



THE TESTING & CALIBRATING LABORATORY

Testing and calibrating laboratory accredited by Polish Centre for Accreditation, a signatory to EA MLA and ILAC MRA that include recognition of calibration certificates and test reports. Accreditation No AB 022 and AP 102



AB 022



Test fields: acoustics, electrotechnics, mechanics, vibrations, photometry, chemical and physical properties, functionality, safety, electromagnetic compatibility, fire resistance, flammability, climatic and mechanical hazard resistance.

Test Report No 400/NZL/NBW/2014/O

| | |
|---------------------------------|--|
| Test object: | The surge protection devices marked: NNO 10/280, NNO 10/440 |
| Applicant: | IzoElektro d.o.o. Limbuška cesta 2, SI – 2341 Limbuš |
| Manufacturer: | as above |
| Mark and date of commission: | 9/14C-PL/0001623 / 02.10.2014 |
| Type of tests | Safety |
| Standard: | PN-EN 61643-11:2013 PN-EN 60112:2003+A1:2010 PN-EN 60695-10-2:2014 |
| Number of pages of test report: | 8 |
| Number of attachments: | 0 |
| Date of receipt of test item: | 15.12.2014 |
| Date of start of test: | 17.12.2014 |
| Date of end of test: | 12.02.2015 |
| Final result of tests: | --- |
| Additional information: | --- |

Warsaw, 20th February 2015

Authorized by:

Manager of SBF

Dariusz Grochowina, Eng.

Approved by:

Head of the Laboratory

Robert Franaszek, M.Sc.

This report shall not be reproduced except in full without the written approval of the testing laboratory.

The test results presented in this report relate only to the object tested.

I. TESTED OBJECT CHARACTERISTICS

Tested object description

Trademark: Izoelektro

Model/Type: NNO 10/280

Ratings: $I_n = 10 \text{ kA}$; $U_p = 2,0 \text{ kV}$; $U_c = 280 \text{ Vac}/355 \text{ Vdc}$; 50/60 Hz

Additional information: New objects

Photographic identification of tested objects



Tested object description

Trademark: Izoelektro

Model/Type: NNO 10/440

Ratings: $I_n = 10 \text{ kA}$; $U_p = 2,0 \text{ kV}$; $U_c = 440 \text{ Vac}/585 \text{ Vdc}$; 50/60 Hz

Additional information: New objects

Photographic identification of tested objects



II. TEST PROGRAM

According to the order, the tests program contained all applicable measurements, necessary for check:

- 1) ball pressure test,
- 2) tracking resistance,
- 3) insulation resistance,
- 4) air clearances and creepage distances

of delivered objects, in test conditions specified in PN-EN 61643-11:2013 standard.

III. TEST RESULT

Re 1 Ball pressure test.

Specimen was tested in the following environmental conditions:

1. Relative humidity $R_H = (49 - 53) \% \pm 5\%$
2. Ambient temperature $T_a = (22,2 - 22,6) ^\circ\text{C} \pm 0,5 ^\circ\text{C}$

Test conditions:

1. Time of stabilization in above environment conditions - 24 h

2. Level of test severity:

- test temperature: $70 ^\circ\text{C} \pm 2 \text{ K}$

- exposure time $t_a = 1 \text{ h}$

3. Kind of preparation of specimen to test: cut sample

4. Specimen dimension: 20 mm x 20 mm x 3 mm

The results of tests summarized in below table:

| Tested object | Number of specimen | Place on or part of sample subjected to test | The spherical portion of the indentation left by the pressure ball (dimension D) [mm] | Test result |
|------------------------|--------------------|--|---|-------------|
| NNO 10/280, NNO 10/440 | 1 | Middle of the sample | $0,3 \pm 0,1$ | positive |

Re 2 Tracking resistance.

Specimens were tested in the following environmental conditions:

1. Relative humidity $R_H = (47 - 58) \% \pm 5\%$
2. Ambient temperature $T_a = (21,2 - 22,4) \text{ }^\circ\text{C} \pm 0,2 \text{ }^\circ\text{C}$

Identification of tested specimens, information about the test preparation and the test result:

| | | |
|----|--|---|
| 1. | Time of stabilization in above environment conditions: | 24h |
| 2. | Specimen dimension: | 20 mm x 20 mm x 5 mm (2 layers) |
| 3. | Kind of preparation of specimens to test: | cut samples, cleaned |
| 4. | State of the surface: | the original surface of the material, no scratches |
| 5. | Cleaning procedure: | electrode was purified by sandpaper |
| 6. | Airflow: | tests were performed in a draught free space |
| 7. | Orientation of the electrodes: | In accordance with clause 7.1 of PN-EN 60112:2 standard. The force exerted by each electrode on the surface of the test specimen was equal to $1,00 \text{ N} \pm 0,05 \text{ N}$ |

Test result: CTI 175

Re 3 Insulation resistance.

Before the test samples were kept in the humidity cabinet for 48 hours at a relative humidity of $93\% \pm 3\%$ and a temperature $(24,7 - 25,3) \text{ }^\circ\text{C} \pm 0,2 \text{ }^\circ\text{C}$. Samples were removed from the cabin and after 30 min insulation resistance was measured. The results of tests summarized in below table:

| Tested object | Resistance of insulation between: | Result |
|---------------|-----------------------------------|--------|
| NNO 10/280 | live parts and the SPD body | >50 MΩ |
| NNO 10/440 | live parts and the SPD body | >50 MΩ |

Re 4 Air clearances and creepage distances.

| U _{max} | Air clearances without accessory | | | Creepage distances without accessory | | | |
|---|----------------------------------|-----------------|------------|--------------------------------------|------------|-----------------|------------|
| | minimum limit (mm) | measured length | | minimum limit (mm) | | measured length | |
| | NNO 10/280 NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 |
| Between live parts of different polarity | ≥3 | 36 | 38 | ≥5 | ≥8 | 39 | 41 |
| Between live parts and: | | | | | | | |
| - screws and other means to fasten a covering, having to be detached for mounting the SPD | ≥3 | - | - | ≥5 | ≥8 | - | - |
| - fastening surfaces | ≥6 | - | - | ≥5 | ≥8 | - | - |
| - screws or other means for fastening the SPD | ≥6 | - | - | ≥5 | ≥8 | - | - |
| - bodies | ≥3 | - | - | ≥5 | ≥8 | - | - |
| Between the metal parts of the disconnecter mechanism and: | | | | | | | |
| - bodies | ≥3 | - | - | ≥5 | ≥8 | - | - |
| - screws or other means for fastening the SPD | ≥3 | - | - | ≥5 | ≥8 | - | - |

| U _{max} | Air clearances with Connector P2 | | | Creepage distances with Connector P2 | | | |
|---|----------------------------------|-----------------|------------|--------------------------------------|------------|-----------------|------------|
| | minimum limit (mm) | measured length | | minimum limit (mm) | | measured length | |
| | NNO 10/280 NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 |
| Between live parts of different polarity | ≥3 | 39 | 41 | ≥5 | ≥8 | 41 | 43 |
| Between live parts and: | | | | | | | |
| - screws and other means to fasten a covering, having to be detached for mounting the SPD | ≥3 | - | - | ≥5 | ≥8 | - | - |
| - fastening surfaces | ≥6 | - | - | ≥5 | ≥8 | - | - |
| - screws or other means for fastening the SPD | ≥6 | - | - | ≥5 | ≥8 | - | - |
| - bodies | ≥3 | 0,4 | 0,4 | ≥5 | ≥8 | 0,4 | 0,4 |
| Between the metal parts of the disconnecter mechanism and: | | | | | | | |
| - bodies | ≥3 | - | - | ≥5 | ≥8 | - | - |
| - screws or other means for fastening the SPD | ≥3 | - | - | ≥5 | ≥8 | - | - |

| U_{max} | Air clearances with Connector P3 | | | Creepage distances with Connector P3 | | | |
|---|----------------------------------|-----------------|------------|--------------------------------------|------------|-----------------|------------|
| | minimum limit (mm) | measured length | | minimum limit (mm) | | measured length | |
| | NNO 10/280 NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 |
| Between live parts of different polarity | ≥3 | 39 | 41 | ≥5 | ≥8 | 41 | 43 |
| Between live parts and: | | | | | | | |
| - screws and other means to fasten a covering, having to be detached for mounting the SPD | ≥3 | - | - | ≥5 | ≥8 | - | - |
| - fastening surfaces | ≥6 | - | - | ≥5 | ≥8 | - | - |
| - screws or other means for fastening the SPD | ≥6 | - | - | ≥5 | ≥8 | - | - |
| - bodies | ≥3 | 8 | 8 | ≥5 | ≥8 | 9 | 9 |
| Between the metal parts of the disconnecter mechanism and: | | | | | | | |
| - bodies | ≥3 | - | - | ≥5 | ≥8 | - | - |
| - screws or other means for fastening the SPD | ≥3 | - | - | ≥5 | ≥8 | - | - |

Tested by: Józef Stańczuk



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Test fields: acoustics, electrotechnics, mechanics, vibrations, photometry, chemical and physical properties, functionality, safety, electromagnetic compatibility, fire resistance, flammability, climatic and mechanical hazard resistance.

Test Report No 178/NZL/NBW/2014/O

| | |
|---------------------------------|--|
| Test object: | The Surge Protection Devices: NNO 10/280, NNO 10/440 |
| Applicant: | IzoElektro d.o.o. Limbuška cesta 2, SI – 2341 Limbuš |
| Manufacturer: | as above |
| Mark and date of commission: | 3/13 B-PL/1623 / 13.05.2014 |
| Type of tests | Flammability |
| Standard: | PN-EN 60695-2-10:2013 (in accordance with the IEC 60695-2-10:2013) PN-EN 60695-2-11:2005 (in accordance with the IEC 60695-2-11:2001 + AC1:2000) IEC 61643-11:2011 |
| Number of pages of test report: | 4 |
| Number of attachments: | 0 |
| Date of receipt of test item: | 13.05.2014 |
| Date of start of test: | 21.05.2014 |
| Date of end of test: | 21.05.2014 |
| Final result of tests: | The tested object have been found in comply with the requirements of above standards. |
| Additional information: | --- |

Warsaw, 6th June 2014

Authorized by:

Manager of SBF

Dariusz Grochowina, Eng.

Zespół Laboratoriów
INSTYTUTU ELEKTROTECHNIKI
ul. Pożaryskiego 28, 04-703 Warszawa
tel. (22) 812-30-53; fax (22) 812-04-06
tel. (22) 812-23-38; fax (22) 812-04-07
e-mail: badania@iel.waw.pl, nwr@iel.waw.pl
NIP 525-000-76-84

Approved by:

Head of the Laboratory

Robert Franaszek, M.Sc.

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Address:
Mieczysława Pożaryskiego 28 St
04-703 WARSZAWA

Bank: Pekao S.A.
Account Number: 90 1240 6074 1111 0000 4999 4364
NIP: 525-000-76-84

Ph.: (0-22) 812 30 53
Fax: (0-22) 812 04 06
badania@iel.waw.pl

I. TESTED OBJECT CHARACTERISTICS

Tested object description

Trademark: Izoelektro

Model/Type: NNO 10/280

Ratings: $I_n = 10 \text{ kA}$; $U_p = 2,0 \text{ kV}$; $U_c = 280 \text{ Vac}/355 \text{ Vdc}$; 50/60 Hz

Additional information: New objects

Photographic identification of tested objects



Tested object description.....:

Trademark: Izoelektro

Model/Type: NNO 10/440

Ratings: $I_n = 10 \text{ kA}$; $U_p = 2,0 \text{ kV}$; $U_c = 440 \text{ Vac}/585 \text{ Vdc}$; 50/60 Hz

Additional information: New objects

Photographic identification of tested objects



II. TEST PROGRAM

According to the order, the test program contained all applicable tests and measurements, necessary for check of delivered objects resistance to heat, in test conditions specified in PN-EN 60695-2-11:2005 standard. Detailed list of test cases has been placed in III part of this Test Report.

III. TEST RESULT

Specimens were tested in the following environmental conditions:

1. Relative humidity $R_H = (46 - 51) \% \pm 5\%$
2. Ambient temperature $T_a = (20,1 - 20,6) ^\circ\text{C} \pm 0,2 ^\circ\text{C}$

Test conditions:

1. Time of stabilization in above environment conditions - 24 h
2. Level of test severity:
 - test temperature: $850 ^\circ\text{C} \pm 15 \text{ K}$
 - exposure time $t_a = 30 \text{ s}$
3. The depth of penetration of glow wire in tested specimen: $\leq 7 \text{ mm} \pm 0,5 \text{ mm}$
4. Kind of preparation of specimens to tests - finished products
5. Specimen's position during the test: long axis situated vertically

The results of tests summarized in below table:

| Typ | Number of specimen | Place on or part of sample subjected to test | Ignition of test specimen during the test | Glowing of test specimen during the test | Time to ignition of the specimen t_i (s) | Duration of burning t_b (s) | Duration of glowing t_e (s) | Limit of burning and/or glowing time (s) | The maximum height of the flame (mm) | Removal of burning material with glow wire | Ignition of the tissue paper | Test result |
|------------|--------------------|--|---|--|--|-------------------------------|-------------------------------|--|--------------------------------------|--|------------------------------|-------------|
| NNO 10/280 | 1 | gray part of SPD | no | no | - | - | - | ≤60 | - | no | no | positive |
| NNO 10/440 | 2 | gray part of SPD | no | no | - | - | - | | - | no | no | positive |

Tested by: Józef Stańczuk



Instytut Elektrotechniki
Electrotechnical Institute

ZESPÓŁ LABORATORIÓW INSTYTUTU ELEKTROTECHNIKI
LABORATORIUM BADAWCZE APARATURY ROZDZIELCZEJ

M. Pożaryskiego str. 28, 04-703 WARSAW

phone. +(48) 22 11 25 300, email: zwarcia@iel.waw.pl



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AB 074

TEST REPORT No. 8602/NZL/NBR/15

Test object:

Surge Protective Devices (SPD)

Client:

IzoElektro d.o.o.
Limbuška cesta 2
SI-2341 Limbuš, EU

Manufacturer:

IzoElektro d.o.o.
Limbuška cesta 2
SI-2341 Limbuš, EU

Test specification:

Type tests

Normative document(s):

EN 61643-11:2012

Reference/Order
number:

505/022800/013
505/024100/013

Date of tests
completion:

February 2015

Test results:

Passed

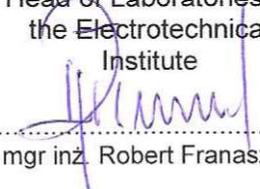
Test manager


mgr inż. Janusz Bandel

Authorised by


mgr inż. Michał Babiuch

Head of Laboratories of
the Electrotechnical
Institute


mgr inż. Robert Franaszek

WARSAW, 12.03.2015.

The Test Report applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designators with that tested rests with the Manufacturer.

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This Test Report comprises 42 sheets in total.

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1. LIST OF APPLICABLE STANDARDS

Standards:

| | |
|-------------------|--|
| EN 61643-11:2012 | Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods. |
| IEC 61643-11:2011 | Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems – Requirements and test methods. |

2. RATINGS ASSIGNED BY THE MANUFACTURER AND PROVED BY TESTS

| Type | NNO 5/440 | NNO 10/440 |
|---|-----------|------------|
| Continuous operating voltage | 440 V ac | |
| Test classification | Class II | |
| Nominal discharge current for class II test | 5 kA | 10 kA |
| Voltage protection level | 1500 V | 1800V |
| Type of LV system | TN-system | |
| I_{max} | 50 kA | |
| U_{REF} | 255 V | |

3. BASIC IDENTIFICATIONS DATA

| | | |
|--------------------------------|--|------------|
| Test objects | Surge Protective Devices | |
| Typ/ type | NNO 5/440; NNO 10/440 | |
| Producent/ <i>Manufacturer</i> | IzoElektro d.o.o. Limbuška cesta 2 SI-2341 Limbuš, EU | |
| <i>Year of manufacture:</i> | 2014 | |
| <i>Drawings</i> | <i>Name</i> | <i>No.</i> |
| | 1. LV Surge arrester NNO 10/440 – 0,5 m | 20 60 60 |
| | 2. LV Surge arrester NNO 10/440 – 0,5 m+ Connector P1 | 20 60 63 |
| | 3. LV Surge arrester NNO 10/440 – 0,5 m + Connector P2 0,5 m | 20 60 64 |
| | 4. LV Surge arrester NNO 10/440 – 0,5 m+ Connector P3 | 20 60 65 |

| | |
|---|------------------|
| Condition of test objects before test : | New |
| Tests performed according to | EN 61643-11:2012 |

3. Testing for protection against direct contact

EN 61643-11:2012 cl. 8.3.1

IEC 61643-11:2011 cl. 8.3.1

Analysis of the SPD construction and test shown that:

- for the SPD type NNO with connector P1 and P2 can be assigned code IP 0X,
- for the SPD type NNO with connectors P3 can be assigned code IP 2X as long as the connectors are mounted tightly with the SPD.

4. IP code

EN 61643-11:2012 cl. 8.5.1

IEC 61643-11:2011 cl. 8.5.1

Analysis of the SPD construction and test shown that:

- for the SPD type NNO with connector P1 and P2 can be assigned code IP 00,
- for the SPD type NNO with connectors P3 can be assigned code IP 23 as long as the SPDs work in defined (normal) position and the connectors are mounted tightly with the SPD,
- for the SPD type NNO with connectors P3 can be assigned code IP 20, when the SPD works in another position than defined (normal).

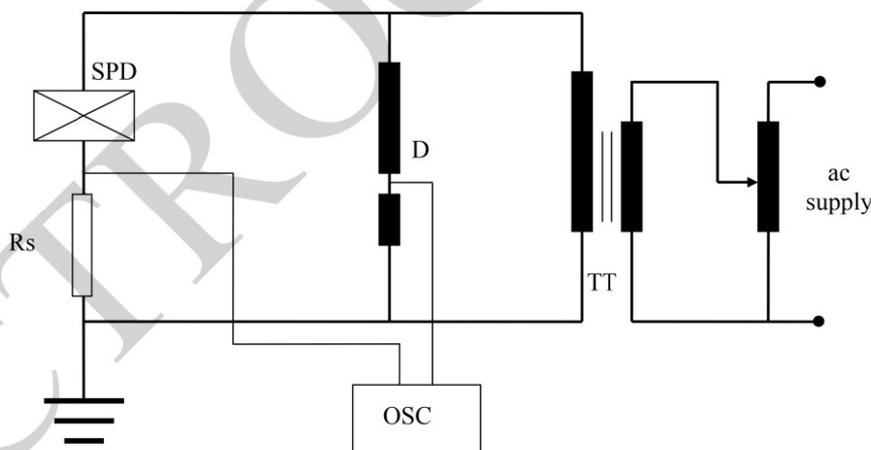
5. Residual current

EN 61643-11:2012 cl. 8.3.2

IEC 61643-11:2011 cl. 8.3.2

TEST CIRCUIT

OP1



TT –test transformer

Rs –ac current shunt 1000 Ω. RN-1 nr NAR 359-II-704

SPD –tested surge arrester

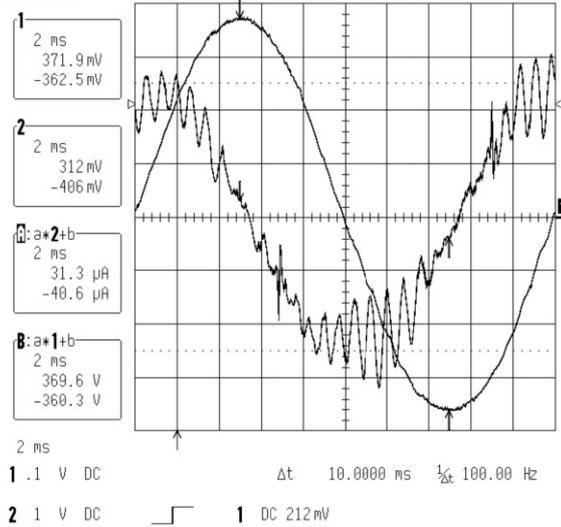
OSC –digital oscilloscope type LeCroy-9350A NWN 801-06400

D – high voltage probe Tektronix nr B059704

Test result

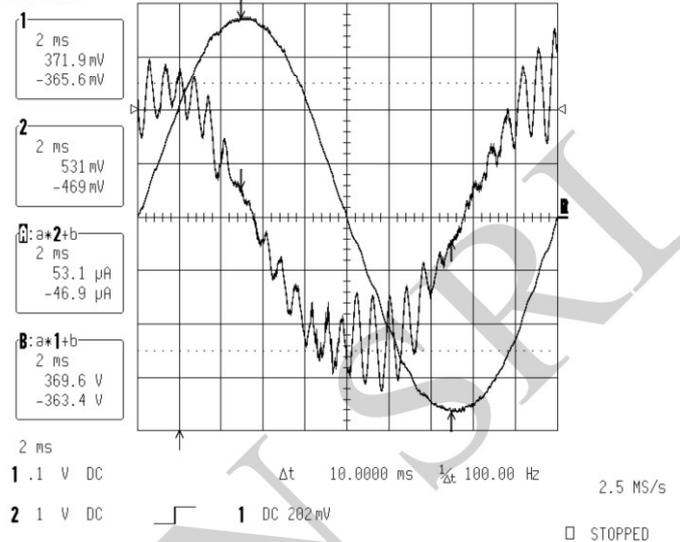
| Sample | U_{REF} [V] | I_{PE} [μA] |
|-------------------|---------------|----------------------|
| NNO 5/440 no. 21 | 258 | 40,6 |
| NNO 5/440 no. 22 | 259 | 53,1 |
| NNO 5/440 no. 23 | 259 | 43,8 |
| NNO 10/440 no. 24 | 260 | 46,9 |
| NNO 10/440 no. 25 | 260 | 40,6 |
| NNO 10/440 no. 26 | 260 | 43,8 |

