VIRRIB

User guide *rev. 1.02*

Soil Moisture Sensor

FIEDLER
ELECTRONICS FOR ECOLOGY

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1. Basic characteristics

It is currently produced in a single narrow variant, with a length of the measuring element 20 cm (28 cm total) and a width of 7,5 cm (9,5 cm total). The measured volume of the substrate is approximately
7–10 liters. The shape of the sensor can be seen in the picture.

Image 1: The VIRRIB sensor

In agriculture, the VIRRIB sensor is used for stationary measurement of volumetric moisture in the soil , but after recalibration it can also be used to measure the volumetric moisture of various other substrates (grain etc.).

The measurement is virtually independent of soil type and chemical composition within a certain range. The response of the sensor to changes in moisture content is instantaneous, which is its main advantage over other sensors used for the same purpose, such as gypsum blocks, etc. Also, the long-term stability of the parameters is better due to the principle of operation and the materials used, which are not subject to changes in a humid environment.

2. Technical parameters

The sensor consists of single metal loop and a central stainless-steel rod, all of which are connected to the sensor body where the electronics are housed. The electronics are mechanically fixed to the measuring elements with a resin compound which also prevents the penetration of water to the electronics. For this reason, the sensor is not repairable.

Basic technical parameters:

Sensor type	VIRRIB LP
Power supply (V)	5.5–18
Consumption (mA)	10–15
Output (mA)	0.2–5
Measurement range (soil moisture, % by volume)	5–50

The cable from the sensor in the standard version is not terminated with any connector. The individual cable cores are designated in the following fashion:

GND	yellow-green
signal output	blue
power	brown

At the customer's request and for an additional charge, the sensors can be equipped with a special waterproof connector.

3. Data collection

The VIRRIB sensors are compatible with most FIEDLER dataloggers and telemetry units. For irrigation control we recommend the H3 and H7 telemetry and control units or for simple use cases our H520 and H531 units. For data collection only, our data loggers STELLA or MINILOG are a great solution.

Image 2: Visualization of collected data

4. Typical use cases

VIRRIB sensors are most commonly used for direct continuous monitoring of soil moisture content at a pre-selected static site. Readings can be taken by using any recording device (datalogger) that has a 0,2–5 mA current input. When connected to an automatic recording device, we do not recommend continuously supplying power to the sensors; in practice, power is usually supplied to the sensors 2 seconds before taking the actual measurement. With continuous power supply, electrochemical processes occur that can corrode the structure of the measuring electrodes and thus shorten the lifetime of the sensors. FIEDLER telemetry stations are particularly suitable for use with the VIRRIB sensors. In addition, the sensors can be used in a system with a master unit that controls the valves of the irrigation system based on the soil moisture content.

Main areas of application:

- Irrigation control.
- Scientific experiments and research.
- Monitoring of moisture conditions in various locations and habitats.

5. Sensor placement

In general, VIRRIB sensors are placed in each individually controllable irrigation section or for every 15 hectares of land. The optimal location is chosen to be typical of the soil types prevailing on the plot.

In sloping terrain, the sensor should be placed in the upper or middle third of the slope, as these areas usually have average humidity conditions. Locations at the top of slopes tend to represent the driest conditions on the property, while wet locations at the bottom of a hill or valley are not well suited for soil moisture monitoring for the purposes of irrigation control.

When irrigating crops grown in rows on a sloping terrain, one sensor is placed one-third from the bottom and another one-third from the top of the slope.

