

# Technical Support

## Bulletin nr. 12 – RS485 Issues



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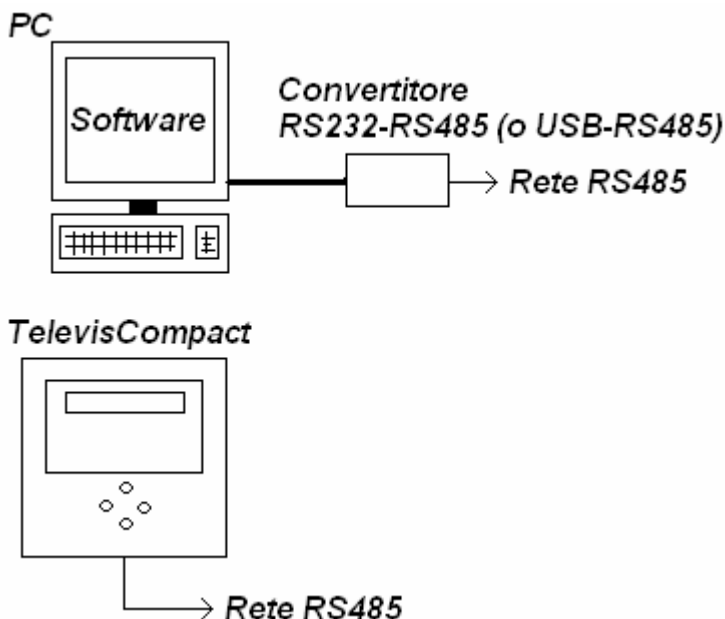
Introduction

The instructions provided below apply to RS485 networks with Eliwell devices and to supervisor units that use both Eliwell and Modbus protocols for communication purposes. This document provides detailed information on the cabling of RS485 networks, and on their use and maintenance, along with troubleshooting guidelines and information on how to correct problems.

General information on networks

Networks are generally constituted by the following elements:

1. **Devices**, i.e. the instrumentation used for communication purposes. The RS485 connection of Eliwell devices is galvanically insulated from the power supply of the controller. This insulation is provided for functional purposes, not for safety.
2. **Transmission means**, i.e. the cable. RS485 networks use a cable with 3 leads, respectively identified with symbols "+", "-" and "Gnd". Eliwell recommends the use of Belden® cables, model 8762. Other cables can be used only if they have equivalent electric and mechanical characteristics. It is however advisable to use RS485 compliant cables with the following characteristics:
  - AWG 20/22
  - Typical impedance of 120Ω
  - Copper braided and twisted leads
  - Sheath shielding and protective insulation
3. **Supervisor unit**, i.e. the unit that receives information from the network. A few examples of supervisor units:



Software installed on the PC. Communications with the network occur through the converter. Software and converter may be manufactured by Eliwell or third parties, even when using a Modbus protocol.

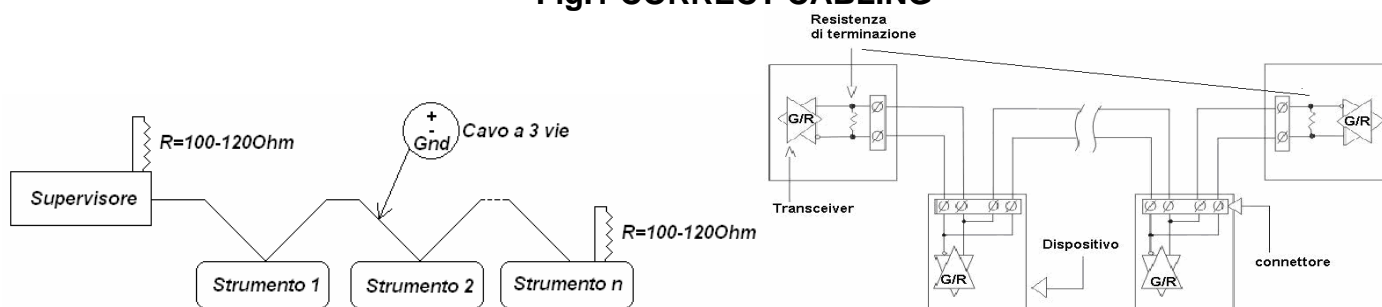
Supervisor unit designed to connect directly to the network. In this case, the unit must be manufactured by Eliwell.

