Digitally signed by Dranga Iurii
Date: 2023.12.04 10:51:25 EET
Reason: MoldSign Signature
Location: Moldova

ASTA TYPE TEST CERTIFICATE OF COMPLETE TYPE TESTS

Project No: G105348906 **Certificate No:** ASTA-TYPE-0002377

Applicant: Zhejiang Jiangshan Transformer Co., Ltd.
No.84, Hushan Road, Jiangshan, Zhejiang Province, China

Apparatus: A three-phase, 66/ 52.8 MVA, ONAF/ ONAN (100%/ 80%), (132±8×1.25%)/ 33/ 11 kV, 50 Hz, Category II, YNyn0+d, oil transformer. The high voltage winding has 17 taps and the principal tap is tap 9B. The transformer is fitted with a MR on-load tap changer.

Manufactured By: Zhejiang Jiangshan Transformer Co., Ltd.
No. 84, Hushan Road, Jiangshan, Zhejiang Province, China

Test Report No: B230035

Designation: SFZ-66000/132

The apparatus which is representative of the designation, supplied drawings and photographs has been evaluated in accordance with:

IEC 60076-1: 2011	**Clauses 11.1.2.1 i), 11.1.2.2 a) to e), 11.1.3 d), 11.1.3 e), 11.1.4 e), 11.1.4 l), 11.2 to 11.10, 11.12 and 12**
IEC 60076-2: 2011	**Clauses 6 and 7**
IEC 60076-3: 2013+A1: 2018	**Clauses 9, 10, 11.2, 11.3, 12, 13.2, 13.3 and 13.4**
IEC 60076-5: 2006	**Clause 4.2**
IEC 60076-10: 2016	**Clauses 11 and 12**

and the STL Guide to IEC 60076 Issue 8.0, 1st June 2022, where applicable

The results are shown in the record of tests attached hereto. The values obtained and the general performance is considered to comply with the above Standard(s) and to justify the ratings assigned by the manufacturer as stated on the ratings page(s) of this Certificate. This Certificate applies only to the apparatus tested. Responsibility for conformity of any apparatus having the same or other designations rests with the Manufacturer.

UKAS PRODUCT CERTIFICATION
0010

C Diack-Evans
Certification Engineer

R W Hayward
Certification Officer

11th April 2023 Date

This Certificate is for the exclusive use of Intertek's client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this Certificate. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek.
Issued by Intertek Testing & Certification Ltd., Academy Place, 1-9 Brook Street, Brentwood CM14 5NQ, United Kingdom
a UKAS accredited certification body No. 0010

Project No: G105348906 **Certificate No:** ASTA-TYPE-0002377

Conditions of use:

ASTA Type Certificates, verification of test is issued by Intertek for the exclusive use of the party applying for the Certificate. Intertek assumes no liability to any parties other than those with which it has an agreement and then only in accordance with the agreed Terms and Conditions.

The Applicant is authorised to copy or distribute Certificates and Test Reports provided the entire contents are included, or Certificate Front Sheets accompanied by any associated pages on which are stated the assigned rated characteristics and no part is obscured or illegible. Permission must be obtained from Intertek before any other kind of reproduction is made.

The holder of a Certificate may claim in Trade Journals, Catalogues, Technical Articles etc., and without the prior approval of Intertek that the product identified in a Certificate is Certified.

To minimise the possibility of any misunderstanding such claims must clearly identify the product(s) certified or approved, the ratings verified and the Standard against which certification/approval has been made.

Any other use of the Intertek or ASTA brand must first be approved in writing by Intertek. Test results and ratings verified by testing included in the Certificate and related Test Reports shall relate specifically to the sample(s) tested.

Authenticity:

Authenticity of any ASTA document can be confirmed by contacting the Intertek ASTA Certification Office at the following address:

Intertek Testing & Certification Ltd., Centre Court, Meridian Business Park, Leicester, LE19 1WD, United Kingdom. Email: asta@intertek.com

This Certificate is for the exclusive use of Intertek's client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this Certificate. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek.
Issued by Intertek Testing & Certification Ltd., Academy Place, 1-9 Brook Street, Brentwood CM14 5NQ, United Kingdom
a UKAS accredited certification body No. 0010

Project No: G105348906 **Certificate No:** ASTA-TYPE-0002377

Verification of a transformer

Characteristic verified	Clause/ Subclause	Verified tests and ratings	
Rated voltages, U_r	IEC 60076-1	132/ 33/ 11 kV	
No-load loss and No-load current	IEC 60076-1 Clause 11.1.3 e)	26484 W at 90 % rated voltage 54045 W at 110 % rated voltage 0.06 % at 90 % rated voltage 0.41% at 110 % rated voltage	
Rated power, S_r	IEC 60076-2 Clause 7	66/ 52.8 MVA, ONAF/ ONAN	
Rated insulation level	IEC 60076-3 Clauses 9, 10, 11.2, 11.3, 12, 13.2, 13.3 and 13.4	HV:	U_m 145/ LI 650/ LIC 715/ AC 275 kV
		HVN:	U_m 52/ LI 250/ AC 95 kV
		LV:	U_m 36/ LI 170/ LIC 187/ AC 70 kV
		LVN:	U_m 36/ LI 170/ AC 70 kV
Ability to withstand short-circuit	IEC 60076-5 Clause 4.2	Verified	
Sound pressure level for the transformer @ 1.0 m under no-load current and rated voltage, ONAN	IEC 60076-10 Clause 11	65 dB(A), Guaranteed 70 dB(A)	
Sound power level for the transformer @ 1.0 m under no-load current and rated voltage, ONAN	IEC 60076-10 Clause 12	86 dB(A), Guaranteed 88 dB(A)	
Sound pressure level for the transformer @ 0.3 m under no-load current and rated voltage, ONAN	IEC 60076-10 Clause 11	67 dB(A), Guaranteed 70 dB(A)	
Sound power level for the transformer @ 0.3 m under no-load current and rated voltage, ONAN	IEC 60076-10 Clause 12	86 dB(A), Guaranteed 88 dB(A)	
Sound pressure level for the transformer @ 2.0 m under no-load current and rated voltage, ONAF	IEC 60076-10 Clause 11	66 dB(A), Guaranteed 70 dB(A)	

This Certificate is for the exclusive use of Intertek's client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this Certificate. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek.
Issued by Intertek Testing & Certification Ltd., Academy Place, 1-9 Brook Street, Brentwood CM14 5NQ, United Kingdom
a UKAS accredited certification body No. 0010

Verification of a transformer (continued)

Sound power level for the transformer @ 2.0 m under no-load current and rated voltage, ONAF	IEC 60076-10 Clause 12	88 dB(A), Guaranteed 90 dB(A)

This Certificate is for the exclusive use of Intertek's client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this Certificate. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek.
Issued by Intertek Testing & Certification Ltd., Academy Place, 1-9 Brook Street, Brentwood CM14 5NQ, United Kingdom
a UKAS accredited certification body No. 0010

Project No: G105348906 **Certificate No:** ASTA-TYPE-0002377

Certificate Contents:

The following documents are attached to and form part of this certificate:

Documents:	**Number of pages**
Test report no. B230035 dated 23 March 2023	109
Drawings	11

Certificate Revision Amendment Table

Certificate Number	**Issue Date**	**Amendment**
ASTA-TYPE-0002377	See page 1	Initial Issue

This Certificate is for the exclusive use of Intertek's client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this Certificate. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek.
Issued by Intertek Testing & Certification Ltd., Academy Place, 1-9 Brook Street, Brentwood CM14 5NQ, United Kingdom
a UKAS accredited certification body No. 0010

APPARATUS TESTED:	A three-phase, 66/ 52.8 MVA, ONAF/ ONAN (100%/ 80%), (132±8×1.25%)/ 33/ 11 kV, 50 Hz, Category II, YNyn0+d, oil transformer. The high voltage winding has 17 taps and the principal tap is tap 9B. The transformer is fitted with a MR on-load tap changer.

STANDARD:

IEC 60076-1: 2011	Clauses 11.1.2.1 i), 11.1.2.2 a) to e), 11.1.3 d), 11.1.3 e), 11.1.4 e), 11.1.4 l), 11.2 to 11.10, 11.12 and 12
IEC 60076-2: 2011	Clauses 6 and 7
IEC 60076-3: 2013+A1: 2018	Clauses 9, 10, 11.2, 11.3, 12, 13.2, 13.3 and 13.4
IEC 60076-5: 2006	Clause 4.2
IEC 60076-10: 2016	Clauses 11 and 12

and the STL Guide to IEC 60076 Issue 8.0, 1st June 2022, where applicable.

MANUFACTURER:	Zhejiang Jiangshan Transformer Co., Ltd. No.84, Hushan Road, Jiangshan, Zhejiang Province, China
TESTING LABORATORY:	Shenyang Transformer Institute Co., Ltd. Transformer Laboratory, No. 18, Hushitai South Street, Shenbei New Area, Shenyang, Liaoning, China

APPROVED BY: Stephen Yu, ASTA Observer, Intertek China

Issue Date: 23 March 2023

CONTENTS

Photographs: The following photographs are included in this document.

Photograph no:	Description
P001	Measurement of winding resistance after the short-circuit withstand test
P002	Measurement of voltage ratio and check of phase displacement after the short-circuit withstand tests
P003	Measurement of short-circuit impedance and load loss for HV to LV after the short-circuit withstand tests
P004	Measurement of no-load loss and current after the short-circuit withstand tests
P005	Measurement of dissipation factor (tan δ) of the insulation system capacitances after the short-circuit withstand tests
P006	Temperature rise type test arrangement in ONAN condition
P007	Temperature rise type test arrangement in ONAF condition
P008	Chopped wave lightning impulse test for LV line terminal after the short-circuit withstand tests
P009	Full wave lightning impulse test for LV neutral terminal after the short-circuit withstand tests
P010	Chopped wave lightning impulse test for HV line terminal after the short-circuit withstand tests
P011	Full wave lightning impulse test for HV neutral terminal after the short-circuit withstand tests
P012	Line terminal AC withstand voltage test (LTAC) after the short-circuit withstand tests
P013	Applied voltage test for HV windings after the short-circuit withstand tests
P014	Induced voltage test with partial discharge measurement (IVPD) after the short-circuit withstand tests
P015	Short-circuit withstand tests arrangement for HV to LV view 1
P016	Short-circuit withstand tests arrangement for HV to LV view 2
P017	Transformer internal HV winding side view before the short-circuit withstand tests
P018	Transformer internal LV winding side view before the short-circuit withstand tests
P019	Transformer internal HV winding side view after the short-circuit withstand tests
P020	Transformer internal LV winding side view after the short-circuit withstand tests

CONTENTS (continued)

CONTENTS (continued)

Schedule of drawings: The following drawings were supplied by the client / manufacturer.

Drawing number	Issue Status		Description
	Revision	Date	
1.710.2930.02	-	2022/12/5	SFZ-66000/132 Power transformer with OLTC
1.710.2930.2MP	-	2022/12/5	SFZ-66000/132 Nameplate
5.700.2930.2	-	2022/12/5	SFZ-66000/132 Active part insulation
5.517.2930.11	-	2022/12/5	SFZ-66000/132 HV LEAD CABLE
5.517.2930.12	-	2022/12/5	SFZ-66000/132 LV LEAD CABLE
5.641.2930.2	-	2022/12/5	SFZ-66000/132 Core assembly
6.600.2930.10	-	2022/12/5	SFZ-66000/132 LV. Winding
6.600.2930.11	-	2022/12/5	SFZ-66000/132 HV coil
6.600.2930.11-1	-	2022/12/5	SFZ-66000/132 HV coil
6.600.2930.12	-	2022/12/5	SFZ-66000/132 W. winding
6.600.2930.13	-	2022/12/5	SFZ-66000/132 Voltage regulating Winding

All of the above drawings were supplied by the manufacturer and the manufacturer guaranteed that the apparatus submitted for tests was manufactured in accordance with the drawings. The ASTA Observer verified that the drawings adequately represented the apparatus tested. The manufacturer is responsible for the correctness of the drawings and the technical data presented.

APPARATUS TESTED

A three-phase, 66/ 52.8 MVA, ONAF/ ONAN (100%/ 80%), (132±8×1.25%)/ 33/ 11 kV, 50 Hz, Category II, YNyn0+d, oil transformer. The high voltage winding has 17 taps and the principal tap is tap 9B. The transformer is fitted with a MR on-load tap changer.

TRANSFORMER DETAILS

Manufacturer	: Zhejiang Jiangshan Transformer Co., Ltd.
Rating	: 66/ 52.8 MVA, ONAF/ ONAN
Rated voltage ratio	: 132/ 33/ 11 kV
Manufacturer's serial no.	: 2813612211001
Product type	: Three-phase power transformer
Tapping	: ± 8 steps of 1.25 %, (17 tap positions)
Connection symbol	: YNyn0+d
Rating plate impedance (75°C)	: 14.30 % for HV to LV on tap 9B
Cooling	: ONAF/ ONAN
Dielectric properties	: HV : U_m 145 / LI 650 / LIC 715 / AC 275 kV HVN : U_m 52 / LI 250 / AC 95 kV LV : U_m 36 / LI 170 / LIC 187/ AC 70 kV LVN : U_m 36 / LI 170/ AC 70 kV
Oil mass	: 19800 kg
Total mass	: 86500 kg
Date of manufacture	: February 2023
Windings	: Circular
Winding material	: Wire (Copper)
Insulation system	: Karamay I-30 °C

On-load tap changer

- Manufacturer	: MR
- Model number	: VVSIII400Y-76-10193W
- Serial number	: 2499425
- Rated motor voltage	: 415 V/ 50 Hz
- Rated control voltage	: 240 V/ 50 Hz

Fans:

- Manufacturer	: Zhejiang ERG Technology Joint Stock Cp., Ltd
- Model number	: DBF-7.3Q10
- Rated voltage	: 415 V/ 50 Hz
- Rated speed	: 580 rpm
- Phase	: 3
- Air volume	: 11800 m^3/h
- Total pressure	: 65 Pa

APPARATUS TESTED (continued)

TRANSFORMER DETAILS

The nominal tapping ratios are detailed below. Tap 9B is the principal tap.

Tap Number	Rated HV Voltage V	Rated HV Current A @ 66MVA	Rated LV Voltage V	Rated LV Current A @66MVA	Rated TV Voltage V	Rated TV Current A @22MVA
1	145200	262.4				
2	143550	265.5				
3	141900	268.5				
4	140250	271.7				
5	138600	274.9				
6	136950	278.2				
7	135300	281.6				
8	133650	285.1				
9B	132000	288.7	33000	1154.7	11000	1154.7
10	130350	292.3				
11	128700	296.1				
12	127050	299.9				
13	125400	303.9				
14	123750	307.9				
15	122100	312.1				
16	120450	316.4				
17	118800	320.8				

HV : High voltage winding
LV : Low voltage winding
TV : Tertiary voltage winding

The transformer was fitted with current transformers on the HV and LV windings. For detailed ratings refer to the tests of the ratio and polarity of the built-in current transformers.

The transformer was fitted with two accessible connections for the insulation separating the core and frame and / or frame and tank.

CLIENT

Zhejiang Jiangshan Transformer Co., Ltd.
No. 84, Hushan Road, Jiangshan, Zhejiang Province, China

DATE OF RECEIPT OF APPARATUS

17 February 2023

ORDER NUMBER

QNS230208003

MANUFACTURER

Zhejiang Jiangshan Transformer Co., Ltd.
No. 84, Hushan Road, Jiangshan, Zhejiang Province, China

WITNESSES OF THE TESTS:

Name	**Organisation**
Mr. Stephen Yu	– ASTA Observer, Intertek China
Mr. Xu Huajun	– Zhejiang Jiangshan Transformer Co., Ltd.

LABORATORY

The tests were carried out at:

Shenyang Transformer Institute Co., Ltd. Transformer Laboratory
No. 18, Hushitai South Street, Shenbei New Area, Shenyang, Liaoning, China

The laboratory accreditation details are:

This Laboratory is recognized by Intertek ASTA for Conformity Assessment to BS EN / ISO / IEC 17025:2017 and Regulations for ASTA Recognized Laboratories, Agreement No. 2019-RTL-L2-319

SCHEDULE OF TESTS

The transformer was tested in accordance with the following standards:

IEC 60076-1: 2011 Clauses 11.1.2.1 i), 11.1.2.2 a) to e), 11.1.3 d), 11.1.3 e), 11.1.4 e), 11.1.4 l), 11.2 to 11.10, 11.12 and 12
IEC 60076-2: 2011 Clauses 6 and 7
IEC 60076-3: 2013+A1: 2018 Clauses 9, 10, 11.2, 11.3, 12, 13.2, 13.3 and 13.4
IEC 60076-5: 2006 Clause 4.2
IEC 60076-10: 2016 Clauses 11 and 12
and the STL Guide to IEC 60076 Issue 8.0, 1st June 2022, where applicable.

Test	Standard	Clause No.	Page no.
Routine tests			
Measurement of winding resistance	IEC 60076-1	Clause 11.2	18 and 19
Measurement of voltage ratio and check of phase displacement	IEC 60076-1	Clause 11.3	20
Measurement of short-circuit impedance and load loss	IEC 60076-1	Clause 11.4	21 and 22
Measurement of no-load loss and current at rated voltage	IEC 60076-1	Clause 11.5	23
Tests on on-load tap changers	IEC 60076-1	Clause 11.7	26
Leak testing with pressure for liquid-immersed transformers (tightness test)	IEC 60076-1	Clause 11.8	26
Check of the ratio and polarity of built-in current transformers	IEC 60076-1	Clause 11.1.2.1 i)	27 and 28
Check of core and frame insulation for liquid immersed transformers with core or frame insulation	IEC 60076-1	Clause 11.12	29
Insulation of auxiliary wiring (AuxW)	IEC 60076-3	Clause 9	58
Line terminal AC withstand voltage test (LTAC)	IEC 60076-3	Clause 12	57
Applied voltage test (AV)	IEC 60076-3	Clause 10	58
Induced voltage withstand test (IVW)	IEC 60076-3	Clause 11.2	59
Induced voltage test with partial discharge measurement (IVPD)	IEC 60076-3	Clause 11.3	60
Determination of capacitances windings-to-earth and between windings	IEC 60076-1	Clause 11.1.2.2 a)	30
Measurement of d.c. insulation resistance between each winding to earth and between windings	IEC 60076-1	Clause 11.1.2.2 b)	29

SCHEDULE OF TESTS(continued)

Test	Standard	Clause No.	Page no.
Routine tests (continued)			
Measurement of dissipation factor (tan δ) of the insulation system capacitances	IEC 60076-1	Clause 11.1.2.2 c)	31
Measurement of dissolved gasses in dielectric liquid	IEC 60076-1	Clause 11.1.2.2 d)	32
Measurement of no-load loss and current at 90 % and 110 % of rated voltage	IEC 60076-1	Clause 11.1.2.2 e)	24 and 25
Type tests			
Temperature rise type test	IEC 60076-2	Clauses 6 and 7	34 to 39
Determination of sound level	IEC 60076-10	Clauses 11 and 12	40 to 48
Measurement of the power taken by the fan and liquid pump motors	IEC 60076-1	Clause 11.1.3 d)	33
Measurement of no-load loss and current at 90 % and 110 % of rated voltage	IEC 60076-1	Clause 11.1.3 e)	24 and 25
Full wave lightning impulse test (LI)	IEC 60076-3	Clause 13.2	Refer to special test
Special tests			
Short-circuit withstand test	IEC 60076-5	Clause 4.2	49 to 52 and 61
Chopped wave lightning impulse test (LIC)	IEC 60076-3	Clause 13.3	53 and 55
Lightning impulse test on a neutral terminal (LIN)	IEC 60076-3	Clause 13.4	54 and 56
Determination of transient voltage transfer characteristics	IEC 60076-1	Clause 11.1.4 e)	62
Measurement of zero-sequence impedance(s) on three-phase transformers	IEC 60076-1	Clause 11.6	63
Vacuum deflection test for liquid immersed transformers	IEC 60076-1	Clause 11.9	64
Pressure deflection test for liquid immersed transformers	IEC 60076-1	Clause 11.10	65
Measurement of frequency response (Frequency Response Analysis or FRA)	IEC 60076-1	Clause 11.1.4 l)	66
Electromagnetic compatibility (EMC) – RIV	IEC 60076-1	Clause 12	67
Measurement of the no-load voltage and current characteristics	-	-	68

SCHEDULE OF TESTS(continued)

Test	Standard	Clause No.	Page no.
Special tests (continued)			
Measurement of the harmonics of the no-load current at 100 % rated voltage	-	-	69
Transition resistance measurement on on-load tap-changers	-	-	70
Measurement of the long-time no-load voltage test			70
Determination of capacitances and dissipation factor (tan δ) of the bushings	-	-	71

GENERAL TEST CONDITIONS

General

1. All tests were performed on transformer Serial no. 2813612211001.
   See Schedule of Tests, Pages 8 and 9.

Routine tests and general special tests

2. For all routine tests except the dielectric tests the transformer was supplied from a sinusoidal three-phase 50 Hz supply.
   For the applied voltage test, the transformer was supplied from a sinusoidal 50 Hz single-phase supply before and after the short-circuit withstand tests.
   For induced voltage withstand test (IVW) and induced voltage test with partial discharge measurement (IVPD), the transformer was supplied from a sinusoidal 200 Hz supply before and after the short-circuit withstand tests.

3. The HV winding resistances were measured using a Jinyuan winding analyser d.c. bridge model JYR (40E) at 10 A before and after the short-circuit withstand tests.

   The LV winding resistances were measured using a Jinyuan winding analyser d.c. bridge model JYR (40E) at 40 A before and after the short-circuit withstand tests.

4. The voltage ratio and check of phase displacement were measured using a Baoding Jinyuan Electrical turns ratio meter model JYT before and after the short-circuit withstand tests.

5. The d.c. insulation resistances of the transformer were measured before and after the short-circuit withstand tests at 5000 V d.c. for the HV and LV windings, using a METREL HV insulation tester, Model MI 2077.

6. The measurement of the dissipation factor (tan δ) of the insulation system capacitances and determination of capacitances windings-to-earth and between windings were measured using a Jinan fanhua automatic insulation diagnosis and analysing tester, model AI-6000K at 10 kV / 50 Hz before and after the short-circuit withstand tests.

7. For the load loss tests, the power, voltages and currents were measured using an Acculoss measurement system ALMS 4100 before and after the short-circuit withstand tests.

   For the load loss test the transformer's HV winding was energised with the LV winding short-circuited such that at least 50 % of rated current flowed in the HV winding.

   The short circuit impedance and the load loss were calculated for a reference temperature of 75^{o}C.

8. For the no-load loss tests, the power, voltages and currents were measured using an Acculoss measurement system ALMS 4100 before and after the short-circuit withstand tests.

   For the no-load loss test the transformer's LV winding was energised at rated voltage with the HV windings open circuit in accordance with clause 11.5 of IEC 60076-1.

9. The transformer oil temperatures were measured via PT resistance temperature detectors placed in the top oil pocket and outlet od the radiator before and after short-circuit withstand tests.

10. All PT resistance temperature detectors measurements were made using a Shengyi Data logger Model No. SWSN before and after short-circuit withstand tests.

GENERAL TEST CONDITIONS *(Continued)*

Routine tests *(Continued)*

11. In accordance with clause 7.2.3 of IEC 60076-3 and clause 4.2.7.4 of IEC 60076-5 the dielectric tests were performed in the following sequences before and after the short-circuit withstand tests:

Test Order	Before short circuit tests	After short circuit tests
1)	Applied voltage test (AV)	Chopped wave lightning impulse test for the line terminals (LIC) and lightning impulse test for the neutral terminals (LIN)
2)	Line terminal AC withstand test (LTAC)	Line terminal AC withstand test (LTAC)
3)	Induced voltage withstand test (IVW)	Applied voltage test (AV)
4)	Induced voltage test with partial discharge measurement (IVPD)	Induced voltage withstand test (IVW)
5)	-	Induced voltage test with partial discharge measurement (IVPD)

Temperature rise type test

12. The temperature rise test was performed on tap 17 applying the total losses of tap 17 and the tapping current of tap 17.

13. The temperature rise test was performed after the short-circuit withstand tests.

14. The load loss, no-load loss and d.c. resistance measurements were used to calculate the total power required for the temperature rise test. The temperature rise results were calculated at the 75^{o}C reference temperature.

15. The transformer was tested in accordance with clause 7.3 of IEC 60076-2 using the short-circuit method.

    The test was performed in ONAF followed by ONAN condition:

    The test was performed in two parts as follows:

    a) Total loss injection-
    The transformer HV winding was subjected to a test voltage sufficient to supply total losses with the LV windings short-circuited together. The test power was maintained until the increase in top oil temperature was below 1 K per hour for a period of 3 hours.
    The corrections of clause 7.13 of IEC 60076-2 were used in determining the top oil and average oil temperature rises

    b) Rated current injection for the HV and LV windings-
    At the completion of part a), the test current was reduced to rated current for 1 hour followed by rapid disconnection of the test supply and the d.c. resistance of the windings were measured to determine their maximum temperatures using the change of resistance method for HV and LV windings.
    The corrections of clause 7.13 of IEC 60076-2 were used in determining the top oil, average oil and winding temperature rises.

16. An Acculoss measurement system ALMS 4100 was used to measure the currents, voltages and power.

17. The HV (B-N) and LV (b-n) winding resistances were measured using a d.c. resistance bridge before and during the hot resistance shutdown.

GENERAL TEST CONDITIONS *(Continued)*

Temperature rise *(Continued)*

18. Two PT resistance temperature detectors were placed in the top oil pockets of the transformer.

19. The top and bottom radiators outlets temperatures were measured with PT resistance temperature detectors 2 inlets and 4 outlet points of the radiator banks.

20. The ambient temperature was the average of 6 T type thermocouples placed in oil pots each with approximately a 2 hours' time constant.
    The oil pots were positioned round the transformer located at about half the transformer's height and about 2 m from the transformer in ONAN condition and at about 0.5 m from the intake of the coolers of the transformer in ONAF condition.

21. All temperature measurements were made using an Acculoss measurement system ALMS 4100.

22. The top oil temperature (θ_o) was determined from the average of the top oil pocket temperatures as per clause 7.4.1.

23. The bottom oil temperature (θ_b) was determined from the average of the bottom oil outlet temperatures of the radiator banks as per clause 7.4.2.

24. The average oil temperature was determined using clause 7.4.2.: $\theta_{om} = (\theta_o + \theta_b)/2$.

25. There was a total of 8 sets of fans, and during the test the fans were energized at rated voltage in ONAF condition and turned off in ONAN condition

Determination of sound level

26. The sound pressure level was measured in accordance with clause 11 of IEC 60076-10.

27. The determination of sound power level was sound pressure method, the sound level tests were performed by point-by-point procedure with the transformer at normal ambient condition, and the sound pressure measurement was executed with the total sound level as specified by the client.

28. The sound pressure level tests were performed with the transformer in a room dimensioned 60.2 m wide 42.4 m deep by 38 m high, rectangular shaped industrial room. The transformer was positioned in the test room as shown in Figure 2.

29. Measurements were made using a Type 1 calibrated sound level meter complying with IEC 61672-1 and IEC 61672-2 and calibrated in accordance with clause 5.2 of ISO 3746 as follows:

    Sound level meter Hangzhou Aihua Type AWA6228, Serial no. 00322954 and associated Calibrator model type AWA6021A, Serial no. 1012336 were used for the tests.

    The sound level calibrator meter was used before and after the test.

30. The sound level meter was hand-held for all sound level measurements. The operator stood to the side of the meter for each measurement.

31. Before and after the sound pressure level tests, the A-weighted sound level pressure level of the background noise was measured at 10 measuring positions around the prescribed contour at one third and two thirds height of the transformer's principal radiating surface.

GENERAL TEST CONDITIONS *(Continued)*

Determination of sound level *(continued)*

32. The transformer sound pressure level was measured under no-load conditions with the LV winding supplied at rated volts from a sinusoidal 50 Hz three-phase supply with the HV windings open circuit in accordance with clause 4.2 of IEC 60076-10.

33. The sound pressure level was measured around the prescribed contour at a distance of 1.0 m and 0.3 m in ONAN condition and 2.0 m in ONAF condition from the transformer's principal radiating surface at one third and two thirds height of the transformer's principal radiating surface.

34. The average sound pressure level and power level were calculated from the measured sound pressure levels in accordance with clauses 11 and 12 of IEC 60076-10.

35. There was a total of 8 sets of fans, and during the test the fans were energized at rated voltage in ONAF condition and turned off in ONAN condition

Chopped wave lightning impulse test for the line terminals and lightning impulse test for the neutral terminals (LIC and LIN)

36. The chopped wave lightning impulse test for the line terminals was conducted on the HV line terminals on taps 1, 9B and 17 and the LV line terminal of the transformer in accordance with clause 13.3 of IEC 60076-3.

37. The full wave lightning impulse test for the neutral terminal was conducted on the HV neutral terminal by direct application of the lightning impulse in accordance with clause 13.4 of IEC 60076-3.

38. The HV line terminals of the transformer were tested at LI 650 / LIC 715 kV.
The LV line terminals of the transformer were tested at LI 170 / LIC 187 kV.
The HV neutral terminal of the transformer was tested at LI 250 kV.
The LV neutral terminal of the transformer was tested at LI 170 kV.

39. For all tests the transformer frame and core were solidly earthed.

40. A full sequence of tests in accordance with clause 13.3 of IEC 60076-3 for the chopped wave lightning impulse and clause 13.4 for the lightning impulse test on a neutral terminal in accordance with IEC 60076-3 was conducted on the transformer under test.

41. The chopped wave lightning impulse tests for the line terminals were applied to one HV line terminal at a time with the HV neutral terminal connected to earth via a current shunt, and with the other winding terminals connected together and to earth.

42. The chopped wave lightning impulse tests for the line terminals were applied to one LV line terminal at a time with the LV neutral terminal connected to earth via a current shunt, and with the other winding terminals connected together and to earth.

43. The lightning impulse tests for the neutral terminals were applied to the HV neutral terminal with the HV line terminals connected together to earth via a current shunt, and with the other winding terminals connected together and to earth.

44. The lightning impulse tests for the neutral terminals were applied to the LV neutral terminal with the LV line terminals connected together to earth via a current shunt, and with the other winding terminals connected together and to earth.

45. Fault detection was by comparison of the oscillographic voltage and current traces between the reference reduced level test and the full level tests.

GENERAL TEST CONDITIONS *(Continued)*

Induced voltage withstand test (IVW)

46. The induced voltage withstand test (IVW) was performed in accordance with clause 11.2 of IEC 60076-3 before and after the short-circuit withstand tests.

47. The low voltage windings of the transformer were energised from a three-phase 200 Hz supply. The HV and LV neutral terminal was earthed directly.

Induced voltage test with partial discharge measurement (IVPD)

48. The induced voltage test with partial discharge measurement (IVPD) was performed in accordance with clause 11.3 of IEC 60076-3 before and after the short-circuit withstand tests at the client's request as special tests.

49. The low voltage windings of the transformer were energised from a three-phase 200 Hz supply. The HV and LV neutral terminal was earthed directly. The test voltage sequence was applied in accordance with Figure 1 of IEC 60076-3.

50. The tests were monitored using the HV bushing test taps by a Baoding Tianwei multi-channel partial discharge analysing tester, model no. TWPD-2B before and after the short-circuit withstand tests.

Short-circuit withstand tests

51. Interpretation of IEC 60076-5 was taken from the STL Guide to IEC 60076 issue 8.0, 1st June 2022.

52. An Acculoss measurement system ALMS 4100 was used in a three-phase circuit before the short-circuit withstand tests to determine short-circuit impedance and X/R ratio. These values were used in the calculation of short-circuit currents.

53. In accordance with clause 4.1.2 of IEC 60076-5 the short-circuit impedance of the transformer was calculated at the reference temperature of 75°C.

54. The theoretical short-circuit currents were calculated based on the impedance of the transformer and the system impedance, which was calculated for a short-circuit apparent power of 10000 MVA at U_{sys} 132 kV (U_{sys} .132 kV was declared by the client, 10000 MVA refer to Table 2 of IEC 60076-5).

55. For the short-circuit tests, single-phase tests were performed. The transformer's HV winding was energized from a two-phase 50 Hz test supply. The pre-short-circuit method was used with the LV windings short-circuited together. Nine consecutive short-circuit tests of nominal 0.25 s duration were performed in accordance with clause 4.2.5 of IEC 60076-5. See Figure 1 for the test circuit arrangement.

    *Remark: The short-circuit withstand tests were performed single-phase due to the limitations of the laboratory test equipment.

56. The reactance of the transformer was measured using a precision LCR analyser model AI6600B before the start of test and after each short-circuit withstand test.

57. For the short-circuit withstand tests, an earth fault detection device consisting of a current shunt between the tank of the transformer and the test station earth was used. The earth current was also monitored oscillographically.

GENERAL TEST CONDITIONS *(Continued)*

Inspection

58. The transformer was detanked and the windings and core inspected after the repeat routine tests and the lightning impulse test.

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of winding resistance

HV winding	Phase	Before short-circuit tests	After short-circuit tests
Tap 1	A-N	0.4757 Ω	0.4694 Ω
	B-N	0.4818 Ω	0.4752 Ω
	C-N	0.4792 Ω	0.4728 Ω
	Average	0.4789 Ω	0.4725 Ω
Tap 2	A-N	0.4689 Ω	0.4627 Ω
	B-N	0.4750 Ω	0.4685 Ω
	C-N	0.4724 Ω	0.4661 Ω
	Average	0.4721 Ω	0.4658 Ω
Tap 3	A-N	0.4621 Ω	0.4560 Ω
	B-N	0.4682 Ω	0.4618 Ω
	C-N	0.4656 Ω	0.4594 Ω
	Average	0.4653 Ω	0.4591 Ω
Tap 4	A-N	0.4553 Ω	0.4493 Ω
	B-N	0.4613 Ω	0.4551 Ω
	C-N	0.4587 Ω	0.4527 Ω
	Average	0.4584 Ω	0.4524 Ω
Tap 5	A-N	0.4486 Ω	0.4426 Ω
	B-N	0.4546 Ω	0.4484 Ω
	C-N	0.4519 Ω	0.4459 Ω
	Average	0.4518 Ω	0.4456 Ω
Tap 6	A-N	0.4418 Ω	0.4359 Ω
	B-N	0.4477 Ω	0.4416 Ω
	C-N	0.4451 Ω	0.4392 Ω
	Average	0.4449 Ω	0.4389 Ω
Tap 7	A-N	0.4350 Ω	0.4292 Ω
	B-N	0.4409 Ω	0.4349 Ω
	C-N	0.4383 Ω	0.4324 Ω
	Average	0.4381 Ω	0.4322 Ω
Tap 8	A-N	0.4283 Ω	0.4225 Ω
	B-N	0.4341 Ω	0.4282 Ω
	C-N	0.4315 Ω	0.4257 Ω
	Average	0.4313 Ω	0.4255 Ω
Tap 9B	A-N	0.4204 Ω	0.4147 Ω
	B-N	0.4261 Ω	0.4203 Ω
	C-N	0.4226 Ω	0.4168 Ω
	Average	0.4230 Ω	0.4172 Ω
Tap 10	A-N	0.4279 Ω	0.4221 Ω
	B-N	0.4343 Ω	0.4284 Ω
	C-N	0.4317 Ω	0.4259 Ω
	Average	0.4313 Ω	0.4255 Ω

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of winding resistance (continued)

HV winding	Phase	Before short-circuit tests	After short-circuit tests
Tap 11	A-N	0.4204 Ω	0.4288 Ω
	B-N	0.4261 Ω	0.4351 Ω
	C-N	0.4226 Ω	0.4326 Ω
	Average	0.4230 Ω	0.4322 Ω
Tap 12	A-N	0.4415 Ω	0.4355 Ω
	B-N	0.4478 Ω	0.4418 Ω
	C-N	0.4453 Ω	0.4394 Ω
	Average	0.4449 Ω	0.4389 Ω
Tap 13	A-N	0.4484 Ω	0.4422 Ω
	B-N	0.4546 Ω	0.4484 Ω
	C-N	0.4521 Ω	0.4460 Ω
	Average	0.4517 Ω	0.4455 Ω
Tap 14	A-N	0.4552 Ω	0.4489 Ω
	B-N	0.4614 Ω	0.4552 Ω
	C-N	0.4589 Ω	0.4527 Ω
	Average	0.4585 Ω	0.4532 Ω
Tap 15	A-N	0.4620 Ω	0.4558 Ω
	B-N	0.4681 Ω	0.4618 Ω
	C-N	0.4656 Ω	0.4594 Ω
	Average	0.4652 Ω	0.4590 Ω
Tap 16	A-N	0.4689 Ω	0.4625 Ω
	B-N	0.4749 Ω	0.4685 Ω
	C-N	0.4725 Ω	0.4661 Ω
	Average	0.4721Ω	0.4657 Ω
Tap 17	A-N	0.4759 Ω	0.4693 Ω
	B-N	0.4817 Ω	0.4753 Ω
	C-N	0.4793 Ω	0.4729 Ω
	Average	0.4790 Ω	0.4725 Ω

LV winding	Phase	Before short-circuit tests	After short-circuit tests
	a-n	0.02041 Ω	0.02015 Ω
	b-n	0.02042 Ω	0.02017 Ω
	c-n	0.02045 Ω	0.02019 Ω
	Average	0.02043 Ω	0.02017 Ω
Temperature- Average oil		16.5 °C	13.8 °C
Date of Tests:		23 February 2023	26 February 2023

Photograph no.: P001

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of HV to LV voltage ratio and check of phase displacement

Tap No.	Rated Primary Voltage	Nominal Ratio*	Difference from nominal ratio before short-circuit tests (%)			Difference from nominal ratio after short-circuit tests (%)		
			AB-ab	BC-bc	CA-ca	AB-ab	BC-bc	CA-ca
1	145200	4.4000	0.23	0.25	0.25	0.24	0.25	0.26
2	143550	4.3500	0.21	0.23	0.23	0.20	0.23	0.24
3	141900	4.3000	0.19	0.21	0.23	0.21	0.22	0.24
4	140250	4.2500	0.16	0.19	0.21	0.18	0.20	0.22
5	138600	4.2000	0.14	0.17	0.19	0.15	0.18	0.19
6	136950	4.1500	0.14	0.14	0.17	0.15	0.16	0.18
7	135300	4.1000	0.12	0.15	0.17	0.14	0.16	0.18
8	133650	4.0500	0.10	0.12	0.15	0.08	0.10	0.13
9B	132000	4.0000	0.07	0.10	0.13	0.08	0.09	0.14
10	130350	3.9500	0.08	0.08	0.13	0.08	0.09	0.13
11	128700	3.9000	0.05	0.08	0.10	0.06	0.09	0.11
12	127050	3.8500	0.03	0.05	0.08	0.04	0.05	.09
13	125400	3.8000	0.03	0.03	0.08	0.03	0.03	0.09
14	123750	3.7500	0.00	0.00	0.05	0.01	0.00	0.06
15	122100	3.7000	-0.03	0.00	0.05	-0.03	0.01	0.04
16	120450	3.6500	-0.03	-0.03	0.03	-0.02	-0.02	0.04
17	118800	3.6000	-0.06	-0.06	0.00	-0.05	-0.05	0.01
Date of Tests:			22 February 2023			26 February 2023		

*The rated voltage of the LV winding was 33000 V
The HV-LV of the transformer connection symbol was verified to be connected as YNyn0.

Photograph no.: P002

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of short-circuit impedance and load loss Tap 1, HV to LV windings

Tap 1	Before short-circuit tests	After short-circuit tests
Average line voltage	11069 V	11604 V
Average line current	134.83 A	141.23 A
Total power	60304 W	65390 W
Average oil temperature	14.8 °C	13.8 °C
Reference temperature	75 °C	75 °C
Load loss at reference temperature @ 66 MVA	262176 W	260266 W
Impedance at reference temperature @ 66 MVA	47.40 Ω	47.44 Ω
Percent impedance at reference temperature @ 66 MVA	14.84 %	14.85 %
X/R ratio at reference temperature	37.34	37.65
Date of Tests:	24 February 2023	28 February 2023

Measurement of short-circuit impedance and load loss Tap 9B, HV to LV windings

Tap 9B	Before short-circuit tests	After short-circuit tests
Average line voltage	9993 V	10722 V
Average line current	152.80 A	163.57 A
Total power	63711 W	72680 W
Average oil temperature	14.8 °C	13.8 °C
Reference temperature	75 °C	75 °C
Load loss at reference temperature @ 66 MVA	264270 W	263711 W
Impedance at reference temperature @ 66 MVA	37.76 Ω	37.85 Ω
Percent impedance at reference temperature @ 66 MVA	14.30 %	14.34 %
X/R ratio at reference temperature	35.71	35.87
Date of Tests:	24 February 2023	28 February 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of short-circuit impedance and load loss Tap 17, HV to LV windings

Tap 17	Before short-circuit tests	After short-circuit tests
Average line voltage	38961 V	9045 V
Average line current	165.93 A	167.28 A
Total power	72815 W	73500 W
Average oil temperature	14.8 °C	13.8 °C
Reference temperature	75 °C	75 °C
Load loss at reference temperature @ 66 MVA	318464 W	317317 W
Impedance at reference temperature @ 66 MVA	31.18 Ω	31.22 Ω
Percent impedance at reference Temperature @ 66 MVA	14.58 %	14.60 %
X/R ratio at reference temperature	30.20	30.35
Date of Tests:	24 February 2023	28 February 2023

Photograph no.: P003

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of no-load loss and current at 100 % rated voltage

		Before short-circuit tests		After short-circuit tests	
		U' mean scaled rms	U rms	U' mean scaled rms	U rms
Line voltage	a-b	19217 V	19261 V	19232 V	19251 V
	b-c	19004 V	19042 V	18958 V	19004 V
	c-a	18977 V	18960 V	18962 V	18964 V
	Average	19066 V	19088 V	19051 V	19073 V
Line current	a	1.46 A		1.44 A	
	b	1.07 A		1.03 A	
	c	1.52 A		1.50 A	
	Average	1.35 A = 0.12 % of rated I_r @ 66 MVA		1.32 A = 0.11 % of rated I_r @ 66 MVA	
Total power	P_m	36727 W		37195 W	
Total power	P_o	36685 W		37152 W	
Ambient conditions					
Ambient air temperature		14.4 °C		13.0 °C	
Oil average temperature		14.8 °C		13.8 °C	
Relative humidity		32 %		44 %	
Date of Tests:		24 February 2023		28 February 2023	

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of no-load loss and current at 90 % rated voltage

		Before short-circuit tests		After short-circuit tests	
		U' mean scaled rms	U rms	U' mean scaled rms	U rms
Line voltage	a-b	17289 V	17317 V	17330 V	17311 V
	b-c	17067 V	17103 V	17072 V	17114 V
	c-a	17105 V	17053 V	17070 V	17056 V
	Average	17154 V	17158 V	17157 V	17160 V
Line current	a	0.80 A		0.77 A	
	b	0.56 A		0.49 A	
	c	0.84 A		0.89 A	
	Average	0.73 A = 0.06 % of rated I_r @ 66 MVA		0.72 A = 0.06 % of rated I_r @ 66 MVA	
Total power	P_m	26490 W		26680 W	
Total power	P_o	26484 W		26675 W	
Ambient conditions					
Ambient air temperature		14.4 °C		13.0 °C	
Oil average temperature		14.8 °C		13.8 °C	
Relative humidity		32 %		44 %	
Date of Tests:		24 February 2023		28 February 2023	

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of no-load loss and current at 110 % rated voltage

		Before short-circuit tests		After short-circuit tests	
		U' mean scaled rms	U rms	U' mean scaled rms	U rms
Line voltage	a-b	21103 V	21009 V	21182 V	20980 V
	b-c	20973 V	20843 V	20919 V	20814 V
	c-a	20795 V	20651 V	20776 V	20622 V
	Average	20957 V	20834 V	20959 V	20805 V
Line current	a	4.96 A		4.93 A	
	b	4.07 A		4.04 A	
	c	5.05 A		5.03 A	
	Average	4.69 A = 0.41 % of rated I_r @ 66 MVA		4.67 A = 0.41 % of rated I_r @ 66 MVA	
Total power	P_m	53730 W		54250 W	
Total power	P_o	54045 W		54649 W	
Ambient conditions					
Ambient air temperature		14.4 °C		13.0 °C	
Oil average temperature		14.8 °C		13.8 °C	
Relative humidity		32 %		44 %	
Date of Tests:		24 February 2023		28 February 2023	

Photograph no.: P004

TEST RESULTS

Transformer Serial no. 2813612211001

Tests on on-load tap changers

The transformer was fitted with a MR 17 step type VVSIII400Y-76-10193W.

The control voltage of the tap-changer was 240 V/ 50 Hz.

The motor voltage of the tap-changer was 415 V/ 50 Hz.

