

Test Report

| | | | | | |
|------------------|--|----------|---|-----------------|----|
| Document No. | B8001026 | Copy No. | 1 | Number of pages | 28 |
| Apparatus | Polymer-housed surge arrester section type PA-DM | | | | |
| Designation | --- | | | | |
| Serial Number | --- | | | | |
| Manufacturer | Joint-Stock Company " Polymer-Apparat" | | | | |
| Client | Joint-Stock Company " Polymer-Apparat" 195427, Saint- Petersburg, Ak. Kostantinova str.,1- Russian Federation | | | | |
| Tested for | --- | | | | |
| Date(s) of tests | January 16 – February 28, 2017 | | | | |
| Tested by | --- | | | | |
| Test performed | Test to verify long term stability under continuous operating voltage | | | | |

PAD B8001026 (2478852) - CONFIDENTIAL USE

The apparatus, constructed in accordance with the description, drawings and photographs incorporated in this document has been subjected to the series of proving tests in accordance with: IEC 60099-4 – Edition 3.0 (2014-06)

The results are shown in the record of proving tests and the oscillograms attached hereto. The ratings assigned by the Manufacturer are listed on the ratings page.
The document applies only to the apparatus tested. The responsibility for conformity of any apparatus having the same designations with that tested rests with the Manufacturer.

March 1, 2018

Date
Gregori Marco
B8001026 3059 AUT
Test Engineer in charge
The Manager - Arcidiaco Lorenzo
B8001026 821814 ASP
Approved By Document Digitally Signed

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LAB N° 0030

The laboratory meets the requirements of the Standard EN ISO/IEC 17025: 2005 "General Requirements for the Competence of Testing and Calibration Laboratories". The in force status of the accreditation and the list of accredited tests may be checked in the WEB site: www.accredia.it



CESI

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Notes

STL-Member

CESI Group members are founder members of the SHORT-CIRCUIT TESTING LIAISON (STL) which has been established in 1969. STL is a forum for voluntary international cooperation of testing organizations.

CESI Group Test Documents description

Type Test Certificate of

Issued for type tests of high voltage products ($> 1 \text{ kV}_{ac}$; $> 1,5 \text{ kV}_{dc}$), which have successfully been carried out in full compliance with the relevant specifications or standards and STL Guides valid at the time of the test. The Type Test Certificate consists of documents unequivocally identifying the test object and describes all conditions under which the tests were conducted. It gives evidence of the unobjectionable behavior of the test object during the tests in line with the normative documents applied as well as of the results of successful testing.

Test Certificate of (complete / selected) Type Tests

Issued if type tests of low voltage products ($< 1 \text{ kV}_{ac}$; $< 1,5 \text{ kV}_{dc}$) requested by the relevant product standard were passed. For these tests the equipment under test must be clearly identified by technical description, drawings, and additional specifications.

Certificate of Design Verification

Issued for passed design verification tests according to IEC 61439. For these tests the equipment under test must be clearly identified by technical description, drawings, and additional specifications.

Type Test Report

Issued for high and low voltage products if parts of selected type tests have been passed; those shall be carried out in full compliance with the relevant standards but (for high voltage products) do not fulfill all STL requirements for issuing a Type Test Certificate. For these tests the equipment under test must be clearly identified by technical description, drawings, and additional specifications.

Test Report

Issued for all other tests on high and low voltage products which have been carried out according to specifications, standards and/or client instructions

On-Site Test Record

Issued as a record of results acquired during the on-site tests / measurements

Test Award

Can be additionally issued for all named types of test documents above if the tests to be referenced were passed

Tests witnessed by:

Identification of the object: Requested

The Manufacturer guarantees that the tested object is manufactured according to the submitted drawings. CESI checked that these drawings adequately represent in shape and dimensions the essential details and the parts of the tested object. These drawing, identified by CESI and numbered B8004656 No. 1 , is annexed to this document.

Test evaluation

With reference to the Standards/Specifications listed in the first page and the characteristics of the tested sample assigned by manufacturer, the carried out tests passed SUCCESSFULLY.

The data necessary to permit repetition of the tests are contained in the document marked: ---

The reported expanded uncertainties are determined in accordance with the Publication JCGM 100 "Evaluation of measurement data – Guide to the expression of uncertainty in measurement" and are based on a standard uncertainty multiplied by a coverage factor $K=2$, which for a normal distribution provides a level of confidence of approximately 95%

| | |
|---|------------------|
| - Voltage a.c. | : ± 3,0% |
| - Residual peak voltage (impulse tests) | : ± 3,0% |
| - Current a.c. | : ± 3,0% |
| - Peak current (impulse tests) | : ± 3,0% |
| - Time (impulse tests) | : ± 10,0% |
| - Time (a.c. tests) | : ± 1,5% |

Laboratory information

| | |
|-----------------------------------|----------------------------------|
| Receipt date of the sample | January 2018 |
| Test location | CESI – Via Rubattino 54 – Milan |
| CESI testing team | Mr. S. Bricchetti, Mr. I Guacci |
| Test laboratory | P177 (Surge Arrester laboratory) |
| ODV SAP | 70006781 |



| content | page | test date |
|--|----------|-------------------|
| Rated characteristics test object | 5 | |
| Photograph of the test sample | 6 | |
| Reference standard | 7 | |
| Test carried out and identification | 7 | |
| Test procedure | 7 | |
| Summary of test results | 8 | |
| Reference voltage test at ambient temperature | 9 | January 16, 2018 |
| Power losses measurement at the beginning of the test | 10 | January 18, 2018 |
| Power losses measurement at the end of the test | 11 | February 28, 2018 |
| Technical data of test circuits | 12 to 14 | |
| Pages annexed: | | |
| Oscillograms ; no.12 pages | | |
| Client's drawing (Polymer-housed surge arrester section type PA-DM) - CESI no.B8004656 - no. 1 page | | |
| Client's drawing (MO resistor type B34/30) - CESI no.B7020387 – no. 1 page | | |

Rated characteristics of the tested object assigned by the Client

The test was carried out on three samples of polymer-housed surge arrester section . A view of the test samples is shown at page 5. The characteristics of the test samples are listed in the tables below.

| | |
|---|--|
| Manufacturer's name | Joint-Stock Company “ Polymer-Apparat” |
| Polymer-housed surge arrester section type | PA-DM |
| Drawing code | PA-LTST.ST.01 |
| Arrester class | Distribution |
| Designation | DM |
| MO-resistor supplier's | Joint-Stock Company “ Polymer-Apparat” |
| MO-resistor type | B34/30 |
| Drawing code | PA.VAR.0400.30 |
| Number of MO resistor fitted | 1 |
| Nominal discharge current - [kA] | 10 |
| Rated voltage - U_r [kV] | $1,077 \times U_{ref.}$ |
| Continuous operating voltage - U_c [kV] | $0,861 \times U_{ref.}$ |
| Repetitive charge transfer rating – Q_{rs} [C] | 0,4 |
| Rated thermal charge transfer rating - Q_{th} [C] | 1,1 |
| Reference current - $I_{ref.}$ [mA] | 1,0 |
| Rated frequency - [Hz] | 48÷62 |
| Year of manufacture | 12/2017 |

geometrical characteristics measured on the MO resistor

| | |
|-------------------|---------|
| Total height [mm] | 31,1 mm |
| Diameter [mm] | 36,6 mm |

Reference Standard

The test was carried out according to the IEC 60099-4 – Edition 3.0 (2014-06) - Clause 10.8.4
 “Metal-oxide surge arresters without gaps for a.c. system”

Test carried out and identification of the test objects

| Test object name | Identification of test sample (given by CESI) | Identification of test sample (given by JSC “Polymer Apparat) |
|--|---|---|
| Polymer-housed surge arrester section type PA-DM | OD1 | 001 |
| | OD2 | 002 |
| | OD3 | 004 |

The test voltage U_{ct} was calculated as:

$$U_{ct} = U_c' \times K_t = 4,839 \times 1,0695 = 5,175 \text{ kV}_{rms}$$

Where :

$U_{ref.max} = 5,620 \text{ kV}$ is the reference voltage measured on sample AG1 (see page n.9)

$$U_r' = U_{ref.max} \times 1,077 = 5,620 \times 1,077 = 6,053 \text{ kV}$$

$$U_c' = U_{ref.max} \times 0,861 = 5,620 \times 0,861 = 4,839 \text{ kV}$$

$K_t = 1,0695$ is a unbalance factor declared by the manufacturer

The oven has been heated up to about 115 °C and then the samples have been energized at the specified power-frequency voltage of 5,175 kV_{rms} for a total duration of 1000 hours while maintained at the temperature of $115 \pm 4 \text{ °C}$.

Power losses have been monitored continuously during the test (see oscillogram no. 10,11& 12).

More detailed data are given for measurements carried out at the beginning (3 hours after energization) and at the end of the test.

Note:

- the schemes of the test chamber and test oven is shown in the test arrangement on page 12



LAB N° 0030

Summary of test results

Details of the measurements carried out at the beginning (3 hours after the voltage application) and at the end of the test are given in the table below.

The trend of the power losses monitored during the test is shown on the oscillogram n. 10, 11& 12.

| Sample | U_{ct} | P_{start} | T_{start} | P_{end} | T_{end} | P_{min} |
|--------|-------------|-------------|-------------|------------|-------------|-----------|
| No. | [1] (kV) | [2] (W) | [3] (°C) | [4] (W) | [5] (°C) | [6] |
| AG1 | 5,175 | 2,614 | 114,5 | 1,630 | 114,0 | 1,614 |
| AG2 | 5,175 | 2,657 | 114,8 | 1,538 | 114,3 | 1,523 |
| AG3 | 5,175 | 2,730 | 114,8 | 1,634 | 114,2 | 1,620 |

Where:

- [1] U_{CT} : the corrected maximum continuous operating voltage
- [2] P_{start} : the power losses measured 3h after the voltage application
- [3] T_{start} : the temperature during power losses measured P_{start}
- [4] P_{end} : the power losses measured at the end of the test
- [5] T_{end} : the temperature during power losses measured P_{end}
- [6] P_{min} : the minimum power losses measured over the 1000 duration

Evaluation criteria and conclusion

During the aging period the following criteria have been met:

- any increase of power losses from P_{min} was not greater than 1,3 times P_{min} for each MO resistor
- all measurements of power losses including the final measurement was not greater then 1,1 times P_{start}

The acceptance criteria are fulfilled and therefore the test result is positive.

Accelerated aging test.

