SIAP+MICROS
Environmental Monitoring Solutions
Since 1925

e022 DA22KE-ET

Data acquisition control unit

(manual also valid for e022 DA22K)

User Manual

Firmware version 0.8.0

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1 Precautions and safety measures

The 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 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 to read all notes carefully.

1.1 Intended use

The DA22K control unit is a local management unit for environmental and meteo-climatic monitoring stations capable of directly interfacing meteorological sensors, analysers, chemical-physical probes, actuators, etc. It has been designed to meet the most diverse data acquisition, processing and transmission needs, from the simplest, for individual stations, to the most complex for networks of stations of various types managed by remote control centres. The construction criteria chosen and, in particular, the open and modular structure of the control unit allow considerable application possibilities both in terms of ease of use and configurability, and in terms of versatility and future expandability.
Keep this manual in a safe place and keep a copy available to operators at all times.

1.2 Warnings

The manufacturer declines all responsibility in the event of faults due to failure to comply with the instructions, tampering, uses not envisaged in this manual, improper use of the device, use by untrained operators. Only authorised and trained personnel are allowed access to the instrument for normal use and maintenance operations.

General safety rules

- The instrument must be connected to an electrical (or safety) earth.
- 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 authorisation.
- Do not take any measurements if you find any abnormalities in the instrument such as, deformation or breakage.
- Replacement of components and interior work may only be carried out by qualified and instructed maintenance personnel, after disconnection of the main power supply.
- Pay attention to any warning labels against potentially dangerous procedures.

1.3 Shift

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

1.4 Removal of packaging

Make sure you take the following precautions before removing the packaging and installing the instrument:

- Use suitable gloves to protect against abrasions etc.
- If any damage is found to have occurred during transport at the supplier's expense, return the instrument to the supplier.
- Once unpacked, place the instrument and its 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 operation.

Before installing the instrument, check that

- The mains voltage of the installation area complies with the operating conditions of the instrument.
- Check that the instrument's main switch is off.

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

1.5 Procedure for safe ignition

The following procedure allows the DA22K control unit to be correctly 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 must 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 carried out with the power supply switched off.
4. Pay attention to polarity: VCC must be connected to the positive terminal and GND to the negative.
5. Switch on the DA22K powered by the battery only, with the external power supply switched off.
6. Switch on the external power supply.

1.6 During operation

During operation, avoid working on the electrical connections for the analogue and digital inputs and the power supply 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 transparent plastic bag along with a

[1] The DA22K is equipped with reverse polarity protection devices. However, care must be taken with the connections.

bag of drying salts and seal the bag with adhesive tape. Label the bag with the contents and weight of the equipment with the words "HANDLE CAREFULLY".

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

1.8 Maintenance

1.8.1 Cleaning the Instrument

Before cleaning the instrument, disconnect all connection cables. Use a soft, dry cloth for cleaning. Never use damp cloths, solvents, water or other liquids.

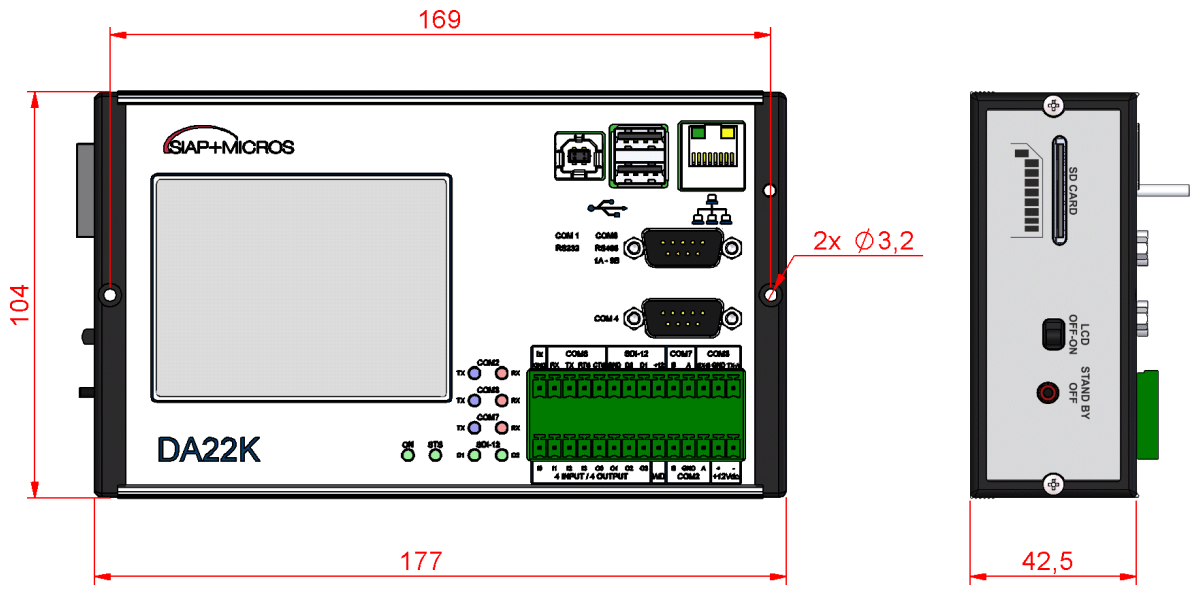
1.8.2 Power line protections

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

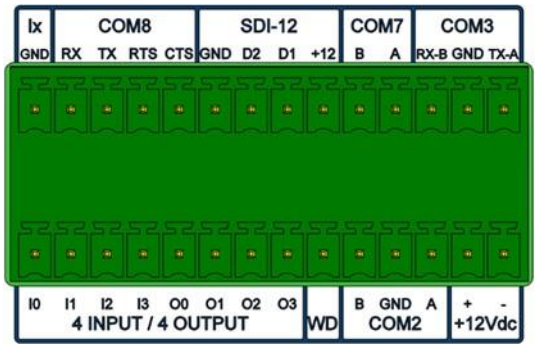
2 Hardware and connections

2.1 Container of processing and storage electronics

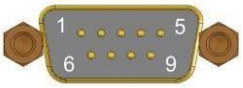
Assembly and dimensions [mm]



Data logger terminal layout



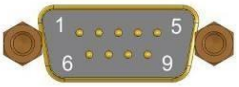
PINOUT COM1 / COM6



2 - RX
3 - TX
5 - GND
7 - RTS
8 - CTS

1 - A - RS485
9 - B - RS485

PINOUT COM4



1 - DCD
2 - RX
3 - TX
4 - DTR
5 - GND

6 - DSR
7 - RTS
8 - CTS
9 - RI

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 internal directories of the data logger can be accessed.
- A USB Type A connector for connecting peripheral devices 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 network over Ethernet protocol.

