EVOWL

Wireless Temperature System
Receiver unit

$C \in$

Operating manual

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Read and scrupulously follow the instructions given in this manual

Before installing the device, read the following warnings:

¤ Read the installation instructions given in this manual before hooking up the device.

¤ The device must be cabled with wiring suited to the limit voltage and current specifications given in the technical data.

¤ The RS485 port is NOT galvanically isolated; if the network is controlled by a master unit equipped with RS232 port, we recommend using an isolated converter; if the master unit is equipped with an RS485 port, we recommend using a galvanic separator or an isolated converter.

¤ Connection errors (e.g. connecting the power to the serial interface's A and B signals) can cause the device to fail; the EvoWL has protection against reversal of the power supply polarity.

¤ The device is not equipped with an ON/OFF switch, and powers up immediately as soon as power is supplied to it.

¤ The device must be powered with DC power of 5 to 30V; voltages higher than 30V DC will cause the device to fail.

¤ Make sure that the working environment falls within the range specified in 9 'Technical specifications'.

¤ The device is not designed for operation in hazardous atmospheres (flammable or explosive): its use in such conditions is therefore **prohibited.**

¤ The device is intended for industrial use only and not for use in situations where compliance with strict safety precautions is required, such as applications directly or indirectly correlated with medical equipment.

¤ The device may not be dismantled or repaired by unauthorised staff. Contact your local dealer for any repairs.

Italcoppie sensori s.r.l. is not liable in any way for damage or injury caused by tampering or incorrect or improper use of the device.

1 Introduction

The EVOWL-Rx receiver unit is used in association with the EVOWL-Tx remote units for monitoring product core temperatures inside blast chillers, cold stores, refrigerated counters, etc.

The use of radio frequency (RF) technology significantly cuts installation costs: the long connection cables necessary for conventional systems are no longer required.

The patch adhesive antenna supplied with the receiver can simply be installed in the area for monitoring (for example on the side of the blast chiller or refrigerator).

The values measured are converted inside the receiver and made available as digital data by means of the RS-485 serial interface and Modbus-RTU* protocol.

Each receiver (EVOWL-Rx) is able to manage up to 4 remote units (EVOWL-Tx), which are each able to monitor up to 4 temperature points simultaneously.

The system can be configured (association of the remote units to the transmitter, serial communication parameters etc.) using the configuration button and the EVOWL-Config software package.

The receiver is designed for installation on a DIN rail (EN60715) in accordance with the DIN 43880 standard (dimensions 71x90x57mm)

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* The *MODBUS* protocol is a standard very widely used in Field Buses: it is ideal for reliably and efficiently handling large data flows with numerous variables.

Thanks to this standard, the EVOWL series can be hooked up directly to the majority of commercially available PLC's and SCADA packages, with the option to connect these modules together with other devices (PLC's, operator panels, CNC equipment, etc...) over a single network.

1.1 How the EVOWL system works

The EVOWL system consists of a receiver unit (EVOWL-Rx) and one or more remote units (EVOWL-Tx probes).

The EVOWL-Tx remote units transmit the data cyclically by wireless (4 temperatures and battery status) every 30 seconds* or every 7 seconds if the temperature variation in the working environment exceeds 1°C.
The data are acquired by the EVOWL-Rx receiver, which makes them available on the Modbus RTU network.
Each receiver is able to manage up to 4 EVOWL-Tx remote probes simultaneously.

The EVOWL-Tx remote units have a unique marking (ID) on the stem which identifies them; the probes whose data is to be acquired therefore have to be associated on the EVOWL-Rx receiver.

If the working temperature is below 0°C the cycling transmission rate may vary from 30 up to 40 seconds.

1.1.1 Typical installation examples
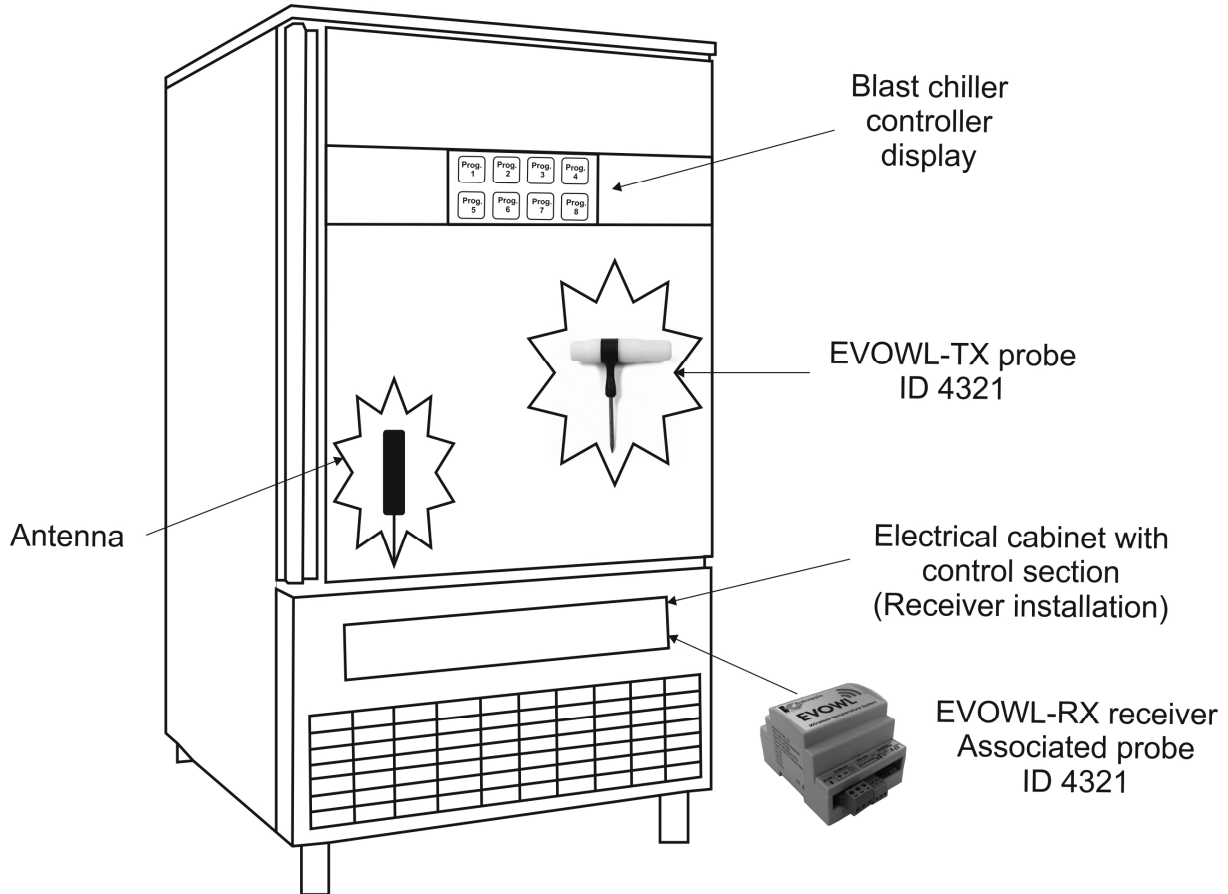
The example shown above is the typical with a EVOWL-Tx remote probe installed inside a blast chiller, with the receiver installed on a DIN rail in the control panel.
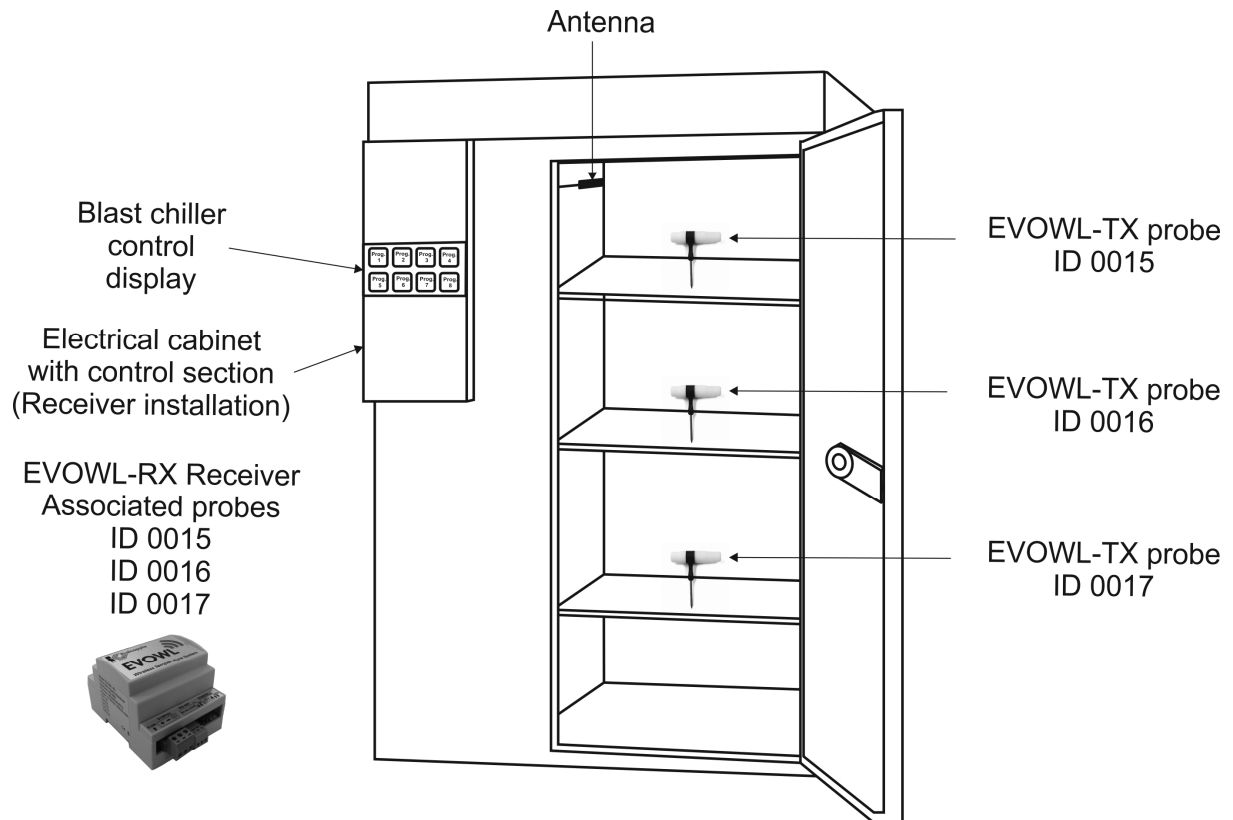
The receiver is connected by means of an RS485 serial line to the blast chiller control section, which in turn is connected to a display with configuration keyboard (or a touch-screen operator panel).

