PLC COUPLER OVER MEDIUM-VOLTAGE POWER LINES

DESCRIPTION OF CAMT-5/LS CAMT-5/LSR

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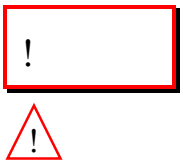
SAFETY SYMBOLS



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 device is a capacitive coupler that allows a high-frequency signal, usually modulated by the communication equipment based on Powerline Communications (PLC) technology, to be injected and transmitted over medium-voltage power lines.

The coupling unit performs the following:

- Transmission of electrical signals in the 2 MHz to 30 MHz band to the MV power line.
- Impedance matching between MV power line and communication equipment.
- Limitation of voltage surges coming from the power line and draining to earth of power frequency current.
- Electrical isolation.

1.2 CONSTITUTION

Figure 1 shows the outside of the coupling unit. The device consists of a coupling capacitor (1), as well as protection, tuning, matching and connection elements (2). All the elements are distributed and encapsulated in two different blocks that are put together to form a compact unit.

The protection elements are the drain coil and two gas surge arresters, one high-voltage side and the other low-voltage side. The tuning circuit is designed to use the unit in the specified frequency range.

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.

As can be seen in Figure 1, the unit can be disassembled in order to make installation easier.

The BNC connector metallic section is not connected to the earth terminal. The output is therefore balanced.

Figure 1 Parts of the coupling unit

1.3 TECHNICAL CHARACTERISTICS

1.3.1 Electrical characteristics

Item code	CAMT-5/LS (*) (*) Under this item code, the manufacturer reserves the right to supply the model CAMT-5/LS or CAMT-5/LSR depending on their production
Coupling type	Phase-to-earth by means of capacitor of 500 pF
MV line maximum voltage	24 kV_{rms} (between phases)
Nominal coupling capacity	500 pF
Dielectric strength (50 Hz/1 min) (1)	50 kV_{rms} according to UNE 21333/(IEC 60358)
Impulse voltage (1,2/50 μs) (1)	125 kV with 15(+) and 15 (-) shots according to UNE 21333/(IEC 60358)
Partial discharges (1)	<5 pC at 16.63 kV_{rms} ($1.2V_{max}$ / $\sqrt{3}$) according to UNE 21333/(IEC 60358)
Matching transformer insulation (2)	5 kV_{rms} /1 min
Creepage distance (piece 1)	685 mm
Distortion and intermodulation	70 dB at 2 MHz
Average power	10 W
Application	Indoors and Outdoors (d-heavy SPS level)

(1) Values were measured by the TECNALIA laboratory (Baracaldo).

(2) The transformers are individually tested. In balanced models the insulation test is repeated once the terminal is manufactured.

1.3.2 Protection elements

Drain coil

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	CG2-230
Nominal AC discharge current	20 A (10 x 1 s)
Nominal impulse discharge current	20 kA (10 impulses of 8/20 µs)

1.3.3 Transmission characteristics

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

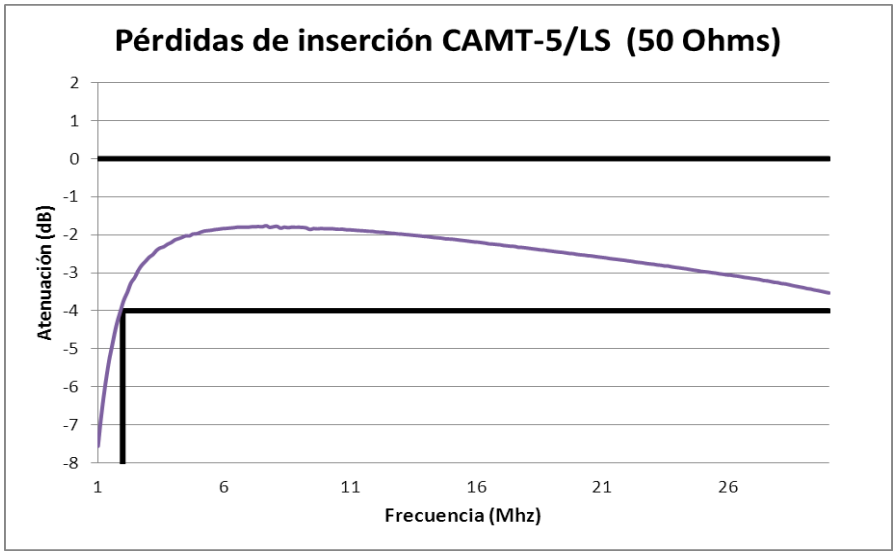


Figure 2 Insertion losses for 50 Ω resistive line impedance

[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.

