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USER GUIDE

DST111

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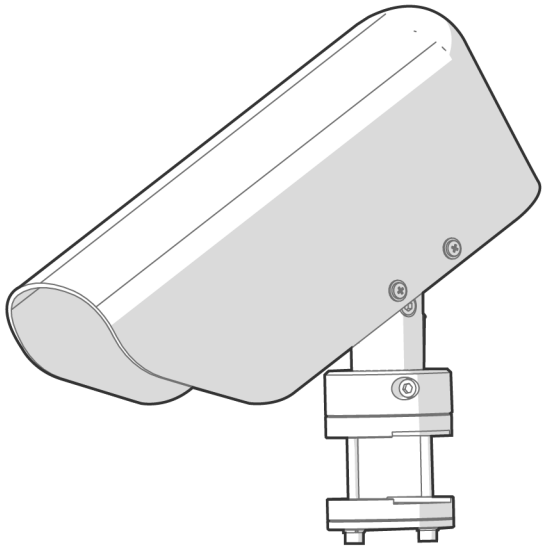


M210716EN-E

User Guide

Vaisala Remote Road Surface Temperature Sensor

DST111



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1. About this document

1.1 Version information

This document provides instructions for installing, operating, and maintaining Vaisala Remote Road Surface Temperature Sensor DST111.

Table 1 Document versions (English)

Document code	Date	Description
M210716EN-E	May 2025	Removed references to DST111R. Updated cleaning instructions. Updated Power in and RS-485 connector pinout information. Added a note to ensure that the silica gel bag is properly placed inside DST111 before reattaching the back plate.
M210716EN-D	April 2013	Updated for new mounting bracket.
M210716EN-C	August 2012	Updated for HMP60.

1.2 Related manuals

Table 2 Related manuals

Document code	Name
M211651EN	*Vaisala Remote Road State Sensor DSC211 User Guide*
M210714EN	*Vaisala Remote Road State Sensor DSC111 User Guide*

1.3 Documentation conventions



WARNING! 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.



CAUTION! Caution warns you of 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

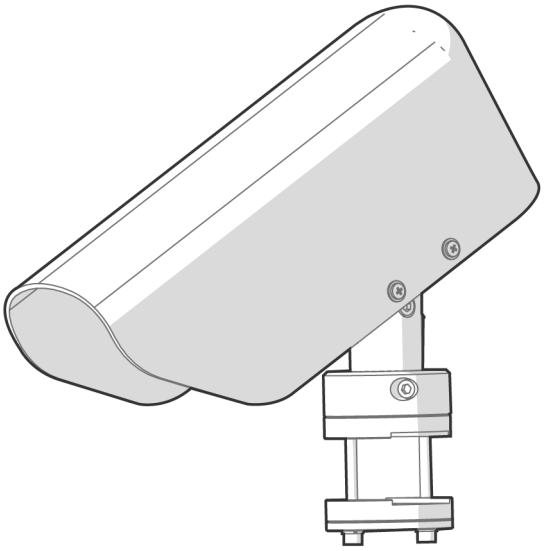
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2. Product overview

2.1 Vaisala Remote Road Temperature Sensor DST111



DST111 is an infrared surface temperature sensor that reports the temperature of the surface in its field of view. DST111 also measures and reports air temperature, relative humidity, and dew point temperature for DST111 operational use.

DST111 provides reliable results in conditions where most of the commercially available infrared sensors fail. At nighttime, when the road surface is cooling under a clear sky, conventional infrared sensors provide an error of up to −3 °C due to emissivity conditions of the road surface. DST111 compensates for this error by using wavelengths where mirrored radiation is not visible. This also eliminates the need for road specific emissivity adjustment.

2.1.1 DST111 surface temperature sensor

DST111 incorporates an RS-485 serial line and is intended to be connected to an RS-485 line or directly to Vaisala Remote Road State Sensor DSC111 or DSC211 or Vaisala Road Weather Station RWS200 or its predecessor ROSA.

2.1.2 Hardware structure

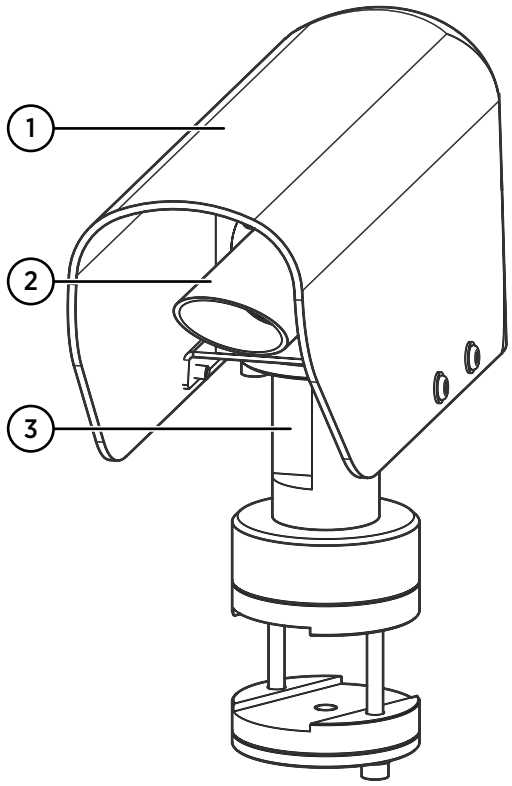


Figure 1 DST111 parts

1 Weather shield
2 Detector hood
3 Base

2.2 Operating principle

DST111 is a remote sensor intended for measuring road surface temperatures. The sensor is located by the road side so that there is a line-of-sight view of a selected spot on the road surface. Installation over the road on a bridge or on a traffic sign gantry is also possible.

DST111 is based on long-wave infrared radiation. The sensor measures and calibrates net heat flow at a selected wavelength range to produce the temperature difference between the unit and the road surface.

All remote thermometers need a way to take care of changes in the emissivity of the target. With DST111, the effect of changing emissivity is minimized to fractions of a degree Celsius by proper selection of the wavelength range. In practice, there is no need to adjust the emissivity for different road surface states.

2.3 Safety

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



WARNING! When performing installation and maintenance procedures at the roadside, follow local and state legislation and regulations for road safety.



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



WARNING! Ground the product and verify outdoor installation grounding periodically. Failure to provide proper grounding can result in injury or death from electrical shock and can severely damage the equipment.



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



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.

2.3.1 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. Getting started

3.1 Operating DST111

For instructions on how to connect and configure DST111 for RWS200, see RWS200 documentation.

DST111 is usually connected to the DSC111 or DSC211 sensor, which collects the data and makes it available to the host computer.

In addition, a set of user commands is provided for configuring and monitoring the sensor performance. These commands can only be given in the command mode.

DST111 has 2 different standard message formats for message output.

3.1.1 Connecting to DST111

To configure DST111, connect your computer to the RS-485 line of DST111. You can establish the RS-485 connection through a USB – RS-485 converter.

If DST111 is connected to a DSC111 or DSC211 sensor, connect the computer to the RS-232 port of DSC111 or DSC211.

Use a terminal software, such as PuTTY, to enter commands and to receive the responses from DST111.

