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检测
TESTING
CNAS L0681

CHPTL

TEST REPORT

№ : CTQC/ZJ-23. 0045

Test object name: Adhesive paper capacitive transformer bushing

Test object type: QXBRP(G)WD-L-126/1600-4

Entrusted by: Shandong Qixing High Voltage Electric CO., Ltd.

Manufacturer: Shandong Qixing High Voltage Electric CO., Ltd.

Kind of testing: Type tests

SHENYANG TRANSFORMER RESEARCH INSTITUTE CO., LTD.

CHINA NATIONAL TRANSFORMER QUALITY DETECTION AND TESTING CENTER

CONTENTS

Page

CTQC

Shenyang Transformer Research Institute Co., Ltd.

China National Transformer Quality Detection And Testing Center

Test Report

№: CTQC/ZJ-23.0045

Test object name	Adhesive paper capacitive transformer bushing	Test object type	QXBRP(G)WD-L-126/1600-4
		Brand	/
Entrusted by	Shandong Qixing High Voltage Electric Co., Ltd.	Kind of testing	Type tests
Manufac-turer	Shandong Qixing High Voltage Electric Co., Ltd.	Sampling date	/
		Test date	Feb. 17, 2023~Feb. 23, 2023
Address	No. 1228, Pengcheng Industrial Park, Pingli Road, Xiazhuang Town, Gaomi City, Weifang City, Shandong Province	Serial №	2302PB001
Standards	IEC60137: 2017 GB/T4109-2022 Technical contract	Test items	Routine tests Type tests
Results	The test results of routine tests, type tests of QXBRP(G)WD-L-126/1600-4 are in accordance with standards and technical contract. The sample passed the above tests. Signing and issuing date: 2023.03.09		
Note			

Approved by: Lv Xiangpeng Checked by: Zhou Jingwei Compiled by: Jiang Anping

Statement: 1. Testing report is invalid without test special seal.
2. Testing report is invalid without compiler, checker and approver's signature.
3. Please inform CTQC in time after received the testing report if you have some disagreement to the testing report.
4. Testing or witnessing only apply to sample.
5. Copying testing certificate or testing report is forbidden without written permission from CTQC(except for copying all the testing report).

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E-mail: ctqc@vip.sina.com http: //www.ctn.cn Tel: (024)23787022

Test Report

№: CTQC/ZJ-23.0045
Total 22 Page 3

Test results

№	Test items	Specified values Standards (Technical contract)	Measured values	Conclu-sions
1	Measurement of dielectric dissipation factor (tanδ) and capacitances at ambient temperature (Before type test)	Applied voltage(kV): 2～20 tanδ: ≤0.007 Providing capacitance of the sample(pF)	10.0 0.00301 395.0	Passed
		Applied voltage(kV): $1.05U_m/\sqrt{3}$ tanδ: ≤0.007 Providing capacitance of the sample(pF)	76.4 0.00347 395.4	
		Applied voltage(kV): U_m tanδ: ≤0.007 Providing capacitance of the sample(pF)	126 0.00360 395.5	
2	Measurement of partial discharge quantity (Before type test)	Applied voltage(kV): U_m Partial discharge level(pC): ≤10	126 <6	Passed
		Applied voltage(kV): $1.5U_m/\sqrt{3}$ Partial discharge level(pC): ≤10	109.1 <6	
		Applied voltage(kV): $1.05U_m/\sqrt{3}$ Partial discharge level(pC): ≤5	76.4 <4	
3	Visual inspection and dimensions check (Type test)	According to standard	See 4.3	Passed
4	Dry lightning impulse voltage withstand test (Type test)	Full wave voltage Positive polarity(kV): 525.5 (Corrected value) ±3% Negative polarity(kV):605 ±3% 15 positive and 15 negative polarity Chopped wave voltage (kV): 665.5 ±3% 5 negative polarity	 523.15~525.73 607.90~619.07 Each 15 times 665.46~669.55 5 times	Passed
5	Wet power-frequency voltage withstand test (Type test)	Applied voltage(kV): 231.2 (Corrected value) Duration(s): 60	 231.2 60	Passed
6	Long-duration power-frequency voltage withstand test (ACLD) (Type test)	$U_1=U_m$(kV) Duration(s): 60	126 60	Passed
		$U_2=1.5U_m/\sqrt{3}$ Duration(min): 60 Partial discharge level(pC): ≤10	109.1 60 <5	
		$1.1U_m/\sqrt{3}$ (kV) Duration(min): 5 Partial discharge level(pC): ≤5	80 5 <4	

Test Report

№: CTQC/ZJ-23.0045
Total 22 Page 4

№	Test items	Specified values Standards (Technical contract)	Measured values	Conclu-sions
7	Radio interference voltage test (Type test)	Applied voltage(kV): 1.1Um/$\sqrt{3}$ Duration(min): 5 Radio interference level(μV): ≤500	80 5 282	Passed
8	Temperature rise test (Type test)	Temperature limit(℃): 120 Temperature rise limit(K): 75	42.8～73.0 31.5～61.7	Passed
9	Verification of thermal short-time current withstand (Type test)	Thermal short-time current(kA): 25I_r Duration(s): 2 Final temperature of the conductor (℃): ≤180	40 2 128.4	Passed
10	Cantilever load withstand test (Type test)	Applied load(N): 3150 Duration(s): 60 Successfully repeat check items	3236 60 Passed	Passed
11	Measurement of partial discharge quantity (After type test)	Applied voltage(kV): U_m Partial discharge level(pC): ≤10	126 <6	Passed
		Applied voltage(kV): 1.5U_m/$\sqrt{3}$ Partial discharge level(pC): ≤10	109.1 <5	
		Applied voltage(kV): 1.05U_m/$\sqrt{3}$ Partial discharge level(pC): ≤5	76.4 <5	
12	Measurement of dielectric dissipation factor (tanδ) and capacitances at ambient temperature (After type test)	Applied voltage(kV): 2～20 tanδ: ≤0.007 Providing capacitance of the sample(pF)	10.0 0.00300 391.4	Passed
		Applied voltage(kV): 1.05U_m/$\sqrt{3}$ tanδ: ≤0.007 Providing capacitance of the sample(pF)	76.4 0.00330 391.7	
		Applied voltage(kV): U_m tanδ: ≤0.007 Providing capacitance of the sample(pF)	126 0.00345 391.7	
13	Visual inspection and dimensions check (Routine test)	According to standard	See 4.13	Passed
14	Tests of tap insulation (Routine test)	Dry power-frequency voltage withstand test on the tap: Applied voltage(kV): ≥2 Duration(s): 60	 3 60	Passed
		Measurement of dielectric dissipation factor (tanδ) and capacitances at ambient temperature on the tap: Applied voltage(kV): ≥1 tanδ: ≤0.05 Capacitance(pF): ≤10000	 2 0.00323 315.8	

Test Report

№: CTQC/ZJ-23.0045

Total 22 Page 5

№	Test items	Specified values Standards (Technical contract)	Measured values	Conclu-sions
15	Dry lightning impulse voltage withstand test (Routine test)	Full wave voltage(kV): 577.5 ±3% 3 negative polarity Chopped wave voltage(kV): 632.5 ±3% 2 negative polarity	575.81~579.11 3 times 629.40~629.97 2 times	Passed
16	Dry power-frequency voltage withstand test (Routine test)	Applied voltage(kV): 255 Duration(s): 60	255 60	Passed
17	Tightness test at the flange (Routine test)	Applied medium Applied pressure(MPa): 0.4 ±0.01 Duration(min): 15 No leakage and damage	Compressed air 0.4 15 No leakage and damage	Passed
18	Measurement of partial discharge quantity (Routine test)	Applied voltage(kV): U_m Partial discharge level(pC): ≤10	126 <5	Passed
		Applied voltage(kV): $1.5U_m/\sqrt{3}$ Partial discharge level(pC): ≤10	109.1 <5	
		Applied voltage(kV): $1.05U_m/\sqrt{3}$ Partial discharge level(pC): ≤5	76.4 <5	
19	Measurement of dielectric dissipation factor (tanδ) and capacitances at ambient temperature (Routine test)	Applied voltage(kV): 2～20 tanδ: ≤0.007 Providing capacitance of the sample(pF)	10.0 0.00301 391.4	Passed
		Applied voltage(kV): $1.05U_m/\sqrt{3}$ tanδ: ≤0.007 Providing capacitance of the sample(pF)	76.4 0.00329 391.7	
		Applied voltage(kV): U_m tanδ: ≤0.007 Providing capacitance of the sample(pF)	126 0.00345 391.7	

Note: 1. All the tests were field tests;

2. Tested in Shandong Qixing High Voltage Electric Co., Ltd. laboratory.

Test Report

1. Test object parameters

Highest voltage for equipment(kV): 126

Rated phase to earth voltage(kV): $126/\sqrt{3}$

Rated current(A): 1600

Rated frequency(Hz): 50

Altitude(m): ≤1000

Thermal class of insulation: E

Test tap(measured tap, tanδ): With

Insulation type of bushing: Adhesive paper

2. Sample condition description

Sample exterior construction and major dimensions(length, diameter) are in compliance with outline drawings.