The EVOWL-Tx probe transmits the data cyclically to the receiver, which transfers them by means of the serial line to the blast chiller control section, which controls and displays the data on the display.

In this configuration, only the ID of one probe has to be associated to the receiver.

In the example, the EVOWL-Tx probe with ID 4321 has been associated to the receiver installed in the electrical panel; with the aid of the data received from the EVOWL-Rx receiver, the control section is able to monitor the product core temperature and inform the operator about the status of the blast chilling process by means of the display.
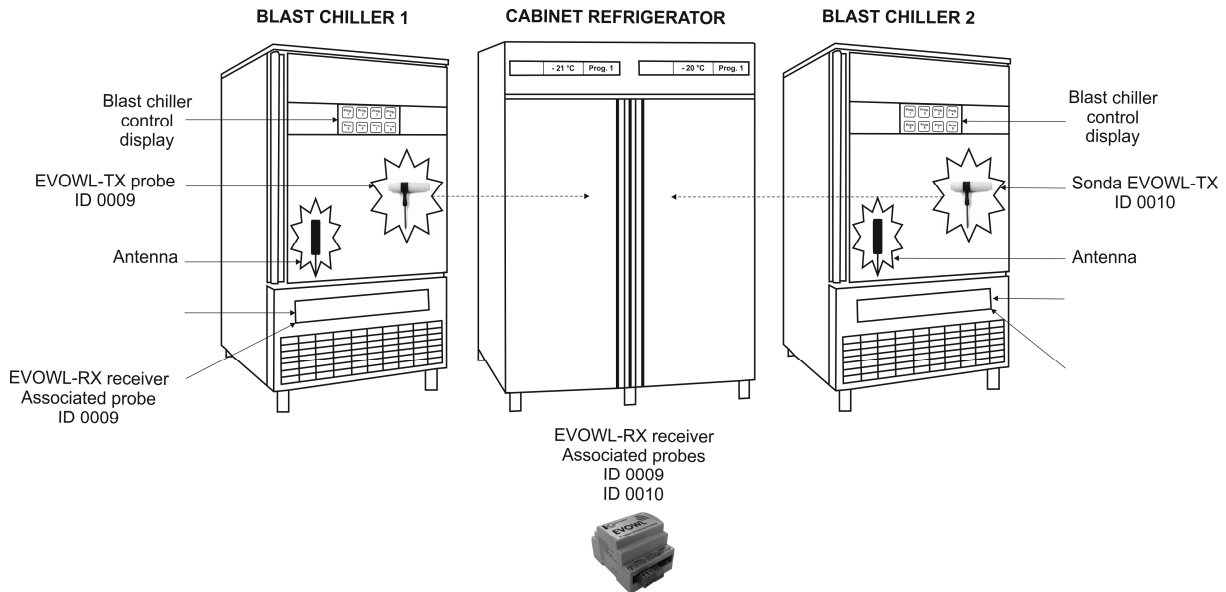
However, in large blast chilling tunnels or blast chillers, it may be necessary to use more than one EVOWL-Tx probe: up to 4 EVOWL-Tx remote units can be associated to a single receiver.

Antenna

Blast chiller control display

Electrical cabinet with control section (Receiver installation)

EVOWL-RX Receiver Associated probes
ID 0015
ID 0016
ID 0017

EVOWL-TX probe ID 0015

EVOWL-TX probe ID 0016

EVOWL-TX probe ID 0017

In the example above, 3 EVOWL-Tx probes with ID 00015 / 0016 and 0017 are installed, associated to the receiver mounted in the electrical panel. With the aid of the data received from the EVOWL-Rx receiver, the control section is able to monitor the product core temperature readings of the three EVOWL-Tx probes on the various trays on the trolley and inform the operator about the status of the blast chilling process by means of the display.

Installation with more than one blast chiller

BLAST CHILLER 1   **CABINET REFRIGERATOR**   **BLAST CHILLER 2**

Blast chiller control display

EVOWL-TX probe ID 0009

Antenna

EVOWL-RX receiver Associated probe ID 0009

- 21 °C | Prog. 1   - 20 °C | Prog. 1

Blast chiller control display

Sonda EVOWL-TX ID 0010

Antenna

EVOWL-RX receiver Associated probes ID 0009 ID 0010

An industrial kitchen may be equipped with several blast chillers and cabinet refrigerators.
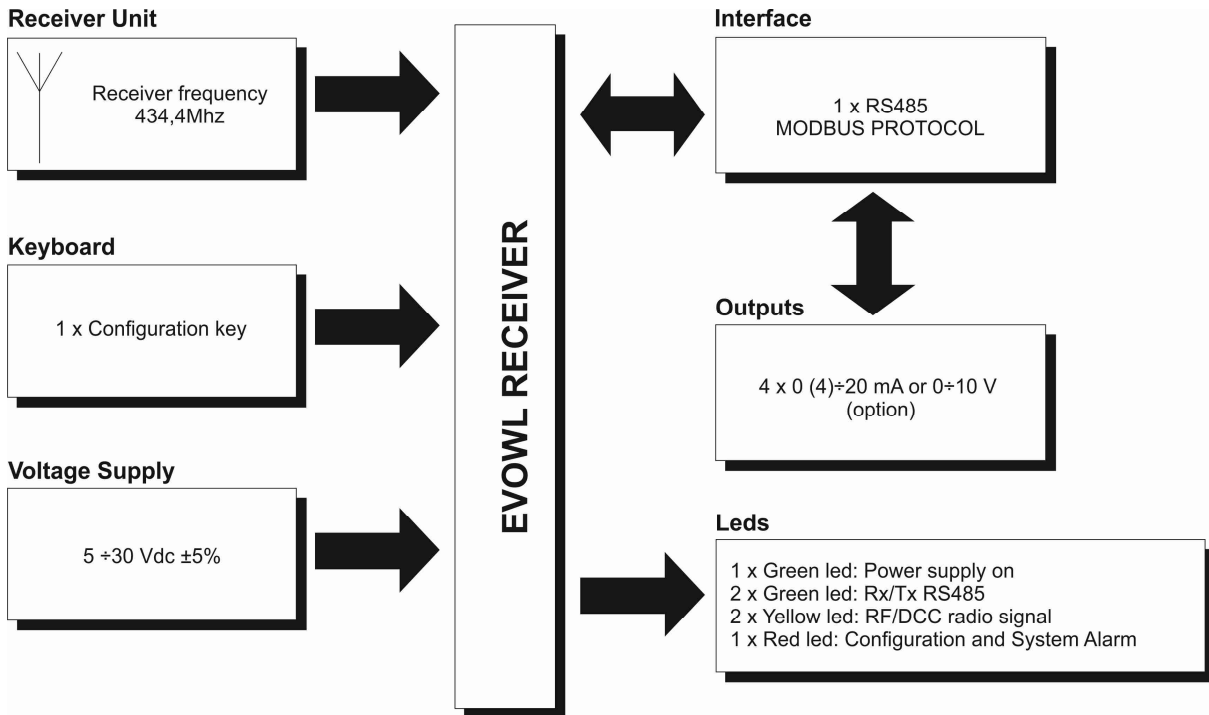The EVOWL system can be installed on different blast chillers, even if they are placed close together.
At the end of the blast chilling cycle, a probe installed inside a blast chiller may be transferred to a cabinet refrigerator or freezer (for example, it may still be inserted inside food that has just been frozen) and keep transmitting data to the control system. If the system includes a data logger, this will provide a record of the temperature trend from the moment when the food entered the blast chilling process through to storage or regeneration.

In the example shown above, two EVOWL-Tx probes are installed on two different blast chillers; blast chiller 1 is fitted with the probe with ID0009, associated to the relative receiver, blast chiller 2 is fitted with the probe with ID0010, associated to the relative receiver, while the receiver of the cabinet refrigerator has been configured to receive the data from both probes (ID 0009 and 0010).
If the 2 probes are transferred to the cabinet refrigerator at the end of the blast chilling cycle, the relative control PCB connected to the receiver will be able to process the data from both the EVOWL-Tx probes.

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1.2 Block diagram

Receiver Unit

Receiver frequency
434,4Mhz

Keyboard

1 x Configuration key

Voltage Supply

5 ÷30 Vdc ±5%

EVOWL RECEIVER

Interface

1 x RS485
MODBUS PROTOCOL

Outputs

4 x 0 (4)÷20 mA or 0÷10 V
(option)

Leds

1 x Green led: Power supply on
2 x Green led: Rx/Tx RS485
2 x Yellow led: RF/DCC radio signal
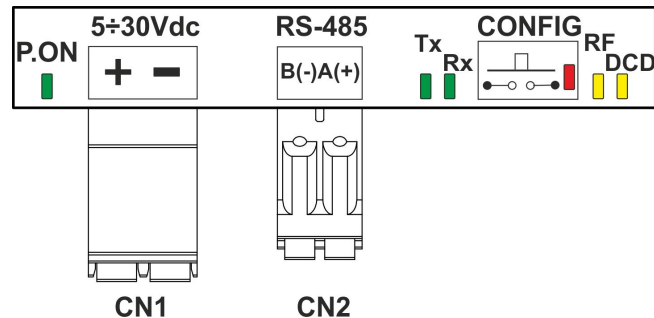1 x Red led: Configuration and System Alarm

2 Installation

Warning: systems must only be installed by qualified staff.

2.1 Electrical connections

CN1   CN2

CN1: power supply connector
Warning: the device is not equipped with an ON/OFF switch, and powers up immediately as soon as power is supplied to it.

Connect the **+** and **−** to a power source that delivers a voltage between 5 and 30 V DC (±5%) (maximum consumption 50mA).

Use flexible cables with cross-sections between 0.2mm^2 and 2.5mm^2 :stripping length 10mm.

CN2: serial interface connector
Connect the A(+), B(-) signals to the RS485 serial interface of the master unit. A shielded, twisted pair should be used: connect the shield at one end of the cable only and at the chassis of machine.

Use flexible cables with cross-sections between 0.2mm^2 and 1.5mm^2 :stripping length 10mm.

For further information see point 2.3 "*Communication cable layout*".

2.2 RS485 port

The EVOWL-Rx device is equipped with an RS-485 serial port with 2 wire connection.

The RS485 port is not galvanically isolated: if the master unit is equipped with an RS232 port, we recommend using an isolated RS232/RS485 converter. If the master unit is equipped with an RS485 port, we recommend using an RS485 galvanic separator (see 'EVOWL options').

Up to 32 devices may be installed in the RS485 network.