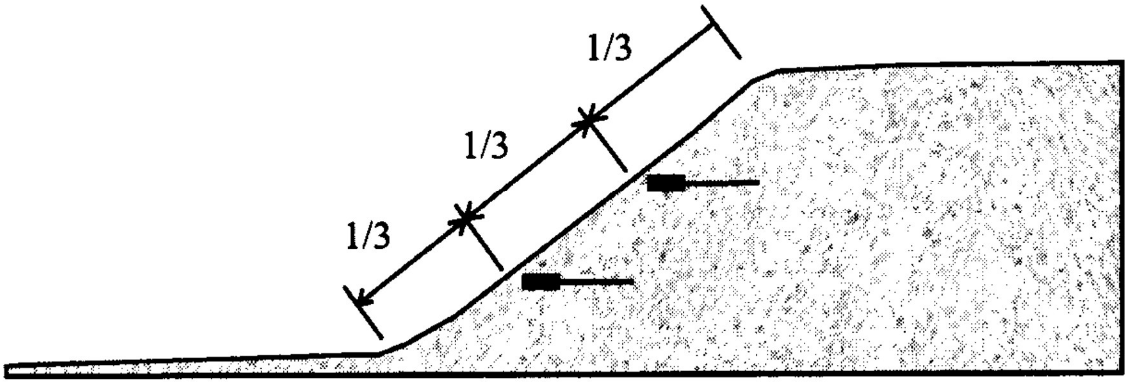

Image 3: Sensor placement in sloping terrain

When placing sensors, it is advisable to take soil samples from the intended measurement site and compare them with the surrounding terrain – this will ensure that the site under consideration is truly representative of the wider surrounding environment. In particular, it is advisable to compare the soil type, moisture and texture, and if necessary, the thickness of the different soil layers and their subsoil.

5.1. Installation in crop rows

When irrigating crops grown in rows, place the VIRRIB sensor directly under the crops or up to 15 cm away from the plants at most. It is not recommended to place the sensor at the edges of the rows or in between the rows, as there are few active roots in those locations and thus the measurement would not be useful for controlling irrigation. Installing the sensors before planting is optimal, as there is no disturbance to the plants while they are being grown and no changes in the distribution of the supplied nutrients. If the sensor has to be installed after planting, it is advisable to choose a location where the roots will soon re-establish a homogeneous environment.

5.2. Installation in orchards

New fruit tree plantings:

The sensor needs to be placed in the areas where the root system development is fastest. Therefore, it is usually placed 30 cm from the trunk of the tree and at a depth of 15 cm. Three years after planting, when the tree has grown in volume, the sensor should be relocated according to the guidelines in the next section.

Established orchards:

Once the trees are producing fruit, the sensor is placed one-third to one-half of the distance between the trunk and the circumference of the crown. This location is usually representative of the total irrigation applied to the orchard section. The roots will grow back into the sensor area in approximately 30 days, after which time the sensor readings will reflect the moisture conditions in the wider area around the sensor. Once the root system has returned to its original state, the sensor becomes an integral part of the soil and the measured soil-plant relationships correspond to reality. Given the shape and relatively small footprint of the sensor, the root structure in the vicinity of the sensor is very similar to the natural state. This results in relatively accurate soil moisture measurements and an immediate response to changes in soil moisture caused by plant transpiration.

5.3. Installation in vineyards

The sensor is placed approximately 30 cm off the axis of the row and between two vine plants. Damaged roots will recover after about 30 days and allow the sensor to function properly.

As the vine is a deep rooting crop, it is recommended to measure soil moisture at a depth of 120 to 200 cm. Placing sensors at these depths requires a special procedure, as described in the chapter 'Installation in deep-rooting crops and vineyards'.

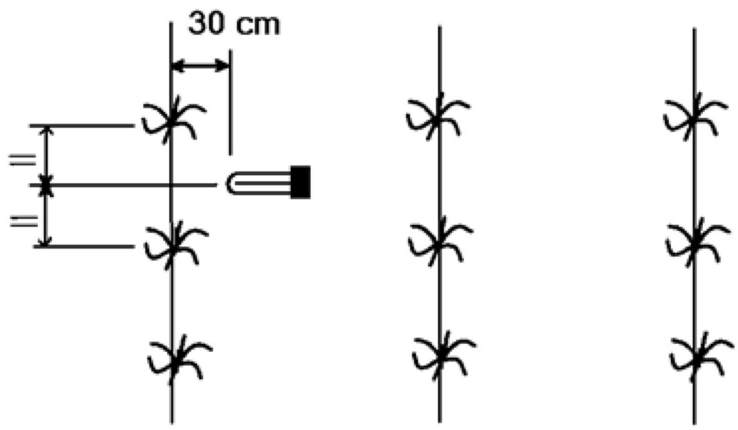

Image 4: Sensor placement in vineyards

5.4. Installation when using drip irrigation

If you want to measure soil moisture and control drip irrigation, it is recommended to place the sensor outside the drip line and between two drip heads. It should not be placed directly under the dripper as there is too much moisture variation, uncharacteristic of the surrounding environment.

