

**TYPE TEST CERTIFICATE OF DIELECTRIC PERFORMANCE****OBJECT** three-phase SF<sub>6</sub> gas/porcelain insulated high voltage circuit breaker**TYPE** 120-SFM-32B**SERIAL No.** X300539Rated voltage (U<sub>m</sub>)

145 kV

Rated current

3150 A

Rated frequency

50 Hz

**MANUFACTURER** Crompton Greaves Ltd.  
Nashik, India**CLIENT** Crompton Greaves Ltd.  
Nashik, India**TESTED BY** KEMA HIGH-VOLTAGE LABORATORY  
Arnhem, the Netherlands**DATES OF TESTS** 25 until 27 September 2007

The apparatus, constructed in accordance with the description, drawings and photographs incorporated in this Certificate, has been subjected to the series of proving tests in accordance with

**IEC 62271-100 clauses 6.2 and 6.3**

This Type Test Certificate of dielectric performance has been issued by KEMA following exclusively the STL Guides.

The results are shown in the record of Proving Tests and the oscillograms attached hereto. The values obtained and the general performance are considered to comply with the above Standard and to justify the ratings assigned by the manufacturer as listed on page 3.

The Certificate applies only to the object tested. The responsibility for conformity of any object having the same designations with that tested rests with the Manufacturer.

This Certificate consists of 41 sheets in total.

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The sealed and bound version of the Certificate is the only valid version.

KEMA Nederland B.V.

P.G.A. Bus  
KEMA T&D Testing Services  
Managing Director

Arnhem, 6 December 2007



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## 1 IDENTIFICATION OF THE TEST OBJECT

### 1.1 Ratings assigned by the manufacturer

|   |        |
|---|--------|
| Rated highest voltage for equipment ( $U_m$ ) | 145 kV |
| Rated current                                 | 3150 A |
| Rated frequency                               | 50 Hz  |

### 1.2 Description of the test objects

|  |   |
|--|---|
| Manufacturer                                   | Crompton Greaves Ltd., Nashik, India                |
| Type   | 120-SFM-32B   |
| Serial number                                  | X300539   |
| Rated highest voltage for equipment ( $U_m$ )  | 145 kV  |
| Rated frequency                                | 50 Hz   |
| Rated current                                  | 3150 A  |
| <i>Rated insulation level (AC/LI)</i>          | <i>275/650 kV</i>                                   |
| Rated SF <sub>6</sub> gas operating pressure   | 0,7 MPa (g) at 20 °C                                |
| Minimum SF <sub>6</sub> gas operating pressure | 0,6 MPa (g) at 20 °C                                |
| Drawing(s)                                     | see appendix B, drawing no. 3942580 and chapter 1.3 |
| <i>Current transformers</i>                    | <i>not applicable</i>                               |
| Spring charging motor                          | KPT, 230 V a.c., 300 W (elec. power)                |
| Closing coil                                   | CGL, 110 V d.c., 605 W                              |
| Opening coil 1                                 | CGL, 110 V d.c., 637 W                              |
| Opening coil 2                                 | CGL, 110 V d.c., 637 W                              |
| Year of manufacture                            | 2007  |



## 2 GENERAL INFORMATION

### 2.1 The tests were witnessed by

**Name**

Mr S.S. Shete

**Company**

Senior Manager – Design, Crompton Greaves Ltd.

### 2.2 The tests were carried out by

**Name**

Mr. P. Kuijpers  
Mr. H.J. Arnoldus  
Mr A.H. Minkhorst

**Company**

KEMA Nederland B.V.,  
Arnhem, the Netherlands

### 2.3 Reference to other reports

**Report no.**

07-1039  
07-1398

2110125.01-QUA/INC

470-07

**Tests described**

Type test certificate of temperature-rise performance  
Report of performance for wet lightning impulse voltage  
withstand tests

Tests of the degree of protection provided by the  
enclosure (IP55)

Mechanical operation test at ambient temperature  
(class M1, 2000 operations)

## **2.4 Purpose of the test**

Purpose of the test was to verify whether the material complies with the specified requirements.

## **2.5 Measurement uncertainty**

A table with measurement uncertainties is enclosed in appendix A. Unless otherwise indicated in the certificate, the measurement uncertainties of the results presented are as indicated in this table.

## **2.6 Applicable standards**

When reference is made to a standard and the date of issue is not stated, this applies to the latest issue, including amendments which have been officially published prior to the date of the tests. Where reference was made in the standard IEC 62271-100 to IEC 60694, it was verified that testing was performed in accordance with both IEC 60694 and the final draft for IEC 62271-1 Ed.1 (17A/799/FDIS), which will cancel and replace IEC 60694 when it will be published in due time.

### 3 GENERAL

For the purpose of the dielectric testing, the three poles of the circuit breaker were assembled by the client on the mounting frame, which was erected on a mobile trolley. A photograph of the test object is presented below.



A drawing of the circuit breaker arrangement is shown in the client's drawing no. 3942580, which is included in appendix B of this certificate. The arrangement of the outer poles of the circuit breaker was considered to be symmetrical with respect to the centre pole and the frame. Therefore the test conditions for dielectric testing were limited to those involving two poles (B and C), while the other outer pole (A) remained earthed throughout the tests. A table with the test conditions and the specified test voltages is presented on the next page.



| condition/situation | voltage applied to | specified test voltage for: |              | circuit breaker position | earthing          |
|---------------------|--------------------|-----------------------------|--------------|--------------------------|-------------------|
|                     |                    | AC-tests, dry and wet (kV)  | LI-test (kV) |                          |                   |
| 1                   | Bb                 | 275                         | 650          | closed                   | Cc and frame      |
| 2                   | Cc                 | 275                         | 650          | closed                   | Bb and frame      |
| 3                   | B                  | 275                         | 650          | open                     | b, C, c and frame |
| 4                   | b                  | 275                         | 650          | open                     | B, C, c and frame |
| 5                   | C                  | 275                         | 650          | open                     | c, B, b and frame |
| 6                   | c                  | 275                         | 650          | open                     | C, B, b and frame |

**Note:** terminals A and a were earthed throughout all the tests

Measurement of the RIV (radio interference voltage) was performed on a single outer pole (C) in 3 test conditions (2, 5 and 6 in the above table).

During the wet tests, the circuit breaker was subjected to artificial rain in accordance with clause 9.1 of IEC 60060-1. Testing under wet conditions was carried out after a pre-wetting period of at least 15 minutes.

Throughout all the tests the circuit breaker was filled with SF<sub>6</sub> gas at the minimum operating pressure.

The wave shape of the impulse voltage was within the requirements during all impulse tests.

Correction factors for atmospheric conditions were calculated and applied, where applicable.

## 4 LIGHTNING IMPULSE VOLTAGE WITHSTAND TEST

Date of test: 25 and 26 September 2007

The lightning impulse voltage withstand test was performed under dry conditions in accordance with clause 6.2.6.2 of IEC 62271-100. The specified test voltage was 650 kV.

Testing was performed in the test conditions as described above in chapter 3. In each test condition, 15 impulses of positive polarity and 15 impulse of negative polarity were applied.

Prior to testing, the correction factors for standard atmospheric conditions were calculated and applied. The results are presented below.

### Atmospheric conditions on 25 September 2007

|                      |                      |
|----------------------|----------------------|
| Ambient temperature  | 21 °C                |
| Ambient air pressure | 1009 hPa             |
| Humidity             | 9,9 g/m <sup>3</sup> |

### Correction factor to standard atmospheric conditions on 25 September 2007

|                        |        |
|------------------------|--------|
| $K_t = K_1 \cdot K_2$  | 0,9825 |
| Corrected test voltage | 639 kV |

### Atmospheric conditions on 26 September 2007

|                      |                       |
|----------------------|-----------------------|
| Ambient temperature  | 21 °C                 |
| Ambient air pressure | 1010 hPa              |
| Humidity             | 10,4 g/m <sup>3</sup> |

### Correction factor to standard atmospheric conditions on 26 September 2007

|                        |        |
|------------------------|--------|
| $K_t = K_1 \cdot K_2$  | 0,9884 |
| Corrected test voltage | 642 kV |

| condition/situation | voltage applied to | earthing          | circuit breaker position | see figure no.'s |
|---------------------|--------------------|-------------------|--------------------------|------------------|
| 1                   | Bb                 | Cc and frame      | closed                   | 11 - 20          |
| 2                   | Cc                 | Bb and frame      | closed                   | 1 - 10           |
| 3                   | B                  | b, C, c and frame | open                     | 41 - 50          |
| 4                   | b                  | B, C, c and frame | open                     | 31 - 40          |
| 5                   | C                  | c, B, b and frame | open                     | 51 - 60          |
| 6                   | c                  | C, B, b and frame | open                     | 21 - 30          |



