Jülich, March 2016

SoilNet Control Panel Application

Functional Description and

Operating Instructions

V3.14

Wireless Sensor Network for Measuring Soil Moisture

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Table of Contents

1 Functional Description

The SoilNet CPA software is described in the following sections.

1.1 Receiving Data Packets from the Coordinator

The coordinator receives the data packets from the components of the sensor network (*SoilNet EndDevice* & *SoilNet Router*) and transmits them to a Laptop (PC). Two data transmission options exist:

- Data is transmitted by modem. In this case the **C**ontrol **P**anel **A**pplication receives the stream of data via a virtual COM connection (HW Virtual Serial Port)
- Data is transmitted using a COM-Server (RS232->TCP/IP) or directly via the serial port.

1.2 Sorting by Packet Type

The received packets are initially sorted by type; an identifier is used to distinguish the source (e.g. SoilNet router packet). .

1.3 Adding the Node Number Using a MAC Address Mapping Table

The node number is determined from the transmitted MAC address of the wireless module using a configured table (NODES tab). Using this table, the data are mapped to corresponding node number.

1.4 Converting the Raw Data into Real Data

In order to be able to verify the transmitted data, the raw data are converted into the calibrated real data (see “calibration”). These data are available in the form of tables.

1.5 Data Output

In addition to the onscreen data visualisation, several output files are also generated:

The following file type contains the information from SoilNet components for entry in a database.

- SoilNet EndDevice: c:\SoilNet\Data\data.dat
- SoilNet RouterDevice: c:\SoilNet\Routing\routing.dat

- Vaisala: c:\SoilNet\Data_Vaisala\data_vai.dat

A script should regularly write the contents into a database. To do this, **move** the existing data files to another destination (Copy & Delete) and start the script parser at destination. New data files will be automatically generated by the CPA Software.

An example batch file can be found here: C:\SoilNet\batch\

The script execution time must be adapted to the measurement interval to ensure that the database is always up-to-date.

Further output files are generated individually for each component of the wireless sensor network. This facilitates a node-related analysis.

- SoilNet EndDevice c:\SoilNet\Protokoll\Box_xxx.dat
- SoilNet RouterDevice c:\SoilNet\Protokoll\Rou_xxx.dat
- Vaisala Weather Transmitter c:\SoilNet\Protokoll\Router_xxx_Vaisala.dat

The specific file formats are documented in Chapter 5.

1.6 Connection Tests

To ensure reliable operation using a modem, a PING command is sent to the modem and the MDEX server (if applicable) at regular intervals. An indicator shows the status “STATE” and “TIME[ms]“.

1.7 Measurement Interval

The measurement interval for each SoilNet EndDevice can be set on the interface within a range from 3 minutes up to 12 hours. (3min, 6min, 12min, 15min, 30min, 60min, 2h, 4h, 6h, 12h)

1.8 Restarting the Coordinator

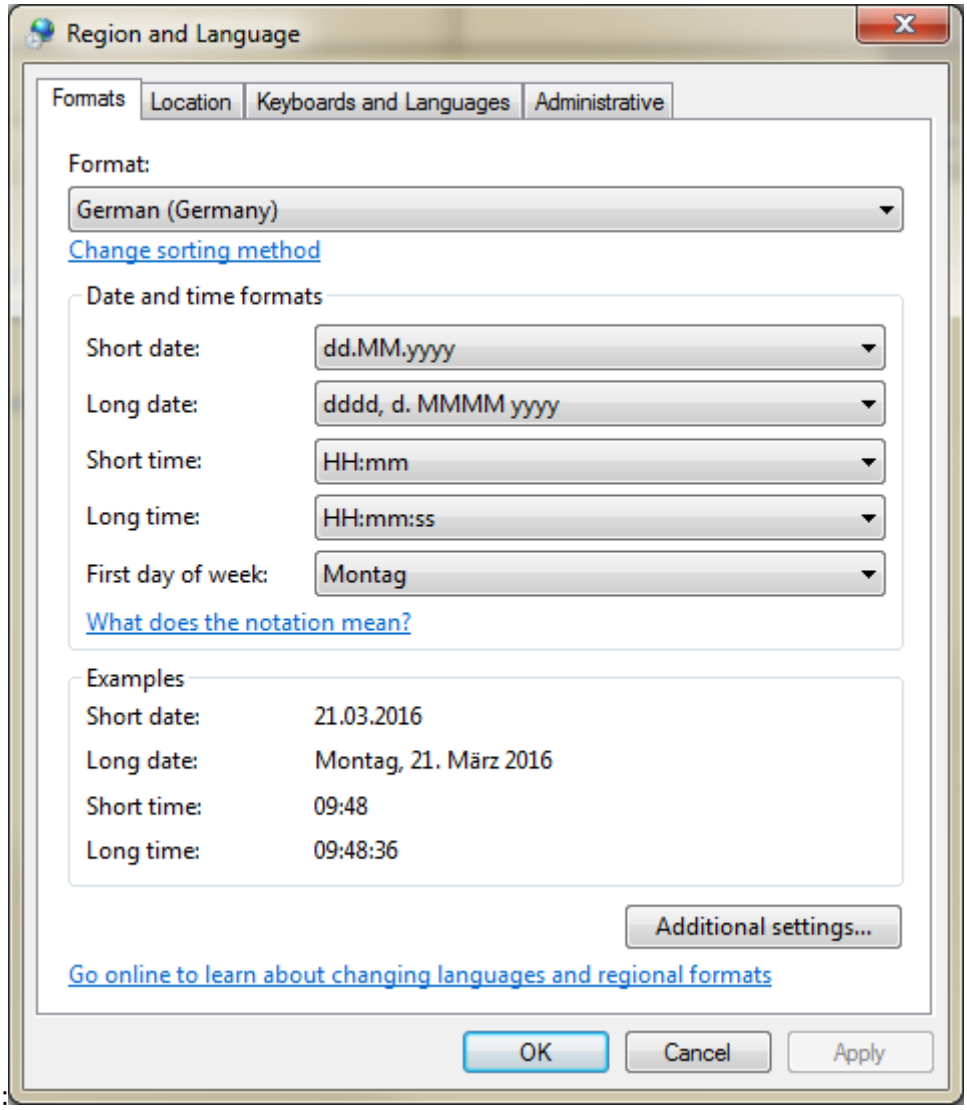
In rare events, e.g. new organizing the routing tables, it may be appropriate to restart the coordinator.

This is not required during normal operation, since the network is self-organizing and has a self-healing function that dynamically ensures sensible routing.

2 Software Installing Instructions

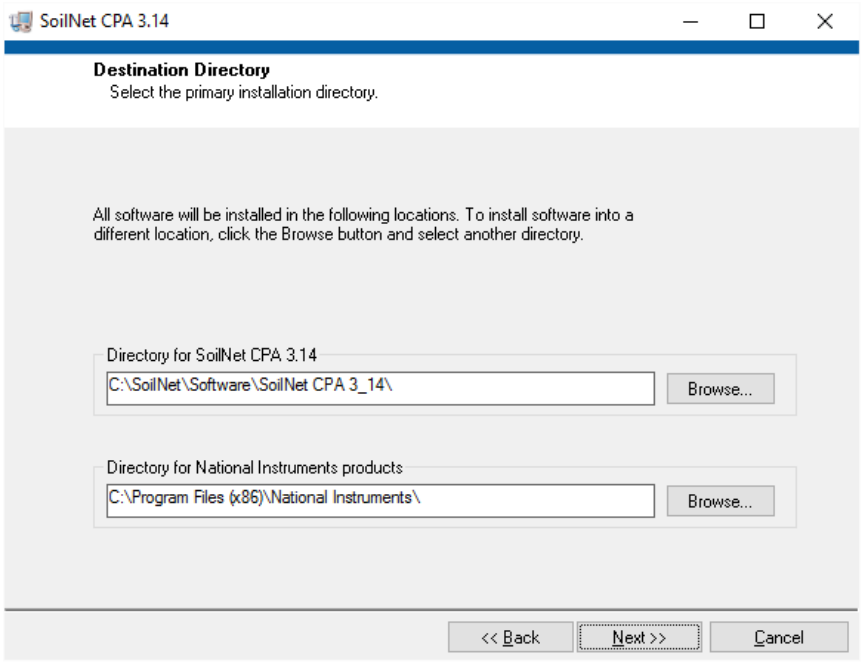
If you have your own unprepared laptop (PC) with MS WINDOWS , follow this steps:

At first please change the region date and time format to german



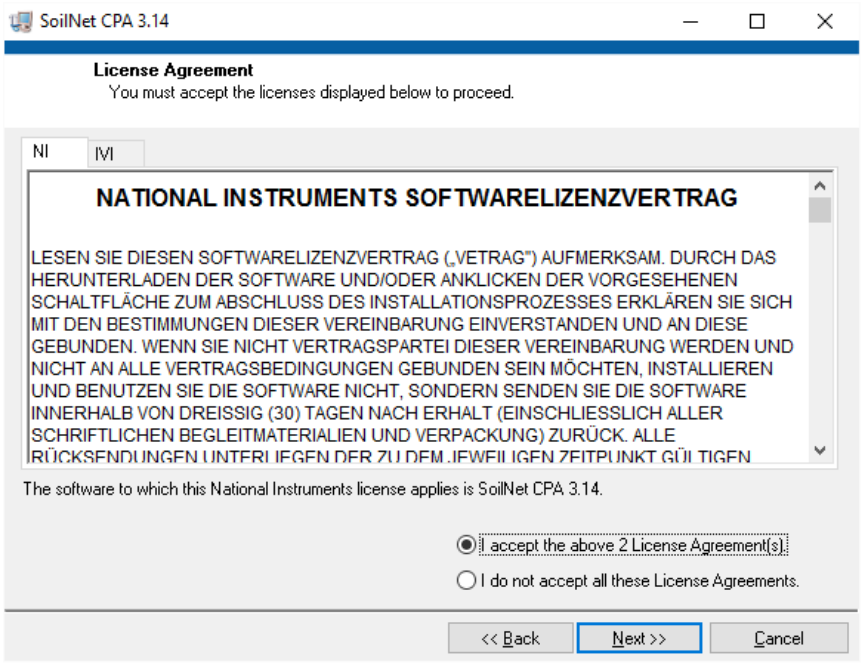
:

After that, install "SoilNet CPA Software" with Setup.exe file.



Check whether all the paths match. It's important to accept the suggested paths.

Click "Next"

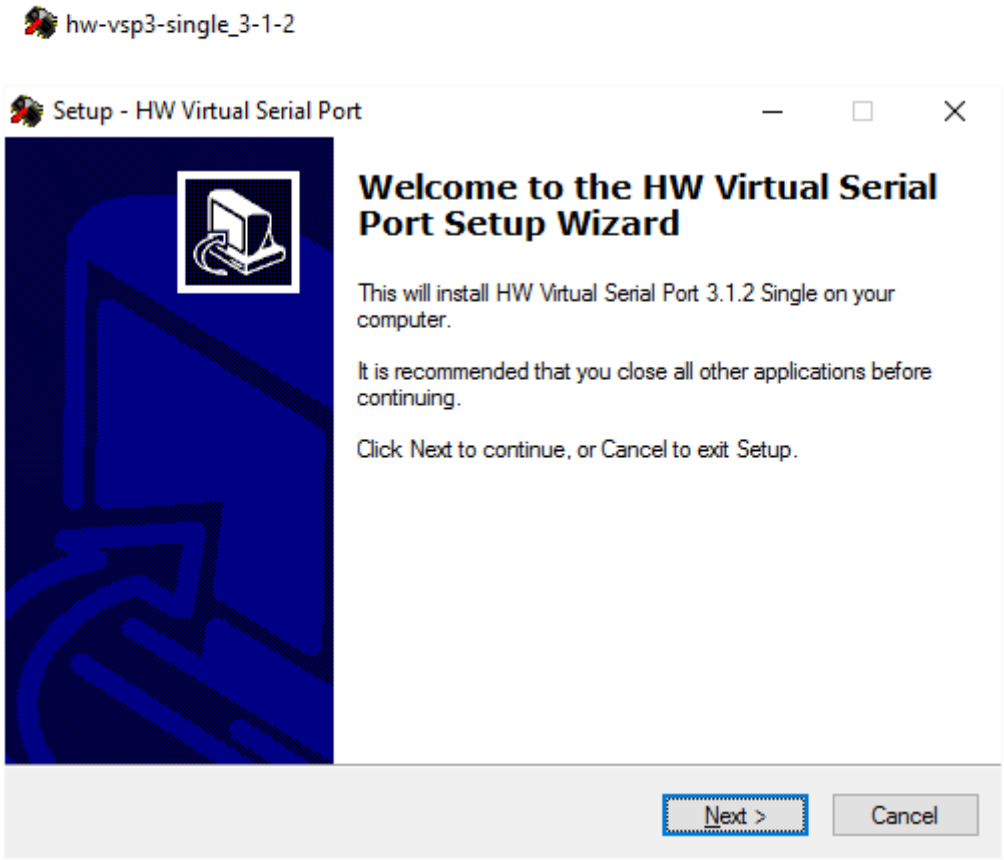


Accept the 2 license agreements.