Convertitore RS232-RS485 (o USB-RS485)	<b>RS232-RS485 (or USB-RS485) converter</b>
Rete RS485	<b>RS485 network</b>

## Correct cabling

The network must be wired only in accordance with the principle shown below, i.e. daisy-chained:

**Fig.1 CORRECT CABLING**



Cavo a tre vie	<b>3-way cable</b>	Strumento 1	<b>Device 1</b>	Dispositivo	<b>Device</b>
Resistenza di terminazione	<b>Termination resistor</b>	Strumento 2	<b>Device 2</b>	Connettore	<b>Connector</b>
Supervisore	<b>Supervisor</b>	Strumento n	<b>Device n</b>		

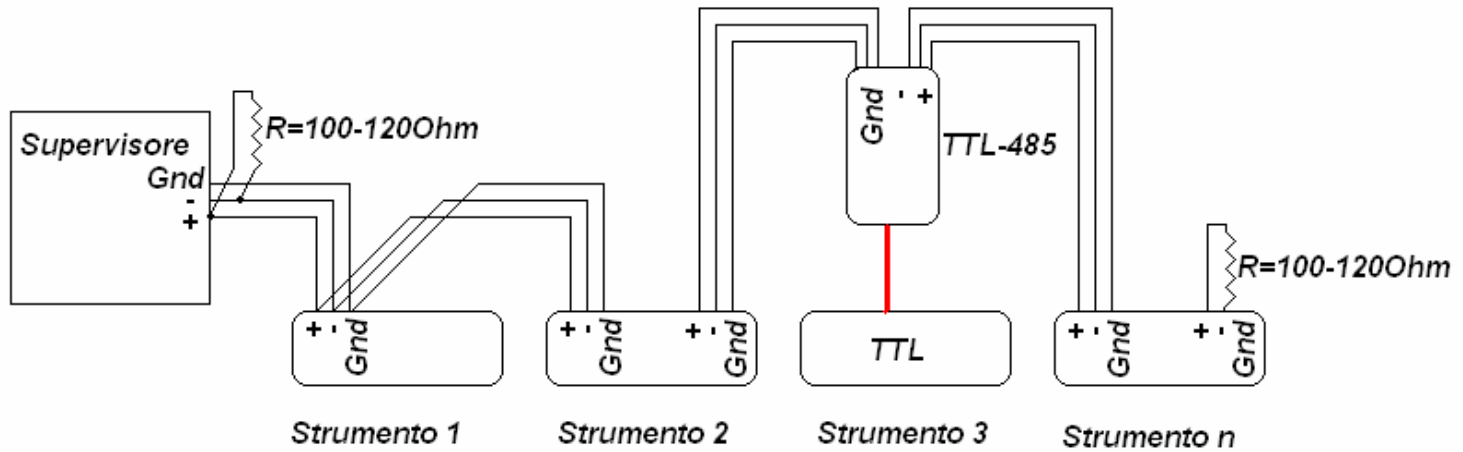
It is particularly important to take into account the following:

1. DO NOT use different types of cables for the same network and always make sure that the same type of cable is used.
2. The network cable transmits signals at a safe voltage (SELV) and must not be wired using the same ducts employed for cables with a dangerous voltage (for example 230 VAC) or that transmit high currents, especially CA. The network cable should never be installed in parallel with power cables.
3. Perform all connections maintaining the cable as linear as possible, avoid tight bending radiuses and do not wind it unnecessarily.
4. Do not wind the cable around power ducts or intersect the cable at 90° with ducts, when this is unavoidable.
5. Maintain the required safety distance from electromagnetic sources such as large engines, switching boards, neon reactors and all kinds of aeriels.
6. Although it is not necessary to insert the cable in a lead, it is generally advisable to avoid conditions that could cause wear or mechanical damage. Said sources may include dangerous heat sources, areas exposed to high humidity and to solvent leakage. Unless otherwise specified, Eliwell devices are designed to be used in areas with an ordinary and standard level of pollution. For outdoor connections, maintain a safety distance from sources that could release electrostatic discharges such as suction plants used to convey plastic material.
7. Verify that the tension of cables does not exceed 110 N (11.3 Kg) to prevent excessive stretching.
8. Preventively plan the shortest route and record the addresses of all connected devices, verifying that they have been positioned in a logical sequence, as this simplifies maintenance.
9. Do not reverse the polarity “+” and “-” of connection terminals.
10. Avoid using short cable sections for the connection terminations of devices to allow maintenance to be carried out without tearing or stretching the cable.
11. Identify the start and end terminations, and avoid leaving "open" sections.
12. The 100-120Ω resistors of terminations must be placed at the end of the network only and not on each device. It is generally advisable to install the resistor at the beginning of the network, although this is not always required (there are several cases of networks operating without initial resistor).

