Cable Test Termination
CTTS series

HAEFELY
HIGH VOLTAGE TEST

Cable Test Termination

Application

Haefely Trench CTTS series cable test terminations are used to test plasticinsulated high-voltage cables. The specific advantages of this series versus conventional terminations are fast and convenient assembly. The terminations can be used for partial discharge (PD) measurements, impulse voltage testing, loss factor (tan delta) measurements and, if the cable ends are carefully prepared, for breakdown testing (step test).

When a cable is being tested, the PD measurement can be followed by an impulse voltage test and by another PD measurement without the need to reconfigure the test arrangement. A loss factor measurement can be made with minor modifications to the arrangement.

The cable is prepared in the same way as for slip-on terminations i.e. by stripping the cable to the outer semiconducting layer and removing the outer semiconducting layer.

The CTT series includes terminations from 75 kV to 800 kV for a maximum cable diameter of 165 mm over the outer semiconducting layer.

PD and tan delta Measurement

Since the CTTS series is free of partial discharge, the PD measurement can be performed up to the rated voltage of the terminations. The Haefely PD measurement system can also be used for locating partial discharges in cables.

The tan delta measurement on plastic-insulated cables poses great demands on measurement techniques due to the extremely low loss factor values.

Reliable loss factor measurement with the Haefely Trench Tettex capacitance and tan delta measuring bridge is ensured thanks to the shield connection.

Impulse Voltage Testing

Water of greater conductivity is used for impulse voltage testing to achieve homogeneous voltage distribution along the terminations for transient voltages. This keeps the total resistance of the termination relatively low (approx. 5 kΩ). The half-value decay time of the impulse voltage can be maintained to within normal cable testing tolerances if the impulse system is tuned to the terminations (50 ±10 µs to IEC Pub 230; SEN 2103; IS 2070-1962; VDE 0472, Part 511).

Breakdown Testing

The following factors must be considered when breakdown tests are performed. The removal of the outer semiconducting layer basically weakens the insulation on the cable ends. This procedure must be carried out with the utmost care to keep this weakening effect within acceptable limits. However, a breakdown of the cable in the termination tubes and the associated damage to them cannot be completely excluded.
The probability of a cable breakdown in the termination increases with decreasing cable length and increasing cable quality. One of the reasons is that, despite optimized field control, the field strength in the termination is much higher than in the coaxial cylindrical field of the cable Haefely Trench has developed special insertion electrodas to ensure the best possible field control for breakdown tests. Breakdown tests on medium-voltage cables using CTT series terminations can be successfully carried out when these electrodes are used.

General Arrangement of the Termination System

The terminations consist of a 2-tube system in which the water circulates (Fig. 1). A closed system is formed when the water conditioning unit (Fig. 2) is connected. After the terminations have been connected to the water conditioning unit by 4 hoses, the termination system operation states can be selected by pushing the respective buttons. It is not necessary to manually actuate any valves.

CTT series terminations are designed for indoor use.

Each termination is mounted on its own trolley.

CTT series terminations come in two versions:

- The standard version with an internal tube diameter of 125 mm can be used to test cables up to 115 mm diameter across the outer semiconducting layer. The terminations are raised with a manually operated hydraulic jacking system.
- The CLX version has an internal tube diameter of 175 mm and can be used to test cables up to 165 mm across the outer semiconducting layer. This version is equipped with a motorised jacking system. Supplementary support tubes increase the mechanical stability of the terminations. This permits the testing of ultra-high-voltage cables with conductor cross sections of 2000 mm^2 and more.