Measured values: length 2497mm, outer diameter Φ400mm.

Outline dimensions	Rating plate
PCB11-620	8QX.860.008G

Rating plate and outline drawings see testing report annex.

The form, performance data, specifications of sample rating plate are in compliance with drawing.

The surface of the sample has no collision and damage.

3. Standards

IEC60137:2017, GB/T4109-2008 Insulated bushings for alternating voltage above 1000V

Technical contract

4. Test items and conclusions

4.1 Measurement of dielectric dissipation factor(tanδ) and capacitances at ambient temperature(Before type test)

Test date: Feb. 17, 2023

Humidity: 43.0%; Ambient temperature: 11.6℃

Applied voltage (kV)	Dielectric dissipation factor (tanδ)	Capacitance(pF)	Result
10.0	0.00301	395.0	Passed
76.4	0.00347	395.4	
126.0	0.00360	395.5	

Note: tanδ(126kV)- tanδ(76.4kV)= 0.00013＜0.001 (Standard value), passed.

4.2 Measurement of partial discharge quantity(Before type test)

Test date: Feb. 17, 2023

Humidity: 43.0%; Ambient temperature: 11.6℃; Atmospheric pressure: 101.6kPa

Prestress voltage (kV)	Duration(s)	Measured voltage (kV)	Partial discharge level (pC)	Result
255	60	126.0	＜6	Passed
		109.1	＜6	
		76.4	＜4	
		126.0	＜6	

Note: Background noise level was＜4pC before and after test.

4.3 Visual inspection and dimensional check(Type test)

Test date: Feb. 17, 2023

It has smooth surface, no cracks. Dimensional check is accordance with the drawing requirement.

Drawing values(mm): 2495±20 1140±10 835±5 Ø400 100

Measured values(mm): 2497 1150 838 Ø400 100

Arcing distance(mm): 1200 Creepage distance(mm): 4585

Result: Passed.

4.4 Dry lightning impulse voltage withstand test(Type test) Test date: Feb. 21, 2023

Test atmospheric conditions

Humidity: 46.0%; Ambient temperature: 12.1℃; Atmospheric pressure: 101.08kPa.

Rated lightning impulse withstand voltage:

Positive: 525.5kV(Corrected value)

Negative: 605kV 15 positive and 15 negative polarity

Chopped lightning impulse withstand voltage: 665.5kV 5 negative polarity

Test sequence

One positive reference full wave impulse;
Fifteen positive rated full wave impulses;
One negative reference full wave impulse;
One negative rated full wave impulse;
Five negative rated chopped wave impulses;
Fourteen negative rated full wave impulses.

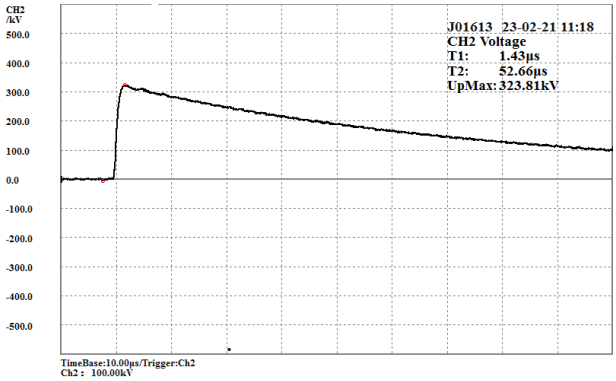
Test oscillogram records

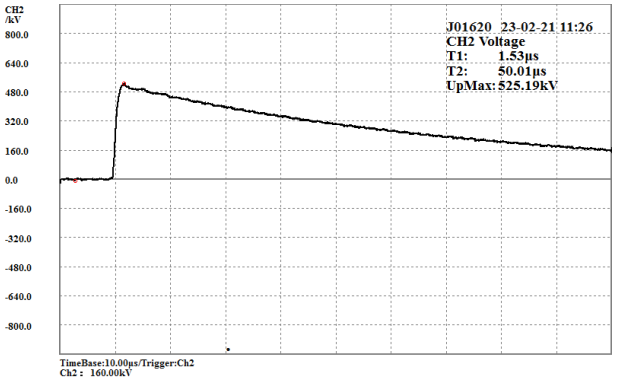
T1: Front time; T2: Time to half value; UpMax/UpMin: Peak voltage;

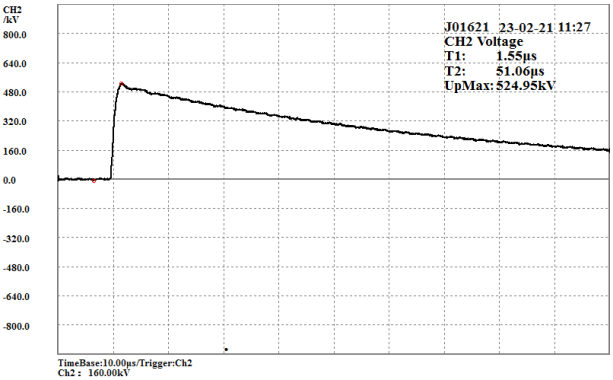
Tc: Time to chopping; K: Factor of over crossing.

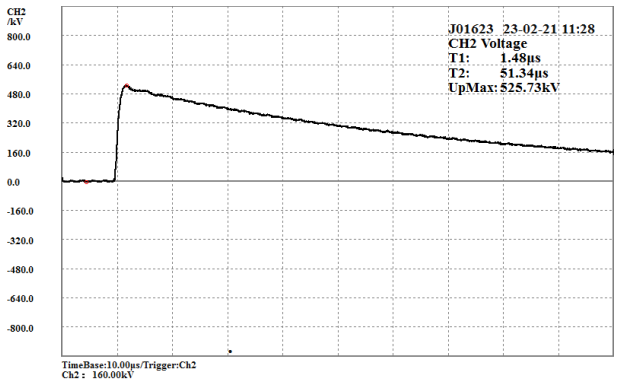
Result: Passed.

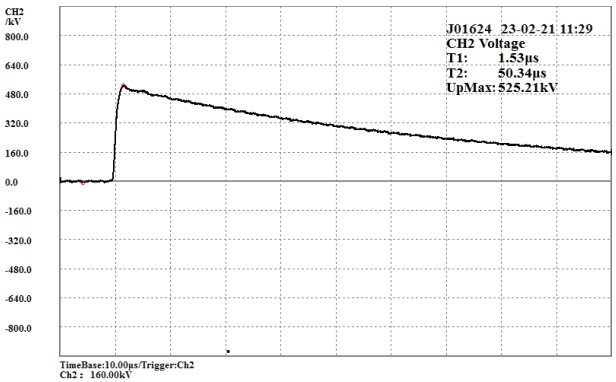
Tested terminal: To earth Test polarity: Positive CH1: Voltage wave

