MINISTERIO DE INDUSTRIA, ENERGÍA Y TURISMO

FUNDACIÓN PARA EL FOMENTO DE LA INNOVACIÓN INDUSTRIAL

T E S T S

Nº: 3/LE130

LCOE

LABORATORIO CENTRAL OFICIAL DE ELECTROTECNIA

FUNDACIÓN PARA EL FOMENTO DE LA INNOVACIÓN INDUSTRIAL

Centro Tecnológico UPM – Tecnogetafe

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TYPE TEST REPORT 2015 11 3D 0683

OBJECT	Voltage Transformer
MANUFACTURER	Arteche
TYPE	UTD-123
APPLICANT	Electrotécnica Arteche Hermanos S.L. *C/ Derio Bidea, 28 – 48100 Munguía (Vizcaya)*
TEST DATES	From 24th November to 14th December 2015
DATE OF ISSUE	17th December 2015
RESULTS	Tests passed according to IEC 61869-3

This report consists of 27 pages and 7 Annexes

Authorized signatory/s

Mr. Tomás García Aguado

Technical Responsible of Testing in HV Lab

INDEX

1 IDENTIFICATION OF THE TEST OBJECT

1.1 Description of the test object

Description:	Voltage Transformer
Manufacturer:	Arteche
Type:	UTD-123
Serial number:	15012274/1
According to Standard:	IEC 61869-3
Year of manufacture:	2015

1.2 Rated characteristics assigned by the manufacturer

Highest Voltage for equipment, U_m:	123 kV
Rated power-frequency withstand test voltage:	230 kV
Rated lightning impulse withstand test voltage:	550 kV
Rated frequency:	50 Hz
Rated primary voltage, U_n:	110 000 / √3 V
Rated ratio and terminal markings:	
a-n U_p 110 000 / √3 V / U_s 100 / √3 V	100 VA Class 0.2/3P
da-dn U_p 110 000 / √3 V / U_s 100 / 3 V	100 VA Class 3P
Rated voltage factor:	1.9 U_n 30 s
Thermal Burden:	1000 VA
Temperature category:	-50ºC / +40ºC
Oil type:	NYNAS NYTRO 10XN
Oil mass:	85 kg
Total mass:	300 kg
Installation:	Outdoor

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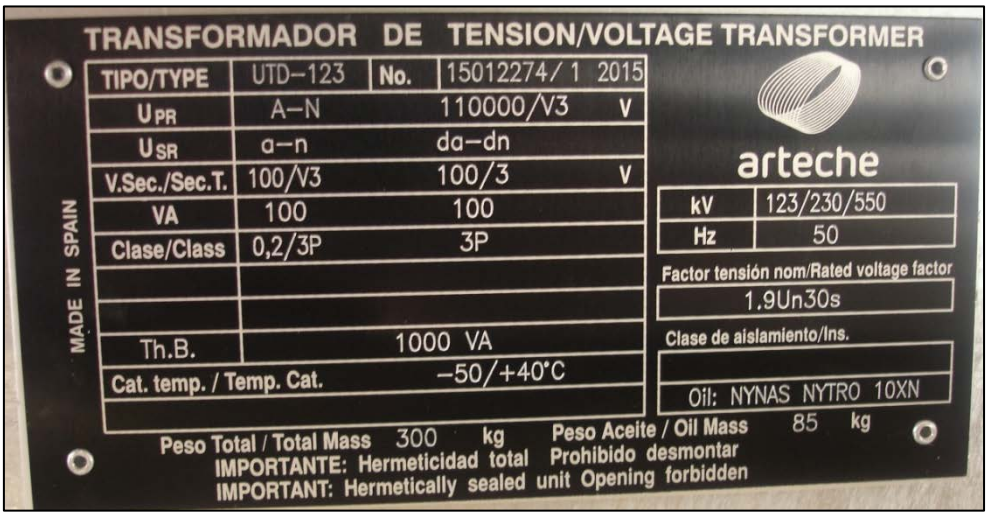
1.3 Rating Plate



Picture 1.1 – Rating plate of voltage transformer.

1.4 Picture of test object.

Picture 1.2 – Voltage transformer UTD-123.

2 GENERAL INFORMATION

2.1 Tests carried out by

Tests have been performed in L.C.O.E. High Voltage laboratory placed at Tecnogetafe, Eric Kandel street, number 1 – 28906 Getafe (Madrid). Tests performed by:

Name	Company
Mr. Miguel Corriols Delgado	L.C.O.E. (High Voltage Department)
Mr. Tomás García Aguado	L.C.O.E. (High Voltage Department)
Mr. Justo Sánchez Fernández	L.C.O.E. (High Voltage Department)
Mr. Javier Sánchez Rico	L.C.O.E. (High Voltage Department)

2.2 Measurement uncertainty

The uncertainty of the test is calculated and at the disposal of the applicant.

2.3 Standards applied

Tests have been performed according to:

- UNE-EN 61869-1:2010, "*Transformadores de medida. Parte 1: Requisitos generales*", Spanish official version of the European Standard EN 61869-1:2009, which adopts the modified International Standard IEC 61869-1:2007.

- UNE-EN 61869-3:2012, "*Transformadores de medida. Parte 3: Requisitos adicionales para los transformadores de tension inductivos"*, Spanish official version of the European Standard EN 61869-3:2011, which adopts the International Standard IEC 61869-3:2011.

- UNE-EN 60060-1:2012, *"Técnicas de ensayo de alta tension. Parte 1: Definiciones generales y requisitos de ensayo"* Spanish official version of the European Standard EN 60060-1:2010, which adopts the modified International Standard IEC 60060-1:2010.

2.4 Additional information

In this report, voltage values corresponding to power frequency withstand tests are expressed in peak value divided by root of two and voltage values corresponding to lightning impulse tests are expressed in peak value.

NO TEXT BELOW THE LINE

3 PERFORMED TESTS

3.1 Verification of terminal markings and rating plate

- Test date: 24th November 2015
- Procedure: UNE-EN 61869-3 section 6.13

  Terminal markings of voltage transformer were verified in accordance with section 6.13.301 and rating plate was verified according to section 6.13.302 of UNE-EN 61869-3 Standard.

- Results:

  Terminal markings of voltage transformer satisfy section 6.13.301 of UNE-EN 61869-3 Standard.

  Primary winding. Terminal markings A-N.

  Secondary windings. Terminal markings of measuring winding a-n and terminal markings of residual voltage winding da-dn.

  Rating plate of voltage transformer satisfies section 6.13.302 of UNE-EN 61869-3 Standard.

- Conclusion: **Test passed**

NO TEXT BELOW THE LINE

3.2 Test for accuracy of voltage transformer

- Test date: 24th and 25th November 2015
- Procedure: UNE-EN 61869-3 section 7.2.6

Ratio and phase displacement errors of voltage transformer were measured in accordance with sections 7.2.6.301 and 7.2.6.302 of UNE-EN 61869-3 Standard.

- Results of secondary winding a-n.

Test for accuracy. Primary A-N and secondary a-n

Ratio	*Voltage (% Un)*	*Burden*	*Errors*	
			Ratio (%)	*Phase (min)*
110000 / √3 / 100 / √3 V	80	25 % (25 VA)	+0.105	-1.4
	100		+0.101	-1.3
	120		+0.085	-1.2
	80	100 % (100 VA)	-0.024	-3.7
	100		-0.029	-3.7
	120		-0.044	-3.6

Secondary winding da-dn without accuracy burden.

Test for accuracy. Primary A-N and secondary a-n

Ratio	*Voltage (% Un)*	*Burden*	*Errors*	
			Ratio (%)	*Phase (min)*
110000 / √3 / 100 / √3 V	2	25 % (25 VA)	+0.039	-2.1
	5		+0.063	-1.9
	100		+0.101	-1.3
	190		-0.152	+0.7
	190 (*)		-0.286	-3.6
	2	100 % (100 VA)	-0.090	-4.5
	5		-0.067	-4.3
	100		-0.029	-3.7
	190		-0.279	-1.8
	190 (*)		-0.412	-6.0

Secondary winding da-dn without accuracy burden.
(*) Secondary winding da-dn loaded with accuracy burden equal to 100 VA.

- Results of secondary winding da-dn.

Test for accuracy. Primary A-N and secondary da-dn

Ratio	*Voltage (% Un)*	*Burden*	*Errors*	
			Ratio (%)	*Phase (min)*
110000 / √3 / 100 / 3 V	2	25 % (25 VA)	-0.003	-3.4
	5		+0.037	-3.1
	100		+0.099	-2.4
	190		-0.412	-0.2
	2	100 % (100 VA)	-0.270	-6.2
	5		-0.230	-5.9
	100		-0.165	-5.3
	190		-0.672	-3.0

Secondary winding a-n without accuracy burden.

Test for accuracy. Primary A-N and secondary da-dn

Ratio	*Voltage (% Un)*	*Burden*	*Errors*	
			Ratio (%)	*Phase (min)*
110000 / √3 / 100 / 3 V	2	25 % (25 VA)	-0.111	-7.8
	5		-0.073	-7.4
	100		-0.027	-6.2
	190		-0.531	-4.5
	2	100 % (100 VA)	-0.375	-10.6
	5		-0.339	-10.2
	100		-0.292	-9.0
	190		-0.787	-7.3

Secondary winding a-n loaded with accuracy burden of 100 VA.

Voltage ratio and phase displacement errors are between the limits specified for the accuracy class of the voltage transformer.

- Conclusion: **Test passed**

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3.3. Lightning impulse and chopped impulse test on primary terminals

- Test date: 25th November 2015

- Procedure: UNE-EN 61869-3 sections 7.2.3 and 7.4.1

Lightning impulse test and chopped impulse test on primary terminals of voltage transformer were performed according to sections 7.2.3 and 7.4.1 of UNE-EN 61869-3 Standard.

Peak value of full impulses was equal to 550 kV and test voltage of chopped impulses was equal to 633 kV (115 % of 550 kV), without correction due to local atmospheric conditions. Test wave polarity of the impulses was both positive and negative and chopping time of chopped impulses was between 2 µs and 5µs.

Terminal N, one terminal of each secondary winding and tank were connected to ground during the impulse test.

