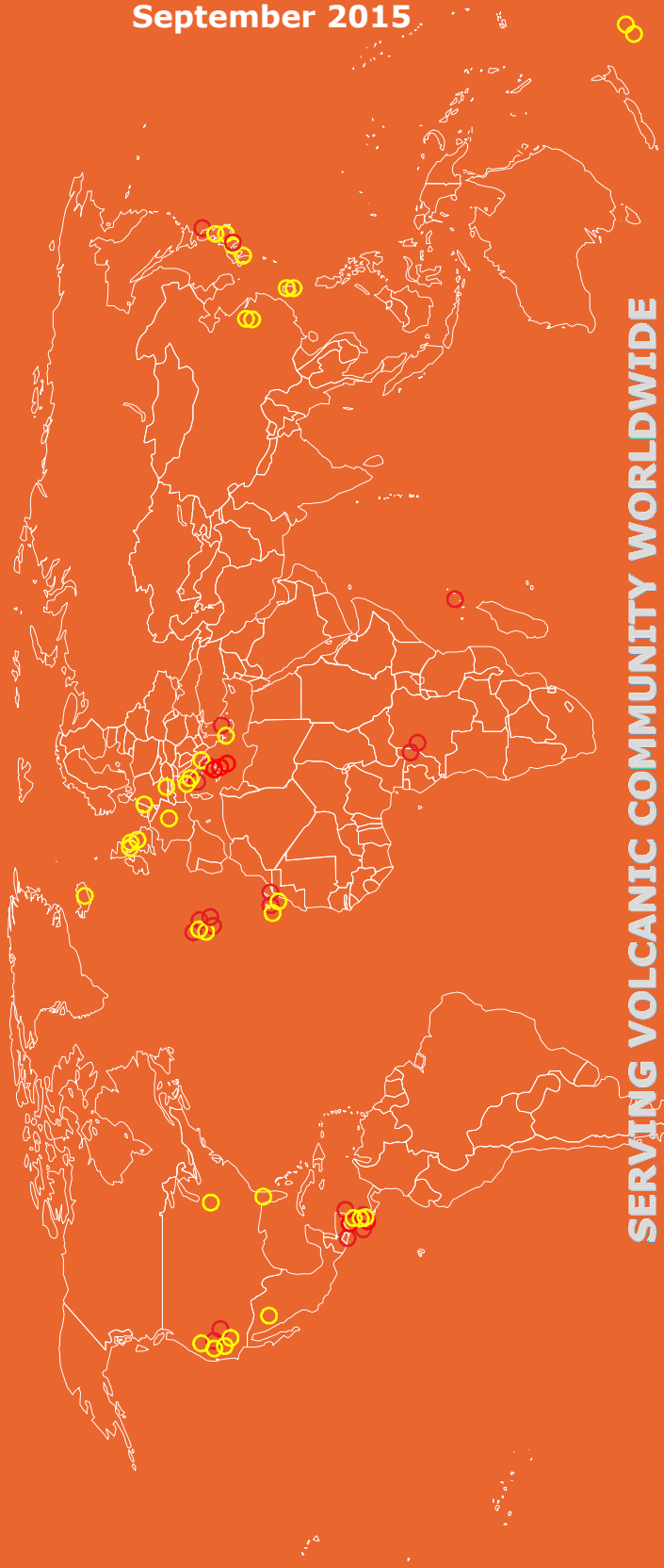
Continuous Monitoring Flux Station

Handbook

Release 3.2
September 2015



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WEST Systems
ITALY

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BEFORE YOU SHIP THE INSTRUMENT BACK TO ITALY REMEMBER:

- When you ask your shipping agent to send the instrument to Italy check that on the Air Waybill the Airport of destination is PISA. Any other airport of destination creates a lot of problems in delivering the items (delay, costs, custom problems, etc).
- Check that the Company your shipping agent chooses lands in Galileo Galilei Airport in Pisa. If not, ask your shipping agent to change the Company or send the items by DHL or UPS or FedEx.
- Mark each item with a serial number, if not already present, and write this number on the document (proforma or original invoice or item list) where you list the parts you are sending back to Italy.
- Specify a correct value of the parts you are sending back in the documents mentioned above.

Pay attention to these rules because Custom law in Italy is very complicated and probably different from your Country.
If you follow these suggestions everything will be easier for you and for us.

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1.Introduction

1.1 Safety information

Carbon dioxide is a TOXIC GAS,
Carbon dioxide is colorless, odorless, tasteless and is heavier than air. Air concentration higher than 5000 ppm can cause dizziness, shortness of breath, rapid pulse. Higher concentrations of carbon dioxide can be **lethal**.

Diffuse carbon dioxide fluxes are normally related to anomalous carbon dioxide air concentration. The user must verify the safety conditions before entering dangerous areas using specific and approvated instrumentation.

The Fluxmeter described in this manual is designed to measure diffuse emission of soil gases and CANNOT be used for different purposes expecially if related with safety.

The instrument and the electronic accessories are NOT designed to work in explosion risk areas.

1.2 Hints

About installation
Before to start the installation of the FluxStation is better to install the Master center telemetry systems and to setup the WS-Scada software suite on the computer.
The on field installation is described on chapter 2.

Fluxstation & computer clocks synchronization
Since the telemetry is usually active only for a certain time window, it's important that the clock of the flux station is correct, otherwise the master centre PC won't be able to communicate.
For example with this station configuration:
- Analysis Frequency (timing 0): 3600 seconds (analysis every hour)
- Radio On (timing 30): 600000 milliseconds (10 minutes)
- Radio Off (timing 31): 900000 milliseconds (15 minutes).

The radio will be ON only for 5 minutes every hour. So if the master centre PC clock and the flux station clock are not synchronized, there won't be communication (and you will have to manually try, continuously for an hour, to call the station..).
To check and eventually set the station clock (see chapter 6) enter in menu [SETTINGS]
[GET CLOCK TIME-DATE].

About carbon dioxide flux
The flux phenomena can be perturbated by the installation, because digging the soil, hammering, placing the collar etc.

1 Introduction

The “normal” regime is restored in few days.

2. On-Field Installation

2.1 Installation of the Shelter

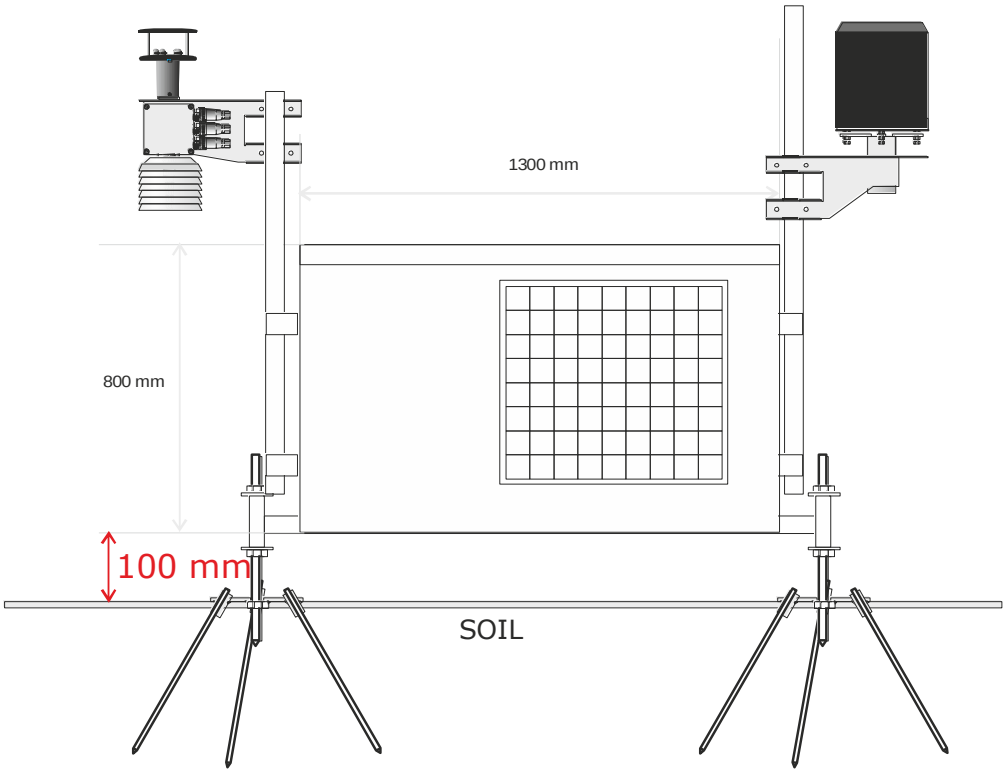
Select the installation site after a carbon dioxide flux survey. The best location is in the middle of an anomalous efflux area with an homogeneous flux distribution. The optimal flux value is in the range from 2 to 250 moles per square meter per day. For the choice of the site, it is necessary to take into account that the solar panel has to be oriented toward in the correct direction and that it must be exposed to sunbeams at least for 4-6 hours per day. It is necessary to take into account also the functioning of the telemetry system.

In case you are using GSM telemetry please verify the coverage and the signal strength using a mobile telephone with a SIM card of the provider you choose for data transmission. In case you use a SSR24 telemetry from the selected site you must have a very good direct visibility of the Master Center or of the site where you will install the radio repeater bridge if necessary.

Moreover it is necessary to evaluate the soil stability and the possibility of flooding.

If besides the carbon dioxide emission also strong water vapour emission are present it is necessary to evaluate the possibility of installation of a water condensing system along the gas sampling line.

Install the box wit the solar panel orientated by means of a compass. Fix the sensors and antenna poles , the different sensors, the accumulation chamber and then the station. Following the instructions described in the next pages connect the different devices.

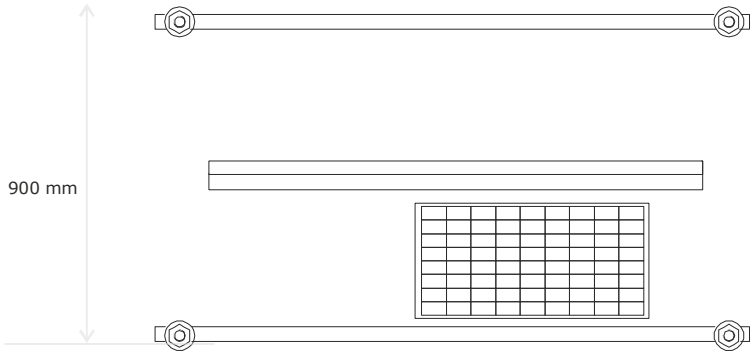


2 On Field Installation

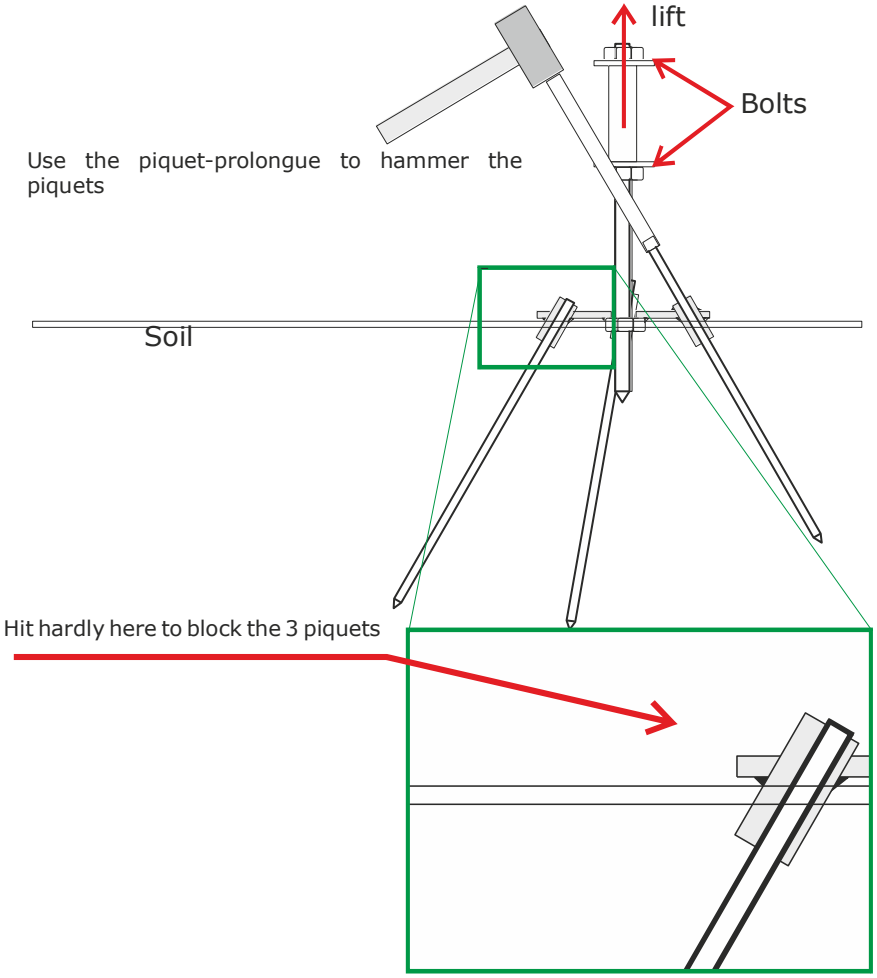
The base of the shelter must be 10 - 15 cm far from the soil, else the length of the accumulation chamber cables could be not enough.

The 10 cm distance allows a good circulation of atmospheric air in the accumulation chamber area, else the entire shelter become a big accumulation chamber....

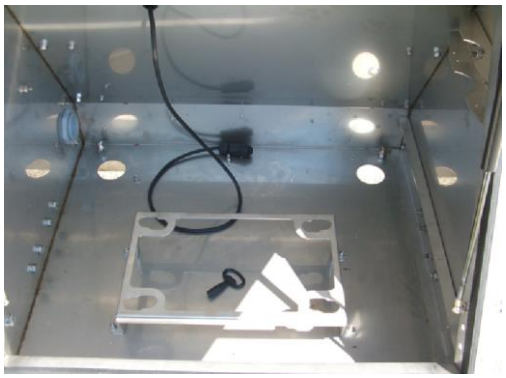
In the drawing the top view of the protection box (DHW), the sensor are not showed.



To place the piquets: Unscrew the bolts and lift at the maximum elevation the shelter:
After the installation of piquets down to the shelter at 10 cm distance from soil.



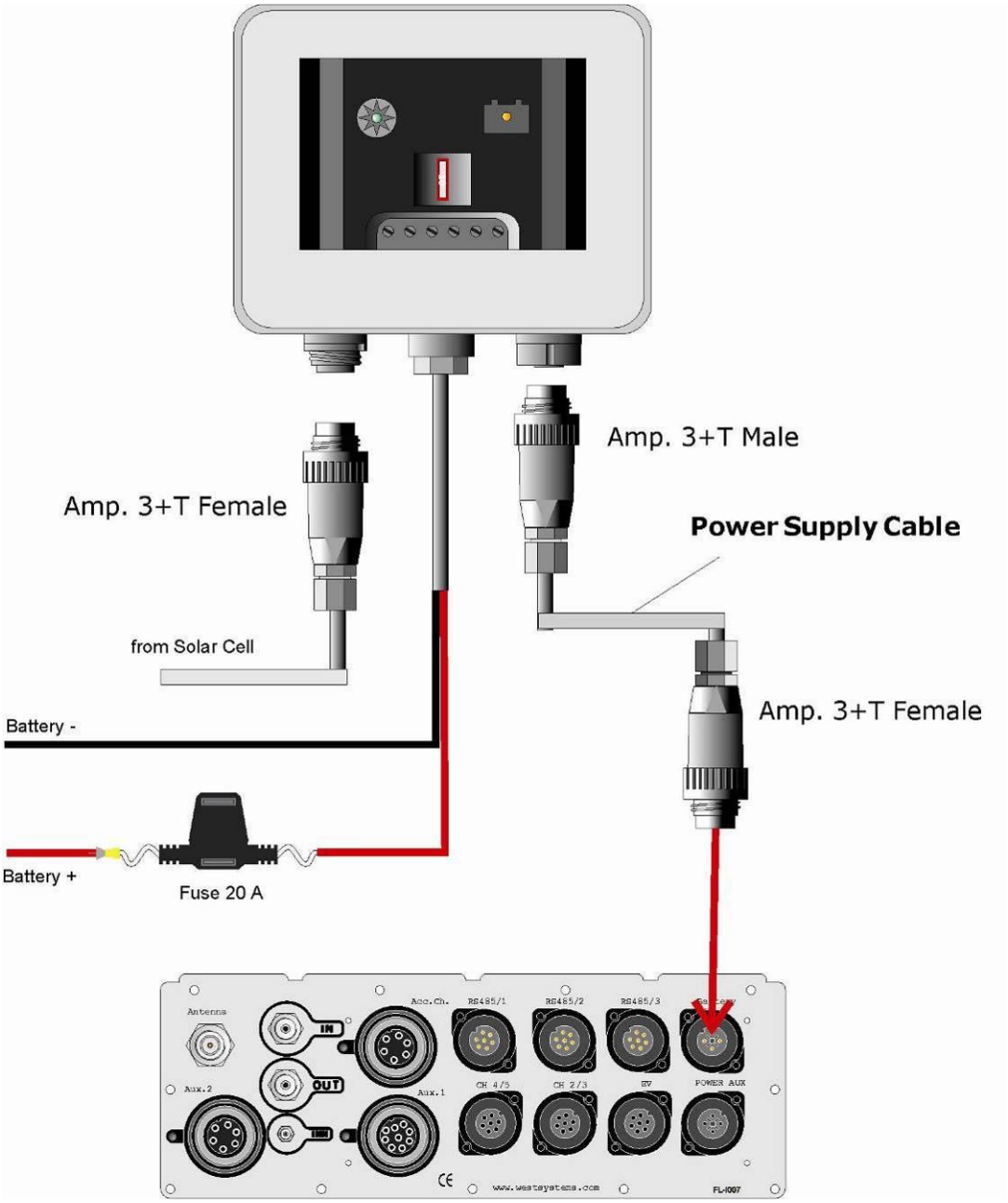
In the picture one of the four stand with the 3 pickets. The soil on the picture is not exactly a “soft” soil...



In the picture the “chair” for the FluxStation case that must be mounted on the right part of the shelter to put the fluxstation in a accessible position.

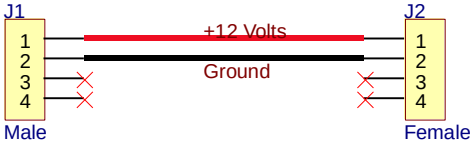
2 On Field Installation

2.2 Power Supply



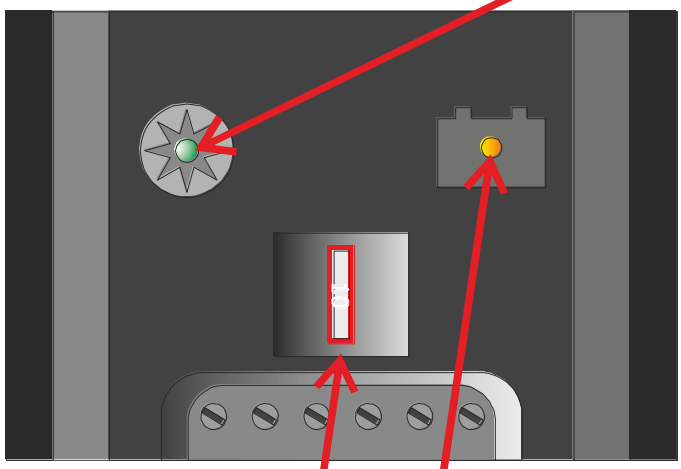
Power supply cable (POW_SUP1)

J1 Amphenol 3 + T Pin Male J2 Amphenol 3 + T Pin Female



2.3 Solar cell charge regulator

The LED light is ON when the solar cell is exposed to sunlight



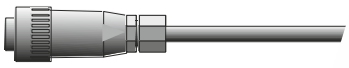
The LED light is:
Green when the battery is full
Yellow normal charge
Red when the battery is empty

10 Ampere fuse (car type)

If the battery voltage fall down to 11.1 Volt the charge regulator turn off the load (the flux station) in order to save the battery against the overdischarge. The load will be reconnected when the battery voltage grows up to 12.6 Volt.

If the battery voltage fall down to 11.1 Volt the charge regulator turn off the load (the flux station) in order to save the battery against the overdischarge.

Solar cell cable



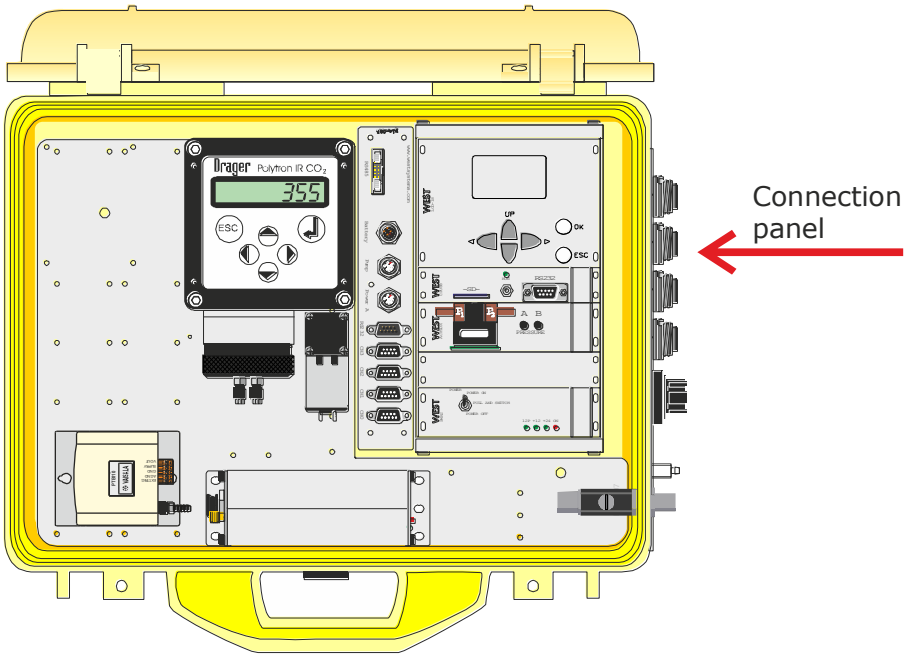
SC Ground

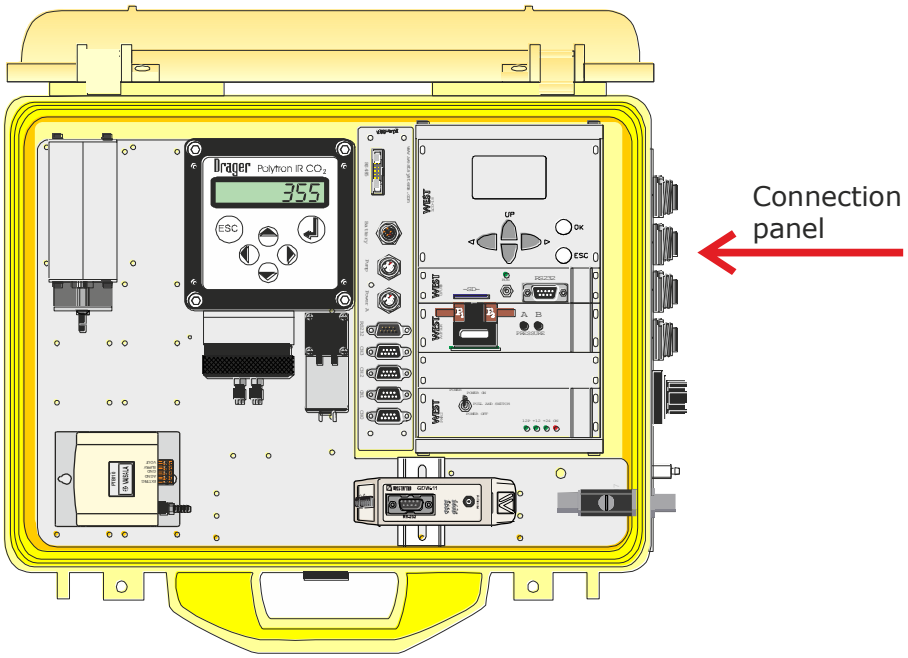
SC +12V

J3 Amphenol 3 + T Pin Female

2 On Field Installation

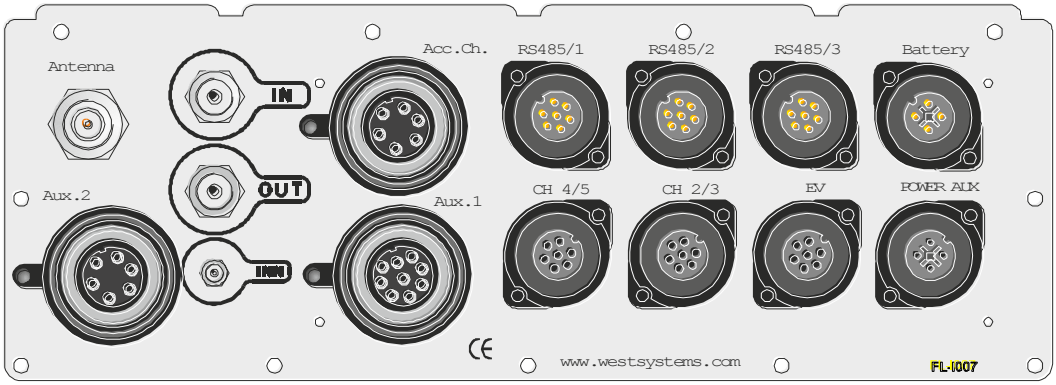
2.4 Station connections





The top layout is about the telemetry stations otherwise the bottom layout is about the gprs stations. All electrical and pneumatic connections to the flux station are on the right side connection panel.

2.5 Station connection panel



Ports RS485 1/2/3 are used for digital sensors. They're all connected to the same RS485 line so you can plug the digital sensors (e.g. airbox, soilbox, weather station) to any port indifferently.

Port Ch 2/3 and Ch 4/5 are used to connect additional sensors with analog output to the station. In the default configuration, channel 2 accepts current input (4-20 mA). Channels 3-4-5 accept voltage input (0-5 Volts). Note that channels 2 and 3 input are replied inside the case in the backplane ports.

Battery is the power input port. It's connected to the charge regulator or to a power supply.

Power AUX is a power output port. It can be used to power any device with the same power input that comes from the Battery port.

EV is the digital output port. The station has 4 digital output signals that can be configured to turn on or off at a certain moment of the flux analysis.

Acc Ch. and Aux.1 ports are used to connect the accumulation chamber.

Follow the instruction on the next pages for the connection of the detectors and devices to the flux station.

External sensors connections

The FluxStation is supplied with several meteorological and soil parameters sensors.
Some of them are managed by the AirBox:

- Air temperature and relative humidity;
- Wind speed and direction;
- Rain fall gauge;

and the others by the SoilBox:

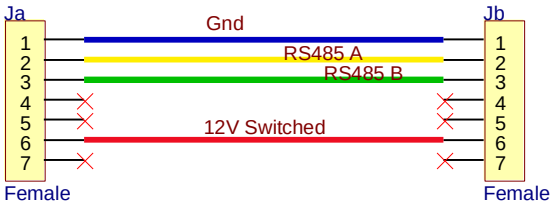
- Soil temperature;
- Soil water content;

SoilBox and AirBox , described in detail in the Appendix S and Appendix A, are connected with the FluxStation using a RS485 cable:

2 On Field Installation

Rs485 cable (RS485_1)

Ja Amphenol 6 + T Pin Female Jb Amphenol 6 + T Pin Female



RS485 Cable

Pin	Function	Color
1	Gnd	Blue
2	RS485 A	Yellow
3	RS485 B	Green
4	n.c.	
5	n.c.	
6	+12V	Red
T	n.c.	

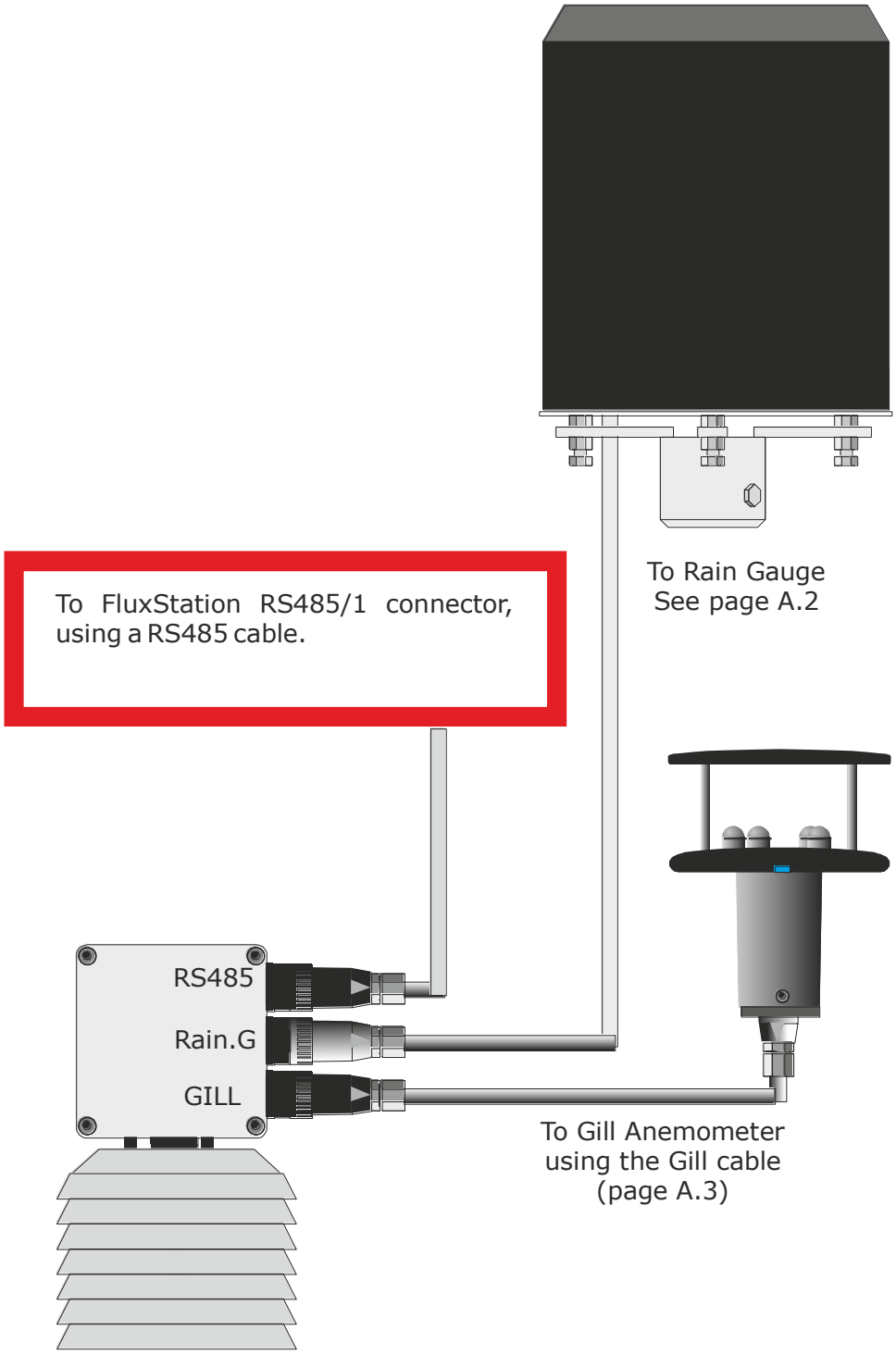
The FluxStation RS485 connectors

The FluxStation is equipped with 3 RS485 connectors , marked as RS485/1, RS485/2, RS485/3;

RS485/1, 2 and 3 have the same pin-out and the same function.

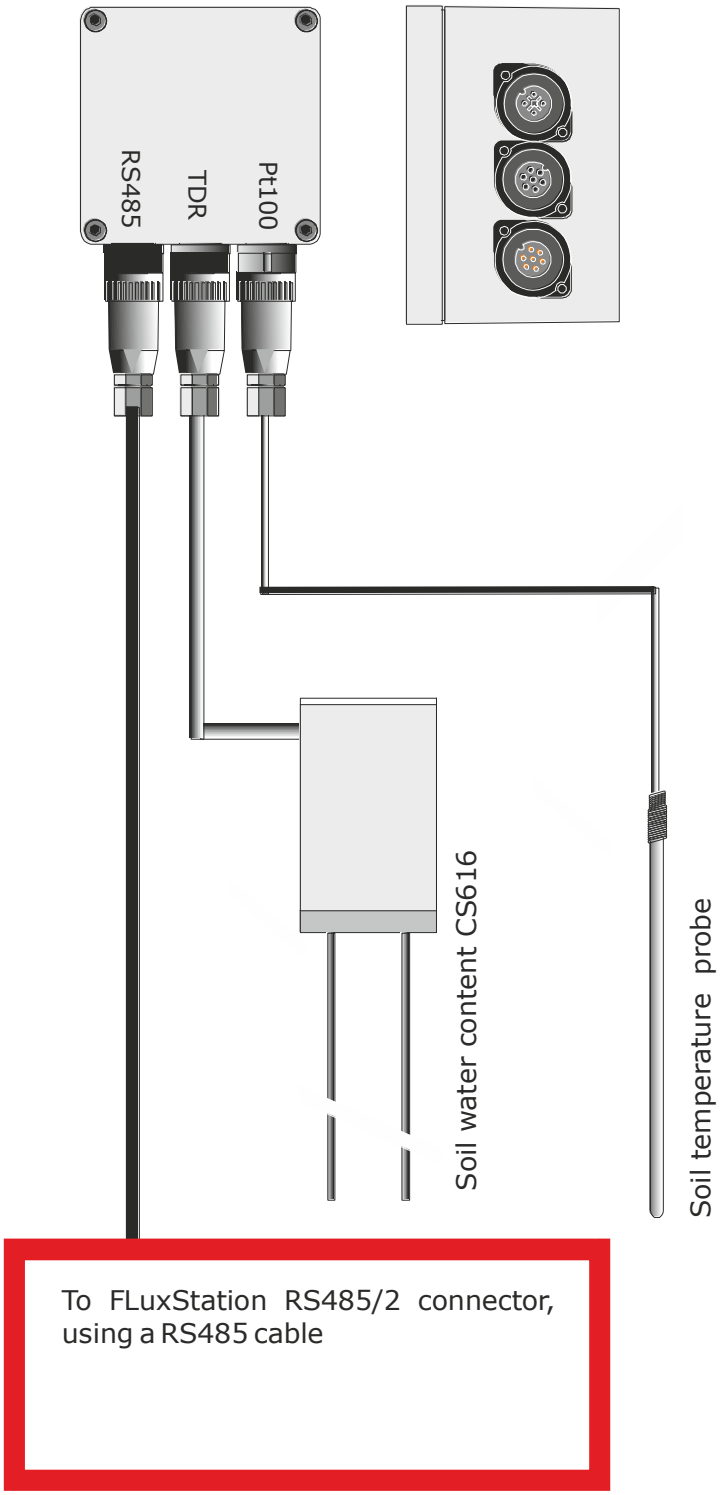
2.6 Meteorological detectors and AirBox connections

The air box is a new interface described in detail in the appendix A that allows the use of the new sonic wind speed and direction gauge as well as the new air temperature and relative humidity digital probe.
A rain gauge can be connected to the AirBox.

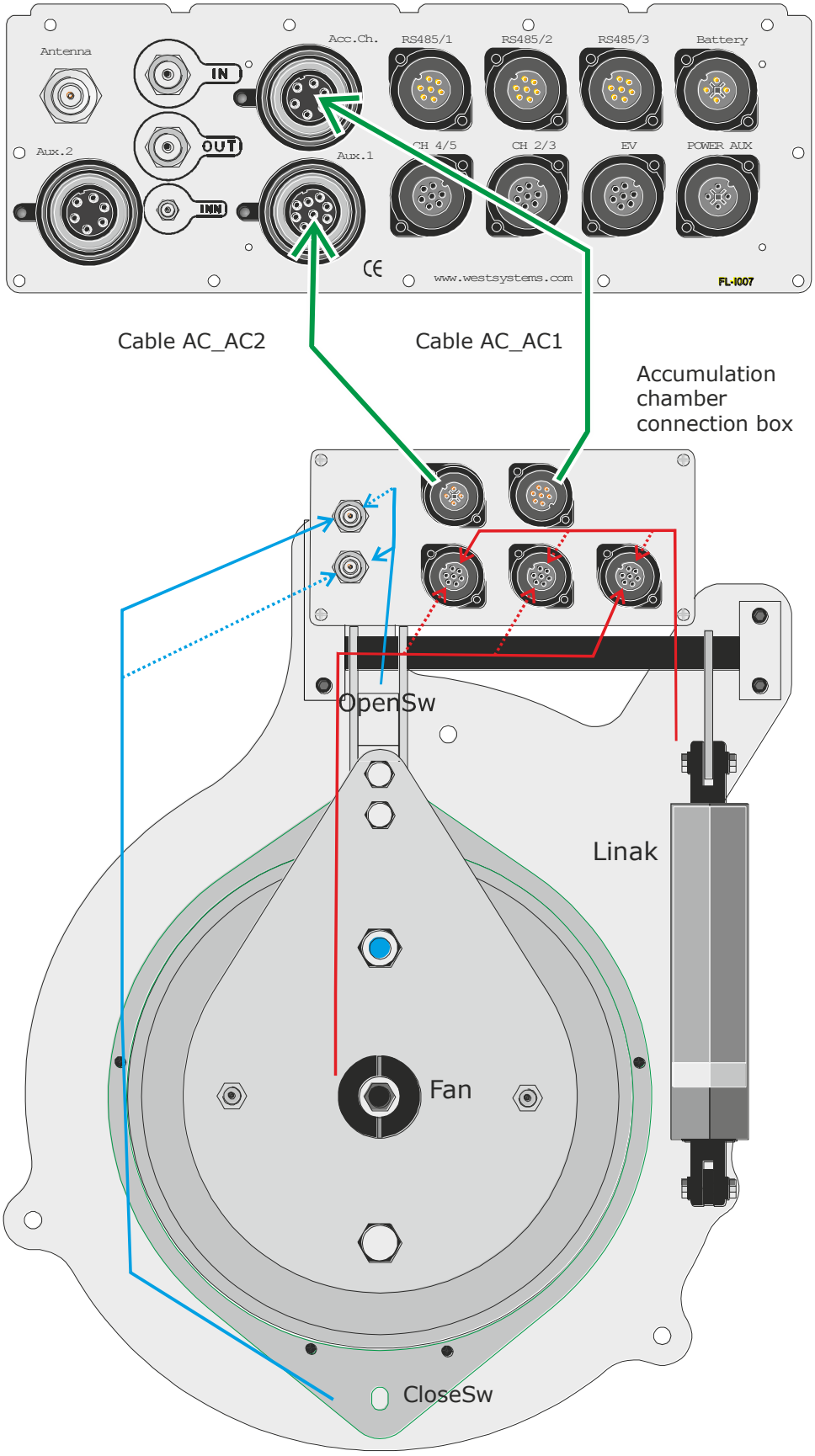


2.7 SoilBox connections

The Soil.Box, described in deep in the appendix S, is the new interface for the soil sensors..
A platinum 100 Ohm temperature probe and a Campbel Scientific CS616 Time Domain Reflectometer can be connected to the soil.box in order to measure the soil temperature and the soil water content.



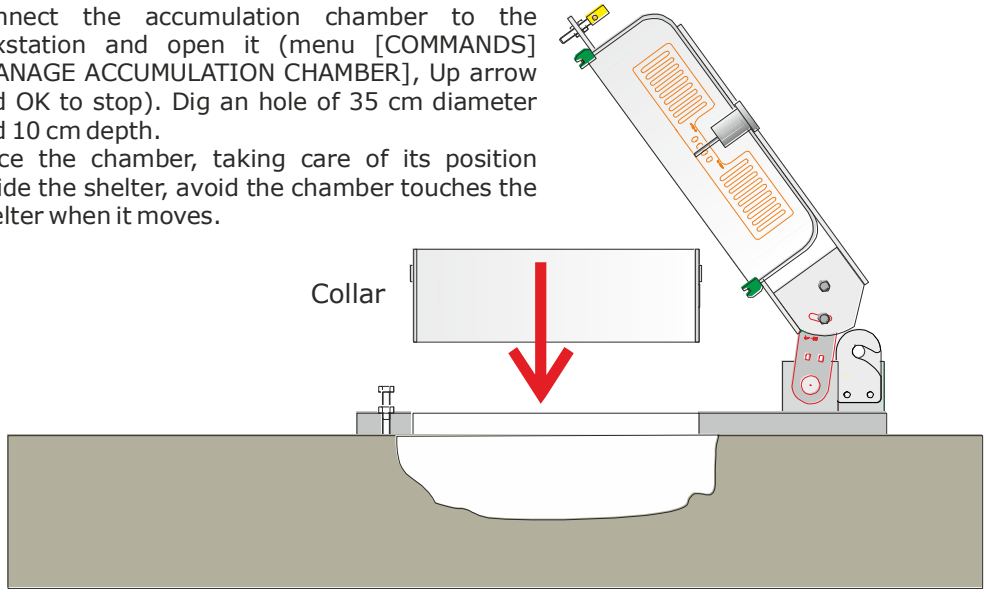
2.8 Accumulation chamber connections



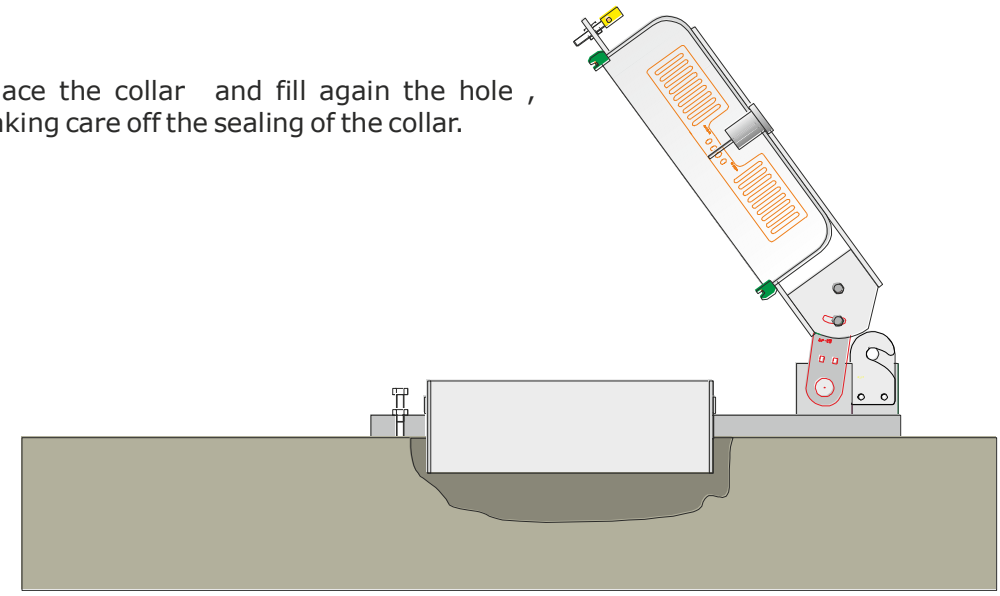
The Fan and Linak cables can be connected in one of the connection plugs indifferently.