1.3.4 Mechanical characteristics

Equipment connection	By means of BNC connector and RG-58 cable (Balanced)
Connection to line	By means of A2-70 stainless steel M10 rod or M10 insert of approx. 20 mm in depth
Connection to earth/mounting	By means of A2-70 stainless steel M12 insert of 16 mm in depth for A2-70 stainless steel M12 screw. It is available an external A2-70 stainless steel M8 ground connection
Dimensions	Height: 249 mm, Ø maximum: 110 ± 3,6% mm See Figure 3
Shed diameter	110 ± 3,6%
Encapsulation material	CAMT-5/LS: Silicone (Piece 1: CEMC-5LS). Polyamide and fiberglass (Piece 2: ESMC-5LS) CAMT-5/LSR: Silicone and epoxy resin (Piece 1: CEMC-5LSR). Polyamide and fiberglass (Piece 2: ESMC-5LS)
Whole weight	1.6 kg
Torque between blocks (piece 1 and piece 2)	A value of 60 Nm is recommended
Line-connection torque	A value of 15 Nm is recommended
M8 earth-connection torque	A value of 10 Nm is recommended
Fixing torque	A value from 40 Nm to 50 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 -20°C to +70°C

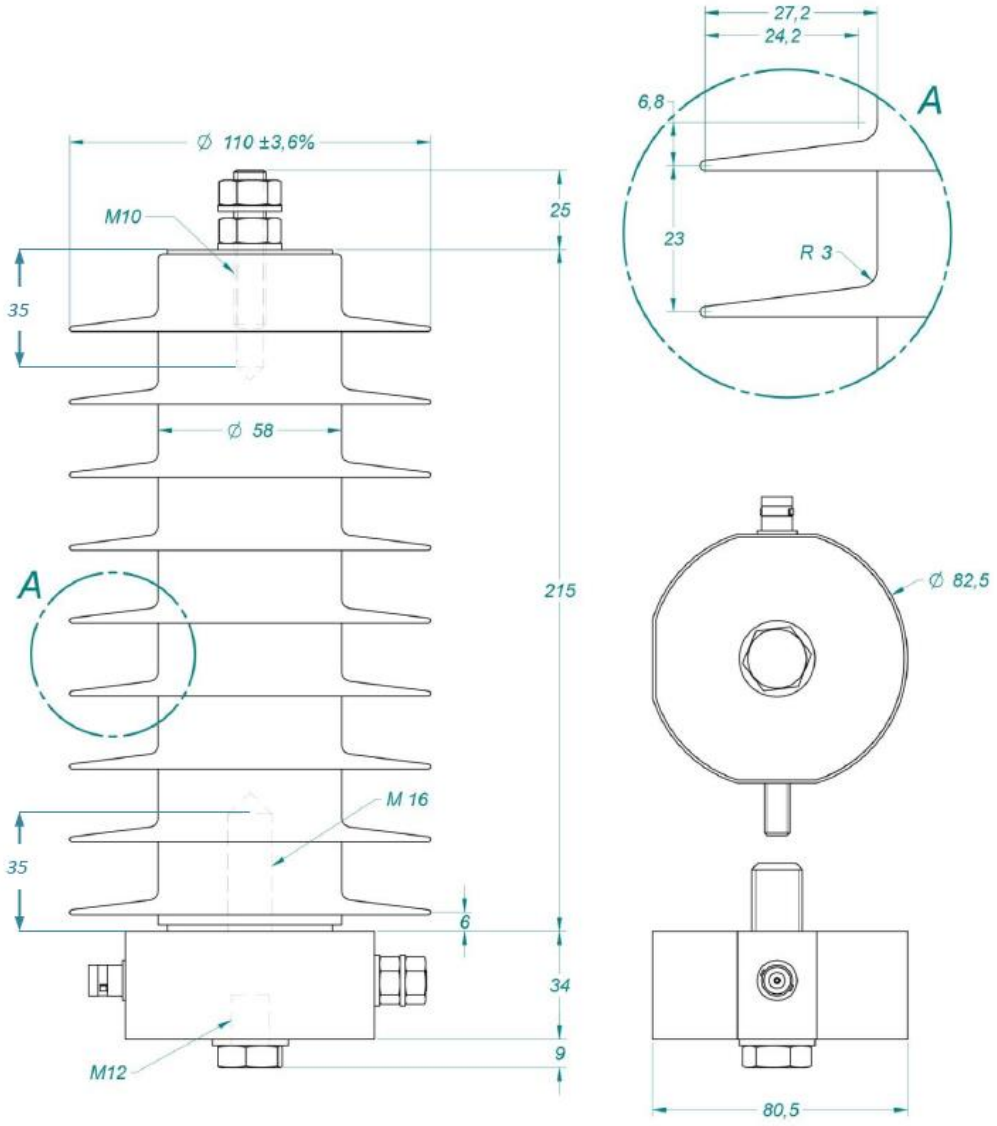


Figure 3 Overall dimensions of the coupling unit

2 INSTALLING THE COUPLER

2.1 WARNINGS BEFORE INSTALLING

! **1.** The coupling unit must be installed and handled following the safety standards (EN 50110-1 and EN 50110-2).

2. Special consideration should be the following:

- Only qualified personnel appointed by the electricity company that owns the installation should carry out the installation and handling of the coupling unit.
- The safety measures and prevention of risks established for this type of work by the electricity company that will use these devices have to be taken in consideration.
