VAISALA

USER'S GUIDE

Vaisala Present Weather Detector PWD22/52

M210543EN-F

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CHAPTER 1
GENERAL INFORMATION

This chapter provides general notes for the product.

About This Manual

This manual provides information for installing, operating, and maintaining Vaisala Present Weather Detector PWD22/52.

Version Information

Table 1   Manual Revisions

Manual Code	Description
M210543EN-F	September 2015. This manual. Added information on the two heating options. Added Appendix D describing how to calibrate the TS sensor. Added cleaning and painting instructions.
M210543EN-E	Previous version.

Related Manuals

Table 2   Related Manuals

Manual Code	Manual Name
M210542EN	Vaisala Present Weather Detector PWD12, User's Guide
M210541EN	Vaisala Visibility Sensor PWD10/20/50, User's Guide

Documentation Conventions

Throughout the manual, important safety considerations are highlighted as follows:

	WARNING!
	Warning alerts you to a serious hazard. If you do not read and follow instructions very 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.

	Note highlights important information on using the product.

Safety

Vaisala Present Weather Detector PWD22/52 delivered to you has been tested for safety and approved as shipped from the factory. Note the following precautions:

WARNING!

The chassis of the PWD22/52 must be connected to a good electrical earth.

WARNING!

Do not touch the surface of the RAINCAP® Rain sensor plate. When you need to touch the sensors plate, for example during cleaning, touch first a metallic part of PWD22/52 to discharge your body's electrostatic load. The measuring principle does not allow for proper ESD protection.

WARNING!

Do not operate the equipment in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

WARNING!

A lightning strike through a communication wire can cause voltage surge dangerous to life at remote sites if the remote units are not properly grounded.

CAUTION!

Do not modify or substitute parts in the instrument. Contact Vaisala or its authorized representative for repairs.

CAUTION!

Tighten the connector properly. The cable connector must not swing in relation to the fixed connector.

CAUTION!

Transport and store the component boards, including CMOS microchips, in conductive packages.

Although new CMOS devices are protected against overvoltage damages caused by static electric discharge of the operator, careful handling is recommended. The operator should be properly grounded.

Avoid handling component boards unnecessarily.

CAUTION!

Servicing the equipment must be performed by qualified personnel.

RADIO FREQUENCY INTERFERENCE STATEMENT (USA)

The United States Federal Communications Commission (in 47 CFR 15.838) has specified that the following notice must be brought to the attention of users of this kind of a product in the USA:

Federal communications commission radio frequency interference statement

This equipment generates and uses radio frequency energy and if not installed and used properly, that is in strict accordance with the manufacturer's instructions, may cause interference to radio and television reception. The Present Weather Detector is designed to provide reasonable protection against such interference in an airport installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment causes 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 the receiving antenna
- Relocate the device with respect to the receiver
- Move the device away from the receiver

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions.

ESD Protection

Electrostatic Discharge (ESD) can cause immediate or latent damage to 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 inside the equipment housing.

To make sure you are not delivering high static voltages yourself:

- Handle ESD sensitive components on a properly grounded and protected ESD workbench. When this is not possible, ground yourself to the equipment chassis before touching the boards. Ground yourself with a wrist strap and a resistive connection cord. When neither of the above is possible, touch a conductive part of the equipment chassis with your other hand before touching the boards.
- Always hold the boards by the edges and avoid touching the component contacts.

Recycling

	Recycle all applicable material.

	Dispose of batteries and the unit according to statutory regulations. Do not dispose of with regular household refuse.

Regulatory Compliances

The PWD series visibility sensors and present weather detectors are in conformity with the provisions of the following EU directive(s):

- EMC Directive (2004/108/EC)

Conformity is shown by compliance with the following standards:

- EN 61326-1:2006-04 Electrical equipment for measurement, control and laboratory use - EMC requirements - for use in industrial locations.
- EN 55022:2006 + Am 1:2007 to EN55022:2006 Class B. Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement.

Trademarks

RAINCAP® is a registered trademark of Vaisala. Microsoft® and Windows® are registered trademarks of Microsoft Corporation in the United States and/or other countries.

License Agreement

All rights to any software are held by Vaisala or third parties. The customer is allowed to use the software only to the extent that is provided by the applicable supply contract or Software License Agreement.

Warranty

Visit our Internet pages for standard warranty terms and conditions: www.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.

CHAPTER 2
PRODUCT OVERVIEW

This chapter introduces Vaisala Present Weather Detector PWD22/52 features, advantages, and product nomenclature.

Introduction to Vaisala Present Weather Detector PWD22/52

PWD22/52 is a multi-variable sensor for automatic weather observing systems. The sensor combines the functions of a forward scatter visibility meter and a present weather sensor. PWD22/52 measures the intensity and amount of both liquid and solid precipitation. If the detector is equipped with a background luminance sensor, it also measures ambient light.

PWD22/52 is typically used as a component of a weather observation system. PWD22/52 is suitable for automatic weather station applications, especially for low-power requirement installations.

Table 3   PWD Sensor Series Model and Performance

Model	Performance
Visibility Sensor PWD10	Visibility range 10 m ... 2000 m
Present Weather Detector PWD12	Visibility range 10 m ... 2000 m 4 precipitation types
Visibility Sensor PWD20	Visibility range 10 m ... 20000 m
Visibility Sensor PWD50	Visibility range 10 m ... 35000 m
Present Weather Detector PWD22	Visibility range 10 m ... 20000 m 7 precipitation types
Present Weather Detector PWD22M	For Vaisala TACMET stations
Present Weather Detector PWD52	Visibility range 10 m ... 35000 m 7 precipitation types

The PWD22/52 measures precipitation water content with a capacitive Vaisala RAINCAP Rain Sensor and combines this information with optical scatter and temperature measurements. Together, these three independent measurements provide data for accurately evaluating the prevailing visibility and weather.

Hardware Structure

PWD22/52 is a self-contained instrument fastened to the side of a mast and into a cross arm using mounting clamps.
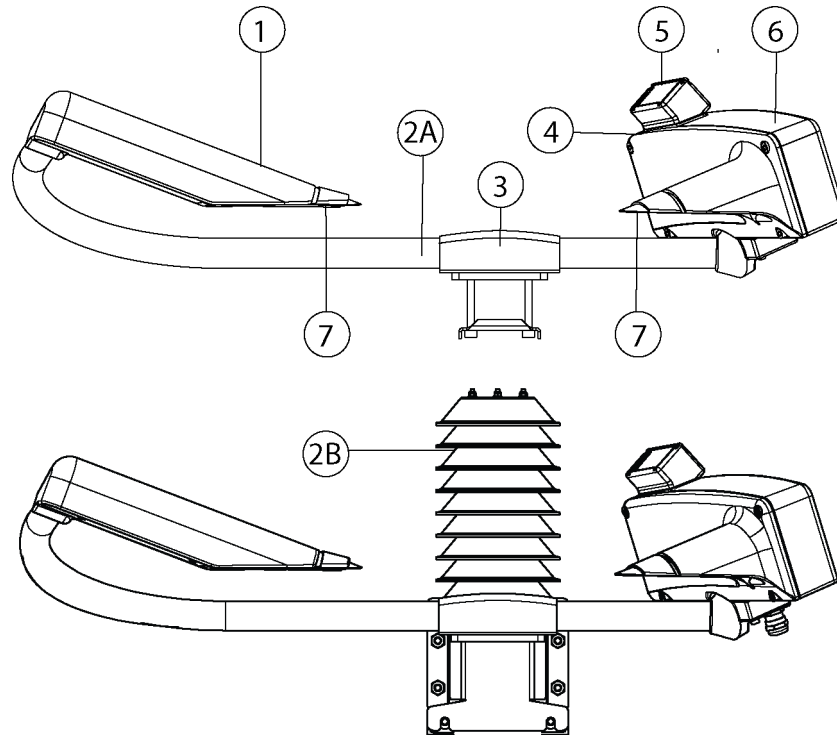
1502-007

Figure 1   **PWD22/52 Present Weather Detector**

1	=	Transmitter
2A	=	Pt100 temperature sensor in the tube (Option A)
2B	=	Pt100 temperature sensor in the radiation shield (Option B)
3	=	Mounting clamp
4	=	Place for Vaisala Luminance Sensor PWL111 (optional)
5	=	PWR211 Vaisala RAINCAP® Rain Sensor (PWR111 in PWD22M)
6	=	Controller/Receiver
7	=	Hood heaters (optional)

PWD22/52 Output

The PWD22/52 output is either:

- Digital serial interface
  The digital serial interface can be configured in two different operating modes: the sensor can be set to send a data message automatically at selected intervals, or PWD22/52 can be polled by the host computer. The same serial line also acts as an operator interface.

- Analog current signal
  The analog current signal can be used to report the prevailing visibility. Three relay controls can be used, driven by visibility limits.

The operator controls PWD22/52 using a maintenance terminal. Built-in commands and test routines are provided for configuring and monitoring.

The standard data messages contain a status character indicating faults detected by internal diagnostics. If the error status is set, the operator can view a status message containing the detailed diagnostics results and a description of the fault. The operator and maintenance personnel use this information to take corrective action.

Product Nomenclature

Table 4   Vaisala Present Weather Detector PWD22/52
               Nomenclature

Code	Common Name	Description
PWT11	Transmitter	LED Transmitter circuit board
PWC22	Controller/Receiver	Controller and photo diode circuit board for PWD22
PWC52	Controller/Receiver	Controller and photo diode circuit board for PWD52
PWR211	RAINCAP® Double-Plate Rain Sensor	A capacitive detector to sense water droplets and/or moisture. Two plate in a 90-degree angle towards each other.

Table 5   Optional Vaisala Present Weather Detector PWD
               Family Nomenclature

Code	Common Name	Description
PWL111	Background Luminance Sensor	
PWH111	Hood Heater Foils	
PWA12	Calibration Set	Includes a pair of precalibrated scatterers, a piece of cloth for cleaning the lenses and tools.
16385ZZ	RS-232 (9-pin) maintenance cable	Connects to standard PC communication port.
APPKP60-set -1/2 75-set -1/2 100-set -1/2	Attachment clamp	60 mm, 75 mm, or 100 mm clamp according to the mast diameter

Spare Parts

For a list of spare parts, contact Vaisala Technical Support at
helpdesk@vaisala.com.

CHAPTER 3
FUNCTIONAL DESCRIPTION

Vaisala Present Weather Detector PWD22/52 optical sensor measures visibility (Meteorological Optical Range, (MOR)), precipitation intensity, and precipitation type.

PWD22/52 measures visibility using forward scatter measurement: light scatters from particles whose diameter is in the order of magnitude of the wavelength of the light. The amount of scatter is proportional to the attenuation of the light beam.

Larger particles behave as reflectors and refractors and their effect on the MOR must be handled separately. Usually these particles are precipitation droplets. The optical arrangement of PWD22/52 allows individual droplets to be detected from rapid signal changes. The PWD22/52 software calculates the precipitation intensity by analyzing the amplitudes of these changes. The intensity estimate is proportional to the volume of the precipitation droplets.

The optical signal also contains precipitation type information. However, additional information is required to reliably identify precipitation types, especially in conditions such as very light precipitation or windy weather. PWD22/52 provides an extra parameter by estimating the precipitation's water content with Vaisala RAINCAP® Rain Sensor. In rain, the water equivalent and the optical volume are equal, while the optical volume in snow is about ten times larger than its water equivalent. PWD22/52 uses this difference to distinguish between rain and snow.

Identifying freezing conditions uses indirect methods that are affected by shortcomings in temperature measurement. Reporting temperatures and freezing conditions should be complemented with an expert familiar with local conditions.
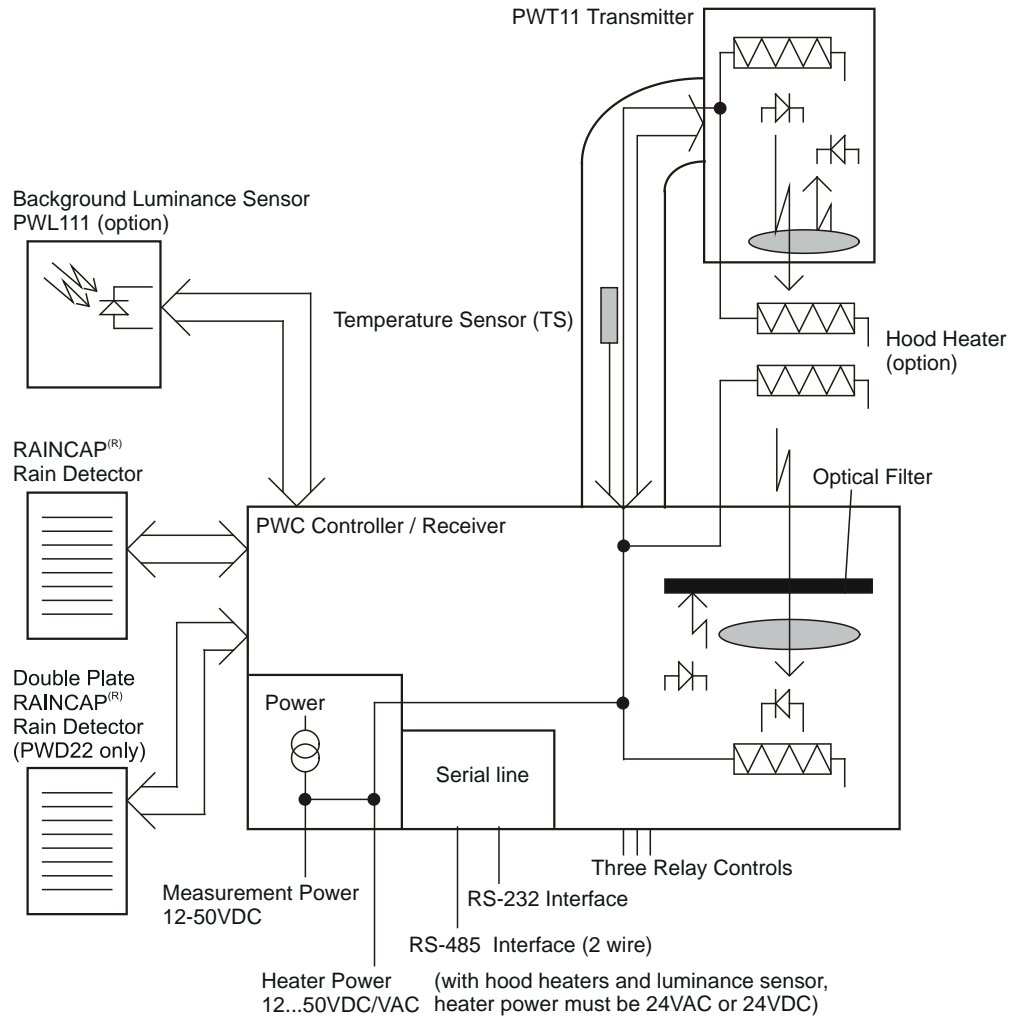
Figure 2   PWD22/52 Block Diagram

Optical Measurements

Optical Arrangement
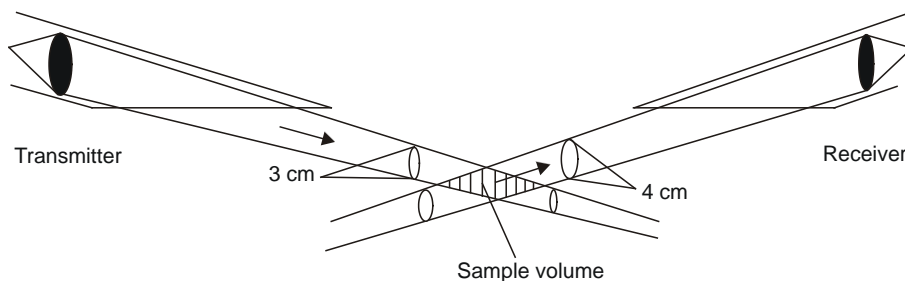
Figure 3   PWD22/52 Optical System

PWD22/52 measures light scattered at an angle of 45°. This angle produces a stable response in various types of natural fog. Precipitation droplets scatter light in a different manner from fog and their contribution to visibility must be analyzed separately. PWD22/52 can detect and measure precipitation droplets from the optical signal and use this information in processing scatter measurement results.

PWD22/52 has a small sample volume of about 0.1 liters (see Figure 3). This allows for independent particles to be measured at relatively heavy precipitation intensities. The signal levels from the smallest precipitation droplets can also be detected.

Transmitter Unit PWT11

The transmitter unit consists of an infrared LED control and triggering circuits, LED intensity monitor, and backscatter receiver.

The transmitter unit electronics pulses the IR-LED at a frequency of 2 kHz. A PIN photodiode monitors the transmitted light intensity. The transmitter intensity level measurement keeps the LED's intensity at a preset value automatically. The CPU monitors the "LEDI" feedback voltage to get information of the aging of the LED and possible defects.

The feedback loop compensates for the LED temperature and aging effects of the LED. On the other hand, the active compensation slightly accelerates the LED aging. The initial LED current is set to a value that ensures several years of operation without maintenance.

An extra photodiode measures the light scattered backwards from the lens, other objects, or contaminants. This signal is also monitored by the CPU.

Light Receiver

The Light Receiver consists of a PIN photodiode, preamplifier, voltage to frequency converter, backscatter measurement light source LED, and control and timing electronics.

The receiving PIN photodiode senses the transmitted light pulses scattered from the aerosol particles. A phase sensitive lock-in amplifier synchronized with the transmitter filters and detects the signal voltage.

An ambient light level as high as 30 kcd/m^2 does not influence the detection of the photo diode and does not saturate the preamplifier. The **AMBL** signal (proportional to the ambient light) is lead to the CPU for monitoring.

Additional Measurements

PWD22/52 includes RAINCAP for estimating the water content of precipitation, and a temperature sensor in the sensor cross arm or in an external radiation shield (TS). Both additional sensors are measured and interfaced by the PWC22/52 board. The RAINCAP temperature TDRD is measured for the RAINCAP heating (drying) control, and the box (PWC22/52) temperature TB is measured for the monitoring box heating.

Vaisala RAINCAP® Rain Sensor

The RAINCAP signal is proportional to the water amount on the sensing surfaces. Water on RAINCAP® changes the capacitance of the sensor elements. The capacitance of the elements controls the output frequency of an oscillator.

The frequency signal is measured once a second. The frequency is handled in the PWD22/52 internal units. The DRY value is about 800, which is also shown in the Status (STA) message.
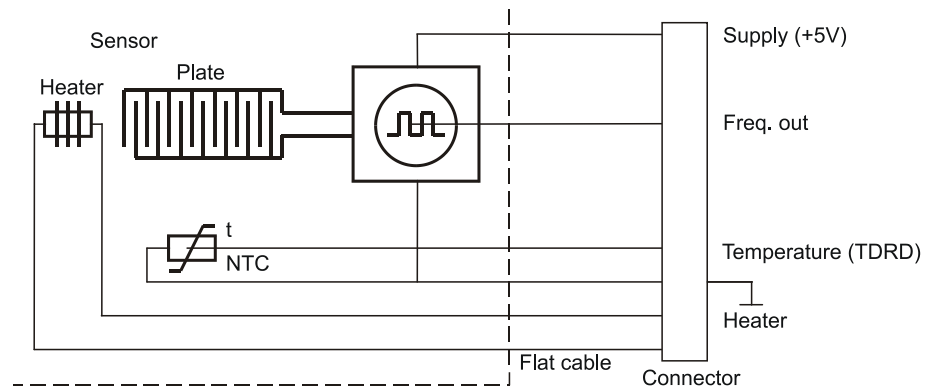
Figure 4   RAINCAP Block Diagram

The heating element built into the surface heats the RAINCAP. The heating power is controlled by software.

PWD22/52 is equipped with a double-plate RAINCAP to improve drizzle detection in certain conditions.

When the sensor element heating is switched off, they become highly sensitive to ambient moisture. If the relative humidity of the air is more than about 70 %, the surfaces produce a measurable signal even with no precipitation. In PWD22/52 this is used as an estimated humidity measurement. The estimated humidity is used to differentiate between dust and mist.

