COMBINED SENSOR & PLC COUPLER FOR SYMMETRICAL SEPARABLE TEE CONNECTOR

DESCRIPTION OF ACA-1/RC

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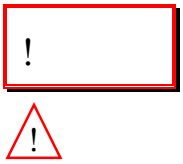
SAFETY SYMBOLS



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.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 GENERAL

The ACA-1/RC is designed to solve, with a single element, voltage measurement and Powerline Communications transmission in medium-voltage (MV) underground cables, as is the case of gas insulated switchgear (GIS).

The ACA-1/RC, when used in combination with two other voltage measuring elements such as the ACA-1/R, provides a complete solution for distribution grid monitoring.

Measuring line voltage is carried out by a resistive divider circuit with a nominal ratio of 10000:1 with an accuracy of 1%.

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

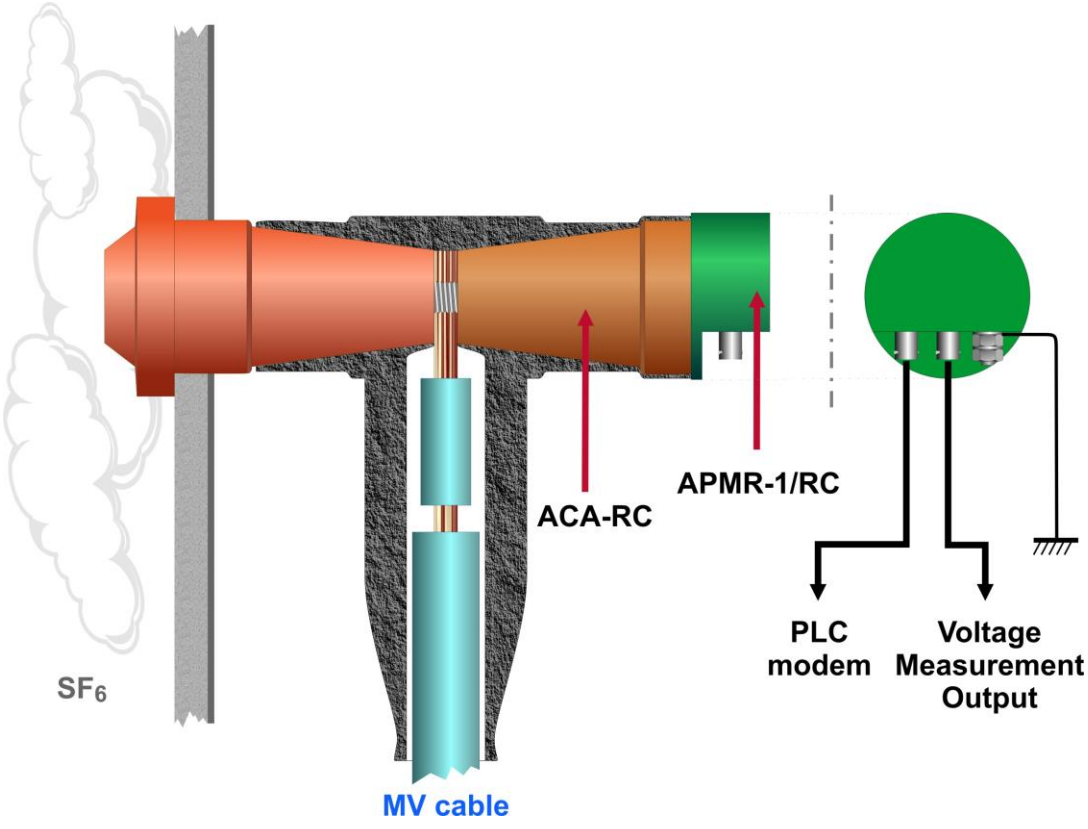


Figure 1 Installation detail of the ACA-1/RC into a symmetrical separable tee connector

1.2 CONSTITUTION

The ACA-1/RC consists of two blocks, ACA-RC and APMR-1/RC, which are assembled together to form a compact assembly.