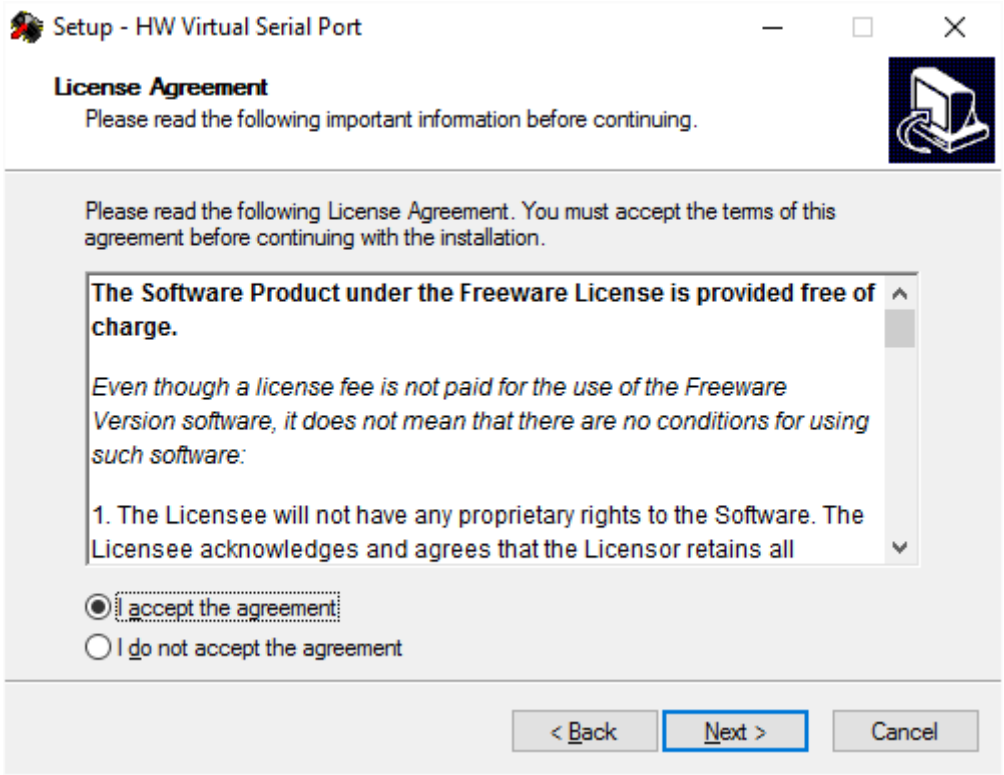
Click "Next" to install the files and finish the installation.

Before you start this application please follow the next steps:

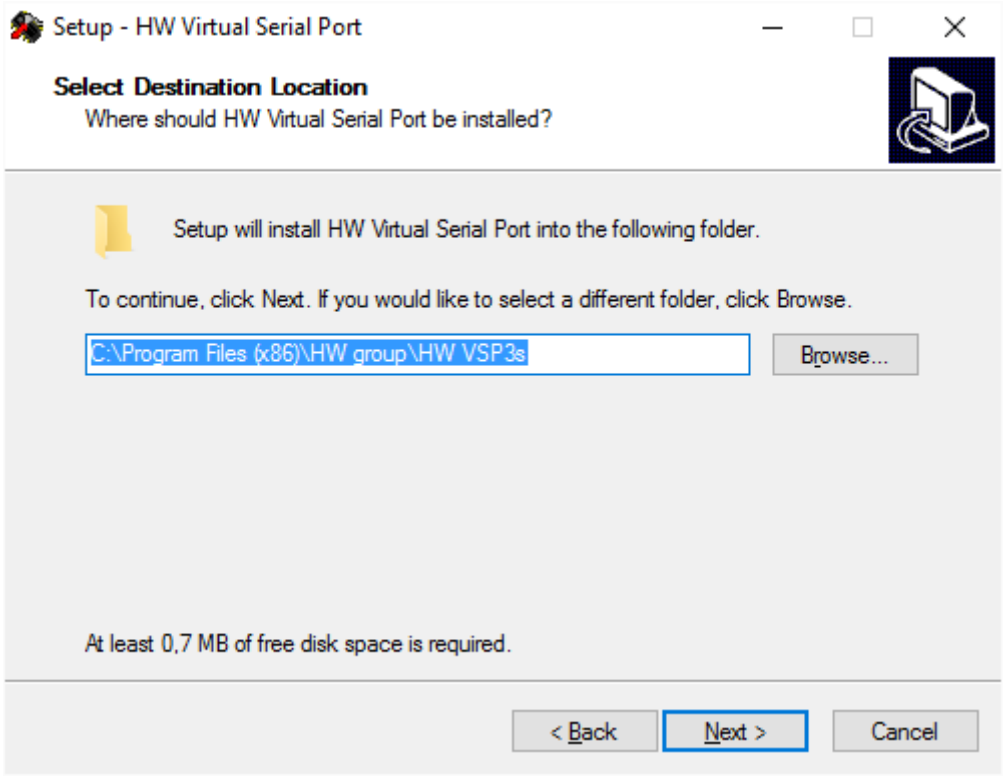
For mobile network connection via modem it is necessary to install the " HW Virtual Serial Port driver":



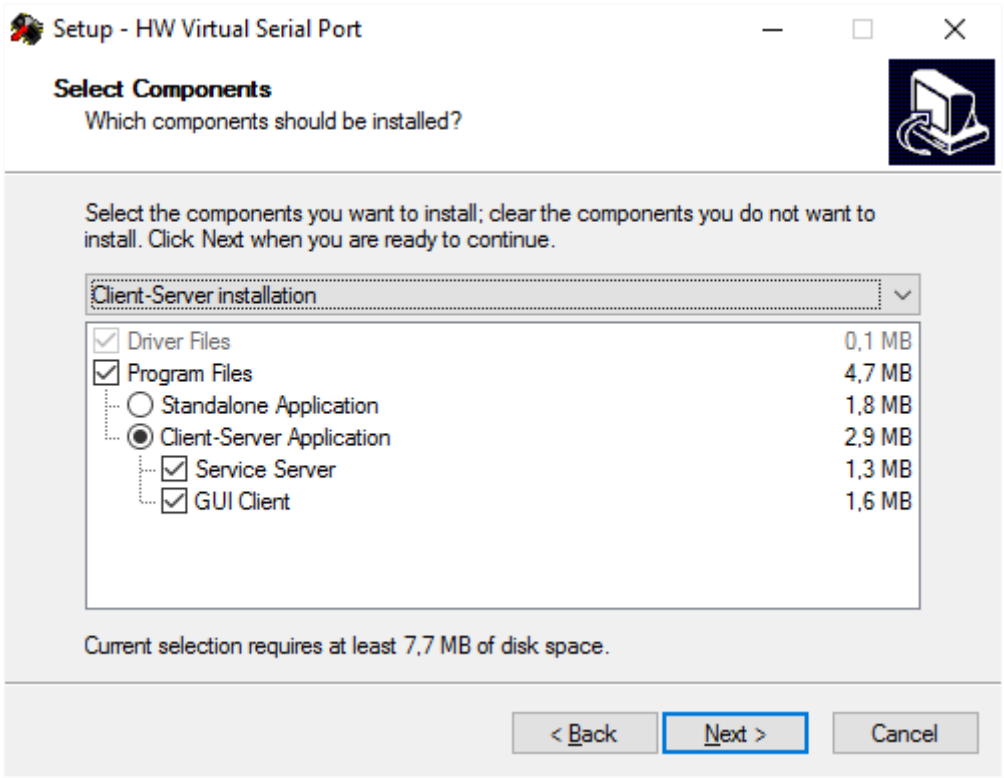
Click "Next"



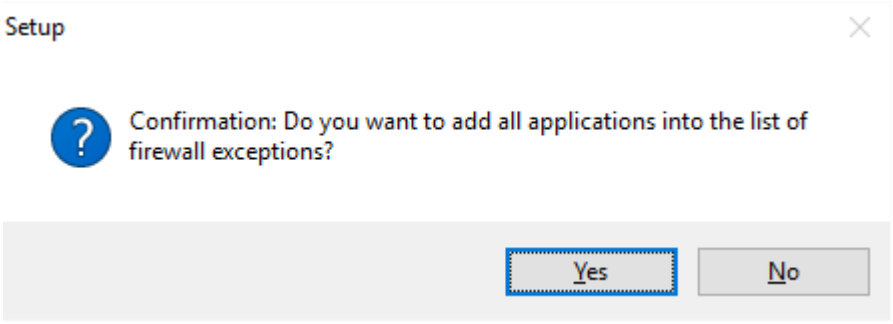
Accept the agreements. Click "Next"



Click "Next"



Click "Next"



Add all applications into the the list of firewall! Click "Yes"

To use the new installed software read chapter 3.

3 Operating Instructions

3.1 Initial Operation of the Software

[1] Connect the power supply unit and the network cable to the notebook.

[2] Switch on the notebook.

[3] Login

[4] Enable internet access, if required, reconfigure.

For mobile network connection via modem follow step 5 to 9,

for LAN network connection via COM Server follow step 10 to 11

[5] If you are using **MDEX Open VPN service** check if "OpenVPNService" is running (Windows Task Manager, Services).If NOT please read chapter 4.1.

[6] Start "HW Virtual Serial Port" by double-clicking on the link(desktop).

A new icon is shown at the task bar on the right side. 

[7] To check the HW VSP parameter, open the relevant window with a right click on this icon(Open HW VSP Client).

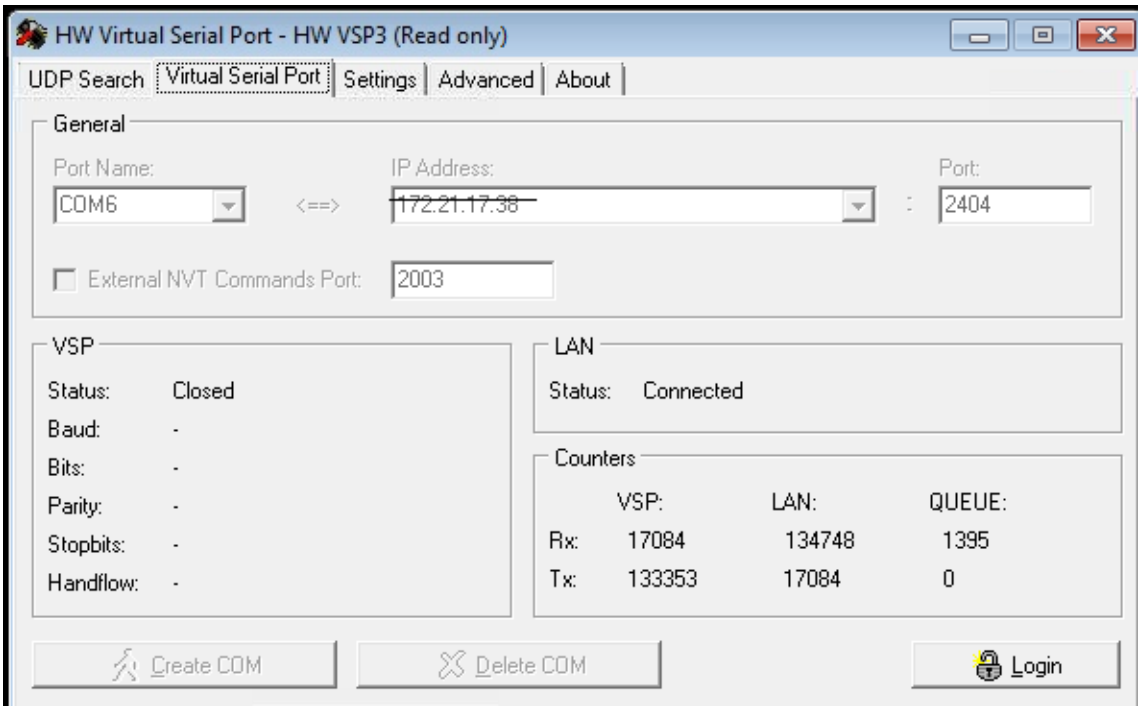


Figure 1 HW VSP1

LAN Status should be "Connected"

This status appears when the mobile router (modem) has been switched on and the connection has been established. IP Address is the address from the mobile router (Modem).