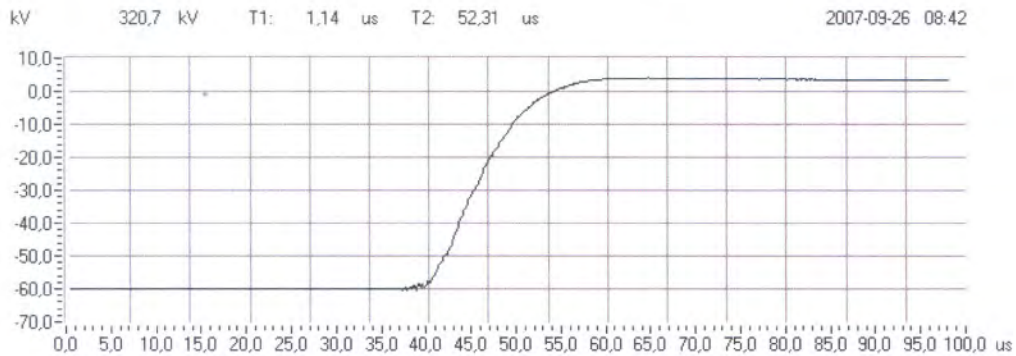


Fig. 1: Waveshape CB closed, voltage on Bb, Cc earthed, 50%

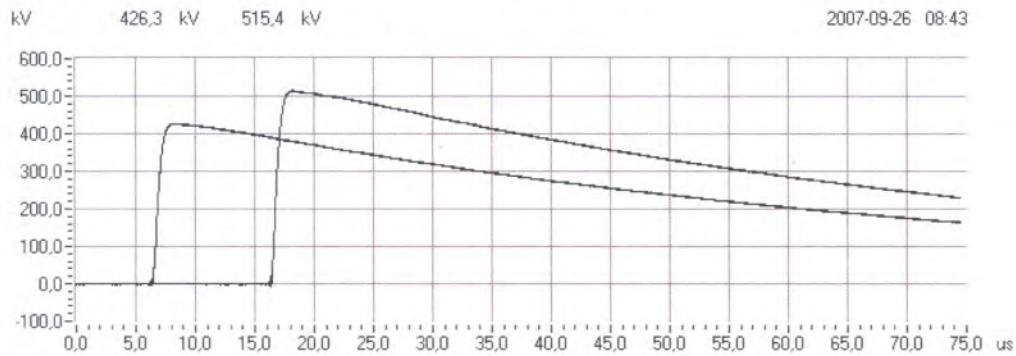


Fig. 2: CB closed, voltage on Bb, Cc earthed, 65% and 80%

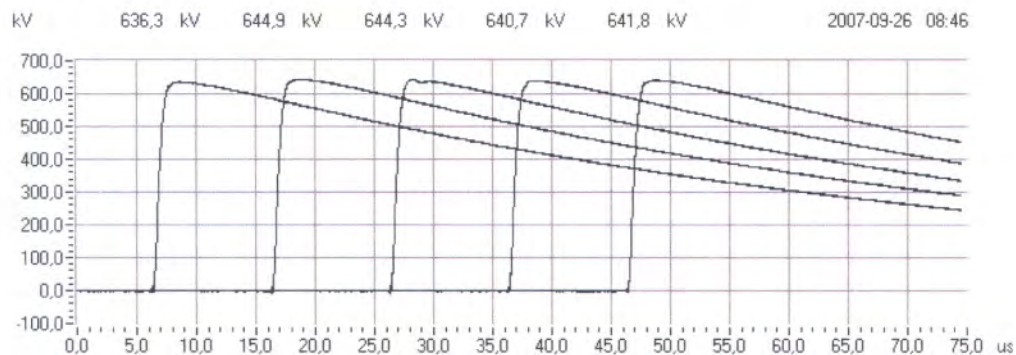


Fig. 3: CB closed, voltage on Bb, Cc earthed, 100%

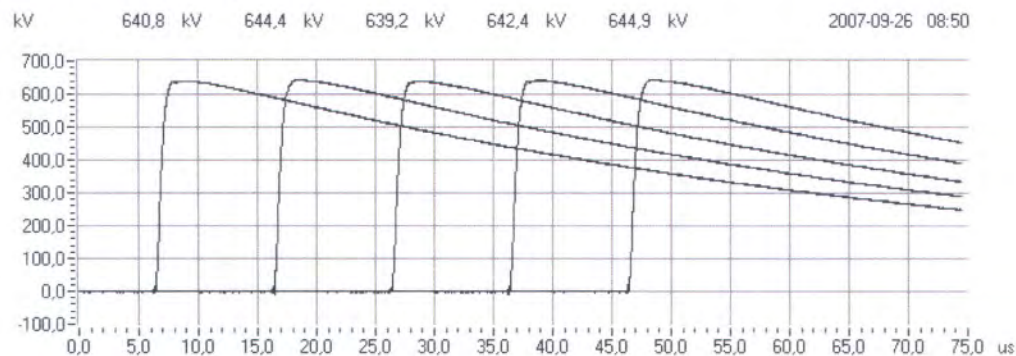


Fig. 4: CB closed, voltage on Bb, Cc earthed, 100%

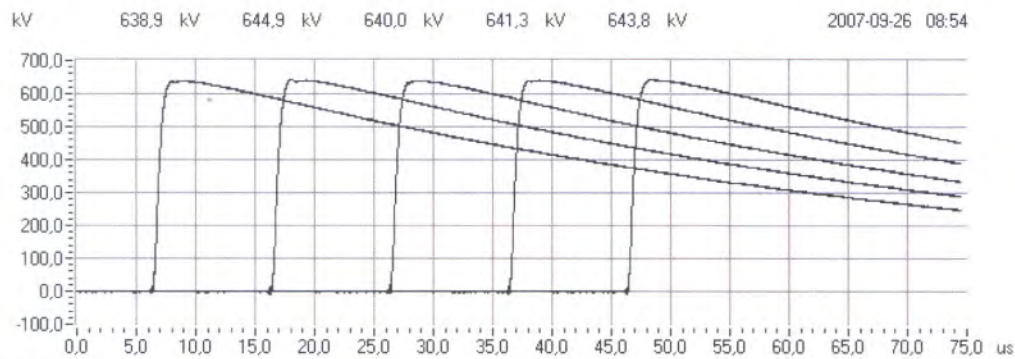


Fig. 5: CB closed, voltage on Bb, Cc earthed, 100%

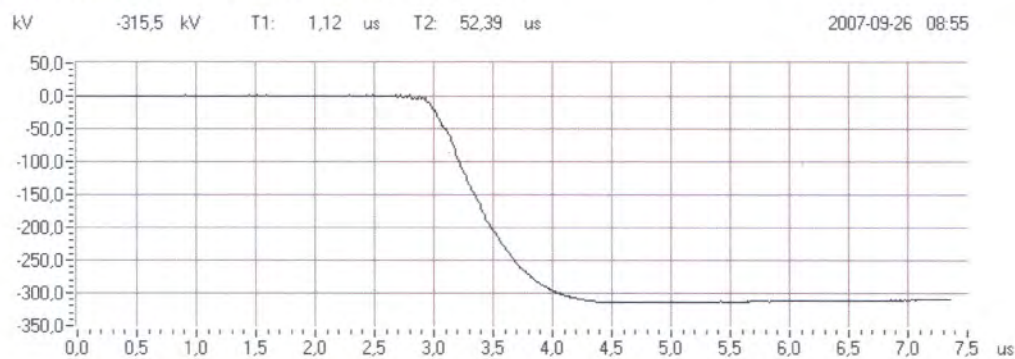


Fig. 6: Waveshape CB closed, voltage on Bb, Cc earthed, -50%

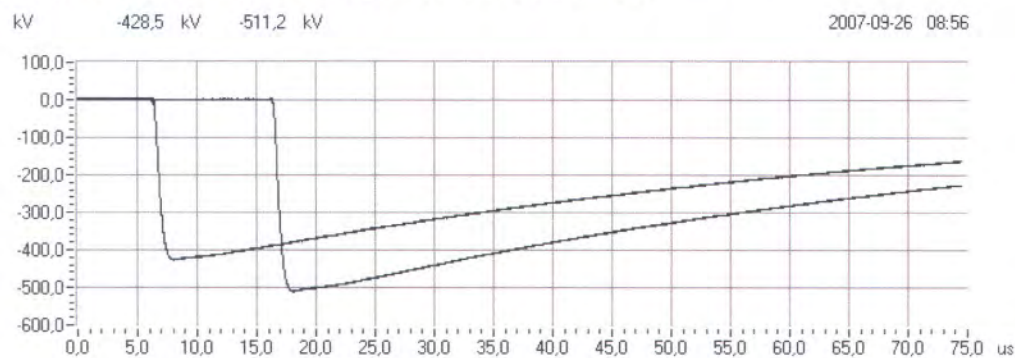


Fig. 7: CB closed, voltage on Bb, Cc earthed, -65% and -80%

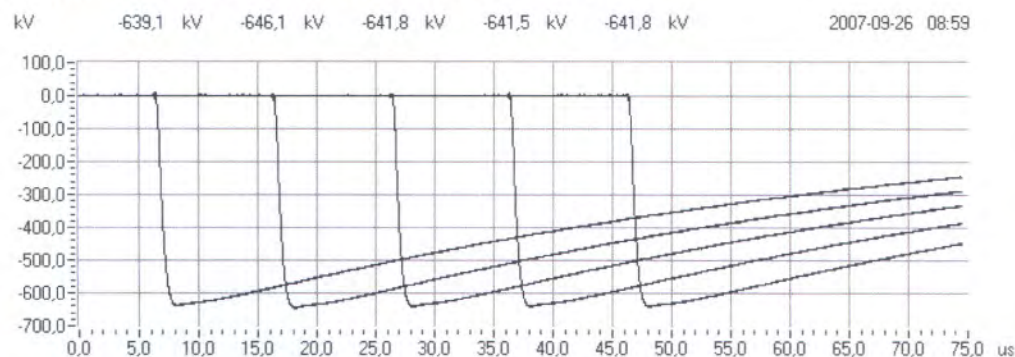


Fig. 8: CB closed, voltage on Bb, Cc earthed, -100%



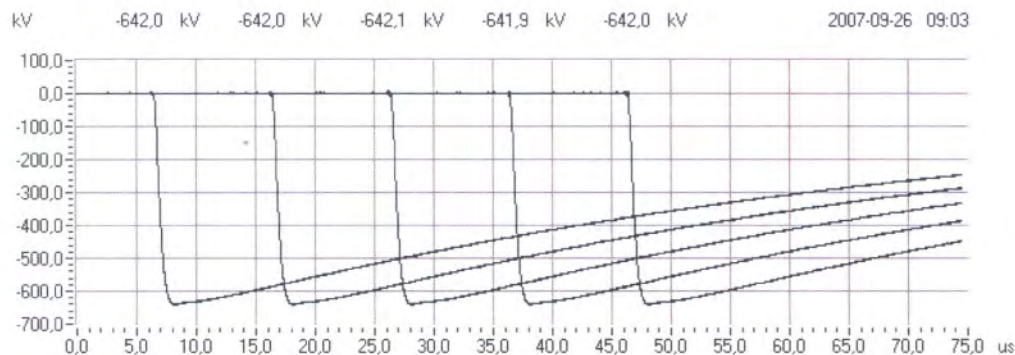


Fig. 9: CB closed, voltage on Bb, Cc earthed, -100%

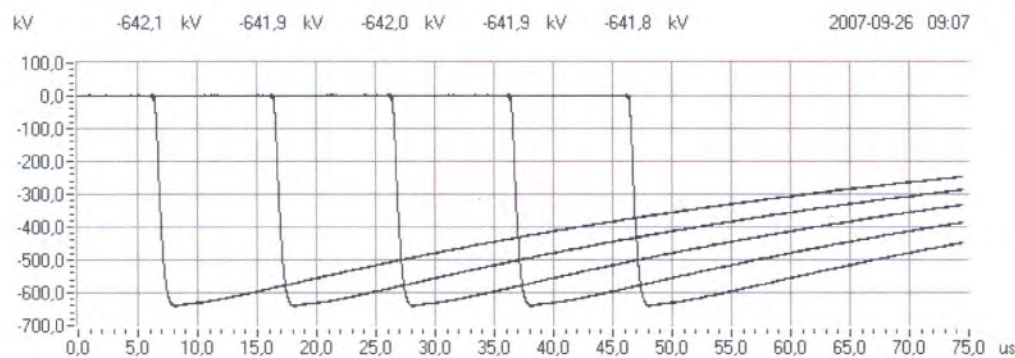


Fig. 10: CB closed, voltage on Bb, Cc earthed, -100%

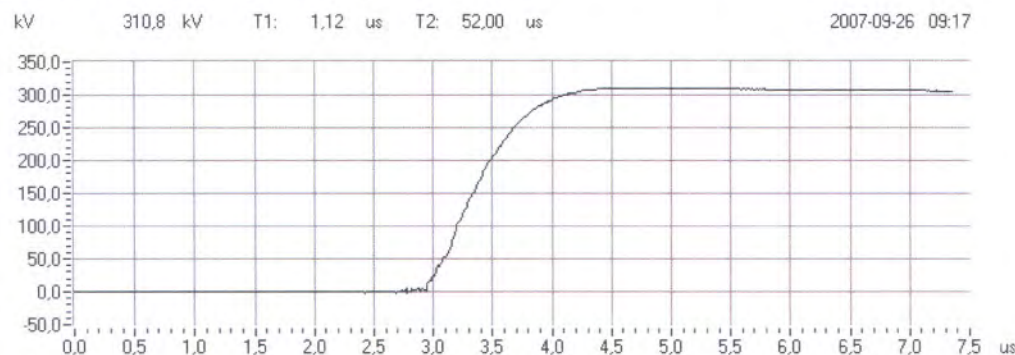


Fig. 11: Waveshape CB closed, voltage on Cc, Bb earthed, 50%

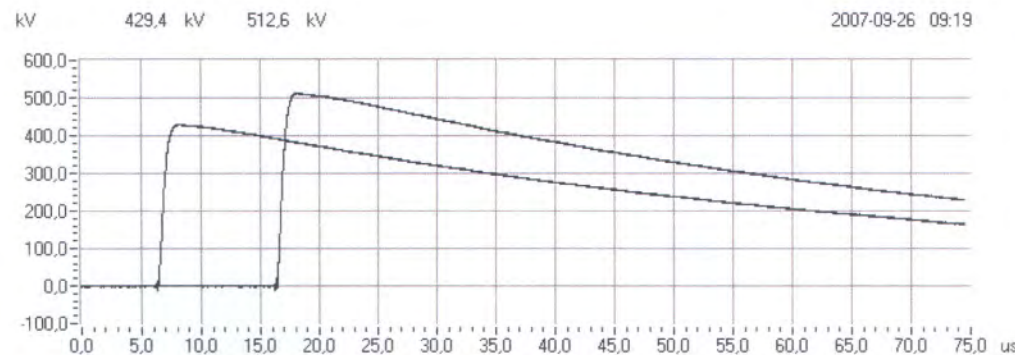


