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**ASSOCIATION of POLISH ELECTRICIANS  
QUALITY TESTING OFFICE**  
ul. M. Pożaryskiego 28, 04-703 Warszawa, Poland

tel./fax: +48 22 815 65 80, e-mail: bbj@bbj.pl

**TESTING LABORATORY**

AB 044



**TEST REPORT  
EN 61643-11**

**Low-voltage surge protective devices**

**Part 11: Surge-protective devices connected to low-voltage power systems- Requirements  
and test methods**

Report Reference No.....: **LA-24.011/E**Date of issue .....: **2024-03-08**Total number of pages .....: **21 pages**

Tested by **Szymon Przybyś**  
(name + position + signature) .....: Specialist

Authorized by **Dariusz Szczepanowski**  
(name + position + signature) .....: Chief Specialist

Testing application number .....: **B-A-24-011**Test item reference .....: **B-A-24-011**

Scope of test.....:  - type test  - partial test  
 - other test

**Test specification:**

Standard/procedure .....: EN 61643-11:2012

Non-standard test methods.....: N/A

Non-accredited test methods.....: N/A

Applicant's name.....: VCX SP. z o.o.

Address .....: 31-060 Kraków, Pl. Wolnica 13/10

Test item description .....: Surge protective device

Trade Mark .....:

Manufacturer.....: VCX SP. z o.o., 31-060 Kraków, Pl. Wolnica 13/10

Model/Type reference .....: VCX-L1-4-B+C

Ratings .....: see page 3

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List of Attachments:		
Attachment	Attachment name	Number of pages
1	Test program and summary of test results:	1
2	Product information and photos of samples	3
3	Parameters and waveforms for the test 8.3.4.3.	3
4	Parameters and waveforms for tests 8.3.4.3 and 8.3.4.4	4
Summary of testing		
<b>Tests performed</b> (in the case of partial tests):  8.2 Identification and marking 8.3.4 Operating duty test for test classes I, II (8/20) 8.3.4.4 Additional duty test for test class I (10/350)	<b>Testing location / address:</b>  Association of Polish Electricians – Quality Testing Office Testing Laboratory Division of Low Voltage Apparatus ul. M. Rapackiego 13, 20-150 Lublin, Poland	
<b>Number of tests with F(Fail) verdict:</b>	0	
<b>Summary conformity/non-conformity with standardization document</b> (if apply):	The tested product complies with the requirements of partial tests for cl. 8.2, 8.3.4 and 8.3.4.4 of the following standard: EN 61643-11:2011	
<b>Summary of compliance with National Differences</b> (if apply):	N/A	
<b>Opinions and interpretation, if needed:</b>	N/A	
<b>Other additional information</b> (e.g. additional information from the client, including information that may affect the validity of the results):	N/A	
<b>Use of uncertainty of measurement for decisions on conformity (decision rule):</b> <input checked="" type="checkbox"/> <i>No decision rule is specified by the standard, when comparing the measurement result with the applicable limit according to the specification in that standard. The decisions on conformity are made without applying the measurement uncertainty ("simple acceptance" decision rule, previously known as "accuracy method").</i>  <input type="checkbox"/> Other:...		
<b>Information on uncertainty of measurement:</b> The uncertainties of measurement are calculated by the laboratory based on application of criteria given by IECCE OD-5014 for test equipment and application of test methods, decision sheets and operational procedures. IEC Guide 115 or ILAC-G8 provides guidance on the application of measurement uncertainty principles and applying the decision rule when reporting test results within testing / certification scheme, noting that the reporting of the measurement uncertainty for measurements is not necessary unless required by the test standard or customer. Calculations leading to the reported values are on file with the NCB and/or Testing Laboratory that conducted the testing.		

**Copy of marking plate:**

The artwork below may be only a draft. The use of certification marks on a product must be authorized by SEP-BBJ Certification Body that own these marks.



**Test item particulars:**

<b>Number of ports</b>	: One port / Two-port
<b>SPD design topology</b> .....	: Voltage switching / Voltage limiting / Combination
<b>SPD classified for test class</b> .....	: I / II / III
<b>Location</b> .....	: Indoor / Outdoor
<b>Accessibility</b> .....	: Accessible / Inaccessible
<b>Mounting method</b> .....	: Fixed / Portable
<b>SPD Disconnecter</b> .....	: Internal / External / Both
<b>Protection functions</b> .....	: Thermal / Leakage current / Overcurrent
<b>Overcurrent protection</b> .....	: Specified / Not-specified
<b>Degree of protection (IP code)</b> .....	: IP20 (front side)
<b>Temperature range</b> .....	: -40 °C...+80 °C
<b>Required SPD-disconnectors</b> .....	: 125 A gL/gG
<b>SPD failure behaviour:</b> .....	: open circuit / short circuit
<b>Date (s) of receipt of test item</b> .....	: 2023-10-30, 2023-11-03
<b>Tests start date</b> .....	: 2023-11-07
<b>Tests end date</b> .....	: 2024-02-29

**Possible test case verdicts:**

- test case does not apply to the test object..... : **N/A (Not Applicable)**
- test object does meet the requirement..... : **P (Pass)**
- test object does not meet the requirement..... : **F (Fail)**



**Test report general remarks:**

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

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2. "(See Enclosure #)" refers to additional information appended to the report.

3. "(See appended table)" refers to a table appended to the report .

4. Throughout this report a comma is used as the decimal separator.

5. Test Report Form is based on TRF No.: IEC61643\_11B, copyrighted by IECCE.

Production place(s) .....: —

**General product information:**


The VCX-L1-4-B+C device is a four-pole surge arrester consisting of identical modules (4+0). Individual modules are connected between L1, L2, L3, N and PE. Each SPD module contains a voltage limiting element, but does not contain a voltage cutting element. According to the manufacturer, this device meets the requirements of test classes T1 and T2. Full labeling of each SPD module is shown on page 3 - copy of nameplate.

Four samples were delivered for testing, marked with the numbers B-A-24-011/1-1...4, B-A-24.011/2-1...4, B-A-24.011/3-1...4, B-A-24.011/4-1...4 ( .../sample number - module number).

Tests for the T2 sample class were performed on three modules of sample number one.

Tests for the T1 sample class were performed on three modules of sample number two.