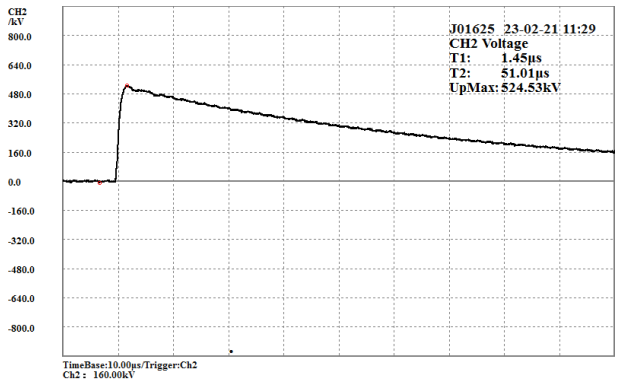


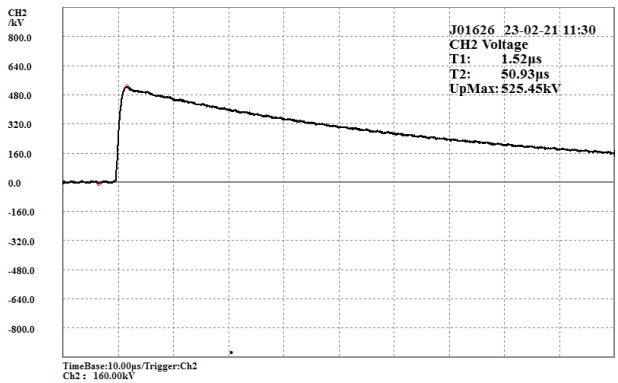


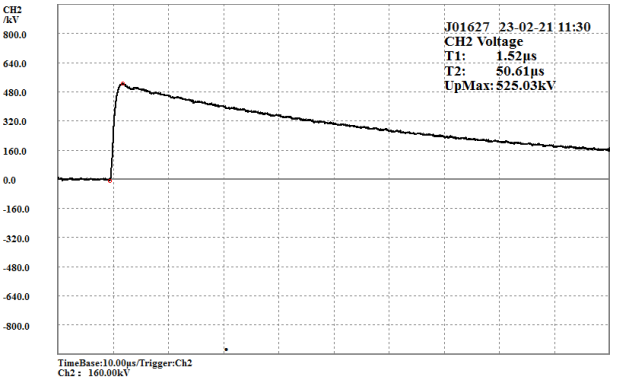




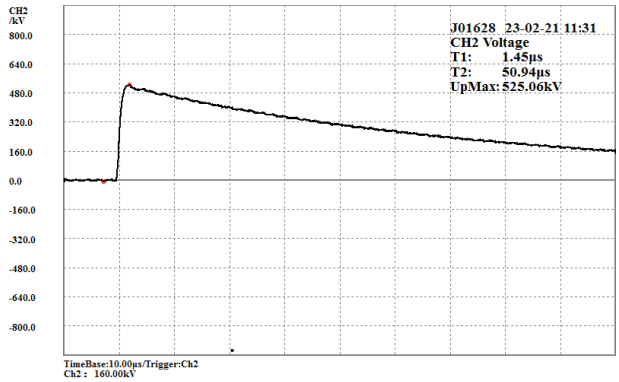


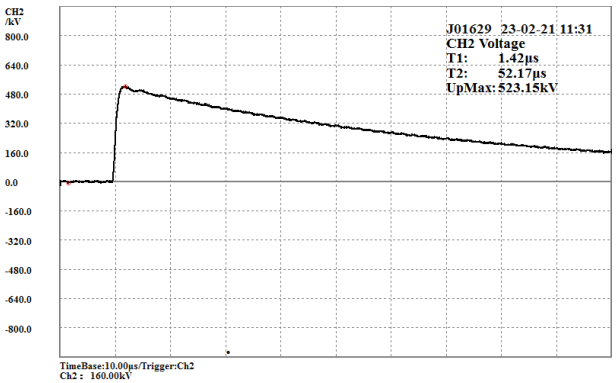


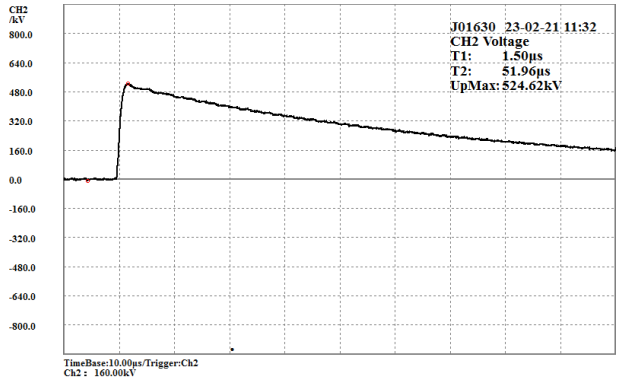


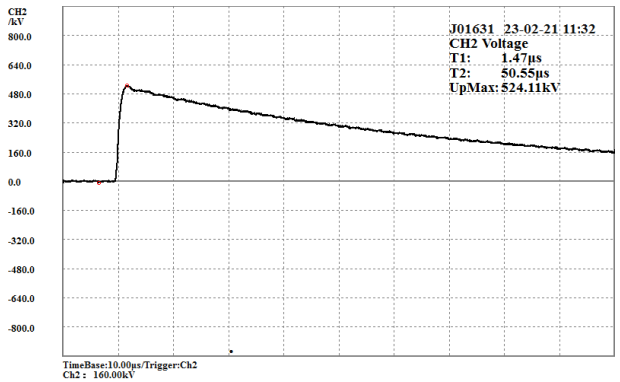


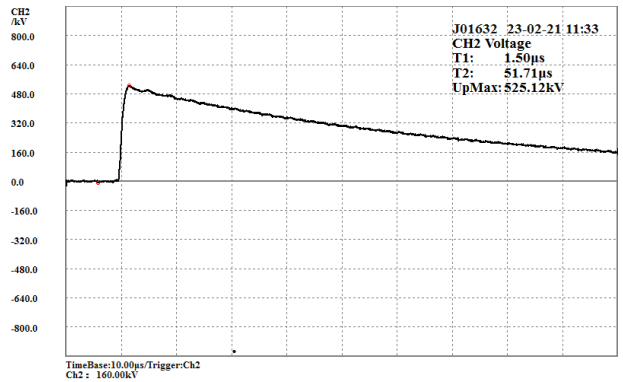
Tested terminal: To earth Test polarity: Positive CH1: Voltage wave

