



SoilNet

Wireless Sensor Network for Measuring Soil Moisture

MAINTENANCE **Manual**

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1 Introduction

1.1 The sense of maintenance

The **SoilNet** is a radio-based network with battery-powered sensor nodes. The sensors and associated electronics are installed in the soil and are therefore exposed to external conditions like weather and water.

For these reasons, the following causes for a necessary maintenance can be defined:

- The network / end device is no longer sending data.
- The observed data is faulty.

This may be because of:

- The radio contact from the SoilNet into the institute is disturbed.
- Power supply of the devices in the field is disturbed.
- Water has penetrated into housing.
- Sensors / electronics are damaged.

1.2 Intervals

There are no fixed intervals that provide for certain maintenance activities.

Nevertheless, a regular check of the incoming data makes sense. [See chapter 2.1](#)

1.3 Documentation

In order to document the maintenance of the network, there are some Excel sheets, in which the history of each individual measuring point can be traced, or the state of batteries is documented.

These sheets should be kept carefully.

Also there are different documents which are useful in the field while maintenance.

Please [see chapter 2.1 and 2.2](#)

1.4 Safety – IMPORTANT !!



1.4.1 Dangerous Goods / Transport

SoilNet devices contain batteries for power supply.

In routers, lead-gel batteries are used, which do not contain dangerous goods.

In End-Devices, Lithium Batteries are used.

Lithium batteries are subject to very strict safety regulations in Europe (all countries that have ratified the **ADR** agreement – The International Carriage of Dangerous Goods). For storage, transport and shipping there are regulations that have to be observed.

Lithium batteries must also comply with the **UN 38.3** safety test.

For this reason, the applicable regulations for transport (for both installation and maintenance) of the SoilNet must be obtained from the employer's safety officer.

For transport of the batteries, we use a Zarges box with corresponding stickers (**UN3090, Class 9 and BAM certificate**):



Used batteries are mechanically placed in polystyrene moulds and the poles must also be covered with adhesive tape.

For these reasons we cannot ship loose batteries, but only in devices (UN3091, one battery per device).

1.4.2 (Technical) characteristics of the lithium batteries used:

- **Type ER 34615 M** (different brands)
... where "M" is most important, it marks the (necessary) pulse capability (4000 mA)
- **Nominal Voltage: 3,6V**
- **Pulse capability: 4000 mA**
- **Capacity: ~ 13000 mAh**

1.4.3 Backup

Please be sure to make backup files on an external medium **immediately after purchasing the system**. To avoid permanent damage to your system, please make a backup of the program files, especially from the INI files you will find at the directory "c:\Soilnet\Init\" (see chapter 2.3.1 also).

2 Procedures

2.1 Observation of data

Since the data usually arrives on the computer with the **CPA (Control Panel Application)** software in “nearly” real-time, a quick check-up is easy.

- If any data comes in, it can be seen in the first tab "Config": The entry "receive packet x sec before ..." provides information about when the last data packet came in. This display should be updated every few seconds. In the box above you'll see the incoming data. The LEDs next to it will show the source device of the data.
- The timestamps of the last measured data are visible in columns 2 and 3 ("Date" & "Time" of the CPA software in the "Data" tab).
- Whether the timestamps of the log files (e.g. "box_010.dat") are current (or the last time the data file was sent) can be found via a **file browser** (explorer, total commander etc.) of your system in the folder "c:\soilnet\protokoll".
- The battery voltages of the end devices can be seen in column 4 ("BAT") of the CPA software, as well as the voltages of the routers (in the "router" tab).
- Of course, the current data of the individual sensors can also be checked in the tab "data" (column 5 to column 26).

For more information on the CPA software please find the documentation in http://www.fz-juelich.de/ibg/ibg-3/EN/Research/Terrestrial_observation_platforms/SoilNet/Downloads/_node.html

2.1.1 Documentation before and after maintenance

Based on the checked data, a table should be created with information that is helpful for maintenance in the field.

Not only the date and type of failure should be noted, but also a brief history and the last state of the sensors, which can be found in the

- **SoilNet_Maintenance.xlsm**

document. [See chapter 2.2.1](#)

An universal Excel sheet has been created for the actual maintenance, which can be taken to the field:

- **SoilNet_Maintenance_Actual.xlsm**

There is also room for handwritten information which is gathered in the field.

A current map can also be created, from the templates:

- **SoilNet_Maintenance_Map_WÜ_Actual.vsd** for Wüstebach test site
- **SoilNet_Maintenance_Map_RO_Actual.vsd** for Rollesbroich test site

to quickly locate the measurement nodes in the terrain.

When returned from the field, the actual sheet and the map are scanned and the data obtained is transferred to the main maintenance file.

The scanned documents will be stored in the directories:

- **n:\SOILNET\Wüstebach\Wartung\Protokoll**
- **n:\SOILNET\Rollesbroich\Wartung\Protokoll**

At least, there is a documentation of the batteries used in

- **n:\SOILNET\Service\Akku\Battery_Maintenance.xlsm**

2.2 The maintenance sheets

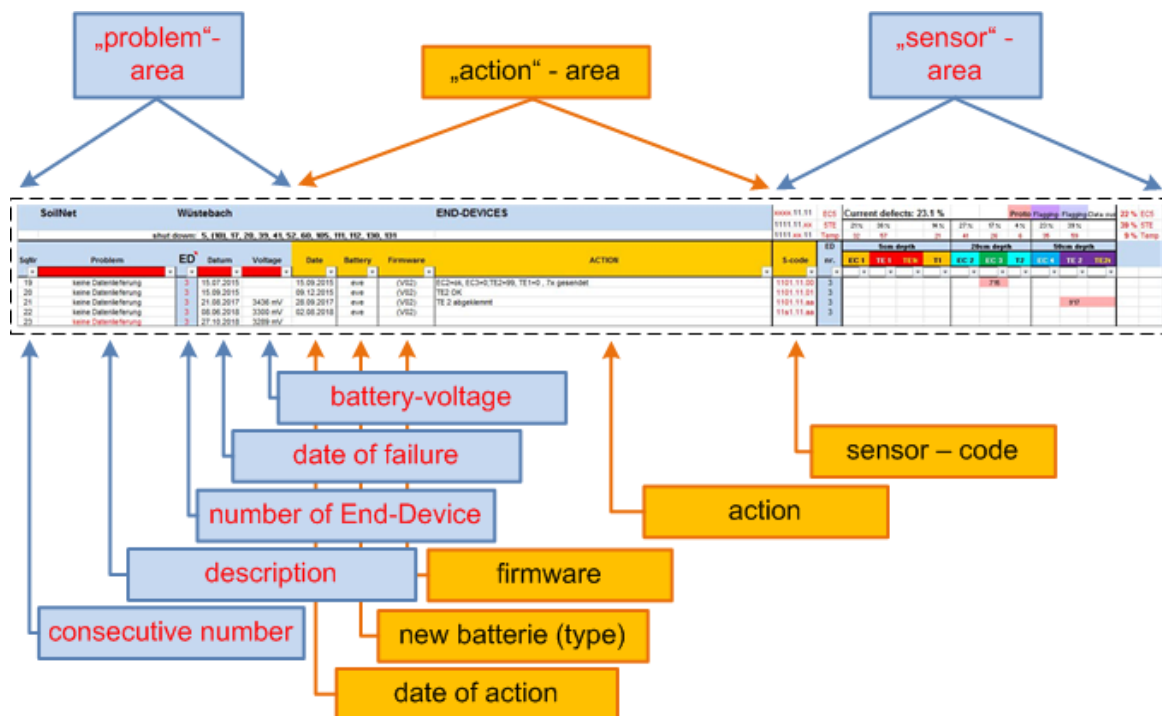
2.2.1 SoilNet_Maintenance sheet

The main protocol file is called **SoilNet_Maintenance.xlsm** and is located in the directory "n:\SOILNET\service\".

There are two sheets per location / per network. The first sheet is the table for the End-Devices and contains a detailed description of the failures and its maintenance. In the second table, the routers are documented.

There are three areas in the ED - table:

- Problem description
- Action
- Sensor data



In detail:

1. Column: consecutive number, the numbers of entries per End-Device. It's increased with every maintenance.
2. Column: description of the problem or failure detected. If a failure has been detected but not yet maintained, this will be signed "red" until the maintenance is completed.
3. Column: number of End-Device.
4. Column: date of failure, when the failure has been detected, or the device has stopped working.
5. Column: the battery voltage at the day of failure (in mV).
6. Column: the date of maintenance in the field.
7. Column: the (new or exchanged) battery type. For practical reasons (transfer to the actual document), sometimes the entry stands in brackets. This means, the battery hasn't changed at this date.
8. Column: the actual firmware on the end-device. Again, if this entry is placed in brackets, the firmware hasn't been updated at this date.
9. Column: a description what has been done in the field.
10. Column: a sensor code (see next chapter).