In the further part of the report, simplified numbering of samples was used, i.e. 1-1

EN 61643-11			
Clause	Requirement + Test	Result - Remark	Verdict
7.1.1/7.1.2	<b>Identification and Marking *)</b>		—
	<b><u>Markings on the body or permanently attached to</u></b>		—
	a1) Manufacturer/Trade mark/Model number	 VCX-L1-4-B+C	P
	a2) Maximum continuous operating voltage $U_c$ (one value for each mode of protection)	$U_c = 275 \text{ V}$	P
	a3) Type of current: a.c. or “~” and/or frequency	<u>AC</u>	P
	a4) Test classification and discharge parameters shall be printed next to each other for each mode of protection declared by the manufacturer  For test class I: either “test class I” and “ $I_{imp}$ ” and the value in kA, and/or “ <b>T1</b> ” (T1 in a square) and “ $I_{imp}$ ” and the value in kA  For test class II: either “test class II” and “ $I_n$ ” and the value in kA, and/or “ <b>T2</b> ” (T2 in a square) and “ $I_n$ ” and the value in kA  For test class III: either “test class III” and “ $U_{oc}$ ” and the value in kV, and/or “ <b>T3</b> ” (T3 in a square) and “ $U_{oc}$ ” and the value in kV	$I_{imp}: 7 \text{ kA (10/350)} [T1]$  $I_n: 20 \text{ kA (8/20) [T2]}$  _____ kV	P  P  N/A
	a5) Voltage protection level $U_p$ (one value for each mode of protection)	$U_p \leq 1,5 \text{ kV}$	P
	a6) Degree of protection if > IP20	<u>IP20</u>	P
	a7) Identification of terminals or leads	<u>L L L N PE</u>	P
	a8) Rated load current $I_L$		N/A
	*) partial test		

<b>EN 61643-11</b>			
Clause	Requirement + Test	Result - Remark	Verdict
7.2.4/8.3.4	<b>Operating duty</b>		
	The SPD shall be capable of withstanding specified discharge currents during application of the maximum continuous operating voltage $U_c$ without unacceptable changes in its characteristics.  The test setup shall comply with the circuit diagram given in Figure 7.		N/A
	Determination of the measured limiting voltage:		
	according to 8.3.3.1, but only at a crest value corresponding to $I_{imp}$ for test class I	$U_{res\ max.}: 0,89\ kV / 7\ kA$ See Annex 4, table 1	P
	according to 8.3.3.1, but only at $I_n$ for test class II	$U_{res\ max.}: 1,16\ kV / 20\ kA$ See Annex 3, table 1	P
	according to 8.3.3.3, but only at $U_{oc}$ for test class III	_____ kA / _____ V	N/A
	SPDs tested acc. to class I and II containing switching components:  Front-of-wave sparkover voltage acc. to 8.3.3.2  All measured peak values (5 pos./5 neg.) below $U_p$	_____ kV	N/A
	Sample connected to power frequency source at $U_c$	_____ V	N/A
8.3.4.2.1	SPDs with follow current < 500A:  Voltage at SPD terminals does not fall below the peak value of $U_c$ by more than 10% during flow of follow current		P
8.3.4.2.2	SPDs with follow current > 500A:  The test sample shall be connected to a power frequency voltage at $U_c$ with a prospective short-circuit current equal to the short circuit current rating $I_{scor}$ declared by the manufacturer and with a power factor in accordance with table 8, except for SPDs which are only connected between neutral and protective earth in TT- and/or TN-Systems, for which the prospective short-circuit current shall be at least 100 A.	_____ kA  $\cos\ \varphi =$ _____	N/A  N/A

<b>EN 61643-11</b>			
Clause	Requirement + Test	Result - Remark	Verdict
8.3.4.3	<b>Class I and II operating duty tests</b>		
	<p>Three groups of five impulses of 8/20 current impulses with positive polarity shall be applied. The test samples are connected to a power source according to 8.3.4.2. Each impulse shall be increased in steps of 30° with a tolerance of ± 5° for each synchronisation angle.</p> <p>time interval between the impulses 50s – 60s time interval between the groups 30 min – 35 min</p>	<p><u>I<sub>n</sub>: 20 kA, I<sub>imp</sub>: 7 kA</u></p> <p>sync. 0°, 30°, 60°, 90°, 120°, 150°, 180°, 210°, 240°, 270°, 300°, 330°, 0°, 30°, 60° el.</p>	P
	<p>The SPD shall be energized at U<sub>c</sub>. The prospective short-circuit current of the power source shall comply with 8.3.4.2 during the application of groups of impulses.</p> <p>After the application of each group of impulses and after the interruption of the last follow current (if any) the SPD shall remain energized without interruption for at least 1 min to check for reignition.</p> <p>After the last group of impulses and the 1 min period the SPD either remains applied or is reapplied within less than 30s to U<sub>c</sub> for another 15 min to check for stability. For that purpose, the short-circuit capability of the power source (at U<sub>c</sub>) may be reduced to 5A.</p>	U <sub>c</sub> = <u>275 V</u>	P  P  P
	When testing SPDs to class I, 8/20 current impulses with a crest corresponding to I <sub>imp</sub> shall be applied.	Current impulse check 8/20 with a peak value I <sub>imp</sub> : 7 kA	P
	When testing SPDs to class II, 8/20 current impulses with I <sub>n</sub> shall be applied.	Current impulse check 8/20 with a peak value I <sub>n</sub> : 20 kA	P
	Current records show no sign of puncture or flashover of the sample		P
8.3.4.5	<b>Class III operating duty tests</b>		
	<p>The SPD is tested with three groups of impulses corresponding to U<sub>oc</sub> with:</p> <ul style="list-style-type: none"> <li>- five positive impulses initiated at crest value of positive half cycle (±5°)</li> <li>- five negative impulses initiated at crest value of positive half cycle (±5°)</li> <li>- five positive impulses initiated at crest value of positive half cycle (±5°)</li> </ul>		N/A