Network connections can be detailed as follows:

There are several connection layouts for RS485 networks:

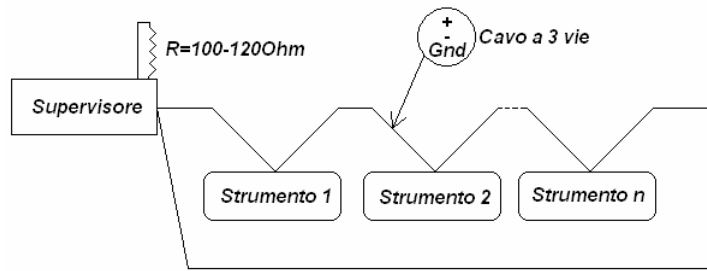
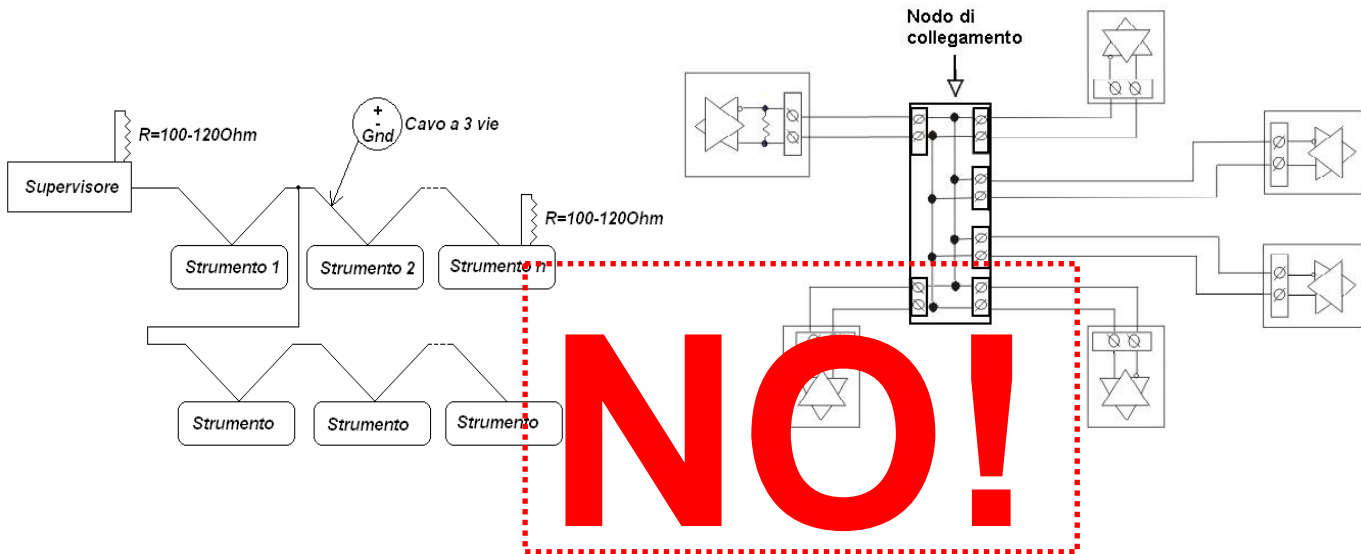
- Device 1: device with one RS485 port
- Device 2: device with two RS485 ports (input and output can be configured freely)
- Device 3: device with TTL connection. In this case it is necessary to use an external TTL-485 adapter (one per device) with double RS485 port (without input limitations)



Supervisore	<b>Supervisor</b>	Strumento 2	<b>Device 2</b>
Strumento 1	<b>Device 1</b>	Strumento n	<b>Device n</b>

The figure below shows, for information purposes only, some examples of incorrect cabling.

**Fig.2 INCORRECT cabling**



Supervisore	<b>Supervisor</b>	Strumento n	<b>Device no.</b>	Cavo a tre vie	<b>3-way cable</b>
Strumento 1	<b>Device 1</b>	Nodo di collegamento	<b>Link</b>		
Strumento 2	<b>Device 2</b>	Strumento	<b>Device</b>		

## Troubleshooting

Operations are described in the order in which they must be carried out, because they are listed from the most probable to the less probable cause.

### - If none of the devices is recognized by the supervisor unit or if these do not communicate with the supervisor unit

1. Check the parameters assigned to FAA and dEA for each device. The pair of numbers must be unique for each controller. It is advisable to observe the following rule:

Device1	FAA=00	dEA=00
Device2	FAA=00	dEA=01
Device3	FAA=....	dEA=....

There is no link between the physical location of the controller and the corresponding attribute address (device 00.00 can represent any device of the network).

2. Verify that all devices (including BusAdapter) are correctly powered at the required voltage.
3. Verify that network connections comply with the requirements specified above.
4. Verify that the RS485 cable is not broken, specifically in the section between the supervisor unit and the first controller (Fig.3.1 device with one RS485 port, Fig.3.2 with two ports, Fig.3.3 with BusAdapter). Disconnect the cable both from the supervisor unit and from the device end, and use a multimeter to check the continuity of each lead. NO short circuits should be present between the leads (“+”, “-” and “Gnd”). The presence of short circuits may be the cause of the problem.

