TÜV Thüringen Group	Record of In-Process Inspection AR-1709-FAT-137 Rev.0

Test confirmation on the given range
of performed electrical tests on

HEAT SHRINKABLE TERMINATION AND JOINT ACCESSORIES FOR THREE-CORE POWER CABLES

ELCOTERM TIS 2482

Types: **ELCOTERM GLS 2475**

ELCOTERM TES 2484

Applicant:
ELCON MEGARAD SpA
Via Nazionale 110, Zona Industriale
83030 Arcella (AV) - ITALY

Inspection Body: TÜV Thüringen - Industrial Services

Inspection date:	Previous inspection date:
07-08/09/2017	03÷06/10/2016

Inspector: Dipl.-Ing. Justo Moreno

Assessment location/ inspection location:
High Voltage Laboratory – ELCON MEGARAD Headquarter

REVISIONS

Revision	Date	Description
0	29/09/2017	Official

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1. REFERENCES – CODES AND STANDARDS

[1] CENELEC HD 629.1 S2:2006 + A1:2008
Test requirements on accessories for use on power cables of rated voltage from 3,6/6 (7,2) kV up to 20,8/36 (42) kV. Part 1: Cables with extruded insulation

[2] Standard CEI EN 61442:2005
Test methods for accessories for power cables with rated voltages from 6 kV (Um = 7,2 kV) up to 36 kV (Um = 42 kV)

2. REVIEW RELATED DOCUMENTS

[A]	ELCON MEGARAD Test Report No.:	512A_17
[B]	Drawings	
	ELCOTERM TIS 2482	844
	ELCOTERM GLS 2475	846
	ELCOTERM TES 2484	834

3. PURCHASE REFERENCE

Not applicable

4. MANUFACTURER

ELCON MEGARAD S.p.A.
Via Nazionale 110, Zona Industriale
83030 Arcella (AV) - ITALY

5. ASSESSMENT PURPOSE	REFERENCE TO THE STANDARD REQUIREMENTS
☒ Pre-inspection meeting in order to plan the arrangement of type test reports as required in tender specification	Identification and stamping of test samples acc. to tender specification. Start of cycling tests acc. to Clauses of the standard EN 61442
☒ Visual examination, checks	Compliance will be obtained by testing acc. to Table 5 test sequence B1-I
☒ **Witnessing tests**	Tests performed in the sequence given in Table 5: Clauses: 4, 5, 6, 7 and 9 (in air)
☐ Manufacturing progress status	Not applicable due to this is a pre-shipment qualification
☒ Final inspection. Examination	Review and approval of load cycling test results (Clause 5). Clause 3
☒ Components check, Marking and labelling	Compliance of components and installation instructions. Clause 3

6. DESCRIPTION AND INSPECTION NOTE

6.1 – *INSPECTION PURPOSE*

Inspection purpose is to validate and approve the arrangement and carrying out of type tests on accessories for 3-core 22kV extruded power cables as specified in the standard CENELEC HD 629 HD 6291 S2 and in the standard CEI EN 61442.

The HV Laboratory of ELCON MEGARAD commissioned us to assist and to witness the performing of each test contained in Table 3 of the standard and provide the attestation that the requirements were met.

The test station structure used for the tests is the Laboratorio Alta Tensione of ELCON MEGARAD at Arcella –Headquarter, which operates under the dispositions of the Manual related to the certified Quality Assurance System implement by the Group.

Instruments and test appliances used are subjected to control and calibration procedures as established in the Manual. (See also point 6.5).

6.2 – *GENERAL PROGRESS OF THE SUPPLY*

Not applicable due to the fact that this is a qualification.

6.3 – *EMPLOYED DOCUMENTS*

- Standard CENELEC HD 629.1 S2 (2006-02) + A1 (2008-09)
- EN 61442: 2005
- Elcon Megarad Test Report No. 459A_16
- Elcon Megarad Instructions for assembling with description of examination objects, as detailed on Section 2.

6.4 – *INSPECTION TASKS, TEST AND RESULTS*

In order to produce written reports on type tests proving compliance with the above mentioned standard for branch joints and terminals had been planned following assessment sequence:

- 03 up to 06 October 2016 – Kick-off Meeting with identification and stamping of test samples. Assembling of samples in the manner specified in the manufacturer's instructions.
  Test arrangements as shown in the five test loops: #1, #2, #3, #4 and #5.
  Carrying out of impulse test, DC/AC voltage dry withstand; partial discharge at ambient temperature and impulse voltage at elevated temperature
- From 30 October up to 25 November 2016 – Heating cycling tests on the samples of terminations (indoor and outdoor) and of joints.
- 10 November 2016 – Thermal short circuit tests (screen and conductor) by SVEPPI-SIEMENS Laboratory; Test Report No. RP LS 16/194.
- From 12 up to 16 December 2016 –Immersion test only for outdoor terminations.
- From 15 March to up 26 April 2017 – Salt fog test closed. Humidity test for indoor terminations.
- From 07 to up 08 September 2017 – AC partial discharge test and impulse voltage test at ambient temperature. Partial discharge test at elevated temperature. A.C. voltage dry withstand test on short circuit tested sample. Test results final examination. Documentation review.

  Visual examination on the tested samples to ascertain whether any damage (cracking of filling media, moisture paths, corrosion effects, leakages) has taken place.

TEST RESULTS

The sampling at 03/10/2016 has been carried out according to the Elcon Megarad internal procedure.

The dimensions of the tested samples were found in compliance with those indicated in the installation instructions supplied by the manufacturer (Section 6.3 of this report)
For the general test sequence were installed five samples

- Joint ELCOTERM GLS-2475; terminations ELCOTERM TIS-2482 and TES-2484:
  3 test loops acc. to schemas Loop #1, loop #2, loop #3
- Termination ELCOTERM TIS-2482 and termination ELCOTERM TES-2484:
  2 test loops acc. to schemas *loop #4, loop #5*

On page 3 of the test report 512A_17 is further described the into the loops assembled cable type:
12/20 kV, Al/S.C/XLPE/S.C/Cu, with cross-section 3 x 240mm^2

Standard EN 61442 – Clauses **Test condition**		**Test result**
5 DC voltage dry withstand 15 min. at **76 kV**	W	No breakdowns occurred on the three test loops
4 AC voltage dry withstand 5 min. at **57 kV**	W	No breakdowns occurred on the three test loops
4 AC voltage wet withstand (outdoor terminations) 1 min. at **51 kV**	W	No breakdowns occurred on the two test loops
7 Partial discharge at **18°C** **22 kV** **25 kV**	W	Loop #1: 1,73U_o -> 3,7pC; 2U_o -> 3,8pC — Loop #2: 1,73U_o -> 3,8pC; 2U_o -> 4,1pC Measurement device calibrated to 10 pC. Measured rates, for each loop and each phase, always less than the max. required
14 Impact test on the joint at 23°C. Three impacts on area of connector: first in the middle and once in the both sealing areas	W	Insulation resistance measurement between conductor and metallic screen. Insulation resistance in air before impact > 51 GΩ. After impacts measurement on joint immersed in H_2O Phase 1 >51 GΩ | Phase 2 >51 GΩ | Phase 3 >51 GΩ
6 Impulse voltage withstand at 95°C 10 impulses of each polarity at **125 kV**	W	No flashovers or breakdowns occurred on the two test loops #1 and #2
9 Heating cycle test in water – only for joint 63 cycles at **95°C** ($T_{conductor}$) **32 kV**	R	No breakdowns occurred on the two test loops
9 Heating cycle test in air at **32 kV** 63 cycles for the joint 126 cycles for terminations	R	No breakdowns occurred on the two test loops
9.4 Immersion test for outdoor terminations 10 8h-cycles: 5h heating ON at 108A; 3h heating OFF with natural cooling at 23°C.	R	During the cooling period, the conductor keeps a value of temperature 5-10K above the ambient temperature 23°C.
7 Partial discharge at **95°C** ($T_{conductor}$) **22 kV** **25 kV**	W	Loop #1: 1,73U_o -> 0,4 pC; 2U_o -> 0,1 pC — Loop #2: 1,73U_o -> 3,8 pC; 2U_o -> 4,5 pC Measurement device calibrated to 10 pC. Measured rates, for each loop and each phase, always less than the max. required
7 Partial discharge at **26°C** **22 kV** **25 kV**	W	Loop #1: 1,73U_o -> 0,5 pC; 2U_o -> 1,0 pC — Loop #2: 1,73U_o -> 0,4 pC; 2U_o -> 0,6 pC Measurement device calibrated to 10 pC. Measured rates, for each loop and each phase, always less than the max. required

Standard EN 61442 – Clauses Test condition		Test result
10 Thermal short circuit test at **8 kA** 2 short-circuits of 1 s duration, applied to the screen. Performed by SVEPPI	R	No visible damage on the test loop #3
11 Thermal short circuit test at **31,5 kA** two short-circuits of 0,915 s duration, applied to the conductor. Performed by SVEPPI-SIEMENS	R	No visible damage on the test loop #3
6 Impulse voltage withstand at 26°C 10 pulses of each polarity at **125 kV**	W	No flashovers or breakdowns occurred on the test loops #1, #2 and #3
4 AC voltage dry withstand 15 min. at **32 kV**	W	No breakdowns occurred on the two test loops #1, #2 and #3
13 Humidity test for indoor terminations 300h at **16 kV**	R	• No flashovers or breakdowns occurred. • No damages that might compromise the functionality of the terminations was observed. • No evidence of dielectric property loss due tracking was detected. • No other anomalies (splitting or puncture of the material) were observed on the test loop #4
13 Salt fog test for outdoor terminations 1000h at **16 kV**; water conductivity 1560mS/m, water pressure 4,5 bar. Test box volume: 25,2 m^3	R	• No flashovers or breakdowns occurred. • No damages that might compromise the functionality of the termination under test was observed. • No evidence of dielectric property loss due tracking was detected. • Light erosion effects on the no-tracking tube (less than 2mm) was detected. • No other anomalies (splitting or puncture of the material) were observed on the test loop #5
Examination	W	Test loops: **#1, #2, #3, #4 and #5** • Joint and terminations passed the test. • No cracking in the filling media and/or tape or tube components. • No moisture path bridging a primary seal. • No corrosion and/or tracking and/or erosion. • No leakage of any insulation material.