<b>EN 61643-11</b>			
Clause	Requirement + Test	Result - Remark	Verdict
8.3.4.4	<b>Additional duty test for test class I</b>		P
	This test is carried out with current impulses in steps up to $I_{imp}$ passing through the SPD.  SPD energized at $U_c$ by a voltage source having a nominal current capability of 5A during the application of impulses.	$I_{imp} = 7 \text{ kA (10/350)}$  $U_c = \underline{275 \text{ V}}$	P
	Current impulses of positive polarity shall be initiated in the corresponding positive crest value of the power frequency voltage source to the energized test sample as follows:  a) One current impulse at $0,1 I_{imp}$ b) One current impulse at $0,25 I_{imp}$ c) One current impulse at $0,5 I_{imp}$ d) One current impulse at $0,75 I_{imp}$ e) One current impulse at $1,0 I_{imp}$	<u>(0,63...0,77) kA</u> <u>(1,575...1,925) kA</u> <u>(3,15...3,85) kA</u> <u>(4,725...5,775) kA</u> <u>(6,3...7,7) kA</u>	P
	After each impulse cool down to ambient temperature		P
8.3.4.6	<b>Pass criteria</b>		
A	After the application of each impulse and after interruption of each follow current (if any) the SPD shall remain energized without interruption for at least 1 min to check for re-ignition.  After that period the SPD either remains applied or is reapplied within less than 30s to $U_c$ for another 15 min to check for stability. For that purpose the short-circuit capability of the power source shall also be 5A.		P  P
B	Voltage and current records and visual inspection show no sign of puncture or flashover.		P
C	No mechanical damage		P
D	Determination of the measured limiting voltage:	$U_P \leq \underline{1500 \text{ V}}$	
	according to 8.3.3.1, but only at a crest value corresponding to $I_{imp}$ for test class I	<u>6,59 kA / <math>U_{res \text{ max}}</math>: 900 V</u> See Anex 4, table 2	P
	according to 8.3.3.1, but only at $I_n$ for test class II	<u>20,15 kA / <math>U_{res \text{ max}}</math>: 1180 V</u>	P
	according to 8.3.3.3, but only at $U_{oc}$ for test class III	_____ kA / _____ V	N/A





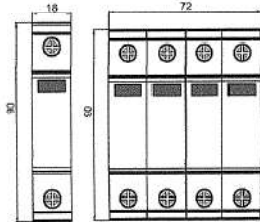
EN 61643-11			
Clause	Requirement + Test	Result - Remark	Verdict
	<p>SPDs tested acc. to class I and II containing switching components:</p> <p>Front-of-wave sparkover voltage acc. to 8.3.3.2</p> <p>All measured peak values (5 pos./5 neg.) below <math>U_P</math></p>	_____ kV	N/A
E	No excessive leakage currents shall occur after the test		
	If there is more than one possible connection arrangement for normal use, this check shall be performed for all arrangements		N/A
	<p>The SPD shall be connected as for normal use according to the manufacturer's instructions to a power supply at the reference test voltage (<math>U_{REF}</math>). The current that flows through each terminal is measured. Its resistive component (measured at the crest of the sine wave)</p> <ul style="list-style-type: none"> <li>shall not exceed a value of 1 mA</li> </ul> <p>or</p> <ul style="list-style-type: none"> <li>the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence</li> </ul>	$U_{REF} = 255$ V	P  P  P
	<p>Any resettable or rearmable disconnecter shall be switched off and dielectric withstand shall be checked by application of two times <math>U_C</math> or 1000V a.c. whichever is greater.</p> <p>During the test, no flashover, breakdown of insulation or any other manifestation of disruptive discharge shall occur.</p>	$U_C =$ _____ V  test voltage  _____ V	N/A  N/A
	<p>For SPD modes connected N-PE only, the current through the PE-terminal shall be measured, whereas the terminals are connected to a power supply at <math>U_C</math>.</p> <p>Its resistive component (measured at the crest of the sine wave)</p> <ul style="list-style-type: none"> <li>shall not exceed a value of 1 mA</li> </ul> <p>or</p> <ul style="list-style-type: none"> <li>the current shall not have changed by more than 20% compared to the initial value determined at the beginning of the test sequence</li> </ul>	$U_C = 275$ V  $I_{PE} = \leq 1$ mA	P  P  P



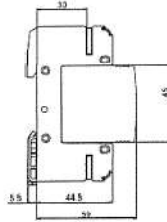
<b>EN 61643-11</b>			
Clause	Requirement + Test	Result - Remark	Verdict
F	External disconnectors shall not operate during the test and shall be in working order after the test.		P
G	Internal disconnectors shall not operate during the test and shall be in working order after the test.		P
M	There shall be no explosion or other hazard to either personnel or the facility.		P

**Attachment No. 1****TEST PROGRAM AND SUMMARY OF TEST RESULTS:****Test program:**

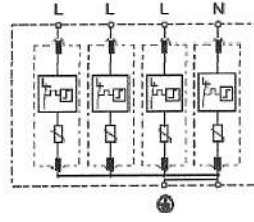
Clause	Test description	Sample numbers	Verdict
8.2	Identification and marking	4-1...4	P
8.3.4	Operating duty test for test classes I, II (8/20)	1-1...4, 2-1...4	P
8.3.4.4	Additional duty test for test class I (10/350)	2-1...4	P

**Attachment No. 2**
**PRODUCT INFORMATION AND PHOTOS OF SAMPLES**
**OGRANICZNIK PRZEPIĘĆ  
VCX-L1-4-B+C  
INSTRUKCJA OBSŁUGI**


Widok z przodu



Wymiary ogranicznika



Schemat połączeń układu

**Dane Techniczne**

- Zgodność z normą: PN-EN 61643-11
- Klas próby SPD: Typ 1+ Typ 2 / klasa I + klasa II
- Typ sieci: TN-S/TT
- Liczba biegunów: 4
- Napięcie znamionowe AC,  $U_N$  : 230/400 V (50/60Hz)
- Największe napięcie pracy ciągłej,  $U_c$  : 275V
- Całkowity prąd udarowy (10/350  $\mu$ s) [L1+L2+L3+N-PE],  $I_{total}$  : 25 kA
- Udarowy prąd wyładowczy (10/350  $\mu$ s) [L/N-PE],  $I_{imp}$  : 7 kA
- Znamionowy prąd wyładowczy (8/20  $\mu$ s) [L/N-PE]  $I_n$  : 20 kA
- Napięciowy poziom ochrony  $U_p$ : (L-PE)/(N-PE)  $U_p$ :  $I_n$ : 20 kA (8/20  $\mu$ s)  $\leq 1,5kV$   
(L-PE)/(N-PE)  $U_p$ :  $I_{max}$ : 40 kA (8/20  $\mu$ s)  $\leq 2,0kV$
- Czas zadziałania  $t_A$ :  $< 25$  ns
- Prąd upływu przy napięciu znamionowym  $I_{pe}$  :  $< 1.6mA$
- Maksymalny bezpiecznik: 125 gL/gG
- Wykonanie: warystorowe
- Moduł: wymienny
- Lokalizacja: Wewnętrzna,
- Stopień ochrony, IP 20. Produkt jest przeznaczony do pracy w miejscach, w których nie występuje wilgoć i zanieczyszczenia..
- Temperatura i wilgotność pracy:  $-40$  to  $+80^\circ C$ , max. Wilgotność 90%
- Waga: 570g

- Montaż za pomocą klipsów w skrzynce rozdzielczej.
- Podłączenie kabli – śruby z zaciskami lub listwa DIN 35mm,
- Kable przyłączeniowe: maksymalny przekrój sztywne 35mm<sup>2</sup> max lub 25mm<sup>2</sup> elastyczne
- Status: zielony ochrona, czerwony : brak ochrony
- Dobór i instalacja ograniczników przepięć serii VCX-L1-4-B+C służą do ochrony instalacji przed przepięciami indukowanymi, łączeniowymi oraz wywołanymi przez czynniki atmosferyczne.
- Dobór i instalacja ograniczników przepięć dokonywane mogą być wyłącznie przez osoby uprawnione/wykwalifikowane oraz zależą od typu zastosowanej instalacji ogromnej jak i typu sieci.