9-Jul-14
14:05:23



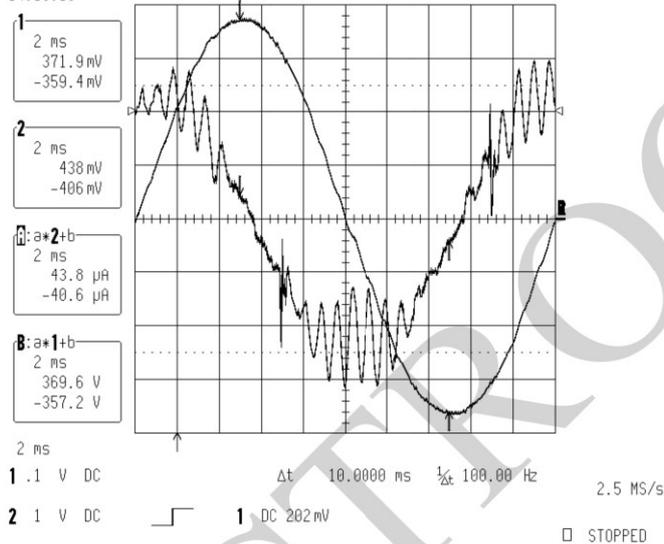
NNO 5/440 no. 21

9-Jul-14
14:08:23



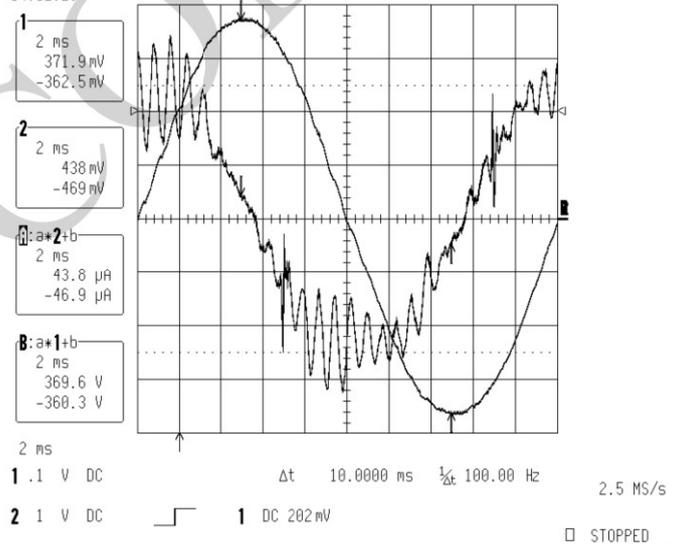
NNO 5/440 no. 22

9-Jul-14
14:10:13



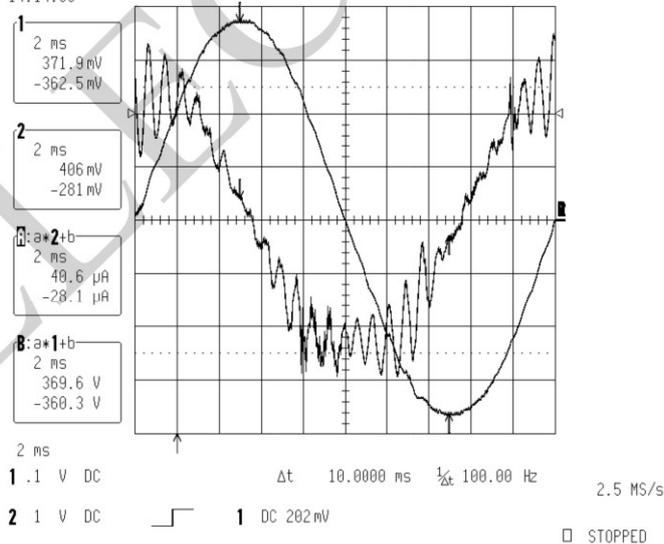
NNO 5/440 no. 23

9-Jul-14
14:12:20



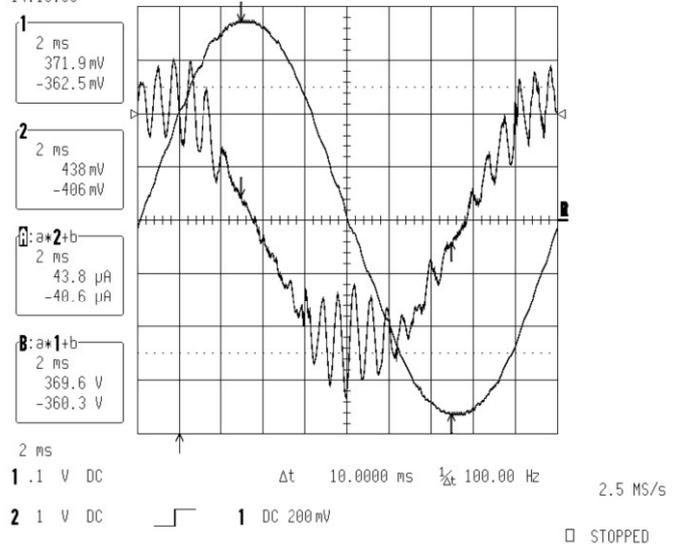
NNO 10/440 no. 24

9-Jul-14
14:14:05



NNO 10/440 no. 25

9-Jul-14
14:18:00



NNO 10/440 no. 26

Measurement of the residual current I_{PE} at U_{REF} .

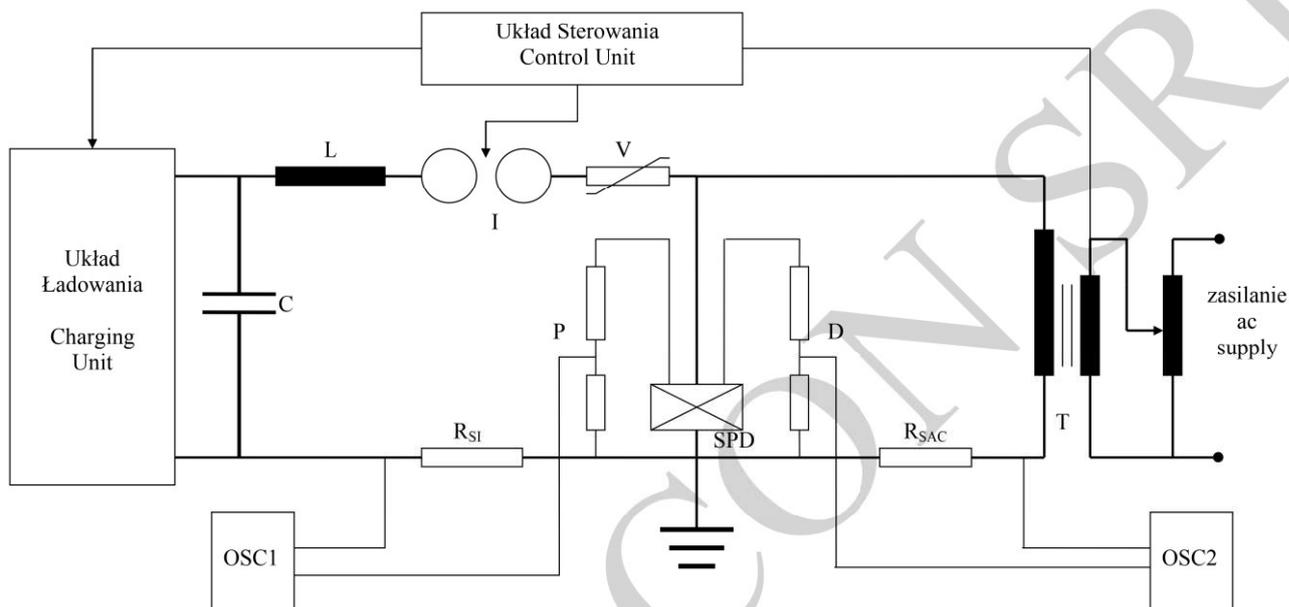
6. Operating duty test for test class II

EN 61643-11:2012 cl. 8.3.4.3

IEC 61643-11:2011 cl. 8.3.4.3

TEST CIRCUIT

OP2



C, L -capacity and inductance of the current surge generator

I - controlled spark gap

V - additional attenuating varistor

C_k , R_k - capacity and resistance for capacitive current compensation

T- Test transformer

SPD - tested surge protective device

OSC1- digital oscilloscope type **LeCroy-9360 NWN 801-I-14500**

OSC2 -digital oscilloscope type **Hioki** type 8861-50 serial number: 080722303

P - high voltage probe Tektronix nr B059704

Scale factor of measurement system: 1078

D -high voltage probe Tektronix P6015A nr NAR 801-16003

Scale factor of measurement system: 1000

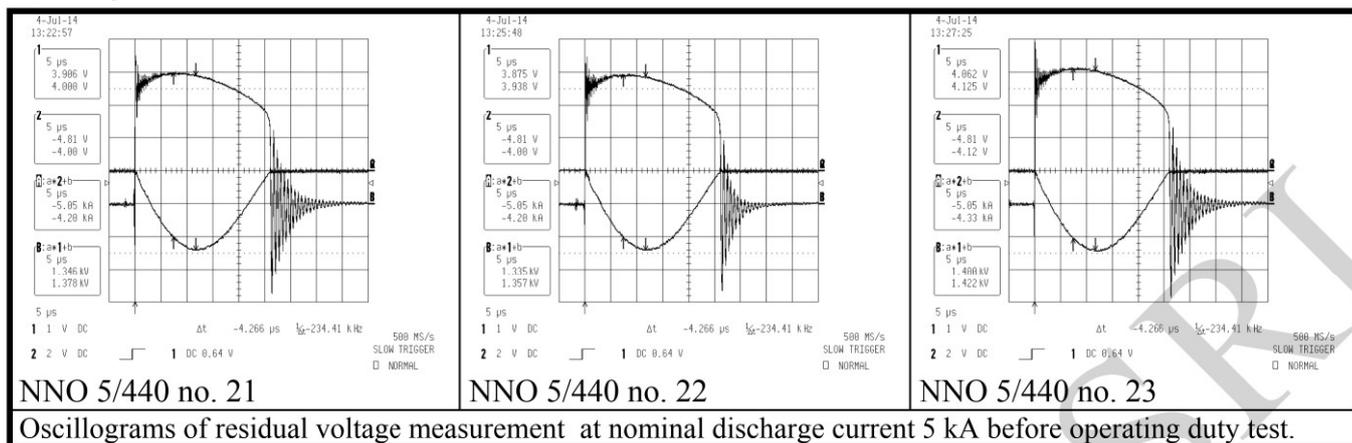
R_{ac} - ac current shunt 1000 Ω nr 6720.

R_{Si} - impulse current shunt

$R_{Si}=19,88 \text{ m}\Omega$

Scale factor of measurement system [shunt ($R_{Si}=19,88 \text{ m}\Omega$), matching attenuator no.4, measurement cable no.1]: 1050 A/V

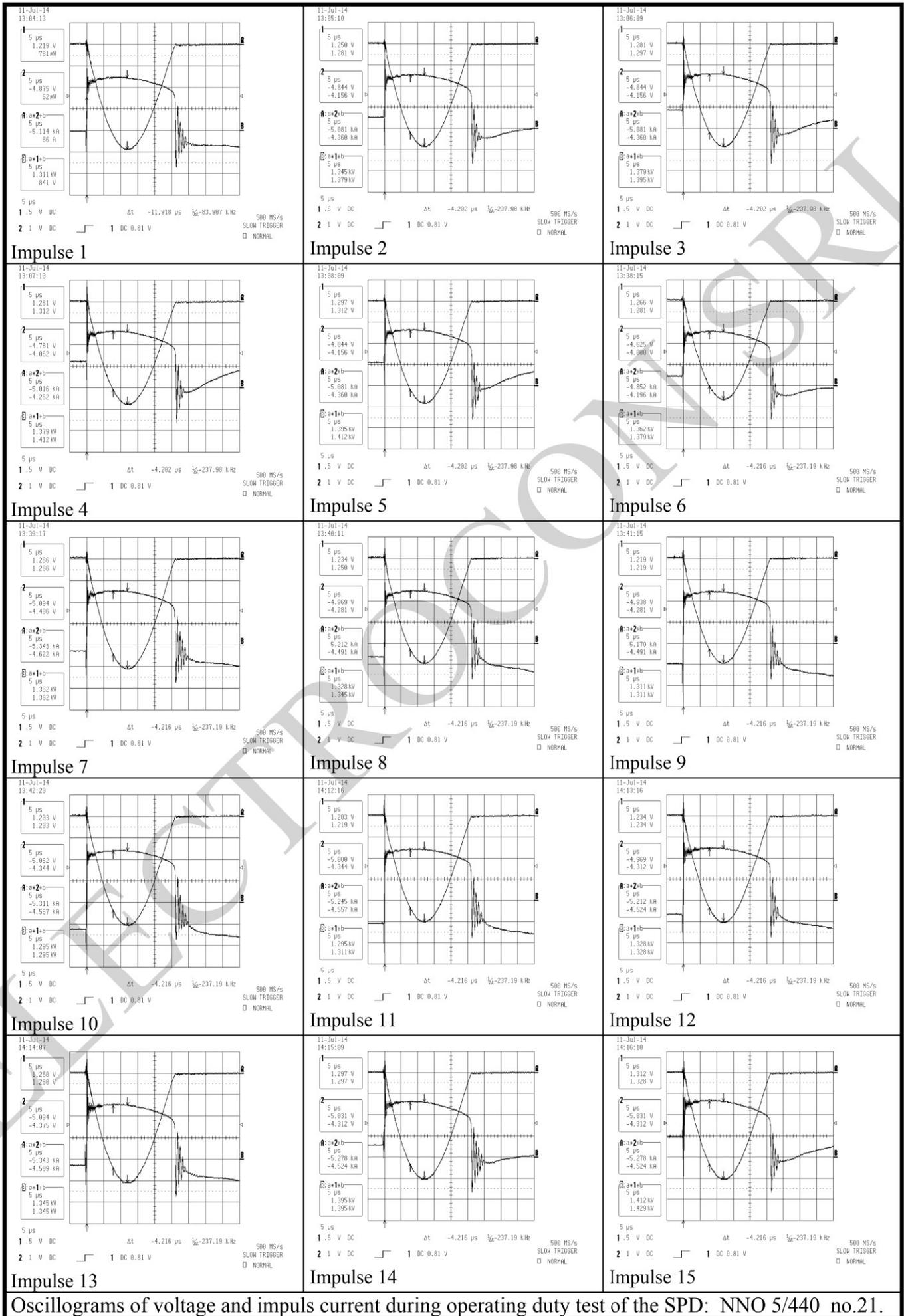
NNO 5/440



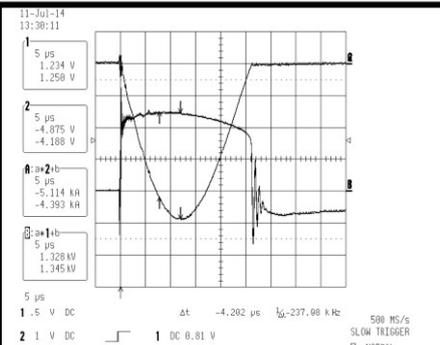
| Synchronization angle | | Sample NNO 5/440 | | | |
|-----------------------|-------|------------------|--------|--------|--------|
| No of the impulse | [°el] | | No. 21 | No. 22 | No. 23 |
| 1 | 0 | [kA] | 5,11 | 5,11 | 5,54 |
| 2 | 30 | [kA] | 5,08 | 5,11 | 5,47 |
| 3 | 60 | [kA] | 5,08 | 5,14 | 5,47 |
| 4 | 90 | [kA] | 5,02 | 5,11 | 5,37 |
| 5 | 120 | [kA] | 5,08 | 5,01 | 5,25 |
| 6 | 150 | [kA] | 4,85 | 5,21 | 5,31 |
| 7 | 180 | [kA] | 5,34 | 5,24 | 5,18 |
| 8 | 210 | [kA] | 5,21 | 5,21 | 5,05 |
| 9 | 240 | [kA] | 5,18 | 5,21 | 5,31 |
| 10 | 270 | [kA] | 5,31 | 5,24 | 5,34 |
| 11 | 300 | [kA] | 5,25 | 5,41 | 5,31 |
| 12 | 330 | [kA] | 5,21 | 5,34 | 5,44 |
| 13 | 0 | [kA] | 5,34 | 5,34 | 5,44 |
| 14 | 30 | [kA] | 5,28 | 5,37 | 5,44 |
| 15 | 60 | [kA] | 5,28 | 5,27 | 5,54 |

| Sample | | No. 21 | No. 22 | No. 23 |
|-----------------|------|--------|--------|--------|
| U _c | [V] | 440 | 440 | 440 |
| P ₁ | [mW] | 56,7 | 70,9 | 47,1 |
| | osc | 1752 | 1756 | 1762 |
| P ₅ | [mW] | 51,6 | 65,0 | 44,1 |
| | osc | 1753 | 1757 | 1764 |
| P ₁₀ | [mW] | 50,5 | 62,7 | 42,8 |
| | osc | 1754 | 1758 | 1766 |
| P ₁₅ | [mW] | 49,7 | 62,0 | 42,0 |
| | osc | 1755 | 1759 | 1767 |

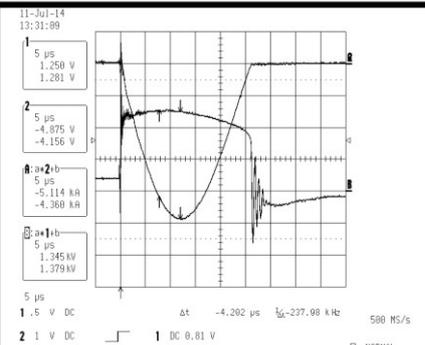
P_x - the power losses after x minutes after 15-th impulse current



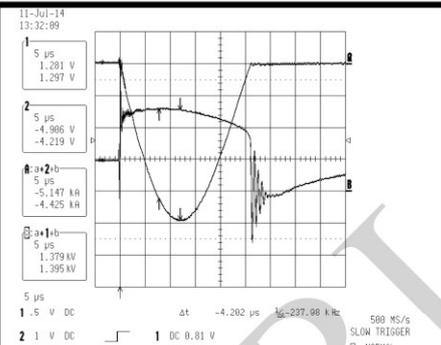
Oscillograms of voltage and impuls current during operating duty test of the SPD: NNO 5/440 no.21.



