

## COMBINED SENSOR & PLC COUPLER OVER MEDIUM-VOLTAGE POWER LINES



### DESCRIPTION OF CAMS-10/RC

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## SAFETY SYMBOLS



**WARNING OR CAUTION:**

This symbol denotes a hazard. Not following the indicated procedure, operation or alike could mean total or partial breakdown of the equipment or even injury to the personnel handling it.



**NOTE:**

Information or important aspects to take into account in a procedure, operation or alike.

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# **1 INTRODUCTION**

## **1.1 GENERAL**

The CAMS-10/RC is designed to solve, with a single element, voltage measurement and Powerline Communications (PLC) transmission through Medium Voltage (MV) lines for overhead and underground cable, in masonry switchgear and air insulated switchgear (AIS).

The CAMS-10/RC, when used in combination with two other voltage measuring elements such as the DRMT-1, provides a three-phase solution for distribution grid monitoring.

Measuring line voltage is carried out by a resistive divider circuit.

The PLC transmission is achieved through a coupling capacitor together with protection, matching and isolating elements.

## **1.2 CONSTITUTION**

The CAMS-10/RC consists of two blocks, CEMC-10/RC and ESMC-10/RC, assembled together to form a compact assembly.

The external appearance of the CAMS-10/RC is shown in Figure 1, and its simplified block diagram in Figure 2.

The CEMC-10/RC block (piece 1) contains the High Voltage resistance (R1), necessary for the resistive divider intended for voltage measurement, and the High Voltage coupler capacitor (Ca), necessary for the transmission of the PLC signals at High Frequency.

The ESMC-10/RC block (piece 2) contains the Low Voltage resistance (R2), used for the resistive divider intended for voltage measurement, the matching unit, the protection elements, the ground connection and mounting elements, as well as the elements for connecting the communication equipment (TNC at the bottom) and the monitoring equipment (TNC at the top).

