IM-EN-PR23 v. 2.00

Instruction Manual

Vaisala K-PATENTS® Process Refractometer

PR-23

VAISALA

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Symbols and terms used in this manual:

This indicates a **warning**. It provides safety precaution information needed to avoid injury while operating the refractometer system.

This indicates that something is **important** for the operation of the refractometer system.

Note. Notes contain additional information and hints.

Warning! The process medium may be hot or otherwise hazardous.

Precautions when removing the sensor from the process line:

- Make positively sure that the process line is not under pressure. Open a vent valve to the atmosphere.
- For a prism wash system, close a hand valve for the wash medium and disable the wash valve.
- Loosen the clamp cautiously, be prepared to tighten again.
- Be out of the way of any possible splash and ensure the possibility of escape.
- Use shields and protective clothing adequate for the process medium, do not rely on avoidance of contact with the process medium.
- After removal of the sensor, it may be necessary to mount a blind cover for security reasons.

It is the user's responsibility to follow manufacturer's safety and operating instructions. The client's organization has the responsibility to develop and maintain occupational safety and create a safety culture where individuals are expected to follow safety instructions at all times. Any negligence towards safety instructions or failure to comply with safe practices should not be tolerated. It is the manufacturer's responsibility to produce goods that are safe to use when instructions are followed.

Warranty

For standard warranty terms and conditions, see 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.

THE PASSWORD FOR PR-23 IS 7 8 4 5 1 2

This product manual is delivered to the end user with a Vaisala K-PATENTS® product. Information in this manual is subject to change without notice. When the manual is changed, a revised copy is published at http://www.kpatents.com/.

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1 Introduction

The PR-23 inline refractometer is an instrument for measuring liquid concentration in the process line. The measurement is based on the refraction of light in the process medium, an accurate and safe way of measuring liquid concentration.

The inline refractometer sensor (in Figure 1.1) measures the refractive index n_D and the temperature of the process medium. This information is sent via the interconnecting cable (B) to the Indicating transmitter (C). The Indicating transmitter DTR calculates the concentration of the process liquid based on the refractive index and temperature, taking pre-defined process conditions into account. The output of the DTR is a 4 to 20 mA DC output signal proportional to process solution concentration. Process data can also be downloaded to a computer via an Ethernet cable.

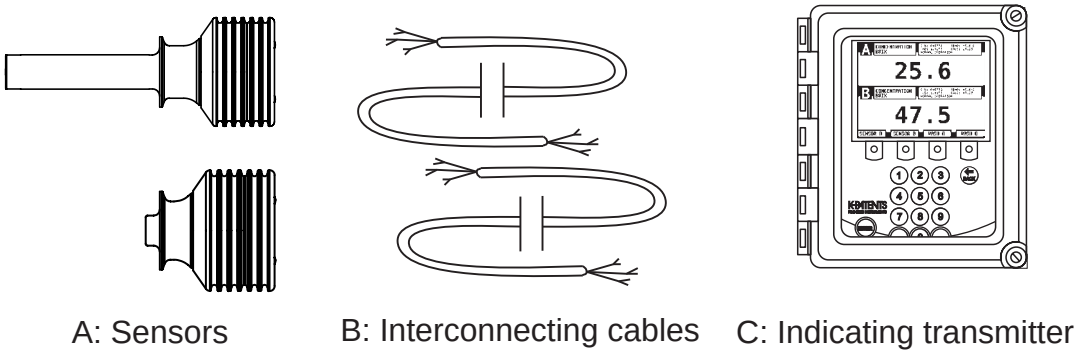


Figure 1.1 Refractometer equipment

1.1 PR-23 refractometer models

The basic system of one or two sensors connected to an Indicating transmitter (DTR) is the same for all PR-23 inline refractometer models. However, there are different sensor models, each model is adapted for different process requirements.

The models PR-23-AC and PR-23-AP meet the 3-A Sanitary Standard requirements. With an ATEX approved PR-23-...-AX sensor or a FM approved PR-23-...-FM sensor or a CSA approved PR-23-...-CS sensor a PR-23 process refractometer system can be used in potentially explosive atmosphere. The ATEX approved Intrinsically safe refractometer PR-23-...-IA can even be used in explosive atmosphere. The Safe-Drive™ system with a PR-23-SD sensor enables safe sensor insertion and removal also when process line is in full operation.

1.2 Principle of measurement

The refractometer sensor determines the refractive index n_D of the process solution. It measures the critical angle of refraction using a yellow LED light source with the same wavelength (580 nm) as the sodium D line (hence n_D). Light from the light source (L) in Figure 1.2 is directed to the interface between the prism (P) and the process medium (S). Two of the prism surfaces (M) act as mirrors bending the light rays so that they meet the interface at different angles.

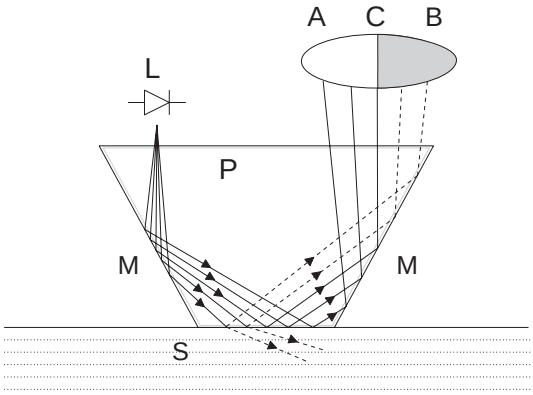


Figure 1.2 Refractometer principle

The reflected rays of light form an image (ACB), where (C) is the position of the critical angle ray. The rays at (A) are totally internally reflected at the process interface, the rays at (B) are partially reflected and partially refracted into the process solution. In this way the optical image is divided into a light area (A) and a dark area (B). The position of the shadow edge (C) indicates the value of the critical angle. The refractive index n_D can then be determined from this position.

The refractive index $n_D$changes with the process solution concentration and temperature. When the concentration changes, the refractive index normally increases when the concentration increases. At higher temperatures the refractive index is smaller than at lower temperatures. From this follows that the optical image changes with the process solution concentration as shown in Figure 1.3. The color of the solution, gas bubbles or undissolved particles do not affect the position of the shadow edge (C).

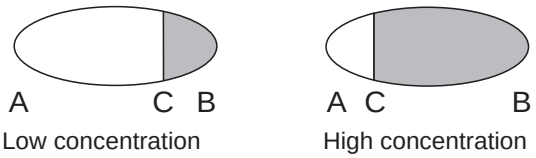


Figure 1.3 Optical images

The position of the shadow edge is measured digitally using a CCD element (Figure 1.4) and is converted to a refractive index value n_D by a processor inside the sensor. This value is then transmitted together with the process temperature via an interconnecting cable to the Indicating transmitter for further processing, display and transmission.

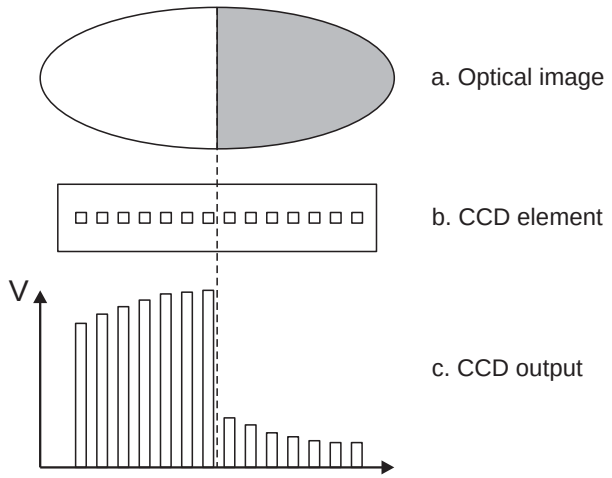


Figure 1.4 Optical image detection

1.3 General safety considerations

The process medium may be hot or otherwise hazardous. Use **shields and protective clothing** adequate for the process medium - do not rely on avoiding contact with the process medium.

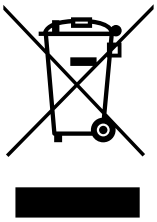
Precautions when removing a standard sensor from the process line :

- Check first that the process line is depressurized. Open a vent valve to the atmosphere.
- For a prism wash system, close a hand valve for the wash medium and disable the wash valve.
- Loosen the flange or the clamp cautiously, be prepared to tighten again.
- Ensure you are clear of any possible spillage and you have a clear emergency escape path.
- After removal of the sensor, it may be necessary to mount a blind cover for security reasons.

Note: For the Safe-Drive™ system safety rules, see Section 11.5 and for additional precautions required by explosive atmosphere, see Section 9.10.2.

1.4 Disposal

When wishing to dispose of an obsolete instrument or any parts of an instrument, please observe local and national regulations and requirements for the disposal of electrical and electronic equipment. An aluminium or stainless steel sensor housing can be recycled with other metallic waste of the same type.



2 Inline refractometer sensor

2.1 Sensor description

Figure 2.1 below shows a cutaway picture of a PR-23 inline refractometer sensor. The measurement prism (A) is flush mounted to the surface of the probe tip. The prism (A) and all the other optical components are fixed to the solid core module (C), which is springloaded (D) against the prism gasket (B). The light source (L) is a yellow Light Emitting Diode (LED), and the receiver is a CCD element (E). The electronics is protected against process heat by a thermal isolator (K) and cooling fins (G). The sensor processor card (H) receives the raw data from the CCD element (E) and the Pt-1000 process temperature probe (F), then calculates the refractive index $n_D$and the process temperature T. This information is transmitted to the Indicating transmitter.

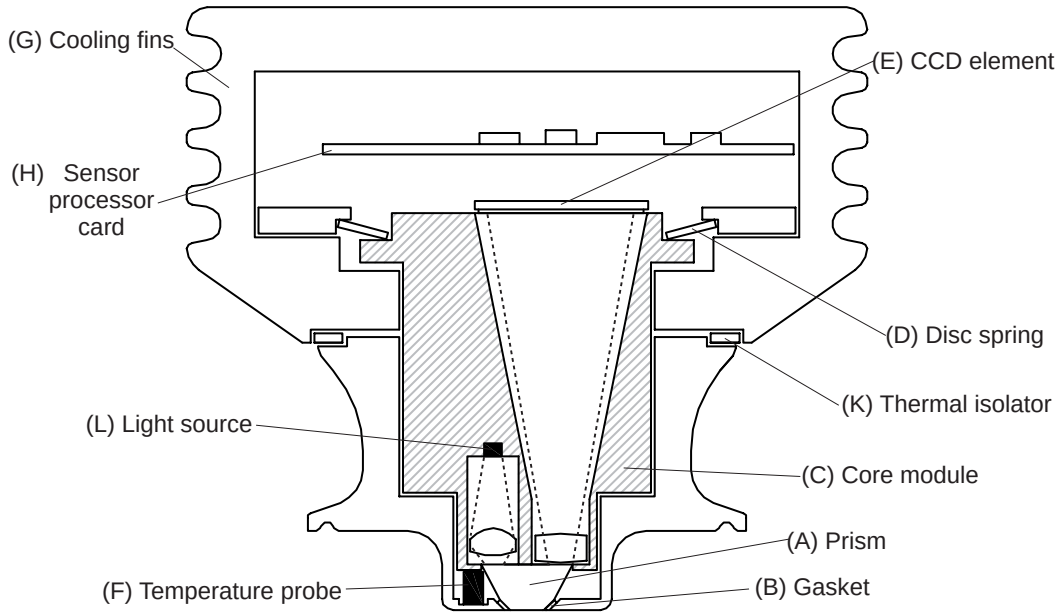


Figure 2.1 PR-23 sensor structure

2.2 Mounting the sensor

The sensor mounting location should be chosen with care to ensure reliable readings from the process. Some basic rules, described in this section, apply to all sensor models. The model specific instructions can be found in Chapter 9, “Sensor specifications”. For the Sanitary compact refractometer PR-23-AC see Section 9.3, for the Probe sanitary refractometer PR-23-AP see Section 9.4, for the Process probe refractometer PR-23-GP see Section 9.6, for the Teflon body refractometer PR-23-M and Teflon body semicon refractometer PR-23-MS see Section 9.8 and for the Saunders body refractometer PR-23-W see Section 9.9. For mounting an ATEX/FM/CSA approved sensor in explosive atmosphere, see Section 9.10.2. For mounting an intrinsically safe refractometer PR-23-...-IA, see Section 9.11. For mounting of the Safe-Drive™ system with the PR-23-SD sensor, see Section 11.4.

2.2.1 Choosing sensor mounting location

A PR-23 refractometer sensor can be located either indoors or outdoors in most climates. However, when a sensor is located outdoors, some basic protection against direct exposure to sunlight and rain should be provided. Special care should be taken if the pipe wall is translucent (e.g. of fiberglass), as light from outside reaching the prism through the pipe wall may disturb the measurement.

The mounting location needs to be such that sediments or gas bubbles cannot accumulate by the sensor. Good flow velocity is essential in keeping the prism clean.