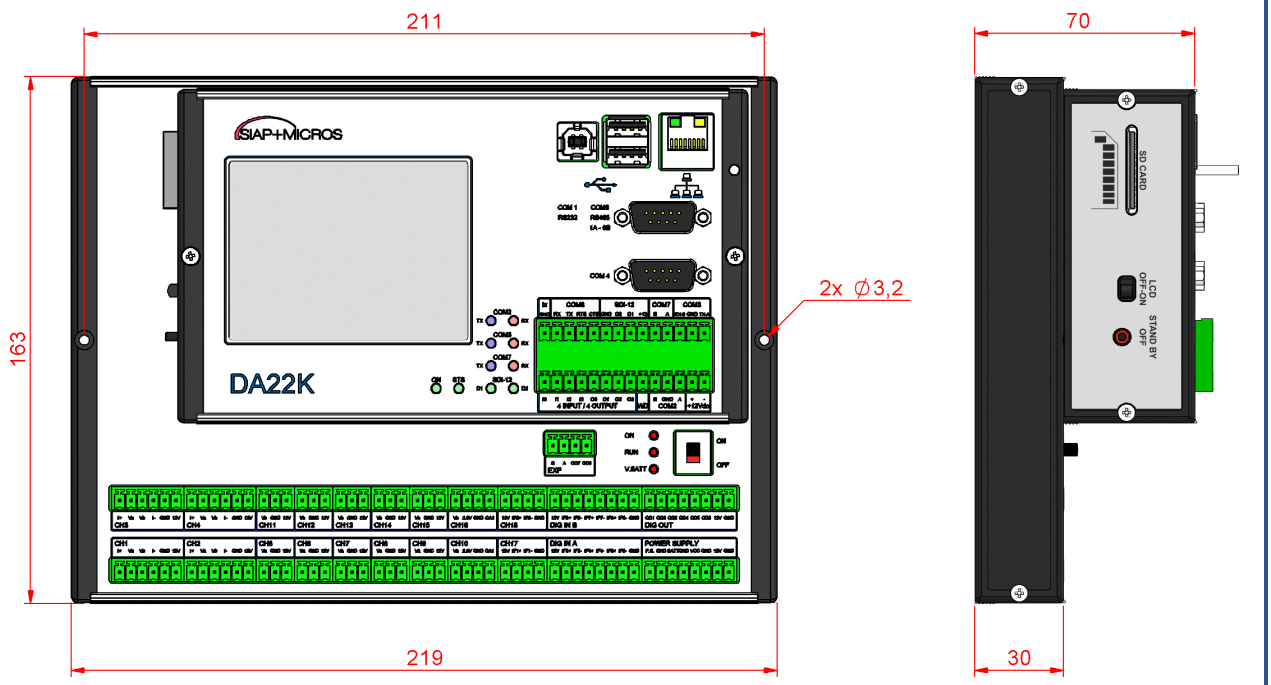
- Two 9-pin male DSUB-type connectors for connecting serial devices such as modems, PCs, sensors and other equipment with an RS-232 or RS-485 interface:
    - **COM1**: RS-232 to pins 2, 3, 5, 7 and 8 of the DSUB connector as per layout image.
    - **COM4**: RS-232 complete with all criteria.
    - **COM6**: RS-485 to pins 1 and 9 of the DSUB connector as per layout image.
- A multifunctional 28-pin 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. COM3 can be converted into an additional RS-232 via a mounting option.
    - **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, and ground. D1 and D2 are seen as two SDI-12 serial lines **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 the digital inputs.
- An SD (Sicure Digital) connector for the insertion of an industrial SD memory used by the programme for backing up recorded data.
- A switch for the display backlight (forces the display backlight to switch off).
- A button for forced exit from the *Suspend* state of the data logger.
- Ten LEDs representing respectively:
    - ON, green LED indicating power-on status.
    - STS, green LED flashing if the data-logger application is in cycle.
    - D1, green LED indicating transmission/reception on SDI-12 COM5
    - D2, green LED indicating transmission/reception on SDI-12 COM9
    - TX, blue LED, and RX, red LED of COM2 indicating the status of the serial transmission and reception 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 transmission and reception lines.
- TX, blue LED, and RX, red LED of COM7 indicating the status of the serial transmission and reception lines.

2.2 Container for acquisition and power management electronics

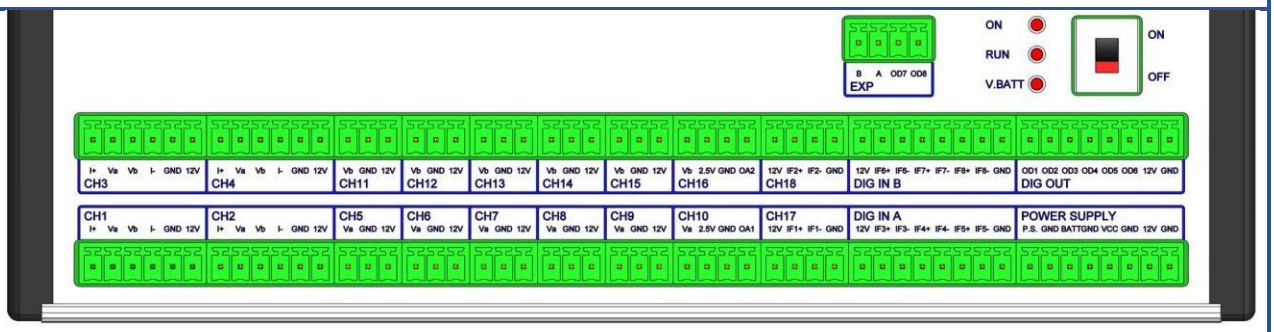
Assembly and dimensions [mm]



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

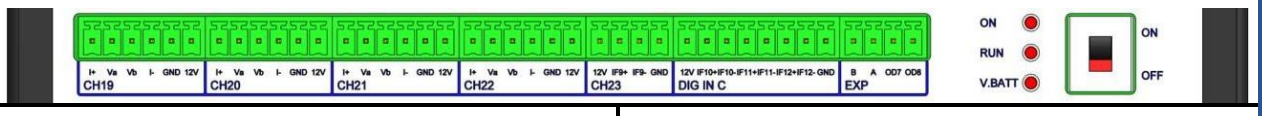
The terminal blocks are briefly described here, and will be discussed in more detail in the following sections.

Basic terminal block connections



CH1 to CH4: Analogue inputs (24 bit)	CH5÷CH9, CH11÷CH15: Analogue inputs (24 bit)
• A differential input (Va - Vb) • Two inputs referenced to ground (Va - GND, Vb - GND) • One PT100 input (I+ - Va - Vb - I-) • $_{VALM}$ sensor supply	• One differential input on each pair of connectors (Va - Vb) (CH5/CH11, CH6/CH12, CH7/CH13, CH8/CH14, CH9/CH15) • One input referenced to ground on single connector (Va - GND, Vb - GND) • $_{VALM}$ sensor supply
CH10, CH16: 24-bit analogue inputs, 12-bit analogue outputs	**CH17, CH18: Opto-isolated digital inputs**
• One differential input on each pair of connectors (Va - Vb) (CH10/CH16) • One input referenced to ground on single connector (Va - GND, Vb - GND) • Precision reference voltage 2.5V - 25mA (e.g. potentiometric wind direction sensor) • Analogue output 0 - 2V, 12 bit	• Frequency • Counter • Logical state • $_{VALM}$ sensor supply
DIG IN A, DIG IN B: Opto-isolated digital inputs	**DIG OUT: Digital open drain and power outputs**
• Frequency • Counter • Logical state • $_{VALM}$ sensor supply	• Open drain digital output • $_{VSWT}$ switch-off power output
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) • $_{VPWR}$ power output (12V - GND)

Additional connections in expanded terminal block (only for DA22KE)



CH19 TO CH22 : Analogue inputs (24 bit)	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-) • $_{VALM}$ sensor supply	• Frequency • Counter • Logical state • $_{VALM}$ sensor 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) • $_{VALM}$ sensor 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 equal to the battery voltage with current limitation of 2.5 A
- VSWT is a voltage normally present but which can be switched off on command, equal 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 on the housing and three status LEDs with the following meanings:

- 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 flash indicates the battery is low, 5 flashes indicate the battery is fully charged).

Regarding the POWER SUPPLY connector, it is possible to use several power sources; the data logger will then manage any redundancy. It is in fact possible to connect, for example, the PS solar panel simultaneously to the external 12VDC power input. The data logger will then charge the battery via the solar panel or via the 12VDC input in case of no sunlight.

The following paragraphs detail the electrical and measurement characteristics of the various functional sections available in the terminal box.