**Należy:**

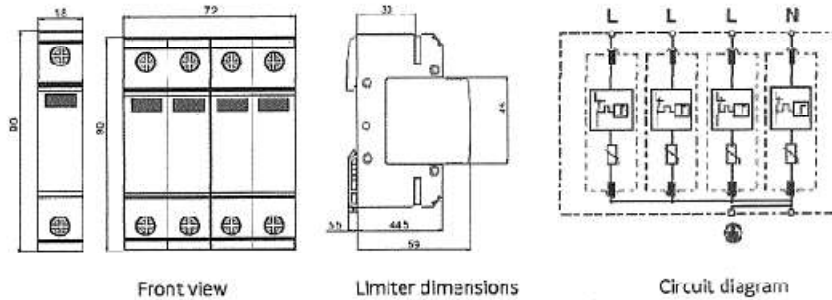
- regularnie sprawdzać stan instalacji oraz stan wskaźnika uszkodzenia wkładki.
- testować ogranicznik co 2 lata lub za każdym razem, gdy piorun uderzy w chroniony obiekt; jeśli kolor ogranicznika zmieni się z zielonego na czerwony, ogranicznik należy wymienić, ponieważ uszkodzony ogranicznik nie zapewnia ochrony.
- Ograniczniki mogą być instalowane wyłącznie przez uprawnione osoby w rozdzielnicach o IP odpowiadającym stopniowi ochrony pomieszczenia.
- zabezpieczyć ograniczniki przed dostępem osób nieupoważnionych.

**Nie wolno:**

- narażać ograniczników na działanie czynników szkodliwych min. temperatury, substancji chemicznych, urazów mechanicznych, itp.
- dokonywać ingerencji w obudowę oraz wewnętrzną budowę ogranicznika, a także dokonywać jakichkolwiek zmian konstrukcyjnych ogranicznika.

**WARUNKI GWARANCJI**

- gwarancja nie obejmuje uszkodzeń mechanicznych jak i innych powstałych z winy użytkownika.
- gwarancja nie obejmuje strat powstałych w wyniku zastosowania nieodpowiedniego typu ochronnika i nieodpowiedniego montażu.
- gwarancja ważna jest tylko wypadku montażu dokonanego przez osoby uprawnione/wykwalifikowane
- gwarancja nie obejmuje uszkodzeń wynikłych z silnych przepięć i wyładowań atmosferycznych, jako czynników naturalnych możliwych do wystąpienia.
- gwarancja nie obejmuje uszkodzeń ograniczników powstałych na skutek działania czynników szkodliwych.
- warunkiem realizacji gwarancji jest posiadanie podbitej przez sprzedawcę karty gwarancyjnej.
- gwarancja trwa 24 miesiące od dnia zakupu.

**Attachment No. 2**
**SURGE PROTECTORS  
VCX-L1-4-B+C  
INSTRUCTION MANUAL**

**Technical data**

- Complies with: EN 61643-11
- SPD test class: Type 1+ Type 2 / Class I + Class II
- Network type: TN-S/TT
- Number of poles: 4
- Rated AC voltage,  $U_N$  : 230/400 V (50/60Hz)
- Highest continuous operating voltage,  $U_c$  : 275V
- Total Lightning Surge Current (10/350  $\mu$ s) [L+L2+L3+N-PE],  $I_{total}$  : 25 kA
- Lightning discharge current (10/350  $\mu$ s) [L/N-PE],  $I_{imp}$  : 7 kA
- Rated discharge current (8/20  $\mu$ s) [L/N-PE]  $I_n$  : 20 kA
- Voltage protection level  $U_P$  (L-PE)/(N-PE)  $U_{p:In:20\text{ kA}(8/20\ \mu\text{s})} \leq 1,5\text{kV}$   
(L-PE)/(N-PE)  $U_{p:I_{max}:40\text{ kA}(8/20\ \mu\text{s})} \leq 2,0\text{kV}$
- Tripping time  $t_A$ : <25 ns
- Leakage current at rated voltage  $I_{le}$  : <1.6mA
- Maximum fuse: 125 gL/gG
- Design: Varistor
- Module: interchangeable
- Location: Interior,
- Degree of protection, IP 20, The product is designed for use in areas free of moisture and Contamination.
- Temp and humidity: -40 to +80° C, max. humidity 90%
- Weight: 570g

- Mounted with clips in the distribution box.
- Cable connection - terminal screws or 35mm DIN rail.
- Connection cables: maximum cross-section rigid 35mm<sup>2</sup> max or 25mm<sup>2</sup> flexible.
- Status: green: protection, red: no protection.
- The selection and installation of surge arresters of the VCX-L1-4-E+C series are used to protect installations against induced, switching and atmospherically induced surges.
- The selection and installation of surge arresters must only be carried out by authorised/qualified persons and depends on the type of lightning protection system and type of network used.

**You should:**

- regularly check the condition of the installation and the status of the insertion fault indicator.
- test the arrester every 2 years, or whenever lightning strikes the protected object; if the colour of the arrester changes from green to red, the arrester must be replaced, as a defective arrester does not provide protection.
- Arresters may only be installed by authorised persons in switchgear with an IP corresponding to the degree of protection of the room.
- protect the stops from unauthorised access.

