OTT HydroMet

KIPP & ZONEN
an OTT HydroMet brand

# LAS MkII Scintillometer

**Operational Manual**


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# Table of contents

# 1 Scope of supply

The following items are included with delivery:

- LAS MkII transmitter with pan and tilt adjuster and baseplate
- LAS MkII receiver with pan and tilt adjuster and baseplate
- 2 alignment telescopes with detachable mounting, adjusted for each transmitter and receiver
- 2 sun shields with two fixing screws
- 2 100 mm diameter aperture restrictor with fixing kit, for transmitter and receiver
- 10 m cable with 4-pin plug for receiver analogue connection (also transmitter test output)
- 10 m cable with 8-pin plug and 9-pin D-plug for receiver digital communication connections
- 2 10 m cable with 4-pin plug for 12 V DC power input
- 2 3 mm hexagonal Allen keys, for fitting the sun shields
- 2 4 mm hexagonal Allen keys, for fitting the telescopes
- 8 spare desiccant packs
- GPS antenna with 2 m cable and 8-pin plug, affixed on aluminium mounting arm
- aluminium transport case to hold above parts
- USB stick containing EVATION software, the LAS MkII instruction manual and the LAS brochure

# 2 Order numbers and variant code

### 2.1 Product variants

| Variant | Order number |
|---|---|
| LAS MkII large aperture scintillometer with transit case | 0371900 |

### 2.2 Accessories and spare parts

| Item | Order number |
|---|---|
| Height Adjustable Tripod (set of 2) | 0357703 |
| Heavy Duty Tripod Floor Stand | 0353710 |
| Height Extension Tube | 0353750 |

# 3 About this manual

### 3.1 Other applicable documents and software

The following documents contain further information on installation, maintenance and calibration:

- Instruction Manual LAS MkII - Scintillometer

The documents above and the following software can be downloaded at www.kippzonen.com:

- EVATION

### 3.2 General signs and symbols

The signs and symbols used in the operational manual have the following meaning:

**Practical tip**

i This symbol indicates important and useful information.

**Action**

✓ Prerequisite that must be met before performing an action.

▸ Step 1

⇨ Intermediate result of an action

▸ Step 2

⇨ Result of a completed action

**List**

- List item, 1st level
  - List item, 2nd level

### 3.3 Explanation of warnings

To avoid personal injury and material damage, you must observe the safety information and warnings in the operating manual. The warnings use the following danger levels:

**WARNING**

WARNING

This indicates a potentially hazardous situation. If the hazardous situation is not avoided, it may result in death or serious injuries.

**CAUTION**

CAUTION

This indicates a potentially hazardous situation. If the hazardous situation is not avoided, it may result in moderately serious or minor injuries.

**NOTICE**

NOTE

This indicates a situation from which damage may arise. If the situation is not avoided, products may be damaged.

# 4 General safety instructions

### 4.1 Intended use
The scintillometer is used to measure turbulence and sensible heat flux at large scales.

### 4.2 Potential misuse
Any use of the product that does not comply with the intended use, be this intentional or negligent, is forbidden by the manufacturer.

- Use the product only as described in the operational manual.

### 4.3 Personnel qualification
The equipment described in this manual must be installed, operated, maintained and repaired by qualified personnel only.

- Obtain training from OTT HydroMet if necessary.

### 4.4 Operator obligations
The installer is responsible for observing the safety regulations. Unqualified personnel working on the product can cause risks that could lead to serious injury.

- Have all activities carried out by qualified personnel.
- Ensure that everybody who works on or with the product has read and understood the operational manual.
- Ensure that safety information is observed.
- File the operational manual together with the documentation of the entire system and ensure that it is accessible at all times.
- The operational manual is part of the product, forward the operational manual together with the product.

### 4.5 Personnel obligations
To avoid equipment damage and injury when handling the product, personnel are obliged to the following:

- Read the operational manual carefully before using the product for the first time.
- Pay attention to all safety information and warnings.
- If you do not understand the information and procedure explanations in this manual, stop the action and contact the service provider for assistance.
- Wear the necessary personal protective equipment.

### 4.6 Correct handling
If the product is not installed, used and maintained correctly, there is a risk of injury. The manufacturer does not accept any liability for personal injury or material damage resulting from incorrect handling.

- Install and operate the product under the technical conditions described in the operational manual.
- Do not change or convert the product in any way.
- Do not perform any repairs yourself.
- Get OTT HydroMet to examine and repair any defects.
- Ensure that the product is correctly disposed of. Do not dispose of it in household waste.

### 4.7 Working outdoor

#### 4.7.1 Installation and maintenance at great heights

It is advised to mount the product in a certain height. Therefore, there is a risk of falling down.

- Observe and follow the local safety regulations.
- Use suitable safety equipment.
- Inspect the safety equipment before use.
- Secure the person mounting or maintaining the device against falling down.
- Secure the device against falling down.

#### 4.7.2 Using long cables

Long cables are required to mount the product at great heights. Therefore, there is a risk of strangulation.

- Use long cables properly.
- Observe manufacturer's instructions.
- Observe safety regulations.

### 4.8 Certification

#### 4.8.1 Europe, USA and Canada

**CE (EU)**

The equipment meets the essential requirements of EMC Directive 2014/30/EU.

**FCC (US)**

FCC Part 15, Class "B" Limits

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

**IC (CA)**

**Canadian Radio Interference-Causing Equipment Regulation, ICES-003, "Class B"**

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numèrique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

# 5 Product description

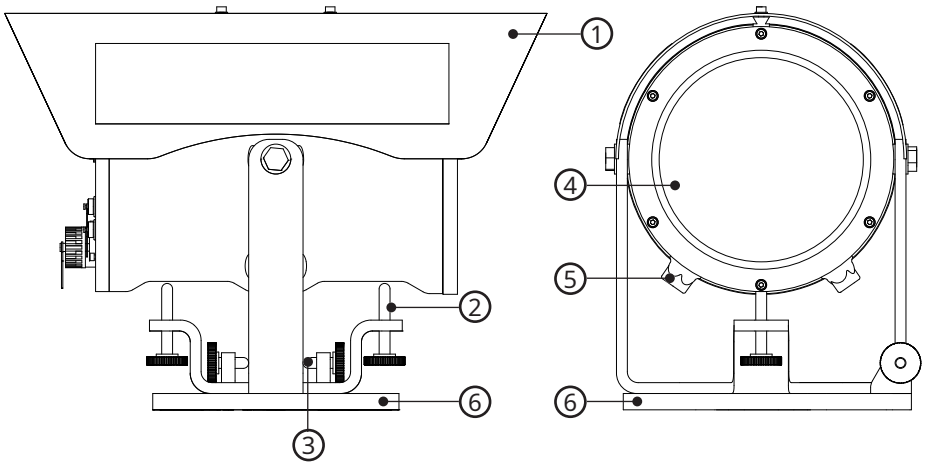
## 5.1 Design and function

The LAS MkII scintillometer measures the path-averaged structure parameter of the refractive index of air ($C_n^2$) over horizontal path lengths.

The instrument is self-contained and can be configured at the receiver with display and menu keys. Additionally, the software EVATION is included.

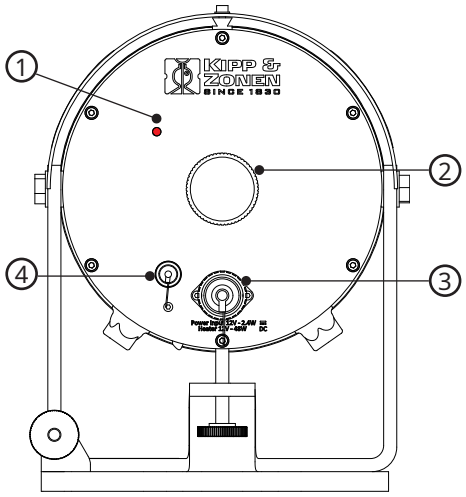
The transmitter is connected with 1 or 2 plugs, and the receiver with up to 4 plugs.

## 5.2 Product overview



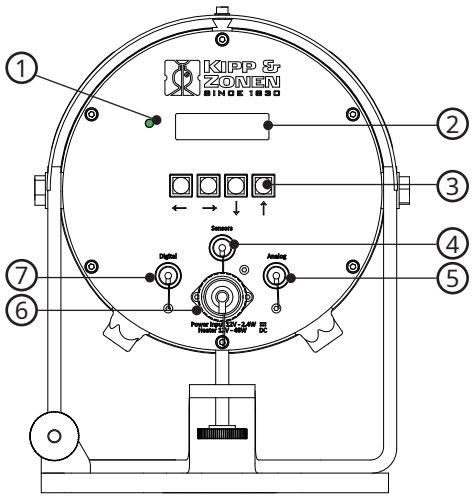

*LAS MkII transmitter and receiver*

| | | | |
|---|---|---|---|
| 1 | Sun shield fitted to the mounting for the alignment telescope | 4 | Transmitter window, with heater and Fresnel lens behind |
| 2 | Tilt (vertical) adjustment screws | 5 | Drying cartridges |
| 3 | Pan (horizontal) adjustment screws | 6 | Baseplate |




*Transmitter rear panel*

1 Power indicator (red)
2 Transmitter power adjustment knob (remove screw-on cover)
3 Power input socket (12 V DC)
4 Diagnostic signal output socket (4-pin)




*Receiver rear panel*

1 Power and status indicator (green)
2 Display
3 Menu navigation keys
4 GPS antenna socket (8-pin)
5 Analogue signal socket (4-pin)
6 Power input socket (12 V DC)
7 Digital interface socket (8-pin)

# 6 Transport, storage, and unpacking

**6.1 Transport**

- Transport the product always in its original packaging.
- Ensure that the product is not mechanically stressed during transport.