Fig.3.1

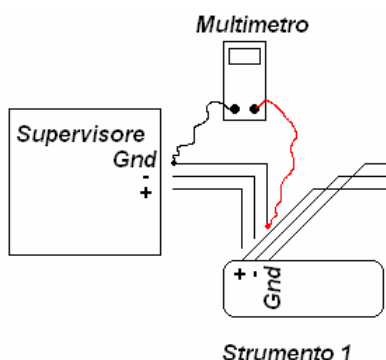


Fig.3.2

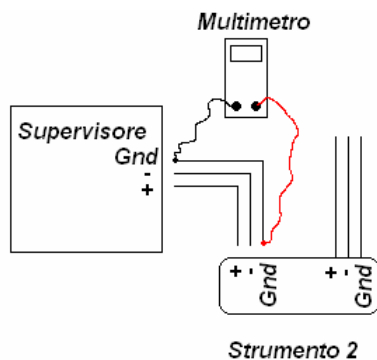
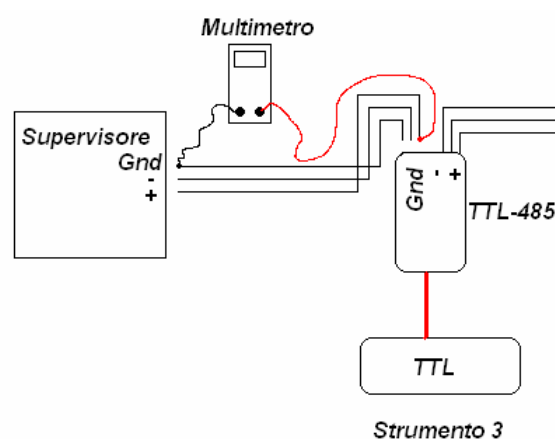


Fig.3.3



5. Exclude the first device that is physically connected to the network (Fig.4.1 device with one RS485 port, Fig.4.2 with two ports, Fig.4.3 with BusAdapter) and disconnect it from the network while maintaining the connection with the rest of the network. If the network is detected, it is necessary to replace the first controller.

Fig.4.1

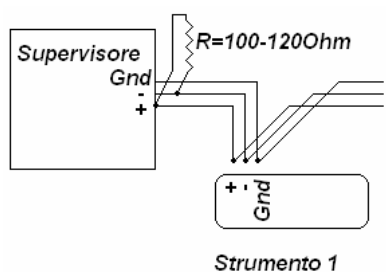


Fig.4.2

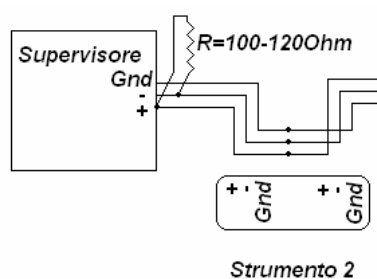
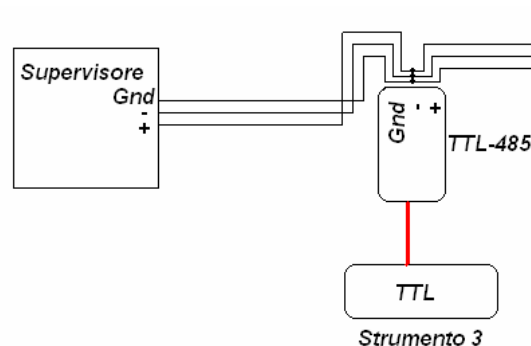


Fig.4.3



Multimetro	<b>Multimeter</b>
Supervisore	<b>Supervisor unit</b>
Strumento	<b>Device</b>

### -If the supervisor unit is unable to detect one device only or if the latter is unable to communicate with the supervisor unit (the first one or any supervisor unit of the network)

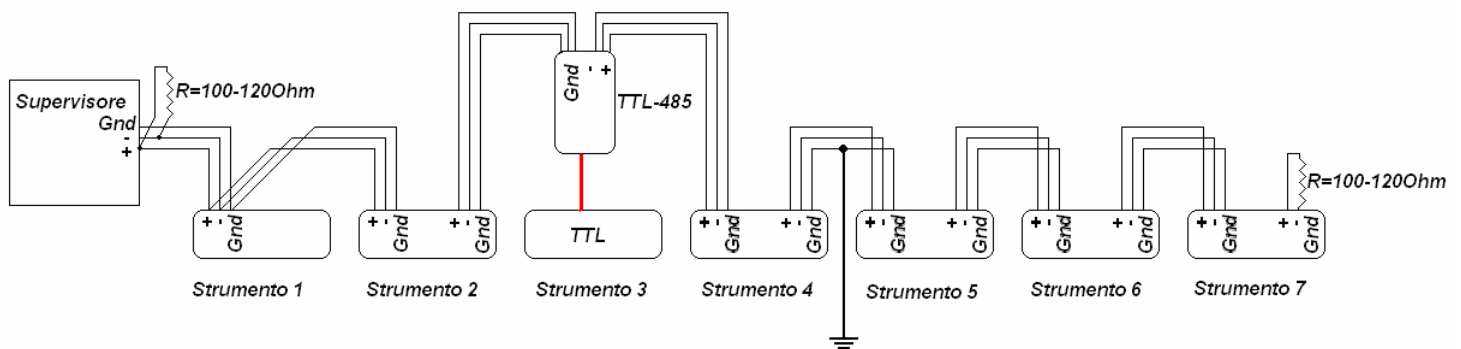
- If several controllers are not detected by the supervisor unit or if they do not communicate with the supervisor, even if they have not been replaced