Fig 1
Cross-section view of a termination

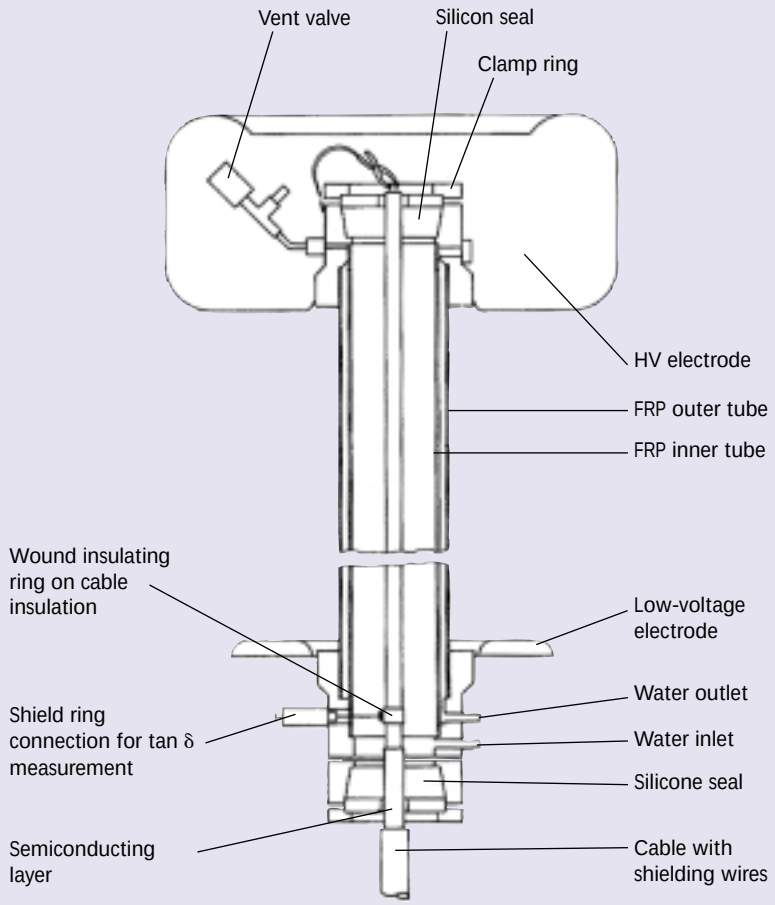
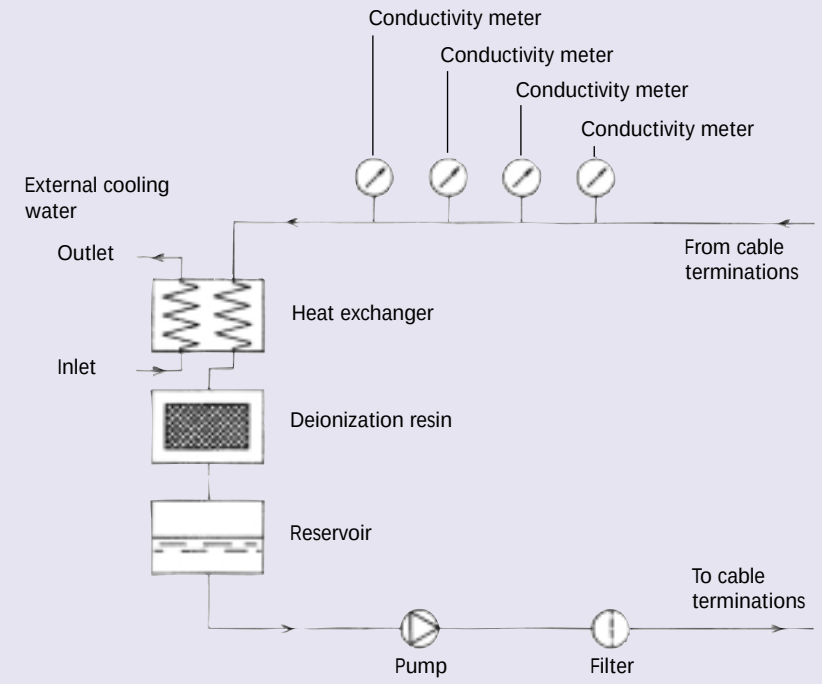