Sequence of the impulse test:

1 Reduced positive impulse (less than 80 % of test voltage)
15 Full positive impulses (100 % of test voltage)

1 Reduced negative impulse (less than 80 % of test voltage)
1 Full negative impulses (100 % of test voltage)
2 Chopped negative impulses (115 % of test voltage)
14 Full negative impulses (100 % of test voltage)

- Lightning impulse test with positive polarity. Test results:

Lightning Impulse Test - Positive polarity	
Peak Value of impulses	550 kV
Positive full impulses	15
Front Time t_1	1.29 µs
Time to half value t_2	53.0 µs
Ambient Conditions	
Ambient temperature	18.7 ºC
Relative Humidity	39.5 %
Atmospheric Pressure	948.3 hPa

NO TEXT BELOW THE LINE

- Lightning impulse and chopped impulse test with negative polarity. Test results:

Lightning Impulse Test - Negative polarity	
Peak Value of full impulses	550 kV
Peak Value of chopped impulses	633 kV
Negative full impulses	15
Negative chopped impulses	2
Front Time t_1	1.27 µs
Time to half value t_2	53.0 µs
Chopping time t_c of chopped impulses	3.03 µs
Ambient Conditions	
Ambient temperature	18.7 ºC
Relative Humidity	39.5 %
Atmospheric Pressure	948.3 hPa

- Test result:

  No external flashover or insulation damage was detected during wet test.

- Conclusion: **Test passed**

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3.4 Wet test for outdoor type transformers

- Test date: 26th November 2015

- Procedure: UNE-EN 61869-3 section 7.2.4

  Wet test for outdoor type transformers was performed on voltage transformer according to section 7.2.4 of UNE-EN 61869-3 Standard.

  Test voltage equal to 230 kV, 120 Hz corrected due to local atmospheric conditions, was applied between high voltage terminal of voltage transformer and ground for 60 seconds under wet condition according to UNE-EN 60060-1 Standard.

  Terminal N, one terminal of each secondary winding and tank were connected to ground during the test.

- Test Parameters:

Wet test on Voltage Transformer	
Test voltage (normal conditions)	230 kV
Test voltage (local conditions)	224.7 kV
Test frequency	120 Hz
Test duration	50 s
Atmospheric factor	0.977
Rain Parameters	
Horizontal flow rate	1.5 mm / min
Vertical flow rate	1.5 mm / min
Water conductivity	91.5 µS / cm
Water temperature	14.4 º C
Ambient Conditions	
Ambient temperature	19.2 ºC
Atmospheric Pressure	952.4 hPa

- Results:

  No external flashover or insulation damage was detected during wet test.

- Conclusion: **Test passed**

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3.5 Power frequency withstand test on primary terminals

- Test date: 26th and 27th November 2015
- Procedure: UNE-EN 61869-3 section 7.3.1

Power frequency withstand test was performed on primary terminals of voltage transformer according to section 7.3.1 of UNE-EN 61869-3 Standard.

Induced Voltage withstand test on primary winding.

Test voltage of 230 kV, 120 Hz was applied for 50 seconds on voltage transformer between high voltage primary terminal and ground with one terminal of each secondary winding and tank connected to earth.

- Test Parameters:

Induced voltage test on winding A-N	
Test voltage	230 kV
Test frequency	120 Hz
Test duration	50 s
Ambient Conditions	
Ambient temperature	19.5 ºC
Relative Humidity	30.9 %
Atmospheric Pressure	950.3 hPa

Separate source withstand test on terminal N.

Test voltage equal to 3 kV, 50 Hz was applied for 60 seconds between terminal N of primary winding and ground, with one terminal of each secondary winding and tank of the transformer connected to earth.

- Test Parameters:

Power frequency test on terminal N	
Test voltage	3 kV
Test frequency	50 Hz
Test duration	60 s
Ambient Conditions	
Ambient temperature	19.3 ºC
Relative Humidity	41.4 %
Atmospheric Pressure	947.1 hPa

No flashover or insulation damage was detected during the test.

- Conclusion: **Test passed**

3.6 Partial discharges measurement

- Test date: 26th November 2015

- Procedure: UNE-EN 61869-3 section 7.3.2

Partial discharges measurement was performed on voltage transformer according to section 7.3.2 of UNE-EN 61869-3 Standard.

After induced voltage withstand test on primary winding, partial discharges were measured at test voltage equal to 147.6 kV (1.2 U_m) and 85.2 kV (1.2 $U_m/\sqrt{3}$).

- Test Parameters:

Partial Discharges Measurement		
Excitation Voltage		230 kV
Test Frequency		120 Hz
Test Duration		50 s
Level 1 1.2 U_m	Test Voltage	147.6 kV
	Partial Discharges Level	4.1 pC
	Standard limit	10 pC
Level 2 1.2 U_m / $\sqrt{3}$	Test Voltage	85.2 kV
	Partial Discharges Level	3.6 pC
	Standard limit	5 pC
PD background noise level		2 pC

- Results:

Partial discharges measured at test voltage equal to 1.2 U_m and 1.2 $U_m/\sqrt{3}$ were lower than limits specified by UNE-EN 61869-3 Standard.

- Conclusion: **Test passed**

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3.7 Power frequency withstand test on secondary terminals

- Test date: 27th November 2015

- Procedure: UNE-EN 61869-3 section 7.3.4

Power frequency withstand test on secondary terminals was performed on voltage transformer according to section 7.3.4 of UNE-EN 61869-3 Standard.

Test voltage equal to 3 kV, 50 Hz was applied for 60 seconds between short-circuited terminals of each secondary winding and earth with the primary terminals of the transformer and the others secondary windings connected to ground.

- Test Parameters:

Voltage applied to secondary windings a-n / da-dn	
Test voltage	3 kV
Test frequency	50 Hz
Test duration	60 s
Ambient Conditions	
Ambient temperature	19.3 ºC
Relative Humidity	41.4 %
Atmospheric Pressure	947.1 hPa

- Results:

No flashover or insulation damage was detected during the test.

- Conclusion: **Test passed**

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3.8 Radio interference voltage measurement

- Test date: 27th November 2015

- Procedure: UNE-EN 61869-1 section 7.2.5

Radio interference voltage measurement was performed on voltage transformer according to section 7.2.5 of UNE-EN 61869-1 Standard.

Test voltage of 106.5 kV (1.5 $U_m/\sqrt{3}$), 50 Hz was applied for 30 seconds between high voltage primary terminal of voltage transformer and ground. Terminal N, one terminal of each secondary winding and tank were connected to ground during the test.

Then test voltage was reduced to 78.1 kV (1.1 $U_m/\sqrt{3}$) and radio interference voltage was measured during 30 seconds with measuring frequency equal to 1.34 MHz.

- Test results:

RIV Measurement	
Test voltage Level 1	106.5 kV
Test voltage Level 2	78.1 kV
Test frequency	50 Hz
Test duration	30 s (each level)
RIV measuring frequency	1.34 MHz
Ambient Conditions	
Ambient temperature	17 ºC
Relative Humidity	46 %
Atmospheric Pressure	948 hPa

Test Voltage (kV)	*RIV (µV)*	*RIV Limits (µV)*	*Result*
106.5 kV	298.5 µV	-	OK
78.1 kV	295.1 µV	2500 µV (IEC)	OK

- Conclusion: **Test passed**

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3.9 Temperature-rise test with accuracy burden

- Test date: 1st and 2nd December 2015

- Procedure: UNE-EN 61869-3 section 7.2.2

Temperature-rise test was performed on voltage transformer according to section 7.2.2 of UNE-EN 61869-3 Standard.

Temperature rise of windings were measured by the increase-in-resistance method and four thermocouples were placed over the surface of the transformer in order to determine thermal stability.

The primary winding of the transformer was subjected to 1.2 U_n, 50 Hz and rated burden equal to 100 VA was connected to secondary winding a-n.

Once the thermal stability of test object was reached, after 22 hours form starting time, a burden equal to 100 VA was connected to residual voltage secondary winding da-dn, test voltage applied to primary winding was increased up to 1.9 U_n during 30 seconds and the resistances of the windings were measured when primary voltage was switched off.

- Temperature-rise of the windings. Test results:

	Temperature-rise of windings.		
	A-N	*a-n*	*da-dn*
R_o (mΩ)	11 340 Ω	0.1663 Ω	0.2046 Ω
θ_o (ºC)	13.2 ºC		
R_t (mΩ)	11 710 Ω	0.1715 Ω	0.2109 Ω
θ_f (ºC)	11.7 ºC		
$\Delta\theta$ (K)	9.8 K ± 3 K	9.5 K ± 3 K	9.3 K ± 3 K

Temperature rise of windings measured by the increase-in-resistance method was lower than limit specified of 60 K (thermal insulation class A) specified by UNE-EN 61869-3 Standard.

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- Temperature-rise measurement of external parts. Test results:

Temperature rise on external parts of the transformer	
Ambient Temperature before the test	14.3 ºC
Ambient Temperature after the test	11.7 ºC
Test voltage 1.2 U_n	76.2 kV
Test voltage 1.9 U_n during 30 seconds	120.7 kV
Test frequency	50 Hz
Burden connected to winding a-n	100 VA
Burden connected to winding da-dn (only during 1.9 U_n test)	100 VA
Temperature rise thermocouple 1 – Tank lower part	3.7 K
Temperature rise thermocouple 2 – Tank upper part	4.2 K
Temperature rise thermocouple 3 – Secondary terminals	1.8 K
Temperature rise thermocouple 4 – Tank lateral side	4.1 K

Temperature rise of external parts of voltage transformer was lower than limit specified of 60 K (thermal insulation class A) specified by UNE-EN 61869-3 Standard.

- Conclusion: **Test passed**

3.10 Temperature-rise test with thermal limiting output

- Test date: 2nd and 3rd December 2015
- Procedure: UNE-EN 61869-3 section 7.2.2

Temperature-rise test was performed on voltage transformer according to section 7.2.2 of UNE-EN 61869-3 Standard.

Temperature rise of windings were measured by the increase-in-resistance method and four thermocouples were placed over the surface of the transformer in order to determine thermal stability.

The primary winding of the transformer was subjected to U_n, 50 Hz and thermal limiting output of 1000 VA was connected to secondary winding a-n. Once the thermal stability of test object was achieved, after 19 hours, the resistances of the windings were measured.

- Temperature-rise of the windings. Test results:

	Temperature-rise of windings.		
	A-N	*a-n*	*da-dn*
R_o (mΩ)	11 340 Ω	0.1663 Ω	0.2046 Ω
θ_o (ºC)	13.2 ºC		
R_t (mΩ)	11 860 Ω	0.1740 Ω	0.2125 Ω
θ_f (ºC)	14.2 ºC		
$\Delta\theta$ (K)	10.7 K ± 3 K	10.8 K ± 3 K	8.8 K ± 3 K

Temperature rise of windings measured by the increase-in-resistance method was lower than limit specified of 60 K (thermal insulation class A) specified by UNE-EN 61869-3 Standard.

