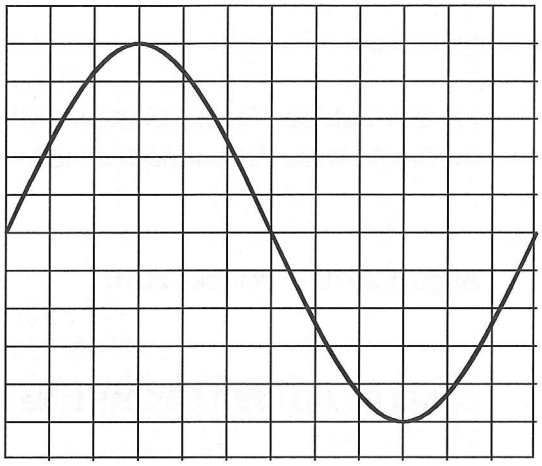


Test Report PPR-3203

Test objects:	Cold shrink Medium Voltage Termination 42kV CSTI/O-6142-ML-6-17 charcoal grey
Test performed:	CENELEC HD 629.1 S3:2015 table 6/7, page 17/18
Pages:	29 incl. Installation instruction EPP-2828-8/16

Tested by:	**Maximilian Biegel** Lab technician	Signature: M. Biegel	Date: 8/11-2016
Prepared by:	**Ernst Liegl** Application Engineer	Signature: E. Liegl	Date: 8/11-2016
Released by:	**Per Christian Olving** Product Manager	Signature: Per Christian Olving	Date: 8/11-2016

Tyco Electronics Raychem GmbH
Energy Division
Finsinger Feld 1
D-85521 Ottobrunn
Munich, Germany
Tel.: +49-89-6089-0
Fax: +49-89-6096-345

Raychem
from TE Connectivity

Subject of Test:	In- and Outdoor Termination type CSTI/O charcoal grey for 42kV for Single Core Polymeric Cables
Date of Tests:	August 2016 – October 2016
Requirements:	CENELEC HD 629.1 S3:2015 table 6/7, page 17/18
Manufacturer:	Tyco Electronics Raychem GmbH, Ottobrunn - Germany
Location of Tests:	Tyco Electronics Raychem Energy Laboratories, Ottobrunn - Germany
Test Purpose:	Qualification testing of CSTO charcoal grey on 36kV single core standard cable, according to CENELEC HD 629.1 S3:2015 table 6/7, page 17/18
Reference:	Laboratory Book
Test Results:	All samples passed the test requirements in accordance with the CENELEC HD 629.1 S3:2015 table 6/7, page 17/18 for the voltage class 20,8/36(42) kV.

Contents:

1 Qualification Test for CSTI/O charcoal grey Termination

1.1 Test Programme

The test sequence of the terminations for 20,8/36 (42) kV was done in accordance with HD 629.1 S3:2015 table 6/7, page 17/18.

Table 1: **Terminations for extruded insulation cables**

	Test	Test clause of EN 61442	Test sequence			Test requirements
			A1	A2	A3	
1	AC voltage dry withstand	4	X			5 min. at 93,5 kV
2	Partial discharge at ambient temperature	7	X			max. 10 pC at 42 kV
3	Impulse voltage at elevated temperature	6	X			10 +/- 200 kV
4	Electrical heat cycling in air	9	X			126 Cycles 5/3 52 kV 95-100°C
5	Immersion Only outdoor termination	9.4	X			10 Cycles
6	Partial discharge at ambient - ambient temperature - elevated temperature	7	X			 max. 10 pC at 42 kV max. 10 pC at 42 kV
7	Impulse voltage at ambient temperature	6	X			10 +/- 200 kV
8	AC voltage dry withstand	4	X			5 min. at 93,5 kV
9	Partial discharge at ambient temperature	7	X			max. 10 pC at 42 kV
10	Examination					

Test Samples

Cable:

Manufacturer:	TFKABLE & CABLEL
Type:	18/30 (36)kV
Construction:	NA2XS2Y
Conductor:	Copper / Aluminium
Cross section:	1x185mm²Cu and 1x400mm²Al
Voltage rating:	36 kV
Length of test loops:	approx. 3 m cable between the test objects
Cable lug:	Mechanical
Number of loops:	8 (four each cross section)

Product:

Kit Description Indoor termination type CSTI-6142-ML-6-17
Content:
Termination body CSTI-35-BD-24-568-FS
Sealing mastic S1278-1-300(B100)
Mechanical cable lug BLMT-185/400-17
Mechanical cable lug HEL-2070.1-Z-AK

Kit Description Outdoor termination type CSTO-6142-ML-6-17
Content:
Termination body CSTO-35-BD-24-566-FS
Sealing mastic S1278-1-300(B100)
Mechanical cable lug BLMT-185/400-17
Mechanical cable lug HEL-2070.1-Z-AK

Installation:
Instruction sheet: EPP-2828-08/16

1.2 Cable identification

Rated voltage U_0/U (U_m):	18/30 (36) kV		
Construction:	☒ 1-core	☐ 3-core	☐ Individually screened
			☒ Overall screen
Conductor:	☐ Al	☒ Cu	
	☒ Stranded	☐ Solid	
	☒ Circular	☐ Shaped	
	☐ 120mm²	☐ 150mm²	☒ 185mm²
	☐ Other cross section:	☐ 400mm²	
Insulation:	☒ XLPE		
	☐ EPR	☐ HEPR	
Insulation screen:	☒ Bonded	☐ Strippable	
Metallic screen:	☐ Wire	☐ Tape	☒ Extruded
Armour:	☐ Wire	☐ Tape	
Over sheath:	☐ PVC	☒ PE (state type)	
Water blocking, if any:	☐ In conductor	☒ Under over sheath	
Diameters:	Conductor:	mm 17,0	
	Insulation:	mm 33,1	
	Insulation screen:	mm 34,1	
	Over sheath:	Mm 42	
Cable marking:	TFKABLES NA2XS2Y 1x185 RM25 18/30 VDE0276		

Rated voltage U0/U (Um):	18/30 (36) kV		
Construction:	☒ 1-core	☐ 3-core	☐ Individually screened
			☒ Overall screen
Conductor:	☒ Al	☐ Cu	
	☒ Stranded	☐ Solid	
	☒ Circular	☐ Shaped	
	☐ 120mm^2	☐ 150mm^2	☐ 185mm^2
	☐ Other cross section:	☒ 400mm^2	
Insulation:	☒ XLPE		
	☐ EPR	☐ HEPR	
Insulation screen:	☒ Bonded	☐ Strippable	
Metallic screen:	☐ Wire	☐ Tape	☒ Extruded
Armour:	☐ Wire	☐ Tape	
Over sheath:	☐ PVC	☒ PE (state type)	
Water blocking, if any:	☐ In conductor	☒ Under over sheath	
Diameters:	Conductor:	mm 23,5	
	Insulation:	mm 41	
	Insulation screen:	mm 42,9	
	Over sheath:	mm 51	
Cable marking:	CABLEL 2011 NA2XS2Y 1x400 RM35 18/30 VDE0276		

1.3 Test Setup

1.3.1 AC voltage withstand test

The AC voltage was generated by a 350kV transformer (see figure 3). The voltage measurement was carried out with a capacitive divider.

Test circuit: technical data

Tr	Test transformer:	350 kV, 175 kVA, 50 Hz
C-Div	Capacitive divider	75 pF
TO	Test objects	

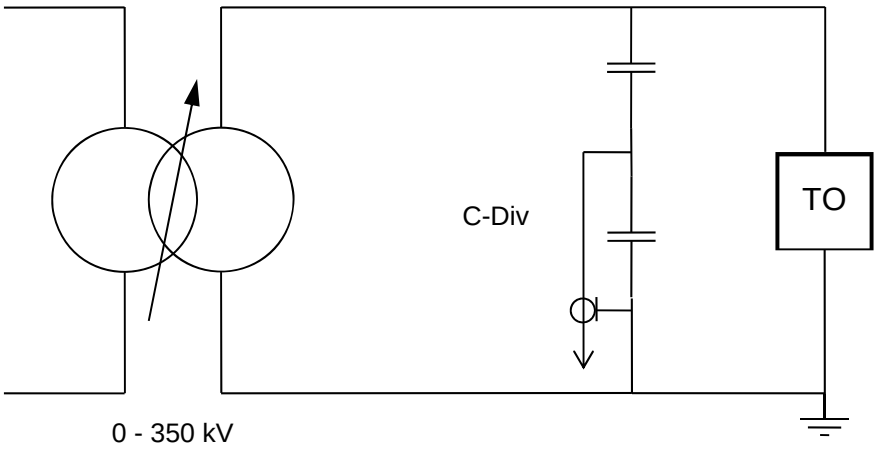


Figure 3: AC test circuit diagram

Measuring equipment:

Object	Type	Calibration number	Calibration date
Capacitive divider	MCF75/350P/MC	1303/DKD/-K-24501/04-11	2015-03-10
Measurement cable		1303/DKD/-K-24501/04-11	2015-03-10
AC peak voltmeter	LDIC-voltage unit	1303/DKD/-K-24501/04-11	2015-03-10

The correction factor for the voltage metering, defined during the calibration, was specified to a value of 0,984. The relative measurement uncertainty of the test circuit was 1,2 %.