2.3 Feeds

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

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

The solar panel input is marked with 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 a voltage of approximately 15.2V and is capable of delivering up to 5A to the battery. The panel input is also equipped with:

- Reverse polarity protection circuit
- Low-pass filtering
- Electrostatic discharge protection circuit up to 30kV with 160W peak power and IEC 61000-4-2; 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 data logger. A lead-acid battery with a nominal voltage of 12V can be connected to these terminals. The battery input is also equipped with:

- Reverse polarity protection circuit

- Electrostatic discharge protection circuit up to 30kV with 160W peak power and IEC 61000-4-2; 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, together with the battery, of supplying power to the data logger. A bench power supply with a nominal voltage of 12V, but 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 160W peak power and IEC 61000-4-2; level 4 (ESD); IEC 61000-4-5 (surge); IPP = 2.5 A; AEC-Q101

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

- 2.5 A current limitation with protection by resettable fuse
- Electrostatic discharge protection circuit up to 30kV with 160W peak power and IEC 61000-4-2; 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.

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

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

- 200 mA current limitation with protection by resettable fuse
- Electrostatic discharge protection circuit up to 30kV with 160W peak power and IEC 61000-4-2; 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 are 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 a further four inputs at connectors CH19, CH20, CH21 and CH22 that can increase the control unit's acquisition capabilities to a maximum of eight [Pt100][3] resistance thermometers.

The measurement of the resistance thermometer value is done using the four-wire technique and involves the terminals **I+** (generation of the excitation current), **Va** and **Vb** (measurement of the voltage at the ends of the resistance thermometer), **I-** (return of the excitation current). The resistance thermometer is connected with one end to I+ and Va and the other end to I- and Vb. Specifically, at each acquisition cycle a pulse [current4][4] is generated at terminal I+ which, flowing over the resistance thermometer, creates a measured potential drop between inputs Va and Vb. The current

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

[4] Only active for the measuring cycle so as not to alter the thermal conditions of Pt100 due to the Joule effect

closes on I- and generates a reference for the radiometric measurement of the potential drop on the resistance thermometer.

Each Pt100 input also has the following features:

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

2.5 Analogue Inputs

The control unit is equipped with a number of 24-bit analogue 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. In particular, the DA22K version has a total of 20 analogue inputs referenced to ground that can be acquired as 10 differential inputs on connectors CH1 to CH16. The DA22KE expansion adds a further 8 ground-referenced inputs that can be acquired as 4 differential inputs on connectors CH19, CH20, CH21 and CH22. All inputs have the following characteristics:

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

We will now consider the three connector types for the 6-, 3- and 4-pole analogue inputs in order to better explain the connection possibilities.

2.5.1 Analogue inputs on 6-pin connector

The connectors of this type are CH1, CH2, CH3 and CH4; the DA22KE expansion version has the additional connectors CH19, CH20, CH21 and CH22. These are multifunctional 6-pin 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 reference should be made for details.

2.5.2 Analogue 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 reference should be made for details.

In addition to the two power supply terminals mentioned above, each connector has a left-hand terminal, denoted Va or Vb, which is an analogue 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 this case Va indicates the positive signal terminal and Vb the negative terminal.

2.5.3 Analogue inputs on 4-pin connector

The connectors of this type are CH10 and CH16 and are entirely analogous to the 3-pin connectors in terms of the functionality of the Va and Vb inputs and their mode of use. A special feature of this type of connector is the presence of:

- **Reference voltage**

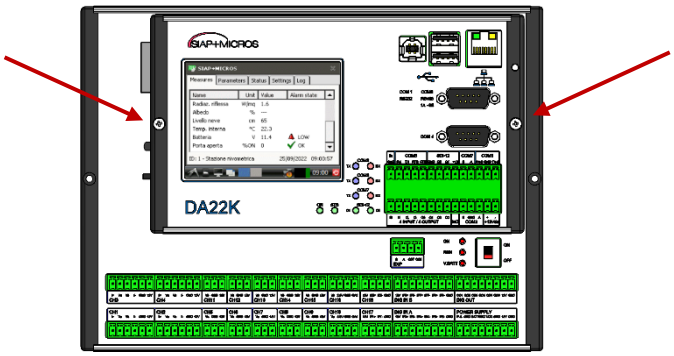
  On both connectors the 2.5V terminal denotes a 2.5V reference useful for measuring e.g. potentiometer signals such as wind direction.

- **Analogue output**

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

2.5.4 Analogue inputs configurable in 4 - 20 mA

The DA22K data logger, as well as the DA22KE, has four of the described analogue inputs that can be configured for the acquisition of 4 - 20mA current signals without the need for external precision resistors. Such resistors, with a value of 100Ω, are in fact already included in the DA22K, allowing conversion of 4 - 20mA current signals into 0.4 - 2V voltage signals. The channels prepared for this functionality are CH8, CH9, CH14, CH15. In order to enable the resistor, the user must proceed by unscrewing the processing electronics box from the one below (see figure below). You will then have access to four switches, each of which enables the resistor on the relevant acquisition channel.



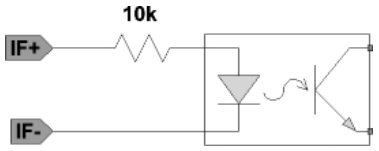
2.6 Digital Inputs

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

Special features of these inputs are:

- Opto-isolated input pair with $_{5KVRMS}$ isolation voltage
- Internal limiting resistor of 10kΩ
- Acquired automatically every second as
  - Frequency
  - Count
  - Logical state

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



This type of input permits the acquisition of either square-wave signals, by 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+ in order to polarise the photo emitter and to connect the dry contact to IF-. For this purpose, a 12 V power supply is brought to the connectors. For example, a dry contact connected on CH17 will have to be bridged between terminal **12V** and terminal **IF1+**, 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 data logger is read as logic high due to internal pull-ups. When the contact closes to ground, a current flows on the photo diode and the signal transmitted to the data logger is read as logic low.

In the case of the data-logger with DA22KE expansion, there are still eight opto-isolated digital inputs as before, to which are added four comparator inputs for sensors in [AC5] (with variable reluctance, for example); these inputs, however, are positioned differently on the connectors concerned. In particular, the channels are divided between 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] E.g. variable reluctance sensors such as some wind speed sensors

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

The opto-isolated inputs have already been discussed, while the other type of input features a differential comparator which, given an input sine wave, produces a square wave of the same frequency which is used for acquisition. This feature makes it possible to accommodate passive sensors such as some wind speed sensors with a sine wave output. As with the opto-isolated inputs, these inputs can also be read in 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.

In addition to these inputs, there are a further four 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 control unit's acquisition base is equipped with eight open drain 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
- Protection circuit against electrostatic discharge 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).

On the 28-pin connector of the processing and control unit there are four further digital outputs, O0, O1, O2, O3 with the characteristics:

- 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)

2.8 Connectivity

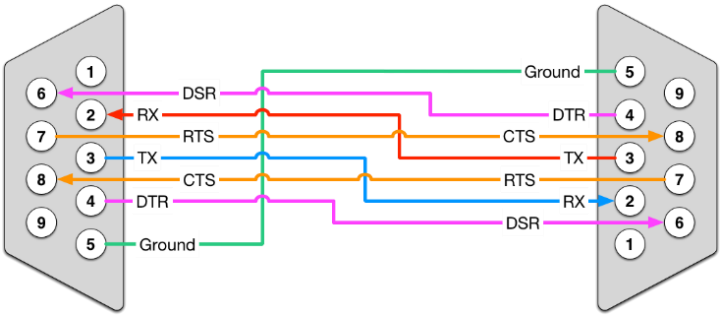
The DA22K has a wide range of communication devices such as RS-232, RS-485, Ethernet, USB, etc... In the following paragraphs, the features of the various communication interfaces present will be analysed.