The tap-changer was subjected to the following four sequences before and after the short-circuit withstand tests at 50 Hz.

The results are:

Sequence	Description	Result
a)	With the transformer de-energized, 8 complete cycles of operation were performed with the control circuit and motor energized at rated voltage	Passed
b)	With the transformer de-energized, 1 complete cycle of operation was performed with the control circuit and motor energized at 85% of rated voltage	Passed
c)	With the transformer energized at rated voltage, 1 complete cycle of operation was performed with the control circuit and motor energized at of rated voltage	Passed
d)	With the LV winding short-circuited and the HV winding energized with rated current flowing through the tapped winding, 10 cycles of tap changer operation were completed from tap 7 to 11. Tap 9B is the principal tap.	Passed

Date of Tests: 24 February and 28 February 2023

Leak testing with pressure for liquid immersed transformers (tightness test)

A pressure of 30 kPa over the normal liquid pressure was applied from the top oil tank with the transformer equipped with all bushings and radiator banks maintained for a period of 24 hours. After the test, there was no evidence of oil leakage.

Date of Tests: 02 to 03 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Check of the ratio and polarity of built-in current transformers

The transformer was fitted with the following built-in current transformers. The ratio and polarity were measured before and after the short-circuit withstand tests and the results are shown below:

Phase	Code	Terminal connection	Current ratio	Accuracy class	Burden VA	Ratio		Polarity
						Before short-circuit	After short-circuit	Before /after short-circuit
A	LRB-132	1S1-1S2	400/1	5P20	20	400/0.988	400/0.990	Verified
		2S1-2S2	400/1	5P20	20	400/0.989	400/0.986	Verified
		3S1-3S2	400/1	5P20	20	400/0.986	400/0.992	Verified
		4S1-4S2	400/1	0.2	10	400/0.989	400/0.985	Verified
B	LRB-132	1S1-1S2	400/1	5P20	20	400/1.012	400/1.005	Verified
		2S1-2S2	400/1	5P20	20	400/0.987	400/0.984	Verified
		3S1-3S2	400/1	5P20	20	400/1.008	400/1.002	Verified
		4S1-4S2	400/1	0.2	10	400/1.010	400/1.007	Verified
		5S1-5S2	400/2	0.2	10	400/2.009	400/2.013	Verified
C	LRB-132	1S1-1S2	400/1	5P20	20	400/0.986	400/0.991	Verified
		2S1-2S2	400/1	5P20	20	400/0.989	400/0.993	Verified
		3S1-3S2	400/1	5P20	20	400/1.002	400/1.006	Verified
		4S1-4S2	400/1	0.2	10	400/1.006	400/0.997	Verified
N	LRB-72.5	1S1-1S2	400/1	5P20	20	400/0.987	400/1.011	Verified
		2S1-2S2	400/1	5P20	20	400/0.989	400/0.984	Verified
a	LRB-33	1S1-1S2	1600/1	5P20	20	1600/1.004	1600/1.013	Verified
	LRB-33	2S1-2S2	1600/1	5P20	20	1600/1.008	1600/1.011	Verified
	LRB-33	3S1-3S2	1600/1	5P20	20	1600/1.005	1600/0.993	Verified
	LRB-33	4S1-4S2	1600/1	0.2	10	1600/1.007	1600/1.002	Verified
b	LRB-33	1S1-1S2	1600/1	5P20	20	1600/1.009	1600/1.008	Verified
	LRB-33	2S1-2S2	1600/1	5P20	20	1600/0.992	1600/0.989	Verified
	LRB-33	3S1-3S2	1600/1	5P20	20	1600/0.991	1600/0.988	Verified
	LRB-33	4S1-4S2	1600/1	0.2	10	1600/1.010	1600/0.997	Verified

TEST RESULTS

Transformer Serial no. 2813612211001

Check of the ratio and polarity of built-in current transformers (continued)

The transformer was fitted with the following built-in current transformers. The ratio and polarity were measured before and after the short-circuit withstand tests and the results are shown below:

Phase	Code	Terminal connection	Current ratio	Accuracy class	Burden VA	Ratio		Polarity
						Before short-circuit	After short-circuit	Before /after short-circuit
c	LRB-33	1S1-1S2	1600/1	5P20	20	1600/0.988	1600/0.984	Verified
	LRB-33	2S1-2S2	1600/1	5P20	20	1600/0.990	1600/0.986	Verified
	LRB-33	3S1-3S2	1600/1	5P20	20	1600/0.986	1600/1.006	Verified
	LRB-33	4S1-4S2	1600/1	0.2	10	1600/1.011	1600/1.015	Verified

Date of Tests: 22 and 27 February 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of d.c. insulation resistance between each winding to earth and between windings and check of core and frame insulation for liquid immersed transformers with core or frame insulation

The d.c. insulation resistances of the transformer were measured before and after the short-circuit withstand tests at 5000 V d.c.
The check of core and frame insulation for liquid immersed transformers with core or frame insulation were measured before and after the short-circuit withstand tests at 2500 V d.c.

The results were:

Condition		**Before short-circuit tests**			**After short-circuit tests**		
		15 s	60 s	600 s	15 s	60 s	600 s
HV to LV, TV and Earth	MΩ	23300	28300	54800	30400	36800	75600
LV to HV, TV and Earth	MΩ	20100	26100	62400	33400	41100	96900
TV to HV, LV and Earth	MΩ	68800	71600	110000	87500	93800	131000
HV, LV to TV and Earth	MΩ	19900	24300	44300	30700	40400	69500
HV, LV and TV to Earth	MΩ	27900	38100	55000	36100	46400	74600
HV to LV	MΩ	-	42500	-	-	66000	-
LV to TV	MΩ	-	102000	-	-	157000	-
HV to TV	MΩ	-	79100	-	-	109000	-
Frame to Core and Earth	MΩ	-	16200	-	-	22300	-
Core to Frame and Earth	MΩ	-	14800	-	-	22000	-
Core to Frame	MΩ	-	18600	-	-	29000	-
Environment conditions							
Ambient air temperature		18.0 °C			13.5 °C		
Average oil temperature		18.3 °C			13.8 °C		
Relative humidity		43 %			43 %		
Atmospheric pressure		1011 hPa			1012 hPa		
Date of Tests:		22 February 2023			27 February 2023		

HV : High voltage winding
LV : Low voltage winding
TV : Tertiary voltage winding

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of capacitances windings-to-earth and between windings

The insulation system capacitances were measured at 10 kV 50 Hz before and after the short-circuit withstand tests. These measurements were made during the dielectric dissipation factor test.

Condition	**Before short-circuit tests**	**After short-circuit tests**
	pF	pF
HV to LV, TV and Earth	12480	12440
LV to HV, TV and Earth	12440	12470
TV to HV, LV and Earth	4823	4814
HV, LV to TV and Earth	15100	15140
HV, LV and TV to Earth	11460	11500
HV to LV	4908	4885
HV to TV	4187	4150
Environment conditions		
Ambient air temperature	18.2 °C	13.5 °C
Average oil temperature	18.0 °C	13.8 °C
Relative humidity	35 %	31 %
Atmospheric pressure	1001 hPa	1012 hPa
Date of Tests:	22 February 2023	27 February 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of dissipation factor (tan δ) of the insulation system capacitances

The dielectric dissipation factor of the transformer was measured before and after the short-circuit withstand tests at 10 kV, 50 Hz.

Condition	**Before short-circuit tests**	**After short circuit tests**
	Tan δ (%)	Tan δ (%)
HV to LV, TV and Earth	0.277	0.291
LV to HV, TV and Earth	0.270	0.287
TV to HV, LV and Earth	0.247	0.265
HV, LV to TV and Earth	0.272	0.286
HV, LV and TV to Earth	0.263	0.270
HV to LV	0.268	0.286
HV to TV	0.276	0.299
Environment conditions		
Ambient air temperature	18.2 °C	13.5 °C
Average oil temperature	18.0 °C	13.8 °C
Relative humidity	35 %	31 %
Atmospheric pressure	1001 hPa	1012 hPa
Date of Tests:	22 February 2023	27 February 2023

Photograph no.: P005

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of dissolved gasses in dielectric liquid

During various stages of the testing process, oil samples were taken from the bottom of the main tank for electrical and chemical analysis. The results were:

Quantity	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7
Tan δ at 90 °C (%)	0.13	-	-	-	-	-	-
Electric strength (kV)	59.9	-	-	-	-	-	-
Water content (mg/L)	8.0	-	-	-	-	-	-
DGA (μL/L)							
Σ_{CH}	0.26	0.28	0.32	0.59	0.64	0.69	0.74
H_2	0.00	0.00	0.73	1.52	1.55	1.59	1.66
CO	1.95	2.26	2.39	3.92	4.24	5.61	6.14
CO_2	98.75	108.8	136.1	211.6	228.7	240.1	276.3
CH_4	0.26	0.28	0.32	0.46	0.52	0.56	0.60
C_2H_4	0	0	0	0.13	0.12	0.13	0.14
C_2H_6	0	0	0	0	0	0	0
C_2H_2	0	0	0	0	0	0	0
-	Before all the tests	Before short-circuit tests	After short-circuit tests	After dielectric tests	After ONAN temperature rise test	After ONAF temperature rise test	After long term no load loss test
Date of sample	21 Feb. 2023	24 Feb. 2023	25 Feb. 2023	01 Mar. 2023	02 Mar. 2023	03 Mar. 2023	04 Mar. 2023

TEST RESULTS

Transformer Serial No. 22X015

Measurement of the power taken by the fan and liquid pump motors

The ratings of the fans were 415 V, 50 Hz, 3 phases. There were a total 8 sets of fans. The power taken by the fans was measured as follows:

Product	Type	Series No.	Rated power	Measured		
				Average line Voltage	Average line Current	Power loss
			W	V	A	W
Fans	DBF-7.3Q10	2301-2207261204-03	420	418.2	1.33	532
		2301-2204270101-19		418.2	1.39	543
		2301-2207261204-02		418.3	1.29	506
		2301-2207261204-05		418.2	1.31	530
		2301-2207261204-01		418.3	1.28	516
		2301-2207261204-06		418.2	1.29	506
		2301-2207261204-04		418.3	1.30	531
		2301-2204270101-20		418.1	1.35	545

Date of Tests: 15 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Temperature rise type test

***Total rated losses of the transformer for temperature-rise test at reference temperature* 75°C in ONAN condition**

Supply to the HV winding and short-circuit of the LV winding.

The total losses were equal to the sum of the load loss at reference temperature on tap 17 plus the no-load loss at rated voltage in ONAN condition.

Test	*Measured value*
Load loss @ 75°C	203093 W
No-load loss	37152 W
Total loss @ 75°C	240235 W
Tapped current on Tap 17	256.6 A

a) Top oil temperature-rise

Average injected power during last hour of the test = 240517 W
Total rated losses = 240235 W

Average ambient temperature during last hour of total rated losses = 14.6 °C
Top oil temperature during last hour of total rated losses, θ_o = 59.9 °C
Top oil temperature rise during last hour of total rated losses = 45.3 K

Average bottom oil temperature during last hour of total rated losses, θ_b = 31.0 °C
Average oil temperature during last hour of total rated losses, θ_{om} = 45.4 °C
Average oil temperature rise during last hour of total rated losses = 30.8 K

Corrected top oil temperature rise
$\Delta\theta_o = 45.3 \times (240235 / 240517)^{0.9} = 45.2$ K

Corrected average oil temperature rise
$\Delta\theta_{om} = 30.8 \times (240235 / 240517)^{0.9} = 30.8$ K

Top oil temperature rise: 45.2 K

Guaranteed limit: 60 K

TEST RESULTS

Transformer Serial no. 2813612211001

Temperature rise type test (Continued)

External hot spot analysis

At the end of the injection of total losses an infrared scan was made on the transformer using a FLIR T840.

Hot spot location was on LV b phase turret.

Measured temperature:	64.0 °C
External ambient:	14.6 °C
Hot spot rise:	49.4 K

Photograph no.: P021

b) Winding temperature rise for the HV and LV windings

Average HV current during last hour of the test	= 256.6 A
Rated HV current	= 256.6 A

Temperatures extrapolated back to time of switch off,

HV winding temperature	= 66.9 °C
LV winding temperature	= 75.1 °C

Average oil temperature at switch off = 44.5 °C

Winding temperature rises above average oil temperature at switch off
HV winding = 66.9 – 44.5 = 22.4 K
LV winding = 75.1 – 44.5 = 30.5 K

Corrected winding temperature rise above average oil temperature:
$\Delta\theta_W$ HV = 22.4 x (256.6/ 256.6)$^{1.6}$ = 22.4 K
$\Delta\theta_W$ LV = 30.5 x (256.6/ 256.6)$^{1.6}$ = 30.5 K

Corrected average oil temperature rise during last hour of the test to Part a) = 30.8 K

HV winding temperature rise = 22.4 + 30.8 = 53.2 K
LV winding temperature rise = 30.5 + 30.8 = 61.3 K

Guaranteed limit: 65 K

TEST RESULTS

Transformer Serial no. 2813612211001

Temperature rise type test (Continued)

Summary of temperature rise test:

Top oil Temperature rise:	45.2 K	Limit 60 K
HV winding Temperature rise:	53.2 K	Limit 65 K
LV winding Temperature rise:	61.3 K	Limit 65 K

Result: The transformer satisfied the requirements of the standard in ONAN condition.

Photograph no.: P006

Date of Tests: 01 to 02 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Temperature rise type test

***Total rated losses of the transformer for temperature rise test at reference temperature* 75°C in ONAF condition**

Supply to the HV winding and short-circuit of the LV winding.

The total losses were equal to the sum of the load loss at reference temperature on tap 17 plus the no load loss at rated voltage in ONAF condition.

Test	*Measured value*
Load loss @ 75°C	317317 W
No load loss	37152 W
Total loss @ 75°C	354469 W
Tapped current on Tap 17	320.8 A

a) Top oil temperature-rise

Average injected power during last hour of the test = 350000 W
Total rated losses = 354469 W

Average ambient temperature during last hour of total rated losses = 16.9 °C
Top oil temperature during last hour of total rated losses, θ_o = 59.1 °C
Top oil temperature rise during last hour of total rated losses = 42.2 K

Average bottom oil temperature during last hour of total rated losses, θ_b = 28.2 °C
Average oil temperature during last hour of total rated losses, θ_{om} = 43.6 °C
Average oil temperature rise during last hour of total rated losses = 26.7 K

Corrected top oil temperature rise
$\Delta\theta_o = 42.2 \times (354469 / 350000)^{0.9} = 42.6$ K

Corrected average oil temperature rise
$\Delta\theta_{om} = 26.7 \times (354469 / 350000)^{0.9} = 27.0$ K

Top oil temperature rise: 42.6 K

Guaranteed limit: 60 K

TEST RESULTS

Transformer Serial no. 2813612211001

Temperature rise type test (Continued)

External hot spot analysis

At the end of the injection of total losses an infrared scan was made on the transformer using a FLIR T840.

Hot spot location was on LV a phase turret.

Measured temperature:	68.0 °C
External ambient:	16.9 °C
Hot spot rise:	51.1 K

Photograph no.: P022

b) Winding temperature rise for the HV and LV windings

Average HV current during last hour of the test	= 320.8 A
Rated HV current	= 320.8 A

Temperatures extrapolated back to time of switch off,

HV winding temperature	= 71.0 °C
LV winding temperature	= 79.5 °C

Average oil temperature at switch off = 42.4 °C

Winding temperature rises above average oil temperature at switch off
HV winding = 71.0 – 42.4 = 28.6 K
LV winding = 79.5 – 42.4 = 37.1 K

Corrected winding temperature rise above average oil temperature:
$\Delta\theta_W$ HV = 28.6 x (320.8/ 320.8)$^{1.6}$ = 28.6 K
$\Delta\theta_W$ LV = 37.1 x (320.8/ 320.8)$^{1.6}$ = 37.1 K

Corrected average oil temperature-rise during last hour of the test to Part a) = 27.0 K

HV winding temperature rise = 28.6 + 27.0 = 55.6 K
LV winding temperature rise = 37.1 + 27.0 = 64.1 K

Guaranteed limit: 65 K

TEST RESULTS

Transformer Serial no. 2813612211001

Temperature rise type test (Continued)

Summary of temperature-rise test:

Top oil Temperature rise:	42.6 K	Limit 60 K
HV winding Temperature rise:	55.6 K	Limit 65 K
LV winding Temperature rise:	64.1 K	Limit 65 K

Result: The transformer satisfied the requirements of the standard in ONAF condition.

Photograph no.: P007

Date of Tests: 02 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of sound level at no-load excitation of the transformer- @ 1.0 m in ONAN condition

Test set up conditions

Height of transformer principal radiating surface (including 0.9 m height test platform)	4.00 m
Sound level measurements made at 1/3 height 2/3 height	 1.93 m 2.97 m
Transformer length	7.62 m
Transformer width	5.31 m
Prescribed contour perimeter, l_m	25.1 m
Measuring distance from prescribed contour	1.0 m
Distance between measuring points	0.96 m
Number of measurement points	30
Measurement point No. 1	HV A phase bushing, numbered anticlockwise
Environmental conditions	
Temperature	17.5 °C
Relative humidity	46 %
Atmospheric pressure	1011 hPa
Date of Tests:	03 March 2023

Evaluation of sound level under rated current and short-circuit voltage conditions	
Transformer rated power, S_r	52.8 MVA
Reference power, S_p	1 MVA
$L_{WA,Ir} = 39 + 18\log(S_r/S_p)$	70
Guaranteed sound power level	88
Guaranteed – $L_{WA,Ir}$	18 dB(A) > 10 dB(A)

As $L_{WA,Ir}$ was more than 10 dB(A) below the guaranteed sound power level then the load current sound level measurements were not required.

Sound level measurements were performed in no-load conditions before the temperature rise test.

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of sound level at no-load excitation of the transformer- @ 1.0 m in ONAN condition (continued)

Test no.	Background Pressure Level - (L_{bgAi}) dB(A)			
	Before the sound level test		After the sound level test	
	1/3 Height	2/3 Height	1/3 Height	2/3 Height
1	33.8	31.2	31.4	31.9
2	31.5	31.8	31.7	32.0
3	31.6	30.9	31.9	31.2
4	31.5	31.8	31.7	32.0
5	31.2	30.9	31.5	31.2
6	31.0	31.1	31.4	31.6
7	31.4	31.5	31.6	31.8
8	31.0	31.2	31.2	31.7
9	31.0	31.5	31.5	31.4
10	31.7	31.9	31.6	32.0
Average	31.5 ($\overline{LbgA}$)		31.6 ($\overline{LbgA}$)	

Position no.	Sound Pressure Level (L_{pAi}) dB(A)		Position no.	Sound Pressure Level (L_{pAi}) dB(A)	
	1/3 Height	2/3 Height		1/3 Height	2/3 Height
1	61.9	63.8	16	65.4	63.6
2	65.9	66.0	17	63.4	64.5
3	65.0	63.2	18	64.2	63.9
4	64.5	63.5	19	62.2	63.2
5	64.8	62.4	20	64.7	64.2
6	63.6	63.6	21	68.9	69.0
7	65.8	64.4	22	70.1	70.5
8	63.4	63.5	23	71.0	71.2
9	63.8	64.5	24	65.4	64.5
10	65.2	66.2	25	63.8	62.9
11	64.8	65.2	26	64.2	64.0
12	65.4	64.2	27	63.8	64.0
13	67.8	68.3	28	64.3	64.6
14	68.2	67.2	29	65.0	64.9
15	63.5	64.2	30	64.5	65.7
Average	65.7 ($\overline{LpA0}$)				

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of sound level at no-load excitation of the transformer- @ 1.0 m in ONAN condition (continued)

Calculation of sound pressure level and sound power level

Sound pressure level ($\overline{LpA0}$)	65.7 dB(A)
Background ($\overline{LbgA}$) *before test*	31.5 dB(A)
Background ($\overline{LbgA}$) *after test*	31.6 dB(A)
Test acceptance	Results are valid as per Table 1 of IEC 60076-10
Prescribed contour perimeter	L_m = 28.9 m
Measurement surface	S = 118.49 m^2
Test chamber	S_V = 12902 m^2
	$A = \sum \alpha_i S_{Vi}$ = 2580.4 m^2
	A/S= 21.78 (>1)
	K = 10log (1+4/21.78) = 0.7 dB(A)

Guaranteed sound pressure under no-load conditions @ 1.0 m: 70 dB(A)

$$\overline{L_{pA}}=10\lg(10^{0.1\overline{L_{pA0}}}-10^{0.1\overline{L_{bgA}}})-K=65\text{dB(A)}$$

Guaranteed sound power limit under no-load conditions: 88 dB(A)

$$L_{WA}=\overline{L_{pA}}+10\lg\frac{S}{S_0}=86\text{dB(A)}$$

Date of Tests: 03 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of sound level at no-load excitation of the transformer- @ 0.3 m in ONAN condition

Test set up conditions

Height of transformer principal radiating surface (including 0.9 m height test platform)	4.00 m
Sound level measurements made at 1/3 height 2/3 height	 1.93 m 2.97 m
Transformer length	7.62 m
Transformer width	5.31 m
Prescribed contour perimeter, l_m	23.5 m
Measuring distance from prescribed contour	0.3 m
Distance between measuring points	0.98 m
Number of measurement points	24
Measurement point No. 1	HV A phase bushing, numbered anticlockwise
Environmental conditions	
Temperature	17.5 °C
Relative humidity	46 %
Atmospheric pressure	1011 hPa
Date of Tests:	03 March 2023

Evaluation of sound level under rated current and short-circuit voltage conditions	
Transformer rated power, S_r	52.8 MVA
Reference power, S_p	1 MVA
$L_{WA,Ir} = 39 + 18\log(S_r/S_p)$	70
Guaranteed sound power level	88
Guaranteed – $L_{WA,Ir}$	18 dB(A) > 10 dB(A)

As $L_{WA,Ir}$ was more than 10 dB(A) below the guaranteed sound power level then the load current sound level measurements were not required.

Sound level measurements were performed in no-load conditions before the temperature rise test.

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of sound level at no-load excitation of the transformer- @ 0.3 m in ONAN condition (continued)

Test no.	Background Pressure Level - (L_{bgAi}) dB(A)			
	Before the sound level test		After the sound level test	
	1/3 Height	2/3 Height	1/3 Height	2/3 Height
1	33.8	31.0	31.5	32.4
2	31.6	31.9	31.5	31.7
3	31.5	30.8	31.2	31.0
4	30.6	31.4	30.9	31.2
5	32.1	31.3	31.9	31.4
6	30.9	31.6	31.0	31.7
7	30.1	31.3	30.5	31.2
8	31.4	31.6	31.2	31.5
9	31.0	30.6	31.2	30.8
10	30.9	32.1	30.8	32.0
Average	31.4 ($\overline{LbgA}$)		31.4 ($\overline{LbgA}$)	

Position no.	Sound Pressure Level (L_{pAi}) dB(A)		Position no.	Sound Pressure Level (L_{pAi}) dB(A)	
	1/3 Height	2/3 Height		1/3 Height	2/3 Height
1	63.2	65.7	13	65.7	63.0
2	64.0	61.2	14	64.5	61.8
3	64.5	62.1	15	67.5	65.6
4	64.4	66.2	16	66.9	65.2
5	66.8	61.4	17	65.6	65.1
6	67.9	67.2	18	62.6	62.4
7	71.2	73.7	19	63.2	63.4
8	71.5	72.2	20	61.9	62.4
9	71.0	72.0	21	68.2	70.0
10	71.1	70.8	22	71.2	70.4
11	69.3	70.0	23	65.4	64.3
12	65.7	63.5	24	63.5	63.6
Average	67.7 ($\overline{LpA0}$)				

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of sound level at no-load excitation of the transformer- @ 0.3 m in ONAN condition (continued)

Calculation of sound pressure level and sound power level

Sound pressure level ($\overline{LpA0}$)	67.7 dB(A)
Background ($\overline{LbgA}$) *before test*	31.4 dB(A)
Background ($\overline{LbgA}$) *after test*	31.4 dB(A)
Test acceptance	Results are valid as per Table 1 of IEC 60076-10
Prescribed contour perimeter	L_m = 23.5 m
Measurement surface	S = 79.9 m^2
Test chamber	S_V = 12902 m^2
	$A = \sum \alpha_i S_{Vi}$ = 2580.4 m^2
	A/S= 32.30 (>1)
	K = 10log (1+4/ 32.30) = 0.5 dB(A)

Guaranteed sound pressure under no-load conditions @ 0.3 m: 70 dB(A)

$$\overline{L_{pA}}=10\lg(10^{0.1\overline{L_{pA0}}}-10^{0.1\overline{L_{bgA}}})-K=67\text{dB(A)}$$

Guaranteed sound power limit under no-load conditions: 88 dB(A)

$$L_{WA}=\overline{L_{pA}}+10\lg\frac{S}{S_0}=86\text{dB(A)}$$

Date of Tests: 03 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of sound level at no-load excitation of the transformer- @ 2.0 m in ONAF condition

Test set up conditions

Height of transformer principal radiating surface (including 0.9 m height test platform)	4.00 m
Sound level measurements made at 1/3 height 2/3 height	 1.93 m 2.97 m
Transformer length	7.62 m
Transformer width	5.31 m
Prescribed contour perimeter, l_m	36.5 m
Measuring distance from prescribed contour	2.0 m
Distance between measuring points	0.99 m
Number of measurement points	37
Measurement point No. 1	HV A phase bushing, numbered anticlockwise
Environmental conditions	
Temperature	17.5 °C
Relative humidity	46 %
Atmospheric pressure	1011 hPa
Date of Tests:	03 March 2023

Evaluation of sound level under rated current and short-circuit voltage conditions	
Transformer rated power, S_r	66 MVA
Reference power, S_p	1 MVA
$L_{WA,Ir} = 39 + 18\log(S_r/S_p)$	72
Guaranteed sound power level	90
Guaranteed – $L_{WA,Ir}$	18 dB(A) > 10 dB(A)

As $L_{WA,Ir}$ was more than 10 dB(A) below the guaranteed sound power level then the load current sound level measurements were not required.

Sound level measurements were performed in no-load conditions before the temperature rise test.

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of sound level at no-load excitation of the transformer- @ 2.0 m in ONAF condition (continued)

Test no.	Background Pressure Level - (L_{bgAi}) dB(A)			
	Before the sound level test		After the sound level test	
	1/3 Height	2/3 Height	1/3 Height	2/3 Height
1	32.5	31.5	32.4	31.6
2	32.8	33.0	32.7	32.9
3	32.4	31.8	32.6	32.0
4	30.8	31.5	32.4	32.1
5	32.0	32.4	31.9	32.0
6	32.6	32.8	32.1	32.2
7	31.9	32.3	31.9	32.3
8	31.8	32.5	32.2	32.0
9	32.4	32.7	32.2	32.4
10	33.0	32.8	32.6	32.7
Average	32.3 ($\overline{LbgA}$)		32.3 ($\overline{LbgA}$)	

Position no.	Sound Pressure Level (L_{pAi}) dB(A)		Position no.	Sound Pressure Level (L_{pAi}) dB(A)	
	1/3 Height	2/3 Height		1/3 Height	2/3 Height
1	68.1	66.4	20	67.8	68.5
2	67.1	66.5	21	68.4	68.6
3	65.9	66.5	22	67.9	68.4
4	66.8	67.0	23	65.4	65.6
5	66.6	65.0	24	66.0	66.2
6	65.8	66.5	25	65.2	65.4
7	71.4	72.3	26	65.8	65.9
8	67.0	68.2	27	66.2	66.0
9	66.5	65.0	28	65.8	65.7
10	68.7	68.8	29	65.8	65.9
11	66.9	69.8	30	66.0	66.2
12	66.1	65.6	31	66.2	66.4
13	66.3	65.4	32	67.8	67.5
14	66.2	67.2	33	67.9	68.0
15	68.6	67.6	34	68.2	68.0
16	67.1	67.4	35	66.5	67.0
17	66.5	66.3	36	65.7	66.8
18	69.5	66.1	37	67.2	66.5
19	68.3	66.3	-	-	-
Average	67.2 $(\overline{LpA0})$				

TEST RESULTS

Transformer Serial no. 2813612211001

Determination of sound level at no-load excitation of the transformer- @ 2.0 m in ONAF condition (continued)

Calculation of sound pressure level and sound power level

Sound pressure level ($\overline{LpA0}$)	67.2 dB(A)
Background ($\overline{LbgA}$) *before test*	32.3 dB(A)
Background ($\overline{LbgA}$) *after test*	32.3 dB(A)
Test acceptance	Results are valid as per Table 1 of IEC 60076-10
Prescribed contour perimeter	L_m = 36.5 m
Measurement surface	S = 162.2 m^2
Test chamber	S_V = 12902 m^2
	$A = \sum \alpha_i S_{Vi}$ = 2580.4 m^2
	A/S= 13.86 (>1)
	K = 10log (1+4/ 13.86) = 1.1 dB(A)

Guaranteed sound pressure under no-load conditions @ 2.0 m: 70 dB(A)

$$\overline{L_{pA}}=10\lg(10^{0.1\overline{L_{pA0}}}-10^{0.1\overline{L_{bgA}}})-K=66\text{dB(A)}$$

Guaranteed sound power limit under no-load conditions: 90 dB(A)

$$L_{WA}=\overline{L_{pA}}+10\lg\frac{S}{S_0}=88\text{dB(A)}$$

Date of Tests: 03 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Short-circuit withstand tests HV to LV windings, supply A-BC single-phase tests

Tapping voltage	-V	145200/ 33000		
Tap		1		
Transformer HV impedance at 75 °C	-Ω/phase	47.40		
X/R ratio at 75°C		37.34		
Theoretical short-circuit phase currents:				
Asymmetrical peak - HV winding	-A	4350		
Average symmetrical - HV winding	-A	1706		
Asymmetrical peak - LV winding	-kA	19.14		
Average symmetrical - LV winding	-kA	7.51		
Peak factor		2.55		
Test no.	B230035-	S02-1	S02-2	S02-3
Single-phase test supply connection		A-BC	A-BC	A-BC
Applied 2 phase HV line voltage during short-circuit tests	-kV	113.4	109.3	108.9
Duration	-s	0.25	0.25	0.25
Asymmetrical peak HV winding phase current	-A	4557	4436	4511
Symmetrical HV winding phase current	-A	1629	1579	1600
Asymmetrical peak LV winding phase current	-kA	19.66	18.73	18.44
Symmetrical LV winding phase current	-kA	7.07	6.79	6.78
Percent change in reactance (%)	- A phase	0.01	0.01	0.02
	- B phase	0.02	0.03	0.03
	- C phase	0.01	-0.13	0.03
Date of Tests: 24 March 2023				

TEST RESULTS

Transformer Serial no. 2813612211001

Short-circuit withstand tests HV to LV windings, supply B-AC single-phase tests

Tapping voltage	-V	132000/ 33000		
Tap		9B		
Transformer HV impedance at 75 °C	-Ω/phase	37.76		
X/R ratio at 75°C		35.71		
Theoretical short-circuit phase currents:				
Asymmetrical peak - HV winding	-A	4922		
Average symmetrical - HV winding	-A	1930		
Asymmetrical peak - LV winding	-kA	19.69		
Average symmetrical - LV winding	-kA	7.72		
Peak factor		2.55		
Test no.	B230035-	S02-1	S02-2	S02-3
Single-phase test supply connection		B-AC	B-AC	B-AC
Applied 2 phase HV line voltage during short-circuit tests	-kV	102.4	102.1	101.9
Duration	-s	0.25	0.25	0.25
Asymmetrical peak HV winding phase current	-A	4904	4925	4914
Symmetrical HV winding phase current	-A	1792	1794	1795
Asymmetrical peak LV winding phase current	-kA	19.23	19.23	19.26
Symmetrical LV winding phase current	-kA	7.11	7.12	7.11
Percent change in reactance (%)	- A phase	0.03	0.01	0.02
	- B phase	0.13	0.16	0.16
	- C phase	-0.14	-0.16	-0.27
Date of Tests: 24 March 2023				

TEST RESULTS

Transformer Serial no. 2813612211001

Short-circuit withstand tests HV to LV windings, supply C-AB single-phase tests

Tapping voltage	-V	118800/ 33000		
Tap		17		
Transformer HV impedance at 75 °C	-Ω/phase	31.18		
X/R ratio at 75°C		30.20		
Theoretical short-circuit phase currents:				
Asymmetrical peak - HV winding	-A	5314		
Average symmetrical - HV winding	-A	2084		
Asymmetrical peak - LV winding	-kA	19.13		
Average symmetrical - LV winding	-kA	7.50		
Peak factor		2.55		
Test no.	B230035-	S03-1	S03-2	S03-3
Single-phase test supply connection		C-AB	C-AB	C-AB
Applied 2 phase HV line voltage during short-circuit tests	-kV	91.1	89.6	89.5
Duration	-s	0.25	0.25	0.25
Asymmetrical peak HV winding phase current	-A	5447	5391	5380
Symmetrical HV winding phase current	-A	1985	1960	1962
Asymmetrical peak LV winding phase current	-kA	18.75	18.50	18.45
Symmetrical LV winding phase current	-kA	6.86	6.81	6.82
Percent change in reactance (%)	- A phase	-0.10	0.02	0.02
	- B phase	0.19	0.19	0.19
	- C phase	-0.39	-0.49	-0.39
Date of Tests: 24 March 2023				

TEST RESULTS

Transformer Serial no. 2813612211001

After test B230035-S03-3 the reactance was re-measured on the relevant taps, as indicated below:

Tap	Phase	Change in reactance %	Note: The maximum allowable percentage change in reactance for transformers with circular concentric coils with wire in accordance with clause 4.2.7.4 a) 5) of IEC 60076-5 is 2 %.
1	A	0.03	
	B	0.03	
	C	-0.13	
9B	A	0.01	
	B	0.21	At the completion of the tests the maximum change of the reactance measured was -0.39 %.
	C	-0.22	
17	A	0.02	
	B	0.10	
	C	-0.39	

Photograph nos.: P015 to P020

TEST RESULTS

Transformer Serial no. 2813612211001

Chopped wave lightning impulse test (LIC) on the LV line terminals

Chopped wave lightning impulse at LI 170/ LIC 187 kV on the LV winding.
Standard lightning impulse wave shape: 1.2 ± 30 % / 50 ± 20 % µs negative impulses.
Chopped impulse wave, chopped between 3 µs and 6 µs.

Terminal tested	**Osc.** B230035-	**Type of Impulse**	**Test Voltage kV**	**Wave shape (µs)**			**Result**
				T_1^*	**T_2**	**T_c**	
c	L001	1 reduced level full wave	-88.9	1.41	54.3	-	Passed
	L002	1 full level full wave	-169.2	1.41	5.4	-	
	L003	1 full level chopped wave	-185.8	1.41	-	3.6	
	L004	1 full level chopped wave	-187.1	1.41	-	3.5	
	L005	1 full level full wave	-170.1	1.41	54.0	-	
	L006	1 full level full wave	-170.1	1.41	54.6	-	
b	L007	1 reduced level full wave	-88.7	1.42	55.7	-	Passed
	L008	1 full level full wave	-169.9	1.43	55.5	-	
	L009	1 full level chopped wave	-186.5	1.43	-	3.8	
	L010	1 full level chopped wave	-187.9	1.43	-	3.8	
	L011	1 full level full wave	-170.1	1.43	55.4	-	
	L012	1 full level full wave	-168.5	1.42	55.4	-	
a	L013	1 reduced level full wave	-90.7	1.43	55.6	-	Passed
	L014	1 full level full wave	-169.0	1.43	55.3	-	
	L015	1 full level chopped wave	-187.6	1.43	-	3.7	
	L016	1 full level chopped wave	-187.2	1.44	-	3.8	
	L017	1 full level full wave	-168.8	1.43	55.1	-	
	L018	1 full level full wave	-169.8	1.43	55.0	-	

Chopped wave lightning impulse test (LIC) on the LV line terminals

Ambient conditions	
Temperature	13.9 °C
Relative humidity	29 %
Atmospheric pressure	1009 hPa
Date of Tests:	27 February 2023

There were no flashovers, punctures or voltage collapses, and there was satisfactory agreement between the reference impulse and those recorded at the full test voltage.

Result: The LV winding of the transformer passed the test with chopped wave lightning test (LIC) and complied with the requirements of clause 13.3 of the IEC 60076-3.

Photograph no.: P008

TEST RESULTS

Transformer Serial no. 2813612211001

Lightning impulse test on a neutral terminal on the LV neutral terminal (LIN)

Full wave lightning impulse at LI 170 kV on the LV neutral terminal.
Standard lightning impulse wave shape: 1.2 ± 30 % / 50 ± 20 % µs negative impulses
The front time up to maximum of 13 µs

Terminal tested	**Osc.** B230035- -	**Type of Impulse**	**Test Voltage kV**	**Wave shape (µs)**			**Result**
				T_1	**T_2**	**T_c**	
n	L019	1 reduced level full wave	-88.6	1.67	44.3	-	Passed
	L020	1 full level full wave	-168.4	1.67	43.8	-	
	L021	1 full level full wave	-169.6	1.68	43.8	-	
	L022	1 full level full wave	-170.0	1.67	43.9	-	
Date of Tests: 27 February 2023							

The ambient conditions during the lightning impulse tests on LV neutral terminal were:

Ambient conditions	
Ambient air temperature	13.9 °C
Relative humidity	29 %
Atmospheric pressure	1009 hPa

There were no flashovers, punctures or voltage collapses, and there was satisfactory agreement between the reference impulse and those recorded at the full test voltage.

Result: The HV neutral terminal of the transformer passed the lightning impulse tests and complied with the requirements of clause 13.4 of the IEC 60076-3.

Photograph no.: P009

TEST RESULTS

Transformer Serial no. 2813612211001

Chopped wave lightning impulse test (LIC) on the HV line terminals

Chopped wave lightning impulse at LI 650/ LIC 715 kV on the HV winding.
Standard lightning impulse wave shape: 1.2 ± 30 % / 50 ± 20 % µs negative impulses.
Chopped impulse wave, chopped between 3 µs and 6 µs.

Terminal tested	**Osc.** B230035-	**Type of Impulse**	**Test Voltage kV**	**Wave shape (µs)**			**Result**
				T_1	**T_2**	**T_c**	
B Tap 9B	L023	1 reduced level full wave	-352.3	1.51	48.0	-	Passed
	L024	1 full level full wave	-647.8	1.51	48.2	-	
	L025	1 full level chopped wave	-713.0	1.51	-	3.8	
	L026	1 full level chopped wave	-715.7	1.52	-	3.8	
	L027	1 full level full wave	-650.7	1.52	48.3	-	
	L028	1 full level full wave	-650.8	1.53	48.4	-	
C Tap17	L029	1 reduced level full wave	-353.1	1.51	46.1	-	Passed
	L030	1 full level full wave	-652.4	1.55	46.4	-	
	L031	1 full level chopped wave	-718.0	1.55	-	4.0	
	L032	1 full level chopped wave	-717.5	1.55	-	3.7	
	L033	1 full level full wave	-651.6	1.55	46.5	-	
	L034	1 full level full wave	-651.9	1.55	46.5	-	
A Tap 1	L035	1 reduced level full wave	-350.4	1.52	49.2	-	Passed
	L036	1 full level full wave	-647.1	.152	49.5	-	
	L037	1 full level chopped wave	-714.6	1.53	-	3.9	
	L038	1 full level chopped wave	-715.7	1.53	-	3.5	
	L039	1 full level full wave	-652.6	1.53	49.7	-	
	L040	1 full level full wave	-652.6	1.53	49.6	-	

Ambient conditions	
Temperature	13.9 °C
Relative humidity	29 %
Atmospheric pressure	1009 hPa
Date of Tests:	27 February 2023

There were no flashovers, punctures or voltage collapses, and there was satisfactory agreement between the reference impulse and those recorded at the full test voltage.

Result: The HV winding of the transformer passed the test with chopped wave lightning test (LIC) and complied with the requirements of clause 13.3 of the IEC 60076-3.

Photograph no.: P010

TEST RESULTS

Transformer Serial no. 2813612211001

Lightning impulse test on a neutral terminal on the HV neutral terminal (LIN)

Full wave lightning impulse at LI 250 kV on the HV neutral terminal.
Standard lightning impulse wave shape: 1.2 ± 30 % / 50 ± 20 % µs negative impulses
The front time up to maximum of 13 µs

Terminal tested	**Osc.** B230035- -	**Type of Impulse**	**Test Voltage kV**	**Wave shape (µs)**			**Result**
				T_1	**T_2**	**T_c**	
N	L041	1 reduced level full wave	-158.2	3.07	42.5	-	Passed
	L042	1 full level full wave	-248.6	3.05	42.5	-	
	L043	1 full level full wave	-252.3	3.07	42.5	-	
	L044	1 full level full wave	-251.6	3.07	42.6	-	
Date of Tests: 27 February 2023							

The ambient conditions during the lightning impulse tests on HV neutral terminal were:

Ambient conditions	
Ambient air temperature	13.9 °C
Relative humidity	29 %
Atmospheric pressure	1009 hPa

There were no flashovers, punctures or voltage collapses, and there was satisfactory agreement between the reference impulse and those recorded at the full test voltage.

Result: The HV neutral terminal of the transformer passed the lightning impulse tests and complied with the requirements of clause 13.4 of the IEC 60076-3.

Photograph no.: P011

TEST RESULTS

Transformer Serial No. 2813612211001

Line terminal AC withstand voltage test (LTAC)

The line terminal AC withstand voltage test (LTAC) of the transformer was performed on tap 3 with a single-phase supply, 200 Hz from the LV winding with HV winding one phase open and the other two phases connected together left open and the neutral was connected to earth before and after short circuit tests.

Applied voltage (kV)		Inducted voltage (kV)		Test frequency	Duration	Result
Terminal	Voltage	Terminal	Voltage			
an	41.6	A	275	200 Hz	30 s	Passed
bn	41.6	B	275	200 Hz	30 s	Passed
cn	41.6	C	275	200 Hz	30 s	Passed

Ambient conditions during Line terminal AC withstand voltage test (LTAC) were:

Ambient conditions	Before short-circuit tests	After short-circuit tests
Ambient air temperature	14.8 ^{o}C	13.8 ^{o}C
Relative humidity	32 %	36 %
Atmospheric pressure	1004 hPa	1009 hPa
Date of Tests:	24 February 2023	28 February 2023

Photograph no.: P012

TEST RESULTS

Transformer Serial no. 2813612211001

Applied voltage test (AV)

The HV winding satisfactorily withstood 95 kV (PK /√2) before and after the short-circuit withstand tests, applied for 60 s between the HV terminals and the LV, TV terminals connected together with the tank and connected to earth.

The LV winding satisfactorily withstood 70 kV (PK /√2) before and after the short-circuit withstand tests, applied for 60 s between the LV terminals and the HV, TV terminals connected together with the tank and connected to earth.

The TV winding satisfactorily withstood 28 kV (PK /√2) before and after the short-circuit withstand tests, applied for 60 s between the TV terminals and the HV, LV terminals connected together with the tank and connected to earth.

Ambient conditions during the applied voltage test (AV) were:

Ambient conditions	Before short-circuit tests	After short-circuit tests
Ambient air temperature	14.8 °C	13.8 °C
Relative humidity	32 %	36 %
Atmospheric pressure	1004 hPa	1009 hPa
Date of Tests:	24 February 2023	28 February 2023

Photograph no.: P013

Insulation of auxiliary wiring (AuxW)

The auxiliary wiring and the control circuitry of the transformer withstood 2 kV a,c, applied for 60 s between the auxiliary wiring and the control circuitry terminals connected together and the tank.

The wiring for the built-in current transformers secondary windings withstood 2.5 kV AC applied for 60 s between the wiring and the tank.

The ambient conditions during the insulation of auxiliary wiring (AuxW) were:

Ambient conditions	Before short-circuit tests	After short-circuit tests
Ambient air temperature	14.8 °C	13.8 °C
Relative humidity	32 %	36 %
Atmospheric pressure	1004 hPa	1009 hPa
Date of Tests:	24 February 2023	28 February 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Induced voltage withstand test (IVW)

The test voltage was applied to LV winding with the HV winding open-circuited, and de-energized tap changer was in tap 9B, the tests were carried out before and after the short-circuit withstand tests.

Line voltage applied to LV winding (kV r.m.s.)	Induced voltage in HV winding (kV r.m.s.)	Induced factor	Frequency (Hz)	Duration (s)	Result
66	264	2	200	30	Withstood

Ambient conditions during the induced voltage withstand test were:

Ambient conditions	Before short-circuit test	After short-circuit test
Ambient air temperature	14.8 °C	13.8 °C
Relative humidity	32 %	36 %
Atmospheric pressure	1004 hPa	1009 hPa
Date of Tests:	24 February 2023	28 February 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Induced voltage test with partial discharge measurement (IVPD) before and after the short-circuit withstand tests.

