№:AG1300955-2025(1)

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检测
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检 验 检 测 报 告

TEST REPORT

Sample: Power transformer

Model,Type: SZ22-31500/35-NX1 31500kVA

Client: Sichuan Zhongxin General Electric Energy Co.,Ltd.

Test Kind: Type test

国家输配电设备质量检验检测中心（山东） 3701127721363

山东省产品质量检验研究院 检验检测专用章 3701127710688

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Shandong Institute for Product Quality Inspection

国家输配电设备质量检验检测中心（山东）

National Inspection and Testing Center for Power Transmission and Distribution Equipment (Shandong)

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Test Report

Sample	Power transformer	Test Kind	Type Test
Client	Sichuan Zhongxin General Electric Energy Co.,Ltd.	Model, Type	SZ22-31500/35-NX1 31500kVA
Manufacturer	Sichuan Zhongxin General Electric Energy Co.,Ltd.	Grade	Qualified products Energy efficiency grade 1
Address of Client	（Industrial Zone）No.998, Xinghua 5 Road, Xinjin District, Chengdu City, Sichuan Province, China	Registered Trademark	/
Sampling Location	/	Client Representative	Xia Fawan
Sample Batch	/	Receipt Date	2025-09-19
Sample Quantity	1 unit	Producing Date	2025-08
Sample Description	Intact	Batch No.	ZX2508161
Environmental for Test	See the test	Test Date	2025-09-19 to 2025-09-26
Test Standard	GB/T 1094.1-2013,GB/T 1094.2-2013,GB/T 1094.3-2017,GB/T 1094.5-2008,GB/T 1094.10-2022,GB/T 6451-2023, JB/T 501-2021,JB/T 501-2006,GB/T 7600-2014,GB/T 261-2021,GB/T 17623-2017,IEC 60076-1:2011,IEC 60076-2:2011, IEC 60076-3:2013+AMD1:2018,IEC 60076-5:2006,IEC 60076-10:2016		
Decision Standard	GB/T 1094.1-2013,GB/T 1094.2-2013,GB/T 1094.3-2017,GB/T 1094.5-2008,GB/T 6451-2023,GB/T 7595-2017, JB/T 10088-2016,JB/T 501-2021,GB 20052-2024,IEC 60076-1:2011,IEC 60076-2:2011,IEC60076-3:2013+AMD1:2018, IEC 60076-5:2006, *Technical Service Contract for Oil-immersed Power Transformers-SDQI（Y）0401-2025*		
Test Item	Measurement of voltage ratio and check of phase displacement+Measurement of winding resistance+Measurement of d.c. insulation resistance each winding to earth and between windings and absorption ratio measurements+Check of core and frame insulation+ Measurement of dissipation factor(tanδ) of the insulation system capacitances+ Determination of capacitances windings-to-earth and between windings+Applied voltage test(AV)+ Auxiliary wiring insulation test+ Induced voltage withstand test(IVW) + Measurement of zero-sequence impedance(s) on three-phase transformers+ Measurement of no-load loss and current+ Measurement of no-load loss and current at 90 % and 110 % of rated voltage+Measurement of short-circuit impedance and load loss+ Insulating liquids test+ Tests on on-load tap-changers-Operation test+ Leak testing with pressure for liquid immersed transformers+ Vacuum deflection test on liquid immersed transformers + Pressure deflection test for liquid immersed transformers+ Determination of sound levels+Temperature-rise test+Winding hot-spot temperature-rise(calculation)+Short-circuit withstand test+ Lightning impulse test+ Measurement of the harmonics of the no-load current		
Test Conclusion	According to the GB/T 1094.1-2013,GB/T 1094.2-2013,GB/T 1094.3-2017,GB/T 1094.5-2008,GB/T 6451-2023, GB/T 7595-2017,JB/T 10088-2016,JB/T 501-2021,GB 20052-2024,IEC 60076-1:2011,IEC 60076-2:2011, IEC 60076-3:2013+AMD1:2018,IEC 60076-5:2006 standards and *Technique service contract for Oil-immersed Power Transformer -SDQI（Y）0401-2025*,all test items meet the requirements. (Chapter Inspection Unit)		
Note	a) This report includes the front cover and the second cover, "/" indicates that no content. b) Testing Address: No. 1, Chidong Avenue, Chiping District, Liaocheng City. c) The client requires measurement of the harmonics of the no-load current of this item according to JB/T 501-2006 testing. d) This report is the English report for AG1300955-2025.		

Approved by: 徐仲春 Date: 2025-09-30

Reviewed by: 魏秀秀 Date: 2025-09-30

Tested by: 王春光 Date: 2025-09-30

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Test Report (Continuation page)

No.	Testing items	Test requirements Guarantee value (Tolerance)	Test result		Verdict
			Before short circuit	After short circuit	
1	Measurement of voltage ratio and check of phase displacement (Routine test)	Voltage ratio at no load no more than: The lower value between a and b on principal tapping or the extreme tapings: a) ±0.5% of the specified ratio; b) ± 1/10 of the actual percentage impedance. On other tappings: ±0.5% of the design value of turns ratio. Phase displacement: YNd11.	-0.05% to 0.20% YNd11	-0.04% to 0.21% YNd11	Qualified
2	Measurement of winding resistance (Routine test)	DC Resistance Unbalance Rate: Phase (%):≤2 Line (%):≤1	HV（Phase）:≤0.13 LV（Line）: 0.08	HV（Phase）:≤0.15 LV（Line）:0.07	Qualified
3	Measurement of d.c. insulation resistance each winding to earth and between windings and absorption ratio measurements (Routine test)	Provide insulation resistance Provide absorptance(R_{60}/R_{15}):	See 4.3	See 4.22.3.3	/
4	Check of core and frame insulation (Routine test)	Core-to-earth（MΩ）：≥500（20℃） Frame-to-earth（MΩ）：≥500（20℃）	See 4.4	See 4.22.3.4	Qualified
5	Measurement of dissipation factor(tanδ) of the insulation system capacitances (Routine test)	Provide dissipation factor(tanδ)	See 4.5	See 4.22.3.5	/

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Test Report (Continuation page)

No.	Testing items	Test requirements Guarantee value (Tolerance)	Test result		Verdict
			Before short circuit	After short circuit	
6	Determination of capacitances windings- to- earth and between windings (Routine test)	Provide capacitances(nF)	See 4.6	See 4.22.3.5	/
7	Applied voltage test(AV) (Routine test)	HV: 85 kV 60s LV: 35kV 60s	85 kV 60s 35 kV 60s No collapse of the test voltages occurred	85 kV 60s 35 kV 60s No collapse of the test voltages occurred	Qualified
8	Auxiliary wiring insulation test (Routine test)	On-load tap-changes control connection to earth: 2 kV 60s	2 kV 60s No collapse of the test voltages occurred	2 kV 60s No collapse of the test voltages occurred	Qualified
9	Induced voltage withstand test (IVW) (Routine test)	Applied voltage(kV):21 Induced AC voltage (kV):70 Duration (s): 30 Frequency(Hz):f>50	21 70 30 200 No collapse of the test voltages occurred	21 70 30 200 No collapse of the test voltages occurred	Qualified
10	Measurement of no-load loss and current (Routine test)	I_0 (%): ≤ 0.24(tolerance +30%) P_0 (kW):≤12.0	0.10 10.9998	0.11 11.1032	Qualified
11	Measurement of no- load loss and current at 90% and 110% of rated voltage (Type test)	At 90% of rated voltage: I_0 (%): / P_0 (kW): / At 110% of rated voltage: I_0 (%): / P_0 (kW): /	0.07 8.6794 0.14 14.0000	/	/

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Test Report (Continuation page)

No.	Testing items	Test requirements Guarantee value (Tolerance)		Test result		Verdict
				Before short circuit	After short circuit	
12	Measurement of short- circuit impedance and load loss (Routine test)	t: 75℃ Z(%): 10.0(tolerance $^{+7.5}_{-7.5}$%) P_k(kW): ≤104.4 P_{total}(kW): ≤116.4		Tapping 4 10.06 102.1426 113.1424	Tapping 4 10.06 102.5219 113.6251	Qualified
13	Insulating liquids test (Routine test, Type test, Entrust test)	Breakdown voltage(kV): ≥40 tan δ (90±1℃): ≤0.010(1.0%) Moisture content(mg/L):≤20 Average Flash point (closed) (℃):≥135		68.4 0.426% 13.6 139.1	63.9 0.442% / /	Qualified
		Gas chromatography analysisof dissolved gas	H_2（μL/L）:＜30 C_2H_2（μL/L）：0 Total hydrocarbon（μL/L）：＜20	See 4.13	/	Qualified
14	Tests on on-load tap-changers-Operation test (Routine test)	After the transformer has been assembled, the on-load tap-changer is subjected to an operational test and does not fail.		Normal	Normal	Qualified
15	Leak testing with pressure for liquid-immersed transformers (tightness test)(Routine test)	Transformers: Applied pressure(kPa): 50 Duration(h): 24 No leakage.		50 24 No leakage	/	Qualified
		On-load tap-Changers oil chamber: Applied pressure(kPa): 50 Duration(h): 24 No leakage.		50 24 No leakage	/	Qualified
16	Vacuum deflection test on liquid immersed transformers (Special test)	Applied vacuum(kPa): 50 Duration(min): 5 Elastic deformation(mm): Box wall≤24 Box lid≤18 Permanent deformation(mm): Box wall≤10 Box lid≤8		See 4.16	/	Qualified
17	Pressure deflection test on liquid immersed transformers (Special test)	Applied positive pressure(kPa): 45 Duration(min): 5 Elastic deformation(mm): Box wall≤24 Box lid≤18 Permanent deformation(mm): Box wall≤10 Box lid≤8		See 4.16	/	Qualified

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Test Report (Continuation page)

No.	Testing items	Test requirements Guarantee value (Tolerance)	Test result	Verdict
18	Measurement of zero-sequence impedance(s) on three-phase transformers (Special test)	Provide zero-sequence impedance (Ω/phase) :/	3.914	/
19	Measurement of the harmonics of the no-load current (Entrust test)	Provide the harmonics of the no-load current each phase	I_1-I_{19} the harmonics of the no-load current	/
20	Determination of sound levels (Type test)	Sound pressure level $\overline{L_{pA}}$ dB(A): ≤58 Sound power level L_{WA} dB(A): ≤77	55.7 74.8	Qualified
21	Temperature- rise test (Type test)	Top insulating liquid temperature rise limit(K):≤53 Winding temperature rise limit(K):≤60 Tank and structural parts surface temperature-rise(K):≤75	Top liquid temperature- rise: 51.1 High- voltage winding temperature- rise: 54.11 Low- voltage winding temperature- rise:57.22 Tank and structural parts surface temperature-rise:59.6	Qualified
22	Winding hot-spot temperature-rise (calculation) （Entrust test）	temperature-rise limit (K):≤78	HV:68.14 LV:72.19	Qualified
23	Short-circuit withstand test (Special test)	Three tests on each phase The duration of each test(s): 0.25(tolerance $^{+10}_{-10}$ %) the oscillograms no anomalies indication. The biggest reactance difference(%):≤2.0 The out-of-tank inspection not reveal any defects The dielectric tests and other routine tests,have been successfully repeated.	3 0.252 to 0.256 pass 1.17 pass pass	Qualified

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No.	Testing items	Test requirements Guarantee value (Tolerance)	Test result	Verdict
24	Lightning impulse test (Type test)	a,b,c Full wave(kV): 75(tolerance $^{+3}_{-3}$ %) Chopped wave(kV):85(tolerance $^{+3}_{-3}$ %) A,B,C Full wave(kV): 200(tolerance $^{+3}_{-3}$ %) Chopped wave(kV):220(tolerance $^{+3}_{-3}$ %) O Full wave(kV): 200(tolerance $^{+3}_{-3}$ %)	Full wave: 75.2 to 76.3 No significant difference in transient waveforms Chopped wave: 83.8 to 85.7 No significant difference in transient waveforms Full wave: 199.1 to 203.0 No significant difference in transient waveforms Chopped wave: 219.2 to 223.8 No significant difference in transient waveforms Full wave: 198.5 to 200.4 No significant difference in transient waveforms	Qualified

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Test Report (Continuation page)

1. Sample parameters

Rated power:	31500kVA
Rated voltage:	35/10.5kV
Rated current	519.6/1732.1A
Number of phases:	3 phase
Rated frequency:	50 Hz
Tapping range:	±3×2.5%
Connection symbol:	YNd11
Type of cooling:	ONAN
Coil structure:	Circular concentric
Temperature class of insulation:	A
Insulation level:	HV Um/LI/LIC/AC 40.5/200/220/85kV
	LV Um/LI/LIC/AC 12/75/85/35kV

2. The sample describes

a) Outdoor.

b) The sample phase sequence marking of high and low winding is clear and accurate.

c) The sample external appearance has no collision, damage.