- Temperature-rise measurement of external parts. Test results:

Temperature rise on external parts of the transformer	
Ambient Temperature before the test	13.6 ºC
Ambient Temperature after the test	14.3 ºC
Test voltage U_n	63.5 kV
Test frequency	50 Hz
Burden connected to winding a-n	1000 VA
Burden connected to winding da-dn	0 VA
Temperature rise thermocouple 1 – Tank lower part	3.1 K
Temperature rise thermocouple 2 – Tank upper part	3.7 K
Temperature rise thermocouple 3 – Secondary terminals	2.1 K
Temperature rise thermocouple 4 – Tank lateral side	3.6 K

Temperature rise of external parts of voltage transformer was lower than limit specified of 60 K (thermal insulation class A) specified by UNE-EN 61869-3 Standard.

- Conclusion: **Test passed**

NO TEXT BELOW THE LINE

3.11 Short-circuit withstand capability test

- Test date: 4th December 2015
- Procedure: UNE-EN 61869-3 section 7.2.301

Short-circuit withstand capability test was performed on voltage transformer in accordance with section 7.2.301 of UNE-EN 61869-3 Standard.

The voltage transformer was energized from the primary winding with the secondary winding short-circuited. Test voltage equal to rated voltage was applied to voltage transformer for one second with test frequency equal to 50 Hz.

- Results of test. Secondary winding a-n short-circuited.

Short-circuit test winding a-n	
Test voltage	65.8 kV
Test frequency	50 Hz
Test duration	1.03 s
Secondary test current	873 A
Ambient temperature	15.5 ºC

- Results of test. Secondary winding da-dn short-circuited.

Short-circuit test winding da-dn	
Test voltage	65.8 kV
Test frequency	50 Hz
Test duration	1.03 s
Secondary test current	763 A
Ambient temperature	15.5 ºC

- Requirements after short-circuit test:

3.11.1 Visual inspection of test object.

- Test date: 4th December 2015
- Results of test:

After short-circuit test voltage transformer is not visibly damaged and the insulation next to the surface of both the primary and the secondary windings does not show significant deterioration.

- Conclusion: **Test passed**

3.11.2 Test for accuracy of voltage transformer after short-circuit test

- Test date: 11th December 2015
- Procedure: UNE-EN 61869-3 section 7.2.6

Ratio and phase displacement errors of voltage transformer were measured after short-circuit capability test in accordance with sections 7.2.6.301 and 7.2.6.302 of UNE-EN 61869-3 Standard.

- Results of secondary winding a-n.

Test for accuracy. Primary A-N and secondary a-n

Ratio	*Voltage (% Un)*	*Burden*	*Errors*	
			Ratio (%)	*Phase (min)*
110000 / √3 / 100 / √3 V	80	25 % (25 VA)	+0.102	-1.4
	100		+0.098	-1.3
	120		+0.083	-1.2
	80	100 % (100 VA)	-0.028	-3.7
	100		-0.036	-3.7
	120		-0.048	-3.6

Secondary winding da-dn without accuracy burden.

Test for accuracy. Primary A-N and secondary a-n

Ratio	*Voltage (% Un)*	*Burden*	*Errors*	
			Ratio (%)	*Phase (min)*
110000 / √3 / 100 / √3 V	2	25 % (25 VA)	+0.041	-2.4
	5		+0.068	-2.0
	100		+0.098	-1.3
	190		-0.155	+0.7
	190 (*)		-0.287	-3.5
	2	100 % (100 VA)	-0.091	-4.8
	5		-0.064	-4.4
	100		-0.034	-3.7
	190		-0.283	-1.7
	190 (*)		-0.416	-5.8

Secondary winding da-dn without accuracy burden.
(*) Secondary winding da-dn loaded with accuracy burden equal to 100 VA.

- Results of secondary winding da-dn.

Test for accuracy. Primary A-N and secondary da-dn

Ratio	*Voltage (% Un)*	*Burden*	*Errors*	
			Ratio (%)	*Phase (min)*
110000 / √3 / 100 / 3 V	2	25 % (25 VA)	-0.002	-3.2
	5		+0.040	-3.0
	100		+0.095	-2.2
	190		-0.422	-0.2
	2	100 % (100 VA)	-0.275	-6.0
	5		-0.234	-5.7
	100		-0.180	-4.9
	190		-0.687	-2.9

Secondary winding a-n without accuracy burden.

Test for accuracy. Primary A-N and secondary da-dn

Ratio	*Voltage (% Un)*	*Burden*	*Errors*	
			Ratio (%)	*Phase (min)*
110000 / √3 / 100 / 3 V	2	25 % (25 VA)	-0.148	-7.3
	5		-0.104	-7.1
	100		-0.032	-6.5
	190		-0.538	-4.4
	2	100 % (100 VA)	-0.420	-10.0
	5		-0.376	-9.8
	100		-0.302	-9.3
	190		-0.817	-7.1

Secondary winding a-n loaded with accuracy burden of 100 VA.

Voltage ratio and phase displacement errors are between the limits specified for the accuracy class of the voltage transformer.

- Conclusion: **Test passed**

NO TEXT BELOW THE LINE

3.11.3 Power frequency withstand test on primary terminals

- Test date: 9th and 11th December 2015

- Procedure: UNE-EN 61869-3 section 7.3.1

Power frequency withstand test was performed on primary terminals of voltage transformer after short-circuit test according to section 7.3.1 of UNE-EN 61869-3 Standard.

Induced Voltage withstand test on primary winding.

Test voltage of 207 kV (90 % of power frequency withstand voltage), 120 Hz was applied for 50 seconds on voltage transformer between high voltage primary terminal and ground with one terminal of each secondary winding and tank connected to earth.

- Test Parameters:

Induced voltage test on winding A-N	
Test voltage	207 kV
Test frequency	120 Hz
Test duration	50 s
Ambient Conditions	
Ambient temperature	17.3 ºC
Relative Humidity	51.3 %
Atmospheric Pressure	965.6 hPa

Separate source withstand test on terminal N.

Test voltage equal to 2.7 kV, 50 Hz was applied for 50 seconds between terminal N of primary winding and ground, with one terminal of each secondary winding and tank of the transformer connected to earth.

- Test Parameters:

Power frequency test on terminal N	
Test voltage	2.7 kV
Test frequency	50 Hz
Test duration	60 s
Ambient Conditions	
Ambient temperature	16.2 ºC
Relative Humidity	49.8 %
Atmospheric Pressure	968.4 hPa

No flashover or insulation damage was detected during the test.

- Conclusion: **Test passed**

3.11.4 Partial discharges measurement after short-circuit test

- Test date: 9th December 2015

- Procedure: UNE-EN 61869-3 section 7.3.2

Partial discharges measurement was performed on voltage transformer after short-circuit test in accordance with section 7.3.2 of UNE-EN 61869-3 Standard.

After induced voltage withstand test on primary winding, partial discharges were measured at test voltage equal to 147.6 kV (1.2 U_m) and 85.2 kV (1.2 $U_m/\sqrt{3}$).

- Test Parameters:

Partial Discharges Measurement		
Excitation Voltage		207 kV
Test Frequency		120 Hz
Test Duration		50 s
Level 1 1.2 U_m	Test Voltage	147.6 kV
	Partial Discharges Level	3.8 pC
	Standard limit	10 pC
Level 2 1.2 U_m / $\sqrt{3}$	Test Voltage	85.2 kV
	Partial Discharges Level	3.5 pC
	Standard limit	5 pC
PD background noise level		2 pC

- Results:

Partial discharges measured at test voltage equal to 1.2 U_m and 1.2 $U_m/\sqrt{3}$ were lower than limits specified by UNE-EN 61869-3 Standard.

- Conclusion: **Test passed**

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3.11.5 Power frequency withstand test on secondary terminals after short-circuit test

- Test date: 11th December 2015

- Procedure: UNE-EN 61869-3 section 7.3.4

Power frequency withstand test on secondary windings was performed on voltage transformer in accordance with section 7.3.4 of UNE-EN 61869-3 Standard.

Test voltage of 2.7 kV (90 % of power frequency withstand voltage), 50 Hz was applied for 60 seconds between short-circuited terminals of each secondary winding and earth with the primary terminals of the transformer and the others secondary windings connected to ground.

- Test Parameters:

Voltage applied to secondary windings a-n / da-dn	
Test voltage	2.7 kV
Test frequency	50 Hz
Test duration	60 s
Ambient Conditions	
Ambient temperature	16.2 ºC
Relative Humidity	49.8 %
Atmospheric Pressure	968.4 hPa

- Results:

No flashover or insulation damage was detected during the test.

- Conclusion: **Test passed**

NO TEXT BELOW THE LINE

3.12 Transmitted Overvoltage Test

- Test date: 14th December 2015
- Procedure: UNE-EN 61869-1 section 7.4.4
- Procedure:

Transmitted overvoltage test was performed on voltage transformer in accordance with section 7.4.4 of UNE-EN 61869-1 Standard.

A low-voltage impulse with a peak value (U_p) of around 25 V was applied to terminal A of primary winding. Test wave polarity was positive, front time around 500 ns and time to half value above 50 µs.

The transmitted voltage at the open secondary terminals (U_s) was measured by using an oscilloscope having a bandwidth of 500 MHz and input impedance equal to 50 Ω.

- Transmitted overvoltage test. Results:

Transmitted overvoltage test		
Peak Value of the impulse,U_1		26 V
Front Time t_1		500 ns
Time to half value t_2		> 50 µs
Secondary a-n	Applied peak value, U_1	26.4 V
	Transmitted peak voltage, U_2	196 mV
	Calculated peak value on secondary	1.19 kV
	Limit of peak value on secondary winding	1.6 kV
Secondary da-dn	Applied peak value, U_1	26.4 V
	Transmitted peak voltage, U_2	196 mV
	Calculated peak value on secondary	0.67 kV
	Limit of peak value on secondary winding	1.6 kV
Ambient temperature		17.5 ºC

- Results:

Transmitted overvoltage peak voltage on secondary windings was lower than limit value specified by UNE-EN 61869-1 Standard.

- Conclusion: **Test passed**

NO TEXT BELOW THE LINE

3.13 Measurement of insulation resistance

- Test date: 14th December 2015

- Procedure:

  Measurement of insulation resistance of the windings was performed on voltage transformer according to specification of the manufacturer.

  Test voltage was applied between each winding of voltage transformer and ground during one minute with other windings short-circuited and connected to ground. Insulation resistance was measured during the test.

- Test results:

Insulation resistance measurement	
Test voltage	2500 V_{DC}
Test duration	60 s
Winding A-N	629 GΩ
Winding a-n	241 GΩ
Winding da-dn	219 GΩ
Ambient temperature	17.5 ºC

- Conclusion: **Test passed**

The test performed is out of the scope of ENAC Accreditation.