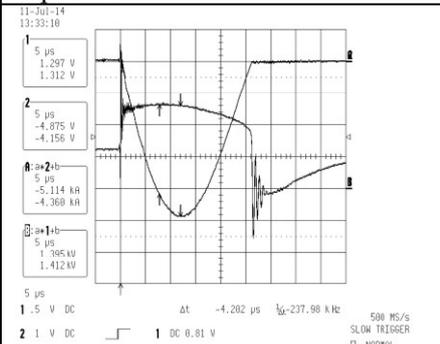
Impulse 1



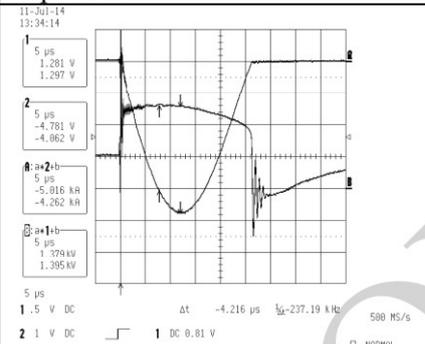
Impulse 2



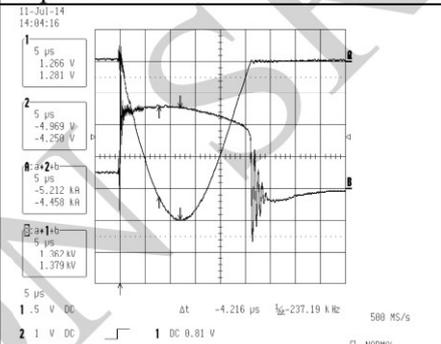
Impulse 3



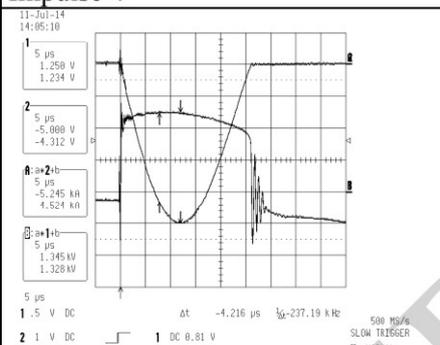
Impulse 4



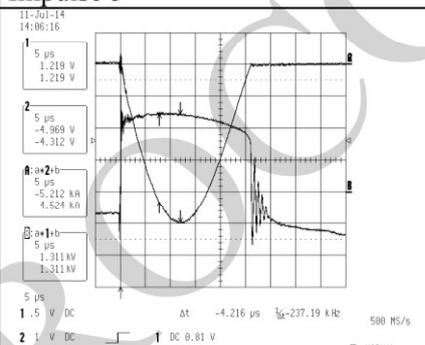
Impulse 5



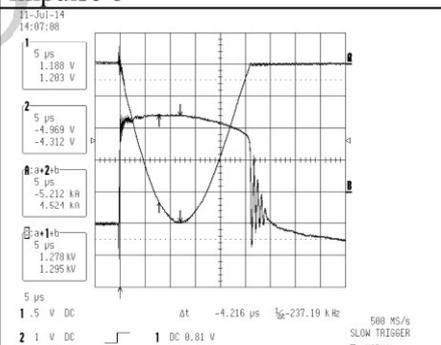
Impulse 6



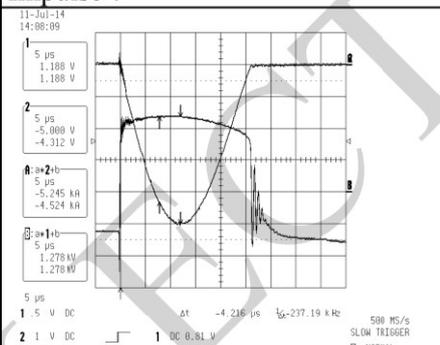
Impulse 7



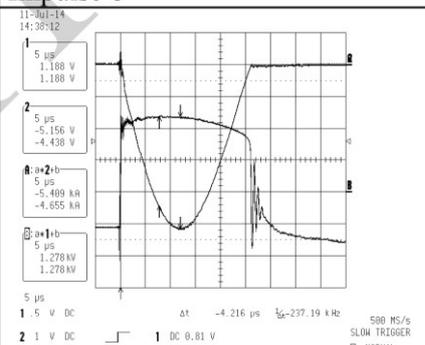
Impulse 8



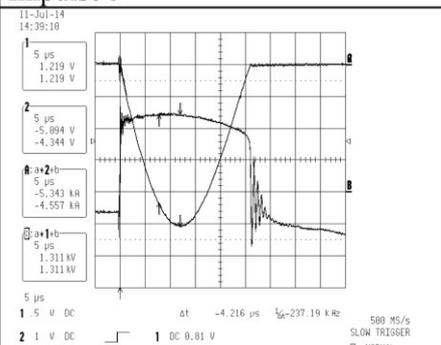
Impulse 9



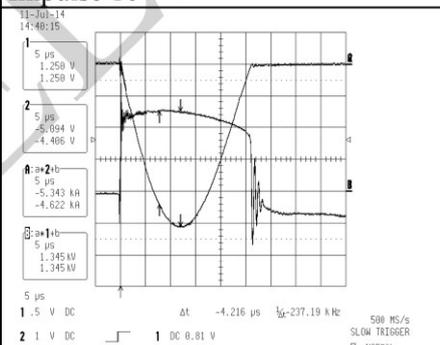
Impulse 10



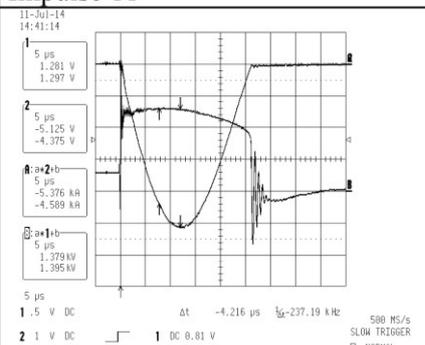
Impulse 11



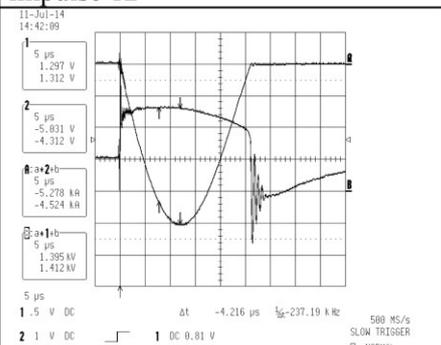
Impulse 12



Impulse 13

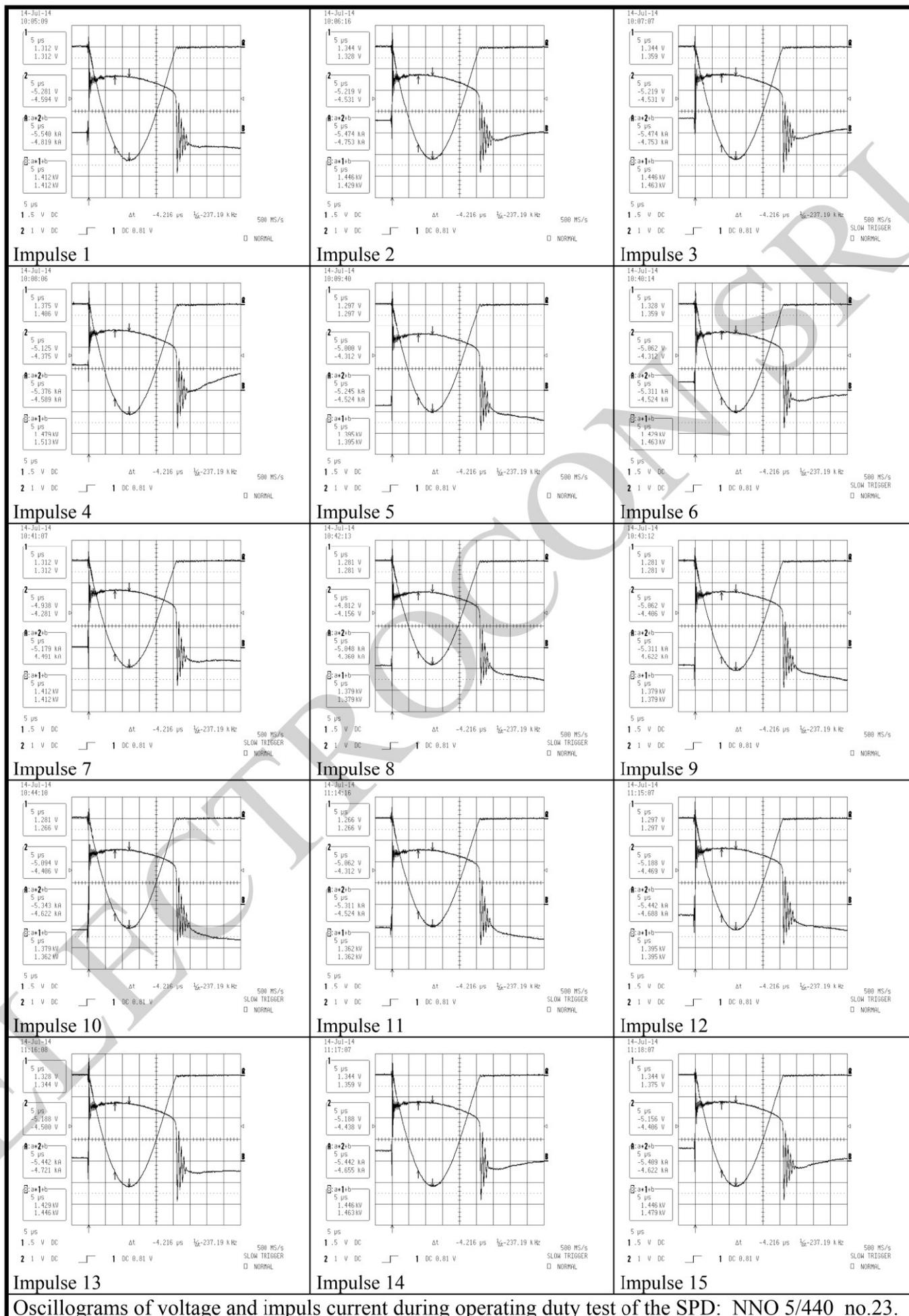


Impulse 14

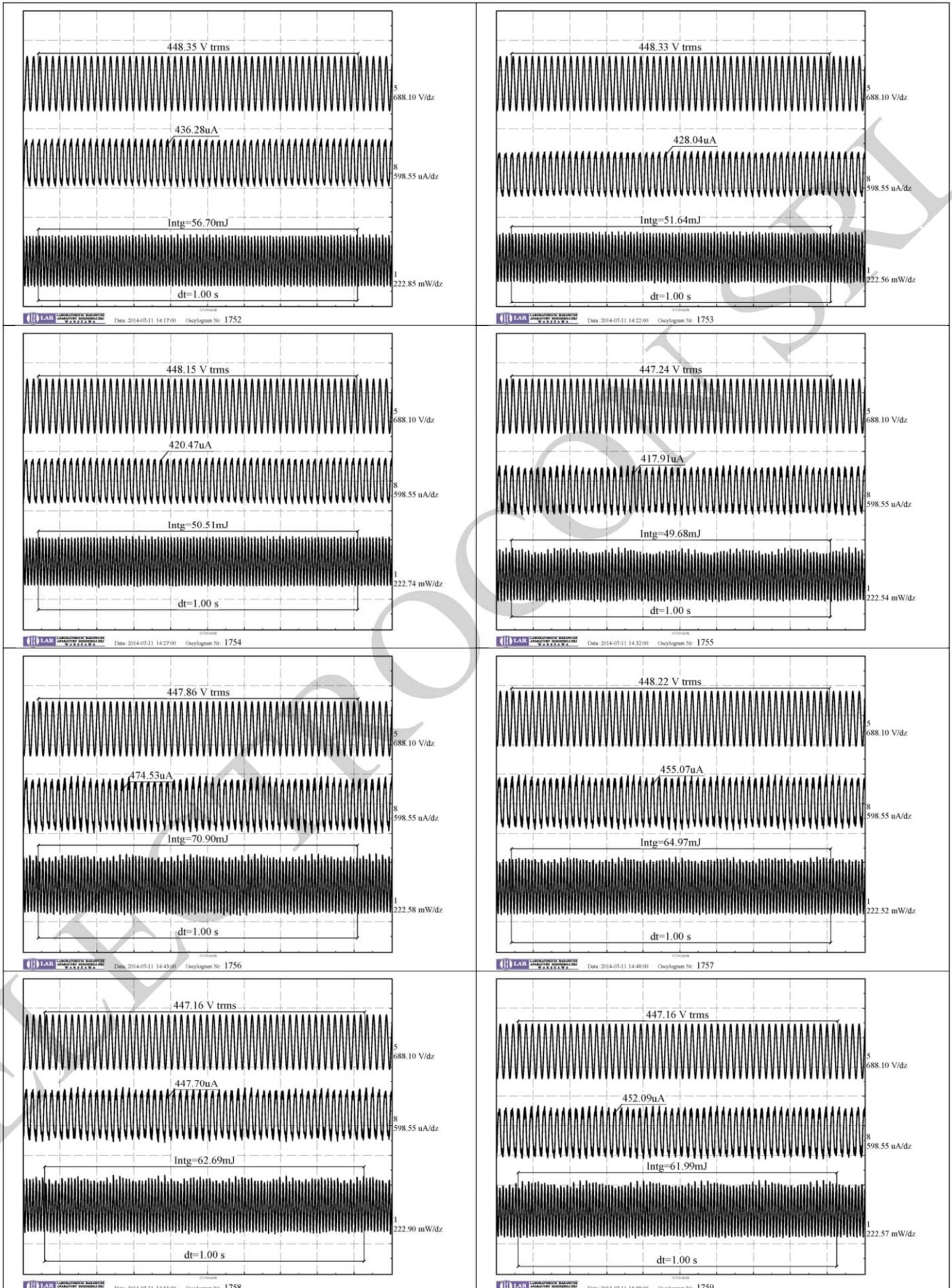


Impulse 15

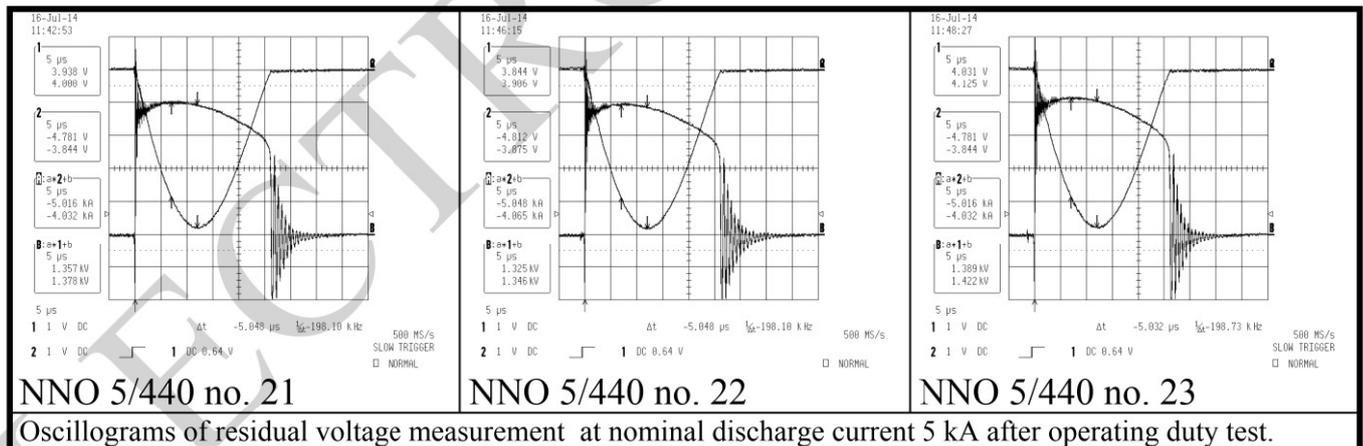
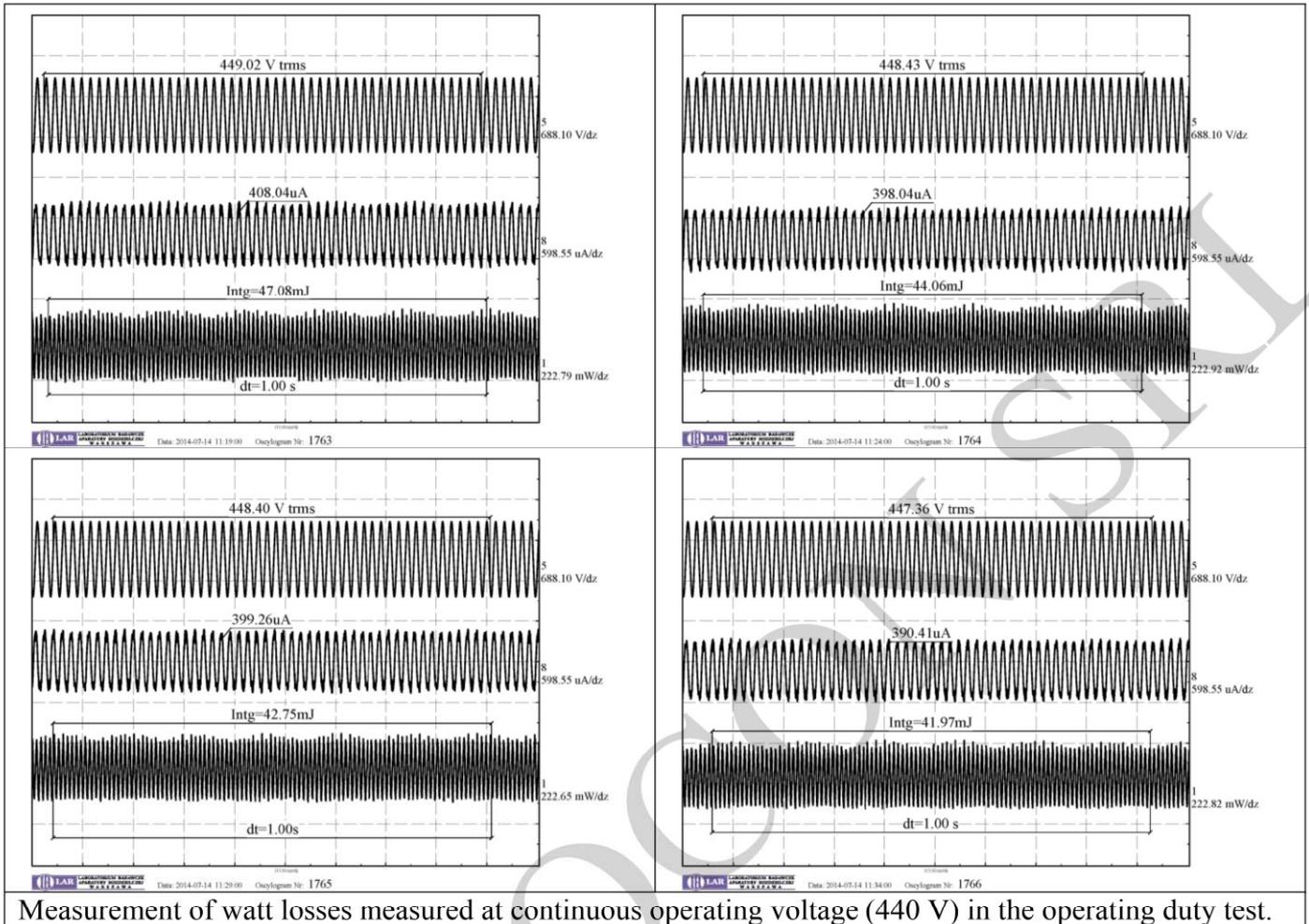
Oscillograms of voltage and impuls current during operating duty test of the SPD: NNO 5/440 no.22.



Oscillograms of voltage and impuls current during operating duty test of the SPD: NNO 5/440 no.23.



Measurement of watt losses measured at continuous operating voltage (440 V) in the operating duty test.



| Residual voltage | | NNO 5/440 | | |
|--------------------------|-----|-----------|--------|--------|
| | | no. 21 | no. 22 | no. 23 |
| before test | [V] | 1378 | 1357 | 1422 |
| after test | [V] | 1378 | 1346 | 1422 |
| Voltage protection level | [V] | 1500 | | |

Residual current after operating duty test

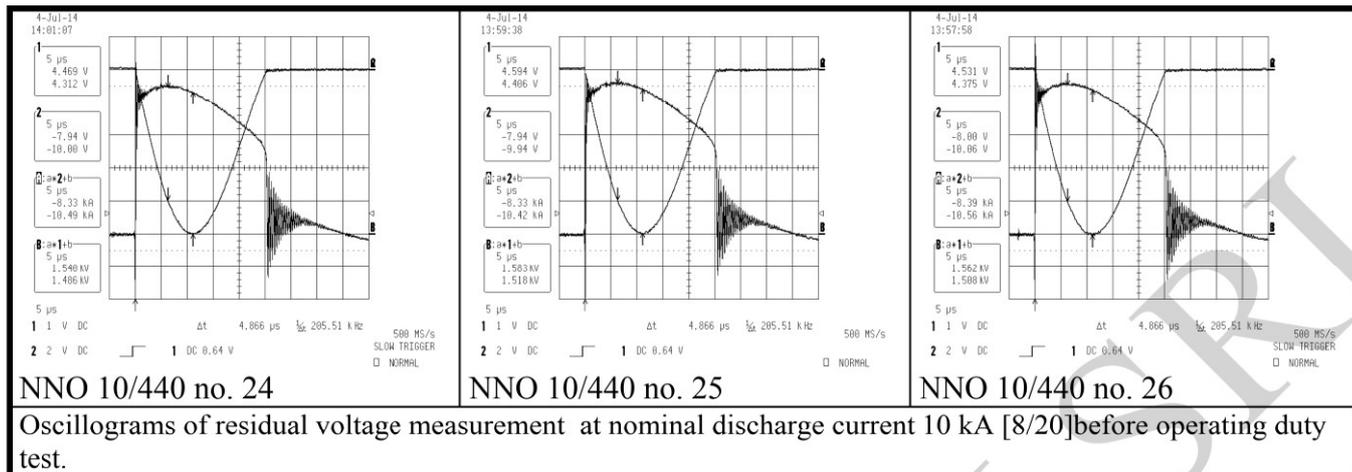
| Sample | U_{REF} [V] | I_{PE} [μ A] |
|------------------|---------------|---------------------|
| NNO 5/440 no. 21 | 256 | 38 |
| NNO 5/440 no. 22 | 256 | 38 |
| NNO 5/440 no. 23 | 257 | 41 |

Pass criteria for operating duty test for NNO 5/440

| | no. 21 | no. 22 | no. 23 |
|-------------|-------------|-------------|-------------|
| A | Was applied | Was applied | Was applied |
| B | | | |
| C | | | |
| D | | | |
| E | | | |
| F | | | |
| G | | | |
| M | | | |
| Test result | Passed | Passed | Passed |

ELECTROCON SRL

NNO 10/440

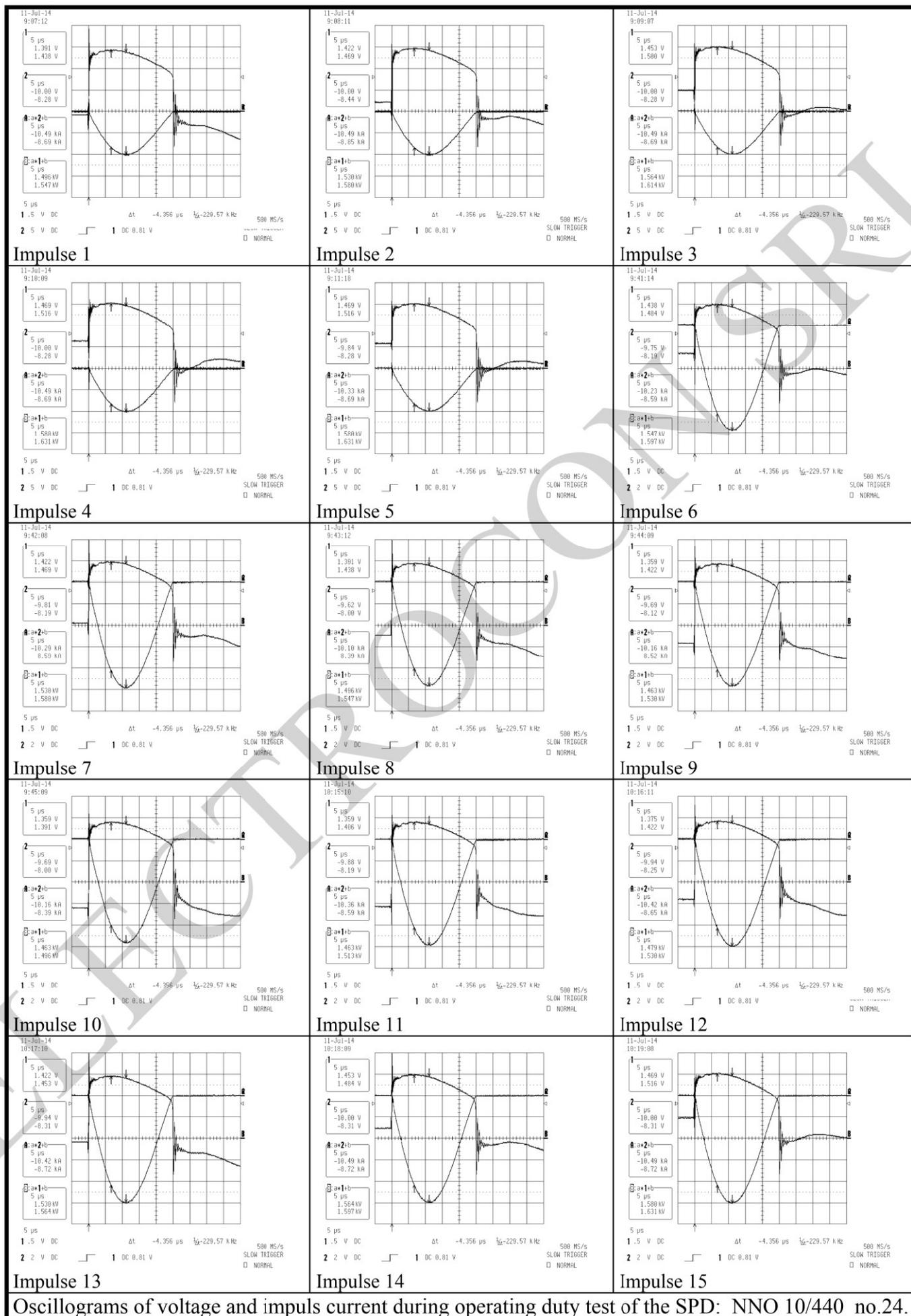


Oscillograms of residual voltage measurement at nominal discharge current 10 kA [8/20] before operating duty test.