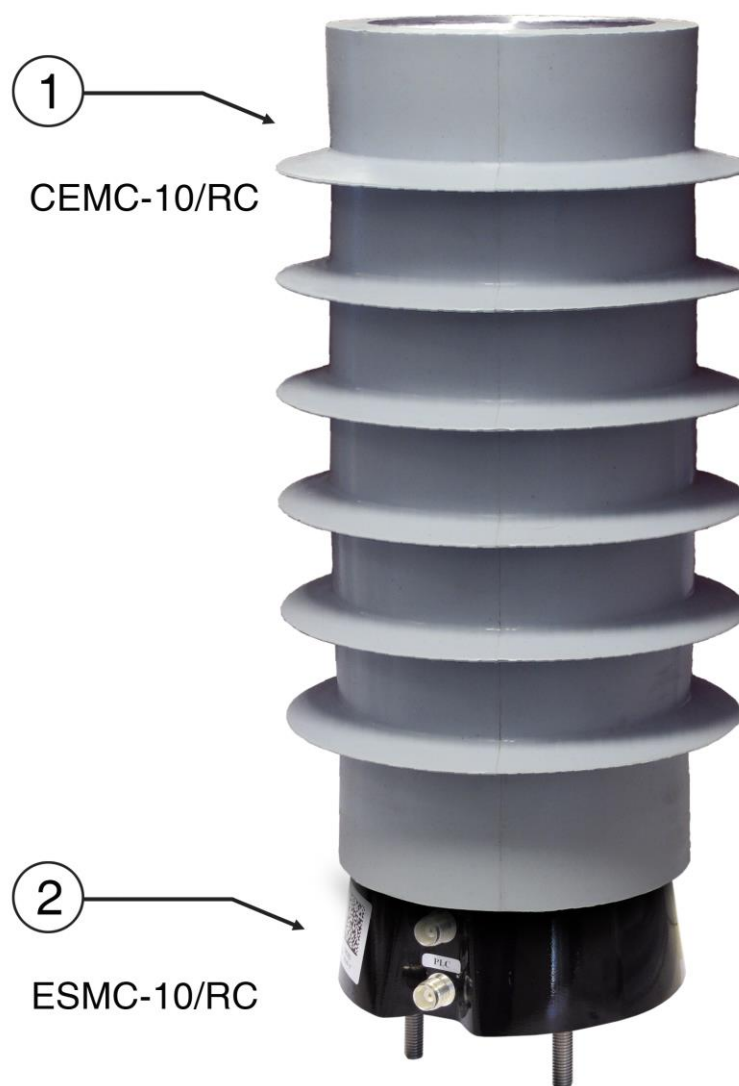


Figure 1 External appearance of the CAMS-10/RC

The matching unit is made up of an isolating transformer, which matches the primary impedance of the phase-to-earth coupling (line side) to the secondary one (equipment side).

Concerning the protection elements there are three gas surge arresters, one in each winding of the isolation transformer, and one in the Low Voltage output.

The **PLC** connector metallic section is NOT grounded, so the connection to the communication equipment is **balanced**.

The **MEASUREMENT** connector metallic section is grounded, so the connection to the monitoring equipment is **unbalanced**.

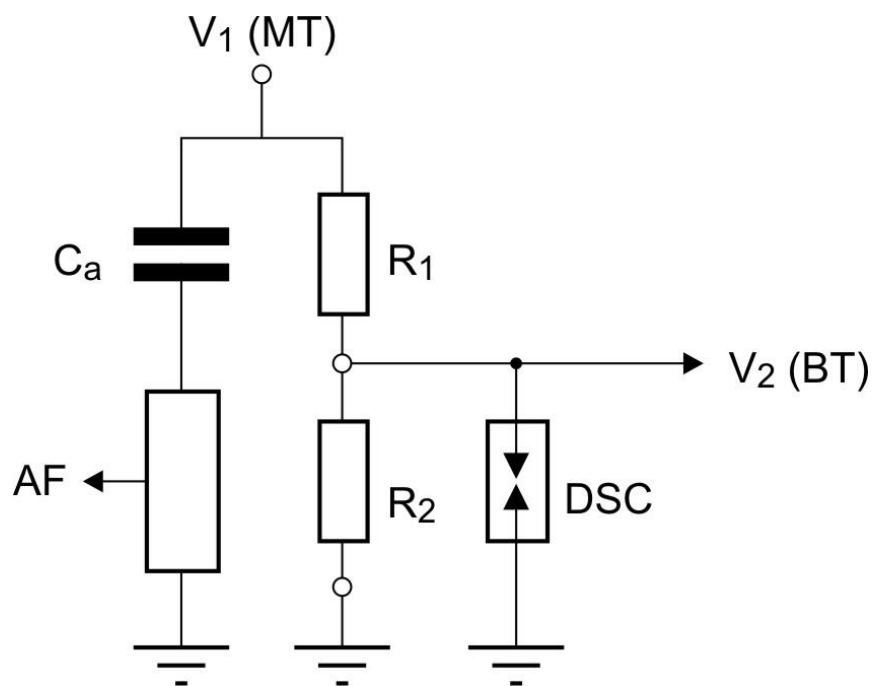


Figure 2 Block diagram of the CAMS-10/RC

**1.3 TECHNICAL CHARACTERISTICS****1.3.1 Electrical characteristics**

Connection type	Phase-to-ground
Use	Indoor and outdoor
Maximum system voltage	24 kV <sub>rms</sub> (phase to phase)
Nominal coupling capacity	10 nF (±15%)
Isolation of ESMC-10/RC block	5 kV <sub>rms</sub> /1 min
Creepage distance (piece 1)	600 mm
Apparent power (S) consumed	P = 1.33 W (at 20/√3 kV) Q = 418.88 Var (at 20/√3 kV)
Sensor divider nominal ratio <sup>(1)</sup>	N = 10000 ±1% for the operating temperature range
Sensor phase shift <sup>(2)</sup>	<1° for the operating temperature range
Accuracy	± 1 % (Class 1 according to UNE-EN 60044-7)
Load impedance	Z <sub>L</sub> ≥ 10 MΩ and C <sub>L</sub> ≤ 400 pF

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<sup>(1)</sup> The impedance of the measurement equipment have an effect on the nominal ratio. It is recommended an impedance higher than 10 MΩ.