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, i.e. which, in addition to transmission and reception, have other control signals carried on the interface connector. These are:

- **COM1:** 9-pin DSUB connector to which pins 2, 3, 5, 7 and 8 of the connector are carried, i.e. the 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:** Is part of the 28-pole connector and carries the signals RX, TX, RTS, CTS.

These can be used 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 data-logger and the computer must be connected by means of a NULL MODEM type cable, i.e. with the two ends both female 9-pin DSUB type and with pins two and three inverted so that the computer's transmission arrives at the data-logger's reception and vice versa.



In terms of 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 data-logger has three serial communication interfaces entirely dedicated to connecting RS-485 devices:

- **COM2**
  It is part of the 28-pin connector and carries signals A, B and ground. B has a 4.7kΩ pull down to ground while A has a 4.7kΩ pull up 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 carries signals A and 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.

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. In particular:

- Protection circuits against electrostatic discharges 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-pole connector and the 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).

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 as, 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 test 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 must 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 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

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

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

The 5V data line, as prescribed by the standard, is left in high impedance via a tristate buffer when not in use. This line also has 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.

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 where 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 discharges up to 15 kV according to IEC 61000-4-2 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 data-logger file system. The interface is equipped with a dedicated transient voltage suppression circuit specific to the USB signal characteristics. The circuit is also protected against electrostatic discharges up to 15 kV according to IEC 61000-4-2 and in particular

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

2.9 External storage units and display

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

On the left side of the data logger there is a connector that can accommodate an SD Card storage device; this is automatically managed by the operating system, which recognises 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 use. It is also possible to select a USB pen-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" TFT - LCD display with 320 x 240 resolution and 16 million colours. 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 programme. More details are provided in the following chapters.

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

[7] If not piloted it is normally white.

3 User's guide and configuration

The following chapter gives an overview of the configuration and use of the DA22K control unit, in particular describing the architecture of the operating system and the functionalities of the internal management software (data-logger application). The application implements typical data-logger functions such as the acquisition of measurement sensors, the recording 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).

The operating system is pre-loaded on the following internal media:

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

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

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

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

List of files:

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

3.1.1 Start

The data-logger management application (firmware **da20k**) is started automatically after the operating system is loaded via a link to the script-shell **start.sh**. On first start-up, the system will create the sub-folders necessary for operation. Any other processes required for operation will also be started automatically after booting the data-logger.

Booting embedded Linux

Wait for the operating system and application to start up for about 1 minute, after which the display will show the main page of the graphic interface (ref. par *3.2 Display pages*).

3.1.2 Remote connection

You 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 instance, **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 data logger:

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
   - **User name**: da22k
   - **Password**: ********
3. Press '**Login**' 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 only enabled to listen on the local address.
Changes to SSH settings are possible within the configuration file: /etc/ssh/sshd_config

3.1.3 Network configuration

The network card setting of the data-logger (**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 8.8.4.4**: 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 to the data logger's COM4 port. The default settings for the modem's 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 located 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 scripts (CHAT)

The PPP configuration invokes a **CHAT** script to initiate the connection to the modem. The telephone number for the anonymous connection is passed via 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, execute the following command:

```
$ pon internet
```

Once the Internet pon command has been started, it can be verified that the PPP interface is active with the command:

```
$ ifconfig ppp0
```

If the connection was successful, a **ppp0** network interface 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

In order to obtain a precise time reference, the data logger has a hardware RTC clock installed on board. The RTC (Real-Time Clock) device is used to periodically synchronise the internal clock of the operating system.

When first switched on, both the system clock and the RTC clock may not be set. To set them correctly

via a system connection, proceed as follows:

Setting the System Clock

Suppose, for example, that you want to set the date 23 September 2024, 12:30 p.m. Use the 'date' command as follows:

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

Synchronisation with the hardware clock (RTC)

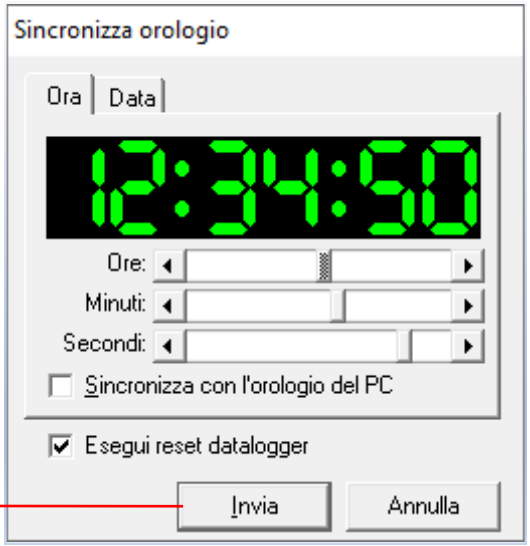
After setting the system clock, the hardware clock (RTC) must be synchronised with the following command:

```
$ hwclock --systohc
```

The above setup and synchronisation procedure can be simplified by using the **DAK** application software as described below:

Clock setting and synchronisation via DAK application

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

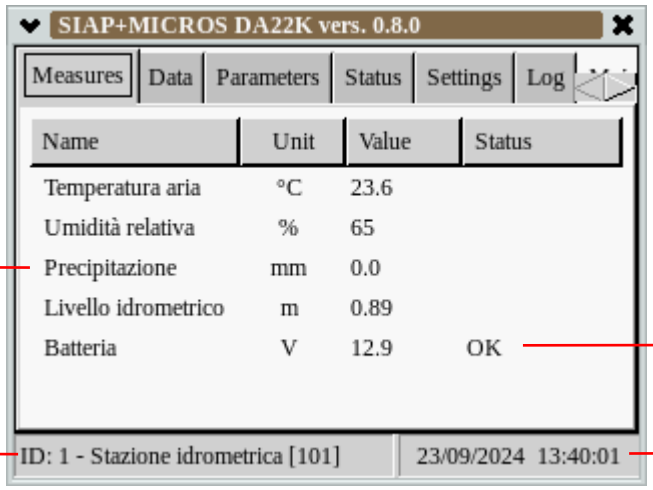


3.2 Display pages

The display of the DA22K control unit has seven graphic pages on which information on acquired measurements and data-logger status is shown. The information displayed depends on the settings and configuration loaded.

3.2.1 Current Measures

The **Measures** page shows the list of sensors being acquired and their respective measured values in real time. Only those items entered in the configuration are displayed as display lines. The page is normally refreshed every 3 seconds.



The fields in the measurement list are detailed:

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

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

✓	OKValue within measuring range
⚠ WARNING LOW / HIGH	Minimum / maximum pre-alarm
measurement🔺	/ HIGH Minimum / maximum alarm
measurement	
⊗ERROR / OVER RANGE	Acquisition error/ Measurement out of
range⚠ STOP	Sensor under maintenance

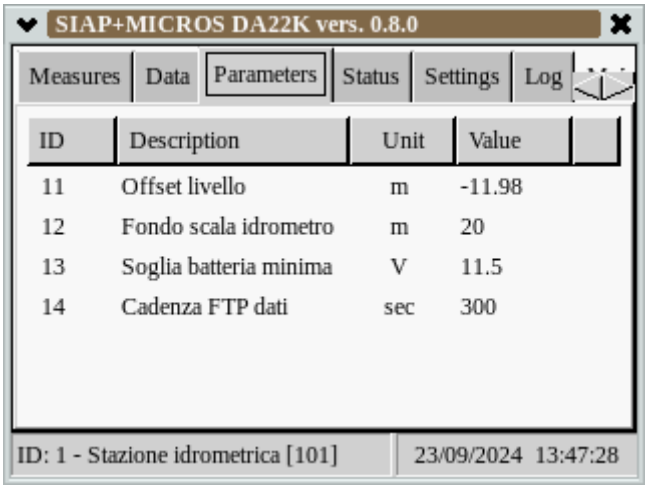
The ID and station name are always displayed in the bottom right-hand section of the window. On the left-hand side the date and time of the data logger.

