Arrow mobile

English version v1.4

1. Copyright

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2. Arrow remote reading system

2.1. Introduction

The Arrow remote reading system enables direct reading of a number of meters without gaining physical access to the meter (remote meter reading) and provides reading data for analysis systems, billing or other purposes. Remote meter reading (or telereading) is extremely useful in those cases where it is difficult to gain access to the meters. For example, to read water meters located inside a meter pit in the middle of a road, the following operations must be performed:

a) Implementation of safety measures (stop or divert traffic, place appropriate road signs, move any vehicles which may be covering the meter pit), causing obvious disruption and possible safety hazards.
b) Opening the meter pit (heavy pig-iron cover, often jammed or frozen or covered in snow)
c) Entering the meter pit (not convenient, often damp or flooded)
d) Manual reading of the meters (often located in locations where access is difficult)
e) Closing the meter pit and restoration of the previous situation

The abovementioned procedures lead to disruption and waste of time. The remote reading system reads the information from outside the meter pits, saving, in this way, time and energy, and gathering all necessary information effortlessly and more frequently.
In other circumstances, the meter may not be accessible to the reader, for example they may be located inside a private home and the owner may not be available: in the best case the meter reader must return at another time (and so make a double journey), while in the worst case it is not possible to read the meter because the homeowner does not allow personnel entering the premises. The remote reading system avoids these inconveniences, allowing the reader to collect the data even if there is nobody at home, or if the homeowner is not available.
The key idea behind the Arrow remote meter reading system lies in coupling each mechanical meter with a device (called Arrow radio module) which transmits the reading and other information. In this way, a receiving radio device placed at a certain distance can receive and store the readings without gaining direct access to the location where the meter is actually located.
The implementation of an Arrow remote reading system requires the following features:

1) A series of installed meters equipped with a pulse emitter. Every time the meter records a unit of measurement the pulse emitter closes a contact, emitting a series of pulses which are proportional to the actual reading. It is important to note that the Arrow system can be applied to <u>any type of meter</u> (water, gas, electricity, heat, etc.) which has a pulse output.
2) The Arrow radio module device for the storage and radio transmission of meter reading data, which must be coupled with each meter's pulse emitter (one radio module for every meter).
3) A system for reading radio modules (consisting of a radio receiver, a Pocket Pc with all necessary software and cables). Usually one reading system suffices for each meter-reading agency.

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Please note that:

1) Each agency determines the consumption and the related billing in its own way, with individual rates, ranges, discounts and policies which differ greatly among each other.
2) In general, each agency can bill different utilities with different modalities (water, gas, electricity etc, or in different combinations)
3) Each agency analyses data in extremely different ways, depending on the situation (a water balance is quite different from average consumption, peak consumption or per capita consumption rates etc.)
4) Most of the time, each agency already has its own management system for billing and consumption management prior to the installation of the remote reading system.

Considering these facts, Arrow remote reading system simply supplies, in an electronic format, the reading data of every single meter which will then be imported into other pre-existing systems, but **does not perform** any billing process, scheduling or data analysis (which will be performed by the agency in charge).

2.2. Operating phases of the system

The installation and use of an Arrow remote reading system on installed meters comprises two distinct phases: installation and use.

first phase: installation
In the first phase the system must be installed and implemented on the installed meters, and, specifically, the required steps are:

- installation of meters suitable for remote reading (equipped with a pulse emitter). In this phase it is possible to replace any meter which is not equipped with the pulse emitter and which cannot assess the consumption, and install new meters where necessary.
- installation of Arrow radio modules, their coupling with the meters and their assessment
- first programming of Arrow radio modules, contextually to their installation. In order to operate, Arrow radio modules must be initially programmed with some essential parameters such as the reading registered by the meter when it is being coupled, or the unit of measurement factor

which must be counted with every pulse (for example 100 lt every impulse). The complete list of the required parameters will be supplied in the following paragraphs. During the first programming phase it is possible to assess the number of radio modules installed in the meter park.

second phase: use
the operational stage consists in the remote reading of the meters via radio modules: each radio module transmits the reading data every 8 seconds, hence the reception and storage of the reading may be taken from even just a short-distance away from the meter. The receiving distance depends on the installation conditions of the meters (see paragraph 3.8 Transmission distance)

3. Arrow Radio Module

The following list comprises the Arrow radio module main features:

3.1. Pulse count

The Arrow radio module has an internal register which records the pulses it receives from the coupled meter output and stores this data as the total amount of recorded units.

3.2. Unidirectional radio system

The traditional bidirectional reading systems are equipped with a transmitter and a radio receiver. When the radio receiver receives a data sending request signal, it alerts the radio transmitter and transmits the required data.
The Arrow radio module is, instead, a unidirectional radio transmitter, in other words it only has a radio transmitter, and, without requiring any sort of alert signal, it transmits the reading data sets via radio every 8 seconds, with or without its receiving counterpart. This kind of system is definitely more advantageous, both in terms of battery consumption and of reading speed, as the information is read without having to wait for a radio interrogation signal. The following chart lists the advantages of the unidirectional system compared to the traditional bidirectional reading systems

	Arrow Radio Module (unidirectional radio transmitter)	**Bidirectional Radio Systems (transceivers)**
Cost	Cheaper circuit board (only the transmitting part)	More expensive circuit board because it has both the receiving and transmitting parts
Data access speed	Data transmission every 8 seconds; in this way the reader may move while reading the meter	Data transmission only on request. It is necessary to query for the information and wait for its retrieval. Therefore it isn't possible to read the meter while moving
Battery consumption	Low battery consumption: most of the time the module is in stand-by mode, with very low consumption, and transmits only for a few fractions of a second every 8	High battery consumption to maintain the receiver alert, as it must remain active for a long time to receive query signals.

	seconds.	
Degree of environmental protection and reliability	As the battery consumption is low, it can be placed in a watertight mould, it has an IP68 protection factor and does not discharge in critical environmental conditions (condensation, submersion etc.)	Owing to the high battery consumption, it is necessary to change the battery and, therefore, it is not possible to use a completely watertight container, exposing the battery to a premature discharge in critical environmental conditions

3.3. Radio Module Programming

As the radio module is not equipped with a receiver, it is programmed through an infrared optical terminal with IRDA technology. In the programming phase the user places an IRDA optical head close to an appropriate infrared LED positioned on one of the sides of the radio module. The optical head is attached to the IRDA LED on the module by a magnet. At this stage the user can programme the radio module's electronics with the initialising data. Once the process has been completed the optical head may be detached.

3.4. Reading data

The Arrow radio module transmits reading data sets, which not only comprise the current meter reading, but also other different parameters set in the meter: the following chart includes a complete list of the transmitted data

Transmitted Data	Description
Serial number	Radio module unique ID
Current meter reading	real time reading data, transmitted from the radio module
Periodic reading and periodicity	Additional reading set on a fixed date (weekly, monthly or yearly – for example on the 1st day of the month or on the 31st December every year)
Fraud alarm	Cable cut attempt or fraud attempt with an external magnetic field: the alarm is activated if the connection cable is disconnected and/or if an attempt is made to interrupt the signal with an external magnetic field
Suspected leak alarm	The alarm is activated if, in 48 hours, the module registers a pulse in every 15-minute time window
Measured medium and unit of measurement	Adopted medium (for example water, gas, heat etc.) and unit of measurement (for example m^3, kWh etc..)

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Battery state	Estimated battery lifetime (in lithium batteries it is impossible to measure the battery charge state with any tool)

3.5. Radio transmission and safety

The Arrow radio module is equipped with a unidirectional frequency modulation radio transmitter (FSK) with 868.95 MHz transmission frequency. This transmission band is specially set for remote reading systems, so no special permits are needed to broadcast on these frequencies. The radio module complies with the Electromagnetic compatibility standards set by EN 300 220 and it is in accordance with European directives for health and safety enforced in EEC countries (R&TTE 1999/5/EC of 09.03.1999).

The maximum transmission power is 7 mW, and the transmitter is activated for just a few fractions of a second every 8 seconds. The following table compares this transmission power to other commonly used devices

Arrow radio module	***868 MHz***	***7 mW***
Bluetooth	2,4 GHz	1 / 2,5 / 100 mW
WLAN	2,4 GHz	100 mW
DECT (wireless)	1900 MHz	250 mW
GSM (E-Net)	1800 MHz	1 W
GSM (D-Net)	900 MHz	2 W
Television relay or radar stations	470 – 790 MHz 1 – 3 GHz	5 MW

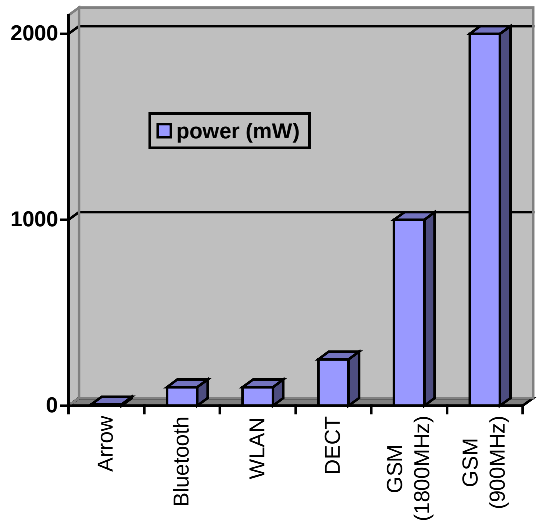

Table containing the transmission power of common radio frequency devices (maximum values)

The PRIOS communication protocol is used for data transmission. This protocol has been developed as an integral part of CEN TC 294 (868 MHz) and can thus be read by any other system which operates within this standard.

3.6. Protection of confidential data

Most of the time, utility consumption data (water, gas etc.) are not considered to be sensitive data and so they are not protected in any specific way. Nevertheless, meter-reading data is intrinsically protected (against non-authorised reading) in the following ways:

- A non-authorized user who attempts to read a meter will obtain a reading associated to some serial numbers of several radio modules. If there is more than one meter, the user will not know which radio module number corresponds to which user and, thus, will not know the reading.

- In the transmitted data set, all information regarding the reading (current and periodical) is password-encrypted by the agency/consortium.

3.7. Intrinsic Safety

The intrinsic safety features comply with European directives. The Arrow radio module has been manufactured in conformity with EEx ia IIA T3.
The following symbol is the EEC mark for products with intrinsic safety approval

This certification testifies that the Arrow radio module can be used even in potentially hazardous environmental conditions, and can thus be used with gas meters.

3.8. Transmission distance

As for all radio appliances, the Arrow module transmission field is greatly influenced by topography and installation conditions. An excellent comparison can be made with the quality of mobile phone signal reception, which is strongly influenced not only by radio coverage, but also by user's position and surrounding environmental conditions. Disturbed radio wave propagation limit the transmission distance: this could occur on account of installation under metal meter pit covers, in cellars or cavities inside reinforced concrete, behind fireproof doors in boiler rooms, or in flooded areas (totally or partially underwater radio module). Considering the natural unpredictability of installation conditions, it is hard to give an exact estimate of how many and which kinds of radio modules are receivable from a specific location. The following table provides some examples of transmission distances in various installation conditions

Arrow module localization	Transmission distance (metres)
Flooded meter pit	5
Meter pit	20
Cellar of a building	40
Ground floor of a building	60
Free field	350

3.9. Average battery lifetime

The radio transmitter module is equipped with two 3.6 Volt lithium batteries, completely moulded in the radio module's casing and, therefore, not replaceable. The complete moulding prevents self-discharge of the battery caused by humidity or water infiltrations which are rather common in critical outdoor installation conditions (such as meter pits in the streets, rain water etc.).
Average battery service life is approximately 15 years, considered the following conditions:

between -15 °C ÷ +0 °C	for 10% of the service life
between 0 °C ÷ +30 °C	for 80% of the service life
between +31 °C ÷ +55 °C	for 10% of the service life

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Battery service life is a theoretical estimate which, however, may not be used to claim replacements under warranty. The estimate assumes that the pulse emitter absorbs a maximum current equal to 2 µA.

The estimate is made inside the radio module, according to memorized factors, such as the estimated consumption of the circuit board in stand-by, the consumption in transmission, the number of transmissions made and the estimated current which is absorbed by the pulse emitter. Therefore the parameter, determined and transmitted with the reading data, gives only an estimate of the remaining battery life.

4. The Arrow radio module in detail

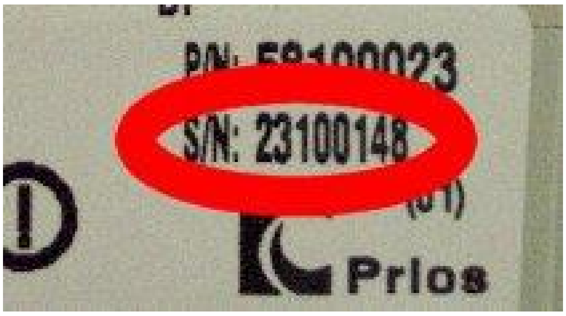
4.1. Identifying the meter and the radio module

In gathering the remote reading data, an important role is played by the identification of the user to whom the reading and, therefore, the consumption, belongs. In the Arrow remote reading system every meter has its own individual Arrow radio module. When coupling the meter and the module during the installation process, two ID parameters must be taken into account:

1. the serial number of the mechanical meter

   this identifier is usually marked on the meter and uniquely distinguishes it from the other meters of the same type and produced by the same manufacturer

2. The Arrow radio module serial number



   The radio module serial number is an 8-digit unique number which is transmitted via radio with the reading data, and is used to identify the readings. The uniqueness of the serial number is guaranteed by the manufacturer. The serial number can be read either via radio transmission, via IRDA optical interface (currently being programmed) or on the label placed on the radio

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module, under S/N (Serial Number).