> Both blocks are set together at factory and they should not be exchanged for another block of other unit.

The block diagram of the ACA-1/RC is shown in Figure 4.

Figure 2 External appearance of the ACA-1/RC

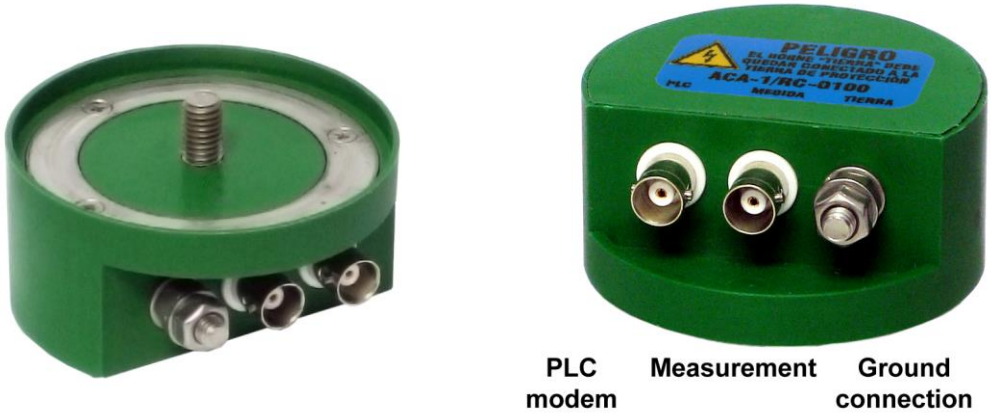
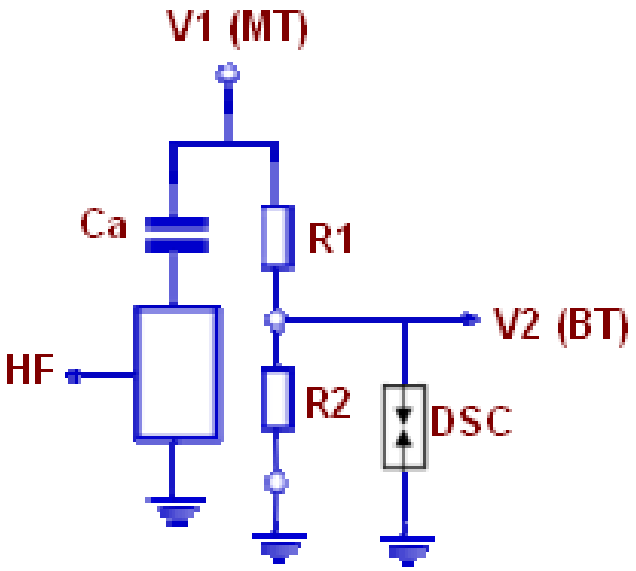


Figure 3 Detail of the APMR-1/RC block connections



NOTE: As in the general case, R1 and R2 may be any combination of series/parallel resistors

Figure 4 Block diagram of the ACA-1/RC

The ACA-RC block is designed to be inserted into a symmetrical separable tee connector for dry insulation cable. It contains the High Voltage resistance (R1), which is necessary for the resistive divider intended for voltage measurement, and the High Voltage coupler capacitor (Ca), which is necessary for the transmission of the PLC signals at High Frequency.

The APMR-1/RC block contains the Low Voltage resistance (R2), which is necessary for the resistive divider intended for voltage measurement, the matching unit, the protection elements, the screw terminal for ground connection (connector 1), as well as the elements for connecting the monitoring equipment (connector 2) and the communication equipment (connector 3).

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**.

The two blocks are assembled together by means, on the one hand, of the central hole of the ACA-RC block and the M8 rod of the APMR-1/RC block and, on the other hand, by means of the metallic contact of the APMR-1/RC block and the four contact points located in the ACA-RC block.