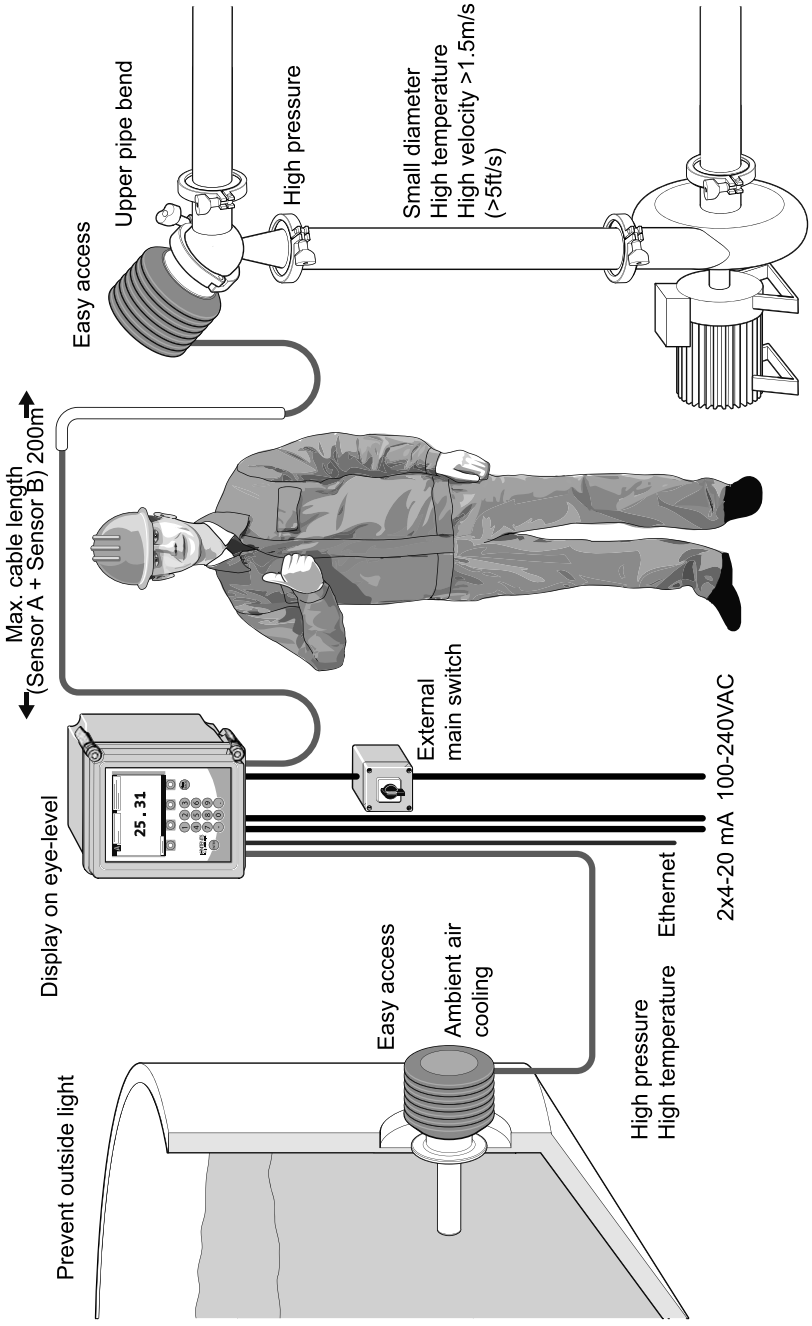
Important: If the process pipe vibrates, support the pipe. A vibrating pipe might damage the in-line sensor mounted on it.

Always check that the sensor head is kept cool enough; the sensor head should not be too hot to keep a hand on. The sensor cover should not be exposed to high temperature radiation. In most cases, draft and natural convection provide sufficient air cooling if the air gets to flow freely around the sensor head.

Additional cooling is necessary when the ambient temperature is higher than 45 °C (113 °F) or when the process temperature is above 110 °C (230 °F) and the ambient temperature is above 35 °C (95 °F). The air cooling is improved by blowing pressurized air against the sensor cover. The pressurized air can be supplied by the ventilation system. If no air is available it is also possible to install water cooling with PR-10038 cooling cover (except for PR-23-SD where sensor head needs to be kept in original size for insertion and retraction).

Important: Always mount the sensor so that the interconnecting cable points downwards from the sensor head.

2.2.2 PR-23 mounting guide



2.2.3 Check list for pipe mounting

Most PR-23 refractometer models are mounted in a pipe. The recommended minimum flow velocity of 1.5 m/s (5 ft/s). The diameter and form of the pipe and the process temperature all affect the measurement and need to be taken into account.

1. If the process pipe diameter varies, select the *position with the smallest diameter* (and accordingly highest velocity). Then the prism keeps better clean.

2. If the refractometer is used in a feed-back control loop, *make the time lag short*. E.g. when a dilution valve is controlled, mount the refractometer close to the dilution point. However, make sure complete mixing has occurred at mounting location.

3. If the temperature varies along the process pipe, select the *position with the highest process temperature*. Then the risk of prism coating is minimized, because higher temperature means higher solubility and also lower viscosity.

4. Often the *position with the highest process pressure* (= after pump + before valve) has favorable flow conditions without sedimentation or air trapping risks.

5. The sensor should be conveniently accessible for service.

2.2.4 Check list for mounting in a tank, a vessel or a large pipe

A probe sensor PR-23-AP or PR-23-GP can be inserted with a flange or clamp into tanks and vessels which either don't have a scraper or where the mixer doesn't touch the vessel wall. A probe sensor can also be flush mounted in a cooker where the scraper touches the wall.

1. The inserted probe sensor is mounted close to a stirrer to ensure representative sample of the process liquid and to keep the prism clean.

2. The sensor should be conveniently accessible for service.

3 Indicating transmitter DTR

3.1 Indicating transmitter description

The Indicating transmitter DTR is a specialized computer designed to process data received from one or two sensors. The Indicating transmitter enclosure (Figure 3.1) contains a front panel with a backlit Liquid Crystal Display (LCD) and a keyboard. The front panel swings open to give access for connections and service. Knockout padlock provisions are included in the enclosure's both cover latches for locks to prevent unauthorized access.

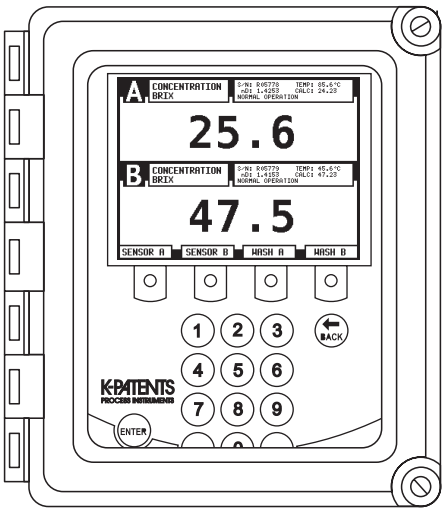


Figure 3.1 The Indicating transmitter enclosure

The sensors send the values of the refractive index $n_D$and the process temperature T to the DTR. The microprocessor system then linearizes the concentration reading (example in Figure 3.2), and performs an automatic temperature compensation.

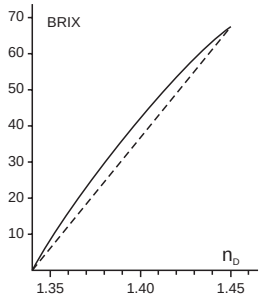


Figure 3.2 A linearized curve

3.2 Mounting Indicating transmitter

The Indicating transmitter is mounted indoors, it should preferably be located in an easily accessible, well lit and dry area. Avoid vibration. Take interconnecting cable length into consideration when choosing the mounting location.

The enclosure is mounted vertically on an upright surface (wall) using four mounting feet, see Figure 3.3. The LCD is best viewed when approximately on the eye level of the user.

In sanitary installations, the recommendation is to use a DTR with stainless steel enclosure. If standard polycarbonate enclosure is used, it should be installed as remotely as practical from the product areas or connections.

Important: Do not drill mounting holes in the enclosure as that will affect the protection class of the enclosure and damage the electronics.

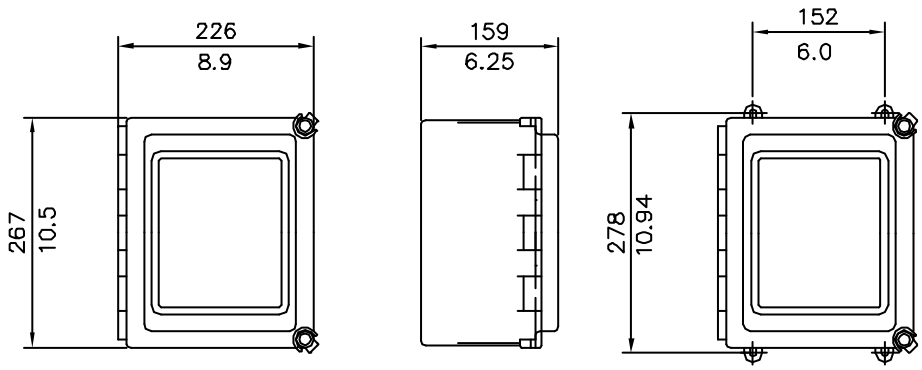


Figure 3.3 Indicating transmitter: dimensions (mm/in) and mounting feet measures

Note: The LCD display has an operating temperature range of 0–50 °C and a storage temperature range of -20–60 °C.

Important: The DTR does not have a built-in power switch. The system is always powered on when connected to a power source. Mounting an external power switch to control the DTR's power supply is recommended, Figure 3.6.

3.3 Electrical connections

3.3.1 Interconnecting cable

The cable contains a pair of twisted signal wires (1, 2) and a cable shield (3) (see Section 3.3.2 and Figure 3.7). Standard delivery is 10 meters (33 feet) of cable. The maximum length of an interconnecting cable is 200 m (660 ft). The signal wires (1, 2) are interchangeable (non-polarized). The cable shield is connected to the protective earth at the Indicating transmitter.

The junction box enables the use of customer's own cable as long as it meets IEC 61158-2 type A standard requirements, see Section 10.3.2, "Interconnecting cable specifications".

3.3.2 Connecting sensor

Important: Sensor connector may not be connected or disconnected when the circuits are energized. Switch OFF the power from Indicating transmitter DTR external power switch before disconnecting the sensor cable from the sensor. After connecting sensor cable back to the sensor you can switch power back on.

1. Remove the four screws holding the Sensor nameplate (Figure 3.4). The terminal strip is under the nameplate.
2. Connect the signal wires to terminal (1) and (2), and the cable shield to terminal (3).
3. Tighten up cable gland. Screw nameplate back on.

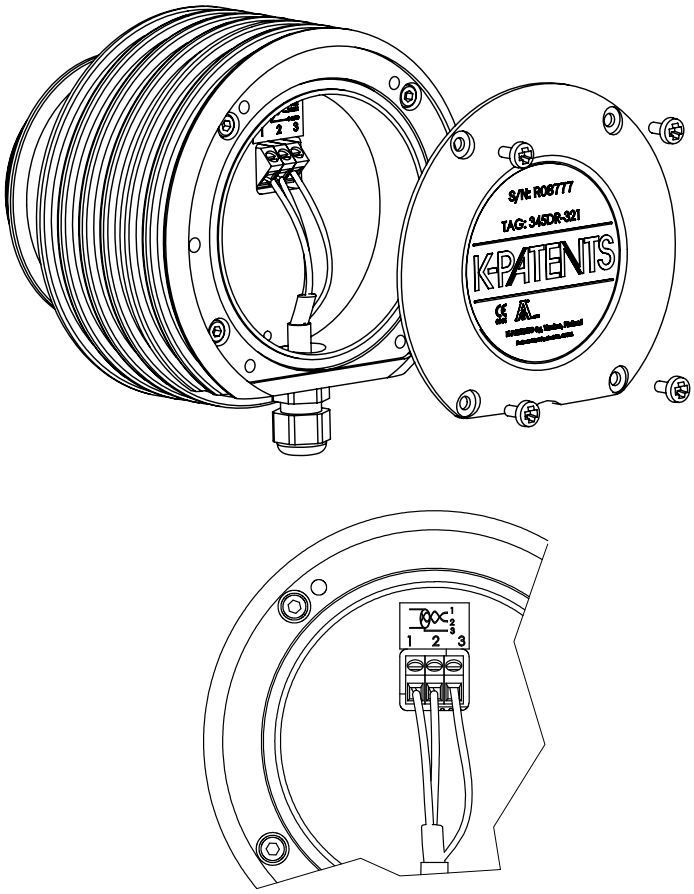


Figure 3.4 Sensor electrical connections

3.3.3 Connecting the Indicating transmitter

All the electrical terminals of the Indicating transmitter are behind the Front panel. To access them, first open the enclosure cover. Then loosen the front panel screw (Figure 3.5) and swing open the Front panel. All terminals are now accessible.

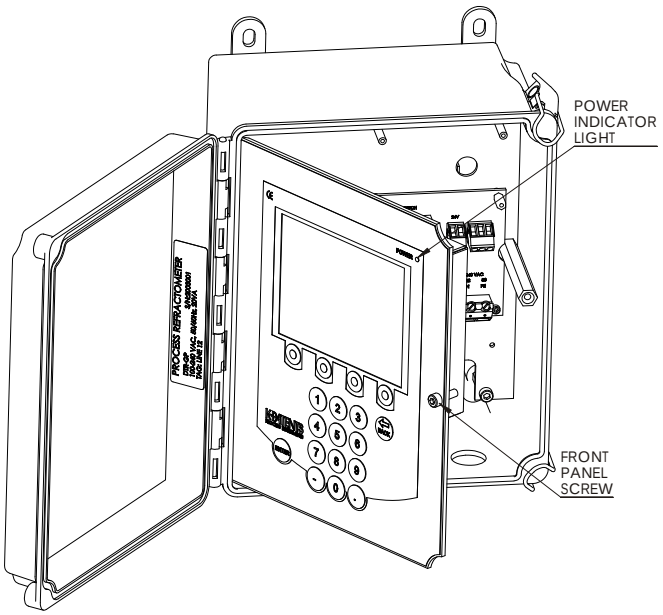


Figure 3.5 Opening the Front panel of the Indicating transmitter

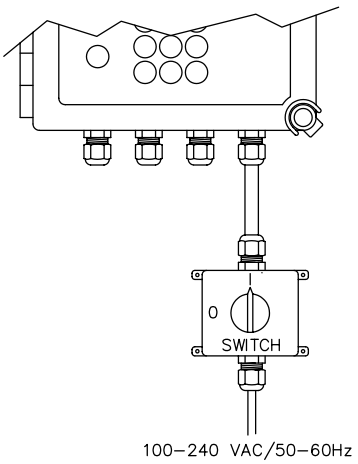


Figure 3.6 The recommended external power switch, spare part nr PR-10900. The ratings of the switch are 10A/230V.

Warning! Check that the power is off before opening the Front panel. If the *green power indicator light* (Figure 3.5) is on, there is still power in the system. To

completely turn the power off, use the external power switch. The external power switch shall be installed in accordance with the local installation requirements.

