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GRUAN Monitor MW41 and the Vaisala RS41 Additional Sensor Interface

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Abstract

This document describes the installation and operation of the GRUAN Monitor MW41 (GM41) software tool version 0.1.9. Also the connection of additional sensors with Xdata interface and protocol to the Vaisala RS41 radiosonde is described in short. The GM41 tool decodes and displays the data stream of such instruments connected to the RS41 using the Xdata protocol. The purpose of GM41 is to verify that the connected instruments are working properly, and that the recorded data are within expected limits. In addition, the pin configuration for the Xdata cable is documented.

Revision history

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1. Introduction

The software tool GRUAN Monitor MW41 (GM41) was developed as an extension to the Vaisala MW41 sounding software with the purpose of decoding Xdata packets from additional sensors connected to the RS41. This allows to monitor the performance of additional Xdata sensors during flight preparation and for data acquisition during laboratory experiments. The Xdata sensors Cryogenic Frost-Point Hygrometer (CFH), Compact Optical Backscatter Aerosol Detector (COBALD), Balloon Optical Fluorescent Hygrometer (FLASH-B), Vaisala MW41 Ozone Interface Board (OIF411) and the ozone interface board on EN-SCI Model 2Z-V7 ozone sondes (V7) are currently supported.

This software is not designated for scientific analysis of flight data, this should be based on Vaisala MW41 MWX archive files for example. The MWX file format is explained in [Vaisala \(2014\)](#). Beside GM41 also the GruanToolRS92 (GT92) is available from the GRUAN Lead Centre that converts Vaisala archive files to ASCII or NETCDF and decodes Xdata simultaneous. Please contact the GRUAN Lead Centre for obtaining that tool. More information about connecting Xdata sensors to the RS41 radiosonde directly or by using the OIF411 while performing ozone soundings is given in [Vaisala \(2015\)](#), [Vaisala \(2016b\)](#) and Appendix C.

The GM41 is constructed as follow: a server takes care of data acquisition from the MW41 sounding software using an IronPython interface, the data visualization is performed by a client running in a web browser. The server can support multiple clients simultaneously. More information on the design of the server and the client is given in chapters 3 and 4.

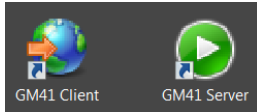
Please note that the license to use this software does not allow distribution to third parties. In case of questions, please contact the GRUAN Lead Centre (gruan.lc@dwd.de).

2. Setup and operation

For proper installation of the tool on the MW41 sounding computer the following settings are suggested: use the working directory `c:\tools\gm41\` and set the GM41 webserver address (`http://127.0.0.1`) and port (8881):

1. Extract the archive file `gm41.zip` to the working directory. Appendix A shows the resulting directory listing. If you need to install in a different working directory or if you are using different webserver settings you need to edit the configuration file as described in the next step. Skip the next step, if you are using the suggested working directory, webserver address and port.
2. Edit the start and configuration file `start.bat`:
 - a) Set the variable `startscript_path` with the absolute path of the main IronPython script `GM41.py`.
 - b) Set the variable `www` with the absolute path to the webserver's home directory `c:\tools\gm41\www`.
 - c) Set the IP address of the webserver with variable `ip`.
 - d) Set the port of the webserver by variable `port`. Be aware that the firewall must pass this communication, if the chosen IP is not the localhost.

3. Copy the shortcuts `GM41Server.lnk` and `GM41Client.URL` to the Desktop. If the configuration of the tools differs from the suggested settings, change the shortcuts accordingly.



4. Start a sounding preparation in the MW41 sounding software.
5. Start the GRUAN Monitor MW41 server by clicking the `GM41Server.lnk` shortcut or directly by running `start.bat` from the command line in the tools root directory and wait some seconds. On some systems, e.g. Windows Server, it is necessary to start with "Run as administrator...".
6. Call the website with a suitable browser using the `GM41Client.URL` shortcut. Suitable browsers are Firefox version 40 or higher, new Chrome versions or Internet Explorer version 11 or higher. Wait some seconds till the website is fully loaded. Please refresh the web page if it stays with a gray background color and you have already started the GM41 server.
7. GM41 will stop automatically when a sounding is terminated. Start the tool again for static data display. GM41 also stops when the terminal is closed. A running sounding will not be affected by closing the client.

During runtime several log files are produced (file extension `.log[0-9]`). When do you want to report bugs, please include these log files.

