

# Soil Analysis Sensor (Digital) + Analog Soil Sensor

**Recording, monitoring and analysis of soil moisture, electrical conductivity and environmental temperature in soils**

**Accurate sensor element** for the **fully automatic measuring of soil moisture** (VWC in percent [%] or dielectric permittivity), **electrical conductivity** (uS/cm or cS/m) and **environmental temperature** (°C or °F) in **soils or other granular substances!**

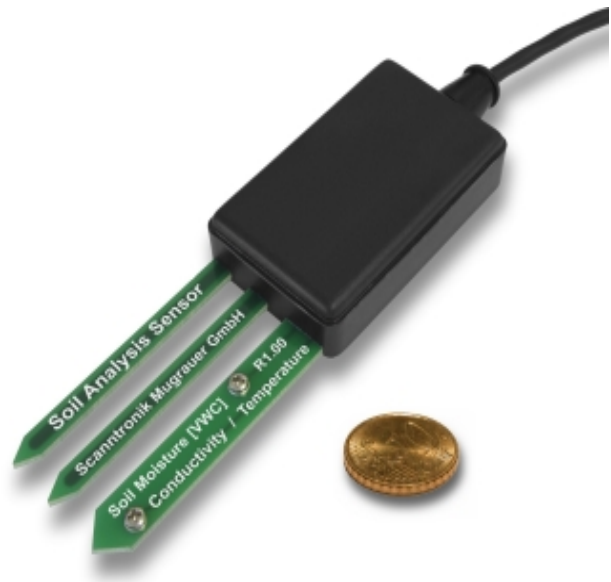
The "**Soil Analysis Sensor**" (**Digital**) as well as the "**Analog Soil Sensor**" (including a soil moisture sensor) are one of the most modern sensor elements / probes for the accurate monitoring, recording and analysis of moisture, electrical conductivity and surrounding temperature in soils and other granular media.

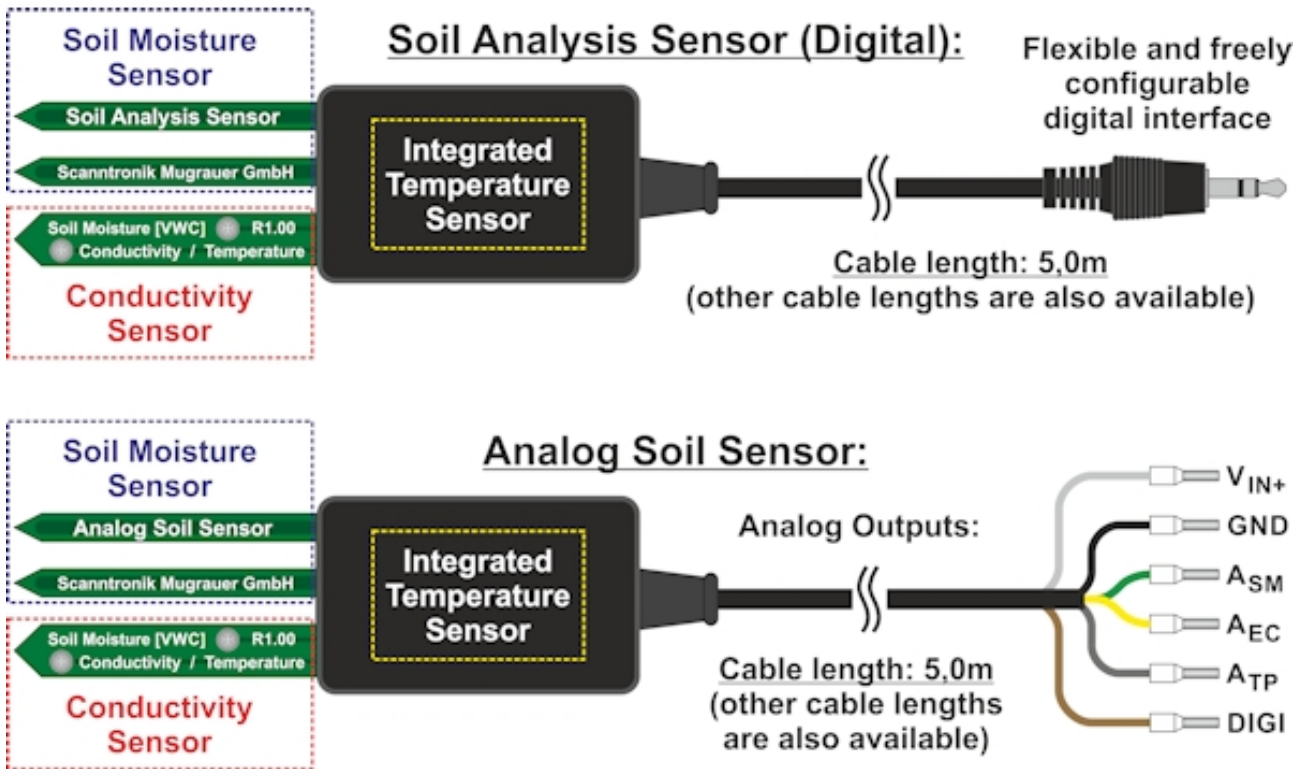
The completely digital "**Soil Analysis Sensor**" has been developed as a versatile **Universal Sensor (extension element)** for the direct connection to our flexible data logger systems (e.g. [Thermofox Universal](#), [Universal HUB](#), [Materialfox](#),...). It allows the easy analysis of different granular substances like mineral soils or similar media.