2.9 Accumulation chamber operation

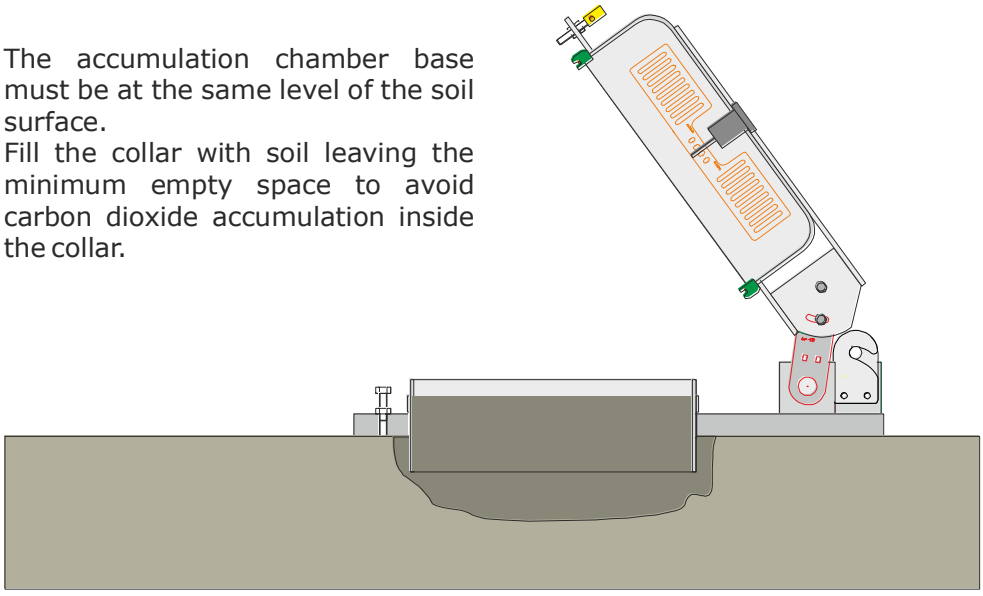
Connect the accumulation chamber to the fluxstation and open it (menu [COMMANDS] [MANAGE ACCUMULATION CHAMBER], Up arrow and OK to stop). Dig an hole of 35 cm diameter and 10 cm depth.
Place the chamber, taking care of its position inside the shelter, avoid the chamber touches the shelter when it moves.



Place the collar and fill again the hole , taking care off the sealing of the collar.



The accumulation chamber base must be at the same level of the soil surface.
Fill the collar with soil leaving the minimum empty space to avoid carbon dioxide accumulation inside the collar.



You can check the status of the accumulation chamber (the information acquired with the proximity sensors) in the following ways:

1- In real time, though the station menu [2.1 Manage Accumulation Chamber]. See chapter 6 Display for more info.

2- When downloading the data with WS-SCADA software. The field AC Status will assume the following values:

OK: the station managed to both close and open the chamber.

NFC (Not Fully Closed): the chamber couldn't close perfectly: The lower proximity sensor didn't light at the end of the Chamber Down run.

A possible cause is that an obstacle is preventing the chamber to close. If the flux curve shows a good accumulation, then it's more likely than the proximity sensor is not well placed.

NFO (Not Fully Opened): the chamber could not open perfectly: The upper proximity sensor didn't light at the end of the Chamber Up run.
In this case, check the proximity sensor is not well placed or if there is an external cause.
Note that when the battery voltage is very low (under 11.5 V) the run will be slower so it can happen that the chamber cannot fully open within the maximum time.

NFC-NFO: we have both NFC and NFO situation.

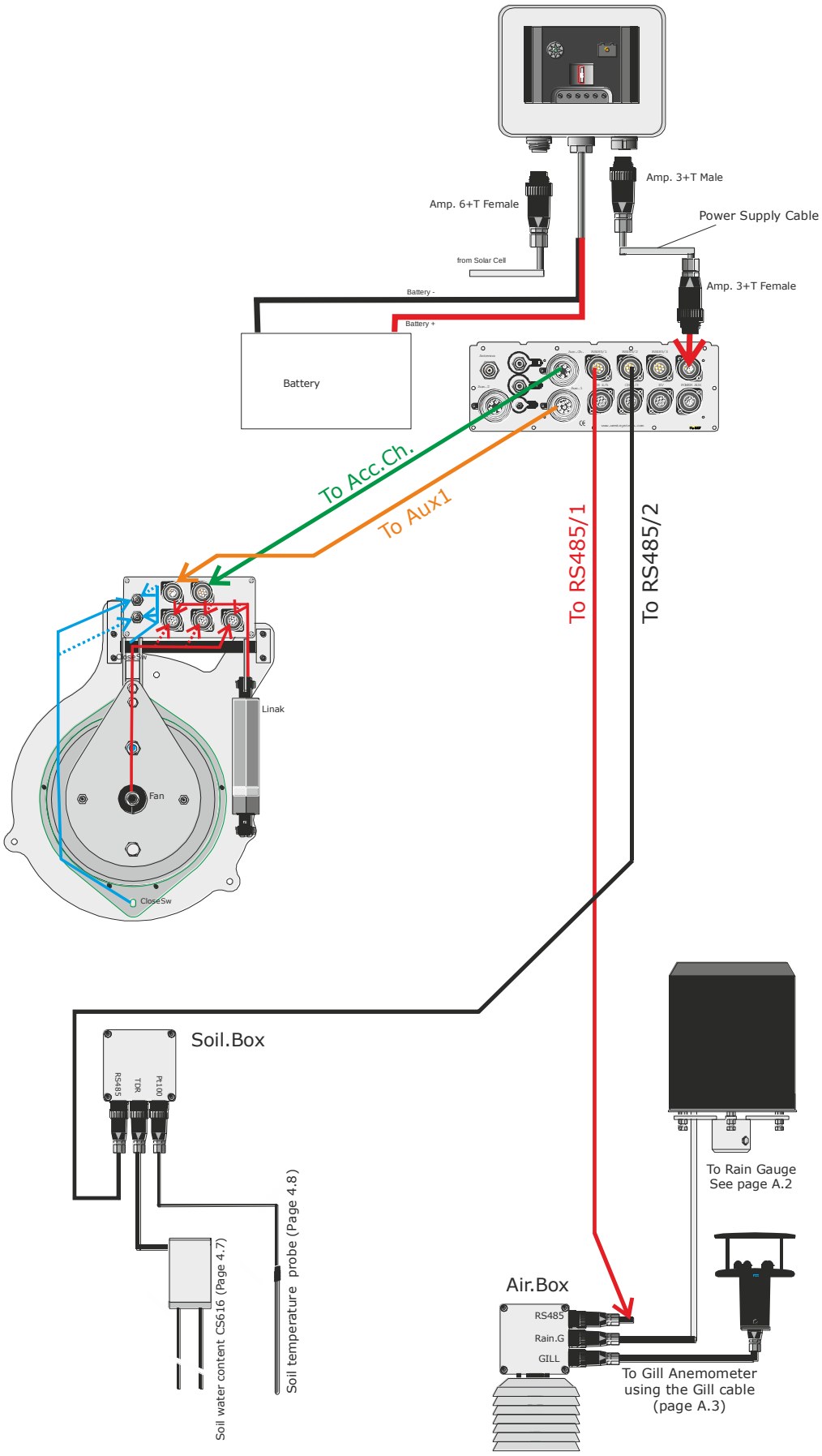
ERR: the proximity sensors didn't respond correctly.

3- Exporting the data into Excel or CSV files using the Query software.
Since numeric values are required, you'll find the following codification:
AC Status:
0: OK
1: NFC
2: NFO
3: NFC-NFO
4: ERR

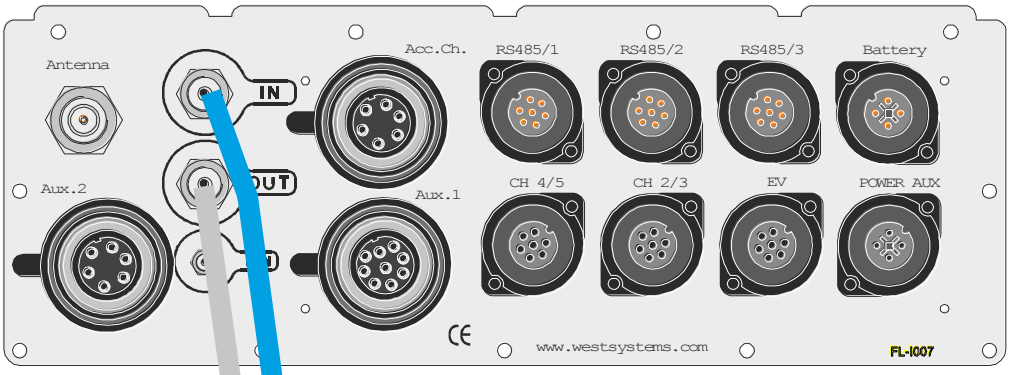
4- Checking the graphs generated by the Monitor software. The same codification shown at point 3 is applied. In normal condition, you should see the plot like a flat line with value 0.

2 On Field Installation

2.10 Connections resume



2.11 Accumulation chamber pneumatic connections

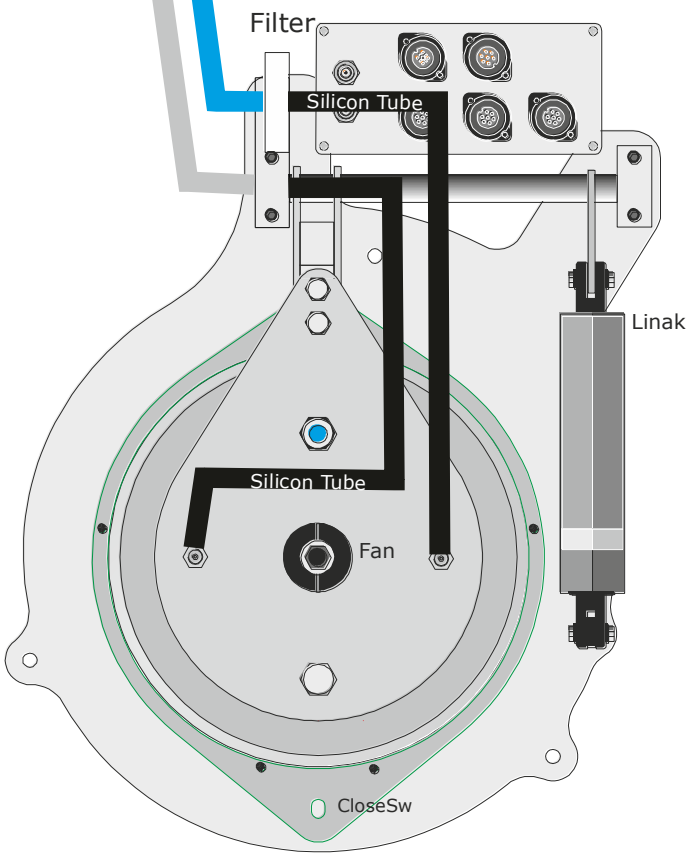


Blue 6x4 Rilsan Tube

Connect the Station INLET (upper joint, blue tube in the image) to the accumulation chamber OUTLET (the one with the PTFE filter)

Connect the station OUTLET (lower joint, gray/white tube in the image) to the accumulation chamber INLET (the one WITHOUT PTFE filter)

White 6x4 Rilsan Tube

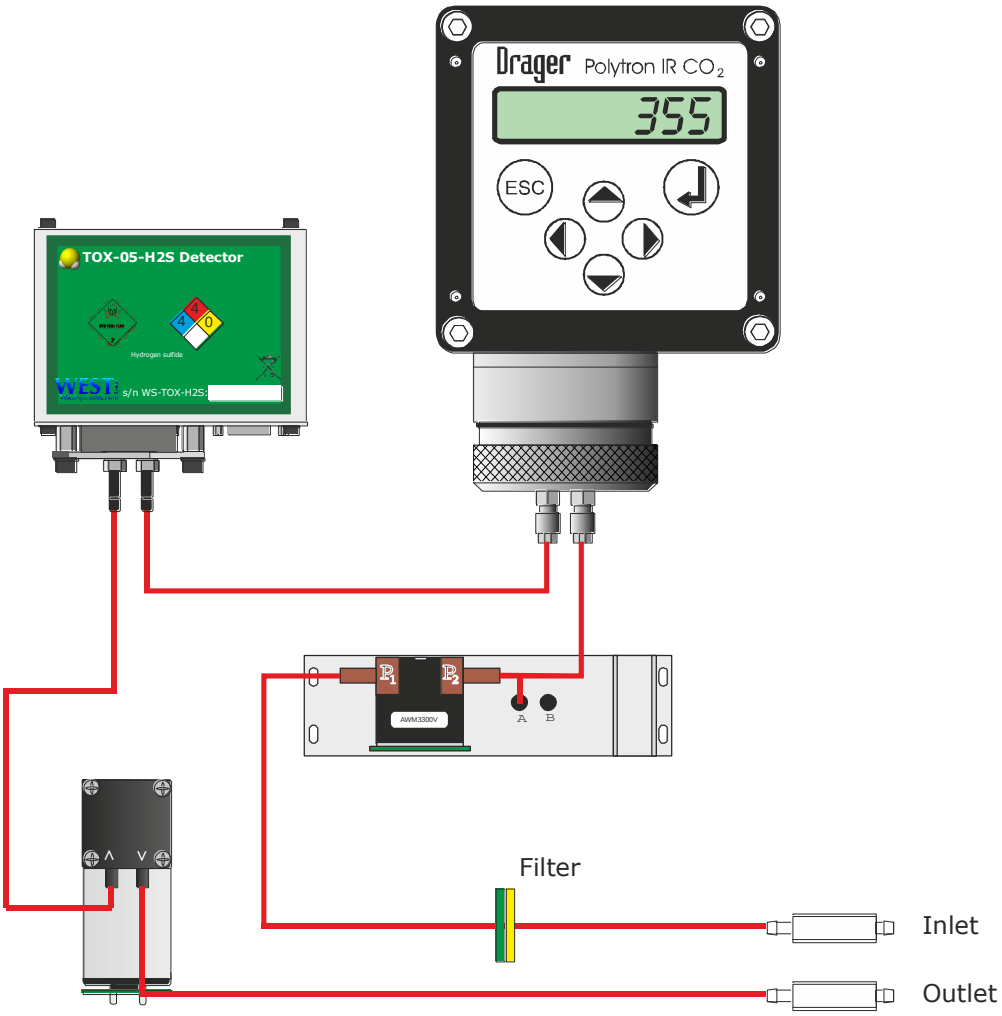


3 Pneumatic circuit

3. Pneumatic circuit

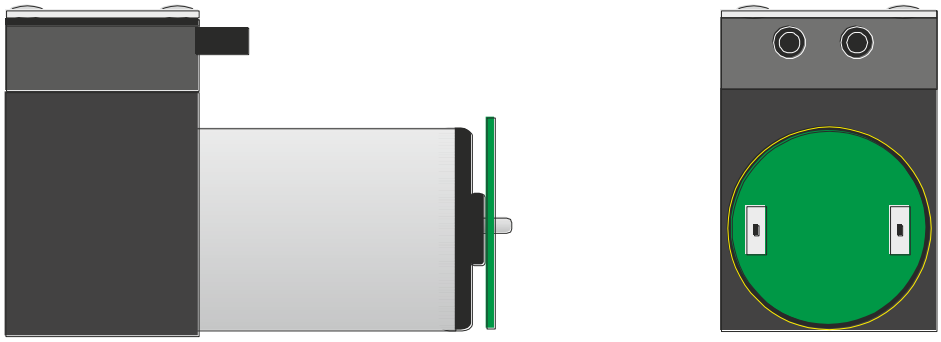
The pneumatic circuit is composed following this order:
1- Inlet
2- 0.20 micron PTFE filter
3- Flowmeter
4- Gas analysers
5- Diaphragm pump
6- Outlet

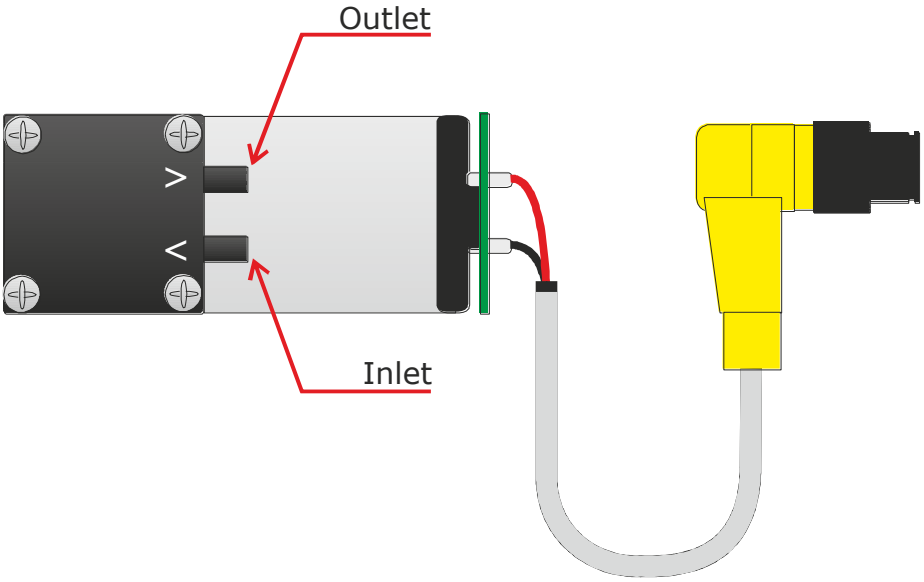
The gas analyzers
In the following diagram, it is described a configuration example, where the gas analyzers are an electrochemical H_2S detector and a Drager Polytron IR CO_2 detector.



All the internal connections are made with silicon tube 8 mm external diameter 3.3 mm internal diameter;

3.1 The pump





Pump connections

Pin	Color	Function
1	Brown	+12V
2	White	n.c.
3	Blue	n.c.
4	Black	Gnd

Pump specifications
Rated flow: 1000 SCCM (Standard cubic centimeter per minute)
Power supply 150 mA @ 12 Volts

Manufacturer KNF, WEST Germany
NMP830KNDC

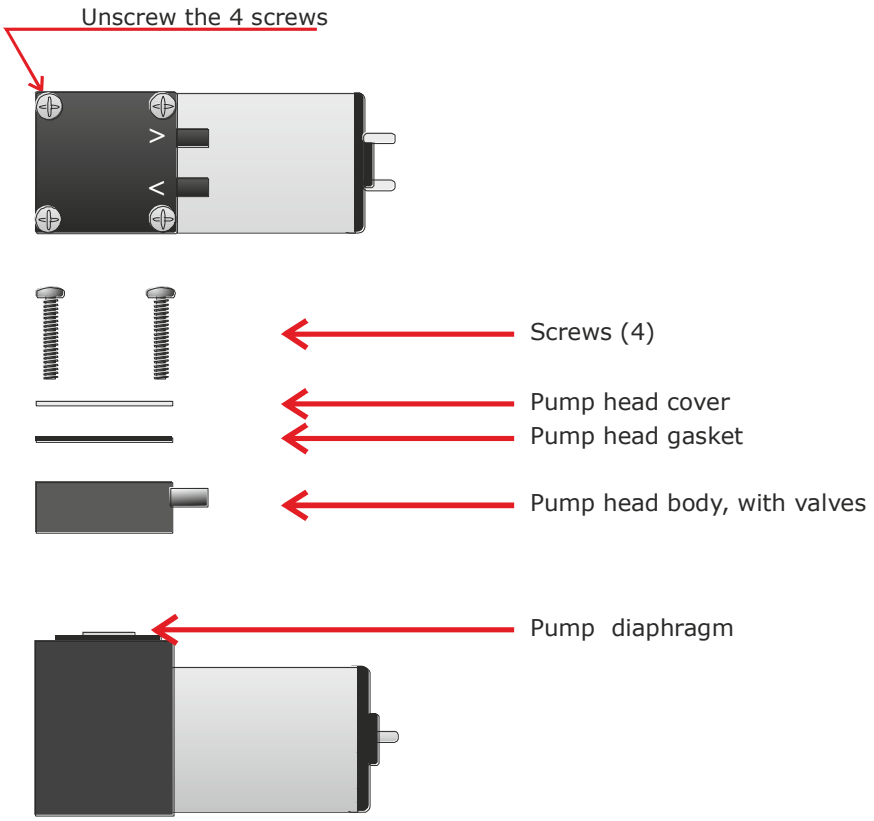
Pneumatic fittings diameter : 4 mm

3 Pneumatic circuit

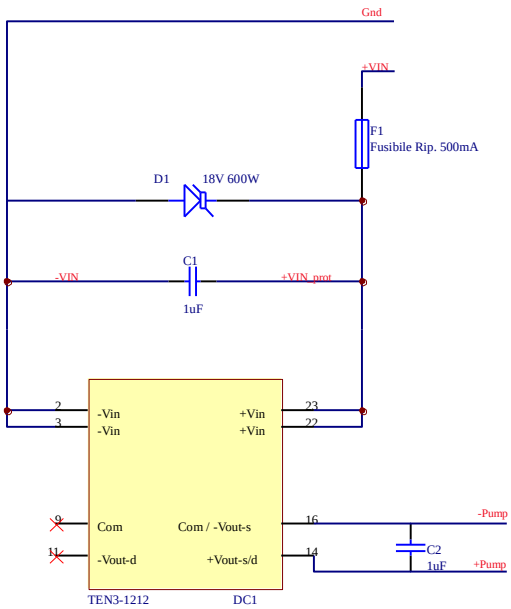
Pump maintenance

The pump efficiency can be affected by deposits of dust or water. When necessary it's possible to clean the pump:

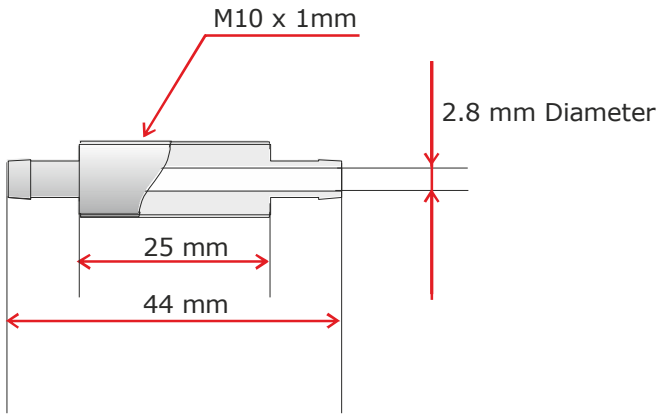
- Disassemble the pumping head
- Clean the diaphragm, the washer, and the valves using a compressed air flow.
- Reassemble the head.



Pump stabilizer scheme



The fittings
WEST Systems Tube fitting for RILSAN 6x4 and Silicon tubes



Material : Chromed brass

The tubes
3 types of tube are used to realize the gas sampling line:

- RILSAN tube 6 mm external diameter 4 mm internal diameter;
- SILICON tube 8 mm external diameter 3.3 mm internal diameter;
- SILICON 12.5 mm external diameter 4.3 mm internal diameter.

The filters

Two types of filters are used to protect the gas sampling line:

- 25 mm diameter 0.22μm PTFE membrane Cole-Palmer 2915-20 or equivalent;
- 50 mm diameter 0.45μm PTFE membrane Cole-Palmer 2915-30 or equivalent.

The PTFE membrane filters are permeable to gases and water vapour and are impermeable to liquid water and dust particles. The use of the filters protects the gas detectors and the other pneumatic parts.
Please check the status of the filters every month.

4.Sensors

The station is able to acquire 8 analog channels and up to 32 digital (RS485 channels).

The RS485 sensors are those connected to AirBox and SoilBox.
While the station is able to acquire automatically the digital sensors configuration (using "Scan RS485" function, please see chapter 5, command 2.9.2), the analog channels need to be configured.

There are two ways of configuring the channels:

- Directly on the display of the station (command 3.1.1), see chapter 6 for detailed instructions.
- Editing the channels on the database (table *phisicalchannels*) and then uploading to the station from WS-Scada (command Set Channels' Configuration); see chapter 10 for detailed instructions.

The following table shows the default configuration.

Channel	Name	FullScale	LowScale	PlotCurve	Conf	Input	Note
0	CO2	50000	0	-1	FF06	4-20 mA	Connected to LI-COR LI-820 Carbon Dioxide output
1	BarP	1700	500	0	FF05	0-5 V	Connected to Vaisala PTB110 Barometer
2	H2S	25	0	-1	FF06	4-20 mA	Connected to WS-TOX-H2S Hydrogen Sulfide detector
3	CellT	100	0	0	FF05	0-5 V	Connected to LI-COR LI-820 Cell Temperature output
4	Ch.4	5000	0	0	FF05	0-5 V	Not used
5	Ch.5	5000	0	0	FF05	0-5 V	Not used
6	dP	1100	800	0	FF05	0-5 V	Not used
7	P.Flow	1000	0	0	FF0F	0-5 V	Connected to flow meter

4.1 Carbon dioxide detector

Specifications

Manufacturer:	LI-COR
Model:	LI-820
Working principles:	Single-Beam Dual-Wavelength NDIR
Measurement range:	from 0 to 20000 ppm
Accuracy:	< 3% of reading
RMS Noise at 370 ppm with 1 sec signal filtering:	< 1 ppm
Pressure compensation range:	from 150 to 1150 mBar
Calibration drift:	zero drift < 0.15 ppm/°C Span drift < 0.03 %/°C Total drift at 370 ppm < 0.4 ppm/°C
DAC Resolution:	14 bits across user-specified range
Source life:	18,000 Hours (~2 years continuous use)
Operating temperature:	-20 to 45°C
Relative Humidity Range:	0 to 95%, Non-Condensing

4 Sensors

Connections
The LI-820 is equipped with a RS232 serial port and a 14-pin terminal strip.
The following table describes the pinout.

LI-820 Terminal Pin	Signal
1	Voltage In, 12-30 VDC
2	Ground
3	High Alarm
4	Ground
5	Low Alarm
6	Ground
7	Voltage output channel 2
8	Ground
9	Voltage output channel 1
10	Ground
11	Current output channel 2
12	Ground
13	Current output channel 1
14	Ground

The LI-820 is connected to the station by two cables:
- CH0 cable (Black cap), which provides power supply and CO2 signal
- CH3 cable (Red cap), which provides Celle temperature signal

The pinout of the each cable is described below.

CH0 cable Pinout

CH0 Cable Pin	Signal	Wire color	Connected to LI-820 pin
1	N.C.		
2	Signal +	Green	11
3	N.C.		
4	N.C.		
5	GND	Blue	2
6	N.C.		
7	Signal GND	Yellow	12
8	N.C.		
9	+12VDC	Red	1

CH3 cable Pinout

CH3 Cable Pin	Signal	Wire color	Connected to LI-820 pin
1	N.C.		
2	Signal +	Red	9
3	N.C.		
4	N.C.		
5	N.C.		
6	N.C.		
7	Signal GND	Blue	10
8	N.C.		

9	N.C.		

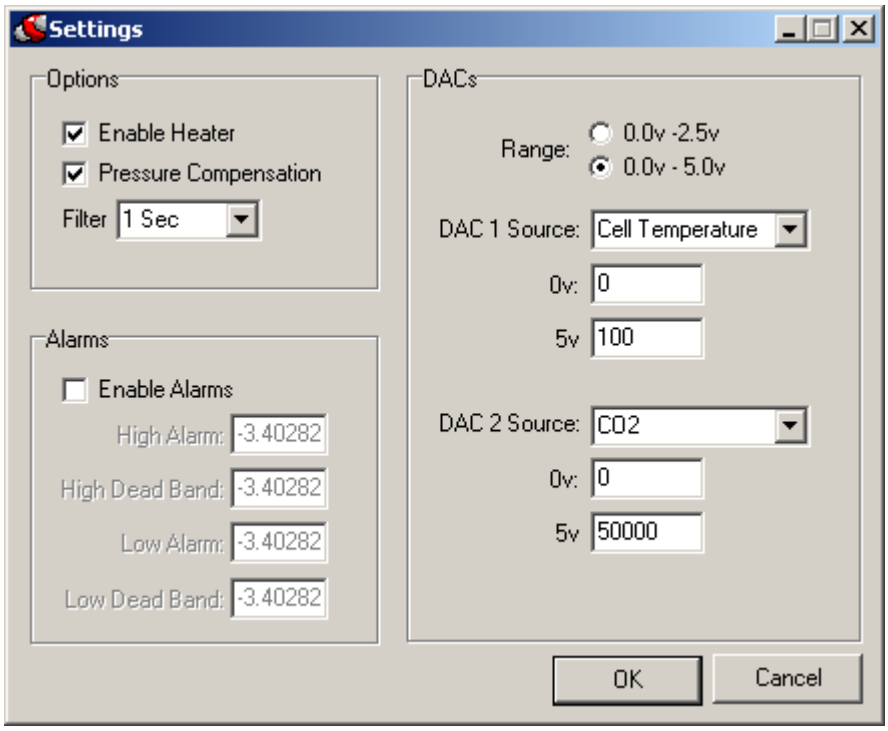
Configuration

In order to configure or calibrate the LI-820 detector, you'll need to connect with a laptop to the LI-820 RS232 serial port, and start the LI-820 PC Software (see the LI-820 manual for detailed instructions).

The sensor comes from West Systems fabric configured as following:

Parameter	**Setting**
Heater	Enabled
Pressure Compensation	Enabled
Filter	1 second
DAC1 Source	Cell temperature
DAC1 Range	0-100 °C
DAC1 Source	CO2
DAC1 Range	0-50000

The following screenshot of the LI-COR PC software shows the configuration.

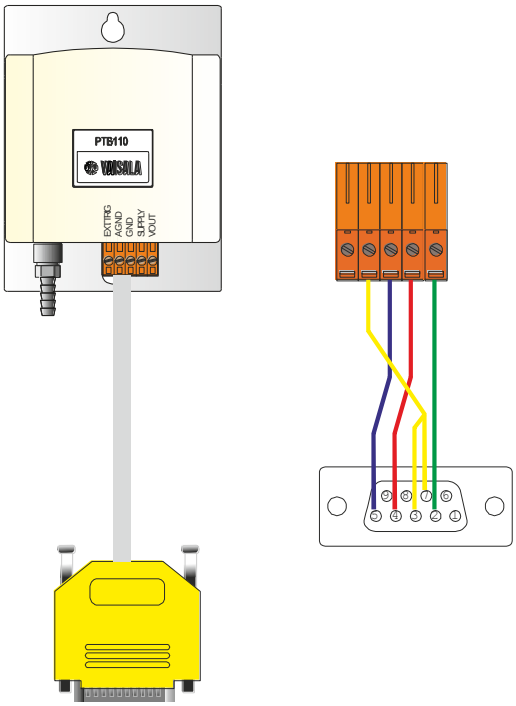


4.2 Hydrogen sulphide detector

Please refer to Appendix I – Hydrogen Sulfide detector.

4.3 Barometric pressure gauge

Manufacturer:	VAISALA
Model:	PTB110 4A0AB
Measurement Range:	500-1100 hPa (mBar)
Accuracy:	±0.3 mBar @ +20°C; ±0.6 mBar @ 0° to 40°C; ±1.0 mBar @ -20° to +45°C; ±1.5 mBar @ -40° to +60°C
Linearity:	±0.25 mBar
Hysteresis:	±0.03 mBar
Repeatability:	±0.03 mBar
Calibration Uncertainty:	±0.15 mBar
Long-Term Stability:	± 0.1 mBar per year
Supply Voltage:	10 to 30 Vdc
Current Consumption:	< 4 mA (active); < 1 µA (quiescent)
Settling Time:	1 s to reach full accuracy after power-up
Response Time:	500 ms to reach full accuracy after a pressure step
Operating Temperature:	-40° to 60°C

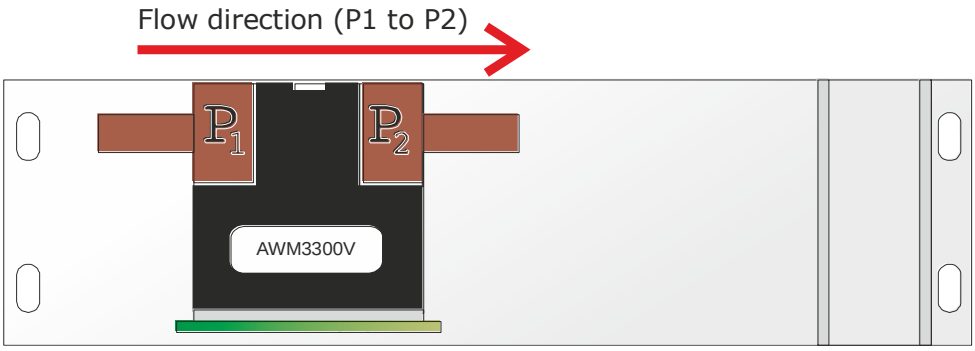


DB 9 Male : Ch.1

Vaisala Cable			
Pin	**Color**	**Function**	**DB9 pin**
Supply	Red	+12V	4
Gnd	Blue	Gnd	5
AGnd	Yellow	S.Low	3,7
VOut	Green	S.High	2

4.4 Gas line flow meter

Manufacturer: WEST Systems
(Sensor made by Honeywell-SensorTechnics)
Ordering code :AWM3300
Gas flow
Range: 0 to 1300 SCCM
Accuracy: 2% of F.S.
Power supply: 10 Volt Typical 30 mA @ 24 Volt



The P.Flow channel measures the gas flow in the sampling line.
The value must be in the range 700-1450 SCCM. A value less than that means there is some kind of obstruction or the filters are dirty.
A value close or less than zero means that the pump is not working.

4.5 Other sensors

Gill sonic wind speed and direction gauge
For the description of the wind and direction gauge refers to the page A.3 in the Air Box's Appendix.

Silicon Air Temperature and relative humidity gauge
For the description of the air temperature and relative humidity gauge refers to the page A.4 in the Air Box's Appendix.

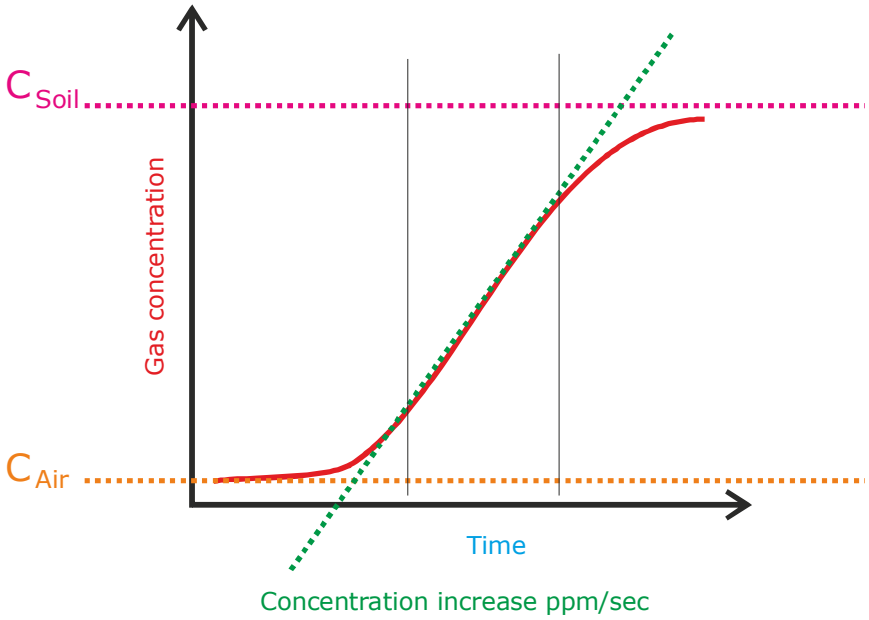
Rain gauge
For the description of the rain gauge refers to the page A.7 in the Air Box's Appendix.

Soil water
For the description of the soil water refers to the page S.5 in the Soil Box's Appendix.

Soil temperature
For the description of the soil temperature refers to the page S.6 in the Soil Box's Appendix.

5.The accumulation chamber

The flux is proportional to the concentration increase ratio ppm/sec. The proportionality factor depends on the chamber volume/surface ratio as well as the barometric pressure and the air temperature inside the accumulation chamber.



The station, in the default configuration record and store the barometric pressure, the air temperature and the soil temperature.
The variation of few degrees of temperature do not affect the evaluation of flux very much, then it's possible to use the air temperature instead of the temperature of the gas mixture into the accumulation chamber.
The instrument measures the barometric pressure, using the integrated barometric pressure gauge, with a good accuracy. A platinum Pt100 it's used to measure the soil temperature and a digital solid state based device measure the air temperature.

Choosing the flux measurement unit
The first measurements made, 10 years ago, with the accumulation chamber was expressed in cm/sec which is a speed, the speed of carbon dioxide flowing out from the soil. During the last ten years several units have been used by volcanologist and by geochemistry researchers. The most common unit is grams/squaremeter per day, but using the same instrument for two gas species to express the flux using this unit means to have two different conversion factors. Actually we use the unit **moles/squaremeter per day** that has two advantages: A single conversion factor for every gas specie and an easy conversion of the flux in grams/sm per day simply multiplying the result expressed in moles/sm per day for the molecular weight of the target gas.

The Scada-suite the flux using the unit "moles/mq/day"

The accumulation chamber factors
Here following the formula used to compute the A.c.K.:

$$K = \frac{86400 \cdot P}{10^6 \cdot R \cdot T_k} \cdot \frac{V}{A}$$

Where
- **P** is the barometric pressure expressed in mBar (HPa)
- **R** is the gas constant 0.08314510 bar L K-1 mol-1
- **Tk** is the air temperature expressed in Kelvin degree
- **V** is the chamber net volume in cubic meters
- **A** is the chamber inlet net area in square meters.

The dimensions of the A.c.K. are

$$K = \frac{moles \cdot meter^{-2} \cdot day^{-1}}{ppm \cdot sec^{-1}}$$

In the table the conversion factors vs temperature and barometric pressure for the Accumulation Chamber Type A and B are reported.

An example:
If the slope of the flux curve is 2.5 ppm/sec, the barometric pressure is 1011 mBar (HPa) and the air temperature is 23 °C.
From the table (Page 5.7) get the value that correspond to the barometric pressure and temperature. In this case I get the value computed for 25°C and 1013 mBar : 0.440

Then the flux is: 2.5 x 0.440 = 1.10 moles per square meter per day.

5 The accumulation chamber

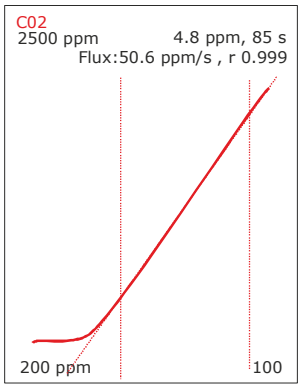
In the following table the factors for the conversion from ppm/sec slope to moles m-2 day-1 are reported

Bar. Pressure	Air.T. °C									
Hpa (mbar)	-10	-5	0	5	10	15	20	25	30	35
1013	0.499	0.489	0.480	0.472	0.463	0.455	0.448	0.440	0.433	0.426
983	0.484	0.475	0.466	0.458	0.450	0.442	0.435	0.427	0.420	0.413
955	0.470	0.461	0.453	0.445	0.437	0.429	0.422	0.415	0.408	0.401
927	0.456	0.448	0.440	0.432	0.424	0.417	0.410	0.403	0.396	0.390
900	0.443	0.435	0.427	0.419	0.412	0.404	0.398	0.391	0.384	0.378
873	0.430	0.422	0.414	0.407	0.400	0.393	0.386	0.379	0.373	0.367
848	0.417	0.410	0.402	0.395	0.388	0.381	0.375	0.368	0.362	0.356
823	0.405	0.398	0.390	0.383	0.377	0.370	0.364	0.358	0.352	0.346
799	0.393	0.386	0.379	0.372	0.366	0.359	0.353	0.347	0.341	0.336
776	0.382	0.375	0.368	0.361	0.355	0.349	0.343	0.337	0.331	0.326
753	0.371	0.364	0.357	0.351	0.345	0.339	0.333	0.327	0.322	0.317
731	0.360	0.353	0.347	0.340	0.334	0.329	0.323	0.318	0.312	0.307
710	0.349	0.343	0.337	0.331	0.325	0.319	0.314	0.308	0.303	0.298
689	0.339	0.333	0.327	0.321	0.315	0.310	0.304	0.299	0.294	0.290
669	0.329	0.323	0.317	0.312	0.306	0.301	0.296	0.291	0.286	0.281
649	0.320	0.314	0.308	0.302	0.297	0.292	0.287	0.282	0.277	0.273
630	0.310	0.305	0.299	0.294	0.288	0.283	0.279	0.274	0.269	0.265

In the following table the factors for the conversion from ppm/sec slope to CO2 grams m-2 day-1 are reported

Bar. Pressure	Air T. °C								
Hpa (mbar)	-10	-5	0	5	10	15	20	25	30
1013	21.94	21.53	21.14	20.76	20.39	20.04	19.70	19.37	19.05
983	21.30	20.90	20.52	20.15	19.80	19.45	19.12	18.80	18.49
955	20.68	20.29	19.92	19.56	19.22	18.88	18.56	18.25	17.95
927	20.07	19.70	19.34	18.99	18.66	18.33	18.02	17.72	17.43
900	19.49	19.12	18.77	18.44	18.11	17.80	17.49	17.20	16.92
873	18.92	18.57	18.23	17.90	17.58	17.28	16.98	16.70	16.42
848	18.37	18.02	17.69	17.38	17.07	16.77	16.49	16.21	15.94
823	17.83	17.50	17.18	16.87	16.57	16.28	16.00	15.74	15.48
799	17.31	16.99	16.67	16.37	16.09	15.81	15.54	15.28	15.02
776	16.80	16.49	16.19	15.90	15.62	15.34	15.08	14.83	14.59
753	16.31	16.01	15.71	15.43	15.16	14.90	14.64	14.40	14.16
731	15.84	15.54	15.26	14.98	14.72	14.46	14.21	13.98	13.75
710	15.37	15.09	14.81	14.54	14.29	14.04	13.80	13.57	13.34
689	14.92	14.65	14.38	14.12	13.87	13.63	13.40	13.17	12.95
669	14.49	14.22	13.96	13.71	13.46	13.23	13.01	12.79	12.58
649	14.06	13.80	13.55	13.31	13.07	12.84	12.63	12.41	12.21
630	13.65	13.40	13.15	12.92	12.69	12.47	12.26	12.05	11.85

5 The accumulation chamber

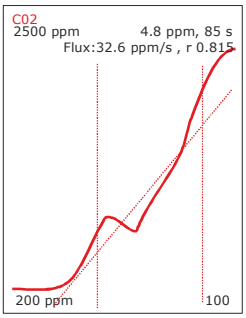


The "perfect" curve

In the figure on the left the plot of a flux mesurement.

