230008349512

中国认可
国际互认
检测
TESTING
CNAS L0681

CHPTL

CERTIFICATE OF TESTS

№ : CTQC/B-23. 0111

Entrusted by: Qingdao Cahors Electrical Equipment Co., Ltd.

Manufacturer: Qingdao Cahors Electrical Equipment Co., Ltd.

Test object name: Three-phase oil-immersed distribution transformer

Test object type: 2000kVA 11.3/0.39kV

Serial №: 287230009C

Test items: Routine tests, type tests, measurement of zero-sequence impedance on three-phase transformers, measurement of the harmonics of the no-load current, short-circuit withstand test, induced voltage test with partial discharge measurement(IVPD).

Standards: IEC60076-1:2011, IEC60076-2:2011, IEC60076-3:2013, IEC60076-5:2006, technical contract.

Results: The test results of routine tests, type tests, measurement of zero-sequence impedance on three phase transformers, measurement of the harmonics of the no-load current, short-circuit withstand test, induced voltage test with partial discharge measurement(IVPD) of 2000kVA 11.3/0.39kV are in accordance with standards and technical contract requirements. The sample passed the above tests.

Approved: Lv Xiangpeng 2023.05.08

沈阳变压器研究院有限公司 变压器实验室

沈阳变压器研究院有限公司 检验专用章

SHENYANG TRANSFORMER RESEARCH INSTITUTE CO., LTD.

CHINA NATIONAL TRANSFORMER QUALITY DETECTION AND TESTING CENTER

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中国认可
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检测
TESTING
CNAS L0681

CHPTL

TYPE TEST REPORT

№:CTQC/B-23.0111

Test object name:	Three-phase oil-immersed distribution transformer
Test object type:	2000kVA 11.3/0.39kV
Entrusted by:	Qingdao Cahors Electrical Equipment Co., Ltd.
Manufacturer:	Qingdao Cahors Electrical Equipment Co., Ltd.
Kind of testing:	Type tests

SHENYANG TRANSFORMER RESEARCH INSTITUTE CO., LTD.

CHINA NATIONAL TRANSFORMER QUALITY DETECTION AND TESTING CENTER

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CTQC

Shenyang Transformer Research Institute Co., Ltd.

China National Transformer Quality Detection And Testing Center

Type Test Report

№: CTQC/B-23.0111

Test object name	Three-phase oil-immersed distribution transformer	Test object type	2000kVA 11.3/0.39kV
		Brand	/
Entrusted by	Qingdao Cahors Electrical Equipment Co., Ltd	Kind of testing	Type tests
Manufac-turer	Qingdao Cahors Electrical Equipment Co., Ltd	Sampling date	April 12, 2023
		Test date	April 12, 2023 ~ April 19, 2023
Address	197 Ping Shan Road, Qingdao Economic and Technological Development Zone	Serial №	287230009C
Standards	IEC60076-1:2011 IEC60076-2:2011 IEC60076-3:2013 IEC60076-5:2006 Technical contract	Test items	Routine test Type test Measurement of zero sequence impedance of three-phase transformer No-load current harmonic measurement Short-circuit withstand test Partial discharge measurement (IVPD)
Result	The test results of routine tests, type tests, measurement of zero sequence impedance of three-phase transformer, measurement of the harmonics of the no-load current, short-circuit withstand test, induced voltage test with partial discharge measurement of 2000kVA 11.3/0.39kV are in accordance with standards and technical contract. The sample passed the above tests. Signing and issuing date: 2023.05.08		
Note			

Approved by: Lv Xiangpeng Checked by: Du Jiansong Compiled by: Song Jialin

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).

Test Report

№：CTQC/B-23.0111
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Test results

№	Test items	Specified values	Measured values		Conclu-sions
		Standards(Technical contract)	Before S.C.T	After S.C.T	
1	Measurement of d.c. insulation resistance each winding to earth and between windings (Routine test)	Providing insulation value(MΩ)	H-L.E：1540 L-H.E：2110 H.L-E：1230 H-L：2530	H-L.E：1280 L-H.E：1710 H.L-E：1060 H-L：2030	/
2	Measurement of voltage ratio and check of phase displacement (Routine test)	The tolerances of voltage ratio on principal tapping: ±0.5% Connection symbol: Dyn11	-0.05%~-0.02% Dyn11	-0.02%~0.02% Dyn11	Passed
3	Measurement of winding resistance (Routine test)	Providing winding resistance value	See 4.3	See 4.15.3	/
4	Measurement of no-load loss and current (Routine test)	I_0%：Providing measured values P_0（kW）：＜1.32	0.17 1.24	0.17 1.24	Passed
5	Measurement of short-circuit impedance and load loss (Routine test)	t：75℃ Z%：7.6 +10% P_k（kW）：＜13.5 P_{Total}（kW）：＜14.82	7.84 12.42 13.66	7.87 12.43 13.67	Passed
6	Test on dielectric liquid (Routine test)	Breakdown voltage（kV）：≥40 tan δ（90℃）：≤0.05 Water dissolved（mg/L）：≤30	59.9 0.02278 15	58.9 0.02279 15	Passed
		Providing gas chromatography	Gas chromatography		
7	Lightning impulse (LI, LIC) (Routine test, special test)	Full wave（kV）：75 ±3% Clipped wave（kV）:85 ±3%	/	See 4.15.3.7	Passed
8	Applied voltage test (Routine test)	HV： 28kV 60s LV： 6kV 60s	28kV 60s 6kV 60s	28kV 60s 6kV 60s	Passed
9	Induced voltage withstand test (Routine test)	Applied voltage（kV）：2Ur Induced voltage（kV）：22.6 Duration（s）：120(f_n/f) Frequency（Hz）：f＞50	0.78 22.6 40 150	See 4.15.3.9	Passed
10	Tightness tests (Routine test)	Applied pressure（kPa）：20 Duration（h）：24 Residual pressure（kPa）：≥14 No oil leakage and damage	20 24 20 No oil leakage and damage		Passed

Address: Hushitai South Avenue No.18, Shenbei New District, Shenyang Postal code: 110122 Tel:(024)23785225
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Test Report

№	Test items	Specified values Standards(Technical contract)	Measured values	Conclu-sions
11	Measurement of no-load loss and current at 90% and 110% of rated voltage (Routine test)	I_0%：Providing measured values P_0（kW）：Providing measured values	90% 110% 0.10 0.29 0.98 1.58	/
12	Measurement of the harmonics of the no-load current (Special test)	Provides harmonic values of no-load current in each phase	See 4.12	/
13	Determination of sound level (Type test)	Sound pressure level $\overline{L_{PA}}$ dB(A)：/ Sound power level $L_{WA,SN}$ dB(A)：≤53	39 52	Passed
14	Temperature rise test (Type test)	Top oil temp.-rise limit（K）： 45 Winding temp.-rise limit（K）： 50	Top oil：41.3 HV： 40.8 LV： 43.4	Passed
15	Short-circuit withstand test （Special test）	Three times each phase Duration(s): 1.0±10% Test waveshapes have no distortion Deviation of reactance before and after S.C.T.: ±4.0% The untanking inspection shows no apparent defects Successfully check items after S.C.T.	3 times 1.0 No distortion 0.21% No apparent defects Passed	Passed
16	Measurement of zero-sequence impedance on three-phase transformers （Special test）	Providing zero-sequence impedance(Ω)	0.00616	/
17	Induced voltage test with partial discharge measurement (IVPD) (Special test)	U_1=2.0Ur/$\sqrt{3}$ （kV） Duration（s）：120（f_n/f）	13.048 40	Passed
		U_2=1.58Ur/$\sqrt{3}$ （kV） Duration（min）：60 Partial discharge(pC)：＜50	10.308 60 ＜15	
		1.2Ur/$\sqrt{3}$ （kV） Duration（min）：1 Partial discharge (pC)：＜50	7.829 1 ＜15	
		0.4Ur/$\sqrt{3}$ （kV） Duration（min）：/ Partial discharge (pC)：＜50	2.610 / ＜15	
		Frequency（Hz）：＞50	150	

Test Report

1. Test object parameters

Rated power：2000kVA
Rated voltage：11.3/0.39kV
Rated current：102.19/2960.77A
Highest voltage for equipment：12kV
Rated frequency：50Hz
Number of phases：3
Connection symbol：Dyn11
Cooling method：KNAN
Altitude：≤1000 m
Temperature class of insulation：E
Insulation level: HV Um/ LI/LIC/AC 12/75/85/28kV
LV Um/AC 1.1/6kV

2. Sample condition description

Sample exterior construction and major dimensions(length, width, height)are in compliance with drawings。
Measured values：length 2329 ㎜，width 2197 ㎜，height 2200 ㎜。
Drawing confirmation

Outline	Nameplate
4600009234	40136169R14

Rating plate and outline drawings are in testing report annex, other drawings should be conserved by enterprise after affirming by CTQC.
The design, performance data, specifications of sample rating plate are in compliance with drawing.
The marking of the phase sequence on HV and LV side of the sample is clear and right.
The surface of the sample has no collision and damage.

3. Standards

IEC60076-1:2011 Power transformers Part 1: General
IEC60076-2:2011 Power transformers Part 2: Temperature rise for liquid-immersed transformers
IEC60076-3:2013 Power transformers Part 3: Insulation levels, dielectric tests and external clearances in air
IEC60076-5:2006 Power transformers Part 5 Ability to withstand short-circuit
Technical contract

Test Report

4. Test items and conclusions

4.1 Measurement of d.c. insulation resistance each winding to earth and between windings (Routine test)

Test date: April 12, 2023

Humidity: 38.2%; Oil temperature: 15.5℃; Atmospheric pressure: 100.0kPa

Measured position	Insulation resistance (MΩ)
HV-LV&E	1540
LV-HV&E	2110
HV, LV-E	1230
HV-LV	2530

4.2 Measurement of voltage ratio and check of phase displacement (Routine test)

Test date: April 12, 2023

Oil temperature: 15.5℃

HV winding	LV winding	Ratio	Measured deviation (%)			Connection symbol
Voltage (kV)	Voltage (kV)		AB/ab	BC/bc	CA/ca	
11.3	0.39	28.974	-0.02	-0.05	-0.05	Dyn11

Result: Passed.

4.3 Measurement of winding resistance (Routine test)

Test date: April 12, 2023

Oil temperature: 15.5℃

Winding	d.c. resistance (Ω)		
HV	A～B	B～C	C～A
	0.19042	0.19017	0.19023
LV	a～b	b～c	c～a
	0.0002996	0.0002925	0.0003106

4.4 Measurement of no-load loss and current (Routine test)

The test circuit is shown in Annex 2-a

Test date: April 12, 2023

Oil temperature: 15.5℃

Voltage multiple	Applied voltage (kV)		No-load current		No-load loss (kW)	
	Mean value	R.M.S.	(A)	(%)	Measured value	Corrected value
90%Ur	0.203	0.203	3.04	0.10	0.98	0.98
100%Ur	0.225	0.226	5.09	0.17	1.25	1.24
110%Ur	0.248	0.249	8.60	0.29	1.59	1.58

Result: Passed.

Test Report

4.5 Measurement of short-circuit impedance and load loss (Routine test) Test date: April 12, 2023

The test circuit is shown in Annex 2-b

Winding	Applied current		Measured voltage (kV)	Short-circuit impedance (Each phase)		Load loss (kW)		Total losses (kW)
				(Ω)	(%)	Measured value	Corrected value	Corrected value
	I (A)	I/Ir (%)		t=75℃	t=75℃ I=Ir	t=15.5℃	t=75℃ I=Ir	t=75℃ I=Ir
HV | LV	59.75	58.47	0.518	5.01	7.84	3.99	12.42	13.66

Result: Passed.

4.6 Test on dielectric liquid (Routine test) Test date: April 12,2023

Ambient temperature: 21.6℃

tanδ (90℃)	Breakdown voltage (kV)	Water dissolved (mg/L)
0.02278	59.9	15

Gas chromatography (After temperature rise test) Test date: April 17,2023

μL/L

H_2	CO	CO_2	CH_4	C_2H_6	C_2H_4	C_2H_2	Total hydrocarbon
48.46	18.07	250.97	1.24	51.17	0.44	0.00	52.85

Result: Passed.

4.7 Lightning impulse test (Type test, special test)

The tests were performed after the short-circuit withstand test,see 4.15.3.7.

4.8 Applied voltage test (Routine test) Test date: April 17,2023

The test circuit is shown in Annex 2-c

Humidity: 38.2%; Oil temperature: 15.5℃; Atmospheric pressure: 100.0kPa

Measured position	Applied voltage(kV)	Duration(s)	Result
HV-LV&E	28	60	Passed
LV-HV&E	6	60	

4.9 Induced voltage withstand test(Routine test)

Test date：April 12,2023

The test circuit is shown in Annex 2-d

Humidity：38.2%；Oil temperature：15.5℃；Atmospheric pressure：100.0kPa

Applied voltage（kV）	Induced voltage（kV）	Induced multiple	Frequency（Hz）	Duration（s）	Result
LV	HV				
0.78	22.6	2	150	40	Passed

4.10 Tightness tests(Routine test)

Test date：April 18,2023

Ambient temperature：15.3℃

Test method	Applied pressure（kPa）	Duration（h）	Residual pressure（kPa）	Result
Atmosphere pressure method	20	24	20	No leakage oil and damage，Passed

4.11 Measurement of no-load loss and current at 90% and 110% of rated voltage(Type test)

See 4.4.