1.3.2 Partial discharge test

The partial discharge test was performed according to figure 4. The voltage measurement was carried out with a capacitive divider. For the extraction of the partial discharge signals a separate capacitive divider was used. The background noise level at test voltage was < 1 pC. Prior to the test, the complete test arrangement including the test object has been calibrated.

Test circuit: technical data

Tr	Test transformer:	350 kV, 175 kVA, 50 Hz
$C\text{-}Div_1$	Capacitive divider	75 pF (voltage measurement)
$C\text{-}Div_2$	Capacitive divider	1000 pF (partial discharge measurement)
TO	Test object	

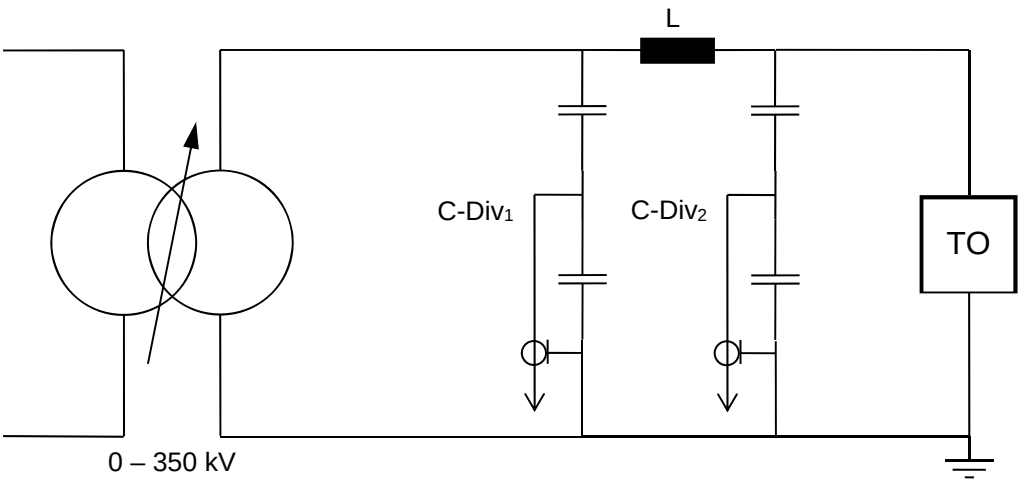


Figure 4: PD test circuit diagram

Measurement equipment:

Object	Type	Calibration number	Calibration date
Calibrator tester	LDC-5/S1	00325201	2015-03-10

1.3.3 Impulse voltage test

For the test an impulse generator with a maximum charging voltage of 800kV and a maximum impulse energy of E_{max} = 24 kJ was used (see figure 5). The voltage measurement was carried out with a resistive-capacitive divider and an impulse measurement system. The relative measurement uncertainty was 1,2 %

Test circuit: technical data

Number impulse generator stages:		4
RC-Div	Damped-Capacitive Divider	Ratio: 800 : 1,4
TO	Test objects	

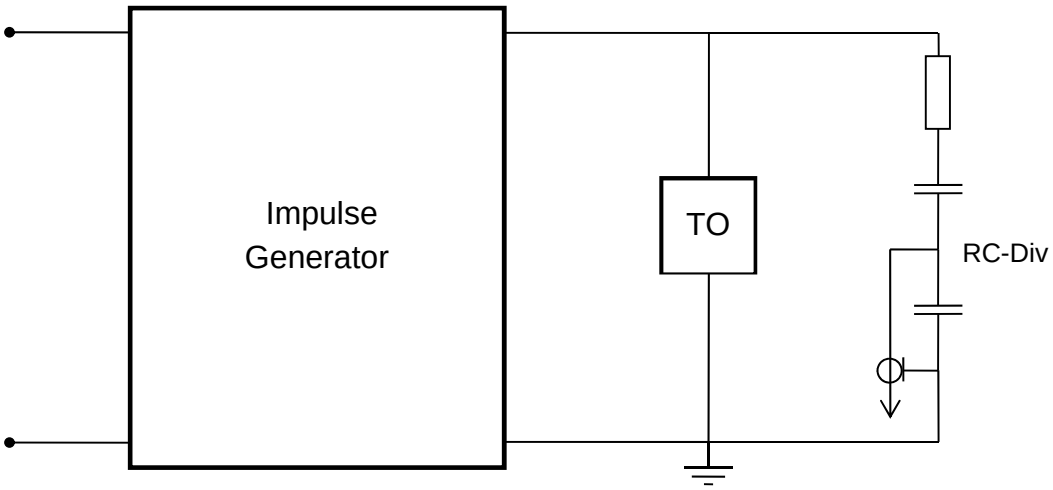


Figure 5: Impulse test circuit diagram

Measurement equipment:

Object	Type	Calibration number	Calibration date
Damped capacitive divider	CS 1000	1302/DKD/-K-24501/04-11	2015-03-10
Measurement cable		1302/DKD/-K-24501/04-11	2015-03-10
Digital recorder	DIAS 730	1302/DKD/-K-24501/04-11	2015-03-10

1.4 Test Sequence

1.4.1 AC voltage test according to section 4 EN 61442

AC voltage of 93,5 kV_{rms}, 50 Hz was applied between the conductor and the grounded screen for 5 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

relative humidity of air	atmospheric pressure	temperature
71 %	955 hPa	25° C

Result: All samples passed

1.4.2 Partial Discharge test at ambient temperature according to section 7 EN 61442

The lugs were made corona-free by using ring electrodes and an AC test voltage of 2.0 U_0 was applied for 1 minute. Then the voltage was decreased to the AC test voltage U_{PD} = 42 kV and within 1 minute the maximum value of the partial discharge magnitude was measured.

relative humidity of air	atmospheric pressure	temperature
71 %	955 hPa	25° C

	Loop 1	**Loop 2**	**Loop 3**	**Loop 4**
	185mm²	185mm²	185mm²	185mm²
	CSTI	CSTI	CSTO	CSTO
PD value @ 42kV	< 1pC	< 1pC	< 1pC	< 1pC

	Loop 1	**Loop 2**	**Loop 3**	**Loop 4**
	400mm²	400mm²	400mm²	400mm²
	CSTI	CSTI	CSTO	CSTO
PD value @ 42kV	< 1pC	< 1pC	< 5pC	< 1pC