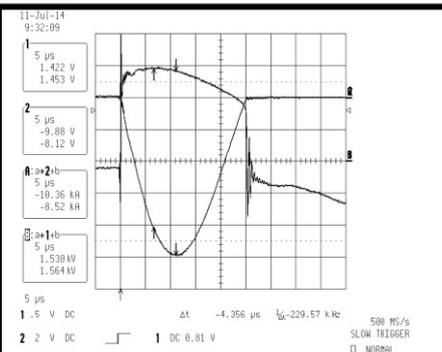
| Synchronization angle | | | Sample NNO 10/440 | | |
|-----------------------|-------|------|-------------------|--------|--------|
| No of the impulse | [°el] | | No. 24 | No. 25 | No. 26 |
| 1 | 0 | [kA] | 10,49 | 10,36 | 10,36 |
| 2 | 30 | [kA] | 10,49 | 10,29 | 10,36 |
| 3 | 60 | [kA] | 10,49 | 10,42 | 10,23 |
| 4 | 90 | [kA] | 10,49 | 10,36 | 10,29 |
| 5 | 120 | [kA] | 10,33 | 10,36 | 10,36 |
| 6 | 150 | [kA] | 10,23 | 10,16 | 10,29 |
| 7 | 180 | [kA] | 10,29 | 10,16 | 10,29 |
| 8 | 210 | [kA] | 10,10 | 10,03 | 10,29 |
| 9 | 240 | [kA] | 10,16 | 10,23 | 10,29 |
| 10 | 270 | [kA] | 10,16 | 10,16 | 10,29 |
| 11 | 300 | [kA] | 10,36 | 10,29 | 10,36 |
| 12 | 330 | [kA] | 10,42 | 10,56 | 10,36 |
| 13 | 0 | [kA] | 10,42 | 10,42 | 10,42 |
| 14 | 30 | [kA] | 10,49 | 10,42 | 10,36 |
| 15 | 60 | [kA] | 10,49 | 10,29 | 10,29 |

| Sample | | No. 24 | No. 25 | No. 26 |
|-----------------|------|--------|--------|--------|
| U _c | [V] | 440 | 440 | 440 |
| P ₁ | [mW] | 65,8 | 57,4 | 52,6 |
| | osc | 1740 | 1744 | 1748 |
| P ₅ | [mW] | 54,1 | 49,2 | 43,6 |
| | osc | 1741 | 1745 | 1749 |
| P ₁₀ | [mW] | 51,7 | 46,8 | 41,6 |
| | osc | 1742 | 1746 | 1750 |
| P ₁₅ | [mW] | 51,0 | 45,7 | 41,0 |
| | osc | 1743 | 1747 | 1751 |

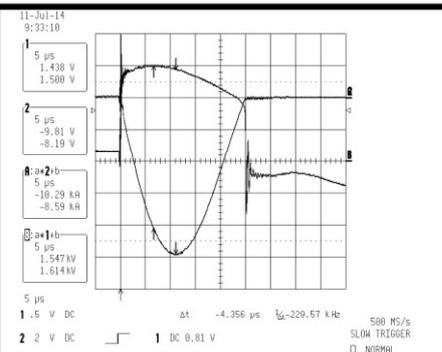
P_x - the power losses after x minutes after 15-th impulse current



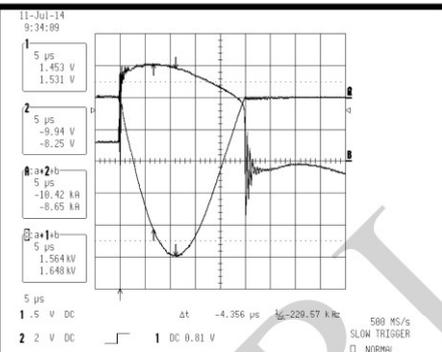
Oscillograms of voltage and impuls current during operating duty test of the SPD: NNO 10/440 no.24.



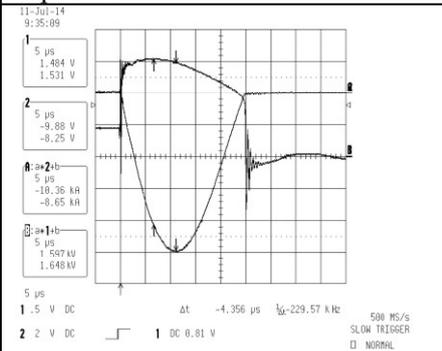
Impulse 1



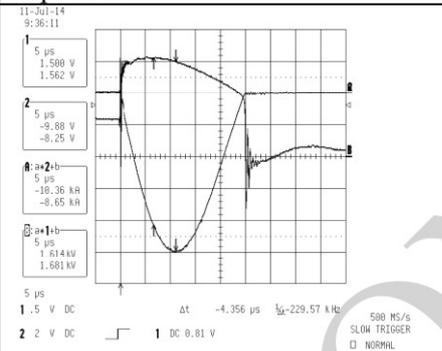
Impulse 2



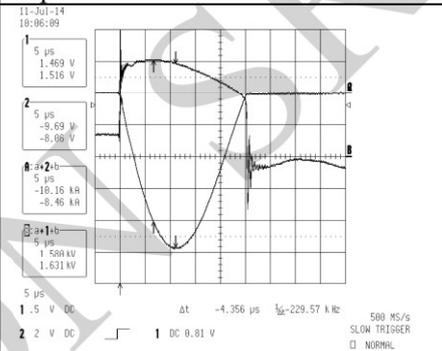
Impulse 3



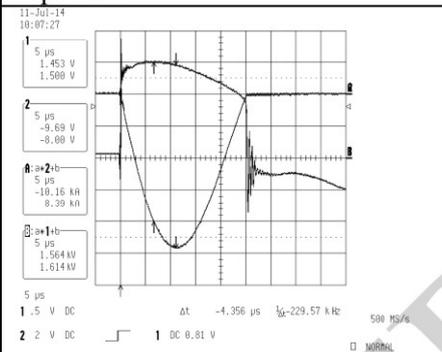
Impulse 4



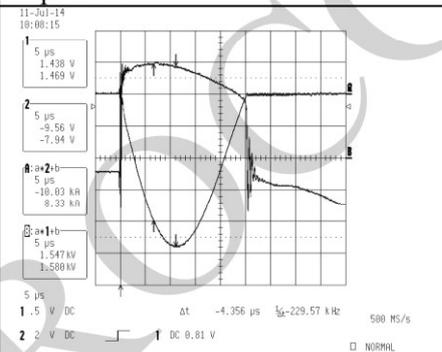
Impulse 5



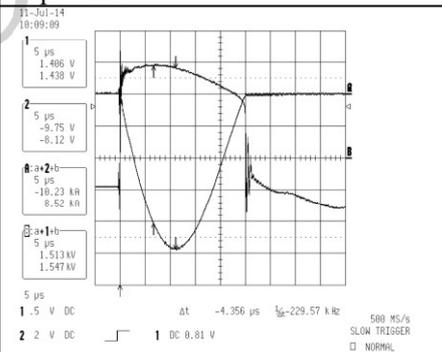
Impulse 6



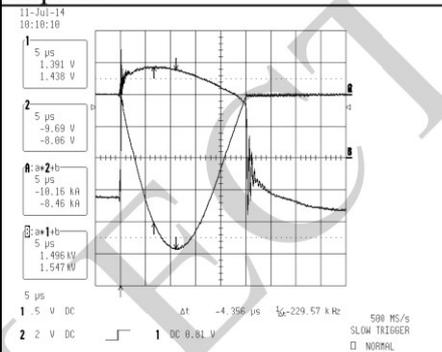
Impulse 7



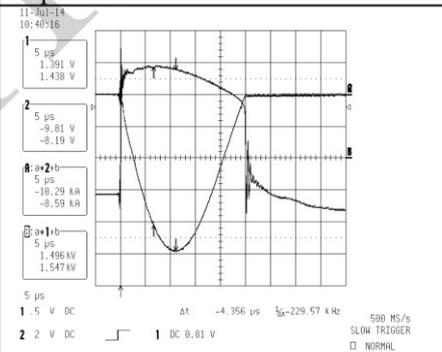
Impulse 8



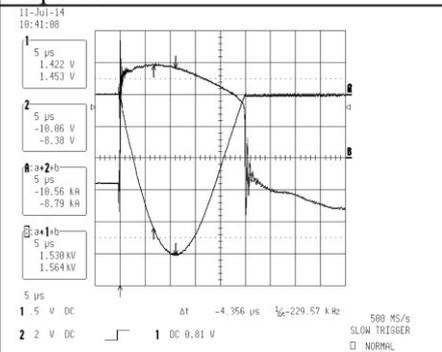
Impulse 9



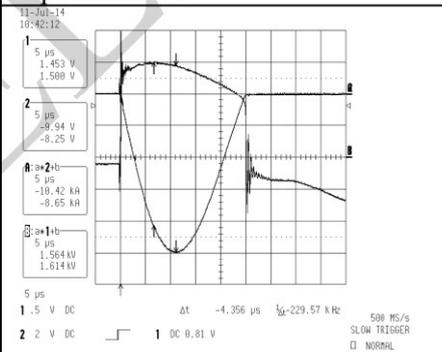
Impulse 10



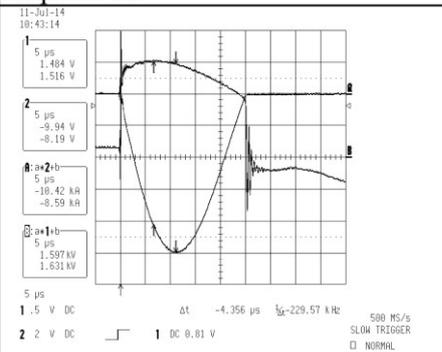
Impulse 11



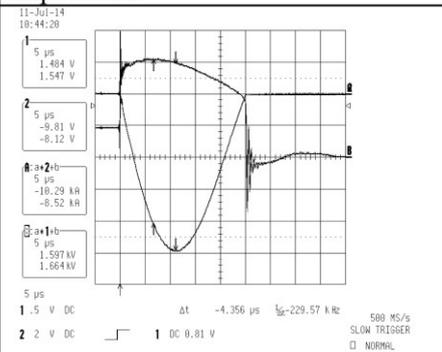
Impulse 12



Impulse 13

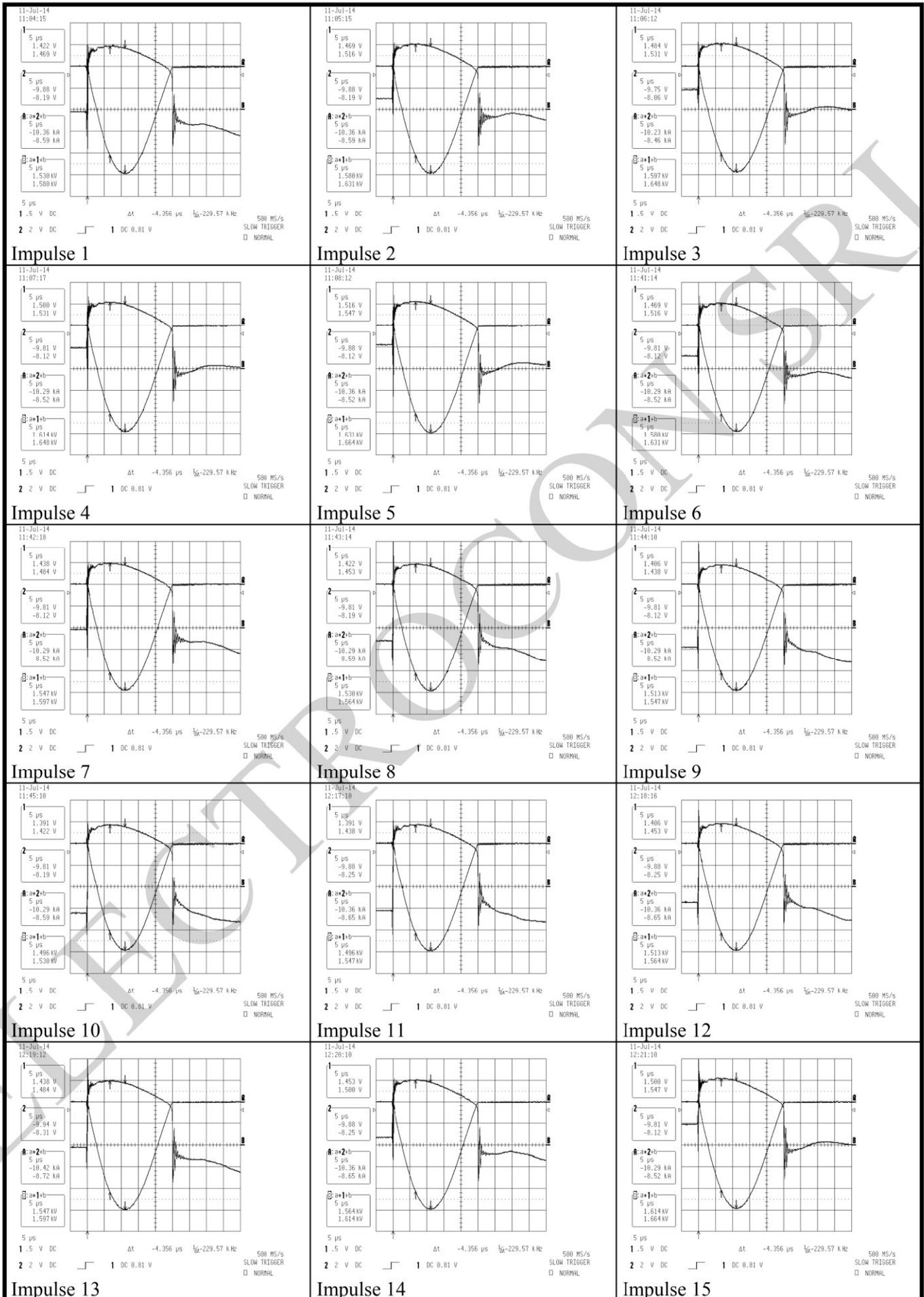


Impulse 14

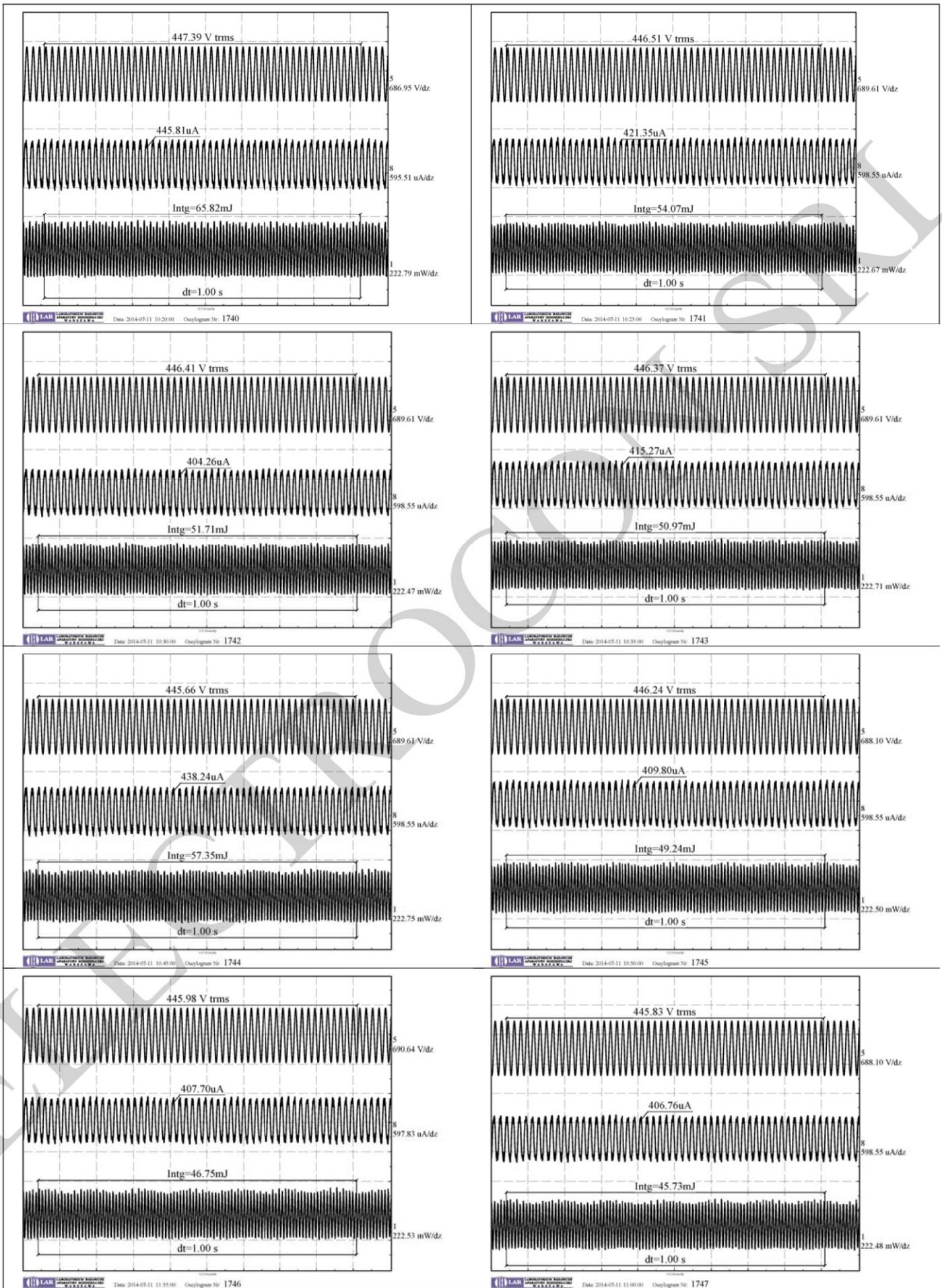


Impulse 15

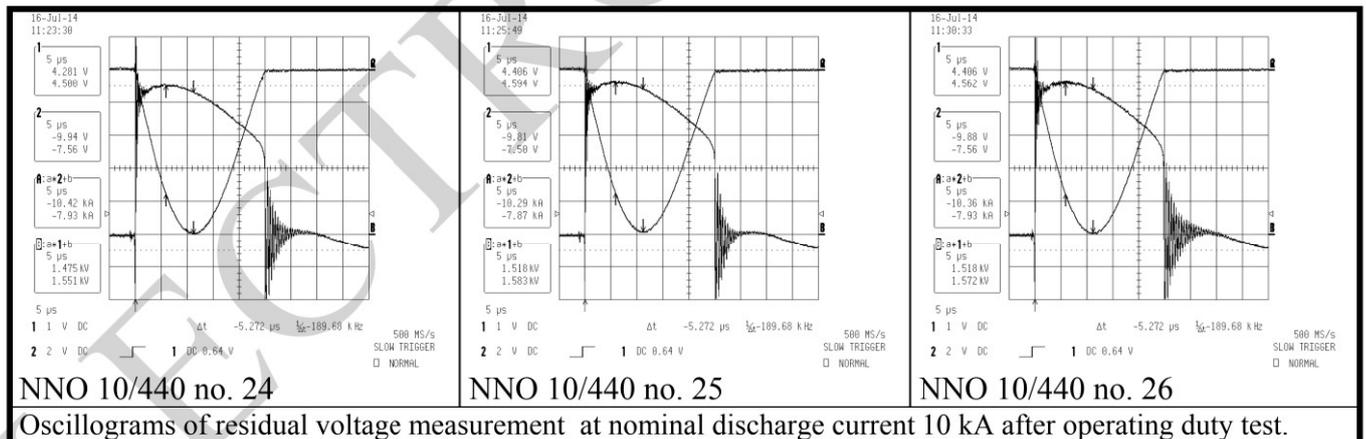
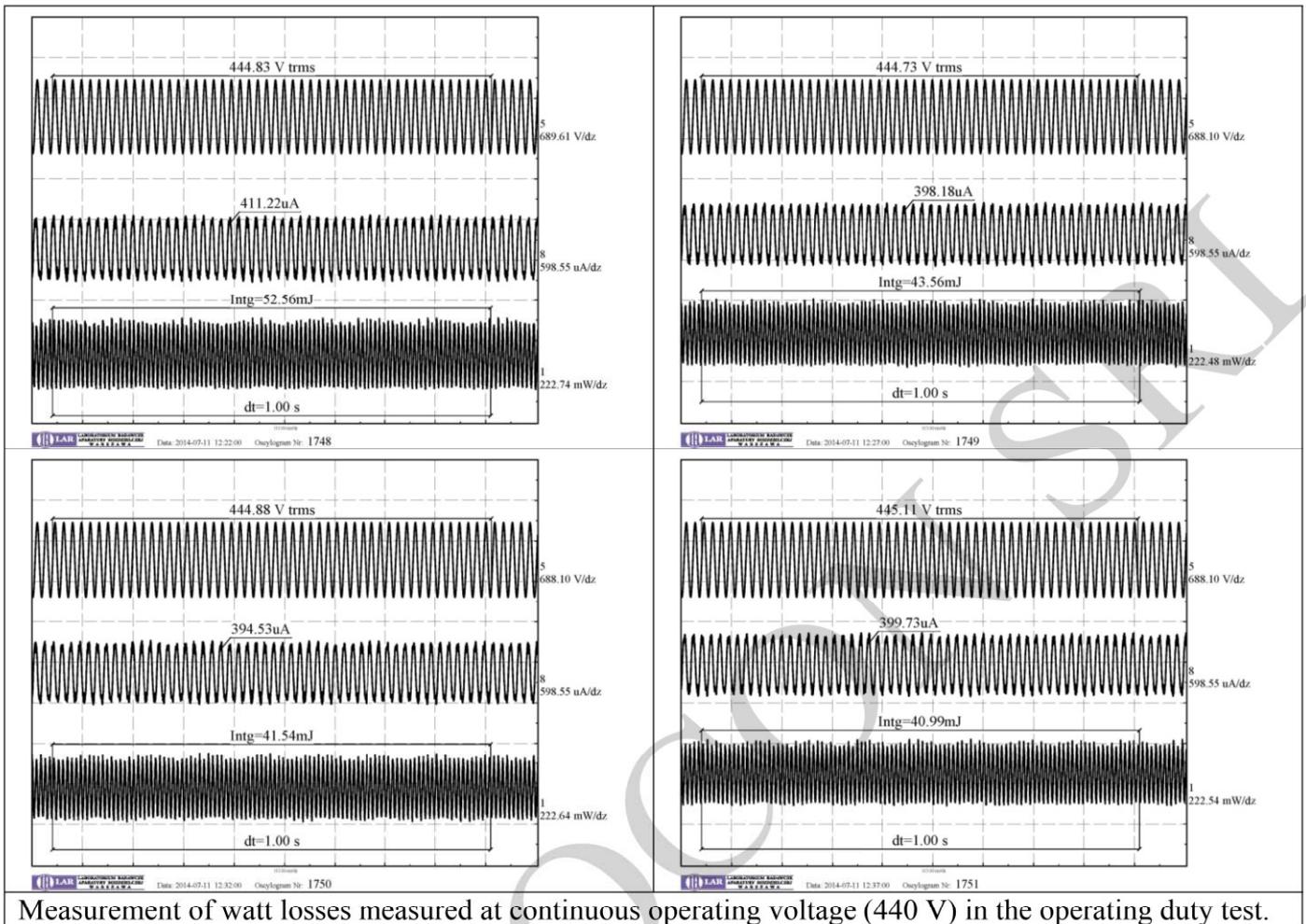
Oscillograms of voltage and impuls current during operating duty test of the SPD: NNO 10/440 no.25.



