Bereich Hochspannungsprüftechnik

Institut für Elektroenergiesysteme und Hochspannungstechnik

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Test Report Nº 2012-06/2

Design Test of 69kV Cold Shrink Silicone Rubber Terminations QT-III

Client: 3M Electrical Markets Division
6801 River Place Blvd
Austin, TX 78726-9000
USA

Reporter: Dr.-Ing. R. Badent
Dr.-Ing. B. Hoferer

1 Purpose of Test

Two 69kV cold shrink silicone rubber terminations QT-III, manufacturer 3M, were subjected to a design test according IEEE Std 48-2009, table 5 class 1A.

2 Miscellaneous Data

Test object:– Two 69kV cold shrink silicone rubber terminations QT-III 7673-S-8-JCN, drawing no. 78-8141-4839-7-A, dated April 2012, Figure 2.1-2.10

Cable: The test objects were mounted on a single wire XLPE-cable with copper conductor 1x3000 kcmil, 69kV, Figure 2.11

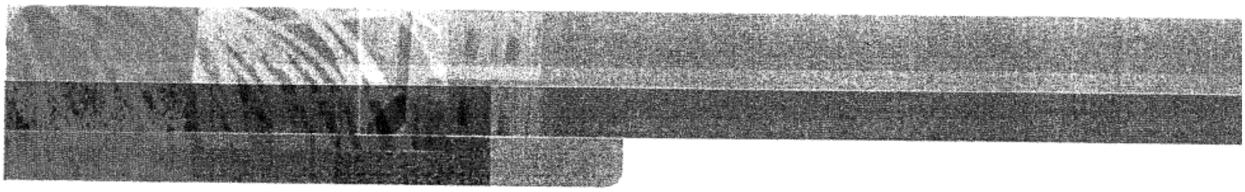
Manufacturer: 3M Electrical Markets Division
6801 River Place Blvd
Austin, TX 78726-9000
USA

Place of test: *Institute of Electric Energy Systems and High-Voltage Technology* – University of Karlsruhe
Kaiserstraße 12 – 76128 Karlsruhe

Testing dates:	Delivery:	16.01.2012
	Mounting:	16.01. – 19.01.2012
	Test date:	20.01. – 29.03.2012
Atmospheric conditions:	Temperature:	18°C - 26°C
	Air pressure:	980 - 1020 mbar
	rel. humidity:	30% - 70%

Representatives *Client´s representatives*
Dipl.-Ing. J. Weichold, 3M Deutschland GmbH

Representatives responsible for the tests
Dr.-Ing. R. Badent
Dr.-Ing. B. Hoferer
Mr. O. Müller



3M™ Cold Shrink Silicone Rubber Termination QT-III 7673-S-8-JCN

For Jacketed Concentric Neutral (JCN) Cable

Instructions

IEEE Std. No. 48-1996
Class 1 Termination
69 kV Class, 350 kV BIL
IEC 60840
72,5 kV

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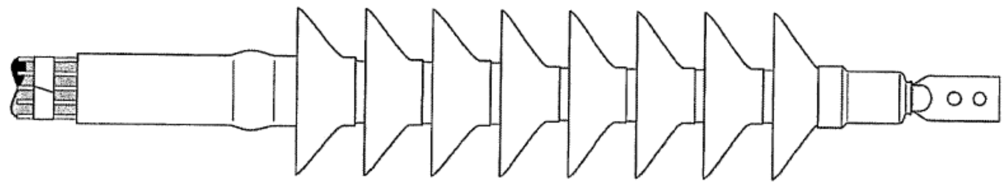
⚠CAUTION

Working around energized systems may cause serious injury or death. Installation should be performed by personnel familiar with good safety practice in handling electrical equipment. De-energize and ground all electrical systems before installing product.



April 2012
78-8141-4839-7-A

3M

Figure 2.1: Cold Shrink Silicone Rubber Termination QT-III

Kit Contents

1 Silicone Rubber Lug Seal Insulator Assembly
1 Hi-K Stress Control Assembly
1 Silicone Rubber Ground Seal Assembly
1 Silicone Rubber Skirted Insulator Assembly
1 Pre-formed Ground Braid Assembly
3 Constant Force Springs
1 Roll Scotch® Electrical Shielding Tape 24
4 Tubes 3M™ Red Compound P55/R (Non-Silicone Grease)
1 Roll 3M Scotch-Seal™ Mastic 2229, 1" (25 mm) wide
1 Roll Scotch® Self-fusing Silicone Rubber Tape 70
1 Roll Scotch® Vinyl Electrical Tape Super 88, 3/4" × 66'
1 Roll Scotch® Rubber Mastic Tape 2228, 2" x 10'
2 3M™ Cable Cleaning Pads CC-3
1 3M™ EMI Copper Foil Shielding Tape Strip 1181, 15" long
3 Instruction Sheets

Note: Do not use knives to open plastic bags.

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Kit Selection Chart

Note: Final determining factor is cable insulation diameter.

Kit Number	Primary Insulation O.D. Range	Jacket O.D. Range	Conductor Size Range AWG (mm^2)
7673-S-8	2.01"–3.45" (51,1–87,6 mm)	2.50"–4.25" (63,5–108,0 mm)	350–3000 (175–1500)

Table 1

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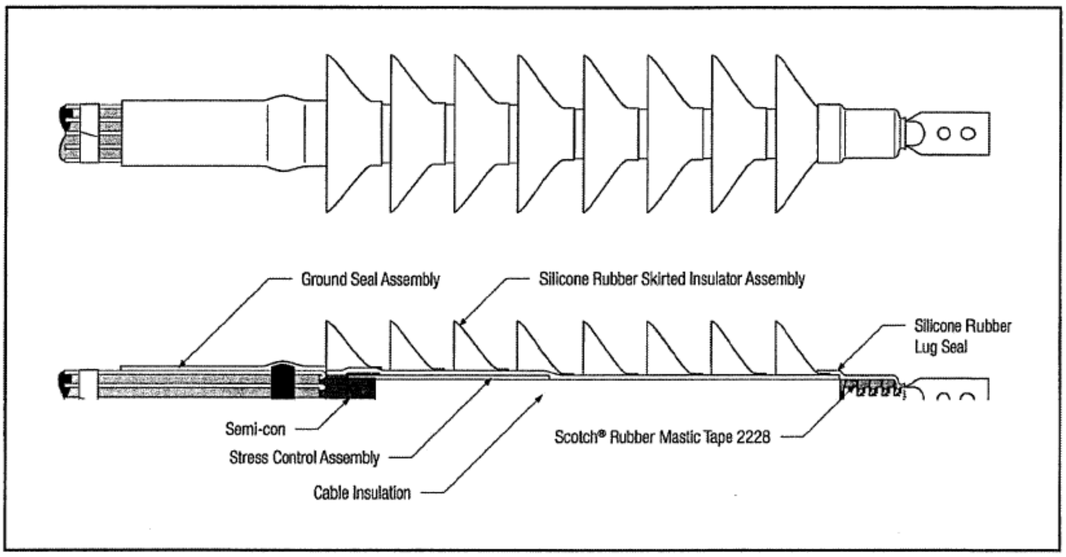
Figure 2.2: Cold Shrink Silicone Rubber Termination QT-III

Correct Installation of Termination



Note: Check to insure that the lug seal tube will fit over the lug. If the lug will not fit through the tube core, contact 3M for an alternative installation procedure.

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Figure 2.3: Cold Shrink Silicone Rubber Termination QT-III

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1.0 Prepare Cable

1.1 Check to be sure the cable fits within the kit ranges as shown in Table 1.

1.2 Prepare cable using dimensions shown in Figure 1. **Be sure to allow for depth of terminal lug plus 0.5" (13 mm) plus crimp growth.**

Note: Provide additional exposed conductor to allow for growth of aluminum lugs or connectors during crimping.