**6.2 Storage**

- Store within specified temperature ranges.
- Store in dry area.
- Store in original box where possible.

**6.3 Unpacking**

- Use two people to carefully remove the product from the packaging.
- Check that the delivery is complete and undamaged.
- If you find any damage or if the delivery is incomplete, then immediately contact your supplier or manufacturer.
- Keep the original packaging for any further transportation.

# 7 Installation

## 7.1 Mechanical installation

### 7.1.1 Required tools and aids

The following tools and aids are required:

- Stable mounting bases for the transmitter and receiver or tripods
- Tape measure for determining the installation height
- 2 radios or mobile phones for communication between transmitter and receiver operators
- 2 sets of mounting bolts and suitable wrenches
- 2 sources of 12 V DC power

i The height extension tube is recommended for the mounting of the instrument.

### 7.1.2 Choosing a site

When choosing a site for the instrument measurements the following requirements must be met:

**Path orientation and avoiding direct sunlight**

To avoid direct sunlight in the transmitter's and receiver's optical axes, the path between the transmitter and the receiver should be approx. parallel to the Earth's surface (i.e. horizontal) and have a north-south orientation. If this is not possible, the orientation must be chosen depending on shadowing objects, e.g. trees and buildings in the background, blocking direct sunlight.

The path between the transmitter and receiver should be perpendicular to the predominant wind direction.

- Position the instrument in such a way that no direct sunlight reaches the optical axes of the transmitter and the receiver.
- Ensure that the optical path between the transmitter and receiver is free of any obstructions.

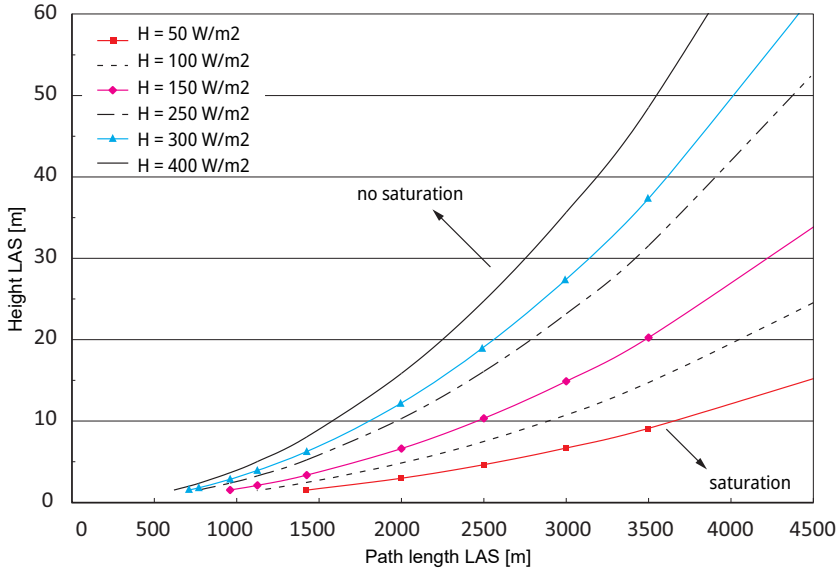
**Minimum installation height to prevent saturation**

The structure parameter of the refractive index of air ($C_n^2$) must stay below a certain saturation criterion ($S_{max}$) to prevent saturation. The dependence of $C_n^2$ on the optical wavelength (λ), the aperture diameter (D), the measurement height ($Z_{LAS}$) and the path length (L) is defined as follows:

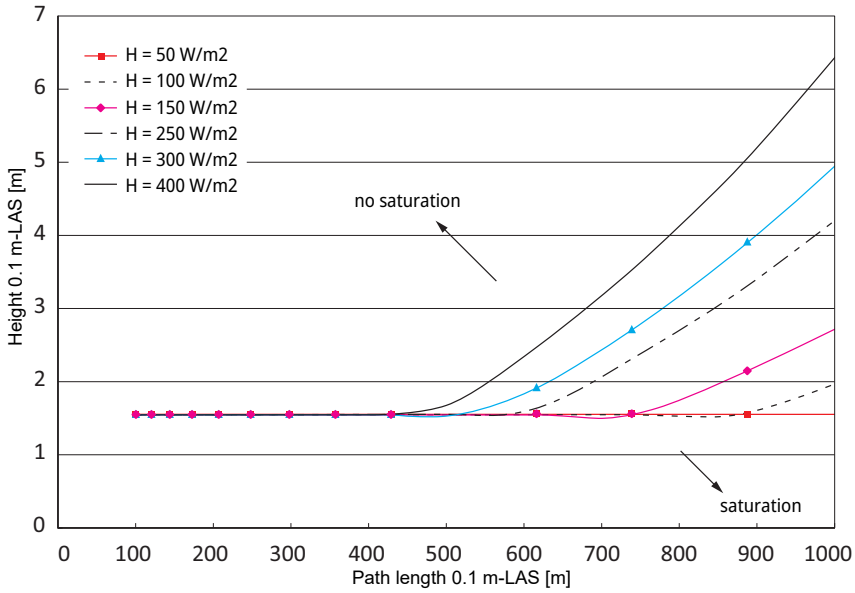
$C_n^2 (\lambda, D, Z_{LAS}, L) < S_{max}$

- Position the instrument high above the earth to prevent saturation.
- Decrease the path length between the transmitter and receiver to observe less scintillation and reduce the chance of saturation.
- Install the instrument depending on the surface conditions and the preferred path length at a minimum height in the "non-saturation" zone (see figures below).

Over dry areas the surface sensible heat flux (H) is large, resulting in higher $C_n^2$ values than over wet surfaces, where the sensible heat flux is small:




*Minimum installation height with full 150 mm aperture*




*Minimum installation height with restricted 100 mm aperture*

For example, an instrument installed over a wet area (H = 100 W/m$^2$) with a path length of 3 km, must be installed at a height of at least 12 m.

**Effective beam height**

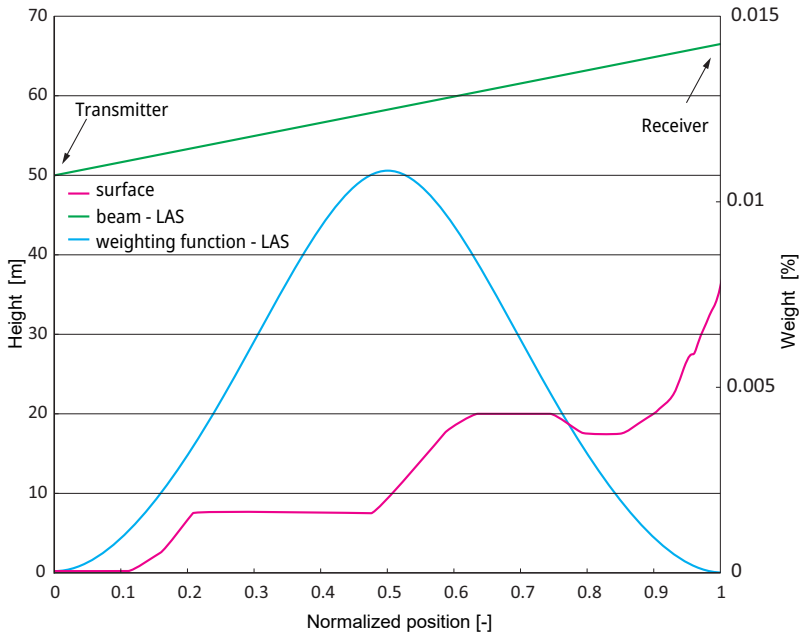
The surface sensible heat flux (H) derived from the structure parameter data is very sensitive to the height, refer to Appendix A in the instruction manual.

When the area is relatively flat and the beam is parallel to the surface the effective beam height of the instrument ($Z_{LAS}$) is determined as follows:

$Z_{transmitter} = Z_{receiver} = Z_{LAS}$

When the area is not flat, it is advised to measure the height of the beam at several points along the path. Based on the surface and the instrument's path-weighting function, the precise beam height can be estimated. The effective height can be calculated with the calculator in the EVATION software, refer to Appendix F in the instruction manual.

- Determine the effective beam height of the instrument along the path precisely.
- For non-flat areas, use the weighting function in order to estimate the precise height of the beam above the surface, see example in the figure below.