Oscillograms of voltage and impuls current during operating duty test of the SPD: NNO 10/440 no.26.



Measurement of watt losses measured at continuous operating voltage (440 V) in the operating duty test.



| | | NNO 10/440 | | |
|---------------------------------|-----|------------|--------|--------|
| | | no. 24 | no. 25 | no. 26 |
| Residual voltage | | | | |
| before test | [V] | 1540 | 1583 | 1562 |
| after test | [V] | 1551 | 1583 | 1572 |
| Voltage protection level | [V] | 1800 | | |

Residual current after operating duty test

| Sample | U_{REF} [V] | I_{PE} [μ A] |
|-------------------|---------------|---------------------|
| NNO 10/440 no. 24 | 257 | 40,6 |
| NNO 10/440 no. 25 | 258 | 38 |
| NNO 10/440 no. 26 | 257 | 38 |

Pass criteria for operating duty test for NNO 10/440

| | no. 24 | no. 25 | no. 26 |
|-------------|-------------|-------------|-------------|
| A | Was applied | Was applied | Was applied |
| B | | | |
| C | | | |
| D | | | |
| E | | | |
| F | | | |
| G | | | |
| M | | | |
| Test result | Passed | Passed | Passed |

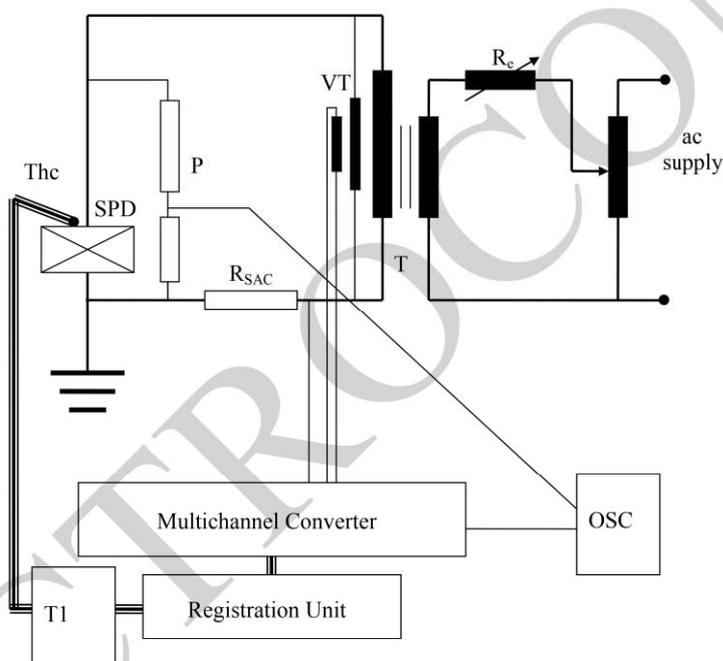
7. Thermal stability

EN 61643-11:2012 cl. 8.3.5.2

IEC 61643-11:2011 cl. 8.3.5.2

TEST CIRCUIT

OP3



OSC - digital oscilloscope type **LeCroy-9350A NWN 801-06400**

VT –voltage transformer

T- Test transformer

SPD –tested surge protective device

Thc –thermocouple type J no.1

T1 – temperature meter **EMT200** no.1

R_{sac} –ac current shunt 100 Ω nr 184.

R_e –Adjustable inductive reactor limiting the test current

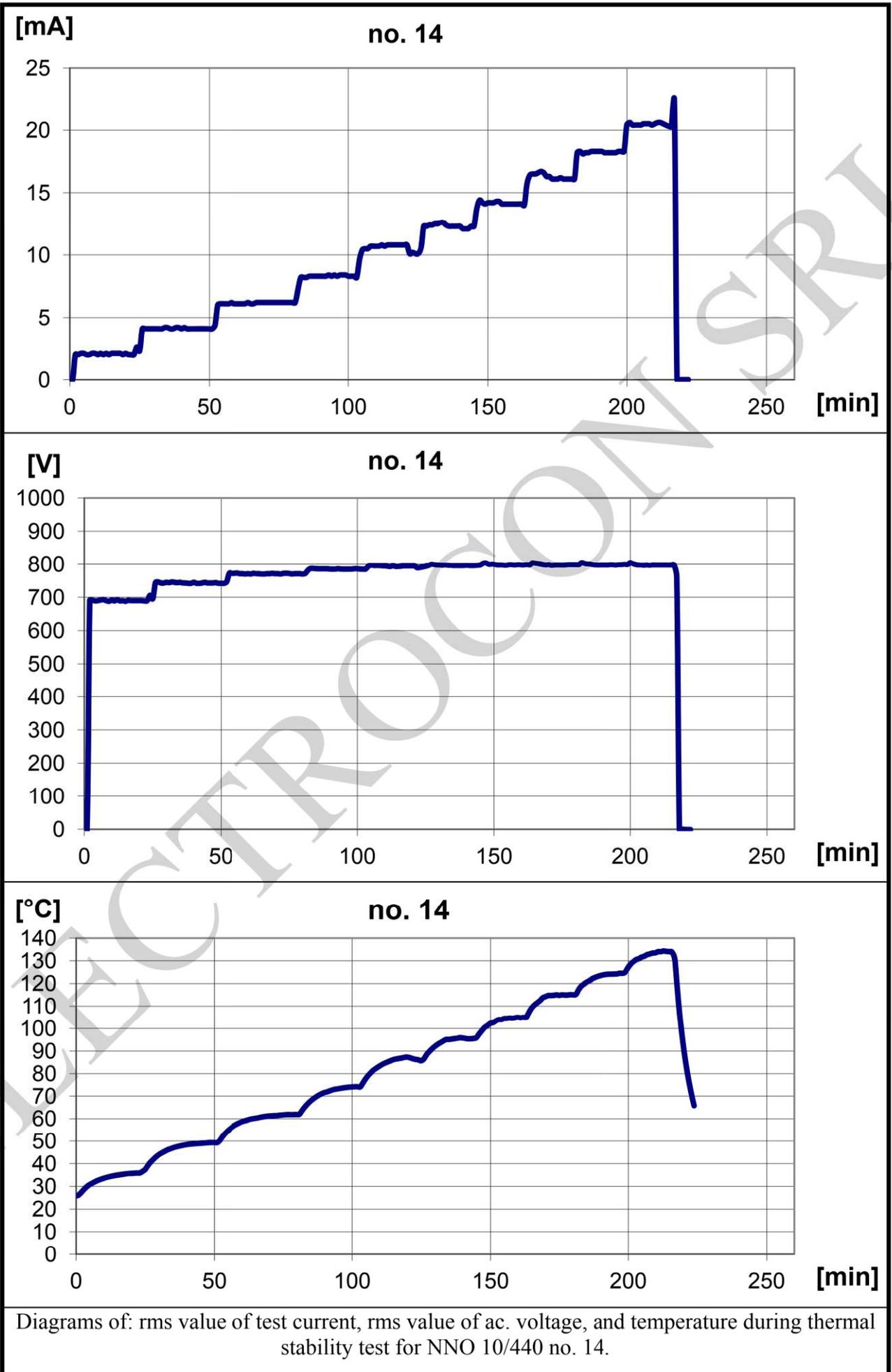
| | NNO 10/440 | | |
|--------------------------------------|--|-------------------------------|-------------------------------|
| | No. 14 | No. 15 | No. 16 |
| Test currents [mA] | 2; 4; 6; 8; 10; 12; 14; 16; 18; 20; 22 | 12; 14; 16; 18; 20; 22; 24 | 12; 14; 16; 18; 20; 22; 24 |
| Max. temperature [°C] | 134,1 | 146,4 | 141,1 |
| Time to disconnector operation [min] | 217 | 127 | 137 |

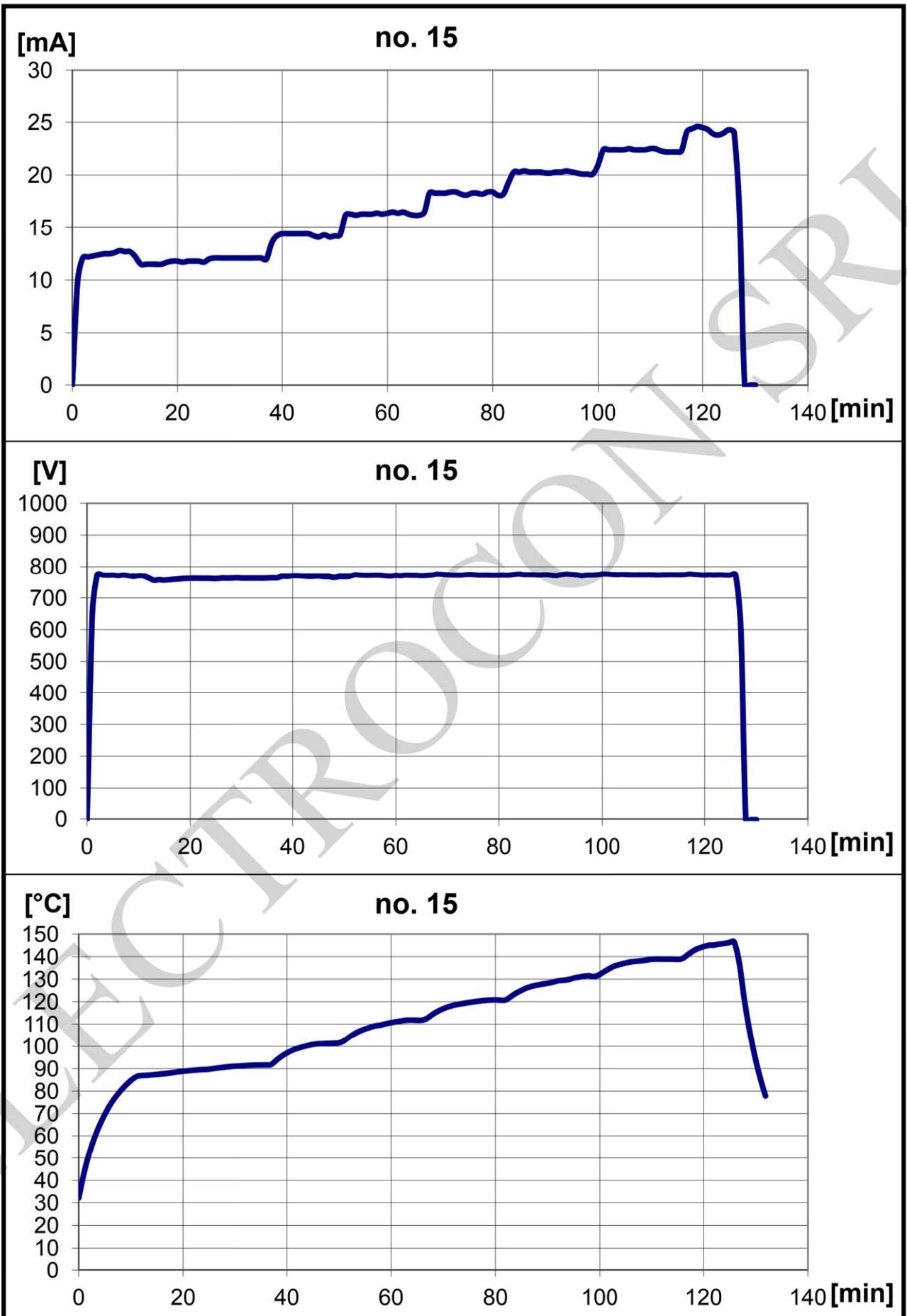
Pass criteria for thermal stability test for NNO 10/440

| | no. 14 | no. 15 | no. 16 |
|-------------|-------------|-------------|-------------|
| C | Was applied | Was applied | Was applied |
| H | | | |
| I | | | |
| J | | | |
| M | | | |
| O | | | |
| Test result | Passed | Passed | Passed |

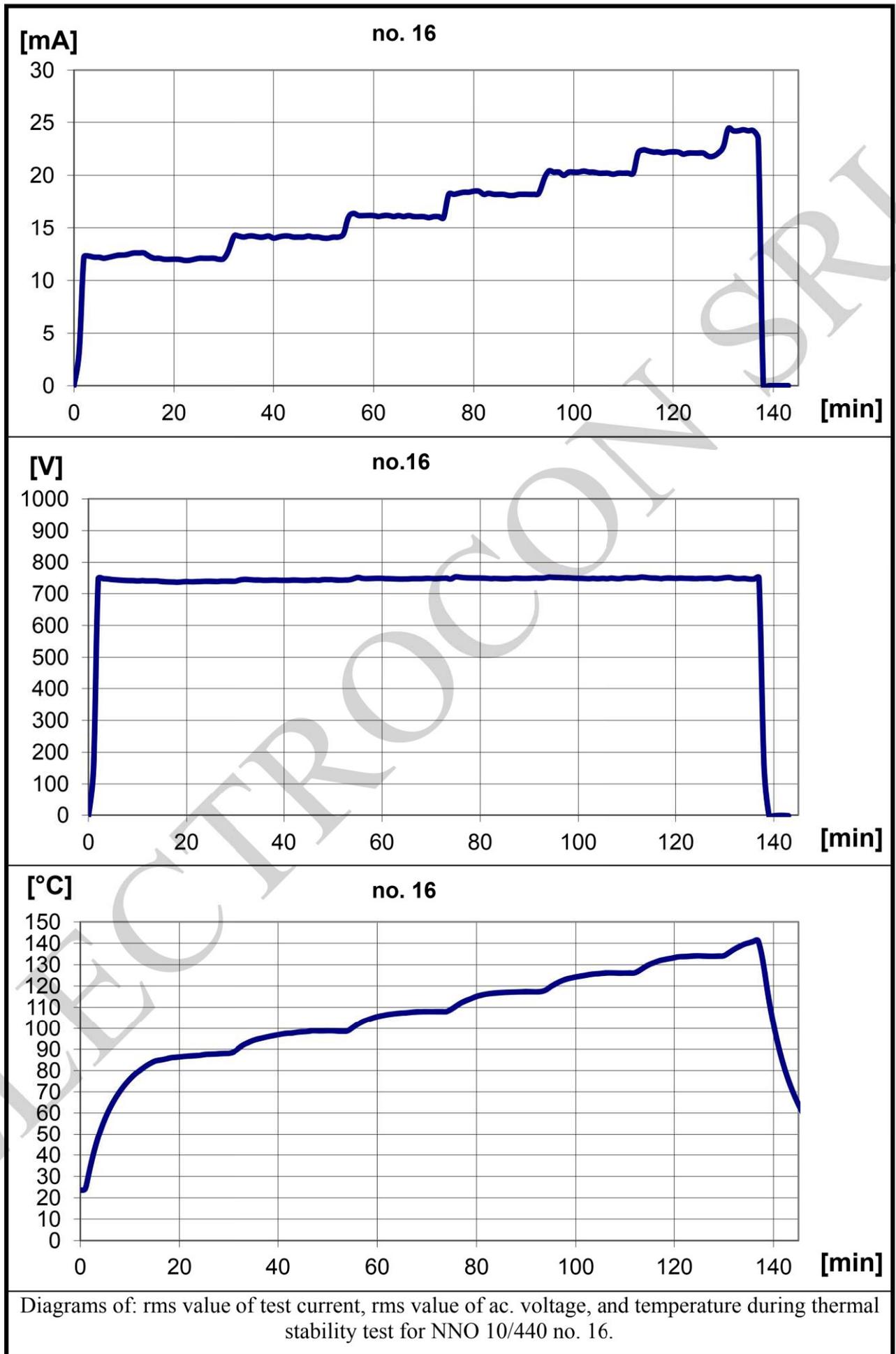


The red arrow shows the point of temperature measurement, which has been determined in the initial test as the hottest spot of the housing of the SPD type NNO 10/440.





Diagrams of: rms value of test current, rms value of ac. voltage, and temperature during thermal stability test for NNO 10/440 no. 15.





View of NNO 10/440 no. 14 after operating.



View of NNO 10/440 no. 15 after operating.



View of NNO 10/440 no. 16 after operating.

8. Air clearances and creepage distances

EN 61643-11:2012 cl. 8.4.3

IEC 61643-11:2011 cl. 8.4.3

The test was carried out in Testing and Calibrating Laboratory (NBW) in the Electrotechnical Institute and was written in test report: 400/NZL/NBW/2014/O

9. Ball pressure test

EN 61643-11:2012 cl. 8.5.3

IEC 61643-11:2011 cl. 8.5.3

The test was carried out in Testing and Calibrating Laboratory (NBW) in the Electrotechnical Institute and was written in test report: 400/NZL/NBW/2014/O.

10. Resistance to abnormal heat and fire

EN 61643-11:2012 cl. 8.5.4

IEC 61643-11:2011 cl. 8.5.4

The test was carried out in Testing and Calibrating Laboratory (NBW) in the Electrotechnical Institute and was written in test report: 178/NZL/NBW/2014/O.

11. Tracking resistance

EN 61643-11:2012 cl. 8.5.5

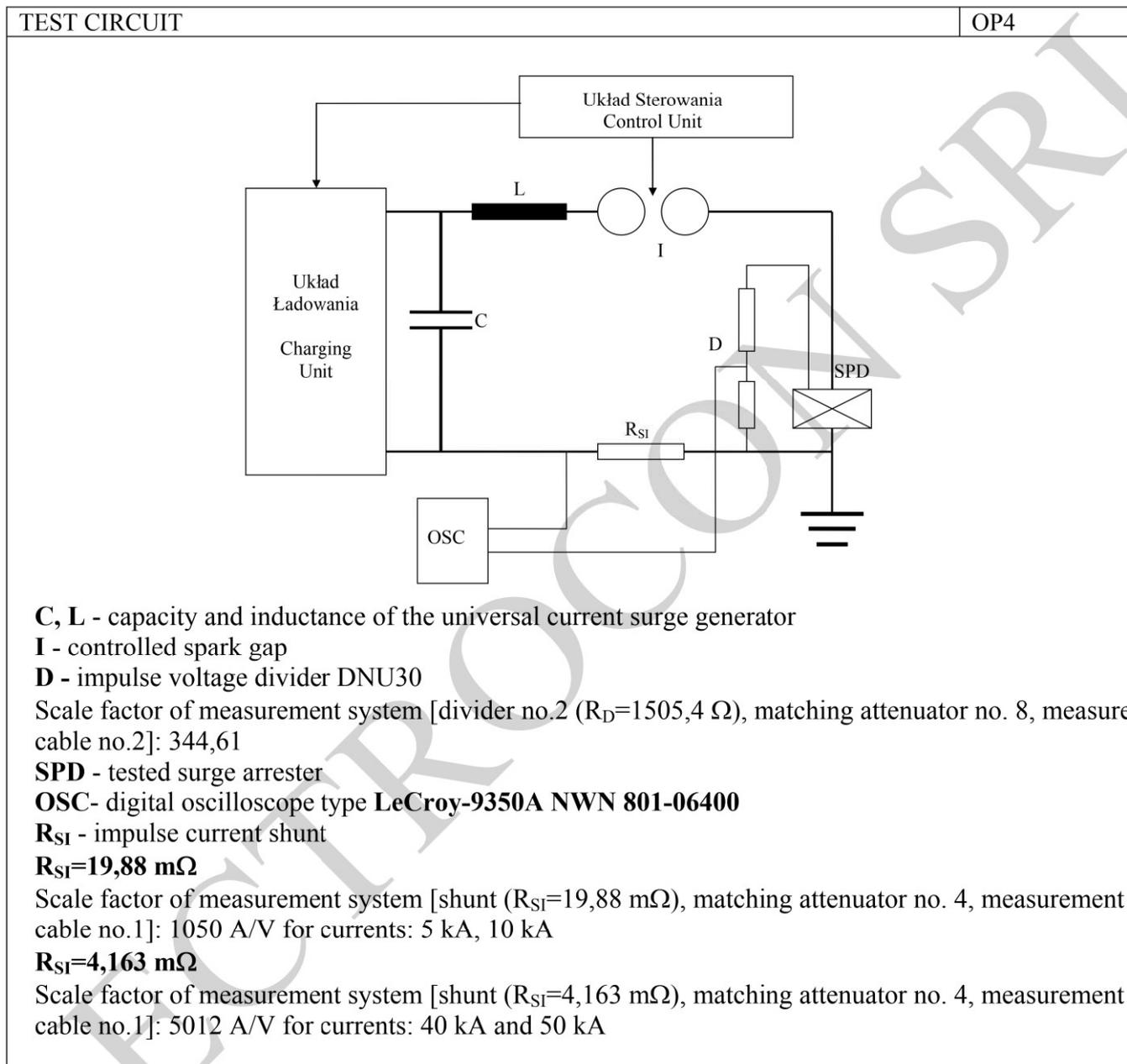
IEC 61643-11:2011 cl. 8.5.5

The test was carried out in Testing and Calibrating Laboratory (NBW) in the Electrotechnical Institute and was written in test report: 400/NZL/NBW/2014/O.