Fig. 12: CB closed, voltage on Cc, Bb earthed, 65% and 80%



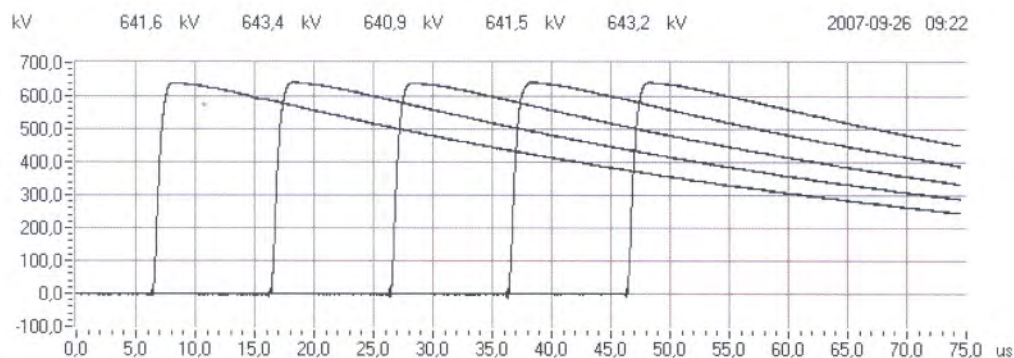


Fig. 13: CB closed, voltage on Cc, Bb earthed, 100%

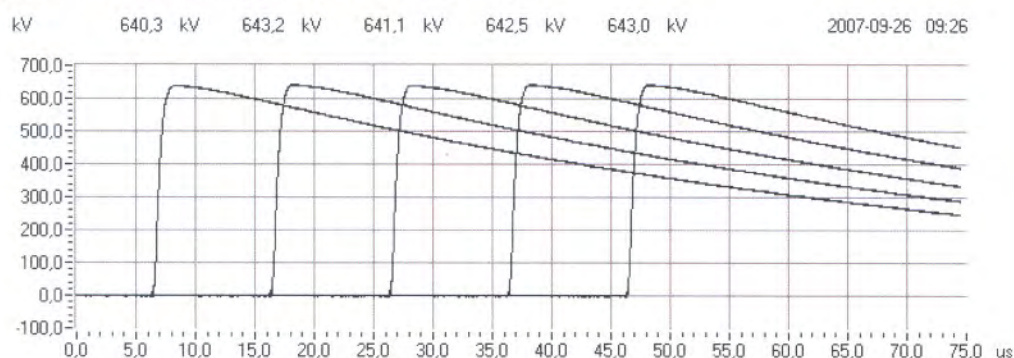


Fig. 14: CB closed, voltage on Cc, Bb earthed, 100%

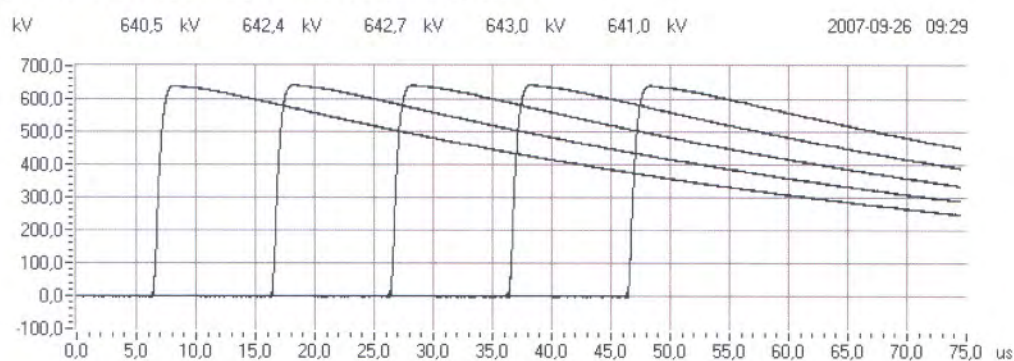


Fig. 15: CB closed, voltage on Cc, Bb earthed, 100%

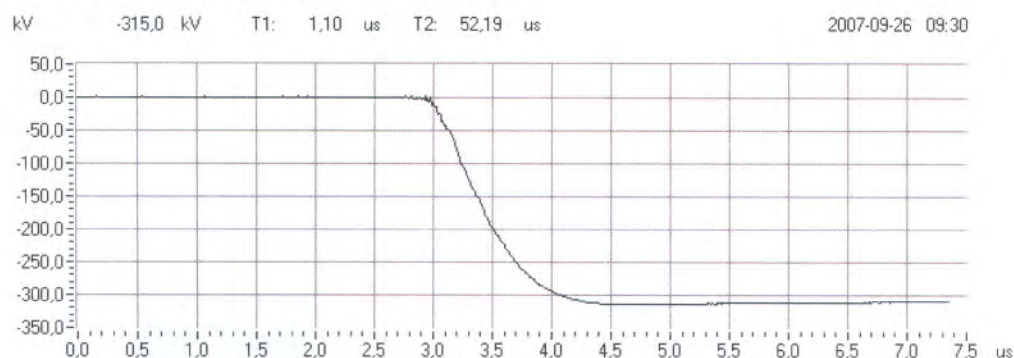


Fig. 16: Waveshape CB closed, voltage on Cc, Bb earthed, -50%

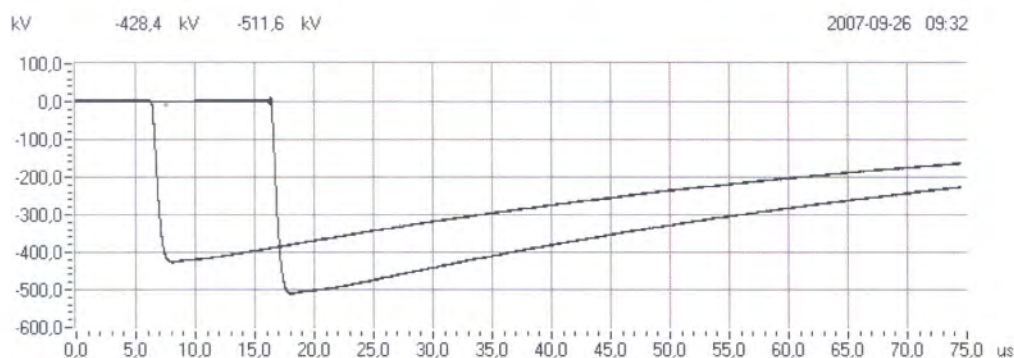


Fig. 17: CB closed, voltage on Cc, Bb earthed, -65% and -80%

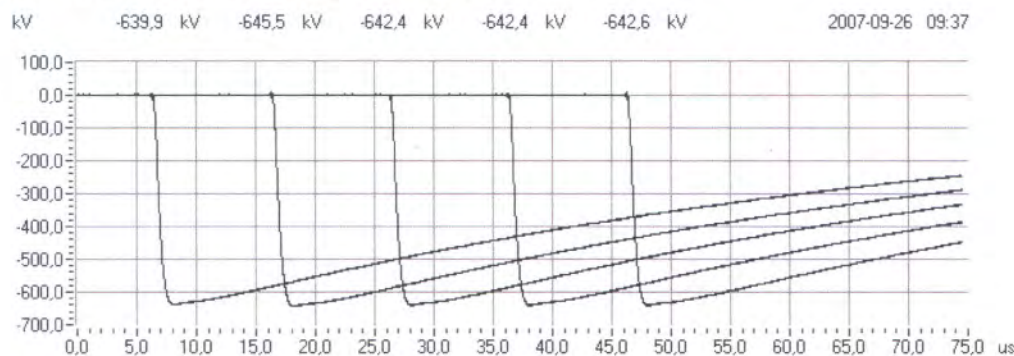


Fig. 18: CB closed, voltage on Cc, Bb earthed, -100%

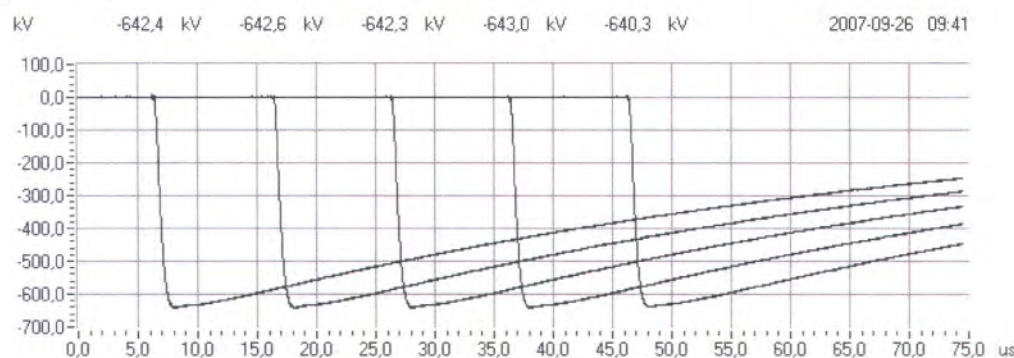


Fig. 19: CB closed, voltage on Cc, Bb earthed, -100%

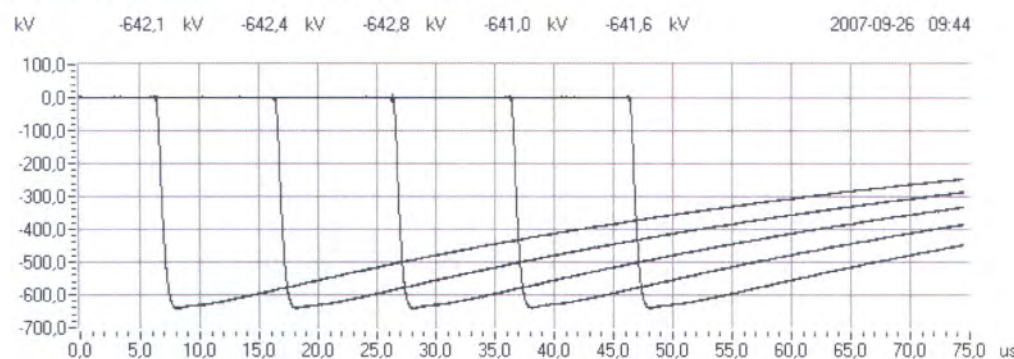


Fig. 20: CB closed, voltage on Cc, Bb earthed, -100%



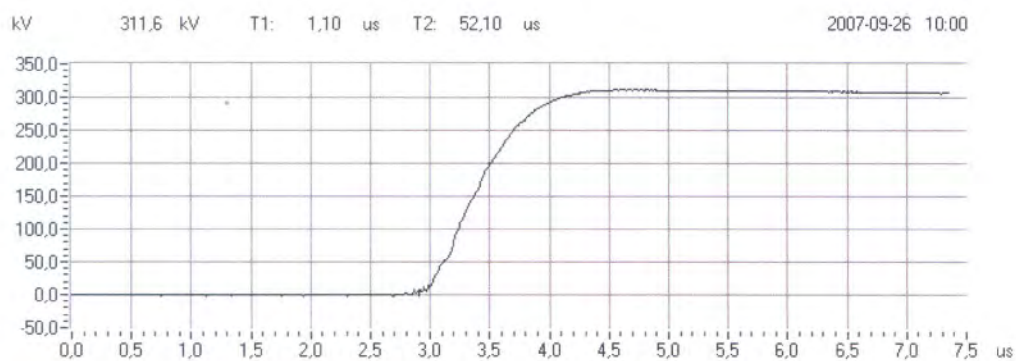


Fig. 21: Waveshape CB open, voltage on c, CBb earthed, 50%

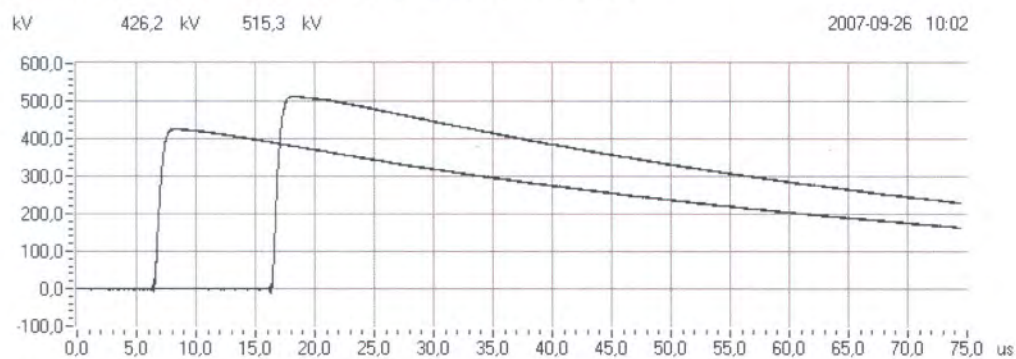


Fig. 22: CB open, voltage on c, CBb earthed, 65% and 80%

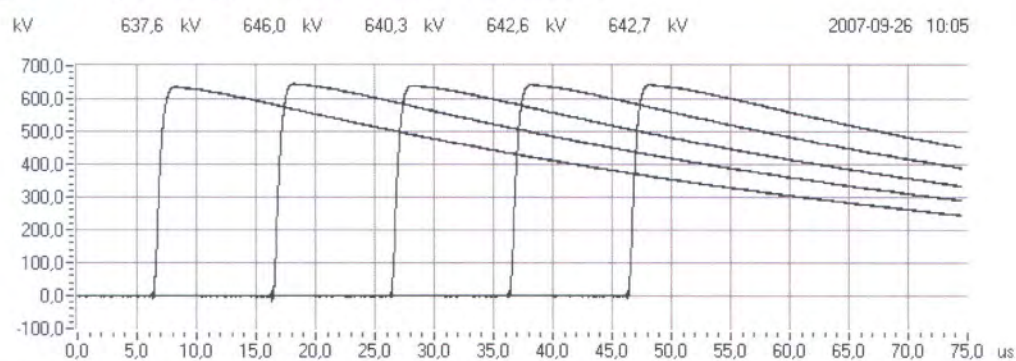


Fig. 23: CB open, voltage on c, CBb earthed, 100%

