Type test report no. VR 3E 001e

Short-circuit current test of diverter switch

Product Approval
CTTP/Wag
10.02.2017

Type test for types: Diverter switches VACUTAP® VRS / VRM / VRH / VRX with maximum rated through-current up to 1000 A.

Test specification: IEC 60214-1:2014, sub-clause 5.2.4: “Short-circuit current test”.

Test sample: VACUTAP® VRM III 1000 Y – 72.5, S/N: 1734908.

Manufacturer: Maschinenfabrik Reinhausen GmbH, Regensburg, Germany.

Date of test: October 2016.

Place of test: Maschinenfabrik Reinhausen GmbH, Regensburg, Germany.

Tests performed: The tests were performed on a single phase, on all contacts of different design carrying current continuously in service.
According to IEC 60214-1:2014 three applications were carried out with an initial peak current of 2.5 times the r.m.s value of the rated short-circuit test current. The contacts were not moved between these applications.

	Requirement IEC 60214-1[1]	Rated values[2]	Tested values
Initial peak current	25.0 kA	30.0 kA	30.7 kA
Short-circuit current (r.m.s)	10.0 kA	12.0 kA	12.3 kA
Test duration	2 s	3 s	3.01 s

Test results: The requirements of IEC 60214-1:2014 were fulfilled, i.e.:

- At the conclusion of the test, the contacts were not damaged, so the capability of carrying the maximum rated through-current continuously was not reduced. This was proved by no load operations with recordings of the switching sequence before and after the test. Comparison of relevant switching times showed suitability for service.
- Other current-carrying parts did not show any signs of mechanical distortion which could influence the normal operation of the diverter switch.

[1] According to IEC 60214-1:2014.
[2] According to technical data.

This report contains 8 pages.

i. V. Dr. Thomas Strof
[valid without signature]

Maschinenfabrik Reinhausen GmbH
- PRODUCT APPROVAL -

Maschinenfabrik Reinhausen GmbH
Falkensteinstraße 8
93059 Regensburg, Germany
Phone +49 941 40 90-0
info@reinhausen.com
www.reinhausen.com

1. Test specification

The type test was performed in accordance with IEC 60214-1:2014 “Tap-changers - Part 1: Performance requirements and test methods”, sub-clause 5.2.4: “Short-circuit current test”.

2. Data of test sample

Type designation:	VACUTAP® VRM III 1000 Y – 72.5
Type characteristics:	Diverter switch
Serial number / IBASE:	1734908 / 561812888
Year of manufacture:	2016
Manufacturer:	Maschinenfabrik Reinhausen GmbH, Regensburg, Germany.

3. Scope of application

Diverter switches type VACUTAP® VR are available in the basic design variants VACUTAP® VRS, VACUTAP® VRM, VACUTAP® VRL, VACUTAP® VRH and VACUTAP® VRX.

The design of current paths and contacts that carry current continuously is the same for all diverter switches type VACUTAP® VRS, VACUTAP® VRM, VACUTAP® VRH and VACUTAP® VRX with maximum rated through-current up to 1000 A.

According to IEC 60214-1:2014 the type test was performed on a single phase (single current path) of diverter switch type VACUTAP® VRM III 1000 Y – 72.5. The tested peak/short-time currents were at least 30 kA / 12 kA.

The short-circuit capability does not depend on the highest voltage for equipment resp. the insulation levels of the diverter switch.

Therefore this type test report is valid for diverter switches type VACUTAP® VR with following characteristics:

- Design variants: VRS, VRM, VRH or VRX
- Number of phases: 1, 2 or 3
- Number sectors (per phase): 1 or 2[3]
- Maximum rated through-current: up to 1000 A

[3] Single phase design with two sectors for applications with variable shunt reactors with maximum rated step voltage 2 x 6000 V (VACUTAP® VRX).