3.2.2 Historical data

Functionality not available in the current version.

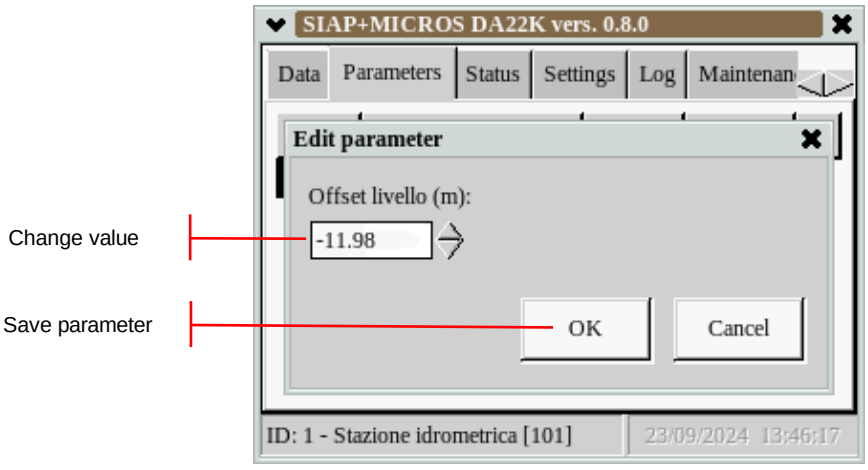
3.2.3 Parameters

The **Parameters** page lists the user parameters in the data-logger configuration. Each parameter is associated with a numeric ID, a description and a value. These values are normally used to parameterise various functions 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 dialogue box will open: ***Edit parameter***
2. Connect an external USB keyboard for typing.
3. Position yourself in 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.



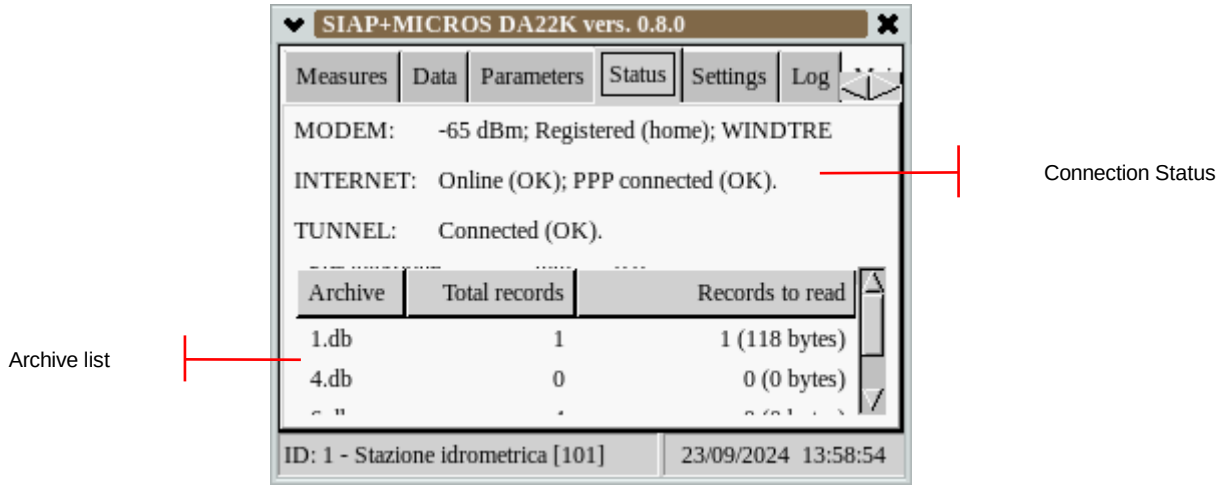
3.2.4 Status

The **Status** page shows some information about the status of the data logger.

In particular 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:

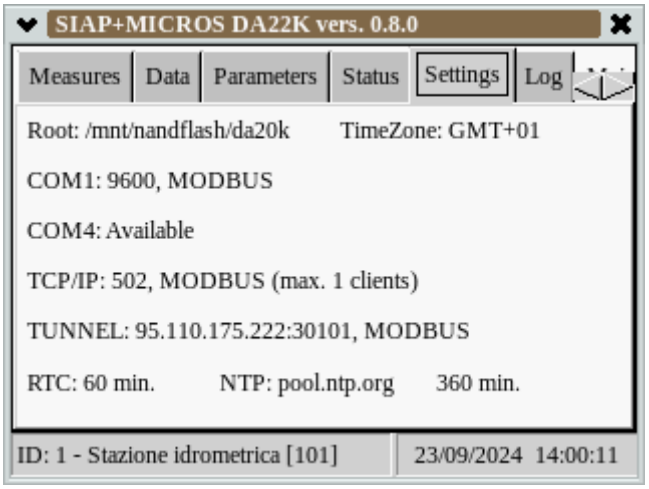


The lower part of the window lists the data logging archives (.db).
For each archive, the total amount of records currently stored (*Total records*) and the amount of records yet to be read/transferred (*Records to read*) are shown.

3.2.5 Settings

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

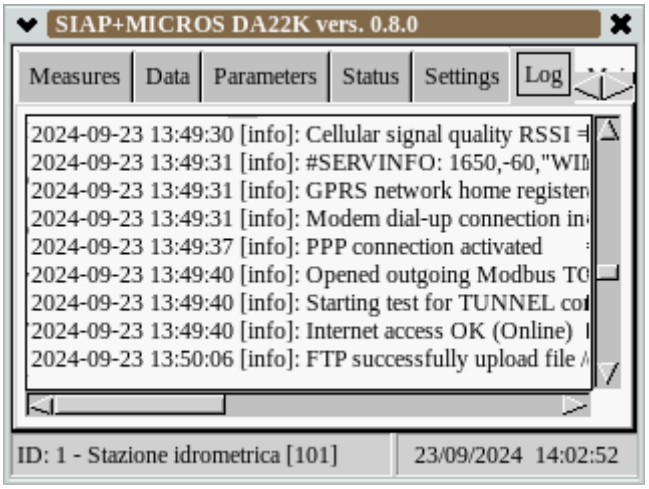
- The *root* path of the application and archives
- The local *time zone* (*TimeZone*)
- The speed and communication protocol for dialogue-enabled serial ports (COM1..COM4)
- The port and communication protocol for the incoming TCP/IP connection
- Address and communication protocol for connection to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



3.2.6 Log

The **Log** 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 synchronisation events (RTC, NTP)
- configuration update events, etc.

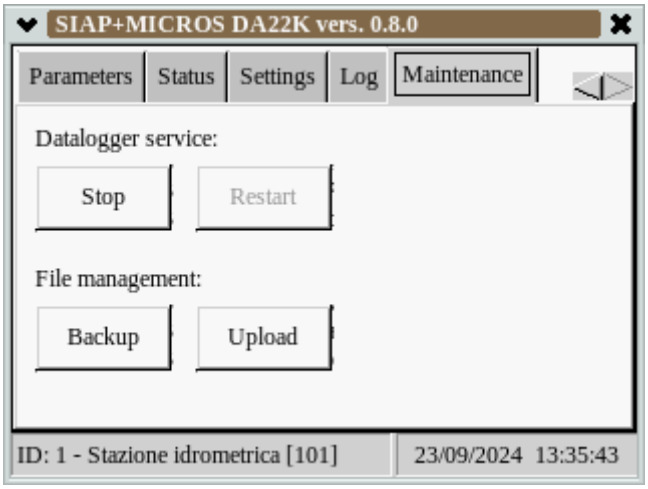


To scroll through messages, press or drag the vertical/horizontal bars.