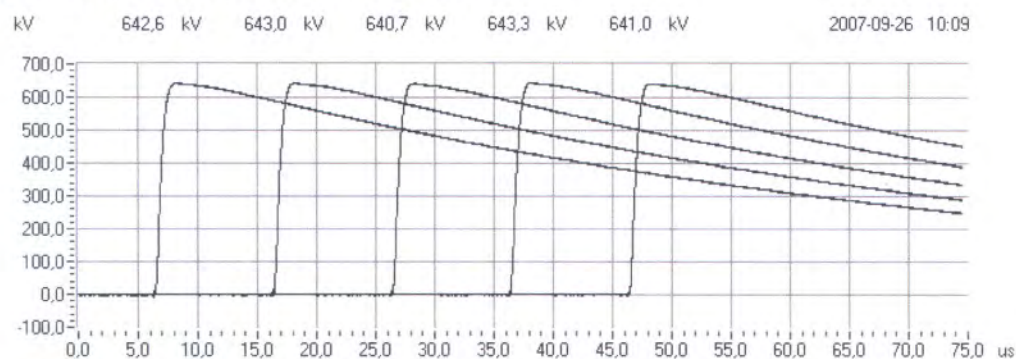


Fig. 24: CB open, voltage on c, CBb earthed, 100%



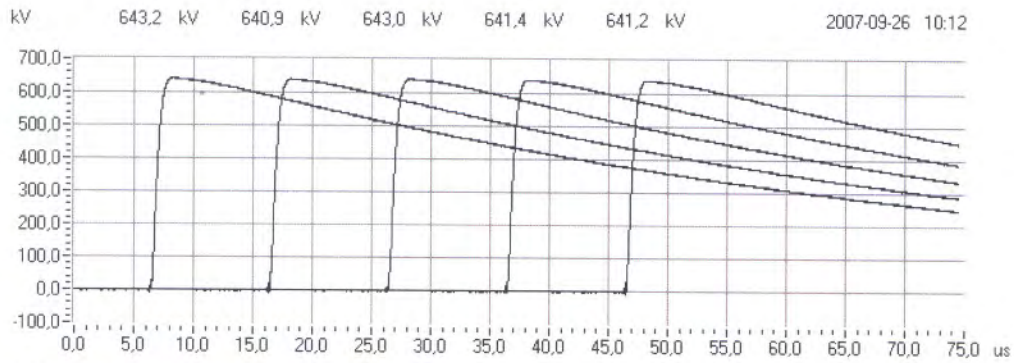


Fig. 25: CB open, voltage on c, CBb earthed, 100%

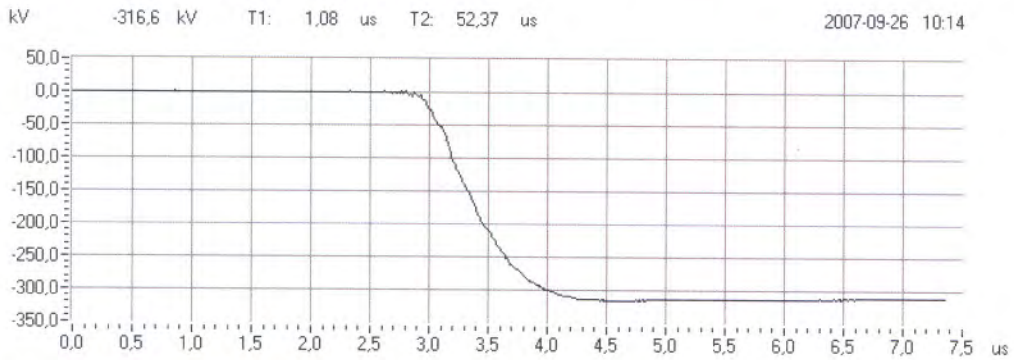


Fig. 26: Waveshape CB open, voltage on c, CBb earthed, -50%

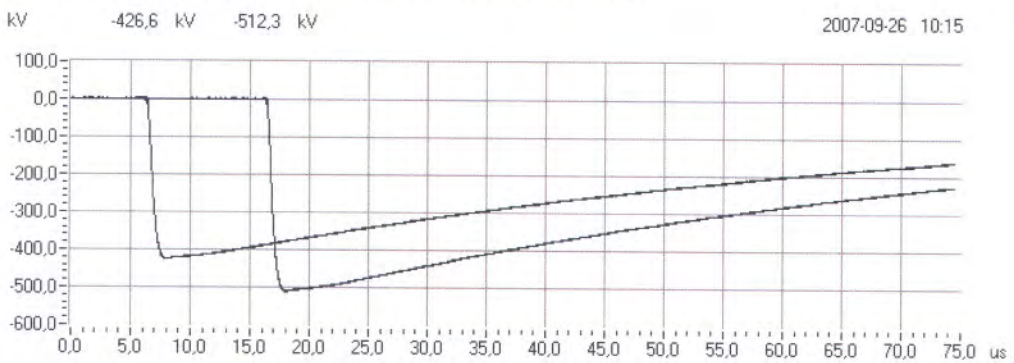


Fig. 27: CB open, voltage on c, CBb earthed, -65% and -80%

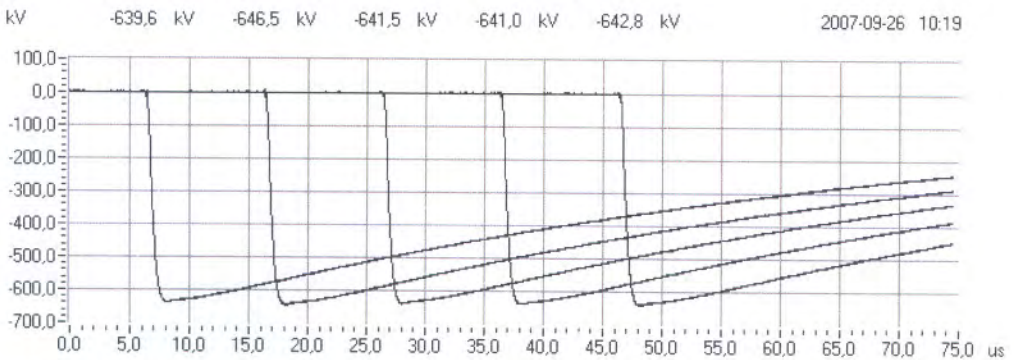


Fig. 28: CB open, voltage on c, CBb earthed, -100%

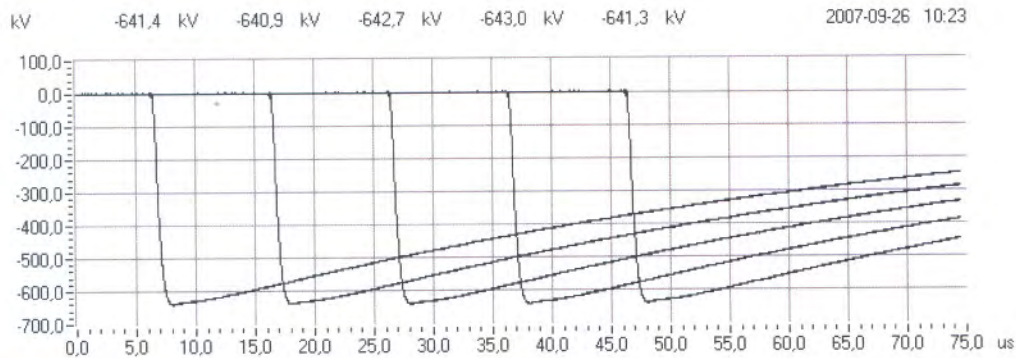


Fig. 29: CB open, voltage on c, CBb earthed, -100%

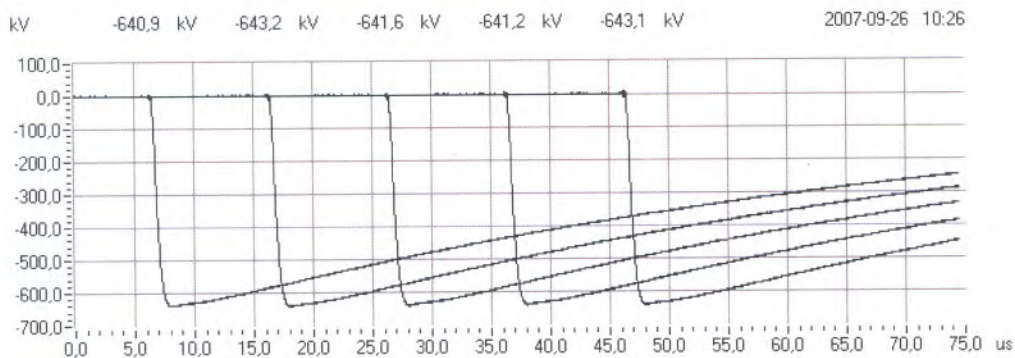


Fig. 30: CB open, voltage on c, CBb earthed, -100%

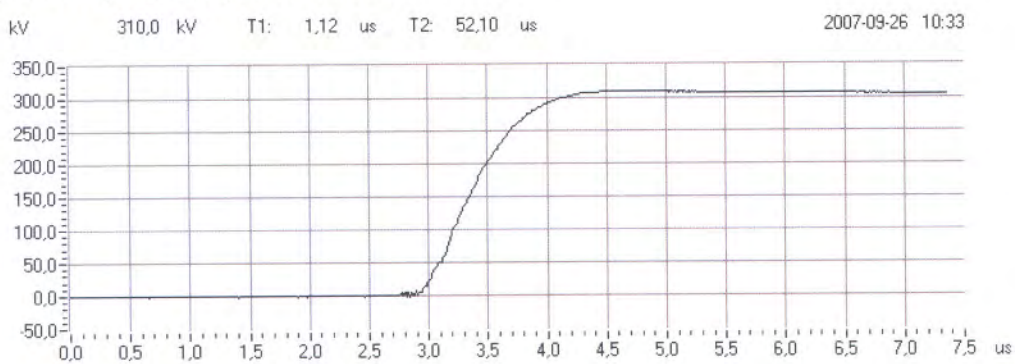


Fig. 31: Waveshape CB open, voltage on b, CcB earthed, 50%

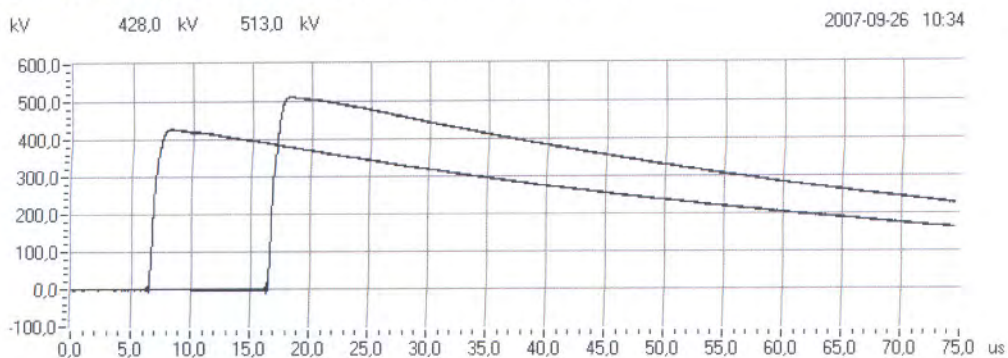
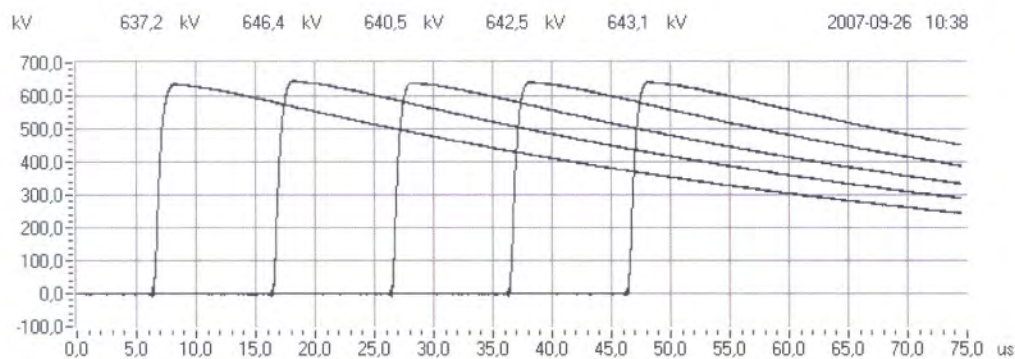
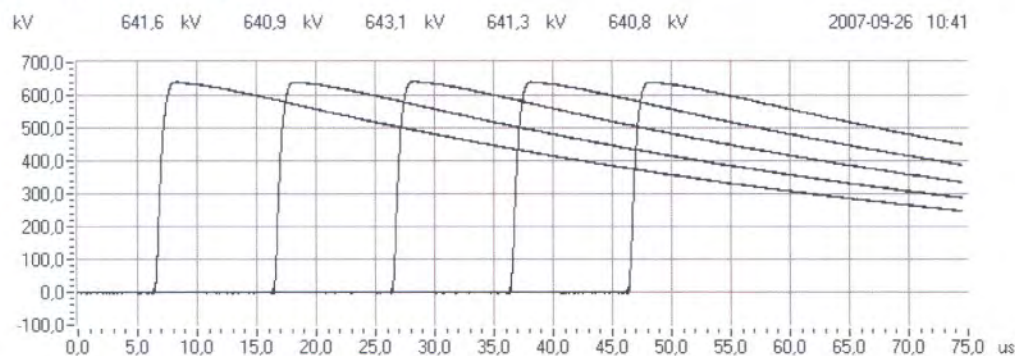


Fig. 32: CB open, voltage on b, CcB earthed, 65% and 80%

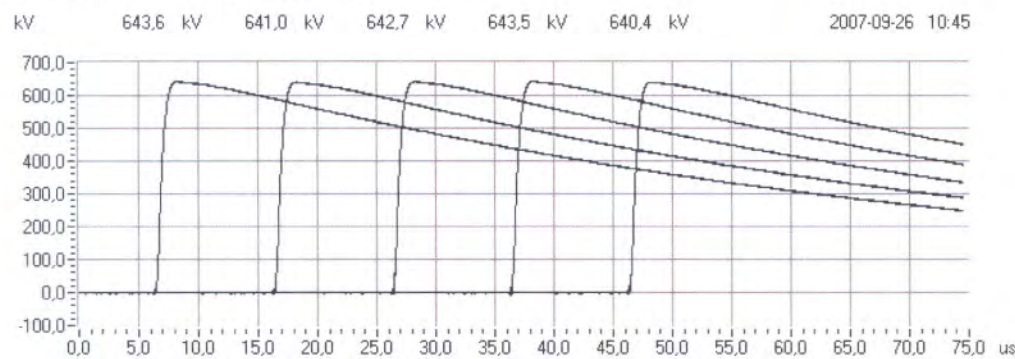




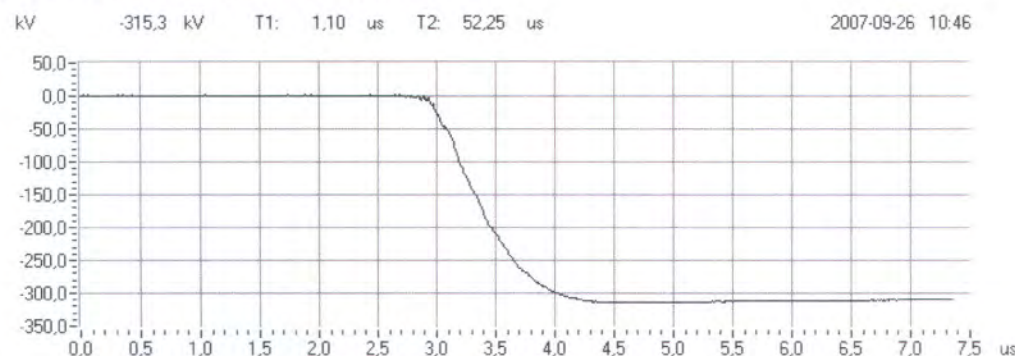
**Fig. 33: CB open, voltage on b, CcB earthed, 100%**