R = Review / W = Witness

6.5 – EMPLOYED TEST INSTRUMENTS AND CALIBRATION

Measuring instruments used					
INSTRUMENT	**MATR.**	**Manufacturer**	**next calibration date**	**FREQUENCY**	**SUPPLIER'S CODE**
DC power supply unit	AT 211	PHOENIX POWER	12/04/2022	5 years	Reg.No. 14-8928
Power supply for dielectric test – area 2	AT 228	AME	18/04/2018		Reg.No.:2334
Power supply for dielectric test – area 3	AT 213	AME	13/04/2022		Reg.No.:2333
Power supply for thermal cycle test. Area 1	AT 302	SPECIAL TRASFO	17/04/2018		- - -
Digital multimeter Data logger	AT 229	AGILENT	11/09/2019 28/01(2022		MY53205896 MY49022503
Impulse voltage recorder	AT 226	DR. STRAUSS	06/04/2022		TR-AS 100-12
Ohmic capacitive divider	AT 169	HAEFELY			99100314.1

Completed list of instruments is attached on ELCON MEGARAD Test Report 512A-17

6.6 – ATTACHMENTS

1. Laboratory Test Report No.: 512A_17
2. Instructions for assembling No. 844, 846 and No. 834

7. CONCLUSIONS AND REQUIRED ACTIONS

Having assessed the reported results, we declare that these are compliant with the standard requirements of CENELEC HD 629.1 S2:2006 + A1:2008.

This standard specifies performance requirements for type tests for cable accessories for use on extruded isolation power cables as specified in HD 620.

Location: Milan **Date:** 2017-09-29

Manufacture Certifications TÜV Thüringen Group Plant Inspection

Dipl.-Ing. Justo Moreno
TÜV THÜRINGEN INSPECTOR

TEST REPORT

N° 512A_17

TÜV Thüringen Italia
☒ Reviewed ☐ Witnessed
Inspector:
08.09.2017

LABORATORIO ALTA TENSIONE - HIGH VOLTAGE LABORATORY
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Prepared by: Francesco Lombardo

Approved by: Generoso De Simone

Manufacture Certification TÜV Thüringen Italia TTI-010 Electrical Equipment

Report n°:	495_17	**Date:** 19/07/2017
Customer:	**ELCON MEGARAD S.p.A.**	
Place:	ELCON MEGARAD S.p.a. - H.V. Laboratory – Via Nazionale, 110 Arcella (AV) ITALY	
Testing date:	03/10/2016 - 08/09/2017	
	Type:	**Drawing**
OBJECTS:	**ELCOTERM TIS 2482** **ELCOTERM GLS 2475** **ELCOTERM TES 2484**	844 846 834
DESCRIPTION:	**THREE CORE HEATSHRINK INTERNAL TERMINATION, STRAIGHT JOINT AND EXTERNAL TERMINATION**	
VOLTAGE:	U_0/U = 12,7/22kV (U_{max} 24kV)	
CABLE MARKING AND CROSS SECTION:	3x240mm² 12/20kV "M 5A3B 3*240//EDL-SP" AL/S.C/XLPE/S.C/Cu tape/PVC/BSTA/PVC- Medium voltage armored cable 3x240 mm²	
REFERENCE STANDARD: TEST METHODS:	CENELEC HD 629-1 S2 :2006 +A1: 2008 EN 61442 (2005)	
RESULTS:	**The tested objects are in accordance with the reference Standards.**	
ELCON MEGARAD Test operators:	Mr. Francesco Lombardo	Lombardo
H.V. Lab. Responsible:	Mr. Generoso De Simone	
TUV Inspector:	Eng. Justo Moreno	
This report consist of:	13 pages	
Attachments:		//
NOTE: *The test results can be applied only to the tested objects.*		

Elcon Megarad
Operator
Lombardo

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TÜV

COMPONENTS CONTROL
ACCESSORIES ASSEMBLING CONTROL

THE COMPONENTS CONTAINED IN THE PACKAGING, AND MENTIONED IN THE BILL OF MATERIAL OF THE DRAWING HAVE BEEN IDENTIFIED AND IN GOOD STATE

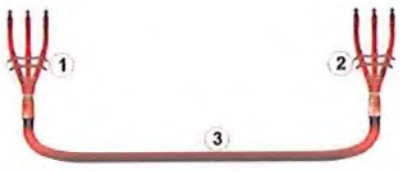
- N° 5 MEDIUM VOLTAGE SINGLE CORE CABLE LINES HAVE BEEN ASSEMBLED BY ELCON MEGARAD OPERATOR, WITH ACCESSORIES ACCORDING TO THE INSTALLATION INSTRUCTION AS FOLLOWS:

COMPOSITION OF THE SINGLE CORE CABLE LINE

Loop	Indoor termination	Joint	Outdoor Termination	Cable
LOOP #1	② ELCOTERM TIS 2482	④ ELCOTERM GLS 2475	① ELCOTERM TES 2484	③ 3x240mm² 12/20kV AL/S.C/XLPE /S.C/Cu tape/PVC/BS TA/PVC
LOOP #2	② ELCOTERM TIS 2482	④ ELCOTERM GLS 2475	① ELCOTERM TES 2484	
LOOP #3	② ELCOTERM TIS 2482	④ ELCOTERM GLS 2475	① ELCOTERM TES 2484	
LOOP #4	①, ② ELCOTERM TIS 2482	-	-	
LOOP #5	-	-	①, ② ELCOTERM TES 2484	

LOOP #1, #2, #3

LOOP #4



LOOP #5

indicative scheme of the 3-core cable loops

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TEST SEQUENCE

CENELEC HD 629.1 S2:2006 + A1:2008 TABLE 5 TEST SEQUENCE B1-I
CENELEC EN 61442: 2005 - 04

N°	TEST	TEST REQUIREMENTS	Test Voltage [kV]
01	D.C. voltage dry withstand	15 minutes at $6U_0$	76
02	A.C. voltage dry withstand	5 minutes at $4,5U_0$	57
03	A.C. voltage wet withstand	1 minutes at $4U_0$	51
04	Partial discharge at ambient temperature	Max 10pC at $1,73U_0$ / $2U_0$	22/25
05	Impact at ambient temperature	Insulation resistance: - Conductor to screen 10^3 MΩ minimum - Screen to water 50 MΩ minimum	-
06	Impulse voltage at elevated temperature	10 impulses of each polarity	125
07	Heating cycle voltage in air	63 cycles at $2,5U_0$	32
08	Heating cycle voltage in water	63 cycles at $2,5U_0$	32
09	Immersion	10 cycles	-
10	Partial discharge at elevated temperature	Max 10pC at $1,73U_0$ / $2U_0$	22/25
11	Partial discharge at ambient temperature	Max 10pC at $1,73U_0$ / $2U_0$	22/25
12	Thermal short circuit (screen)	8 kA; 1 s	-
13	Thermal short circuit (conductor)	31.5 kA; 0,915 s	-
14	Impulse voltage at ambient temperature	10 impulses of each polarity	125
15	A.C. voltage dry withstand	15 minutes at $2,5U_0$	32
16	Humidity	300 h duration at 1,25 Uo	16
17	Salt Fog	1 000 h duration at 1,25 Uo	16
	Examination	For information only	---

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TESTS RESULTS

TEST 01	D.C. voltage dry withstand 15 minutes at $6U_0$ (clause 5 of EN 61442)			
OK	**LOOP:**	**LOOP - #1**	**LOOP - #2**	**LOOP - #3**
	Applied Voltage [kV]:	**76**	**76**	**76**
	Testing time [min]:	**15**	**15**	**15**
	RESULT:	**No flashovers or breakdowns**	**No flashovers or breakdowns**	**No flashovers or breakdowns**
	Note: The DC test has been performed on each line with a negative polarity DC generator.		Date: 03/10/2016	
	Measuring Test Equipment : AT 241			

TEST 02	A.C. voltage dry withstand 5 minutes at $4,5U_0$(clause 4 of EN 61442)			
OK	**LOOP:**	**LOOP - #1**	**LOOP - #2**	**LOOP - #3**
	Applied Voltage [kV]:	**57**	**57**	**57**
	Testing time [min]:	**5**	**5**	**5**
	RESULT:	**No flashovers or breakdowns**	**No flashovers or breakdowns**	**No flashovers or breakdowns**
	Note: The AC test has been performed on each line with AC HV transformer.		Date: 03/10/2016	
	Measuring Test Equipment : AT 213			

TEST 03	A.C. voltage wet withstand 1 minute at 4 U_0 (clause 4 of EN 61442)		
OK	**LOOP:**	**LOOP - #1 only outdoor termination**	**LOOP - #2 only outdoor termination**
	Applied Voltage:	**51 kV**	
	Testing time:	**1 min**	
	Rain Parameters	Precipitation condition Vertical: 1,2 mm/min Horizontal: 1,6 mm/min	Resistivity of the water : >100 Ω m Temperature of the water: 23°C
	RESULT:	**No flashovers or breakdowns**	
	Note: The test has been performed, on all phases together, of the cable loops at ambient temperature (21°C).		Date: 03/10/2016
	Measuring Test Equipment : AT 228		

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TEST 04	Partial discharge at ambient temperature Max 10pC at 1,73U_0 (clause 7 of EN 61442)		
OK	**LOOP:**	**LOOP - #1**	**LOOP - #2**
	Applied Voltage [kV]:	**22**	**22**
	Test Temperature [°C]	**18**	**18**
	Partial discharge level [pC]	**3,7**	**3,8**
	Applied Voltage [kV]:	**25***	**25***
	Partial discharge level [pC]	**3,8**	**4,1**
	RESULT:	**Partial discharge measurement, referring to 2 steps above mentioned is always less than the maximum required.**	
	Note: The PD measurement has been performed,, on the cable line at ambient temperature. The PD measurement device has been calibrated to 10pC. * = measurement at $2U_0$		Date: 04/10/2016
	Measuring Test Equipment calibrated before the test with AT219		