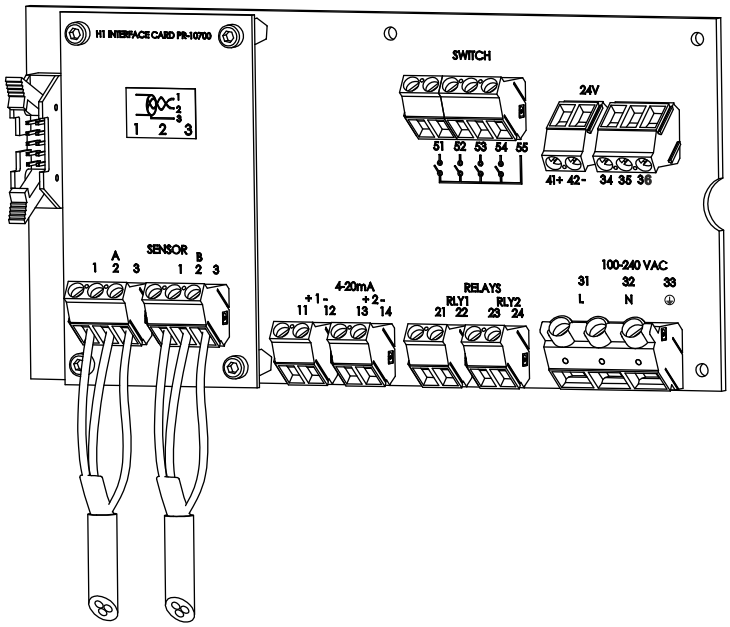


Figure 3.7 Motherboard of the Indicating transmitter for AC power

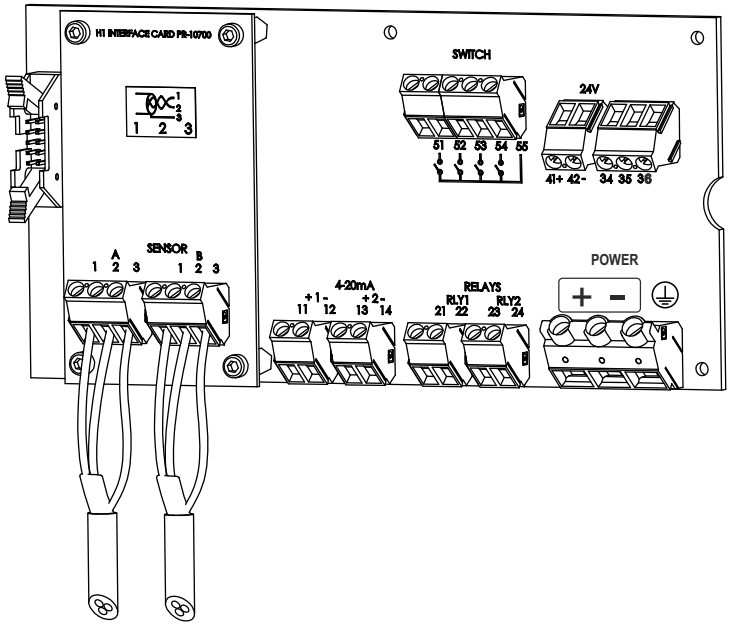


Figure 3.8 Motherboard of the Indicating transmitter for 24V DC power

Description of the terminals on the H1 interface card PR-10701 and on the Transmitter motherboard PR-10600 (Figure 3.7):

On H1	
A 1 2 3	Connection for Sensor A, signal wires (1, 2), cable shield (3).
B 1 2 3	Connection for Sensor B, signal wires (1, 2), cable shield (3).
On Motherboard	
11 12	4–20 mA output 1, positive (11), negative (12), max. load 1000 Ohm, galvanically isolated.
13 14	4–20 mA output 2, positive (13), negative (14), max. load 1000 Ohm, galvanically isolated.
21 22	Relay 1, one contact output, max. 250 V AC, max. 3 A.
23 24	Relay 2, one contact output, max. 250 V AC, max. 3 A.
31 32 33	Power, L (31), N (32), protective earth (33), 100-240 V AC, 50–60 Hz. An external power switch (Figure 3.6) is recommended.
41 42	24V terminal for DTR internal use only. **Note:** Connecting terminal to external 24V supply will void warranty. Connecting external devices to 24V terminal will void warranty.
51 52 53 54 55	Switch inputs: switch 1 (51), switch 2 (52), switch 3 (53), switch 4 (54) and common 3 volts for all inputs (55). The switch terminals are galvanically isolated.

3.3.4 Power terminals for AC power

The primary AC power is connected to a separate terminal strip 31/32/33 marked POWER in the lower right-hand corner of the Motherboard (Figure 3.7). The three terminals are marked 31/L, 32/N and 33/⏚ (protective earth). The power terminal 33/⏚ is directly connected to the exposed metal parts of the Indicating transmitter DTR. Wiring to the terminals shall be 1.5mm^2 minimum. The protective fuse in the building system shall comply with the local requirements.

3.3.5 Power terminals for 24V DC power

The DC power is connected to a terminal stripe marked POWER in the lower right-hand corner of the Motherboard (figure 3.8). The three terminals are marked +, - and ⏚ (protective earth). The power terminal ⏚ is directly connected to the exposed metal parts of the Indicating transmitter DTR.

The 24V DC power to this terminal stripe shall be supplied from a secondary circuit which is double or reinforced insulated from the mains supply within the limits for a limited-energy circuit (maximum 200 VA/U) according to the IEC 61010-1.

3.3.6 Reset button

It is possible to reset and restart both the Indicating transmitter DTR and the sensor(s) by pushing the reset button. The button is accessed through the cable hole in the front panel shield (see Figure 3.9 below). You need a thin stick or similar utensil, preferably of non-conducting material, to reach the reset button. After pressing the

reset button, the display will black out for a few seconds. The instrument will be back to full operation within 30 seconds.

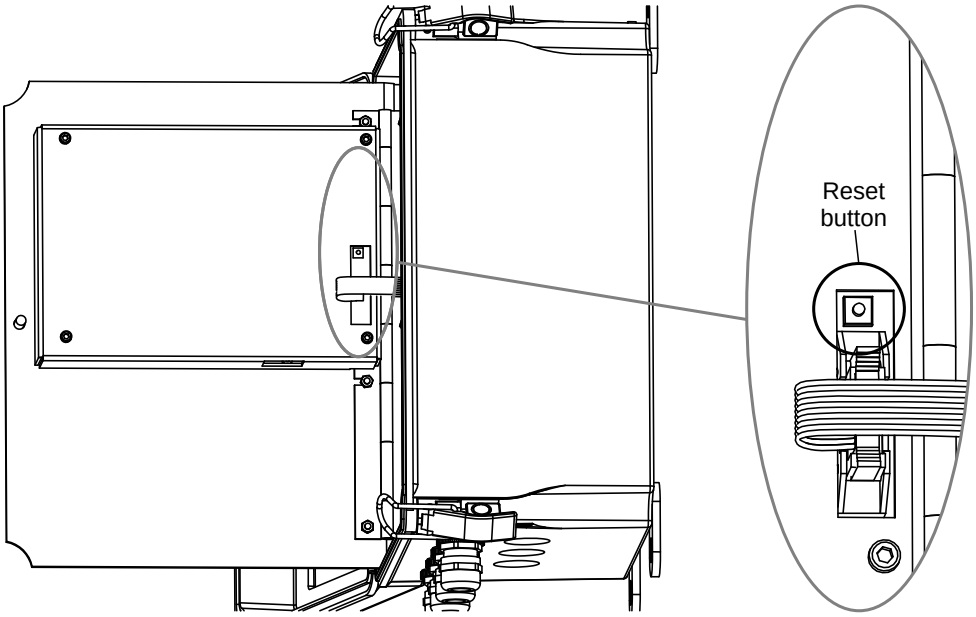


Figure 3.9 Location of the reset button

4 Prism wash systems

4.1 Prism coating

Deposit build-up on the prism surface disturbs the measurement. Look out for *an abnormally high concentration reading* or *an upward concentration (CONC) drift*.

In most applications the prism will keep clean due to the self-cleaning effect. If coating occurs, check the following:

- Sufficient flow velocity, see Section 2.2.3, “Check list for pipe mounting”.
- A temperature difference between process fluid and sensor probe may cause coating. This may happen with small flows if the thermal insulation is inadequate. In some cases it helps to also insulate the clamp connector.

In case of a coating problem, the preferred solution is to try to increase the flow velocity, e.g. by installing a pipe portion with smaller diameter.

Installing a wash nozzle can be considered, if increasing the velocity or using a flow booster does not provide a solution (Section 4.2).

4.2 Prism wash

Three alternative media can be used for prism wash: *steam*, *water*, *high pressure water*. The built-in relays of the Indicating transmitter can be configured to control the prism wash cycle, see Section 6.3.1, “Configuring relays”.

Important: In food industry applications, wash media must be *culinary steam* or *safe water*. Shut-off valve and check valve must meet 3-A sanitary standards (see Figures 4.2 and 4.7).

Culinary Steam: Shall mean steam produced using a system meeting criteria in the 3-A Accepted Practices for a Method of Producing Steam of a Culinary Quality, Number 609.

Safe Water: Shall mean water from a supply properly located, protected, and operated, and shall be of safe, sanitary quality. The water shall meet the standards prescribed in the National Primary Drinking Water Regulation of the Environmental Protection Agency (EPA) as referenced in The Code of Federal Regulations (CFR), Title 40, Parts 141, 142, and 143.

4.2.1 Recommended wash pressures and times

The recommended wash pressures and times are given in the tables below.

Wash medium parameters for integral wash nozzles in PR-23-AP/GP					
	Minimum *above process pressure*	**Maximum** *above process pressure*	**Wash time**	**Recovery**	**Interval**
Steam (SN)	2 bar (30 psi)	4 bar (60 psi)	3 s	20–30 s	20–30 min
Water (WN)	2 bar (30 psi)	4 bar (60 psi)	10 s	20–30 s	10–20 min
High pressure water (WP)	15 bar (220 psi)	40 bar (600 psi)	10 s	20–30 s	10–20 min

Wash medium parameters for flow cell wash nozzle AFC					
	Minimum *above process pressure*	**Maximum** *above process pressure*	**Wash time**	**Reco-very**	**Interval**
Steam (SN)	3 bar (45 psi)	6 bar (90 psi)	3–5 s	20–30 s	20–30 min
Water (WN)	3 bar (45 psi)	6 bar (90 psi)	10–15 s	20–30 s	10–20 min
High pressure water (WP)	25 bar (350 psi)	35 bar (500 psi)	10–15 s	20–30 s	10–20 min

Wash medium parameters for Safe-Drive Isolation valve nozzle SDI						
	CONC % value	**Minimum** *above process pressure*	**Maximum** *above process pressure*	**Wash time**	**Reco-very**	**Interval**
Steam (SN)	10–30 %	2 bar (30 psi)	4 bar (60 psi)	2–3 s	20 s	120–360 min
	30–60 %	3 bar (45 psi)	6 bar (90 psi)	3 s	20 s	20-60 min
	60–90 %	4 bar (60 psi)	8 bar (120 psi)	3–5 s	20 s	15-25 min
High pressure water (WP)		20 bar (290 psi)	30 bar (435 psi)	10–15 s	20 s	5–20 min

Important: In steam wash, do not exceed the recommended wash times, because some process media may burn to the prism surface if steamed for longer time. In case of coating, shorten the wash interval.
See also Section 6.5.2 for the Automatic wash cut parameter.

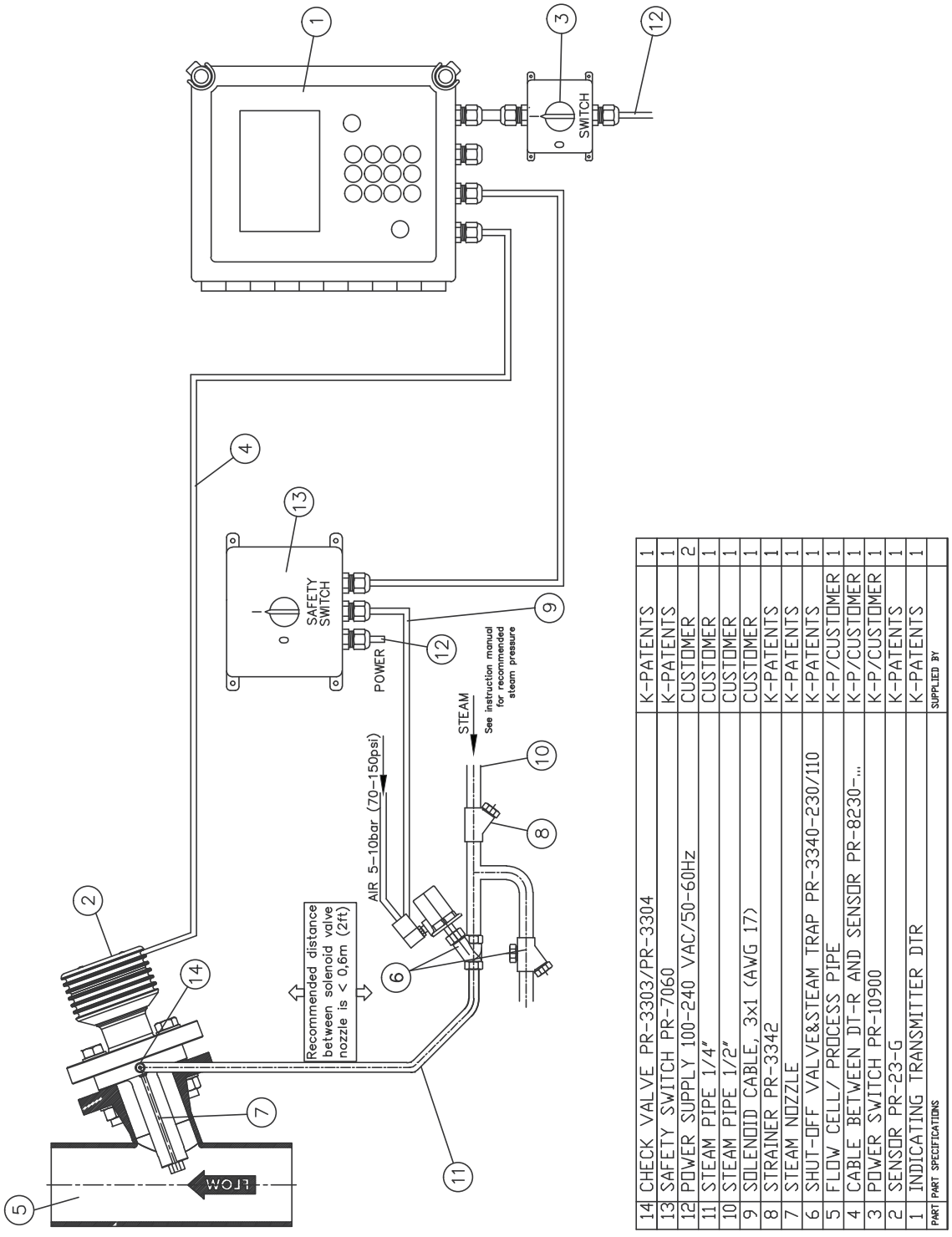
Note: In water wash, water temperature should be above the process temperature.

Note: The check valve pressure drop is 0.7 bar (10 psi).

