100 years Since 1925 SIAP+MICROS Environmental Monitoring Solutions

e022 DA22KE

Data acquisition systems

User's Manual

DA22K and DA22KE Datalogger
Version 2.0.0

Siap+Micros S.p.A.
Via del Lavoro, 1
31020 - San Fior (TV) - ITALY

tel.: +39 0438 491411 - fax: +39 0438 401547
e-mail: info@siapmicros.com
www.siapmicros.com

INDEX

1 Precautions and safety measures

DA22K is a measuring instrument for acquiring electrical quantities, processing and storing them. It consists of two parts: a CPU module for processing and storing data and a base module for acquiring physical measurements and managing the power supply for the entire system.

This equipment complies with the required requirements of the Low Voltage Directive (LVD) 2014/35/EU and the Electromagnetic Compatibility Directive (EMC) 2014/30/EU.

For the safety of the operator, it is necessary to follow the procedures described in this manual and read all notes with special care.

1.1 Intended Use

The DA22K Datalogger is a local management unit for environmental and weather-climate monitoring stations capable of directly interfacing meteorological sensors, analyzers, chemical-physical probes, actuators, etc. It was designed to meet a wide variety of data acquisition, processing and transmission needs, from the simplest, for individual stations, to the most complex for networks of stations of various kinds managed by remote control centers. The construction criteria chosen and in particular the open and modular structure of the control unit allow for considerable application possibilities both in terms of ease of use and configurability, and in terms of versatility and future expandability.
Follow this manual carefully and keep a copy available to operators at all times.

1.2 Warnings

The manufacturer disclaims all liability for failures due to failure to follow instructions, tampering, uses not provided for in this manual, improper use of the instrument, use by untrained operators. Only authorized and trained personnel are allowed access to the instrument for normal operation and maintenance.

General safety standards

- The instrument must be connected to an electrical (or safety) ground.
- The instrument must not operate in the presence of flammable gases, fumes or in any explosive environment.
- Do not remove, replace or modify, any electrical or mechanical parts without permission.
- Do not make any measurement if any abnormality is found in the instrument such as, deformation or breakage.
- Component replacement and interior work should be carried out only by qualified and trained maintenance personnel after disconnecting the main power supply.
- Pay attention to any warning labels against potentially dangerous procedures.

1.3 Handling

To avoid damage to the equipment, always keep it upright during transport without shaking it.

1.4 Unpacking

Be sure to take the following precautions before unpackaging and installing the instrument:

- Use suitable gloves to protect against abrasions, etc.
- If any damage done during transportation at the supplier's expense is found, return the instrument to the supplier.
- Once unpacked, lay the instrument and its component parts on a flat surface.
- Always avoid turning the instrument upside down to safeguard the display.
- Pay attention to the connectors on the front and side of the instrument case during the operation.

Before installing the instrument check that:

- The mains voltage of the installation area is in accordance with the operating conditions of the instrument.
- Check that the main switch of the instrument is turned off.

Avoid turning on the instrument before carefully following the installation and start-up instructions in this manual.

1.5 Procedure for safe powering

The following procedure allows the DA22K control unit to be properly powered by an external power supply or a backup battery.

1. Connect the battery to the power connector at the BATT - GND pins (see Chapter 2).
2. Pay attention to the polarity of the battery: BATT should be connected to the positive terminal and GND to the negative .[1]
3. Connect the external 12V DC power supply to the VCC and GND pins of the power connector (see Chapter 2). The operation must be performed with the power supply turned off.
4. Pay attention to the polarity: VCC should be connected to the positive terminal and GND to the negative.
5. Turn on DA22K powered by battery only, with external power off.
6. Turn on the external power supply.

1.6 During operation

During operation, avoid working on the electrical connections related to analog and digital inputs and power supply connections.

[1] The DA22K is equipped with reverse polarity protection devices. However, it is good to pay attention to the connections.

1.7 Storage

If you do not plan to use the equipment for an extended period of time (at least one year) disconnect all cables from the equipment, place it in a clear plastic bag along with a bag of drying salts, and seal the bag with tape. Appropriately mark the bag with the contents and weight of the equipment by inserting the words "HANDLE CAREFULLY."

Store the instrument in an environment with temperature between 0 and 60 degrees with humidity not exceeding 80%. Ensure that the instrument is stored in a stable position and cannot be damaged or moved by inexperience or distraction. Do not stack other instruments or weights on top of each other. Do not stack the instrument on top of other instruments and in any case ensure the solidity and stability of the underlying support.

1.8 Maintenance

1.8.1 Cleaning the instrument

Disconnect all connecting cables before cleaning the instrument. Use a soft, dry cloth for cleaning. Never use damp cloths, solvents, water or other liquids.

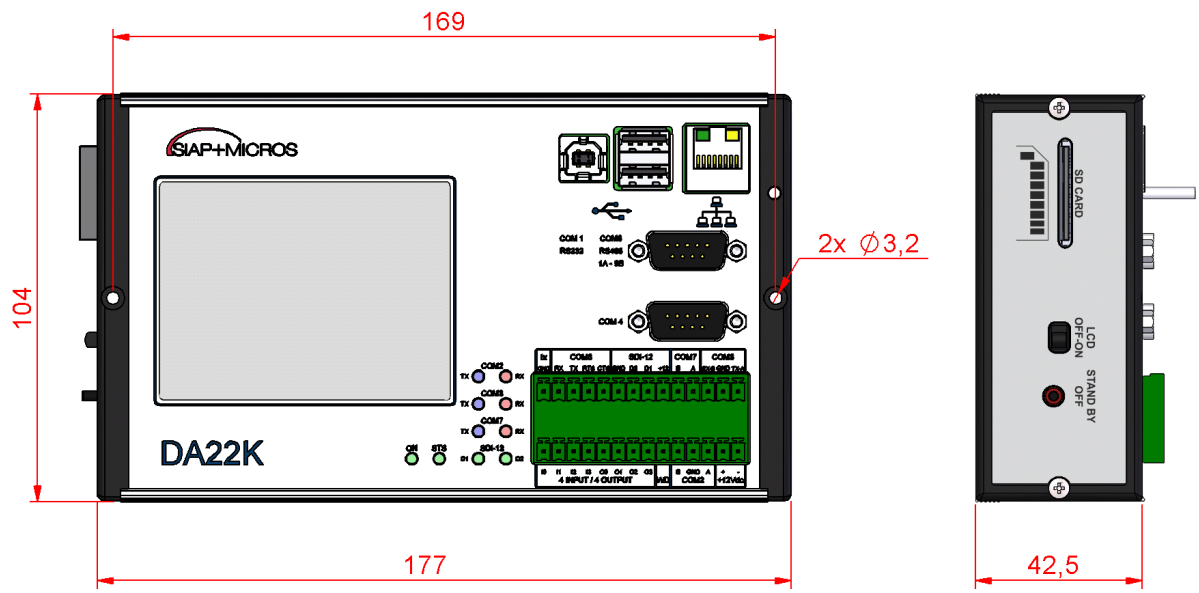
1.8.2 Protections of power lines

The product is equipped on each channel and peripheral with protection devices against electrostatic discharge. The power supplies also have circuitry against reverse polarity and self-resetting overcurrent protection fuses. See Chapter 2 for more details.

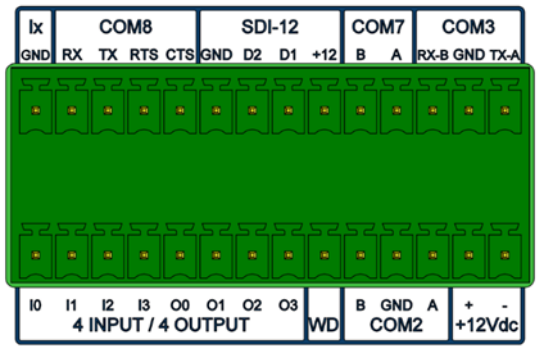
2 Hardware and connections

2.1 Container of processing and storage electronics

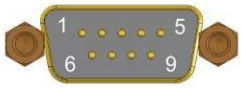
Assembly and dimensions [mm]



Datalogger terminal block layout

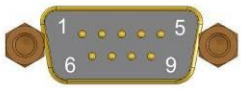


PINOUT COM1 / COM6



2 - RX	1 - A - RS485
3 - TX	9 - B - RS485
5 - GND	
7 - RTS	
8 - CTS	

PINOUT COM4



1 - DCD	6 - DSR
2 - RX	7 - RTS
3 - TX	8 - CTS
4 - DTR	9 - RI
5 - GND	

The container of processing and storage electronics provides:

- A USB Type B connector for connection via USB cable to a PC or terminal with which the datalogger's internal directories can be accessed.
- A USB Type A connector for connecting peripherals such as a keyboard, mouse or Pen-Drive. Although the connector has two ports, only the upper port can be used. Do not connect peripherals on the lower port.
- A UTP connector for connection to a local area network over Ethernet protocol.

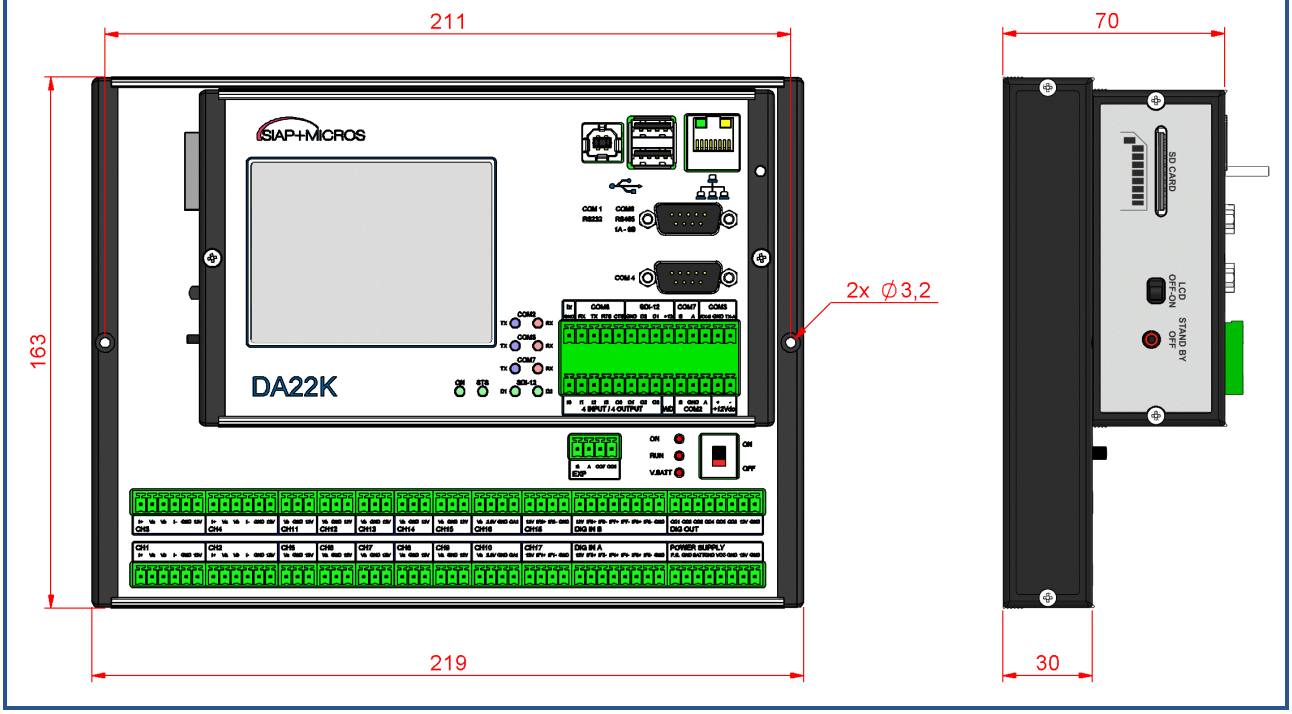
- Two 9-pin male DSUB-type connectors for connecting serial devices such as modems, PCs, sensors and other equipment with RS-232 or RS-485 interface:
    - **COM1**: RS-232 to pins 2, 3, 5, 7 and 8 of the DSUB connector as per the layout image.
    - **COM4**: Full RS-232 with all criteria.
    - **COM6**: RS-485 to pins 1 and 9 of the DSUB connector as per the layout image.
- A 28-pin multifunctional connector for connecting respectively:
    - Possible power supply[2] : two pins for 12Vdc power supply input.
    - **COM2**: Three pins for an RS-485 serial for connecting serial devices such as modems, PCs, sensors, and other equipment with an RS-485 interface.
    - **COM3**: three pins for an RS-485 serial for connecting serial devices such as modems, PCs, sensors and other equipment with an RS-485 interface. By mounting option, COM3 can be converted into an additional RS-232.
    - **SDI-12**: Four pins for two independent ports for connecting peripheral devices with standard SDI-12 protocol. The port consists of a 12V power supply, two data lines D1 and D2, the ground. D1 and D2 are seen as two SDI-12 serial **COM5** and **COM9**, respectively.
    - **COM7**: Two pins for an RS-485 serial for connecting serial devices such as modems, PCs, sensors, and other equipment with an RS-485 interface.
    - **COM8**: Four pins for an RS-232 serial with flow control (RTS/CTS) for connecting serial devices such as modems, PCs, sensors, and other equipment with an RS-232 interface.
    - Watch-dog: a watch-dog signal to the outside world.
    - **Digital outputs**: No.4 *Open Collector* digital outputs.
    - **Digital inputs**: No.4 opto-isolated digital inputs.
    - **Isolated** ground: an isolated reference ground for digital inputs.
- An SD (Sicure Digital) connector for inserting an industrial SD-type memory used by the program to back up recorded data.
- A display backlight switch (forces the display backlight to turn off).
- A button for forced exit from the *Suspend* state of the datalogger.
- Ten LEDs representing respectively:
    - ON, green LED indicating power status.
    - STS, green LED flashing if the datalogger application is in cycle.
    - D1, green LED indicating transmission/reception on SDI-12 COM5
    - D2, green LED indicating transmission/reception on the SDI-12 COM9
    - TX, blue LED, and RX, red LED of COM2 indicating the status of the serial transmit and receive lines.

[2] Only in case the power supply does not come from the base module.

- TX, blue LED, and RX, red LED of COM3 indicating the status of the serial transmit and receive lines.
- TX, blue LED, and RX, red LED of COM7 indicating the status of the serial transmit and receive lines.

2.2 Container of acquisition electronics and power management

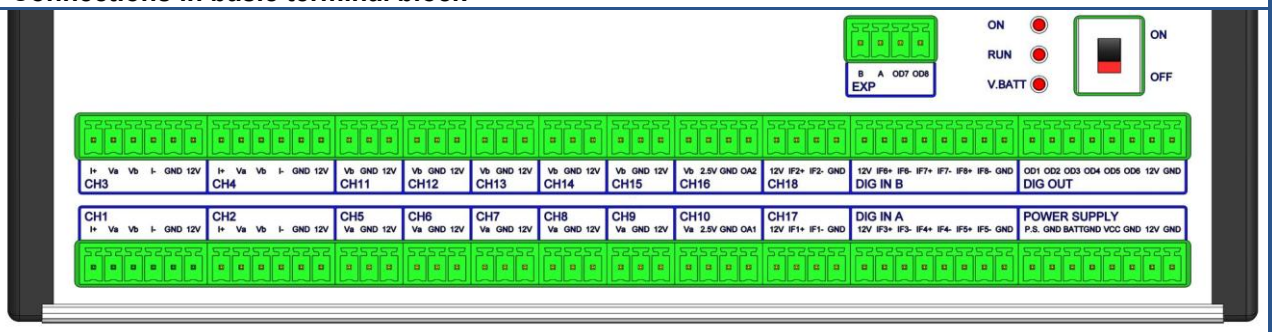
Mounting and Dimensions [mm]



DA22K is available in two versions that differ in the number of analog/digital inputs on the capture board: a basic DA22K version, and an expanded DA22KE version.