For further information, refer to the "Guide to RS-485 network" section.

2.3 Communication cable layout

To prevent external interference with the serial signal and obtain the highest efficiency between the master and the EVOWL-Rx, a number of small precautions must be observed.

The most important (and simplest) is to physically separate the power and communications cables and route them as far as possible from contactors, electromagnets, powerful motors, etc.

The type of cable used is essential to the operation of the system as a whole. The most important specification is capacitance per meter (pF/m); the lower the capacitance of the cable the longer the line may be. In this regard, the power cable and generic ducting cables are absolutely to be avoided inasmuch as they have a very high capacitance per meter. Furthermore, to obtain high resistance to disturbances, the cables must be twisted together and equipped with a metal shield connected to a good ground plant (**at one end only**), with a characteristic impedance of around 120 ohm.

If these simple precautions are observed, the line will operate at its highest possible speed over a distance of up to 1,200 meters.
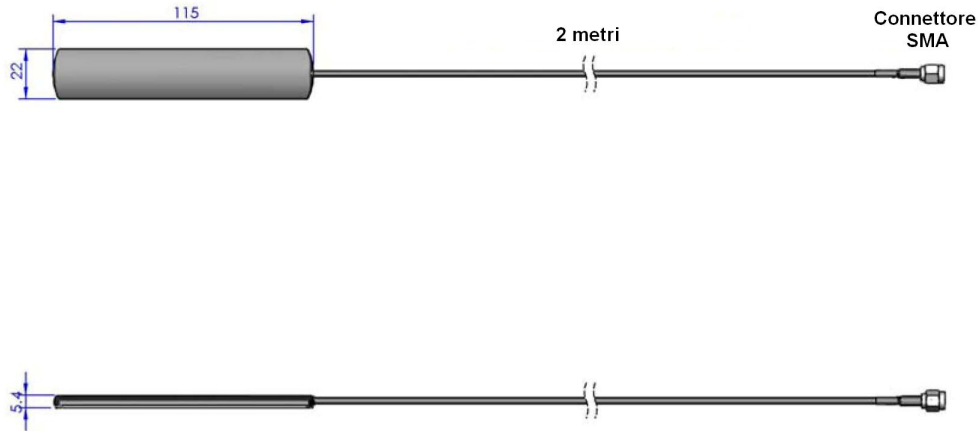
The two devices (master and last slave) at each end of the line must be terminated; star type connections are not allowed, since each wire would be terminated, thus significantly lowering the impedance of the line and blocking communications completely.
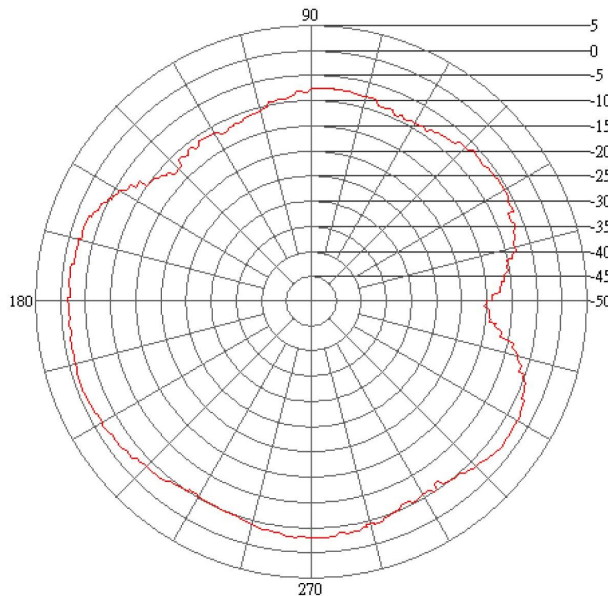
2.4 Installing the antenna

The receiver comes complete with a patch adhesive antenna.

Mechanical dimensions

Footprint

The antenna <u>must be installed inside the area for monitoring</u> (blast chiller, cold store, etc.) **on a metal surface of the machine**; it is important to lay the antenna cable well away from contactors, electromagnets, high-power motors, digital communication cables, etc.

The remote units (EvoWL-Tx probes) must be placed more than 0.4 metres away from the antenna to prevent saturation of the radio signal, leading to wireless communication problems.

The antenna must be glued (using the integral glue stick) to a clean, flat metallic surface at room temperature (20°÷28°C); wait about 9 hours before varying the temperature of the chamber where it has been installed.

2.5 Indicator lights (LEDs)

On the receiver fitted with 6 indicator lights (LEDs):

Green P.ON (Power on) LED
When on, indicates that power is present: the transmitter is operational.

Green Tx / Rx (Transmission / Reception) LEDs
When flashing, they indicate that Modbus communication is active on the RS485 network: the Rx (receiver) LED comes on when the master unit is querying the slaves for data, while the Tx (transmitter) LED illuminates when the EVOWL-Rx device is transmitting the data.

Red Config (Configuration) LED
A status indicator which also signals any system errors (for further information, refer to "Config button and LED functions").

Yellow DCD / RF LEDs
A short flash of the RF led indicates the presence of a radio signal at the frequency of 433.4MHz.
A short flash of the DCD (Detect Correct Data) LED indicates that the transmitted by the EVOWL-Tx remote units are being received correctly.

2.6 Config button and LED functions

The "Config" button is used to configure the receiver's parameters or restore the factory settings, while the relative red LED indicates the device's various operating modes, which are described below.

1- *"Receiver parameter configuration" mode*
   This mode is used to configure the receiver's operating parameters; to activate it, first press the button then power up the receiver: in configuration status, the red LED is on with a steady light.
   In this mode, the receiver self-sets with the following serial communication parameters: Baud rate 9,600 bps, 8 data bits, 1 start bit, 1 stop bit, parity none (9600-N-8-1) and Modbus communication address #1. With the aid of the specific kit (code EVO018) the user can configure the receiver parameters as required; however, the unit can also be configured using a commercial app (e.g. Modbus polling) or using the master Modbus unit that is to control the receiver itself.
2- *"Parameter default settings" mode*
   This mode is used to restore the receiver's parameters to their factory settings:
   - Modbus address = 1
   - Baud rate = 9,600 bps

- Parity - none
- Stop bit = 1
- Modbus delay = 1 (20mS)
- ID of the 4 associated transmitters = -1 (no associated transmitter)

To restore the parameter default settings, hold the Config button down for about 10 seconds during normal operation of the receiver; the red LED will flash quickly to confirm the reset.

3- *"EVOWL-Tx probe ID autolearning" mode*

Every EVOWL-Tx probe is programmed in the factory with a unique 4-figure ID code indelibly marked on its metal stem. For the probe to be able to transmit data to the receiver, the ID must associated to the receiver concerned. This can be done using the specific configuration kit (code EVO018) or simply using the autolearning* mode described below:

- Power up the receiver.
- Make sure that all the EVOWL-Tx probes present in the vicinity of the receiver are connected to their docking stations (out-of-use mode).
- Press the Config button: the red LED flashes at the constant rate of once a second to indicate that autolearning is in progress.
- Place the EVOWL-Tx probe to be associated (still fitted into its docking station) near to the receiver.
- Remove the EVOWL-Tx probe from the docking station and wait for the flashing red LED to go out.
- When the red LED goes out, the EVOWL-Tx probe has been associated to the receiver.

N.B.: the autolearning mode allows just one probe to be associated to the receiver, while if the configuration kit is used up to 4 probes can be associated.*

System errors

The red Config LED also signals the system errors described below:

4- *EEprom error*
The receiver is equipped with an EEprom memory used for permanent storage of the functional parameters; if the parameter data are corrupted (due to exceptional events) the red LED indicates this error by giving 5 short flashes and one long one.
To restore operation of the receiver, the default settings of the parameters have to be restored (see "Parameter default settings mode").

5- *Wireless module communication error*
The transmitter is equipped with an RF section that handles wireless communications: a malfunction is signalled by two quick flashes of the red LED followed by a 1 second pause. If the error persists even after the receiver has been switched off and back on, the after-sales service must be called in.

3 GUIDE TO RS-485 NETWORK

The RS485 serial interface is based on a balanced differential communications line with typical impedance of 120 ohm. The maximum cable run is not defined, but depends on the speed of communications, the signal noise ratio and the quality of the cable used. The line is generally guaranteed to operate up to 1,200 m.
The cable can be unshielded if the run is of a few metres in an electrically only slightly noisy area. For distances from 15 to 100 m, you can use a shielded and twisted cable without special characteristics, while for connections over 100 metres, we recommend using a category 5 cable.
The ends of the line must be terminated in parallel with a 120 ohm resistance.
The shield of the cable must be connected to pin Nr.13 (SG) on the CH connector, and grounded at one end only; if the other end must be grounded to reduce disturbance, fit a 10nF capacitor.

3.1 Capacitive load of the line

With very long cables, the capacitance of the cable starts to be the dominant factor in power consumption. For this reason, it is not usually possible to achieve maximum cable run and highest transmission speed in a single installation.
The following table is a rough guide to the compromise between distance and speed

Baud Rate	Total max. capacitance cable (pF)
2,400	200,000
4,800	100,000
9,600	50,000
19,200	25,000
38,400	12,000

The capacitance of the cable (in pF/m) can be obtained from the manufacturer, and is typically between 50pF/m (for high quality cables, e.g. category 5) and 100pF/m.
Naturally, the resistance and inductance of the cable, which may be neglected for short cable runs, influence the signal level if the cable run is very long. It is hard to give general rules, since he minimum section depends on the line termination, number of connected devices and spacing between them. In case of doubt, always choose the larger section cable.

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3.2 Line polarity

As per the RS485/422 standard, the line connections are indicated as **A** and **B**: the line may however be marked differently, for example HI/LO or +/-. It is usually assumed that A/B correspond respectively to HI/LO, or +/-, but this is not always the case. In case of malfunction, try swapping the connections even if everything seems to be OK.

4 Modbus RTU

4.1.1 Preliminary notes

MODBUS was used primarily in industrial applications, thanks to the dominating presence of Modicon in the PLC market, which developed the standard for its own equipment.
When the specifications became public and open, the Modbus protocol was adopted in numerous automation applications and subsequently in all sectors.
For many years it has been a *de facto* standard, and the Modbus protocol can be found on any "intelligent" equipment (IFD - Intelligent Field Device): programmable controllers, NC, drivers, man/machine terminals, measurement equipment, etc.

