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AP3968 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 “EPA_2.0” Requirement

Key Performance



Item	Spec	Test Conditions	Test Data	Result
Output Voltage 输出电压	4.75~5.25V	90~264Vac @ 0~1A	4.926~5.162V	Pass
Ripple 输出纹波	<120mVp-p	90~264Vac @ 0~1A	109mVp-p	Pass
Standby Power 待机功耗	<100mW	230Vac @ 0A	54mW	Pass
Dynamic 动态特性	4.5~5.5V	90~264Vac @ 0.1~0.9~0.1A 5mS 0.1A/uS	4.71~5.31V	Pass
Common Mode Noise 共模噪声	<2Vp-p	90~264Vac @ 0.5A 30k~500kHz	<1Vp-p	Pass
EMC 传导辐射	EN55022B	115Vac 230Vac@ 1A	-10dB	Pass
ESD 静电防护	15kV	230Vac @ 1A	20kV	Pass

Specification



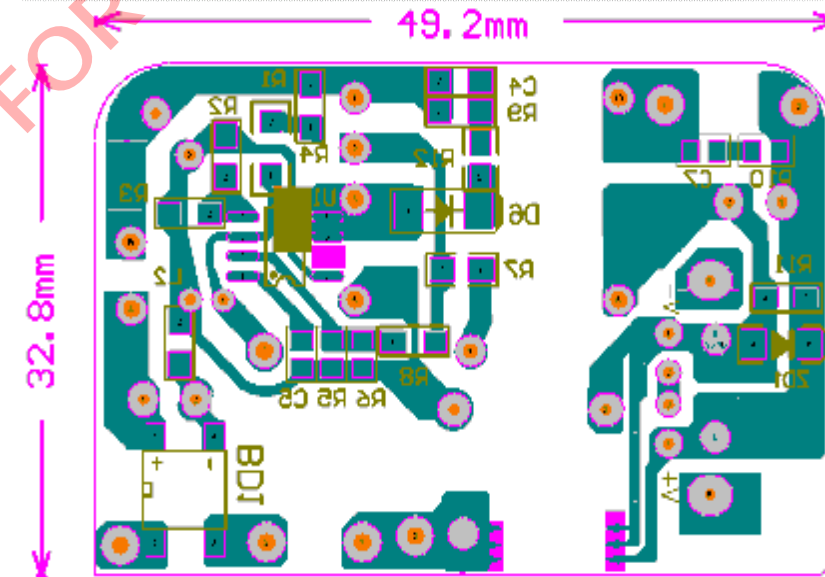
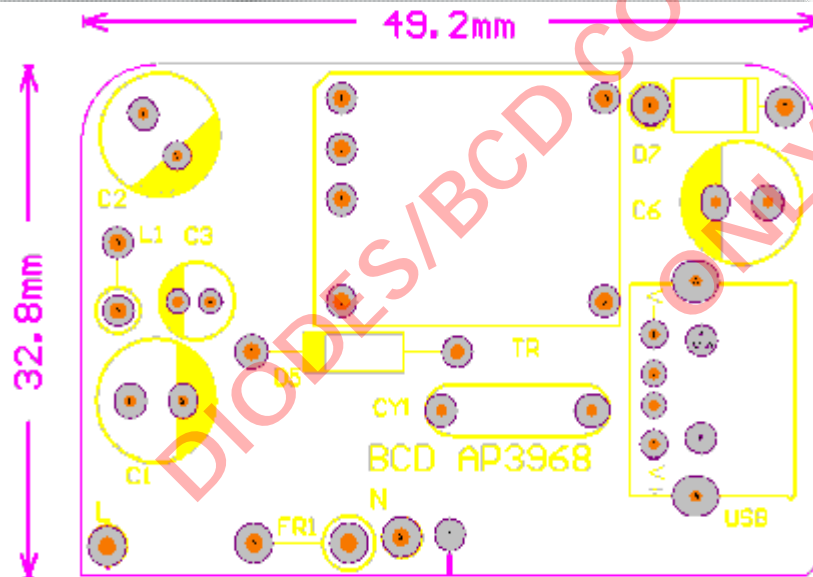
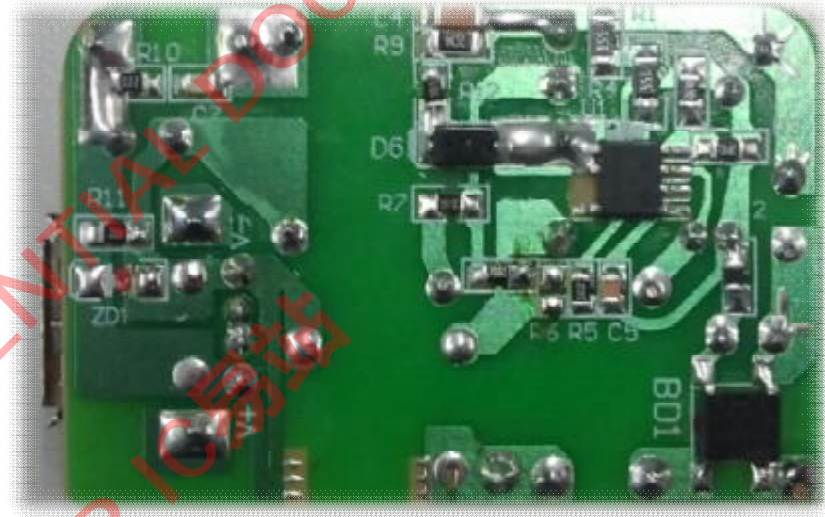
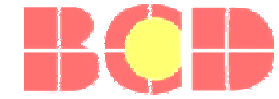
Description	Min	Type	Max	Units	Conditions
Input					
Voltage	90		264	VAC	
Frequency	47	50/60	63	Hz	
No-Load Input Power (230Vac)			100	mW	
Output					
Output Voltage	4.75	5	5.25	V	
Output Current	0		1	A	
Output Power		5		W	
Output Ripple Voltage			120	mVp-p	I _{out} = 1A @ 25°C, 20MHz bandwidth
Common Mode Noise			2	Vp-p	30k~500kHz, Load with 10ohm Resistor
Output Over Current Protection	1		1.2		Hiccup, Auto Restart
Ambient Temperature			40	°C	
Efficiency					
Average Efficiency (EPS 2.0)	68.2			%	Measured at end of output DC-Cable, 115Vac & 230Vac @ 25°C
EMI	Pass EN55022 Class B with 10dB Margin				