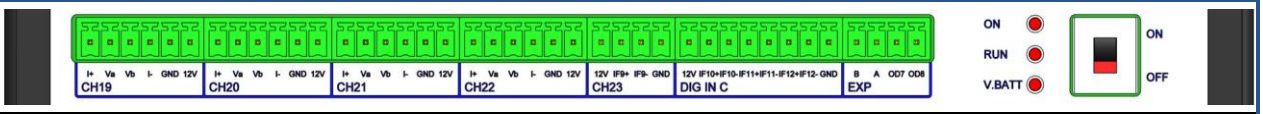
Briefly described here are the terminal blocks that will be discussed in more detail in the sections of the following paragraphs.

Connections in basic terminal block



CH1 to CH4: Analog inputs (24 bits)	CH5÷CH9, CH11÷CH15: Analog inputs (24 bits)
• A differential input (Va - Vb) • Two inputs referenced to ground (Va - GND, Vb - GND) • One PT100 input (I+ - Va - Vb - I-) • V_{ALM}sensor power supply	• One differential input on each pair of connectors (Va - Vb) (CH5/CH11, CH6/CH12, CH7/CH13, CH8/CH14, CH9/CH15) • One input referred to ground on single connector (Va - GND, Vb - GND) • V_{ALM}sensor power supply
CH10, CH16: Analog inputs 24 bit, analog outputs 12 bit	**CH17, CH18: Opto-isolated digital inputs**
• One differential input on each pair of connectors (Va - Vb) (CH10/CH16) • One input referred to ground on single connector (Va - GND, Vb - GND) • Precision reference voltage 2.5V - 25mA (e.g., potentiometric wind direction sensor) • Analog output 0 - 2V, 12 bit	• Frequency • Counter • Logical state • V_{ALM}sensor power supply
DIG IN A, DIG IN B: Opto-isolated digital inputs.	**DIG OUT: Open drain digital outputs and power outputs.**
• Frequency • Counter • Logical state • V_{ALM}sensor power supply	• Open drain digital output • $V_{(SWT)}$ power output at shutdown
EXP: RS-485 and open drain digital outputs	**POWER SUPPLY: Power supplies.**
• RS-485 • Open drain digital outputs	• Solar Panel Input (SP - GND) • Battery input (BATT - GND) • External power input (VCC - GND) • $V_{(PWR)}$ power output (12V - GND)

Additional connections in expanded terminal block (only for DA22KE)



CH19 TO CH22 : Analog inputs (24 bits)	CH23 : Opto-isolated digital inputs
• A differential input (Va - Vb) • Two inputs referenced to ground (Va - GND, Vb - GND) • One PT100 input (I+ - Va - Vb - I-) • V_{ALM}sensor power supply	• Frequency • Counter • Logical state • V_{ALM}sensor power supply
DIG IN B: Opto-isolated digital inputs.	**DIG IN C: Opto-isolated digital inputs.**
• Sinusoidal input (IF7 - IF8)	• Frequency • Counter • Logical state • Sinusoidal inputs (IF11 - IF 12) • $V_{(ALM)}$ sensor power supply

In the tables above consider that:

- VALM is a fixed voltage of value equal to the battery voltage with current limitation of 200 mA
- VPWR is a fixed voltage of value equal to the battery voltage with current limitation of 2.5 A
- VSWT is a voltage that is normally present but can be switched off on command, equal in value to the battery voltage with current limitation of 2.5 A

In addition to the terminal blocks just described, there is an ON/OFF switch and three status LEDs with the following meanings on the case:

- ON flashes with each measurement cycle
- RUN indicates the status of the internal watch-dog
- VBATT indicates the charge status of the backup battery (1 blink indicates the battery is low, 5 blinks indicate the battery is fully charged).

Regarding the POWER SUPPLY connector, multiple power sources can be used; the datalogger will then handle any redundancy. It is indeed possible to connect, for example, the PS solar panel simultaneously to the external 12VDC power input. It will then be the datalogger that will charge the battery through the solar panel or through the 12VDC input in case of no insolation.

The next sections detail the electrical and measurement characteristics of the various functional sections available in the terminal block.

2.3 Feeds

The power supply section includes the connector named POWER SUPPLY and is capable of handling three possible power sources:

- Solar panel
- 12V lead-acid battery
- 12V nominal bench power supply

The solar panel input is marked by the **P.S.** (positive) and **GND** (negative) terminals and has the main function of maintaining the charge on the supply lead-acid battery. Solar panels are supported for charging 12V batteries, with power up to 100W. Under solar irradiation, the battery charging circuit forces the panel to work at the voltage of about 15.2V and is capable of delivering up to 5A on the battery. The panel input is also equipped with:

- Reverse polarity protection circuit
- Low-pass filtering
- Electrostatic discharge protection circuit up to 30kV with peak power of 160W and IEC 61000-4-2 standards; level 4 (ESD); IEC 61000-4-5 (surge); IPP = 2.5 A; AEC-Q101

The battery input is marked by the **BATT** (positive) and **GND** (negative) terminals and has the function of supplying power to the datalogger. A lead-acid battery with a nominal voltage of 12V can be connected to these terminals. The battery input also has:

- Reverse polarity protection circuit

- Electrostatic discharge protection circuit up to 30kV with peak power of 160W and IEC 61000-4-2 standards; level 4 (ESD); IEC 61000-4-5 (surge); IPP = 2.5 A; AEC-Q101

The bench power supply input is marked by the terminals **VCC** (positive) and **GND** (negative) and has the function, jointly with the battery, of supplying power to the datalogger. A bench power supply with a nominal voltage of 12V and in any case less than 15V can be connected to these terminals. The input is also equipped with:

- Reverse polarity protection circuit
- Electrostatic discharge protection circuit up to 30kV with peak power of 160W and IEC 61000-4-2 standards; level 4 (ESD); IEC 61000-4-5 (surge); IPP = 2.5 A; AEC-Q101

Finally, there is a power output supply on the connector that equals in value the battery voltage, which is useful for powering current-consuming equipment such as radio modems and the like. The output is always present and marked by the **12V** (positive) and **GND** (negative) terminals. Special features of the output are:

- Current limitation of 2.5 A with protection by resettable fuse
- Electrostatic discharge protection circuit up to 30kV with peak power of 160W and IEC 61000-4-2 standards; level 4 (ESD); IEC 61000-4-5 (surge); IPP = 2.5 A; AEC-Q101

Other output voltages, always identical in absolute value to the supply voltage, are present, with different amperages, on each connector.

Specifically at the DIG OUT connector at the **12V** (positive) and **GND** (negative) terminals is a power supply with characteristics and amperage identical to the power supply just described with the only peculiarity that this output can be turned off at will with a MODBUS command.

On all other connectors there is an output supply, marked as **12V**, which equals the battery voltage in absolute value and has the following characteristics:

- Current limitation of 200 mA with protection by resettable fuse
- Electrostatic discharge protection circuit up to 30kV with peak power of 160W and IEC 61000-4-2 standards; level 4 (ESD); IEC 61000-4-5 (surge); IPP = 2.5 A; AEC-Q101

These low-power supplies are particularly useful for powering sensors that need to be acquired.

2.4 PT100 inputs

The DA22K control unit has four inputs with Pt100 acquisition capabilities at connectors CH1, CH2, CH3 and CH4. In the expanded version, DA22KE, there are an additional four inputs at connectors CH19, CH20, CH21 and CH22 that can increase the acquisition capabilities of the control unit to a maximum of eight Pt100 resistance thermometers . [3]

Measurement of the resistance thermometer value is done with the four-wire technique and involves terminals **I+** (generation of excitation current), **Va** and **Vb** (measurement of voltage at the ends of the resistance thermometer), **I-** (return of excitation current). The resistance thermometer should be connected with one end to I+ and Va and the other end to I- and Vb. Specifically, at each acquisition cycle a pulse current[4] is generated at terminal I+, which, flowing over the resistance thermometer, creates a measured

[3] Pt100s are acquired on differential channels therefore each Pt100 inserted removes one differential channel from the total number of available channels

[4] Active only for the measurement cycle so as not to alter the thermal conditions of Pt100 by Joule effect

potential drop between inputs Va and Vb. The current closes on I- and generates a reference for radiometric measurement of the potential drop on the resistance thermometer.

Each Pt100 input also has the following features:

- Electrostatic discharge protection circuit up to 20kV with peak power of 25W and IEC 61000-4-2; level 4 (ESD); IEC 61000-4-5 (surge) standards; IPP = 2.5 A on both measurement inputs and current return for reference generation.
- Differential low-pass filtering with 530Hz cutoff frequency
- Common mode low-pass filtering with a cut-off frequency of 780Hz
- 24 bit resolution

2.5 Analog Inputs

The control unit is equipped with a number of 24-bit analog inputs, denoted on the connectors with Va and Vb that are acquired either individually referenced to ground or in pairs as differential inputs Va - Vb. Specifically, the DA22K version has a total of 20 analog inputs referenced to ground that can be acquired as 10 differential inputs on connectors CH1 to CH16. The DA22KE expansion adds another 8 ground-referred inputs that can be acquired as 4 differential inputs at connectors CH19, CH20, CH21 and CH22. All inputs have the following characteristics:

- Electrostatic discharge protection circuit up to 20kV with peak power of 25W and IEC 61000-4-2; level 4 (ESD); IEC 61000-4-5 (surge) standards; IPP = 2.5 A on both measurement inputs and current return for reference generation.
- Differential low-pass filtering with 530Hz cutoff frequency
- Common mode low-pass filtering with a cut-off frequency of 780Hz
- 24 bit resolution

We will now consider the three connector types for 6-, 3- and 4-pin analog inputs to better explain the connection possibilities.

2.5.1 Analog inputs on 6-pin connector

The connectors of this type are CH1, CH2, CH3 and CH4; however, the DA22KE expansion version has the additional connectors CH19, CH20, CH21 and CH22. These are 6-pin multifunction connectors in which it is possible to connect alternatively to each other,

- A Pt100-type resistance thermometer at terminals I+, Va, Vb, I-.
- A differential voltage signal between Va (positive) and Vb (negative)
- Two signals referenced to ground Va and Vb

Please refer to the DA22K technical specifications for electrical limits.

There is also a low-power (200 mA) 12V power supply on these connectors as described in the previous paragraphs to which we refer for details.

2.5.2 Analog inputs on 3-pin connector

The connectors of this type are CH5, CH6, CH7, CH8, CH9, CH11, CH12, CH13, CH14 and CH15; the DA22KE expansion version has the same connectors of this type.

There is also a low-power (200 mA) 12V power supply on these connectors as described in the previous paragraphs to which we refer for details.

In addition to the two power supply terminals mentioned above, each connector has the left terminal, denoted Va or Vb, which is an analog input referenced to ground. However, it is possible to use the connectors in pairs of two to acquire differential signals. In particular, the pairs CH5 - CH11, CH6 - CH12, CH7 - CH13, CH8 - CH14 and CH9 - CH15 can be used to connect a differential signal. In that case Va indicates the positive signal terminal and Vb the negative terminal.

2.5.3 Analog inputs on 4-pin connector

The connectors of this type are CH10 and CH16 and are quite similar to the 3-pin connectors in terms of the functionality of the Va and Vb inputs and their mode of use. A peculiarity of this type of connectors is the presence of:

- **Reference voltage**

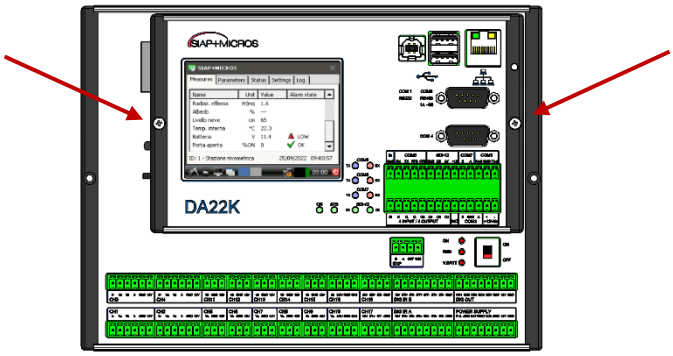
  On both connectors the **2**.5V terminal denotes a 2.5V reference useful for measuring, for example, signals reported by potentiometer such as wind direction.

- **Analog output**

  On CH10, terminal **OA1** denotes a 12-bit 0 - 2.5V analog output that can be set by MODBUS command. On CH16 the similar terminal is denoted by **OA2**.

2.5.4 Analog inputs configurable in 4 - 20 mA

The DA22K datalogger, as well as the DA22KE, has four of the described analog inputs that can be configured to acquire 4 - 20mA current signals without resorting to external precision resistors. Such resistors, with a value of 100Ω, are in fact already included in the DA22K allowing a conversion of 4 - 20mA current signals to 0.4 - 2V voltage signals. The channels set up for such functionality are CH8, CH9, CH14, and CH15. In order to enable the resistor, the user must proceed by unscrewing the processing electronics case from the one below (see figure below). Four switches will then be accessed, each of which enables the resistor on the relevant acquisition channel.



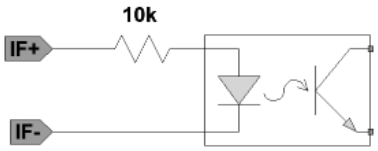
2.6 Digital Inputs

The ECU acquisition base has eight digital inputs at connectors CH17, CH18, DIG IN A and DIG IN B. The inputs are intended to be in pairs so the pair (IF1+ ÷ IF1-) on CH17 is an input and so on for all others.

Distinctive features of these inputs are:

- Pair of opto-isolated inputs with an isolation voltage of $5KV_{RMS}$
- Internal limiting resistor of 10kΩ
- Acquired automatically with cadence of the second as
    - Frequency
    - Count
    - Logical state

The principle diagram of the input is shown in the next figure.



The input type makes it possible to acquire either square-wave signals, connecting IF- to ground and IF+ to the positive signal, or dry contacts. In the latter case, it is necessary to bring a supply voltage to IF+ to polarize the photo emitter and connect the dry contact to IF-. For this purpose the 12V supply is brought to the connectors. For example, a dry contact connected on CH17 will have to be bridged between the **12V** terminal and the **IF1+** terminal, the dry contact can then be connected between **IF-** and **GND**. When the contact is open, no current flows on the photo diode and the signal transmitted to the datalogger is read as logic high state because of internal pull-ups. When the contact closes to ground, a current flows on the photo diode and the signal transmitted to the datalogger is read as logic low state.

In the case of datalogger with DA22KE expansion, one still has eight opto-isolated digital inputs like the previous ones to which one adds four comparator inputs for sensors in AC[5] (with variable reluctance for example); these inputs, however, are positioned differently on the connectors concerned. Specifically, the channels are divided among the connectors as follows:

- CH17
    - IF1 opto isolated digital input
- CH18:
    - IF2 opto isolated digital input
- DIG IN A:
    - IF3, IF4 and IF5 opto isolated digital inputs
- DIG IN B
    - IF6 opto isolated digital input
    - IF7, IF8 differential comparator inputs
- CH19:
    - IF9 opto isolated digital input

[5] For example, variable reluctance sensors such as some wind speed sensors

- DIG IN C:
    - IF10 opto isolated digital input
    - IF11, IF12 comparator differential inputs

The opto-isolated inputs have already been discussed while the other type of input features a differential comparator that, given a sine wave input, produces a square wave of equal frequency that is used for acquisition. This particularity makes it possible to accommodate passive sensors such as some wind speed sensors with sine wave output. As with the opto-isolated inputs, these inputs can also be read as frequency, count or logic state and are equipped with a protection circuit against electrostatic discharge up to 23kV with peak power of 500W and IEC 61000-4-2 level 4 (ESD), IEC 61000-4-5 (surge) Ipp = 18 A standards.