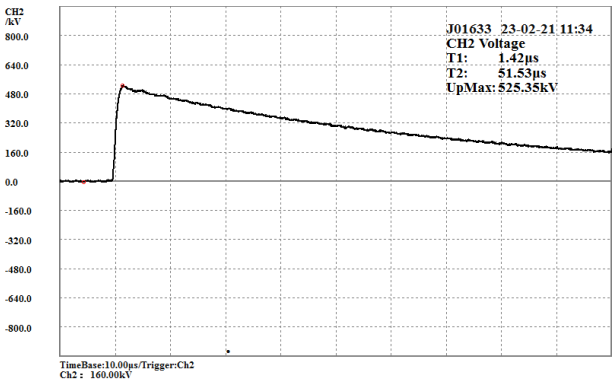


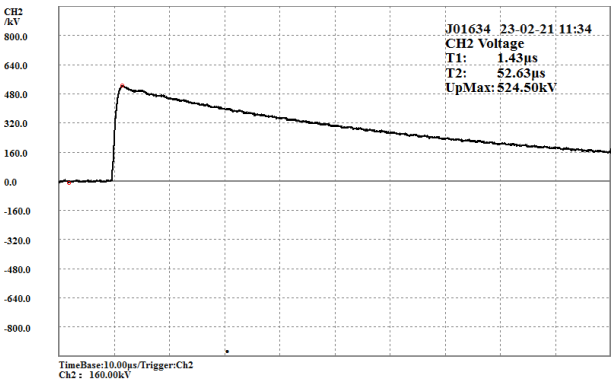


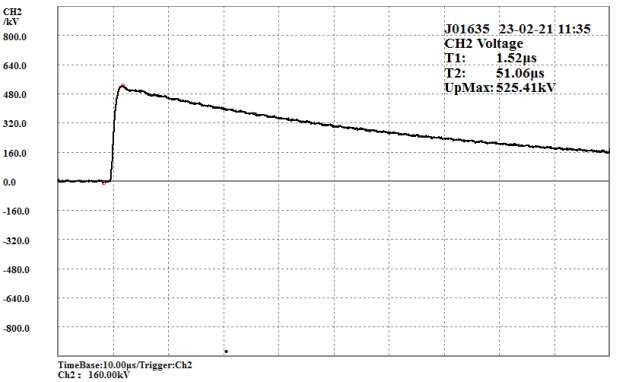










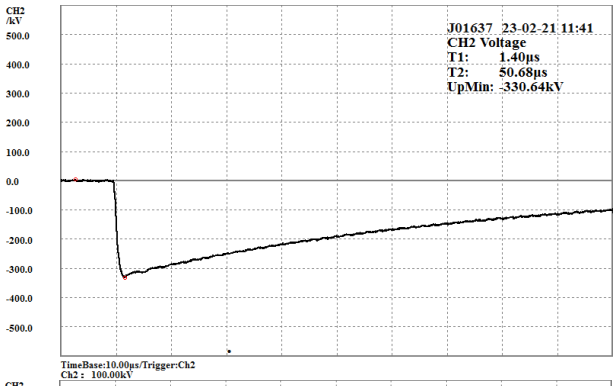


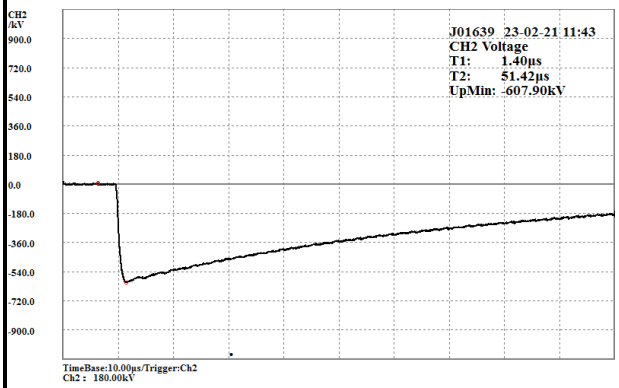
Test Report

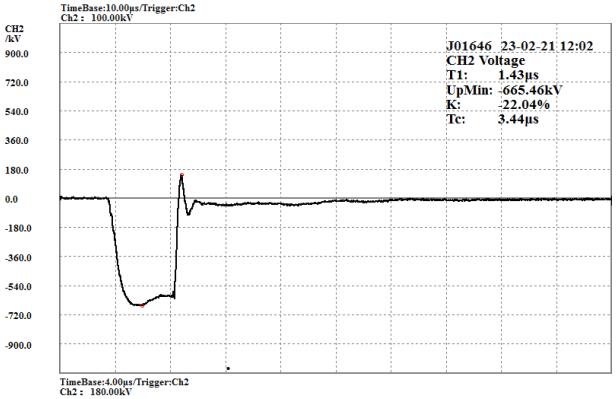
Tested terminal: To earth

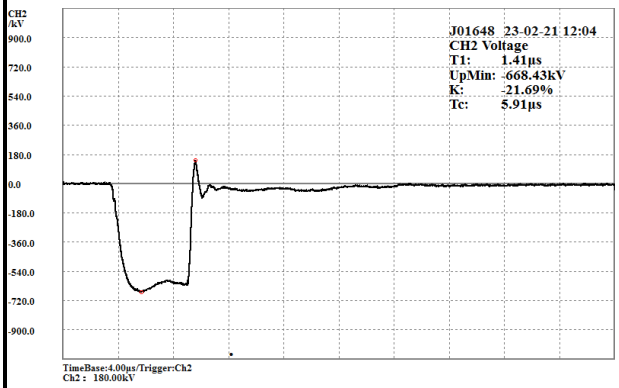
Test polarity: Positive

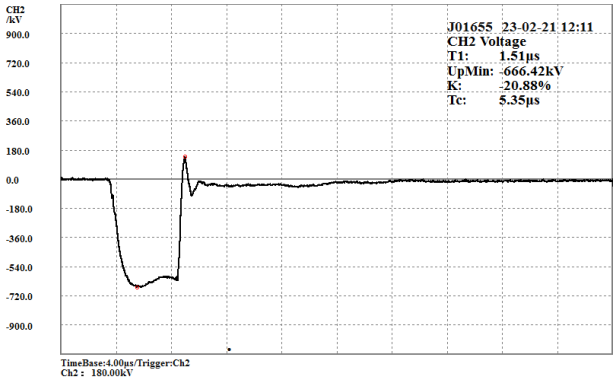
CH1: Voltage wave

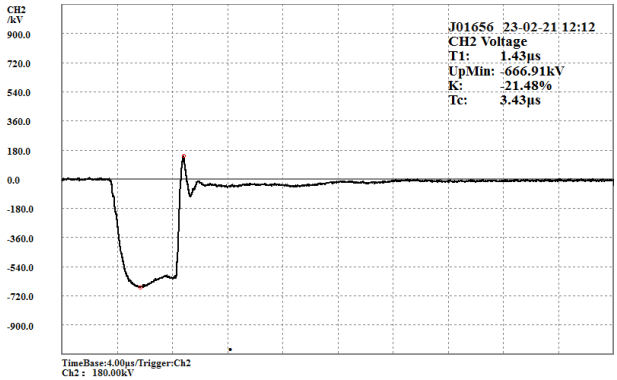


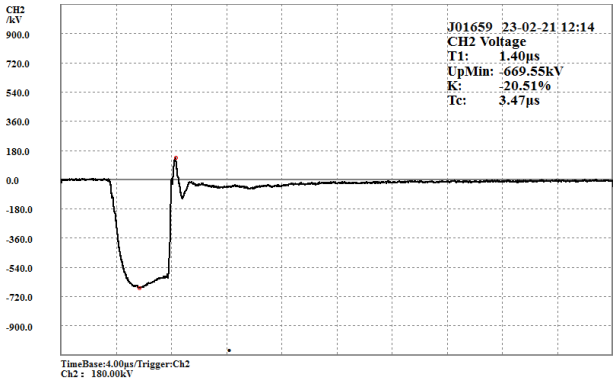




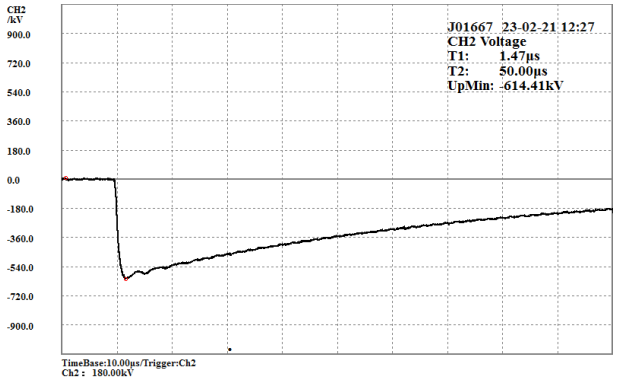


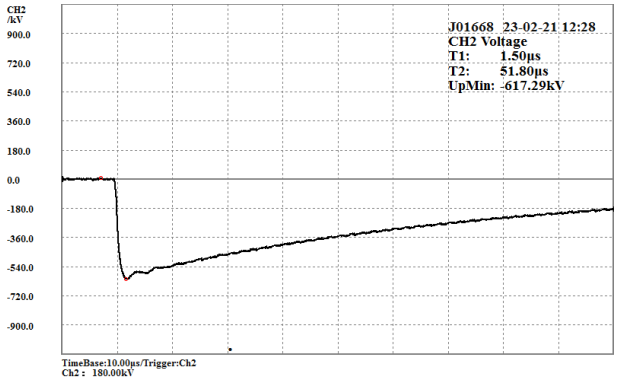


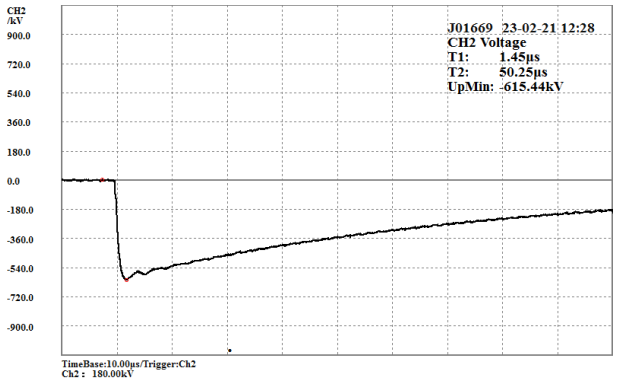


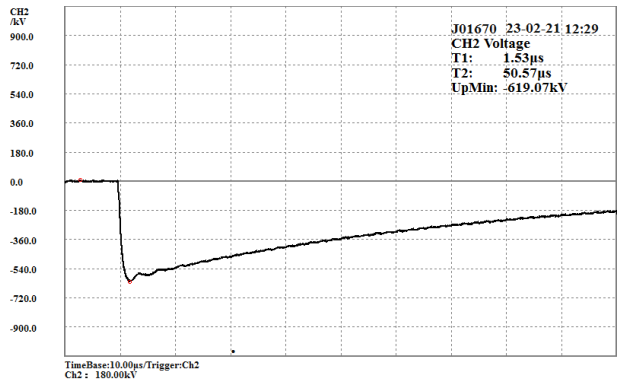


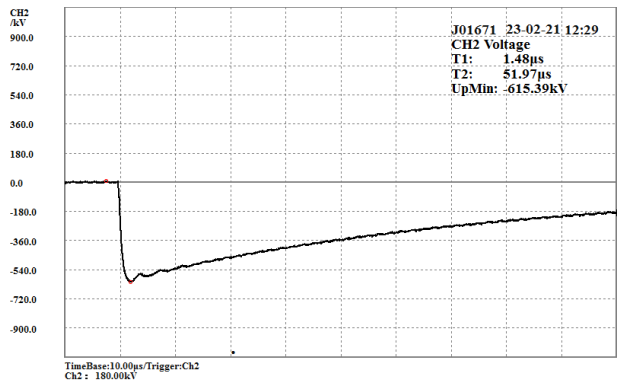
Tested terminal: To earth Test polarity: Negative CH1: Voltage wave