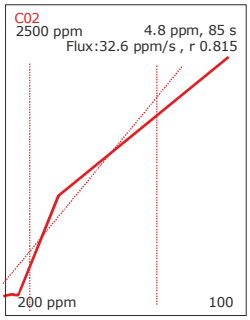
For clearness only the CO2 flux curve is shown.
The shape of the curve is quite perfect and the computation of the flux is done with a very good accuracy: r (regression quality factor) very close to 1.

In the following figures some examples of strange shape flux curves:



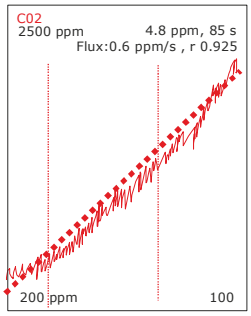
Air contamination

The flux curve is no longer "linear", the linear best fit curve do not fit exactly the flux curve as pointed out by the regression quality factor (0.815 in the example). This effect is probably due to atmospheric air contamination.
If you obtain this kind of curve check the sealing of the accumulation chamber with the soil or check that tubes, filters and pump are intact.



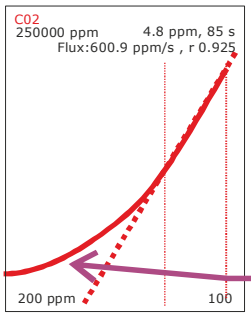
Gas stratification

This shape of curve indicates that the concentration of the target in air, close to the soil, is very high. This stratification is quite common in case of very high flux combined with a very stable atmosphere.
In this case clean the gas line making a measure in air, one meter above the soil surface, and afterwards repeat the flux measurement.
You can use the measurement choosing the second part of the curve for regression computation.



Low fluxes

This type of curve is normal when the flux is low and the "noise" of the detector is comparable with the increase of concentration.

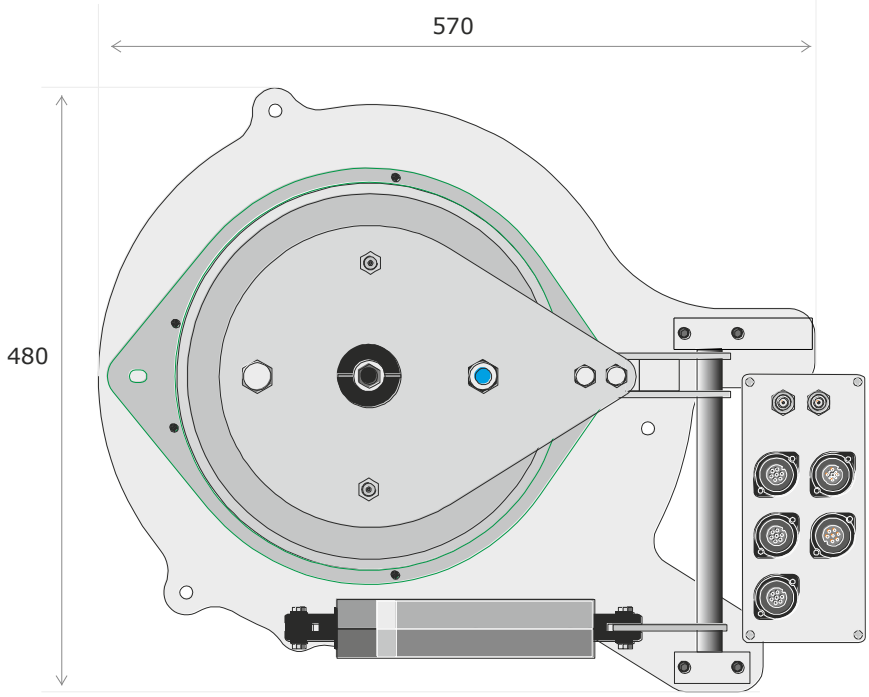


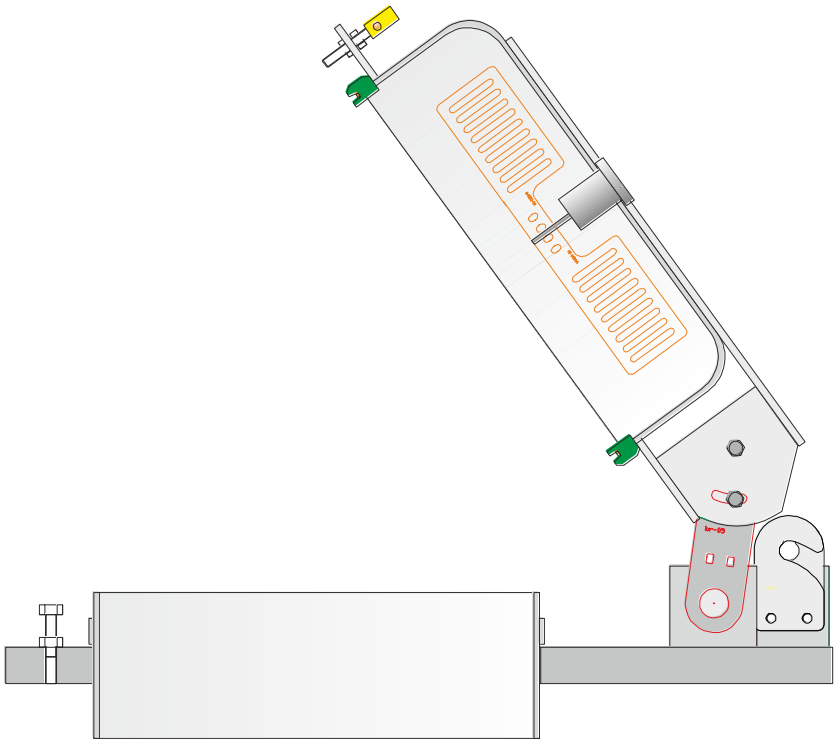
Very high flux

The first part of the curve is not linear. The problem is due to the combined effect of the high flux and the sampling line cleaning. To avoid this increase the flux curve record time until the concentration of gas reachs the full scale value and select the last part of the curve for the flux computation.

This effect is due to the cleaning of the sampling line dead volumes

Foot print size

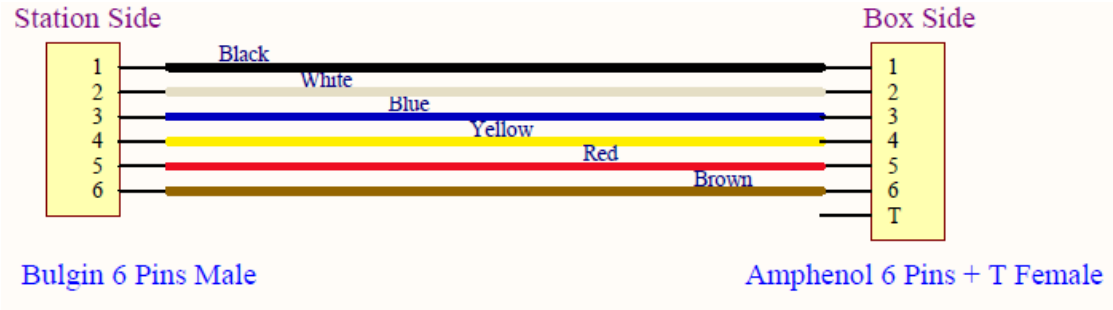




5 The accumulation chamber

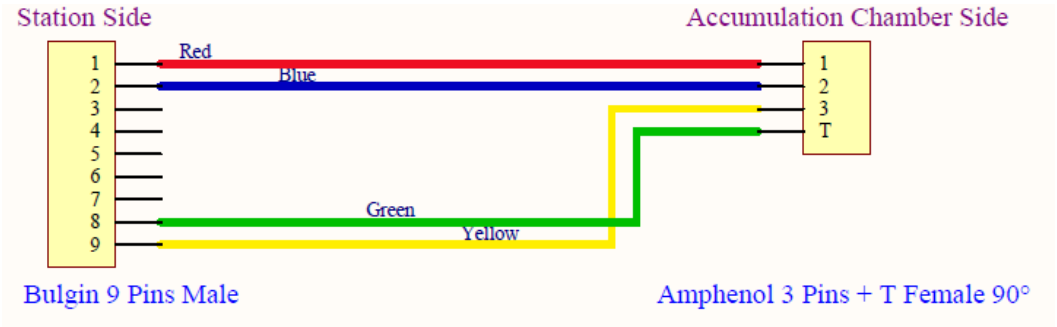
AC1 CABLE (AC_AC1)

Bulgin 6 pin male Amph 6+T pin female

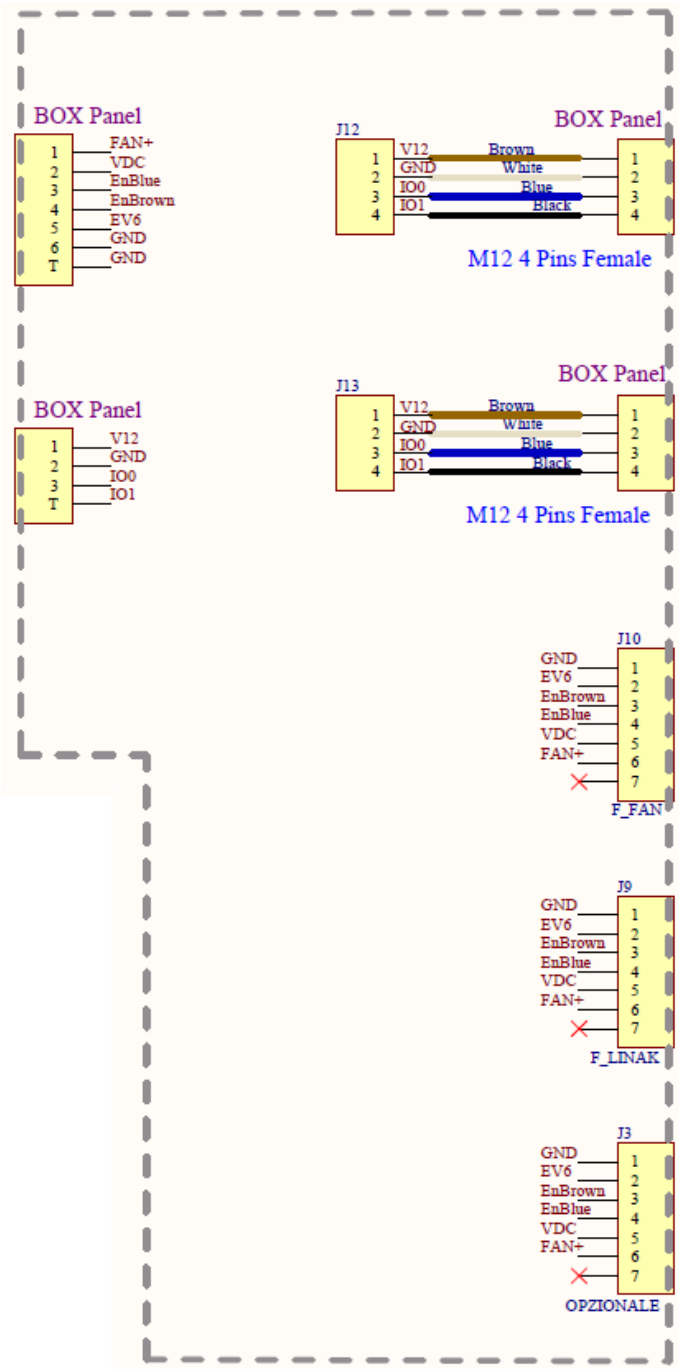


AC2 CABLE (AC_AC2)

Bulgin 9 pin male Amph 3+T pin female



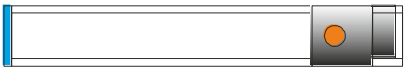
AC Box schematics



Proxi sensor

Two proximity switches control the full opening and full closing of the accumulation chamber.

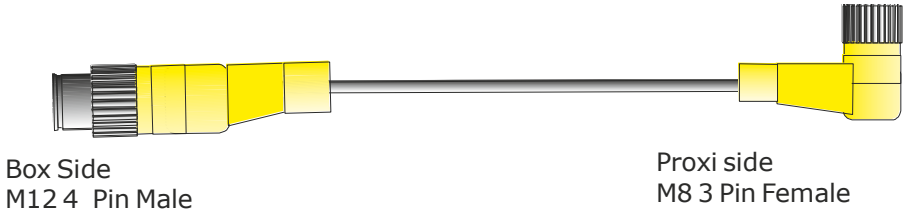
Type: inductive proximity;
Model: IM020BM60TB8
Range: 2mm- Shielded;
Protection grade: IP67;
Made by Wenglor
Thread: M8

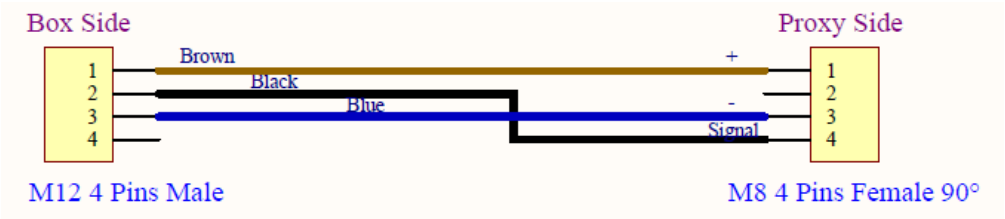


LED Light - On/Off

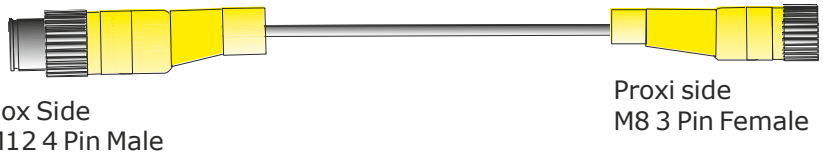
5 The accumulation chamber

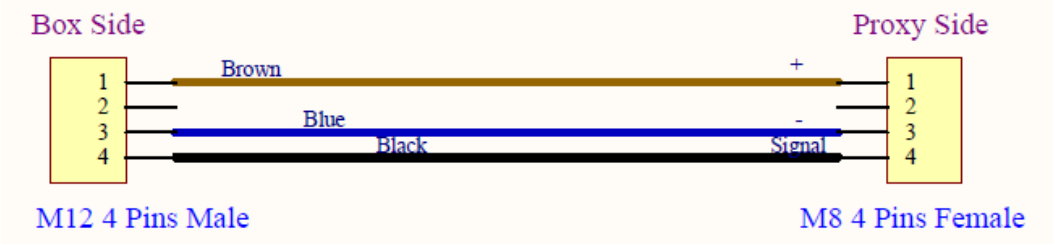
OPEN Proxi cable (AC_OP1)
Part #:XZCP0666L5
Brand: Schneider electric



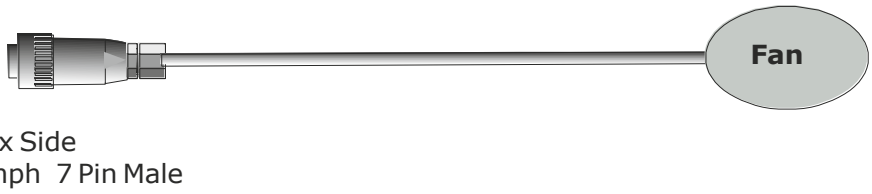


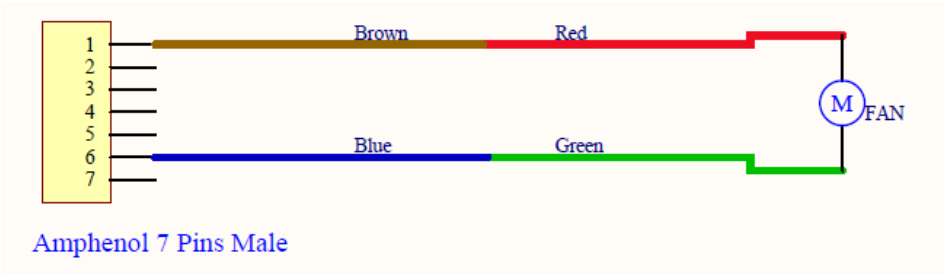
CLOSE Proxi cable (AC_CP1)
Part #:XZCP0566L5
Brand: Schneider electric





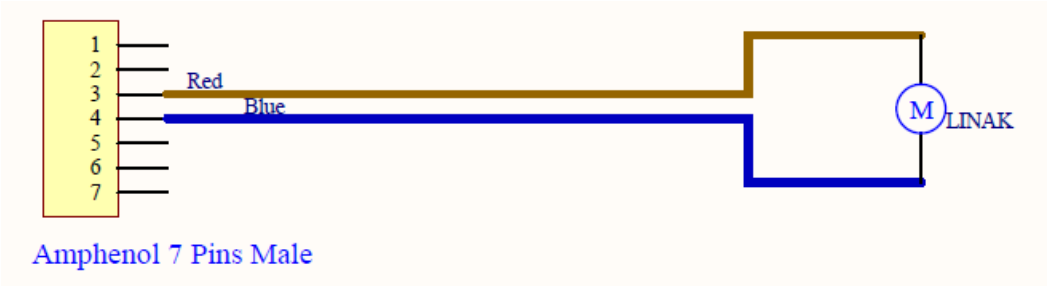
Fan Cable (AC_FAN1)





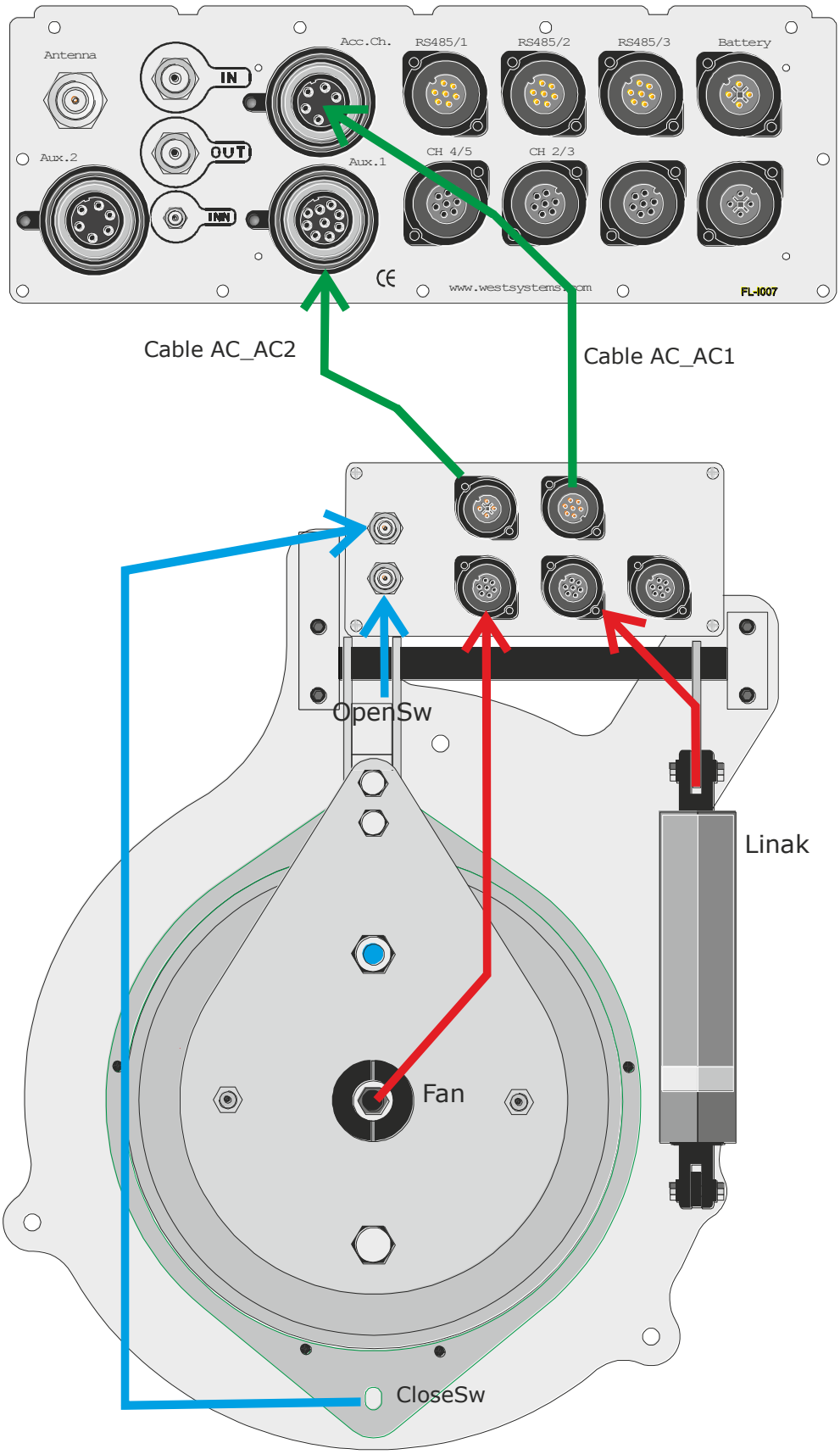
Linak Cable (AC_LIN1)

Box Side
Amph 7 Pin Male



5 The accumulation chamber

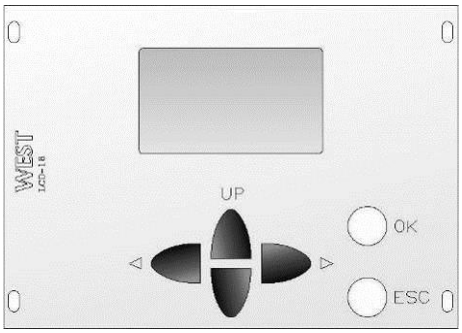
Accumulation chamber's connections



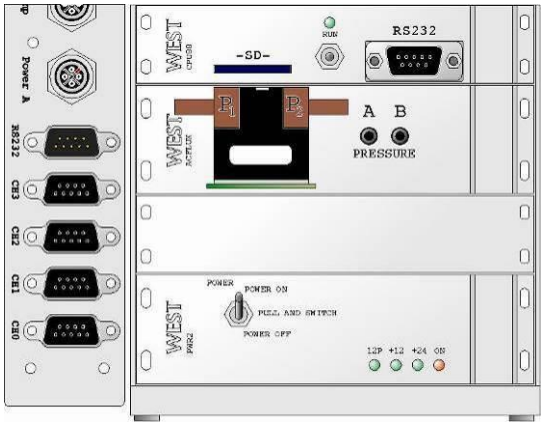
6. Display

6.1 General considerations

The station is equipped with a LCD monochromatic display for configuration and testing of the sensors.



Readable surface: 5.1 cm X 3.1 cm
Input: 6 buttons (up, down, left, right arrows, OK, ESC).



The display is kept usually off in order to minimize power consumption. To wake it up, press the "RUN" button.
At the startup, the display will show the West Systems logo. If no buttons are pressed, the display will remain in this state. Otherwise after 2 seconds the main menu will be showed.

Pressing ESC from the main menu, a frame will show the current status of the station, the next status and the remaining time.

Example 1:

STATION STATUS : IDLE
Current Event:
Waiting to start analysis
Next event:
...
Time to Next Event:
900 s

6 Display

The station is waiting for the next measurement that will start in 15 minutes.

Example 2:

```
STATION STATUS :   BUSY
Current Event:
  Pump start
Next event:
  Chamber Down start
Time to Next Event:
  3000 ms
```

The station is performing the measurement cycle. The last action was starting the pump. In 3 seconds the chamber will start closing.

Press any key to return to the main menu.

General menu and keyboard rules:

- To enter onto a submenu: Select the 'Entry' and press OK.
- To exit from a submenu: - Select 'Back' and press OK.
  or
  - Press ESC.
- To navigate between multi pages submenu:
  - Select 'Prev page' or 'next page' and press OK.
  or
  - Press LEFT for previous page or RIGHT for next page.

6.2 Menu structure

- 1 MEASURE
  - 1.1 SHOW ANALOG VALUES
  - 1.2 SHOW DIGITAL VALUES
  - 1.3 START ANALYSIS (MAIN SCH.)
  - 1.4 START ANALYSIS (SEC SCH.)
  - 1.5 STOP ANALYSIS
- 2 COMMANDS
  - 2.1 MANAGE ACCUMULATION CHAMBER
  - 2.2 SET RADIO STATUS
  - 2.3 SET FAN STATUS
  - 2.4 SET PUMP STATUS
  - 2.5 GET STATION STATUS
  - 2.6 GET CLOCK TIME-DATE
  - 2.7 GET INTERNAL TEMPERATURE
  - 2.8 GET BATTERY VOLTAGE
  - 2.9 RS485 MENU
  - 2.10 FILE MENU
  - 2.11 POWER SUPPLY MENU
  - 2.12 HANDLE EVS
  - 2.13 SELECT ACTIVE CHAMBER
  - 2.14 GET GSM SIGNAL
- 3 SETTINGS
  - 3.1 STATION SETTINGS
  - 3.2 LCD SETTINGS
  - 3.3 STATION VERSION
- 4 POWER MANAGEMENT
  - 4.1 LCD STAND-BY
  - 4.2 LCD SWITCH OFF
  - 4.3 CPU RESET
  - 4.4 RADIO OFF - CPU SLEEP

When you're finished your job, you can turn off the LCD display with the menu POWER MANAGEMENT and then LCD SWITCH-OFF, but it is not usually necessary because the display will automatically shut down after a certain amount of time (configurable in LCD SETTINGS menu).

6 Display

[1 MENU MEASURE]

[1.1 SHOW ANALOG VALUES]
The real-time readings of the 8 analog channels are displayed. The analog channels are the ones connected to the internal Backplane (for example the CO2 detector, the pressure sensor, the flowmeter) or plugged to the external connector (CH 2/3 and CH 4/5).

[1.2 SHOW DIGITAL VALUES]
The real-time readings of the digital channels are displayed. The digital channels are the ones connected to the RS485 chain. Their number is variable from 0 to 31.

[1.3 START ANALYSIS (MAIN SCH.)]
Start one cycle of measure using the Main Scheduler. The cycle starts from the lower timing (usually "+24 ON") and ends with the higher one (usually "radio off" or "write file"). This command executes manually what is automatically executed by the scheduler (for example every hour).

[1.4 START ANALYSIS (SEC. SCH.)]
Start one cycle of measure using the Secondary Scheduler (if enabled). The cycle starts from the lower timing (usually +24 ON) and ends with the higher one (usually radio off). This command executes manually what is automatically executed by the scheduler (for example every hour).

[1.5 STOP ANALYSIS]
Stop the current analysis if it's running. So the station will remain in idle mode until another measure is started manually or by the scheduler.

[2 MENU COMMANDS]

[2.1 MANAGE ACCUMULATION CHAMBER]
The accumulation chamber is equipped with 2 proximity sensor to evaluate remotely if the chamber can close and open without obstacles. This page shows the current status of the proximity sensors on the accumulation chamber. Press and release the up and down arrows to start moving the chamber. Press Ok to stop. When the chamber is fully opened, you should see "PXY UP" ON the other OFF. While the chamber is going up or down you should
see both proxies off and when the chamber is closed you should see the "PXY DN" ON and the other OFF. If you see both "PXY DN" and "PXY UP" the chamber is not working or the proximity sensors are not well placed. See chapter 5 for more details.

[2.2 SET RADIO STATUS]
Allows to temporarily switch ON and OFF the radio. Then when a measure will start, the radio will return to be managed by the station. To set the radio always ON, you have to modify the event timings (set Radio ON e Radio Off to 0, see chapter 10 for more details)

[2.3 SET FAN STATUS]
Allows to temporarily switch ON and OFF the accumulation chamber mixing fan. Then when a measure will start, the fan will return to be managed by the station.

[2.4 SET PUMP STATUS]
Allows to temporarily switch ON and OFF the pump. Then when a measure will start, the pump will return to be managed by the station.

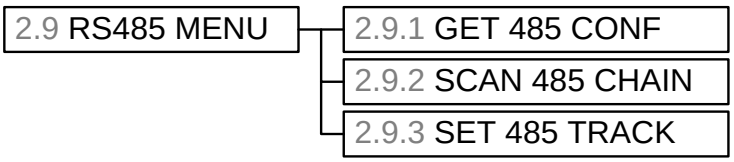
[2.5 GET STATION STATUS]
Show the status of the station and the current event of the measure (if 0 a measure is not running).

[2.6 GET CLOCK TIME-DATE]
Shows the station internal date and time. It's very important that this clock is correct because the measure files that will be recorded will be marked with this date. A wrong clock could make useless all the saved data. However the clock is automatically synchronized every time the master centre computer is able to communicate with the station (we advise furthermore to set the master centre personal computer to automatically synchronize its clock every day from a time server, e.g. time.windows.com). If the telemetry or the master centre are not active, synchronize the clock manually, using the [SET CLOCK DATE] and [SET CLOCK TIME] functions in the menu [SETTINGS].
Note: the clock is powered by the station or, when the station is switched on, by a 3V battery on the CPU board. If the station remains off for a large amount of time, the 3V battery will run down and the station clock will reset to January 1, 2000. In both cases, the clock integrated in the station is not so accurate (it could lose or gain even 1 or 2 seconds per day). So consider that if the station remains isolated (not interrogated by the master centre) for a large period of time, the date of the measures will derive.

[2.7 GET INTERNAL TEMPERATURE]
Show the station internal temperature.

[2.8 GET BATTERY VOLTAGE]
Shows the battery status. Since the battery is recharged by a solar panel, the voltage should fluctuate reaching the maximum value on the afternoon and the minimum at dawn. A value lower than 10 Volts is critical and the station could shut down.

[2.9 RS485 MENU]



[2.9.1 GET 485 CONF] shows the list of connected RS485 sensors.
The following fields are displayed:
- ID: hexadecimal view of the sensor ID in the RS485 chain
- Name: description of the sensor

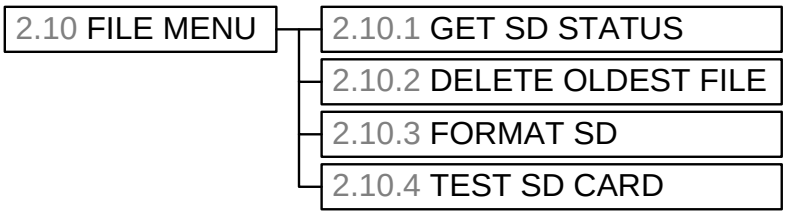
- Track On/Off: if you select Track=On a curve will be acquired for the selected channel. Otherwise only one sample per sensor will be saved. If one or more sensors are connected but they're missing on the list you should execute a RS485 SCAN.

[2.9.2 SCAN 485 CHAIN] update the list of digital sensors connected to the station. Perform this action if you added a new digital sensor, as SoilBox and AirBox. An RS485 scan will take several minutes.

[2.9.3 SET 485 TRACK] allows to set/unset the track of the sensor (see GET RS485 CONF). First select the sensor you'd like to set and then select ON or OFF.
This operation can be also executed remotely with Scada (allows to change the track of all channels, both analog and digital):

- Select "Get channels' configuration" and then "Call now".
- Open the table "PhisicalChannels" on the database
- Set the "PlotCurve" field of the corresponding row to 0 if you want to disable the track or to -1 if you want to enable it. Close the database.
- Select "Set channels' configuration" and then "Call now".

[2.10 FILE MENU]



[2.10.1 GET SD STATUS] checks if the SD card is working and retrieves information about the capacity, space left and number of files on device. This process could take several minutes.

[2.10.2 DELETE OLDEST FILE] removes from the SD card the oldest file. It's the same operation done by Scada when a file is successfully downloaded.

[2.10.3 FORMAT SD] executes the memory card formatting. Warning: this operation will erase all the recorded data. Don't execute this command unless you want to empty the card.

[2.10.4 TEST SD CARD] executes a deep read/write access to the SD card. If this test is passed, we can be sure the SD is working fine. The same test is executed every time the station is switched on. We strongly advice to make this test every time you insert a new memory card, to make sure not to use damaged or unsupported SD card (example: SDHC).

[2.11 POWER SUPPLY MENU]

- 2.11 POWER SUPPLY MENU
  - 2.11.1 SET +12V RS485
  - 2.11.2 SET +12V
  - 2.11.3 SET +24V
  - 2.11.4 SET +5V BT

[2.11.1 SET +12V RS485]

Allows to temporarily switch ON and OFF the 12 Volt RS485 power supply (which powers the RS485 detectors like airbox and soilbox). Then when a measure will start, the supply will return to be managed by the station.

[2.11.2 SET +12V]

Allows to temporarily switch ON and OFF the 12 Volt power supply (which powers for example the barometric pressure probe, the flowmeter). Then when a measure will start, the supply will return to be managed by the station.

[2.11.3 SET +24V]

Allows to temporarily switch ON and OFF the 24 Volt power supply (which powers for example the CO2 detector). Then when a measure will start, the supply will return to be managed by the station.

[2.11.4 SET +5V BT]

Allows to temporarily switch ON and OFF the 5 Volt power supply (which powers for example the BlueTooth module). Then when a measure will start, the supply will return to be managed by the station.

[2.12 HANDLE EVs]

Allows to read and set the status of the digital output EV0, EV1, EV2, EV3.

[2.13 SELECT ACTIVE CHAMBER]

(Only in multi-chamber mode) This command selects one of the accumulation chambers on the multiplexer. When a chamber is selected, the actions you call on the station (motor up, motor down, fan on) are forwarded to the active chamber, and the sampling line is switched.

[2.14 GET GSM SIGNAL]

Allows to check the GSM signal quality (if a GSM/GPRS modem is connected).
To check the signal of GSM network, follow the procedure:

- Turn on the GSM modem (menu 2.12 Handle EV, then activate EV3)
- Get back to GSM menu (2.14). The display will show a couple of numbers separated by a comma

The first number is the RSSI (Received signal strength indication). It has the following meaning:

0: –113 dBm or less
1: –111 dBm
30: –109 to –53 dBm
31: –51dBm or greater

6 Display

99: not known or not detectable
The second number is the BER (Bit Error Rate).
You may need an RSSI greater than 20 to have a good communication with the master center.

[3 MENU SETTINGS]

- 3.1 STATION SETTINGS
  - 3.1.1 SET CHANNELS PARAMETERS
  - 3.1.2 SET SAMPLE PARAMETERS
  - 3.1.3 SET EVENT TIMINGS
  - 3.1.4 SET STATION ADDRESS
  - 3.1.5 SET CLOCK DATE
  - 3.1.6 SET CLOCK TIME
  - 3.1.7 SET GPS TIME ZONE
  - 3.1.8 SET COMM SPEED
  - 3.1.9 SET CHAMBER NUMBER

[3.1.1 SET CHANNELS PARAMETERS]

Allows to modify the settings of the analog channels. Use the left and right arrows to move from the channel 0 to 7. Use the up and down arrows to move between the fields of one channel. Press OK to edit selected field. You can modify the following parameters:

- Conf: Is the type of channel, and it defines the way the station translate an analog input to a readable measure unit.

Valid Conf are:

- FF05: the output of sensor connected to the channel is 0-5V and the station will consider 0 V equal to the "Low Scale" value and the 5 V equal to the "Full Scale" value.
- FF06: the output of sensor connected to the channel is 4-20 mA and the station will consider 4mA equal to the "Low Scale" value and the 20 mA equal to the "Full Scale" value.
- FF07: the output of sensor connected to the channel is 1-5V and the station will consider 1 V equal to the "Low Scale" value and the 5 V equal to the "Full Scale" value.
- FF0F: special Conf. reserved to the P.Flow sensor (AWM3300). A special trasfer function is applied to this channel to linearize the answer.

Since an hardware adjustement is necessary to change the input from current to voltage these field must considered read only.

- Name: is a description of the channel, to help the operator.

- Gain/Offset: the reading of the channel can be calibrated using these 2 parameters as result of the formula: y=ax+b where x = original value, a = gain, b = offset, y = calibrated value. Use the Gain/Offset to correct the

answer of a detector. Default values are Gain=1 Offset = 0. These values leave the original reading.

- Offset: See Gain.

- Low Scale/Full Scale: see Conf. Usually you will need to change those parameters only if you change a sensor of if you modify its measurement range. Instructions to change the detector full scale are reported in the following pages.

- Track: If you select Track=On a curve will be acquired for the selected channel. Otherwise only one sample per sensor will be saved.

[3.1.2 SET SAMPLE PARAMETERS]
Allows to set the number of samples that will be recorded for a curve (default: 120) and the time interval between 2 samples (default: 1000 milliseconds). Note: if you want to enlarge the sampling window by increasing one of those 2 parameters, you have also to modify the timings (for example to shift the time of the pump power off or of the chamber rise). Don't hesitate to contact West Systems support before to perform those operations.

[3.1.3 SET EVENT TIMINGS]
Allows to set the station event timings. Use left and right arrows for fast scrolling. Those settings allow to manage the frequency of the measures and the analysis cycle . Those parameters can also be accessed in remote by calling in Scada "Get station parameters" and opening the table "HWR7_Parameters" of the database scada_data.
Modifying the timings is a delicate operation so don't hesitate to contact West Systems support before.
The event timings (timings from 1 to 31 included) are those timings that regulate at what instant a certain event is executed. All event timings are relative to the start of the analysis cycle.
For example if the timing 7 (event Pump On) is set to 120000, the pump will start 2 minutes after the start of the cycle.
Scada furnishes (menu "Edit station parameters") a simplified interface to set all the timings starting from the wanted settings.
For example if you desire a Warm-Up time of 10 minutes, Scada will automatically delay all the following events. See chapter 7.3 for a detailed list of the timings and the related default values.

[3.1.4 SET STATION ADDRESS]
Allows setting the station address. The default station address is 0001. There are 65535 possible addresses from 0001 to FFFF. If you have more that a station on the same network, it's strongly advised to assign a different address to every station, in order to prevent Scada to download data from the wrong station. However, this parameter is set in the factory so you won't need to perform this operation. A station will respond only to the request having the correct address. Changing the station address without configuring also Scada will result in the impossibility of the communication with the master centre. It corresponds on the database to the StationIP field of the table Stations.

[3.1.5/6 SET CLOCK DATE / SET CLOCK TIME]

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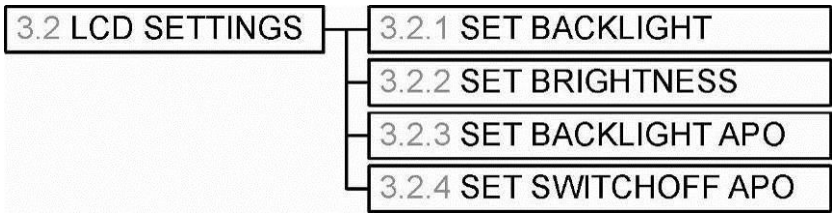
Allows setting the internal clock of the station. It is very important that this clock is correct because the measure files that will be recorded will be marked with this date. A wrong clock could make useless all the saved data. However the clock is automatically synchronized every time the master centre computer is able to communicate with the station, so use this operation only if the telemetry is down.
We advise furthermore to set the master centre personal computer to automatically synchronize its clock every day from a time server (like time.windows.com).
Note: the clock is powered by the station or, when the station is switched on, by a 3V battery on the CPU board. If the station remains off for a large amount of time, the 3V battery will run down and the station clock will reset to January 1, 2000. In both cases, the clock integrated in the station is not so accurate (it could lose or gain even 1 or 2 seconds per day). So consider that if the station remains isolated (not interrogated by the master centre) for a large period of time, the date of the measures will derive.

[3.1.7 SET GPS TIME ZONE]
This section allows to change time zone when the GPS device is available. In this case the station clock is synchronized with GPS Time shifted by the time zone selected.

[3.1.8 SET COMM SPEED]
This section allows to change the baud rate settings of the serial ports. It is a very delicate operation that will be needed only in particular circumstances, so we strongly advise not to change this parameters because this will interrupt the communication with the master centre or with the digital sensors.

[3.1.9 SET CHAMBER NUMBER]
Allows the setting of the number of accumulation chambers that are connected directly to the station (1 chamber) or to the multiplexer (from 2 to a maximum of 8).

[3.2 LCD SETTINGS MENU]



[3.2.1 SET BACKLIGHT]
Allows to regulate the power of the LCD backlight.

[3.2.2 SET BRIGHTNESS]
Allows to regulate the brightness of the LCD.

[3.2.3 SET BACKLIGHT APO] (Auto Power Off)
Allows to set the time interval after which if any of the buttons will be pressed the station will switch off LCD backlight.

[3.2.4 SET SWITCHOFF APO] (Auto Power Off)

Allows to set the time interval after which if any of the buttons will be pressed the station will switch off the display.

[3.3 STATION VERSION]
Displays the serial number of the station and the firmware version of the station.

[4 MENU POWER MANAGEMENT]

[4.1 LCD STAND BY]
The display is temporarily switched off. It can be awaken by pressing the OK button.

[4.2 LCD SWITCH OFF]
The display is turned off and will be turned on again only when the CPU wakes up from a sleep state (or obviously if you switch on the station again). This operation doesn't affect the station behavior, only the LCD display will be shut down.