1. Verify that FAA and dEA have been correctly set.
2. Verify that all network connections have been correctly performed, as explained in the previous chapter.
3. Verify that “+”, “-“ and “Gnd” are correctly connected for all devices.
4. Verify that all devices (including BusAdapter) are correctly powered at the required voltage.

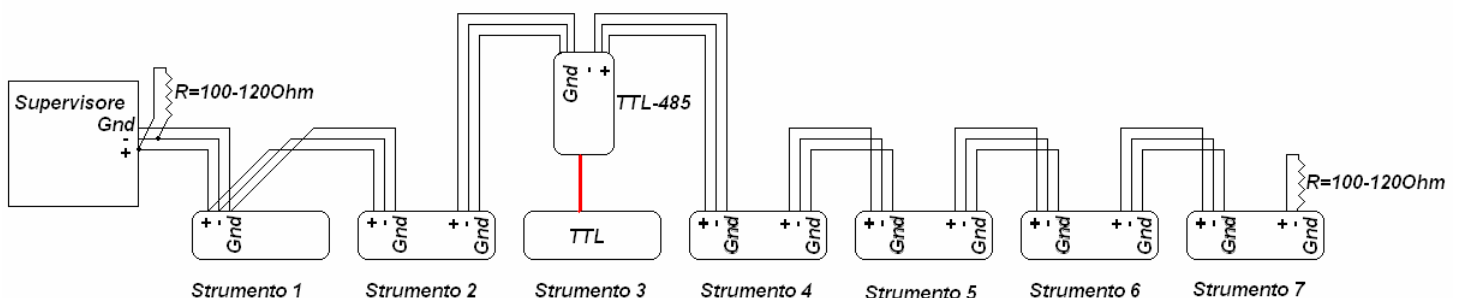
If none of the above conditions is the cause of the problem, replace the controller;

- If several controllers are not detected by the supervisor unit or if they do not communicate with the supervisor unit, even if they have not been replaced.

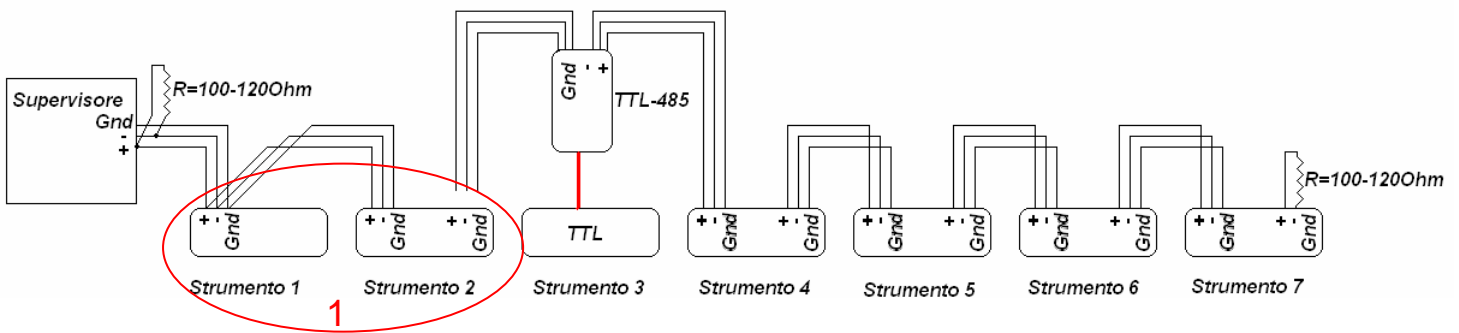
5. Verify that FAA and dEA have been correctly set.
6. Verify that all network connections have been correctly performed, as explained in the previous chapter.
7. Verify that “+”, “-“ and “Gnd” are correctly connected for all devices.
8. Verify that all devices (including BusAdapter) are correctly powered at the required voltage.
9. After verifying that the loop and grounding system are working correctly, connect lead “Gnd” or the sheath to the earth of the electric system. The connection should preferably be performed halfway along the network or as close as possible to the supervisor unit. This connection is not recommended if the grounding system is not reliable. If the latter complies with the specified requirement, the connection may further impair both the operation of the RS484 network and electric safety.