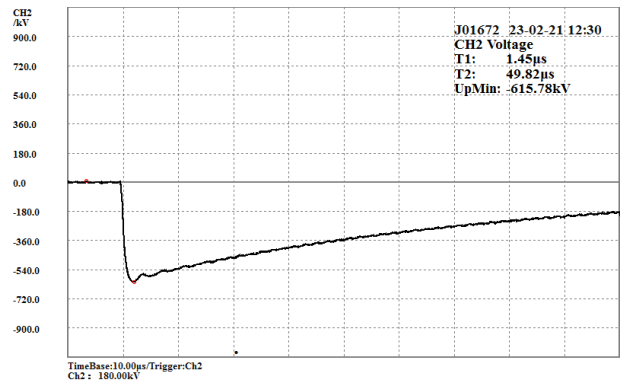


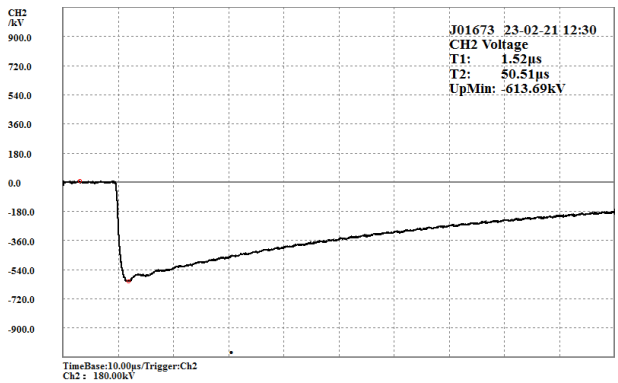


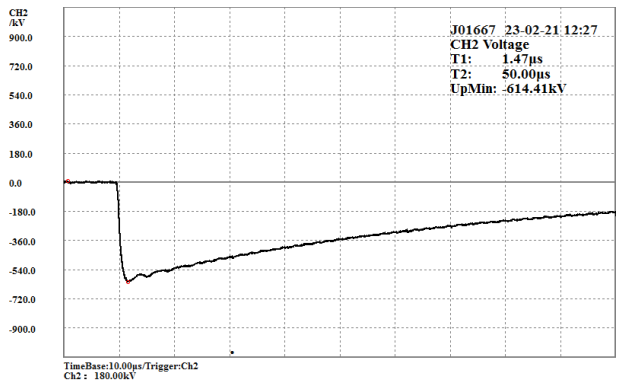






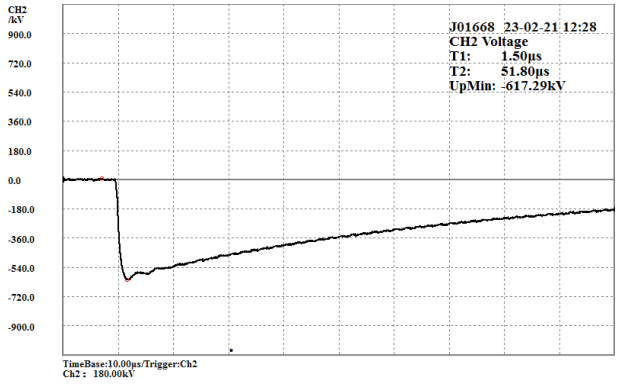


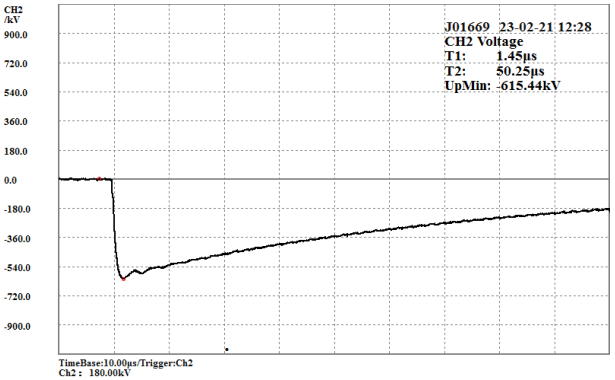


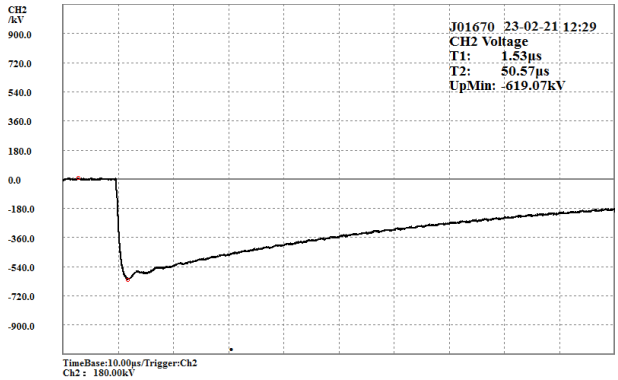


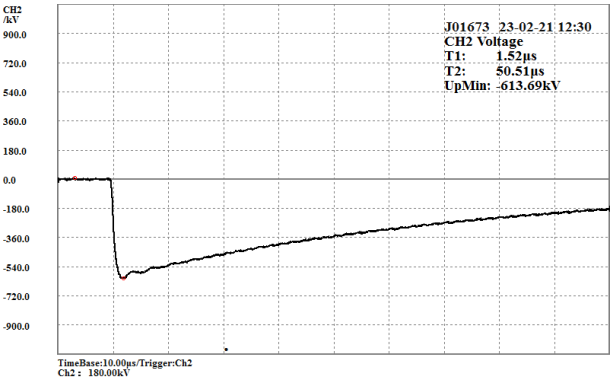
Test Report

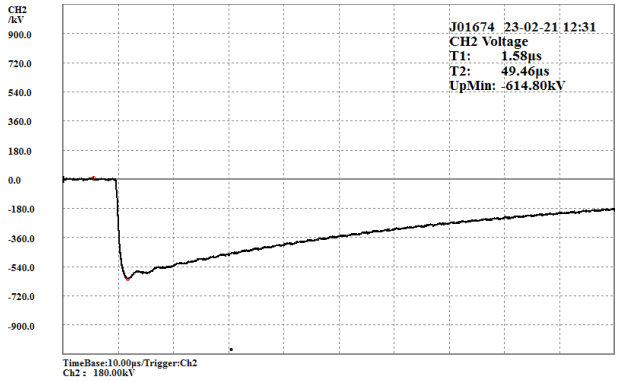
Tested terminal: To earth Test polarity: Negative CH1: Voltage wave

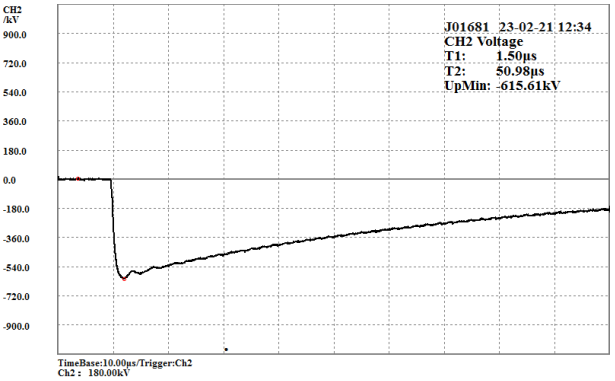












Test Report

4.5 Wet power-frequency voltage withstand test(Type test) Test date: Feb. 21, 2023

Humidity: 46.0%; Ambient temperature: 12.1℃; Atmospheric pressure: 101.8kPa

Applied position	Applied voltage(kV)			Frequency (Hz)	Duration (s)	Result
	Standard value	Atmospheric corrected value	Applied value			
Terminals-earth	230	231.2	231.2	50	60	Passed

Note: The conductivity of collected water is 100.9μS/cm at 20℃.

The average precipitation rate: Vertical component 1.3mm/min, horizontal component 1.2mm/min.

4.6 Long-duration power-frequency withstand voltage test(ACLD)(Type test)

Test date: Feb. 22, 2023

Ambient temperature: 11.4℃

Applied voltage		Duration(min)	Partial discharge level(pC)
Multiple	Phase-earth(kV)		
$1.1U_m/\sqrt{3}$	80	5	＜4
$U_2=1.5U_m/\sqrt{3}$	109.1	5	＜4
$U_1=U_m$	126	1	/
$U_2=1.5U_m/\sqrt{3}$	109.1	5	＜4
		10	＜5
		15	＜5
		20	＜5
		25	＜5
		30	＜5
		35	＜5
		40	＜5
		45	＜5
		50	＜5
		55	＜5
		60	＜5
$1.1U_m/\sqrt{3}$	80	5	＜4

Note: U_m=126kV;

Background level is＜4pC before and after test.

Result: Passed.