TEST 05	Impact at ambient temperature (clause 14 of EN 61442) and insulation resistance measurement between conductor and metallic screen						
OK	**LOOP:**	**LOOP #1**			**LOOP #2**		
	Phase	1	2	3	1	2	3
	Measurement of Insulation resistance in air	>51 GΩ	>51 GΩ	>51 GΩ	>51 GΩ	>51 GΩ	>51 GΩ
	IMPACT	The Test has been performed applying, with a 4kg mass form an height of 1 m, n° 3 impacts on the joints, the first in the middle of connector area, the second in the right sealing and the third in the left sealing.					
	IMMERSION	After the impact test the joints were immersed in water at ambient temperature with a height of water of 1,00 m over the top surface of the joint for 3 hours					
	Phase	1	2	3	1	2	3
	Measurement of Insulation resistance in water	>51 GΩ	>51 GΩ	>51 GΩ	>51 GΩ	>51 GΩ	>51 GΩ
	RESULT:	**The joints passed the test**					
	Note:				Date: 05/10/2016		

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TEST 06	Impulse voltage at elevated temperature 10 impulses for each polarity(clause 6 of EN 61442)																			
OK	Applied Voltage [kV]	125																		
		Positive Polarity										Negative Polarity								
	Temperature on the sheath	65°C (equivalent to 95°C on the conductor)										65°C (equivalent to 95°C on the conductor)								
	LOOP - #1	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	LOOP - #2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	RESULT:	No flashovers or breakdowns										No flashovers or breakdowns								
	Note: T_{amb}= 20 ° C, P = 1040 hPa Hr = 60 %.											Date: 05/10/2016								
	Measuring Test Equipment : AT 169, AT 226																			

TEST 07	Heating Cycles voltage in air (clause 9 of EN 61442)		
OK	LOOP:	LOOP - #1	LOOP - #2
	Test Voltage [kV]	32	
	Number of cycles [n]:	63 for the Joint 126 for the indoor and outdoor termination	
	Reference Temperature on the sheath [°C]	65° C (equivalent to 95° C on the conductor)	
	RESULT:	No Failure	No Failure
	Note: Each heating cycle is completed in 8h and it is carried out in 5h of heating ON with injection of the loading current and 3h heating OFF, with natural cooling of the cable until ambient temperature. During the heating time, the cable conductor keeps a value of temperature 5-10K above the maximum cable conductor temperature for at least 2 hours.		Date: 06/10/2016 ÷ 25/11/2016
	Measuring Test Equipment : AT 302, AT 236, AT 185, AT 186, AT 187, AT188		

TEST 08	Heating Cycles voltage in water (clause 9 of EN 61442)		
OK	LOOP:	LOOP - #1 – only the Joint	LOOP - #2 – only the Joint
	Test Voltage [kV]	32	
	Number of cycles [n]:	63	
	Reference Temperature on the sheath [°C]	65° C (equivalent to 95° C on the conductor)	
	RESULT:	No Failure	No Failure
	Note: Each heating cycle is completed in 8h and it is carried out in 5h of heating ON with injection of the loading current and 3h heating OFF, with natural cooling of the cable until ambient temperature. During the heating time, the cable conductor keeps a value of temperature 5-10K above the maximum cable conductor temperature for at least 2 hours.		Date: 30/1/2016 ÷ 25/11/2016
	Measuring Test Equipment : AT 302, AT 236, AT 185, AT 186, AT 187, AT188		

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TEST 09	Immersion (clause 9.4 of EN 61442)		
OK	LOOP:	LOOP - #1 – only the Outdoor Termination	LOOP - #2 – only the Outdoor Termination
	Number of cycles [n]:	10	
	Reference Temperature on the sheath [°C]	65° C (equivalent to 95° C on the conductor)	
	RESULT:	No Failure	No Failure
	Note: Each heating cycle is completed in 8h and it is carried out in 5h of heating ON with injection of the loading current and 3h heating OFF, with natural cooling of the cable until ambient temperature. During the heating time, the cable conductor keeps a value of temperature 5-10K above the maximum cable conductor temperature for at least 2 hours.	Date: 12/12/2016 ÷ 16/12/2016	
	Measuring Test Equipment : AT 302, AT 236, AT 185, AT 186, AT 187, AT188		

TEST 10	Partial discharge at elevated temperature Max 10pC at 1,73U_0 (clause 7 of EN 61442)		
OK	LOOP:	LOOP - #1	LOOP - #2
	Applied Voltage [kV]:	22	22
	Test Temperature [°C]	65°C (equivalent to 95°C on the conductor)	
	Partial discharge level [pC]	0.4	3.8
	Applied Voltage [kV]:	25*	25*
	Partial discharge level [pC]	1.0	4.5
	RESULT:	Partial discharge measurement, referring to 2 steps above mentioned is always less than the maximum required.	
	Note: The PD measurement device has been calibrated to 10pC. * = measurement at $2U_0$	Date: 07/09/2017	
	Measuring Test Equipment calibrated before the test with AT219		

TEST 11	Partial discharge at ambient temperature Max 10pC at 1,73U_0 (clause 7 of EN 61442)		
OK	LOOP:	LOOP - #1	LOOP - #2
	Applied Voltage [kV]:	22	22
	Test Temperature [°C]	26	26
	Partial discharge level [pC]	0.5	0.4
	Applied Voltage [kV]:	25*	25*
	Partial discharge level [pC]	1.0	0.6
	RESULT:	Partial discharge measurement, referring to 2 steps above mentioned is always less than the maximum required.	
	Note: The PD measurement device has been calibrated to 10pC. * = measurement at $2U_0$	Date: 07/09/2017	
	Measuring Test Equipment calibrated before the test with AT219		

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TEST 12	Thermal short circuit (screen) (clause 10 of EN 61442)		
OK	LOOP:	LOOP - #3	
	Applied current [kA]:	8	
	Testing time [s]:	1	
	RESULT:	No flashovers or breakdowns	
	Note: Test performed at SIEMENS - SVEPPI lab report N° RP LS 16/194	Date:	10/11/2016

TEST 13	Thermal short circuit (conductor) (clause 11 of EN 61442)		
OK	LOOP:	LOOP - #3	
	Applied current [kA]:	31,5	
	Testing time [s]:	0,915	
	RESULT:	No flashovers or breakdowns	
	Note: Test performed at SIEMENS - SVEPPI lab report N° RP LS 16/194	Date:	10/11/2016

TEST 14	Impulse voltage at ambient temperature 10 impulses for each polarity(clause 6 of EN 61442)																			
OK	Applied Voltage [kV]	125																		
		Positive Polarity										Negative Polarity									
	LOOP - #1	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	LOOP - #2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	LOOP - #3	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	RESULT:	No flashovers or breakdowns										No flashovers or breakdowns									
	Note: T_{amb}= 26 ° C, P = 735 mmHg, Hr = 60 %.											Date: 07/09/2017									
	Measuring Test Equipment : AT 169, AT 226																				

TEST 15	A.C. voltage dry withstand 15 minutes at 2,5U_0(clause 4 of EN 61442)			
OK	LOOP:	LOOP - #1	LOOP - #2	LOOP - #3
	Applied Voltage [kV]:	32	32	32
	Testing time [min]:	15	15	15
	RESULT:	No flashovers or breakdowns	No flashovers or breakdowns	No flashovers or breakdowns
	Note: The AC test has been performed on each line with AC HV transformer.		Date:	08/09/2017
	Measuring Test Equipment : AT 213			

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TEST 16	Humidity 300h at 1,25U0 (clause 13 of EN 61442)			
OK	LOOP:	LOOP - #4		
	Applied Voltage:	16 kV		
	Testing time:	300 h		
	TEST SPECIFICATION			
	Water pressure:	4,5 bar	Air pressure:	5,1 bar
	Average diameter water drops atomized	10 µm	Conductivity	70 ±10 mS/m
	Water flow rate	10,1 ±2,5 l/h	Air flow rate	34 l/m
	Test Room Volume	25,2 m^3		
	RESULT:	• No breakdowns, no flashovers happened. • No damages that might compromise the functionality of the terminations were observed. • No evidence of dielectric quality loss due to tracking was detected. • No other anomalies (splitting or puncture of the material) were observed. • The sample passes the test		
	Measuring Test Equipment : AT 301, AT 162		Date: 15/03/2017 to 26/04/2017	

TEST 17	Salt Fog test 1000h at 1,25U0 (clause 13 of EN 61442)			
OK	LOOP:	LOOP - #5		
	Applied Voltage:	16 kV		
	Testing time:	1000 h		
	TEST SPECIFICATION			
	Water pressure:	4,5 bar	Air pressure:	5,1 bar
	Average diameter water drops atomized	10 µm	Conductivity	1600 ±200 mS/m
	Water flow rate	10,1 ±2,5 l/h	Air flow rate	34 l/m
	Test Room Volume	25,2 m^3		
	RESULT:	• No breakdowns, no flashovers happened. • No damages that might compromise the functionality of the terminations were observed. • No evidence of dielectric quality loss due to tracking was detected. • No other anomalies (splitting or puncture of the material) were observed. • The sample passes the test		
	Measuring Test Equipment : AT 301, AT 162		Date: 15/05/2017 to 26/06/2017	

	Examination	
OK	LOOP:	LOOP - #1; LOOP - #2; LOOP - #3; LOOP - #4; LOOP - #5
	No anomalies on the earth screen connections are been observed. Cable insulations are in good conditions with no visual presence of electrical activity. No presence of air bubbles in the electric stress control component.	
	Note: ---	Date: 08/09/2017

