

# RadioAdapter Test Kit



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# 1 INTRODUCTION

## 1.1 General Information

- **RadioAdapter** is a Eliwell device that enables the use of RF (Radio Frequency) technology, to allow wireless communication between controllers, devices and the supervisor.
- There are various technologies that allow wireless communication, and these include:
  - ZigBee
  - Bluetooth
  - WiFi
- The three main characteristics to bear in mind in wireless technology are:
  - the ability to cover distances
  - the communication speed
  - the cost
  - power consumption

### Eliwell solution

- Based on standard IEEE 802.15.4 (Wireless Personal Area Networking - WPAN).
- Allows the nodes to be reached via multiple paths: in the case of one or more non-operating nodes communication is still guaranteed!

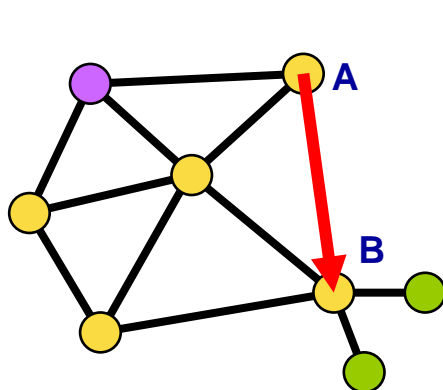


Fig. 1a

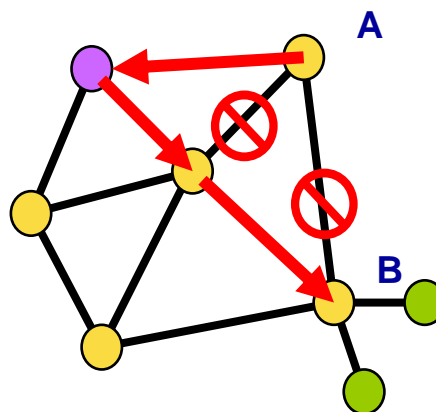


Fig. 1b

- Communication takes place in the 2.4000 - 2.4835 GHz band, which contains 16 channels. This is a free band that is not restricted by licenses, and is recognised by the following Countries:

US	2.4000 - 2.4835 GHz
<b>Europe</b>	<b>2.4000 - 2.4835 GHz</b>
Japan	2.471 - 2.497 GHz
France	2.4465 - 2.4835 GHz
Spain	2.445 - 2.475 GHz

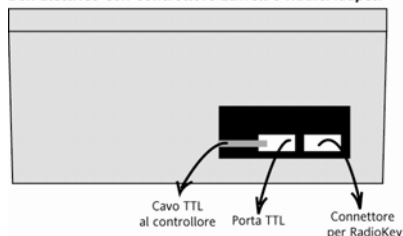
The **RadioAdapter** Test Kit comprises the following items:

- 1 robust kit carrying case
- 1 electrical box containing an RS-232 / TTL interface and a RadioAdapter (to configure as PAN-C)
- 3 electrical boxes containing Eliwell controllers and RadioAdapters (to configure as NODES)
- 1 Televis RadioKey
- 4 power cables for the electrical boxes
- 1 RS-232 serial cable for connecting the RS-232/TTL interface to a PC/Palmtop
- 1 *RadioAdapter Viewer* software CD for PC/Palmtop, containing this guide in electronic format
- the present RadioAdapter test kit guide
- the RadioAdapter manual

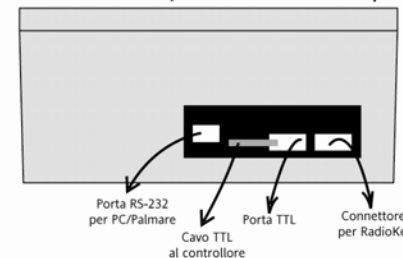
The devices and the RadioAdapters are not configured.  
It is necessary to configure the devices (network address, it is suggested that you use network addresses starting from 01.00) and the RadioAdapters (Pan-C plus nodes configuration)

**IMPORTANT:** Read this guide and the RadioAdapter manual thoroughly before using the kit.  
In order to use this kit you need to configure the network addresses of the controllers and initialise the RadioAdapter network using the RadioKey supplied with the kit. Disconnect and reconnect the TTL cable as instructed in the RadioAdapter manual.

Box Elettrico con controllore Eliwell e RadioAdapter



Box Elettrico con interfaccia RS-232/TTL RadioAdapter

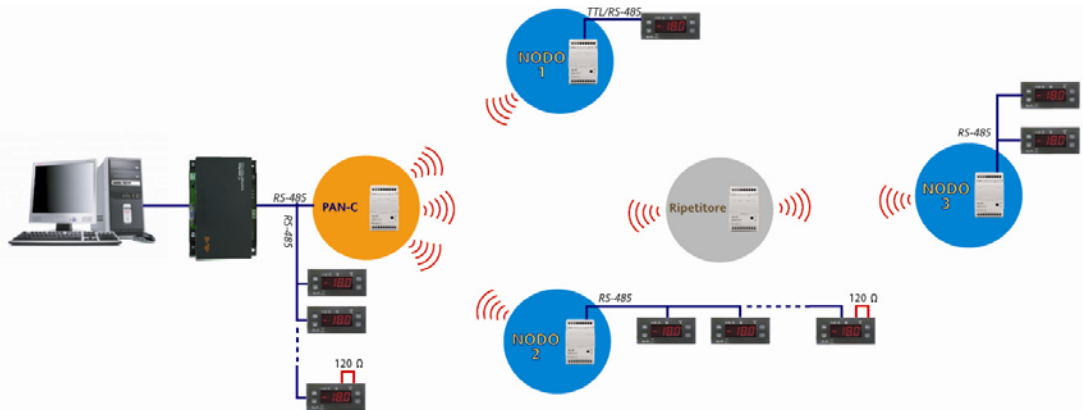


### 1.1.1 Installation precautions

- The electrical boxes supplied in the kit are marked as having an index of protection of IP65. This rating is not valid, since Eliwell has modified the boxes. Assume the electrical boxes in the RadioAdapter Kit to have a protection rating of 0.
- You need to open the electrical boxes in order to configure the addresses of the Eliwell instruments and to see the **RadioAdapter** LEDs when performing the configuration.
- Take the greatest care not to touch live parts carrying potentially dangerous voltages when working on an open box with the power on.
- Maximum operating ambient temperature is 40°C.