4.1.2 Communication model

The connection is made over an RS-485 multipoint network, typically by means of a twisted two-wire cable with shielding.
The communications technique is of the Master-Slave type, multipoint half-duplex, in which only the Master (typically a Host PC) can initiate communications with a request ("Query"), while the Slaves respond with a message ("Response") only to the queries addressed directly to themselves.
One master can control up to 247 slaves on a single line; note that this is a logical limit of the protocol, however the physical interface may further limit the number of devices, for example, the standard RS-485 interface supports a maximum of 31 slaves on a single line. If we replace the last device on the line with a bridge or repeater, a further 31 slaves can be installed, an so on up to the logical limit.
The Modbus protocol establishes the format of the query, which contains the address of the slave being queried, a function code for the requested action, various fields for exchanging data (registries, coils, etc...), and a field to check for communications errors (CRC).
The slaves respond with messages which are structured in the same way; if a slave is unable to complete the requested action, it sends an error code in the response.

4.1.3 Transmission

The EVOWL-Rx device employ the RTU Modbus protocol; the serial mode and setup must be the same for all devices on the Modbus network.

In RTU (Remote Terminal Unit) mode, the messages, which are composed of single bytes, are sent in the form of two 4 bit hexadecimal characters. The advantage of this is that the quality of data exchange is better than that provided by the ASCII mode for a given transmission speed. Each communications packet must be transmitted in a continuous cycle.

The format for each RTU mode byte is:

Coding system: 8 binary bits, from 00 to FF
Two hexadecimal characters are contained in each 8 bit field of the message.
Each 8 bit character of the message corresponds to one data byte.

Character format:
1 start bit ,
8 data bits,
the 1st bit is the least significant,
no parity bit (None),
1 stop bit.

Address: Modbus transactions always involve the master, which controls the line, and one slave at a time (except for broadcast messages, but these are not implemented in the EVOWL-Rx firmware). To identify the target of the query, the first byte contains the numerical address of the desired slave. Each slave has a unique address number which uniquely identifies it. Legal addresses run from 1 to 247, while 0, which cannot be assigned to a slave, at the head of a message identifies the message as "broadcast", directed at all slaves at the same time. Only messages which do not require a response to complete may be transmitted as broadcast, in other words, only assignments.

Function code:
The second character of the message identifies the function to be executed, to which the slave responds with the same code to indicate that the function has been executed. The EVOWL system implements a subset of Modbus functions, including:

Modbus function code	Function
01	Read Coil status
02	Read Input Status
03	Read Holding register
04	Read Input register

05	Force single Coil
06	Preset single register
07	Read Status

In the EVOWL-Rx device, functions 01 and 02 are operatively identical and interchangeable, as are functions 03 and 04.

4.1.4 CRC16

The CRC field is the last in the section and allows the master and the devices to detect transmission errors. Occasionally, due to electrical noise or interferences of another kind, some modification may be caused in the message while it is being transmitted. CRC control of errors ensures that the receiver devices or the master will not perform incorrect actions due to an accidental modification of the message.

The CH controller does **NOT** send any reply when it detects a CRC error in the section received. Stop bits and parity bits are not considered in calculating the CRC. Only the data bits.

The sequence for the CRC calculation is described in the following:

1. Load a 16 bit register at 1's.
2. Perform an exclusive OR of the first 8 bits received with the high byte of the register, saving the result in the register.
3. Move the register one bit to the right.
4. a) If the displaced bit is a 1, carry out an exclusive OR of the value of 1010 0000 0000 0001 with the content of the register and save it in the register.
4. b) If the displaced bit is a 0, return to step 3.
5. Repeat steps 3 and 4 to 8 bit displacements.
6. Carry out an exclusive OR of the following byte of the section with the 16 bit register.
7. Repeat steps 3 to 6 until all of the bytes of the section have been processed.
8. The content of the 16 bit register is the CRC, which is added to the message with the most significant bit first.

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4.1.5 CRC16 Visual Basic example

```
Function CRC16(Stringa As String) As String

        Dim N As Integer, I As Integer, NByte As Integer
        Dim CRC As Long, a As Byte
Dim Buffer As String

NByte = Len(Stringa)
CRC = 65535


    For i = 1 To NByte
       a = Asc(Mid$(Stringa, I, 1)) 'C(I)
     CRC = (CRC Xor a) And &HFFFF

       For N = 0 To 7

         If CRC And 1 Then
              CRC = (CRC \ 2)
            CRC = (CRC Xor 40961)
         Else
            CRC = CRC \ 2
         End if

      Next

    Next

    Buffer = Right$("0000" + Hex$(CRC And &HFFFF), 4)
CRC16 = Chr$ ("&H"+ Right$(Buffer, 2)) + Chr$("&H" + Left$(Buffer,2))
    End Function
```
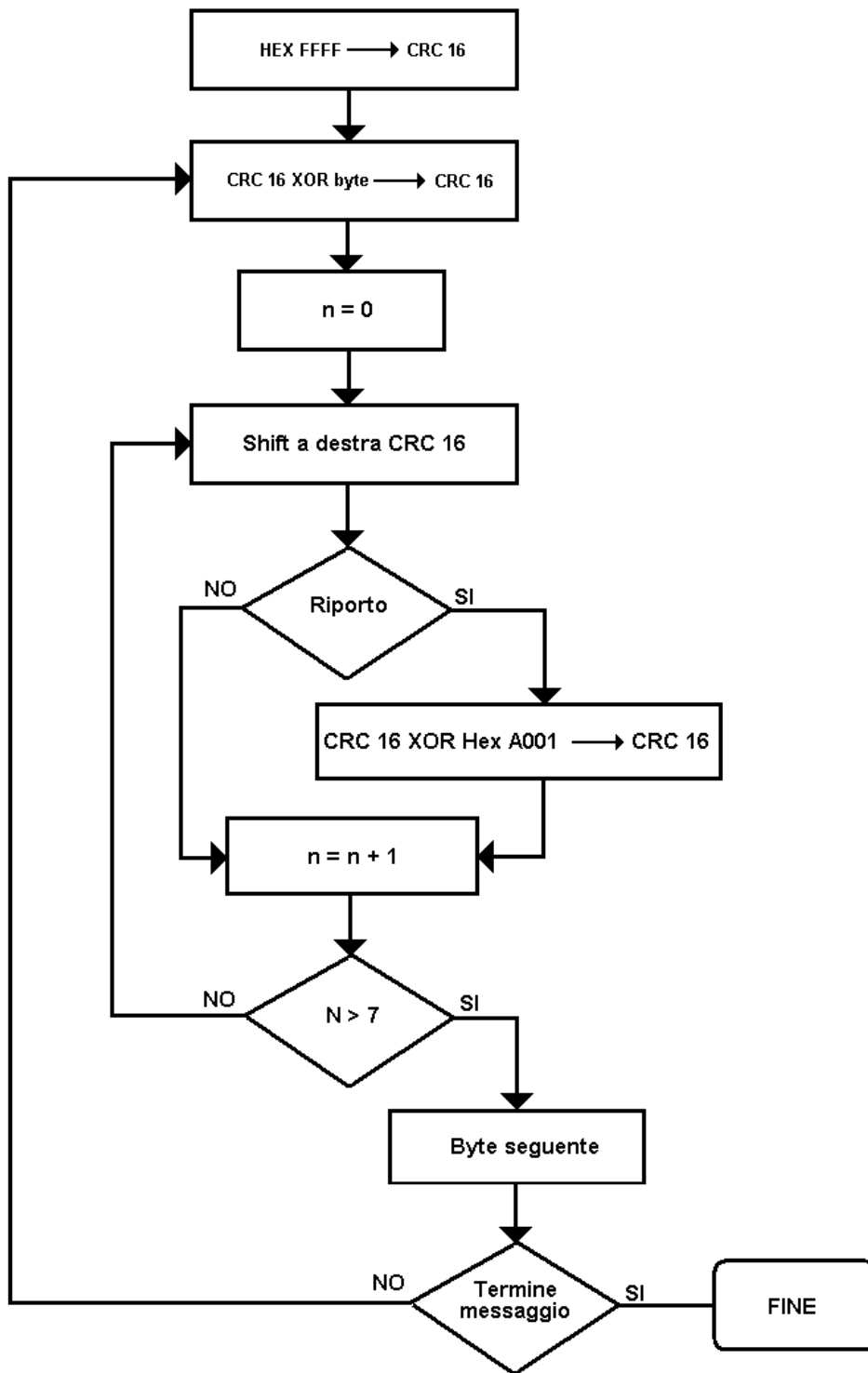
4.1.6 CRC16 calculation Flow chart

```
                    ┌─────────────────────────┐
                    │  HEX FFFF ──→ CRC 16     │
                    └─────────────────────────┘
                                 │
        ┌───────────────────────▼─────────────┐
        │         CRC 16 XOR byte ──→ CRC 16   │
        │        └──────────────────────────┘  │
                                 │
                    ┌─────────────────────────┐
                    │          n = 0           │
                    └─────────────────────────┘
                                 │
              ┌──────────────────▼─────────────┐
              │       Shift a destra CRC 16     │
              └────────────────────────────────┘
                                 │
              NO             ◇ Riporto ◇            SI
                                 │
                    ┌────────────────────────────────────┐
                    │  CRC 16 XOR Hex A001 ──→ CRC 16     │
                    └────────────────────────────────────┘
                                 │
                    ┌─────────────────────────┐
                    │        n = n + 1         │
                    └─────────────────────────┘
                                 │
              NO            ◇  N > 7  ◇           SI
                                 │
                    ┌─────────────────────────┐
                    │      Byte seguente       │
                    └─────────────────────────┘
                                 │
              NO         ◇ Termine        SI    ┌──────────┐
                           messaggio ◇          │   FINE   │
                                                └──────────┘
```

4.1.7 Message synchronisation

The message between the transmitter and receiver is synchronised by inserting a pause between messages of at least 3.5 times the time it takes to transmit a character; this pause therefore depends on the baud rate.

If the receiver does not receive for a period of 3.5 characters, it assumes the previous message to be complete and considers the subsequent byte to be the first of a new message, and thus an address.

The network devices constantly monitor the bus, including the silent pause. The admissible characters transmitted for all fields are 8 bit numbers, hence in the range 0 to 255.

The first transmitted field is the address of the device.

When the first field (address) has been received, each device decodes it to determine whether the message is addressed to itself.

After the last transmitted character, an interval of 3.5 characters follows to indicate the end of the current message. A new message can start immediately after expiry of this delay. The entire message frame must be transmitted continuously.

If a new message starts before the delay of 3.5 characters has expired, the receiver will consider it to be the continuation of the previous message; this generates an error, since the value of the last field (CRC) will not be valid for the combined messages.