3.2.7 Maintenance

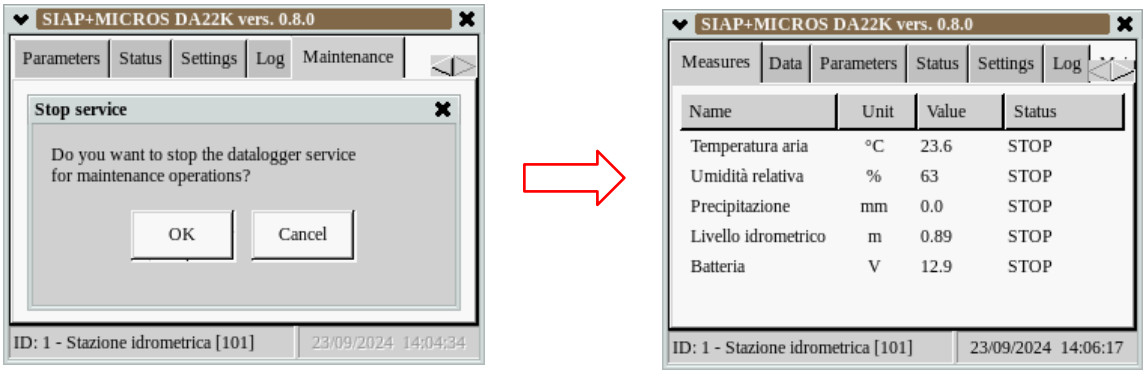
Via the Maintenance page, maintenance personnel can manage the following operations:

1. Stop the data-logger service for maintenance work on measuring sensors.
2. Back up or update configuration files from external disk media.



Data-logger service

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



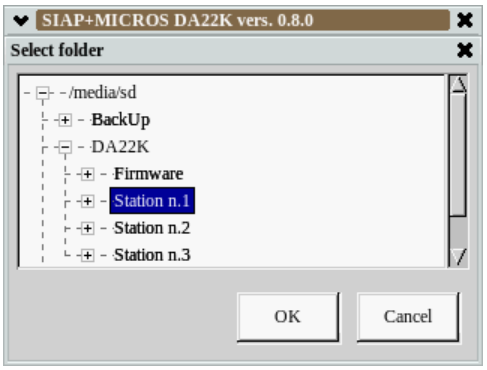
When finished, reactivate the service by pressing the **Restart** button.

In the event of a failed restart, the service will restart automatically after 4 hours of inactivity.

File Management

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

1. Insert SD Card or external USB disk.
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 No. 1*



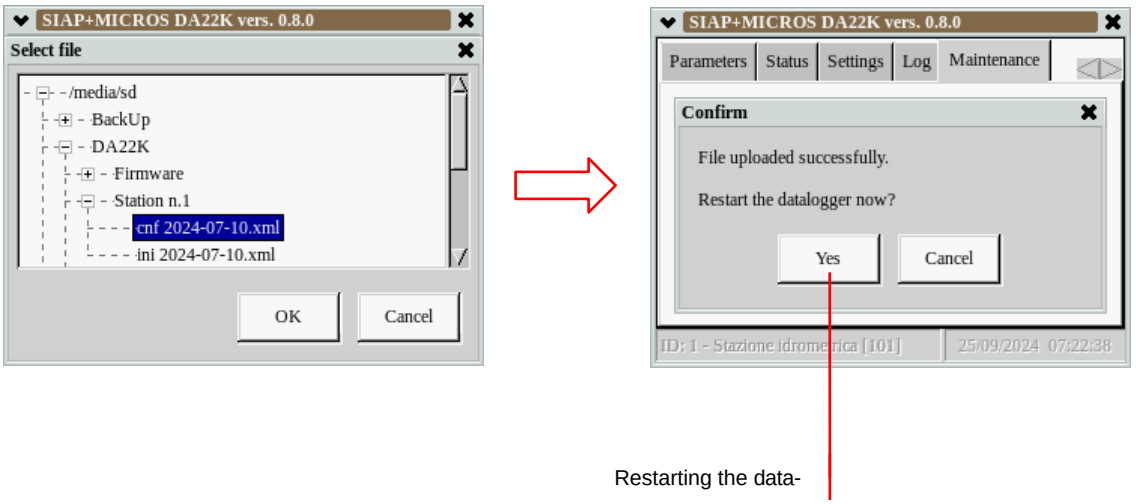
Files will be saved under the following names:

ini yyyy-mm-dd.xml

cnf yyyy-mm-dd.xml

To update a configuration file or data-logger application firmware, proceed as follows:

1. Insert SD Card or external USB disk.
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 data-logger application must be restarted for the update to take effect. Press *Yes* to confirm the restart.



Restarting the data-

3.3 Datalogger configuration

The configuration settings that the data-logger uses for its operation are contained in the following files:

- **ini.xml** Initialisation files
- **cnf.xml** Configuration files

The data-logger application loads the configuration settings at start-up and uses them as work programme instructions. Note that all data-loggers with factory settings are devoid of these files.

The content of each file is structured in XML language and is normally compiled and sent to the data logger via configuration management software. This does not preclude files from being created and edited directly by an XML text editor.

For the creation and management of the configuration, please refer to the use of the **DAK** application software with specific reference to ***the s012-d DAK*** *programming manual (DA9000/DA15K/DA18K/DA22K series datalogger programming manual)*.

The following paragraphs describe in detail all the XML elements provided. Examples of the files displayed via *Notepad++* are given for demonstration purposes.

3.3.1 Initialisation file

The **ini.xml** initialisation file is used for basic device settings, in particular for station identification and to configure the data-logger communication ports.
The settings are enclosed within the <SYSTEM> <INI> sections.

Example 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">
        <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 assume default values if they are omitted.

General settings:

- **device-id**: communication device identifier (ModBus Slave ID). Range: 1 to 247, Default = 1.
- storage-id: storage identifier (station ID). Range: 1 ÷ 9999, Default = *device-id*.
- station-name: name of the station.
- 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. To avoid DST, names such as *Etc/GMT, Etc/GMT-1*, etc. must be used. In this case, no change will be applied to the clock during the year.

Input connections for serial communication with the datalogger: a COMx serial port is opened for 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 criteria (0=Disable, 1=Enable, 2=Handshake, 3=Toggle). Default = 3;

Incoming 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: TCP port listening (Default = 502);
- protocol: communication protocol (1=S&F, 2=MODBUS, 4=PSE);
- max: maximum number of accepted *client* connections. Default = 3;

Outgoing connection to a remote Tunnel server; this mode allows the datalogger to be reachable via a TCP/IP port-to-port connection 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-hand 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**: test character sending interval (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 on RSSI signal, network registration, telephone operator, etc. (e.g. 'AT+CSQ;AT#SERVINFO');

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

<PPP/>

- **isp-name**: name of the PPP connection configuration provider file. The file must be located in the system folder: `/etc/ppp/peers` (Default: `internet`);
- **persist**: specifies whether the PPP connection is to be persistent (1 = always active) or whether it is activated when required (0 = only if required) e.g. before starting 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);

DDNS (Dynamic Domain Name System) 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 the IP address (e.g.: https://dynupdate.no-ip.com/nic/update)
- **username**: user name registered to the service;
- **password**: access password;
- hostname: associated domain name;

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

<NTP/>

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

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

<RTC/>

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

Watchdog used to ensure the correct functioning of the device. It solves situations where the system is blocked 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 switches off the power supply to reset the data logger.
- **run-timeout**: maximum idle time of the main cycle (Default: 60 seconds);
- data-timeout: maximum time of no data transfer. Set 0 to disable control (Default: 86400 seconds);

In the event of expiry of the set maximum times (timeout), the internal process sends a particular sequence of impulses that immediately triggers the Watchdog with a consequent restart of the data-logger.