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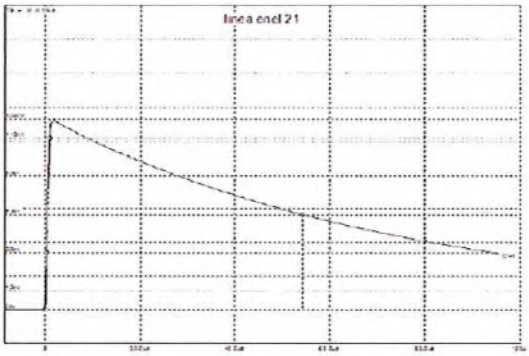
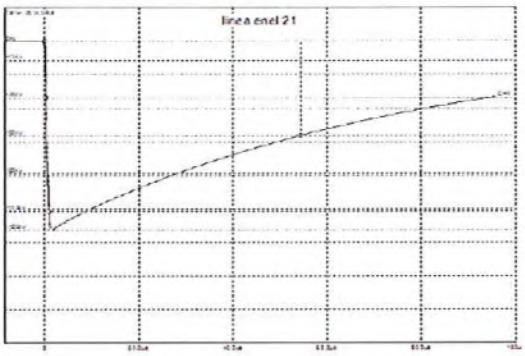
Example of impulse wave shape

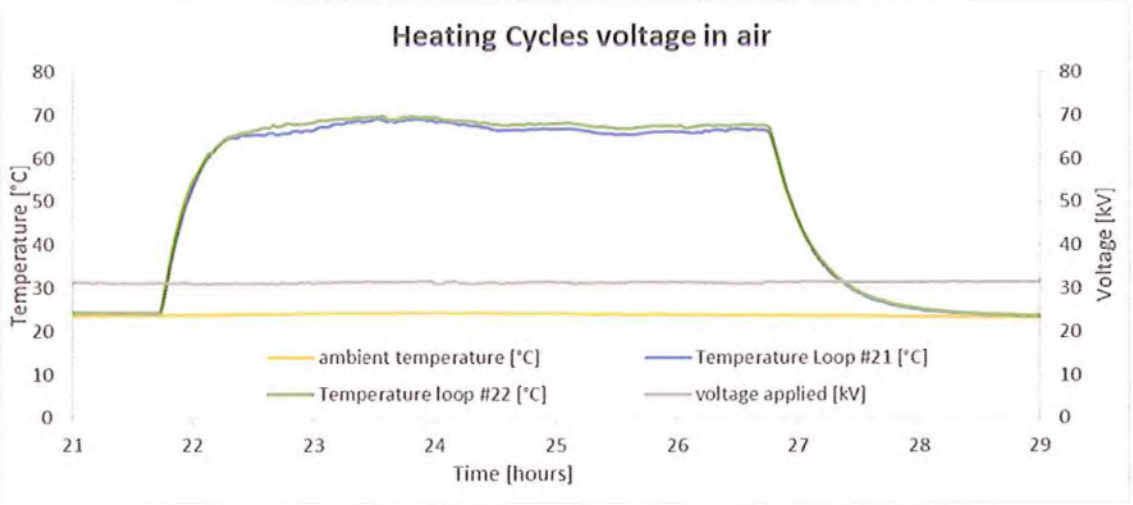
Up[kV]: 125,9 T1[µs]:1,06 T2[µs]: 54,4

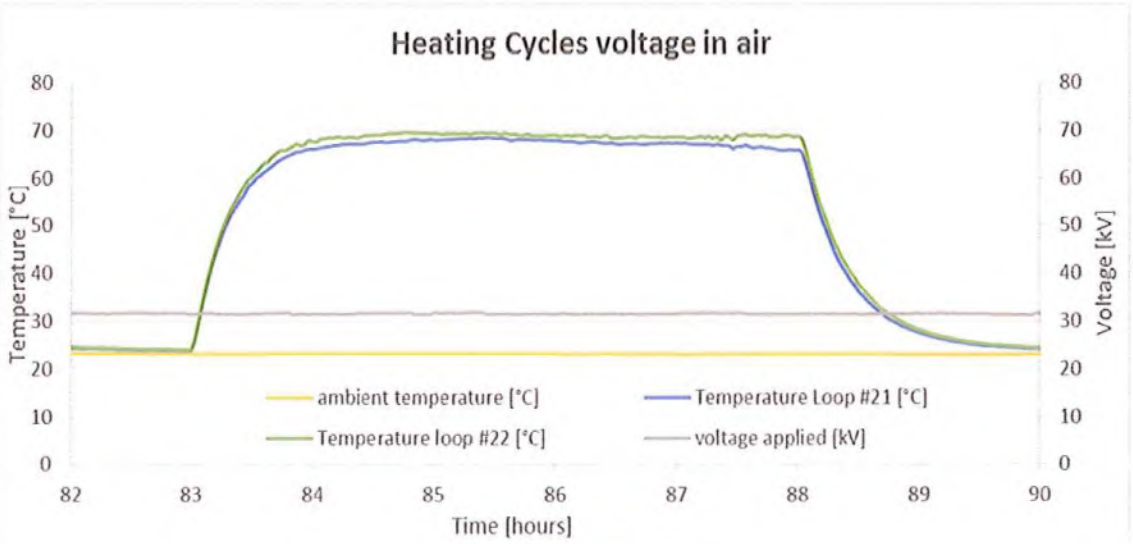


Up[kV]: -125,5 T1[µs]:1,06 T2[µs]:54,4



Example of Heating Cycles voltage diagrams





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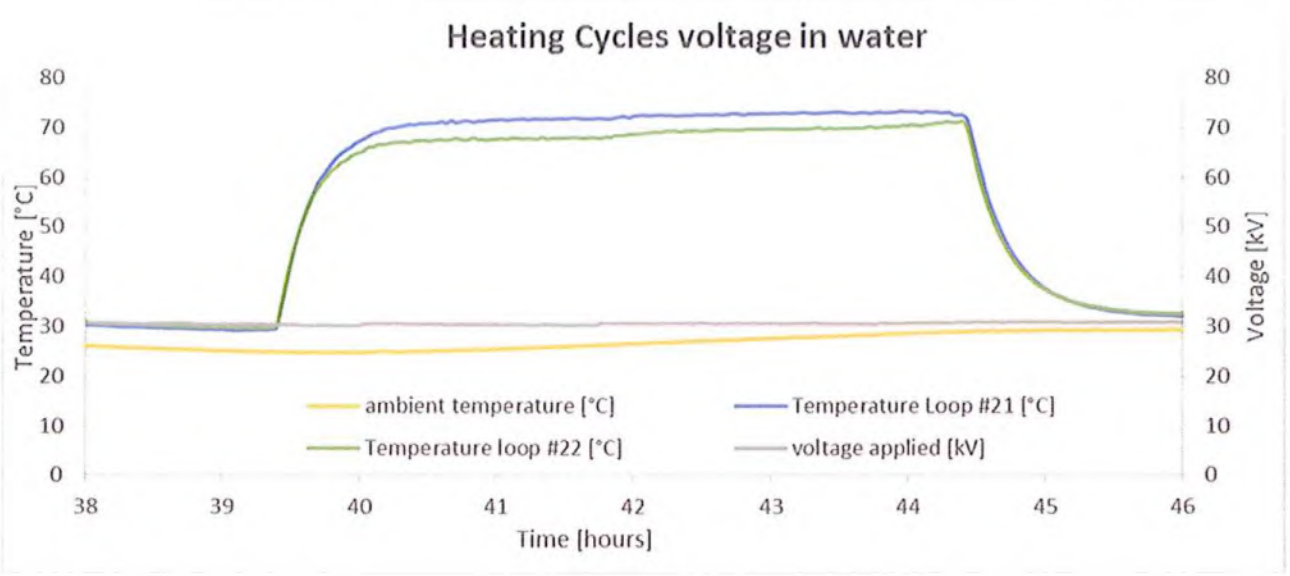

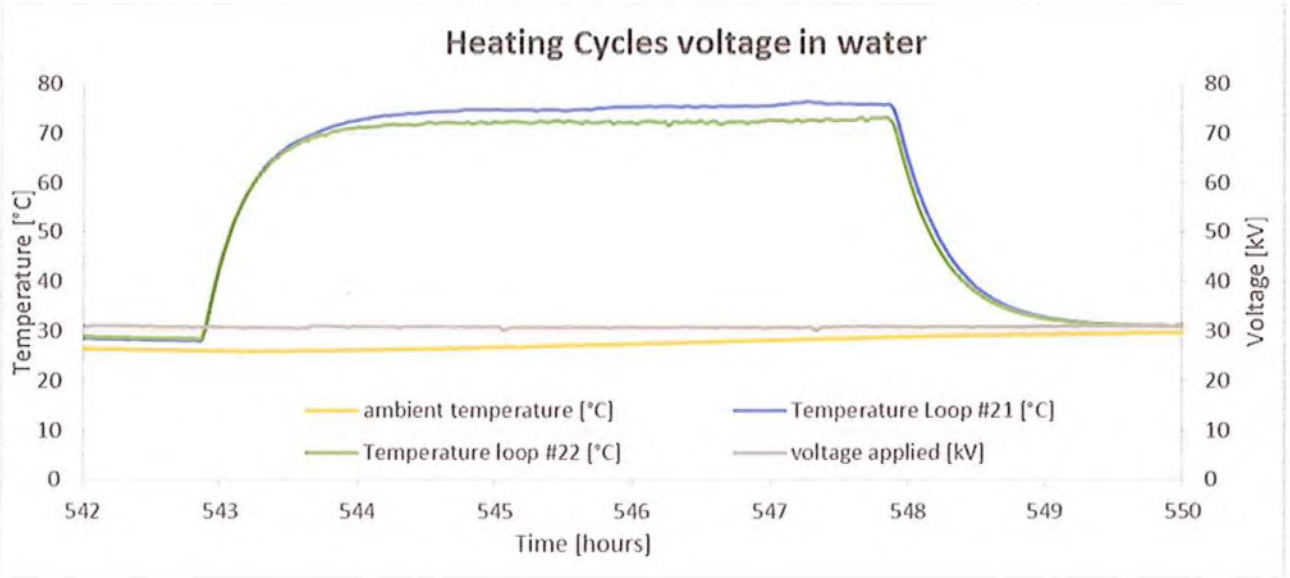

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ELCON MEGARAD LAB AT EQUIPMENT LIST

