akribis

USER GUIDE

DA10

Vaisala · Authorized Partner

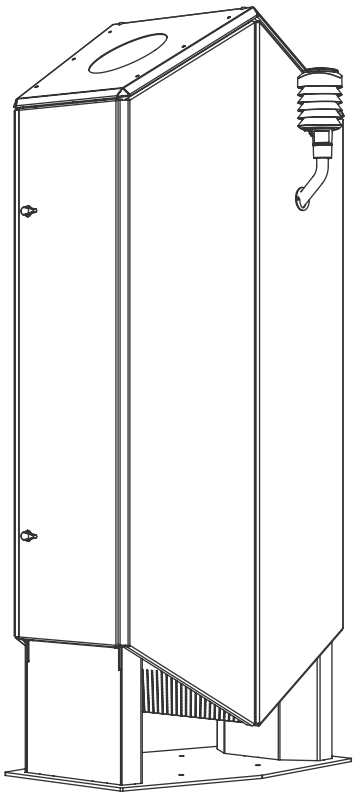
Distributed by AKRIBIS

M212895EN-F

User Guide

Vaisala DIAL Atmospheric Profiler

DA10



VAISALA

AKRIBIS · www.akribis.info · contacto@akribis.info

PUBLISHED BY

Vaisala Oyj
Vanha Nurmijärventie 21, FI-01670 Vantaa, Finland
P.O. Box 26, FI-00421 Helsinki, Finland
+358 9 8949 1
vaisala.com
docs.vaisala.com

© Vaisala 2026

No part of this document may be reproduced, published, or publicly displayed in any form or by any means, electronic or mechanical (including photocopying), nor may its contents be modified, translated, adapted, sold, or disclosed to a third party without prior written permission of the copyright holder. Translated document and translated portions of the document are based on the original English version. Parts of the translation may have been created using machine-assisted translation. In ambiguous cases, the English version is applicable, not the translation.

The contents of this document are subject to change without prior notice.

Local rules and regulations applicable to the products and services may vary, and they shall take precedence over the information contained in this document. Vaisala makes no representations on this document's compliance with the local rules and regulations applicable at any given time, and hereby disclaims any and all responsibilities related thereto. You are instructed to confirm the applicability of the local rules and regulations and their effect on the intended use of the products and services.

This document does not create any legally binding obligations for Vaisala towards customers or end users. All legally binding obligations are set forth exclusively in the applicable contract or in the relevant set of General Conditions of Vaisala (vaisala.com/policies).

This product contains software developed by Vaisala or third parties. Use of the software is governed by license terms and conditions included in the applicable contract or, in the absence of separate license terms and conditions, by the General License Conditions of Vaisala Group.

This product may contain open-source software (OSS) components. In the event this product contains OSS components, then such OSS is governed by the terms and conditions of the applicable OSS licenses, and you are bound by the terms and conditions of such licenses in connection with your use and distribution of the OSS in this product. Applicable OSS licenses are included in the product itself or provided to you on any other applicable media, depending on each individual product and the product items delivered to you.

Table of contents

1. About this document 7
1.1 Version information 7
1.2 Related documentation 8
1.3 Documentation conventions 8
1.4 Trademarks 9

2. Product overview 10
2.1 Vaisala DIAL Atmospheric Profiler DA10 10
2.2 Product and part names 11
2.3 Ordering options 11
2.4 Safety 11
2.4.1 Eye safety 14
2.4.2 Hot surface safety 18
2.4.3 ESD protection 20

3. Functional description 21
3.1 Mechanical structure 21
3.2 DA10 connectors 22
3.3 Measurement units 23
3.4 Interface unit 25
3.4.1 Vaisala DA10GW Gateway 26
3.4.2 AC/DC power supply unit 26
3.5 Vaisala Weather Transmitter WXT534 27
3.5.1 PTU measurement principle 27
3.6 Software tools 28
3.6.1 DA10 Client 28
3.6.2 DA10 Web UI 29

4. Measurements 30
4.1 Measurement principle 30
4.2 Atmospheric profiles 31
4.2.1 Water vapor profile 32
4.2.2 Uncertainty for water vapor profile 33
4.2.3 Attenuated backscatter profile 34
4.2.4 Offline and online profiles 34
4.3 Atmospheric parameters 35
4.3.1 Cloud base height 35
4.3.2 Vertical visibility 35
4.3.3 Cloud thickness and cloud penetration depth 35
4.3.4 Precipitation and fog detection 35
4.3.5 Sky condition algorithm 36
4.3.6 Surface PTU 36
4.4 Data quality and data availability 37

5. Data reporting 38
5.1 Data outputs 38
5.2 NetCDF files 38
5.2.1 File naming 39
5.2.2 Global attributes 39
5.2.3 Missing data and special cases 40
5.2.4 Variables and dimensions in water vapor mixing ratio files 41
5.2.5 Variables and dimensions in attenuated backscatter files 50

5.3 Visualization files....59

6. Configuration....61
6.1 Connection options....61
6.1.1 Connecting to device locally....62
6.1.2 Connecting to device remotely....63
6.2 Configuring device location....63
6.3 Changing data storage location....65
6.4 Configuring mixing ratio temporal averaging....66
6.5 Configuring DA10 laser bandwidth factors....66

7. Operation....68
7.1 Retrieving netCDF files....68
7.2 Visualizing mixing ratio files....68

8. User management....70
8.1 Managing user accounts....70
8.2 User roles....70
8.3 Adding new user accounts....70

9. Firmware update....73
9.1 Updating device control modules....73
9.2 Updating DA10GW....74
9.3 Factory resetting DA10....75
9.4 Updating DA10 Client....76
9.5 Setting up data collection....76
9.6 Verifying operation....76
9.7 Rerunning device control module firmware update....77

10. Maintenance....78
10.1 Maintenance safety....78
10.2 DA10 maintenance....81
10.3 Cleaning window....82
10.4 Checking door gasket....83
10.5 Cleaning and maintaining painted surfaces....83
10.6 Replacing PTU module....83
10.7 Replacing DA10GW battery....85

11. Service instructions....88
11.1 Spare parts....88
11.2 Replacing surge protection units and relay units....89
11.2.1 Replacing surge protection units for AC....89
11.2.2 Replacing surge protection unit for Ethernet....90
11.2.3 Replacing relay units....92
11.3 Replacing window blower....93

12. Troubleshooting....97
12.1 Viewing alerts....97
12.2 Troubleshooting DA10 firmware update....99
12.3 Factory resetting DA10....101

13. Technical data....105
13.1 DA10 specifications....105
13.2 DA10GW specifications....110
13.3 AC (mains) power supply specifications....113
13.4 WXT534 specifications....113

Appendix A: NetCDF example file, water vapor mixing ratio.....117

Appendix B: NetCDF example file, attenuated backscatter.....125

Appendix C: Maintenance checklist.....132

Appendix D: Recycling instructions.....133

Appendix E: FCC/ISED regulatory notices.....137

Warranty.....139

Technical support.....139

Recycling.....139

1. About this document

1.1 Version information

This document provides detailed information about Vaisala DIAL Atmospheric Profiler DA10.

Table 1 Document versions (English)

Document code	Date	Description
M212895EN-F	September 2026	For SW release 2.5 with the following changes: • Updated water vapor profile information. • Added information about offline and online profiles. • Adjusted power supply description. • Updated the global attributes list. • Added information about configuring laser bandwidth. • Added instructions for configuring mixing ratio temporal averaging interval. • Added new global attributed: `gateway_serial_number`, `dac_near_serial_number`, and `dac_far_serial_number`. • Added new variables: `offline_backscatter`, `offline_backscatter_noise_level`, `online_backscatter`, `online_backscatter_noise_level`, `internal_humidity`, and `internal_temperature`. • Updated the netCDF dimensions in water vapor mixing ratio files. • Changed measurement range information. • Changed averaging time information. • In the specifications, added the corresponding wattage to the nominal voltage information. • Updated compliance marks.
M212895EN-E	October 2025	For SW release 2.3 with the following changes: • DMU801-DA10 name changed to DA10GW. • Added information about advanced autocalibrator. • Added cloud base height, cloud penetration depth or cloud thickness, precipitation and fog detection, sky condition algorithm. • Added user management in Web UI. • Added firmware update instructions. • Added alert information. • Added spare part instructions for replacing window blower, relay units, and surge protection units. • Updated laser safety label. • Updated water vapor mixing ratio (MR) netCDF file and attenuated backscatter (ABS) netCDF file with new parameters. • Updated attenuated backscatter (ABS) netCDF file with range starting from 0 m (0 ft), layer added as one dimension. • Updated water vapor mixing ratio file (MR) netCDF file with layer added as one dimension.

Document code	Date	Description
M212895EN-D	February 2024	For SW release 2.0 with the following changes: • Added Web UI. • Added DA10 Client. • Added PNG visualization files. • Added configuration and operation instructions. • Updated water vapor mixing ratio (MR) netCDF file (parameters `receiver_gain` and `window_condition`). • Updated attenuated backscatter (ABS) netCDF file (parameters `receiver_gain` and `window_condition`). • Updated specifications.

1.2 Related documentation



For the latest versions of these documents, see docs.vaisala.com.

A printed version of Vaisala DIAL Atmospheric Profiler DA10 Installation Guide is included in each delivery.

Table 2 DA10 manuals

Document code	Name
M212895EN	Vaisala DIAL Atmospheric Profiler DA10 User Guide
M212894EN	Vaisala DIAL Atmospheric Profiler DA10 Installation Guide

Table 3 Related manuals

Document code	Name
M212436EN	Vaisala Data Management Unit DMU801 User Guide
M212429EN	Vaisala Data Management Unit DMU801 Quick Guide
M211786EN	Grounding and Lightning Protection in Vaisala Outdoor Installations Technical Reference
M211840EN	Vaisala Weather Transmitter WXT530 Series User Guide

1.3 Documentation conventions



WARNING! Alerts you to a serious hazard. If you do not read and follow instructions carefully at this point, there is a risk of injury or even death.

AKRIBIS · www.akribis.info · contacto@akribis.info



CAUTION! Alerts you to a potential hazard. If you do not read and follow instructions carefully at this point, the product could be damaged or important data could be lost.



Highlights important information on using the product.



Gives information for using the product more efficiently.



Lists tools needed to perform the task.



Indicates that you need to take some notes during the task.

1.4 Trademarks

Vaisala® is a registered trademark of Vaisala Oyj.

BAROCAP® is a registered trademark of Vaisala Oyj.

HUMICAP® is a registered trademark of Vaisala Oyj.

Linux® is a registered trademark of Linus Torvalds.

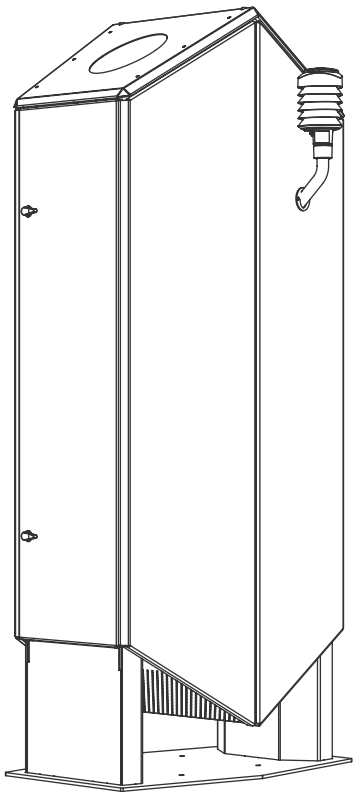
Python® is a trademark or registered trademark of the Python Software Foundation.

Windows® is either a registered trademark or trademark of Microsoft Corporation in the United States and other countries.

All other product or company names that may be mentioned in this publication are trade names, trademarks, or registered trademarks of their respective owners.

2. Product overview

2.1 Vaisala DIAL Atmospheric Profiler DA10



Vaisala DIAL Atmospheric Profiler DA10 is a high-performance differential absorption lidar (DIAL) instrument for enhanced severe weather forecasting and climate modeling with advanced, real-time water vapor profiles. DA10 offers continuous and unattended real-time water vapor profiling for operational observation networks.

DA10 measures the water vapor content in the atmosphere from low altitudes up to the top of the boundary layer or cloud base layer - whichever is lower. The advanced real-time water vapor profiles can be used as input to severe weather nowcasting and, for example, for the possible detection of atmospheric rivers.

DA10 is essentially a ceilometer and a water vapor profiler combined. It provides cloud height information and real-time high-quality water vapor profiling data, as well as atmospheric profiles such as the attenuated backscatter profile.

The measurement data is available in the universal and accessible netCDF format. This allows for integration to various types of systems, but also sharing of files across organizations. The netCDF data includes both measurement data and monitoring data. This makes the data easily available for numerical weather prediction (NWP) models.

2.2 Product and part names

Table 4 Product and part names

Product or part	Name
DA10	Vaisala DIAL Atmospheric Profiler DA10
DA10GW	Vaisala DA10 Gateway
WXT534	Vaisala Weather Transmitter WXT534

2.3 Ordering options

Table 5 DA10 ordering options

Option	Details
Vaisala DIAL Atmospheric Profiler	110/115 V AC
	230 V AC
Installation	
Standard installation	-
Installation with guy wires	For sites with winds > 30 m/s (67 mph)
Cabling	
• 5-m power cable • 10-m Ethernet cable	For 230 V AC
• 25-m power cable • 25-m Ethernet cable	
• 5-m power cable • 10-m Ethernet cable	For 115 V AC
• 25-m power cable • 25-m Ethernet cable	

Table 6 DA10 accessories

Accessory	Order code
Maintenance cable, Ethernet, 2 m	DA10MCABLE2M
USB-C cable	261928

2.4 Safety

This product has been tested for safety. Note the following precautions:

WARNING! Failure to comply with these precautions or with specific warnings elsewhere in these instructions violates safety standards of design, manufacture, and intended use of the product. Vaisala assumes no liability for the customer's failure to comply with these requirements.

WARNING! If the equipment is used in a manner not specified by Vaisala, the protection provided by the equipment may be impaired.

WARNING! Do not substitute parts or modify the system, or install unsuitable parts in the system. Improper modification can damage the product or lead to malfunction.

WARNING! Do not operate in an explosive atmosphere, for example, when flammable gases or fumes are present. Operation of electrical equipment in such an environment constitutes a safety hazard.

WARNING! Do not perform installation or maintenance procedures when there is a risk of thunderstorm or lightning activity in the area.

WARNING! Do not service the system alone. Do not reach into parts and assemblies that are AC (mains) powered and live except in the presence of someone who can provide first aid.

WARNING! Only qualified maintenance personnel may perform maintenance procedures. Make sure unauthorized persons cannot access the work area during service operations.

WARNING! Only licensed experts may install electrical components. They must adhere to local and state legislation and regulations.

AKRIBIS · www.akribis.info · contacto@akribis.info



WARNING! Follow local and state legislation and regulations on occupational safety.



WARNING! Make sure that you prepare or connect only de-energized wires.



WARNING! Do not replace components when the system is powered up. Disconnect all power sources before performing maintenance procedures.



WARNING! After disconnecting the power cable, dangerous voltages can exist for some time. To avoid injury, disconnect the power and discharge circuits before touching them.



WARNING! To avoid injuries and to avoid damaging the instrument, do not place a ladder or similar against the instrument.



WARNING! Do not look directly into the transmitter with magnifying optics (such as glasses, binoculars, and telescopes).



WARNING! Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.



CAUTION! Keep the radiation shield doors closed during operation.

2.4.1 Eye safety

This Vaisala DIAL Atmospheric Profiler DA10 is classified as a Class 1M optical device in accordance with International Standard IEC/EN 60825-1:2014. Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 ED. 3., as described in Laser Notice No. 56, dated May 8, 2019.

For the receiver and transmitter specifications, see the technical data.

Table 7 DA10 transmitter specifications

Property	Value
Radiated pattern emitted from protective housing, from DA10 window of near-range measurement unit telescope	
Maximum pulse energy	4.7 µJ
Laser wavelength	910.55 nm and 910.99 nm
Peak power	40 W
Maximum average power	44 mW
Maximum average power through 7-mm aperture	520 uW
Pulse duration	160 ns FWHM
Pulse repetition frequency	8.244 kHz
Beam divergence	±0.051 mrad × ±0.33 mrad
Radiated pattern emitted from protective housing, from DA10 window of far-range measurement unit telescope	
Maximum pulse energy	10.3 µJ
Laser wavelength	910.55 nm and 910.99 nm
Peak power	40 W
Maximum average power	97 mW
Maximum average power through 7-mm aperture	260 uW
Pulse duration	352 ns FWHM
Pulse repetition frequency	8.244 kHz
Beam divergence	±0.027 mrad × ±0.18 mrad

The following table describes the properties of the sole transmitter module. DA10 must never be operated and powered when the transmitter module is not attached to the optics unit.

Table 8 DAT111N transmitter and DAT111F transmitter specifications

Property	Value
Incorporated laser (DAT111N transmitter of near-range measurement unit telescope)	

Property	Value
Laser wavelength	910.55 nm and 910.99 nm
Peak power	50 W
Maximum average power	61 mW
Pulse duration	160 ns FWHM
Pulse repetition frequency	8.244 kHz
Typical beam divergence	±7 degrees
Incorporated laser (DAT111F transmitter of far-range measurement unit telescope)	
Laser wavelength	910.55 nm and 910.99 nm
Peak power	50 W
Maximum average power	134 mW
Pulse duration	352 ns FWHM
Pulse repetition frequency	8.244 kHz
Typical beam divergence	±7 degrees

The device is equipped with the following labels:

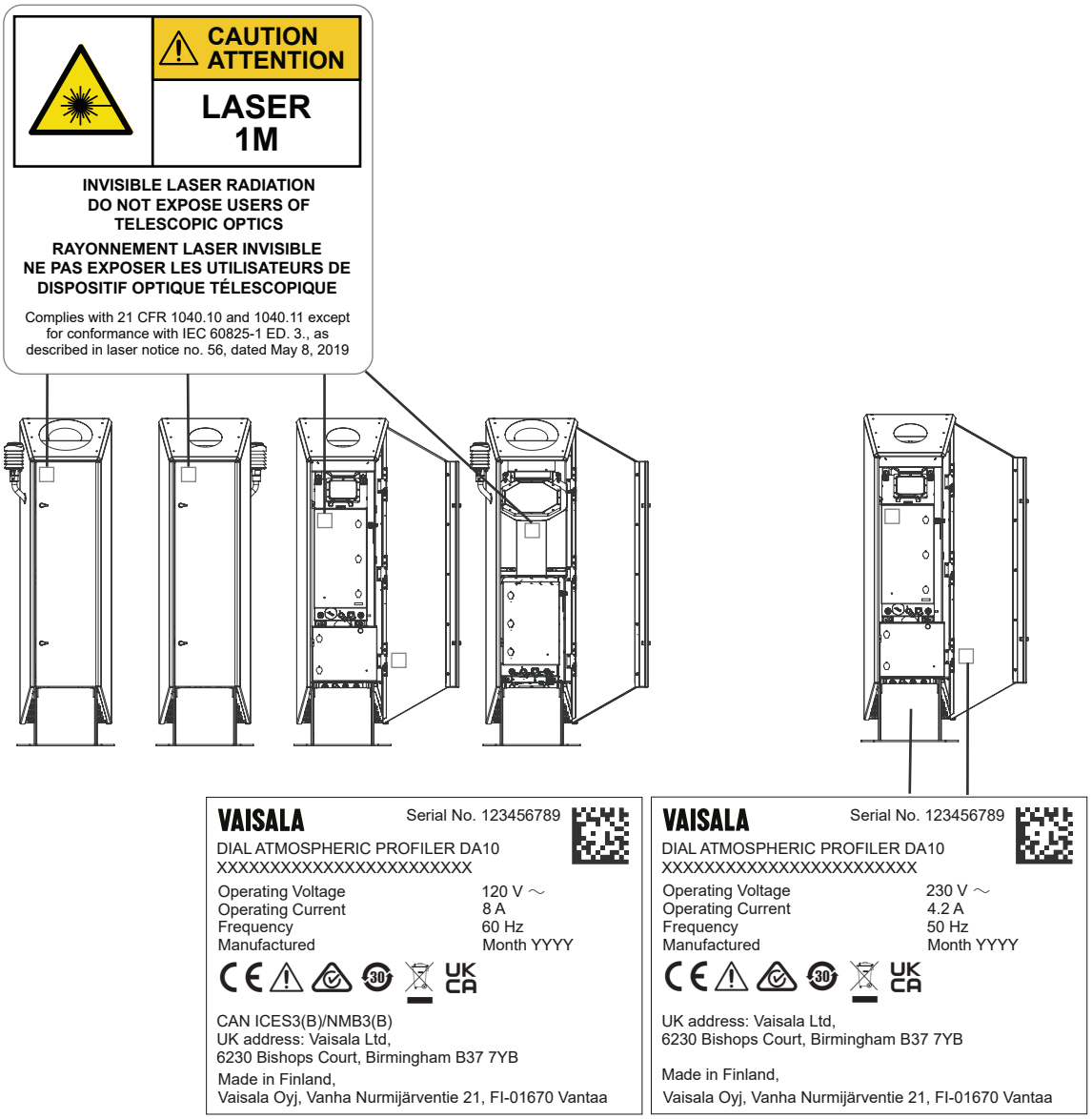


Figure 1 Location of explanatory and certification labels on DA10

Take the following precautions during installation, operation, and maintenance:

WARNING! Viewing the laser output with telescopic optical instruments (for example, telescopes or binoculars) may pose an eye hazard. Do not direct the beam into an area where such instruments are likely to be used.

AKRIBIS · www.akribis.info · contacto@akribis.info

WARNING! Only qualified maintenance personnel may perform maintenance procedures. Make sure unauthorized persons cannot access the work area during service operations.

WARNING! Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

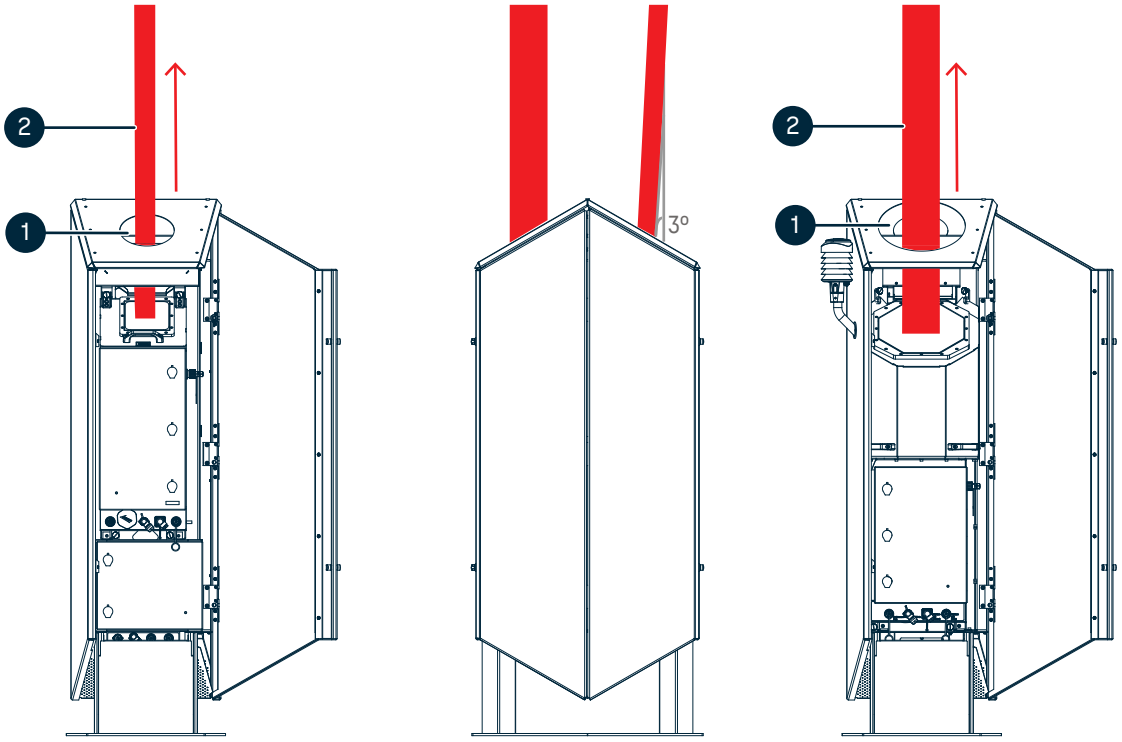


Figure 2 Location of DA10 laser apertures and direction of transmitted light

1 Laser aperture (2 pcs)
2 Laser class 1M, direction of transmitted light

Laser class of the incorporated laser (transmitter module) is 3B.

The transmitter modules have a laser aperture and label as shown in the following figures. Do not remove the transmitter. It is optically aligned at the factory.

WARNING! Do not remove the transmitter. It emits Class 3B laser radiation when powered.

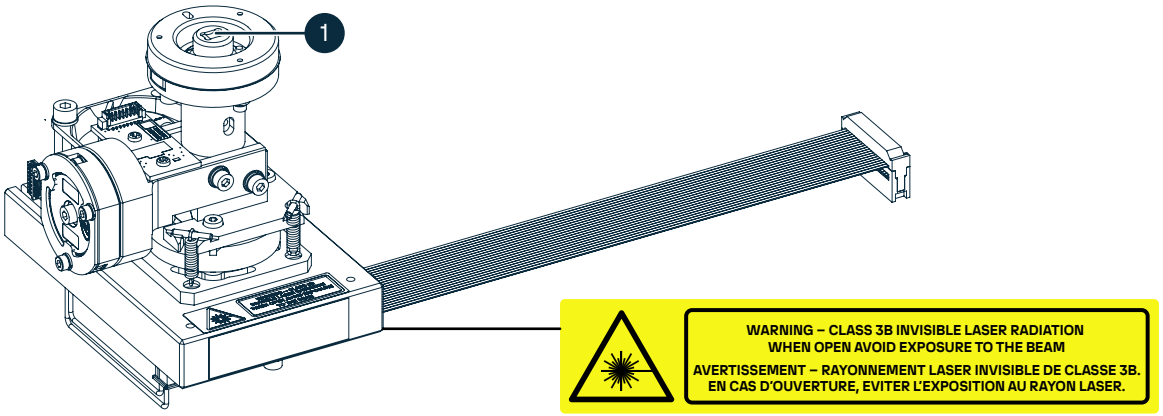


Figure 3 Location of warning and explanatory labels on transmitter modules

1 Laser aperture

2.4.2 Hot surface safety

The internal heater module gets hot when the heater is activated.

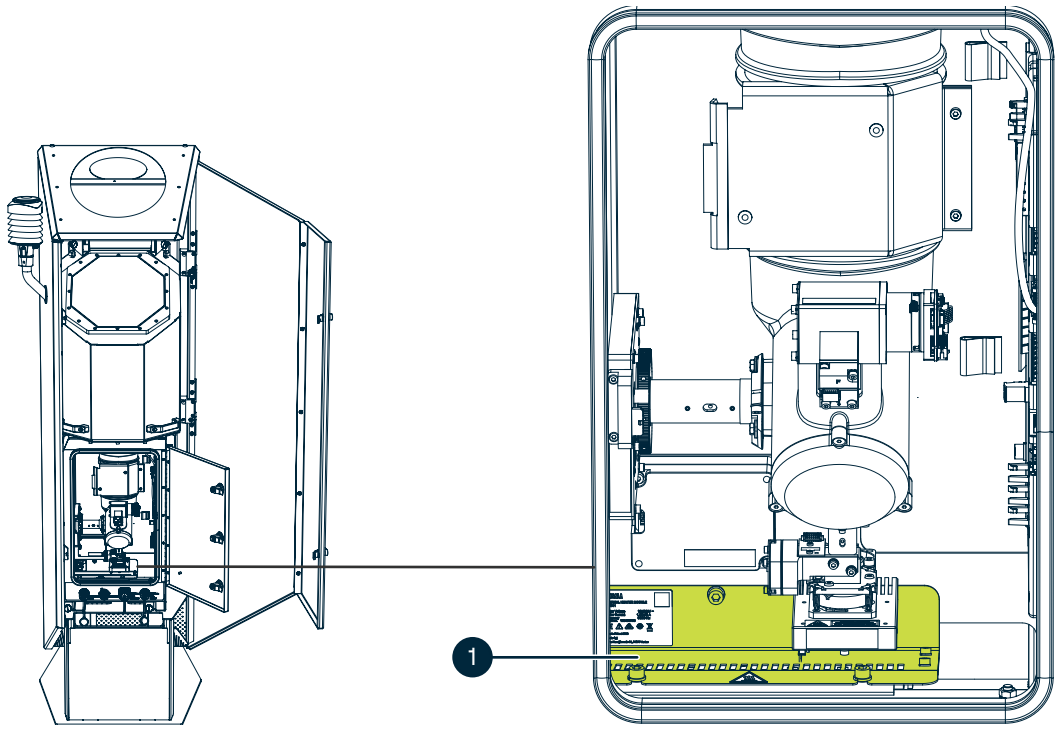


Figure 4 Location of hot surface and label on far-range measurement unit

1 Potentially hot surface and warning label

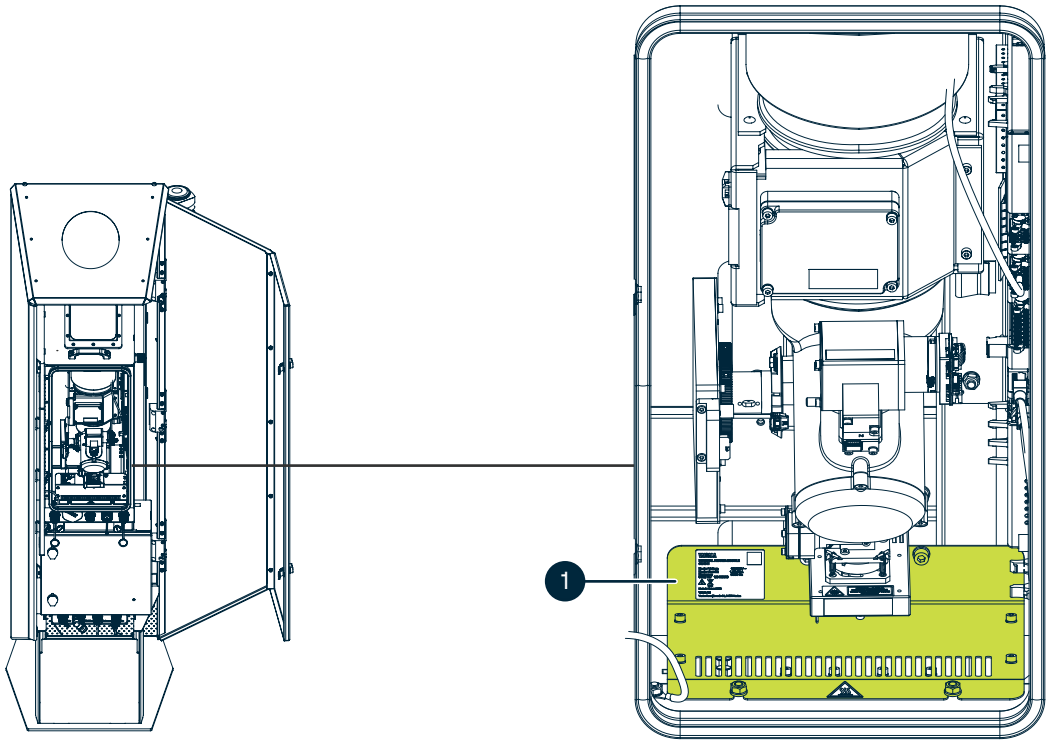


Figure 5 Location of hot surface and label on near-range measurement unit

1 Potentially hot surface and warning label

2.4.3 ESD protection

Electrostatic discharge (ESD) can damage electronic circuits. Vaisala products are adequately protected against ESD for their intended use. However, it is possible to damage the product by delivering electrostatic discharges when touching, removing, or inserting any objects in the equipment housing.