[4.3 CPU RESET]
Reset the CPU. This operation corresponds to switching off and on the station.

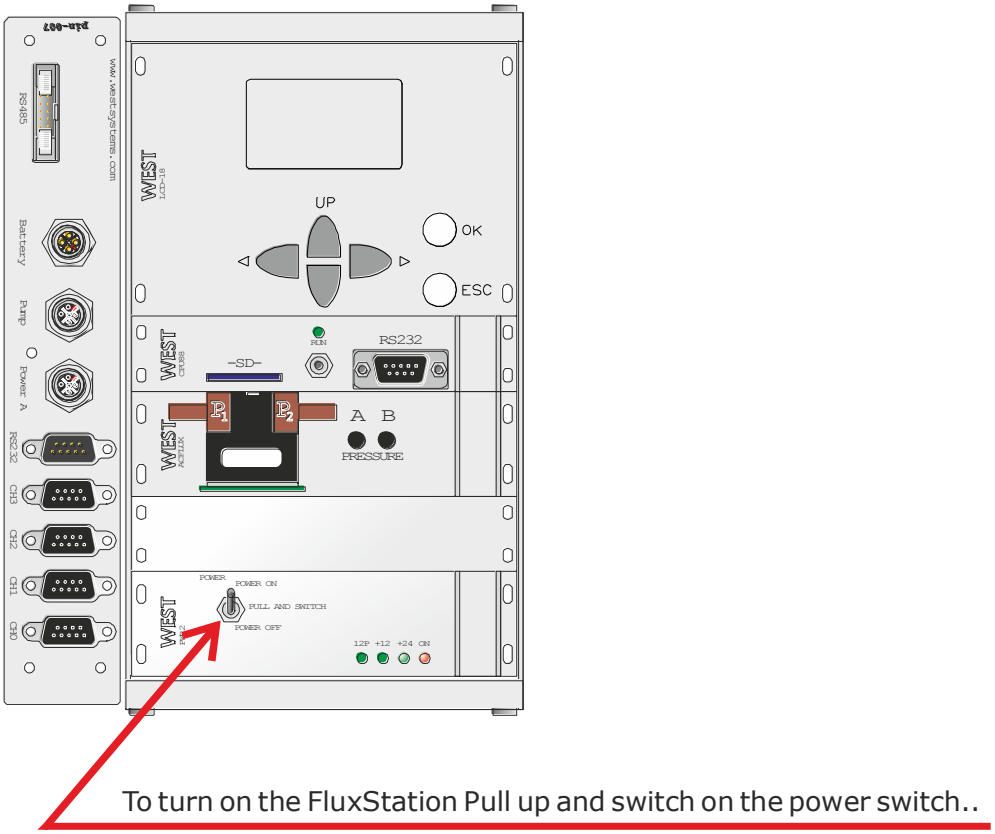
[4.4 RADIO OFF - CPU SLEEP]
Put the CPU in sleep mode. While in sleep mode, the station is like switched off, except for the fact that it will be woke up by its internal alarm clock or by pressing the CPU run button. It's the state of minimum power consumption.
The station goes to sleep mode in the following circumstances:

- After writing a file to the SD card: it will wake up at the event Radio ON (if different from 0) or at the next measure.
- After Radio Off: it will wake up at the next measure
- When Scada has finished interrogating the station, sending a specific command.
- Through this command on the LCD display.

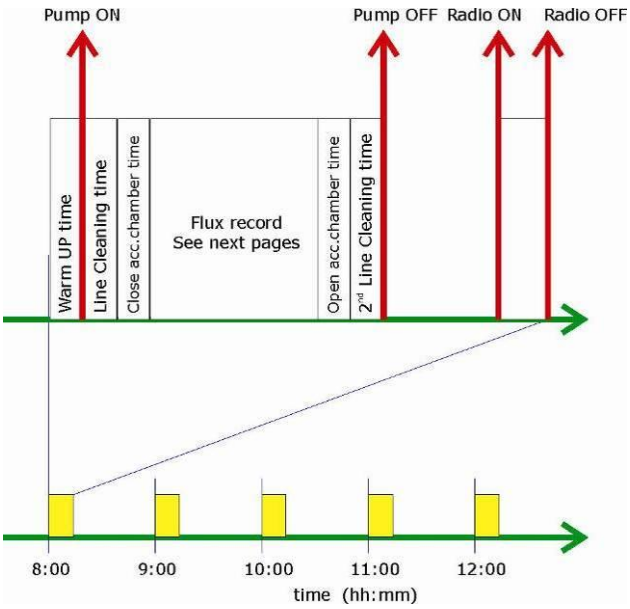
6 Display

7. Running FluxStation

7.1 Quasi-continuous monitoring

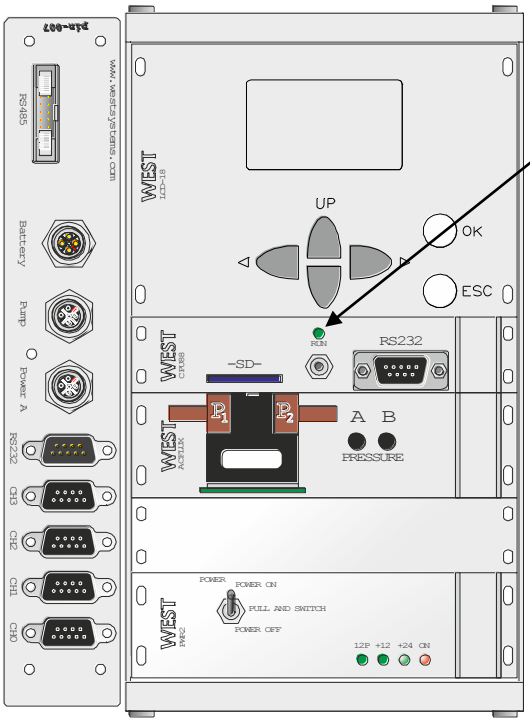


After a quick boot the station starts the quasi-continuous monitoring task. There is no need to manually activate the measurements. The next measurement will start automatically according to the Analysis Frequency timing.



7 Running Flux Station

Following the default configuration parameters the station performs one analysis cycle every hour (By default). See chapter 5.



CPU RUN LED/BUTTON:

- If the LED is off, the station is in sleep mode. To wake up, press the same button
- If the LED is blinking every 2 seconds, the station is runninng
- If the LED is on, the station is going to write the file to the SD card (it's a warning to wait replacing the card

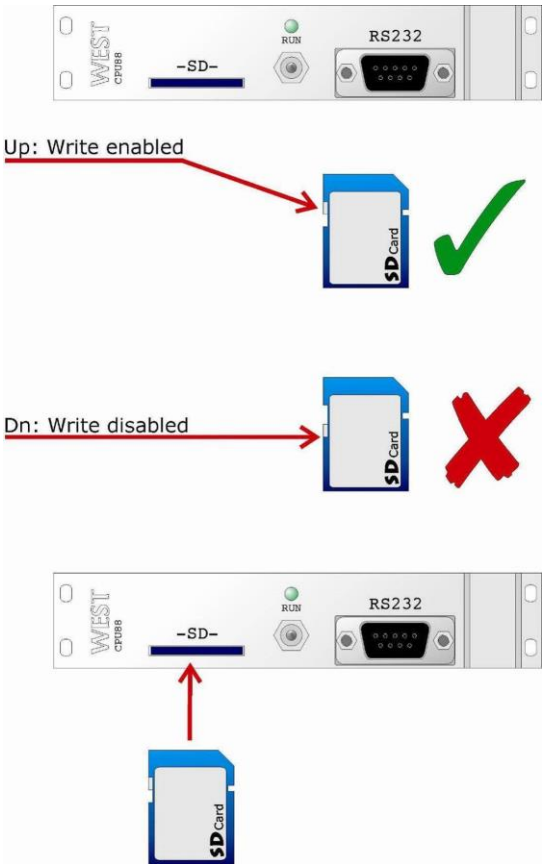
The station stores the result of analysis cycles on a SD memory card. The SD card is formatted using the FAT32 file system and can be read directly from every operating system on a PC.

Each analysis cycle requires a couple of kilobytes on the SD card (it depends on the number of tracks and the number of samples per track), but due to the file system the "disk dimension" of file is 4 KBytes. Then for the default sampling frequency (one measure every hour) are necessary 96 KB/day (35 MB/year). An SD card with 1 GB capacity will store data for 28 years.

But if the station is regularly interrogated, the SD card will contain only 1 file at once, because as WS-Scada downloads a file and saves it on the database, commands the station to remove the file from the SD card.

Note: the station is NOT compatible with High-Capacity (SDHC) cards.
Please use standard SD cards (capacity up to 2 GB).

Before inserting the SD memory card in the CPU slot verify that the Write On/Off switch of the card is in the enabled position.



After inserting the SD card check if it's working correctly making a read/write test though the menu [2.10.4 Test SD Card]

This menu displays also the space left on device.

The station writes on the card at the end of the measurement cycle. Removing the card during the cycle can cause the loss of data.

In order to inform the operator of the next writing operation, the CPU run led light will be solid ON for a 60 second period before starting to write on the card.

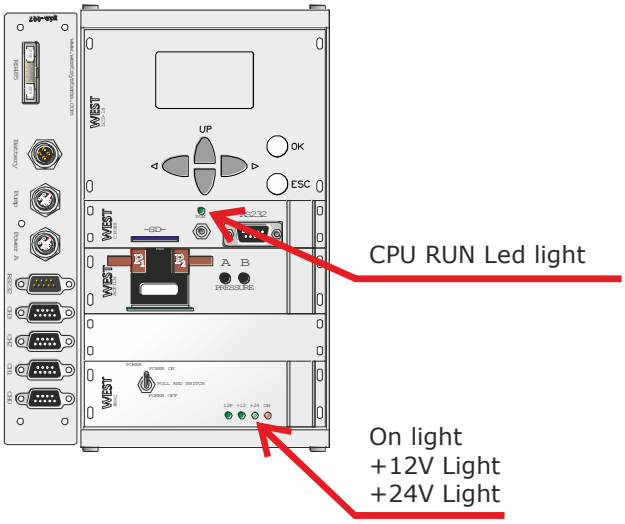
Then if you have to swap the card on the FluxStation you've to:

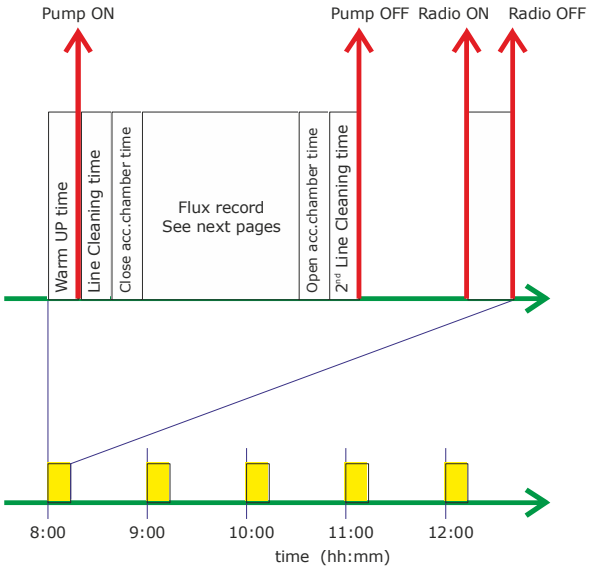
- Prepare the empty SD card. The SD card has to be not SDHC. High Capacity cards are NOT compatible with the station. The card has to be formatted with FAT32;
- Check that the "CPU RUN LED" is flashing once every 2 seconds or that it's OFF;
- Remove the card on the slot;
- Place the empty card in the slot.

7 Running Flux Station

If you want to be sure the card is correctly inserted and functional, execute a read-write test: menu [COMMANDS][FILE MENU][TEST SD CARD].

7.2 Anaysis cycle





The station has two working states:

1) Standby: the time between the analysis cycles;

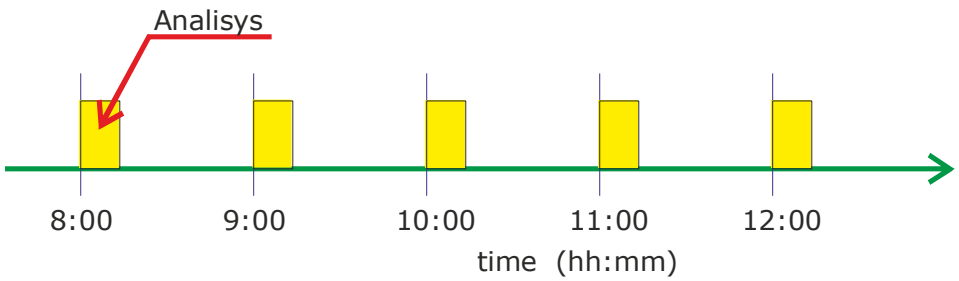
2) Analysis cycle (Yellow boxes in the drawings).

Stand-By State
During the stand-by state the CPU RUN led light, on the CPU board, flashes once every 2 seconds and the ON light on the Power board is solid ON.

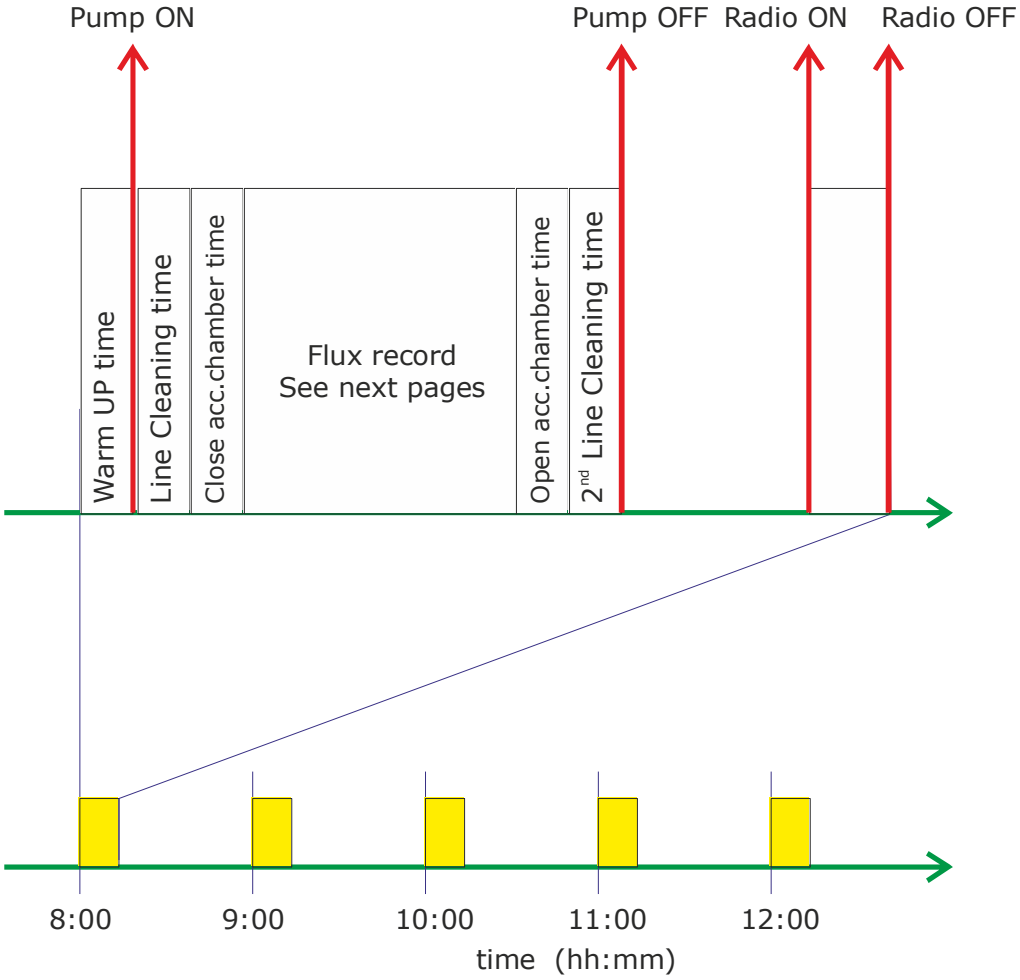
Analysis running state
While the analysis cycle is running the CPU RUN led light, on the CPU board, flashes once every 2 seconds and the ON light on the Power board is solid ON. The +12V and +24V led light are solid ON (or OFF) depending on the phase of the analysis.

Analisys frequency
Normally the station performs an analysis every hour and then the default value of the parameter is 3600 sec;
Valid range is from 300 seconds to 24 hours.

If the time between two cycles is 3600 secs (1 hour), the analysis will start exactly at the beginning of hour, for instance the sampling time will be 8 sharp, 9 sharp etc.



Every measurement cycle is composed by several actions that are scheduled by some parameters described below.

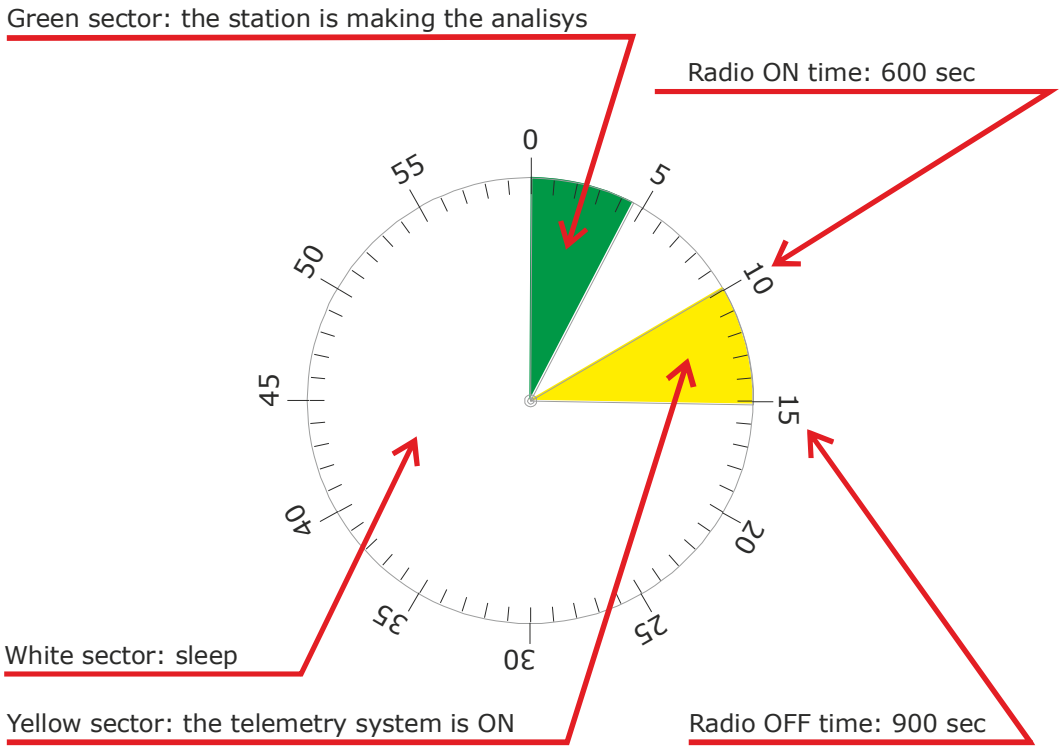


Set RADIO On/OFF:
In order to reduce the power consumption the telemetry system is managed as follow:

- RADIO ON time (sec)
The telemetry system will be turned ON usually at the end of the cycle, at the moment expressed by the timing 30 (see chapter 7.3).

7 Running Flux Station

- RADIO Off time (sec)
The telemetry system will be turned ON usually at the end of the cycle, at the moment expressed by the timing 31 (see chapter 7.3).



In the drawing an example of
Radio On time = 600 (sec)
Radio Off time = 900 (sec)

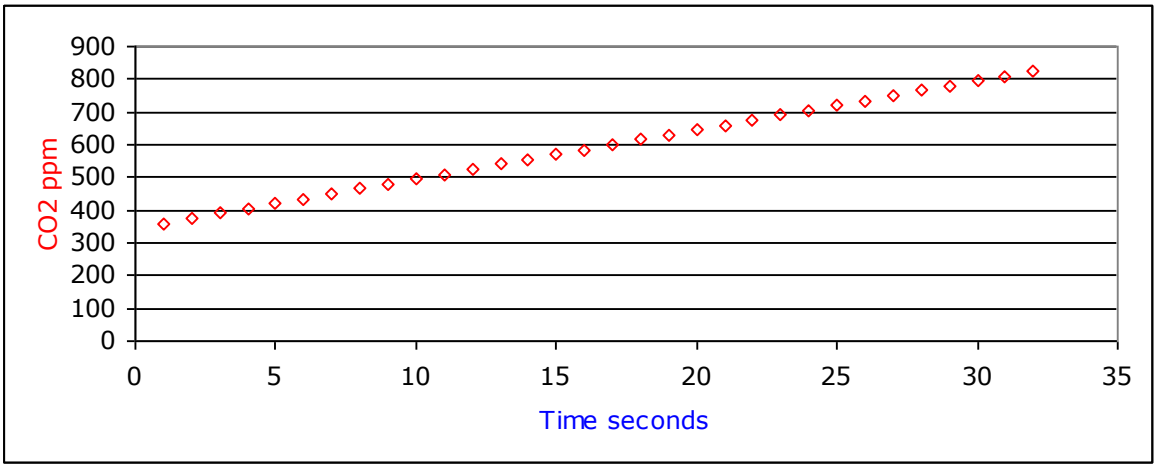
If Radio Off Time or Radio On Time are set to 0, the station will keep the radio ALWAYS ON and will never go to sleep mode.

Num. Samples: Is the number of points in the flux record. Normally the value is between 32 and 256 points. The increase of this parameter will increase the size of the record, reducing the capability of station data storage and increasing the data transmission time.

Delta T.: Is the time, expressed in millisecond, between two consecutive points sampled in the flux record.
Normally the value is between 500 (0.5 seconds) and 3000 (3 seconds).

The global flux record time is**: Delta T. x Num. Samples/ 1000**

In the following plot a sample of flux record with Num of Samples = 32 and DeltaT. = 1000 (1 second). The overall flux record length is 32 second.



The normal record length must be in the interval 90 ... 240 seconds. If the flux is quite high the length can be 90 seconds, is the flux is quite low is better to increase the record length.

7.3 Analysis timings

The analysis cycle and frequency can be modified by editing the stations timings.
There are two ways of modifying such values:

- Directly on the display of the station (command 3.1.3), see chapter 6 for detailed instructions.
- From WS-Scada (command Edit Station Parameters), see chapter 10 for detailed instructions.

Since this is an advanced configuration, please contact support@westsystems.com before applying any modification on the timings.

The following table shows the timings which affect the analysis cycle.

ParamID	Description	Default Value	Note
0	Analisys frequency [s]	3600	One measure every hour
1	+24 on [ms]	1	The 24V sensors (LI-COR LI-820) are immediately turned on after the start of the analysis cycle in order to guarantee a proper warm up

7 Running Flux Station

2	+24 off [ms]	0	0 = not executed. The station never turns off the LI-COR LI-820 because, after each power-on, it takes several minutes to warm up, which require a lot of power consumpion (it has an internal heater for warming up the cell). For this reason is more convenient to keep the LI-COR sensor on all the time
3	AC Down start [ms]	80000	After 60 seconds warm-up + 20 seconds cleaning
4	AC Down stop [ms]	110000	Chamber closing time: 30 seconds
5	AC Up start [ms]	233000	At the end of accumulation curve recording
6	AC Up stop [ms]	263000	Chamber opening time: 30 seconds
7	Pump on [ms]	60000	After 60 seconds warm-up
8	Pump off [ms]	283000	At the end of analysis cycle
9	Fan on [ms]	60000	After 60 seconds warm-up
10	Fan off [ms]	283000	At the end of analysis cycle
11	+12 on [ms]	1	The 24V sensors (LI-COR LI-820) are immediately turned on after the start of the analysis cycle in order to guarantee a proper warm up
12	+12 off [ms]	283000	The 12V sensors are turned off at the end of the analysis cycle because they do not require long warm-up
13	Sampling [ms]	111000	Start of recording accumulation curve
14	All Off [ms]	284000	At the end of analysis cycle
15	RS485 Sampling [ms]	264000	Sampling of SoilBox and AirBox sensors
16	Write File to SD [ms]	285000	At the end of analysis cycle
17	+12 RS485 on [ms]	1	The RS485 sensors (AirBox and SoilBox) are immediately turned on after the start of the analysis cycle in order to guarantee a proper warm up
18	+12 RS485 off [ms]	283000	At the end of analysis cycle
19	EV0 on [ms]	0	not used
20	EV0 off [ms]	0	not used
21	EV1 on [ms]	0	not used
22	EV1 off [ms]	0	not used
23	EV2 on [ms]	0	not used
24	EV2 off [ms]	0	not used
25	EV3 on [ms]	0	not used
26	EV3 off [ms]	0	not used
27	BT on [ms]	0	not used
28	BT off [ms]	0	not used
29	-	0	not used

30	Radio on [ms]	600000	The Moxa Wireless serial server is turned on 10 minutes after the start of the analysis cycle
31	Radio off [ms]	900000	The Moxa Wireless serial server is turned off 15 minutes after the start of the analysis cycle

8. Calibration

8.1 Calibration of LI-COR LI-820

The subjects regarding calibration of your instrument for the measurement of diffuse flux will be discussed in this chapter.

As explained previously the flux measurement is proportional to the slope of the concentration curve versus time. The proportionality factor depends on the volume/surface ratio of the accumulation chamber used for the measurement, as well as, the barometric pressure and air temperature at the time of the measurement.
The most important aspect to understand is that the flux is proportional to the gradient of concentration over time: ppm/second.
This aspect allows us to simplify the control of the response of the gas sensors.

When to calibrate

The recommended calibration interval is one year. The operating conditions affect the long-term stability. In a harsh operating environment, it is recommended to check readings more often than in easy environments.

What you need in order to check the calibration of the GMP343

- A cylinder of nitrogen or CO_2-free mixture.
- A cylinder of standard mixture of a known concentration of carbon dioxide in air (or nitrogen) *;
- Two Tedlar gas sampling bags, of 5 or 10 liters capacity.

* The carbon dioxide concentration should be between 50% and 95% of the detector measurement range. If the full-scale value of the detector is 20,000 ppm, you can use a standard with a concentration of CO2 between 10,000 and 19,000 ppm. If the concentration is less than the 50% of the full-scale value, you will increase the calibration error.
If the full scale of the detector is 1,000 ppm, you can use a standard with concentration of CO2 between 500 and 950 ppm.

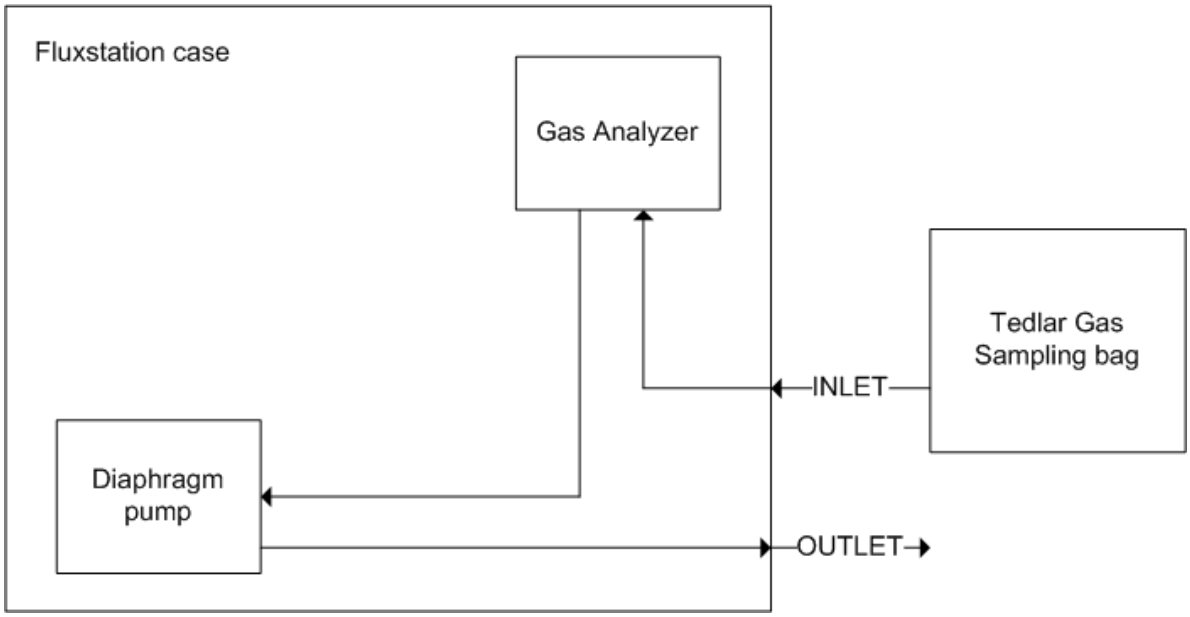
How to perform a calibration check

1- Before verifying the calibration, turn on the detectors (menu [MEASURE] [SHOW ANALOG VALUES]) and leave it on for a minimum of 5 minutes to warm up.

2- Start the pump from the menu [COMMANDS] [SET PUMP STATUS]

3- Fill the first Tedlar bag with nitrogen.

4- Connect the Tedlar bag to the inlet port of the flux station, as shown in the following diagram. In this way the pump will get the content of the bag into the detector and finally to exhaust passing from the outlet port.



5- Check the reading on the station display (menu [MEASURE] [SHOW ANALOG VALUES]). Wait for the value to stabilize and finally take note of the reading.

6- Disconnect the bag from the inlet.

7- Fill the second Tedlar bag with the CO_2 mixture.

8- Connect the Tedlar bag to the inlet port of the flux station.

9- Check the reading on the station display (menu [MEASURE] [SHOW ANALOG VALUES]). Wait for the value to stabilize and finally take note of the reading.

To simplify the explanation, please see the following example:

Let's suppose that the check performed gave the following results:
Injecting a mixture at zero concentration of carbon dioxide the CO2 detector returns a reading of 10 ppm.
Injecting a mixture containing a 10,000 ppm concentration of carbon dioxide the CO2 detector returns a reading of 9940 ppm.
At a variation of concentration set at 10,000 ppm the instrument has a slightly different response: 9930 ppm (=9940-10 ppm). The evaluation error is of about 70 ppm, which in percentage points over the span corresponds to 0.6% less.

8 Calibration

The error in evaluating the increment in concentration manifests as a systematic error in the evaluation of flux and, therefore, must be corrected by calibrating the instruments when it is too high (> 5%).

If the calibration check results are not satisfactory, it's necessary to re-calibrate the detector.

What you need in order to calibrate the LI-COR LI-820

- A cylinder of nitrogen or CO_2-free mixture.
- A cylinder of standard mixture of a known concentration of carbon dioxide in air (or nitrogen) *;
- Two Tedlar gas sampling bags, of 5 or 10 liters capacity.
- A laptop with Microsoft Windows operating system, and a RS232 serial port (native or USB adapter).
- A Null-Modem serial cable (furnished).

How to perform a calibration

1- Switch on the LI-820 detector and wait for the sensor to warm up, until the cell temperature reaches about 51°C. You can check the value through the menu [MEASURE] [SHOW ANALOG VALUES]).
If the station is configured not to keep the LI-820 always ON, entering the menu [SHOW ANALOG VALUES] will wake up the LI-820.

2- Connect the LI-820 to the laptop and start the LI820 PC Software. Select the port and press *Connect*. The application will show CO2 real time data.

3- Select View, Calibration to open the calibration window. Connect the first sampling bag, previously filled with nitrogen, to the INLET of the station.

4- Start the station pump, menu [COMMANDS][2.4 SET PUMP STATUS]. The LI-820 start to analyse the bag content.

5- Wait for the CO2 reading to stabilize and press *Zero*.

6- Once finished, connect the second sampling bag, previously filled with CO2 mixture, to the INLET of the station.

7- Wait for the CO2 reading to stabilize; then input the ppm concentration of your calibration mixture (e.g. 15000) in the field *Span gas concentration*. Then press Span.

8- Once finished, check the CO2 reading of the two gas standards. Repeat calibration if necessary.

Refer to LI-820 manual (Chapter 3: Operation) for more detailed instructions.

8.2 Calibration of H2S detector

Please refer to Appendix I – Hydrogen Suplfide detector.

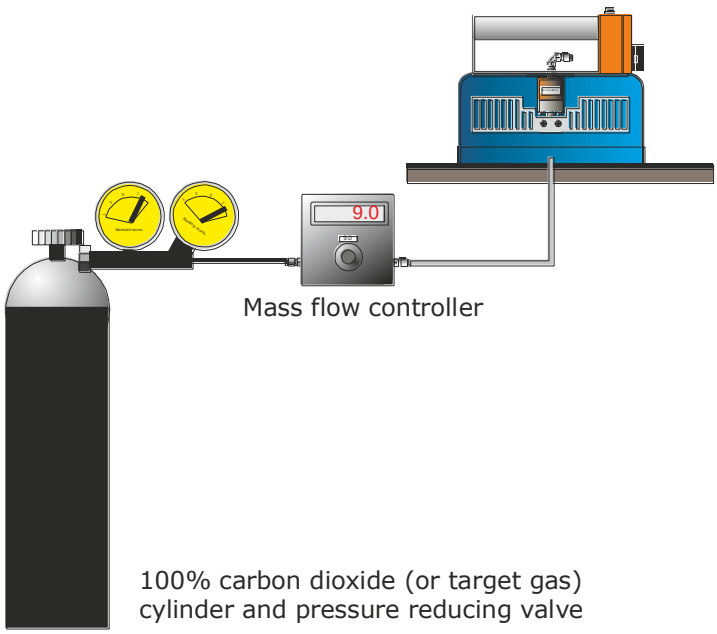
8.3 Calibration of the flux meter

As the computation of flux is a function of the gradient of concentration vs. time, barometric pressure, air temperature and the accumulation chamber volume / surface ratio, the calibration of the instrument depends only on the detector calibration. The accuracy of the barometric pressure and air temperature measurement affect the evaluation of flux: 3 degrees Celsius of error while evaluating the temperature will cause a 1% error when computing the flux. A 10 HPa (mBar) error measuring the barometric pressure will cause a 1% error in the flux evaluation.

How to verify the fluxmeter calibration

The calibration described refers to carbon dioxide calibration, for other gases, like methane or hydrogen sulphide, the same procedure has been followed.

Sketch of calibration device

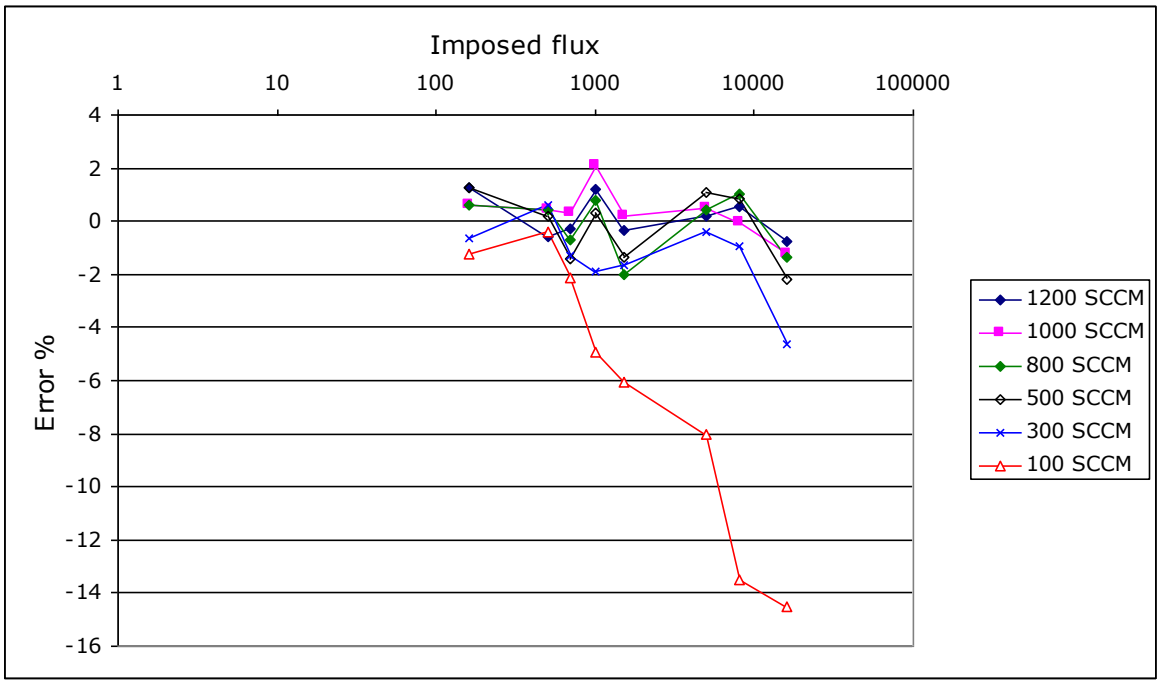


CO2 fluxes from soil are simulated by injecting a known flow of gas into the accumulation chamber. The interface between the accumulation chamber and the calibration table is built to minimize the gas leakage.
The equipment is shown in figure 1.
The injected flux is controlled and measured with a precision mass flow controller. This MFC, calibrated for CO2, is electronically stabilized, with accuracy: ± (0.8% of Reading + 0.2% of Full Scale).

8 Calibration

A thermometer and barometer were utilized to measure the barometric pressure and the air temperature during the experiment in order to select the correct accumulation chamber conversion factor.
A flow meter is utilized to measure the pumping flow during the experiment.
During all the measures a 100% CO2 flow was utilized.
The same procedure was utilized to check the instrumental response to methane / Hydrogen Sulphide.

The influence of pumping flow
Influence of pumping efficiency on the flux measurement results:
We have carried out some sets of measures utilizing the same injected flux but with different pumping flow from the accumulation chamber to the detector.
The pumping flow was changed by means of a mechanical flow reducer and measured with a Microbridge Mass Airflow sensor (Accuracy 2%).
We have not noted a significant variation of the measures except when the pumping flow is less than 200 SCCM.



In the diagram the plot of the measurement error versus the imposed flux of carbon dioxide (expressed in grams per square meter per day) at different pumping flow rates is shown.

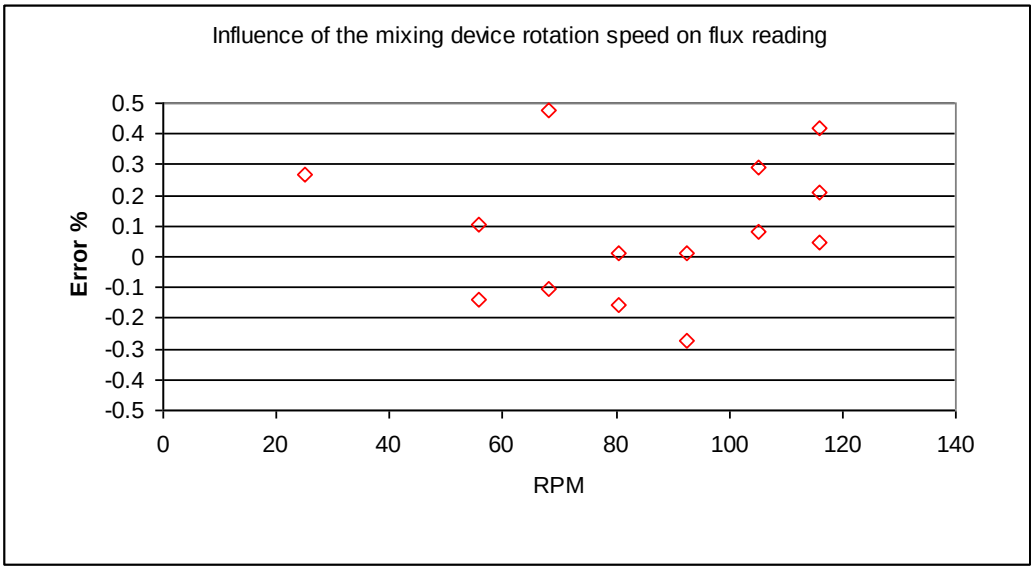
In order to avoid unwanted variation of pumping flow due to power supply the pump is supplied at 12 V DC with a stabilized voltage regulator.

The pumping flow, after the power supply stabilization, is set to about 1 LPM. The efficiency of pump can vary due to dust or moisture in the pump body. Periodic maintenance is necessary.

The influence of mixing device
The mixing device was suspected, by some researcher, to affect the accuracy of the flux measurement.

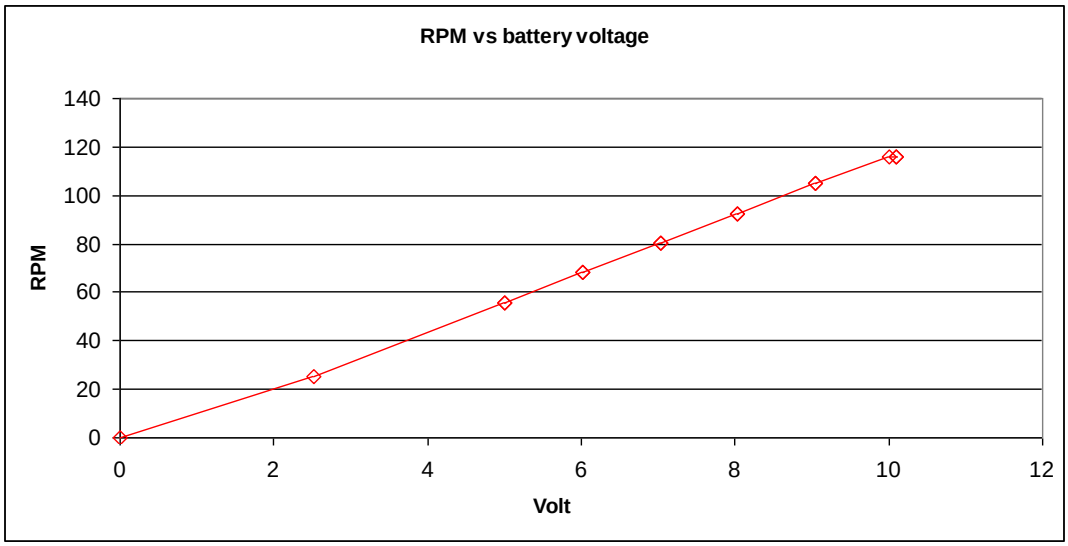
In our experience the precision of the measurements was notably reduced without a mixing device present.
In the two plots below the measurements at various regimes of mixing device rotation are reported.