Description	Manufacturer	Supplier's code	Next calibration	Elcon ID	Accuracy
DC power supply unit	PHENIX POWER	Reg. No. 14-8928	12/04/2022	AT 241	3%
Power supply area No. 2 for dielectric test	AME	Reg. No. 2334	18/04/2018	AT 228	3%
Power supply area No. 3 for dielectric test	AME	Reg. No. 2333	13/04/2022	AT 213	3%
PD calibrator unit CAL542	OMICRON	Reg. No. HH462D	14/03/2022	AT 219	1%
Impulse voltage test technique digital recorder	DR. STRAUSS	Reg. No. TR-AS 100-12	06/04/2022	AT 226	3%
Ohmic capacitive divider	HAEFELY	Reg. No. 99100314.1	06/04/2022	AT 169	3%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 181	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 182	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 183	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 184	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 185	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 186	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 187	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 188	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 189	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 190	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 191	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 192	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 198	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 200	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 201	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 202	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 280	2%
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Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 282	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 283	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 284	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 285	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 286	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 287	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 288	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 289	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 290	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 291	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 292	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 293	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 294	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 295	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 296	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 297	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 298	2%
Thermocouple type "T"	ITALCOPPIE	Not applicable	28/04/2018	AT 299	2%
Digital multimeter	AGILENT	MY53205896	11/09/2019	AT 229	1%
Data logger	AGILENT	MY49022503	28/01/2022		1%
Digital multimeter	AGILENT	MY530205663	10/09/2019	AT 236	1%
Data logger	AGILENT	MY49017680	22/05/2019		1%
Digital multimeter	AGILENT	MY53205871	10/09/2019	AT 214	1%
Data logger	AGILENT	MY49017674	22/05/2019		1%
Digital multimeter	FLUKE	355	07/11/2017	AT 176	3%
Conductivity meter	HANNA INSTRUMENT	Not applicable	06/03/2018	AT 162	2%
Power supply salt fog	SPECIALTRASFO	Not applicable	17/04/2018	AT 301	3%
Power supply area No. 1 for thermal cycle test	SPECIALTRASFO	Not applicable	17/04/2018	AT 302	3%

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LABORATORIO ALTA TENSIONE HIGH VOLTAGE LABORATORY elcon megarad

INSPECTOR

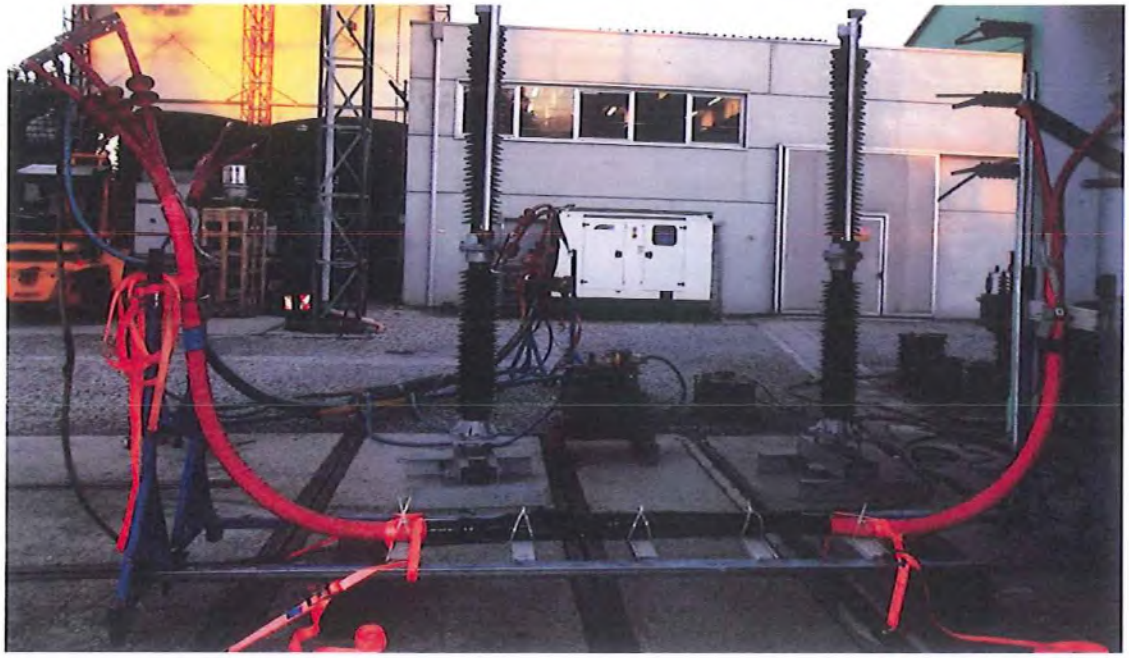
TÜV IT TTI-010

SIEMENS

ACCREDIA
L'ENTE ITALIANO DI ACCREDITAMENTO

LAB N° 0935

SVEPPI
LABORATORY



TEST REPORT

N° RP LS 16/194

SVEPPI LABORATORY	TEST REPORT	SIEMENS
ilac-MRA ACCREDIA L'ENTE ITALIANO DI ACCREDITAMENTO LAB N° 0935	N° RP LS 16/194	PAGE 1 OF 16

CLIENT:	ELCON MEGARAD S.p.A. Via Nazionale, 110 83030- Montefredane (AV) – Loc. Arcella (AV)
DEVICES UNDER TEST:	MV 12,7 kV heat shrink three core cable accessories
TYPES:	ELCOTERM TIS-2482 ELCOTERM TES-2484 ELCOTERM GLS-2475
PURPOSE OF THE TEST:	Type test
TEST PERFORMED ACCORDING TO:	CEI EN 61442: 2006-06 clause 11 - 10
TEST PERFORMED AT:	Power Test Section of SVEPPI Laboratory Via Alessandro Volta, 34/A - 30037 Scorzè (VE) ITALY
LIST OF TESTS PERFORMED:	Thermal short circuit test on main conductor and screen/armour
RECEIPT'S DATE OF TEST OBJECT:	07th November 2016
PERIOD OF TEST:	10th November 2016
TEST WITNESSED BY:	Mr. G. De Simone ELCON MEGARAD

Siemens S.p.A.
Laboratorio SVEPPI

THIS TEST REPORT IS COMPOSED BY:

Nr. total pages 16 Nr. oscillograms 04 Nr. Drawings -

The data necessary to permit repetition of the tests are contained in the document marked "TEST'S DOCUMENTATION" n. LS 16/194.

Issue	Charged of test	Laboratory's Manager
November 2016	*Sandro Samartinaro*	*Giuseppe Canonico*

MANUFACTURER: ELCON MEGARAD S.p.A.
Via Nazionale, 110
83030- Montefredane (AV) – Loc. Arcella (AV)

SERIAL NUMBER OF DEVICE UNDER TEST: Loop 3

The sampling has been carried out by the customer

RATINGS ASSIGNED BY MANUFACTURER OF DEVICE UNDER TEST

Rated voltage U_0/U	12,7/22	**kV**
Maximum system voltage	24	**kV**
Cross section (aluminium)	240	**mm^2**

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1. TESTS PERFORMED

1.1. Thermal short-circuit test on conductor

On the conductors of test loop, were performed two three-phase thermal short-circuit test of 31,5 kA for 0,915 seconds. The test current value is given by the calculation to reach the maximum allowable temperature as described in the standard CEI EN 61442: 2006-06 clause 11 (aluminium conductor). Before first thermal short-circuit test, the test loop was at ambient temperature of 8,5 °C, and before the second short-circuit test, the test loop was at 16,0 °C;

1.2. Thermal short-circuit test on screen/armour

On screen of test loop, were performed two single-phase thermal short-circuit test of 8 kA for 1 second. Before the tests the cables were heated to a stabilized temperature on main conductor of extruded cables of 90°C and kept for two hours at this temperature. The corresponding temperature on sheath at above cable temperature was 65 °C with ambient temperature of 10 °C (to see photo nr. 08). The setting of temperature, was determined by two thermocouples applied in the sheath of the cable, at 0.5 meter of the terminals under test.

2. TEST ARRANGEMENT

2.1. Thermal short-circuit test on conductor

The test loop was formed by three-core cable type 12,7/22 (24) kV-240 mm^2 Al, Indoor Terminations type ELCOTERM TIS-2482/T7, Outdoor Terminations type ELCOTERM TES-2484/T7
and Shrinkable Joints type ELCOTERM GLS-2475/E7. One end of the test cable loop was connected to the power supply, while the other end was short-circuited by means a copper bar. The short-circuit point and the screen/armour of the cable, were connected to earth point. The cable was fixed to the supporting structure by means some anchor systems, positioned at about 2 m from each other (photo nr. 01)

2.2. Thermal short-circuit test on screen/armour

The test loop was formed by three-core cable type 12,7/22 (24) kV -240 mm^2 Al, Screen/Armour. The single phase power supply was applied between the two terminations of the Screen/Armour. The cable was fixed to the supporting structure by means some anchor systems, positioned at about 2 m from each other (and photo nr. 09)

3. OSCILLOGRAM TABLE

Oscillogram Nr.	*Current r.m.s. value [kA]*	*Energy I^2t [(kA)^{2}s]*	*duration [s]*	*Note*
176828	31,5 (*)	906	0,916	Test on conductor
176829	31,6 (*)	910	0,913	Test on conductor
176834	8,2	68	1.014	Test on screen/armour
176835	8,2	68	1.011	Test on screen/armour

(*): mean value on three phases

Note: between the two short-circuits, the test loop shall be allowed to cool to a temperature less than 10 K above its temperature prior to the first short-circuit.

4. CONDITIONS OF TEST OBJECT AFTER TESTS

4.1. Test on conductor

A visual inspection did not show deteriorations (to see also photos nr. 5-6-7).