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

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

(2) NTP synchronisation updates both the system clock and the hardware clock RTC.

3.3.2 Configuration Files

The configuration file **cnf.xml** contains the settings and functions programmed by the user for the data-logger work cycle. These are enclosed 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 executed by the data-logger programme sequentially within a main work cycle.

The execution sequence of the main cycle consists of the following work steps in this order: 1°

MEASURE ACQUISITION

2ND DATA PROCESSING

3° CHECKS

4TH DATA STORAGE

5TH DATA TRANSMISSION

Note how the functions are entered in the order described in the configuration file.

Other functions that require longer execution times or that would otherwise be blocking for cycle time purposes are executed in separate work processes, in particular the data transmission functions and the management of communication peripherals with the data-logger.

The secondary processes (or work *threads*) can be listed as follows:

- Serial communication thread (reception on COM1..COM4 ports).
- TCP/IP communication thread (incoming TCP/IP connection).
- Dial-up modem connection process (PPP).
- Tunnel server connection process.
- FTP file transfer process.
- Date/time synchronisation process (NTP, RTC).
- Display measurement process.

3.3.4 User Parameters

The parameters section allows user-defined parameters to be entered and maintained in the configuration file. Parameter values can be changed locally from the data-logger display (see section *3.2.3 Parameters*).

The parameters can be used in the following cases:

- as a flag to disable measures or other functionalities;
- in measurement conversion expressions or any other evaluation expression;
- 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 ***$id***, i.e. to specify the numerical identifier of the parameter preceded by the '$' 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**: numerical identifier of the parameter;
- **name**: parameter name.
- unit: unit of measurement;
- **value**: value assigned;

3.3.5 Measurement acquisition

The measurement acquisition section is configured by entering the sensors and/or cards 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 interrogation undergoes pre-processing to convert the value into engineering units and a subsequent validity check.

An example of the XML structure describing the acquisition section of several 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 (main communication standards highlighted):
    0. Internal data-logger system (tag variable, date/time, RSSI signal, connection status)
    1. <reserved>
    2. MODBUS standard
    3. <reserved>
    4. <reserved>
    5. <reserved>
- **id**: alphanumeric identifying 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. <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 - 2 bits; (default: 1);
- **ip**: IP address (TCP/IP sensor);
- port: port (TCP/IP sensor);
- **scan**: interval, in milliseconds, at which the sensor is interrogated; in some cases the scan may be defined successively 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 identifies the internal memory location; for MODBUS sensors it identifies the read address according to the data addressing convention standard[(1)].
- 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 = Long integer (32-bit), 4 = Swapped Long (32-bit), 5 = Floating-Point (4 bytes), 6 = Swapped F.P. (4 bytes), 7= Double float (8 bytes), 8 = Swapped Double (8 bytes)
- **scan**: interval, in milliseconds, at which the channel is interrogated (if not already specified at sensor level).
- **cmd**: specifies a possible command for a generic ASCII serial device (e.g. 'SEND' for barometric sensorA).
- **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* of measurement validity range;
- **upp**: *upper limit* range of validity of the measurement (*upper limit*)**;**
- **tag**: memory location in which the acquired measurement (*tag*) is stored;

[(1)] Addressing convention reading MODBUS data:

(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, takes care of processing the acquired measurements at specific intervals. Valid samples of input measurements (*tag_inp*) are fed 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*).

Example of 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. Statistical processing (standard)
    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***: set of tag variable locations provided as input (measurements).
- **tag_out1**...***tag_outN***: set of tag variable locations resulting in output (data).

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

Statistical processing (standard)

Attribute		*Description*
param1	→	Acceptability criterion given (maximum permissible 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	←	Valid measurement counter
tag_out3	←	Percentage of valid measurements [%].
tag_out4	←	Summation
tag_out5	←	Media
tag_out6	←	Minimum
tag_out7	←	Minute of minimum [daily minute]
tag_out8	←	Maximum
tag_out9	←	Minute of maximum [daily minute]
tag_out10	←	Variance
tag_out11	←	Standard deviation
tag_out12	←	Measurement reference (value of 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 permissible variation: 0 = not applied)
tag_inp1	→	Instantaneous measurement (input)
tag_out1	←	Cyclic counter
tag_out2	←	Valid measurement counter
tag_out3	←	Percentage of valid measurements [%].
tag_out4	←	Mobile accumulation
tag_out5	←	Moving average
tag_out6	←	Mobile drift
tag_out7	←	Mobile minimum
tag_out8	←	Maximum mobile

Rainfall processing (rainfall)

Attribute		*Description*
tag_inp1	→	Pluviometric measurement acquired [mm] (input)
tag_out1	←	Cyclic counter
tag_out2	←	Valid measurement counter
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 rain [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 speed measurement (input)
tag_inp2	→	Instantaneous direction measurement (input)
tag_out1	←	Cyclic counter
tag_out2	←	Valid speed measurement counter
tag_out3	←	Counter valid measurements direction
tag_out4	←	Speed 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 (resulting 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 [Minute per day].
tag_out17	←	DIRECTION AT MAXIMUM SPEED [°N].
tag_out18	←	DIR. SET. AT MAXIMUM SPEED [°N]
tag_out19	←	Prevailing 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(*) [Minute per day].
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 only available at the end of the processing period

3.3.7 Control functions

The control section is dedicated to alarm management and the control of digital and/or analogue outputs to external devices or locally on the data logger itself.

The control functions currently available are:

- Alarm control
- MODBUS output control

Example of the control 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 carried out (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: variable tag location in output (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 rises (or falls) above the relevant maximum (or minimum) threshold after a specified dwell time, the corresponding alarm is 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 to 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 - 2 bits; (default: 1);
- **ip**: IP address (Modbus TCP/IP);
- port: port (Modbus TCP/IP);
- **scan**: interval at which the check is carried out (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 = Long integer (32-bit), 4 = Swapped Long (32-bit), 5 = Floating-Point (4 bytes), 6 = Swapped F.P. (4 bytes), 7= Double
      float (8 bytes), 8 = Swapped Double (8 bytes)

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

3.3.8 Data storage

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

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

Each file is a *SQLite 3* database named as follows:

<*n*>.db with **<*n*> =** number assigned to the archive
.db extension for database type files

Each archive may contain one of the following record types:

- Plotting historical data.
- Plotting instant data.
- Alarm trace.

The archives are managed by the data logger in circular mode. Once the maximum number of records (86400) has been reached, storage continues by overwriting the oldest records.
Data logging autonomy is in any case determined by the configuration adopted on the data logger. An estimate can be deduced from the following table:

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

The configuration for data logging 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>
```

Registration configuration: <RECORD ...>

- **name**: name or description of the record;
- **id:** alternative storage identifier (optional if different from station ID);
- **type**: type of record layout:
    0. HISTORICAL Record
    1. INSTANT record
    2. Record ALARM (1)
- format: record format:
    0. SIAP+MICROS standard dynamic record format
- **scan**: interval in seconds at which the record is made;
- **shift**: interval shift (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 back-up of the record (not in use);
- **view**: enables/disables data display (not in use);

(1) Alarm logging is performed for events not yet logged at the end of the scan interval.

Data field configuration: <WRITE .../>

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

(2) Letter identifying the type of statistical data:

- 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
- L' = Minute of the minimum
- M' = Minute of maximum
- 'R' = Error code
- J' = Diagnostic status

Data retention function in memory

The function performs a maintenance copy of the last archived data. This functionality 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 hold period;
- **shift**: interval shift to delay or advance storage (seconds);

3.3.9 Data Transmission

The data-logger can be configured to transmit the following data in various ways:

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

The main transmission function uses the following protocols:

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

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="Send 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_DATAdat      " dir="/..."/>
    </FTP>
</TRANSMISSIONS>.
```

The FTP function uses a secondary process to transfer data by taking files from a local source folder. 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 secure the transfer process.