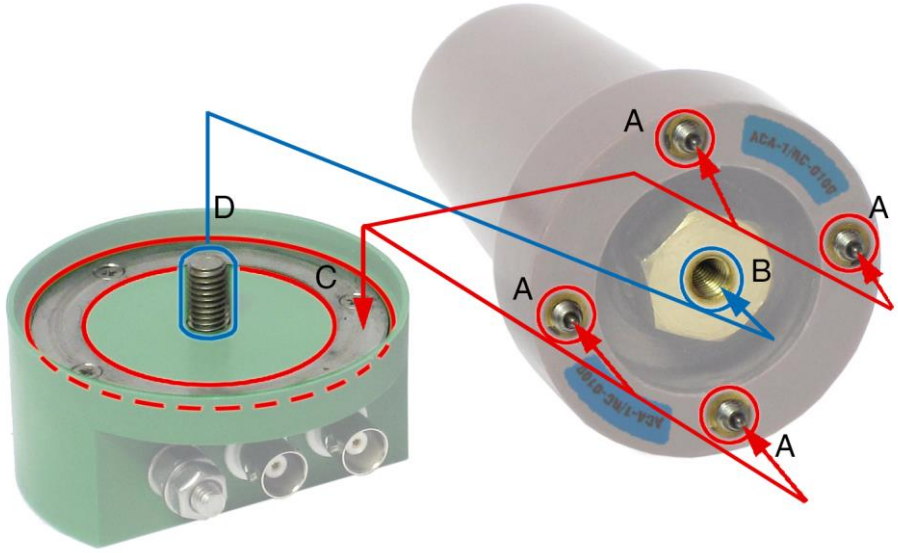


Figure 5 Detail connection of the two blocks

1.3 TECHNICAL CHARACTERISTICS

1.3.1 Electrical characteristics

Connection type	Phase-to-earth
Use	Indoors
Maximum system voltage	24 kV_{rms} (between phases)
Load impedance	$Z_l \geq 10$ MΩ
Load capacitance	$C_l \leq 2.7$ nF
Dielectric strength (50 Hz/1 min)	50 kV_{rms} according to UNE 21333/IEC 60358)
Impulse voltage (1.2/50 μs)	125 kV with 15(+) and 15 (-) shots according to UNE 21333/IEC 60358)
Partial discharges	<5 pC at 16.63 kV_{rms} ($1.2V_{max} / \sqrt{3}$) according to UNE 21333/IEC 60358)
Resistive divider nominal ratio [1]	N = 10000 ±1%
Resistive divider ratio shift (with the temperature)	$\left\|\frac{\Delta N}{N}\right\| < 1\%$ for the operating temperature range
Phase shift [2]	< 1º for the operating temperature range
Accuracy	±1%

[1] The impedance of the measurement equipment have an effect on the nominal ratio. It is recommended an impedance higher than 10 MΩ.
[2] The connection cable capacity have an effect on the phase.

Matching transformer insulation [3]	5 kV_{rms} /1 min
Harmonic distortion and intermodulation	70 dB at 2 MHz

1.3.2 Transmission characteristics

Nominal frequency range	2 ÷ 30 MHz
Nominal impedances	50 Ω
Insertion losses [3]	See graph in Figure 6