Reference voltage test at ambient temperature

Test circuit: A0019

Ambient temperature 24 °C

Date: January 16, 2018

| Sample No. AG1 | | | | | | |
|----------------|---------|--------------------|--------------------|-------------------|-------|------------------------|
| oscillogram | voltage | current | current | current | power | 3rd harmonic amplitude |
| No. | kV | + mA _{cr} | - mA _{cr} | mA _{rms} | W | μA |
| 1 | 5,62 | 0,92 | 1,00 | 0,57 | 1,46 | -- |

| Sample No. AG2 | | | | | | |
|----------------|---------|--------------------|--------------------|-------------------|-------|------------------------|
| oscillogram | voltage | current | current | current | power | 3rd harmonic amplitude |
| No. | kV | + mA _{cr} | - mA _{cr} | mA _{rms} | W | μA |
| 2 | 5,61 | 1,00 | 0,96 | 0,57 | 1,48 | -- |

| Sample No. AG3 | | | | | | |
|----------------|---------|--------------------|--------------------|-------------------|-------|------------------------|
| oscillogram | voltage | current | current | current | power | 3rd harmonic amplitude |
| No. | kV | + mA _{cr} | - mA _{cr} | mA _{rms} | W | μA |
| 3 | 5,58 | 1,00 | 0,99 | 0,59 | 1,50 | -- |

Accelerated ageing test

Power losses measurement at the beginning of the test (3 hours after the voltage application)

Test circuit: A0119

Date: January 18, 2018

| Sample No. AG1 | | | | | |
|----------------|---------|--------------------|--------------------|-------|-------------|
| oscillogram | voltage | current | current | power | temperature |
| No. | kV | + mA _{cr} | - mA _{cr} | W | °C |
| 4 | 5,175 | 1,306 | 1,306 | 2,614 | 114,5 |

| Sample No. AG2 | | | | | |
|----------------|---------|--------------------|--------------------|-------|-------------|
| oscillogram | Voltage | current | current | power | Temperature |
| No. | kV | + mA _{cr} | - mA _{cr} | W | °C |
| 5 | 5,175 | 1,334 | 1,346 | 2,657 | 114,8 |

| Sample No. AG3 | | | | | |
|----------------|---------|--------------------|--------------------|-------|-------------|
| oscillogram | Voltage | current | current | Power | Temperature |
| No. | kV | + mA _{cr} | - mA _{cr} | W | °C |
| 6 | 5,175 | 1,383 | 1,385 | 2,730 | 114,8 |

Accelerated ageing test.

Power losses measurement at the end of the test

Test circuit: A0119

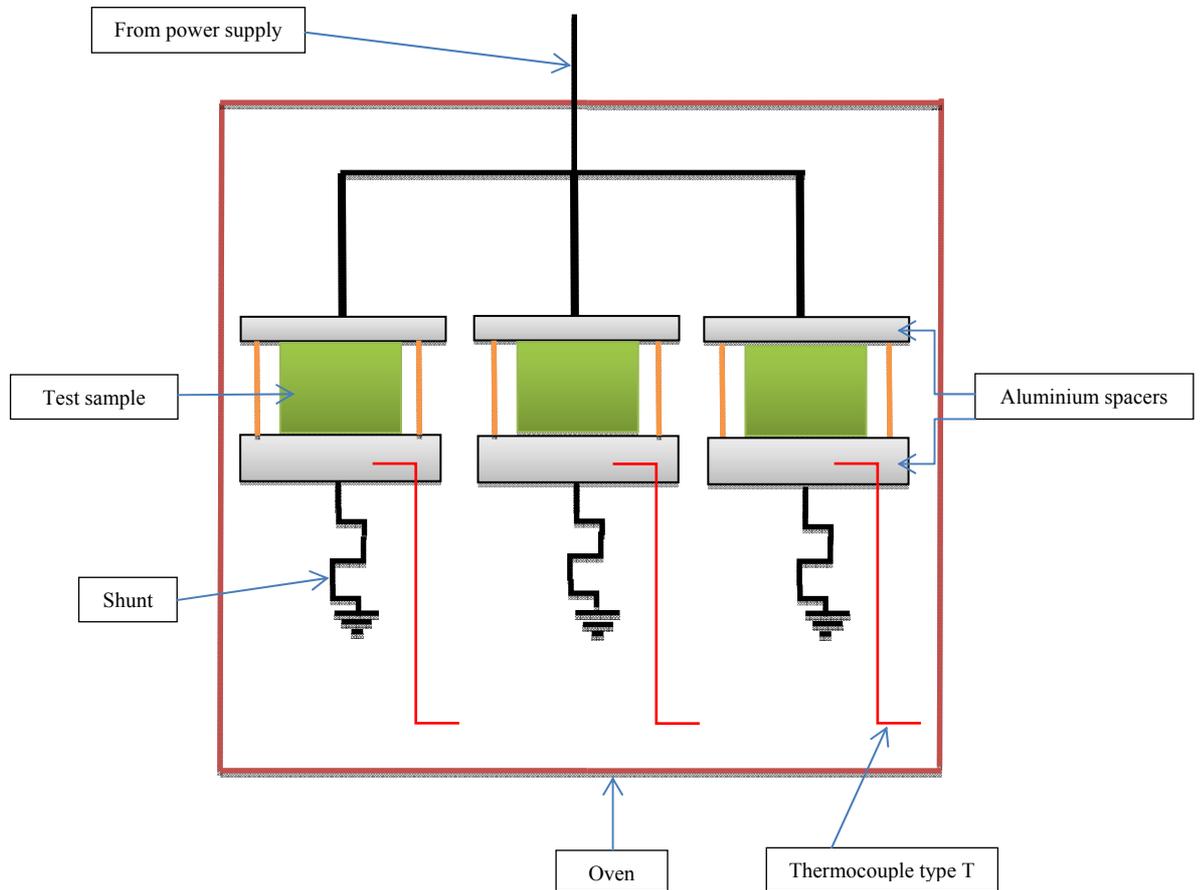
Date: February 28, 2018

| Sample No. AG1 | | | | | |
|----------------|---------|--------------------|--------------------|-------|-------------|
| oscillogram | voltage | current | current | power | temperature |
| No. | kV | + mA _{cr} | - mA _{cr} | W | °C |
| 7 - 10 | 5,175 | 0,814 | 0,798 | 1,630 | 114,0 |

| Sample No. AG2 | | | | | |
|----------------|---------|--------------------|--------------------|-------|-------------|
| oscillogram | Voltage | current | current | power | Temperature |
| No. | kV | + mA _{cr} | - mA _{cr} | W | °C |
| 8 - 11 | 5,175 | 0,776 | 0,752 | 1,538 | 114,3 |

| Sample No. AG3 | | | | | |
|----------------|---------|--------------------|--------------------|-------|-------------|
| oscillogram | Voltage | current | current | Power | temperature |
| No. | kV | + mA _{cr} | - mA _{cr} | W | °C |
| 9 - 12 | 5,175 | 0,807 | 0,806 | 1,634 | 114,2 |

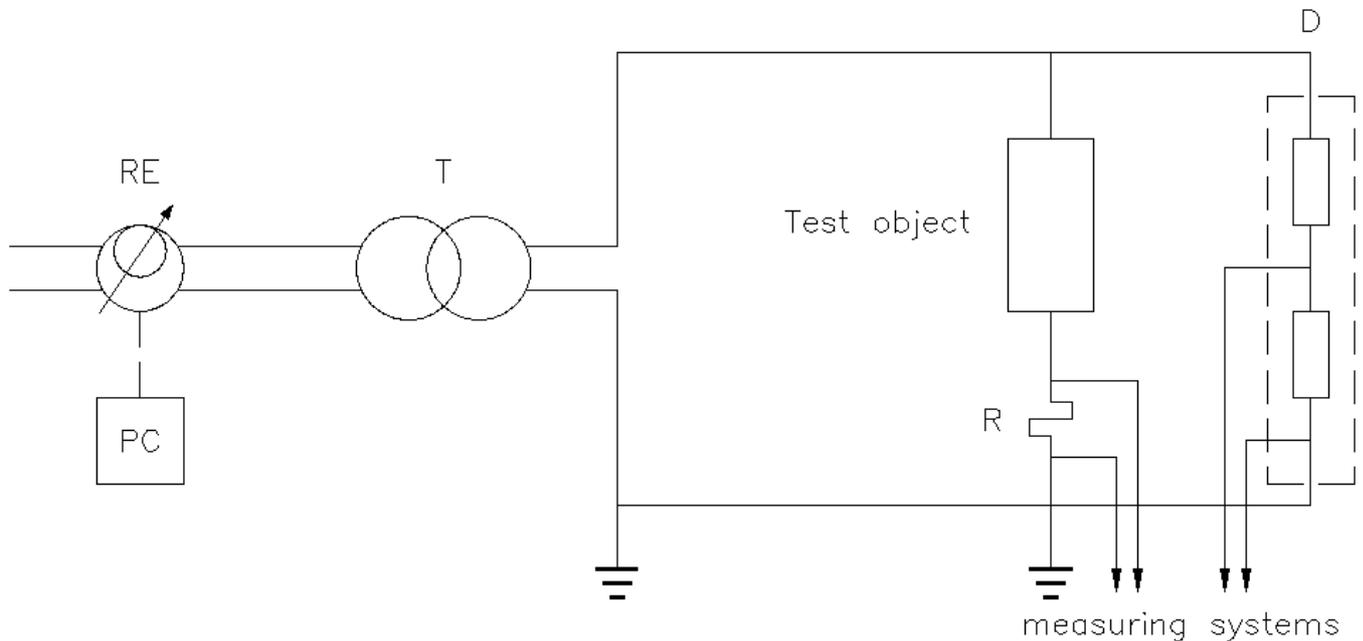
Test-setting for the test



Notes:

- 1 Oven type Angelantoni ; volume =1m³; CESI no. 29801

Circuit A0019



Power frequency supply

- RE - programmable supply type PACIFIC A.C. Power Source 140 ASX.; CESI no. 0560408
- PC - personal computer
- T - voltage transformer type SPECIALTRASFO; power 30 kVA; voltage 200 V/15-30 kV

Current measuring system

- R - Current shunt CESI No.31120; R= 941,4 Ω
-Electro optical system HBM CESI No. 57986(Rx) – 57987 (Tx)
- OSC - Oscilloscope type NATIONAL INSTRUMENT NI PXI-1031/NI-PXI 8108/NI-PXI 5122;
- CESI No 056227- 0562226 (on channel No.1)