Influence of the mixing device rotation speed



In the plot the measured flux vs the mixing device rotation speed.

Battery status vs RPM.



In the plot the mixing device RPM (Rotation per minute) vs power supply voltage. The normal range for the battery voltage is between 9.6 V (new battery) and 6 Volt (discharged battery)

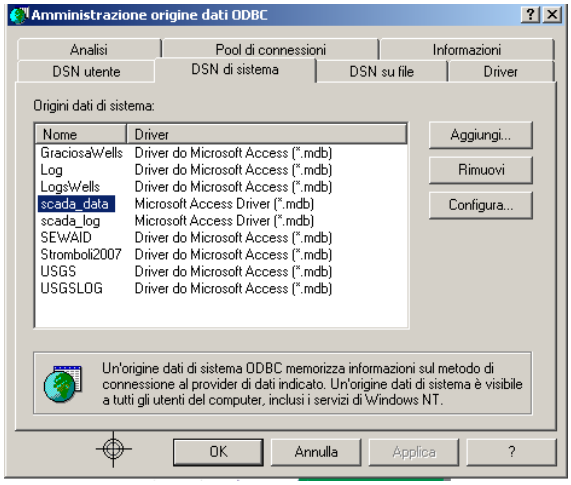
9. Database Structure

9.1 The databases

All the information necessary to run WS-Scada, as well as the data acquired by the fluxstation, are stored in the database *scada_data*.

A second database (*scada_log*) is used by WS-Scada to log messages, error reports and other information that are generated by WS-Scada and that can be helpful to diagnose some malfunctions of the system.

WS-Scada accesses the two databases via ODBC. For this reason, two DSN entries are stored in the ODBC manager of the operating system.



Both DSN are created automatically by the WS-Scada setup. Normally it's not necessary to modify it manually.

The four applications of WS-Scada suite read the system DSN from the ODBCName.txt file, located in the C:\WEST\scada\source\ folder.

The first line sets the DSN that point to the data and settings database and the second line sets the DSN that point to the log database.

Database *scada_log*

The database *scada_log* is composed by several tables:

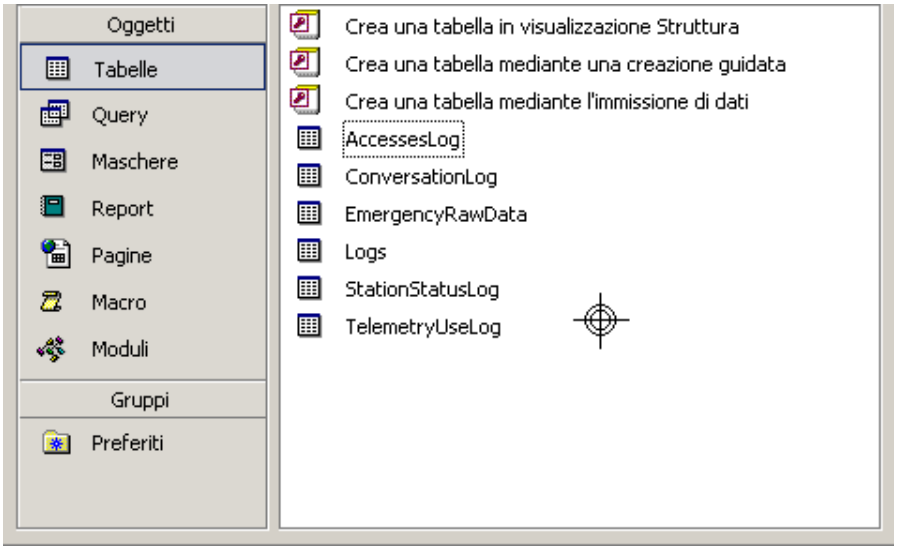
AccessesLog:

ConversationLog: Information about the "conversation between Scada and the FluxStation(s);

EmergencyRawData: Raw data coming from the fluxstations: usefull for malfunction diagnostic;

StationStatusLog: Informations about the status of the fluxstations;

TelemetryUseLog: information about the use of the telemetry system. Designed to check the bill, in case of GSM based telemetries.



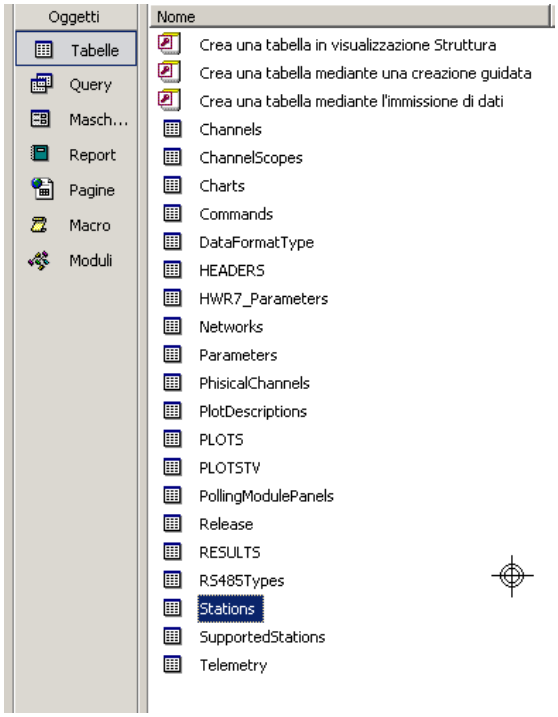
The information in scada_log.mdb is not useful during the "normal" operation of the system. Some of troubleshooting can be understood using its information.

Database *scada_data*

To understand the structure of the database is not important for the standard use of the system. This information is reported for documentation purpose.

scada_data is composed by several tables, some of them are to define the fluxstations and their configuration. Some of them contain the results acquired by the fluxstations.

9 Database structure



The tables:
HEADERS
RESULTS
PLOTS
PLOTTV
contain the data generated by the fluxstations

The tables:
ChannelScopes
Commands
Parameters
DataFormatType
RS485Types
SupportedStations

contain the auxiliary data necessary for the correct working of the Scada software suite.

The tables:

Networks
Stations
Channels
PlotDescription
PhisicalChannels
Telemetry
HWRT_Parameters

contain the description of the monitoring network(s).

Each FluxStation must be defined in the ***Stations*** table.

Field	*Value*	*Description*
ID	13	Record ID (Counter)
Active	-1	-1 = Active // 0 Not active
NetworkID	WS	Has to be **WS**
StationID	OVK01	Identifier of station
StationIP	0001	Address of station
Description	Flux Station 2007	
TelemetryID	SSR24	Type of telemetry
TelemetryName	2427581	* Address of remote telemetry system
TelemetryPath		* Optional repeater address
Site		Name of the site
Latitude		Localization of site
Longitude		Localization of site
Elevation		Localization of site
Responsible		Name of responsible
Type	HWR7	Station type
Model	1	Station subtype
PollingFrequency	24	** See note
PollingTimeShift	00.15.00	** See note
PollingRetryDelay	5	** See note

note *

The **telemetryname** and **telemetrypath** formats and values are depending on the telemetry type (**TelemetryID**). If the station is connected with a serial cable (**TelemetryID = "COM_1"**), or with a point to point radio connection these to fields are not considered, simply because there is not necessity to address the communication. If your system has a SSR24 (SpreadSpectrum radio system) based telemetry you'll find more information about this argument on the Appendix.F

note **

PollingFrequency is the number of telemetry calls that Scada will perform during a day to download the FluxStation data.

PollingTimeShift is a delay, expressed in hh:mm:ss, that will be added to the time of telemetry call: If pollingfrequency is 24 Scada will execute a call every hour plus the PollingTimeShift time. Then Scada will call the station at 1:15, 2:15 , 3:15 and so on. The PollingShiftTime must be synchronized with the radio ON and radio OFF parameters of the FluxStation in order to call the station when the telemetry is ON.

PollingRetryDelay, expressed in minutes, is used in case of fail if the communication. If Scada is not able to call the remote station it retry to call after PollingRetryDelay minutes. If PollingRetryDelay is set to zero Scada will retry to call the station only at the next scheduled time.

The Site, Latitude, Longitude, Elevation and Responsible fields contain only descriptive data.

9 Database structure

Type and *Model* are critical parameters that indicate to Scada how to manage the station and must be not modified.

StationID is the station identifier and cannot to be modified. The *StationIP* is the logical address of the station and cannot to be modified.

9.2 Databases structure

Database *scada_data*
The *PhisicalChannels* table contain information about the "phisical" configuration of the station channels.

ID	StationID	Number	Name	FullScale	LowScale	Gain	Offset	Statistics	PlotCurve	Conf	Type
47	OVK01	0	CO2	20000	0	1	0	1	-1	FF06	ANALOG
48	OVK01	1	Bar.P	1060	600	1	0	1	0	FF05	ANALOG
49	OVK01	2	Ch.2	5000	0	1	0	1	0	FF06	ANALOG
50	OVK01	3	Ch.3	5000	0	1	0	1	0	FF05	ANALOG
51	OVK01	4	Ch.4	5000	0	1	0	1	0	FF05	ANALOG
52	OVK01	5	Ch.5	5000	0	1	0	1	0	FF05	ANALOG
53	OVK01	6	dP	1100	600	1	0	1	0	FF05	ANALOG
54	OVK01	7	P.Flow	1000	0	1	0	1	0	FF0F	ANALOG
55	OVK01	1	SOILBOX Soil W.	100	0	1	0	1	0	A0	DIGITAL
56	OVK01	2	SOILBOX Soil W. Raw	35	15	1	0	1	0	A1	DIGITAL
57	OVK01	3	SOILBOX Soil T.	200	0	1	0	1	0	22	DIGITAL
58	OVK01	4	SOILBOX Soil T. Raw	200	0	1	0	1	0	A2	DIGITAL
59	OVK01	169	AIRBOX Air RH	0	0	1	0	1	0	DA	DIGITAL
60	OVK01	170	AIRBOX Air T	0	0	1	0	1	0	D9	DIGITAL
61	OVK01	171	AIRBOX Wind Speed	0	0	1	0	1	0	D7	DIGITAL
62	OVK01	172	AIRBOX Wind Dir	0	0	1	0	1	0	D8	DIGITAL
63	OVK01	173	AIRBOX Rain Gauge	0	0	1	0	1	0	DF	DIGITAL

There are two basic type of "channel": ANALOG or DIGITAL; The 8 analog channels are managed by the AC board of the flux station. The digital channels are devices (AirBox and SoilBox in the base configuration) that are connected to the station with a serial connection (RS485).

ANALOG
Number is the phisical ADC ID;
Name is a short mnemonic description;
FullScale, **LowScale** and **Conf** are used to set the type of signal to be read (Voltage or Current) and the range of the detector connected to the channel;
Gain and **OffSet** can be used to scale the result of the measurement;
Statistics change the statistic treatment reserved to the channel;
PlotCurve: Setting to -1 this value force the flux station to acquire a Flux Curve of the signal coming from this detector.

DIGITAL
Number is the logical RS485 ID of the device;
Name is a short mnemonic description;
Conf is the type device connected;
FullScale and **LowScale** depends on Conf and must not modified.
Gain and **OffSet** must not modified.

Statistics change the statistic treatment reserved to the channel;
PlotCurve: Setting to -1 this value force the flux station to acquire a Flux Curve of the signal coming from this detector.

Information about how to change the configuration and to send it to the FluxStation are reported on Chapter 10.

***Channels* table**

The *Channels* table is derived from the *PhisicalChannels* one, integrated with additional records and contain all the "definition" necessary to manage the several signals managed by the station.

Each record define a **channel** , for instance **Air temperature** or **CO2 Flux**.

Most of the field of the table must not be modified by the user and are not documented here.

PanelPage: set the Scada panel where the channel information are displayed;

RowOnPanel: set the row on the Scada panel where the information are displayed;

RevisionPriority: When using Query.exe the list of channels will be in descending order and only the channels with RevisionPriority > 0 will be visible;

Monitored: Monitor.exe will show the channels with monitored <> 0, see chapter 11;

MonitoringGroup: see chapter 11;

AlarmType, **ActiveThresholds**, **UPAlarm**, **UPPrealarm**, **DnPrealarm**, **DnAlarm**: these fields are related with an "alarm" signal managed by Scada.exe: see chapter 10;

Gain, **OffSet**: by varing these fields it's possible to scale the result values of the channel, ask to West Systems;

Name, **Description**: The name and the description of the channels;

Active: If active = -1 the channel will be managed by Scada.exe. To exclude a channel set active=0;

The direct (manual) modification of the *Channels* table can be very critical. Ask support to West Systems before to make any modification.

Telemetry table

The *Channels* table is derived from the *PhisicalChannels* one, integrated with additional records and contain all the "definition" necessary to manage the several signals managed by the station.

There are 3 possible base types of telemetry (Field *BaseType*):

- **DISK**

The station has not a telemetry system and the data is transferred via SDmemory card. In the telemetry table we defined a telemetry of this base type:

TelemetryID = SD
WindowStart=00:00:00
WindowStop=23:59:59
CommPort= 0
HostID= <blank>
Settings=<blank>
TelemetryType=DISK
BaseType=DISK
CommTimeOut=<blank>

If you want to set this telemetry for your station you've to put the ***Stations.TelemetryID = SD*** in the record of the *Stations* table that define your station.

- **ETH**

The station telemetry system is based on a
ethernet to serial converter (as the Moxa DE211)..

TelemetryID = Moxa_1
WindowStart=00:00:00
WindowStop=23:59:59
CommPort= Socket port of the IP.
HostID= IP address of the Moxa
Settings= RS232 parameters of the RS232 port of the moxa;
TelemetryType=MOXA
BaseType=ETH
CommTimeOut=2000

If you want to set this telemetry for your station you've to put the ***Stations.TelemetryID = Moxa_1*** in the record of the Stations table that define your station.

- **RS232**

The base type RS232 supports several TelemetryTypes:

GSM: Gsm based data modems;

SSR24: Spread spectrum 2.4 or 0.9 GHz in switched mode;

RS232: Direct cable connection.

The base type RS232 supports several TelemetryTypes:

The configuration of each type is described in the telemetry handbook.

SSR24 : Appendix F;
GSM : Appendix G; (not included)
RS232 : Appendix M;

General settings:
WindowStart, **WindowStop**: are used to define an activity time window for the telemetry: If Scada.exe has to share the telemetry with another application is possible to define a time window, for instance between 11:00:00 and 16:00:00.
Scada.exe will use the telemetry system only during this interval.

CommTimeOut: Is a TimeOut interval, expressed in milliSeconds. The communications can suffer of latency times (as for example a Moxa device connected via a IEEE802.xx network, or via an ADSL connection). By setting a proper value to CommTimeOut can solve the problems due to long latency times.

10. WS-Scada software suite

10.1 Software installation

The Scada software runs on Microsoft Windows operating system (XP, Vista, 7, 8). Microsoft .NET Framework is required (if it is not present you'll receive a warning during the installation: download it from Microsoft website and install it). The .NET Framework is installed by default from Windows Xp Service Pack 3 and

WS-Scada Software Suite is compatible with the following DBMS:

- MYSQL (default)
- PostgreSQL
- Microsoft SQL Server
- Microsoft Access

In this chapter the MYSQL and Microsoft Access installations will be described.

10.1.1 Microsoft Access based Installation

To install the Scada suite (WS-Scada, Monitor, Query, DataRevision), just run the installer (Setup_Scada_XXX.exe) furnished by West Systems on the software CD. The installer will automatically extract the database files (scada_data.mdb and scada_log.mdb) and generate ODBC references.

10.1.2 MYSQL based Installation

This manual assumes the following prerequisites:

- On the Windows machine on which you're going to install the Scada Suite, the MYSQL ODBC Connector must be installed. If it isn't, the installer it is furnished with the West Systems installation CD or it can be downloaded from MySql website.
- The machined has access to a MYSQL server instance (version 5 or later), already active on the local machine or in remote. Otherwise, a MYSQL server version is also furnished in the West Systems installation CD.

Examples of the commands to be executed (and the corresponding responses by the server) will be shown in red.

1 – Launch the West Systems Scada setup application. The installer will extract the applications file in C:\WEST\Scada\source and the database dump files (C:\WEST\Scada\scada_data.sql and C:\WEST\Scada\scada_log.sql) which you'll need in the next steps.

2 - Create user and schemas

2.1 - Open a Windows console (press Start, then Run and digit cmd). Log in to the MYSQL server as super-user. Replace in the following examples the IP address 127.0.0.1 with the IP address of the machine where your MySql server is active, or leave it if the server is local. Replace also root and password with your credentials. Example:

```
mysql -h 127.0.0.1 -u root -ppassword

Welcome to the MySQL monitor.  Commands end with ; or \g.
```

```
Your MySQL connection id is 636577
Server version: 5.0.45 Source distribution
Type 'help;' or '\h' for help. Type '\c' to clear the buffer.
mysql>
```

2.2 - Once authenticated, create the 2 schemas scada_data and scada_log.

```
mysql> create database scada_data;
Query OK, 1 row affected (0.04 sec)

mysql> create database scada_log;
Query OK, 1 row affected (0.04 sec)
```

2.3 - Create a user for the access to the database scada_data you've just created. The example shows how to create the user "scada_admin" setting the password "scada_admin", to be replaced with a more secure password.

```
mysql> grant all privileges on scada_data.* to scada_admin identified by
'scada_admin';
Query OK, 0 rows affected (0.10 sec)
```

2.4 - Grant privileges to the other database (scada_log) to the same user scada_admin.

```
mysql> grant all privileges on scada_log.* to scada_admin;
Query OK, 0 rows affected (0.10 sec)
```

2.5 - Finally, execute a flush to allow the settings to take effect immediately.

```
mysql> flush privileges;
Query OK, 0 rows affected (0.07 sec)
```

2.6 - Log out

```
mysql> exit
Bye
```

3 - Database import

At this point, we have two empty databases. To populate them with tables and data it's necessary to import the structures using the dump files furnished by West Systems. In the following example the 2 sql files has been previously copied to C:\scada_data.sql and C:\scada_log.sql.

3.1 - Access to the console and digit:

```
mysql -h 127.0.0.1 -u scada_admin -pscada_admin scada_data <
c:\scada_data.sql
```

At this point the import process will start. It could take several minutes. Wait until the command execution is completed.

3.2 - Import the structure of the second database:

```
mysql -h 127.0.0.1 -u scada_admin -pscada_admin scada_log <
c:\scada_log.sql
```

4 - Create ODBC connections

Once the databases are created, you need to make them accessible to the software suite. The software accesses the database using the ODBC layer (Open Database Connectivity).

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4.1 - On the Windows machine where the application WS-Scada will be running, you need to install the MYSQL ODBC Connector, if not already installed. Execute the setup file mysql-connector-odbc-5.1.8-win32.msi.

4.2 - Once the Connector installation is completed, open the Windows Control Panel (Start – Setttings – Control panel). Open Administrative Tools, then Data Sources (ODBC).

4.3 - Move to the System DNS tab and press Add. Select MySQL ODBC 5.1 Driver and press Finish. The MySQL Connector/ODBC panel will show.

4.4 - Fill the fields as illustrated and press OK

Data Source Name:	scada_data
Description:	West Systems Scada database (data)
Server:	127.0.0.1 (replace with your MYSQL server IP)
Port:	3306 (replace with your MYSQL server port)
User:	scada_admin
Password:	scada_admin (replace with the password you have inserted at point 2.3)
Database:	scada_data

4.5 - Repeat steps 4.3 and 4.4 for the second database using the following settings:

Data Source Name:	scada_log
Description:	West Systems Scada database (log)
Server:	127.0.0.1 (replace with your MYSQL server IP)
Port:	3306 (replace with your MYSQL server port)
User:	scada_admin
Password:	scada_admin (replace with the password you have inserted at point 2.3)
Database:	scada_log

The databases are ready. You can launch now WS-Scada.

Note: How to execute a database dump
A dump exports into a single sql file both the structures of the tables and the data of a database. A dump can be used for several purposes:
Make a backup of the database
Export the data to be archived or sent to someone.
Open a console and digit:

```
mysqldump -h 127.0.0.1 -u scada_admin -pscada_admin scada_data >
c:\dump_scada_data.sql
mysqldump -h 127.0.0.1 -u scada_admin -pscada_admin scada_log >
c:\dump_scada_log.sql
```

10.2 General description

The software suite of Scada is composed by 4 applications:

WS-Scada: This application, designed to run continuously, performs the polling of the stations in your network, downloads and stores the data in a

database and allow you to configure and manage the remote stations using a telemetry system.
Scada reads the network configuration from the scada_data ODBC data souce name (Chapter 9). Once reads the configuration it runs continuously to manage the information of all the stations that compose your network.

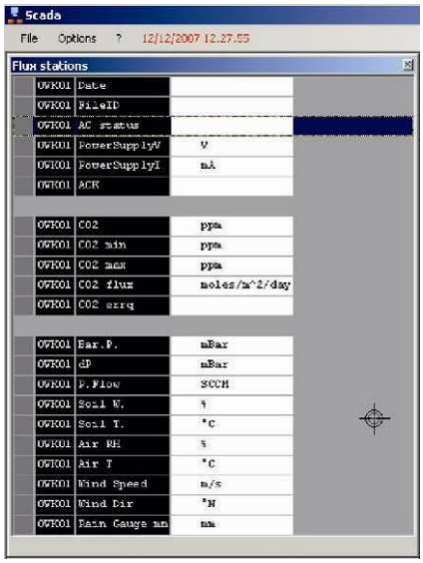
DataRevision: This application allows you to review the curves acquired by the stations.

Monitor: This application displays graphical charts of the last days of data.

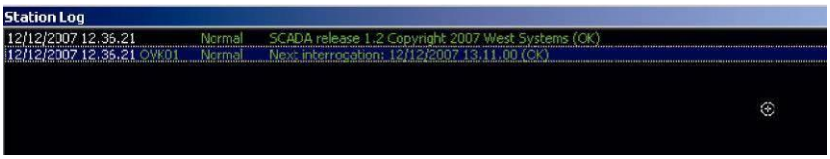
Query: This application allows you to query the database and obtain a table in the .xls or .csv format of the data stored in the database.

10.3 WS-Scada

Scada Panel
The Panel form resumes all the information of the station and its channels;
In the first column is reported the name of the station (Stations.StationID).
In the second column the name of each channel (Channels.Name) and in the third column the result (empty in the example) of the last downloaded measurement and the unit.



Station Log dialog box



The dialog "Station log" reports all the events related with the management of station and telemetries. This information is saved in the ***Conversation*** table of the **scada_log** database.

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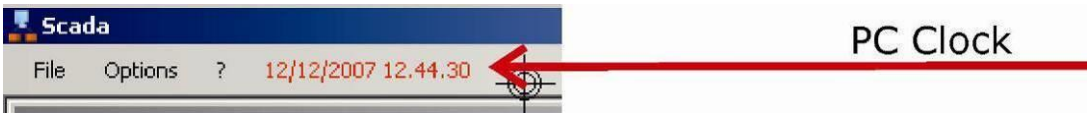
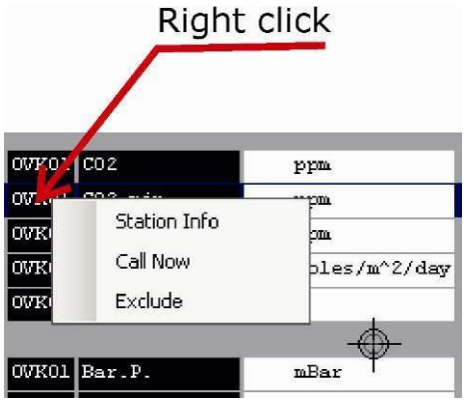
Normal events are reported in green, **Warnings** are reported in yellow and **Alarms** and **Errors** are reported in red.
In the drawing, after the CopyRight message, a Normal event is reported:

The next interrogation of the OVK01 station is scheduled at 13:11:00 of 12/12/2007.

The log can be saved as text file by right clicking the text box and selecting {Save as}.



On the left-top corner of Scada the pc clock is shown: WS-Scada will use this date/time information to set the clock of each station managed every time it will be able to talk with the station. Then to avoid confusion in the data you get you must check that the PC clock is correctly set.



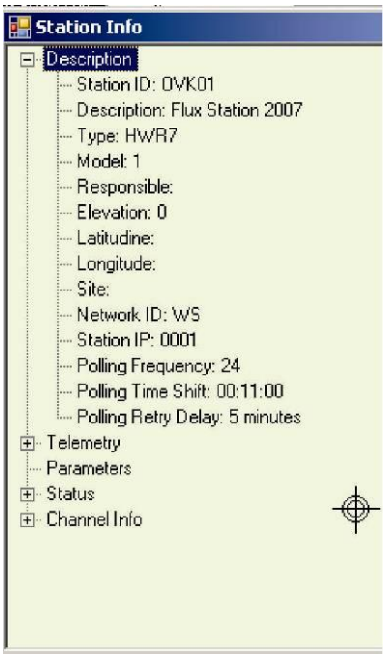
By right clicking on the StationID field of a station a menu appears.

{Station Info}

By selecting {StationInfo} you can get a report where all the information about the station, the telemetry , the configuration parameters, the status and about all the channels that belong to the station are present. The StationInfo report will be automatically closed after 30 seconds.

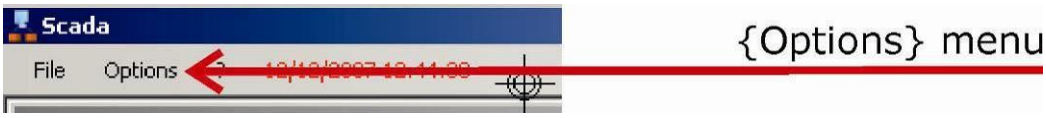
{Exclude}

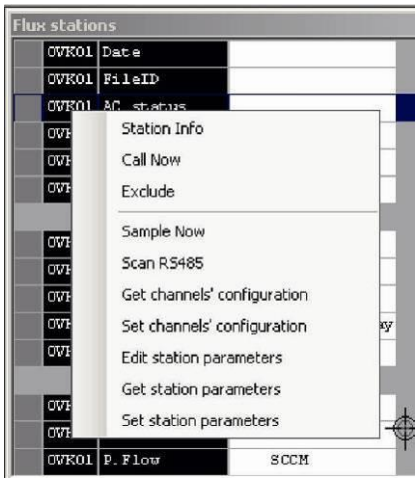
By selecting {Exclude} you can temporary exclude the station. While excluded a station is not managed by the application. This feature is normally used when a station is under maintenance to avoid useless telemetry calls. While excluded the background color of the station will be red. To reactivate the station select {Include} from the same menu.



{Call Now}

By selecting {Call Now} the application re-schedule the next call to now. Of course you've to consider that the remote telemetry system can be off and then the call will be not successful.





By selecting {Options}{Show advanced menu} an advanced station menu will be enabled, then now right clicking the StationID field a more complete menu is shown.

{Sample Now}

By selecting {Sample Now} you force the immediate execution of an analisys cicle. The command will be sent to the station during the next call, then to have an immediate effect {Sample Now} must be followed by {Call Now}.

{Get channels configuration}

By selecting {Get channels configuration} the application will download the configuration of the channels from the station and will store this configuration in the database. The action will be performed during the next scheduled call.

{Set channels configuration}

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By selecting {Set channels configuration} the application will upload the configuration of the channels from the database to the station, reconfiguring the station with the database settings. The action will be performed during the next scheduled call.

{Get station parameters}

By selecting {Get station parameters} the application will download the timing parameters of from the station and will store it in the database. The action will be performed during the next scheduled call.

{Set station parameters}

By selecting {Set station parameters} the application will upload the timing parameters from the database to the station and will re-configure the timings of the analysis cycle. The action will be performed during the next scheduled call.

{Edit station parameters}

By selecting {Edit station parameters} the application allows you to modify the timings of the analysis cycle (parameters) and to save it in the database..

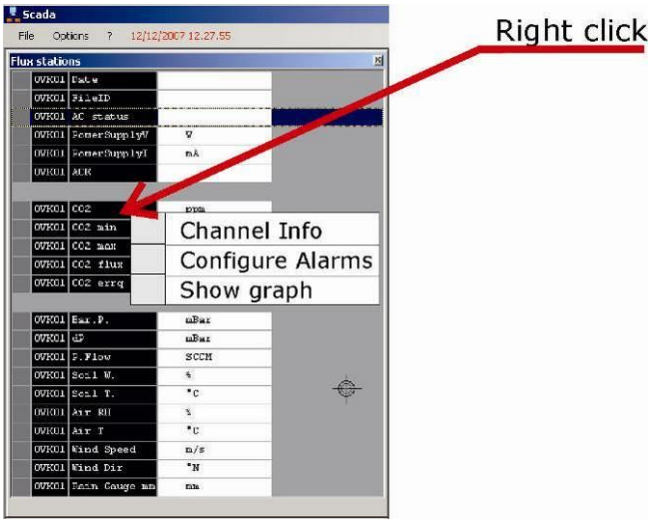
Since all the actions described in this page, except {Sample Now}, are quite critical we advise you to follow this procedure:

a) Do NOT get or set the channels configuration unless big malfunction of the system. Anyway before to do that, please contact West Systems support.

b) To change the parameters:

1) select {Get Station Parameters}; wait the next successful call;
2) Edit the parameters {Edit station parameters} and save into the database;
3) select {Set Station Parameters}; wait the next successful call;

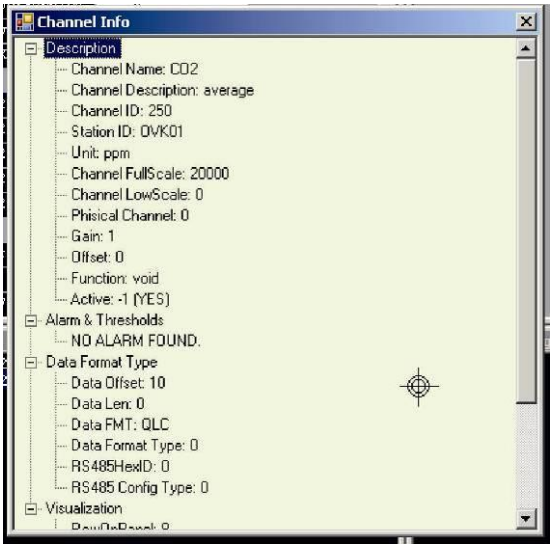
Now the station is set with new parameters



By right clicking on the Channel.Name field of a station a menu appears.

{Channel Info}

By selecting {Channel Info} a report of the channel configuration and status will be shown.



{Configure Alarms}

By selecting {Configure Alarms} will be possible to set alarm level and modalities for the channel.
All thresholds / only upper thresholds / only lower thresholds / Alarm not active;

{Show graph}

By selecting {Show Graph}, active only for the channels that are configured to be acquired as curve, the last downloaded curve will be displayed.

The StationID field backcolor and forecolor change in function of the status of the call.

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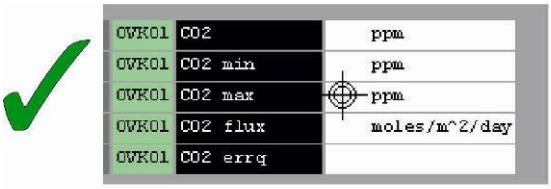
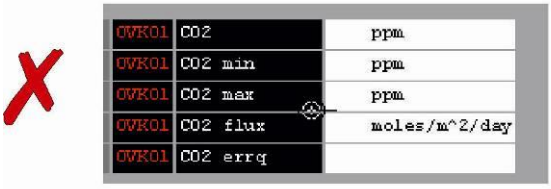
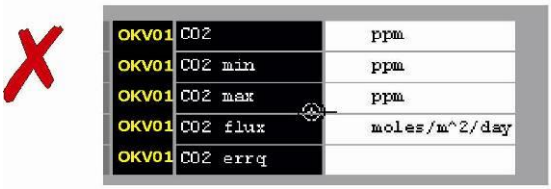


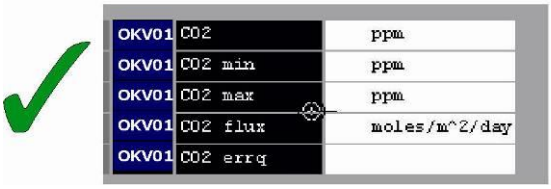
Green, Black:
Scada is calling the station;



Black, Red:
Scada was not able to reach the station: The remote telemetry is off / the telemetry is not working ;



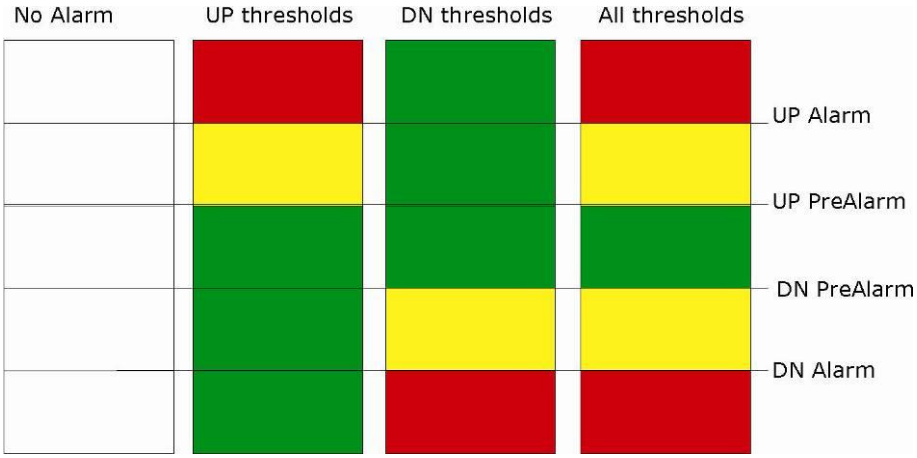
Black, Yellow:
Scada was able to reach the station, but the station is not answering correctly;



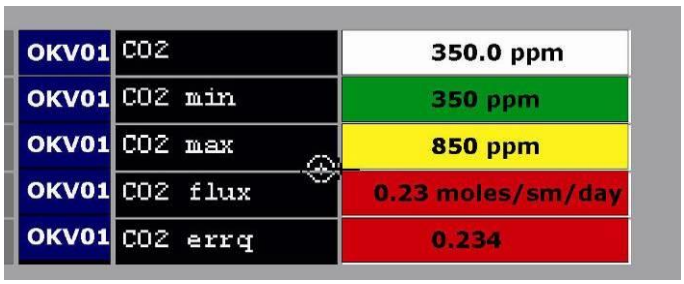
Blue, White:
Scada was able to reach the station and get the data; This mus be the "normal" situation when Scada is waiting the next call.

10.4 The alarms

For each channel is possible to set an alarm:



The alarm management will modify the backcolor of the result field of the channel in order to highlight when a value is not "correct"



The channel result field backcolor can be:

WHITE : if the channel has not alarms configurated. All the values are considered OK;

GREEN : The channel has alarms configurated and the value is in the normal range;

YELLOW: The channel value is between the prealarm and alarm thresholds;

RED: The channel value higher than the UPalarm threshold (Or is less than the DNAlarm one);

In the lower right corner a dialog shows the "binary" communication that flows on the coomunication stream between computer and telemetry device:

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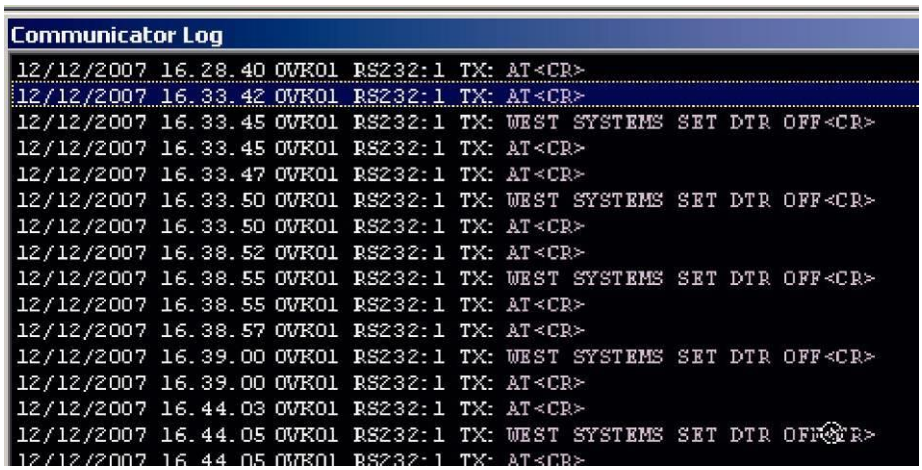


Some of the byte are "translated" in a visible format: for example the byte &0D (That correspond to the Enter key) is displayed as <CR>.

The format is:

dd/mm/yyyy hh:mm:ss : 12/12/2007 16.28.40
stationID : OVK01
Telemetry Type : RS232
Communication port: 1
Direction of communication: TX (or RX)
Transmitted data: AT<CR>

The communication log can be saved on a text file by right clicking on the text box and selecting {Save as}.

10.5 How to download data without telemetry

In case of a telemetry fault, it could be useful to download the data manually taking the SD card from the station and copying the files into the personal computer where WS-Scada is running.

Extract the memory card

You should avoid extracting the memory card while the "CPU RUN" LED is green still, in order not to risk losing any data: this is a warning that the station is going to access the card. The station turns on the "CPU RUN" LED 60 seconds before writing the measure file (usually every hour). Any other moment (LED off or blinking) is useful to safely extract and replace the card.

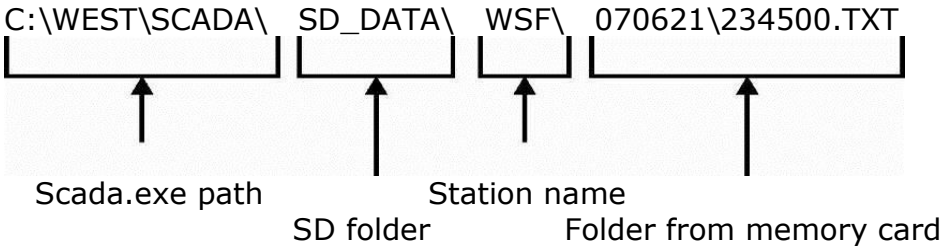
Copy the data to the PC

The station produces and writes to the memory card one folder per day. The folder is named according to the format YYMMDD (year, month, day): for example "070621" is referred to the 21th of June, 2007. In the folder are placed the analysis files named according to the format HHMMSS, for example "182900.txt" means that the file has been written at 6.29 PM. With the default configuration a folder can contain a maximum of 96 files, one every 15 minutes.

WS-Scada supports both remote and local download of the data. In this case we'll use the local one, because the files are manually transferred to the PC.

You have to place the folders copied from the SD card into the directory C:\WEST\Scada\SD_DATA\STATION_NAME

This is an example of a probable complete path:

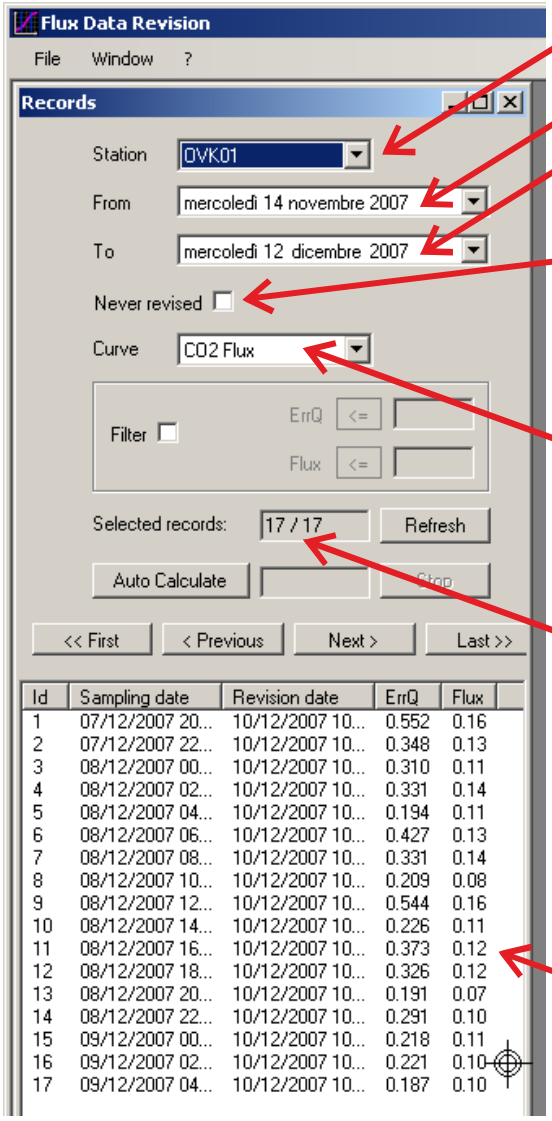


Import the files

When the station is called, WS-Scada scans its "SD_DATA" directory before accessing the telemetry, and imports the analysis file in the database. When a file is successfully read and saved to the database, WS-Scada automatically deletes it.

10.6 Data revision

DataRevision allows analysing the plots acquired by the station.



Select your station.

Select the initial date of the period.

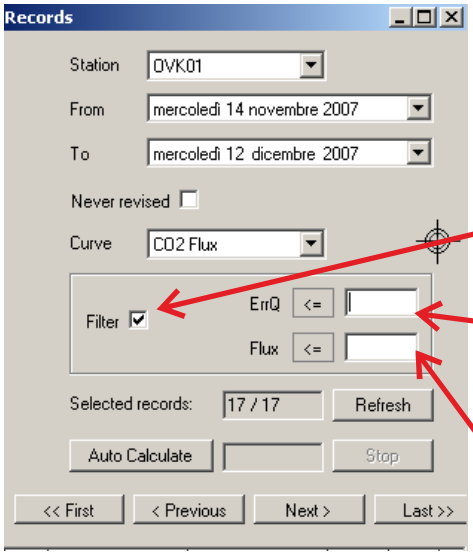
Select the end date of the period.

By selecting "Never revised" you can select the curves you never checked

Select the gas specie (If the station has additional gas detectors)

Number of selected curves / Total number of curves in the query period.