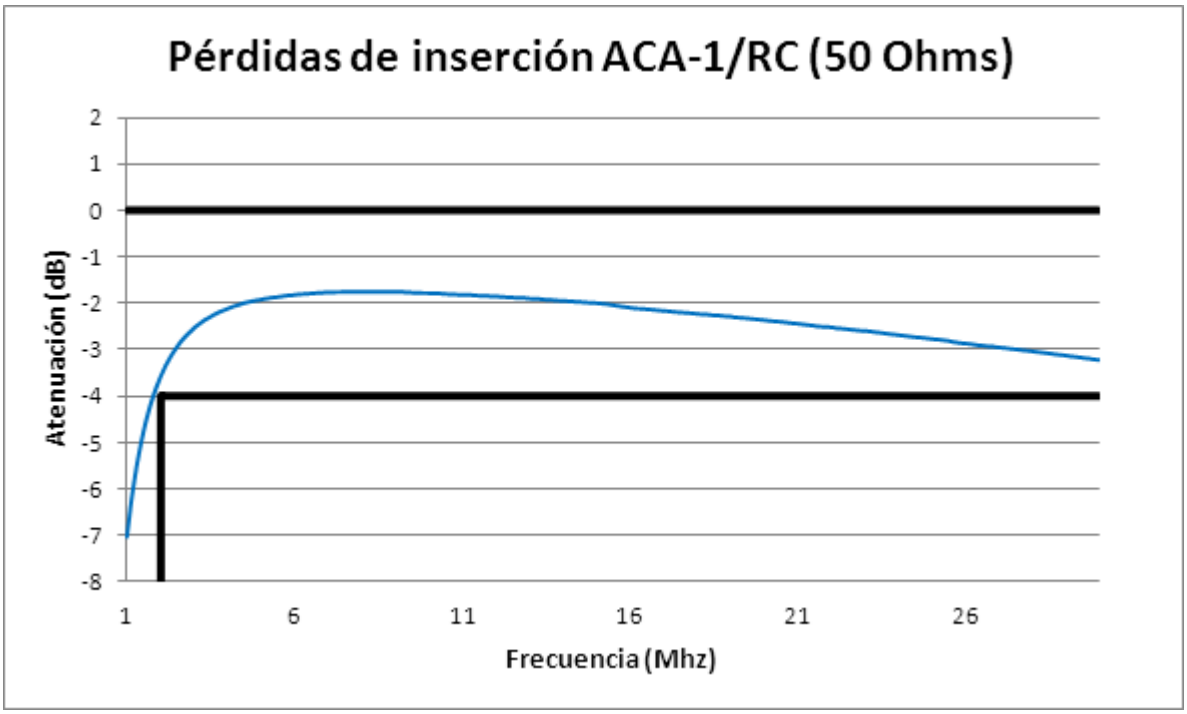


Figure 6 Insertion losses (dB/MHz) for 50 Ω line impedance

[3] The transformers are individually tested.

[3] The insertion losses depend on the generator and line impedances. The graph shows the losses for a 50 Ω impedance generator and 50 Ω impedance line.

1.3.3 Protection elements

Draining to earth of 50 Hz current

Impedance at 50/60 Hz	< 1Ω
Current carried at 50/60 Hz	1 A_{rms} permanently. 50 A_{rms} for 0.2 s

Gas surge arrester

Model	CG-90
Nominal voltage	90 VP
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

Measurement connection	By means of BNC connector and RG-174/U cable (unbalanced)
PLC connection	By means of BNC connector and RG-58 cable (balanced)
Earth connection	By means of A2-70 stainless steel M6 rod
Dimensions of ACA-RC[4] block	See Figure 7
Dimensions of APMR-1/RC block	See Figure 8
Whole length	148 mm

[4] The dimensions of the ACA-RC block are suitable for installation into a symmetrical separable tee connector, the dimensions of which comply with UNE EN-50181 standard.

Encapsulation material	Epoxy resin (Piece 1: ACA-RC). Polyamide and fiberglass (Piece 2: APMR-1/RC)
Whole weight	0.930 kg
Nominal torque of ACA-RC block	See the value specified by the manufacturer. A value from 30 Nm to 40 Nm is recommended. The value should not be higher than 60 Nm
Ground-connection torque	A value below 7 Nm is recommended
Torque between ACA-RC and APMR-1/RC blocks	A value of 10 Nm is recommended

1.3.5 Operating and storage conditions

Temperature range	From -10°C to +60°C
Temperature and humidity	In accordance with EN 60870-2-2 class C2 (climatogram 3K6)
Storage conditions	From -25°C to +70°C