Table 3 Default communication settings for DST111

Setting	Default value
Bit rate	9600
Data bits	8
Parity	None
Stop bits	1

3.1.2 Entering and exiting command mode in standalone DST111

1. Before giving any configuration commands, open the command mode.

```
<ENTER> OPEN 1 <ENTER>
DST 1 OPENED FOR OPERATOR COMMANDS
>
```

If you do not know the ID for DST111, use the following command.

```
<ENTER> OPEN DST * <ENTER>
DST 8 OPENED FOR OPERATOR COMMANDS
>
```

2. After giving the desired commands, close the command mode.

```
>CLOSE <ENTER>
LINE CLOSED
```

More information

- CLOSE command (page 29)
- OPEN command (page 29)

3.1.3 Entering and exiting command mode in DST111 connected to DSC111

1. Open the command mode of DSC111 or DSC211.

```
>OPEN 23<ENTER>
DSC 23  OPENED FOR OPERATOR COMMANDS
```

2. Open the communication link.

```
LINK<ENTER>
RS LINK IS ON
```

3. Open the command mode of DST111.

```
>OPEN DST *<ENTER>
DST 1 OPENED FOR OPERATOR COMMANDS
```

4. After having entered the desired commands, close the command mode of DST111.

```
>CLOSE<ENTER>
LINE CLOSED
```

5. Close the communication link.

```
<ESC><ESC><ESC>
RS LINK CLOSED
```

6. Close the command mode of DSC111 or DSC211.

```
>CLOSE<ENTER>
LINE CLOSED
```

   The command mode closes automatically approximately 15 seconds after the last character is given to the serial line. If the command mode closes, give the **OPEN** command again to open it.

More information

- CLOSE command (page 29)
- OPEN command (page 29)

3.2 Configuring DSC111 and DST111 connected to ROSA station

This example shows how to configure DSC111 and DST111 when they are connected to ROSA road weather station. For instructions on connecting DST111 to RWS200, see RWS documentation.



Set the RS-232 interface setting of ROSA DRI521 card according to the communication device. See *ROSA User's Guide (M210242EN)*.

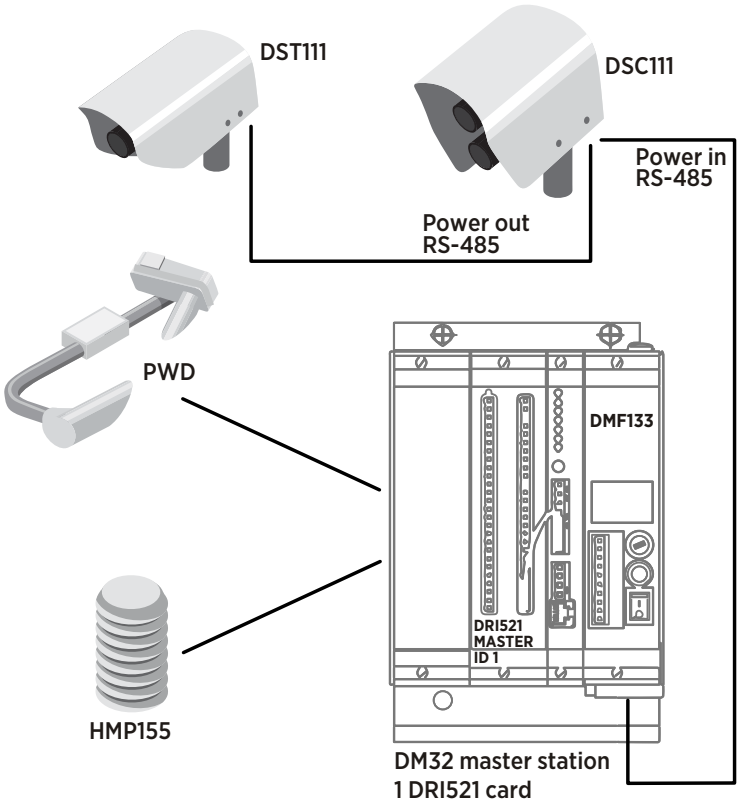


Figure 2 DSC111 and DST111 connected to ROSA station

1. Connect your computer to the RS-232 port of the DRI521 card.

   You can use the port for all configuration work. The IDs are:
   - DRI521 = **1**
   - DSC111 = **2**
   - DST111 = **3**

3.2.1 Configuring DRI521 card for DSC111 and DST111

1. Open the connection to ROSA.

```
<ENTER>OPEN 1<ENTER>
2022-04-21 17:52 01 ROSA
LINE A OPENED
```

2. Configure DSC111 and DST111 as remote devices to the master DRI521 card.
   a. Add DSC111 (ID 2) to the remote device list.

```
>REMO ROSA 2<ENTER>
REMOTE LIST UPDATED
```

   b. Add DST111 (ID 3) to the remote device list.

```
>REMO ROSA 3<ENTER>
REMOTE LIST UPDATED
```

   c. Change the mode to master.

```
>MODE MASTER<ENTER>
MODE UPDATED
```

3. Check the configuration.

```
>CONF<ENTER>
VER: DM32 V1.07 2011-09-09 SN:A22405
CONFIGURED PARAMETERS, ROSA
ID: 01, MASTER
BAUD 232: 9600
BAUD 485: 9600
RS232 INTERFACE: RS232
SALT TYPE: 1 (NaCl)
HISTORY INTERVAL: 10M
REMOTE SYSTEM
ROSA 2
ROSA 3
```

4. Close the connection to ROSA.

```
>CLOSE<ENTER>
SAVING PARAMETERS...
2022-04-21 17:52 01 ROSA
LINE A CLOSED
```

3.2.2 Configuring DSC111 connected to DST111 for ROSA

1. Open the ROSA communication link to the RS-485 line.

```
<ENTER>LINK<ENTER>
ROSA communication link on
```

2. Configure the date, time, ID, and name for DSC111.
3. Set DSC111 to listen to DST111.

   Set the `Slave A` parameter to be the same as the ID of DST111.
   Example:

```
>CONF 4 3<ENTER>
4 Slave A     3.000
```

4. Check that the configuration succeeded.

```
>CONF 1<ENTER>
1 Mode          0.000
```

```
>CONF 4<ENTER>
4 Slave A      3.000
```

5. (Optional) Copy the data parameters to be polled from the DRI521 card.

   If you prefer polling only the DRI521 card, you can copy the following data parameters from DSC111 to the DRI521 card:
   - Air temperature (data number 01 in messages)
   - Relative humidity (02)
   - Dew point (03)
   - Input voltage (14)
   - Road temperature (30)
   - Coverage thickness (42)
   - Surface state (66)

3.2.3 Configuring DST111 connected to DSC111 for ROSA

1. Open the connection to DST111.

```
>OPEN 1<ENTER>
DST 1 OPENED FOR OPERATOR COMMANDS
```

2. Change DST111 ID to **3**.

```
>ID 3 <ENTER>
ID STRING: 3
```

3. Check the system parameters.

```
>PAR<ENTER>
DST PARAMETERS
ID STRING: 3
VERSION: V1.05 2013-02-15
SERIAL NUMBER: A23403
BAUD: 9600
AUTOMATIC MESSAGE: -1 0
```

4. Close the connection.

```
>CLOSE<ENTER>
LINE CLOSED
```

5. Close the communication link.

```
<ESC><ESC><ESC>
LINK CLOSED
```

6. Request a message from DSC111.

```
<ENTER> @2 MES 16 <ENTER>
02
2005-06-08 14:05,01,M16,DSC
01  -1.5;02    20;03  -3.0;14  23.8;60  -2.0;61    00;66   206;68  0.15;
71    00;72  0.00;73  0.05;74  0.35;
=
```

All data parameters measured by DSC111 and DST111 are available in the message requested from the DSC111 sensor.
All data parameters measured by the DRI521 card, for example wind speed and direction, are available in the messages requested from the DRI521 card.