[8] Start the SoilNet CPA by double-click on the link in the centre of the desktop.

[9] After SoilNet CPA Software is running, the HW Virtual Serial Port Parameter looks like:

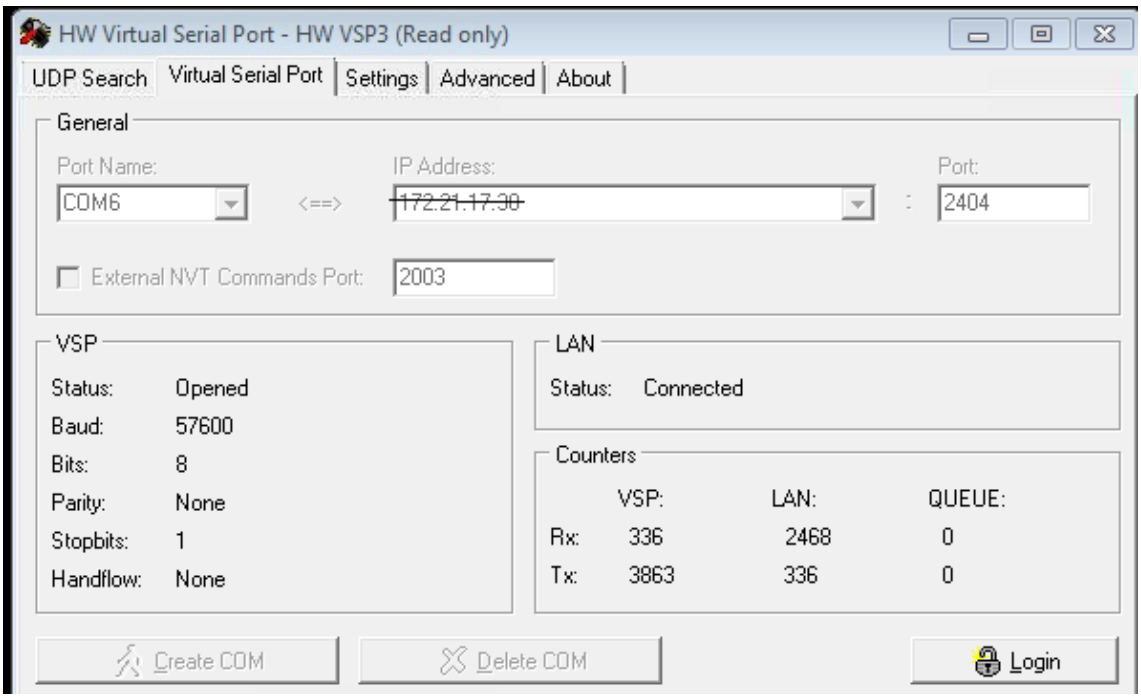


Figure 2 HW VSP 2

VSP Status is “Opened” with 57600 Baud.

Now you can see incoming data packets from different network sources, in the CPA Software (Chapter 2.2 Figure 4.)

For LAN network connection via COM Server:

[10] Read Chapter 3.3 and 3.4 to set up the virtual COM Port.

[11] After the COM Port exists, start the SoilNet CPA 3.12 by double-click on the link in the centre of the desktop.

3.2 “CONFIG” Tab

Figure 3 COM PORT

[1] Selection of the COM PORT (Coordinator Connection)

Select the virtual COM PORT for data transmission via a MODEM or via COM Server. The HW VSP software (MODEM) or the “COM UMLENKUNG” software (COM SERVER) will convert the IP data stream into the corresponding serial data stream. For details, see chapter 3.2 ,3.3,3.4.

“INIT” shows serial COM initialization status

“ERR” shows serial COM error status

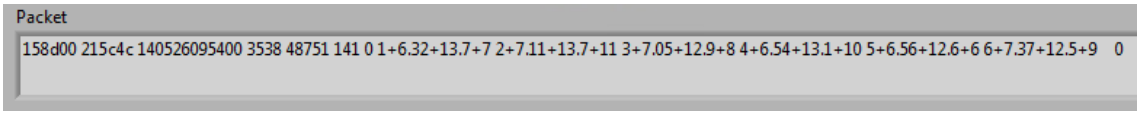


Figure 4 COORDINATOR PACKET

Data stream received from the coordinator

Figure 5 PACKET PROPERTIES

- Age of the displayed data packet in sec
- Type of source node

ED: EndDevice (Version 1)

ED2: EndDevice (Version 2)

ED3: EndDevice (Version 3)

R1: Router Part 1

R2: Router Part 2

R3: Vaisala

C1: Coordinator Part 1

C2: Coordinator Part 2

- Source node of the data
- MAC address of the source node

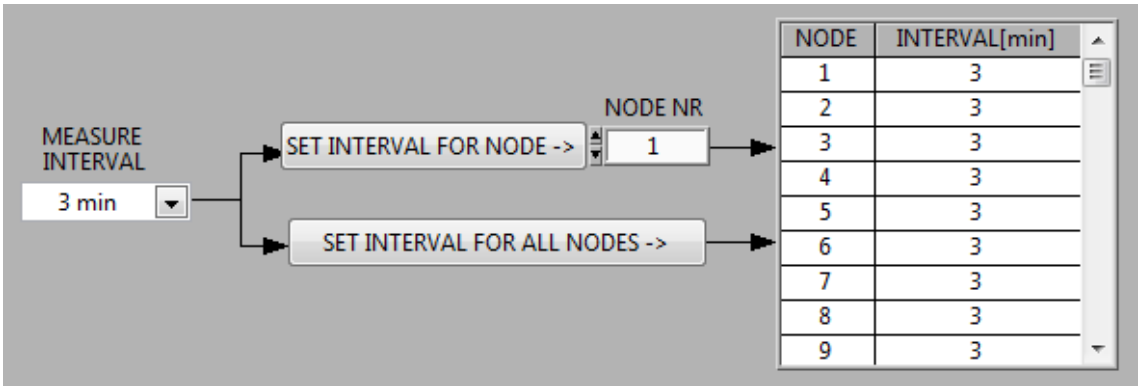


Figure 6 MEASURE INTERVAL

- MEASURE INTERVAL
  Choose the required measurement interval for one (SET INTERVAL FOR NODE) or for all (SET INTERVAL FOR ALL NODES)
- INTERVAL LIST
  shows chosen measurement intervals

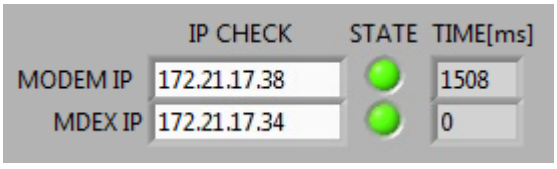


Figure 7 IP CHECK FUNCTION

- Entered MODEM or COM Server IP address
  insert the Modem IP address, find it in your MDEX confirmation email
- Entered MDEX IP address (not necessary with COM Server)
  insert the Mdex IP address, find it in your MDEX confirmation email

The IP Ping “STATE” result is updated every 15s. The LED shows if the ping packet is returned and the TIME[ms] how long it takes.

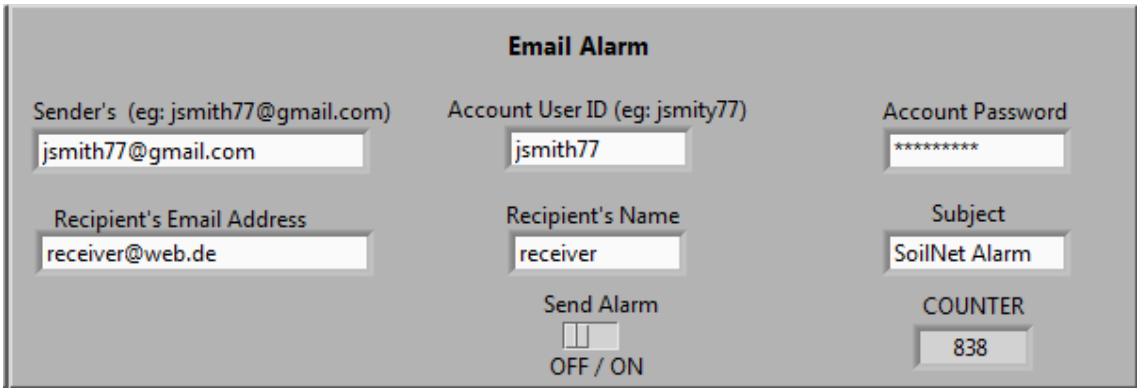


Figure 8 EMAIL ALARM

If the CPA Software receive no data from the coordinator for 900 seconds, the email alarm function sends a message to a configurable recipient.
Additionally, a message will be send if the coordinator or router battery voltage value falls below 11.5 Volt (Battery is nearly empty).

- Sender -> Email comes from….(only gmail account)
- Recipient -> Email goes to…
- Recipients Name -> Name of the sender
- Account User -> Username from senders email account
- Account Password -> Password from senders email account
- Subject -> Mails Subject
- Send Alarm -> If activated, the alarm email is send **one time,** triggered by the alarm conditions
- Counter -> With every incoming packet from the coordinator this value is set to 900. Counter decreases every second (Count down)

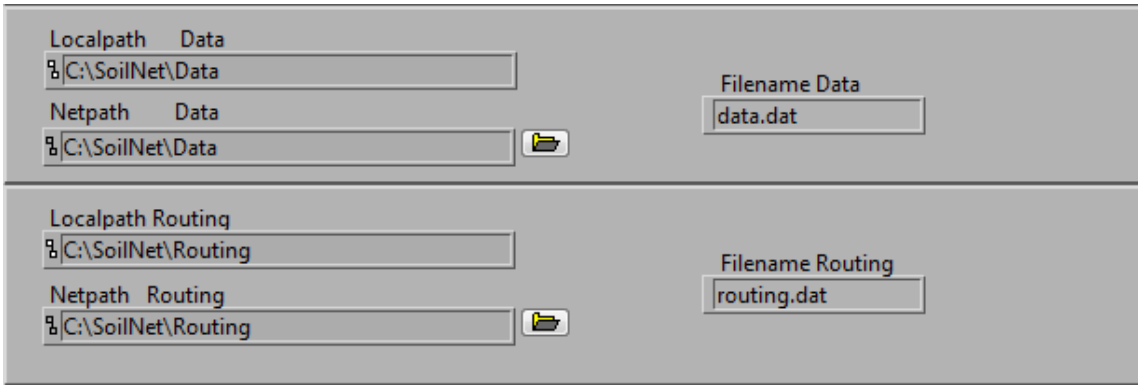


Figure 9 Path Data & Routing

The data output format is described in chapter 5

- **Localpath** data: directory for the SoilNet end device data.

  The directory is fixed located on the notebook (C:\SoilNet\Data).

  The data are stored here when the storage location on the network

- **Netpath data**

  is unavailable.

- **Filename data**

  The filename “data.dat” is selectable.

- **Localpath Routing**: directory for the SoilNet router data.

  The directory is fixed located on the notebook (C:\SoilNet\Routing).

  The router data are stored here when the storage location on the network

- **Netpath Routing**

  is unavailable.

- **Filename router data**

  The filename “router.dat” is selectable.