In the case of drippers with a capacity of 2–4 l/hr, a placement distance of 30 cm from the dripper is recommended. For lower water supply, around 15 cm of distance is recommended. If the drip hose is placed between two crop rows, the sensor is placed in the row, below or between the plants.

In clay and loam soils the diameter of the wetted soil volume is larger than in sandy soils – this needs to be taken into account when installing the sensor.

The VIRRIB sensor measures the average humidity around its active parts, whether it is positioned vertically or horizontally. In most cases, its range extends to about 7 cm from the sensor.

5.5. Installation when using fixed sprinklers and micro-spraying

In this case, the sensor is placed at one third to half the distance between the sprinkler and the edge of the irrigation circle. The distribution characteristics of the sprinkler in question must also be taken into account here, as not all types of sprinklers irrigate the entire area evenly. Some irrigate more in the centre, while others irrigate more at the perimeter – it is therefore necessary to place the sensor in a uniformly irrigated area.

5.6. Sensor placement depth

We recommend using two to three sensors for each site. Place one or two near the surface to monitor the moisture needs of the crop and one deeper to monitor water seepage. Since most crops have 80 % or more of their active roots located within the topmost 30 centimeters, monitoring moisture in this layer is critical.

The use of two sensors in the top layer is recommended, especially for high-yielding crops – one sensor at a depth of 10 cm and the other at a depth of 30 cm. The third sensor is placed at a depth of 50–60 cm, according to which the amount of irrigation is regulated to prevent excess seepage, thus preventing the leaching of nutrients from the root zone.

If two sensors are used, the top sensor is placed at a depth of 15 cm and the deeper sensor at a depth of 50 cm.

If three sensors are used, the top sensor is placed at a depth of 10–15 cm, the next one at 30 cm and the third one at 60 cm. When growing shallow-rooted crops, the top sensor should be placed at a depth of 12–15 cm, the second at 20 cm and the deepest at 40 cm.

Note:

When installing the sensors, it is important that the top sensor is at least 10 cm below the soil surface. A shallower sensor may not give accurate readings.

In some cases, measuring and regulating soil moisture in the deeper soil layers allows better control of plant water stress and better harvest quality, especially in the case of grapevine. The sensors can be placed down to a depth of 1–2 m using the special procedure described in the chapter 'Installation in deep-rooted crops and vineyards'.

5.7. Sensor orientation

Sensors can be placed vertically or horizontally in the soil profile, with horizontal placement being preferable in most cases. With this method of placement, the space around the active sensor elements can be better filled with soil during installation and the measured values are therefore a better representation of reality. The measurement zone extends up to 7 cm from the active elements.

When positioned vertically, the sensor provides data on the average moisture content in the layer adjacent to the active parts. This placement may be appropriate when using a single sensor to measure moisture in a layer containing the majority of the active roots of a given crop.