3. Test and decision standard

GB/T 1094.1-2013 *Power transformers-Part 1:General*

GB/T 1094.2-2013 *Power transformers-Part 2: Temperature rise for liquid-immersed transformers*

GB/T 1094.3-2017 *Power transformers-Part 3: Insulation levels, dielectric tests and external clearances in air*

GB/T 1094.5-2008 *Power transformers-Part 5:Ability to withstand short circuit*

GB/T 1094.10-2022 *Power transformers-Part 10:Determination of sound levels*

GB/T 6451-2023 *Specification and technical requirements for oil-immersed power transformers*

JB/T 501-2021 *Test guide for power transformers*

JB/T 501-2006 *Test guide for power transformers*

GB/T 7600-2014 *Determination of water content in transformer oils and turbine oils in service by coulometric method*

GB/T 261-2021 *Determination of flash point-Pensky-Martens closed cup method*

GB/T 17623-2017 *Determination of componental contents of gases dissolved in insulating oil by gas chromatography method*

GB/T 7595-2017 *Quality of transformer oils in service*

JB/T 10088-2016 *Sound level for 6 kV-1 000 kV power transformers*

GB 20052-2024 *Minimum allowable values of energy efficiency and the energy efficiency grades for power transformers*

IEC 60076-1:2011 *Power transformers- Part 1: General*

IEC 60076-2:2011 *Power transformers- Part 2: Temperature rise for liquid- immersed transformers*

IEC 60076-3:2013+AMD1:2018 *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60076-5:2006 *Power transformers-Part 5:Ability to withstand short circuit*

IEC 60076-10:2016 *Power transformers-Part 10:Determination of sound levels*

Technical Service Contract for Oil-immersed Power Transformers-SDQI（Y）0401-2025

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Test Report (Continuation page)

4. Test items and result

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

Date: Sept 22, 2025

Ambient temperature:28.8℃; RH: 54%; Atmospheric pressure:101.2kPa

HV winding		LV winding	Voltage ratio	Voltage ratio deviation (%)			Connection symbol
Tapping	Voltage (kV)	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	37.625	10.5	3.583	0.20	0.17	0.16	YNd11
2	36.750		3.500	0.05	0.08	0.08	
3	35.875		3.417	-0.05	-0.03	-0.01	
4	35.000		3.333	0.04	0.03	0.07	
5	34.125		3.250	0.06	0.07	0.05	
6	33.250		3.167	0.06	0.07	0.05	
7	32.375		3.083	0.05	0.06	0.04	

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4.2 Measurement of winding resistance (Routine test) Date: Sept 22, 2025

Liquid average temperature: 28.8℃; RH: 54%; Atmospheric pressure:101.2kPa

Winding	Tapping	Winding resistance			Resistance unbalance rate(%)
		A to O	B to O	C to O	
High-voltage (mΩ)	1	68.01	67.99	68.06	0.10
	2	66.95	66.93	67.01	0.12
	3	65.88	65.86	65.93	0.11
	4	64.81	64.79	64.85	0.09
	5	63.68	63.66	63.72	0.09
	6	62.52	62.51	62.59	0.13
	7	61.35	61.35	61.43	0.13
Low-voltage (mΩ)	/	a to b	b to c	c to a	/
		7.421	7.419	7.415	0.08

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4.3 Measurement of d.c. insulation resistance each winding to earth and between windings and absorption ratiomeasurements (Routine test) Date: Sept 22, 2025
Liquid average temperature: 28.8℃; RH: 54%; Atmospheric pressure:101.2kPa

Measurement position	R_{15} (GΩ)	R_{60} (GΩ)	R_{60}/R_{15}
High-voltage winding to low-voltage winding, core, frame and oil tank of transformer	21.6	34.2	1.58
Low -voltage winding to high -voltage winding, core, frame and oil tank of transformer	25.4	41.0	1.61
High-voltage winding and low-voltage winding to core, frame and oil tank of transformer	21.8	33.2	1.52

4.4 Check of core and frame insulation(Routine test)
Liquid average temperature: 28.8℃; RH: 54%; Atmospheric pressure:101.2kPa Date: Sept 22, 2025

Measurement position	Measured (GΩ)	Corrected (20℃)（MΩ）
Core - earth	15.8	22574
Frame - earth	14.3	20431
Core - Frame	15.4	22003

4.5 Measurement of dissipation factor(tanδ) of the insulation system capacitances (Routine test)
Ambient temperature: 28.9℃; RH: 53%; Atmospheric pressure:101.1kPa Date: Sept 22, 2025

Measurement position	Earthed part	Dissipation factor(%)
High- voltage	low- voltage,core, frame and oil tank	0.242
Low- voltage	High- voltage, core, frame and oil tank	0.261
High voltage,and low voltage	Core, frame and oil tank	0.262

4.6 Determination of capacitances windings- to- earth and between windings (Routine test)
Ambient temperature: 28.9℃; RH: 53%; Atmospheric pressure:101.1kPa Date: Sept 22, 2025

Measurement position	Earthed part	Capacitances(nF)
High- voltage	low- voltage,core, frame and oil tank	5.912
Low- voltage	High- voltage, core, frame and oil tank	7.935
High-voltage,and low- voltage	Core, frame and oil tank	6.321

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Test Report (Continuation page)

4.7 Applied voltage test(AV) (Routine test) Date: Sept 22, 2025
Ambient temperature: 28.9℃; RH: 53%; Atmospheric pressure:101.1kPa

Position	Test voltage (kV)	Time(s)	Test result
High–voltage winding to low–voltage winding, tank and earth	85	60	Qualified
Low–voltage winding to high–voltage winding,tank and earth	35	60	

4.8 Auxiliary wiring insulation test (Routine test) Date: Sept 22, 2025
Ambient temperature: 28.9℃; RH: 53%; Atmospheric pressure:101.1kPa

Test positon	Applied voltage value(kV)	Time(s)
On-load tap-changers connection-earth	2.0	60

4.9 Induced voltage withstand test (IVW) (Routine test) Date: Sept 22, 2025
Oil temperature: 29.0℃; RH: 53%; Atmospheric pressure:101.1kPa

Tapping	Applied voltage (kV)	Induced AC voltage (kV)	Induction factor	Frequency (Hz)	Time(s)	Test result
	L.V.	H.V.				
4	21	70	2	200	30	Qualified

4.10 Measurement of no-load loss and current (Routine test) Date: Sept 22, 2025
Ambient temperature:29.0℃; RH: 52%; Atmospheric pressure:101.1kPa;Transformer temperature:29.0℃

Test voltage(V)		No – load current		No – load loss(kW)	
Average voltage	RMS value of voltage	(A)	(%)	Measured	Corrected
10515	10543	1.8132	0.10	11.0292	10.9998

4.11 Measurement of no – load loss and current at 90% and 110% of rated voltage (Type test)
Date: Sept 22, 2025
Ambient temperature:29.0℃; RH: 52%; Atmospheric pressure:101.0kPa;Transformer temperature:29.0℃

Proportion of rated voltage	Test voltage(V)		No – load current		No – load loss(kW)	
	Average voltage	RMS value of voltage	(A)	(%)	Measured	Corrected
90%	9456.2	9481.2	1.2958	0.07	8.7024	8.6794
110%	11567	11599	2.4192	0.14	14.0388	14.0000

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Test Report (Continuation page)

4.12 Measurement of short – circuit impedance and load loss (Routine test)

Date: Sept 22, 2025

Liquid average temperature:29.0℃; RH: 52%; Atmospheric pressure:101.0kPa

Test winding	Tapping	Applied current		Short – circuit impedance		Load loss(kW)	Total loss(kW)
		（A）	I/Ir（%）	(%)	（Ω）	Correct	Correct
				t=75℃ I=Ir		t=75℃ I=Ir	t=75℃ I=Ir
HV – LV	1	400.26	82.8	10.20	4.59	100.7327	111.7325
	4	442.65	85.2	10.06	3.91	102.1426	113.1424
	7	492.74	87.7	9.92	3.30	109.6607	120.6605

4.13 Insulating liquids test (Routine test, Type test ,Entrust test)

Date: Sept 21, 2025&Sept 25, 2025

Ambient air temperature:28.2℃; RH: 49%; Atmospheric pressure: 100.9kPa

Strike voltage(kV)	Dielectric loss factor(90℃)
68.4	0.426%

Ambient air temperature:28.2℃; RH: 49%; Atmospheric pressure: 101.0kPa

Moisture content (mg/L)	13.6

Ambient air temperature:28.2℃; RH: 49%; Atmospheric pressure: 101.0kPa

Average Flash point (closed)(℃)	139.1

Ambient air temperature: 28.2 to 28.3℃; RH:43 to 49%; Atmospheric pressure: 101.0 to 101.1kPa

	Components (μL/L)	H_2	CO	CO_2	CH_4	C_2H_4	C_2H_6	C_2H_2	Total hydrocarbons
Gas chromatography analysis of dissolved gas	Before temperature-rise	14.58	2.45	204.24	4.42	0	0	0	4.42
	After temperature-rise	15.75	2.50	225.44	4.59	0	0	0	4.59

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Test Report (Continuation page)

4.14 Test On-load tap-Changers-Operation test (Routine test)

Date: Sept 22, 2025

Ambient air temperature:29.0℃; RH: 52%; Atmospheric pressure: 101.0kPa

Test specifications	Test result
with the transformer un-energized, eight complete cycles of operation (a cycle of operation goes from one end of the tapping range to the other, and back again).	Qualified
with the transformer un-energized, and with the auxiliary voltage reduced to 85 % of its rated value, one complete cycle of operation.	
with the transformer energized at rated voltage and frequency at no load, one complete cycle of operation.	
with one winding short-circuited and, as far as practicable, rated current in the tapped winding, 10 tap-change operations across the range of two steps on each side from where a coarse or reversing changeover selector operates, or otherwise from the middle tapping(the tapchanger will pass 20 times through the changeover position)	

4.15 Leak testing with pressure for liquid-immersed transformers (Routine test)

Date: Sept 19, 2025 to Sept 21, 2025

Ambient temperature: 28.1 to 28.8℃; RH: 45 to 50%; Atmospheric pressure: 100.6 to 100.9kPa

Test position	Test method	Applied pressure(kPa)	Duration(h)	Result
Transformer	Inflatable pressure method	50	24	No leakage
On-load tap-Changers oil chamber	Inflatable pressure method	50	24	No leakage

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Test Report (Continuation page)

4.16 Vacuum deflection test and pressure deflection test on liquid immersed transformers (Special test)

Date: Sept 21, 2025

Ambient temperature: 28.1℃; RH: 50%; Atmospheric pressure: 100.9kPa

Testing items	Test method	Test pressure(kPa)	Duration(min)
Vacuum deflection test on liquid immersed transformers	Pumping method	-50	5
Pressure deflection test on liquid immersed transformers	Inflatable pressure method	45	5

Measurement items		Test part										
		Box wall								Box lid		
		High- voltage			Low- voltage			L surface	R surface	Length direction middle position		
		L	M	R	L	M	R	M	M	L	M	R
Vacuum degree	Elastic deformation (mm)	12.21	11.16	10.21	9.26	9.35	8.86	9.46	9.98	8.26	8.02	8.16
	Permanent deformation (mm)	0.96	1.14	0.86	0.88	0.96	0.92	0.94	0.92	0.99	0.82	0.84
Positive pressure	Elastic deformation (mm)	13.02	12.82	12.81	11.17	11.86	11.25	11.08	11.01	10.66	10.24	10.27
	Permanent deformation (mm)	1.25	1.06	0.92	0.86	0.92	0.95	0.89	1.01	0.91	0.95	0.98

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

Date: Sept 22, 2025

Ambient temperature: 29.0℃; RH: 52%; Atmospheric pressure: 101.0kPa

Connection symbol	Power supply terminal	Open circuit terminal	Short circuit terminal	Applied current(A)	Measuring voltage(V)	Impedance (Ω/phase)
YNd11	ABC-O	abc	/	519.5	677.8	3.914

The test current per phase is I/3.

4.18 Measurement of the harmonics of the no-load current (Entrust test)

Date: Sept 22, 2025

Ambient air temperature: 29.0℃; RH:52%; Atmospheric pressure: 101.0kPa

Harmonic order	A（%）	B（%）	C（%）
1	100.00	100.00	100.00
2	6.35	7.11	6.72
3	10.95	10.87	10.31
4	4.98	5.63	5.12
5	11.98	12.13	12.97
6	4.06	4.85	4.73
7	6.07	6.12	6.98
8	3.14	3.85	3.37
9	4.66	4.65	4.72
10	3.28	4.10	3.16
11	1.55	2.04	1.77
12	0.96	1.43	1.28
13	0.39	0.77	0.54
14	0.26	0.45	0.29
15	0.09	0.17	0.39
16	0.08	0.11	0.07
17	0.01	0.01	0.01
18	0.00	0.00	0.00
19	0.00	0.00	0.00

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Test Report (Continuation page)

4.19 Determination of sound levels (Type test) Date: Sept 22, 2025

Ambient temperature: 29.0℃;RH: 52%;Atmospheric pressure: 101.0kPa

4.19.1 The load current sound power level:

Equation: $L_{WA,Ir} \approx 39 + 18 \times \lg \frac{S_r}{S_p} =$ 66 dB(A)

Where: L_{WA,I_r} —— the A-weighted sound power level of the transformer at rated current, rated frequency and impedance voltage, dB(A).

Sr——the rated power in megavolt amperes, 31.5 MVA

Sp—the reference power ,1MVA.

Because the $L_{WA,Ir}$ value is more than 10dB(A) lower than the guaranteed sound power level of 77 dB(A), no load current sound level measurement was conducted.

4.19.2 The sound power level measurements

The L.V. Winding test voltage:10500V; Frequency:50.00Hz; Tapping:4;

Measuring point:24; Measuring point height:1.200m; Distance of measuring point:1.000m.

Environmental conditions

The total area of the surface of the test room- S_{Vi} （m²）		The average acoustic absorption coefficient- α_i		The sound absorption area of the test room -A（m²）	Distance to the principal radiating surface(m)	The area of the measurement surface-S（m²）	Environmental correction-K(dB)
Hard ground	Ceiling and walls	Hard ground	Ceiling and walls				
285	1277.8	0.1	0.3	411.84	1.0	81.6	2.53

Result dB(A)

Type of cooling	$\overline{L_{pA0}} = 10 \times \lg(\frac{1}{N}\sum_{i=1}^{N} 10^{0.1L_{pAi}})$	$\overline{L_{pA}} = 10 \times \lg\left(10^{0.1\overline{L_{pA0}}} - 10^{0.1\overline{L_{bgA}}}\right) - K$	$L_{WA} = \overline{L_{pA}} + 10 \times \lg \frac{S}{S_0}$
ONAN	58.2	55.7	74.8

Note: The initial average background noise pressure levels:28.7dB(A),

The final average background noise pressure levels:28.7dB(A).

$\overline{L_{bgA}}$: The lower of the two total spatially average A-weighted background noise levels.

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4.20 Temperature- rise test (Type test) Date: Sept 24, 2025 to Sept 25, 2025

Ambient air temperature:29.9 to 30.9℃

Test by short – circuit method, tapping 7. Test time : 10h, Settling time, 4h. Rated total loss :120.6605kW, Applied total loss: 120.6910kW, Rated current : 561.7A, Applied current : 562.2A.