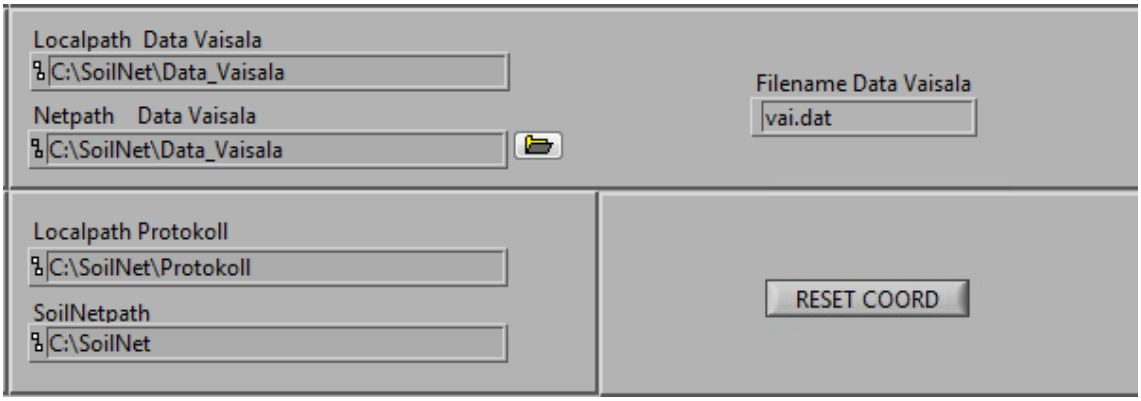


Figure 10 Path Vaisala & Protokoll

- **Localpath Data Vaisala**: directory for “Vaisala WXT 520” data.

  The directory is fixed located on the notebook (C:\SoilNet\Data_Vaisala

  The data are stored here when the storage location on the network

  - **Netpath Data Vaisala**

  is unavailable.

- **Filename Data Vaisala**

  The filename “vai.dat” is selectable.

- **Localpath Protokoll**

  The data from each SoilNet component (EndDevice, Coordinator, Router, Vaisala) are also saved separately in the directory

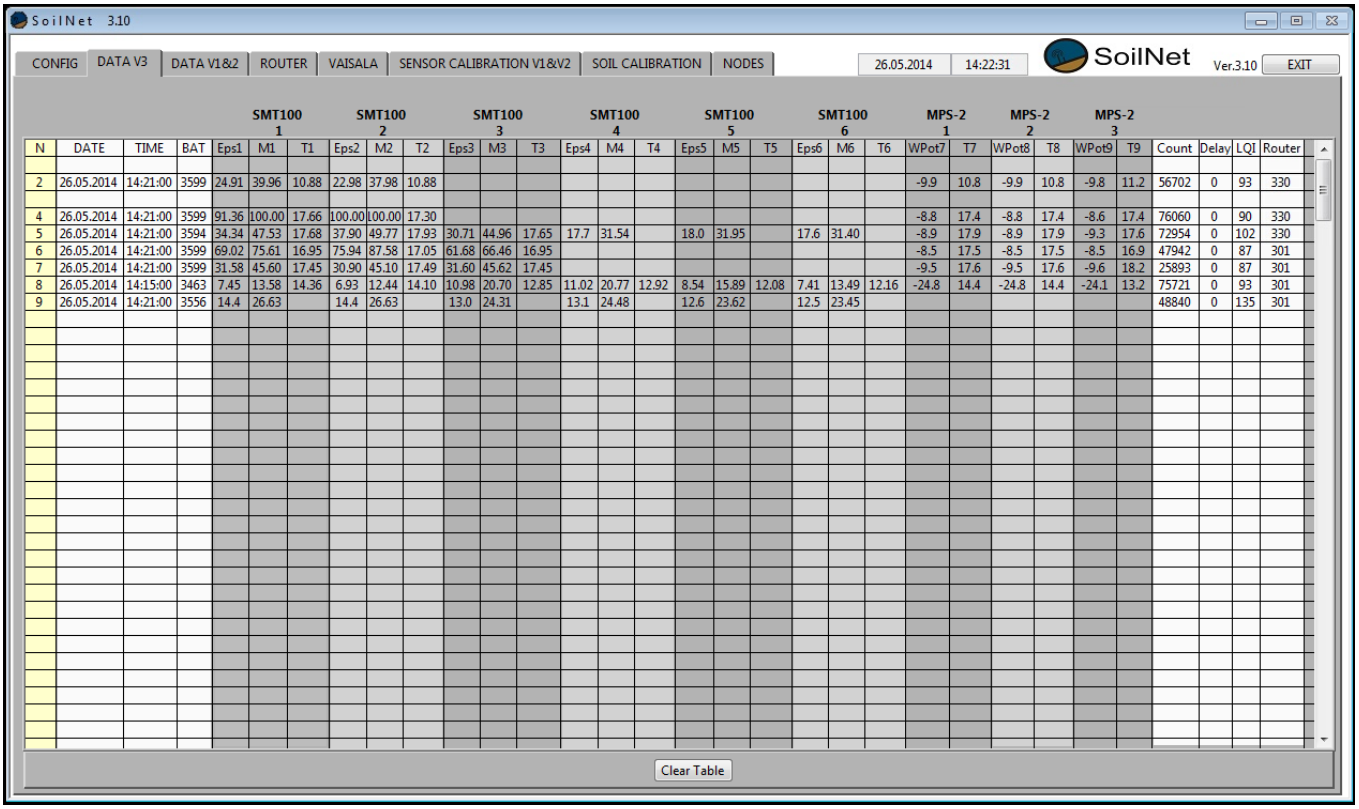
  C:\SoilNet\Protokoll\.

  These files are therefore well suited for component specific analysis.

- **SoilNet Path**

  Fixed directory for all necessary SoilNet files.

3.3 “DATA” Tab



				SMT100 1			SMT100 2			SMT100 3			SMT100 4			SMT100 5			SMT100 6			MPS-2 1		MPS-2 2		MPS-2 3					
N	DATE	TIME	BAT	Eps1	M1	T1	Eps2	M2	T2	Eps3	M3	T3	Eps4	M4	T4	Eps5	M5	T5	Eps6	M6	T6	WPot7	T7	WPot8	T8	WPot9	T9	Count	Delay	LQI	Router
2	26.05.2014	14:21:00	3599	24.91	39.96	10.88	22.98	37.98	10.88													-9.9	10.8	-9.9	10.8	-9.8	11.2	56702	0	93	330
4	26.05.2014	14:21:00	3599	91.36	100.00	17.66	100.00	100.00	17.30													-8.8	17.4	-8.8	17.4	-8.6	17.4	76060	0	90	330
5	26.05.2014	14:21:00	3594	34.34	47.53	17.68	37.90	49.77	17.93	30.71	44.96	17.65	17.7	31.54		18.0	31.95		17.6	31.40		-8.9	17.9	-8.9	17.9	-9.3	17.6	72954	0	102	330
6	26.05.2014	14:21:00	3599	69.02	75.61	16.95	75.94	87.58	17.05	61.68	66.46	16.95										-8.5	17.5	-8.5	17.5	-8.5	16.9	47942	0	87	301
7	26.05.2014	14:21:00	3599	31.58	45.60	17.45	30.90	45.10	17.49	31.60	45.62	17.45										-9.5	17.6	-9.5	17.6	-9.6	18.2	25893	0	87	301
8	26.05.2014	14:15:00	3463	7.45	13.58	14.36	6.93	12.44	14.10	10.98	20.70	12.85	11.02	20.77	12.92	8.54	15.89	12.08	7.41	13.49	12.16	-24.8	14.4	-24.8	14.4	-24.1	13.2	75721	0	93	301
9	26.05.2014	14:21:00	3556	14.4	26.63		14.4	26.63		13.0	24.31		13.1	24.48		12.6	23.62		12.5	23.45								48840	0	135	301

Figure 11 DATA V3

The data last received from the SoilNet EndDevice (measuring box) are listed in folder DATA V3 tab.

In detail:

NODE

Measuring box number in ascending order.

DATE, TIME

Time stamp of the last measurement received.

BAT

Voltage of the lithium battery (please replace the battery if the voltage drops below 3.0 V).

Eps1

Measured dielectric permittivity by SMT100 sensor 1

M1

Computed soil moisture value in % vol. from measured dielectric permittivity of SMT100 sensor 1

T1

Measured temperature in C° by SMT100 sensor 1

Eps2

Measured dielectric permittivity by SMT100 sensor 2

M2

Computed soil moisture value in % vol. from measured dielectric permittivity of SMT100 sensor 2

T2

Measured temperature in C° by SMT100 sensor 2

…

Eps6

Measured dielectric permittivity by SMT100 sensor 6

M6

Computed soil moisture value in % vol. from measured dielectric permittivity of SMT100 sensor 6

T6

Measured temperature in C° by SMT100 sensor 6

COUNT

Measurement counter increased by the end device for every measurement and transmitted after each measurement.

DELAY

Number of measurements buffered on site. Measurement data that cannot be transmitted correctly is stored on the device and are transmitted again as soon as the transmission path has been reactivated. Over 3 million measurements can be stored in this way.

LQI (Line Quality Index)

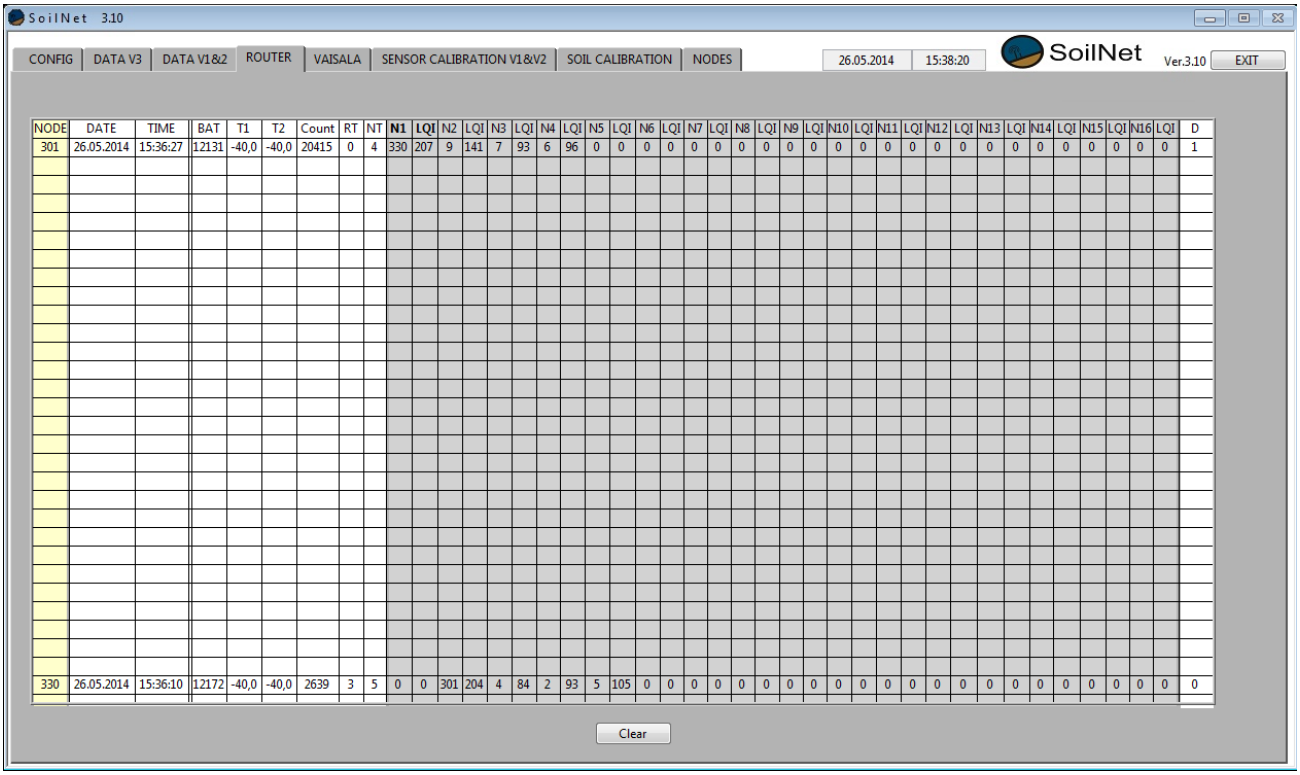
Transmission quality index indicating the signal strength of the wireless link between the SoilNet end device and the associated router (value range 0–255, sufficient if above 60).