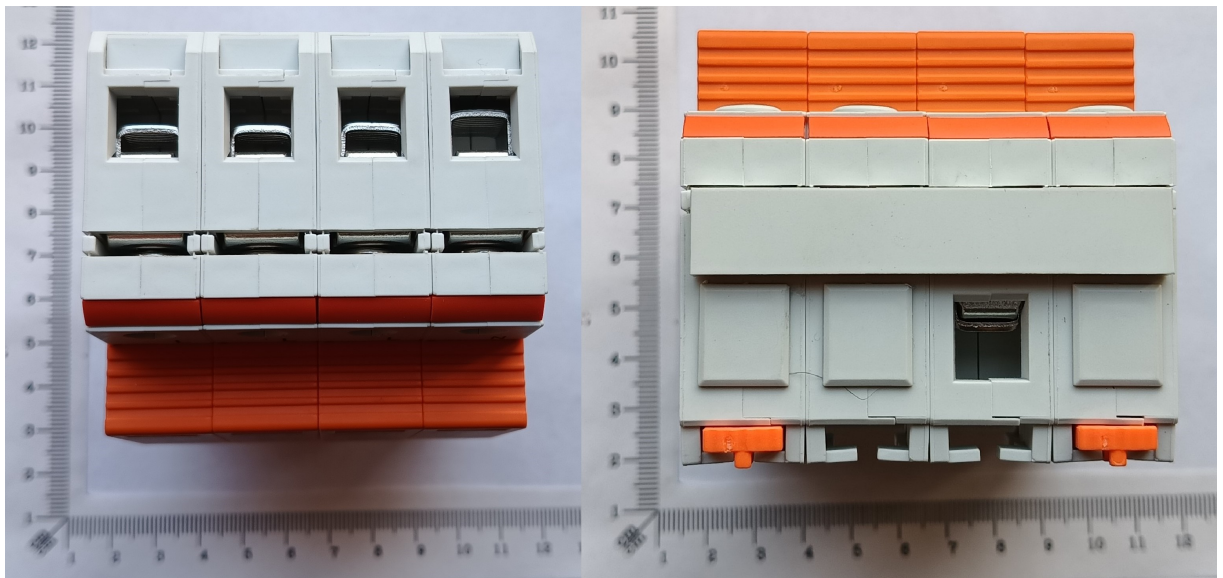
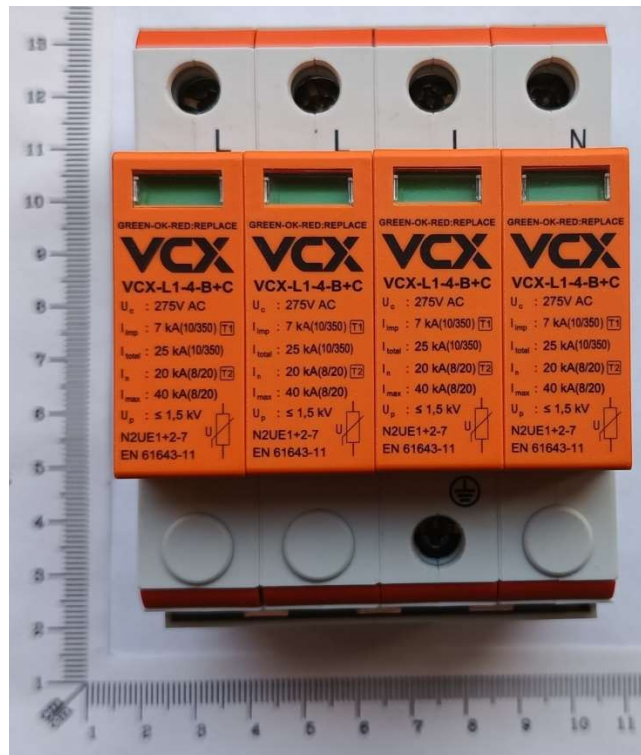
**Not allowed:**

- expose the arresters to harmful factors, e.g temperature, chemicals, mechanical injury, etc.
- to tamper with the housing and the internal structure of the arrester or to make any structural changes to the arrester.

**WARRANTY CONDITIONS**

- the guarantee does not cover mechanical or other damage caused by the user.
- the guarantee does not cover losses resulting from the use of an unsuitable type of protector and from inadequate installation.
- the guarantee is only valid in the event of installation by authorised/qualified persons
- the guarantee does not cover damage resulting from severe overvoltage and lightning, as naturally occurring factors.
- the guarantee does not cover damage to the arresters caused by harmful factors.
- The warranty can only be honoured if the seller has stamped the warranty card.
- The guarantee lasts 24 months from the date of purchase.



**Attachment No. 2****General view of the VCX-L1-4-B+C surge protective device**

**Attachment No. 3**
**Test results according to 8.3.4.3**

Table 1. Residual voltage during current impulses 8/20, measurements before operating duty test according to 8.3.4.3.

Sample No.	Current amplitude 8/20	Value of the residual voltage $U_{res}$	Polarity	Permissible value residual voltage $U_P$
	kA	kV	+/-	kV
1-1	18,60	1,08	+	1,5
1-1	20,47	1,12	-	1,5
1-2	20,32	1,16	+	1,5
1-2	20,16	1,14	-	1,5
1-3	20,45	1,12	+	1,5
1-3	20,31	1,12	-	1,5

Table 1. Residual voltage during current impulses 8/20, measurements after operating duty test according to 8.3.4.3.

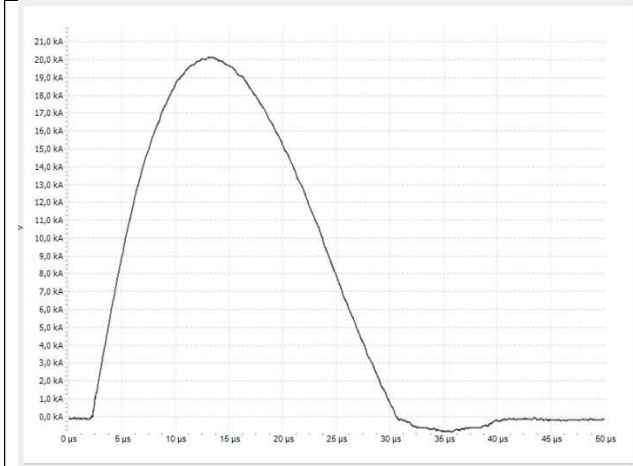
Sample No.	Current amplitude 8/20	Value of the residual voltage $U_{res}$	Polarity	Permissible value residual voltage $U_P$
	kA	kV	+/-	kV
1-1	20,43	1,14	+	1,5
1-1	20,13	1,10	-	1,5
1-2	20,15	1,18	+	1,5
1-2	20,11	1,16	-	1,5
1-3	20,13	1,14	+	1,5
1-3	20,28	1,12	-	1,5



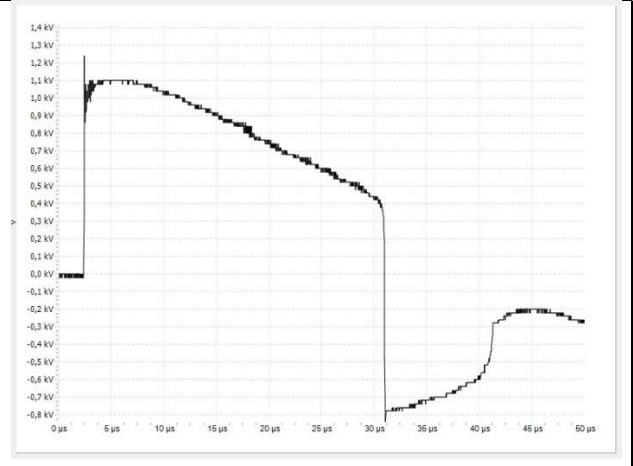
**Attachment No. 3**

Example recording of residual voltage (negative polarization) + surge current waveform 8/20.