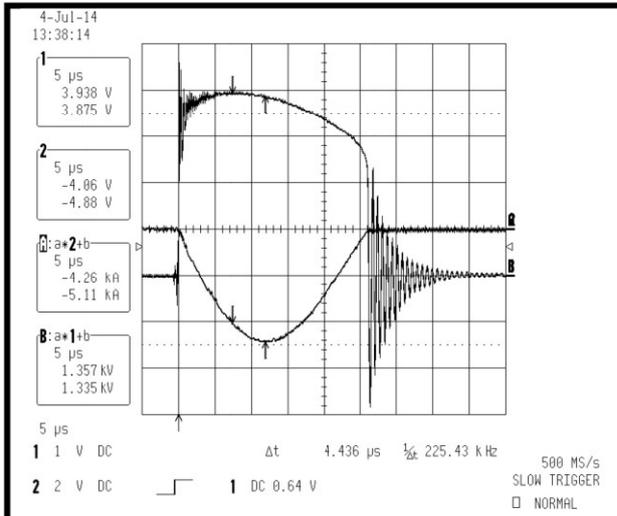
12. Residual voltage

EN 61643-11:2012 cl. 8.3.3.1

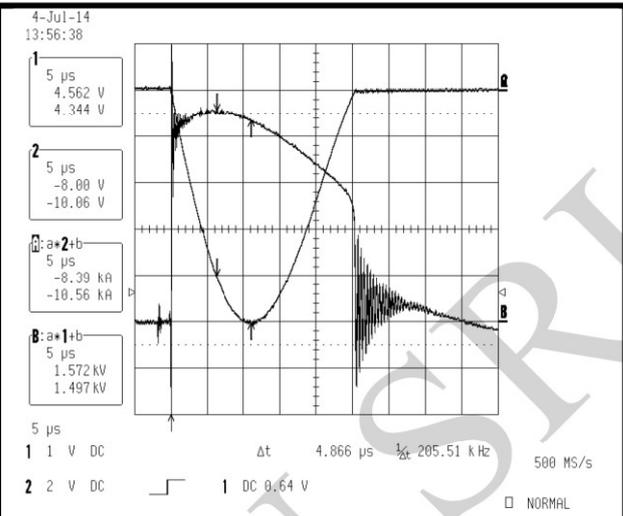
IEC 61643-11:2011 cl. 8.3.3.1



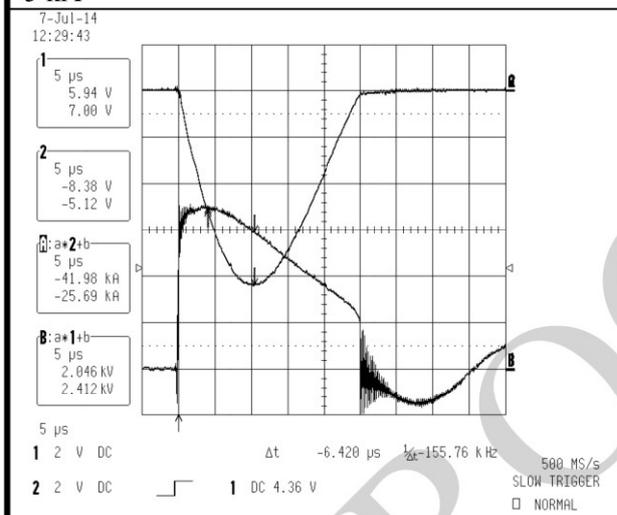
| NNO 10/440 No. 27 | | | NNO 10/440 No. 28 | | | NNO 10/440 No. 29 | | |
|--------------------|------------------|---------------|--------------------|------------------|---------------|--------------------|------------------|---------------|
| $I_{8/20}$ [kA] | U_{RES} [V] | Energy [J] | $I_{8/20}$ [kA] | U_{RES} [V] | Energy [J] | $I_{8/20}$ [kA] | U_{RES} [V] | Energy [J] |
| Positive polarity | | | | | | | | |
| 5,11 | 1357 | | 5,11 | 1368 | | 5,05 | 1389 | |
| 10,56 | 1572 | | 10,49 | 1583 | | 10,49 | 1605 | |
| 41,98 | 2412 | 1239 | 40,42 | 2434 | 1201 | 40,10 | 2412 | 1213 |
| 50,44 | 2649 | 1607 | 50,13 | 2692 | 1600 | 49,82 | 2692 | 1611 |
| Negative polarity | | | | | | | | |
| 5,05 | 1335 | | 5,11 | 1357 | | 5,05 | 1357 | |
| 10,10 | 1529 | | 10,03 | 1551 | | 10,23 | 1583 | |



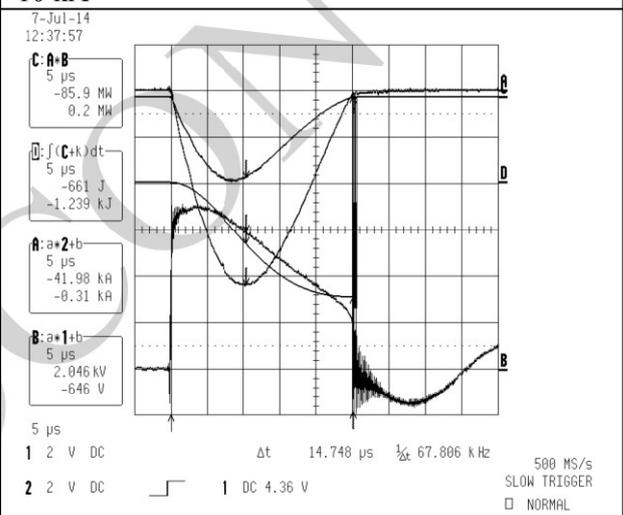
5 kA



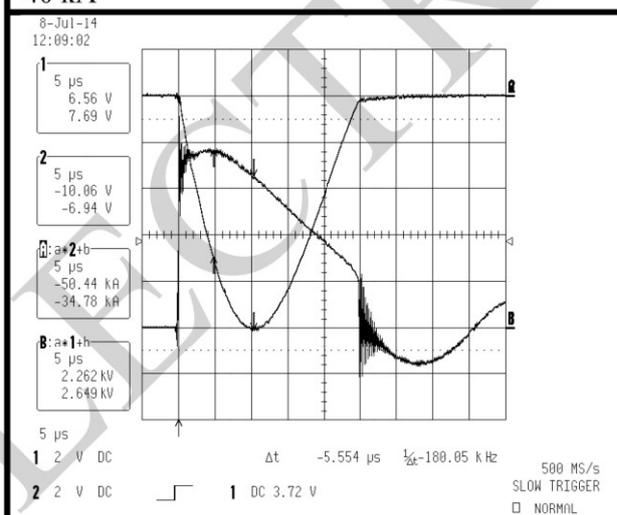
10 kA



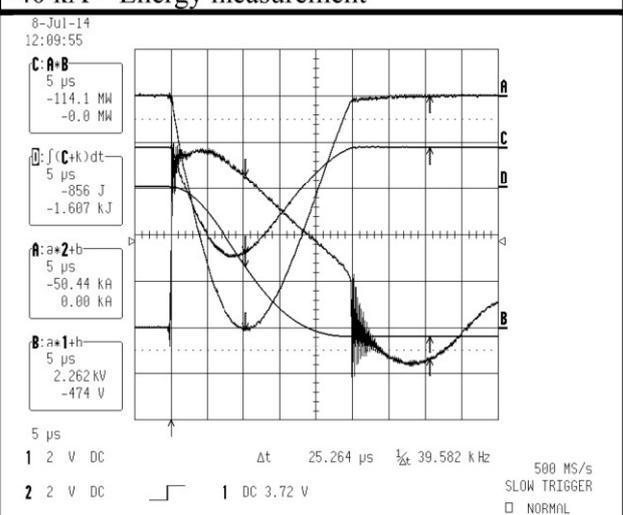
40 kA



40 kA – Energy measurement

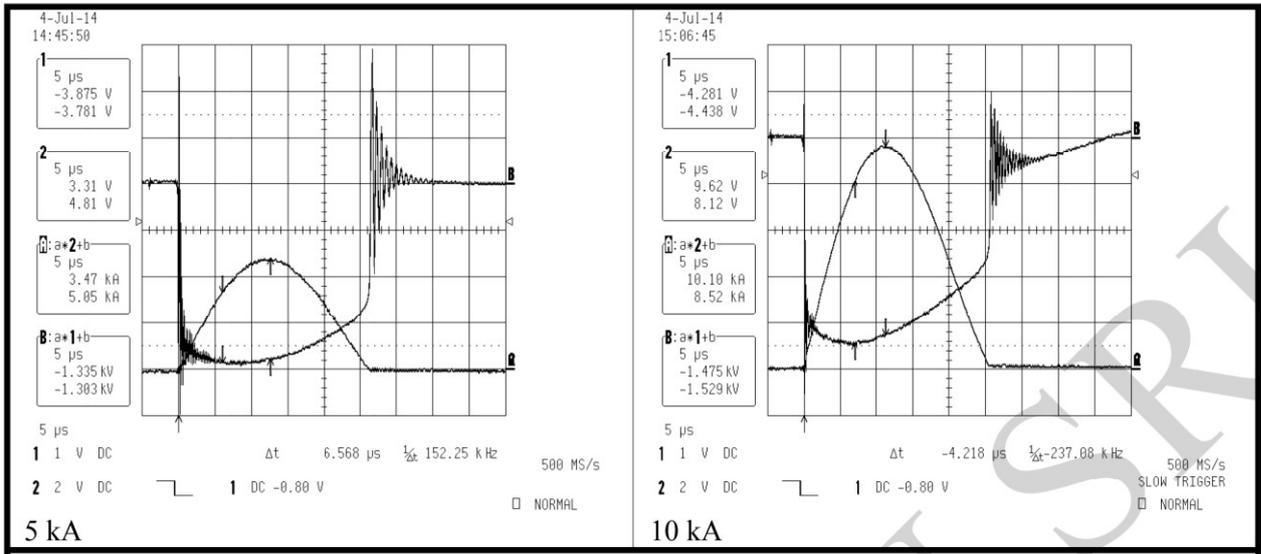


50 kA

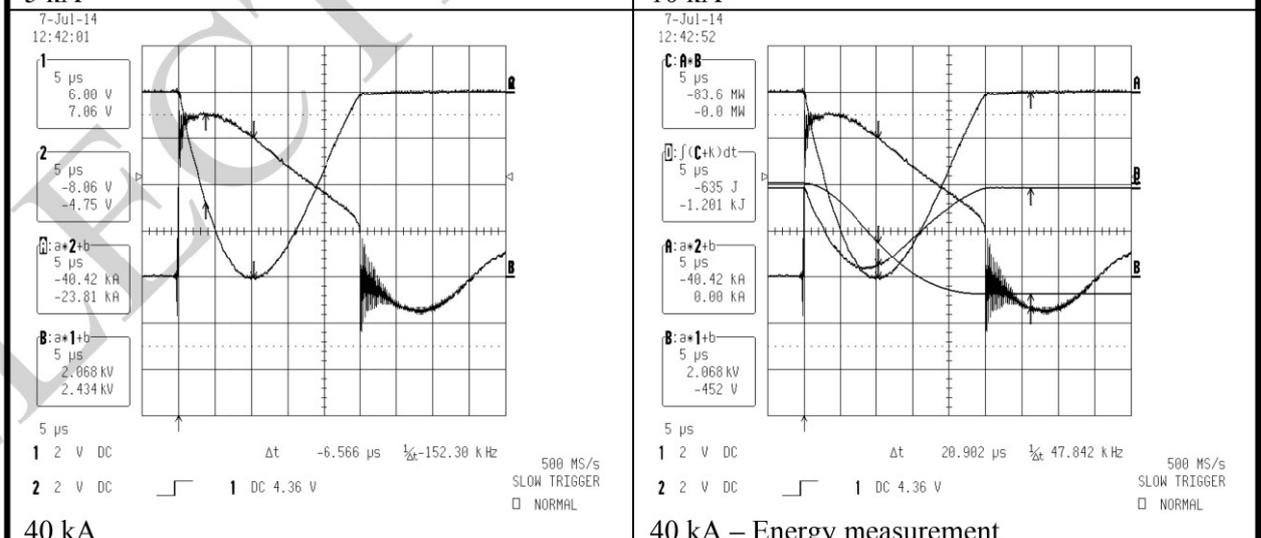
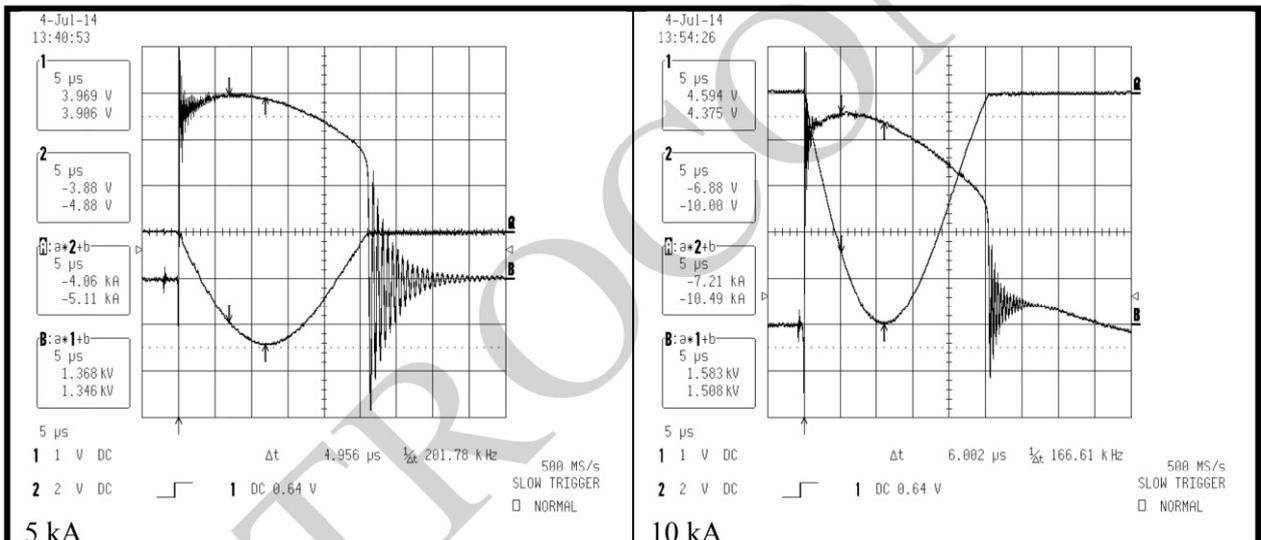


50 kA – Energy measurement

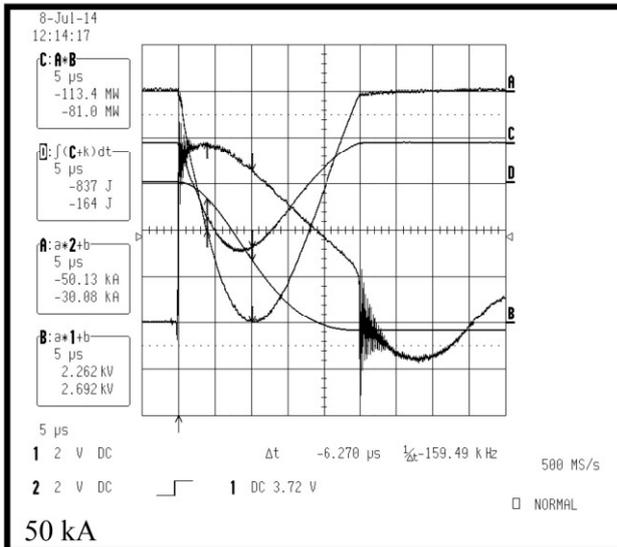
Oscillograms of voltage and impulse current during residual voltage test of the SPD: NNO 10/440 No. 27.



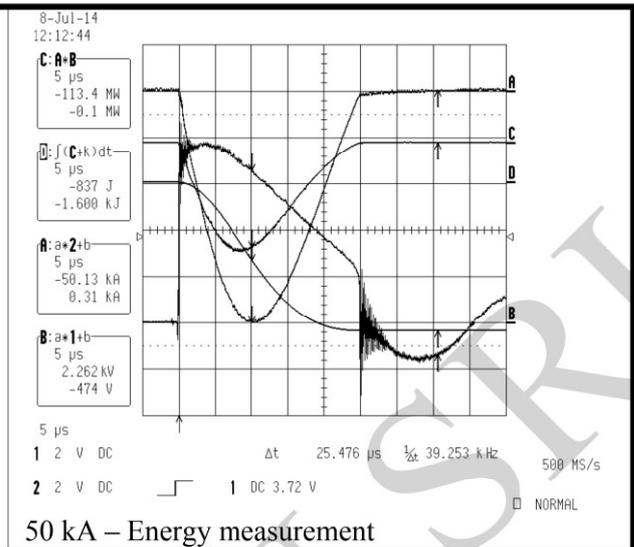
Oscillograms of voltage and impulse current during residual voltage test of the SPD: NNO 10/440 No. 27.



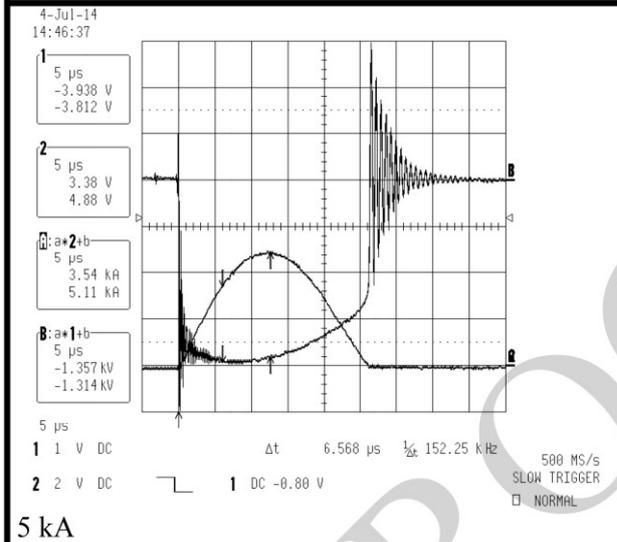
Oscillograms of voltage and impulse current during residual voltage test of the SPD: NNO 10/440 No. 28.



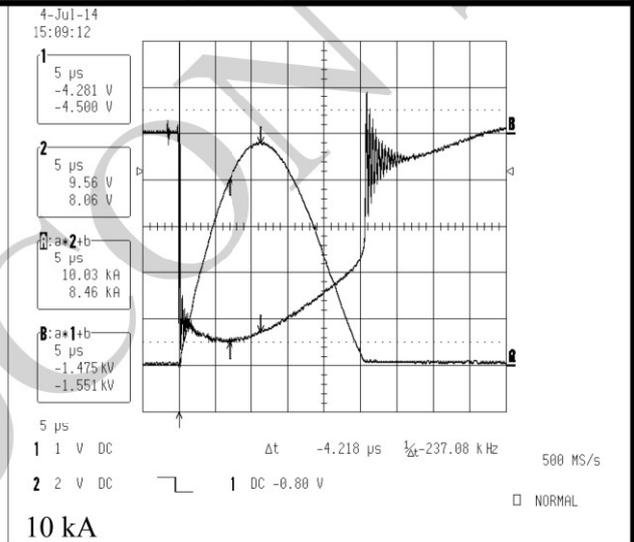
50 kA



50 kA – Energy measurement

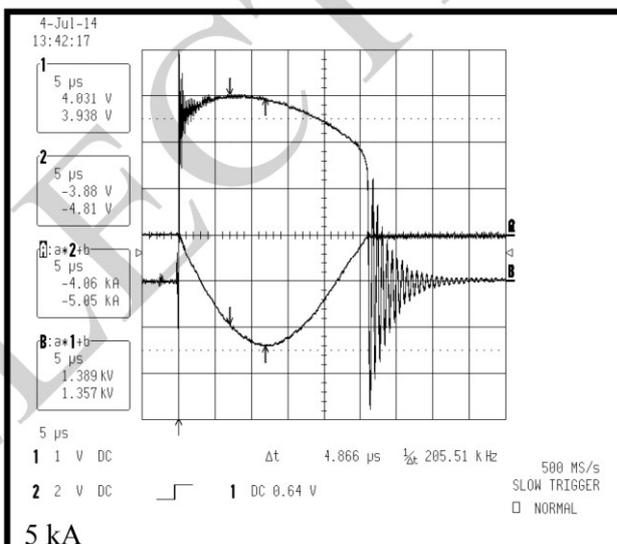


5 kA

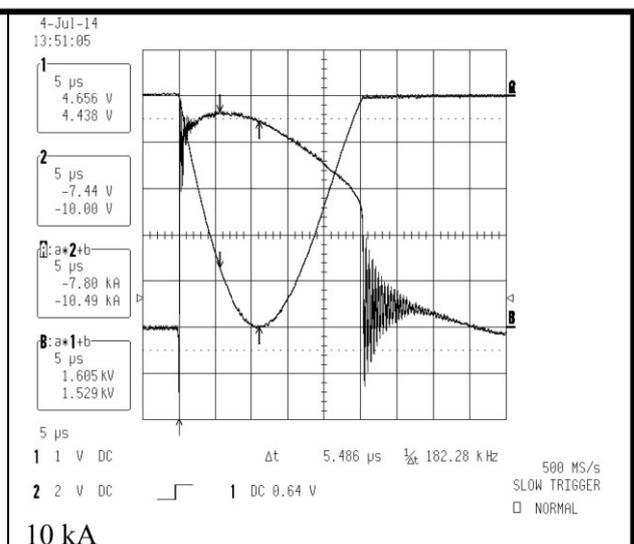


10 kA

Oscillograms of voltage and impulse current during residual voltage test of the SPD: NNO 10/440 No. 28.