4.12 Measurement of the harmonics of the no-load current (Special test)

Test date：April 12,2023

The test circuit is shown in Annex 2-e

Oil temperature：12.9℃

Or.	U1 [V]	hdf[%]	I1 [A]	hdf[%]
Tot.	225.22		5.643	
dc				
1	225.21	100.000	5.513	100.000
2	0.16	0.072	0.100	1.822
3	0.94	0.419	0.272	4.939
4	0.08	0.035	0.035	0.632
5	1.80	0.800	1.139	20.663
6	0.01	0.004	0.004	0.071
7	0.17	0.077	0.234	4.249
8	0.11	0.047	0.008	0.153
9	0.41	0.181	0.047	0.845
10	0.06	0.027	0.007	0.125
11	0.48	0.215	0.032	0.585
12	0.05	0.021	0.005	0.089
13	0.67	0.296	0.048	0.874
14	0.03	0.012	0.002	0.045
15	0.09	0.041	0.076	1.378
16	0.01	0.004	0.002	0.034
17	0.03	0.013	0.010	0.177
18	0.00	0.000	0.001	0.022
19	0.19	0.086	0.023	0.426
20	0.01	0.005	0.001	0.024

Or.	U2 [V]	hdf[%]	I2 [A]	hdf[%]
Tot.	226.50		4.343	
dc				
1	226.48	100.000	4.162	100.000
2	0.08	0.037	0.089	2.149
3	1.40	0.618	0.522	12.554
4	0.07	0.030	0.040	0.950
5	2.00	0.883	1.077	25.889
6	0.03	0.013	0.004	0.090
7	0.15	0.067	0.278	6.672
8	0.03	0.013	0.004	0.108
9	0.20	0.090	0.016	0.375
10	0.08	0.034	0.007	0.159
11	1.90	0.839	0.094	2.254
12	0.08	0.035	0.001	0.013
13	0.42	0.185	0.050	1.212
14	0.03	0.011	0.003	0.063
15	0.06	0.027	0.082	1.977
16	0.01	0.004	0.003	0.067
17	0.05	0.021	0.008	0.184
18	0.00	0.000	0.000	0.012
19	0.17	0.076	0.022	0.519
20	0.01	0.004	0.000	0.009

Or.	U3 [V]	hdf[%]	I3 [A]	hdf[%]
Tot.	224.81		5.274	
dc				
1	224.79	100.000	5.112	100.000
2	0.11	0.051	0.094	1.834
3	0.60	0.265	0.480	9.382
4	0.04	0.019	0.037	0.732
5	1.80	0.799	1.171	22.897
6	0.03	0.015	0.003	0.049
7	0.17	0.077	0.231	4.515
8	0.07	0.032	0.005	0.107
9	0.21	0.092	0.025	0.492
10	0.11	0.048	0.007	0.146
11	1.85	0.822	0.093	1.827
12	0.08	0.037	0.004	0.073
13	0.35	0.157	0.020	0.392
14	0.04	0.019	0.002	0.048
15	0.04	0.018	0.078	1.523
16	0.01	0.005	0.003	0.066
17	0.09	0.040	0.004	0.083
18	0.01	0.004	0.001	0.010
19	0.17	0.075	0.024	0.471
20	0.01	0.005	0.001	0.019

4.13 Determination of sound level (Type test) Test date: April 14,2023

4.13.1 Sound power level calculation under on load current

Calculation equation：

$$L_{WA,IN}=39+18\lg\frac{Sr}{Sp}\approx 44dB\ (A)$$

In which：S_r—Rated power ： 2MVA；

S_p—Base power ： 1MVA。

$L_{WA,IN}$ is found to be 9dB(A) below the guaranteed sound power level 53dB(A), according to standard, the load current sound measurements are not appropriate.

4.13.2 Sound level measurement and sound power level calculation

Transformer was energized at rated voltage.The outline was 0.3m away from the principal radiating surface, there were 10 measured points，the measured point interval was 0.98m，the height of oil tank was 1.65m，the heights of measured points were 0.83m.

Environmental conditions Oil temperature：16.7℃

Area of the surface of the test room Sv（㎡）	Mean sound absorption coefficient α	Sound Absorption （㎡）	Distance from the reference transmitting surface（m）	Area of effective surface S（㎡）	Environmental corrected value factor K dB（A）
2300	0.2	460	0.3	20.21	0.7

Test results dB（A）

Cooling method	The average noise level of background		The average noise level of transformer $\overline{L_{PAO}}$	A-weighted surface sound pressure level $\overline{L_{PA}}=10\lg(10^{0.1\overline{L_{PA0}}}-10^{0.1\overline{L_{bgA}}})-K$	A-weighted sound power level $L_{WA,UN}=\overline{L_{PA}}+10\lg(S/S_0)$
	Before	Before			
KNAN	30.3	30.4	40.2	39	52

Note：$\overline{L_{PA0}}$ ： Uncorrected average A-weighted sound pressure level; $\overline{L_{PAO}}=10\lg(\frac{1}{N}\sum_{i=1}^{N}10^{0.1L_{PAi}})$

$\overline{L_{bgA}}$ ： The lower of the two calculated average A-weighted background sound pressure level.

Result: Passed.

Test Report

4.14 Temperature rise test (Type test) Test date: April 14,2023

The test was conducted by means of short-circuit method.
The test duration was 13h, stability duration was 3h.
Measuring top oil temperature rise: the specified total losses was 13.67kW, injected total losses of 13.64kW
Measuring winding temperature rise: the specified current was 102.19A, injected current of 105.9A during the test.

Conclusions of temperature rise Ambient temperature: 17.2℃

Top oil temperature rise(K)	41.3	
Winding temperature rise(K)	HV	40.8
	LV	43.4

Note: The results of temperature rise were corrected value at specified total losses and current.

Result: Passed.

Legend: Data to be inserted

Time interval	Δt=	1 min
Initial average liquid temp.	θom_start=	50.2 ℃
Final average-liquid temp.	θom_end=	47.5 ℃
Liquid temperature slope	k=	0.14 K/min

Estimated winding time constant	Tw=	23.25 min
Estimated average liquid temp.	Ao=	51.47 ℃
Estimated winding to liquid temp.	B=	7.02 K
Average winding temp. at the instant of shut down	θwo=	58.5 ℃

Auxiliary variables:

tc= -2.2624

te= 0.0440

	n	sa	sb	sc	sd	se
Abs Sums:	18	3.47	1005.41	194.59	56175.43	11.25

Time (min)	R(i) (Ω) ×10^{-1}	θom(i)= Ao-kt	θwm(i) as measured	θwval(i)	θwcor(i)	u{ _ (0/1)	θw(i) as corrected and validated	△θw(i) as per eq. (C.5)	θw(i) × △θw(i)	(θw(i))^2	e$^{(-i/Tw}$	θw(i) as calculated
0		51.47										58.49
1		51.34										58.06
2	2.232	51.20	57.65	57.65	57.92	1						57.64
3	2.229	51.07	57.25	57.25	57.66	1	57.66	-0.258	-14.90	3324.52	0.8789	57.23
4	2.226	50.93	56.86	56.86	57.40	1	57.40	-0.258	-14.83	3294.79	0.8419	56.84
5	2.223	50.80	56.47	56.47	57.14	1	57.14	-0.258	-14.76	3265.20	0.8065	56.45
6	2.220	50.66	56.07	56.07	56.88	1	56.88	-0.258	-14.70	3235.74	0.7725	56.08
7	2.217	50.53	55.68	55.68	56.63	1	56.63	-0.258	-14.63	3206.42	0.7400	55.72
8	2.215	50.39	55.42	55.42	56.50	1	56.50	-0.127	-7.19	3192.03	0.7088	55.36
9	2.212	50.26	55.02	55.02	56.24	1	56.24	-0.258	-14.53	3162.90	0.6790	55.02
10	2.209	50.12	54.63	54.63	55.98	1	55.98	-0.258	-14.46	3133.91	0.6504	54.68
11	2.207	49.99	54.37	54.37	55.85	1	55.85	-0.127	-7.11	3119.68	0.6230	54.36
12	2.204	49.85	53.98	53.98	55.60	1	55.60	-0.258	-14.36	3090.89	0.5968	54.04
13	2.202	49.72	53.71	53.71	55.47	1	55.47	-0.127	-7.06	3076.76	0.5717	53.73
14	2.200	49.58	53.45	53.45	55.34	1	55.34	-0.127	-7.04	3062.66	0.5476	53.42
15	2.198	49.45	53.19	53.19	55.21	1	55.21	-0.127	-7.02	3048.60	0.5245	53.13
16	2.195	49.31	52.80	52.80	54.96	1	54.96	-0.258	-14.20	3020.13	0.5024	52.84
17	2.193	49.18	52.53	52.53	54.83	1	54.83	-0.127	-6.98	3006.17	0.4813	52.55
18	2.191	49.04	52.27	52.27	54.70	1	54.70	-0.127	-6.96	2992.23	0.4610	52.28
19	2.189	48.91	52.01	52.01	54.57	1	54.57	-0.127	-6.94	2978.33	0.4416	52.00
20	2.187	48.77	51.75	51.75	54.45	1	54.45	-0.127	-6.93	2964.46	0.4230	51.74
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												

H.V. Winding temp.-rise (K): $\Delta\theta_{WH} = (\theta_{w0} - \theta_{om\_star}) \times \left(\frac{I_{rated}}{I_{start}}\right)^{y} + \Delta\theta_{om} = (\quad 58.5 - 50.2 \quad) \times \left(\frac{102.19}{105.9}\right)^{1.6} + 33.0 = 40.8$

Legend: Data to be inserted

Time interval	Δt=	1	min
Initial average liquid temp.	θom_start=	50.2	℃
Final average-liquid temp.	θom_end=	47.5	℃
Liquid temperature slope	k=	0.14	K/min

Estimated winding time constant	Tw=	5.56	min
Estimated average liquid temp.	Ao=	52.22	℃
Estimated winding to liquid temp.	B=	8.96	K
Average winding temp. at the instant of shut down	θwo=	61.2	℃

Auxiliary variables:

tc= -10.2796

te= 0.1969

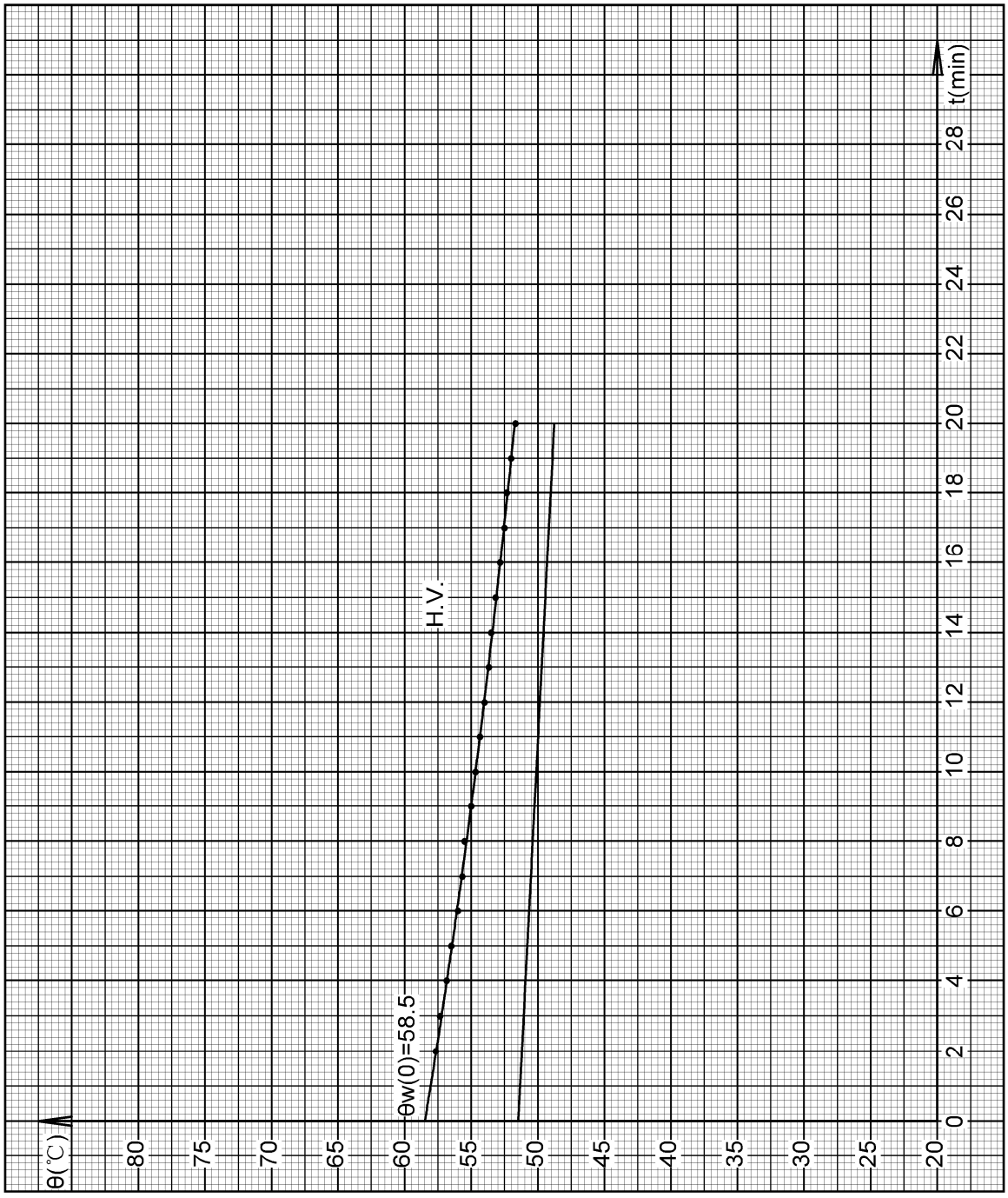
	n	sa	sb	sc	sd	se
Abs Sums:	18	6.01	970.41	330.79	52350.98	3.41