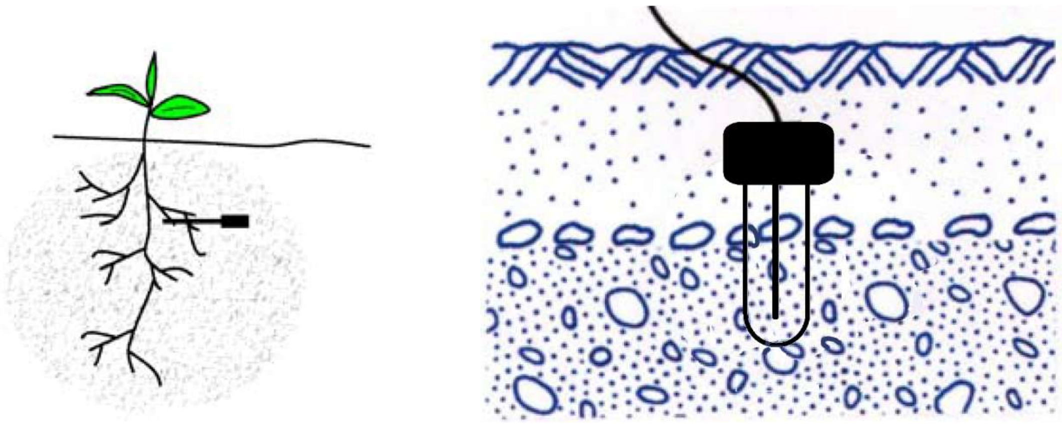

Image 5: Horizontal and vertical sensor orientation

Caution:

Installing the sensor vertically can lead to a situation where the upper part of the measured area is dry and the lower part is wet. The sensor reading is the average moisture content, so it may happen that if the roots are concentrated mostly in the upper part, the crop may suffer from drought even if the recorded soil moisture content is high enough.

Special care must also be taken when covering the sensor with soil to avoid air pockets between the soil and the active parts of the sensor.

5.8. Sensor installation

The most suitable tool for installing the sensors is a long narrow spade, preferably 8–14 cm wide and 25–36 cm long.

Note: the narrower the excavation, the better the contact between the sensor and the undisturbed soil layers.

Image 6: Example of a hole for sensor placement

Dig a hole at the optimal location (see above), preferably with a diameter of 35–38 cm and the recommended depth. The sensor is placed at the bottom of the hole, ideally on an undisturbed layer of soil – do not make the pit deeper than absolutely necessary. It is recommended that the excavated soil be set aside in the exact order of the layers as they were taken from the soil profile, and when back filling the hole, place them in the correct order to maintain original succession of the layers.

After leveling and cleaning the bottom of the hole, create a small 1.5 cm deep depression at one side of the hole into which the black plastic sensor body will be placed. On top of the sensor, first create a layer of soil about 5 cm high and press it down with your hand. Care must be taken to ensure that no air pockets are formed around the sensor body and its active parts; if the soil is rocky, remove all rocks and pebbles from this first layer. When filling the pit further, proceed in 10 cm thick layers and compact each layer carefully.

It is recommended to run the cable from the sensor horizontally at least 5 cm away from the sensor in order to prevent irrigation or rainwater from running along the cable into the measured area.

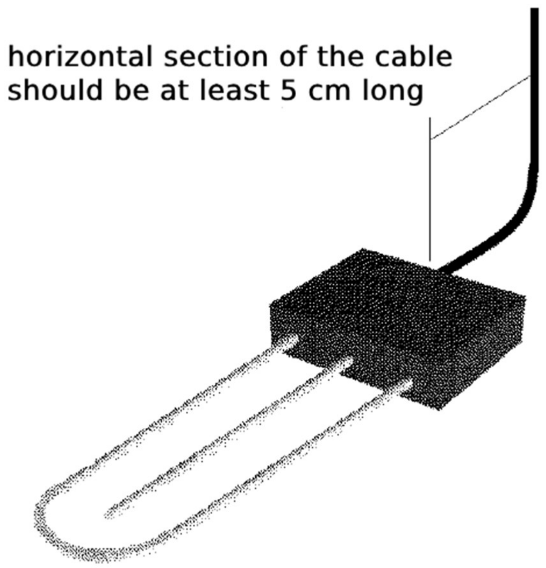

Image 7: Cable orientation

Note:

Do not use lumpy soil for backfill, which could cause inhomogeneity of the soil profile around the sensor.

Generally, dry soil requires stronger compaction, wetter soil requires less compaction. For best results, it is advisable to use all the soil that has been dug out to backfill the hole. If you use more soil, the measured values will be higher than reality, if less, they will be lower.

When placing multiple sensors at one site, as recommended above, dig a separate hole for each sensor at a distance of 60 cm from each other. When using multiple sensors, it is recommended that they are placed horizontally at the bottom of the pit.