## 2 INSTALLATION OF THE NETWORK

### 2.1 Network architecture



The elements that make up an Eliwell system are:

- **RadioAdapter:** this is the Eliwell module, without any configuration. Quantity according to the number of points to be monitored
- **PAN-C:** PersonalAreaNetwork-Coordinator. This is a RadioAdapter, suitably configured to represent the RF network co-ordination point. It is only possible to have one PAN-C in each RF network.
- **Node:** This is a RadioAdapter, suitably configured, to which one or more controllers are connected. Using the node, the devices connected to it can communicate with the supervisor. The node will also act as a repeater
- **Repeater:** This is a RadioAdapter, suitably configured, to which NO controllers are connected, and it is used as a "bridge" to reach nodes that would not otherwise be visible

Configuration of the system is carried out using

- **RadioKey:** this is the device that allows the RadioAdapter to be configured as a PAN-C or as a NODE. It is also used to select whether the protocol to be used is Televis or Modbus

**N.B:** PAN-C, Node and Repeater are obtained by programming the RadioAdapter modules with the RadioKey.

## 2.2 Installation

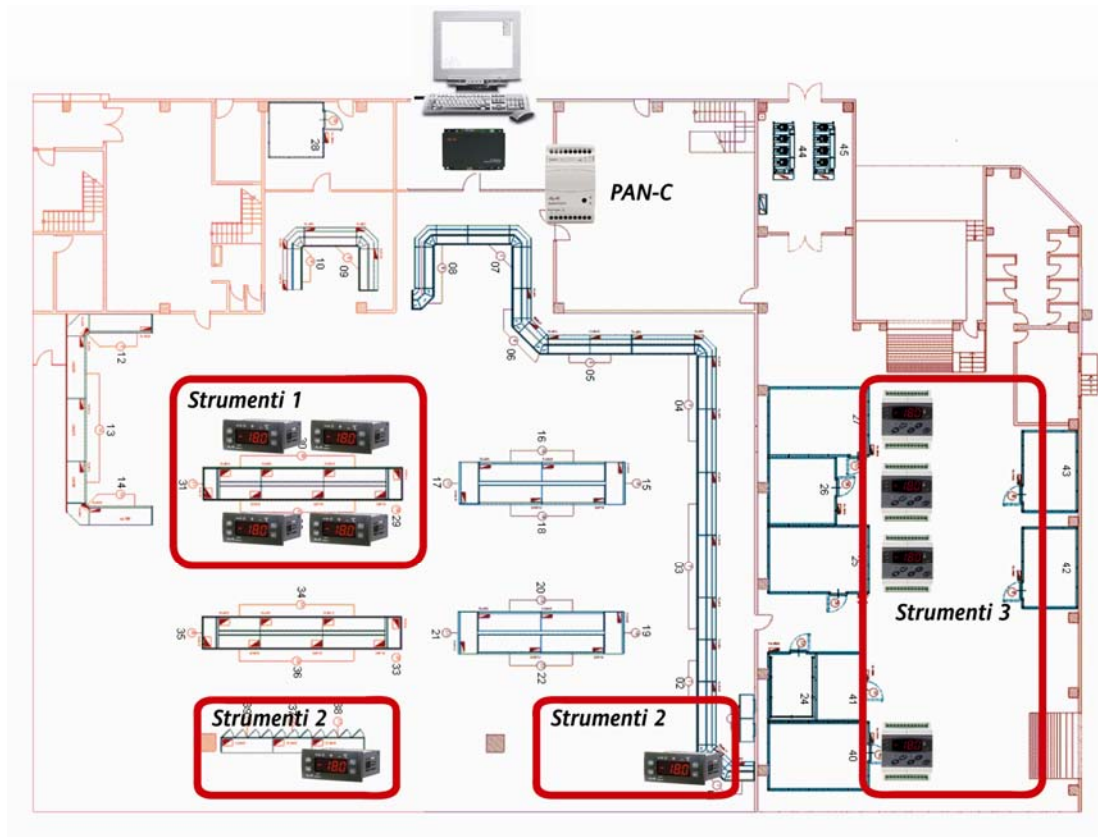
### 2.2.1 Initial checks: lay-out on paper

It is possible to position the components described above on a plan of the room, so as to find:

- Positioning of the PAN-C
- Position of the points to be monitored, and as a result the position and number of NODES

**N.B.:**

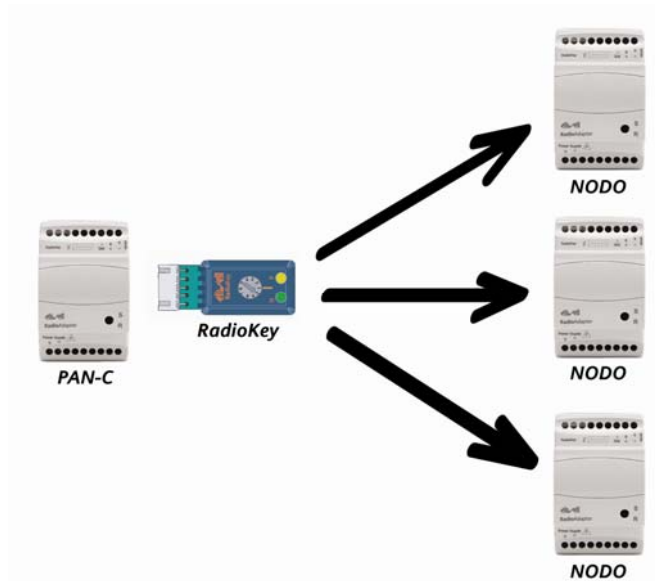
**If there is no plan of the room available, an on-site survey is essential in order to find the references indicated**



## 2.2.2 Selecting the PAN-C

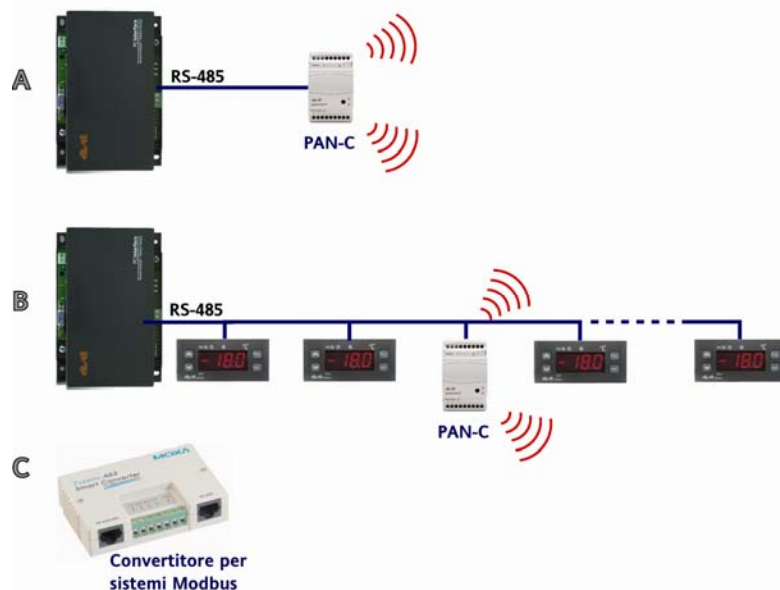
1. The PAN-C in each *installation* must have RS485, so is:
  - **RadioAdapter/S**which will be programmed using the RadioKey to become PAN-C
2. The RadioKey will be selected from one of two possible solutions:
  - **CCA0B0T01T000** if the system foresees Eliwell and TelevisNet instruments
  - **CCA0B0T01MX00** if the system foresees Modbus instruments and not TelevisX=changes according to the speed, parity, stop bits...