It is clear that these two identifiers must be associated to one user only, so that the consumption can be calculated correctly. The connection between the two identifiers must be made by the user, as it is not possible to store in memory the meter's serial number among the fields transmitted by the radio module. It is therefore important to record the correspondence between the meter serial number and the Arrow radio module serial number during the installation process, as shown in the following example:

User	Meter Serial N.	Radio module serial N.
Mario Rossi	FA123456-06	23100148
Franco Bianchi	FA987654-06	23524569
…	…	…

Whenever a mechanical meter or an Arrow radio module is replaced, it is important to re-associate the two identifying numbers, as shown in the following example:

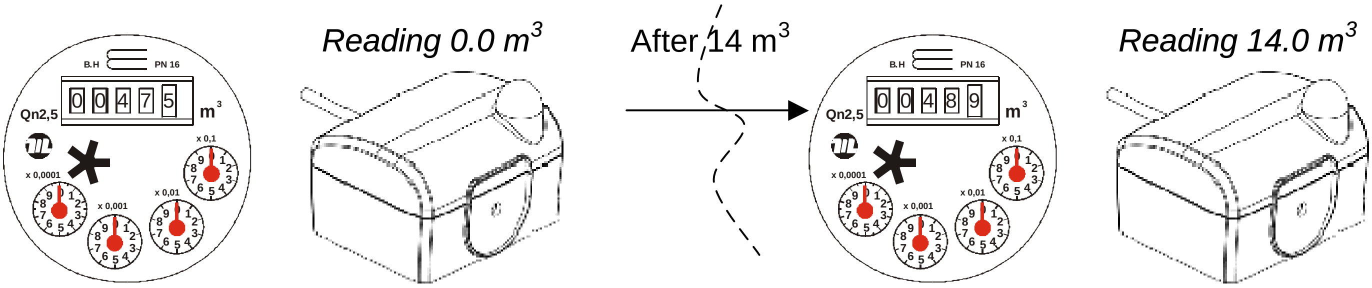
User	Meter Serial N.	Radio module serial N.
Mario Rossi	FA123456-06	23100148
Franco Bianchi	**FA987654-06 Replaced by FA025486-06**	**23524569**
…	…	…

4.2. Synchronization of the mechanical reading

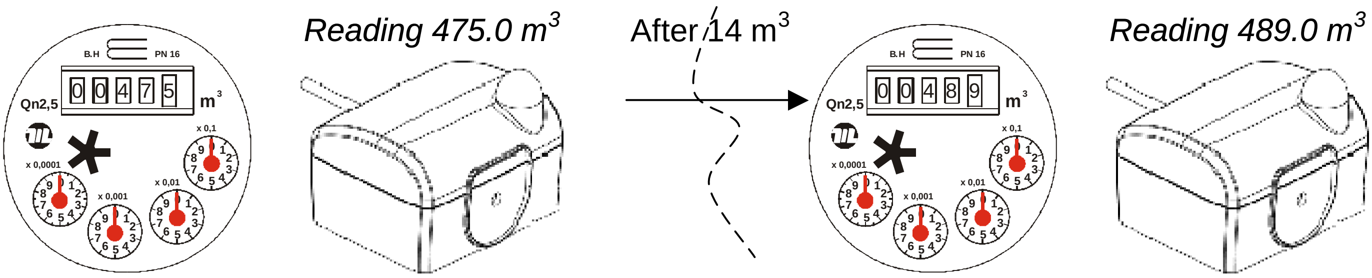
The module for remote reading has a memory area which stores the progressive count of the pulses received from the pulse emitter sensor. When a remote reading is read via radio, the module transmits this memory area, with the pulse totalizer which represents the mechanical meter reading. The internal pulse totalizer is obviously increased by each incoming pulse, so as to be perfectly synchronized with the mechanical meter's count. In a new module for remote reading, the totalizer memory's initial value is equal to zero pulses. The mechanical counter, on which the module for remote reading is installed, even if new, does not usually show "0". This is why, when the mechanical meter and the remote reading unit are coupled, the mechanical meter reading and the corresponding module for remote reading are usually different, and need to be synchronized so that the totalizer in the module for remote reading shows the same value as the mechanical totalizer and, from that moment onwards, the figures of the mechanical and the remote reading systems are synchronized and, thus, corresponding.

4.2.1. Examples of synchronization with mechanical meters

As shown in the illustration, we assume that we are coupling a module for remote reading on a previously installed water meter with a 1P= 1000L rate (one pulse per cubic meter) pulse emitter. When it was coupled, the meter registered 475 m^3, while the module for remote reading registered, as its factory setting, zero.



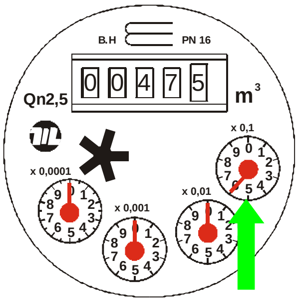
If no synchronization takes place, after, for example, 14 m^3 (equivalent to 14 pulses), the mechanical meter would register 489 m^3 (475+14 = 489) while the module of the remote reader would register 14 m^3 (i.e. the total of the 14 incoming pulses).
Please note that even in this case of non-synchronization, the CONSUMPTION, i.e. the difference between the readings in two different instants, is accurate. What is not accurate is the fact that the mechanical meter and the remote reading totalizer do not register the same value, and indicate different values in relation to a reading taken in a specific moment.
The first synchronization of the module for remote reading takes place during the installation, by simply reading the mechanical meter and recording the registered reading (initial) in the Arrow module pulse totalizer memory, so that the reading of both meters after their coupling is the same.



In the given example, once the synchronization has taken place, both the mechanical meter and the module for remote reading register an initial reading of 475 m^3. After having totalized 14 m^3, for example, the mechanical meter registers 489 m^3 (475+14 = 489) and the module reading, having received 14 pulses, has registered a 14-unit increase on the pulse totalizer, which now registers 489 (m^3). In this case, therefore, not only the consumption is congruous, but even the reading of the mechanic meter and the Arrow module for remote reading are equivalent.

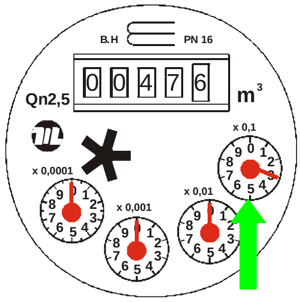
4.2.2. Synchronization problems

The following example considers a water meter with a pulse emitter whose pulse rate is one pulse every m^3 (the illustration depicts a needle only for ease of description. In the actual installation the hectolitres needle is replaced by a magnet).



The exact initial reading is 475.6 m^3. However, the needle indicating the hectolitres in a meter with 1P=1000L is, in reality, covered by a reed sensor, and the needle is replaced by a magnet, therefore it is impossible for the meter reader to read the hectolitre needle, as depicted in the following illustration:

At this stage the first synchronization of the module for remote reading is usually accomplished by inserting an initial reading without registering the hectolitres, so that the module is synchronized with an initial reading equivalent to 475 m^3 (instead of the correct 475.6). Let us now assume that an equivalent of 700 litres of water has passed through the meter



In the mechanical meter the hectolitre needle, which was on “6”, has passed zero, adding an extra cubic meter (the 476th one), and has stopped on “3”, showing the correct reading of 476.3 m^3 (475.6+0.7=476.3).

The pulse emitter sensor emits a pulse with every complete rotation of the magnet, which replaces the hectolitre needle, i.e. one pulse every 10 hectolitres or, in other words, every cubic meter. The exact point of the meter face where the pulse emitter sensor emits a pulse depends on the position of the reed sensor and on the installation of the magnet poles and, in general, this point may not coincide with the zero on the face. In the previous illustrations we assume that this point is somewhere near “5”, as is indicated by the arrow. By comparing the two figures, it is evident that the needle (after completing 7/10 of the complete rotation, equal to 700 litres) has not yet accomplished a complete rotation, and has not yet passed over “5” (arrow), therefore the magnet still hasn’t triggered an impulse from the pulse emitter.

For this reason, the module for remote reading totalizer still registers 475 m^3, while the mechanical totalizer has already reached 476 m^3. This synchronization problem, however, is not exactly a mistake: the example actually shows that if another 200 litres pass through the meter (making the needle go on “5”) a pulse is emitted and, consequently, the mechanical totalizer reading and the module reading coincide again.
It is therefore necessary to consider that a ±1 unit difference between the mechanical totalizer and the electronic one (related to the pulse factor) is a predictable consequence of the inaccuracy of the first synchronization.

4.2.3. Replacing a meter

For the abovementioned reasons, when either a mechanical meter and/or the module for remote reading is replaced, it is necessary to newly synchronize the module with the mechanical meter so as to guarantee the same radio and mechanical reading

4.3. The pulse factor

The pulse emitter is a meter which not only has the conventional task of keeping count, but also has an electric output sensor, called pulse emitter, which can short-circuit itself (emit a pulse) every time the meter totalizes a specific unit of measurement. We will now consider the case of a water flow meter, but the same example can be applied to any other meter reading any other medium. The most common pulse emitter is mainly composed by a sort of switch, called reed sensor, which is magnetically sensitive and closes whenever within range of an appropriately positioned magnetic field. One of the meter needle indicators is replaced by a magnet, which rotates right under the reed

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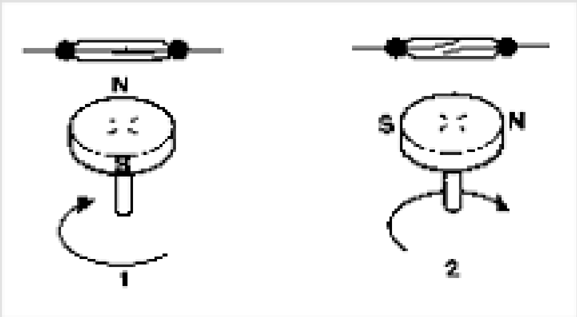
sensor. Every time the needle accomplishes a complete rotation and it positions itself on the same place, the reed switch shuts itself off and the pulse is generated.



Operating principle of the reed switch

The flow running between one pulse and the next depends on the needle which is replaced by a magnet inside the meter and, consequently, by the reed sensor's position (located above the magnet) The flow rate between two pulses determines the so-called pulse emitter "factor": there are, for example, pulse emitting meters that emit a pulse every litre, every hectolitre, every cubic metre etc.

4.3.1. The pulse emitter factor

Two different numeric notations are used to describe the pulse emitter factor: the K notation and the 1P notation. Let's consider the case of water meters (which may be easily applied to other mediums)

K-notation pulse emitter factor:

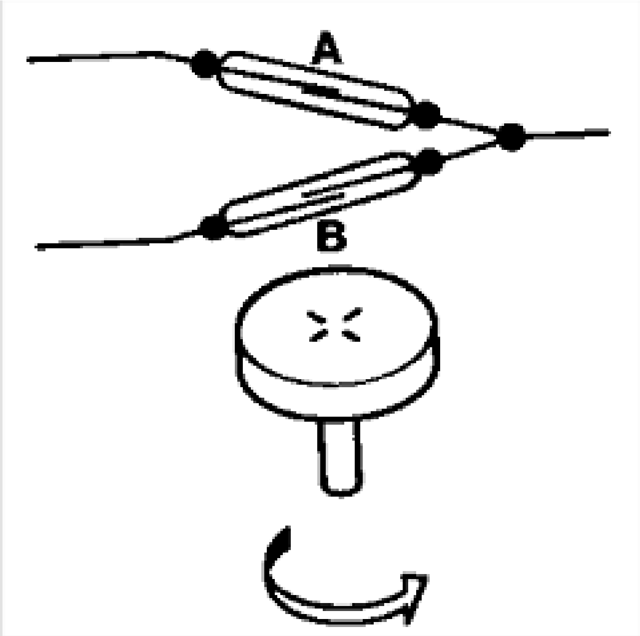
It expresses the number of pulses for every totalized litre. As the pulse emitter meter emits pulses for volumes higher than a litre, the K notation pulse emitter factor is usually a decimal number; the following table shows some examples:

K=1	1 pulse for every litre
K=0.1	0.1 pulses for every litre (i.e.1 pulse every 10 litres)
K=0.01	0.01 pulses for every litre (for 1 pulse you need 100 litres)
K=0.001	0.001 pulses every litre (for 1 pulse you need 1000 litres, i.e. one cubic metre)
K=4	4 pulses every litre (i.e. one pulse every quarter litre – 25 cl)

1P (1 pulse) notation pulse emitter factor:

It expresses the number of totalized litres for every pulse. The 1P notation number is, by definition, the reciprocal of the number expressed by K notation. Usually the 1P notation factor is an integer number; the following table shows some examples:

1P=1L	1 pulse every litre
1P=10L	1 pulse every 10 litres
1P=100L	1 pulse every 100 litres
1P=1000L	1 pulse every 1000 litres, i.e. one cubic metre
1P=0.25L	1 pulse every 0.25 litres (i.e. 4 pulses per litre)



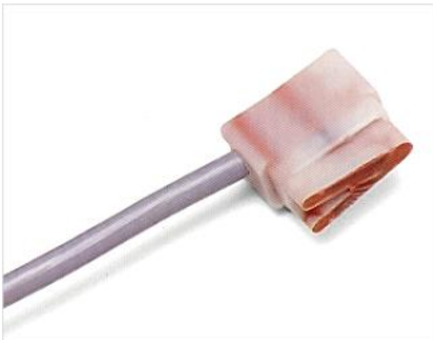
Bidirectional pulse emitter sensor (2-reed)

The single-switched pulse emitter sensor, however, does not show if the meter is reading forwards or backwards (retro-counting, as for example with back-flow). If it is necessary to know the direction, the pulse emitter sensor is equipped with two out-of-phase reed switches with an angle similar to that of the illustration. The underlying magnet closes the reeds according to an A-B or B-A sequence, depending on the direction of rotation (and so depending if it is counting or retro-counting). By analyzing the closing sequence it is possible to establish in which direction the water is flowing in the meter. This type of sensor is called bidirectional pulse emitter sensor.