The "**Analog Soil Sensor**" supports the same functions and features as its digital counterpart. In addition, it offers **3 x precise and flexibly configurable analog signal outputs**. Via these outputs, the current measurement value can easily be passed on as a voltage signal (0V - 2.5V) to other measuring devices, control and regulation systems, data loggers and many more.

The measuring probe of both sensor versions offers **3 x high-sophisticated sensing elements**:

The **moisture content of the soil** (VWC = Volumetric Water Content in %) is determined by measuring the dielectric permittivity / dielectric constant  $\epsilon = 1$  (air) to  $\epsilon = 80$  (water) with a soil moisture sensor. This physical property of the soil varies greatly depending on the water content and is recognised worldwide as the standard for measuring the moisture in the soil and in other materials. The dielectric permittivity is measured using capacitive frequency domain technology at a frequency of 80 MHz.





This high frequency was specifically selected in order to reduce influences by the salt content and the structure of the medium to be examined. This also makes the sensor very accurate and suitable for different types of soil. **In mineral soil types, the conversion of the permittivity into volumetric water content (VWC in %) takes place fully automatic directly in the sensor by means of the widely used and validated "Topp equation"**. Custom-made calibrations can of course also be carried out on request. For this purpose, the soil moisture sensor provides access to all digital raw data, making it even more flexible.

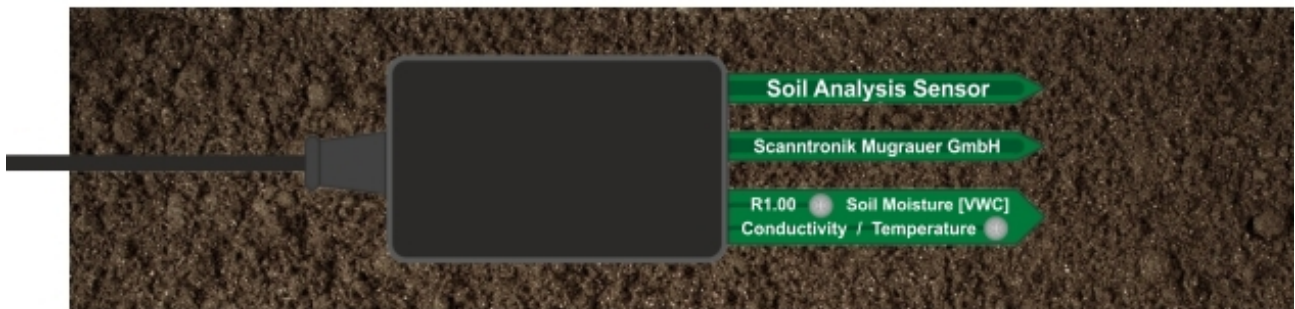


The **electrical conductivity of the soil** (Electrical Conductivity = EC, measured in  $\mu\text{S}/\text{cm}$  or  $\text{cS}/\text{m}$ ) is measured directly at the sensor using **two high-quality and very robust V4A stainless steel electrodes**. To achieve good results, a reliable and firm contact between the measuring substrate and the electrodes is important. **The measurement range of the sensor is between 0 and 20,000  $\mu\text{S}/\text{cm}$  (or 0 and 200  $\text{cS}/\text{m}$ )**, thus enabling monitoring the influence of salts or fertiliser on the conductivity of the soil, for example. On request, the sensor also performs a **fully**

**automatic temperature compensation** of the measured conductivity. The user can choose between the following three options: either a linear temperature compensation with adjustable compensation coefficient, a special temperature compensation matched to soil analysis based on the recommendations of the "US Salinity Handbook 60" or no temperature compensation.