More information

- PAR command (page 27)
- ID command (page 28)

4. Installation

4.1 Installing DST111

To prevent corrosion, oxidation, and seizing, use a non-conductive, non-water-soluble, non-silicone-based grease, such as ceramic or Teflon paste, between different kinds of metal.

4.2 Placing DST111

Install the sensor on a mast or pole adjacent to the road. For the most reliable measurements:

- Avoid obstacles between the sensor optics and the road surface.
- Do not aim the sensor against traffic flow.
- Use a steep installation angle for the sensor.
- Ensure that the rising or setting sun does not cause reflections from the road surface to the sensor optics.
- Park stationary maintenance vehicles with flashing lights outside the sensor's measurement area.

In the Northern Hemisphere, point the sensor to the North, or at an angle of incidence higher than the local maximum solar elevation. This protects the sensor from direct solar beam reflection from a wet surface that could result in an increase in the surface temperature reading.

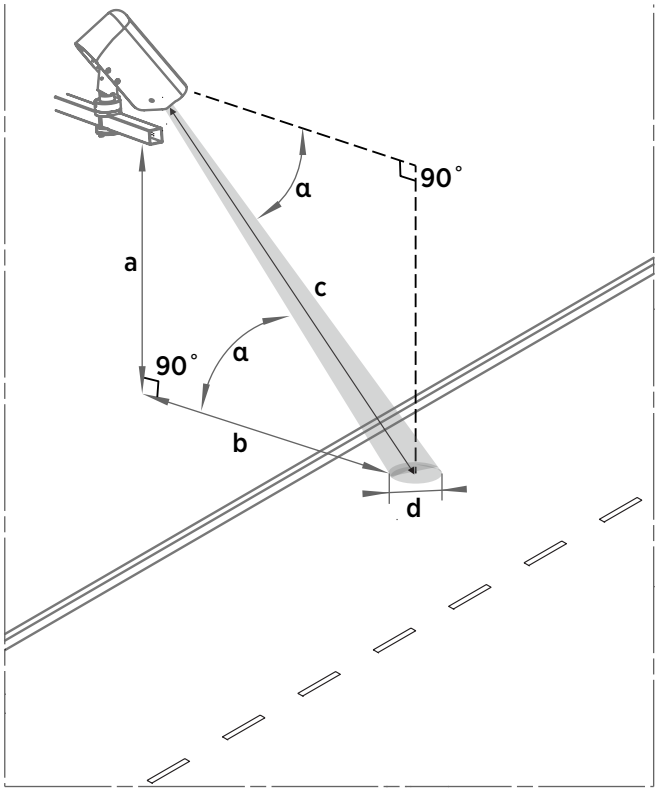


Figure 3 Aiming DST111

If you can choose between different installation angles (α) and measuring distances (c), choose a short measuring distance.

Table 4 Limits for DST111 measuring distance and installation angle

Dimension	Range
Measuring distance	2–15 m (6 ft 8 in – 49 ft 3 in)
Installation angle from the horizontal line	30–85° (35–65° recommended)

Table 5 Examples of valid DST111 installation dimensions

Height a (m)	Length b (m)	Installation angle α (°)	Measuring distance c (m)
3	3	45	4.2
3	4	37	5.0
4	3	53	5.0
4	4	45	5.7
4	5	39	6.4
5	5	45	7.1
5	7	36	8.6

Height a (m)	Length b (m)	Installation angle α (°)	Measuring distance c (m)
6	6	45	8.5
6	8	37	10.0
7	7	45	9.9
7	9	38	11.4
8	8	45	11.3

The diameter of the measuring area is proportional to the measuring distance:

- At 10 meters (32 ft 10 in), the diameter is 150 cm (59 in).
- At 5 meters (16 ft 5 in), the diameter is 75 cm (30 in).

This area covers approximately 50 % of the total measured signal.

You can also calculate the installation angle and the measuring distance as follows:

$$\alpha = \arctan\frac{a}{b}$$

$$c = \sqrt{a^2 + b^2}$$

4.3 Mounting DST111



- 5-mm Allen key (included)
- Laser distance meter with incline measurement capability (not included)

1. Assemble the mounting bracket.

   Leave the long screws loose so that you can slide the bracket on the support arm. If you cannot slide the bracket on the support arm, leave one of the screws unattached so that you can lift the sensor to its place.

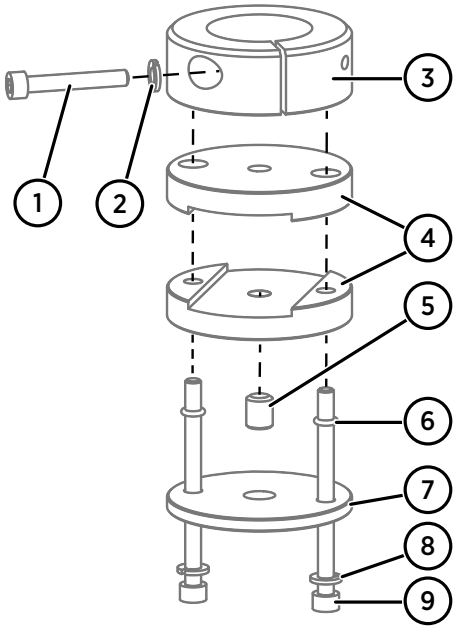
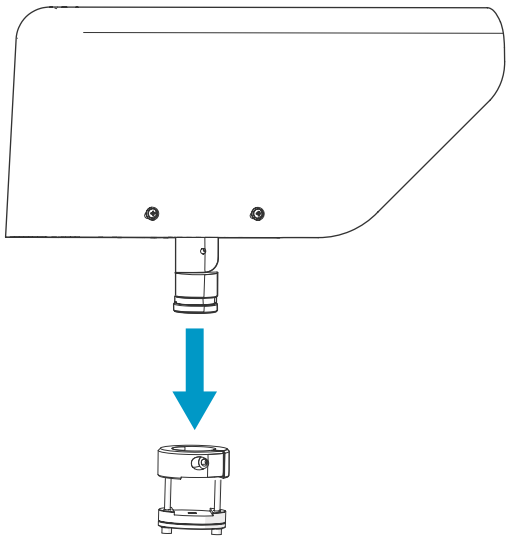


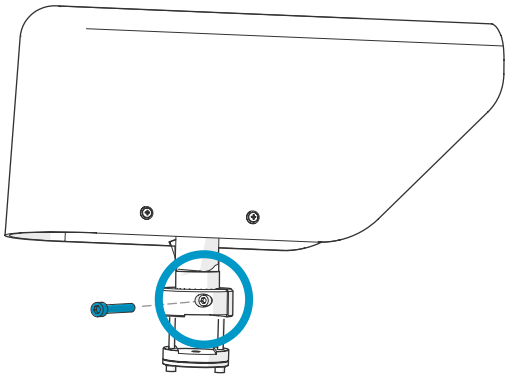
Figure 4 DSC/DST mounting bracket

1 Hex screw M6×40 DIN912 A4 (installation bolt)
2 Spring washer M6 DIN127 A4
3 Bracket
4 Support arm fixture part (2 pcs)
5 Hex screw M10×50 DIN916 A4
6 O-ring 4×2 silicone (2 pcs)
7 Sensor bar fixture plate
8 Spring washer B6 DIN127 A4 (2 pcs)
9 Hex screw M6×80 DIN912 A4 (2 pcs)

2. Remove the installation bolt and place the sensor onto the mounting bracket.



3. Insert the installation bolt and spring washer. Tighten the bolt. Tightening torque 10 Nm.



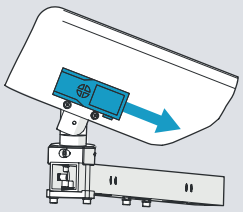
4. Connect the sensor cable to the **POWER IN** connector at the bottom of the sensor.