As PWD22/52 can detect the beginning of precipitation from the optical signal, RAINCAP can be used as a cross-check for the detection of above zero temperatures. This eliminates false detection of rain caused by, for example, mosquitoes.

Temperature Sensor

The primary temperature sensor of PWD22/52 is a Pt100 thermistor. The temperature is measured once a minute using a high resolution A/D converter. The sensor temperature (TS) is used to select an initial default precipitation type for the algorithm.

Possible temperature sensor locations in the PWD22/52 include:
- Inside the cross arm
  The cross arm temperature sensor provides adequate performance for most PWD22/52 applications.

- Inside an external radiation shield
  In some conditions, for example in calm winds, the hood heaters can cause a bias in the cross arm temperature measurement due to heat conduction. The optional temperature sensor in an external radiation shield avoids this bias.

Temperature measurement plays a role in identifying freezing conditions. Due to the effects described above, in some applications it is beneficial to augment the PWD temperature sensing with data from an external temperature sensor and/or an additional ice detection sensor. Reporting freezing conditions should be complemented with an expert familiar with local conditions.

Background Luminance Sensor PWL111 (optional)

PWL111 is used as a day/night switch for distinguishing day and night conditions. Its luminance measurement is rudimentary and indicative.

PWD22/52 measures the PWL111 signal every second and calculates a new one-minute running average every 15 seconds. The one-minute average is reported in the corresponding messages. The value range is 4 ... 20000 cd/m^2.

The sensor heaters are controlled in the same way as the other PWD22/52 heaters.

BLSC Command

The background luminance sensor can be used in continuous or day/night switch modes. When you give 1.0 as the BLSC value, the background luminance measurement mode is continuous. When you give a zero as the value, the measurement uses day/night switch mode.

When PWL111 is activated, its background luminance value is reported in message 7 and in the Status message.

Continuous Mode

The following command activates the sensor and gives a positive scaling factor to the luminance value.

```
>BLSC 1.0
```

The response is the following:

```
BL SCALE 1.000
```

Background luminance is reported in a range of 4 ... 20000 cd/m^2 with the above setting.

Day/night Switch Mode

The following command activates the sensor in day/night switch mode, that is, the luminance value is either 0 or 1. 0 indicates night time and 1 indicates day time.

```
>BLSC 0
```

Disabling PWL111

The negative scale directs PWD22/52 to skip the background luminance action. See the example below:

```
>BLSC -1
```

BLCAL Command

PWD22/52 calculates the new BL scale if the current background luminance in cd/m^2 is known. The PWL111 sensor must be activated by the BLSC command and the BLSC must be 1.0. where 12300 is the current background luminance in cd/m^2. Do not enter this command repeatedly with less than one minute intervals. Use the command only in stable weather with clear skies.

PWD22/52 calculates the BL scale in response to the following command:

```
>BLCAL 12300
```


HEATER POWER
12V or 24V

GAIN
ADJUSTMENT

OUTPUT

MEASUREMENT
POWER, 5VDC
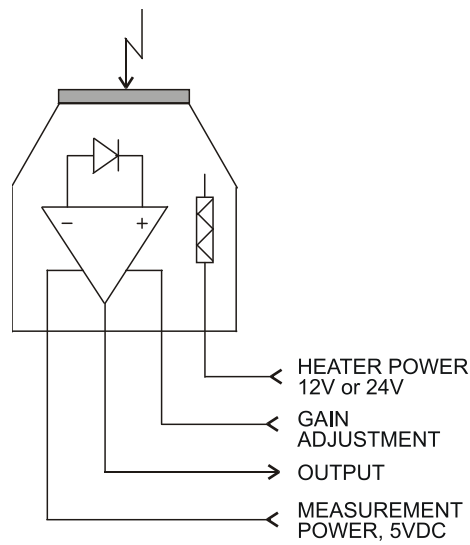
0310-001

Figure 5   PWL111 Block Diagram

Internal Monitoring

Built-in Tests

Built-in tests are included in the PWD22/52 operation to measure various voltages and check the corresponding alarm and warning limits. Optical contamination of both the transmitter and the receiver is continuously monitored by measuring the backscattered light. An additional transmitting LED is installed in the receiver for this purpose.

The software generates alarms if visibility is less than a given limit. PWD22/52 generates warnings of suspected faulty hardware. If a fatal hardware failure is detected, visibility data is not generated; it is substituted with slashes (/////). A status message displays the cause of the error in status bits.

Built-in tests include memory test, analog monitoring, and signal measurement monitoring. Results of the monitoring measurements are displayed in volts or hertz depending on their origin.

Watchdog circuitry monitors program operation. If the circuit is not triggered in about two seconds, it performs a hardware reset.
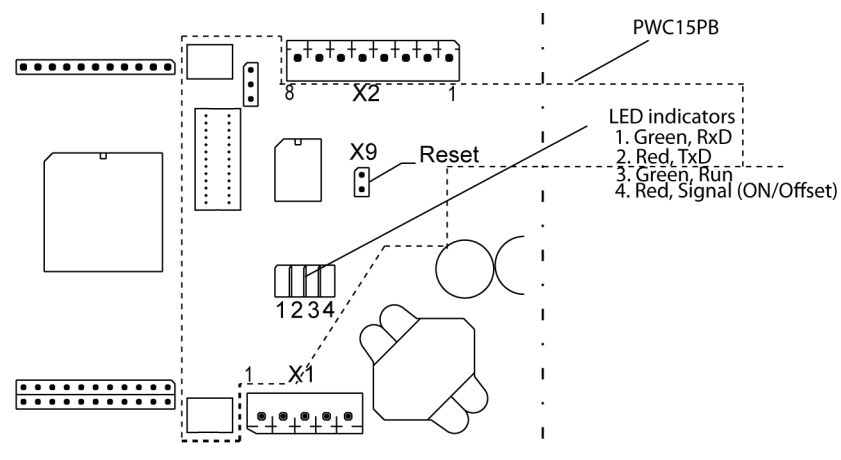
1206-026

Figure 6   LED Indicators on the PWC22/52 Board

Normal operation is indicated by the Run LED blinking once every second. The Signal/Offset LED is on, when PWD22/52 measures the visibility signal.

The RxD and TxD LEDs are directly controlled by the serial line hardware indicating all action in the serial line.

Memory Tests

After resetting, PWD22/52 tests and clears its SRAM data memory. It indicates an error by the Signal/Offset LED blinking. After 50 blinks PWD22/52 tries to start the program anyway. Usually this causes a watchdog reset, if the SRAM is really faulty.

The data SRAM test is also done continuously in the background in normal operation. If a SRAM error is detected, the watchdog resets the system.

The checksum of the parameter memory (EEPROM) is calculated and checked for test. An error in the checksum may be fatal (visibility is indicated using /////). The cause is displayed in the status message.

The EEPROM checksum is calculated and checked during every update of saved parameters and after restart.

Signal Monitoring

PWD22/52 measures the optical signal, receiver backscatter, and offset as frequencies in about eight millisecond samples. As the measuring times are 10 s, 1 s, and 4 s correspondingly, they must have different numbers of samples in a batch. PWD22/52 checks that the frequencies are not zero and signal sample count is bigger than the offset sample count.

Errors in signal or offset are fatal, and data is set to /////.

Offset drift is monitored separately. The reference offset frequency is given in the configuration session. If the drift is more than 10 Hz, the software generates a warning.

The user can follow the progress of the measurement sequence as the Signal/Offset LED sequence of 10 seconds on, and 5 seconds off.

Hardware Monitoring

An eight-channel analog-to-digital converter is used to measure hardware signals and voltages. The **STA** command displays the internal monitoring values (See section STA on page 75).

Monitoring Contamination

PWD22/52 monitors both transmitter and receiver contamination by measuring the backscattered signal.

The **CLEAN** command sets the clean reference values of the backscatter signals. Deviation of the backscatter signal from the clean values is proportional to the contamination on the lenses.

The alarm and warning limits are given in the configuration session. If the alarm limit is exceeded, data is set to ///// and an alarm is generated. The measured values are used only for warnings and alarms. No compensation for the visibility signal is calculated.

Transmitter backscatter is measured by an analog circuit using the transmitter LED as a light source. Its identifier is TR.BACKSCATTER in the status message. TR.BACKSCATTER is smaller for higher backscatter signals. Receiver backscatter is measured with the signal receiver using an additional, controlled LED as a transmitter. The result is in hertz. It is bigger, when more light is scattered back (REC. BACKSCATTER).

Data Message Formats

PWD22/52 is a fully automatic instrument for continuous weather measurement. Usually, PWD22/52 is set to either send data messages automatically or be polled by a host computer.

In addition, a set of user commands is provided for configuring and monitoring system performance. These commands are given in command mode (see section Entering and Exiting Command Mode on page 51).

PWD22/52 has seven standard message formats for data message output.

PWD22/52 presents the weather type using:

- World Meteorological Organization (WMO) code table 4680 (WaWa, Present Weather reported from an automatic weather station).
- WMO code table 4678 (METAR) format.
- United States National Weather Service (NWS) abbreviations.

Appendix C, NWS and WMO Code Tables, on page 113 lists the NWS list and WMO codes.

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CHAPTER 4
INSTALLATION

This chapter provides information intended to help you install the product.

Selecting Location

Finding a suitable site for Vaisala Present Weather Detector PWD22/52 is important for getting representative ambient measurements.

The main requirements for the location of PWD22/52 are:

1. Locate PWD22/52 a way that ensures measurements will be representative of surrounding weather conditions.
    -   The ideal site for PWD22/52 has a minimum clearance of 100 m from all large buildings and other structures that generate heat and obstruct precipitation droplets. Avoid the shade of trees because the trees may cause changes in the microclimate.

2. Ensure the site is free of obstacles and reflective surfaces disturbing the optical measurement as well as obvious sources of contamination.
    -   It is recommended that there are no obstacles in the line-of-sight of the transmitter and receiver units (see Figure 7 on page 32). If obstacles reflect the transmitter beam back to the receiver unit, the sensor indicates too low MOR values because the reflected signal cannot be distinguished from the actual scatter signal. To detect reflections, rotate the sensor cross arm. Check the visibility readings the corresponding visibility reading will change depending on the cross arm orientation.

0308-003
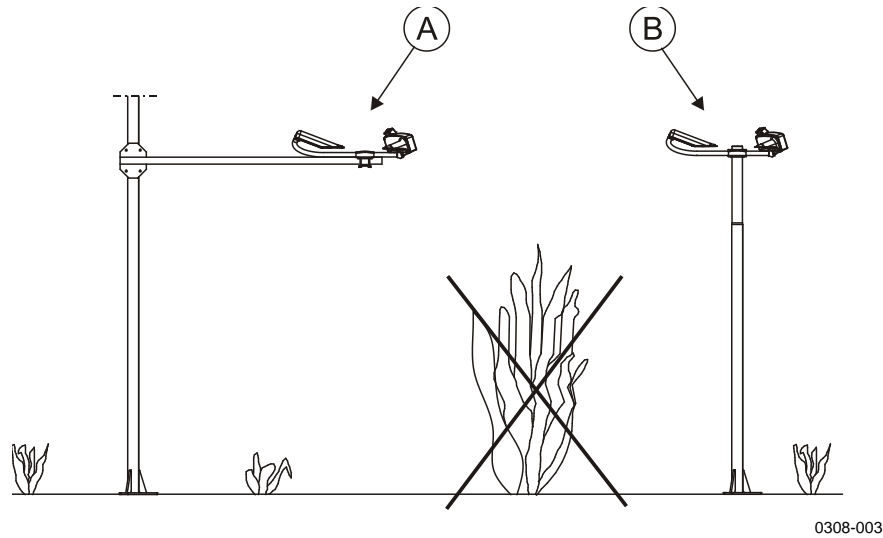
Figure 7   Recommended Location of PWD22/52 Sensor.

A = Sensor mounted on a supporting arm.
B = Sensor mounted on top of a mast.

- Do not point the receiver and transmitter optics towards powerful light sources. It is recommended that the receiver points north in the northern hemisphere, and south in the southern hemisphere. The receiver circuit may become saturated in bright light, in which case the built-in diagnostics indicate a warning. Bright daylight also increases the noise level in the receiver.

- Face the transmitter and receiver away from any obvious source of contamination such as spray from passing vehicles. Dirty lenses cause the sensor to report too high visibility values. Excessive contamination is automatically detected by the sensor.

- In the road environment, face the receiver away from passing vehicles. The preferred orientation is along the road, with a receiver pointing towards driving direction of the closest lane. The possible reflections from the passing cars can generate false snow detections in winter.

3.   Ensure power supply and communication lines are available.

- Consider the available power supply and communication lines, as this influences the amount of work and accessories needed, and installation cost.

Although PWD22/52 is designed to withstand harsh weather conditions, there are locations where the environment places further demands on the equipment. For harsh wintry conditions, optional hood heaters are available to prevent ice and snow accumulation.

Grounding and Lightning Protection

Equipment Grounding

Equipment grounding protects the electrical modules of PWD22/52 against lightning and prevents radio frequency interference. Equipment grounding for PWD22/52 is done using the weather station grounding cable.

Follow the grounding principles:

- Install the grounding rod as close to the pole mast as possible to minimize the length of the grounding cable. The grounding cable can also be cast inside the concrete base.
- The length of the grounding rod depends on the local groundwater level. The lower end of the grounding rod should touch moist soil continuously.
- Check the quality of the grounding with a georesistance meter. The resistance must be less than 10 Ω.

Internal Grounding

The electronics enclosure of PWD22/52 is grounded by the power/data cable jacket. The other parts of the sensor are in galvanic contact with each other.

Grounding the Remote Units and the Communication Cable

Ground remote units such as the PC data logger and display, and protect them against lightning.

WARNING!

A lightning strike through a communication wire can cause a voltage surge dangerous to life at remote sites if the remote units are not properly grounded.

Installation Procedure

This section describes only one installation alternative using a sensor support arm and Vaisala weather station as the host computer.

Unpacking PWD22/52

The delivery contents are specified in the packing list included with the delivery documents. The PWD22/52 equipment is usually delivered in one case.

!	Handle the case gently. Do not drop it.

To unpack PWD22/52:

1. Read the packing list supplied with the delivery documents. Compare the packing list against the purchase order to make sure that the shipment is complete.
2. Open the cover. In case of any discrepancies or damage, contact the supplier immediately.
3. Place the packing materials and cover back in the delivery case and store them for possible reshipment.

!	Do not touch or hit the Vaisala RAINCAP® Rain Sensor plate. It is fragile. Do not bend the signal cable with less than 2 cm (1 inch) radius, and do not leave it unsupported to lean to the ground or table.

Storage

Store PWD22/52 in its package in dry conditions, not in the open air. The storage conditions are as follows:

- Temperature -40 °C to 70 °C
- Relative humidity up to 95 %

Mounting

To mount PWD22/52, do one of the following:

- Attach PWD22/52 on the support arm with the Standard Mounting Clamp.
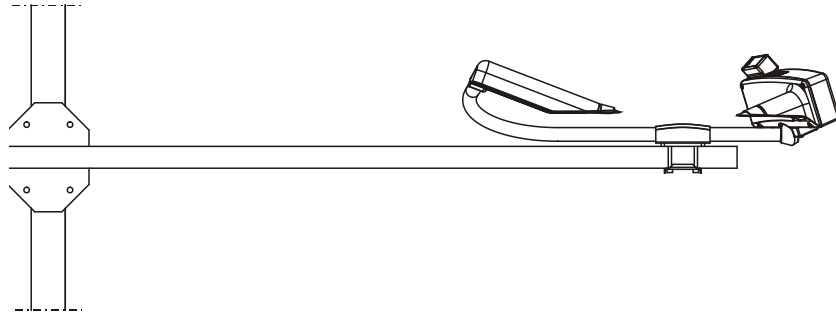
0308-005

Figure 8   Installing PWD22/52 on the Support Arm

- Install the sensor on the mast with Vaisala Clamp Assembly. Note that you need an optional Mounting Clamp for Pole Mast for the mast assembly.
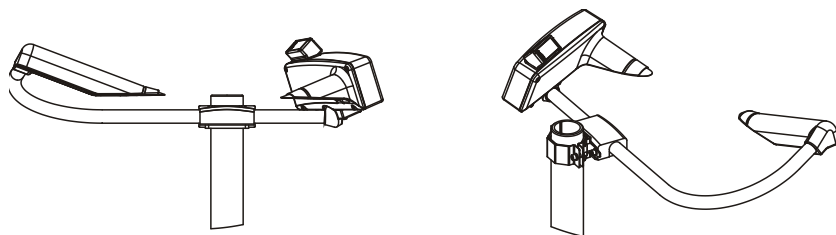
0308-004

Figure 9   Installing the Sensor on the Mast with Optional Mounting Clamp

Do not touch the RAINCAP® plate.

Connections

Connecting Cables

The PWD22/52 enclosure is equipped with a connector for connecting the signal and power cable. The connector enables easy installation and maintenance. The cable shield and connector is grounded to the PWD22/52 enclosure to keep EMI levels within the specifications.

1. Connect the PWD22/52 mast cable (power and signal cable) to a fixed connector underneath the PWD22/52 housing.

2. Test if the connector swings. If it swings, the mating surface of the connector is not sealed and it will leak. The connector terminals will be exposed to weather.
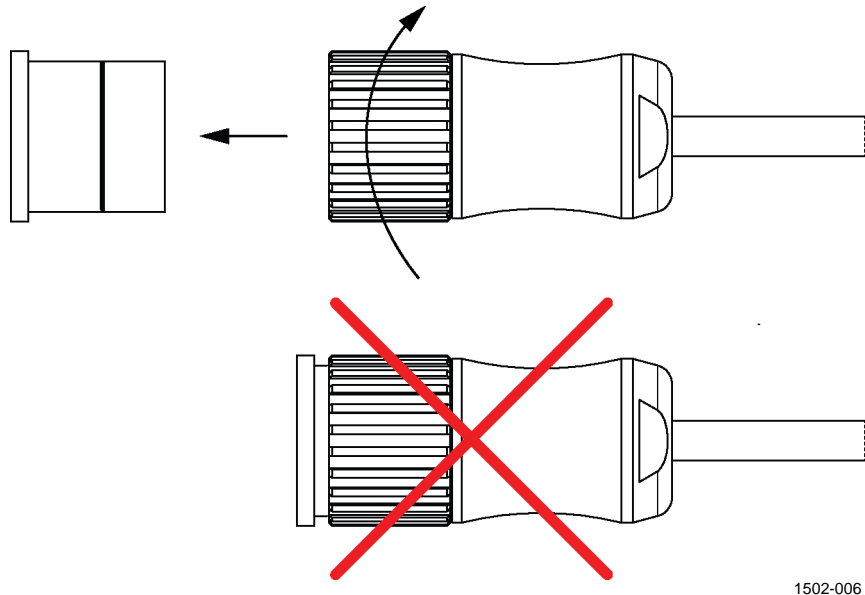
1502-006

Figure 10   Testing the Connector

3. Tighten the connector.

CAUTION!

Tighten the connector so that the cable connector does not swing when tightened.

Insulate the unused wires of the PWD22/52 mast cable from each other, for example, by connecting them to void screw terminals in the junction box.

Basic Wiring

The PWD22/52 cable has 16 connection wires.