ROUTER

The SoilNet router device that relays the packets from the end device.

The network will automatically configure the best communication path.

3.4 “ROUTER” Tab



NODE	DATE	TIME	BAT	T1	T2	Count	RT	NT	N1	LQI	N2	LQI	N3	LQI	N4	LQI	N5	LQI	N6	LQI	N7	LQI	N8	LQI	N9	LQI	N10	LQI	N11	LQI	N12	LQI	N13	LQI	N14	LQI	N15	LQI	N16	LQI	D
301	26.05.2014	15:36:27	12131	-40,0	-40,0	20415	0	4	330	207	9	141	7	93	6	96	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
330	26.05.2014	15:36:10	12172	-40,0	-40,0	2639	3	5	0	0	301	204	4	84	2	93	5	105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 12 Router parameter table

The data last transmitted by the SoilNet router are listed on the ROUTER tab.

In detail:

NODE

Router number, in ascending order.

DATE, TIME

Time stamp of the last measurement received.

BAT

Voltage of the lead gel battery (12 V) in mV.
Replace the battery when voltage < **11.5 V**.

T1

Outside temperature in °C (2 m above ground)

T2

Outside temperature in °C (0.2 m above ground)

COUNT

Measurement counter, increased by the router and transmitted for each measurement.

RT

Routing table size, number of entries in the local routing table. Every packet sent via the router requires an entry.

NT

Neighbour table size; each component directly connected to the router will generate an entry. The value corresponds to the number of entries.

N1–N16

Entry in the neighbour table. The component that is directly connected to the router is displayed here.

LQI1–LQI16

Quality of the connection (link) to the respective component (value range 0–255, sufficient if above 60).

D

Hierarchy of the router within the routing tree.

CLEAR BUTTON

Deletes the entries in the table; does not delete the tables themselves (located on the routers), but only their visualizations.

3.5 “SOIL CALIBRATION” Tab

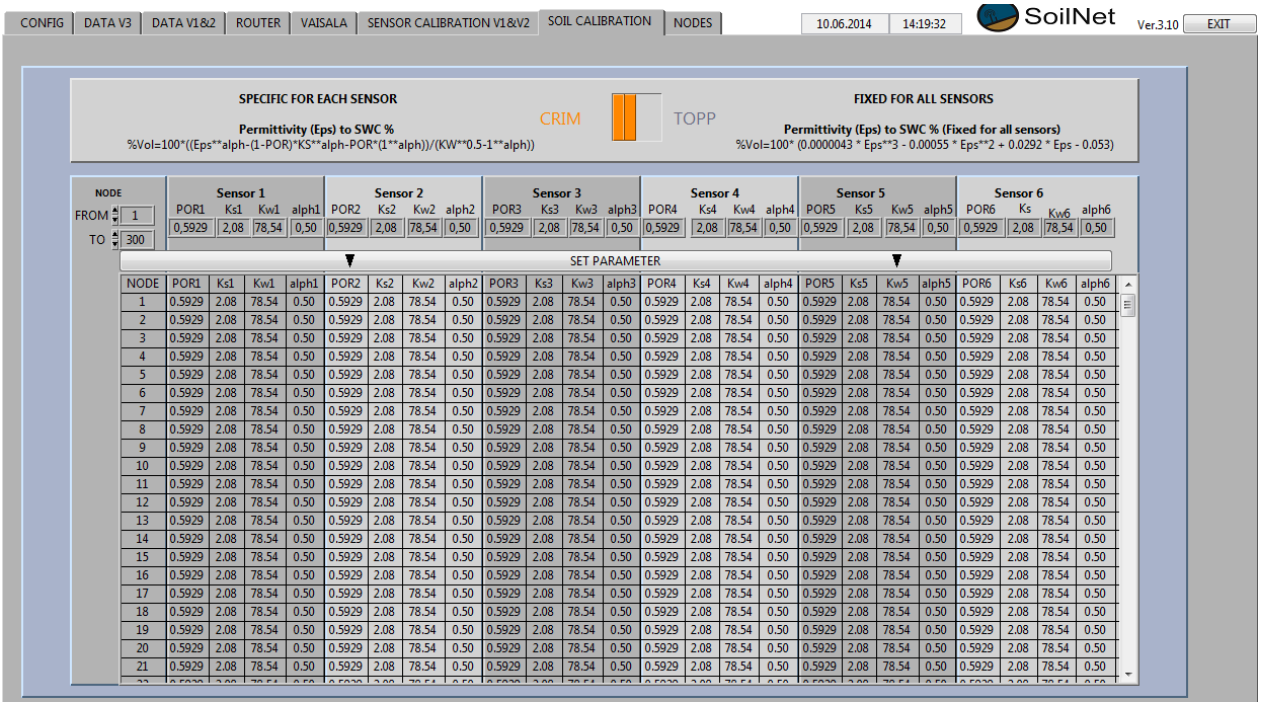


Figure 13 Soil Calibration

The apparent dielectric permittivity needs to be converted to soil water content. There are two options:

Option “**TOPP”:** In case the switch is set on the right side a standard equation to calculate soil water content (SWC) according to Topp et al. (1980) is used for all sensors.

SWC [Vol.%]=100* (0.0000043 * Eps**3 - 0.00055 * Eps**2 + 0.0292 * Eps - 0.053)

Option **“CRIM”:** In case the switch is set on the left side the CRIM equation according to Roth et al. (1990) is used:

%Vol=100*((Eps**alph-(1-POR)*KS**alph-POR*(1**alph))/(KW**0.5-1**alph))

This equation enables the use of soil specific parameter for each sensor and therefore higher measurement accuracy can be achieved.
For this option you have to enter the soil specific parameters for each sensor into the input fields and push SET PARAMETER to activate it. You can do this for a group of boxes using the “FROM, TO” fields. Another possibility is to edit careful the caltab.ini file (C:\SoilNet\Init\..). Please exit the CPA-Software before changing this file and restart the program after saving the file.

3.6 “NODES” Tab

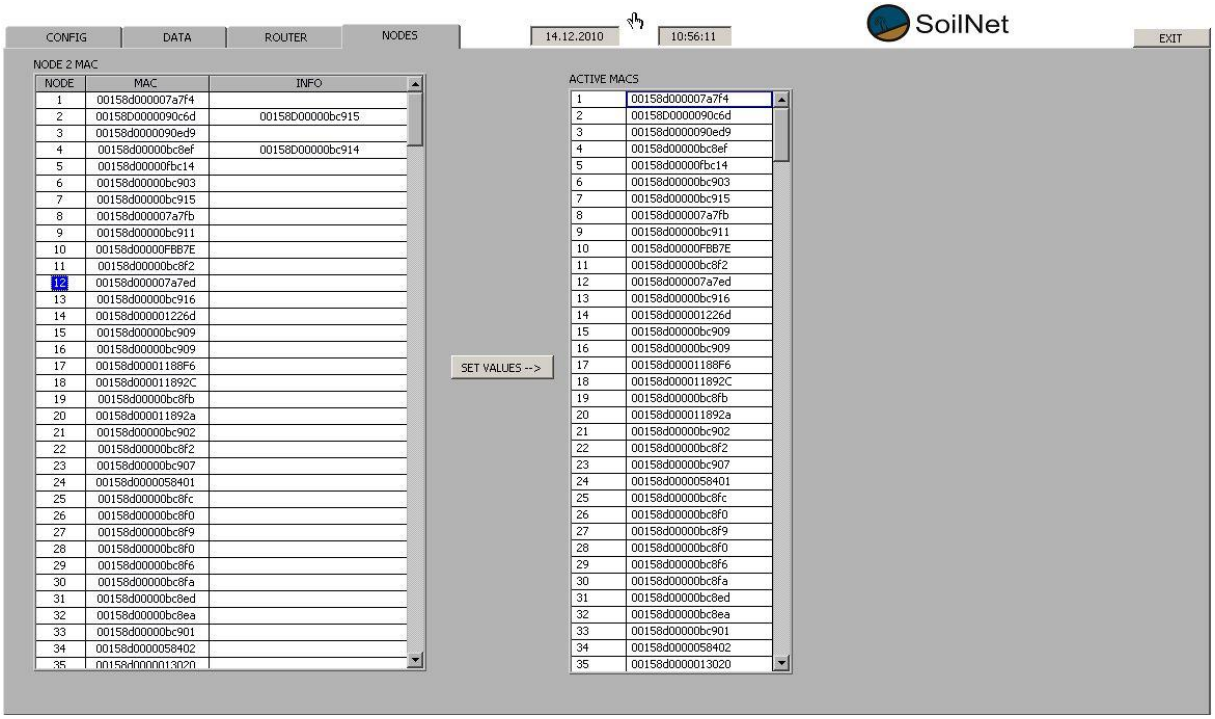


Figure 14 Nodes

Numbers are assigned here to the wireless modules using the individual MAC address.

- SoilNet end devices must be assigned numbers between 1 and 300.

- SoilNet routers must be assigned numbers between 301 and 329.

- SoilNet coordinator must always have the number 330.

When the entries in the NODE 2 MAC table have been change, they should be activate by clicking the SET VALUES button.

The ACTIVE MACS table serves to verify the entries.

The table is backed up whenever changes are made to the file

C:\SoilNet\Init\maclist.ini.

This file is used to initialize the table every time the application is restarted.

You should save a backup of the files in the INIT directory at regular intervals.

4 Supporting Programs

The software components described below are required for the “SoilNet Control Panel Application” to function properly.

Using the mobile network:

MDEX OpenVPN Client Software, HW Virtual Serial Port Driver

Using LAN Network:

Wutility Tool, COM-Umlenkung

4.1 MDEX OpenVPN Client (only for mobile network connection)

In order to enable data communication with the modem, an OpenVPN connection is established to the MDEX server. The associated VPN client is installed and configured on the notebook.

If it is necessary to (re)install this software follow the install instructions:

https://wiki.mdex.de/Support/DOCLeitstellentunnelWindows

https://wiki.mdex.de/Support/QNALeitstellentunnel

https://wiki.mdex.de/Support/QNAWieKannDerLeitstellentunnelAutomatischBeimPCNeustartStarten

4.2 HW Virtual Serial Port (only for mobile network connection)

The CPA receives and sends the SoilNet data packets via a virtual COM interface . This is implemented with HW Virtual Serial Port Driver.

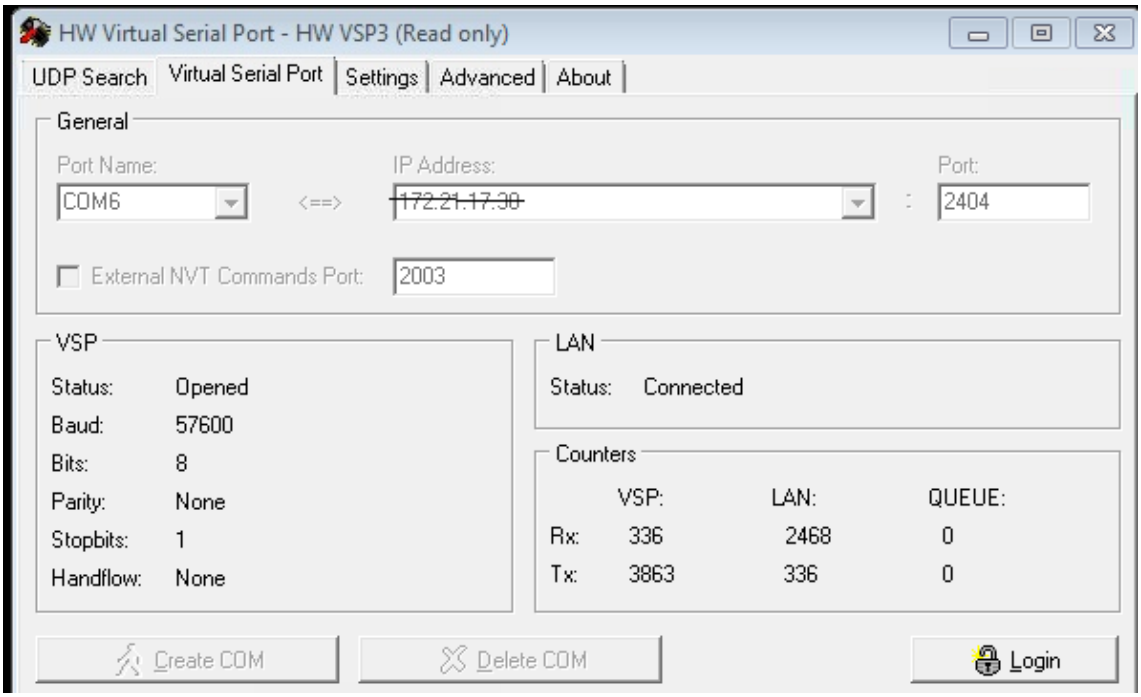


Figure 15 HW VSP 3

Virtual Serial Port -- General:

Port Name is COM6 as default. It is possible to use another Com Port. Ensure that this Port must be equal to CPA Software Com Port.