Fig 2
Water conditioning unit schematic diagram



Function

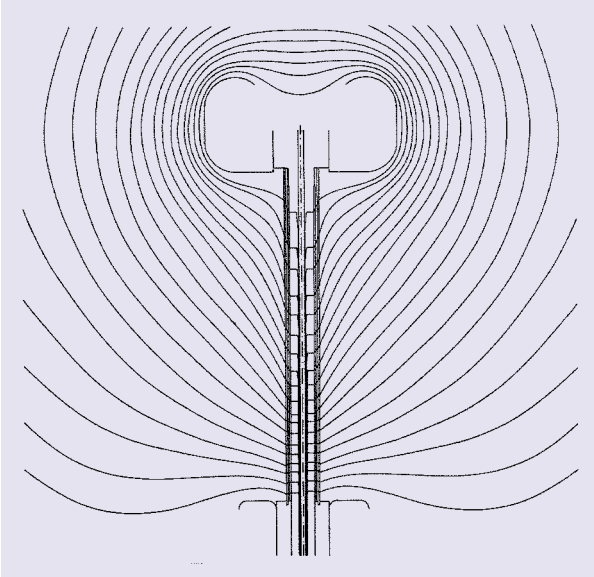


Fig 3
Typical test termination field distribution

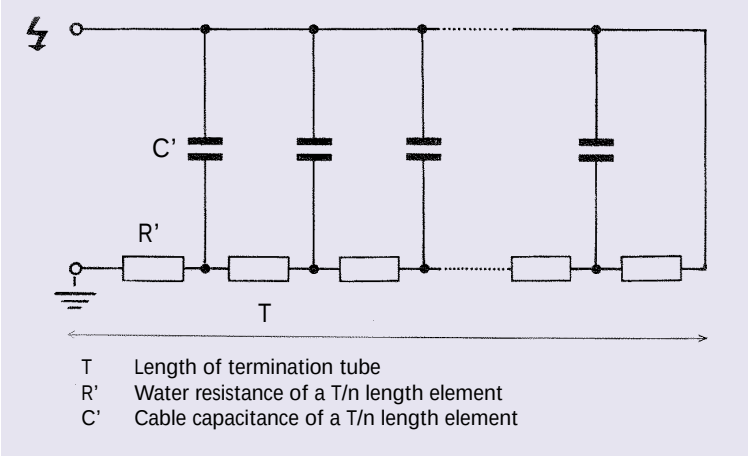


Fig 4
Equivalent circuit diagram of a CTT test termination

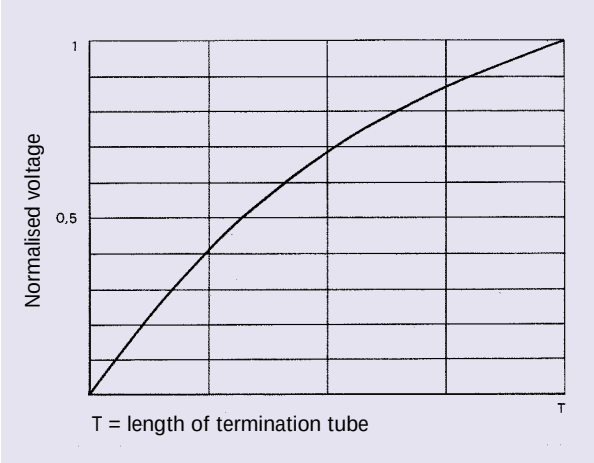


Fig 5
Voltage distribution in the cable termination

The cylinder field of the cable changes in the termination. The aim of the termination is to attain a close approximation to the cylinder field of the cable in this zone. The approximation to a cylinder field is particularly important, due to the higher field strengths compared to the operating field strengths of the cable to be tested.

The Haefely Trench CTT series terminations are distinguished by outstanding field control in this zone. Fig. 3 shows the typical field of a Haefely Trench CTT series termination. This field exhibits a substantially linear potential drop along the tube of the termination. The reason for this is the resistive (water) and capacitive (cable) arrangement of the termination.