Test Report

4.7 Radio interference voltage test(Type test)

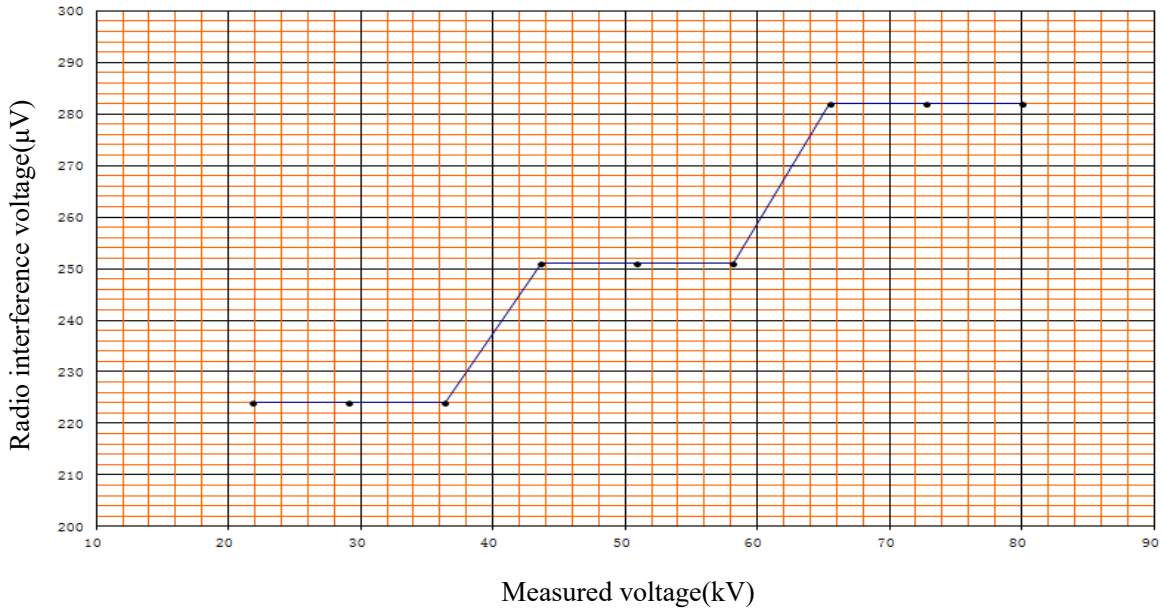
Test date: Feb. 22, 2023

Humidity: 40.0%; Ambient temperature: 11.4℃; Atmospheric pressure: 100.2kPa

Measured frequency (MHz)	Attenuation factor of measurement circuit (dB)	Attenuation factor of resistance network (dB)	Measured voltage (kV)	Duration (min)	Radio interference reading B_m (dB)	Radio interference level (μV)
1.0	14	22	80	5	13	282
			72.7	/	13	282
			65.5		13	282
			58.2		12	251
			50.9		12	251
			43.6		12	251
			36.4		11	224
			29.1		11	224
			21.8		11	224

Result: Passed.

Radio interference curve



4.8 Temperature rise test(Type test) Test date: Feb. 22, 2023

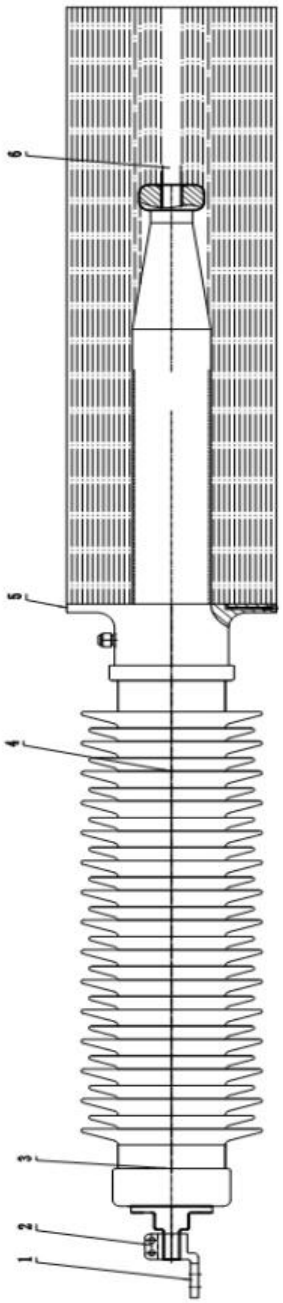
Specified current was 1600A, injected current was 1600A during test, the test duration was 6h, stability duration was 1h.

Calculated result of temperature rise

№.	Measured position	Temperature of bushing (℃)	Temperature rise of bushing (K)	Ambient temperature (℃)	Oil temperature (℃)	Result
1	Terminal in the air	62.1	50.8	11.3	71.5	Passed
2	Firmness of terminal in the air	55.6	44.3			
3	Conducting rod top part	42.8	31.5			
4	Conducting rod middle part	54.2	42.9			
5	Flange	51.9	40.6			
6	Conducting rod tail part	73.0	61.7			

The schematic diagram of measured points shown in page 17.

Schematic diagram of measured point of temperature rise



1. Terminal in the air 2. Firmness of terminal in the air 3. Conducting rod top part 4. Conducting rod middle part
5. Flange 6. Transformer oil 7. Conducting rod tail part

4.9 Verification of thermal short-time current withstand(Verified by the calculation)

(Type test) Test date: Feb. 23, 2023

The standard value of thermal short-time current of bushing I_{th}=40kA, duration was 2s. According to calculation final temperature of the conductor θ_f =128.4℃. If $\theta_f \leqslant$180℃, it was considered that the bushing could withstand the standard value I_{th} of thermal short-time current.

Sample parameters

Conductor material of sample	Copper
Conductor resistivity ρ(μΩ·cm)	1.75
Total cross section area S_t(cm^2)	11.3354
Measured temperature rise of the bushing(K)	61.7
Rated current I_r(A)	1600
Standard value of rated thermal short-time current I_{th}(kA)	40
Rated duration(s)	2
θ_0(℃)	101.7
Current penetration depth d(cm)	0.942
Diameter of the conductor D(cm)	3.8
α[(K/s)/(kA/cm^2)^2]	0.8
Equivalent cross section area considering the skin effect S_e(cm^2)	8.4536

Verify by the calculation:

$$\theta_f = \theta_0 + \alpha \frac{I_{th}^2}{S_t \times S_e} t_{th} = 128.4℃$$

Result: Passed.

4.10 Cantilever load withstand test(Type test) Test date: Feb. 23, 2023

Load direction	Applied position	Standard value		Applied value		Result
		Load(N)	Duration(s)	Load(N)	Duration(s)	
Vertical	Terminal	3150	60	3236	60	No damage,distortion, passed.

4.11 Measurement of partial discharge quantity(After type test) Test date: Feb. 23, 2023

Humidity: 41.0%; Ambient temperature: 11.8℃; Atmospheric pressure: 101.8kPa

Prestress voltage (kV)	Duration(s)	Measured voltage(kV)	Partial discharge level(pC)	Result
255	60	126	＜6	Passed
		109.1	＜5	
		76.4	＜5	

Note: Background noise level was＜5pC before and after test.

4.12 Measurement of dielectric dissipation factor(tanδ) and capacitances at ambient temperature(After type test) Test date: Feb. 23, 2023

Humidity: 41.0%; Ambient temperature: 11.8℃

Applied voltage(kV)	Dielectric dissipation factor(tanδ)	Capacitance (pF)	Result
10	0.00300	391.4	Passed
76.4	0.00330	391.7	
126	0.00345	391.7	

Note: tanδ(126kV)- tanδ(76.4kV)= 0.00015＜0.001 (Standard value), passed.

4.13 Visual inspection and dimensional check(Routine test) Test date: Feb. 23, 2023

It has smooth surface, no cracks. Dimensional check is accordance with the drawing requirement. Dimensional check see 4.3.

Result: Passed.

4.14 Tests of tap insulation(Routine test) Test date: Feb. 23, 2023

Dry power-frequency voltage withstand test on the tap

Humidity: 41.0%; Ambient temperature: 11.8℃; Atmospheric pressure: 101.8kPa

Applied position	Applied voltage(kV)	Frequency(Hz)	Duration(s)	Result
Tap-earth	3	50	60	Passed

Measurement of dielectric dissipation factor (tanδ) and capacitances at ambient temperature on the tap

Humidity: 41.0%; Ambient temperature: 11.8℃

Applied voltage(kV)	Dielectric dissipation factor(tanδ)	Capacitance(pF)	Result
2	0.00323	315.8	Passed

4.15 Dry lightning impulse voltage withstand test(Routine test) Test date: Feb. 23, 2023

Test atmospheric conditions

Humidity: 41.0%; Ambient temperature: 11.8℃; Atmospheric pressure: 101.8kPa.

Rated lightning impulse withstand voltage: 577.5kV 3 negative polarity

Chopped lightning impulse withstand voltage: 632.5kV 2 negative polarity

Test sequence

One negative reference full wave impulse;

One negative rated full wave impulses;

Two negative rated chopped wave impulses;

Two negative rated full wave impulses.