As a third analysis element, the waterproof **Soil Analysis Sensor** as well as the **Analog Soil Sensor** include a high-precision NTC temperature sensor to measure the exact **temperature in the soil** (measured in °C or °F). **The measurement range of the sensor is between -30°C and +80°C with a resolution of 0.1°C.** The sensor is already pre-calibrated. In addition to that, the user has flexible access to the internal adjustment offset.

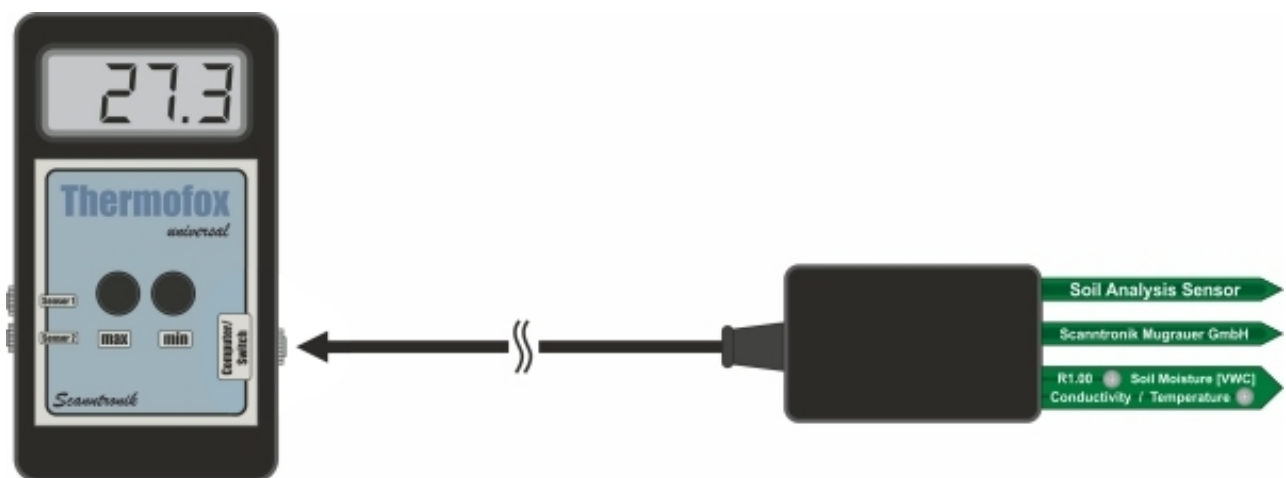
The compact **Soil Analysis Sensor** as well as the **Analog Soil Sensor** can be easily installed at any time. The waterproof sensor element is simply pushed directly and firmly into the unaffected soil. This provides good contact between the sensor and the soil and maximises the accuracy of the system.