**Fig. 34: CB open, voltage on b, CcB earthed, 100%**



**Fig. 35: CB open, voltage on b, CcB earthed, 100%**



**Fig. 36: Waveshape CB open, voltage on b, CcB earthed, -50%**



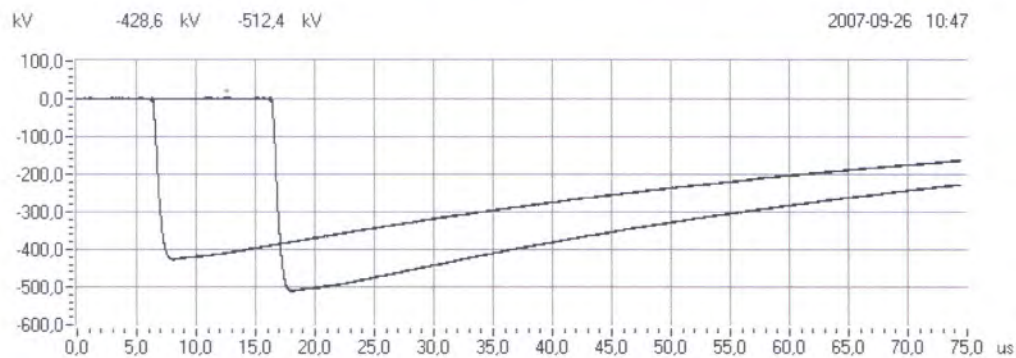


Fig. 37: CB open, voltage on b, CcB earthed, -65% and -80%

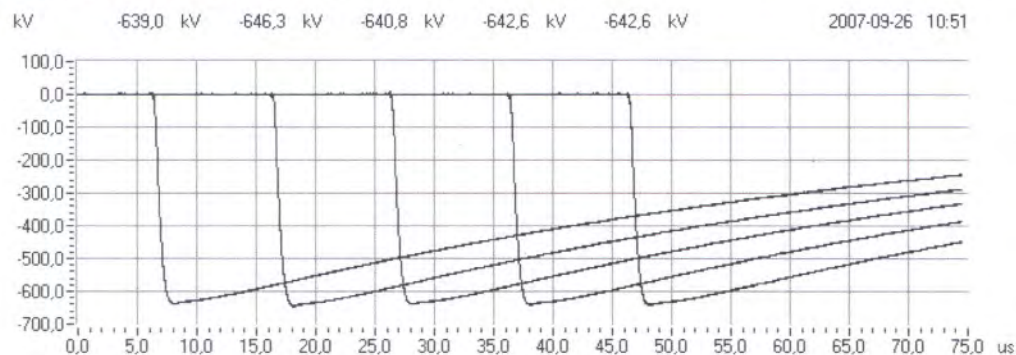


Fig. 38: CB open, voltage on b, CcB earthed, -100%

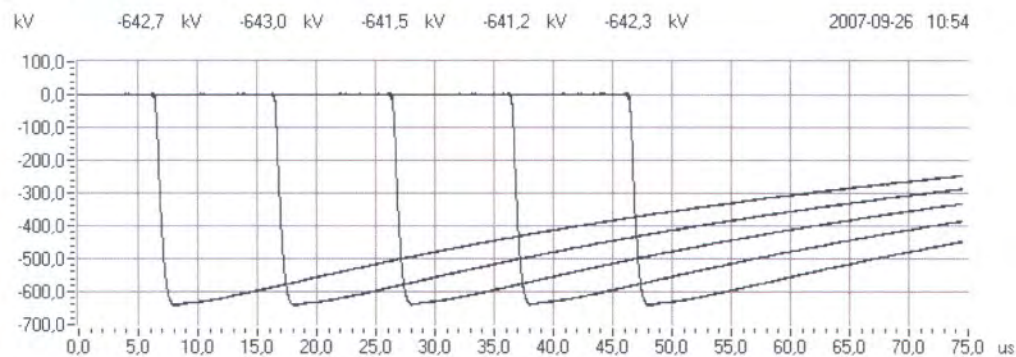


Fig. 39: CB open, voltage on b, CcB earthed, -100%

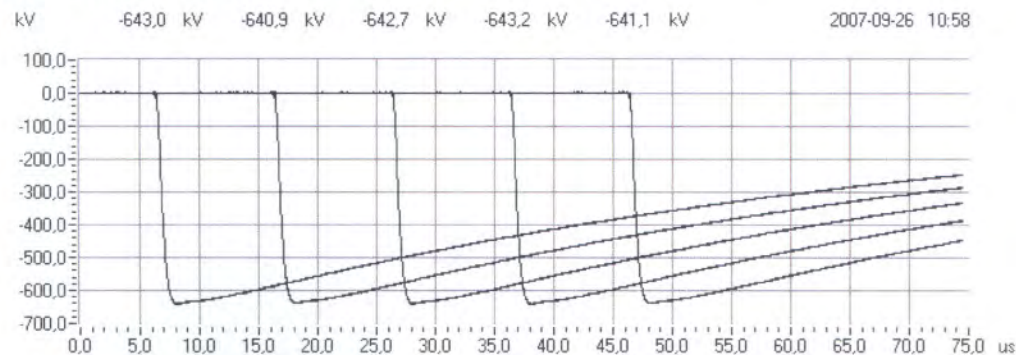


Fig. 40: CB open, voltage on b, CcB earthed, -100%

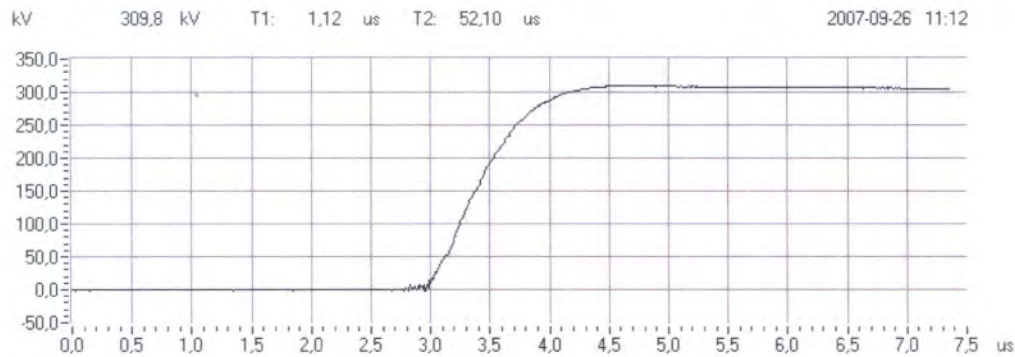


Fig. 41: Waveshape CB open, voltage on B, Ccb earthed, 50%

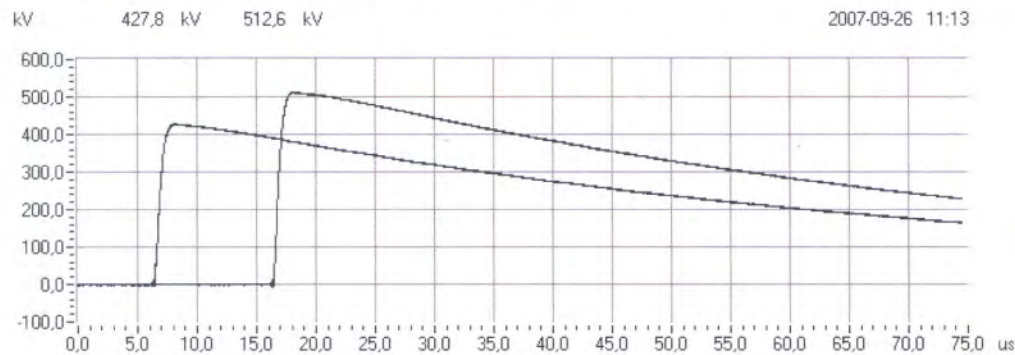


Fig. 42: CB open, voltage on B, Ccb earthed, 65% and 80%

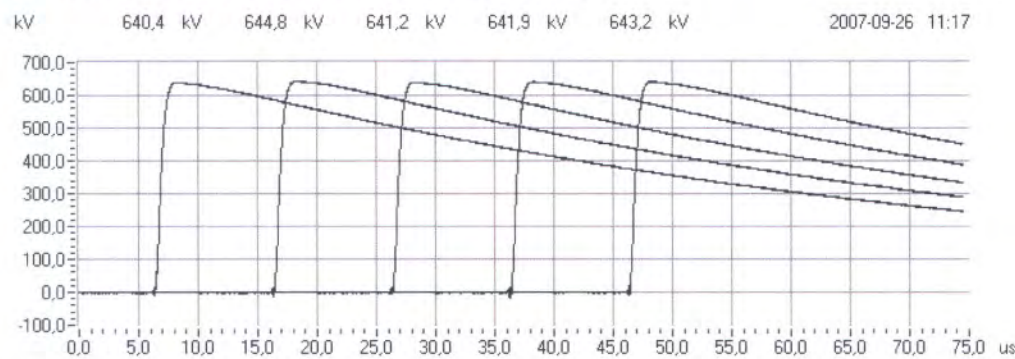


Fig. 43: CB open, voltage on B, Ccb earthed, 100%

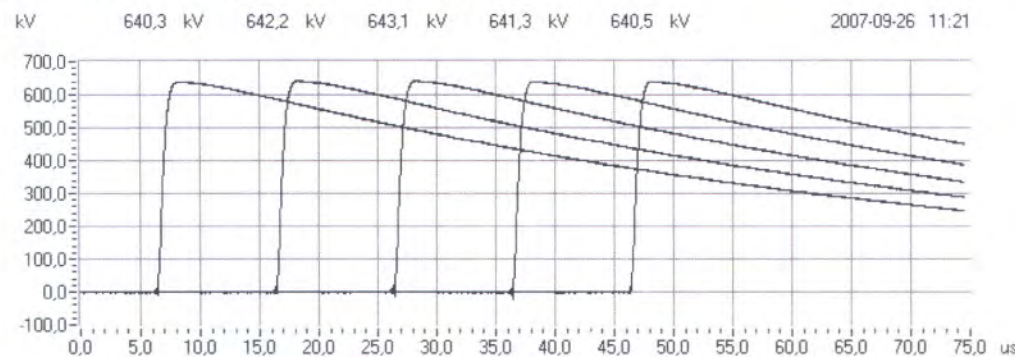


Fig. 44: CB open, voltage on B, Ccb earthed, 100%



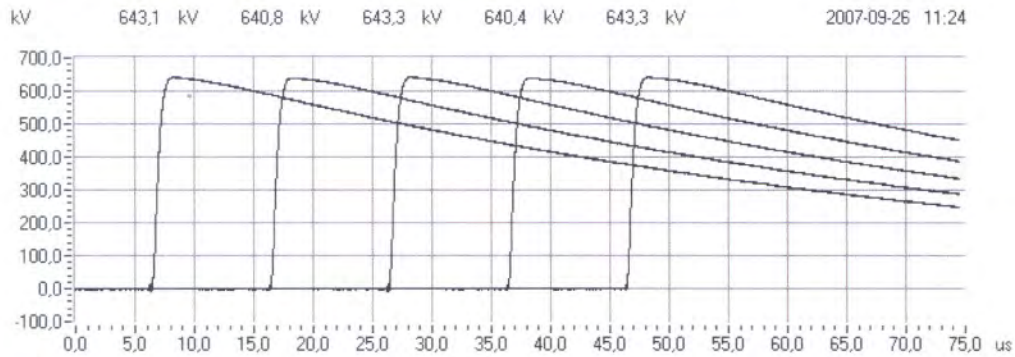


Fig. 45: CB open, voltage on B, Ccb earthed, 100%

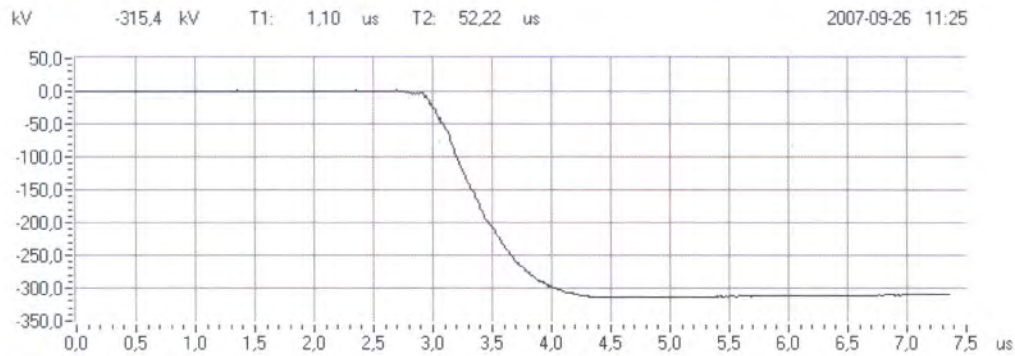


Fig. 46: Waveshape CB open, voltage on B, Ccb earthed, -50%

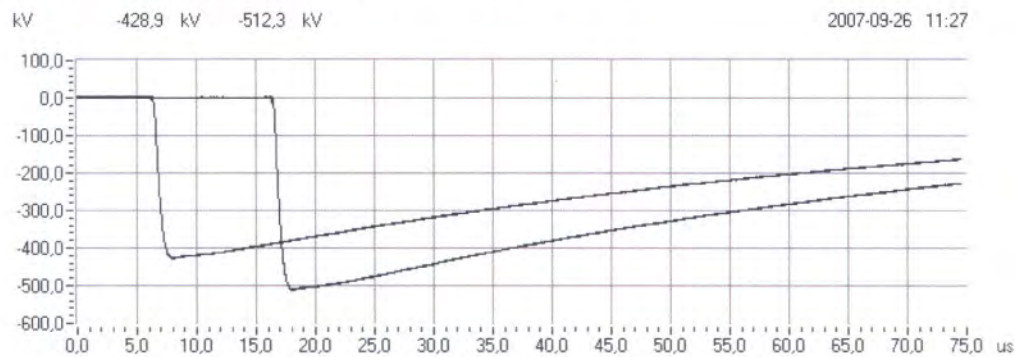


Fig. 47: CB open, voltage on B, Ccb earthed, -65% and -80%

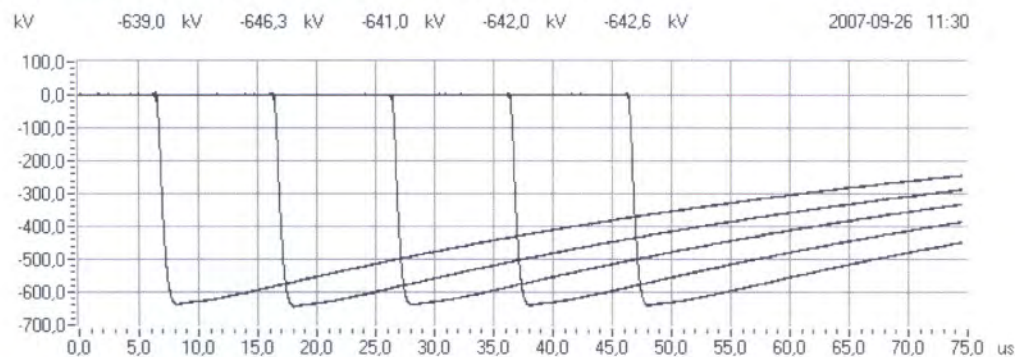


Fig. 48: CB open, voltage on B, Ccb earthed, -100%



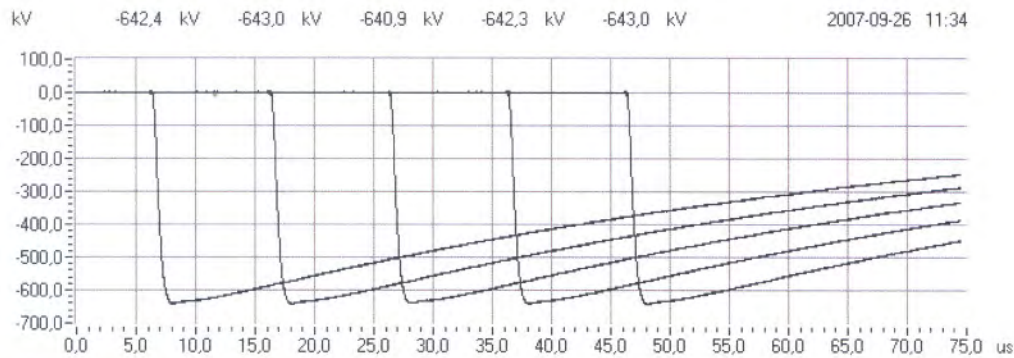


Fig. 49: CB open, voltage on B, Ccb earthed, -100%

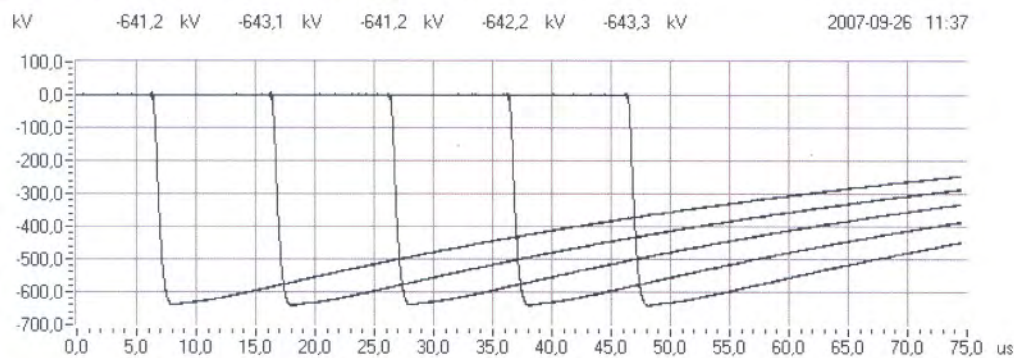


Fig. 50: CB open, voltage on B, Ccb earthed, -100%

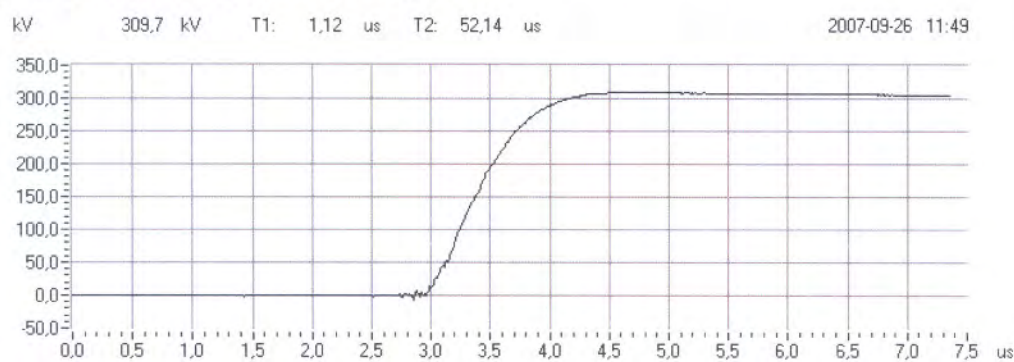


Fig. 51: Waveshape CB open, voltage on C, Bbc earthed, 50%

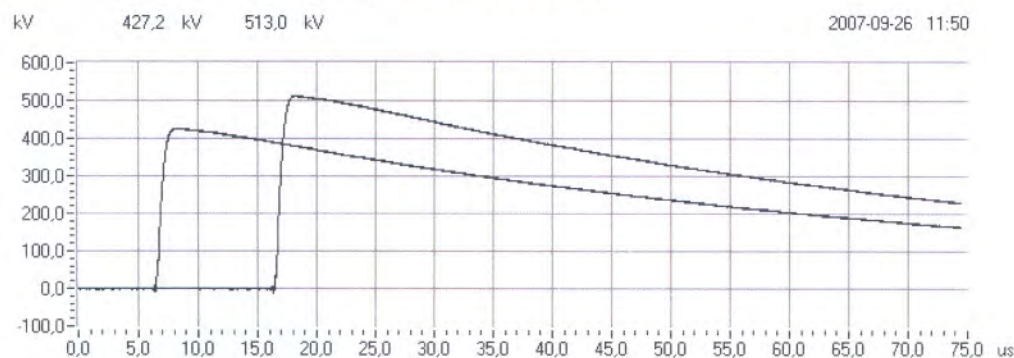


Fig. 52: CB open, voltage on C, Bbc earthed, 65% and 80%

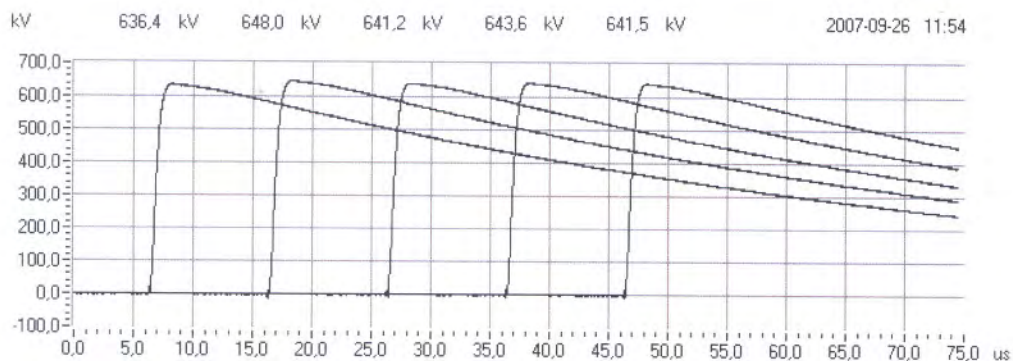


Fig. 53: CB open, voltage on C, Bbc earthed, 100%

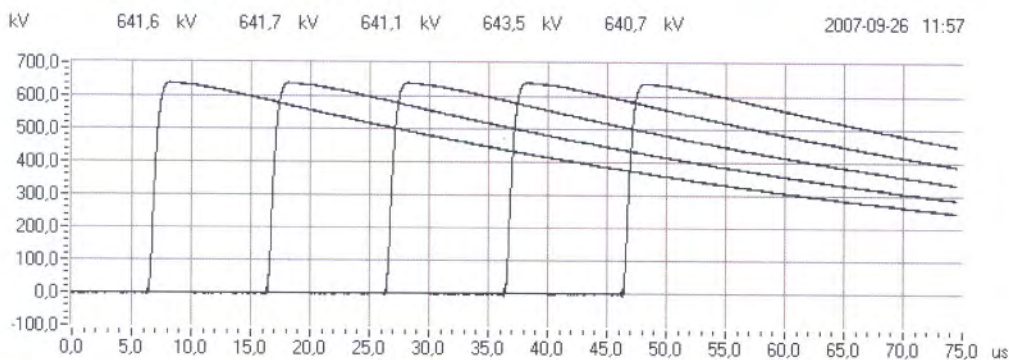


Fig. 54: CB open, voltage on C, Bbc earthed, 100%

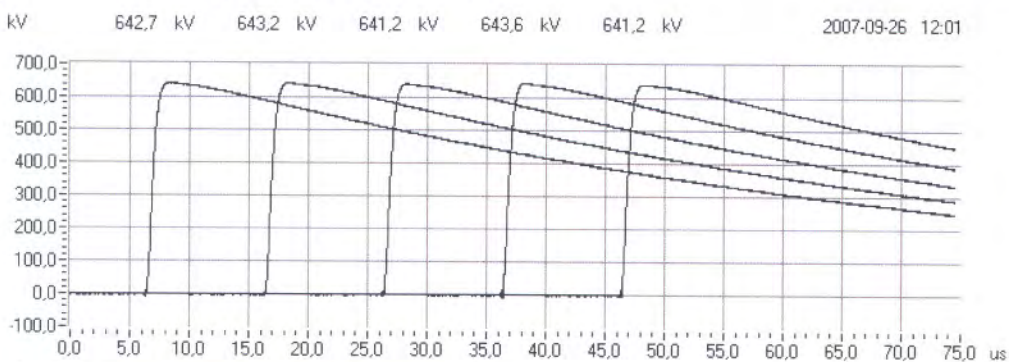


Fig. 55: CB open, voltage on C, Bbc earthed, 100%

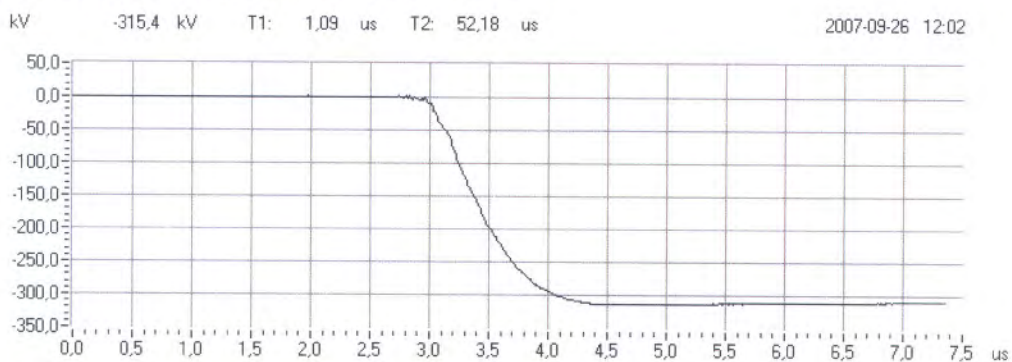


Fig. 56: Waveshape CB open, voltage on C, Bbc earthed, -50%



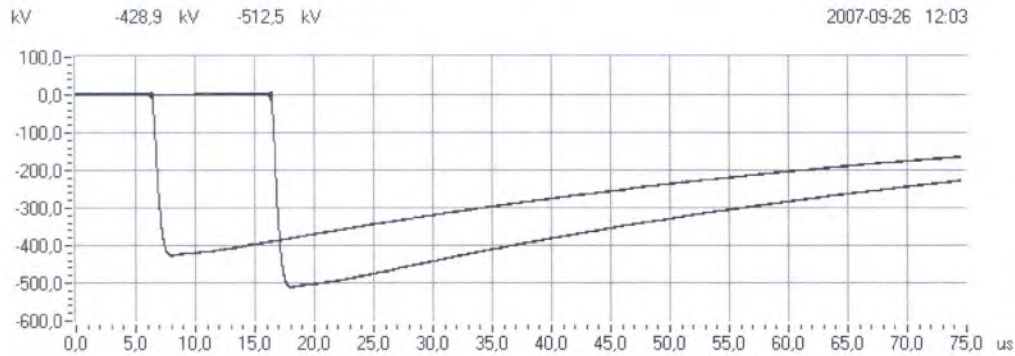


Fig. 57: CB open, voltage on C, Bbc earthed, -65% and -80%

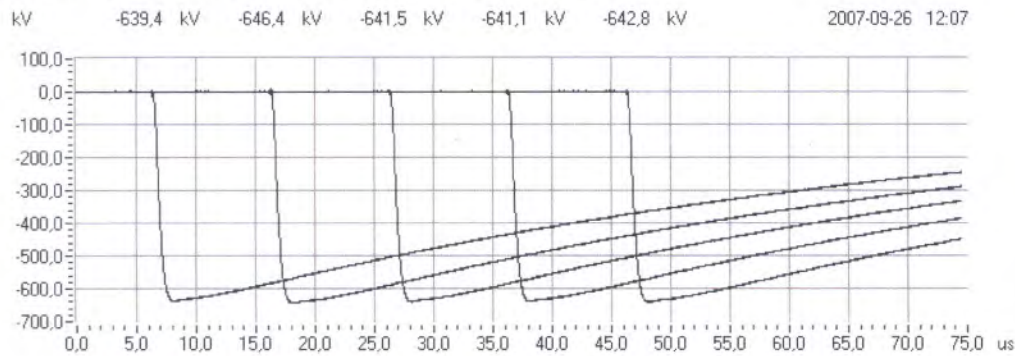


Fig. 58: CB open, voltage on C, Bbc earthed, -100%

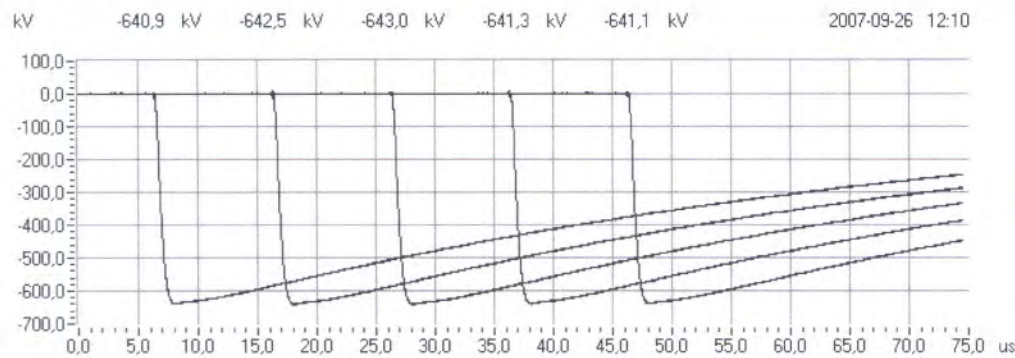


Fig. 59: CB open, voltage on C, Bbc earthed, -100%

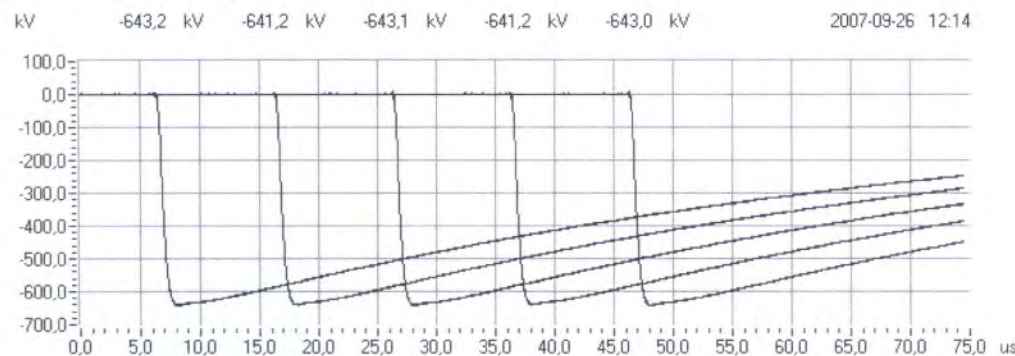


Fig. 60: CB open, voltage on C, Bbc earthed, -100%



### **Requirement**

The requirements were as mentioned in IEC 60694 clause 6.2.4:

- no more than 2 disruptive discharges on self-restoring insulation per series of 15 impulses
- no disruptive discharges on non self-restoring insulation

### **Result**

Neither flashover nor breakdown occurred during the impulse testing. The test was passed.

## 5 DRY POWER-FREQUENCY VOLTAGE WITHSTAND TEST

Date of test: 27 September 2007

The dry power-frequency voltage withstand testing was performed in accordance with clause 6.2.6.1 of IEC 62271-100. The specified test voltage was 275 kV.

Testing was performed in the test conditions as described above in chapter 3. In each test condition, the test voltage was applied for the duration of 1 minute. Prior to testing, the correction factors for standard atmospheric conditions were calculated, but the correction was negligible and was not applied. The results are presented below.

### Atmospheric conditions on 27 September 2007

|                      |                      |
|----------------------|----------------------|
| Ambient temperature  | 21 °C                |
| Ambient air pressure | 1010 hPa             |
| Humidity             | 9,3 g/m <sup>3</sup> |

### Correction factor to standard atmospheric conditions on 27 September 2007

$$K_t = K_1 \cdot K_2 = 0,996$$

Correction was negligible and not applied

| condition/<br>situation | voltage<br>applied to | earthing          | circuit breaker<br>position | applied<br>voltage<br>(kV, 50 Hz) | duration<br>(s) | result |
|-------------------------|-----------------------|-------------------|-----------------------------|-----------------------------------|-----------------|--------|
| 1                       | Bb                    | Cc and frame      | closed                      | 275                               | 60              | passed |
| 2                       | Cc                    | Bb and frame      | closed                      | 275                               | 60              | passed |
| 3                       | B                     | b, C, c and frame | open                        | 275                               | 60              | passed |
| 4                       | b                     | B, C, c and frame | open                        | 275                               | 60              | passed |
| 5                       | C                     | c, B, b and frame | open                        | 275                               | 60              | passed |
| 6                       | c                     | C, B, b and frame | open                        | 275                               | 60              | passed |

**Note:** terminals A and a were earthed throughout all the tests

### Requirement

The requirements were as mentioned in IEC 60694 clause 6.2.4:

- no disruptive discharges shall occur

### Result

Neither flashover nor breakdown occurred during the testing. The test was passed.

## 6 WET POWER-FREQUENCY VOLTAGE WITHSTAND TEST

Date of test: 27 September 2007

The wet power-frequency voltage withstand testing was performed in accordance with clause 6.2.6.1 of IEC 62271-100. The specified test voltage was 275 kV. The wetting procedures were in accordance with IEC 60060-1.