Conductor Size	350	400–650	750–1000	1100–3000
Growth Allowance	0.25" (6 mm)	0.5" (13 mm)	0.75" (19 mm)	Field Determined

Table 2

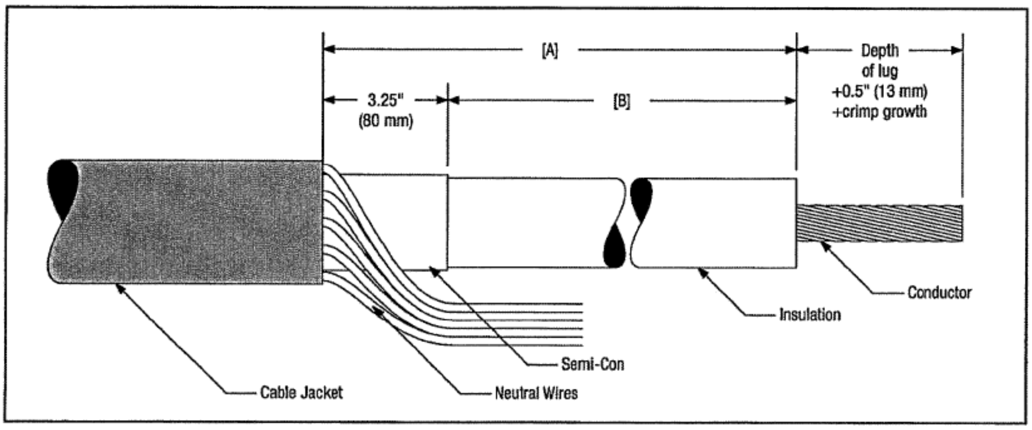

Figure 1

Typical Conductor Size Kcmil (mm^2)	Insulation OD after Preparation Inches (mm)	[A] Inches (mm)	[B] Inches (mm)
350-1250 (175-625)	2.01 – 2.73 (51.1 – 69.3)	29.25 (745)	26 (660)
1500-3000 (750-1500)	2.74 – 3.45 (69.4 – 87.6)	28.25 (720)	25 (635)

Table 3

1.3 Select the roll of 1" (25 mm) wide 3M™ Scotch-Seal™ Mastic 2229 from the kit. Cut a length of the mastic long enough to wrap around the cable jacket. Remove the release liner from the mastic and, using a light tension, apply a single wrap of mastic around the cable jacket 1" (25 mm) from the cut edge. (*Figure 2*)

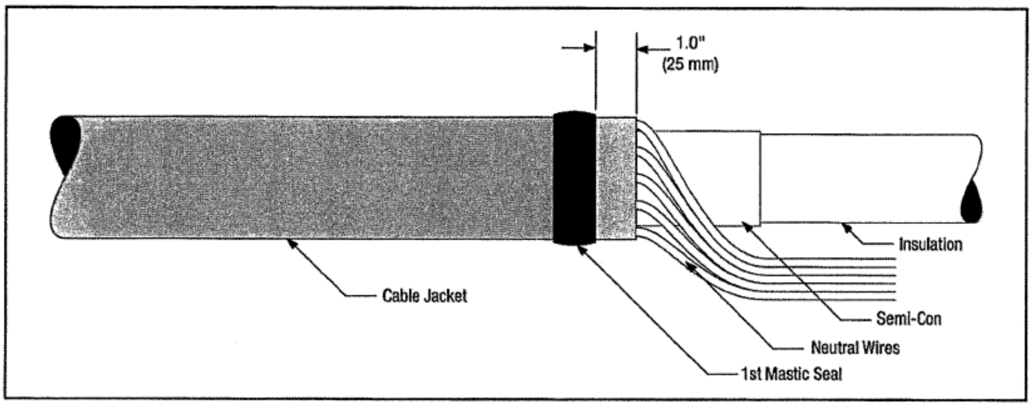

Figure 2

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Figure 2.4: Cold Shrink Silicone Rubber Termination QT-III

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1.4 Bend neutral wires back over applied sealing mastic and secure to cable jacket with vinyl tape 6" (150 mm) below jacket cutback. (*Figure 3*)

1.5 Select the roll of 1" (25 mm) wide 3M™ Scotch-Seal™ Mastic 2229 from the kit and cut a length of the mastic. Remove the release liner and, using a light tension, apply a single wrap of mastic around the cable jacket over the neutral wires and previously applied mastic. (*Figure 3*)

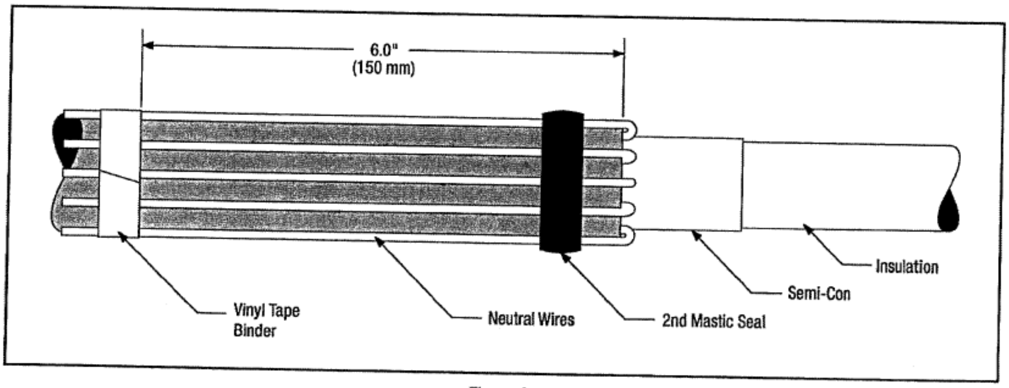

Figure 3

1.6 Compress mastic into neutral wires by over-wrapping seal strips with two half-lapped layers of highly-tensioned Scotch® Vinyl Electrical Tape Super 88 as shown. Do not cover cable semi-con. Cover all exposed mastic, overlapping 0.25" (4 mm) onto the exposed cable semi-con. (*Figure 4*)

Note: Take care to leave 3.0" (76 mm) of exposed semi-con. This will be a marker tape location later.

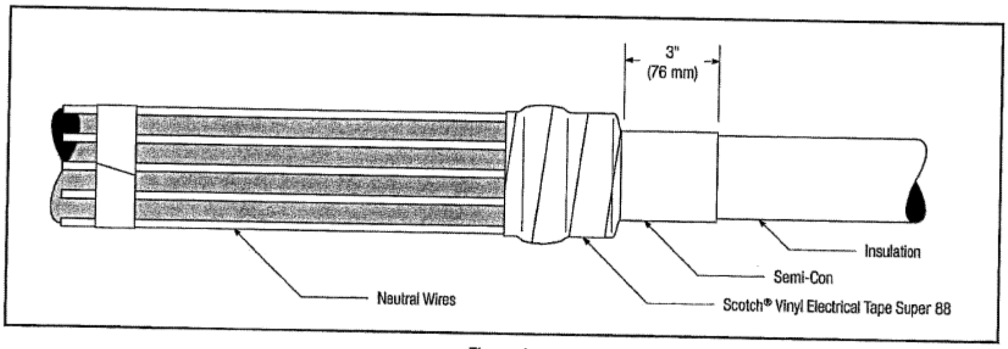

Figure 4

2.0 Clean Cable Insulation Using Standard Practice

2.1 Use only aluminum oxide abrasive (300 grit or higher) to finish and polish insulation surface.

2.2 Use abrasive only on cable insulation. **Do not use on semi-con.**

2.3 When using abrasive, do not reduce the cable insulation diameter below that allowed by the kit.

2.4 Wipe the cable insulation clean with an approved solvent. **Do not allow the solvent to touch semi-con insulation shield.**

Note: Remove any remaining solvent with 3M™ CC-DRY Cable Cleaning Pads (not supplied with kit) or lint-free cloth.