Admissible Partial Discharge Magnitude: 10 pC

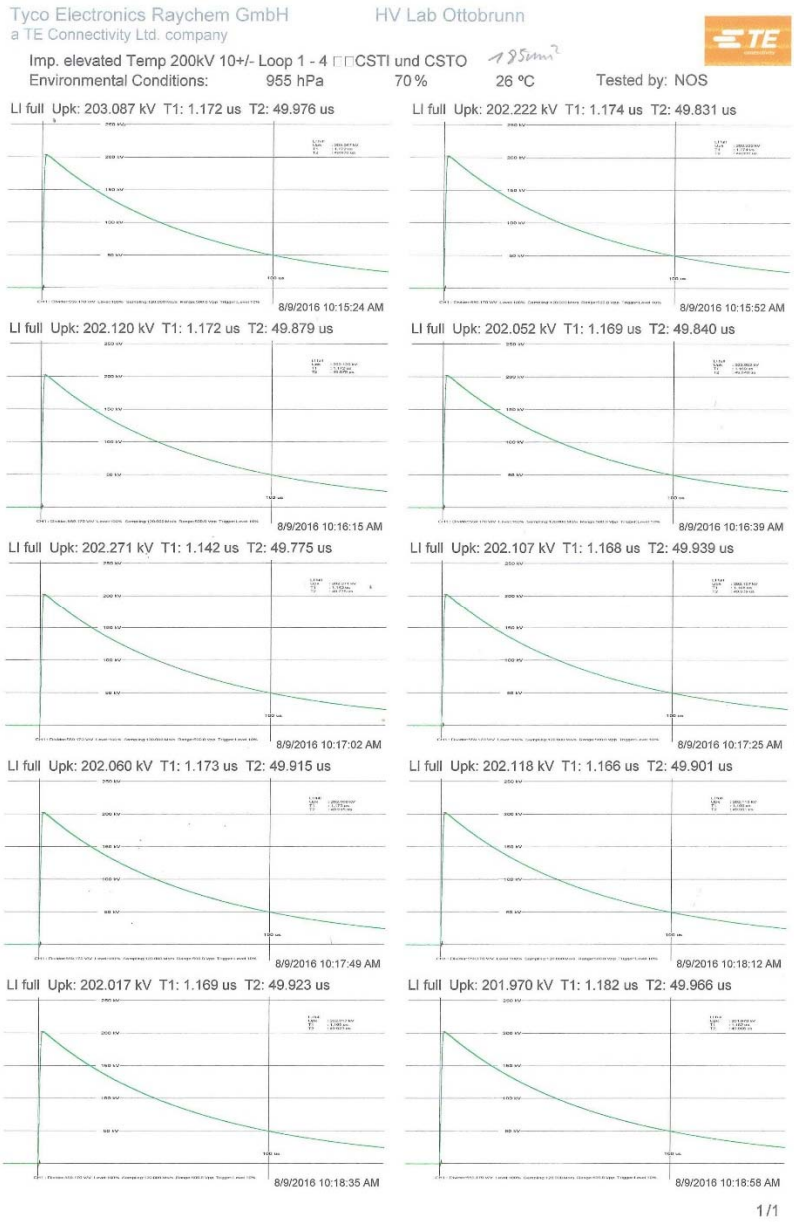
Result: All samples passed

1.4.3 Impulse voltage withstand test at elevated temperature acc. to section 6 EN61442

An impulse voltage with rise time approx. 1.2 µs and half-value decay time with approx. 50 µs was applied. The test loop was exposed to 10 impulses each of an impulse voltage of 200 kV of positive and negative polarity between the conductor and the grounded screen.

relative humidity of air	atmospheric pressure	temperature
70 %	955 hPa	26° C

Sample 185mm² CSTI/O



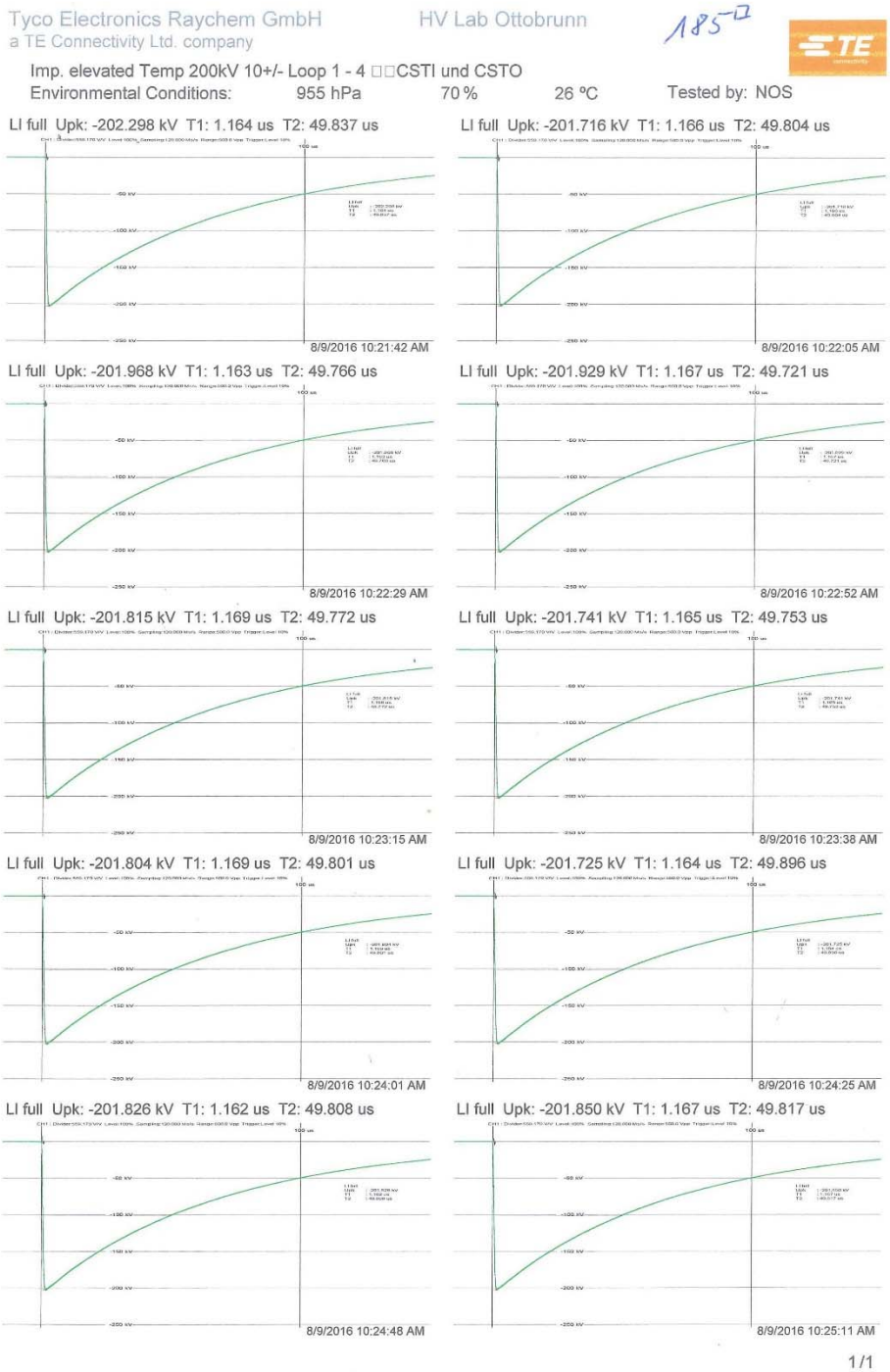


Fig. 1: **Impulse oscillograms for 185mm² XLPE cable, loop 1- 4**

The impulse oscillograms in figure 1 don't show any discrepancies from the calibration oscillogram.

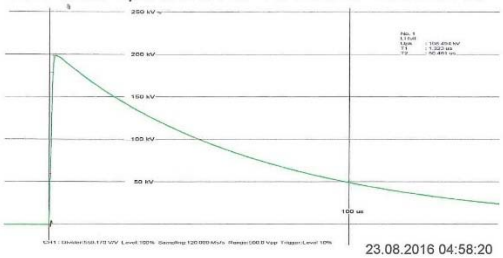
Result: All samples passed

Sample 400mm² CSTI/O

Tyco Electronics Raychem GmbH HV Lab Ottobrunn
a TE Connectivity Ltd. company

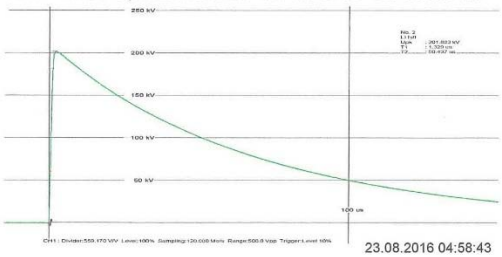
elevated Imp. 200 kV 10+/-□□CSTI und CSTO Loop 1-4 400mm
Environmental Conditions: 953 hPa 62 % 25 °C Tested by: MXB