In addition to all these inputs, there are four other inputs on the 28-pin connector of the processing and control part of the control unit. These inputs are also opto-isolated with an isolation voltage of 3.75kV but can only be read as status inputs.

To recap, the DA22K offers 8 opto-isolated mixed (frequency, count, status) and 4 opto-isolated status digital inputs. The expansion adds to these inputs another 4 mixed (frequency, count, status) digital inputs for sinusoidal inputs.

2.7 Digital Outputs

The ECU acquisition base is equipped with eight open drain type digital outputs, six on the DIG OUT connector and two on the EXP connector. Each digital output has the following characteristics:

- Open drain type with 1Ω limiting resistor - 0.25W
- Maximum current 500mA
- Electrostatic discharge protection circuit up to 25kV with peak power of 350W and IEC 61000-4-2 (ESD) 15 kV (air) 8 kV (contact), IEC 61000-4-4 (EFT) 40 A (5/50 ns), IEC 61000-4-5 (lightning) 23 A (8/20 µs) standards.

There are an additional four digital outputs, O0, O1, O2, O3 with the characteristics, on the 28-pin connector of the processing and control unit:

- Open collector type
- Maximum current 100 mA
- Electrostatic discharge protection circuit up to 30kV with peak power of 200W and IEC 61000-4-2 (ESD) 30 kV (air) 30 kV (contact), IEC 61000-4-4 (EFT) standards

2.8 Connectivity

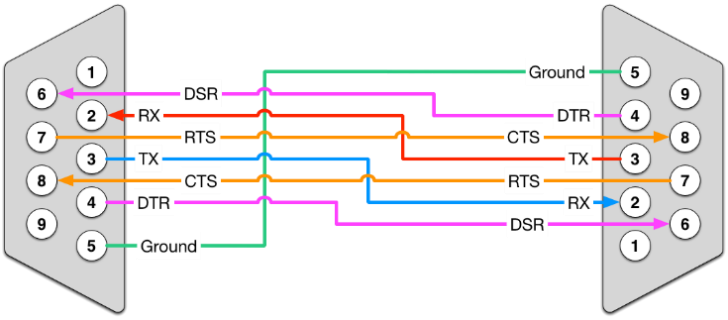
The DA22K has a wide range of communication devices such as RS-232, RS-485, Ethernet, USB, etc... In the following sections, the features of the various communication interfaces present will be analyzed.

2.8.1 RS-232 serial interfaces with criteria: COM1, COM4, COM8

The control unit is equipped with three RS-232 type serial interfaces with criteria, that is, in addition to transmitting and receiving, they have carried on the interface connector other control signals. These are:

- **COM1:** 9-pin DSUB connector to which pins 2, 3, 5, 7 and 8 of the connector are carried i.e., signals: RX, TX, GND, RTS, CTS.
- **COM4:** 9-pin DSUB connector to which all connector signals are carried viz: DCD, RX, TX, DTR, GND, DSR, RTS, CTS, RI.
- **COM8:** This is part of the 28-pin connector and has carried the signals RX, TX, RTS, CTS.

On these it is possible to connect communication devices such as cellular modems, radio interfaces, etc... They can also be used for direct connection to a configuration terminal such as a personal computer. In the latter case, the datalogger and the computer must be connected via a NULL MODEM type cable, i.e., with the two ends both female 9-pin DSUB type and with pins two and three reversed so that the computer's transmission comes to the datalogger's reception and vice versa.



Regarding protections, each RS-232 serial port is equipped with a 15kV electrostatic discharge protection circuit (IEC 61000-4-2 Air Gap and Human Body Model).

2.8.2 RS-485 serial interfaces: COM2, COM6, COM7

The datalogger has three serial communication interfaces entirely dedicated to connecting devices in RS-485:

- **COM2**
  It is part of the 28-pin connector and has A, B and ground signals carried. B has a pull down of 4.7kΩ to ground while A has a pull up of 4.7kΩ to the internal power supply. This interface is also carried internally on the lower acquisition base at the EXP connector, terminals **B** and **A**, and is used by the processing and storage unit to retrieve acquired data from the acquisition base.
- **COM6**
  It is part of a 9-pin DSUB connector, the same as COM1, where at pin 1 we have A and at pin 9 B. B has a pull down of 4.7kΩ to ground while A has a pull up of 4.7kΩ to the internal power supply.
- **COM7**
  It is part of the 28-pin connector and has A and B signals carried. B has a pull down of 4.7kΩ to ground while A has a pull up of 4.7kΩ to the internal power supply.

The interfaces can be used to acquire sensors or to communicate with devices with an RS-485 interface. The interfaces are equipped with protection circuitry against electrostatic discharge. Specifically:

- Protection circuits against electrostatic discharge up to 30 kV with reference standards IEC 61000-4-2 ±30 kV contact discharge, ± 30 kV air discharge, AEC-Q101: human body model class H3B > 8 kV are provided on the 28-pin connector and DSUB.
- There is a protection circuit on the EXP connector against electrostatic discharge up to 30 kV and IEC 61000-4-2 (ESD) 30 kV (air) 30 kV (contact), IEC 61000-4-4 (EFT) 50 A (5/50 ns), IEC 61000-4-5 (lightning) 19 A (8/20 µs) standards.

2.8.3 RS-232 and RS-485 hybrid serial interfaces: COM3

The DA22K is equipped with a hybrid serial port, COM3, which can be either RS-485 or RS-232; the choice must be specified at the time of ordering since, normally, this port is configured as RS-485 while the RS-232 configuration is optional. The corresponding terminals on the 28-pin connector of the processing and testing unit are:

- **RX -** B: B (negative) of RS-485 or reception of RS-232 if required.
- **GND**: ground
- **TX -** A: A (positive) of RS-485 or transmission of RS-232 if required.

Any pull ups and pull downs should be inserted externally.

The interface, when used as RS-485, is equipped with a protection circuit against electrostatic discharge up to 30 kV with reference standards IEC 61000-4-2 ±30 kV contact discharge, ± 30 kV air discharge, AEC-Q101: human body model class H3B > 8 kV.

If it is used as RS-232, it is equipped with a 15kV electrostatic discharge protection circuit (IEC61000-4-2 Air Gap and Human Body Model).

2.8.4 SDI-12 interfaces: COM5, COM9

There are two communication interfaces on the 28-pin connector for sensor acquisition according to the SDI - 12 communication standard. The interfaces consist of the terminals:

- **+12**: 12V nominal sensor power supply with 100mA limitation according to the standard
- **D1**: COM5 data line at 5V.
- **D2**: COM9 data line at 5V.
- **GND**: power supply ground.

The given 5V line, as prescribed by the standard, is left in high impedance via a tristate buffer when not in use. This line also has an electrostatic discharge protection circuit up to 30 kV with reference standards IEC 61000-4-2 ±30 kV contact discharge, ± 30 kV air discharge, AEC-Q101: human body model class H3B > 8 kV.

2.8.5 Network interface

There is an Ethernet connector to which is connected a 10/100 Mbps base-T network card managed at a low level by the operating system. The electrostatic discharge immunity characteristics for this interface are:

- ± 4 kV Human Body Model according to ANSI/ESDA/JEDEC standard JS-001
- ± 1 kV Charged Device Model according to JEDEC specification JESD22-C101

2.8.6 USB host interfaces

There is a female USB Host Type A interface to which devices such as storage Pen-Drives, keyboard, mouse, etc. can be connected...

The interface is equipped with a dedicated transient voltage suppression circuit specific to USB signal characteristics. The circuit is also protected against electrostatic discharge up to 15 kV according to IEC 61000-4-2 standards and in particular

- ± 15 kV Human Body Model
- ± 2 kV Machine Model

2.8.7 USB slave interfaces

There is a USB Slave type B female interface for connection and access to the datalogger file system. The interface has a dedicated transient voltage suppression circuit specific to the USB signal characteristics. The circuit is also protected against electrostatic discharge up to 15 kV according to IEC 61000-4-2 standards and in particular

- ± 15 kV Human Body Model
- ± 2 kV Machine Model

2.9 External storage units and display units

During the normal cycle of use, collected data are stored in a database archive in the device's internal memory (non-volatile memory flash). However, it is also possible to make a copy of the data on removable external storage media (data backup).

On the left side of the datalogger is the connector that can accommodate an SD Card storage device; this is automatically managed by the operating system, which recognizes it as an external disk drive[6] . Should it be necessary to increase the overall storage capacity, there is an internal SD Card connector with the same type of use. It is also possible to insert a USB Flash Drive mounted on the USB Host connector and use it as a data storage drive[6].

In terms of display, there is a 3.5-inch TFT - LCD touchscreen display with 320 x 240 resolution and 16 million colors. The display is a transmissive type with white backlight . [7]

The display provides a graphical interface to the Linux operating system and allows user interaction with the management program. More details are provided in the following chapters.

[6] The larger the capacity of the storage device (SD Card or USB Flash), the longer the initial recognition will take.

[7] If not driven it is normally white.

3 User's guide and configuration

The following chapter provides a comprehensive overview of the configuration and use of the DA22K control unit. In particular, it describes the architecture of the operating system and the functionality of the integrated management software (datalogger application). The latter implements the main functions of a datalogger, including acquisition from measurement sensors, logging of processed data, and their transmission via communication peripherals.

3.1 Operating system

DA22K is a device equipped with Linux Embedded Yocto Project vers 4.0 LTS (Kirkstone) system.

The operating system is preloaded on the following internal media:

- **SD Card**
  Removable memory support industrial grade SD Card (capacity: 1GB)

Instead, the datalogger application and data archives reside on the following drive:

- **NAND Flash**
  Internal non-volatile NAND flash memory support (capacity: 256MB)

Application management files are located in the default folder: **/mnt/nandflash/da20k**

List of files:

- **arc** Data archives folder (.db)
- **log** Log file folder (.log)
- **ftp** Support folder for FTP transfer.
- **ini.xml** Initialization file.
- **cnf.xml** Configuration file.
- **da20k** Datalogger management application (firmware).
- **start.sh** Startup script-shell.

3.1.1 Startup

The datalogger management application (***da20k*** firmware) is started automatically after the operating system has finished loading, thanks to a link to the shell script ***start.sh.*** On first startup, the system automatically creates the subfolders required for proper operation. Any additional processes required by the datalogger are also started automatically during the boot phase.

Booting embedded Linux

Wait for the operating system and application to start up for about 2 minutes after which the display will show the main page of the GUI (ref. par *3.2 Display pages*).

3.1.2 Remote connection

One can connect on the LAN network card via **SSH** (Secure Shell) access to the following host name:
da22k@192.168.1.5

Terminal use:

```
ssh da22k@192.168.1.5
```

For better control over system settings, it is advisable to use software that allows remote connection via SSH or SFTP protocol, providing a graphical interface to explore and manage files.

For example, **WinSCP** is a graphical SFTP client for Microsoft Windows that allows you to browse and transfer files to the remote device via SSH protocol.
To connect to the DA22K datalogger:

1. Open WinSCP.
2. Create the remote site to connect to by entering the following information:
   - **Protocol**: SFTP
   - **Server**: 192.168.1.5
   - **Door**: 22
   - Username: da22k
   - **Password**: ********
3. Press "**Sign In**" to connect and browse the contents of the device.

Example of application folder display with WinSCP:

/mnt/nandflash/da20k/

Nome	Dimensione	Modificato	Diritti	Proprietario
..		23/09/2024 15:19:49	rwxr-xr-x	root
arc		25/09/2024 13:19:00	rwxr-xr-x	root
log		25/09/2024 02:00:05	rwxr-xr-x	root
ftp		23/09/2024 15:31:13	rwxr-xr-x	root
cnf.xml	9 KB	23/09/2024 15:56:54	rw-r--r--	root
ini.xml	1 KB	23/09/2024 10:00:00	rw-r--r--	root
da20k	1 474 KB	20/09/2024 18:32:17	rwxr-xr-x	root
start.sh	2 KB	26/06/2024 11:00:00	rw-r--r--	root
openvpn.sh	1 KB	08/11/2023 08:00:00	rw-r--r--	root
resolv.conf.head	1 KB	04/08/2023 10:00:00	rw-r--r--	root

(*)Note: The device's SSH server is enabled to listen only on the local address.
Changes to SSH settings are possible within the configuration file: /etc/ssh/sshd_config

3.1.3 Network configuration

The datalogger network card setting (**eth0** interface) is defined within the Linux network interfaces configuration file located at the path: /etc/network/interfaces

The eth0 interface is normally configured with the default static IP address: **192.168.1.5**

/etc/network/interfaces

```
# Configurazione delle interfacce di rete

# Abilita l'interfaccia eth0 all'avvio
auto eth0

# Configurazione dell'interfaccia eth0 con un indirizzo IP statico
iface eth0 inet static
    address 192.168.1.5        # Indirizzo IP del dispositivo
    netmask 255.255.255.0      # Maschera di rete
    network 192.168.1.0        # Indirizzo di rete
    gateway 192.168.1.1        # Gateway predefinito
    dns-nameservers 8.8.8.8 8.8.4.4  # Server DNS
```

Configuration details:

- **auto eth0**: Indicates that the eth0 interface will be activated automatically at system boot.
- **iface eth0 inet** static: Specifies that the eth0 interface uses a static IPv4 address.
- **address 192.168.1.5**: Sets the IP address of the device to 192.168.1.5.
- **netmask 255.255.255.0**: Defines the netmask, which determines which IP addresses belong to the same network.
- **network 192.168.1.0**: Specifies the network address, which represents the local network.
- **gateway 192.168.1.1**: Sets the default gateway (used to route traffic to external networks).
- dns-nameservers **8.8.8.8 8.8.4.4**: Indicates the DNS servers to be used for name resolution. In this case, Google's public DNS servers are used.

If you want the IP address to be assigned dynamically via **DHCP**, use the following configuration:

```
# Configurazione delle interfacce di rete

# Abilita l'interfaccia eth0 all'avvio
auto eth0

# Configura eth0 per utilizzare DHCP
iface eth0 inet dhcp
```

3.1.4 Modem configuration

The modem configuration allows the connection to the Internet to be established through the use of a modem for **3G/4G** mobile networks.

The modem is normally connected on the COM4 port of the datalogger. The default settings for the modem serial port are:

- **Baud Rate:** 38400 bps
- **Data Bits:** 8
- **Parity:** None
- **Stop Bits:** 1

To establish the connection, the system uses the **Point-to-Point Protocol (PPP)** by generating a network interface called **ppp0**.

The files for configuring the PPP connection are described below.

PPP (internet) configuration

PPP uses the configuration file found in: /etc/ppp/peers/internet

```
# /etc/ppp/peers/internet

# Parametri generali
debug           # Abilita il debug per log dettagliati
local           # Non utilizza DCD (Data Carrier Detect)

# Parametri modem
/dev/ttySC0     # Seriale COM4 (dove il modem è collegato)
38400           # Velocità seriale (baud rate)

# Parametri di connessione PPP
noauth          # Non richiedere autenticazione locale
defaultroute    # Imposta la rotta predefinita
usepeerdns      # Usa il DNS del provider
connect "/usr/sbin/chat -v -f /etc/chatscripts/dialup -T *99***1#"
```

CHAT connection scripts

Connection script (CHAT)

The PPP configuration invokes a **CHAT** script to initiate the connection with the modem. The phone number for the anonymous connection is passed through the **-T *99***1#** parameter.