4.2.2 Prism wash systems

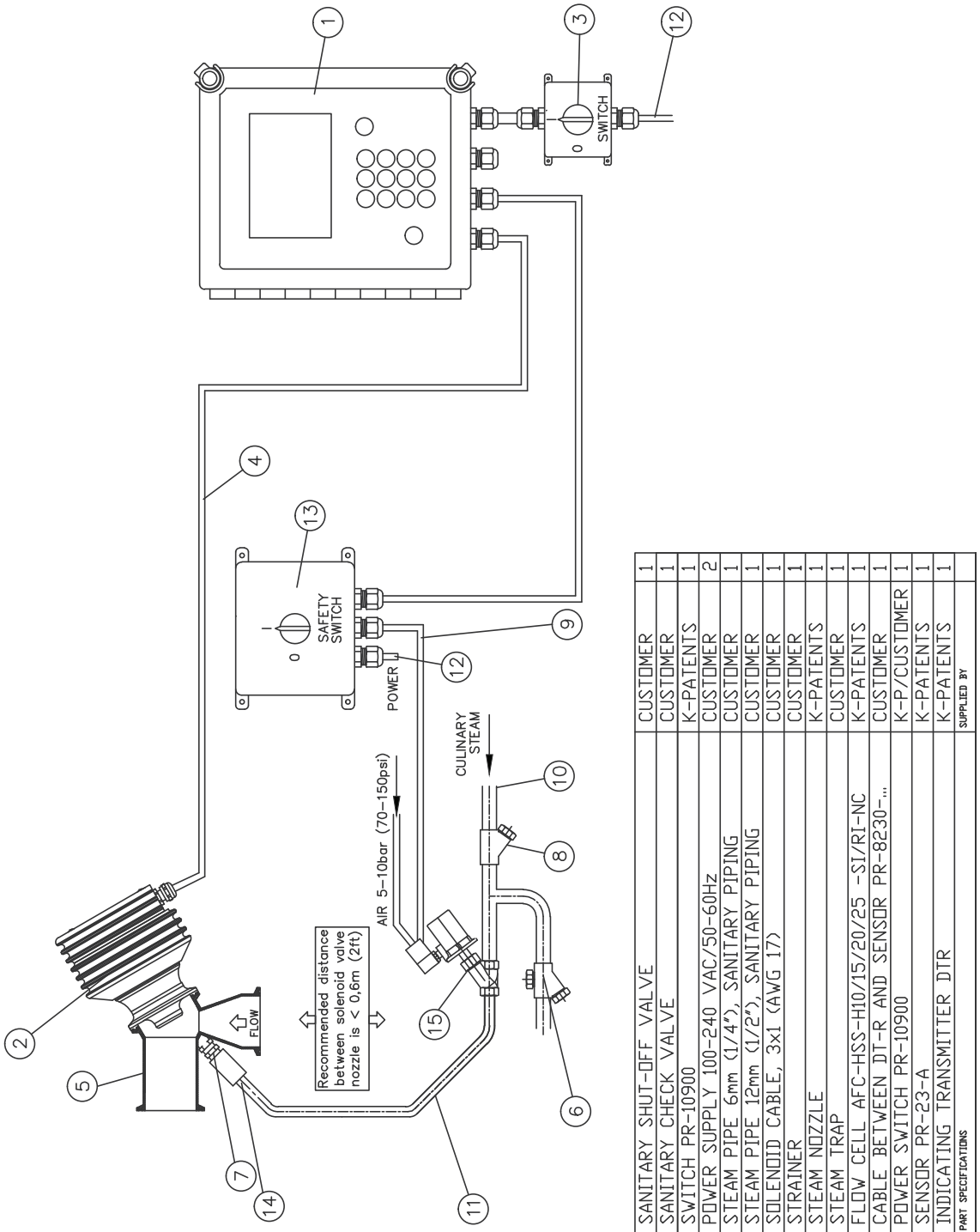
The prism wash system for steam is described by Figure 4.1 and for sanitary systems Figure 4.2. The prism was system for high pressure water is described by Figure 4.6 and for sanitary systems Figure 4.7.

Warning! In high pressure wash systems, pressure increase can occur in a closed pipe section when the high pressure pump is operated. The recommendation is to mount a pressure relief valve in the pipe section. Relief pressure should be according to pipe pressure rating.



PART	PART SPECIFICATIONS	SUPPLIED BY	
14	CHECK VALVE PR-3303/PR-3304	K-PATENTS	1
13	SAFETY SWITCH PR-7060	K-PATENTS	1
12	POWER SUPPLY 100-240 VAC/50-60Hz	CUSTOMER	2
11	STEAM PIPE 1/4"	CUSTOMER	1
10	STEAM PIPE 1/2"	CUSTOMER	1
9	SOLENOID CABLE, 3x1 (AWG 17)	CUSTOMER	1
8	STRAINER PR-3342	K-PATENTS	1
7	STEAM NOZZLE	K-PATENTS	1
6	SHUT-OFF VALVE&STEAM TRAP PR-3340-230/110	K-PATENTS	1
5	FLOW CELL/ PROCESS PIPE	K-P/CUSTOMER	1
4	CABLE BETWEEN DT-R AND SENSOR PR-8230-...	K-P/CUSTOMER	1
3	POWER SWITCH PR-10900	K-P/CUSTOMER	1
2	SENSOR PR-23-G	K-PATENTS	1
1	INDICATING TRANSMITTER DTR	K-PATENTS	1

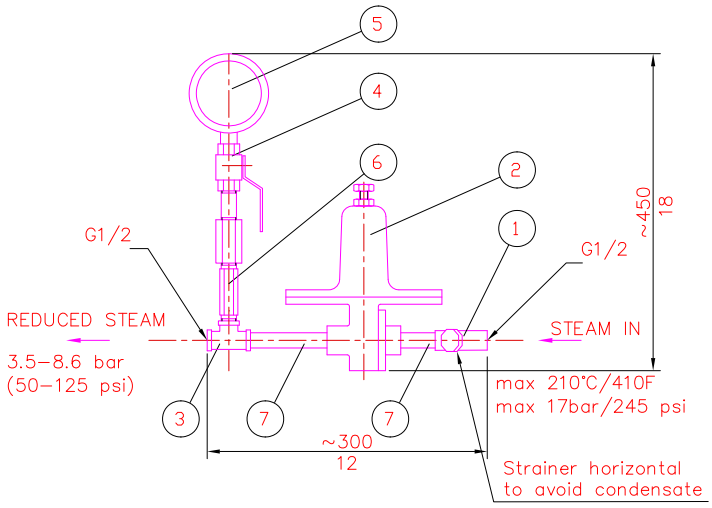
Figure 4.1 A prism wash system for steam (non-sanitary)



PART	PART SPECIFICATIONS	SUPPLIED BY	
15	SANITARY SHUT-OFF VALVE	CUSTOMER	1
14	SANITARY CHECK VALVE	CUSTOMER	1
13	SWITCH PR-10900	K-PATENTS	1
12	POWER SUPPLY 100-240 VAC/50-60Hz	CUSTOMER	2
11	STEAM PIPE 6mm (1/4"), SANITARY PIPING	CUSTOMER	1
10	STEAM PIPE 12mm (1/2"), SANITARY PIPING	CUSTOMER	1
9	SOLENOID CABLE, 3x1 (AWG 17)	CUSTOMER	1
8	STRAINER	CUSTOMER	1
7	STEAM NOZZLE	K-PATENTS	1
6	STEAM TRAP	CUSTOMER	1
5	FLOW CELL AFC-HSS-H10/15/20/25 -SI/RI-NC	K-PATENTS	1
4	CABLE BETWEEN DT-R AND SENSOR PR-8230-...	CUSTOMER	1
3	POWER SWITCH PR-10900	K-P/CUSTOMER	1
2	SENSOR PR-23-A	K-PATENTS	1
1	INDICATING TRANSMITTER DTR	K-PATENTS	1

Figure 4.2 A sanitary prism wash system for steam

In case of excessive pressure in steam systems: If the steam pressure exceeds to maximum pressure differential, a pressure reducing valve PR-3341-J needs to be installed to reduce the steam pressure to optimal design.



DIMENSIONS: 300x450x140 (12x18x5.5)

7	SEAMLESS PIPE NIPPLE 1/2"		AISI 316	2
6	HEX VALVE SYPHOUS			1
5	PRESSURE METER			1
4	BALL VALVE			1
3	T-COUPLING 1/2"			1
2	PRESSURE REGULATOR			1
1	STRAINER			1

Figure 4.3 Pressure reducing valve PR-3341-J

Note the orientation of the strainer.