The RadioKey is also used to transfer *information* from the various nodes to the PAN-C



## 2.2.3 Connecting the PAN-C

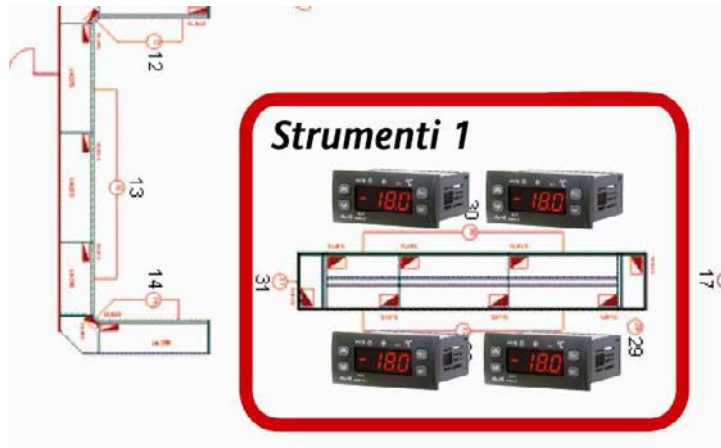
1. The PAN-C is connected to the PCInterface (or equivalent serial converter for Modbus systems) using an RS485 connection
  - A. Direct connection between PC-Interface and PAN-C with PC Interface
  - B. Connection between PC-Interface and a network composed by controllers and a PAN-C
  - C. Modbus converter to use for network with Modbus protocol



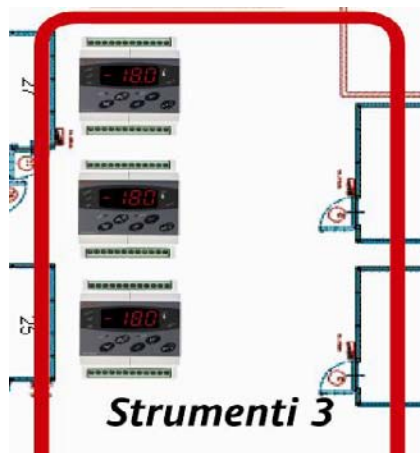
## 2.2.4 Selecting the Nodes: CASE 1

Considering in the building the following groups of devices:

- Instruments-1-: 4 controllers in selling are, one close to the other



- Instruments-3-: 3 controllers in cold room zone, one close to the other

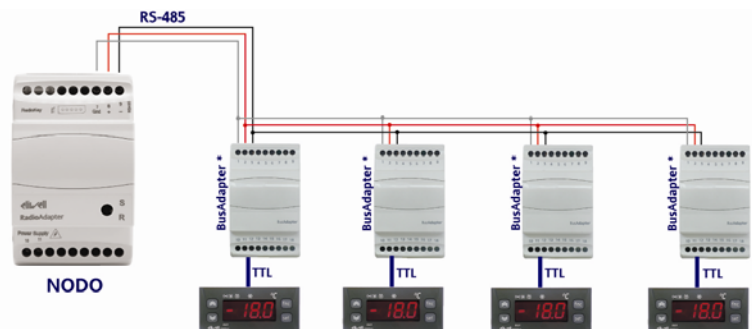


For each group it's possible to use one RadioAdapter only, with RS485 connection to manage more controllers. So use:

- **RadioAdapter/S**

## 2.2.5 Connection of the instruments to the nodes: CASE 1

- RS485 max 1200m
- Use Televis serial rules (screened cable, resistors...)
- It is possible to connect up to 240 instruments to a single RadioAdapter
- Check whether or not the BusAdapter is necessary !!!



\* You have to use **BusAdapter** to connect the controllers without RS-485 to **RadioAdapter**!



### 2.2.6 Selecting the Nodes: CASE 2

Considering in the building the following groups of devices:

- Instruments-2-: 2 single devices, in selling area, on independent application



- Instruments-2-: 1 single controller for cold room

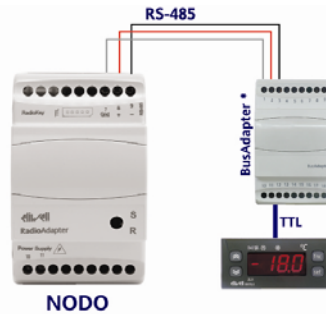


For each device it necessary to use one RadioAdapter only, dedicated. See next slide for more info

### 2.2.7 Connection of the instruments to the nodes: CASE 2

Use **RadioAdapter/S**, if device has **connection RS485** (on board or via BusAdapter)

- RS485 max 1200m
- Use Televis serial rules (screened cable, resistors...)
- Check whether or not the BusAdapter is necessary !!!



**RadioAdapter/S + BusAdapter + instrument without RS-485**



**RadioAdapter/S + instrument with RS-485**

Use **RadioAdapter/S**, or **RadioAdapter** if device has **connection TTL**

- TTL cable supplied with RadioAdapter

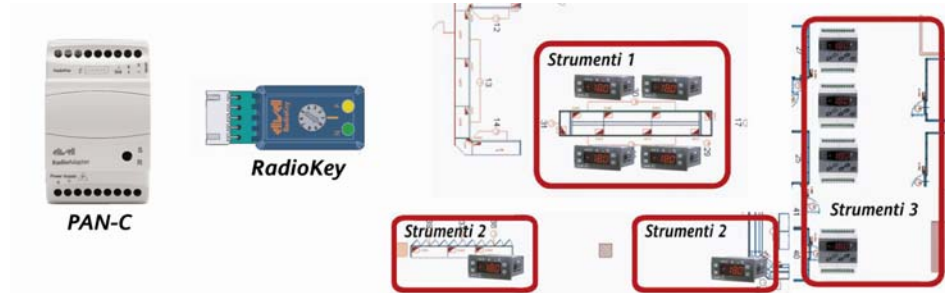


### 2.2.8 Programming the Nodes-Repeaters

- Using the same RadioKey selected previously for the PAN-C, it will be possible to carry out the following procedures on each Radio Adapter:
- Configuration as RadioAdapter. During this procedure the instruments for the Radio Adapter in question must be disconnected
- Recognition (by each RadioAdapter) of the instruments connected

If necessary,

- Modification of the communication channel
- Configuration of a new node in the event of replacement
- Device reset



### 2.2.9 On-site verification – Communication channel

Before any *installation*, it is strongly recommended that an on-site verification be carried out to check the availability of one or more communication channels.

Eliwell suggests that you use a device known as Wi-Spy® for this purpose.

- Of the 15 channels (from 11 to 26) this highlights that channels 12, 14, 16, 18 and 26 have higher peak uses than the others, while channels 11, 15, 24 and 25 are very infrequently used.
- It will thus be best to use one of channels



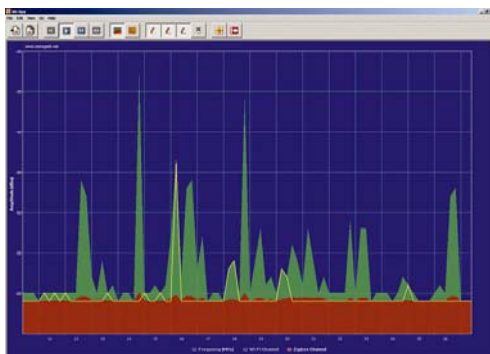
15, 24 and 25.