To avoid delivering high static voltages to the product:

- Handle ESD-sensitive components on a properly grounded and protected ESD workbench or by grounding yourself to the equipment chassis with a wrist strap and a resistive connection cord.
- If you are unable to take either precaution, touch a conductive part of the equipment chassis with your other hand before touching ESD-sensitive components.
- Hold component boards by the edges and avoid touching component contacts.

3. Functional description

3.1 Mechanical structure

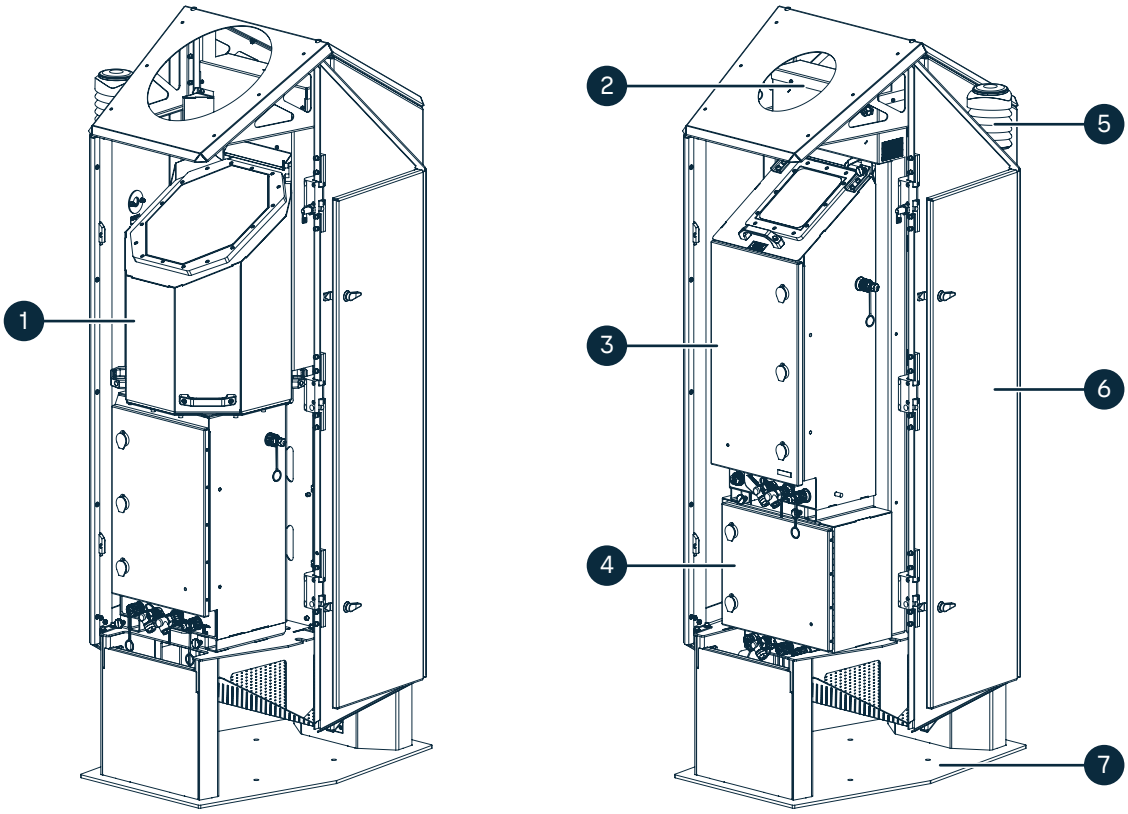


Figure 6 DA10 physical structure

#	Component	Description
1	Far-range measurement unit	Unit that provides measurements up to 18 000 m (59 000 ft)
2	Window blower	Fan that reduces ice and frost formation on the measurement unit windows
3	Near-range measurement unit	Unit that provides measurements up to 800 m (2625 ft)
4	Interface unit	Unit that contains electronics, including a gateway DA10GW, a power supply, as well as surge protectors and the mains power switch
5	Vaisala Weather Transmitter WXT534	Sensor for pressure, temperature, and humidity surface measurements
6	Radiation shield	Cover that protects the equipment against severe weather
7	Pedestal	Physical structure on which DA10 stands

3.2 DA10 connectors

DA10 has a number of connectors that connect the measurement units and the interface unit.

The interface unit cables have been connected at the factory.

Connect the measurement unit cables during installation.

For details about connecting the cables, see DA10 Installation Guide (M212894EN).

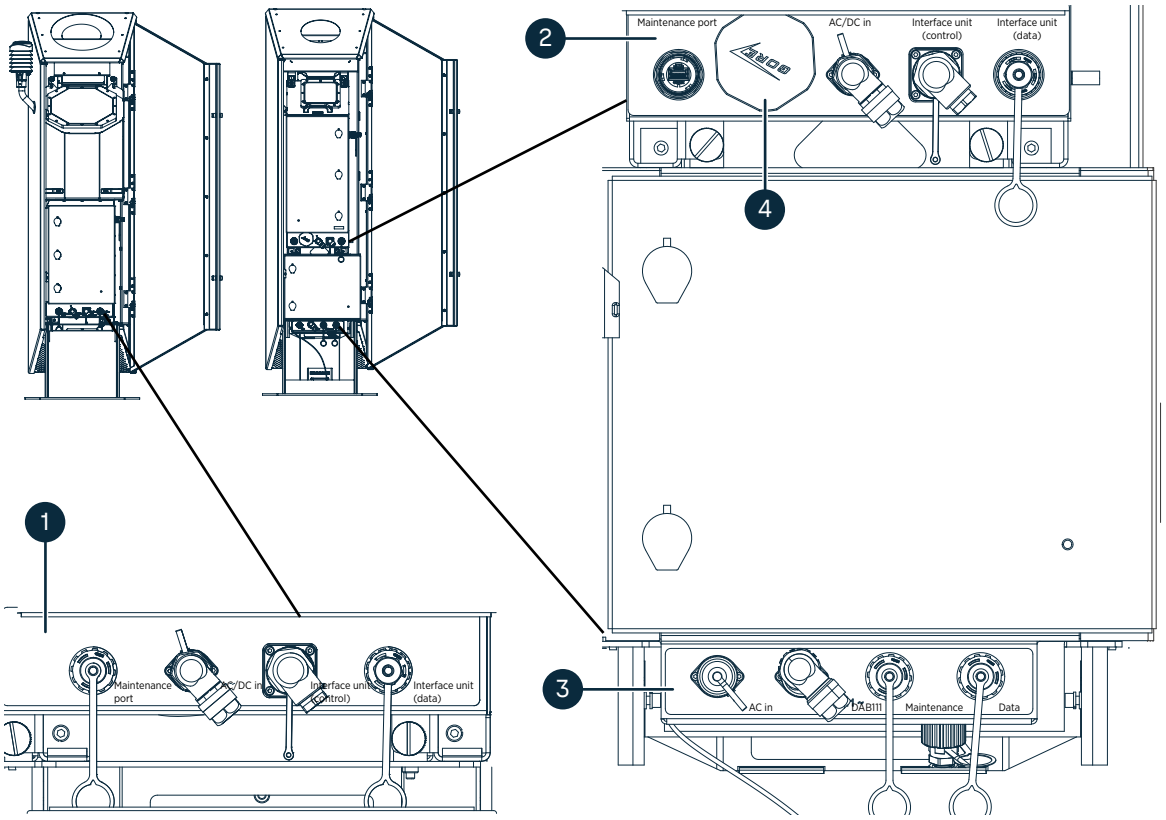


Figure 7 DA10 connectors on measurement units and interface unit

1. Far-range measurement unit	2. Near-range measurement unit	3. Interface unit
Maintenance port	**Maintenance port**	**AC in**
AC/DC in	4 Gore valve	**DAB111~** (for window blower)
Interface unit (control)	**AC/DC in**	**Maintenance**
Interface unit (data)	**Interface unit (control)**	**Data**
	Interface unit (data)	

3.3 Measurement units

DA10 contains 2 measurement units. The far-range measurement unit measures up to 18 000 m (59 000 ft) and the near-range measurement unit measures up to 800 m (2625 ft).

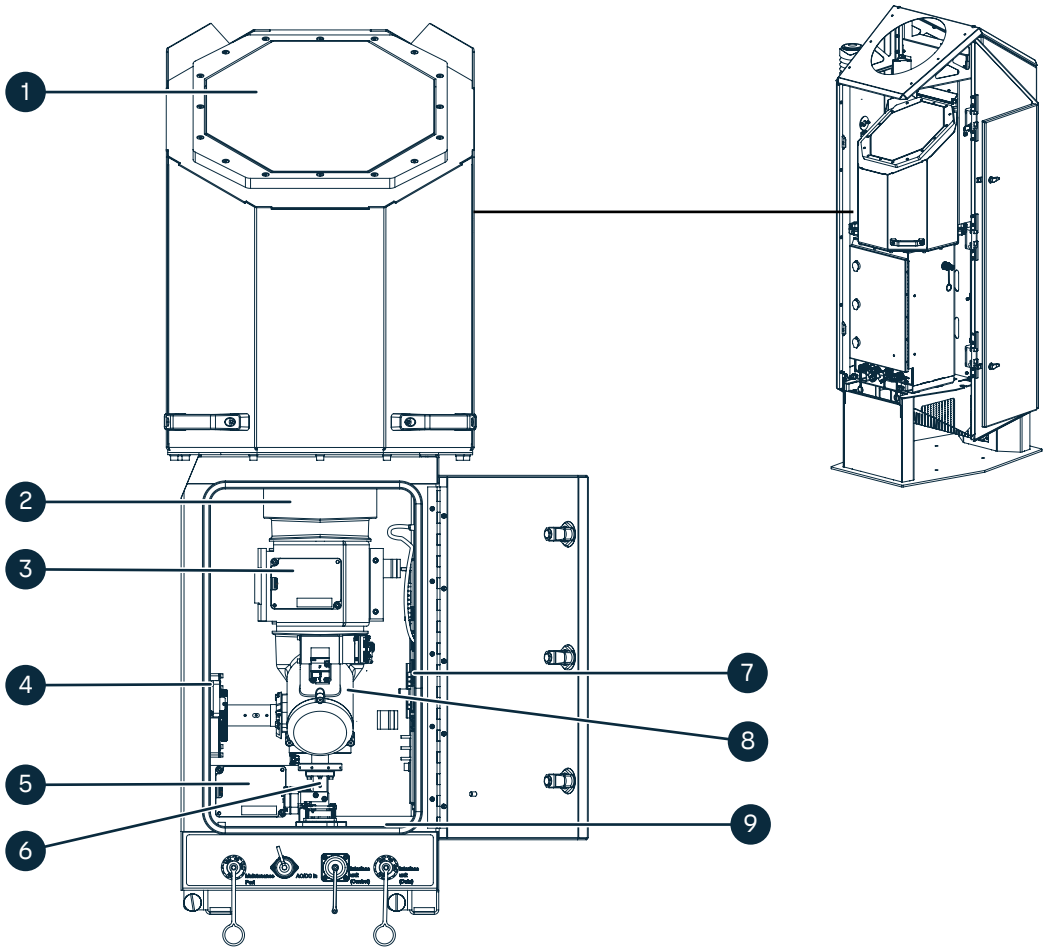


Figure 8 Far-range measurement unit

1 Window
2 Expander optics unit
3 Servo drive module
4 Receiver module
5 Servo drive module
6 Transmitter module
7 Device control module
8 Advanced autocalibrator
9 Internal heater module (not shown)

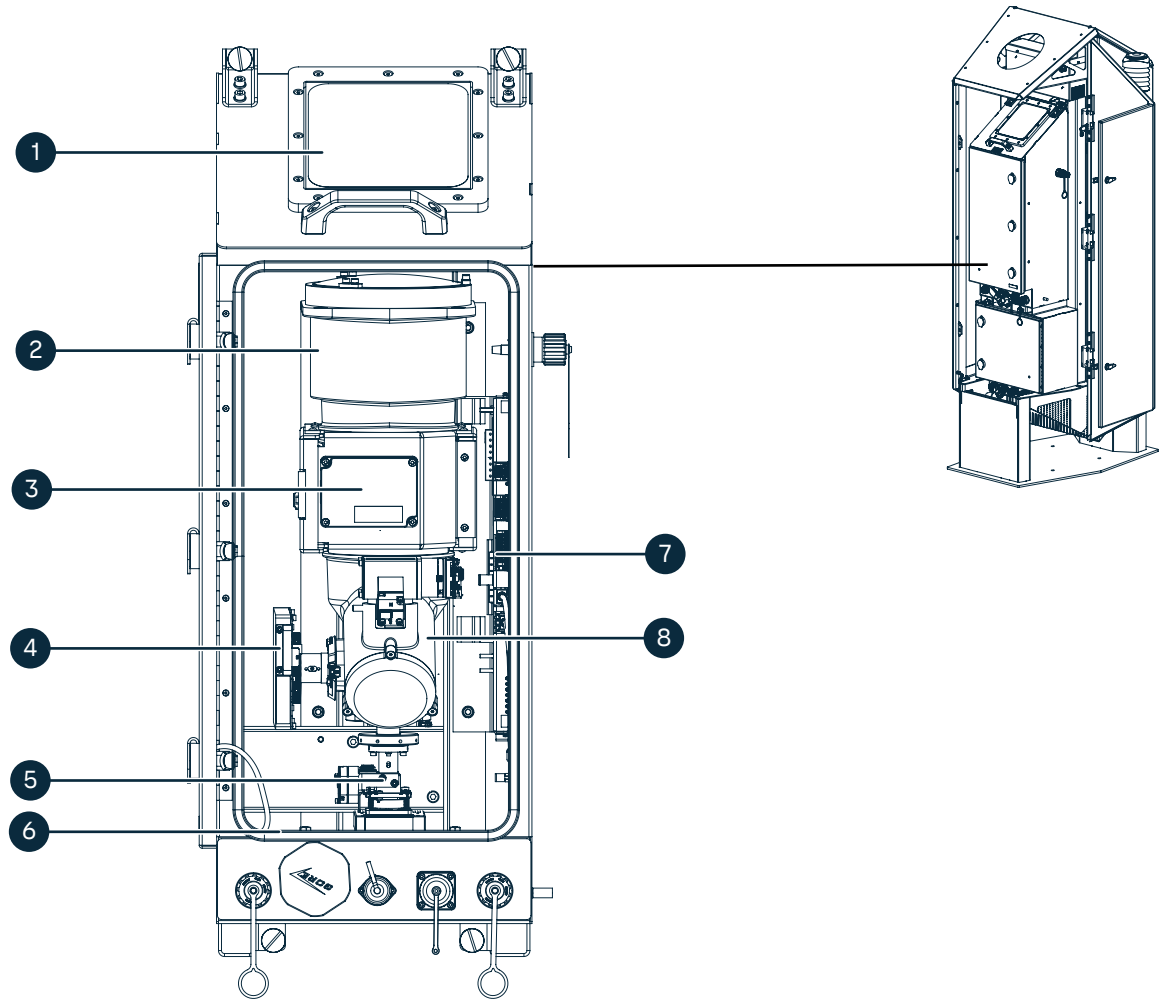


Figure 9 Near-range measurement unit

1 Window
2 Optics unit
3 Servo drive module
4 Receiver module
5 Transmitter module
6 Internal heater module (not shown)
7 Device control module
8 Advanced autocalibrator

3.4 Interface unit

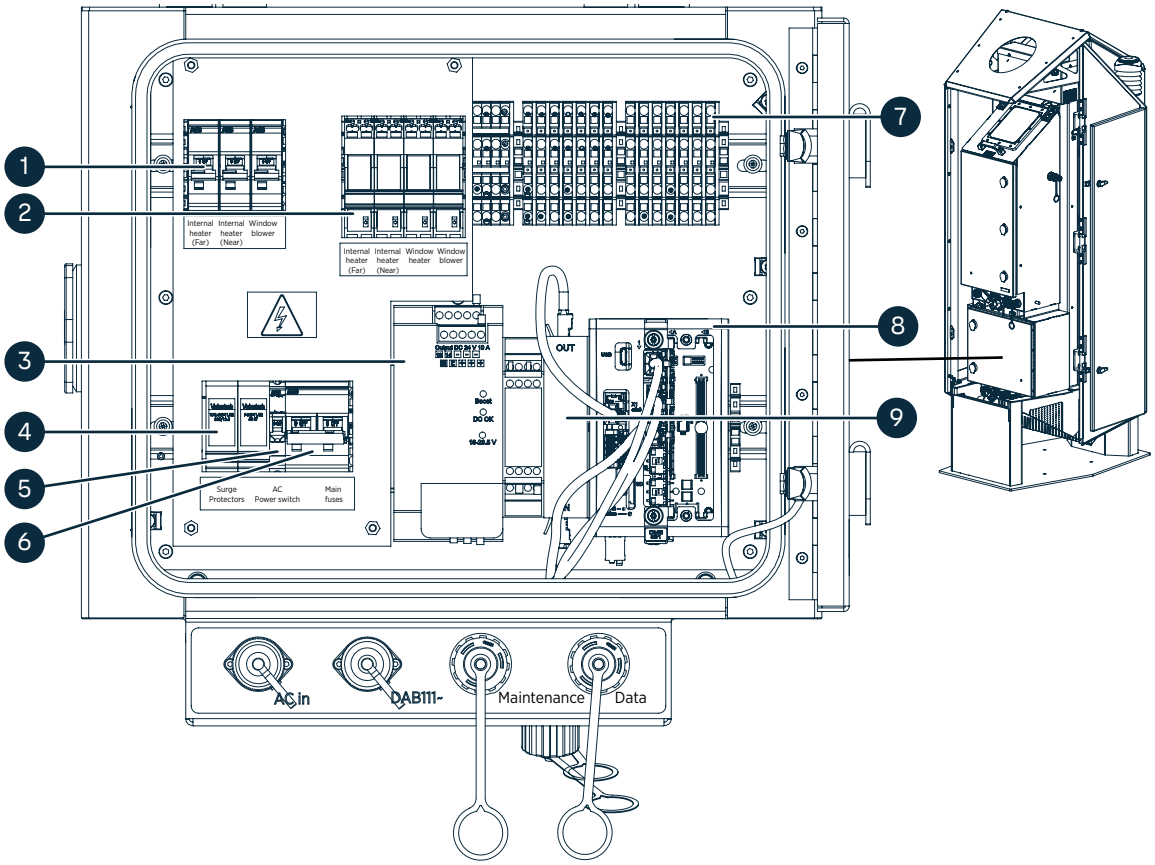
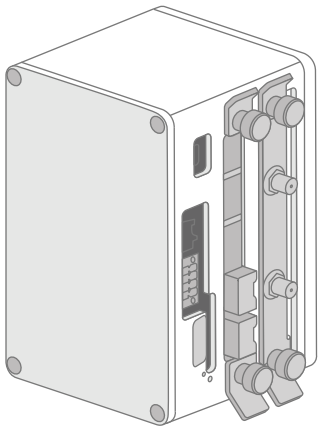


Figure 10 Interface unit

1 Window blower and internal heater switch
2 Window blower and internal heater control
3 AC/DC power supply
4 Surge protectors
5 AC (mains) power switch
6 Fuses
7 Terminal block
8 Gateway DA10GW
9 Ethernet surge protector

3.4.1 Vaisala DA10GW Gateway

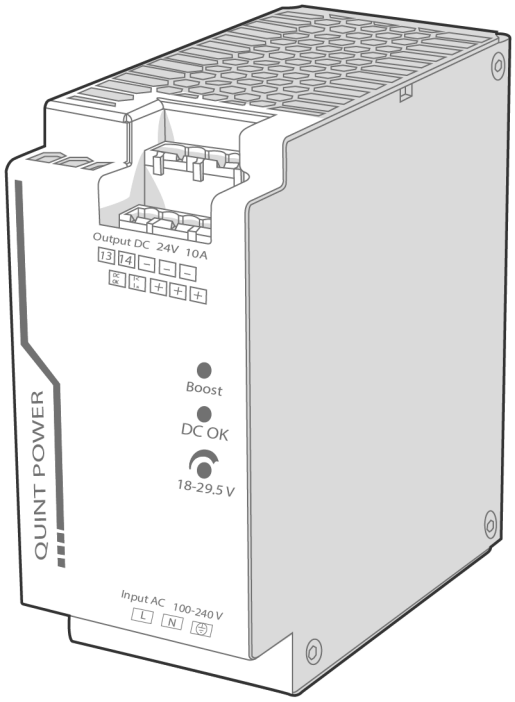


Vaisala DA10GW Gateway is based on Vaisala Data Management Unit DMU801 and includes the Ethernet Switch Module DME801.

DA10GW controls the power and provides heating power through a separate connector.

DA10GW has an embedded web server through which observation data and maintenance functions can be managed. Information can be viewed and managed through a browser-based graphical user interface, the Web UI.

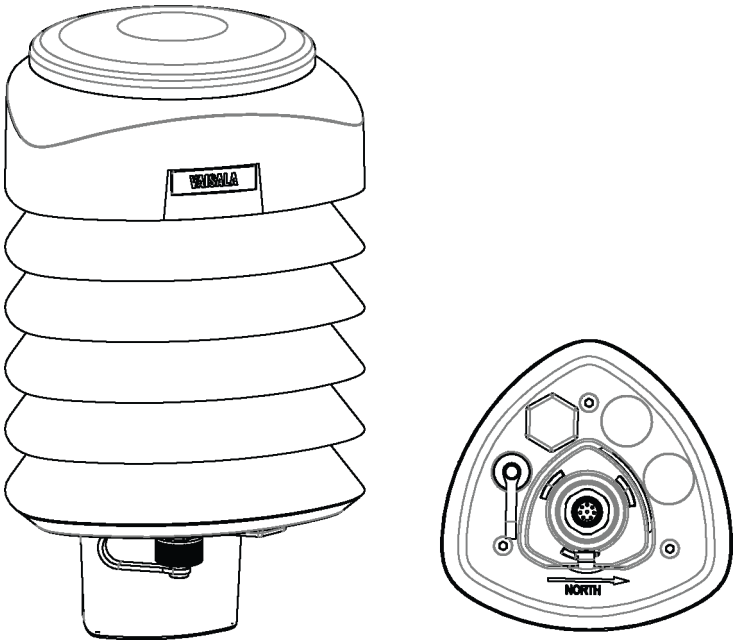
3.4.2 AC/DC power supply unit



The AC/DC power supply unit is a 240 W universal power supply that has been specified and tested to suit operation in harsh environments, even as cold as −40 °C (−40 °F). The unit operates from the universal AC (mains) input between 100–240 V AC and 50/60 Hz. The output voltage is adjustable, and set to 24 V DC in the factory.

The power supply unit has power factor correction and short-circuit protection. Most of the output power reserve is intended to be used for the measurement electronics.

3.5 Vaisala Weather Transmitter WXT534



DA10 uses WXT534 from Vaisala Weather Transmitter WXT530 series for surface PTU measurements. WXT534 contains a PTU module.

3.5.1 PTU measurement principle

The PTU module contains separate sensors for pressure, temperature, and humidity measurement.

The PTU module includes:

- Capacitive silicon BAROCAP sensor for pressure measurement
- Resistive thin-film Pt1000 sensor for air temperature measurement
- Capacitive thin-film polymer HUMICAP R2 sensor for humidity measurement

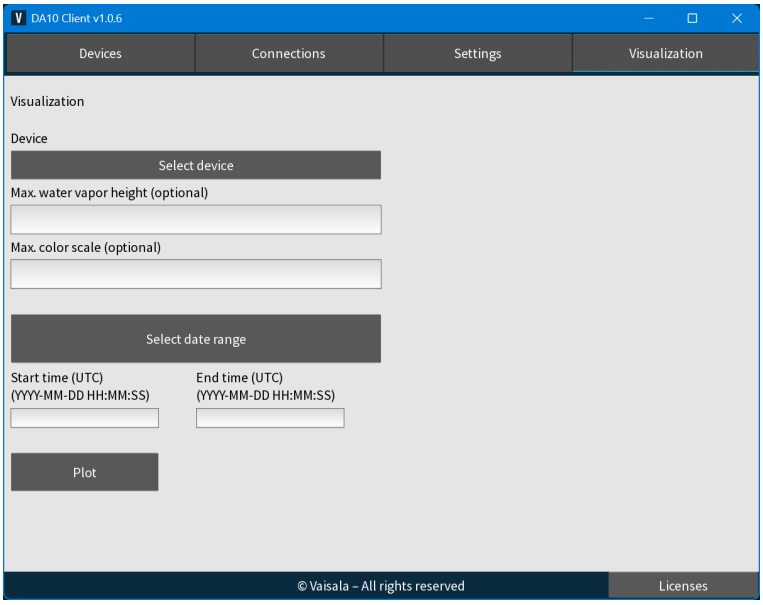
In case of capacitive sensors, the measurement principle of the transmitter is based on an advanced RC oscillator and reference capacitors against which the capacitance of a sensor is continuously measured. The resistive Pt1000 sensors are measured with a voltage divider circuit incorporating a reference resistor and a stable voltage source.

3.6 Software tools

The following software is used together with DA10:

- DA10 Client
- DA10 Web UI

3.6.1 DA10 Client



DA10 Client is a software application for fetching the generated netCDF files from the device and for visualizing water vapor mixing ratio files as PNG files.

Connect the instrument to DA10 Client over the Ethernet and define file storage location.

With DA10 Client, you can:

- Retrieve netCDF files from the instrument.
- Create visualization files (PNG) of selected plots with set time range.

DA10 Client is available for download at docs.vaisala.com.

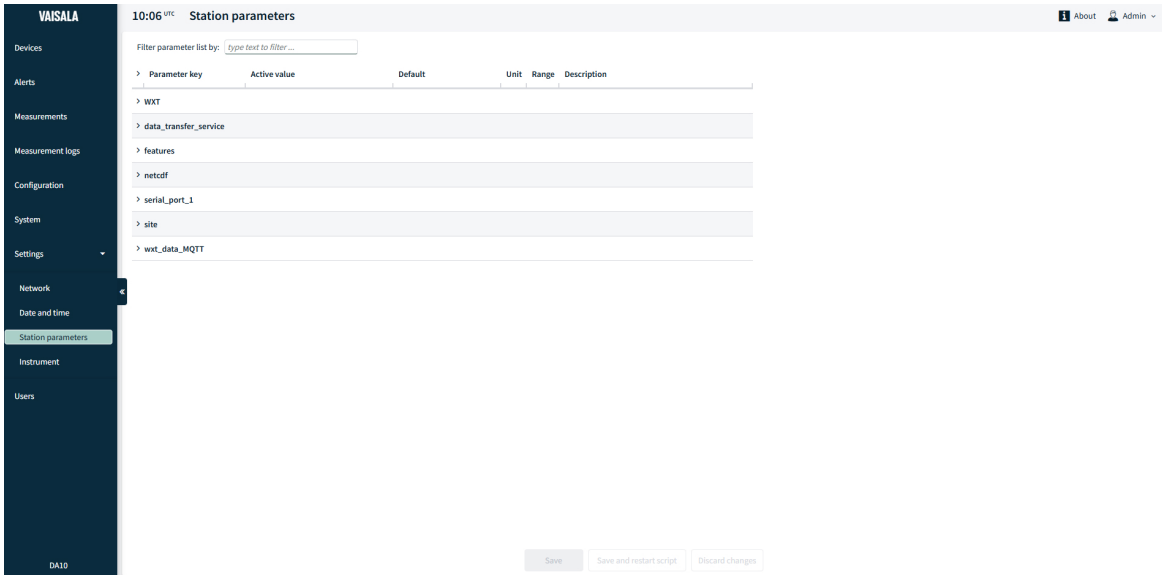
For information about DA10 Client setup, see DA10 Installation Guide (M212894EN).

More information

- Retrieving netCDF files (page 68)
- Visualizing mixing ratio files (page 68)
- Visualization files (page 59)

AKRIBIS · www.akribis.info · contacto@akribis.info

3.6.2 DA10 Web UI



The DA10 Web UI is available through a web browser. It has been tested with the latest versions of Microsoft Edge, Mozilla Firefox, and Google Chrome at the time of publishing this document.

Use the DA10 Web UI for activation and pairing during instrument setup, for configuration purposes such as configuring network settings of the instrument, adding an API key for data retrieval, and setting instrument location and name, and for instrument firmware updates.

You can also use it for user management and checking the device status, including possible alerts.

More information

- User management (page 70)

4. Measurements

4.1 Measurement principle

DA10 is a remote sensing instrument that uses differential absorption lidar (DIAL) technology to measure water vapor profiles. Similarly to the Vaisala ceilometers, it also provides attenuated backscatter profiles, and cloud base height, cloud depth and cloud penetration information, precipitation/fog detection, and sky condition.

DA10 uses the laser light detection and ranging (LiDAR) method where short, powerful pulses from a diode laser are sent out in vertical or near-vertical direction at 2 wavelengths:

- Online wavelength (911.0 nm) in a section of the electromagnetic spectrum that has high water vapor absorption.
- Offline wavelength (910.6 nm) in a nearby section of the spectrum with low water vapor absorption.

DA10 alternates transmission of the online and offline signals with a measurement time of approximately 30 ms for each wavelength. Part of the pulsed signals scatter back towards the instrument from atmospheric particles – liquid cloud droplets, precipitation, haze, fog, and aerosols – at each height. Also the weak molecular scatter can often be observed, due to the good sensitivity of DA10. The rest of the light is either absorbed or scattered in directions not seen by the instrument. The portion of backscattered light is registered at the receiver using an avalanche photodiode detector. The online and offline profiles are time averaged separately for 5 s before analysis.

DA10 uses broadband DIAL approach where the spectrum of the laser output overlaps multiple water vapor absorption lines. The estimates of the water vapor mixing ratio are based on the ratio of the zero-level corrected online and offline signals. The retrieval method minimizes a cost function between the measured and a modeled online-to-offline signal ratio with respect to an estimated water vapor concentration. The retrieval starts at ground level using surface measurements from a weather transmitter and then progresses upward in range. Most instrument and atmospheric factors are canceled out as the closely spaced measurement wavelengths are similarly affected by perturbing forces on their common path, leaving only the water vapor dependent component of the retrieved signals.

The instrument contains 2 independent lidar systems. One is optimized for the near-range measurements and the other for the far-range measurements. Each lidar system consists of a single-lens telescope used for both transmitting and receiving. The height measurement is based on the time-of-flight measurement. Time-of-flight is the time needed for a light pulse to traverse the atmosphere from the transmitter to a backscattering particle and back to the receiver.

The instrument's near and far optics units have a separate advanced autocalibrator measurement unit embedded to the system. The advanced autocalibrator continuously monitors the measurement signal as part of the measurement chain. The advanced autocalibrator data is used in signal processing and it enables accurate calibration of the

measured atmospheric signal against small changes that might otherwise occur due to varying instrument temperature, for instance. The advanced autocalibrator not only helps to produce a stable attenuated backscatter signal level during the operation, but also enables the improvement of the signal-to-noise ratio together with the internal receiver gain control.

More information

- Atmospheric profiles (page 31)
- Atmospheric parameters (page 35)
- Data quality and data availability (page 37)

4.2 Atmospheric profiles

DA10 provides the following vertical profiles:

- Water vapor profile (WV)
- Uncertainty for water vapor profile (UC)
- Attenuated backscatter profile (ABS)
- Offline wavelength backscatter
- Online wavelength backscatter

The following figures show water vapor and attenuated backscatter profiles covering a period of 6 days. The detected data shows dry and humid layers, as well as liquid cloud layers, precipitation, and the aerosol signal in the boundary layer.