Table 6   Receptable Connector Default Wiring

Signal Name	PWC15PB	PWC-board	Mast cable connector	Wire Color	Remarks
Sensor DC Power +	X1 - 1	X1 - 4		RED	Jump wire
Sensor DC Power +	X1 - 2		1	RED	
Sensor DC Power GND	X1 - 3		2	BLK	
Sensor DC Power GND	X1 - 4	X1 - 5		BLK	Jump wire
Hood heater foil	X1 - 5			BLK	PWC15PB→Heater foil
Hood heater foil	X1 - 6			BLK	PWC15PB→Heater foil
Heating power +	X1 - 7		13, 14	WHT/GRN BRN/GRN	*All four heating power wires must be connected due to high current.*
Heating power -	X1 - 8		15, 16	WHT/YEL BRN/YEL	
RS-485B (-)		X1 - 2	3	WHT	
RS-485A (+)		X1 - 3	4	BRN	
RS-232Tx/PWD		X2 - 2	5	GRN	PC serial port connector D9 pin 2 or ROSA Service Connector pin 4
RS-232 Rx		X2 - 3	6	YEL	PC serial port connector D9 pin 3 or ROSA Service Connector pin 3
RS-232 GND		X2 - 1	7	GRY	PC serial port connector D9 pin 5 or ROSA Service Connector pin 5
Relay Control 1		X4 - 6	10	GRY/PNK	
Relay Control 2		X4 - 7	11	RED/BLU	
Relay Control 3/ Ext Vb		X4 - 5	12	VIO	Function of the pin is chosen by jumper X11.
Ext Vb		X3 - 9	8	PNK	Output voltage of the pin is +12VDC in reference to GND (X4-8 and X2-1).
Analog output		X3 - 12	9	BLU	Current range is chosen by jumper X13 located under the PWC15PB.
Shield	Chassis	Chassis	Shield	Shield	Connected to equipment grounding.
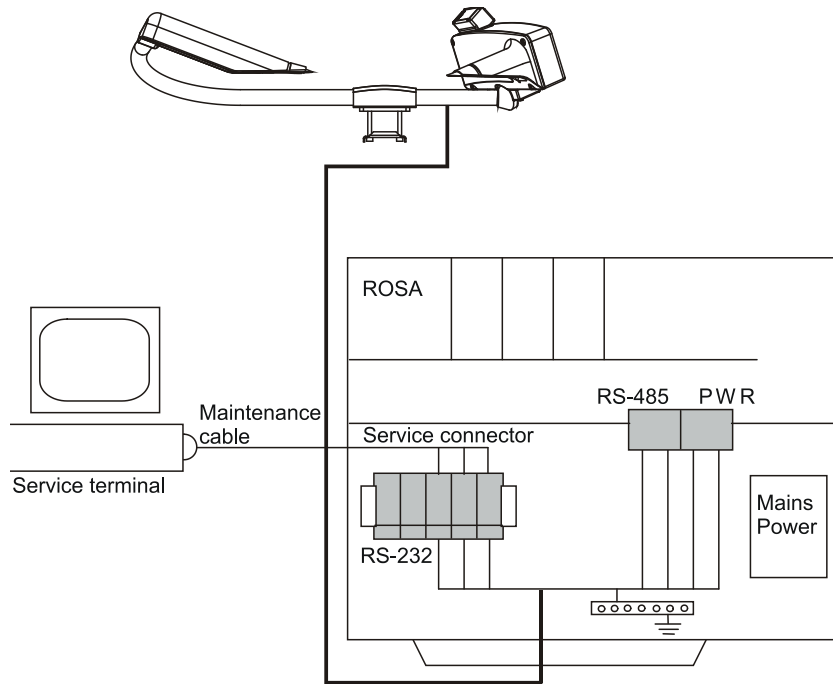
0104-002

Figure 11   Cabling Principle
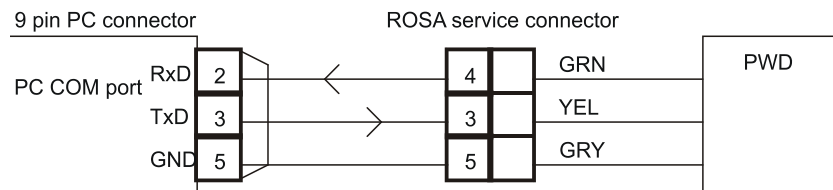
0309-044

Figure 12   Maintenance Cable

Power Supply

Power supply can be connected separately for the measurement electronics and heating. This allows for the battery backup to be limited to the measurement power supply.

Measurement electronics require 12 VDC ... 50 VDC. All the heaters can take AC, DC, or rectified AC. The heater voltage dimensions are specified below.

Internal Heaters and Heaters for PWL111

The heaters for Background Luminance Sensor PWL111 (optional) are parallel to the PWD22/52 internal heaters (connector X18 on the PWC22/52 board). Both heaters are powered by the PWD operating voltage line and the DC voltage level must be between 12 V and 28 V (24 V recommended).

If the DC voltage is as low as 12 V, the jumpers inside PWL111 must be set to 12 V to guarantee sufficient heating power. To access the jumpers, open the two screws on PWL111 back cover. See jumper settings in Figure 13.
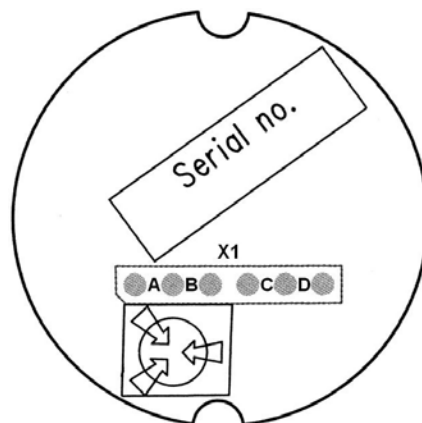
1206-035

Figure 13   PWL111 Jumper Settings

Heating Voltage	Jumper Locations
12 V	A, D
24 V	B, C

PWH111 Hood Heaters

A separate heating power of 24 V must be applied when using hood heaters. They use 30 W each, for a total of 60 W.

Communication Options

PWD22/52 has one serial line with two interfaces. The two-wire RS-485 is the standard interface. The PWD22/52 software is designed to allow the RS-232 interface to be used as a service line, when the RS-485 interface is connected to the host computer.

Usually, PWD22/52 waits for input from both the RS-232 and RS-485 interfaces. Any character from the RS-232 interface disables the RS-485 communication for 10 seconds or until the line is closed by the operator.

Automatic messages are sent to both interfaces along with the messages polled from the RS-485 interface.

Serial Communication Settings

The default settings of the serial communications port are:

- 9600 baud
- Even parity
- 7 data bits
- 1 stop bit

Serial Transmission RS-232

For the RS-232 communication, connect the PWD22/52 signal wires:

- YEL   to PC 3/9: TxD RS-232
- GRN   to PC 2/9: RxD RS-232
- GRY   to PC 5/9: GND

Vaisala recommends that the maximum length of the RS-232 cable is 50 m. Usually, the RS-232 connection can be used with distances up to 100 m without problems but that cannot be guaranteed.

Serial Multipoint Transmission RS-485

The RS-485 transmission standard allows several PWD22/52s to communicate (half duplex) with the host computer using a single twisted pair. For the RS-485 communication connect the PWD22/52 signal wires to:

- BRN   RS-485 A (+)
- WHT   RS-485 B (-)

> In some RS232/RS-485 converters, the markings may be mixed. If the connection does not work properly, switch the position of the wires.

> The wiring and wire colors are identical in PWD11 and PWD22/52.

Connection of the Maintenance Terminal

Any computer equipped with terminal emulation software or a VT 100 compatible terminal with RS-232 serial interface can be used as a Maintenance Terminal for PWD22/52.

Relay Controls

PWD22/52 has three open collector relay controls that are controlled by software using the alarms limits set in the **CONF** command.

The three PWD22/52 relay controls can be driven by the visibility limits. The third relay control can also be driven by the hardware status.

- ALARM LIMIT 1
- ALARM LIMIT 2
- ALARM LIMIT 3

These are visibility alarm limits of 10-minute average. Limit value 0 indicates that this limit is not used. The three visibility limits are independent of each other, which means that ALARM LIMIT 1 sets the limit for RELAY CONTROL 1 only. ALARM LIMIT 2 sets the limit for RELAY CONTROL 2 only and so on. For example, RELAY CONTROL 1 is pulling whenever visibility is lower than ALARM LIMIT 1. See Table 7 and Table 8 below.

- RELAY ON DELAY
- RELAY OFF DELAY

The visibility alarm conditions must last the corresponding time in minutes specified in RELAY ON/OFF DELAY parameter before the relay control changes. The default delays are five minutes.

Below is a table with a control logic example of relay controls 1 and 2 when the third relay control is driven by hardware status.

Table 7   Control Logic of Relay Controls 1 and 2

States of Relay 1 and 2	Corresponding Visibility Conditions
1 OFF 2 OFF	When visibility is higher than LIMIT 1 and LIMIT 2.
1 ON 2 OFF	When visibility is lower than LIMIT 1 but higher than LIMIT 2.
1 ON 2 ON	When visibility is lower than LIMIT 1 and LIMIT 2.

The table below shows a control logic example of relay controls 1 and 2 and 3 when all the relay controls are driven by visibility limits.

Table 8   Control Logic of Relay Controls 1, 2, and 3

Relay States	Corresponding Visibility Conditions
1 OFF 2 OFF 3 OFF	When visibility is higher than all the limits.
1 ON 2 OFF 3 OFF	When visibility is lower than LIMIT 1 but higher than LIMIT 2 and LIMIT 3.
1 ON 2 ON 3 OFF	When visibility is lower than LIMIT 1 and LIMIT 2 but higher than LIMIT 3.
1 ON 2 ON 3 ON	When visibility is lower than all the limits.

When the third relay control output is set to be driven by the hardware status, it pulls whenever a hardware alarm is detected. For details, see section System Configuration Commands on page 64.

PWC board | Cable | Box

VB12V — X3-9 (X4-5)

Control 1 — X4-6

Control 2 — X4-7

Control 3 — X4-5

DGND — X4-8

Relay 1

Relay 2

Relay 3

wires: X3-9 or X4-5 PNK
X4-5 VIO
X4-6 GRY/PNK
X4-7 RED/BLU

1008-015
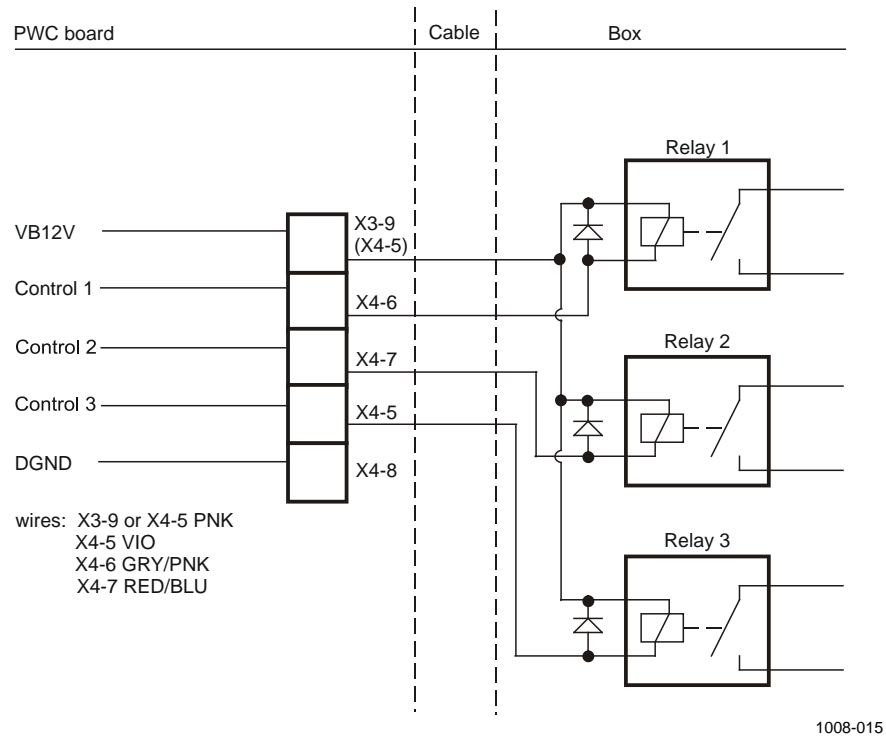
Figure 14   Relay Connection: PWD22/52 Supplies

Figure 14 illustrates the external relay connections when relay coils are powered by PWD22/52. Voltage pin VB 12 V and relay controls 1, 2, and 3 are wired by default.

The 100R series resistors limit the current of the relay ports. A typical relay recommendation for the minimum operating or pick-up voltage over the relay is around 0.8 *12 V. Thus the relay's pick-up current must be not more than 24 mA which means the coil resistance is 400 or more.

If external relays require a higher coil current, an external power supply must be used for one or two of them.

Relay control 3 can be changed to 12 V external voltage output by jumper X11.

Figure 15 illustrates external relays connecting when relay coils are powered by external voltage. In this case, one of the unused wires must be changed to ground pin (X4-8, see Appendix B). For example, if voltage pin X3-9 is not used, the pink wire may be changed to pin X4-8. The other end of the changed wire must be connected to the ground potential of the external relay power source.
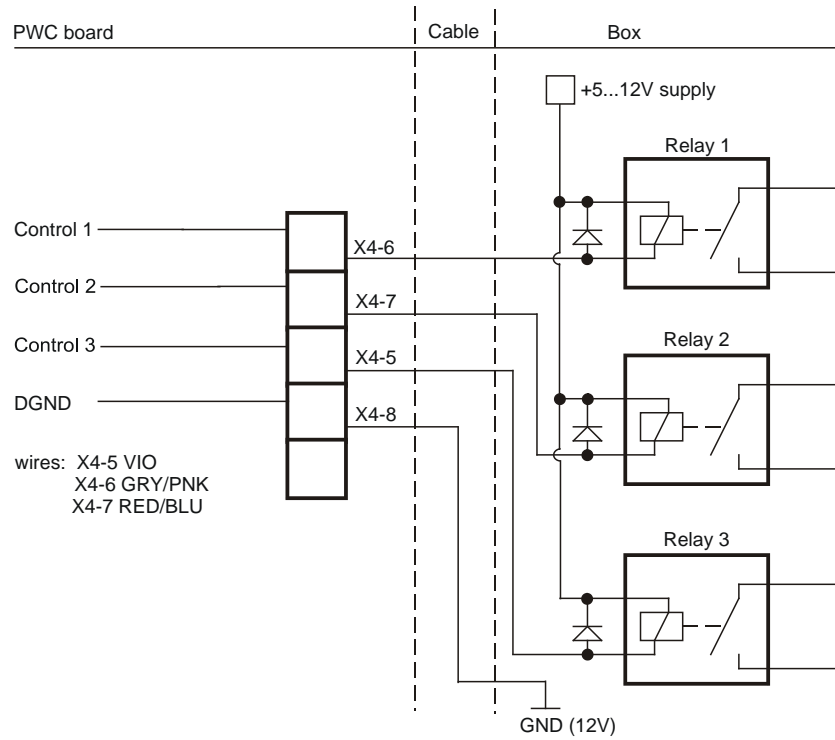
Figure 15   Relay Connection: External Relay Supply

> You can also use Ext Vb voltage, nominally 12V, to supply the relays.
> Then PWD limits the corresponding current to < 200 mA.

RELAY Command

Set/display the relay control states.

When you type the following:

```
>RELAY
```

The result is the following:

```
RELAYS OFF OFF OFF
```

All relay controls can be set on by typing the following:

```
>RELAY ON
```

Relay control 1 can be set on until ESC is pressed. See the example below:

```
>RELAY 1 ON
```

Initial Settings

PWD22/52 typically interfaces with a host computer or data logger in an automatic weather observing system. After the physical connection has been made, the details of the communication can be configured in the software. Suitable communication settings depend on the system implementation.

By default the sensor is on a polled mode. That is, a data message is only sent when the host computer requests one with a command.

The sensor can also be used in an automatic message mode. The automatic message mode transmits a new ASCII data message through the serial line automatically. The interval and message type can be changed by the user (the AMES command). In addition, the baud rate of the serial line can be changed to other value, and the data frame can be selected between 7 data bits, even parity, one stop bit, and 8 data bits, no parity, one stop bit.

Table 9 describes the default communication settings.

Table 9   Default Communication Settings

Setting	Default
Baud rate	9600 bps (7E1)
Polled or automatic mode, message type	Polled mode
Sensor ID	No ID set

In multipoint communication, where several sensors share the same communication line, use PWD22/52 in polled mode with distinct identifiers for individual sensors.

Table 10 lists the commands for changing the default settings. For details on the commands, see Chapter 5, Operation on page 49.

Table 10   Default Settings Commands

Operation	Command
Baud rate selection	BAUD
Polled or automatic mode, message type setting	AMES
Sensor ID configuration	CONF

Weather Parameters

PWD22/52 has several changeable parameters, which control the operation of the present weather algorithm and precipitation measurement. The parameter values set at the factory have been tested and found appropriate. They usually do not need to be changed. There

may, however, be conditions where other parameter values give better results.

Table 11 below lists the commands for displaying and changing the parameters.

Table 11   Display and Change Parameters Commands

Operation	Command
Parameter listing	WPAR
Parameter setting	WSET

Local practice may require changes, especially in the precipitation intensity limits (moderate, heavy). See section WSET on page 61 for a description of the **WSET** command.

The precipitation intensity and amount measurement is not calibrated at the factory. Higher accuracy can be achieved by adjusting a scaling factor (RAIN INTENSITY SCALE) with the **WSET** command. The new scaling factor can be calculated by comparing PWD22/52 against a reference rain gauge. See section WSET on page 61 for a description of the **WSET** command, and for further instructions.

The low visibility alarm limits (3) are zero by default. That is, no alarms are generated and no relays are activated.

Use the **CONF** command to set the alarm limits.

Verifying the Installation

Before connecting PWD22/52 to a weather station or other host verify the basic installation:

1.   Connect a terminal through RS-232 serial line to the sensor.
2.   Set the terminal baud rate to 9600 bps and the data frame to contain 7 data bits, 1 stop bit, even parity.
3.   Switch the power supply on.
4.   After startup, the PWD22/52 output is the following:
      ```
      VAISALA PWDxx V x.xx YYYY-MM-DD SN:XXXXXX
      ```

      ID is also included, if configured. Example:

      ```
      VAISALA PWDxx V x.xx YYYY-MM-DD SN:XXXXXX ID STRING: 1
      ```

      If the output is not as in the above example, check the cabling and baud rate of the service terminal (program). If wrong characters are shown, try other baud rates, such as, 300, 1200, 2400, and 4800.

5.   Wait 20 seconds and go to command mode with the **OPEN** command.

6.   Check with the **STA** command that no hardware errors or warnings are detected.

7.   Leave the command mode by typing **CLOSE.** If it has not been disabled, check that the automatic message appears in the display.

Other commands are described in Chapter 5, Operation, on page 49.

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CHAPTER 5
OPERATION

This chapter contains information needed to operate this product.

Getting Started

Vaisala Present Weather Detector PWD22/52 is a fully automatic instrument for continuous weather measurement. Usually, PWD22/52 is set either to send a data message automatically or it is polled by a host computer. In addition, a set of user commands is provided for configuring and monitoring the system performance. These commands can be given in the command mode (see Entering and Exiting Command Mode on page 51).

PWD22/52 has seven different standard message formats for data message output. It presents the weather type using the World Meteorological Organization (WMO) code table 4680 (WaWa, in other words, Present Weather reported from an automatic weather station). PWD22/52 reports present weather also in WMO code table 4678 (METAR) format. In addition, the United States National Weather Service (NWS) abbreviations are available. The NWS list and WMO codes is presented in Appendix C, NWS and WMO Code Tables, on page 113.

Operating Instructions

Normal operation of PWD22/52 does not require user intervention. Operator commands are used during the initial setup, routine maintenance, and troubleshooting.

When the sensor is installed, the user may need to change some default settings. Initial Settings on page 45 describes the initial setup. Table 12 describes the settings and corresponding commands.

Table 12   Settings and Corresponding Commands

Setting	Command
Baud rate	BAUD
Polled or automatic mode, message type	AMES
Sensor ID	CONF
Weather algorithm parameters	WSET

Table 13 describes the commands for routine maintenance operations.