- The voltage of the medium-voltage power line should be eliminated and the conductors connected to line.
- The environment in which it is to operate should be suitable for the coupling 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

The installation of the coupling unit involves different steps, beginning with the fastening and connection to earth and ending with the connection to the medium-voltage power line and to the communication equipment.

2.2.1 Fastening and connection to earth

The coupling unit is usually housed in transformer stations or substations, inside different types of cabins or cells, such as: masonry, modular cubicles, SF6 isolated cubicles, etc.

The placement must be decided taking into account the minimum clearance distance between the high-voltage terminal and metallic parts, walls and non-insulated parts of the cell (see Table 1).

Rated Voltage (kV)	Distance (mm)
3.6	60
7.2	90
12	120
24	220

Table 1 Minimum distances between the high-voltage connection 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 position has been decided:

1. Drill a hole for a M12 screw (see Figure 4) in the prefabricated metallic structure, cell fittings or wall or ground of the metallic cell.
2. Fix the coupling unit by means of the supplied M12x16 screw and washer. A torque from 40 Nm to 50 Nm is recommended.
3. Connect the coupling unit to earth with an extra cable of at least 16 mm^2 of section using the external M8 ground connection (a torque of 10 Nm is recommended).

The fastening and connecting to earth of the coupling unit is much easier if the unit is disassembled (see Figure 1).