No. 1 LI full Upk: 198.494 kV T1: 1.323 us T2: 50.461 us



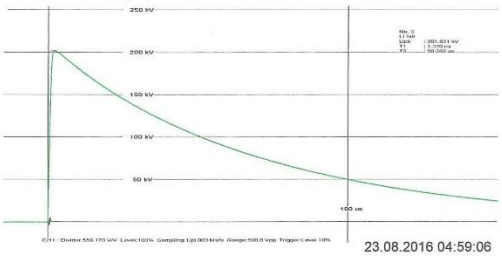
23.08.2016 04:58:20

No. 2 LI full Upk: 201.883 kV T1: 1.329 us T2: 50.437 us



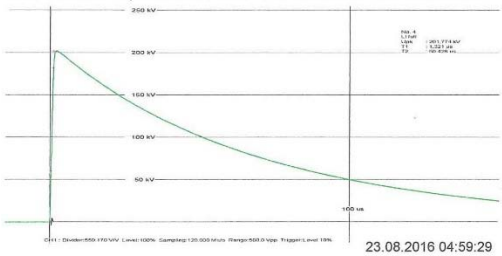
23.08.2016 04:58:43

No. 3 LI full Upk: 201.831 kV T1: 1.330 us T2: 50.392 us



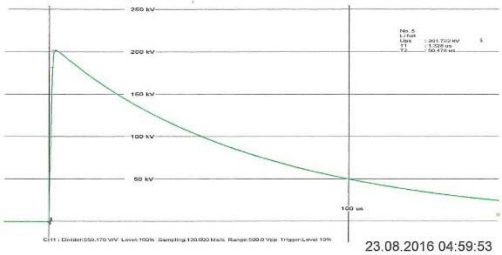
23.08.2016 04:59:06

No. 4 LI full Upk: 201.774 kV T1: 1.321 us T2: 50.428 us



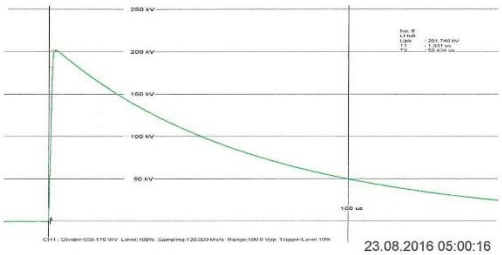
23.08.2016 04:59:29

No. 5 LI full Upk: 201.722 kV T1: 1.328 us T2: 50.478 us



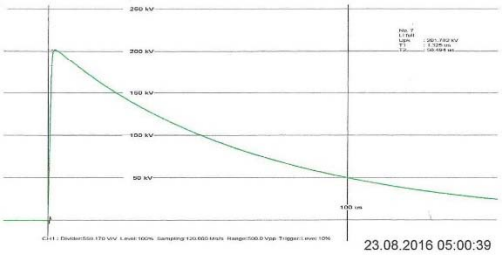
23.08.2016 04:59:53

No. 6 LI full Upk: 201.746 kV T1: 1.331 us T2: 50.434 us



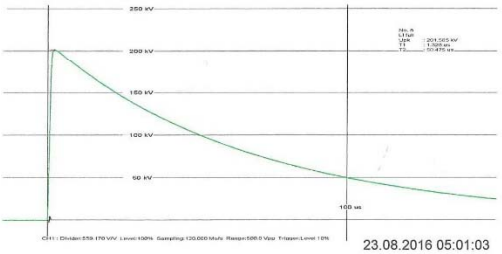
23.08.2016 05:00:16

No. 7 LI full Upk: 201.782 kV T1: 1.325 us T2: 50.494 us



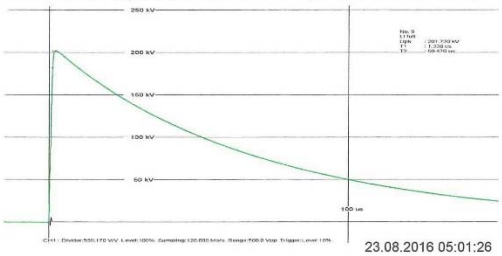
23.08.2016 05:00:39

No. 8 LI full Upk: 201.585 kV T1: 1.328 us T2: 50.475 us



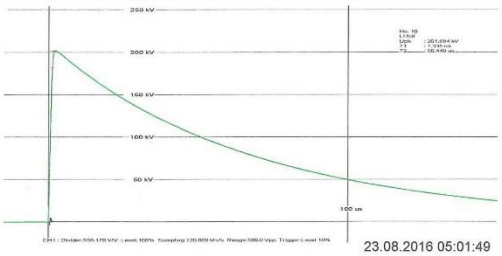
23.08.2016 05:01:03

No. 9 LI full Upk: 201.730 kV T1: 1.336 us T2: 50.470 us



23.08.2016 05:01:26

No. 10 LI full Upk: 201.684 kV T1: 1.335 us T2: 50.449 us



23.08.2016 05:01:49

1/1

Fig. 2: **Impulse oscillograms for 400mm² XLPE cable, loop 1- 4**

The impulse oscillograms in figure 2 don't show a discrepancy from the calibration oscillogram.

Result: All samples passed

1.4.4 Continuous AC voltage test with cyclic current load acc. to section 9 EN 61442

The test loop, suspended free in air, was subjected to 126 load cycles with a continuously applied AC test voltage of 52 kV. Each load cycle consist of a 3 hours load period, 2 hours hold period and 3 hours cooling period. The current was adjusted to a level which heated up the cable core to a temperature of 95° C. The ambient temperature during the load cycles was approx. 24° C.

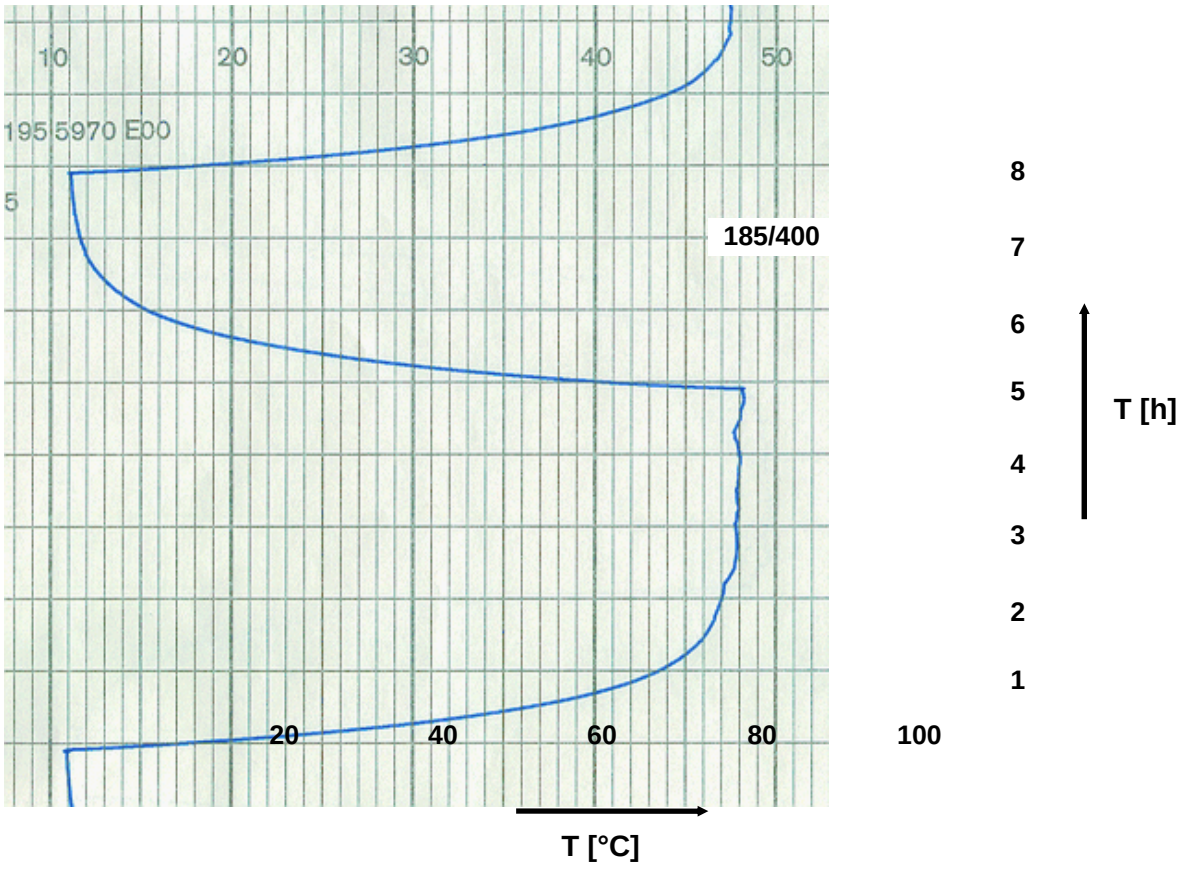


Fig. 3: **Temperature during one load cycle**

Result: All samples passed

1.4.5 Immersion test acc. to section 9 EN 61442

The terminations of a test loop, were immersed in water at ambient temperature with a height of water 0,03m above every part of the termination. The test loop was installed upside down in a water tank at ambient temperature, in such a way that the terminations were fully immersed in water, including the end of the sealing element. The test loop was subjected to 10 load cycles each cycle consist of a 3 hours load period, 2 hours hold period and 3 hours cooling period. The current was adjusted to a level which heated up the cable core to a temperature of 95° C. The ambient temperature during the load cycles was approx. 24° C.