> Mark the cable so that you can keep track of the cables after installation.

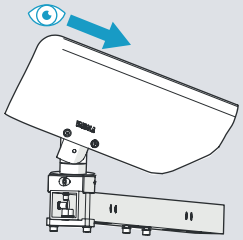
5. Haul the sensor up.
6. Slide the mounting bracket on the support arm, and tighten the screws. Tightening torque 5 Nm.

7. Aim the sensor using a laser distance meter.

For proper aim, place the distance meter onto the 2 screws below the Vaisala logo.



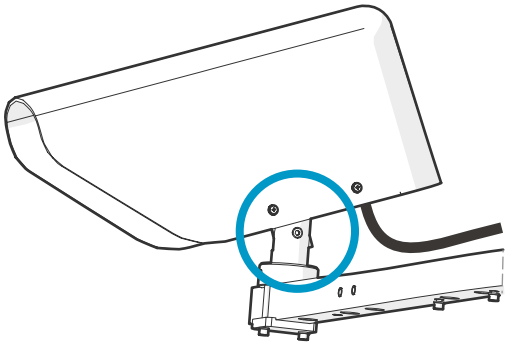
If you do not have a laser distance meter, aim the sensor by looking along the straight part of the edge of the weather shield.



8.

Make sure that the sensor points to an area that contains homogeneous material. Avoid painted lines on the road surface and, if possible, surface only partly covered in snow during the winter.

9. Tighten the tilt screw and all other bolts firmly. Tightening torque 5 Nm.



10. Measure the distance of the sensor from the road and the installation angle.

4.4 Setting measuring distance

The measuring distance is individual to each installation location, and DST111 must be configured according to that distance. Each unit has been adjusted for a 10-meter (33-foot) distance at the factory.

1. Open the connection to DST111.

```
>OPEN 1<ENTER>
DST 1 OPENED FOR OPERATOR COMMANDS
```

2. Configure the DST111 slope distance to the road surface.

   Set the **DISTA** parameter (**CONF 8**) to the measuring slope distance from the DST111 sensor to the road surface in meters. For example, to set the measuring distance to 9 meters, give the following command:

```
>CONF 8 9<ENTER>
8 DISTA  9.000
```

3. Check the configuration parameters.

```
>CONF <ENTER>
VER: DST111 V1.05 2013-02-15 SN:A23407
CONFIGURED PARAMETERS
1 A0      0.00, 2 A1     1.000, 3 SA0    0.4000,
4 SA1    1.600, 5 SSCAL 14.000, 6 SOFFS    0.00,
7 LOFFS   0.00, 8 DISTA  5.000, 9 DISSI  0.0200,
10 ECHO  1.000,
```

4. Close the connection.

```
>CLOSE<ENTER>
LINE CLOSED
```

More information

- CONF command (page 26)
- CONF 8 command (page 27)

5. Operation

5.1 Network commands

You can give network commands directly to the sensor without opening the command mode. The sensor responds to the network commands as if the commands were given at the command prompt level with the exception that all response messages are preceded by an identification number.

Network commands must be preceded by the string `@[ID]`:

```
<ENTER>@[ID] {command} [parameters]<ENTER>
```

Table 6 Format of network command

Part	Explanation
`<ENTER>`	Carriage return character, ASCII 13
`[ID]`	DST111 device ID (for example, `1`)
`{command}`	Command (for example, MES 16)
`[parameters]`	Possible parameters of the command

For example, to request the MES 16 data message, give the following command:

```
<ENTER>@1 MES 16<ENTER>
```

Example of output:

```
01
2005-01-23 12:34,01,M16,DST
01  22.5;02  36.8;03   7.1;14  23.4;60  22.2;61     0;
=
```

The response to a network command starts with the device ID line in the following format:

```
<CR><LF>[DSC111 address with a leading zero]
```

5.2 System configuration commands

5.2.1 BAUD command

The **BAUD** displays or sets the baud rate of the serial line.

Table 7 Communication settings

Setting	Possible values
Baud rate	`300`, `1200`, `2400`, `4800`, or `9600` (default)
Data bits	`8`
Parity	`None`
Stop bits	`1`

To display the current baud rate, give the following command:

```
BAUD<ENTER>
```

To set the baud rate, give the following command:

```
>BAUD [rate]<ENTER>
```

5.2.2 CONF command

The **CONF** command displays or sets the system and calibration parameters. Usually, you only need to change the `DISTA` and `ECHO` parameters.

Table 8 **CONF** command syntax

Command	Description
CONF<ENTER>	Displays all parameters.
CONF [n]<ENTER>	Displays the value of parameter **n**.
CONF [n] [value]<ENTER>	Sets the given value for parameter **n**.

Example of configuration parameters

```
CONF<ENTER>
VER: DST111 V1.05 2013-02-15 SN:A23407
CONFIGURED PARAMETERS
1 A0     0.00,     2 A1 1.000,   3 SA0 0.4000,
4 SA1   1.600, 5 SSCAL 14.000,   6 SOFFS 0.00,
7 LOFFS  0.00, 8 DISTA 10.000, 9 DISSI 0.0200,
10 ECHO 1.000,
```

More information

- Setting measuring distance (page 24)

5.2.2.1 CONF 8 command

DISTA displays or sets the measuring distance of DST111 in meters. The distance indicates the direct slope distance from the sensor to the target area on the road surface.

Example:

```
>CONF 8<ENTER>
8 DISTA 10.000
```

More information

- Setting measuring distance (page 24)

5.2.2.2 CONF 10 command

ECHO enables or disables the status of the command mode echo of the serial line. The current status is shown. By default, the echo is off.

- `0` = Echo is off. The characters typed to the serial line are not echoed.
- `1` = Echo is on. The characters typed to the serial line are echoed.

Example:

```
>CONF 10<ENTER>
```

Do not enable echo when DST111 is operated through the DSC111 or DSC211 communication link or a DRI521 card because the response will be too slow.
For information about RWS200, see RWS200 documentation.