Table 13   Routine Maintenance Commands

Operation	Commands
Sensor cleaning	CLEAN (optional)
Visibility calibration	ZERO, CHECK, CAL

The standard output messages contain a status character, which presents the results of the internal diagnostics to the host computer or the user. If the sensor indicates a warning or an alarm in a standard output message, the host computer or the user can get a detailed status report with the **STA** command. The status report can also be polled (Message 3) in place of the standard data message. Usually, the detailed status information is sufficient for locating the fault.

Entering and Exiting Command Mode

Before any commands can be given to PWD22/52, the communication line in PWD22/52 has to be assigned to the operator. Otherwise, it is assigned to automatic messages or polled communication. The user assigns the command mode with the **OPEN** command.

OPEN

If no device identifier (ID) is defined, type:

```
OPEN
```

If the ID is defined, for example, as A, type:

```
OPEN A
```

If the ID is defined but forgotten, type:

```
OPEN *
```

If there are two or more different sensors connected to the same RS-485 line, and if the sensors have the same ID, open PWD22/52 by typing the following command:

```
OPEN PWD {id number}
```

PWD22/52 answers as follows:

```
LINE OPENED FOR OPERATOR COMMANDS
```

If no input is given within 60 seconds, PWD22/52 closes the line automatically.

CLOSE

Use the **CLOSE** command to release the line to automatic data messages or polling commands.

PWD22/52 answers as follows:

```
LINE CLOSED
```

Message Types

Message 2 is the standard present weather message. The length of the **STA** Message 3 depends on the possible alarm and warning states.

PWD22/52 adds frame strings to the polled and automatic messages. The content of the frame strings is presented in the following:

^S_H**PW** id^S_Xmessage body$^E_X$$^C_R$$^L_F$

where

^S_H	= Start of heading (ASCII 1, non-printable character)
PW	= PWD sensor identifier
	= Space character
id	= Unit identifier, 2 characters. If the ID is not defined, characters space and 1 are shown.
^S_X	= Start of text (ASCII 2, non-printable character)
	message body
^E_X	= End of text (ASCII 3, non-printable character)
$^C_R$$^L_F$	= CR + LF (ASCII 13 + ASCII 10)

Figure 16 below shows the contents of Messages 0, 1, and 2.

```
10    680  1230              ← THE FIRST ROW IS THE OUTPUT
↓↓         ↓      ↓
          ------ 10 min average visibility      ⌠   FIELD
   ------- one minute average visibility  ⎨  DESCRIPTIONS
  - 1=hardware error, 2= hardware warning, ⎩
    3= backscatter alarm, 4= backscatter warning
- 1= visibility alarm 1, 2= visibility alarm 2,
  3 = visibility alarm 3

Example with frames

□PW  1□00     680   1230□

SHPW  1Sx00     680   1230EXCRLF
12345678901234567890123345

NUMBERS mark the character positions.
```

Figure 16   Contents of Messages 0, 1, and 2

Message 0

Message 0 displays the one-minute average visibility and ten-minute average visibility.

```
00    680  1230
          ------ 10 minute average visibility
  ------- one minute average visibility
 - 1=hardware error, 2= hardware warning,
   3= backscatter alarm, 4= backscatter warning
- 1= visibility alarm 1,  2= visibility alarm 2,
  3=visibility alarm 3
```

The following is an example with frames:

```
□PW  1□00    680  1230□
```

```
S  PW  1S 00    680  1230E C L
 H       X             X R F
12345678901234567890012345
```

Message 1

Message 1 displays the one-minute average visibility, instant precipitation type, and the one-minute average water intensity.

```
00   1839 61   0.3
             ------ water intensity 1min ave, mm/h
         --- instant precipitation type, 0 ... 99
  ------- visibility one minute average
 - 1=hardware error, 2= hardware warning,
   3= backscatter alarm, 4= backscatter warning
- 1= visibility alarm 1,  2= visibility alarm 2,
  3= visibility alarm 3
```

The following is an example with frames:

```
□PW  1□00    1839 61    0.3□
```

```
S  PW  1S 00    1839 61    0.3E C L
 H       X                    X R F
12345678901234567890012345678
```

Message 2

Message 2 is the standard present weather message used in data loggers or display units and set as a default at the factory.

Example for PWD22:

```
00  1839  1505  R- 61 61 61  0.33  12.16  0
                                    --- cumulative snow
                                        sum,0...999mm
                              ------ cumulative water
                                     sum,0...99.99mm
                          ------- water intensity 1 min
                                  ave,mm/h
                    --- one hour present weather code,
                        0...99
                  --- 15 minute present weather code,
                      0...99
              --- instant present weather code, 0 ... 99
            ---- instant present weather, NWS codes
       ------ visibility ten minute average, max 20000m
  ------ visibility one minute average, max 20000m
 - 1=hardware error, 2= hardware warning
   3= backscatter alarm, 4= backscatter warning
- 1= visibility alarm 1,  2= visibility alarm 2,
  3= visibility alarm 3
```

The following is an example with frames:

```
☐PW  1☐00  1839  1505  C  61 61 61   0.33  12.16    0☐

S HPW  1Sx00  1839  1505  C  61 61 61   0.33  12.16    0Ex CR LF
12345678901234567890123456789012345678901234567890123456
```

The examples illustrate message 2 when using PWD22. The maximum visibility varies according to the product model. The messages are otherwise identical.

Message 3

Message 3 is the same as the status message obtained by the **STA** command. See status message description in section Maintenance Commands on page 75.

Message 4

Message 4 is for replacing Fumosens E visibility sensors.

Messages 5 and 6

Messages 5 and 6 are for message emulation of MITRAS Transmissometer.

Message 7

Message 7 is for aviation-specific purposes. The message format is same as in FD12P message 7.

Example for PWD22:

```
00  6839  7505  R  61 61 61   0.33  12.16     0  23.4 12345
                                                    -----
                                                    background
                                                    luminance,
                                                    cd/m²
                                         ------ Temp
                                    ----- cum. snow sum
                                ------- cumulative water sum
                            ------- prec. water intensity,mm/h
                        --- 1 hour pw code, 0... 99
                      --- 15 minute pw code, 0 ... 99
                    --- instant present weather code, 0 ... 99
              ---- instant present weather, NWS codes
         ------ visibility ten minute average, max 20000m
   ------ visibility one minute average, max 20000m
  - 1=hardware error, 2= hardware warning,
    3= backscatter alarm, 4= backscatter warning
- 1= visibility alarm 1,  2= visibility alarm 2,
  3= visibility alarm 3

-RA  , instant METAR weather codes
RERA , recent METAR weather (RE criteria used)
```

The following is an example with frames:

```
□PW  1□00  6839  7505  R  61 61 61   0.33  12.16     0  23.4 12345
-RA
RERA
□
SHPW  1SX00  6839  7505  R  61 61 61   0.33  12.16     0  23.4 12345CRLF
-RACRLF
RERACRLF
EXCRLF
123456789012345678901234567890123456789012345678901234567890123456 7
```

Message 7 consists of three lines. METAR present weather codes are output on the second and third lines. These lines are not of fixed length because the METAR codes can be combined in many ways. The METAR codes may be omitted, but the message lines are always terminated by a carriage return and line feed characters.

> **!** The examples illustrate message 7 when using PWD22. The maximum visibility varies according to the product model. The messages are otherwise identical.

Automatic Message Sending

In the automatic (**CLOSE**) mode PWD22/52 sends the predefined message at defined intervals.

The **AMES** command defines the automatic message internal AMES *Message_number Message_interval*

where

Message_number	=	Valid range 0 ... 7. Selects the corresponding message. Negative message numbers are converted to 0. If only the message number is given, the previous message interval setting is used.
Message_interval	=	Given in multiples of 15 s (= measuring interval). Therefore, intervals 15, 30, 45... are valid. Other intervals are converted to multiples of 15 s. The maximum sending interval is 255 s (4 min 15 s).

See the example below:

```
AMES 0 60
```

Selects message number 0 to be sent once in a minute.

Messages can also be displayed in the command mode with the **MES** command, as described in section MES on page 60.

Message Polling

In the polled (**CLOSE**) mode, PWD22/52 sends a data message when the host computer transmits a polling command. The message polling mode is selected with the following command:

AMES *Message_number 0*

where

Message_number	=	Valid range 0 ... 7. Selects the corresponding message as the default polled message. Negative message numbers are converted to 0.
Message_interval	=	Use the negative or zero interval to disable automatic sending when messages are polled.

For example:

```
AMES 0 0
```

The above command selects message 0 for default answer for the polling and cancels the automatic sending.

The polling command format is the following:

$^C_R{}^E_Q$**PW** *id message_number*^C_R

where

^C_R	=	ASCII character 13 hex (Carriage Return)
^E_Q	=	ASCII character 05 hex (CTRL-E).
id	=	Selected in the configuration.
message number	=	This is optional.
^C_R	=	ASCII character 13 hex (Carriage Return)

When the PWD22/52 unit number one (ID=1) is polled for message number 3 (status), the command format is the following:

$^C_R{}^E_Q$PW 1 3 ^C_R

This format can be used in all cases.

Use character 1 as the ID if the ID has not been set but a specific message type is polled. This allows the PWD22/52 software to distinguish the ID from the message number.

Use the $^C_R{}^E_Q$**PW**^C_R command only if one PWD22/52 unit is on the line (no ID is set) and the default message is wanted.

PWD22/52 does not echo the polling character string.

The answer message format is the following:

^S_HPW id^S_Xtext$^E_X$$^C_R$$^L_F$

The ID has a two-character field because it can be two characters long.

An example of the polled (and automatic) message 0 format is the following:

^S_HPW 1^S_X00   500   700$^E_X$$^C_R$$^L_F$

PWD22/52 waits about 100 ms before it transmits the polled message to give the host time to switch the RS-485 line to the receive mode.

For compatibility in the system level, PWD22/52 also accepts FD instead of PW in the polling commands because the data message formats and framing are the same as in the VAISALA FD12 and FD12P sensors. If PWD22/52 is polled by $^C_R$$^E_Q$**FD** 1 2$^C_R$, the answer starts with ^S_H**FD** 1^S_X..

Precipitation Sums

PWD22/52 has no internal clock for automatic resetting of the sum data at certain times. This can be done by the host with the following command:

^E_C**PW** 0 C^C_R

where

^E_C	=	ESC (ASCII character 1B hex).
^C_R	=	Carriage Return (13 hex.)

PWD22/52 responds to the accepted command with the ASCII character $<^A_K$ (06 hex).

The host computer can also maintain its own sum calculated from the continuous PWD22/52 data. This may be safer, if the PWD22/52 power breaks often and resets the sums before the scheduled time. The water sum automatically resets when it reaches 99.99 mm and the snow sum at 999 mm.

Commands

PWD22/52 Commands

HELP

Use **HELP** to get information about available commands.

Table 14   Command Set

Command	Description
OPEN	Assigns the line for operator commands.
CLOSE	Releases the line for automatic messages.
MES *Number*	Displays data message.
AMES *Number Interval*	Automatic message (with parameters *Number* and *Interval*)
CLRS	Clears precipitation sums.
STA	Displays status.
PAR	Parameter message.
HIST *Parameter*	For Vaisala systems use.
INTV *Time*	For Vaisala systems use.
TIME *hh:mm:ss*	Set/Display system time.
DATE *yyyy:mm:dd*	Set/Display system date.
WPAR	Weather parameter message.
CHEC	Displays calibrator test signal.
ZERO	Displays zero and noise test status.
CAL *Calibrator_frequency*	Calibration.
CONF *Password*	Updates configuration.
WSET	PRW reference values.
CLEAN	Sets clean references.
BAUD *Rate* C*ommn._type*	Baud rate setting (*Rate* 300, 1200, 2400, 4800, 9600) (*Communication type* E *(7E1)* or N *(8N1)*)
DRY ON	Sets RAINCAP® dry offset.
WET ON	Sets RAINCAP® wet scale.
ACAL	Analog output calibration.
BLSC	Background luminance scale / enable.
RESET	Hardware reset by watchdog.

MES

After opening the line for operator commands (see section Entering and Exiting Command Mode on page 51), use the **MES** command to display a data message. See section Message Types on page 52 for message type descriptions.

The command format is the following:

MES *Message_number*

The valid range is 0 ... 7.

For example, to choose the data message number 0, type the following:

```
>MES 0
```

AMES

The **AMES** command defines the message, which PWD22/52 transmits as the automatic message or as the default polled message. See section Automatic Message Sending on page 56.

Weather Related Commands

Use the following commands to display/set the weather analysis parameters and results.

- **WPAR**   Weather parameter message

- **WSET**   PRW reference values

- **CLRS**   Clear precipitation sums

WPAR

The **WPAR** command displays the present weather analysis parameters.

```
WEATHER PARAMETERS

PRECIPITATION LIMIT      40
WEATHER UPDATE DELAY      6
RAIN INTENSITY SCALE   1.00
HEAVY RAIN LIMIT         8.0
LIGHT RAIN LIMIT         2.0
SNOW LIMIT               5.0
HEAVY SNOW LIMIT         600
LIGHT SNOW LIMIT        1200
DRD SCALE                1.0
DRD DRY OFFSET         809.5
DRD WET SCALE         0.0017
```

WSET

Use the **WSET** command to modify present weather analysis parameters.

The **WSET** command asks for one parameter at a time, showing the parameter name and the current setting. Accept the current value by pressing ENTER. Add a new value by typing the value before pressing ENTER.

The output is as follows:

```
SET PRESENT WEATHER PARAMETERS
PRECIPITATION LIMIT ( 40)
WEATHER UPDATE DELAY ( 6)
SYNOP HAZE LIMIT ( 10000)
METAR HAZE LIMIT ( 5000)
RAIN INTENSITY SCALE ( 1.00)
HEAVY RAIN LIMIT ( 8)
LIGHT RAIN LIMIT ( 2)
SNOW LIMIT ( 5.0)
HEAVY SNOW LIMIT ( 600)
LIGHT SNOW LIMIT ( 1200)
DRD SCALE ( 1.0)
```

where

Precipitation limit	=	The threshold of accumulated particle magnitudes (in PWD22/52 internal units) to report the precipitation state 'on'. A typical parameter value is 20 to 60 (max. 255). A smaller value is more sensitive operation and faster response at the beginning of an event. It is also more sensitive to false rain and snow reports.
Weather update delay	=	A time as multiple of 15 seconds, during which the instant precipitation type is not changed. The intensity may change faster.
Synop haze limit	=	Maximum visibility when mist or haze is reported.
Metar haze limit	=	Maximum visibility when mist or haze is reported.
Rain intensity scale	=	It is multiplied by the measured raw intensity gives the reported precipitation intensity (optical). The rain amount is scaled with the same coefficient because the amount is a direct integral of 15-second intensities. A typical value for the *Rain intensity scale* is 1.0. Since the optimal value depends on the optical, optoelectronic, and electronic parameters in a very complex way, no applicable factory calibration method has been developed yet.
Heavy rain limit	=	The minimum rain intensity (mm/h), when the intensity is reported as heavy.

where

Light rain limit	=	The maximum rain intensity (mm/h), when the intensity is reported as light. If rain intensity is between the above heavy and light limits, it is reported as moderate.
Snow limit	=	The minimum ratio of optical precipitation intensity to surface sensor (RAINCAP®) precipitation intensity, when precipitation is snow.
		A typical value for *Snow limit* is 5. Smaller value directs PWD22/52 to report more wet precipitation as snow.
Heavy snow limit	=	The maximum visibility (m) of two-minute average in heavy snow.
Light snow limit	=	The minimum visibility (m) of two-minute average in light snow. If snow is detected and the two-minute average visibility is between the above heavy and light limits, snow intensity is reported as moderate.
DRD scale	=	The scaling factor for the calculated intensity of the RAINCAP® surface sensor. A typical value for this parameter is 1.0.

To calibrate the precipitation measurement, compare the PWD22/52 rain amount to measurements made with a suitable reference rain gauge.

Make the comparison after a few rain events with 5 mm or more of total accumulated rain. Calculate a new scaling factor using the following formula:

NEWSCALE = OLDSCALE * (REF_AMOUNT / PWD_AMOUNT)

where

OLDSCALE	=	The old value of rain intensity scale.
REF_AMOUNT	=	The amount measured with the reference rain gauge.
PWD_AMOUNT	=	The corresponding amount measured by PWD22/52.

CLRS

The **CLRS** command resets (to 0.00) the precipitation cumulative sums.

This can be done by the host with the following command:

^E_C**PW** *id* C^C_R

where

^E_C	=	ESC (ASCII character 1B hex.
$<^A_K$	=	ASCII character (06 hex).
^C_R	=	ASCII character (13 hex.)
id	=	Identification number of PWD, for example, id = 0

System Configuration Commands

Use the following commands to display system parameters and to edit the current system configuration:

- **PAR**, Parameter message
- **CONF** *password*, Updates configuration
- **BAUD** *rate comm. type*, Sets baud rate and type (Rate 300, 1200, 2400, 4800, 9600), (*Communication type* E (7E1) or N (8N1)

PAR

Use the **PAR** system parameters command to display the current system parameters.

The system output is the following (example for PWD22):

```
SYSTEM PARAMETERS
VAISALA PWD22 v 1.00 2003-04-09 SN:X1234567 ID STRING:
AUTOMATIC MESSAGE 0 INTERVAL 0
BAUD RATE: 9600 N81
ALARM LIMIT 1 0
ALARM LIMIT 2 0
ALARM LIMIT 3 0
RELAY ON DELAY 10 OFF DELAY 11
OFFSET REF 152.38
CLEAN REFERENCES
TRANSMITTER 5.0 RECEIVER 1200
CONTAMINATION WARNING LIMITS
TRANSMITTER 0.5 RECEIVER 300
CONTAMINATION ALARM LIMITS
TRANSMITTER 3.0 RECEIVER 600
SIGN SIGNAL 1 1.000
DAC MODE: EXT1
MAX VIS 20000, 20.0 mA
```

```
MIN VIS 180, 4.5 mA
20 mA SCALE_1 184.6, SC_0 -2.8
1 mA SCALE_1 184.8, SC_0 -1.4
```

CONF

Use the **CONF** configuration command to set or update system
parameters and adjust calibrations, reference values, and limits. Use
password protection to limit the use of this command. New parameter
values are saved in non-volatile memory (EEPROM).

With the **CONF** command, PWD22/52 retrieves the system parameters
one by one, showing the current value in most cases as the default. The
old settings do not change if users only press ENTER as the answer.

System parameters saved in the EEPROM are:

- *Automatic message number*
- *Visibility alarm limits*
- *Offset reference*
- *Signal scale*
- *Password characters*
- *Unit id characters (2)*
- *References and limits for contamination monitoring*
- *Baud rate*
- *Serial number*
- *EEPROM checksum*
- *Relay control mode and Relay delays*
- *Analog output mode and range*
- *Hood heater usage*

To prevent unauthorized changes to the system parameters, a four-
character password can be set. If no password is set, the command
continues as if it had the correct password.

When no password has been set, the command is the following:

CONF

When a password has been set in a previous session, the command
format (max. four character string, printable characters) is the following:

CONF *password*

If the previous password is known, the password can be changed with the
CONF *password* **N** command, where the N character stands for new.

After receiving the correct password, the system requests a new password. Press ENTER to remove the password. Otherwise, type a new password.