The script file is located in: /etc/chatscripts/dialup

```
# /etc/chatscripts/dialup

#ECHO           ON
ABORT           "BUSY"
ABORT           "NO CARRIER"
ABORT           "NO ANSWER"
ABORT           "ERROR"
ABORT           "+CGATT: 0"
TIMEOUT         12
""              ATV1
OK              ATE0
OK              ATH
OK              \d\dATD\T
TIMEOUT         22
CONNECT         ""
```

PPP connection test

To manually activate the PPP connection, run the following command:

```
$ pon internet
```

Once the internet pon command is started, you can verify that the PPP interface is active with the command:

```
$ ifconfig ppp0
```

If the connection was successful, a network interface **ppp0** with an assigned IP address will be displayed:

```
ppp0: flags=4305<UP,POINTOPOINT,RUNNING,NOARP,MULTICAST>  mtu 1500
        inet 10.13.17.172  netmask 255.255.255.255  destination 10.64.64.64
        ppp  txqueuelen 3  (Point-to-Point Protocol)
        RX packets 161  bytes 12224 (11.9 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 176  bytes 9876 (9.6 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

3.1.5 Clock setting

To obtain an accurate time reference, the datalogger has a hardware RTC clock installed on board. The RTC (Real-Time Clock) device is used to periodically synchronize the internal clock of the operating system.

When first turned on, both the system clock and RTC clock may not be set.

To set them up correctly through a connection to the system, proceed as follows:

Setting the system clock

For example, suppose we want to set the date September 23, 2024, 12:30 pm. Use the 'date' command in the following way:

```
$ date -s "2024-09-23 12:30:00"
```

Synchronization with the hardware clock (RTC)

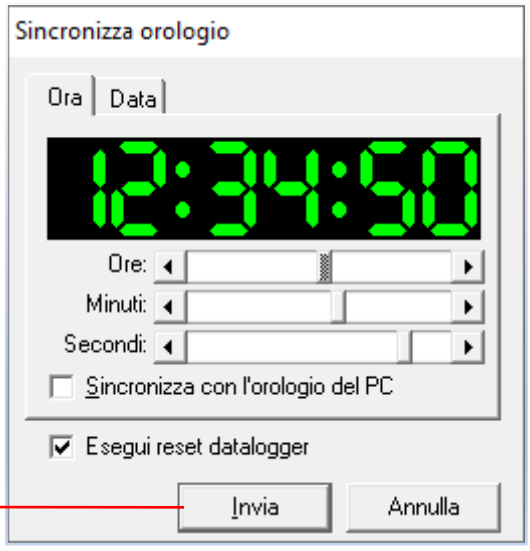
After setting the system clock, it is necessary to synchronize the hardware clock (RTC) with the following command:

```
$ hwclock --systohc
```

The above setup and synchronization procedure can be simplified through the use of **DAK** application software as described below:

Clock setting and synchronization via DAK application

1) Select: *Run - Synchronize Clock*
2) Set the date.
3) Set the time (or select: *Synchronize with PC clock*).
4) Press *Send* and confirm the operation.



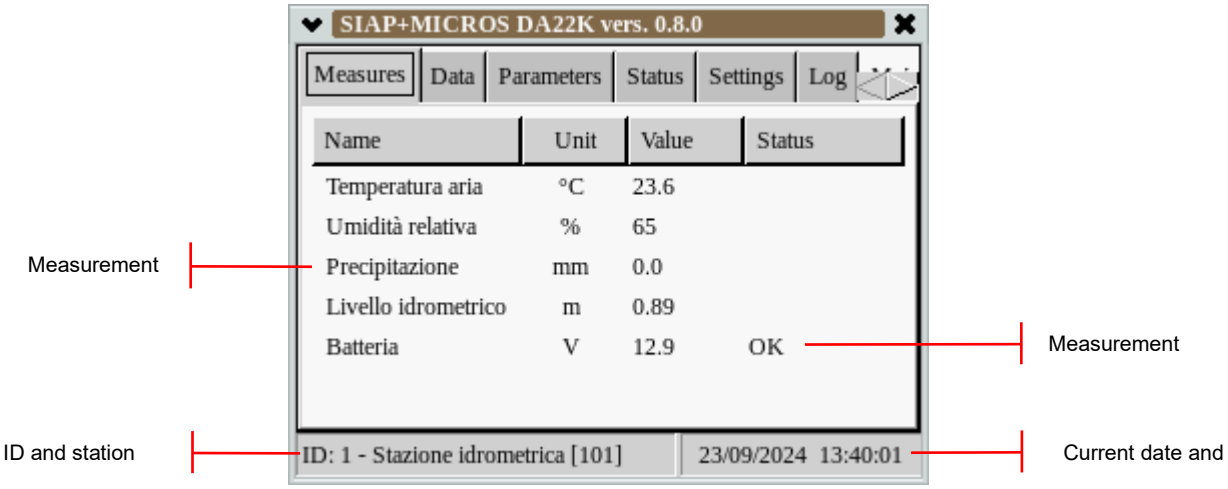
Send date and

3.2 Pages of display

The display of the DA22K control unit has seven graphical pages showing information about the acquired measurements and the status of the datalogger. The data displayed varies according to the settings and configuration loaded. The user can interact with the touch-screen display to navigate between pages and confirm desired actions.

3.2.1 M current isures

The **Measures** page shows the list of sensors being acquired and their respective measurement values in real time. Only the items entered in configuration as display rows are displayed. Refresh of the page normally occurs every 3 seconds.



In detail the fields in the measures list:

- *Name* Measurement Name;
- *Unit* Engineering Unit;
- *Value* Value of the measurement;
- *Status* Status of the measure;

The status is present only if the acquired measurement has an associated alarm check, otherwise it will remain blank. Possible values are:

✓	OK	Value within measuring range
⚠	WARNING LOW / HIGH	Pre-warning measurement low / high
⚠	LOW / HIGH	Measure in minimum / maximum alarm
⊗	ERROR / OVER RANGE	Acquisition error / over range measurement
⚠	STOP	Sensor in maintenance

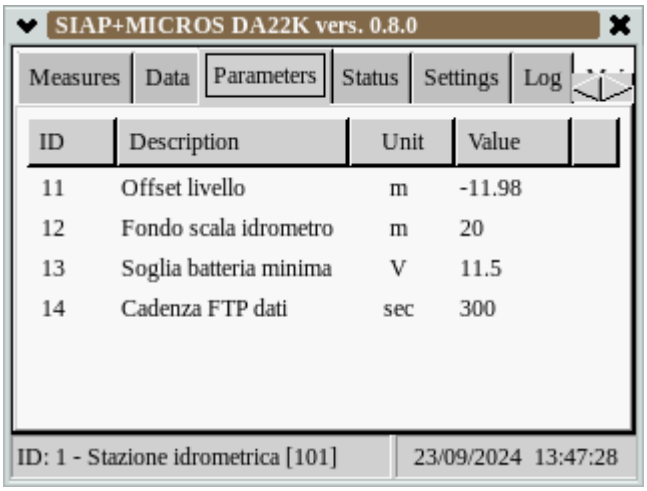
In the lower right part of the window the IDs and station name are always displayed. In the left part the date and time of the datalogger.

3.2.2 Dat i historical

Feature not available in the current version.

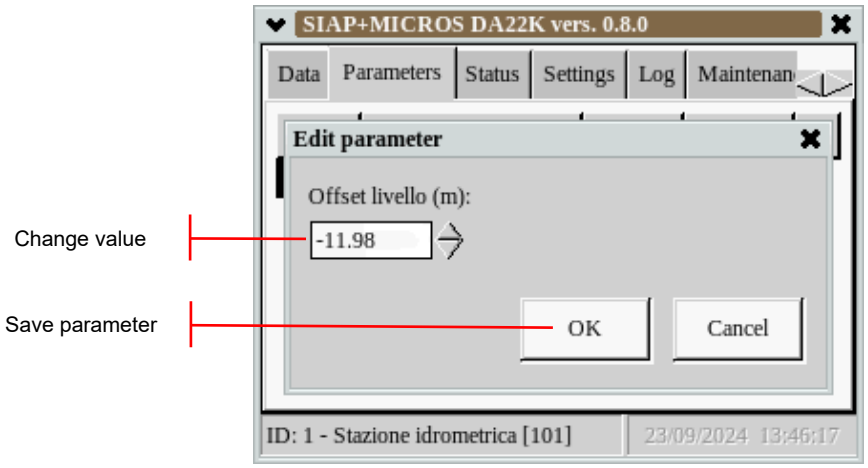
3.2.3 Paramet ri

The **Parameters** page lists the user parameters present in the datalogger configuration. Each parameter is associated with a numeric ID, a description, and a value. These values are normally used to parameterize various features within the configuration itself (calculation expressions, alarm thresholds, time intervals, etc.).



To change the value of a parameter, proceed as follows:

1. Select the line corresponding to the parameter. The dialog box will open: ***Edit parameter***
2. Connect an external USB keyboard for typing.
3. Position yourself on the box and type in the new value. For small changes, you can use the increment/decrement buttons
4. Press OK to confirm and save the change.



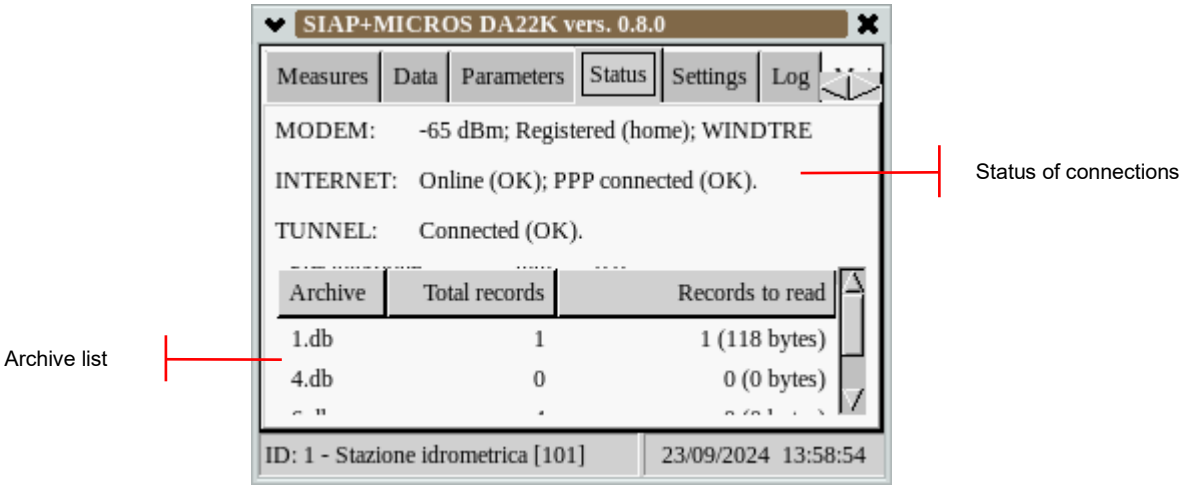
3.2.4 Stat o

The **Status** page reports some information about the status of the datalogger.

Particularly at the top of the window:

- 3G/4G MODEM information (RSSI signal; network registration status; telephone operator).
- INTERNET access status and Dial-up modem connection (PPP).
- TCP/IP connection status to a TUNNEL server.

Example:

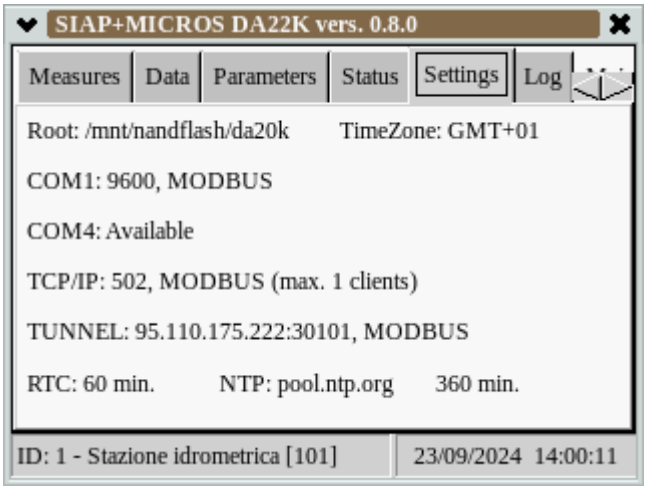


Instead, the lower part of the window lists the data logging archives (.db).
For each archive, the total records currently stored (*Total records*) and the amount of records yet to be read/transferred (*Records to read*) are reported.

3.2.5 Settings

The **Settings** page shows the main settings of the datalogger as listed below:

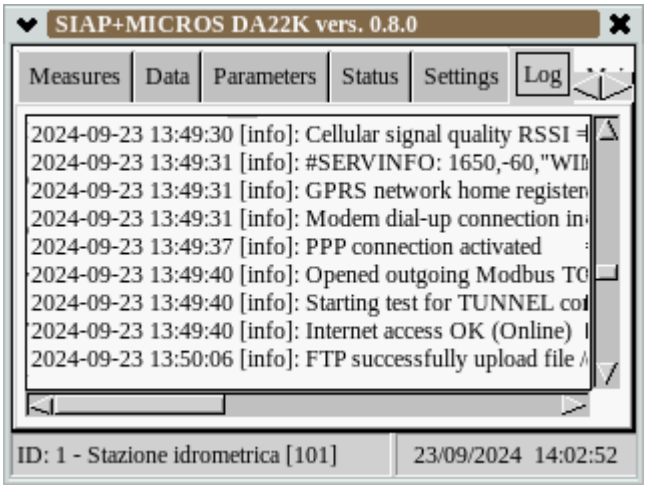
- The root path of the application and archives (*Root*)
- The local time zone (*TimeZone*)
- The speed and communication protocol for dialogue-enabled serial ports (COM1..COM4)
- The port and communication protocol for the incoming TCP/IP connection
- Address and communication protocol for connecting to the TUNNEL server.
- The update interval of the system clock (RTC).
- The server and the NTP (Network Time Protocol) time synchronization interval.



3.2.6 Log

The **Logs** window displays in real time the list of application events recorded during operation. We can find messages such as:

- information on starting work threads
- states of outgoing connections (PPP, FTP, TUNNEL, etc.).
- Sensor acquisition errors or alarm events on acquired measurements
- clock synchronization events (RTC, NTP)
- configuration update events, etc.

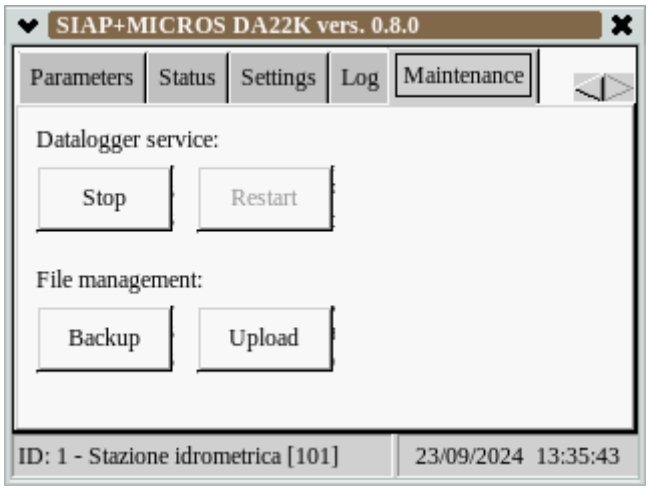


To scroll through messages press or drag the vertical/horizontal bars.

3.2.7 Maintenance

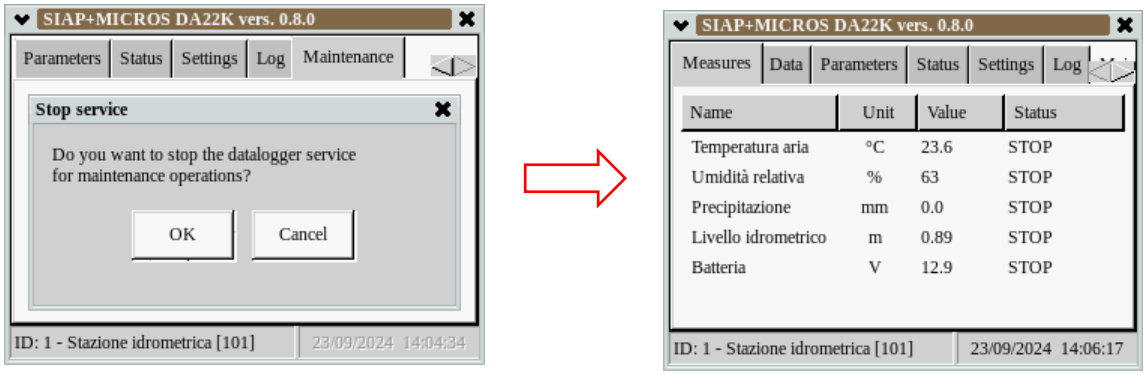
Through the Maintenance page, maintenance personnel have opportunities to manage the following operations:

1. Stop datalogger service for maintenance operations on measurement sensors.
2. Make a copy or update configuration files from external storage media.



Datalogger service

To stop the datalogger service, press the **Stop** button and confirm the operation. The window will move to the current measurements display, which will appear in the STOP state. In this case the datalogger will invalidate the data recording to prevent the acquisition of false measurements.



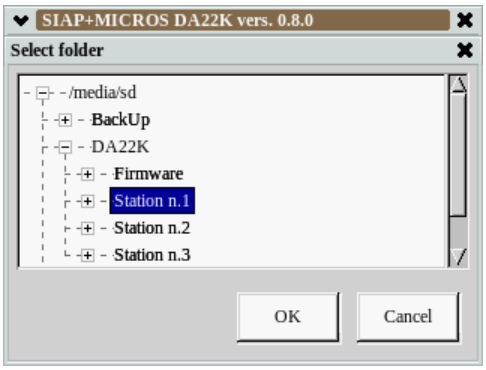
When finished, reactivate the service by pressing the **Restart** button.

In case of failure to restart, the service will automatically restart after 4 hours of inactivity.

File management

To make a copy of the configuration files, proceed as follows:

1. Insert the external SD Card or USB Disk media.
2. Press the **Backup** button.
3. Select and confirm the path to the destination folder where the files are to be saved. For example: */media/sd/DA22K/Station #1*



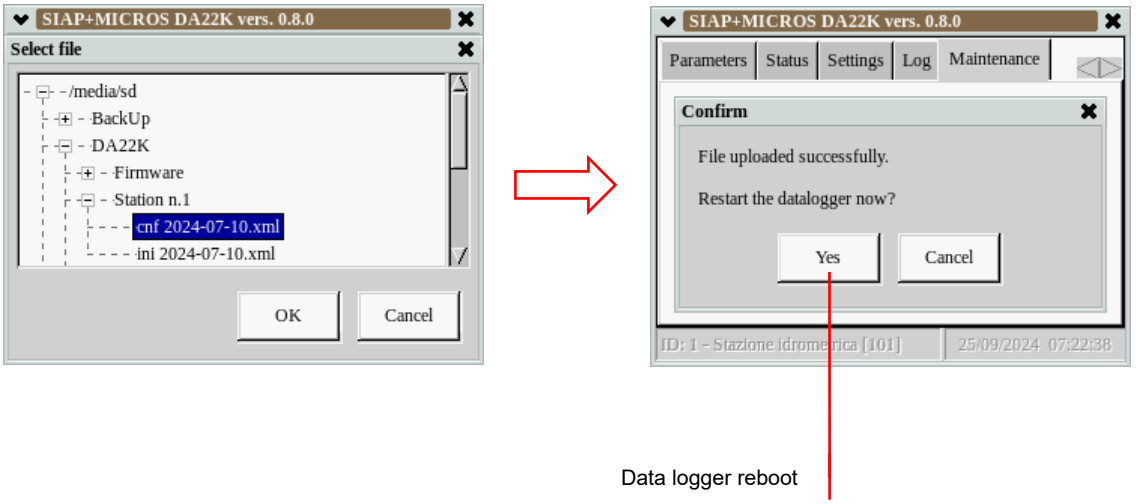
The files will be saved with the following names:

ini yyyy-mm-dd.xml

cnf yyyy-mm-dd.xml

To update a configuration file or datalogger application firmware, proceed as follows:

1. Insert the external SD Card or USB Disk media.
2. Press the **Upload** button.
3. Select and confirm the upload of the new file. For example: *cnf 2024-07-10.xml*
4. When finished, the datalogger application must be restarted to make the update effective. Press *Yes* to confirm the restart.



3.3 Datalogger configuration

The configuration settings required for datalogger operation are contained in the following files:

- **ini.xml** Initialization file
- **cnf.xml** Configuration files

At startup, the datalogger application loads these settings and uses them as operating instructions for the work program. Note that dataloggers with factory settings do not include these files.

The contents of each file are structured in XML language and are generally generated and sent to the datalogger using configuration management software. However, files can also be created or edited manually using an XML-compatible text editor.

For configuration creation and management, please refer to the use of **DAK** application software with specific reference to the guidance provided in the ***s012-d DAK*** manual *(DA22K/DA22KE series datalogger programming manual)*.

In the following paragraphs, all supported XML elements are described in detail. For demonstration purposes, examples of the files displayed using *Notepad* are included .++

3.3.1 File of initialization

The **ini.xml** initialization file is used for basic device settings, specifically station identification and to configure the datalogger communication ports.
The settings are enclosed within the <SYSTEM> < INI> sections.

Sample file: *ini.xml*

ini.xml

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!--Setting created by S+M DAK v 3.7 on 23/set/2024 10:00:00-->
<SYSTEM>
    <INI device-id="1" storage-id="101" station-name="Stazione idrometrica" time-zone="Etc/GMT-1">
        <BACKUP enable="1" path1="/mnt/sd" path2=""/>
        <CONNECTIONS>
            <TCP port="502" protocol="2" max="1"/>
            <COM1 bps="9600" protocol="2" rts="3"/>
            <TUNNEL ip="95.110.175.222" port="30101" protocol="2" echo="A" scan="10"/>
        </CONNECTIONS>
        <PPP isp-name="internet" persist="1" test-url="www.google.com"/>
        <NTP sync="360" server="pool.ntp.org"/>
        <RTC sync="60"/>
        <WD scan="1" run-timeout="60" data-timeout="21600"/>
        <MODEM info="AT+CSQ;AT#SERVINFO"/>
    </INI>
</SYSTEM>
```