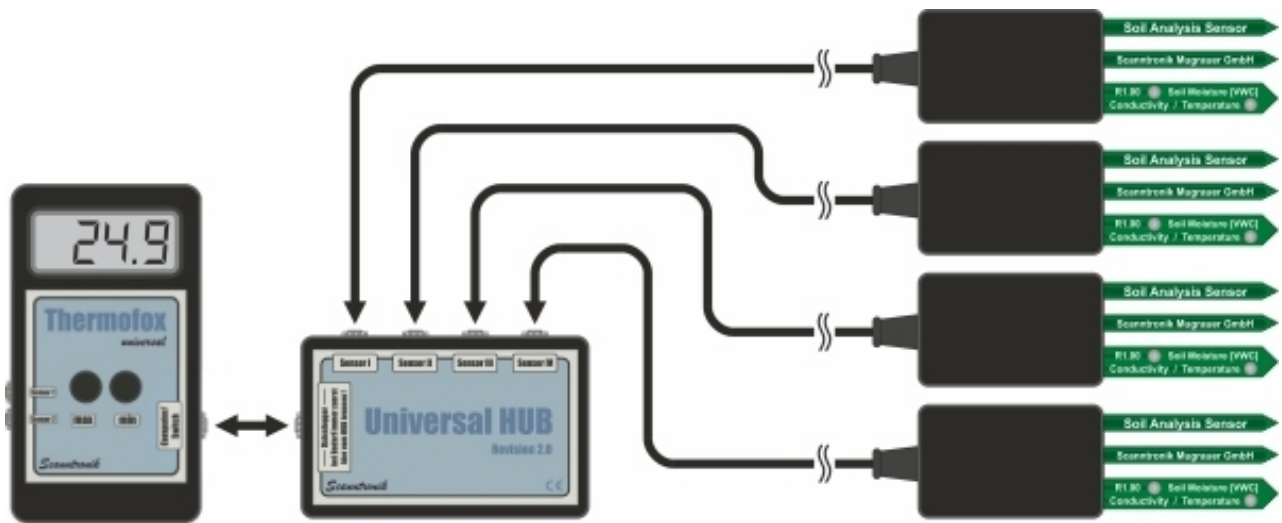
### More information about the "Soil Analysis Sensor" (Digital):

In many cases, the **Soil Analysis Sensor** is combined with our convenient data logger [Thermofox Universal](#). Its large, clear display, memory for up to 64,000 readings, an additional internal temperature sensor and two external temperature sensor inputs for NTC thermistors (measuring range: -30°C to +120°C, **wired sensors** or **wireless sensors**) as well as its **Universal Sensor® bus for numerous extensions** like the **Soil Analysis Sensor** make this data logger especially versatile.

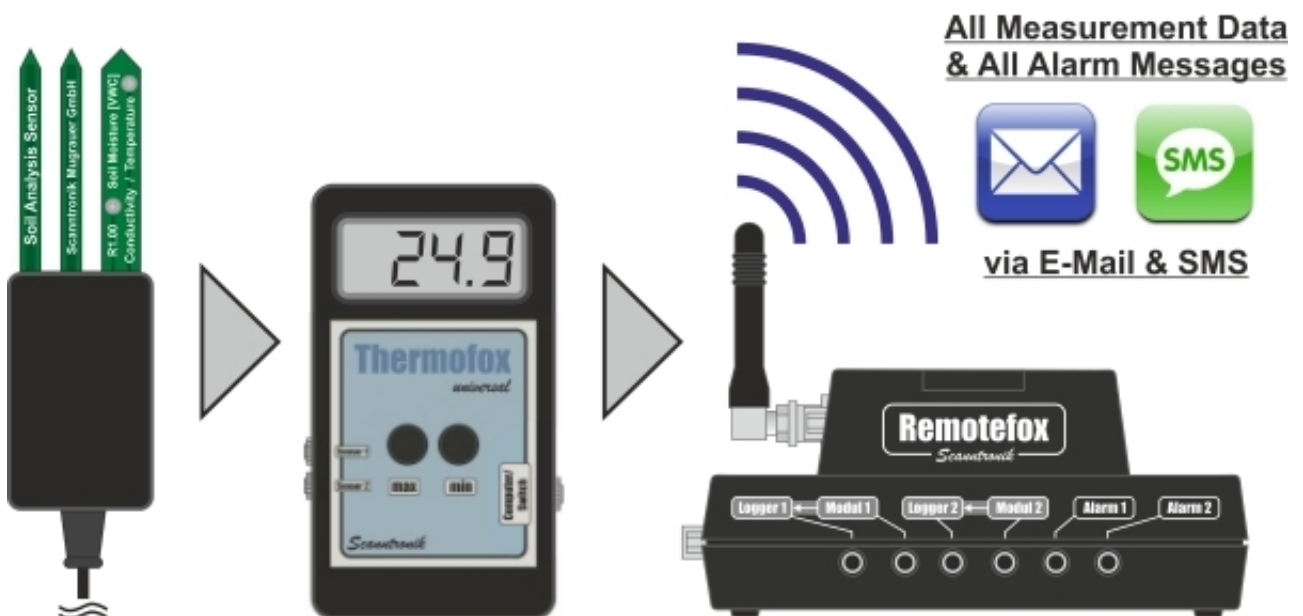
Depending on the particular application, the **Soil Analysis Sensor** can either be connected directly, as stand-alone sensor, to one of our flexible data logger systems (e.g. [Thermofox Universal](#)):