5.2.3 PAR command

The **PAR** command shows the DST111. parameters.

```
>PAR<ENTER>
```

Example:

```
>PAR<ENTER>
DST PARAMETERS
ID STRING: 1
VAISALA DST111: V1.05 2013-02-15
SERIAL NUMBER: A23403
BAUD: 9600
AUTOMATIC MESSAGE: -1 0
```

More information

- Configuring DST111 connected to DSC111 for ROSA (page 16)

5.3 Device identification commands

5.3.1 ID command

The **ID** command displays or sets the identification string of DST111.

```
>ID [ID]<ENTER>
```

- ID = 1 … 99

Example:

```
>ID 1<ENTER>
ID STRING:  1
```

More information

- Configuring DST111 connected to DSC111 for ROSA (page 16)

5.3.2 VER command

The **VER** command shows the software version of DST111.

```
VER<ENTER>
```

Example:

```
>VER<ENTER>
VAISALA DST111: V1.05 2013-02-15
```

5.4 Other commands

5.4.1 CLOSE command

The **CLOSE** command closes the command mode of DST111.

```
>CLOSE<ENTER>
```

Example:

```
>CLOSE<ENTER>
LINE CLOSED
```

More information

- Entering and exiting command mode in standalone DST111 (page 11)
- Entering and exiting command mode in DST111 connected to DSC111 (page 11)

5.4.2 HELP command

The **HELP** command shows all commands.

```
HELP<ENTER>
```

5.4.3 OPEN command

Before giving any commands other than network commands to DST111, you must open the command mode.

```
>OPEN [ID]<ENTER>
```

- **ID** = DST111 address

Example:

```
>OPEN 1<ENTER>
DST 1 OPENED FOR OPERATOR COMMANDS
```

The default ID is 1. If you do not know the ID, use the following command:

```
>OPEN DST *<ENTER>
```

Example:

```
>OPEN DST *<ENTER>
DST 1 OPENED FOR OPERATOR COMMANDS
```

The command mode closes automatically approximately 15 seconds after the last character is given to the serial line. If the command mode closes, give the **OPEN** command again to open it.

More information

- Entering and exiting command mode in standalone DST111 (page 11)
- Entering and exiting command mode in DST111 connected to DSC111 (page 11)

5.4.4 RESET command

The **RESET** command restarts DST111.. Parameter values are not affected by restart.

```
RESET<ENTER>
```

Example:

```
>RESET<ENTER>
VAISALA DST111: V1.05 2013-02-15
```

5.4.5 STA command

The **STA** (status) command provides useful information on the internal measurement results. This helps to locate the source of an error.

Example:

```
>STA<ENTER>
DST STATUS
DST111 V1.05 2013-02-15 SN: A23407 ID STRING: 1
TS 24.17
TA 23.2
RH 44.5
TDET 24.02
VB 24.1
OFFSET 1.7 0.979
```

If a valid parameter is not correctly measured, its value is replaced with 5 slash characters (/////).

Table 9 STATUS command parameters

Parameter	Explanation
TS	Road surface temperature
TA	Air temperature from HMP60
RH	Relative humidity from HMP60
TDET	Temperature of the detector. The difference between TDET and TA should be less than ±0.5 °C if the sensor has been in fairly unchanged temperature for approximately 1 hour or longer. The first number of the OFFSET should be between 0 and 100.
VB	Input voltage in volts
OFFSET	Offset of the AD converter

More information

- Checking DST111 functionality (page 36)

6. Data reporting

6.1 Data messages

The recommended message to be polled is MES 16. MES 14 is provided only for compatibility with ROSA. RWS200 supports both message formats.

If a valid parameter is not correctly measured, its value is replaced with 5 slash characters (/////).

All message lines end with CR and LF characters.

The date and time stamps in the messages do not change. They have permanent values of `2005-01-23` and `12:34`.

6.1.1 MES 16 format and contents

MES 16 format:

```
2005-01-23 12:34,01,M16,DST
01  22.5;02  36.8;03   7.1;14  23.4;60  22.2;61     0;
=
```

Table 10 MES 16 contents

Source	Data number	Name	Code	Range, resolution, and unit
DST111	01	Air temperature	T1	−40.0 ... +60.0 °C
DST111	02	Relative humidity	RH1	000.0–100.0 %
DST111	03	Dew point	TD1	−40.0 ... +60.0 °C
DST111	04–13	Reserved	–	–
DST111	14	Power supply voltage	BT1	9.0–30.0 V
DST111	15–59	Reserved	–	–
DST111	60	Road temperature	TS3	−40.0 ... +60.0 °C
DST111	61	DST111 hardware status	HTS	00–99. See DST111 hardware status code (page 33).

6.1.2 MES 14 format and contents

MES 14 format:

```
2005-01-23 12:34,01,M14,DST
01  22.6;02  36.9;03   7.1;14  23.4;60  22.3;61     0;
=
```

Table 11 MES 14 contents

Source	Data number	Name	Code	Range, resolution, and unit
DST111	01	Air temperature	T1	–40.0 ... +60.0 °C
DST111	02	Relative humidity	RH1	000.0–100.0 %
DST111	03	Dew point	TD1	–40.0 ... +60.0 °C
DST111	04–13	Reserved	–	–
DST111	14	Power supply voltage	BT1	9.0–30.0 V
DST111	15–29	Reserved	–	–
DST111	30	Road temperature	TS3	–40.0 ... +60.0 °C
DST111	31–60	Reserved	–	–
DST111	61	DST111 hardware status	HTS	00–99. See DST111 hardware status code (page 33).

6.1.3 DST111 hardware status code

Table 12 DST111 hardware status code

Code	Explanation
0	Hardware OK
1	CPU hardware warning
2	Detector hardware warning
3	Humidity and air temperature measurement failure

6.2 Data request commands

6.2.1 AMES command

The **AMES** command defines the message number and time interval for an automatically sent message.

```
>AMES [n] [t]<ENTER>
```

- `n` = The message number, for example, `16`.
- `t` = Time interval in minutes. If the value is set to `0`, the message is sent as soon as possible, approximately every 30 seconds.

The default setting is **`AMES -1 0`**, which disables the sending of automatic messages.

Example:

```
>AMES 16 1<ENTER>
AUTOMATIC MESSAGE: 16 1

2005-01-23 12:34,01,M16,DST
01 22.7;02 46.1;03 10.5;14 23.4;60 22.4;61 0;
=
```

DST111 sends Message 16 to the serial line every minute.

6.2.2 MES command

The **`MES`** (or **`M`**) command shows the contents of the given data message. This command also functions as a network command.

```
MES {n}<ENTER>
```

- `n` = Message number: `14`, or `16`. The recommended message to be polled is MES 16.

Example:

```
>MES 16<ENTER>
01
2005-01-23 12:34,01,M16,DST
01  22.5;02  36.8;03   7.1;14  23.4;60  22.2;61     0;
=
```

More information

- Checking DST111 functionality (page 36)

6.3 Polling command

The standard way to request data from the site is to use the **`MES`** command as a network command.

```
<ENTER>@[ID] MES [n]<ENTER>
```

- **ID** = DST111 ID
- **n** = Data message number (**14** or **16**)

The following shows how to poll DST111.

1. Give the following command:

   ```
   <ENTER>@1 MES 16<ENTER>
   ```

   Example of output:

   ```
   01
   2005-01-23 12:34,01,M16,DST
   01  22.6;02  41.0;03   8.7;14  23.5;60  22.0;61     0;
   =
   ```

The first **<ENTER>** of the polling command is used to awaken the RS-485 line.

If there are other devices such as DSC111, DSC211, or a DRI521 card connected to the same RS-485 line, you can poll it in a similar way.

7. Maintenance

7.1 DST111 maintenance

Preventive maintenance for DST111 includes:

- Checking that the sensor is aimed at the wheel track. The wheel track may change its place over the winter. To check that the sensor is aimed at the desired area on the road surface, look along the straight part of the edge of the weather shield.
- Cleaning the sensor.
- If you suspect that the humidity observation values are not accurate, change the humidity sensor and the filter.
- If you suspect that the air temperature observation values are not accurate, contact Vaisala for instructions on how to replace the HMP60 probe.