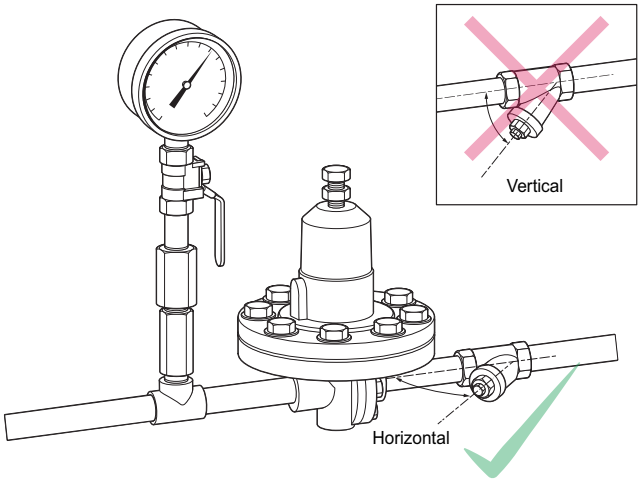


Figure 4.4 Install strainer horizontally

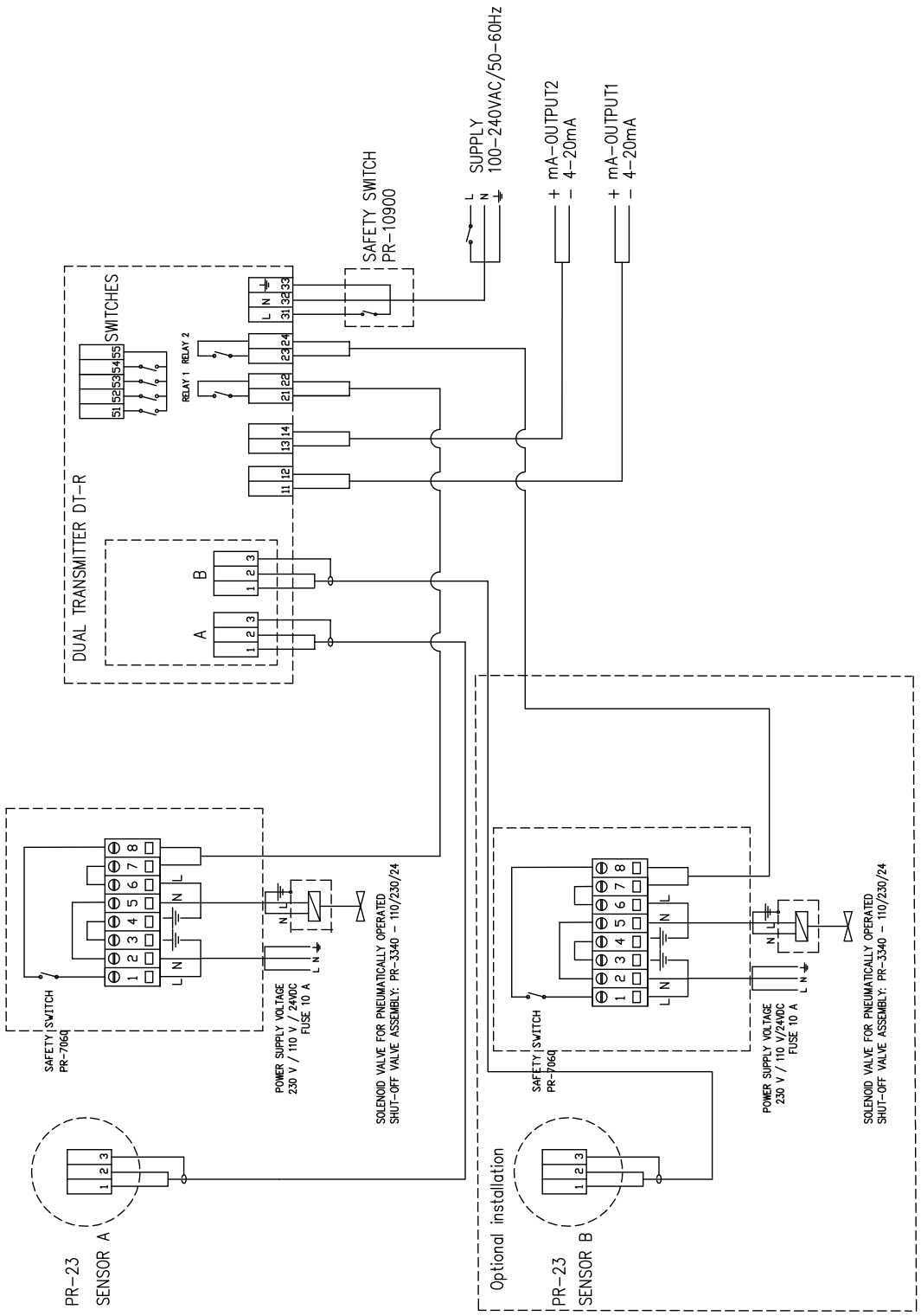
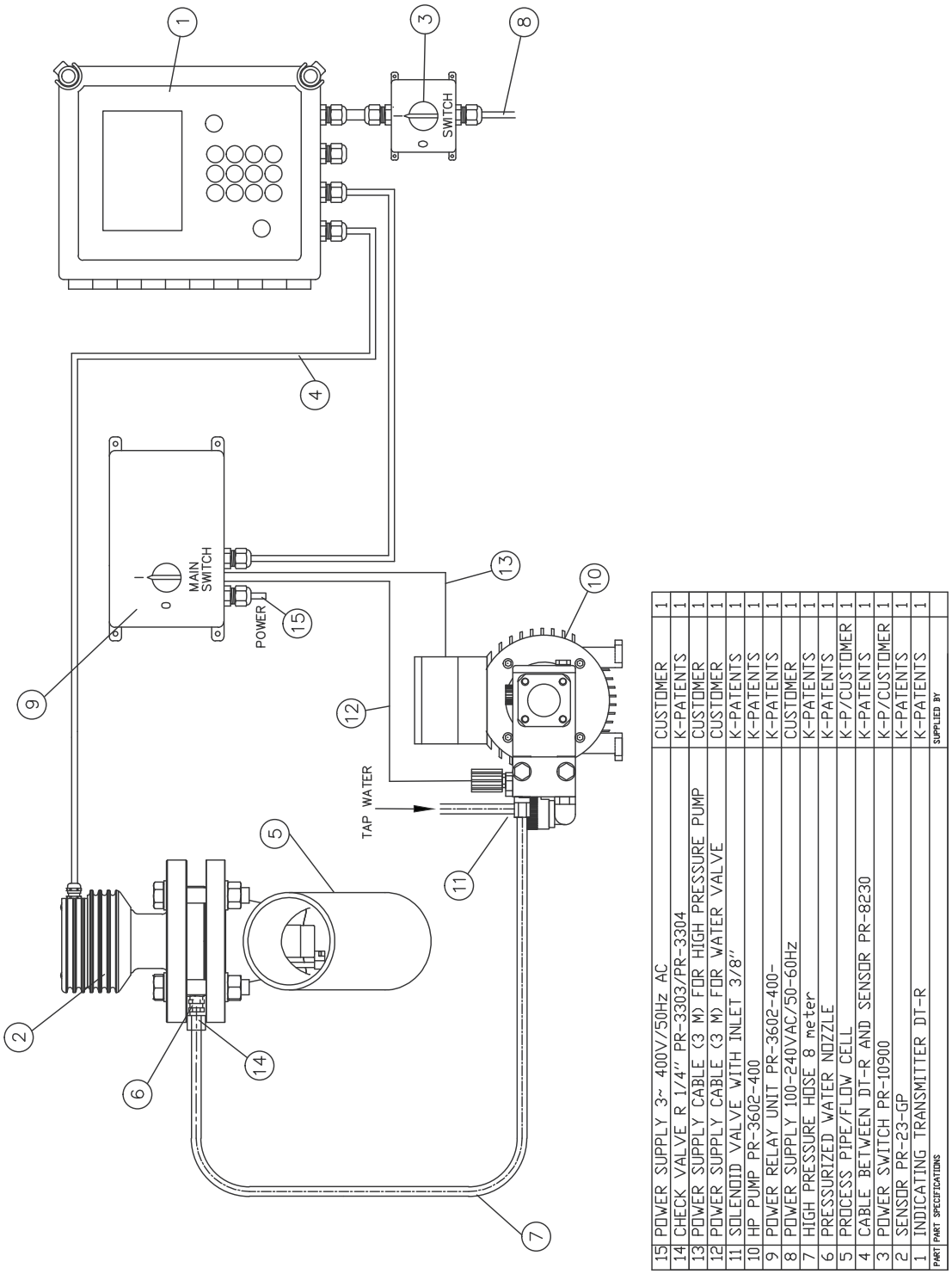
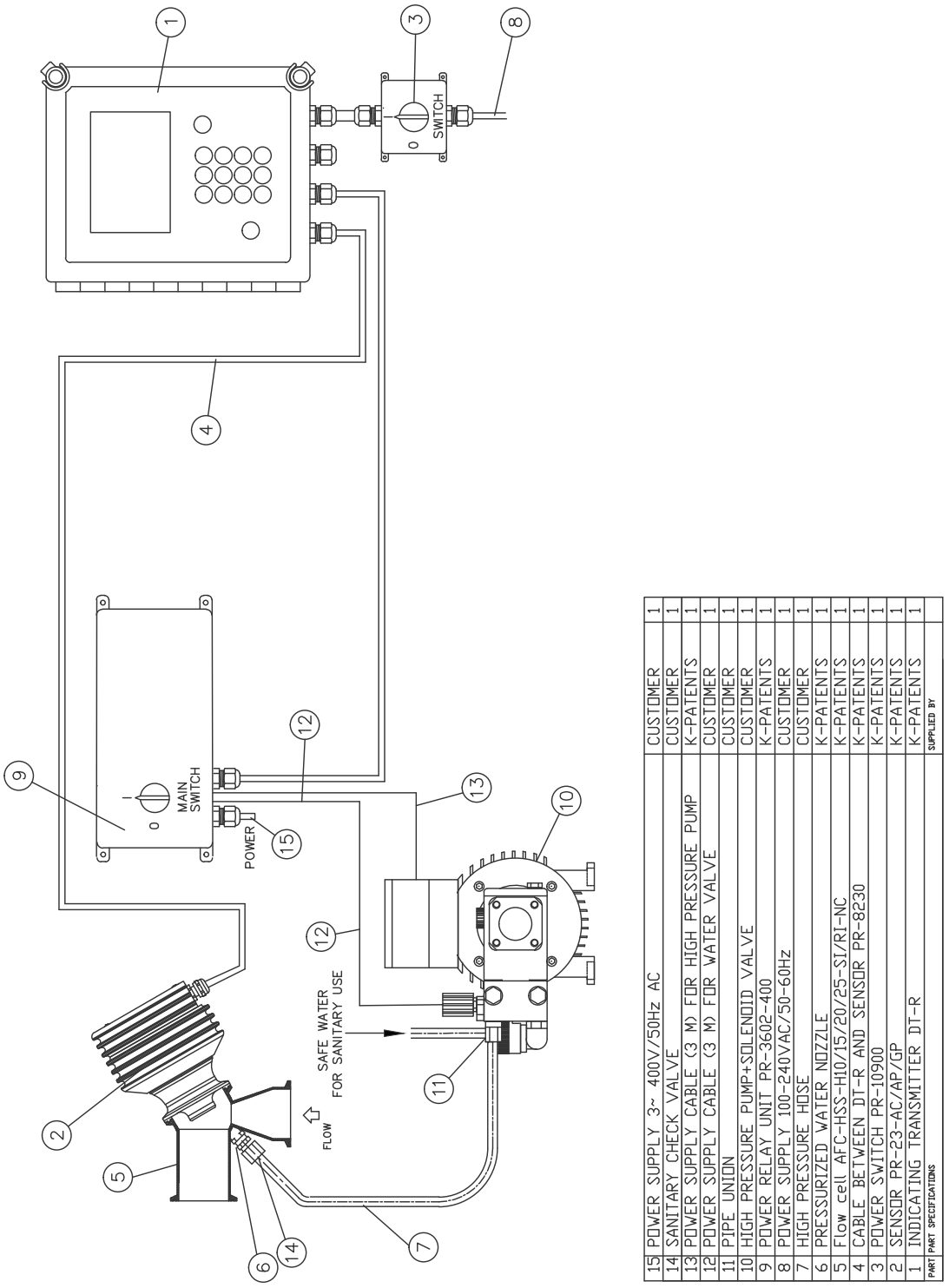


Figure 4.5 Wiring for a prism wash system for steam



PART	PART SPECIFICATIONS	SUPPLIED BY	
15	POWER SUPPLY 3~ 400V/50Hz AC	CUSTOMER	1
14	CHECK VALVE R 1/4" PR-3303/PR-3304	K-PATENTS	1
13	POWER SUPPLY CABLE (3 M) FOR HIGH PRESSURE PUMP	CUSTOMER	1
12	POWER SUPPLY CABLE (3 M) FOR WATER VALVE	CUSTOMER	1
11	SOLENOID VALVE WITH INLET 3/8"	K-PATENTS	1
10	HP PUMP PR-3602-400	K-PATENTS	1
9	POWER RELAY UNIT PR-3602-400-	K-PATENTS	1
8	POWER SUPPLY 100-240VAC/50-60Hz	CUSTOMER	1
7	HIGH PRESSURE HOSE 8 meter	K-PATENTS	1
6	PRESSURIZED WATER NOZZLE	K-PATENTS	1
5	PROCESS PIPE/FLOW CELL	K-P/CUSTOMER	1
4	CABLE BETWEEN DT-R AND SENSOR PR-8230	K-PATENTS	1
3	POWER SWITCH PR-10900	K-P/CUSTOMER	1
2	SENSOR PR-23-GP	K-PATENTS	1
1	INDICATING TRANSMITTER DT-R	K-PATENTS	1

Figure 4.6 A prism wash system for high pressure water (non-sanitary)



PART	PART SPECIFICATIONS	SUPPLIED BY	
15	POWER SUPPLY 3~ 400V/50Hz AC	CUSTOMER	1
14	SANITARY CHECK VALVE	CUSTOMER	1
13	POWER SUPPLY CABLE (3 M) FOR HIGH PRESSURE PUMP	K-PATENTS	1
12	POWER SUPPLY CABLE (3 M) FOR WATER VALVE	CUSTOMER	1
11	PIPE UNION	CUSTOMER	1
10	HIGH PRESSURE PUMP+SOLENOID VALVE	CUSTOMER	1
9	POWER RELAY UNIT PR-3602-400	K-PATENTS	1
8	POWER SUPPLY 100-240VAC/50-60Hz	CUSTOMER	1
7	HIGH PRESSURE HOSE	CUSTOMER	1
6	PRESSURIZED WATER NOZZLE	K-PATENTS	1
5	Flow cell AFC-HSS-H10/15/20/25-SI/RI-NC	K-PATENTS	1
4	CABLE BETWEEN DT-R AND SENSOR PR-8230	K-PATENTS	1
3	POWER SWITCH PR-10900	K-PATENTS	1
2	SENSOR PR-23-AC/AP/GP	K-PATENTS	1
1	INDICATING TRANSMITTER DT-R	K-PATENTS	1

Figure 4.7 A sanitary prism wash system for high pressure water

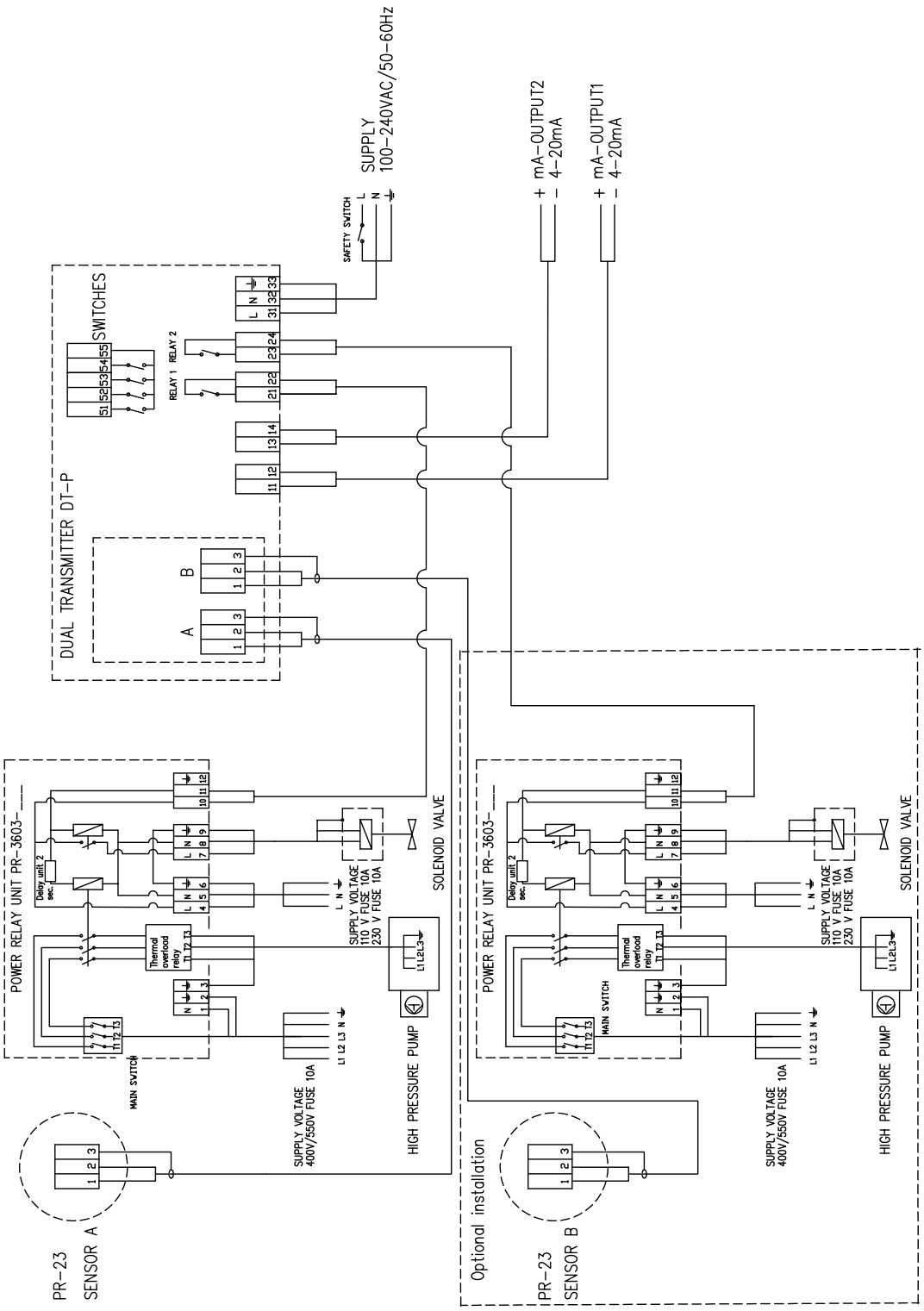


Figure 4.8 Wiring for a prism wash system for high pressure water

4.2.3 Prism wash nozzles

When selecting a wash nozzle for a **compact refractometer**, take into account both the wash medium and the flowcell model: flowcells with larger pipe diameters need longer wash nozzles. Figure 4.9 below shows a wash nozzle for a flowcell and gives the measurements and part numbers for each nozzle type.

Flowcell -H10 or -H15			
	A	B	part nr
steam	64.75	4.0	PR-3365
water	75	2.5	PR-3369
pressurized water	75	1.5	PR-3368
Flowcell -H20 or -H25			
	A	B	part nr
steam	72.15	4.0	PR-3375
water	97	2.5	PR-3379
pressurized water	97	1.5	PR-3378
Flowcell -H30			
	A	B	part nr
steam	103	4.0	PR-3393
water	113	2.5	PR-3394
pressurized water	113	1.5	PR-3395
Flowcell -H40			
	A	B	part nr
steam	133	4.0	PR-3390
water	143	2.5	PR-3391
pressurized water	143	1.5	PR-3392

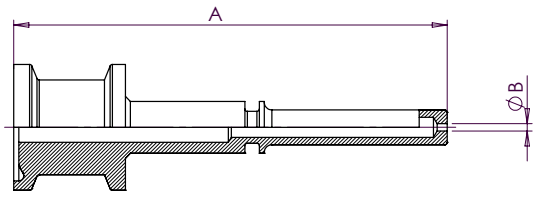


Figure 4.9 Wash nozzles for flowcell AFC-HSS-XXX-XX-NC

Figure 4.10 shows how the nozzle is mounted in a flow cell (-NC with stud for a wash nozzle). **Note:** See Section 9.3.5 for more information on flowcells.

For **probe refractometers**, select the wash nozzle according to wash medium and refractometer model, see Table 4.1 below.

Figure 4.11 shows the mounting of the wash nozzle for Sanitary probe refractometer PR-23-AP. Figure 4.12 shows the mounting of the wash nozzle for Process refractometer PR-23-GP.