Example system response to the **CONF** command for PWD22:

```
CONF. PASSWORD (4 CHARS MAX)

UPDATE CONFIGURATION PARAMETERS
UNIT ID (2 CHAR) () 1
 UPDATED
SET REFERENCE PARAMETERS
OFFSET (  156.47) Y
 OFFSET REFERENCE UPDATED
MODE UPDATED
ALARM LIMIT 1 (       0) 1500
 ALARM LIMIT 1 UPDATED
ALARM LIMIT 2 (       0) 1000
 ALARM LIMIT 2 UPDATED
ALARM LIMIT 3 (       0) 500
 ALARM LIMIT 3 UPDATED
RELAY CONTROL MODE
 0 = 3*VIS, 1 = 2*VIS & HW ( 0) 1
RELAY ON DELAY (   5)
RELAY OFF DELAY (   5)
TRANSMITTER CONTAMINATION LIMITS
WARNING LIMIT ( 0.5)
ALARM LIMIT ( 3.0)
RECEIVER CONTAMINATION LIMITS
WARNING LIMIT (    300)
ALARM LIMIT (    600)
ANALOG OUTPUT MODE
 0=LINEAR, 1=LN, 2=EXTI, 3=VGI, 4=VG2 ( 4)
ANALOG OUTPUT RANGE
 MAX VISIBILITY ( 20000)
  = mA ( 20.0)
 MIN VISIBILITY (   10)
  = mA (  4.0)
HOOD HEATERS USED 1=YES, 0=NO (     0)

END OF CONFIGURATION
```

The output illustrates the response to the command when using PWD22. With PWD52 the maximum visibility is 35000 meters. The system responses are otherwise identical for PWD22 and PWD52.

The meaning of the questions asked by the system is described below. **Bold** text indicates user actions. The old settings do not change if the user only presses ENTER as the answer.

1.   If there is no valid password, the system requests a new password:

```
CONF. PASSWORD (4 CHARACTERS MAX)
```

> If a password update is requested by the *N* parameter and an empty line is given as an answer, the password is removed. Otherwise, the user enters a new password.

2.   The system asks the following:

```
UPDATE CONFIGURATION PARAMETERS
UNIT ID (2 CHAR) ( 1)
```

> If the PWD22/52 unit is named by one or two character ID codes, the **OPEN** and polling commands use it as a parameter.
>
> The ID code is also included in the data message heading. If no other ID is given, the default value is ID 1 in the message heading.
>
> The user can remove the current ID by pressing the hyphen (-) as an answer to the question.
>
> In multidrop configuration, where several sensors are on the same communication line, the units are differentiated by the ID.

3.   The next *CONF* parameters are hardware or system dependent. They can be changed from the factory set values to improve performance or for maintenance purposes.

> In the example configuration session:
>
> The currently measured **offset** value (not a parameter) is shown in the brackets:

```
OFFSET (  136.86) Y
OFFSET REFERENCE UPDATED
```

4.   After receiving the Y answer, the system accepts the offset frequency as the reference parameter for hardware monitoring. The parameter value is further compared with the current value to detect drift or other failure in the optical signal measurement electronics.

5.   Visibility alarm limits are checked to ensure that Limit 1 is higher than Limit 2, and Limit 2 higher than Limit 3. Limit values are expressed in meters.

```
ALARM LIMIT 1 (   1000)
ALARM LIMIT 2 (    200) 300
```

```
                ALARM LIMIT 2 UPDATED
                ALARM LIMIT 3 (    100)
```

>In the example above, alarm Limit 2 gets a new value 300 m. When the visibility weakens below Limit 2, the data message (0 ... 2) data status is set to 2. The **STA** message does not show the visibility alarm.

>The alarm limits are also used to control the two (pull down) alarm controls. Control 1 sets when alarm 1 is on. Control 2 sets when alarm 2 is on. Control 3 sets when alarm 3 is on. The controls are usually used to for external relays. For details on relay logic, see section Relay Controls on page 42.

5. The **CLEAN** command performs backscatter/contamination by checks compare the current values of the backscatter signal with the reference values. The limits given here are limits for the change in backscatter signals for the transmitter and receiver.

>The transmitter values are in volts (V). The measurement range is 0 ... 13 V, where 0 V is a blocked lens. The limit value is given as a positive value although the signal becomes smaller when contamination increases. A contamination change of 5 V represents about a 10 % decrease in the transmitter's lens transmittance (and also a 10 % increase in visibility indication).

```
TRANSMITTER CONTAMINATION LIMITS
WARNING LIMIT ( 1.0) 1.5
WARNING LIMIT UPDATED
ALARM LIMIT (  5.0)
```

>The receiver values are in hertz (Hz). The measurement range is 0 ... 10 000 Hz, where 10000 Hz is a blocked lens. A contamination change of 500 Hz represents about a 10 % decrease in the receiver's lens transmittance.

```
RECEIVER CONTAMINATION LIMITS
WARNING LIMIT (    200)
ALARM LIMIT (    500) 600
ALARM LIMIT UPDATED
```

>For details on the analog output modes, see section Analog Output Modes on page 71.

```
ANALOG OUTPUT MODE
 0=LINEAR, 1=LN, 2=EXTI, 3=VGI, 4=VG2 ( 4)
ANALOG OUTPUT RANGE
 MAX VISIBILITY ( 20000)
  = mA ( 20.0)
 MIN VISIBILITY (   10)
  = mA (   4.0)
```

Hood Heaters

By default 0, no hood heaters are used. The hood heater option is factory installed and may be used or disabled in the **CONF** session. All the PWD22/52 heaters are switched ON below 2 °C and off at 5 °C. When using hood heaters, a separate 24 V heating power must be supplied. Hood heating power is 30 W for each hood.

BAUD

Use the following command to change the baud rate and communication type:

BAUD *value communication_type*

Baud rates *300, 1200, 2400, 4800, 9600*

Communication types E (7E1) and N (8N1)

The new value is saved in EEPROM and it is used also after reset or power up. The default baud rate set at the factory is 9600 bps (7E1). The communication type definition is optional. It does not change if the baud rate is changed.

The **BAUD** command displays the current baud rate and communication type.

```
BAUD RATE: 9600 E71
```

Analog Output

Analog output is wired in the default configuration.

The analog output connection is set at the factory as shown in Figure 17. You must do the differential measurement connection at the user's end, which is also shown in Figure 17.
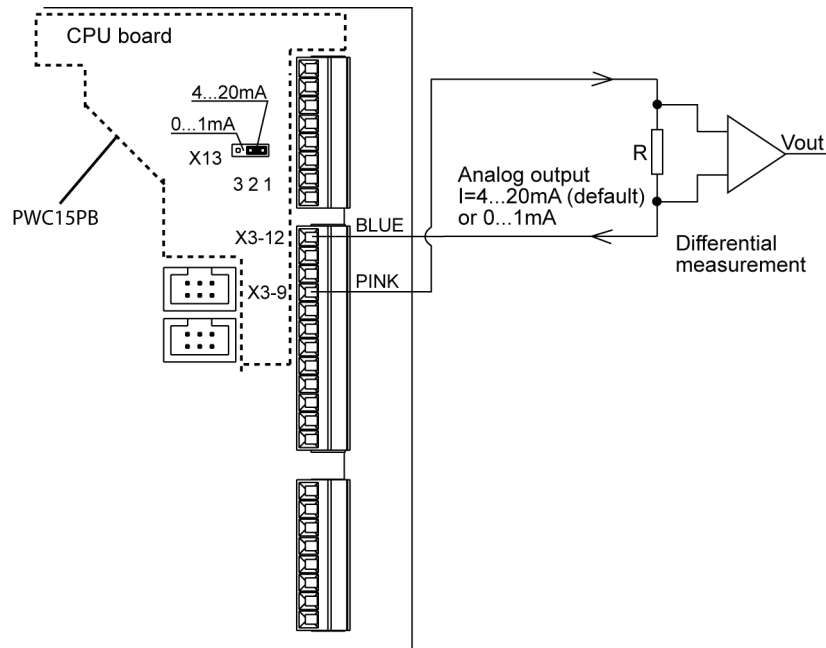
1206-027

Figure 17   Analog Current Output Connection

If the PWD cable is so long that the 12 V power output is inadequate, create an analog output connection as shown in Figure 18 on page 71. When using the external power output, one unused wire must be connected between the X4-8 connector on the PWD CPU board and the ground of the data collector at the user's end. One of the following wires can be used for this if they are not in use anywhere else:

- VIO
- GRY/PNK
- RED/BLU
- PNK
- GRY

For instructions on how to remove the protection board, see Figure 22 on page 91.
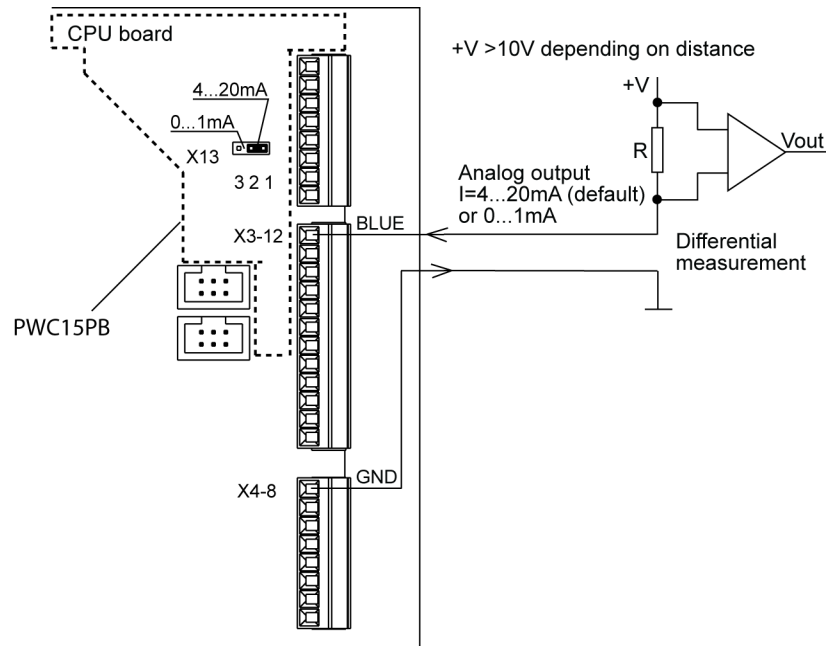
1206-028

Figure 18   Analog Current Output Connection (External Current Source)

Analog Output Modes

By default, the analog outputs are disabled. The default value of MAX VISIBILITY and MIN VISIBILITY is 0. You can enable the analog outputs by setting the analog output range. Use the **CONF** command to set the ANALOG OUTPUT RANGE parameters MAX VISIBILITY and MIN VISIBILITY. For further information on the **CONF** command, refer to CONF on page 65.

MIN VISIBILITY defines the visibility value where the analog output has its lowest value. In most cases this is 10, but other values can also be used depending on the application.

MAX VISIBILITY defines the visibility value where the analog output has its highest value. In most cases this is the visibility measurement range of the sensor (20000 for PWD22 and 35000 for PWD52), but other values can also be used.

The analog output range can be either 0 … 20 mA or 0 … 1 mA, you can select this by using jumper X13. For details, see Appendix B, PWC22/52 Connectors and Jumper Settings on page 109.

Mode 0

Mode 0 indicates standard linear visibility to the current mode. The maximum visibility must be higher than the minimum visibility as well as the corresponding currents.

Mode 1

Mode 1 is the logarithmic mode and it uses ln (visibility) values for the output. The calculation is the following:

$$I_{out} = I_{min} + \left(I_{range} \cdot X_{coeff} \right),$$

where

I_{out}	=	Current that flows to analog output current sink.
I_{min}	=	Specified lowest output current value (for example 4 mA)
I_{range}	=	Current range specified (for example I_{range} = 20 mA - 4 mA =16 mA)

$$X_{coeff} = \frac{\ln(VIS_i) - \ln(VIS_{min})}{\ln(VIS_{max}) - \ln(VIS_{min})} = \frac{\ln\left(\dfrac{VIS_i}{VIS_{min}}\right)}{\ln\left(\dfrac{VIS_{max}}{VIS_{min}}\right)},$$

where

VIS_i	=	Initial visibility value in meters
VIS_{min}	=	Lowest visibility value specified in configuration (for example 10 m or 100 m).
VIS_{max}	=	Corresponding maximum visibility value (for example 2000 m or 20000 m).

The corresponding DAC output LSB value is calculated from I_{out} by using *DAC scale* parameters.

Mode 2

Mode 2 is the extinction mode, which gives lower output for higher visibility. The maximum visibility must be higher than the minimum. The corresponding currents are automatically handled so that the lower current corresponds to the maximum visibility. The calculation is the following:

$$I_{out} = I_{max} - \left(I_{range} \cdot X_{coeff} \right),$$

where

I_{out}	=	Current that flows to analog output current sink.
I_{max}	=	Specified highest output current value (for example 20 mA).
I_{range}	=	Current range specified (for example I_{range} = 20 mA - 4 mA =16 mA)

$$X_{coeff} = \frac{\ln(VIS_i) - \ln(VIS_{min})}{\ln(VIS_{max}) - \ln(VIS_{min})} = \frac{\ln\left(\dfrac{VIS_i}{VIS_{min}}\right)}{\ln\left(\dfrac{VIS_{max}}{VIS_{min}}\right)},$$

where

VIS_i	=	Initial visibility value in meters.
VIS_{min}	=	Lowest visibility value specified in configuration (for example 10 m or 100 m).
VIS_{max}	=	Corresponding maximum visibility value (for example 2000 m or 20000 m).

The corresponding DAC output LSB value is calculated from I_{out} by using *DAC scale* parameters.

Mode 3

Mode 3 is the non-linear Videograph mode . The visibility range from 100 m to 10000 m corresponds to the current range of 1 ... 0 mA.

Mode 4

Mode 4 is the non-linear Videograph mode . The visibility range from 180 m to 20000 m corresponds to the current range of 1 ... 0.1 mA.

Analog Output Calibration

The analog output is initially calibrated at the factory. The analog output has two ranges, 0 ... 1 mA and 0 ... 20 mA. The range is selected according to the jumper.

In the calibration command, the internal scaling factors for milliamperes to hardware control bits are calculated.

PWD22/52 set two-bit patterns to the DAC circuit and asks for the corresponding measured currents. If the higher current is less than 2 mA, PWD22/52 calculates the current range of 0 ... 1 mA. Otherwise, it calculates the current range of 0 ... 20 mA.

To perform analog output calibration:

1.   Connect a multimeter between the pink and the blue wires in PWD22/52.
2.   Give the **ACAL** command to PWD22/52.

3.   PWD22/52 sets two-bit values to the DAC hardware and requests the corresponding currents. The currents can be measured with a standard (calibrated) multimeter.

4.   PWD22/52 calculates the bits/current scales.

Example of the calibration of PWD22 (current sink, 20 mA jumper):

Type the following command:

```
>ACAL
```

The output is the following:

```
MEASURED CURRENT (mA)
```

Enter the value, for example, 21.69.

The output is the following:

```
MEASURED CURRENT (mA) 4.35
```

The output is the following:

```
DAC MODE: EXT1

MAX VIS 20000, 20 mA

MIN VIS 180, 4.5 mA

20mA SCALE_1 184.5, SC_0 -2.8

1mA SCALE_1 184.8, SC_0 -1.4
```

The parameters of the **ACAL** command in the current range of 0 ... 1 mA are the following:

DAC scale 1

DAC scale 0

The parameters of the **ACAL** command in the current range of 0 ... 20 mA are the following

DAC scale 21

DAC scale 20

Maintenance Commands

The maintenance commands are used in installation, maintenance, and troubleshooting. They are as follows:

- **STA**, Displays status
- **CAL** *Calibrator _frequency*, Calibration
- **CLEAN**, Sets clean references
- **ZERO**, Displays zero and noise test status
- **CHEC**, Displays calibrator test signal
- **DRY ON**, Sets RAINCAP® dry offset
- **WET ON**, Sets RAINCAP® wet scale
- **TCAL**, Sets the TS temperature (ambient)
- **HEAT**, Pulls hood heater relays on

STA

The **STA** command (or **MES 3** command) displays the results from the built-in test system as a status message.

The system output is the following (example for PWD22):

```
PWD STATUS
VAISALA PWD22 V 1.00 2003-12-15 SN:Y46101

SIGNAL        3.43 OFFSET     146.11 DRIFT        0.00
REC. BACKSCATTER      2802 CHANGE        2
TR. BACKSCATTER       -2.3 CHANGE      0.0
LEDI    2.3  AMBL     -1.0
VBB    12.6  P12      11.4  M12      -11.3
TS     24.6  TB         29
TDRD     24     25 DRD      858  854  DRY      857.5
BL       26
RELAYS   OFF OFF OFF

HOOD HEATERS OFF
HARDWARE :
 OK
```

The length of the message varies depending on the options configured in PWD22/52 and whether there are warning messages. An asterisk (*) before a value indicates an exceeded limit.

If the Background Luminance Sensor PWL111 is not installed, line BL 26 is omitted. If the optional hood heaters are not installed, the line HOOD HEATERS OFF is omitted. For details on message values, see Appendix A, Internal Monitoring, on page 105.

If warnings or errors are detected, one or several of the following texts appear at the end of the message.

See Table 15 and Table 16 below.

Table 15   Hardware Error Texts

Error Text	Description
Backscatter High	Receiver or transmitter contamination signal has increased more than the ALARM limit given in the configuration allows.
Transmitter Error	LEDI signal is more than 7 V or less than -8 V.
±12 V Power Error	Receiver/transmitter power is less than 10 V or more than 14 V.
Offset Error	Offset frequency is <80 or over 170 (PWC22/52 hardware).
Signal Error	Signal frequency + offset frequency = 0, Signal frequency - offset frequency < -1
Receiver Error	Too low signal in receiver backscatter measurement.
Data RAM Error	Error in RAM read/write check.
EEPROM Error	EEPROM checksum error.
TS Sensor Error	Measurement is out of limits.
DRD Error	RAINCAP® signal is close to zero.
Luminance Sensor Error	PWL111 signal is out of limits.

Table 16   Warnings

Warning	Description
Backscatter Increased	Receiver or transmitter contamination signal has increased above the WARNING limit selected in the configuration.
Transmitter Intensity Low	LEDI signal less than -6 V.
Receiver Saturated	AMBL signal is less than -9 V.
Offset Drifted	Offset Drifted
Visibility Not Calibrated	Visibility calibration coefficient has not been changed from the default value (see section CAL below).

CAL

Use the **CAL** command to calibrate the visibility measurement. The calibration is done using opaque glass plates with known scatter properties. The plates belong to the PWA12 calibrator kit.

The command is the following:

CAL *Calibrator_signal_value*

For example:

```
>CAL 485
```

The calibrator signal value is printed on the labels of the glass plates. Typically the signal is close to 500 Hz. PWD22/52 calculates a new scaling factor and stores it in the non-volatile memory (EEPROM).

> **!** If the PWC22/52 board has been changed and the status message shows the VISIBILITY NOT CALIBRATED error, use **FCAL** instead of **CAL** to make a factory-like calibration.

CLEAN

Use the **CLEAN** command to set the clean references for contamination control . Give this command during maintenance procedures after cleaning the lenses or after replacing the transmitter or receiver electronics. This command has no parameters.

Give the following command:

```
>CLEAN
```

The PWD22/52 output is the following:

```
CLEAN REFERENCES
TRANSMITTER 12.0
RECEIVER 1402

UPDATED
>
```

ZERO

Use the **ZERO** command when calibrating visibility to display the zero signal status. This command has no parameters.

When the signal blocker of the PWA12 calibrator kit is installed to the lens hood of the receiver (box), the PWD22/52 software checks for the very low signal and low noise. If the signal or noise is out of the internal check limits, an error message appears.

Give the following command:

```
>ZERO
```

The output is the following:

```
ZERO SIGNAL: OK

>
```

Or in the case of failure in the receiver (PWC22/52) one of the following:

```
ZERO SIGNAL: FAIL
ZERO SIGNAL: NOISE HIGH
```

CHEC

Use the **CHEC** command when calibrating visibility to display the one-minute average signal frequency in hertz (Hz). This command has no parameters.

Press ESC to terminate the display. If you press any other key, the display pauses. In the beginning, the four-location buffer, which is used to calculate the average, is filled with the first value.

When the calibrator is installed, the value displayed in the message should be the same as the value printed on the calibrator glass plate.

Give the following command:

```
>CHEC
```

The output is the following:

```
SCALED FREQUENCY AVE (1 MIN)
 499.9938
 499.9880
```

DRY ON and WET

Use the **DRY ON** and **WET** commands to check and adjust the operation of the Vaisala RAINCAP® Rain Sensor measurement.