7.2 Checking DST111 functionality



When DST111 is part of RWS200, check the functionality of the sensor through the Web UI. See RWS200 documentation.

1. Open the connection to DST111.

```
>OPEN 1<ENTER>
DST 1 OPENED FOR OPERATOR COMMANDS
```

2. Give the **MES 16** command and check that all data parameters are displayed.

```
>MES 16<ENTER>
01
2005-01-23 12:34,01,M16,DST
01  22.5;02  36.8;03   7.1;14  23.4;60  22.2;61     0;
=
```

If a valid parameter is not correctly measured, its value is replaced with 5 slash characters (/////).

3. Give the **STA** command and check that all parameters have a valid value.

```
>STA<ENTER>
DST STATUS
DST111 V1.05 2013-02-15 SN: A23407 ID STRING: 1
TS 24.17
TA 23.2
RH 44.5
TDET 24.02
VB 24.1
OFFSET 1.7 0.979
```

4. Close the connection.

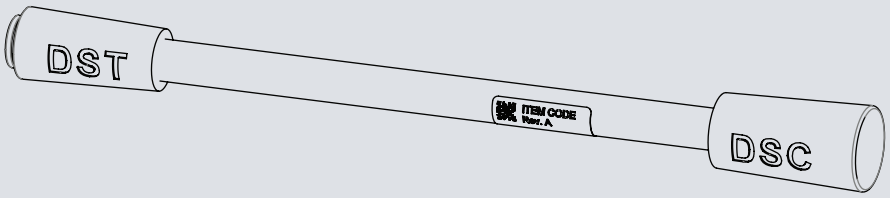
```
>CLOSE<ENTER>
LINE CLOSED
```

More information

- STA command (page 30)
- MES command (page 34)

7.3 Cleaning DST111

- Soft, lint-free cloth
- 50 % isopropyl alcohol
- DSC and DST cleaning tool (DSCDSTCLEANINGTOOL)



Whenever you visit the site, clean the DST111 window.

1. Using low pressure, spray 50 % isopropyl alcohol on the window. Spray enough solution to dissolve and loosen any dirt.
2. Wrap a soft, lint-free cloth around the DST end of the cleaning tool.
3. Wipe the window until it is clean.

4. Take a new, clean cloth and wipe the receiver window until it is clean.
5. Wait until the windows are dry.

7.4 Checking HMP60

Hand-held temperature and humidity meter

1. Compare DST111 air temperature and relative humidity readings with those received from a hand-held temperature and humidity meter.

   If possible, place the sensor head of the meter near the HMP60 probe under the DST111 cover.
   The maximum difference allowed between the readings is approximately ±1 °C and ±6 %RH.

7.4.1 Replacing HMP60 filter and humidity sensor

- 1.5 and 5-mm Allen key
- Crosshead screwdriver

The INTERCAP humidity sensor of HMP60 and the membrane filter of the probe head are interchangeable.

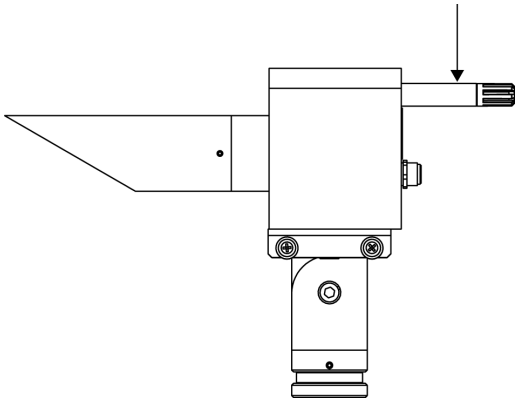
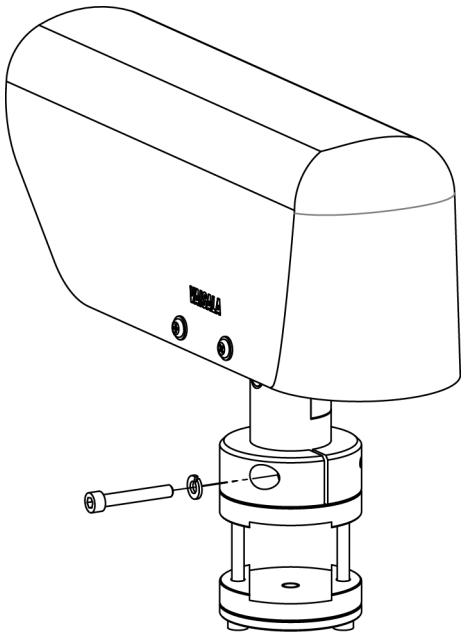


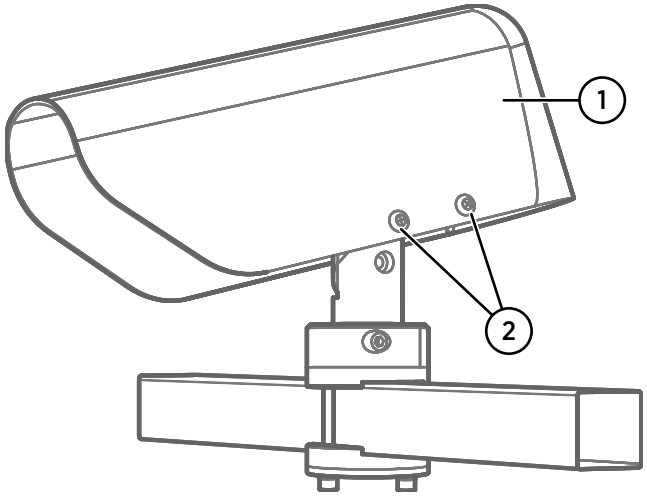
Figure 5 HMP60 inside DST111

1. Disconnect the sensor cable from the sensor.

2. Remove the installation bolt and lift DST111 down from the mast.

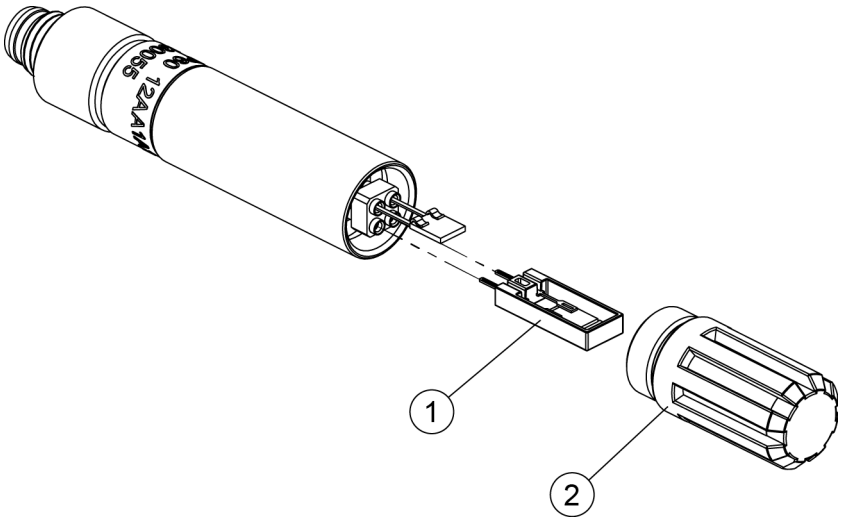


3. Remove the weather shield.



1 Weather shield
2 Shield screws (4 pcs)

4. To remove the filter, turn the filter counterclockwise.



1 Humidity sensor
2 Filter

5. Pull out the old humidity sensor and insert a new one. Handle the new sensor by its plastic frame.

> **CAUTION!** Do not touch the sensor plate. It is fragile.