3. Description of server site

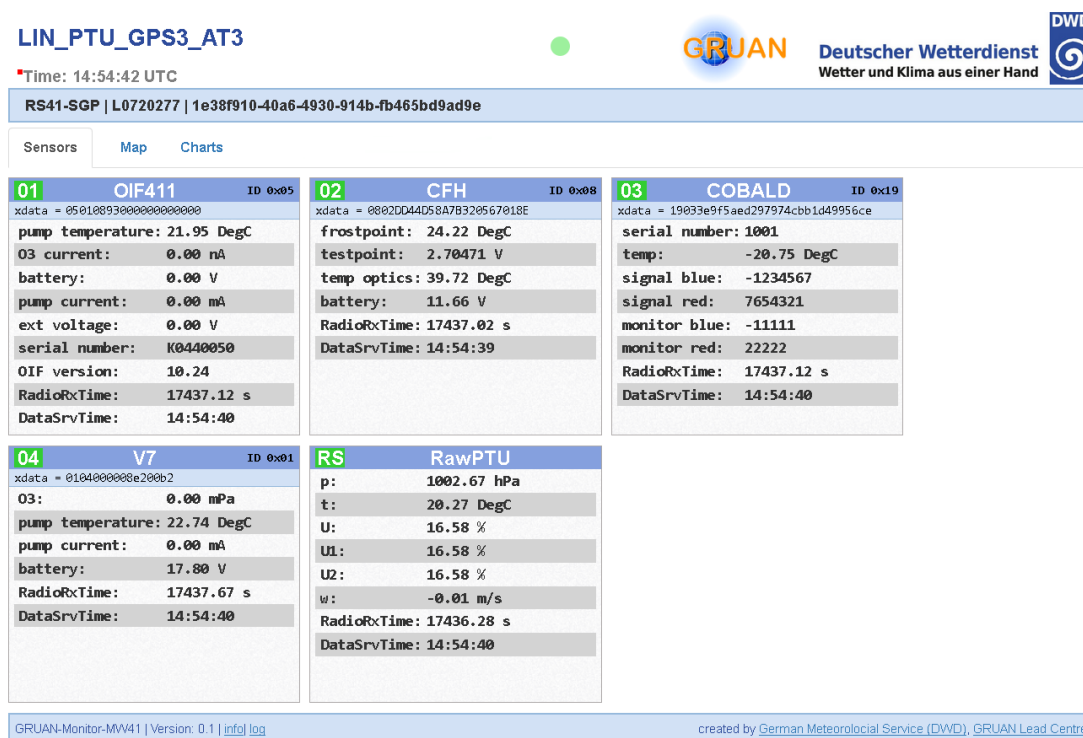
The main IronPython script of GM41 `GM41.py` implements the `IExecutableScript` interface and is called as argument with the Vaisala MW41 `ScriptExecutor.exe` tool [Vaisala \(2016a\)](#). Through that interface it receives requested notifications from the sounding system and has limited access to the sounding database by `ISounding` methods. In Appendix B a scheme of the Vaisala MW41 Scripting Architecture is shown including both interfaces. GM41 selects sounding software events as well as Xdata sensor messages and radiosonde data from the notifications payload and decodes sensor-specific Xdata as needed. A second webserver process provides data for the client site.

4. Description of client site

Calling the configured website starts background processes in the client which requests data from the webserver and display this on a single page website. The relevant parameters are displayed in a header, a tabbing section and a footer. Figure 1 shows the sensor tab that displays incoming sensor data. The parameters are refreshed in 2-5 second intervals.

4.1. Header section

The header displays, shown in Figure 2, the station name, as configured in the MW41 sounding software, the client time, the radiosonde type, the radiosonde serial number and a sounding id. The MW41

Figure 1: Screenshot of the client, showing the *Sensors* tab.

sounding software generates these unique sounding id. A solid green circle indicates a working data flow between the GM41 server and the client site.

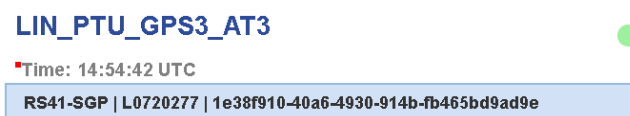


Figure 2: The header section.

4.2. Tabbing section

4.2.1. Sensors

Separate frames display the decoded Xdata packets from the connected sensors. The RawPTU and Synchronized Data data streams from the MW41 software are also displayed. The decoding and displaying of other data streams from the MW41 software are under development. The Sensors tab, shown in Figure 3, displays the decoded Xdata packets of the sensors OIF411, CFH, COBALD, V7 as well as the RawPTU data stream.