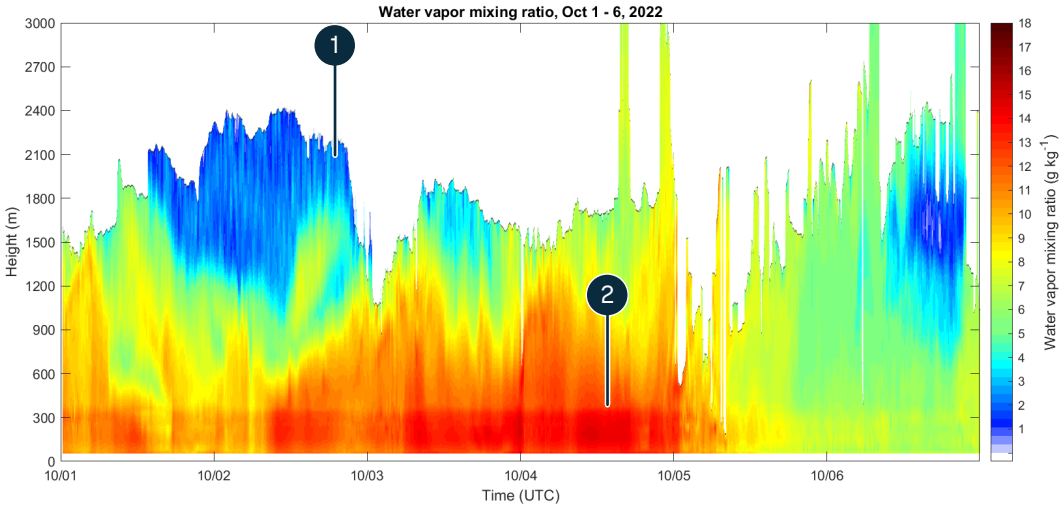


Figure 11 Example of water vapor profiles

1 Dry layer
2 Humid layer

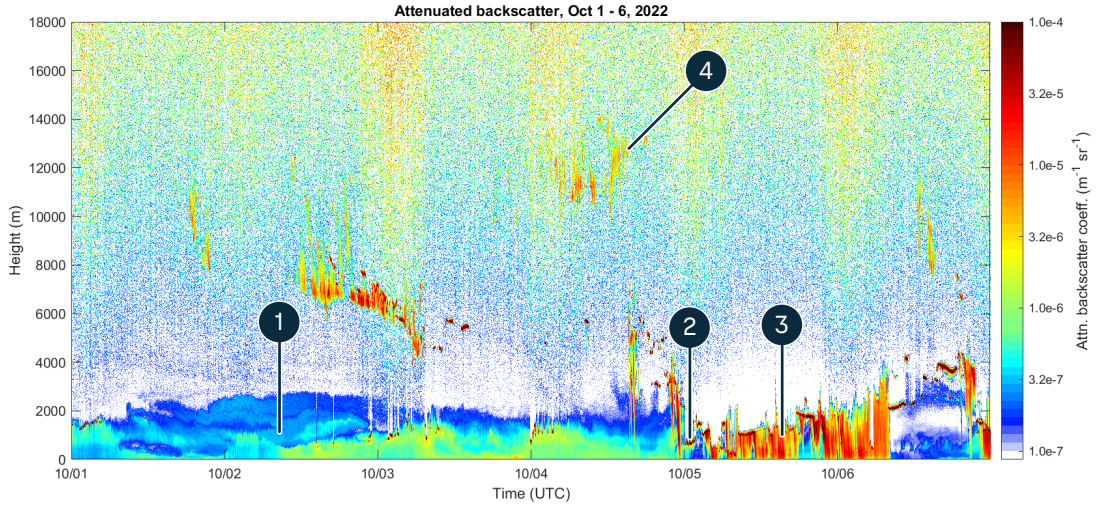


Figure 12 Example of attenuated backscatter profiles

1 Aerosol signal
2 Cloud base
3 Precipitation
4 Ice crystals

More information

- Water vapor profile (page 32)
- Uncertainty for water vapor profile (page 33)
- Attenuated backscatter profile (page 34)
- Offline and online profiles (page 34)

4.2.1 Water vapor profile

DA10 measures water vapor profiles from 57.6 m (189 ft) to the top of the boundary layer max. 4032 m (13 228 ft) or cloud base height – whichever is lower. Profiles are reported at 9.6 m (31 ft 6 in) height intervals. The quality-controlled, maximum valid measurement range is reported with each profile.

The measurement is based on the differential absorption observed between the attenuated backscatter profiles at online and offline wavelengths. The unit for the reported water vapor mixing ratio is gram of water vapor per kilogram of dry air (g kg^{-1}).

The measurement data is processed in real time and a water vapor profile is generated every minute based on the data collected during the configured temporal averaging interval. The interval is 20 minutes by default. The profile timestamp indicates the end of the data collection period.

The online and offline profiles are vertically averaged before water vapor retrieval using Gaussian-like weighting functions, which produce a fine resolution near the ground and an increasingly coarse resolution at higher altitudes. The resulting vertical resolution of the water vapor profiles is 100 m at 200 m height above ground level (AGL) (328 ft at 656 ft), 220 m at 1000 m AGL (722 ft at 3280 ft), and 500 m at 3000 m AGL (1640 ft at 9840 ft) (full width at half-maximum of weighting functions).

The reported profiles are combinations of the measured profiles from the near-range measurement unit and the far-range measurement unit. The measurement algorithm adjusts the transition from the near-range to the far-range adaptively based on the signal-to-noise ratio to optimize the result. The transition region is typically between 427 m and 477 m (1401 ft and 1565 ft).

The following figure shows an example of the water vapor profile. The 1-dimensional profile is taken from within a 20-minute period contained in the 2-dimensional data displayed in Figure 11 (page 31). The horizontal dashed black line shows the maximum valid measurement range. The blue dotted lines show the lower and upper limits of uncertainty, computed as the difference and the sum of the water vapor profile and the uncertainty profile.

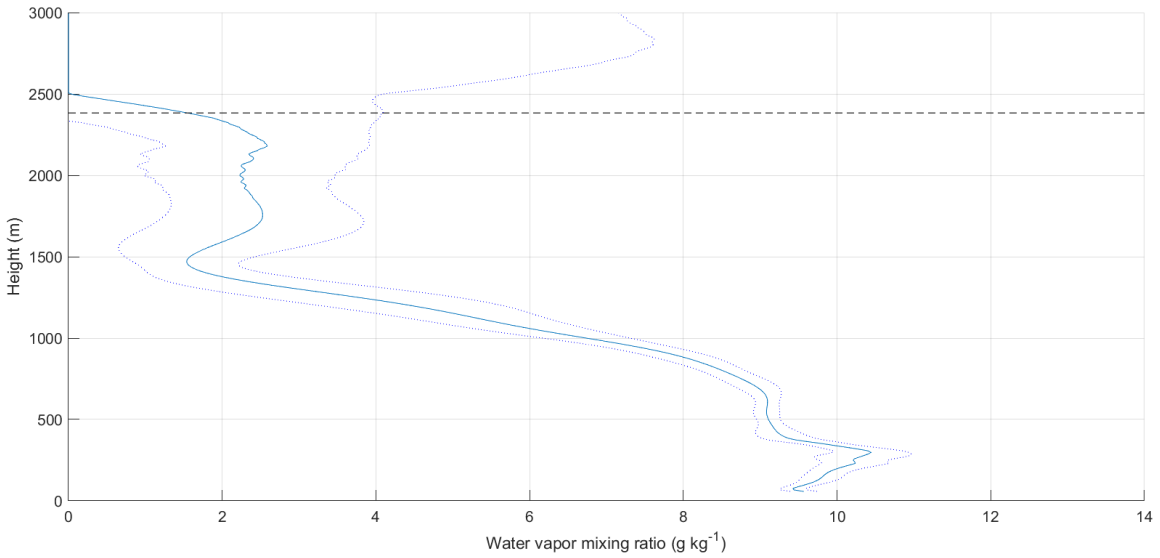


Figure 13 Water vapor mixing ratio profile with maximum valid range and uncertainty limits

4.2.2 Uncertainty for water vapor profile

DA10 provides an estimate of the measurement uncertainty for each value in the water vapor profile. The uncertainty profile is based on short timescale water vapor profiles computed only for use in internal algorithms. The standard deviation of the short timescale data over the averaging time is computed and reported as the uncertainty. This is an estimate that describes the random uncertainties in the measurement.

The unit for uncertainty is gram of water vapor per kilogram of dry air (g kg^{-1}). The uncertainty values are valid within the valid range of water vapor profiles.

4.2.3 Attenuated backscatter profile

DA10 measures attenuated backscatter profiles from the ground to a measurement range of 18 000 m (59 000 ft). Profiles are reported at 4.8 m (15 ft 9 in) height intervals. The averaging time is 1 minute. The profile timestamp indicates the end of the data collection period.

The measurement is based on the attenuated backscatter profile measured at offline wavelength to minimize the impact of water vapor absorption. The unit for attenuated backscatter profile intensity is one per meter per steradian (m^{-1} sr^{-1}).

The reported profiles are combinations of measured profiles from the near-range measurement unit and the far-range measurement unit. The transition from the near-range measurement to the far-range measurement occurs between the 600 m and 800 m (1968 ft and 2624 ft) range. The transition is a linear change with a 100 % weighting of the near-range measurement at the lower limit and a 100 % weighting of the far-range measurement at the upper limit.

The following figure shows an example of the attenuated backscatter profile. The 1-dimensional profile is taken from within a 1-minute period contained in the 2-dimensional data displayed in Figure 12 (page 32). The signal between 1150 m and 1300 m (3773 ft and 4265 ft) is from cloud, and the signal below it from precipitation.

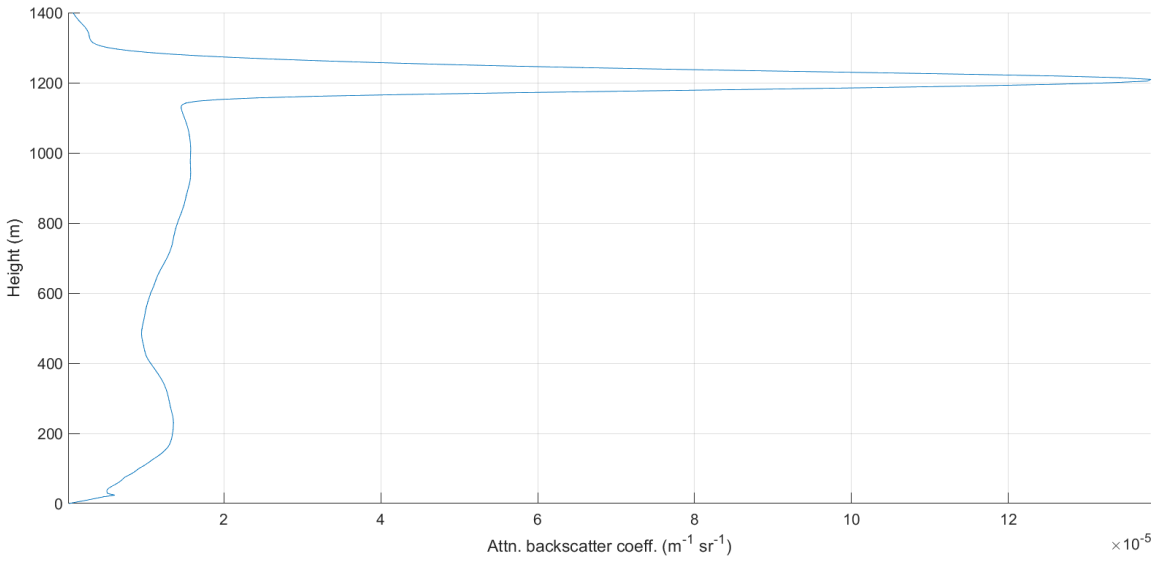


Figure 14 Attenuated backscatter profile

4.2.4 Offline and online profiles

DA10 also outputs the offline and online wavelength backscatter profiles as auxiliary data. These data products are reported on the same range grid as the water vapor profiles, and their temporal averaging interval is the same as for attenuated backscatter. The profile timestamp indicates the end of the data collection period. The profiles are unitless as they have not experienced overlap correction, range normalization or amplitude calibration and they are reported separately from the near and far\u0002range measurement units.

4.3 Atmospheric parameters

DA10 provides the following atmospheric parameters:

- Cloud base heights (up to 5 layers) or vertical visibility
- Cloud penetration depth or cloud thickness
- Precipitation detection and fog detection
- Sky condition
- Surface PTU (pressure, temperature, and humidity measured by WXT534)

4.3.1 Cloud base height

Clouds have a large signal in the attenuated backscatter profile. The cloud algorithm searches the profiles for cloud signatures. Cloud detection is based on the signal strength and the rate of change.

4.3.2 Vertical visibility

If there is obscuration in the atmosphere and a cloud signature is not identified in the attenuated backscatter profile, the instrument reports vertical visibility instead. This typically occurs in the event of heavy precipitation where the transmitted signal is heavily attenuated, or in the event of ground-based visibility obscuration like fog or haze. Vertical visibility is used for aviation purposes to report to the pilot at which height they will be able to see the ground.

4.3.3 Cloud thickness and cloud penetration depth

For each detected cloud, either cloud thickness or cloud penetration depth is reported. Cloud thickness and cloud penetration depth are reported in meters, corresponding to the distance that the light travelled inside the cloud.

Cloud thickness is reported in cases where a cloud is detected and significant signal is detected above the cloud. Cloud thickness is also always reported in cases of optically thin clouds. Cloud penetration depth is reported in cases of optically thick clouds and clouds above precipitation where it is likely that the signal has attenuated completely.

In case of vertical visibility reporting, neither cloud thickness nor cloud penetration depth is reported.

4.3.4 Precipitation and fog detection

Precipitation detection is a proxy from the instrument to identify cases of precipitation occurring at ground level. Fog detection is a proxy for low visibility cases, likely formation of fog.

Precipitation and fog detection are reported as `0` (no detection) or `1` (detection). Only precipitation or fog can be reported at a time.

4.3.5 Sky condition algorithm

The sky condition algorithm is calculated every 5 seconds based on data collected during the last 30 minutes. The last 10 minutes are double-weighted to make the algorithm more responsive to variations in cloudiness.

Instead of forming a histogram of hit heights, the algorithm uses both height and timing information to find hits close to each other. These hits are combined into clusters and a height value is calculated for each cluster. This height gives the base height of a cloud or cloud layer represented by the cluster. The algorithm reports layers by combining clusters whose heights are close to each other and then selecting clusters that cover the greatest amount of sky.

The sky condition algorithm reports the total sky cover in octas with values between 0 and 9. (One octa equals one eighth.) Value 9 is reported only in a vertical visibility condition. In addition, the sky cover can attain the value −99. The value −99 is reported after the instrument start-up, indicating that there is not enough data for algorithm processing.

Table 9 Sky cover values from sky condition algorithm

Volume	Sky cover
0 – 8	Cloudiness in octas
9	Vertical visibility (VV)
−99	Not enough data

4.3.6 Surface PTU

The spectral parameters of the water vapor absorption cross section (line positions and widths) are temperature and pressure dependent. For this reason, DA10 incorporates WXT534 that measures surface temperature, pressure, and humidity. The temperature and pressure measurements are vertically extrapolated assuming the International Organization for Standardization ISO 2533:1975 standard atmospheric model. The extrapolated profiles are then used to estimate the depths and widths of the water vapor absorption lines from the high-resolution transmission molecular absorption database (HITRAN) to model the observed signal in the water vapor retrieval algorithm.

The surface humidity measurements are used to establish the water vapor mixing ratio at the ground level and below the lowest range retrieved by DA10.

More information

- Vaisala Weather Transmitter WXT534 (page 27)

4.4 Data quality and data availability

To ensure eye-safe operation, the transmitted laser power is limited, which results in backscattered signal levels below the noise of the ambient daylight. To counteract this, a large number of laser pulses are sent, and the returns are summed. During this process, the random noise partially cancels itself out. The water vapor measurement requires much longer averaging times and more vertical averaging compared to the attenuated backscatter (ABS) measurement. Signal processing is used to filter out outliers caused by targets such as insects and birds.

The water vapor data quality and data availability depend mostly on the atmospheric scatterer concentration and the height of the boundary layer, as well as cloud conditions and the amount of background noise. Vaisala software analyzes the backscatter signal levels and selects the maximum valid measurement range depending on the atmospheric conditions. Occasionally, moderate precipitation from high clouds, or aerosol layers above the boundary layer, can extend the observed profile.



The output files always report water vapor profiles up to 4032 m (13 228 ft). The netCDF file variable `water_vapor_max_range` indicates the maximum acceptable measurement range for each water vapor profile, as determined by Vaisala software. Values above this range must be discarded and/or clearly indicated in visualizations.

The DA10 software controls the gain of the avalanche photodiode (APD):

1. To avoid receiver saturation, for example, in case of low clouds, fog, or heavy precipitation.
2. To optimize the signal-to-noise ratio (SNR) of measurements.

To maintain the amplitude calibration of the ABS profiles despite the varying gain, an advanced autocalibrator is embedded in the DA10 hardware. The improved SNR shows up as decreased noise in the profiles.

The improved SNR increases the accuracy of the water vapor mixing ratio profiles and the maximum retrieval range, particularly during nighttime when it is possible to operate DA10 with high gain. The near-range and far-range measurement units have their independent gain control and own advanced autocalibrator units.

The vertically increasing smoothing maintains a more consistent measurement quality as the signal levels decrease with height. Due to the characteristics of the retrieval process, low signal levels do not show as random noise in the water vapor profile - rather, the profile shape may have small oscillations.

Additional information on data quality can be obtained from the measurement uncertainty estimate.

For details about the data quality reporting, see information about the netCDF format.

More information

- Uncertainty for water vapor profile (page 33)
- NetCDF files (page 38)

5. Data reporting

5.1 Data outputs

DA10 outputs data in the netCDF format to:

- Water vapor mixing ratio (MR) files with uncertainty profile and offline and online profiles
- Attenuated backscatter (ABS) files

In addition, you can generate visualization files (PNG files) of the selected water vapor mixing ratio files.

More information

- NetCDF files (page 38)
- Visualization files (page 59)
- NetCDF example file, water vapor mixing ratio (page 117)
- NetCDF example file, attenuated backscatter (page 125)

5.2 NetCDF files

Network Common Data Form (netCDF) is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array oriented scientific data.

NetCDF data access libraries are available for Python, Java, and other programming languages.

The netCDF format used in DA10 is built on netCDF-4 which is built on Hadoop Distributed File System (HDFS). You can open and read DA10 netCDF files with any HDFS or netCDF-4 reader, for example, Panoply.

For more information about netCDF, see https://www.unidata.ucar.edu/software/netcdf/.

The netCDF file format allows the grouping of data types into a single file. A netCDF file is made of one or several variables. Each variable consists of:

- Data: value or a multidimensional table
- Metadata: data that characterizes the data

For information about the netCDF conventions, see https://cfconventions.org/latest.html.

More information

- File naming (page 39)
- Global attributes (page 39)
- Missing data and special cases (page 40)
- Variables and dimensions in water vapor mixing ratio files (page 41)
- Variables and dimensions in attenuated backscatter files (page 50)
- Retrieving netCDF files (page 68)

5.2.1 File naming

The netCDF file name format is the following:

`<product_code>_<data_output>_<serial_number>_<yyyymmdd>T<hhmmss>Z.nc`

For example:

DA10_WV_V0424001_20230428T120100Z.nc

DA10_ABS_V0424001_20230428T120100Z.nc

Table 10 Filename format

Name	Description	Value
`<product_code>`	Product that outputs the netCDF file.	DA10
`<data_output>`	Type of data output file.	• **WV** = water vapor mixing ratio file • **ABS** = attenuated backscatter file
`<serial_number>`	Serial number of product.	-
`<yyyymmdd>T<hhmmss>Z`	Timestamp when the file was created. **T** and **Z** are fixed characters.	UTC time

5.2.2 Global attributes

The global attributes are used in the DA10 netCDF files.

Table 11 Global, ungrouped attributes

Attribute	Description
`_NCProperties`	Information about the used netCDF libraries.
`title`	Device type, description. Displayed in the file title.
`institution`	Information about the producer of the data. User configurable. Empty by default.
`source`	Information about the origin of the data. User configurable. Empty by default.
`instrument_serial_number`	Serial number of the instrument.
`gateway_serial_number`	Gateway serial number
`dac_near_serial_number`	Near-range measurement unit serial number

Attribute	Description
dac_far_serial_number	Far-range measurement unit serial number
Conventions	NetCDF convention version of the file. Fixed to CF-1.8.
schema_version	Version of the netCDF schema. Distinguishes between schema versions to parse the version-specific content. A version update is required if any change is made to the file structure.
algorithm_version	Algorithm version.
gateway_firmware_version	Firmware version of the gateway.
dac_near_firmware_version	Firmware version of the device control module in the near-range measurement unit.
dac_far_firmware_version	Firmware version of the device control module in the far-range measurement unit.
history	For use as an audit trail for modifications to the original data. User configurable with your preferred netCDF interface. Empty by default.
comment	Miscellaneous information about the data. User configurable. Empty by default.
unit	Reporting unit, always meters.
file_temporal_span_in_minutes	Time period that the file covers in minutes. • In attenuated backscatter files, always 5 minutes. • In water vapor mixing ratio files, always 20 minutes.
profile_interval_in_seconds	Time between consecutive profiles in seconds. Always 60 seconds.
overlap_function_provided	In attenuated backscatter files only. Overlap function provided in the netCDF file. • 1 = true • 0 = false
overlap_is_corrected	In attenuated backscatter files only. File overlap is corrected. • 1 = true: always true • 0 = false

5.2.3 Missing data and special cases

In netCDF, you can create an attribute for the variable (of the same type as the variable) called `_FillValue` that contains a value that you have used for missing data. Applications that read the data file can use this to know how to represent these values. Most netCDF readers disregard fill values and do not visualize them.

In addition to the fill value, selected variables have a dedicated value with a special interpretation. The fill value is not typically visualized, but the dedicated value is visualized.

The following variables have both the fill value and a dedicated value.

Table 12 Values for selected variables

Variables	Value	Description
• `cloud_base_heights` • `cloud_penetration_depth` • `cloud_thickness` • `sky_condition_cloud_layer_covers` • `sky_condition_cloud_layer_heights` • `sky_condition_total_cloud_cover` • `vertical_visibility`	`-99`	Fill value No detection, for example, there are no clouds to report when the sky is clear. The device operates normally.
	`-999`	Dedicated value Missing data. Reported in error situations instead of measurement data.

All other variables are assigned a numerical value under normal operation and fill value `-999` in error situations.

5.2.4 Variables and dimensions in water vapor mixing ratio files

The following tables list the DA10 netCDF dimensions and variables in the water vapor mixing ratio files. For the full list of attributes, types, and dimensions associated with each variable, see the example file in the appendix.



The dimensions and variables are listed in alphabetical order. The order in output files depends on the software used.

Table 13 NetCDF dimensions in water vapor mixing ratio files

Dimension	Description
`layer`	Vector that gives the number of the observed cloud layer, ordered from lowest to highest with length 5.
`module`	Vector for the 2 measurement units ordered from the near-range measurement unit to the far-range measurement unit, with length 2.
`range`	Range grid vector with a resolution of 9.6 m (31 ft 6 in) and a length of 495. The first range is 57.6 m (189 ft 0 in) and last range is 4800 m (15 748 ft). The result at 57.6 m (189 ft 0 in) is the first one retrieved by DA10, the lower results come from WXT534.
`time`	Temporal grid of the measurements, length unlimited.

Table 14 Variables in water vapor mixing ratio files

Variable	Attribute	Value/Description
airplane_filter_max_range	airplane_filter_max_range:units	m
	airplane_filter_max_range:long_name	Airplane filter max. range
	airplane_filter_max_range:comment	Maximum range where airplane echoes are filtered to prevent false cloud detection
azimuth_angle	azimuth_angle:units	Degrees
	azimuth_angle:long_name	Measurement azimuth angle
	azimuth_angle:standard_name	sensor_azimuth_angle
	azimuth_angle:comment	Azimuth direction of tilted beam for each optics unit, clockwise positive from north
cloud_base_heights	cloud_base_heights:units	m
	cloud_base_heights:long_name	Cloud base heights
	cloud_base_heights:coordinates	Time layer longitude latitude
	cloud_base_heights:comment	Reported in vertical, or in the instrument beam direction, depending on tilt_correction setting
cloud_penetration_depth	cloud_penetration_depth:units	m
	cloud_penetration_depth:long_name	Cloud penetration depth
	cloud_penetration_depth:coordinates	Time layer longitude latitude
	cloud_penetration_depth:comment	Reported in the instrument beam direction
cloud_thickness	cloud_thickness:units	m
	cloud_thickness:long_name	Cloud thickness
	cloud_thickness:coordinates	Time layer longitude latitude
	cloud_thickness:comment	Reported in the instrument beam direction

Variable	Attribute	Value/Description
elevation	elevation:units	m
	elevation:long_name	Ground level altitude
	elevation:standard_name	ground_level_altitude
	elevation:comment	Measurement site height above or below a fixed reference point, most commonly mean sea level
fog_detection	fog_detection:long_name	Detection of fog
	fog_detection:coordinates	Time longitude latitude
	fog_detection:comment	• 1= detected • 0 = not detected
height_offset	height_offset:units	m
	height_offset:long_name	Instrument height offset to ground level
	height_offset:positive	Up
	height_offset:comment	Instrument height offset relative to ground level, for example, when the instrument is placed on a roof of a building or below the ground level: the offset is added to the cloud base height results
latitude	latitude:units	Degrees north
	latitude:long_name	Latitude
	latitude:standard_name	latitude
layer	layer:units	Layer
	layer:long_name	Cloud layer
	layer:comment	1–5: observed cloud layer or cloud base
longitude	longitude:units	Degrees east
	longitude:long_name	Longitude
	longitude:standard_name	longitude

Variable	Attribute	Value/Description
merging_region	merging_region:units	m
	merging_region:long_name	Merging region from near range to far range
	merging_region:comment	Region where transition from near-range measurement to far-range measurement occurs: region adapts based on signal levels
module	module:long_name	Measurement unit
	module:comment	• 1 = near-range measurement unit • 2 = far-range measurement unit
offline_backscatter	offline_backscatter:units	1
	offline_backscatter:long_name	Offline wavelength backscatter
	offline_backscatter:coordinates	Time range longitude latitude
	offline_backscatter:comment	Offline wavelength backscatter is expressed in arbitrary units, no overlap correction, range normalization, or amplitude calibration
	offline_backscatter:averaging_time_in_seconds	60
offline_backscatter_noise_level	offline_backscatter_noise_level:units	1
	offline_backscatter_noise_level:long_name	Noise level of the offline backscatter
	offline_backscatter_noise_level:comment	A unitless number describing the noise level

Variable	Attribute	Value/Description
online_backscatter	online_backscatter:units	1
	online_backscatter:long_name	Online wavelength backscatter
	online_backscatter:coordinates	Time range longitude latitude
	online_backscatter:comment	Online wavelength backscatter is expressed in arbitrary units, no overlap correction, range normalization, or amplitude calibration.
	online_backscatter:averaging_time_in_seconds	60
online_backscatter_noise_level	online_backscatter_noise_level:units	1
	online_backscatter_noise_level:long_name	Noise level of the online backscatter
	online_backscatter_noise_level:comment	A unitless number describing the noise level
precipitation_detection	precipitation_detection:long_name	Detection of ground reaching precipitation
	precipitation_detection:coordinates	Time longitude latitude
	precipitation_detection:comment	• 1= detected • 0 = not detected
range	range:units	m
	range:long_name	Measurement range
	range:axis	Z
	range:positive	Up
	range:comment	Measurement distance from the instrument in the direction of the transmitted laser beam
range_resolution	range_resolution:units	m
	range_resolution:long_name	Range resolution
	range_resolution:comment	Distance between consecutive profile elements in the direction of the transmitted laser beam

Variable	Attribute	Value/Description
receiver_gain	receiver_gain:long_name	Receiver gain status
	receiver_gain:comment	Value 1 corresponds to normal gain
sky_condition_cloud_layer_covers	sky_condition_cloud_layer_covers:units	Oktas
	sky_condition_cloud_layer_covers:long_name	Cloud cover per cloud layer
	sky_condition_cloud_layer_covers:coordinates	Time layer longitude latitude
	sky_condition_cloud_layer_covers:averaging_time_in_seconds	1800
	sky_condition_cloud_layer_covers:comment	Amount of cloud cover for different cloud layers for up to 5 layers
sky_condition_cloud_layer_heights	sky_condition_cloud_layer_heights:units	m
	sky_condition_cloud_layer_heights:long_name	Cloud layer heights
	sky_condition_cloud_layer_heights:coordinates	Time layer longitude latitude
	sky_condition_cloud_layer_heights:averaging_time_in_seconds	1800
	sky_condition_cloud_layer_heights:comment	Heights for different cloud layers for up to 5 layers, reported in vertical, or in the instrument beam direction, depending on tilt_correction setting
sky_condition_total_cloud_cover	sky_condition_total_cloud_cover:units	Oktas
	sky_condition_total_cloud_cover:long_name	Total cloud cover
	sky_condition_total_cloud_cover:coordinates	Time longitude latitude
	sky_condition_total_cloud_cover:averaging_time_in_seconds	1800
	sky_condition_total_cloud_cover:comment	Total amount of cloud cover aggregated across cloud layers

Variable	Attribute	Value/Description
surface_pressure	surface_pressure:units	hPa
	surface_pressure:long_name	Surface pressure
	surface_pressure:coordinates	Time longitude latitude
	surface_pressure:comment	Measurement from weather transmitter
surface_temperature	surface_temperature:units	Celsius
	surface_temperature:long_name	Surface temperature
	surface_temperature:coordinates	Time longitude latitude
	surface_temperature:comment	Measurement from weather transmitter
surface_water_vapor	surface_water_vapor:units	g/kg
	surface_water_vapor:long_name	Surface water vapor mixing ratio
	surface_water_vapor:coordinates	Time longitude latitude
	surface_water_vapor:comment	Measurement from weather transmitter
tilt_angle	tilt_angle:units	Degrees
	tilt_angle:long_name	Optics unit tilt angle from the vertical
	tilt_angle:standard_name	zenith_angle
tilt_correction	tilt_correction:long_name	Tilt correction
	tilt_correction:comment	When correction is on, cloud bases are reported in vertical direction; when correction is off, in beam direction • 1 = on • 0 = off

Variable	Attribute	Value/Description
time	time:units	Seconds since 1970-01-01 00:00:00.000
	time:long_name	UTC time
	time:axis	T
	time:standard_name	time
	time:cf_role	profile_id
	time:comment	Represents the end of the measurement period
vertical_visibility	vertical_visibility:units	m
	vertical_visibility:long_name	Vertical visibility
	vertical_visibility:coordinates	Time longitude latitude
	vertical_visibility:comment	Reported in the instrument beam direction
water_vapor	water_vapor:units	g/kg
	water_vapor:long_name	Water vapor mixing ratio
	water_vapor:coordinates	Time range longitude latitude
	water_vapor:averaging_time_in_seconds	Configurable
water_vapor_max_range	water_vapor_max_range:units	m
	water_vapor_max_range:long_name	Maximum valid water vapor measurement range
	water_vapor_max_range:coordinates	Time longitude latitude
	water_vapor_max_range:sensitivity_threshold	-
	water_vapor_max_range:comment	Maximum valid water vapor measurement range based on quality control

Variable	Attribute	Value/Description
water_vapor_uncertainty	water_vapor_uncertainty:units	g/kg
	water_vapor_uncertainty:long_name	Measurement uncertainty of water vapor mixing ratio
	water_vapor_uncertainty:coordinates	Time range longitude latitude
	water_vapor_uncertainty:comment	Uncertainty estimate is valid in the same measurement range where water vapor measurement is valid
water_vapor_valid	water_vapor_valid:long_name	Validity of water vapor mixing ratio
	water_vapor_valid:coordinates	Time range longitude latitude
	water_vapor_valid:comment	Flag for each measurement range based on quality control • 1 = valid • 0 = invalid

Table 15 Variables, group `monitoring`

Variable	Attribute	Description
background_radiance	background_radiance:long_name	Background radiance
	background_radiance:range	0–1747
	background_radiance:comment	Measurement of the amount of sky background radiance, at the receiver field-of-view, arbitrary units Sky background radiance (for each optics unit) in arbitrary units at the receiver field-of-view; values are low at night and high in the presence of sun-illuminated clouds.
internal_humidity	internal_humidity:units	Percent
	internal_humidity:long_name	Internal humidity
	internal_humidity:comment	Percent relative humidity

Variable	Attribute	Description
`internal_temperature`	`internal_temperature:units`	Celsius
	`internal_temperature:long_name`	Internal temperature
`laser_power_percent`	`laser_power_percent:units`	Percent
	`laser_power_percent:long_name`	Laser power percent
	`laser_power_percent:comment`	Laser output power relative to the laser power measured at factory
`time`	`time:units`	Seconds since 1970-01-01 00:00:00.000
	`time:long_name`	UTC time
	`time:axis`	T
	`time:standard_name`	`time`
`window_condition`	`window_condition:units`	Percent
	`window_condition:long_name`	Window condition (near-range measurement unit)
	`window_condition:comment`	0–100 % • `100` = Clean window • `0` = Dirty window

More information

‣ NetCDF example file, water vapor mixing ratio (page 117)

5.2.5 Variables and dimensions in attenuated backscatter files

The following tables list the DA10 netCDF dimensions and variables in the attenuated backscatter (ABS) files. For the full list of attributes, types, and dimensions associated with each variable, see the example file in the appendix.