4.3.2. The pulse emitter on Maddalena meters

Maddalena pulse emitter sensors can be only fitted on meters which are equipped for this kind of sensor, in other words on meters where the needle has been replaced by the appropriate magnet. Therefore, it is not possible to fit the pulse emitter sensor on a regular, non specific meter.

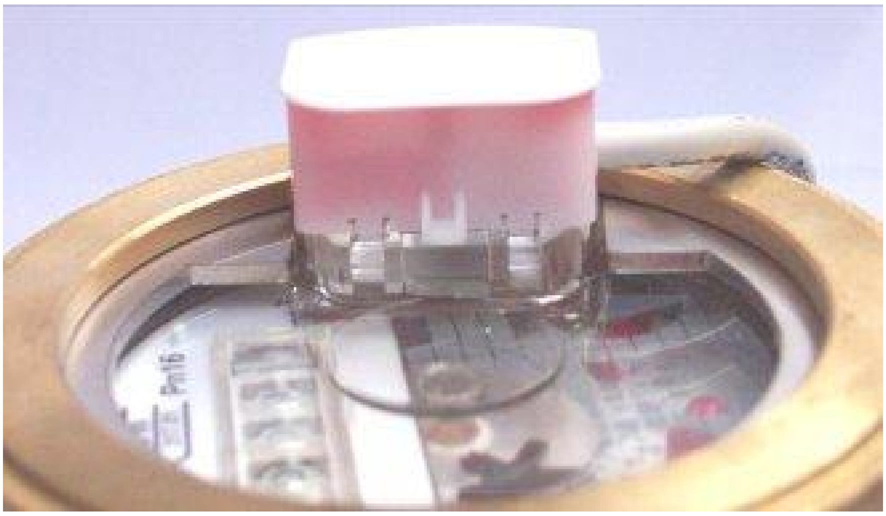
Maddalena standard pulse emitter



Previous version of the pulse emitter

The correct fitting of the pulse emitter sensor requires the following precautions:

1. The place where the meter will be fitted must be clean and free from dust, debris or other impurities. If the area is dirty it is advisable to clean it with a jet of compressed air, because often cloths or other cleaning tools tend to leave a number of impurities. The area must be clean to ensure proper fastening of the sensor and also to guarantee the appropriate distance between the reed sensor and the magnet (which may otherwise compromise the correct functioning of the pulse emitter).
2. The pulse emitter sensor head must be clean and intact (for the abovementioned reasons)
3. The standard sensor must be inserted and fixed to the meter face with the appropriate clamping screw, in the position corresponding to the pulse emitter magnet.
4. The previous type of sensor must be clipped to the appropriate slot, making sure that the sensor enters the slot until it clicks into place. If this does not occur, the sensor may slide off, dirt may enter and, consequently, the pulse emitter will not function correctly .



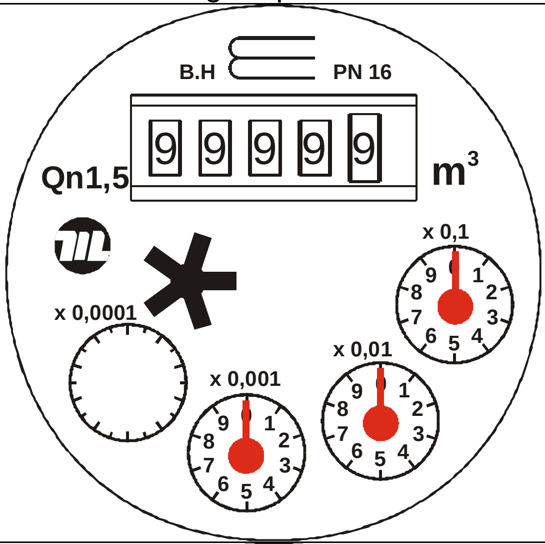
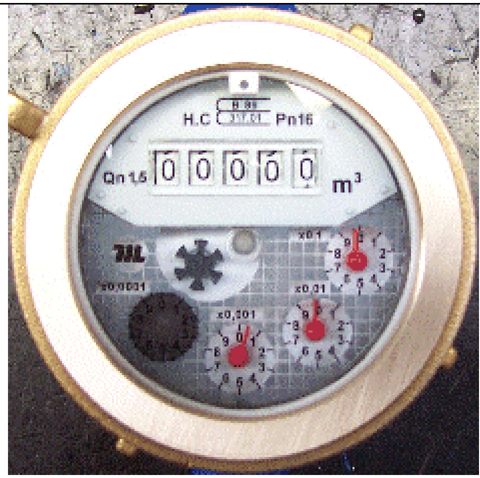
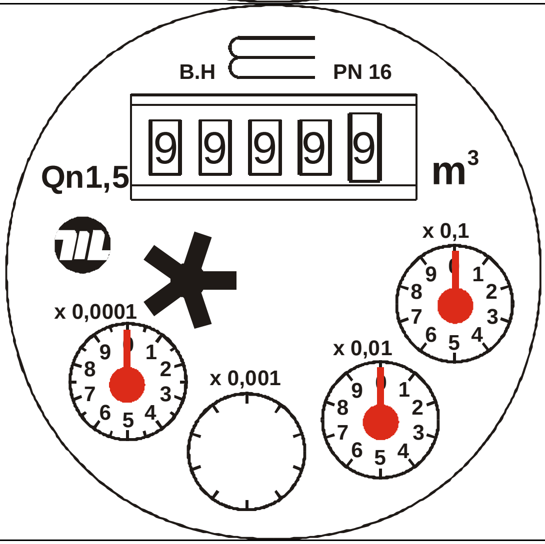
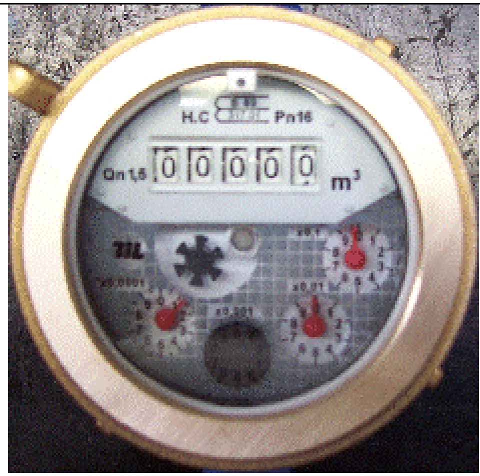
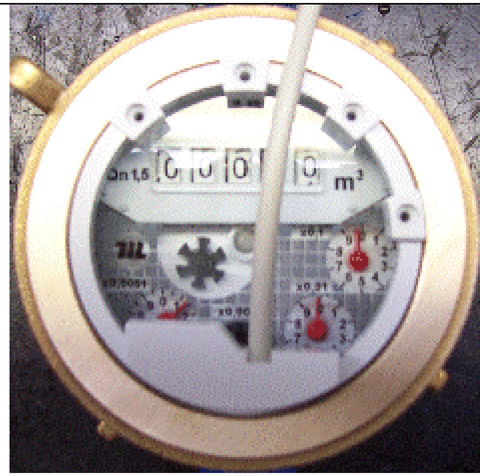
Previous type of sensor: correct installation and correctly inserted sensor

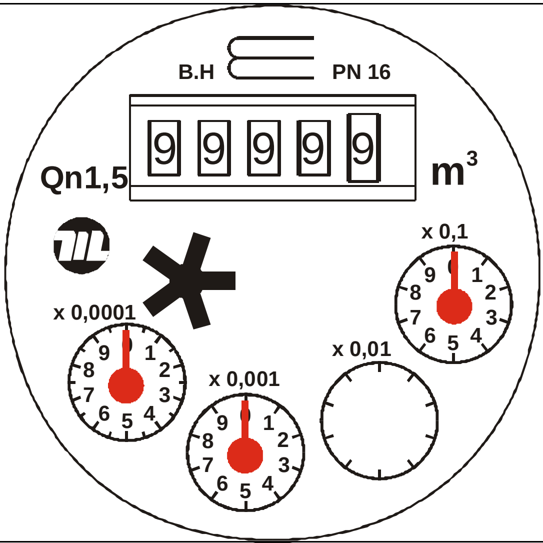
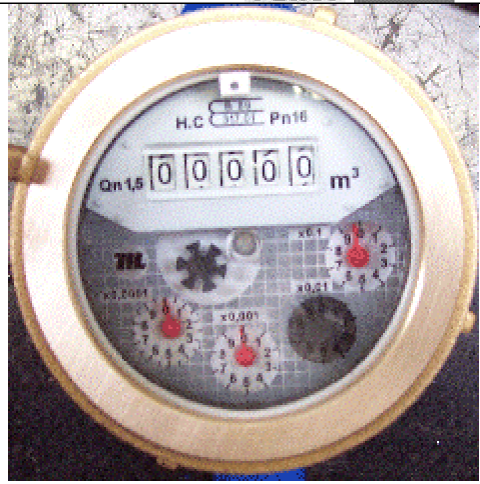
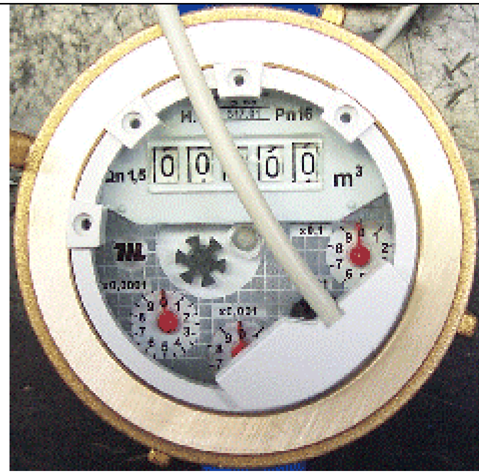
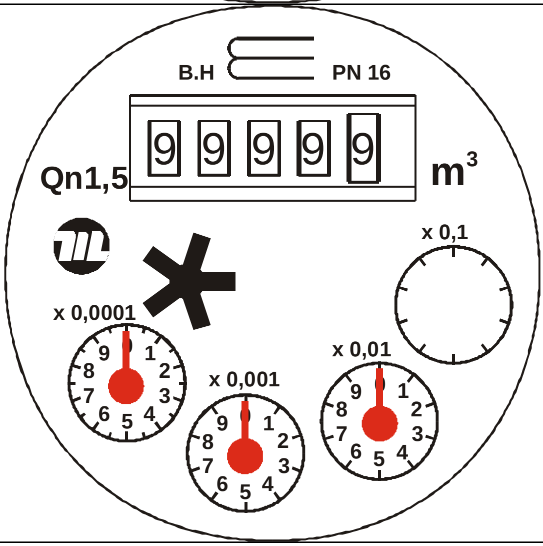
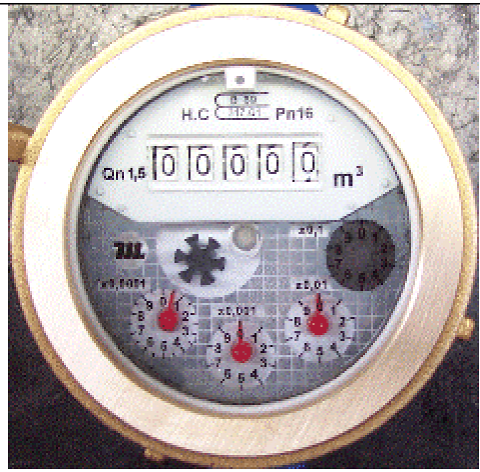
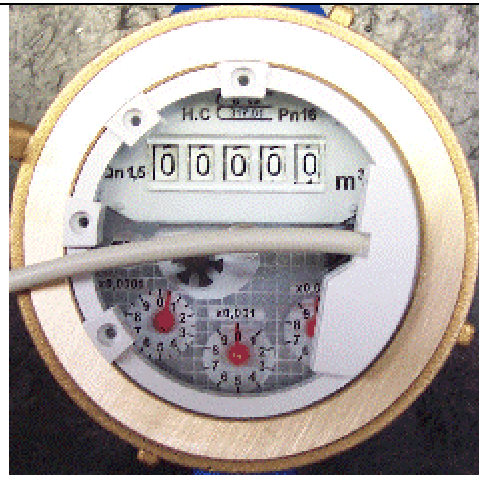
Previous type of sensor: improper installation with sensor inserted but not fixed correctly