Testing was performed in the test conditions as described above in chapter 3. In each test condition, the test voltage was applied for the duration of 1 minute. Prior to testing, the correction factors for standard atmospheric conditions were calculated, but the correction was negligible and was not applied. The results are presented below.

### Atmospheric conditions on 27 September 2007

|                      |                      |
|----------------------|----------------------|
| Ambient temperature  | 21 °C                |
| Ambient air pressure | 1010 hPa             |
| Humidity             | 9,3 g/m <sup>3</sup> |

### Artificial rain parameters

|                        |            |
|------------------------|------------|
| Water temperature      | 21 °C      |
| Water conductivity     | 101 Ωm     |
| Angle of precipitation | 45 °       |
| Horizontal amount      | 1,2 mm/min |
| Vertical amount        | 1,5 mm/min |
| Pre-wetting period     | ≥ 15 min   |

### Correction factor to standard atmospheric conditions on 27 September 2007

$K_1 = K_1$  (no correction for humidity) 0,999

Correction was negligible and not applied

| condition/<br>situation | voltage<br>applied to | earthing          | circuit breaker<br>position | applied<br>voltage<br>(kV, 50 Hz) | duration<br>(s) | result |
|-------------------------|-----------------------|-------------------|-----------------------------|-----------------------------------|-----------------|--------|
| 1                       | Bb                    | Cc and frame      | closed                      | 275                               | 60              | passed |
| 2                       | Cc                    | Bb and frame      | closed                      | 275                               | 60              | passed |
| 3                       | B                     | b, C, c and frame | open                        | 275                               | 60              | passed |
| 4                       | b                     | B, C, c and frame | open                        | 275                               | 60              | passed |
| 5                       | C                     | c, B, b and frame | open                        | 275                               | 60              | passed |
| 6                       | c                     | C, B, b and frame | open                        | 275                               | 60              | passed |

**Note:** terminals A and a were earthed throughout all the tests



#### **Requirement**

The requirements were as mentioned in IEC 60694 clause 6.2.4:

- no disruptive discharge on external self-restoring insulation shall occur.

#### **Result**

Neither flashover nor breakdown occurred during the testing. The test was passed.

## 7 DIELECTRIC TESTS ON THE AUXILIARY AND CONTROL EQUIPMENT

Date of tests: 26 September 2007

The auxiliary and control equipment of the test object was subjected to dielectric tests.

The tests were carried out in accordance with clause 6.2.10 of IEC 62271-100 and reference is made here to IEC 60694 clause 6.2.10.

For the purpose of these tests, the auxiliary and control equipment was grouped into the following 6 parts:

- part 1: SF<sub>6</sub> CB control circuit (terminals 1-11)
- part 2: alarm/indication contacts (terminals 20-25)
- part 3: lamp & heater control circuit (terminals 12 + 14, jumpers 12-13 and 14-15 removed)
- part 4: motor control circuit (terminals 13 + 15, jumpers 12-13 and 14-15 removed)
- part 5: spare auxiliary contacts 52a (terminals 26-41)
- part 6: spare auxiliary contacts 52b (terminals 42-57)

For each part, the respective terminals were interconnected by means of 1 mm<sup>2</sup> copper wire and subsequently each part was subjected to power-frequency voltage withstand tests and lightning impulse voltage withstand tests. The test voltage was applied to each part separately in turn, while all the other parts and the frame were earthed.

All parts were tested at a power-frequency voltage of 2 kV for the duration of 1 minute.

All parts were tested at a lightning impulse voltage of 5 kV (5 impulses at positive polarity and 5 impulses at negative polarity), except for the motor control circuit (part 4), for which the specified lightning impulse voltage withstand level amounted to 2,5 kV.

### Results of the power-frequency voltage withstand tests

| part under test | earthed parts        | applied test voltage<br>(kV, 50 Hz) | duration<br>(s) | result |
|-----------------|----------------------|-------------------------------------|-----------------|--------|
| 1               | 2, 3, 4, 5, 6, frame | 2                                   | 60              | passed |
| 2               | 1, 3, 4, 5, 6, frame | 2                                   | 60              | passed |
| 3               | 1, 2, 4, 5, 6, frame | 2                                   | 60              | passed |
| 4               | 1, 2, 3, 5, 6, frame | 2                                   | 60              | passed |
| 5               | 1, 2, 3, 4, 6, frame | 2                                   | 60              | passed |
| 6               | 1, 2, 3, 4, 5, frame | 2                                   | 60              | passed |

### Results of the lightning impulse voltage withstand tests

| part under test | voltage applied to   | applied test voltage<br>(kV) | see figure no.'s |
|-----------------|----------------------|------------------------------|------------------|
| 1               | 2, 3, 4, 5, 6, frame | 5                            | 1 and 2          |
| 2               | 1, 3, 4, 5, 6, frame | 5                            | 5 and 6          |
| 3               | 1, 2, 4, 5, 6, frame | 5                            | 3 and 4          |
| 4               | 1, 2, 3, 5, 6, frame | 2,5                          | 11 and 12        |
| 5               | 1, 2, 3, 4, 6, frame | 5                            | 7 and 8          |
| 6               | 1, 2, 3, 4, 5, frame | 5                            | 9 and 10         |