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Figure 2.5: Cold Shrink Silicone Rubber Termination QT-III

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3.0 Install Termination

3.1 Slide the ground seal assembly onto the cable jacket, loose core end first. (*Figure 5*)

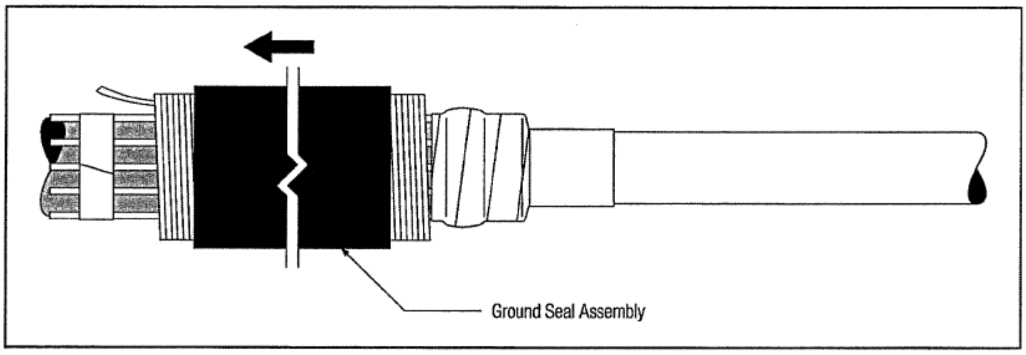

Figure 5

3.2 Place a marker tape on the cable semi-con located 1.75" (45 mm) from the end of the semi-con.(*Figure 6*)

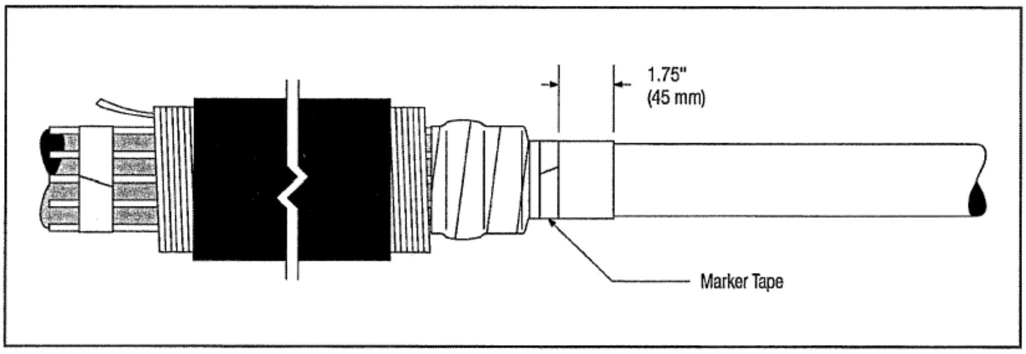

Figure 6

3.3 Apply 1 tube 3M™ Red Compound P55/R starting at marker tape and continuing onto the cable insulation for approximately 8" (200 mm). (*Figure 7*)

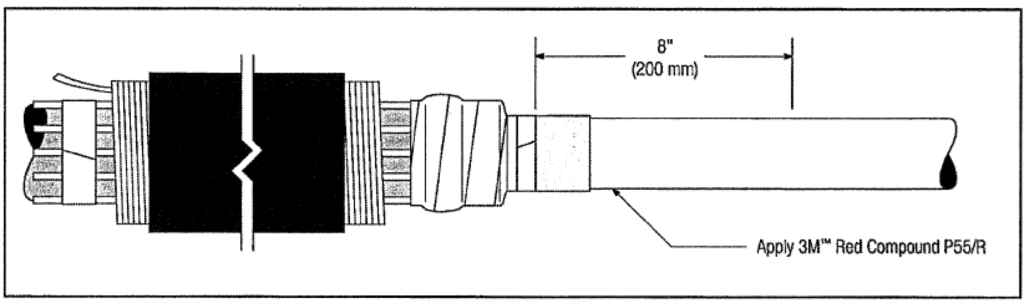

Figure 7

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Figure 2.6: Cold Shrink Silicone Rubber Termination QT-III

3.4 Select the Stress Control Assembly (medium length tubular assembly on white core) from the kit. Slide the Stress Control Assembly over the cable with the loose core end toward the cable end. Align the Stress Control Assembly Tube (not the core) with the marker tape, and remove the core by pulling the loose end while unwinding counter-clockwise. (*Figure 8*)

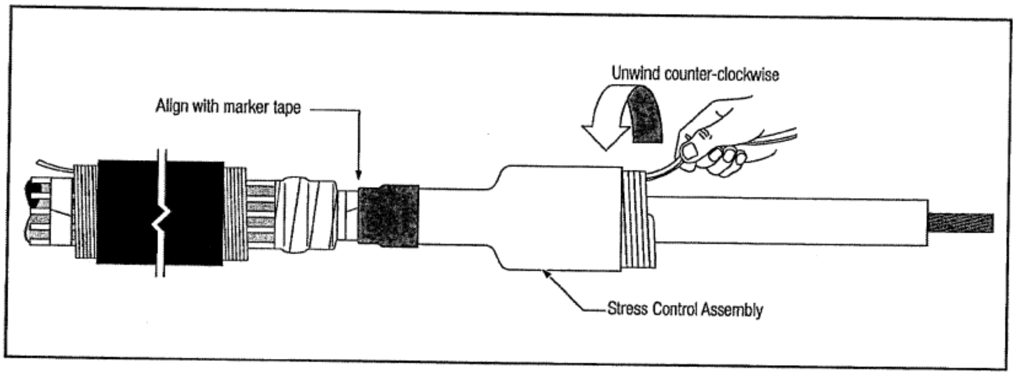

Figure 8

3.5 Apply 2 tubes 3M™ Red Compound P55/R to the exposed insulation and stress control adapter. Fill the top edge of the stress control tube with the 3M Red Compound P55/R. (*Figure 9*)

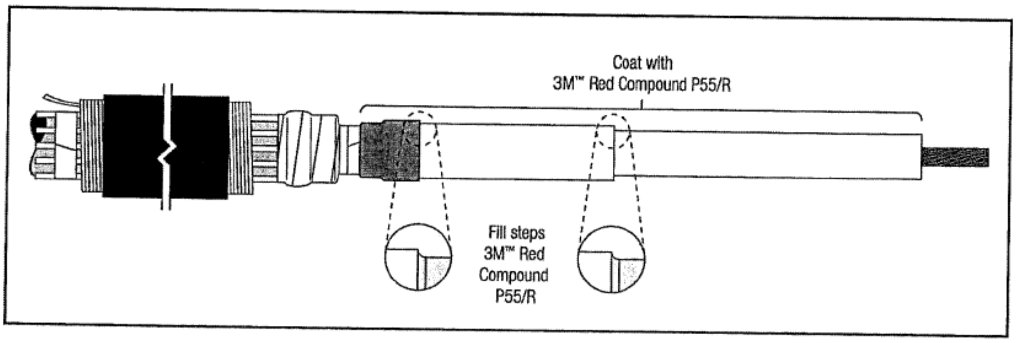

Figure 9

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Figure 2.7: Cold Shrink Silicone Rubber Termination QT-III

3.6 Slide the Silicone Rubber Skirted Insulator Assembly onto the cable. Align the assembly tube (not the core) with the sealing mastic/wire cover tape located 3.0" (76 mm) from the end of the cable semi-con, and remove the core by pulling the loose end while unwinding counter-clockwise. (*Figure 10*)

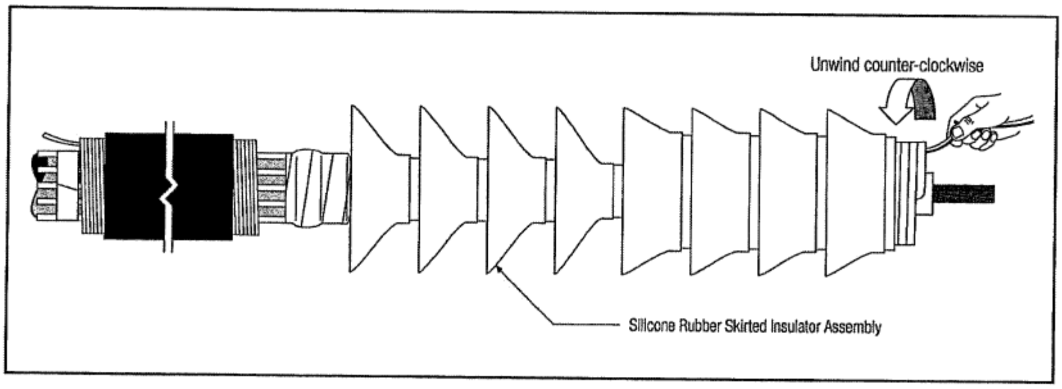

Figure 10

4.0 Install Lug or Connector

4.1 Position lug/connector and crimp according to manufacturer's directions. Remove excess oxide inhibitor and sharp crimp flashing following crimping.