*Instrument path (beam) over a non-flat area*

**Operation in the constant flux layer**

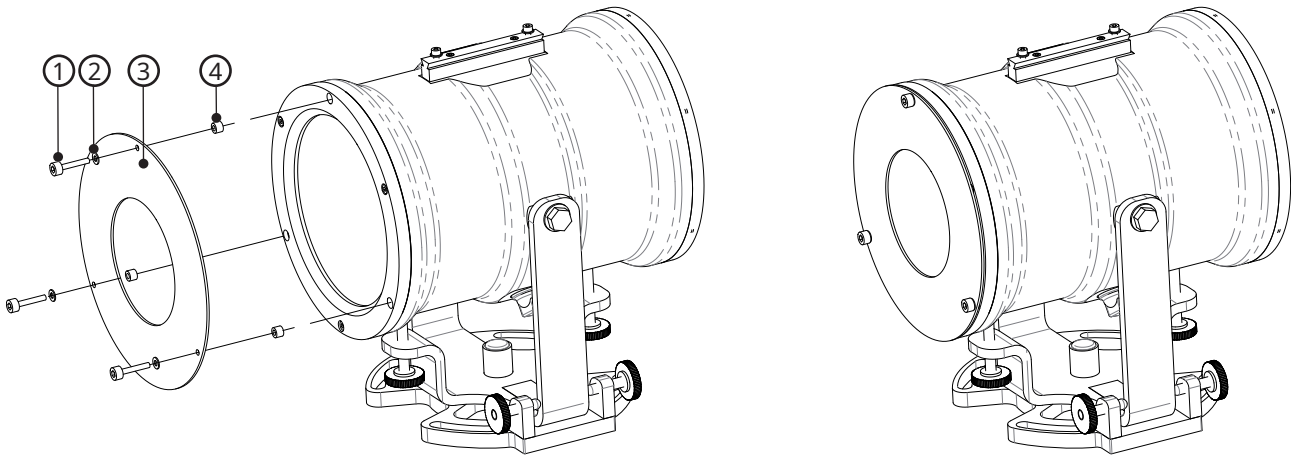
The MOST (Monin-Obukhov Similarity Theory) is applied to derive the surface fluxes of sensible heat from the scintillometer measurements ($C_n^2$), refer to Appendix A in the instruction manual.

- Install the instrument at a height above the Roughness Sub-layer (RS) and within the Constant Flux Layer (CFL) for accurate measurements.

Further information can be found in the Instruction Manual LAS MkII Scintillometer.

### 7.1.3 Installing aperture restrictors

The instrument's full beam aperture of 150 mm enables operation over path lengths from 250 m to 4.5 km. For path lengths from 100 m to 500 m (max. 1 km), restrictors with apertures of 100 mm should be fitted in front of the windows of the transmitter and receiver.



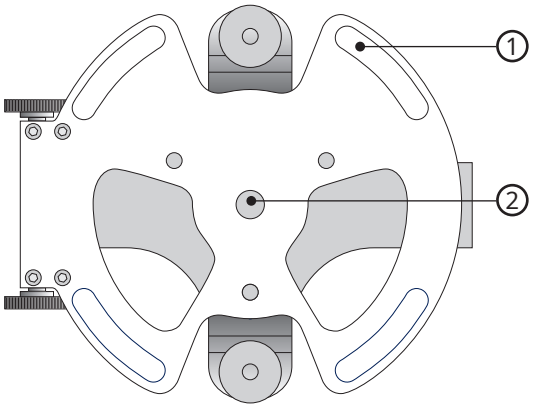

| | | | |
|---|---|---|---|
| 1 | Cap screw M4 x 25 | 3 | Aperture restrictor |
| 2 | Nylon washer | 4 | Nylon spacer |

The 100 mm diameter aperture restrictors are fitted to the transmitter and receiver windows as follows:

- Remove 3 of the 6 retaining screws of the respective window.
- Replace the screws with the nylon spacers.
- Place the restrictor on the window.
- Secure the restrictor with 3 nylon washers and 3 M4 x 25 mm cap screws.
- Adjust the *Aperture Diameter* in the software *Configuration* menu, refer to Establishing connections [▸ 30].

### 7.1.4 Mounting instrument

The transmitter and receiver must be mounted on a stable and vibration-free support. If tripods are used on an uneven or soft surface, a board should be used under the tripod legs.



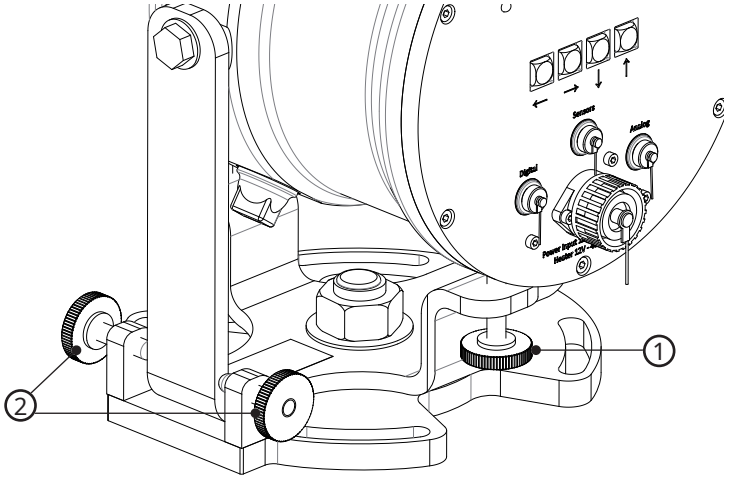

*Bottom view of the baseplate*

| | | | |
|---|---|---|---|
| 1 | Mounting slot for 10 mm bolt on 184.2 mm diameter | 2 | M16 threaded hole |

- Ensure there are at least two people at the installation site to install the device.
- Mount the transmitter and receiver to a support (such as the optional height extension tube) with the baseplate.
- Fasten the transmitter and receiver to the baseplate by hand using the 4 mounting slots for 10 mm bolts.
- Ensure that the transmitter and receiver can still be turned around their vertical axes.
- If a tripod is used: fit the mounting bolt through the central M16 threaded hole in the baseplate.
- Further, tie down the middle of the tripod with a ratchet cargo strap to a ground anchor.

### 7.1.5 Installation and initial alignment of instrument

The transmitter and receiver can be rotated around both vertical and horizontal axes. The final alignment should be carried out under weather conditions of clear visibility (i.e. visibility > 10 km) and low wind to establish the optimum signal strength.




1 Thumbscrews for vertical fine adjustment (tilt) 2 Thumbscrews for horizontal fine adjustment (pan)

- Ensure there are two people at the installation site, equipped with a communication device: one at the receiver and one at the transmitter.
- The person at the receiver: Clamp the "receiver" telescope to the rail on top of the receiver using the 4 mm hexagonal Allen keys.
- The person at the transmitter: Clamp the "transmitter" telescope to the rail on top of the transmitter using the 4 mm hexagonal Allen keys.
- Adjust the transmitter both horizontally (pan) and vertically (tilt) such that the crosshairs of the telescope are centered just above the receiver window, on the opposing riflescope.
- Tighten the bolt(s) fixing the transmitter baseplate to the support.
- For fine adjustment, turn the appropriate thumbscrews.
- Adjust the receiver both horizontally (pan) and vertically (tilt) such that the crosshairs of the telescope are centered just above the transmitter window, on the opposing riflescope.
- Tighten the bolt(s) fixing the receiver baseplate to the support.
- For fine adjustment, turn the appropriate thumbscrews.

## 7.2 Electrical installation

### 7.2.1 Electrical connections

The instrument has 2 waterproof plugs on the rear panel of the transmitter and 4 on the rear panel of the receiver, as described in the following chapters.

#### 7.2.1.1 Power connection

The transmitter and receiver are each provided with a 4-pin waterproof plug fitted to a 10 m long cable that is terminated in tinned wires, for 12 V DC (nominal) power to the instrument and heater.

**Pin assignment**

| Wire | | | |
|---|---|---|---|
| Number | Color | Function | Value |
| 1 | Red | Instrument power + | 12 V DC nominal (9.6 to 18 V DC) |
| 2 | Orange | Heater power + | 12 V DC nominal (9.6 to 18 V DC) |
| 3 | Brown | Heater return - | 0 V |
| 4 | Black | Instrument return - | 0 V |

The instrument transmitter and receiver must be grounded through pin 4 of the power plug.

i The transmitter and receiver power inputs must be protected by a fuse: Instrument power +, 1 A normal or slow-blow type. Heater power +, 4 A slow-blow type.

The wiring to the heater and electronics is separate, thus depending on the climatic conditions the heater power can be used as needed. The transmitter heater power is controlled proportional to temperature, and the receiver heater is set at a programmable temperature in a desired time span (default: 18 °C, all day).

#### 7.2.1.2 Transmitter signal output socket

The transmitter is provided with a 4-pin socket for test signal outputs (for diagnostic purposes).

**Pin assignment**

| Wire | | | |
|---|---|---|---|
| Number | Color | Function | Value |
| 1 | Red | 5 V DC power output | 5 V / 220 kΩ |
| 2 | Blue | 8 kHz pulse LED driver 2 and 50 % duty cycle | 0 to 1.65 V / 220 kΩ proportional to LED power setting (1.65 V = 0.5 A peak) |
| 3 | Green | 8 kHz pulse LED driver 1 and 50 % duty cycle | 0 to 1.65 V / 220 kΩ proportional to LED power setting (1.65 V = 0.5 A peak) |
| 4 | Yellow | signal - | 0 V |
| Shield | Thick black | cable screen | housing ground |

#### 7.2.1.3 Receiver analog signal plug

The receiver is provided with a 4-pin plug for analog signal outputs, fitted to a 10 m long yellow cable that is terminated in tinned wires.