Measurement data

Measurement of average winding temperature			The average liquid temperature(℃)			Ambient temperature(℃)	Top liquid temperature at total loss(℃)
Winding	Cold resistance ($\times 10^{-3}\Omega$)	The average winding temperature (℃)	During cold resistance	Total loss end	Rated current end	Total loss end	
H. V. (BC)	116.39	83.81	28.8	71.0	70.7	30.0	81.1
L. V. (bc)	7.419	86.92					

Temperature rise calculation results

Top liquid temperature rise(K)	51.1	
Winding temperature rise(K)	High-voltage	54.11
	Low - voltage	57.22
Surface of oil tank and structural parts temperature rise(K)	59.6	

Note: The temperature rise calculation result is the corrected value under the specified total loss and current.

4.21 Winding hot-spot temperature-rise (calculation) (Entrust test) Date: Sept 25, 2025

Hot-spot winding temperature-rise	High-voltage (K)	68.14
	Low-voltage (K)	72.19

Note: The hot- spot factor H is taken according to GB/ T 1094.7-2008: 1.3.

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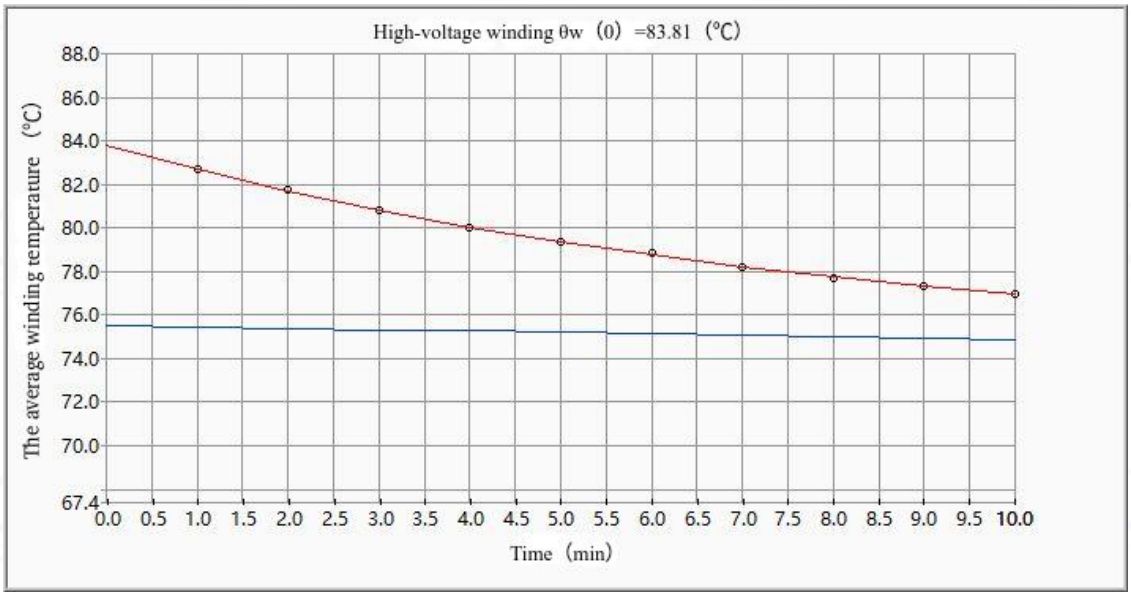
Average temperature curve of high – voltage winding : F1



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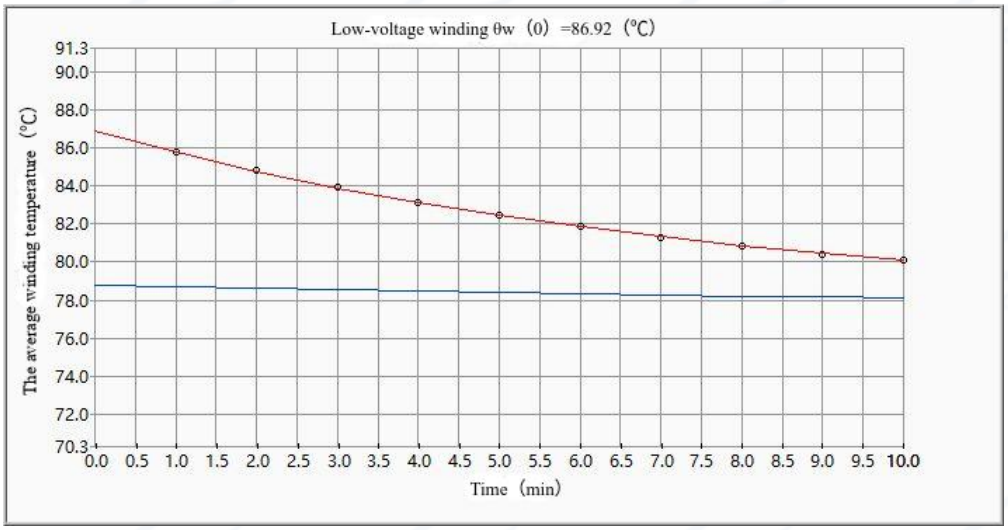
Average temperature curve of low – voltage winding : F2



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Test Report (Continuation page)

4.22 Short-circuit withstand test (Special test) Date: Sept 25, 2025

Ambient temperature:28.2℃ ;RH:43%;Atmospheric pressure:101.1kPa

4.22.1 Calculation of short circuit current (Reference temperature 75℃)

Tapping	The peak value of the current(kA)	Value of symmetrical short-circuit current (kA)	Values for factor($K\sqrt{2}$)
1	10.254（tolerance $^{+5}_{-5}$ %）	4.021（tolerance $^{+10}_{-10}$ %）	2.55
4	10.894（tolerance $^{+5}_{-5}$ %）	4.272（tolerance $^{+10}_{-10}$ %）	2.55
7	11.574（tolerance $^{+5}_{-5}$ %）	4.539（tolerance $^{+10}_{-10}$ %）	2.55

4.22.2 Applied current

Using a three-phase current test with a short circuit on the low-voltage side, the supply voltage is applied to the outer winding (high-voltage side)

Tapping	Phase	Sequence	Measurement of current					
			The peak value of the current		Value of symmetrical short-circuit current		Duration (ms)	Oscillogram No.
			(kA)	(%)	(kA)	(%)		
1	A	1	10.408	101.50	4.052	100.77	255	B1
		2	10.359	101.02	4.056	100.87	256	B2
		3	10.348	100.92	4.061	100.99	256	B3

Sequence	Reactance					
	Reactance(Ω)			Tolerance(%)		
	A	B	C	A	B	C
Before the test	4.5822	4.5522	4.5732	/	/	/
1	4.5915	4.5558	4.5755	0.18	0.08	0.05
2	4.5997	4.5635	4.5796	0.36	0.25	0.14
3	4.6048	4.5699	4.5841	0.47	0.39	0.24

The biggest reactance difference:0.47%.

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Test Report (Continuation page)

4.22.2 Applied current(continued)

Tapping	Phase	Sequence	Measurement of current					
			The peak value of the current		Value of symmetrical short-circuit current		Duration (ms)	Oscillogram No.
			(kA)	(%)	(kA)	(%)		
4	B	1	10.952	100.53	4.362	102.11	253	B4
		2	10.984	100.83	4.329	101.33	253	B5
		3	10.977	100.76	4.323	101.19	252	B6

Sequence	Reactance					
	Reactance(Ω)			Tolerance(%)		
	A	B	C	A	B	C
Before the test	3.9110	3.8790	3.9051	/	/	/
1	3.9330	3.8971	3.9202	0.56	0.47	0.39
2	3.9381	3.9012	3.9227	0.69	0.57	0.45
3	3.9423	3.9043	3.9269	0.80	0.65	0.56

The biggest reactance difference:0.80%.

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4.22.2 Applied current(continued)

Tapping	Phase	Sequence	Measurement of current					
			The peak value of the current		Value of symmetrical short-circuit current		Duration (ms)	Oscillogram No.
			(kA)	(%)	(kA)	(%)		
7	C	1	11.675	100.87	4.594	101.21	256	B7
		2	11.719	101.25	4.599	101.32	256	B8
		3	11.723	101.29	4.603	101.41	256	B9

Sequence	Reactance					
	Reactance(Ω)			Tolerance(%)		
	A	B	C	A	B	C
Before the test	3.2995	3.2632	3.2927	/	/	/
1	3.3315	3.2916	3.3152	0.97	0.87	0.68
2	3.3337	3.2958	3.3180	1.04	1.00	0.77
3	3.3381	3.2989	3.3212	1.17	1.09	0.87

The biggest reactance difference:1.17%.

No abnormality in test waveform.The biggest reactance difference is 1.17 %.After Short circuit test, reveal no defects such as displacements ,deformation of windings ,connections or supporting structures. No traces of internal electrical discharge were found.

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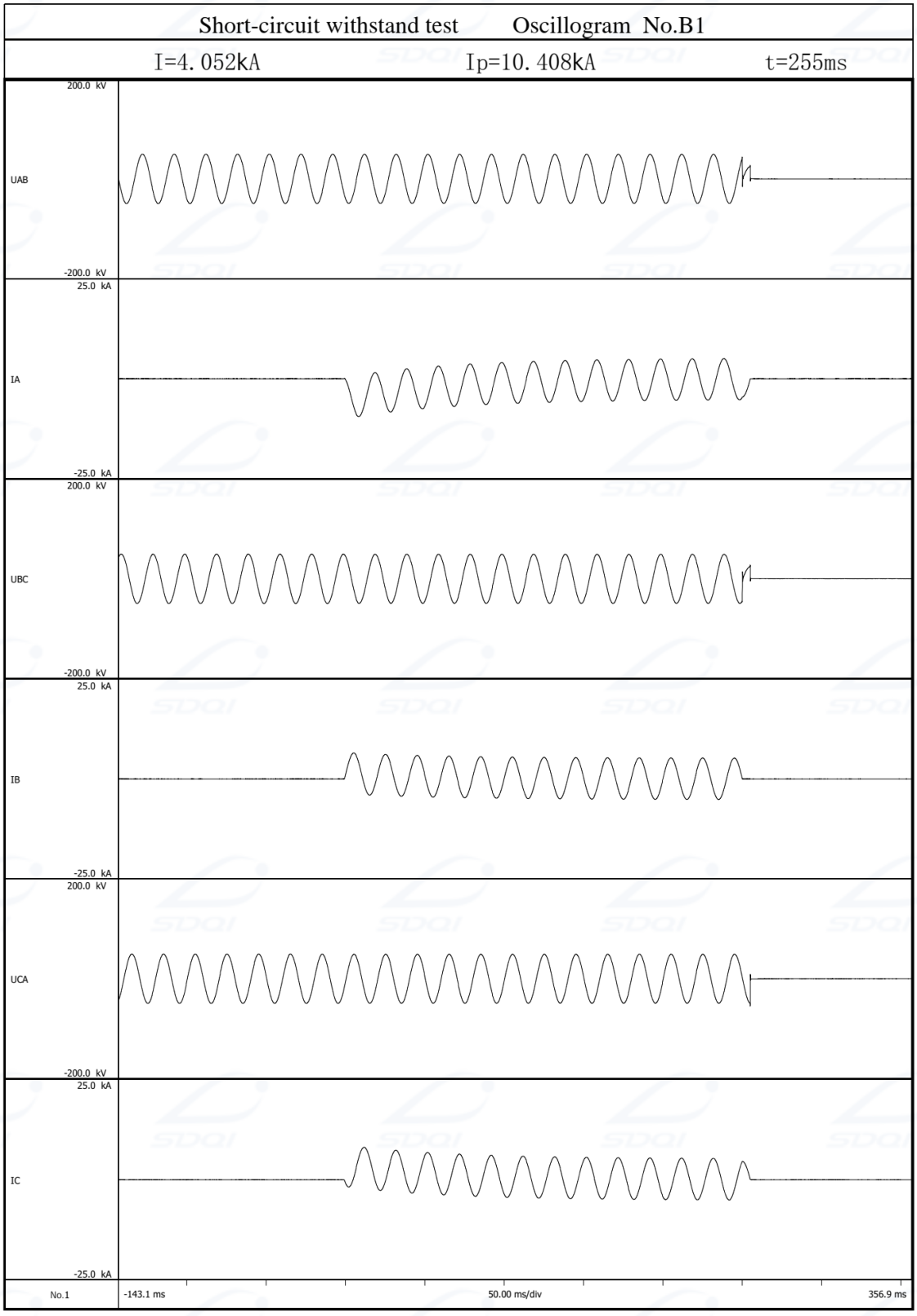
Test Report (Continuation page)