The first part of the header line of the data frames shows the sensor position (daisy chain index, e.g. "01", "02" and so on), or "RS" in case of a MW41 data stream. The background color of this position indicates the status of the data connection, green means that new data is coming in regularly, whereas red means that no new data has been received in the last 6 seconds. This feature depends on a well-synchronized system clock (accurate within 3 seconds) and a good connection between the GM41 server and the client site without noticeable delays. The sensor name or data branch is displayed in the center of the header line and the Xdata sensor ID is shown on the right.

The decoded measurement values are shown as a table in the frame. For Xdata sensors the raw message is shown directly below the header line. The displayed data is updated every two seconds.

If a Xdata sounding is configured during radiosonde ground check, the MW41 sounding software also displays raw Xdata packets [Vaisala \(2015\)](#). This is sufficient for checking that the communication between the Xdata sensor and the RS41 is working properly.

01	OIF411	ID 0x05
xdata = 05010A79017E0A406300		
pump temperature: 26.81 DegC		
O3 current: 0.61 uA		
battery: 16.40 V		
pump current: 99.00 mA		
ext voltage: 0.00 V		
serial number: K0440073		
OIF version: 0.00		
RadioRxTime: 4302.19 s		
DataSrvTime: 15:04:12		
02	CFH	ID 0x08
xdata = 0802A2D58B8050FE08290174		
frostpoint: -19.15 DegC		
testpoint: 2.50618 V		
temp optics: 32.83 DegC		
battery: 10.90 V		
RadioRxTime: 4301.69 s		
DataSrvTime: 15:04:12		
MixingRatio: 2179.02 ppmV		
03	COBALD	ID 0x19
xdata = 1903136086001b2500021a408a4f0a		
serial number: 310		
temp: 16.75 DegC		
signal blue: 6949		
signal red: 538		
monitor blue: 16522		
monitor red: 20234		
RadioRxTime: 4301.79 s		
DataSrvTime: 15:04:12		
RS	RawPTU	
p:		515.31 hPa
t:		-16.03 DegC
U:		61.42 %
w:		6.67 m/s
Dewpoint:		-21.75 DegC
Frostpoint:		-19.54 DegC
MixingRatio:		2100.8 ppmV
RadioRxTime:		4301.83 s
DataSrvTime:		15:04:13

Figure 3: The *Sensors* tab with frames displaying the connected Xdata sensors and a datastream of the MW41 sounding system.

4.2.2. Map

After launch, the radiosonde's position and simplified flight track is displayed on a map, as shown in Figure 4. The radiosonde's coordinates (latitude, longitude, and altitude) are displayed by clicking on the balloon burst point or last received position icon. The map is scaleable and printable. Two checkboxes above the map control the data refresh and radiosonde location centering. Different maps can be selected with the controls on the right hand side. It is possible to use an offline map for remote operation without internet access. In that case the necessary map-data have to be copied to the webserver image path. Contact the GRUAN Lead Centre for support (gruan.lc@dwd.de).

4.2.3. Charts

Plotting functionality is rudimentary implemented in the *Charts* tab, as shown in Figure 5. After selecting a data source and the x and y parameters, the plot is generated by pushing the "request plot" button. If the *automatic update* checkbox is selected, the plot is updated every few seconds. Changes in the data selection or switching to other tabs terminates the automatic update functionality.