**Pin assignment**

| Wire | | | | |
|---|---|---|---|---|
| Number | Color | Function | Value | Impedance |
| 1 | Red | Log $UC_n^2$ signal + | 0 to 2.4 V, $10^{-17}$ to $10^{-11}$ $m^{-2/3}$ | 680 Ω, 4700 pF |
| 2 | Blue | 8 kHz AC carrier signal + | 0 to 1 V RMS, 100 % = 152 mV RMS | 120 Ω, 4700 pF |
| 3 | Green | demodulated carrier signal ($U_{demod}$) + | 0 to 2 V, 100 % = 606 mV | 680 Ω, 4700 pF |
| 4 | Yellow | signal - | 0 V | |
| Shield | Thick black | cable screen | housing ground | |

### 7.2.1.4 Receiver digital interface plug without GPS

**NOTICE**

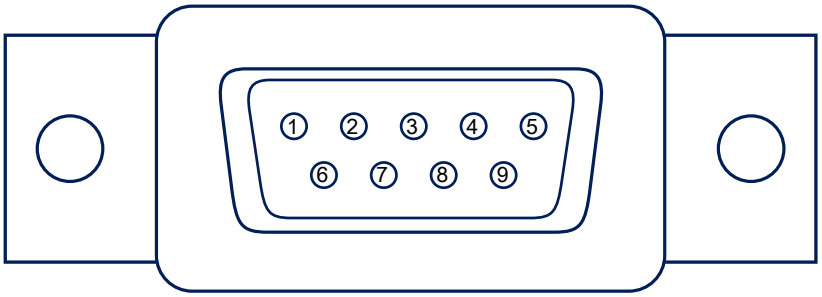
**Damage due to lack of insulation!**

The power supply units of portable computers such as laptops can generate large voltage peaks. This may cause damage to the instrument's digital interface.

- Ensure that the converter has galvanic isolation between the inputs and outputs.

The receiver is provided with an 8-pin waterproof plug for the digital communication, fitted to a 10 m long yellow cable that is terminated in a 9-pin D plug. The 9-pin D plug can be connected to the serial port on most PCs. If unavailable, an isolated serial to USB converter can be used.

The RS-232 communication mode is set by default and the connector is wired for RS-232 communication. For wiring and communication with 4-wire RS-422, refer to chapter 2.5.4 in the instruction manual.




*Digital interface female 9-pin D plug*

**Pin assignment**

| Wire | | | |
|---|---|---|---|
| Number | Color | Function | RS-232 function |
| 1 | White | N/C | DCD (Data Carrier Detect) |
| 2 | Red | Connected | RXD (Receive Data) |
| 3 | Grey | Connected | TXD (Transmit Data) |
| 4 | Brown | N/C | DTR (Data Terminal Ready) |
| 5 | Black | Connected | GND (digital ground) |

| Wire | | | |
|---|---|---|---|
| Number | Color | Function | RS-232 function |
| 6 | Green | N/C | DSR (Data Set Ready) |
| 7 | Yellow | N/C | RTS (Request to Send) |
| 8 | Blue | N/C | CTS (Clear to Send) |
| 9 | - | N/C | RI (Ring Indicator) |
| shield | Thick black | | cable screen |

Only pin 2, 3 and 5 of the 9-pin D plug are connected.

#### 7.2.1.5 Receiver digital interface plug with GPS

**Pin assignment**

| Wire | | | | |
|---|---|---|---|---|
| Number | Color | Signal | Direction | Description RS-232-C |
| 1 | Red | RD1 | Input | Receive data 1, arriving data from DCE |
| 2 | Blue | CTS1 | Input | Clear to send 1, to DCE |
| 3 | Green | N/A | N/A | Do not use |
| 4 | Yellow | RTS1 | Output | Request to send 1, to DCE |
| 5 | Grey | TD1 | Output | Transmit data 1, transmitting data to DCE |
| 6 | Brown | DTR | Output | Data terminal ready 1 |
| 7 | White | GPS, monitor | Output | Data received from the GPS is available on this pin as output (TD2). This pin can be used to monitor the data transmitted by the GPS. This pin is connected with pin 3 of the sensor input connector. |
| 8 | Black | SG | Ground | Signal ground |

#### 7.2.1.6 Receiver sensor plug

The 8-pin plug marked "sensors" must only be used with the GPS antenna and / or appropriate 4 - 20 mA meteorological sensors.

**Pin assignment**

| Wire | | | |
|---|---|---|---|
| Number | Color | Function | Value |
| 1 | Red | Power supply for GPS | 5 V DC, 200 mA |
| 2 | Blue | RS-232-C Transmit data COM2 | |
| 3 | Green | RS-232-C Transmit data COM2 | |
| 4 | Yellow | Power supply for sensor kit | 9.6 to 18 V DC*[1] output, do not ground! |
| 5 | Grey | Temperature input | 4 to 20 mA |
| 6 | Brown | Air pressure input | 4 to 20 mA |
| 7 | White | Wind speed input | 4 to 20 mA |

| Wire | | | |
|---|---|---|---|
| Number | Color | Function | Value |
| 8 | Black | Sensors ground | 0 V |
| Shield | Thick black | Cable screen | housing ground |

*[1]The 9.6 to 18 V DC output is 1 to 1 coupled with the 9.6 to 18 V DC power input voltage on the receiver power plug and therefore is not fused.

### 7.2.2 Connecting the transmitter

- Connect a suitable 12 V DC power supply to the transmitter.
- Switch on the power supply.
  - ⇨ The red power indicator on the transmitter rear panel will illuminate.
- Unscrew the cover of the power adjustment knob.
- Set the 10-turn dial (scaled from 0 to 1000) to the middle of the range, i.e. 500 or 5 turns.
- If the instrument is installed for a long path length (2 to 4.5 km), turn the dial to maximum.

### 7.2.3 Connecting the receiver

- Connect a suitable 12 V DC power supply to the receiver.
- Switch on the power supply.
  - ⇨ The green power and status indicator on the receiver rear panel provides information on the operation of the instrument receiver, as shown in the following table:

| Green indicator function | Status |
|---|---|
| Normal blinking (0.15 s on, 2.35 s off) | The instrument is operational |
| Fast blinking (0.2 s on, 0.2 s off) | A hardware error was detected |
| Slow blinking | The boot loader is running |
| Always on | The boot loader is halted, no application is running |
| Always off | The power is switched off, the instrument has a hardware error, or the supply voltage is too low |

The display on the rear panel of the receiver will cycle through the following start-up messages:

- Serial number and production document
- Software release and hardware release
- Communication parameters (interface type, baud rate, data bits, parity)
- Message about completed start-up, *no errors* or *check 12 V heater*

- If a hardware error message occurs, turn off the power and restart the receiver.
- If the error persists, contact the technical support department of OTT HydroMet.

A configuration error message is displayed, if one or more of the configuration parameters stored in the memory are not correct, refer to Appendix D in the instruction manual.

- At the receiver ensure that the instrument is configured as described in the chapter Configuration using display and navigation keys [▸ 24].

- At the receiver set the signal gain using the navigation keys as follows:
  **Main Menu** - **2. Configuration** - **1. Installation** - **6. Signal Gain** - 1
- Return to the main menu and select: **Main Menu** - **1. View RealTime** - **1. Signal Level**

# 8 Commissioning

### 8.1 Configuration using display and navigation keys

The waterproof display and menu navigation keys on the rear panel of the instrument receiver enable configuration and control of the instrument.