Or, as an alternative, the **Universal HUB** enables you to simultaneously process up to four **Soil Analysis Sensors** with one of our data logger systems (e.g. [Thermofox Universal](#)):



If you do not want to read out the **Soil Analysis Sensor - System (incl. soil moisture sensor)** and the associated data logger (e.g. [Thermofox Universal](#)) manually on site, you can also easily connect the measuring system with our mobile [Remotefox - Remote Data Transmission System](#). This way, you **regularly get all measurement data via mobile service, internet and email** even if you are hundreds of kilometers away from the measurement site. As all our data loggers, the [Remotefox](#) also operates completely battery-powered and does not require any access to the power grid. This allows effortless stand-alone use, also for several months or even years!



This way, even very extensive and geographically dispersed long-term recordings can easily be performed.

The fields of application for the **Soil Analysis Sensor** in combination with our data logger systems are almost unlimited and range from irrigation planning and control, over the use in greenhouses, the prognosis of plant diseases, soil respiration, watershed characterization through to fertilization management, plant ecology and many more...

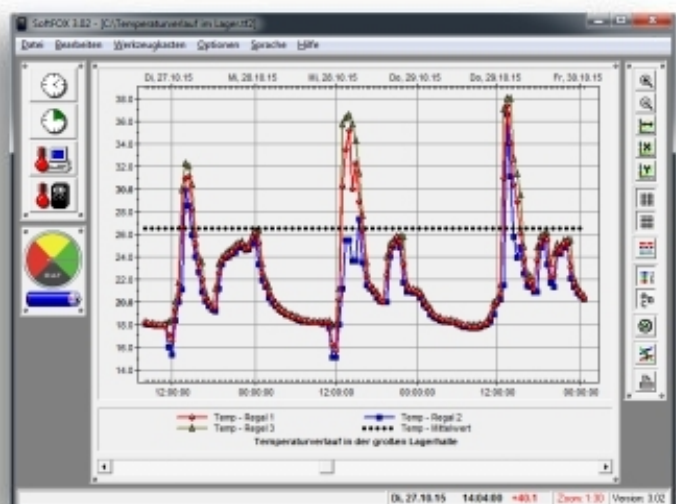
If you also need reliable alerting in addition to the analysis and recording of measurement data, this is also easily possible with the **Soil Analysis Sensor**. Just combine the measurement system with our flexible **Universal Alarm**. This optional alarm module can be individually configured and features a **highly flexible and independent alarm output**. There are **alarm functions** for e.g. exceeding or falling below a user-defined threshold, but also for the entry or exit of an alarm range. The freely programmable **alarm delay** completes the range of alarm functions. Alarm systems include our **SMS-Alarm-System** for the mobile sending of SMS alarm messages to one or more recipients, our **SMS-Power-Pack** or our **Acoustic-Alarm**.



The independent power supply to the **Soil Analysis Sensor** is provided by a high-quality, durable and replaceable standard 3.6V lithium battery, supplied as part of the power-/setup-module included in the delivery. The sensor can also be configured as desired using this module. Depending on the selected measuring rhythm, the battery life is up to 2 years.

The programming of the **Soil Analysis Sensor – System** and the used data logger (logger type depending on the application) as well as the data evaluation is done via the [SoftFOX - Universal Analysis Software](#) under Microsoft Windows® XP, 7, 8, 10 or 11. Newer operating systems are naturally also supported. After the sensor or the corresponding data logger is connected to the computer via a PC interface cable, the system can be read out or configured immediately.

The software offers numerous general functions like for example dynamic project management, graphic data analysis, guide lines, overlay function for curves originating from different data loggers, mathematical curve calculation, statistical curve analysis, export function, auto backup, flexible zoom and many more. Besides that the **Soil Analysis Sensor** as well as the used data logger system itself can be configured arbitrarily.