The LV winding of the transformer was energized from a three-phase, 200 Hz.
The HV winding was set on tap 9B with the neutral terminal earthed.
The partial discharges were monitored on the HV bushings continuously throughout the test.

Test Voltage			Test Duration	Partial Discharge Measurement (pC)					
Specified Voltage	Winding Voltage(kV)			Before short-circuit tests			After short-circuit tests		
	HV (phase to earth)	LV (phase to earth)		A	B	C	A	B	C
$0.4U_r/\sqrt{3}$	30.5	7.6	-	9	10	11	20	20	20
$1.2U_r/\sqrt{3}$	91.5	22.9	1 min	12	15	15	20	30	50
$1.58U_r/\sqrt{3}$	120.4	30.1	5 min	20	25	20	30	40	50
$1.8U_r/\sqrt{3}$	137.2	34.3	30 s	-	-	-	-	-	-
$1.58U_r/\sqrt{3}$	120.4	30.1	5 min	25	30	35	40	60	110
			10 min	25	30	35	50	60	110
			15 min	25	30	35	40	60	110
			20 min	25	40	35	40	60	110
			25 min	25	40	40	40	60	110
			30 min	30	40	40	40	60	110
			35 min	30	40	40	40	60	110
			40 min	30	40	45	40	60	110
			45 min	30	40	45	40	60	110
			50 min	30	40	45	40	60	110
			55 min	30	50	45	40	60	110
			60 min	30	50	45	40	60	110
$1.2U_r/\sqrt{3}$	91.5	22.9	5 min	20	30	40	20	20	90
$0.4U_r/\sqrt{3}$	30.5	7.6	-	9	15	15	20	20	90

Ambient conditions	Before short-circuit tests	After short-circuit tests
Ambient air temperature	14.8 °C	13.8 °C
Relative humidity	32 %	36 %
Atmospheric pressure	1004 hPa	1009 hPa
Date of Tests:	24 February 2023	28 February 2023

Result: The test was successful. There was no collapse of the test voltage and the PD levels recorded during the PD measurement voltage period did not exceed 250 pC. The PD level measured at a level of $1.2U_r/\sqrt{3}$ after the PD measurement voltage period did not exceed 100 pC.

Photograph no.: P014

TEST RESULTS

Transformer Serial no. 2813612211001

Inspection

Following the completion of all tests the transformer was de-tanked and examined.

There was no visible damage to the structural integrity, the windings or the core.

Therefore, the transformer complied with the requirements of IEC 60076-5 clause 4.2.7.4 a) 3).

Date of final Inspection: 17 March 2023

Summary Clause 4.2.7.4.a) of IEC 60076-5

Transformer Category II

1. The results of the short-circuit withstand tests and the measurements and other checks during the tests did not reveal any faults.
2. The dielectric tests and the other routine tests were successfully repeated.
3. The inspection was satisfactory.
4. There were no traces of any electrical discharge.
5. The maximum change in reactance as a result of the short-circuit withstand tests did not exceed the specified limit.

Result: The transformer passed the short-circuit withstand tests.

TEST RESULTS

Transformer Serial No. 2813612211001

Determination of transient voltage transfer characteristics

A low voltage impulse was applied between phase A of the HV terminal and neutral, and phase a of LV winding terminals and neutral were measured.

Applied voltage terminal	Applied voltage V	Test terminals	Resistance between a and n	Test voltage V
A-N Tap 9B	100	a-n	50 Ω	1.589
		a-n	100 Ω	2.934
		a-n	200 Ω	5.281
		a-n	300 Ω	7.005
		a-n	400 Ω	8.388
		a-n	800 Ω	12.320
		a-n	Open circuit	20.410

Date of Tests: 16 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of zero-sequence impedance on three-phase transformer

Test supply terminals	N – ABC	N – ABC	abc-n	abc-n
Short-circuit terminals	-	abc-n	-	
Open-circuit terminals	abc-n	-	N – ABC	N – ABC
Test Voltage, U	2137.0 V	795.6 V	229.6 V	90.4 V
Test Current, I	107.82 A	113.77 A	103.86 A	114.95 A
Tap	9B	9B	9B	9B
Test Current / phase	35.94 A	37.92 A	34.62 A	38.82 A
Z_0 = 3 U/I	59.460 Ω	20.987 Ω	6.633Ω	2.360Ω
Ambient air temperature		12.2 °C		
Oil average temperature		12.3 °C		

Photograph no.: P019

Date of Tests: 13 March 2023

TEST RESULTS

Transformer Serial No. 2813612211001

Vacuum deflection test for liquid immersed transformers

13 reference measuring points were selected as close as possible to the points on the tank where the maximum deflection under vacuum was expected, taking into account the expected deflection. Refer to Figure 3 for detail. The distances from the reference points to the tank wall in a direction approximately normal to the tank were measured and recorded.

A vacuum pressure (absolute pressure ≤ 0.133 kPa) as specified by the client was applied to the transformer for 30 min with the radiator banks and the distances between the reference points and the tank wall measured again. The maximum difference between these measurements and the 1st measurements was the deflection under vacuum. The vacuum was then reduced back to the originally established level and a 3rd measurement of the distances was taken. The maximum difference between these measurements and the 1st measurements was the permanent deflection.

The selected measuring points and the measurements are shown in the following table.

Measure point	The value before test (mm)	The value during test (mm)	The value after the test (mm)	Elastic deformation value (mm)	Permanent deflection (mm)
P01	300	311	300	11	0
P02	286	300	286	14	0
P03	272	288	272	16	0
P04	302	309	302	7	0
P05	245	253	245	8	0
P06	294	304	294	10	0
P07	296	308	296	12	0
P08	319	330	319	11	0
P09	503	511	503	8	0
P10	491	500	491	9	0
P11	256	265	256	9	0
P12	262	270	262	8	0
P13	270	279	270	9	0

Result: No visible deformation of the flanges, no weld or stiffener cracks and the permanent deflection after the vacuum was released was not more than 1 mm. The transformer complied with the requirement of the standard.

Date of Tests: 17 March 2023

TEST RESULTS

Transformer Serial No. 2813612211001

Pressure deflection test for liquid immersed transformers

The transformer was fully assembled with radiator banks, tank welded and conservator, and filled with oil, the pressure was applied by compress air.

13 reference measuring points were selected as close as possible to the points on the tank where the maximum deflection under pressure was expected, taking into account the expected deflection. Refer to Figure 3 for detail. The distances from the reference points to the tank wall in a direction approximately normal to the tank were measured and recorded.
A pressure of 65 kPa over the normal operational pressure as specified by the client was applied, and the distances between the reference points and the tank wall measured again. The maximum difference between these measurements and the 1st measurements was the deflection under pressure. The pressure was then released, after being held at the required level for 30 minutes and a 3rd measurement of the distances was taken. The maximum difference between these measurements and the 1st measurements was the permanent deflection.

The selected measuring points and the measurements are shown in the following table.

Measure point	The value before test (mm)	The value during test (mm)	The value after the test (mm)	Elastic deformation value (mm)	Permanent deflection (mm)
P01	265	261	265	4	0
P02	254	250	253	4	1
P03	241	237	240	4	1
P04	246	243	245	3	1
P05	267	264	266	3	1
P06	227	225	227	2	0
P07	239	236	238	3	1
P08	254	249	254	5	0
P09	270	268	269	2	1
P10	213	212	213	1	0
P11	254	252	254	2	0
P12	242	240	241	2	1
P13	256	255	256	1	0

Result: No visible deformation of the flanges, no weld or stiffener cracks, no oil leaks, and the permanent deflection after the pressure was released was not more than 1 mm. The transformer complied with the requirements of the standard.

Date of Tests: 16 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of frequency response (Frequency Response Analysis or FRA)

A frequency response analysis (FRA) was made on the transformer on each winding by a MEGGER sweep frequency response analyzer, model No. FRAX-99.

The results are reported for information only as they are a signature of the transformer windings and are not classified as a rating.

Terminals Tested	Test condition			FRA Oscillogram No.	
	Tap	Short circuited	Open circuited	Before short-circuit tests	After short-circuit tests
A-N	1	-	Other terminals	B230035-FRA01	B230035-FRA11
B-N	1	-	Other terminals	B230035-FRA02	B230035-FRA12
C-N	1	-	Other terminals	B230035-FRA03	B230035-FRA13
A-N	9B		Other terminals	B230035-FRA04	B230035-FRA14
B-N	9B		Other terminals	B230035-FRA05	B230035-FRA15
C-N	9B		Other terminals	B230035-FRA06	B230035-FRA16
a-b	-	-	Other terminals	B230035-FRA07	B230035-FRA17
b-c	-	-	Other terminals	B230035-FRA08	B230035-FRA18
c-a	-	-	Other terminals	B230035-FRA09	B230035-FRA19
wc-wa			Other terminals	B230035-FRA10	B230035-FRA20

Date of Test: 24 February and 15 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Electromagnetic compatibility (EMC) – RIV

The transformer was in a clean condition, and the HV terminal was shielded to prevent spurious discharges.

The measuring frequency was to 1.0 MHz.

The rated voltage U_m = 145 kV

The voltage applied on the HV terminal, and HV terminals A, B and C on tap 1 were measured separated.

Required value	**HV Test voltage kV**	**Test value (dB)**		
		A	**B**	**C**
1.1 Um/√3	92.09	53.0	52.0	52.0

The ambient conditions during the test were:

Ambient air temperature	17.5 °C
Relative humidity	37 %
Atmospheric pressure	1004 hPa

Date of tests:04 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of the no-load voltage and current characteristics

Required value	Applied average mean voltage (kV)	Measured average current (A)
0.5 U_r	9.530	0.315
0.6 U_r	11.434	0.373
0.7 U_r	13.337	0.442
0.8 U_r	15.251	0.539
0.9 U_r	17.145	0.720
0.95 U_r	18.111	0.929
1.0 U_r	19.057	1.324
1.05 U_r	20.000	2.233
1.1 U_r	20.959	4.667
1.15 U_r	21.922	9.963

Date of Tests: 03 March 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Measurement of the harmonics of the no load current at 100 % rated voltage

Series	I_a (% H01)	I_b (% H01)	I_c (% H01)
1	100.00	100.00	100.00
2	0.31	1.05	0.41
3	16.81	32.42	7.99
4	0.23	0.74	0.30
5	34.55	35.40	30.03
6	0.23	0.68	0.17
7	17.38	17.18	14.92
8	0.10	0.32	0.17
9	0.89	3.25	1.48
10	0.11	0.27	0.15
11	3.33	3.52	3.14
12	0.21	0.27	0.19
13	1.72	1.90	1.72
14	0.12	0.14	0.20
15	0.19	0.07	0.32
16	0.17	0.16	0.10
17	0.77	0.77	0.66
18	0.06	0.16	0.12
19	0.78	0.68	0.49
20	0.07	0.20	0.12

Dates of Tests: 28 February 2023

TEST RESULTS

Transformer Serial no. 2813612211001

Transition resistance measurement on on-load tap-changers

The transformer was fitted with a 17 step MR tap-changer type VVSIII400Y-76-10193W.

The transition resistances were measured phase by phase by a Baoding Jindyuan on-load tap-changer tester model no. JYK-I with the tap-changer switched from tap 5 to tap 6 and from tap 6 to tap 5. The results are as shown below:

Tap change direction	Transition duration (ms)			Transition resistance (Ω)		
	Phase A	Phase B	Phase C	Phase A	Phase B	Phase C
5 to 6	59.0	59.0	59.0	1.8	1.8	1.8
6 to 5	73.2	73.2	73.2	1.9	1.9	1.9

Dates of Tests: 22 February 2023

Measurement of the long-time no-load voltage test

The test was performed by applying 1.1 times rated voltage as per clause 11.5 of IEC 60076-1 and maintained for 12 hours and then the DGA test (refer to the Measurement of dissolved gasses in dielectric liquid test) was performed.

Date of Tests: 03 to 04 March 2023

TEST RESULTS

Transformer Serial No. 2813612211001

Determination of capacitances and dissipation factor (tan δ) of the bushings

Condition	Capacitances pF	Dissipation factor Tan δ (%)
Neutral N	391.2	0.306
Phase A	308.5	0.281
Phase B	311.0	0.279
Phase C	307.9	0.269
Environment conditions		
Ambient air temperature	16.5 °C	
Average oil temperature	16.9 °C	
Relative humidity	38 %	
Atmospheric pressure	1014 hPa	
Date of Tests:	23 February 2023	

Figure 1

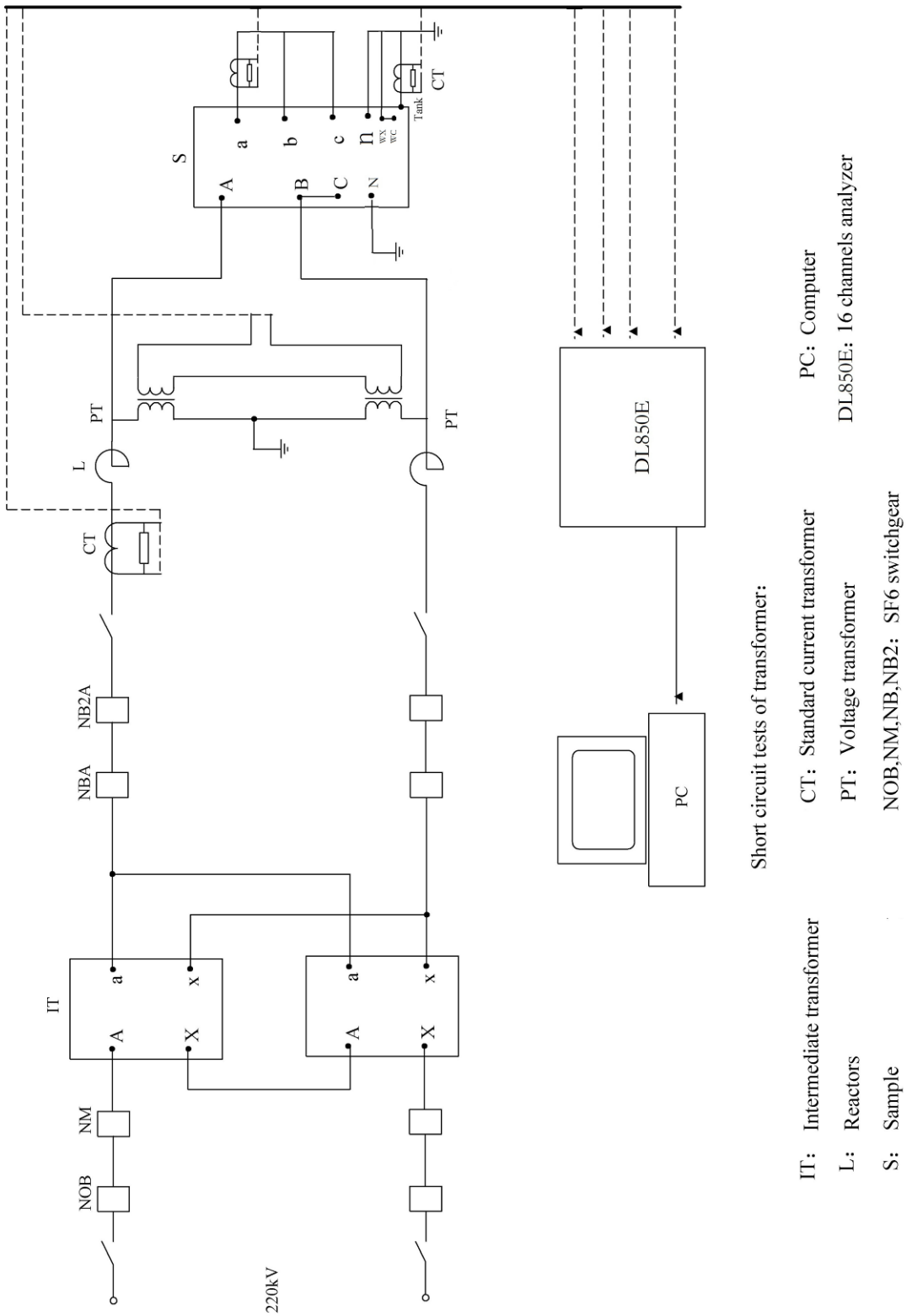

S
A
B
C
N
a
b
c
n
WX
WC
Tank
CT
PT
L
CT
PT
NB2A
NBA
IT
a
x
A
X
NM
NOB
220kV
DL850E
PC
Short circuit tests of transformer:
IT: Intermediate transformer
L: Reactors
S: Sample
CT: Standard current transformer
PT: Voltage transformer
NOB,NM,NB,NB2: SF6 switchgear
PC: Computer
DL850E: 16 channels analyzer

Figure 2

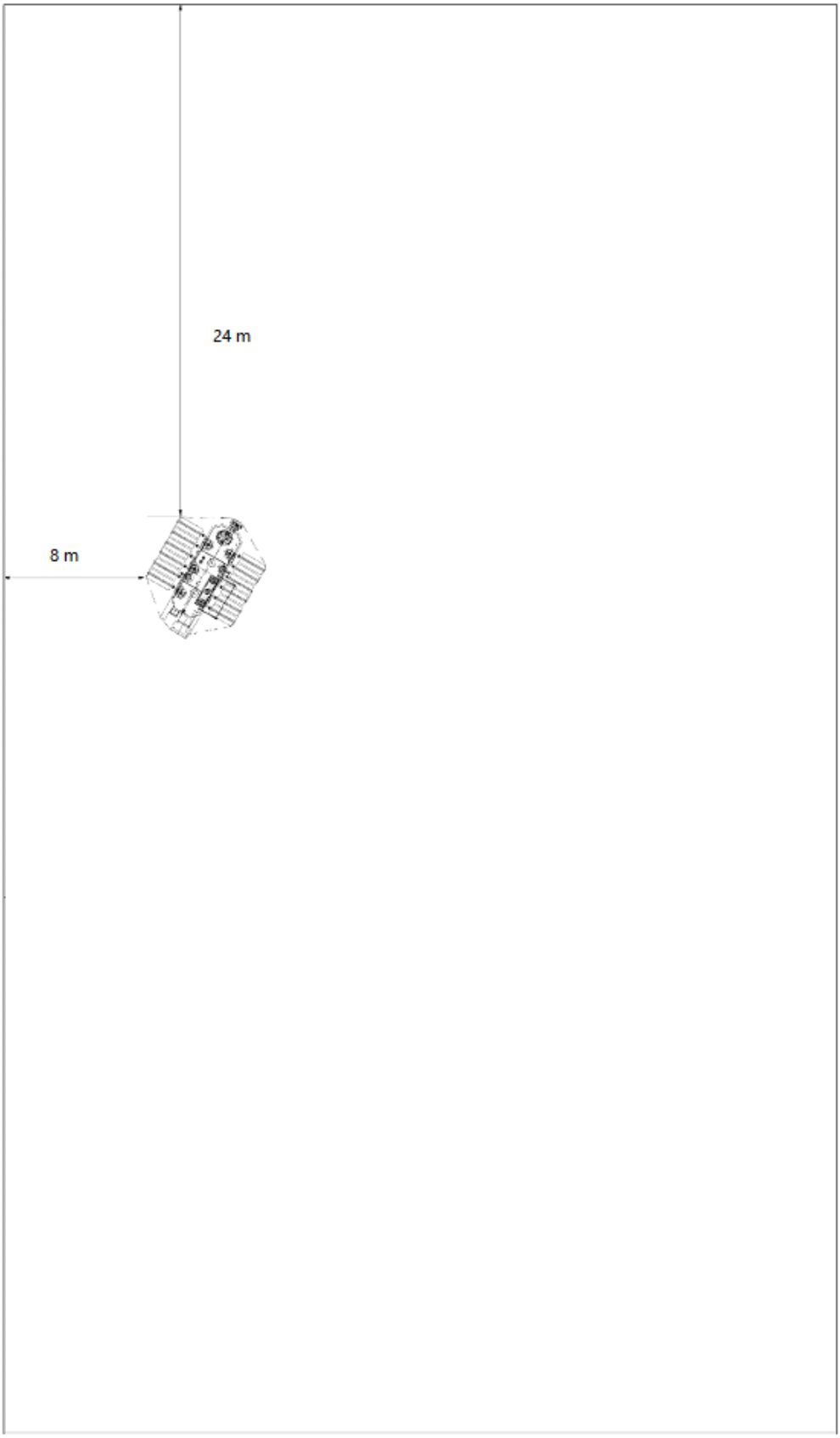
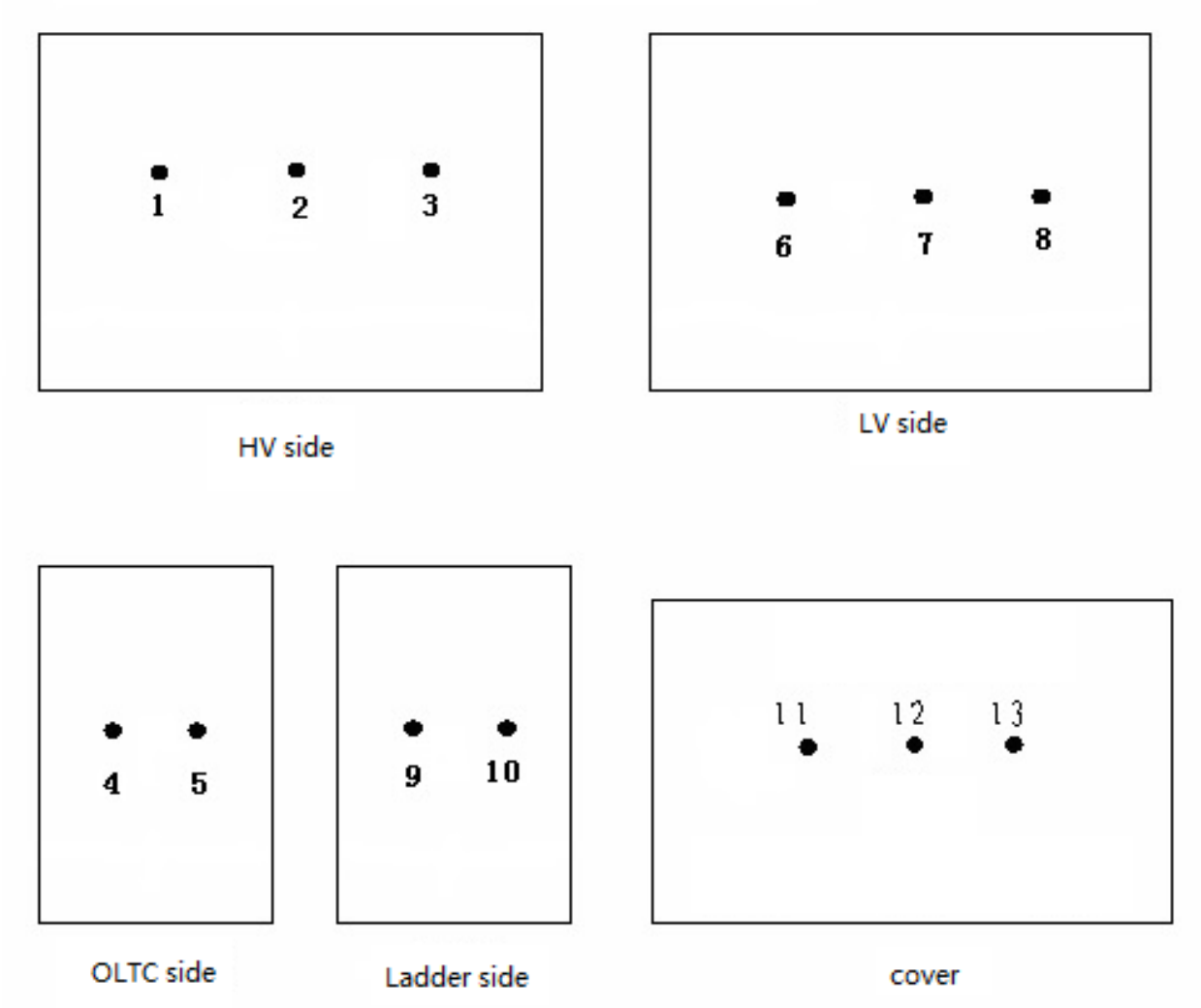
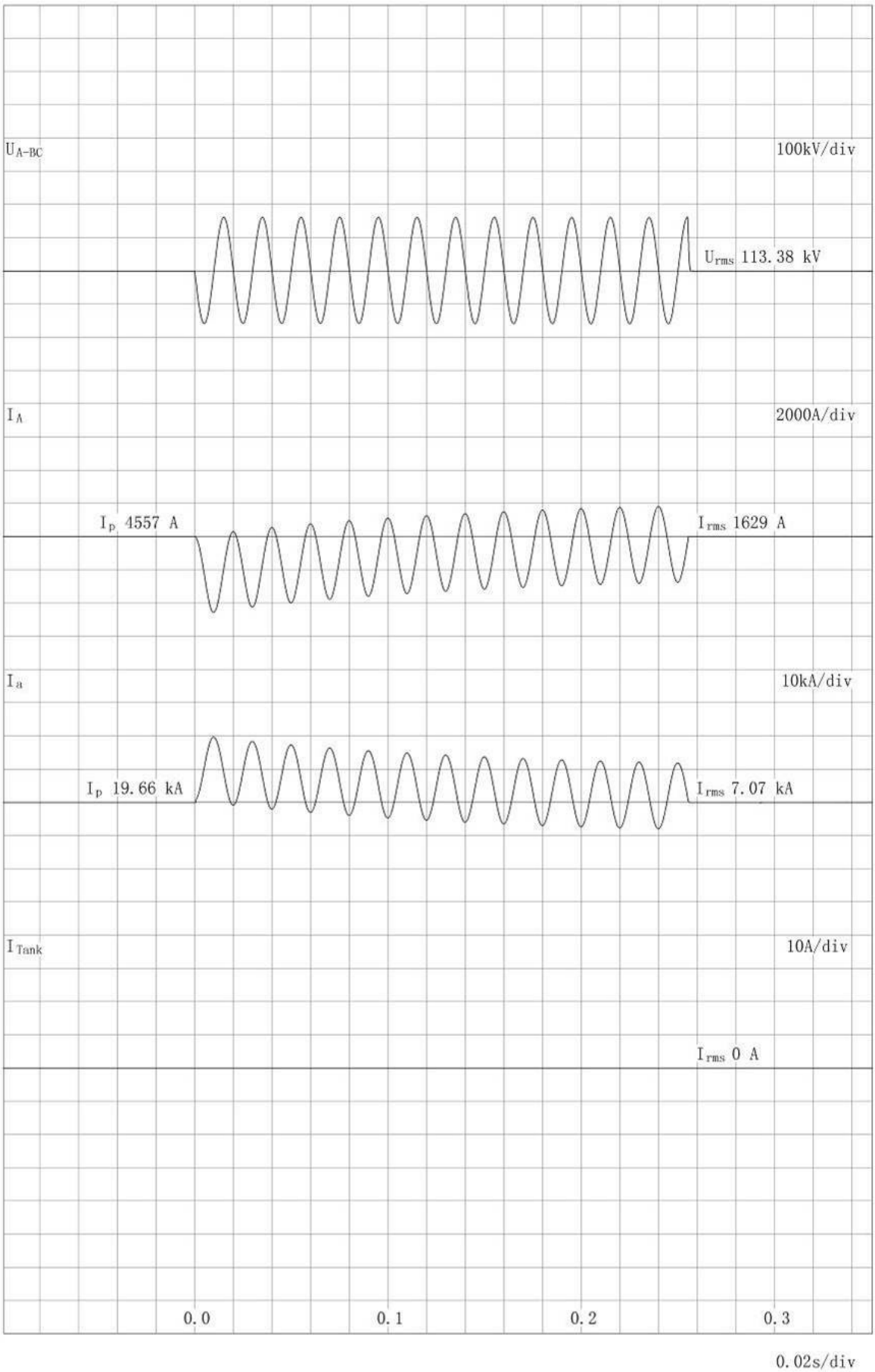
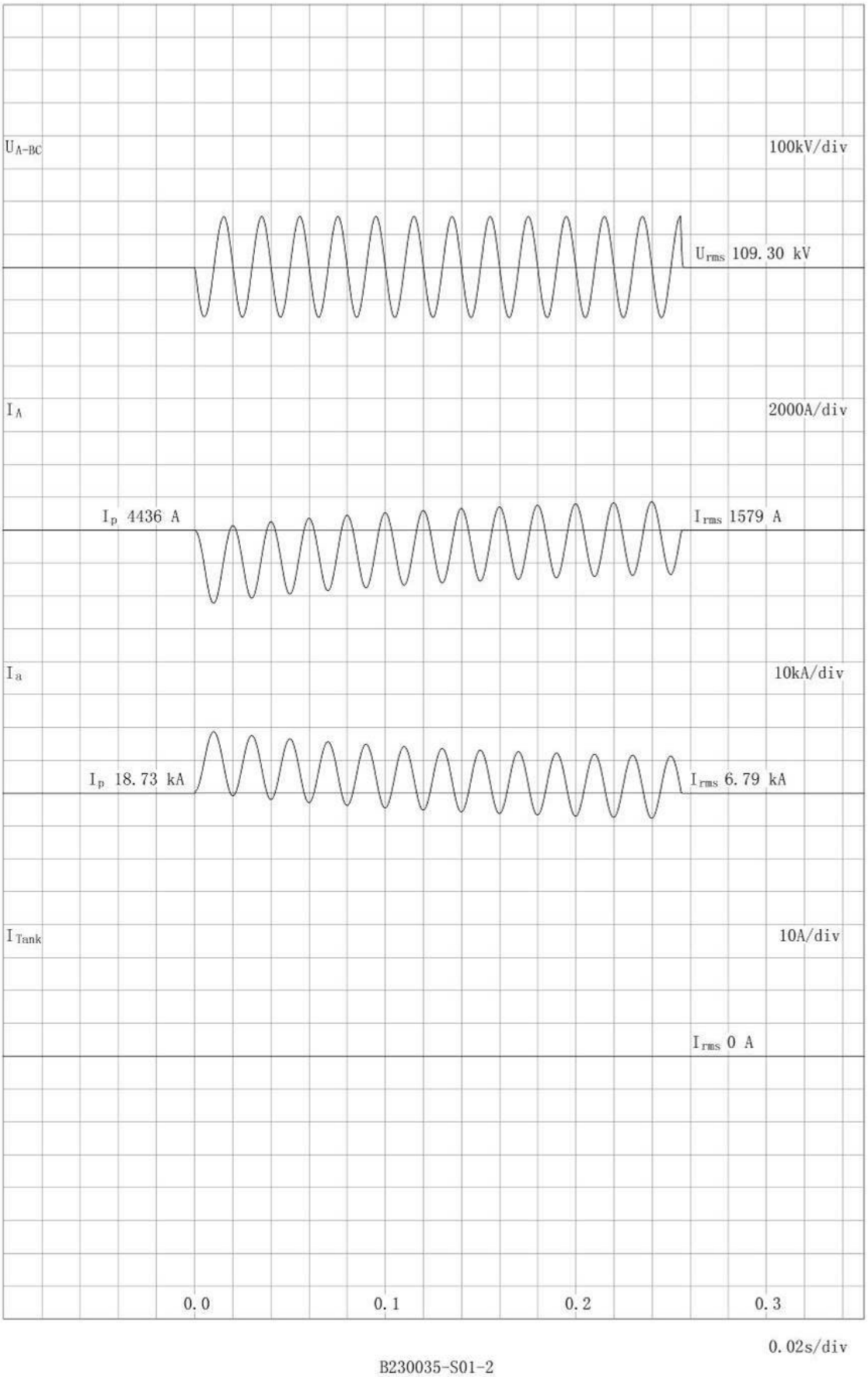


Figure 3

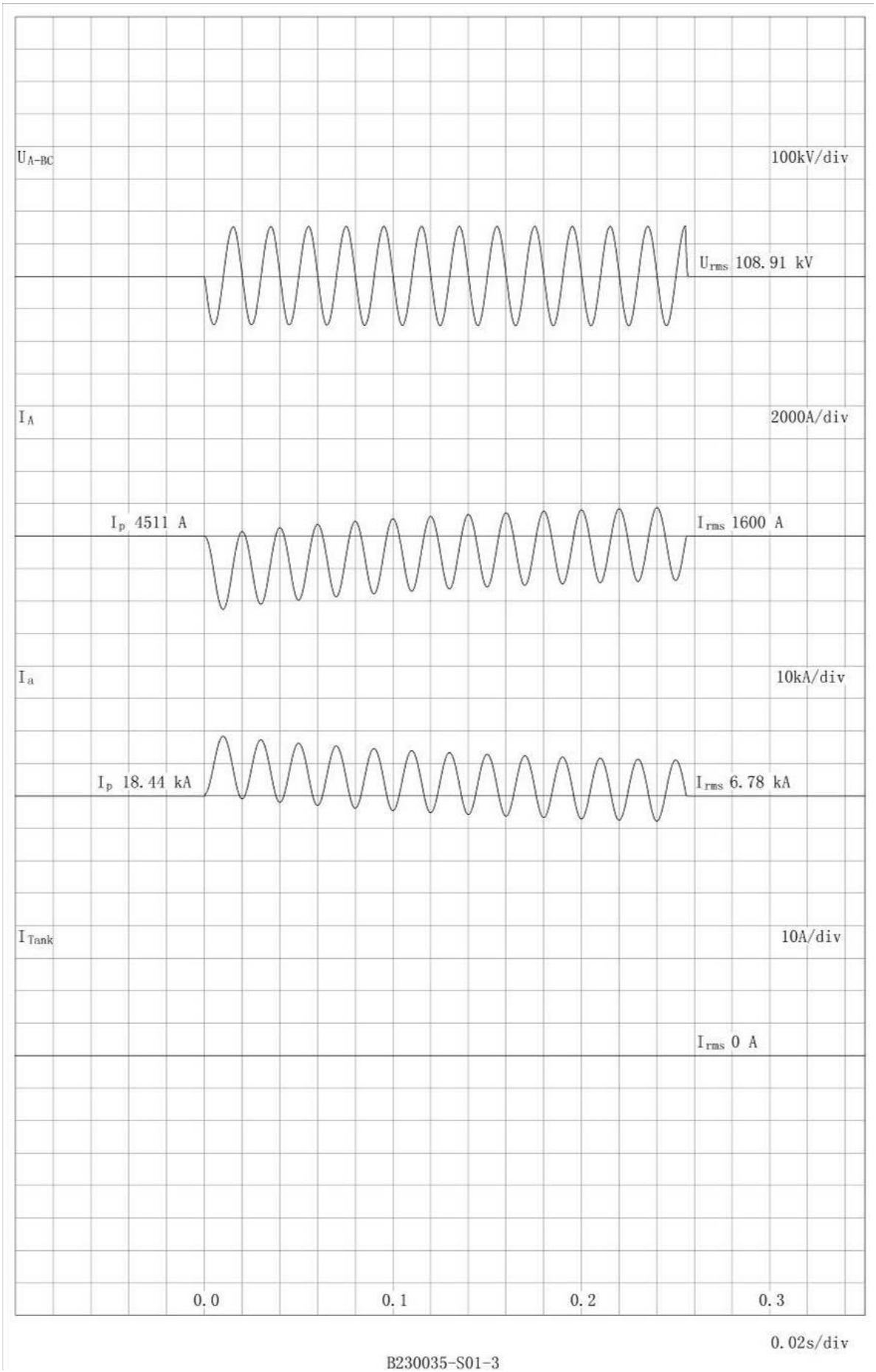

1
2
3
HV side
6
7
8
LV side
4
5
OLTC side
9
10
Ladder side
11
12
13
cover

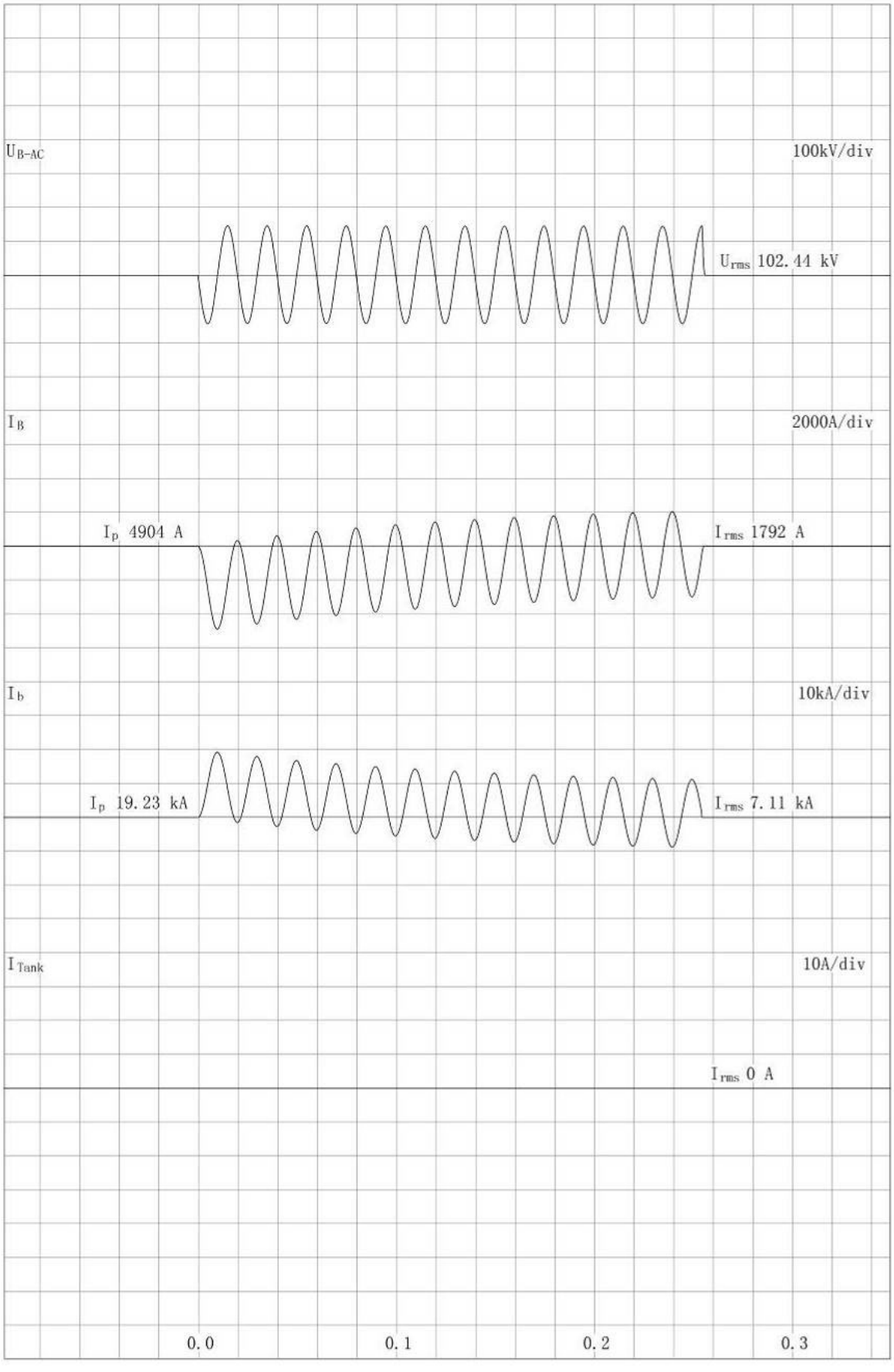


B230035-S01-1

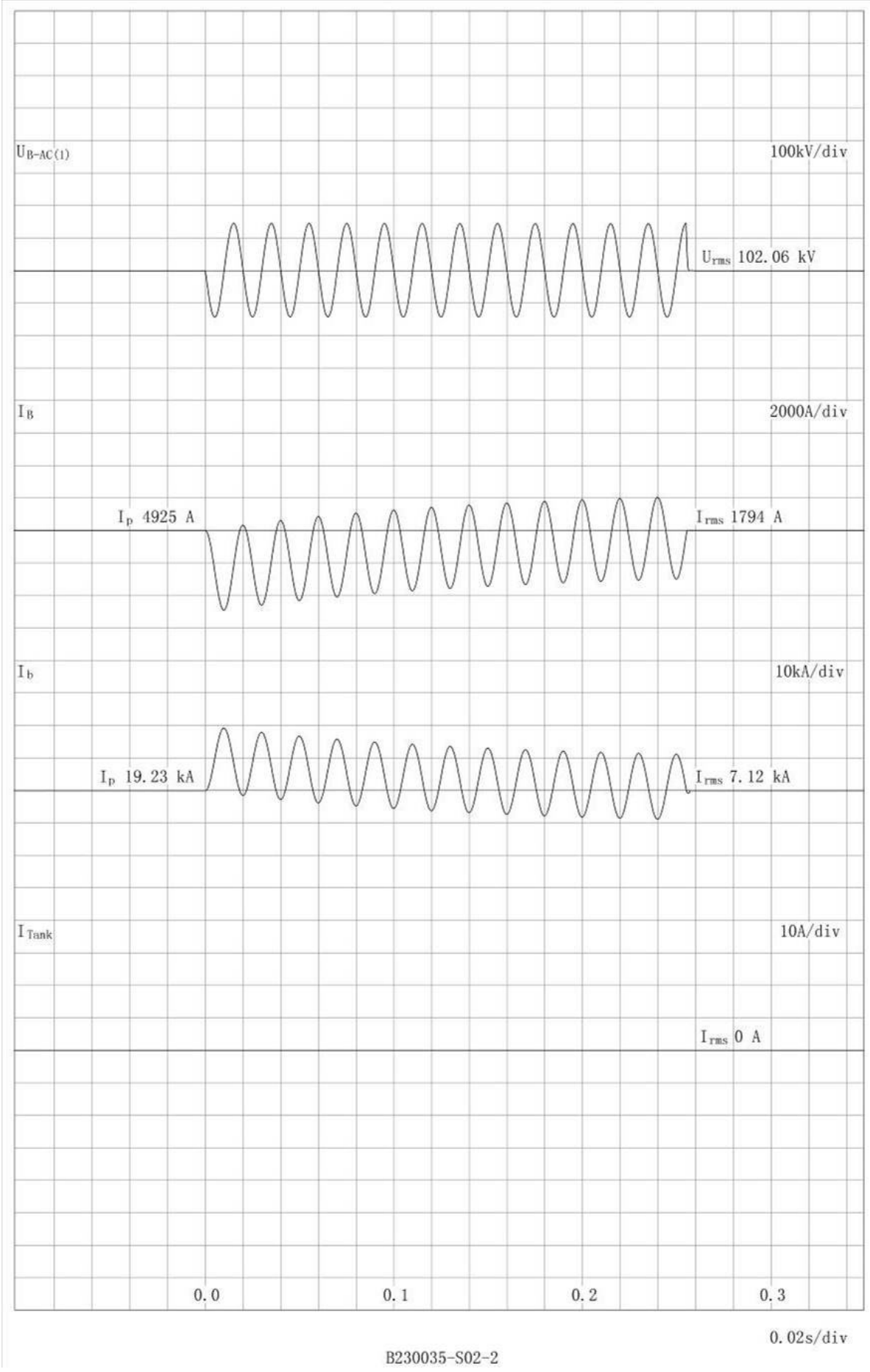


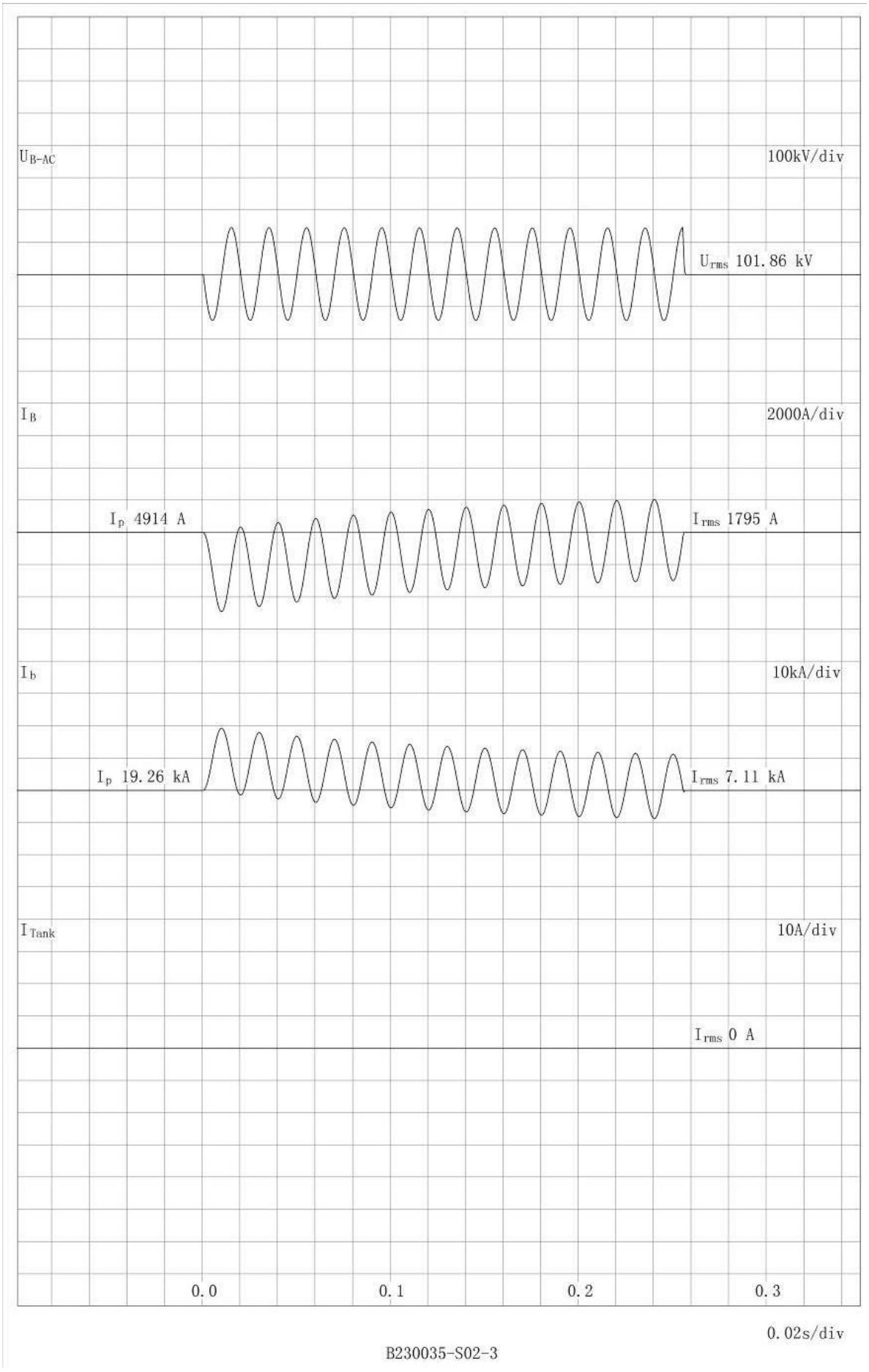
B230035-S01-2

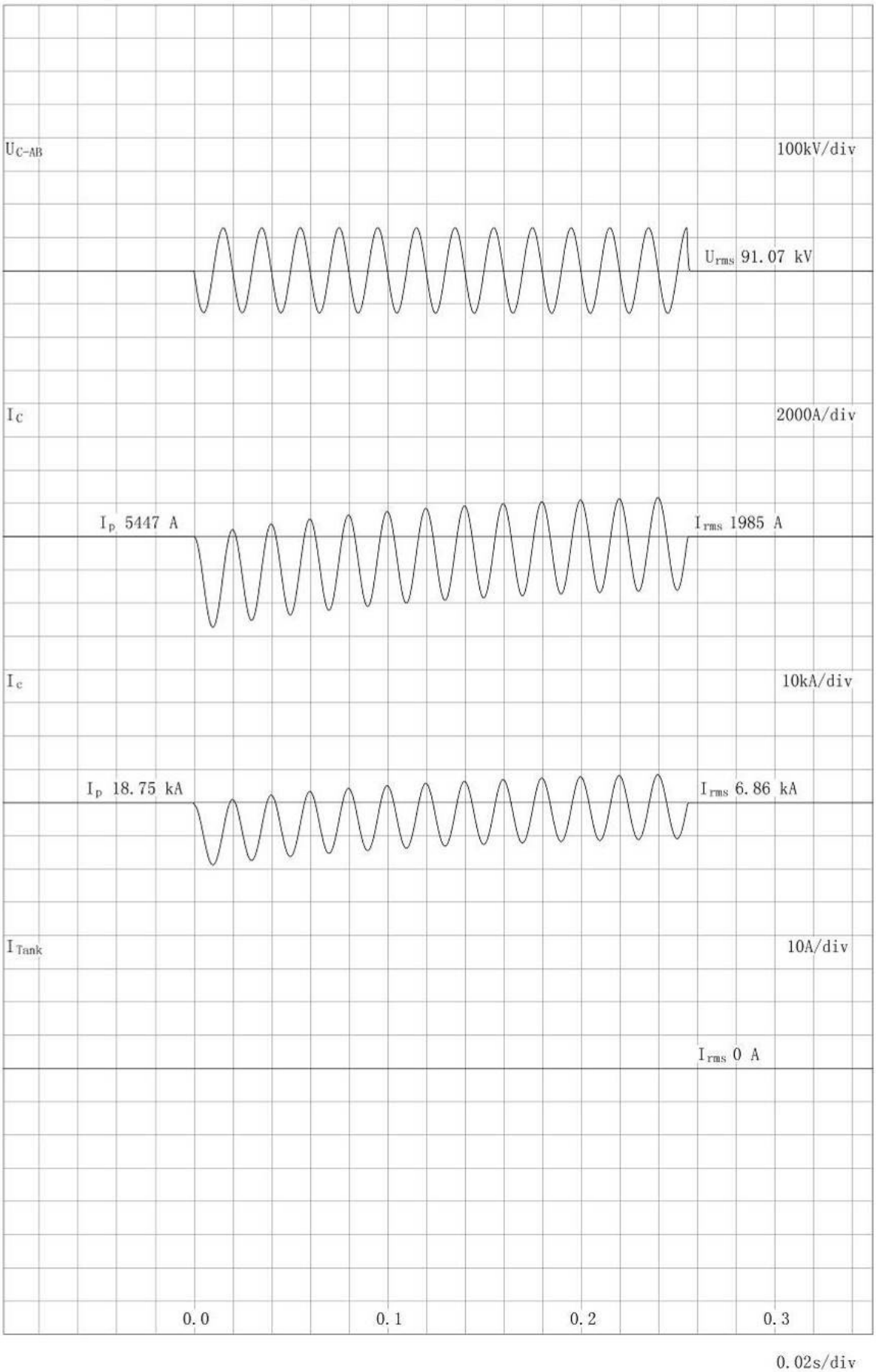

U_{A-BC}
100kV/div
U_{rms} 108.91 kV
I_A
2000A/div
I_p 4511 A
I_{rms} 1600 A
I_a
10kA/div
I_p 18.44 kA
I_{rms} 6.78 kA
I_{Tank}
10A/div
I_{rms} 0 A
0.0
0.1
0.2
0.3
0.02s/div
B230035-S01-3