DRY ON

Use the **DRY ON** command to set the reference level of the dry signal for the RAINCAP® signal normalization calculation. When giving the **DRY ON** command, the sensor surface and weather conditions must be dry.

The output is the following:

```
DRD DRY OFFSET 715.6
```

The DRY OFFSET value must be between 700 and 900, when the RAINCAP® hardware operates normally. The **DRY** command without a parameter just shows this parameter.

WET

The **WET** command without a parameter shows the scaling factor that normalizes the RAINCAP® signal change from the dry state to the wet state to be 1.00. A typical value is close to 0.0015.

```
DRD WET SCALE 0.00169
```

Use the **WET ON** command to set the parameter. The RAINCAP® measuring surfaces must be coated with a wet cloth or immersed in water for at least 30 seconds, when the **WET ON** command is given. Make sure the wet cloth touches only the RAINCAP® sensor.

The wet scale normalizes the measured signal range (DRY - WET) to 1.00.

TCAL

Use the **TCAL** command to set the ambient temperature.

When you type the command **TCAL** without a parameter

```
>TCAL ↵
```

PWD responds

>TS 1 1.0000 TS 0 0.00 TS -0.5

where TS 1 <always 1.0000> TS 0 <offset correction> TS <measured and corrected temperature>Ts sensor inside the cross arm is measured every 15 sec by PWD.

HEAT

Use this test command to test the heater control relays and the heating elements and power. For example:

```
HEAT ON
```

Press ESC to stop the heater test and quit the test mode.

In warm conditions, do not leave the heater testing on for long periods of time.

Other Commands

TIME

Use the **TIME** command during maintenance to display the current system time:

```
TIME
```

The following is an example of the system output:

```
10:11:12
```

To set the time, use the following command:

TIME *hh mm ss*

where

hh	=	hours
mm	=	minutes
ss	=	seconds

> ! The time and date has to be reset after a power break. There is no battery backup.

DATE

Use the **DATE** command to display the current date.

To set a new system date, type the following:

```
DATE yyyy mm dd
```

where

yyyy	=	year
mm	=	month
dd	=	day

RESET

The **RESET** command makes the hardware reset by the watchdog circuitry.

VER

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

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CHAPTER 6
MAINTENANCE

This chapter provides information needed in basic maintenance of the product.

Periodic Maintenance

PWD22/52 is calibrated at the factory and no initial calibration is required.

Periodic maintenance of PWD22/52 includes:

- Cleaning the transmitter and receiver lenses and hoods.
- Cleaning the RAINCAP® Rain Detector.
- Checking the visibility calibration and calibrating it, if necessary.
- Cleaning PWL111 lenses.

PWD22/52 is designed to operate continuously for several years without other maintenance than cleaning of the lenses and the RAINCAP® sensing surface.

Before any commands can be given to PWD22/52, open the communication line by typing the following:

```
OPEN
```

PWD22/52 answers as follows:

```
LINE OPENED FOR THE OPERATOR
```

To release the line to automatic messages, use the CLOSE command. For details, see Chapter 5, Operation on page 49.

Cleaning

It is important to clean PWD22/52. No specific operations are necessary before cleaning the sensor and it is possible to use the service terminal while cleaning. Some erroneous data may, however, be generated. To minimize this problem, restart PWD22/52 after cleaning by pressing power OFF/ON.

Cleaning Lenses and Hoods

The lenses of the PWD22/52 transmitter and receiver units must be relatively clean to get reliable results as dirty lenses give too good visibility values. Clean the units at least every six months, more often if the conditions require it (for example, if there are roads nearby).

The hardware alarm field of the data message (2nd character on the message) indicates when cleaning is needed. See section Message Types on page 52.

Number 3 = backscatter alarm indicates that the contamination level is too high and cleaning must be done at once. The measurement values are not shown in the data message.

Number 4 = backscatter warning indicates that the contamination level has increased and cleaning must be performed in the near future. The measurement values are still reliable and are shown in the data message.

To clean PWD22/55 and PWL111 lenses and hoods:

1. Moisten a soft, lint-free cloth with isopropyl alcohol and wipe the lenses. Be careful not to scratch the lens surfaces.
    Confirm that the lens heating works by checking that the lenses dry after wiping.
2. Check that the hoods and lenses are free of condensed water, or ice and snow deposits.
3. Wipe the dust from the inner and outer surfaces of the hoods.
4. After the optical surfaces are properly cleaned, give the **CLEAN** command.

It is not necessary to give the **CLEAN** command after every cleaning.

Alternatively, give the **STA** command and check that the Backscatter **CHANGE** value of both the receiver and the transmitter is close to zero (set to zero by the previous **CLEAN** command).

Cleaning RAINCAP®

Clean Vaisala RAINCAP®Rain Sensor at least every six months, more often if local conditions require it.

> **!** The measuring principle does not allow for proper ESD protection of the RAINCAP® electronics, so you must follow the following instructions:

- Ground your hand first by touching grounded metallic parts of the installation to remove excessive static charges from your body.
- Clean the RAINCAP® rain detector carefully with a soft, lint-free cloth moistened with mild detergent. Be careful not to scratch the surface.
- Check that the detector is free of ice and snow deposits.

Calibration

PWD22/52 is calibrated at the factory. Normally, PWD22/52 needs no recalibration as long as the circuit boards are not changed and there are no warnings or alarms.

The circuit boards do not need hardware calibration.

A periodic check every 6 months is recommended to check the visibility calibration using the PWA12 calibration kit. If the check shows less than ±5 % change, recalibration is not recommended, because the change is within the repeatability of the calibration procedure.

If any mechanical damage changes or weakens the optical measurement path, that is, either the receiver or the transmitter, or the cross arm supporting them, PWD22/52 must be replaced. If the receiver unit (PWC22/52) or transmitter unit (PWT11) is replaced, both visibility and contamination measurements need recalibration.

For information on how to calibrate the temperature sensor, see Appendix D, Calibrating the TS Sensor, on page 115.

Visibility Calibration

The calibration is checked and adjusted with the PWA12 calibration kit. The kit consists of a blocking plate and two opaque glass plates with known scatter properties. The **ZERO**, **CHEC**, and **CAL** commands are used in the procedure. The calibration procedure checks two points; zero scatter signal and a very high scatter signal. The zero signal is obtained using a blocking plate and the high signal using opaque glass plates.

When calibrating visibility measurement, make sure that visibility is 500 meters or higher. Calibration is not recommended in heavy rain or in bright sunshine. Bright sunlight on the calibrator plates increases noise in the scatter measurement and makes the **CHEC** command output less stable. However, light rain does not matter.

Calibration Check

The calibration check procedure determines whether or not the unit needs calibrating. Before performing the calibration check:

- Clean the lenses following the instructions in section Cleaning Lenses and Hoods on page 84.
- Check the opaque glass plates and clean them if necessary.

To perform the calibration check:

1. Block the light path by placing the blocking plate in the receiver hood and wait 30 seconds.
2. Give the **ZERO** command.
    PWD22/52 responds as follows:

    ZERO SIGNAL: OK
3. Move the blocking plate.
4. Install the calibrator plates on the lens hoods. See Figure 19 on page 87.
5. Fasten the opaque glass plates to the hoods.
    Note the signal value printed on the plates, you will need it during the following steps.
6. Move away from the optical path and wait 30 seconds.
7. Give the **CHEC** command.
8. After one minute, read the displayed signal.
9. The signal value must be close to the one printed on the plates. If the difference is less than 5 %, calibration is correct. If not, continue with the calibration procedure.
10. Press the ESC key to terminate the **CHEC** command.
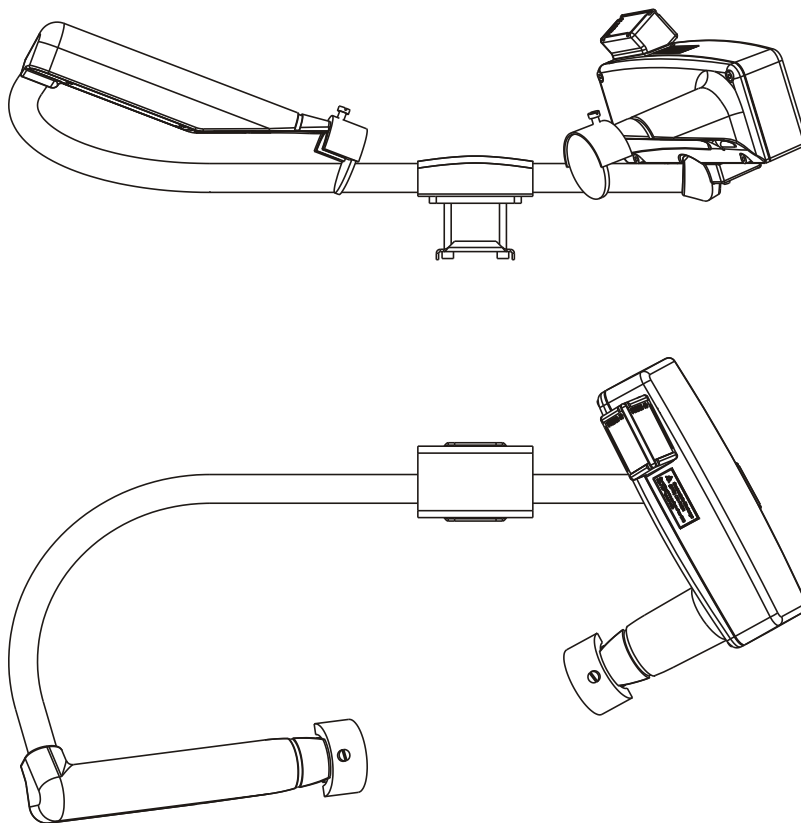
0308-006

Figure 19   Assembling the Opaque Glass Plates

Calibration Procedure

If calibrating is needed according to the calibration check (see section Calibration Check on page 86), calibrate the unit:

1.   Give the following command:

        CAL *calibrator signal value*

        For example: CAL   485

        The calibrator signal value is printed on the labels of the glass plates. Typically the signal is close to 500 Hz. PWD22/52 calculates a new scaling factor and stores it in the non-volatile memory (EEPROM).

2.   Type **CHEC** to verify that the new scaling factor is in use. The displayed signal value should be equal to the calibrator signal value.
        If the difference between the new scaling factor and the factory calibrated scaling factor is more than 20 %, the **CAL** command is ignored. Check PWD22/52 and the calibrator for hardware or

mechanical errors and consult Vaisala.

If the optical units PWC22/52 or PWT11 have been replaced, the new scaling factor might change more than 20 % from the original scaling factor, value and the **CAL** command is ignored. In this case, use the **FCAL** command (factory calibration) instead of **CAL** during the calibration procedure.

Repair

This section describes how to remove and replace the optical units PWT11, Transmitter, and PWC22/52 Controller/Receiver.

Removing and replacing units may be required if PWD22/52 malfunctions are caused by faults in the optical units or the rain detector.

Removing and Replacing Optical Units

CAUTION!

Equipment servicing must be performed by qualified personnel.

After replacing the optical units you need factory calibration. (See section Calibration Procedure on page 87).

Removing PWT11

To remove the transmitter:

> ⓘ Use gloves suitable for handling optics.

1. Open the four countersunk screws and remove the transmitter cover and the gasket.
2. Disconnect the control cable connector (2).
3. Loosen the set screw (3) to release the transmitter module (5).
4. Pull the module out of the transmitter head by prying it from the back by a screwdriver.
5. Loosen the nylon screw (6) and slide the transmitter board (4) off the module (5).
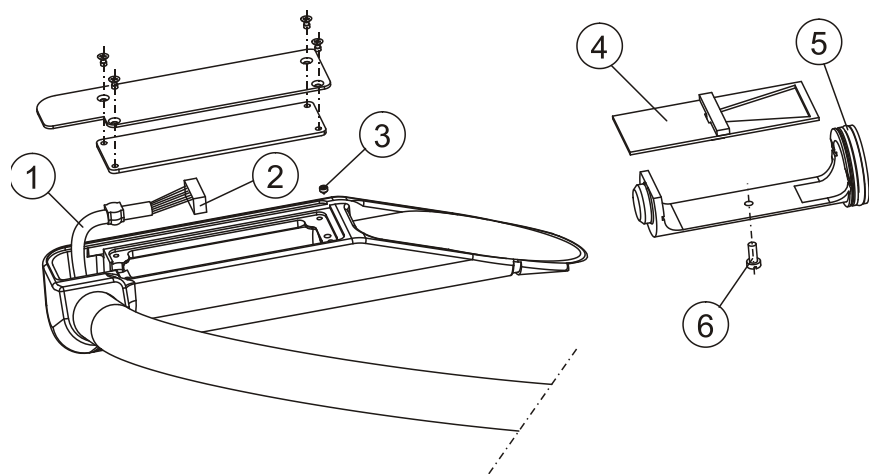
0308-007

Figure 20   Removing PWT11

```
1  =  Signal and power cable
2  =  Empty pin
3  =  Set screw
4  =  PWT11
5  =  O-ring and module
6  =  Plastic screw
```

Perform the re-assembly in the reverse order:

1. Slide the transmitter board (4) to the module (5) and tighten the nylon screw (6).

2. Lightly grease the O-ring (5) surface on the optics module with silicon grease.

3. Press the optics assembly into the transmitter. Be careful not to touch the lens. Make sure that the module seats properly. If not, lead it to the sink by pointed pliers.

4. Lock the module with an M4x4 set screw.

5. Connect control cable (1) and make sure the cable gasket seats tight into its groove.

6. Check that all the optical surfaces, LED and lens, are clean.

7. Close the transmitter cover with the gasket by four counter sunk screws.

Removing PWC22/52

1. Open the four box screws in the corners of the controller box. See (1) in Figure 21.

.
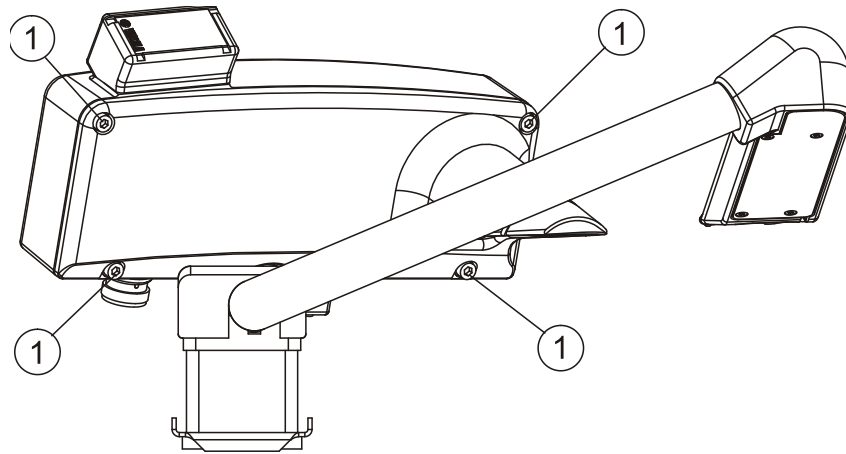
0308-008

Figure 21   Opening Box Screws

2.   Remove the PWC15PB protection board by opening the two
      screws shown in Figure 22 below.
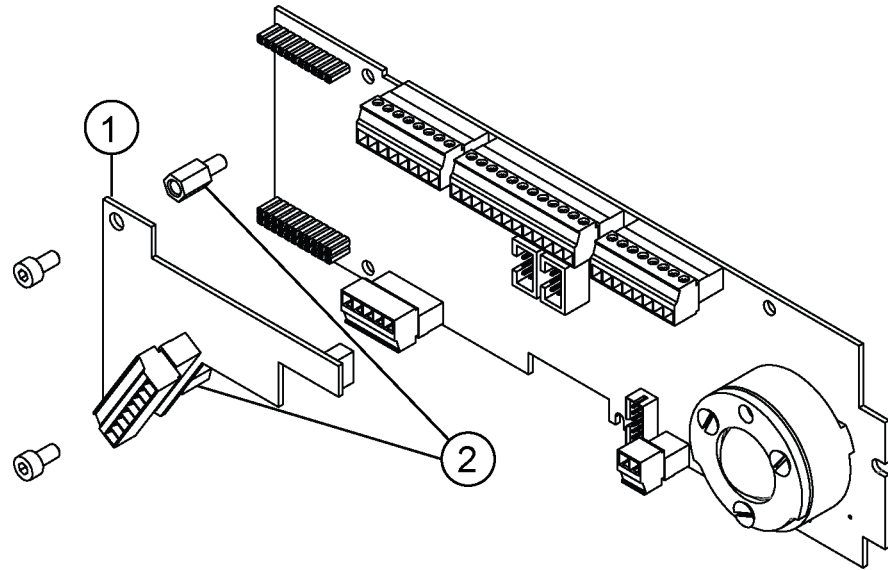
1502-004

Figure 22   Removing the PWC15PB Protection Board

1   =   PWC15PB
2   =   Screws

3.   Remove the PWC22/52 board by opening the five screws to replace
      the board with a spare part. See Figure 23 below.
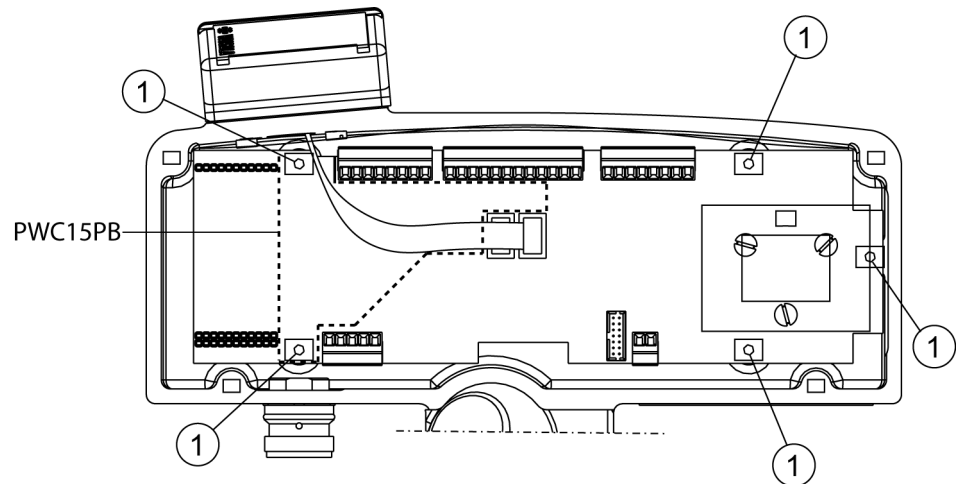
1206-029

Figure 23   Removing the PWC22/52 Board

Replacing RAINCAP®

1. Open the control box (see section Removing PWC22 on page 90).

2. Remove the two screws of the PWC15PB protection board, see Figure 22 on page 91.

3. Unplug the rain sensor cables (X6 and X7).

4. Remove the two screws below RAINCAP®.

5. Remove RAINCAP® by pulling it out of the control box.

6. Reassemble in the reverse order. Note that the flat cable marked with a stripe is connected to X6.

7. Calibrate the new RAINCAP® by giving the **DRY ON** command as described in section DRY ON on page 78.

8. Re-install the PWC15PB protection board.
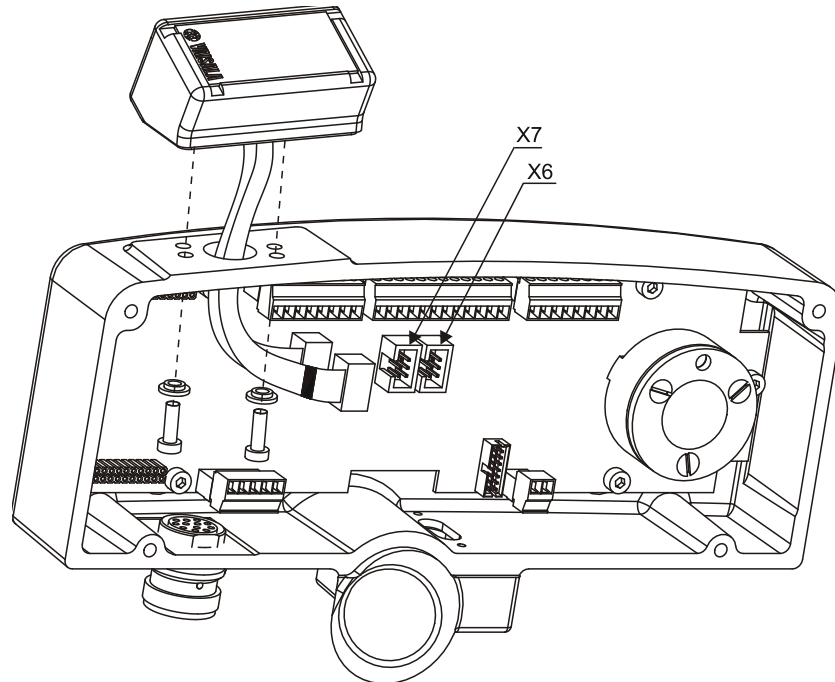
0312-112

Figure 24   Removing the Rain Sensor

Cleaning and Maintaining Painted Surfaces

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

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

Preparing for Painting

To prepare the surface for painting:

1. Clean the surface and remove any loose coating with a scraper and a steel brush.
2. Use sandpaper on damaged areas and around the damaged area's edges.
3. Remove impurities, such as dirt and grease, with warm soapy water.
4. Rinse with warm water.