Test Equipment

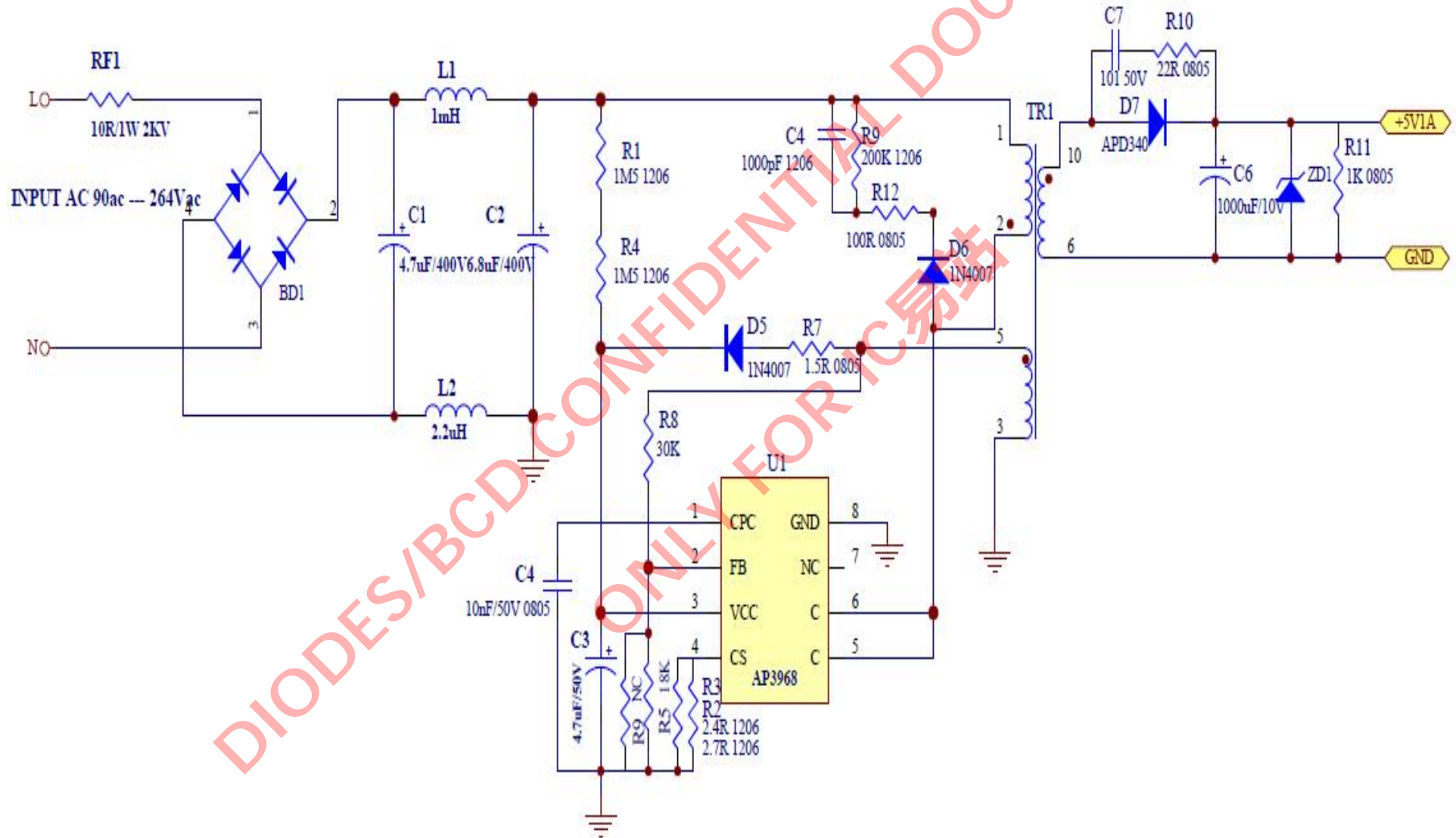


Item	Model
AC Source	Chroma 61602
Power Meter	YOKOGAWA WT210
Electronic Load	Chroma 63100
Oscilloscope	YOKOGAWA DLM2024 2.5GS/s 200MHz
Digit Multimeter	Agilent 34410A
Data Acquisition	Agilent 34970A