Sample No. 1-1, pole L1

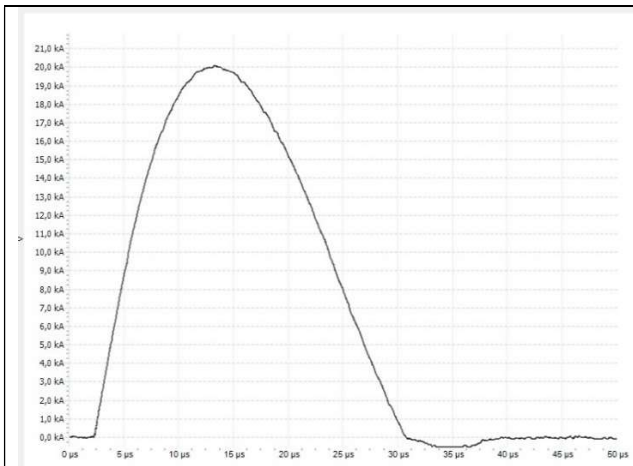


Oscilloscope 1 - 8/20  
 front time: 8.425 μs (+5%)  
 time to half-peak: 21.66 μs (+8%)  
 peak value: 20.13 kA

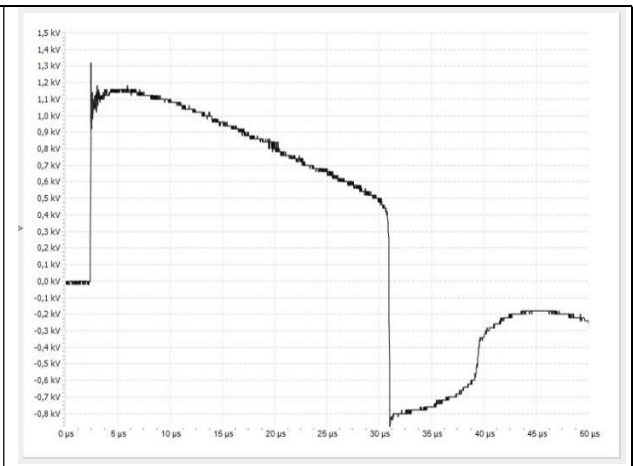


Oscilloscope 2 - NO  
 peak value: 1.10 kV

Sample No. 1-2, pole L2



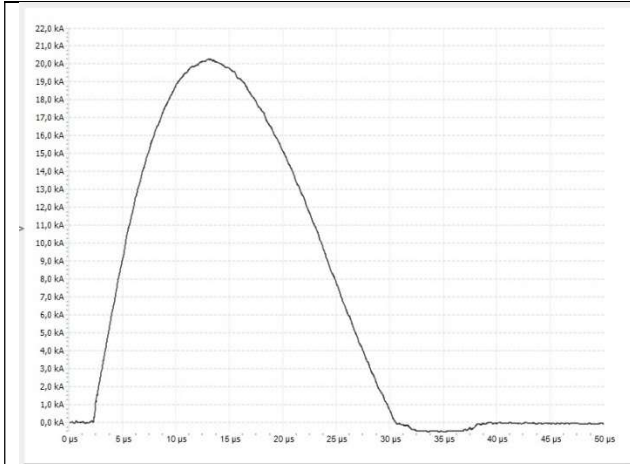
Oscilloscope 1 - 8/20  
 front time: 8.425 μs (+5%)  
 time to half-peak: 21.68 μs (+8%)  
 peak value: 20.11 kA



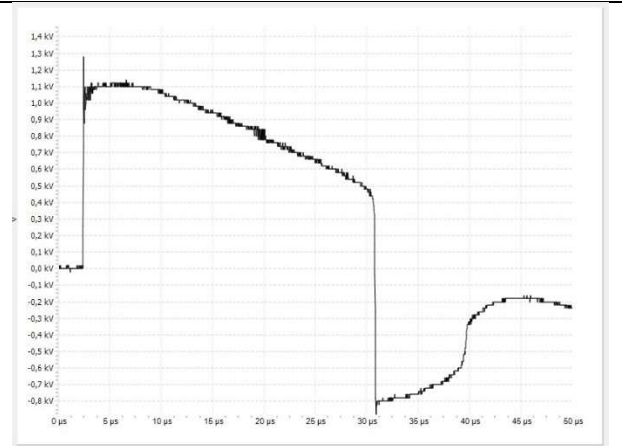
Oscilloscope 2 - NO  
 peak value: 1.16 kV

**Attachment No. 3**

Sample No. 1-3, pole L3



Oscilloscope 1 - 8/20  
front time: 8.425 μs (+5%)  
time to half-peak: 21.58 μs (+8%)  
peak value: 20.28 kA



Oscilloscope 2 - NO  
peak value: 1.12 kV

**Attachment No. 4**
**Test results according to 8.3.4.3**

Table 1. Residual voltage during current impulses 8/20, measurements before operating duty test according to 8.3.4.3.