Test records:

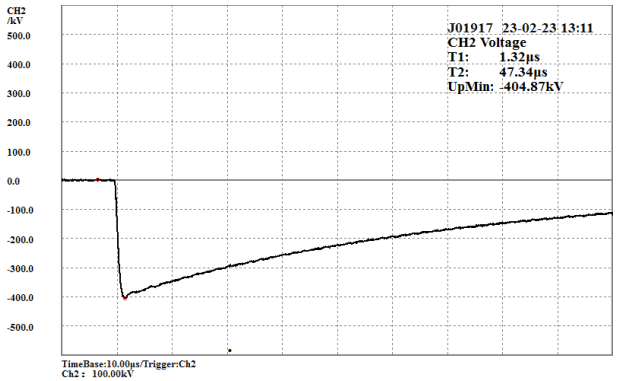
T1: Front time; T2: Time to half value; UpMax/UpMin: Peak voltage;

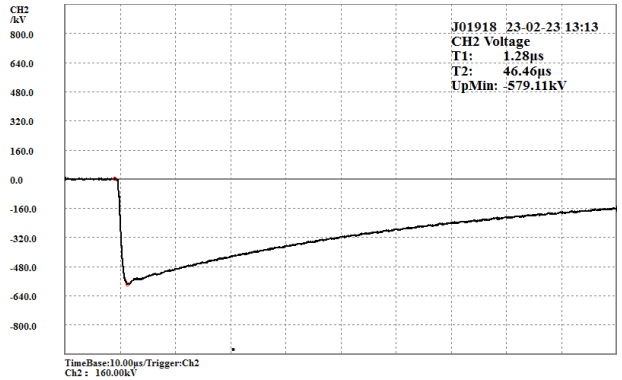
Tc: Time to chopping; K: Factor of over crossing.

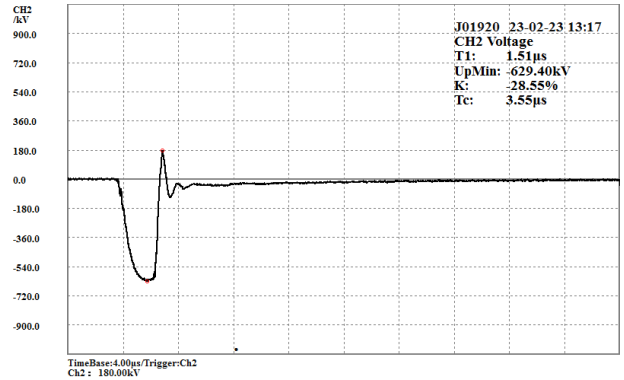
Result: Passed.

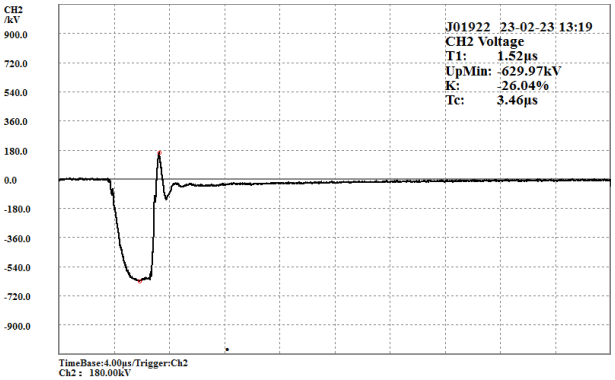
Test Report

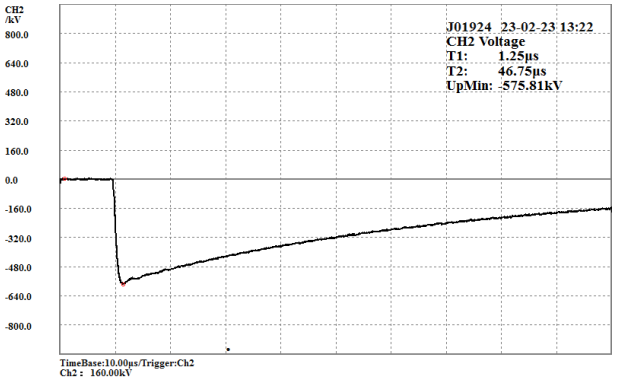
Tested terminal: To earth Test polarity: Negative CH1: Voltage wave

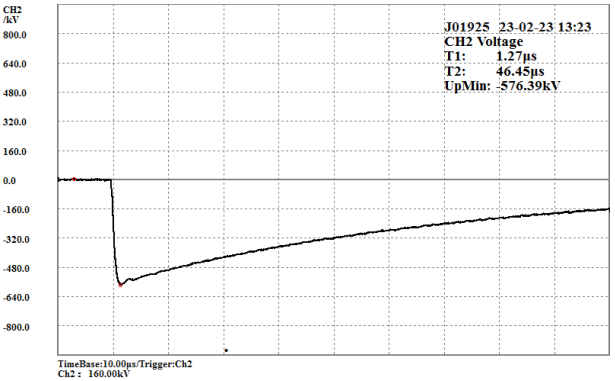












Test Report

4.16 Dry power-frequency voltage withstand test(Routine test) Test date: Feb. 23, 2023

Humidity: 41.0%; Ambient temperature: 11.8℃; Atmospheric pressure: 101.8kPa

Applied position	Applied voltage(kV)			Frequency (Hz)	Duration (s)	Result
	Standard value	Atmospheric corrected value	Applied value			
Terminals-earth	255	/	255	50	60	Passed

4.17 Tightness test at the flange(Routine test) Test date: Feb. 23, 2023

Applied pressure(MPa)	Duration(min)	Residual pressure(MPa)	Result
0.4	15	0.4	No leakage and damage, passed.

4.18 Measurement of partial discharge quantity(Routine test) Test date: Feb. 23, 2023

Humidity: 41.0%; Ambient temperature: 11.8℃; Atmospheric pressure: 101.8kPa

Prestress voltage (kV)	Duration (s)	Measured voltage (kV)	Partial discharge level(pC)	Result
255	60	126	＜5	Passed
		109.1	＜5	
		76.4	＜5	

Note: Background level was＜5pC before and after test.

4.19 Measurement of dielectric dissipation factor(tanδ) and capacitances at ambient temperature(Routine test) Test date: Feb. 23, 2023

Humidity: 41.0%; Ambient temperature: 11.8℃; Atmospheric pressure: 101.8kPa

Applied voltage(kV)	Dielectric dissipation factor(tanδ)	Capacitance(pF)	Result
10	0.00301	391.4	Passed
76.4	0.00329	391.7	
126	0.00345	391.7	

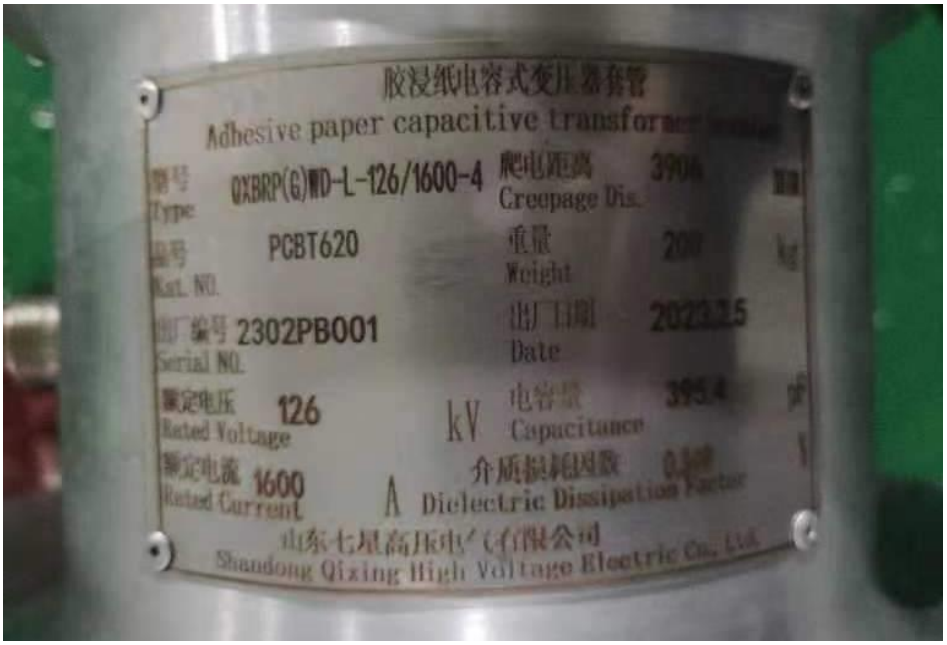
Note: tanδ(126kV)- tanδ(76.4kV)= 0.00016＜0.001 (Corrected value), passed.