<sup>(2)</sup> The connection cable capacity have an effect on the phase.

**Individual tests**

Dielectric strength (50 Hz/1 min)	50 kV <sub>rms</sub> according to UNE 21333 (IEC 60358)
Partial discharges	<10 pC at 16.63 kV <sub>rms</sub> ( $1.2V_{max} / \sqrt{3}$ )

**Type tests**

Dielectric strength (50 Hz/1 min) <sup>(3)</sup>	50 kV <sub>rms</sub> according to UNE 21333 (IEC 60358)
Impulse voltage (1,2/50 μs) <sup>(3)</sup>	125 kV with 15 (+) and 15 (-) shots according to UNE 21333 (IEC 60358)
Partial discharges <sup>(3)</sup>	<10 pC at 16.63 kV <sub>rms</sub> ( $1.2V_{max} / \sqrt{3}$ )

**1.3.2 Transmission characteristics**

Nominal frequency range	100 kHz ÷ 1 MHz (with insertion losses < 1 dB for line impedance of 200 Ω).  Up to 10 MHz (with insertion losses < 2 dB for line impedance of 200 Ω)
Nominal impedance of the PLC terminal	50 Ω
Line characteristic impedance	200 Ω ÷ 400 Ω
Coupling insertion losses	See Figure 3

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<sup>(3)</sup> Values were measured by the TECNALIA laboratory (Baracaldo).



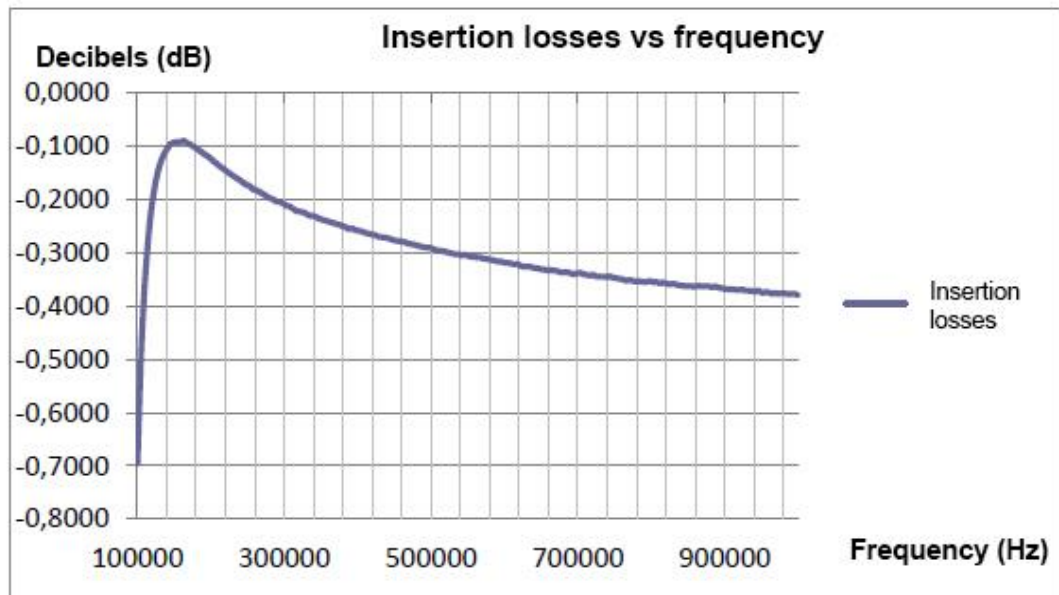


Figure 3 Insertion losses (dB/Hz) for 200 Ω line impedance

1.3.3 Protection elements

Gas surge arrester

Quantity	Three: one in each winding of the isolation transformer, and one in the low voltage output
Model	CG2-350
Nominal voltage	350 V <sub>p</sub>
Nominal AC discharge current	20 A (10 x 1 s)
Nominal impulse discharge current	20 kA (10 shots of 8/20 μs)