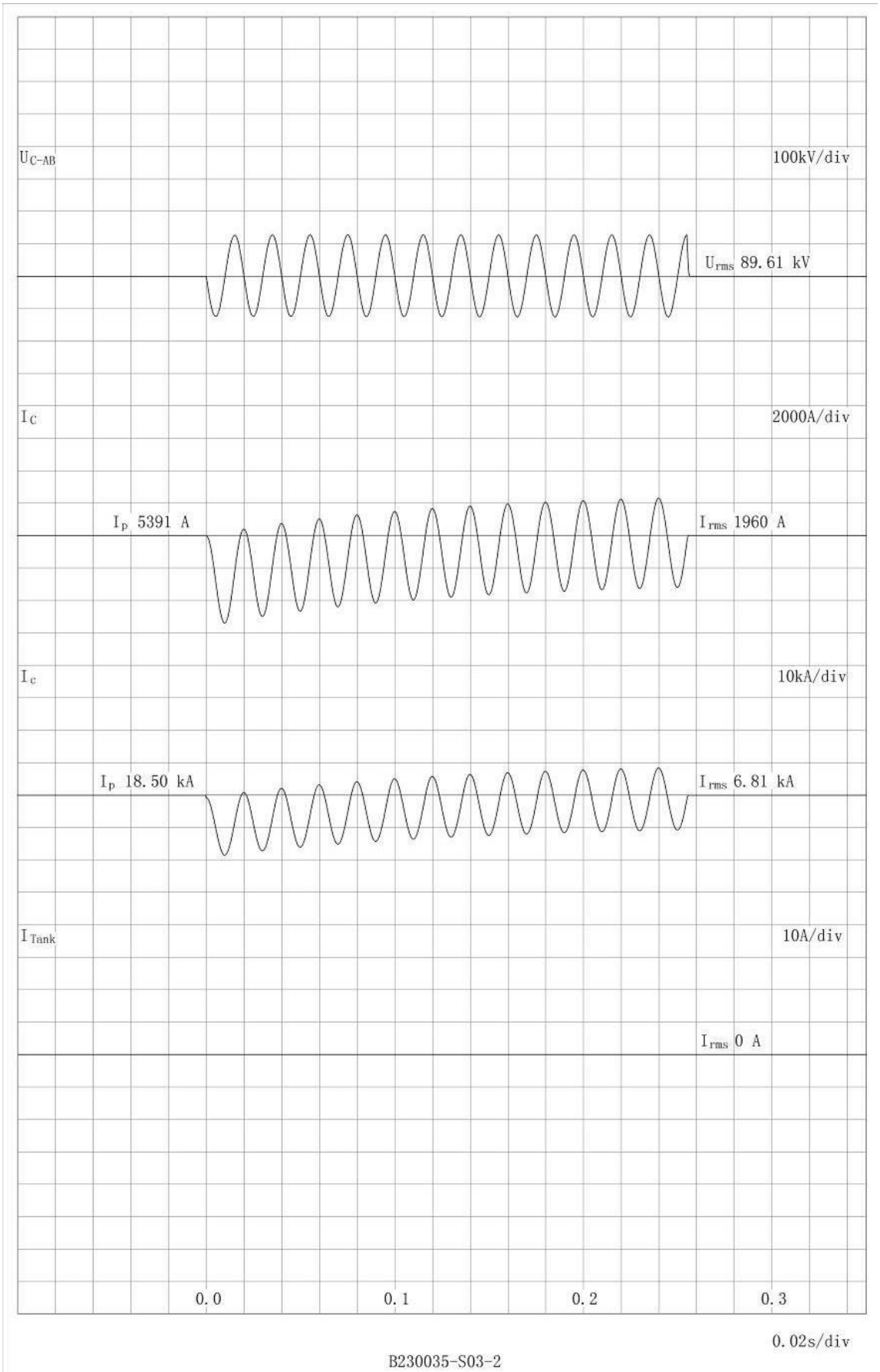
B230035-S02-1

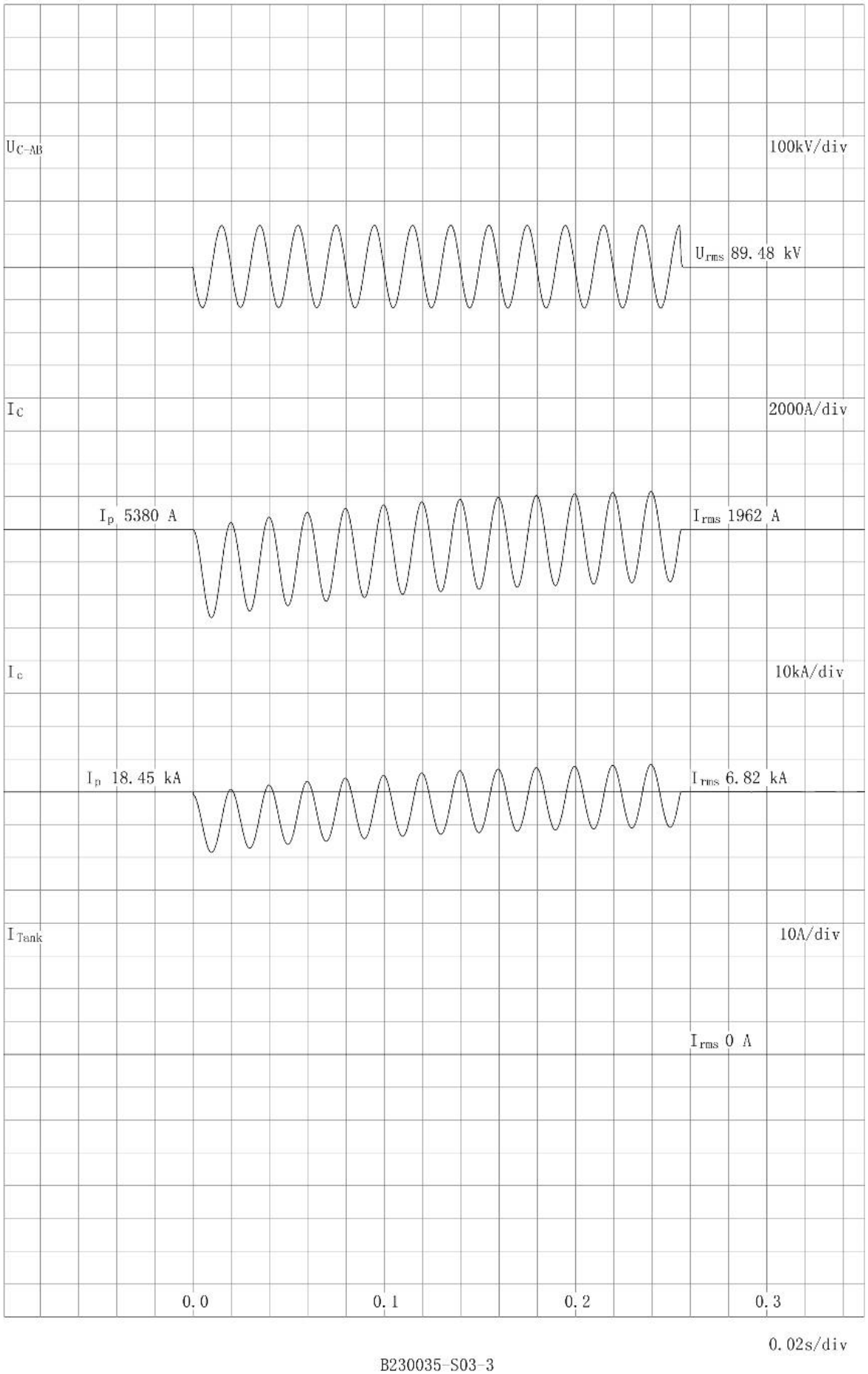

$U_{B-AC(1)}$
100kV/div
U_{rms} 102.06 kV
I_B
2000A/div
I_p 4925 A
I_{rms} 1794 A
I_b
10kA/div
I_p 19.23 kA
I_{rms} 7.12 kA
I_{Tank}
10A/div
I_{rms} 0 A
0.0
0.1
0.2
0.3
0.02s/div
B230035-S02-2


U_{B-AC}
100kV/div
U_{rms} 101.86 kV
I_B
2000A/div
I_p 4914 A
I_{rms} 1795 A
I_b
10kA/div
I_p 19.26 kA
I_{rms} 7.11 kA
I_{Tank}
10A/div
I_{rms} 0 A
0.0
0.1
0.2
0.3
0.02s/div
B230035-S02-3

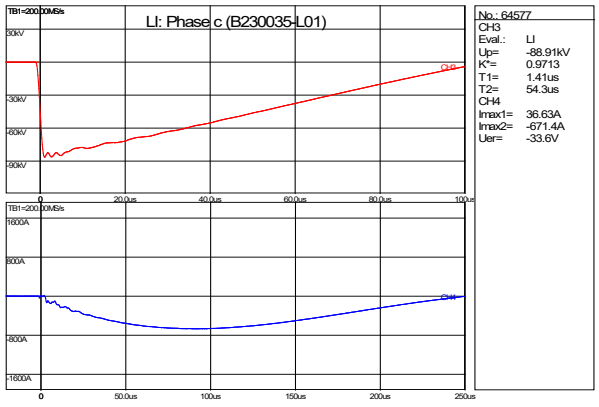


B230035-S03-1

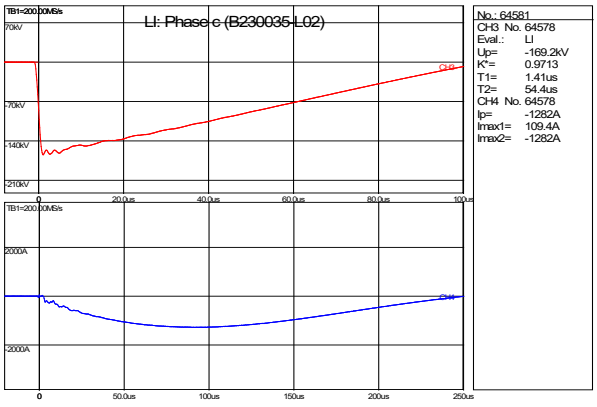

U_{C-AB}
100kV/div
U_{rms} 89.61 kV
I_C
2000A/div
I_p 5391 A
I_{rms} 1960 A
I_c
10kA/div
I_p 18.50 kA
I_{rms} 6.81 kA
I_{Tank}
10A/div
I_{rms} 0 A
0.0
0.1
0.2
0.3
0.02s/div
B230035-S03-2