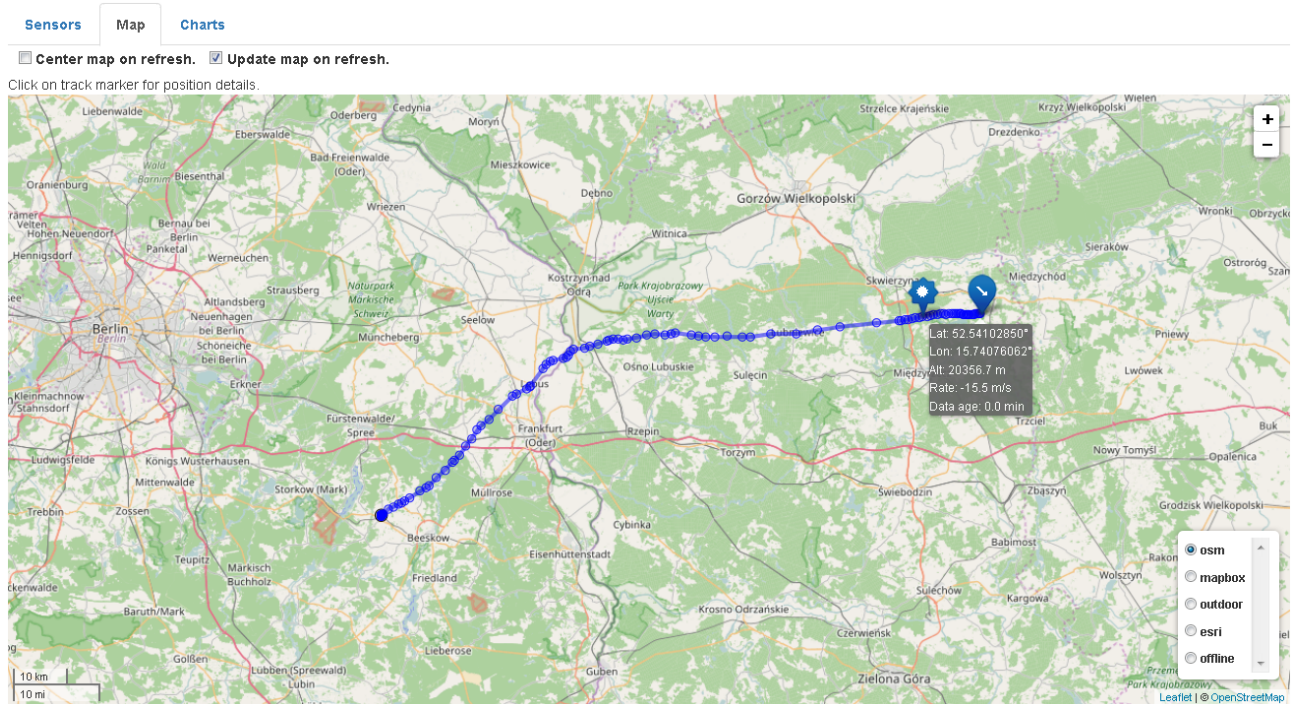


Figure 4: Visualization of the radiosondes flight track and station location on an interactive map. Different map-sources can be selected.