4. Test conditions / Test arrangement

Test tank content:	Transformer oil according to specification IEC 60296.
Oil temperature:	Room temperature.
Condition of test sample:	Transition impedance test carried out before.
Treatment before testing:	The test sample was vacuum dried in accordance with the instructions of the manufacturer.
Servicing during the tests:	The contacts were not renewed.
Testing transformer:	4000 kVA, 20 kV, open-circuit voltage U_0 = 200 V.
Adjustment and measurement:	Short-circuit current adjusted by air-core reactor and measured by a Rogowski current probe. The test current was switched by means of a time-controlled circuit breaker. The test circuit and measurement circuit for the switching sequence are shown in figures 1a and 1b.
Recording and evaluation:	Each application was recorded and evaluated by a transient recorder.

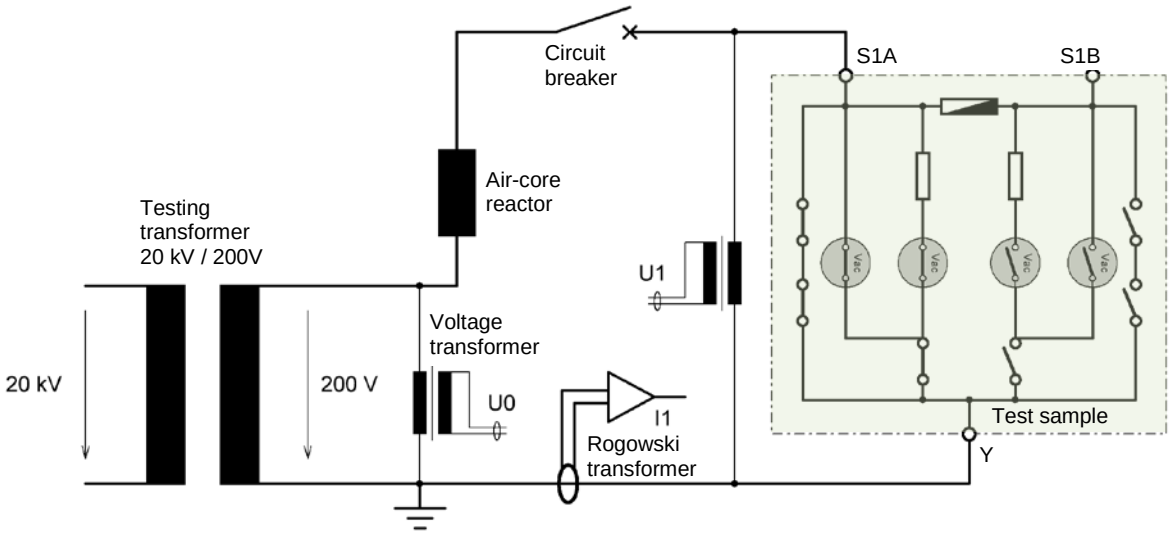

Figure 1a: Test circuit for the short-circuit current test.

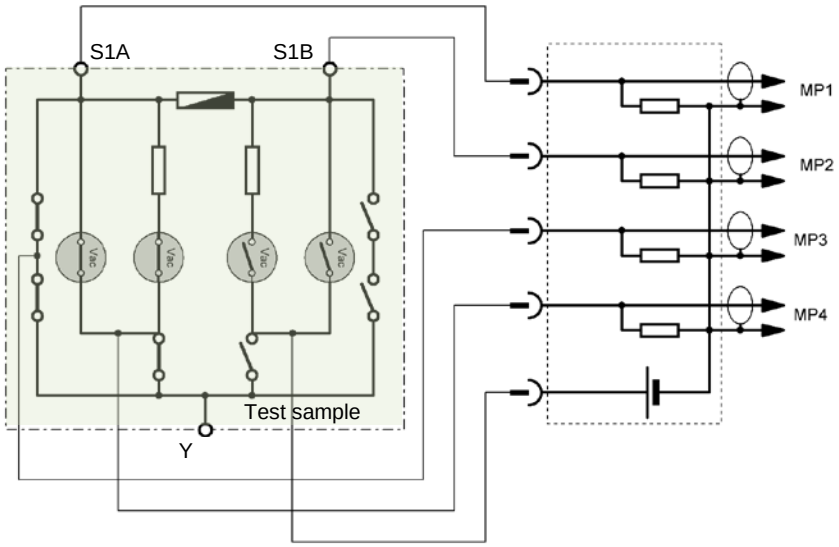

Figure 1b: Measurement circuit for the switching sequence.

