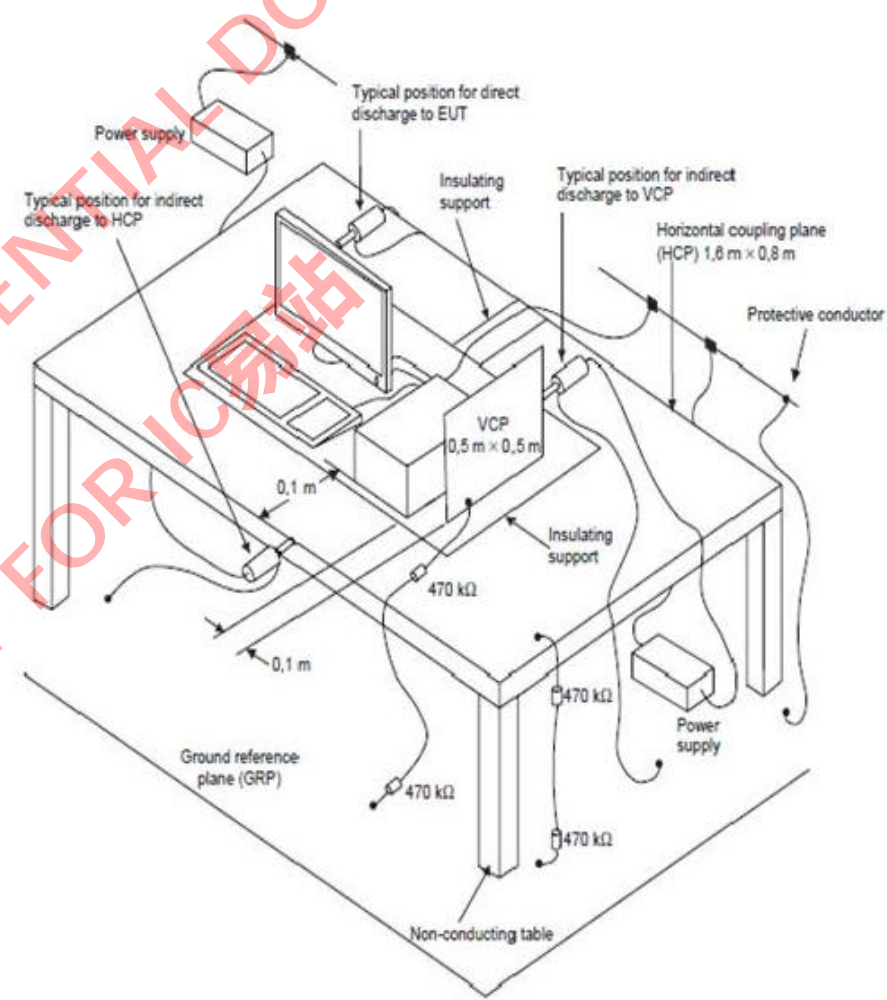
Date: 20.AUG.2012 07:44:36

Date: 20.AUG.2012 07:46:13

Margin: >6dB

Margin: >6dB

Air Discharged		No Load Result	Full Load Result
230Vac No Load and Full Load			
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!!!