#### 8.1.1 Receiver display and menu navigation keys

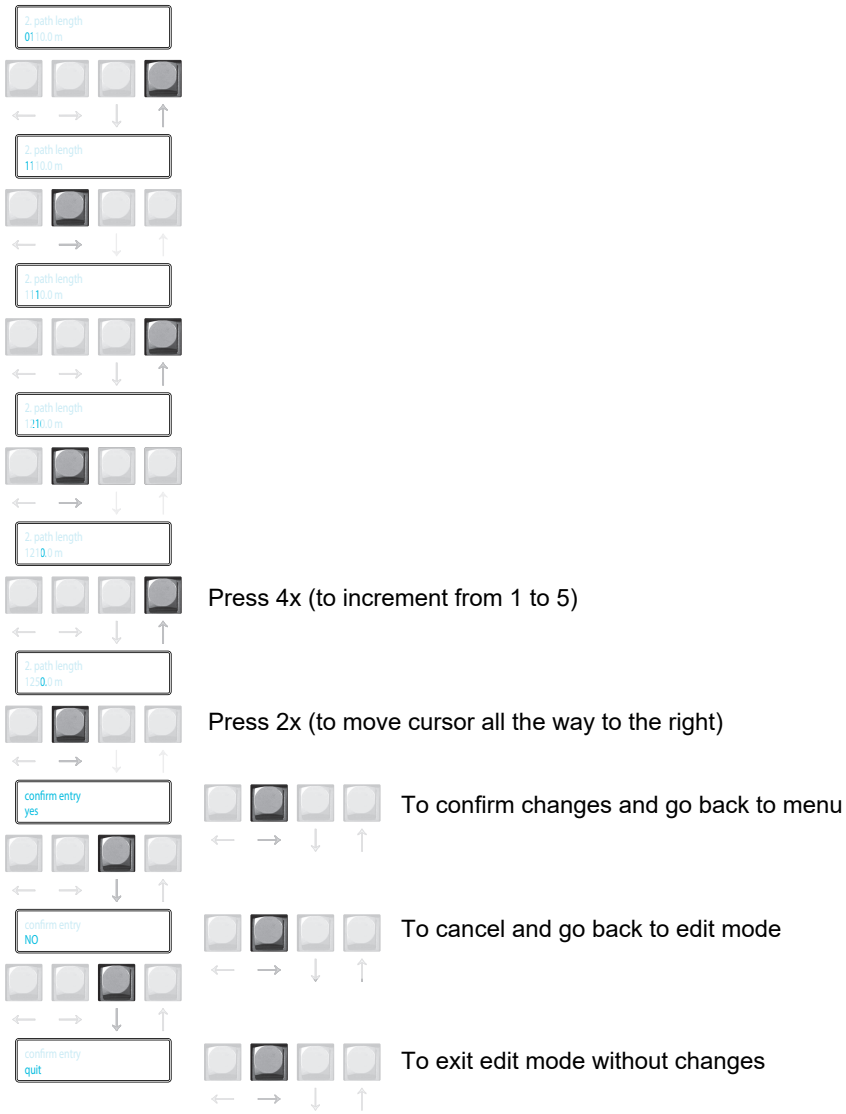
The following keys are used to navigate through the (sub-)menus or to select or enter a value:

| | |
|---|---|
| **Scroll mode** | |
| Up key | Select next menu item |
| Down key | Select previous menu item |
| Left key | Go one menu level back |
| Right key | Select displayed menu item |
| **Edit mode** | |
| Up key | Increment digit |
| Down key | Decrement digit |
| Left key | Select previous digit |
| Right key | Select next digit |
| **Confirm (edit mode)** | |
| Display shows | Confirm Entry - Yes |
| Up or down key | Cycles through options: Yes, No, Quit |
| Right key | Completes selected action:<br>Yes - confirm changes and go back to menu<br>No - cancel and go back to edit mode<br>Quit - exit edit mode without changes |

i The receiver display is turned off, if no keys are pressed for 4 minutes. Pressing any key turns the display on again.

Example of how to change the path length setting from 110 to 1250 m in detail:

- First navigate through the menu to the screen displaying **2. Path length** as follows:
  **Main Menu** - **2. Configuration** - **1. Installation** - **2. Path length**




*Steps to change the path length setting from 110 m to 1250 m*

### 8.1.2 Configuration for measurement

The sub-menus in the configuration menu require setting up before, or during installation. For configuration prior to installation, refer to Connecting the receiver [▶ 22].

The following table shows the adjustable parameters in the configuration menu.

| Sub-menu | Sub-menu item | Function | Range | Default*[1] |
|---|---|---|---|---|
| **1. Installation** | 1. Aperture*[2] | Set or show effective diameter | 20 to 499.9 mm | 149 mm |
| | 2. Path length | Set or show path length | 100 to 19999.9 m | 890 m |
| | 3. Install height | Set or show installation height | 0.2 to 4999.9 m | 1.5 m |
| | 4. Z.Displ.height | Set or show zero displacement height | 0.0 to 199.99 m | 0 m |
| | 5. Signal gain | Show signal strength and set gain | 1x, 2x, 4x, 8x, 16x, 32x, 64x, 128x | 1 |
| | 6. Set defaults | Restore default configuration | 0 = No, 1 = Yes | 0 = No |
| | 7. << Back | Back to higher menu | | |

| Sub-menu | Sub-menu item | Function | Range | Default*[1] |
|---|---|---|---|---|
| | | | | |
| **2. Advanced** | 1. Rel. humidity | Set or show relative humidity | 0 to 99.9 % | 50 % |
| | 2. Heat capacity | Set or show heat capacity of air | 500.0 to 1999.9 | 1000 |
| | 3. Bowen ration | Set or show Bowen Ratio | 0.01 to 9.999 | 2 |
| | 4. Empir. constant | Set or show empirical constant | 0 to 9.999 | 0.48 |
| | 5. << Back | Back to higher menu | | |
| | | | | |
| **3. Sensors** | 1. Air temp | Set or show air temperature | -39.9 to 69.9 °C | +17 °C |
| | 2. Air pressure | Set or show air pressure | 600 to 1100 mBar | 1012 mBar |
| | 3. Wind speed | Set or show wind speed | 0 to 80.0 m/s | 2.2 m/s |
| | 4. Device temp | Set or show receiver temperature | -39.9 to 69.9 °C | N/A (99.9) |
| | 5. << Back | Back to higher menu | | |
| | | | | |
| **4. Data Logger** | 1. Set date | Set date | yy/mm/dd | ECT |
| | 2. Set time | Set time | hh:mm:ss | ECT |
| | 3. Wakeup time | Set or show time start measure and log | hh:mm | 99.99=Off |
| | 4. Sleep time | Set or show time stop measure and log | hh:mm | 99.99=Off |
| | 5. Log interval | Set data average and log interval | 0 to 29999 s | 600 s |
| | 6. Send interval | Set send interval of data to computer | 0 to 29999 s | 0=Off |
| | 7. << Back | Back to higher menu | | |
| | | | | |
| **5. Interface COM1** | 1. Set default | Restore default configuration | COM1 | |
| | 2. BaudRate | Set or show baud rate | 1200 to 38400 | 19200 |
| | 3. Parity | Set or show parity | 0=None, 1=Odd, 2=Even | 0 |
| | 4. Databits | Set or show number of databits | 7 or 8 | 8 |
| | 5. Interface type | Set or show interface type | RS-232-C or RS-422 | 232-C |
| | 6. DeviceID | Set device address | 0 to 255 | 255 |
| | 7. Restart | Restart the receiver | 0=No, 1=Yes | |
| | 8. << Back | Back to higher menu | | |
| | | | | |
| **6. Interface COM2** | 1. Set default | Restore default configuration | COM2 (for GPS) | |
| | 2. BaudRate | Set or show baud rate | 1200 to 38400 | 38400 |
| | 3. Parity | Set or show parity | 0=None, 1=Odd, 2=Even | 0 |
| | 4. Databits | Set or show number of databits | 7 to 8 | 8 |
| | 5. Restart | Restart the receiver | 0=No, 1=Yes | |
| | 6. << Back | Back to higher menu | | |

*[1]The sensor sub-menu default values are used when external meteorological sensors are not connected. These values can be changed by the user, within the ranges shown.

*[2]The aperture maximum value depends on the effective diameter (see menu **Device**).

The signal gain can also be set in menu 1:

- Select **Realtime data - 1. Signal level**.

#### 8.1.2.1 Parameters to measure Cn2

$C_n^2$ is measured with the aperture diameter (D), the path length (L) and the measured variance of the natural logarithm of intensity fluctuations ($\sigma_{lnI}^2$) with the following general algorithm:

$$C_n^2 = 1.12\ \sigma_{lnI}^2 D^{7/3} L^{-3}$$

- Set the parameters for aperture and path length in the receiver.

#### 8.1.2.2 Parameters to measure sensible heat flux

Surface sensible heat flux (H) is measured with the parameters for measurement of $C_n^2$ and additionally:

- Installation height
- Zero Displacement Height
- Bowen Ratio
- Roughness Length
- From external meteorological sensors, when connected: Temperature, pressure and wind speed. Otherwise entered default values are used.

The surface sensible heat flux (H) can be calculated with the EVATION software, the data from the instrument and the meteorological sensor kit, and additional parameters, such as the roughness length.

When the instrument is installed at a measurement height > 20 m and for unstable day-time conditions, the free convection method can be applied.

The free convection sensible heat flux ($H_{free}$) is not as accurate as the standard method, because it does not allow for surface topography (roughness length, etc.).

When the meteorological sensor kit is connected the instrument can internally calculate and log the $H_{free}$. Refer to Appendix A and C in the instruction manual.

#### 8.1.2.3 External sensors

When a meteorological sensor kit is connected, the correct factory sensitivities and ranges are automatically selected.

When the kit is not connected, fixed values typical of the measurement location can be entered in sub-menu 3.