NO TEXT BELOW THE LINE

4 SUMMARY AND CONCLUSIONS

The following tests according to UNE-EN 61869-1 and UNE-EN 61869-3 Standards have been performed on voltage transformer manufactured by Arteche, type UTD-123 and identification 15012274/1.

- Verification of terminal markings.
- Test for accuracy of voltage transformer.
- Lightning impulse test on primary terminals.
- Chopped impulse voltage withstand test on primary terminals.
- Wet test for outdoor type transformers.
- Power frequency withstand test on primary terminals.
- Partial discharges measurement.
- Power frequency withstand test on secondary terminals.
- Radio interference voltage test.
- Temperature-rise test.
- Short-circuit withstand capability test.
- Transmitted overvoltage test.
- Insulation resistance measurement.

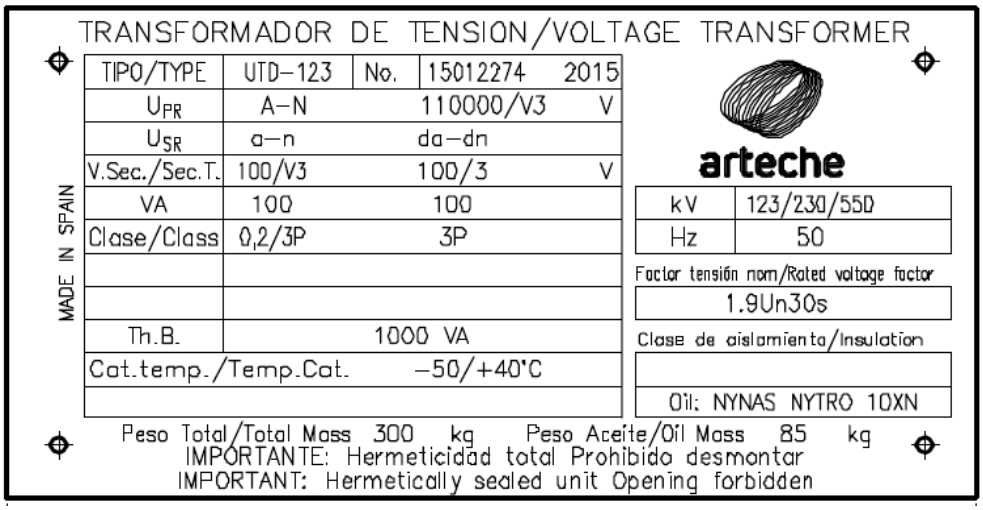
All test performed on Voltage Transformer have been successful**.**

NO TEXT BELOW THE LINE

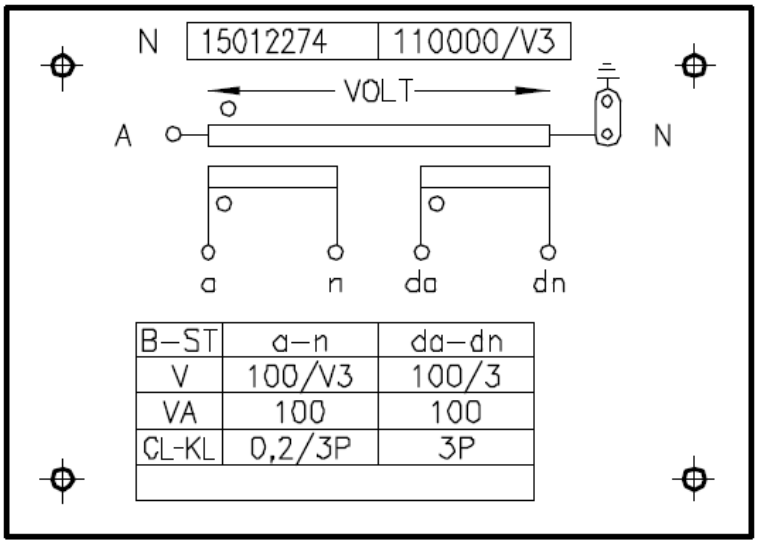
Annex 1

Rating plate and drawing of voltage transformer

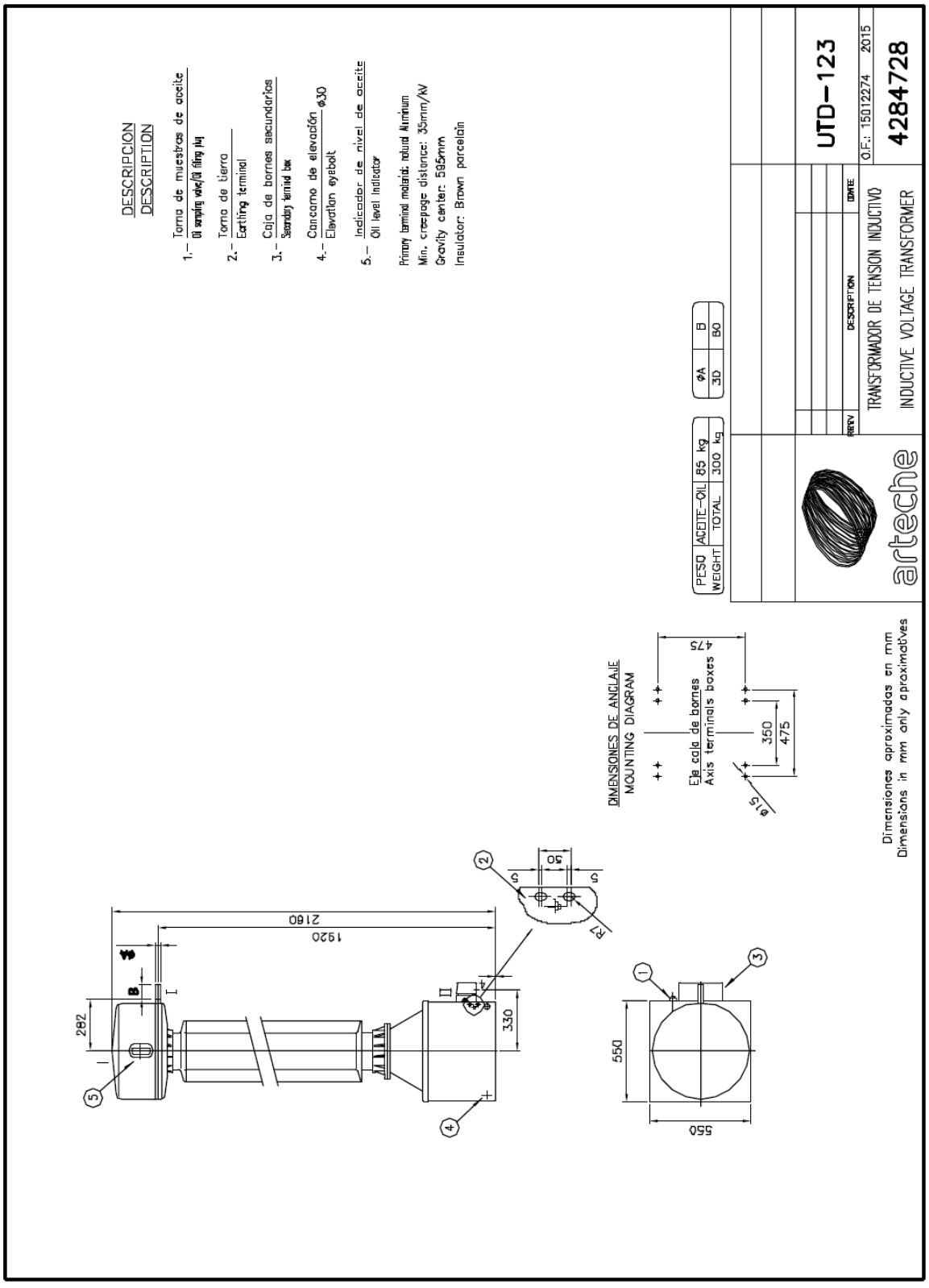
- Rating plate of voltage transformer UTD-123.



- Secondary connection plate of voltage transformer UTD-123.



➢ Drawing of voltage transformer UTD-123.



Annex 2

Lightning impulse test

➢ Lightning Impulse test. Impulses of positive polarity Nº 1 –Nº 9.

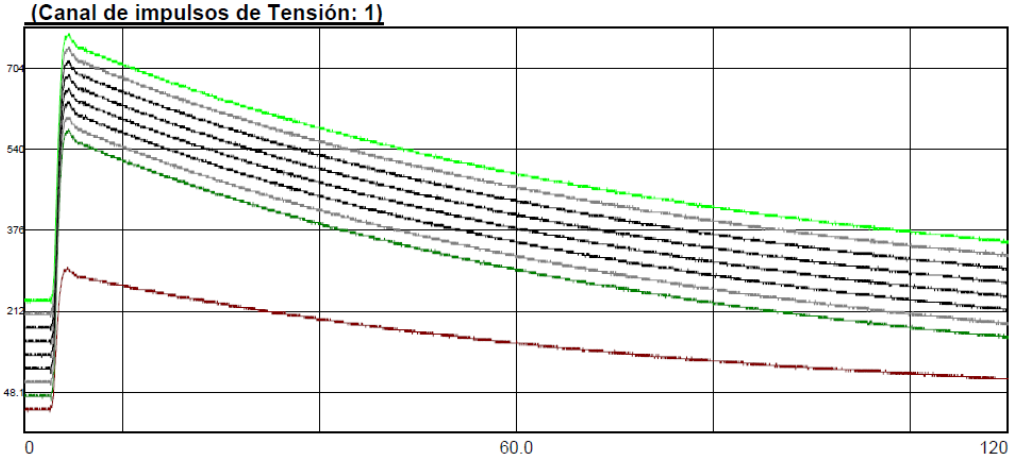
Ensayo nº2015113D0683-POS

L.C.O.E.