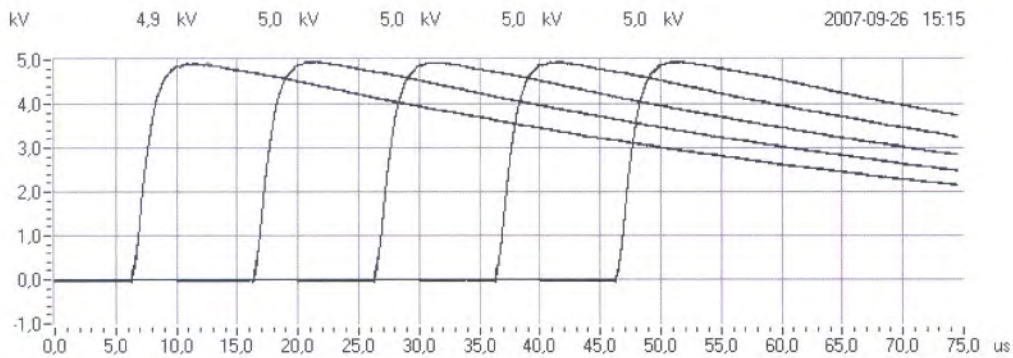


Fig. 1: Crompton GCB, secondary circuit 1

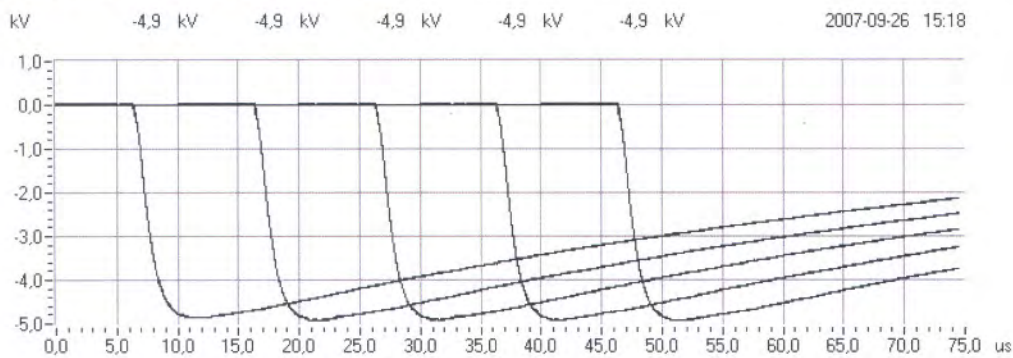


Fig. 2: Crompton GCB, secondary circuit 1

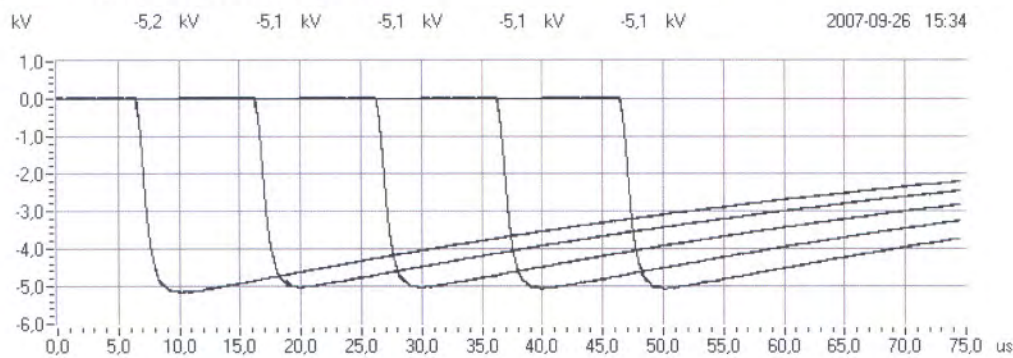


Fig. 3: Crompton GCB, secondary circuit 3

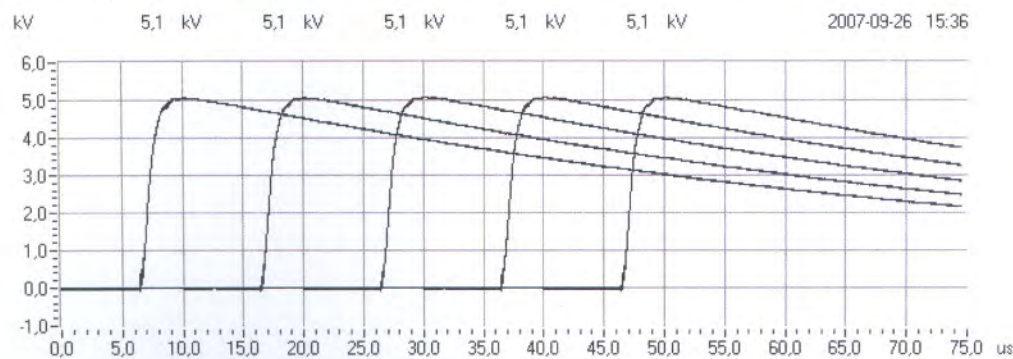


Fig. 4: Crompton GCB, secondary circuit 3



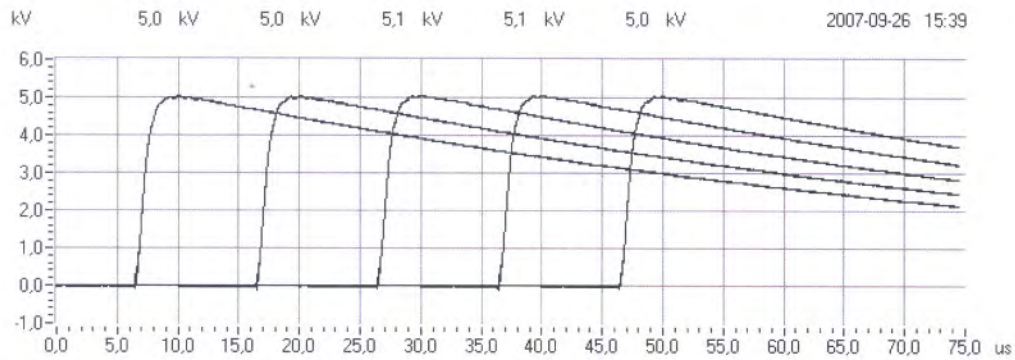


Fig. 5: Crompton GCB, secondary circuit 2

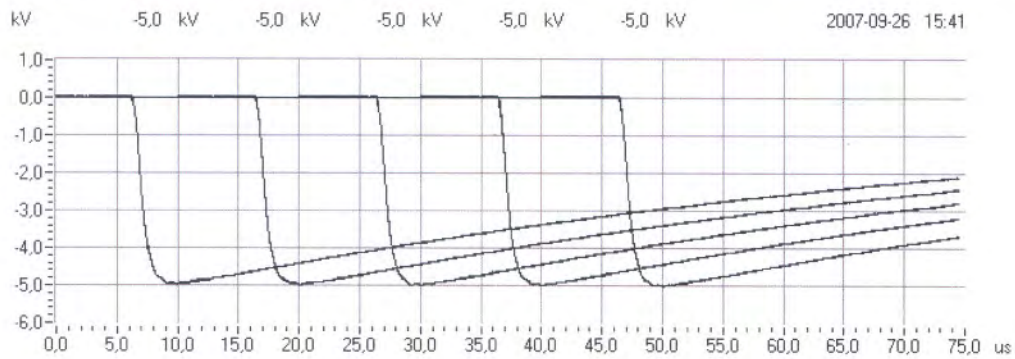


Fig. 6: Crompton GCB, secondary circuit 2

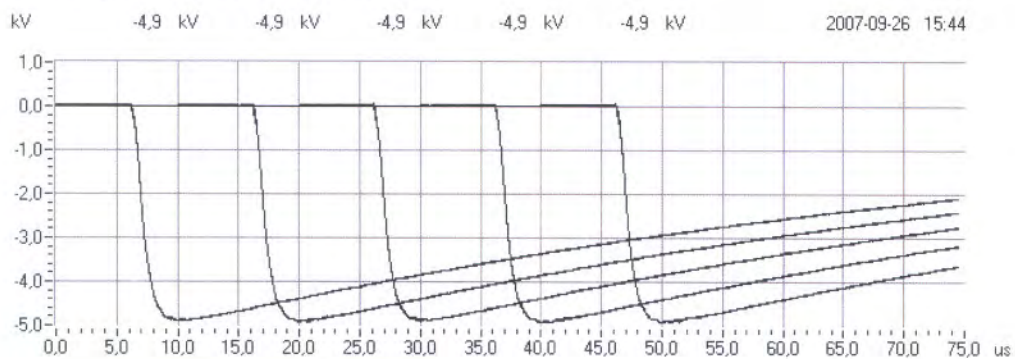


Fig. 7: Crompton GCB, secondary circuit 5

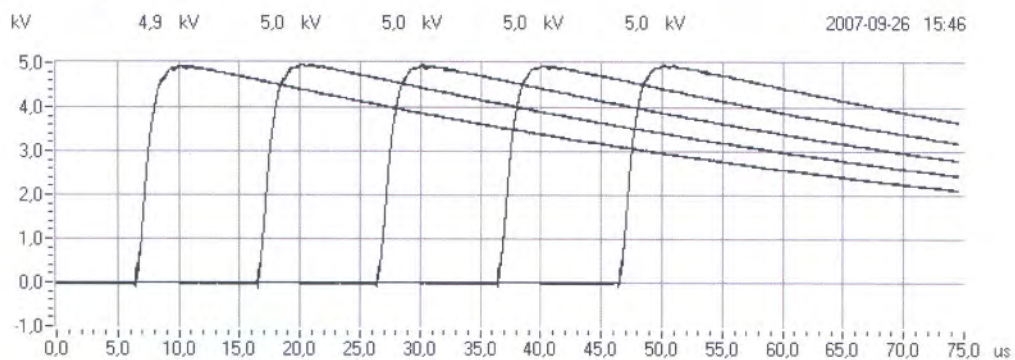


Fig. 8: Crompton GCB, secondary circuit 5

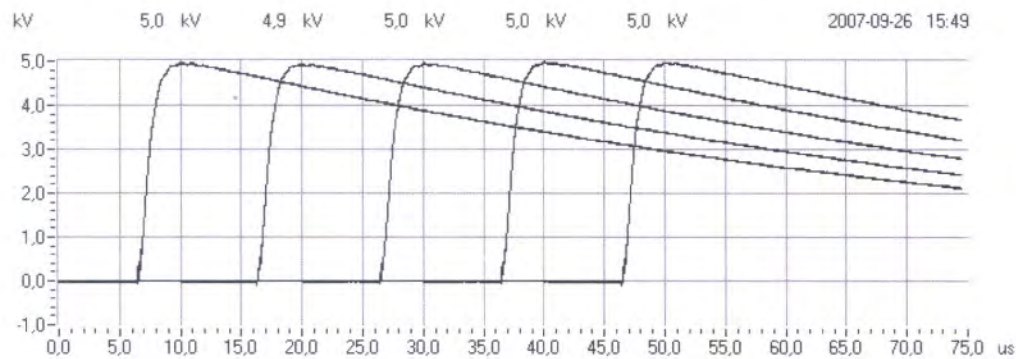


Fig. 9: Crompton GCB, secondary circuit 6

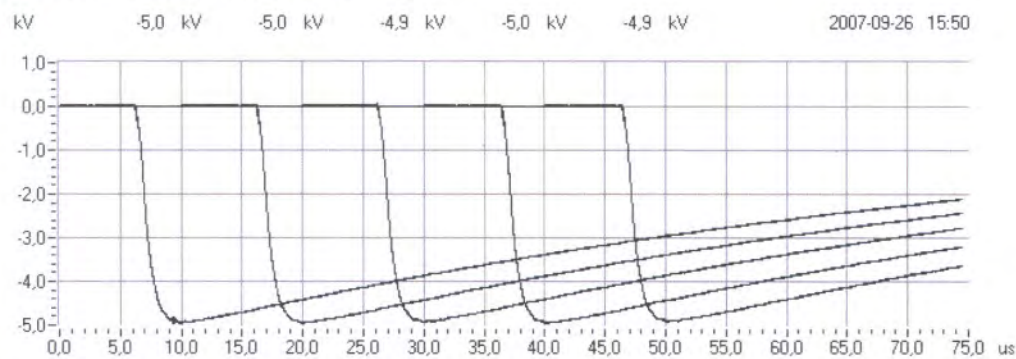


Fig. 10: Crompton GCB, secondary circuit 6

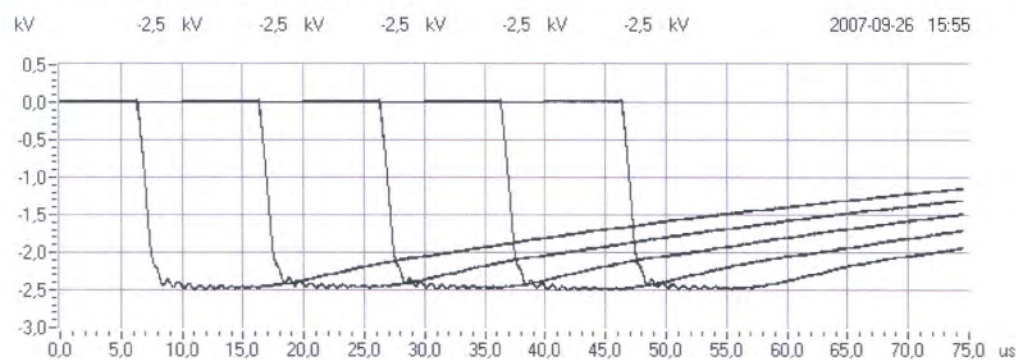


Fig. 11: Crompton GCB, secondary circuit 4

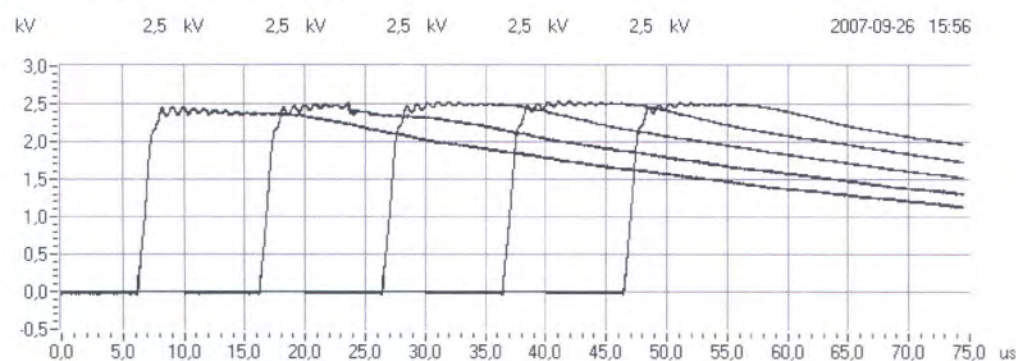


Fig. 12: Crompton GCB, secondary circuit 4



### **Requirements**

The requirements were as mentioned in IEC 60694 clause 6.2.10:

- no disruptive discharge shall occur
- after the tests, the auxiliary and control circuits shall still be fully operational

### **Result**

Neither flashover nor breakdown occurred during the tests. Upon completion of the tests, the auxiliary and control equipment was functionally tested and was still working properly.

The test was passed.

## 8 RADIO INTERFERENCE VOLTAGE (RIV) TEST

Date of test: 27 September 2007

The radio interference voltage test was performed under dry conditions in accordance with clause 6.3 of IEC 62271-100. Testing was performed in 3 test conditions as described above in chapter 3 (test conditions 2, 5 and 6) on one of the outer poles (C). Care was given to avoid influencing the measurements by earthed or non-earthed objects near to the switchgear. The measuring circuit was in compliance with CISPR 18-2.

In each test condition a power-frequency voltage of  $1,1 \cdot U_r / \sqrt{3}$  (50 Hz) was applied to the switchgear and maintained for at least 5 minutes. The voltage was then decreased by steps down to  $0,3 \cdot U_r / \sqrt{3}$ , raised again by steps up to the initial value and finally decreased by steps down to  $0,3 \cdot U_r / \sqrt{3}$ . At each step, the radio interference measurement was taken and the radio interference level, as recorded during the last series of voltage reductions, was plotted versus the applied voltage.

No correction factors for standard atmospheric conditions were applied.

The results are presented below.