If an area of a complete device is dyed in orange, it means, this device has been shut down, data is no longer available.

2.2.1.1 The Sensor Code

The “sensor area” of the table is different for every SoilNet network. It can have its own configuration, as the number and type of sensors may vary. For instance: Our old “Wüstebach” Network has 8 sensors from various companies, at the “Rollesbroich” network, every device has 6 sensors and some of them have 9 sensors.

In the sensor columns these sensors have their own cells to see if they are working or not.

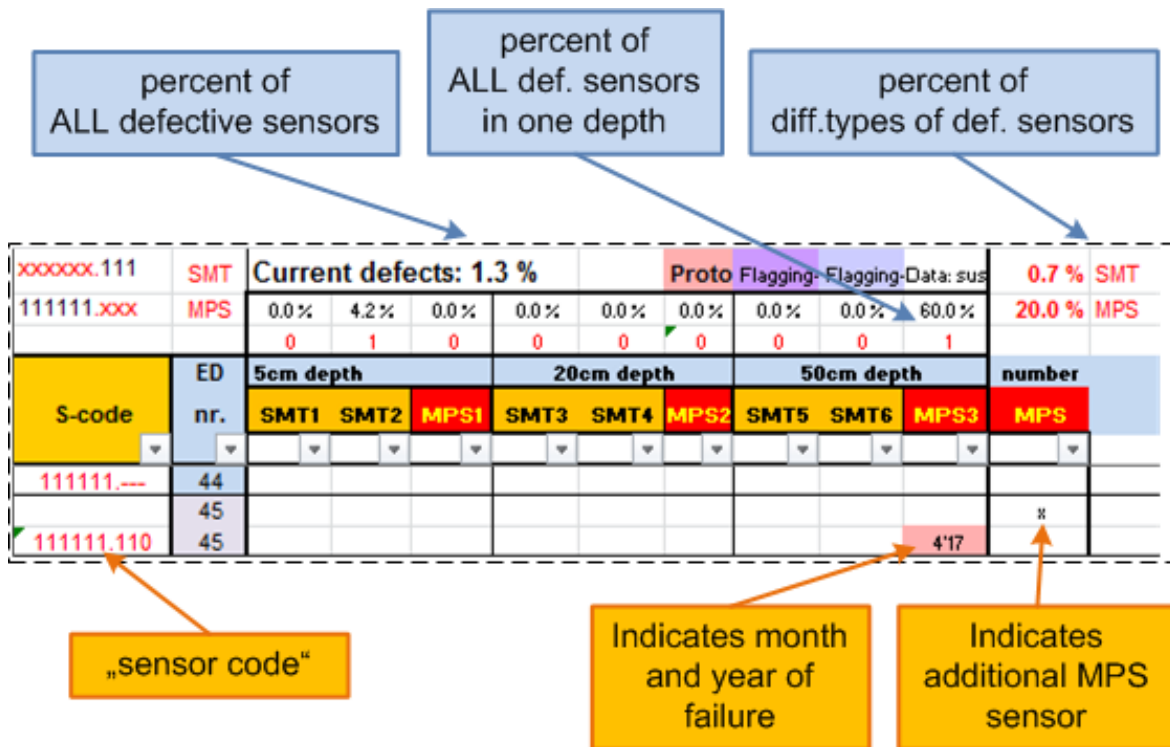
The Institute has decided not to replace single defective sensors, since the exchange destroys the measuring point, say the soil, and thus the continuity of the data is no longer guaranteed.

In the column 10 (J), an abbreviation is used for the actual sheet which is taken into the field while maintenance is done (see next chapter). This is the “sensor code”.

So, a “1” means the sensor is working, a “0” means, the sensor is not working anymore.

At some entries, there is also an “s”, which stands for “**short link**”. In case of analog sensors, it is necessary to shorten the input of the logger if the sensor is damaged to prevent misinterpretations of shown values.

Also there may be an “a” which is an abbreviation for the german word “abgezogen” and just means the electrical connection of the sensor is **removed** (as the sensor failed, it may happen that an unnecessary current is drawn, so it has to be disconnected).



The next cells indicate for each individual sensor whether it has failed and when this happened. For this purpose, the corresponding field of the defective sensor has to be colored and provided with a date (here: 4'17 : month/year). The sum is then calculated in the table header and the percentage of failed sensors is displayed.

2.2.1.2 Some Examples for description entries

Some description entries have their special meaning:

- **μFL149C5C**
a new Jennic module have been installed, this is the MAC address.
- TE1=0, EC2=SL
Here, two sensors are damaged, TE1 shows a value=0 (impossible)
the EC2 sensor was also damaged (maybe the current drawn was too high) and was short linked (=SL).
- Reset, rst
The device stopped working, it was only reset and started new.
- ***** überprüfung *****
only data was checked (from institute) => sensor code created.

2.2.2 The Router sheet

In the file **SoilNet_Maintenance.xlsm**, the second worksheet is where the routers have been documented.

Mostly the same as the End-Device sheet, but it has two more columns (between battery type and firmware: "Runtime". This is the interim period (in days) between two dates where the battery was exchanged. This entry is automatically calculated by excel when the dates were entered.

The other additional column, called "Supply", shows how the router is supplied (e.g. by solar panel or mains).

Usually, there are no sensors connected to the routers (*but it could, as the pcb board is the same as the board in End-Devices of version 1, but with a different firmware*).

SoilNet		Rollesbroich		ROUTER							
Sq/Nr	Problem	NR	Date	Voltage	Date	Battery	Runtime	Firmware	Supply	Action	Nr
5	BAT	R 311 (316)	12.03.2012		12.03.2012	A16	46 Days	(Ro V08)			R 311 (316)
6	BAT	R 311 (316)	27.04.2012		27.04.2012	A27	38 Days	(Ro V08)			R 311 (316)
7	BAT	R 311 (316)	04.06.2012		04.06.2012	A37	53 Days	(Ro V08)			R 311 (316)
8	---	R 311 (316)	21.06.2012		21.06.2012				2 P	2. SolarPanel installiert	R 311 (316)
9	BAT	R 311 (316)	27.07.2012		27.07.2012	A39	1432 Days	(Ro V08)	(2 P)		R 311 (316)
22	BAT	R 311 (316)	28.06.2016		28.06.2016	A69	304 Days	(Ro V19)	(2 P)	Frei geschritten Akku	R 311 (316)
23	BAT	R 311 (316)	28.04.2017	4730 mV	28.04.2017	wip		(Ro V19)	(2 P)	Batterie entfernt -> stillgelegt	R 311 (316)

Router Numbers
if in yellow := solar supply

Runtime of
battery

in black: router is terminated

2.2.3 Actual_Maintenance (sheet)

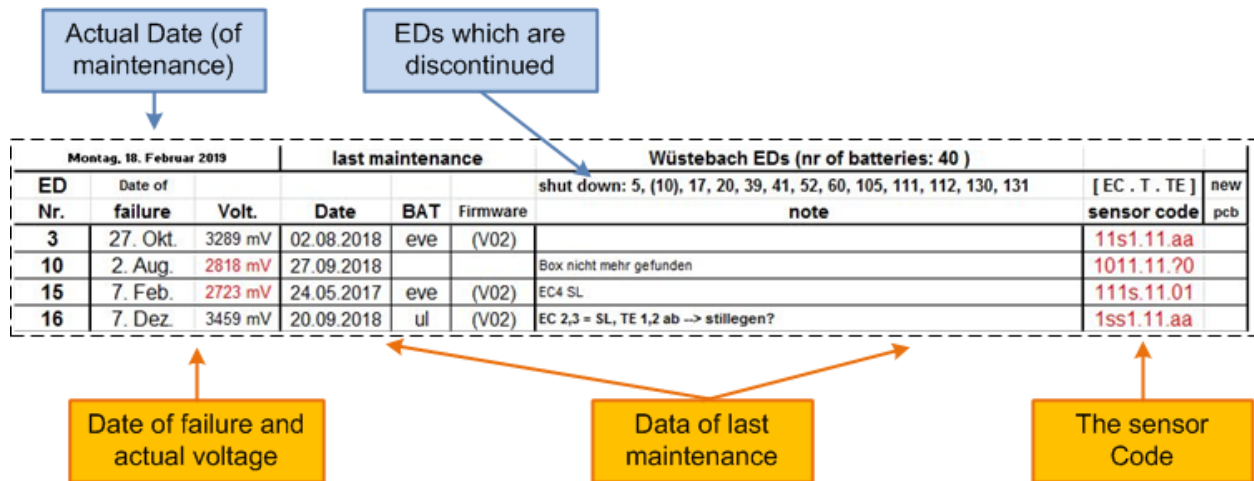
This sheet is created in advance from the maintenance files to then go into the field and carry out the maintenance: **SoilNet_Maintenance_Actual.xlsm**

The current state of the network (see incoming data via CPA software) is compared with the maintenance files and this sheet is created from this.