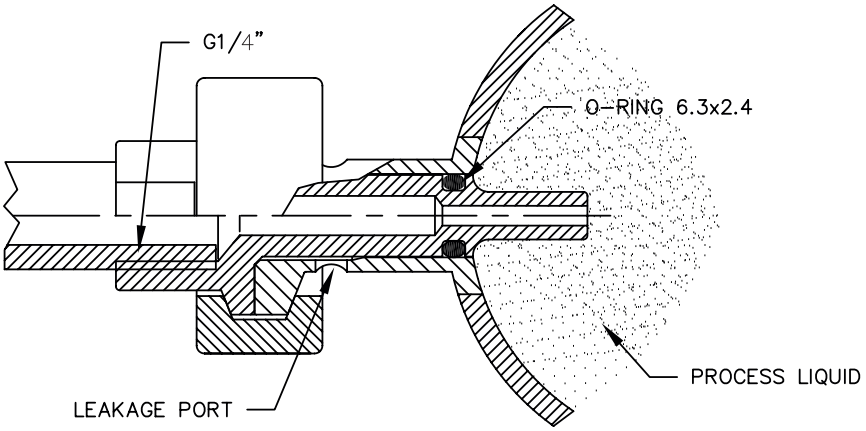
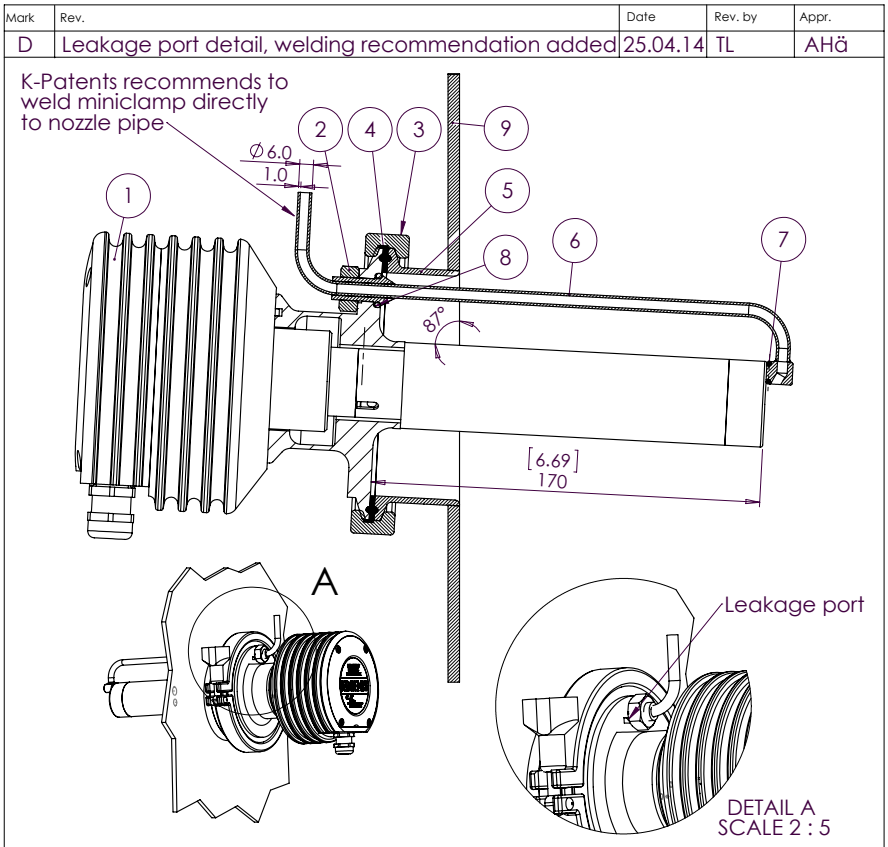


Figure 4.10 Process connection of a wash nozzle in a flow cell

	PR-23-AP	PR-23-GP
Steam nozzle	PR-9321	PR-9324
Water nozzle	PR-9320	PR-9323
Pressurized water nozzle	PR-9322	PR-9325

Table 4.1 Prism wash nozzle selection



#	Description	Material	Supplied by	Qty
1	PR-23-AP-RSS-NC sensor	-	K-Patents	1
2	Nut M10 A4	A4	K-Patents	1
3	4" Sanitary clamp	AISI 304	K-Patents	1
4	4" Sanitary gasket	EPDM, PTFE	K-Patents	1
5	4" Sanitary ferrule	AISI 316L	K-Patents	1
6	476, Nozzle assenbly	AISI 316L	K-Patents	1
7	O-ring 11 x 2.0	EPDM	K-Patents	1
8	O-ring 10 x 2.5	EPDM	K-Patents	1
9	Tank wall	-	-	-

Figure 4.11 Mounting of the wash nozzle for Sanitary probe refractometer PR-23-AP

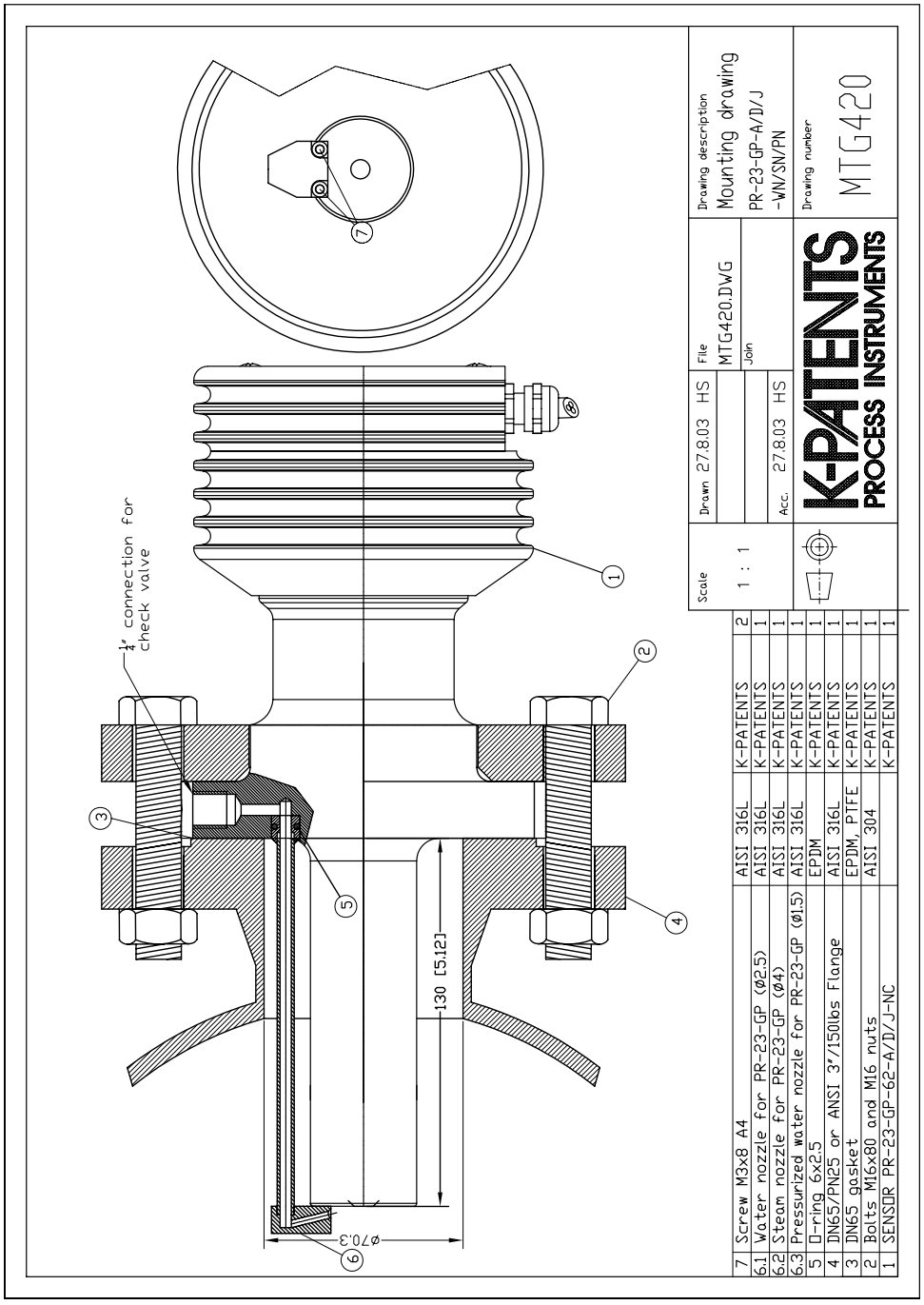


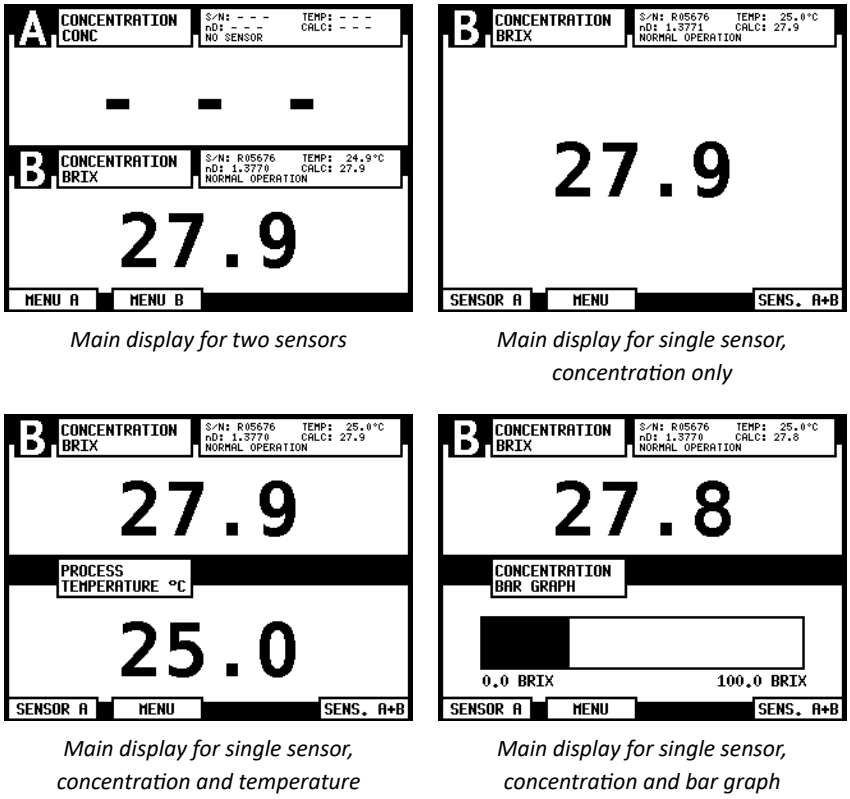
Figure 4.12 Mounting of the wash nozzle for Process refractometer PR-23-GP

5 Startup and use

5.1 Startup

5.1.1 Initial check

1. Check the wiring, Section 3.3, “Electrical connections”.
2. Connect the power. The **Power indicator light** (Figure 3.5) and the screen should light up within a few seconds.
3. The Main display should come up on the display, Figure 5.1.



Main display for two sensors

Main display for single sensor, concentration only

Main display for single sensor, concentration and temperature

Main display for single sensor, concentration and bar graph

Figure 5.1 Main display alternatives

4. In case the display shows a row of dashes, there is no corresponding sensor (for example in Figure 5.1, upper left, there’s no sensor A, only sensor B is connected). The diagnostic message is for that sensorNO SENSOR.
5. Check the serial number of the sensor at the upper right corner in the display.

6. For a connected sensor, the diagnostic message at start-up should be NORMAL OPERATION or, if the process pipe is empty, NO SAMPLE. Otherwise, see Section 8.4, “Diagnostic messages table”.

7. The TEMP value should show the current process temperature.

8. The value and the correct setup of the two mA output signals can be checked by selecting DESCRIPTION in the Main menu and then mA OUTPUTS in the Description menu (Section 5.3).

9. If internal relays or switch inputs are used, their settings can also be checked through the Description menu (Section 5.3).

5.1.2 Calibration check

Wait until normal process conditions occur. The concentration reading is precalibrated at delivery and a copy of the Sensor calibration certificate is inside the Indicating transmitter. If the diagnostic message is NORMAL OPERATION but the concentration reading does not agree with the laboratory results, then consult Section 6.4, “Calibrating the concentration measurement”.

5.1.3 Testing prism wash

1. Check that the steam or water washing parts are connected (Section 4.2.2, “Prism wash systems”).

2. In the Main display, press MENU. Then press 3 (to give the command SENSOR STATUS). In this Sensor status display by pressing the soft key WASH. If soft key WASH does not appear, no internal relay is configured for this purpose.

3. Check the $n_D$reading, for a successful wash it must drop below 1.34 during steam wash and drop to approximately 1.33 during water wash.

Important: Before testing prism wash, check that there is liquid in the pipe in front of the refractometer sensor.

5.2 Using the Indicating transmitter

The Indicating transmitter DTR receives the refractive index value $n_D$and the process temperature from the sensor(s). Starting from these values, it calculates the concentration of the process media for display and further transmission. The DTR can also be programmed to give alarm for high or low concentration. If the refractometer has a prism wash system, the DTR can control the wash with its built-in timer.

For information on how to use the Indicating transmitter DTR for configuration and calibration, see Chapter 6, “Configuration and calibration”.

5.2.1 Keyboard functions

Number keys: The 10 number keys, minus sign, and decimal point are used to enter numerical parameters. They are also used for menu selections.

ENTER key: The ENTER key is used to implement the selected (highlighted) menu command or to accept an entered value.

BACK key: The commands are arranged into a decision tree, the BACK key is used to move one step backward to the preceding display. It is also used to erase or cancel a numerical input.

Soft keys: The meaning of the soft key is shown on the display immediately above the key. Figure 5.2 gives an example the soft key functions, from left to right:

1. SENSOR A: Switch to corresponding menu for Sensor A.
2. Arrow down: Move one step down in the menu.
3. Arrow up: Move one step up in the menu
4. SELECT: Select the highlighted command (equivalent to pressing ENTER).

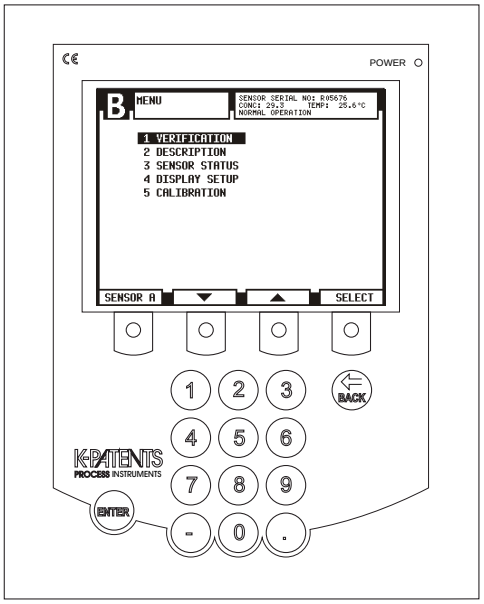


Figure 5.2 The DTR keyboard and the Main menu for sensor B

Note: Press the key *under the display*. The display is *not* touch sensitive.