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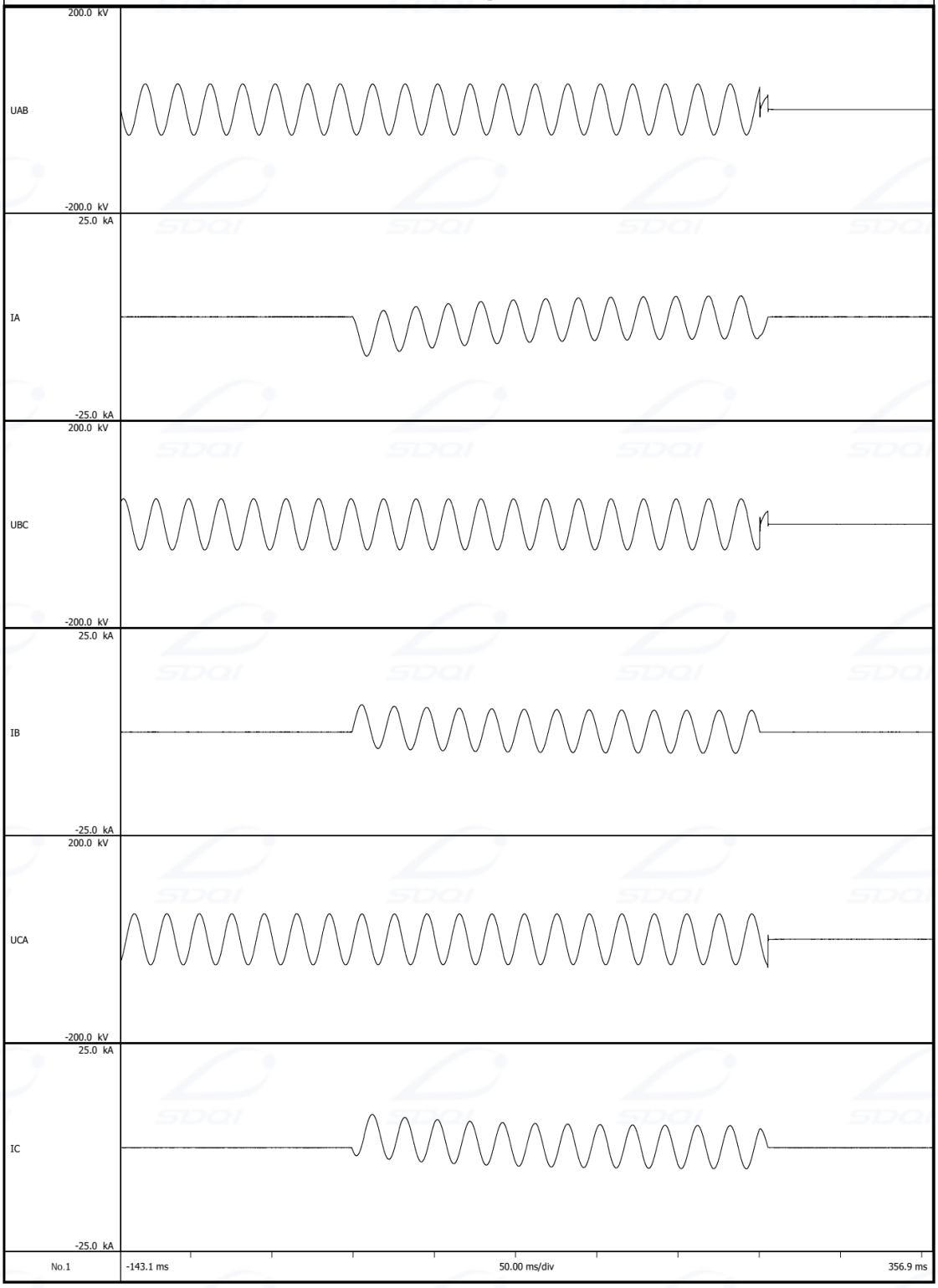
Short-circuit withstand test Oscillogram No.B2

I=4.056kA Ip=10.359kA t=256ms



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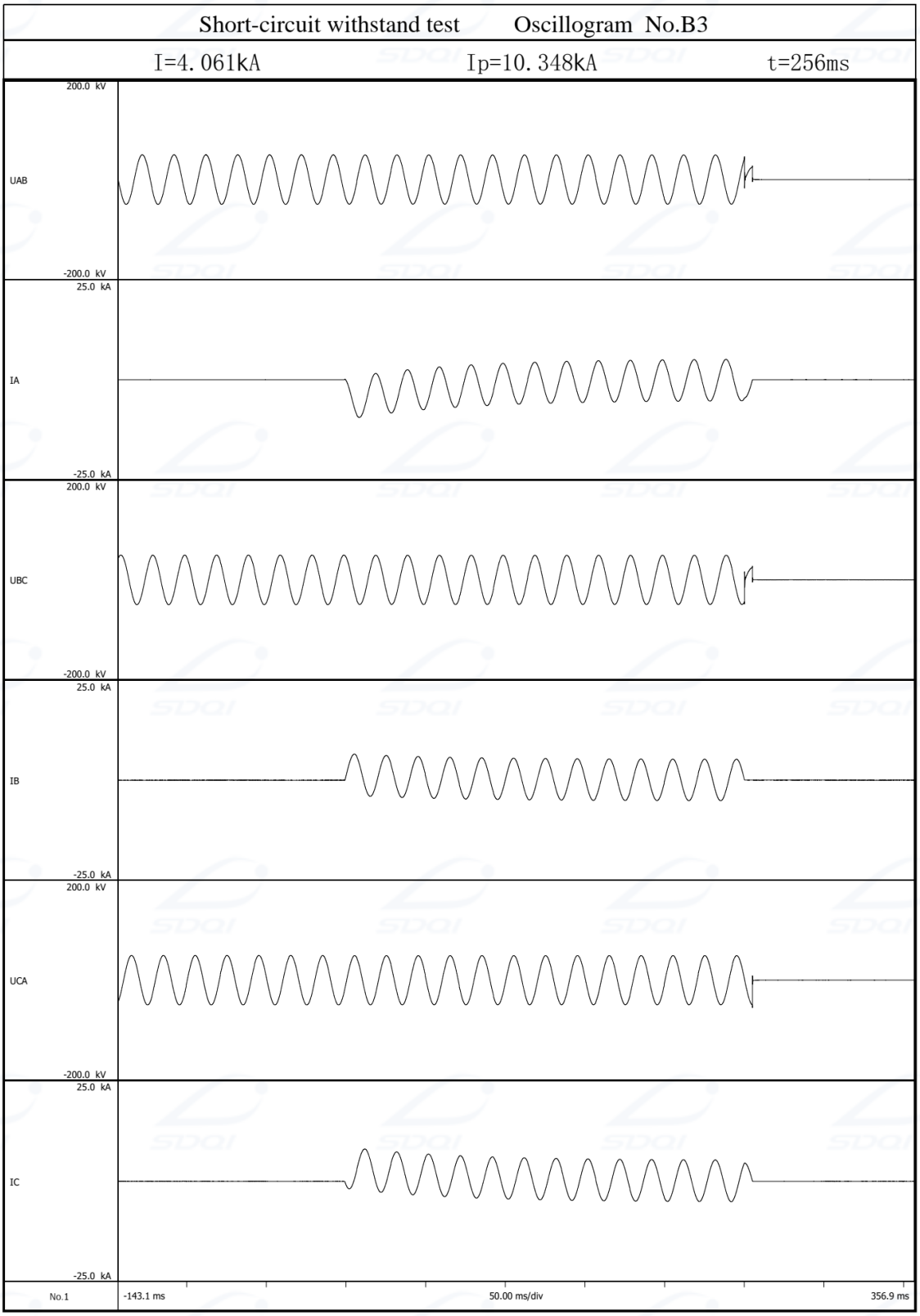
Test Report (Continuation page)



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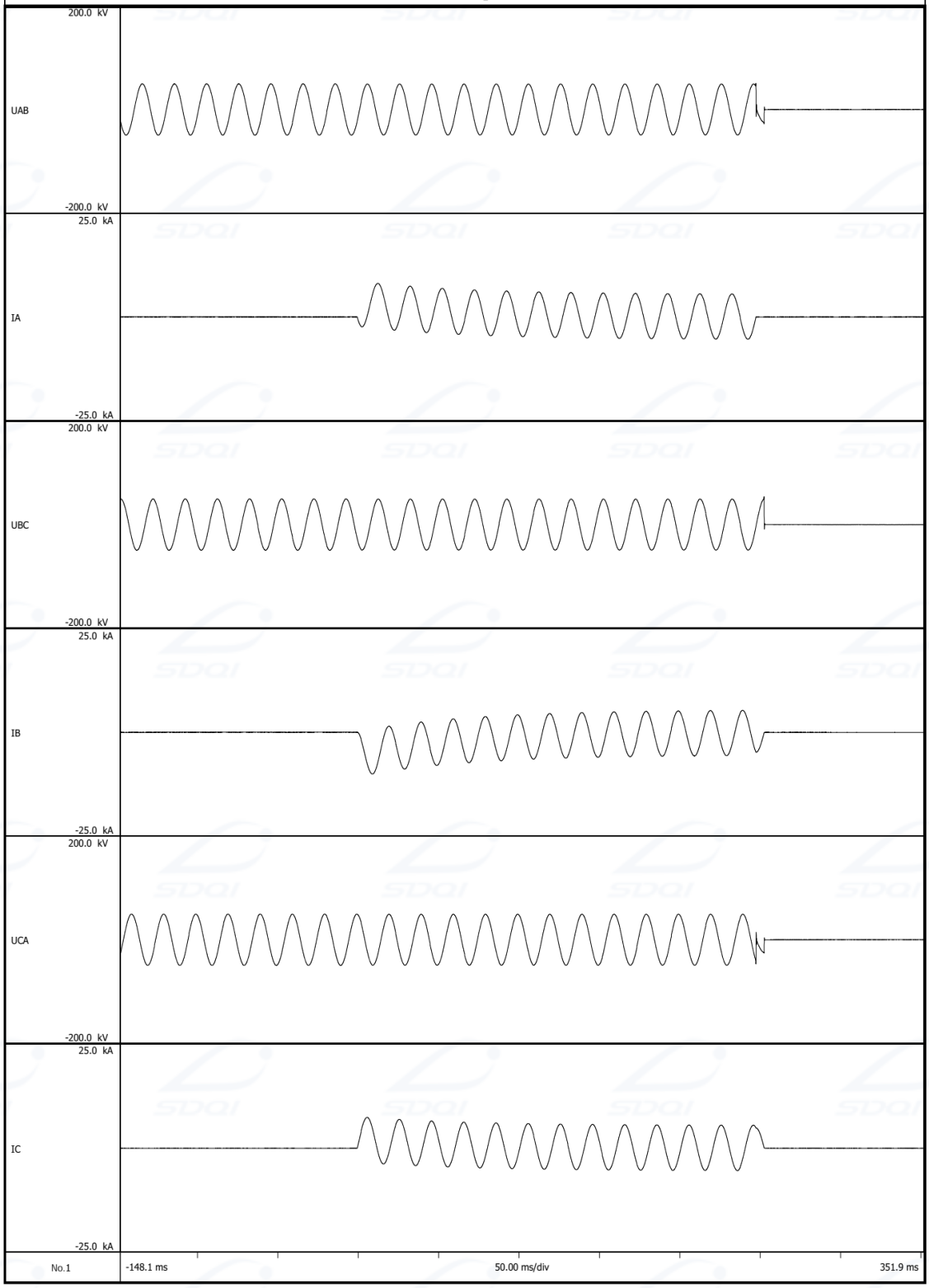
Test Report (Continuation page)

Short-circuit withstand test Oscillogram No.B4

I=4.362kA Ip=10.952kA t=253ms



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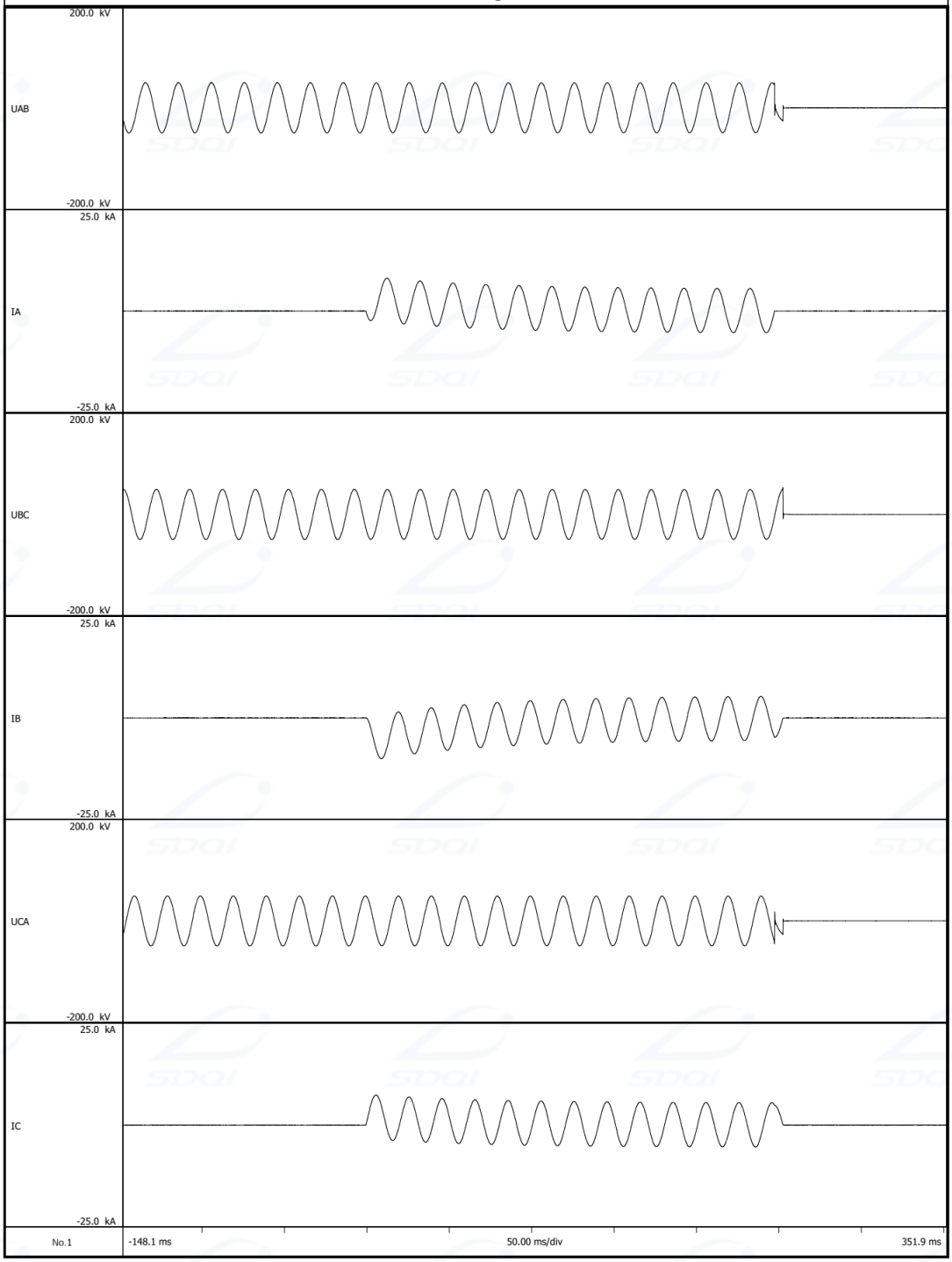
Test Report (Continuation page)