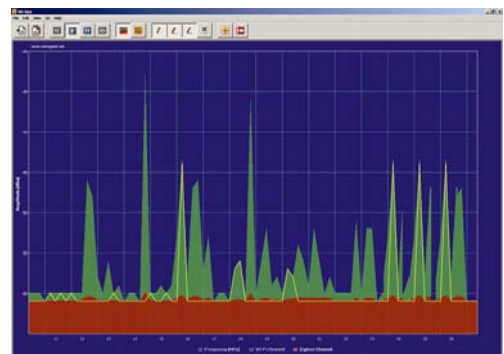
Verification using Wi-Spy® will be carried out wherever the RF devices are positioned, because the free channel in one zone might not be available in other zones within the same building;

The result of verifications on the various points will allow selection of the best channel for all the points in the same building.

**NOTE: PAN-C is able to select automatically the channel**



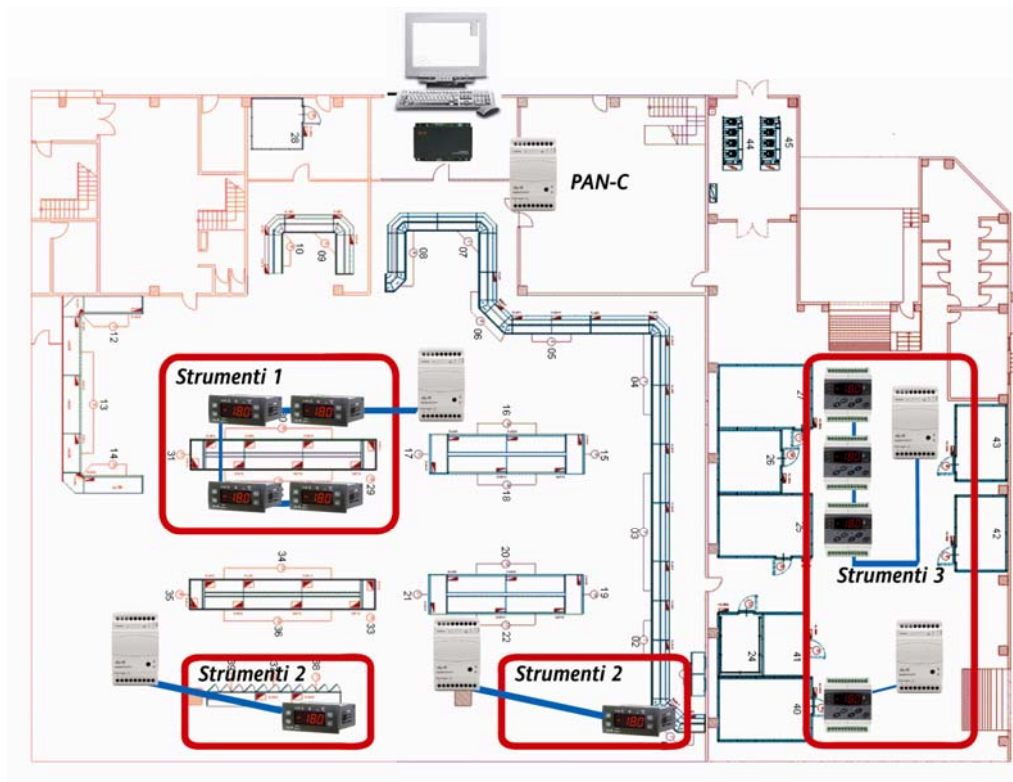
Zone 1



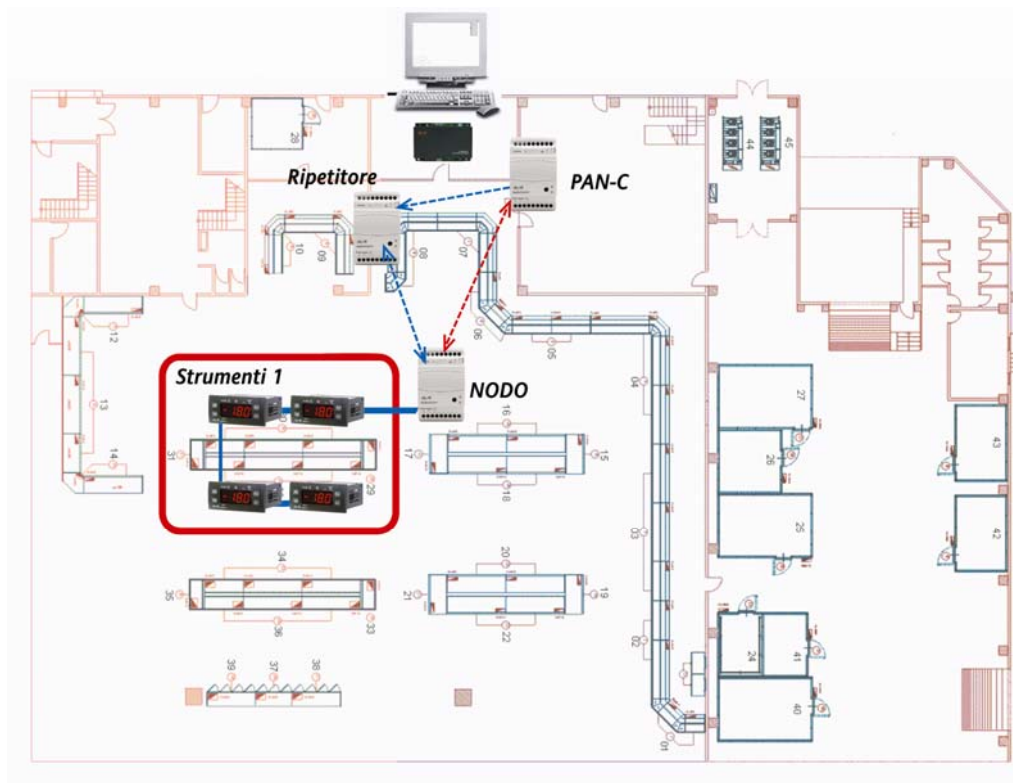
Zone 2

### 2.2.10 Pratical pre-installation test

It is suggested that communication with the various nodes be verified using a practical test, taking into account the results obtained with the various verifications described in points 1.2.1 and 1.3.1. It is suggested that the verifications be carried out using the test kit.