If you are used to work with Excel, you can copy/paste the entries. Please note that the insertion should be done without formats (only values).

The voltage at the date of failure is automatically set in "red" if it is below 3100 mV.

The number of devices to be serviced is counted and displayed in the header line (nr. of batteries: xx).



2.2.4 Maintenance_Maps

To locate the devices to be serviced quickly in the field, a „road“ map can be created.

As a template, the files:

n:\SOILNET\Wüstebach\Wartung\SoilNet_Maintenance_Map_WÜ.vsd or
n:\SOILNET\Rolesbroich\Wartung\SoilNet_Maintenance_Map_RO.vsd

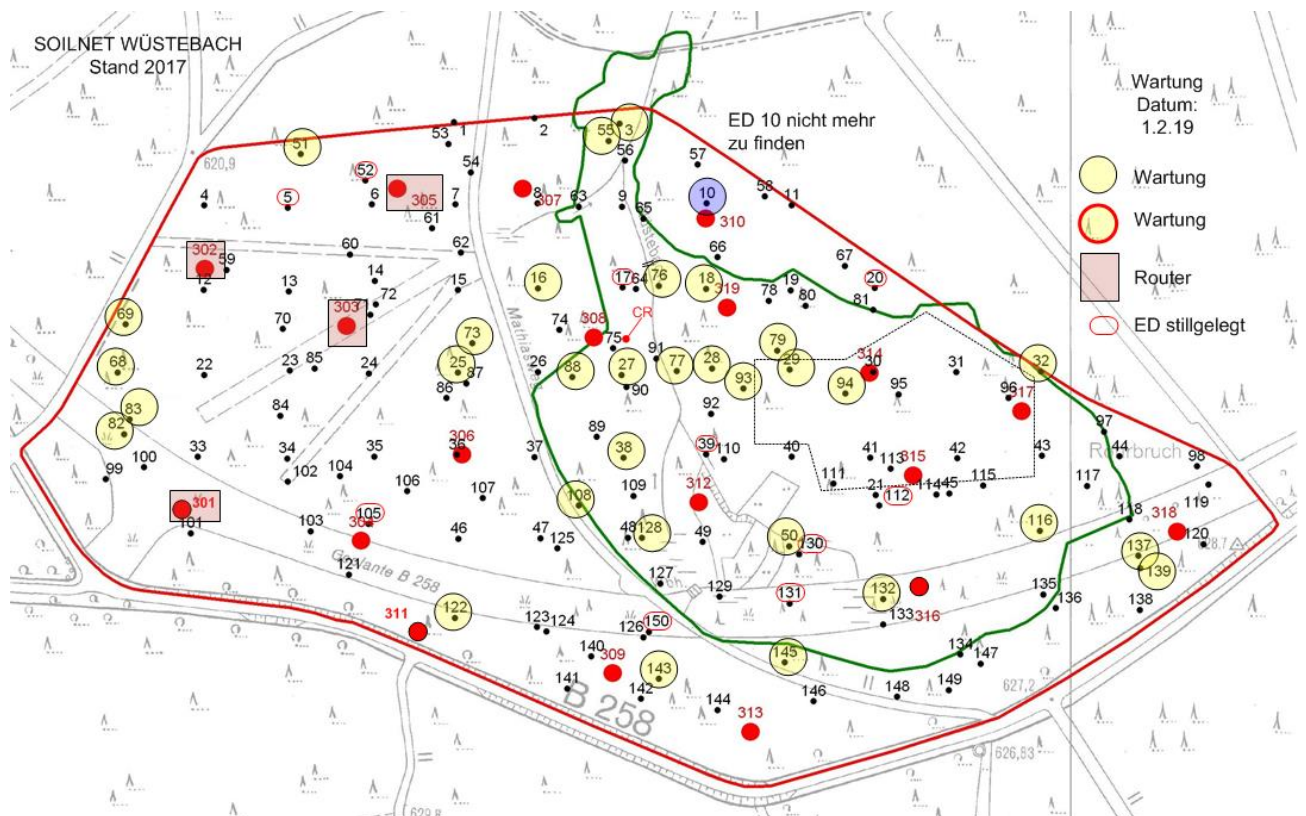
can be used.

Edited with Microsoft® Visio, it shows the locations of maintenance:

The normal maintenance is marked by the yellow circles (with or without red border), the last ones serve special cases, e.g. board exchange.

The maintenance of routers is marked with pink rectangles.

The devices which have already been shut down are marked with a narrow red border, these are already entered in the template.



Together with the current maintenance sheet, this document is scanned after use and stored in the "Protocol" folders (e.g. n:\SOILNET\Rolesbroich\Wartung\Protokoll).

2.2.5 Maintenance sheet for Batteries

Three types of batteries are used:

- Rechargeable batteries for routers
- Non rechargeable batteries for End-Devices
- Rechargeable batteries in combination with solar panels for End-Devices

Regarding End-Devices: Documentation of consumption of disposable batteries in End-Devices is only available in maintenance documentation (see 2.2.1).

Please also note the safety instructions, because these batteries contain Lithium and are therefore subject to strict regulations with regard to transport and handling. (see 1.4.1).

Much more important is the documentation of the batteries that are operating in routers either with or without solar panels and need to be charged regularly. If their voltage drops too often below 10,8V they can be damaged – and they will!

Please find this Excel sheet under n:\SOILNET\Service\Akku\Battery_Maintenance.xlsm

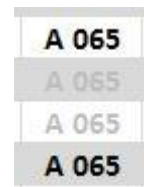
The screenshot shows an Excel spreadsheet with the following columns: SqNr, NR, Type, Use, Date, Location, Date, Location, Return Voltage, Runtime, Volt.Loss, Capacity, Note, Status, and Statistics. Callouts point to various features: 'sequential number' points to the 'SqNr' column; 'used, when and where' points to the 'Use', 'Date', and 'Location' columns; 'test results' points to the 'Capacity' column; 'status and statistics' points to the 'Status' and 'Statistics' columns; 'Battery-Number and type' points to the 'NR' and 'Type' columns; 'return state of the battery' points to the 'Return Voltage' and 'Runtime' columns. A 'sort button' is also indicated on the 'NR' column header.

The first column is a consecutive number per battery for each entry. If it is “1”, the cell will be shown inverted, this is only for optical reasons.

The second and third column are date and location, where and when the battery is currently used (if so). The status is also entered in the "status" column. Only valid values are allowed here (via dropdown):

Status
Available
Spare
In Use
Rejected
Uncertain
Test, current

If “rejected” or “uncertain”, the battery number will be grey:



If the capacity of a battery is tested, the result is entered in the “Capacity” column. Depending on that value, the color also changes. If the capacity is bad (below 30Ah) the entry for “Status” should be “Spare” or, if it is too low, the battery should be rejected.

If the battery is returned from use, the cells in the columns “Return” should be filled. The running time is calculated in days and if the last measured voltage is entered, the voltage loss per day is calculated also.

At least, there is a little statistical display at the upper right corner, for information.

2.3 Practical Maintenance

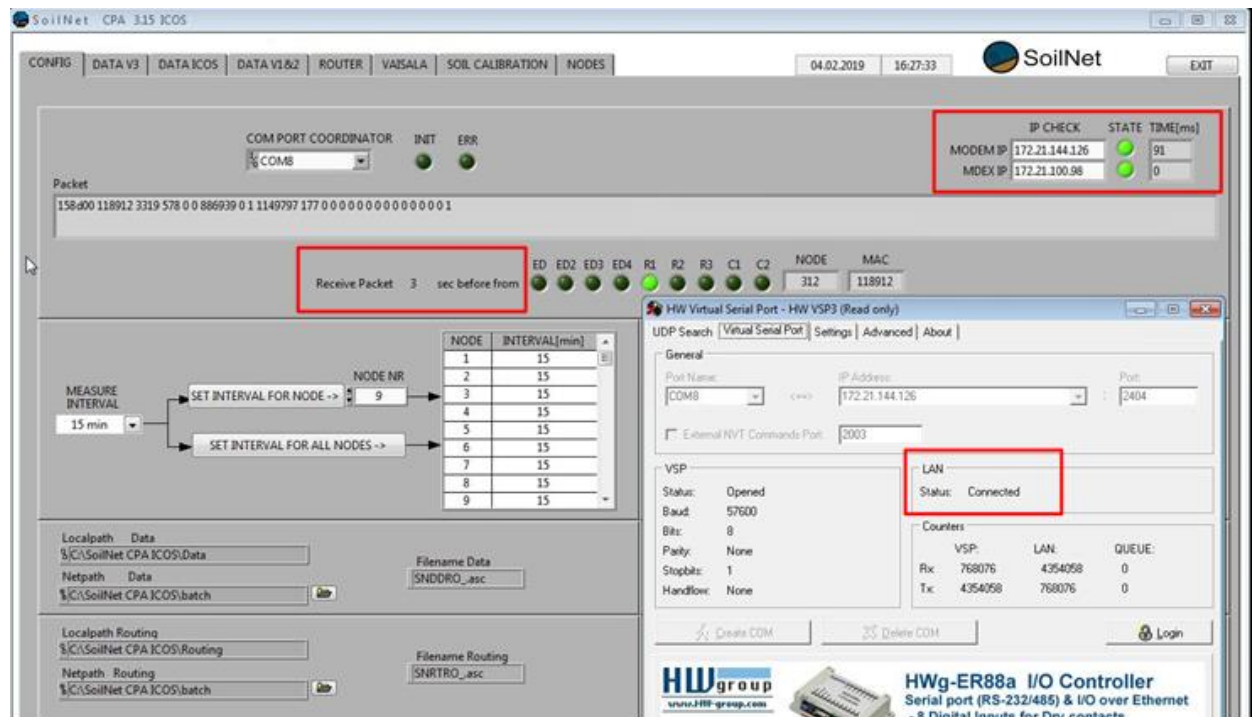
2.3.1 Radio and Mobile Net

If no data are received at all, the radio link and the mobile connection should be checked. These depend on the customers arrangement and can be very individual.