START	ADDRESS	FUNCTION	DATA	CRC CHECK	END
T1-T2-T3-T4	1 CHAR (8 bits)	1 CHAR (8 bits)	N CHARS (n x 8 bits)	2 CHARS (16 bits)	T1-T2-T3-T4

4.2 Modbus functions

We describe in detail the Modbus functions implemented on EVOWL-RX device.

4.2.1 Read N bit (Function code 01 or 02)

This function allows the user to obtain the logical values (ON / OFF) of the bits of the addressed device. The reply data are packed in bytes in such a way that the first bit requested occupies the bit of least weight of the first data byte. The following carry on so that if they are not a number that is a multiple of 8, the last byte is completed with zeros.

Master-device package:

Device address	Function code (01 o 02)	Address of the first bit		Number of bit to be read (max 255)		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Device-master section:

Device address	Function code	Number of bytes read	First data byte	....	Last data byte	CRC	
1 byte	1 byte	1 byte	1 byte	....	1 byte	MSB	LSB

Example: Read 2 bits from the bit with address 2, of the device with the address 2.

Master-device package:

Device address	Function code	Address of the first bit		Number of bit to be read (max 16)		CRC	
02	01	00	02	00	02	1C	38

Device-master section:

Device address	Function code	Number of bytes read	First data byte	CRC	
02	01	01	11	91	C0

The reply tell us that the coil with address 2 is active (value = 1) and the coil with address 3 is NOT active (value = 0). Excluding the first 2 bits the others bit are not important.
It is possible read up to 16 bit together.

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4.2.2 Read N Registers (Function code 03 or 04)

This function enables the user to obtain the values of the registers of the addressed device. These registers store the numerical values of the parameters and variables of the controller.

Master–device package:

Device address	Function code (03 / 04)	Address of first register		Number of register to be read (max 16)		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Device–master package:

Device address	Function code	Number of byte read	Value of first register		.....	Value of last register		CRC	
1 byte	1 byte	1 byte	MSB	LSB	.....	MSB	LSB	MSB	LSB

Example: Read 2 registers from the register with address 0, of the device address 1.
Master–device package:

Device address	Function code	Address of first register		Number of register to be read		CRC	
01	03	00	00	00	02	C4	0B

Device-master package:

Device address	Function code	Number of bytes read	Value of first register		Value of last register		CRC	
01	03	04	00	61	00	50	AB	D1

The reply tell us that the register 0 and 1 have respectively the hexadecimal value 0x0061 (97) and 0x0050 (80).

The maximum number of register to be read is 16; a request of an higher number than 16, will make a frame error**.**

4.2.3 Assign a register (Function code 06)

This function enables the user to modify the content of the parameters of the addressed device.

Master–device section:

Device address	Function code (06)	Register address		Register value		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Device-master package:

Device address	Function code (06)	Register address		Register value		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Example: Assign the value 15 (000Fh) to address register with address 01 , of device with address 2.

Master-device package:

Device address	Function code	Register address		Register value		CRC	
02	06	00	01	00	0F	98	3D

Device-master package:

Device address	Function code	Register address		Register value		CRC	
02	06	00	01	00	0F	98	3D

The reply tell us that register 1 has received the value of 15 .

4.2.4 Assign multiple registers (Function code 16)

This function allows the user to set the value of a block of consecutive 16 bit registers.

In the EVOWL-Rx implementation, while this function is available for reasons of compatibility, it does not allow more than 16 register to be set.

Master – device package:

Device address	Function code (16)	Address of first register		Number of WORDS		Number of BYTES	...DATA...		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	1 byte	MSB	LSB	MSB	LSB

Device – master package:

Device address	Function code (16)	Address of first register		Number of WORDS		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Example: Write two registers at the same time. Assign the value 4556h to the register with address 13, and 4F54h to the register with address 14, device address 1.

Master – device package:

Device address	Function code	Address of first register		Number of WORDS		Number of BYTES	DATA				CRC	
01	10	00	0D	00	02	04	45	56	4F	54	F2	E5

Device – master package:

Device address	Function code (16)	Address of first register		Number of WORDS		CRC	
01	10	00	0D	00	02	D0	0B

4.3 Modbus error codes

The Modbus protocol provides for two types of error, which are handled in different ways: transmission errors and operational errors. Transmission errors are errors which change the message in terms of format, parity (if used) or CRC16. A device which detects this type of error considers the message to be invalid and does not respond. If, on the other hand, the message format is correct but the requested function cannot be executed for any reason, this is an operational error. The device responds to this type of error with an exception message. Such a message is composed of the address, code of the requested function, error code and CRC. To indicate that the response is an error, the function code is returned with its most significant bit set to '1'.
Although the Modbus standard provides for 8 different exception codes, the EVOWL-Rx implementation only has 3:

Error code	Name	Description
01	ILLEGAL FUNCTION	Function not valid
02	ILLEGAL DATA ADDRESS	Data address field not valid
03	ILLEGAL DATA VALUE	Data field not valid

4.4 Communication times

The messages, as described above, must be exchanged without internal pauses of more than 3.5 times the transmission time of a character, since a pause of this duration indicates the end of a message. Between a master query and the response from the addressed EVOWL-Rx device, a latency time passes which can be set from 0 to 2 seconds, set in steps of 10 ms with the parameter 'Modbus delay' (register address 4).

5 Table of registers

All the data shared by a module communicating with the Modbus protocol are mapped into tables, in which each datum is given an address.
Each datum can be of two types:
- "COIL", composed of a single bit: in the EVOWL-Rx implementation, these bits are logical states.
- "REGISTER", composed of 2 bytes (16 bit): the variables and parameters are coded as signed integers (notation in complement of 2) without decimal point (for example: a temperature displayed as "25.0" is transmitted as 250). Assignment is only possible to the field admitted for each parameter; if you attempt to assign a value outside the admitted field, the EVOWL-Rx device will return an error message with exception code 3 and will not execute the assignment.
Assigning word values with functions 06 and 16 is only allowed for addresses in which this is possible (parameters marked "R/W" in the table [R=read, W = write]).

Function codes admitted: reading (03 / 04); writing (06 / 16)

Modbus Address	Parameter name	Range	R/W
0x0000 (0)	Modbus address	1÷247	R/W
0x0001 (1)	Baud rate	0: 9600bps 1: 19200bps 2: 38400bps	R/W
0x0002 (2)	Parity	0: None 1: Even 2: Odd	R/W
0x0003 (3)	Stop Bits	0: 1 stop bit 1: 2 stop bits	R/W
0x0004 (4)	Modbus delay	0÷200 (x 10mS)	R/W
0x0005 (5)	System's errors	0: Operation OK 1: Error RF section 2: Setup system step 3: EEprom memory error 4: Autolearning step	R
0x0006 (6)	Firmware version	0.0÷99.9	R
0x0007 (7)	Hardware version	0.0÷99.9	R
0x0008 (8)	EVOWL-Rx Serial number	0÷255	R
0x0009 (9)	Production batch	0÷65535	R
0x000A (10)	Firmware version RF section	0.0÷99.9	R
0x000B (11)	Hardware version RF section	0.0÷99.9	R
0x000C (12)	ID first probe	0÷FFFE (0xFFFF not present)	R/W
0x000D (13)	ID second probe	0÷FFFE (0xFFFF not present)	R/W

0x000E (14)	ID third probe	0÷FFFE (0xFFFF not present)	R/W
0x000F (15)	ID fourth probe	0÷FFFE (0xFFFF not present)	R/W
0x0010 (16)	Reserved	---	---
0x0011 (17)	Reserved	---	---
0x0012 (18)	Software reset of receiver	0xAA	W
Data block EVOWL-Tx with first associated ID			
0x0064 (100)	Temperature of point 1 (top of the sensor)	-40.0÷125.0°C	R
0x0065 (101)	Temperature point 2	-40.0÷125.0°C	R
0x0066 (102)	Temperature point 3	-40.0÷125.0°C	R
0x0067 (103)	Temperature point 4 (sensor tip)	-40.0÷125.0°C	R
0x0068 (104)	Battery status	0÷3 (0= discharge / 3 = charge) 3:>2.9V; 2: 2.5 ÷ 2.9V; 1: 2÷2.5V; 0: <2V	R
0x0069 (105)	Wireless signal strength	1: Min ÷ 4: Max.	R
0x006A(106)	Reserved	---	---
0x006B (107)	Seconds since last reception	0÷65535	R
0x006C (108)	Data available	0÷1	R/W
Data block EVOWL-Tx with second associated ID			
0x006D (109)	Temperature of point 1 (top of the sensor)	-40.0÷125.0°C	R
0x006E (110)	Temperature point 2	-40.0÷125.0°C	R
0x006F (111)	Temperature point 3	-40.0÷125.0°C	R
0x0070 (112)	Temperature point 4 (sensor tip)	-40.0÷125.0°C	R
0x0071 (113)	Battery status	0÷3 (0= discharge / 3 = charge) 3:>2.9V; 2: 2.5 ÷ 2.9V; 1: 2÷2.5V; 0: <2V	R
0x0072 (114)	Wireless signal strength	1: Min ÷ 4: Max.	R
0x0073 (115)	Reserved	---	---
0x0074 (116)	Seconds since last reception	0÷65535	R
0x0075 (117)	Data available	0÷1	R/W
Data block EVOWL-Tx with third associated ID			
0x0076 (118)	Temperature of point 1 (top of the sensor)	-40.0÷125.0°C	R
0x0077 (119)	Temperature point 2	-40.0÷125.0°C	R
0x0078 (120)	Temperature point 3	-40.0÷125.0°C	R
0x0079 (121)	Temperature point 4 (sensor	-40.0÷125.0°C	R

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Modbus Address	Parameter name	Range	R/W
	tip)		
0x007A (122)	Battery status	0÷3 (0= discharge / 3 = charge) 3:>2,9V; 2: 2,5 ÷ 2,9V; 1: 2÷2,5V; 0: <2V	R
0x007B (123)	Wireless signal strength	1: Min ÷ 4: Max.	R
0x007C (124)	Reserved	---	---
0x007D (125)	Seconds since last reception	0÷65535	R
0x007E (126)	Data available	0÷1	R/W
Data block EVOWL-Tx with fourth associated ID			
0x007F (127)	Temperature of point 1 (top of the sensor)	-40.0÷125.0°C	R
0x0080 (128)	Temperature point 2	-40.0÷125.0°C	R
0x0081 (129)	Temperature point 3	-40.0÷125.0°C	R
0x0082 (130)	Temperature point 4 (sensor tip)	-40.0÷125.0°C	R
0x0083 (131)	Battery status	0÷3 (0= discharge / 3 = charge) 3:>2,9V; 2: 2,5 ÷ 2,9V; 1: 2÷2,5V; 0: <2V	R
0x0084 (132)	Wireless signal strength	1: Min ÷ 4: Max.	R
0x0085 (133)	Reserved	---	---
0x0086 (134)	Seconds since last reception	0÷65535	R
0x0087 (135)	Data available	0÷1	R/W

5.1 Table of Coils

Function codes admitted: reading (01 / 02)

Modbus Address	Parameter name	Range	R/W
0x0000 (0)	Status of EVOWL-Tx with first ID	0: EvoWL-Tx active 1: EvoWL-Tx into docking station	R
0x0001 (1)	Status of EVOWL-Tx with second ID	0: EvoWL-Tx active 1: EvoWL-Tx into docking station	R
0x0002 (2)	Status of EVOWL-Tx with third ID	0: EvoWL-Tx active 1: EvoWL-Tx into docking station	R
0x0003 (3)	Status of EVOWL-Tx with fourth ID	0: EvoWL-Tx active 1: EvoWL-Tx into docking station	R

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6 Description of the registries

Address 0: Receiver Modbus address [R/W]
Default: 1
This parameter identifies the device on the Modbus serial network.
Changes to this parameter only take effect when the device is next powered on.
Note: no two or more devices may have the same address on the Modbus network.