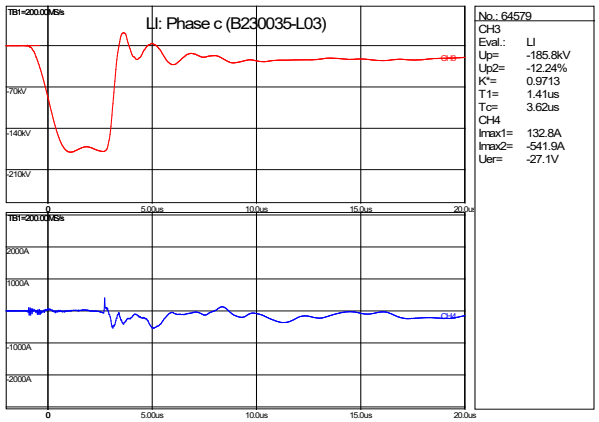
B230035-S03-3



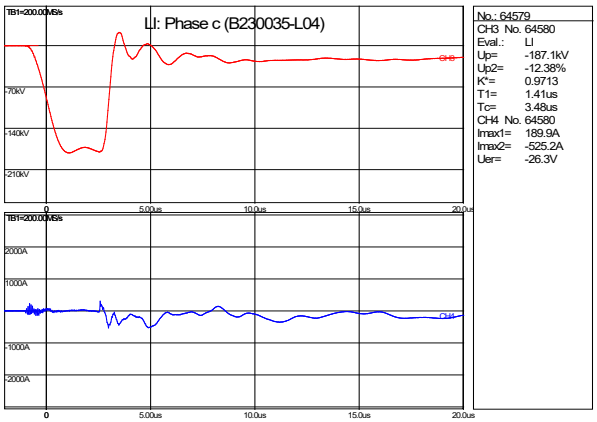
B230035-L001



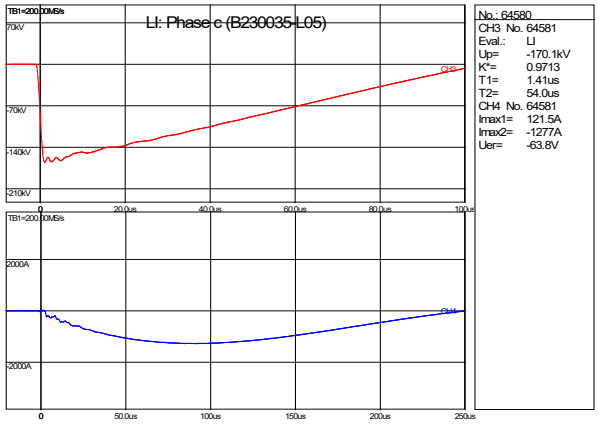
B230035-L002



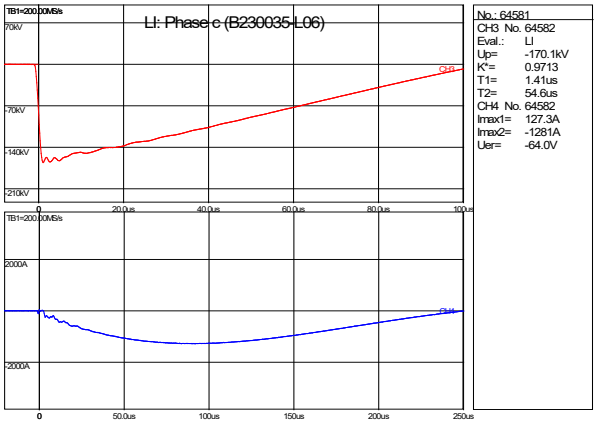
B230035-L003



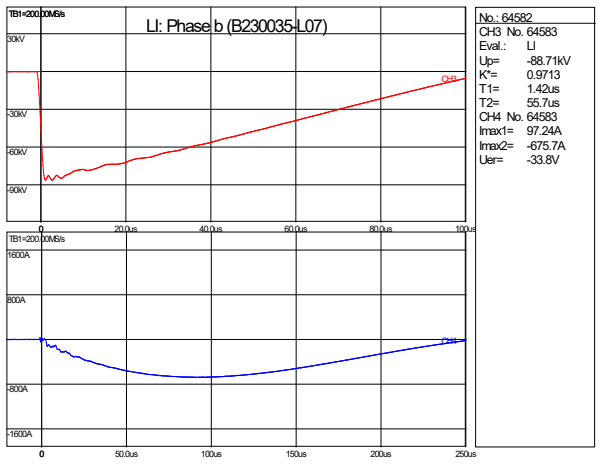
B230035-L004



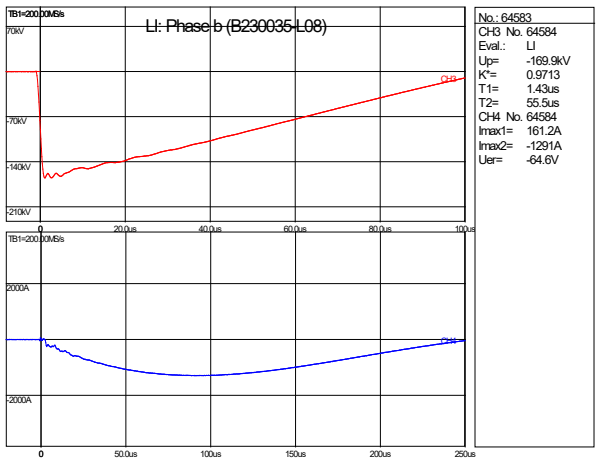
B230035-L005



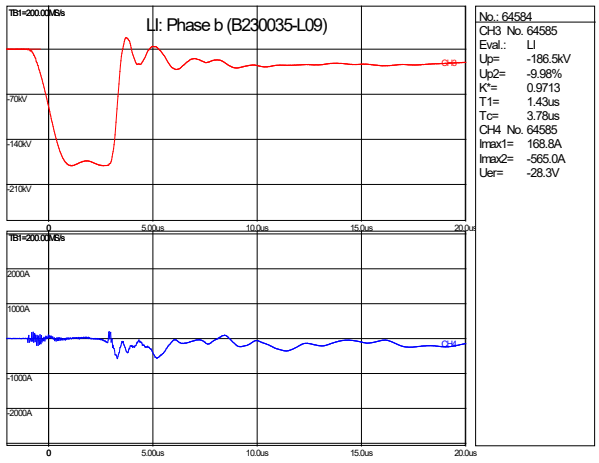
B230035-L006



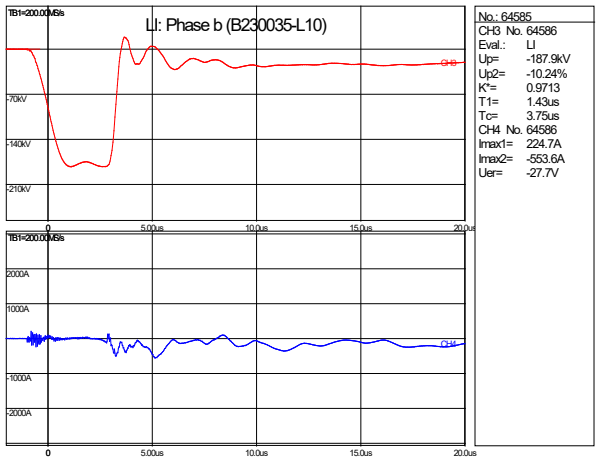
B230035-L007



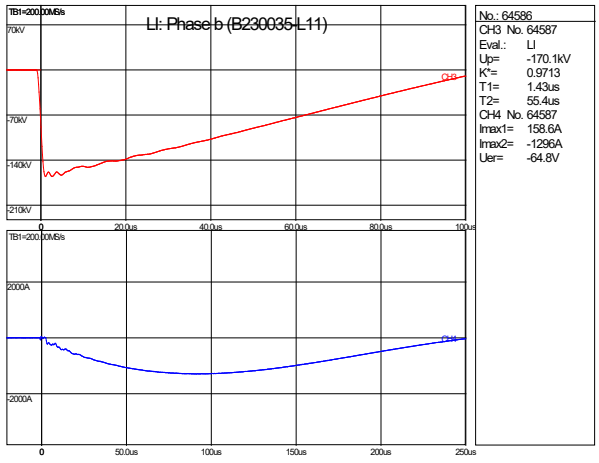
B230035-L008



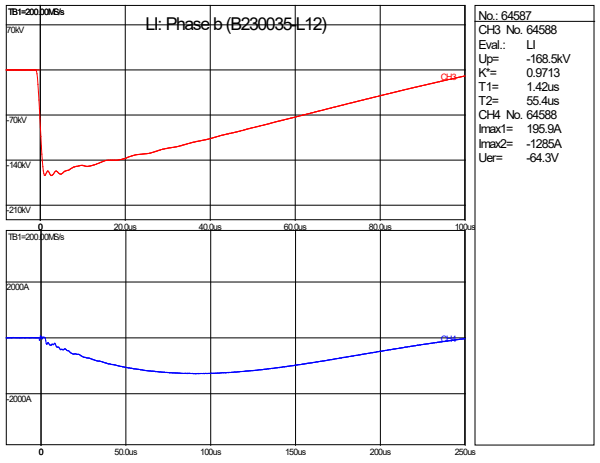
B230035-L009



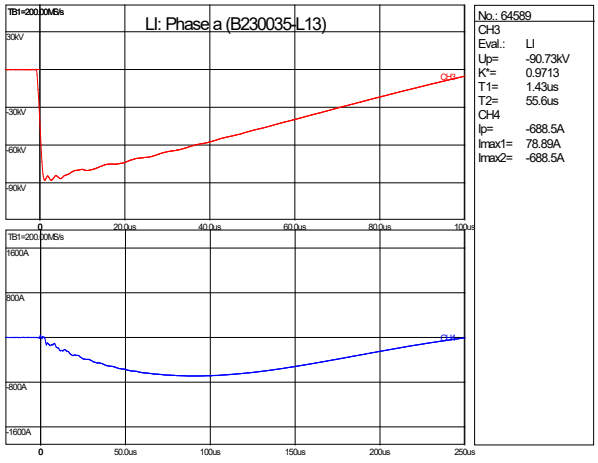
B230035-L010



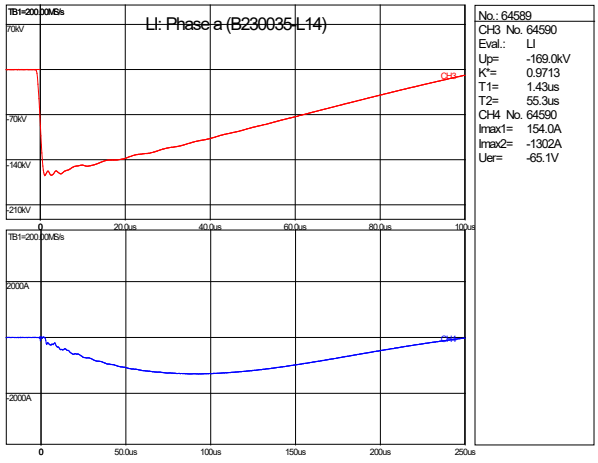
B230035-L011



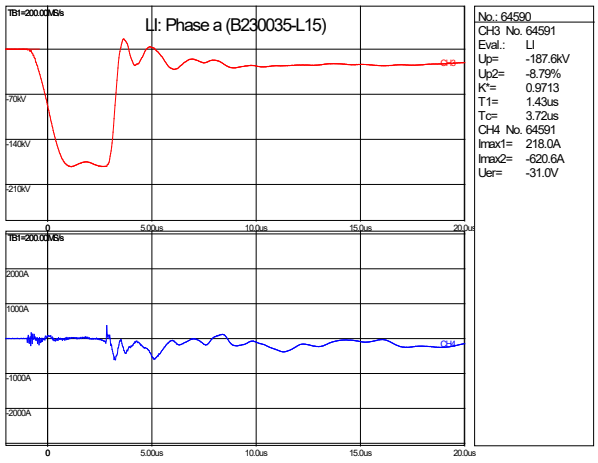
B230035-L012



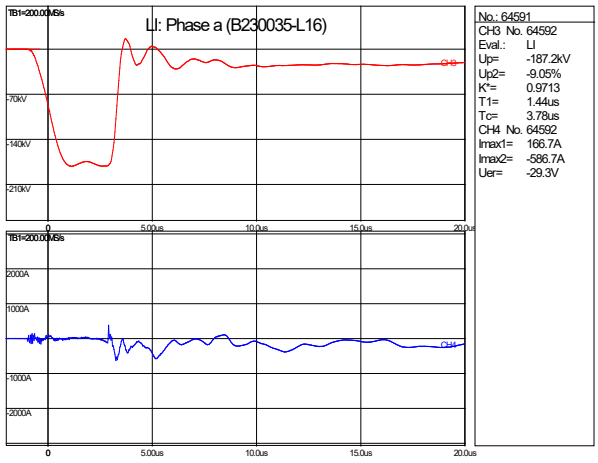
B230035-L013



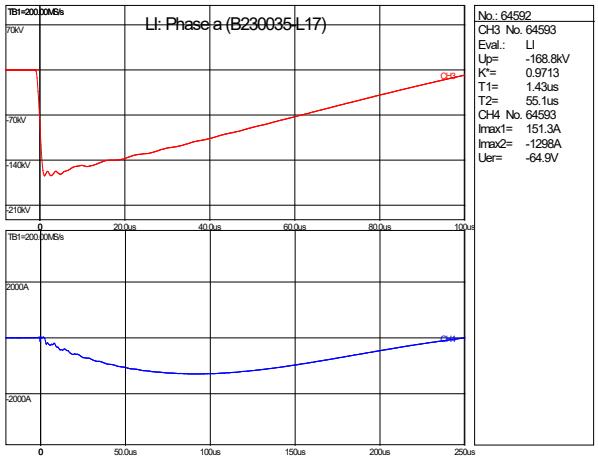
B230035-L014



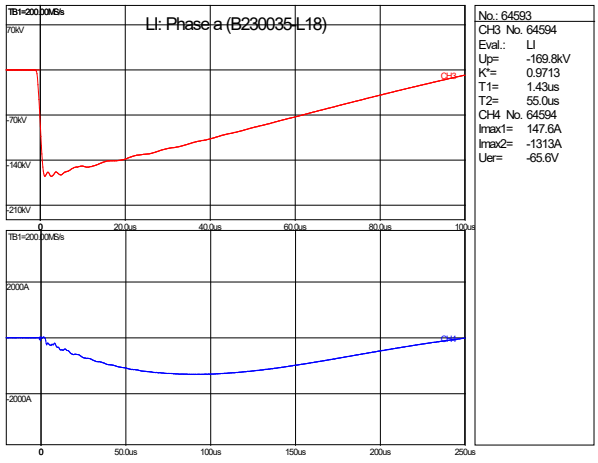
B230035-L015



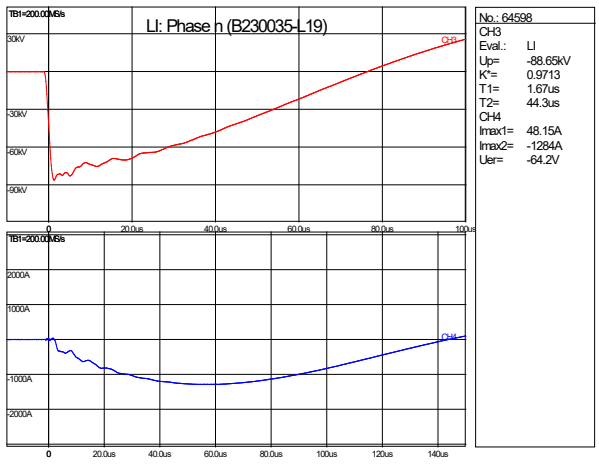
B230035-L016



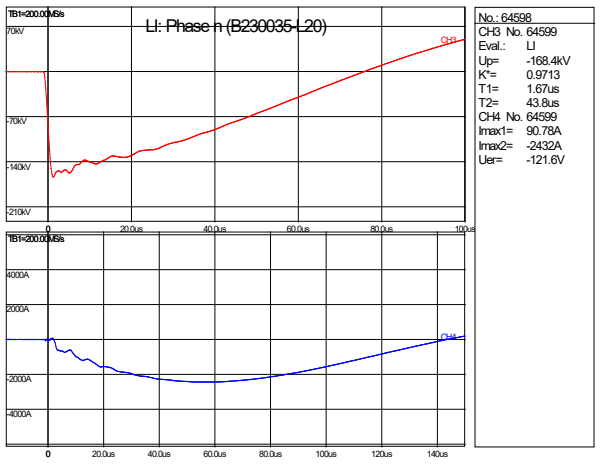
B230035-L017



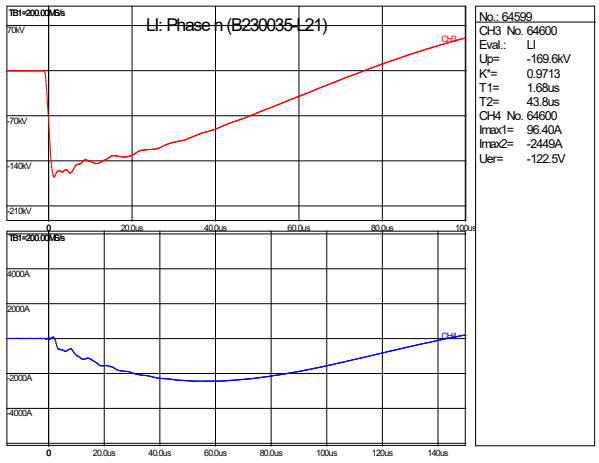
B230035-L018



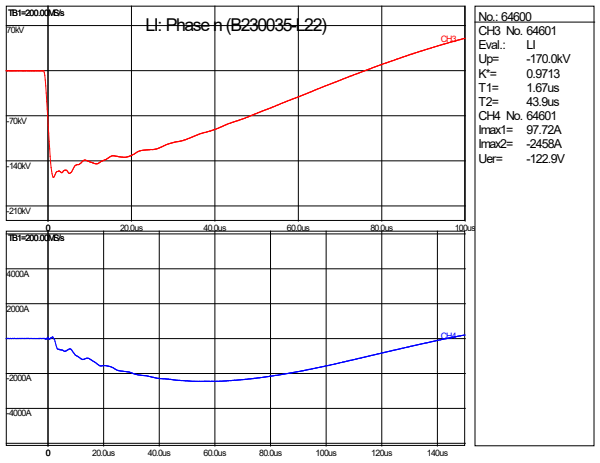
B230035-L019



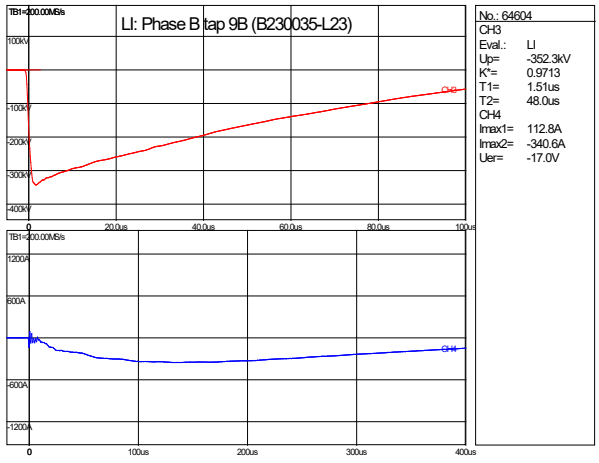
B230035-L020



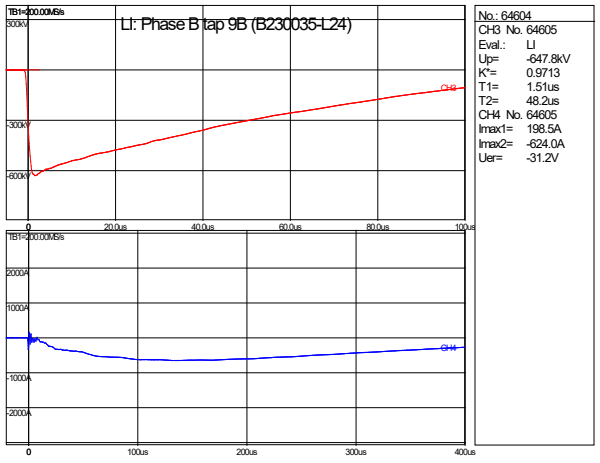
B230035-L021



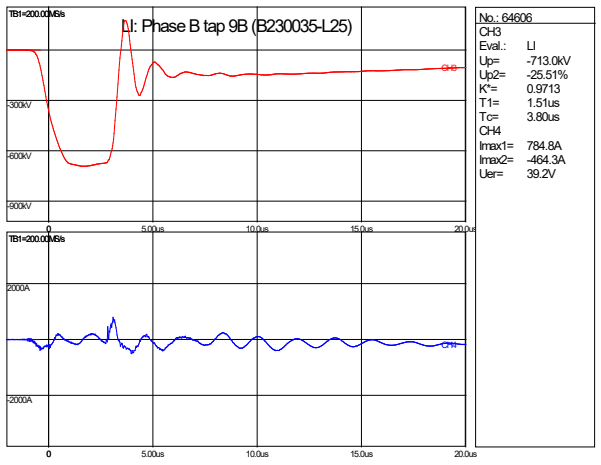
B230035-L022



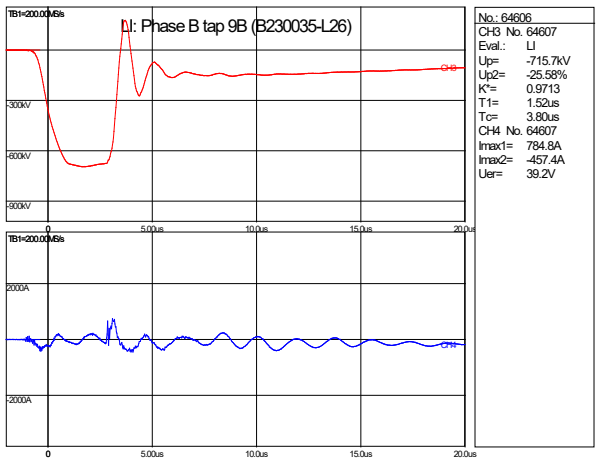
B230035-L023



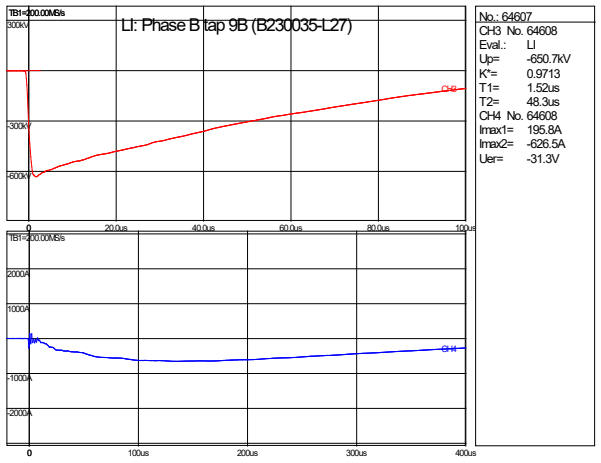
B230035-L024



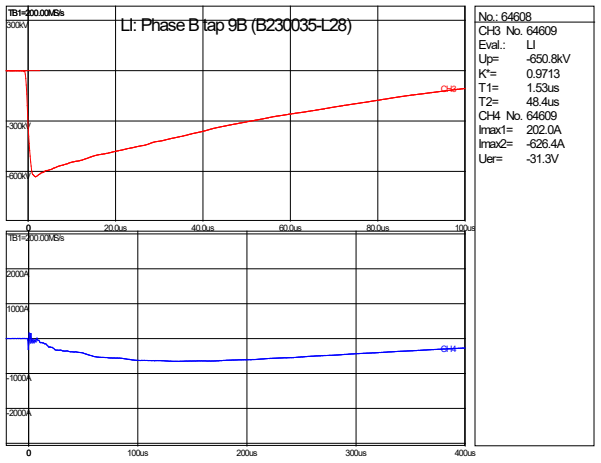
B230035-L025



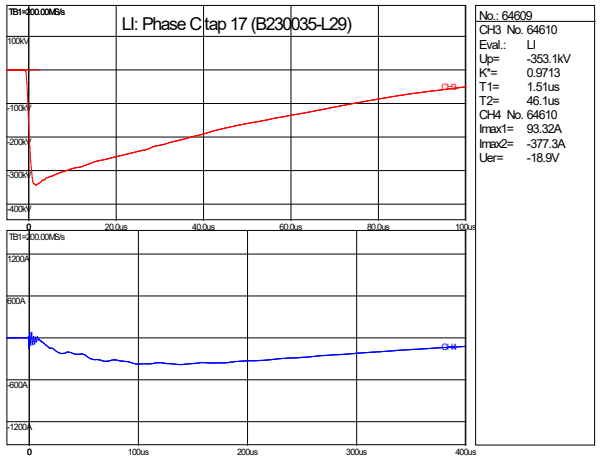
B230035-L026



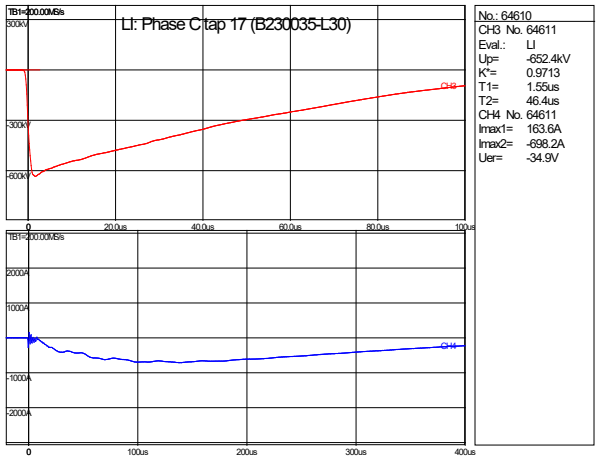
B230035-L027



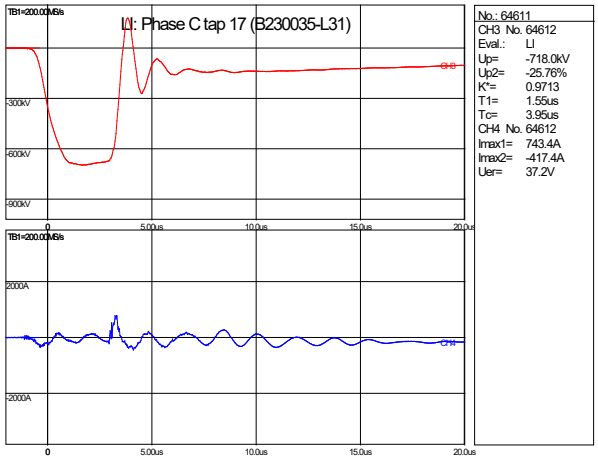
B230035-L028



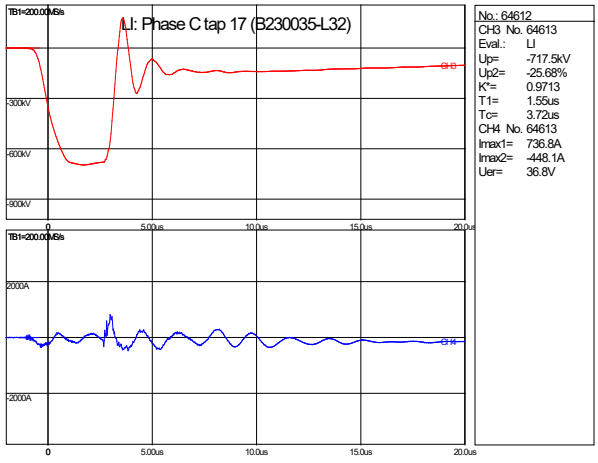
B230035-L029



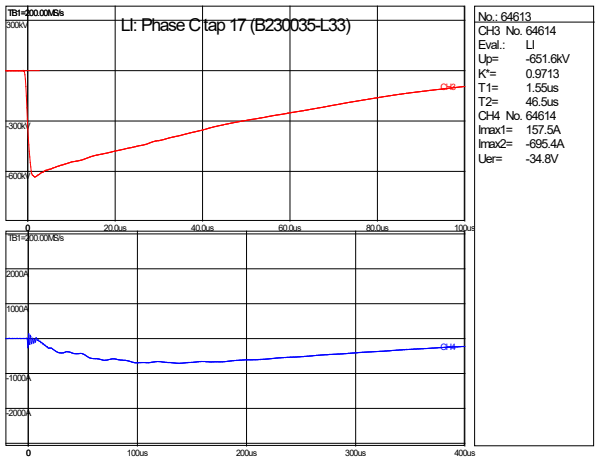
B230035-L030



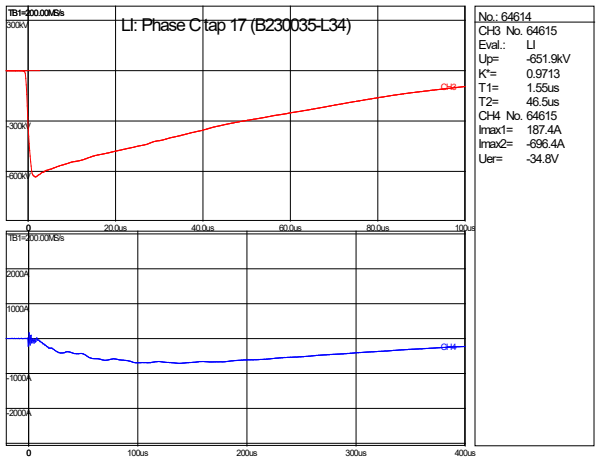
B230035-L031



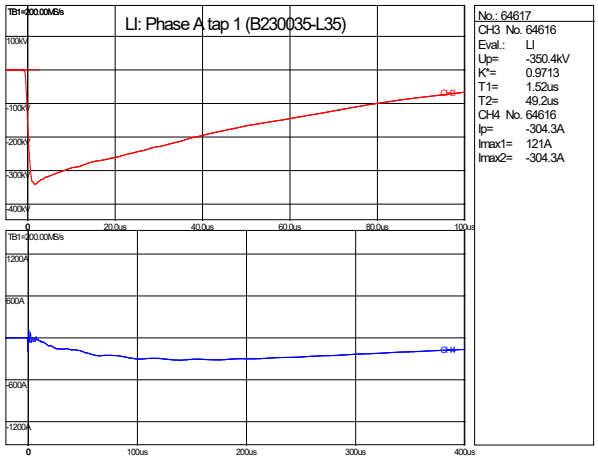
B230035-L032



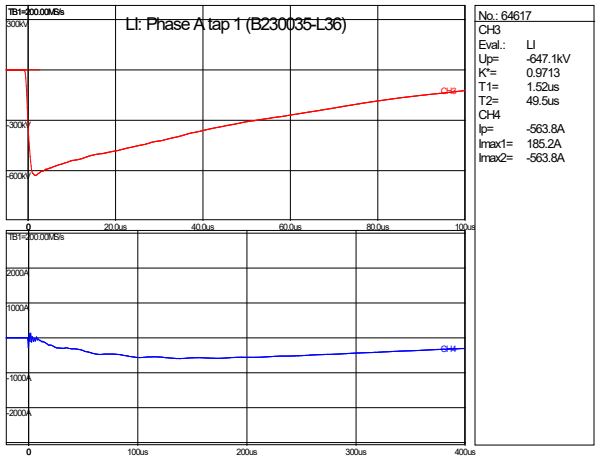
B230035-L033



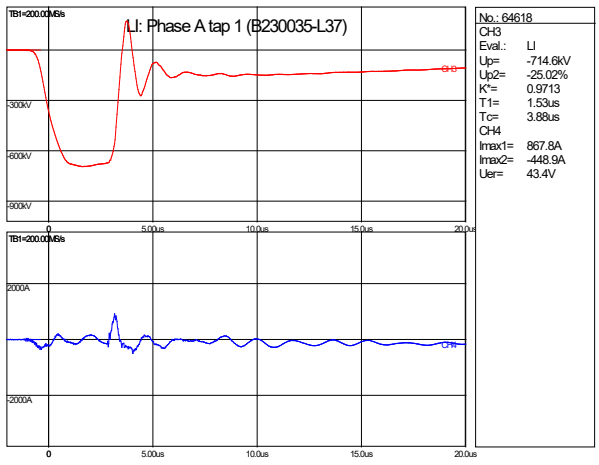
B230035-L034



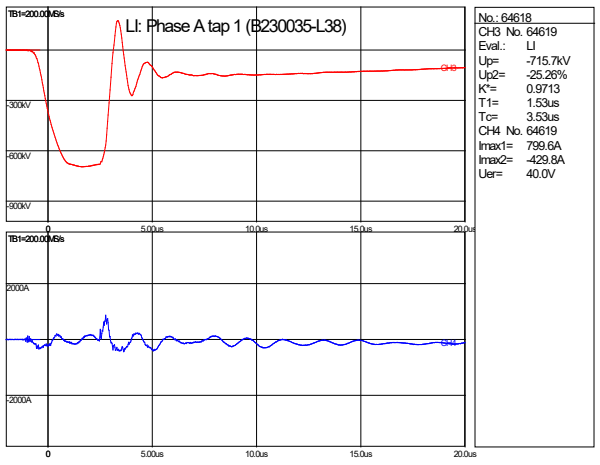
B230035-L035



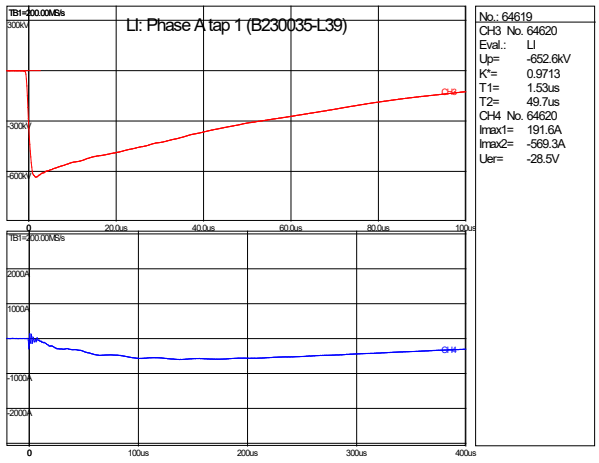
B230035-L036



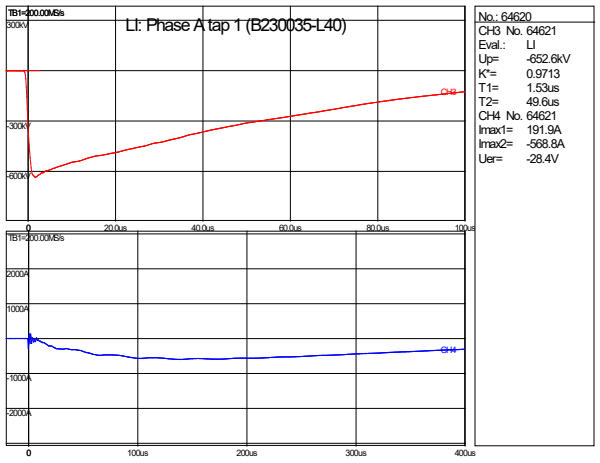
B230035-L037



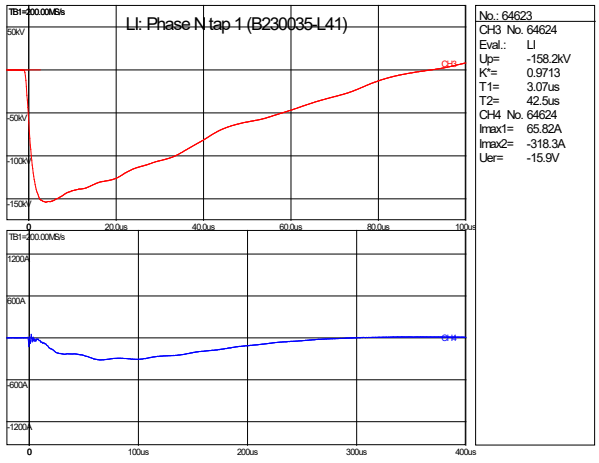
B230035-L038



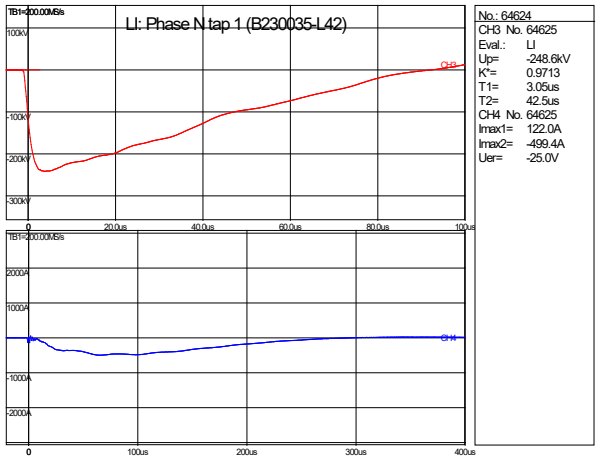
B230035-L039



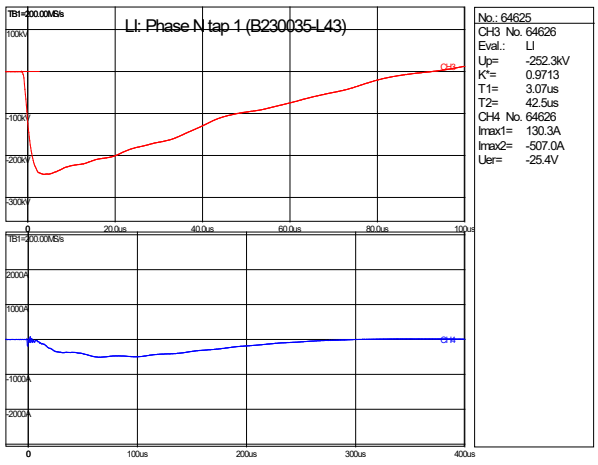
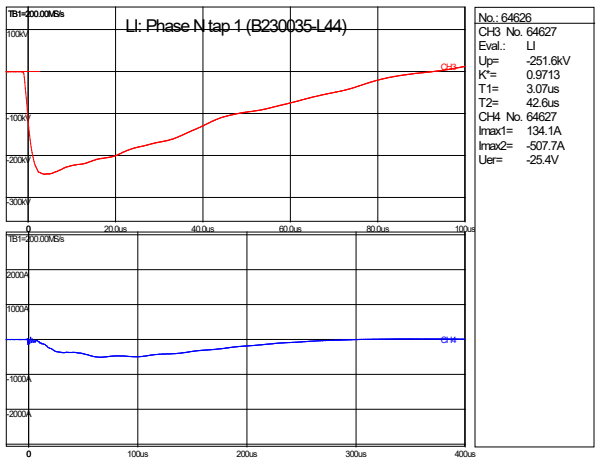
B230035-L040