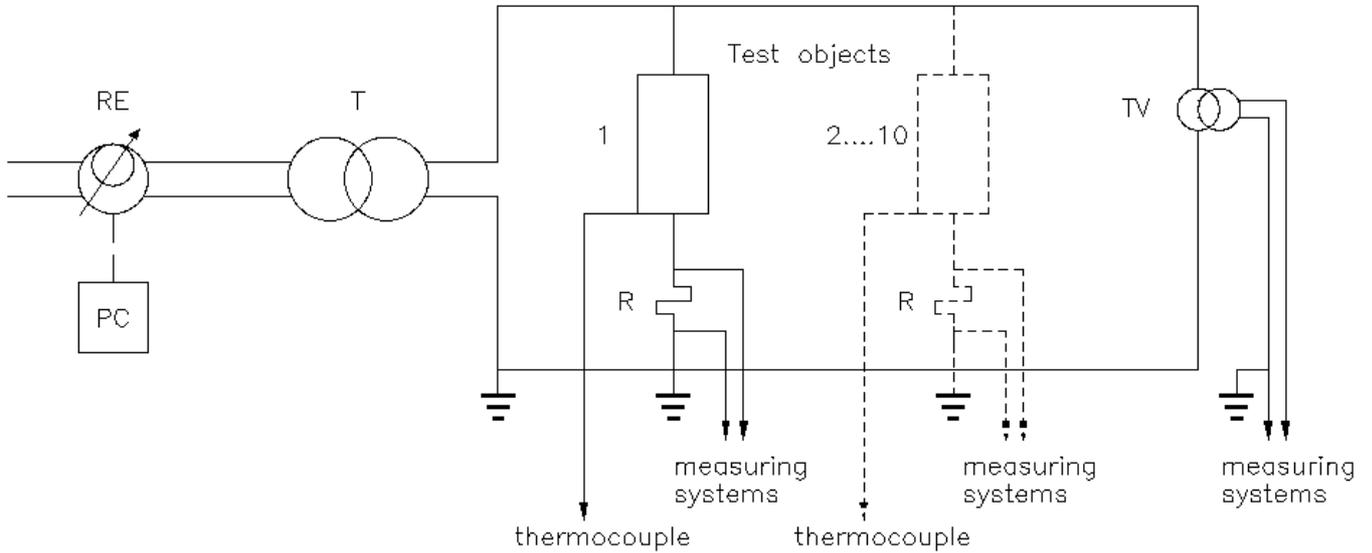
Voltage measuring system

- D - Voltage divider SAGI; CESI No.11120
Electro optical system type HBM CESI No. 57986(Rx) – 57991 (Tx)
- OSC - Oscilloscope type NATIONAL INSTRUMENT NI PXI-1031/NI-PXI 8108/NI-PXI 5122;
- CESI No 056227- 0562226 (on channel No.2)

Software system:

- SW - S.A.D. Surge arrester version 2.0

Circuit A0119



Power frequency supply

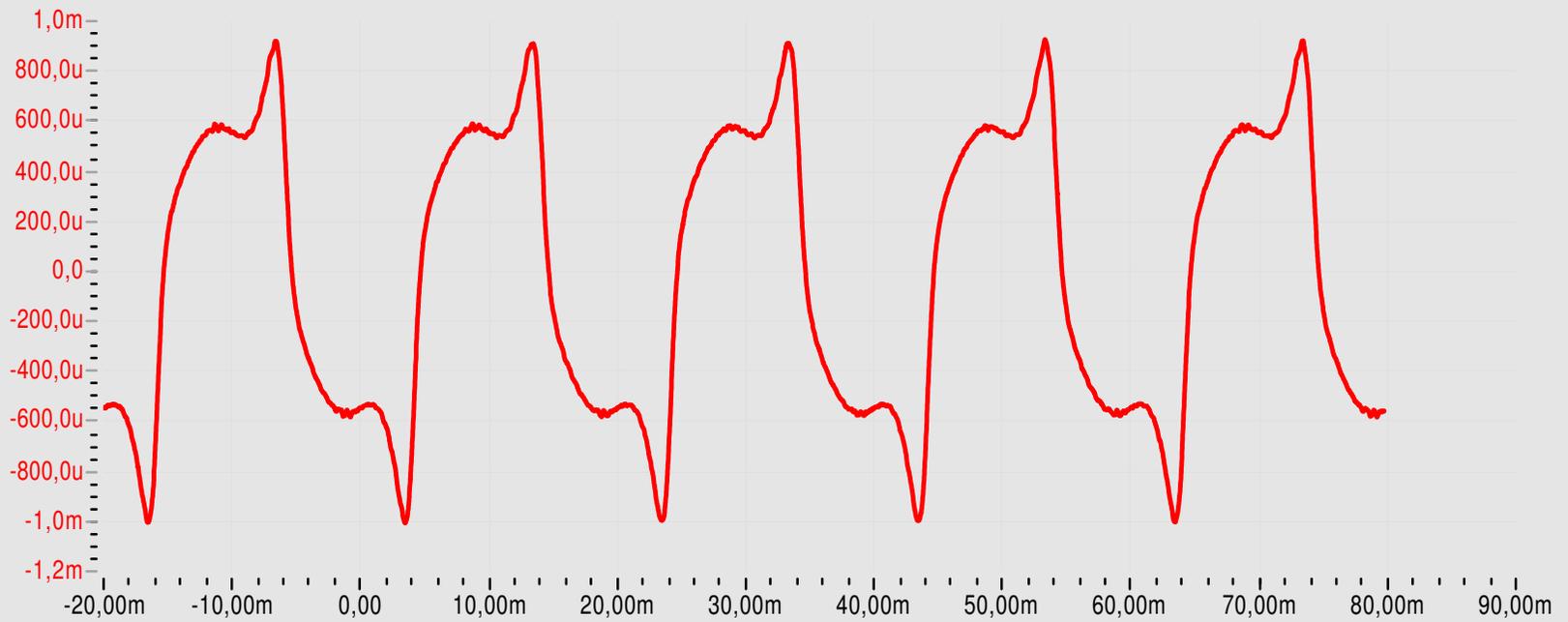
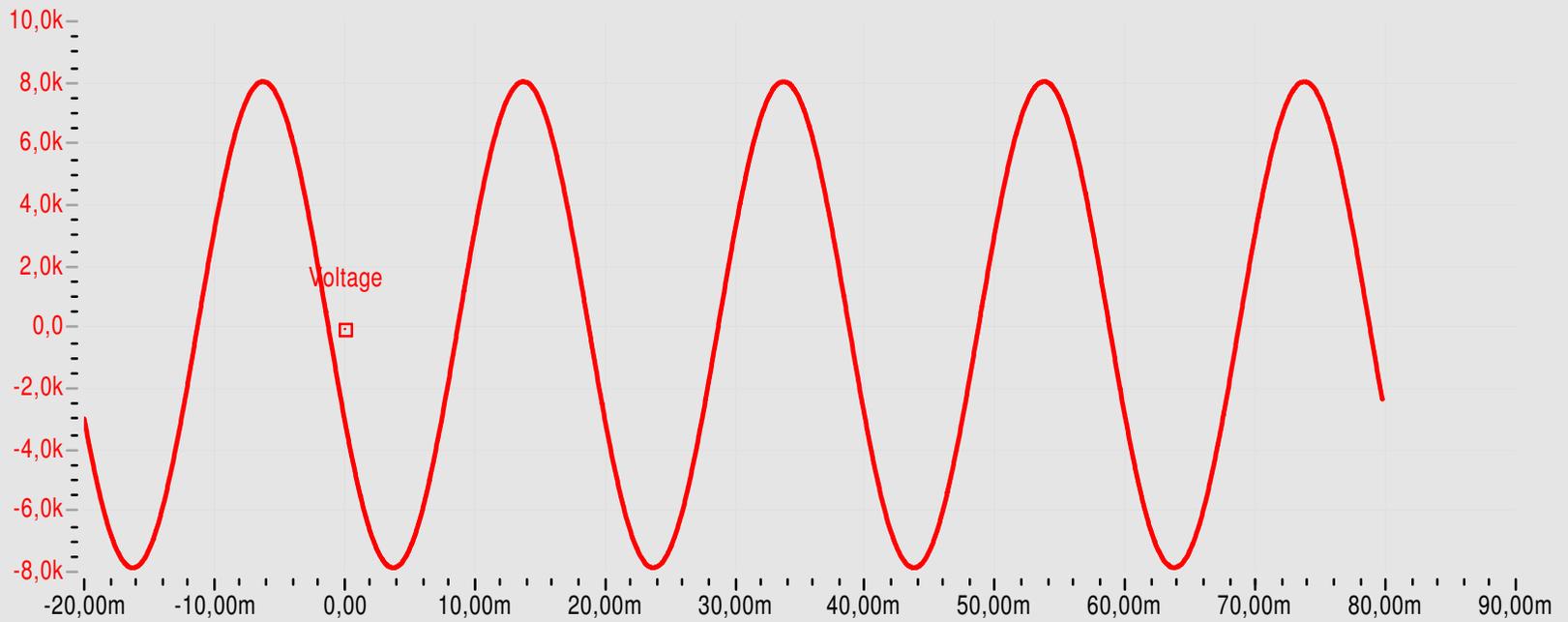
- RE - programmable supply type PACIFIC A.C. Power Source 140 ASX.; CESI no. 0560408
- PC - personal computer
- T - voltage transformer type PIVI; power 10 kVA; voltage 220 V/12,5 kV
- R - Current shunt type SECI ; R= 1000 Ω
- TV - Voltage divider; CESI no. 57188

Data acquisition system type :