PCB Layout



Schematic Circuit

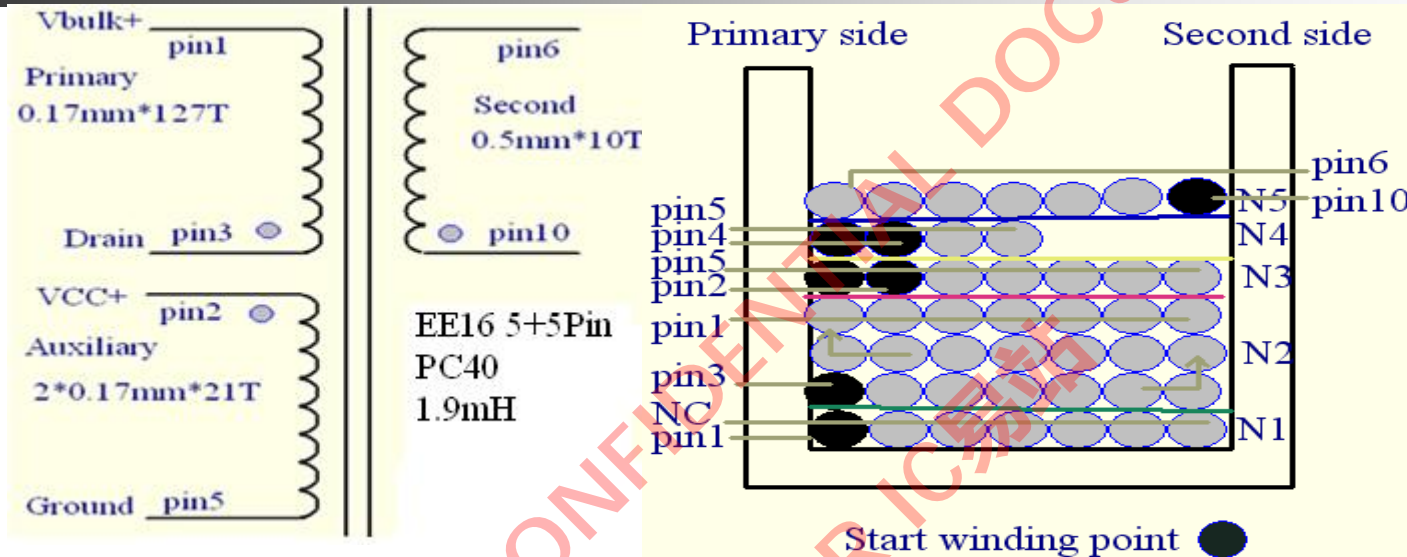


Bill Of Material



NO.	Spec.	Position	NO.	Spec.	Position
1	1000pF/250V \pm 15% 1206 X7R Ceramic	C4	15	1N4007 1A 1000V	D6
2	10nF/50V \pm 15% 0805 X7R Ceramic	C5	16	APD340 3A40V DO-15	D7
3	100pF/50V \pm 15% 0805 X7R Ceramic	C7	17	Bridge SMD MB6S 0.5A 600V	BD1
4	1.5M Ω \pm 5% 1206 1/4W	R1, R4	18	AP3968MTR-G1 SOIC-7	U1
5	2.7 Ω \pm 5% 1206 1/4W	R2	19	4.7uF 400V 8*12mm Electrolytic	C1
6	2.4 Ω \pm 5% 1206 1/4W	R3	20	6.8uF 400V 8*14mm Electrolytic	C2
7	18K Ω \pm 1% 0805 1/6W	R5	21	4.7uF 50V 6.3*11mm Electrolytic	C3
8	510K \pm 1% 0805 1/6W (Optional)	R6	22	1000uF 10V 8*12mm Electrolytic	C6
9	1.5 Ω \pm 1% 0805 1/4W	R7	23	1N4007 1A 1000V	D5
10	30K Ω \pm 1% 0805 1/6W//510K	R8	24	EE-16 5+5	TR
11	200K Ω \pm 5% 1206 1/4W	R9	25	1mH 1W	L1
12	22 Ω \pm 2% 0805 1/6W	R10	26	2.2uH 0805	L2
13	4.7K Ω \pm 5% 0805 1/4W	R11	27	USB A母4+2Pin	X1
14	100 Ω \pm 5% 0805 1/6W	R12	28	22F 49.2*32.8 *1.6mm 22F	*

Transformer Specification



WINDING DETAILS 详细绕线

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	1	Floating	42T	φ0.17mm	单线一层一次绕完	RIGHT	
1 layers of Polyester Yellow tape, T=0.05 mm							
W2	3	1	127T	φ0.17mm	单线三层一次绕完	RIGHT	
1 layers of Polyester Yellow tape, T=0.05 mm							
W3	2	5	21T	φ0.17mm*2	双线一层一次绕完	RIGHT	
1 layers of Polyester Yellow tape, T=0.05 mm							
W4	4	5	8T	φ0.17mm*2	双线密绕	RIGHT	
1 layers of Polyester Yellow tape, T=0.05 mm							
W3	10	6	10T	φ0.5mm 三层 绝缘线	单线一层一次绕完	RIGHT	
3 layer of Polyester Yellow tape, T=0.05mm							
Timed first times							
Assembling the core and curing							