## 1.3.4 Mechanical characteristics

PLC connection	By means of TNC connector (balanced) and RG-213/U cable. Upon request, the unit can be delivered with 12 meters of RG-58 coaxial cable or another type of cable and/or connector
Measurement connection	By means of TNC connector referred to earth (unbalanced) and RG-213/U cable. Upon request, the unit can be delivered with 12 meters of RG-58 coaxial cable or another type of cable and/or connector.
Phase shift per meter of the cable (RG-58 or similar)	0.017°/m.  The cable capacitance can considerably affect the relative angle variation between the low-voltage terminal and the high-voltage terminal. For example, 20 meters of RG-58 coaxial cable cause a shift of 0.34°
Line connection	By means of A2-70 stainless steel M16 hexagon-head screw x 30 mm
Connection to earth/mounting	By means of three A2-70 stainless steel M8 rods (see anchoring template in Figure 6).
Dimensions of CEMC-10/RC block	See Figure 4
Dimensions of ESMC-10/RC block	See Figure 5

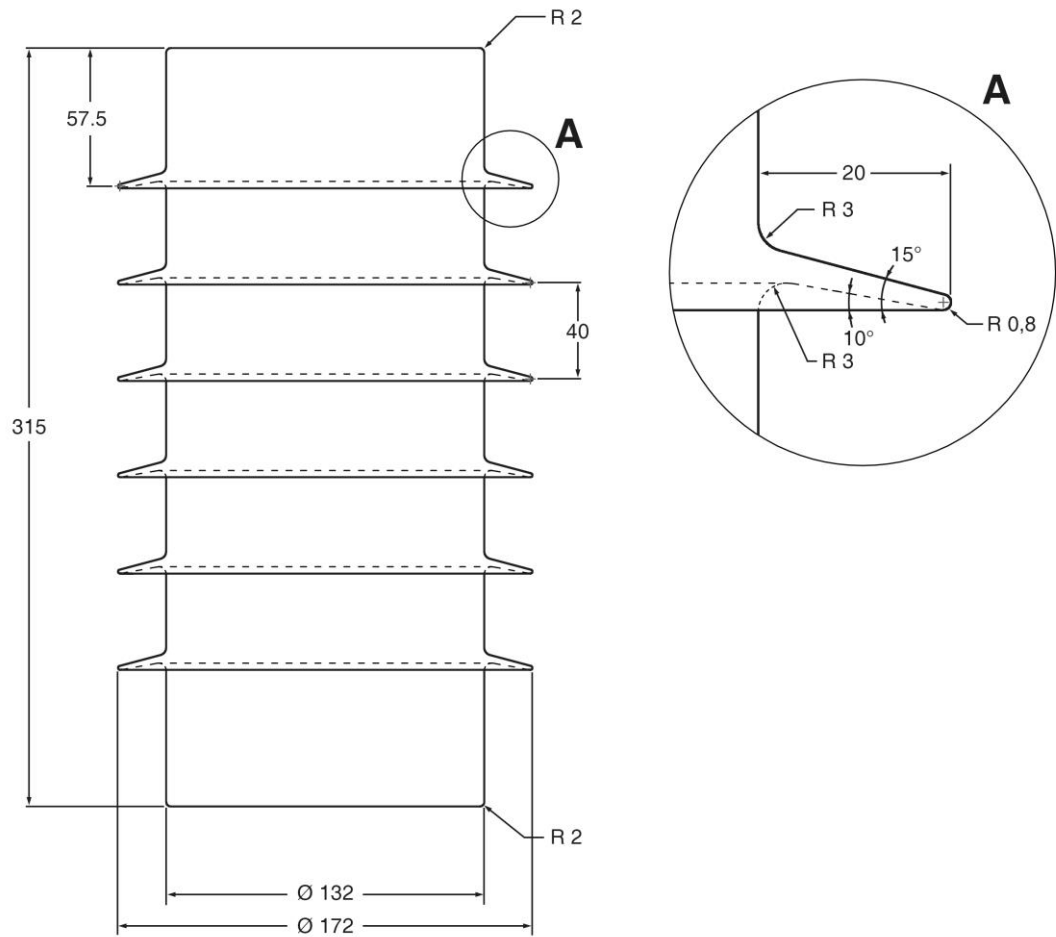


Figure 4 Overall dimensions of CEMC-10/RC block

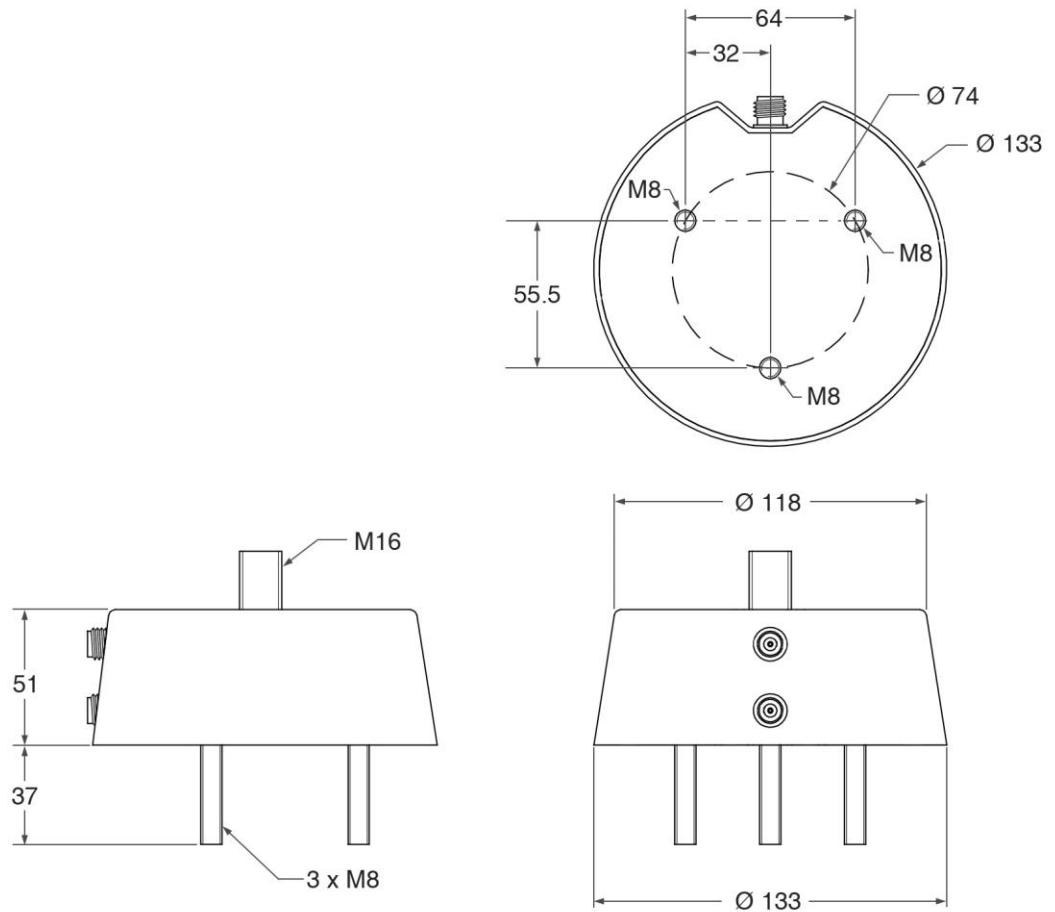


Figure 5 Overall dimensions of ESMC-10/RC block

## CAMS-10/RC

Shed diameter	172 mm
Whole length	403 mm
Whole weight	8.9 kg
Encapsulation material	Silicone and epoxy resin (Piece 1: CEMC-10/RC). Polyamide and fiberglass and epoxy resin (Piece 2: ESMC-10/RC)
Line-connection torque	A value of 80 Nm is recommended
Fixing torque	A value of 10 Nm is recommended