The dimensions and variables are listed in alphabetical order. The order in output files depends on the software used.

Table 16 NetCDF dimensions in attenuated backscatter files

Dimension	Description
`layer`	Vector that gives the number of the observed cloud layer, ordered from lowest to highest with length 5.
`module`	Vector for the 2 measurement units ordered from the near-range measurement unit to the far-range measurement unit, with length 2.
`range`	Range grid vector with a resolution of 4.8 m (15 ft 9 in) and a length of 3751. Starts at 0 m (0 feet) and ends at 18 000 m (59 000 ft).
`time`	Temporal grid of the measurements, length unlimited.

Table 17 Variables in attenuated backscatter files

Variable	Attribute	Value/Description
`airplane_filter_max_range`	`airplane_filter_max_range:units`	m
	`airplane_filter_max_range:long_name`	Airplane filter max. range.
	`airplane_filter_max_range:comment`	Maximum range where airplane echoes are filtered to prevent false cloud detection.
`azimuth_angle`	`azimuth_angle:units`	Degrees
	`azimuth_angle:long_name`	Measurement azimuth angle
	`azimuth_angle:standard_name`	`sensor_azimuth_angle`
	`azimuth_angle:comment`	Azimuth direction of tilted beam for each optics unit, clockwise positive from north.
`beta_att`	`beta_att:units`	1/(m*sr)
	`beta_att:long_name`	Attenuated volume backscatter coefficient
	`beta_att:coordinates`	Time range longitude latitude
	`beta_att:averaging_time_in_seconds`	60
`beta_att_noise_level`	`beta_att_noise_level:long_name`	Noise level of the attenuated volume backscatter coefficient.
	`beta_att_noise_level:comment`	Unitless number describing the noise level.

Variable	Attribute	Value/Description
beta_att_sum	beta_att_sum:units	1/(10^4*sr)
	beta_att_sum:long_name	Scaled integral of the attenuated volume backscatter coefficient
cloud_base_heights	cloud_base_heights:units	m
	cloud_base_heights:long_name	Heights (range) of the detected cloud bases
	cloud_base_heights:coordinates	Time layer longitude latitude
	cloud_base_heights:comment	Reported in vertical, or in the instrument beam direction, depending on **tilt_correction** setting
cloud_calibration_factor_far	cloud_calibration_factor_far:long_name	Far-range unit factory cloud calibration value
	cloud_calibration_factor_far:comment	Instrument specific **beta_att** calibration value measured at the factory
cloud_calibration_factor_near	cloud_calibration_factor_near:long_name	Near-range unit factory cloud calibration value
	cloud_calibration_factor_near:comment	Instrument specific **beta_att** calibration value measured at the factory
cloud_calibration_factor_user_far	cloud_calibration_factor_user_far:long_name	Far-range unit user set cloud calibration value
	cloud_calibration_factor_user_far:comment	Instrument specific **beta_att** calibration value set by the user, same as the factory value by default
cloud_calibration_factor_user_near	cloud_calibration_factor_user_near:long_name	Near-range unit user set cloud calibration value
	cloud_calibration_factor_user_near:comment	Instrument specific **beta_att** calibration value set by the user, same as the factory value by default

Variable	Attribute	Value/Description
`cloud_penetration_depth`	`cloud_penetration_depth:units`	m
	`cloud_penetration_depth:long_name`	Cloud penetration depth in the direction of the instrument beam
	`cloud_penetration_depth:coordinates`	Time layer longitude latitude
	`cloud_penetration_depth:comment`	Reported in the instrument beam direction
`cloud_thickness`	`cloud_thickness:units`	m
	`cloud_thickness:long_name`	Cloud thickness in the direction of the instrument beam
	`cloud_thickness:coordinates`	Time layer longitude latitude
	`cloud_thickness:comment`	Reported in the instrument beam direction
`elevation`	`elevation:units`	m
	`elevation:long_name`	Ground-level altitude
	`elevation:standard_name`	`ground_level_altitude`
	`elevation:comment`	Measurement site height above or below a fixed reference point, most commonly mean sea level
`fog_detection`	`fog_detection:long_name`	Detection of fog
	`fog_detection:coordinates`	Time longitude latitude
	`fog_detection:comment`	• `1` = detected • `0` = not detected

Variable	Attribute	Value/Description
height_offset	height_offset:units	m
	height_offset:positive	Up
	height_offset:long_name	Instrument height offset to ground level.
	height_offset:comment	Instrument height offset relative to ground level, for example, when the instrument is placed on a roof of a building or below the ground level: the offset is added to the cloud base height results
latitude	latitude:units	Degrees north
	latitude:long_name	Latitude
	latitude:standard_name	latitude
layer	layer:units	Layer
	layer:long_name	Cloud layer
	layer:comment	1–5: observed cloud layer or cloud base
longitude	longitude:units	Degrees east
	longitude:long_name	Longitude
	longitude:standard_name	longitude
merging_region	merging_region:units	m
	merging_region:long_name	Merging region from near range to far range.
	merging_region:comment	Region where transition from near-range measurement to far-range measurement occurs.
module	module:long_name	Measurement unit
	module:comment	• 1 = near-range measurement unit • 2 = far-range measurement unit

Variable	Attribute	Value/Description
overlap_function_far	overlap_function_far:long_name	Far-range unit instrument specific overlap function
	overlap_function_far:comment	The part of the transmitted power that hits the receiver detector, as a function of distance, normalized to be unity at the distance of the best focus
overlap_function_near	overlap_function_near:long_name	Near-range unit instrument specific overlap function
	overlap_function_near:comment	The part of the transmitted power that hits the receiver detector, as a function of distance, normalized to be unity at the distance of the best focus
precipitation_detection	precipitation_detection:long_name	Detection of ground reaching precipitation
	precipitation_detection:coordinates	Time longitude latitude
	precipitation_detection:comment	• 1 = detected • 0 = not detected
range	range:units	m
	range:long_name	Measurement range
	range:axis	Z
	range:positive	Up
	range:comment	Measurement distance from the instrument in the direction of the transmitted laser beam
range_resolution	range_resolution:units	m
	range_resolution:long_name	Range resolution.
	range_resolution:comment	Distance between consecutive profile elements in the direction of the transmitted laser beam.

Variable	Attribute	Value/Description
receiver_gain	receiver_gain:long_name	Receiver gain status
	receiver_gain:comment	Value 1 corresponds to normal gain
sky_condition_cloud_layer_covers	sky_condition_cloud_layer_covers:units	Oktas
	sky_condition_cloud_layer_covers:long_name	Cloud cover per cloud layer
	sky_condition_cloud_layer_covers:coordinates	Time layer longitude latitude
	sky_condition_cloud_layer_covers:averaging_time_in_seconds	1800
	sky_condition_cloud_layer_covers:comment	Amount of cloud cover for different cloud layers for up to 5 layers
sky_condition_cloud_layer_heights	sky_condition_cloud_layer_heights:units	m
	sky_condition_cloud_layer_heights:long_name	Cloud layer heights
	sky_condition_cloud_layer_heights:coordinates	Time layer longitude latitude
	sky_condition_cloud_layer_heights:averaging_time_in_seconds	1800
	sky_condition_cloud_layer_heights:comment	Heights for different cloud layers for up to 5 layers, reported in vertical, or in the instrument beam direction, depending on tilt_correction setting
sky_condition_total_cloud_cover	sky_condition_total_cloud_cover:units	Oktas
	sky_condition_total_cloud_cover:long_name	Total cloud cover
	sky_condition_total_cloud_cover:comment	Total amount of cloud cover aggregated across cloud layers.
	sky_condition_total_cloud_cover:coordinates	Time longitude latitude
	sky_condition_total_cloud_cover:averaging_time_in_seconds	1800

Variable	Attribute	Value/Description
tilt_angle	tilt_angle:units	Degrees
	tilt_angle:long_name	Optics unit tilt angle from the vertical
	tilt_angle:standard_name	zenith_angle
tilt_correction	tilt_correction:long_name	Tilt correction
	tilt_correction:comment	When correction is on, cloud bases are reported in vertical direction; when correction is off, in beam direction. • 1 = on • 0 = off
time	time:units	Seconds since 1970-01-01 00:00:00.000
	time:long_name	UTC time
	time:axis	T
	time:standard_name	time
	time:cf_role	profile_id
	time:comment	End of the averaging period
vertical_visibility	vertical_visibility:units	m
	vertical_visibility:long_name	Vertical visibility
	vertical_visibility:coordinates	Time longitude latitude
	vertical_visibility:comment	Reported in the instrument beam direction

Table 18 Variables, group `monitoring`

Variable	Attribute	Description
background_radiance	background_radiance:long_name	Background radiance
	background_radiance:range	0–1747
	background_radiance:comment	Measurement of the amount of sky background radiance, at the receiver field-of-view, arbitrary units Sky background radiance in arbitrary units at the receiver field-of-view: values are low at night and high in the presence of sun-illuminated clouds
internal_humidity	internal_humidity:units	Percent
	internal_humidity:long_name	Internal humidity
	internal_humidity:comment	Percent relative humidity
internal_temperature	internal_temperature:units	Celsius
	internal_temperature:long_name	Internal temperature
laser_power_percent	laser_power_percent:units	Percent Point measurement of the laser output power, with a PIN photodiode at CLL board.
	laser_power_percent:comment	Laser output power relative to the laser power measured at factory.
	laser_power_percent:long_name	Laser power percent
time	time:units	Seconds since 1970-01-01 00:00:00.000 The timestamp of the monitoring values. Common reporting frequency with profiles.
	time:long_name	UTC time
	time:axis	T
	time:standard_name	UTC time

Variable	Attribute	Description
`window_condition`	`window_condition:units`	Percent
	`window_condition:long_name`	Window condition (near-range measurement unit)
	`window_condition:comment`	0–100 % • `100` = Clean window • `0` = Dirty window

More information

- NetCDF example file, attenuated backscatter (page 125)
- NetCDF example file, attenuated backscatter (page 125)

5.3 Visualization files

You can generate visualization files (PNG files) of the selected water vapor mixing ratio files. Use DA10 Client for this purpose.

The example data visualization shows the continuously monitored water vapor mixing ratio profile over 24 hours. The x-axis shows the time in UTC and y-axis show the height above the instrument in meters. The colors illustrate the water vapor mixing ratio in units of g/kg. Black dots show the maximum height for valid measurements, meaning that values below the dotted line are considered reliable by the instrument self-diagnostics.

In this example both the amount of water vapor mixing ratio and the maximum quality controlled range vary with changing atmospheric conditions. The maximum quality controlled range is at its lowest during the low optically thick cloud between 07 and 13 UTC and at its highest during the precipitation event between 04 and 05 UTC and during nighttime after 21 UTC. The water vapor mixing ratio varies between 2 g/kg and 10 g/kg during the 24-hour period.

The image of attenuated backscatter from the same time period provides context about the atmospheric conditions.

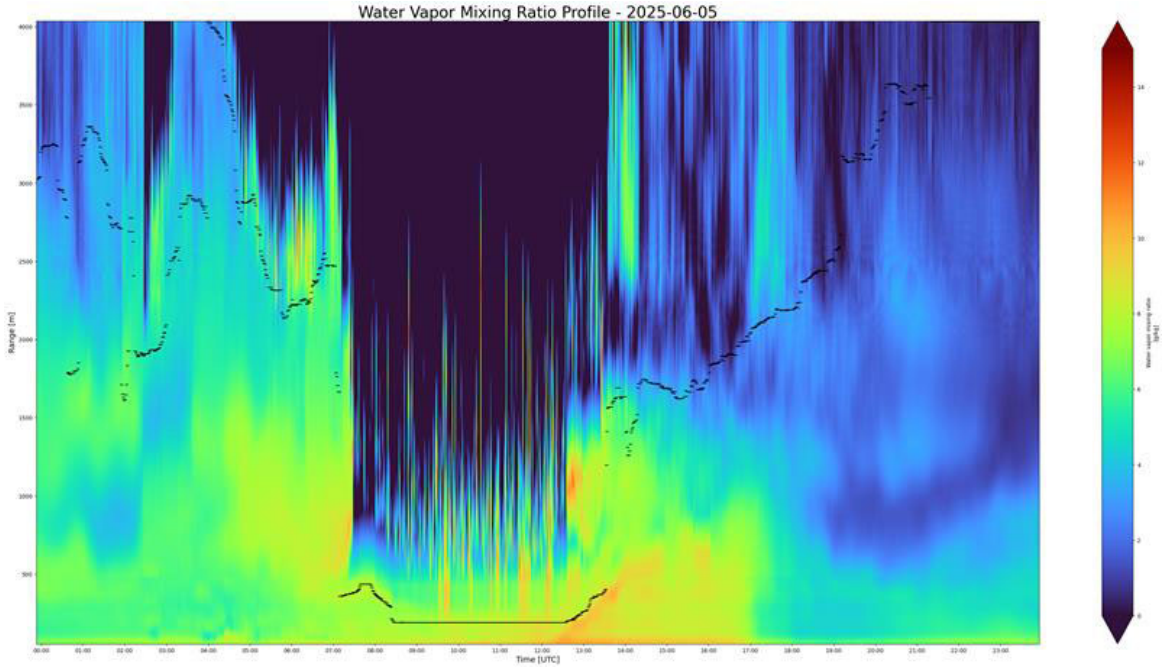


Figure 15 Example of water vapor mixing ratio visualization

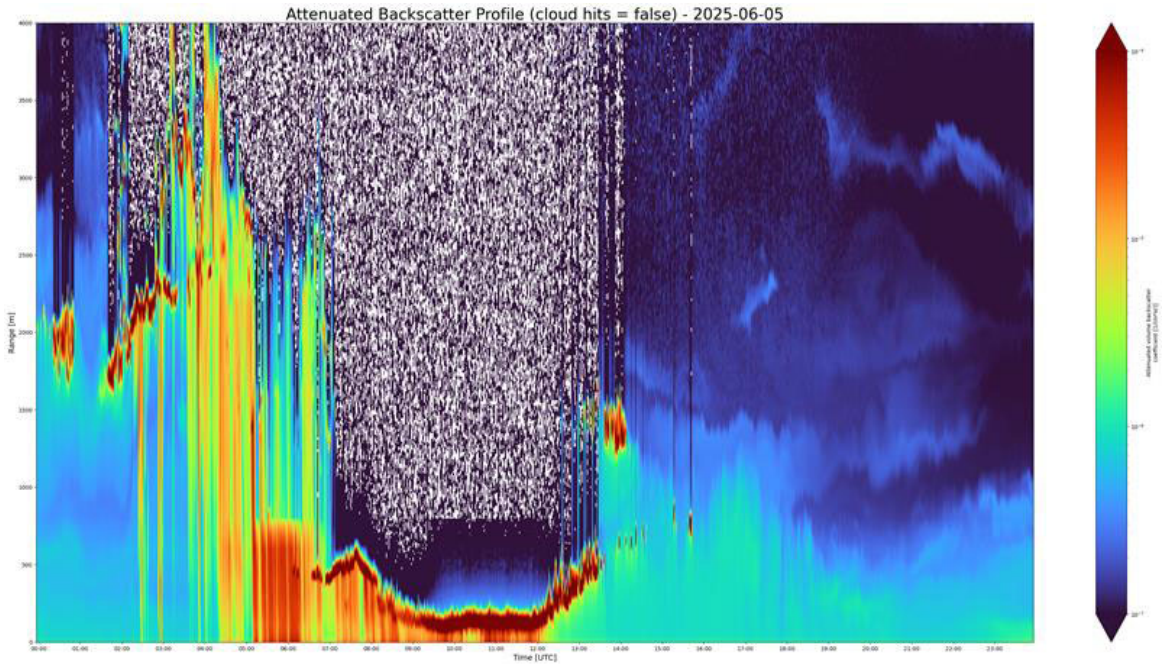


Figure 16 Example of attenuated backscatter visualization

More information

- DA10 Client (page 28)
- Visualizing mixing ratio files (page 68)

6. Configuration

6.1 Connection options

The following options are available for connecting to DA10.

Table 19 DA10 connection options

Option	Connection	Description	IP address
USB-C cable connection	Local	Connect the USB-C cable between DA10GW and your laptop. Recommended option on the field.	192.168.10.2
Ethernet maintenance connection	Local	Connect the Ethernet cable between the maintenance port of the interface unit and your laptop. Alternative option on the field.	192.168.2.110
Ethernet data line connection	Remote	Connect remotely over Ethernet to the defined IP address.	As configured in your network

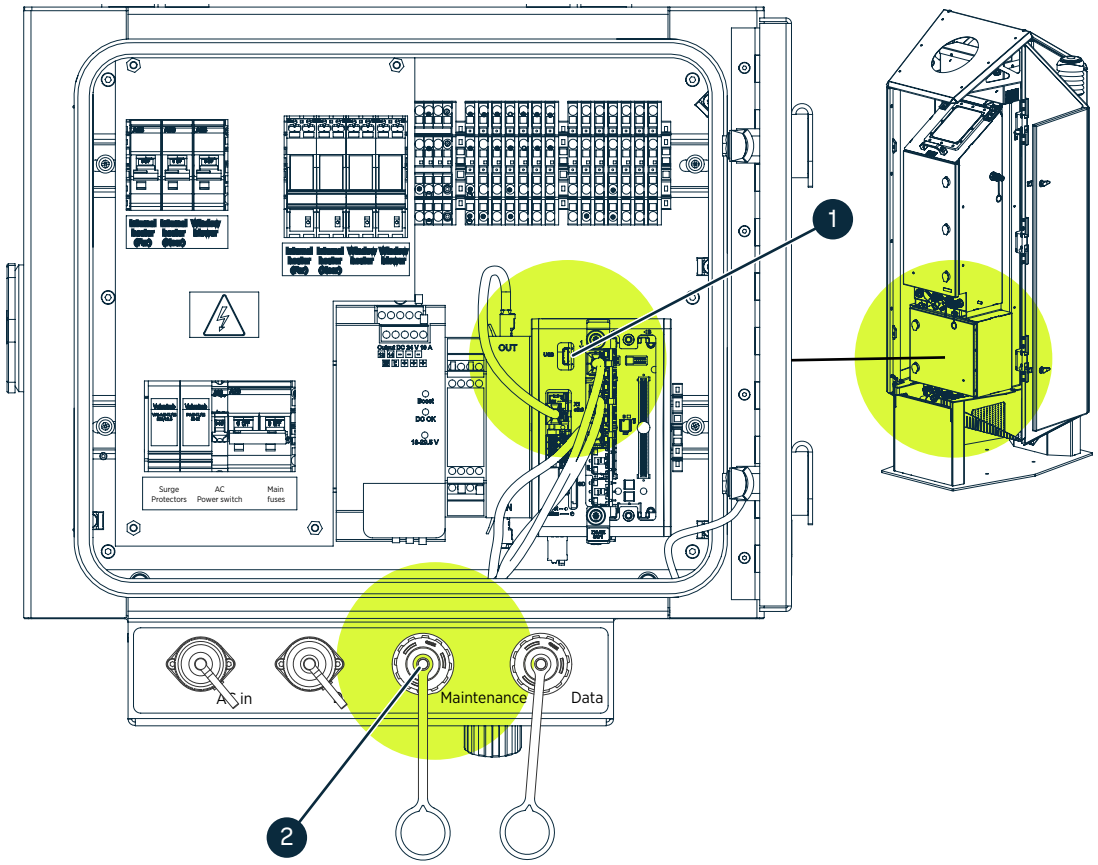


Figure 17 Connecting to DA10 locally

1 USB-C cable connection
2 Ethernet maintenance connection

6.1.1 Connecting to device locally

- Ethernet cable (for Ethernet maintenance connection)
- USB-C cable (for USB-C cable connection)
- Laptop

You can connect to DA10 locally using:

- USB-C cable connection
- Ethernet maintenance connection

1. Choose one of the local connection options:
   - Connecting with USB-C: connect your laptop to the USB port of DA10GW and type *`https://192.168.10.2`* in the browser.
   - Connecting with Ethernet cable: continue from step 3.
2. Connect your laptop to the maintenance port of DA10 with the Ethernet maintenance cable and type *`https://192.168.2.110`* in the browser.

3. Log in.
4. Configure your laptop settings to match the DA10 network settings.
   a. On your laptop select **Control Panel**, and **Network & internet** or **Network and Sharing Center** .
   b. Select **Change adapter settings**.
   c. Right-click **Ethernet** and select **Properties**.
   d. Select **Internet Protocol Version 4 (TCP/IPv4)**.
   e. Use the following settings on your laptop.

      Table 20 Network settings

Property	Value
IP address	192.168.2.5
Subnet mask	255.255.255.0
Default gateway	192.168.2.1

   When you have configured your laptop settings, select **OK** on both pop-up windows to close them. The settings are saved when you close the windows.
5. Open Command Prompt app on your laptop.
6. To test the connection to DA10, type the following in Command Prompt:

```
ping 192.168.2.110
```

To close the connection, select your username from top right in the Web UI and **Logout**. Disconnect the cable.

6.1.2 Connecting to device remotely

1. Connect to the device using the IP address you defined in the Web UI, in **Settings > Network**.

To close the connection, select your username from top right in the Web UI and **Logout**. Disconnect the cable.

6.2 Configuring device location



- Laptop with browser and USB-C port
- USB-C to USB-C cable (not needed if connecting remotely over Ethernet)

When starting to use the device or moving it to a new location, define the device location information in the Web UI. This information helps to distinguish several devices from each other.

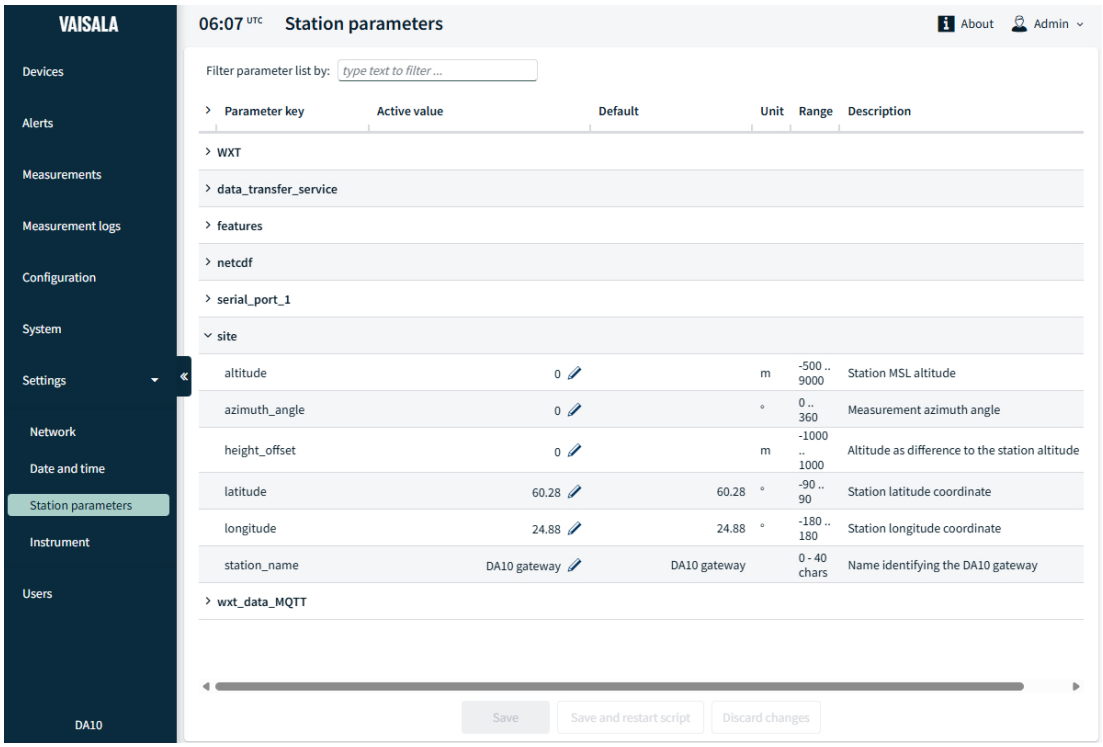
1. In a web browser, type the following Web UI address:

   https://192.168.10.2

2. In the Web UI, go to **Settings > Station parameters**.
3. Select **site**, and type the altitude, height offset, latitude, and longitude information, and set a name for the device or site in **station_name**.

   - For altitude the range is −500 … 9000 meters.
   - For the azimuth angle the range is 0 … 360 degrees.
   - For height offset, the range is −1000 … 1000 meters.
   - For latitude the range is −90.000000 … 90.000000.
   - For longitude the range is −180.000000 … 180.000000.

   For values below ground or sea level, use a negative value (−).
   For the station name, use the device serial number if possible.



4. Select **Save and restart script**.

6.3 Changing data storage location

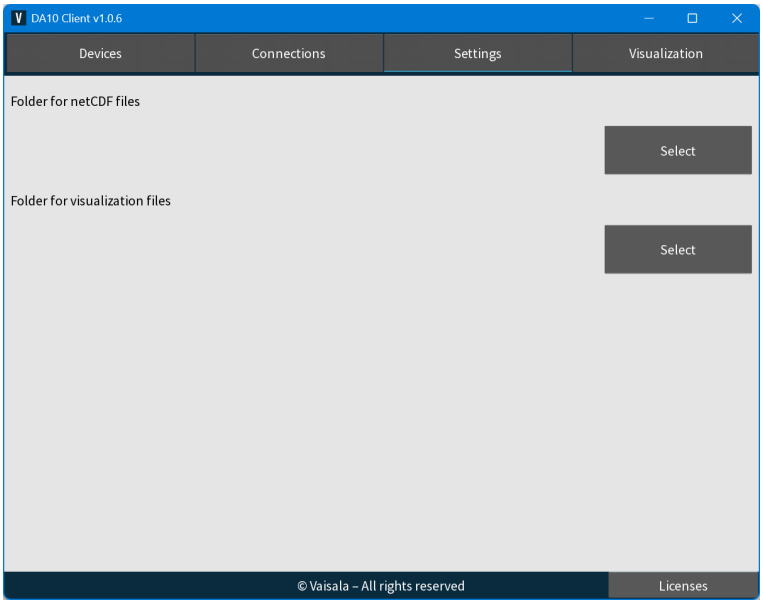
- DA10 Client

The netCDF files are generated automatically to a folder of your choice. Define the folder with DA10 Client.

The files are stored in the folders when you have the computer and DA10 Client open.

1. Go to the folder that is currently defined as the data storage location and move those files to the new location.
2. Open DA10 Client.
3. Select **Settings** and select a folder for the data files and for the visualization files.

   The data files are generated for water vapor mixing ratio and attenuated backscatter. The visualization files are generated for water vapor mixing ratio only.



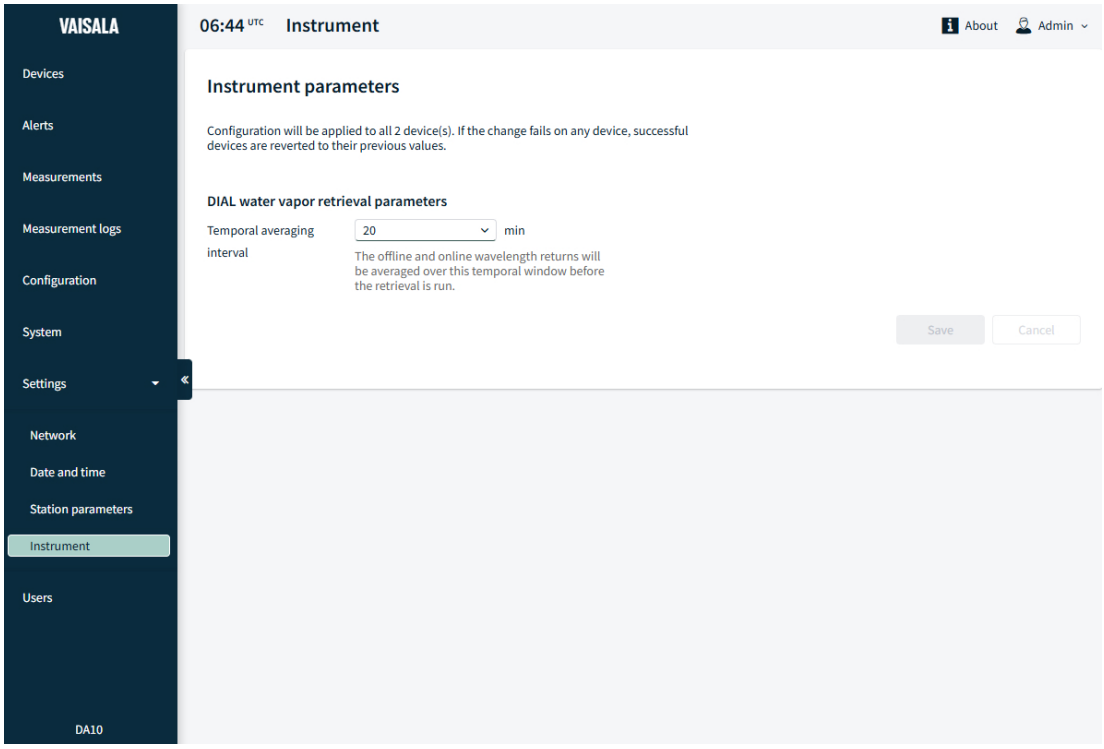
More information

- Retrieving netCDF files (page 68)

6.4 Configuring mixing ratio temporal averaging

You can configure the dial algorithm mixing ratio averaging interval. It can be set between 10 and 60 minutes in steps of 5 minutes. The offline and online wavelength backscatter returns will be averaged over this temporal window before the retrieval is run.

1. In the Web UI, select **Settings > Instrument**.
2. Select **DIAL water vapor retrieval parameters > Temporal averaging interval** and adjust the interval.



The offline and online wavelength returns are averaged over the temporal window before the retrieval is run.

6.5 Configuring DA10 laser bandwidth factors

For optimal performance, Vaisala recommends setting the laser bandwidth factor to match the value in the Test and quality report. The laser bandwidth factor affects the estimated laser spectrum, which is used in transmission modeling during the water vapor retrieval. When the laser bandwidth factor is not properly set, the water vapor mixing ratio profiles can show dry or wet bias.