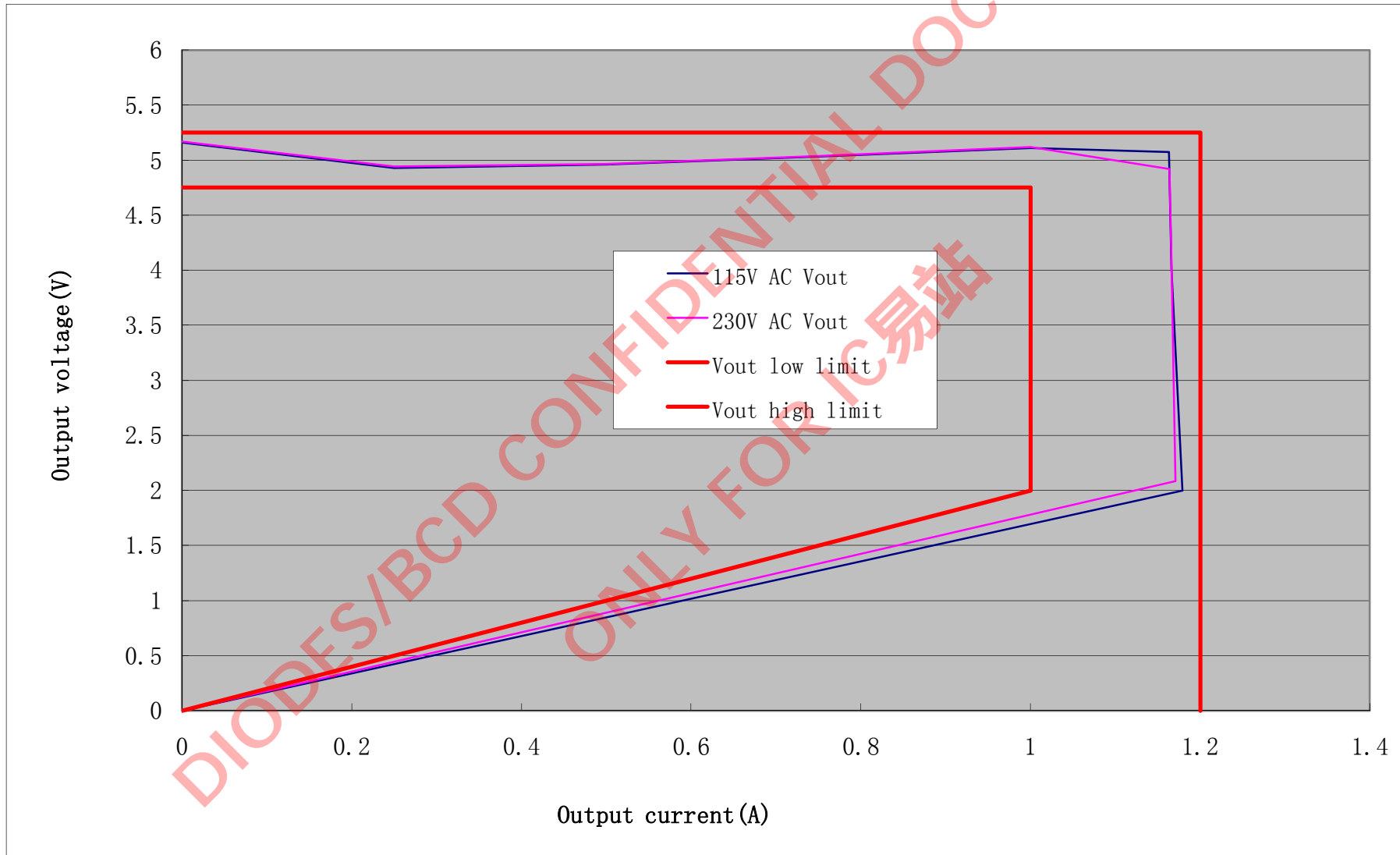
Regulation, Ripple, OCP and Efficiency



V _{IN} (V)	P _{IN} (W)	V _{OUT} (V)	I _O (A)	Ripple (mV)	P _{OUT} (W)	η	OCP	Average η	SPEC.
90V/60Hz	1.631	4.926	0.25	64	1.2315	75.51%	1.142	75.52%	EPS2.0 68.17%
	3.258	4.946	0.5	94	2.473	75.91%			
	4.977	5.015	0.75	98	3.76125	75.57%			
	6.785	5.095	1	109	5.095	75.09%			
115V/60Hz	1.63	4.929	0.25	64	1.23225	75.60%	1.152	76.54%	
	3.23	4.959	0.5	92	2.4795	76.76%			
	4.901	5.031	0.75	92	3.77325	76.99%			
	6.656	5.111	1	93	5.111	76.79%			
230V/50Hz	1.744	4.943	0.25	62	1.23575	70.86%	1.149	74.82%	
	3.27	4.965	0.5	89	2.4825	75.92%			
	4.924	5.036	0.75	90	3.777	76.71%			
	6.755	5.119	1	91	5.119	75.78%			
264V/50Hz	1.804	4.941	0.25	62	1.23525	68.47%	1.153	73.40%	
	3.326	4.962	0.5	92	2.481	74.59%			
	4.988	5.036	0.75	92	3.777	75.72%			
	6.836	5.115	1	92	5.115	74.82%			