The Maddalena meter with the pulse emitter sensor

Even though various pulse emitter factors exist, Maddalena equips most of the pulse emitter preset meters with 1l, 10l, 100l and 1000l pulse factors, as illustrated in the following tables

<table>
<tr><th>Factor</th><th>Magnet position</th><th>Preset meter without the sensor</th><th>Meter with installed sensor</th></tr>
<tr><td>1P=1l
K=1

1 pulse every litre</td><td>
</td><td></td><td></td></tr>
<tr><td>1P=10l
K=0.1
1 pulse every 10 litres</td><td>
</td><td></td><td></td></tr>
</table>

1P=100l K=0.01 1 pulse every 100 litres			
1P=1000l K=0.001 1 pulse every 1000 litres			

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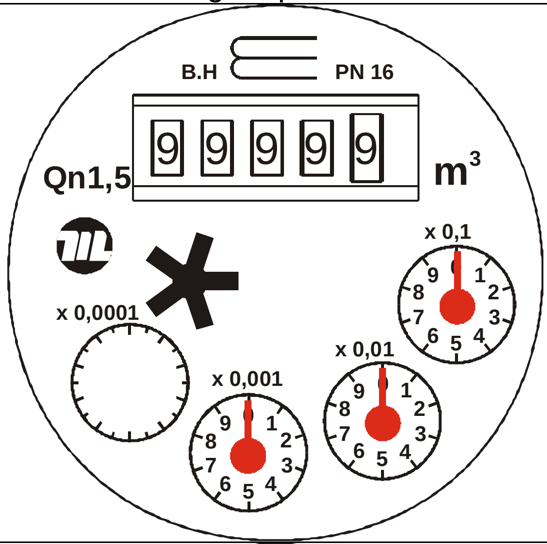
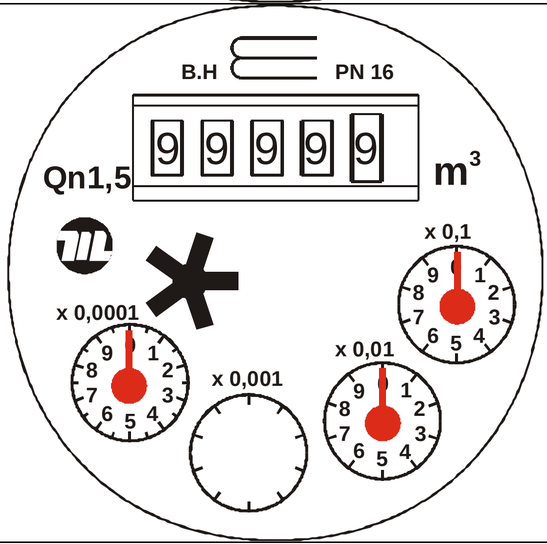
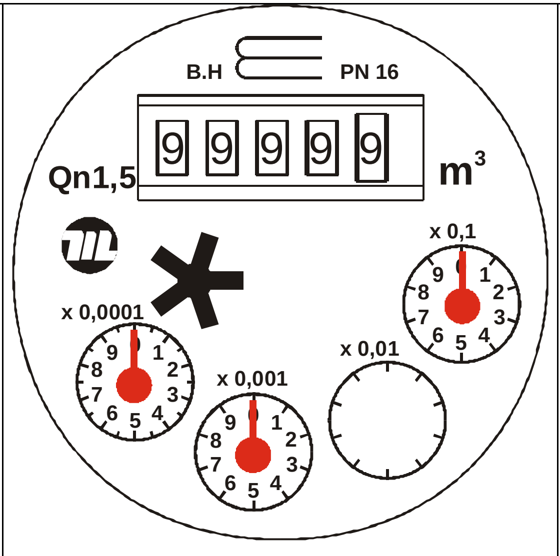
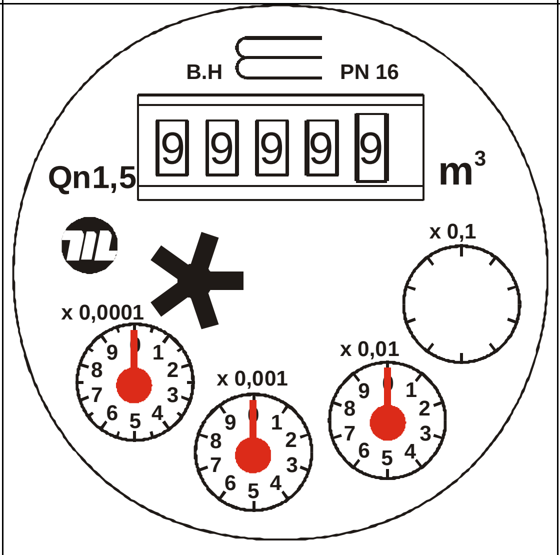
Factor	Magnet position	**Previous version** without the sensor	**Previous version** with the sensor
1P=1l K=1 1 pulse every litre			
1P=10l K=0.1 1 pulse every 10 litres			

1P=100l K=0.01 1 pulse every 100 litres			
1P=1000l K=0.001 1 pulse every 1000 litres			

4.3.3. Special pulse factors

In general, not all pulse factors are numbers to the power of 10 (as in 1,10,100 etc…), but they could be any number. These "special" pulse factors are described in 1P notation (pulses every litre) as the combination of a numerator, a denominator (of a fraction) and a power of 10 (always considering the chosen unit of measurement for the medium registered by the meter):

$$\text{pulse factor} = \frac{\text{numerator}}{\text{denominator}} \times 10^{\text{power}}$$

Here are some examples of pulse factors used for volumes of water:

example a: 2 pulses every cubic metre

$$\text{Pulse factor} = \frac{1}{2} \times 10^{3} = 500 \text{ L}$$

example b: 1 pulse every 4 litres

$$\text{Pulse factor} = \frac{4}{1} \times 10^{0} = 4 \text{ L}$$

example c: 7 pulses every 40 hectolitres

$$\text{Pulse factor} = \frac{40}{7} \times 10^{2} = 571.42 \text{ L}$$

Every special pulse factor is therefore expressed by the set of the three values

< numerator, denominator, power >

Thus, it is possible to express any decimal number.

4.3.4. The optimal choice of the pulse factor

In general it is more convenient to choose a pulse factor which supplies a higher resolution, i.e. the one with the lowest number of litres per pulse (lower 1P factor or greater K factor). For the standard Maddalena meters the best option lies in the one pulse per litre factor (1P=1l o K=1).

This choice can be explained in two ways:

1) The factor with the higher resolution allows for a smaller number of litres for every impulse so, given the same consumption, less time passes between one pulse and the next. In this way it is possible to realize rather rapidly if a reading has changed. Also, the significant number of the reading which changes more rapidly is the most accurate possible.

2) Leak detection is simplified by a factor with a lower amount of litres per impulse. Let's suppose we connect the meter to a supply system which seems to be closed. A 10 litres/h leak in this system would be revealed by 1 pulse every 6 minutes if the meter has a 1 pulse per litre pulse factor, while if, for example, a one pulse every 100 litres factor was chosen, the pulse frequency would drop to one pulse every 10 hours.

4.4. Periodic reading

The Arrow remote reading modules can store the so-called periodic reading, i.e. store a reading on a specific date. In practice, on the periodic reading day, the progressive reading data of the module for remote reading is copied and filed in a separate memory area, with the date in which this reading was made (copied). In this way, it is possible to retrieve a series of past readings made all in the same day, even if they are read later on and in different moments. The periodic reading features the following characteristics:

1) It is repeated periodically, so that, when the fixed date arrives, the reading is stored in memory with the current date. Then the periodic reading date is rescheduled after a certain interval (for example it is set for the following month) so that this operation is repeated cyclically. It is possible to program three types of periodicity: weekly, monthly and yearly. The following periodic reading dates are scheduled respectively in the following 7 days, one month and 1 year. It is possible to set two values in the periodic reading: periodicity and date of the following periodic reading, specifically

periodic reading	**Scheduled periodic reading date**
Weekly (7 days)	Day of the week (from Monday to Sunday)
Monthly (1 month)	Day of the month (from the 1st to the 28th)
Yearly (1 year)	Day (from the 1st to the 28th) and month (from January to December) of the year

2) **<u>Only one</u>** periodic reading is stored in memory, and the following ones overwrite the previous reading. For example, if the periodic reading is scheduled on the 15th of every month, the reading registered on the 15th June will be stored in memory as the periodic reading until the14th July. On the 15th July, the monthly periodic reading will overwrite the reading registered on the 15th June, which will therefore be lost. This implies that, considering monthly periodic readings as in this example, there is one month's time to read the data before it is overwritten, so the periodic reading registered on the 15th will be available until the 14th of the following month, after which it will be overwritten. The same applies to the weekly periodic reading (the periodic reading is stored in memory for a week) or the yearly reading (the periodic reading is stored in memory for a year).

4.4.1. Some examples of periodic reading

Current date	Periodic reading setting	Next periodic reading	Following Periodic reading
14th January 2005 (Friday)	Weekly; Wednesday	19th January 2005 (Wednesday)	26th January 2005 (Wednesday)
12th December 2004	Monthly; 3rd of the month	3rd January 2005	3rd February 2005
25th January 2005	Yearly; 14th July	14th July 2005	14th July 2006

4.4.2. Considerations on periodic reading annotation

- Periodic reading can be particularly useful when you want to take a "picture" of the consumption in a given moment on a network controlled by modules for remote reading, or if it is necessary to make a precise bill of the consumption at a certain date, but it isn't possible or it isn't convenient to read the meter on the established day (for example 1st January).

- The radio module does not carry out any congruency tests as far as the date accuracy is concerned, so if the established date for the periodic reading does not exist (for example the 30th February), the periodic reading simply does not take place until the next suitable date (in this case the 30th March). For this reason, in the monthly periodic reading, the days have been restricted between 1 and 28.

- The reading takes place at midnight at the end of the periodic reading day: basically, if the periodic reading was scheduled for the 14th January, the exact instant in which the meter is read is the 14th January at 11:59:59 pm.

- The periodic reading, in general, has a numerical value equal to or lower than the current reading.

- When the periodic reading is set (for example during the first programming stage or after modifying the configuration of the module for remote reading) the value is conventionally set to zero.

- The date and the time on the clock inside the module for remote reading control the activation and calculation of the periodic readings. If this clock is not set properly, the time and date of the periodic readings will consequently be erroneous.

4.5. Manipulation alarm

The Arrow radio module has an alarm signal also known as manipulation alarm, which is activated if the connection cable is disconnected or if a fraud has been attempted on the reed sensor of the pulse emitter by applying an external magnetic field (only in sensors equipped with the antifraud reed). The manipulation alarm has two modes: the "currently active" mode which is immediately triggered in case of fraud (cable cutting or magnetic field), and the "previous manipulation" mode which is activated if the fraud alarm lasts more than 15 minutes. This double manipulation alarm state has the following advantages:

- If the user programs the module immediately before inserting it into the meter, no trace whatsoever of the "previous manipulation" mode will remain in memory.

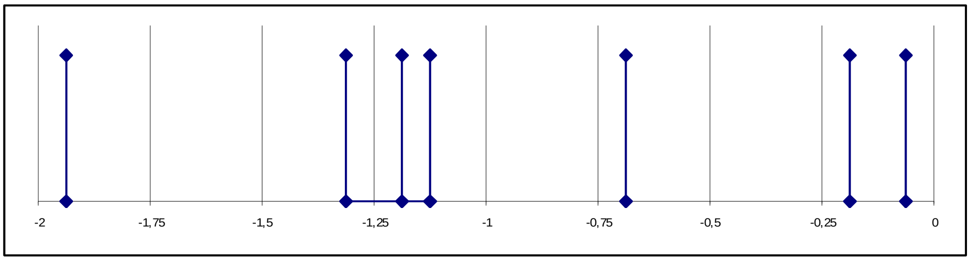
- If the meter is detached or the cables have been accidentally removed for a short while, no alarm will be memorized.

Please note that both cable disconnection and the application of an external magnetic field generate a manipulation alarm (where provided), though it is not possible to distinguish the cause.
Once the alarm mode has been discovered, the agency must determine the cause of the alleged fraud and re-establish the correct reading conditions (if the cable has been cut there should be a realignment between the mechanical reading of the meter and the reading that has been stored in memory on the radio module). Once the working conditions have been re-established, the alarm mode can only be cancelled by reprogramming or cancelling the error by programming through the optical head (the only way to write inside the Arrow radio module).