5. Required short-circuit strength of the diverter switch acc. to IEC 60214-1:2014

- Peak withstand current 25.0 kA
- Short-time current (r.m.s) 10.0 kA
- Short-circuit duration 2 s

6. Tests performed

The tests was performed on a single phase (single current path) of the test sample. Three applications of short-circuit current were applied. The contacts were not moved between the applications. The test was performed on all contacts of different design which carry current continuously in service.

Rated values and nominal test values:

- Peak withstand current 30.0 kA
- Short-time current (r.m.s) 12.0 kA
- Short-circuit duration 3 s

Table 1 shows the tested short-circuit values of the test sample. Table 2 shows the rated short-circuit parameters of diverter switches type VACUTAP® VRS, VACUTAP® VRM, VACUTAP® VRH and VACUTAP® VRX covered by this type test.

Application no.	Initial peak current I_{1p}	Short-circuit current I_1 (r.m.s)	Short-circuit duration t
1	30.4 kA	12.3 kA	3.01 s
2	30.9 kA	12.3 kA	3.01 s
3	30.8 kA	12.3 kA	3.01 s
Mean values	30.7 kA	12.3 kA	3.01 s

Table 1: Tested short-circuit current values.

Maximum rated through-current of diverter switch VACUTAP® VR	Basic design variants	Number of phases	Number of sectors (per phase)	Rated peak current	Rated short-time current (r.m.s)
650 A	VRX	1	2	25	10 kA - 3 s
	VRH	1, 2 or 3	1		
700 A	VRS, VRM	1, 2 or 3	1	25	10 kA - 3 s
1000 A	VRS, VRM	1, 2 or 3	1	30	12 kA - 3 s

Table 2: Diverter switches covered by this type test.

Figures 2 to 4 show recordings of the performed three applications.

At the beginning and at the conclusion of the test, the switching sequence of the diverter switch was oscillographically recorded and evaluated. Comparison of relevant switching times measured before and after the test showed suitability for service (see table 3).
Figure 5 shows an exemplary oscillogram of the switching sequence taken before the test. Figure 6 shows the oscillogram of the first operation after the test.

Switching time	Before the test[3]	After the test[4]	Test result
MDC close – MDC open	92.3 ms	93.0 ms	passed
MSV open – MSV close	47.6 ms	47.9 ms	passed
TTV close – TTV open	9.7 ms	9.7 ms	passed
MDC close – MSV open	28.0 ms	28.5 ms	passed
MSV open – TTV close	21.0 ms	21.2 ms	passed
MDC close – TTV close	49.0 ms	49.8 ms	passed
MSV open – TTV open	30.8 ms	31.0 ms	passed
TTV open – MSV close	16.8 ms	16.9 ms	passed
TTV close – MSV close	26.5 ms	26.6 ms	passed
MSV close – MDC open	16.8 ms	16.6 ms	passed

Table 3: Relevant switching times measured before and after the short circuit current test.

[3] Mean values out of 5 operations.

[4] First operation after the short-circuit current test.