IP Address:

Please enter here the IP address of the modem (gateway). You can find it in your MDEX confirmation email.

Port is fixed to 2404

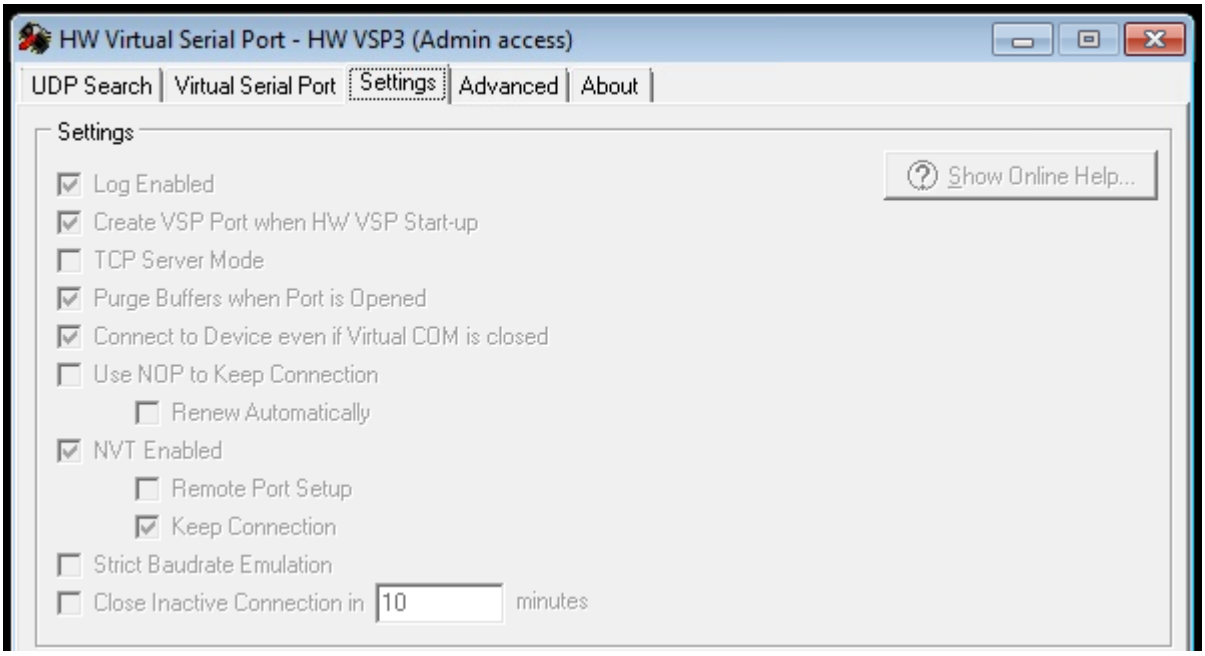


Figure 16 HW VSP 4

Settings:

Set all checkboxes as shown in figure 16

4.3 WuTility (only for LAN network connection)

Using the COM-Server TCP/RS232 from W&T (Typ 58631,58665) you need “WuTility” Tool to connect the device with your Laptop. Scan the device and define your specific IP address (Select Com-Server & click “IP-Adresse”).

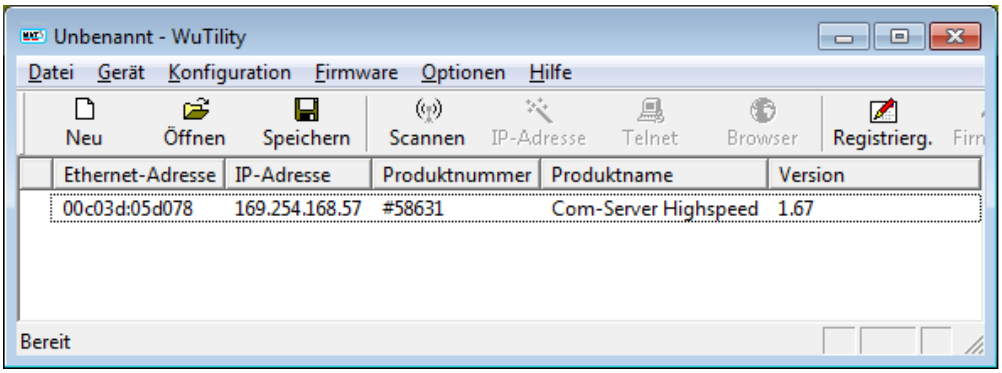


Figure 17 WuTility 1

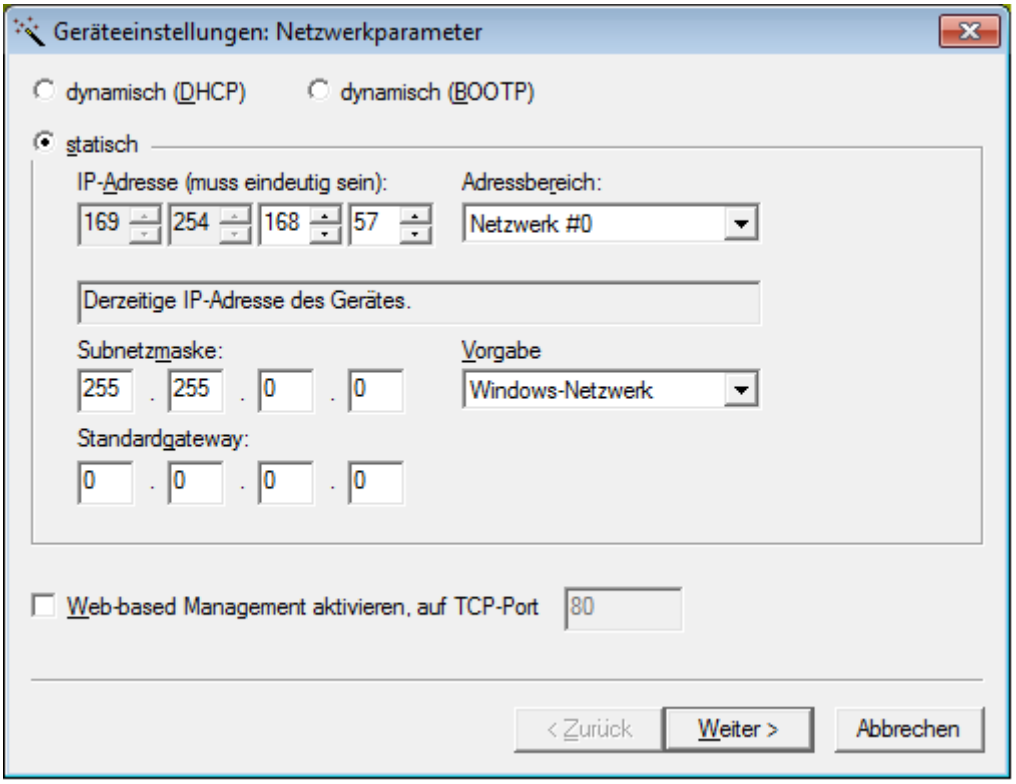


Figure 18 WuTility 2

4.4 COM-Umlenkung (only for LAN network connection)

To create a new COM Port with the Software „COM-Umlenkung“,

Define with “Hinzufügen” a new entry. With a right click change the COM Port if necessary.

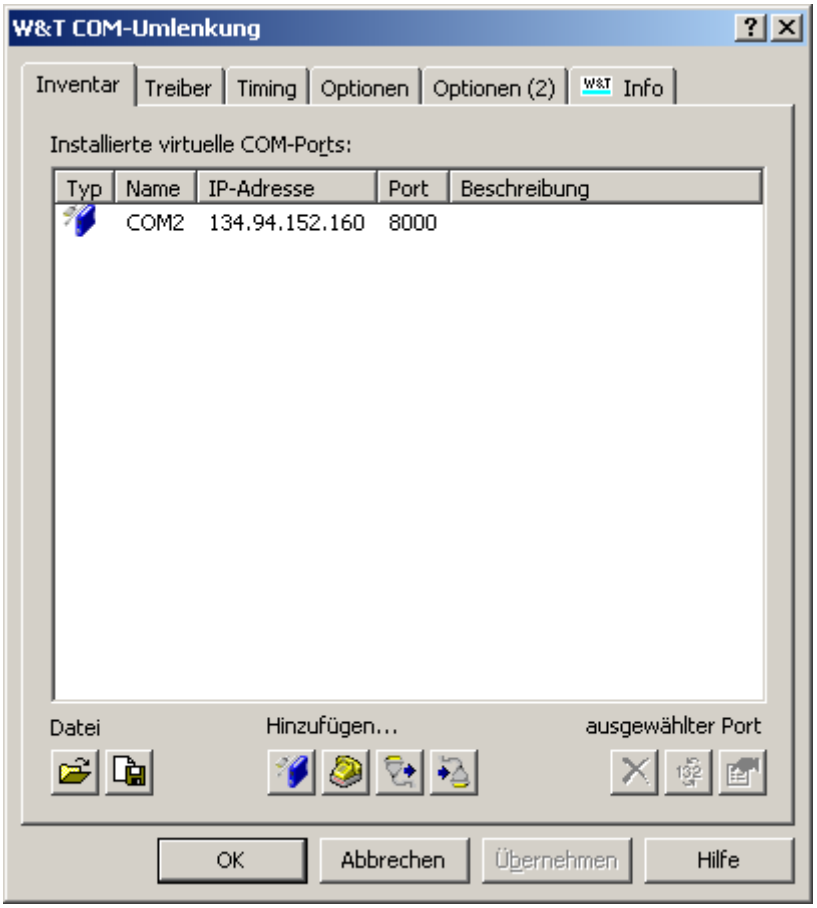


Figure 19 COM-Umlenkung

Select the new existing COM-Port in the CPA Software, (Coordinator Connection)
-> restart to activate.

5 Mobile-Router (Modem) Configuration

An mobile router device from "Conel" like LR77 v2 is used to connect the coordinator to the notebook. The following instructions describe how important changes to the configuration can be made.
If you are not using MDEX.de to realize the fixed ip address for the mobile router device some steps are different. Please read the mobile router device manual for the correct configuration or ask us directly via email.

5.1 Configure OpenVPN connection (Router to MDEX)

The router configuration is preconfigured. It is only necessary to change SIM Card parameter to allow internet access and to check the MDEX Login parameter.