When placing sensors in orchards, orient the excavated hole so that its longer side is in the direction towards the trunk. This results in less root damage and faster root recovery.

In most cases, the sensor gives readings immediately after installation and soil compaction. However, more accurate readings are not obtained until two to four weeks (depending on the amount of rainfall and irrigation during this period) after the disturbed soil profile has been restored to its normal state.

5.9. Installation in deeply rooted crops and vineyards

Narrow VIRRIB sensors can also be placed at depths of 1–2 m (for deeper rooting crops) using the following procedure:

- Using a soil auger with a diameter of at least 10 cm, drill a hole to the appropriate depth. Make sure that the drilled soil is deposited in such a way that it can be placed back in reverse order.
- Lower the VIRRIB sensor vertically by the cable to the bottom of the drilled hole.
- First, gradually pour the loose soil from the bottom 25 cm into the hole and continuously tamp it down, preferably with a wooden or plastic rod with a diameter of about 2–3 cm. Avoid creating air-filled pockets around the sensor.
- Slide a protector onto the cable, preferably a plastic hose with an internal diameter of at least 15 mm.
- Gradually add 15 cm layers of soil and lightly compact.
- The sensor cable has a standard length of 2 m. If you want to place the sensor at a greater depth, sensors with a longer cable can be ordered.

5.10. Cable protection

The cable used for the sensor is suitable for direct covering with soil or exposure to weather. Unfortunately, in nature it is sometimes damaged by rodents or during cultivation of crops or other activities. Most problems with sensors are usually caused by cable damage. Therefore, we recommend that a plastic protector with a minimum diameter of 15 mm be slid onto the cable. This protector should be used as shown in the picture, i.e. first it is laid horizontally, then upwards about one meter above the ground and then the opening of the protector is turned downwards. It is recommended to seal this opening with a suitable silicone sealant.

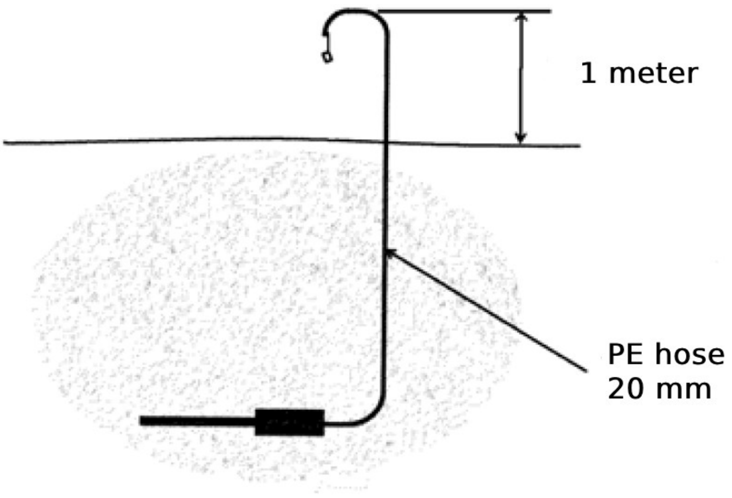

Image 8: Installing plastic hose to protect the sensor cable

Compact the soil around the protective hose/pipe to prevent water from seeping into the measured area and distorting the measured values.

5.11. Cable extension

The sensor cable can be extended to a length of up to 300 m if needed. This extension allows readings to be taken at the edge of the plot, but in most cases is used when connecting the sensor to an irrigation controller or a data logging device. Each sensor is connected with a 3-core cable – if you want to use one cable for several sensors, it is possible to connect the GND wires into one and connect e.g. 3 sensors with a single 7-core cable.

It is recommended to protect the cable from mechanical damage. All connections must be made watertight.

CE marking

The manufacturer declares that the product conforms to all relevant provisions of European Union regulations:

Directive 2014/30/EU of the European Parliament and of the Council ("EMC Directive")

Directive 2011/65/EU of the European Parliament and of the Council ("ROHS Directive")

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