* Note: Output Voltage measured at end of PCB

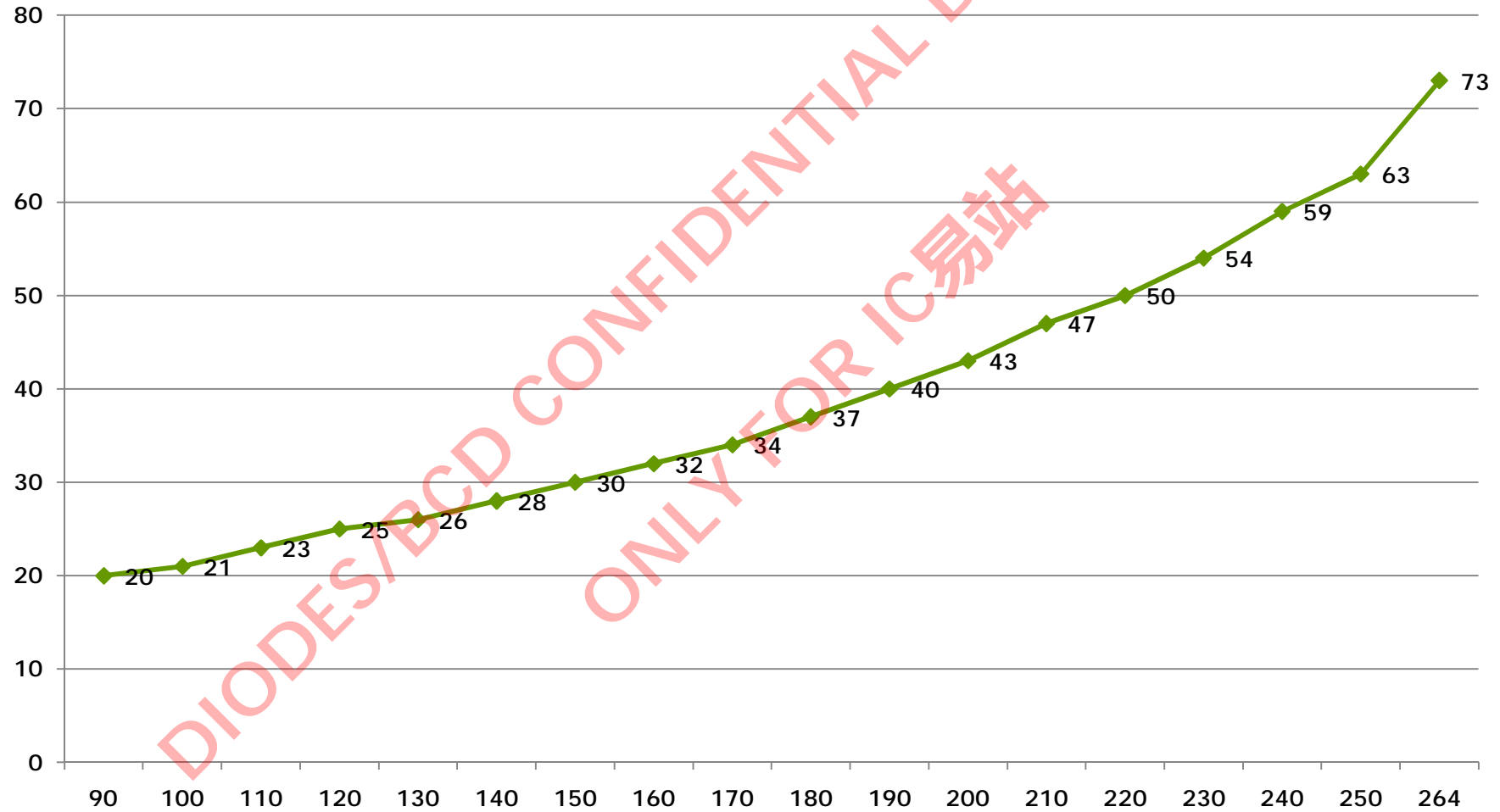
Output V-I Characteristics



Standby Power



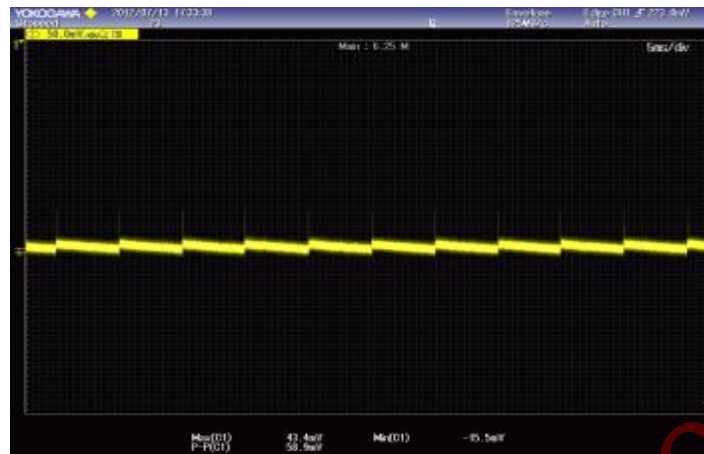
Stb Power



Output Ripple & Noise



90Vac No Load



44.8mV

115Vac No Load



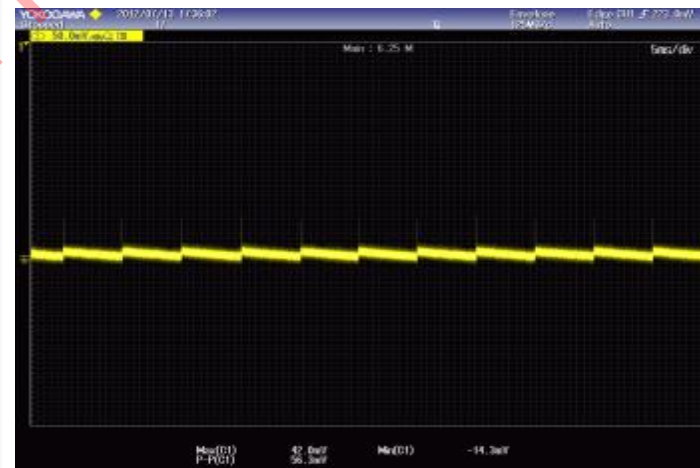
45.1mV

230Vac No Load



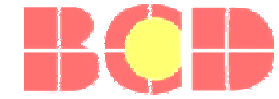
45.2mV

264Vac No Load

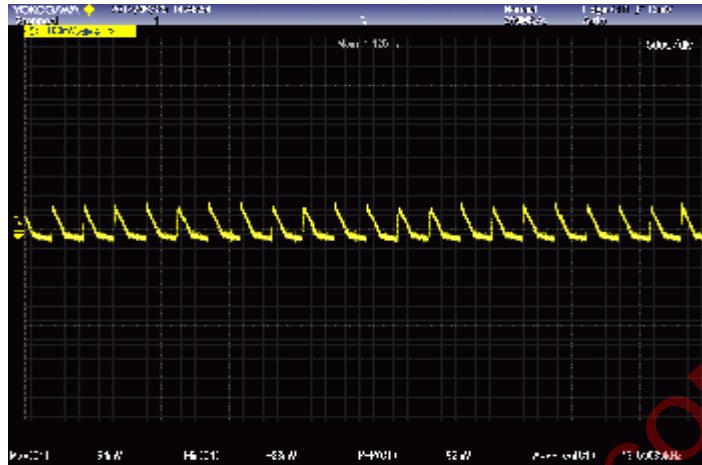


46.1mV

Output Ripple & Noise

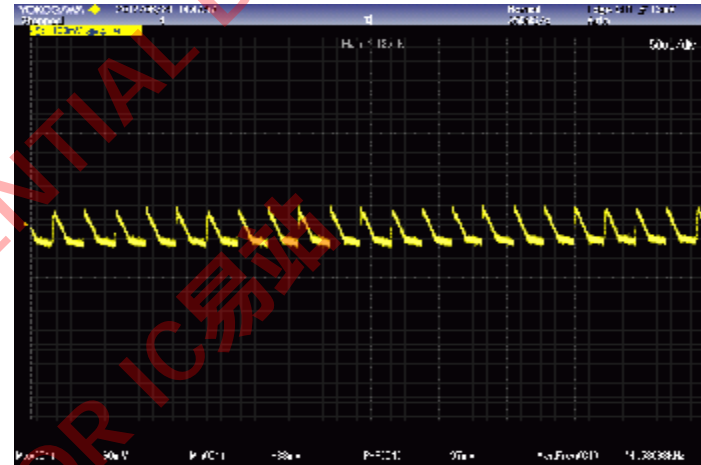


90Vac Full Load



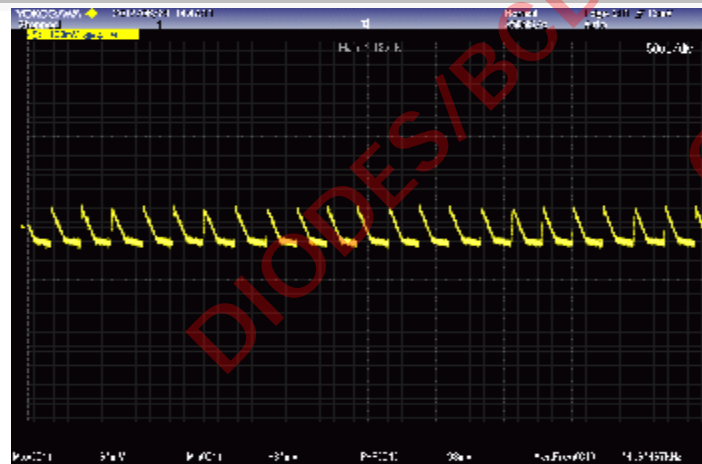
92mV

115Vac Full Load



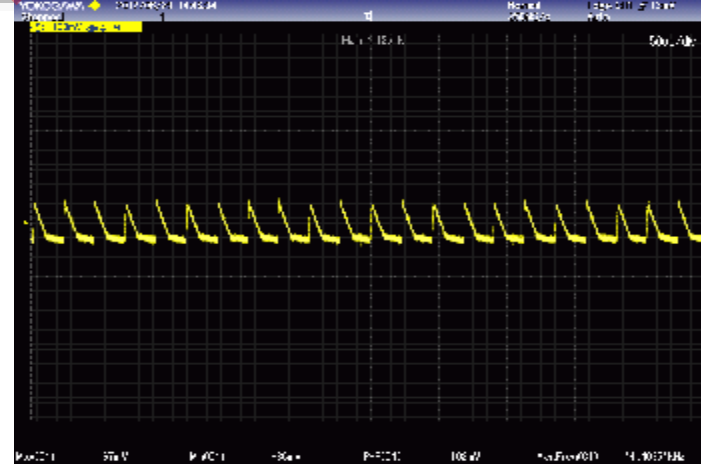
91mV

230Vac Full Load



93mV

264Vac Full Load



94mV

Turn On Delay Time

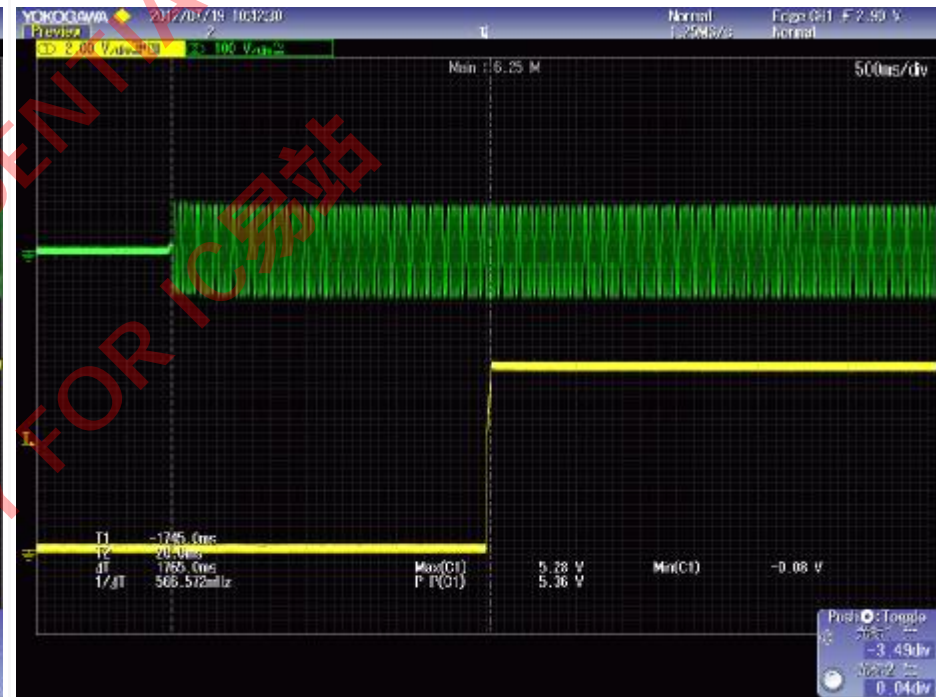