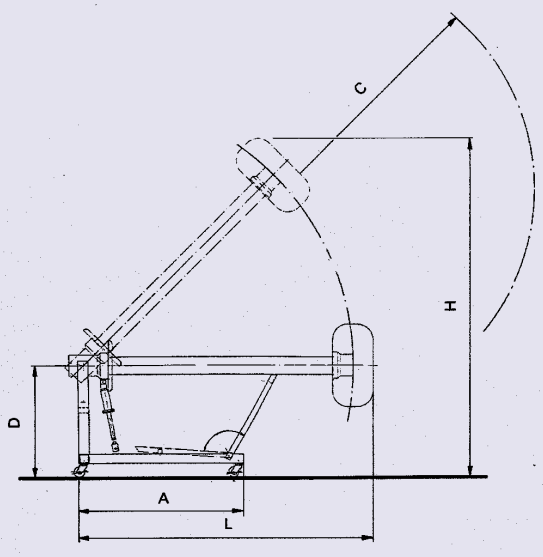
Fig. 4 shows the equivalent circuit diagram of the arrangement. The uniformity of the voltage distribution increases with increasing water conductivity.
Fig. 5 shows the voltage distribution along the water column in the termination. This was calculated using the iterative network equivalent circuit diagram.
A substantially linear field distribution is aimed when the termination is in operation. The distribution is dependent on the system geometry and the cable to be tested. The conductivity for any particular operating mode can be preset and is automatically regulated by the Haefely Trench water conditioning unit. This ensures that the system can be accurately adjusted to meet the requirements imposed by the particular termination used, the cable, and desired test mode (short or long period).

Technical Data
Dimensions

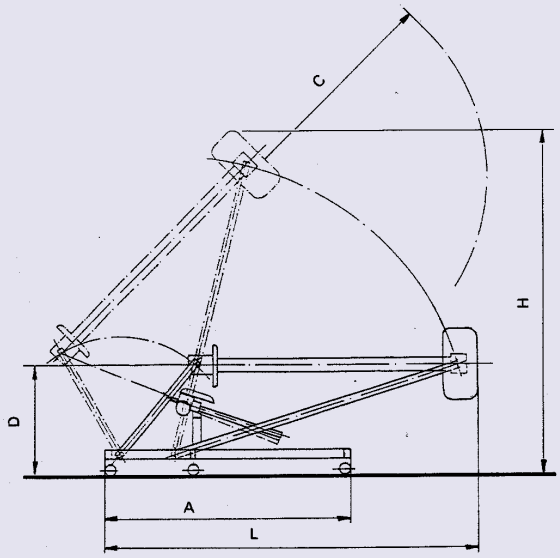
Code	U_n 50/60 Hz	Lightning impulse voltage 1.2/50 µs neg. pol	PD level at U_n	Max cable dia. across outer semi-conducting layer	C Min safety clearance	L Length	B Width	A Trolly length	H Overall height	D Cable instal-lation heigth	Weight of 2 units without water	Associated water conditioning unit
	kV	kV	pC	mm	m	m	m	m	m	m	kg	
CTT 75	75	280	≤ 1	115	0.8	1.4	0.9	1.6	2.1	1.1	260	WC 120
CTT 150	150	550	≤ 1	115	1.0	1.8	1.2	1.6	2.4	1.1	260	WC 120
CTT 250	250	800	≤ 1	115	1.4	2.4	1.2	1.6	2.8	1.1	320	WC 120
CTT 350	350	1100	≤ 1	115	1.7	2.9	1.2	1.6	3.2	1.1	360	WC 120
CTT 350 L	350	1100	≤ 1	130	1.7	4.3	1.4 [2]	3.6	4.2	1.6	840	WC 120
CTT 400	400	1100	≤ 2	115	1.9	3.0	1.2	1.6	3.3	1.1	400	WC 120
CTT 400 L	400	1100	≤ 2	130	1.9	4.4	1.4 [2]	3.6	4.3	1.6	880	WC 120
CTT 600	600	1700	≤ 2	115	2.4	4.4	1.2 [1]	2.7	4.4	1.1	500	WC 120
CTT 600 L	600	1700	≤ 2	130	2.4	5.5	1.4 [2]	3.6	5.1	1.6	900	WC 120
CTT 700 L	700	1800	≤ 5 [4]	130	2.8	5.8	1.4 [2]	3.6	5.3	1.6	900	WC 120
CTT 800 L	800	1900	≤ 5 [4]	130	3.2	6.7	1.4 [2]	3.6	6.0	1.6	1000	WC 120
CTT 800 XL	800	1900	≤ 5 [4]	165	3.2	8.1	1.8 [3]	4.9	6.8	2.1	1000	2 x WC 120 [5]

