AgroBee-L Manual

# AgroBee-L SDI-12 System

Very low consumption radio modules and integrated parts of the AgroBee-L system for reading up to 4 (VWC: Volumetric Water Content) soil water content, Temperature, and EC (electric conductivity) or VIC (Volumetric Ion Content) tri-sensors through an SDI-12 communication bus that allows you to connect different sensors to the same point, since each one of them has a cirtain direction that distinguishes it from the rest.

The AgroBee-L SDI-12 model offers the following, according to the available format:

- 1 digital input for a maximum of 4 soil water content, temperature, and EC tri-sensors with the following type of SDI-12 communication bus:
    - Decagon 5TE: VWC, EC, and Temperature
    - Decagon GS3: VWC, EC, and Temperature
    - Campbell CS650: VWC, EC, and Temperature
    - Stevens Hydraprobe-II: VWC, EC, and Temperature
    - AquaCheck-4 (maximum 1 sensor): VWC and Temperature
    - AquaCheck-8 (maximum 1 sensor): VWC and Temperature
    - Sentek Drill&Drop Moisture-Temperature (maximum 1 sensor) : VWC and Temperature
    - Sentek Drill&Drop TriScan (maximum 1 sensor): VWC, VIC (Volumetric Ion Content) and Temperature
    - Meter Group TEROS-12: VWC, EC, and Temperature
    - Apogee NDVI/PRI (per pair; maximum 2 pairs of sensors)
    - MeterGroup TEROS-21: Potential water in soil and Temperature
    - EnviroPro (1 sensor maximum): VWC, EC and Temperature.
- 1 counter or digital sensor or rain gauge input



AgroBee-L SDI-12

AgroBee-L SDI-12

Multi-level Bi-sensor / Tri-sensor

Tri-sensors (VWC, EC and Temp)
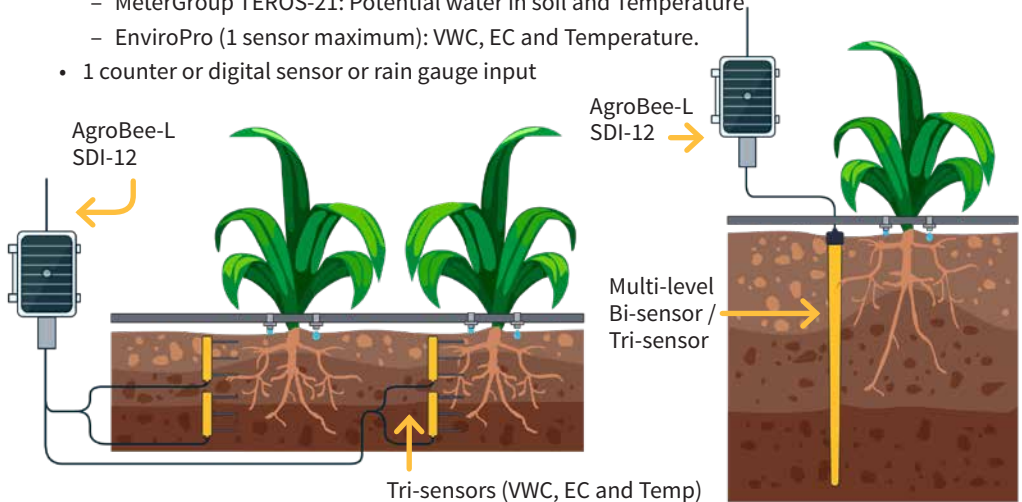
This module is powered by a 1.05 W solar panel + supercapacitors, already incorporated into the machine (no need to replace batteries).

The number of sensors a module uses, as well as their type, can be configured using a Module Reader of the module itself, or from the controller to which said module is associated.

All sensors connected to a module should be the same type. Only one physical sensor can be connected to the AquaCheck sensor (internally, it can have up to 4 or 8 sensors, depending on whether you choose AquaCheck-4 or AquaCheck-8, respectively). Likewise, only one physical sensor can be connected to the Sentek Drill&drop sensor, (internally, it can have 3, 6, or 9 levels of sensors).

For the Apogee NDVI/PRI sensor: 2 sensors are required to provide this parameter, the hemispherical one (pointing up) and the field-stop (towards the plant). Therefore, both sensors are always meant to give a PRI/NDVI measurement. An AgroBee-L SDI-12 module may provide 2 PRI/NDVI measurements (maximum 4 sensors): sensor-1 (up) and sensor-2 (toward the plant) will provide a PRI/NDVI measurement; Sensor-3 (up) and Sensor-4 (toward the plant) will provide another PRI/NDVI measurement.

The module itself supplies each sensor with the necessary supply voltage according to the type of sensor configured. Likewise, the read timing of the sensors can be chosen from 3 different values: 5, 10, or 20 minutes, with the default value being 5 minutes.

## Technical characteristics

| Power supply | | |
|---|---|---|
| Power supply: | SDI-12:<br>Solar: 5V / 1,05W → 3,3V | Panel plus high capacity supercapacitors |
| Energy consumption:<br>SDI-12 | Average consumption:<br>0,90 mW | |

| Outputs | |
|---|---|
| Number | 1 |
| Type | 5 Vcc or 12 Vcc (Sensor power supply)<br>Maximum current: 50 mA |

| Inputs | |
|---|---|
| **Maximum distance betweeen sensor and AgroBee-L: 50m** | |
| Number | 1 |
| Type | For potential-free contacts |
| Number | 1 |
| Type | SDI-12 Bus |

| Environment | |
|---|---|
| Temperature | -10 °C to +60 °C |
| Moisture | < 95 % |
| Altitude | 2000 m |
| Pollution | Grade II |

| Box dimensions SDI-12 | |
|---|---|
| Height | 150 mm |
| Width | 100 mm |
| Depth | 70 mm |
| Weight (approx.) | 0,4 Kg |

This symbol indicates that electrical and electronic controller must not be disposed of along with household waste at the end of its useful life. The product must be taken to the corresponding collection point for the recycling and proper treatment of electrical and electronic controller in accordance with national legislation.

## AgroBee-L System Operation

The AgroBee-L radio modules are used for the activation of valves and other irrigation elements, as well as the reading of sensors and meters. It is very low consumption and follows the LoRa radio modulation, which operates in the 868MHz, 433 MHz and 915 MHz, free bands, obtaining radio coverage of up to 2500 m between two points (depending on the orography).

Currently, they can be incorporated into the Agrónic 2500, Agrónic 4500, Agrónic 5500 and Agrónic Bit Con fertirrigation controllers.



The AgroBee-L system consists of a coordinator device (located in the Agrónic 2500, Agrónic 4500, Agrónic 5500 or Agrónic Bit Con controllers) and by field elements with different functions, depending on the model in question. This system does not include the use of repeater elements, so all modules must connect directly with their coordinator. The field modules manage their consumption by activating the communication in the precise time of the exchange; the rest of the time, they are asleep or attending to irrigation control.
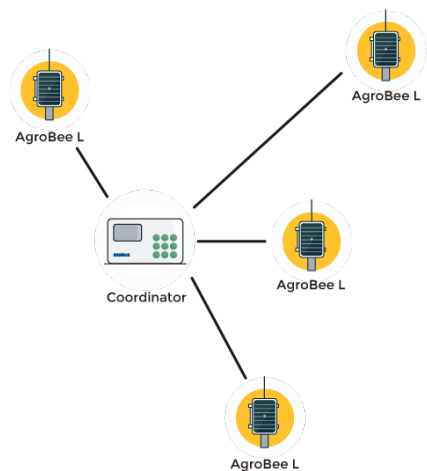
Its low consumption allows it to operate with a solar panel integrated into the module and supercapacitors or battery (depending on the model). The solar panel stores the energy in the supercapacitors/battery, offering a long operational life. It is only necessary to replace batteries in models that include batteries instead of supercapacitors.

The maximum number of modules that an Agrónic controller can manage is 20 units in standard mode, which can be configured as modules of any of the available types. There is also a priority mode, which makes it possible for the modules to communicate more often: in this case, the number of modules (10) is halved.

To use AgroBee-L modules, it is necessary to assign their outputs to the sectors or generals of the controller in question, and their inputs to the digital, analog, or counters sensors.