90Vac No Load

90Vac Full Load



$T_{\text{DELAY}}: 1.740\text{S}$



$T_{\text{DELAY}}: 1.765\text{S}$

Output Rise Time



115Vac Full Load



Trise: 17.15mS

230Vac Full Load



Trise: 18.6mS

Dynamic



90Vac 10%~90%~10% 0.1A/uS



Vomin
4.675
Vomax
5.265

115Vac 10%~90%~10% 0.1A/uS



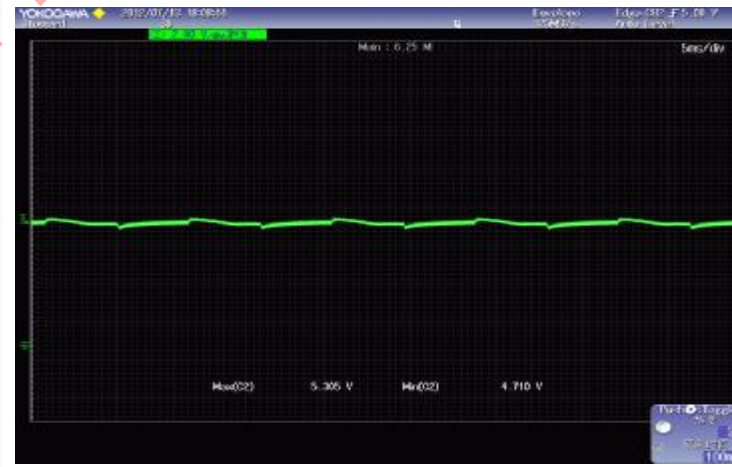
Vomin
4.69
Vomax
5.28

230Vac 10%~90%~10% 5mS 0.1A/uS



Vomin
4.71
Vomax
5.305

264Vac 10%~90%~10% 5mS 0.1A/uS



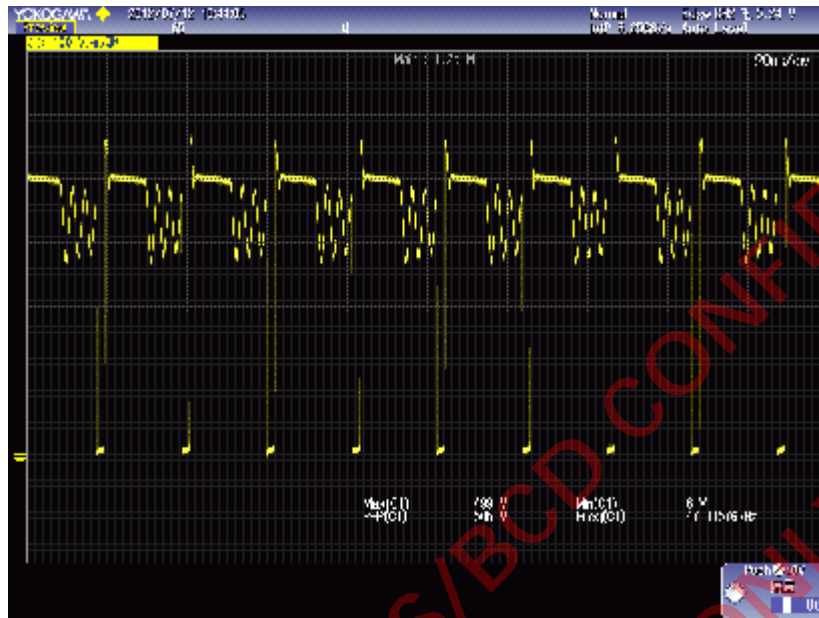
Vomin
4.71
Vomax
5.305

BJT Voltage Stress



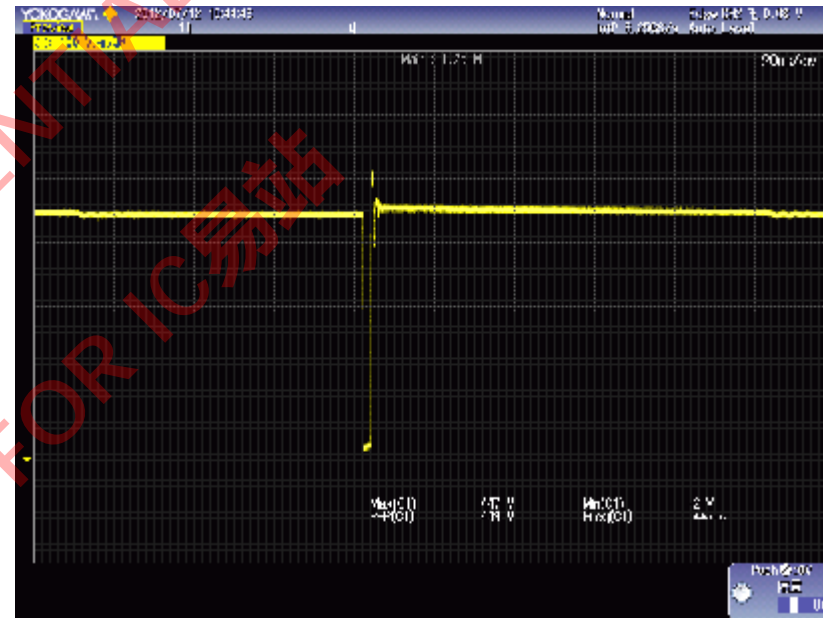
264Vac Full Load

$V_{MAX}: 499V$



264Vac Short

$V_{MAX}: 449V$



Primary Side Power Switcher for Off-line SMPS

AP3968/69/70/70S

Absolute Maximum Ratings (Note 2)