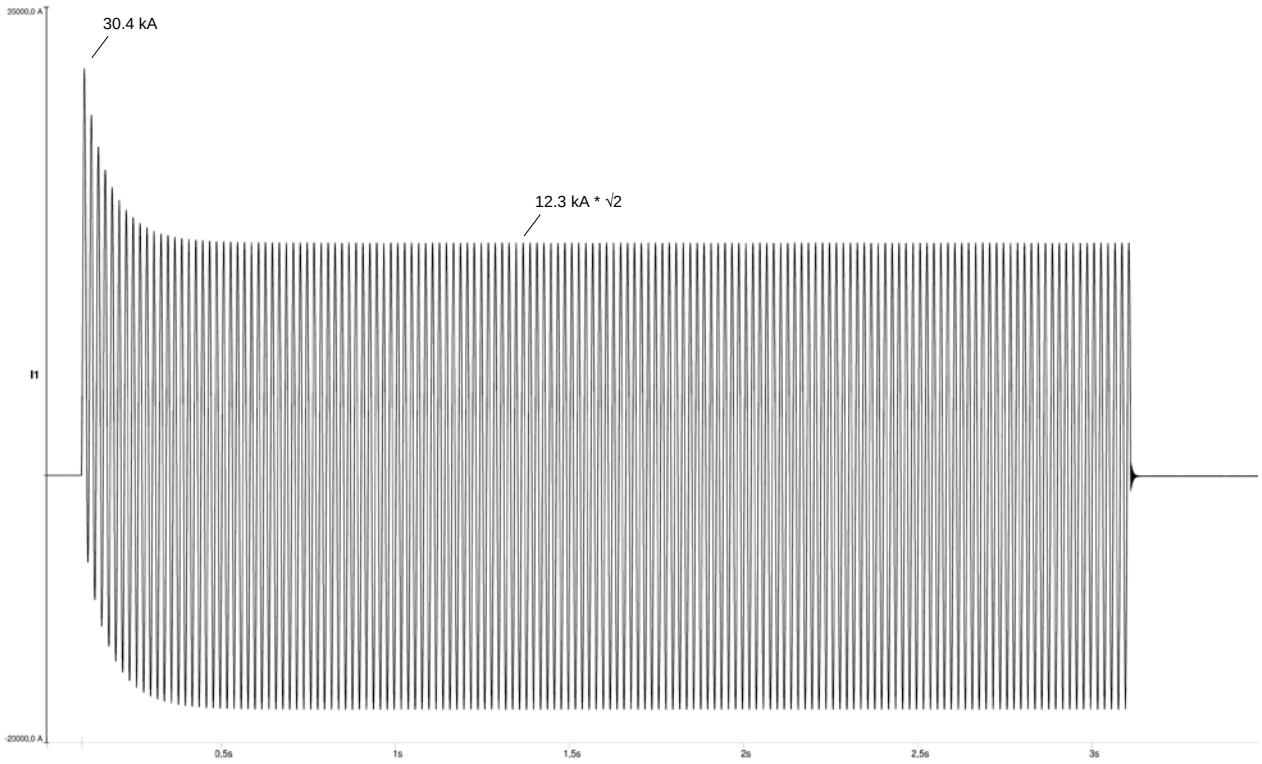

Figure 2: Recording of application no. 1.