4.2 Wrap Scotch® Rubber Mastic Tape 2228 half-lapped over the lug barrel and insulation/lug gap, building to a diameter equal to the cable insulation. Cover 2" (50 mm) of the lug barrel. (*Figure 11*)

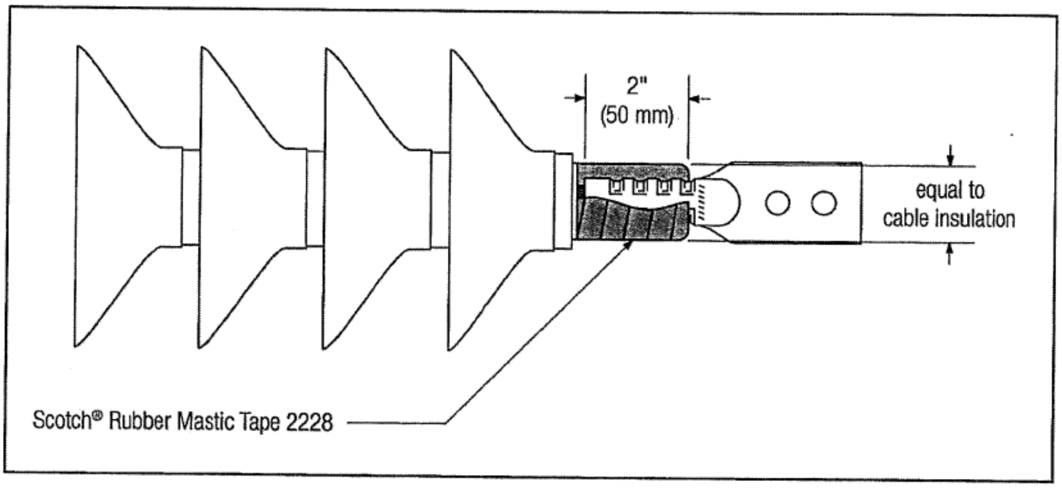

Figure 11

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Figure 2.8: Cold Shrink Silicone Rubber Termination QT-III

5.0 Install Sealing Tubes

5.1 Slide the parked ground seal assembly onto the termination. Start to shrink underneath the first skirt. Remove the core by pulling the loose end while unwinding counter-clockwise. (*Figure 12*)

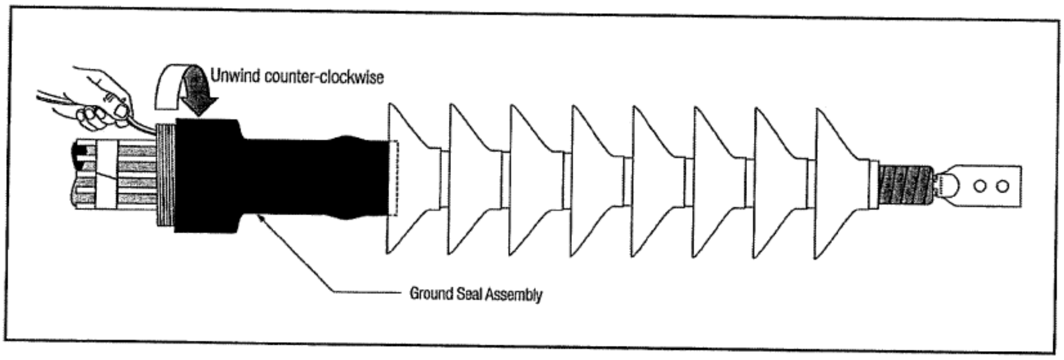

Figure 12

5.2 Slide the lug sealing tube onto the lug/termination, as shown. Start to shrink the tube near the top of the last skirt and onto the lug barrel. If the tube overlaps the lug pad or is not tight to the lug barrel, carefully trim the tube just past (1/4" or 6 mm) the Scotch® Rubber Mastic Tape 2228 sealing tape. A roll of Scotch® Self-fusing Silicone Rubber Tape 70 is provided to cover the edge of the trimmed tube, apply with moderate tension, stretching only enough to conform to the lug barrel and tube.

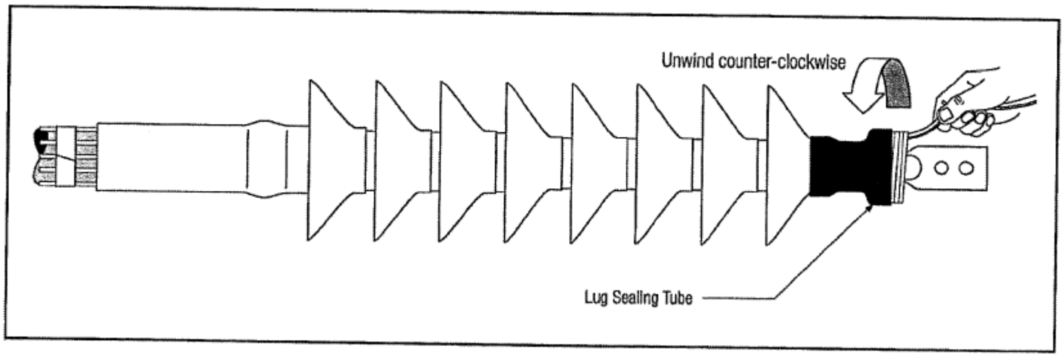

Figure 13

5.3 Connect the completed termination to equipment/system following standard practice.

5.4 Connect the neutral wires to the ground system following standard practice.

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Figure 2.9: Cold Shrink Silicone Rubber Termination QT-III

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Figure 2.10: Cold Shrink Silicone Rubber Termination QT-III

Identification of Test Cable

Rated voltage U:	69 kV		
Construction:	☒ 1-core		☐ 3-core
Conductors:	☐ Al		☒ Cu
	☒ Stranded		☐ Solid
	Cross-section:	3000 kcmil	
Insulation:	☒ XLPE	☐ PE	☐ EPR
Insulation screen:	☒ Bonded	☐ Strippable	☐ Graphite
Metallic screen:	☒ Wires	☐ Tape	☐ Extruded
	Cross-section:	42 x AWG14	
Armour:	☐ Wire		☐ Tape
Oversheath:	☐ PVC		☒ PE
	☐ Laminated	☐ Al	☐ Cu
	☒ Conductive Layer		

Diameters:	Conductor	49.8	mm
	Insulation	86.7	mm
	Insulation screen	90.3	mm
	Oversheath	104	mm

Cable marking: SOUTHWIRE HV SOLUTIONS 3000KCMIL CU 69KV
XLPE INSULATION 650 MILS JUN 2010

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Figure 2.11: 69kV XLPE-cable

Tests: Test volume, chronological order and requirements conform to IEEE Std. 48-2009 table 5, class 1A.

Pos. 1	Partial Discharge Test $\hat{u}/\sqrt{2}$ = 72 kV 10 s thereafter ; $\hat{u}/\sqrt{2}$ = 60 kV; PD ≤ 5pC
Pos.2	AC-voltage withstand test $\hat{u}/\sqrt{2}$ = 175 kV, t = 1 min
Pos.3	AC-voltage withstand test, wet $\hat{u}/\sqrt{2}$ = 145 kV, t = 10 s
Pos.4	DC-voltage withstand test U = -240 kV, t = 15 min
Pos.5	Lightning impulse voltage test at ambient temperature $\hat{u}$ = 350 kV, 10 impulses each polarity
Pos.6	Lightning impulse voltage test at elevated temperature T = 125°C - 135°C, at least 6h, $\hat{u}$ = 350 kV, 10 impulses each polarity
Pos. 7	Partial Discharge Test $\hat{u}/\sqrt{2}$ = 72 kV 10 s thereafter ; $\hat{u}/\sqrt{2}$ = 60 kV; PD ≤ 5pC
Pos. 8	Heating cycle voltage test Load cycle: 24 h 11h loading up to 125°C - 135 °C conductor temperature with at least 6h at 125°C - 135°C 13h cooling Test voltage: $\hat{u}/\sqrt{2}$ = 79,6 kV Number of cycles: 30
Pos. 9	Partial Discharge Test $\hat{u}/\sqrt{2}$ = 72 kV 10 s thereafter ; $\hat{u}/\sqrt{2}$ = 60 kV; PD ≤ 5pC
Pos.10	AC-voltage withstand test $\hat{u}/\sqrt{2}$ = 100 kV, t = 6 h
Pos.11	Lightning impulse voltage test at ambient temperature $\hat{u}$ = 350 kV, 10 impulses each polarity
Pos. 12	Partial Discharge Test $\hat{u}/\sqrt{2}$ = 72 kV 10 s thereafter ; $\hat{u}/\sqrt{2}$ = 60 kV; PD ≤ 5pC

Pos. 13 Leak test
Load cycle: 24 h
11h loading up to 125°C - 135 °C conductor temperature with at least 6h at 125°C - 135°C
13h cooling
Test voltage: No voltage
Number of cycles: 10

Pos.14 AC-voltage withstand test
$\hat{u} / \sqrt{2}$ = 79,6 kV, t = 1 h

3 Mounting

The cable preparation, assembling and mounting of the cable system was accomplished by technicians of 3M Deutschland GmbH.