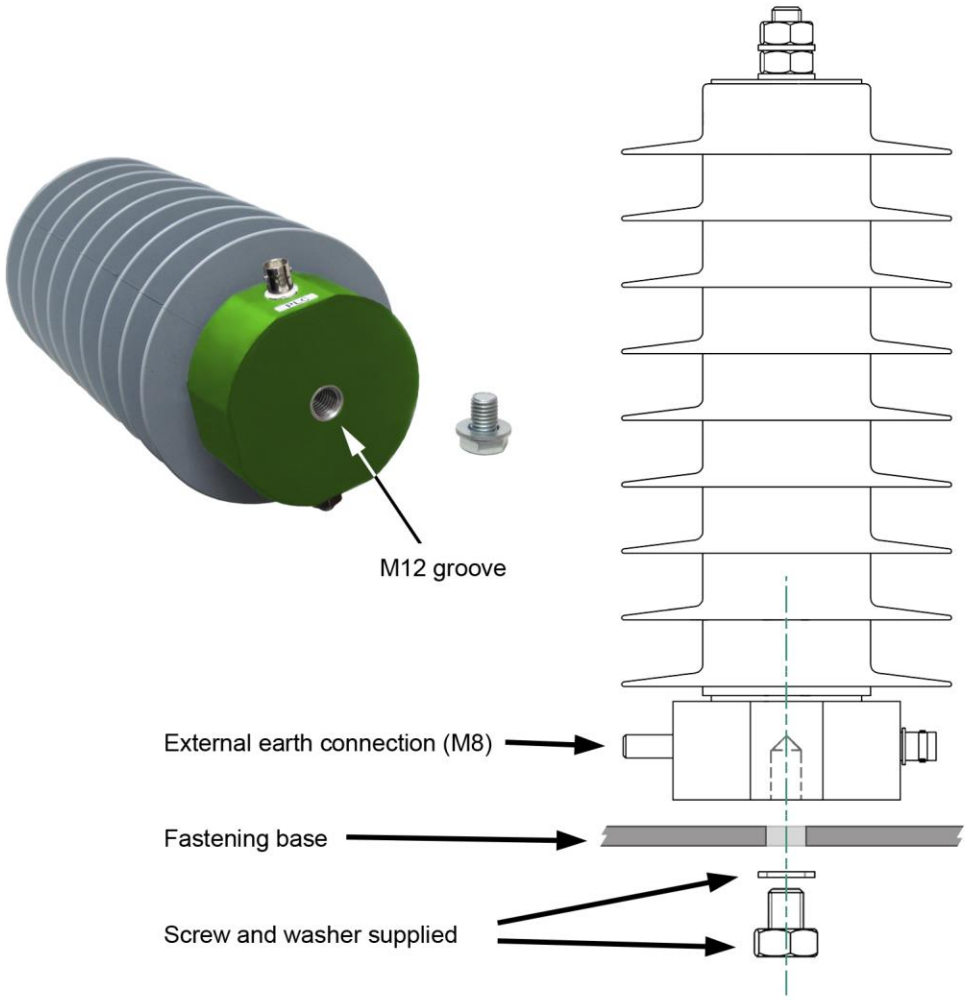


Figure 4 Coupling unit fixing

The following figures show examples of the fastening and connection to earth of the coupling unit. Figure 5 shows how the unit fastening and connection to earth has been carried out using the cell metal surface. In Figure 6, however, the unit has been installed using a specific structure, and the connection to earth has been carried out by means of an extra cable.

Figure 5 Fastening of a CAMT-5/LS unit using the floor of the cell

Figure 6 Fastening of a CAMT-5/LS unit using a specific structure in masonry cells

2.2.2 Electrical connection to the medium-voltage power line

The coupling unit is connected to the medium-voltage power line by means of the M10 rod at the top of the unit (a torque of 15 Nm is recommended). The cable is fixed to the rod by means of two nuts and two washers, in the order shown in Figure 7.