Annex 1

RATING PLATE AND OUTLINE PHOTOS

№: CTQC/ZJ-23.0045

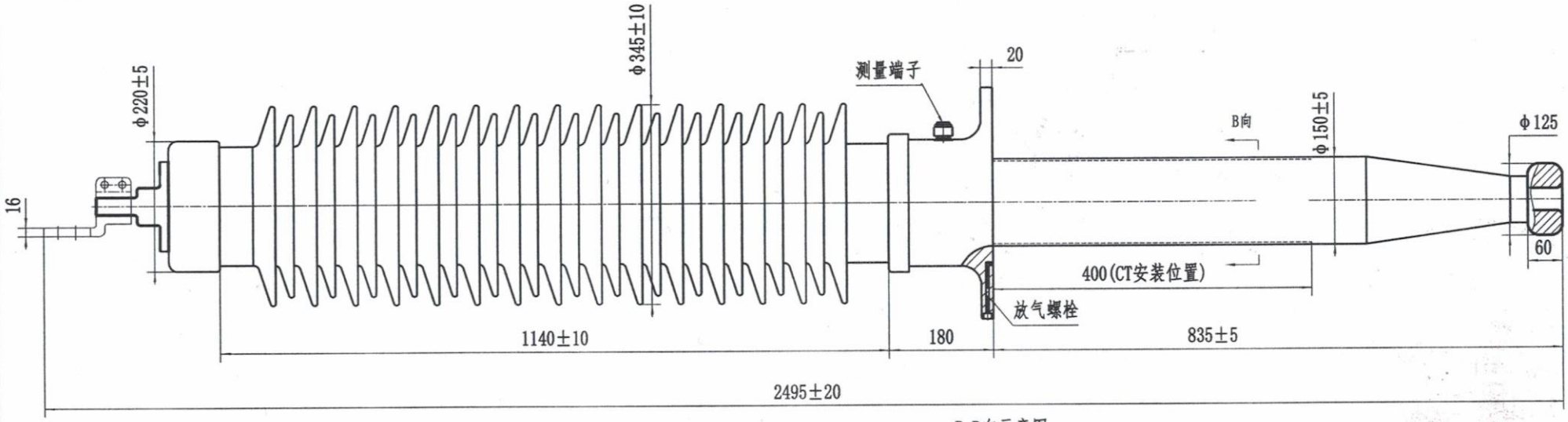
Rating plate:



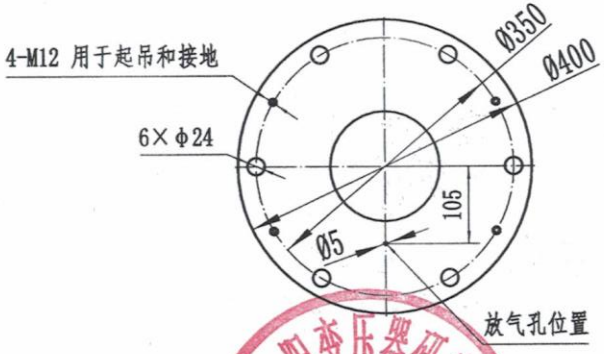
Outline:

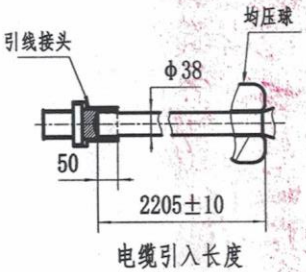
Annex 2

BUSHING DRAWINGS

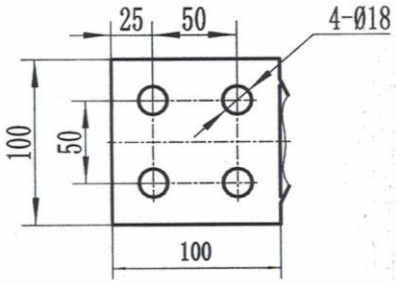


B-B向示意图





A向示意图



雷电冲击　　550kV
工频耐受电压　　255kV/1min
局部放电　126kV≤10pC
介质损耗因数<0.4%
爬电比距　31mm/kV(爬距≥3906mm)
海拔高度　≤1000m
抗弯负荷：3150N
其他要求符合最新版GB/T4109和IEC60137的规定

标记	处数	分区	更改文件号	签名	年、月、日
设计	张学明	2023.2.2	标准化		
审核	石孝刚	2023.2.2			
工艺			批准	曹明波	2023.2.2

QXBRP(G)WD-L-126/1600-4

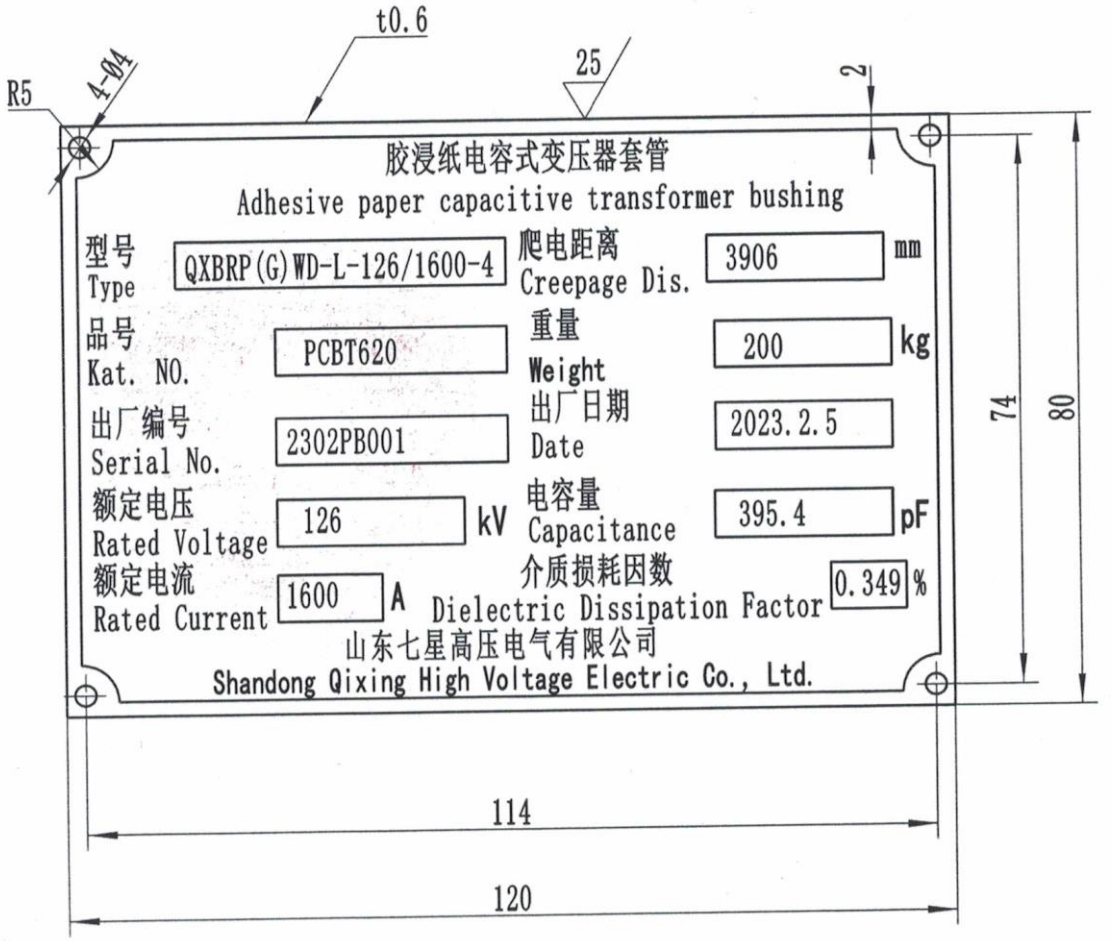
阶段标记	重量	比例
		1:10
共　张　第　张		

山东七星高压电气有限公司

胶浸纸变压器套管外形图

图号：PCB11-620

产品品号：PCBT620



借（通）用件登记											
旧底图总号									产品型号	装配图代号	序号
底图总号									铭牌nameplate	8QX.860.008G	
签字										图样标记	重量 / 比例
日期	标记	处数	分区	更改文件号		签字	日期			S	0.030 / 1:1
	设计	张学明	2023.2.2	标准化						共 张	第 张
档案员 日期	校核	石孝刚	2023.2.2	审定					316L	Shandong Qixing High Voltage Electric Co. LTD山东七星高压电气有限公司	
	会签			批准		曹明波	2023.2.2				

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