Sample No.	Current amplitude 8/20	Value of the residual voltage $U_{res}$	Polarity	Permissible value residual voltage $U_P$
	kA	kV	+/-	kV
2-1	6,74	0,82	+	1,5
2-1	6,74	0,83	-	1,5
2-2	6,66	0,88	+	1,5
2-2	6,66	0,87	-	1,5
2-3	6,65	0,89	+	1,5
2-3	6,61	0,89	-	1,5

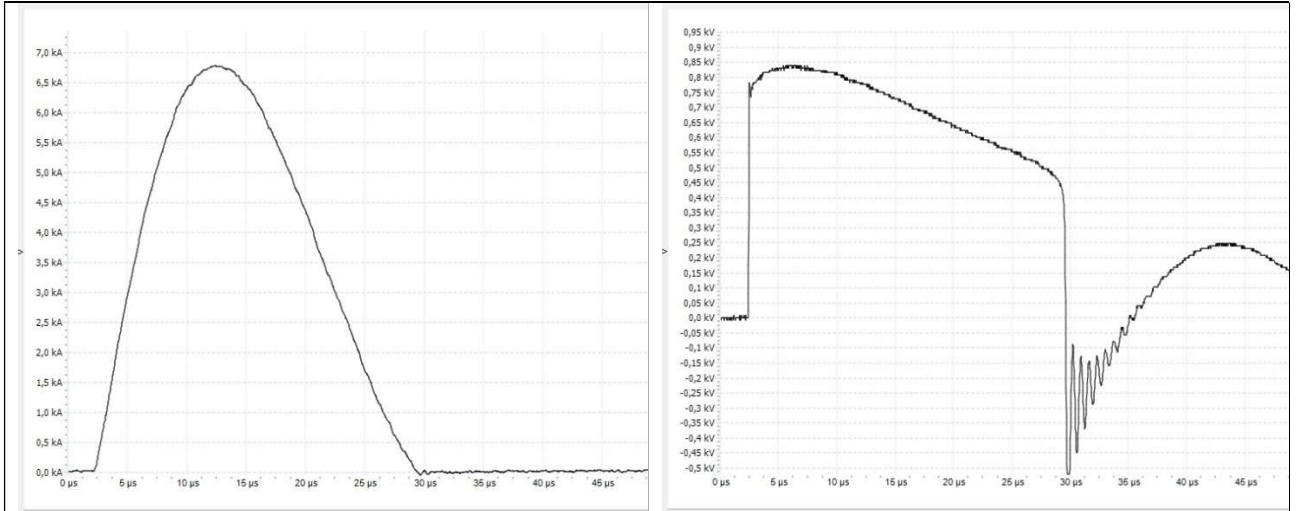
Table 1. Residual voltage during current impulses 8/20, measurements after operating duty test according to 8.3.4.3.

Sample No.	Current amplitude 8/20	Value of the residual voltage $U_{res}$	Polarity	Permissible value residual voltage $U_P$
	kA	kV	+/-	kV
2-1	6,81	0,84	+	1,5
2-1	6,78	0,84	-	1,5
2-2	6,59	0,90	+	1,5
2-2	6,61	0,90	-	1,5
2-3	6,62	0,87	+	1,5
2-3	6,62	0,86	-	1,5

**Attachment No. 4**

Example recording of residual voltage (negative polarization) + surge current waveform 8/20.

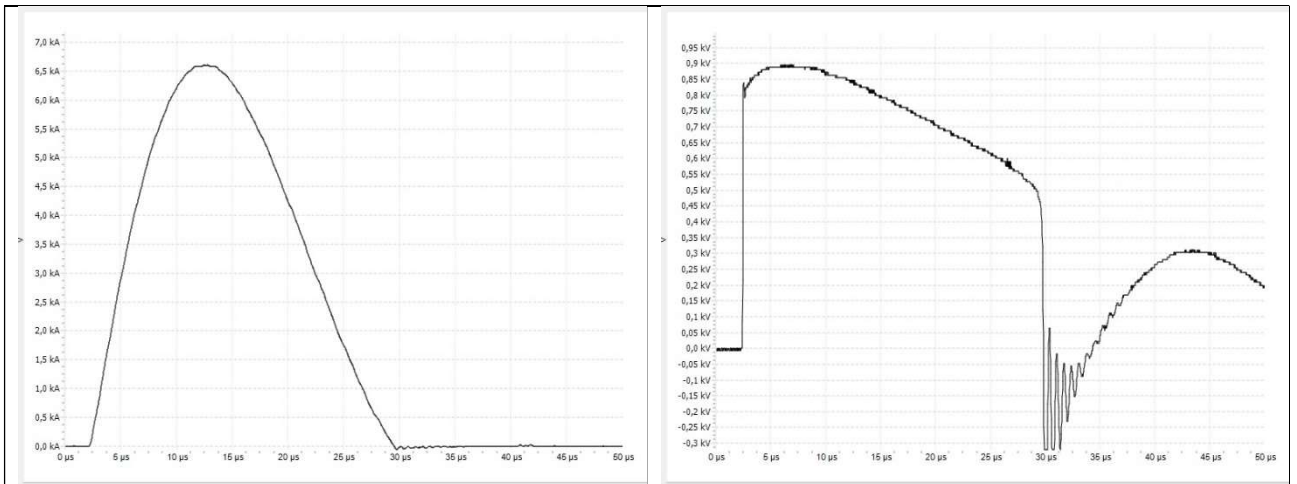
Sample No. 2-1, pole L1



Oscilloscope 1 - 8/20  
 front time: 7.875  $\mu$ s (-2%)  
 time to half-peak: 19.60  $\mu$ s (-2%)  
 peak value: 6.78 kA