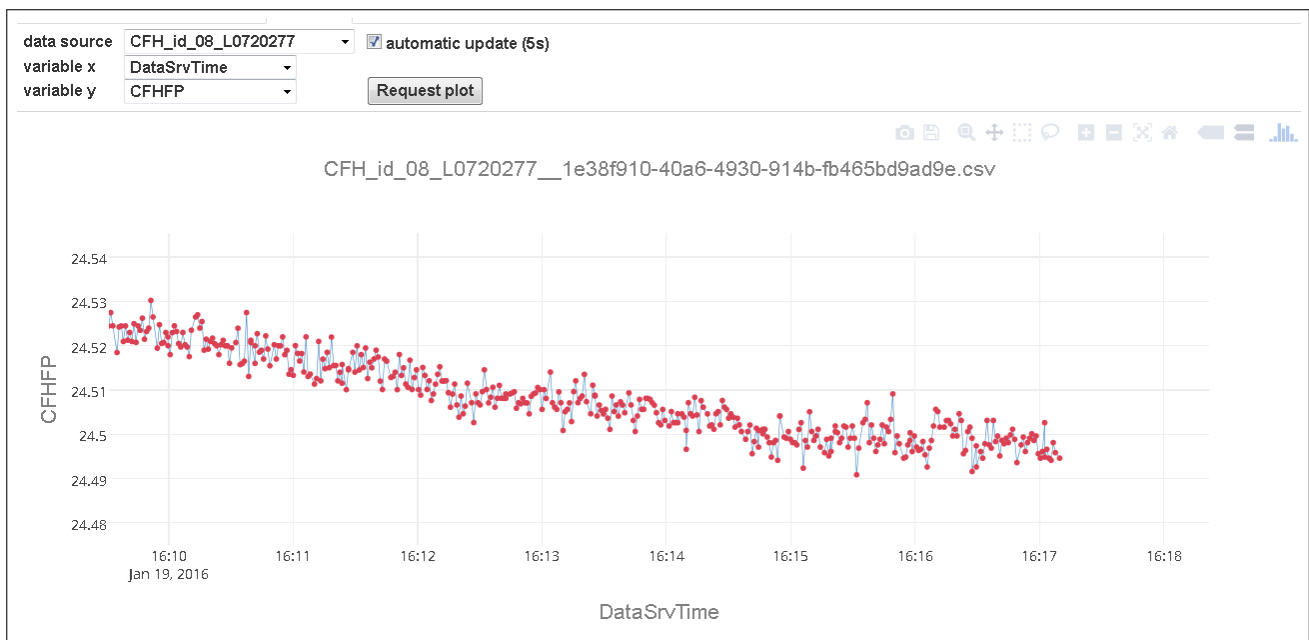


Figure 5: GM41 has a simple charting functionality. Hovering the plot, additional control elements appears in the top right of the chart for zooming, moving, storing and other possibilities. A tool tip explain the controls.

5. Known issues

- The background color of the Xdata sensor position stays red while the data lines are getting updated: The real time clock of the webserver and client computer are out of sync. A synchronization of both clocks is needed.
- If a connection is closed by the browser before answered from the webserver, the webserver throws an exception. The exception is caught, but displayed in the terminal session. The server stays online.
- Using GM41 while simulating an sounding with simulation speed more than 1 leads to freezing on slow machines.
- GM41 hangs on slow computers while two or more clients requests data.

Appendix

A. Directory listing

c:\	1
tools\	2
gm41\	3
www\	4
css \...	5
doc \...	6
js \...	7
libs \...	8
images \...	9
index.html	10
doc \...	11
simplejson \...	12
start.bat	13
GM41.py	14
mw4lgm.dll	15
rs4l_config.json	16
std.dll	17
version.txt	18
License.pdf	19
...	20