6. Attach the new filter on the probe, and fasten the weather shield.
7. Reinstall the sensor on the mast and reconnect the sensor cable.

7.5 Checking measurement accuracy

Check the measurement accuracy using a contact thermometer instead of an infrared thermometer to achieve better accuracy and to avoid emissivity and reflection errors.

1. Make a firm contact to the road surface with the contact thermometer probe.

   Make sure that the following conditions are met:
   - The weather is cloudy. There is no excessive heat flow to or from the road surface that causes the temperature distribution to be unequally spread.
   - The difference between the air temperature and the road surface temperature is less than ±10 °C.

Changing calibration is not straightforward and requires several dozens of measurements. Vaisala recommends that you send the sensor to Vaisala for recalibration.

8. Troubleshooting

8.1 Connecting termination resistor



Crosshead screwdriver

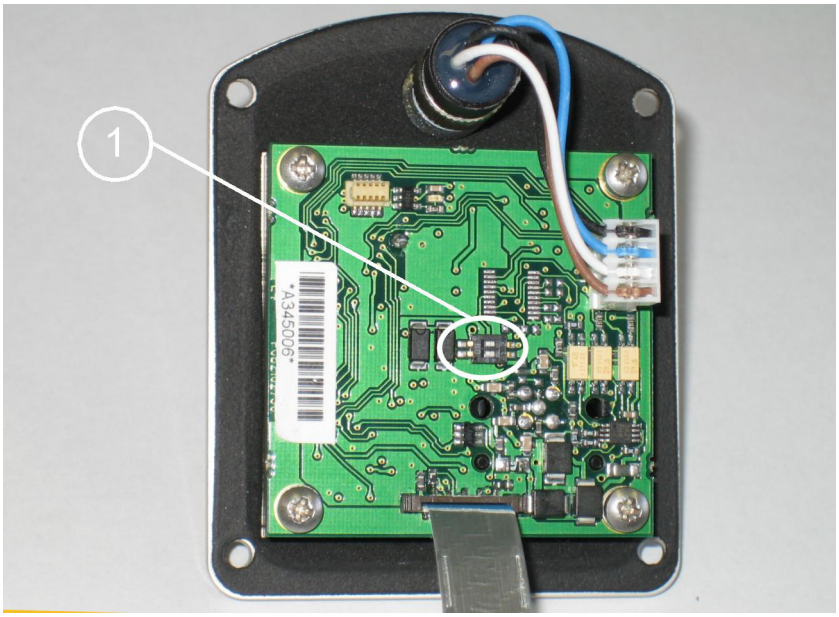
If DST111 is connected to an RS-485 line that is longer than 200 meters (656 ft), the line may need a termination resistor to match the impedances of the cable and the device. If there are no communication problems, the line does not need a resistor.

The sensor contains an internal termination resistor that is normally not connected, but may need to be connected in some circumstances.

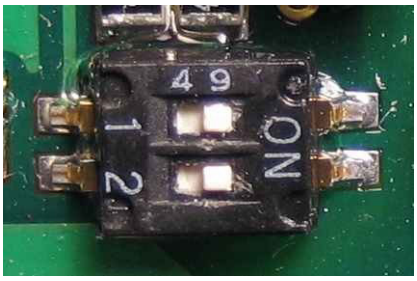
1. Disconnect power from the sensor.
2. Remove the weather shield.
3. Remove the 4 screws of the back plate.
4. Gently pull the back plate off from the sensor body. Use a screw driver if needed.

   The CPU board is connected to the detector board with a flexible flat cable. If the cable comes off from the connector, pull up the brown clip of the connector, insert the cable, and push the clip back.

5. In the termination resistor, switch both actuators **1** and **2** of the switch to **ON**.



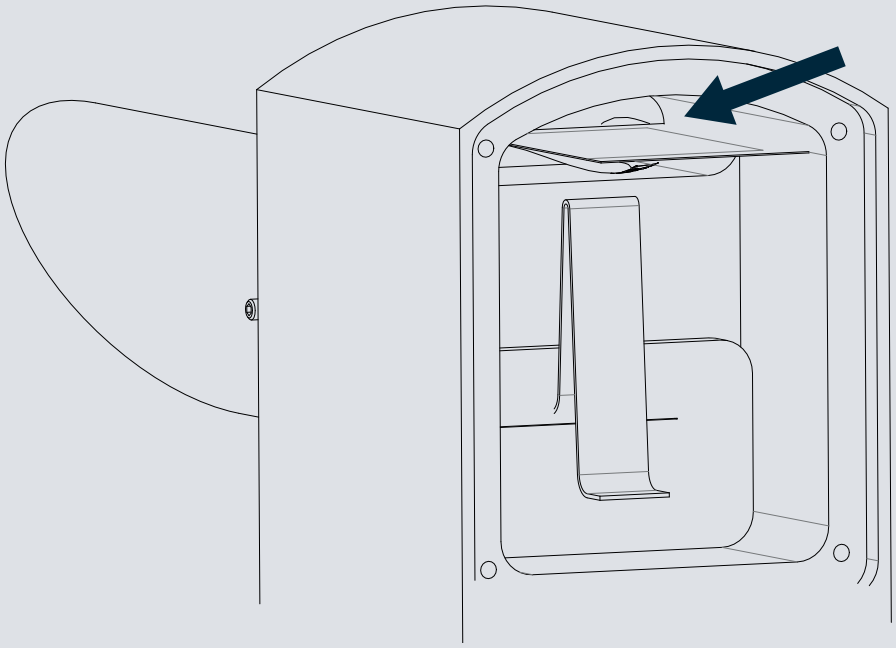
1 Termination resistor



The termination resistor is connected only when both actuators are in the **ON** position.

6. Reattach the back plate and the weather shield.

Make sure that the silica gel bag is properly placed inside the device and not caught between the cover, as this may break the bag.



7. Connect a termination resistor also to the other end of the long RS-485 line. A typical value for the resistor is 100 Ω.

Do not connect more than 2 termination resistors to the entire system.

9. Technical data

9.1 DST111 connector

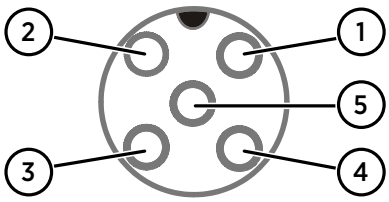


Figure 6 Connector pin numbers

Table 13 DST111 connector: Power in and RS-485, male M12

Pin	Signal	Connect to RWS200	Wire color
1	+Vin 9–30 V	+24 V out	Brown
2	RS-485 D+	RS-485 D+	White
3	GND	GND	Blue
4	RS-485 D–	RS-485 D–	Black
5	Not connected	–	Gray
Shield	SGND	Grounding rail	–

9.2 DST111 specifications

Table 14 Measurement performance

Property	Description/Value
Measuring distance	2–15 m (6 ft 7 in – 49 ft)
Installation angle from the horizontal line	30–85° (35–65° recommended)
Measuring area diameter	150 cm at 10 m (59.1 in at 32 ft)
Road temperature	
Observation range	−40 ... +60 °C (−40 ... +140 °F)
Resolution	0.1 °C
Accuracy (RMS error [1)])	0.3 °C (0.5 °F)
Time constant	1 min