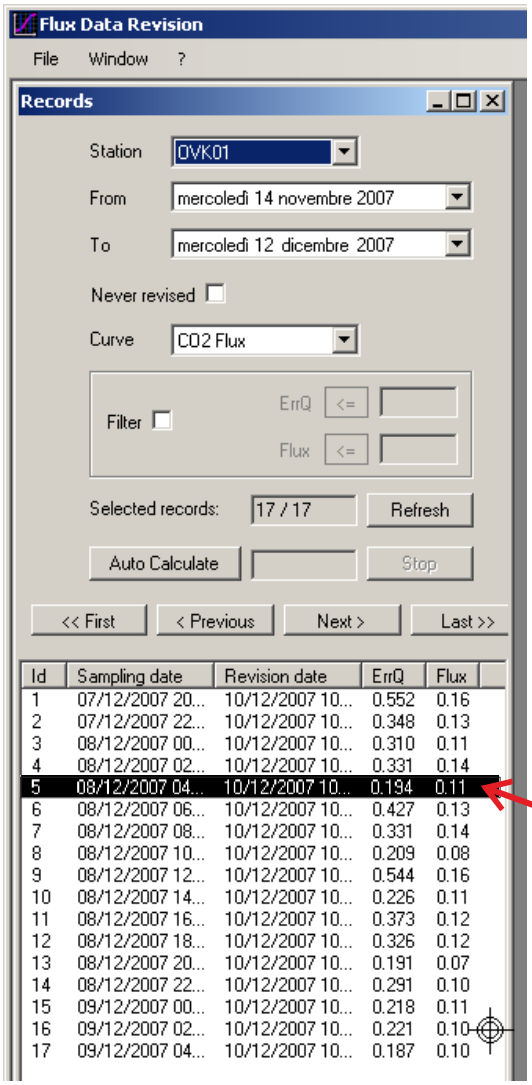
The list of flux curves that correspond to your selection



By selecting [Filter] you can apply a more restrictive filter to your query.

ErrQ <= 0.9 will select the curves where ErrQ is less than 0.9 (That means not very well shaped curves).

Flux >= 1500 Moles/sm/day will select the curves where the flux is more than 1500 moles/sm/day (That means exceptionally high flux).



To see the flux curve click on the list.

List of plots that corresponds to the selection

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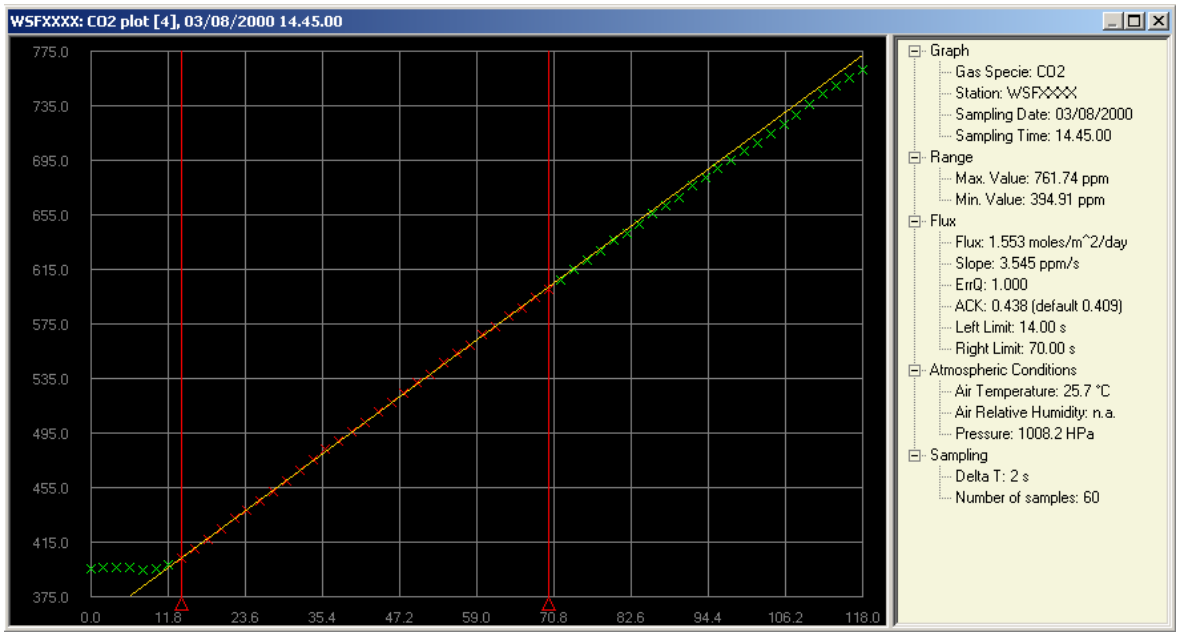
The flux curve



On the right part of the form is reported the information related with the flux curve.

The interval used to compute the regression is highlighted in red.

The regression computed is drawn in yellow.

The limit of the interval are the two red vertical lines.

The left and right limits are automatically selected by Scada when downloading of the data. Scada tries to pick the right fit using the DataRevision parameters. To modify the settings open the menu [File] [Settings].

The settings are individual for every gas specie and accumulation chamber, because different gas detectors, as well as different accumulation chamber tube lenghts, can produce different response time.

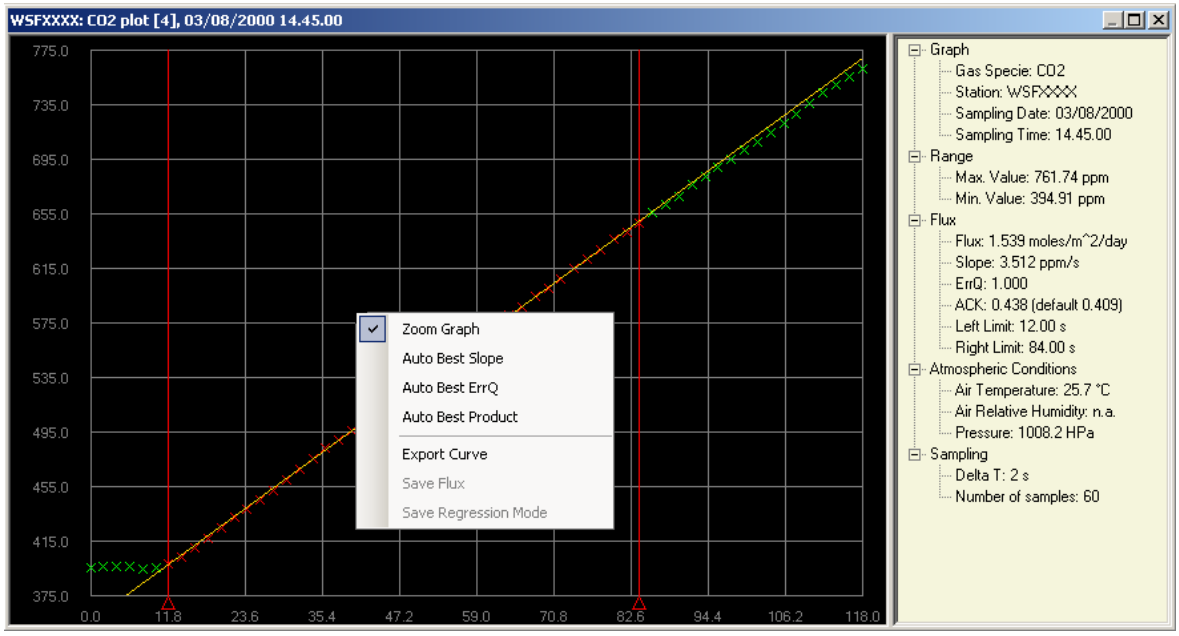
See *Batch Processing* paragraph in the next pages for further detail.

Manual revision

Modify the limits by dragging the vertical lines in the desired position.

The flux, the slope and the ErrQ will be automatically updated.

To save the new result right clik and select {Save Flux}



Using the manual revision the computation of flux is completely under your responsability. You can select wrong interval and get wrong results, as in the drawing.

The slope of the curve is positive, but the seleted interval, too short, gives a negative result.

Automatic computation of flux.

DataRevision can compute the flux following 3 different algorithms:

By selecting {Auto Best slope}: the flux will be computed searching for the higher flux;
By selecting {Auto Best ErrQ}: the flux will be computed searching for the better regression quality;

By selecting {Auto Best Product}: the flux will be computed searching for a compromise between higher flux and best regression quality.

The automatic computation uses, as minimum interval to be used, the interval selected by left and right limits (The two red vertical lines), then if you want to compute the flux using at least 50% of the points in the curve you've to select approximately the 50% of the curve and after select one of the 3 methods for the auto computation. After that you've to select {Save regression mode} to save this settings.

The saved settings will be used by the batch processing of DataRevision and by WS-Scada, when it process the curves while downloading for the station.

Batch processing

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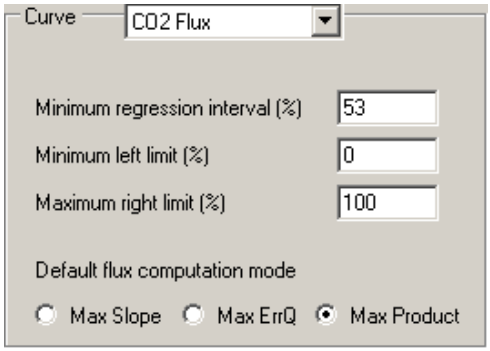
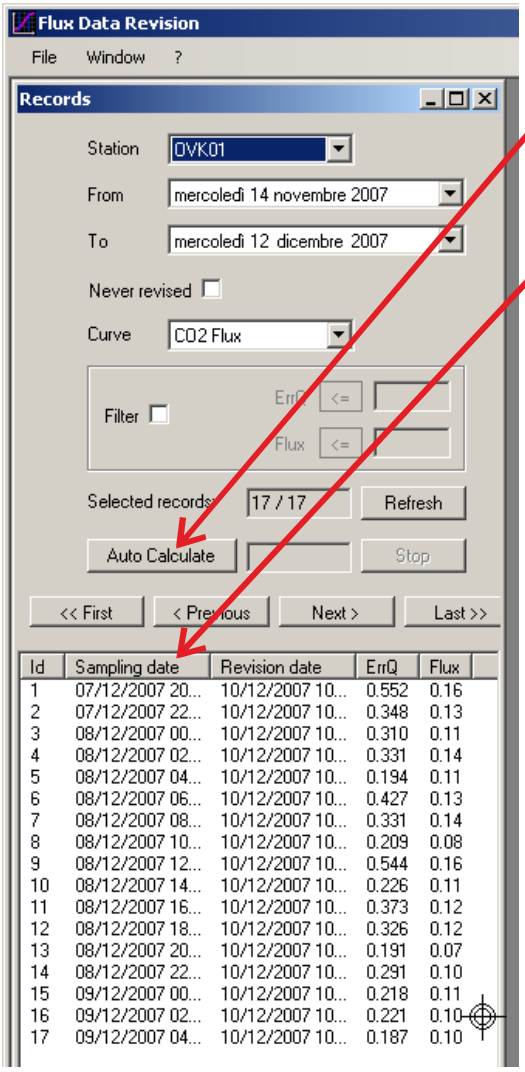
By pressing the [Auto Calculate] button DataRevision will process all the flux curves in the list. The method and the minimum interval will be the one selected with the procedure described before.

More restrictive settings to the automatic processing can be set by opening the {File}{Settings} menu.



For each gas species you can set the minimum interval, the minimum left limit and the maximum right limit, as well as the processing algorithm.
If you need a rigid processing you can set rigid parameters as:

Interval : 80%
Minimum left: 10%
Maximum right:10%
With these settings WS-Scada and DataRevision are obliged to compute the flux in the range from 10% to 90% of the curve.



Batch processing

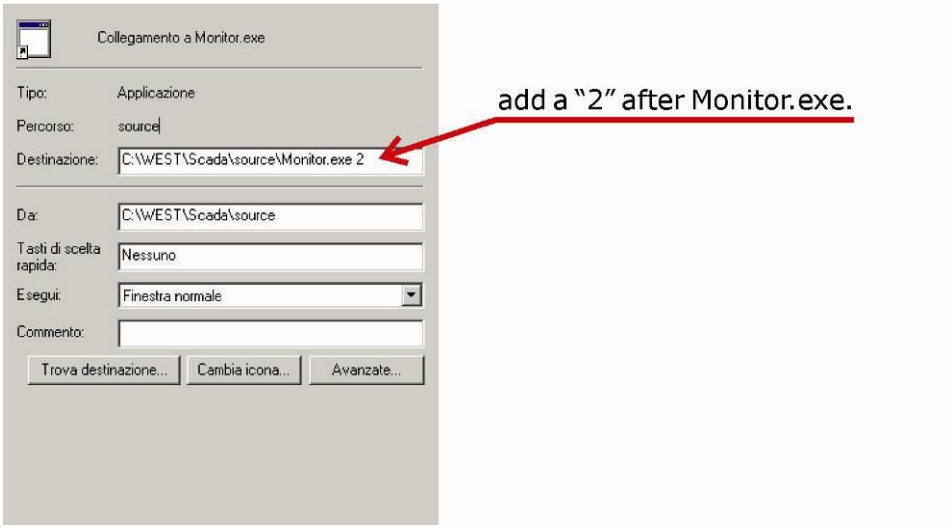
By clicking on [Sampling Date] you can order the list by date in ascending or descending mode .

same consideration for the Revision date, the ErrQ and the Flux.

10.7 Monitor

Monitor is a simple application designed to have a quick view of the last days of data (typically last week or last month).
Monitor displays the data of the channels that are active and having the field Channels.Monitored > 0 and the Channels.MonitoringGroup = 1;
The field Channels.MonitoringGroup can be used to assign a group of channels to a specific instance of Monitor.
To have two instances of Monitor, one showing a group of channels and the second showing a second group of channels you've to:

1) Open the Channels table of the database, put the value 2 on the Channels.MonitoringGroup of the channels you want to assign to the second group.
2) Create a new ShortCut of Monitor and modify the properties of the shortcut as following:

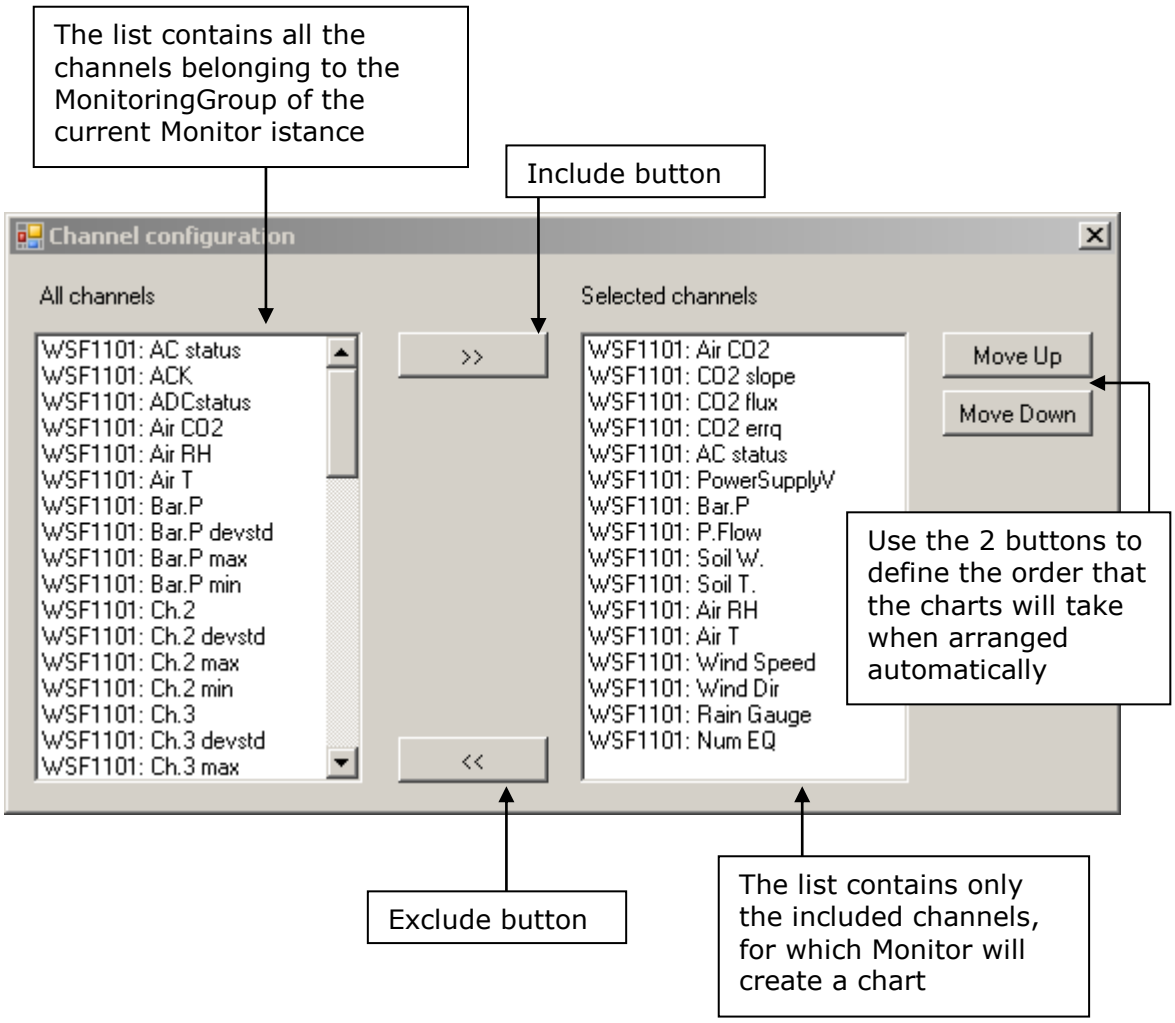


10.7.1 Channels

Each Monitor window shows the values of a single parameter (channel). Each instance of Monitor displays the channels belonging to a *MonitoringGroup*. A channel cannot belong to more than one *MonitoringGroup*, so if you have more Monitor instances, a single channel can compare only in one of them.
Once you defined a *MonitoringGroup*, you can configure the channels to be displayed on the current Monitor instances, by opening the menu [Channels][Configure].

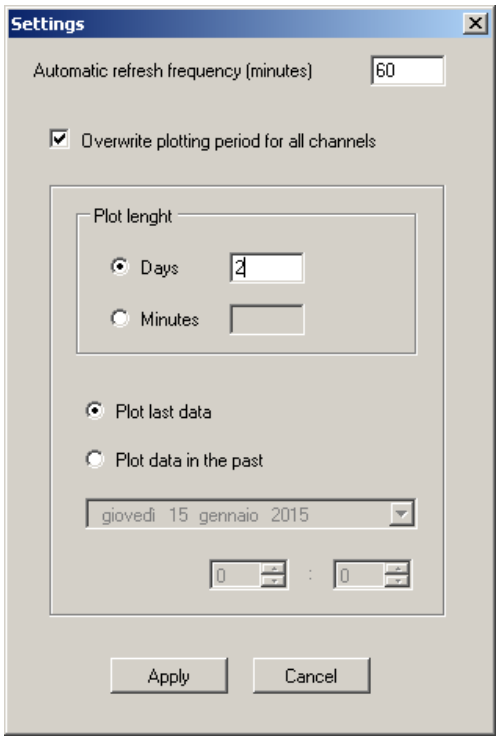
The following configuration panel will appear:

10 Scada software suite



10.7.2 Global settings

The global settings are accessible though the menu File – Settings.

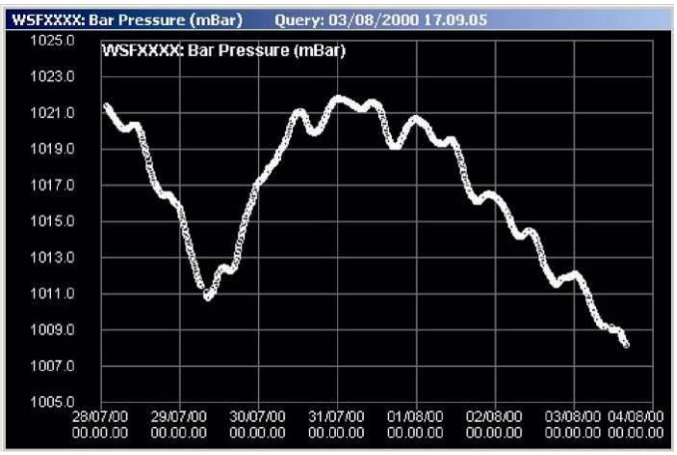


Automatic refresh frequency expresses the time between two refreshes of the charts. Edit this setting according to the sampling frequency: if for example the station takes flux measurement once every hour, it is useless to refresh the charts every 10 minutes.

Checking the box *Overwrite plotting period for all channels*, it's possible to determine global settings that applies for all the charts. In this way Monitor will overwrite the settings that you may have previously edited with *Plot Period* and *Plot Custom Dates* menu (see next paragraph).

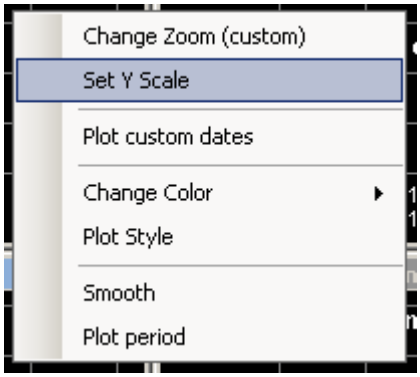
10.7.3 Chart appearance

By right-clicking on a chart window, you can modify the appearance properties of that chart, as the color of the grid, background, styles, filters.



With a right-click on the plot the following context menu will appear:

10 Scada software suite



Change Zoom: changes the y-scale of the plot. This command will switch among 3 options:

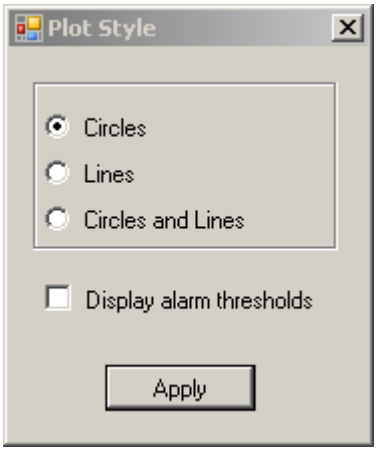
- Auto: selects automatically the best zoom fit
- Min-Max: it's the maximum zoom level that displays all the points.
- Custom: allows entering specific values (see Set Y Scale). Warning: this option will not display points outside the thresholds.

Set Y Scale: allows setting the minimum and maximum values to be displayed when in Custom Zoom mode.

Plot custom dates: By default, the last *x* days of data are plotted (where *x* is editable through Plot Period menu), so the right limit of the x-axis is the current day at midnight. Selecting *Plot Custom dates*, it's possible to plot any date in the past.

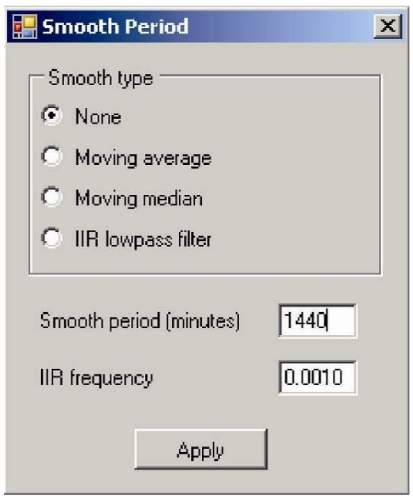
Change color: allows changing the color of grid, background, plot and labels.

Plot style: allows switching between points-based and lines-based plot. If you check the *Display alarms threshold* box, Monitor draws the plots basing on the value represented by the point. The values above alarm threshold are drawn red, the values in pre-alarm yellow and the rest green. If the box is not checked or the channel doesn't have any alarm limit set, the plot is painted with the default color (see *Change color* menu above).



Smooth: allows applying a filter on the plot. Three filters are available: moving average, moving median and lowpass filter.

The *Smooth period* setting refers to Moving average and Moving Median filters. *IIR frequency* is the cutoff frequency of the low pass IIR filter.

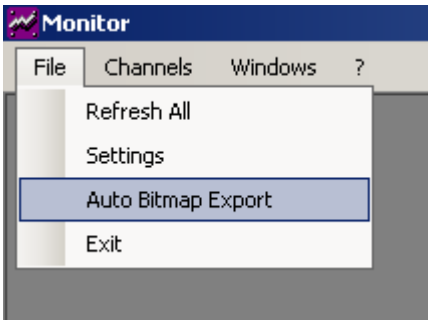


Plot period: Sets the time period to be displayed. Enter for example 14 to monitor the last two-weeks of data.

10.7.4 Automatic bitmap export function

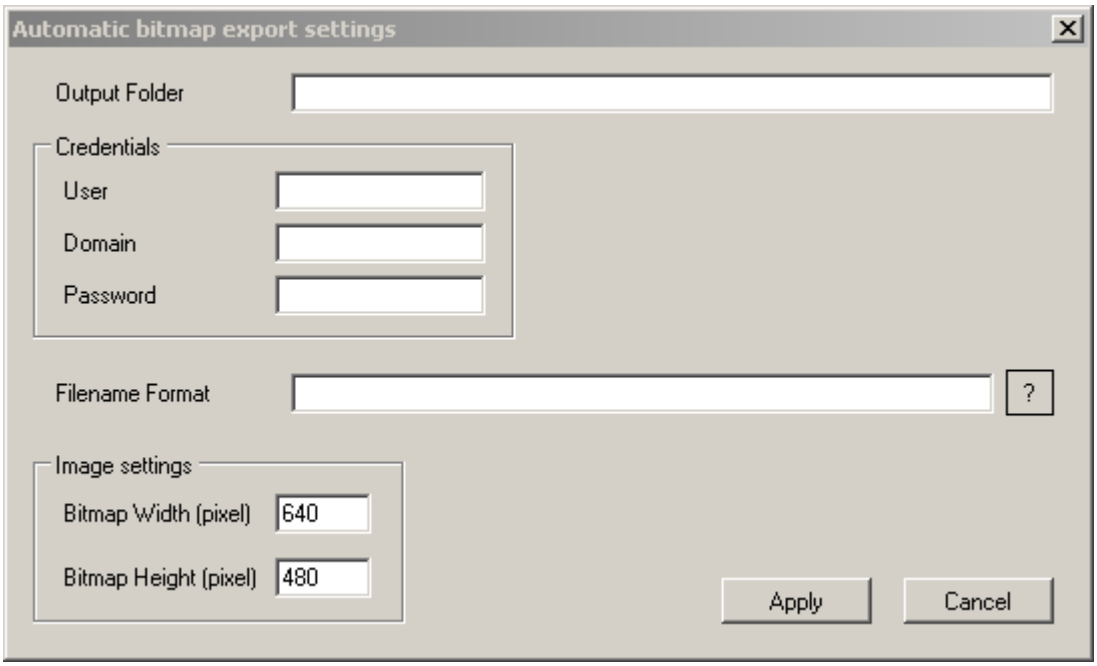
Monitor can be configured to automatically export the generated plots to bitmap files.
The files are generated when the automatic scheduler of the application updates the charts (see global settings paragraph). To force the drawing and writing of the files, select on the menu [File][Refresh all]

To activate and configure the function, select [File][Auto Bitmap Export]



The following window will appear:

10 Scada software suite



Insert into the field *Output folder* the path of the directory where you want to have the files saved. Remember that when setting the folder, the directory must exist. The application will try to access it when pressing *Apply*.

Examples:

C:\data\export
\\server\data\export

If the path requires particular credentials, because it is not accessible by the user which started the Monitor application, insert into the fields *User*, *Domain* and *Password* the needed credentials.
Otherwise just leave the fields empty.

Then insert into *Filename Format* a string that will be used by the software to assign a name to the saved file. You can insert into the filename the following keys:

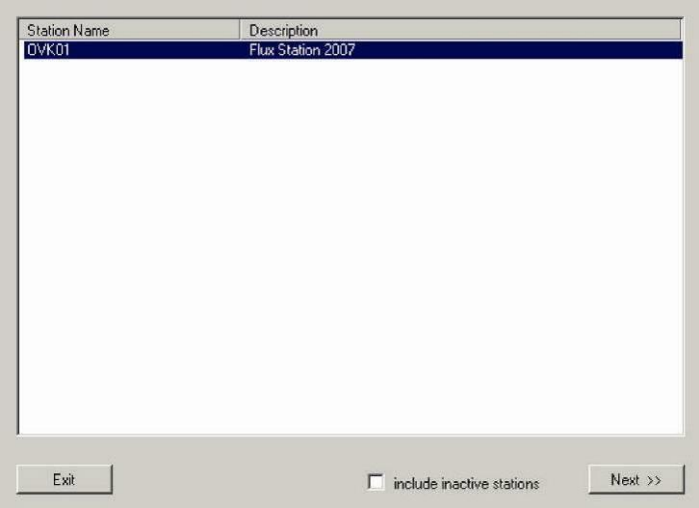
%station% : Name of the station
%chid% : Id of the channel (numeric)
%chname% : Name of the channel
%chdesc% : Description of the channel
%monitored% : Id of the chart
%querydatetime% : Date and time of the chart drawing
%querydate% : Date of the chart drawing
%lastsampledatetime% : Date and time of the last sample
%lastsampledate% : Date of the last sample

The default value is %station%_%chname%

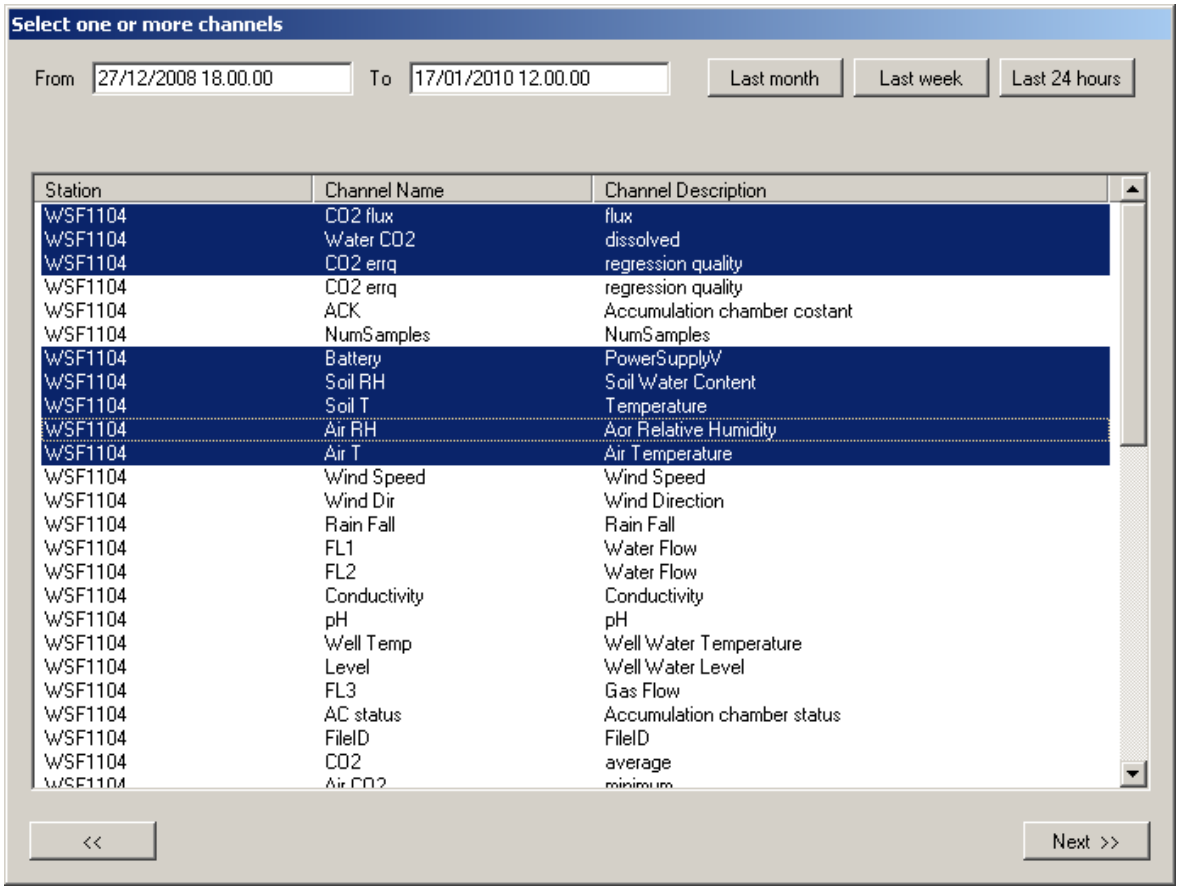
Any string which is not one of the listed key will be just replied into the name files.
Finally, insert into *Bitmap Width* and *Bitmap Height* the dimensions (in pixel) that you want the image files to have.

10.8 Query

The Query application allows you to extract the data from the database and to save into a Microsoft Excel spread sheet or into a text file (CSV comma separated value)
Run **Query** and select the station(s) you want to query.



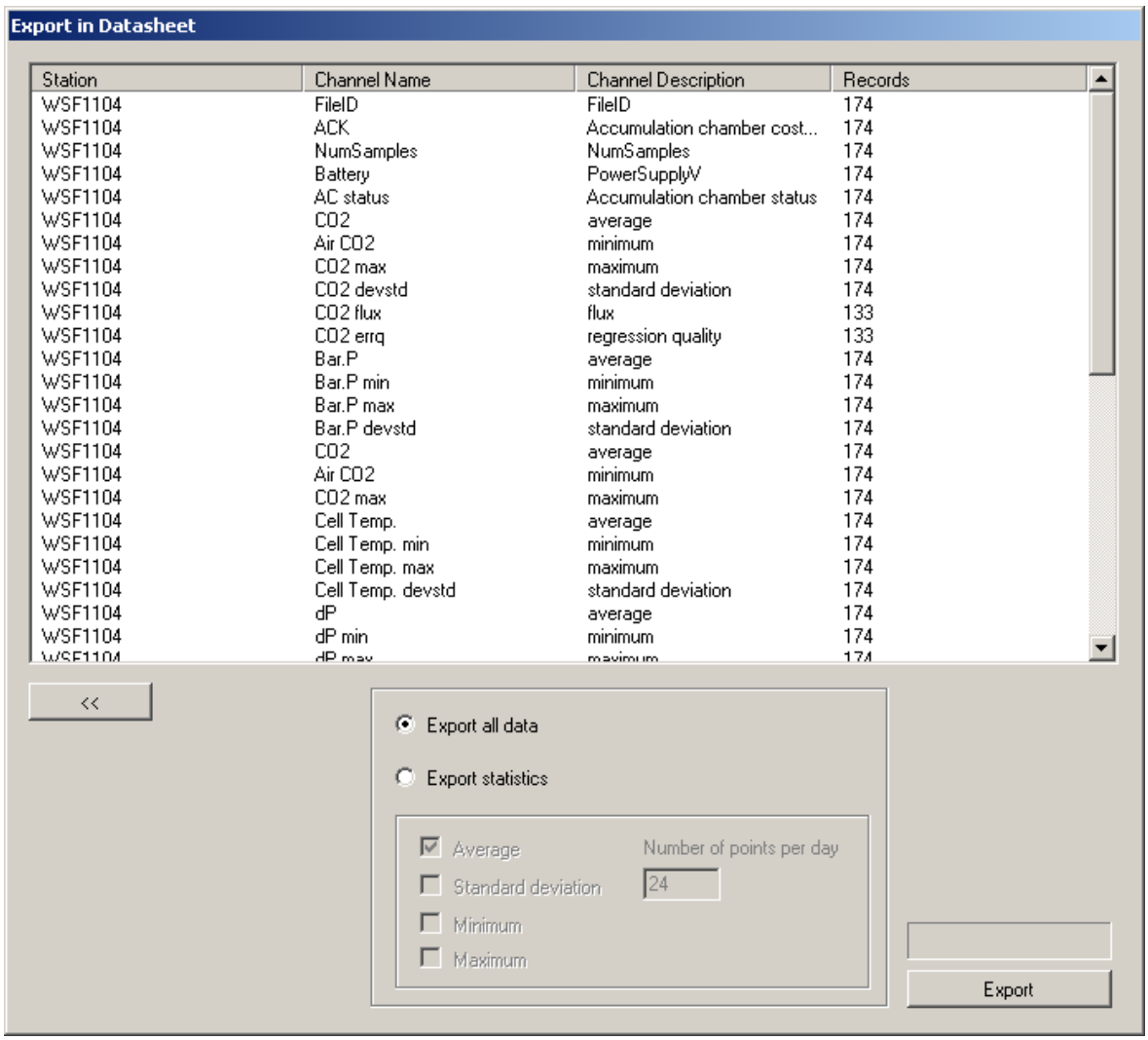
Press the [Next >>] button.



Set the date interval you want to query and Select the Channels then press [Next >>];

10 Scada software suite

The buttons [Last month], [Last week] [Last 24 hours] will help you by setting a "standard" time interval.



Station	Channel Name	Channel Description	Records
WSF1104	FileID	FileID	174
WSF1104	ACK	Accumulation chamber cost...	174
WSF1104	NumSamples	NumSamples	174
WSF1104	Battery	PowerSupplyV	174
WSF1104	AC status	Accumulation chamber status	174
WSF1104	CO2	average	174
WSF1104	Air CO2	minimum	174
WSF1104	CO2 max	maximum	174
WSF1104	CO2 devstd	standard deviation	174
WSF1104	CO2 flux	flux	133
WSF1104	CO2 errq	regression quality	133
WSF1104	Bar.P	average	174
WSF1104	Bar.P min	minimum	174
WSF1104	Bar.P max	maximum	174
WSF1104	Bar.P devstd	standard deviation	174
WSF1104	CO2	average	174
WSF1104	Air CO2	minimum	174
WSF1104	CO2 max	maximum	174
WSF1104	Cell Temp.	average	174
WSF1104	Cell Temp. min	minimum	174
WSF1104	Cell Temp. max	maximum	174
WSF1104	Cell Temp. devstd	standard deviation	174
WSF1104	dP	average	174
WSF1104	dP min	minimum	174
WSF1104	dP max	maximum	174

A resume of the query is reported: The column "Records" shows how many record are present in the time interval you selected for each channel;

By selecting [Export all data], you'll get a file containing a row for each record (and a column for each channel, plus one for the date/time).

By selecting [Export statistics], you'll get a file containing a number of rows corresponding on the specified "Number of points per day". For example, insert "1" for daily average, "24" for hourly average, etc. Query will generate for each channel one column for every checked statistic (average, standard deviation, minimum, maximum).

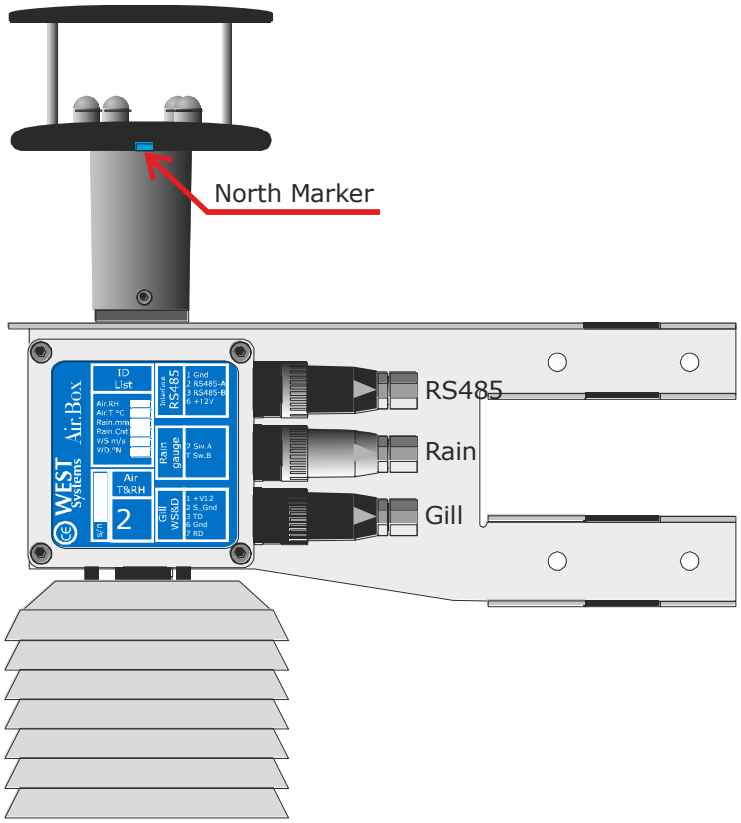
After pressing the button you have to choose the format (Excel or CSV) and the output path.

11. Appendix A - Airbox

General description

The air box is an hardware/software interface that convert the signal of Air Temperature/ Relative Humidity gauge and Sonic wind speed / direction gauge to a digital format compatible with the DF1A soilflux station.

The output of the air box is a RS485 with the standard WEST Systems pin out. Since the AirBox is designed to be the last device in the bus the RS485 line is terminated with a 120 Ohm embedded resistor.



Description	Conf	Unit	Sw6 Off	Sw6 On
Rain Gauge	DF	mm	**A8**	AD
Wind direction	D8	°N	**A7**	AC
Wind Speed	D7	m/s	**A6**	AB
Air Temperature	D9	°C	**A5**	AA
Air rel.humidity	DA	%	**A4**	A9

The air box is designed to be mounted on a 50 mm diameter pole. Avoid obstacles that can affect the wind speed and direction measurement accuracy. **The blue marker must be pointed in NORTH direction, using a compass, to get the correct reading of wind direction.**

The rain-gauge must be levelled using the bubble gage

Appendix A, Airbox

Connectors pinout

GILL Connections

Panel 6+T female connector			PCB Pin	
Pin 1:	+V12	RED	5)	+12V
Pin 3:	SGND	Green	8)	Gnd
Pin 5:	TD	Yellow	7)	RD
Pin 6:	Gnd	Black	8)	Gnd
Pin 7 (T):	RD	Blue	6)	TD

Air RH & T Connections

Panel 6+T female connector			PCB Pin	
Pin 2:	+5V	Red	9)	+5V
Pin 3:	Data	Yellow	11)	Data
Pin 5:	Sck	Blue	10)	Sck
Pin 6:	Gnd	Black	12)	Gnd

Rain Gauge Connections

Panel 3+T male connector		PCB Pin
Pin 2:	SW_A	13)
Pin T:	SW_B	14)

RS485 Connections

Panel 6+T male connector			PCB Pin	
Pin 1:	Gnd	Black	4)	Gnd
Pin 2:	A	Yellow	1)	A
Pin 3:	B	Green	2)	B
Pin 6:	+V12	Red	3)	+Vin

DIP switch settings

SW1	Air RH%	**On**
SW2	Air T.°C	**On**
SW3	W.Speed m/s	**On**
SW4	W.Dir °N	**On**
SW5	Rain G.	**On**
SW6	ID Base/Extended	**On**
SW7	Set Conf=05	Off
SW8	Calibration enabled	Off

SW7 : If your station firmware is older than release 9.14 please set SW7 to ON in order to allow the correct configuration of the RS485 chain. You can read the firmware release of the station resetting it. (Power off, wait at least 10 seconds and power on the station).