4.6. Suspected leakage alarm

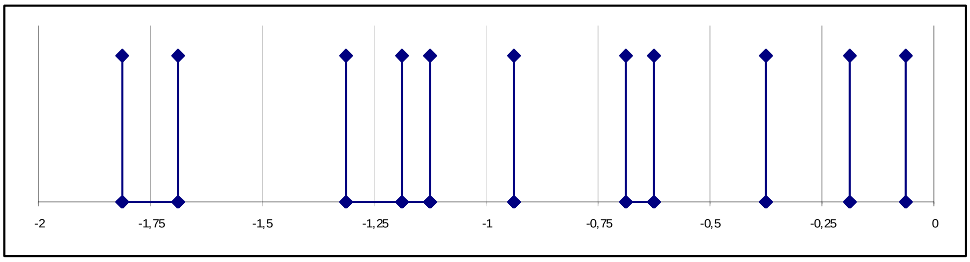
The suspected leakage alarm was created to provide the user with a tool which, if possible, can discover any probable leaks (water leakage as far as water meters are concerned, or, with other meters, constant abnormal consumption). The Arrow radio module implements the following calculation algorithm to establish the existence of a suspected leak:

The period within the last 48 hours is divided into 15-minute time intervals. If inside at least one of these intervals **no** pulse whatsoever has been detected, then the suspected leak does not exist.



example: some 15 min. intervals are without pulses: suspected leak not present

If at least one pulse is detected in **all** these intervals, then the suspected leakage alarm is present.



example: all the intervals have a minimum of one pulse: the suspected leakage alarm is activated

The algorithm used by the Arrow radio module is only one of the algorithms which can be devised: moreover, it is not possible to establish the existence of a leak only by analysing the consumption (for example if a meter is located at the entry of a public fountain, the leak alarm would be constantly active). For this reason the term “suspected” leakage is used.

An efficient use of the suspected leakage alarm greatly depends on the mechanical meter's pulse factor. Indeed the leak algorithm reveals the presence of a "constant" consumption of at least 1 pulse every 15 minutes. This means that (for example, in the case of a water meter) the minimum amount of water lost in the leak is of 4 pulses per hour. If the pulse factor is, for example, at 1 pulse every litre, then the minimum traceable leak is of 4 l/h. If, instead, the pulse factor is 1 pulse every m^3, the minimum traceable leak is of 4 m^3/h. This leak shows its effects much sooner than the signal sent by the Arrow radio module. The effectiveness of the suspected leakage alarm strongly depends, therefore, on the chosen pulse factor: the lower the factor, the smaller will the traced suspected leak be.

Factor pulse emitter	**Minimum traceable leak**
1P=1l	4 l/h
1P=10l	40 l/h
1P=100l	400 l/h
1P=1000l	4 m^3/h

Example of the minimum traceable leak detectable in a water meter according to its pulse emitter factor

4.7. The remote reading module internal clock

Inside the Arrow radio module there is a clock which makes the internal calendar advance. The calendar runs the periodic reading system: the exact date is important as it is necessary to know if it is the moment to save the current reading in the periodic reading buffer, and this may be achieved only with the change of date.
Obviously the exact time is only required to indicate the exact moment of the change of date, and it is important to synchronize the time inside the installed radio modules if a water balance is to be drawn (in this way the readings have all been stored in memory at the same moment, and not some hours in advance or later).
Bad internal clock synchronization of installed radio modules could lead to distorted periodic reading data, as these data have not been read at the same instant in all the installed meters.
With the radio module programming software, which is currently being programmed via optical interface, it is not possible to set the clock and the calendar randomly, while the synchronization of the time and date on the module with the time and date on the computer is allowed. Great attention must be paid to the correct setting of the date and time on the Pocket Pc, especially after total battery discharge.

4.7.1. Summer Time

Please note that, for convenience of use, the radio module DOES NOT adopt summer time. This implies that if the Pocket Pc is kept synchronized with the exact time, and one radio module is programmed in winter and one is programmed in summer, the matching internal clocks will register a difference of one hour. For the same reason, a radio module which has been programmed in winter, will show a one-hour difference if examined in summer.

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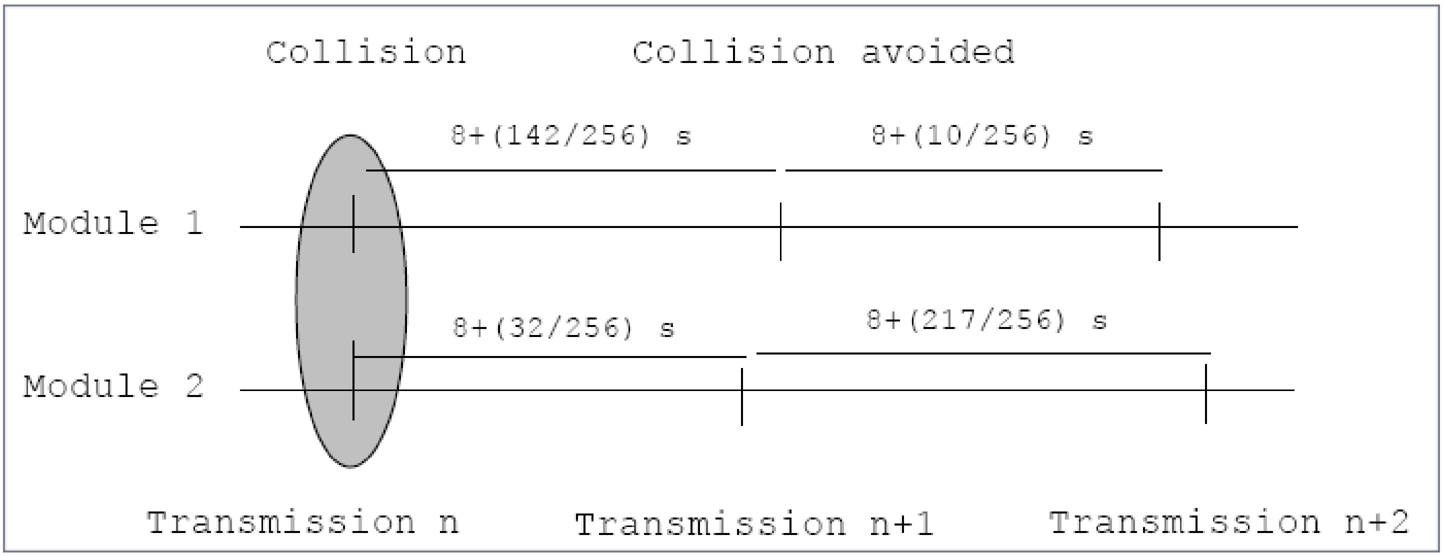
4.8. Data reception and collisions

The Arrow radio module operates in a unidirectional mode (transmission only), and it transmits data sets every 8 seconds. Logically, a radio receiver within range of the two radio modules which transmit data in the same instant, is confused by the simultaneous transmission and cannot receive the transmitted data correctly. This is what is called a “collision”. The only thing the receiver can do is to identify said collision and invalidate any data it has received. Obviously, if the two radio mod ules were to transmit again after exactly 8 seconds, there would be e repeated data collision problem and therefore it would always be impossible to read the two modules.
To avoid consecutive data collisions between two radio modules, each module is equipp ed with a random generator which slightly shifts the instant of transmission arbitrarily. In the example illustrated below, we assume that, at the n-th transmission, the two modules transmit simultaneously, originating a collision:



The following instant of transmission (at the N+1-th transmission) is slightly modified in the two modules: module 1 generates the casual number 142, and so it performs the transmission after 8 seconds plus 142/256 of a second. The second module, instead, generates the casual number 32, and so it transmits after 8 seconds plus 32/256 of a second. In this way the collision is avoided. The same occurs for the following instant of transmission (at the N+2-th transmission) where module 1 generates the casual number 10, while modu le 2 generates the casual number 217.

Sometimes, if a certain quantity of radio modules are located in the same receiving area, the collisions slow down the total reading time (and it is necessary to wait for an average of over 8 seconds to read all the modules). Obviously, the higher the amount of modules read in the same location, the more frequent this phenomenon will be.

5. Programming and reading

5.1. Introduction

Arrow radio module's programming carried out during the first installation stage and the subsequent radio reading (in the second stage of the remote reading system) both require a reading system, composed essentially of three components: a handheld terminal with software, a radio receiver and an optical head.

The handheld terminal is a Pocket Pc which can be found in various compatible models. It is equipped with Arrow Mobile software, which supports Windows CE 2002 and 2003 operating systems.

The Pocket Pc can connect to external peripheral devices in two ways (IRDA optical interface and radio receiver):

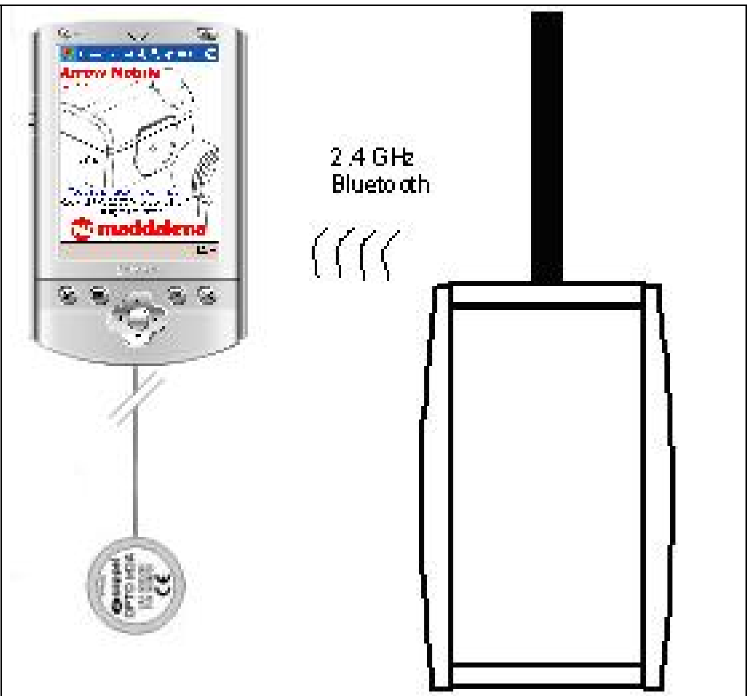
- Via serial port (com 0)
  the serial port is situated on the bottom part of the Pocket Pc and it requires a special cable fitted with a jack plug at the Pocket Pc end and with a 9-pin serial connector at the other end.
- Via Bluetooth interface
  some Pocket PCs can be used with Bluetooth cable-free technology. To connect the Pocket Pc to a peripheral device via Bluetooth, both the Pocket Pc and the peripheral must be Bluetooth-compatible.

The possible configurations, therefore, depend on the connected peripheral devices. The following illustrations show some of the possible connection configurations

Connection to PRT receiver and IRDA optical head (ex. installation)

Connection to PRT receiver (ex. reading)

Direct connection to IRDA optical head (ex. installation)



Connection to IRDA optical head and connection to Bluetooth radio receiver (ex. reading)

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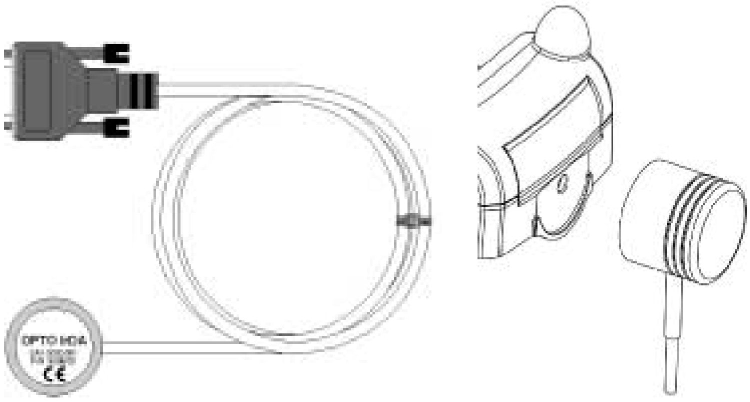
The Arrow Mobile software can operate both in the installation phase and in the reading of the Arrow radio modules. It can also manage the meters which are not equipped with radio modules (manual reading), so that it is possible to arrange specific or mixed situations with only a part of the installed meters controlled by the remote system.

5.2. Programming

To programme the module, the IRDA interface must be positioned in front of the programming diode at the rear of the radio unit, and placed in the appropriate housing.



The IRDA optical head is equipped with a magnet which fixes it to its housing (where a metal part has been incorporated).
In normal conditions, the optical interface of the radio module is deactivated to save the module battery energy. When starting the programming, the Pocket Pc sends a train of pulses via the IRDA probe, which reactivates the radio module IRDA communication interface, and triggers the communication. To avoid leaving it on, the IRDA communication part of the radio module switches itself off automatically after 20 seconds inactivity.
Sometimes the reading or writing of the information on the module via IRDA probe may not succeed: in this case the following measures may be taken:

- Check that the radio module infrared LED diode is free from dirt. If necessary clean it gently, being extremely careful not to scratch it.
- Check that the optical head surface is clean and dry, and that the protective slide is not damaged or excessively scratched. Scratches, impurities or drops of water can deviate the head's infrared beam
- Slightly move the optical head in its housing. Sometimes the optical alignment between the head and the module may not be precise.
- Repeat the reading/writing process. If the process accidentally coincides with the instant of data radio transmission (every 8 seconds), the reading/writing via IRDA will not be accomplished (the module does not operate the two processes simultaneously). When the process is repeated, it usually occurs before/after the following instant of radio transmission.