4.2. Test on screen/armour

A visual inspection did not show deteriorations (to see also photos nr.13-14-15).

MEASUREMENT OF THE RESISTANCES

4.3. Test on conductor

The resistance measurement was carried out at ambient temperature with $100A_{dc}$.

Note		Measured phase			External air temperature
		"1"	"2"	"3"	°C
Before test	Resistance [μΩ]	920,0	909,0	923,0	12,0 ±1,5
After test	Resistance [μΩ]	964,0	879,0	886,5	8,5 ±1,5

5. LIST OF INSTRUMENTS USED

5.1. Short-circuit tests

Quantities	*Symbol used on oscillogram*	*Symbol used on circuit diagram*	*Instrument's tag*	*Uncertainty*
Test current phase R	I_R	I_R	CM 862	±4,5% of the reading
Voltage phase R	U_R	U_R	CM 865V	±3,5% of the reading
Test current phase S	I_S	I_S	CM 863	±4,5% of the reading
Voltage phase S	U_S	U_S	CM 866	±3,5% of the reading
Test current phase T	I_T	I_T	CM 864	±4,5% of the reading
Voltage phase T	U_T	U_T	CM 881	±3,5% of the reading

Note: Expanded uncertainty with coverage factor K=2, confidence level = 95 %

5.2. Measurement of the resistance

Measure	*Symbol used*	*Measure chain tag*	*Uncertainty*
Voltage	-	MU 082	±1% of the reading
Current	-	MI 850	±1,6% of the reading
Resistance	-	-	±2% of the reading

Note: Expanded uncertainty with coverage factor K=2, confidence level = 95 %

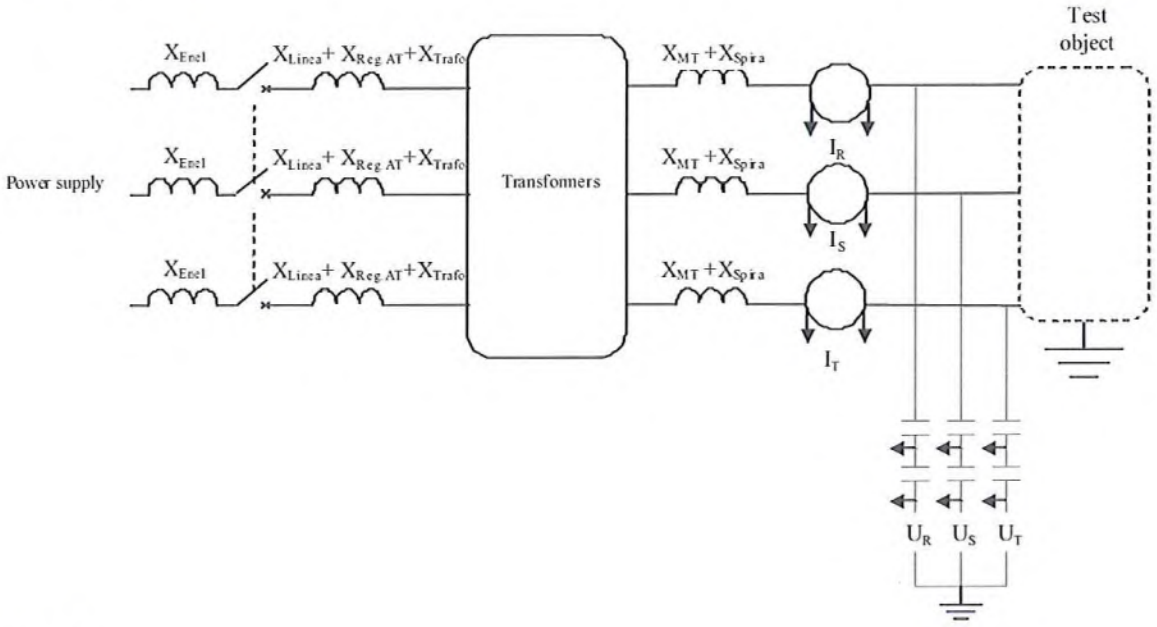
5.3. Measurement of cable temperature

Measure chain tag	*Uncertainty*
TE 015	± 1,8 °C (range 0÷150°C)

Note: Expanded uncertainty with coverage factor K=2, confidence level = 95 %

6. CIRCUIT DIAGRAM

6.1. Test on conductor



Power supply

230 kV 50Hz

Transformers

Primary 132 +66 Star with neutral point (windings)

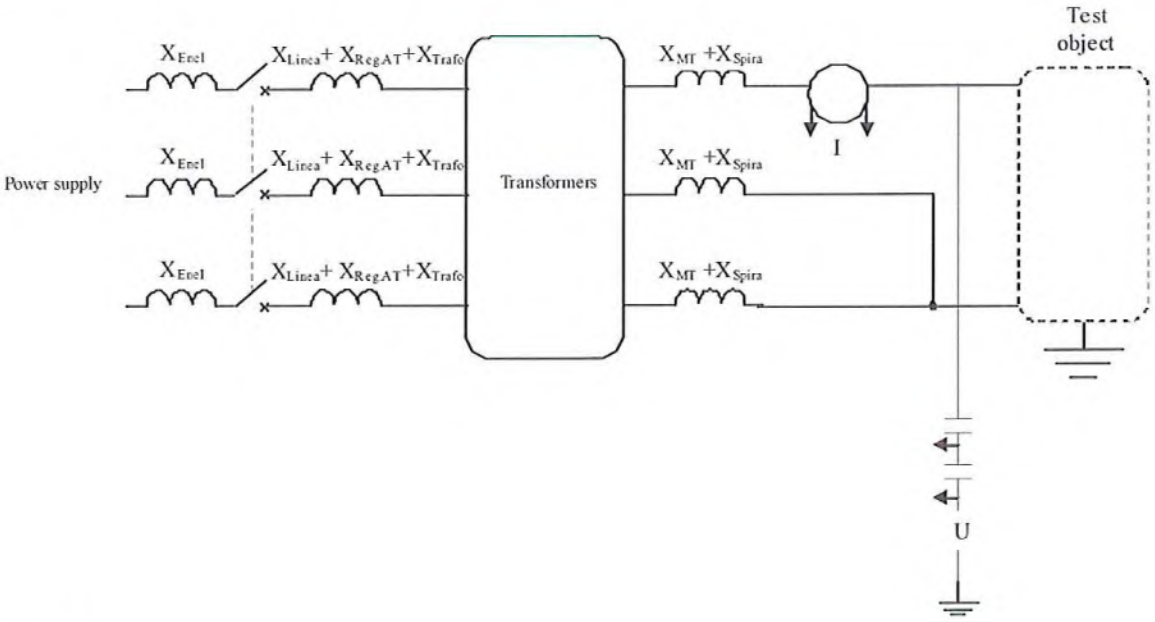
Secondary 11 Triangle (windings)

Ratio 31.18

Test voltage 7.3 kV

X_{Enel} [Ω]	X_{Linea} [Ω]	$X_{Reg.AT}$ [Ω]	X_{Trafo} [Ω]	X_{MT} [Ω]	X_{Spira} [Ω]	Note
5.5	25	6 x 5.2	10.25	0.051	0.010	

6.2. Test on screen/armour



Power supply

230 kV 50Hz

Transformers

Primary 132 +66 Star with neutral point (windings)

Secondary 11 Star (windings)

Ratio 18

Test voltage 12,8 kV

X_{Enel} [Ω]	X_{Linea} [Ω]	$X_{Reg.AT}$ [Ω]	X_{Trafo} [Ω]	X_{MT} [Ω]	X_{Spira} [Ω]	Note
5.5	25	6 x 5.2	10.25	0.648	0.010	

7. PHOTOS

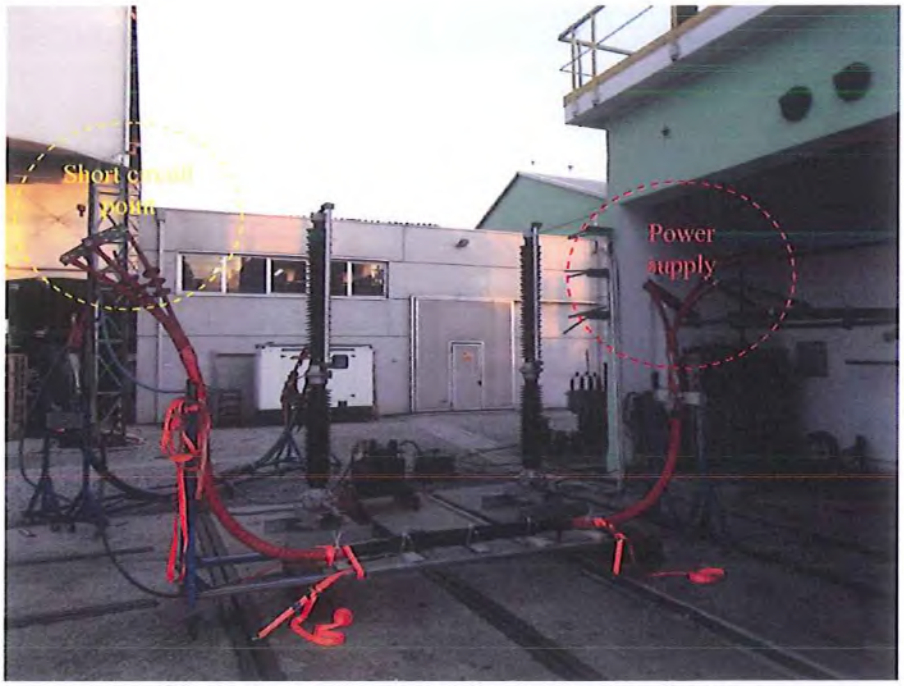


Photo 1: arrangement for test on conductor

Photo 2: before thermal short-circuit tests on conductor (nr. 176828)