Operario **Miguel / Javier**
Departamento **Alta Tensión**
Sede **Tecnogetafe**

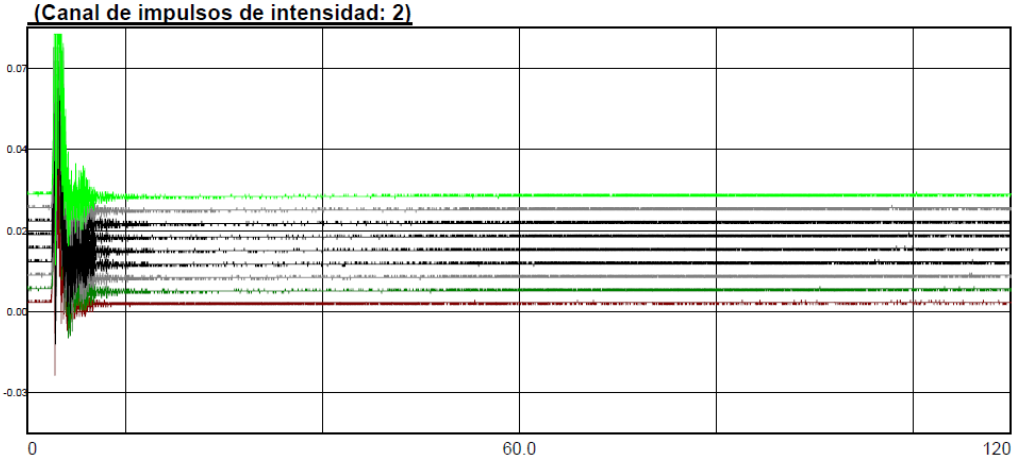
Archivo : **ARTECHE UTD123 POS.gen**
Fecha: **25/11/2015**
Hora: **15:27**

(Canal de impulsos de Tensión: 1)



Impulso	Tipo	Up (kV)	T1 (µs)	T2/Tc (µs)
1º	Pleno	292.4	1.29	52.3
2º	Pleno	549.0	1.29	53.0
3º	Pleno	544.4	1.28	53.0
4º	Pleno	549.1	1.29	53.1
5º	Pleno	548.9	1.29	53.0
6º	Pleno	548.9	1.29	53.0
7º	Pleno	549.1	1.29	53.0
8º	Pleno	549.2	1.29	53.0
9º	Pleno	548.9	1.29	53.1

(Canal de impulsos de intensidad: 2)



Impulso	Ip (kA)
1º	0.0477
2º	0.0478
3º	0.0478
4º	0.0477
5º	0.0478
6º	0.0477
7º	0.0478
8º	0.0478
9º	0.0477

➢ Lightning Impulse test. Impulses of positive polarity Nº 10 –Nº 16.

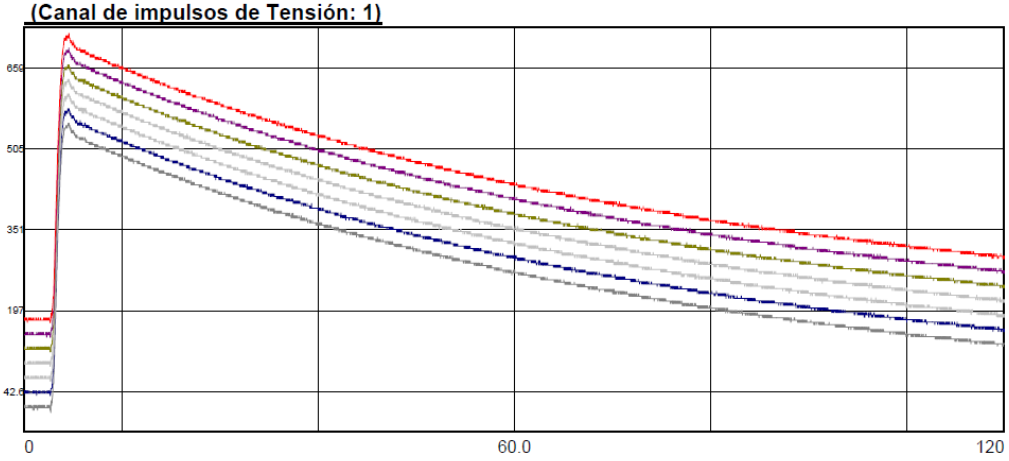
Ensayo nº2015113D0683-POS

L.C.O.E.

Operario **Miguel / Javier**
Departamento **Alta Tensión**
Sede **Tecnogetafe**

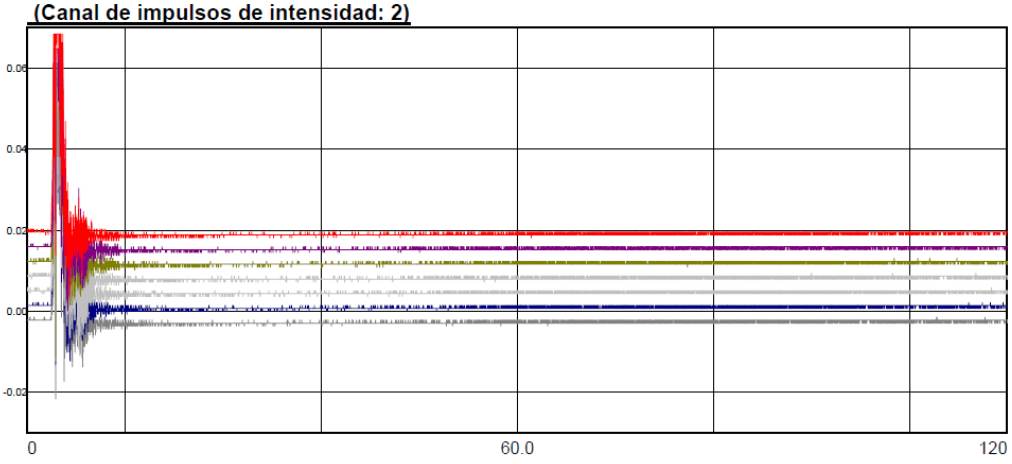
Archivo : **ARTECHE UTD123 POS.gen**
Fecha: **25/11/2015**
Hora: **15:27**

(Canal de impulsos de Tensión: 1)



Impulso	Tipo	Up (kV)	T1 (µs)	T2/Tc (µs)
10º	Pleno	548.9	1.28	53.1
11º	Pleno	548.9	1.29	53.1
12º	Pleno	548.9	1.29	53.1
13º	Pleno	549.0	1.29	52.9
14º	Pleno	548.9	1.28	53.1
15º	Pleno	553.6	1.29	53.1
16º	Pleno	553.6	1.29	52.8

(Canal de impulsos de intensidad: 2)



Impulso	Ip (kA)
10º	0.0478
11º	0.0478
12º	0.0478
13º	0.0477
14º	0.0478
15º	0.0478
16º	0.0477

➢ Lightning Impulse test. Impulses of negative polarity Nº 1 –Nº 9.

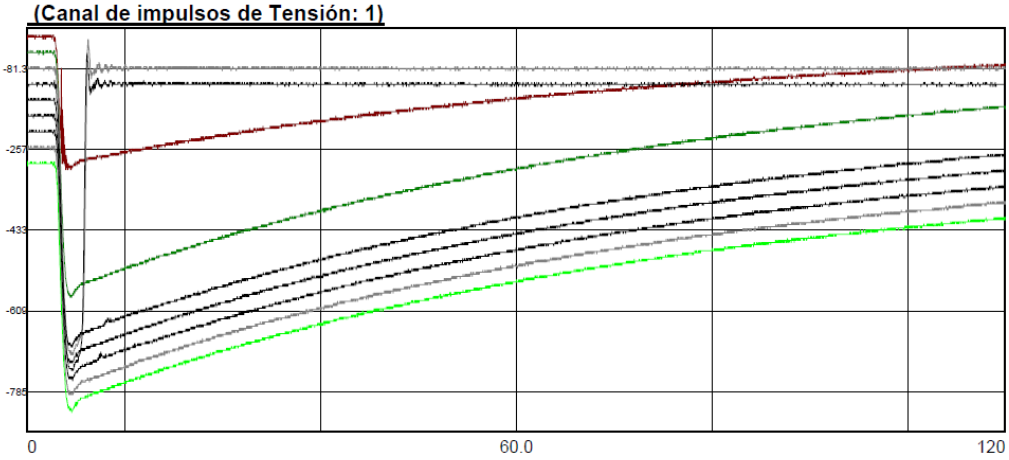
Ensayo nº2015113D0683

L.C.O.E.

Operario **Miguel / Javier**
Departamento **Alta Tensión**
Sede **Tecnogetafe**

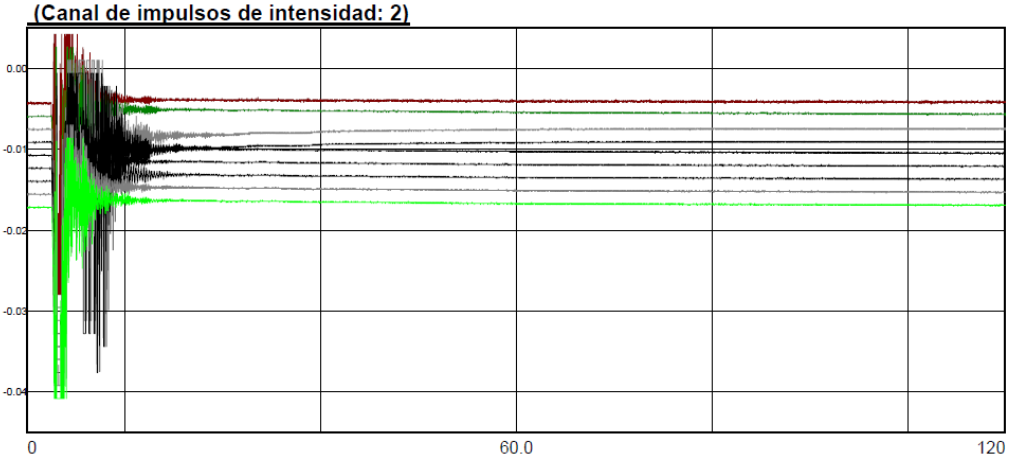
Archivo : **ARTECHE UTD123 NEG.gen**
Fecha: **25/11/2015**
Hora: **13:28**

(Canal de impulsos de Tensión: 1)



Impulso	Tipo	Up (kV)	T1 (µs)	T2/Tc (µs)	Uc (kV)
1º	Pleno	294	1.39	52.4	-
2º	Pleno	541	1.26	52.8	-
3º	Cortado	633	1.27	3.09	578
4º	Cortado	633	1.27	2.97	581
5º	Pleno	546	1.27	53.0	-
6º	Pleno	546	1.27	52.9	-
7º	Pleno	550	1.26	53.0	-
8º	Pleno	550	1.27	53.0	-
9º	Pleno	550	1.27	52.9	-

(Canal de impulsos de intensidad: 2)



Impulso	Ip (kA)
1º	0.0265
2º	0.0264
3º	0.0264
4º	0.0264
5º	0.0264
6º	0.0264
7º	0.0264
8º	0.0264
9º	0.0264

➢ Lightning Impulse test. Impulses of positive polarity Nº 10 –Nº 18.