Check that PAN-C communicates with the group Instruments-1-



#### Legenda:



Direct communcation between elements of the net (for example PAN-C and Node)

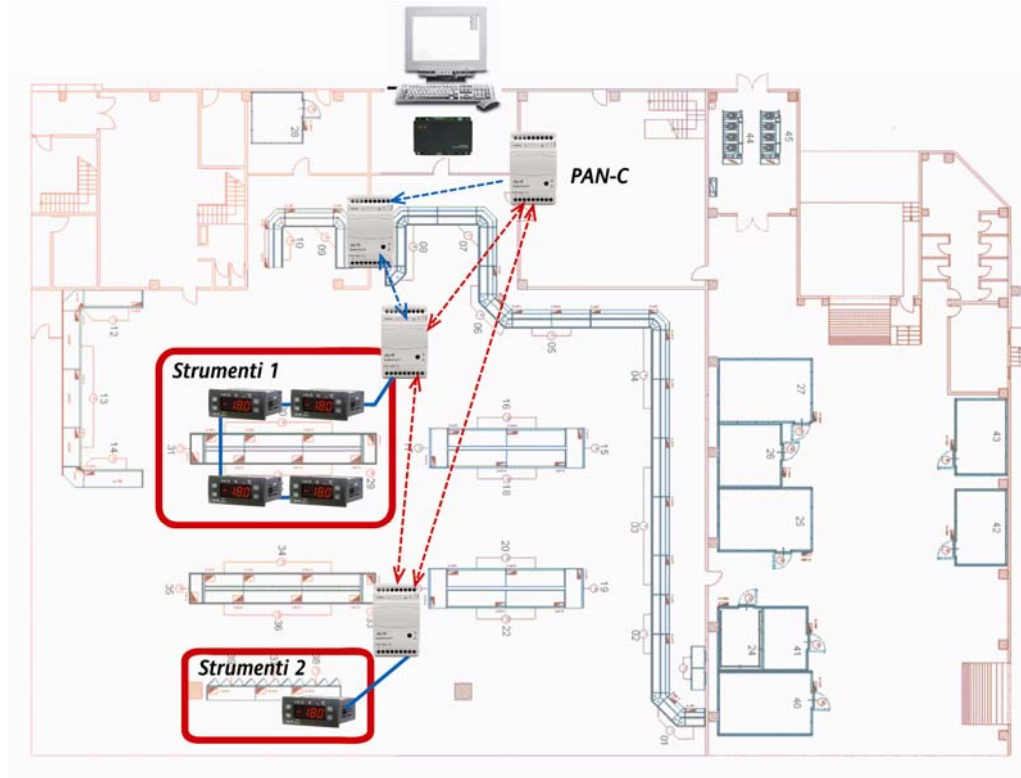
Communication between elements using a Repeater

(for example PAN-C → Repeater → Node)

If PAN-C can reach the node, no further verification is required.



In the absence of communication:

1. Move the Radio Adapter (higher, lower...)
2. Or position a RadioAdapter that merely acts as a repeater between the two points
3. Check that the channel detected by the PAN-C is also free for the group of instruments



### 2.2.11 Communication PAN-C→Position of Group Instruments-2-

Legenda:

-  Direct communication between elements of the net (for example PAN-C and Node)
-  Communication between elements using a Repeater (for example PAN-C → Repeater → Node)

If PAN-C can reach the node, no further verification is required

In the absence of communication:

1. Move the Radio Adapter (higher, lower...)
2. Or position a RadioAdapter that merely acts as a repeater between the two points
3. Check that the channel detected by the PAN-C is also free for the group of instruments

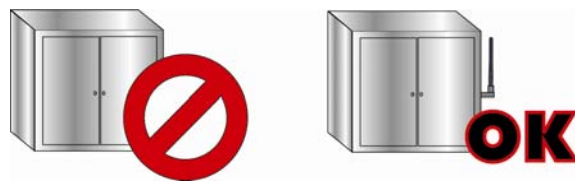
## 2.3 Recommendations!

### 2.3.1 Mounting into fuse boxes, containers

- Wherever possible, position the NODE "in view" in the room in which it is to provide communication. It can be inserted in plastic fuse boxes



- It must not be inserted in completely closed boxes metal fuse or containers. Consider that in presence of a window in plastic 16X16cm it could work. If this is not possible, use the version with external antenna and position the antenna outside



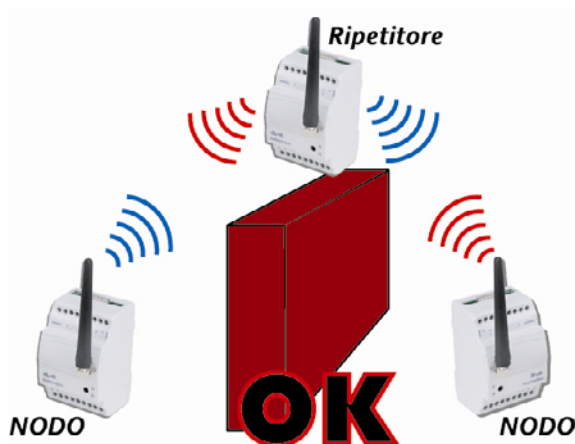
### 2.3.2 Distance and obstacles between nodes

- The max-min distance between two nodes cannot be defined. Experience shows case of few to tenth of meter, but longer distances could work

- Any type of metal object represents an obstacle to communication (as it reflects), as do walls and other structures in reinforced concrete. Concrete walls weaken the signal (the larger they are, the more the signal is weakened). Very humid ambients



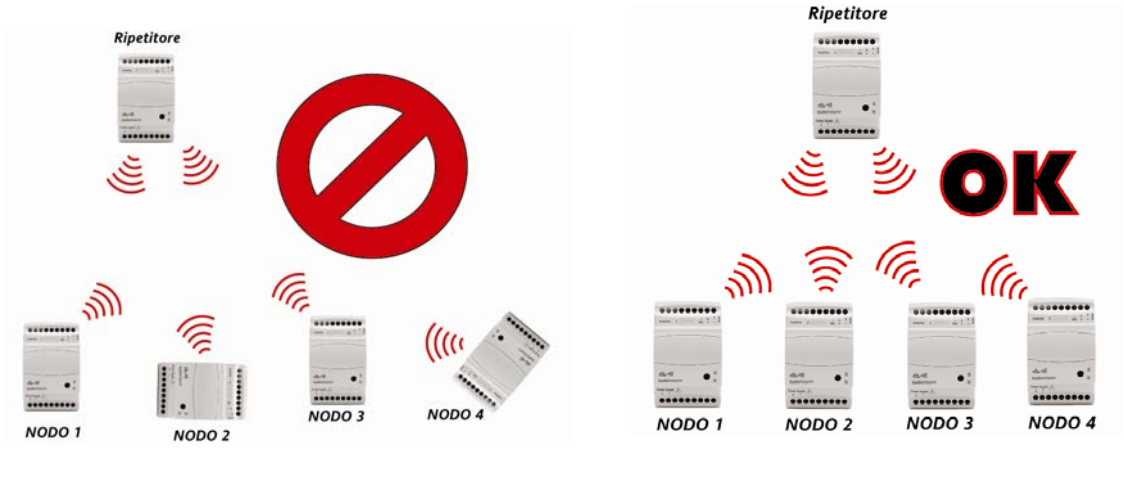
- If the instruments are on different floors, be careful to check the thickness of the flooring and whether or not it is reinforced