4 Test Setup

4.1 AC Voltage Withstand Test

The test voltage was generated by a 200-kVA transformer. The voltage was measured with a capacitive divider (C_H = 1000 pF; ratio = 1.000:1) and a peak voltmeter reading $\hat{u}\,/\sqrt{2}$. The primary side of the AC-transformer was connected to a motor-generator set consisting of a variable frequency DC motor and a synchronous generator with variable excitation. The generator delivers voltages from 0 ... 500 V with currents up to 1000 A.

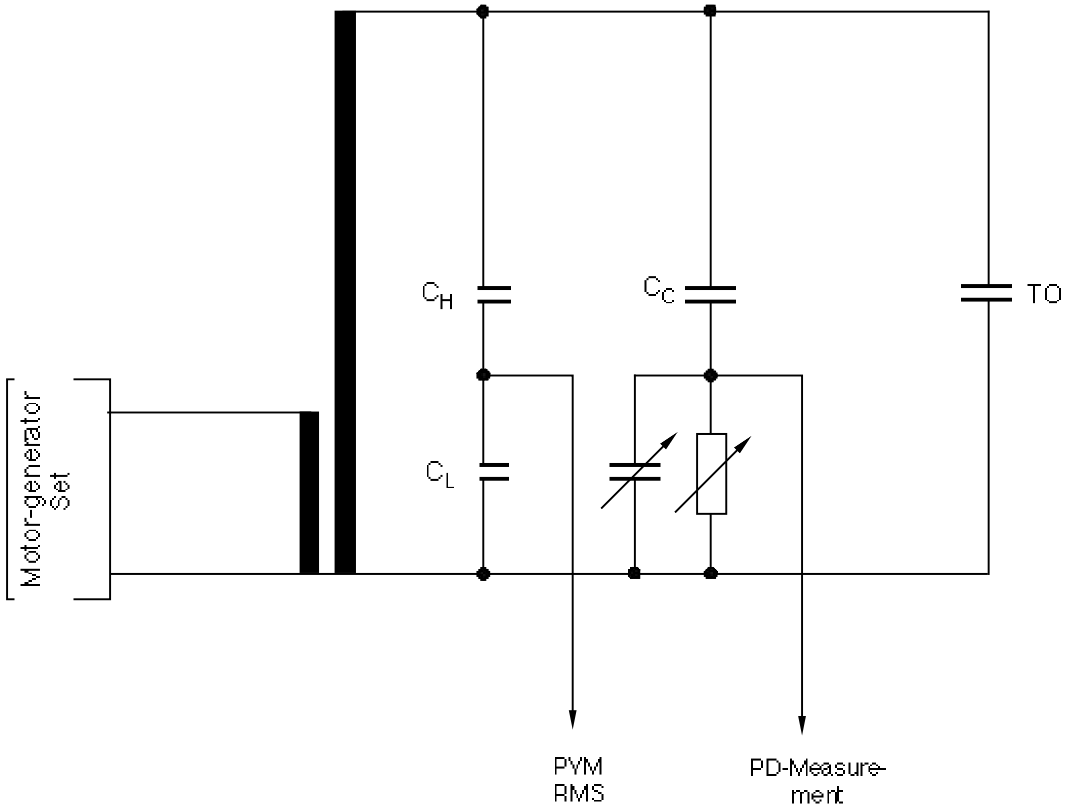

Figure 4.1: Test-setup for AC-voltage withstand test and PD measurement

AC-transformer:	400V/200kV; S_N = 200 kVA
Voltage measurement:	C_H = 1000 pF; ratio 1.000:1 uncertainty 3 %
PD measurement:	C_C = 1000 pF; U_N = 800 kV_{rms} uncertainty 5 %

4.2 Partial-Discharge Test

The PD-measurement was performed with an analog bridge according to *Kreuger*, Figure 4.2. External PDs producing common mode signals at the detector are rejected by the differential amplifier. Internal PDs represent differential mode signals and are amplified. The background noise level at 60 kV_{rms} was 1,0 pC.

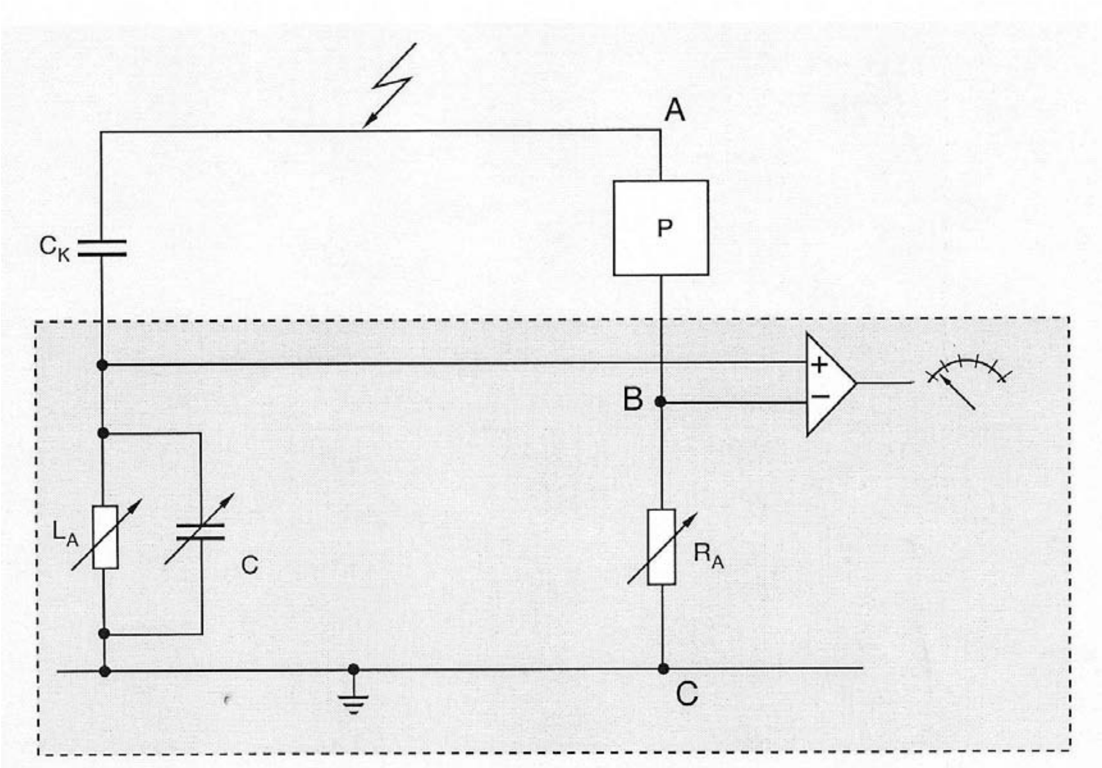

Figure 4.2: Scheme of PD test circuit
TO : Test object
C_C: Coupling Capacitor

For balancing the bridge a calibrating impulse with q_A = 100 pC is applied between the terminals A (high-voltage) and C (ground) and the amplifier output is minimized. A pulse between the terminals A and C corresponds to an external PD. For the calibration a PD pulse, q_A = 5 pC, is applied between A and B. Subsequently, the amplifier output of the PD measuring unit is adapted to the applied pulse.

4.3 AC Voltage Withstand Test, wet

The test was carried out according IEEE Std. 4-1995. The terminations were sprayed with water of prescribed resistivity and temperature (ρ = 178±27 Ωm, T = 20°C ± 15 °C) falling on it as droplets, whereby the vertical and horizontal components of the spray intensity had been approximately equal.

The intensities were measured with divided collecting vessel having openings of 225 cm^2 on horizontal and on vertical alternatively, the vertical opening facing the spray.

During the measuring period (60s) the collecting vessel was slowly moved over the whole measuring zone.

For measuring the water conductivity a sample was taken after the nozzles.
Before starting the test, the test object was prewetted for at least 30 minutes.

4.4 DC-Voltage Withstand Test

The DC-voltage was generated by a high-voltage transformer and a half-wave rectifier. It was measured via a resistive divider, measurement uncertainty less than 3%.