The surface must be completely dry before starting maintenance painting. Protect the surfaces that will not be painted with tape or paper.

Make sure the air temperature, the paint, and the painted surface are at least +10 °C and the relative humidity below 80% during painting and drying. Do not paint in rain or in direct sunlight.

Painting

After preparing the surface, coat the surface as soon as possible. Follow your paint manufacturer's instructions carefully.

1. Use a primer, such as Teknos INERTA PRIMER 5 epoxy paint 60-80 µm.
2. Paint the surface 2-3 times, so that the dry film layer thickness is 40-60 µm. Use, for example, Teknos TEKNODUR 0190 polyurethane 40 µm, so that the total thickness is 100-120 µm.

Commonly Used Vaisala Colors

- Solid White, Semi Gloss RAL 9003
- Shade Grey, Semi Gloss RAL 7035
- Construction Grey, Semi Gloss RAL 7024
- Signal Red, Semi Gloss RAL 3001

For more information on the paints, visit the paint manufacturer's website www.teknos.com.

> **!** If you use other paints, make sure the paint is compatible with the polyester powder coating.

CHAPTER 7
TROUBLESHOOTING

This chapter describes common problems, their probable causes and remedies, and provides contact information for technical support.

Common Problems

> ⚠ **CAUTION!**
>
> Servicing the equipment must be performed by qualified personnel.

Message Indicating Warning or Alarm

Open the command mode and check the status information with the **STA** command (or poll Message 3 to get the same information).

- See section STA on page 75 for status message error and warning descriptions.
- Check the monitoring values against the internal monitoring limits. See Appendix A, Internal Monitoring, on page 105.
- If the Backscatter increased warning is active (see section STA on page 75), clean the lenses and remove possible disturbances from the optical path.

Message Missing

1. Does your terminal have the right settings?
   - Change the baud rate, for example, to 9600 bps.
   - Check that you have 7 data bits, even parity, 1 stop bits.
2. Give the **OPEN** command (see section OPEN on page 51).
3. Give other commands to see if PWD22/52 is already in the command mode.
4. Go to the site.
   - Take the maintenance PC (terminal), tools, and the calibrator set with you.

5. Check that PWD22/52 has power by opening the PWC22/52 electronics enclosure cover and checking that the Run and Signal/Offset LEDs are blinking.

6. If no LED is on:
   - Check the power supply voltage.
   - Check that all the connectors are properly inserted.
   - Check the power cable and connections.

7. If the Run LED is blinking (once per second for correct operation):
   - Connect a maintenance terminal to the RS port.
   - Check steps 1 and 2.
   - Try resetting by turning the power off/on.

8. If the Run LED is lit:
   - Try resetting as above.
   - If the state is continues, it is probably caused by either the program memory or CPU fault.

Message Exists but Visibility Value Does Not

1. PWD22/52 control electronics is probably working.
   - Check the status information with the **STA** command (see section STA on page 75). If there are any active alarms, the visibility value does not exist.
   - Check P12, M12, BACKSCATTER and LEDI. See Appendix A, Internal Monitoring, on page 105 for internal monitoring values of the limits.

2. Go to the PWD22/52 site.
   - Check the cable connectors.
   - Check the receiver and transmitter units. Follow the instructions in section Removing and Replacing Optical Units on page 88 when removing the units.
   - Visually inspect the condition of the electronics.

Visibility Value is Continuously Too Good

This can be caused by several reasons. Most probably the light path from the transmitter to the receiver is disturbed.

1. The lenses may be excessively contaminated. A warning has been received.
    - Clean the lenses (see section Cleaning Lenses and Hoods on page 84).
2. One of the hoods has been filled with, for example, snow or leaves,. A warning is generated.
    - Clean the hoods (see section Cleaning Lenses and Hoods on page 84).
3. There is condensation on the lens surfaces. This is a sign of heating failure.
4. There is an electrical fault in the transmitter or receiver.
    - Check the status information with the **STA** command (see section STA on page 75).
    - Go to section Message Exists but Visibility Value Does Not on page 96.
5. Mechanical alignment of the sensor has changed and the receiver beam and the transmitter beam have lost their overlap. This can be caused by, for example, a colliding vehicle.
    - Return the sensor to Vaisala Calibration and Repair to get a new chassis.

Visibility Constantly Too Low

Usually there is something disturbing the sample volume.

1. Check the condition of the hoods. If the hoods are twisted, consult Vaisala.
2. Try to find a better direction for the receiver/transmitter optics. See section Selecting Location on page 31.
3. Electrical fault. See items in section Message Exists but Visibility Value Does Not on page 96.

PWD22/52 Reports Precipitation When There Is None

In temperatures under 0 °C, only the optical measurement is used in detecting precipitation. In temperatures above 0 °C, the RAINCAP® detection is used to cross-check the optical detection -- false detection can only be caused by problems in both measurements.

1. Check that there are no flashing lights close to PWD22/52. Flashing lights may cause PWD22/52 to detect peaks in the optical signal.
2. Check that there are no foreign objects in the sample volume. Tree branches or other moving objects may cause sudden changes in the scatter signal.
3. Check that receiver is not facing cars passing by. If the sun beams reflect from passing cars towards the receiver, this could cause false precipitation reports, especially in winter. These short sun beam reflections can cause short spikes to the PWD22/52 optical signal and they are interpreted as light snow.
    This might happen if there are sharp changes of the lighting condition of the ground where the receiver is looking. If the area where the receiver is looking at is bright and shiny and passing cars cause shadows to that area, this can cause similar short spikes to the receiver signal.
4. If the false detection has occurred in temperatures above 0 °C, RAINCAP® does not function correctly. Clean the RAINCAP® sensing surfaces.

PWD22/52 Reports Frozen Precipitation during Rain

The ratio of optical intensity measurement to the RAINCAP® measurement is too high.

1. Check the optical calibration and RAINCAP® operation.
2. If everything else seems to be functioning correctly, change the parameter settings.
    -   If possible, check the accumulated water sum against a reference rain gauge. This will indicate how close the Rain intensity scale is to the optimal value. Decrease the scaling factor if the PWD22/52 rain amount is too high.
    -   Otherwise, increase DRD scale (the **WSET** command).

PWD22/52 Electrical Troubleshooting

PWD22/52 is protected against reverse polarity connected to power feed wires. If the power feed is connected to other leads than those for power supply, damage may occur depending on feed voltage and current limiting features of the supply.

If there is no response from PWD22/52:

1. Check the connections. PWD22/52 diagnosis can be done through the RS-232 maintenance line.

2. Check the baud rates:
   - The factory default is 9600,7,E,1.

3. Open the cover of the receiver.

4. Connect the power and watch the internal LEDs.

   Initialization sequence (3 seconds):
   LED 4 RED lit (Signal lit / offset off)
   LED 3 YEL lit (RUN, 1 Hz)
   LED 2 RED off (Transmit Data)
   LED 1 YEL off (Receive Data)

Start sequence (1 second):
   LED 4 RED lit (Signal lit / offset off)
   LED 3 YEL off (RUN, 1 Hz)
   LED 2 RED off (Transmit Data)
   LED 1 YEL off (Receive Data)

   Running sequence from start:
   LED 4 RED lit 10s / off 5s, continuing sequence
   LED 3 YEL flashing, 1 Hz
   LED 2 RED short live when sending initialization string (Transmit Data)
   LED 1 YEL off (Receive Data)

5. If the sequence is working and the transmit indicator gives response, check following:
   - Initialization string "VAISALA PWDxx Vn.nn yyyy-mm-dd SN:___" should give a response to the maintenance terminal, if the response is not understandable:
   - Check the terminal communication set-up.
   - Try with other expected baud rates.

6. If the LEDs are not lit, check the internal connector connections of PWD22/52. The following measurement can be done:

    - Measure the input voltage:
      X1-5 = power GND, X1-4 = power + V

7. If the LEDs are lit but the sequence starts again and again, try the following:

    - Check the cable end for short-circuit with neighboring leads. Unused wires of the PWD22/52 mast cable must be insulated from each other, for example, by connecting them to void screw terminals in the junction box.

    - Try with a power with a higher current supply capability (the power supply may go to current limiting state for a short while).

    - Try with a higher supply voltage (max. 55 VDC.) This helps the starting current need.

Technical Support

For technical questions, contact the Vaisala technical support by e-mail at helpdesk@vaisala.com.

Provide at least the following supporting information:

- Name and model of the product in question
- Serial number of the product
- Name and location of the installation site
- Name and contact information of a technically competent person who can provide further information on the problem.

For Vaisala Service Center contact information, see www.vaisala.com/servicecenters.

CHAPTER 8
TECHNICAL DATA

This chapter provides the technical data of PWD22/52.

Mechanical Specifications

Table 17   PWD22/52 Mechanical Specifications

Property	Description / Value
Dimensions	199 mm (h) × 695 mm (w) × 404 mm (d)[1]
Weight	3 kg
Mounting	To a metal rod or directly to the mast.
Material	Aluminum

1) Height × width × depth (with maximum options)

Electrical Specifications

Table 18   PWD22/52 Electrical Specifications

Property	Description / Value
Maximum power consumption	6 W, 12-50 VDC Optional luminance sensor: 2 W, 24 V Optional hood heaters: 65 W, 24 V
Sensor electronics	Lock-in amplifier.
	LED power stabilizer.
	Contamination monitor.
	Lens heater.
	Temperature sensor.
Outputs	Serial data line may be used either as RS-232 or RS-485 (2-wire) level signals.
	Three relay controls (open collector).
	Analog output
	8-m power/data cable standard. The PWD22/52 end is equipped with connector.
Output data	Automatic or polled data messages.
	Visibility, present weather, precipitation, and status data.
	Automatic message type and interval is selectable at 15 s ... n x 15 s (n < 18) intervals.
Auxiliary data	Low visibility alarms in the data messages. Three adjustable alarm limits to set the three relay controls.
	Hardware status (fail/warning) in the data messages. Third relay output can also be driven by hardware status.

Optical Specifications

The operating principle of the device is to measure forward scatter at an angle of 45°.

Table 19   Light Transmitter Optical Specifications

Property	Description / Value
Light source	Near-infrared Light Emitting Diode
Peak wavelength	875 nm
Reference photodiode	For light source control
Backscatter photodiode	For contamination and blockage measurement
Eye safety	Eye safe in accordance with International Standard IEC/EN 60 825-1; edition 1.2

Table 20   Light Receiver Optical Specifications

Property	Description / Value
Detector	Photodiode
Optical filter/window	RG780 glass
Backscatter light source	Near-infrared LED for contamination and blockage measurement

Visibility Measurement Specifications

Table 21   Visibility Measurement Specifications

Property	Description / Value
Measurement range of MOR [1]	10 ... 20000 m (PWD22) 10 ... 35000 m (PWD52)
Accuracy PWD22	+/-10%, range 10 m ... 10000 m +/-15%, range 10 km ... 20 km
Accuracy PWD52	+/-10%, range 10 m ... 10000 m +/-20%, range 10 km … 35 km
Instrument consistency	+ 5%
Update interval	15 seconds

1)   Meteorological Optical Range

Weather Sensing Specifications

Table 22   Weather Sensing Specifications

Property	Description / Value
Precipitation detection sensitivity	0.05 mm/h or less, within 10 minutes
Weather type identification	7 different types of precipitation (rain, freezing rain, drizzle, freezing drizzle, mixed rain/snow, snow, ice pellets) Precipitation (unknown type) Fog (mist), haze (smoke, sand) or clear
Weather type reporting	WMO code table 4680
	Code letters for precipitation, NWS (National Weather Service, USA)
Precipitation intensity measurement	Range 0.00 ... 999.99 mm/h
Precipitation amount measurement	Range 0.00 ... 99.99 mm
Amount of new snow	Range 0.00 ... 999 mm

Environmental Specifications

Table 23   Environmental Specifications

Property	Description / Value
Operating temperature range	-40 ... +60 °C
Operating humidity range	Up to 100 % RH
Wind speed	Up to 60 m/s
Sun orientation	Sunlight into the light receiver must be avoided

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APPENDIX A
INTERNAL MONITORING VALUES

Typical values come from factory testing and may change within the given Min/Max limits. Fault limits give hints for troubleshooting.

Table 24   STA Message Values

Status Message	Typical	Min. / Max.	Fault	Description	Action
AMBL					
Ambient light	-0 V	-9 V / +3 V	> 3 V 'RECEIVER ERROR'	Preamplifier is not working.	Change PWC22/52.
			< -9 V 'RECEIVER SATURATED'	The sun is shining directly or from reflecting surface such as snow, to the receiver.	Check the orientation of PWD22/52
OFFSET					
Measurement signal offset. The lowest frequency for measurement signal	140Hz... 150Hz	80 Hz / 170 Hz	< 80 Hz >170 Hz 'OFFSET ERROR'	Drifting may be caused by other disturbing optical sensors nearby or other interference problems.	1) Check other parts of STA message. 2) If offset does not remain stable, change the control unit PWC22/52.
REC. BACKSCATTER					
Measurement signal from the receiver contamination control circuit. 'CHANGE' value is the instant signal difference to clean value.			Rec.backscatter change (Instant backscatter minus clean backscatter) > alarm limit 'BACKSCATTER HIGH'	Rising value can be caused by contamination of receiver optics, snow inside the receiver hood, spider net in front of the hood etc. Check the contamination limits also.	Clean the outside of optical surfaces and remove possible disturbances from optical path.

Status Message	Typical	Min. / Max.	Fault	Description	Action
			Rec.backscatter change (Instant backscatter minus clean backscatter) > warning limit 'BACKSCATTER INCREASED'		
			Instant backscatter < clean backscatter / 2 'BACKSCATTER HIGH'		1) Clean the outside of the optical surfaces and remove possible disturbances from the optical path. 2) Replace the clean contamination setting by giving the **CLEAN** command. 3) Change the PWC22/52 control unit.
TR. BACKSCATTER					
Control signal for the transmitter contamination.

'CHANGE' value is the instant signal difference to clean value. | | | <-15 V >14 V 'TRANSMITTER ERROR' | The decreasing value can be caused as above: (REC. BACKSCATTER) | |
LEDI					
LED intensity. Actuating signal for the LED control (transmitter)		-8 V / +7 V	>+7 V <-8 V 'TRANSMITTER ERROR'	Changes in voltage can be caused by aging of the LED (voltage decreases).	Change the PWT11 Transmitter unit.
			<-6 'TRANSMITTER INTENSITY LOW'	If the voltage is between -6 V... -7 V, the control loop is operating properly but the IR LED must be changed in the near future.	

Status Message	Typical	Min. / Max.	Fault	Description	Action
TS					
Temperature sensor. Ambient temperature	-40 °C... +50 °C	-75°C / +98°C	'TS SENSOR ERROR' (Measurement value under -75°C)	Sensor or cable short-circuits.	Check the temperature sensor cable on control unit. Resistance of Pt-100 should be 80Ω...130Ω.
			'TS SENSOR ERROR' (Measurement value over +98°C)	Sensor disconnected or bad connection.	Check X4 connection on control unit. Resistance of Pt-100 should be 80Ω...130Ω.
TB					
Temperature of the CPU board	Some degrees higher than ambient temp.		-	-	-
SIGNAL					
Frequency of the transmission signal between transducer and CPU (Hz), inversely proportional to visibility	0.00 Hz.... 10000.00 Hz		'SIGNAL ERROR' Signal frequency plus offset frequency = 0 or Signal frequency minus offset frequency < -1	Interference with other sensor of the same kind. Suddenly increased noise level. Failure in receiver circuitry.	Make sure that the device does not receive reflections or scattering from other sensors. Aim the receiver away from high intensity light sources. Change PWC22/52.
VBB					
Raw, unregulated voltage in the internal transformer output	12V... 13V	12 V / 15 V	<12 V >15 V	Switched-mode power supply is overloaded or working wrong. VBB measurement may also fail due to heavy electrostatic discharge to RAINCAP® plate.	1) Reset. 2) Check connectors and cable. 3) Change the control unit PWC22/52.

| Status Message	Typical	Min. / Max.	Fault	Description	Action
P12					
Positive voltages of the DC/DC converter for the transmitter and receiver	11.5 V	10 V / 14 V	<10.0 V >14.0 V '+-12 V POWER ERROR'	DC/DC converter is overloaded or working wrong. P12 measurement may also fail due to heavy electrostatic discharge to RAINCAP® plate.	1) Reset. 2) Disconnect transmitter. 3) Change the PWC22/52 control unit.
M12					
Negative voltages of the DC/DC converter for the transmitter and receiver	-11.5 V	-14 V / -10 V	<-14.0 V >-10.0 V '+-12 V POWER ERROR'	DC/DC converter is overloaded or working wrong. M12 measurement may also fail due to heavy electrostatic discharge to RAINCAP® plate.	1) Reset. 2) Disconnect transmitter. 3) Change the PWC22/52 control unit.
DRD					
Instant value of RAINCAP® Rain Sensor	64...900Hz	64 / DRY	< 64 Hz 'DRD ERROR'	Cable disconnected or rain detector RAINCAP® short-circuits	1) Check connector X7 and X6 on the PWC22/52 control unit. 2) Change the RAINCAP® Rain Sensor.
BL					
Background luminance	4...20000 cd/m²	4 cd/m² / 20000 cd/m²	'LUMINANCE SENSOR ERROR'	Cable disconnected or PWL111 short-circuits	Check connector X3 pins 1,2,3,4.
RELAYS					
States of the three external relays controls	ON / OFF		-	-	-
HOOD HEATERS					
Hood heater automatics are switched either on or off.	ON / OFF		-	If set to ON state, heater current starts flowing when ambient temperature goes below +2°C and stops when it raises over +5°C.	Heaters can be tested by the **HEAT ON** command. Warming of the heater foils should be felt by hand. If not check powering and cabling.