In most cases, such connection problems can be fixed from the institute.

Please check your installed CPA software. There are two LEDs in the right upper corner of the “Config” tab. They should be lit. If the upper LED is not lit, the modem or the connection to the modem is not working.

There is an additional tool installed, the virtual COM port driver. This driver represents the connection from the mobile network to the CPA via a serial COM port. The state of the Driver should be “connected” (it’s icon you can find in the system tray). If not, check the parameters of the driver (see picture).



For further information, please refer to the manual “**SoilNet CPA**”.

Further reasons for the failure of the modem can be:

- Power supply
- INI-files destroyed:

Since Windows10 regularly shuts down the computer to make updates, it can happen that the program CPA is simply terminated irregularly. It is likely that the initialization files will be corrupted and the program will not work properly after a restart.

Therefore, the CPA has to be shut down (be sure to use the Exit button at the top right.) and the initialization files must be restored from the backup folder (simply copied).

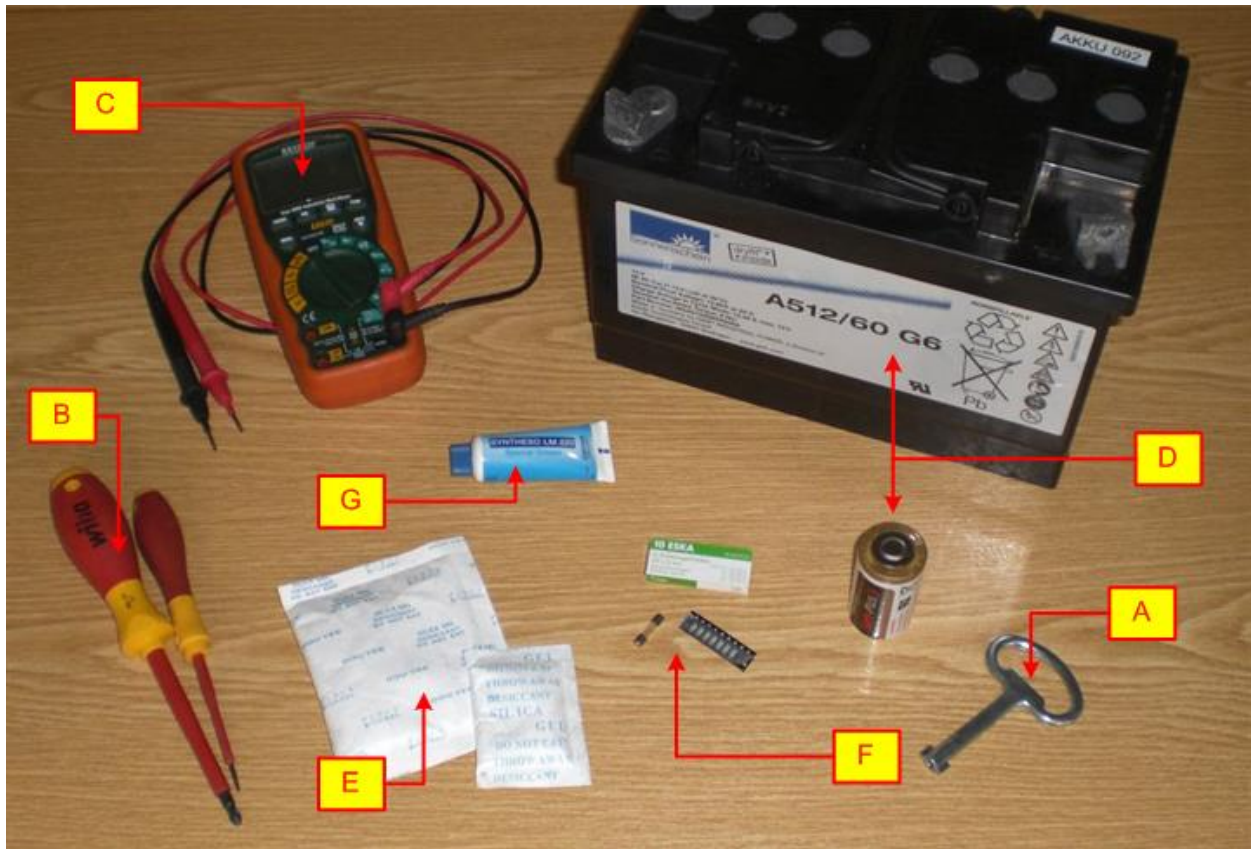
The backup folder should be created on an external medium **immediately after purchasing the system**, from which the INI files are then restored into the directory “\Soilnet\Init”.

Also, this backup should be made at regular intervals to keep it up to date (always after terminating the CPA).

2.3.2 Maintenance in the field

When performing maintenance in the field, you should be equipped with the following tools:

- (A) Key for the router housing
- (B) Screwdriver (Philips cross type, PH2; little slotted type)
- (C) Multimeter
- (D) Spare batteries for:
 - Routers: 12V lead-gel
 - End-Devices: 3.6V lithium
 - End-Devices w solar: Rechargeable AA type (1,2V; 3 pcs in series)
- (E) Spare Desiccant (dried)
- (F) Spare fuses, for:
 - Router-PCB, ED-PCB, Vers.1: smd type, 125mA / 500mA
 - Router battery: Fine Fuse 5x20mm, 1A
 - End-Device, PCB, Vers >1: smd type 3A
- (G) Special grease for sealing



Generally: a general tool set is highly recommended!

Many errors in the field are caused by poor electrical contact.

Please check any connections between the components.

If water or moisture is visible in the equipment, it must be completely dried. This may require components, e.g. pcb-boards to be removed. Only when everything has dried and cleaned, the device may be switched on again. Before the housing is closed, fresh (dried) desiccant must be added.

Desiccant is available in various sizes, it must match the housing size. For our End-Device 10g bags are used, for the routers 50g or more.

2.3.3 Router / Coordinator (Wüstebach & Rollesbroich), V1 – V3

Version differences:

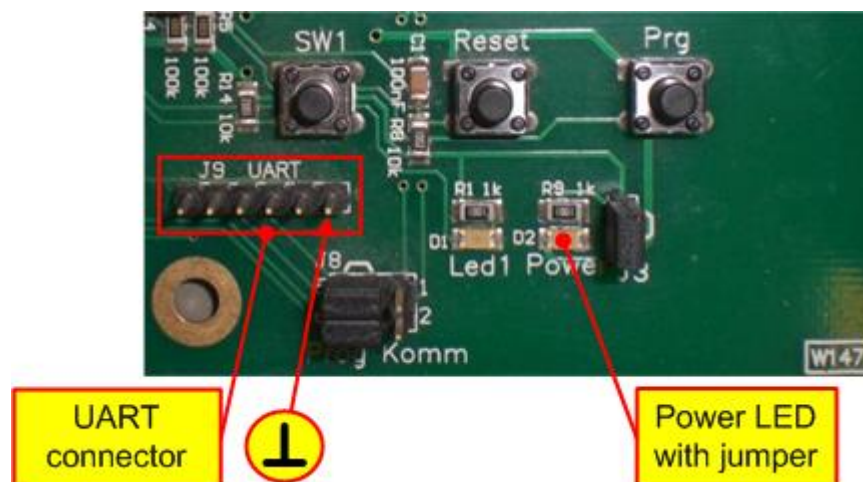
- SoilNet V1: same PCB for Routers, Coordinator & End-Devices (W147, W228)
- SoilNet V2 ... V3: same PCB for Routers & Coordinator (W147, W228)
different End-Devices
- SoilNet V4 ... V5: no Routers anymore,
similar End-Devices as versions before,
Concentrator (raspberry pie) instead of Coordinator

Power Supply

The power supply of routers / coordinator may vary:

- Battery
Batteries are Lead/Gel type 12V/60Ah, the running time lasts about 3-4 months.
The voltage of these batteries should not fall below 10.8V.
Therefore a battery guard should be installed (which is not the case with older models), to protect the battery against deep discharge, which destroys the battery.
- Solar
Also, a battery like above is installed to buffer the voltage if the panel fails (like bad weather, snow etc). A solar charge controller with voltage protection should be installed.
- Mains
A buffer battery is also installed. Instead of solar supply, there is a power supply for mains, which is normally 230V.