### 1.3.5 Operating and storage conditions

Temperature range	From -20°C to +65°C
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## 2 INSTALLING THE CAMS-10/RC

### 2.1 WARNINGS BEFORE INSTALLING



- !
1. The CAMS-10/RC must be installed and handled following the safety standards (EN 50110-1 and EN 50110-2).
  2. Special attention should be paid to the following aspects:
    - Only qualified personnel appointed by the electricity company that owns the installation should carry out the installation and handling of the unit.
    - The safety measures and prevention of risks established by the electricity company that will use these devices for this activity have to be taken into consideration.
    - The voltage of the medium-voltage power line should be eliminated and the conductors connected to ground.
    - The environment in which it is to operate should be suitable for the CAMS-10/RC, fulfilling all the conditions indicated in section 1.3, *Technical characteristics*.
  3. ZIV will not accept responsibility for any injury to persons, installations or third parties, caused by the non-fulfilment of points 1 and 2.

## 2.2 INSTALLATION

This section describes the steps for the connection of the equipment.



In overhead installations, the different cables must be properly secured since the unit may suffer from wind vibration.



The ESMC-10/RC and CEMC-10/RC blocks are assembled in the factory so that they fit together perfectly with each other. Therefore, the two blocks must always work together and at no time cannot be disassembled.

### 2.2.1 Fastening and connection to ground

The CAMS-10/RC is suitable for indoor and outdoor applications. When used indoors, it is usually housed in transformer stations or substations, inside different types of cabins or cells such as masonry switchgear and air insulated switchgear (AIS). When used outdoors, it is installed in overhead medium-voltage distribution lines (see examples in Figure 8 and 9).

The unit location must be decided taking the minimum clearance distance between the high-voltage terminal and other live elements and between the cabin earthed metallic parts, and the walls and non-insulated parts of the cabin into account.

Minimum air clearances, based on IEC 60071-1:2006 standard, are indicated as guidance in Table 1. However, with regard to this table, the clearances specified in the current version of the standard must always prevail.

Rated Voltage (kV)	Distance (mm)
3.6	60
7.2	90
12	120
<b>24</b>	<b>220</b>

Table 1 Minimum distances between the high-voltage connection and other live elements and earth metallic parts

In order to maximize the transmission features, connections to the MV power line and ground must be as short as possible.

Once the location has been decided:

1. Drill the holes in the prefabricated metallic structure, cell fittings or wall or ground of the metallic cell according to the anchoring template (see Figure 6).