The preparation of the data file takes place according to the programmed scan interval. Any data recovery after a communication interruption will be handled with more frequent scans (up to 5 minutes).

When transferring image files from webcams or other file types, 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, it is also possible to perform data compression (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: access password;
- **dir**: remote destination (or pick-up) directory;
- tag: outgoing tag variable location (transfer outcome);

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

- **name**: sending description;
- **scan**: session interval at which the copy of the file to be sent is prepared (seconds);
- **shift**: interval shift;
- **source**: number or name of the archive from which the data is to be taken (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**: transformation of the record layout:
  0. No transformation (SIAP+MICROS standard native record layout)
  1. SIAP+MICROS Standard Normalised Dynamic Record Track
  2. <reserved>
  3. <reserved>
- **cpr:** file compression (default: 0=No);
- target: name of the target remote file (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 at which the file to be downloaded is searched (seconds);
- **shift**: interval shift;
- source: name of the source file to be downloaded (e.g. cnf.xml);
- **target**: name of the local target file (default: = source);
- **dir**: remote pick-up directory (optional); if different from the one specified above;

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

%iiiID of station storage

%yyy%mm%ddCurrent year, month and day

%hh%nn%ssCurrent hour , minute and second

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

3.3.10 Display visualisation

In this section, the user defines the rows of data to be shown on the display (section *3.2.1 Current Measurements*). The display order 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:

```
<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="Water 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: variable tag location of the data to be displayed.
- unit: unit of measurement.
- **dec**: number of decimals (value formatting).

3.3.11 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 ***id*** (e.g. $11 = parameter value 11)
Mi	Value of 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 current measurement just acquired.
Vi	Validation status of memory variable ***i*** (e.g. V1 = validation status 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
^	Power elevation
MOD	Remainder of division

Logical operators

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

Comparison operators

=	Equal
>	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 to 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 Track data record

The data stored in the data-logger archive are natively formatted according to the SIAP+MICROS standard defined as ***Dynamic Record Track*.**

The Dynamic Record Track contains information regarding the station of origin (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 paths with a *dynamic structure*, the length of the path varies according to the number and type of data contained. Therefore, in situations where the data to be entered in the layout is minimal, the length of the layout 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 (*Instant Data, Statistical Data, Alarm Data,* 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 carried out in separate areas of the memory. The division into areas is dictated, as described below, by precise archiving requirements.
Data are stored in the corresponding memory area and are written as recognisable ASCII character sequences. The storage modes depend on the specific type of *data* in question. These modes are described by the *Record Paths* that define their structure. Four different storage modes have been implemented, one for each type of *data*.

The track types are:

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

For a detailed description of the Siap+Micros record tracks, please refer to the ***s011-d Dynamic Records*** manual.

3.5 Command interpretation

Using the Modbus RTU / TCP/IP input communication protocol, the data-logger implements *the User-Defined* function No. 65 with which a set of specific commands (*Siap+Micros* command set) can be conveyed.

Below is the function specification and the complete list of commands that can be interpreted by the data logger.

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 commands are not sent correctly, the data-logger will respond with:

<*command* name>	for unrecognised command
-1	for incorrect parameters

3.5.2 General commands

Communication identifier <device-id>.

Reading command: **R IDSTAZ**
Response: IDSTAZ <device-id>.

Write command(*): **W IDSTAZ=<device-id>.**
Response: IDSTAZ <device-id>.

Storage identifier *<storage-id>* Read

command: **R ID_MEM**
Response: ID_MEM <storage-id>.

Write command(*): **W ID_MEM=<storage-id>.**
Response: ID_MEM <storage-id>.

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

Clock

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

command: **CLK**
Response: <hh> <nn> <ss> <dd> <mm> <yyy>

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

Firmware version

Read command: **FW**
Response: DA22K vers. <x>.<y>.<z>.

Reset data-logger (software restart)

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

Reboot data-logger (hardware reboot)

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

3.5.3 Variable and parameter management

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.

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

User parameter (identifier: <*id*>)

Read command:	**!RP <id>.**
Response:	<value>
Write command:	**!WP <id> <value>.**
Response:	<value>

3.5.4 Archive management

Specify the archive number with: <file>.

Size (KB)

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

Free space (KB)

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

Space used (KB)

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

Sequential *Read Data*

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

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

Read Set Confirmation

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

Command: **!RS <file> <user>.**
Response: *no answer*

Restore data reading

The command returns the read pointer immediately after the write pointer so that the entire file can be read again. Specify: archive number <*file*> and user <user>.

Command: **!RE <file> <user>.**
Response: *no answer*

Data erasure (*Scratch*)

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

Command: **!SC <file>.**
Response: *no answer*

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> <nn> <ss>**
Response: *<bytes to* read>

(*) Note: This command only uses user no. 1

Writing data (*)

The command performs a write to the specified data file (file no. 1 ÷ 253):

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

(*) Obsolete command. Use the !WRB command as an alternative

Writing data with pointer

The command writes to the specified data file (file no.1 ÷ 253) or to a predefined system 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 answer*

Latest data request

The command returns the data of the last record that occurred or the last records that occurred in a pre-configured retention period (retention interval).
For example, with a retention interval pre-configured at 30 minutes, sending a request in the time slot 08:30÷08:59, the reply received will contain the records present from 08:01 to 08:30 inclusive.
If you send 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 reply will only contain the last record.
In the request message, it is mandatory to specify the archive from which you want to read the data (*file*).

Syntax:

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

The command can additionally synchronise the data-logger 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 synchronisation will only be performed if the current setting of the data logger differs between ±3 sec. and ±50 min.

Historical data request

The command can be used to request/retrieve data records within a specific historical interval. If present, all records prior to the requested instant within the pre-configured 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 back will be returned. To retrieve data from 00:31 to 01:00, a request must be sent specifying 01:00:00.
If the retention period is not configured, the response will only contain the requested record.
In the request message it is mandatory to specify not only the archive from which you want to read the data (*file*), but also 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 *path*> (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 (data-logger DA22K)

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

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 output O0 to ON

Digital outputs DIG OUT OD1 to 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 digital output OD1

OD1 OFF // Deactivates digital output OD1

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

12V OFF // Deactivates the 12V powered digital output

4 Regulations

4.1 Safety Standards

The detailed examination of the design and method of implementation has made it possible to establish what risks the product will 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 fulfilled regardless of which directive they belong to. Two conditions are therefore necessary for the application of a directive to a product:

- the product falls within its scope of application

- the product presents hazards to which the essential requirements of the directive relate.

The risk analysis conducted, described on the following pages, showed that the European directives applicable to the product in question are as follows:

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

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

4.2 EMC

This equipment has been designed in accordance with the requirements of the directives indicated in the EC declaration enclosed with 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.
Reasonable foreseeable misuse and contraindications of use	Use in a domestic, consumer or hobby environment is improper; use by unqualified and/or inadequately trained persons.
Environment of use	It is not intended for use in environments with corrosive and flammable explosive gases or vapours.
Critical environmental factors, if any	The environmental conditions for proper use are: - Reference temperature: 20 °C - Temperature range -40 ÷ 80 °C - Maximum permissible 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 appropriately trained and informed of the risks involved.

NOTES

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