The AgroBee-L system has the following features, among others:

- Operation in 868 MHz, 433 MHz and 915 MHz free bands.
- Availability of 13 communication channels plus 18 transmission modes, which allow for the operation of more than one network in the same area working on the same channel.
- Availability of network code, which allows for filtering the information of several networks configured with the same parameters.
- Self-adjustable communication rate according to the chosen transmission mode and the timing mode:
  – Timing in standard mode (60 –200"). Up to 20 modules.
  – Timing in priority mode (30 –100"). Up to 10 modules.
- Distances of up to 2500 metres between any module and its coordinator (depending on the orography).
- Manual actions, consultations, and configuration of the network number, channel, transmission mode, and communication timing (standard/priority):
  – In-situ: Through the Module Reader
  – From a distance: Through the Agrónic
- Battery/charge level reading and solar panel (if any).
- Reading SNR level (signal-to-noise ratio) reception in the module and coordinator (in [%]).
- Reading the status of the last 16 communications and remaining time indicator until the next communication.

## Installation

For the supply of radio controller, it is essential to have a coverage study. This study verifies the viability of the system according to the profile of the terrain, the location of the points to be controlled, and the distance between them. The study is delivered along with the controller offer.

The AgroBee-L modules have the antenna integrated into the module, so they are installed on top of a post.

For good radio communication, it is very important to place the modules in areas free of vegetation, walls, and metal structures.

**The minimum recommended height to place the module is 4.5 metres from the ground.** If there are tall crops (corn, trees, ...) this minimum height of the module must be increased by 2 metres above the height of the crop. In all cases, it must always have direct visibility with the controller's antenna that sends the information (coordinator located in Agrónic). The 7 metres of cable supplied already include these assembly recommendations.

Module →

Post →

min. 4,5 m

min. 2 m
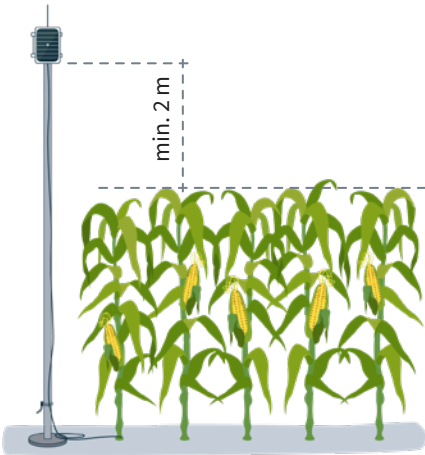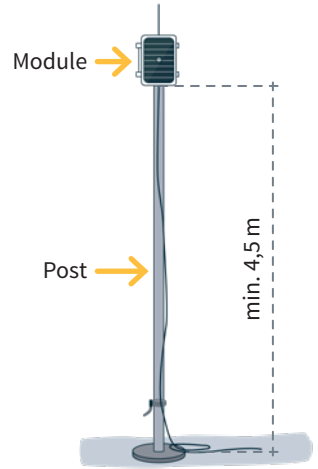
To increase the coverage, and if necessary, the best system is made by raising the module as high as the length of the cable allows.

The modules with solar panels must be placed orienting the panel to the South (Northern hemisphere) or North (Southern hemisphere) to obtain the best solar coverage.

To keep it watertight, it is necessary to always leave the lid closed.

The modules can be fixed on a 35 to 45mm post by means of the support and flange, incorporated (Endless stainless steel clamp, measure 32-50mm DIN3017) in such a way that the cable output passes through the inside of the post.

It is recommended to install it on folding or extendible posts for easy access to the module.

Flange

Folding posts

# Inputs and Outputs

## DIGITAL INPUTS

There is 1 digital input in an AgroBee-L SDI-12 module, which can function either as a digital input or counter/rain gauge input. When the input is connected to a counter, the minimum time between pulses must be 0.1 seconds. Maximum allowed distance between AgroBee-L module and a digital sensor or meter is 50m.

## DIGITAL INPUT SDI-12 BUS

This model has 1 digital SDI-12-type input for reading and managing a maximum of 4 soil water content, temperature, and EC sensors, which must all be of the same type, among: "Decagon 5TE", "Decagon GS3", "TEROS-12", "Campbell CS-650", "Stevens Hydraprobe-II", "AquaCheck-4" (only soil water content and temperature), "AquaCheck-8" (only soil water content and temperature), "Sentek Drill&Drop", "Apogee NVDI/PRI", "MeterGroup TEROS-21". Since this module manages sensors with an SDI-12 output, the outputs of all the sensors are connected to the same input of the module.

## CONNECTION

Said module is provided with a cable tube that allows different connections to be made more easily without the need to access the interior of the module:

- SDI-12 5-wire tube

The cables of the different tubes will come identified by colours and numbers. Connect them according to the following table and according to their functionality.

| SDI-12 | | |
|---|---|---|
| Wire colour | | Function |
| | White | Common power supply sensors SDI-12 (0V) |
| | Brown | Sensor input SDI-12 (ED2-SDI12) |
| | Green | Sensor power supply SDI-12 (+V1) |
| | Yellow | Digital Input 1 (ED1) |
| | Grey | Common Digital Input (CD) |

AgroBee-L SDI-12 module    Watertight connection terminals    Sensor
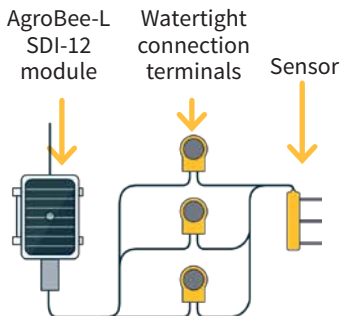


Consult the SDI-12 sensor manual for information about its installation.

To ensure the seal of the module's cable connections, it is recommended to use watertight terminals. The connection through these terminals must be made without stripping the cable's wires.

The 3M Scotchlok series (www.3m.com), ES Caps from TYCO Electronics (www.tycoelectronics.com), or Cellpack resin splicing and junction kits (www.cellpackiberica.com) can be used as connecting elements.

# Settings

For any AgroBee-L module to enter the correct operating mode, you must have an Agrónic controller (Agrónic 2500, Agrónic 4500, Agrónic 5500 and Agrónic Bit Con) with the AgroBee-L option installed, which includes the internal coordinator and an antenna with 10 metres of cable. This can be verified by doing the following in the controller:

Consult ⟶ Communication ⟶ AgroBee-L ⟶ Status: Correct

In the same way, a module must be configured to communicate with the Agrónic with which you want to associate it. To do this (if the module is not already configured at the factory) you must use the Module Reader (or Agronic Radio Reader, LAR) consisting of a screen and four keys, that is connected to the AgroBee-L module through the only connector visible on the inside.

A wireless module reader is also available that allows you to perform functions without the need for a cable. Consult the wireless AgroBee Reader manual to learn about the steps to link it to the controller.

Press the ⏎ key to enter the main menu. Use the ➖ and ➕ keys to change the options within the menu. Use the ⏎ key to enter the selected menu option. Use the C/c key to return to the previous hierarchy's menu.

You will see the following options in the main menu:
- Consult controller
- Consult communications
- Consult digital and analog inputs
- Communication parameters
- Input-Output parameters
- Various parameters

**NOTE**  Once the AgroBee-L module is linked with an Agrónic, all the consultations and parameters are accessible through the Agrónic.

General query menu of the module, where the following parameters are displayed:

- Module and serial number:
    - Module: It refers to the module number (1 to 20) according to the established communication parameters. There can only be one same module number for each Agrónic.
    - Serial number: Information regarding the controller. It comes from the factory.
- Battery voltage and solar panel:
    - Vbat: Battery voltage:
        · Panel+Supercapacitors: Maximum value: 3.4V; Minimum value: 2.2V
        · Panel+Battery: Maximum value: 4.2V; Minimum value 3.4V
    - Vsol: Voltage of the solar panel

These same data can be viewed in the Agrónic by accessing "Consult - Communications - AgroBee," as you will see in the next section.