Short-circuit withstand test Oscillogram No.B5

I=4.329kA Ip=10.984kA t=253ms



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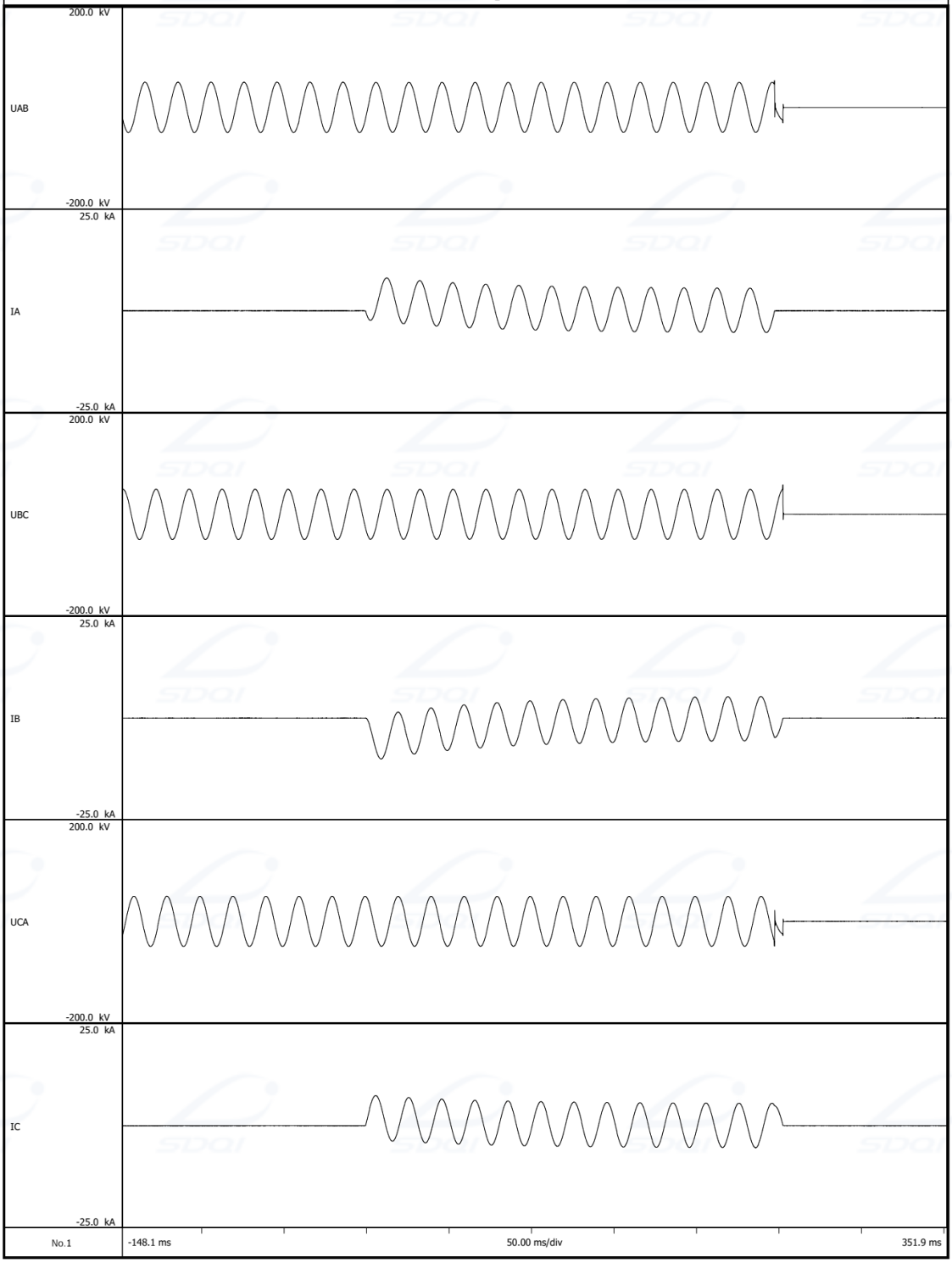
Test Report (Continuation page)

Short-circuit withstand test Oscillogram No.B6

I=4.323kA Ip=10.977kA t=252ms



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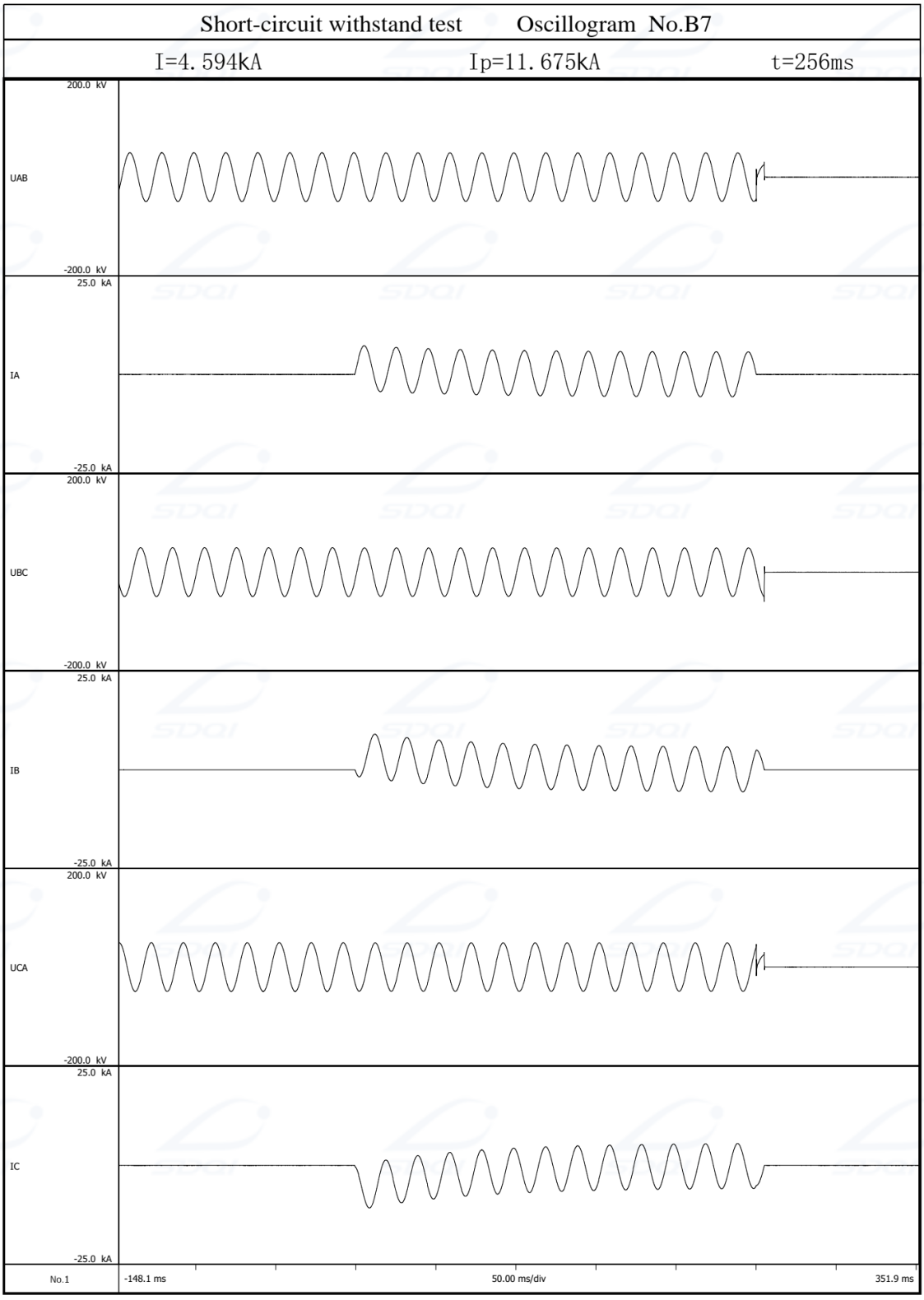
Test Report (Continuation page)



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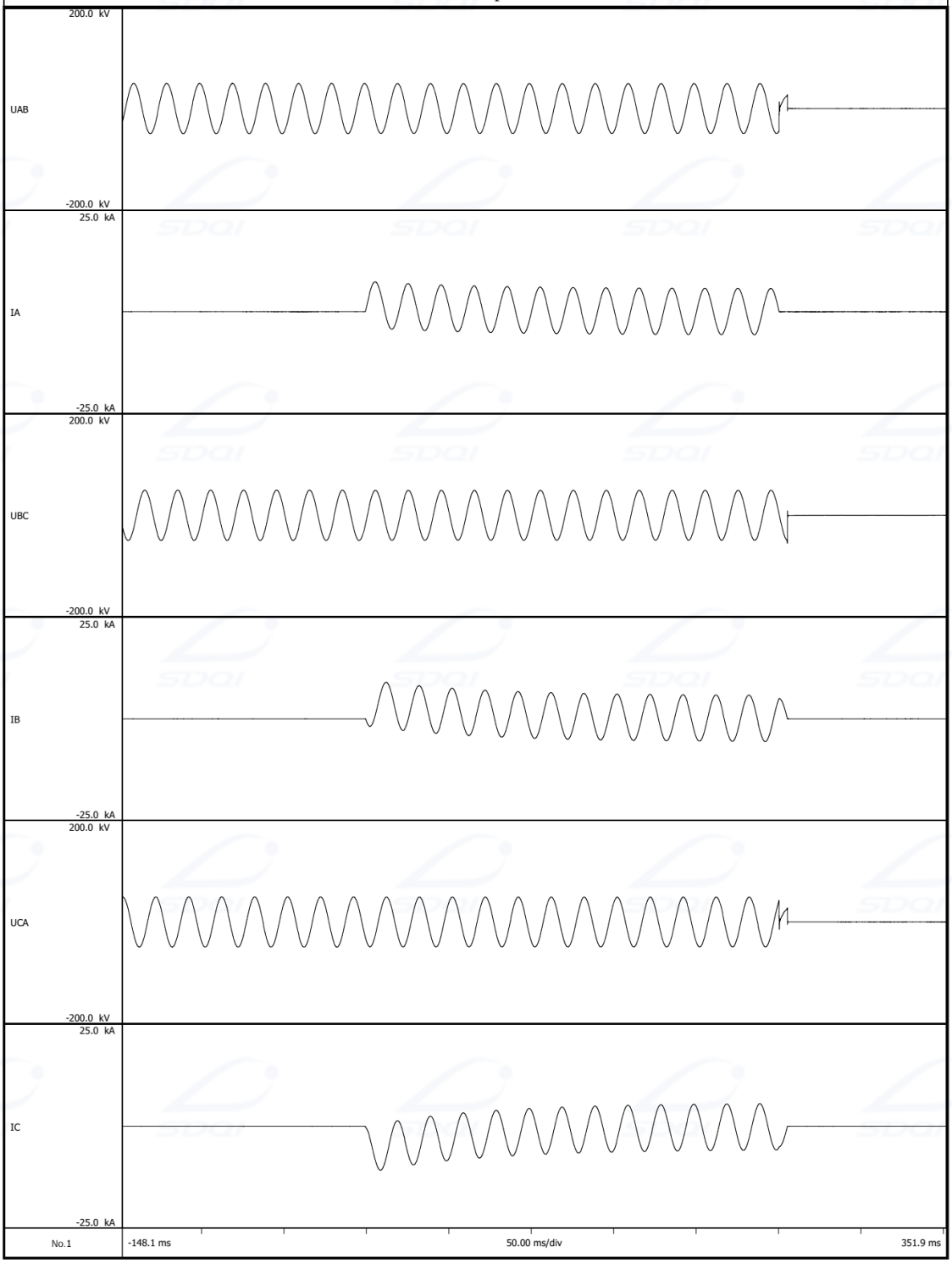
Test Report (Continuation page)

Short-circuit withstand test Oscillogram No.B8

I=4. 599kA Ip=11. 719kA t=256ms



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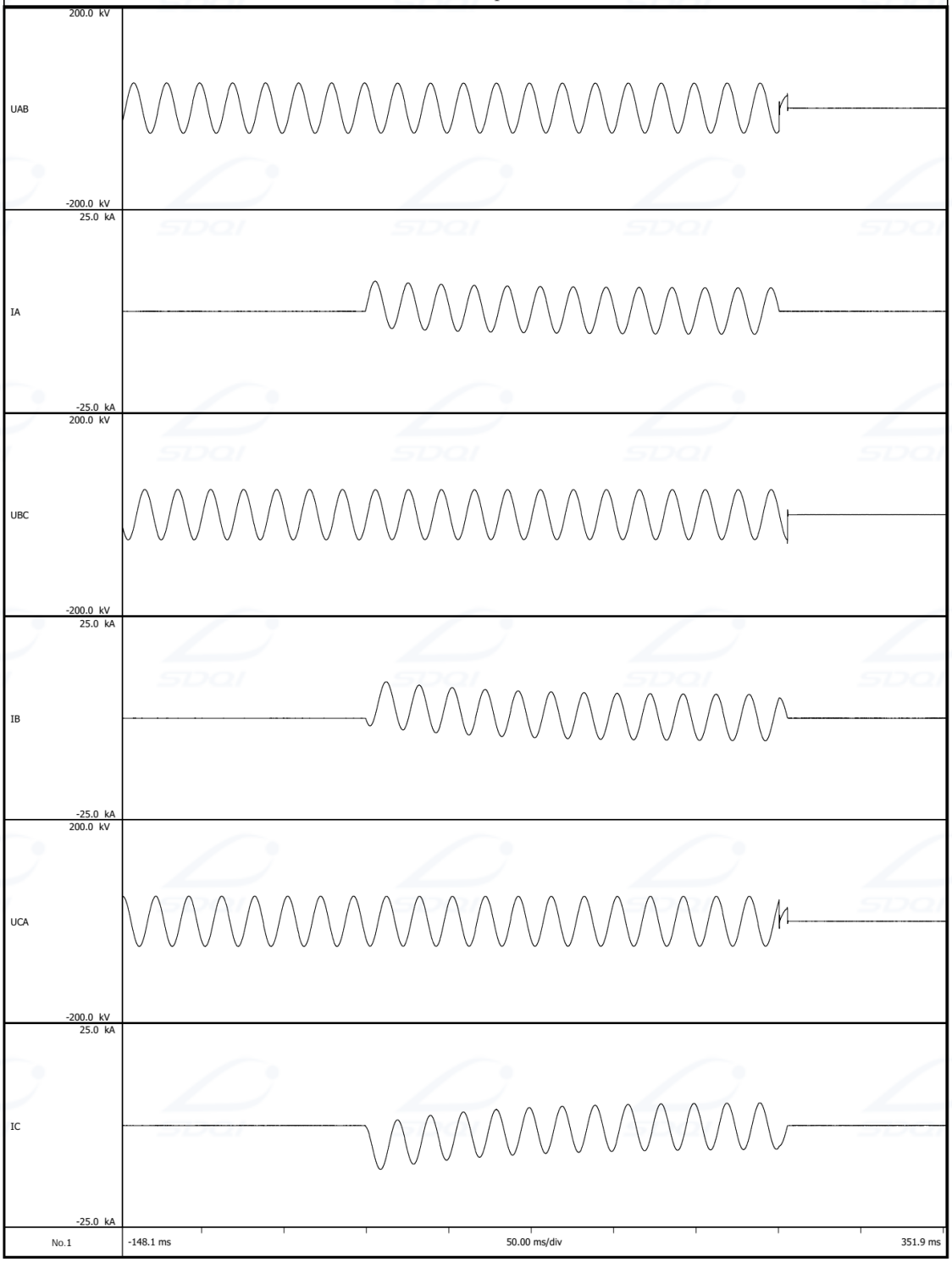
Test Report (Continuation page)