Time (min)	R(i) (Ω) ×10^{-4}	θom(i)= Ao-kt	θwm(i) as measured	θwval(i)	θwcor(i)	u{_ (0/1)	θw(i) as corrected and validated	△θw(i) as per eq. (C.5)	θw(i) × △θw(i)	(θw(i))^2	e$^{(-i/Tw}$	θw(i) as calculated
0		52.22										61.18
1		52.08										59.57
2	3.437	51.95	58.05	58.05	58.32	1						58.20
3	3.422	51.81	56.77	56.77	57.18	1	57.18	-1.144	-65.41	3269.46	0.5833	57.04
4	3.410	51.68	55.75	55.75	56.29	1	56.29	-0.888	-50.00	3168.68	0.4873	56.04
5	3.401	51.54	54.98	54.98	55.66	1	55.66	-0.632	-35.20	3097.88	0.4072	55.19
6	3.394	51.41	54.39	54.39	55.20	1	55.20	-0.462	-25.49	3046.69	0.3402	54.45
7	3.387	51.27	53.79	53.79	54.73	1	54.73	-0.462	-25.28	2995.91	0.2842	53.82
8	3.382	51.14	53.36	53.36	54.44	1	54.44	-0.291	-15.86	2964.11	0.2375	53.26
9	3.376	51.00	52.85	52.85	54.07	1	54.07	-0.377	-20.36	2923.24	0.1984	52.78
10	3.372	50.87	52.51	52.51	53.86	1	53.86	-0.206	-11.10	2901.00	0.1658	52.35
11	3.368	50.73	52.17	52.17	53.65	1	53.65	-0.206	-11.06	2878.85	0.1385	51.97
12	3.364	50.60	51.83	51.83	53.45	1	53.45	-0.206	-11.01	2856.78	0.1157	51.63
13	3.360	50.46	51.49	51.49	53.24	1	53.24	-0.206	-10.97	2834.80	0.0967	51.33
14	3.356	50.33	51.15	51.15	53.04	1	53.04	-0.206	-10.93	2812.90	0.0808	51.05
15	3.353	50.19	50.89	50.89	52.92	1	52.92	-0.121	-6.39	2800.10	0.0675	50.80
16	3.350	50.06	50.64	50.64	52.80	1	52.80	-0.121	-6.38	2787.33	0.0564	50.56
17	3.347	49.92	50.38	50.38	52.67	1	52.67	-0.121	-6.36	2774.59	0.0471	50.34
18	3.343	49.79	50.04	50.04	52.47	1	52.47	-0.206	-10.81	2752.92	0.0394	50.14
19	3.341	49.65	49.87	49.87	52.43	1	52.43	-0.036	-1.86	2749.20	0.0329	49.95
20	3.338	49.52	49.61	49.61	52.31	1	52.31	-0.121	-6.32	2736.54	0.0275	49.76
21												
22												
23												
24												
25												
26												
27												
28												
29												
30												

L.V. Winding temp.-rise (K): $\Delta\theta_{WL} = (\theta_{w0} - \theta_{om\_star}) \times \left(\frac{I_{rated}}{I_{start}}\right)^{y} + \Delta\theta_{om} = (\ 61.2 - 50.2\ ) \times \left(\frac{102.19}{105.9}\right)^{1.6} + 33.0 = 43.4$

Test Report

Temperature curve

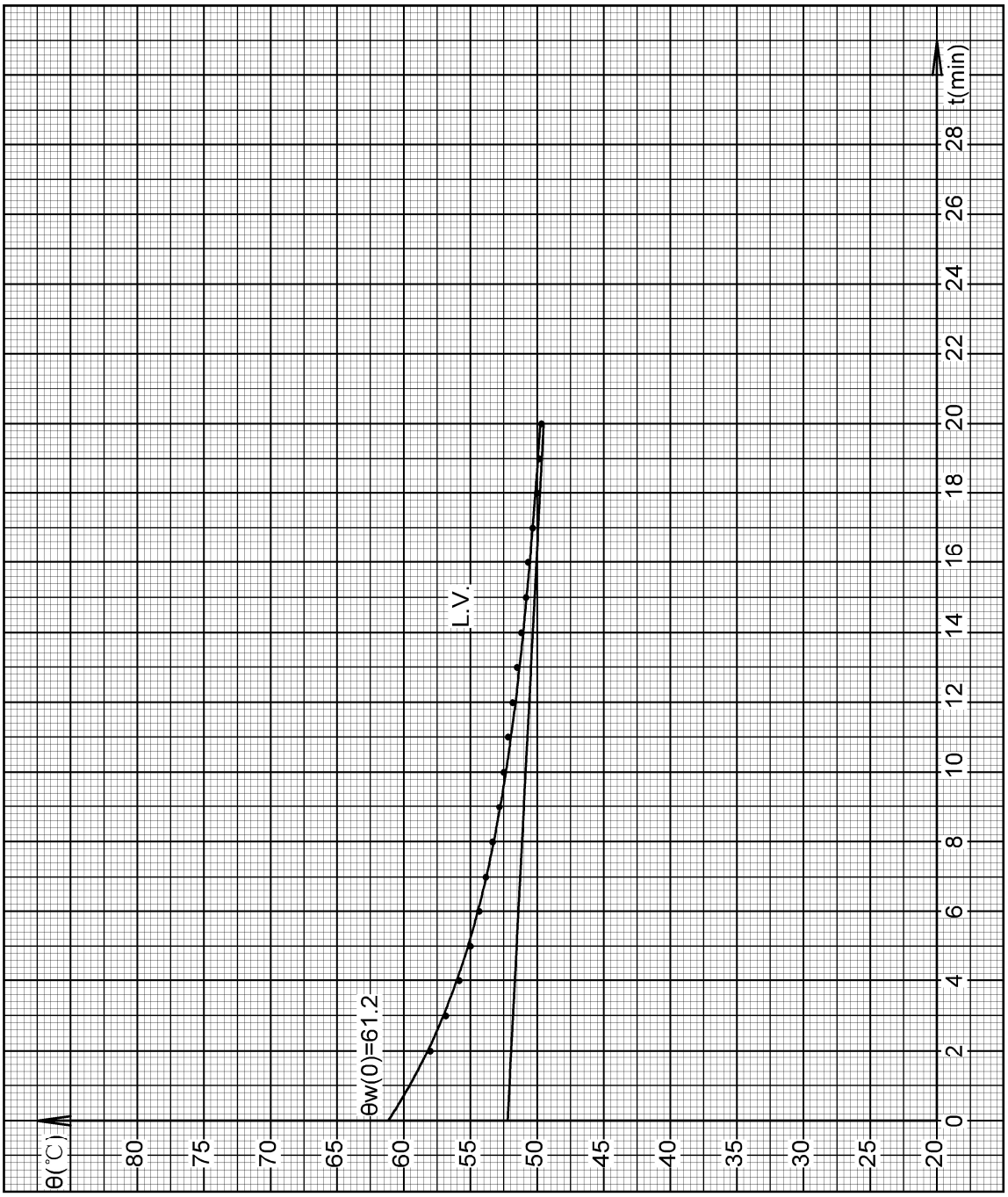


Address: Hushitai South Avenue No.18,Shenbei New District,Shenyang Postal code: 110122 Tel:(024)23785225
E-mail: ctqc@vip.sina.com http: //www.ctn.cn Tel:(024)23787022

Test Report

№: CTQC/B-23.0111
Total 30 Page 15

Temperature curve



Address: Hushitai South Avenue No.18,Shenbei New District,Shenyang Postal code: 110122 Tel:(024)23785225
E-mail: ctqc@vip.sina.com http: //www.ctn.cn Tel:(024)23787022

Test Report

4.15 Short-circuit withstand test (Special test)　　Test date：April 12,2023

4.15.1 Calculated short-circuit current (reference temperature 75℃)

Ambient temperature：14.5℃

The first peak of the asymmetrical phase short-circuit current (A)	The r.m.s. value of the symmetrical phase short-circuit current (A)	The r.m.s. value of the symmetrical line short-circuit current (A)	Peak factor ($K\sqrt{2}$)
1803	716	1240	2.518

4.15.2 Measurement of short-circuit current

The test circuit is shown in Annex 2-f

Perform single-phase test, the voltage was applied between two corners of the delta, total 9 times. Test waveshapes had no distortion, test oscillograms were shown in pages 26～28. The percentage for the first peak of the phase asymmetrical phase short-circuit value and the r.m.s. value of the phase symmetrical short-circuit current is the ratio of measured current to calculated current.

Corrected value = measured value /1.5

Applied voltage terminal	№.	Measurement of current						Duration (s)	Waveform serial №
		The first peak of the asymmetrical phase short-circuit current			The r.m.s. value of the symmetrical phase short-circuit current				
		Measured value (A)	Corrected value (A)	(%)	Measured value(A)	Corrected Value(A)	(%)		
AB	1	2669	1779	98.7	987	658	91.9	1.0	B230111-S01-1
	2	2684	1789	99.2	988	659	92.0	1.0	B230111-S01-2
	3	2687	1791	99.3	989	659	92.0	1.0	B230111-S01-3

№.	Measurement of reactance					
	Phase reactance value(Ω)			Deviation of phase reactance(%)		
	A	B	C	A	B	C
Before	14.71	14.55	14.95	/	/	/
1	14.67	14.54	14.92	-0.27	＜0.1	-0.20
2	14.68	14.55	14.93	-0.20	＜0.1	-0.13
3	14.69	14.55	14.93	-0.14	＜0.1	-0.13

Test Report

Applied voltage terminal	№.	Measurement of current						Duration (s)	Waveform serial №
		The first peak of the asymmetrical phase short-circuit current			The r.m.s. value of the symmetrical phase short-circuit current				
		Measured value (A)	Corrected value(A)	(%)	Measured value(A)	Corrected Value(A)	(%)		
BC	1	2670	1780	98.7	986	657	91.8	1.0	B230111-S02-1
	2	2667	1778	98.6	985	657	91.8	1.0	B230111-S02-2
	3	2673	1782	98.8	986	957	91.8	1.0	B230111-S02-3

№.	Measurement of reactance					
	Phase reactance value (Ω)			Phase reactance deviation (%)		
	A	B	C	A	B	C
Before	14.71	14.55	14.95	/	/	/
1	14.73	14.56	14.93	0.14	＜0.1	-0.13
2	14.73	14.57	14.93	0.14	0.14	-0.13
3	14.73	14.58	14.93	0.14	0.21	-0.13

Applied voltage terminal	№.	Measurement of current						Duration (s)	Waveform number
		The first peak of the asymmetrical phase short-circuit current			The r.m.s. value of the symmetrical phase short-circuit current				
		Measured value (A)	Corrected value(A)	(%)	Measured value(A)	Corrected value (A)	(%)		
CA	1	2720	1813	100.6	1005	670	93.6	1.0	B230111-S03-1
	2	2729	1819	100.9	1005	670	93.6	1.0	B230111-S03-2
	3	2737	1825	101.2	1007	671	93.7	1.0	B230111-S03-3

№.	Measurement of reactance					
	Phase reactance value (Ω)			Phase reactance deviation (%)		
	A	B	C	A	B	C
Before	14.71	14.55	14.95	/	/	/
1	14.71	14.58	14.91	＜0.1	0.21	-0.27
2	14.72	14.59	14.92	＜0.1	0.27	-0.20
3	14.72	14.58	14.93	＜0.1	0.21	-0.13

Measurement of short-circuit reactance after S.C.T.

Phase reactance value (Ω)			Phase reactance deviation (%)		
A	B	C	A	B	C
14.72	14.58	14.93	＜0.1	0.21	-0.13

The maximum phase reactance deviation was 0.21%.

4.15.3 Repeated routine tests after short-circuit withstand test

4.15.3.1Measurement of d.c. insulation resistance each winding to earth and between windings

Test date：April 14,2023

Humidity：38.3%；Oil temperature：16.7℃；Atmospheric pressure：100.4kPa

Measured position	Insulation resistance（MΩ）
HV-LV&E	1280
LV-HV&E	1710
HV, LV-E	1060
HV-LV	2030

4.15.3.2 Measurement of voltage ratio and check of phase displacement

Test date：April 14,2023

Oil temperature：16.7℃

HV winding	LV winding	Ratio	Measured deviation(%)			Connection symbol
Voltage（kV）	Voltage（kV）		AB/ab	BC/bc	CA/ca	
11.3	0.39	28.974	0.02	-0.02	0.02	Dyn11

Result: Passed.