## CONSULT COMMUNICATIONS IN AN AGROBEE-L MODULE

Communication consultation menu of the module, where the following parameters are displayed:

- Transceiver: Type of emitter installed in the module. It tells you if the module works at 868MHz/433MHz or 915MHz
    - RN2483 (868MHz/433MHz)
    - RN2903 (915MHz)
- Band and transmission mode:
    - Band: 868MHz, 433MHz, 915MHz
    - Transmission Mode: 1 to 18 (mode 5 will be set by default)
- Consult parameters of the communication type:
    - Channel: 1 to 13
    - Network code: It is usually the associated Agrónic serial number
    - BW: Bandwidth of the radio modulation (125KHz, 250KHz, 500KHz). It is set according to the transmission mode chosen in the communication parameters.
    - Radio modulation factor: SF7, SF8,…, SF12. It is set according to the transmission mode chosen in the communication parameters.
    - Communication status:
        · Status message:
            - Correct Communication
            - Network error
            - Communication error
            - Model error
            - Does not communicate
        · Signal-Noise ratio of the last received message: Reliable communication if >40%.
    - Time until next radio emission: time in [s]

- Status of the last 16 communications (the previous communications appear on the right side of the screen):
  - · 1: It indicates that the emission has been made and the correct information received in the last communication
  - · 0: Indicates that the radio emission has been made, but the correct data has not been received or no data has been received

Part of this information is available through the Agrónic by accessing "Consultation | Communications | AgroBee", where you can also see the query regarding the controller and the parameters of the communication.

| CONSULT COMMUNICATIONS | CONSULT COMMUNICATIONS |
|---|---|
| AgroBee-L 868 | M01 (ns. 236) V1.00 |
| Status: Correct | Status: Correct (40") |
| Timing: 60" | Level: 80%  / 82% |
| Channel: 01     TX Mode: 05 | Vbat: 04.0 V   Vsol: 05.8 V |
| Network code:  00001 | 1111111111111111 |

## CONSULT THE AGROBEE-L MODULE DIGITAL/SDI-12 INPUTS

Menu to check the status of digital inputs, counters, and SDI-12 inputs. The information shown on the different screens is as follows:

- Check digital inputs: For each of the digital inputs available to the module in question, its status is shown either as '0' (open contact) or '1' (closed contact)
- See accumulated counter sensors: The total number of pulses detected will be displayed for each digital input configured as a counter sensor. If this entry is not configured as a counter, the text 'N-A' (Not-Activated) will appear.
- See instant flow rate (time between pulses): The time in [ms] between the last 2 pulses detected will be displayed for each digital input that is configured as a counter sensor. If this entry is not configured as a counter, the text 'N-A' (Not-Activated) will appear.
- Consult SDI-12 sensors: For each of the sensors that can be connected to the bus, the following information is displayed:
  - 5TE, GS3, Campbell CS650, Stevens Hydraprobe-II, TEROS-12 type sensors  VWC, EC, and Temperature. If a sensor is not activated, the text 'N-A' (Not-Activated) will appear in each of these parameters.
  - AquaCheck-4 type sensors  VWC, EC, and Temperature. The values for each of the 4 sensors that the AquaCheck-4 can hold inside will appear: with number 1 corresponding to the one located in the highest part, and 4 being located in the lowest part of the sensor. If a sensor is not activated, the text 'N-A' (Not-Activated) will appear in each of these parameters. 'N-A' will always appear in the EC parameter since the AquaCheck does not input EC values.

– AquaCheck-8 type sensors  VWC and Temperature. The values for each of the 8 sensors that the AquaCheck-8 can hold inside will appear: with number 1 corresponding to the one located in the highest part, and 8 being located in the lowest part of the sensor. Likewise, it will also deliver the Temperature value of sensors 1, 3, 5, and 7 (due to physical limitations, the temperature value of all the sensors that the AquaCheck-8 encompasses cannot be delivered. If a sensor is not activated, the text 'N-A' (Not-Activated) will appear in each of these parameters.

– Drill&Drop type sensors Moisture-Temperature  VWC and Temperature. The VWC and temperature values for the different sensors will be shown according to the format established in the input/output parameters: with number 1 corresponding to the sensor located in the highest part.

– TriScan Drill&drop type sensors: VWC, VIC, and Temperature  The values of VWC, VIC and temperature for the different sensors will be displayed according to the format established in the input/output parameters: with number 1 corresponding to the sensor located in the highest part.

– Apogee PRI/NDVI type sensors  The possible PRI/NDVI values will be displayed. Sensor-1 (hemispheric) and sensor-2 (field-stop) must be connected and activated to give the first PRI/NDVI measurement; and sensor-3 (hemispheric) and sensor-4 (field-stop) must be connected and activated to give the first PRI/NDVI measurement.

– MeterGroup TEROS-21 sensors  The values of Water Potential in soil and Temperature for the different sensors will be displayed. If a sensor is not activated, the text 'N-A' (Not-Activated) will appear in each of these parameters.

– EnviroPro type sensors  The VWC, EC and temperature values for the different sensors will be displayed, and according to the format established in the input/output parameters: the number 1 will correspond to the sensor located in the higuest part.

• Check the supply voltage of the analog sensors: The value of the supply voltage sent to the active analog sensors is displayed in [mV].

From the Agrónic, press the '1' key in the module's consultation screen to view the analog/digital inputs.

Nomenclature used in these queries:

• ED  status of digital inputs. With a '1' indicating that the contact is closed and a '0', that it is open.

• EA

– 5TE Decagon, GS3 Decagon, Campbell CS650, Stevens Hydraprobe-II, AquaCheck-4/-8, TEROS-12: value of each one of the SDI-12 bus sensors (12 in total) in mV. They will appear in the format: 4-20mA, 4mA=800mV, and 20mA=4000mV. The number next to EA indicates the sensor number (1 to 12: 1, 2, 3 refer to the first sensor and its VWC, EC, and Temperature parameters, respectively; 4, 5, 6 refer to the second sensor; 7, 8, 9 refer to the third sensor; and 10, 11, 12 refer to the fourth sensor. For AquaCheck-8, 1-8 refer to the VWC of the internal sensors 1 to 8, and 8, 10, 11, 12 are the temperatures of the internal sensors 1, 3, 5, 7).

| Sensor | 5TE Decagon<br>GS3 Decagon<br>Campbell CS650<br>Stevens Hydraprobe-II<br>TEROS-12 | AquaCheck-4[1] | AquaCheck-8[2] |
|---|---|---|---|
| 1 | VWC/ε sensor #1 | VWC sensor #1 | VWC sensor #1 |
| 2 | EC sensor #1 | -- | VWC sensor #2 |
| 3 | Temperature sensor #1 | Temperature sensor #1 | VWC sensor #3 |
| 4 | VWC/ε sensor #2 | VWC sensor #2 | VWC sensor #4 |
| 5 | EC sensor #2 | -- | VWC sensor #5 |
| 6 | Temperature sensor #2 | Temperature sensor #2 | VWC sensor #6 |
| 7 | VWC/ε sensor #3 | VWC sensor #3 | VWC sensor #7 |
| 8 | EC sensor #3 | -- | VWC sensor #8 |
| 9 | Temperature sensor #3 | Temperature sensor #3 | Temperature sensor #1 |
| 10 | VWC/ε sensor #4 | VWC sensor #4 | Temperature sensor #3 |
| 11 | EC sensor #4 | -- | Temperature sensor #5 |
| 12 | Temperature sensor #4 | Temperature sensor #4 | Temperature sensor #7 |

(1): AquaCheck-4 In this case, there is only one physical sensor, and sensors #1 to #4 are the sensors that the physical sensor encases inside, where #1 is the highest and #4 is located in the lowest position. The EC values always appear as 'N-A', because this sensor does not provide measurements for this parameter.

(2): AquaCheck-8 In this case, there is only one physical sensor, and sensors #1 to #8 are the sensors that the physical sensor encases inside, where #1 is the highest and #8 is located in the lowest position.