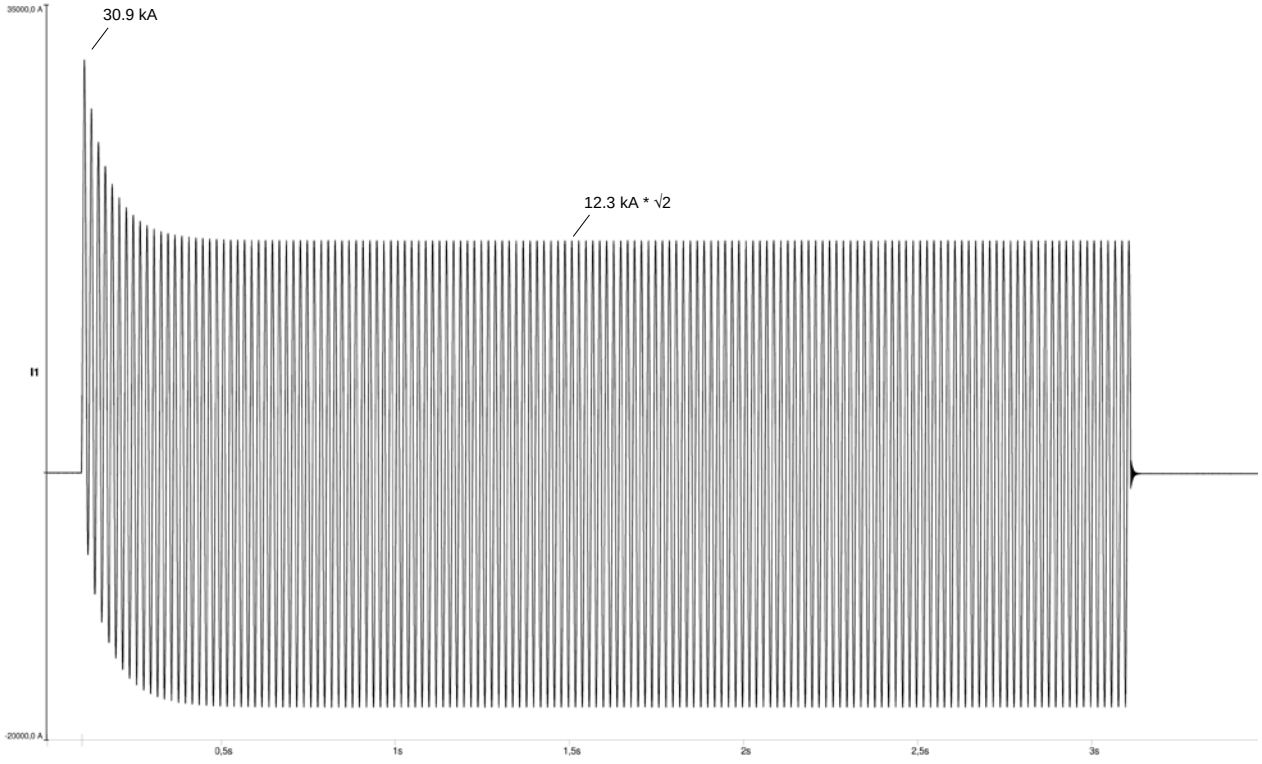

Figure 3: Recording of application no. 2.