Address 1: Baud rate [R/W]
Default: 2 (9,600 bps)
This parameter sets the serial communications rate in bits per second.
Changes to this parameter only take effect when the device is next powered on.
Note: all devices must have the same baud rate on the Modbus network.

Address 2: Parity [R/W]
Default: 0 (none)
This parameter sets the serial protocol to include or exclude a parity bit.
Changes to this parameter only take effect when the device is next powered on.
Note: all devices must have the same serial criteria on the Modbus network.

Address 3: Number of stop bits [R/W]
Default: 0 (1 Stop bit)
This sets the number of stop bits in the serial frame.
Note: all devices must have the same serial criteria on the Modbus network.

Address 4: Modbus Tx-Rx delay [R/W]
Default:1 (10 mS)
This is the delay between reception of a query and the transmission of a response, specified with a 10 ms resolution.
0x0000 = 0 mS
0x0001 = 10 mS
0x000A = 10x10 = 100mS

Address 5: System errors and messages [R]
This registry identifies system errors, as follows:
0: Normal operation: no error.
1: RF section error (see point 2.6, section 3). Also indicated by the config LED flashing slowly: 2 quick flashes followed by a 1 second pause.
2: Configuration phase: indicates that receiver parameter configuration is in progress (red LED on with steady light).

3: EEprom error: A system error occurred while data was being written to the microprocessor's EEprom: the red Config LED flashes quickly.
The after-sales service normally has to be called to deal with this error; however, users may try resetting the EEprom default values using the procedure described in point 2.6 section 2.
4: Autolearning: indicates that receiver autolearning is in progress; the red LED flashes to indicate this condition (see point 2.6 section 3).

Address 6: Firmware version [R]
This read-only registry identifies the version of the firmware installed on the processor: a value of 10 corresponds to firmware version 1.0.

Address 7: Hardware version [R]
This read-only registry identifies the version of the receiver's hardware: a value of 10 corresponds to hardware version 1.0.

Address 8: Receiver serial number [R]
This read-only registry identifies the receiver's production number.

Address 9: Production lot [R]
This read-only registry identifies the receiver's production lot (year and week of production).

Address 10: RF section Firmware version [R]
This read-only registry identifies the version of the firmware of the RF section: a value of 10 corresponds to firmware version 1.0.

Address 11: RF section Hardware version [R]
This read-only registry identifies the version of the RF section's hardware: a value of 10 corresponds to hardware version 1.0.

Address 12/13/14/15: EVOWL-Tx probe ID [R/W]
These registries identify the association of the EVOWL-Tx probes with the receiver; the stem of each probe is marked with a unique 4-digits alphanumeric code. Typing this number in one of these registries associates the probe to the receiver, meaning that the data will be available in the relative EVOWL-Tx data block.
A receiver is able to manage up to four EVOWL-Tx probes.
If the value 0xFFFF (-1) is typed, the probe is not associated.
Example:
[first probe] Registry 12 = 0001 (EVOWL-Tx is associated with the probe marked ID 0001)
[second probe] Registry 13 = 002B (EVOWL-Tx is associated with the probe marked ID 002B)
[third probe] Registry 14 = -1 (no probe associated to the third data block)
[fourth probe] Registry 15 = -1 (no probe associated to the fourth data block)

The data (4 temperatures, battery status, etc.) of the EVOWL-Tx with ID 0001 will be present in the EVOWL-Tx data block with the first ID associated (registry address 100).

The data (4 temperatures, battery status, etc.) of the EVOWL-Tx with ID 002B will be present in the EVOWL-Tx data block with the second ID associated (registry address 109).

Address 18: Receiver reset [W]
Writing the value 0xAA (170) on this register, it is possible made a software reset of the device (corresponding to a cycle of power off/on). The device, after a reset request does not send any response.
Note: it is possible reset the receiver by writing this register only if the device is supplied with a voltage between 10 and 30 Vdc.

From the registry with address 100, there are 4 data blocks, corresponding to the 4 probes associated by means of registries 12/13/14/15.
The characteristics of the 4 blocks are as described below:

Point 1, 2, 3, 4 temperature (value with sign) [R]
These registries contain the values of the 4 temperatures of the EVOWL-Tx probe; the data are expressed in tenths of a degree (105 = 10.5°C) and the value is between -40° and +120°C .
Temperature 1 refers to the sensor in the top of the stem (towards the probe's handle), while temperature 4 refers to the sensor on the tip of the rod.

Battery status [R]
The status of the battery of the EVOWL-Tx; it is expressed in 4 steps from 0 (battery flat status) to 3 (battery charged status).
The battery should be replaced when the level reaches 1.

Wireless signal strength [R]
This register is the wireless signal strength between the EVOWL-Tx and EvoWL-Rx expressed in 4 steps from 1 (minimum level) to 4 (maximum level).

Seconds since last reception [R]
This is an incremental counter expressed in seconds that identifies how long has passed since receipt of the latest data transmitted by the EVOWL-Tx probe.
The EVOWL-Tx probes transmit the data cyclically every 30 seconds (about 45 if the temperature measured is less than 0°C); this means that the respective data blocks are updated and the counter is reset accordingly.
If this counter reaches times of a few minutes, the EVOWL-Tx probe is outside the wireless communication range or has been placed on the docking station. (Probe not in use, low power consumption).

Data available [R/W]
This register (of read/write type) is set at 1 as soon as new data are received from the EVOWL-Tx probe and the "seconds since last reception" counter is reset accordingly; this registry must be reset by the master unit.

6.1 Descriprion of the Coils

For each EVOWL-Tx associated to receiver, it is possible know the functional status: <u>active</u> indicated by the respective coils at 0 or in <u>energy saving mode</u> (when the EVOWL-Tx is inserted in the docking station) indicated by the respective coil at 1.

7 Options

7.1 Serial isolator

Ordering code: EVO005

As previous described, the RS485 serial interface of EVOWL-Rx is not insulated; it is suggested to fit a serial isolator between the master unit and the EVOWL-Rx device.

Technical characteristics

Power supply	10-30Vdc 9-18Vac
Transmission speed	From 75 to 115,200 baud
Typical line impedance	100 ohm
Isolation between the 2 lines	2,000Vca, 50Hz, 1min.
Distance up to:	1,200 metres
Consumption	25mA @ 24Vcc
RX/TX switching time	150µS
Operating temperature	-20 ÷ 70 °C
Storage temperature	-40 ÷ 100 °C
Relative humidity without condensation	0 ÷ 90%
Dimensions (WxHxT) in mm	101 x 119 x 22.5
Adapted to installation with DIN bar	
Automatic speed adaptation	
Serial connection on removable terminals	

7.2 EVOWL-SET: Configuration Kit

Order code: EVO018

This kit comprises a USB/RS485 converter and a memory stick containing the *EVOWL-Config* configuration software and drivers.
The latest version of the *EVOWL-Config* configuration software can be downloaded from the www.italcoppie.it website.

This kit enables the user to configure the EVOWL-Rx receiver and monitor the transmitters (up to 4 of them) in real time.
For further information about the configuration software, see 8 "EVOWL-Config Configuration Software".

8 EVOWL-Config Configuration Software

This application, created for the Windows operating system, can be used to configure EVOWL series devices.

Once the *EVOWL-Config* software has been installed, connect the communication cable to one of the PC's USB ports (for the installation procedure, refer to the manual provided on the memory stick in the EVO018 configuration kit), then proceed as follows:
- Connect the small pale green three-pin connector to the receiver (RS485 side).
- Hold down the Config button.
- connect the large dark green three-pin connector to the power supply side of the receiver (marked 5-30Vdc).
- Release the Config button at once; the red Config LED will come on (with steady light, see point 2.6.1) indicating that the receiver is in configuration status.