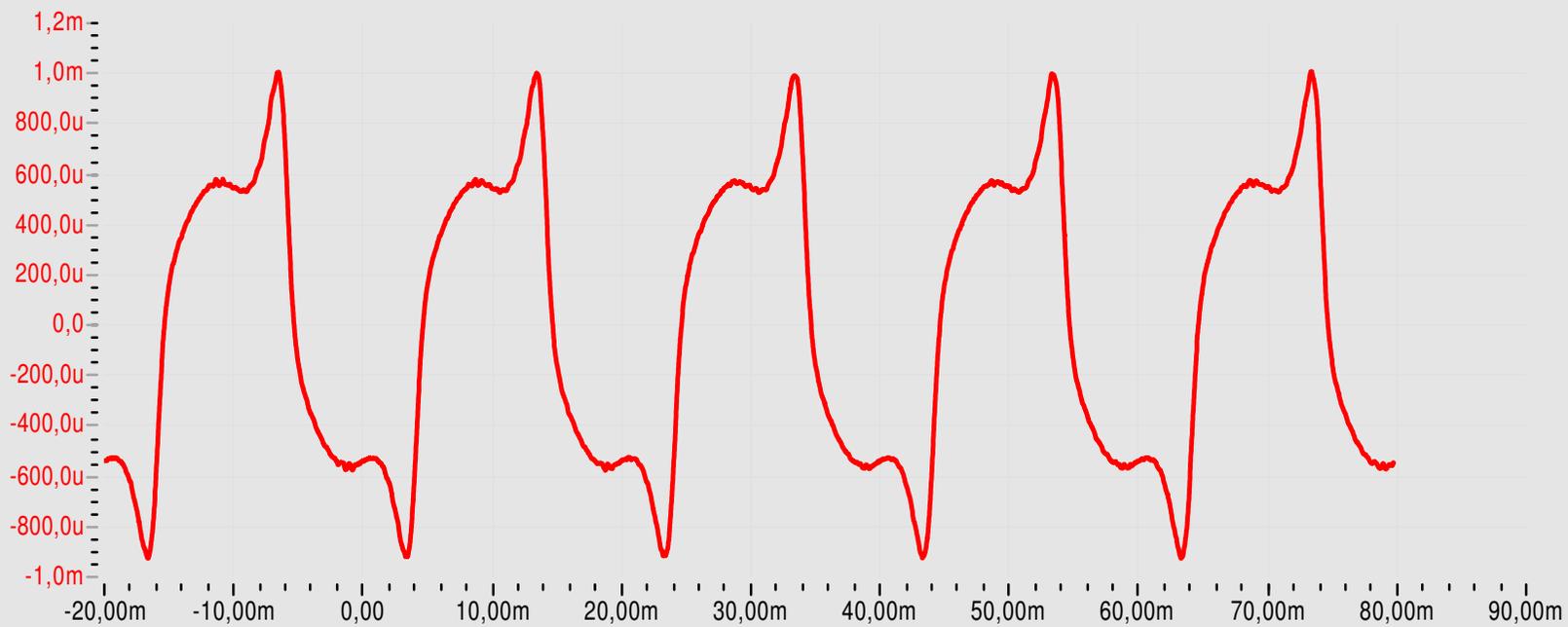
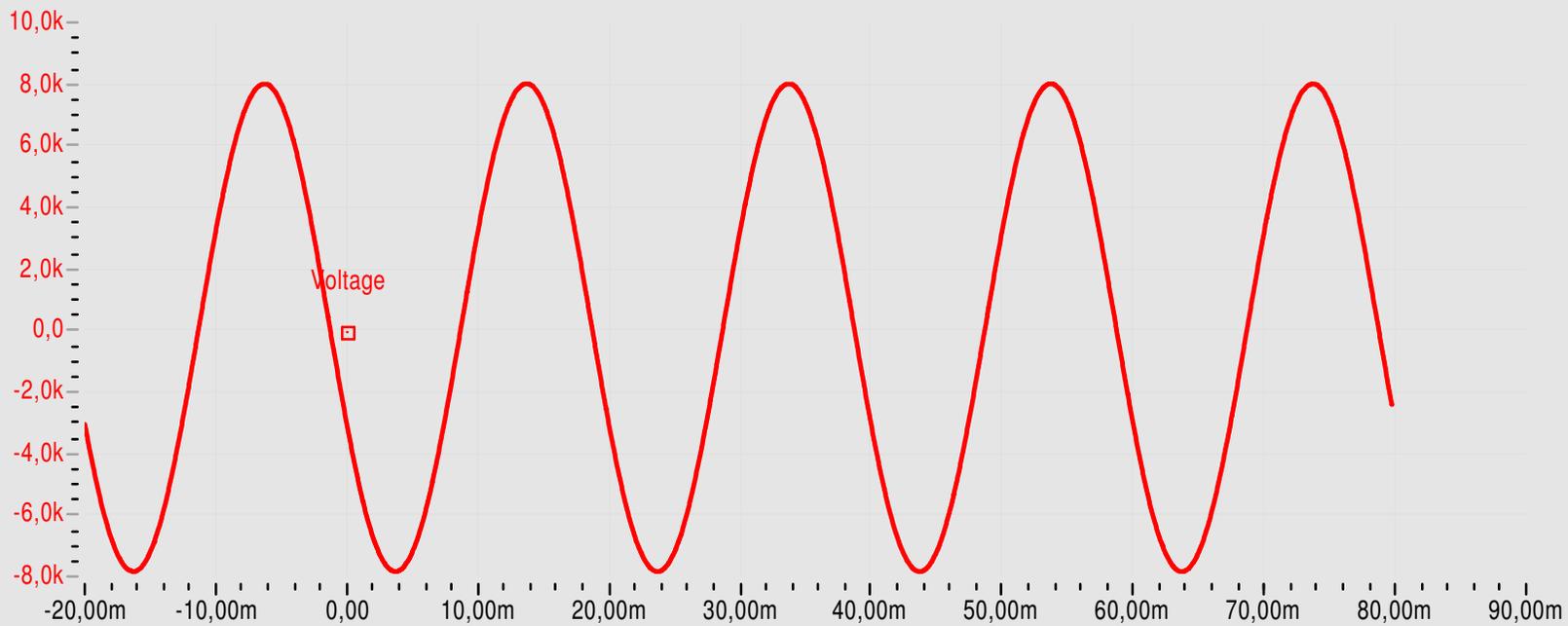
- NATIONAL INSTRUMENTS NI PXI-8108 ;CESI no. 58021
- NATIONAL INSTRUMENTS NI PXI-6133 ;CESI no. 58024

Yokogawa MV 200 ;CESI no. 56659

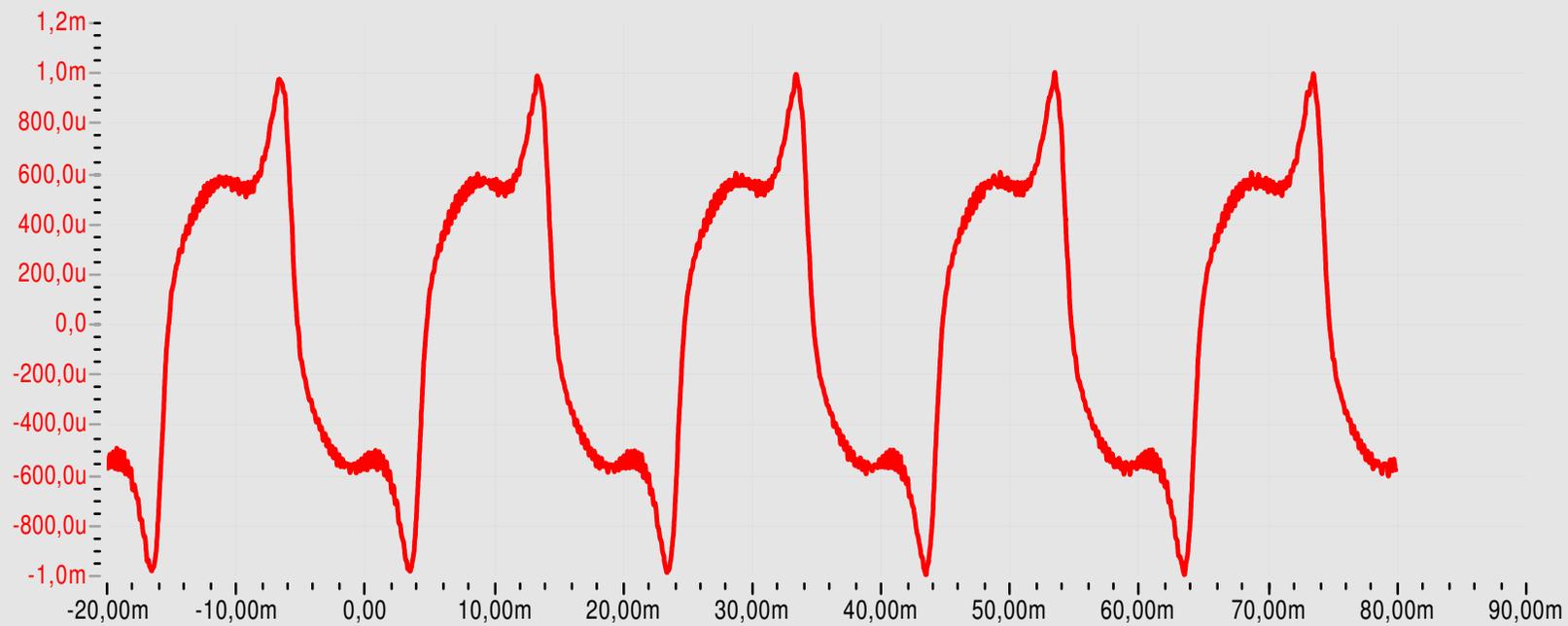
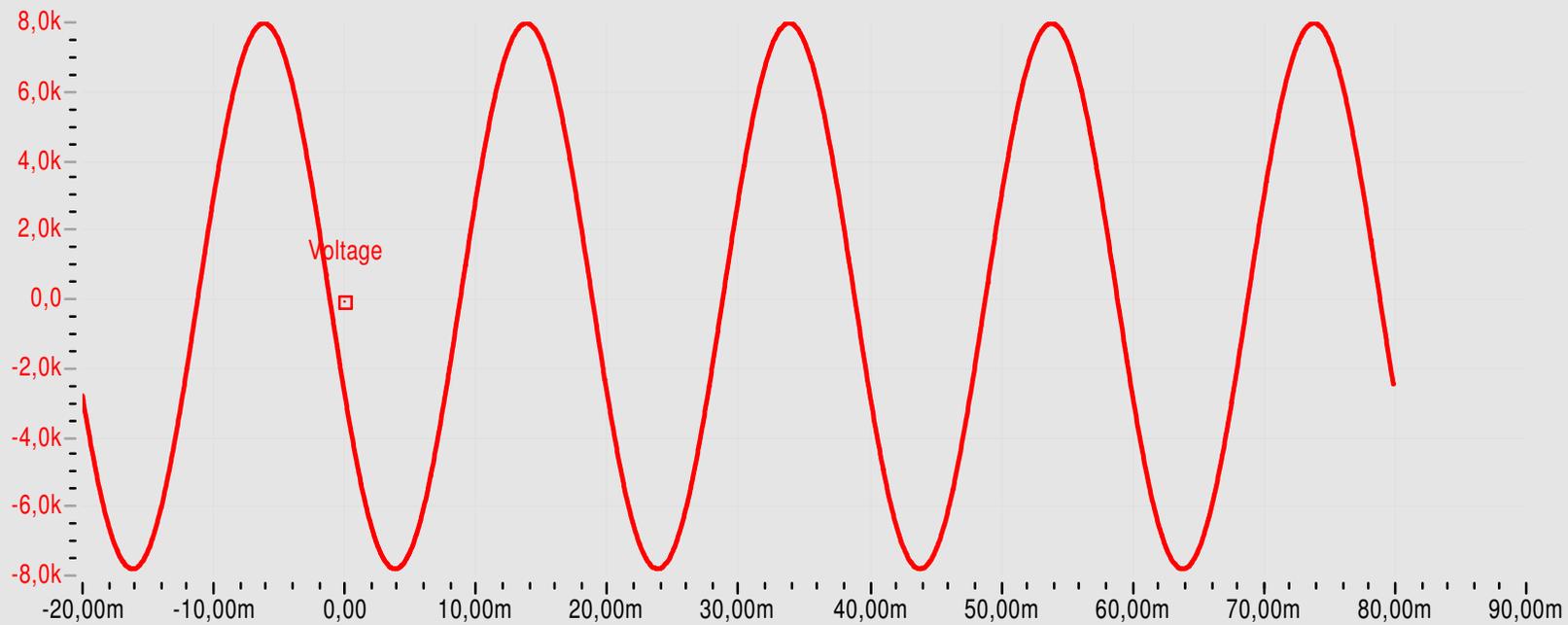
CESI B8001026 Oscillogram n. 1