What you need to do this, is:

- Laptop or PC
- EDGE router ER75i v2 (coordinator case)
- Network Cable
- EDGE router Power Supply or Battery Power Supply (12V)
- Mobile network antenna (Top of the coordinator case)
- SIM Card with internet access (incl. volume 500 Mbyte/month)
  Choose a SIM card from a mobile network provider with good
  signal quality at the coordinator location.
- SIM Card parameter APN, username, password
- MDEX fixed.IP+ via OpenVPN parameter (Username,Password,IP)

1. EDGE router ER75i v2: Check that no SIM Card is installed

2. Connect antenna (router), power supply (router), yellow network cable (between router & Laptop PC)

3. Configure Laptop for router connection as seen bellow:

(System Settings/Network connection -> Ethernet->TCP/IP)

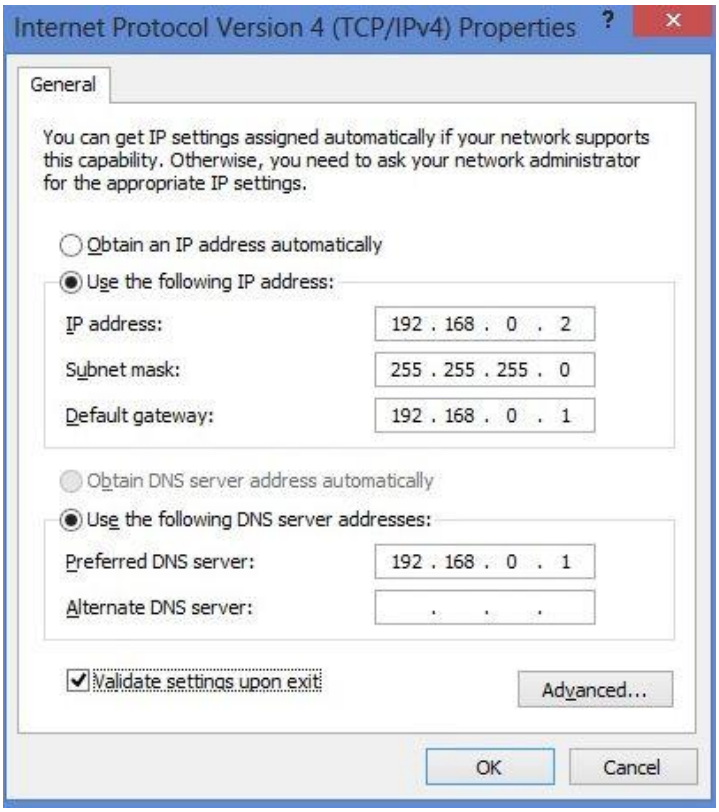


Figure 20 TCP/IP Properties

4. Open Browser software (Internet Explorer or Firefox) and address 192.168.0.1 to connect.

EDGE router login:

username: root

Password: soilnet

Figure 21 Mobile-Router Login

5. Click Configuration -> Mobile WAN and insert YOUR SIM Card parameter (APN, Username, Password , PIN)

Push “Apply” Button at the end of this web side.

6. Click Configuration -> OpenVPN -> 1st Edit Button and insert your MDEX Product: fixed.IP+ via OpenVPN parameter (username, password) and Push “Apply”

See mail from MDEX.

Figure 22 OpenVPN Parameter

7. Disconnect Power Supply and insert SIM card into modem

8. Reconnect Power Supply

9. After modem reboot chose Status -> Network. If everything is O.K. you see 3 entries like below:

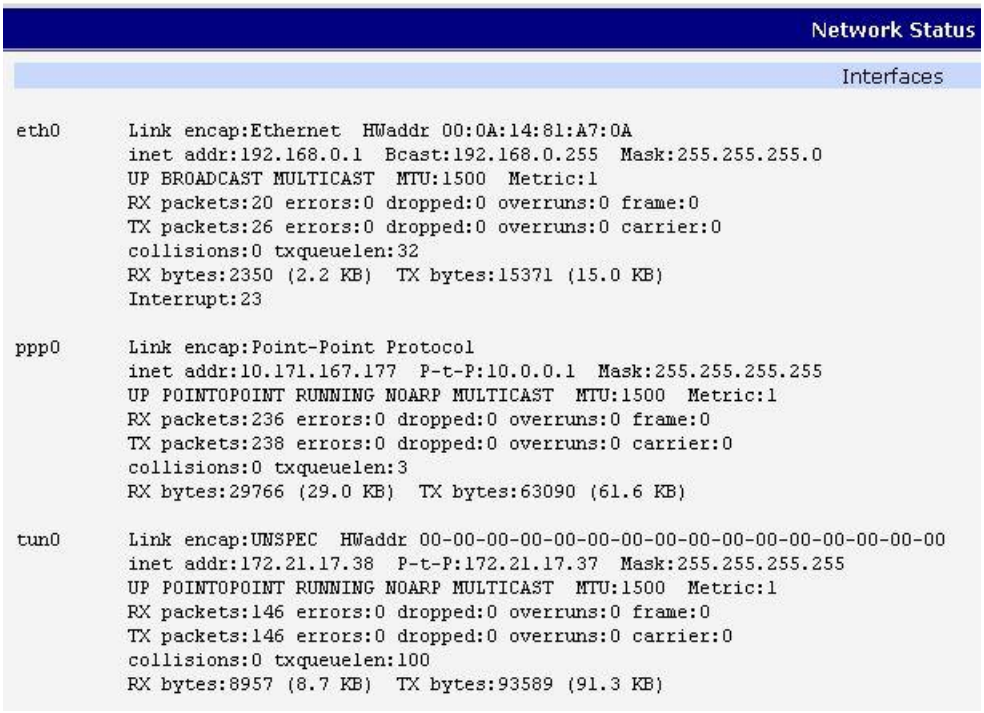


Figure 23 Mobile-Router Network status

- Eth0 is LAN network status
- ppp0 is internet access
- tun0 is OpenVPN tunnel to MDEX

Now you have opened the OpenVPN connection from your "EDGE router ER75i v2" to MDEX.

B) The second connection for data transport is from your Soilnet Laptop to MDEX named "Leitstellentunnel".

Internet access for the Laptop is now necessary.

RECONFIGURE NETWORK PARAMETER TO HAVE ACCESS

10. To configure this connection, change login information in this file:

C:/Program Files(x86)/OpenVPN/config/mdex.login

to your Login information from the Product : Leitstellentunnel

See mail from MDEX.

Save the changes.

11. restart the laptop to check the connections. See Chapter 2.1

6 Export Files

6.1 Data.dat

The file **data.dat** in the directory **c:/SoilNet/Data/** for entering the measurement data of the SoilNet **EndDevice** into the database contains the following entries per line:

sensor-specific -> see chapter7.1

Identifier	Unit	Example	Description
Date	(DD.MM.YYYY)	09.12.2010	Date of measurement
Time	(HH:MM:SS)	14:33:11	Time of measurement
Box identifier.	None	RO_SE_22	Mapped box number with identifier
Battery voltage	mV	3588	Voltage of the lithium cell
Count		1234	Counts each measurment
Lqi		200	Link quality indication (1 - 255)
reed sw. count		234	Tipping bucket (e.g. rain gauge).
SDI_1_1	sensor-specific	11844	SDI-12 Sensor with address 1 , parameter 1
SDI_1_2	sensor-specific	15.05	SDI-12 Sensor with address 1 , parameter 2
SDI_1_3	sensor-specific	27.65	SDI-12 Sensor with address 1 , parameter 3
SDI_1_4	sensor-specific	24.15	SDI-12 Sensor with address 1 , parameter 4
SDI_1_5	sensor-specific	4.97	SDI-12 Sensor with address 1 , parameter 5
SDI_2_1	sensor-specific	11467	SDI-12 Sensor with address 2 , parameter 1
SDI_2_2	sensor-specific	17.46	SDI-12 Sensor with address 2 , parameter 2
SDI_2_3	sensor-specific	31.21	SDI-12 Sensor with address 2 , parameter 3
SDI_2_4	sensor-specific	24.23	SDI-12 Sensor with address 2 , parameter 4
SDI_2_5	sensor-specific	4.91	SDI-12 Sensor with address 2 , parameter 5
SDI_3_1	sensor-specific	11844	SDI-12 Sensor with address 3 , parameter 1
SDI_3_2	sensor-specific	15.05	SDI-12 Sensor with address 3 , parameter 2
SDI_3_3	sensor-specific	27.65	SDI-12 Sensor with address 3 , parameter 3
SDI_3_4	sensor-specific	24.15	SDI-12 Sensor with address 3 , parameter 4
SDI_3_5	sensor-specific	4.97	SDI-12 Sensor with address 3 , parameter 5
SDI_4_1	sensor-specific	11467	SDI-12 Sensor with address 4 , parameter 1
SDI_4_2	sensor-specific	17.46	SDI-12 Sensor with address 4 , parameter 2
SDI_4_3	sensor-specific	31.21	SDI-12 Sensor with address 4 , parameter 3
SDI_4_4	sensor-specific	24.23	SDI-12 Sensor with address 4 , parameter 4
SDI_4_5	sensor-specific	4.91	SDI-12 Sensor with address 4 , parameter 5
SDI_5_1	sensor-specific	11844	SDI-12 Sensor with address 5 , parameter 1
SDI_5_2	sensor-specific	15.05	SDI-12 Sensor with address 5 , parameter 2
SDI_5_3	sensor-specific	27.65	SDI-12 Sensor with address 5 , parameter 3
SDI_5_4	sensor-specific	24.15	SDI-12 Sensor with address 5 , parameter 4
SDI_5_5	sensor-specific	4.97	SDI-12 Sensor with address 5 , parameter 5

SDI_6_1	sensor-specific	11467	SDI-12 Sensor with address 6 , parameter 1
SDI_6_2	sensor-specific	17.46	SDI-12 Sensor with address 6 , parameter 2
SDI_6_3	sensor-specific	31.21	SDI-12 Sensor with address 6 , parameter 3
SDI_6_4	sensor-specific	24.23	SDI-12 Sensor with address 6 , parameter 4
SDI_6_5	sensor-specific	4.91	SDI-12 Sensor with address 6 , parameter 5
SDI_7_1	sensor-specific	11844	SDI-12 Sensor with address 7 , parameter 1
SDI_7_2	sensor-specific	15.05	SDI-12 Sensor with address 7 , parameter 2
SDI_7_3	sensor-specific	27.65	SDI-12 Sensor with address 7 , parameter 3
SDI_7_4	sensor-specific	24.15	SDI-12 Sensor with address 7 , parameter 4
SDI_7_5	sensor-specific	4.97	SDI-12 Sensor with address 7 , parameter 5
SDI_8_1	sensor-specific	11467	SDI-12 Sensor with address 8 , parameter 1
SDI_8_2	sensor-specific	17.46	SDI-12 Sensor with address 8 , parameter 2
SDI_8_3	sensor-specific	31.21	SDI-12 Sensor with address 8 , parameter 3
SDI_8_4	sensor-specific	24.23	SDI-12 Sensor with address 8 , parameter 4
SDI_8_5	sensor-specific	4.91	SDI-12 Sensor with address 8 , parameter 5
SDI_9_1	sensor-specific	11844	SDI-12 Sensor with address 9 , parameter 1
SDI_9_2	sensor-specific	15.05	SDI-12 Sensor with address 9 , parameter 2
SDI_9_3	sensor-specific	27.65	SDI-12 Sensor with address 9 , parameter 3
SDI_9_4	sensor-specific	24.15	SDI-12 Sensor with address 9 , parameter 4
SDI_9_5	sensor-specific	4.97	SDI-12 Sensor with address 9 , parameter 5

TAB is used as a delimiter.

6.2 Routing.dat

The file **routing.dat** in the directory **c:/SoilNet/Routing/** for entering the measurement data of the SoilNet **router** into the database contains the following entries per line:

SPACE is used as a delimiter.