Run the EVOWL-Config application from the application toolbar or the icon on the desktop (if activated during installation); the following window will appear:
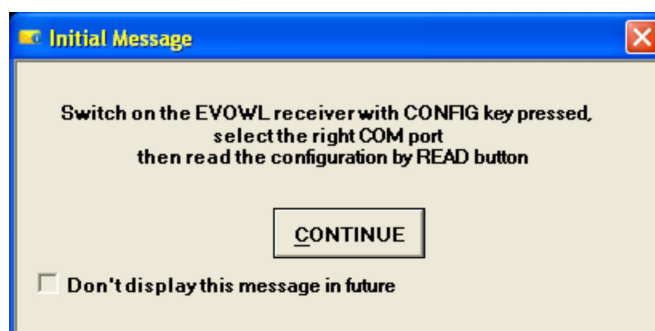
containing the instructions provided above. If you do not wish this window to appear again in the future, select the "Don't display this message in future" check box. Now press the "continue" button.
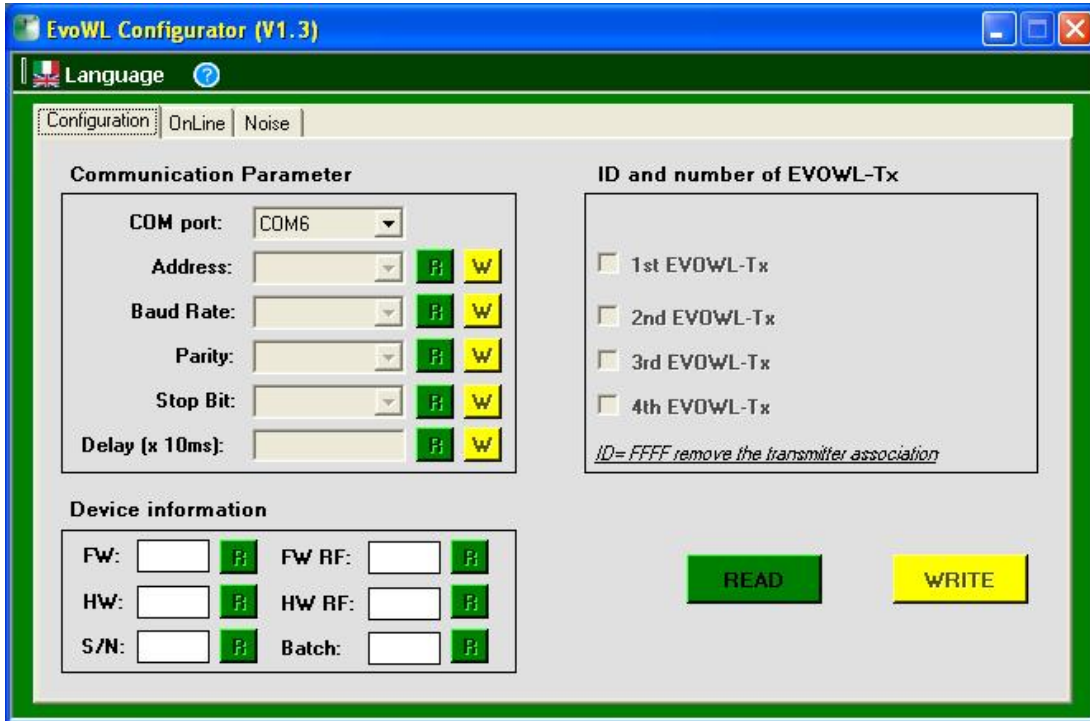
At this point, before reading the receiver configuration the serial communication port has to be set from the "COM Port" combo

To find out which COM port the USB converter has been installed on, use the Windows system windows:
"Control Panel→Hardware→System→Peripherals→Ports (COM and LPT)"
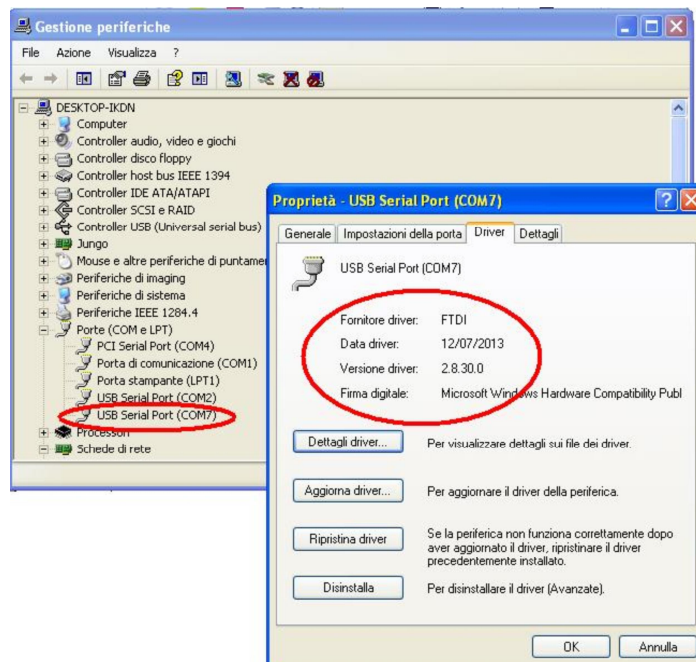
N.B.: the above refers to the Windows XP operating system. Refer to the installation manual of the *EVOWL-Config* for the operating system in use.

In the case shown above, set the COM port combo on COM7, then press
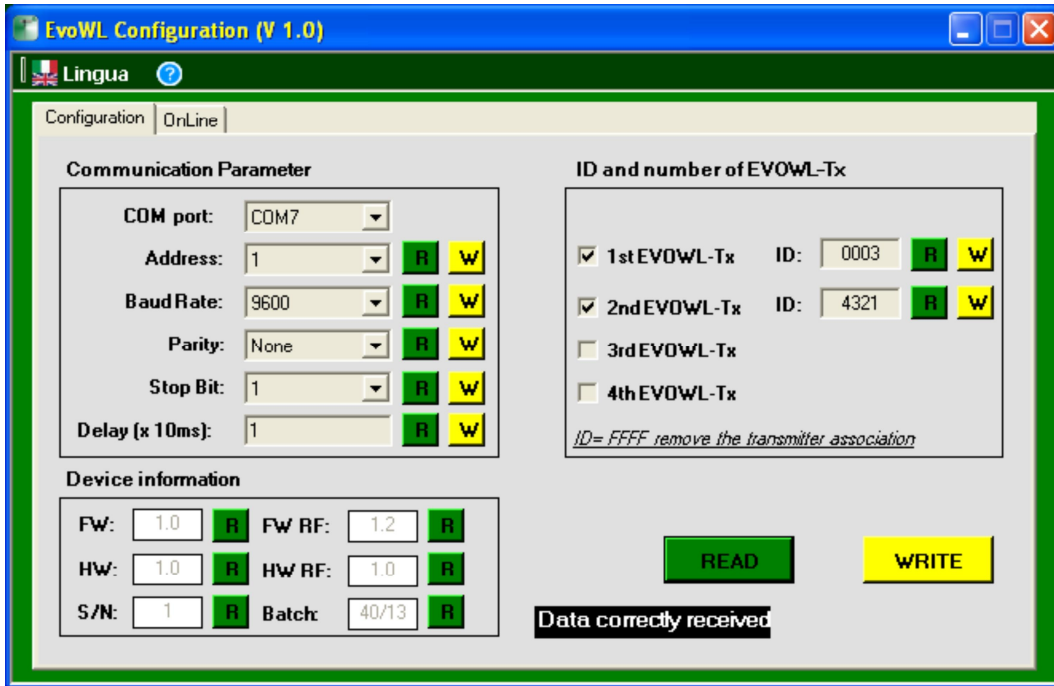
Communication parameters
The serial communication parameters of the receiver with the Modbus master unit which will control the EVOWL system can be set in this box.

Address [Modbus Registry 0]
Modbus address of the receiver. An unused, unique address of the Modbus network must be set; the master will query the receiver at this address.

Baud Rate [Modbus Registry 1]
Parity [Modbus Registry 2]
Stop bit [Modbus Registry 3]
The serial communication criteria are set in these three combos; these parameters must be the same in the Modbus network within which the receiver is to be used.

Delay (x 10mS) [Modbus Registry 4]
The time in x10mS (for example 3 = 30mS) that passes from the moment when the EVOWL receives the query from the master unit to the moment when

it replies with the data. This parameter is useful when the Modbus network contains several devices with slow response times; if the Modbus network only contains the EVOWL receiver, this parameter can be left at the default value (1 = 10mS).

Device information
This box contains all the information relating to the receiver.

Fw / Hw: These fields indicate the receiver's firmware and hardware versions.
S/N / Batch: These fields indicate the serial number and production batch.

Fw RF / Hw RF: These fields indicate the firmware and hardware of the radio frequency (RF) section.

ID and number of EVOWL-Tx
This box is used to associate the EVOWL-Tx probe with the receiver; up to four EVOWL-Tx probes can be associated.
The ID number of the EVOWL-Tx (ID) is marked on the metal stem.

In the photograph shown above, the probe's ID number is **0003**.

To associate it to the receiver, click on the *1st EVOWL-Tx* check box, type the code **0003** then press WRITE
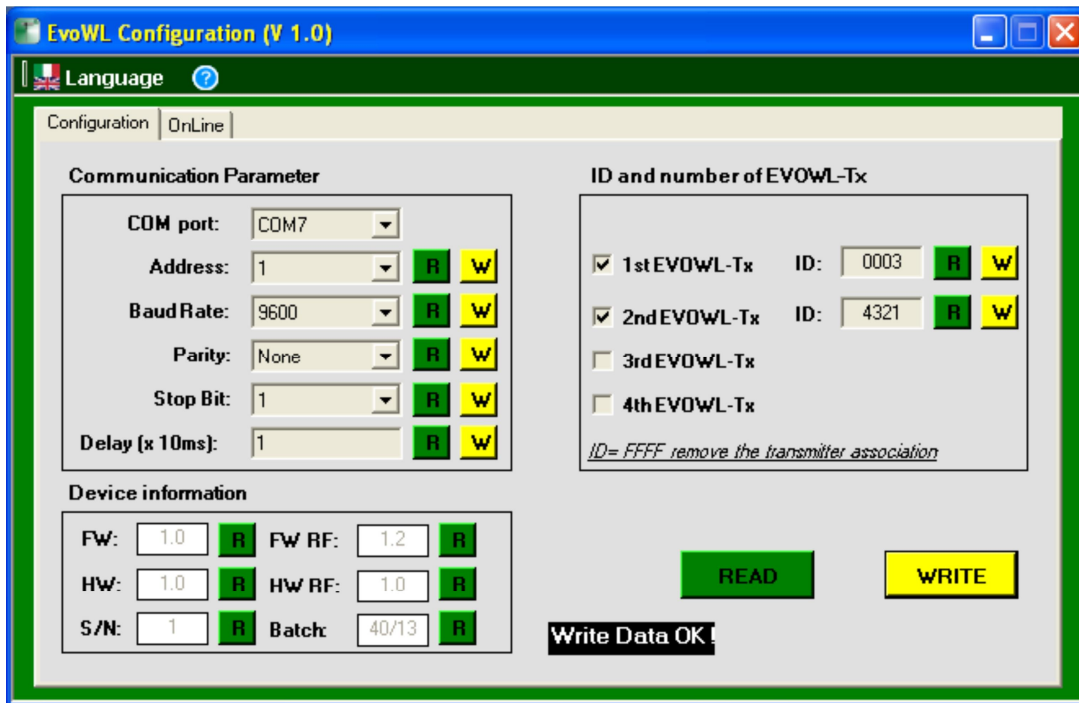
The "*Write Data OK!*" message indicates that the configuration has been transferred to the receiver correctly.
In the example shown above, two EVOWL-Tx probes have been associated to the receiver, the first with ID 0003 and the second with ID 4321.

1st EVOWL-Tx refers to Modbus registries 100 to 108 (refer to the table of Modbus registries provided in chapter 5).

2nd EVOWL-Tx refers to Modbus registries 109 to 117 (refer to the table of Modbus registries provided in chapter 5).

3rd EVOWL-Tx refers to Modbus registries 118 to 126 (refer to the table of Modbus registries provided in chapter 5).