5.3. Reading

The Arrow radio receiving unit is a radio receiver which can interface itself and decode the data transmitted by the Arrow radio modules. There are two types of these units: the PRT unit and the Bluetooth unit.

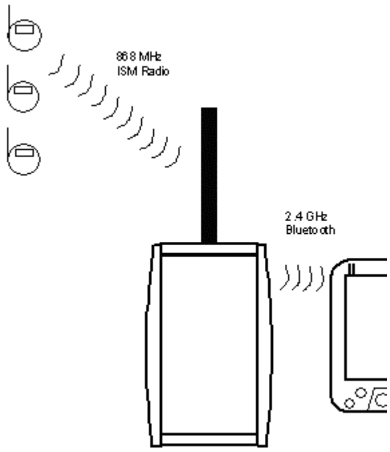
5.3.1. The PRT radio receiver

The Arrow PRT radio receiver is connected to the Pocket Pc with an appropriate serial cable.

In addition to the connection to the handheld computer, the unit also has an output connection for an IRDA optical head and another connection (COM2-MRP) which currently is no longer used (it is used for programming older radio module models).

5.3.2. The Bluetooth radio receiver

The Bluetooth radio receiver is characterised by the fact that there is no cable connection with the Pocket Pc, because the connection takes place through Bluetooth technology. The Bluetooth radio receiver acts like a serial port emulator, creating a virtual serial connection between the Pocket Pc and the receiving unit.
If the user wants to connect an IRDA interface for programming, it must be accomplished directly on the Pocket Pc serial port.



5.3.3. Organization of the readings in tours

When reading meters, it is more convenient to split the whole number of installed meters in groups of meters, called **tours**. The term "tour" has a deliberately vague meaning, because every user groups his meters in his own way, according to various criteria.

A tour may represent a group of meters in a block of flats, in a street, in a small village, in a single meter pit, in a group of houses, etc. There are no limits to how many meters may be contained in a tour. The reading process takes place in tours, in the sense that with the software it is possible to open a tour and take a reading. The reason for taking a reading for every tour lies in the fact that, for example, if the reader is near a block of flats, the only criterion to find out if the readings have been made is to check if all the radio units of the chosen tour have responded. If some radio modules have not replied, the reader's position can be slightly adjusted so as to receive the radio module. If, instead, this type of grouping did not exist, there would be no way of finding out if it is possible to move on to read another site or if it is still necessary to wait for a module reading. Therefore, the subdivision of the installed meters in tours is a simple way to assemble a group of associated meters (usually belonging to the same site), this way improving the management of large meter parks.

The subdivision into groups may take place either during the installation of the radio unit (in this phase, it is fairly straightforward to locate the meters and, consequently, group them), or later, if two tours are united or if some radio modules are moved to a different tour. Even meters without radio modules (manual reading) are managed in tours: in this case the tour is essential to find out, once the reader has reached the measuring site, how many and which meters must be read manually by the reader.

6. Guidelines on how to install a remote reading system for water meters

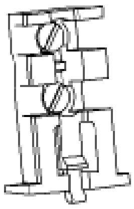
The following paragraphs show some suggestions on how to plan and install an Arrow remote reading system correctly, applied, in this specific case, to water meters. To obtain an efficient metering system, it is essential to select the correct type and size of meter; conversely, the selection of an incorrect size of installed meters could lead to an inefficient or impractical installation of the remote reading system. For all aspects concerning the selection of an appropriate meter park please consult Maddalena experts.

6.1. Suggestions on how to install water meters in meter pits

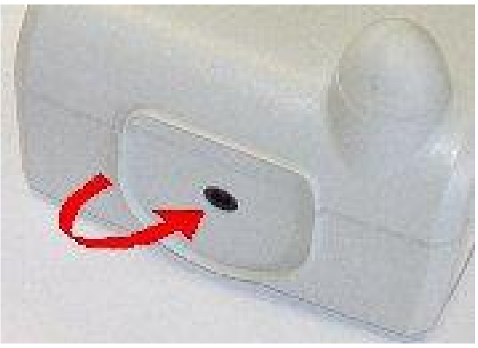
- When installing more than one meter in a meter pit, make sure that there is a minimum distance of 20cm to enable the operator entering into the pit (in case of maintenance) to place his feet between the meters.
- The size of the meters should take into account the number of meters installed and leave enough space for maintenance (or replacement).
- The meters must not be on the perpendicular projection of the meter pit cover rim, as rain could enter and drip from the rim into the pit, falling onto the meter sensor reed.

6.2. Suggestions on how to install the Arrow radio modules

- If the Arrow radio module is fixed to the wall, especially in locations that are hard to reach, insert a spacer between the wall and the fixing element (a wedge is sufficient) to simplify the fitting and the removal of the module.

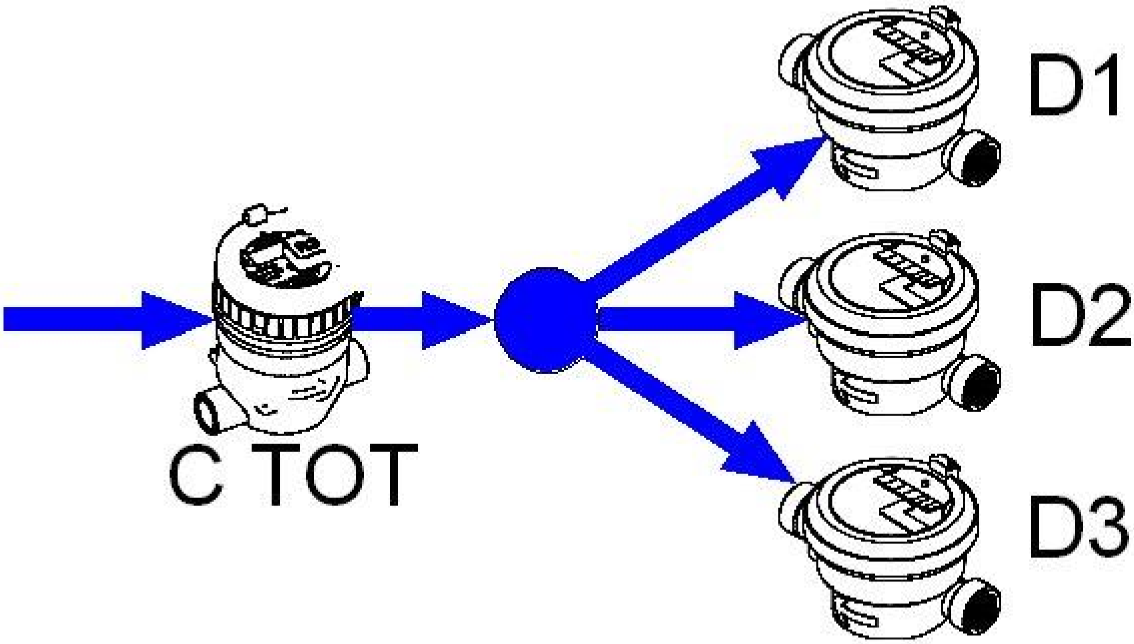


- If the module is coupled to the reed sensor with connectors, place the connector joint close to the radio modules, trying to ensure that it won't be submerged or fall into water-flood areas.
- Fix the radio modules in the highest position possible, to prevent them from being submerged in case of potential flooding of the radio module installation area (for example of the meter pits): though the radio module is protected against submersion, the transmission distance is greatly reduced when under water.
- If the reed sensor is clipped, carefully check that it is properly inserted: the sensor must be securely fastened and not just loosely resting in its seat.
- The reed sensor seat must be accurately cleaned before its installation or before its re-installation. Where possible, we recommend cleaning the area with compressed air.
- The length of the cable between the reed sensor and the Arrow radio module must not be too long (maximum 1,5 - 2 metres).
- To avoid dirt entering and damaging the infrared LED used for the radio module IRDA programming, apply an adhesive label once the module has been programmed.



6.3. Water balances

Arrow remote reading systems can be used for drawing up the so-called water balances. Let's consider the situation shown in the illustration:



A flow of water is passing through the CTOT meter and is then distributed to the divisional meters D1, D2 and D3.

In an ideal situation we would expect that the CTOT meter reading would be equal to the sum of the readings taken from the divisional meters

Ideal situation: $V_{CTOT} = V_{D1} + V_{D2} + V_{D3}$ **(i)**

In reality, however, all meter readings are subject to error. Let's assume that a constant flow of water passes through the piping and that, therefore, the absolute errors ε at that given flow capacity have been established.

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The measured meter values M are, consequently, equal to the volume V plus the absolute error ε.

For the CTOT meter: $M_{CTOT} = V_{CTOT} + e_{CTOT}$ **(ii)**

For the other three meters: $M_{D1} = V_{D1} + e_{D1}$; $M_{D2} = V_{D2} + e_{D2}$; $M_{D3} = V_{D3} + e_{D3}$ **(iii)**

By combining the expression (i) with (ii) and (iii) we obtain:

$$V_{CTOT} = V_{D1} + V_{D2} + V_{D3} \quad \textbf{(i)}$$

$$M_{CTOT} - e_{CTOT} = (M_{D1} - e_{D1}) + (M_{D2} - e_{D2}) + (M_{D3} - e_{D3}) \quad \textbf{(iv)}$$

$$M_{CTOT} = M_{D1} + M_{D2} + M_{D3} + (e_{CTOT} - e_{D1} - e_{D2} - e_{D3}) \quad \textbf{(v)}$$

The expression **(v)** highlights the fact that the sum of the actual readings of the divisional meters D1,D2 and D3 **do not** coincide with the CTOT meter reading because of absolute error propagation. Additionally, as the errors depend on flow capacity, it is even more difficult to express the total absolute error with an irregular flow capacity.

In considering a water supply system used by consumers (water mains, blocks of flats etc.), the so-called water balance may be attained by measuring the amount of water which has entered the system and by subsequently measuring the sum of the individual uses. Usually these two values are not identical, but the difference should be smaller than the error propagation of the individual meters. This type of balance can prove useful when assessing the presence of significant leaks in the system.

The necessary condition for a valid water balance is that the readings take place simultaneously. If this does not occur, the amount of water in the system will not coincide with the sum of the consumptions, as the system is functioning while the readings are being taken and the consumption of that water is being read.

With the Arrow remote reading system the agency/consortium has a more accurate water balance on account of the periodic meter reading. By synchronizing the periodic reading of all the consortium radio modules so that they take place in the same instant (for example the 1st day of each month), it is possible to obtain the reading of the radio modules immediately after the periodic reading has occurred. This comprises not only the current reading, but also the reading status on the exact instant of the periodic reading of all the radio modules.
Considering our example, it is therefore possible to take all the module readings related to the end of the 1st day of last month, thus achieving a water balance free from any mistakes caused by reading the meters in different instants (which would have happened if the readings had been taken manually).

In order to minimise errors in the water balance, the following criteria should be used in selecting the meters:

- Utility meters must be sized with the appropriate nominal flow rate. Specifically, an oversized meter has low flow rates, increasing the possibility of inaccurate readings (which is higher with low flow rates)

- Select the pulse emitter factor with the most frequent pulses possible (high resolution) to minimize the amount of fluid passing through the mechanical meter which has not yet been counted as a pulse. For example, by selecting a 1P=1000 l. factor, we assume that the pulse which has made the radio module register a 100 m^3 volume has just been detected. If 900 l pass through the meter and the radio module is read again, the same volume of 100 m^3 will be recorded (because the 101st m^3 pulse has not been registered yet). The water balance will therefore show an error of 900 litres of water which has not yet been read. If, instead, a 1P=10 l. pulse emitter factor had been selected, the error between two subsequent pulses would have been of only 10 l. maximum, providing a more accurate water balance.