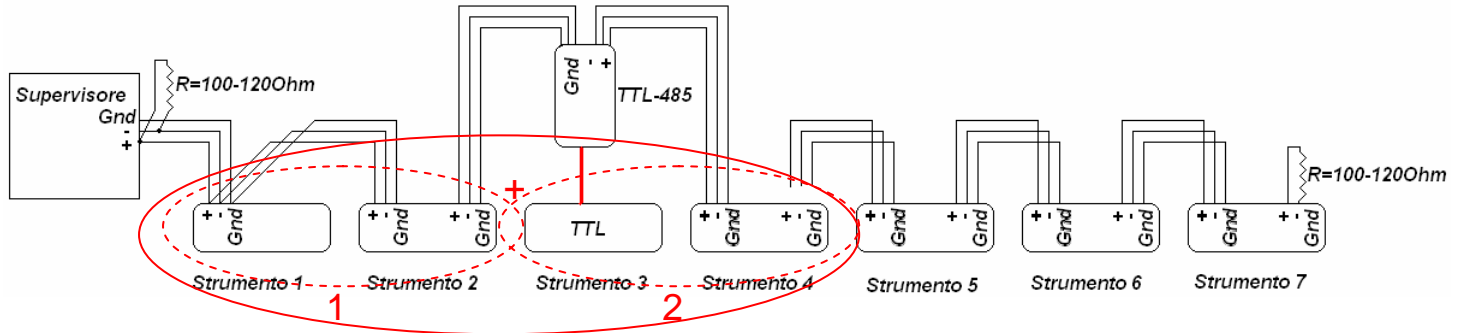
10. If the recommended solutions do not solve the problem, section the network testing the single sections in order to identify the faulty controller (i). The figure below refers to a complete and wired network:



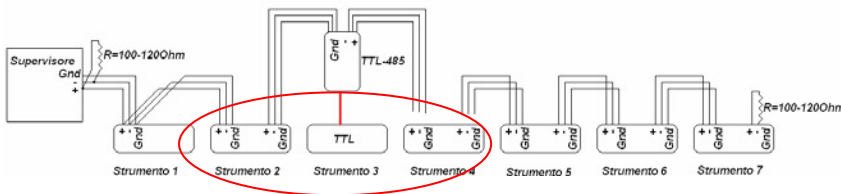
- Leave the first 2 controllers connected (group 1 highlighted in red), as shown in the figure below. Test the operation of the network with this connection.



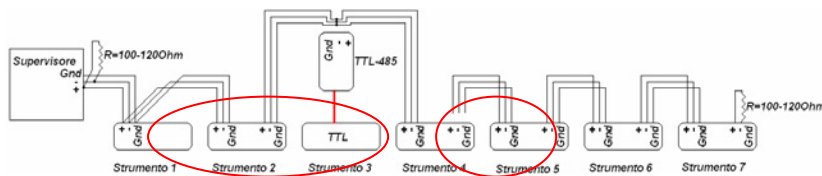
- If the network is working regularly, the connected controllers are not faulty or at any rate do not cause problems. Add 2 additional controllers (group 2 highlighted in red), as shown in the figure below. Test the operation of the network with this connection, i.e. group 1 + group 2.



- If the network is not working regularly and exhibits the initial problem, the problem may originate from one of the two controllers connected in the last step (or by both, although this is quite unusual). Connect group 2 to one controller only and test once more the operation of the network. The example of Figure 5.1 assumes that the network is not working correctly for Devices 1, 2 and 3, therefore the device causing the problem is no. 3. To confirm this condition, perform the cross-check illustrated in Figure 5.2.