– Drill&Drop Sentek (Moisture-Temperature, and TriScan): value of each one of the SDI-12 bus sensors (12 in total) in mV. They will appear in the format: 4-20mA, 4mA=800mV, and 20mA=4000mV. The number next to EA indicates the sensor number. The following table shows the relationship between the sensor number and the corresponding parameter according to the established format (2 available formats) and the probe's number of levels:

| Drill & Drop Sentek - Format 0 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 levels | | 6 levels | | 9 levels | | 12 levels | |
| Sensor | Hm-Tmp | TriSCAN | Hm-Tmp | TriSCAN | Hm-Tmp | TriSCAN | Hm-Tmp | TriSCAN |
| 1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-2 |
| 2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-4 |
| 3 | VWC-3 | VWC-3 | VWC-3 | VWC-3 | VWC-3 | VWC-3 | VWC-3 | VWC-6 |
| 4 | TEMP-1 | VIC-1 | VWC-4 | VWC-4 | VWC-4 | VWC-4 | VWC-4 | VWC-8 |
| 5 | TEMP-2 | VIC-2 | VWC-5 | VWC-5 | VWC-5 | VWC-5 | VWC-5 | VWC-10 |
| 6 | TEMP-3 | VIC-3 | VWC-6 | VWC-6 | VWC-6 | VWC-6 | VWC-6 | VWC-12 |
| 7 | | TEMP-1 | TEMP-1 | VIC-1 | VWC-7 | VWC-7 | VWC-7 | VIC-2 |
| 8 | | TEMP-2 | TEMP-2 | VIC-2 | VWC-8 | VWC-8 | VWC-8 | VIC-4 |
| 9 | | TEMP-3 | TEMP-3 | VIC-3 | VWC-9 | VWC-9 | VWC-9 | VIC-6 |
| 10 | | | TEMP-4 | VIC-4 | TEMP-1 | VIC-1 | VWC-10 | VIC-8 |
| 11 | | | TEMP-5 | VIC-5 | TEMP-5 | VIC-5 | VWC-11 | VIC-10 |
| 12 | | | TEMP-6 | VIC-6 | TEMP-9 | VIC-9 | VWC-12 | VIC-12 |

(1): In this case, there is only one physical sensor, and the number that appears next to each parameter refers to the level that the physical sensor encases inside, where #1 is the highest and #12 is located in the lowest

| | Drill & Drop Sentek - Format 1 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 levels | | 6 levels | | 9 levels | | 12 levels | |
| Sensor | Hm-Tmp | TriSCAN | Hm-Tmp | TriSCAN | Hm-Tmp | TriSCAN | Hm-Tmp | TriSCAN |
| 1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-2 | VWC-1 |
| 2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-4 | VWC-3 |
| 3 | VWC-3 | VWC-3 | VWC-3 | VWC-3 | VWC-3 | VWC-3 | VWC-6 | VWC-5 |
| 4 | TEMP-1 | VIC-1 | VWC-4 | VWC-4 | VWC-4 | VWC-4 | VWC-8 | VWC-7 |
| 5 | TEMP-2 | VIC-2 | VWC-5 | VWC-5 | VWC-5 | VWC-5 | VWC-10 | VWC-9 |
| 6 | TEMP-3 | VIC-3 | VWC-6 | VWC-6 | VWC-6 | VWC-6 | VWC-12 | VWC-11 |
| 7 | | TEMP-1 | TEMP-1 | VIC-1 | VWC-7 | VWC-7 | TEMP-2 | VIC-1 |
| 8 | | TEMP-2 | TEMP-2 | VIC-3 | VWC-8 | VWC-8 | TEMP-4 | VIC-3 |
| 9 | | TEMP-3 | TEMP-3 | VIC-6 | VWC-9 | VWC-9 | TEMP-6 | VIC-5 |
| 10 | | | TEMP-4 | TEMP-1 | TEMP-1 | VIC-2 | TEMP-8 | VIC-7 |
| 11 | | | TEMP-5 | TEMP-3 | TEMP-5 | VIC-5 | TEMP-10 | VIC-9 |
| 12 | | | TEMP-6 | TEMP-6 | TEMP-9 | VIC-8 | TEMP-12 | VIC-11 |

(1): In this case, there is only one physical sensor, and the number that appears next to each parameter refers to the level that the physical sensor encases inside, where #1 is the highest and #12 is located in the lowest

| | Drill & Drop Sentek - Format 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 3 levels | | 6 levels | | 9 levels | | 12 levels | |
| Sensor | Hm-Tmp | TriSCAN | Hm-Tmp | TriSCAN | Hm-Tmp | TriSCAN | Hm-Tmp | TriSCAN |
| 1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-1 | VWC-2 | VWC-1 |
| 2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-2 | VWC-4 | VWC-3 |
| 3 | VWC-3 | VWC-3 | VWC-3 | VWC-3 | VWC-3 | VWC-4 | VWC-6 | VWC-5 |
| 4 | TEMP-1 | VIC-1 | VWC-4 | VWC-4 | VWC-4 | VWC-6 | VWC-8 | VWC-7 |
| 5 | TEMP-2 | VIC-2 | VWC-5 | VWC-5 | VWC-5 | VWC-8 | VWC-10 | VWC-9 |
| 6 | TEMP-3 | VIC-3 | VWC-6 | VWC-6 | VWC-6 | VWC-9 | VWC-12 | VWC-11 |
| 7 | | TEMP-1 | TEMP-1 | VIC-2 | VWC-7 | VIC-3 | TEMP-2 | VIC-3 |
| 8 | | TEMP-2 | TEMP-2 | VIC-4 | VWC-8 | VIC-6 | TEMP-4 | VIC-6 |
| 9 | | TEMP-3 | TEMP-3 | VIC-6 | VWC-9 | VIC-9 | TEMP-6 | VIC-9 |
| 10 | | | TEMP-4 | TEMP-2 | TEMP-3 | TEMP-3 | TEMP-8 | TEMP-3 |
| 11 | | | TEMP-5 | TEMP-4 | TEMP-6 | TEMP-6 | TEMP-10 | TEMP-6 |
| 12 | | | TEMP-6 | TEMP-6 | TEMP-9 | TEMP-9 | TEMP-12 | TEMP-9 |

(1): In this case, there is only one physical sensor, and the number that appears next to each parameter refers to the level that the physical sensor encases inside, where #1 is the highest and #12 is located in the lowest

– Apogee NDVI/PRI: PRI value of each pair of sensors in 4-20mA format (4mA=800mV and 20mA=4000mV) and the calibrated value read for each sensor and for each of the 2 possible wavelengths (these are the values used to calculate the NDVI/PRI parameter):

| Sensor | Apogee NDVI/PRI | Type |
|---|---|---|
| 1 | PRI/NDVI Sensor-1 & Sensor-2 | PRI/NDVI |
| 2 | Value-1 (λ low) Sensor-1 | Raw |
| 3 | Value-2 (λ high) Sensor-1 | Raw |
| 4 | Value-1 (λ low) Sensor-2 | Raw |
| 5 | Value-2 (λ high) Sensor-2 | Raw |
| 6 | - | |
| 7 | PRI/NDVI Sensor-3 & Sensor-4 | PRI/NDVI |
| 8 | Value-1 (λ low) Sensor-3 | Raw |
| 9 | Value-2 (λ high) Sensor-3 | Raw |
| 10 | Value-1 (λ low) Sensor-4 | Raw |
| 11 | Value-2 (λ high) Sensor-4 | Raw |
| 12 | - | |

– TEROS-21: value of each of the sensors of the SDI-12 bus (8 in total) in mV. Potential values [kPa] and temperature [° C] will appear. The number next to EA indicates the sensor number (1 to 4):

| Sensor | Teros 21 |
|---|---|
| 1 | Potential sensor #1 |
| 2 | Temperature sensor #1 |
| 3 | -- |
| 4 | Potential sensor #2 |
| 5 | Temperature sensor #2 |
| 6 | -- |
| 7 | Potential sensor #3 |
| 8 | Temperature sensor #3 |
| 9 | -- |
| 10 | Potential sensor #4 |
| 11 | Temperature sensor #4 |
| 12 | -- |

– EnviroPro (Humidity-Conductivity-Temperature): value of each of the sensors on the SDI-12 bus (12 in total) in mV. They will appear in 4-20 mA format, 4mA=800mV and 20mA=4000mV. The number next to EA indicates the sensor number. The following table shows the relationship between the sensor number and the parameter to which is corresponds, according to the established format (2 formats available) and the number of sensor levels:

| EnviroPro - Format 0 | | | |
|---|---|---|---|
| Sensor | 4 levels | 8 levels | 12 levels |
| 1 | VWC-1 | VWC-1 | VWC-1 |
| 2 | VWC-2 | VWC-2 | VWC-2 |
| 3 | VWC-3 | VWC-3 | VWC-3 |
| 4 | VWC-4 | VWC-4 | VWC-4 |
| 5 | EC-1 | VWC-5 | VWC-5 |
| 6 | EC-2 | VWC-6 | VWC-6 |
| 7 | EC-3 | VWC-7 | VWC-7 |
| 8 | EC-4 | VWC-8 | VWC-8 |
| 9 | TEMP-1 | EC-1 | VWC-9 |
| 10 | TEMP-2 | EC-3 | VWC-10 |
| 11 | TEMP-3 | EC-5 | VWC-11 |
| 12 | TEMP-4 | EC-7 | VWC-12 |

| EnviroPro - Format 1 | | | |
|---|---|---|---|
| Sensor | 4 levels | 8 levels | 12 levels |
| 1 | VWC-1 | VWC-1 | VWC-2 |
| 2 | VWC-2 | VWC-2 | VWC-4 |
| 3 | VWC-3 | VWC-4 | VWC-6 |
| 4 | VWC-4 | VWC-6 | VWC-8 |
| 5 | EC-1 | VWC-7 | VWC-10 |
| 6 | EC-2 | VWC-8 | VWC-12 |
| 7 | EC-3 | EC-2 | EC-3 |
| 8 | EC-4 | EC-4 | EC-6 |
| 9 | TEMP-1 | EC-6 | EC-9 |
| 10 | TEMP-2 | EC-8 | EC-12 |
| 11 | TEMP-3 | TEMP-2 | TEMP-3 |
| 12 | TEMP-4 | TEMP-8 | TEMP-12 |

• Vsen  value of the voltage in mV supplied to the SDI-12 bus sensors.