Short-circuit withstand test Oscillogram No.B9

I=4.603kA Ip=11.723kA t=256ms



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Test Report (Continuation page)

The out-of-tank inspection before Short-circuit withstand test(HV)

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Test Report (Continuation page)

The out-of-tank inspection after Short-circuit withstand test(HV)

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Test Report (Continuation page)

The out-of-tank inspection before Short-circuit withstand test(LV)

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The out-of-tank inspection after Short-circuit withstand test(LV)

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Test Report (Continuation page)

4.22.3 Inspection after Short-circuit test

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

Date: Sept 26, 2025

Ambient air temperature: 28.8℃; RH: 45%; Atmospheric pressure: 100.8kPa

H. V. winding		L. V. winding	Voltage ratio	Voltage ratio deviation (%)			Connection symbol
Tapping	Voltage (kV)	Voltage (kV)		AB/ab	BC/bc	CA/ca	
1	37.625	10.5	3.583	0.21	0.18	0.17	YNd11
2	36.750		3.500	0.08	0.09	0.09	
3	35.875		3.417	-0.04	-0.03	0.00	
4	35.000		3.333	0.05	0.04	0.07	
5	34.125		3.250	0.07	0.08	0.06	
6	33.250		3.167	0.07	0.08	0.05	
7	32.375		3.083	0.08	0.06	0.05	

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Test Report (Continuation page)

4.22.3.2 Measurement of winding resistance (Routine test) Date: Sept 26, 2025

Liquid average temperature: 28.8℃; RH: 45%; Atmospheric pressure:100.8kPa

Winding	Tapping	Winding resistance			Resistance unbalance rate(%)
		A to O	B to O	C to O	
High-voltage (mΩ)	1	68.04	68.02	68.08	0.09
	2	66.97	66.96	67.03	0.10
	3	65.90	65.88	65.96	0.12
	4	64.84	64.81	64.88	0.11
	5	63.71	63.69	63.74	0.08
	6	62.54	62.52	62.60	0.13
	7	61.36	61.38	61.45	0.15
Low-voltage (mΩ)	/	a to b	b to c	c to a	/
		7.446	7.451	7.449	0.07

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4.22.3.3 Measurement of d.c. insulation resistance each winding to earth and between windings and absorption ratio measurements (Routine test)

Liquid average temperature: 28.9℃; RH: 45%; Atmospheric pressure: 100.8kPa Date: Sept 26, 2025

Measurement position	R_{15}(GΩ)	R_{60}(GΩ)	R_{60}/R_{15}
High-voltage winding to low-voltage winding, core, frame and oil tank of transformer	20.1	30.1	1.50
Low -voltage winding to high -voltage winding, core, frame and oil tank of transformer	23.2	36.4	1.57
High-voltage winding and low-voltage winding to core, frame and oil tank of transformer	20.5	29.8	1.45

4.22.3.4 Check of core and frame insulation(Routine test) Date: Sept 26, 2025

Liquid average temperature: 28.9℃; RH: 45%; Atmospheric pressure: 100.8kPa

Measurement position	Measured value R_{60}(GΩ)	Calibration to 20℃ insulation resistance(MΩ)
Core – earth	14.6	20945
Frame – earth	13.2	18936
Core – frame	14.2	20371

4.22.3.5 Measurement of dissipation factor(tanδ) of the insulation system capacitances and determination of capacitances windings-to-earth and between windings (Routine test)

Date: Sept 26, 2025

Ambient air temperature: 28.9℃; RH: 45%; Atmospheric pressure: 100.8kPa

Measurement position	Earthed part	Dissipation factor(%)	Capacitance（nF）
High- voltage	Low- voltage, core, frame and oil tank	0.282	6.016
Low- voltage	High - voltage, core, frame and oil tank	0.351	8.027
High-voltage and Low-voltage	Core, frame and oil tank	0.285	6.509

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4.22.3.6 Applied voltage test (Routine test) Date: Sept 26, 2025
Oil temperature: 28.9℃; RH: 45%; Atmospheric pressure: 100.8kPa

Position	Test voltage(kV)	Time(s)	Test result
High–voltage winding to low–voltage winding, oil tank and earth	85	60	Qualified
Low–voltage winding to high–voltage winding, oil tank and earth	35	60	

4.22.3.7 Auxiliary wiring insulation test (Routine test) Date: Sept 26, 2025
Oil temperature: 28.9℃; RH: 45%; Atmospheric pressure: 100.8kPa

Test positon	Applied voltage value(kV)	Time(s)
On- load tap- changers connection - earth	2.0	60

4.22.3.8 Induced voltage withstand test (Routine test) Date: Sept 26, 2025
Oil temperature: 29.0℃; RH: 46%; Atmospheric pressure: 100.8kPa

Tapping	Applied voltage(kV)	Induced voltage(kV)	Induction factor	Frequency (Hz)	Time(s)	Test result
	L. V.	H. V.				
4	21	70	2	200	30	Qualified

4.22.3.9 Measurement of no – load loss and current (Routine test) Date: Sept 26, 2025
Ambient air temperature: 29.0℃; RH: 46%; Atmospheric pressure: 100.8kPa; Transformer temperature: 29.0℃

Test voltage(V)		No – load current		No – load loss(kW)	
Average voltage	RMS value of voltage	(A)	(%)	Measured	Corrected
10517	10539	1.8332	0.11	11.1265	11.1032

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4.22.3.10 Measurement of short – circuit impedance and load loss (Routine test) Date: Sept 26, 2025
Liquid average temperature: 29.0℃; RH: 46%; Atmospheric pressure: 100.8kPa

Test winding	Tapping	Applied current		Short – circuit impedance		Load loss(kW)	Total loss(kW)
		（A）	I/Ir（%）	（%）	（Ω）	Correct	Correct
				t=75℃ I=Ir		t=75℃ I=Ir	t=75℃ I=Ir
H. V. – L. V.	1	403.65	83.5	10.21	4.59	101.1032	112.2064
	4	445.72	85.8	10.06	3.91	102.5219	113.6251
	7	493.76	87.9	9.93	3.30	110.0215	121.1247

4.24.3.11 Insulation liquid test (Routine test) Date: Sept 26, 2025
Ambient air temperature: 29.0℃; RH: 46%; Atmospheric pressure: 100.8kPa

Strike voltage(kV)	Dielectric loss factor(90℃)
63.9	0.442%

4.24.3.12 Test on on-load tap-changers-Operation test (Routine test) Date: Sept 26, 2025
Ambient air temperature: 29.0℃; RH: 46%; Atmospheric pressure: 100.8kPa

Test content	Test results
With the transformer de-energized, eight complete cycles of operation(a cycle of operation goes from one end of the tapping range to the other, and back again)	Qualified
With the transformer de-energized, and with the auxiliary voltages reduced to 85% of its rated value, one complete cycle of operation	
With the transformer energized at rated voltages and frequency at no load, one complete cycle of operation	
With one winding short-circuited and, as far as practicable, rated current in the tapped winding, 10 cycles of tap-change operations across the range of two steps on each side from where a coarse or reversing changeover selector operates, or otherwise from the middle tapping(the tapchanger will pass 20 times through the changeover position)	

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Test Report (Continuation page)

4.23 Lightning impulse test(Type test) Date: Sept 26, 2025

Ambient air temperature: 29.2℃; RH: 47%; Atmospheric pressure: 100.9kPa

Withstand terminals	a, b, c	A, B, C	O
Tapping	/	A1, B4,C7	1
Test polarity	Negative	Negative	Negative
Peak voltage(kV)	75（tolerance $^{+3}_{-3}$ %）	200（tolerance $^{+3}_{-3}$ %）	200（tolerance $^{+3}_{-3}$ %）
Chopped voltage(kV)	85（tolerance $^{+3}_{-3}$ %）	220（tolerance $^{+3}_{-3}$ %）	/
Wave front time T_1(μs)	1.2（tolerance $^{+30}_{-30}$%）		1.2（tolerance $^{+30}_{-30}$%）
Half-wave peak time T_2(μs)	50（tolerance $^{+20}_{-20}$%）		50（tolerance $^{+20}_{-20}$%）
Chopped time T_C(μs)	3~6		/
Chopped impulse of reverse polarity peak K	≤30%Chopped impulse peak		/
Test sequence	One time full-wave reference impulse of 50%~ 70% of full voltage One time full-wave impulse of 100% full voltage Two times chopped wave impulse of lightning impulse test voltage Two times full-wave impulse of 100% full voltage		One time full- wave reference impulse of 50%~ 70% full voltage Three times full- wave impulse of 100% full voltage

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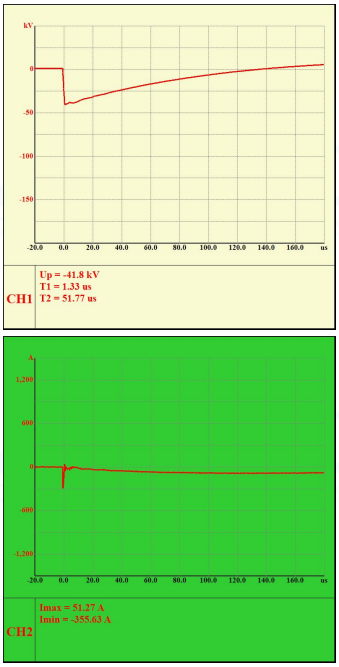
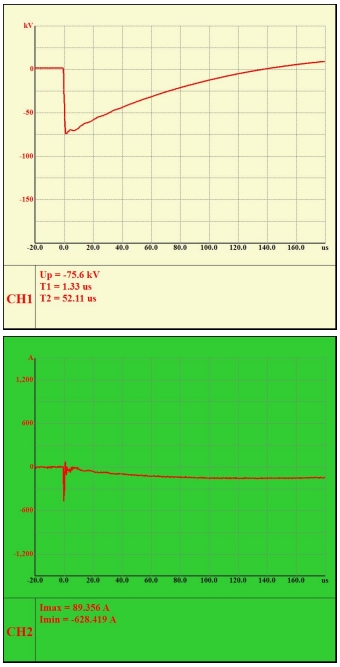
Test Report (Continuation page)

Lightning impulse Test terminal: a Test polarity: Negative

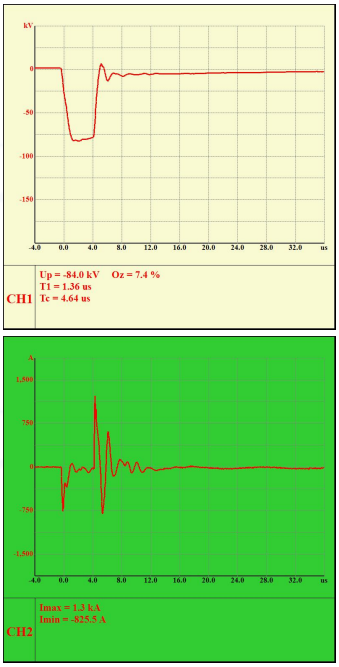
50%~70% Full wave



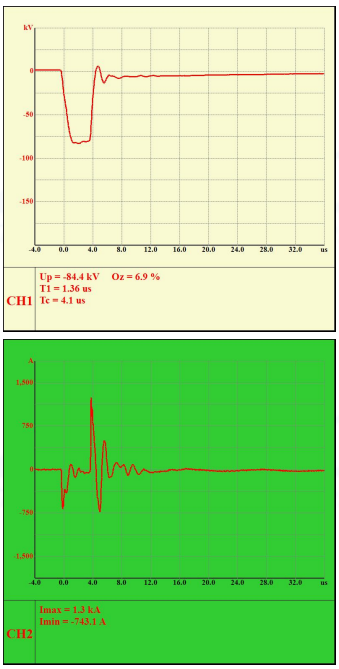
First 100% Full wave



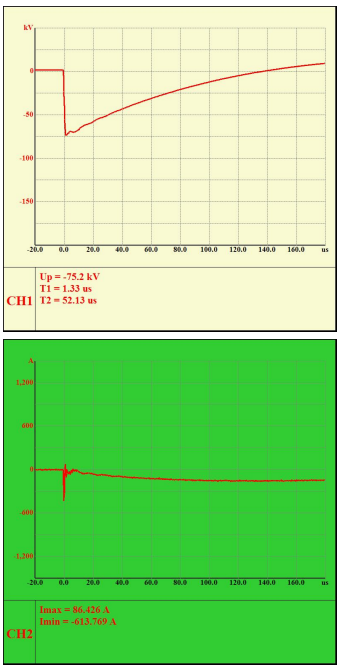
First chopped wave



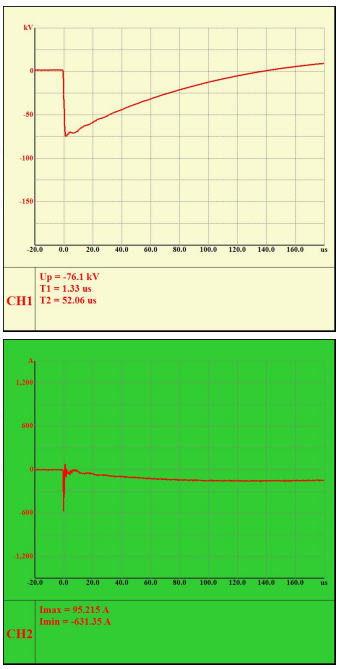
Second chopped wave



Second 100% Full wave



Third 100% Full wave



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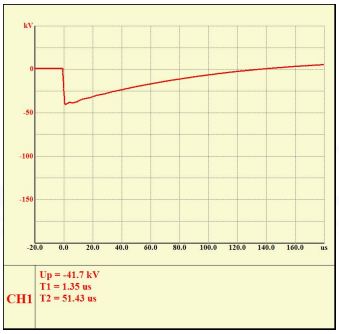
National Inspection and Testing Center for Power Transmission and Distribution Equipment(Shandong)