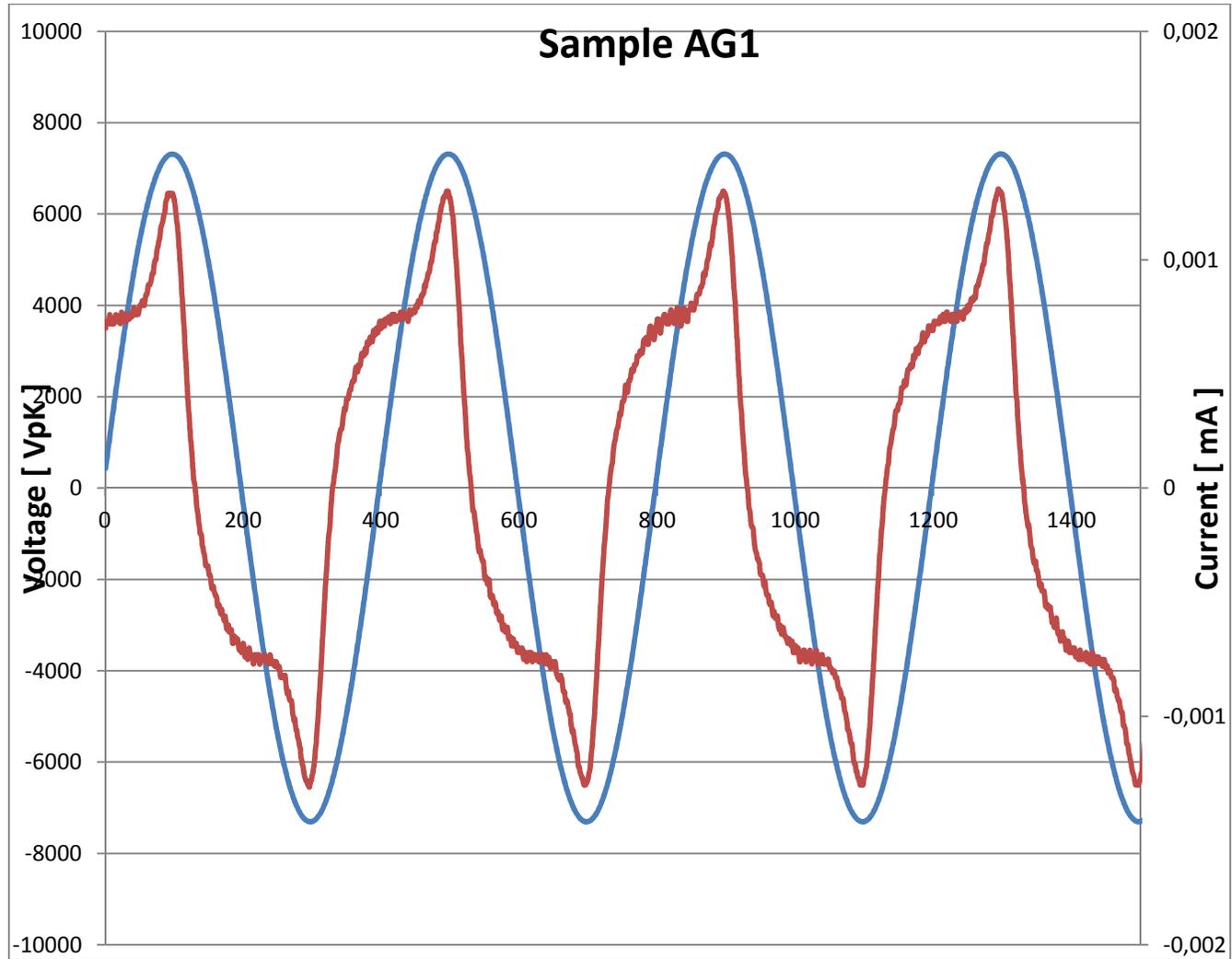


CESI B8001026 Oscillogram n. 2

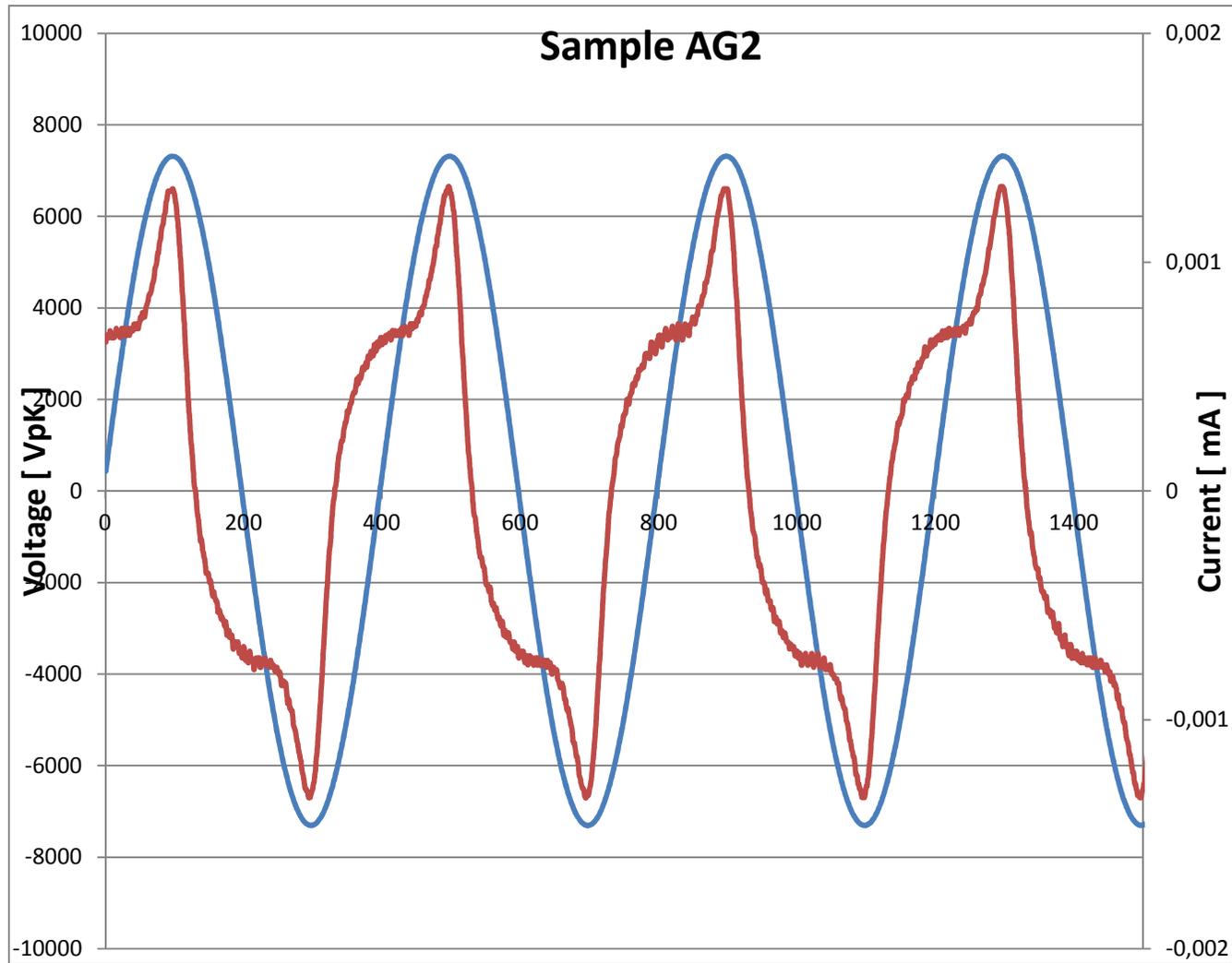


CESI B8001026 Oscillogram n. 3

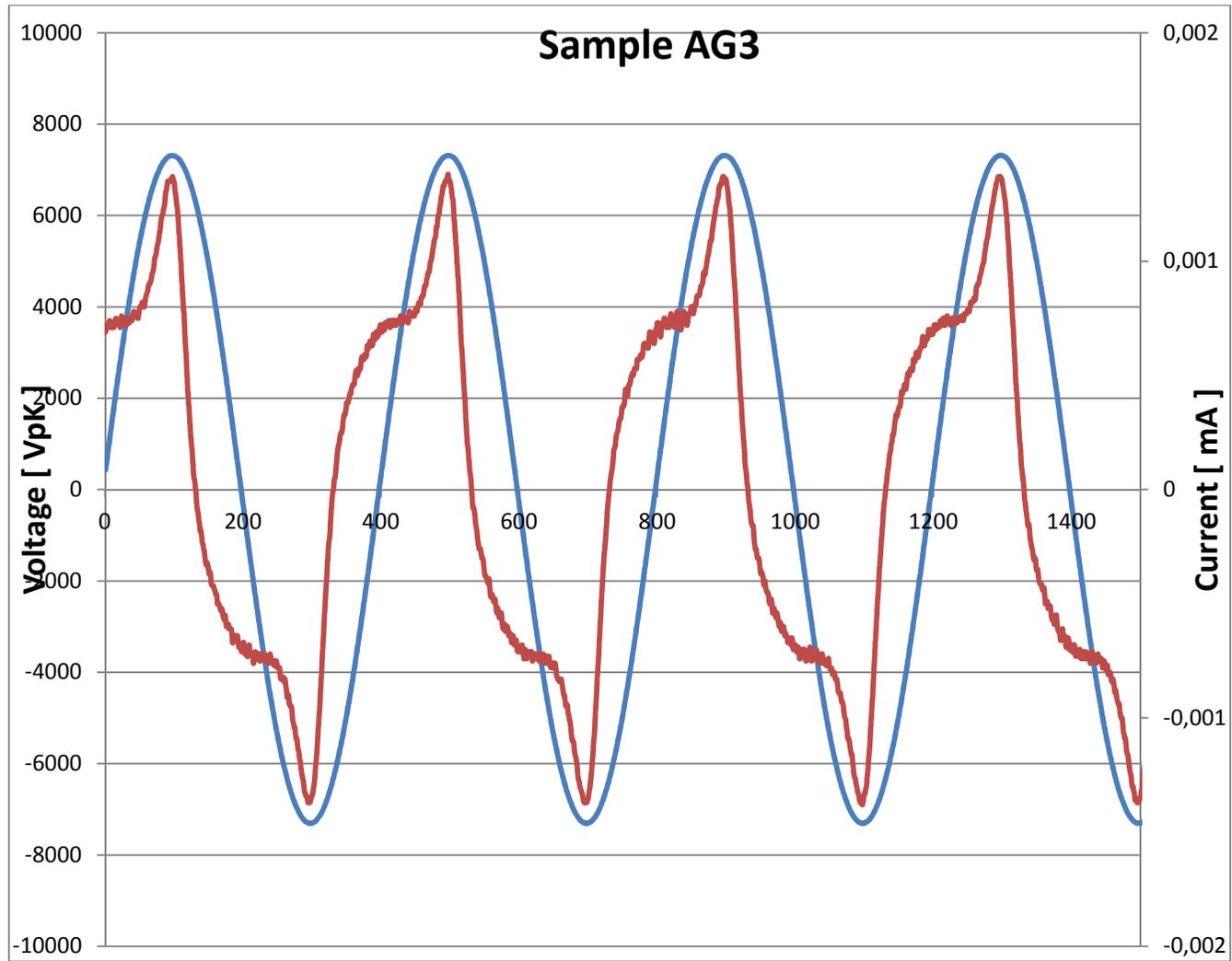




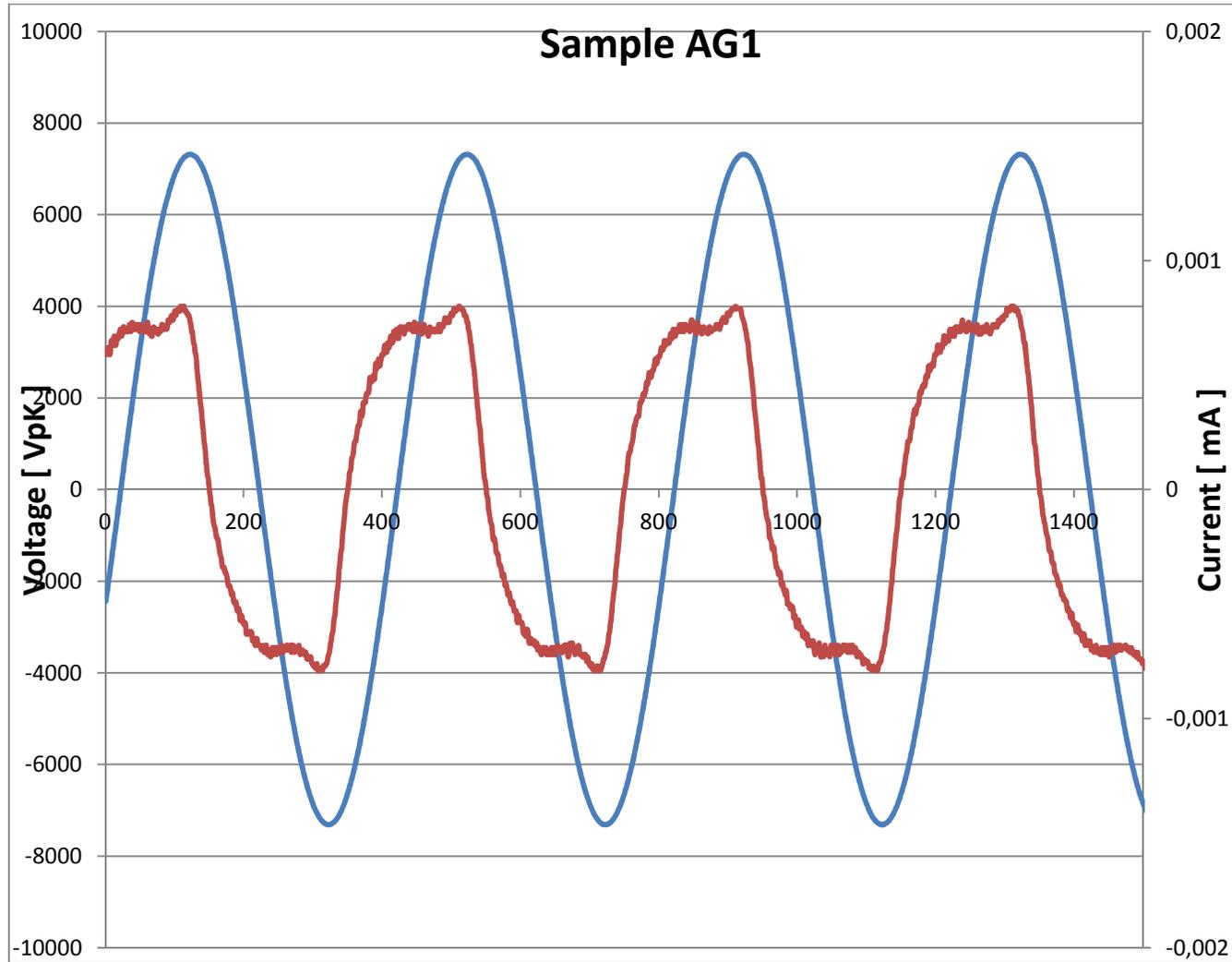
CESI B8001026 oscillogram n.4



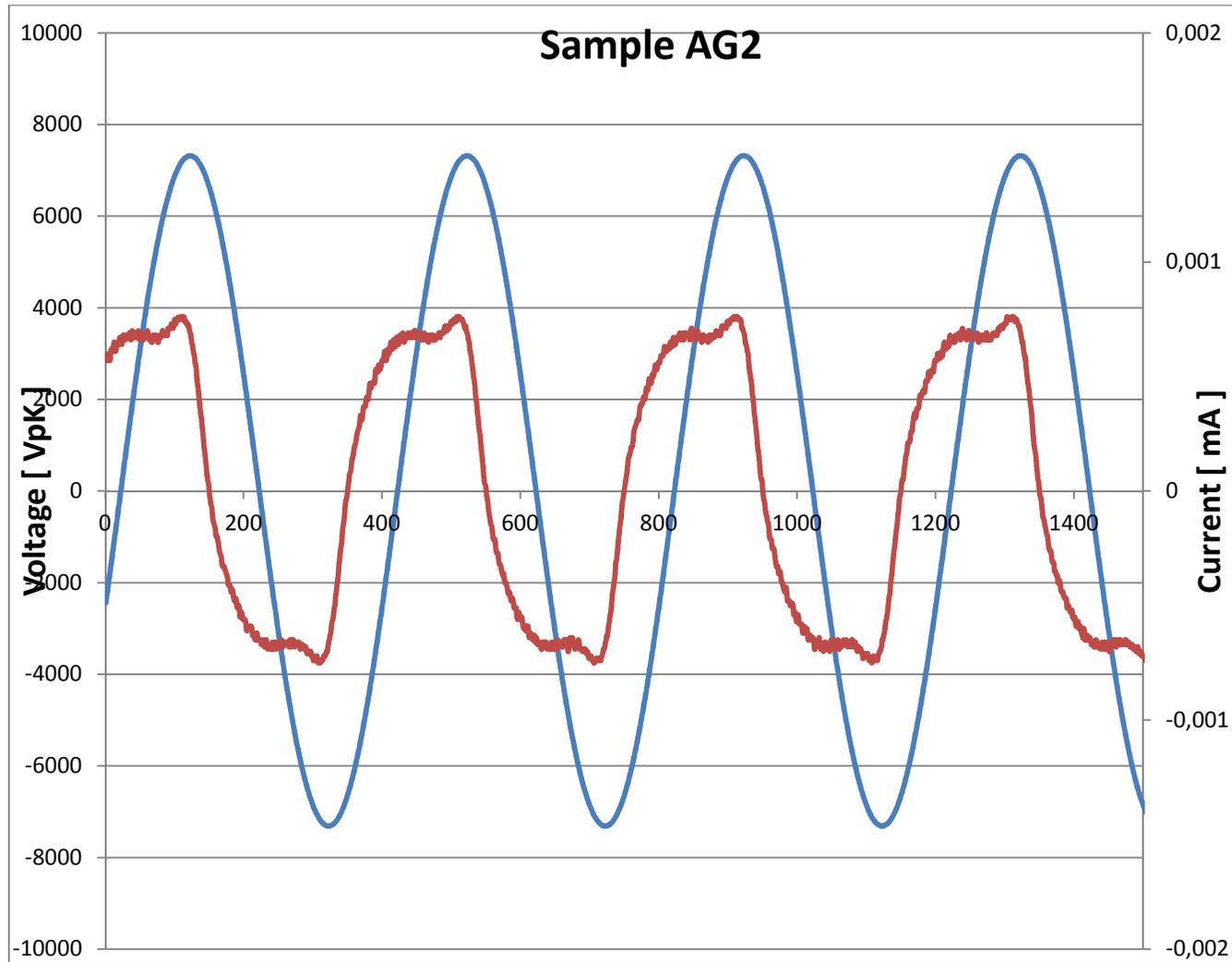
CESI B8001026 oscillogram n.5



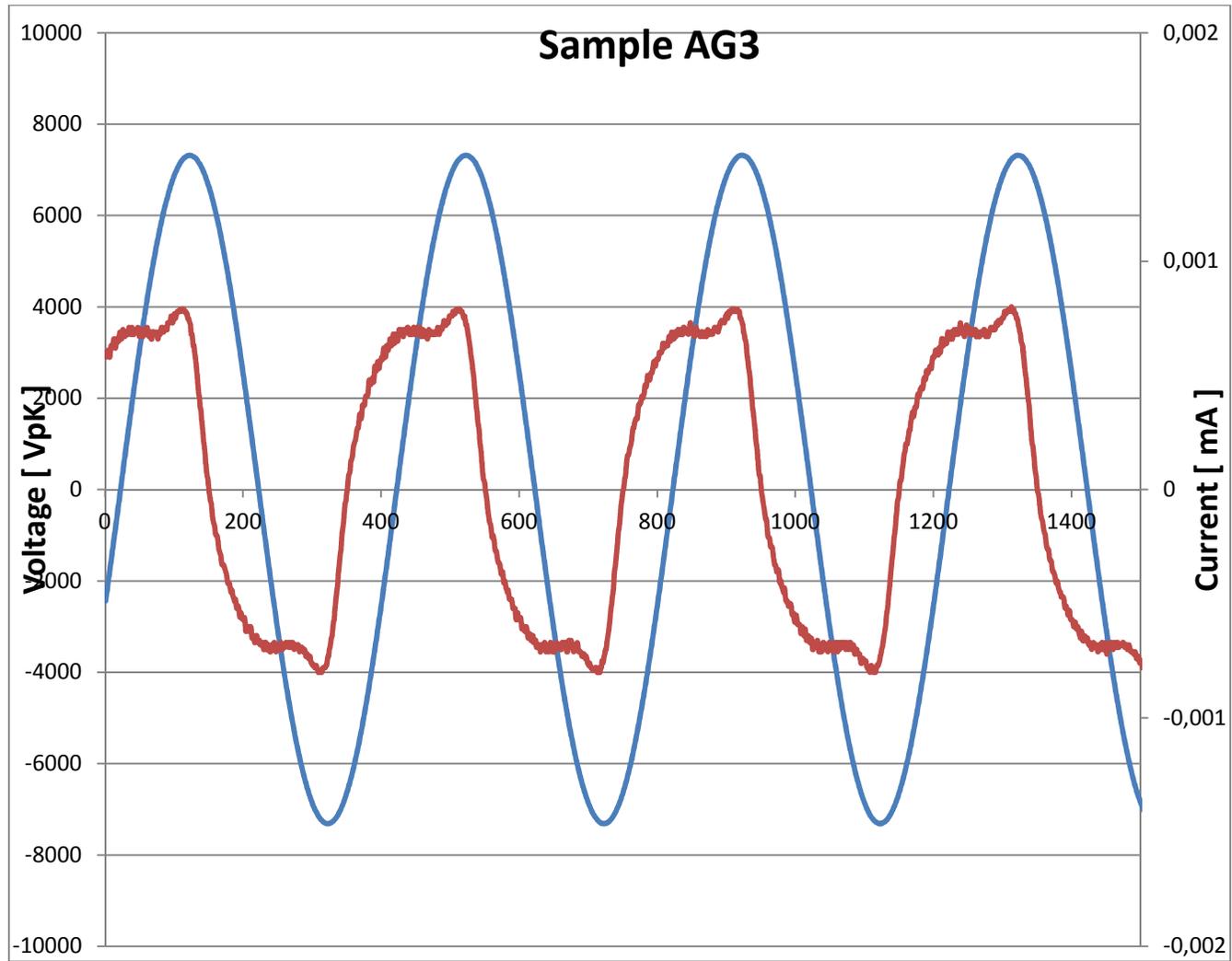
CESI B8001026 oscillogram n.6



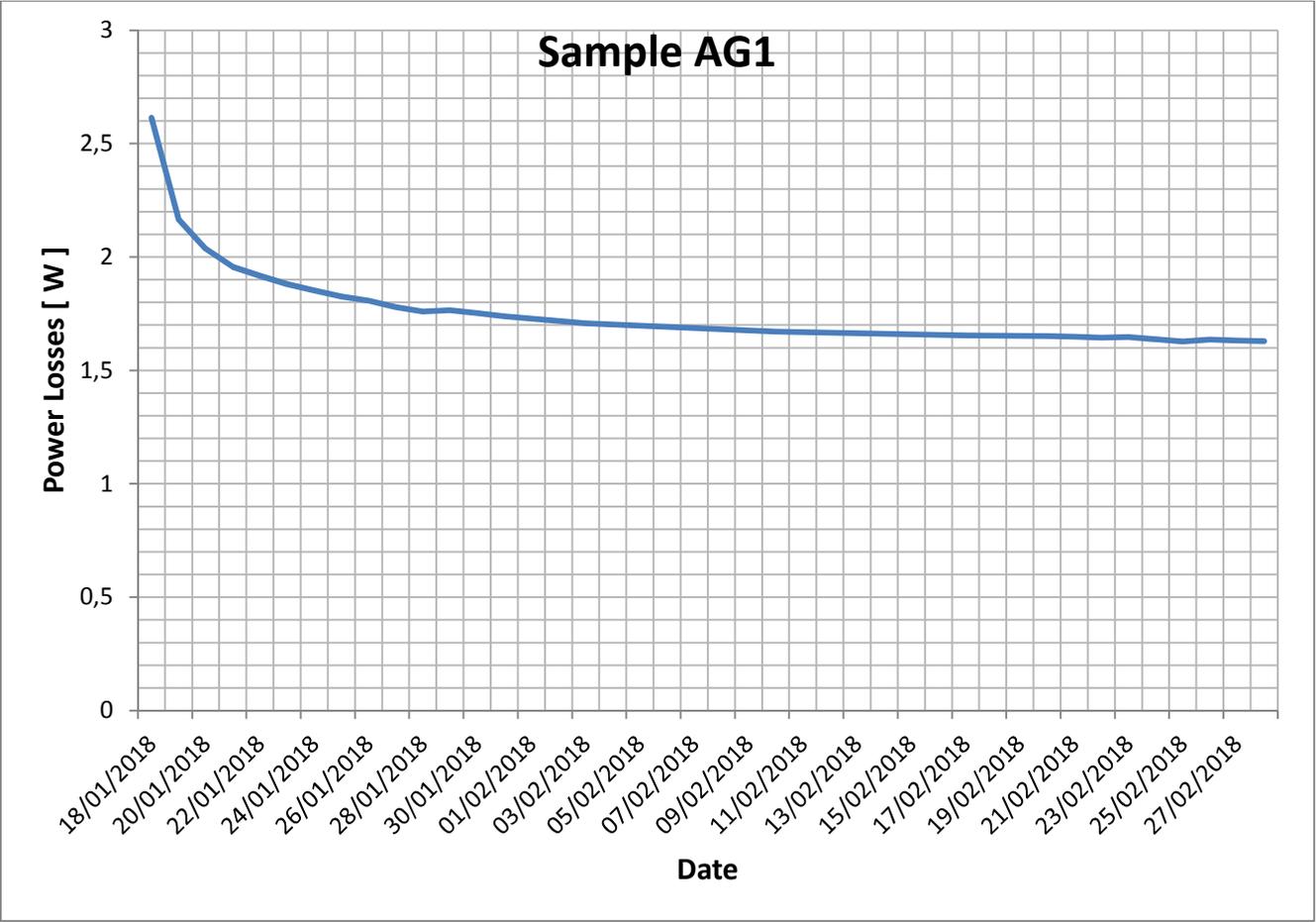
CESI B8001026 oscillogram n.7

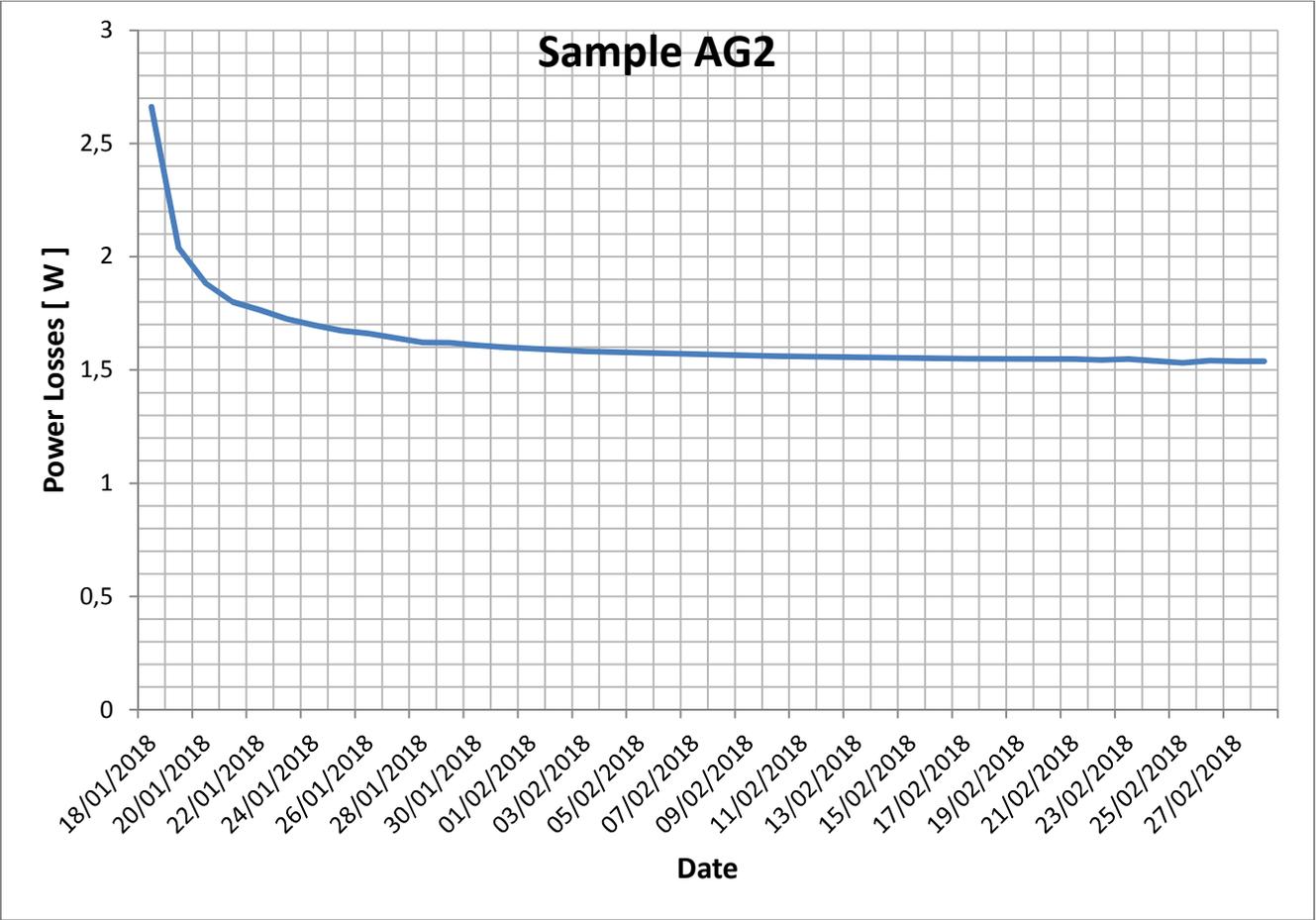


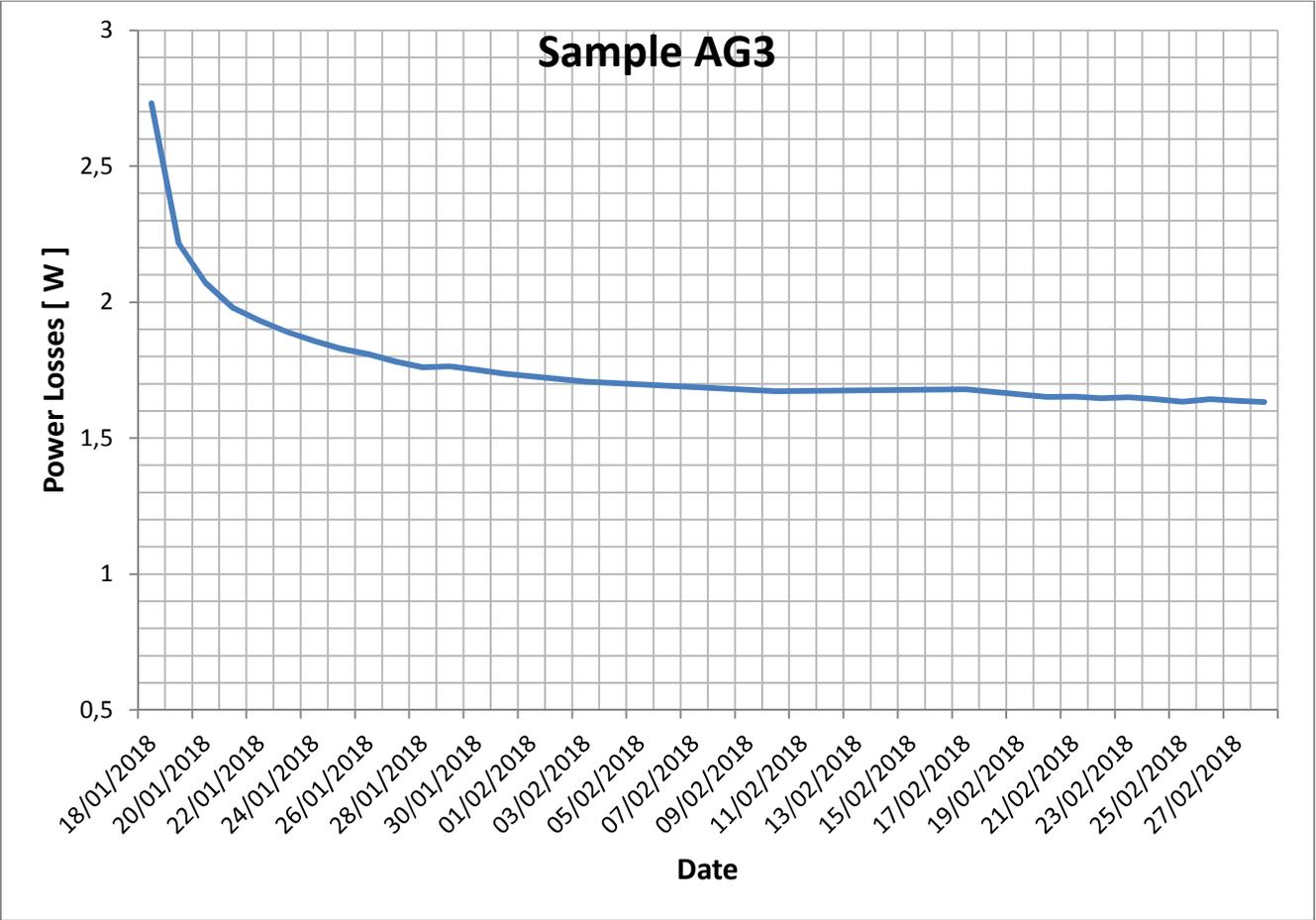
CESI B8001026 oscillogram n.8



CESI B8001026 oscillogram n.9