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

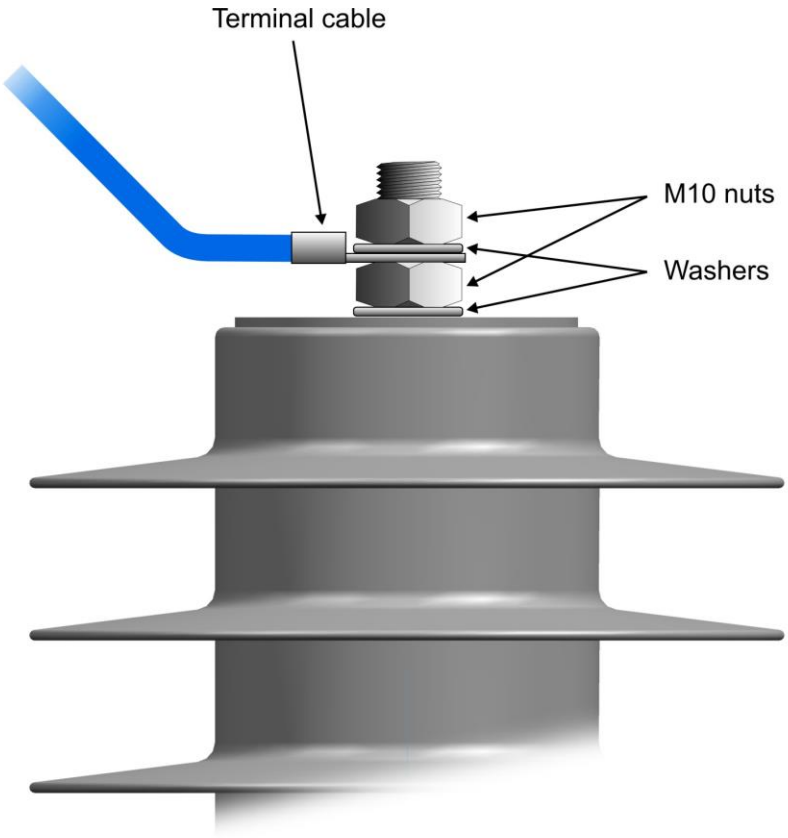


Figure 7 Fixing of the flexible connection line cable to the M10 rod

The M10 rod can be removed from the unit by means of a number 5 ALLEN spanner. Once removed, a M10 screw base of approximately 20 mm in depth is then available for the installation of the user rod.

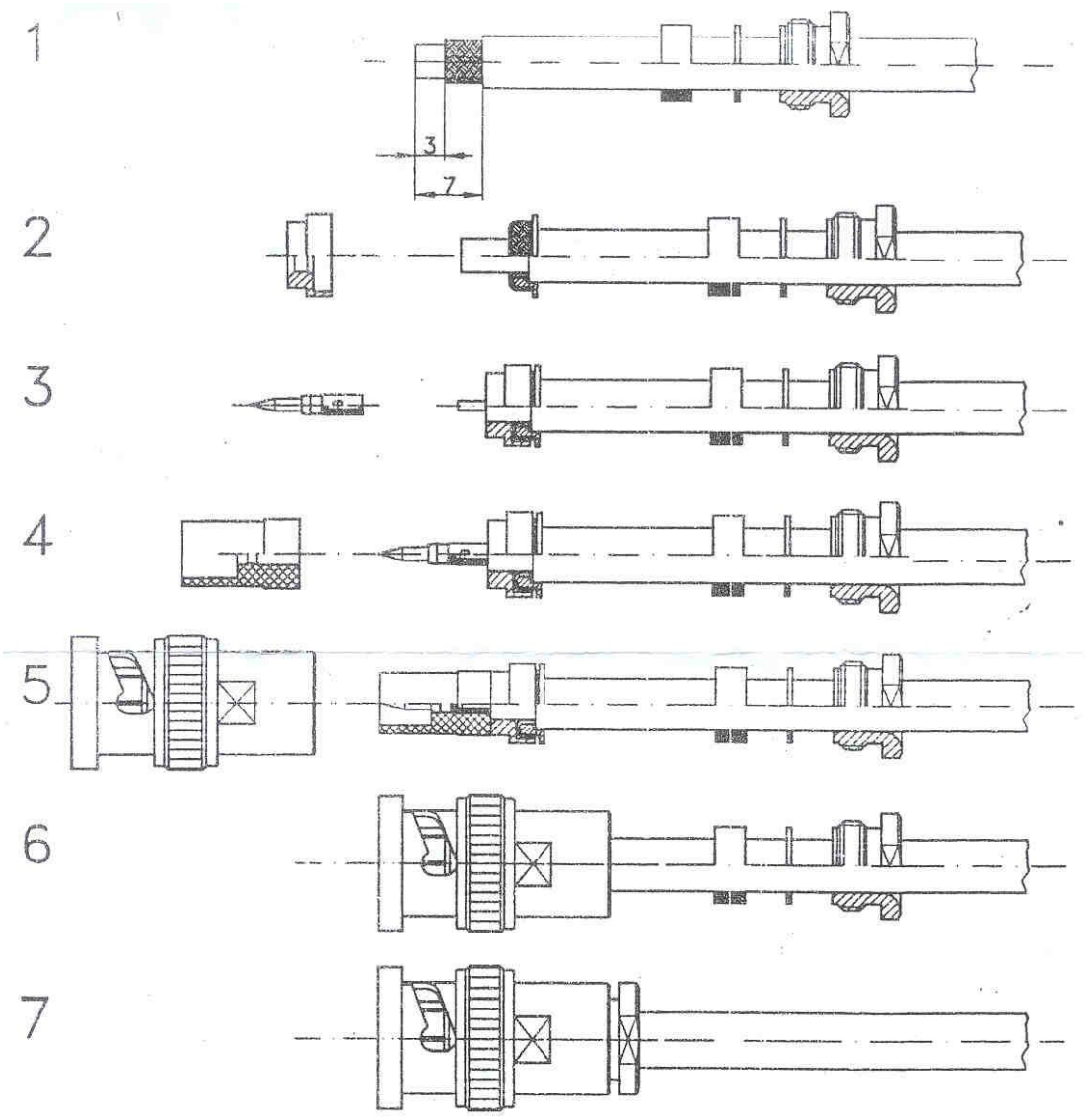
2.2.3 Connection to the communication equipment