#### 8.1.2.4 Data Logger

The following internal data logger settings must be configured: date, time, sleep time, wakeup time, log-interval and send interval.

| Setting | Function |
|---|---|
| wakeup time | The wakeup time defines the start of the operational mode. When the operational mode is active the instrument is measuring and logging data. The receiver heater is turned on when the temperature of the receiver is below the *operating temperature* in the heater menu. |
| sleep time | The sleep time defines the start of the low power *sleep* mode, during which there is no measurement and the receiver heater is turned on only when the temperature of the receiver is below the *standby temperature* in the heater menu. |
| log-interval | The log-interval defines the interval over which measurements will be averaged and then stored in the internal flash data memory. |
| send interval | The send interval defines the interval at which the current data values will be sent automatically to a computer. |

#### 8.1.2.5 Interface COM1

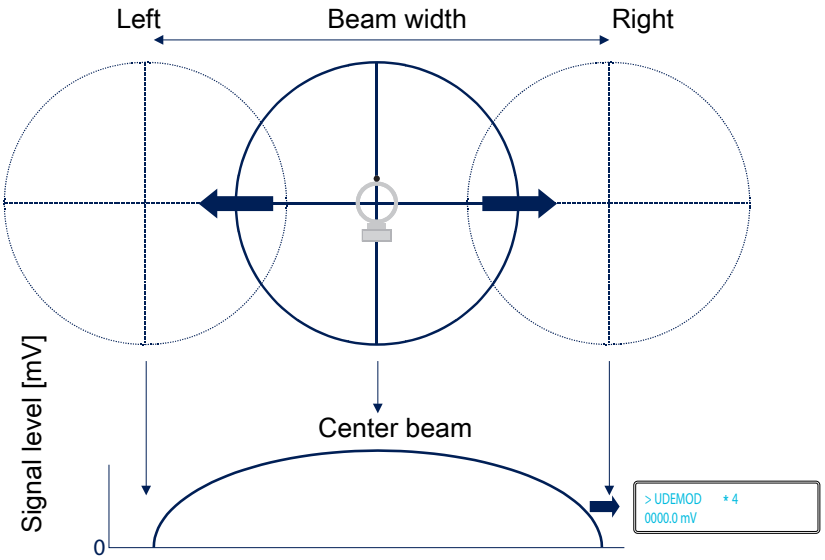
The following interface settings must be configured for the receiver serial communication with a host (PC): baud rate, parity, data bits and interface type.

#### 8.1.2.6 Interface COM2

The following interface settings must be configured for the internal communication with the GPS receiver: baud rate, parity and data bits.

### 8.2 Transmitter optical alignment

There should be a "plateau" region of approx. the same signal strength between the horizontal edges of beam. The mid-point of this region is the center of the beam.




*Maximum signal "plateau"*

- Ensure there are two people at the installation site: one at the receiver and one at the transmitter.
- The person at the receiver: observe the signal level and communicate the values to the person at the transmitter.
- The person at the transmitter: slowly turn the transmitter horizontally (pan) left and right using the adjustment screws until the max. signal strength is reached.
- Find the mid-point of the "plateau" region, which will be the center of the beam.

- Adjust the transmitter slowly vertically up and down using the adjustment screws to find the mid-point max. signal strength.
- If the receiver signal strength is more than 200 %, reduce the transmitter power for a reading of about 100 %.
- Optimize the horizontal and vertical alignment for the max. signal strength in the middle of the "plateau" region. Each time the signal strength is more than 200 %, reduce the transmitter power for a reading of about 100 %.
- Repeat the previous steps adjusting the transmitter, until the best transmitter optical alignment is achieved.
- Tighten the transmitter adjustment screws, checking that the signal strength has not changed.

### 8.3 Receiver optical alignment

- Ensure there are two people at the installation site: one at the receiver and one at the transmitter.
- The person at the receiver: observe the signal level and optimize the alignment.
- Slowly turn the receiver horizontally (pan) left and right using the adjustment screws until the max. signal strength is reached.
- Find the mid-point of the "plateau" region, which will be the center of the beam.
- Adjust the receiver slowly vertically up and down using the adjustment screws to find the mid-point max. signal strength.
- If the receiver signal strength is more than 200 %, reduce the transmitter power for a reading of about 100 %.
- Optimize the horizontal and vertical alignment for the max. signal strength in the middle of the "plateau" region. Each time the signal strength is more than 200 %, reduce the transmitter power for a reading of about 100 %.
- Repeat the previous steps adjusting the receiver, until the best receiver optical alignment is achieved.
- Tighten the receiver adjustment screws, checking that the signal strength has not changed.
- If necessary, employ the riflescope to check the receiver is not tilting, while tightening the adjustment screws.

### 8.4 Finalizing optical alignment

- Adjust the transmitter power to give signal strength of 100 - 120 %.
- Lock the knob with the small black tab.
- Note the dial setting for future reference.

> i At path lengths of ≥ 3000 m and depending upon visibility, a signal strength of 100 - 120 % is possibly not achievable. LAS will operate correctly with a signal strength of ≥ 25 %. The receiver signal gain must not be increased.

- Screw on the cover of the power adjustment knob, hand-tighten only.
- In the **View Realtime** menu, select sub-menu 3 ($C_n^2$).
  - ⇨ Data measurement and logging according to configuration of the data logger.

> i The transmitter or receiver is possibly not perfectly aligned with the center of the crosshairs of its telescope. This may be due to a difference between the operating path length and the range at which the telescopes were adjusted at the factory or operator experience. If desired, the crosshairs of the telescopes can be adjusted using the instructions provided.

- Remove the telescopes.
- Fit the sun shields to the transmitter and receiver with the fixing screws and the 3 mm hexagonal Allen keys.

- For the receiver only, place the GPS mounting bracket with GPS antenna on top of the instrument and place the sun shield on top of the mounting bracket.
- Fasten the sun shield and mounting bracket with two M4 x 16 hexagonal head screws and washers.
- Store the telescopes carefully for future use.

### 8.5 Configuration using EVATION

The software EVATION allows the instrument user to derive the surface fluxes of sensible heat from recorded scintillometer data and additional meteorological data, such as air temperature (T), air pressure (P), wind speed (u) and Bowen ratio (β).

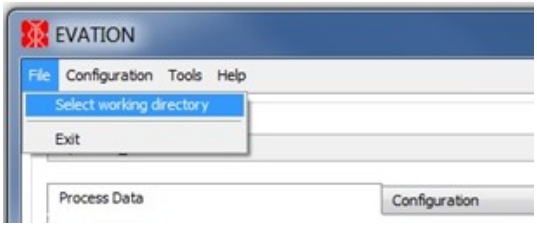
If an expanded flux system of the instrument is available, EVATION can also calculate the latent heat flux (L, E) and evapotranspiration (ET).

- Download the latest version of the EVATION software: https://www.kippzonen.com/Download/733/EVATION-V2R5-Software?ShowInfo=true
- Install the software on the computer.
- Get familiar with the software in general.

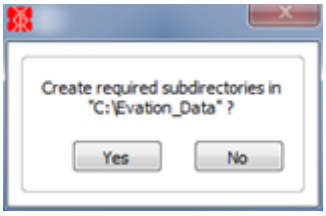
#### 8.5.1 Starting the software

> For each instrument configuration or other measurement location a new working directory must be created.

- Run the file *EvationSetup.exe* from the downloaded file or USB stick provided, if not yet installed.
- Create or select a user-defined folder to store the instrument data and processing settings.
- Open the *File* menu and click on **Select working directory**:




- Select or create a new user-defined folder.
- Click on **Current Folder**.
- If the selected folder is new or empty, click on **Yes**:



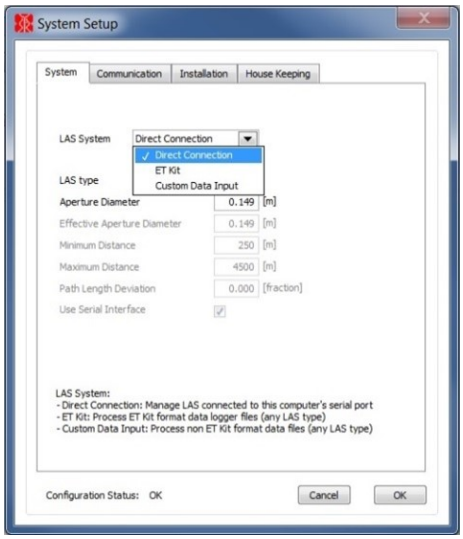

  ⇨ The required folder structure is created by the software.

⇨ The path is shown in the *LAS Working Directory* bar.

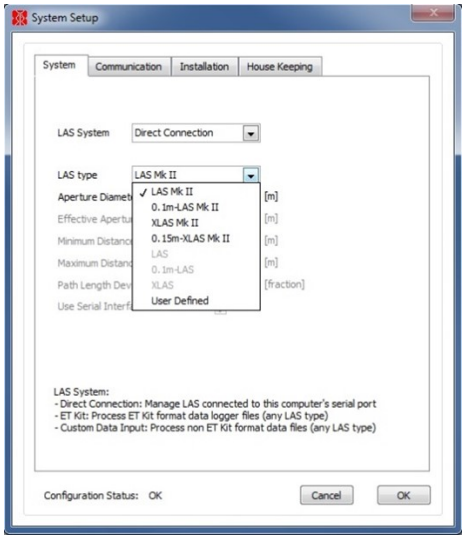
#### 8.5.2 Establishing connections

- Open the *Configuration* menu and click on **System Setup**.
- To establish a connection to the instrument, open the *System* tab.

- In the drop-down list under *LAS System* select *Direct Connection*.



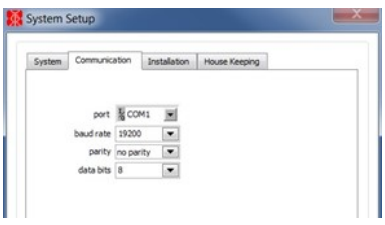

- In the drop-down list under *LAS type* select the appropriate instrument.