In all cases when the router is switched on and the jumper J8 is set, the “Power” LED should lit.

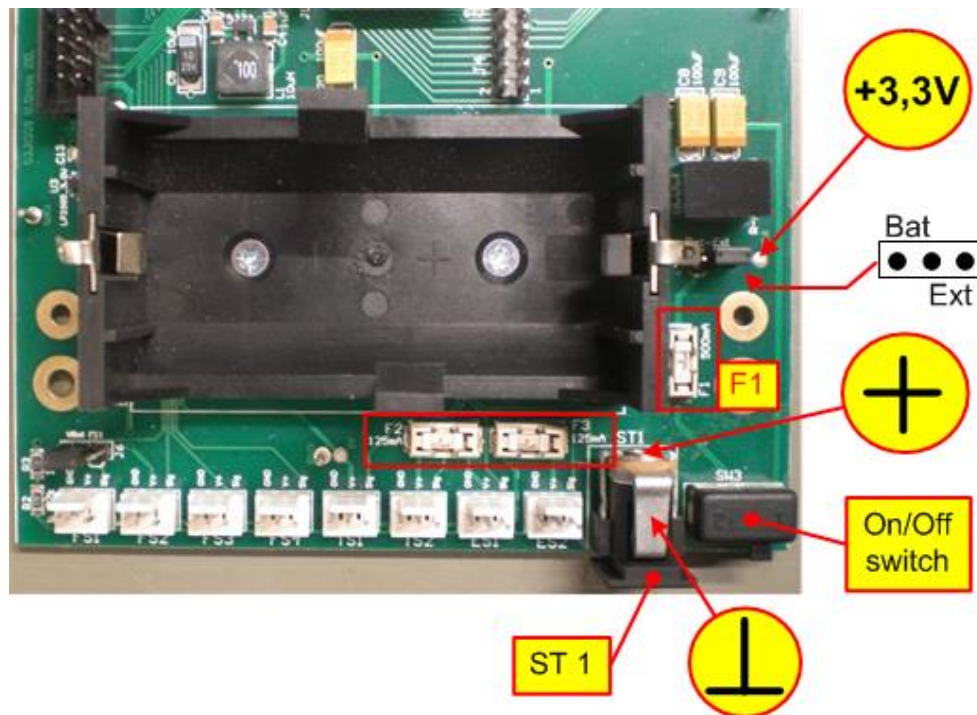


If the router is connected to the network, the LED1 to the left of the power LED should blink.

The UART connector J9 is used to update the firmware ([see next chapter 2.3.8](#))

2.3.3.1 Power by battery / solar panel

- Check the extern battery voltage (should be above **10,8 V DC**).
- Check the voltage of the solar panel and the output voltage of the solar charge controller. The voltage can be measured at the input socket ST1 of the PCB, the inner pin is positive, the outer contact is ground.
- Check the fuse **F1** (smd type, 500mA) on the router board.
F2 and F3 are to protect sensors. Normally no sensors are connected to routers (except two temperature sensors in older routers).
- There could be an additional fuse before the battery. This is a fine fuse (5x20mm, 1A quick).
- The Jumper J2 must be set to the right, "Ext".
- At the test point "Vext" the voltage regulator can be tested, it should show +3,3V.



2.3.3.2 Power by mains supply (230V)

Also the router could be supplied with mains power. Check the mains voltage (in Europe normally 230V AC) and the function and output of the charger (around 12-13V DC).

2.3.3.3 Antenna / Modem Electronics

Please check also all connections of the antenna in the router. The outer connection (at the antenna, mostly N-type) should be protected by **self-bonding electrical tape**.

Between the pcb board and the antenna cable there is a very thin cable, called a “**pigtail**”. It connects the microprocessor with the antenna cable. The connection is very small and sensitive (snap fastener), so be sure everything is in the right place.



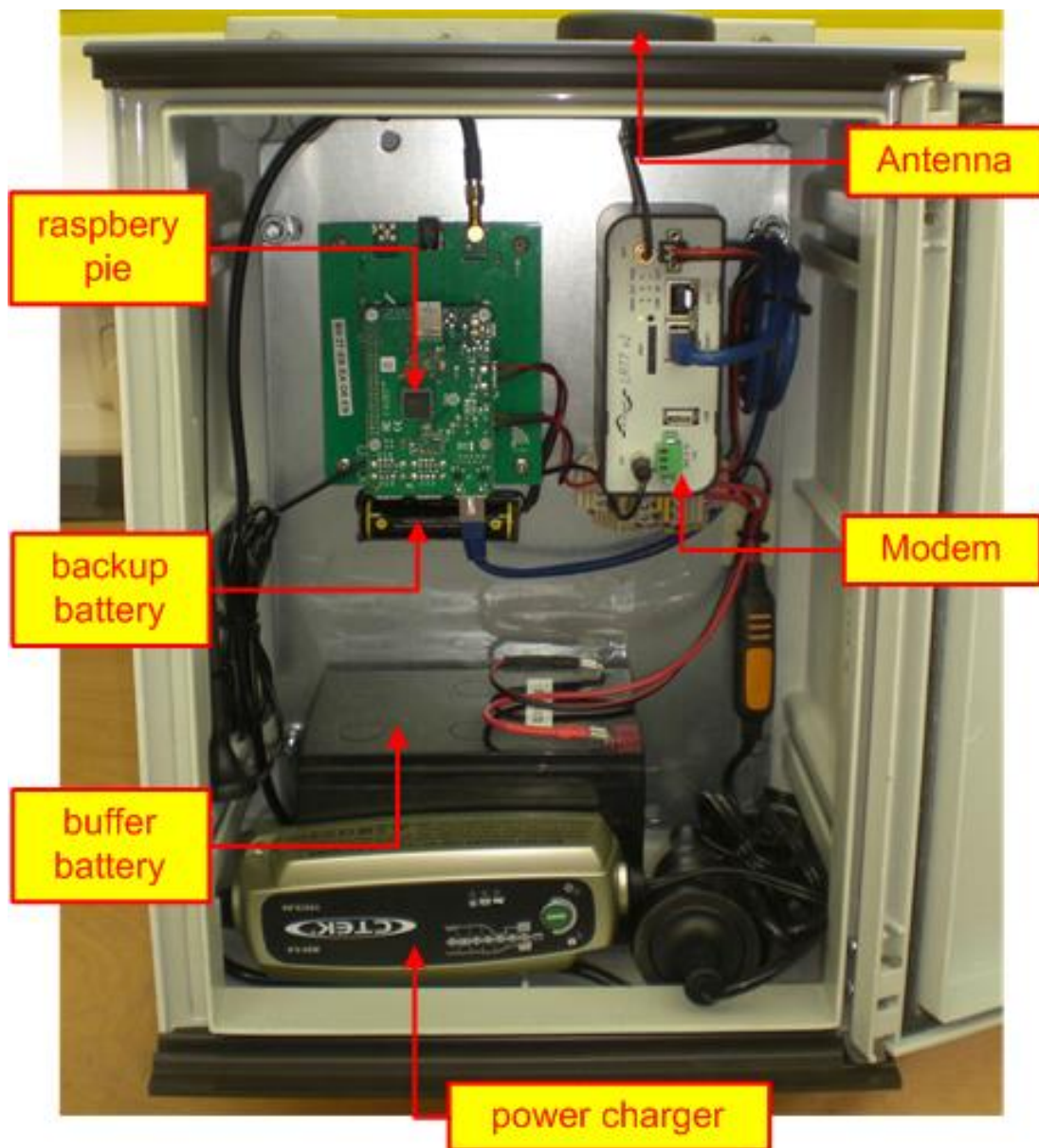
2.3.4 Gateway (V5)

With SoilNet Vers.5 the “Coordinator” of previous versions has changed to a Gateway (LoRa). It is based on a Raspberry Pi computer. No more additional routers are needed in the network because of the extended range of a LoRa network.

As well as for the maintenance of routers, all connections must be checked here. The buffer battery for the mains is some smaller, a 15Ah type is used here.

The power charger should be enabled (standard loading, see CTEk manual).

Additional there is a special backup battery (ecell Lilon Battery, 2600 mAh, 3,7V) for the raspberry pie.