4.15.3.3 Measurement of winding resistance

Test date：April 14,2023

Oil temperature：16.7℃

Winding	d.c. resistance(Ω)		
HV	A～B	B～C	C～A
	0.19217	0.19197	0.19204
LV	a～b	b～c	c～a
	0.0003000	0.0002952	0.0003123

4.15.3.4 Measurement of no-load loss and current

Test date：April 15,2023

Oil temperature：16.7℃

Applied voltage（kV）		No-load current		No-load loss（kW）	
Means value	R.M.S.	（A）	(%)	Measured value	Corrected value
0.225	0.224	5.12	0.17	1.23	1.24

Result: Passed.

4.15.3.5 Measurement of short-circuit impedance and load loss

Test date：April 15,2023

Winding	Applied current		Measured voltage (kV)	Short-circuit impedance (Each phase)		Load loss (kW)		Total losses (kW)
				（Ω）	(%)	Measured value	Corrected value	Corrected value
	I （A）	I/Ir （%）		t=75℃	t=75℃ I=Ir	t=16.7℃	t=75℃ I=Ir	t=75℃ I=Ir
HV | LV	59.83	58.55	0.520	5.02	7.87	4.01	12.43	13.67

Result: Passed

4.15.3.6 Test on dielectric liquid

Test date：April 14,2023

Ambient Temperature：21.6℃

tanδ(90℃)	Breakdown voltage(kV)	Water dissolved(mg/L)
0.02279	58.9	15

Result: Passed

Test Report

4.15.3.7 Lightning impulse test (LI, LIC) Test date：April 14,2023

The test circuit is shown in Annex 2-g

Test atmospheric conditions: Humidity: 38.5%;Ambient temperature: 15.2℃; Atmospheric pressure: 101.2kPa

Test items and voltage

Tested terminals	Rated withstand voltage(kV)		Tap position
	Full	Chopped	/
A，B，C	75	85	

Note: According to the requirements of the technical service contract, lightning full wave impact test shall be carried out before the short-circuit bearing capacity test.

Test voltage：Full wave(kV)：73.25～75.77kV

Chopped wave(kV)：84.96～85.70kV

Line terminal

One reduced negative polarity full wave impulse;；

One rated negative polarity full wave impulse；

Two rated negative polarity chopped wave impulses；

Two rated negative polarity full wave impulses；

Test oscillogram records:

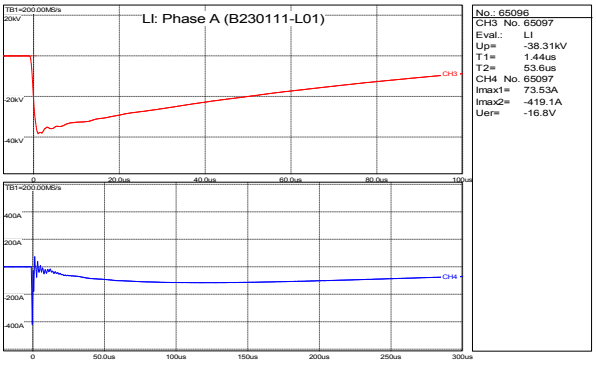
T1: Front time; T2:Time to half value; Tc: Time to chopping;

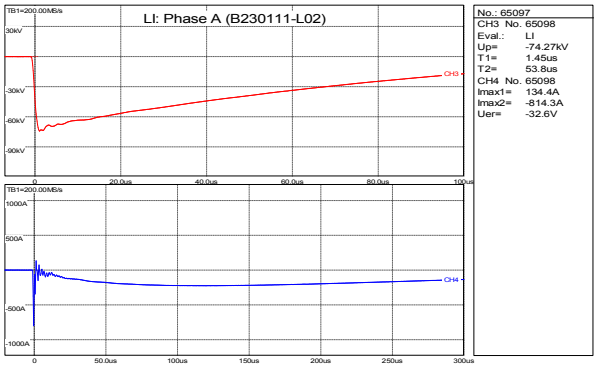
Up: Peak voltage. Up2: Time to zero.

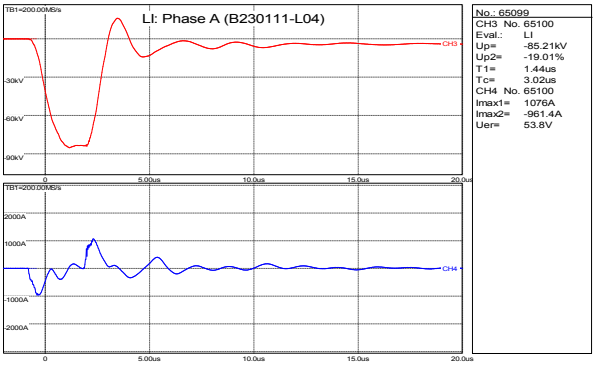
Result: Passed

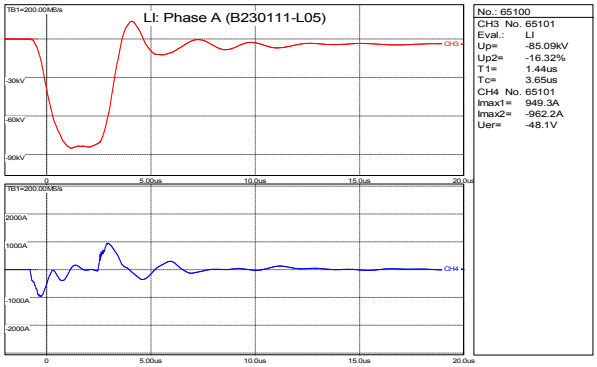
Test Report

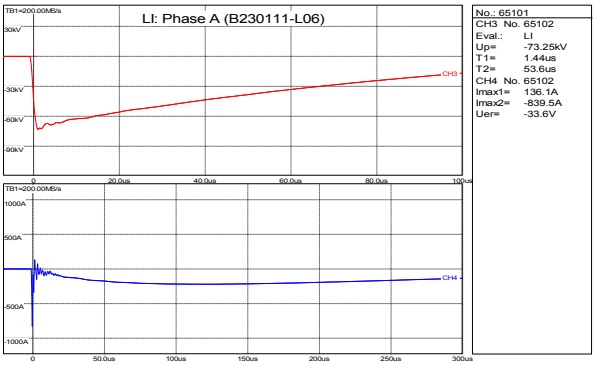
Tested terminal: A; Test polarity: Negative CH1: Voltage records CH2: Neutral current records

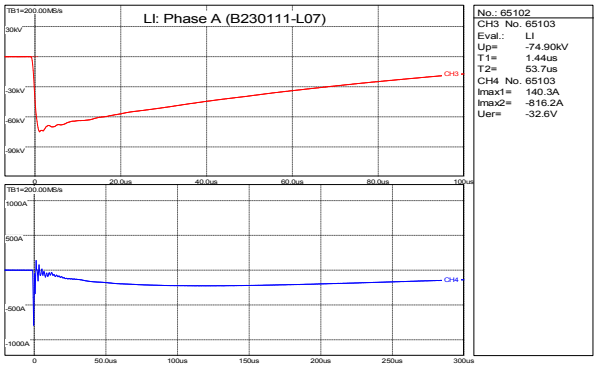






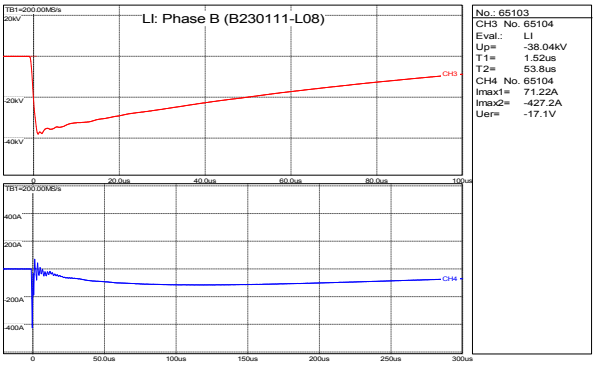


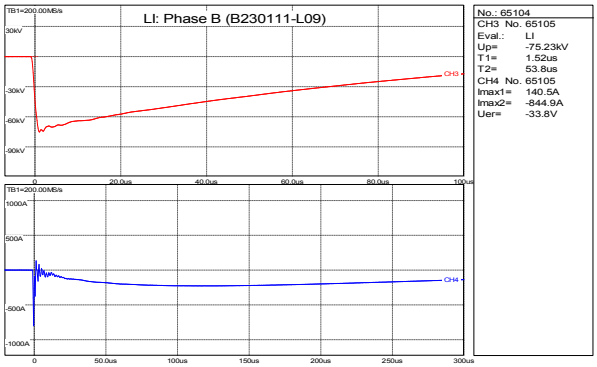


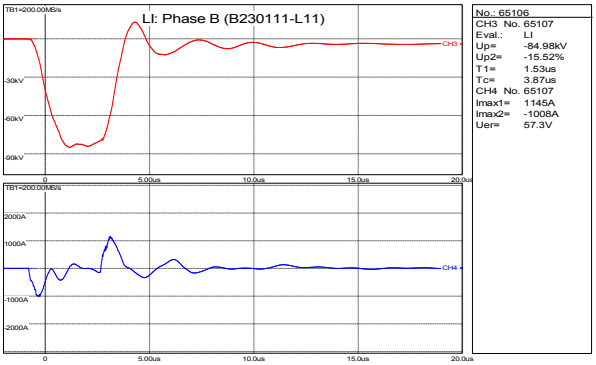


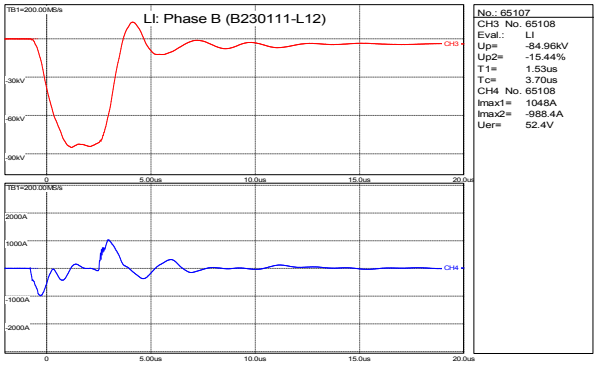
Test Report

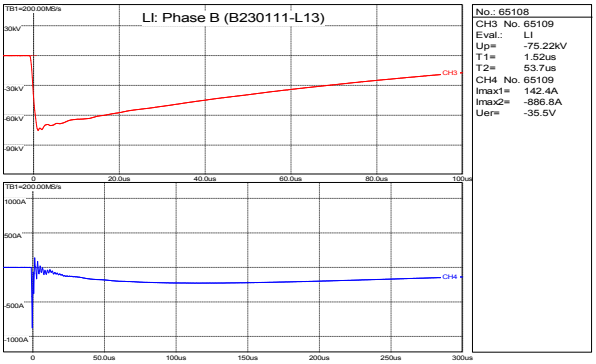
Tested terminal: B; Test polarity: Negative CH1: Voltage records CH2: Neutral current records