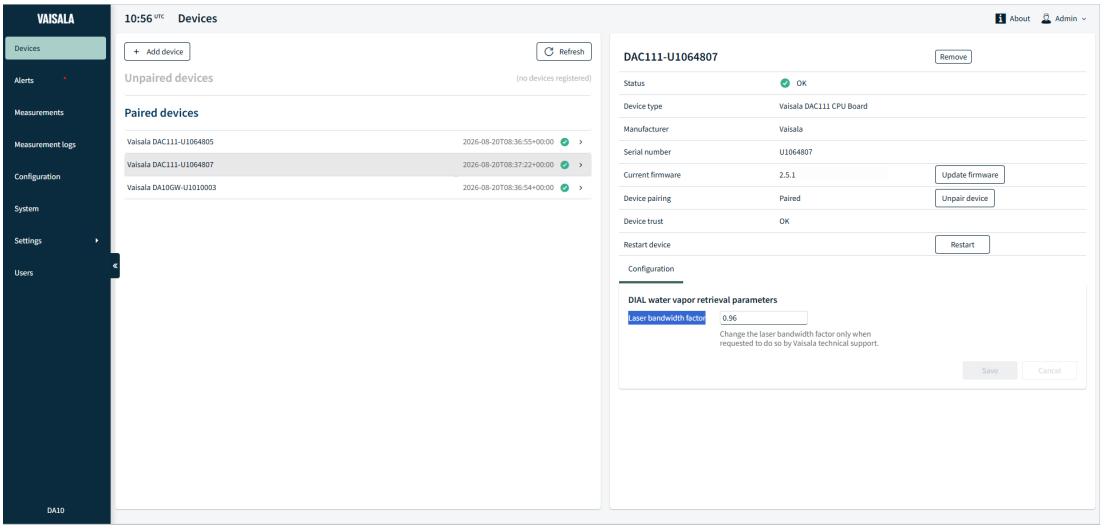
AKRIBIS · www.akribis.info · contacto@akribis.info

You can change the laser bandwidth factor for one measurement unit or both measurement units. The measurement units can have different laser bandwidth factors.

Check that the instrument uses firmware version 2.5, or newer. Update the firmware if needed.

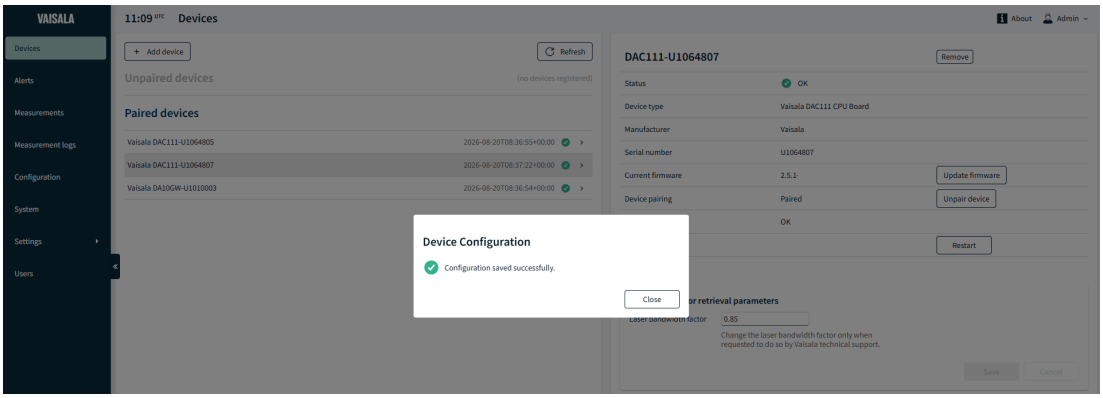
1. Open a connection to DA10.
2. After logging in, select the DAC measurement unit to modify.

   In the following example, the unit with serial number U1064807 is selected for modification.



3. Change **Laser bandwidth factor** to the desired value and select **Save**.

   The following window opens.



4. Repeat the steps for the other measurement unit, if needed.

7. Operation

Use DA10 Client for retrieving netCDF files and for creating visualization files.

DA10 Client is available for download at docs.vaisala.com.

For information about DA10 Client setup, see DA10 Installation Guide (M212894EN).

More information

- DA10 Client (page 28)

7.1 Retrieving netCDF files

The netCDF files are generated to a folder of your choice based on the setting in DA10 Client.

The file generation interval is defined with parameter `file_temporal_span_in_minutes`. You can check the value of the parameter from the netCDF files (`global attributes`) and from the Web UI (**Settings > Station parameters > netcdf**).

1. Open DA10 Client and check the folder you have defined as the storage place.
2. Go to the folder and fetch the files you need.

More information

- DA10 Client (page 28)
- NetCDF files (page 38)
- Changing data storage location (page 65)

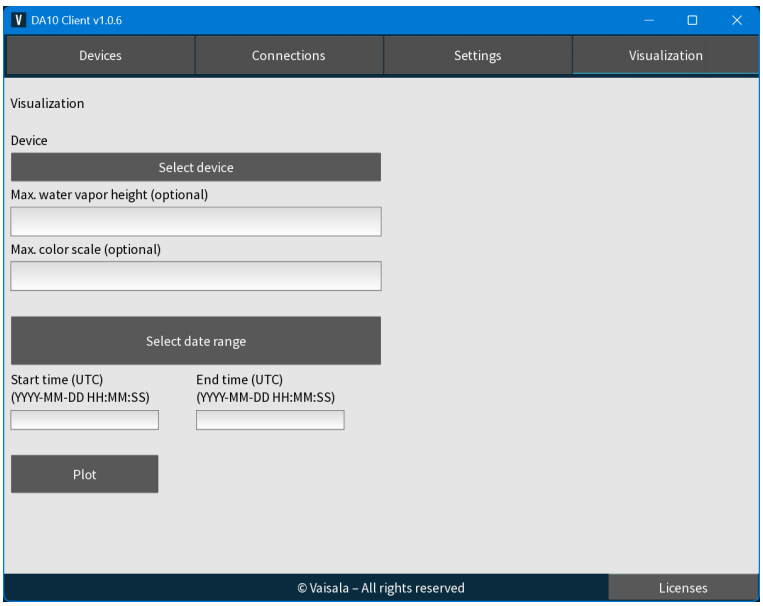
7.2 Visualizing mixing ratio files

The visualization of data is available for the water vapor mixing ratio files.

DA10 Client outputs a PNG file based on the visualization settings defined for the selected time period.

1. Open DA10 Client.

2. In **Visualization**, select a device (**Select device**) and set the following.



Max. water vapor height (optional)
Select a value between 58–4032 m (190–13 228 ft).
Use full numbers (no decimals). If no value is given, the default of 4032 m (13 228 ft) is used.

Max. color scale (optional)
Select the maximum mixing ratio value (g/kg) to be used in plotting. The range is from 0 to selected value.
If no value is given, the maximum value available in the data is used as the value.

3. Select the date range.

   Use the calendar or type the range manually. Use slashes (/) between the YYYY, DD, and MM.
   Select a maximum of 1 week as the date range.
   The data from the selected time period is plotted and 1 PNG file created.

4. Select **Plot**.

   Generating the file may take a while.

5. Go to the folder that you defined in **Settings** and open the file.

More information

- DA10 Client (page 28)
- Visualization files (page 59)

8. User management

User management is available in the Web UI where you can:

- Add new users
- Edit and delete user accounts
- Change password

More information

‣ DA10 Web UI (page 29)

8.1 Managing user accounts

To be able to use the Web UI , you need a user account. User accounts are managed in the Web UI.

Only a user with the **Administrator** role can add, edit, or delete user accounts.

An administrator account is created in the initial login, after the device has been activated with the device activation code. There can be several **Administrator** users.

8.2 User roles

User management is handled through user roles with different levels of access rights.

For security reasons, passwords cannot be retrieved from the system. If you forget your username or password, you have to reset DA10 to factory default settings.

Table 21 User roles and access rights

User role	Purpose
Administrator	• View metadata, system status, and settings • Modify station and network settings • Perform maintenance tasks • Manage users • Update firmware and application
Operator	• View metadata, system status, and settings • Modify station and network settings • Perform maintenance tasks
Viewer	• View metadata, system status, and settings

8.3 Adding new user accounts

1. Log in to the Web UI as an **Administrator**, and select **Users**.

2. Select **Add new user**, and set the following:

Username

Username for the user.

The acceptable characters are:

- Small letters a–z
- Capital letters A–Z
- Numbers 0–9
- Unicode characters 0x00A1-0xFFFF
- Following characters:
  - @ (at symbol)
  - = (equal sign)
  - . (period)
  - , (comma)
  - + (plus sign)
  - – (minus sign)
  - _ (underscore character)

First name

First name of the user (optional).

Last name

Last name of the user (optional).

Role

The role of the user.

New password

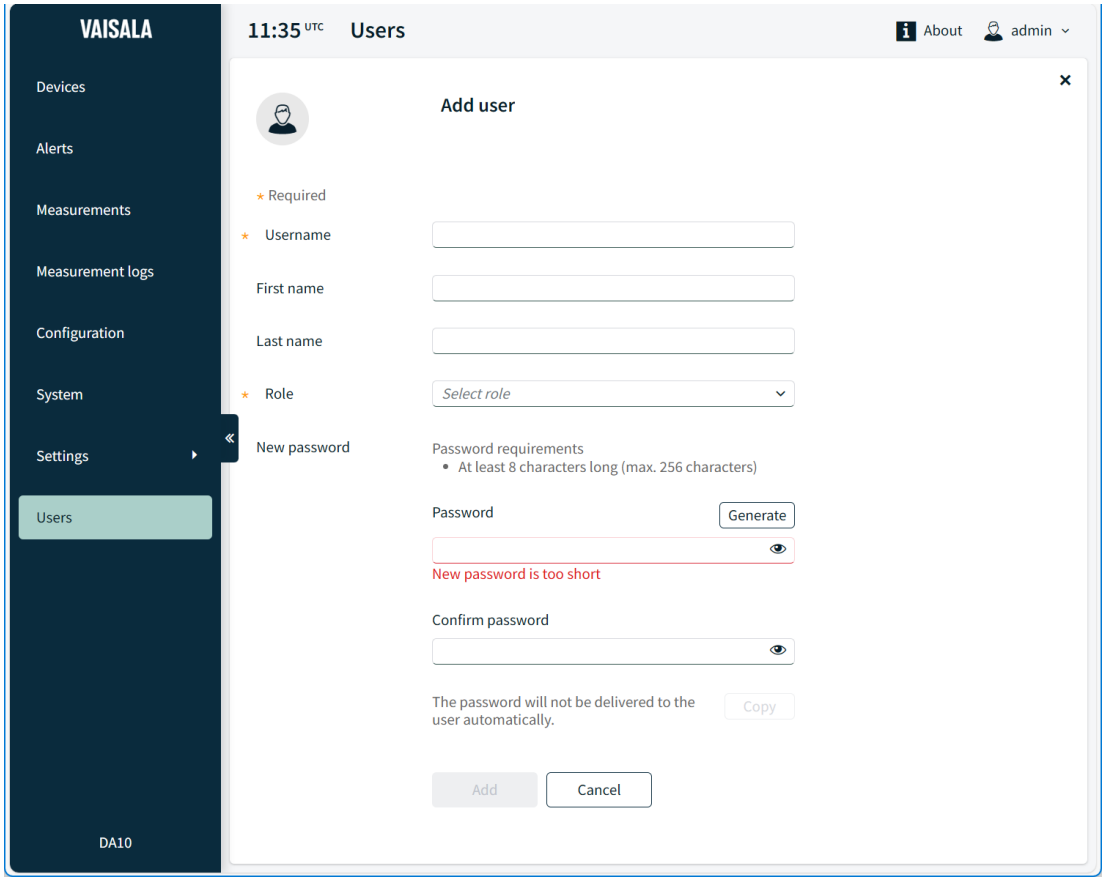
The user's password.

To use an automatically generated password, select **Generate password**.

Confirm password

Confirm the password.

To copy the password and send it to the user, select **Copy**.



3. To add the user account, select **Add**.

AKRIBIS · www.akribis.info · contacto@akribis.info

9. Firmware update

For the firmware update you need the following equipment and software.

- Administrator username and password to Web UI
- Connection to device through Web UI
- Firmware update package (includes the necessary firmware files and release notes): download the package from docs.vaisala.com
- Object for pressing factory reset buttons (if device reset is required)
- Screwdriver for opening instrument doors (if device reset is required)

If the firmware update requires a reset, update the firmware at the installation site.
If a reset is not required, you can update the firmware remotely.
Check the release notes for the requirements for the specific release. Factory reset is typically not needed.

Perform the following procedures in the order stated here unless the release notes instruct something else:

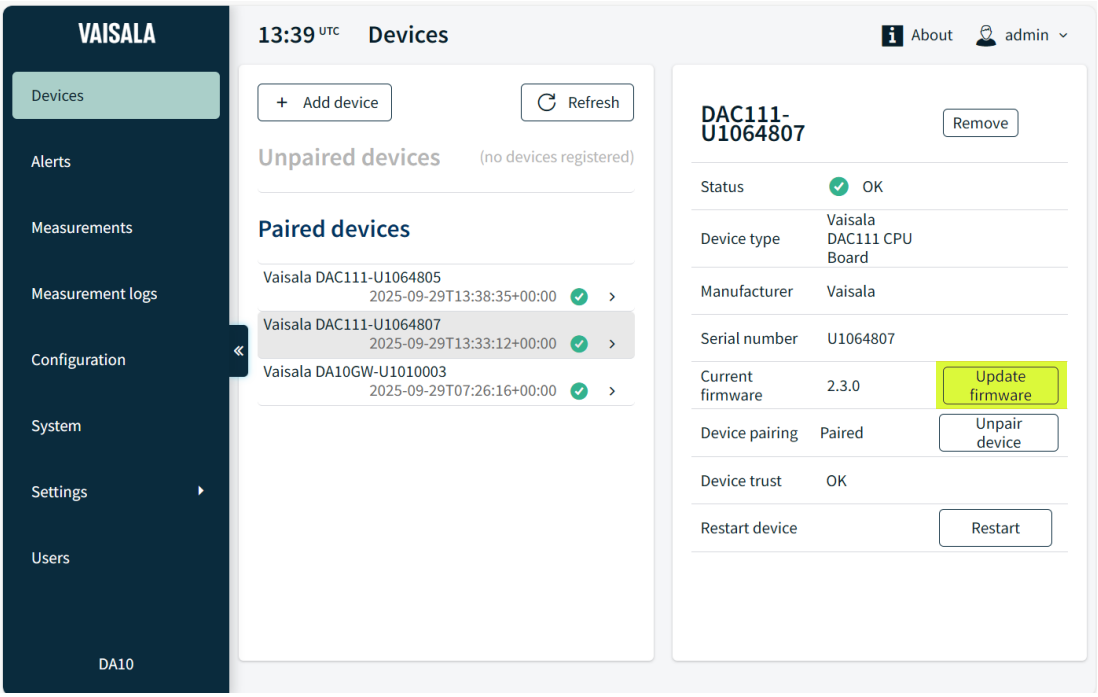
1. Updating device control modules (page 73)
2. Updating DA10GW (page 74)
3. Factory resetting DA10 (page 75) (if required, see the release notes)
4. Updating DA10 Client (page 76)
5. Setting up data collection (page 76)
6. Verifying operation (page 76)
7. Rerunning device control module firmware update (page 77)

9.1 Updating device control modules

- Administrator username and password to Web UI
- Connection to device through Web UI
- Firmware update package (includes the necessary firmware files and release notes)

1. Save the firmware update file on your computer.
2. Connect to the device.
3. Log in to the Web UI as an **Administrator**.
4. In the Web UI, select **Devices**.
5. Select a device from the list of paired devices with name *`Vaisala DAC111-xxxxxxxx`*.
6. Check the current firmware version from **Current firmware**.

7. Select **Update firmware**.



8. Select **Browse**, locate the new firmware file, select the file, select **Open**, and **Update**.

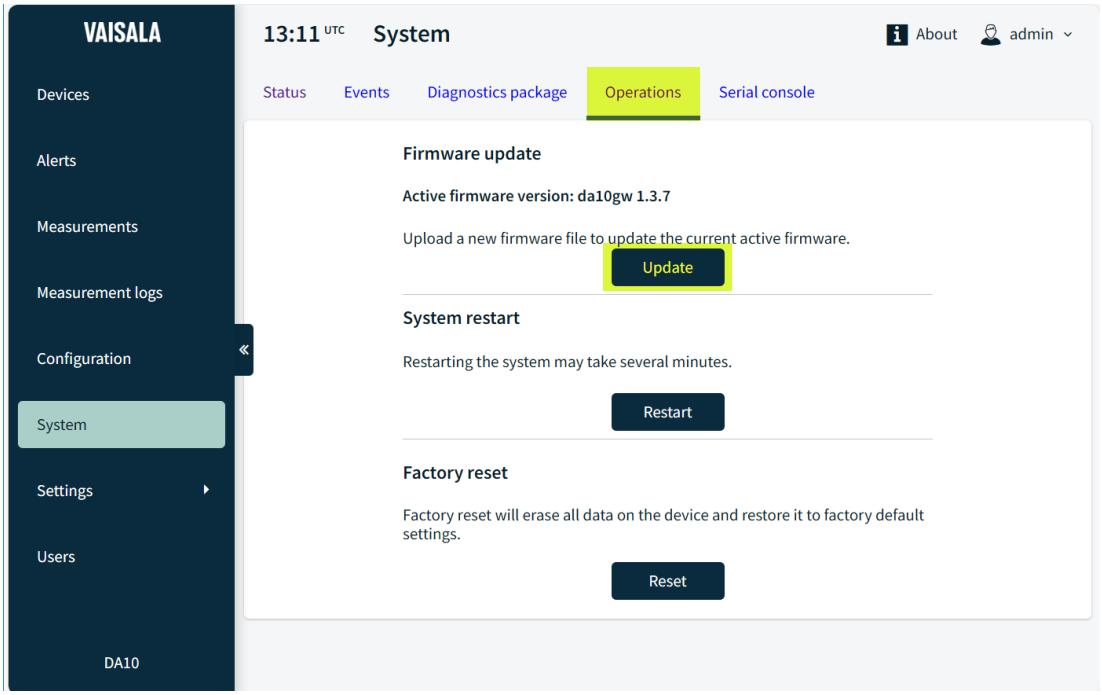
   The filename is *DAC111-<version>.firmware*.
   Wait for the update to finish and for the following message to appear:
   `Firmware update successful. The device is now restarting.`
   The device reboots automatically.
   The pairing takes a couple of minutes. When the firmware is updated, the device has a green icon next to it.
9. Update the other device control module in the same way.
10. Check the firmware version from **Current firmware**.

Update the DA10GW without any delay.

9.2 Updating DA10GW

- Administrator username and password to Web UI
- Connection to device through Web UI
- Firmware update package (includes the necessary firmware files and release notes)

1. In the Web UI, select **System > Operations** and check the current firmware version. Select **Update**.



2. Select **Browse**, locate the new firmware file, select the file, select **Open**, and **Update**.

   The filename is *DA10GW-<version>.firmware*. The update takes a couple of minutes.
   When the firmware is updated, the device restarts, and you are directed to the **Log in** page.

3. Log in to the Web UI.

If the firmware is not updated, try again to update it. If the firmware is still not updated, see Troubleshooting DA10 firmware update (page 99).

9.3 Factory resetting DA10

1. Check the release notes to see if a factory reset is required.

   If a factory reset is required, see the instructions about factory reset.
   If a factory reset is not required, proceed to Updating DA10 Client (page 76).

More information

- Factory resetting DA10 (page 101)

9.4 Updating DA10 Client

Check the release notes for information about the DA10 Client version. If there is a newer version of DA10 Client, install it.

1. Unzip file *DA10 Client <version>.zip* on your computer.
2. To open DA10 Client, double-click file *DA10Client.exe*.

DA10 Client opens. Leave it open in the background.

9.5 Setting up data collection



- Connection to device through Web UI

Set up data collection with DA10 Client when either or both of these are part of the firmware update:

- Factory reset of DA10GW.
- DA10 Client update.

This includes, for example, setting the API key in the Web UI and DA10 Client.

1. Set up data collection. See DA10 Installation Guide (M212894EN).

9.6 Verifying operation



- Administrator username and password to Web UI
- Connection to device through Web UI

When the informative alert confirms that the device has recently started up, DA10 is fully functional.

1. In the Web UI, select **Alerts**.

   Check that there are no active alerts.

2. In the Web UI, select **Configuration > Debug console**.

   The view shows the recently occurred warnings and errors. Check that there are no errors. Errors are shown in red color.
   You can ignore the following:
   - `netcdf.netcdf_generator WARNING: Missing data for: <item>` (shown until the first MR data is received, which may take up to 40 minutes)
   - `… WARNING: 'abs_netcdf' calculation took a long time: 448ms`
   - `… WARNING: 'cut_mr_and_uc_profiles' calculation took a long time: 261ms`
   - Debug messages

3. Check that netCDF data is coming through and the data is valid.

If there are alerts, errors, or other warnings or data is not coming through, troubleshoot the device.

More information

- Troubleshooting (page 97)
- Troubleshooting DA10 firmware update (page 99)

9.7 Rerunning device control module firmware update

You must update the firmware of the device control modules again. The device control modules keep the old firmware for critical error cases and revert to it if the current firmware fails to load.

1. Update the device control modules. See Updating device control modules (page 73).

10. Maintenance

10.1 Maintenance safety

WARNING! Do not look directly into the instrument transmitter or optics with magnifying optics (such as glasses, binoculars, and telescopes). Do not direct the beam into an area where such instruments are used. Viewing the laser output may pose an eye hazard.

WARNING! Do not remove the ceilometer transmitter from its normal position without first switching off both the line and the battery power and detaching the transmitter ribbon cable from the Ceilometer Engine Board.

WARNING! When operating the ceilometer, do not look at the ceilometer unit from the beam direction. When tilting the unit, make sure that it cannot be viewed from the beam direction with magnifying optics.

WARNING! Only qualified maintenance personnel may perform maintenance procedures. Make sure unauthorized persons cannot access the work area during service operations.

WARNING! After disconnecting the power cable, dangerous voltages can exist for some time. To avoid injury, disconnect the power and discharge circuits before touching them.

WARNING! Always consult local authorities on decisions that relate to aviation safety, grounding, lightning protection, safe installation, and power supply. Follow local and state legislation and regulations.

WARNING! Do not service the system alone. Do not reach into parts and assemblies that are AC (mains) powered and live except in the presence of someone who can provide first aid.



WARNING! Do not substitute parts or modify the system, or install unsuitable parts in the system. Improper modification can damage the product or lead to malfunction.



WARNING! Do not perform maintenance procedures when the wind speed is more than 25 m/s (55 mph).



WARNING! Do not perform installation or maintenance procedures when there is a risk of thunderstorm or lightning activity in the area.



WARNING! Do not operate in an explosive atmosphere, for example, when flammable gases or fumes are present. Operation of electrical equipment in such an environment constitutes a safety hazard.



WARNING! Do not replace components when the system is powered up. Disconnect all power sources before performing maintenance procedures.



WARNING! Do not open the power supply unit. There are no user-serviceable parts inside the unit. If the power supply unit is faulty, replace it.



WARNING! Failure to comply with these precautions or with specific warnings elsewhere in these instructions violates safety standards of design, manufacture, and intended use of the product. Vaisala assumes no liability for the customer's failure to comply with these requirements.



WARNING! Follow local and state legislation and regulations on occupational safety.



WARNING! Keep away from live circuits. Operating personnel must observe safety regulations at all times.



WARNING! Make sure that you prepare or connect only de-energized wires.



WARNING! Only licensed experts may install electrical components. They must adhere to local and state legislation and regulations.



WARNING! To avoid injuries and to avoid damaging the instrument, do not place a ladder or similar against the instrument.



CAUTION! Contact Vaisala or its authorized representative for repairs.



CAUTION! Only qualified maintenance personnel may perform maintenance procedures.



CAUTION! Always use the specified cables. The wrong type of cable can damage sensors or the system.



CAUTION! Do not damage or change the wiring. Incorrect wiring can cause damage and prevent or limit operation.



CAUTION! Make sure that the grounding wire is longer than the phase and neutral wires. Under mechanical stress, the grounding wire must be the last to disconnect from the protective ground terminal.



CAUTION! Improper modification can damage the product or lead to malfunction. Any modification voids your warranty.

AKRIBIS · www.akribis.info · contacto@akribis.info

CAUTION! To maximize performance, complete the maintenance tasks according to the recommended schedule.

10.2 DA10 maintenance

The instrument's self-diagnostic system runs in the background and generates warnings and alarms according to the issues discovered. Malfunctions are reported in netCDF and status messages.

DA10 requires the following periodic maintenance.

Table 22 DA10 maintenance

Task	Frequency
Clean the windows.	Minimum once a year, recommended every 6 months
Perform a general check.	Annually
Check the door gaskets.	Annually
Clean and maintain painted surfaces.	Annually
Replace the PTU module in WXT534.	Every 2 years
Replace the DA10GW battery.	Every 15 years

WARNING! Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Vaisala office or authorized depot for service and repair to make sure that safety features are maintained.

WARNING! Verify outdoor installation grounding periodically to minimize shock hazard.

WARNING! Do not perform periodic maintenance on the system alone. Do not reach into parts and assemblies that are AC (mains) powered and live except in the presence of someone who can provide first aid.

10.3 Cleaning window

- Mild detergent
- Soft, lint-free cloth
- Water

WARNING! Do not look directly into the instrument transmitter or optics with magnifying optics (such as glasses, binoculars, and telescopes). Do not direct the beam into an area where such instruments are used. Viewing the laser output may pose an eye hazard.

WARNING! Only qualified maintenance personnel may perform maintenance procedures. Make sure unauthorized persons cannot access the work area during service operations.

The netCDF files include information about the window condition of the near-range measurement unit.

Clean the windows when dirty and at least once a year (recommended every 6 months). Clean windows of both measurement units at the same time.

1. Make sure that the doors are closed. Rinse the windows with clean water to remove coarse grains.

   CAUTION! Do not use pressure cleaners.

2. Clean the windows with a soft, lint-free cloth moistened with a mild detergent.

   CAUTION! Be careful not to scratch the window surface.

You can also check the operation of the window blower. Place your hand in front of the window blower to verify that air is coming out of the blower.

10.4 Checking door gasket

The interface unit and measurement unit doors have an electrically conductive gasket to suppress electromagnetic radiation.

1. When you open the door, check that the gasket and the opposite contact surfaces are clean.
2. If necessary, use a wet cloth for cleaning.

10.5 Cleaning and maintaining painted surfaces

Vaisala recommends that you wash all the painted surfaces at least once a year. Use only warm water or warm, mildly soapy water. Wipe with soft cloth or sponge and rinse with clean water.



CAUTION! Do not use solvents or abrasive sponges when cleaning painted surfaces.

10.6 Replacing PTU module



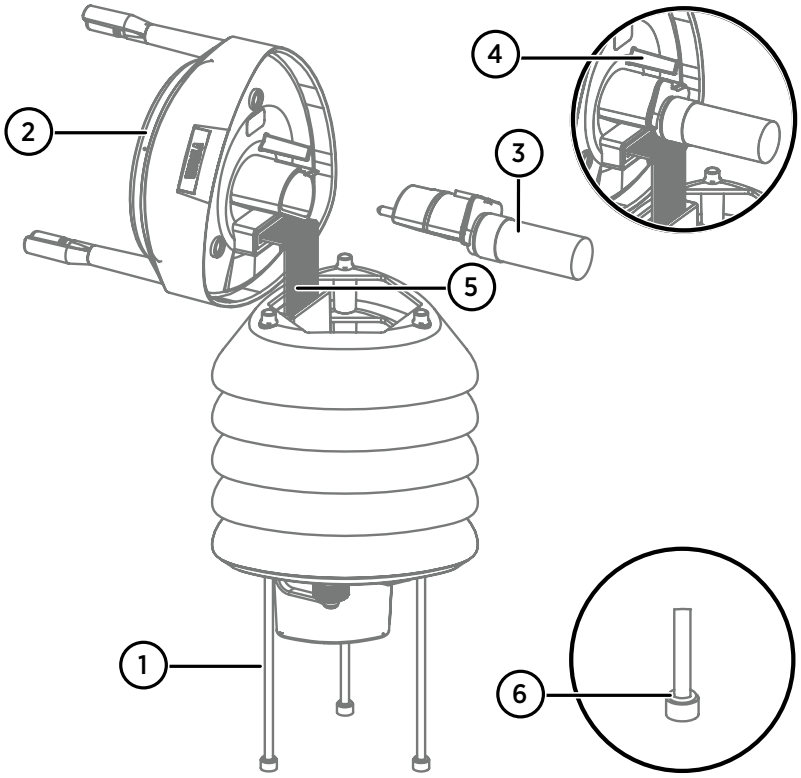
- 3-mm Allen key



In demanding applications, Vaisala recommends changing the PTU module every 2 years.

1. Turn off the power.
2. Remove the transmitter from the mounting adapter and disconnect the cable.

3. Loosen the 3 mounting screws at the bottom assembly of the transmitter and pull them out.



1 Fixing screws
2 Top of transmitter
3 PTU module
4 Latch
5 Flat cable
6 O-ring

4. Turn out the top of the transmitter.
5. Release the small white latch and remove the PTU module.
6. Remove the vacuum bag protecting the PTU module.
7. Connect the new PTU module.

> **CAUTION!** Avoid touching the white filter cap.

8. Turn the top back in. Make sure the flat cable does not get stuck or squeezed between the top and the funnel for the flat cable and it is properly connected.
9. If the O-rings are damaged, replace them with new ones.

10. Connect the cable to the transmitter and mount the transmitter on the mounting adapter.
11. Tighten the fixing screws.

> To make sure that the radiation shield stays straight, do not tighten the screws all the way in one go. Do not overtighten.

12. Turn on the power.

10.7 Replacing DA10GW battery

DA10GW contains a lithium real-time clock (RTC) battery to keep the system clock running during power outages. The battery type used is CR1225/BR1225, which lasts for a minimum of 5 years if DA10 is powered down. When DA10 is operating normally, the battery lasts longer.

Replace the battery before it runs out. When DA10 is operating normally (and the battery is not used), Vaisala recommends replacing the battery every 15 years, or when the expected date of expiration determined by the battery manufacturer is reached.

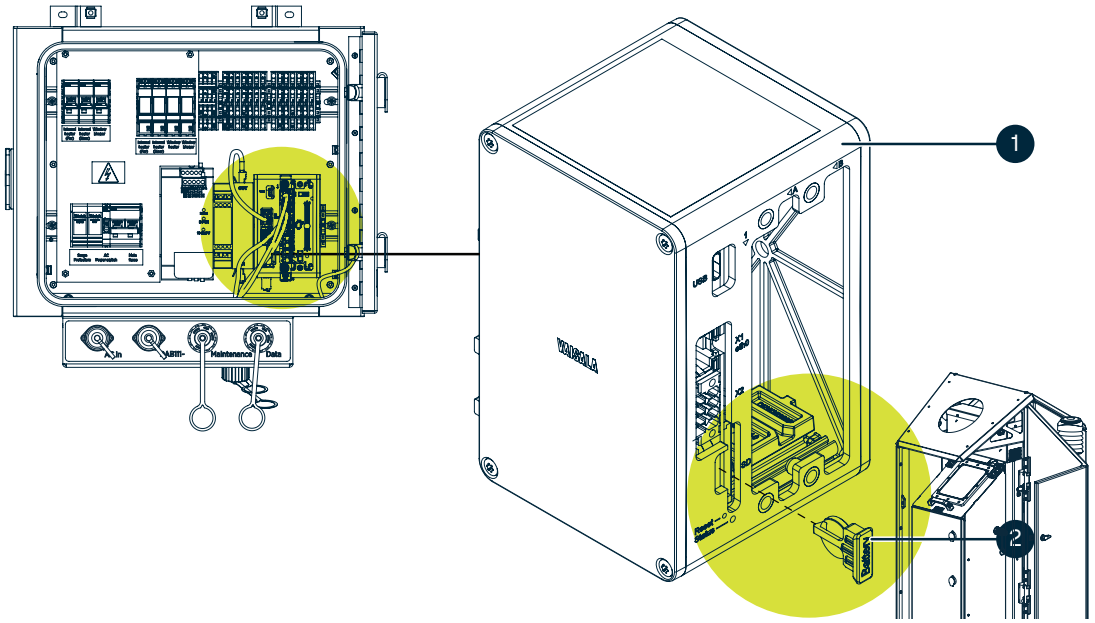
> Vaisala recommends using a Panasonic, Varta, or Renata battery.