2.3.5 End-Devices Wüstebach



SoilNet End Device V1



SoilNet End Device V3

The SoilNet in Wüstebach was the first SoilNet installed (V1).

The Sensors used were mainly from Decagon (EC5 and 5TE), the temperature sensors were from the Dutch company SmarTec.

The problems that have emerged over time are mainly:

- No Radio contact
Each covering with biomass or water produces a damping of the radio contact.
- Battery is empty.
- Water penetrates into the housing
- Sensors are defective

Generally:

If an End-Device is not working anymore, please check first the common radio contact ([see Router maintenance -> 2.3.3](#)).

First, check the device for optical issues:

- Open the device by unscrewing the four screws on top and remove the lid.
- Check the sealing in the lid. The silicone should be undamaged and clean and lies straight in the groove of the lid.
- If any moisture or water has penetrated into the housing, the device must be completely dried.
There is often only little condensation in the lid or on the walls of the enclosure, but it can also happen that the complete circuit board has to be removed. In this case, mostly it is not necessary to remove the connections to the sensors.
When the board has been unscrewed, it can carefully be lifted and the enclosure can be dried with a paper towel or a tissue.
- Check the cable glands to be tightened firmly.
- If the board shows any corrosion, or even conductor lines are damaged, or some components on the board are attacked, the board must be removed and repaired or replaced.
Keep in mind, the Jennic modules uses an MAC-address, which is registered in the CPA software. There, it has to be changed if the module is replaced in the device.
- If the sensor connections have to be removed, remind the connection sequence.

Now, check the electrical issues:

- Switch off the device.
- The Jumper J2 has to be set to “Bat”.
- In “running” mode, the “Power” LED is switched off by a jumper (J3) right near the LED. To check, please set the jumper temporarily. Check, if the LED is lit.
- If the LED is not lit, check the battery voltage with a multimeter, it should show above 3,1V.

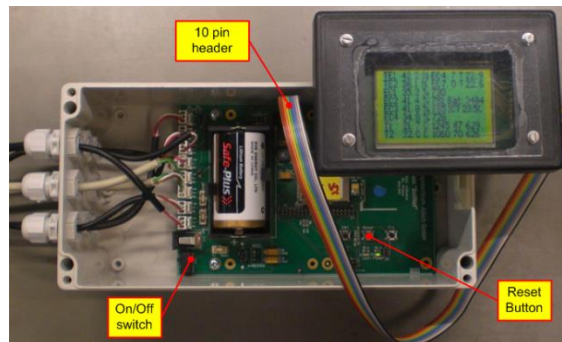
Replace the Battery if needed.

Observe the rules for handling lithium batteries! – see 1.4.1

Don't forget to remove the jumper after check to prevent unnecessary power consumption.

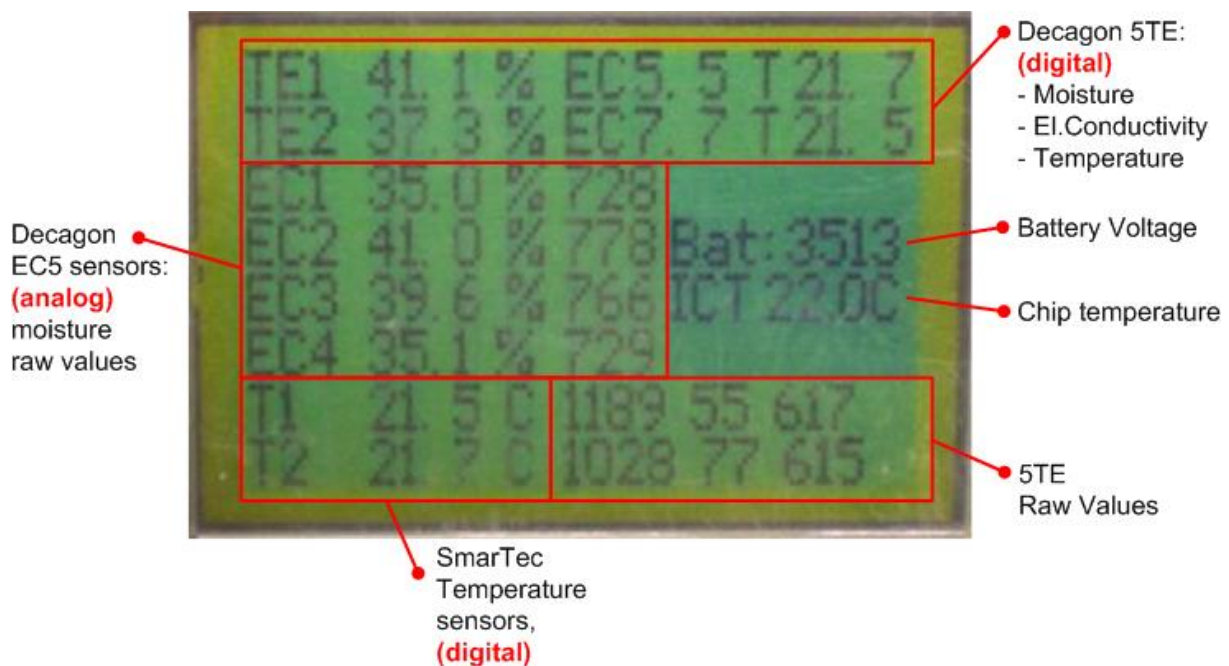
After the power supply is checked and the device is made to work, the data display can be connected:

- Make sure, the device is switched off.
- Connect the Display to the End-Device (using the 10-pin header).
- Switch on the device by holding the “reset” button, then release “reset”.



The device should start measuring and after a short time, the display should show the results.

Now, check the values of the display:



Upper rows, *Decagon 5TE sensors:*

- Soil moisture, volume percent
- Electrical Conductivity
- Temperature

Middle rows, left, **Decagon EC5 sensors:**

- Soil moisture, volume percent
- Raw Values

Middle rows, right, **Device values:**

- Battery voltage
- Chip temperature of Jennic Module

Lower rows, *Smartec Temperature sensor:*

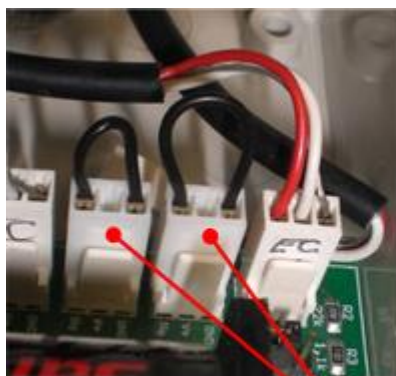
- Temperature
- (5TE: raw values)

Sensor failures

Sometimes, even with a new battery, the display shows a low voltage, 3,3V or 3,1 V, for example. The reason may be a defective sensor, which is drawing a lot of current and therefore the voltage drops.

So the individual sensors have to be tested by disconnecting them piece by piece. If one sensor is disconnected and the voltage significantly rises about 100mV or so, the power consumption of the sensor is too high and the sensor should no longer be connected.

Depending on the operating mode of the sensor, analog or digital, the input of the circuit board should be short-circuited **if analog (here: EC5 sensors)**. Otherwise, with open inputs, the value is floating and the display shows random values.



PCB	
ung sinkt schnell	UL EC 3=0/SL
+2=0	UL W25FR
TEs weg ??	RST
?	EC1=99=SL, UL, W
=0	RST hängt UL
laufen	UL
!!!	EC2=SL UL

SL = Short Link

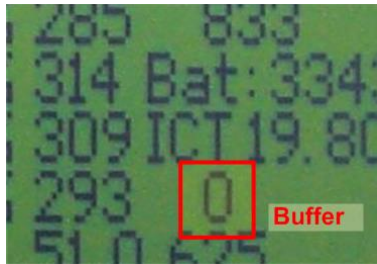
As you can see in the picture, EC2 & EC3 have been replaced by short-circuit bridges.

Defective sensors often show values of about 0% or 99%, this has to be noted on the protocol sheet and at least in the excel file also.

On **digital inputs (like 5TE or Smartec)**, no shortlink is needed, if the input is open the value shows 0%.

Switching on and connecting to the network

If you're done with your maintenance and have the End Device running, take a last look at the display. Start the device again, after some time you should see a "1" and, after a while later you should see a "0" on the display underneath the chip temperature.



Internally spoken, this is a number of data buffer, but practically these are confirmations that the data packages are received at the institute. After that, the device will go to sleep mode.

If there will be no confirmation, the radio contact or the mobile network may be disturbed temporarily. Nevertheless, the device is working and (hopefully) getting confirmation the next time, data will be sent.