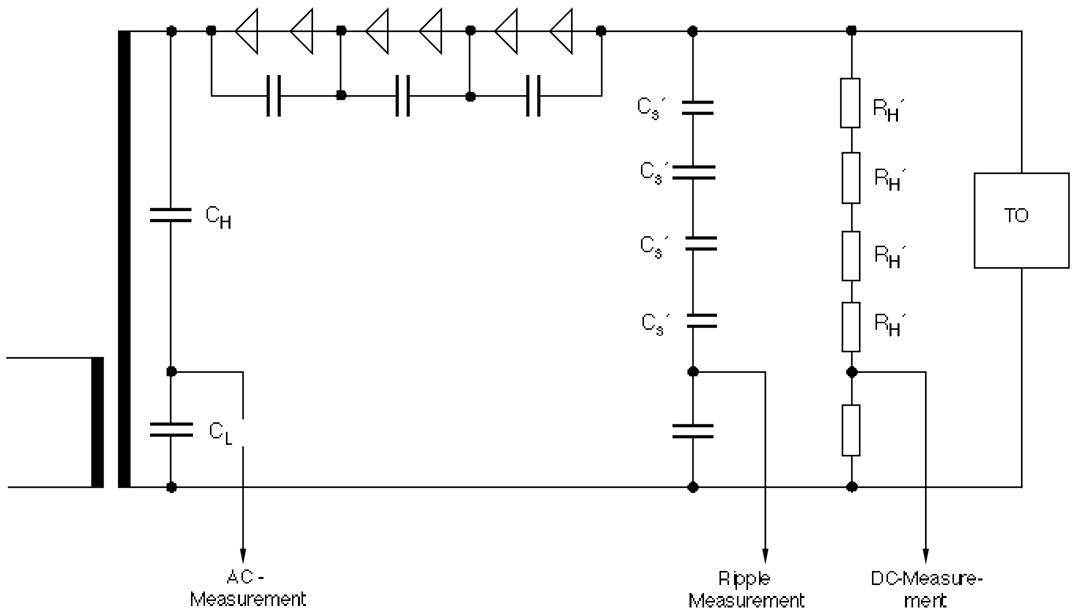

Figure 4.4: DC-voltage test setup.
C_S = 10 nF; R_H = 5,775 GΩ
Ratio of ripple measurement: 1600:1
Ratio of DC-measurement: 10.000:1
C_H = 351 pF; ratio: 10.000:1

4.5 Cyclic Current Loading

According to IEEE Std. 48-2009 the test objects must be heated by a current which provides the conductor temperature midway between the terminations within 5°C of the cable's maximum rated emergency operating temperature, that means 125°C – 135°C for a period of 6h. The required heating current I was determined via a dummy cable. A 5 m sample of the cable used for the test, was provided with a 1 mm diameter drilling hole down to the center conductor. The temperature was measured with a thermo couple NiCr-Ni. Furthermore two additional thermocouples NiCr-Ni were placed on the outer sheath of the cable, one on the dummy and one on the test loop. Figure 4.5 illustrates the temperature rise at the conductor with a maximum heating current of I = 3300 A, 11h. Current inception was accomplished by a transformer (U_1 = 400 V; U_2 = 20 V) which used the cable as secondary winding. The current was regulated by a control unit and measured by a current transformer, 6000/5, and a digital multimeter. The measurement uncertainty was 1%.

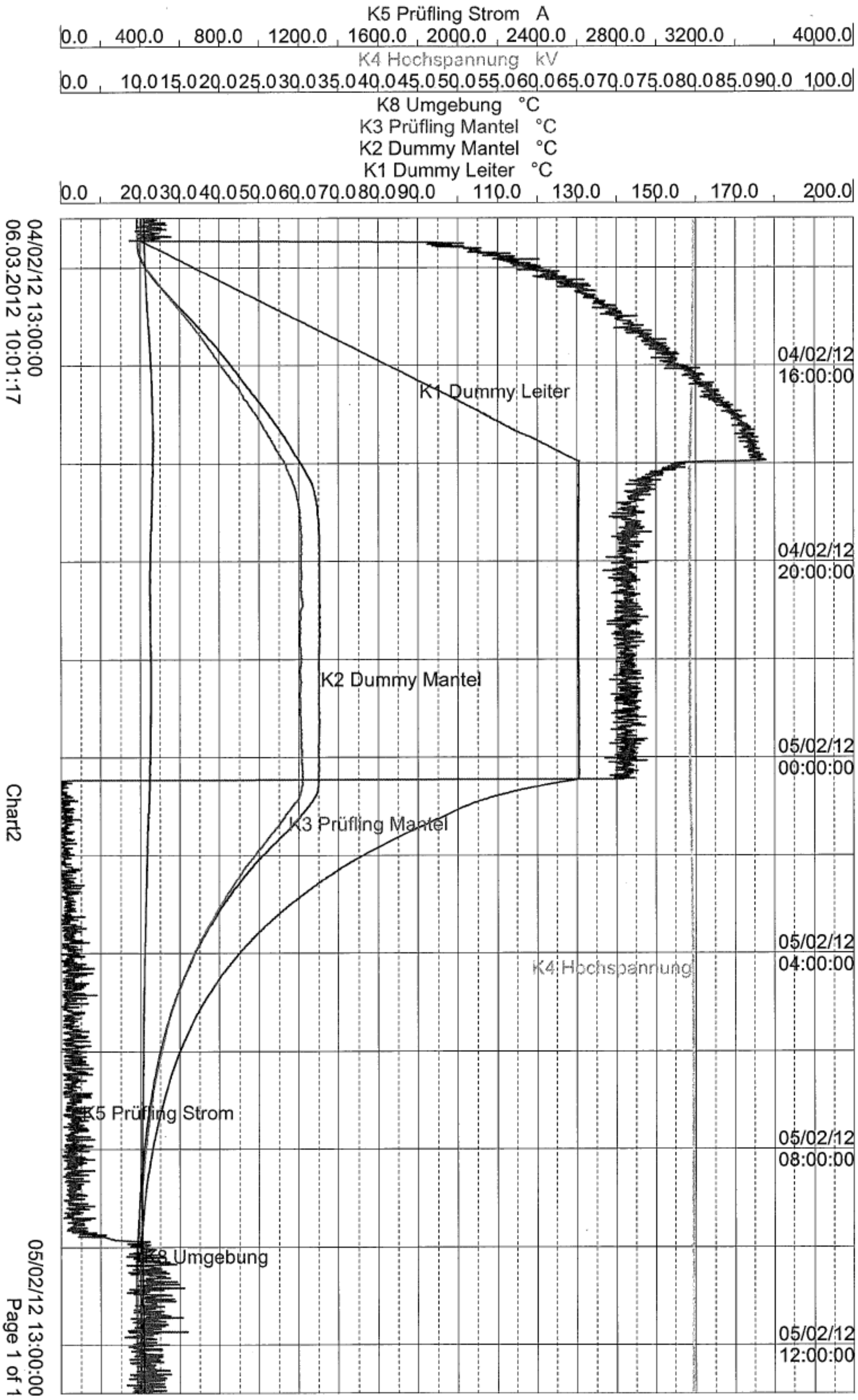

Figure 4.5: Heat cycle I = 2800..3300 A regulated, 11h; I = 0A, 13 h

4.6 Lightning Impulse Voltage Test

For lightning impulse testing 3 stages of a Marx generator (Haefely) with a maximum cumulative charging voltage of U = 600 kV and a maximum impulse energy of E_{max} = 30 kW_s were used. The crest value of the impulse voltage was measured by a damped capacitive divider and a subsequent impulse peak voltmeter (Haefely). The front time and the time to half value were evaluated from the oscillographs.

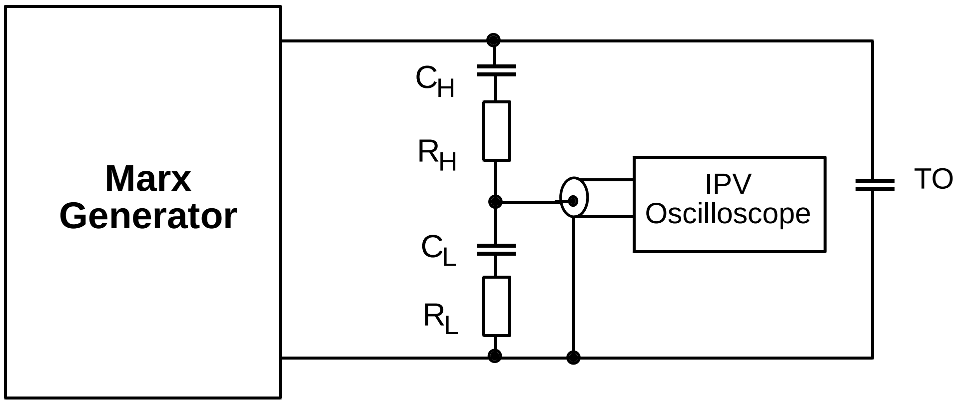

Figure 4.6.1: Scheme of lightning impulse voltage test circuit
C_H: 1200 pF ; R_H = 70 Ω ; ratio: 3215:1
IPV: impulse-peak-voltmeter (Haefely) – measurement uncertainty 3%
Oscilloscope: Tektronix TDS 3044B – measurement uncertainty 2%

The waveform parameters were determined at reduced charging voltage. Figure 4.6.2 shows the front time, Figure 4.6.3 the time to half value for positive polarity each. Figure 4.6.4 shows the front time, Figure 4.6.5 the time to half value for negative polarity each.