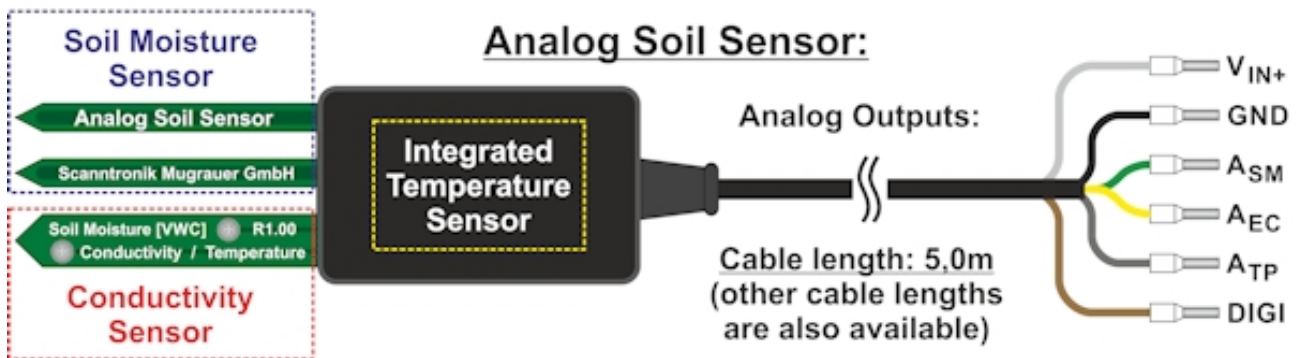
Functions like setting the measuring rhythm, min./max. monitoring for extreme value recording without interruption for even slow measuring rhythms, configuration of

the real time clock, reading out the measurement data, test of the memory fill level, digital serial number and many more are available here.

### More information about the "Analog Soil Sensor":

The **Analog Soil Sensor** is supplied with power using the two power connectors **VIN+** and **GND**. The applied supply voltage can range from 3V DC to 12V DC. Within approximately 1 second after applying the supply voltage, the measurement values for the soil moisture (SM), the electrical conductivity of the soil (EC) as well as the soil temperature (TP) are available as analog voltage signal at the **three outputs Ax**. The measurement value of each sensor channel is mapped proportionally and with high precision to the output voltage range between 0V DC and 2.5V DC. The analog output signals are updated every 5 seconds by default (freely configurable).

The sensor can also be addressed digitally (RS-232 / UART / USB / Universal Bus®) via the **DIGI** interface connector. Simply use our optionally available Power-/Setup-Module for this purpose. By this means, you can easily adjust all settings of the sensor and thus flexibly configure, for example, the measurement rhythm or the mapping range of the measurement values to the analog 0 - 2.5V output signal. For all questions regarding the configuration or installation of the **Analog Soil Sensor**, our support team is, of course, always at your disposal.



## General features of both sensor versions:

- Simultaneous analysis of **soil moisture, electrical conductivity and ground temperature**
- Capacitive measurement of the permittivity at **80 MHz** (frequency domain technology=FDR)
- Measuring volume for the local soil moisture determination: **approx. 750 mL (0,75 l)**
- Measurement of soil moisture insensitive against salt content and structure of the ground
- Measurement of the electrical conductivity via high-quality **stainless steel contacts (V4A)**
- Conductivity temperature compensation: None, linear or according to US Salinity Handbook
- **Both sensor versions** can be configured freely via the universal [SoftFOX - Software](#)
- Waterproofed, sealed and robust sensor element with 5m (opt. longer) connection cable
  
- Measurement readings for soil moisture: VWC[%] (Topp's equation), permittivity or raw data
- Measurement readings for conductivity: EC [cS/m] with / without compensation or raw data
- Measurement readings for temperature: Degrees Celsius [°C] or Degrees Fahrenheit [°F]
  
- Measuring range for the soil moisture (permittivity):  $\epsilon = 1$  (air) to  $\epsilon = 80$  (water)
- Measuring range for the soil moisture (Topp's equation): **VWC = 0 % to VWC = 100 %**
- Measuring range for the electrical conductivity: **EC = 0 to 20000  $\mu\text{S/cm}$**  or 0 to 200 cS/m
- Measuring range for the temperature: **T = -30 °C to +80 °C** or -22 °F to +176 °F
  