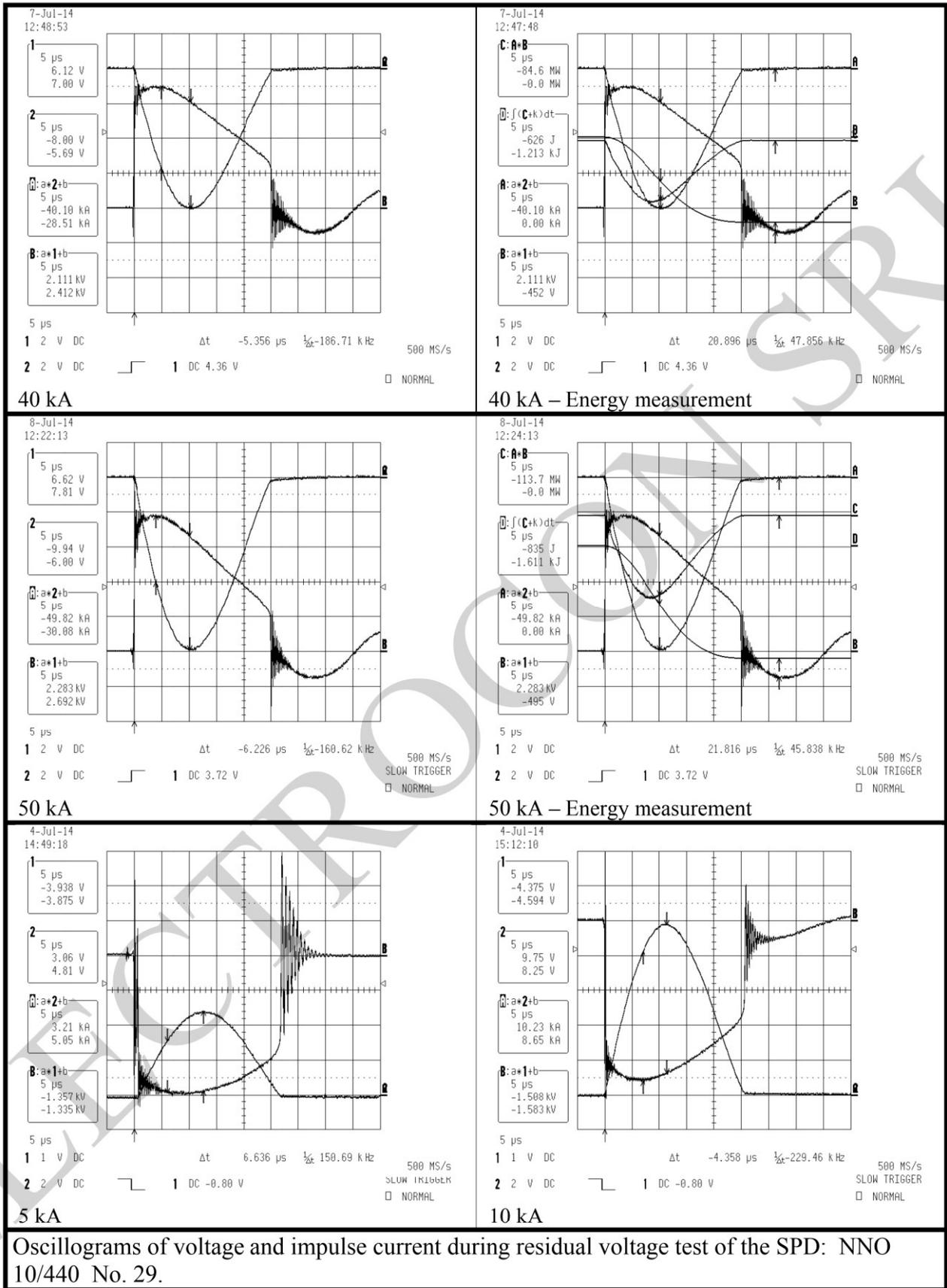


5 kA



10 kA

Oscillograms of voltage and impulse current during residual voltage test of the SPD: NNO 10/440 No. 29.



Oscillograms of voltage and impulse current during residual voltage test of the SPD: NNO 10/440 No. 29.

For the residual voltage test were used SPD's with 0,13 m length earthing wire.

13. Insulation resistance

EN 61643-11:2012 cl. 8.3.6

IEC 61643-11:2011 cl. 8.3.6

The test was carried out in Testing and Calibrating Laboratory (NBW) in the Electrotechnical Institute and was written in test report: 400/NZL/NBW/2014/O.

14. Dielectric withstand

EN 61643-11:2012 cl. 8.3.7

IEC 61643-11:2011 cl. 8.3.7

For the test were used SPD's without varistors.

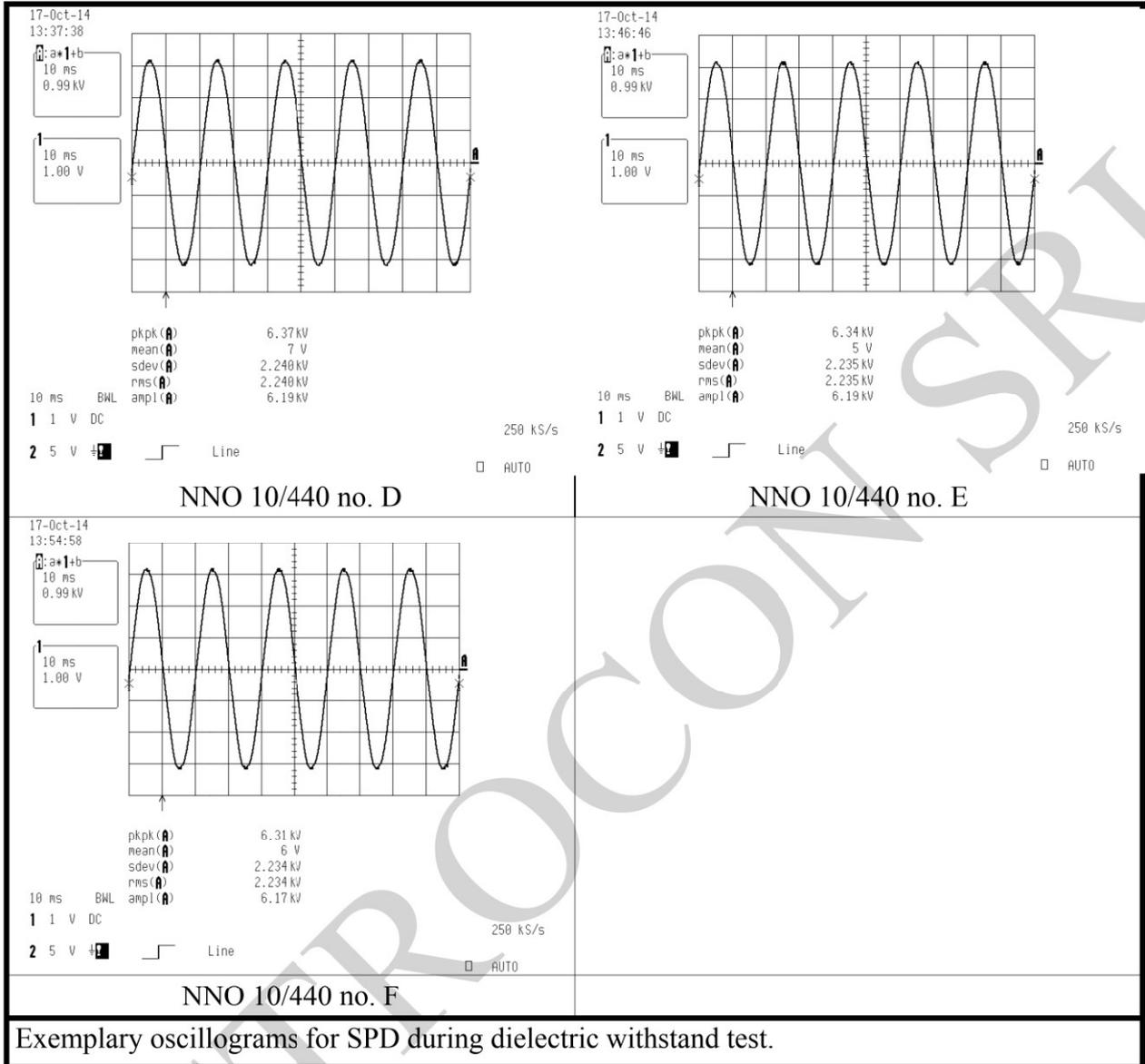
Ambient conditions:

| | |
|----------------------|---------------------|
| Ambient temperature | 18,9 ⁰ C |
| Atmospheric Pressure | 1002 hPa |
| Relative humidity | 49,7% |

Precipitation conditions for wet test

| | |
|--|----------|
| Temperature of the water | 16 °C |
| Resistivity of the water | 115 Ωm |
| Average precipitation – vertical component | 2 mm/min |
| Average precipitation – horizontal component | 2 mm/min |

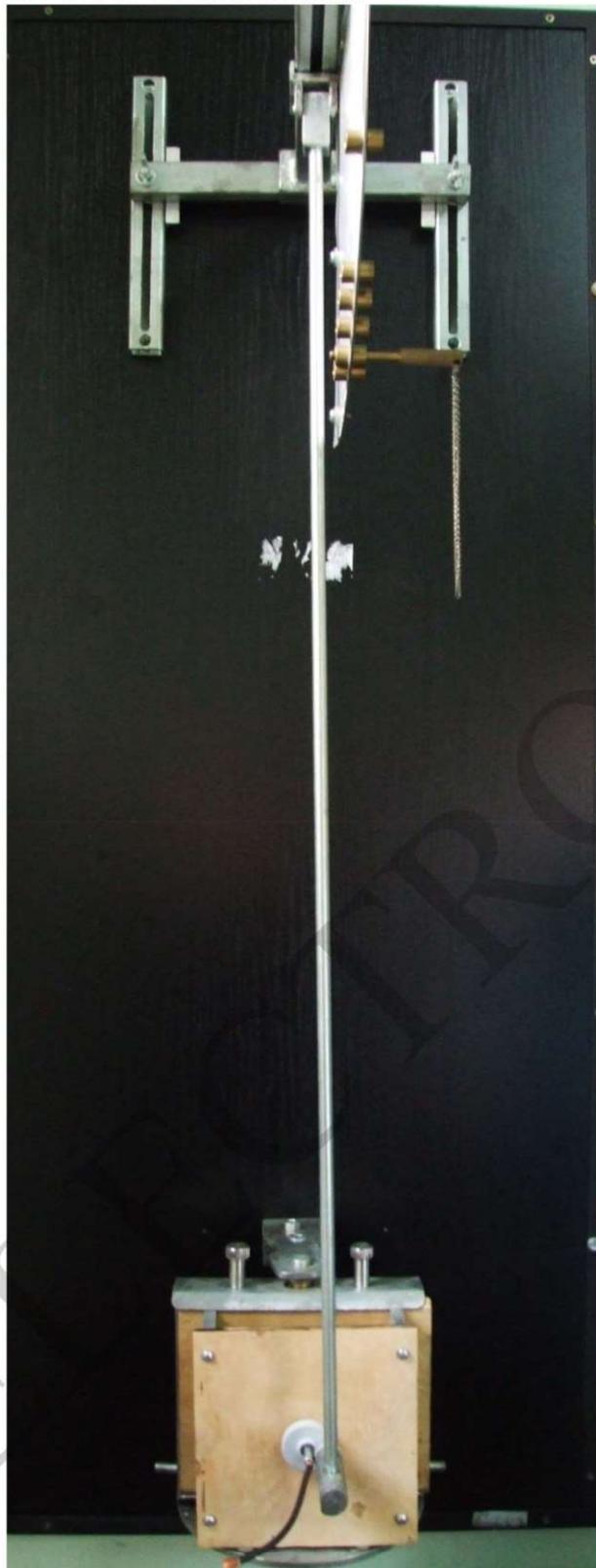
| Dielectric withstand | NNO 10/440 | | |
|--|--------------------------------|--------------------------------|--------------------------------|
| | No. D | No. E | No. F |
| Initially pre-wetted before test - unconditioned mains water [min] | 15 | 15 | 15 |
| Initially pre-wetted before test - standard water with all precipitation condition [min] | 2 | 2 | 2 |
| Test voltage [50Hz][V] | 2240 | 2235 | 2234 |
| Duration [s] | 60 | 60 | 60 |
| Remarks | Didn't arcing or puncturing | Didn't arcing or puncturing | Didn't arcing or puncturing |
| Result of the test | Passed | Passed | Passed |



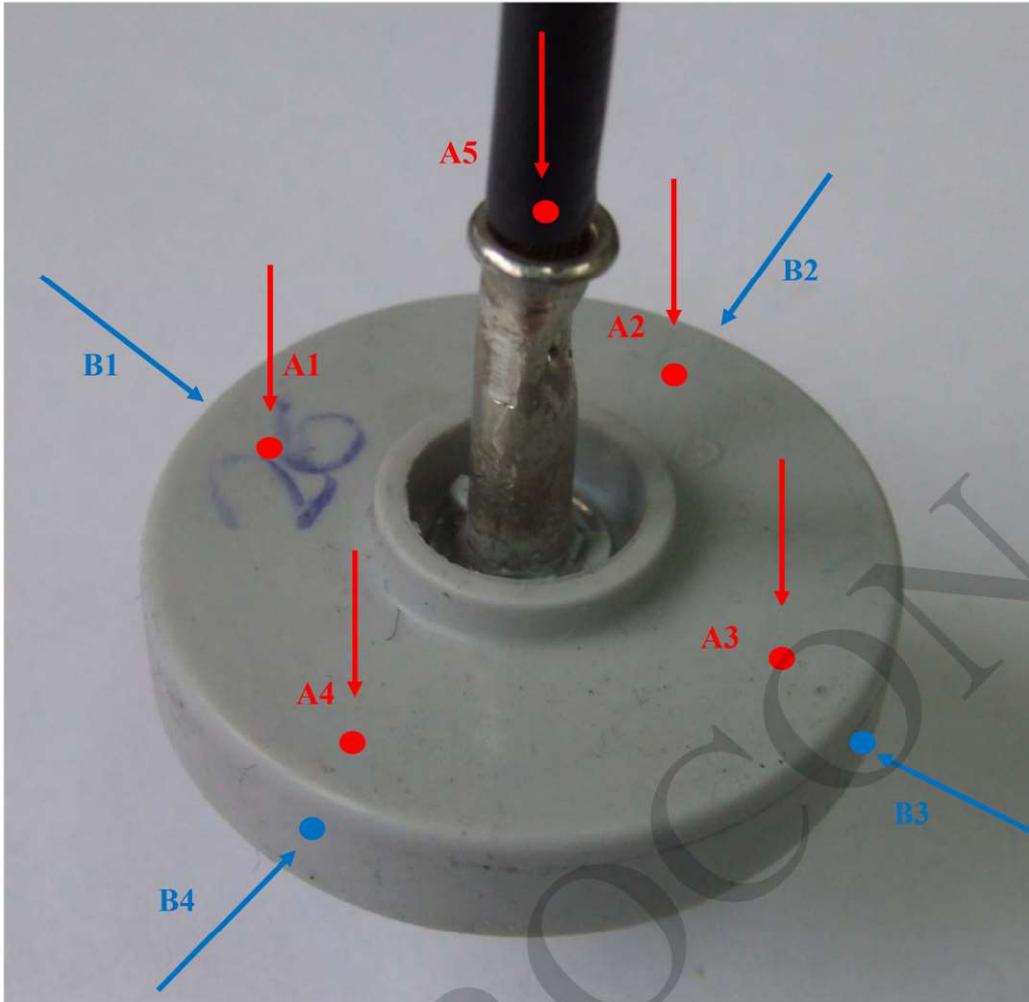
15. Mechanical strength – Impact test

EN 61643-11:2012 cl. 8.4.4

IEC 61643-11:2011 cl. 8.4.4



Test apparatus for impact test.



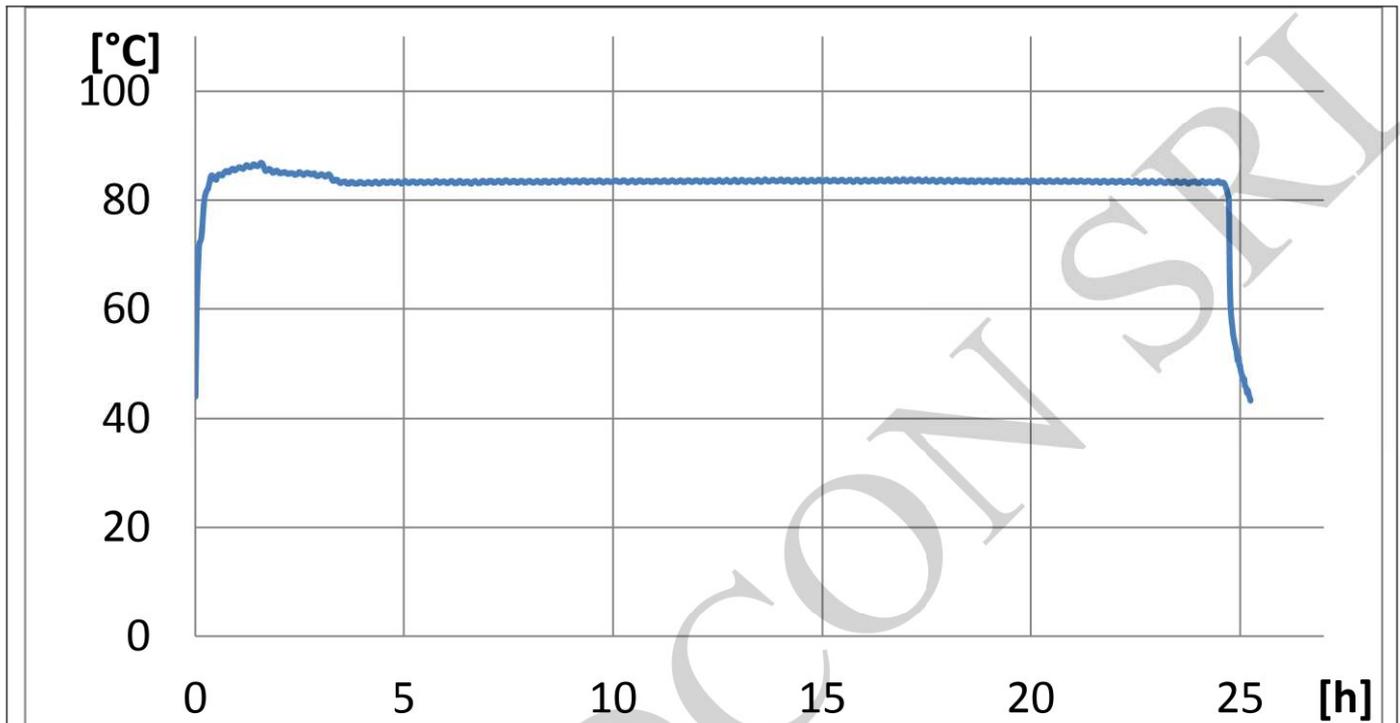
Points , where the striking element hit on the SPD's surface. Red points – parts A. Blue points – parts B.

| Impact test | NNO 10/440 No. 24 [cm] | NNO 10/440 No. 25 [cm] | NNO 10/440 No. 26 [cm] |
|-------------|------------------------------|------------------------------|------------------------------|
| A1 | 10 | 10 | 10 |
| A2 | 10 | 10 | 10 |
| A3 | 10 | 10 | 10 |
| A4 | 10 | 10 | 10 |
| A5 | 10 | 10 | 10 |
| B1 | 10 | 10 | 10 |
| B2 | 10 | 10 | 10 |
| B3 | 10 | 10 | 10 |
| B4 | 10 | 10 | 10 |
| Remarks | No damage | No damage | No damage |
| Test result | Passed | Passed | Passed |

16. Temperature withstand

EN 61643-11:2012 cl. 8.3.5.1

IEC 61643-11:2011 cl. 8.3.5.1



The temperature registered in the heated cabinet during temperature withstand test.

Pass criteria for temperature withstand test for NNO 10/440:

| | no. 10 | no. 11 | no. 12 |
|-------------|-------------|-------------|-------------|
| C | Was applied | Was applied | Was applied |
| G | Was applied | Was applied | Was applied |
| Test result | Passed | Passed | Passed |

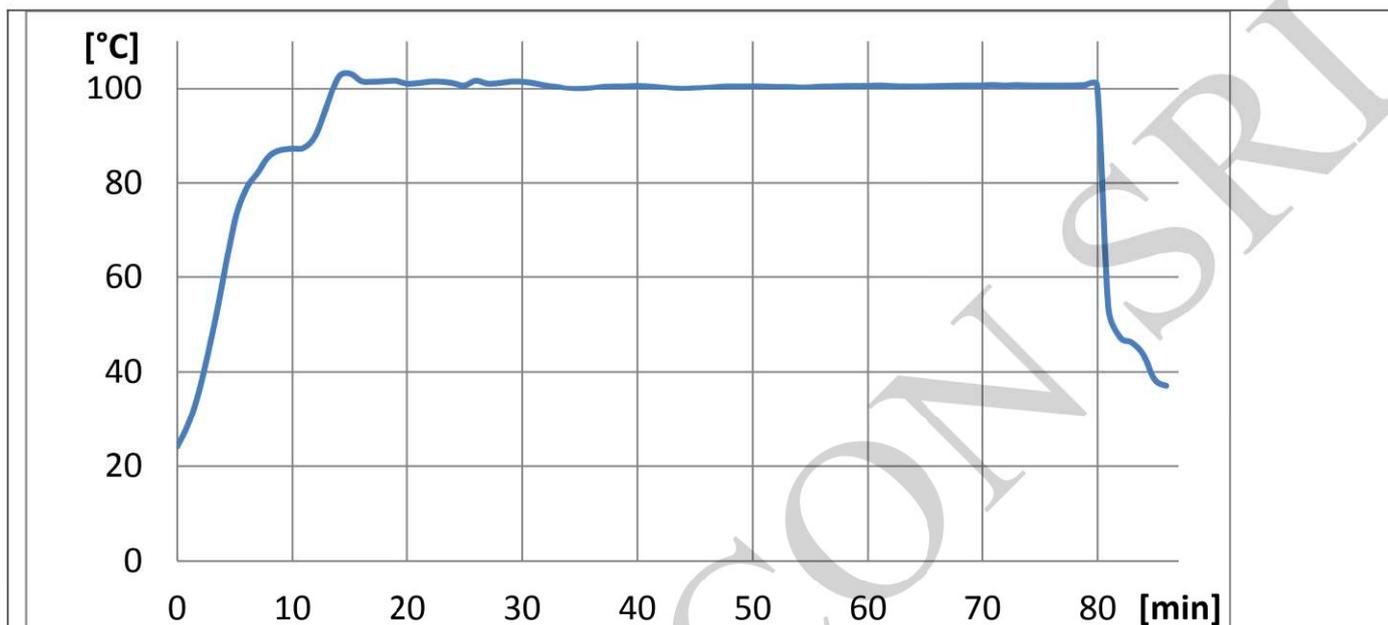


View of the SPD's type NNO after temperature withstand test.