**Fig.5.1 Network not working**



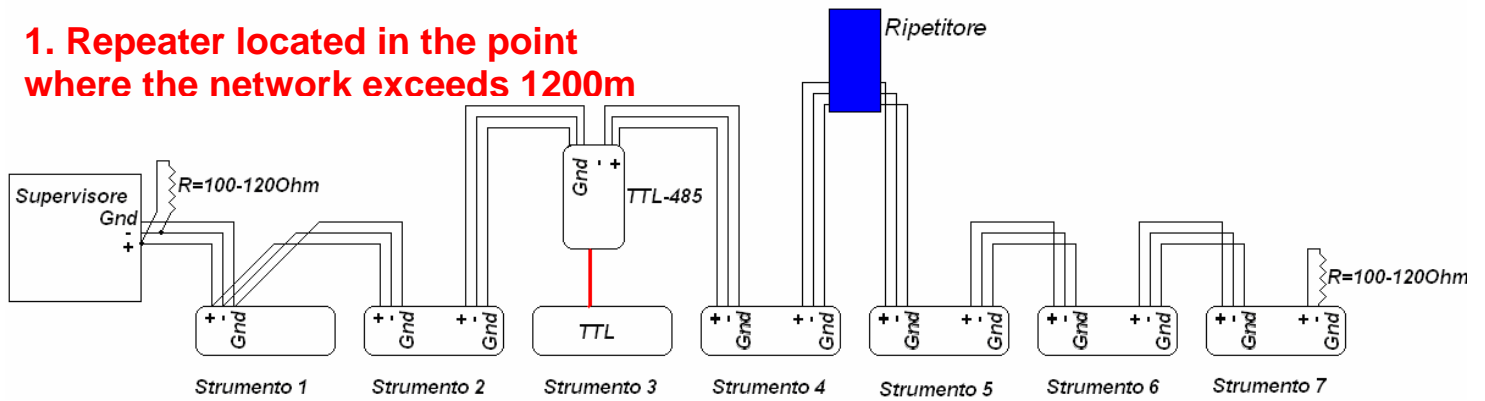
**Fig.5.2 Network working**

Supervisore	<b>Supervisor</b>
Strumento 1-2...7	<b>Device 1-2..7</b>

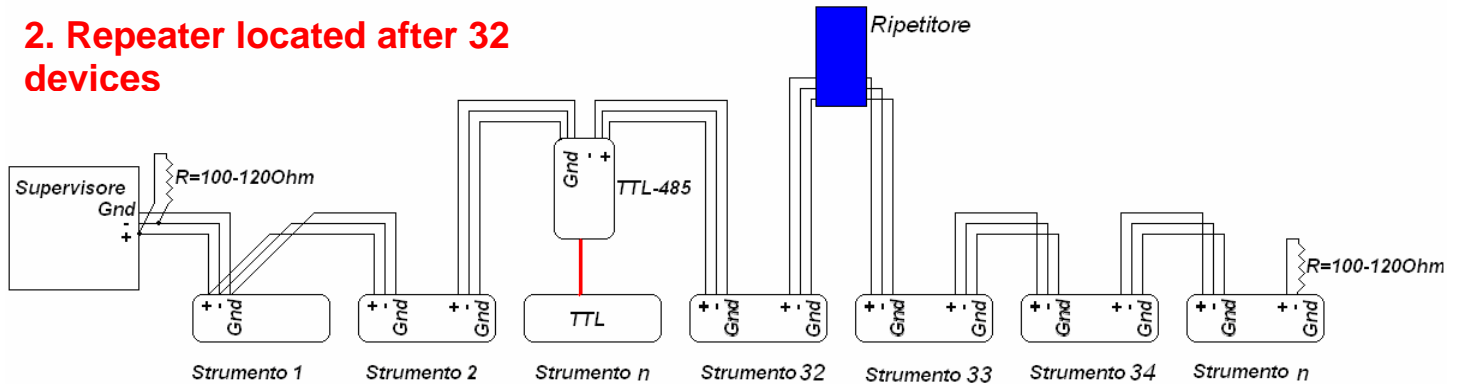
**NOTE:** if the device is connected using a BusAdapter, it is advisable to replace first the BusAdapter, then the connection cable (if the installation of a new BusAdapter does not solve the problem) and finally of the device (if the installation of a new BusAdapter and cable does not solve the problem).

RS485 standards admit a maximum length of 1200m and/or 32 devices on each network. The less compliant the network is with the requirements of this standard and the more likely are communication problems. This phenomenon is not systematic and may occur once only. However, if it reoccurs and none of the solutions illustrated in this chapter have solved the problem, it is advisable to connect a repeater (Eliwell code RP000000), as shown in the figures below:

## 1. Repeater located in the point where the network exceeds 1200m



## 2. Repeater located after 32 devices



Supervisore	<b>Supervisor</b>
Strumento 1-2...7, n, 32-33-34	<b>Device 1-2...7, n, 32-33-34</b>
Ripetitore	<b>Repeater</b>