- Average resolution for the soil moisture (permittivity):  $\Delta\epsilon = 0,1$  from  $\epsilon = 1$  to  $\epsilon = 30$
- Average resolution for the soil moisture (permittivity):  $\Delta\epsilon = 0,7$  from  $\epsilon = 30$  to  $\epsilon = 80$
- Average resolution for the soil moisture (Topp):  $\Delta\text{VWC} = 0,15\%$  from VWC = 0 to 50%
- Average resolution for the conductivity:  $\Delta\text{EC} = 10 \mu\text{S/cm}$  from EC = 0 to 5000  $\mu\text{S/cm}$
- Average resolution for the conductivity:  $\Delta\text{EC} = 50 \mu\text{S/cm}$  from EC = 5000 to 10000  $\mu\text{S/cm}$
- Average resolution for the temperature:  $\Delta T = 0,1 \text{ °C}$  from -30 °C to +80°C
  
- Accuracy of the soil moisture (permittivity):  $\epsilon = \pm 1$  from  $\epsilon = 1$  to  $\epsilon = 40$  (typical for soils)
- Accuracy of the soil moisture (permittivity):  $\pm 15\%$  from  $\epsilon = 40$  to  $\epsilon = 80$
- Accuracy of the soil moisture (Topp): VWC =  $\pm 3\%$  (electrical conductivity < 10000  $\mu\text{S/cm}$ )
- Accuracy of the electrical conductivity: EC =  $\pm 10\%$  from EC = 0 to 10000  $\mu\text{S/cm}$
- Accuracy of the temperature: T =  $\pm 1 \text{ °C}$  from -30 °C to +80°C
- Specific calibration will increase the accuracy for arbitrary granular media/soils even more
  
- Dimensions of both sensor versions (without connection cable): 36 x 114 x 16 mm (HxWxD)
- Weight of both sensor versions without or with the connection cable: 50g or 130g

## Features of the Soil Analysis Sensor (Digital):

- Can directly be used with various of our data loggers (e.g., [Thermofox Universal](#), HUB,...)
- Additional sensors can be connected to the data logger in use ([e.g. 2 x object temperature](#))
- Directly combinable with our [Remotefox \(remote data communication system\)](#)
- Extension of the measuring system with a **flexible alarm** using the **Universal Alarm**
- Many different ways of alerting available, e.g: **SMS Alarm System, Acoustic Alarm**,...
- Readings are saved directly in the data memory of the connected data logger (accessories)
- Collected readings remain in memory of the data logger even without batteries
- Power supply via one commercially available 3,6V lithium battery (size: 1/2 AA - 1200mAh)
- Battery life up to two years (see configuration). Batterie can be replaced at any time

## Features of the Analog Soil Sensor:

- **3 x Analog voltage outputs** for soil moisture, soil conductivity and soil temperature
- Voltage range of the three analog signal outputs (Ax): 0V DC - 2.5V DC
- Mapping range of the measurement values to the output signals flexibly configurable
- Update of the analog voltage outputs periodically every 5 seconds (freely configurable)
- Analog output signal of all sensors already available approx. 1 second after power-on
- Easy sensor connection by means of color-coded signal lines with wire end ferrules
- Power supply voltage of the **Analog Soil Sensor** (VIN+): 3V DC to 12V DC
- Average current consumption of the **Analog Soil Sensor** during operation: < 1 mA

Depending on the memory equipment (4,000 up to 64,000 readings) of the used data logger system (e.g. [Thermofox Universal](#)), the active sensors and the selected measuring rhythm, the maximum measuring time for the **Soil Analysis Sensor (Digital)** can be calculated.

Here some examples:

Memory capacity	Active sensors	Measuring rhythm	Measuring time
4,000 readings	Soil Moisture Conductivity Temperature	1 hour	56 days
4,000 readings	Soil Moisture Conductivity Temperature	2 hours	111 days
16,000 readings	Soil Moisture Conductivity Temperature	1 hour	222 days
16,000 readings	Soil Moisture Conductivity Temperature	2 hours	444 days
64,000 readings	<b>2 x</b> Soil Moisture <b>2 x</b> Conductivity <b>2 x</b> Temperature	30 minutes	222 days
64,000 readings	<b>2 x</b> Soil Moisture <b>2 x</b> Conductivity <b>2 x</b> Temperature	1 hour	444 days
64,000 readings	<b>4 x</b> Soil Moisture <b>4 x</b> Conductivity <b>4 x</b> Temperature	30 minutes	111 days
64,000 readings	<b>4 x</b> Soil Moisture <b>4 x</b> Conductivity <b>4 x</b> Temperature	1 hour	222 days