17. Heat resistance

EN 61643-11:2012 cl. 8.5.2

IEC 61643-11:2011 cl. 8.5.2



The temperature registered in the heated cabinet during heat resistance test.

Pass criteria for heat resistance test for NNO 10/440:

| | no. 24 | no. 25 | no. 26 |
|--------------------------|----------------|----------------|----------------|
| C | Was applied | Was applied | Was applied |
| I | Was applied | Was applied | Was applied |
| Additional pass criteria | Was applied | Was applied | Was applied |
| Disconnecter | didn't operate | didn't operate | didn't operate |
| Test result | Passed | Passed | Passed |

18. TOVs caused by faults or disturbances in the low voltage system

EN 61643-11:2012 cl. 8.3.8.1

IEC 61643-11:2011 cl. 8.3.8.1

Acc. to cl. 7.2.8.1 for NNO 5/440 and NNO10/440 is no need to perform this test because test voltage U_T is lower and equal to U_c .

19. TOVs caused by faults in the high (medium) voltage system

EN 61643-11:2012 cl. 8.3.8.2

IEC 61643-11:2011 cl. 8.3.8.2

The SPDs type NNO are designed only for TN-systems. For TN-system is not carried out this test.

20. Short-circuit current behaviour

EN 61643-11:2012 cl. 8.3.5.3

IEC 61643-11:2011 cl. 8.3.5.3

The SPDs type NNO are classified for outdoor use and for mounting out of reach. For this use and mounting is not carried out this test.

5. IDENTIFICATION DOCUMENTATION. DRAWINGS

PROPERTY OF **IZOELEKTRO** s.p.a.
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cancelled production!

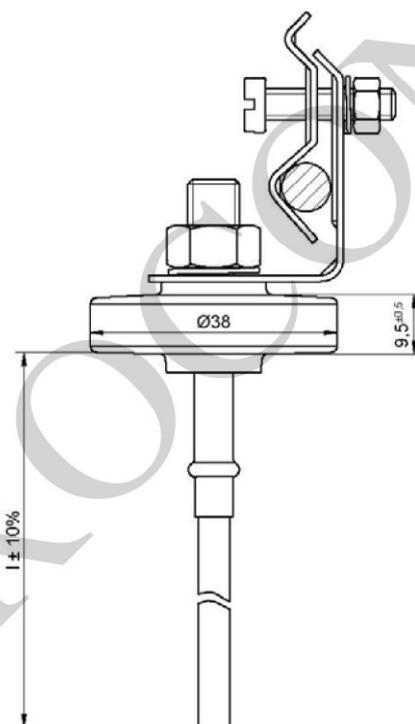
Copying and reproduction, handing
to unauthorised persons or use for
non-agreed purposes with the
manufacturer is strictly
forbidden!

| | Date | Name | Signature | Name | |
|-----------|------------|------------|-----------|--------------------------------------|-------------------|
| Construct | 16.01.2015 | M. Medved | | LV Surge arrester NNO 10/440 - 0,5 m | IZOELEKTRO |
| Revision | 20.01.2015 | D. Vouk | | | |
| Approved | 22.01.2015 | J. Hrasnik | | Code 20 60 60 | |
| Archive: | | | | | Units: mm |



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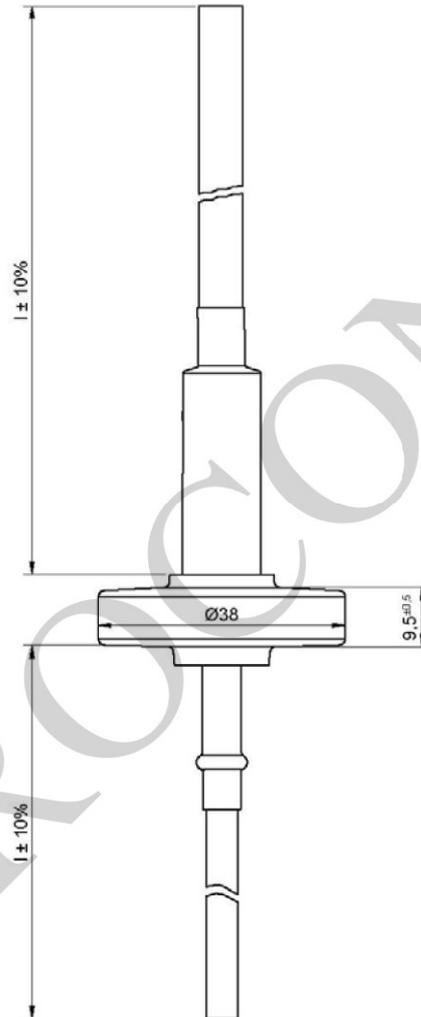


| | Date | Name | Signature | Name | |
|-----------|------------|-------------|-----------|--|-------------------|
| Construct | 16.01.2015 | M. Medved | | LV Surge arrester NNO 10/440 - 0,5 m + Connector P1 | IZOELEKTRO |
| Revision | 20.01.2015 | D. Vouk | | | |
| Approved | 22.01.2015 | J. Hrastnik | | | |
| Archive: | | | | Code | 20 60 63 |
| | | | | | Units: mm |



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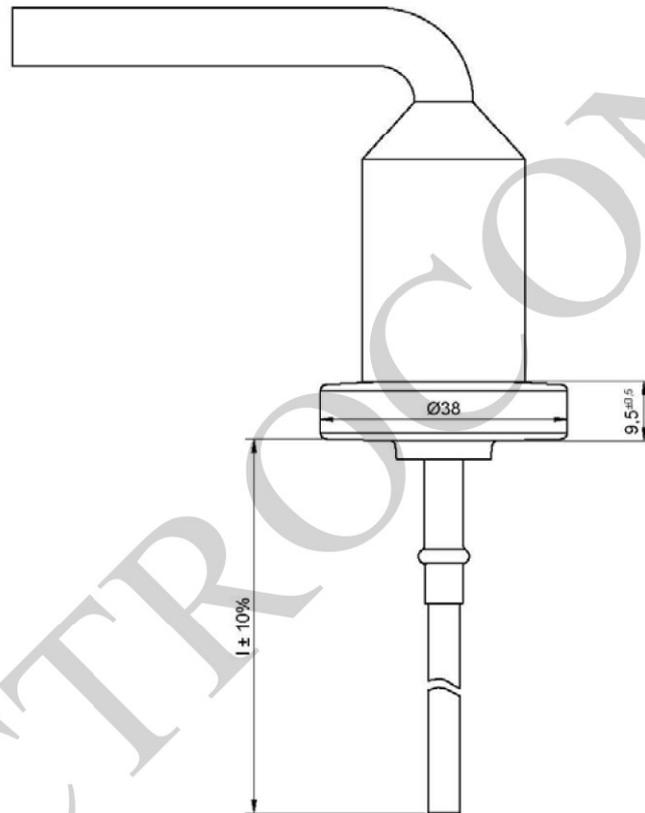


| | Date | Name | Signature | Name | |
|-----------|------------|-------------|-----------|---|-------------------|
| Construct | 16.01.2015 | M. Medved | | LV Surge arrester NNO 10/440 - 0,5 m + Connector P2 0,5m | IZOELEKTRO |
| Revision | 20.01.2015 | D. Vouk | | | |
| Approved | 22.01.2015 | J. Hraštnik | | | |
| Archive: | | | | Code | 20 60 64 |
| | | | | | Units: mm |



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forbidden!



| | Date | Name | Signature | Name | |
|-----------|------------|-------------|-----------|--|-------------------|
| Construct | 16.01.2015 | M. Medved | | LV Surge arrester NNO 10/440 - 0,5 m + Connector P3 | IZOELEKTRO |
| Revision | 20.01.2015 | D. Vouk | | | |
| Approved | 22.01.2015 | J. Hraštnik | | | |
| Archive: | | | | Code | 20 60 65 |
| | | | | | Units: mm |

THE TESTING LABORATORIES ASSOCIATION OF THE ELECTROTECHNICAL INSTITUTE



THE TESTING & CALIBRATING LABORATORY

Testing and calibrating laboratory accredited by Polish Centre for Accreditation, a signatory to EA MLA and ILAC MRA that include recognition of calibration certificates and test reports. Accreditation No AB 022 and AP 102



Test fields: acoustics, electrotechnics, mechanics, vibrations, photometry, chemical and physical properties, functionality, safety, electromagnetic compatibility, fire resistance, flammability, climatic and mechanical hazard resistance.



Test Report No 178/NZL/NBW/2014/O

| | |
|---------------------------------|--|
| Test object: | The Surge Protection Devices: NNO 10/280, NNO 10/440 |
| Applicant: | IzoElektro d.o.o. Limbuška cesta 2, SI – 2341 Limbuš |
| Manufacturer: | as above |
| Mark and date of commission: | 3/13 B-PL/1623 / 13.05.2014 |
| Type of tests | Flammability |
| Standard: | PN-EN 60695-2-10:2013 (equivalent with the IEC 60695-2-10:2013) PN-EN 60695-2-11:2005 (equivalent with the IEC 60695-2-11:2001 + AC1:2000) PN-EN 61643-11:2013 (equivalent with the EN 61643-11:2012) |
| Number of pages of test report: | 4 |
| Number of attachments: | 0 |
| Date of receipt of test item: | 13.05.2014 |
| Date of start of test: | 21.05.2014 |
| Date of end of test: | 21.05.2014 |
| Final result of tests: | The tested object in the scope of test have been found in comply with the requirements of PN-EN 60695-2-11:2005 and PN-EN 62643-11:2013 (point 8.5.4) standards. |
| Additional information: | --- |

Warsaw, 6th June 2014

Authorized by:

Manager of SBF

Dariusz Grochowina, Eng.

Zespół Laboratoriów
INSTYTUTU ELEKTROTECHNIKI
ul. Pożaryskiego 28, 04-703 Warszawa
tel. (22) 11-25-290, 11-25-300
fax: (22) 11-25-444, 11-25-445
e-mail: badania@iel.waw.pl, zwarcia@iel.waw.pl
NIP: 525-000-76-84

Approved by:

Head of the Laboratory

Robert Franaszek, M.Sc.

This report shall not be reproduced except in full without the written approval of the testing laboratory.

The test results presented in this report relate only to the object tested.

I. TESTED OBJECT CHARACTERISTICS

Tested object description

Trademark: Izoelektro

Model/Type: NNO 10/280

Ratings: $I_n = 10 \text{ kA}$; $U_p = 2,0 \text{ kV}$; $U_c = 280 \text{ Vac}/355 \text{ Vdc}$; 50/60 Hz

Additional information: New objects

Photographic identification of tested objects



Tested object description.....:

Trademark: Izoelektro

Model/Type: NNO 10/440

Ratings: $I_n = 10 \text{ kA}$; $U_p = 2,0 \text{ kV}$; $U_c = 440 \text{ Vac}/585 \text{ Vdc}$; 50/60 Hz

Additional information: New objects

Photographic identification of tested objects



II. TEST PROGRAM

According to the order, the test program contained all applicable tests and measurements, necessary for check of delivered objects resistance to heat, in test conditions specified in PN-EN 60695-2-11:2005 and PN-EN 62643-11:2013 (point 8.5.4) standards. Detailed list of test cases has been placed in III part of this Test Report.

III. TEST RESULT

Specimens were tested in the following environmental conditions:

1. Relative humidity $R_H = (46 - 51) \% \pm 5\%$
2. Ambient temperature $T_a = (20,1 - 20,6) ^\circ\text{C} \pm 0,2 ^\circ\text{C}$

Test conditions:

1. Time of stabilization in above environment conditions - 24 h
2. Level of test severity:
 - test temperature: $850 ^\circ\text{C} \pm 15 \text{ K}$
 - exposure time $t_a = 30 \text{ s}$
3. The depth of penetration of glow wire in tested specimen: $\leq 7 \text{ mm} \pm 0,5 \text{ mm}$
4. Kind of preparation of specimens to tests - finished products
5. Specimen's position during the test: long axis situated vertically

The results of tests summarized in below table:

| Typ | Number of specimen | Place on or part of sample subjected to test | Ignition of test specimen during the test | Glowing of test specimen during the test | Time to ignition of the specimen t_i (s) | Duration of burning t_b (s) | Duration of glowing t_g (s) | Limit of burning and/or glowing time (s) | The maximum height of the flame (mm) | Removal of burning material with glow wire | Ignition of the tissue paper | Test result |
|------------|--------------------|--|---|--|--|-------------------------------|-------------------------------|--|--------------------------------------|--|------------------------------|-------------|
| NNO 10/280 | 1 | gray part of SPD | no | no | - | - | - | ≤60 | - | no | no | positive |
| NNO 10/440 | 2 | gray part of SPD | no | no | - | - | - | | - | no | no | positive |

Tested by: Józef Stańczuk

THE TESTING LABORATORIES ASSOCIATION OF THE ELECTROTECHNICAL INSTITUTE



THE TESTING & CALIBRATING LABORATORY

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Test fields: acoustics, electrotechnics, mechanics, vibrations, photometry, chemical and physical properties, functionality, safety, electromagnetic compatibility, fire resistance, flammability, climatic and mechanical hazard resistance.

Test Report No 400/NZL/NBW/2014/O

| | |
|---------------------------------|--|
| Test object: | The surge protection devices marked: NNO 10/280, NNO 10/440 |
| Applicant: | IzoElektro d.o.o. Limbuška cesta 2, SI – 2341 Limbuš |
| Manufacturer: | as above |
| Mark and date of commission: | 9/14C-PL/0001623 / 02.10.2014 |
| Type of tests | Safety |
| Standard: | PN-EN 61643-11:2013 PN-EN 60112:2003+A1:2010 PN-EN 60695-10-2:2014 |
| Number of pages of test report: | 8 |
| Number of attachments: | 0 |
| Date of receipt of test item: | 15.12.2014 |
| Date of start of test: | 17.12.2014 |
| Date of end of test: | 12.02.2015 |
| Final result of tests: | --- |
| Additional information: | --- |

Warsaw, 20th February 2015

Authorized by:

Manager of SBF

Dariusz Grochowina, Eng.

Zespół Laboratoriów
INSTYTUTU ELEKTROTECHNIKI
ul. Pożaryskiego 28, 04-703 Warszawa
tel. (22) 812-30-53; fax (22) 812-04-06
tel. (22) 812-23-38; fax (22) 812-04-07
e-mail: badania@iel.waw.pl, nwr@iel.waw.pl
NIP 525-000-76-84

Approved by:

Head of the Laboratory

Robert Franaszek, M.Sc.

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The test results presented in this report relate only to the object tested.

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Mieczysława Pożaryskiego 28 St
04-703 WARSZAWA

Bank: Pekao S.A.
Account Number: 90 1240 6074 1111 0000 4999 4364
NIP: 525-000-76-84

Ph.: (0-22) 812 30 53
Fax: (0-22) 812 04 06
badania@iel.waw.pl

I. TESTED OBJECT CHARACTERISTICS

Tested object description

Trademark: Izoelektro

Model/Type: NNO 10/280

Ratings: $I_n = 10 \text{ kA}$; $U_p = 2,0 \text{ kV}$; $U_c = 280 \text{ Vac}/355 \text{ Vdc}$; 50/60 Hz

Additional information: New objects

Photographic identification of tested objects



Tested object description.....:

Trademark: Izoelektro

Model/Type: NNO 10/440

Ratings: $I_n = 10 \text{ kA}$; $U_p = 2,0 \text{ kV}$; $U_c = 440 \text{ Vac}/585 \text{ Vdc}$; 50/60 Hz

Additional information: New objects

Photographic identification of tested objects



II. TEST PROGRAM

According to the order, the tests program contained all applicable measurements, necessary for check:

- 1) ball pressure test,
- 2) tracking resistance,
- 3) insulation resistance,
- 4) air clearances and creepage distances

of delivered objects, in test conditions specified in PN-EN 61643-11:2013 standard.

III. TEST RESULT

Re 1 Ball pressure test.

Specimen was tested in the following environmental conditions:

1. Relative humidity $R_H = (49 - 53) \% \pm 5\%$
2. Ambient temperature $T_a = (22,2 - 22,6) ^\circ\text{C} \pm 0,5 ^\circ\text{C}$

Test conditions:

1. Time of stabilization in above environment conditions - 24 h

2. Level of test severity:

- test temperature: $70 ^\circ\text{C} \pm 2 \text{ K}$

- exposure time $t_a = 1\text{h}$

3. Kind of preparation of specimen to test: cut sample

4. Specimen dimension: 20 mm x 20 mm x 3 mm

The results of tests summarized in below table:

| Tested object | Number of specimen | Place on or part of sample subjected to test | The spherical portion of the indentation left by the pressure ball (dimension D) [mm] | Test result |
|------------------------|--------------------|--|---|-------------|
| NNO 10/280, NNO 10/440 | 1 | Middle of the sample | $0,3 \pm 0,1$ | positive |

Re 2 Tracking resistance.

Specimens were tested in the following environmental conditions:

1. Relative humidity $R_H = (47 - 58) \% \pm 5\%$
2. Ambient temperature $T_a = (21,2 - 22,4) \text{ }^\circ\text{C} \pm 0,2 \text{ }^\circ\text{C}$

Identification of tested specimens, information about the test preparation and the test result:

| | | |
|----|--|---|
| 1. | Time of stabilization in above environment conditions: | 24h |
| 2. | Specimen dimension: | 20 mm x 20 mm x 5 mm (2 layers) |
| 3. | Kind of preparation of specimens to test: | cut samples, cleaned |
| 4. | State of the surface: | the original surface of the material, no scratches |
| 5. | Cleaning procedure: | electrode was purified by sandpaper |
| 6. | Airflow: | tests were performed in a draught free space |
| 7. | Orientation of the electrodes: | In accordance with clause 7.1 of PN-EN 60112:2 standard. The force exerted by each electrode on the surface of the test specimen was equal to $1,00 \text{ N} \pm 0,05 \text{ N}$ |

Test result: CTI 175

Re 3 Insulation resistance.

Before the test samples were kept in the humidity cabinet for 48 hours at a relative humidity of $93\% \pm 3\%$ and a temperature $(24,7 - 25,3) \text{ }^\circ\text{C} \pm 0,2 \text{ }^\circ\text{C}$. Samples were removed from the cabin and after 30 min insulation resistance was measured. The results of tests summarized in below table:

| Tested object | Resistance of insulation between: | Result |
|---------------|-----------------------------------|--------|
| NNO 10/280 | live parts and the SPD body | >50 MΩ |
| NNO 10/440 | live parts and the SPD body | >50 MΩ |

Re 4 Air clearances and creepage distances.

Minimum creepage distances and minimum air clearances for SPD were determined for pollution degree 3 and material group III.

| U _{max} | Air clearances without accessory | | | Creepage distances without accessory | | | |
|---|----------------------------------|-----------------|------------|--------------------------------------|------------|-----------------|------------|
| | minimum limit (mm) | measured length | | minimum limit (mm) | | measured length | |
| | NNO 10/280 NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 |
| Between live parts of different polarity | ≥3 | 36 | 38 | ≥5 | ≥8 | 39 | 41 |
| Between live parts and: | | | | | | | |
| <ul style="list-style-type: none"> screws and other means to fasten a covering, having to be detached for mounting the SPD | ≥3 | - ^{*)} | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> fastening surfaces | ≥6 | - | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> screws or other means for fastening the SPD | ≥6 | - | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> bodies | ≥3 | 0 | 0 | ≥5 | ≥8 | 0 | 0 |
| Between the metal parts of the disconnector mechanism and: | | | | | | | |
| <ul style="list-style-type: none"> bodies | ≥3 | - | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> screws or other means for fastening the SPD | ≥3 | - | - | ≥5 | ≥8 | - | - |

^{*)}symbol: - means the requirement does not apply to the tested object

| U _{max} | Air clearances with Connector P2 | | | Creepage distances with Connector P2 | | | |
|---|----------------------------------|-----------------|------------|--------------------------------------|------------|-----------------|------------|
| | minimum limit (mm) | measured length | | minimum limit (mm) | | measured length | |
| | NNO 10/280 NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 |
| Between live parts of different polarity | ≥3 | 39 | 41 | ≥5 | ≥8 | 41 | 43 |
| Between live parts and: | | | | | | | |
| <ul style="list-style-type: none"> screws and other means to fasten a covering, having to be detached for mounting the SPD | ≥3 | - ^{*)} | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> fastening surfaces | ≥6 | - | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> screws or other means for fastening the SPD | ≥6 | - | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> bodies | ≥3 | 0,4 | 0,4 | ≥5 | ≥8 | 0,4 | 0,4 |
| Between the metal parts of the disconnecter mechanism and: | | | | | | | |
| <ul style="list-style-type: none"> bodies | ≥3 | - | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> screws or other means for fastening the SPD | ≥3 | - | - | ≥5 | ≥8 | - | - |

^{*)}symbol: - means the requirement does not apply to the tested object

| U _{max} | Air clearances with Connector P3 | | | Creepage distances with Connector P3 | | | |
|---|----------------------------------|-----------------|------------|--------------------------------------|------------|-----------------|------------|
| | minimum limit (mm) | measured length | | minimum limit (mm) | | measured length | |
| | NNO 10/280 NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 | NNO 10/280 | NNO 10/440 |
| Between live parts of different polarity | ≥3 | 39 | 41 | ≥5 | ≥8 | 41 | 43 |
| Between live parts and: | | | | | | | |
| <ul style="list-style-type: none"> screws and other means to fasten a covering, having to be detached for mounting the SPD | ≥3 | - ^{*)} | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> fastening surfaces | ≥6 | - | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> screws or other means for fastening the SPD | ≥6 | - | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> bodies | ≥3 | 8 | 8 | ≥5 | ≥8 | 9 | 9 |
| Between the metal parts of the disconnecter mechanism and: | | | | | | | |
| <ul style="list-style-type: none"> bodies | ≥3 | - | - | ≥5 | ≥8 | - | - |
| <ul style="list-style-type: none"> screws or other means for fastening the SPD | ≥3 | - | - | ≥5 | ≥8 | - | - |

^{*)}symbol: - means the requirement does not apply to the tested object

Tested by: Józef Stańczuk