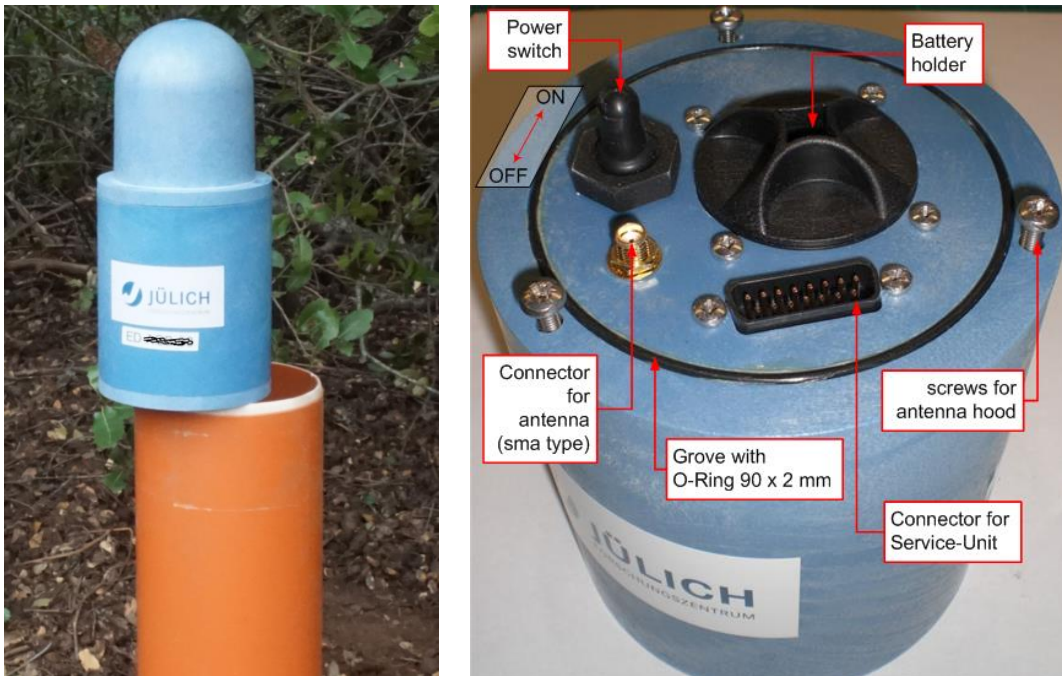
Closing the housing

- Now you can close the device, but don't forget to fit the housing with desiccant gel.
- Check the cable glands for tightness.
- Also, please check the O-ring in the lid of the housing for correct position and intactness.
- When screwing down the device, please tighten the screws evenly crosswise.

2.3.6 End Devices Rollesbroich / Wüstebach 2

To the routers and the coordinator, the same applies as in chapter 2.3.3.

Since Version 2, the End-Devices got a new housing and are covered with a KG tube in the soil.



Also, there are different sensors for soil moisture used: **Truebner SMT-100** and sometimes **Decagon MPS-6** sensors for matrix potential.

Basically, any SDI-compliant sensor can be connected as long as the power consumption and supply voltage are not too high.

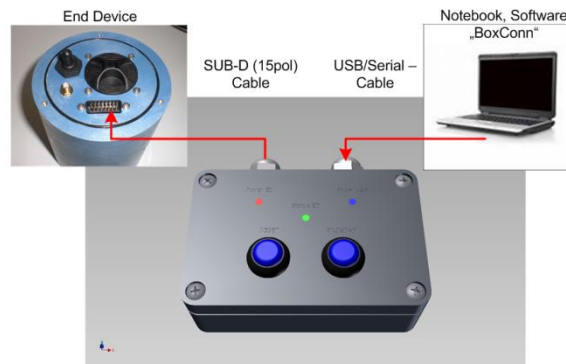
Maintaining the End-Devices requires the following steps:

- Open the lid of the KG tube.



This can be done with a special tool we also provide:

- Pull the device out of the tube and place it on the edge of the tube (see picture above). *Attention: the cables of the sensors have to be long enough. This must be taken into account during installation.*
- Loosen the three screws at the base of the antenna hood. The screws do not have to be unscrewed completely because of the bayonet locks of the hood.
- With a short turn to the left, the hood then can be removed, paying attention to the antenna cable (do **NOT** remove!).
- There should be no water or moisture inside the hood or the surface of the End-Device. Check the O-ring also and dry if necessary.
- Switch off the end device.
- Connect the Service-Unit with its multi-pin plug to the End-Device. Watch out for the right direction.



- Connect the Service-Unit via USB to a (off road) laptop where the following software is installed already:
 - FTDI serial to USB drivers (see above)
 - NXP JN51xx Flash Programmer (possibly, if updates needed)
 - BoxCon software (especially for SoilNet from FZJ Jülich, please use “BoxCon Manual V1.17.pdf” also)

(The “power USB” LED on the service unit should lid if a PC is connected).

- Start the “**BoxCon**” software.
- Set the right COM port (as seen in device manager) and watch the “data” tab.
- Push and hold the reset button on the service unit and switch on the End-Device, then release the reset button.
The “Power ED” LED on the service unit should lid. **If NOT:**

Change the battery of the End-Device.

- Again: **Observe the rules for handling lithium batteries! – see 1.4.1**
- Switch off the device
- Just turn the lid of the battery holder counterclockwise.
- Insert a new battery (with plus pole upwards).
- Close the lid again.
- Switch on the device and continue with checking the data with **BoxCon**.
- In the upper frame of the **BoxCon** software, you see a progress bar running while the End-Device is taking a measurement. After that, the values of the sensors will be shown. *If a log file is required, the switch “data record” in the frame of the software should be set. Under the chosen path, a file “Box_xxx.dat” will be created.*
- Beside the measurements, some general data will be shown also: ED number, firmware version, MAC address and some state LEDs are visible in the frame area of the program.
- Check the displayed data of the sensors if they are correct. If any sensor doesn’t show valid data, it must be replaced (or just disconnected if the expenditure is not desired or justified, [see below](#)).
- Check the configuration of the End-Device:
 - Chose the second tab in the BoxCon: “Box Config & Data download”
 - Click the big red button called “Push To Activate Config Mode”
The color of the button changes to yellow and shows “Push ED reset button”. After resetting the device, the tab will show the configuration data.
 - Please check the values: Timestamp, Measure Mode, Interval, ED-Number
Some buttons “Set” are highlighted, so they can be set, if wrong data is stored.

- For more information about the config tab, please refer to “BoxCon Manual V1.17.pdf”

Disconnecting defect sensors

If the End-Device does not work even though the battery has been replaced and the configuration is valid, the reason may be in the sensors, electronics or their connections.

- Open the lower lid (with the cable gland) by unscrewing the six screws.
- Check the device for water or moisture inside the housing, dry it if necessary.
- Check also the O-ring is undamaged and embedded correctly in the groove.
- Pull out a little bit the board, so that you can get the connections.

Sometimes, even with a new battery, the voltage drops to 3,3V or even 3,1 V, for example. The reason may be a defective sensor, which is drawing a lot of current.

So the individual sensors have to be tested by disconnecting them piece by piece. If one sensor is disconnected and the voltage significantly rises about 100mV or so, the power consumption of the sensor is too high and the sensor should no longer be connected.

- Disconnect the sensor detected as faulty by pulling the connector carefully, possibly using a flat screw driver to bend the rear flap backwards if needed.
- Since the V3 boards only connect digital SDI-12 sensors, there's no need of short circuit the inputs ([compare with V1:chapter 2.3.5., page 19](#)).
At least,leave the connection open.
- Switch on the device while monitoring it with the **BoxCon**.
The line of the disconnected sensor should be left empty after the measurement.
- If the device is working correctly so far, close the box:

Closing the housing

- Make sure to provide the device with a dry desiccant.
- When inserting the board again, take care of the pigtail (the thin cable between processor and antenna socket).
- Check the O-ring again in its groove and that it is lubricated with grease.
- Ensure a clean surface on the housing parts.
- Carefully close the lid, watch on the drill holes of the screws.
- When you tighten the screws be very careful:
tighten the screws hand-tight crosswise.

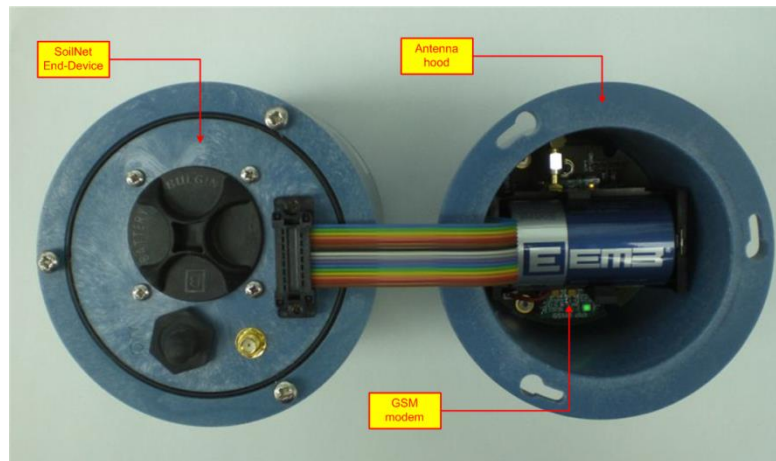
After all: Leave the End-Device running.