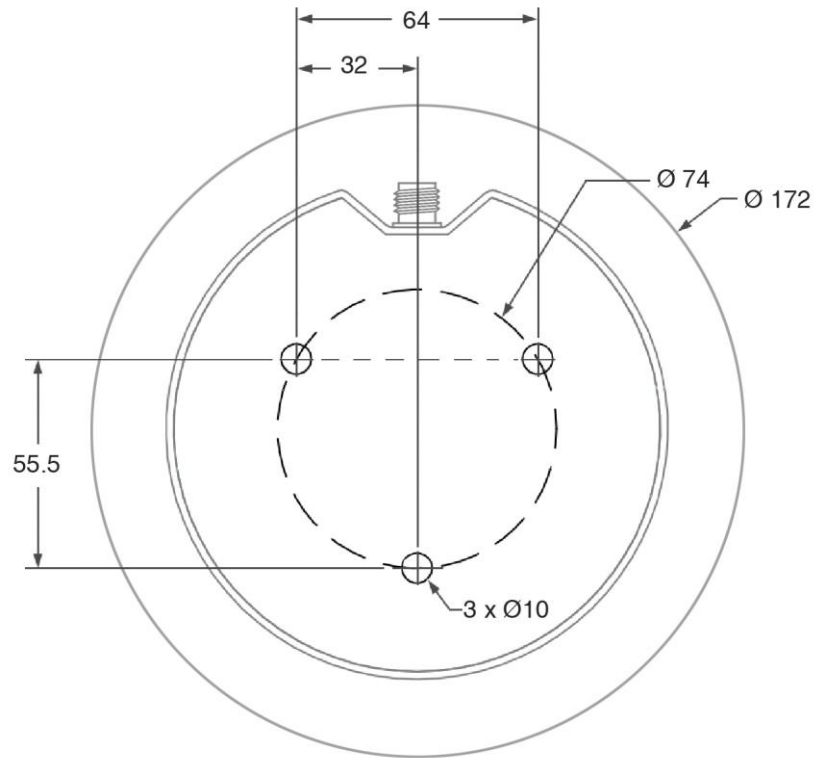


Figure 6 CAMS-10/RC anchoring template

2. Fix the unit to the base chosen in the previous point by means of the three M8 rods of the ESMC-10/RC block and the M8 nuts and washers supplied (see Figure 7).  
A torque of 10 Nm is recommended.
3. Make the ground connection. Make sure that one of the M8 rods of the ESMC-10/RC block is grounded by means of an extra cable of at least 16 mm<sup>2</sup> of section.