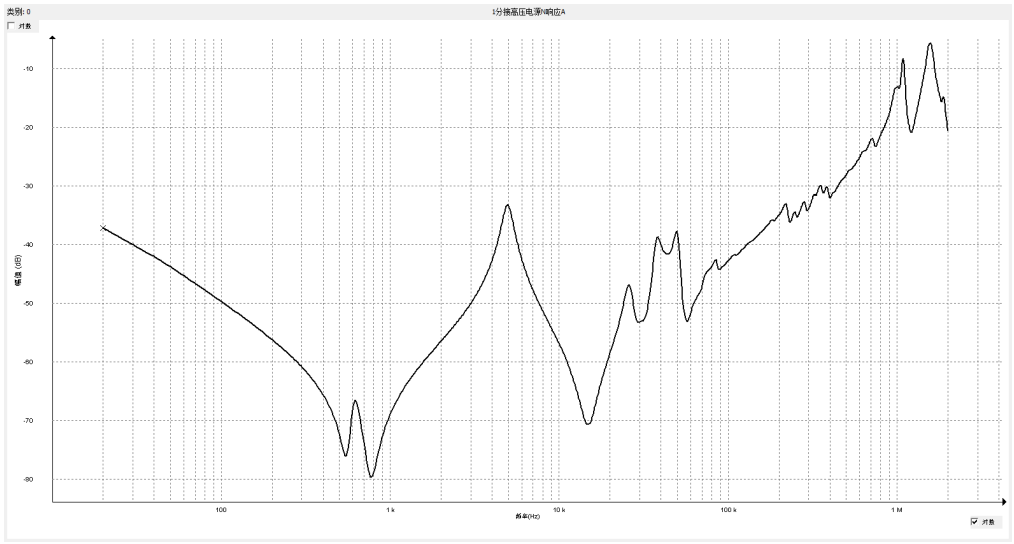


B230035-L041

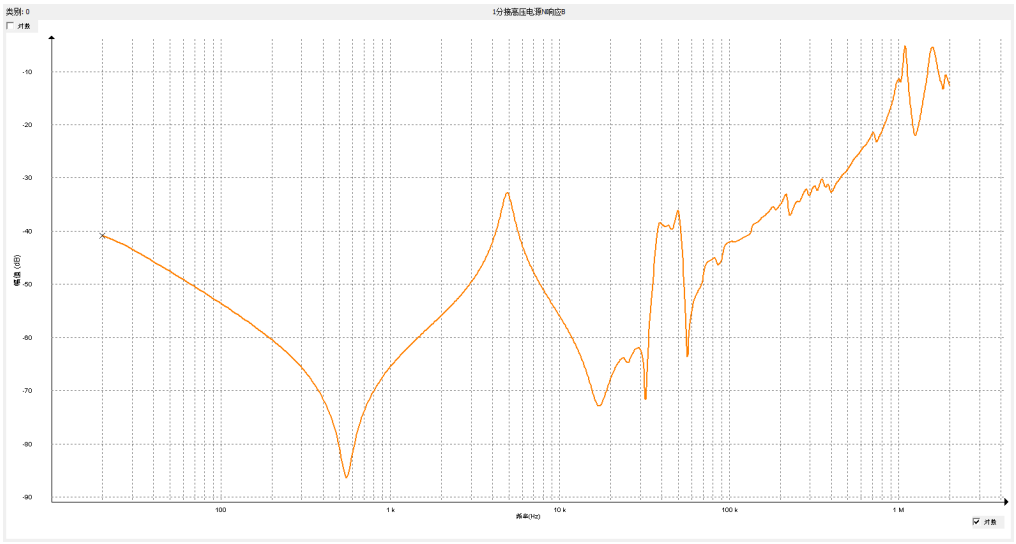


B230035-L042

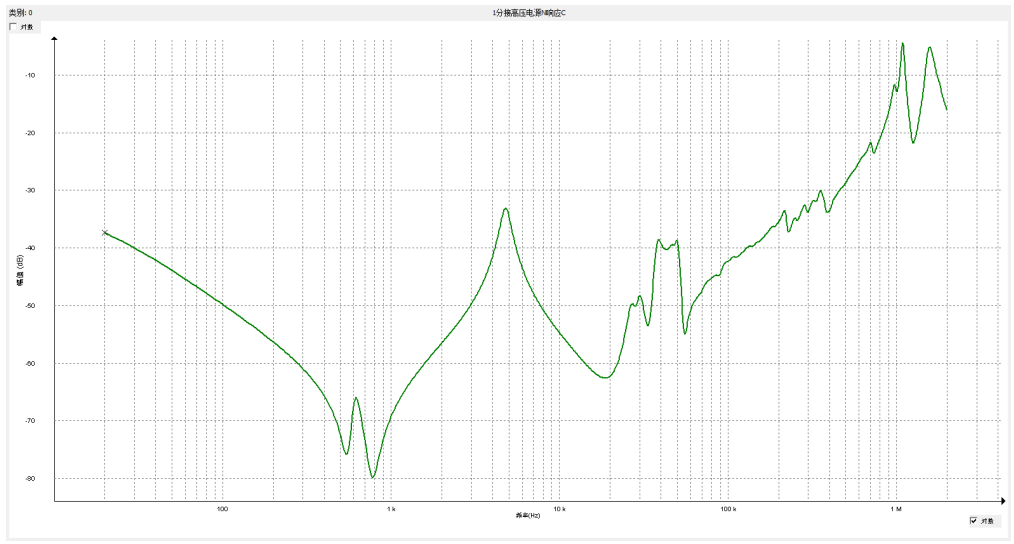
	
B230035-L043	B230035-L044



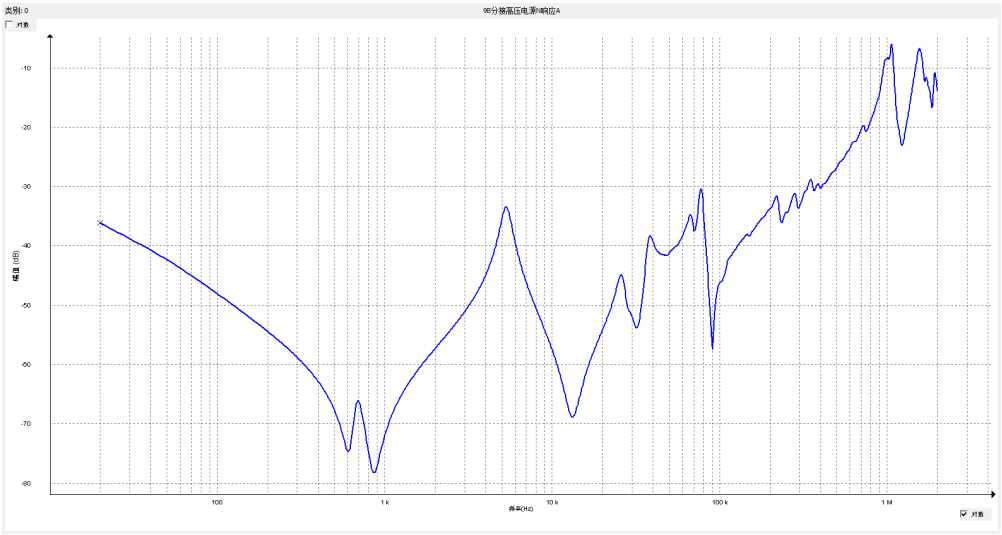
B230035-FRA01



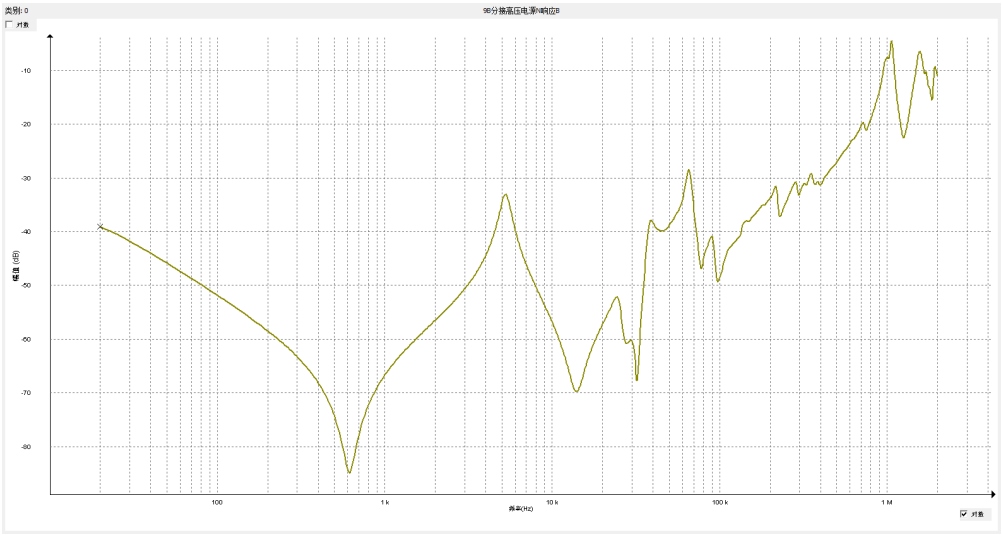
B230035-FRA02



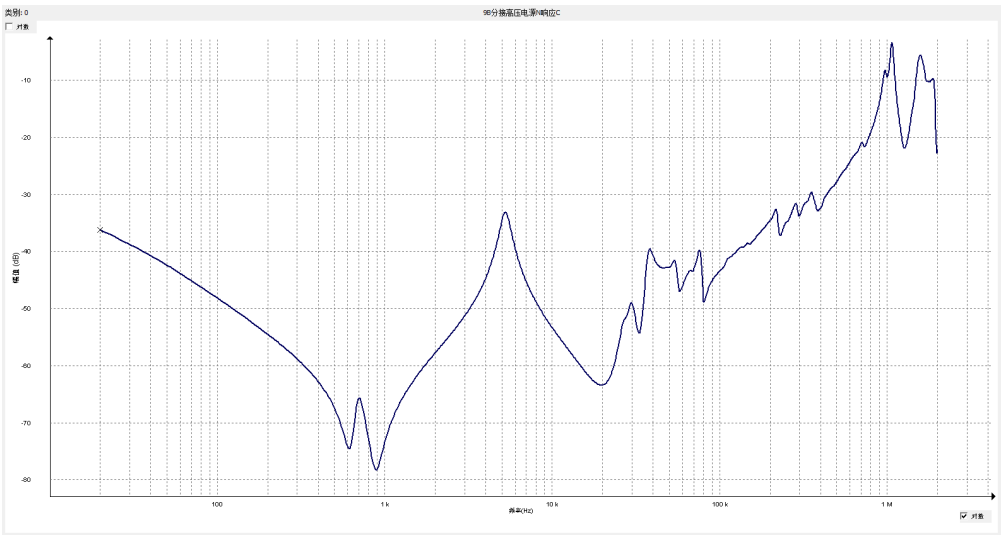
B230035-FRA03



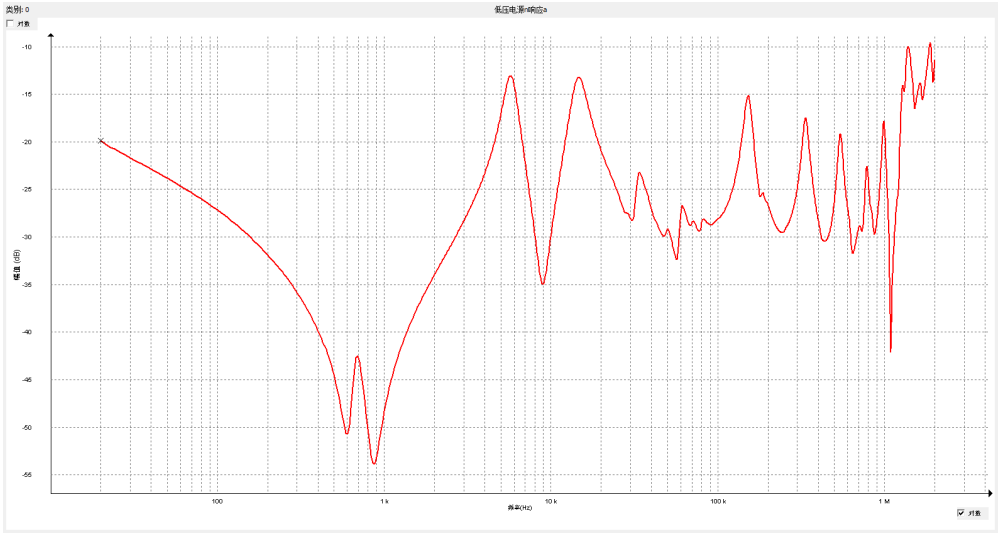
B230035-FRA04



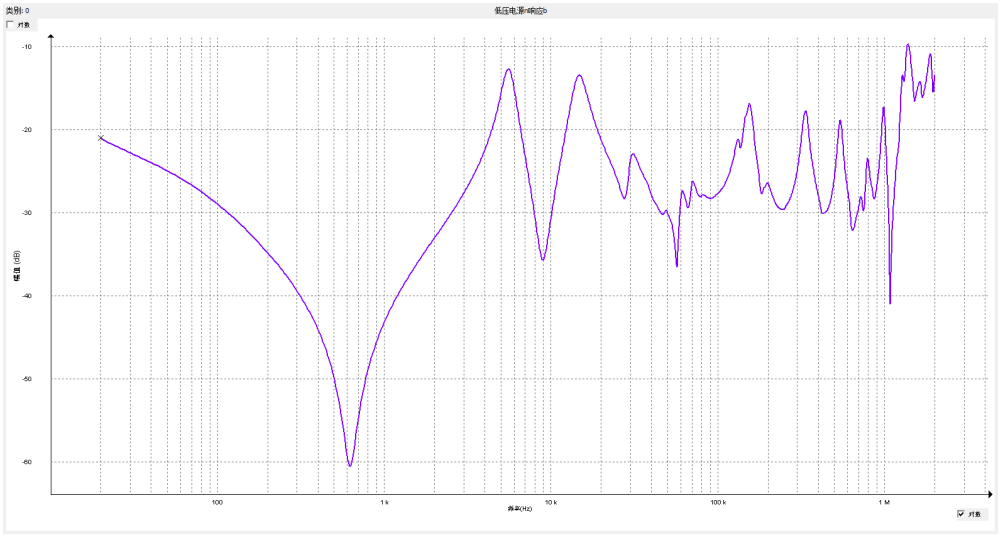
B230035-FRA05



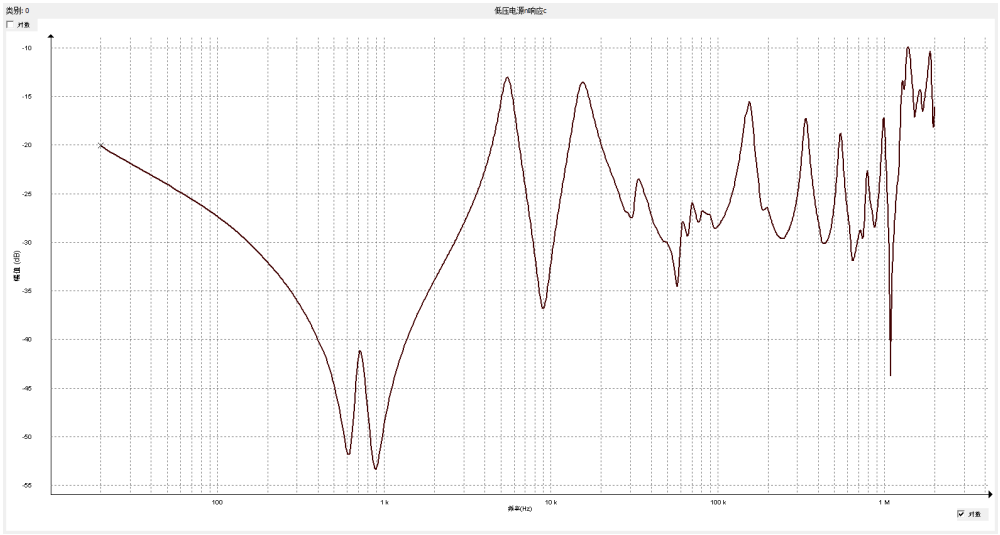
B230035-FRA06



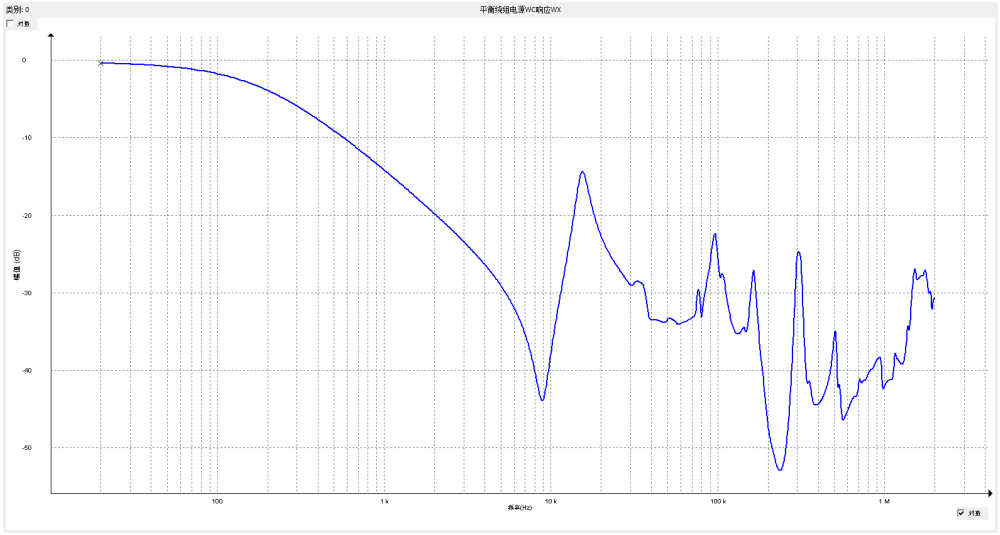
B230035-FRA07



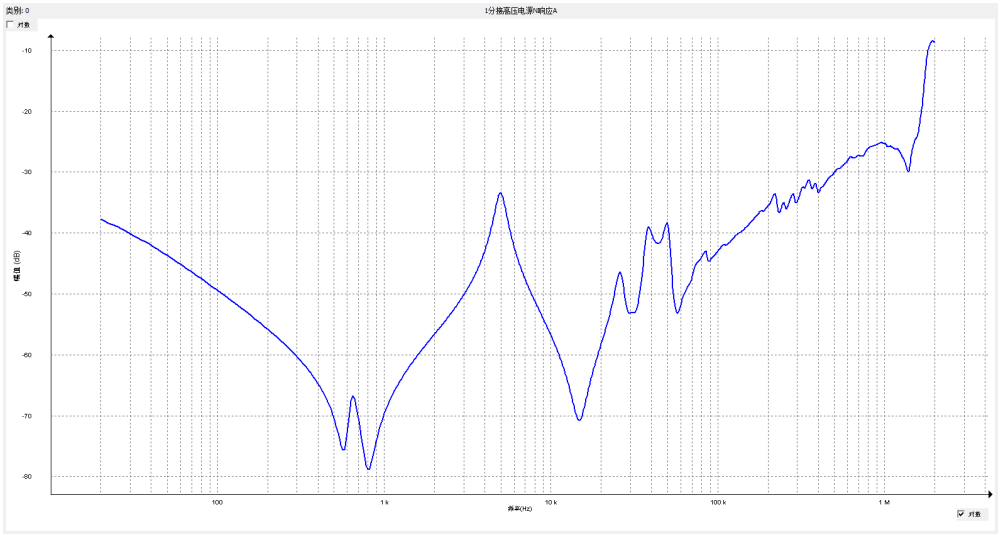
B230035-FRA08



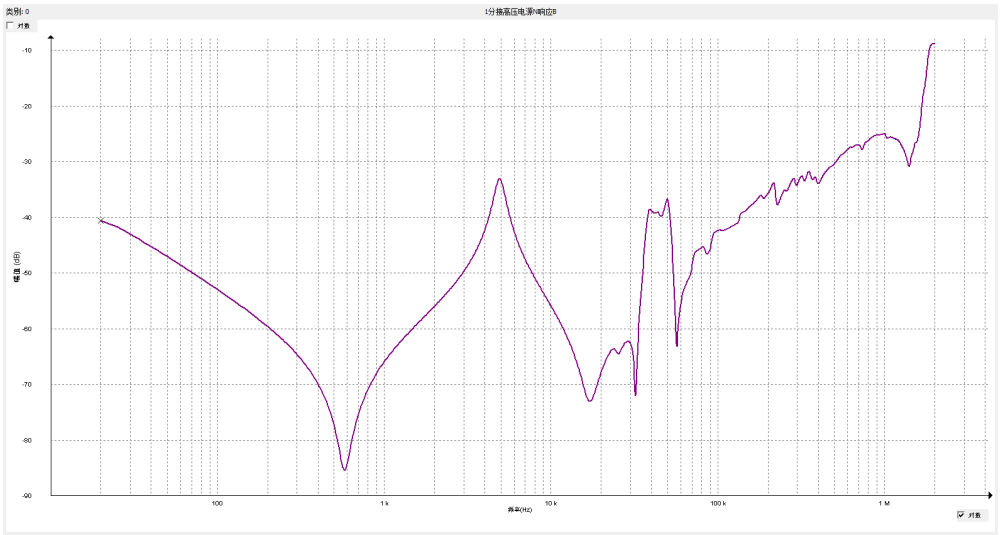
B230035-FRA09



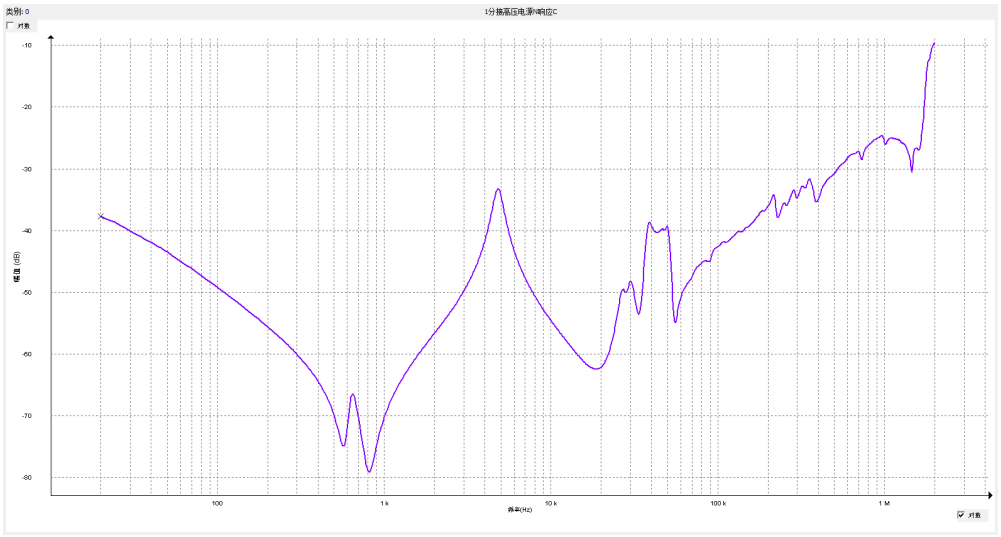
B230035-FRA10



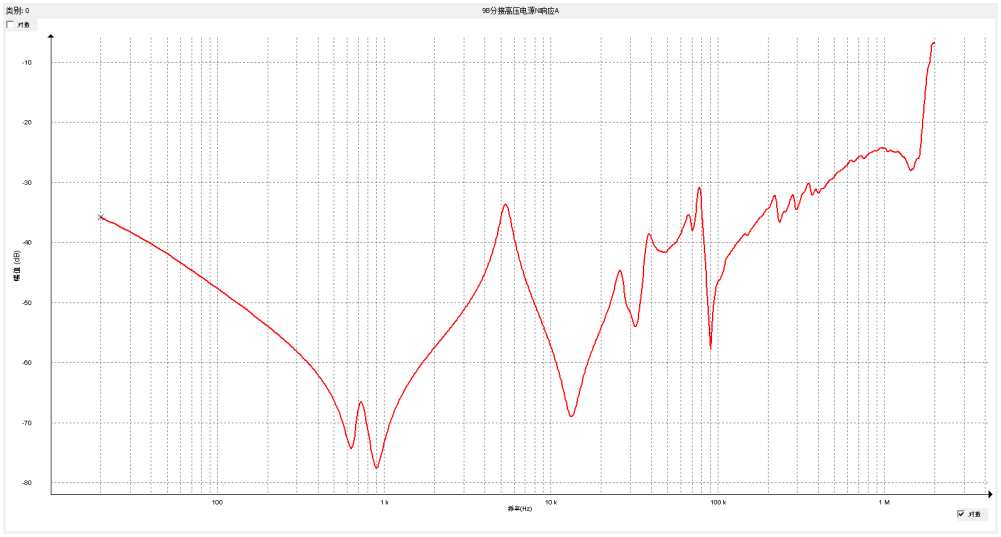
B230035-FRA11



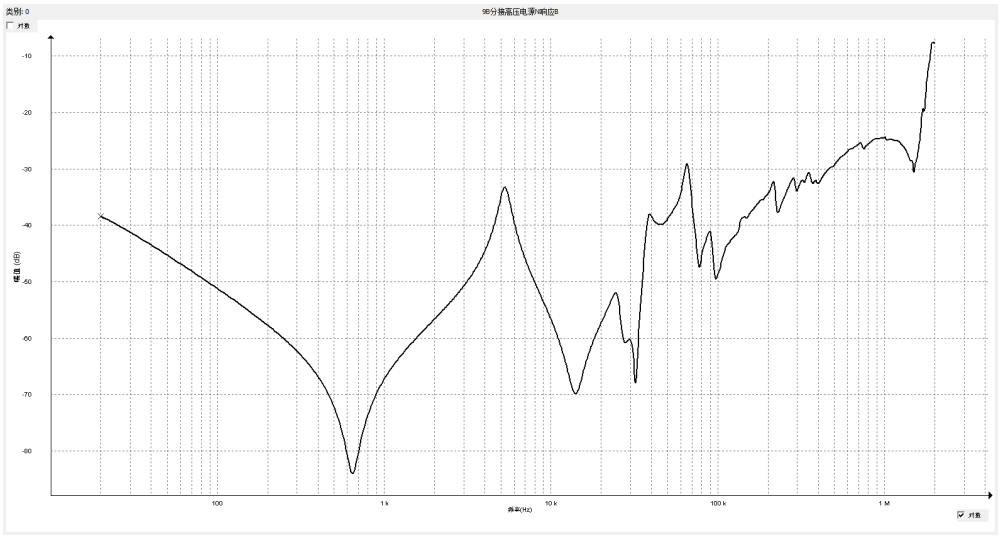
B230035-FRA12



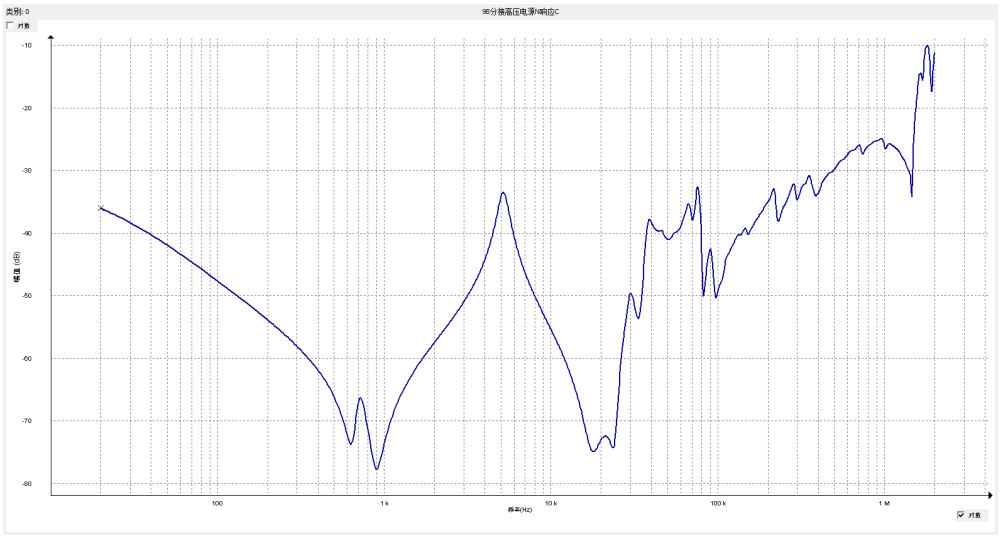
B230035-FRA13



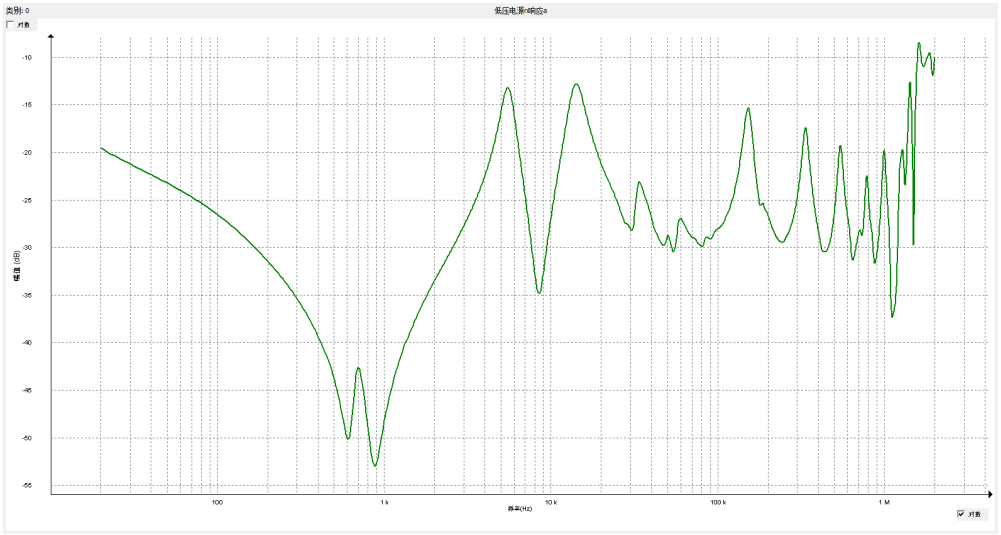
B230035-FRA14



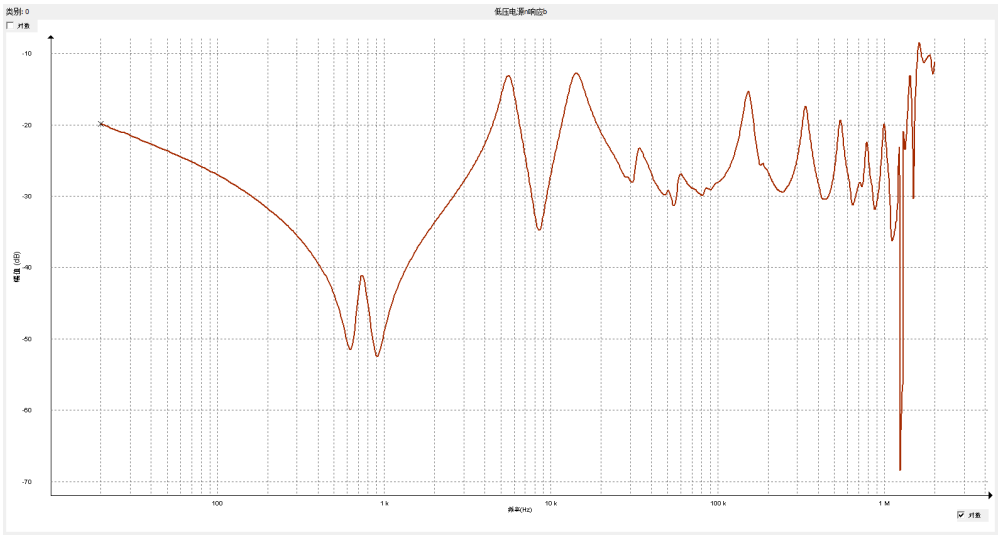
B230035-FRA15



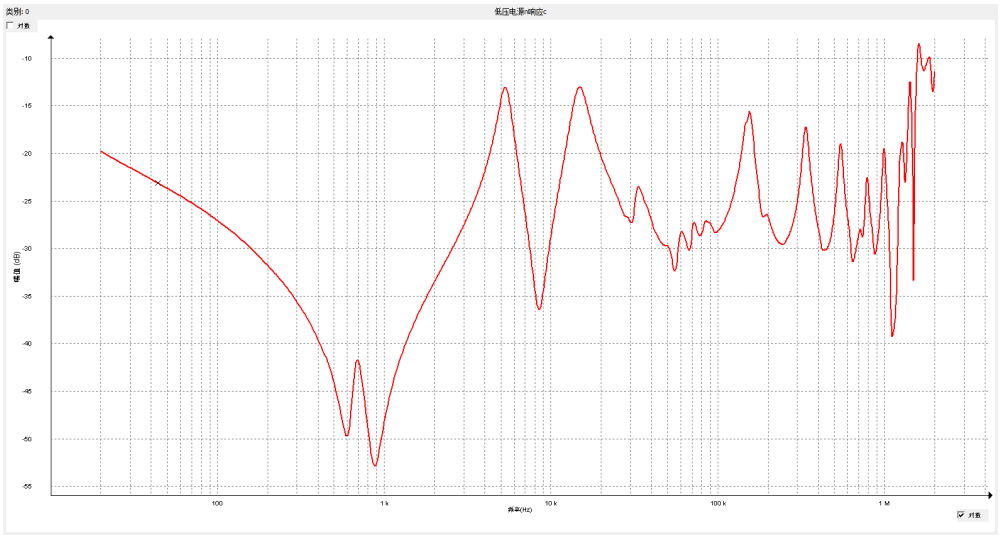
B230035-FRA16



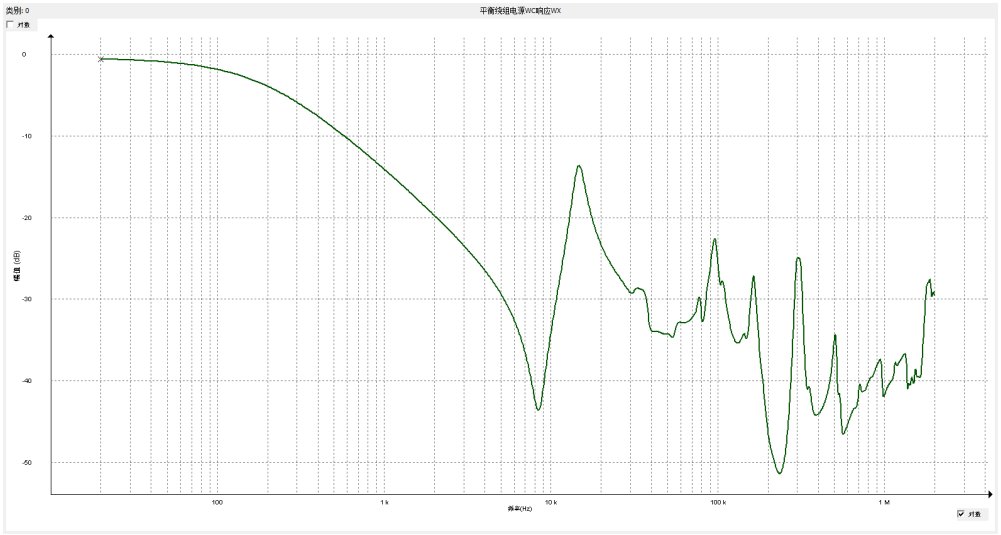
B230035-FRA17



B230035-FRA18



B230035-FRA19



B230035-FRA20

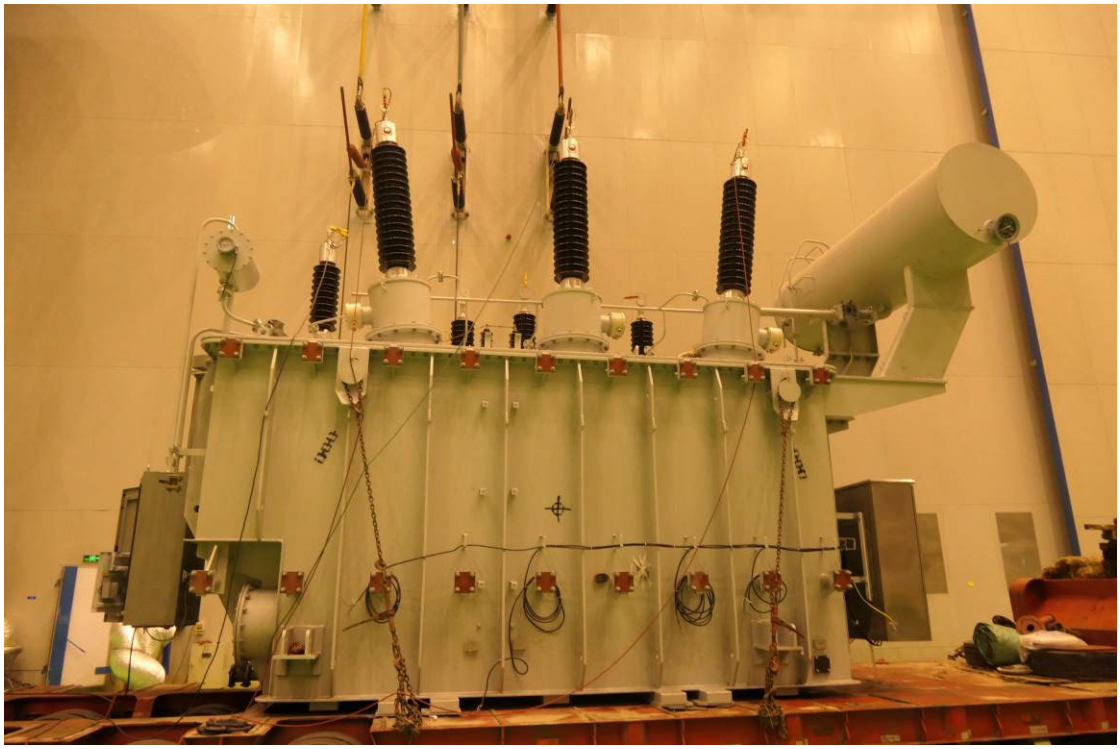


Photo No.: P001

Photo No.: P002

Photo No.: P003

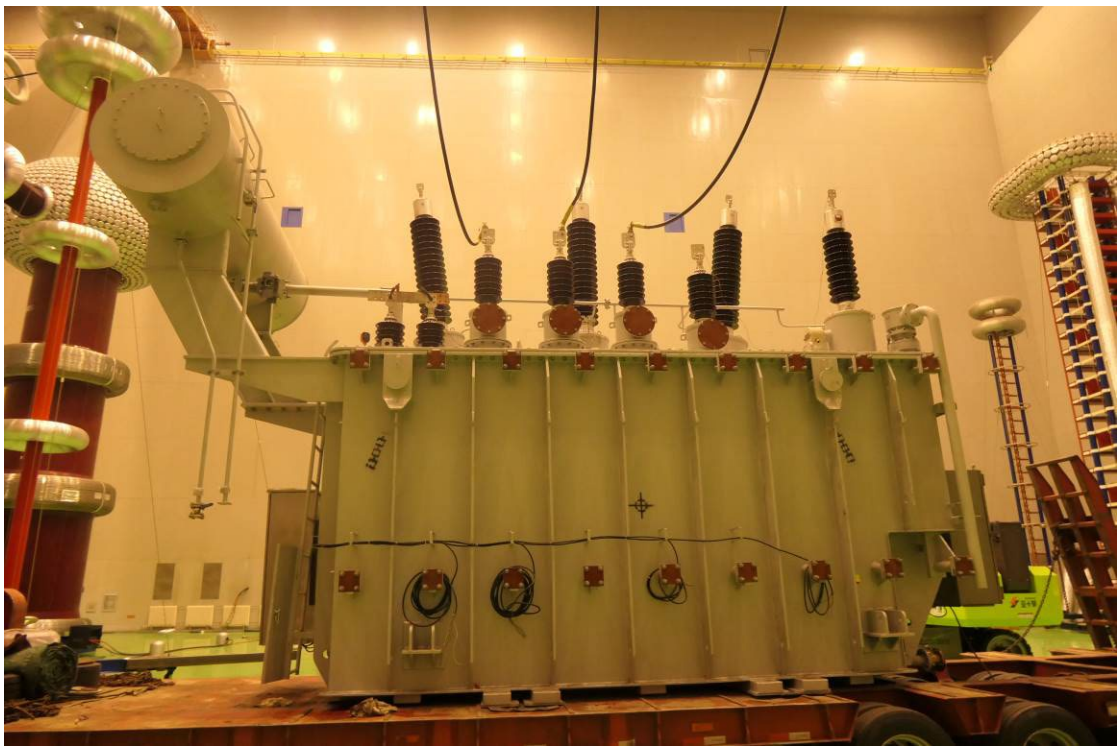


Photo No.: P004

Photo No.: P005

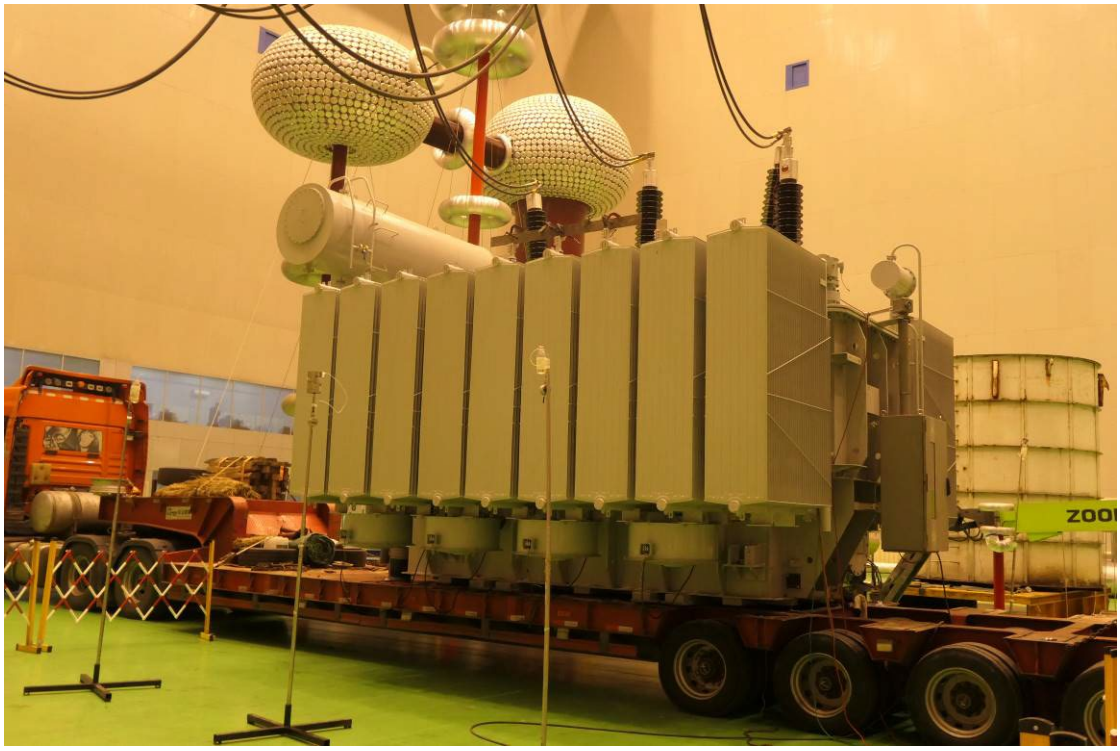


Photo No.: P006

Photo No.: P007

Photo No.: P008

Photo No.: P009

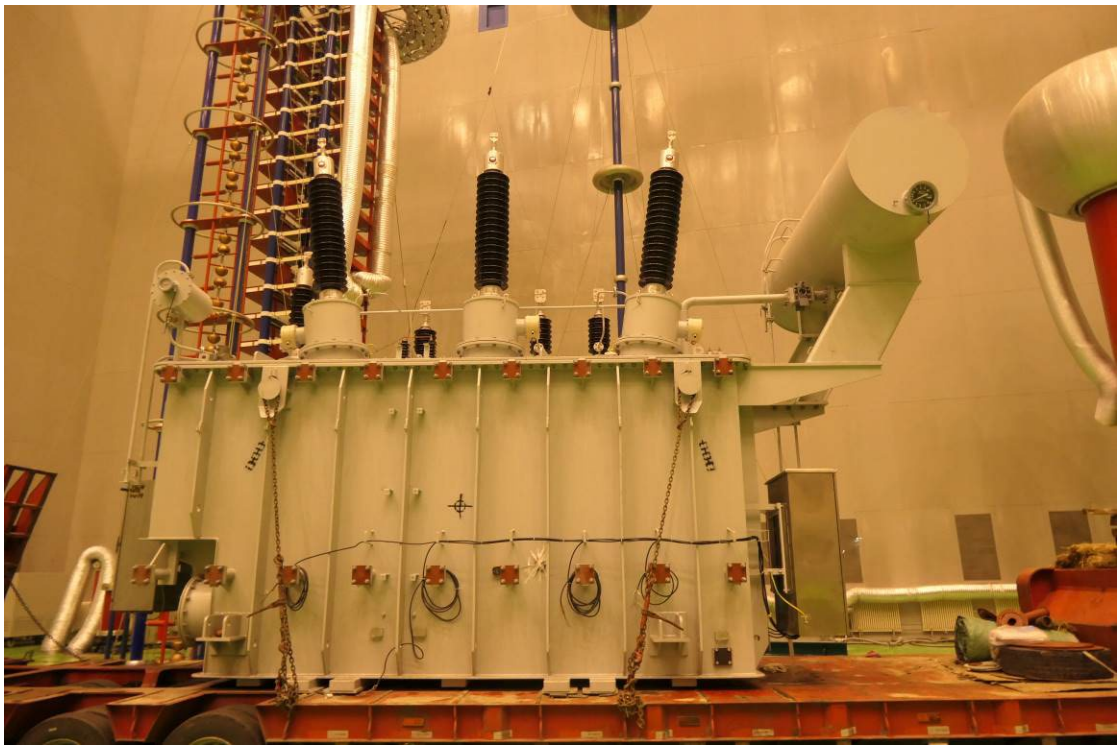


Photo No.: P010

Photo No.: P011

Photo No.: P012

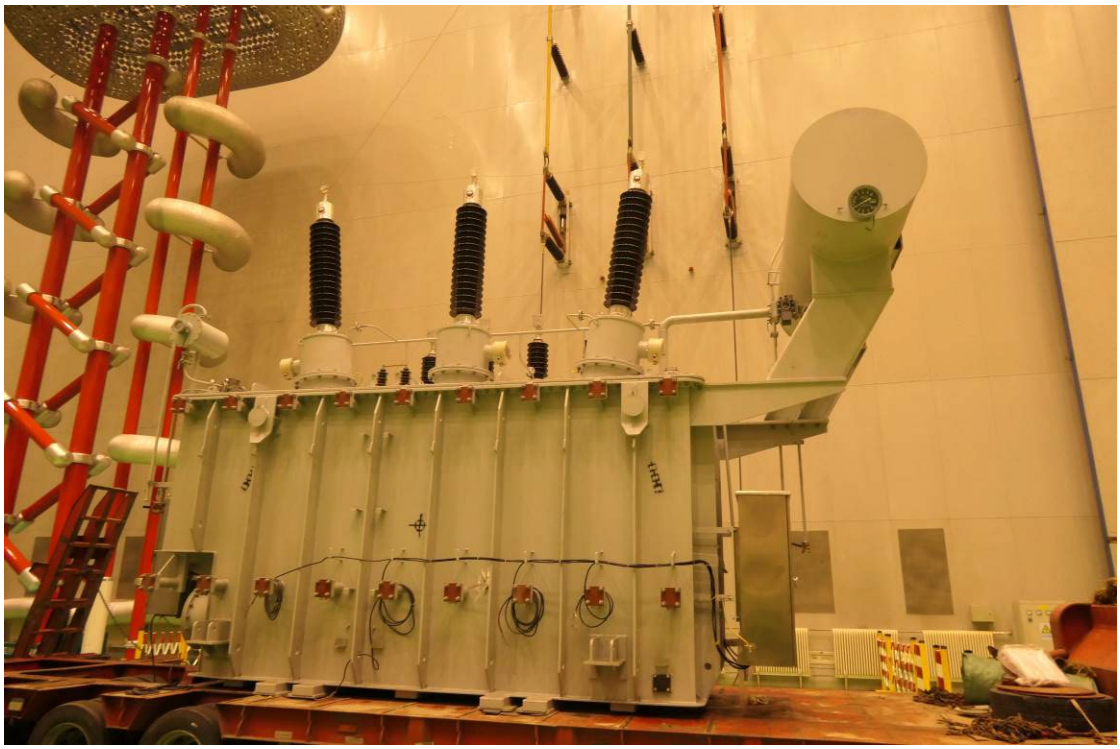


Photo No.: P013

Photo No.: P014

Photo No.: P015

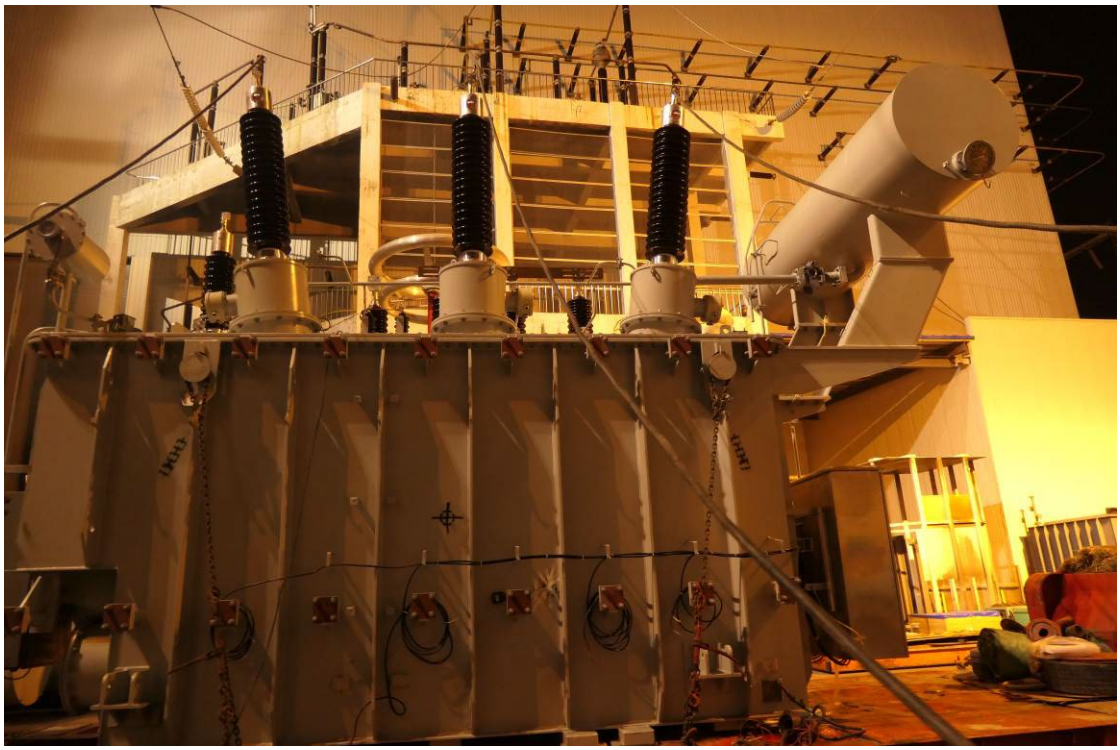


Photo No.: P016

Photo No.: P017

Photo No.: P018

Photo No.: P019

Photo No.: P020

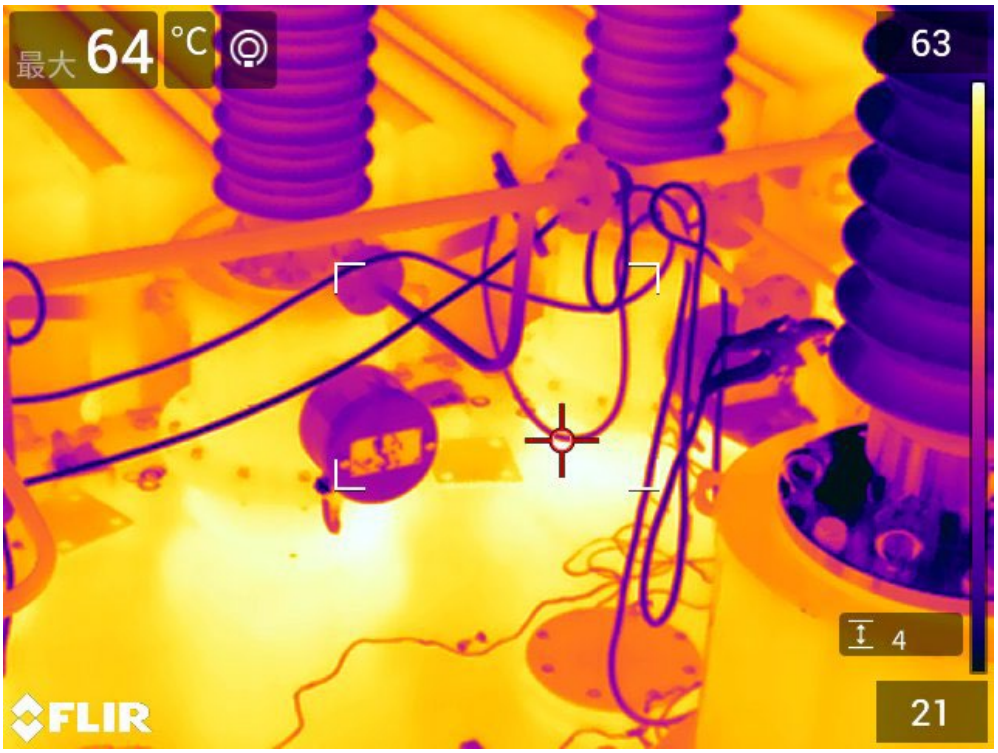


Photo No.: P021

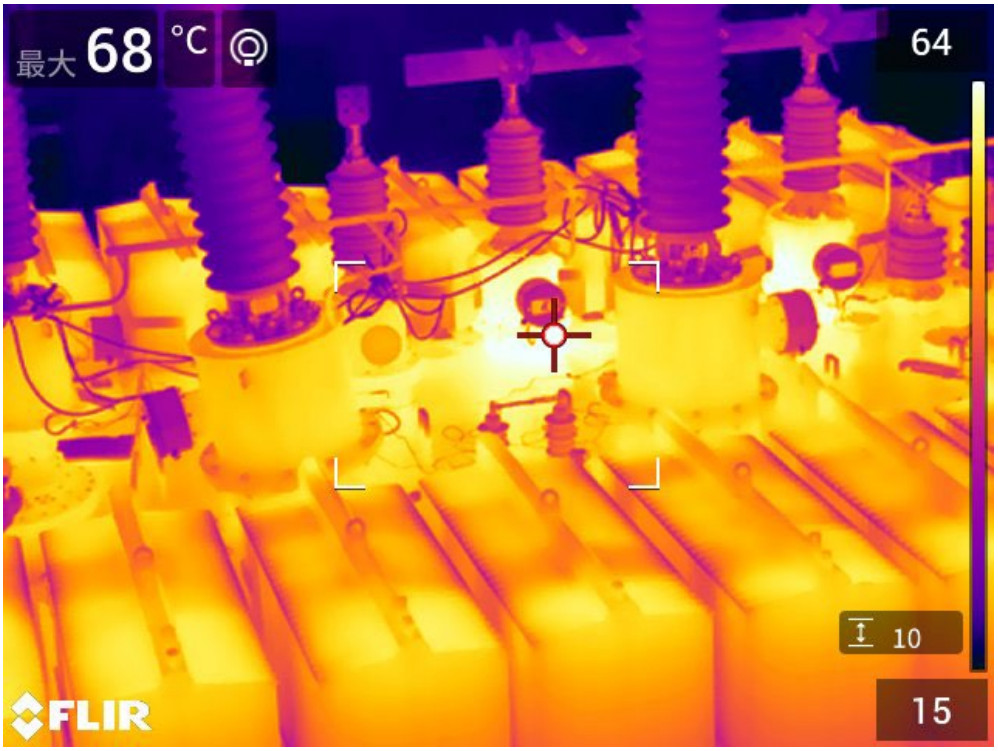
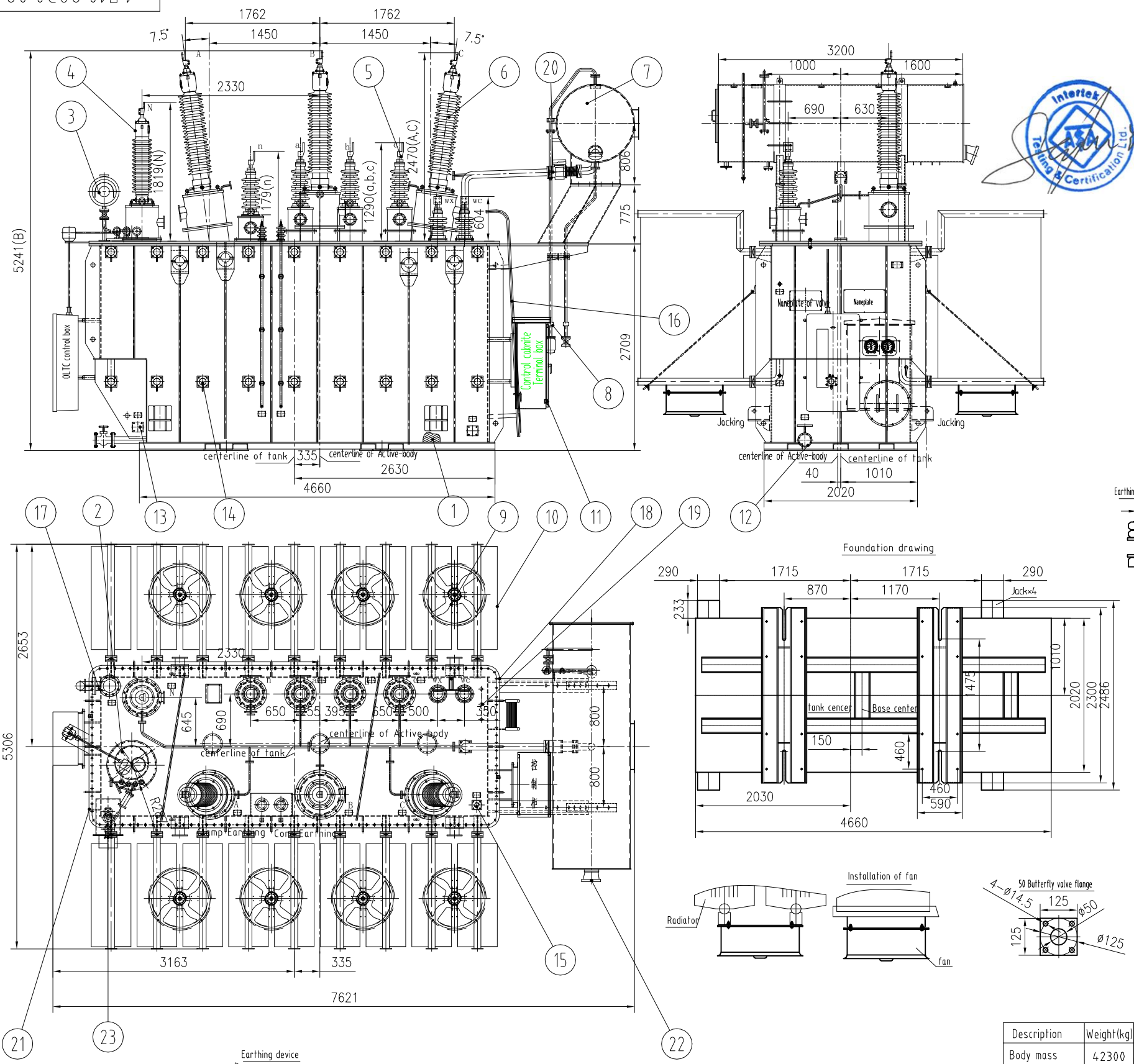
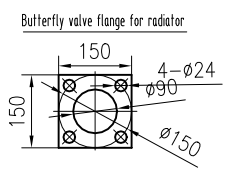
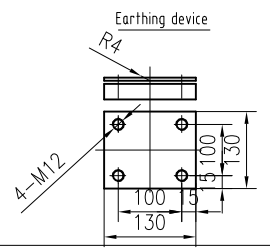


Photo No.: P022

1.710.2930.02



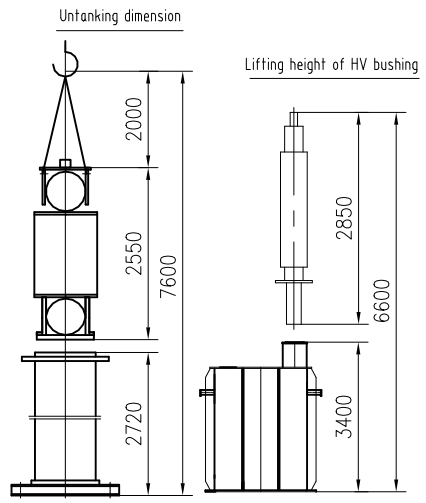


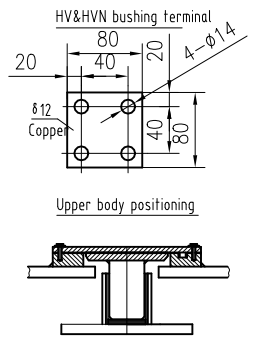


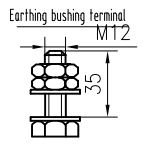
Technical Requirements

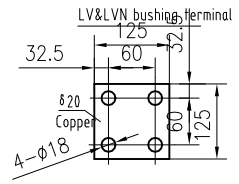
1.Oil filling under vacuum, the components of the transformer shall be pre-assembled in the factory and marked;

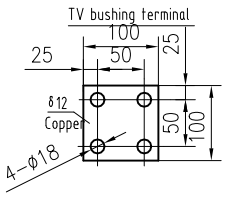
2. Mark the jack and traction hole with red paint at the indicated position (4 places for each);











23		Oil level for O.L.T.C conservator	1	
22		Oil level for main conservator	1	
21		Dehydrating breather for O.L.T.C conservator	1	
20		80 Buch relay	1	
19		Winding thernometer base	1	
18		Oil thernometer base	1	
17	YSF9-55/130DKJTHB	Pressure relief valve	1	
16		Ladder	1	
15	BDZ-50	Vacuum butterfly valve	1	
14		Butterfly valve for radiators	1	
13		Earthing device	2	
12		Φ80 Copper valve	1	
11		Control cabnite for fans and terminals	1	
10	JPC-1700(2200)-31/520	Radiators	18	
9	DBF-7.3Q10	Fans	8	
8		Dehydrating breather for main conservator	1	
7		Conservator for main tank	1	
6	BRDLW-145/800-4(BR5154K.3	HV bushing	3	
5	BFWC-40.5/2000-4(C3543)	LV bushings	4	
4	BRDLW-72.5/630-4(BR4144A)	HV neutral bushing	1	
3		Conservator for O.L.T.C	1	
2	VVSⅢ400Y/76-10193W	O.L.T.C	1	
1		Oil 45#	1	19800

Description	Weight(kg)
Body mass	42300
Oil	19800
Total	86500
Shipping with nit	54000
up Tank	11500
Active part	12530
Tank and fittings	24000
Added oil quality	19500

I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature:

Marker	Number of plates	Change file number	Signature	Date
Designer			Standard reviewer	
Checker			Markuper	
Auditer			Date	2022/12/5
Process reviewer				

SFZ-66000/132

Power Transformer

1.710.2930.02

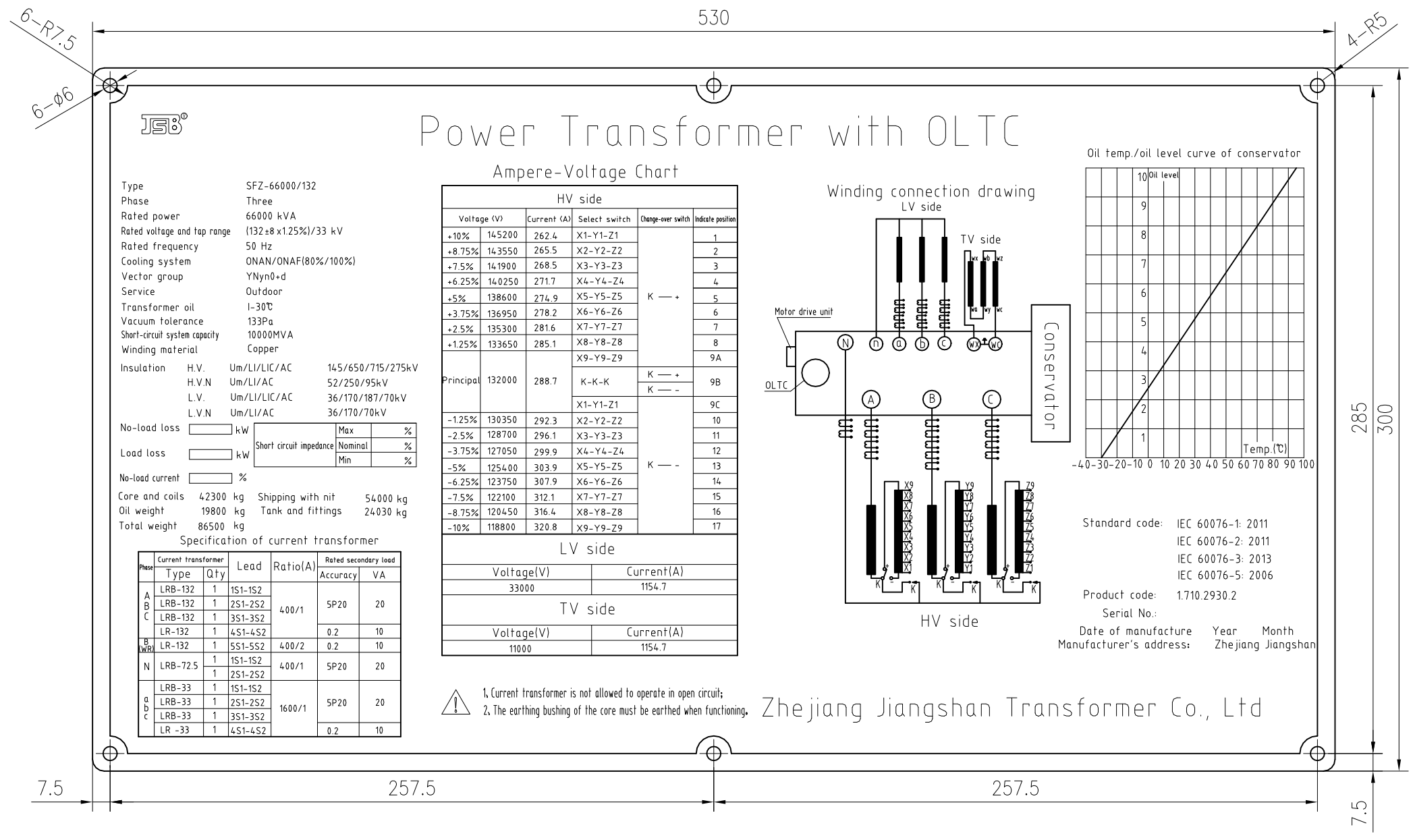
Pattern marking	Weight	Versions	Proportion

Power Transformer

Zhejiang Jiangshan Transformer Co.,Ltd

1.710.2930.2MP

1、字体大小：产品名为14号字，国名，公司名为10号字，其余汉字为7号字，5号字或3.5号字。数字和字母克按实际情况为5号字，3.5号字或2.5号字。字体均为仿宋体。
2、铭牌表面为本色底，除"
⚠ 1. Current transformer is not allowed to operate in open circuit;
2. The earthing bushing of the core must be earthed when functioning.
的字样为红色外，其余字样均为黑色。
3、字体入底面0.5mm。
4、凹入底面涂氨基烘漆A0.5-9。



Power Transformer with OLTC

Type	SFZ-66000/132
Phase	Three
Rated power	66000 kVA
Rated voltage and tap range	(132±8 x1.25%)/33 kV
Rated frequency	50 Hz
Cooling system	ONAN/ONAF(80%/100%)
Vector group	YNyn0+d
Service	Outdoor
Transformer oil	I-30℃
Vacuum tolerance	133Pa
Short-circuit system capacity	10000MVA
Winding material	Copper

Insulation			
	H.V.	Um/LI/LIC/AC	145/650/715/275kV
	H.V.N	Um/LI/AC	52/250/95kV
	L.V.	Um/LI/LIC/AC	36/170/187/70kV
	L.V.N	Um/LI/AC	36/170/70kV

No-load loss	kW	Short circuit impedance	Max	%
Load loss	kW		Nominal	%
			Min	%
No-load current	%			

Core and coils	42300 kg	Shipping with nit	54000 kg
Oil weight	19800 kg	Tank and fittings	24030 kg
Total weight	86500 kg		

Specification of current transformer

Phase	Current transformer Type	Qty	Lead	Ratio(A)	Rated secondary load Accuracy	VA
A B C	LRB-132	1	1S1-1S2	400/1	5P20	20
	LRB-132	1	2S1-2S2			
	LRB-132	1	3S1-3S2			
	LR-132	1	4S1-4S2		0.2	10
B (WRK)	LR-132	1	5S1-5S2	400/2	0.2	10
N	LRB-72.5	1	1S1-1S2	400/1	5P20	20
		1	2S1-2S2			
a b c	LRB-33	1	1S1-1S2	1600/1	5P20	20
	LRB-33	1	2S1-2S2			
	LRB-33	1	3S1-3S2			
	LR -33	1	4S1-4S2		0.2	10

Ampere-Voltage Chart

HV side

Voltage (V)		Current (A)	Select switch	Change-over switch	Indicate position
+10%	145200	262.4	X1-Y1-Z1	K — +	1
+8.75%	143550	265.5	X2-Y2-Z2		2
+7.5%	141900	268.5	X3-Y3-Z3		3
+6.25%	140250	271.7	X4-Y4-Z4		4
+5%	138600	274.9	X5-Y5-Z5		5
+3.75%	136950	278.2	X6-Y6-Z6		6
+2.5%	135300	281.6	X7-Y7-Z7		7
+1.25%	133650	285.1	X8-Y8-Z8		8
Principal	132000	288.7	X9-Y9-Z9		9A
			K-K-K	K — +	9B
				K — -	
			X1-Y1-Z1	K — -	9C
-1.25%	130350	292.3	X2-Y2-Z2		10
-2.5%	128700	296.1	X3-Y3-Z3		11
-3.75%	127050	299.9	X4-Y4-Z4		12
-5%	125400	303.9	X5-Y5-Z5		13
-6.25%	123750	307.9	X6-Y6-Z6		14
-7.5%	122100	312.1	X7-Y7-Z7		15
-8.75%	120450	316.4	X8-Y8-Z8		16
-10%	118800	320.8	X9-Y9-Z9		17

LV side

Voltage(V)	Current(A)
33000	1154.7

TV side

Voltage(V)	Current(A)
11000	1154.7

⚠ 1. Current transformer is not allowed to operate in open circuit;
2. The earthing bushing of the core must be earthed when functioning.

Zhejiang Jiangshan Transformer Co., Ltd

Winding connection drawing

Oil temp./oil level curve of conservator

Standard code: IEC 60076-1: 2011
IEC 60076-2: 2011
IEC 60076-3: 2013
IEC 60076-5: 2006

Product code: 1.710.2930.2

Serial No.:

Date of manufacture Year Month

Manufacturer's address: Zhejiang Jiangshan

I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature: 高小石

Marker	Number of pieces	Change file number	Signature	Date
Designer		刘耀辉	Standard reviewer	王胜
Checker		王士英	Markuper	高小石
Auditer		高小石	Date	2022/12/5
Process reviewer		王轩		

SFZ-66000/132

Nameplate

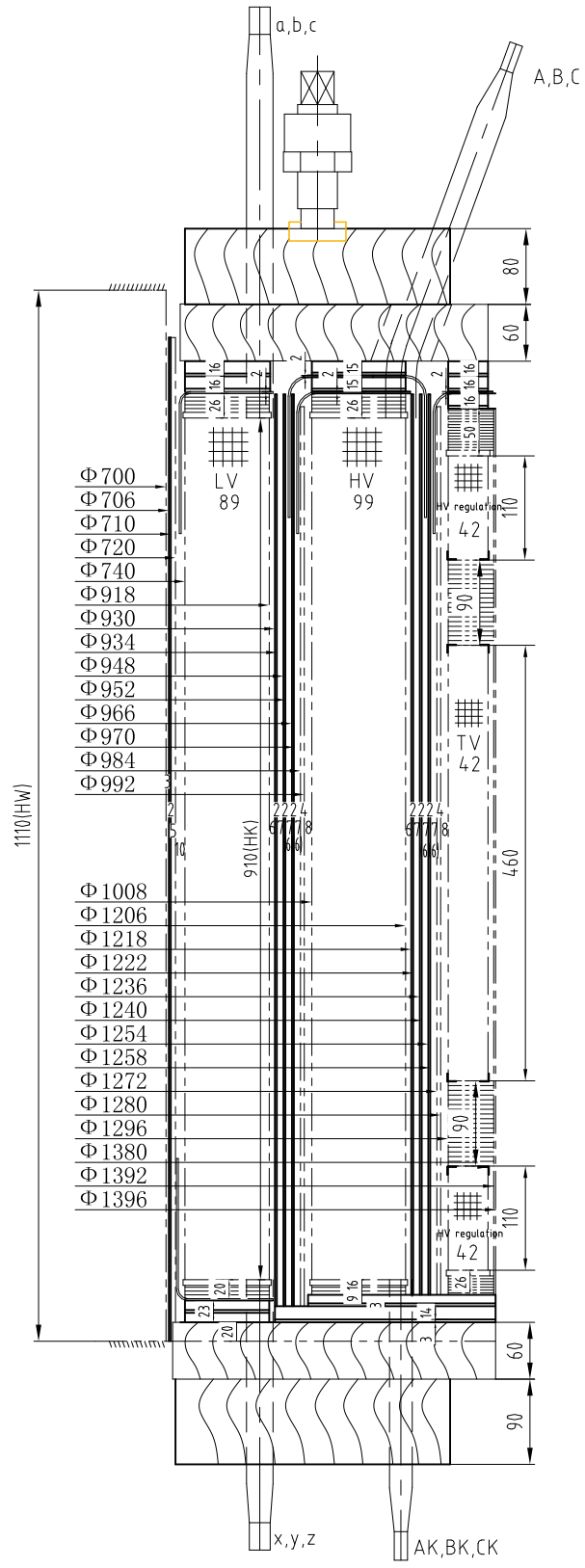
1.710.2930.2MP

Pattern marking	Weight	Versions	Proportion
	1		1:2

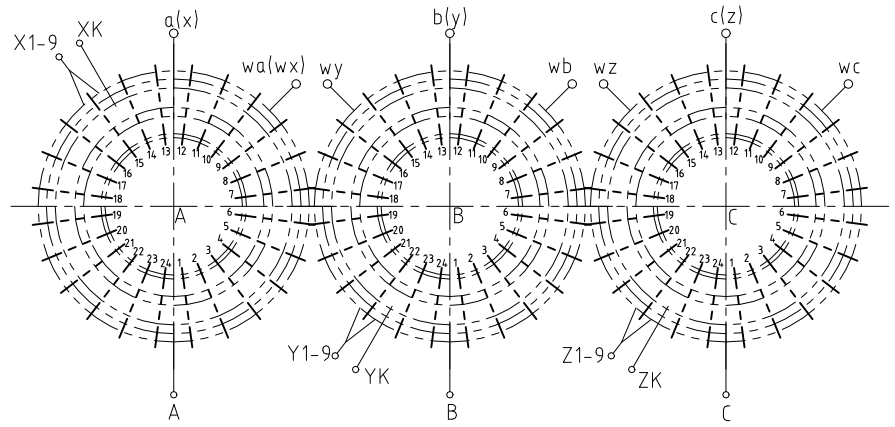
Zhejiang Jiangshan Transformer Co.,Ltd

5.700.2930.2

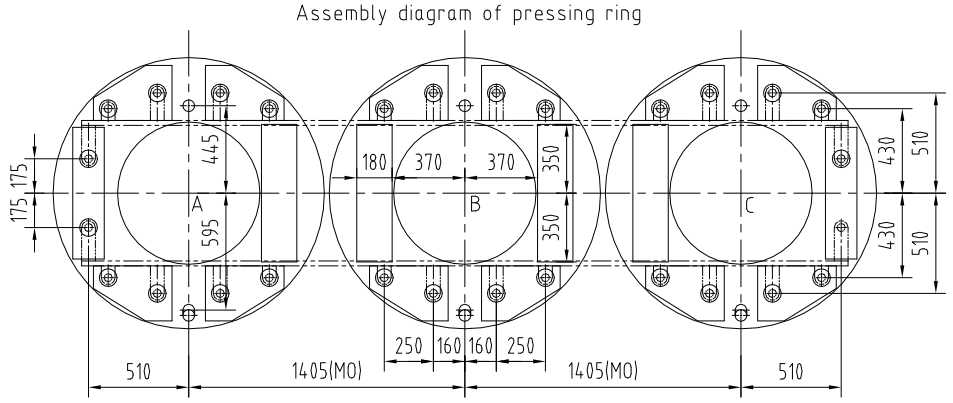
Technical requirements:
1.The active body assembly shall be carried out before the main body assembly, that is, the low, high and voltage regulating coils shall be assembled together according to this drawing;
The radial fit of coil assembly shall be tight, and the axial height after assembly shall be consistent, and the compaction shall be ensured as required;
2.After the voltage regulating coil is sleeved, pull out the high voltage coil and straighten it out, and then wrap the insulation for 10mm on each side;
3.After the active body has been dried, insert item 29 base plate, which can be adjusted with paperboard;
4.The paper ring at the head and end of the high voltage coil can be cut according to the actual situation, and the coamings are equipped with openings;
5.The outer shroud of the main body is fastened with high shrinkage belt;
6.The paperboard is spliced by 1mm thick paperboard, and the lap joint of about 80mm must be ensured,
The lap joint shall be placed between two gears, and the lap joint of each layer of paperboard shall be staggered more than two gears' distance
7.After the coil is inserted into the iron core, the tightness can be adjusted according to the No. 1 paper cylinder



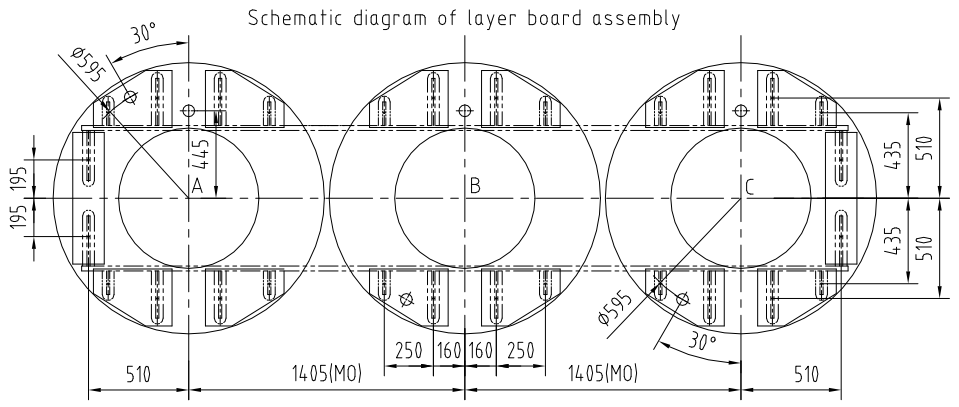
Schematic diagram of coil outlet lead position