B. MW41 Scripting Architecture

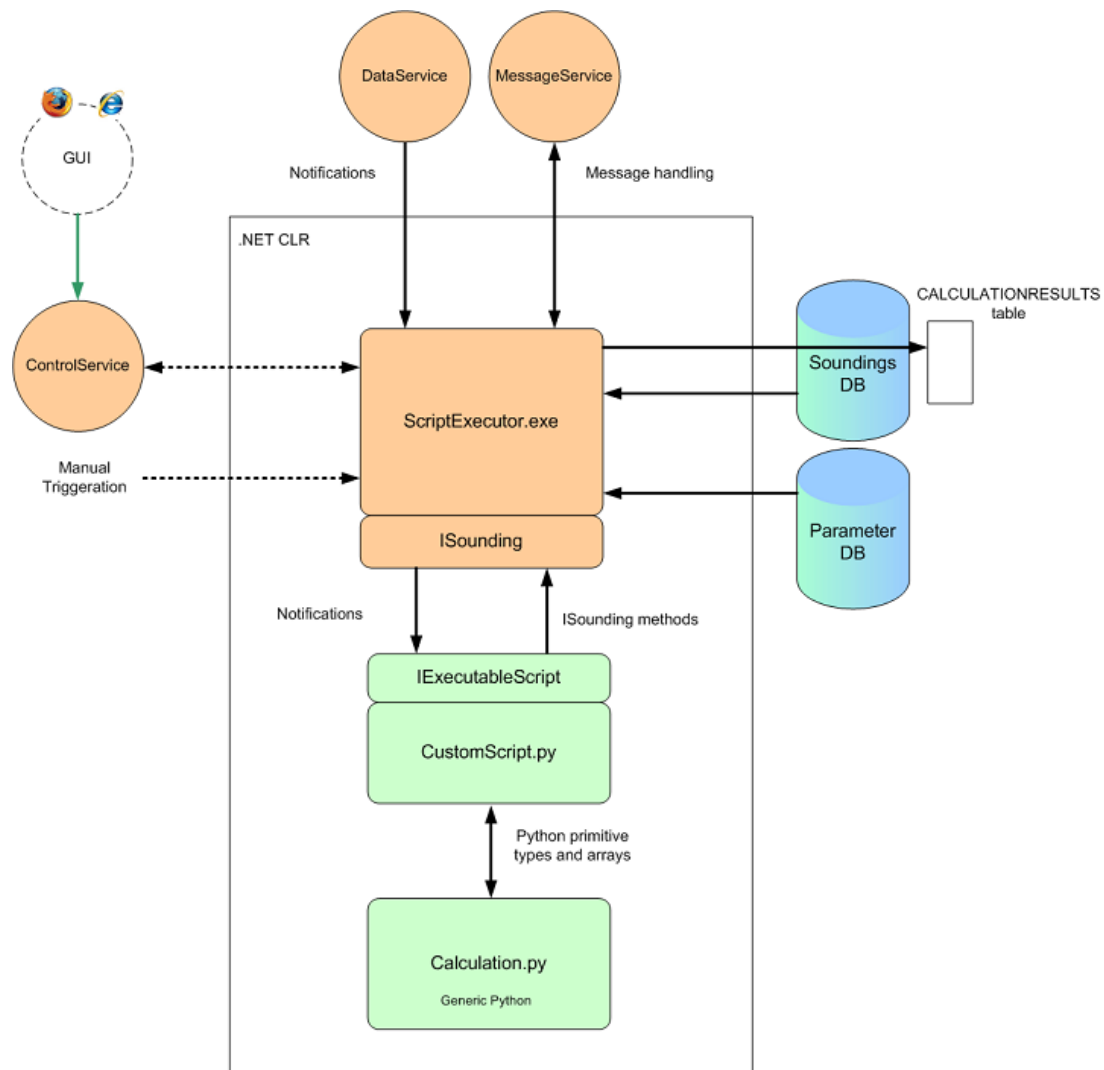


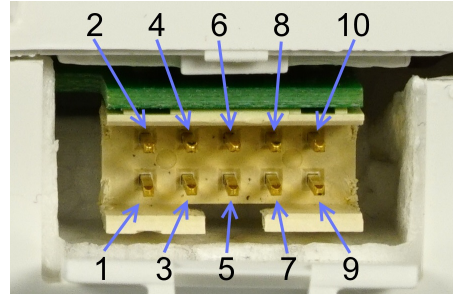
Figure 6: Scheme of the Vaisala MW41 Scripting Architecture [Vaisala \(2016a\)](#).

C. Additional Sensor connection to RS41

After describing the RS41 additional sensor interface with Figures 7 and 8, two approaches for connecting additional Xdata sensors to the RS41 without and with the Vaisala MW41 Ozone Interface Board (OIF411) are shown in appendix C.2 and C.1.

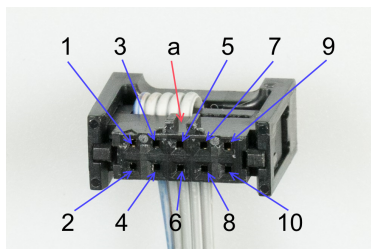


(a) Vaisala RS41 radiosonde with opened additional sensor interface port right hand from the antenna (marked with a black circle).



(b) Close view to the Vaisala RS41 radiosonde additional sensor interface port with labeled pin order.

Figure 7: RS41 additional sensor Interface location and pin order. The pin function is: **1** and **10** GND, **2** RXD (from additional sensor), **3** TXD (to additional sensor), **4** reserved, **5** supply voltage to additional sensor (3.7 V, $\pm 3\%$), **6** to **10** reserved.



(a) Wire housing with pin numbers. See Figure 7 for a the pin function description. The orientation pin is marked with "a".



(b) Assembled wire housing and wire with one turn on a ferrite tube.

Figure 8: Wire housing (Mfr. Amphenol FCI, part no. 89361-710SLF) for RS41 additional sensor Interface cable - radiosonde site. Visible in (b) is also a suitable ferrite tube (Mfr. Wurth Elektronik, part no. 74270032) and wire (Mfr. 3M, part no. HF625/10). Pitch space is 2 mm.

C.1. Connections with using OIF411

The OIF411 ozone board is technically an additional Xdata sensor with ozone sonde measurement / supply ports and the option for connecting one additional Xdata sensor. Figure 9 shows the pin connection of OIF411 to RS41 and one next additional Xdata sensor. Xdata messages are forwarded to the RS41 (daisy chaining). The OIF411 is a part of the Vaisala RSA411 Ozone Interface Kit with cables to radiosonde and ozone sonde. Therefore no adapter cable to the radiosonde must be assembled in this approach. Only the cable to the additional Xdata sensor is needed and often included with the additional Xdata sensors.