> **WARNING!** Do not replace the battery with a battery of an incorrect type. If you do, there is a risk of deflagration. Dispose of used batteries according to statutory regulations.

1. Locate DA10GW in the interface unit.

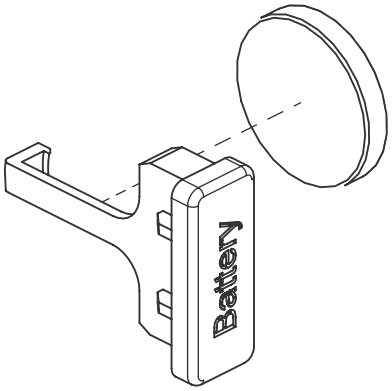
2. Pull out the battery holder with your fingers.

   The battery is in the battery holder.



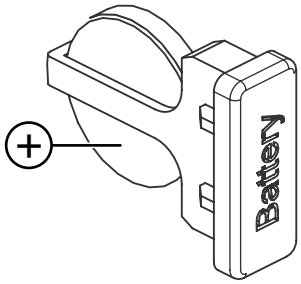
1 DA10GW
2 Battery in battery holder

3. Remove the battery from the battery holder.



4. Insert the new battery in the battery holder.

> Make sure to place the battery text (**+**) side facing towards the holder.



5. Insert the battery holder including the new battery back in DA10GW.

11. Service instructions

WARNING! Do not service the system alone. Do not reach into parts and assemblies that are AC (mains) powered and live except in the presence of someone who can provide first aid.

WARNING! Keep away from live circuits. Operating personnel must observe safety regulations at all times.

WARNING! Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Vaisala office or authorized depot for service and repair to make sure that safety features are maintained.

1. If the instrument is not transmitting data, see the troubleshooting information for help.
2. If you suspect damage in a module, contact Vaisala for repair.

More information

- Spare parts (page 88)
- Replacing surge protection units and relay units (page 89)
- Replacing window blower (page 93)
- Troubleshooting (page 97)

11.1 Spare parts

Table 23 DA10 spare parts

Spare part	Order code
Surge protection unit and relay kit, including: • Surge protection unit for AC (2 pcs) • Surge protection unit for Ethernet (1 pc) • Relay unit (4 pcs)	DA10ELESP
Window blower for 115 V AC	DAB111-115SP
Window blower for 230 V AC	DAB111-230SP

More information

- Service instructions (page 88)

AKRIBIS · www.akribis.info · contacto@akribis.info

11.2 Replacing surge protection units and relay units

Vaisala item DA10ELESP includes the following spare parts:

- Surge protection unit for AC (2 pcs)
- Surge protection unit for Ethernet (1 pc)
- Relay unit (4 pcs)

More information

- Service instructions (page 88)

11.2.1 Replacing surge protection units for AC

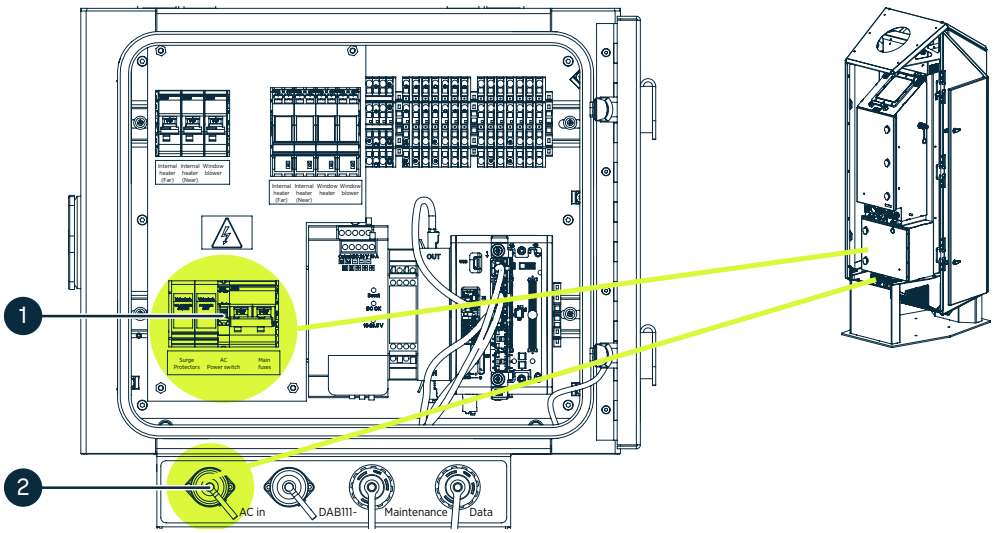
- Flathead screwdriver (for releasing unit from DIN rail)

Make sure that you have the replacement spare part available.

Replace both surge protection units at the same time.

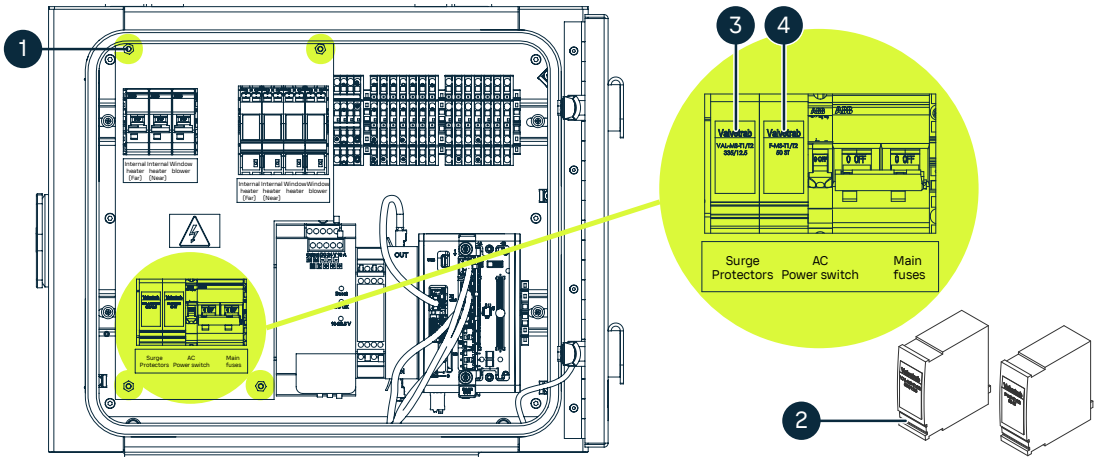
1. Switch off AC (mains) power.

WARNING! To make sure that there is no AC (mains) power available for the system, disconnect the AC (mains) cable (**AC in**).



1 **AC Power switch**
2 **AC in**

2. Remove the 4 screws from the protective cover and remove the protective cover.



1 Screws for protective cover (4 pcs)
2 Surge protection unit for AC spare part (2 pcs)
3 Surge protection unit with red label
4 Surge protection unit with black label

3. Press from beneath the surge protection unit and pull it out.
4. Attach the replacement surge protection units.
5. Reattach the protective cover.
6. Connect the power.

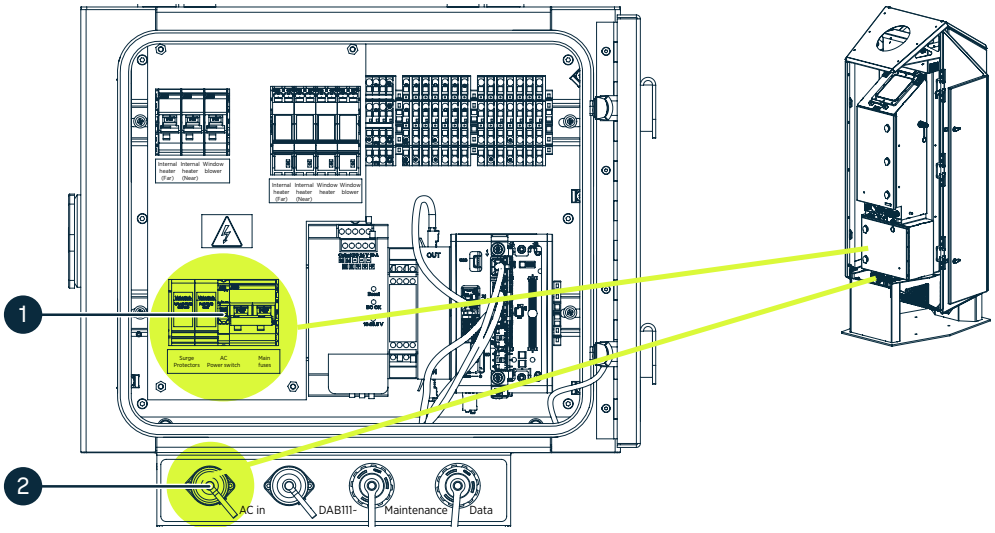
11.2.2 Replacing surge protection unit for Ethernet

- Flathead screwdriver (for releasing unit from DIN rail)

Make sure that you have the replacement spare part available.

1. Switch off AC (mains) power.

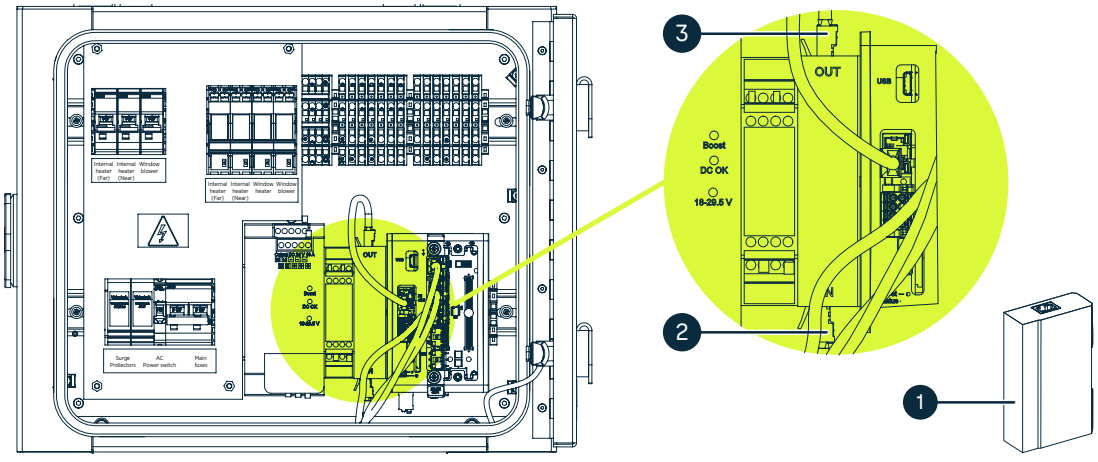
> **WARNING!** To make sure that there is no AC (mains) power available for the system, disconnect the AC (mains) cable (**AC in**).



1 **AC Power switch**
2 **AC in**

2. Disconnect the Ethernet cables and pull out the component from the DIN rail.

   Place the screwdriver to the bottom edge of the surge protection unit and push towards the DIN rail to release the surge protection unit.



1 Ethernet surge protection unit spare part
2 Ethernet cable (in)
3 Ethernet cable (out)

3. Attach the replacement component on the DIN rail.

   Push the top part in place and then the bottom of the surge protection unit.
4. Connect the Ethernet cables.
5. Connect the power.

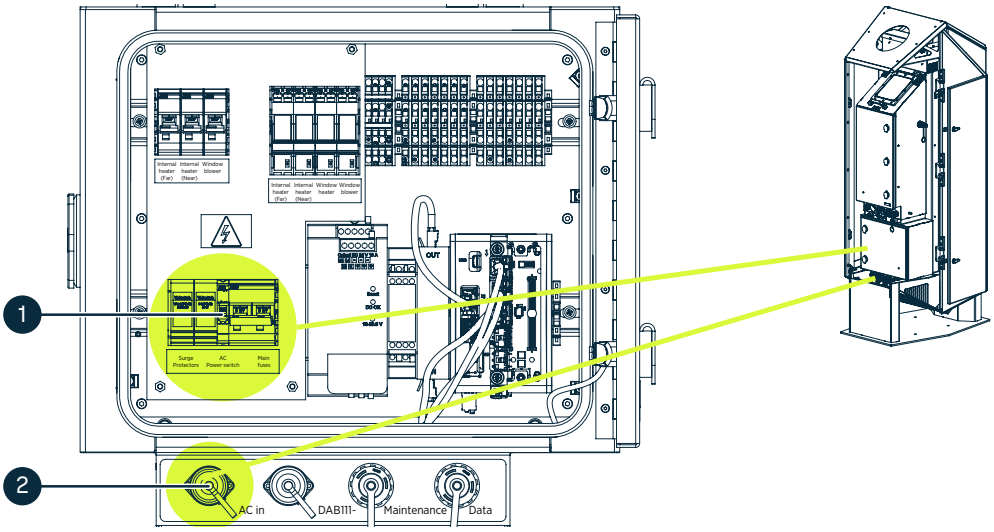
11.2.3 Replacing relay units

Make sure that you have the replacement spare part available.

The interface unit has relay units for the internal heaters, window heaters, and window blower.

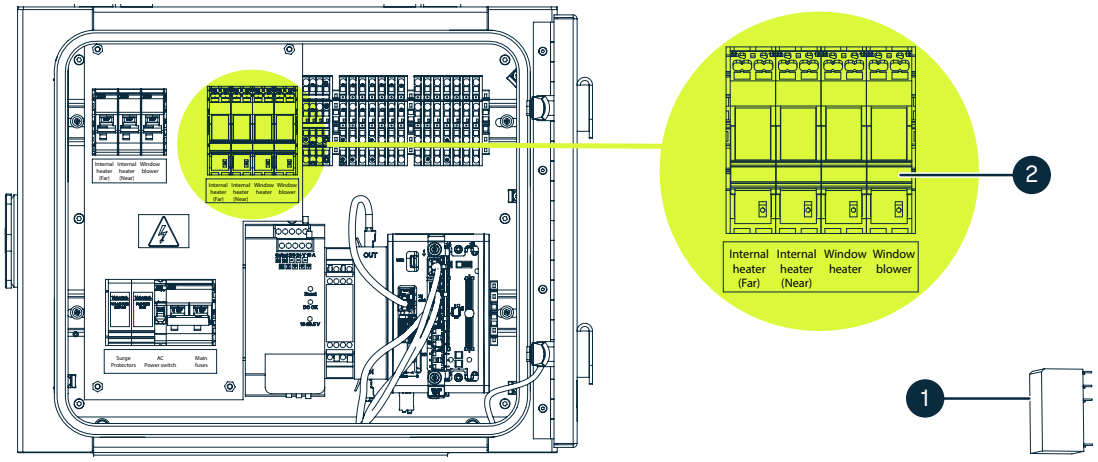
1. Switch off AC (mains) power.

> **WARNING!** To make sure that there is no AC (mains) power available for the system, disconnect the AC (mains) cable (**AC in**).



1 **AC Power switch**
2 **AC in**

2. To replace a relay unit, pull the orange lever downwards until the relay unit snaps out.



1 Relay unit spare part (4 pcs)
2 Lever

3. Attach the replacement relay unit.

   Pull the orange lever back up and push the relay unit to the bottom. Make sure that it attaches properly.

4. Connect the power.

11.3 Replacing window blower

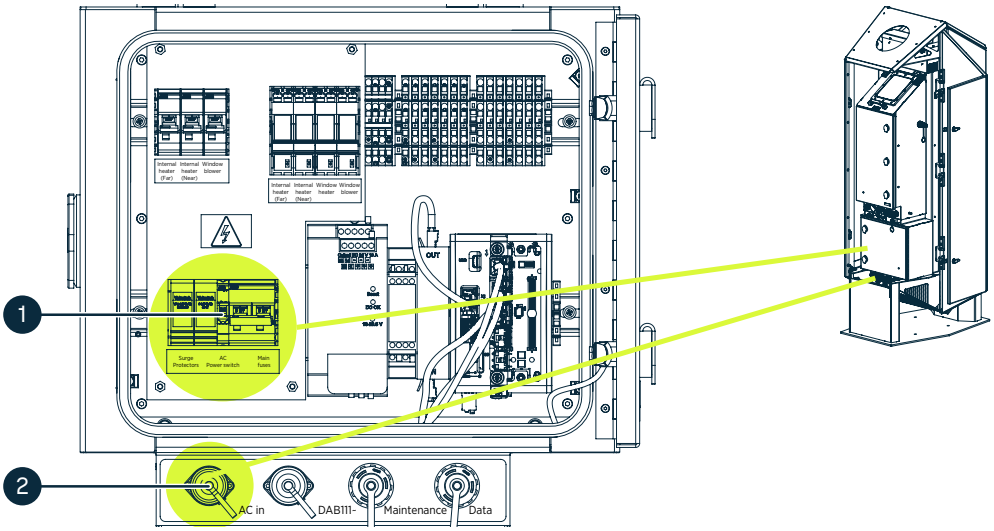
- Cable ties (3 pcs)
- Socket wrench

Make sure that you have the replacement spare part available.

This instruction is for replacing the DA10 window blower with spare part DAB111-115SP or DAB111-230SP, depending on the used voltage (115 or 230 V AC).

1. Switch off AC (mains) power.

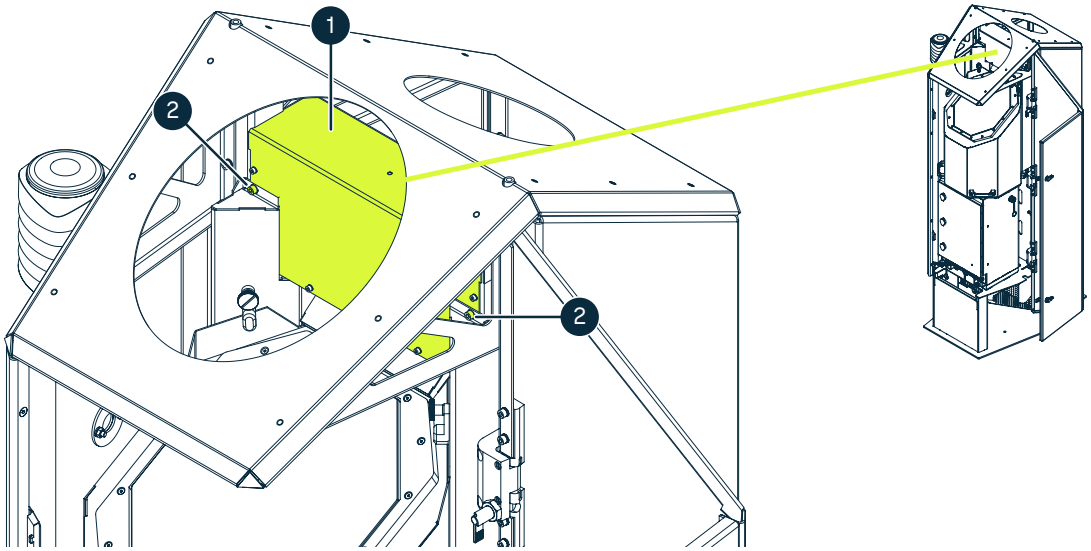
> **WARNING!** To make sure that there is no AC (mains) power available for the system, disconnect the AC (mains) cable (**AC in**).



1 **AC Power switch**
2 **AC in**

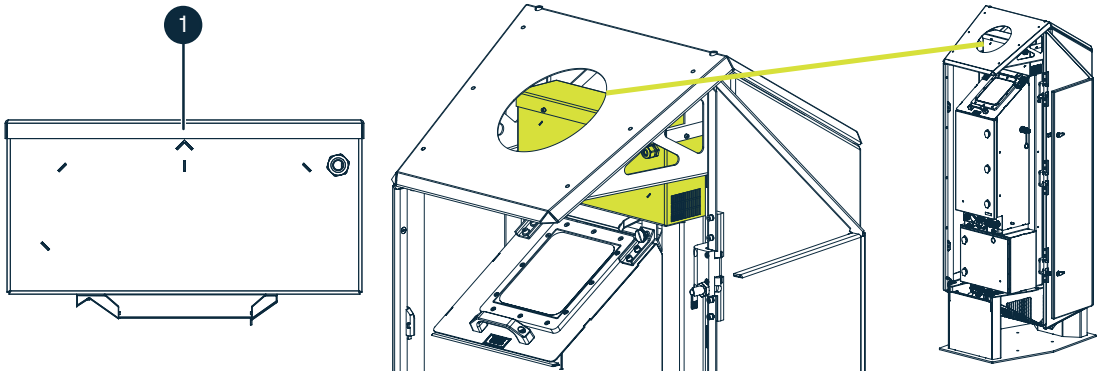
2. Disconnect the blower cable from the window blower port (**DAB111~**) at the bottom of the interface unit.

3. Remove the nuts and washers that are behind the window blower.



1 Window blower
2 Nut and washer (2 pcs each)

4. Move to the other side and pull at the window blower to remove it and its cable.

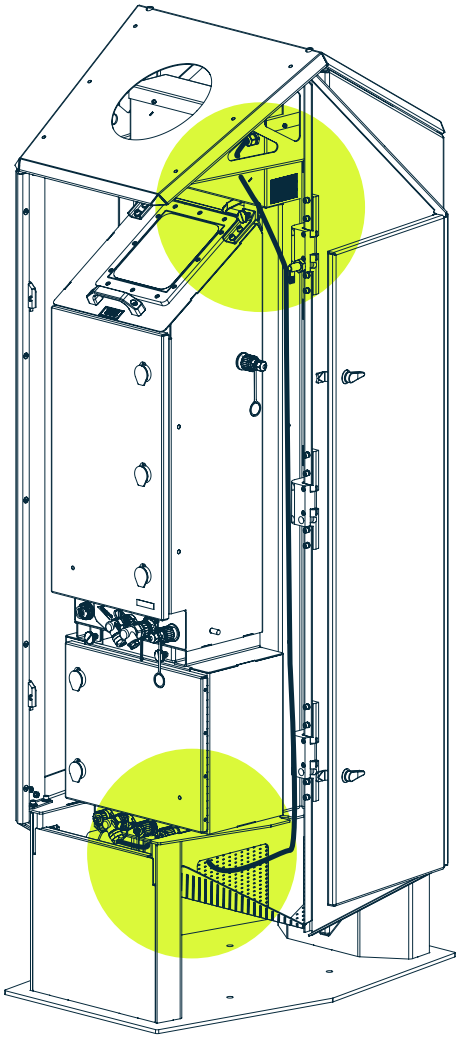


1 Window blower spare part

5. Attach the replacement window blower with nuts and washers.

6. Route the blower cable towards the bottom of the interface unit and connect the cable to port **DAB111~**.

   Secure the cable to the side of the radiation shield with cable ties.



7. Connect the power.

More information

- Service instructions (page 88)

12. Troubleshooting

Failure situations are usually caused by module malfunction. External conditions may also be the source of problems.

Table 24 Troubleshooting DA10

Problem	Probable cause	Action
Data missing after power cut	Data processing malfunction due to short interruptions and voltage variations in power supply.	Disconnect the power cable and reconnect it.

1. In a web browser, type the following Web UI address:

   https://192.168.10.2

2. In the Web UI, select **Configuration > Debug console** and check the messages.
3. To filter the data:
   - Select **Filter level** to sort the logs according to the defined categories.
   - Type the filter text in the **Filter** field.
4. If you suspect damage in a module, contact Vaisala for repair.

12.1 Viewing alerts

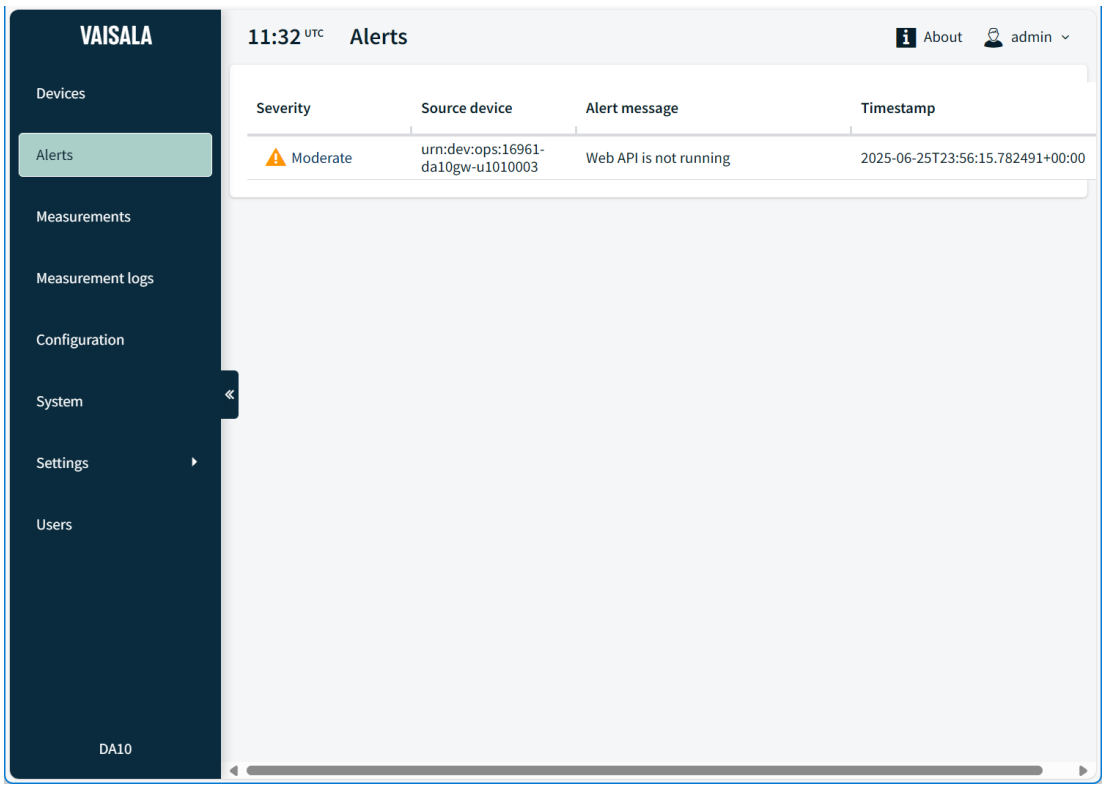


- Laptop with browser and USB-C port
- USB-C to USB-C cable or Ethernet cable

1. Check that you are connected to the device with the USB-C cable.
2. In a web browser, type the following Web UI address:

   https://192.168.10.2

3. In the Web UI, select **Alerts**.



Alerts are shown with the following information.

Table 25 Alerts in Web UI

Field	Description
Severity	Alerts are classified into critical, moderate, and informational.
Source device	Device control module (DAC) or data management unit (DA10GW) issuing the alert.
Alert message	Alert description.
Timestamp	Time when alert was triggered.

The following alerts are in use.

Table 26 DA10 alerts

Message	Probable cause	Actions
Critical alerts		
`Measurement error. Results unreliable. Code: <error code>`	Algorithm error condition detected.	Try restarting the device. If the issue persists, contact Vaisala technical support and provide the error code.

AKRIBIS · www.akribis.info · contacto@akribis.info

Message	Probable cause	Actions
`EEPROM error in module <module>`	The EEPROM in a module was not read.	Restart the instrument.
Warnings		
`Web API is not running`	The Web API is not configured correctly or has some other issue.	Set the Web API key in the station parameters.
`Communication lost with Web API client since <last connection>`	No client has connected to the gateway since the specified timestamp. The gateway should have at least one client connected to it.	Check the client connection to the gateway.
`Communication lost with internal component <component>`	The internal component has not sent any data for a while. The component should be sending data periodically.	Check the internal component configuration.
`Communication lost with component <component>`	The component has not sent any data for a while. The component should be sending data periodically.	Check that the devices are paired and operational.
`Measurement sharing between device control modules has paused`	Measurement sharing between device control modules has paused. The device control modules should be sharing data periodically.	Switch off AC (mains) power and check that the sync cable between device control modules is connected. Wait for the device to power up.
Informational alerts		
`Device is getting ready after restart`	The device is getting ready after a restart. The device should be ready for operation soon.	Wait for the device to be ready.

12.2 Troubleshooting DA10 firmware update

The following messages can appear during the firmware update.

Table 27 Info messages during firmware update

Message	Probable cause	Actions
`Invalid firmware image file`	Incorrect file or file type.	Check that you have the correct firmware file for the device.
`Error in firmware installation stage`	Incorrect file or no connection to device.	Check that you have the correct firmware file for the device. Check that the device is still online. If the problem persists, see the information about contacting Vaisala Technical Support.
`Error in firmware activation stage`		

The following troubleshooting can be helpful after the firmware update.

Table 28 Troubleshooting DA10 after firmware update

Problem	Probable cause	Actions
No netCDF files coming to DA10 Client	API key is missing or web API is not enabled.	In the Web UI, select **Alerts**. • If the message `Web API is not running` appears, set the API key. • If the message `Communication lost with Web API client since <last connection>` appears, check that you have the same API key in DA10 Client and in the Web UI in **Settings > Station parameters**. For instructions, see DA10 Installation Guide (M212894EN). For the full list of possible alerts, see the instructions about viewing alerts.
	Data sending is not configured on the Web UI.	In the Web UI, go to **Settings > Station parameters**. Select **features** and check that **WEB-API** is enabled.
Alerts do not disappear	Firmware update did not succeed or settings are incorrect.	Select **Devices** and check that the firmware versions of the devices match the versions listed in the release notes.
		In the Web UI, select **Configuration > Debug console** and check the messages. To restart the configuration select **Configuration > Info** and **Restart script**. Select **Debug console** and follow the progress. 1. For information about the alerts, see the instructions about viewing alerts. 2. Install the firmware update again. 3. Contact Vaisala Technical Support.

If none of the other actions help, disconnect power from the device and connect it again.

Contacting Vaisala technical support

If the failure persists, contact Vaisala technical support and provide the following information:

- Detailed description of the steps you tried and what did not succeed.
- ZIP file of events: download the file from the Web UI (**System > Events**).

- ZIP file of diagnostics: download the file from the Web UI (**System > Diagnostics package**).