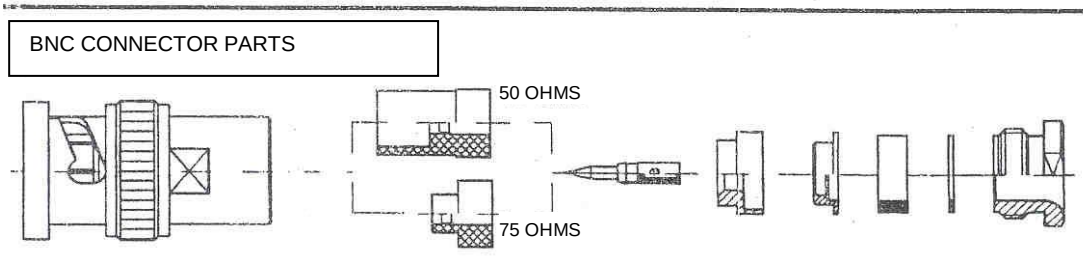
The connection cable between the communication equipment and the capacitive coupling must be a 50 Ω impedance characteristic coaxial cable type RG-58. This cable can be protected, if necessary, against animals by inserting it in a corrugated PVC pipe.

As a guide when mounting the male BNC connector in the coaxial cable, there are two instructions at the end. One for a soldering connector and the other for a crimping one.

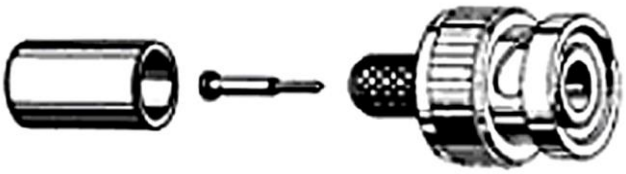
The coaxial cable should first be checked in order to avoid having to carry out a new discharge of the medium-voltage line because the cable is wrong.

Once the male BNC connector has been mounted, the test should be carried out in the following way. First, without connecting the coaxial cable to the coupling unit, 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 coupling unit, in the said end, a short circuit must be measured because the transformer of the coupling unit is now present.



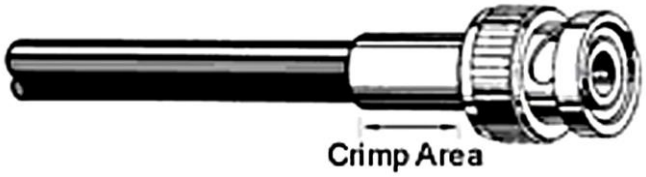


Instructions for a soldering BNC connector



Trim cable as shown, being careful not to nick the inner conductor or braid.

Slip crimp sleeve over cable. Put inner conductor into contact. Note that the end of contact and inner dielectric are butted and square. Crimp with appropriate tool.



Flair outer braid and gently but firmly push the contact into the connector housing until a gentle snap is felt, indicating the contact is in place. Slip the crimp sleeve in place, butting the flange against the connector body, and crimp with appropriate tool.

Instructions for crimping the 3 pieces of a BNC connector