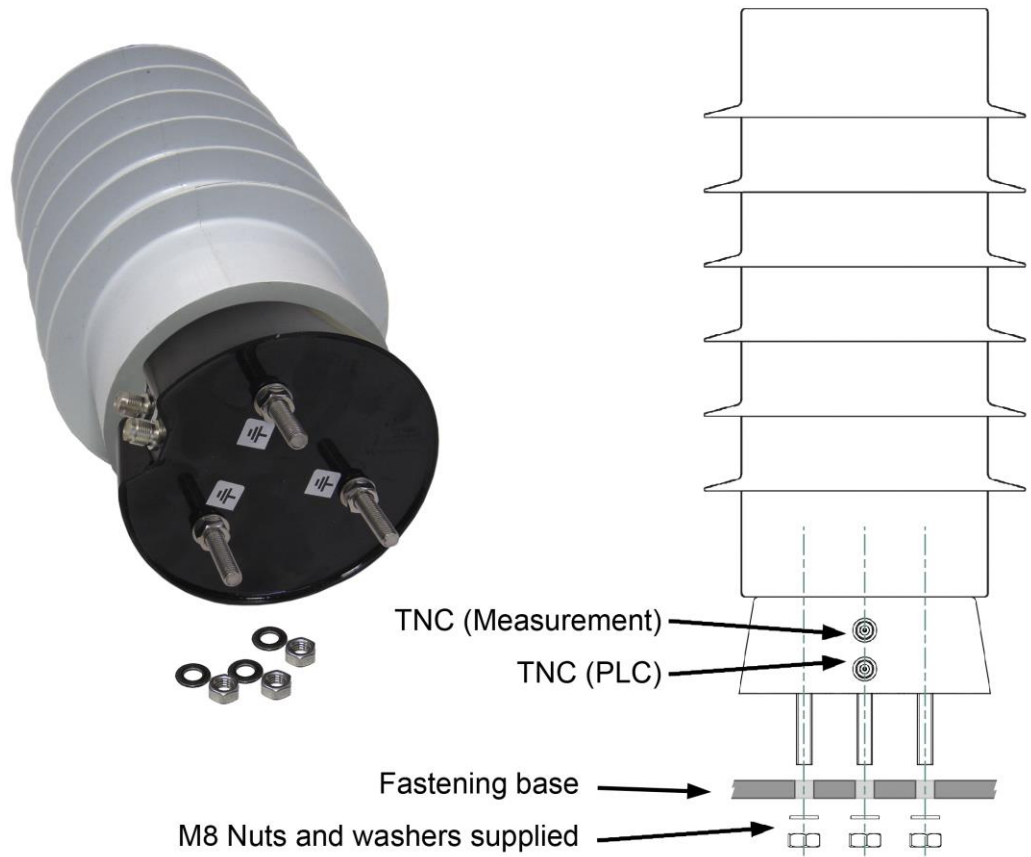


Figure 7 Fastening of the CAMS-10/RC unit



Figure 8 Example of fitting attached to the electrical tower



Figure 9 Example of installation of the CAMS-10/RC in overhead line

**2.2.2 Electrical connection to the medium-voltage power line**

The connection to the medium-voltage power line is carried out by means of the M16 hexagon-head screw x 30 mm, located at the top of the CEMC-10/RC block.

As can be seen in Figure 10, connect the MV cable to the screw using the Grower washer and the tubular blade terminal supplied.

A torque of 80 Nm is recommended.

The connection cable must be as short as possible. The recommended minimum section is 16 mm<sup>2</sup>. It must also be flexible in order to maintain the connection shape that complies with the distances indicated in Table 1.

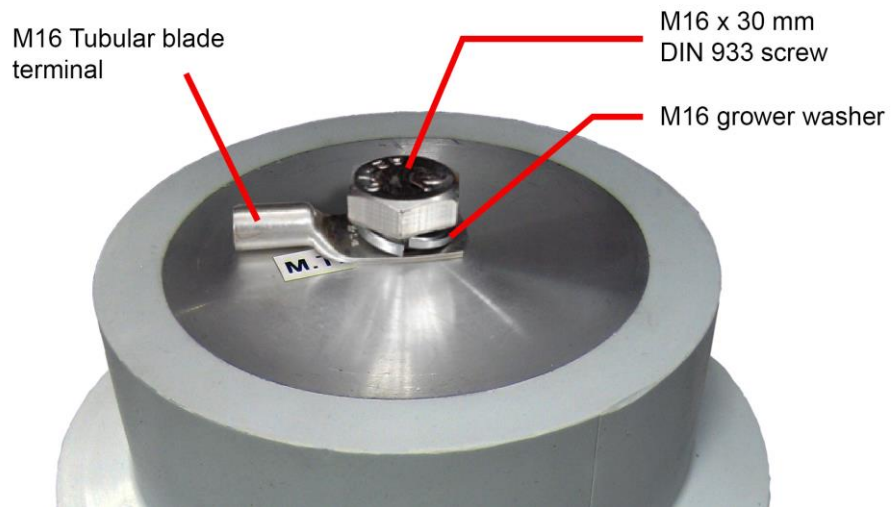


Figure 10 Fixing of the line connection flexible cable to the M16 screw

## 2.2.3 Connection to the monitoring equipment

The connection of the cable from the measurement equipment is made in the upper TNC connector of the ESMC-10/RC block, identified as “MEAS (MEASUREMENT)”.

Guidelines for mounting the male TNC connector in the coaxial cable are given in document *Instructions for crimping a TNC connector on RG-213/U cable*.

Upon request, the product can be delivered with 12 meters of RG-58 coaxial cable or another type of cable and/or connector.

It is recommended that the coaxial cable be protected against rodents by protecting it with a corrugated pipe suitable for this type of installation.

## 2.2.4 Connection to the communication equipment

The connection cable from the communication equipment is made in the lower TNC connector of the ESMC-10/RC block, identified as “PLC”.

Guidelines for mounting the male TNC connector in the coaxial cable are given in document *Instructions for crimping a TNC connector on RG-213/U cable*.

Upon request, the product can be delivered with 12 meters of RG-58 coaxial cable or another type of cable and/or connector.

It is recommended that the coaxial cable be protected against rodents by protecting it with a corrugated pipe suitable for this type of installation.