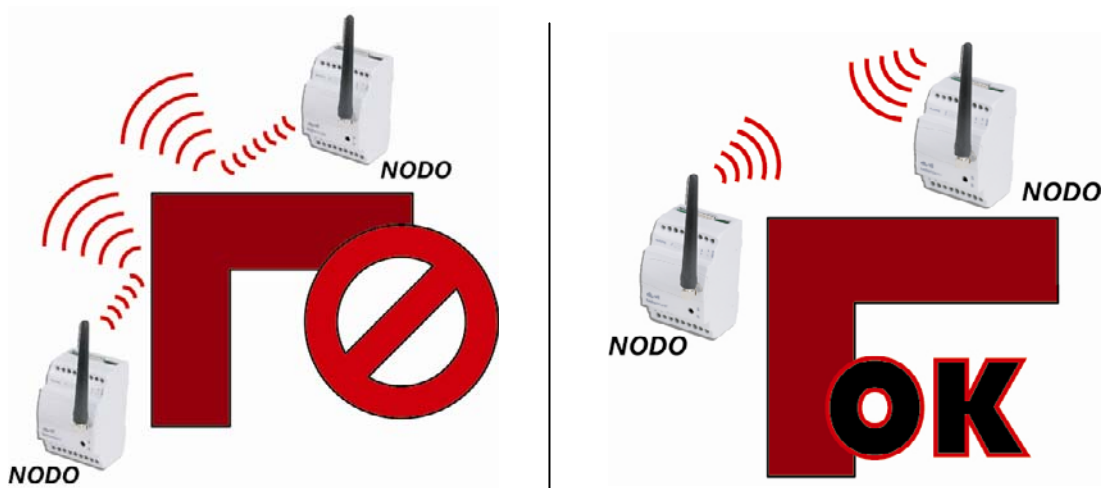
- If two nodes are unable to communicate it is possible to use a repeater positioned between the two, although this might not restore communication completely or might be altogether useless
- repeaters should be mounted at a height to "illuminate" the areas they are to cover
- Radios are designed to communicate using the shortest path available, and in any case they will NEVER make more than 5 leaps



- In order to operate well, a network should be “dense” but not too much so, with lots of nodes close to each other. This also serves to guarantee more than one path to the Mesh network
- Although the antennas are omnidirectional it is best to position the NODES all in the same way (for example with the power connector at the top)



- Presence of angles could be obstacle for the communication. Therefore avoid configuration able to create problem, fixing the modules in the way they can be reached



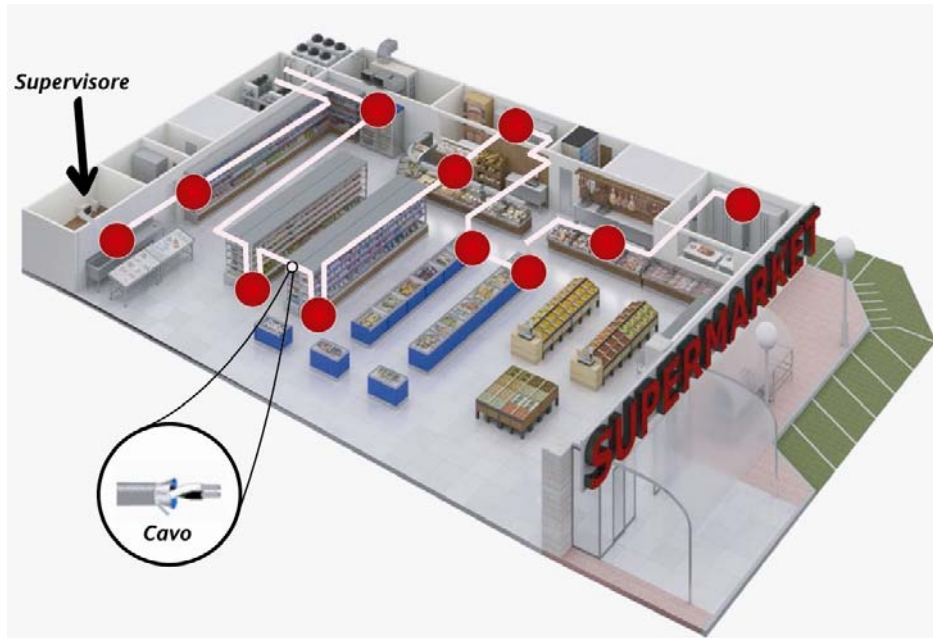
- Modules must be fixed, in the plant in the most omogeneous mode possible (in terms of distance between modules)

### 3 APPENDIX

#### 3.1 EXAMPLES

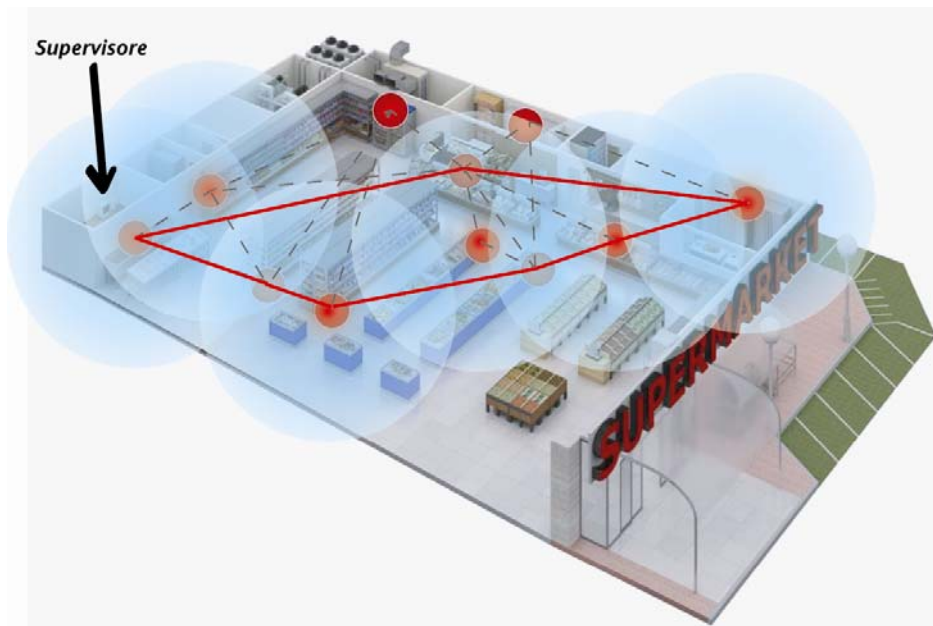
##### 3.1.1 Wiring with cable

The example shows a conventional cabled system. The following are the main characteristics and disadvantages of this type of system.



- Standard cable
- Variable length RS-485 network
- Plug-ins are not easily connected
- In the case of retrofitting of components there are obvious difficulties and costs!

##### 3.1.2 Connection with RadioAdapter



In the following system, the various instruments are connected via **RadioAdapter** and not by cable.