PA-LTST.ST.01

Перв. примен.

Созаб. №

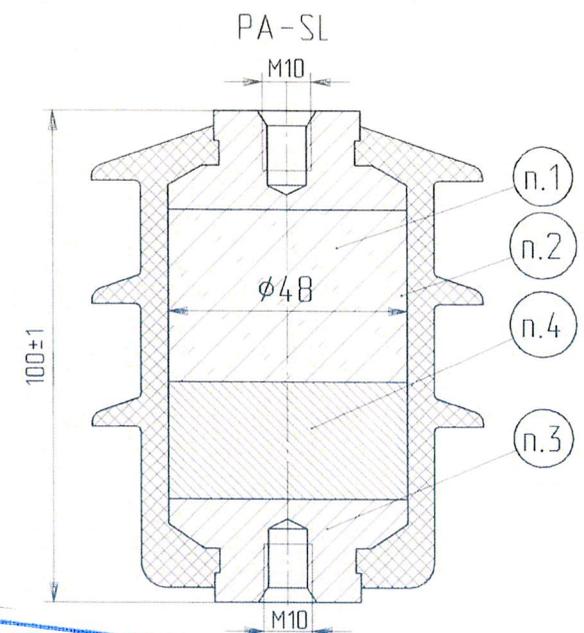
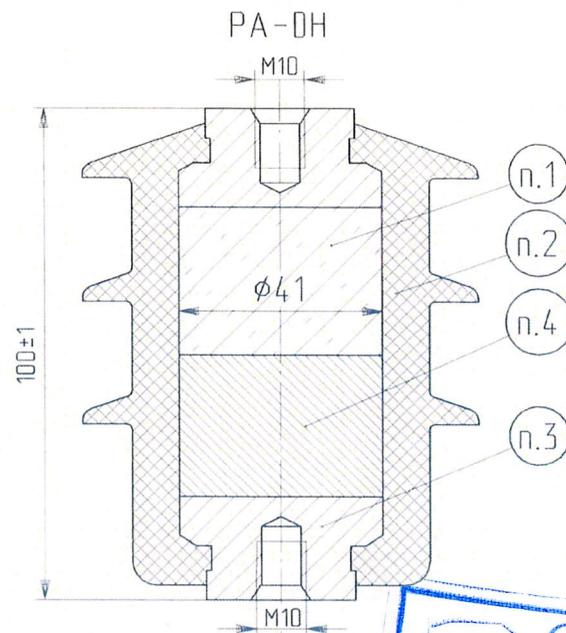
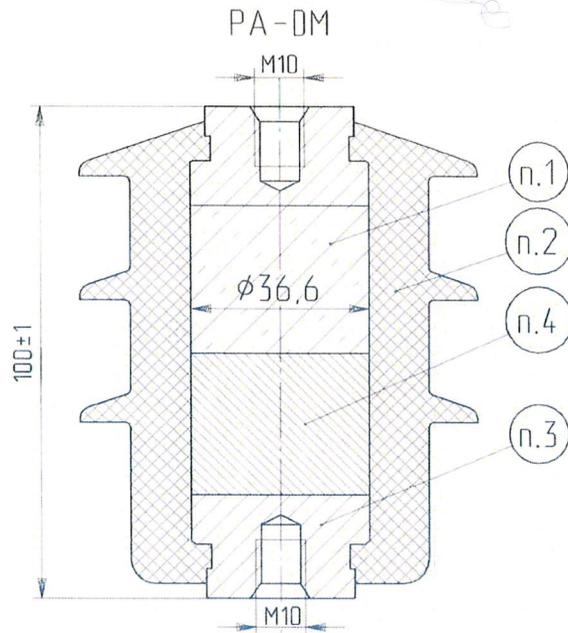
Подп. и дата

Инв.№эф.дл.

Взам.инв.№

Подп. и дата

Инв.№подл.



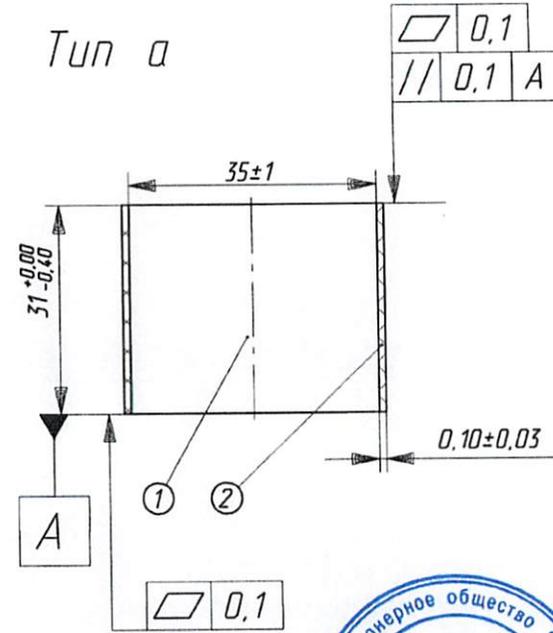
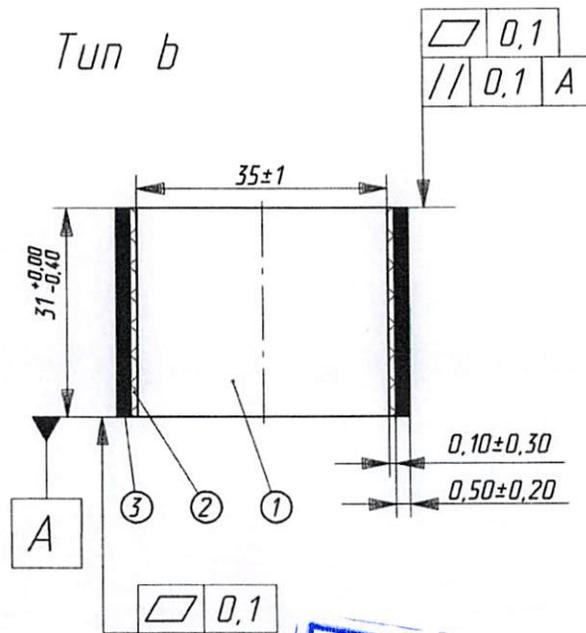
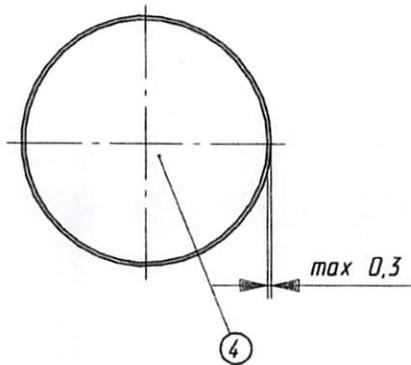
| № п.п. | Name | PA-DM | PA-DH | PA-SL |
|--------|-----------------------|--------|--------|--------|
| 1 | Varistor | B34/30 | B41/30 | B48/35 |
| 2 | Housing | - | - | - |
| 3 | Metal flange | - | - | - |
| 4 | Metal expansion joint | - | - | - |
| | Unit weight, kg | 0,595 | 0,645 | 0,765 |