- Adjust the *Aperture Diameter* to 100 mm, if aperture restrictors are installed.
  - ⇨ For the LAS types *LAS Mk II*, *XLAS Mk II* or *User Defined* in combination with *Direct Connection*, the tabs *Communication*, *Installation* and *House Keeping* are available.

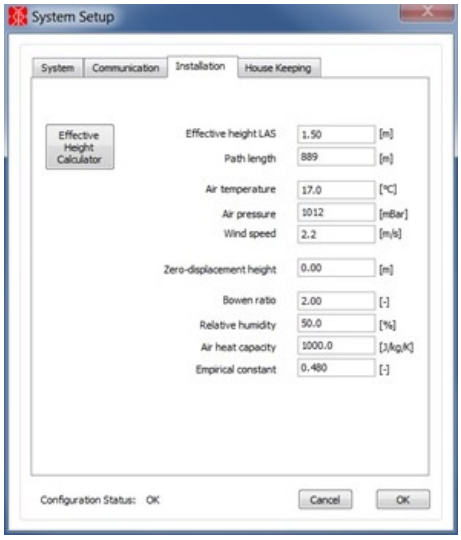
### 8.5.3 Adjusting the communication parameters

- Open the *Configuration* menu and click on **System Setup**.
- Open the *Communication* tab.
- Select the serial communications port of the computer that the instrument is connected to.
- Set the baud rate, parity and number of data bits to match the instrument receiver settings (The default baud rate is 19200 with no parity, 8 data bits):



### 8.5.4 Installation parameters

- Open the *Configuration* menu and click on **System Setup**.
- Open the *Installation* tab.
- The following parameters regarding the installation can be adapted:




| Parameter | Description |
|---|---|
| Effective height LAS | For an even terrain with minimal changes in elevation along the path, the effective height of the beam is relative to the ground.<br>For an uneven terrain use the effective height calculator (refer to Appendix E in the instruction manual). |
| Path length | The distance between the transmitter and the receiver |
| Air temperature<br>Air pressure<br>Wind speed | When unchecked values from connected external meteorological sensors will be used.<br>When checked fixed user values can be entered. |
| Zero-displacement height | Refer to the instruction manual. |
| Bowen ratio | The ratio between the sensible and latent heat flux, H/LvE |
| Air density | Calculated value |
| Air heat capacity | Can be set to other than the default value if required |
| Empirical constant | Only change from the default value for advanced applications |

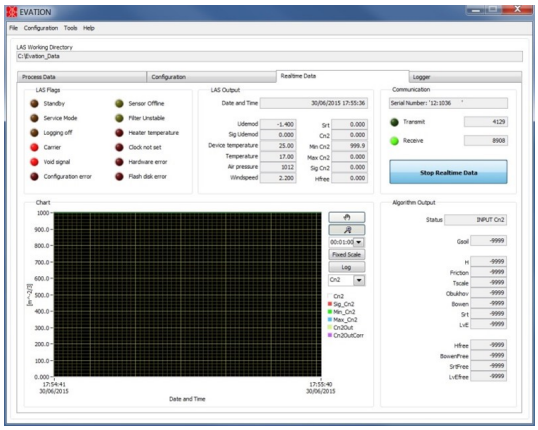
i For more information on the instrument configuration, refer to the instruction manual.

# 9 Operation

### 9.1 Collecting data

The software EVATION collects data from the receiver's internal data logger and has a real-time display function. This real-time or downloaded data can be processed into heat flux data.

- Connect the instrument receiver to a computer running EVATION.
- Select the *Real-time Data* tab from the main screen.
  - ⇨ The serial number of the connected instrument is shown at the top right.
- Click on **Show Realtime Data**.
  - ⇨ The graph in the middle of the screen and the data fields are activated.




- ⇨ The currently measured values are shown in the upper center and graphed at the lower left.
- ⇨ The output of the data processing algorithm (if the Process Data Configuration is set up and a valid signal is received), is displayed at the lower right.

| Parameter | Description |
|---|---|
| LAS Flags | Diagnostic flags will light up in case there is a warning or error message from the instrument |
| LAS Output | These data fields show the real time data as processed by the instrument receiver electronics. Between Date and Time, and Udemod and Srt, the GPS location will be shown when a GPS is connected. The location will be greyed out if the GPS has no fix. |
| Communication | If the receiver is not connected correctly, or if communication parameters are not configured, the communication status field will display *Awaiting instrument identification* |
| Fixed Scale | The time scale of the chart can be set with a choice of linear or logarithmic scaling, use the zoom button to view details of measurement graphs. The scales can be changed by choosing between *Fixed Scale* and *Auto Scale*. |
| Chart | This chart shows real-time data with time |
| Algorithm Output | These fields show the real-time data as processed by EVATION |

- Click on **Stop Realtime Data** at any point to stop updating the screen with new data.
- Select the *Logger* tab from the main screen.
- Download data from the internal data logger and configure the instrument time with the parameters in the below table.

⇨ Downloaded data is automatically placed in the *Input* folder.

| Parameter | Description |
|---|---|
| Read new | Only new data is downloaded |
| Read all | All data in the memory is downloaded |
| Download: Manual | Download data at the user's request at slow speed, while continuing logging / LAS operation |
| Download: Automatic | Download new data records as soon as they are available in the receiver |
| Download: Fast | Stops logging and downloads data at the user's request at high speed |
| Start download | Start the data download process |
| Date and time settings | Four options for setting the instrument internal clock from a computer: Local time without DST, local time with DST, Greenwich Mean Time (UTC), manual time (user defined date and time) |
| Set date | Sets the instrument receiver date from the choices above |
| Set time | Sets the instrument receiver date from the choices above |
| Logger date and time | Displays the current date and time in the instrument receiver |

i The instrument time is synchronized to the computer time, if the instrument does not have a GPS installed. The software detects at which time the instrument runs (local with DST, local without DST or UTC). The instrument time is only synchronized, if it deviates less than 5 minutes.
If the instrument has a GPS installed, the instrument time is synchronized to GMT (UTC) from the GPS. It is not possible to set the instrument to local or custom time with the GPS connected.

i For more information on the instrument operation, refer to the instruction manual.

### 9.2 Calibrating the instrument

The instrument receiver has built-in diagnostics and calibration features to ensure correct operation of the system. These functions can be accessed using the navigation keys and display.

#### Checking $C_n^2$ processing

The internal processing of $C_n^2$ can be checked as follows:

- For Firmware 2.10 and lower: Enter **Main Menu** - **2. Configuration** - **1. Installation** - **1. Aperture** - 152 mm - **Confirm**
- Enter **2. Configuration** - **1. Installation** - **2. Path length** - 1184 m - **Confirm**
- For Firmware 3.00 and higher: No need to alter the aperture and path length settings.
- Enter **Main Menu** - **4. Diagnostics** - **1. Gain** - 10 Hz - **Confirm**
  - ⇨ A reference signal is processed internally with the following characters: Ratio high / low level of pulse: 2; scintillation frequency: 10 Hz.
  - ⇨ The $C_n^2$ value on the display shows: $1.0 * 10^{-12}$ $m^{-2/3}$ ± 0.5 %.
- If the result is outside the limits, have a recalibration performed.

#### Electronics offset noise check

The electrical noise of the electronics can be checked as follows:

- For Firmware 2.10 and lower: Enter **Main Menu** - **2. Configuration** - **1. Installation** - **1. Aperture** - 152 mm - **Confirm**

- Enter **2. Configuration** - **1. Installation** - **2. Path length** - 1184 m - **Confirm**
- For Firmware 3.00 and higher: No need to alter the aperture and path length settings.
- Enter **Main Menu** - **4. Diagnostics** - **2. Offset**
  - ⇨ The detector is disconnected from the input electronics and $C_n^2$ is displayed < $1.0 * 10^{-17}$ $m^{-2/3}$.
  - ⇨ This offset depends on the setting of filter1 and the DNL filter (see menu Device). If filter1 is set between 800 and 2500 the recommended value of the DNL filter = 2. If filter1 > 2500 the recommended value of the DNL filter = 10 and below 800 the recommended value of the DNL filter = 0.
- If the result is outside the limits, have a recalibration performed.

**Analog output check**

The analog output can be checked as follows:

- Connect a digital voltmeter or data logger between the yellow and red wires of the analog output plug cable (see chapter Receiver analog signal plug [▶ 19]).
- Enter **Main Menu** - **4. Diagnostics** - **3. Analog Output** - 1000
  - ⇨ The measured output is between 998.25 mV and 1001.75 mV.
- If the result is outside the limits, have a recalibration performed.
- Connect a digital voltmeter or data logger between the yellow and red wires of the analog output plug cable.
- Enter **Main Menu** - **4. Diagnostics** - **3. Analog Output** - 10 mV
  - ⇨ The measured output is between 0 mV and 34 mV.
- Return the configuration to the correct operational settings for aperture, path length and analog output.

# 10 Maintenance

**10.1 Maintenance schedule**

The frequency of cleaning is dependent upon the local weather and environmental conditions. Regular cleaning of the transmitter and receiver windows and checking the optical alignment will prevent unneccessary signal attenuation and data loss.