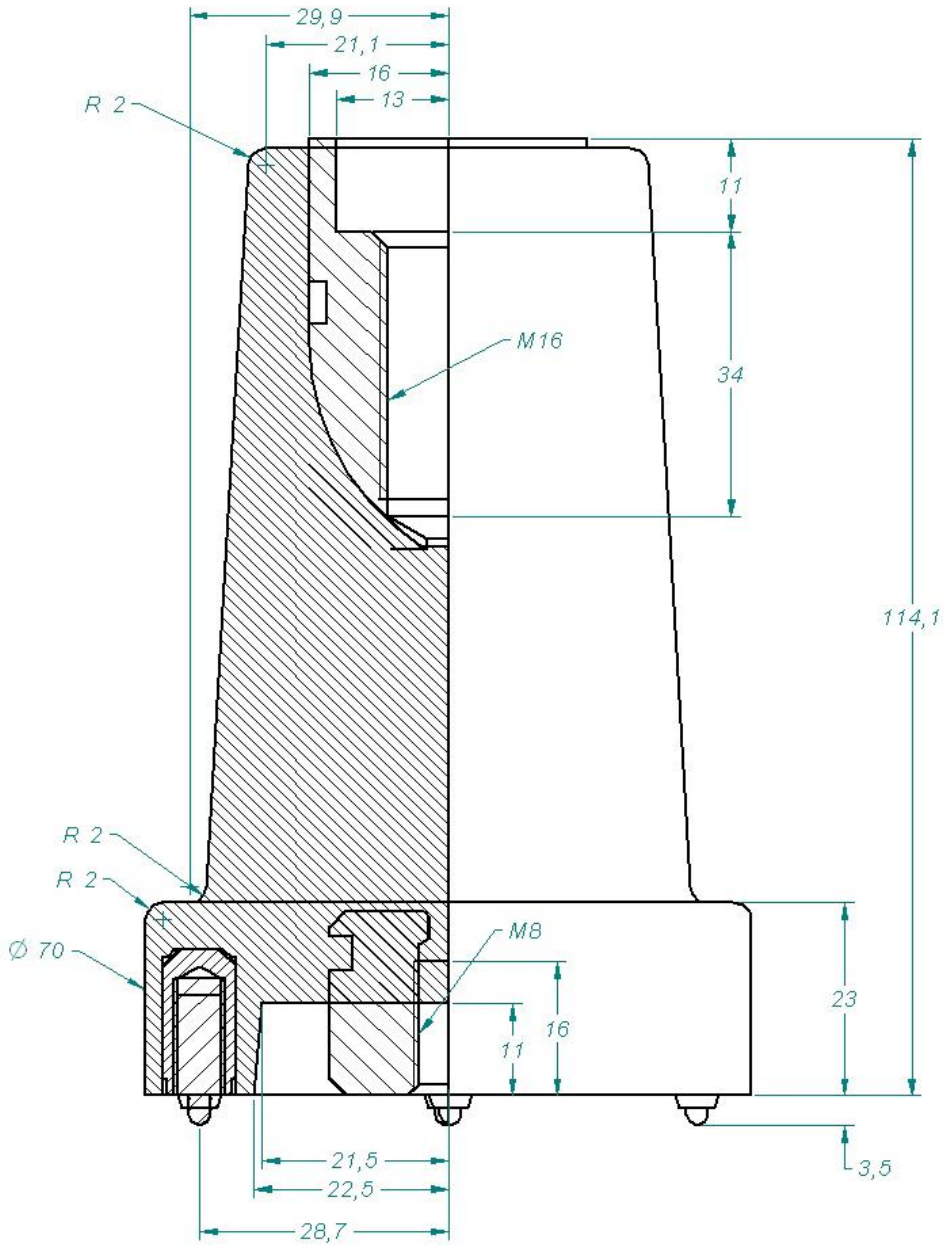


Figure 7 Dimensions of ACA-RC block

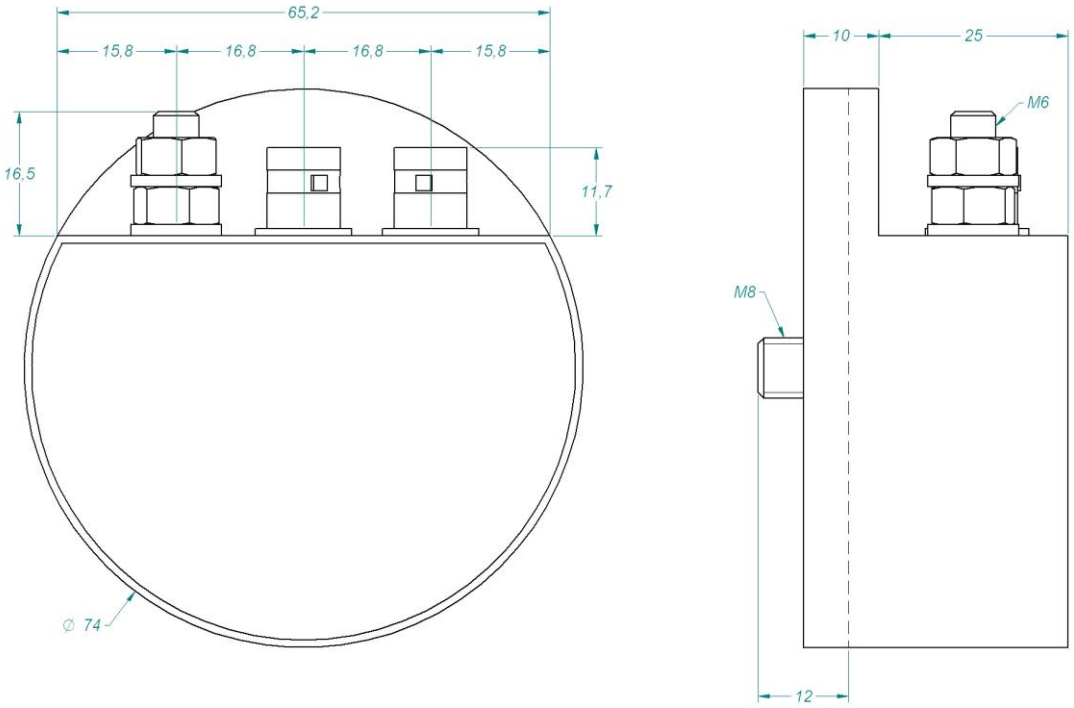


Figure 8 Dimensions of APMR-1/RC block

2 INSTALLING THE ACA-1/RC

2.1 WARNINGS BEFORE INSTALLING

! **1.** The installation of the ACA-1/RC unit in a medium-voltage power line is generically subject to the fulfilment of all the safety measures and prevention of risks established for this type of work by the electricity company that will use these devices and the Safety standards.

2. In order to install and handle the ACA-1/RC unit the following points must be complied with:

- Only qualified personnel appointed by the electricity company that owns the installation should carry out the installation and handling of the ACA-1/RC.
- The ACA-1/RC should only be installed WITHOUT VOLTAGE in the medium-voltage power line, and the conductors have to be connected to ground.
- The environment in which it is to operate should be suitable for the unit, fulfilling all the conditions indicated in section *1.3*, *Technical characteristics*.