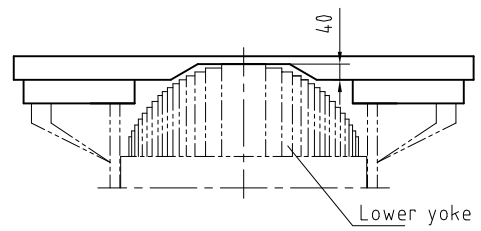
Assembly diagram of pressing ring



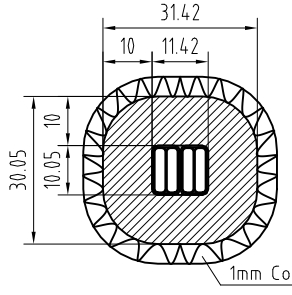
Schematic diagram of layer board assembly



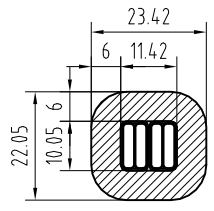
Schematic diagram of pallet placement



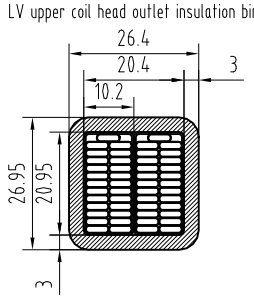
HV upper coil head outlet insulation binding



HV lower coil head outlet insulation binding



LV upper coil head outlet insulation binding



NO.	Code	Name	QTY	Material	Each Weight	Total Weight	Remark
33	E040103	White cloth band 0.1×16	1	0.1X16 White cloth band			Sufficient
32	E040104	High shrinkage insulation strip 0.28×25	1	0.28X25 High shrinkage insulation strip			Sufficient
31	8BT.123.1203	Corrugated cardboard 4×160×120×60×60	3		0.023	0.069	
30	8T.760.3005.1	Backing board 700×170	4	15 paperboard 100/00	2.14	8.56	
29	5.711.2930.24	Iron yoke insulation	3		3.96	11.88	
28	8T.751.3008.5	paperboard 3008×963	6	1 paperboard 100/00	3.48	20.88	
27	8T.123.3018.6	Stay strip 960	72	7 paperboard 100/00	0.323	23.256	
26	8T.751.3008.5	paperboard 3085×963	6	1 paperboard 100/00	3.57	21.42	
25	8T.751.3008.5	paperboard 3121×963	6	1 paperboard 100/00	3.61	21.66	
24	8.123.2930.22	Stay strip	144	6 paperboard 100/00	0.48	69.12	
23	8.090.2930.24	Supporting board	1	30 Laminated wood -3	142	142	
22	8.090.2930.22	Supporting board	1	60 Laminated wood -3	230.5	230.5	
21	5.711.2930.23	Lower Iron yoke insulation	1		39.22	39.22	
20	5.711.2930.22	Iron yoke insulation	3		6.28	18.84	
19	8T.751.3008.5	paperboard 3913×950	6	1 paperboard 100/00	4.46	26.76	
18	8T.123.3018.24	Stay strip 950×7	72	3 paperboard 100/00	0.399	28.728	
17	8T.751.3008.5	paperboard 3970×950	6	1 paperboard 100/00	4.53	27.18	
16	8T.751.3008.5	paperboard 4025×950	6	1 paperboard 100/00	4.59	27.54	
15	8.123.2930.21	Stay strip	144	6 paperboard 100/00	0.48	69.12	
14	5T.759.3002.1	Angle ring 1264×1390×5	3	Sulfate pulp	2.04	6.12	
13	5T.711.3005.7	Iron yoke insulation 1296×1380×16×0×0	9		1.74	16	
12	5T.759.3002.4	Antiangular ring 1138×1250×5	3	Sulfate pulp	1.9	5.7	
11	5T.711.3005.7	Iron yoke insulation 1008×1206×15×60×45	6		3.63	21.78	
10	5T.759.3002.1	Angle ring 976×1216×5	3	Sulfate pulp	2.08	6.24	
9	5T.759.3002.1	Angle ring 958×1078×5	3	Sulfate pulp	1.53	4.59	
8	8.090.2930.23	Auxiliary platen	1	40 Laminated wood -3	142	142	
7	8.959.2930.21	Press nail base	28	75 round steel Q235	0.1	2.8	
6	C02011242	Blackened thin nut M42	28	GB/T 6172.1	0.252	7.056	
5	8T.900.3006.2	Press nail M42×160	28		1.6	44.8	
4	8.090.2930.21	Pressboard	1	60 Laminated wood -3	230.5	230.5	
3	5T.759.2570.60	Corner Ring 728×926×5	(6)	Sulfate pulp	20		
2	5.711.2930.21	Iron yoke insulation	6		2.53	15.18	
1	8T.751.3008.5	Paperboard 2302×1060	6	1 Paperboard 100/00	2.93	18	

Marker	Number of pieces	Change file number	Signature	Date
Designer			Standard reviewer	
Checker			Markuper	
Auditer			Date	2022/12/5
Process reviewer				

SFZ-66000/132

Active part insulation

5.700.2930.2

Pattern marking	Weight	Versions	Proportion

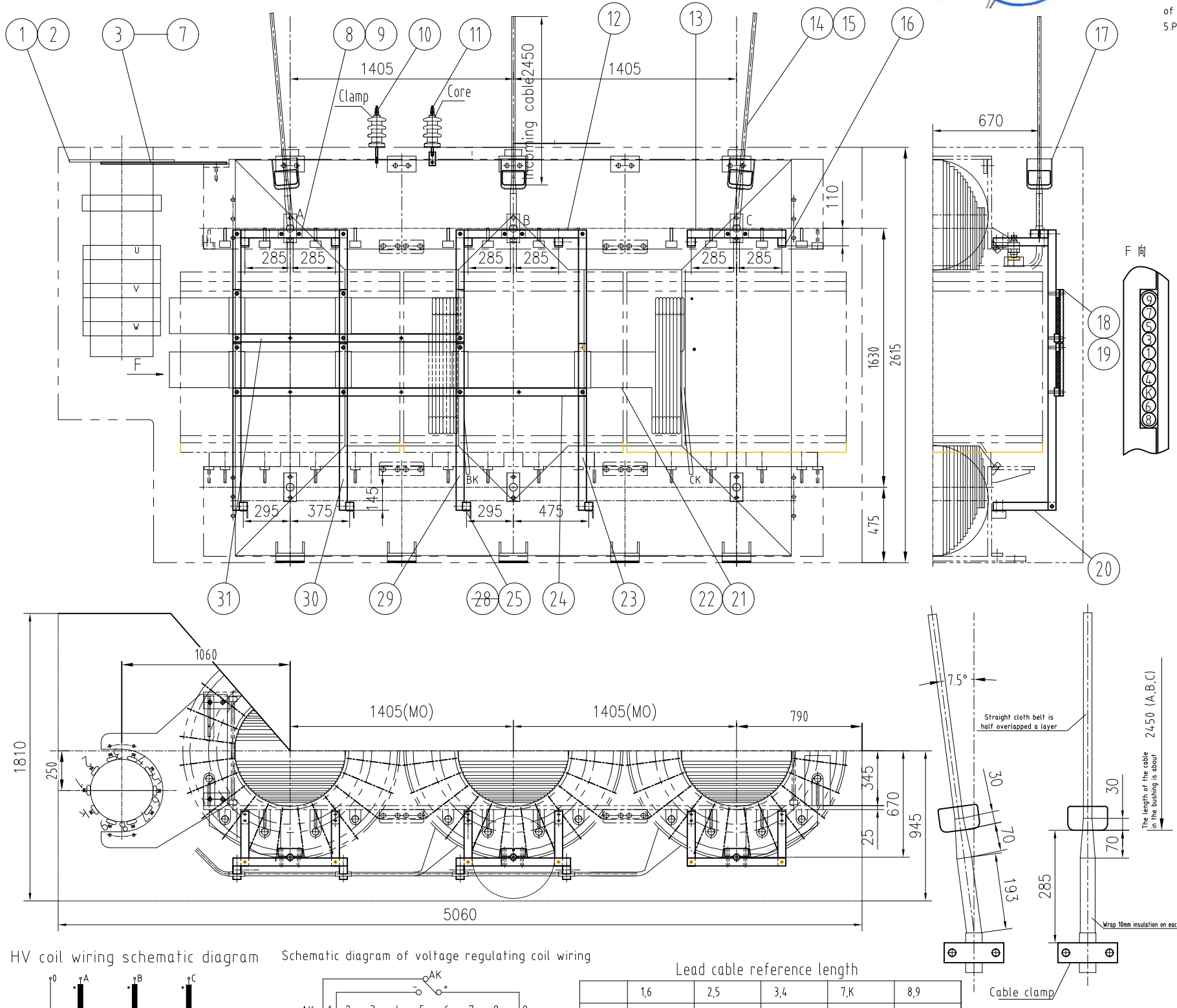
Active part insulation

Zhejiang Jiangshan Transformer Co.,Ltd

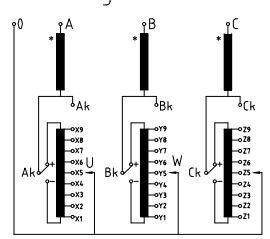
I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature:

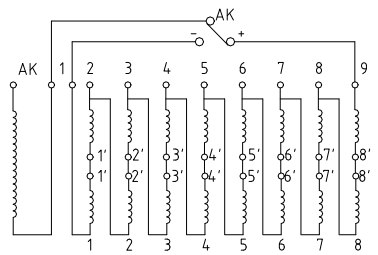
5.517.2930.11



HV coil wiring schematic diagram



Schematic diagram of voltage regulating coil wiring



Lead cable reference length

	1,6	2,5	3,4	7,K	8,9
C相	4400	4600	4800	4200	4000
B相	3000	3200	3400	2800	3200
A相	2400	2200	2000	2600	2800

I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature: 高小石

Technical requirements:

1.120mm^2 stranded wire TJR1 is used for HV A.B.C cable, with insulation of 10mm wrapped on one side

2. HV tap cable, 0-phase lead is 95mm^2 copper stranded wire TJR1, with side wrapped insulation of 4mm

3.All coil outgoing cables are arranged in an approximate circle, and the copper cable is filled and then cold pressed with the cold pressed pipe

4.All lead cables passing through the cable clamp shall be wrapped with insulation of 2mm on one side, and each side of the additional insulation shall extend 25mm out of the cable clamp;

5.Phase A, B and C lead cables shall be wrapped into a taper when entering the bushing, the taper length is 100mm

NO.	Code	Name	QTY	Material	Each Weight	Total Weight	Remark
42	8T.570.3014.2	Reducing straight sleeve KSF95-70	9	Red copper T2	0.04	0.36	Cold pressing of each joint of tapping wire 1.9_4
41	8T.570.3013.1	Straight sleeve KSF50	24	Red copper T2	0.03	0.72	Cold pressing the voltage regulating coils between 1 and 8
40	8T.750.3008.10	Paperboard 60000×100	1	0.5 paperboard 100/00	3.48	3.48	
39	E02021404	Aluminum foil crepe paper	0	AL-FOIL/3A Aluminun foil crepe paper			
38	E040104	High shrinkage insulating strip 0.28×25	0	0.28×25 High shrinkage insulating strip			
37	E02020903	Insulating crepe paper 0.05×25	0	0.05×25 Insulating crepe paper			
36	C020207	Nylon thin nut M16	35		0.002	0.07	
35	C020203	Nylon nut M16	35		0.002	0.07	
34	C0102310	Nylon bolt M16×140	6		0.037	0.222	
33	C0102309	Nylon bolt M16×130	25		0.034	0.85	
32	C0102308	Nylon bolt M16×120	4		0.031	0.124	
31	8.110.2930.44	Cable clamp	1	30 Laminated wood -3	1.5	2	
30	8.110.2930.41	Cable clamp	2	50 Laminated wood -3	5.28	10.56	
29	8.110.2930.40	Cable clamp	1	50 Laminated wood -3	5.28	5.28	
28	C0405050604	Blackened washer 12	18	GB/T 97.1	0.006	0.144	
27	C02010642	Blackened thin nut M12	18	GB/T 6172.1	0.006	0.108	
26	C02010641	Blackened nut M12	18	GB/T 6170	0.012	0.288	
25	C01010614304	Blackened bolt M12×85	18	GB/T 5783	0.08	1.92	
24	8.110.2930.43	Cable clamp	1	30 Laminated wood -3	2	2	
23	8.110.2930.39	Cable clamp	1	50 Laminated wood -3	5.28	5.28	
22	8T.570.3014.3	Reducing straight sleeve KSF120-95	21	Red copper T2	0.04	0.84	cold pressing of each lap cable 2-0 connector
21	8T.516.3017.1	Paper wrapped copper stranded wire 115000	1	95 mm2 Bare copper stranded wire	97.23	97.23	HV tap and HV 0
20	8T.110.3002.13	Cable clamp 395×25	4	50 Laminated wood -3	1.18	4.72	
19	8T.110.3002.20	Cable clamp 50	6	20 Laminated wood -3	0.06	0.36	
18	8.110.2930.6	Cable clamp	7	20 Laminated wood -3	0.43	3.01	
17	8.759.2930.1	Shield cap	4	pulp	1.42	5.68	
16	8T.110.3002.12	Cable clamp 345×25	6	50 Laminated wood -3	1.03	6.18	
15	8T.570.3014.3	Reducing straight sleeve KSF120-95	3	Red copper T2	0.04	0.12	Cold pressing of HV phase outlet cable
14	8T.516.3017.1	Paper wrapped copper stranded wire 10000	1	120 mm2 Bare copper stranded wire	10.68	10.68	Unilateral wrapping 10mm
13	8.110.2930.38	Cable clamp	1	50 Laminated wood -3	1.99	1.99	
12	8.110.2930.37	Cable clamp	1	50 Laminated wood -3	2.1	2.1	
11	5T.516.3007.1	Clamp grounding lead cable	1		0.566	0.566	About 500mm
10	5T.516.3007.2	Clamp grounding lead cable	1		0.321	0.321	About 500mm
9	8T.110.3002.3	Cable clamp 110×22	3	50 Laminated wood -3	0.45	1.35	
8	8.110.2930.42	Cable clamp	1	50 Laminated wood -3	2	2	
7	C0405050704	Blackened washer 16	8	GB/T 97.1	0.011	0.088	
6	C04022091	Blackened butterfly spring 34×16.3×1.5×2.4	16	GB/T 1972	0.006	0.096	
5	C02010741	Blackened nut M16	8	GB/T 6170	0.029	0.232	
4	C01010711304	Blackened bolt M16×70	8	GB/T 5783	0.124	0.992	
3	8.043.2930.5	OLTC support	1	12 steel plate Q235	29	29	
2	8T.570.3017.8	Connection terminal KRF95-10	49	Red copper T2	0.09	4.41	
1	D0101323052041072	OLTC VVSⅢ400Y/76-10193W	1		290	290	

Marker	Number of sheets	Change file number	Signature	Date
Designer		吴帅	Standard reviewer	王胜
Checker		王志勇	Markuper	高小石
Auditer		柳金鸿	Date	2022/12/5
Process reviewer		王轩		

SFZ-66000/132

HV LEAD CABLE

5.517.2930.11

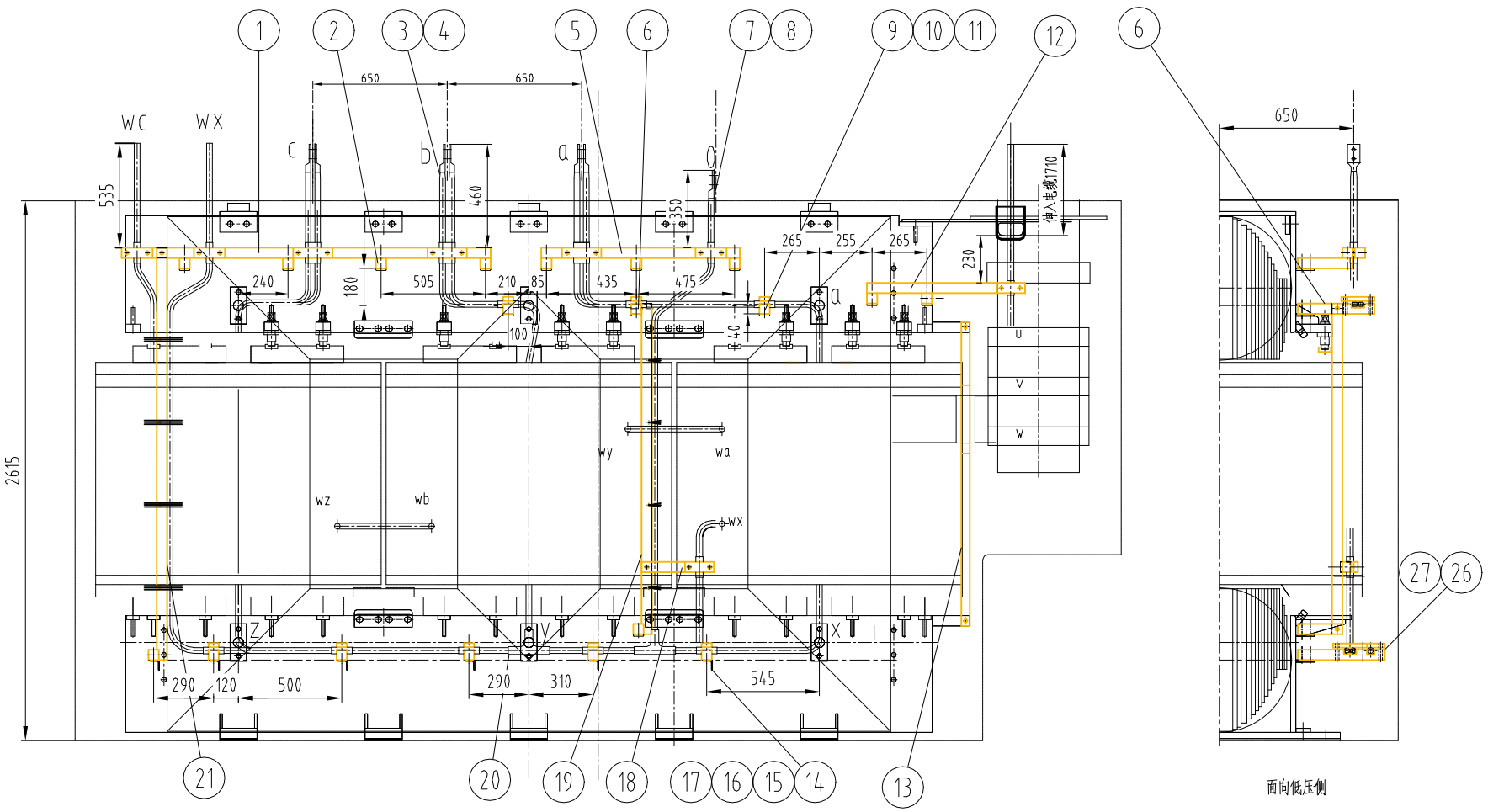
Pattern marking	Weight	Versions	Proportion

Zhejiang Jiangshan Transformer Co.,Ltd

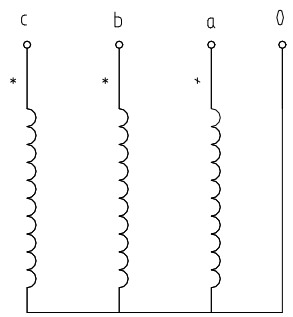
5.517.2930.12

Lead cable	WC-WC	WX-WX	0	a-a	b-b	c-c	Z-X	N
Lead cable length	2000	6000	2800	2500	1800	1400	3000	3500
240mm² Paper wrapped flexible copper stranded wire-3				2×150mm² Paper wrapped flexible copper stranded wire-3				95mm² Paper wrapped flexible copper stranded wire-4

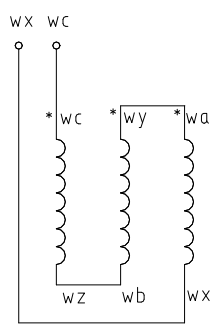
Technical requirements:
1. LV leads shall be made of 2 × 150mm² flexible copper stranded wire, with 3mm wrapped on one side, 240mm² flexible copper stranded cable for LV 0-phase lead, 4mm wrapped on one side, 95mm² flexible copper stranded cable for HV 0-phase lead, and 4mm wrapped on one side
2.All coil outgoing cables are arranged in an approximate circle, the copper cable shall be compacted before cold pressing with the cold pressing pipe.
3.All lead cables passing through the cable clamp shall be wrapped with insulation of 2mm on one side, and each side of the additional insulation shall extend 25mm out of the cable clamp;
4.HV Phase 0 lead cables shall be wrapped into a taper when entering the bushing, the taper length is 100mm.



面向低压侧



平衡绕组



NO.	Code	Name	QTY	Material	Each Weight	Total Weight	Remark
43	8T.570.3016.7	Reducing straight sleeve KTSF240/400	1	Red copper T2	0.93	0.93	LV-N and lead cable cold pressing
42	8T.570.3013.7	Straight sleeve KSF240L	4	Red copper T2	0.16	0.64	Tertiary cable cold pressing
41	8T.570.3014.11	Reducing straight sleeve KSF400-240	2	Red copper T2	0.29	0.58	z、x cold pressing of outlet and lead cable
40	8T.750.3008.10	Paperboard	1	0.5 paperboard 100/00	2.61	2.61	
39	E02021404	Aluminum foil crepe paper	0	AL-FOIL/30 Aluminum foil crepe paper			
38	E040104	High shrinkage insulating strip 0.28×25	0	0.28×25 High shrinkage insulating strip			Sufficient
37	E02020903	Insulating crepe paper 0.05×25	0	0.05×25 Insulating crepe paper			
36	C020207	Nylon thin nut M16	50		0.002	0.1	
35	C020203	Nylon nut M16	50		0.002	0.1	
34	C0102304	Nylon bolt M16×80	2		0.021	0.042	
33	C0102309	Nylon bolt M16×130	18		0.034	0.612	
32	8T.110.3002.13	Cable clamp 315×25	1	50 Laminated wood -3	0.945	0.945	
31	8T.110.3002.5	Cable clamp 100	2	20 Laminated wood -3	0.168	0.336	25 Laminated wood
30	8.110.2930.32	Cable clamp	1	50 Laminated wood -3	1.2	1.2	
29	8T.110.3002.13	Cable clamp 215×25	1	50 Laminated wood -3	0.645	0.645	
28	8.110.2930.31	Cable clamp	1	50 Laminated wood -3	1.2	1.2	
27	8T.110.3002.5	Cable clamp 210	4	20 Laminated wood -3	0.3	1.2	25 Laminated wood
26	8.110.2930.28	Cable clamp	4	50 Laminated wood -3	1.2	4.8	
25	C0102310	Nylon bolt M16×140	14		0.037	0.518	
24	8.110.2930.33	Cable clamp	3	50 Laminated wood -3	0.6	1.8	
23	8.110.2930.34	Cable clamp	3	50 Laminated wood -3	0.6	1.8	
22	8T.110.3002.3	Cable clamp 100×15	1	50 Laminated wood -3	0.42	0.42	
21	8.110.2930.26	Cable clamp	1	50 Laminated wood -3	4.4	4.4	
20	8T.570.3015.7	Tee sleeve KTSF400	1	Red copper T2	1.3	1.3	Outlet y and lead cable cold pressing
19	8.110.2930.27	Cable clamp	1	50 Laminated wood -3	3.6	3.6	
18	8.110.2930.36	Cable clamp	1	50 Laminated wood -3	1.2	1.2	
17	C0405050604	Blackened washer 12	34	GB/T 97.1	0.006	0.204	
16	C02010642	Blackened thin nut M12 M12	34	GB/T 6172.1	0.006	0.204	
15	C02010641	Blackened nut M12	34	GB/T 6170	0.012	0.408	
14	C01010614304	Blackened bolt M12×85	34	GB/T 5783	0.08	2.72	
13	8.110.2930.23	Cable clamp	1	50 Laminated wood -3	4.8	4.8	
12	8.110.2930.25	Cable clamp	1	50 Laminated wood -3	1.57	1.57	
11	C0102308	Nylon bolt M16×120	16		0.031	0.496	
10	8T.110.3002.5	Cable clamp 120	4	20 Laminated wood -3	0.192	0.768	25 Laminated wood
9	8.110.2930.30	Cable clamp	2	50 Laminated wood -3	1.2	2.4	
8	8T.516.3017.1	Paper wrapped copper stranded wire 11000	1	240 mm2 Bare copper stranded wire	23.5	23.5	
7	8.570.2930.2	Connection terminal	1	Red copper T2	0.08	0.08	
6	8.110.2930.29	Cable clamp	1	50 Laminated wood -3	1.2	1.2	
5	8.110.2930.24	Cable clamp	1	50 Laminated wood -3	2.4	2.4	
4	8T.516.3017.1	Paper wrapped copper stranded wire 11400	1	150 mm2 Bare copper stranded wire	15.22	15.22	
3	8.570.2930.1	Connection terminal	6	Red copper T2	0.08	0.48	
2	8T.110.3002.12	Cable clamp 265×25	9	50 Laminated wood -3	0.795	7.155	
1	8.110.2930.35	Cable clamp	1	50 Laminated wood -3	4.4	4.4	

I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature: 高小石

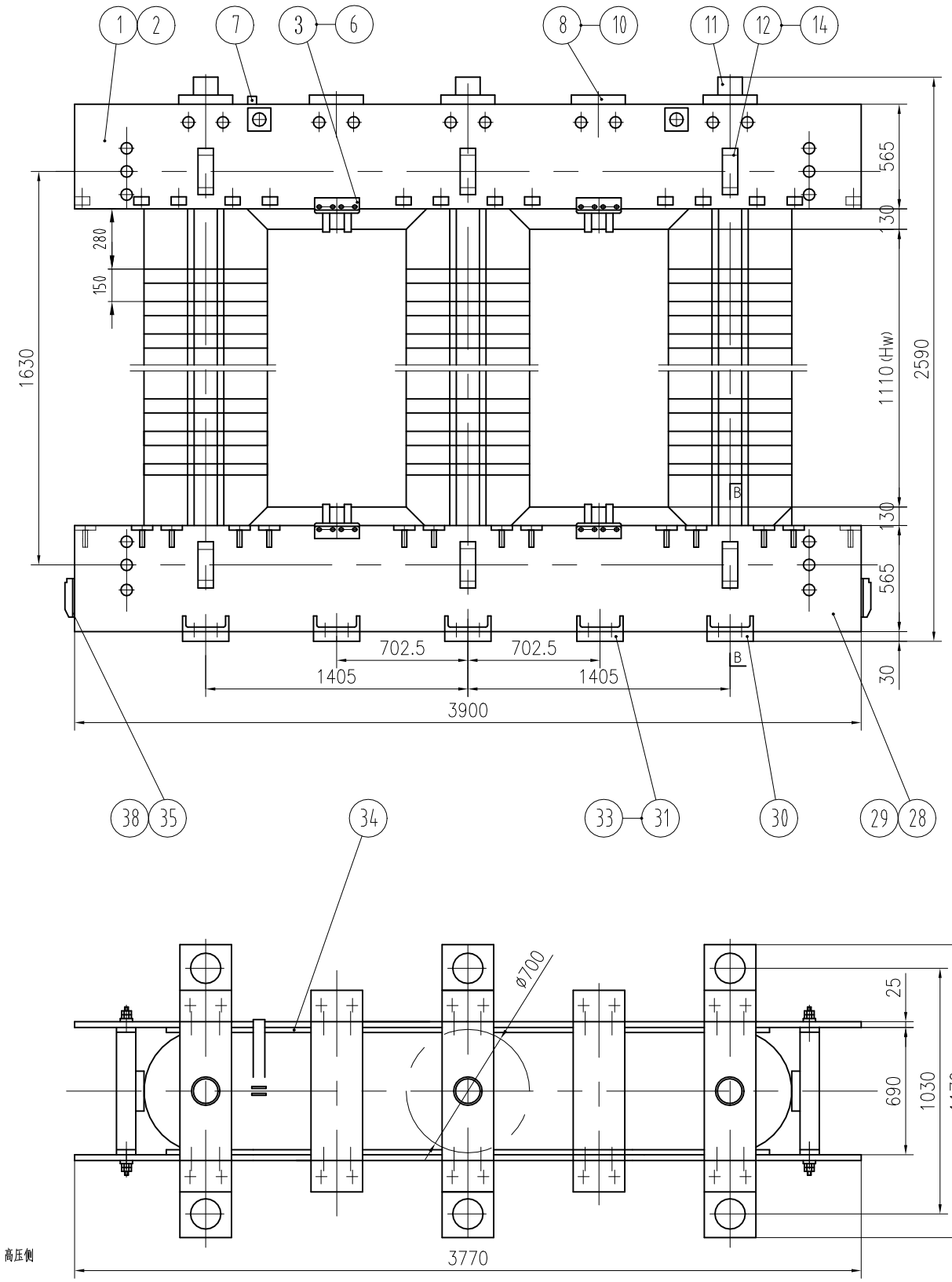
Marker	Number of pages	Change file number	Signature	Date
Designer	朱帅	Standard reviewer	王胜	
Checker	王兰芳	Markuper	高小石	
Auditer	倪金涛	Date	2022/12/5	
Process reviewer	王轩			

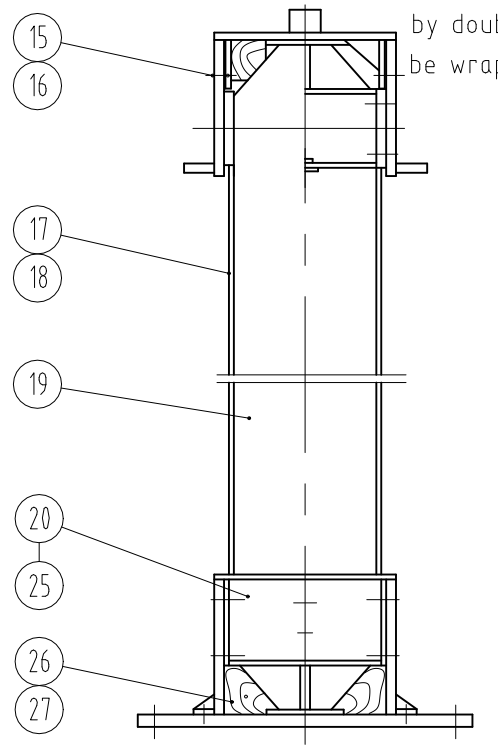
SFZ-66000/132
LV LEAD CABLE

5.517.2930.12

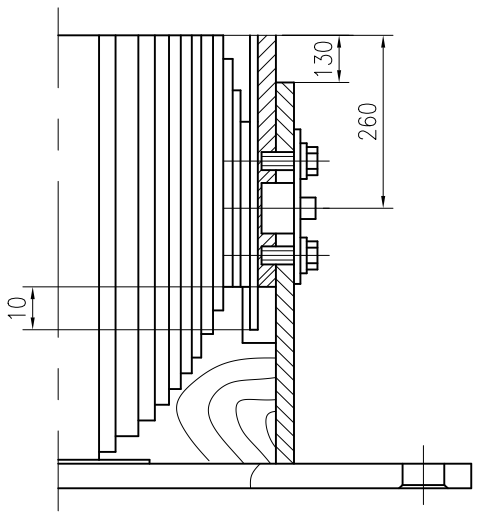
Pattern marking	Weight	Versions	Proportion

Zhejiang Jiangshan Transformer Co.,Ltd





B-B
(M1: 5)



Technical requirements:

1.The iron core shall be bound firmly before being hold up , and the inclination of iron core column shall be less than 2/1000

2.Item 4 Insulating cardboard shall be padded between iron yoke and tension strap.

3.The core grounding lug shall be inserted into the core depth ≥ 100mm and led out by double folding,The core grounding lead and grounding lug (exposed part) shall be wrapped insulation by 3mm on each side.

NO.	Code	Name	QTY	Material	Each Weight	Total Weight	Remark
38	C0405050604	Blackened washer 12	8	GB/T 97.1	0.006	0.048	
37	C04022211	Blackened butterfly spring 28×14.2×1.5×2.15	8	GB/T 1972	0.005	0.04	
36	C01010609304	Blackened bolt M12×60	8	GB/T 5783	0.056	0.448	
35	8.193.2930.1	Cushion block	4	60 Laminated wood -B	1.2	4.8	
34	5T.750.3005.5	Clamp insulation 1405×280×106×10	4		3.14	12.56	
33	C04022121	Blackened butterfly spring 45×22.4×2.5×3.5	40	GB/T 1972	0.012	0.48	
32	C02010841	Blackened nut M20	20	GB/T 6170	0.052	1.04	
31	5T.022.3027.2	Pad foot 405	2		18.13	36.26	
30	5T.022.3027.1	Pad foot 405×90	3		18.13	54.39	
29	5.071.2930.14	LV lower clamp	1		511.31	511.31	
28	5.071.2930.13	HV lower clamp	1		509.76	509.76	
27	8T.786.3003.2	Pad foot insulation 260	5	3 Paperboard 100/00	0.344	1.72	
26	8T.193.3013.30	Foot pad	10	50 Laminated wood -B	7.26	72.6	
25	C04022121	Blackened butterfly spring 45×22.4×2.5×3.5	64	GB/T 1972	0.012	0.768	
24	C01010808303	Blackened bolt M20×55	24	GB/T 5782	0.159	3.824	
23	8T.193.3015.30	Side beam cushion block	8	50 Laminated wood -B	2.4	19.2	
22	8T.751.3004.4	Side beam insulation	4	1.5 Paperboard 100/00	0.41	1.64	
21	8T.751.3004.2	Side beam paperboard	40	1.0 Paperboard 100/00	0.02	0.8	
20	5T.070.3001.4	Side beam 620	4		40.32	161.28	
19	5.640.2930.10	Core	1		27609.56	27609.56	
18	8T.751.3008.4	Pull plate insulation 1430	6	3 Paperboard 100/00	0.946	5.676	
17	8T.137.3008.5	Pull plate 1630	6	16 Nonmagnetic steel plate 20Mn23Al	36.78	220.68	
16	C0404020401	High strength enlarged gasket 20×60×3	20	GB/T 97.2	0.016	0.32	
15	C01010807304	Blackened bolt M20×50	20	GB/T 5783	0.145	2.9	
14	C04022101	Blackened butterfly spring 35.5×18.3×2×2.8	24	GB/T 1972	0.007	0.168	
13	C01010708304	Blackened bolt M16×55	24	GB/T 5783	0.098	2.352	
12	5T.210.3001.3	Axle sleeve 41	12		2.65	31.8	change 41 to 40
11	5T.070.3001.5	Upper beam 740×340	3		26.5	79.5	
10	8T.193.3012.30	Upper beam cushion block	10	50 Laminated wood -B	7.26	72.6	
9	8T.786.3003.1	Upper beam insulation 160	5	3 Paperboard 100/00	0.212	1.06	
8	5T.070.3001.1	Upper beam 740×340	2		25.19	50.38	
7	5T.577.3012.2	Grounding copper strip	1		0.34	0.34	
6	C04022101	Blackened butterfly spring 35.5×18.3×2×2.8	32	GB/T 1972	0.007	0.224	
5	C02010741	Blackened nut M16	32	GB/T 6170	0.029	0.928	
4	8T.750.3008.10	Paperboard 740×120	8	1 Paperboard 100/00	0.103	0.824	
3	5T.137.3005.1	Pull strap 740	8		0.88	7.04	Match the actual length
2	5.071.2930.12	LV upper clamp	1		501.51	501.51	
1	5.071.2930.11	HV upper clamp	1		498.56	498.56	

Marker	Number of pieces	Change file number	Signature	Date
Designer		李杨帆	Standard reviewer	王胜
Checker		王士昊	Markuper	高小石
Auditer		吴炳	Date	2022/12/5
Process reviewer		王轩		

SFZ-66000/132

Core assembly

5.641.2930.2

Pattern marking	Weight	Versions	Proportion

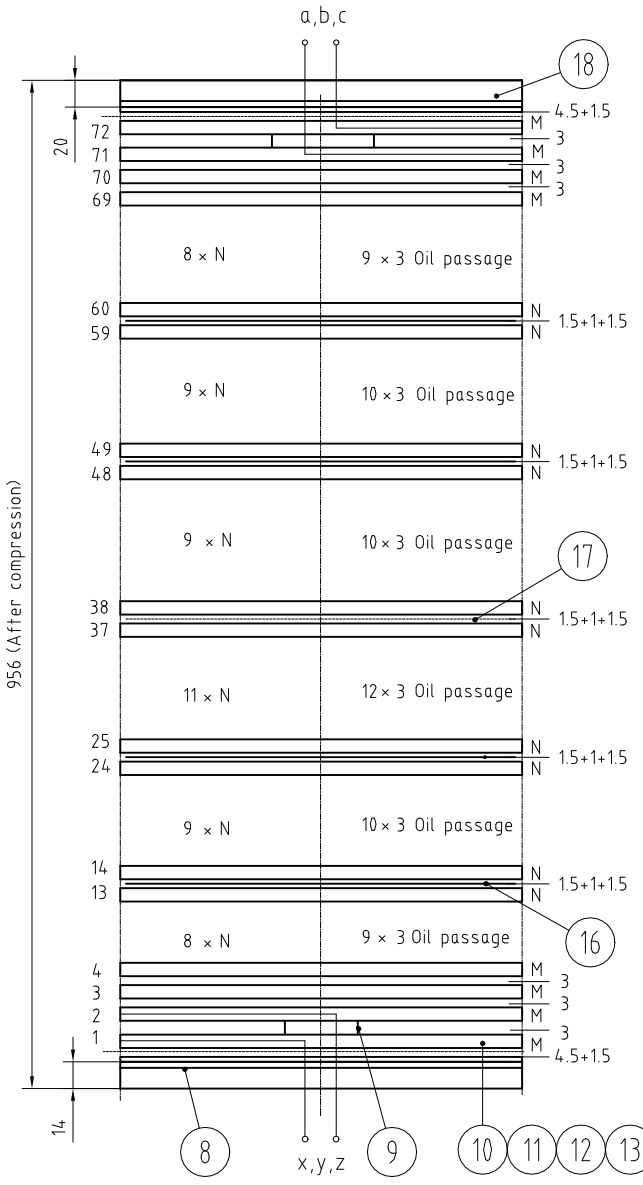
Zhejiang Jiangshan Transformer Co.,LTD.

I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

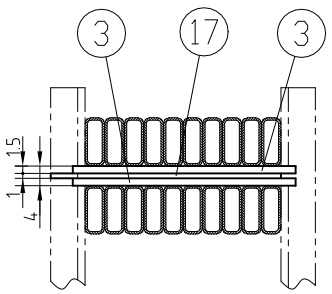
Signature: 高小石

Intertek Testing & Certification Ltd.

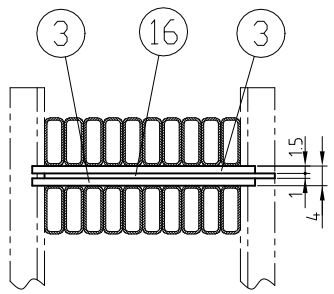
6.600.2930.10



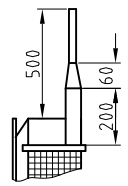
Layout drawing of inner oil baffle



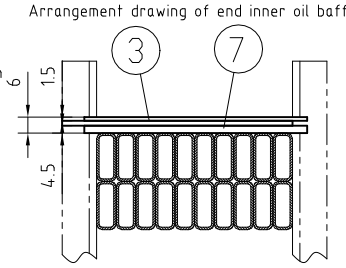
Layout drawing of outer oil baffle



Outlet binding schematic diagram



Arrangement drawing of end inner oil baffle



Technical requirements

1.The coil is of double continuous type, with left winding direction, and the outlet is placed in the middle of the two gears brace.

2.4 cakes of the beginning and end of the coil shall be bound with tightening strip 8mmd at the interval of 1 quart, and the transposition shall be wrapped with insulation and padded with transposition paperboard.

3.The coil is dry at constant pressure, the constant pressure pressing force is 3Mpa, and the coil is not immersed in paint.

4.The outgoing length is 500, The paint shall not be peeled off for 250mm at the end.

5.The shift position can be shifted according to the actual span brace, and the cushion block of the span shift position can be replaced by redundant cushion blocks or trimmed with long cushion blocks.

6.Wedge cushion blocks shall be placed at the internal and external transposition according to the transposition height requirements.

7.Iron A is used at both ends of the coil.

8.Insulated heat-shrinkable pipes are used to bind 4 cakes every other gear, and each 4 cakes from the north to the south cross one cake at the top and bottom.