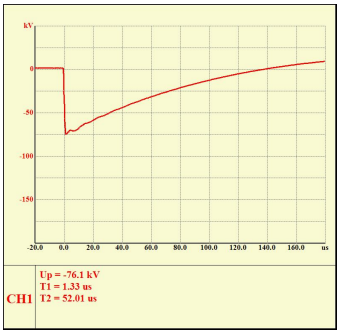
Test Report (Continuation page)

Lightning impulse Test terminal: b Test polarity: Negative

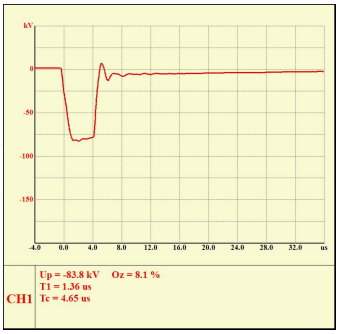
50%~70% Full wave



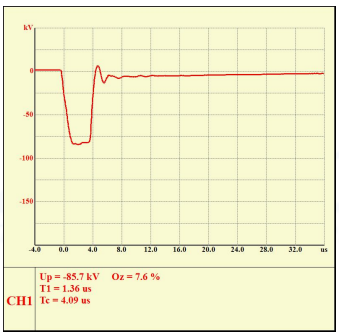
First 100% Full wave



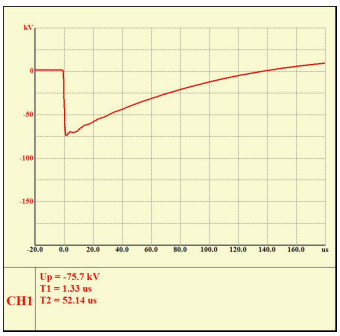
First chopped wave



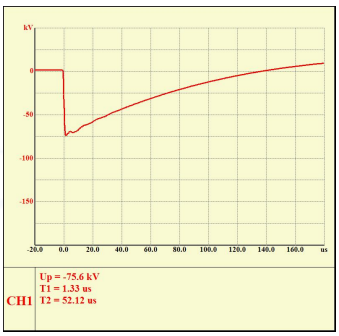
Second chopped wave



Second 100% Full wave



Third 100% Full wave



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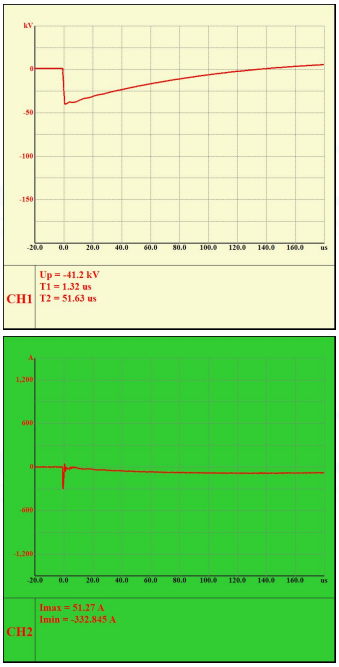
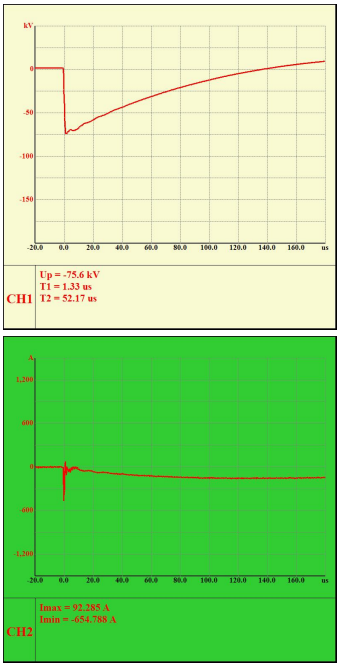
Test Report (Continuation page)

Lightning impulse Test terminal: c Test polarity: Negative

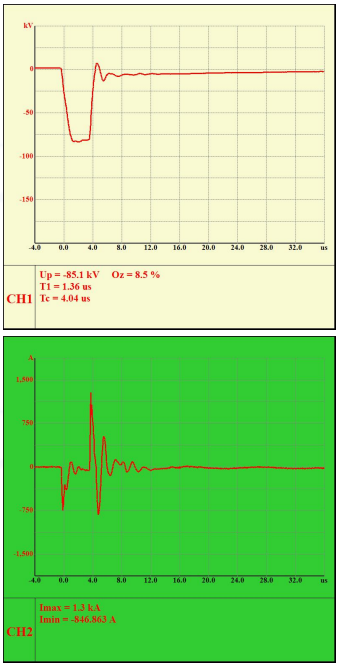
50%~70% Full wave



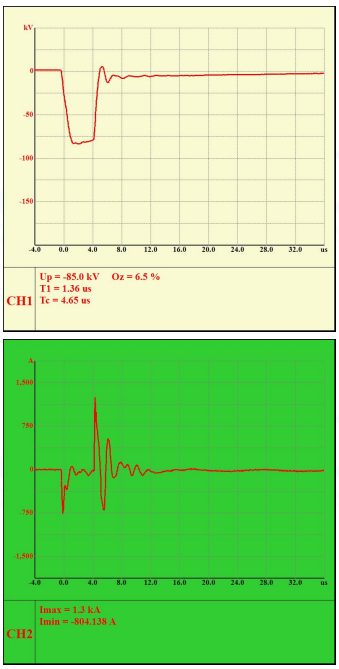
First 100% Full wave



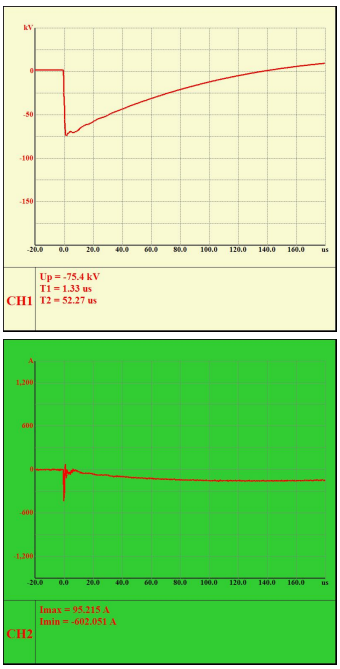
First chopped wave



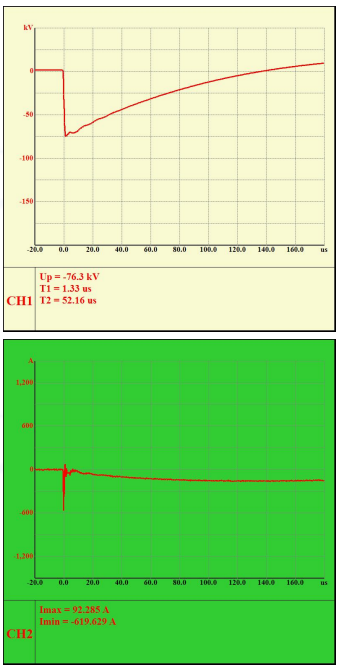
Second chopped wave



Second 100% Full wave



Third 100% Full wave



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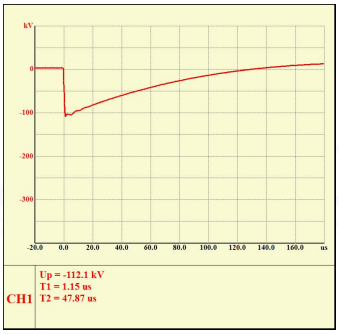
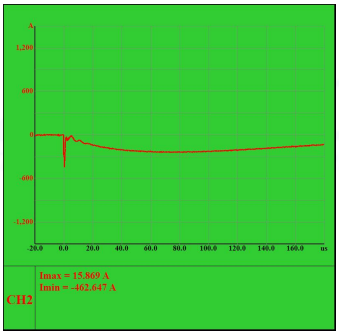
National Inspection and Testing Center for Power Transmission and Distribution Equipment(Shandong)

Test Report (Continuation page)

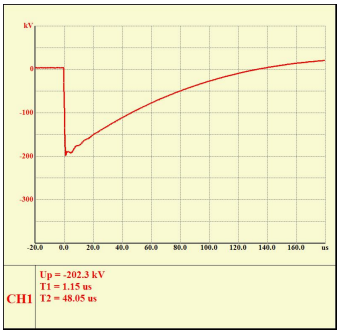
Lightning impulse Test terminal: A Test polarity: Negative

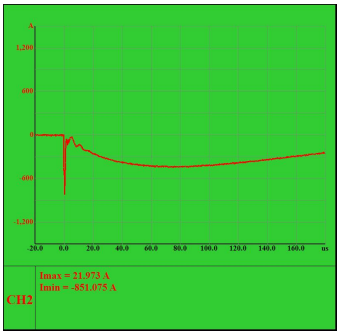
50%~70% Full wave



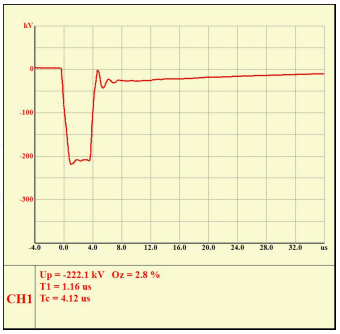


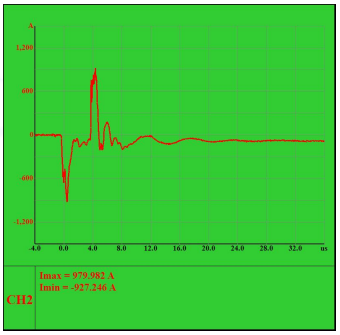
First 100% Full wave



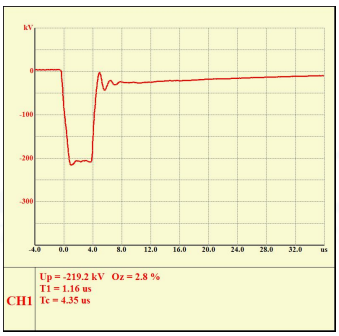


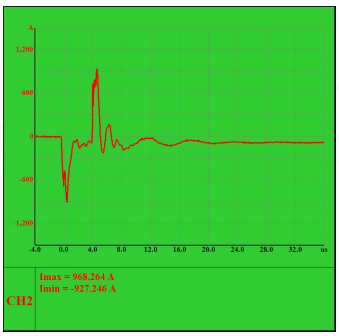
First chopped wave



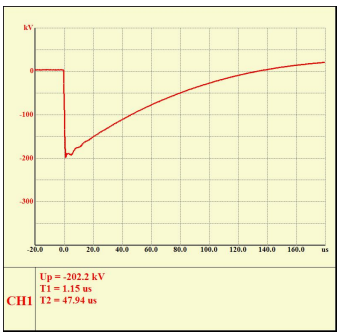


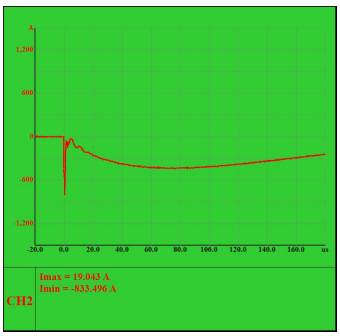
Second chopped wave



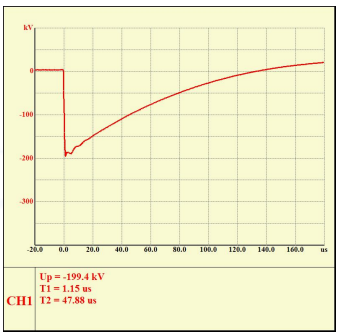


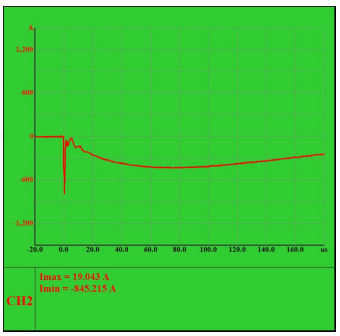
Second 100% Full wave





Third 100% Full wave





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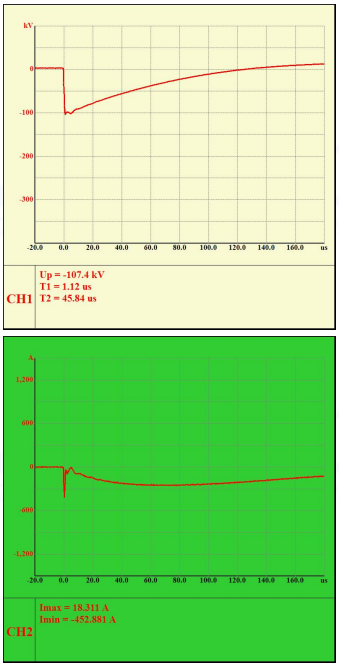
National Inspection and Testing Center for Power Transmission and Distribution Equipment(Shandong)