APPENDIX B

PWC22/52 CONNECTORS AND JUMPER SETTINGS

X1-1		Chassis (GND)
X1-2		RS-485 (B) (WHT)
X1-3		RS-485 (A) (BRN)
X1-4	1)	DC power for measurement electronics (+, RED)
X1-5	1)	DC power for measurement electronics (-, BLK)
X2-1		RS-232 (GND, GRY)
X2-2		RS-232 (TxD, GRN)
X2-3		RS-232 (RxD, YEL)
X2-4		Module 5
X2-5		Module 4
X2-6		Module 3
X2-7		Module 2
X2-8		Module 1
X3-1		Background Luminance Sensor PWL111 (Range, YEL)
X3-2		Background Luminance Sensor PWL111 (Level, GRN)
X3-3		Background Luminance Sensor PWL111 (+5 VA, RED)
X3-4		Background Luminance Sensor PWL111 (AGND, BLK)
X3-5	1)	Separate heating power input for PWH111hood heaters (+, BRN/GRN and WHT/GRN)
X3-6	1)	Separate heating power input for PWH111hood heaters (-, WHT/YEL and YEL/BRN)
X3-7	1)	PWH111hood heater foil (+)
X3-8	1)	PWH111hood heater foil (-)
X3-9		Ext Voltage +12 V (analog output current source (PNK)
X3-10		Ext (modem) control 1
X3-11		Ext (modem) control 2
X3-12		Analog output current sink (range is chosen by jumper X13 located under the PWC15PB), (BLU)
X4-1		Temperature sensor PT100 (+, BLU)
X4-2		Temperature sensor PT100 (+, YEL)
X4-3		Temperature sensor PT100 (-, RED)
X4-4		Temperature sensor PT100 (-, GRN)
X4-5		Ext relay control 3 (default) or Ext voltage +12 V (chosen by jumper X11), (VIO)
X4-6		Ext relay control 1 (GRY/PNK)
X4-7		Ext relay control 2 (RED/BLU)
X4-8		GND
X5 and X8		Factory setting 2-3. Do not change.

X6	RAINCAP® connector No. 1. Connect single plate rain detector to this connector. The cable marked with a black stripe (forward tilted plate) is connected to X6 in double rain plate assemblies at PWD22/52.
X7	RAINCAP® connector No. 2 is used in PWD22/52 only (backward tilted plate).
X9	Reset
X10-1 2)	+5 VA
X10-2 2)	AUX: CPU ADC input (internally connected to X3-2)
X10-3 2)	AGND
X11	The jumper between terminals 1 and 2 (default): output pin X4-5 acts as External relay control 3. The jumper between terminals 2 and 3: output pin X4-5 acts as external voltage output.
X12 2)	FLASH programming connector
X13 2)	The jumper between terminals 1 and 2 (default): the analog current output range is 4 ... 20 mA (pins X3-9 and X3-12). The jumper between terminals 2 and 3: the analog current output range is 0 ... 1 mA (pins X3-9 and X3-12).
X14	Module connector
X15	Module connector
X16	Transmitter connector (pin 14 is not used).
X18-1	Background Luminance Sensor PWL111 heater (-, WHT)
X18-2	Background Luminance Sensor PWL111 heater (+, BLU)

1) These signals are guided through the PWC15PB protection board. See the more detailed connection table in Basic Wiring on page 37.
2) located under the PWC15PB. See also Figure 25 on page 111.
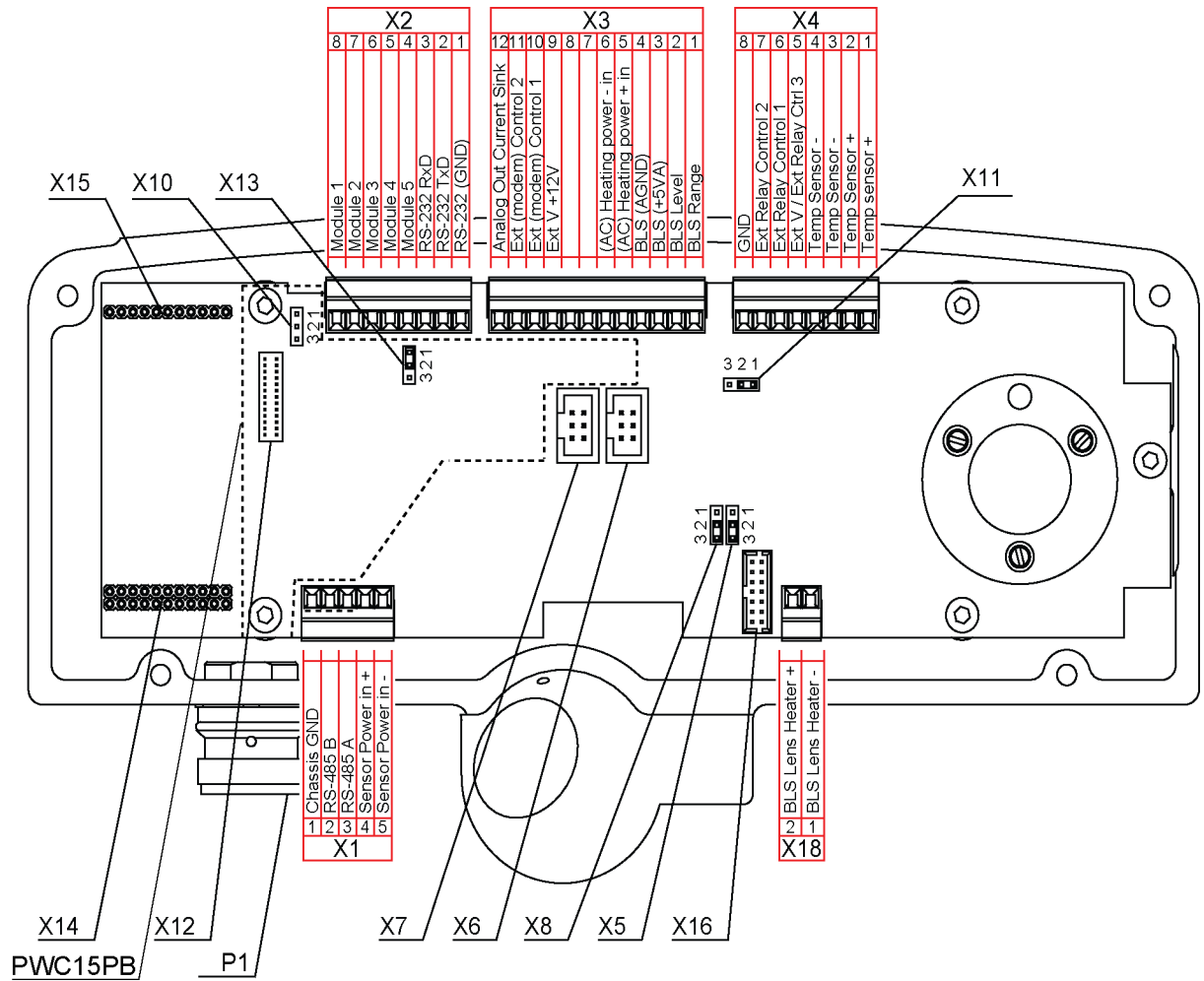
1504-013

**Figure 25   Jumpers and Connectors on the PWC22/52
Processor/Receiver Board**

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APPENDIX C
NWS AND WMO CODE TABLES

Table 25   Internal Weather Types and Supported NWS Codes

Internal Weather Types	NWS Codes
NO PRECIPITATION	C
PRECIPITATION	P
DRIZZLE	L
RAIN	R
SNOW	S
SLEET	IP
FREEZING DRIZZLE	ZL
FREEZING RAIN	ZR

NWS codes are used with intensity indicator '+' (plus) for heavy intensity, '-' (minus) for light, and none (space) for moderate. For example, 'R+' means heavy rain.

Table 26   WMO SYNOP Codes (Table 4680, W_aW_a) Used by PWD22/52

SYNOP Codes	Weather Types
00	Clear
04	Haze or smoke, or dust in suspension in the air, visibility equal to, or greater than, 1 km
05	Haze or smoke, or dust in suspension in the air, visibility less than 1 km
10	Mist
Code figures 20 to 25 are used, if precipitation or fog was observed during the preceding hour but not at the time of observation	
20	Fog
21	PRECIPITATION
22	Drizzle (not freezing) or snow grains
23	Rain (not freezing)
24	Snow
25	Freezing rain or freezing drizzle
The following code figures are used if precipitation or fog is observed at the time of observation	
30	FOG
31	Fog or ice fog, in patches
32	Fog or ice fog, has become thinner during the past hour
33	Fog or ice fog, no appreciable change during the past hour
34	Fog or ice fog, has begun or become thicker during the past hour
40	PRECIPITATION
41	Precipitation, slight or moderate
42	Precipitation, heavy
50	DRIZZLE

SYNOP Codes	Weather Types
51	Drizzle, not freezing, slight
52	Drizzle, not freezing, moderate
53	Drizzle, not freezing, heavy
54	Drizzle, freezing, slight
55	Drizzle, freezing, moderate
56	Drizzle, freezing, heavy
60	RAIN
61	Rain, light
62	Rain, moderate
63	Rain, heavy
64	Rain, freezing, light
65	Rain, freezing, moderate
66	Rain, freezing, heavy
67	Rain (or drizzle) and snow, light
68	Rain (or drizzle) and snow, moderate or heavy
70	SNOW
71	Snow, light
72	Snow, moderate
73	Snow, heavy
74	Ice pellets, light
75	Ice pellets, moderate
76	Ice pellets, heavy
80	SHOWERS OR INTERMITTENT PRECIPITATION
81	Rain showers, light
82	Rain showers, moderate
83	Rain showers, heavy
84	Rain showers, violent (>32 mm/h)
85	Snow showers, light
86	Snow showers, moderate
87	Snow showers, heavy

Table 27   WMO METAR Codes (Table 4678) Used by PWD22/52

Qualifier			Weather Phenomena				
INTENSITY 1	DESCRIPTOR 2		PRECIPITATION 3		OBSCURATION 4		OTHER 5
- Light	BC	Patches	DZ	Drizzle	BR	Mist	
Moderate (No qualifier)	SH	Shower(s)	RA	Rain	FG	Fog	
+ Heavy	FZ	Freezing	SN	Snow	DU	Widespread dust	
			PL	Ice pellets	HZ	Haze	

APPENDIX D

CALIBRATING THE TS SENSOR

This appendix describes how to calibrate the TS sensor.

Vaisala recommends checking the TS sensor accuracy once a year. If the TS value differs more than 2.5 °C from the ambient temperature, it is recommended that you calibrate and adjust the sensor.

For optimal results, perform the checking, calibration, and adjustment procedure at the PWD site on a cloudy day when the ambient temperature is close to 0 °C (0 … +10 °C).

The checking and calibration is carried out with the TS sensor removed from the cross arm to avoid the possible heating effects by electronics or hood heaters.

The known ambient temperature is gained from a calibrated reference sensor, such as Vaisala HMT330TS.

Checking TS Sensor Temperature

PWD can compute the offset at any temperature of Tref, but Vaisala recommends a temperature close to 0 °C because it is used to identify freezing rain.
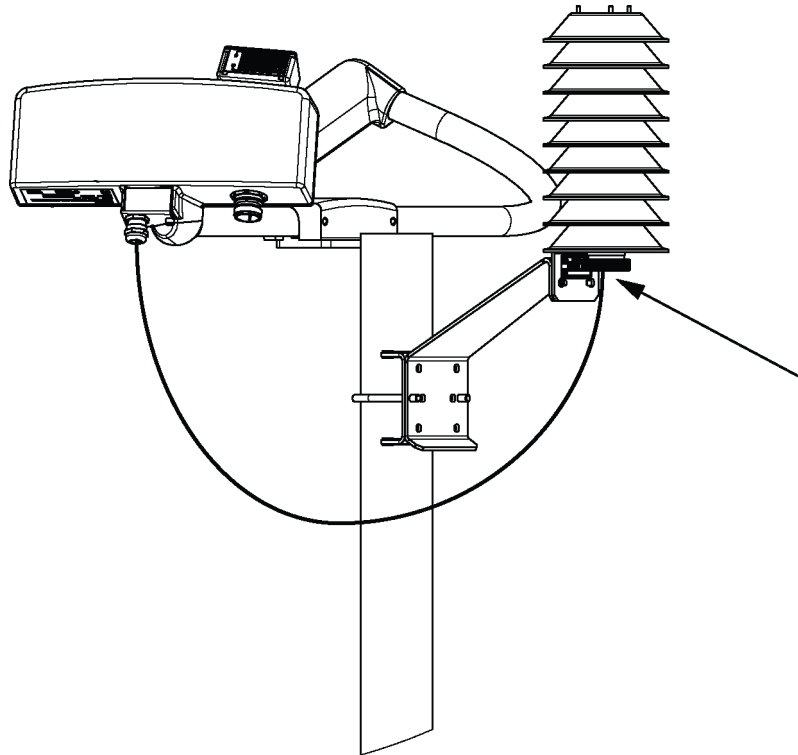
To check the TS sensor temperature:

1.   Connect to PWD using a laptop computer and a terminal program.
2.   Depending on whether your PWD has an internal or an external temperature sensor, perform either a. or b.

   a.   If your PWD has an internal temperature sensor:
        Use a 2.5 mm Allen key to open the small cable cover under the receiver housing, remove the cover plate, and pull the light grey 4 mm thick TS sensor cable out of the tube. Make sure you do not pull the other end of the cable that comes through the rubber gasket as that would degrade the watertightness of the enclosure.

1502-009
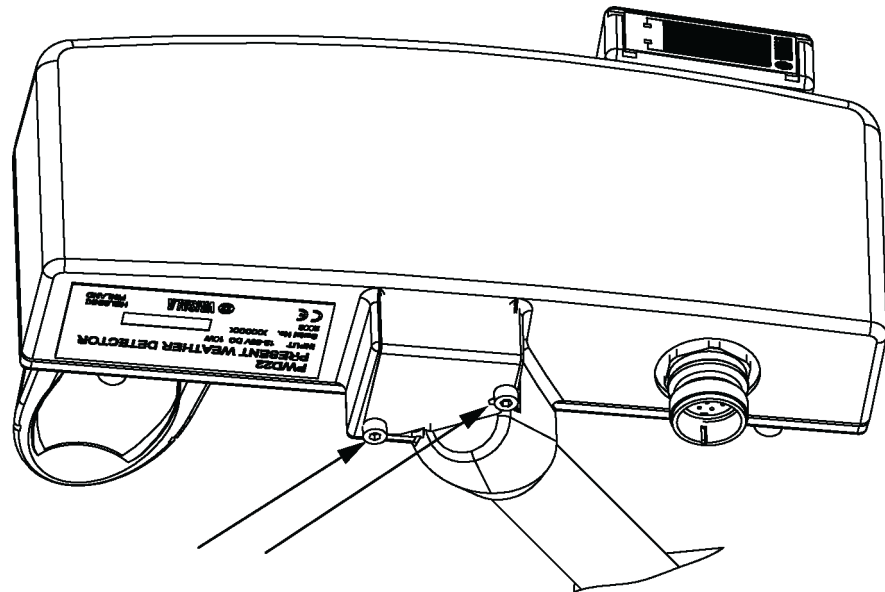
Figure 26   Removing Internal Temperature Sensor for Calibration

b. If your PWD has an external temperature sensor:
   Unscrew the TS probe and remove it from the tube.

1502-010

**Figure 27   Removing External Temperature Sensor for
                Calibration**

3.   Let the TS sensor and the reference sensor stabilize for at least five
     minutes.

4.   Use the **TCAL** command without a parameter to check the TS
     sensor temperature:

     Enter

     >TCAL

     PWD responds with

     >TS 1 1.0000 TS 0 0.00 TS -0.5

     Where

     TS 1 = always 1.0000

     TS 0 = offset correction

     TS = measured and corrected temperature

5. Compare the values. If the TS value differs more than 2.5 °C from the reference sensor reading, proceed to Calibrating and Adjusting the TS Sensor on page 119. If the TS value differs less than 2.5 °C from the reference sensor reading, you do not need to calibrate the sensor. Continue with step 6.

6. Insert the TS sensor back to its original place. Note that right after the TS sensor is inserted back it may show a slightly higher temperature than the reference.

PWD measures the TS sensor every 60 seconds.

Calibrating and Adjusting the TS Sensor

Vaisala recommends using an ice bath for calibrating the TS sensor.

Prepare an ice bath in a large enough (>1 liter) thermos container (glass or polystyrene). Vaisala recommends preparing the container in a laboratory before going out to the field.

To prepare the ice bath:

1.   Fill the thermos with crushed ice.
2.   Leave the reference sensor (for example, HMT330) for two minutes in the mixture to stabilize.
3.   Note how close to zero the sensor reading gets, stir the bath and see if it has an effect on the reading.
4.   Pour out excess water and see if there is an effect on the reading. If the changes are smaller than 0.05 °C, the ice bath is ready to be used in calibration.
5.   Close the thermos bottle with an insulating cap for transportation.

To calibrate the TS sensor using an ice bath:

1.   Use a sturdy ramp or ladders where you can place the reference sensor and the ice bath container and have your hands free.

2.   Depending on whether your PWD has an internal or an external temperature sensor, perform either a. or b.

   a. If your PWD has an internal temperature sensor:
       Use a 2.5 mm Allen key to open the small cable cover under the receiver housing, as shown in Figure 26 on page 116, remove the cover plate, and pull the light grey 4 mm thick TS sensor cable out of the tube. Make sure you do not pull the other end of the cable that comes through the rubber gasket as that would degrade the watertightness of the enclosure.

b. If your PWD has an external temperature sensor:
Unscrew the TS probe and remove it from the tube as shown in
Figure 27 on page 117.

3. Insert the reference probe in the ice bath. Let it stabilize and
compare the sensor reading with the value that was measured in the
laboratory.

4. When the reference sensor has stabilized, insert the TS sensor in
the ice bath and let both sensors stabilize for a few minutes. Stir the
mixture occasionally. Monitor the readings of both the reference
sensor and the TS sensor (by TCAL) and note when stabilized.

5. Input your reference T value in PWD by entering the **TCAL**
command with the value (for example, 0,0) as the parameter

```
>TCAL 0.0

TEMPERATURE SCALES

TS 1 1.0000 TS 0 -0.02 TS -0.0
```

If TS shows the temperature of the reference, the adjustment has
succeeded. The difference of +/-0.1 °C is acceptable.

6. Dry the TS probe and the reference probe and let the sensors
stabilize for at least five minutes. Repeat steps 5 and 6 described in
Checking TS Sensor Temperature on page 116.

7. Insert the TS sensor back to its original place. Note that right after
the TS sensor is inserted back it may show a slightly higher
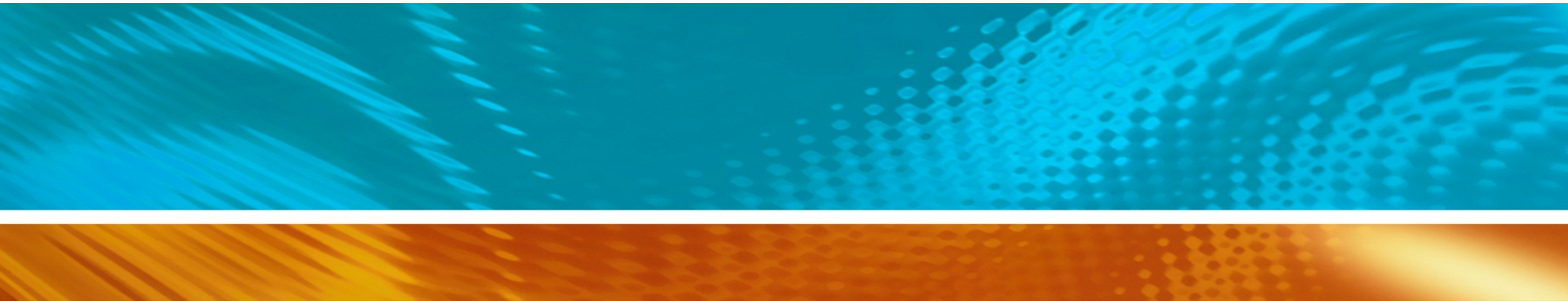temperature than the reference.

If the ice bath is prepared carefully, the ice bath method is accurate
enough and the TS sensor can be adjusted even without a reference
meter. However, if possible, Vaisala recommends that you use a
reference meter.

Vaisala recommends that you use the ice bath method for calibration and
adjusting. However, if it is not possible, you can calibrate with water
and/or isopropyl alcohol.

Instead of inserting the probe in ice bath, immerse the reference probe
and the TS sensor in a water container and let them stabilize for a few
minutes. Monitor the readings and note when they are stabilized.

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