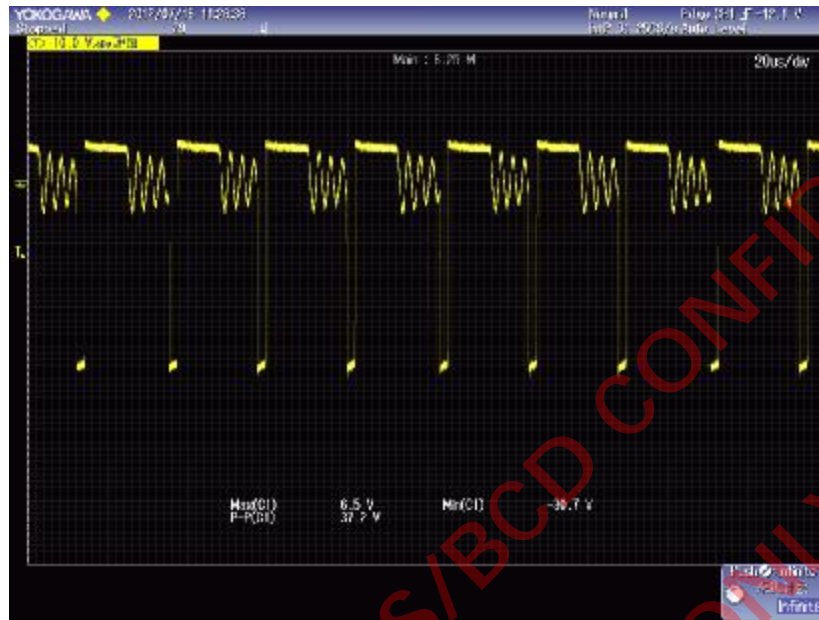
Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	-0.3 to 22	V
FB Input Voltage	V_{FB}	-1 to 10	V
Collector-emitter Voltage	V_{CE0}	700	V

Schottky Voltage Stress



264Vac Full Load

$V_{MAX}: 37.2V$



264Vac Short

$V_{MAX}: 32.6V$



SCHOTTKY BARRIER RECTIFIERS

APD340

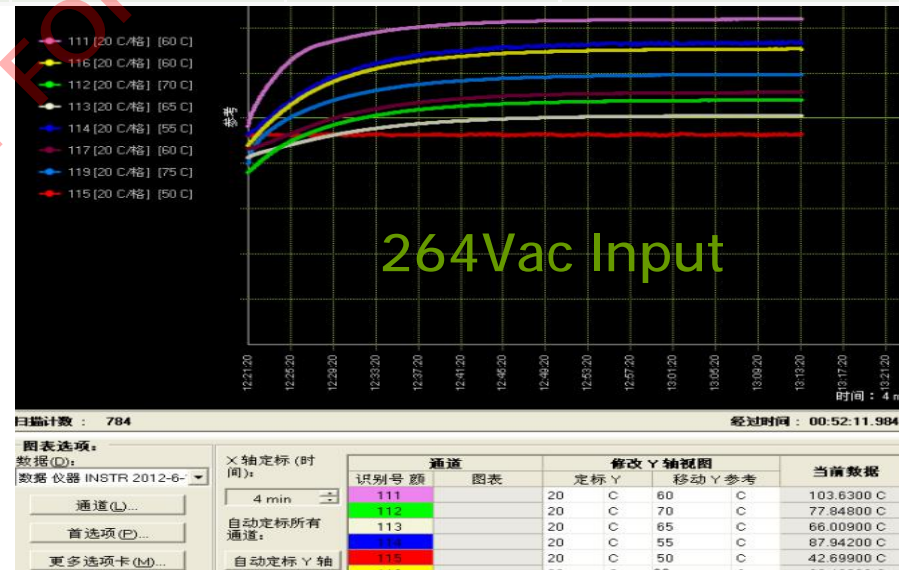
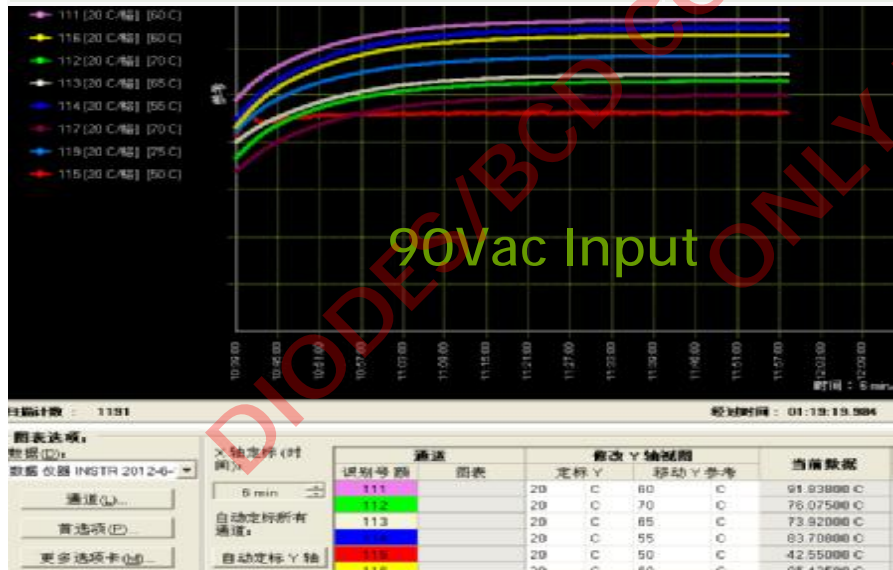
Absolute Maximum Ratings ($T_A=25^{\circ}C$, unless otherwise noted) (Note 1)

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

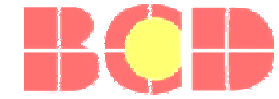
Temperature Rise



Location	Rated temp (°C)	90V/AC (°C)	264V/AC (°C)	T _{MAX} (°C)	Utilization ratio
C2(6.8uF/400V)	105	69.80	71.26	71.26	67.87%
IC(AP3968)	110	91.84	103.63	103.63	94.2%
Coil	130	85.43	90.43	90.43	69.56%
Core	130	83.71	87.94	87.94	67.65%
Schottky (APD340)	110	91.84	94.16	94.16	85.6%
Ambient temperature		42.55	42.70	42.70	