5.2.2 Display setup

Selecting MENU/MENU A/MENU B or SENSOR A or SENSOR B (depending on your Main display format) in the Main display gives the Menu display. Choose 4 DISPLAY SETUP to change the Main display format and bar graph settings, to adjust backlight or contrast and to invert the display. In DTR program version 2.0 or newer you can also switch between the existing display languages.

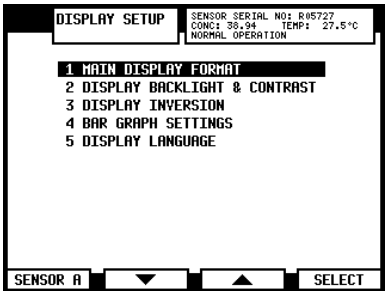


Figure 5.3 Display setup menu

Main display format: As you can see in Figure 5.1, there are four different Main display formats: the dual sensor format shows information on both sensors while the three different single sensor formats show selected information on one sensor at a time. Choose 1 MAIN DISPLAY FORMAT in the Display setup menu to change the Main display. The current format is shown on the display format selection display, see Figure 5.4 below.

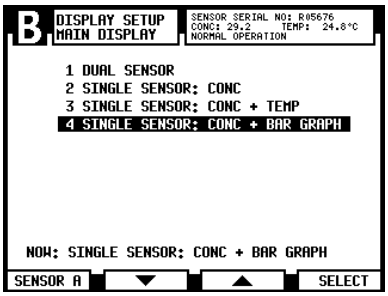


Figure 5.4 Main display format selection.

Note: An automatic 60 s (in verification 5 min) timeout will make backsteps from any display until the Main display is reached.

Display appearance: The 2 DISPLAY BACKLIGHT & CONTRAST can be selected from the Display setup menu (Figure 5.3). The values can be changed by using the arrow soft keys or alternatively a one digit input, for example 8 designates 80 % when adjusting contrast.

The 3 DISPLAY INVERSION contains two choices. The default setting of the display is 1 POSITIVE DISPLAY, i.e. yellow background and black text. However, in some environments the display may be clearer if 2 NEGATIVE DISPLAY, i.e. black background and yellow text, is chosen.

Bar graph settings: The command 4 BAR GRAPH allows you to set the bar graph span and zero separately for sensors A and B.
Note: Bar graph is only visible when Main display is in the bar graph format, see above.

Display language: The command 5 DISPLAY LANGUAGE lets you choose the DTR display language from the existing display languages, i.e. the languages that are loaded into

the DTR. The default language is English and it is always available. The order and number of the languages in the language menu varies depending on what languages are loaded into the DTR. Language change through this menu is immediate.

5.3 Viewing system information

The DESCRIPTION selection from the Main menu (Figure 5.2) opens a path to complete information about the system and calibration. This path is risk-free in the sense that no values can be changed through this menu. To be able to make changes, CALIBRATION must be selected from the main menu.

The Description menu (Figure 5.5) leads to the following information:

1. SYSTEM: See Figure 5.5, right side.
2. mA OUTPUTS: See Section 6.3.3, “Configuring mA outputs”
3. RELAYS: See Section 6.3.1, “Configuring relays”.
4. SWITCHES: See Section 6.3.2, “Configuring input switches”.
5. PRISM WASH: See Sections 6.3.1 and 6.5, “Configuring prism wash”.
6. PARAMETERS: See Section 6.4, “Calibrating the concentration measurement”.
7. NETWORK: The Ethernet address and card ID of the DTR. See Section 12, “Ethernet connection specification”.

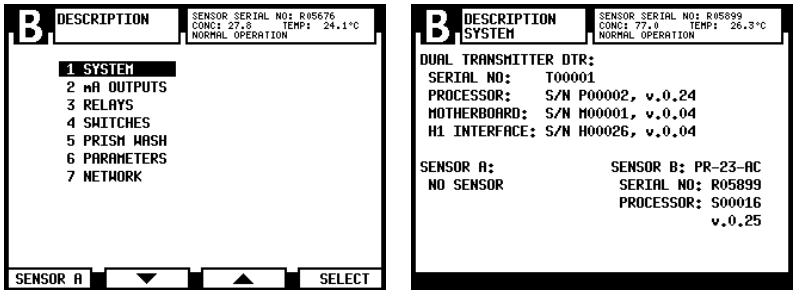


Figure 5.5 System description

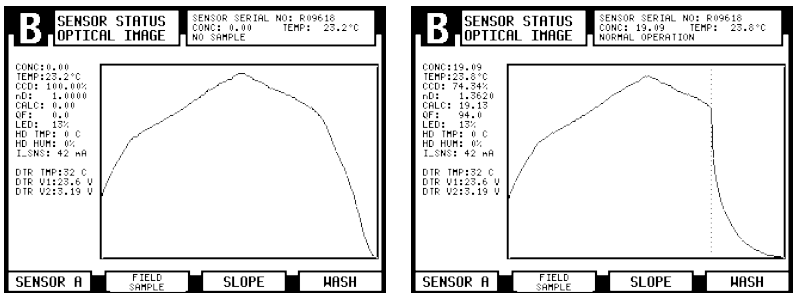
5.4 Viewing sensor status

Select SENSOR STATUS at the Main menu.

5.4.1 Optical image

There are two different image detection algorithms in the PR-23. The original image detection algorithm has been complemented with an advanced IDS (Image Detection Stabilization) algorithm which compensates for some unwanted noise in the image. These algorithms differ somewhat in how the image looks like, but the meaning of different diagnostic values is the same.

With the original image detection algorithm the Optical image graph (See Figure 1.4 for explanation) should look like Figure 5.6, right side. The vertical dotted line indicates the position of the shadow edge. For empty pipe, the optical image looks like Figure 5.6, left side. The soft key SLOPE leads to a graph (Figure 5.7) showing the slope (or first differential) of the optical image graph in Figure 5.6.
Note: In case there is no signal from the sensor, the image field is crossed over.



Empty pipe *Normal conditions*

Figure 5.6 Typical optical images without IDS

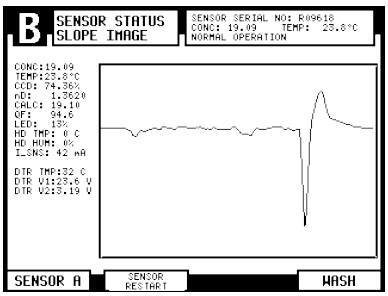
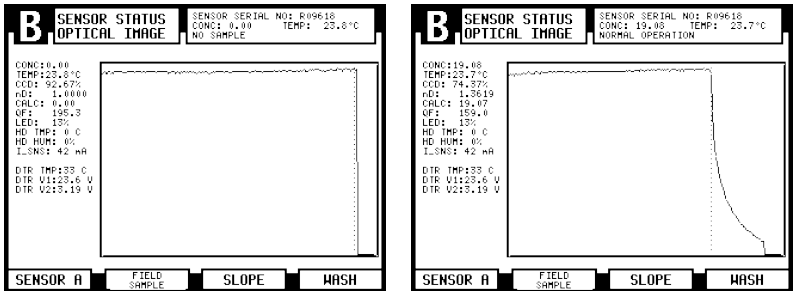


Figure 5.7 A slope graph without IDS

5.4.2 Optical image with IDS

For the IDS enabled image detection algorithm the images look like figure 5.8 and the slope like figure 5.9.



Empty pipe *Normal conditions*

Figure 5.8 Typical optical images with IDS

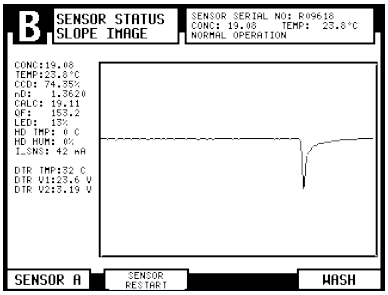
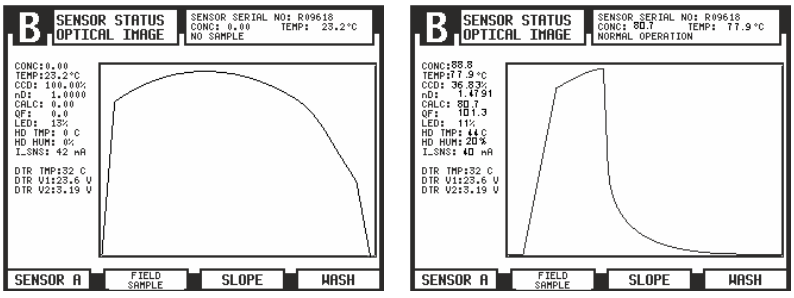


Figure 5.9 A slope graph with IDS

It should be noted that the "empty" optical image may have vertical left and/or right edge close to the edge of the image. In the example, only the right edge is visible.

5.4.3 Optical image with VD

A PR-23-GP can be ordered with option -VD, Vertical Borderline Image Detection. This is typically used in a sugar vacuum pan. With vertical borderline the optical image is without IDS, and the sides of the optical image are straight and slightly sloping. This is achieved programmatically, the optical module in the sensor is the same as for a PR-23-GP without the -VD option.



Empty pipe *Normal conditions*

Figure 5.10 Typical optical images with Vertical Borderline Image Detection

5.4.4 Diagnostic values

The values at the left of the graph are used for diagnostic purposes:

- CONC is the final concentration value including Field calibration adjustment, see Figure 6.12.
- TEMP, see Section 5.4.5.
- CCD gives the position of the shadow edge on CCD in %.
- nD is the refractive index value $n_D$from the sensor.
- CALC is the calculated concentration value without Field calibration adjustment, Section 6.4.3
- QF or Quality Factor is a value in the range 0–200. It measures the image sharpness, a typical good value is 100. A QF value below 40 usually indicates prism coating.
- LED is a measure of the amount of light from the light source in %. Should be below 100 %.
- HD TMP = sensor head temperature, see Section 5.4.5.
- HD HUM = sensor head humidity, see Section 5.4.6.
- I_SNS value shows the current to sensor, the nominal value is 40 mA.
- DTR TMP = Indicating transmitter temperature, see Section 5.4.5.
- DTR V1 gives the voltage from the power module, the nominal value is 24V.
- DTR V2 gives the DC supply voltage, the nominal value is 3.3 V.

Note: The Slope display also has a soft key SENSOR RESTART which can be used to restart the current sensor (see upper left corner of the display for sensor letter) after a sensor software update.

5.4.5 Temperature measurement

The system contains three different temperature measurements displayed to the left of the graphs in Figure 5.8:

TEMP is the process temperature used for automatic temperature compensation in the Indicating transmitter (Section 6.4, “Calibrating the concentration measurement”).

HD TMP measures the temperature on the Sensor processor card PR-10100 (Figure 2.1).

DTR TMP measures the temperature on the Motherboard of the Indicating transmitter (Figure 3.7, “Motherboard of the Indicating transmitter for AC power”).

Both sensor head temperature and DTR temperature are monitored by the built-in diagnostics program, see Sections 8.1.8, “Message HIGH SENSOR TEMP”, and 8.1.9, “Message HIGH TRANSMITTER TEMP”.

5.4.6 Sensor head humidity

The Sensor processor card contains also a humidity sensor. The value HD HUM is the relative humidity inside the Sensor. It is monitored by the diagnostics program, see Section 8.1.7, “Message HIGH SENSOR HUMIDITY”.

5.5 Sensor verification

A company maintaining quality system according to ISO 9000 quality standards must have defined procedures for controlling and calibrating its measuring equipment. Such procedures are needed to demonstrate the conformance of the final product to specified requirements. For the recommended verification procedure, please see Chapter 13.

6 Configuration and calibration

All changes of configuration and calibration are made through the Calibration menu selected from the Main menu by 5 CALIBRATION.

Password: It may be necessary to enter a password before proceeding to the Calibration menu. The password is printed on the title page of this manual. The password function is activated and deactivated via the 6 PASSWORD command in the Calibration menu.
By default the password is activated.

6.1 Configuring output signal damping

The Outputs display also provides the possibility to enter signal damping to diminish the influence of process noise. The damping is applied to the CONC value (and thus the output signal) of the current sensor (see upper edge of the display to check which sensor is currently chosen and switch in the Outputs display if necessary).

The PR-23 offers three types of signal damping. The damping parameter is set separately through the Outputs menu selected from the Calibration menu by 2 OUTPUTS. What the damping time means in practice depends on the damping type.

6.1.1 Exponential damping

Exponential (standard) damping works for most processes and is the standard choice for slow and continuous processes. The factory setting is always exponential damping, access the 3 DAMPING TYPE command to switch between different damping algorithms. In the exponential damping (standard damping), the damping time is the time it takes for the concentration measurement to reach half of its final value at a step change. For example, if the concentration changes from 50 % to 60 % and damping time is 10 s, it takes 10 seconds for the DTR to display concentration 55 %. A damping time of 5–15 seconds seems to work best in most cases, the factory setting is 5 seconds. Use the 4 DAMPING TIME menu item to set the damping time. Figure 6.1 shows how exponential damping time affects the measurement.

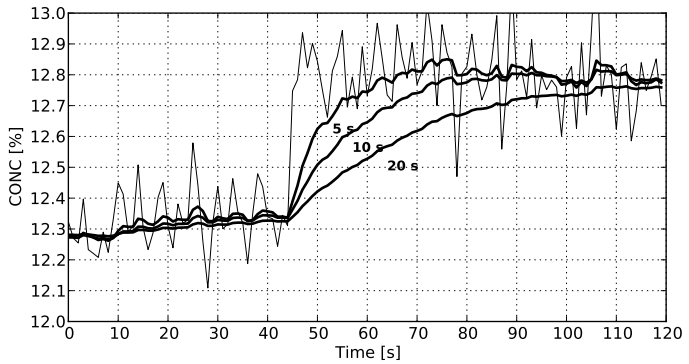


Figure 6.1 Exponential damping

6.1.2 Linear damping

If the process has fast step changes, linear (fast) damping gives shorter settling time. In the linear damping (fast damping), the output is the running average of the signal during the damping time. After a step change the signal rises linearly and reaches the final value after the damping time. The linear damping gives the best trade-off between random noise suppression and step change response time. Use the 4 DAMPING TIME menu item to set the damping time. Please note that for similar noise suppression a longer damping time has to be specified than for the exponential damping.