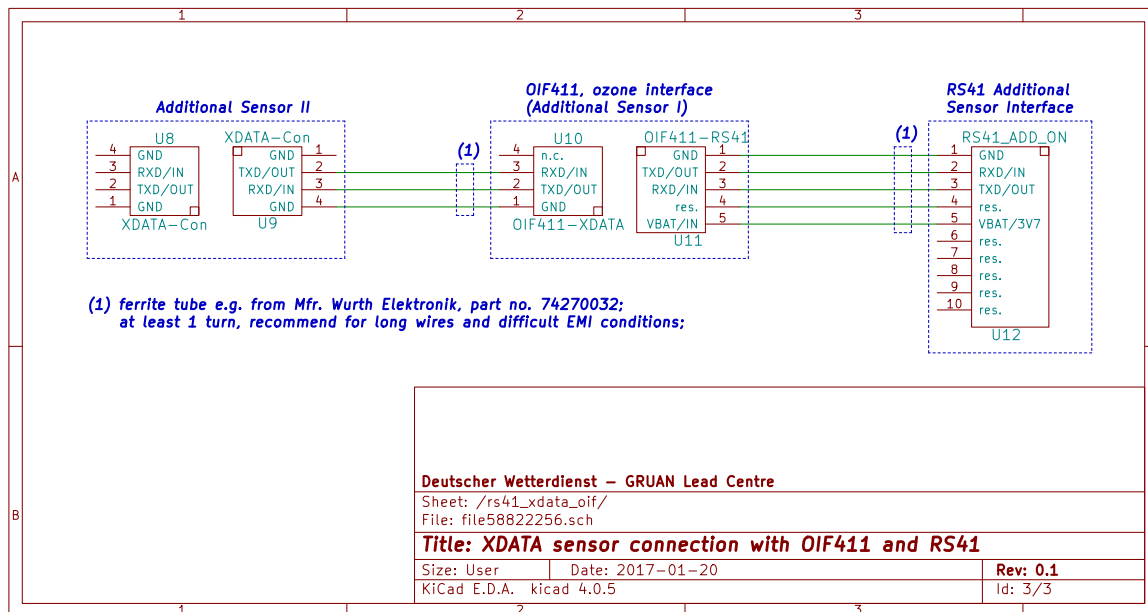


Figure 9: Pin configuration scheme for two additional sensors (daisy-chain configuration) using the OIF411 (see Figure 10) connected to the RS41 additional sensor interface. Connector details as also manufacturer and order codes can be gathered from Figures 7, 8 and 12 or from [Vaisala \(2015\)](#).

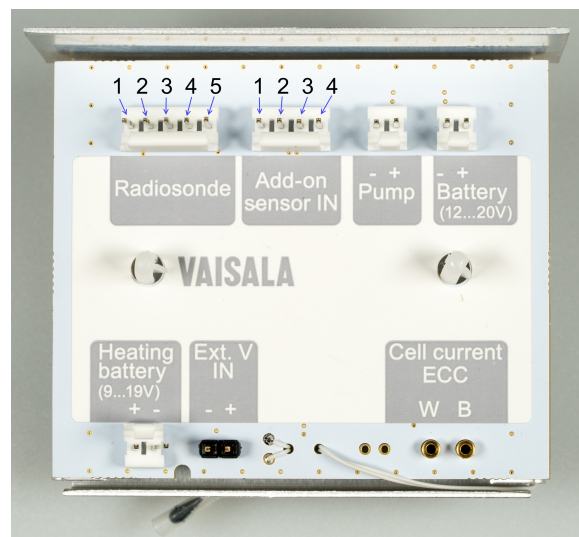


Figure 10: Vaisala MW41 Ozone Interface Board (OIF411) for connecting additional Xdata sensors (through connector "Add-on sensor IN") and an ECC ozone sonde with the RS41 radiosonde. The interface is powered by the radiosonde connected to port "Radiosonde". Note that board and cables to radiosonde and ozone sonde are already included with the Vaisala RSA411 Ozone Interface Kit.

C.2. Connections without using OIF411

When no ozone sonde is used on the payload or connected through other Xdata compatible ozone interface board respectively (e.g. V7), additional Xdata sensors can also be connected with their Xdata port directly to the RS41. Only an adapter cable without active components is needed as described in Figure 11.