| PA-LTST.ST.01 | | | | Лист | Масса | Масшт. |
|---------------|--------------|----------|-------|-------|-------------------|----------|
| Изм. | Лист | № докум. | Подп. | Дата | | 1:1 |
| Разраб. | Потапов В.В. | Иван | 05.17 | | | |
| Проб. | Потапов А.В. | Жонин | 05.17 | | Лист 1 | Листов 1 |
| Т.контр. | | | | | 3А0 | |
| И.контр. | | | | | "Полимер-Аппарат" | |
| Утв. | Шедцов И.В. | | | 02.12 | Формат А3 | |

Копировал

PA.VAR.0400.30



1. Металлооксидный варистор (MOV disk)
2. Изоляционное покрытие стекло (Glass insulating collar)
3. Изоляционное покрытие полиуретан (PU insulating collar)
4. Алюминиевый электрод (Al - electrode)



| | |
|--------------|--------------|
| Инв. № дубл. | Подп. и дата |
| Взам. инв. № | Подп. и дата |
| Инв. № подл. | Подп. и дата |

| | | | | |
|----------|------|--------------|-----------|-------|
| Изм. | Лист | № докум. | Подп. | Дата |
| | | | | |
| Разраб. | | Потолов А.В. | Игорь | 09.17 |
| Проб. | | Петухов А.П. | Александр | 09.17 |
| Т.контр. | | | | |
| Н.контр. | | | | |
| Утв. | | Шевцов И.В. | Игорь | 09.17 |

PA.VAR.0400.30

Varistor B34/30

Оксид цинка

| | | |
|--------------------------|----------|--------|
| Лит. | Масса | Масшт. |
| | 0.177 | 1:1 |
| Лист 1 | Листов 1 | |
| ЗАО "Полимер-Аппарат" | | |