Below is an example of the screens you can see:

```
AgroBee-L 02  SDI-12
EA1: 963      EA2: 1258
EA3: 963      EA4: 1258
EA5: 963      EA6: 1258
Vsen: 5125
ED:  1
```

If you press the '1' key again, you will see the remaining SDI-12 sensors:

```
AgroBee-L 02  SDI-12
EA7: 963      EA8: 1258
EA9: 963      EA10: 1258
EA11: 963     EA12: 1258
```

The following parameters are in the Communication Parameters menu of the Module Reader, which allow you to establish the communication of a certain AgroBee-L module with a controller:

- **Module** Module number in the network. It is used to distinguish all modules that may be associated with an Agrónic. The module number cannot be repeated in the same Agrónic:
  - 1 to 20 (timing in normal mode)
  - 1 to 10 (timing in priority mode)
- **Band** Frequency Band:
  - 868MHz or 915MHz (default value, depending on the model)
  - 433MHz (only available in models that also support 868MHz band)
- **Channel** Frequency channel number:
  - 1 to 13 (independent from the band used)
- **TX Mode** Transmission method. Set the radio's transmission and reception parameters.
  - 1 to 18 (mode 5 set by default):
    - · Mode 1: The shortest coverage length permitting the lowest lag time
    - · Mode 18: The greatest coverage length, but with the most lag time
- **Timing** 2 timing modes:
  - Normal mode (recommended): It is automatically set according to the chosen transmission mode, but always includes the communication of up to 20 modules. Value between 60" and 200".
  - Priority mode: It is automatically set according to the chosen transmission mode and includes the communication of up to 10 modules. Value between 30" and 100".
- **Network code** It differentiates the information from several controllers with the same communication parameters (band, channel, and transmission mode). The Agrónic serial number is assigned by default.

To modify any of the sub-menu's fields, press ↵ . The screen will display that you are in edit mode. Use the ─ and ＋ keys to set the desired value. Confirm with ↵ or dismiss with C/C Press C/C to exit the menu and access the previous hierarchy's menu, which will change the parameters and let them take effect.

| | |
|---|---|
| For an AgroBee-L module to establish communication with a certain Agrónic, you must set, through the reader, the parameters that have just been described, according to those established in the Agrónic in question. In the Agrónic, you can modify these parameters in 'Parameters \| Installer \| Communications \| AgroBee \| Coordinator': | AgroBee-L<br>Channel: 01<br>Network code: 00001<br>Timing: standard<br>Band: 868MHz<br>TX Mode: 05 |

In the Input-Output Parameters menu of the Module Reader, you can set the parameters of the AgroBee-L module's different inputs and outputs, available through the following sub-menu:

- Digital Inputs Configuration of digital sensors or counters.
    - Configuration of functions of each of the available digital inputs:
        · Digital input
        · Counter
    - Anti-bounce filter: (default 300 ms) only applicable when digital input is setup as counter. A filter time between 0.0" and 10.0" can be fixed, and it represents the minimum time that a contact must be closed to count a new pulse. Same time is considered for all the inputs of the module. This filter time can only be setup by using the Module Reader (it cannot be setup from the programmer to which this module is linked).
- SDI Addr. Allows you to change the SDI-12 address of a specific sensor. To change this parameter, it is essential that only one sensor is connected to the device. The type of connected sensor must also be specified: Press ⏎ to read the current address and, when it appears, change it with the – and + keys. Press ⏎ again to make the change. Exit this menu using the c/c key.
- Sensors Configuration of analog SDI-12 bus sensors:
    - S1: Active/Not Active (In the case of the AquaCheck and Sentek Drill&Drop probes, this is the only one that applies, as, in this case, there can only be 1 physical sensor).
    - S2: Active / Not Active
    - S3: Active / Not Active
    - S4: Active / Not Active
    - Sensor type: 5TE-Decagon, GS3-Decagon, TEROS-12, CS650, Hydraprobe-II, AquaCheck, AquaCheck-8, Drill&Drop Humedad-Temperatura, Drill&Drop TriScan, NDVI-PRI.
    - Type of soil: The different soil possibilities according to the type of sensor are shown in the following table (not applicable for NDVI-PRI or for TEROS-21):

| Table on the selection of terrain according to sensor | | | | | | |
|---|---|---|---|---|---|---|
| Sensor | Terrain | | | | | |
| | Mineral | Mulch | Mineralwool | Perlite | Peat | Coconut |
| Decagon 5TE | X | X | X | X | | |
| Decagon GS3 | X | | X | | X | X |
| TEROS-12 | X | | | | X | |
| Campbell CS650 | X | | | | | |
| Stevens Hydraprobe-II | X[1] | | | | | |
| Sentek Drill&Drop (Hum-Temp, TriScan) | X | | | | | |
| EnviroPro | X | | | | | |

(1) The sensor lets you select the type of terrain. This can be ordered from the sensor manufacturer or changed according to the procedure indicated in the sensor manual, since the AgroBee SDI-12 module does not offer this possibility for this sensor.

| Table on the selection of terrain according to sensor | | | | | | |
|---|---|---|---|---|---|---|
| Sensor | Terrain | | | | | |
| | Mineral | Sand | Clay | Mud/Loam | Loam | Clay/Loam |
| AquaCheck-4/-8 | X | X | X | X | X | X |

– Reading rate: 5min (default), 10min, 20min
– Reading format:
  · Sensors 5TE, GS3 from Decagon, and TEROS-12 from Meter Group: refers to the format in which each of the 3 parameters of each sensor are delivered):
    - Format 0 (Agronomic):
      » Value-1: VWC [%]
      » Value-2: EC soil solution/pore water [dS/m=mS/cm]
      » Value-3: Temperature [ºC]
    - Format 1 (raw values):
      » Value-1: Dielectric medium constant $\varepsilon$[]
      » Value-2: EC bulk [dS/m=mS/cm]
      » Value-3: Temperature [ºC]
    - Format 2 (raw values):
      » Value-1: VWC [%]
      » Value-2: EC saturation [dS/m=mS/cm]
      » Value-3: Temperature [ºC]

· Sentek Drill&Drop sensors Mo-Temp and TriScan and EnviroPro sensors: refers to the type of data that will be delivered to the associated controller through the 12 available sensor positions (see format tables in the section, 'View Digital/SDI-12 Inputs of an AgroBee-L module'):
   - Format 0
   - Format 1

- Apparent density Sensor-1, Sensor-2, Sensor-3, Sensor-4. Applicable only to the 5TE, GS3 Decagon and TEROS-12 sensors when the format of readings is Format-2 (EC given in saturation). The apparent density of the medium must be a value equal to or greater than 0 and less than 2.65.
- Probe Levels: Only applicable to Sentek Drill&Drop Mo-Temp and TriScan sensors. You can choose between 3, 6, 9 and 12 levels.

*IMPORTANT*

An SDI-12 sensor must have an address that differentiates it from the rest. When more than one sensor is connected, sensor #1 should have address 1, sensor #2 should have address 2, sensor #3 should have address 3, and sensor #4 should have address 4.

When there is a single physical sensor connected to an AgroBee-L SDI-12 module, this one's address does not matter: this will always be the case for AquaCheck and Sentek Drill&Drop sensors, since only a physical sensor of this type can be connected to an AgroBee-L SDI-12 module.