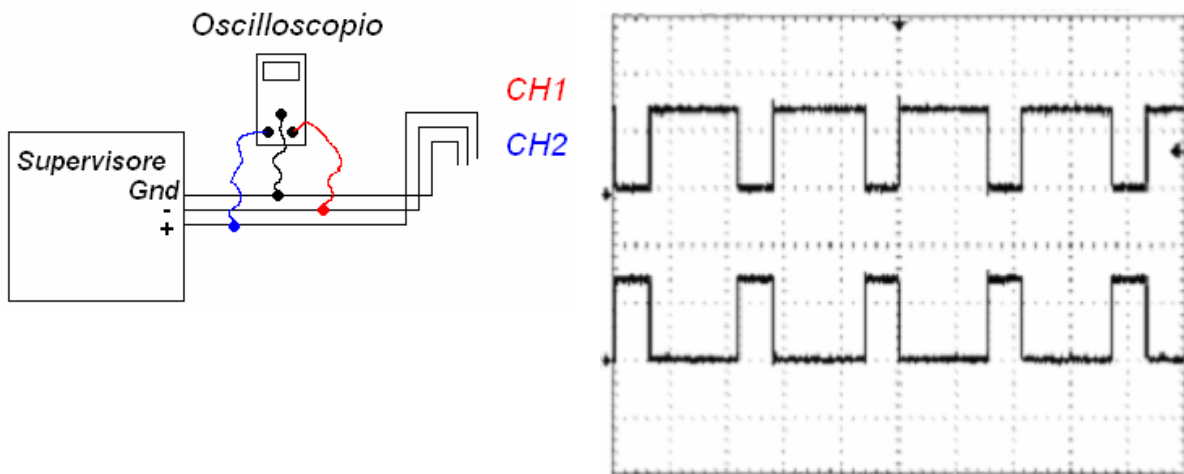
### Advanced network testing

It is sometimes possible to perform advanced network tests with an oscilloscope. Please take into account the following information:

- In an ideal network, the system is perfectly balanced because the signal on one lead is always the exact opposite of the signal on the second lead. In other words, if one lead is transmitting a high level, the other will transmit a low level and vice versa. See the following figure for more information:

CH1:channel 1 of the oscilloscope connected between “-” and “GND

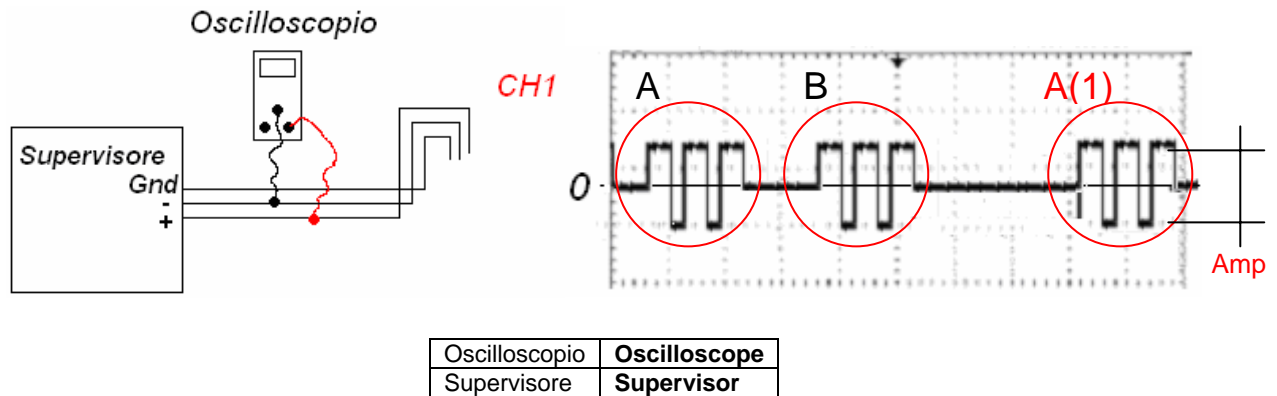
CH2:channel 1 of the oscilloscope connected between “+” and “GND



Oscilloscopio	<b>Oscilloscope</b>
Supervisore	<b>Supervisor</b>

This layout, viewed from a point located at a close distance from the supervisor unit, applies to all the points of the network.

2. The following figure shows the typical network "traffic" measured by connecting the oscilloscope between "+" and "-". The data packet "A" represents the supervisor's request, while the data packet "B" represents the controller's response. If packet "B" is not detected, the controller is probably not communicating with the supervisor system. The response is generated soon after the request is received. After a specific interval of time, the supervisor request packet A(1) is again sent and followed by a response (B1) and so on, until the procedure is interrupted by the supervisor unit. The interval between the request packages (A and A(1)) varies according to the speed and operating features of the supervisor unit.



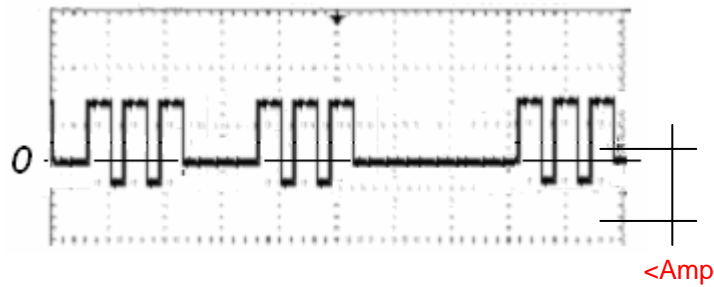
Taking into account the consideration of paragraph 1, it is useful to notice that:

Signals are symmetrical as compared to zero

The signal is set to 0 when there is no traffic and the network is idle.

The amplitude of signal "Amp" ranges from a minimum of 1.5 V to a maximum of 5 V

3. If the network is unbalanced or the amplitude is below the value specified above (and shown in the opposite figure), the communication with the devices could be discontinuous or non-existent. If this occurs, it is generally advisable to perform the tests described above.





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