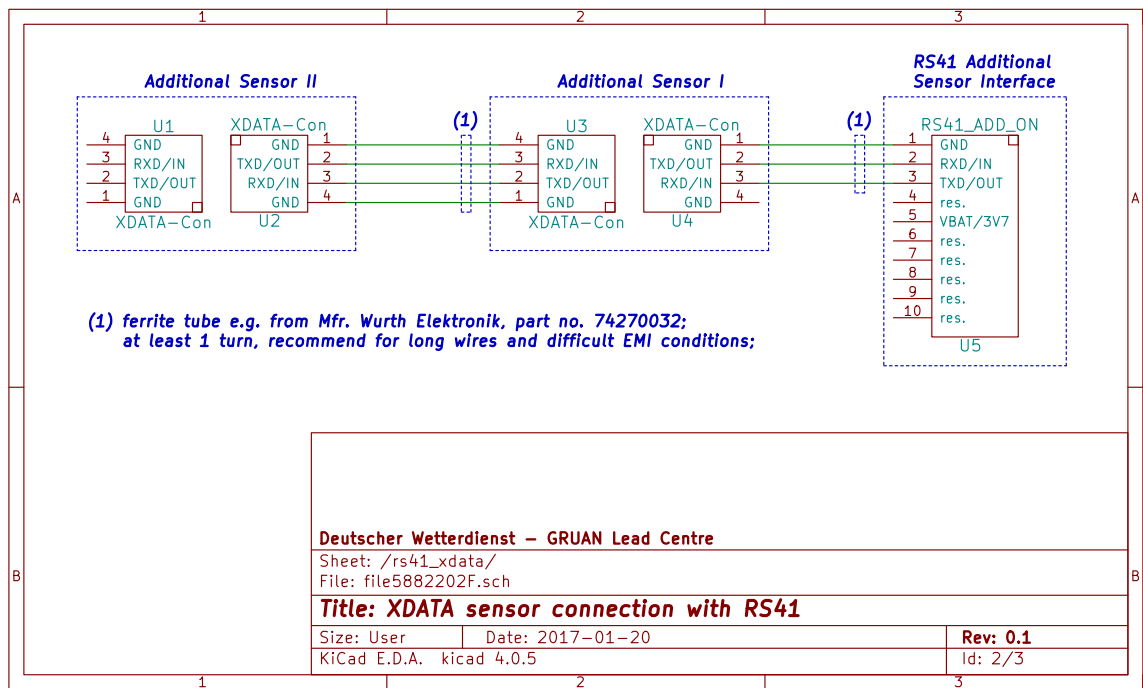
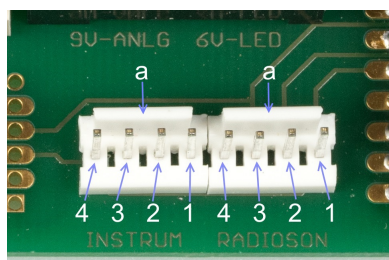
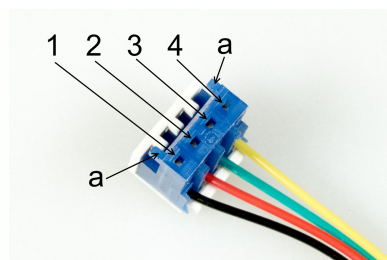


Figure 11: Pin configuration scheme for two additional sensors (in daisy-chain configuration) connected directly to the RS41 additional sensor interface. Connector details as also manufacturer and order codes can be gathered from Figures 7, 8 and 12 or from [Vaisala \(2015\)](#).



(a) Headers (Mfr. TE Connectivity, part no. 640456-4, MTA100 series) on COBALD electronics board for connection to next additional Xdata sensor (left) and to radiosonde (right).



(b) Wire housing (Mfr. TE Connectivity, part no. 3-643816-4, MTA100 series) for cables between additional Xdata sensors.

Figure 12: Header (a) and wire housing (b) mostly used for Xdata additional sensor connections. 1 to 4 are pin numbers. Orientation pins are indicated with a.

Acronyms

CFH	Cryogenic Frost-Point Hygrometer
COBALD	Compact Optical Backscatter Aerosol Detector
GM41	GRUAN Monitor MW41
FLASH-B	Balloon Optical Fluorescent Hygrometer
OIF411	Vaisala MW41 Ozone Interface Board
V7	the ozone interface board on EN-SCI Model 2Z-V7 ozone sondes

References

- Vaisala, *Vaisala DigiCORA Sounding System MW41*, Vaisala Oyi, P.O. Box 26 FI 00421 Helsinki Finland, 2014, technical Reference, filename M211415EN-J.pdf.
- Vaisala, *Vaisala Radiosonde RS41 Additional Sensor Interface*, Vaisala Oyi, P.O. Box 26 FI 00421 Helsinki Finland, 2015, users Guide, filename M211604EN-C.pdf.
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