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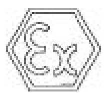
7. Appendix: technical sheets and wiring diagrams

7.1. Arrow radio module

7.1.1. Technical data and features

Communication protocol	PRIOS
Frequency	868.95 MHz
Frequency modulation	FSK
Normative reference	EN 300 220
CE certification	CE RTTE
Batteries	2 Lithium 3.6 V batteries
Battery service life	15 years (average)
Input	Reed Switch (THES)
Operating temperature	-15 °C ÷ +55 °C
Storage temperature	-15 °C ÷ +55 °C
Protection degree	IP 685
Programming interface	IRDA via infrared diode

The intrinsic safety characteristics comply with European directives. The Arrow radio module has been manufactured in conformity with: EEx ia IIA T3.
The following symbol is the EEC mark for products with intrinsic safety approval

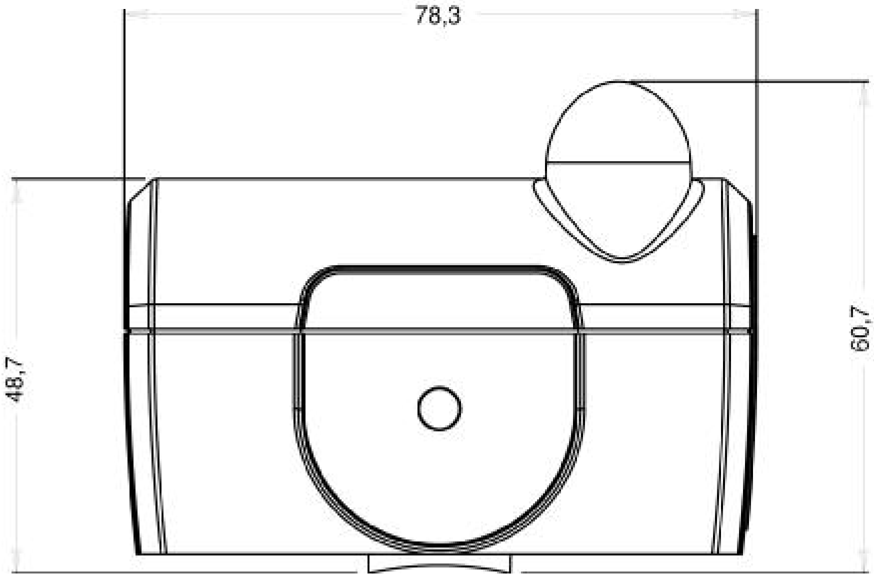


The product complies with the European requirements applied in the EEC (R&TTE 1999/5/EC, 9 March1999)
The Arrow radio module is homologated in the following countries: France, Spain, Portugal, Italy, Germany, Austria, Belgium, Great Britain, Ireland, Denmark, Finland, Sweden, Norway, Holland, Luxemburg and Switzerland.

The Arrow radio module does not require any specific maintenance. It should not be cleaned with solvents or abrasive agents, as they may damage the container. If necessary, clean the unit with soft rags and a specific detergent.

The product must be kept in a dry place, with a storage temperature between –15°C and +55°C.

7.1.2. Dimensions

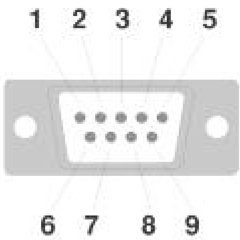


The illustration's dimensions are expressed in mm.

7.2. Optical head programming head

The IRDA Arrow interface is a unit used for programming Arrow radio modules. It uses IRDA infrared optical communication protocol and is equipped with a 1,5 metre connection cable and a DB9 type serial connector.
The optical probe can be connected either to the Arrow radio receiver (in the PRT version) or to the Pocket Pc.
The intensity of the optical signal falls within the IRDA Nr. 1.0 output specifications.

DB9 connector connection to the optical interface:



View of the interface:

Colour	Signal	Terminal num.
Brown	GND	5
White	TCS	7
Gray	DSR	4
Yellow	RX	3
Green	TX	2

DB9 connector connection to the Pc

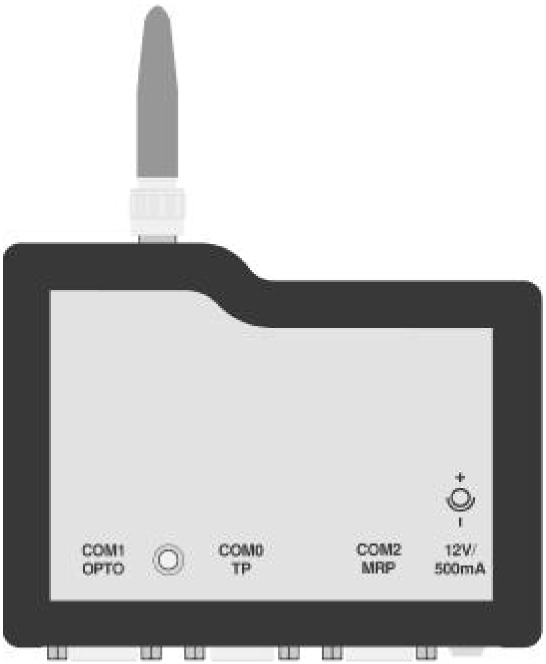
Connection	Signal	Terminal num.
Optical interface data (output)	RDX	2
Optical interface data (input)	TXD	3
Power supply	DTR	4
Power supply	RTS	5
mass	GND	6

The optical interface unit has an IP54 environmental protection rating.
The storage and operating temperature range is –20°C ÷ +70°C.

Arrow optical interface unit cannot operate with voltage higher than 15 V. The IRDA unit has been designed and manufactured in accordance with the latest safety requirements. To reduce the risk of eye injury, do not point the optical interface directly into eyes.

7.3. PRT radio receiver

7.3.1. Technical data and features

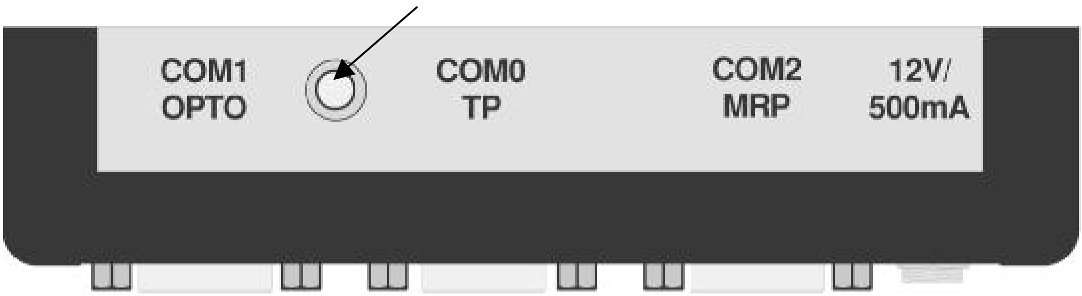


Battery	NiMH 4.8 V – 12 A
Battery autonomy	1-2 days of use
Weight	410 g with antenna
Power supply	12 V DC. (Only use the provided power supply unit. Do not charge for more than 4 hours. Protected

	against polarity inversion).
Battery charging operations	500 charging operations before replacing the battery
Protection degree	IP 43
Operating temperature	-15°C ÷ +55°C
Storage temperature	-20°C ÷ +80°C

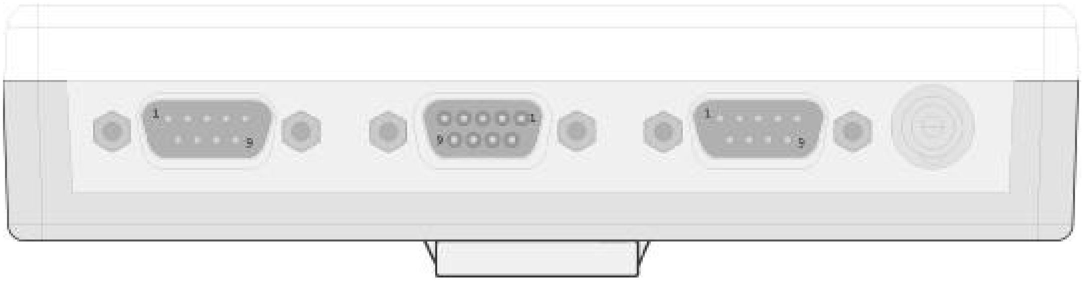
The PRT receiver is activated by the Pocket Pc application software. The unit goes into stand-by mode when the Pocket Pc application software has finished or if it hasn't been used for more than 5 minutes.

The diode LED light indicates the radio receiver's various operating stages:



Short flash every second	Unit is operating and the battery is charged
Short flash every ½ second	Unit is operating, but the battery has a low charge
Long flash every second	Battery is being charged
LED off	Battery is fully charged

There are 3 connections on the bottom side of the PRT radio receiver:



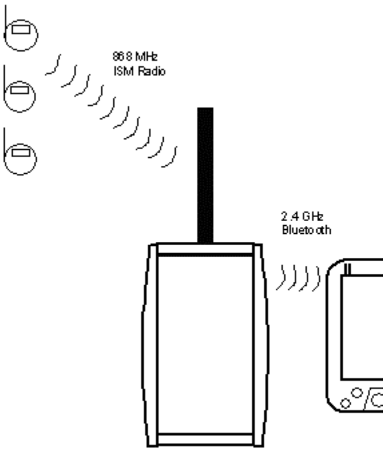
COM 0 TP	Pocket Pc connector
COM 1 OPTO	IRDA optical probe connector
COM 2 MRP	Not used

Dimensions: width: 14 cm; height 18 cm

Maintenance: do not clean the unit with solvents, avoid knocks and only use the supplied battery charger.

7.4. Bluetooth radio receiver

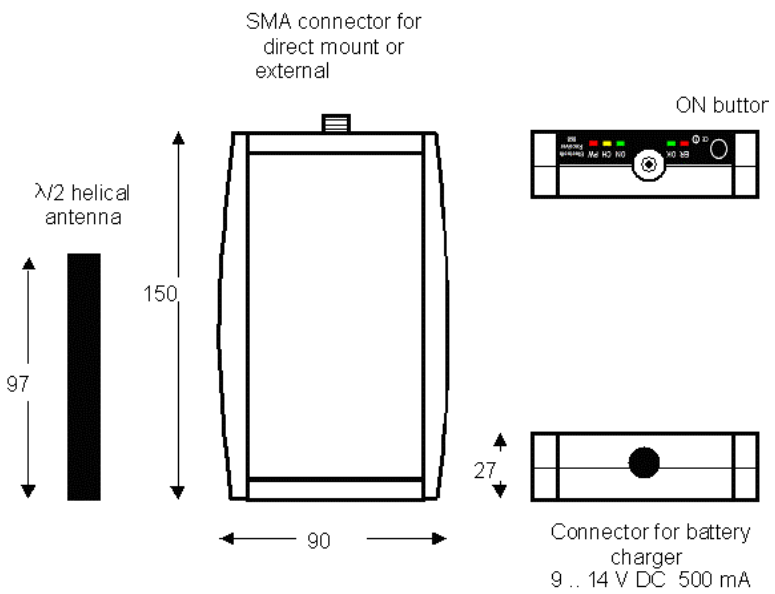
7.4.1. Technical data and features



Bluetooth connection	1.1 a 2.4 GHz Bluetooth version, class 2 (max power output +4 dBm)
Connection capacity	Approximately 10 m
Bluetooth connection profile	Serial emulator, 115200 baud transmission speed
Arrow receiver modules	868 MHz Arrow radio receiver modules
Internal storage capacity	256 radio telegrams
Battery charger	Rapid battery charger module for NiMH, 12 V, 500 mA batteries
Battery charging time	4 hours with low charge indicator
Battery autonomy	Approximately 15 hours with fully charged batteries
Protection degree	IP44
Operating temperature	Between +0°C and +60 °C, with relative humidity between 10% and 70 %
Weight	Approximately 350 g

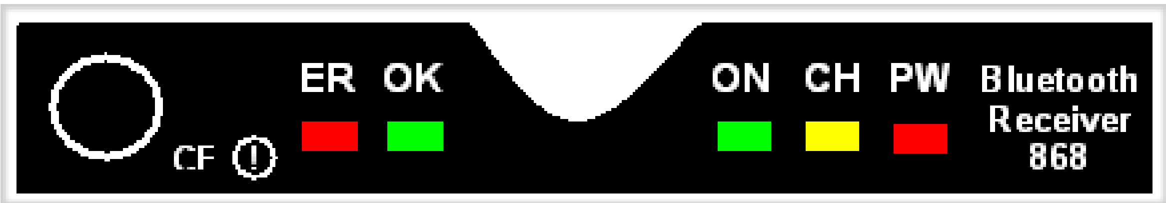
The battery charger disconnects itself automatically when the fast charge is completed, so it is possible to leave the receiver permanently connected to the power supply.

The module is supplied in a plastic container with a belt clip, measuring approximately 155 x 95 x 27 mm (without the antenna) and with approximately 95 mm antenna length.



Important Note: please run a complete battery charging cycle before using the Bluetooth receiver for the first time. The red light LED indicators (PW) and the yellow ones (CH) are switched on: do not disconnect or use the Bluetooth receiver until the batteries are fully charged and the yellow LED (CH) has switched itself off.
Use of any battery charger, other than the one supplied, can destroy the NiMH batteries.
The batteries reach their full capacity only if they have been fully charged and discharged when used for the first two or three times. For this reason, it is advisable to disconnect the receiver from the battery charger the first two or three times it is charged.

LED light indicators



ON Button	Press the ON button to access the Bluetooth Arrow radio receiver. After 4 minutes of inactivity (no Bluetooth connection made) the receiver switches itself off to save the battery life
PW (red)	Indicates that the battery charger is connected to the unit
CH (yellow)	Indicates that the batteries are being charged. Once the batteries are fully charged, the LED switches itself off
ON (green)	Indicates that the receiver is on. After pressing the ON button, the LED should switch itself on; if not, the unit must be recharged
OK (green)	Indicates valid data reception from a radio module
ER (red)	Indicates invalid data reception from a radio module

Immediately after switching on the radio receiver, the “OK” and “ER” LEDs light up for approximately 1 second if the internal diagnostic test is successful. If, on the other hand, the internal diagnostic test is not successful, the two LEDs stay permanently lit, and the unit must be checked.

7.5. Pocket Pc

Maddalena usually supplies the Pocket Pc with the Arrow Mobile software. To be compatible with the Arrow remote reading device, the Pocket PCs must have Windows CE 2003 operating system and a sufficient RAM memory for the number of meters, which are to be read in the meter park. If Bluetooth peripherals are to be used, the Pocket Pc must also have a Bluetooth interface.