Identifier	**Unit**	**Example**	**Description**
Date	(DD.MM.YYYY)	09.12.2010	Date of measurement
Time	(HH:MM:SS)	14:33:11	Time of measurement
Router identifier.	None	RO_SR_301	Mapped router number with identifier.
Module voltage	mV	3300	Voltage of module supply
Lead gel battery voltage	mV	12342	Voltage of the lead gel battery (12 V)
Temperature Digital1	Spec.	625	Temperature sensor 5 cm formula T=(value/10)-40
Temperature Digital2	Spec.	620	Temperature sensor 200cm formula T=(value/10)-40
Routing table	None	2	Routing table entries (number of paths)
Neighbour table	None	1	Neighbour table entries (number of neighbours)
Neighbour 1	None	5	Registered neighbour
LQI 1	None	170	Neighbour link quality
Neighbour 2	None	5	Registered neighbour

LQI 2	None	170	Neighbour link quality
Neighbour 3	None	5	Registered neighbour
LQI 3	None	170	Neighbour link quality
Neighbour 4	None	5	Registered neighbour
LQI 4	None	170	Neighbour link quality
Neighbour 5	None	5	Registered neighbour
LQI 5	None	170	Neighbour link quality
Neighbour 6	None	5	Registered neighbour
LQI 6	None	170	Neighbour link quality
Neighbour 7	None	5	Registered neighbour
LQI 7	None	170	Neighbour link quality
Neighbour 8	None	5	Registered neighbour
LQI 8	None	170	Neighbour link quality
Neighbour 9	None	5	Registered neighbour
LQI 9	None	170	Neighbour link quality
Neighbour 10	None	5	Registered neighbour
LQI 10	None	170	Neighbour link quality
Neighbour 11	None	5	Registered neighbour
LQI 11	None	170	Neighbour link quality
Neighbour 12	None	5	Registered neighbour
LQI 12	None	170	Neighbour link quality
Neighbour 13	None	5	Registered neighbour
LQI 13	None	170	Neighbour link quality
Neighbour 14	None	5	Registered neighbour
LQI 14	None	170	Neighbour link quality
Neighbour 15	None	5	Registered neighbour
LQI 15	None	170	Neighbour link quality
Neighbour 16	None	5	Registered neighbour
LQI 16	None	170	Neighbour link quality
Depth	None	1	Depth of position in wireless network (tree structure)

6.3 Data_vai.dat

The file **data_vai.dat** in the directory **c:/SoilNet/Data_Vaisala/** for entering the measurement data of Vaisala Weather Transmitter WXT520 into the database contains the following entries per line:

Identifier	**Unit**	**Example**	**Description**
Date	(DD.MM.YYYY)	09.12.2010	Date of measurement
Time	(HH:MM:SS)	14:33:11	Time of measurement
Router identifier.	None	RO_SV_301	Mapped router number with identifier.
Wind direction	deg	143	Wind direction , degree
Wind Speed av.	[m/s]	1	Wind Speed av. , m/s
Wind Speed max	[m/s]	2	Wind Speed max , m/s
Air Temp [C]	Celsius	20,1	Air Temp , C°
Rel.humidity	[%RH]	2	Rel.humidity , %RH
Air Pressure	[hPa]	1	Air Pressure
Rain Accumulation	[mm]	5	Rain Accumulation , mm

Hail Accumulation	[hits/cm2]	170	Hail Accumulation , rate/cm2
Supply	[V]	5	Power Supply , Volt
Delay	none	0	Stored data on device (router)

SPACE is used as a delimiter.

Vaisala Weather Transmitter is optional.

6.4 Box_xxx.dat

The "Box_xxx.dat" files in the directory c:/SoilNet/Protokoll/ contain the following entries per line:
(xxx is the mapped box number) sensor-specific -> see chapter7.1

Identifier	Unit	Example	Description
Box no.	None	22	Mapped box number
Date	(DD.MM.YYYY)	09.12.2010	Date of measurement
Time	(HH:MM:SS)	14:33:11	Time of measurement
Battery voltage	mV	3588	Voltage of the lithium cell
Count		1234	Counts each measurment
Lqi		200	Link quality indication (1 - 255)
reed sw. count		234	Tipping bucket (e.g. rain gauge).
SDI_1_1	sensor-specific	11844	SDI-12 Sensor with address 1 , parameter 1
SDI_1_2	sensor-specific	15.05	SDI-12 Sensor with address 1 , parameter 2
SDI_1_3	sensor-specific	27.65	SDI-12 Sensor with address 1 , parameter 3
SDI_1_4	sensor-specific	24.15	SDI-12 Sensor with address 1 , parameter 4
SDI_1_5	sensor-specific	4.97	SDI-12 Sensor with address 1 , parameter 5
SDI_2_1	sensor-specific	11467	SDI-12 Sensor with address 2 , parameter 1
SDI_2_2	sensor-specific	17.46	SDI-12 Sensor with address 2 , parameter 2
SDI_2_3	sensor-specific	31.21	SDI-12 Sensor with address 2 , parameter 3
SDI_2_4	sensor-specific	24.23	SDI-12 Sensor with address 2 , parameter 4
SDI_2_5	sensor-specific	4.91	SDI-12 Sensor with address 2 , parameter 5
SDI_3_1	sensor-specific	11844	SDI-12 Sensor with address 3 , parameter 1
SDI_3_2	sensor-specific	15.05	SDI-12 Sensor with address 3 , parameter 2
SDI_3_3	sensor-specific	27.65	SDI-12 Sensor with address 3 , parameter 3
SDI_3_4	sensor-specific	24.15	SDI-12 Sensor with address 3 , parameter 4
SDI_3_5	sensor-specific	4.97	SDI-12 Sensor with address 3 , parameter 5
SDI_4_1	sensor-specific	11467	SDI-12 Sensor with address 4 , parameter 1
SDI_4_2	sensor-specific	17.46	SDI-12 Sensor with address 4 , parameter 2
SDI_4_3	sensor-specific	31.21	SDI-12 Sensor with address 4 , parameter 3
SDI_4_4	sensor-specific	24.23	SDI-12 Sensor with address 4 , parameter 4
SDI_4_5	sensor-specific	4.91	SDI-12 Sensor with address 4 , parameter 5
SDI_5_1	sensor-specific	11844	SDI-12 Sensor with address 5 , parameter 1
SDI_5_2	sensor-specific	15.05	SDI-12 Sensor with address 5 , parameter 2
SDI_5_3	sensor-specific	27.65	SDI-12 Sensor with address 5 , parameter 3
SDI_5_4	sensor-specific	24.15	SDI-12 Sensor with address 5 , parameter 4
SDI_5_5	sensor-specific	4.97	SDI-12 Sensor with address 5 , parameter 5

SDI_6_1	sensor-specific	11467	SDI-12 Sensor with address 6 , parameter 1
SDI_6_2	sensor-specific	17.46	SDI-12 Sensor with address 6 , parameter 2
SDI_6_3	sensor-specific	31.21	SDI-12 Sensor with address 6 , parameter 3
SDI_6_4	sensor-specific	24.23	SDI-12 Sensor with address 6 , parameter 4
SDI_6_5	sensor-specific	4.91	SDI-12 Sensor with address 6 , parameter 5
SDI_7_1	sensor-specific	11844	SDI-12 Sensor with address 7 , parameter 1
SDI_7_2	sensor-specific	15.05	SDI-12 Sensor with address 7 , parameter 2
SDI_7_3	sensor-specific	27.65	SDI-12 Sensor with address 7 , parameter 3
SDI_7_4	sensor-specific	24.15	SDI-12 Sensor with address 7 , parameter 4
SDI_7_5	sensor-specific	4.97	SDI-12 Sensor with address 7 , parameter 5
SDI_8_1	sensor-specific	11467	SDI-12 Sensor with address 8 , parameter 1
SDI_8_2	sensor-specific	17.46	SDI-12 Sensor with address 8 , parameter 2
SDI_8_3	sensor-specific	31.21	SDI-12 Sensor with address 8 , parameter 3
SDI_8_4	sensor-specific	24.23	SDI-12 Sensor with address 8 , parameter 4
SDI_8_5	sensor-specific	4.91	SDI-12 Sensor with address 8 , parameter 5
SDI_9_1	sensor-specific	11844	SDI-12 Sensor with address 9 , parameter 1
SDI_9_2	sensor-specific	15.05	SDI-12 Sensor with address 9 , parameter 2
SDI_9_3	sensor-specific	27.65	SDI-12 Sensor with address 9 , parameter 3
SDI_9_4	sensor-specific	24.15	SDI-12 Sensor with address 9 , parameter 4
SDI_9_5	sensor-specific	4.97	SDI-12 Sensor with address 9 , parameter 5
Delay	None	0	Number of data records buffered on the end device

An **TAB** is used as a delimiter.

6.5 Rou_xxx.dat

The “Rou_xxx.dat” files in the directory c./SoilNet/Protokoll/ contain the following entries per line:

(xxx is the mapped router number) An **TAB** is used as a delimiter.

Identifier	Unit	Example	Description
router no.	None	302	Mapped router number
date	(DD.MM.YYYY)	09.12.2010	Date of measurement
time	(HH:MM:SS)	14:33:11	Time of measurement
modul voltage	mV	3300	Voltage of the module
Battery voltage	mV	12342	Voltage of the battery (12V)
temperature digital1	°C	19.7	temperature sensor 5cm
temperature digital2	°C	20.1	temperature sensor 200cm
Count	None	2	Router packet send counter
Routingtable	None	2	routing table entries
Neighbourtable	None	1	neighbour routing table entries
Neighbour 1	None	5	Neighbour 1
LQI 1	None	170	Connection Quality 1
Neighbour 2	None	5	Neighbour 2
LQI 2	None	170	Connection Quality 2
Neighbour 3	None	5	Neighbour 3
LQI 3	None	170	Connection Quality 3
Neighbour 4	None	5	Neighbour 4
LQI 4	None	170	Connection Quality 4
Neighbour 5	None	5	Neighbour 5
LQI 5	None	170	Connection Quality 5
Neighbour 6	None	5	Neighbour 6
LQI 6	None	170	Connection Quality 6
Neighbour 7	None	5	Neighbour 7
LQI 7	None	170	Connection Quality 7
Neighbour 8	None	5	Neighbour 8
LQI 8	None	170	Connection Quality 8
Neighbour 9	None	5	Neighbour 9
LQI 9	None	170	Connection Quality 9
Neighbour 10	None	5	Neighbour 10
LQI 10	None	170	Connection Quality 10
Neighbour 11	None	5	Neighbour 11
LQI 11	None	170	Connection Quality 11
Neighbour 12	None	5	Neighbour 12
LQI 12	None	170	Connection Quality 12
Neighbour 13	None	5	Neighbour 13
LQI 13	None	170	Connection Quality 13
Neighbour 14	None	5	Neighbour 14
LQI 14	None	170	Connection Quality 14
Neighbour 15	None	5	Neighbour 15
LQI 15	None	170	Connection Quality 15

Neighbour 16	None	5	Neighbour 16
LQI 16	None	170	Connection Quality 16
Depth	None	1	Network depth

6.6 Router_xxx_Vaisala.dat

The files **Router_xxx_Vaisala.dat** in the directory **c:/SoilNet/Protokoll/** contain the following entries per line: (xxx is the mapped router number)

Identifier	**Unit**	**Example**	**Description**
router no.	None	302	Mapped router number
date	(DD.MM.YYYY)	09.12.2010	Date of measurement
time	(HH:MM:SS)	14:33:11	Time of measurement
Wind direction av.	deg	143	Wind direction av.
Wind Speed av.	[m/s]	1	Wind Speed av.
Wind Speed max	[m/s]	2	Wind Speed max m/s
Air Temp [C]	Celsius	20,1	Air Temp C°
Rel.humidity	[%RH]	2	Rel.humidity %RH
Air Pressure	[hPa]	1	Air Pressure
Rain Accumulation	[mm]	5	Rain Accumulation mm
Hail Accumulation	[hits/cm2]	170	Hail Accumulation Rate/cm2
Supply	[V]	5	Supply , Volt
Delay	none	0	Stored data on device (router)

An **TAB** is used as a delimiter.

7 Initialization Files

The following ".ini" files can be found in the directory C:\SoilNet\Init\:

var.ini	->	Backup of set program variables
reftime.ini	->	Backup of the timestamp reference
datlist.ini	->	Backup of the DATA V1&V2 table view
datlist_icos.ini	->	Backup of the DATA ICOS table view
datlist2.ini	->	Backup of DATA V3 table view
roulist.ini	->	Backup of the ROUTER table view
maclist.ini	->	Backup of the NODE table view (mapping)
vaisalalist.ini	->	Backup of the VAISALA table view
Reftime_Vaisala.ini	->	Backup of the timestamp (VAISALA)
coordinates.ini	->	Backup of coordinates (special)
caltab2.ini	->	Backup of sensor calibration table
caltab.ini	->	Backup of soil calibration table
inter.ini	->	Backup of interval table

Users should copy these data onto a separate data carrier every week (backup).

7.1 Sensor Type specific SDI-12 Parameter

Sensor Type	**Producer**	**SDI Parameter 1**	**SDI Parameter 2**	**SDI Parameter 3**	**SDI Parameter 4**	**SDI Parameter 5**
SMT100	truebner.de	COUNT	PERMITTIVITY	MOISTURE[Vol%]	TEMP[C°]	SUPPLY[V]
MPS-6	decagon.com	WATER POT[kPa]	TEMP[C°]			
GS3 R3.85	decagon.com	DIELECTRIC	TEMP[C°]	ELEC.COND.[dS/m]		
CTD R3.46	decagon.com	WATER DEPTH[mm]	TEMP[C°]	ELEC.COND.[dS/m]		
5TE R2.03	decagon.com	DIELECTRIC	TEMP[C°]	ELEC.COND.[dS/m]		