The following maintenance intervals are recommended:

| Interval | Activity | Performed by |
|---|---|---|
| Weekly | ▸ Check the signal strength | Operator |
| Weekly | ▸ Clean the transmitter and receiver windows | Operator |
| Monthly | ▸ Inspect the desiccant cartridges for saturation | Operator |
| Monthly | ▸ Check the optical alignment | Operator |
| Monthly | ▸ Check the electrical stability | Operator |
| Monthly | ▸ Check the data logger memory capacity | Operator |
| Quarterly | ▸ Check all cables and connectors | Operator |
| Quarterly | ▸ Check the mountings are secure | Operator |
| 10 years or during recalibration | ▸ Replace the internal desiccant in the transmitter and receiver. | OTT HydroMet |

# 11 Troubleshooting

### 11.1 Error elimination

| Error | Possible cause | Corrective action |
|---|---|---|
| Communication problems between the instrument and a computer | Power interruptions or disconnecting cables whilst the EVATION software is running | ▸ Check if the port number is still correct.<br>▸ Close the software and turn off the computer.<br>▸ Turn off the power to the instrument receiver and disconnect the digital interface cable.<br>▸ Reconnect the digital interface cable and turn on the power to the receiver.<br>▸ Wait for a few minutes and turn on the computer.<br>▸ Restart the software. |
| Hardware error message on the receiver display | | ▸ Turn off the power and restart the receiver.<br>▸ If the error persists, make a note of the code and contact solar-service@otthydromet.com. |
| Configuration error message is displayed | One or more configuration parameters stored in the memory are not correct | ▸ Check the receiver configuration settings. |
| Output signal not available or incorrect | Instrument does not work properly | ▸ Check there is 12 V DC power to the transmitter and receiver<br>▸ Check the windows for contamination.<br>▸ Check optical alignment using the telescopes.<br>▸ Check for obstacles in the path of the beam.<br>▸ Check the transmitter pulse and LED pulse are present.<br>▸ Check the performance of the real-time $C_n^2$ calculations of the receiver<br>▸ Report any malfunctions or damage to the representative of OTT HydroMet. |

### 11.2 Testing the GPS

The LAS should display Firmware 3.00, when the power supply is switched on.

- ▸ To check the GPS is obtaining a fix, select menu **1. RealTime Data - 14. Latitude/15. Longitude**
  - ⇨ The display should show the latitude position of the LAS.
  - ⇨ If the display shows *GPS timed out* after some time, no communication is possible with the GPS.
  - ⇨ If the display shows *GPS not enabled*, the baud rate should be correctly set.
  - ⇨ If the display shows *no location data*, the GPS is enabled and running, but does not have a valid fix to locate the instrument.

| GPS status message | Description |
|---|---|
| XYZ North (or XYZ East), etc. whereby: XYZ = Longitude (or Latitude) | Valid location received |
| *No location data* | No valid location data received from the GPS or void signal |

| GPS status message | Description |
|---|---|
| *GPS timed out* | No data received from the GPS (GPS cable not connected, no communication, GPS hardware problems, cable problems or wrong baud rate / parity etc.); the GPS times out after 30 sec of no communication. |
| *GPS not enabled* | The communication port COM2 is not enabled or the baud rate of the GPS is not set (baut rate = 0), see configuration menu **Interface COM2** |
| *No GPS board* | GPS interface board is not installed |

- Test the GPS without the cable from the digital output on the LAS to the serial port on the host:
- If the GPS fails, disconnect the cable from the LAS to the host.
- Check if the GPS operates without the cable.
- Reinstall the cable.
  - ⇨ If the GPS fails again after reinstalling the cable, there is a conflict between the GPS out signal and the DCD (data carrier detect) signal on the host.
- Cut the white wire in the (yellow) cable from the digital output on the LAS to the host computer.
- If there is no communication after some time, check the baud rate of the GPS as follows:
  select the configuration menu **2. Configuration** - **6. Interface COM2** - **2. BaudRate**
- Enter the baud rate, confirm and restart the device as follows:
  **2. Configuration** - **6. Interface COM2** - **5. Restart**.

> The default baud rate of the GPS is set to 38400 baud by the manufacturer of the GPS, but if the GPS has no valid configuration data then the baud rate defaults to 9600 baud or some other value.

- If the GPS doesn't work after trying different baud rates, connect a standard 8 wire yellow cable to the sensor output.
- Measure the voltage between the red and black wire (5 V).
- Measure the voltage between the yellow and black wire (approx. 12 V). The voltage depends on the input voltage applied to the LAS on the power input socket.
- Install a special serial data cable.
- When the GPS is connected to the Sensor Input: monitor the GPS output on the digital plug to the host or PC.
- Connect the black wire of the digital output to the signal ground of a RS-232-C input on the computer.
- Connect the white wire (GPS out) to the RS-232-C Receive Data (RD) input on the computer.
- Start a terminal emulation program on the computer.

# 12 Repair

**12.1 Customer support**

- Have repairs carried out by OTT HydroMet service personnel.
- Only carry out repairs yourself, if you have first consulted OTT HydroMet.
- Contact your local representative: www.otthydromet.com/en/contact-us
- Include the following information:

– instrument model
– instrument serial number
– details of the fault or problem
– examples of data files
– readout device or data acquisition system
– interfaces and power supplies
– history of any previous repairs or modifications
– pictures of the installation
– overview of the local environment conditions

*OTT HydroMet repair service*

# 13 Notes on disposing of old devices

**Member States of the European Union**

In accordance with the German Electrical and Electronic Equipment Act (ElektroG; national implementation of EU Directive 2012/19/EU), OTT HydroMet takes back old devices in the Member States of the European Union and disposes of them in the proper manner. The devices that this concerns are labeled with the following symbol:

- For further information on the take-back procedure contact OTT HydroMet:

OTT HydroMet B.V.
Service & Technical Support
Delftechpark 36
2628 XH Delft
The Netherlands
phone: +31 15 2755 210
email: solar-info@otthydromet.com

**All other countries**

- Dispose of the product in the proper manner following decommissioning.
- Observe the country-specific regulations on disposing of electronic equipment.
- Do NOT dispose of the product in household waste.

# 14 Technical data

## 14.1 Optical and electrical data

### Specifications of the LAS MkII transmitter and receiver

| Specification | Value |
|---|---|
| Supply voltage | nominal 12 V DC (9.6 to 18 V DC |
| Window heater | Self-regulating (heater off at approx. +55 °C) |
| Surge protection | For transmitter power, but not for heater |
| Operating temperature | -20 °C to +50 °C |
| Humidity range (non-condensing) | 0 to 100 % |
| Protection rating | IP65 |

### Specifications of the LAS MkII transmitter

| Specification | Value |
|---|---|
| Power | 6 W maximum with heater off<br>54 W maximum with heater on, typical 26 W |
| Centre wavelength of transmitting LED | 850 nm |
| Modulation frequency | 8 kHz (duty cycle 0.5) |
| Beam width | Approx. 1 m at 100 m distance |
| Fresnel lens diameter (clear aperture) and focal length | 149 mm / 152 mm |

### Specifications of the LAS MkII receiver

| Specification | Value |
|---|---|
| Power | 3 W maximum with heater off<br>51 W maximum with heater on, typical 23 W |
| Centre wavelength of optical filter for photodiode detector | 850 nm |
| Fresnel lens diameter (clear aperture) and focal length | 149 mm / 152 mm |
| Scintillation signal bandwidth | 0.1 to 400 Hz |
| Typical value signal 1 ($U_{C2}^{n}$, log $C^2_n$ signal) | 0 to 2.4 V (2.5 V max) |
| Typical value signal 2 (8 kHz carrier) | 0 to 1 V, 8 kHz, 0.5 duty cycle |
| Typical value signal 3 ($U_{DEMOD}$, signal strength I) | 0 to 2 V |
| $C^2_n$ turbulent range | $10^{-17}$ to $10^{-11}$ $m^{-2/3}$ |
| Noise level of electronics | < $10^{-17}$ $m^{-2/3}$ |

### Specifications of the LAS MkII scintillometer system

| Specification | Value for LAS MkII | Value with restrictors |
|---|---|---|
| Nominal aperture | 150 mm | 100 mm |
| Minimum path length | 250 m | 100 m |

| Specification | Value for LAS MkII | Value with restrictors |
|---|---|---|
| Maximum path length | 4.5 km* | 1 km |
| Minimum height | 1.5 m | 1.5 m |
| Maximum height for $C_n^2$ (or turbulence) measurements | no operational restriction | no operational restriction |
| Maximum height for H measurements Constant Flux Layer | Approx. 100 m | Approx. 100 m |

*The transmitter has sufficient power to reach 6 km with clear atmospheric conditions, but the user must be careful to check that the LAS is at a sufficiently high height (on a high tower) to avoid saturation, but not outside the Constant Flux layer. In warm regions with high fluxes this is not possible, but in cool high latitudes it may be possible to meet these criteria.

### 14.2 Dimensions and weight

#### LAS MkII transmitter and receiver

| Specification | Value |
|---|---|
| Dimensions (width x depth x height) | 229 x 266 x 297 cm* |
| Weight | 8500 g* |

*Including pan and tilt assembly, but excluding sun shield or telescope

OTT HydroMet

Contact Information