For the Apogee NDVI/PRI: A minimum of 2 sensors must always be connected and activated, and must be configured as follows:
- PRI/NDVI # 1 (uses sensor-1 and sensor-2):
   – Sensor-1 must have address 1 and must be hemispherical (pointing up)
   – Sensor-2 must have address 2 and must be field-stop (pointing toward the plant)
- PRI/NDVI # 2 (uses sensor-3 and sensor-4):
   – Sensor-3 must have address 3 and must be hemispherical (pointing up)
   – Sensor-4 must have address 4 and must be field-stop (pointing towards the plant)

**NOTE** When Sistemes Electrònics Progrés does not supply the chosen sensor, it is the responsibility of the client to acquire the sensors with the proper addresses according to what is established in the previous point.

To modify any of the parameters' fields, press ⏎ . The screen indicates that you are in edit mode. Use the − and + keys to set the desired value. Confirm with ⏎ or dismiss with C/c Press C/c to exit the menu and access the previous hierarchy's menu, which will cause the changed parameters to take effect.

The detailed input/output parameters can also be entered in the Agrónic. In this case, the module will receive the parameters upon communicating with it. If not, and these parameters have been changed through the Module Reader in the same module, the Agrónic will receive and update said parameters.

To modify these parameters from the Agrónic, you must access "Parameters – Installer - Communications – AgroBee – Module". Specify the module number in the Agrónic network in question, after which you will see the following screens to modify the detailed parameters (see the Agrónic manual in question for more details):

> AgroBee-L 01
> Sensor: [5TE Decagon]….[AquaCheck-8]
> Terrain: [Mineral][Mulch]…
> Timing: 5'
> S1:[yes/no]     S2:[yes/no]     S3:[yes/no]
> S4:[yes/no]

In the case of Sentek's AquaCheck and Drill&Drop sensors, only the possibility of activating the first sensor will appear in the last row, since there can physically only be a single sensor connected to the module.

> AgroBee-L 01
> Format: [0] [1]
> Probe levels: [0][1][2]

The following screen will only be displayed when the sensor is 5TE Decagon, GS3 Decagon or TEROS-12:

> AgroBee-L 01
> Format: [0][1][2]
> S1 Density: 1.22
> S2 Density: 1.23
> S3 Density: 0.25
> S4 Density: 1.42

## FORMATS OF THE SDI-12 MODULE SENSORS

The possibility of selecting one or another type of terrain is determined by the sensor manufacturer itself. Being able to make this selection allows the SDI-12 module to perform one process or the other with the sensor readings, as recommended by the manufacturer:

Decagon 5TE    In addition to the temperature value [°C] and EC [mS/cm], the sensor gives you the value of the permissiveness of the medium ε, which the SDI-12 module transforms into VWC [%] (Volumetric Water Content) with the following expression:

VWC [%] = $g\sqrt{\varepsilon}$ + f$\varepsilon$ 5+e$\varepsilon$ 4+d$\varepsilon$ 3+c$\varepsilon$ 2+b$\varepsilon$ +a , and according to the type of terrain:

i.Mineral:

a = -5.03E-2

b = +2.92E-2

c = -5.50E-4

d = +4.30E-6

e = 0

f = 0

g = 0

ii.Mulch:

a = -2.47E-1

b = +7.24E-2

c = -2.06E-3

d = +2.25E-5

e = 0

f = 0

g = 0

iii.Mineral wool:

a = +2.66E-2

b = +6.56E-2

c = -1.68E-3

d = 0

e = 0

f = 0

g = 0

iv.Perlite:

a = -2.4161E-1

b = -8.2297E-3

c = 0

d = 0

e = 0

f = 0

g = +2.1189E-1

For this type of sensor, it is possible to configure the method by which the 3 parameters provided by the sensor are sent to the controller (see sensor settings):

– Format 0: VWC[%], EC_pore water [mS/cm], Temp[°C]

– Format 1: ε, EC_bulk [mS/cm], Temp [°C]

– Format 2: VWC[%], EC_saturation [mS/cm], Temp[°C]

Regardless of the data format chosen, the values read from the three magnitudes are converted, by the module itself, to the standard 4-20 mA (800-4000 mV) format, so you must select the suitable data format in the controller in question according to the type of sensor and type of terrain selected. In the case of the Agrónic, the controller itself already selects the most suitable format when registering a sensor corresponding to an SDI-12 module. It is the user's responsibility to change the data that characterize this format. In the case of a 5TE sensor connected to the SDI-12 module:

| Parameter | 5TE format sensors | | | |
|---|---|---|---|---|
| | Default value | | | |
| | Value 1 | Value 2 | Value 3 | |
| | ε [ ] | VWC [%] | EC [mS/cm] | Temperature [°C] |
| No. of integers | 2 | 3 | 2 | 2 |
| No. of decimals | 1 | 1 | 2 | 1 |
| Sign | No | No | No | Yes |
| Units | - | % | mS/cm | °C |
| Calibration Point 1 | | | | |
| Actual Value | 800 mV | 800 mV | 800 mV | 800 mV |
| Logical value | 01,0 | 000,0 % | 00,00 mS/cm | -40.0 °C |
| Calibration Point 2 | | | | |
| Actual Value | 4000 mV | 4000 mV | 4000 mV | 4000 mV |
| Logical value | 80,0 | 100,0 % | 23,00 mS/cm | +50.0 °C |

**Decagon GS3**  In addition to the temperature value [°C] and EC [µS/cm], the sensor gives you the value of the permissiveness of the medium ε, which the SDI-12 module transforms into VWC [%] (Volumetric Water Content) with the following expression:

VWC [%] = $g\sqrt{\varepsilon} + f\varepsilon^5 + e\varepsilon^4 + d\varepsilon^3 + c\varepsilon^2 + b\varepsilon + a$ , and according to the type of terrain:

| i. Mineral: | ii. Mineral wool: | iii. Peat: | iv. Coconut fibre: |
|---|---|---|---|
| a = -7.53E-2 | a = +2.04E-1 | a = -1.17E-1 | a = +9.91E-2 |
| b = +3.67E-2 | b = +1.63E-2 | b = 0 | b = +2.32E-2 |
| c = -7.62E-4 | c = -8.85E-5 | c = 0 | c = -1.63E-4 |
| d = +5.89E-6 | d = 0 | d = 0 | d = 0 |
| e = 0 | e = 0 | e = 0 | e = 0 |
| f = 0 | f = 0 | f = 0 | f = 0 |
| g = 0 | g = 0 | g = +1.18E-1 | g = 0 |

Like in the previous case, for this type of sensor, it is possible to configure the method by which the 3 parameters provided by the sensor are sent to the controller (see sensor settings):

– Format 0: VWC[%], EC_pore water [mS/cm], Temp[°C]
– Format 1: ε, EC_bulk [mS/cm], Temp [°C]
– Format 2: VWC[%], EC_saturation [mS/cm], Temp[°C]

Regardless of the chosen data format, the read values of the three magnitudes are converted, by the module itself, to the standard 4-20 mA (800-4000 mV) format, so, you have to select the ideal data format in the controller in question according to the type of sensor and type of terrain selected. In the case of the Agrónic, the controller itself already selects the most suitable format when registering a sensor corresponding to an SDI-12 module. It is the user's responsibility to change the data that characterize this format. In the case of a GS3 sensor connected to the SDI-12 module:

| *GS3 format sensors* | | | |
|---|---|---|---|
| | Default value | | |
| Parameter | Value 1 | Value 2 | Value 3 |
| | ε [ ]    VWC [%] | EC [mS/cm] | Temperature [°C] |
| No. of integers | 2    3 | 2 | 2 |
| No. of decimals | 1    1 | 2 | 1 |
| Sign | no    no | no | Yes |
| Units | -    % | mS/cm | °C |
| Calibration Point 1 | | | |
| Actual Value | 800 mV    800 mV | 800 mV | 800 mV |
| Logical value | 01,0    000,0 % | 00,00 mS/cm | -40.0 °C |
| Calibration Point 2 | | | |
| Actual Value | 4000 mV    4000 mV | 4000 mV | 4000 mV |
| Logical value | 80,0    100,0 % | 23,00 mS/cm | +50.0 °C |

**Meter-Group TEROS-12** Replaces Decagon's 5TE and GS3 models. In addition to the temperature value [°C] and EC [µS/cm] (the AgroBee-L module changes the reading to [mS/cm]=[dS/m]), the sensor gives you a RAW value, which the SDI-12 module transforms into VWC [%] (Volumetric Water Content) with the following expression:

VWC [%] = a*RAW3 + b*RAW2 + c*RAW + d, and according to the type of terrain:

| i.Mineral: | ii.Peat: |
|---|---|
| a = 0 | a = +6.771E-10 |
| b = 0 | b = -5.105E-6 |
| c = +3.879E-4 | c = +1.302E-2 |
| d = -0.6956 | d = -10.848 |