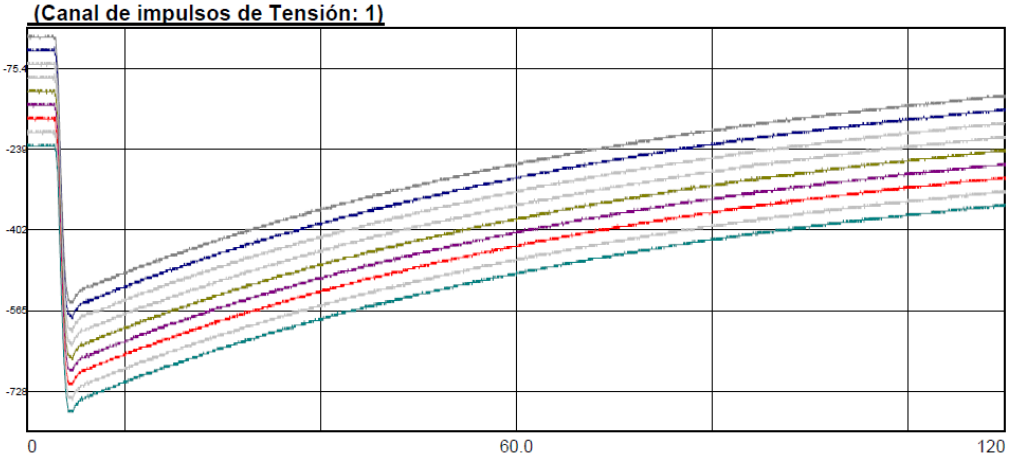
Ensayo nº2015113D0683

L.C.O.E.

Operario **Miguel / Javier**
Departamento **Alta Tensión**
Sede **Tecnogetafe**

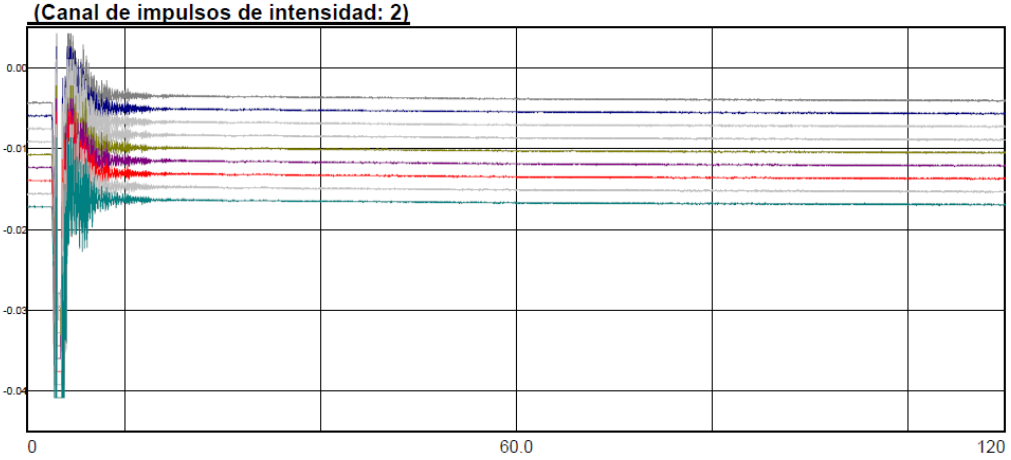
Archivo : **ARTECHE UTD123 NEG.gen**
Fecha: **25/11/2015**
Hora: **13:28**

(Canal de impulsos de Tensión: 1)



Impulso	Tipo	Up (kV)	T1 (µs)	T2/Tc (µs)	Uc (kV)
10º	Pleno	546	1.26	53.1	-
11º	Pleno	550	1.27	52.9	-
12º	Pleno	550	1.27	53.1	-
13º	Pleno	550	1.27	53.0	-
14º	Pleno	550	1.27	53.1	-
15º	Pleno	550	1.27	53.1	-
16º	Pleno	546	1.25	53.2	-
17º	Pleno	550	1.27	53.1	-
18º	Pleno	546	1.26	53.2	-

(Canal de impulsos de intensidad: 2)



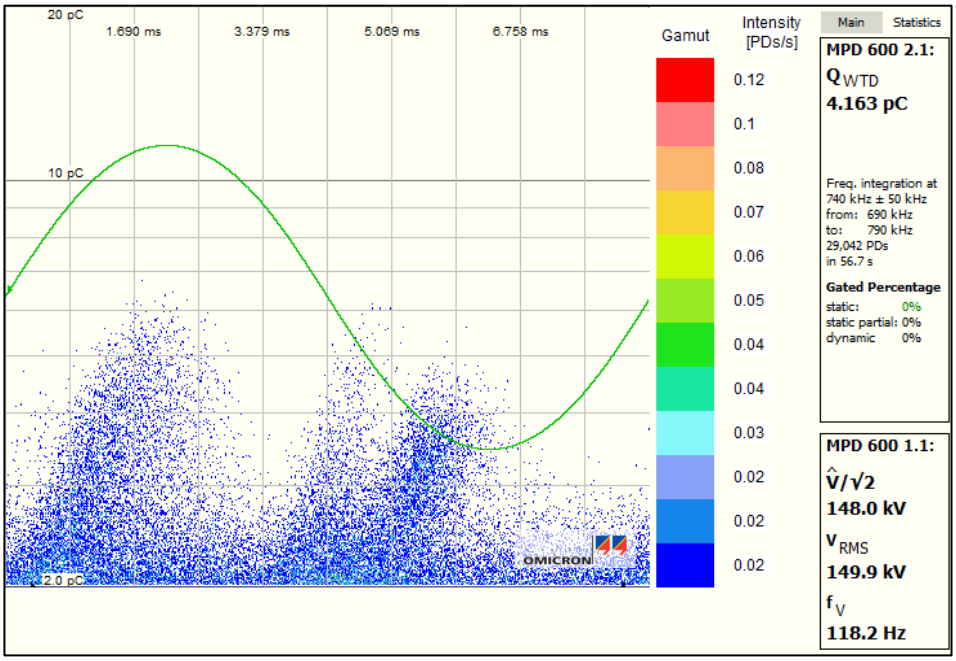
Impulso	Ip (kA)
10º	0.0264
11º	0.0264
12º	0.0264
13º	0.0264
14º	0.0264
15º	0.0264
16º	0.0264
17º	0.0264
18º	0.0264

Annex 3

Partial Discharge Measurement

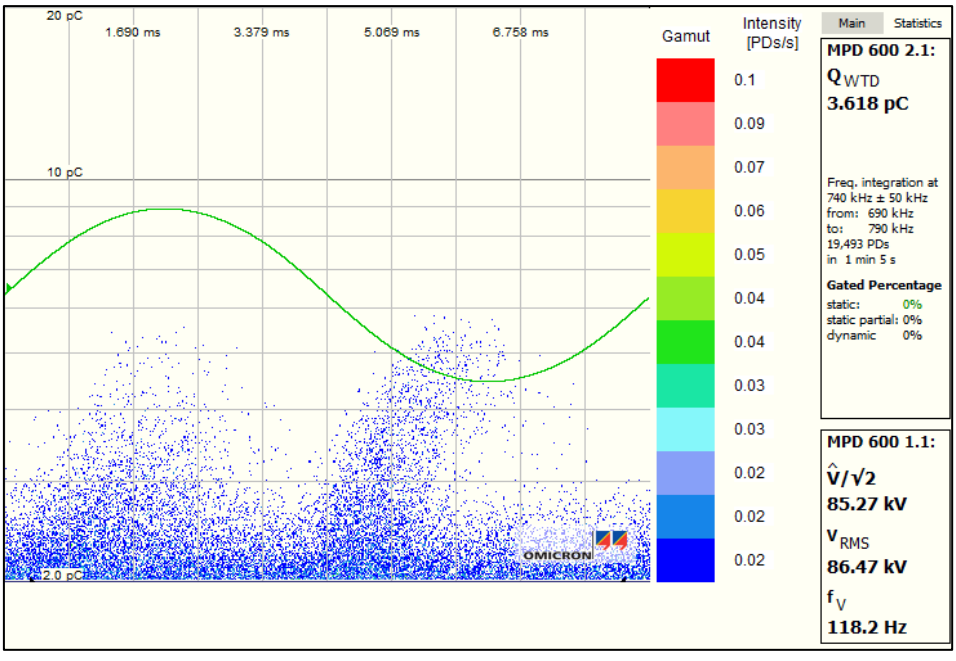
➢ *Figure 1 – Partial Discharges Measurement. Record 1.*

Test Voltage ⇒ 148 kV
Measuring Frequency ⇒ 740 kHz ± 100 kHz
Partial Discharges Level ⇒ 4.2 pC



➢ *Figure 2 – Partial Discharges Measurement. Record 2.*

Test Voltage ⇒ 85.2 kV
Measuring Frequency ⇒ 740 kHz ± 100 kHz
Partial Discharges Level ⇒ 3.6 pC