- Disconnect the Service-Unit.
- Check the O-ring under the hood for correct position and intactness.
- Lubricate the O-ring if needed.
- Ensure a clean surface on the housing parts.
- Close the Antenna hood, tighten the three screws handtight!
- Insert the device back into the KG-tube and close it with the cover.

2.3.7 GSM Modem Version

The transmission paths of SoilNet can be different:

- Version 1-3: Radio (2.4 GHz with routers / coordinator - Jennic Technik)
- Version 3b: Direct transmission via modem / e-mail
- Version 5a: LoRa (Long Range 868 Mhz with "concentrator")
- Version 5b: nbIoT (narrow band Internet of things)



Due to its high power consumption, the modem has its own battery and due to the space requirement it is housed in the antenna hood. The antenna for the modem is very tiny, so everything fits in the hood.

- If you maintain an End-Device with modem, follow these steps:
- Switch off the device
- Disconnect the ribbon cable to the modem from the service connector.
- Maintain the End-Device as described before.
- Re-connect the ribbon cable to the modem.
- Insert a new battery for the modem into the hood.
- Switch on the device.

After 15 seconds, have a look at the LED light inside the Modem.

One LED shows that the modem is on and a second LED (flashing) shows the status of the mobile connection.

The Modem LEDs are only ON during the sending progress.

After nearly 1 minute this progress is ready and the lights are switched off.

IMPORTANT:

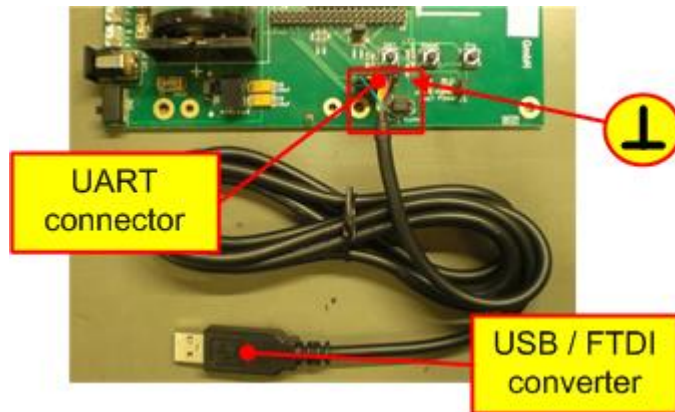
After switching on, it is recommended to call a colleague in the institute, sitting at the computer with the CPA software, to find out that the device has measured and sent the data packet via modem.

At least, the hood can be closed. Leave the box powered on. The device can now be re-inserted into the KG-tube.

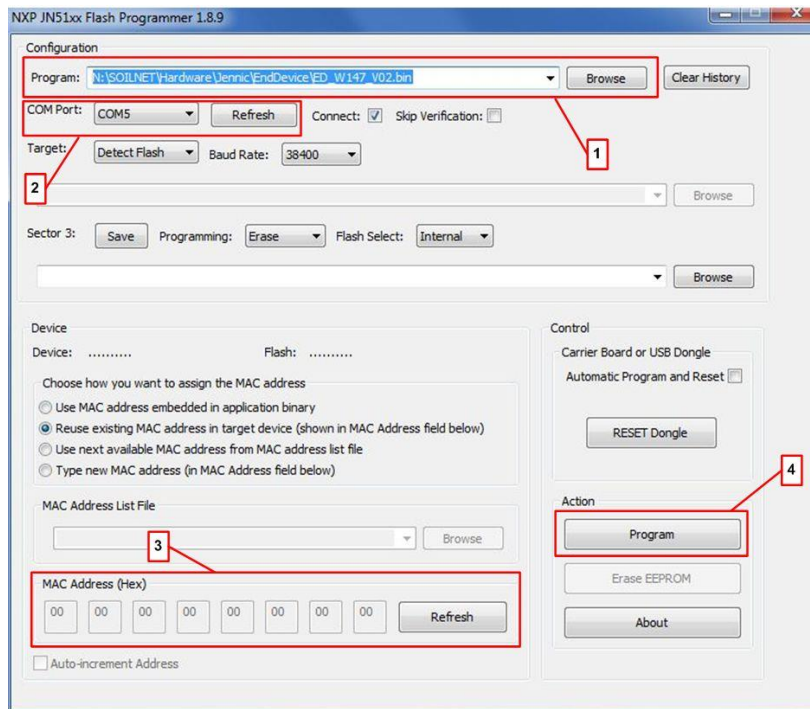
2.3.8 Updating the firmware

2.3.8.1 End-Devices V1 / Router & Coordinator until V3

(PCBs W147 and W228)



- Make sure, the PCB is switched off
- Connect the shown USB-Serial Converter to the PC.
This must be an 3.3V FTDI converter.
At the 6-pin UART connector, the **black wire is ground**, which is the rightmost pin.
- Install the Virtual COM Port driver on a PC.
*For **WIN XP** you need to download the driver from the Internet at <http://www.ftdichip.com/FTDrivers.htm>.
When you connect the USB serial cable for the first time, Windows XP will detect the new hardware and open the “New hardware detected” window.
Windows XP will then install two drivers: the USB driver and the driver for the virtual COM interface.
On **Windows 7** or later, the hardware detection will automatically recognize the serial cable and will install the drivers automatically.*
- Install and run the Jennic Firmware software (NXP JN51xx Flash Programmer).
- Set the PCB of the router to “programming mode”:
 - Press and hold the button “reset” and “prg” while switching on the board
 - First, release the reset button, then release the “program” button.
- In the software
 - Set the COM port [2]
(you’ll find the number in the device manager of windows, under “Ports (Com & LPT)”)
 - Press “Refresh”
The actual MAC Address of the device is shown [3].
If the Address is not shown (maybe the module has lost the address), you can type it by hand in the fields to the left of the “refresh” button. Therefore, the checkbox “type new MAC address ...” above the fields must be enabled.
 - Choose the right flash file, e.g. “R_C17_W228_V025_Rollesbroich.bin” with the “browse” button [1] from your backup files.
 - Press the “program” button [4]

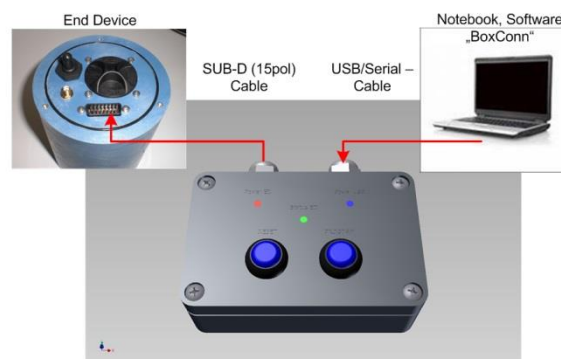


- After the update process is finished, you can start the router by pressing “reset”. If it connects to the network, the LED1 should blink.

2.3.8.2 End-Devices V3

(PCBs W218 and above)

Updating the V3 End-Devices is fairly easy, what you need is the Service-Unit we provide. As well as for maintenance, connect the unit to the device and a PC.



Please follow these steps:

- Switch off the End-Device.
- Connect the Service-Unit with its multi-pin plug to the End-Device. Watch out for the right direction.
- Connect the Service-Unit via USB to a (off road) Notebook (The “power USB” LED on the service unit should lid if connected). The following software should be installed already:
 - FTDI serial to USB drivers (see above)
 - NXP JN51xx Flash Programmer
- While pressing and holding the **reset** and the **program** button, switch on the End-Device.

- Release the **reset** button first, then release the **program** button
The End-Device is now in programming mode.
- Open the Flash programmer software on the PC.

Note:

If you do the next steps in the software while the End-Device is not yet switched on in programming mode, the flash software may quit with an error (“check cabling and power”), so you have to start again.

- Check the COM port [2] to be the right one (see previous chapter and figure).
- Press “Refresh”.
The actual MAC Address of the device is shown [3].
If the Address is not shown (maybe the module has lost the address), you can type it by hand in the fields to the left of the “refresh” button. Therefore, the checkbox “type new MAC address ...” above the fields must be enabled.
- Choose the right flash file, e.g. “ED_C17_W251_V047_80_2gb.bin” with the “browse” button [1] from your backup files.
- Press the “program” button [4]

The End-Device will be updated with the chosen firmware. If you get the message to be ready, you may start the End-Device by pressing “Reset” on the Service-Unit again. If you want to check the measurement, first close the flash programmer, open the “BoxCon” software and then reset the End-Device.

Note:

You can never run two programs using the same COM port at the same time. As both the NXP programmer and “BoxCon” use the same COM port, they can only be used alternatively.