The elements provided in the file are described in detail below. Some attributes may take default values in case they are omitted.

General settings:

- device-id: communication device identifier (ModBus Slave ID). Range: 1 ÷ 247, Default= 1.
- **storage-id**: storage identifier (Station ID). Range: 1÷ 9999, Default= *device-id*.
- station-name: station name.
- time-zone: local time zone (IANA standard conventional name). Default = UTC

  Note: The most common format composed *as Continent/City* (e.g., *Europe/Rome*) adopts the Daylight Saving Time (DST) changeover. Names such as *Etc/GMT, Etc/GMT-1*, etc. should be used to avoid DST. In this case no change will be applied to the clock during the year.

Backup data to external storage devices (SD Memory Card and/or USB Flash Drive):

<BACKUP/>

- enable: enable backup copy (0=Disable, 1=Enable).
- **path1**: mount path */mnt/sd* for backup to SD Card if present (primary drive);
- **path2**: mount path */mnt/usb* for backup to USB Disk if present (secondary drive); Default = "" (not present);

Input connections for serial communication with the datalogger: a COMx serial port is opened in reception (e.g., COM1[)] [((1))]:

<COMx/>

- **bps**: serial speed (baud rate: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200);
- protocol: communication protocol (1=S&F, 2=MODBUS, 4=PSE);
- **rts***:* RTS criterion (0= Disable, 1= Enable, 2= Handshake, 3= Toggle). Default= 3;

Input connection for TCP/IP communication with the datalogger; a *socket server* listening on a specified port (e.g., 502) is opened [(1)]:

<TCP/>

- **ip**: specific IP address on which to enable listening (optional). Default = "";
- port: listening TCP port (Default = 502);
- protocol: communication protocol (1=S&F, 2=MODBUS, 4=PSE);
- **max**: maximum number of *client* connections accepted. Default 3; =

Outbound connection to a remote Tunnel server; this mode allows the datalogger to be reachable via a TCP/IP port-to-port link on a server running *Socket Tunnel* software:

<TUNNEL/>

- **ip**: IP address of the Tunnel server to which the datalogger is to connect;
- port: TCP port of the Tunnel server (left side for the station);
- protocol: communication protocol (1=S&F, 2=MODBUS);
- **echo**: test character to be sent periodically to keep the connection active (default = "A");
- **scan**: interval for sending the test character (Default = 10 sec).

Modem device:

<MODEM/>

- **com**: serial port where the modem is connected (Default: 4 = COM4):
- **baud**: serial speed of the modem (Default: baudrate = 38400);
- **info**: specifies one or more additional AT commands to obtain information about RSSI signal, network registration, telephone operator, etc. (e.g., "AT+CSQ;AT#SERVINFO");

Point-to-Point Protocol (PPP) dial-up modem connection:

<PPP/>

- **isp-name**: name of the PPP connection configuration provider file. The file should be in the system folder: /etc/ppp/peers (Default: internet);
- **persist**: specifies whether the PPP connection is to be persistent (1 = always on) or whether it is enabled when needed (0 = only if requested) e.g. before initiating an FTP data transfer. If a Tunnel connection is present, PPP persistence must be enabled;
- **test-url**: URL or remote IP address that is used as a test to verify access to the Internet (Default = www.google.com);

Dynamic Domain Name System (DDNS) service; allows a domain name (e.g., *da22k-0001-siapmicros.ddns.net*) to be automatically associated and updated with the dynamic IP address of the datalogger device even if the address changes over time.

<DDNS/>

- **url**: Specific URL for updating IP address (e.g., https://dynupdate.no-ip.com/nic/update).
- username: user name registered to the service;
- **password**: login password;
- hostname: associated domain name;

Network Time Protocol (NTP); used to synchronize the clock(() [2)]with a precise time reference from a time server on the network:

<NTP/>

- sync: interval in minutes how often to synchronize (Default: 360 minutes);
- **server**: name of the time server to be used (Default time server: pool.ntp.org)

Real Time Clock (RTC) device; internal hardware clock used to synchronize the system clock with a more accurate time reference:

<RTC/>

- sync: interval in minutes how often to synchronize (Default: 60 minutes);

Watchdog used to ensure proper operation of the device. It solves situations where the system is stuck or not responding properly by automatically restarting it:

<WD/>

- **scan**: pulse period of the WD digital output (seconds). The pulse is intended for the Watchdog of the datalogger base board (RUN led). If the pulse is not received, the board will turn off power to reset the datalogger.
- **run-timeout**: maximum idle time of the main cycle (Default: 60 seconds);
- **data-timeout**: maximum time of no data transfer. Set 0 to disable the check (Default: 86400 seconds);

In case of expiration of the maximum set times (timeout), the internal process sends a particular sequence of pulses that immediately triggers the Watchdog with subsequent restart of the datalogger.

[1)]Connection default: If no communication connection is set, the datalogger will still be reachable through:

- COM1 serial at 9600 bps in *Modbus RTU* protocol
- TCP/IP listening on port 502 in *Modbus TCP/IP* protocol

[2)]NTP synchronization updates both the system clock and the hardware clock RTC.

3.3.2 Configuration files

The **cnf.xml** configuration file contains user-programmed settings and functions for the datalogger duty cycle. They are encapsulated within the following XML sections:

<CONFIG>
<PARAMETERS> ...
<ACQUISITIONS> ...
<PROCESSING> ...
<CONTROLS> ...
<STORAGES> ...
<TRANSMISSIONS> ...
<DISPLAY> ...
</CONFIG>

Example file: *cnf.xml*:

cnf.xml

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<!--Configuration created by S+M DAK v 3.7 on 23/set/2024 10:00:00 ClassLib v. 1.3.0-->
<CONFIG>
    <REMARKS>
        <REMARK name="1.0.0" ClsId="REMARK" author="SIAP+MICROS" note="Configurazione stazione idrometeo"/>
    </REMARKS>
    <PARAMETERS>
        <PARAMETER name="Offset livello" ClsId="PARAMETER" id="11" unit="m" value="-2.78"/>
        <PARAMETER name="Fondo scala idrometro" ClsId="PARAMETER" id="12" unit="m" value="20"/>
        <PARAMETER name="Soglia batteria minima" ClsId="PARAMETER" id="13" unit="V" value="11.5"/>
        <PARAMETER name="Cadenza FTP dati" ClsId="PARAMETER" id="14" unit="sec" value="300"/>
    </PARAMETERS>
    <ACQUISITIONS>
        <SENSOR name="Scheda BASE15K - Misure ingressi analogici/digitali" ClsId="BASE15K_AI" type="2" id="1" com="2" baud="57600" scan=
            <CHANNEL name="TAN" ClsId="PT100_CH01" enab="1" addr="300001" type="5" expr="" low="-30" upp="60" tag="30"/>
            <CHANNEL name="RHN" ClsId="SING_CH05" enab="1" addr="300017" type="5" expr="(M0*1e-6)*100" low="0" upp="100" tag="32"/>
            <CHANNEL name="RLS" ClsId="SING_CH08" enab="1" addr="300023" type="5" expr="$12*(M0*1e-6-0.4)/1.6" low="0.30" upp="20" tag="
            <CHANNEL name="PLUV" ClsId="COUNT_DIA03" enab="1" addr="300063" type="3" expr="M0*0.2" low="0" upp="+2E9" tag="40"/>
            <CHANNEL name="VBAT" ClsId="V_BATT" enab="1" addr="300079" type="5" expr="" low="0" upp="24" tag="48"/>
        </SENSOR>
        <SENSOR name="Acquisizione interna" ClsId="SYSTEM" type="0" scan="10000">
            <CHANNEL name="LIV" ClsId="GET_TAG" addr="0035" type="0" expr="($12-M0)+$11" low="-5" upp="15" tag="36"/>
        </SENSOR>
    </ACQUISITIONS>
    <PROCESSINGS>
        <PROCESSING name="Elab. PLUV" ClsId="ELAB_PLUV" type="3" scan="300" shift="0" rate="0" tag_inp1="0040" tag_out1="100" tag_out2="
        <PROCESSING name="Elab. P24H" ClsId="ELAB_PLUV" type="3" scan="86400" shift="0" rate="0" tag_inp1="0040" tag_out1="111" tag_out2
        <PROCESSING name="Elab. TA" ClsId="ELAB_STD" type="1" scan="1800" shift="0" rate="50" param1="0" param2="0" tag_inp1="0030" tag_
        <PROCESSING name="Elab. RH" ClsId="ELAB_STD" type="1" scan="1800" shift="0" rate="50" param1="0" param2="0" tag_inp1="0032" tag_
        <PROCESSING name="Elab. LIV" ClsId="ELAB_STD" type="1" scan="900" shift="0" rate="50" param1="0" param2="0" tag_inp1="0036" tag_
        <PROCESSING name="Elab. VBAT" ClsId="ELAB_STD" type="1" scan="1800" shift="0" rate="50" param1="0" param2="0" tag_inp1="0048" ta
    </PROCESSINGS>
    <CONTROLS>
        <ALARM name="Batteria scarica" ClsId="ALARM_MEASURE" type="0" scan="10" tag_inp="0048" min="$13" prn="" prx="" max="" ret="0.5"
    </CONTROLS>
    <STORAGES>
        <RECORD name="Record istantanei" ClsId="RECORD" id="" type="1" format="0" scan="10" shift="0" file="1" merge="0" backup="0" view
            <WRITE name="TA ist" ClsId="DATA_FIELD" id="1" type="A" tag="0030" unit="°C" dec="1" hide="0" sts=""/>
            <WRITE name="RH ist" ClsId="DATA_FIELD" id="2" type="A" tag="0032" unit="%" dec="0" hide="0" sts=""/>
            <WRITE name="PLUV sum" ClsId="DATA_FIELD" id="3" type="A" tag="0108" unit="mm" dec="1" hide="0" sts=""/>
            <WRITE name="LIV ist" ClsId="DATA_FIELD" id="4" type="A" tag="0036" unit="m" dec="2" hide="0" sts=""/>
            <WRITE name="VBAT ist" ClsId="DATA_FIELD" id="8" type="A" tag="0048" unit="V" dec="1" hide="0" sts=""/>
        </RECORD>
        <RECORD name="Record allarmi" ClsId="RECORD" id="" type="2" format="0" scan="30" shift="0" file="4" merge="1" backup="0" view="0
            <WRITE name="VBAT ist" ClsId="DATA_FIELD" id="8" type="A" tag="0048" unit="V" dec="1" hide="0" sts=""/>
        </RECORD>
        <RECORD name="Record storici 5'" ClsId="RECORD" id="" type="0" format="0" scan="300" shift="0" file="6" merge="1" backup="0" vie
            <WRITE name="PLUV sum" ClsId="DATA_FIELD" id="3" type="B" tag="0108" unit="mm" dec="1" hide="0" sts=""/>
        </RECORD>
        <RECORD name="Record storici 15'" ClsId="RECORD" id="" type="0" format="0" scan="900" shift="0" file="6" merge="1" backup="0" vi
            <WRITE name="LIV med" ClsId="DATA_FIELD" id="4" type="B" tag="0216" unit="m" dec="2" hide="0" sts=""/>
            <WRITE name="LIV min" ClsId="DATA_FIELD" id="4" type="C" tag="0217" unit="m" dec="2" hide="0" sts=""/>
            <WRITE name="LIV max" ClsId="DATA_FIELD" id="4" type="D" tag="0219" unit="m" dec="2" hide="0" sts=""/>
            <WRITE name="LIV dev" ClsId="DATA_FIELD" id="4" type="F" tag="0222" unit="m" dec="6" hide="0" sts=""/>
            <WRITE name="LIV ist" ClsId="DATA_FIELD" id="4" type="A" tag="0225" unit="m" dec="2" hide="0" sts=""/>
        </RECORD>
        <RECORD name="Record storici 30'" ClsId="RECORD" id="" type="0" format="0" scan="1800" shift="0" file="6" merge="1" backup="0" v
            <WRITE name="TA med" ClsId="DATA_FIELD" id="1" type="B" tag="0160" unit="°C" dec="1" hide="0" sts=""/>
            <WRITE name="TA min" ClsId="DATA_FIELD" id="1" type="C" tag="0161" unit="°C" dec="1" hide="0" sts=""/>
```

The following paragraphs describe the configurable functions in detail.

3.3.3 Main cycle and secondary processes

All priority data acquisition, processing and storage functions are performed by the datalogger program within a main work cycle.

The execution sequence of the main cycle consists of the following working steps in order:

1° ACQUISITION MEASURES
2° DATA PROCESSING
3° CHECKS
4° DATA STORAGE
5° DATA TRANSMISSION

Note that in writing the configuration file, the functions are defined in the order described above. A special exception is made for the measurement acquisition process, which is further divided into parallel *threads*, one for each serial or TCP/IP communication port on which the sensors themselves are connected.

Other functions, which require longer execution times or may be blocking the main cycle, are handled through separate work processes. These include data transmission functions and the management of communication peripherals with the datalogger.

Secondary processes (or work *threads*) executed in parallel include:

- Serial communication thread: reception management on COM1..COM4 ports.
- TCP/IP communication threads: handling incoming TCP/IP connections.
- Dial-up modem connection process: managing the PPP protocol.
- Tunnel server connection process: for managing dedicated communications.
- FTP file transfer process: for uploading or downloading files.
- Date/time synchronization process: via NTP protocol and RTC management.
- Display measurement process: updating data on the control panel.

3.3.4 User parameters

The parameters section allows user-defined parameters to be entered and maintained in the configuration file. Parameter values are editable locally from the datalogger display (see Sec. *3.2.3 Parameters*).

The parameters can be used in the following cases:

- as a flag to disable measures or other features;
- in measure conversion expressions or any other evaluation expressions;
- as measurement offset or alarm threshold;
- As a data processing and/or storage interval;
- To manage telephone numbers, IP addresses, etc.

To refer to a parameter within the configuration, it is necessary to use the notation**$ *id*** i.e., specify the numerical identifier of the parameter preceded by the symbol "$" (examples: $11, $12, $13.)

XML example of the parameter section:

```
<PARAMETERS>
    <PARAMETER name="Offset level" id="11" unit="m" value="-2.78"/>
    <PARAMETER name="Full scale hydrometer" id="12" unit="m" value="20"/>
    <PARAMETER name="Minimum battery threshold" id="13" unit="V" value="11.5"/>
    <PARAMETER name="Data FTP cadence" id="14" unit="sec" value="300"/>
</PARAMETERS>
```

Parameter configuration: <PARAMETER ... >

- **id**: numeric identifier of the parameter;
- name: parameter name.
- unit: unit of measurement;
- value: value assigned;

3.3.5 Acquisition measures

The measurement acquisition section is configured by entering the sensors and/or boards to be acquired, each with its own communication settings. Within each sensor, the measurement channels to be interrogated are then added.
The raw data obtained from the query undergo preprocessing for value conversion to engineering units and a subsequent validity check.

An example of the XML structure describing the acquisition section of multiple sensors is given:

```
<ACQUISITIONS>
    <SENSOR name="BAS card..." type="2" id="1" com="2" baud="57600" scan="3000" timeout="500" delay="0">
        <CHANNEL name="TAN" enab="1" addr="300001" type="5" expr="" low="-30" upp="60" tag="30"/>
        <CHANNEL name="RHN" enab="1" addr="300017" type="5" expr="M0*100" low="0" upp="100" tag="32"/>
        <CHANNEL name="RLS" enab="1" addr="300023" type="5" expr="$12*(M0*1e-6-0.4)/1.6" low="0... tag="35"/>
        <CHANNEL name="PLUV" enab="1" addr="300063" type="3" expr="M0*0.2" low="0" upp="+2E9" tag="40"/>
        <CHANNEL name="VBAT" enab="1" addr="300079" type="5" expr="" low="0" upp="24" tag="48"/>
    </SENSOR>
    <SENSOR name="Internal acquisition" ClsId="SYSTEM" type="0" scan="10000">
        <CHANNEL name="LIV" addr="0035" type="0" expr="($12-M0)+$11" low="-5" upp="15" tag="36"/>
    </SENSOR>
</ACQUISITIONS>
```

Sensor configuration: <SENSOR ...>

- name: name of the sensor;
- **type**: type of sensor (identifies the communication protocol):

    0. Internal datalogger system (tag variable, date/time, RSSI signal, connection states)
    1. <reserved>
    2. **MODBUS standard**
    3. **Standard SDI-12**
    4. <reserved>
    5. <reserved>

- id: alphanumeric that identifies the hardware address of the sensor (e.g., Modbus ID: 1 ÷ 247);
- **com**: communication port on which the sensor is connected:

    0. LAN (TCP/IP sensor)
    1. COM1 RS-232
    2. COM2 RS-485
    3. COM3 RS-485
    4. COM4 RS-232
    5. COM5 SDI-12 (D1)
    6. COM6 RS-485
    7. COM7 RS-485
    8. COM8 RS-232
    9. COM9 SDI-12 (D2)

- **baud**: serial communication speed: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps
- par: parity: N = None, E = Even, O = Odd; (default: N);

- data: number of data bits: 8 - 7 bits; (default: 8);
- stop: stop bits: 1 to 2 bits; (default: 1);
- **ip**: IP address (TCP/IP sensor);
- port: port (TCP/IP sensor);
- **cmd**: acquisition command to be sent for SDI-12 or generic ASCII sensor (e.g., M!);
- **scan**: interval, in milliseconds, at which the sensor is interrogated; in some cases the scan might be defined later for each channel;
- **timeout**: maximum response waiting time (milliseconds);
- delay: delay/pause after acquisition (milliseconds);

Channel configuration: <CHANNEL .../>

- name: descriptive name of the channel;
- **enab**: channel enable flag (1 = In scan, 0 = Out of scan);
- **addr**: channel address (for tag variable acquisitions it identifies the internal memory location; for MODBUS sensors it identifies the read address according to the standard data addressing convention(() ([1)), for SDI-12 sensors it identifies the location of the value in the response).
- type: data type:
  - Internal system: 0 = Tag variable, 1 = Date/time, 2 = Digital input I0÷I3, 3 = Modem RSSI signal, 4 = Connection status
  - Modbus data: 0 = Boolean (0/1), 1 = Signed (16-bit), 2 = Unsigned (16-bit), 3 = Swapped Long (32-bit), 4 = Long integer (32-bit), 5 = Swapped F.P. Little-endian (CDAB), 6 = Floating-Point Big-endian (ABCD)
- **scan**: interval, in milliseconds, at which the channel is interrogated (if not already specified at the sensor level).
- **cmd**: specifies a possible command for a generic ASCII serial device (e.g., "SEND" for barometric sensor).
- **conv**: pre-conversion expression of the acquired signal (optional);
- **expr**: conversion expression or correction formula to be applied to the acquired signal to obtain the measured value in engineering units;
- low: lower limit range of validity of the measurement (*lower limit*);
- **upp**: upper limit range of measurement validity (*upper limit*);
- **tag**: memory location in which the acquired measurement (*tag*) is stored;

[1)]MODBUS data reading addressing convention:

(0x) 000001..065536 Function 1: Read Output Coils
(1x) 100001..165536 Function 2: Read Discrete Inputs
(3x) 300001..365536 Function 4: Read Input Registers
(4x) 400001..465536 Function 3: Read Holding Registers

Note: Modbus acquisition automatically calculates the starting address and the amount of registers/coils to be requested based on the channels entered.

3.3.6 Processing functions

The processing section, immediately following acquisition, is responsible for processing the acquired measurements at specific intervals. Valid samples of input measurements (*tag_inp*) are entered into the respective processing function for processing. When the configured interval expires, each function will return a set of statistical data that will be available in the assigned output locations (*tag_out*).

Sample XML section for processing:

```
<PROCESSINGS>
    <PROCESSING name="Elab. PLUV" type="3" scan="300" shift="0" rate="0" tag_inp1="0040" tag_out1="100" .../>
    <PROCESSING name="Elab. TA" type="1" scan="1800" shift="0" rate="50" tag_inp1="0030" tag_out1="156" .../>
    <PROCESSING name="Elab. RH" type="1" scan="1800" shift="0" rate="50" tag_inp1="0032" tag_out1="170" .../>
</PROCESSINGS>
```

Processing configuration: <PROCESSING .../>

- name: processing name or description;
- type: type of processing:
    1. **Standard statistical processing**
    2. **Dragged (mobile) processing**
    3. **Rainfall processing (rainfall)**
    4. **Anemometer processing (wind)**
- **scan**: data processing interval (seconds);
- **shift**: interval offset (seconds);
- rate: minimum rate of valid data required;
- **param1**...***paramN***: set of parameters required for processing;
- **tag_inp1**... **tag_inp *N***: series locations of tag variables provided as input (measures).
- **tag_out1**...***tag_outN***: series locations of resulting tag variables in output (data).

The following pages give lists of input parameters and resulting output locations (processing data) for each type of processing.

Standard statistical processing

Attribute		*Description*
param1	→	Acceptability criterion given (maximum allowable variation: 0 = not applied)
param2	→	Limit standard deviation (maximum validation threshold: 0 = not applied)
tag_inp1	→	Instantaneous measurement (input)
tag_out1	←	Cyclic counter
tag_out2	←	Counter valid measurements
tag_out3	←	Percentage of valid measurements [%]
tag_out4	←	Summation
tag_out5	←	Media
tag_out6	←	Minimum
tag_out7	←	Minute of the minimum [daily minute]
tag_out8	←	Maximum
tag_out9	←	Minute of the maximum [daily minute]
tag_out10	←	Variance
tag_out11	←	Standard deviation
tag_out12	←	Measurement reference (value of the last measurement sample)
tag_out13	←	Measurement deviation (deviation of the measurement from the initial sample)
tag_out14	←	Snapshot last valid measurement

Dragged (mobile) processing

Attribute		*Description*
param1	→	Acceptability criterion given (maximum allowable variation: 0 = not applied)
tag_inp1	→	Instantaneous measurement (input)
tag_out1	←	Cyclic counter
tag_out2	←	Counter valid measurements
tag_out3	←	Percentage of valid measurements [%]
tag_out4	←	Mobile accumulated
tag_out5	←	Moving average
tag_out6	←	Mobile drift
tag_out7	←	Mobile minimum
tag_out8	←	Maximum mobile

Rainfall processing (rainfall)

Attribute		*Description*
tag_inp1	→	Acquired rainfall measurement [mm] (in input)
tag_out1	←	Cyclic counter
tag_out2	←	Counter valid measurements
tag_out3	←	Percentage of valid measurements [%]
tag_out4	←	*Confidential data*
tag_out5	←	*Confidential data*

tag_out6	←	*Confidential data*
tag_out7	←	*Confidential data*
tag_out8	←	Instantaneous rainfall [mm] (current precipitation in the cycle)
tag_out9	←	Accumulated rainfall [mm] (accumulated precipitation in the interval)
tag_out10	←	Total rainfall [mm] (total accumulated precipitation)
tag_out11	←	Test rain gauge [mm] (rain gauge test count)

Anemometer processing (wind)

Attribute		*Description*
param1	→	Direction validation threshold [m/s] (typical = 0.5 m/s)
param2	→	Number of wind sectors [0, 8, 16, 36]
tag_inp1	→	Instantaneous velocity measurement (input)
tag_inp2	→	Instantaneous measurement of direction (input)
tag_out1	←	Cyclic counter
tag_out2	←	Counter valid speed measurements
tag_out3	←	Counter valid measurements direction
tag_out4	←	Velocity value summation
tag_out5	←	Summation sine direction
tag_out6	←	Summa cosine direction
tag_out7	←	sine vector component summation
tag_out8	←	cosine vector component summation
tag_out9	←	AVERAGE SPEED (scalar calculation) [m/s]
tag_out10	←	AVERAGE DIRECTION (trigonometric calculation) [°N]
tag_out11	←	VECTOR VELOCITY (resultant vector modulus) [m/s]
tag_out12	←	VECTOR DIRECTION (resultant vector angle) [°N].
tag_out13	←	MINIMUM SPEED VALUE [m/s].
tag_out14	←	MINUTE MINIMUM SPEED [Daily Minute].
tag_out15	←	MAXIMUM SPEED VALUE [m/s].
tag_out16	←	MINUTE MAXIMUM SPEED [Daily Minute].
tag_out17	←	DIRECTION AT MAXIMUM SPEED [°N]
tag_out18	←	DIR. SET. TO MAXIMUM SPEED [°N]
tag_out19	←	Prevalent sector: SECTOR DIRECTION(() (*))[°N]
tag_out20	←	Prevailing sector: AVERAGE INTENSITY(() (*))[m/s]
tag_out21	←	Prevailing sector: MAXIMUM INTENSITY VALUE(() (*))[m/s]
tag_out22	←	Prevailing sector: MINUTE MAXIMUM INTENSITY(() (*)) [Daily minute]
tag_out23	←	STANDARD DEVIATION SPEED [m/s].
tag_out24	←	STANDARD DEVIATION DIRECTION [°N]
tag_out25	←	LAST MEASURE SPEED [m/s].
tag_out26	←	LAST MEASUREMENT DIRECTION [°N]

(*) Values available only at the end of the processing period

3.3.7 Control functions

The controls section is dedicated to managing alarms and controlling digital and/or analog outputs to external devices or locally on the datalogger itself.

The control functions currently available are:

- **Measurement alarm control**
- **MODBUS output control**

Example of the controls section:

```
<CONTROLS>
    <ALARM name="Low battery" type="0" scan="10" tag_inp="0048" min="$13"... max="" ret="0" wait="0" tag... />
    <ALARM name="Door open" type="0" scan="5" tag_inp="0050" min="50" ... max="" ret="0" wait="0" tag... />
    <MODBUS name="BASE control" type="2" id="1" com="2" baud="57600" par="N" data="8" stop="1" scan="3"...>
        <OUTPUT name="Command" addr="0" type="0" expr="$20<>0" low="-2E9" upp="+2E9" mode="0"/>
    </MODBUS>
</CONTROLS>
```

Alarm control configuration: < ALARM .../>

- **name**: name or description of the control;
- type: control type: 0 = MEASURE ALARM
- **scan**: interval at which the check is made (seconds);
- **shift**: interval offset (seconds);
- **tag_inp**: variable tag input location (measure or data);
- min: minimum alarm threshold; default: "" = none;
- **prn**: minimum pre-alarm/warning threshold; default: "" = none;
- **prx**: maximum pre-alarm/warning threshold; default: "" = none;
- max: maximum alarm threshold; default: "" = none;
- ret: return offset (hysteresis on threshold); default = 0;
- **wait**: dwell time before alarm entry (seconds); default = 0;
- tag_out: output tag variable location (alarm status);

  Alarm status code list:

  -2. MINIMUM ALARM.
  -1. MINIMUM PRE-ALARM
  0. NORMAL
  1. MAXIMUM PRE-ALARM
  2. MAXIMUM ALARM
  3. ACQUISITION ERROR
  4. OUT OF RANGE MEASUREMENT
  5. OUT-OF-SERVICE MEASUREMENT

The alarm check on the measurement is carried out periodically according to the set interval. If the measurement value exceeds upward (or downward) the relevant maximum (or minimum) threshold after a specified dwell time, the corresponding alarm will be generated. The alarm status code is stored in the assigned output location.

MODBUS control configuration:< MODBUS ...>

- **name**: name or description of the control;
- type: control type: 2 = MODBUS OUTPUT
- **id**: hardware address of the Modbus device (Slave ID: 1 ÷ 247);
- **com**: communication port on which the device is connected:
    0. LAN (Modbus TCP/IP)
    1. COM1 RS-232
    2. COM2 RS-485
    3. COM3 RS-485
    4. COM4 RS-232
    5. <reserved>
    6. COM6 RS-485
    7. COM7 RS-485
    8. COM8 RS-232
    9. <reserved>
- **baud**: serial communication speed: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200 bps
- par: parity: N = None, E = Even, O = Odd; (default: N);
- data: number of data bits: 8 - 7 bits; (default: 8);
- stop: stop bits: 1 to 2 bits; (default: 1);
- **ip**: IP address (Modbus TCP/IP);
- port: port (Modbus TCP/IP);
- **scan**: interval at which the check is performed (seconds);
- **timeout**: maximum response waiting time (milliseconds)

Output configuration: <OUTPUT .../>

- **name**: output name or description;
- **addr**: output address for MODBUS devices identifies the address to be written according to the standard data addressing convention:

  (0x) 000001..065536 Function 5/15: Write Single/Multiple Coils
  (4x) 400001..465536 Function 6/16: Write Single/Multiple Registers

- type: data type:
  - Output Coils: 0 = Boolean (0/1)
  - Holding Registers: 1 = Signed (16-bit), 2 = Unsigned (16-bit), 3 = Swapped Long (32-bit), 4 = Long integer (32-bit), 5 = Swapped F.P. Little-endian (CDAB), 6 = Floating-Point Big-endian (ABCD)

- **expr**: value conversion expression to be applied to the data to be written;
- low: lower limit range of validity of the data (*lower limit*);
- **upp**: upper limit range of data validity (*upper limit*);
- mode: execution mode (0 = only when value changes, 1 = always at each interval);

3.3.8 Data storage

Data storage, depending on the set configuration, can be performed on several separate logging archives.

The storage medium for recording is the device's internal NAND Flash. The archive files are stored within the **arc** folder (path: */mnt/nandflash/da20k/arc*).

Each file is a *SQLite* database named in the following format:

<*n*> .db where **<*n*>** represents the number assigned to the archive
.db indicates the extension of a database type file.

Each archive can contain one of the following types of records:

- Historical data plot.
- Instantaneous data plot.
- Alarm track.

The archives are managed by the datalogger in circular mode. Once the maximum number of records (86,400) is reached, storage continues by overwriting the oldest records.
However, the autonomy of data logging depends on the configuration adopted on the datalogger. An estimate of the autonomy can be derived from the following table

Recording interval	*Data maintenance*
1 minute	~ 60 days
5 minutes	~10 months
15 minutes	~ 2 years
1 hour	~ 9 years old

The configuration for data recording is described below.

Example storage section:

```
<STORAGES>
    <RECORD name="Snapshots" id="" type="1" format="0" scan="60" shift="0" file="1" >
        <WRITE name="TA ist" id="1" type="A" tag="0030" unit="°C" dec="1"/>
        <WRITE name="RH ist" id="2" type="A" tag="0032" unit="%" dec="0"/>
        <WRITE name="PLUV sum" id="3" type="A" tag="0108" unit="mm" dec="1"/>
    /RECORD>
    <RECORD name="Historical 5' id="" type="0" format="0" scan="300" shift="0" file="6" merge="1" backup="0" ...>
        <WRITE name="PLUV sum" id="3" type="B" tag="0108" unit="mm" dec="1"/>
    </RECORD>
    <RECORD name="Historical 30'" id="" type="0" format="0" scan="1800" shift="0" file="6" merge="1" backup="0"
    ...>
        <WRITE name="TA med" id="1" type="B" tag="0160" unit="°C" dec="1"/>
        <WRITE name="TA min" id="1" type="C" tag="0161" unit="°C" dec="1"/>
        <WRITE name="TA max" id="1" type="D" tag="0163" unit="°C" dec="1"/>
        <WRITE name="TA dev" id="1" type="F" tag="0166" unit="°C" dec="6"/>
        <WRITE name="RH med" id="2" type="B" tag="0174" unit="%" dec="0"/>
        <WRITE name="RH min" id="2" type="C" tag="0175" unit="%" dec="0"/>
        <WRITE name="RH max" id="2" type="D" tag="0177" unit="%" dec="0"/>
        <WRITE name="RH dev" id="2" type="F" tag="0180" unit="%" dec="6"/>
    </RECORD>
</STORAGES>
```

Recording configuration: < RECORD ...>

- name: name or description of the record;
- **id:** alternate storage identifier (optional if different from station ID);
- type: type of record layout:
    0. HISTORIC Record
    1. INSTANT record
    2. Record ALARM (() (1) ())
- format: format of the record:
    0. SIAP+MICROS Standard Dynamic Record Format.
- **scan**: interval in seconds at which the record is made;
- shift: interval offset (to delay or advance the recording time (seconds);
- **file**: archive file number (example: specifying 1 will create the database file "1.db");
- merge: option to merge records with the same time (not in use);
- backup: enables/disables backup copy of the record to external storage devices;
- view: enables/disables the display of historical data on the display (not available);

(() (1) ())Alarm logging is performed for events not yet logged when the scan interval expires.

Data field configuration: < WRITE .../>

- name: given name;
- id: sensor identifier (measurement ID);
- **type**: attribute(() (2) ())of the data;
- **tag**: memory location of the data;
- unit: unit of measurement of data;
- **dec**: number of decimal places with which the value is formatted;
- hide: hides the data in the display view (not in use);

(() (2) ())Letter identifying the statistical data type:

- 'A' = Instantaneous value
- 'B' = Average value
- 'C' = Minimum value
- 'D'= Maximum value
- 'E'= Counting
- 'F'= Standard deviation
- 'G'= Variance
- 'H'= Summation
- 'I'= Percentage of invalidation
- 'The'= Minute of the minimum
- 'M'= Minute of the maximum
- 'R'= Error code
- 'J'= Diagnostic status

Data retention function in memory

The function performs a maintenance copy of the last archived data. This feature is useful for reducing the response time to a real-time data request command (data cache).

<RETAIN name="Memory retention" file="6" scan="1800" shift="0"/>

Configuration:

- name: name or description;
- **file**: archive file number (on which to apply retention);
- **scan**: interval in seconds corresponding to the data holding period;
- **shift**: interval offset to delay or advance storage (seconds);

3.3.9 Data backup

Data records stored in archive files can also be configured for backup to external storage media, such as SD Memory Card and/or USB Flash Drive. In this case, the media's memory will be managed sequentially, filling up progressively until the available space is exhausted.

The backup functionality must be enabled in advance in the initialization file by selecting the memory drive to be used. The primary backup drive is the ***SD Card*** type removable storage media (default folder mount path: ***/mnt/sd/backup/data***). Alternatively or in addition to the SD card, a ***USB Disk*** stick can also be inserted as a secondary drive (in this case the default folder will be***: /mnt/usb/backup/data***).

The path to the backup folder expands into additional subfolders that successively identify the archive number to which they belong and the year of record. Example:

/mnt/sd/backup/data/6/2024

identifies the folder for data archive #6 for the year 2024.

Data are copied into daily files progressively named in:

***YYYYYMMDD*.dat** with: YYYY = year, MM = month, DD = day.

Example data backup files:

20240101.dat
20240102.dat
20240103.dat

Replacement of memory media:

SD Card and/or USB Flash memory media can be removed and replaced without any problems even while the datalogger is running. To ensure compatibility between Linux and Windows operating systems, devices must be formatted with **FAT32** file system.

3.3.10 Transmission data

The datalogger allows it to be configured to transmit the following data in various modes:

- ✓ historical archival data
- ✓ alarm recording
- ✓ images (e.g., from WebCam)

The main transmission function uses the following protocols:

- ➢ FTP(S) protocol file transfer;
- ➢ SFTP protocol file transfer (SSH);

Example XML transmission section:

```
<TRANSMISSIONS>
    <FTP name="Transfer" type="0" host="95.110.175.7" port="21" ssl="0" user="da22k" pass="*******" dir="" tag="...>
        <PUT name="Sending alarms" scan="60" shift="0" source="4.db" ... target="ST%iii_ALARM.. .dat." dir="/Data"/>
        <PUT name="Send historical data" scan="$14" shift="0" source="6.db" ... target="ST%iii_DATA... .dat" dir="/..."/>
    </FTP>
</TRANSMISSIONS>
```

The FTP function uses a secondary process to transfer data by taking files from a local source folder. The files to be sent are prepared by taking the data not yet transmitted from the archive and assigning the file a name already formatted for the destination. Each individual file will have a predefined maximum size (*pack*) to speed up and ensure the transfer process.

Data file preparation is done according to the scheduled scan interval. Any data recovery after a communication breakdown will be handled with more frequent scans (up to 5 minutes).

For transferring image files from Webcam or other types of files, it is necessary to specify the path to the source file to be sent, the function will then perform a move is rename locally.

To further reduce the size of the files to be sent, data compression can also be performed (this must, however, be in accordance with the decompression to be performed on the server).

Local files are automatically deleted only after confirmation of successful transfer.

FTP transfer configuration:< FTP ...>

- **name**: transfer description;
- **type**: protocol: 0 = FTP (File Transfer Protocol), 1 = SFTP (SSH File Transfer Protocol)
- host: host name or IP address of the server;
- port: server port (default: 21);
- **ssl**: data encryption: 0=None, 1=SSL/TLS if available, 2=SSL/TLS explicit, 3=SSL implicit;
- user: user name (account);
- pass: login password;
- **dir**: remote destination (or pickup) directory;
- **tag**: outgoing tag variable location (transfer outcome);

Send file (upload):< PUT .../>

- **name**: sending description;
- **scan**: session interval with which the copy of the file to be sent is prepared (seconds);
- **shift**: interval phase shift;
- **source**: number or name of the archive from which to take data (e.g., 6.db) or path to a source file to be copied (e.g., mnt/nandflash/image/current.jpg);
- pack: maximum size of the data packet to be sent (default: 64 KB);
- **format**: record plot transformation:
    0. No transformation (SIAP+MICROS standard native record layout)
    1. SIAP+MICROS standard normalized dynamic record plot.
    2. <reserved>
    3. <reserved>
- **cpr:** file compression (default: 0=No);
- target: target remote file name [(1)];
- **dir**: remote destination directory (optional) if different from the one specified at the top level;

Receive file (download):< GET .../>

- **name**: reception description;
- **scan**: session interval with which the file to be downloaded is searched (seconds);
- **shift**: interval shift;
- source: name of the source file to download (e.g., cnf.xml);
- target: target local file name (default: = source);
- **dir**: remote pickup directory (optional) if different from the one specified at the top level;
- action: action to be performed when transfer completed: 0=None, 1=Software restart.

[(1)]The name can be formatted with the following placeholder characters:

%iii	Station storage ID
%yyyy%mm%dd	Current year, month and day
%hh%nn%ss	Current hour, minute and second

example: ST%iii_DATA_%yyyy%mm%dd%hh%nn%ss.dat"

3.3.11 Display visualization

In this section, the user defines the rows of data to be shown on the display (sec. *3.2.1 Current measurements*). The order of display corresponds to the order in which the items are entered in the section. The scan with which the display is updated is normally 3 sec.

Example of display visualization:

```
<DISPLAY scan="3">
    <ROW name="TA" text="Air temperature" tag="0030" unit="°C" dec="1"/>
    <ROW name="RH" text="Relative humidity" tag="0032" unit="%" dec="0"/>
    <ROW name="PLUV" text="Precipitation" tag="0108" unit="mm" dec="1"/>
    <ROW name="LIV" text="Hydrometric level" tag="0036" unit="m" dec="2"/>
    <ROW name="VBAT" text="Battery" tag="0048" unit="V" dec="1"/>
</DISPLAY>
```

Display line configuration: <ROW .../>

- **name**: line name/description;
- text: displayed text (label);
- **tag**: tag variable location of the data to be displayed.
- unit: unit of measurement.
- **dec**: number of decimal places (value formatting).

3.3.12 Variables and operators

The following tables list the variables and operators that can be used in configuration expressions.

Parameters and variables (tags)

$id	Parameter value with identifier ***id*** (e.g., $11 = parameter value 11)
Mi	Value of the variable at memory location ***i*** (e.g., M1 = value of location 1). If the variable takes the value = -9999 it indicates invalid data. Note: M0 indicates the raw data of the newly acquired current measurement.
There	Validation state of memory variable ***i*** (e.g., V1 = validation state of variable M1). 1 = Valid data 0 = Invalid data.
Qi	Quality code of memory variable ***i*** (e.g., Q1 = quality code of variable M1). 1 = Valid data 3 = Acquisition error 4 = Value out of scale 5 = Out of service or disabled

Arithmetic operators

+	Addition
-	Subtraction
/	Division
*****	Multiplication
^	Elevation to power
MOD	Remainder of division

Logical operators

NOT	Logical negation (equivalent operator: **!**)
AND	Logical Conjunction
OR	Logical disjunction

Comparison operators

=	Same
>	Major
>=	Greater than or equal to
<	Minor
<=	Less than or equal to
<>	Different

Bit comparison operators

&	Bitwise AND
|	Bitwise inclusive OR

Boolean constants

FALSE	Equivalent to value **0**
OFF	
TRUE	Equivalent to value **1**
ON	

Mathematical functions

ABS	Absolute value of a number
ATN	Arcotangent of a number
COS	Cosine of an angle
EXP	Power elevation of the base of natural logarithms *and*
INT	Integer part of a number
LIM	Maximum or minimum value of a number between two limits
LN	Natural logarithm of a number
LOG	Logarithm in base 10 of a number
MAX	Maximum value between two numbers
MIN	Minimum value between two numbers
SGN	Sign of a number
SIN	Sine of an angle
SQR	Square root of a number
TAN	Tangent of an angle

3.4 Data record plot

Data stored in the datalogger archive are natively formatted according to the SIAP+MICROS standard defined as ***Dynamic Record Tracing*.**

The Dynamic Record Track contains information regarding the source station (storage ID), the date/time of the record, and the type of data stored.
Date and time of storage constitute the time stamp of the record, which always refers to the end of the processing period.
In record layouts with a *dynamic structure*, the length of the layout varies according to the number and type of data contained. Therefore, in situations where the data to be included in the plot are minimal, the length of the plot itself and consequently also the space occupied by the data will be very small.

The dynamic plot is adapted to contain current instantaneous data, statistical data obtained from processing functions, and alarm records.

The track consists of three distinct parts named respectively:

HEAD **BODY** **TERMINATOR**

Each of these parts is divided internally into fields separated from each other by the character "," (ASCII 44).
All data (*Instantaneous Data*, *Statistical Data, Data in Alarm,* etc.) managed by the system are recorded in the internal memory (Flash) of the control unit and, if present, in the external memory (SD memory card).
Depending on the type of data, recording is done in separate areas of the memory. The division into areas is dictated, as described below, by precise storage requirements.
Data are stored in the memory area corresponding to them and are written as recognizable ASCII character sequences. The storage modes depend on the specific type of *data being* stored. These modes are described by *Record Tracks*, which define their structure. Four different storage modes have been implemented, one for each *data* type.

The track types are:

- **Plot Record *Statistical Data***
- **Track Record *Instant Data***
- **Track Record *Data in Alarm***

For detailed description of the Siap+Micros record tracks, consult the ***s011-d Dynamic Records*** manual.

3.5 Command interpretation

Through the Modbus RTU / TCP/IP input communication protocol, the datalogger implements *the User-Defined* function #65 with which a set of specific commands (*Siap+Micros* command set) can be conveyed.

The function specification and the complete list of commands interpretable by the datalogger is given below.

3.5.1 Modbus protocol specification

User-Defined Modbus function code **65 (0x41) - SIAP+MICROS commands**

Request:

Field	*Size*	*Range value*
Slave ID	1 Byte	0x00 to 0xF7, 0xFF
Function code	1 Byte	0x41
Bytes count	2 Bytes	0x0000 to 0xFFFF (*N*)
Data request	*N* Bytes	0x00 to 0xFF
CRC-16	2 Bytes	0x00 to 0xFF

Valid response:

Field	*Size*	*Range value*
Slave ID	1 Byte	0x00 to 0xF7, 0xFF
Function code	1 Byte	0x41
Bytes count	2 Bytes	0x0000 to 0xFFFF (*N*)
Data response	*N* Bytes	0x00 to 0xFF
CRC-16	2 Bytes	0x00 to 0xFF

Error response:

Field	*Size*	*Range value*
Slave ID	1 Byte	0x00 to 0xF7, 0xFF
Error code	1 Byte	0xC1
Exception code	1 Byte	0x01, 0x02, 0x03, 0x04
CRC-16	2 Bytes	0x00 to 0xFF

The following paragraphs give the syntax of the commands.

Note:

If the commands are not sent correctly, the datalogger will respond with:

?<*command* name >	for unrecognized command
-1	for incorrect parameters

3.5.2 General commands

Communication identifier< *device-id*>

Reading command:	**R IDSTAZ**
Response:	IDSTAZ< *device-id*>
Command write(() (*)):	**W IDSTAZ=< *device-id*>**
Response:	IDSTAZ< *device-id*>

Storage-id< *storage-id*>

Read command:	**R ID_MEM**
Response:	ID_MEM< *storage-id*>
Command write(() (*)):	**W ID_MEM=< *storage-id*>**
Response:	ID_MEM< *storage-id*>

(*)Note: For the setting commands to take effect, the datalogger application must be restarted.

Clock

The write command will perform the setting of the system clock and RTC clock:

Command reading:	**CLK**
Response:	*<hh nn> <> < ss dd> <> < mm yyyy> <>*
Write command:	**CLK *<hh nn> <> < ss dd> <> < mm>* < yy[*yy*]>**
Response:	*<hh nn> <> < ss dd> <> < mm yyyy> <>*

Firmware version

Command reading:	**!FW**
Response:	DA22K vers. <x>.<y>.<z>.

Reset datalogger (software restart)

Command:	**MICROS RESET**
Response:	RESET MICROS

Reboot datalogger (hardware reboot)

Command:	**!TW**
Response:	Terminating Watchdog

3.5.3 Management variables and parameters

Variable locations (memory tags)

The read command requests the values of <*n*> locations from the starting address <*index*>.
The write command sets the values of <*n*> locations by specifying the index and value for each.

Reading command:	**!IM n <> < *index*>**
Response:	*< val1 >< val2> ...< valn>*
Write command:	**!WA *<n> <index1> <val1> < index2> <val2>...< indexn> valn>***
Response:	*no response*

User parameter (identifier:*< id)>*

Command reading:	**!RP < *id*>**
Response:	*< value>*
Write command:	**!WP < *id*> < *value*>**
Response:	*< value>*

3.5.4 Archives management

Specify the archive number with: <*file*>

Size (KB)

Command:	***R_FILE<file>***
Response:	*_FILE<file> < size>*

Free space (KB)

Command:	**!FR < *file*>**
Response:	*< bytes free>*

Space used (KB)

Command:	**!MR < *file*>**
Response:	*< bytes used>*

Sequential Data Reading (*Read Data*)

The command reads the data and performs the temporary move of the user read pointer used. Specify in order: archive number < *file*>, user <*user*>, number of packages to be read < *pack*>

Command:	**!RD < *file*> < *user*> < *pack*>**
Response:	*< data records>*

Data Read Confirmation (*Read Set*)

The command performs alignment of the read pointer with the temporary pointer. Specify: archive number < *file*> , user <*user*>

Command: **!RS < *file*> < *user*>**
Response: *no response*

Data Reading *Restore* (*Restore*)

The command brings back the read pointer just after the write pointer so that the whole file can be reread. Specify: archive number < *file*> and user <*user*>

Command: **!RE < *file*> < *user*>**
Response: *no response*

Data Deletion (*Scratch*)

The command resets the write and read pointers so that the archive can be rewritten from the beginning:

Command: **!SC < *file*>**
Response: *no response*

Reading Positioning (*Point Reading*) [(*)]

Specify the year, month, day, hour, minute, and second of the record in which to place the read pointer. The response will contain the number of bytes to be read:

Command: **!PR < *file yyyy*> <> < *mm dd hh*> <> <> <> < *nnss*>**
Response: *<bytes to read>*

(*)Note: This command uses only user #1

Writing data (*)

The command performs writing to the specified data store (file #1 ÷ 253):

Command: **!WR < *file*> < *data to write*>**
Response: *no response*

((*))Obsolete command. Alternatively, use the command !WRB

Writing data with pointer

The command performs a write to the specified data store (file #1 ÷ 253) or to a system default file using a write start pointer. Normally used for writing the following system files: 0 = Configuration file (cnf.xml), 254 = Setup file (ini.xml), 255 = Application firmware (da20k):

Command: **!WRB < *file*> < *pointer*> < *data to write*>**
Response: *no response*

Latest data request

The command returns data from the last record that occurred or the last records that occurred in a preconfigured retention period (retention interval).
For example, with a retention interval preconfigured at 30 minutes, sending a request in the time slot 08:30÷ 08:59, the response received will contain records present from 08:01 to 08:30 inclusive. Sending the same request after 09:00, you will receive records from 08:31 to 09:00 inclusive. If the holding period is not configured, the response will contain only the last recorded record.
In the request message you must mandatorily specify the archive from which you want to read the data (*file*).

Syntax:

Command	**!LTR | !LBR | !LKR | !LXR** *file [yyyyy mm dd hh nn ss]*
Answer	*<Data plot>*(1)

The command can additionally perform synchronization of the datalogger clock if date and time settings are specified. Optional parameters are *yyyy* (year), *mm* (month), *dd* (day), *hh* (hour), *nn* (minutes) and ss (seconds).

Note: Clock synchronization will be performed only if the current datalogger setting differs between ±3 sec. and ±50 min.

Data request historical

The command can be used to request/retrieve data records recorded in a specific historical interval. If present, all records prior to the requested instant within the preconfigured retention period (including the record specified in the request) will be sent.
For example, with a holding interval set to 30 minutes, data up to 30 minutes backward will be returned. To retrieve data from 00:31 to 01:00 hours, it will be necessary to send the request specifying 01:00:00 hours.
If the retention period is not configured the response will contain only the requested record.
In the request message you must mandatorily specify in addition to the archive from which you want to read the data (*file*), the date and time of the recording: *yyyy* (year), *mm* (month), *dd* (day), *hh* (hour), *nn* (minutes) and ss (seconds).

Syntax:

Command	**!DTR | !DBR | !DKR | !DXR** *file yyyy mm dd hh nn ss*
Answer	*<Data plot>*(1)

(1)The format of the data path received in response depends on the type of command sent:

!LTR (*Last Text Records*)	*Standard dynamic trace (ASCII)*
!DTR (*Data Text Records*)	
!LBR (*Last Binary Records*)	*Standard binary track*
!DBR (*Data Binary Records*)	
!LKR (*Last Kompressed Binary Records*)	*Compressed binary track*
!DKR (*Data Kompressed Binary Records*)	
!LXR (*Last eXtra Binary Records*)	*Compressed binary track with diagnostics*
!DXR (*Data eXtra Binary Records*)	

3.5.5 Output controls

Digital outputs O0 to O3 (DA22K datalogger)

Command: **!CO n <> < *act1*> < *out1*> < *act2*> < *out2*> ... <*actn*> < *outn*>**
Response: *no response*

Activation values <*act*>:

1: ON

2: OFF

3: PULSE (ON/OFF)

4: PULSE (OFF/ON)

Outputs < *out*>: 0 ÷ 3

Example: **!CO 1 1 0** // Sets the output O0 to ON.

Digital outputs DIG OUT OD1 ÷ OD8, 12V (DA22K base board)

Command: **!OD n<> < *act*>**
Response: OD<n> *ON/OFF*

Activation values <*act*>:

0: OFF

1: ON

Outputs <*n*>: 0 ÷ 8

Example commands:

!OD1 ON // Activates the digital output OD1

!OD1 OFF // Turns off the digital output OD1

!12V ON // Activates digital output powered 12V

!12V OFF // Turns off the 12V powered digital output.

4 Regulations

4.1 Safety Standards

The detailed examination of the design and mode of execution has made it possible to determine what hazards the product is likely to present throughout its life, if properly used, and thus to define the essential requirements that apply to it. These requirements may be contained in one or more directives and all must be met regardless of which directive they belong to. Two conditions are therefore necessary for a directive to apply to a product:

- the product falls within its scope of application
- the product presents hazards to which the essential requirements of the directive relate.

From the risk analysis conducted, described in the following pages, it was found that the European directives applicable to this product are as follows:

European Directive	Title	Transposition law reference in Italy
2014/35/EU	Low Voltage Directive (LVD)	Legislative Decree No. 86 of May 19, 2016
2014/30/EU	Electromagnetic Compatibility (EMC) Directive	Legislative Decree No. 80 of May 18, 2016

This product falls within the scope of the Low Voltage Directive 2014/35/EU implemented in Italy by Legislative Decree No. 86 of May 19, 2016, and the Electromagnetic Compatibility Directive 2014/30/EU implemented in Italy by Legislative Decree No. 80 of May 18, 2016, both of which came into force on May 26, 2016.

4.2 EMC

This equipment has been designed in accordance with the requirements of the directives indicated in the CE declaration attached to the product.

5 Environmental conditions of use

The equipment is designed to be used according to the specifications given in the table below:

INTENDED USE AND LIMITATIONS OF THE EQUIPMENT	***DATA / INFORMATION AVAILABLE***
Intended use	Intended use exclusively includes measurements of physical and chemical parameters for meteorology, agrometeorology, hydrometry, environmental and climatic monitoring, remote control and automation of aqueducts, purifiers, sewers, etc., distributed logic control and automation systems, special applications for landslide control, microbiological processes, chemicals, etc.
Reasonably foreseeable misuses and contraindications of use	Use in a home, consumer or hobby environment is improper; use by unqualified and/or inadequately trained persons.
Usage environment	Not intended for use in environments with corrosive and flammable explosive gases or vapors.
Any critical environmental factors	The environmental conditions for proper use are: - Reference temperature: 20 °C - Operating temperature: -40 ÷80 °C - Maximum allowable relative humidity: 99% non-condensing - Storage temperature: 0÷ 60 °C - Storage humidity: 80% maximum
Professionalism or experience required of operators	Personnel must be qualified or properly trained and educated about the risks involved.

NOTES

- Periodic updates are made to the information contained in this document. These are incorporated into new editions of the document.
- The manufacturer may make modifications and/or changes to the product described in this document at any time without notice.
-

6 Revision history

The following table provides a description of the changes made to this document.

Version	Date	Updates
01	15/10/2024	Initial document.
02	02/12/2024	Sensor acquisition standard SDI-12 protocol. Data backup to external storage devices.

7 EU Declaration of Conformity

MD 751.1 rev. 03

EU Declaration of Conformity (DoC)

Manufacturer: SIAP+MICROS S.p.A.
Via del Lavoro, 1 – 31020 S. Fior (TV) – Italy
https://www.siapmicros.com/en/

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration:

Description	Product Code/Model
Multifunction datalogger with Linux embedded	PEM-e022b-DA22KE

The object of the declaration described above is in conformity with the relevant Union harmonization legislation:

- **2014/53/EU** The Radio Equipment Directive (RED)
- **2011/65/EU** The Restriction of Hazardous Substances Directive (RoHSD)

The following harmonised standards and technical specifications have been applied:

RED references:

ELECTROMAGNETIC COMPATIBILITY (Article 3.1b):

EN 61326-1 2021-06	Electrical equipment for measurement, control and laboratory use - EMC requirements - General requirements
EN 301 489-1 V2.2.3:2019	ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard for ElectroMagnetic Compatibility
EN 301 489-52 V1.2.1:2021-11	ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 52: Specific conditions for Cellular Communication User Equipment (UE) radio and ancillary equipment; Harmonised Standard for ElectroMagnetic Compatibility

EFFECTIVE AND EFFICIENT USE OF RADIO SPECTRUM (Article 3.2):

EN 301 511 V12.5.1:2017-03	Global System for Mobile communications (GSM); Mobile Stations (MS) equipment; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
EN 301 908-1 V13.1.1:2019-11	IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 1: Introduction and common requirements
EN 301 908-2 V13.1.1:2020-06	IMT cellular networks; Harmonised Standard Standard for access to radio spectrum; Part 2: CDMA Direct Spread (UTRA FDD) User Equipment (UE)

EN 301 908-13 V13.1.1:2019-11	IMT cellular networks; Harmonised Standard for access to radio spectrum; Part 13: Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE)

HEALTH & SAFETY (Article 3.1a):

EN 61010-1 2010+A1:2021-11	Safety requirements for electrical equipment for measurement, control and laboratory use Part 1: General requirements
EN 62311 2019	Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz to 300 GHz)

RoHSD references:

EN 63000 2016+AMD1:2022	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Date
31-01-2023

CEO
Alex Stevanin