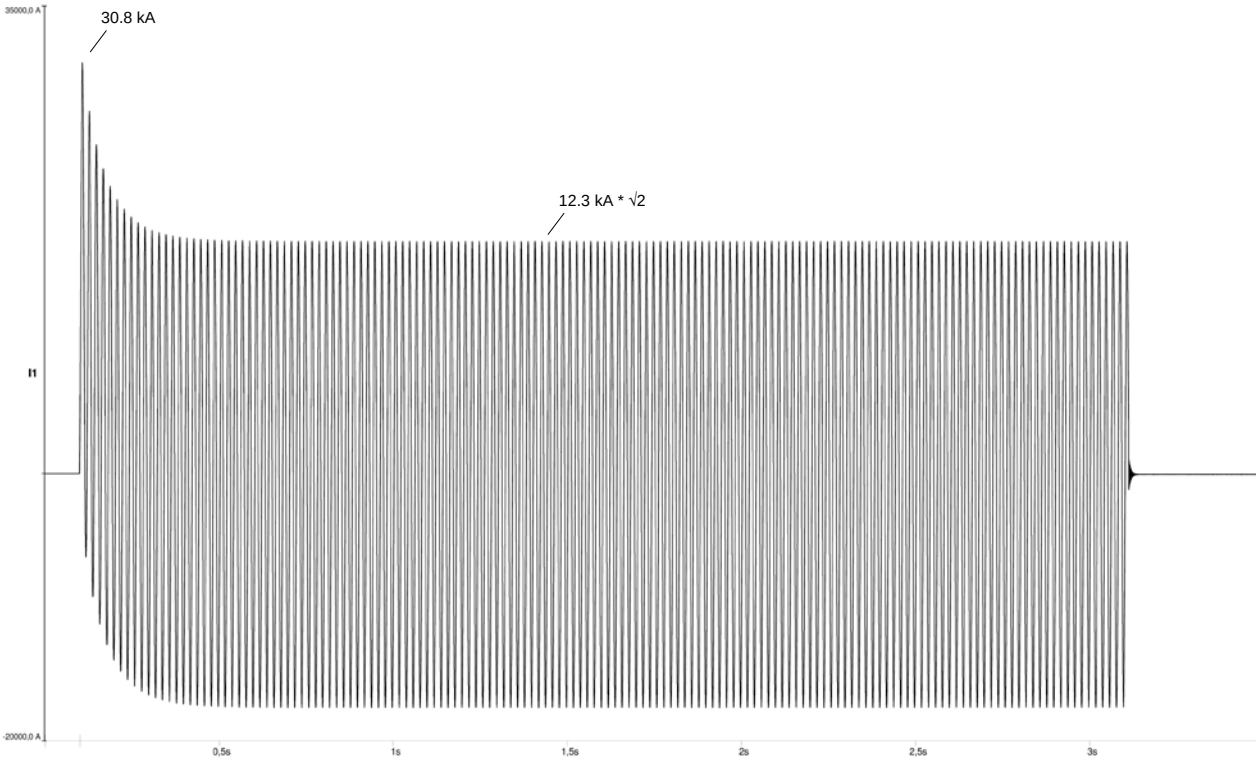

Figure 4: Recording of application no. 3.

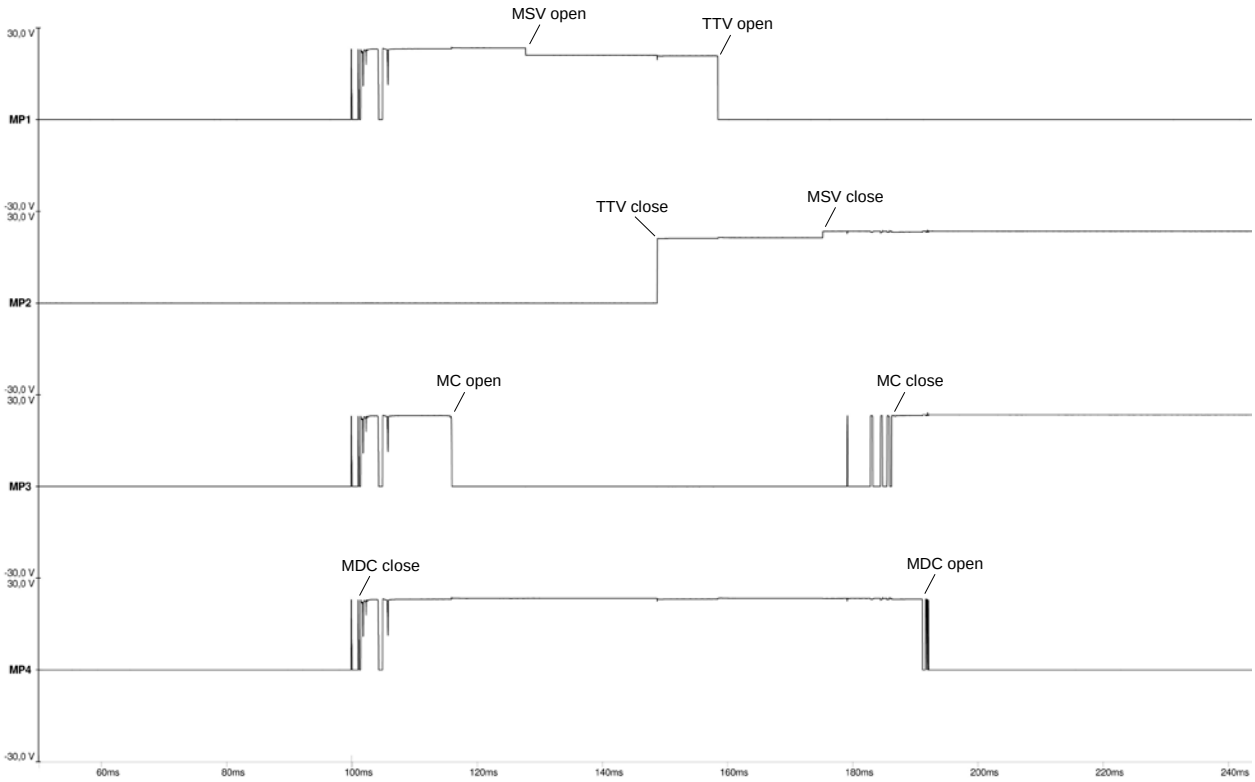

Figure 5: Example of recording of the switching sequence before the short-circuit current test.