- **RadioAdapter** removes cables and wiring complexities
- It makes retrofitting easier
- It is possible to install up to 100 **RadioAdapters**
- Plug-ins can be detected easily, even if they are not in a fixed position
- Communication is possible even in disturbed environments

Main advantages :

- Mobile units (such as plug-ins) can now be connected to the supervisor
- It is now much easier to renovate existing systems
- The arrangement of elements in the application may change, without having to make changes to the network
- Lower costs: no cables need to be used!

### 3.2 RadioAdapter: Models available



#### With INTERNAL OMNIDIRECTIONAL Antenna

- BARF0DS00NH00 RadioAdapter/S with RS485+TTL, BARF0TS00NH00 RadioAdapter with TTL
- Power supply 90...240V~
- Container 3 DIN
- Transmission ISM 2,4GHz DSSS, multiple channel
- RF power < 10 mW in unlicensed applications

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#### With EXTERNAL OMNIDIRECTIONAL Antenna

- BARF0DS20NH00 RadioAdapter/S EXT with RS485+TTL, BARF0TS20NH00 RadioAdapter EXT with TTL
- BAKTOAK100000 external antenna (The antenna can be connected to the module (1), or at a max. distance of 1m with the cable provided (2). This is the only antenna that can be used!)
- Power Supply 90...240V~
- Container 3 DIN
- Transmission ISM 2,4GHz DSSS, multiple channel
- RF power < 10 mW in unlicensed applications



#### NOTA: LED: There are two LED indicators:

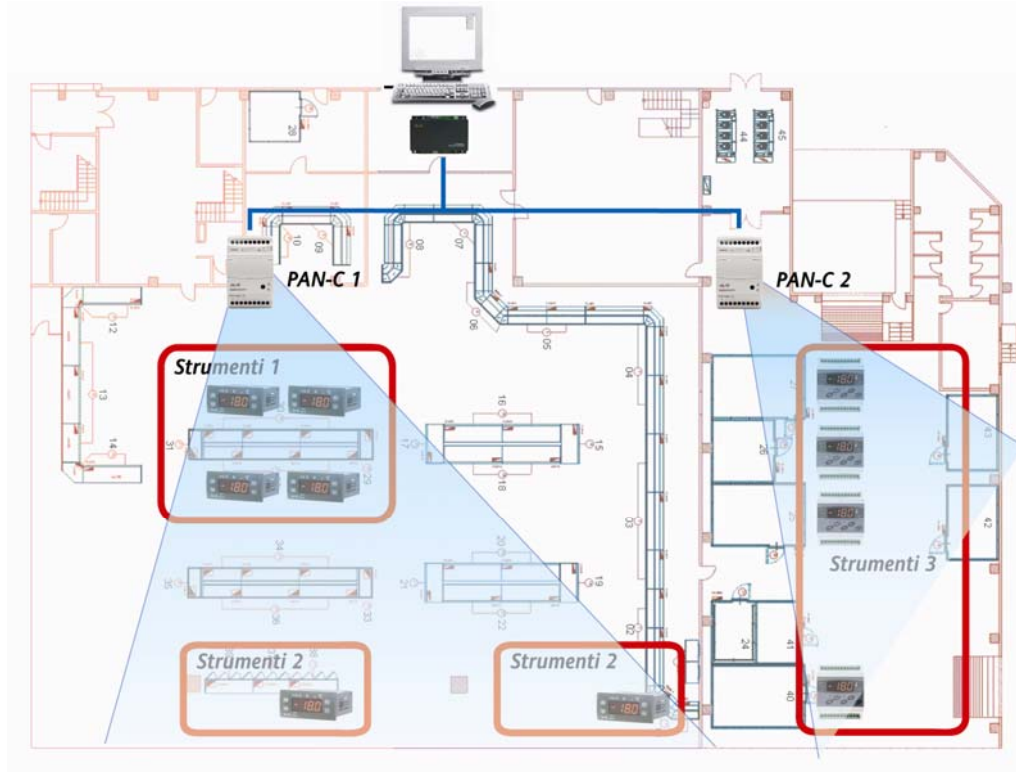
**S:** when flashing, this indicates the presence of communication between the RadioAdapter and the instruments connected to it

**R:** when flashing, this indicates RF communication between the module and the rest of the network



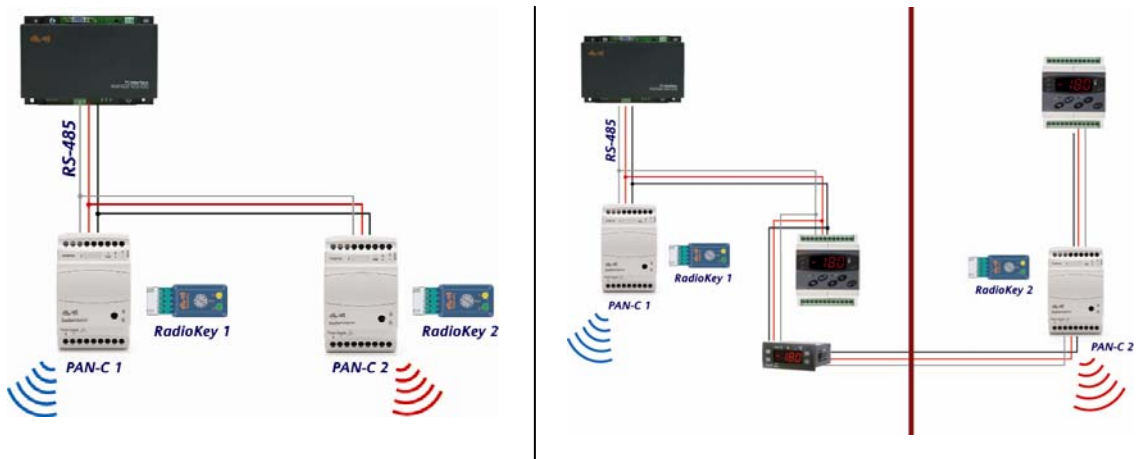
### 3.3 Particular cases – Networks with more than 1 PAN-C

In case of huge plants, with possibility to don't reach all the point, it's possible the connection of more RF networks:



PAN-C are connected to the PCInterface (or equivalent Modbus) through RS485. Each PAN-C must have its RadioKey

- RS485 max 1200m
- Use Televis serial rules (screened cable, resistors...)



### 3.4 Other Applications

RadioAdapter can be used in different applications, like AirConditioning to manager controllers mounted on board.