Property	Description/Value
Data refresh time	30 s

1) *The RMS (root mean square) error of the surface temperature reading is 0.3 °C in typical freezing conditions when compared to a reference thermometer installed on the road surface. This accuracy is valid when the difference between the device temperature and the surface temperature is less than 10 °C and the device temperature is in the range of −40 … +40 °C. (In the range of +40 … +60 °C the error may be increased by an offset of ±1.5 °C.)*

Table 15 HMP60 measurement performance

Property	Description/Value
Relative humidity [1)]	
Measurement range	0–100 %RH
Resolution	0.1 %RH
Typical accuracy at +20 °C (+68 °F)	±3 %RH (0–90 %RH) ±5 %RH (90–100 %RH)
Air temperature [1)]	
Measurement range	−40 … +60 °C (−40 … +140 °F)
Resolution	0.1 °C
Typical accuracy at +20 °C (+68 °F)	±0.6 °C (±1.1 °F)
Dew point temperature [1)]	
Measurement range	−40 … +60 °C (−40 … +140 °F)

1) *The relative humidity, air temperature, and dew point readings of HMP60 are mainly intended for internal compensation of DST111. The accuracy is not as high as that of the HMP155 sensor with a proper solar radiation shield.*

The accuracy of HMP60 may be further decreased under intense solar radiation or radiation loss due to the properties of the DST111 weather shield.

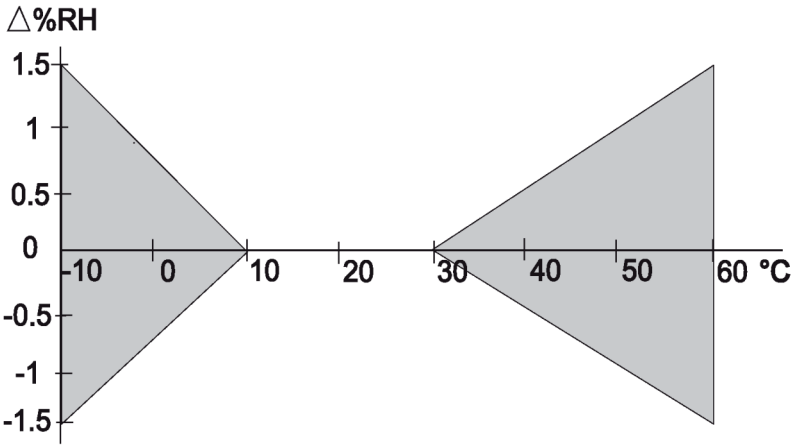


Figure 7 Temperature dependence of relative humidity measurement

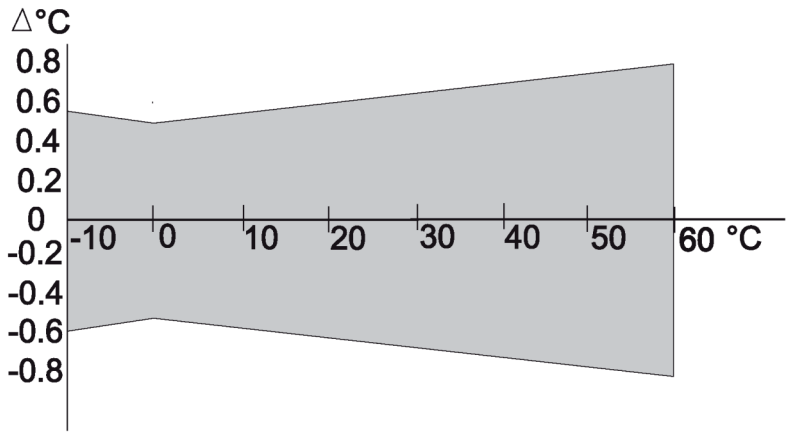


Figure 8 Accuracy of air temperature measurement over temperature range

Table 16 Inputs and outputs

Property	Description/Value
Input voltage	9–30 V DC
Average input current	1.4 mA at 24 V
Average power consumption	0.05 W at 24 V
Communication interface	Isolated RS-485
Connectors	Male M12 (5 pins) including RS-485 and power in Cable connector Ø 15 mm (0.59 in)
Cables	3–150 m (9 ft 10 in – 492 ft) [1)] One end without connector 0.6 m (1 ft 12 in) extension cable to DSC111 or DSC211

1) Cables longer than 50 m (164 ft) require a minimum of 24 V input.

Table 17 Operating environment

Property	Description/Value
Operating temperature	–40 ... +60 °C (–40 ... +140 °F)
Storage temperature	–55 ... +60 °C (–67 ... +140 °F)
Operating humidity	0–100 %RH
IP rating	IP65: Dust-tight. Protected from water jets from any direction.

Table 18 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 FCC part 15 B, Class B ICES-3 / NMB-3 (Class B)
Environmental	EN IEC 63000:2018
Vibration	IEC 60068-2-6, Level 2 g

Table 19 Mechanical specifications

Property	Description/Value
Dimensions (H × W × D)	125 × 100 × 320 mm (4.92 × 3.94 × 12.60 in)
Weight	1.9 kg (4.19 lb)
Mounting	Fits on a support arm with cross-section of 40 × 40 mm (1.57 × 1.57 in)
Materials	
Cover	ABS plastic
Mounting bracket	POM-C
Other parts	Aluminum

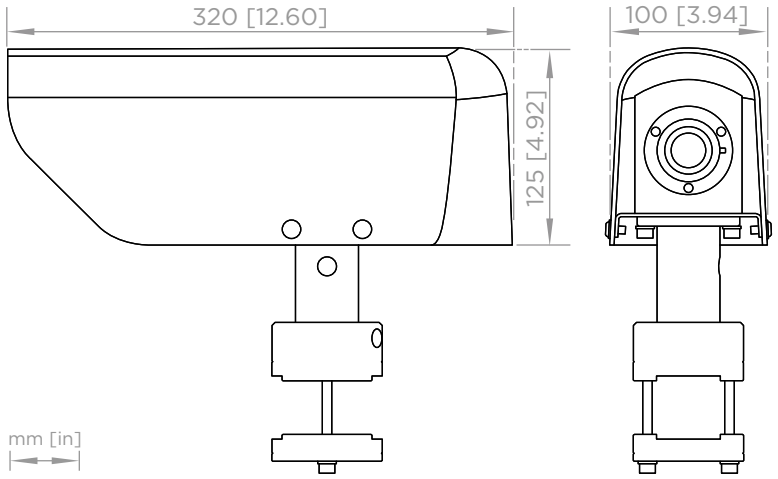


Figure 9 Dimensions

Appendix A. 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.

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.

Warranty

For standard warranty terms and conditions, see vaisala.com/warranty.

Please observe that any such warranty may not be valid in case of damage due to normal wear and tear, exceptional operating conditions, negligent handling or installation, or unauthorized modifications. Please see the applicable supply contract or Conditions of Sale for details of the warranty for each product.

Technical support



Contact Vaisala technical support at helpdesk@vaisala.com. Provide at least the following supporting information 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 on the problem

For more information, see vaisala.com/support.

Product returns

If the product is faulty, these steps help to speed up the return process and avoid extra costs.

1. Read the warranty information.
2. Contact Vaisala technical support and request a Return Material Authorization (RMA) and shipping instructions.



Always request the RMA before returning any faulty material.

Provide the failure report as requested.

Recycling



Recycle all applicable material according to local regulations.

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VAISALA

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