[1] Width with boom 2.6 m
[2] Width with boom 4.2 m
[3] Width with boom 4.6 m
[4] ≤ 2 pC at 600 kV
[5] Please contact Haefely Trench

Standard version
(with manual jacking system)



L version
(with motorised jacking system)



B=width of termination

WC 120 Water Conditioning Unit

The water conditioning unit is used to remove the heat generated by the current flowing through the water and to deionize the water that circulates through the terminations.

In the AC mode, the terminations and water conditioning unit form a closed water circuit. Since the treated deionized water remains in the system, the consumption of deionization resin is minimised.

WC 120

Water capacity (deionized water [l]	500
Max. temperature (deionized water)[°C]	60
Conductivity control range [µS/cm]	0.1-2
Max. cooling capacity [kW]	120
Max. ambient temperature [°C]	35
Min. ambient temperature [°C]	3
Max. cooling water temperature [°C]	20
Min. flow rate in external cooling circuit [l/min]	85
Hose connection, external cooling circuit	1”
Bayonet connection for terminations	3/4”
Weight (without water) [kg]	450
Length [m]	1.2
Width [m]	1.4
Height [m]	1.7
Power supply [50/60 Hz]	230 V / 20 A

Control unit type 218

WC 120

Special features

- Operating modes are selected by pressing a button; it is not necessary to operate valves manually
- Toggle switch changes operating modes from impulse to AC; no change to water connections necessary
- Cooling capacity up to 120 kW in a compact unit
- 500 liter tank for deionized water ensures large thermal time constant
- Fully automatic conductivity control (control range 0.1 to 2,0 µS / cm
- Control module of water conditioning unit can be built into a separate Haefely Trench control desk. (max. separation distance 30 m)
- Separate, readily accessible container for deionization resin
- All components used are corrosion-resistant
- Self-priming pumps eliminate start-up problems

After Sales Service and Factory Tests

Technical Support services

A cable test termination is always part of a complete system which typically consists of a high-voltage source,test object, measuring instruments, high-voltage connections, earth connection and cooling water supply

The support provided by our specialists during installation, system integration, and initial operation activities as well as the training on the operating personnel ensure that the test terminations are optimally used.

Tests include:

Terminations

Type testing (with cable)

- PD measurement at U_n
- Voltage test at 1.2 x U_n
- Impulse voltage test with U_L negative polarity
- 2 hours thermal stability test at U_n with water conditioning unit

Routine Tests
(without cable)

- Mechanical test
- Test for pressure and water tightness
- PD measurement at U_n from CTT 350 up
- Voltage tests at 1.2 x U_n from CTT 350 up

Water Conditioning Units

Routine tests

- Control unit test
- Functional test
- Operating test at increased pressure (2.5 bar)