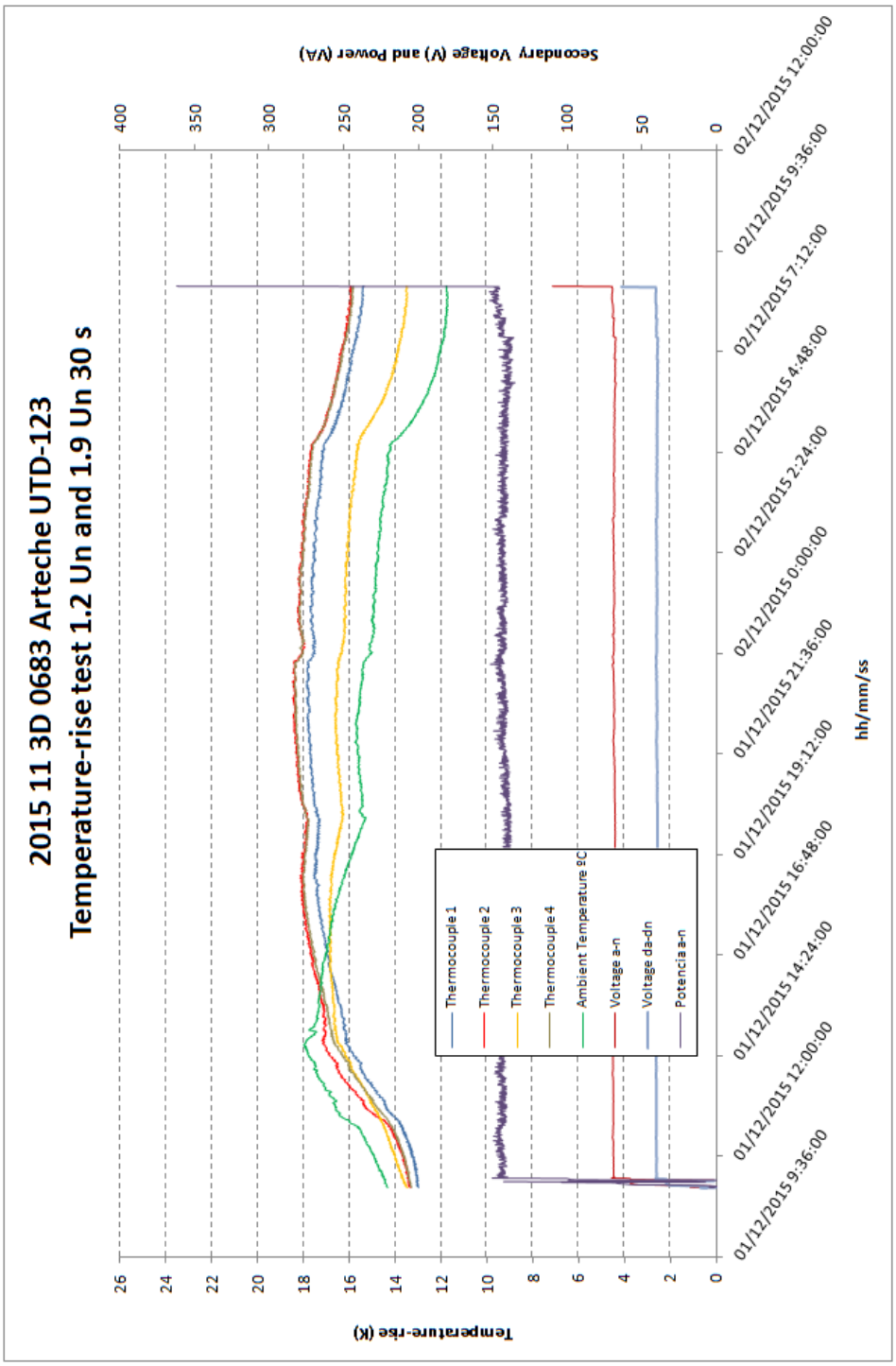


Annex 4

Temperature-rise test

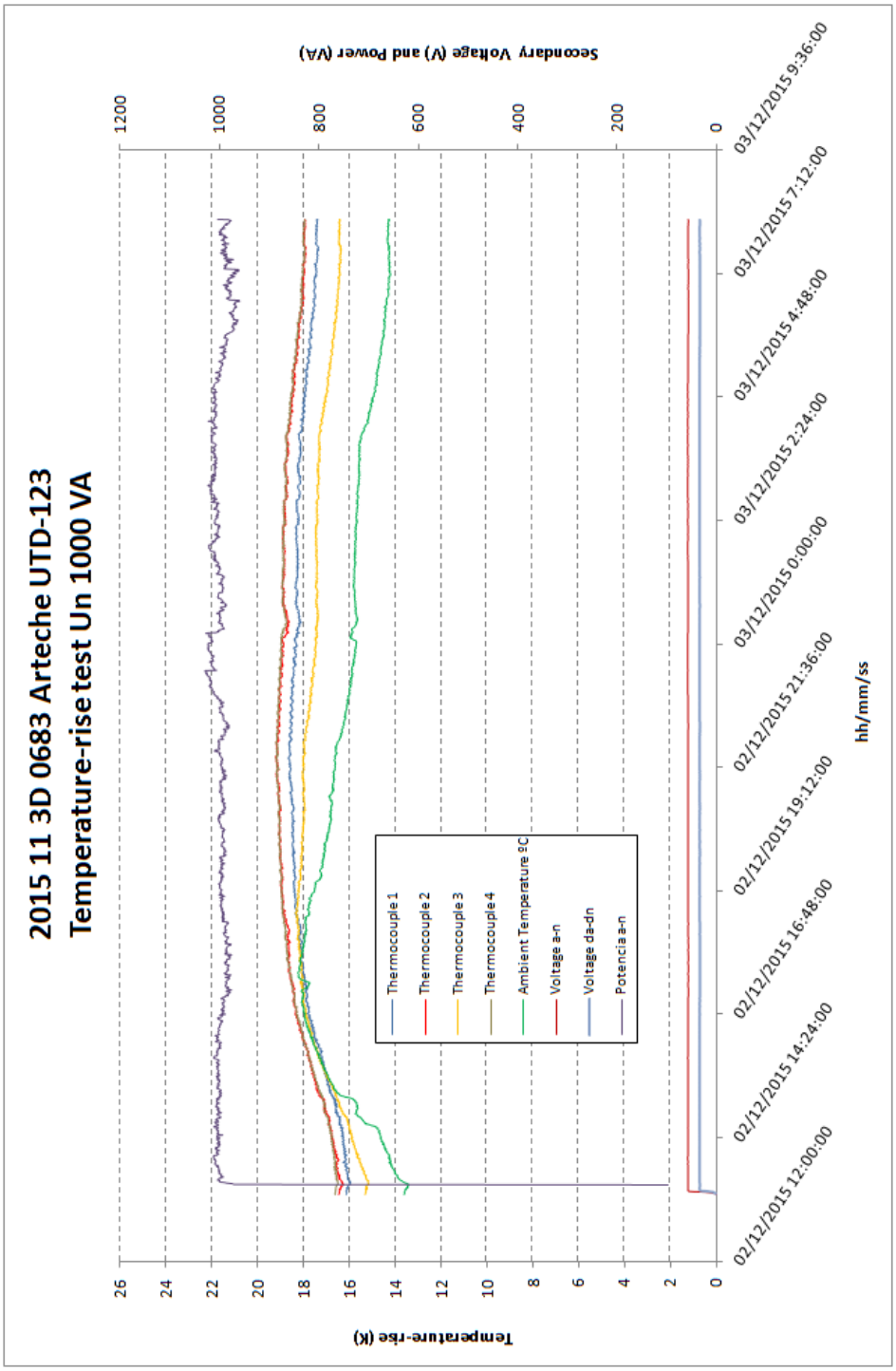
➢ *Figure 1 – Temperature-rise test on voltage transformer with accuracy burden.*

Test Voltage ⟹ 76.2 kV and 120.7 kV 30 s
Secondary burden ⟹ 100 VA on secondary a-n



➢ *Figure 2 – Temperature-rise test on voltage transformer with rated thermal burden.*