4th EVOWL-Tx refers to Modbus registries 127 to 135 (refer to the table of Modbus registries provided in chapter 5).

Once the EVOWL-Tx probes have been associated to the receiver, the probe data can be displayed by selecting the "OnLine" window.
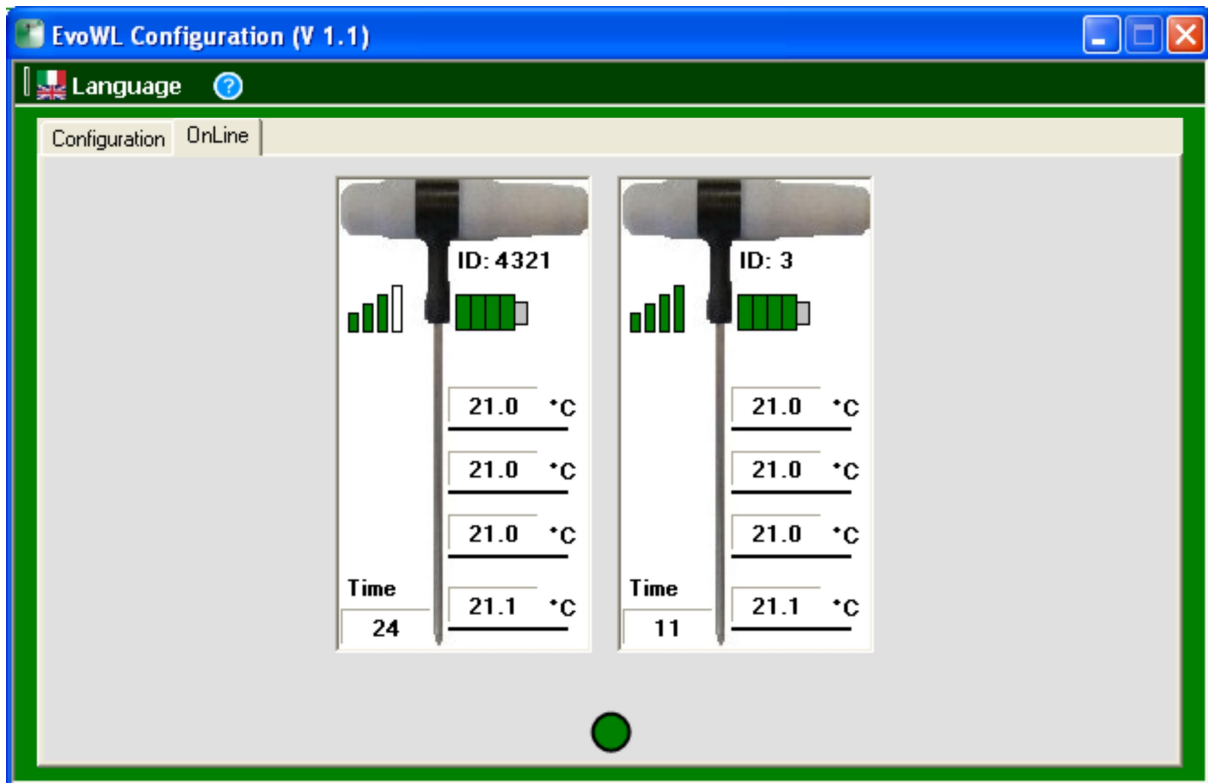
The window shown above displays the two probes associated to the receiver; the probe with ID 0003 and the probe with ID 4321

The 4 temperatures appear beside the stem of each probe, while "Time" indicates the time since the last data were received; this incremental counter is reset whenever the receiver receives data from the remote EVOWL-Tx probes.

Battery status: the battery status of each EVOWL-Tx probe is displayed as shown below:
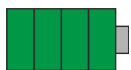
 Battery level 3: charged (voltage above 2.9 Vdc)

 Battery level 2: (voltage 2.5÷2.9 Vdc)

 Battery level 1: (voltage 2.0÷2.5 Vdc)

Battery level 0: flat (voltage below 2.0 Vdc)

Wireless signal strength: the wireless signal level (4 steps) of each EVOWL-Tx is displayed as show below:

Maximum level (4)
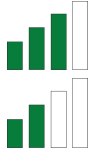
Minimum level (1)

Wireless communication absent (no data received from over 70 seconds)

When the EVOWL-Tx probe is put in the docking station, goes into energy saving mode.
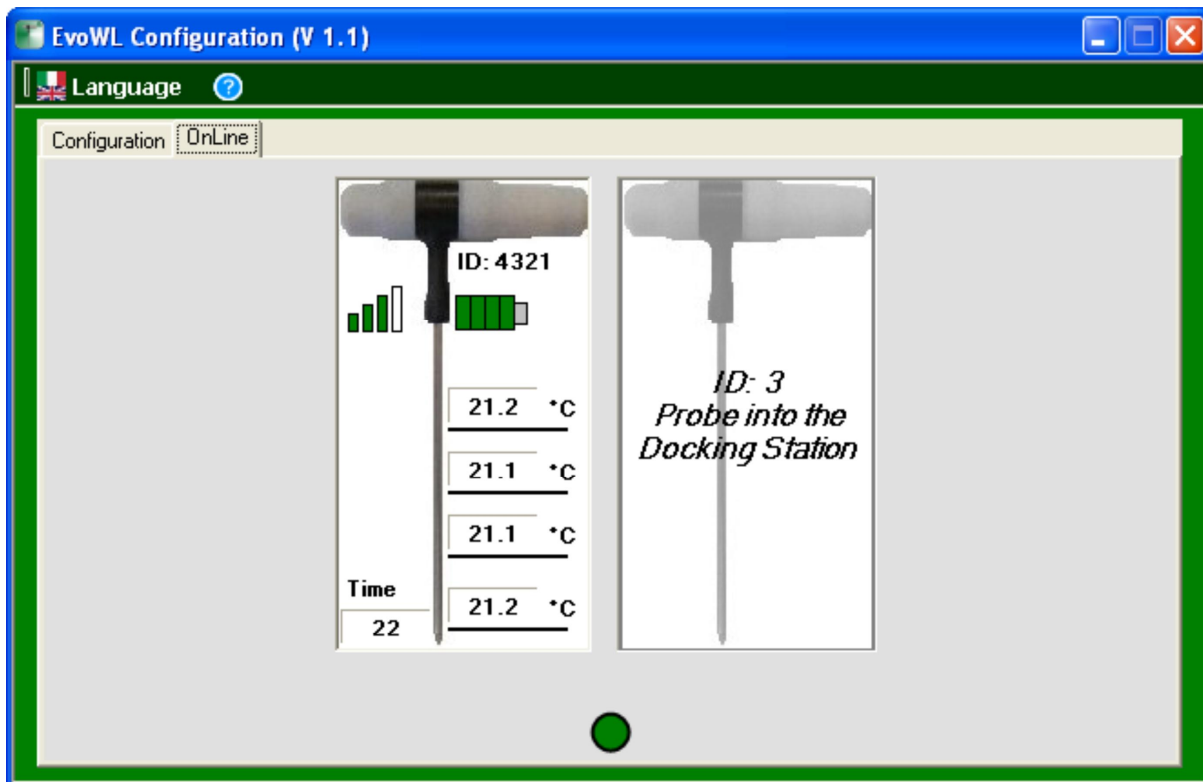
In the above image, the probe EVOWL-Tx with ID0003 is into docking station.

8.2 Removing the EVOWL-Tx association from the receiver

The association of the EVOWL-Tx probe with the receiver can be removed at any moment by deselecting the relative check box.
The following window displays:
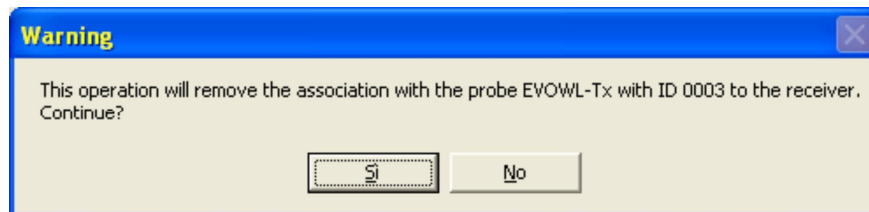
The "Sì" ["Yes"] button confirms removal of the association, while the "No" button cancels the request, so the associated ID will be unchanged.

The EVOWL-Tx sensor association can also be removed by typing FFFF.

8.3 Read / Write / R / W BUTTONS

The **READ** button reads the entire configuration of the receiver.

The **WRITE** button writes the configuration shown on the screen on the receiver (all parameters).

The **R** button reads the value of the parameter next to it only.

The **W** button writes the value of the parameter next to it only.

8.4 Noise window

This feature is available only if the HW version is equal to or greater than 1.1.
Through this window you can see the background noise received by the antenna, the lower the value the better is the wireless communication. With the antenna disconnected, the background noise should have a value between 500 and 600mV: with the antenna the noise increases by 100 / 200mV.
This feature is very useful when installing the antenna inside the blast chiller; viewing the graph of the noise you can find the best location for the placement of the antenna where the background noise turns out to be as low as possible.

9 Technical characteristics

Operating conditions:	
Temperature:	-10 ÷ 60 °C
Relative Humidity:	<80% non condensing
Degree of protection:	IP20
Case:	ABS, with DIN rail fixtures
Electrical characteristics	
Power supply:	5÷30Vdc (Max. consumption 0,5W)
Communication frequency:	434,4MHz (PPM)
Serial interface:	RS485 (not isolated)
Communication protocol:	Modbus RTU slave
Removable connectors:	For power supply and serial interface
Antenna connector:	SMA
Antenna:	Patch type, rear adhesive 433 MHz
Indicator LEDs:	Serial communication
	Wireless communications
	Power supply
	Configuration and system errors

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9.1 Mechanical dimensions (mm)

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Warranty: We warrant that the products will be free from defects in material and workmanship for 1 years. The warranty above shall not apply for any failure caused by the use of the product not in line with the instructions reported on this manual.

Product return: the instruments can be returned under warranty only after Italcoppie sensori authorization.

<div align="center">

ITALCOPPIE SENSORI s.r.l.
Via A. Tonani, 10
26030 Malagnino (Cremona) Italy
Tel. +39 0372-441220
Fax. +39 0372-441238
http:www.italcoppie.it

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This product must be disposed of according to the European WEEE (Waste Electrical & Electronic equipment)

Engineered and manufactured in Italy

Pensato, progettato e prodotto in Italia

Rev. 2 Feb.'14
Man-UK EVOWL-Rx

SENSORI

Rev. 2 Feb. '14