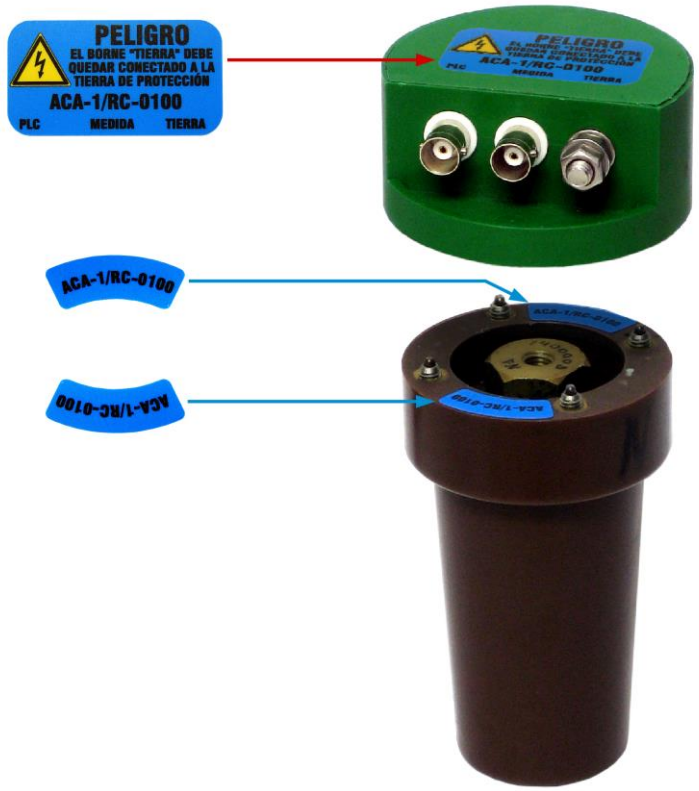
3. ZIV will not accept responsibility for any injury to persons, installations or third parties, caused by the non-fulfilment of points 1 and 2.

2.2 INSTALLATION PROCEDURE

2.2.1 Disassembling the device

ACA-1/RC is comprised of two separate blocks, ACA-RC and APMR-1/RC (see Figure 9), which are assembled together to form a compact unit. In order to make installation easier, the unit must be disassembled by turning it anticlockwise.

⚠ The two blocks that make up the ACA-1/RC are factory set to work together and, therefore, should not be exchanged for another block of other unit.



APMR-1/RC block

ACA-RC block

Figure 9 Unit identification

2.2.2 Installation instructions

Figure 10 shows an installation detail of the two blocks of the ACA-1/RC, and Figure 11 an installation example of the ACA-1/RC.

The instructions for the ACA-1/RC installation are the following:

1. Clean the inside of the T connector (piece 1 in figure 10) and that of the ACA-RC block (piece 2 in Figure 10), making sure that the surfaces are completely dry and there are no traces of liquid.

2. Spread the dielectric silicone grease inside of the T connector and over the ACA-RC block.

3. Put the ACA-RC inside the connector until it begins to screw into the rod. It is advisable to use a fishing rope or nylon wire in order to let the air go out during ACA-RC block insertion. In this case, before inserting the ACA-RC cone completely, do not forget to remove the nylon wire completely, making sure that no part is trapped.

4. Tighten the ACA-RC cone using the torque wrench and the 24 mm socket. The torque depends on the manufacturer of the T connector. Consult the manufacturer instructions. The value should not be higher than 60 Nm.

5. Tighten the APMR-1/RC (a value of 10 Nm is recommended) until the four contact points located in the ACA-RC block come into contact with the metallic contact of the APMR-1/RC (see Figure 5). From here, you have two laps to ensure that the BNC connectors are arranged on the side of interest, usually downwards. Once in the desired position, make sure that the piece is mounted securely.

6. Connect the ground connection to the protection earth nearest the connection of the shield of the phase under transmission (a value below 7 Nm is recommended). The cable must be as short as possible. A 16 mm^2 section is usually enough, as it uses to be the section of the connections of the medium voltage cable shields to ground.

7. Bear in mind the following:

The connection to ground of the ground connection of the APMR-1/RC block is important for the security of the terminals and personnel.

Not carrying out the connection would entail a risk, given that the coupling capacitor would remain connected directly to the output terminals without there being a current flow to ground.

When removing, the two blocks that make up the ACA-1/RC must be removed and replaced with the BASIC INSULATING PLUG, together with the semiconductor plug, recommended by the manufacturers of the plug.