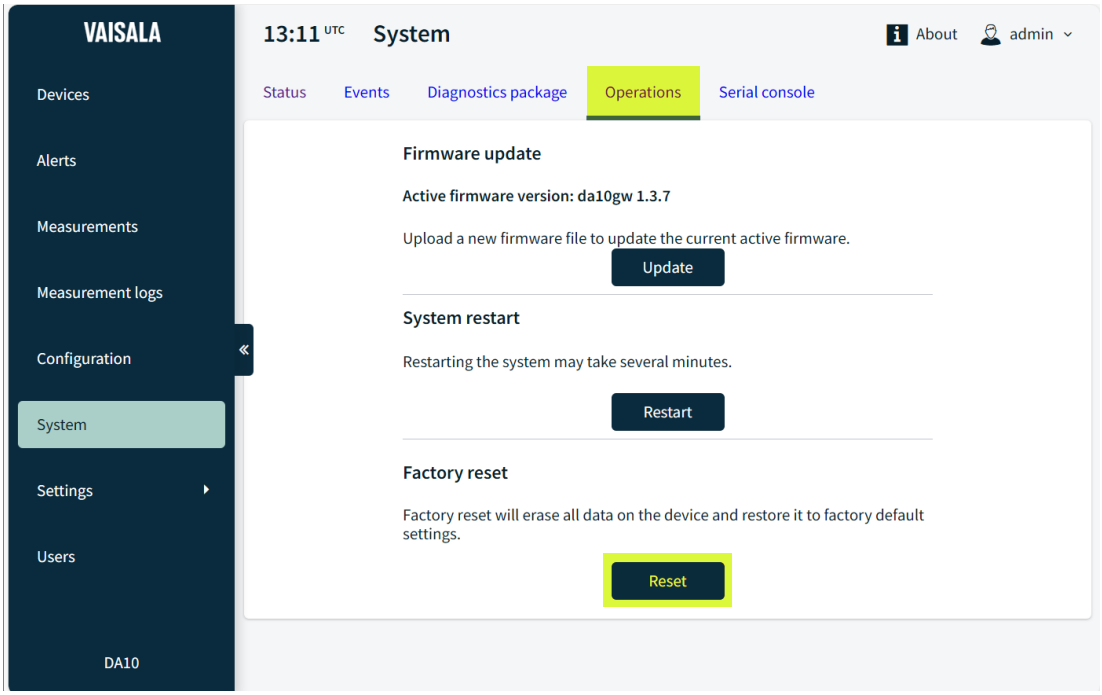
12.3 Factory resetting DA10

- Administrator username and password to Web UI
- Connection to device through Web UI; for the connection options, see DA10 User Guide (M212895EN).
- Object for pressing factory reset buttons
- Screwdriver to open instrument doors

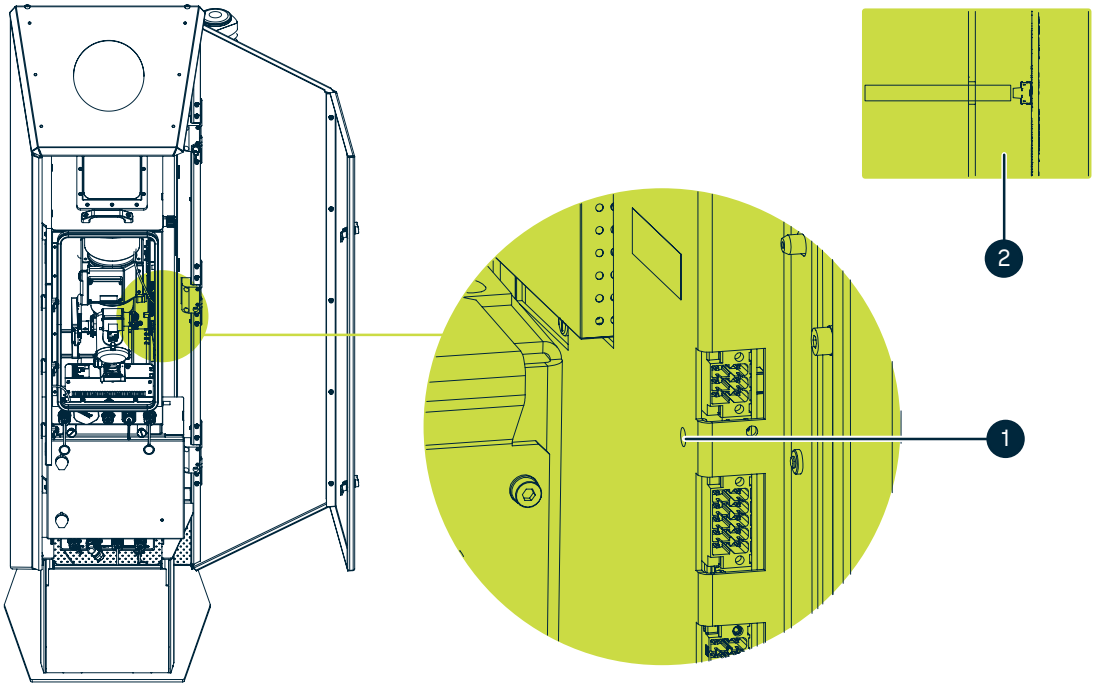
Factory reset is required in case you forget the administrator password, after a firmware update if instructed so in the release notes, or when instructed to do so by Vaisala.

DA10 reset includes resetting the 3 devices: DA10GW and the device control modules. This removes the defined password and remote Ethernet settings. Perform the reset next to the device.

1. In the Web UI, select **System > Operations > Reset**.

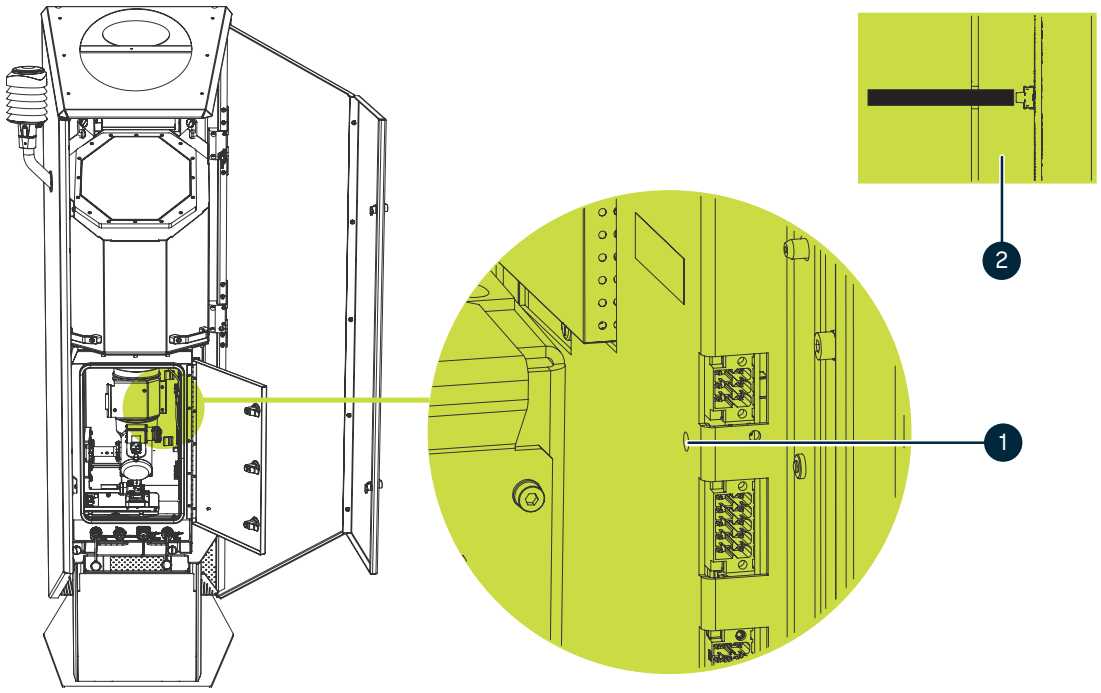


2. To factory reset the near-range measurement unit, press and hold down the reset button for 15 seconds.



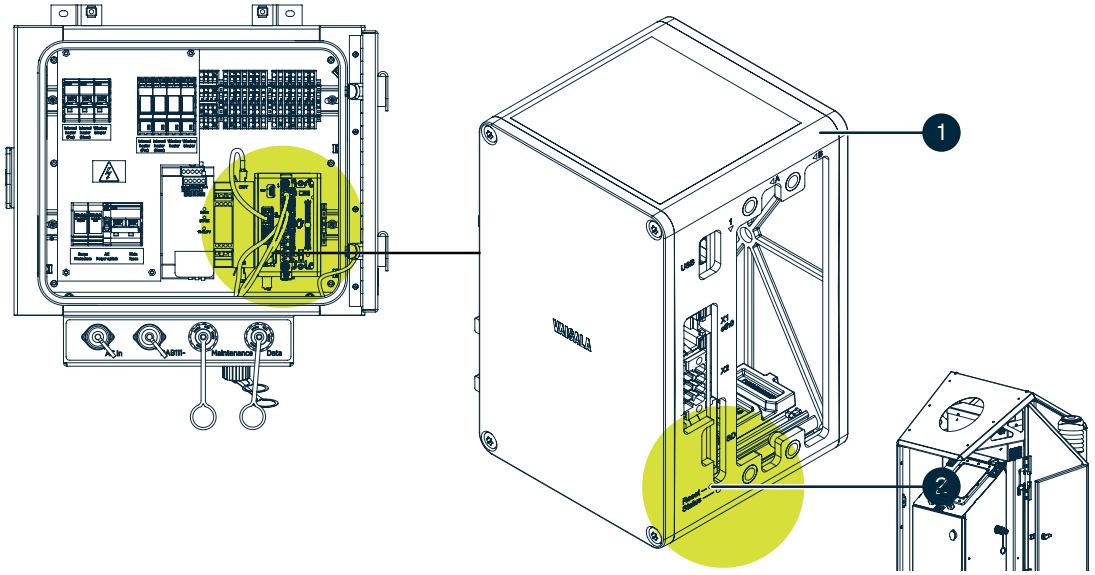
1 Reset button on device control module of near-range measurement unit
2 Pressing reset button with blunt instrument, side view

3. To factory reset the far-range measurement unit, press and hold down the reset button for 15 seconds.



1 Reset button on device control module of far-range measurement unit
2 Pressing reset button with blunt instrument, side view

4. To factory reset DA10GW, press and hold down the **Reset** button with a small pin for 15 seconds.



1 DA10GW
2 **Reset** button

5. Wait for 5 minutes for the system to boot up.
6. Activate DA10. For instructions, see DA10 Installation Guide (M212894EN).
7. Configure the network settings. See DA10 Installation Guide (M212894EN).
8. Set up data collection. See DA10 Installation Guide (M212894EN).

More information

- Factory resetting DA10 (page 75)

13. Technical data

13.1 DA10 specifications

Table 29 DA10 measurements

Property	Description/Value
Atmospheric profiles	Water vapor mixing ratio profile in g/kg Attenuated backscatter profile Uncertainty for water vapor mixing ratio Offline backscatter profiles Online backscatter profiles
Atmospheric parameters	Cloud base heights (up to 5 layers) Cloud penetration depth or cloud thickness Precipitation/fog detection Sky condition Surface PTU (pressure, temperature, and humidity measured by WXT534)

Table 30 DA10 measurement performance

Property	Description/Value
Measurement range accuracy against hard target	±5 m (16 ft 5 in)
Water vapor profiles	
Measurement range	57.6–4032 m (189–13 228 ft) [1)]
Reporting time resolution	1 min
Reporting height resolution	9.6 m (31 ft 6 in)
Averaging time	Configurable, from 10 to 60 minutes in steps of 5 minutes
Attenuated backscatter profiles	
Measurement range	0–18 000 m (0–59 000 ft)
Reporting time resolution	1 min
Reporting height resolution	4.8 m (15 ft 9 in)

1) 4032 m (13 228 ft) or up to cloud base or top of boundary layer.

Table 31 DA10 operating environment

Property	Description/Value
Operating environment	Outdoor use

Property	Description/Value
Use in wet location	Yes
Operating temperature	−50 … +55 °C (−58 … +131 °F) [1)]
Storage temperature	−50 … +60 °C (−58 … +140 °F)
Operating humidity	0–100 %RH
Maximum wind speed, without guy wires	30 m/s (67 mph)
Maximum wind speed, with guy wires	50 m/s (112 mph)
Pollution degree for inside electronics	2
Maximum operating altitude	3000 m (approx. 9800 ft)
IP rating (when inside radiation shield, excluding window blower)	IP66: Dust-tight. Protected from powerful water jets from any direction.

1) The power cable plug (EU and US version) is specified to a maximum of −40 °C (−40 °F).

Table 32 DA10 data communication

Property	Description/Value
Data interface	Ethernet (> 10 Mbit/s)
Maintenance interface	Ethernet
Message format	NetCDF
Status information	Internal monitoring data

Table 33 DA10 powering

Property	Description/Value
Nominal voltage	120 V AC, 8 A (960 W) 230 V AC, 4.2 A (960 W)
Operating voltage	90–130 / 200–250 V AC
AC (mains) fuse	• 10 A for 230 V supply • 15 A for 120 V supply
Overvoltage category	CAT II
Operating frequency	50–60 Hz
Power consumption	
With heating	Max. 960 W
Without heating	Max. 200 W

Table 34 DA10 receiver specifications

Property	Value
Detector	Silicon avalanche photodiode (APD)
Surface diameter	0.5 mm (0.02 in)
Receiver bandwidth	3 MHz (–3 dB)
Interference filter	Center wavelength 910.6 nm typical
50 % pass band	2.4 nm typical
Transmittance at pass band	85 % minimum
Field-of-view divergence	
At near-range telescope	±0.56 mrad
At far-range telescope	±0.10 mrad × ±0.30 mrad

Table 35 DA10 transmitter specifications

Property	Value
Radiated pattern emitted from protective housing, from DA10 window of near-range measurement unit telescope	
Maximum pulse energy	4.7 µJ
Laser wavelength	910.55 nm and 910.99 nm
Peak power	40 W
Maximum average power	44 mW
Maximum average power through 7-mm aperture	520 uW
Pulse duration	160 ns FWHM
Pulse repetition frequency	8.244 kHz
Beam divergence	±0.051 mrad × ±0.33 mrad
Radiated pattern emitted from protective housing, from DA10 window of far-range measurement unit telescope	
Maximum pulse energy	10.3 µJ
Laser wavelength	910.55 nm and 910.99 nm
Peak power	40 W
Maximum average power	97 mW
Maximum average power through 7-mm aperture	260 uW
Pulse duration	352 ns FWHM
Pulse repetition frequency	8.244 kHz
Beam divergence	±0.027 mrad × ±0.18 mrad

Table 36 DAT111N transmitter and DAT111F transmitter specifications

Property	Value
Incorporated laser (DAT111N transmitter of near-range measurement unit telescope)	
Laser wavelength	910.55 nm and 910.99 nm
Peak power	50 W
Maximum average power	61 mW
Pulse duration	160 ns FWHM
Pulse repetition frequency	8.244 kHz
Typical beam divergence	±7 degrees
Incorporated laser (DAT111F transmitter of far-range measurement unit telescope)	
Laser wavelength	910.55 nm and 910.99 nm
Peak power	50 W
Maximum average power	134 mW
Pulse duration	352 ns FWHM
Pulse repetition frequency	8.244 kHz
Typical beam divergence	±7 degrees

Table 37 DA10 mechanical specifications

Property	Description/Value
Dimensions (H × W × L)	1970 × 850 × 585 mm (77.56 × 33.46 × 22.03 in)
Weight, total	180 kg (400 lb)
Weight, radiation shield	90 kg (200 lb)
Weight, far-range measurement unit	60 kg (135 lb)
Weight, near-range measurement unit	25 kg (55 lb)
Material	Aluminum
Color	White (RAL9003)
Coating	Multi-layer coating to prevent environmental corrosion

Table 38 DA10 packaging

Property	Description/Value
Material	Plywood
Radiation shield package	
Dimensions (H × W × L)	868 × 1000 × 2150 mm (34.17 × 39.37 × 84.65 in)

Property	Description/Value
Weight	180 kg (400 lb)
Far-range measurement unit package	
Dimensions (H × W × L)	600 × 548 × 1400 mm (23.62 × 21.57 × 55.12 in)
Weight	80 kg (180 lb)
Near-range measurement unit package	
Dimensions (H × W × L)	465 × 498 × 1040 mm (18.31 × 19.61 × 40.94 in)
Weight	45 kg (100 lb)

Table 39 DA10 compliance

Property	Description/Value
EU directives and regulations	EMC Directive (2014/30/EU) Low Voltage Directive (2014/35/EU) RoHS Directive (2011/65/EU) as amended by 2015/863
EMC immunity	EN 61326-1, industrial environment
EMC emissions	CISPR 32 / EN 55032, Class B FCC part 15 B, Class B CAN ICES-3(B)/NMB-3(B)
Safety	IEC/EN/UL/CSA-C22.2 61010-1
Eye safety	Class 1M laser product, IEC 60825-1:2014 (Edition 3.0) and EN 60825-1:2014 + A11:2021 Complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019
Compliance marks	CE, China RoHS, FCC, ICES, RCM, UKCA

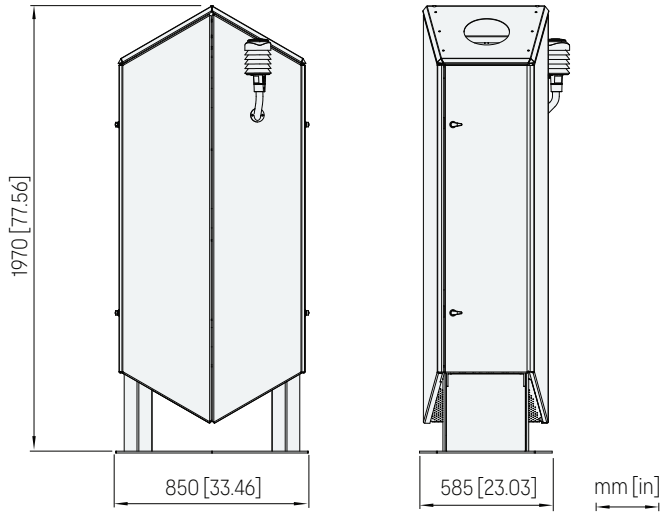


Figure 18 DA10 dimensions

13.2 DA10GW specifications

Table 40 DA10GW operating environment

Property	Description/Value
Operating temperature [1)]	−40 … +85 °C (−40 … +185 °F)
Extended operating temperature (available on request)	−60 … +85 °C (−76 … +185 °F)
Storage temperature	−60 … +85 °C (−76 … +185 °F)
Operating humidity	0–100 %RH, non-condensing

1) Operating temperature of some of the DA10GW plug-in modules may be different. See the plug-in module datasheets.

Table 41 DA10GW powering specifications

Property	Description/Value
Operating voltage	8–32 V DC (maximum 10 A)
Power consumption, typical	500 mW
Heating voltage	24 V DC nominal
Maximum input current for heating	12 A
Mating connectors (power/heating input)	2 × Phoenix Contact FKCN 2,5/2-ST-5,08 (included)

Table 42 DA10GW processing system

Property	Description/Value
Processor	ARM Cortex A9, 800 MHz

AKRIBIS · www.akribis.info · contacto@akribis.info

Property	Description/Value
Memory	1 GB DDR3L RAM, 8 GB eMMC Flash
External memory	SD card up to 32 GB [1)]
Operating system	Linux
Communications protocol	IPv4 and IPv6
Real-time clock (standard)	
Accuracy	Better than 20 s/month
Backup battery	CR1225/BR1225
Backup time	Minimum 5 years

1) SD card available as an accessory.

Table 43 DA10GW compliance

Property	Description/Value	
EU directives and regulations	EMC Directive (2014/30/EU) RoHS Directive (2011/65/EU) as amended by 2015/863	
EMC immunity	EN 61326-1, industrial environment	
EMC emissions	CISPR 32 / EN 55032, Class B FCC part 15 B, Class B CAN ICES-3(B)/NMB-3(B)	
Cybersecurity	Developed in accordance with ISO/IEC 27001 and IEC 62443-4-1 for secure product development practices	
Compliance marks	CE, China RoHS, FCC, ICES, RCM, UKCA	
Test	**Applied standard**	**Description/Value**
Maritime	IEC 60945	–
Vibration (sinusoidal)	IEC 60068-2-6	5–13.2 Hz, 1 mm (0.04 in) amplitude 13.2–200 Hz, 0.7 g
Rough handling	IEC 60068-2-31	Drop height 100 cm (39.37 in)
Shock	IEC 60068-2-27	15 g, 11 ms, saw-tooth
Dry heat	IEC 60068-2-2	+85 °C (+185 °F)
Damp heat	IEC 60068-2-78	+40 °C (+104 °F), 95 %RH
Cold	IEC 60068-2-1	−60 °C (−76 °F)

Table 44 DA10GW inputs and outputs

Property	Description/Value
Ethernet	

Property	Description/Value
Ports	**eth0** on CPU, additional ports with plug-in modules
Supported standard	IEEE 802.3u
Physical layer	Base-T
Data rate	10/100 Mbps
Connectors	RJ45 with link LEDs
Data transmission	Full/Half-duplex with auto-negotiation
USB	
Ports	1
Supported standard	USB 2.0
Signaling	High speed
Connectors	USB-C
Serial	
Ports	• 1 × RS-232 / RS-485 / SDI-12 port • 2 × RS-485 ports • Additional ports with plug-in modules
Supported bit rate	1200–115 200 bps
Power output	5 × software controllable power output pins
Signals	• RS-232: RXD, TXD • RS-485: D+/D−
Digital I/O	4 × 3.3 V logic level GPIO pins, pulse count capable
Mating connectors	• 2 × Phoenix Contact DFMC 1,5/4-ST-3,5-LR (included) • 1 × M8 4-pin male
Note: 4-wire RS-485/RS-422 is supported by using 2 × 2-wire RS-485.	
TCP/IP	
Supported protocols	DHCP, DNS, NTP, ARP, ICMP Echo, TCP/IP, SSH, UDP, DTLS, HTTPS [1)]

1) The list is subject to change.

Table 45 DA10GW mechanical specifications

Property	Description/Value
Weight	2-slot unit: 0.35 kg (0.77 lb)
Mounting	DIN rail 35 mm (1.4 in)
Dimensions (H × W × D)	
2 slots	120 × 77 × 84 mm (4.72 × 3.03 × 3.31 in)

Property	Description/Value
Materials	
Screws, washers	Stainless steel AISI 316
DIN rail locking piece	Stainless steel AISI 630
Frame profile	Aluminum EN AW-6060 T6
End covers	Plastic PC/ABS

13.3 AC (mains) power supply specifications

Table 46 AC (mains) power supply specifications

Property	Description/Value
Output power	240 W
Input voltage	100–240 V AC, ±10 %
Frequency	50/60 Hz, ±10 %
Nominal output voltage	24 V DC, ±1 %
Efficiency	> 92.5 % (for 230 V AC and nominal values)
Mean time between failures	> 530 000 h at below +40 °C (+104 °F) (according to IEC 61709)

13.4 WXT534 specifications

Table 47 WXT530 barometric pressure measurement performance

Property	Description/Value
Observation range	500–1100 hPa
Accuracy (for sensor element) at 600–1100 hPa	±0.5 hPa at 0 ... +30 °C (+32 ... +86 °F) ±1 hPa at −52 ... +60 °C (−60 ... +140 °F)
Output resolution	0.1 hPa / 10 Pa / 0.001 bar / 0.1 mmHg / 0.01 inHg
Units available	hPa, Pa, bar, mmHg, inHg

Table 48 WXT530 air temperature measurement performance

Property	Description/Value
Observation range	−52 ... +60 °C (−60 ... +140 °F)
Accuracy (for sensor element) at +20 °C (+68 °F) [1)]	±0.3 °C (±0.54 °F)

Property	Description/Value
Output resolution	0.1 °C (0.1 °F)
Units available	°C, °F

1) *A naturally aspirated radiation shield is applied which can affect readings in calm wind.*

Table 49 WXT530 relative humidity measurement performance

Property	Description/Value
Observation range	0–100 %RH
Accuracy (for sensor element) [1)]	±3 %RH at 0–90 %RH ±5 %RH at 90–100 %RH
Output resolution	0.1 %RH
PTU measuring interval	1–3600 s (= 60 min), at 1 s steps

1) *A naturally aspirated radiation shield is applied which can affect readings in calm wind.*

Table 50 WXT530 inputs and outputs

Property	Description/Value
Operating voltage	6–24 V DC (–10 … +30 %)
Average power consumption	Minimum: 0.1 mA at 12 V DC (SDI-12 standby) Typical: 3.5 mA at 12 V DC (typical measuring intervals) [1)] Maximum: 15 mA at 6 V DC (constant measurement of all parameters)
Heating voltage	DC, AC, or full-wave rectified AC 12–24 V DC (–10 … +30 %) 12–17 V AC_{rms} (–10 … +30 %)
Typical heating current	12 V DC: 800 mA, 24 V DC: 400 mA 12 V AC_{rms}: 1.1 A 17 V AC_{rms}: 800 mA
Digital outputs	SDI-12, RS-232, RS-485, RS-422
Communication protocols	SDI-12 v1.3, Modbus RTU, ASCII automatic and polled, NMEA 0183 v3.0 with query option
Self-diagnostic	Separate supervisor message, unit/status fields to validate measurement stability
Startup	Automatic, < 5 seconds from power on to the first valid output

1) *Wind 10-second average with 2-minute interval at 4 Hz sampling rate, RS-232 19200 bps with jumper wires, PTU 10-second interval, Pt1000, level, tipping bucket, and solar radiation 5-second interval.*

Table 51 WXT530 operating environment

Property	Description/Value
Operating environment	Outdoor use
Operating temperature	–52 ... +60 °C (–60 ... +140 °F)
Storage temperature	–60 ... +70 °C (–76 ... +158 °F)
Operating humidity	0–100 %RH
Operating pressure	500–1100 hPa
Wind [1)]	0–60 m/s (0–134 mph)
IP rating	Without mounting kit: IP65: Dust-tight. Protected from water jets from any direction. With mounting kit: IP66: Dust-tight. Protected from powerful water jets from any direction.

1) *Due to the measurement frequency used in the sonic transducers, RF interference in the 200–400 kHz range can disturb wind measurement.*

Table 52 WXT530 compliance

Property	Description/Value
EU directives and regulations	EMC Directive (2014/30/EU) RoHS Directive (2011/65/EU) as amended by 2015/863
Electromagnetic compatibility (EMC)	EN 61326-1, industrial environment CISPR 32 / EN 55032, Class B
Environmental	IEC 60068-2-1, 2, 6, 14, 30, 31, 78 IEC 60529, VDA 621-415
Maritime	IEC 60945 (Exposed) DNV GL Type Examination Certificate No. TAA00000VF
Compliance marks	CE, RCM, RoHS, China RoHS, UKCA

Table 53 WXT530 mechanical specifications

Property	Description/Value
Weight	
	0.7 kg (1.54 lb)
Materials	
Radiation shield, top, and bottom parts	Polycarbonate +20 % fiberglass
Precipitation sensor plate	Stainless steel (AISI 316)