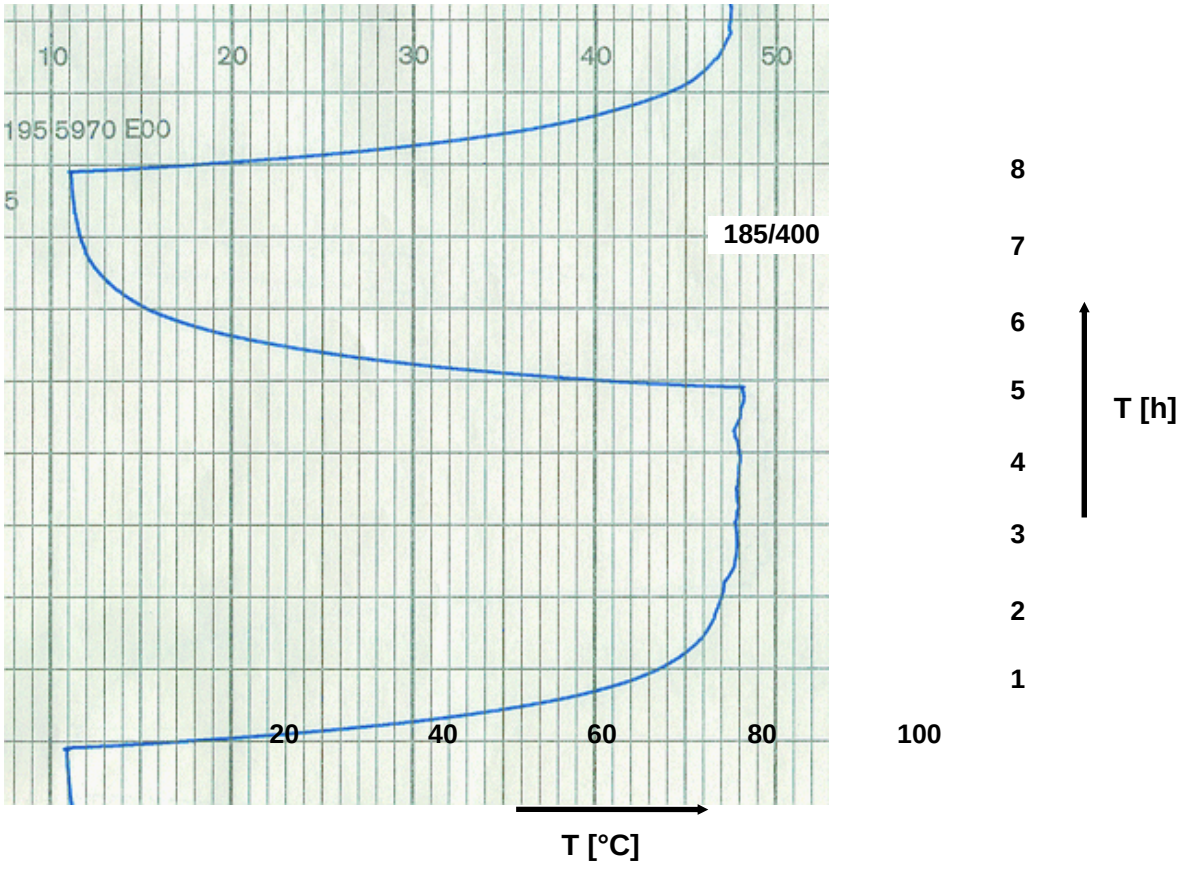


Fig. 4: **Temperature during one load cycle**

Result: All samples passed

1.4.6 Partial Discharge test according to section 7 EN 61442

After the 126th load cycle the Partial Discharge test as in 1.4.2 was repeated.

a) Partial Discharge Test at ambient temperature

relative humidity of air	atmospheric pressure	temperature
38 %	953 hPa	25° C

	Loop 1	Loop 2	Loop 3	Loop 4
	185mm²	185mm²	185mm²	185mm²
	CSTI	CSTI	CSTO	CSTO
PD value @ 42kV	< 1pC	< 1pC	< 1pC	< 1pC

	Loop 1	Loop 2	Loop 3	Loop 4
	400mm²	400mm²	400mm²	400mm²
	CSTI	CSTI	CSTO	CSTO
PD value @ 42kV	< 1pC	< 1pC	< 1pC	< 1pC

Admissible Partial Discharge Magnitude: 10 pC

Result: All samples passed

b) Partial Discharge Test at elevated temperature

The PD-Measurement was done as in 1.4.2, but the conductors were heated up to a temperature of 95 - 100° C.

relative humidity of air	atmospheric pressure	temperature
38 %	953 hPa	25° C

	Loop 1	Loop 2	Loop 3	Loop 4
	185mm²	185mm²	185mm²	185mm²
	CSTI	CSTI	CSTO	CSTO
PD value @ 42kV	< 1pC	< 1pC	< 1pC	< 1pC

	Loop 1	Loop 2	Loop 3	Loop 4
	400mm²	400mm²	400mm²	400mm²
	CSTI	CSTI	CSTO	CSTO
PD value @ 42kV	< 1pC	< 1pC	< 1pC	< 1pC

Admissible Partial Discharge Magnitude: 10 pC

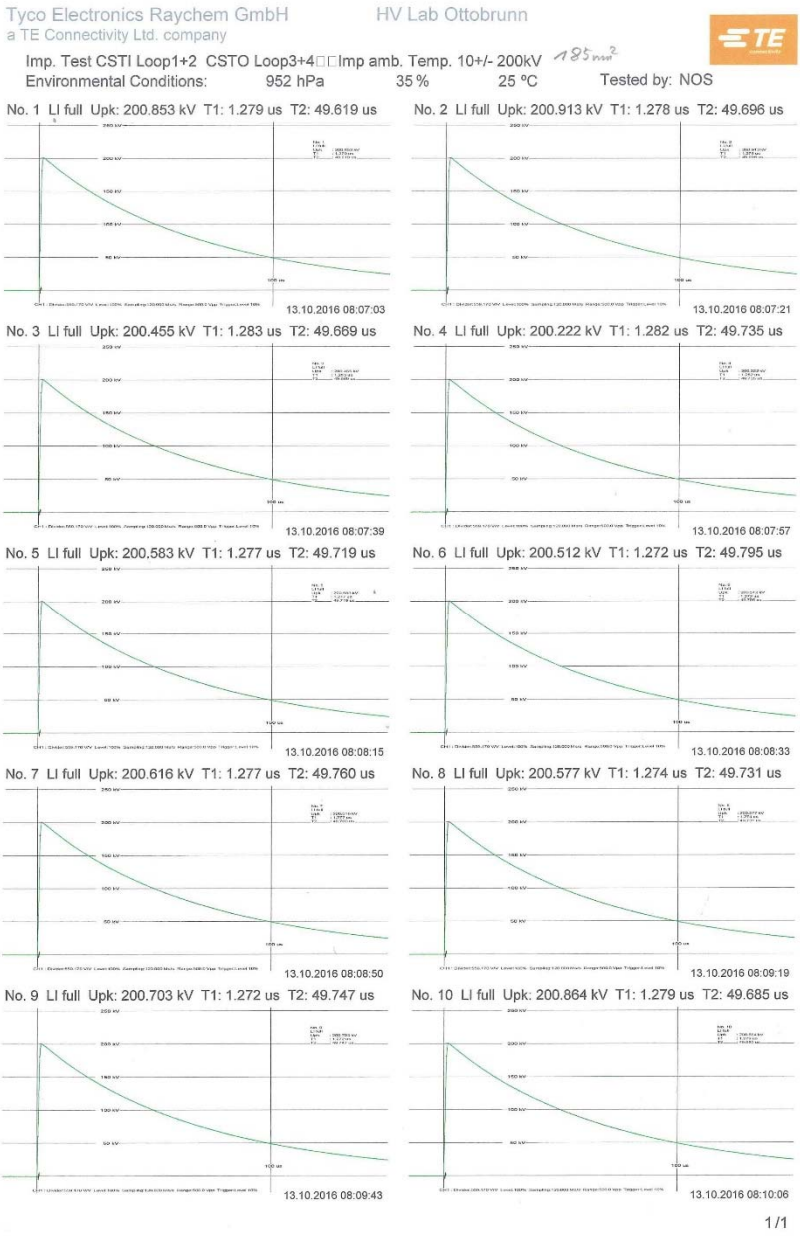
Result: All samples passed

1.4.7 Impulse voltage withstand test at ambient temperature acc. to section 6 EN61442

An impulse voltage with rise time approx. 1.2 µs and half-value decay time with approx. 50 µs was applied. The test loop was exposed to 10 impulses each of an impulse voltage of 200 kV of positive and negative polarity between the conductor and the grounded screen.