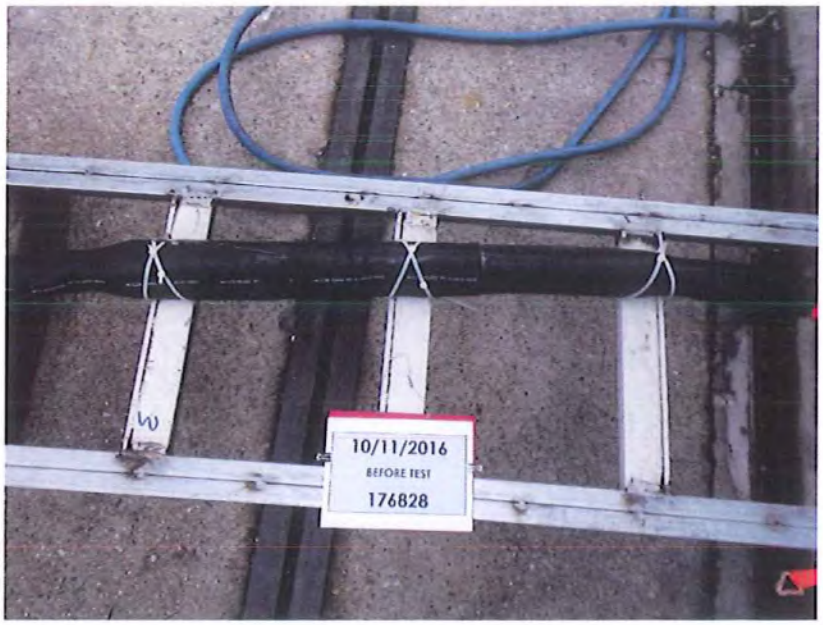


Photo 3: before thermal short-circuit tests on conductor (nr. 176828)

Photo 4: before thermal short-circuit tests on conductor (nr. 176828)

Photo 5: after thermal short-circuit tests on conductor (nr. 176829)

Photo 6: after thermal short-circuit tests on conductor (nr. 176829)

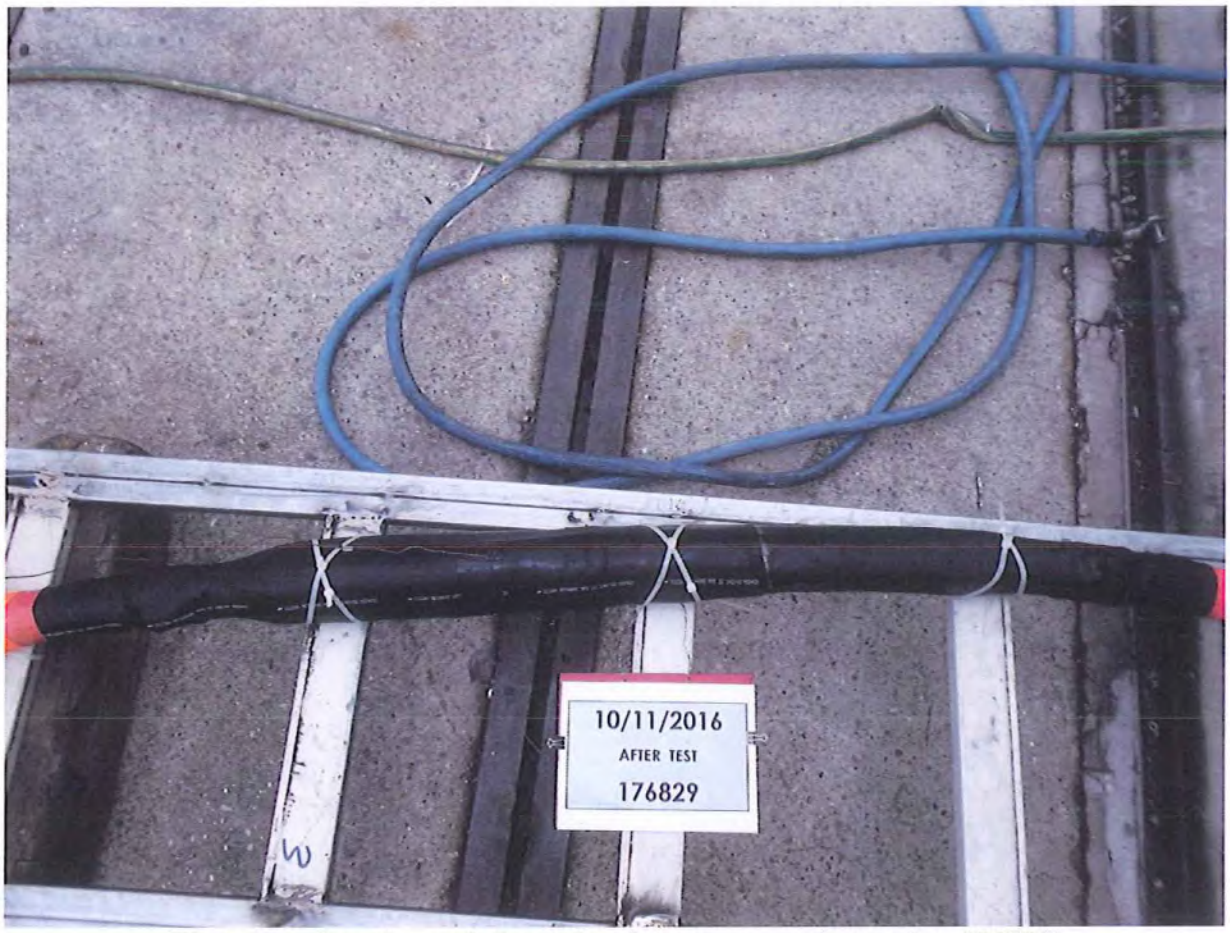


Photo 7: after thermal short-circuit tests on conductor (nr. 176829)

Photo 8: arrangement for heating the test loop

Photo 9: arrangement for test on screen/armour

Photo 10: before thermal short-circuit tests on screen/armour (nr. 176834)

Photo 11: before thermal short-circuit tests on screen/armour (nr. 176834)

Photo 12: before thermal short-circuit tests on screen/armour (nr. 176834)

Photo 13: after thermal short-circuit tests on screen/armour (nr. 176835)

Photo 14: after thermal short-circuit tests on screen/armour (nr. 176835)

Photo 15: after thermal short-circuit tests on screen/armour (nr. 176835)

test current

phase R
R.M.S. value 31.4 kA
peak value 49.6 kA

phase S
R.M.S. value 31.3 kA
peak value 56.6 kA

phase T
R.M.S. value 31.7 kA
peak value 63.5 kA

mean value 31.5 kA

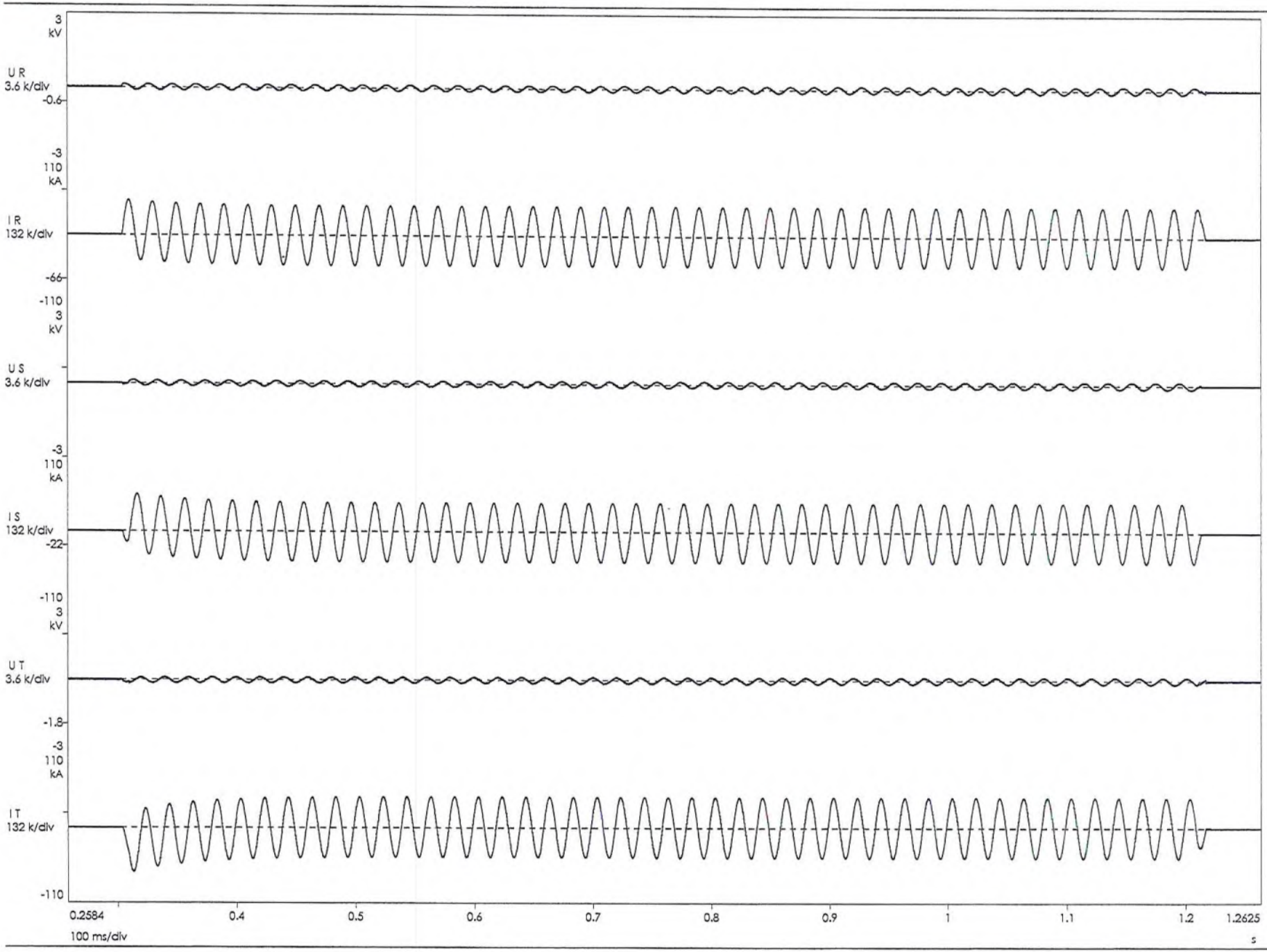
duration 0.916 s

I^2t 906 $(kA)^2s$

Note

Sampling : B1= 60.0 kHz
Bandwith (-1 dB) : $U_{R,S,T}$ = 1.00 kHz ; $I_{R,S,T}$ = 1.00 kHz