Like in the previous case, for this type of sensor, it is possible to configure the method by which the 3 parameters provided by the sensor are sent to the controller (see sensor settings):
– Format 0: VWC[%], EC_pore water [mS/cm], Temp[°C]
– Format 1: ε, EC_bulk [mS/cm], Temp [°C]
– Format 2: VWC[%], EC_saturation [mS/cm], Temp[°C]

Regardless of the data format chosen, the values read from the three magnitudes are converted, by the module itself, to the standard 4-20 mA (800-4000 mV) format, so you must select the suitable data format in the controller in question according to the type of sensor and type of terrain selected. In the case of the Agrónic, the controller itself already selects the most suitable format when registering a sensor corresponding to an SDI-12 module. It is the user's responsibility to change the data that characterize this format. In the case of a TEROS-12 sensor connected to the SDI-12 module:

| Parameter | TEROS-12 format sensors | | | |
|---|---|---|---|---|
| | Default value | | | |
| | Value 1 | | Value 2 | Value 3 |
| | ε [ ] | VWC [%] | EC [mS/cm] | Temperature [°C] |
| No. of integers | 2 | 3 | 2 | 2 |
| No. of decimals | 1 | 1 | 2 | 1 |
| Sign | no | no | no | Yes |
| Units | - | % | mS/cm | °C |
| Calibration Point 1 | | | | |
| Actual Value | 800 mV | 800 mV | 800 mV | 800 mV |
| Logical value | 01,0 | 000,0 % | 00,00 mS/cm | -40.0 °C |
| Calibration Point 2 | | | | |
| Actual Value | 4000 mV | 4000 mV | 4000 mV | 4000 mV |
| Logical value | 80,0 | 100,0 % | 23,00 mS/cm | +60.0 °C |

In addition to the temperature value [°C] and EC [mS/cm], the sensor directly gives you the value of VWC [%] (Volumetric Water Content). The sensor itself uses the following Topp equation to calculate the VWC:

VWC [%] = $-5.3*10-2+2.92*10-2Ka-5.5*10-4Ka2+4.3*10-6Ka3$, where Ka is the average dielectric constant.

In the case of a CS650 sensor connected to the SDI-12 module:

| Parameter | CS650 format sensors | | |
|---|---|---|---|
| | Default value | | |
| | Value 1 | Value 2 | Value 3 |
| | VWC [%] | EC [mS/cm] | Temperature [°C] |
| No. of integers | 2 | 1 | 2 |
| No. of decimals | 1 | 2 | 1 |
| Sign | no | no | Yes |
| Units | % | mS/cm | °C |
| Calibration Point 1 | | | |
| Actual Value | 800 mV | 800 mV | 800 mV |
| Logical value | 5,0 % | 00,00 mS/cm | -10,0 °C |
| Calibration Point 2 | | | |
| Actual Value | 4000 mV | 4000 mV | 4000 mV |
| Logical value | 50,0 % | 8,00 mS/cm | +70,0 °C |

This equation is valid for any type of mineral terrain.

The values read from the three magnitudes are converted, by the module itself, to the standard 4-20 mA (800-4000 mV) format, so you must select the suitable data format in the controller in question according to the type of sensor and type of terrain selected. In the case of the Agrónic, the controller itself already selects the most suitable format when registering a sensor corresponding to an SDI-12 module. It is the user's responsibility to change the data that characterize this format.

Stevens Hydraprobe-II   Important: For this sensor, the AgroBee-L SDI-12 module only delivers the first three values obtained through the default SDI-12 command "aM!", that is, the temperature value [°C], EC [mS/cm], and the value of VWC [%] (Volumetric Water Content).

The calculated value of the VWC is valid for any clay-type terrain. If you want to configure the sensor according to another type of terrain, it must be configured before being connected to the AgroBee SDI-12 module through the appropriate tool (see the sensor manual) or order it from the factory, as the AgroBee-L module does not allow you to select the type of terrain for this sensor.

The values read from the three magnitudes are converted, by the module itself, to the standard 4-20 mA (800-4000 mV) format, so you must select the suitable data format in the controller in question according to the type of sensor and type of terrain selected. In the case of the Agrónic, the controller itself already selects the most suitable format when registering a sensor corresponding to an SDI-12 module. It is the user's responsibility to change the data that characterize this format. In the case of a Hydraprobe-II sensor connected to the SDI-12 module:

| Hydraprobe-II format sensor | | | |
|---|---|---|---|
| | Default value | | |
| Parameter | Value 1 | Value 2 | Value 3 |
| | VWC [%] | EC [mS/cm] | Temperature [°C] |
| No. of integers | 3 | 1 | 2 |
| No. of decimals | 1 | 2 | 1 |
| Sign | no | no | Yes |
| Units | % | S/m | °C |
| Calibration Point 1 | | | |
| Actual Value | 800 mV | 800 mV | 800 mV |
| Logical value | 000,0 % | 0,01 S/m | -10,0 °C |
| Calibration Point 2 | | | |
| Actual Value | 4000 mV | 4000 mV | 4000 mV |
| Logical value | 100,0 % | 1,50 S/m | +55,0 °C |

AquaCheck-4 / AquaCheck-8  This sensor delivers a value between 0 and 100, which represents the VWC (Volumetric Water Content). In order to obtain the desired VWC value, the relevant equation must be applied according to the type of terrain, which is already done internally by the AgroBee-L module:

i. Mineral:
VWC[%] = -7.4347 + 0.5564*(SF-reading)

ii. Sand:
VWC[%] = -8.6463 + 0.5219*(SF-reading)

iii. Clay:
VWC[%] = -5.9575 + 0.6193*(SF-reading)

iv. Mud-Loam:
VWC[%] = -2.7900 + 0.4392*(SF-reading)

v. Loam:
VWC[%] = +4.8372 + 0.4851*(SF-reading)

vi. Clay-Loam:
VWC[%] = -8.4439 + 0.5650*(SF-reading)

, where the "SF-reading" is the value that the sensor directly delivers.

In the case of AquaCheck-4, temperature values are also provided for each one of the bi-sensors that the sensor integrates. In the case of AquaCheck-8, only the temperatures of the sensors 1, 3, 5, 7 are delivered.

The obtained values of temperature [°C] and VWC [%] are converted by the module itself to the standard 4-20 mA (800-4000 mV) format, so, in the controller in question,

you have to select the ideal data format according to the type of sensor and type of terrain selected. In the case of the Agrónic, the controller itself already selects the most suitable format when registering a sensor corresponding to an SDI-12 module. It is the user's responsibility to change the data that characterize this format. In the case of a AquaCheck-4/-8 sensor connected to the SDI-12 module:

| AquaCheck format sensor | | | |
|---|---|---|---|
| | Default value | | |
| Parameter | Value 1 | Value 2 | Value 3 |
| | VWC [%] | EC [mS/cm] | Temperature [°C] |
| No. of integers | 3 | - | 2 |
| No. of decimals | 1 | - | 1 |
| Sign | no | - | Yes |
| Units | % | - | °C |
| Calibration Point 1 | | | |
| Actual Value | 800 mV | - | 800 mV |
| Logical value | 000,0 % | - | -40,0 °C |
| Calibration Point 2 | | | |
| Actual Value | 4000 mV | - | 4000 mV |
| Logical value | 100,0 % | - | +50,0 °C |

Sentek Drill& Drop Moisture-Temperature / Sentek Drill&Drop TriScan  This sensor delivers the VWC (Volumetric Water Content), the volumetric ion content (VIC, only for TriScan) and temperature.