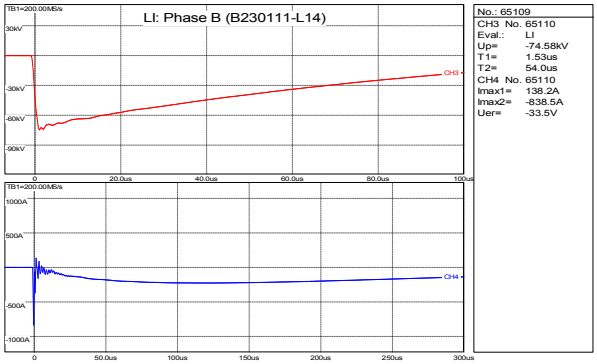






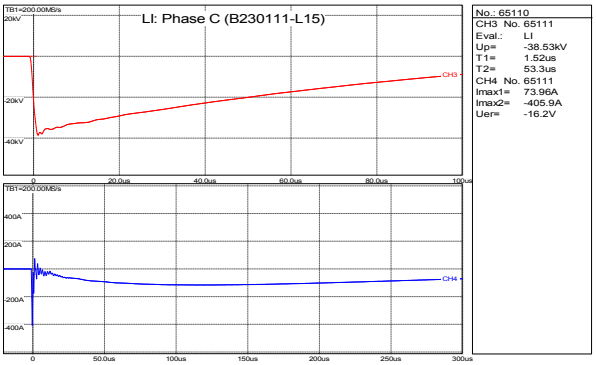


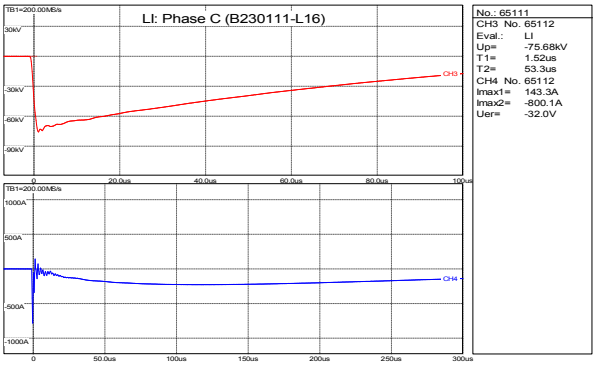


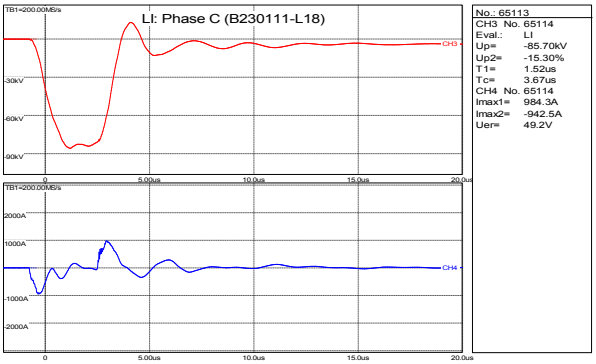


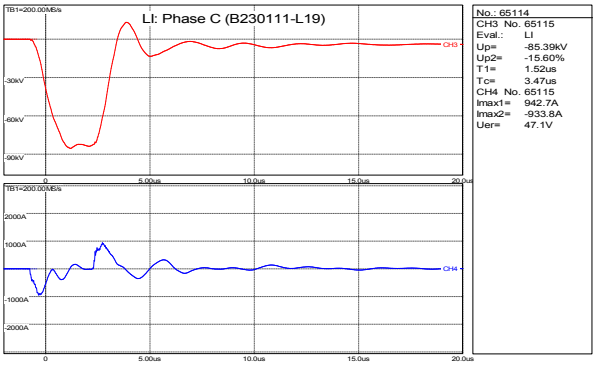
Test Report

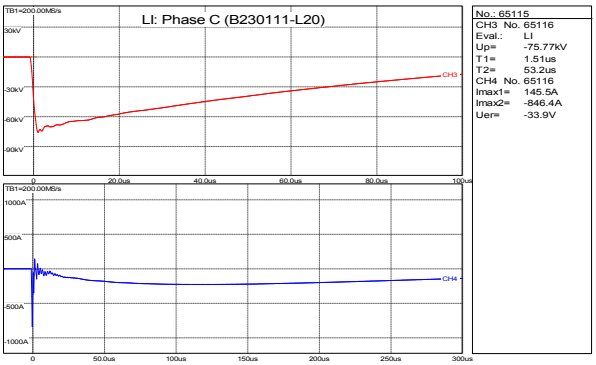
Tested terminal: C; Test polarity: Negative CH1: Voltage records CH2: Neutral current records

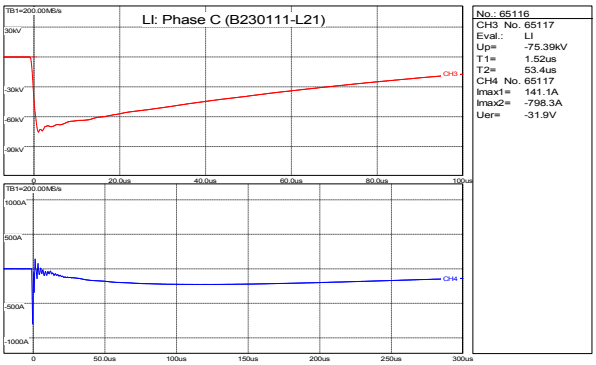












4.15.3.8 Applied voltage test

Test date：April 14,2023

Humidity: 38.3%;Ambient temperature: 16.7℃; Atmospheric pressure: 100.4kPa

Measured position	Test voltage（kV）	Duration（s）	Result
ABC	28	60	Passed
abcn	6	60	

4.15.3.9 Induced voltage withstand test

See 4.17.

4.15.4 The out of tank inspection

There is no deformation of winding, connection and supporting structures, no traces of electrical discharge was found after S.C.T. The active part photos taken before and after S.C.T. were shown in pages 29～30.

See page 29~30 for photos of hanging core before and after the test.

4.15.5 The result of short-circuit withstand test: passed.

4.16 Measurement of zero-sequence impedance on three-phase transformers (Special test)

Test date：April 14,2023

The test circuit is shown in Annex 2-h

Oil temperature：16.7℃

Connection symbol	Power supply terminal	Open terminal	Applied current（A）	Measured voltage（V）	Zero-sequence impedance（Ω）
Dyn11	abc-n	A，B，C	501.04	1.029	0.00616

Test Report

4.17 Induced voltage test with partial discharge measurement(IVPD)(Special test)

Test date：April 14,2023

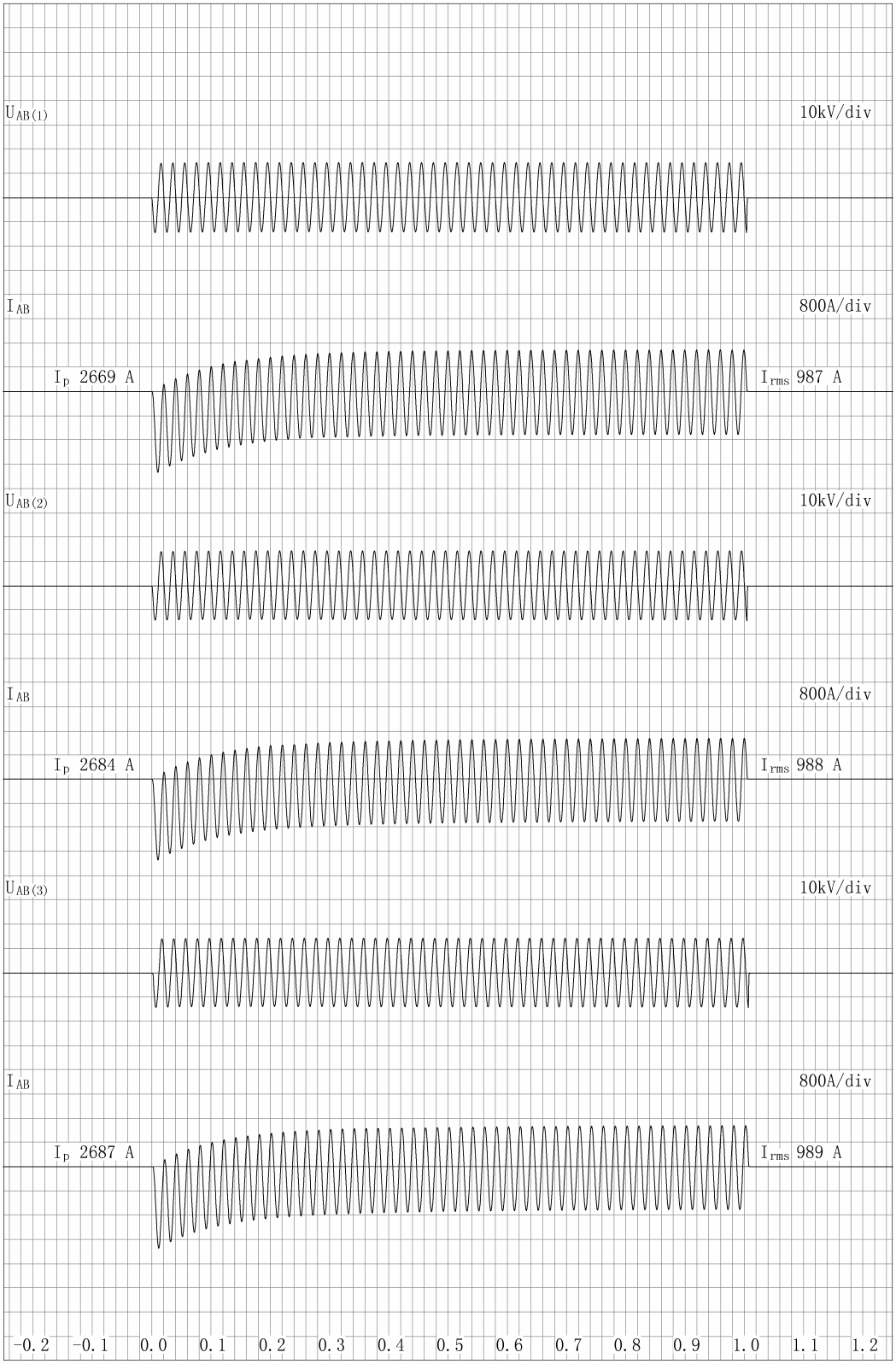
Test frequency :150Hz

Oil temperature：16.7℃

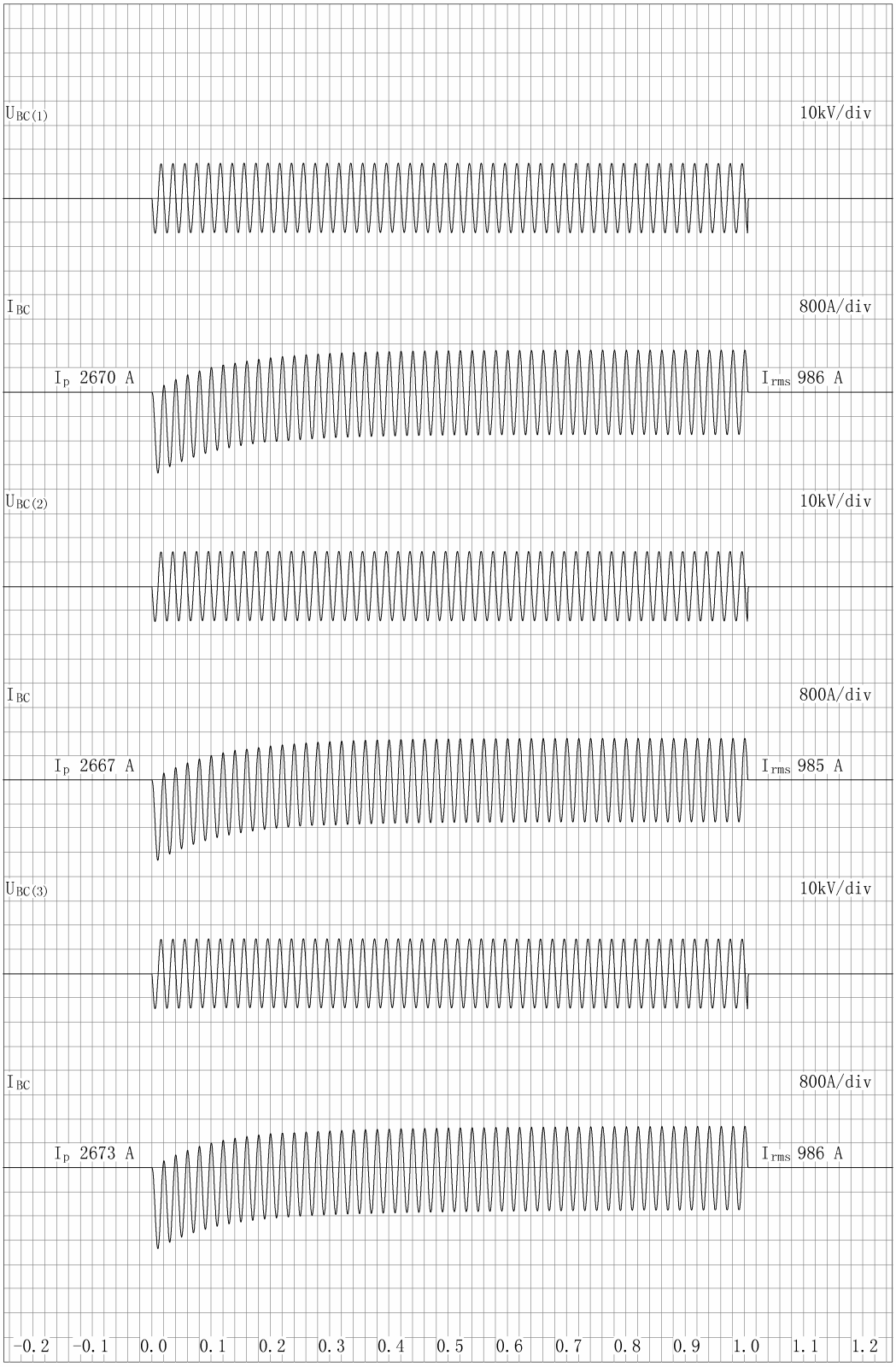
Applied voltage（kV）			Duration	Local discharge（pC）		
Multiple	HV	LV		A	B	C
$0.4Ur/\sqrt{3}$	2.610	0.090	/	＜10	＜15	＜10
$1.2Ur/\sqrt{3}$	7.829	0.270	1min	＜10	＜15	＜10
$U_2=1.58Ur/\sqrt{3}$	10.308	0.356	5min	＜10	＜15	＜10
$U_1=2.0Ur/\sqrt{3}$	13.048	0.450	40s	/	/	/
$U_2=1.58Ur/\sqrt{3}$	10.308	0.356	5min	＜10	＜15	＜10
			10min	＜10	＜15	＜10
			15min	＜10	＜15	＜10
			20min	＜10	＜15	＜10
			25min	＜10	＜15	＜10
			30min	＜10	＜15	＜10
			35min	＜10	＜15	＜10
			40min	＜10	＜15	＜10
			45min	＜10	＜15	＜10
			50min	＜10	＜15	＜10
			55min	＜10	＜15	＜10
			60min	＜10	＜15	＜10
$1.2Ur/\sqrt{3}$	7.829	0.270	1min	＜10	＜15	＜10
$0.4Ur/\sqrt{3}$	2.610	0.090	/	＜10	＜15	＜10