relative humidity of air	atmospheric pressure	temperature
35 %	952 hPa	25° C

Sample 185mm² CSTI/O



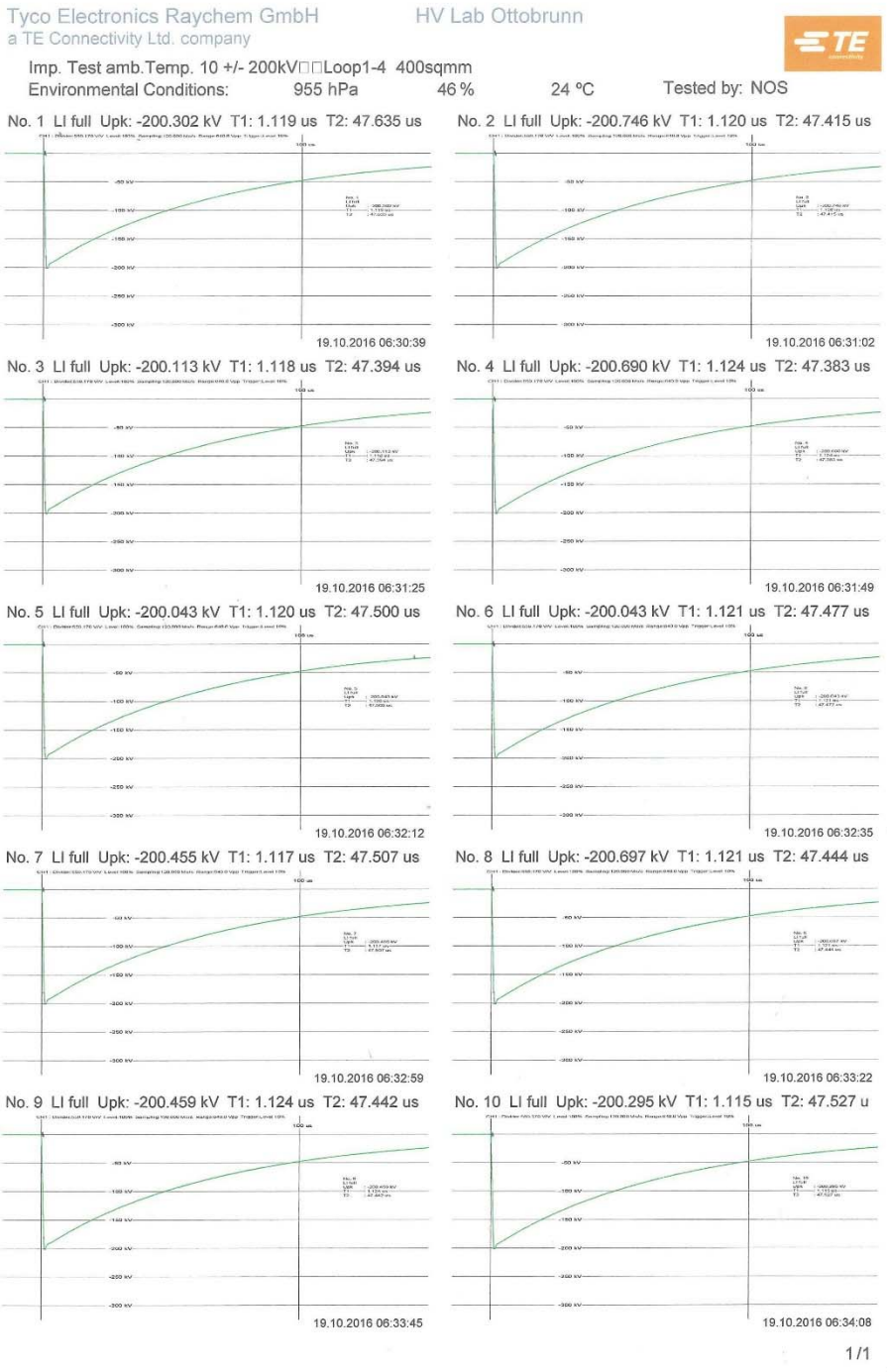


Fig. 5: **Impulse oscillograms for 185mm² XLPE cable, loop 1- 4**

The impulse oscillograms in figure 5 don't show any discrepancies from the calibration oscillogram.

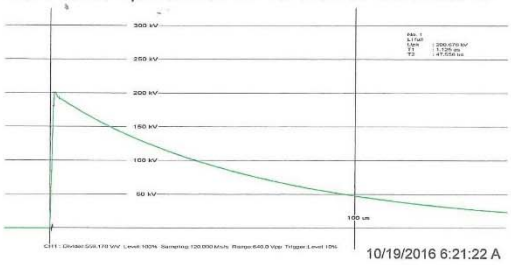
Result: All samples passed

Sample 400mm² CSTI/O

Tyco Electronics Raychem GmbH HV Lab Ottobrunn
a TE Connectivity Ltd. company

Imp. Test amb.Temp. 10 +/- 200kV□□Loop1-4 400sqmm
Environmental Conditions: 955 hPa 46 % 24 °C Tested by: NOS

No. 1 LI full Upk: 200.676 kV T1: 1.125 us T2: 47.558 us



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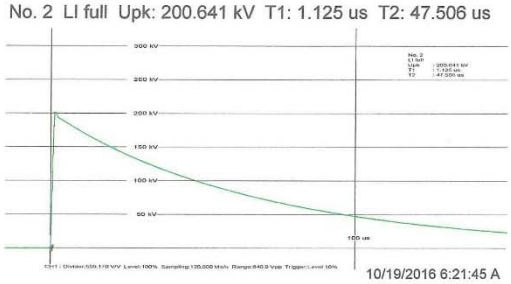
No. 2 LI full Upk: 200.641 kV T1: 1.125 us T2: 47.506 us



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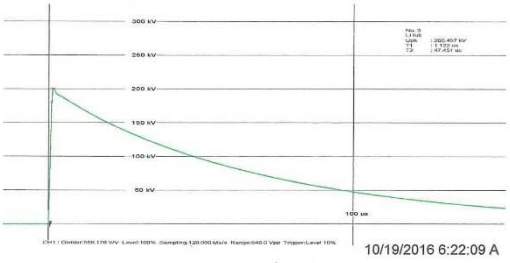
No. 3 LI full Upk: 200.497 kV T1: 1.122 us T2: 47.451 us



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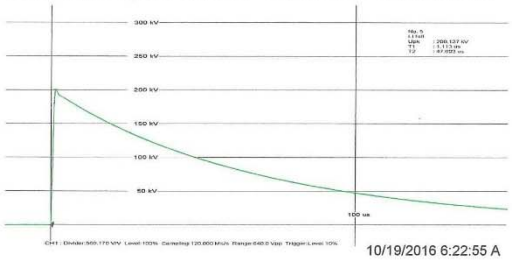
No. 5 LI full Upk: 200.137 kV T1: 1.113 us T2: 47.603 us



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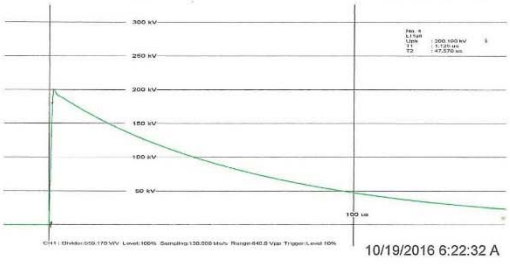
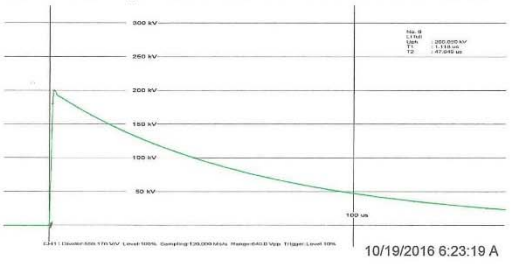
No. 4 LI full Upk: 200.190 kV T1: 1.125 us T2: 47.570 us