### Atmospheric conditions on 27 September 2007

|                      |                      |
|----------------------|----------------------|
| Ambient temperature  | 21 °C                |
| Ambient air pressure | 1010 hPa             |
| Humidity             | 9,3 g/m <sup>3</sup> |

### General information

|                        |         |
|------------------------|---------|
| Measuring frequency    | 0,5 MHz |
| Primary test frequency | 50 Hz   |

### Calibration test set-up

|                              |   |
|------------------------------|---|
| Calibration voltage          | 100 mV (100 dB(μV))                                     |
| Calibration frequency        | 0,5 MHz   |
| Reading measurement receiver | 84,5 dB(μV)   |
| Correction factor            | 15,5 dB(μV) ( = calibration voltage – reading receiver) |

### Background noise

|                              |   |
|------------------------------|---|
| Measuring frequency          | 0,5 MHz   |
| Reading measurement receiver | 15 dB(μV)   |
| Background noise             | 30,5 dB(μV) ( = reading receiver + correction factor) |



**Test condition 2: circuit breaker closed, Cc on high voltage, Aa, Bb and frame grounded**

| applied test voltage                             |                     | receiver reading | correction factor | actual RIV value |      | remark     |
|--|---------------------|------------------|-------------------|------------------|------|------------|
| kV   | % of $U_r/\sqrt{3}$ | dB(μV)           | dB(μV)            | dB(μV)           | μV   |            |
| 92,1 kV (110 % of $U_r/\sqrt{3}$ ) for 5 minutes |                     |                  |                   |                  |      |            |
| 92,1   | 110                 | 16               | 15,5              | 31,5             | 37,6 | background |
| 83,7   | 100                 | 16               | 15,5              | 31,5             | 37,6 | background |
| 75,3   | 90                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 67,0   | 80                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 58,6   | 70                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 50,2   | 60                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 41,9   | 50                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 33,5   | 40                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 25,1   | 30                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 33,5   | 40                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 41,9   | 50                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 50,2   | 60                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 58,6   | 70                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 67,0   | 80                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 75,3   | 90                  | 16               | 15,5              | 31,5             | 37,6 | background |
| 83,7   | 100                 | 16               | 15,5              | 31,5             | 37,6 | background |
| 92,1   | 110                 | 16               | 15,5              | 31,5             | 37,6 | background |
| 92,1 kV (110 % of $U_r/\sqrt{3}$ ) for 1 minute  |                     |                  |                   |                  |      |            |
| 92,1   | 110                 | 15               | 15,5              | 30,5             | 33,5 | background |
| 83,7   | 100                 | 15               | 15,5              | 30,5             | 33,5 | background |
| 75,3   | 90                  | 15               | 15,5              | 30,5             | 33,5 | background |
| 67,0   | 80                  | 15               | 15,5              | 30,5             | 33,5 | background |
| 58,6   | 70                  | 15               | 15,5              | 30,5             | 33,5 | background |
| 50,2   | 60                  | 15               | 15,5              | 30,5             | 33,5 | background |
| 41,9   | 50                  | 15               | 15,5              | 30,5             | 33,5 | background |
| 33,5   | 40                  | 15               | 15,5              | 30,5             | 33,5 | background |
| 25,1   | 30                  | 15               | 15,5              | 30,5             | 33,5 | background |

**Test condition 6: circuit breaker open, c on high voltage, C, A, a, B, b and frame grounded**

| applied test voltage                             |                     | receiver reading | correction factor | actual RIV value |      | remark     |
|--|---------------------|------------------|-------------------|------------------|------|------------|
| kV   | % of $U_r/\sqrt{3}$ | dB(μV)           | dB(μV)            | dB(μV)           | μV   |            |
| 92,1 kV (110 % of $U_r/\sqrt{3}$ ) for 5 minutes |                     |                  |                   |                  |      |            |
| 92,1   | 110                 | 14,5             | 15,5              | 30               | 31,6 | background |
| 83,7   | 100                 | 14,5             | 15,5              | 30               | 31,6 | background |
| 75,3   | 90                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 67,0   | 80                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 58,6   | 70                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 50,2   | 60                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 41,9   | 50                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 33,5   | 40                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 25,1   | 30                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 33,5   | 40                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 41,9   | 50                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 50,2   | 60                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 58,6   | 70                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 67,0   | 80                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 75,3   | 90                  | 14,5             | 15,5              | 30               | 31,6 | background |
| 83,7   | 100                 | 14,5             | 15,5              | 30               | 31,6 | background |
| 92,1   | 110                 | 14,5             | 15,5              | 30               | 31,6 | background |
| 92,1 kV (110 % of $U_r/\sqrt{3}$ ) for 1 minute  |                     |                  |                   |                  |      |            |
| 92,1   | 110                 | 14               | 15,5              | 29,5             | 29,8 | background |
| 83,7   | 100                 | 14               | 15,5              | 29,5             | 29,8 | background |
| 75,3   | 90                  | 14               | 15,5              | 29,5             | 29,8 | background |
| 67,0   | 80                  | 14               | 15,5              | 29,5             | 29,8 | background |
| 58,6   | 70                  | 14               | 15,5              | 29,5             | 29,8 | background |
| 50,2   | 60                  | 14               | 15,5              | 29,5             | 29,8 | background |
| 41,9   | 50                  | 14               | 15,5              | 29,5             | 29,8 | background |
| 33,5   | 40                  | 14               | 15,5              | 29,5             | 29,8 | background |
| 25,1   | 30                  | 14               | 15,5              | 29,5             | 29,8 | background |



**Test condition 5: circuit breaker open, C on high voltage, c, A, a, B, b and frame grounded**

| applied test voltage                             |                     | receiver reading | correction factor | actual RIV value |      | remark     |
|--|---------------------|------------------|-------------------|------------------|------|------------|
| kV   | % of $U_r/\sqrt{3}$ | dB(μV)           | dB(μV)            | dB(μV)           | μV   |            |
| 92,1 kV (110 % of $U_r/\sqrt{3}$ ) for 5 minutes |                     |                  |                   |                  |      |            |
| 92,1   | 110                 | 15,5             | 15,5              | 31               | 35,5 | background |
| 83,7   | 100                 | 15,5             | 15,5              | 31               | 35,5 | background |
| 75,3   | 90                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 67,0   | 80                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 58,6   | 70                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 50,2   | 60                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 41,9   | 50                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 33,5   | 40                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 25,1   | 30                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 33,5   | 40                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 41,9   | 50                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 50,2   | 60                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 58,6   | 70                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 67,0   | 80                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 75,3   | 90                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 83,7   | 100                 | 15,5             | 15,5              | 31               | 35,5 | background |
| 92,1   | 110                 | 15,5             | 15,5              | 31               | 35,5 | background |
| 92,1 kV (110 % of $U_r/\sqrt{3}$ ) for 1 minute  |                     |                  |                   |                  |      |            |
| 92,1   | 110                 | 15,5             | 15,5              | 31               | 35,5 | background |
| 83,7   | 100                 | 15,5             | 15,5              | 31               | 35,5 | background |
| 75,3   | 90                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 67,0   | 80                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 58,6   | 70                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 50,2   | 60                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 41,9   | 50                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 33,5   | 40                  | 15,5             | 15,5              | 31               | 35,5 | background |
| 25,1   | 30                  | 15,5             | 15,5              | 31               | 35,5 | background |

**Requirements**

The requirements were as mentioned in IEC 60694 clause 6.3:

- RIV limit at  $1,1 \cdot U_r/\sqrt{3}$  : 68 dB( $\mu$ V) = 2500  $\mu$ V

**Result**

The measured RIV value was well below the required limit in the entire applied voltage range for all test conditions. The test was passed.

## APPENDIX A MEASUREMENT UNCERTAINTIES

The measurement uncertainties in the results presented are as specified below unless otherwise indicated.

| measurement   | measurement uncertainty   |
|---|---|
| dielectric tests<br>and impulse current tests         | peak value: $\leq 3\%$<br>time parameters: $\leq 10\%$  |
| capacitance measurement                               | 0,3%  |
| $\tan \delta$ measurement                             | $\pm 0,5\% \pm 5 \times 10^{-5}$  |
| partial discharge measurement                         | $< 10 \text{ pC} : 2 \text{ pC}$<br>$10 - 100 \text{ pC} : 5 \text{ pC}$<br>$> 100 \text{ pC} : 20 \%$  |
| measurement of impedance<br>ac-resistance measurement | $\leq 1\%$  |
| measurement of losses                                 | $\leq 1\%$  |
| measurement of insulation resistance                  | $\leq 10\%$   |
| measurement of dc resistance                          | $1 \mu\Omega - 5 \mu\Omega : 1\%$<br>$5 \mu\Omega - 10 \mu\Omega : 0,5\%$<br>$10 \mu\Omega - 200 \mu\Omega : 0,2\%$   |
| radio interference test                               | 2 dB  |
| calibration of current transformers                   | $2,2 \times 10^{-4} \text{ li/Iu}$ and $290 \mu\text{rad}$  |
| calibration of voltage transformers                   | $1,6 \times 10^{-4} \text{ Ui/Uu}$ en $510 \mu\text{rad}$   |
| measurement of conductivity                           | 5%  |
| measurement of temperature                            | $-50^\circ\text{C} - -40^\circ\text{C} : 3 \text{ K}$<br>$-40^\circ\text{C} - 125^\circ\text{C} : 2 \text{ K}$<br>$125^\circ\text{C} - 150^\circ\text{C} : 3 \text{ K}$ |
| tensile test  | 1%  |
| sound level measurement                               | type 1 meter as per IEC 651 and<br>ANSI S1.4.1971   |
| measurement of voltage ratio                          | 0,1%  |



**APPENDIX B MANUFACTURER'S DRAWINGS**

2 pages

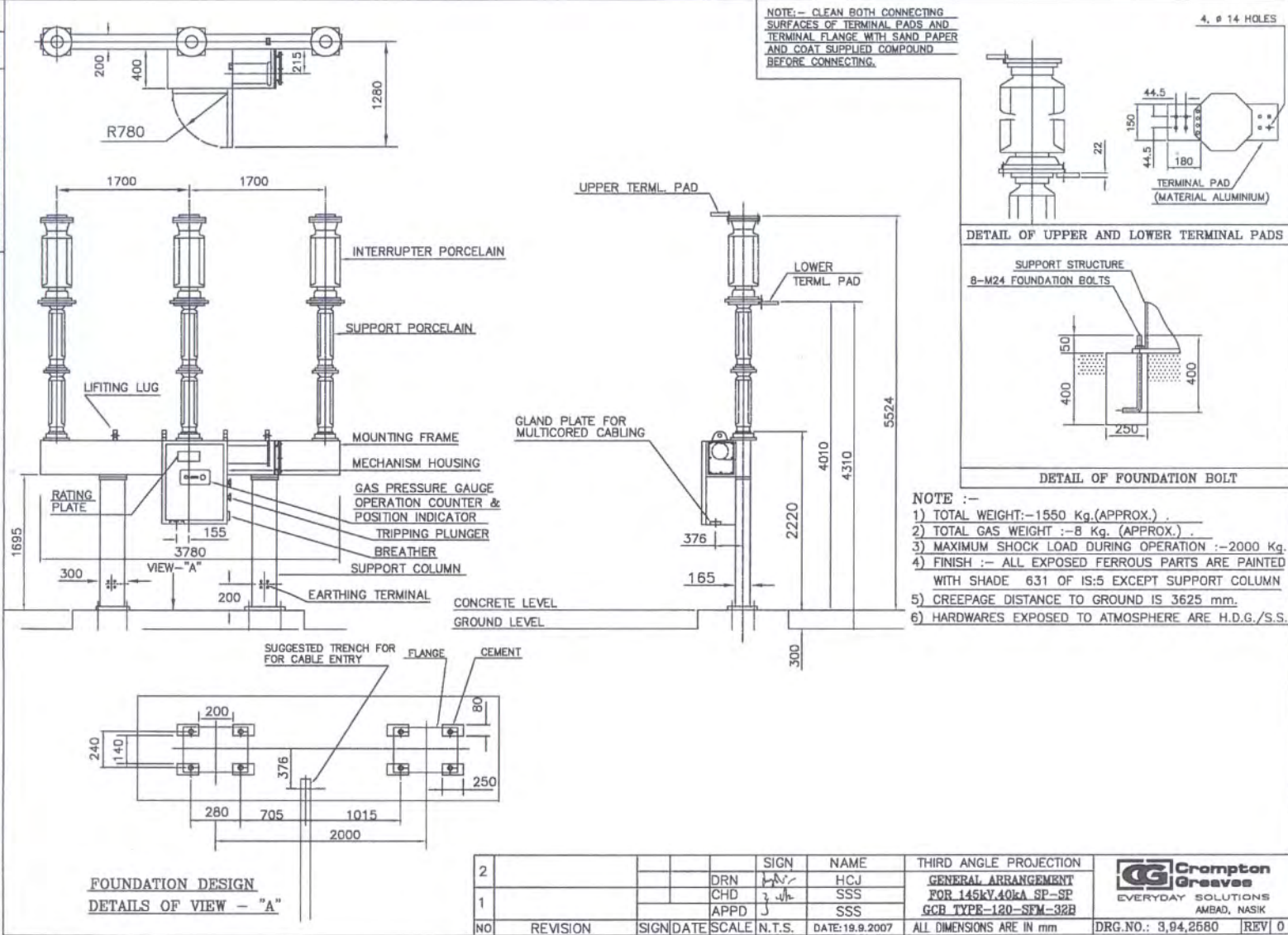
| Drawing no. | Description   | Date       | Rev. |
|-------------|---|------------|------|
| 3942580     | General arrangement for 145 kV, 40 kA SP-SP GCB type-120-SFM-32B  | 19-9-2007  | 0    |
| 4942584     | Rating plate details for 145 kV, 40 kA SP-SP GCB type-120-SFM-32B | 20-09-2007 | 0    |

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IF IN DOUBT ASK

DRG.NO.: 3,94,2580

REV 0





DRG.NO.:4,94,2584 REV 0

IF IN DOUBT ASK

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**Crompton Greaves**

EVERYDAY SOLUTIONS

# GAS CIRCUIT BREAKER

|  |  |                   |
|--|--|-------------------|
| TYPE 120-SFM-32B   | SR. NO. :                                    | YEAR 2007         |
| RATED VOLTAGE 145 kV                                     | RATED FREQUENCY                              | 50 Hz             |
| RATED NORMAL CURRENT 3150 A                              | RATED MAKING CAPACITY                        | 100 kAp           |
| RATED SHORT CIRCUIT BREAKING CURRENT 40 kA               | RATED SHORT TIME CURRENT 40 kA FOR 3 SECONDS |                   |
| RATED LIGHTNING IMPULSE WITHSTAND VOLTAGE 650 kVp        | FIRST POLE TO CLEAR FACTOR 1.5               |                   |
|  | RAT.OPR.SEQ. 0-0.3SEC-CO-3MIN-CO             |                   |
| RATED SF6 GAS PRESSURE 7 kg/cm <sup>2</sup> -g(AT 20°C)  | GAS WT 8 Kg                                  | TOTAL WT. 1550 Kg |
| RATED COIL VOLTAGE - CLOSING 110 V DC ,TRIPPING 110 V DC |  |                   |
| MOTOR VOLTAGE 230 V AC                                   | AUX CIRCUIT VOLTAGE 1ø,230V AC,50 Hz         |                   |

MATERIAL: STAINLESS STEEL 0.5THK

|    |          |           |       |        |               |                          |                         |
|----|----------|-----------|-------|--------|---------------|--------------------------|-------------------------|
| 2  |          |           |       | SIGN.  | NAME          | THIRD ANGLE PROJECTION   |                         |
|    |          |           | DRN   | HCJ    |               | RATING PLATE DETAILS     |                         |
| 1  |          |           | CHD   | SSS    |               | FOR 145kV,40KA SP-SP     |                         |
|    |          |           | APPD  | SSS    |               | GCB TYPE-120-SFM-32B     |                         |
| NO | REVISION | SIGNATURE | SCALE | N.T.S. | DATE 20.09.07 | ALL DIMENSIONS ARE IN mm | DRG.NO.:4,94,2584 REV 0 |



EVERYDAY SOLUTIONS  
AMBAD, NASHIK

KEMA