test date 10/11/2016 time 11.09.02 - Test report no. RP-LS-16/194 - Test no. 00176828



test current

phase R
R.M.S. value 31.5 kA
peak value 52.1 kA

phase S
R.M.S. value 31.4 kA
peak value 55.9 kA

phase T
R.M.S. value 31.8 kA
peak value 64.9 kA

mean value 31.6 kA

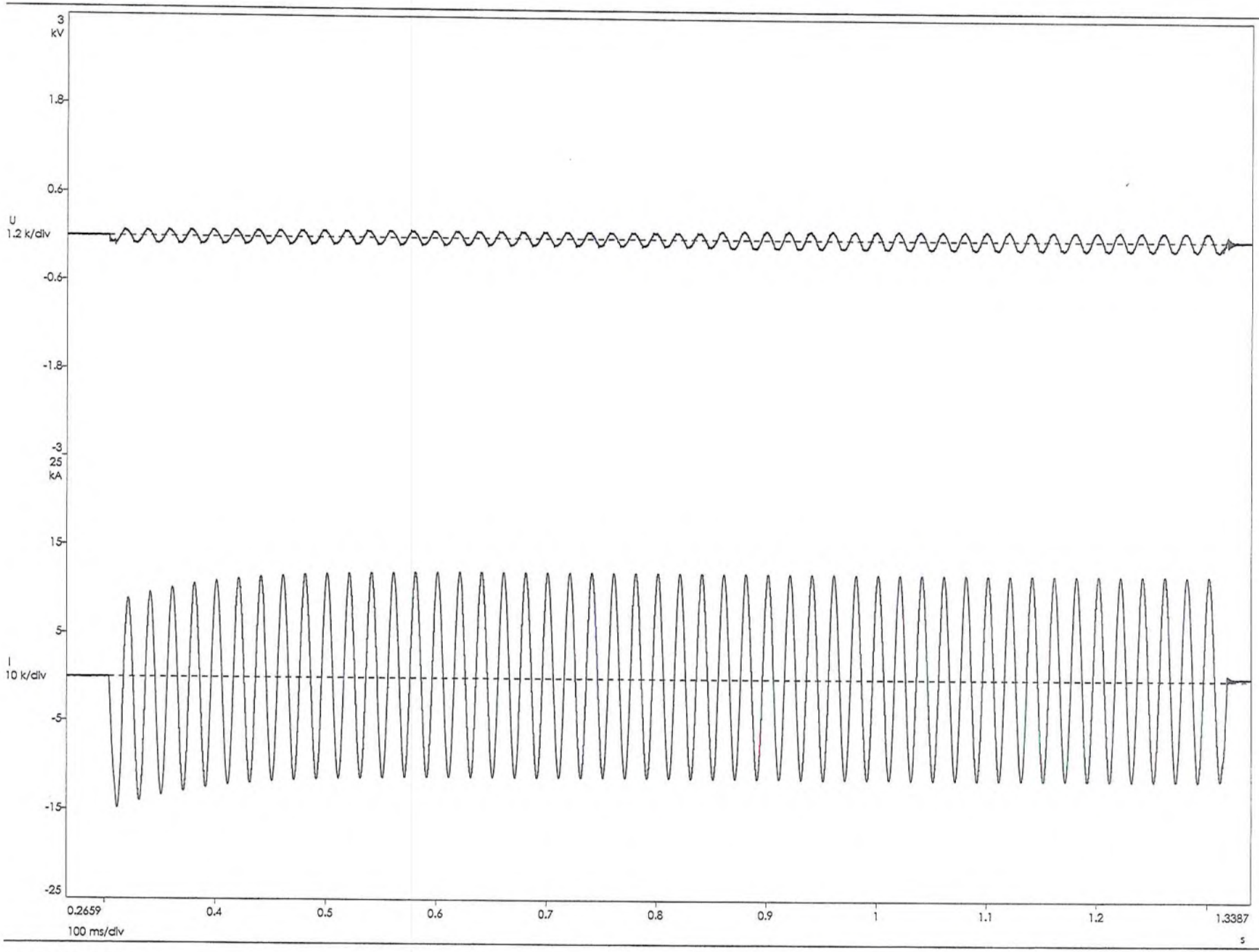
duration 0.913 s

I^2t 910 $(kA)^2s$

Note

Sampling : B1= 60.0 kHz
Bandwith (-1 dB) : $U_{R,S,T}$ = 1.00 kHz : $I_{R,S,T}$ = 1.00 kHz

test date 10/11/2016 time 13.12.46 - Test report no. RP-LS-16/194 - Test no. 00176829



test current

R.M.S. value	8.2 kA
peak value	14.8 kA
duration	1.014 s
I^2t	68 $(kA)^2s$

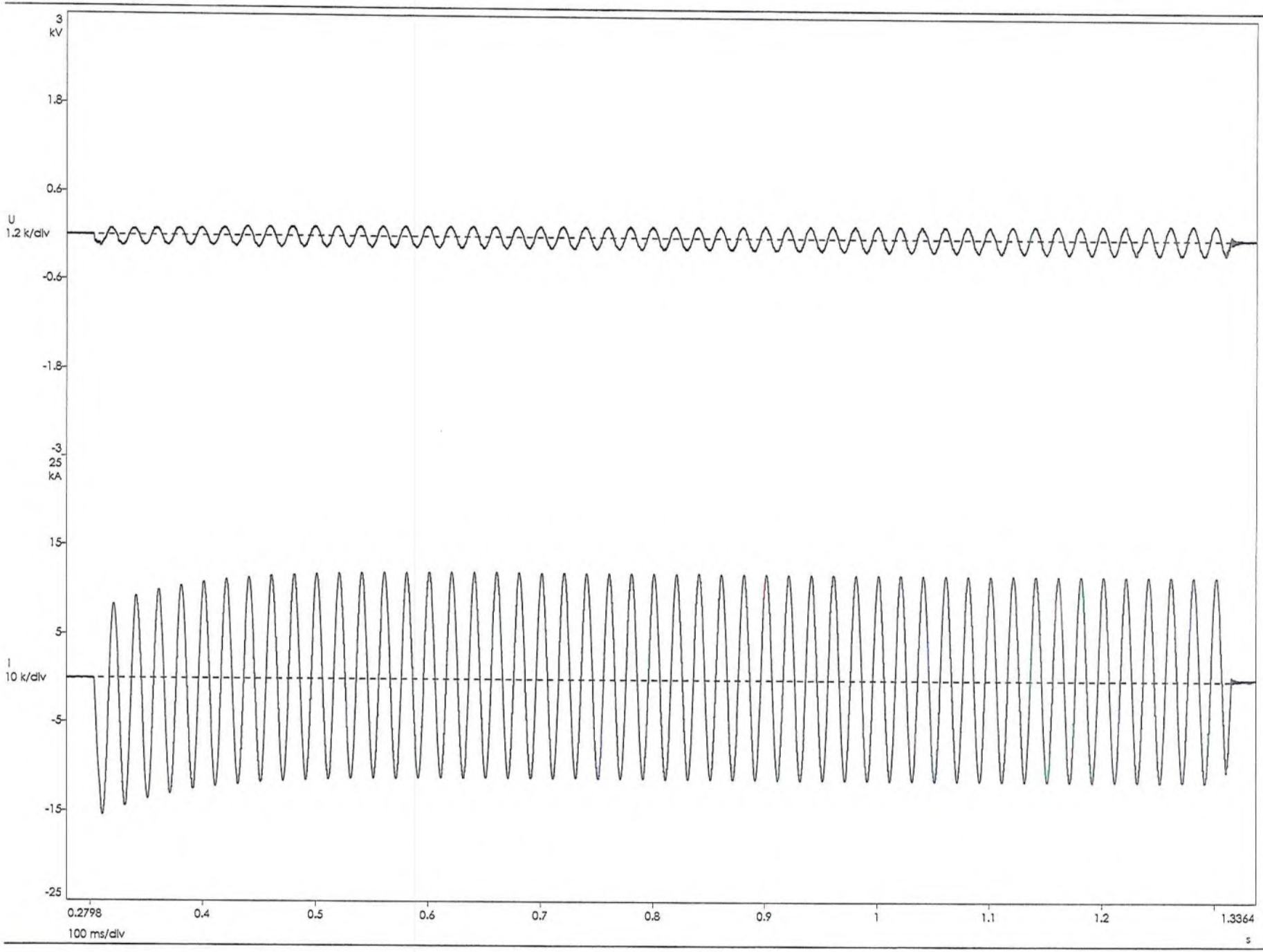
Note

Sampling : B1 = 60.0 kHz
Bandwith (-1 dB) : U $_{R.S.T}$ = 1.00 kHz ; I $_{R.S.T}$ = 1.00 kHz

test date 10/11/2016 time 16.29.21 - Test report no. RP-LS-16/194 - Test no. 00176834

LABORATORIO SVEPPI

Laboratorio SVEPPI



test current

R.M.S. value	8.2 kA
peak value	15.4 kA
duration	1.011 s
I^2t	68 $(kA)^2s$

Note

Sampling : B1= 60.0 kHz
Bandwith (-1 dB) : U $_{R.S.T}$ = 1.00 kHz ; I $_{R.S.T}$ = 1.00 kHz

test date 10/11/2016 time 16.39.54 - Test report no. RP-LS-16/194 - Test no. 00176835

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