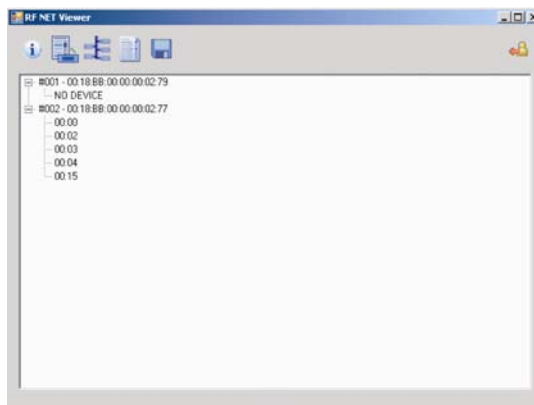
### 3.5 RadioAdapter Viewer

Program for analysis of the RF network

- To be used with a special 232-TTL adapter and crossed TTL cable for connection to the PAN-C
- Via this connection it will be possible to view operation of the communication link



- Read the network configuration (PAN-C and nodes) from the PAN-C

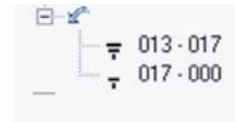


- Read the addresses of the instruments associated with each node
- Visualise the paths used to reach each node, both outgoing and incoming
- For each path it is possible to display the signal quality

#### Other options:

- Sending a single command to check all the nodes
- Sending a single command to check an individual node
- Saving the values detected by the software in a file

#### 3.5.1



#### Minimum HW requirements

##### **Personal Computer**

Pc: Pentium III  
Operating System: Windows 2000 / XP Home / XP Pro  
HDU: 1Gb  
RAM: 512 Mb  
Connectivity: RS232 serial port  
Display resolution: 1024x768

##### **Palmtop (PDA)**

Palmtop: based on ARMv4i architecture  
Operating System: Win CE 5.0, Win Mobile 5.0  
Flash memory: 128 Mb  
RAM: 64 Mb  
Connectivity: RS232 serial port or a suitable palmtop/RS232 interface cable (+DTE/DTE serial cable if relevant).  
Resolution: 240x320

#### 3.5.2 Installing the program

Run the "Setup.exe" program from the CD.

The *installation* routine lets you select whether to install Windows based software for a Desktop/Laptop or a PDA.

If necessary the *installation* program will also install Microsoft .NET Framework 2.0 components.



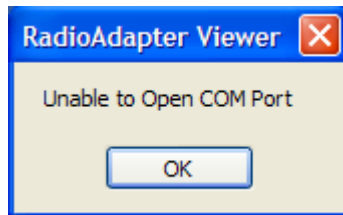
### 3.5.3 Using the program

An Eliwell "RS-232/TTL Converter" interface module is needed to communicate with the RadioAdapter network. This must be connected to one of the serial ports on the PC or PDA on one side and to the TTL port of the RadioAdapter configured as PAN-Coordinator on the other.

The program uses port COM1 by default on startup. If port COM1 is not available on the PC on which *RadioAdapter Viewer* is running, proceed as follows to change the setting in the RFNET.ini file in the folder "C:\Program files\Eliwell\*RadioAdapter Viewer*".

Open the RFNET.ini file using any text editor. Edit the ComPort value in the first line, specifying the first available port after COM1 (e.g. "COM4"). Save and close the file. Start the *RadioAdapter Viewer* program.

If the port you have just set is not available, *RadioAdapter Viewer* will display the following warning on startup:



*RadioAdapter Viewer* will not run until you edit the RFNET.ini as instructed above and specify the first available port

```
RFNET.ini - Blocco note
File Modifica Formato Visualizza ?
ComPort=COM1
RouteLoopPeriod=1000
HistoryLength=100

[RSSI]
RssiLevel1=80
RssiLevel2=95
RssiLevel3=130
RssiLevel4=185

[IPV6]
Timeout=100
NumRetry=3
RetryPeriod=100

[TLV]
Timeout=800
NumRetry=3
RetryPeriod=333

[MDB]
Timeout=800
NumRetry=3
RetryPeriod=333
```

The selection menu on the program's main screen lets you choose what COM port to use for communications.

You can start the program by selecting Start\Programs\Eliwell\*RadioAdapter Viewer*. All functions are directly accessible from the toolbar on the program's main screen.

### 3.5.4 Available functions

#### 3.5.4.1 Information

When you click the *Information* button, the program tries to communicate with the PAN-Coordinator module. This can take a few minutes.

At the end of the communication a dialog box appears showing *information* on program version, and PAN-Coordinator module data including network settings (protocol, serial port settings for Modbus protocol and current communication channel).

#### 3.5.4.2 Saved network configurations

Click the "*Saved network configurations*" button to display a list of network configurations previously saved to the hard disk or flash memory.

You can expand each configuration in the list to display its contents.

Configuration files are saved in the program *installation* folder (e.g. C:\Program files\Eliwell\*RadioAdapter Viewer*). The file name is generated using the date and time of the save operation in the following format: "SNAP\_yymmdd\_hhmmss.XML".

#### 3.5.4.3 Configuring the network

When you press the "Network configuration" button, the program tries to communicate with the PAN-Coordinator module. This can take a few minutes.

At the end of this communication the program's main screen displays the hierarchy of the network of RadioAdapters and connected controllers.

The main nodes represent the RadioAdapters. You can identify each RadioAdapter by the unique code made up of 8 pairs of letters/numbers printed on its data label.

For each RadioAdapter the program lists the controllers configured and accessible over the wireless network.

Click Save Data to save the current configuration to the hard disk / flash memory.

#### **3.5.4.4 Testing the network**

When you press the "Test Network" button, the program tries to communicate with the PAN-Coordinator module. This can take a few minutes.

At the end of this communication the program's main screen displays the hierarchy of the network of RadioAdapters and connected controllers.

You can select more than one RadioAdapter to test by checking a number of check-boxes. You can then run a communications test on all selected nodes.

At the end of this communication test, the program displays for each RadioAdapter the path of the message sent via all nodes starting from the PAN-Coordinator (which is always identified as node #000). For each path the program displays signal strength in the form of a bar graph similar to those used on GSM mobiles. Signal strength ranges from 4 bars (excellent) to 1 bar (weak). A question mark indicates communication failure.

You can repeat the test a number of times to identify variations in path and/or signal strength for all nodes.

You can select one RadioAdapter by checking its check-box. The list on the left of the screen displays the controllers associated with it.

You can test each individual node using the same method described above for the entire network.

You can also run a continuous test on a selected node. The program tests the node cyclically and refreshes the display accordingly. This enables you to identify fluctuations in signal strength and/or path variations caused by interference.

Note: This process only tests wireless communications between the RadioAdapter modules. It does not test the controllers that are physically connected to the nodes.

#### **3.5.4.5 Exiting the program**

Note: Click Save Data to save the current configuration to the hard disk / flash memory. The program does not ask you to confirm the save before exiting.

## 4 USE OF THE DEVICE

### 4.1 Permitted Use

For safety purposes, the control device must be installed and used in accordance with the instructions supplied. Users must not be able to access parts with dangerous voltage levels under normal operating conditions. The unit must be resistant to water and dust, depending on the specific application, and be accessible only by using special tools.

**The use of the unit for applications other than those described is forbidden.**

## 5 RESPONSABILITY AND RESIDUAL RISKS

Eliwell Controls s.r.l. shall not be liable for any damages deriving from:

- *installation*/use other than that prescribed which does not comply with the safety standards specified in the regulations and/or herein;
- use on equipment that does not guarantee adequate protection against electric shock, water or dust when assembled.
- use on equipment that allows dangerous parts to be accessed without the use of tools;
- *Installation*/use on equipment that is not compliant with the standards and regulations in force.

## 6 DISCLAIMER

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