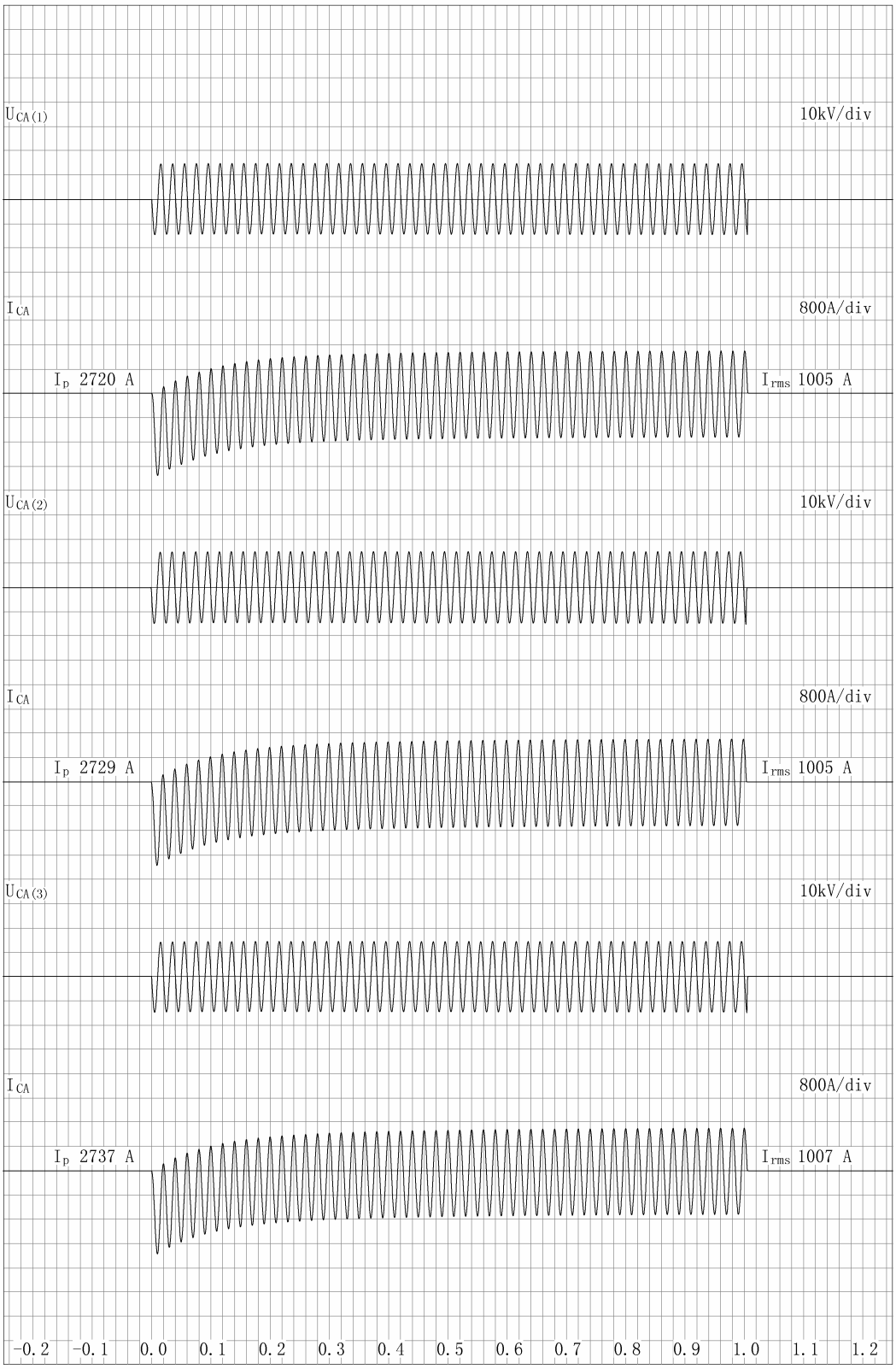
Note：$U_1=2.0Ur/\sqrt{3}$ instead of inductive voltage withstand test

Result: Passed


$U_{AB(1)}$
10kV/div
I_{AB}
800A/div
I_p 2669 A
I_{rms} 987 A
$U_{AB(2)}$
10kV/div
I_{AB}
800A/div
I_p 2684 A
I_{rms} 988 A
$U_{AB(3)}$
10kV/div
I_{AB}
800A/div
I_p 2687 A
I_{rms} 989 A
-0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
0.02s/div

B230111-S01


$U_{BC(1)}$
10kV/div
I_{BC}
800A/div
I_p 2670 A
I_{rms} 986 A
$U_{BC(2)}$
10kV/div
I_{BC}
800A/div
I_p 2667 A
I_{rms} 985 A
$U_{BC(3)}$
10kV/div
I_{BC}
800A/div
I_p 2673 A
I_{rms} 986 A
-0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2


$U_{CA(1)}$
10kV/div
I_{CA}
800A/div
I_p 2720 A
I_{rms} 1005 A
$U_{CA(2)}$
10kV/div
I_{CA}
800A/div
I_p 2729 A
I_{rms} 1005 A
$U_{CA(3)}$
10kV/div
I_{CA}
800A/div
I_p 2737 A
I_{rms} 1007 A
-0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2
0.02s/div

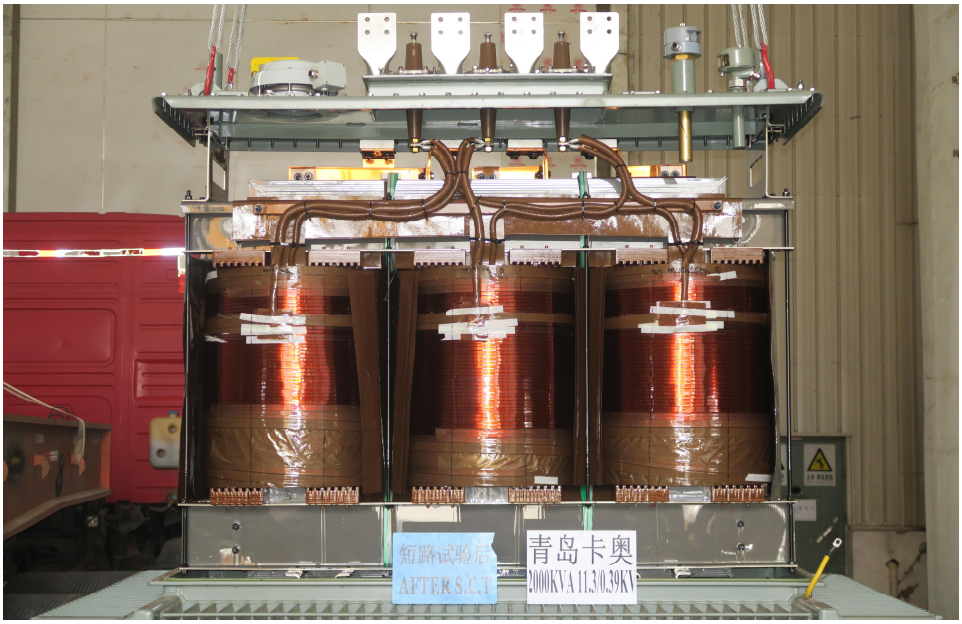
B230111-S03

HV side before test:

LV side before test:

HV side after test:

LV side after test:

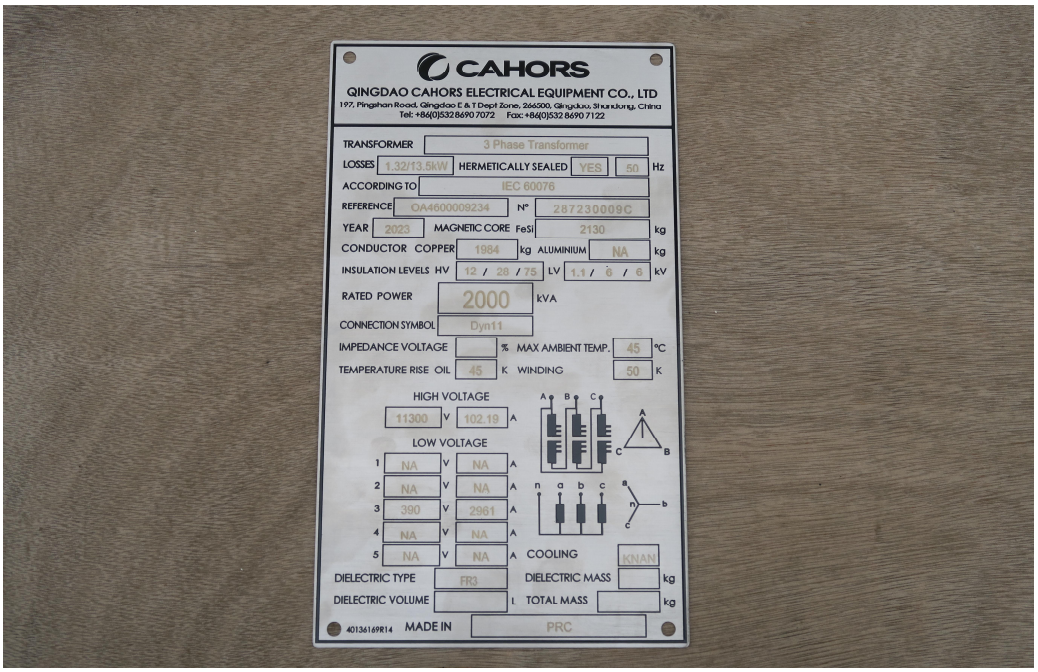


Annex1

NAMEPLATE AND OUTLINE PHOTOS

№：CTQC/B-23.0111

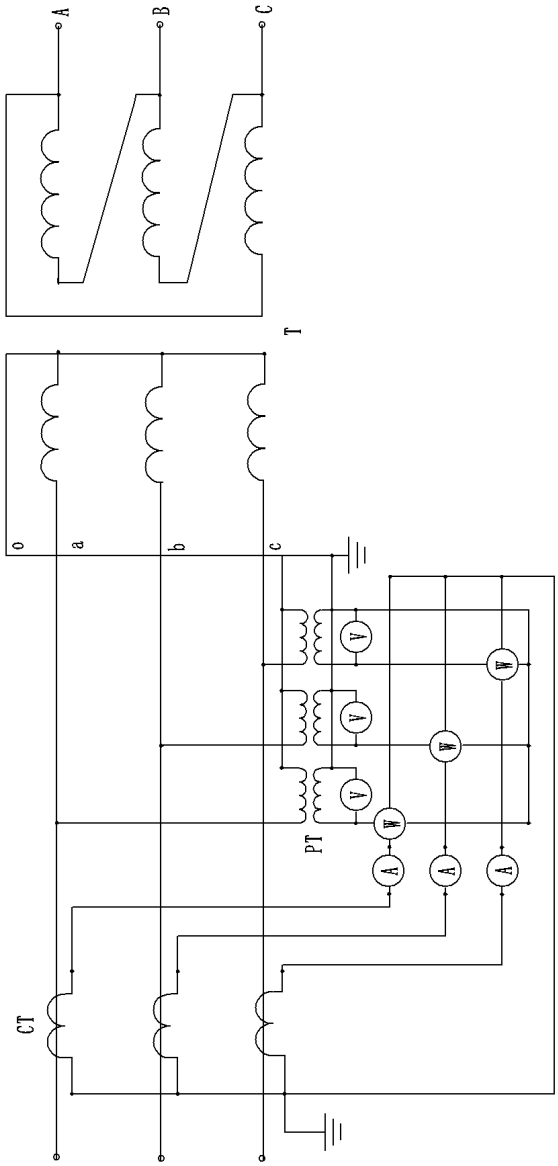
Nameplate：



Outline：

Annex2

SCHEMATIC DIAGRAM OF TEST CIRCUIT



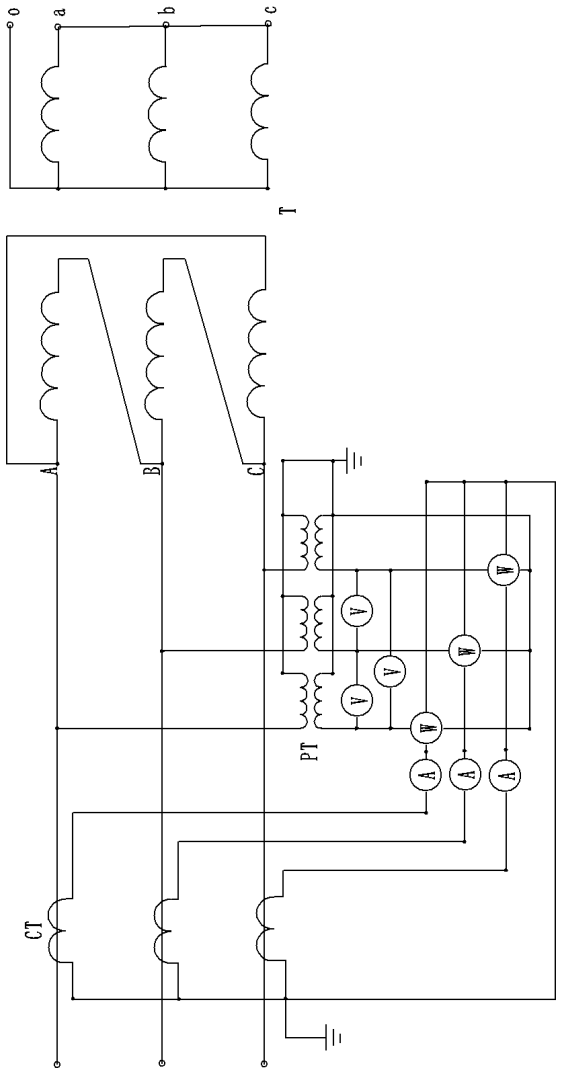
空载损耗及空载电流测量线路图

No-load loss and current measurement circuit

T-被试变压器 Sample　　CT-电流互感器 Current transformer

PT-电压互感器 Voltage transformer　　A-电流表 Amperemeter

W-瓦特表 Wattmeter　　V-电压表 voltmeter



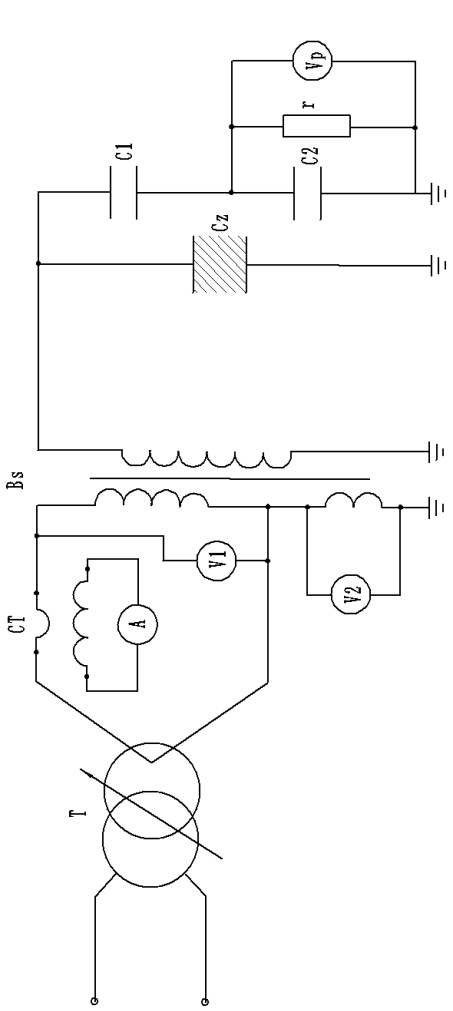
短路阻抗及负载损耗测量线路图

Short circuit impedance and on load loss measurement circuit

T-被试变压器 Sample　　CT-电流互感器 Current transformer

A-电流表 Amperemeter　　PT-电压互感器 Voltage transformer

W-瓦特表 Wattmeter　　V-电压表 Voltmeter



外施耐压试验线路图

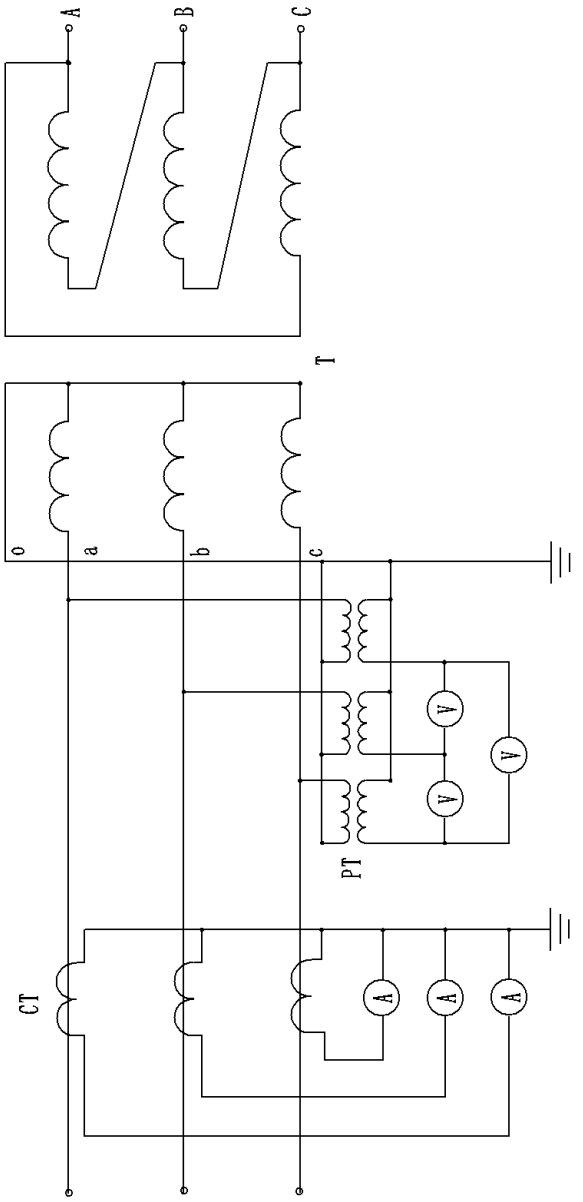
Separate-source voltage withstand diagram

T-调压器 Regulator　　A-电流表 Amperemeter　　Bs-试验变压器 Testing transformer

CT-电流互感器 Current transformer　　V1,V2-电压表 Voltmeter

C1,C2-分压电容 Capacitive devider　　Cz-试品 Sample

r-放电电阻 Discharge resistance　　Vp-峰值电压表 Peak value voltmeter



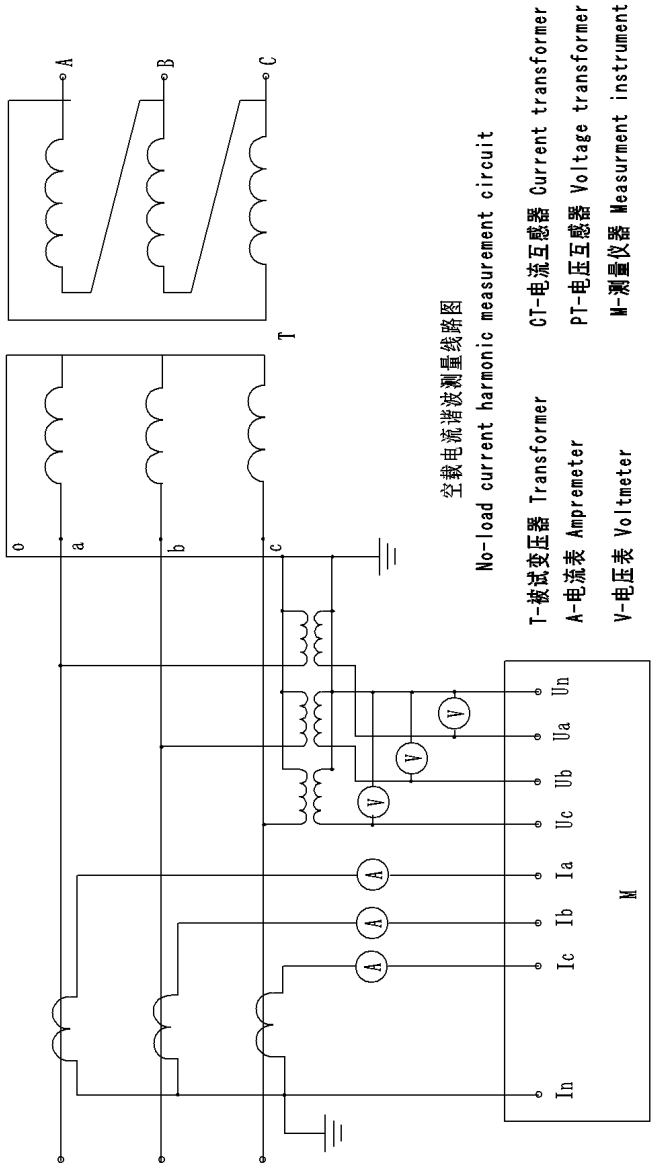
感应耐压试验线路图

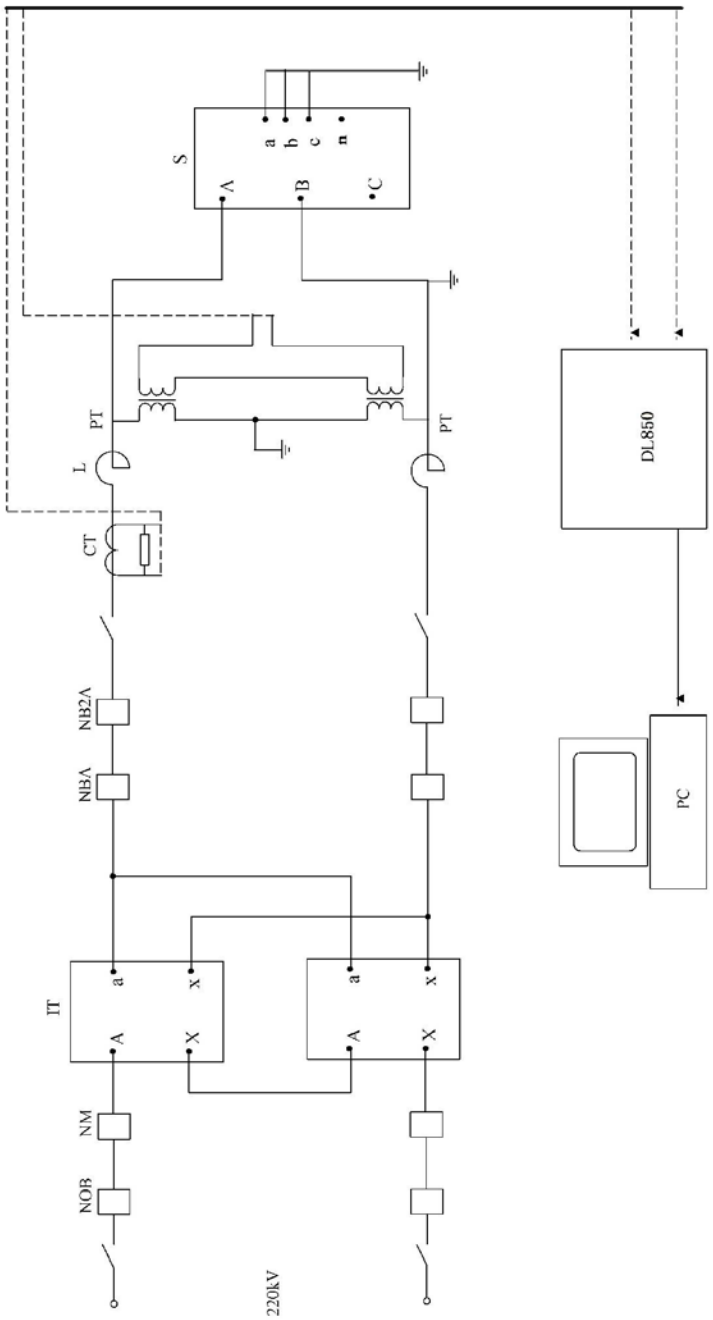
Induced overvoltage withstand test circuit

T-被试变压器 Sample　　CT-电流互感器 Current transformer

PT-电压互感器 Voltage transformer　　A-电流表 Amperemeter

V-电压表 Voltmeter


空载电流谐波测量线路图
No-load current harmonic measurement circuit
T-被试变压器 Transformer
A-电流表 Ampremeter
V-电压表 Voltmeter
CT-电流互感器 Current transformer
PT-电压互感器 Voltage transformer
M-测量仪器 Measurment instrument
A
B
C
T
o
a
b
c
In
Ic
Ib
Ia
Uc
Ub
Ua
Un
M

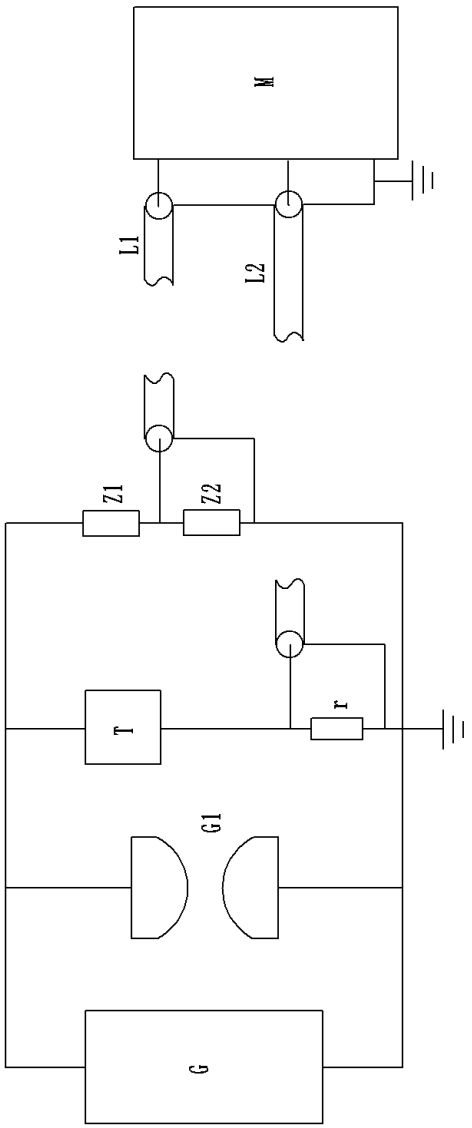


短路承受能力试验线路图　　Short circuit tests of transformer:

IT：中间变压器 Intermediate transformer　CT：电流互感器 Standard current transformer　PC：计算机 Computer