Should it be necessary, due to any circumstance for the ACA-RC to remain connected, the M8 screwed terminal must be remain connected to the protection ground by means a 16 mm^2 section cable.

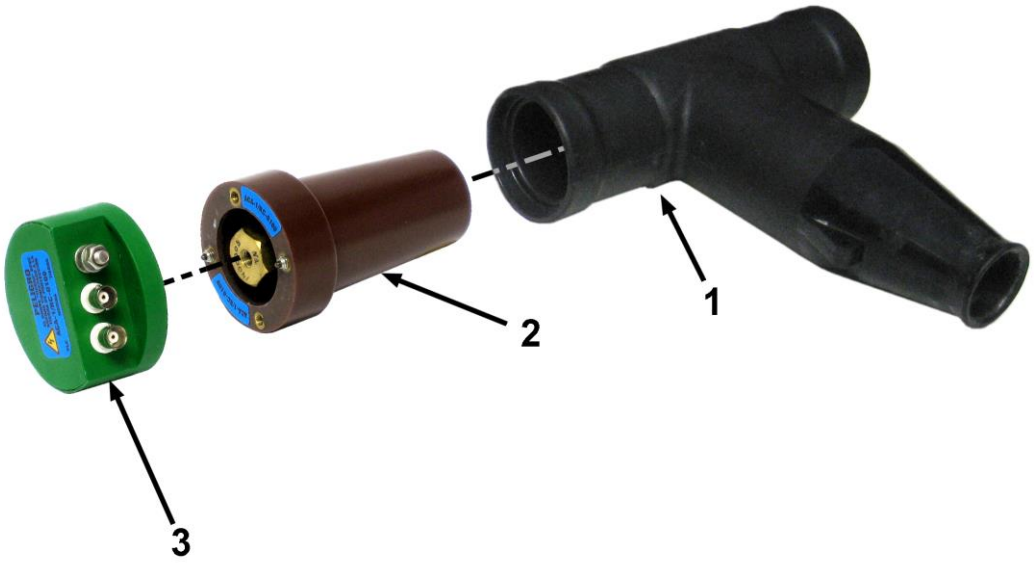


Figure 10 Instructions to assemble the ACA-RC (2) and APMR-1/RC (3) blocks

Figure 11 Example of installation of the ACA-1/RC

2.2.3 Connection to the monitoring equipment

The connection cable between the measurement equipment and the ACA-1/RC must be a 50 Ω impedance characteristic coaxial cable type RG-174U. This cable can be protected, if necessary, against animals by inserting it in a corrugated PVC pipe.

The connection of the cable coming from the monitoring equipment is carried out in the BNC MEASUREMENT connector (middle connector).

> The coaxial cable should first be checked in order to avoid having to carry out a new discharge of the medium-voltage line because the cable is wrong.

First, without connecting the coaxial cable to the ACA-1/RC, an open circuit must be measured at the end of the cable which is communication-terminal side. Second, once the cable is connected to the BNC MEASUREMENT connector, in the said end, an impedance of approximately 20kΩ-30kΩ must be measured. If not measured, the cable is wrong and must be replaced.

2.2.4 Connection to the communication equipment

The connection cable between the communication equipment and the ACA-1/RC must be a 50 Ω impedance characteristic coaxial cable type RG-58. This cable can be protected, if necessary, against animals by inserting it in a corrugated PVC pipe.

The connection of the cable coming from the communication equipment is carried out in the BNC PLC connector (end connector).

> The coaxial cable should first be checked in order to avoid having to carry out a new discharge of the medium-voltage line because the cable is wrong.

First, without connecting the coaxial cable to the ACA-1/RC, an open circuit must be measured at the end of the cable which is communication-terminal side. Second, once the cable is connected to the BNC PLC connector, in the said end, a short circuit must be measured because the transformer of the ACA-1/RC is now present. If not measured, the cable is wrong and must be replaced.