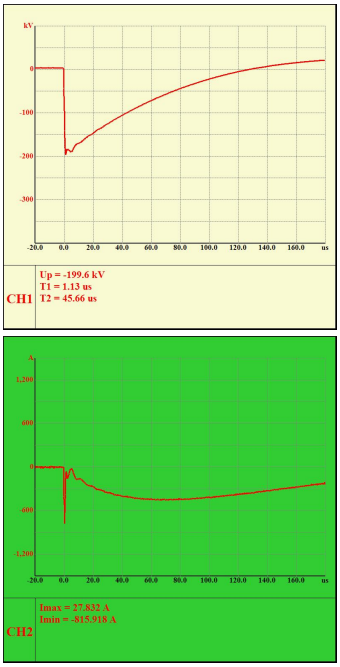
Test Report (Continuation page)

Lightning impulse Test terminal: B Test polarity: Negative

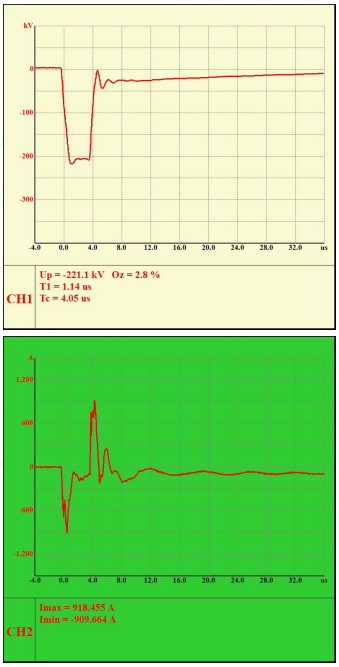
50%~70% Full wave



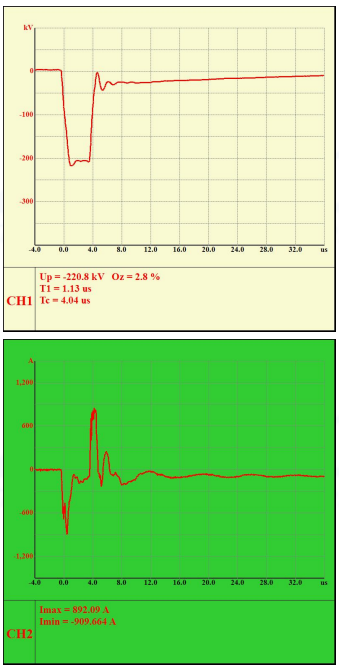
First 100% Full wave



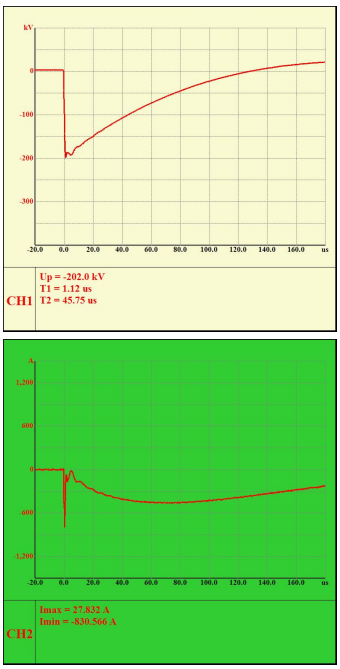
First chopped wave



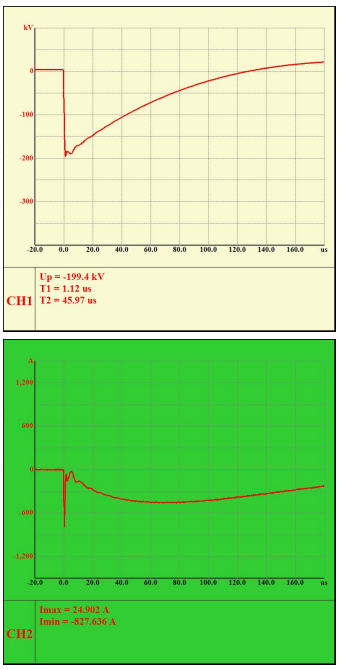
Second chopped wave



Second 100% Full wave



Third 100% Full wave



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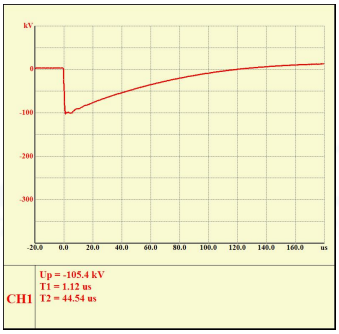
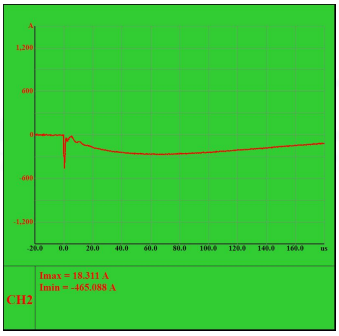
Test Report (Continuation page)

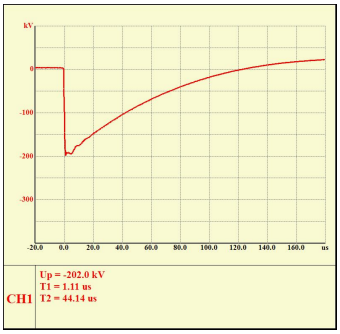
Lightning impulse Test terminal: C Test polarity: Negative

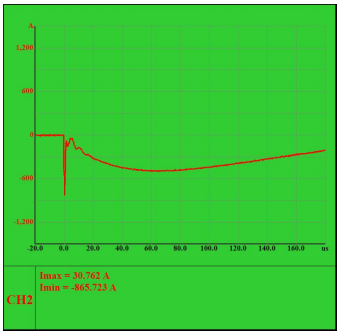
50%~70% Full wave



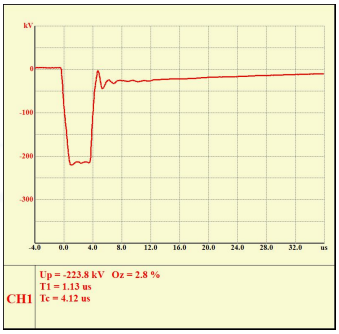


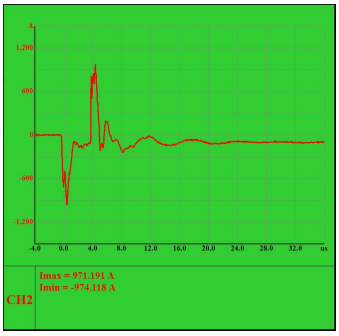
First 100% Full wave



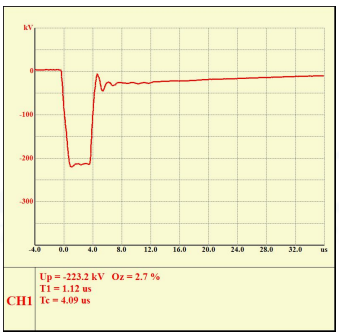


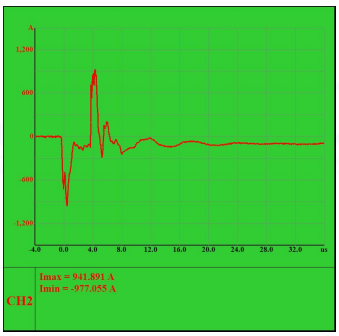
First chopped wave



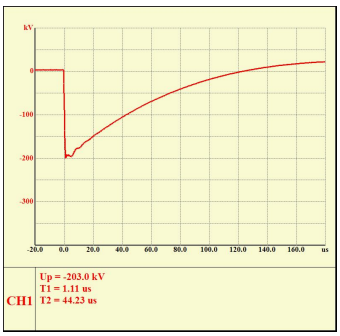


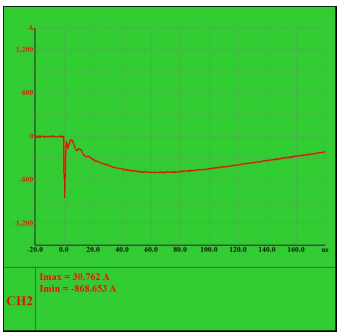
Second chopped wave



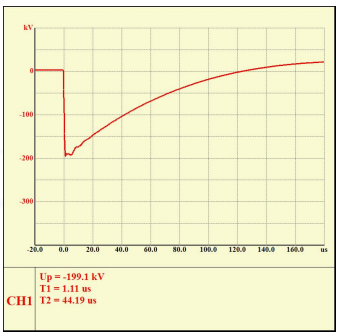


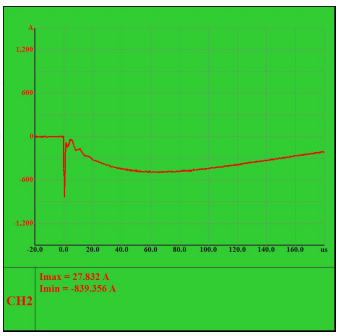
Second 100% Full wave





Third 100% Full wave





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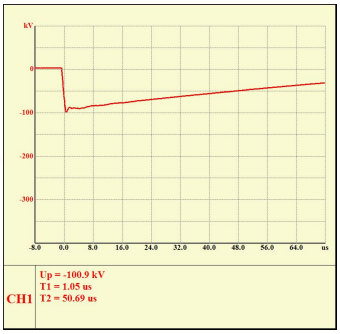
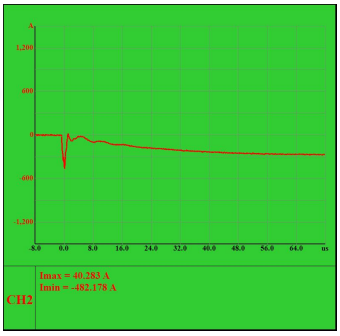
National Inspection and Testing Center for Power Transmission and Distribution Equipment(Shandong)

Test Report (Continuation page)

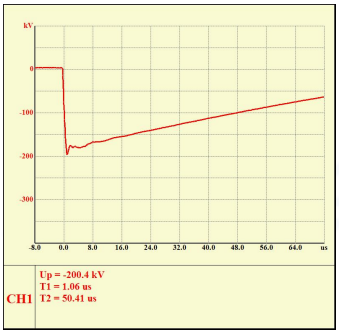
Lightning impulse Test terminal:O Test polarity: Negative

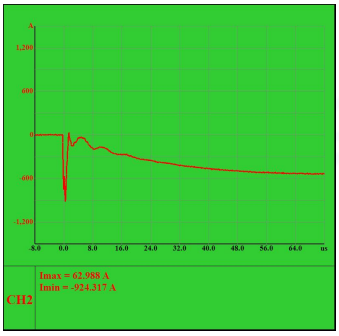
50%~70% Full wave



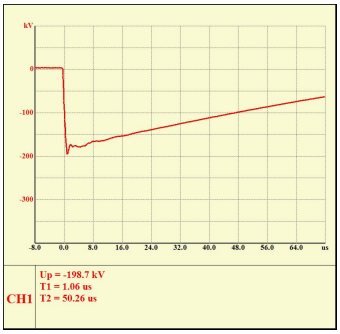


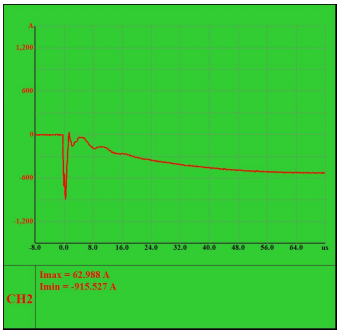
First 100% Full wave



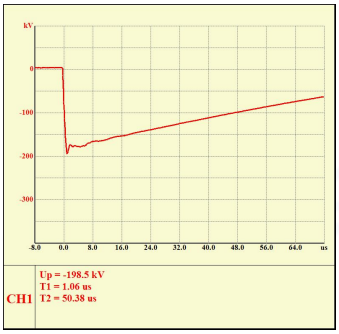


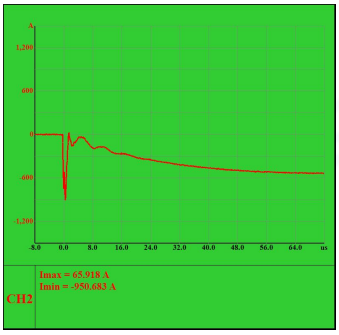
Second 100% Full wave





Third 100% Full wave



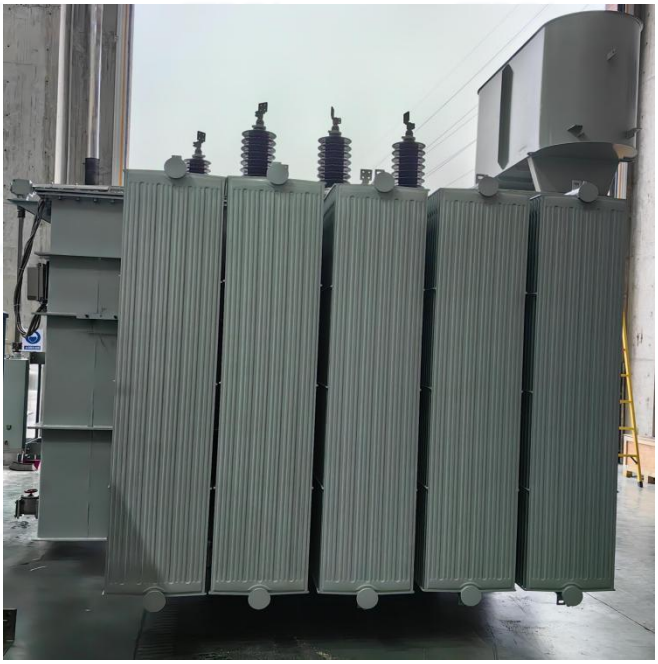


Shandong Institute for Product Quality Inspection

National Inspection and Testing Center for Power Transmission and Distribution Equipment(Shandong)

Test Report (Continuation page)

Sample and nameplate photos



山东省产品质量检验研究院

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