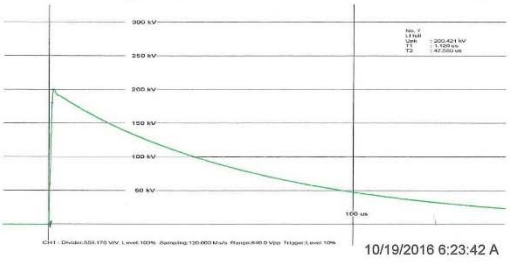
10/19/2016 6:22:32 A

No. 6 LI full Upk: 200.050 kV T1: 1.118 us T2: 47.649 us



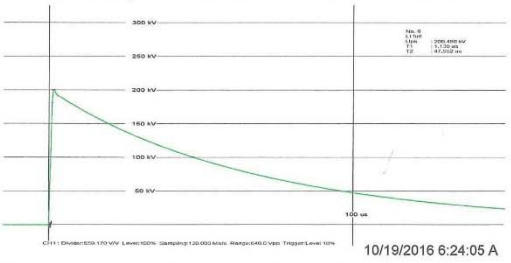
10/19/2016 6:23:19 A

No. 7 LI full Upk: 200.421 kV T1: 1.120 us T2: 47.580 us



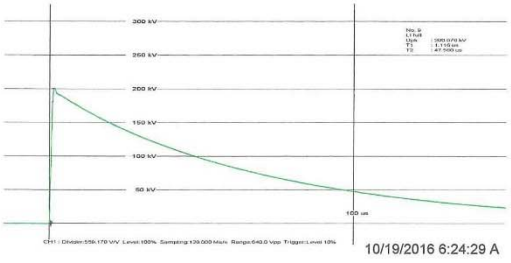
10/19/2016 6:23:42 A

No. 8 LI full Upk: 200.480 kV T1: 1.130 us T2: 47.552 us



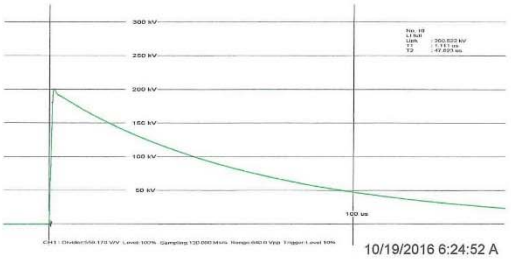
10/19/2016 6:24:05 A

No. 9 LI full Upk: 200.676 kV T1: 1.116 us T2: 47.560 us



10/19/2016 6:24:29 A

No. 10 LI full Upk: 200.522 kV T1: 1.111 us T2: 47.623 us



10/19/2016 6:24:52 A

1/1

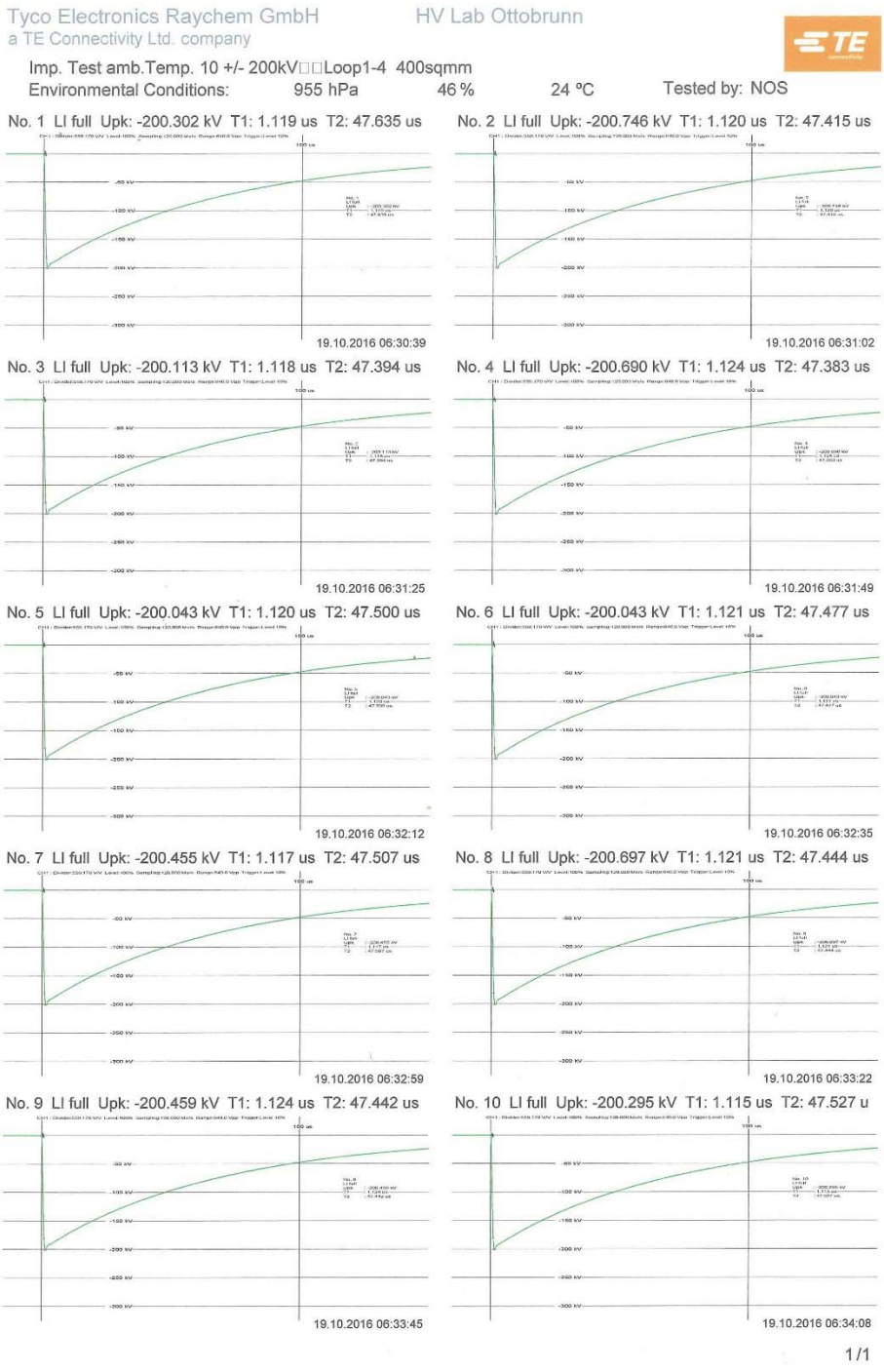


Fig. 6: **Impulse oscillograms for 185mm² XLPE cable, loop 1- 4**

The impulse oscillograms in figure 6 don't show any discrepancies from the calibration oscillogram.

Result: All samples passed

1.4.8 AC voltage test according to section 4 EN 61442

AC voltage of 93,5 kV_{rms}, 50 Hz was applied between the conductor and the grounded screen for 5 minutes. The voltage was continuously increased within 10 seconds to the specified value and then held constant during the required test period.

relative humidity of air	atmospheric pressure	temperature
35 %	952 hPa	25° C

Result: All samples passed

1.4.9 Partial Discharge test at ambient temperature according to section 7 EN 61442

The lugs were made corona-free by using ring electrodes and an AC test voltage of 2.0 U_0 was applied for 1 minute. Then the voltage was decreased to the AC test voltage U_{PD} = 42 kV and within 1 minute the maximum value of the partial discharge magnitude was measured.

relative humidity of air	atmospheric pressure	temperature
35 %	952 hPa	25° C

	Loop 1	**Loop 2**	**Loop 3**	**Loop 4**
	185mm²	185mm²	185mm²	185mm²
	CSTI	CSTI	CSTO	CSTO
PD value @ 42kV	< 1pC	< 1pC	< 1pC	< 1pC

	Loop 1	**Loop 2**	**Loop 3**	**Loop 4**
	400mm²	400mm²	400mm²	400mm²
	CSTI	CSTI	CSTO	CSTO
PD value @ 42kV	< 1pC	< 1pC	< 1pC	< 1pC

Admissible Partial Discharge Magnitude: 10 pC

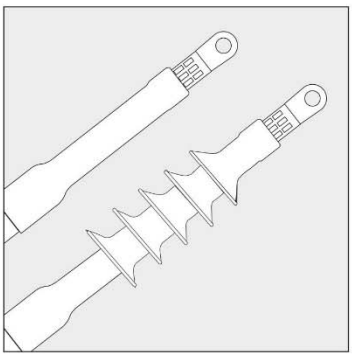
Result: All samples passed

1.5 Summary Test Results

All samples passed the test requirements in accordance with the CENELEC HD 629.1 S3:2015 table 6/7, page 17/18 for the voltage class 20,8/36 (42) kV.