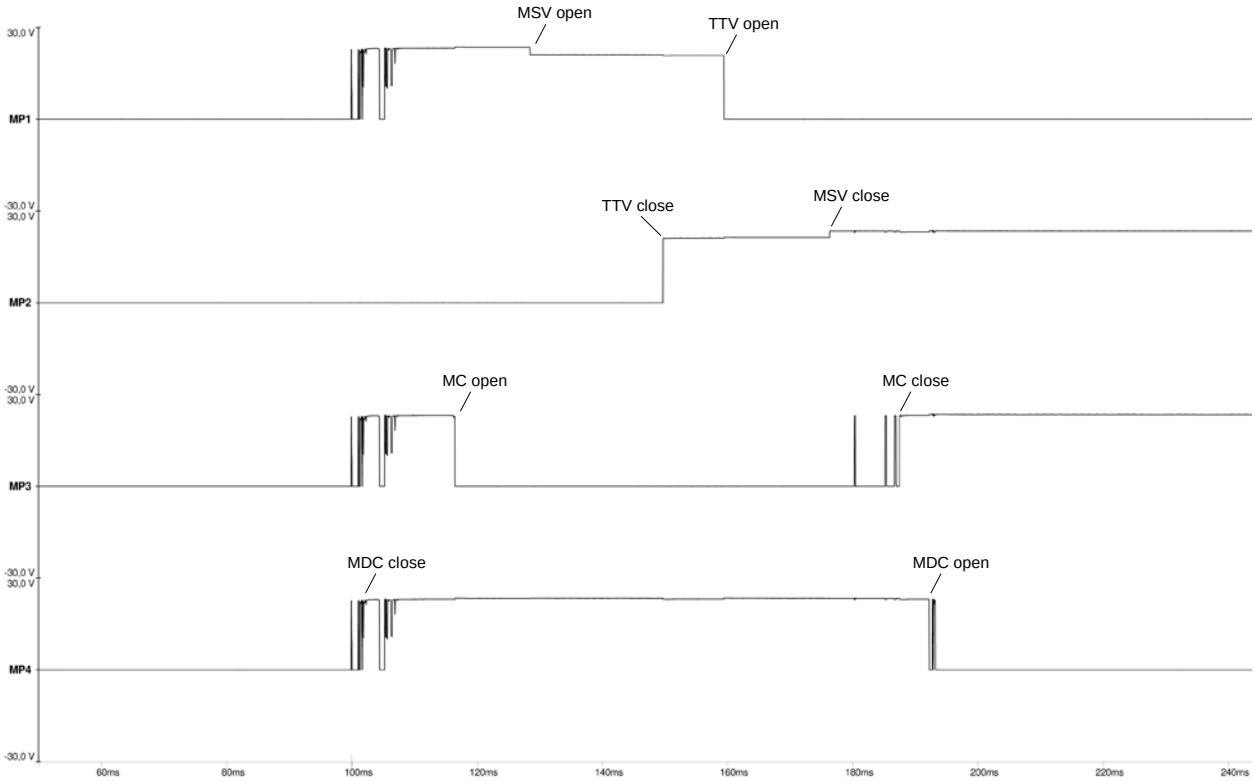

Figure 6: Recording of the switching sequence of the first operation after the short-circuit current test.

MC: Main contact
MDC: Main path, disconnect switch
MSV: Main path, switching contacts (vacuum interrupter)
TTV: Transition path, transition contacts

7. Test results

The requirements of IEC 60214-1:2014 “Tap-changers - Part 1: Performance requirements and test methods”, sub-clause 5.2.4 “Short-circuit current test” were met, i.e.:

The tested short-circuit current values were higher than the required nominal values (see table 1). Further, the recordings of the performed three applications did not show something unusual (see figures 2...4).

At the conclusion of the test, the contacts were not damaged, so the capability of carrying the maximum rated through-current continuously was not reduced.

At the beginning and at the conclusion of the test, the switching sequence of the diverter switch was oscillographically recorded and evaluated (see figures 5 and 6). Comparison of relevant switching times measured before and after the test showed suitability for service (see table 3).

Other current-carrying parts did not show signs of permanent mechanical distortion, which could influence the normal operation of the diverter switch.