Positive impulse: : T_1 = 1,80 µs T_2 = 48,2 µs

Negative impulse: T_1 = 1,80 µs T_2 = 48,0 µs

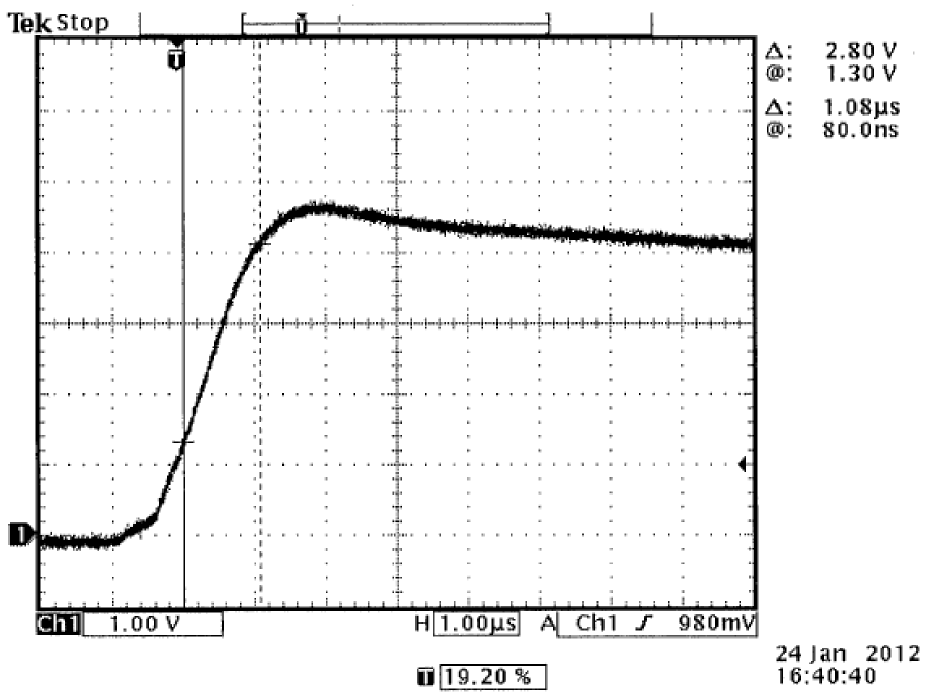

Figure 4.6.2: Front time, positive polarity
horiz.: 1 µs/Div; vert.: 1 V/Div; probe 10:1; ratio 3215:1

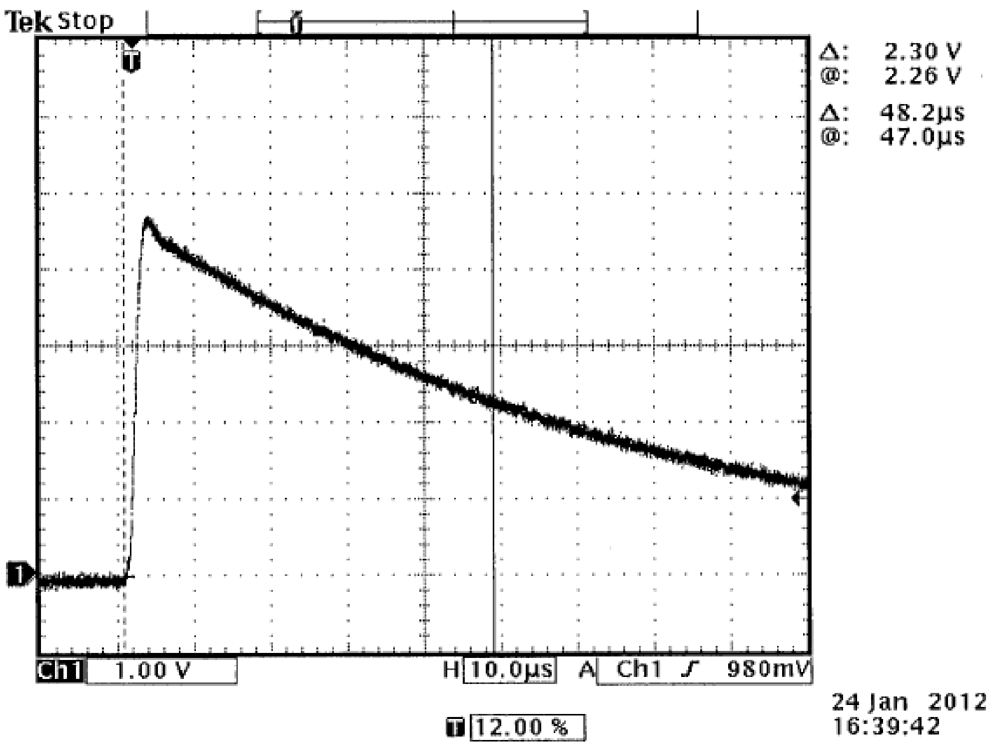

Figure 4.6.3: Time to half value, positive polarity
horiz.: 10 µs/Div; vert.: 1 V/Div; probe 10:1; ratio 3215:1

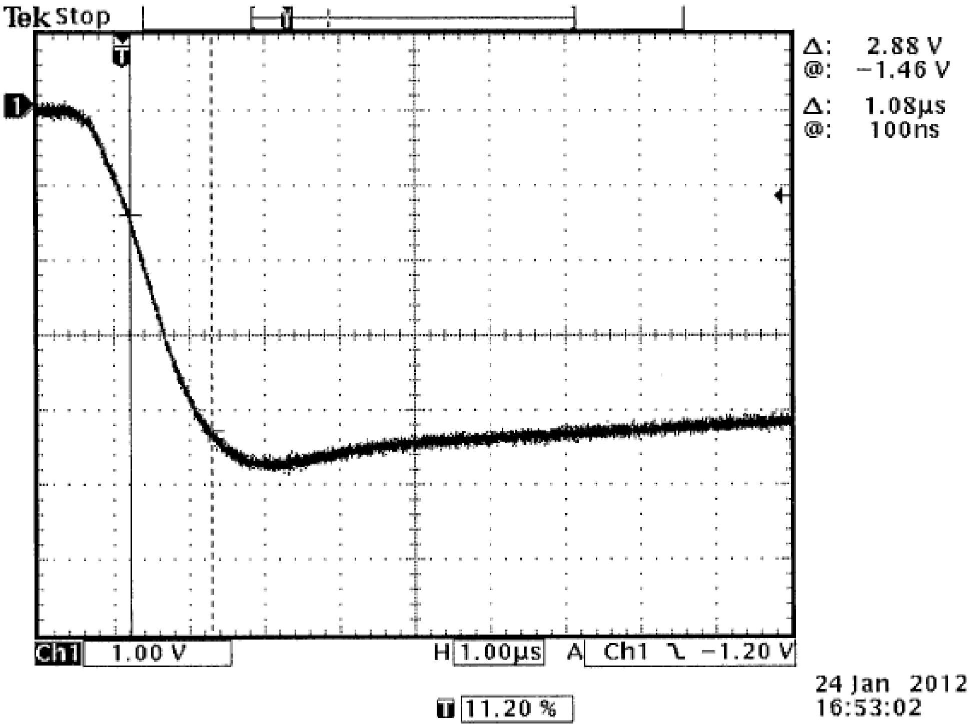

Figure 4.6.4: Front time, negative polarity
horiz.: 1 µs/Div; vert.: 1 V/Div; probe 10:1; ratio 3215:1