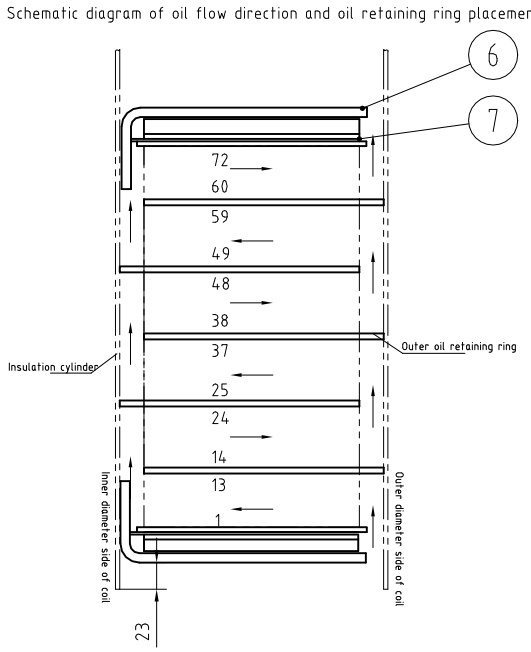
Rated voltage 33 kV			Phase current 1154.7A		Rated capacity 66000 kVA		Three-phase	yn Vector group
Winding per set 3			Turns per winding 138		Graded per winding 2X36		Phase resistance 0.0248591	

Segment No	Number of segments	Turns per segments			Total turns	Wireway				Padding strip			Size of winding		
		Continuity	Tangle	Shield		Array	Wire specification	Length(m)	Weight(kg)	Internal diameter	Interturn	External diameter	Internal diameter	External diameter	Radial direction
M	2X4	3-12/24			14	20.95 / 10.2	HWNC1-0.8 1.4×4.5 / 20.95×10.2 25	3X1X360.7	2930 /2976 /2987				Φ740	Φ918	89
N	2X32	3-21/24			124								Φ740	Φ918	89

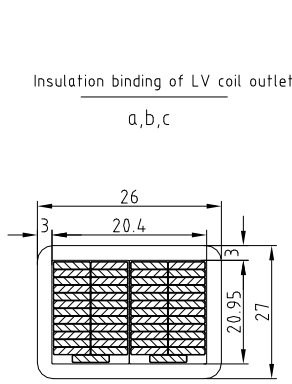
Total height of cushion block before compression 218 | Cushion block compression 19 | Compression ration (8.72 %)

Line end			
	Name	a,b,c	x,y,z
	Material	Original line	Original line
	Length	500	500
	Wrap insulation	Every side 3mm	Every side 3mm

Schematic diagram of oil flow direction and oil retaining ring placement

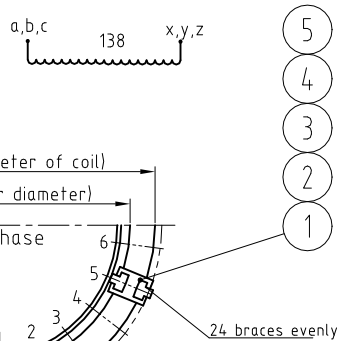


Insulation binding of LV coil outlet



Coil profile

Sketch of number of turns



NO.	Code	Name	QTY	Material	Each Weight	Total Weight	Remark
21	E040103	White cloth band 0.1×16	1	0.1×16 White cloth band			
20	E040104	High shrinkage insulating strip 0.28×25	1	0.28×25 High shrinkage insulating strip			
19	E02020903	Insulating crepe paper 0.05×25	1	0.05×25 Insulating crepe paper			
18	5T.711.3005.7	Core yoke insulation 742×914×20×70×40	3		3.75	11.25	Cushion block width changed to 60
17	8T.711.3007.3	Inner oil baffle 360×457×10×15	72	1.0 Paperboard 100/00	0.025	1.793	
16	8.711.2930.8	Outer oil baffle	9	1.0 Paperboard 100/00	0.58	5.22	
15	8.193.2930.8	Cushion block	120	3 High-density paperboard	0.16	19.2	
14	8.193.2930.7	Cushion block	120	3 High-density paperboard	0.14	16.8	
13	8T.751.3006.2	Transposition pad plate 194×25×37×10	120	1.0 Paperboard 100/00	0.006	0.72	Bottom, for 3, 4.5mm oil passage
12	8T.751.3006.2	Transposition pad block 240×25×37×10	120	1.0 Paperboard 100/00	0.008	0.96	Open position, for 3, 4.5mm oil passage
11	8T.751.3008.5	Paperboard 600000×10	1	1 Paperboard 100/00	7.2	7.2	
10	B0109503050710	Transposed copper conductor HWNC(1-0.8(1.4×4.5)×25	2987		1	2987	
9	8T.193.3009.1	Fan shaped pad 371×458×120×15	12	3 High-density paperboard	0.034	0.408	
8	5T.711.3005.7	Core yoke insulation 742×914×14×70×40	3		2.71	8.13	Cushion block width changed to 60
7	8T.711.3007.3	Inner oil baffle 363×457×8×15	72	1.0 Paperboard 100/00	0.024	1.742	Change the thickness to 15mm
6	5T.759.2570.60	Angular ring 728×926×5	6	Sulphate Plup	20	120	
5	8T.193.3008.2	Cushion block 73.5	450	15 High-density paperboard	0.00529	2.38	
4	8T.123.3018.2	Brace strip 956	72	6 Paperboard 100/00	0.141	10.152	With margin, Allowance is not required
3	8T.193.3008.8	Cushion block 100	10850	15 High-density paperboard	0.007	78.12	
2	8T.123.3018.14	Brace strip 1110×650	72	10 Paperboard 100/00	0.222	15.984	
1	8.770.2930.7	Insulation cylinder	3	3 High-density paperboard	4.2	12.6	With height, Check the assembly size of the bottom

Marker	Number of pieces	Change file number	Signature	Date
Designer		姜增林	Standard reviewer	王坤
Checker		刘振辉	Markuper	高小石
Auditer		王志军	Date	2022/12/5
Process reviewer		王军		

SFZ-66000/132

LV. Winding

6.600.2930.10

Pattern marking	Weight	Versions	Proportion

Zhejiang Jiangshan Transformer Co.,Ltd

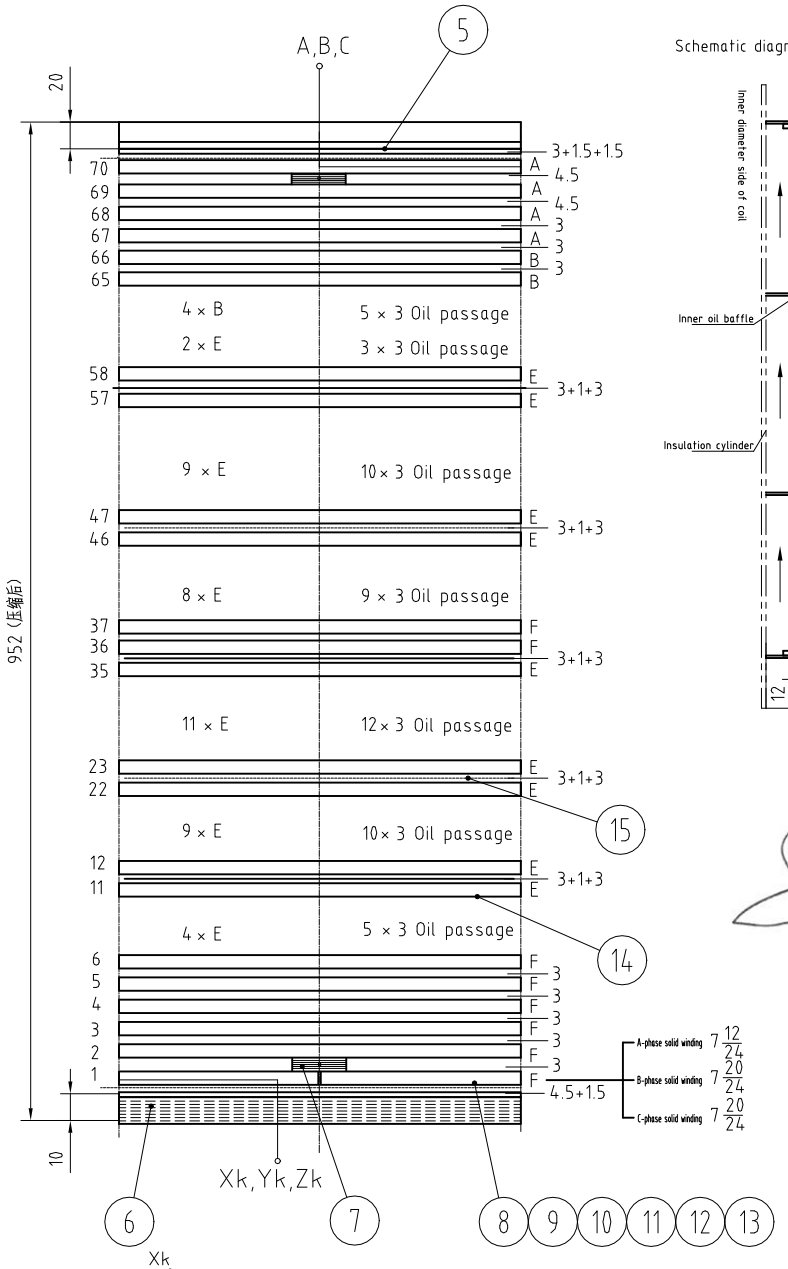
I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature: 高小石

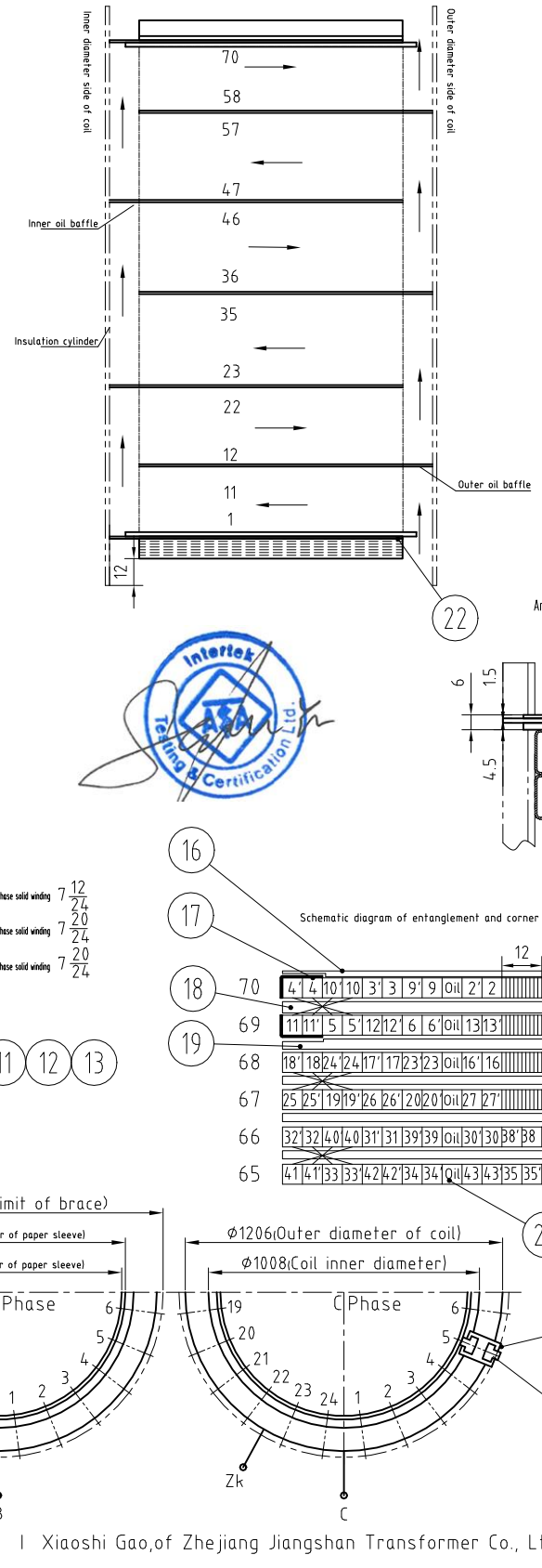
Intertek Testing & Certification Ltd

6.600.2930.11

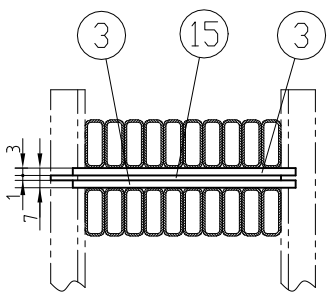
Schematic diagram of line segment and oil passage arrangement



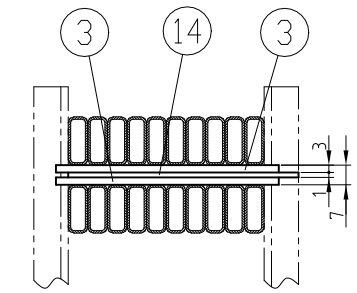
Schematic diagram of oil flow direction and oil retaining ring placement



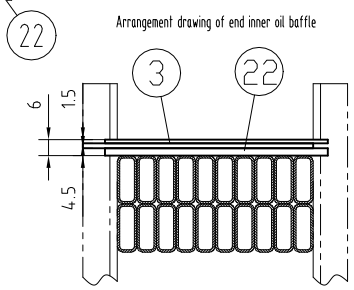
Layout drawing of inner oil baffle



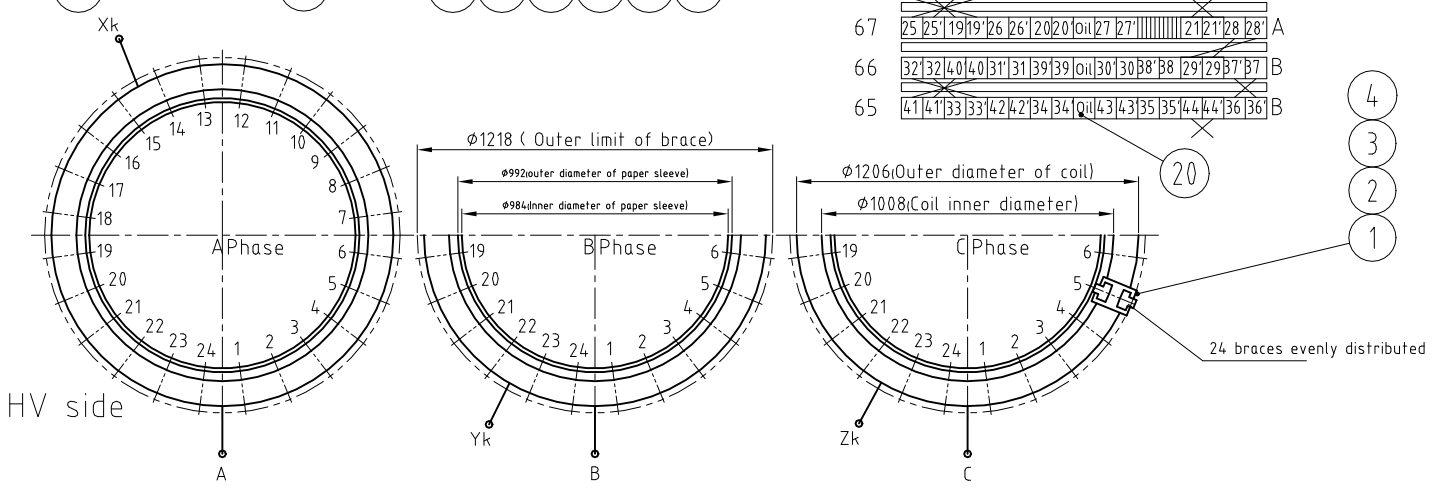
Layout drawing of outer oil baffle



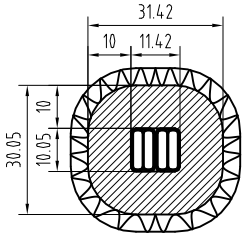
Arrangement drawing of end inner oil baffle



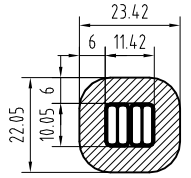
Schematic diagram of entanglement and corner ring placement



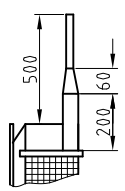
HV upper coil head insulation binding



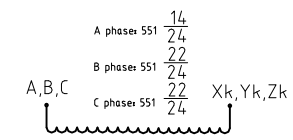
HV lower outlet coil head insulation binding



Outlet binding schematic diagram



Sketch of number of turns



Technical requirements:

1.The coil is entangled and continuous, with left winding direction;

2.Place a fan-shaped cushion block at the beginning and end of the outlet head and tie it firmly with the outlet head.

3.The coil shall be bound firmly in the axial direction at the front and back of the coil head and at the end of the coil, with a total of 6 coils at 4 intervals;

4.Place the transposition pad at the transposition position of the coil, and then wrap it with Denison paper.

5.The transposition conductor spans the transposition between 36-37.

6.Insulated heat-shrinkable pipes are used to bind 4 cakes every other gear, and each 4 cakes from the north to the south cross one cake at the top and bottom.

Rated voltage 132 kV				Phase current 288.7 A			Rated capacity 66000 kVA			Three-phase	YN Vector group			
Winding per set 3				Turns per winding 552			Graded per winding 70			Phase resistance 0.52302				
Segment No.	Number of segments	Turns per segments			Total turns	Wireway				Padding strip			Size of winding		
		Continuity	Tangle	Shield		Array	Wire specification	Length(m)	Weight(kg)	Internal diameter	Interturn	External diameter	Internal diameter	External diameter	Radial direction
A	4		6 21/24		27 12/24	11.42 / 10.05	ZZB-1.05 2.18×9 5.71×10.05 X2	3X2X1921	3951 /4122		12		Φ1008	Φ1206	99
B	6		7 21/24		47 6/24								Φ1008	Φ1206	99
E	54	7 23/24			429 18/24								Φ1008	Φ1206	99
F	6	7 22/24			47 12/24								Φ1008	Φ1206	99

Total height of cushion block before compression 230			Cushion block compression 19.3 Compression ration (8.39 %)	
Line end	Name	A,B,C	X,Y,Z	
	Material	Original line	Original line	
	Length	500	500	
	Wrap insulation	Every side 10mm	Every side 10mm	

NO.	Code	Name	QTY	Material	Each Weight	Total Weight	Remark
26	E02021106	Denison paper 22HCC/24mm	1	22HCC Denison paper			Sufficient
25	E040103	White cloth band 0.1×16	1	0.1×16 White cloth band			
24	E040104	High shrinkage insulating strip 0.28×25	1	0.28×25 High shrinkage insulating strip			
23	E02020903	Insulating crepe paper 0.05×25	1	0.05×25 Insulating crepe paper			
22	8T.711.3007.3	Inner oil baffle 496×602×8×15	72	1.0 Paperboard 100/00	0.037	2.635	Change the thickness to 0.5mm
21	8T.759.3001.2	Narrow edge anti-angle ring 1204×655×13×11	36	1.0 Sulphate Plus	0.017	0.612	
20	5.750.2930.2	Insulated oil passage	220		0.07	15.4	
19	5T.193.3001.5	Cushion block 110×83.5×8	72		0.018	1.296	
18	5T.193.3001.5	Cushion block 110×85.5×19	72		0.018	1.296	
17	8T.759.3001.1	Narrow edge positive angle ring 1008×560×13×11	36	1.0 Sulphate Plus	0.015	0.54	
16	5T.193.3001.5	Cushion block 110×72.5×19	72		0.018	1.267	
15	8T.711.3007.3	Inner oil baffle 496×602×8×15	72	1.0 Paperboard 100/00	0.037	2.635	
14	8.711.2930.9	Outer oil baffle	9	1.0 Paperboard 100/00	0.74	6.66	
13	8T.751.3006.2	Transposition pad plate 132×30×27×10	16	1.0 Paperboard 100/00	0.003		Bottom, for 1mm oil passage
12	8T.751.3006.2	Transposition pad plate 158×30×27×10	16	1.0 Paperboard 100/00	0.004		Open position, for 1mm oil passage
11	8T.751.3006.2	Transposition pad plate 132×30×23.5×10	200	1.0 Paperboard 100/00	0.003	1	Bottom, for 3, 4.5mm oil passage
10	8T.751.3006.2	Transposition pad plate 158×30×23.5×10	200	1.0 Paperboard 100/00	0.003	1	Open position, for 3, 4.5mm oil passage
9	8T.751.3008.5	Paperboard 200000×10	1	1 Paperboard 100/00	2.4	2.4	
8	B01101527114 1631	Combined copper conductor ZZB-1.05(0.75×0.3)(2.18×9)5.71×10.5)×2	4122		1	4122	
7	8T.193.3009.2	Fan shaped pad 505×602×157×15	6	3 High-density paperboard	0.051	0.304	
6	8T.711.3006.2	Insulation ring 1010×1204×60×40	3	10 Paperboard 100/00	4.05	12.15	
5	5T.711.3005.7	Core yoke insulation 1010×1204×20×60×40	3		4.54	13.62	
4	8T.123.3018.2	Brace strip 950	72	6 Paperboard 100/00	0.14	10.08	*When press allowance is not required
3	8T.193.3008.7	Cushion block 110	11300	1.5 High-density paperboard	0.01	111.87	
2	8T.123.3018.2	Brace strip 950	72	8 Paperboard 100/00	0.184	13.248	
1	8T.770.3003.1	Insulation cylinder 984×992×950×3164	3	4 Paperboard 100/00	14.15	42.45	

Marker	Number of plies	Change file number	Signature	Date
Designer		姜增林	Standard reviewer	
Checker			Markuper	
Auditer			Date	2022/12/5
Process reviewer				

SFZ-66000/132

HV coil

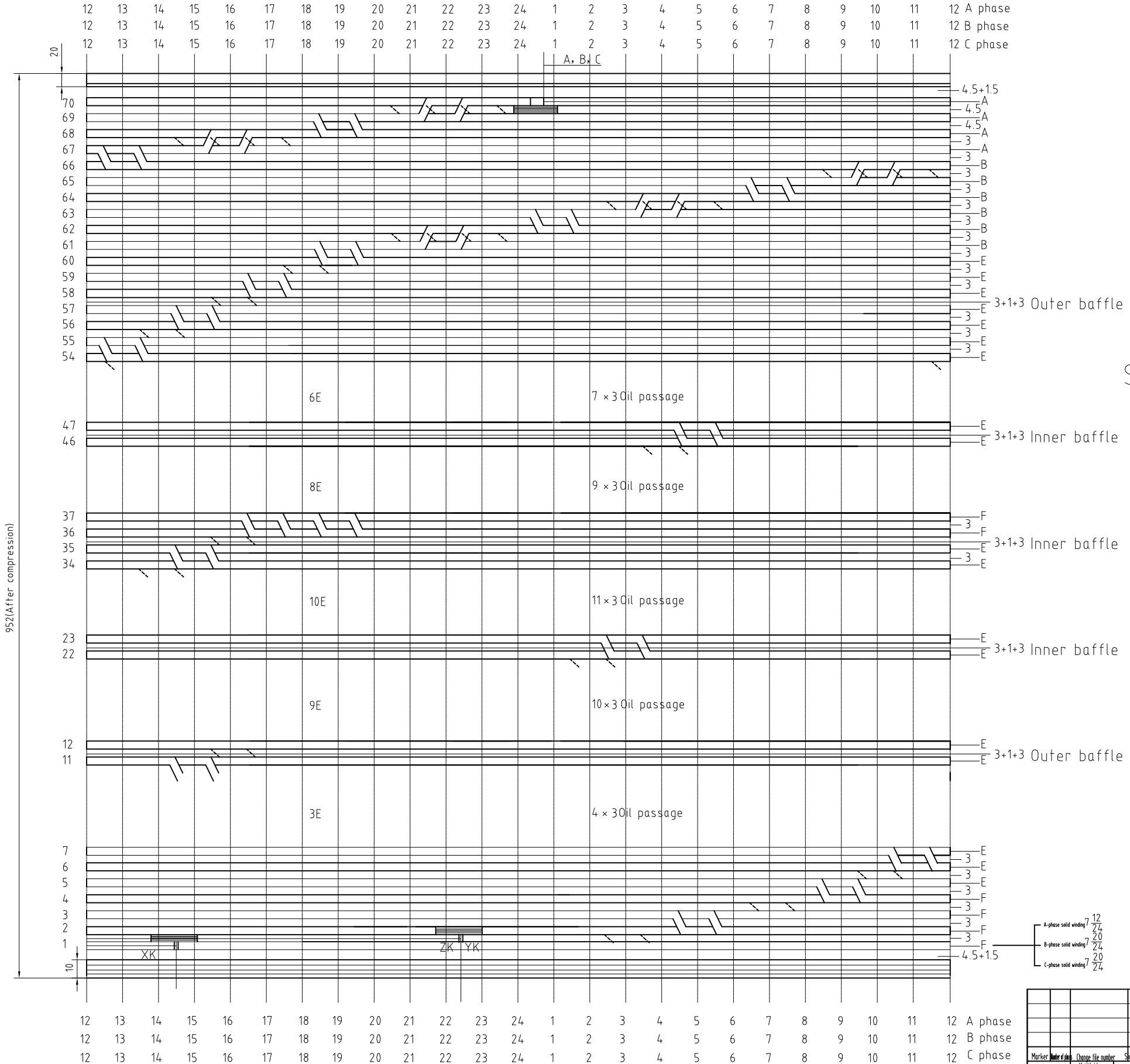
6.600.2930.11

Pattern marking	Weight	Versions	Proportion

Zhejiang Jiangshan Transformer Co.,Ltd

I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature:



Supplementary expanded view

I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature:

Marker	Number of sheets	Change file number	Signature	Date
Designer		姜增林	Standard reviewer	
Checker			Markuper	
Auditer			Date	2022/12/5
Process reviewer				

SFZ-66000/132

HV coil

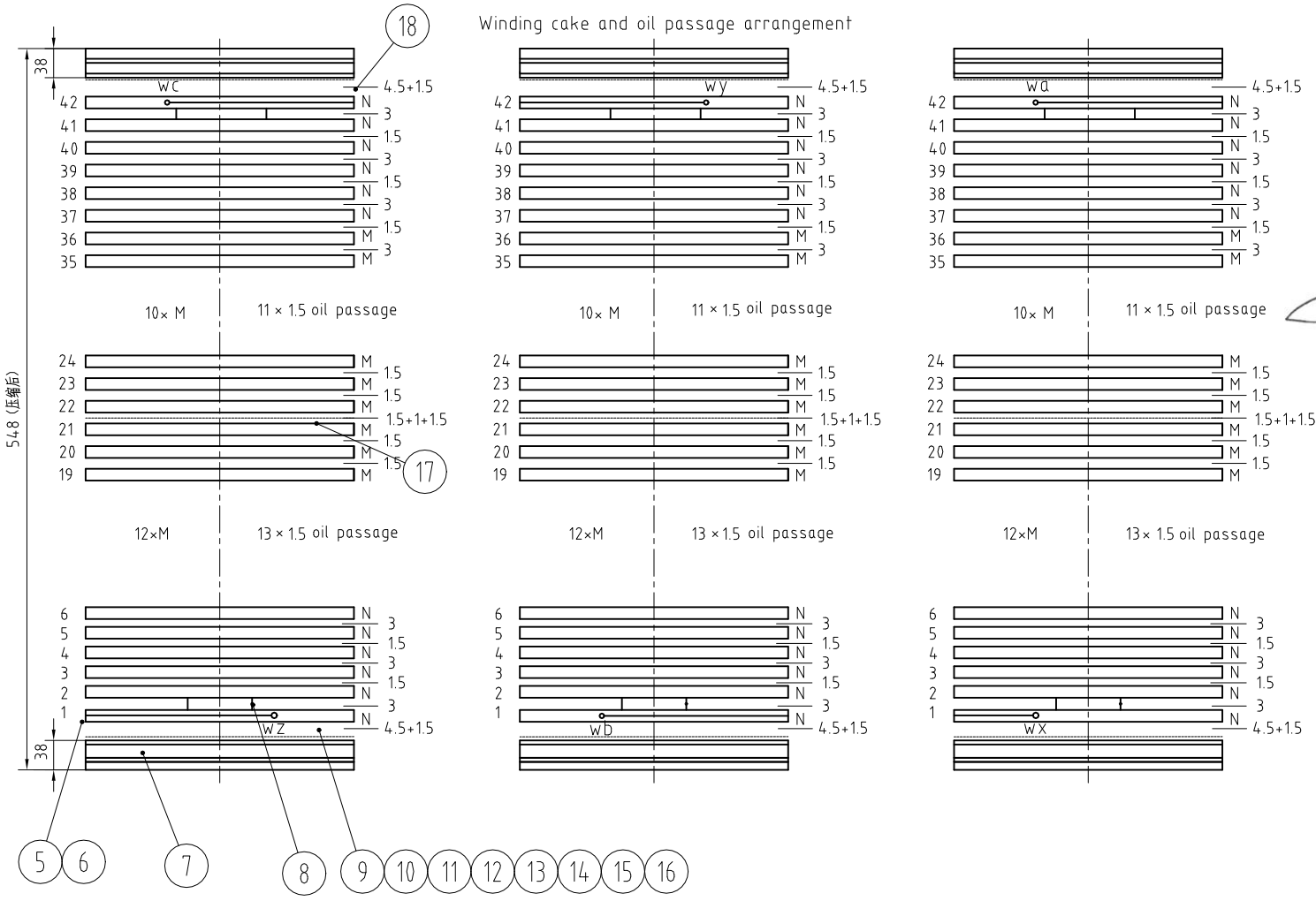
6.600.2930.11-1

Pattern marking	Weight	Versions	Proportion

Zhejiang Jiangshan Transformer Co.,Ltd

6.600.2930.12

Winding cake and oil passage arrangement



Technical requirements:

1.Coils are continuous, with phases A and C wound leftward and phase B wound rightward.

2.4 cakes at the beginning and end of the coil shall be bound with tightening strip (bound at the interval of 1 gear), and the transposition shall be wrapped with insulation and padded with transposition paperboard;

3.The coil is dry at constant pressure, the constant pressure pressing force is 3Mpa, and the coil is not immersed in paint;

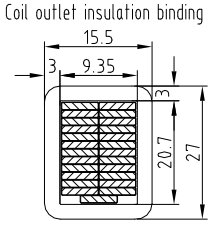
4.The shift position can be shifted according to the actual span brace, and the cushion block at the span shift position can be replaced by redundant cushion blocks or trimmed with long cushion blocks.

5.Wedge cushion blocks shall be placed at the internal and external transposition according to the transposition height requirements.

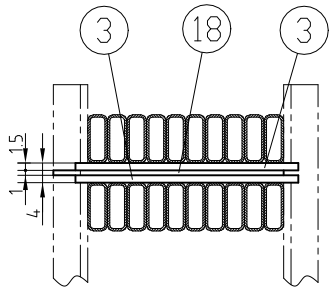
6.Insulated heat-shrinkable pipes are used to bind 4 cakes every other gear, and each 4 cakes from the north to the south cross one cake at the top and bottom.

Rated voltage 11 kV				Phase current 666.6 A				Rated capacity 66000 kVA				Three-phase	d	Vector group			
Winding per set 3				Turns per winding 80				Graded per winding 42				Phase resistance 0.4172666					
Segment No	Number of segments	Turns per segments				Total turns		Wireway				Padding strip			Size of winding		
		Continuity	Tangle	Shield				Array	Wire specification	Length(m)	Weight(kg)	Internal diameter	Interturn	External diameter	Internal diameter	External diameter	Radial direction
N	12	1-21/24				22-12/24		9.35 / 20.7	HNC1-0.55 1.4×4.2 / 20.7×9.35 25	3X1X337.5	1261 /1289				Φ1296	Φ1380	42
M	30	1-22/24				57-12/24									Φ1296	Φ1380	42
Total height of cushion block before compression 74.5								Cushion block compression 6.5 (Compression ration (8.7 %)									
Line end	Name	wa,wb,wc						wx,wy,wz									
	Material	Original line						Original line									
	Length	500						500									
	Wrap insulation	Every side 3mm						Every side 3mm									

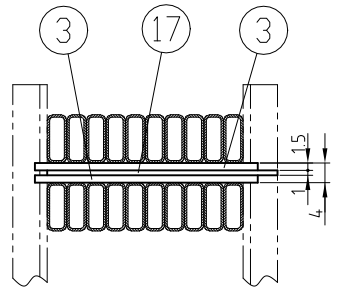
Coil outlet insulation binding



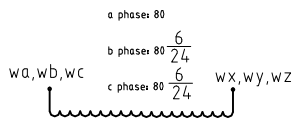
Layout drawing of inner oil baffle



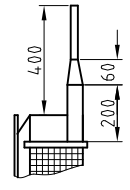
Layout drawing of outer oil baffle



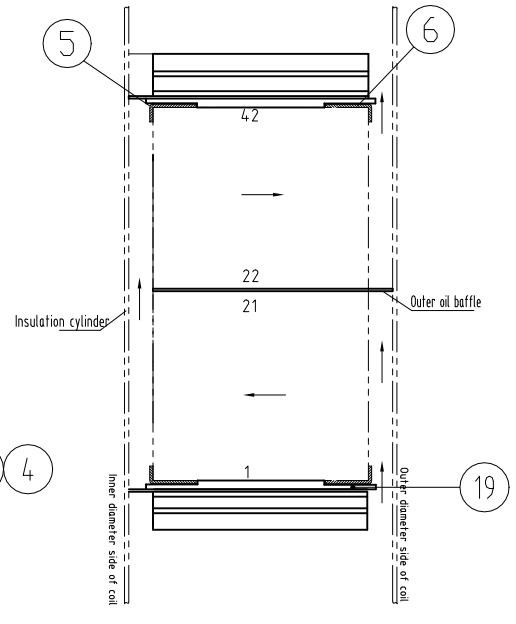
Sketch of number of turns

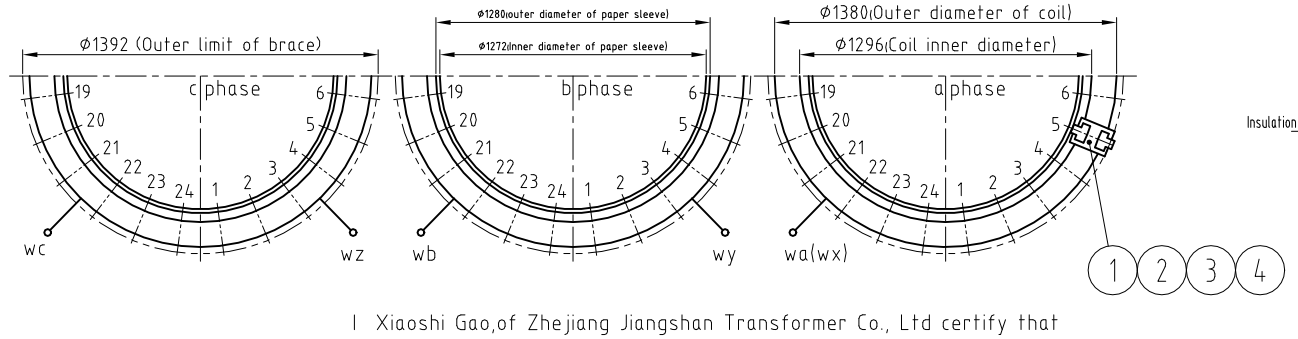


Outlet binding schematic diagram



Schematic diagram of oil flow direction and oil retaining ring placement





NO.	Code	Name	QTY	Material	Each Weight	Total Weight	Remark
22	E040103	White cloth band 0.1×16	1	0.1×16 White cloth band			
21	E040104	High shrinkage insulating strip 0.28×25	1	0.28×25 High shrinkage insulating strip			
20	E02020903	Insulating crepe paper 0.05×25	1	0.05×25 Insulating crepe paper			
19	5T.193.3001.5	Cushion block 53×21×16	144		0.008	1.097	
18	8T.711.3007.3	Inner oil baffle 640×689×8×15	72	1.0 Paperboard 100/00	0.021	1.476	Change the thickness to 15mm
17	8.711.2930.10	Outer oil baffle	3	1.0 Paperboard 100/00	0.74	2.22	
16	8.193.2930.10	Cushion block	126	3 High-density paperboard	0.16	20.16	
15	8.193.2930.9	Cushion block	126	3 High-density paperboard	0.14	17.64	
14	8T.751.3006.2	Transposition pad plate 180×30×21.5×9	12	1.0 Paperboard 100/00	0.004	0.044	Open position, for 3mm oil passage
13	8T.751.3006.2	Transposition pad plate 170×30×21.5×9	12	1.0 Paperboard 100/00	0.003	0.041	Bottom, for 3mm oil passage
12	8T.751.3006.2	Transposition pad plate 180×30×20×9	55	1.0 Paperboard 100/00	0.003	0.19	Open position, for 15mm oil passage
11	8T.751.3006.2	Transposition pad plate 170×30×20×9	55	1.0 Paperboard 100/00	0.003	0.178	Bottom, for 15mm oil passage
10	8T.751.3008.5	Paperboard 25000×9	1	1 Paperboard 100/00	0.27	0.27	
9	B0109116050510	Transposed copper conductor HNC1-0.55(1.4×4.2)×25	1289		1	1289	
8	8T.193.3009.1	Fan shaped pad 649×689×180×15	6	3 High-density paperboard	0.025	0.151	
7	5.711.2930.10	Core yoke insulation	6		3.79	22.74	
6	8T.759.3001.2	Narrow edge anti-angle ring 1378×295×10×9	48	1.0 Sulphate Plup	0.006	0.288	
5	8T.759.3001.1	Narrow edge positive angle ring 1296×530×10×9	48	1.0 Sulphate Plup	0.011	0.533	
4	8T.123.3018.2	Brace strip 920	(72)	6 Paperboard 100/00	0.136		20 mm press Allowance to be required
3	8T.193.3008.7	Cushion block 53	4000	15 High-density paperboard	0.005	19.08	
2	8T.123.3018.2	Brace strip 920	(72)	8 Paperboard 100/00	0.178		
1	8T.770.3003.1	Insulation cylinder 1272×1280×920×4.070	(3)	4 Paperboard 100/00	17.7		

I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature: 高小石

Marker	Number of pieces	Change file number	Signature	Date
Designer		姜增林	Standard reviewer	王胜
Checker		刘德辉	Markuper	高小石
Auditer		王之民	Date	2022/12/5
Process reviewer		王胜		

SFZ-66000/132

W. Winding

6.600.2930.12

Pattern marking	Weight	Versions	Proportion

Zhejiang Jiangshan Transformer Co.,Ltd

6.600.2930.13

Upper coil outlet length table

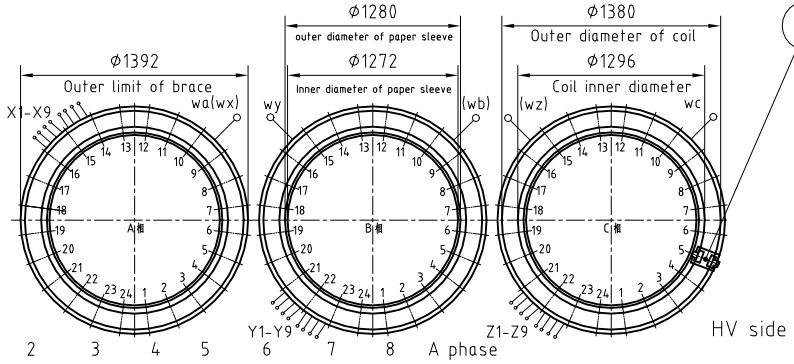
	2	3	4	5	6	7	8	9
A	500	500	500	500	500	500	500	500
B	500	500	500	500	500	500	500	500
C	1000	1000	1000	1000	1000	1000	1000	1000

Up and down of middle outlet1'--8'- All 500mm

Lower coil outlet length table

	1	2	3	4	5	6	7	8
A	1200	1200	1200	1200	1200	1200	1200	1200
B	1200	1200	1200	1200	1200	1200	1200	1200
C	600	600	600	600	600	600	600	600

Winding outlet position diagram



Technical requirements:

1.The coil is of double spiral type, with the left winding direction and the upper and lower parts in series. The coil is wound at both ends of the tertiary winding;

2.Place the transposition pad at the transposition position of the coil, and then wrap it with Denison paper.

3.The first gear of the coil interval is bound with a tightening belt.

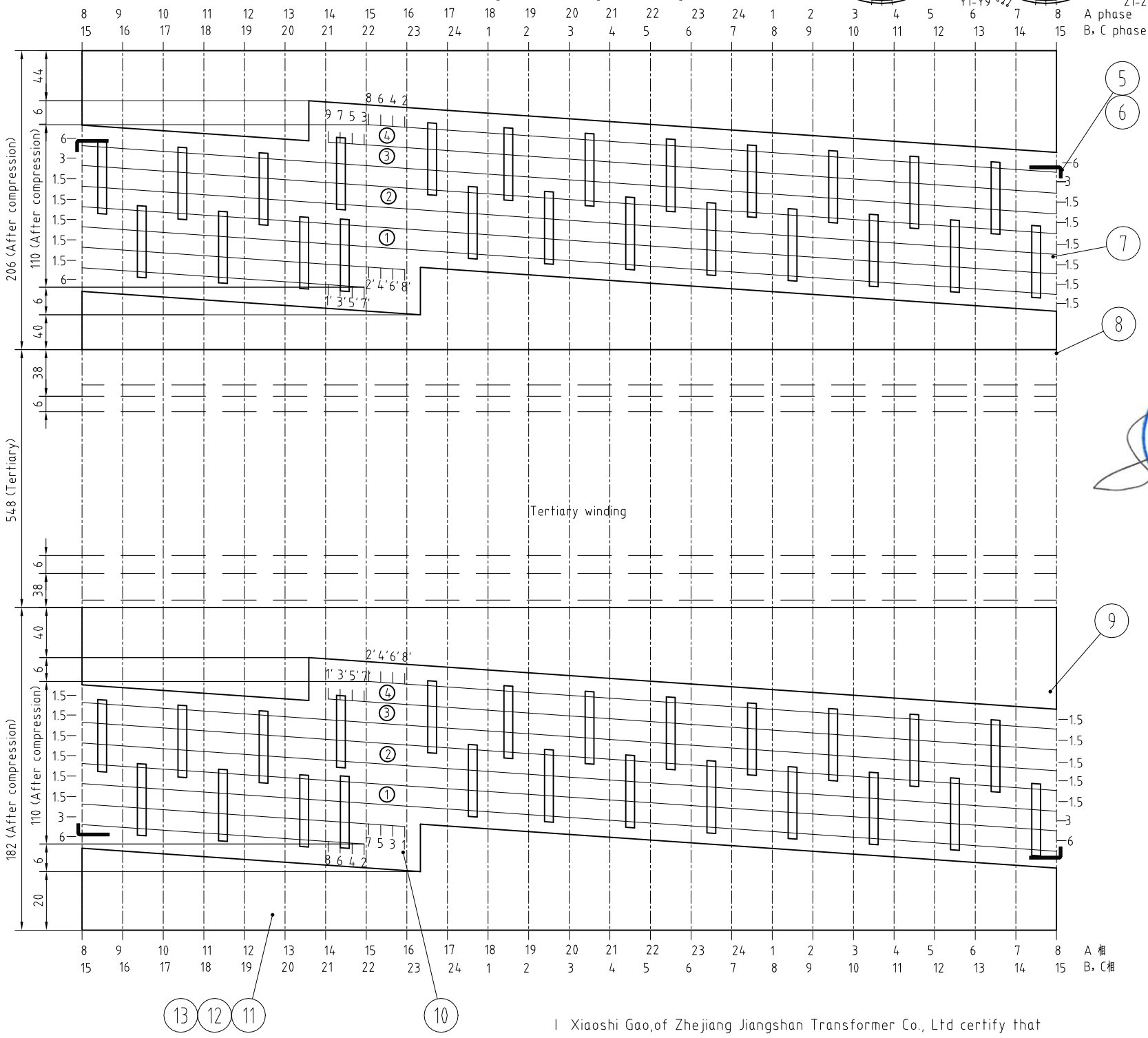
4.The coil is divided into two positions, each side of which is wrapped with 3mm, and each outlet and wire turn are bound firmly.

5.Insulated heat-shrinkable pipes are used to bind 4 cakes every other gear, and each 4 cakes from the north to the south cross one cake at the top and bottom.

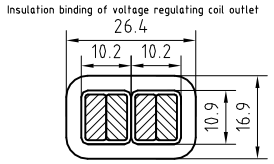
Rated voltage 132±8×1.25%		Phase current 320.8 A		Rated capacity 66000 kVA	
Winding per set 3		Three-phase	Y Vector group	Graded per winding 8×7	
Wireway				Size of winding	
Array	Wire specification	Length(m)	Weight(kg)	Internal diameter	External diameter	Radial direction	Axial
2×4	ZZB-1.65 4.25×9.3 10.15×10.95	3x1x8x31.3	517/539	Φ1296	Φ1380	42	110

Line end	Name	1 - 9 , 1' - 8'
	Material	Original line
	Length	See table
	Wrapped insulation	The head of the coil is wrapped with 1mm of electrician's crepe paper, and the outside is wrapped with a half stack of white cloth strip.
Coil type: double helix		Phase resistance (75℃):8×0.0084158

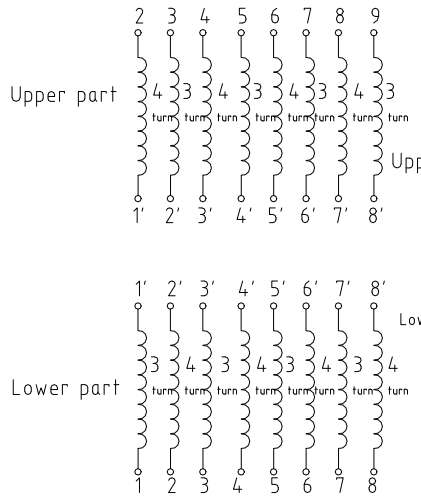
Schematic diagram of winding end binding



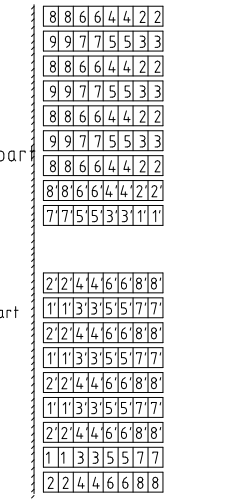
Insulation binding of voltage regulating coil outlet



Turns number diagram of voltage regulating coil



Profile of voltage regulating coil



NO.	Code	Name	QTY	Material	Each Weight	Total Weight	Remark
16	E040103	White cloth band 0.1×16	1	0.1×16 White cloth board			
15	E02020903	Insulating crepe paper 0.05×25	1	0.05×25 Insulating crepe paper			
14	E040104	High shrinkage insulating strip 0.28×25	1	0.28×25 High shrinkage insulating strip			
13	5T.711.3005.10	End ring 1298×1378×44×67×24	3		7.45	22.35	
12	5T.711.3005.10	End ring 1298×1378×40×63×24	6		5.78	34.68	
11	5T.711.3005.10	End ring 1298×1378×20×43×24	3		4.05	12.15	
10	8T.193.3009.1	Fan shaped pad 649×689×180×15	6	3 High-density paperboard	0.025	0.15	
9	8T.751.3008.5	Paperboard 25000×10	1	1 Paperboard 100/00	0.3	0.3	
8	8.750.2930.1	Puncture screen	3	2 insulation paperboard 100/00	28.5	85.5	
7	B011037263240621	Combined copper conductor ZZB-1.65(N+1.65)(4.25×9.3/10.15×10.95)×2	539		1	539	
6	8T.759.3001.2	Narrow edge anti-angle ring 1378×295×10×9	48	1.0 Sulphate Plup	0.006	0.288	
5	8T.759.3001.1	Narrow edge positive angle ring 1296×530×10×9	48	1.0 Sulphate Plup	0.011	0.528	
4	8T.123.3018.2	Brace strip 920	72	6 Paperboard 100/00	0.136	9.792	70N·m press.Allowance is not required
3	8T.123.3018.2	Brace strip 920	72	8 Paperboard 100/00	0.178	12.816	
2	8T.770.3003.1	Insulation cylinder 1272×1280×920×4.070	3	4 Paperboard 100/00	17.7	53.1	
1	8T.193.3008.7	Cushion block 53	700	15 High-density paperboard	0.005	3.5	

Marker	Number of plates	Change file number	Signature	Date
Designer	姜增林	Standard reviewers	王晓	
Checker	刘晓辉	Markuper	高小磊	
Auditer	王晓	Date	2022/12/5	
Process reviewer	王晓			

SFZ-66000/132

Voltage regulating Winding

6.600.2930.13

Pattern marking	Weight	Versions	Proportion

Zhejiang Jiangshan Transformer Co.,Ltd

I Xiaoshi Gao,of Zhejiang Jiangshan Transformer Co., Ltd certify that this drawing is a true representation of the apparatus tested.

Signature: 高小磊