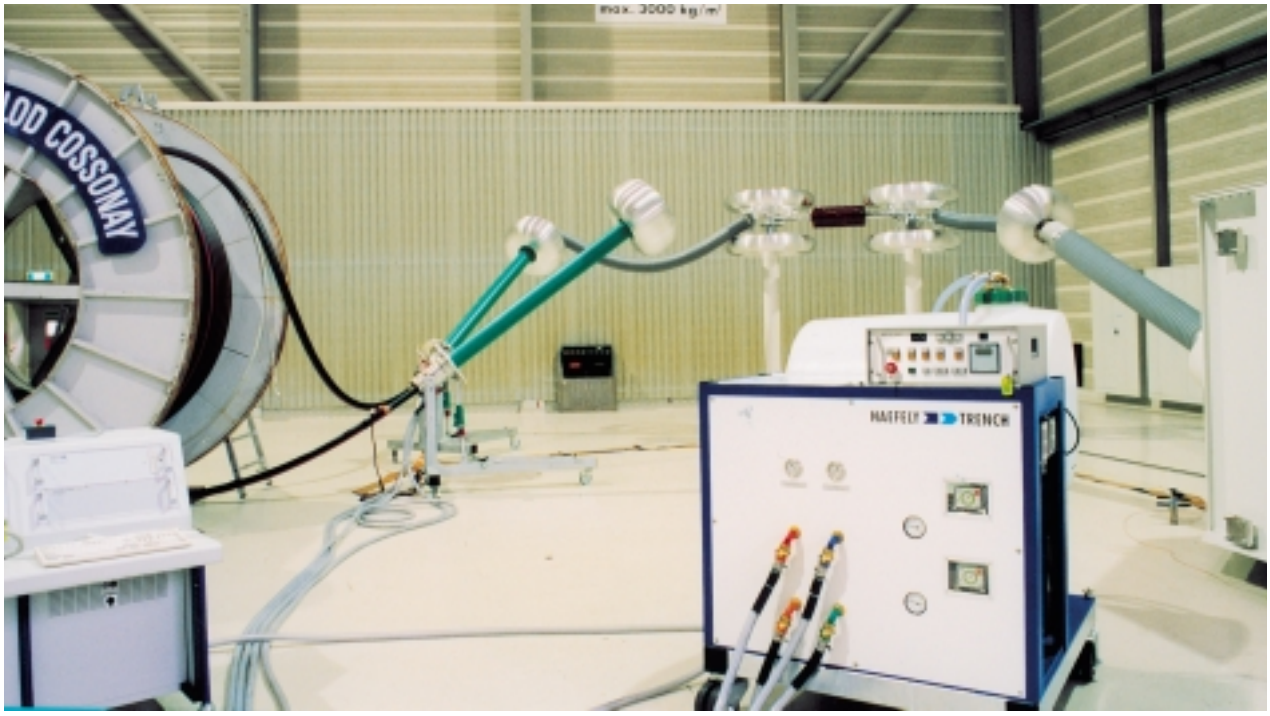
Acceptance Tests

The acceptance test at the factory in the presence of the customer is not a part of the standard delivery schedule. However, such an acceptance test can be arranged. An acceptance test consists of:

- Voltage test at 50 Hz, 1.2 x U_n without cable (at U_n with cable)
- Lightning impulse voltage tests with U_L neg. polarity (according to IEC 600 60-1)

The above tests can be carried out with a cable if the customer provides a correctly prepared one.

Ordering Text	Code	Scope of Supply
Termination system for cable testing	CTTS. . .	2 test terminations on separate trolleys with one mould for seals, including silicone sealing compound for 4 seals 1 water conditioning unit with four 1" hoses, each 12 m long 50 liters of deionization resin (non-regenerable) 1 replacement filter bag for resin 1 replacement parts case
1 pair of terminations	CTT. . .	2 test terminations on separate trolleys with one mould for seals, including silicone sealing compound for 4 seals
Repair kit	CTT RS	1 repair kit for termination tubes
Replacement outer tube	CTT A. . .	1 replacement outer tube
Replacement inner tube	CTT I . . .	1 replacement inner tube
Silicone sealing compound	CTT SD	5 kg silicone sealing compound
Water conditioning unit	WC 120	1 water conditioning unit with four 1" hoses, each 12 m long 50 liters of deionization resin (non-regenerable) 1 replacement filter bag for resin 1 replacement parts case
Deionization resin	WC MB 5	50 liters of deionization resin (non-regenerable)
Filter bag for resin	WC FB	1 replacement filter bag for resin



110 kV power cable under test conditions

Subject to change without notice
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