SW6: If two airbox are installed on the same RS485 chain the SW6 switch of one of them must be set to On in order to avoid addresses interference.

SW8: No actual user enabled function

Gill sonic wind speed and direction gauge

Speed

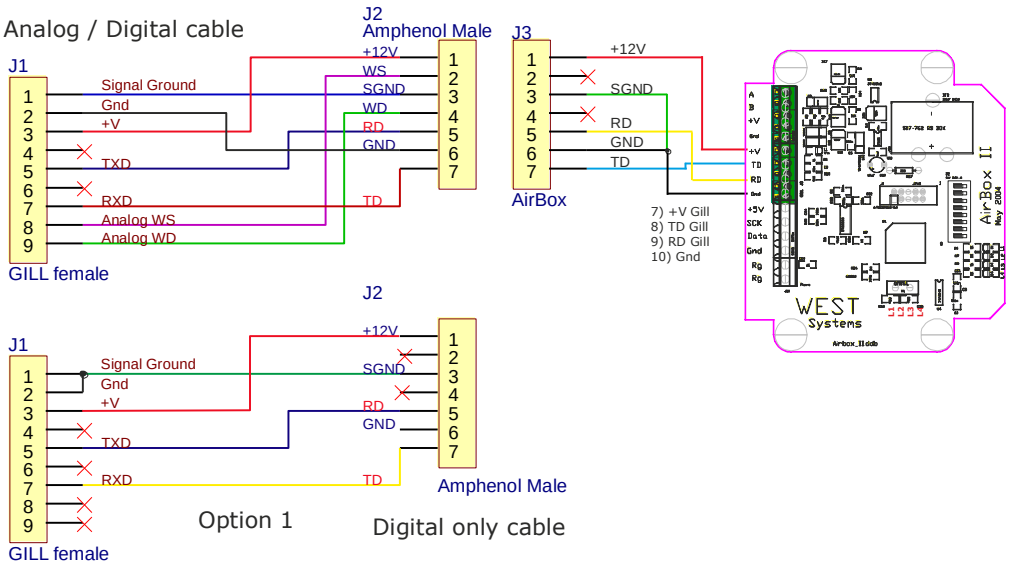
- Range 0..60 m/sec
- Accuracy : 4%
- Resolution : 0.01 m/sec

Direction

- Range 0..360 degree North without dead zone.
- Accuracy : 3%
- Resolution : 1 degree

Power supply

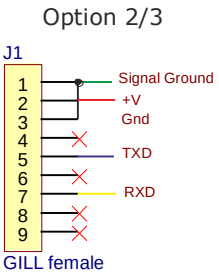
- 9..30 VDC 40 mA typical @ 12VDC

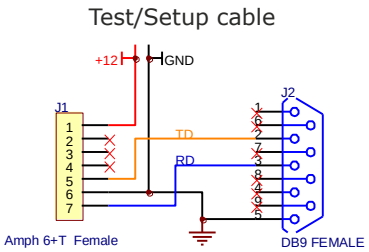


Gill configuration

M2 Gill Polar Continuous data format mode
U1 WInd Speed Unit meter/second
O1 Comma Separated Format CSV
L1 CR/LF Message terminator
P1 Out rate 1 sample / second
B3 Baud rate 9600
F1 No parity 8 bit
H1 Power-up message on
NQ Node address not defined
E3 communication protocol E3 = RS232

If analogue output is present:
S6 = 0-60 m/sec Wind Speed analogue range output
C2 = Wrap around 0-359°
T1 = 0..5 Volts analoge voltage output (T2=4-20mA)



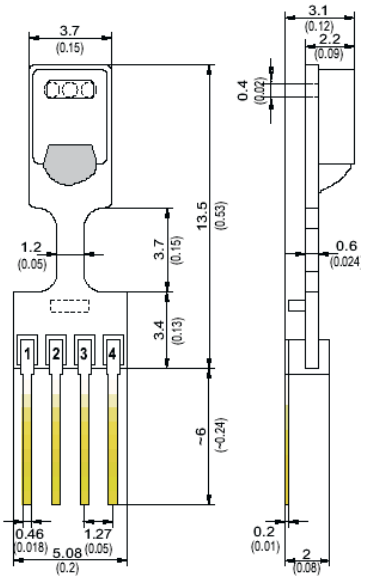


Appendix A, Airbox

To configure the GILL connect it via RS232 using a 9600-n-8-1 configured terminal.
Send a "*" to enter in the set mode and D3 to list the actual settings.
Send a
E3<Enter>
and check it sending an
E<Enter>

Turn off the GILL, wait 5 second and turn on it.
Enter * and D3 to check that the configuration changed.
The GILL save the modifications automatically

Silicon Air Temperature and relative humidity gauge

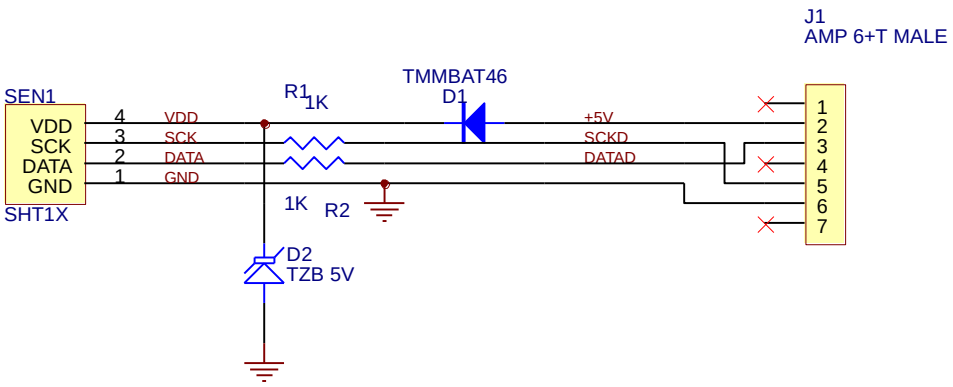


Sensor specifications

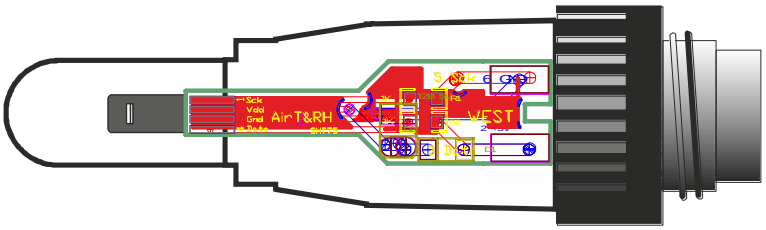
2 sensors for relative humidity & temperature

- Measurement range: 0-100% RH
- Absol. RH accuracy: +/- 2% RH (10...90% RH)
- Repeatability RH: +/- 0.1% RH
- Temp. accuracy: +/- 0.4°C (5-40 °C)
- Calibrated & digital output
- Fast response time < 3 sec.

Probe schematics

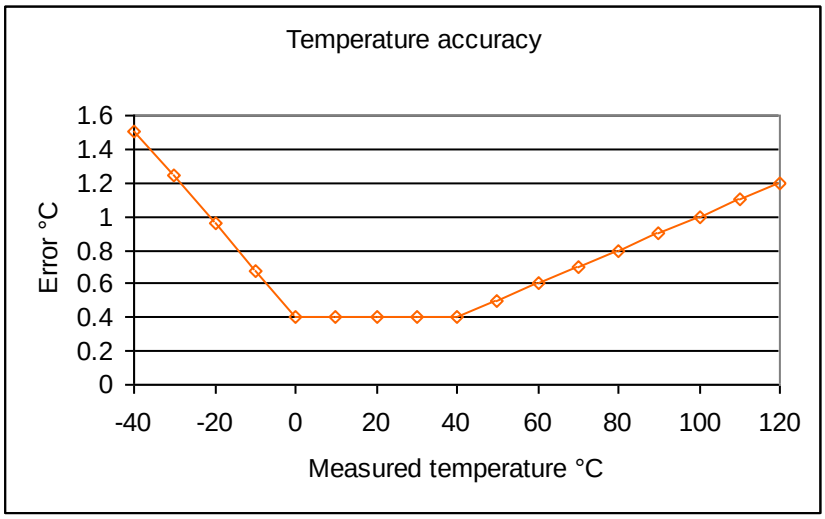


Probe Layout (actual size)

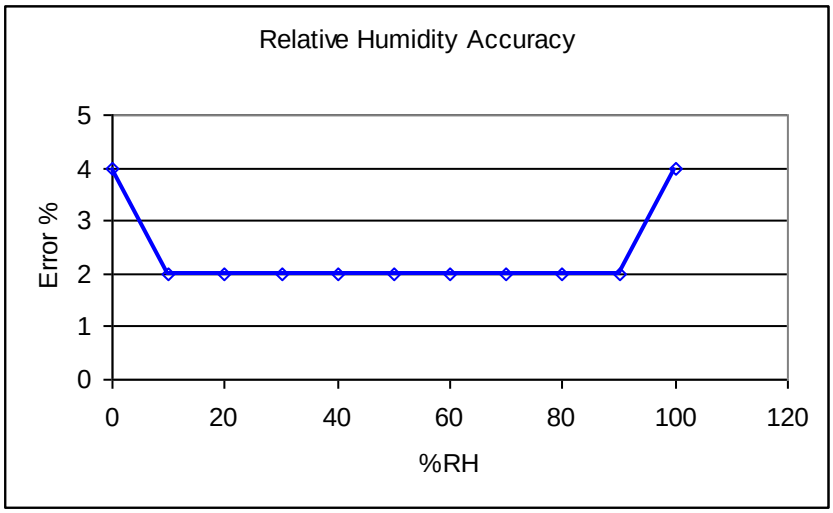


Amphenol 6T male

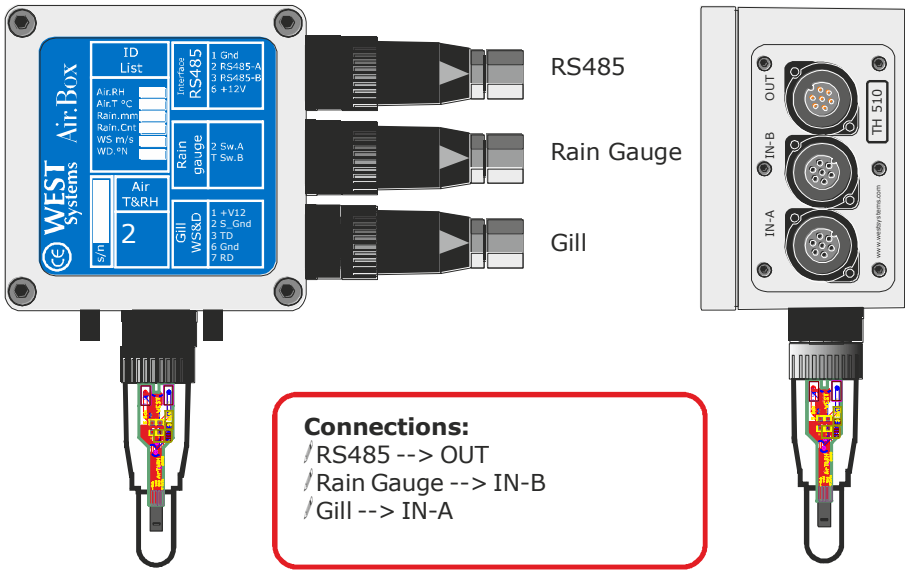
Air Temperature accuracy Vs. temperature



Relative Humidity accuracy Vs. RH%



Appendix A, Airbox

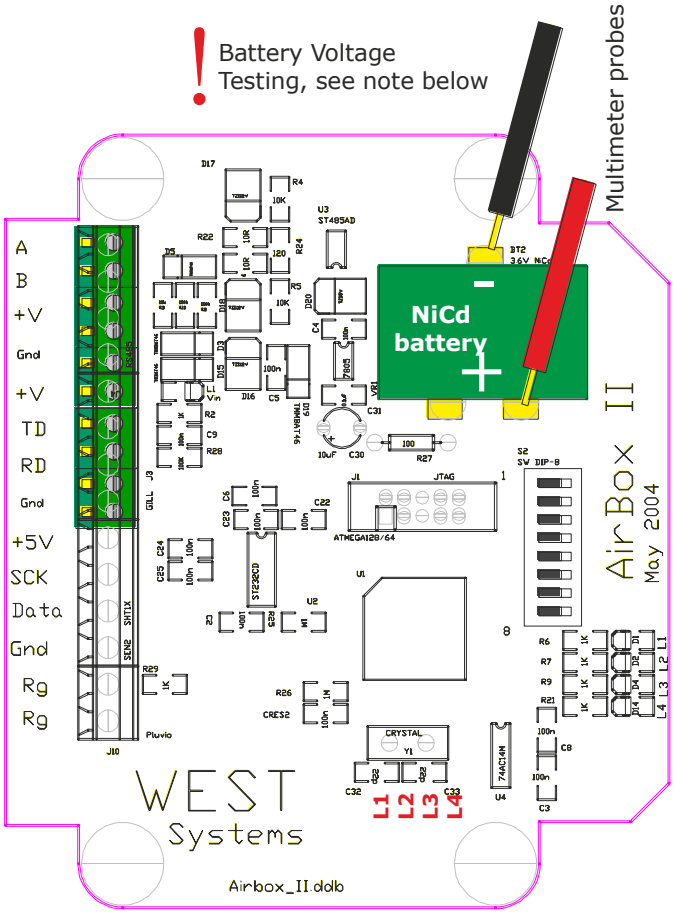


Connections:
/ RS485 --> OUT
/ Rain Gauge --> IN-B
/ Gill --> IN-A

Air TH & T. Probe

PCB Layout

1) RS485_A
2) RS485_B
3) +V in
4) Ground
5) Gill +12V
6) Gill TD
7) Gill RD
8) Gill Gnd
9) Ss +5V
10) Ss SCK
11) Ss Data
12) Ss Gnd
13) Rg Sw.A
14) Rg Sw.B



The correct working of RAIN gauge, when the station is in stand-by, is substained by the internal NiCd battery. To allow the proper operation of the system the battery voltage must be more than 4.6 Volt.

To test it:

1) power off the station;
2) measure the NiCd battery voltage;
3) drop 100 cc of water inside the RainGauge: the 4 LED lights must Flash for a 1/5 second period per each raing gauge balance "click".

Rain gauge

Manufacturer: LSI-LASTEM

Ordering code: DQA130
Heated Rain gauge
Range: incremental
Accuracy 1%
Resolution 0.2 mm
Collector surface area: 324 square centimeter
Collector area diameter: 203 mm
Temperature range 0..+50°C

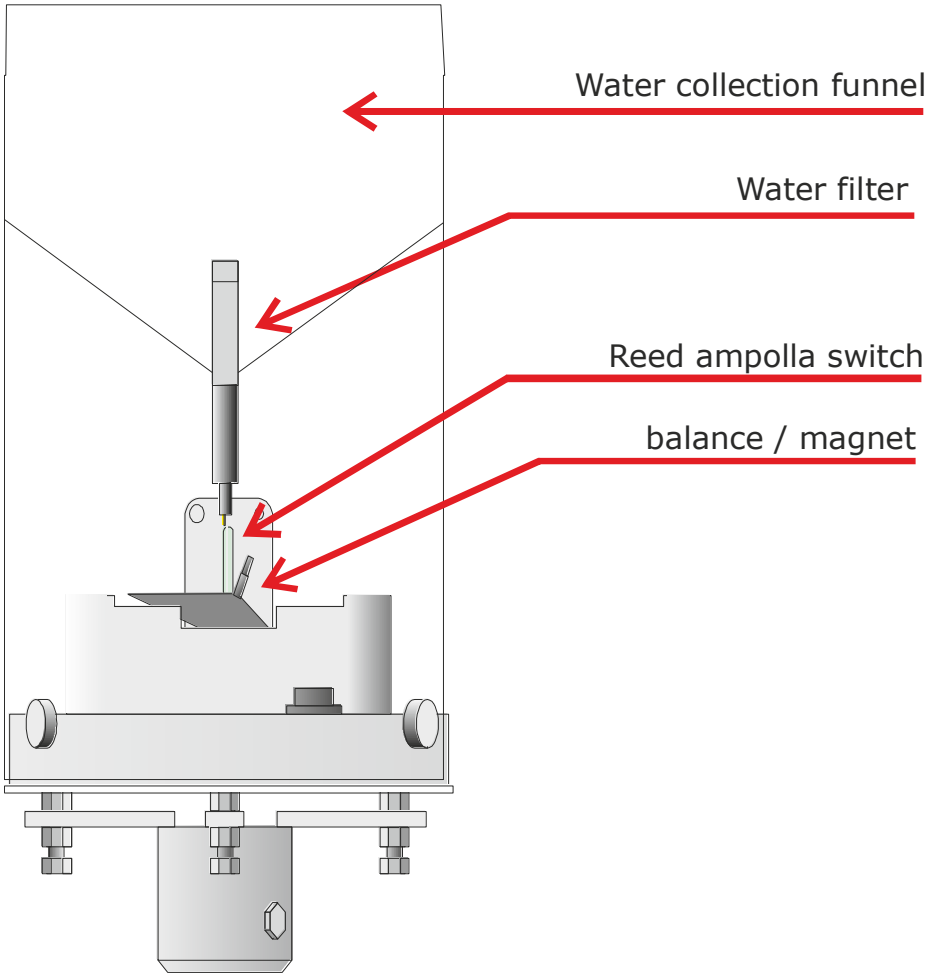
Rain gauge support for 50 mm diameter mast mounting

AirBox

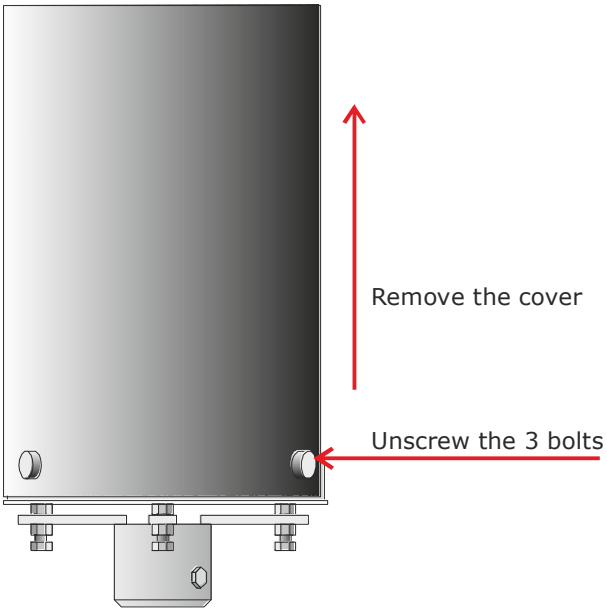
While the FluxStation is in stand-by state the airbox reads and store the reading of the rain gauge. The airbox is power supplied with a 3.6V rechargeable battery that's charged by the FluxStation every analysis cycle.

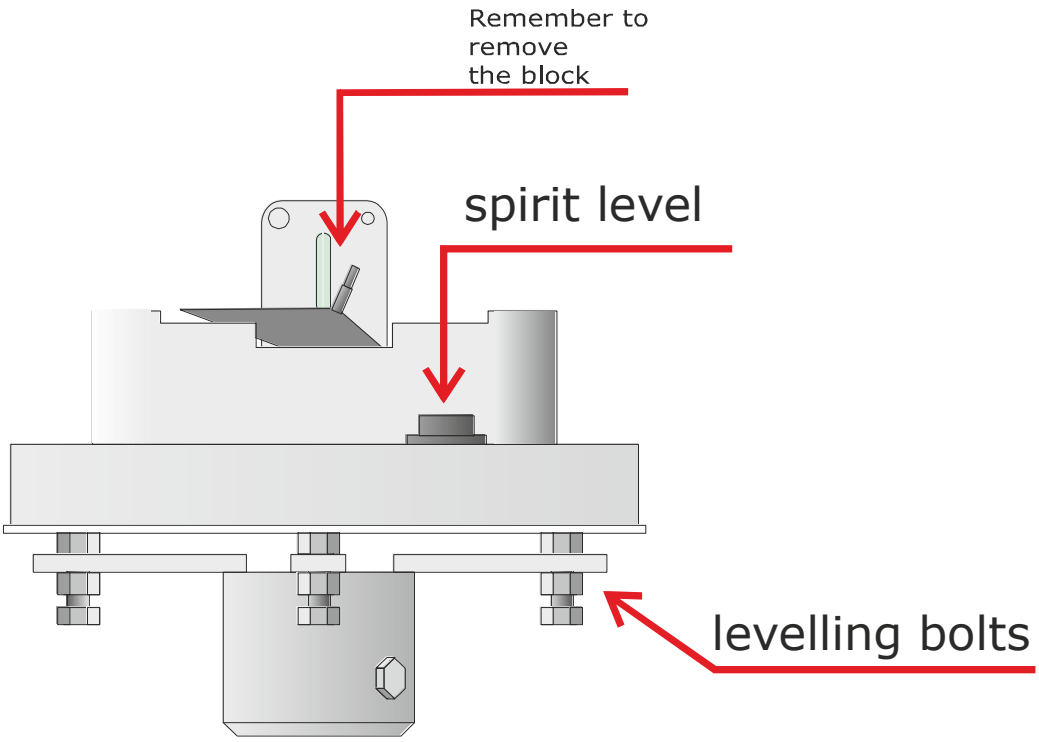
Check

To check the calibration of the raingauge:
Enter, slowly, 1.0 liter of water in the funnel. The reading must be increased of 30.8 mm.
Since the rain gauge channel reading is cumulative, you've to note any test you made, in order to do not confuse tests with real rain.



Appendix A, Airbox





In order to have a correct working the raing-gauge must be levelled by trimming the 3 levelling bolts. A spirit-level will help in the levelling.

12. Appendix W – Wi-Fi Telemetry

The Wi-Fi telemetry allows integrating the flux station into an existing IEEE 802.11 network.
For this purpose, the station is equipped with an industrial grade serial server: Moxa NPort W2150A-T.
The station is equipped with a native RS232 communication channel, which is converted into an Ethernet channel by the serial server. This device is configured as a TCP server: it waits for an incoming connection. Once it is contacted by TCP client (WS-Scada application), a socket is opened and the data transfer can begin.

12.1 Specifications

Serial Server Moxa NPort W2150A-T specifications:

Ethernet Interface
Number of Ports: 1
Speed: 10/100 Mbps, auto MDI/MDIX
Connector: RJ45
Magnetic Isolation Protection: 1.5 KV built-in

WLAN Interface
Standard Compliance: 802.11a/b/g
Network Modes: Infrastructure, Ad-Hoc
Transmit Power:
802.11a: 14 dBm (typical)
802.11b: 17 dBm (typical)
802.11g: 15 dBm (typical)
Receive Sensitivity: -80 dBm
Radio Frequency Type: DSSS/OFDM
Transmission Rate:
802.11a: 54 Mbps
802.11b: 11 Mbps
802.11g: 54 Mbps (max.) with auto fallback (54, 48, 36, 24, 18, 12, 11, 9, 6, 5.5, 2, 1 Mbps)
Transmission Distance:
Up to 100 meters (in open areas)
Wireless Security:
• WEP: 64-bit/128-bit data encryption
• WPA, WPA2, 802.11i: Enterprise mode and Pre-Share Key (PSK) mode
• Encryption: 128-bit TKIP/AES-CCMP EAP-TLS, PEAP/GTC, PEAP/MD5, PEAP/MSCHAPV2, EAP-TTLS/PAP, EAP-TTLS/CHAP, EAP-TTLS/MSCHAP, EAP-TTLS/MSCHAPV2, EAP-TTLS/EAP-MSCHAPV2, EAP-TTLS/EAP-GTC, EAP-TTLS/EAP-MD5, LEAP
Antenna Connector: Reverse SMA

Serial Interface
Serial Standards: RS-232/422/485 (DB9 male connector)

Off-line Port Buffering:
NPort W2150A: 20 MB
Serial Line Surge Protection: 1 KV (level 2)
Serial Communication Parameters
Data Bits: 5, 6, 7, 8
Stop Bits: 1, 1.5, 2
Parity: None, Even, Odd, Space, Mark
Flow Control: RTS/CTS, XON/XOFF
Baudrate: 50 bps to 921.6 Kbps
Serial Data Log: 64 KB
Serial Signals
RS-232: TxD, RxD, RTS, CTS, DTR, DSR, DCD, GND
RS-422: TxD+, TxD-, RxD+, RxD-, GND
RS-485-4w: TxD+, TxD-, RxD+, RxD-, GND
RS-485-2w: Data+, Data-, GND

Environmental Limits
Operating Temperature:
Standard Models: 0 to 55°C (32 to 131°F)
Wide Temp. Models: -40 to 75°C (-40 to 167°F)
Storage Temperature: -40 to 85°C (-4 to 185°F)
Ambient Relative Humidity: 5 to 95% (non-condensing)

Power Requirements
Input Voltage: 12 to 48 VDC
Power Consumption:
NPort W2150A: 237 mA @ 12 VDC
NPort W2250A: 237 mA @ 12 VDC

Standards and Certifications
Safety: UL 60950-1, EN 60950-1
EMC: CE, FCC
EMI: FCC Part 15 Subpart B Class A, FCC Subpart C/E, VCCI, EN 55022 Class A
EMS: EN 55024, EN61000-4-2 (ESD), EN61000-4-3 (RS), EN61000-4-4 (EFT), EN61000-4-5 (Surge), EN61000-4-6 (CS), EN61000-4-8, EN61000-4-11
Radio: CE (ETSI EN 301 893, ETSI EN 300 328), ARIB RCR STD-33, ARIB STD-66
Power Line Surge Protection: 2 KV (level 3)

Reliability
Alert Tool: RTC (real-time clock)
Automatic Reboot Trigger: Built-in WDT (watchdog timer)

12.2 Configuration

The serial server can be configured through the web interface using a common web browser. Please follow the steps below:

1- Connect the W2150A LAN Interface to a laptop using an Ethernet cable.

2- Switch on the W2150A. If the W2150A is connected inside the station, switch on the Radio Power Supply (command *2.2 Set Radio*, see Chapter 5 for details).

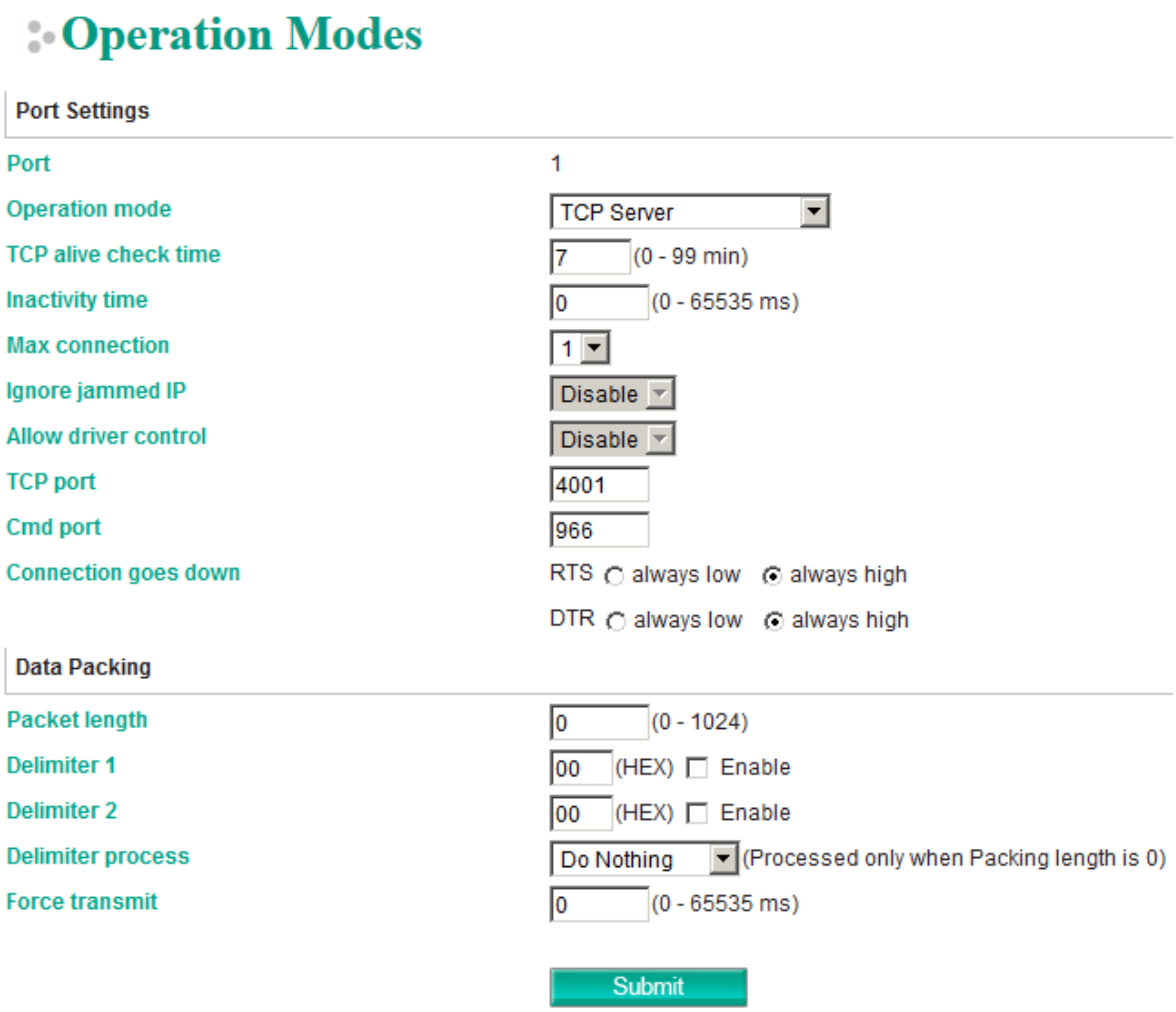
3- Open the web browser (e.g. Chrome, Firefox) and digit the W2150A address, which is written on a label on the W2150A case. If the IP address is unknown, reset the unit to the fabric configuration using the reset button: the default address is reset to 192.168.126.254.

4- Default access parameters are: user *admin*, no password.

5- Access to Serial Port Settings / Operation Modes and configure as following *

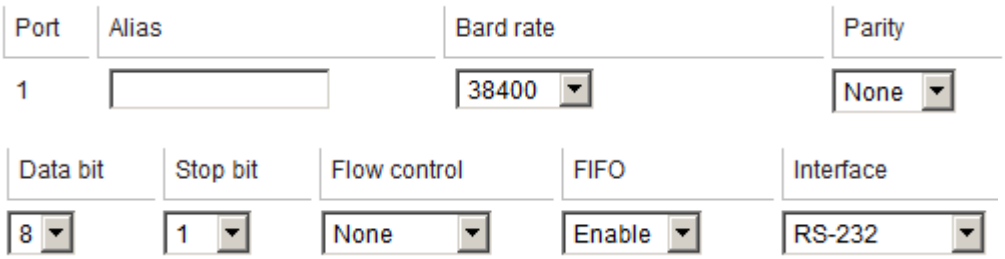
Mode	TCP Server
TCP Port	4001

Mode: TCP Server
TCP Port: 4001

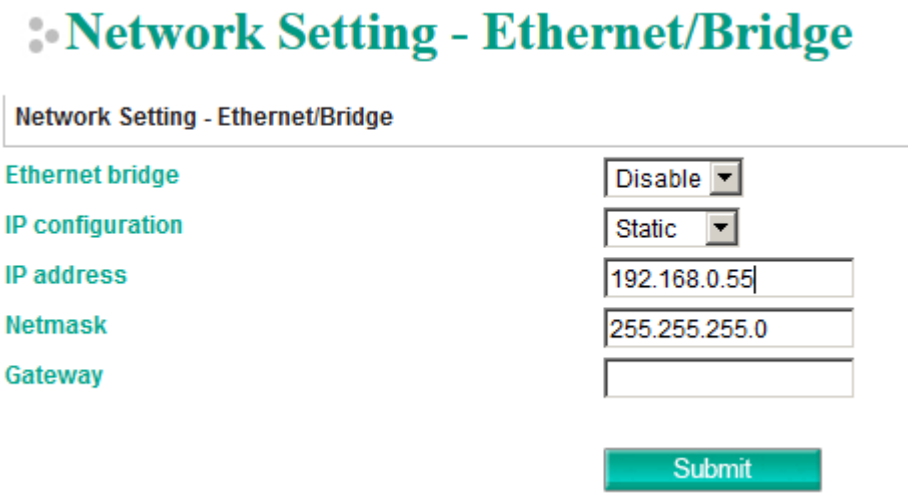


6- Access to Serial Port Settings / Serial Parameters and configure as following:

Baudrate	38400
Parity	None
Data Bits	8
Stop Bits	1
Flow Control	None
Interface	RS232



7- Access to Network Settings / Ethernet/Bridge Settings and disable Ether brige. If you want, you can set an IP Address which you'll have to use when connecting to the Ethernet Port (e.g. for setting the unit).



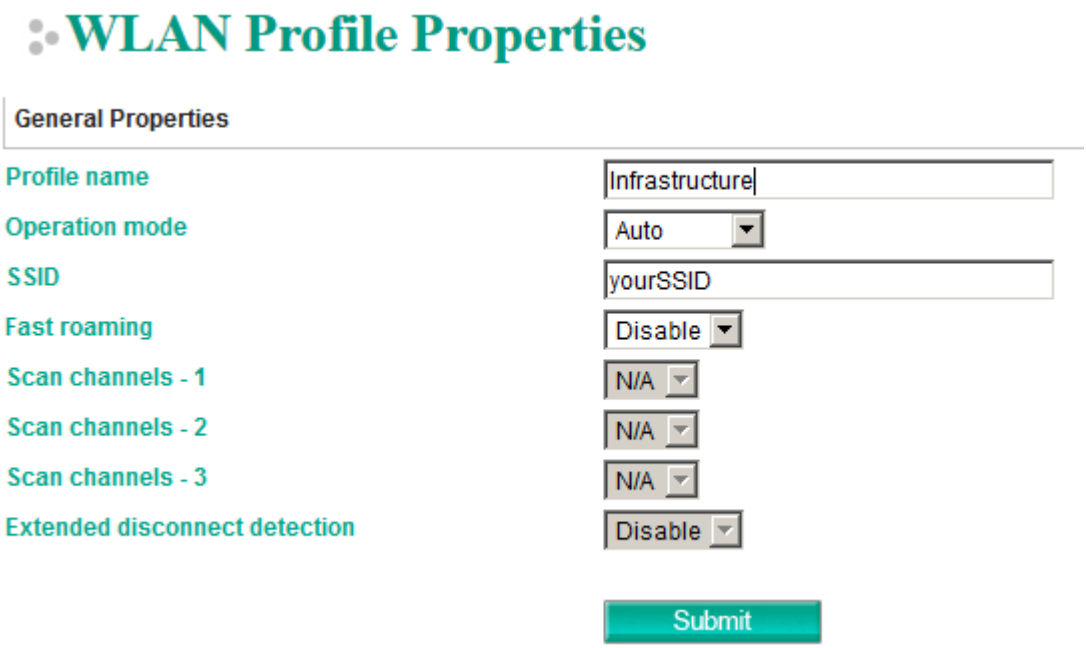
For more information on Ethernet Bridge mode, please refer to Moxa manual.

8- Access to WLAN Settings / WLAN and configure as following:

IP Configuration: Static
IP Address / Netmask / Gateway: your network administrator will provide this information.

Please take note of the IP Address because you'll need to input that information to WS-Scada.

9- Access to WLAN Settings / *Profile* and set the Network Type to Infrastructure. Press *General* and input the SSID of the network you're willing to connect to. Press *Submit*.



10- Access to Security and input the type of authentication, encryption and password of the network you're willing to connect to. Press *Submit*. Press *Activate*.

11- You can leave the other options to default. The W2150 is now ready to operate. Disconnect the Ethernet cable and reset the power supply. Now the W2150 will try to connect to the Wi-Fi network. If the unit is within the Wi-Fi range, check the status LED of the W2150 (WLAN and signal strength) to verify the correct configuration.

* The configuration is already setup as the W2150 leaves the West Systems fabric. Therefore, there is no need to apply that step unless you made a fabric reset of the unit.

12.3 WS-Scada Configuration

Once the W2150 is properly configured, you'll need to instruct WS-Scada on the new IP address to connect to.

1- Within WS-Scada GUI, select the Menu *Options*, then *Show Advanced Menu*.

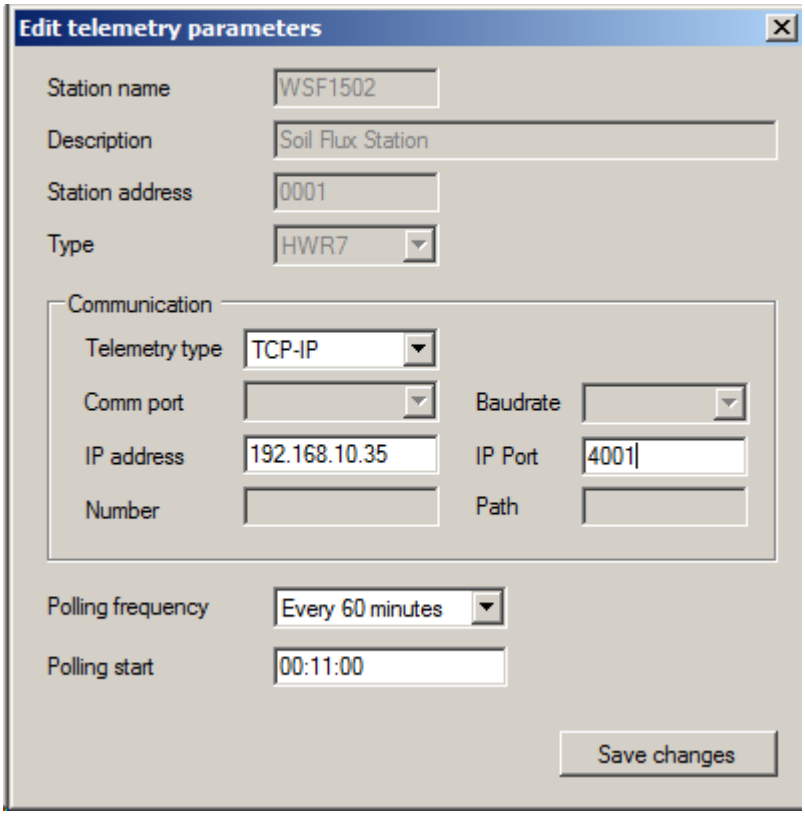
2- Right-click on the name of the station that needs to be configured. Select *Edit Telemetry*.

3- Select "TCP-IP" as *Telemetry type*, as shown in the following screenshot.
4- Fill the *IP Address* field with the IP address you just entered in the W2150 configuration (menu *WLAN Settings*). Your Wi-Fi network administrator will provide a valid IP address.

5- Fill the *IP Port* field with the port number you just entered in the W2150 configuration (menu *Operation Modes*). Default is 4001.

6- Finally, set the *Polling Frequency* and *Polling start* with values coherent with the station configuration, in particular:
   - Timing 0 (Analysis frequency) will determine the frequency of the interrogations (even though you can decide to interrogate less frequently than the sampling; in this way WS-Scada will download multiple measures for each interrogation).
   - Timing 30 (Radio ON) will determine the start time of interrogation. For example: if Radio ON is set to 600000 msec (= 10 minutes), the station will turn on the W2150 every hour with 10 minutes delay (00:10, 01:10, 02:10, etc.).
     Give a few seconds to the W2150 for powering on and connecting to the Wi-Fi network. We suggest setting the *Polling Start* to the Radio On setting + 1 minute = 11 minutes.
   - Timing 31 (Radio OFF): make sure WS-Scada has enough time to interrogate the station before it switches the radio OFF.

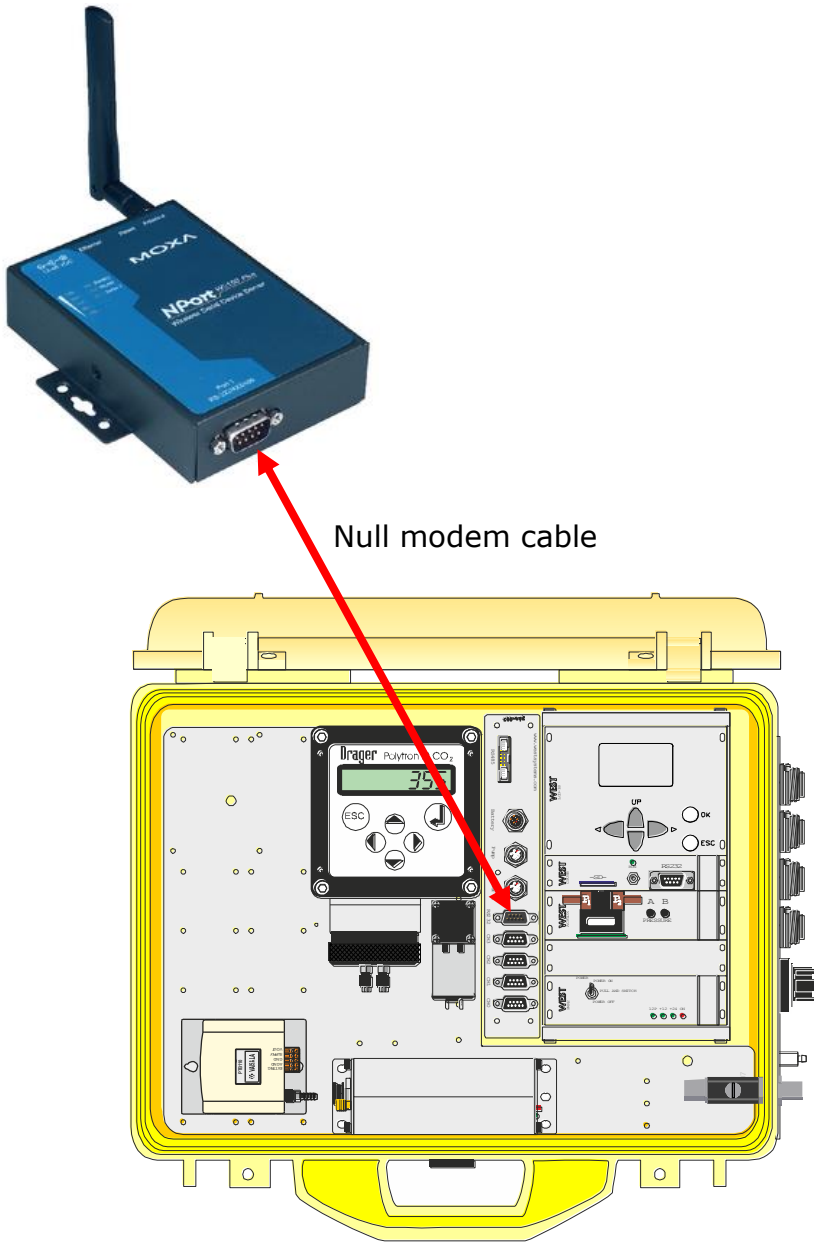
7- Press *Save changes* to finalize the operation.