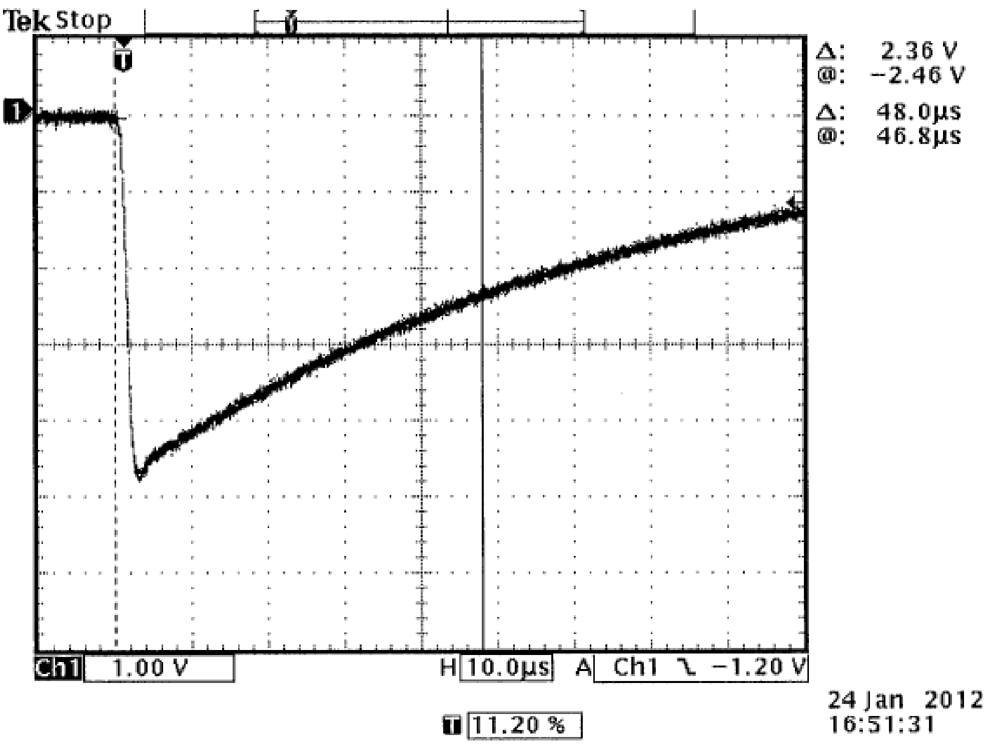

Figure 4.6.5: Time to half value, negative polarity
horiz.: 10 µs/Div; vert.: 1 V/Div; probe 10:1; ratio 3215:1

4.7 Leak Test

The test objects were placed in a tank and filled with water. The water surface was 30 mm above each part of the test object. The test objects were placed in the tank in opposite direction at ambient temperature, so that the test objects including the sealing was completely in water. The conductivity of the water at 20°C was 63 mS/m.

5 Results

5.1 PD-Test

The test was carried out as described in 4.

Test date:	20.01.2012
Calibration pulse:	q_{cal} = 5 pC
Background noise level:	0,8 pC
Test voltage:	$\hat{u} / \sqrt{2}$ = 72 kV; t = 10 s, thereafter
	$\hat{u} / \sqrt{2}$ = 60 kV; with pd reading
PD:	< 5 pC

The test was passed successfully

5.2 AC Voltage Withstand Test

The test was carried out as described in 4.

Test date:	20.01.2012
Test voltage:	$\hat{u} / \sqrt{2}$ = 175 kV; t = 1 min

Neither breakdown nor flashover occurred.

The test was passed successfully.

5.3 AC Voltage Withstand Test, wet

This test was carried out as described in 4.

Test date:	22.01.2012
Amount of water:	vertical: 5,2 mm/min horizontal: 5,2 mm/min
Conductivity:	σ = 173 Ωm
Pre-wetting time:	30 min
Test voltage:	$\hat{u} / \sqrt{2}$ = 145 kV , t = 10 s

With each test object neither flashover nor breakdown occurred at the test objects during the AC voltage withstand test.

The test was passed successfully.

5.4 Dry DC Voltage Withstand Test

The test was carried out as described in 4.

Test date:	24.01.2012
Ripple:	δ = 1,10%
Voltage:	U = -240 kV, 15 min

Neither breakdown nor flashover of the test object occured.

The test was passed successfully.

5.5 Lightning Impulse Voltage Withstand Test at ambient Temperature

This test was carried out as described in 4.

Test date:	24.01.2012
Test voltage:	û = 350 kV
Impulse:	1-5µs / 40-60 µs
Number of tests:	10 positive polarity, 10 negative polarity

Neither flashover nor breakdown occurred at the test objects during all lightning impulse voltage tests.

The test was passed successfully

5.6 Lightning Impulse Voltage Withstand Test at elevated Temperature

This test was carried out as described in 4.

Test date:	26.01.2012
Test voltage:	û = 350 kV
Heating current:	I = 2800..3300 A regulated, 11h
Temperature:	130°C
Impulse:	1-5µs / 40-60 µs
Number of tests:	10 positive polarity, 10 negative polarity

Neither flashover nor breakdown occurred at the test objects during all lightning impulse voltage tests.

The test was passed successfully

5.7 PD-Test

The test was carried out as described in 4.

Test date:	27.01.2012
Calibration pulse:	q_{cal} = 5 pC
Background noise level:	0,8 pC
Test voltage:	$\hat{u}/\sqrt{2}$ = 72 kV; t = 10 s, thereafter
	$\hat{u}/\sqrt{2}$ = 60 kV; with pd reading
PD:	< 5 pC

The test was passed successfully

5.8 Heating cycle voltage test

The test was carried out as described in 4.

Test date:	02.02. – 03.03.2012
Test voltage:	$\hat{u}/\sqrt{2}$ = 79,6 kV
Heating current:	I = 2800..3300 A regulated, 11h
	I = 0A, 13 h
Cycle:	11 h heating; 13 h cooling
Number of cycles:	30

Neither breakdown nor flashover occurred.

The test was passed successfully.

5.9 PD-Test

The test was carried out as described in 4.

Test date:	09.03.2012
Calibration pulse:	q_{cal} = 5 pC
Background noise level:	0,8 pC
Test voltage:	$\hat{u}/\sqrt{2}$ = 72 kV; t = 10 s, thereafter
	$\hat{u}/\sqrt{2}$ = 60 kV; with pd reading
PD:	< 5 pC

The test was passed successfully

5.10 AC Voltage Withstand Test

The test was carried out as described in 4.

Test date:	10.03.2012
Test voltage:	$\hat{u} / \sqrt{2}$ = 100 kV; t = 6 h

Neither breakdown nor flashover occurred.

The test was passed successfully.

5.11 Lightning Impulse Voltage Withstand Test at ambient Temperature

This test was carried out as described in 4.

Test date:	10.03.2012
Test voltage:	û = 350 kV
Impulse:	1-5µs / 40-60 µs
Number of tests:	10 positive polarity, 10 negative polarity

Neither flashover nor breakdown occurred at the test objects during all lightning impulse voltage tests.

The test was passed successfully

5.12 PD-Test

The test was carried out as described in 4.

Test date:	10.03.2012
Calibration pulse:	q_{cal} = 5 pC
Background noise level:	0,8 pC
Test voltage:	$\hat{u} / \sqrt{2}$ = 72 kV; t = 10 s, thereafter
	$\hat{u} / \sqrt{2}$ = 60 kV; with pd reading
PD:	< 5 pC

The test was passed successfully

5.13 Leak test

This test was carried out as described in 4.

Test date:	16.03. – 26.03.2012
Conductivity:	63 mS/m
Heating current:	I = 2800..3300 A, regulated, 11 h
Cycle:	11 h heating; 13 h cooling
Number of cycles:	10
Height of water:	30 mm above the test object

The test was passed successfully.

5.14 AC Voltage Withstand Test

The test was carried out as described in 4.

Test date:	29.03.2012
Test voltage:	$\hat{u} / \sqrt{2}$ = 79,6 kV; t = 1 h

Neither breakdown nor flashover occurred.

The test was passed successfully.

6 Conclusion

The 69kV cold shrink silicone rubber termination, manufacturer 3M Electrical Markets Division, passed all tests described in Chapter 2 successfully.

The test object fulfilled the requirements according IEEE Std. 48-2009, table 5 class 1A.

Karlsruhe, 13.04.2012

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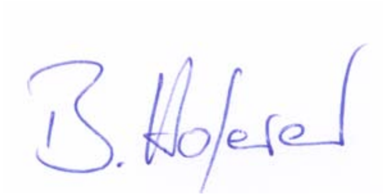

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