L：限流电抗器 Reactors　　PT：电压互感器 Voltage transformer　　DL850：瞬态记录仪 16 channels analyzer

S：被试变压器 Samplc　　NOB,NM,NB,NB2：SF6断路器 SF6 switchgear



雷电冲击试验线路图

Lightning impulse withstand test system circuit

G-冲击电压发生器 Impulse generator

Z1,Z2-阻容分压器 Voltage divider

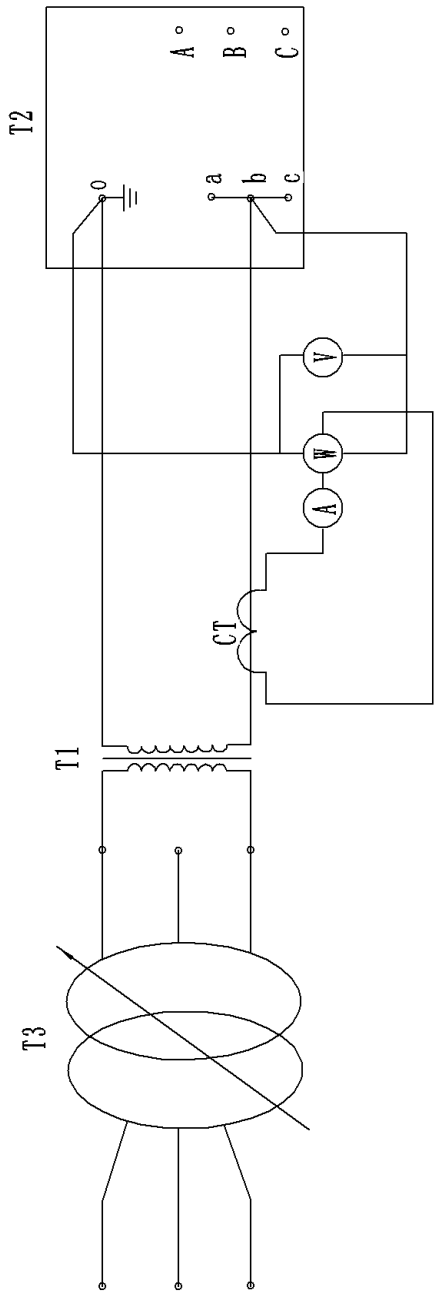
L1,L2-高频传输电缆 High frequency transmission cable

r-分流器 Shunt

G1-截断装置 Chopping device

M-测量仪器 Measurement instrument

T-试品 Sample



变压器零序阻抗测量线路图

Zero-sequence impedence measurement circuit

T1-大电流变压器 Heavy current testing transformer

T2-被试变压器 Sample

T3-调压器 Regulator

V-电压表 Voltmeter

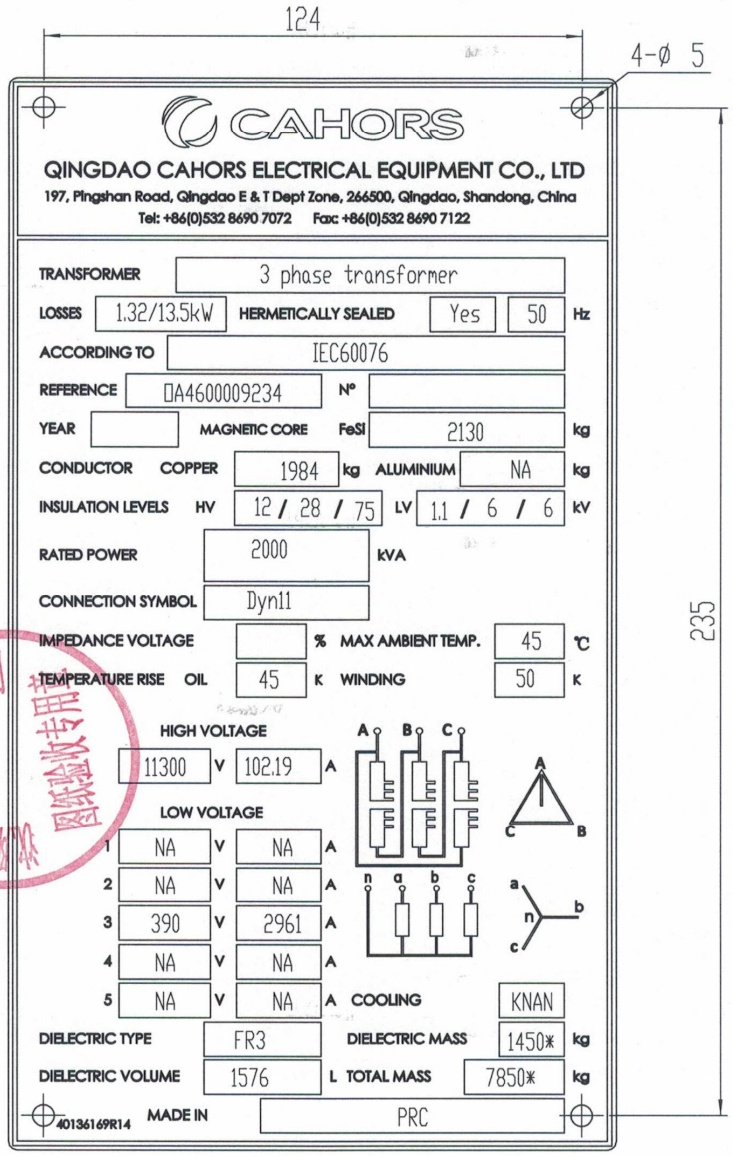
A-电流表 Amperemeter

W-瓦特表 Wattmeter

CT-电流互感器Current transformer

Annex3

TRANSFORMER DRAWINGS



NOTES
1.Material: 316L thickness:1mm;
2.The blank tolerance with * is ±5%;
3.Impedance voltage will imprint measured value.

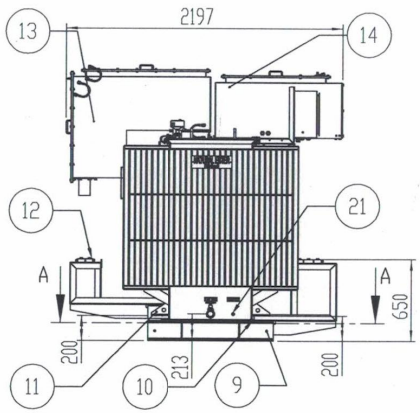
NO	DATE	DESIGN	CHECK	REASON FOR MODIFICATION
01				
00	2022/11/29	YY.Cheng		

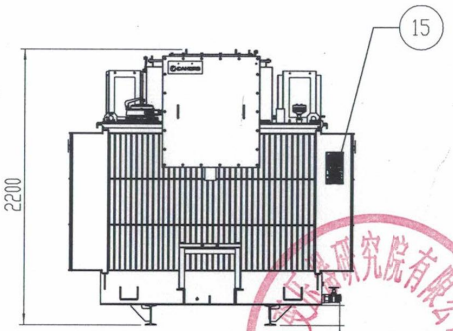
PLATE NAME ENG 316L

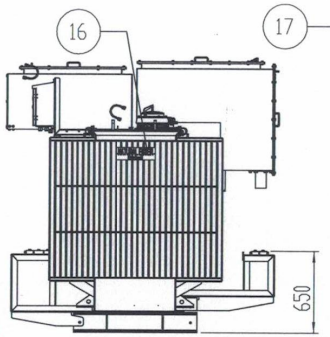
CAHORS
Medium Voltage Division
TRANSFIX

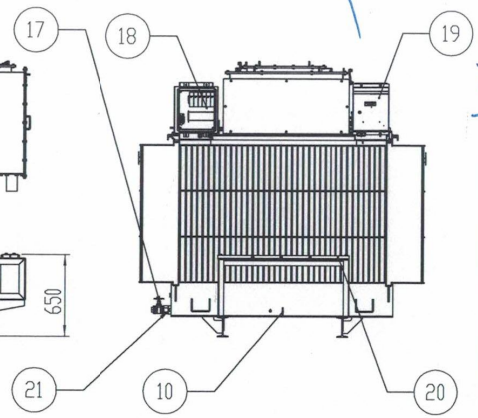
ECH: 1:1.5
Format A4

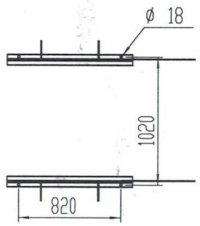
40136169R14 | 00



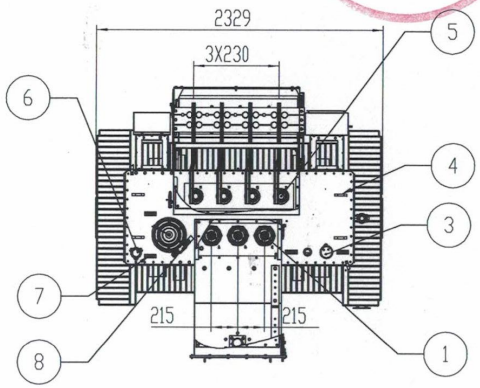








Section : A-A



Oil Weight(kg)	1450
Total weight(kg)	7850

No.	Item	Description	Qua.	Maker
21	Sampling Valve	L14N-C	1	Checkfluid INC
20	LV Cable bracket	Adjustable by 100mm	1	QCEE
19	Alarm terminal box	IP55	1	QCEE
18	Auxiliary supply Fuse box	IP55 with lock and handle	1	QCEE
17	Drain Valve	Gate valve with sampling	1	QCEE
16	Fluid Plate	BS316L	2	QCEE
15	Rating Plate	BS316L	1	QCEE
14	LV Cable box	IPX2 with view window	1	QCEE
13	HV Cable box	IP43	1	QCEE
12	HV Cable Bracket	Adjustable by 100mm	1	QCEE
11	Jacking Pad	125X125	4	QCEE
10	Earthing Terminal	65x65X6 BS316L with tin	2	QCEE
9	Base Support	I-Beams	2	QCEE
8	Pressure relief Device	LPRD	1	Qualitrol
7	Label	BS316L	8	QCEE
6	Oil Filling Orifice	D60	1	QCEE
5	LV bushing	Porcelain 1kV/3150A	4	TianHua
4	Lift-Lug	WLL=4tons/unit D40	4	QCEE
3	Oil Level indicator	Magnetic type	1	Qualitrol or Maier
2	Oil Temperature indicator	With contacts	1	Qualitrol or Maier
1	HV bushing	36kV 630A TypeC EN50180	3	KUVAG

Note:
(1) All dimensions are subject to 1% tolerance,and weight are subject to 5% tolerance
(2) Major components and equipments will be labelled clearly
(3) The shape and position of major components and equipments maybe changed in detailed design
(4) The manufacture of components maybe changed to other quanlified one
(5) HV cable box is faciliated with earth copper bar or strap
(6) Rating plate is fixed onto a cooling-fin cover with stainless steel rivet or bolt
(7) Transformer is equipped with 4 lift-lugs on cover that can lift the whole transformer without deformation
(8) Alarm wiring through metallic is connected from pressure relief device,oil temperature-indicator and oil level indicator to the alarm terminal box
(9) M10 A4-70 bolt and nut is used to fix cover and tank together, between them there is O-ring to seal, which is compatible to ester oil
(10)HV and LV cable box have appropriate to hold the all the rated size cables
(11)Painting color is RAL7033

CLP 中電

REV.	DESCRIPTION	DATE	CHK.

CONTRACTOR: QingDao Cahors Electrical Equipment Company

DRAWN: W.L	DATE: 20221214
CHECKED: YY.C	APPROVED: L.F
SCALE:	SHEET(S) IN SET:1/22

ASSET MANAGEMENT

TITLE:
NATURAL ESTER(FR3) IMMERSED
DISTRIBUTION TRANSFORMER
2000kVA 11.3/0.39kV KNAN
GENERAL LAYOUT

PROJECT NO.: 4501440366
CONTRACT NO.: 4600009234
DRG. NO. TSDD542102DCHR0001 01 - S

INFORMATION CLASS: PROPRIETARY

CHPTL

中国大容量试验联盟（简称 CHPTL）是中国同类试验机构的唯一协作组织，隶属于中国电工技术学会。其主要目标是规范国家标准、行业标准及 IEC 标准在电力设备(交流 1000V 以上，直流 1200V 以上)型式试验中的协调应用。

China High Power Testing liaison (CHPTL) is the only organization in China which is formed to promote and coordinate the application of IEC/GB standard as well as industry standards in power electrical equipment type test (AC above 1000V, DC above 1200V). CHPTL is under the leadership and management of China Electro-technical Society.

CHPTL 成员单位如下:

The members of CHPTL are as follows:

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Xi'an High Voltage Apparatus Research Institute Co., Ltd. (XIHARI)

中国电力科学研究院(CEPRI)

China Electrical Power Research Institute (CEPRI)

辽宁高压电器产品质量检测有限公司(AQTC)

Liaoning High Voltage Apparatus Quality Test Co., Ltd. (AQTC)

沈阳变压器研究院有限公司变压器实验室(STRI)

Shenyang Transformer Institute Co., Ltd Transformer Laboratory (STRI)

上海电气输配电试验中心有限公司(SETC)

Shanghai Electric Power Transmission & Distribution Testing Center Co., Ltd. (SETC)

电力工业无功补偿成套装置质量检验测试中心(PRCIQTC)

Power Industry Reactive Compensation Equipment Quality Inspection & Test Center(PRCIQTC)

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CHPTL as a collaboration does not itself issue test reports. Each CHPTL member issuing a test report is responsible for the validity and contents of that report.