Important: for clear viewing, the Pocket Pc screen must have at least 240 x 320 pixel resolution. It is not possible to use the programme on a smaller screen (for example 240 x 240 as in the HP IPAQ series hw6500 model).
The following table shows a list (**not** exhaustive) of Pocket Pcs which have been tested with the Arrow remote reading application:

Pocket Pc model
COMPAQ IPAQ 3850
HP IPAQ 2210
HP IPAQ 3715

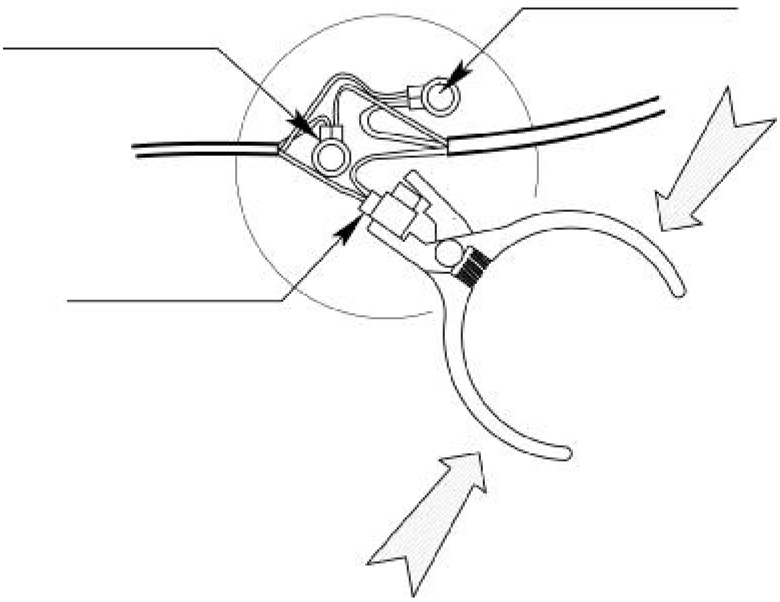
Any Pocket Pc which does not appear on the list is not considered to be compatible, and is subject to approval and compatibility testing on behalf of Maddalena.

Maddalena does not guarantee the correct functioning of the reading system if the Pocket Pc employed is not included in the list or has not been tested for compatibility; furthermore, Maddalena does not accept any responsibility for bad or malfunctioning reading system, software and for erroneous performance of the connected peripherals.

7.6. Connection to external pulse emitters

The Arrow radio module can be connected to any pulse emitting device. In case of pulse emitters not manufactured by Maddalena, it is necessary to connect the 4 wires of the Arrow radio module with the special 3M Scotchlok type crimp connectors.

Connect all Arrow unit wires to the crimp connector, including the unconnected wires. Do not remove the insulation from the wires before their connection, but insert them in the crimp terminal completely.



The terminals are suitable for use in an outdoor environment (moisture, etc.) but **not** for continuous submersion. In case of submerged applications, please use the appropriate 3M kit.

7.6.1. 3M Scotchlok connectors

Scotchlok UR connector, for connecting the user cable. Ø Max. 0,4-0,9 mm
Scotchlok UY2 connector, for connecting 2 conductors. Ø Max. 0,4-0,9 mm

Technical features:
The connectors can connect a wide range of wires, up to 2,08 mm insulation diameter.
The Scotchlok series has been specifically designed for telephone wiring. These connectors are self-stripping, self-sealing and preinsulated and provide a reliable and constant contact, assuring high protection against moisture and contamination. Completely suitable for data transmission networks.

CONTATORI PER ACQUA – STRUMENTI DI MISURA / WATER METERS - MEASURING INSTRUMENTS
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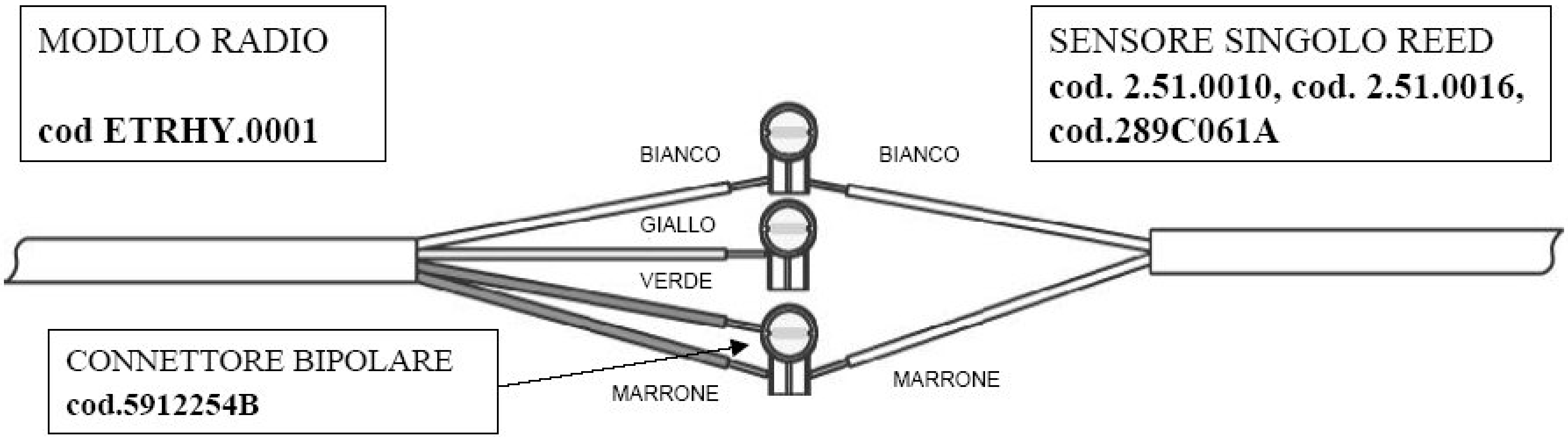
7.6.2. Reed sensor – Arrow radio module wiring diagram

COLLEGAMENTO MONODIREZIONALE (2 FILI)



MODULO RADIO

Bianco = Impulsi

Giallo = Direzione

Verde = Frode

Marrone = Massa

SENSORE SINGOLO REED

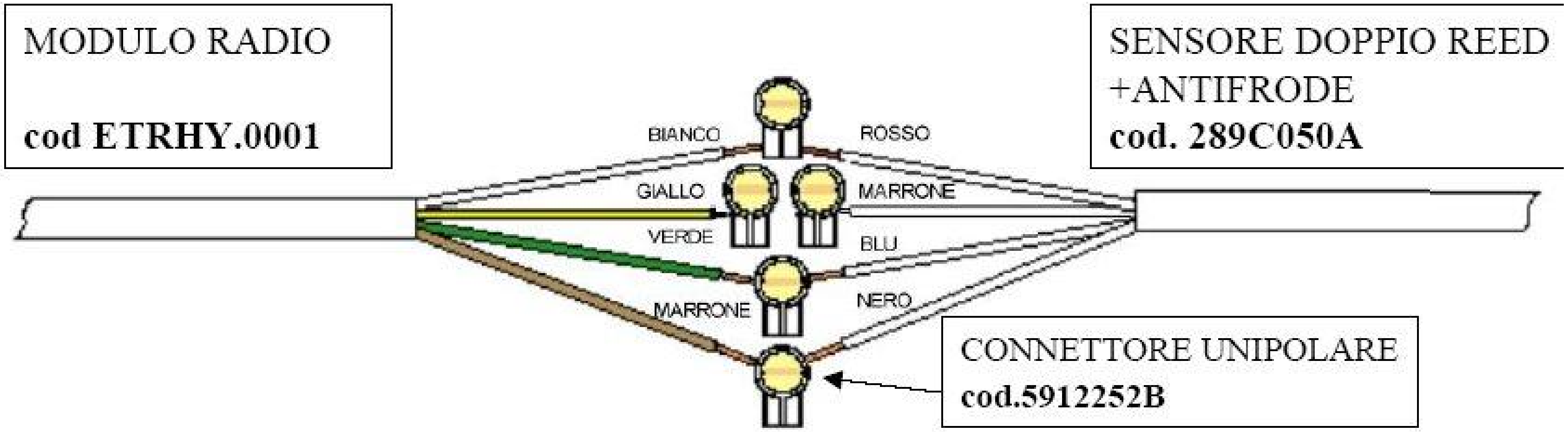
Bianco = Impulso Reed

Marrone = Massa

UNIDIRECTIONAL (2 WIRES) CONNECTION

RADIO MODULE **Code ETRHY.0001**	WHITE YELLOW GREEN BROWN	WHITE BROWN	SINGLE REED SENSOR **Code 2.51.0010, code 2.51.0016, code 289C061A**
BIPOLAR CONNECTOR **Code 5912254B**			
RADIO MODULE White = Pulses Yellow = Direction Green = Fraud Brown=Ground			SINGLE REED SENSOR White = Reed Pulse Brown = Ground

COLLEGAMENTO MONODIREZIONALE + ANTIFRODE (3 FILI)



MODULO RADIO

Bianco	= Impulsi
Giallo	= Direzione
Verde	= Frode
Marrone	= Massa

SENSORE DOPPIO REED

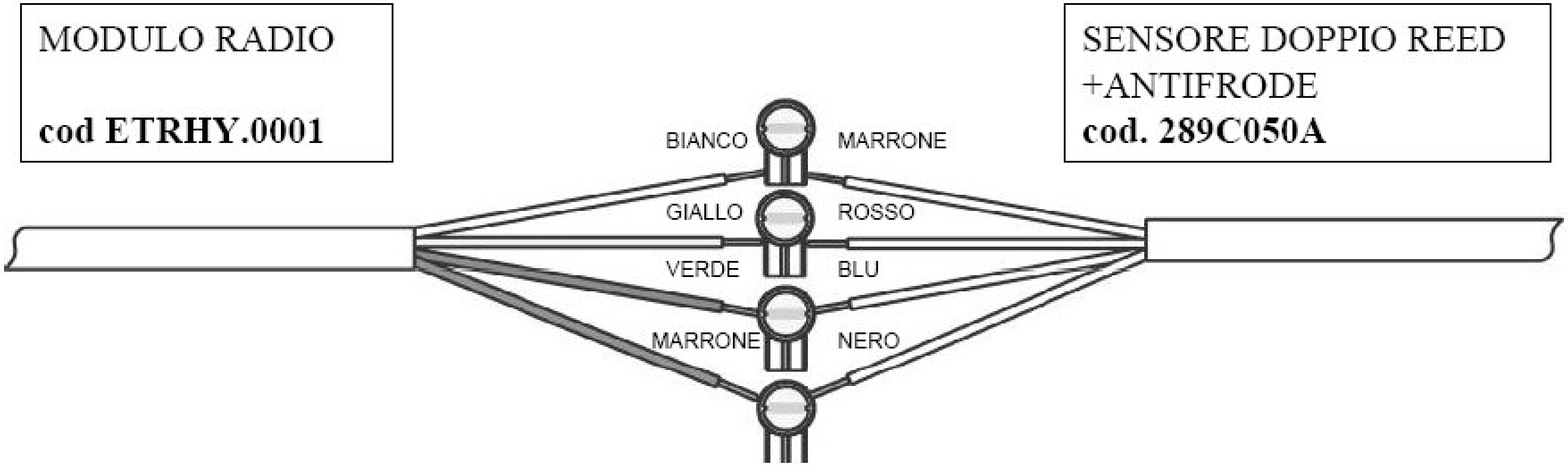
Rosso	= Reed Down
Marrone	= Reed UP
Blu	= Frode
Nero	= Massa

UNIDIRECTIONAL/ANTIFRAUD (3 WIRES) CONNECTION

RADIO MODULE **Code ETRHY.0001**	WHITE YELLOW GREEN BROWN	RED BROWN BLUE BLACK	DOUBLE REED SENSOR + ANTIFRAUD **Code 289C050A**
			UNIPOLAR CONNECTOR **Code 5912252B**
RADIO MODULE White = Pulses Yellow = Direction Green = Fraud Brown=Ground			DOUBLE REED SENSOR Red = Reed Down Brown = Reed UP Blue = Fraud Black = Ground

7.6.3. Double reed sensor – Arrow radio module wiring diagram

COLLEGAMENTO BIDIREZIONALE + ANTIFRODE (4 FILI)



MODULO RADIO		SENSORE DOPPIO REED	
Bianco	= Impulsi	Marrone	= Reed UP
Giallo	= Direzione	Rosso	= Reed Down
Verde	= Frode	Blu	= Frode
Marrone	= Massa	Nero	= Massa

BIDIRECTIONAL/ANTIFRAUD (4 WIRES) CONNECTION

RADIO MODULE **Code ETRHY.0001**	WHITE YELLOW GREEN BROWN	BROWN RED BLUE BLACK	DOUBLE REED SENSOR + ANTIFRAUD **Code 289C050A**
RADIO MODULE White = Pulses Yellow = Direction Green = Fraud Brown=Ground			DOUBLE REED SENSOR Brown = Reed UP Red = Reed Down Blue = Fraud Black = Ground