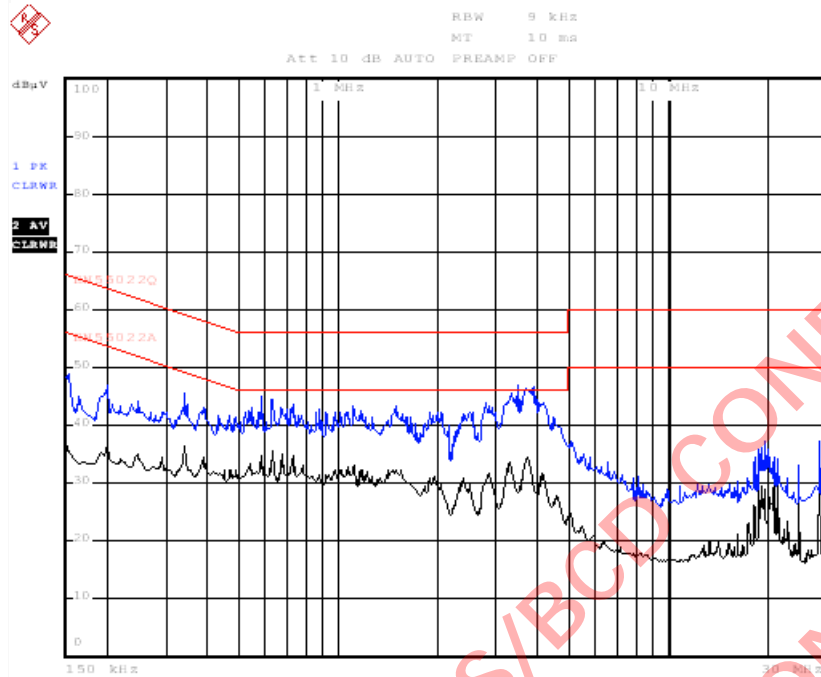


Conduction



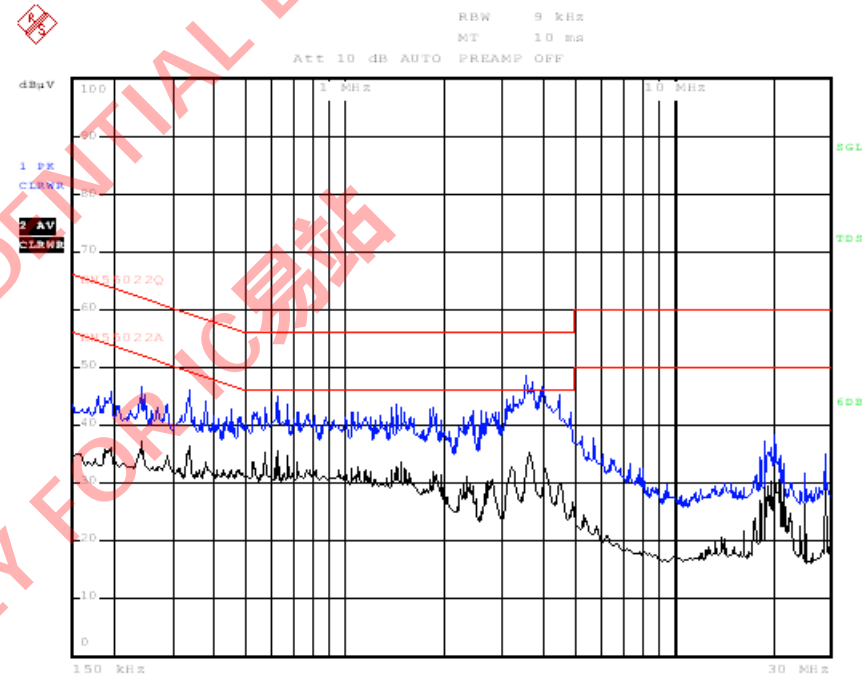
230Vac Full Load L

230Vac Full Load N



Date: 18.JUL.2012 23:04:52

Margin: >10dB



Date: 18.JUL.2012 23:02:55

Margin: >10dB

Common Mode Noise



90Vac 10ohm Resistor Load



340mV

115Vac 10ohm Resistor Load



620mV

230Vac 10ohm Resistor Load



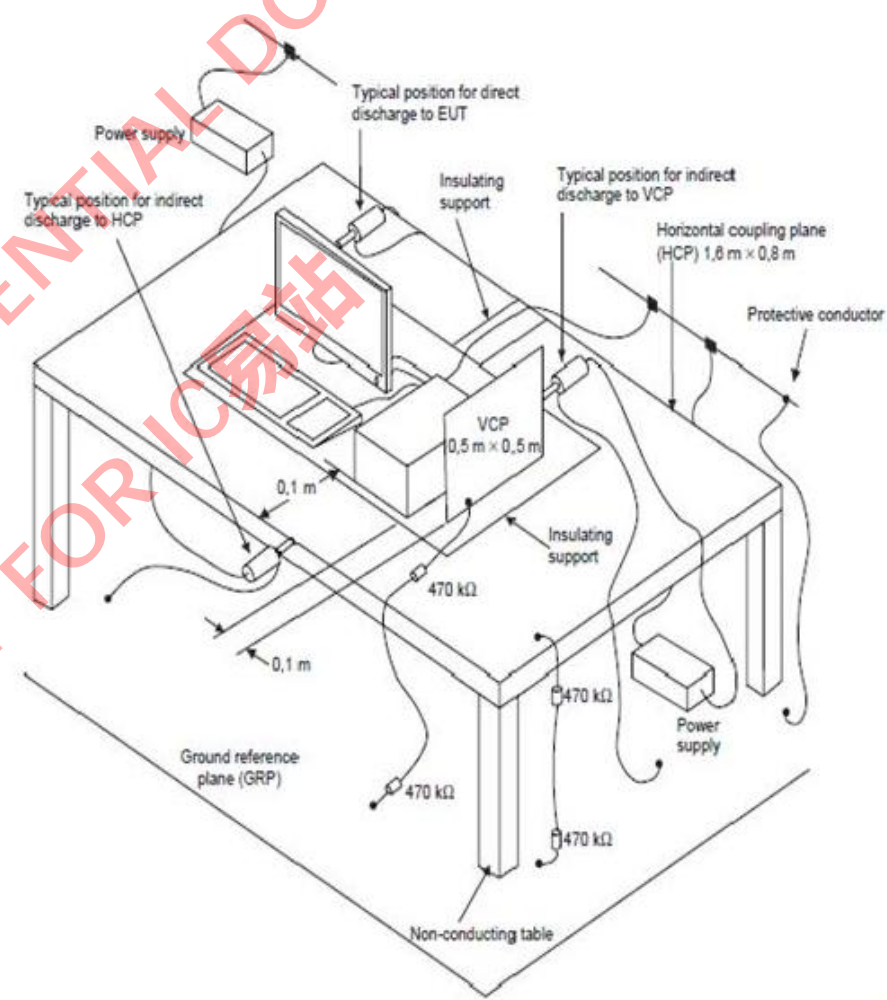
800mV

264Vac 10ohm Resistor Load



1000mV

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
	-	Pass	Pass





Thank You!!!