The temperature values obtained [°C], VIC[] and VWC [%] are converted, by the module itself, to the standard 4-20 mA (800-4000 mV) format, so you must select the suitable data format in the controller in question according to the type of sensor selected. In the case of the Agrónic, the controller itself already selects the most suitable format when registering a sensor corresponding to an SDI-12 module. It is the user's responsibility to change the data that characterize this format. In the case of a Drill&Drop sensor connected to the SDI-12 module:

| Drill&Drop format sensor | | | |
|---|---|---|---|
| | Default value | | |
| Parameter | Value 1 | Value 2 | Value 3 |
| | VWC [%] | VIC [](1) | Temperature [°C] |
| No. of integers | 3 | 5 | 2 |
| No. of decimals | 1 | 0 | 1 |
| Sign | no | No | Yes |
| Units | % | - | °C |
| Calibration Point 1 | | | |
| Actual Value | 800 mV | 800 mV | 800 mV |
| Logical value | 000,0 % | 0 | -20,0 °C |
| Calibration Point 2 | | | |
| Actual Value | 4000 mV | 4000 mV | 4000 mV |
| Logical value | 100,0 % | 10000 | +60,0 °C |

(1): VIC (Volumetric Ion Content): Only available in the TriScan model

**Apogee NDVI/PRI** These sensors should be installed in pairs: hemispheric sensor (pointing up) and field-stop sensor (pointing towards the plant). The value of PRI/NDVI is calculated based on the measurements of both sensors, and the module itself delivers the processed PRI/NDVI value to the programmer (type PRI/NDVI). The 2 measured values are also delivered directly to each of the sensors (Raw type).

| Apogee format sensor | | | |
|---|---|---|---|
| | Default value | | |
| Parameter | Value 1 | | Value 2 |
| | PRI | NDVI | Raw |
| No. of integers | 1 | 1 | 1 |
| No. of decimals | 3 | 3 | 3 |
| Sign | Yes | Yes | Yes |
| Units | - | - | - |
| Calibration Point 1 | | | |
| Actual Value | 800 mV | 800 mV | 800 mV |
| Logical value | -1,000 | +1,000 | -2,000 |
| Calibration Point 2 | | | |
| Actual Value | 4000 mV | 4000 mV | 4000 mV |
| Logical value | +1,000 | -1,000 | +2,000 |

This sensor delivers the Agual Potential in Soil (kPa) and soil temperature [ºC].

The values obtained from temperature [° C], and Potential [%] are converted, by the module itself, to standard 4-20 mA (800-4000 mV) format, so that in the programmer in question the format must be selected of suitable data according to the type of sensor selected. In the case of Agrónic, the programmer himself already selects the most appropriate format when registering a sensor corresponding to an SDI-12 module. It is the responsibility of the user to change the data that characterizes said format. In the case of a TEROS-21 sensor connected to the SDI-12 module

| Sensor Format Teros-21 | | |
|---|---|---|
| | Default Value | |
| Parameter | Value 1 | Value 2 |
| | Potential [kPa] | Temperature [°C] |
| No. of integers | 4 | 2 |
| No. of decimals | 1 | 1 |
| Sign | Si | Si |
| Units | kPa | - |
| Calibration point 1 | | |
| Real Value | 800 mV | 800 mV |
| Logical Value | -9.0 | -40,0 |
| Calibration point 2 | | |
| Real Value | 4000 mV | 4000 mV |
| Logical Value | -2000,0 | +50,0 |

**EnviroPro**   This sensor provides the soil water content index (VWC), Electrical Conductivity (EC) and temperature.

The values obtained for temperature[°C], EC[dS/m] and VWC [%] are converted, by the module itself, to the standard format 4-20 mA (800-4000 mV), so that in the controller in question, you must select the ideal data format according to the type of sensor selected. In the case of the Agrónics, the controller himself already selects the most appropriate format when registering a sensor corresponding to an SDI-12 module. It is the responsability of the user to change the data that characterizes said format. For the case of an EnviroPro sensor connected to the SDI-12 module.

| Parameter | EnviroPro format sensor | | |
|---|---|---|---|
| | Default value | | |
| | Value 1 | Value 2 | Value 3 |
| | VWC [%] | EC []<sup>(1)</sup> | Temperature [°C] |
| No. of integers | 2 | 1 | 2 |
| No. of decimals | 1 | 2 | 1 |
| Sign | No | No | Yes |
| Units | % | dS/m | °C |
| Calibration Point 1 | | | |
|     Actual Value | 800 mV | 800 mV | 800 mV |
|     Logical Value | 000,0 % | 0,00 dS/m | -20,0 °C |
| Calibration Point 2 | | | |
|     Actual Value | 4000 mV | 4000 mV | 4000 mV |
|     Logical Value | 100,0 % | 6,00 dS/m | +60,0 °C |

(1): The format of the unit EC is dS/m or also mS/cm.

## VARIOUS PARAMETERS OF AN AGROBEE-L MODULE

In the Various Parameters menu of the Module Reader, you can select the language among Spanish, Catalan, English, French, Italian, and Portuguese.

From this menu, you can also can completely erase the module's data, restoring it to factory settings, maintaining the serial number and the model.

# Battery levels and radio signal/quality

You have already seen how to consult the different parameters of an AgroBee-L module through the Module Reader. In the Agronic to which the AgroBee-L module is associated, it also shows the battery information and radio link performance of said module.

Consultation ⟶ Communications ⟶ AgroBee-L ⟶
(down and up arrow to go through the different modules)
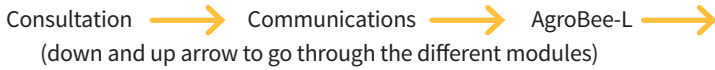
The information provided is:
- Module number, serial number, and firmware version
- Signal level received by the Agrónic and the module. It is displayed in % and indicates the level of the signal-to-noise ratio.
- Advisable/recommended value > 40%
- Vbat: Battery level in mV:
    - Module with panel + supercapacitors: VBat max = 3.4 V; VBat min = 2.2 V.
- VSol: Voltage level delivered by the solar panel.

# Estimated battery life

| Battery life with standard communication rate mode 5: 60 seconds | |
|---|---|
| Type | SDI-12 |
| Panel + Supercapacitors[1] | < 3 days |

(1): The duration of the battery with its maximum charge and without recharging. This case can occur when the solar panel does not recharge the battery (with clouds or fog).

Battery life is approximate since there are several factors that can affect consumption. Frequent reading of digital sensors (when counters are configured) shortens the duration. Likewise, if a priority mode rate is set, the battery life will decrease.

Conversely, for the SDI-12 model, if a higher sensor reading rate is selected, the battery life will increase.

Battery replacement you do not need to replace any battery in any case, since the power supply of the modules is based on a system of supercapacitors.

## TURNING OFF THE CONTROLLER

If a module does not find the Agronic with which it communicates, said module will follow its own course, and will send data every certain time, according to the established timing. However, in order to avoid possible collisions and/or interferences, the module will slightly offset the pre-established communication time. The consumption of an AgroBee-L module is practically unchanged due to the fact that it is not connected to any Agrónic.

## Updating the AgroBee-L module software

Whenever there is a new software version for an AgroBee-L module, the user can update it. To do this, you must perform the following steps:

- Have a computer with an Internet connection and a USB to miniUSB cable.
- Download the program "AgronicUpg" + "drivers" + update file (dfu) by typing this address bit.ly/actualizaragronic into the computer's browser.
- Select and download the AgroBee-L folder.
- Go to the module and turn it off using the switch.
- Place the other switch inside the module in the recording position (by default, it is in the 'Normal' position).
- Connect the USB to the computer and the miniUSB to the module.
- Start up the module using the ON/OFF switch.
- On the computer, run the program "AgronicUpg". If you do not see the "Internal Flash" line on the screen as seen in the image, you must install the drivers. If you already have the drivers installed, skip to the next step.
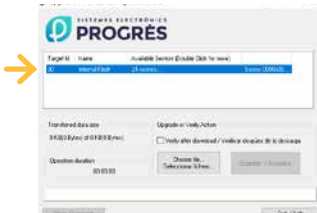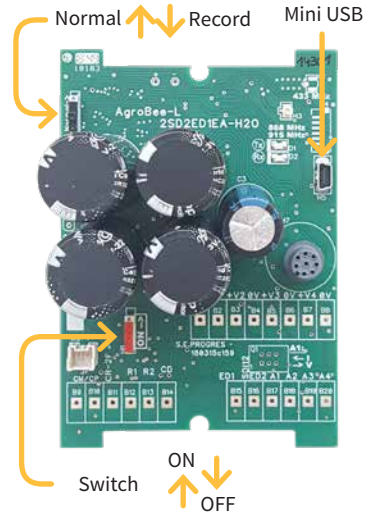


- To install the drivers, go to the files you have downloaded and select the folder that corresponds to your Windows version. Run the file "dpinst_" and follow the steps. If you use Windows XP, call Progrés to help you with the installation.
- Press the "Choose file" button and select the file "xxx.dfu". Once loaded, press the "Update" button and wait for the process to finish.
- Once the process is finished, the module is updated.
- To finish, turn off the module, disconnect the miniUSB cable, and place the second switch in the 'Normal' position.
- Finally, the module can be started up again.

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