Test Voltage ⟹ 63.5 kV
Secondary burden ⟹ 1000 VA on secondary a-n

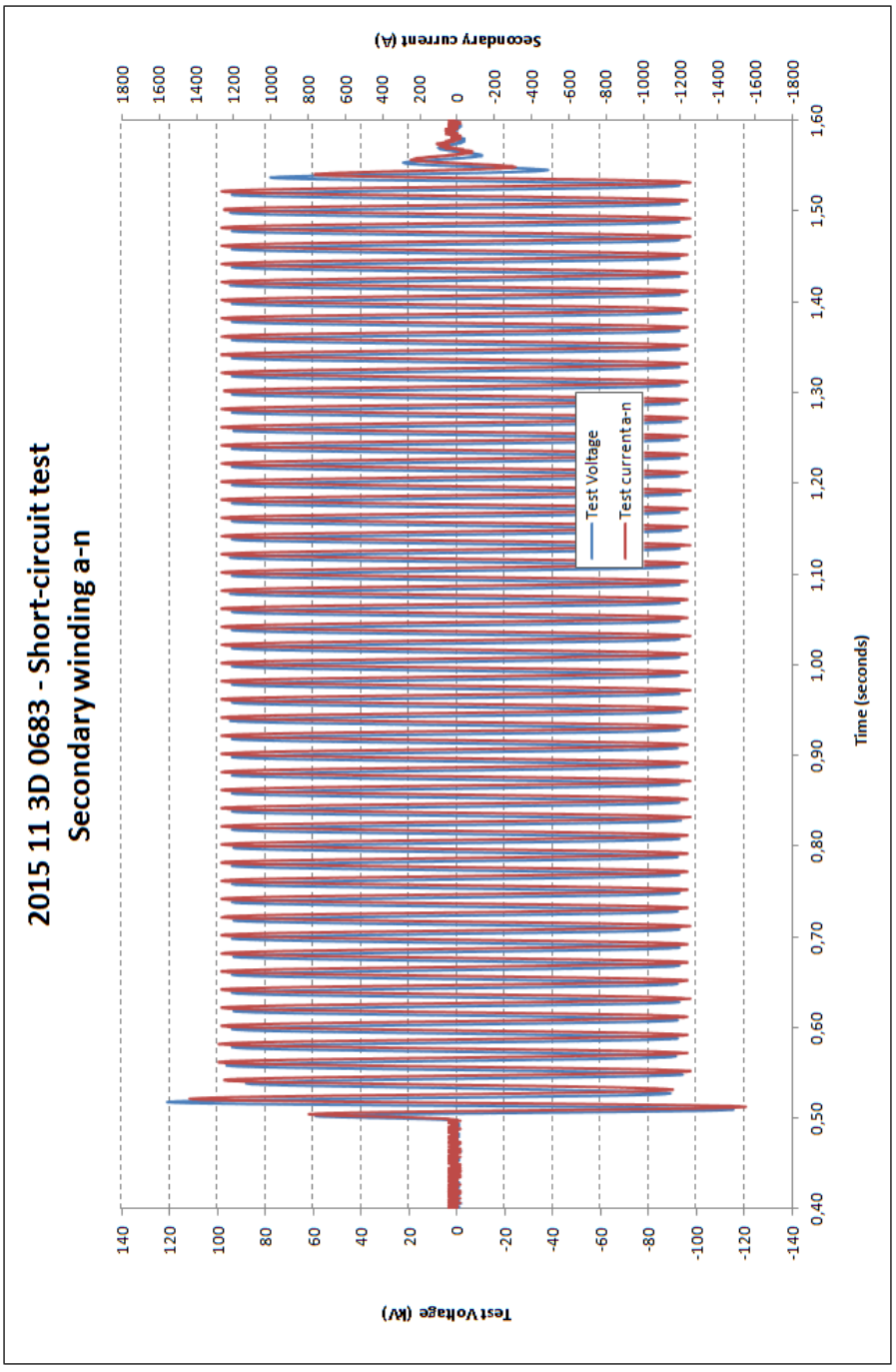


Annex 5

Short-circuit withstand capability test

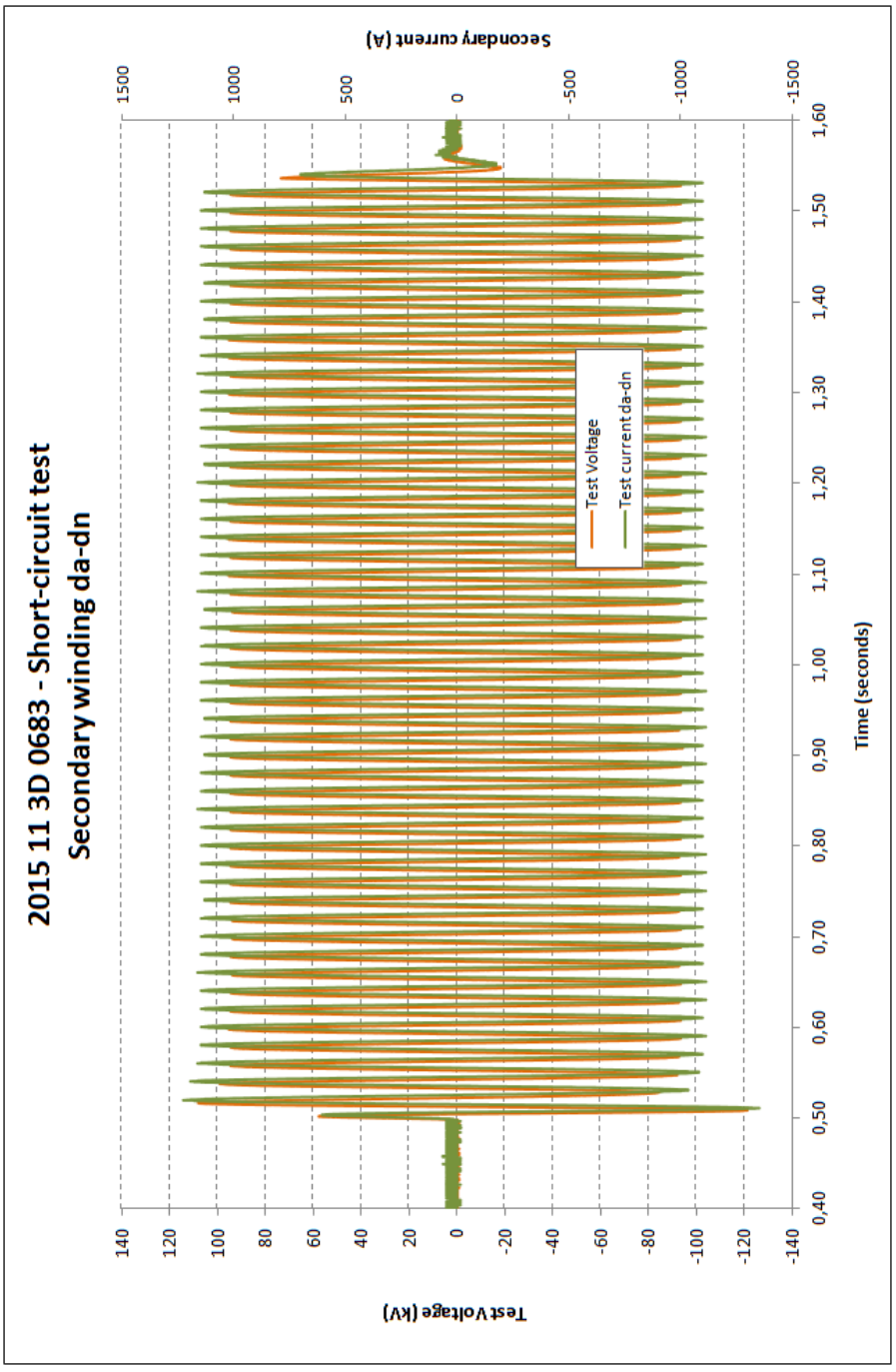
➢ Short-circuit test on secondary winding a-n.

Test voltage ⇒ 65.8 kV
Test duration ⇒ 1.03 s
Secondary test current ⇒ 873 A



➢ Short-circuit test on secondary winding da-dn.

Test voltage ⇒ 65.8 kV
Test duration ⇒ 1.03 s
Secondary test current ⇒ 763 A

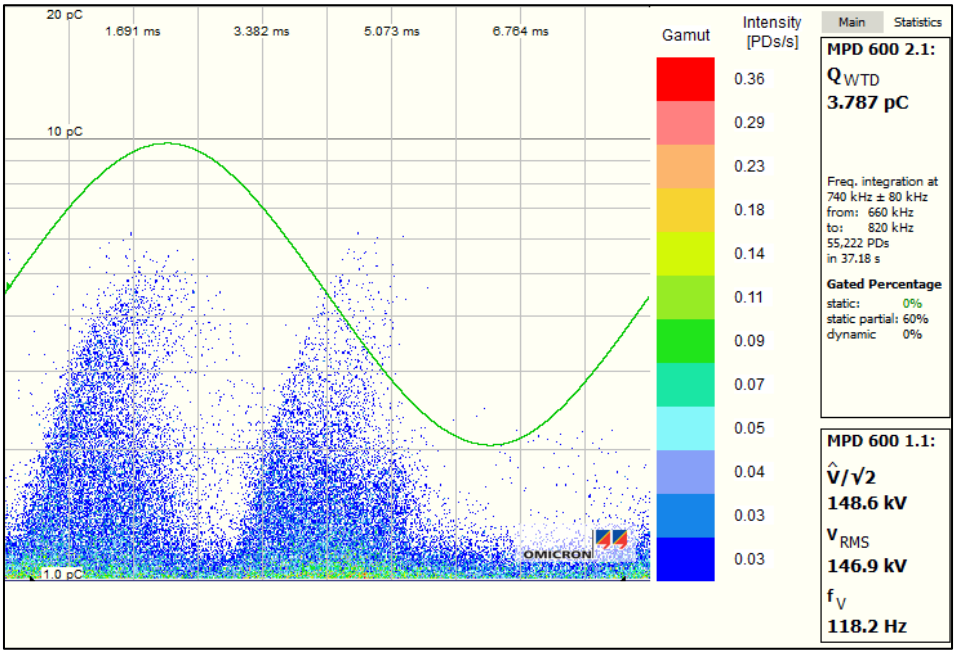


Annex 6

Partial Discharge Measurement after short-circuit test

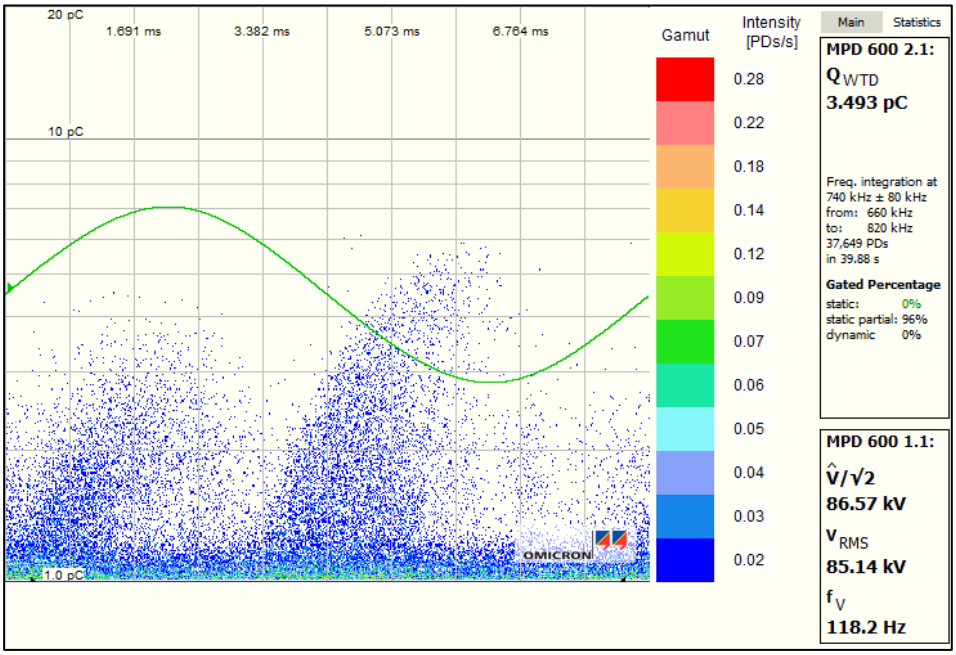
➢ *Figure 1 – Partial Discharges Measurement. Record 1.*

Test Voltage ⇒ 148 kV
Measuring Frequency ⇒ 740 kHz ± 100 kHz
Partial Discharges Level ⇒ 3.8 pC



➢ *Figure 2 – Partial Discharges Measurement. Record 2.*

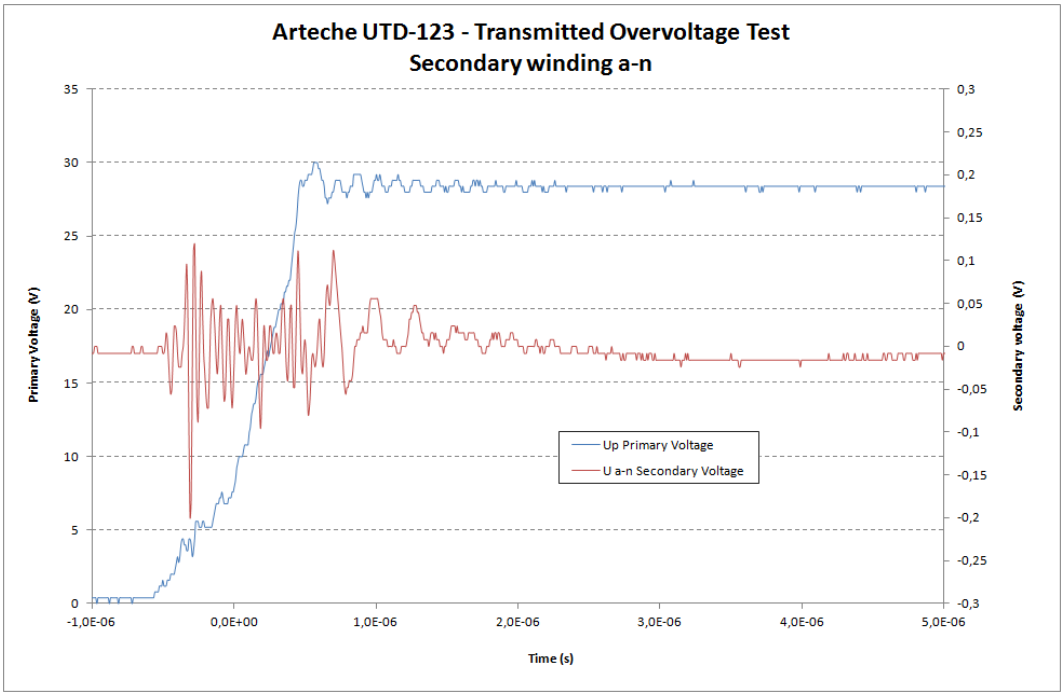
Test Voltage ⇒ 85.2 kV
Measuring Frequency ⇒ 740 kHz ± 100 kHz
Partial Discharges Level ⇒ 3.5 pC



Annex 7

Transmitted Overvoltage Test

➢ *Figure 1 – Transmitted overvoltage test. Secondary winding a-n.*



➢ *Figure 2 – Transmitted overvoltage test. Secondary winding da-dn.*