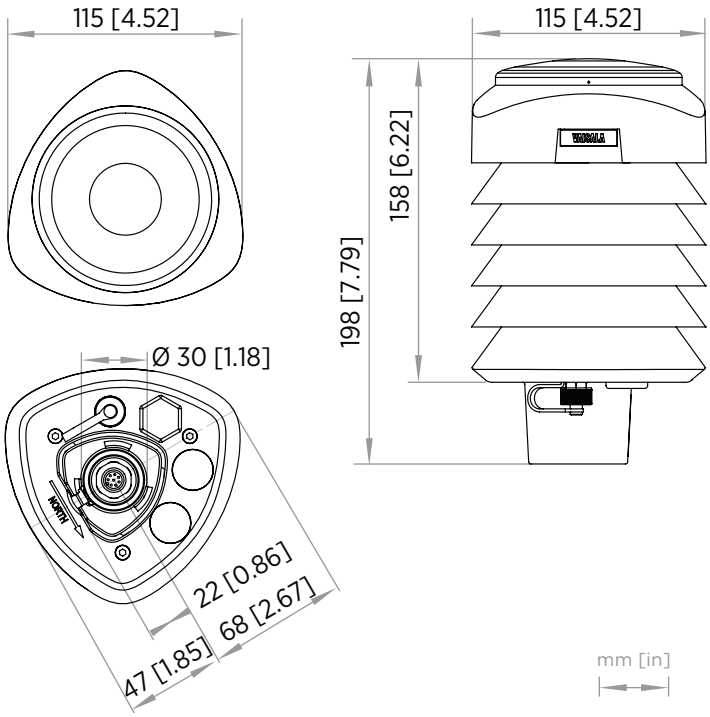


Figure 19 WXT535 and WXT534 dimensions

Appendix A. NetCDF example file, water vapor mixing ratio

Here is an example of a netCDF water vapor mixing ratio file that DA10 produces.

```
netcdf DA10_WV_M12334567_20260430T074450Z.nc {
  dimensions:
    layer = 5;
    module = 2;
    range = 495;
    time = 20;
  variables:
    int airplane_filter_max_range;
      :long_name = "Airplane filter max range";
      :comment = "maximum range where airplane echoes are filtered to prevent
false cloud detection";
      :_FillValue = -999; // int
      :units = "m";

    float azimuth_angle;
      :_FillValue = -999.0f; // float
      :units = "degrees";
      :long_name = "Measurement azimuth angle";
      :standard_name = "sensor_azimuth_angle";
      :comment = "azimuth direction of tilted beam for each optics unit,
clockwise positive from north";

    int cloud_base_heights(time=20, layer=5);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Cloud base heights";
      :coordinates = "time layer longitude latitude";
      :comment = "reported in vertical, or in the instrument beam direction,
depending on tilt_correction setting";

    int cloud_penetration_depth(time=20, layer=5);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Cloud penetration depth";
      :coordinates = "time layer longitude latitude";
      :comment = "reported in the instrument beam direction";

    int cloud_thickness(time=20, layer=5);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Cloud thickness";
      :coordinates = "time layer longitude latitude";
      :comment = "reported in the instrument beam direction";

    int elevation;
      :_FillValue = -999; // int
      :units = "m";
      :long_name = "Ground level altitude";
```

```
      :standard_name = "ground_level_altitude";
      :comment = "measurement site height above or below a fixed reference
point, most commonly mean sea level";

    short fog_detection(time=20);
      :_FillValue = -999S; // short
      :long_name = "Detection of fog";
      :coordinates = "time longitude latitude";
      :comment = "detected/not-detected (1/0)";

    short height_offset;
      :_FillValue = -999S; // short
      :units = "m";
      :long_name = "Instrument height offset to ground level";
      :positive = "up";
      :comment = "instrument height offset relative to ground level, for
example, when the instrument is placed on a roof of a building or below the
ground level; the offset is added to the cloud base height results";

    float latitude;
      :_FillValue = -999.0f; // float
      :units = "degrees_north";
      :long_name = "Latitude";
      :standard_name = "latitude";

    int layer(layer=5);
      :_FillValue = -999; // int
      :units = "layer";
      :long_name = "Cloud layer";
      :comment = "1 ... 5: observed cloud layer or cloud base";

    float longitude;
      :_FillValue = -999.0f; // float
      :units = "degrees_east";
      :long_name = "Longitude";
      :standard_name = "longitude";

    float merging_region(time=20, module=2);
      :_FillValue = -999.0f; // float
      :units = "m";
      :long_name = "Merging region from near range to far range";
      :comment = "region where transition from near-range measurement to far-
range measurement occurs";

    int module(module=2);
      :_FillValue = -999; // int
      :long_name = "Measurement unit";
      :comment = "1: near-range measurement unit, 2: far-range measurement
unit";

    float offline_backscatter(time=20, module=2, range=495);
      :_FillValue = -999.0f; // float
      :units = "1";
      :long_name = "Offline wavelength backscatter";
      :coordinates = "time range longitude latitude";
```

```
      :comment = "offline wavelength backscatter is expressed in arbitrary
units, no overlap correction, range normalization or amplitude calibration";
      :averaging_time_in_seconds = 60; // int

    float offline_backscatter_noise_level(time=20, module=2);
      :_FillValue = -999.0f; // float
      :units = "1";
      :long_name = "Noise level of the offline backscatter";
      :comment = "a unitless number describing the noise level";

    float online_backscatter(time=20, module=2, range=495);
      :_FillValue = -999.0f; // float
      :units = "1";
      :long_name = "Online wavelength backscatter";
      :coordinates = "time range longitude latitude";
      :comment = "online wavelength backscatter is expressed in arbitrary
units, no overlap correction, range normalization or amplitude calibration";
      :averaging_time_in_seconds = 60; // int

    float online_backscatter_noise_level(time=20, module=2);
      :long_name = "Noise level of the online backscatter";
      :comment = "a unitless number describing the noise level";
      :_FillValue = -999.0f; // float
      :units = "1";

    short precipitation_detection(time=20);
      :_FillValue = -999S; // short
      :long_name = "Detection of ground reaching precipitation";
      :coordinates = "time longitude latitude";
      :comment = "detected/not-detected (1/0)";

    float range(range=495);
      :_FillValue = -999.0f; // float
      :units = "m";
      :long_name = "Measurement range";
      :axis = "Z";
      :positive = "up";
      :comment = "measurement distance from the instrument in the direction of
the transmitted laser beam";

    float range_resolution;
      :_FillValue = -999.0f; // float
      :units = "m";
      :long_name = "Range resolution";
      :comment = "distance between consecutive profile elements in the
direction of the transmitted laser beam";

    float receiver_gain(time=20, module=2);
      :_FillValue = -999.0f; // float
      :long_name = "Receiver gain";
      :comment = "Value 1 corresponds to normal gain";

    short sky_condition_cloud_layer_covers(time=20, layer=5);
      :_FillValue = -99S; // short
      :units = "oktas";
```

```
      :long_name = "Cloud cover per cloud layer";
      :coordinates = "time layer longitude latitude";
      :comment = "amount of cloud cover for different cloud layers for up to 5
layers";
      :averaging_time_in_seconds = 1800; // int

    int sky_condition_cloud_layer_heights(time=20, layer=5);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Cloud layer heights";
      :coordinates = "time layer longitude latitude";
      :comment = "heights for different cloud layers for up to 5 layers,
reported in vertical, or in the instrument beam direction, depending on
tilt_correction setting";
      :averaging_time_in_seconds = 1800; // int

    short sky_condition_total_cloud_cover(time=20);
      :_FillValue = -99S; // short
      :units = "oktas";
      :long_name = "Total cloud cover";
      :coordinates = "time longitude latitude";
      :comment = "total amount of cloud cover aggregated across cloud layers";
      :averaging_time_in_seconds = 1800; // int

    float surface_pressure(time=20);
      :_FillValue = -999.0f; // float
      :units = "hPa";
      :long_name = "Surface pressure";
      :coordinates = "time longitude latitude";
      :comment = "measurement from weather transmitter";

    float surface_temperature(time=20);
      :_FillValue = -999.0f; // float
      :units = "Celsius";
      :long_name = "Surface temperature";
      :coordinates = "time longitude latitude";
      :comment = "measurement from weather transmitter";

    float surface_water_vapor(time=20);
      :_FillValue = -999.0f; // float
      :units = "g/kg";
      :long_name = "Surface water vapor mixing ratio";
      :coordinates = "time longitude latitude";
      :comment = "measurement from weather transmitter";

    float tilt_angle(time=20, module=2);
      :_FillValue = -999.0f; // float
      :units = "degrees";
      :long_name = "Optics unit tilt angle from the vertical";
      :standard_name = "zenith_angle";

    short tilt_correction(time=20);
      :_FillValue = -999S; // short
      :long_name = "Tilt correction";
      :comment = "on/off (1/0): when correction is on, cloud bases are
```

```
reported in vertical direction; when correction is off, in beam direction";

    double time(time=20);
      :_FillValue = -999.0; // double
      :units = "seconds since 1970-01-01 00:00:00.000";
      :long_name = "UTC time";
      :axis = "T";
      :standard_name = "time";
      :cf_role = "profile_id";
      :comment = "represents the end of the averaging period";

    int vertical_visibility(time=20);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Vertical visibility";
      :coordinates = "time longitude latitude";
      :comment = "reported in the instrument beam direction";

    float water_vapor(time=20, range=495);
      :_FillValue = -999.0f; // float
      :units = "g/kg";
      :long_name = "Water vapor mixing ratio";
      :coordinates = "time range longitude latitude";
      :averaging_time_in_seconds = 900; // int

    float water_vapor_max_range(time=20);
      :_FillValue = -999.0f; // float
      :units = "m";
      :long_name = "Maximum valid water vapor measurement range";
      :coordinates = "time longitude latitude";
      :comment = "maximum valid water vapor measurement range based on quality
control";

    float water_vapor_uncertainty(time=20, range=495);
      :_FillValue = -999.0f; // float
      :units = "g/kg";
      :long_name = "Measurement uncertainty of water vapor mixing ratio";
      :coordinates = "time range longitude latitude";
      :comment = "uncertainty estimate is valid in the same measurement range
where water vapor measurement is valid";

    int water_vapor_valid(time=20, range=495);
      :_FillValue = -999; // int
      :long_name = "Validity of water vapor mixing ratio";
      :coordinates = "time range longitude latitude";
      :comment = "valid/invalid (1/0) flag for each measurement range based on
quality control";

  group: monitoring {
    variables:
      double time(time=20);
        :_FillValue = -999.0; // double
        :units = "seconds since 1970-01-01 00:00:00.000";
        :long_name = "UTC time";
        :axis = "T";
```

```
        :standard_name = "time";

      float internal_humidity(time=20, module=2);
        :_FillValue = -999.0f; // float
        :units = "percent";
        :long_name = "internal humidity";
        :comment = "percent relative humidity";

      float internal_temperature(time=20, module=2);
        :_FillValue = -999.0f; // float
        :units = "Celsius";
        :long_name = "internal temperature";

      float laser_power_percent(time=20, module=2);
        :_FillValue = -999.0f; // float
        :units = "percent";
        :long_name = "Laser power percent";
        :comment = "laser output power relative to the laser power measured at
factory";

      float window_condition(time=20);
        :_FillValue = -999.0f; // float
        :units = "percent";
        :long_name = "Window condition (near range unit)";
        :comment = "100 for a clean, 0 for a totally dirty window";

      float background_radiance(time=20, module=2);
        :_FillValue = -999.0f; // float
        :long_name = "Background radiance";
        :range = "0 ... 1747";
        :comment = "sky background radiance in arbitrary units at the receiver
field-of-view; values are low at night and high in the presence of sun-
illuminated clouds";

  }

  // global attributes:
  :institution = "";
  :dac_near_serial_number = "V4142511";
  :schema_version = "v2.0";
  :history = "";
```

```
    :comment = "";
    :unit = "m";
    :dac_near_firmware_version = "2.4.1+default.20260412.b1783";
    :dac_far_firmware_version = "2.4.1+default.20260412.b1783";
    :source = "DA10 gateway";
    :gateway_serial_number = "U2910121";
    :dac_far_serial_number = "V4142519";
    :Conventions = "CF-1.8";
    :algorithm_version = "3.1.69";
    :title = "Vaisala DIAL Atmospheric Profiler DA10";
    :instrument_serial_number = "M12334567";
    :gateway_firmware_version = "1.3.7+default.20260412.b1163";
    :file_temporal_span_in_minutes = 20; // int
    :profile_interval_in_seconds = 60; // int
  }
```

More information

- Variables and dimensions in water vapor mixing ratio files (page 41)

Appendix B. NetCDF example file, attenuated backscatter

Here is an example of a netCDF attenuated backscatter file that DA10 produces.

```
netcdf DA10_ABS_M12334567_20260430T074536Z.nc {
  dimensions:
    layer = 5;
    module = 2;
    range = 3751;
    time = 5;
  variables:
    int airplane_filter_max_range;
      :long_name = "Airplane filter max range";
      :comment = "maximum range where airplane echoes are filtered to prevent
false cloud detection";
      :_FillValue = -999; // int
      :units = "m";

    float azimuth_angle;
      :_FillValue = -999.0f; // float
      :units = "degrees";
      :long_name = "Measurement azimuth angle";
      :standard_name = "sensor_azimuth_angle";
      :comment = "azimuth direction of tilted beam for each optics unit,
clockwise positive from north";

    float beta_att(time=5, range=3751);
      :_FillValue = -999.0f; // float
      :units = "1/(m*sr)";
      :long_name = "Attenuated volume backscatter coefficient";
      :coordinates = "time range longitude latitude";
      :averaging_time_in_seconds = 60; // int

    float beta_att_noise_level(time=5, module=2);
      :_FillValue = -999.0f; // float
      :long_name = "Noise level of the attenuated volume backscatter
coefficient";
      :comment = "a unitless number describing the noise level";

    float beta_att_sum(time=5);
      :_FillValue = -999.0f; // float
      :units = "1/(10^4*sr)";
      :long_name = "Scaled integral of the attenuated volume backscatter
coefficient";

    int cloud_base_heights(time=5, layer=5);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Cloud base heights";
      :coordinates = "time layer longitude latitude";
      :comment = "reported in vertical, or in the instrument beam direction,
depending on tilt_correction setting";
```

```
    float cloud_calibration_factor_far;
      :_FillValue = -999.0f; // float
      :long_name = "Far-range unit factory cloud calibration value";
      :comment = "instrument specific beta_att calibration value measured at
the factory";

    float cloud_calibration_factor_near;
      :_FillValue = -999.0f; // float
      :long_name = "Near-range unit factory cloud calibration value";
      :comment = "instrument specific beta_att calibration value measured at
the factory";

    float cloud_calibration_factor_user_far;
      :_FillValue = -999.0f; // float
      :long_name = "Far-range unit user set cloud calibration value";
      :comment = "instrument specific beta_att calibration value set by the
user, same as the factory value by default";

    float cloud_calibration_factor_user_near;
      :_FillValue = -999.0f; // float
      :long_name = "Near-range unit user set cloud calibration value";
      :comment = "instrument specific beta_att calibration value set by the
user, same as the factory value by default";

    int cloud_penetration_depth(time=5, layer=5);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Cloud penetration depth";
      :coordinates = "time layer longitude latitude";
      :comment = "reported in the instrument beam direction";

    int cloud_thickness(time=5, layer=5);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Cloud thickness";
      :coordinates = "time layer longitude latitude";
      :comment = "reported in the instrument beam direction";

    int elevation;
      :_FillValue = -999; // int
      :units = "m";
      :long_name = "Ground level altitude";
      :standard_name = "ground_level_altitude";
      :comment = "measurement site height above or below a fixed reference
point, most commonly mean sea level";

    short fog_detection(time=5);
      :_FillValue = -999S; // short
      :long_name = "Detection of fog";
      :comment = "detected/not-detected (1/0)";
      :coordinates = "time longitude latitude";

    short height_offset;
      :comment = "instrument height offset relative to ground level, for
```

```
example, when the instrument is placed on a roof of a building or below the
ground level; the offset is added to the cloud base height results";
      :_FillValue = -999S; // short
      :units = "m";
      :long_name = "Instrument height offset to ground level";
      :positive = "up";

    float latitude;
      :_FillValue = -999.0f; // float
      :units = "degrees_north";
      :long_name = "Latitude";
      :standard_name = "latitude";

    int layer(layer=5);
      :_FillValue = -999; // int
      :units = "layer";
      :long_name = "Cloud layer";
      :comment = "1 ... 5: observed cloud layer or cloud base";

    float longitude;
      :_FillValue = -999.0f; // float
      :units = "degrees_east";
      :long_name = "Longitude";
      :standard_name = "longitude";

    float merging_region(time=5, module=2);
      :_FillValue = -999.0f; // float
      :long_name = "Merging region from near range to far range";
      :comment = "region where transition from near-range measurement to far-
range measurement occurs";
      :units = "m";

    int module(module=2);
      :_FillValue = -999; // int
      :long_name = "Measurement unit";
      :comment = "1: near-range measurement unit, 2: far-range measurement
unit";

    float overlap_function_far(range=3751);
      :_FillValue = -999.0f; // float
      :long_name = "Far-range unit instrument specific overlap function";
      :comment = "overlap function describes the part of the transmitted power
that hits the receiver detector, as a function of distance, normalized to be
unity at the distance of the best focus";

    float overlap_function_near(range=3751);
      :_FillValue = -999.0f; // float
      :long_name = "Near-range unit instrument specific overlap function";
      :comment = "overlap function describes the part of the transmitted power
that hits the receiver detector, as a function of distance, normalized to be
unity at the distance of the best focus";

    short precipitation_detection(time=5);
      :_FillValue = -999S; // short
      :long_name = "Detection of ground reaching precipitation";
```

```
      :comment = "detected/not-detected (1/0)";
      :coordinates = "time longitude latitude";

    float range(range=3751);
      :_FillValue = -999.0f; // float
      :units = "m";
      :long_name = "Measurement range";
      :axis = "Z";
      :positive = "up";
      :comment = "measurement distance from the instrument in the direction of
the transmitted laser beam";

    float range_resolution;
      :_FillValue = -999.0f; // float
      :units = "m";
      :long_name = "Range resolution";
      :comment = "distance between consecutive profile elements in the
direction of the transmitted laser beam";

    float receiver_gain(time=5, module=2);
      :_FillValue = -999.0f; // float
      :long_name = "Receiver gain";
      :comment = "Value 1 corresponds to normal gain";

    short sky_condition_cloud_layer_covers(time=5, layer=5);
      :_FillValue = -99S; // short
      :units = "oktas";
      :long_name = "Cloud cover per cloud layer";
      :coordinates = "time layer longitude latitude";
      :comment = "amount of cloud cover for different cloud layers for up to 5
layers";
      :averaging_time_in_seconds = 1800; // int

    int sky_condition_cloud_layer_heights(time=5, layer=5);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Cloud layer heights";
      :coordinates = "time layer longitude latitude";
      :comment = "heights for different cloud layers for up to 5 layers,
reported in vertical, or in the instrument beam direction, depending on
tilt_correction setting";
      :averaging_time_in_seconds = 1800; // int

    short sky_condition_total_cloud_cover(time=5);
      :_FillValue = -99S; // short
      :units = "oktas";
      :long_name = "Total cloud cover";
      :comment = "total amount of cloud cover aggregated across cloud layers";
      :coordinates = "time longitude latitude";
      :averaging_time_in_seconds = 1800; // int

    float tilt_angle(time=5, module=2);
      :_FillValue = -999.0f; // float
      :units = "degrees";
      :long_name = "Optics unit tilt angle from the vertical";
```

```
      :standard_name = "zenith_angle";

    short tilt_correction(time=5);
      :_FillValue = -999S; // short
      :long_name = "Tilt correction";
      :comment = "on/off (1/0): when correction is on, cloud bases are
reported in vertical direction; when correction is off, in beam direction.";

    double time(time=5);
      :_FillValue = -999.0; // double
      :units = "seconds since 1970-01-01 00:00:00.000";
      :long_name = "UTC time";
      :axis = "T";
      :standard_name = "time";
      :cf_role = "profile_id";
      :comment = "represents the end of the averaging period";

    int vertical_visibility(time=5);
      :_FillValue = -99; // int
      :units = "m";
      :long_name = "Vertical visibility";
      :coordinates = "time longitude latitude";
      :comment = "reported in the instrument beam direction";

  group: monitoring {
    variables:
      double time(time=5);
        :_FillValue = -999.0; // double
        :units = "seconds since 1970-01-01 00:00:00.000";
        :long_name = "UTC time";
        :axis = "T";
        :standard_name = "time";

      float internal_humidity(time=5, module=2);
        :_FillValue = -999.0f; // float
        :units = "percent";
        :long_name = "internal humidity";
        :comment = "percent relative humidity";

      float internal_temperature(time=5, module=2);
        :_FillValue = -999.0f; // float
        :units = "Celsius";
        :long_name = "internal temperature";

      float laser_power_percent(time=5, module=2);
        :_FillValue = -999.0f; // float
        :units = "percent";
        :long_name = "Laser power percent";
        :comment = "laser output power relative to the laser power measured at
factory";

      float window_condition(time=5);
        :_FillValue = -999.0f; // float
        :units = "percent";
        :long_name = "Window condition (near range unit)";
```

```
        :comment = "100 for a clean, 0 for a totally dirty window";

      float background_radiance(time=5, module=2);
        :_FillValue = -999.0f; // float
        :long_name = "Background radiance";
        :range = "0 ... 1747";
        :comment = "sky background radiance in arbitrary units at the receiver
field-of-view; values are low at night and high in the presence of sun-
illuminated clouds";

  }

  // global attributes:
  :institution = "";
  :history = "";
  :comment = "";
  :unit = "m";
  :source = "DA10 gateway";
  :gateway_serial_number = "U2910121";
  :dac_near_serial_number = "V4142511";
  :dac_far_serial_number = "V4142519";
  :Conventions = "CF-1.8";
  :schema_version = "v2.0";
  :algorithm_version = "3.1.69";
  :dac_near_firmware_version = "2.4.1+default.20260412.b1783";
  :title = "Vaisala DIAL Atmospheric Profiler DA10";
  :file_temporal_span_in_minutes = 5; // int
  :instrument_serial_number = "M12334567";
  :profile_interval_in_seconds = 60; // int
  :gateway_firmware_version = "1.3.7+default.20260412.b1163";
  :dac_far_firmware_version = "2.4.1+default.20260412.b1783";
  :overlap_function_provided = 1; // int
  :overlap_is_corrected = 1; // int
}
```

More information

- Variables and dimensions in attenuated backscatter files (page 50)
- Variables and dimensions in attenuated backscatter files (page 50)

Appendix C. Maintenance checklist

Fill in the checklist and save it to record completed tasks.
Make copies of the list as needed.

Table 54 DA10 maintenance checklist

Maintenance details	
Customer name:	
Site name:	
Instrument serial number:	
Maintenance person:	
Date (day/month/year):	

#	Task	Reference	OK / Not OK	Remarks
Maintenance preparations				
1	Check the software version.			
2	Check warnings and alarms.			
As needed				
3	Clean the window.	Cleaning window (page 82)		
4	Check the door gaskets.	Checking door gasket (page 83)		
Annual maintenance				
5	Clean the painted surfaces.	Cleaning and maintaining painted surfaces (page 83)		
6	Perform a general check.	-		
Every 2 years				
	Replace the PTU module in WXT534.	Replacing PTU module (page 83)		
Every 15 years				
	Replace the battery in DA10GW.	Replacing DA10GW battery (page 85)		
Notes for next maintenance check				

Appendix D. Recycling instructions

These recycling instructions guide you on the end-of-life treatment of this Vaisala product. As waste regulations and infrastructure vary in each country, these instructions only indicate the different components to be separated and common ways to handle them. Always follow local requirements when disposing of the product. Vaisala encourages to use the best available recycling practices to minimize related environmental impacts.



Vaisala is committed to meeting the requirements of the EU Waste Electrical and Electronic Equipment (WEEE) Directive. This directive aims to minimize the impact of electrical and electronic goods on the environment, by increasing reuse and recycling, and reducing the amount of WEEE going to landfill. This symbol indicates that the product should be collected separately from other waste streams and treated appropriately.

AKRIBIS · www.akribis.info · contacto@akribis.info

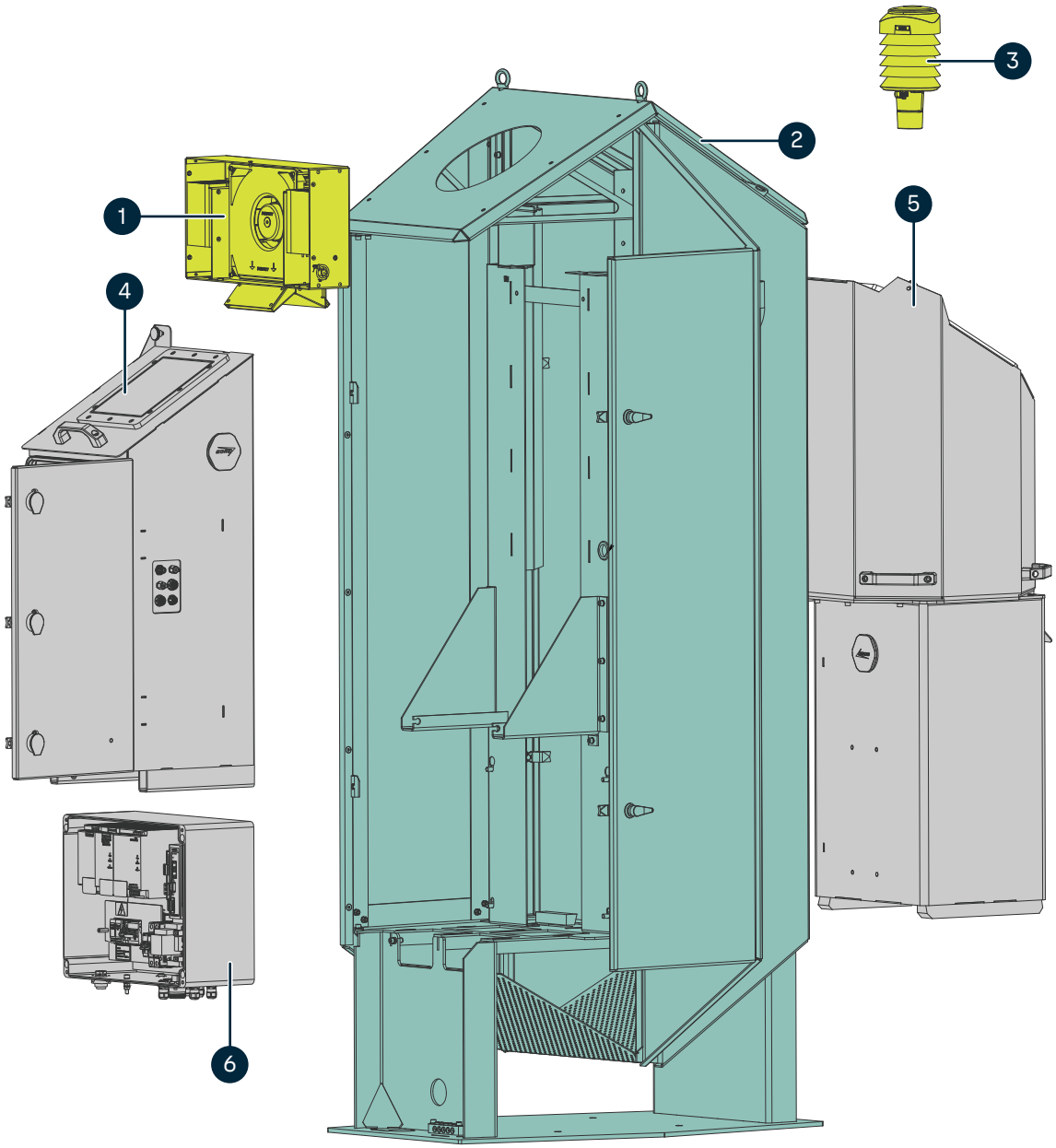


Figure 20 DA10 recycling

Recycling	Part	Material
Electrical and electronic waste	1, 3	Various
Metal waste	2	Aluminum
See Figure 21 (page 135)	4, 5	Various
See Figure 22 (page 136)	6	Various

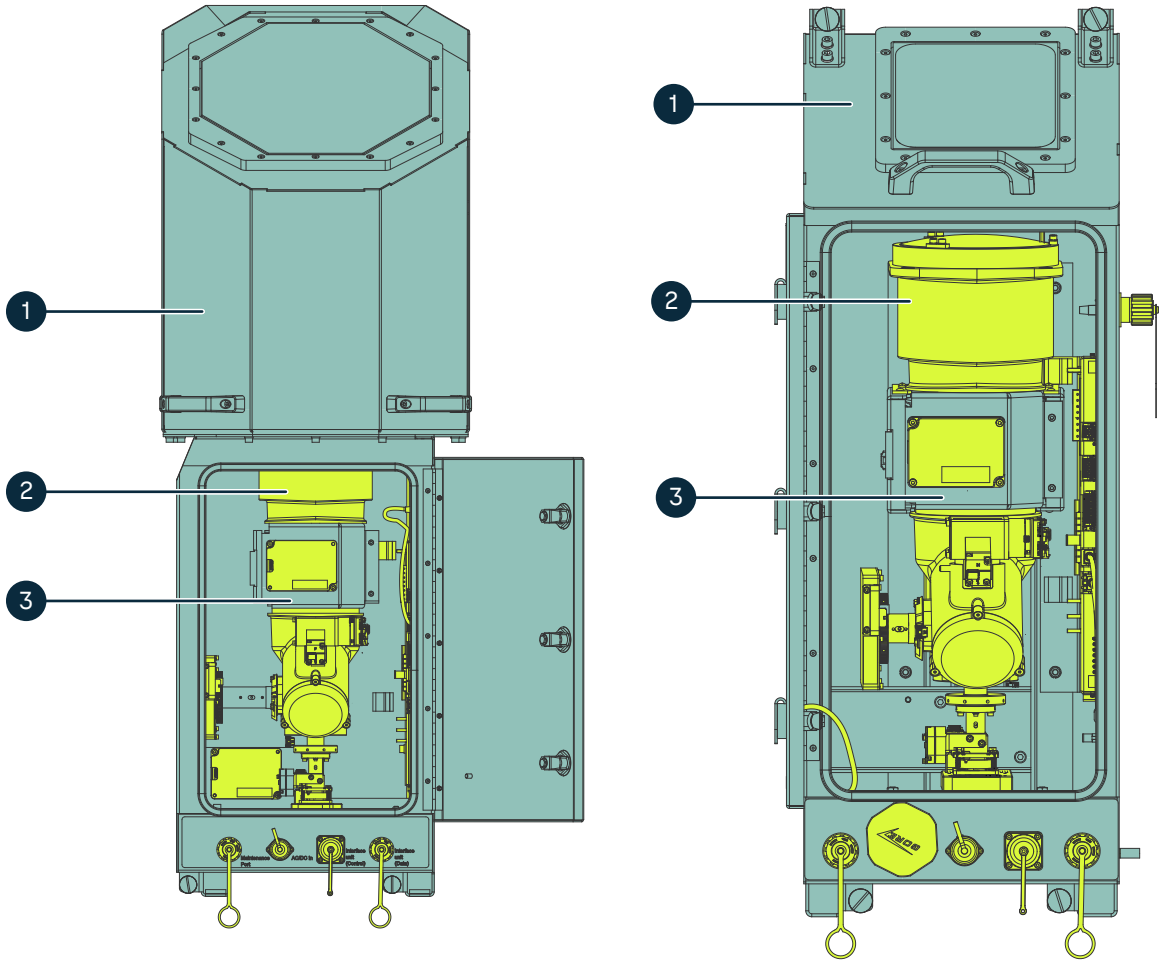


Figure 21 Far-range and near-range measurement unit recycling

Recycling	Part	Material
Electrical and electronic waste	2	Various
Metal waste	1	Aluminum
	3	Various

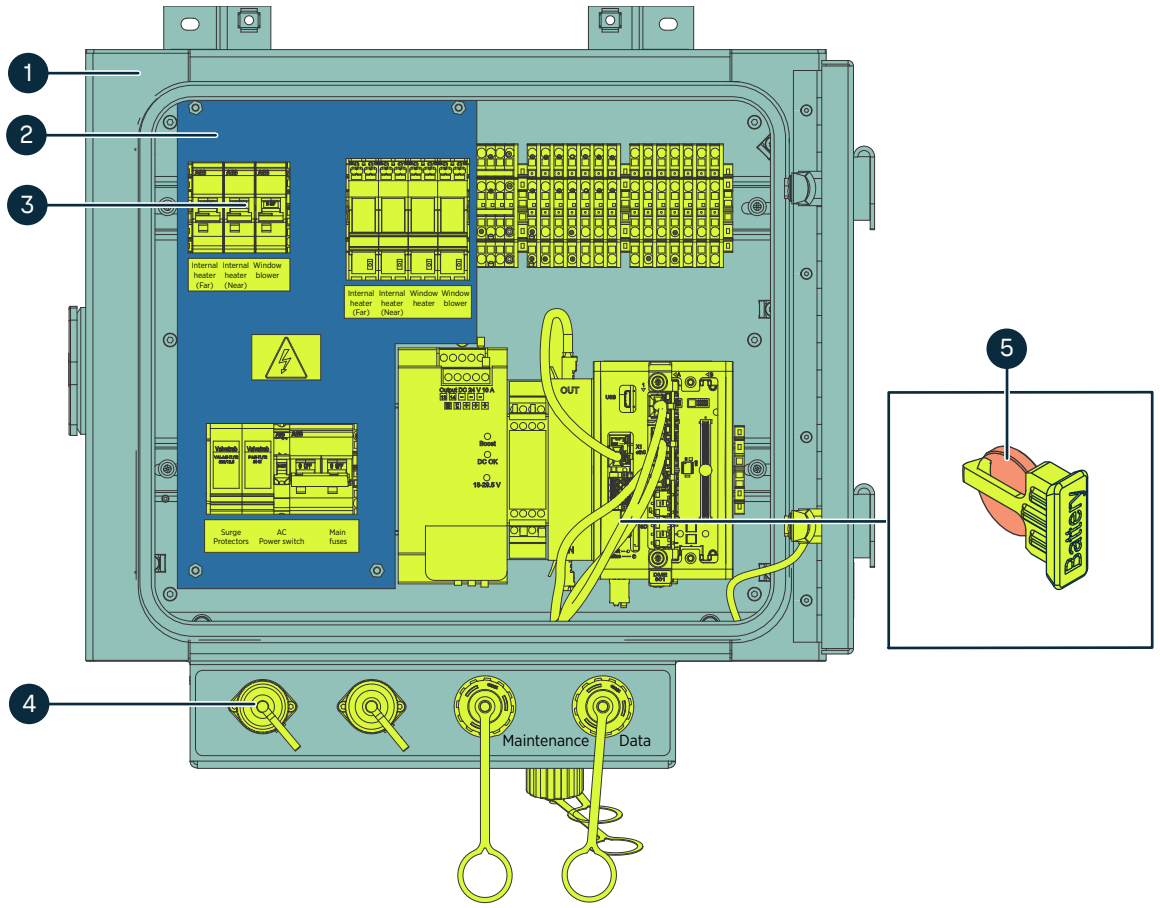


Figure 22 Interface unit recycling

Recycling	Part	Material
Battery waste	5	Lithium
Electrical and electronic waste	4, 3	Various
Metal waste	1	Aluminum
Plastic waste	2	Polycarbonate (PC)

Appendix E. FCC/ISED regulatory notices

Modification statement

Vaisala Oyj has not approved any changes or modifications to this device by the user. Any changes or modifications could void the user's authority to operate the equipment.

Vaisala Oyj n'approuve aucune modification apportée à l'appareil par l'utilisateur, quelle qu'en soit la nature. Tout changement ou modification peuvent annuler le droit d'utilisation de l'appareil par l'utilisateur.

Interference statement

This device complies with Part 15 of the FCC Rules and Innovation, Science and Economic Development Canada (ISED) licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR Innovation, Sciences et Développement économique Canada (ISDE) applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Wireless notice

This equipment complies with FCC and ISED radiation exposure limits set forth for an uncontrolled environment. The antenna should be installed and operated with minimum distance of 20 cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Cet appareil est conforme aux limites d'exposition aux rayonnements de l'ISDE pour un environnement non contrôlé. L'antenne doit être installée de façon à garder une distance minimale de 20 centimètres entre la source de rayonnements et votre corps. L'émetteur ne doit pas être colocalisé ni fonctionner conjointement avec à autre antenne ou autre émetteur.

FCC Class B digital device notice

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that the interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

CAN ICES-3 (B) / NMB-3 (B)

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de classe B est conforme à la norme canadienne NMB-003.

AKRIBIS · www.akribis.info · contacto@akribis.info

Warranty

For warranty terms and conditions and the warranty claim process, see vaisala.com/warranty.

Note that warranty coverage may not apply if the product is damaged due to normal wear and tear, exceptional operating conditions, negligent handling or installation, or unauthorized modifications. See the applicable supply contract or Conditions of Sale for details of the warranty for each product.

Technical support



You can contact Vaisala technical support at vaisala.my.site.com/myvaisala or helpdesk@vaisala.com. You can find all our support channels at vaisala.com/support.

When contacting technical support, provide the following as applicable:

- Product name, model, and serial number
- Software/Firmware version
- Name and location of the installation site
- Name and contact information of a technical person who can provide further information
- Diagnostics package for the application

If applicable, also provide the following details:

- What failed (what worked / did not work)?
- Where did it fail (location and environment)?
- When did it fail (date, immediately / after a while / periodically / randomly)?
- How many failed (only one defect / other same or similar defects / several failures in one unit)?
- What was done when the failure was noticed?
- What was connected to the product and to which connectors?
- What is the input power source type, voltage, and what else (such as lighting, heaters, and motors) was connected to the same power output?
- Are all parts connected and grounded properly? Take a photo to help the troubleshooting.

Recycling



Recycle all applicable material according to local regulations.

AKRIBIS · www.akribis.info · contacto@akribis.info

VAISALA

vaisala.com

AKRIBIS · www.akribis.info · contacto@akribis.info