12.4 Connections

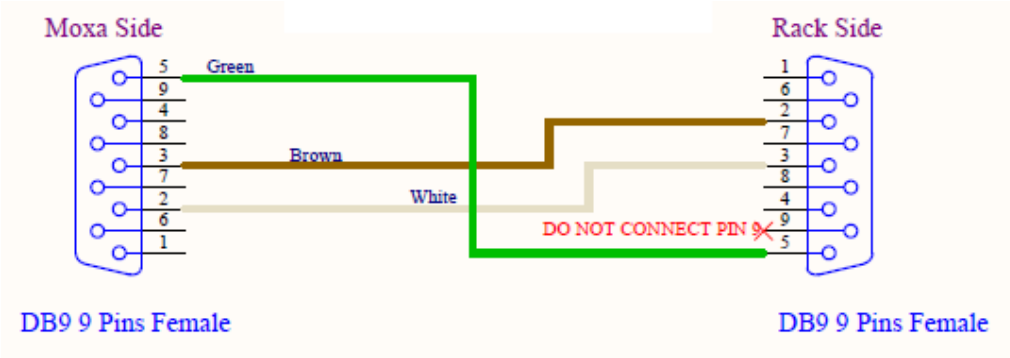
A – Serial Communication

Since both the W2150 and the flux station are equipped with a DB9 Male RS232 port, a NULL MODEM RS232 cable (furnished) is necessary to connect the unit.
Plug the cable between the W2150 (label "Port 1 RS232/422/485") and the flux station (label "RS232"), as shown in figure.



Note: the station is equipped with a second RS232 port (located on the CPU board, near the RUN LED). This is a hardware independent serial port, but has identical function than the RS232 on the panel. The two ports can be used indiscriminately.

Comm. Cable pinout



B – Power supply

The W2150 is equipped with both a 3-pin terminal strip and a jack connector, for power supplying.
West Systems provides a power supply cable which makes use of the first option. The wiring is explained below:

W2150 Power supply cable

Wire	Signal	Wire color	W2150 terminal
1	N.C.		
2	+12V	White	"+V"
3	N.C.		
4	GND	Black	"-V"

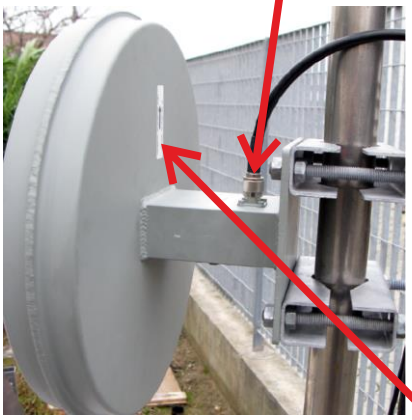
The power supply cable needs to be connected to the internal connector panel of the flux station (label "Power A");

12.5 External Antenna

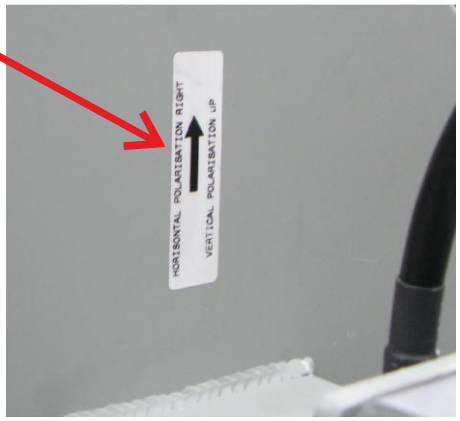
In order to optimize the range of the W2150 (maximum distance between the station and the Wi-Fi access point), West Systems provides a 2.4 GHz external antenna. This must be pointed in direction of the access point.

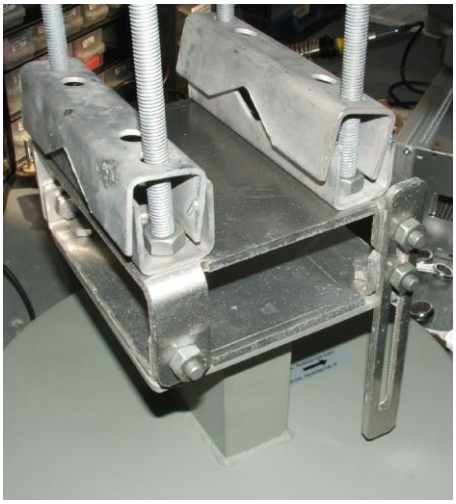
Connect the coaxial cable to the pass-through connection on the right panel of the station.

Protect the connector with **self-bolding** tape.



Pay attention to antenna polarization (Vertical in the picture).





The antenna is furnished with a tilt adapter to point the antenna in the vertical plane. Due to space problems the tilt adapter must be assembled by you.

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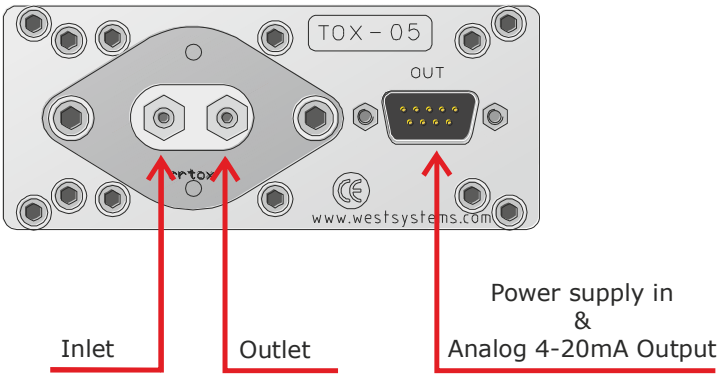
13. Appendix I – WS-TOX-H2S



Pin	Signal
1	
2	2 Black (L)
3	
4	4 RED (H)
5	
6	
7	
8	
9	

Sensor specifications
Ambient conditions:
Air temperature -40°C to 65 °C
Air pressure 700 hPa to 1300 hPa
Air RH 5% - 95% non condensing.
Expected sensor life > 24 months.
Chemical cell order code: WEST H2S-BH
Detector order code: WEST TOX-05-H2S-BH
Factory calibration: 20 ppm
RMS Noise <= 0.02 ppm
Zero Offset <= 0.2 ppm
Max Overrange >= 200 ppm

The chemical cell reaction is:

$$H_2S + 2O_2 = H_2SO_4$$

the gas sample specific consumption is very low:

2.5 x 10-10 moles/Sec per ppm

Appendix I, WS-TOX-H2S

Consideration about the use of TOX-05 family sensors to measure flux with the accumulation chamber method.
Due to this consumption the H2S flux is methodically underestimated by a -10% with the Accumulation Chamber A and by a -5% when using the accumulation chamber B. Then we advise to use the accumulation chamber B except when the flux is very very low.

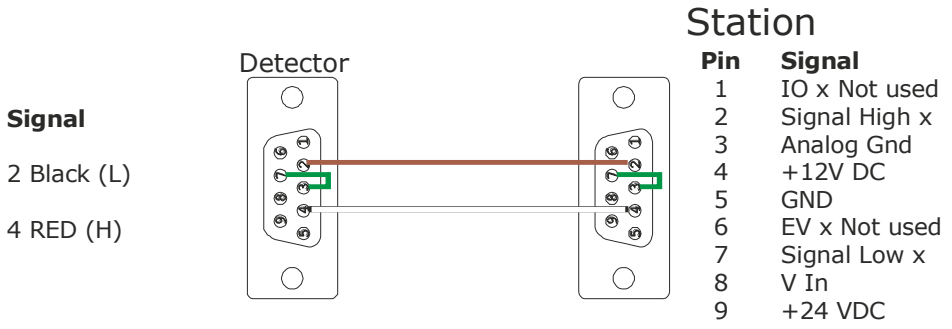
Hydrogen Sulfide Detector

Cross sensitivity tables

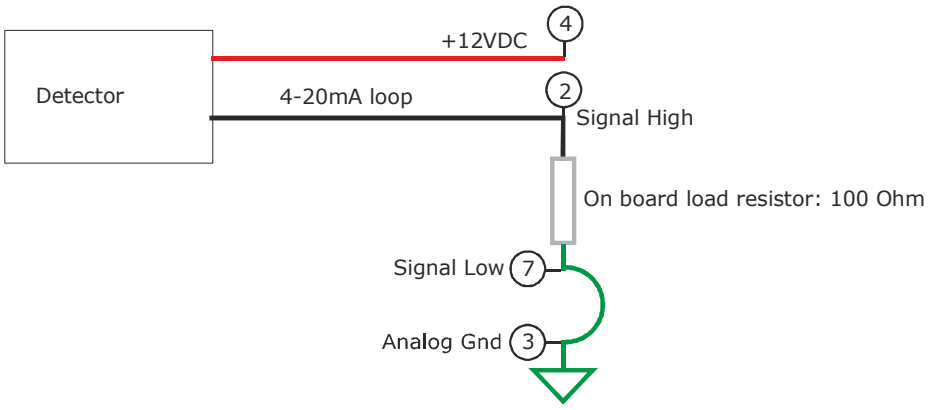
Unfortunately, the hydrogen sulphide detector is affected by cross sensitivity with several gas species: In the table below these cross sensitivity are reported:

		Test @ ppm	Reading ppm
SO_2	Sulfur Dioxide	20	< 1.60
NO	Nytrogen monoxide	50	< 1.50
NO_2	Nytrogen dioxide	10	< -3.00
Cl_2	Chlorine	10	< -2.50
H_2	Hydrogen	400	< 0.60
C_2H_4	Ethylene	400	< 0.40
CO	Carbon monoxide	400	< 2.00
NH_3	Ammonia	20	< 0.02

Example: If the detector is exposed to a 20 ppm, concentration of sulphur dioxide the reading can reach a maximum of 1.60 ppm.
The reading is negative when exposed to chlorine or nitrogen dioxide.



Equivalent circuit



Hydrogen Sulfide Detector Calibration

Calibration dates:

Date:		By:	
Standard gas mixture:	ppm	Zero:	ppm
Barometric pressure	HPa	Air T.	°C

Date:		By:	
Standard gas mixture:	ppm	Zero:	ppm
Barometric pressure	HPa	Air T.	°C

Date:		By:	
Standard gas mixture:	ppm	Zero:	ppm
Barometric pressure	HPa	Air T.	°C

Each time a measurement campaign is initiated the instrumental response of the gas sensors must be verified and, if necessary, their calibration fine tuned. To simplify the explanation see the following example:

Calibration control example:

Before verifying the calibration turn on the instrument and leave it on for a minimum of 20 minutes to stabilise the temperature of the detector.

Step1: Verifying the zero:
Inject a flow (1 liter per minute) of nitrogen, or synthetic air, into the instrument and on the palmtop screen read the concentration. Obviously, it is important that the injected mixture not contain the target gas.

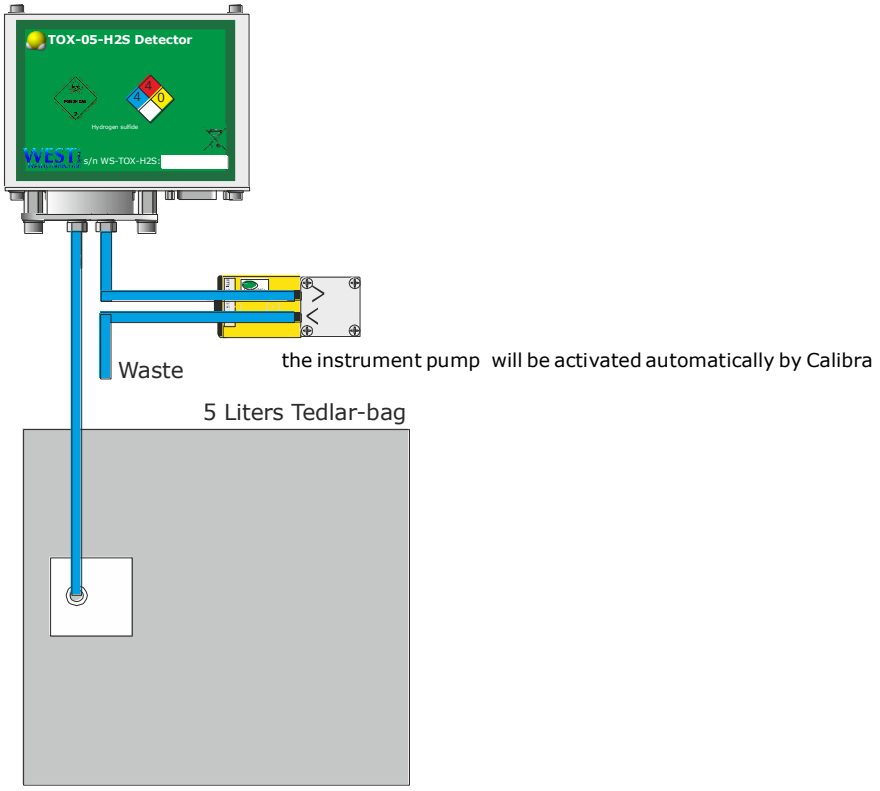
The method for injecting standard gas mixtures is explained in detail in the following pages.

Step2: Verification of the span:
Inject a standard mixture containing approximately 70% of span value (The concentration must be > 50% and <100 % of span) and check the response of the instrument.

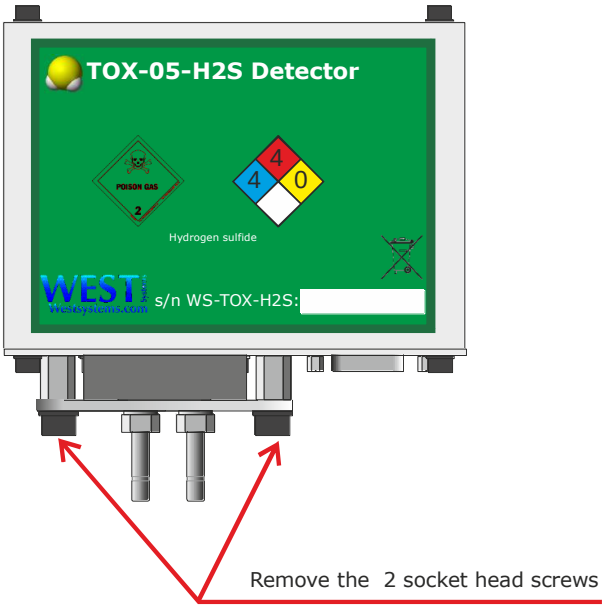
TOX05- Detector Calibration

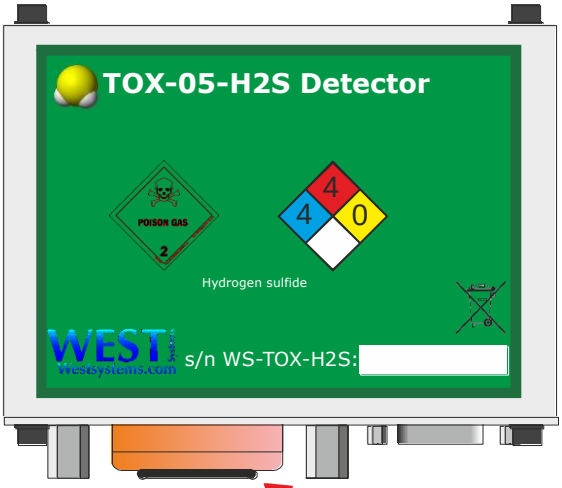
Step 1 : Calibrating the Zero

Fill a 5 liters Tedlar-bag with nitrogen, or synthetic air and connect it to the instrument:



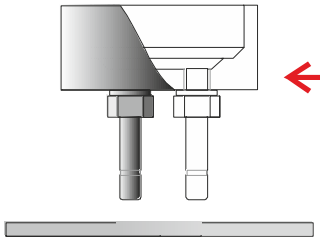
Replacing the sensor head





Now proceed following the instruction from step 1 to step 4.

(Step 4) Remove the O-ring gasket

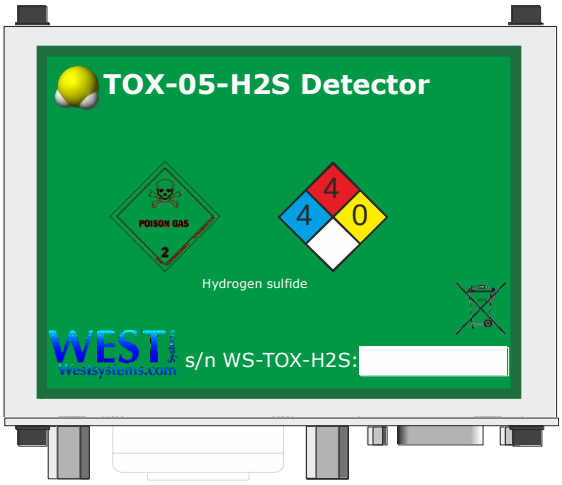


(Step 3) remove the online adapter

(Step 2) remove the flange

ADDRESS combo box

(Step 1) remove the socket head screws



Extract carefully the sensor head

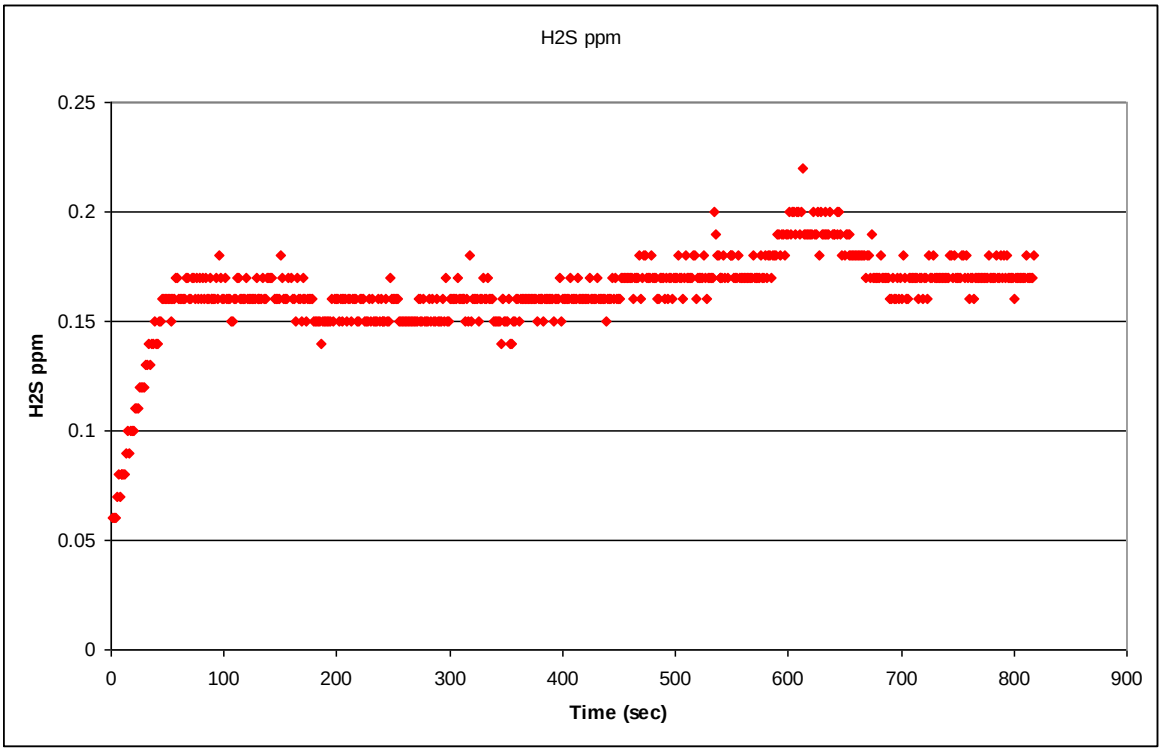
Appendix I, WS-TOX-H2S

Now install the new sensor head WS-H2S-BH-Head (Orange cap) and re-assemble the detector. Please check the O-Ring status and check the sealing of the sensor head/on line adapter.

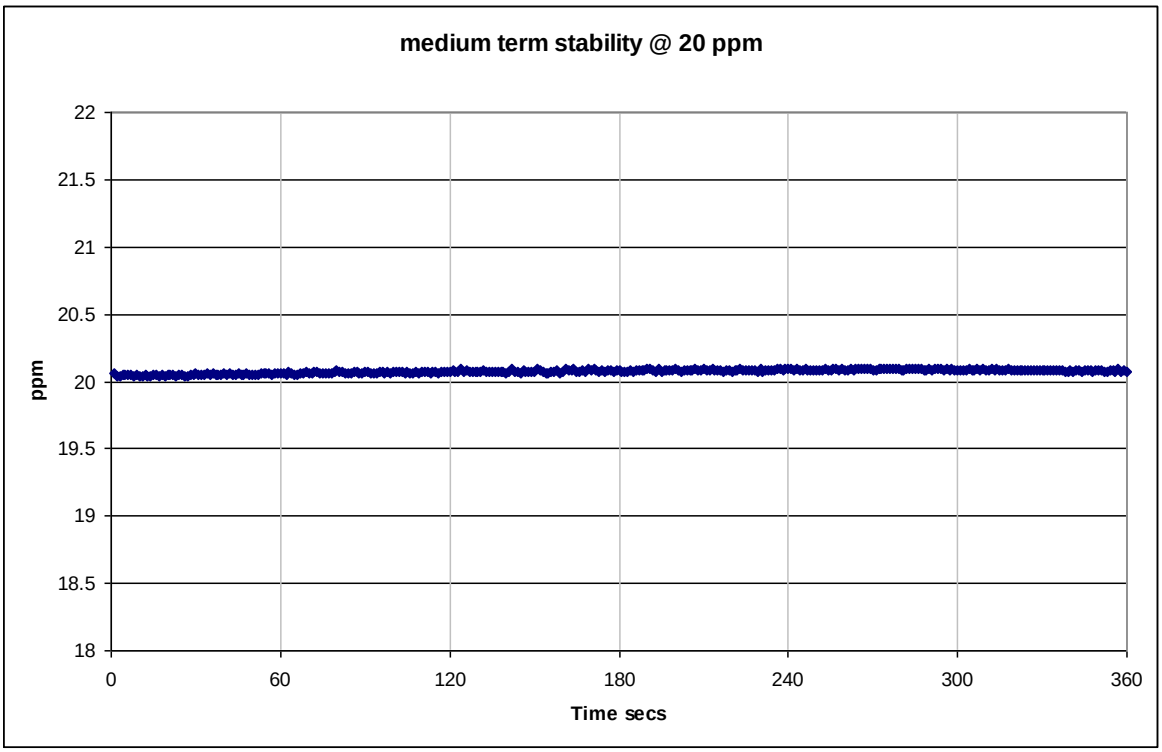
After changing the head you have to re-calibrate the detector.

Flux and concentration calibration results

In the plot below the "base line" of the hydrogen sulphide detector output is reported. The initial drift is due to the sensor temperature adjustment when the pump is switched on. The injected gas mixture was the laboratory air.



In the plot below the stability of the hydrogen sulfide detector output is reported. The injected gas mixture at 1 liter per minute was 20.3 ppm of H2S in nitrogen.


medium term stability @ 20 ppm
ppm
22
21.5
21
20.5
20
19.5
19
18.5
18
0
60
120
180
240
300
360
Time secs

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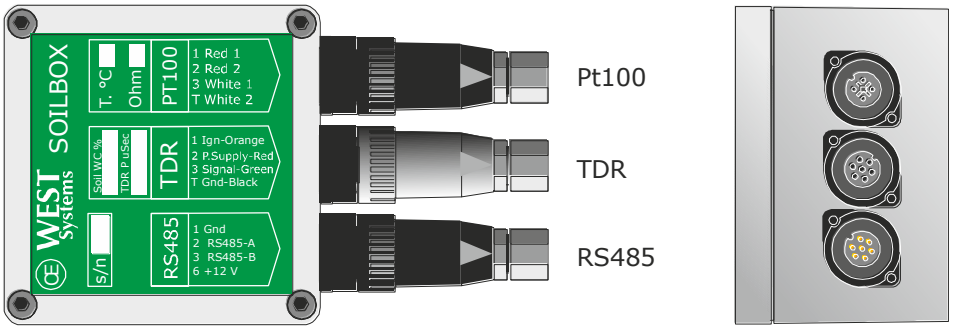
14. Appendix S - Soil Box

General description

The Soil Box is an hardware/software interface that convert the signal of Soil Temperature and of the Soil Water Content TDR CS616 sensor to a digital format compatible with the DF1A soil flux station.

The output of the Soil Box is a RS485 with the standard WEST Systems pinout. Since the Soil Box is designed to be the last device in the bus, the RS485 line is terminated with a 120 Ohm embedded resistor.



Connections:

- RS485 --> IN A
- CS616 --> IN-B
- Pt100 --> OUT

Addresses

Description	LCD	Conf	Unit	LS	FS	ID0	ID1	ID2	ID3
Water Content %	TDR	A0	%	0	100	**1**	5	9	0D
Water C. Pulse	TDR RAW	A1	uSec	15	35	**2**	6	0A	0E
Soil temperature	6B13	22	°C	0	200	**3**	7	0B	0F
PT100 Resistance	6B13 R.	A2	Ohm			**4**	8	0C	10

Where:
LCD is the caption that the station display when the channel is selected.
Conf. Is the channel type
Unit is the measure unit.
LS is the minimum reading
FS is the maximum reading

The RED highlighted is the default set.
ID0 .. ID3 are the base RS485 address of the device that you can set following the next table:

DIP SW	SW5	SW6	SW7	Addr 0
ID0	0	0	0	01
ID1	0	0	1	05
ID2	0	1	0	09
ID3	0	1	1	13

Dip SW 8: Reserved for calibration / no actual function.

Please note that the soil box is designed to works only with the CS616 CS water content TDR probe. The obsolete CS615 can not be used.

Please follow the instructions on the RS485 Expansion chapter of the station Handbook to configure the station.

Connectors pinout

Soil Temperature Pt100 Connections

```
Panel 3+T female connector
Pin 1:     Red 1
Pin 2:     Red 2
Pin 3:    White 1
Pin T:    White 2
```

CS616 Connections

```
Panel 6+T  female connector
Pin 1: Orange (Ignition)
Pin 2: Red (Power supply)
Pin 3: Green (Signal)
Pin 4: Black + Screen (Ground)
```

RS485 Connections

```
Panel 6+T male connector
Pin 1: Gnd   Black
Pin 2: A     Yellow
Pin 3: B     Green
Pin 6: +V12  Red
```

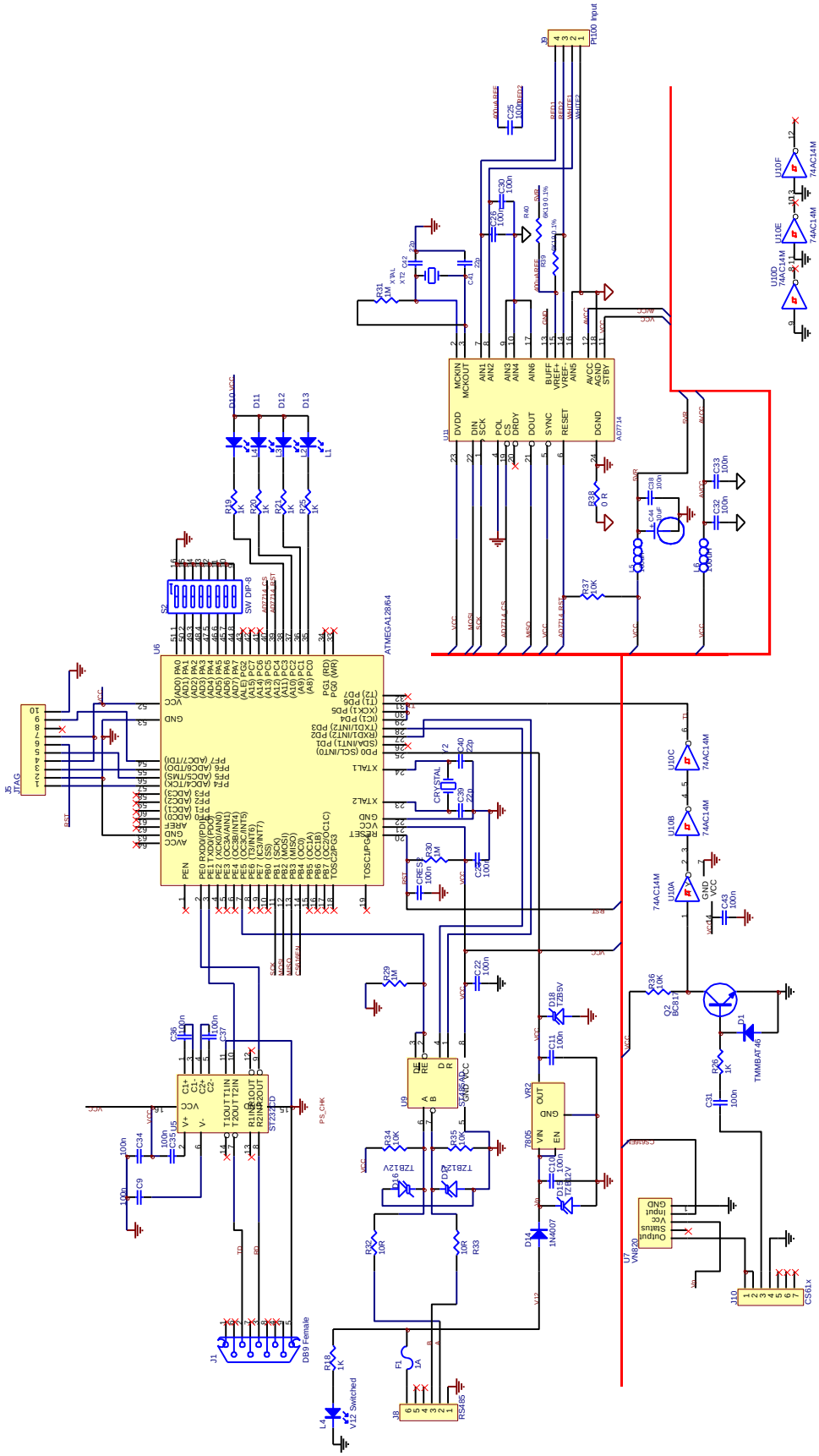
DIP switch settings

DIP SW	Enable/Disable	Factory Default
SW1	TDR	1
SW2	TDR RAW	1
SW3	6B13	1
SW4	6B13 R.	1

DIP SW	Enable/Disable	Factory Default
SW5	ID Set 0	0
SW6	ID Set 1	0
SW7	ID Set 2	0
SW8	Calibration	0

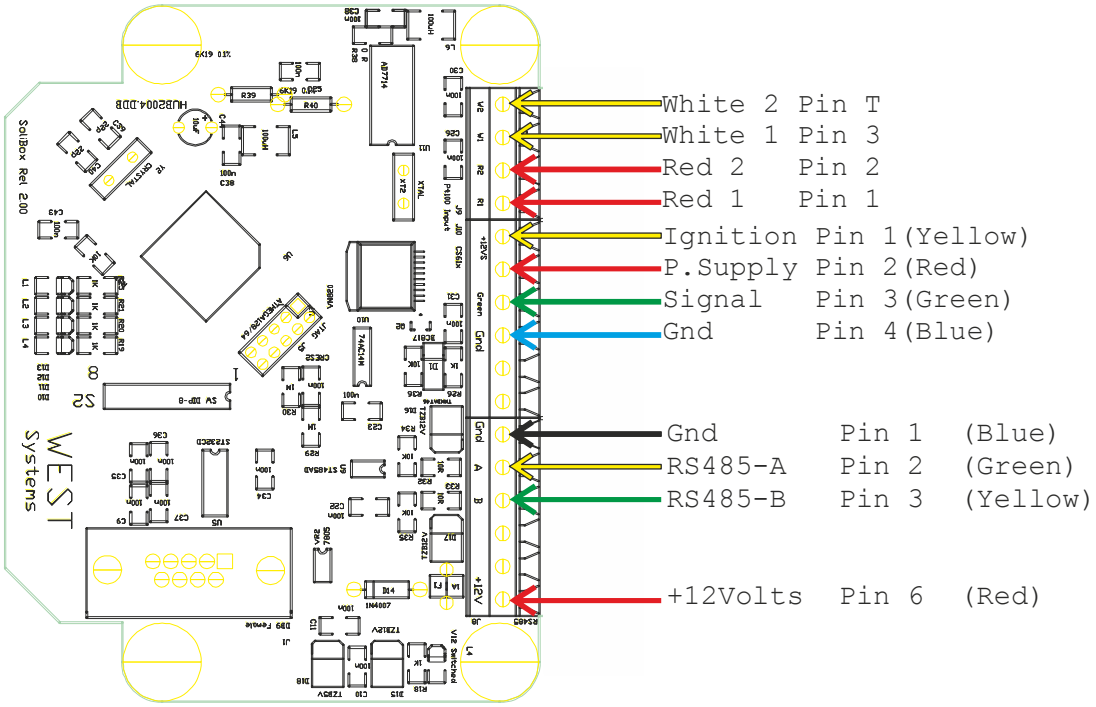
See page S.1

Schematic


ATMEGA128/64
AD7714
Pt100 Input
74AC14M
DB9 Female
ST232CD
SW DIP-8
JTAG
CRYSTAL
RS485
12V Switched
VR4820
Output
Status
Vcc
Input
GND
CSMIX
TMMBAT46
1N4007
BC811
7805
TZB12V
TZB22V
TZB5V

Appendix S, Soil Box

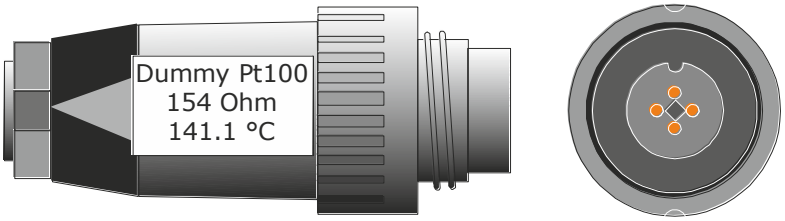
PCB Layout



Testing temperature channel

Connect the dummy Pt100 probe, you can ask with no charge to WEST Systems, to the soil box and check that the 6B13 channel reading is equal to the reading reported on the label attached to the dummy probe. The Dummy probe resistance has a tolerance of 1/1000 of the value reported on the label. The temperature reading error must be less than 0.5°C

WEST Systems provides a 100 Ohm (Zero degree Celsius) and a 154 Ohm (141.1°C) dummy probes.

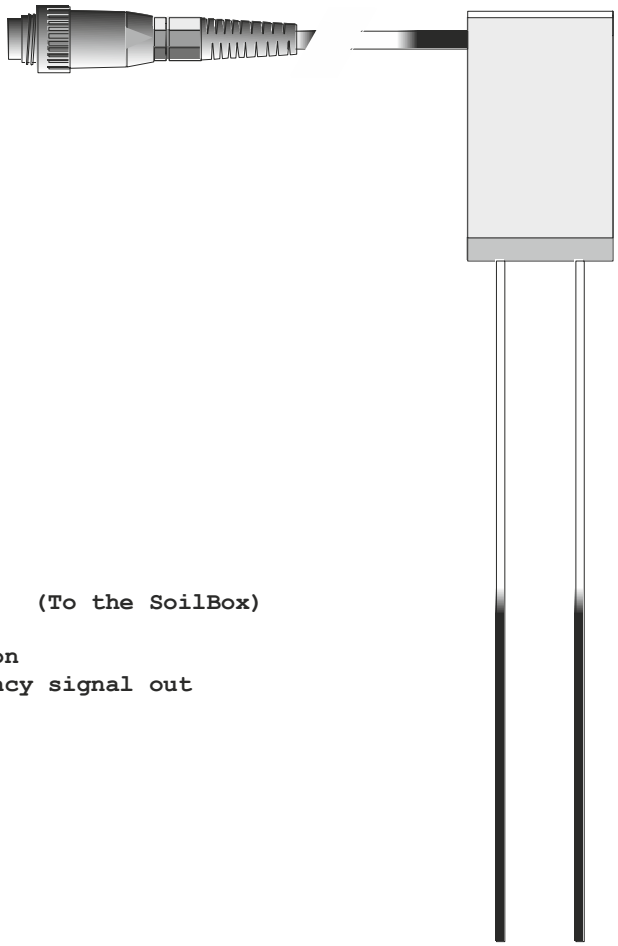


To check the soil pt100 probe use a calibrated thermocouple or pt100 (better) portable gauge and compare the reading with the station one. A 1.6°C tolerance must be accepted if you use a K thermocouple, a 0.5°C tolerance is normal if you use a Pt100 probe.

Soil water

Manufacturer: Campbell Scientific
Ordering code: CS616 / CS615 (Out of stock)
Water content
Range 5-50 %
Accuracy 3%

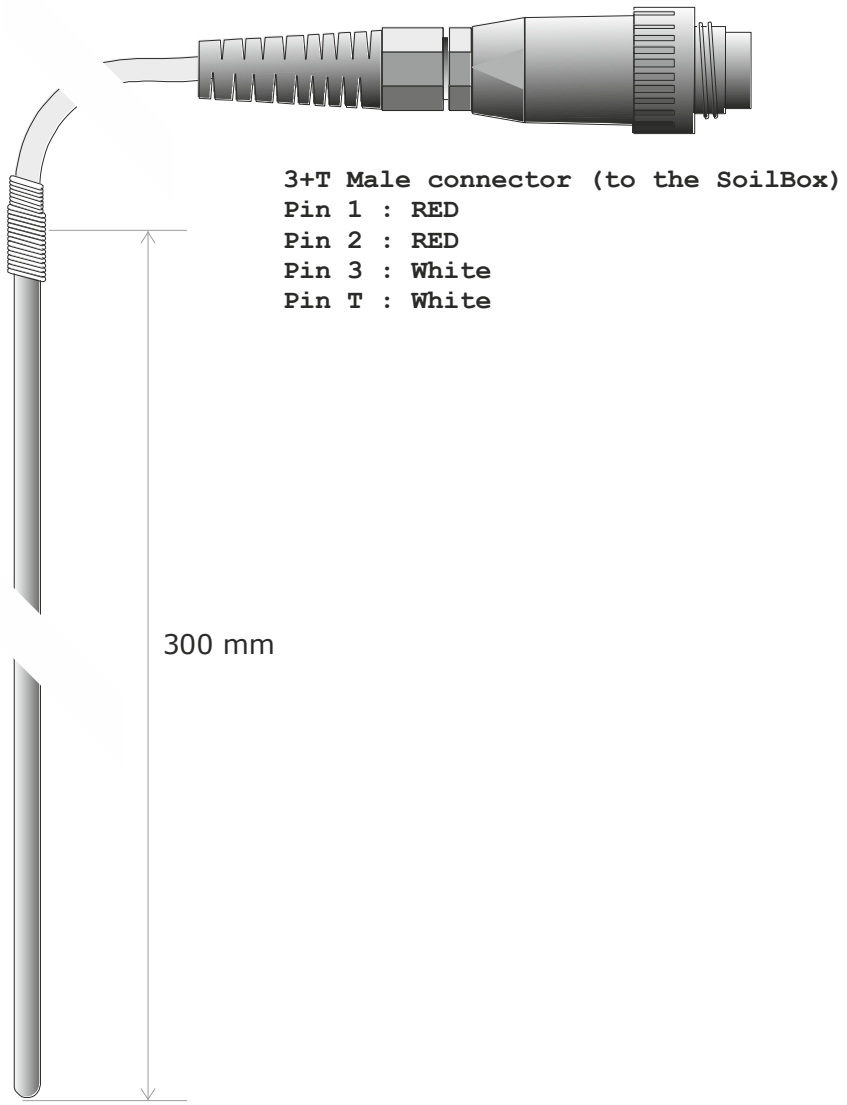
The CS616 (CS615) Water Content Reflectometer measures the volumetric water content of porous media using time-domain measurement methods.
The Water Content Reflectometer consists of two stainless steel rods connected to a printed circuit board. A shielded four-conductor cable is connected to the circuit board to supply power, enable the probe, and monitor the pulse output. The circuit board is encapsulated in epoxy. The probe rods can be inserted from the surface or the probe can be buried at any orientation to the surface.
The CS616 (CS615) response is dependent on the dielectric constant of the material surrounding the probe rods. Water is the principal contributor to the dielectric constant value, but the solid constituents such as quartz, clay and organic matter also affect the measurement. The same calibration of volumetric water content to probe output signal period may not apply to all soils. Accuracy can be optimized by using calibrations derived for a specific soil. Accuracy of ± 2.0% over the entire water content range and for a wide range of soil types is routinely obtained in our laboratory. Applying the general calibrations from the operating manual provides accuracy of ± 3.0%.



```
6+T Male cable connector   (To the SoilBox)
Pin 1 : Red  +12 Volt
Pin 2 : Orange    Ignition
Pin 3 : Green     Frequency signal out
Pin 4 : Black+Sh. Ground
Pin 5 : n.c.
Pin 6 : n.c.
Pin T : n.c.
```

Appendix S, Soil Box

Soil temperature
Manufacturer : RS
Ordering code :RS 321-6090
Type : Pt100 DIN IEC 751 Class B 4 wires
Range 0 to 200 °C
Max operating temperature 200°C
Accuracy 0.3°C
Probe length 300 mm
Probe diameter 6 mm
Cable length 3 Meter
Cable PTFE and silicon insulated



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