Oscilloscope 2 - NO  
 peak value: 0.84 kV

Sample No. 2-2, pole L2

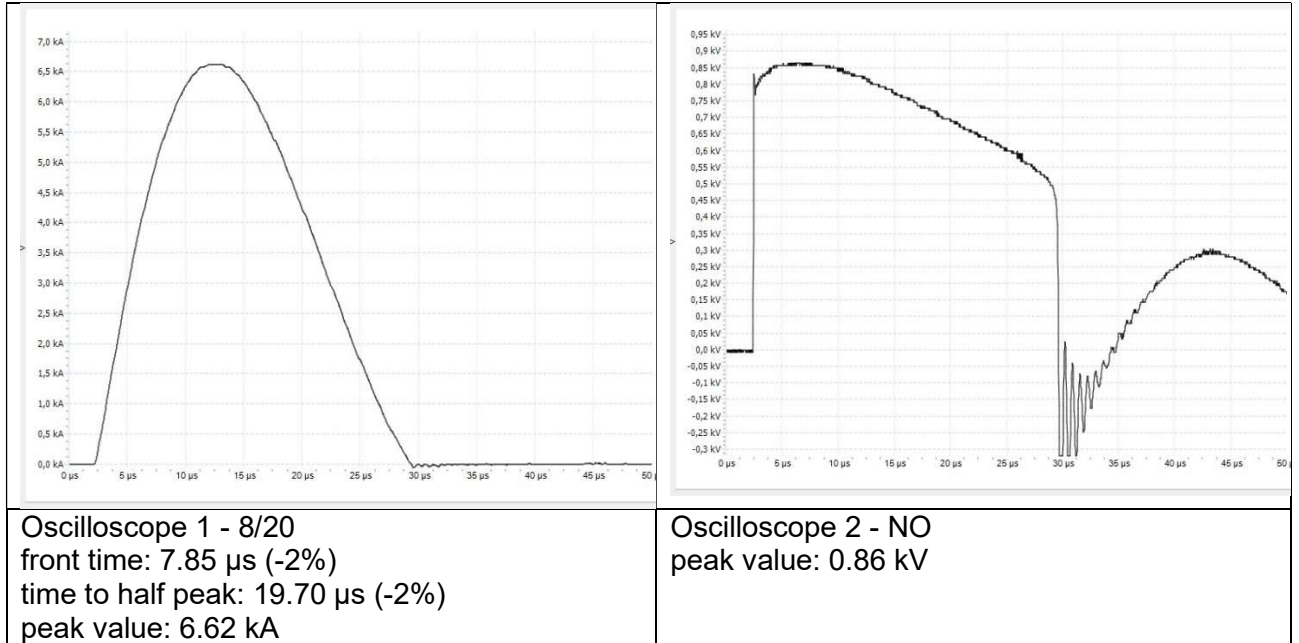


Oscilloscope 1 - 8/20  
 front time: 7.925  $\mu$ s (-1%)  
 time to half-peak: 19.74  $\mu$ s (-1%)  
 peak value: 6.61 kA

Oscilloscope 2 - NO  
 peak value: 0.90 kV

**Attachment No. 4**

Sample No. 2-3, pole L3



**Test results according to 8.3.4.4**

Table 3. Parameters of 10/350  $\mu$ s impulses for the value of 1.0  $I_{imp}$

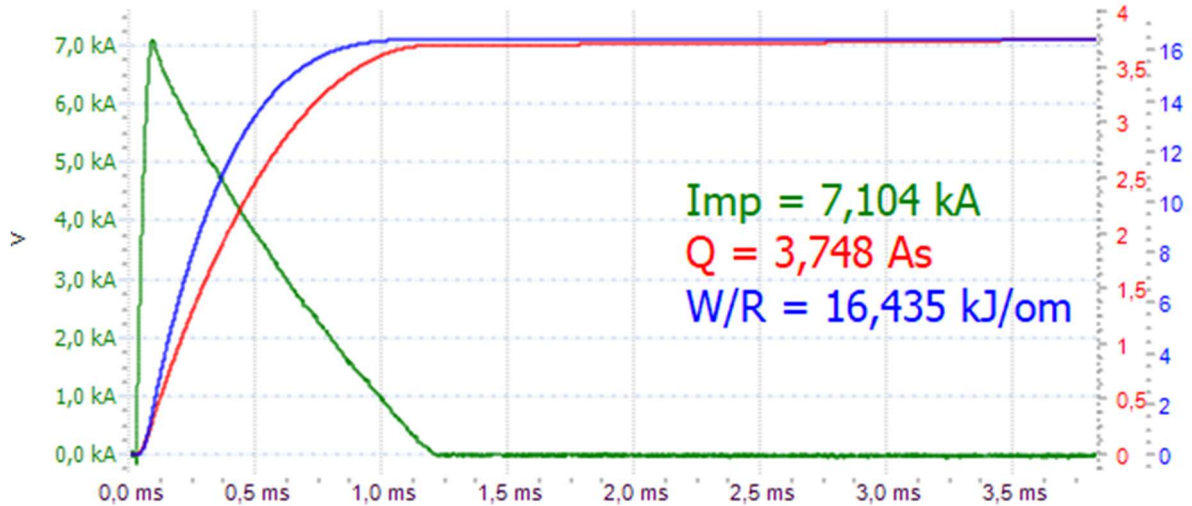
Sample No.	$I_{imp}$ (kA)	Tolerance $I_{imp}$ (kA)	Q (As)	Tolerance Q (As)	W/R (kJ/ $\Omega$ )	Tolerance W/R (kJ/ $\Omega$ )
2-1	7,104	6,3 ... 7,7	3,748	3,15 ... 4,2	16,435	11,025 ... 17,763
2-2	7,04		3,538		15,342	
2-3	7,04		3,621		15,707	

$Q = I_{imp} \times 5 \times 10^{-4}$  (As);  $W/R = I_{imp}^2 \times 2,5 \times 10^{-4}$  (kJ/ $\Omega$ )  
 Values of charge tolerance Q and specific energy W/R calculated for the rated  $I_{imp}$

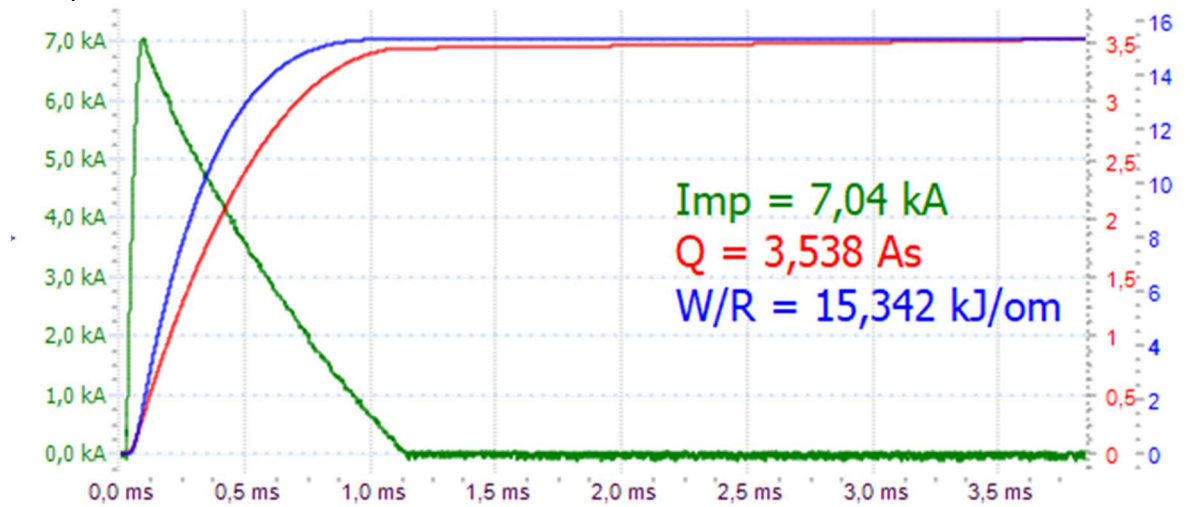
**Attachment No. 4**

Registration of current, charge and specific energy according to 8.3.4.4

Sample 2-1



Sample 2-2



Sample 2-2