1.6 Appendix

Raychem
from TE Connectivity



Installation Instruction EPP-2828-8/16

Raychem Termination for Screened Single Core Polymeric Cable without Armour

Type: CSTI/CSTO Indoor/Outdoor

36 kV / 42 kV

To view the TE Energy website:

Tyco Electronics Raychem GmbH
a TE Connectivity Ltd. Company
TE Energy
Finsinger Feld 1
85521 Ottobrunn/Munich, Germany
Tel: +49-89-6089-0
Fax: +49-89-6096-345
energy.te.com

Before Starting

Check to ensure that the kit you are going to use is suitable for the size of cables being jointed.

Refer to the kit label and the title of the installation instruction.

Components or working steps may have been modified since you last installed this product.

Carefully read and follow the steps in the installation instruction.

General Instructions

Clean and degrease all parts that will come into contact with adhesive.

If a solvent is used follow the manufacturer's handling instructions.

Check cable ends for ingress of moisture before starting with cable preparation.

For easy strip screen layers always use a round file to cut radially through the core screen.

Cable Preparation

Before Starting

Check to ensure that the kit you are going to use fits the cable.
Refer to the kit label and the title of the installation instruction.
Components or work steps may have been improved since you last installed this product.
Carefully read and follow the steps in the installation instruction.

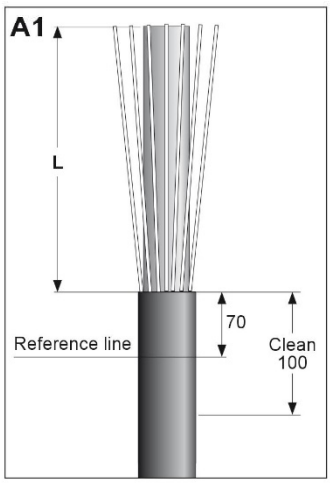
Table for cutback dimensions

	Cable	Termination
Mechanical lug BLMT	Cross Section	Indoor/Outdoor 36 kV/42 kV
	mm^2	mm
BLMT 25/95	95	435
BLMT 35/150	50 Cu	460
BLMT 35/150	150 Al	450
BLMT 95/240	185	475
BLMT 95/240	240	440
BLMT 120/300	120 – 300	
BLMT 185/400	185	475
	400	445
BLMT 500/630	500 Al	485
BLMT 500/630	630 Al	485
BLMT 500/630	630 Cu	485
BLMT 800/1000	1000 Al	460

For cable cross section 50 - 630 mm²

Cut the cable to the required length. Remove the oversheath according to **L**. Clean and degrease the end of the oversheath for approximately 100 mm.

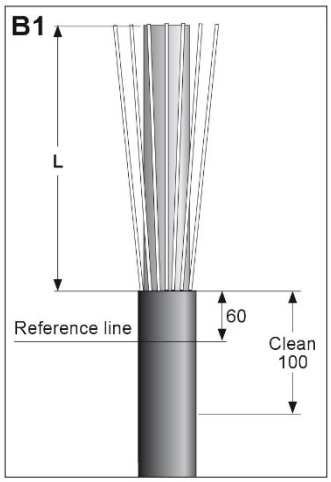
Mark a line 70 mm below the oversheath cut.



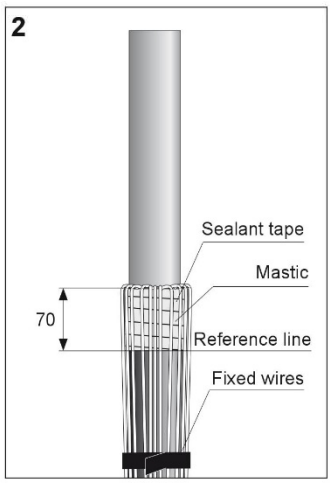
For cable cross section 800 - 100 mm²

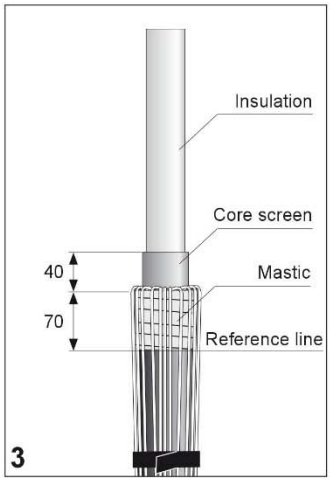
Cut the cable to the required length. Remove the oversheath according to **L**. Clean and degrease the end of the oversheath for approximately 100 mm.

Mark a line 60 mm below the oversheath cut.



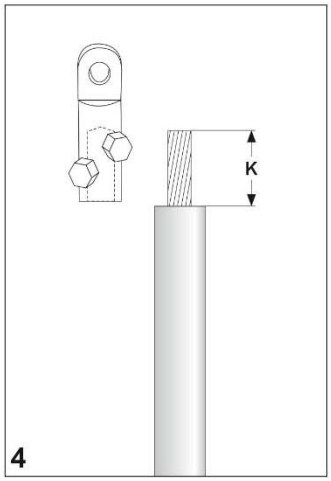
Wrap two layers of sealant tape (grey) with a small overlap and slight tension around the end of the oversheath as shown. Bend the shielding wires back onto the oversheath. Avoid crossing the individual wires. Fix the shielding wires with a tape to the oversheath.



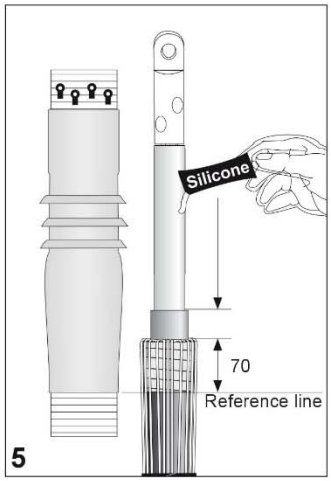


Thoroughly remove the core screen to within 40 mm of the oversheath cut. The surface of the insulation should be free from all traces of conductive material.
Smooth out any irregularities.

Note: Do not nick the insulation.



Cut back the insulation according to **Mechanical lugs:**
K = depth of cable lug barrel hole
Install the cable lug and remove all sharp edges. Clean and degrease the core insulation and the lug.



Apply a thin layer of silicone grease onto the insulation and the core screen cut.

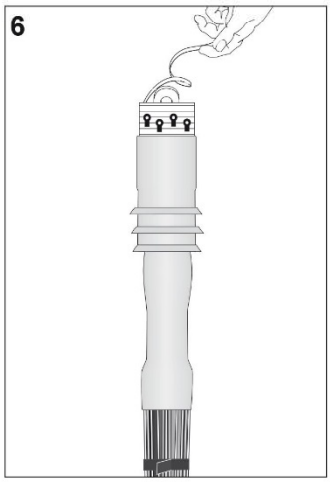
Position the termination body.

Pull the spiral gently until the termination body butts to the reference line.

If the termination is not correctly positioned, it is possible to gently slide it into place.

Remove the spiral holdout completely from the termination by pulling it counterclockwise.

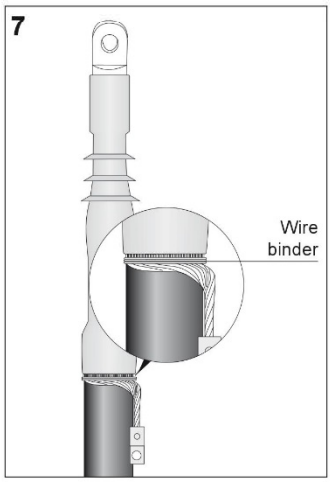
Do not twist the spiral holdout during removal. Avoid the spiral to hook up over the termination.



Degrease and clean the termination.

Fix the shield wires with a wire binder along the lower edge of the termination body. Install the cable lug on the shield wires.

Termination completed.

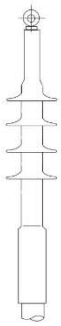


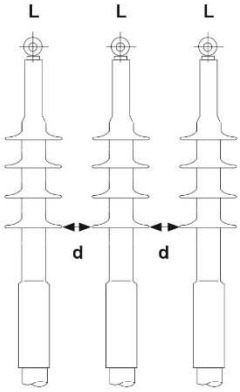
Please dispose of all waste according to local environmental regulations.

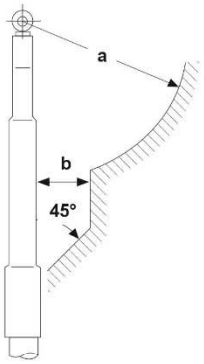
CSTI/CSTO – Product family

Indoor

Outdoor







Min. clearances		Max. system voltage in kV	
		36	42
a	Air clearance	as for local specifications	
b	ph/ph and ph/ground in mm	35	45
d	Between skirts in mm	25	35