Figure 6.2 shows how linear damping time affects the measurement.

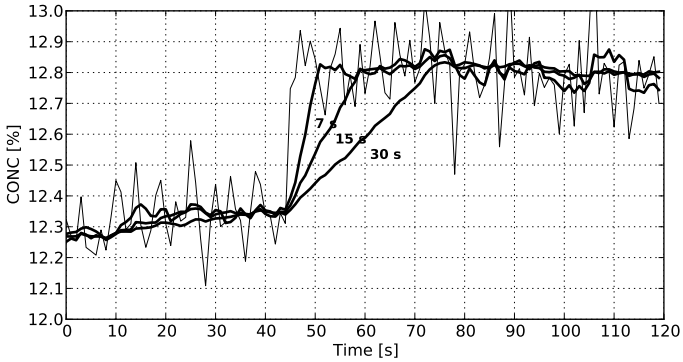


Figure 6.2 Linear damping

6.1.3 Slew rate limit

If the process signal has short erroneous high or low peaks, the slew rate limiting can be used to cut their effects. The slew rate damping limits the maximum change for the output signal in one second. It should be noted that the slew rate limit damping is recommended for random noise suppression as it is non-linear.

The slew rate limit can be set through the menu item 5 SLEW RATE. Typical values depend on the concentration unit but are typically from 0.05 % to 1 % when the concentration is measured in percentages. Figure 6.3 gives an example of different slew rate limits.

Note: Avoid overdamping, the signal should not be made insensitive.

6.2 Configuring output signal hold functionality

The instrument can be configured to temporarily hold its measurement result in three different cases.

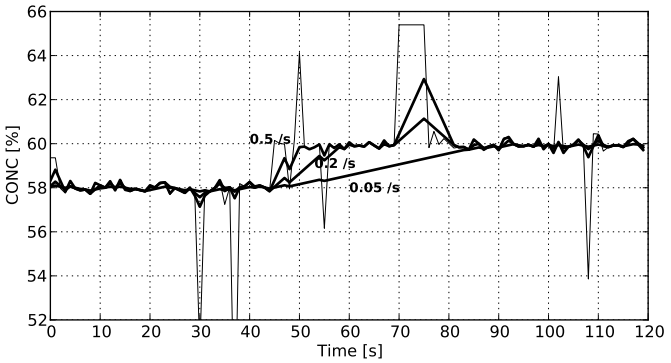


Figure 6.3 Slew rate damping

1. By using an external hold switch (see Section 6.3.2)
2. During prism wash (see Section 6.5.2)
3. For a preprogrammed time when there is an intermittent loss of sample on the prism (due to voids in the process)

When the measurement result is in hold, the displayed concentration value and mA output do not change. The diagnostic values (e.g. nD) shown on-screen always reflect the actual state of the measurement.

The measurement hold takes place after the CALC value and field corrections have been calculated but before the signal filtering (damping) takes place (see Section 6.4). If the hold is on, the output filter remains in its earlier state, and the output signal is stationary. If the hold is started when there is no output signal (e.g. no sample on the prism), there will be no measurement signal during the hold.

6.2.1 External hold

When a switch input is configured for external hold functionality (see Section 6.3.2), and the switch contact is closed, the measurement result is in hold. The measurement result is kept in hold until the switch contact is opened. A status message EXTERNAL HOLD will be shown.

6.2.2 Hold during wash

When the setting "Hold during wash" (see Section 6.5.2) is configured ACTIVE, the output signal is in hold when the instrument is washing. The signal will be in hold during all three phases (preconditioning, wash, recovery) of the wash process.

This setting can be used to avoid dips in the measurement signal during the prism wash.

6.2.3 Tolerance time

The tolerance time setting can be used in processes where there are intermittent breaks in the measurement due to non-representative sample on the prism. This typically occurs when there are large voids in the process liquid.

If the optical image can be interpreted, the tolerance time setting does not have any effect. When the optical image can no longer be interpreted (status messages, e.g., NO SAMPLE, NO OPTICAL IMAGE, PRISM COATED), the measurement is held for the given number of seconds.

For example, a setting of 10 seconds ensures that any NO SAMPLE state which is shorter than 10 seconds will not make a dip into the output signal. The factory setting is 5 seconds, access the 6 TOLERANCE TIME menu item to set the tolerance time.

The tolerance time counter is reset always when there is a representative sample on the prism (e.g., the nD can be determined). Figure 6.4 illustrates this behaviour with an intermittent measurement signal. When the signal drop is shorter than the tolerance time (e.g. at t = 10 s or t = 35 s in the figure), the output signal does not drop. If the signal drop is so long that the tolerance time counter reaches zero, there will be a drop in the output signal (at t = 80 s in the figure).

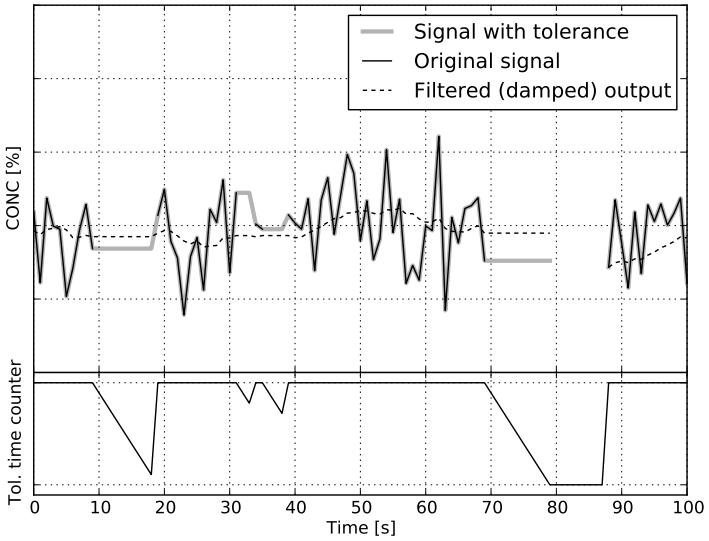


Figure 6.4 Effect of tolerance time on output

6.2.4 QF threshold

The QF threshold setting can be used to prevent the instrument from measuring when the image quality is below a certain limiting value. When QF value becomes less than the user defined value the image status changes to NO OPTICAL IMAGE after the user

defined tolerance time (see Section 6.2.3 for tolerance time). By default the QF threshold value is -500.

6.2.5 Hold source interactions

There are three different reasons why the measurement signal may be in hold. All three result in the same behaviour, but they also interact with each other.

Wash-related hold (Section 6.2.2) and external hold (Section 6.2.1) are connected in parallel. If at least one of them is active, the measurement result will be in hold. Tolerance time (Section 6.2.3) is independent of these two, but the tolerance time will be reset whenever there is another reason for the measurement hold.

For example, if the tolerance time is set to 10 seconds, and wash hold becomes active after 7 seconds, the remaining tolerance time will be reset to 10 seconds After the wash is over, there is still 10 seconds of tolerace time remaining.

6.2.6 Hold and signal damping

The signal filtering (damping) is stopped during hold. The last filtered value is shown on the screen and set to the mA output (if the concentration output is configured). Figure 6.5 illustrates this behaviour (gray areas represent the periods when the hold is active).

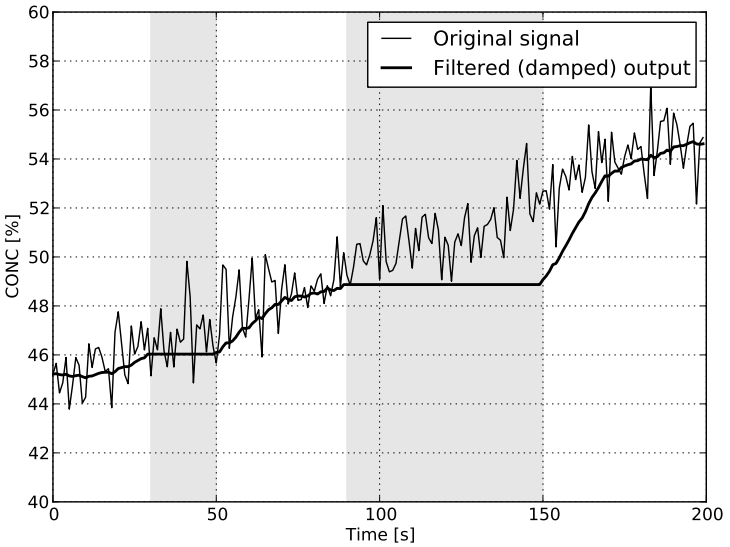


Figure 6.5 Damping stops during hold

6.2.7 Hold functions with DD-23

The Digital Divert Control System DD-23 uses the displayed concentration value in its decision logic. Due to this, the external hold functionality must not be used with a DD-23, as it could potentially render the system unsafe by freezing the measurement result.

The "hold during wash" must be used with DD-23. Otherwise the signal damping combined with low nD values caused by the wash process may give erroneous information to the DD-23 after the wash is over.

The selection of tolerance time with DD-23 requires a careful risk analysis. The use of the tolerance time functionality does not slow down the response of the instrument when the instrument is in NORMAL OPERATION. It does, however, slow down the malfunction alarm in the DD-23 in case the process pipe becomes empty or some other reason makes the optical image impossible to interpret. The recommended value for tolerance time is 5 seconds when a DTR is used in a DD-23 system.

6.3 Configuring refractometer system

The Indicating transmitter has **two** built-in **4–20 mA outputs** (mA OUTPUT 1, mA OUTPUT 2), **two relay contact outputs** (RELAY 1, RELAY 2), and **four switch inputs** (SWITCH 1, SWITCH 2, SWITCH 3, SWITCH 4). Each of these resources can be freely assigned to either sensor A or sensor B.

6.3.1 Configuring relays

For the electrical properties of the built-in relays, see Section 3.3.3. Each of the two relays can be configured individually to either Sensor A or Sensor B, i.e. 0–2 relays can be assigned to a sensor. Relays can also be opened and closed manually, mainly to test them.

To configure the relays, follow the instructions below:

1. Select 5 CALIBRATION from the Main menu.
2. Select 3 RELAYS from the Calibration menu.
3. Select the relay, either 1 RELAY 1 or 2 RELAY 2, to be configured.
4. In the Relay menu (see Figure 6.6) select 1 SENSOR to assign the current relay to either Sensor A or Sensor B.
   Note: The current assignment of the relay is shown at the bottom of the Relay menu display, e.g. Figure 6.6 Relay 1 is assigned to Sensor A with function Low limit.
5. In the relay menu, select 2 FUNCTION to set the relay function:

1	NOT DEFINED	Factory setting.
2	NORMAL OPERATION	Closed contact if diagnostic message is NORMAL OPERATION during HOLD (see Section 6.3.2). The contact is also closed when message is NO SAMPLE.

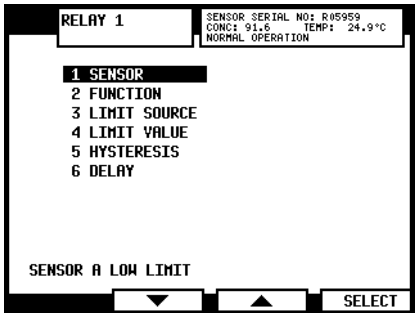


Figure 6.6 Relay menu for Relay 1

3	INSTRUMENT OK	Closed contact if there is no equipment malfunction. See also Section 8.4 on page 74.
4	LOW LIMIT	Used as alarm relay, closing contact if source value is below set limit. (See below for limit source selection.)
5	HIGH LIMIT	Used as alarm relay, closing contact if source value is above set limit. (See below limit source selection.)
6	PRECONDITION	See Figure 6.14.
7	WASH	See Section 6.5.
8	PRISM WASH FAILURE	Closed contact if diagnostic message is PRISM WASH FAILURE (see Section 6.5.2).

6. If you choose either low limit or high limit as relay function, you'll have define a limit source. For this, select 3 LIMIT SOURCE in the Relay menu (Figure 6.6).
   Limit source selection:

1	NOT DEFINED	Factory setting.
2	CONCENTRATION	Measured concentration CONC
3	PROCESS TEMPERATURE	Process temperature

7. The **Limit value** is set separately by choosing 4 LIMIT VALUE in the Relay menu (Figure 6.6) and entering a numeral limit value.
8. The **Hysteresis** value is set by choosing 5 HYSTERESIS in the Relay menu (Figure 6.6). The value indicates how soon the relay opens after the process has temporarily gone over the high limit or under the low limit. For example if the high limit is 50 and the hysteresis is 2, the relay will not reopen until the process drops below 48.
9. To change the **relay delay time**, choose 6 DELAY in the Relay menu (Figure 6.6). The delay is given in seconds, factory setting is 10 s.

For **manual set**, go (back) to the Select relay menu and choose 3 MANUAL SET. In the manual set display you can open and close the any relay by pressing the appropriate soft key. The current status of the relay (open or closed) is displayed next to the relay name, see Figure 6.7 below:

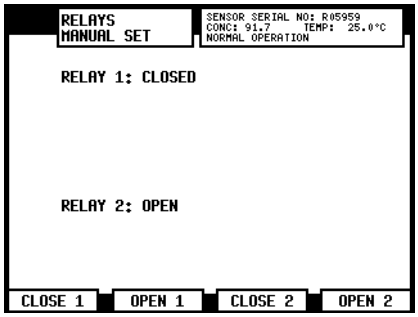


Figure 6.7 The manual set display for relays

6.3.2 Configuring input switches

For the electrical properties of the four input switches, see Section 3.3. To see which switches are closed, check the Description menu, see Section 5.3. To configure the switches, follow the instructions below:

1. Select Menu to get to the Main menu.
2. Select 5 CALIBRATION from the Main menu.
3. Select 5 SWITCHES from the Calibration menu.
4. Select the switch, 1, 2, 3 or 4, to be configured. You now get the Switch menu, see Figure 6.8 below.

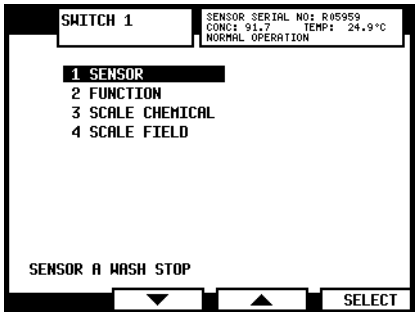


Figure 6.8 Switch menu

5. First select 1 SENSOR to assign the chosen switch to a given sensor.
   Note: The selection line will automatically go to the currently valid setting, i.e. in Figure 6.9 next page Switch 1 has been assigned to Sensor A.
6. In the Switch menu, select 2 FUNCTION to set switch function.
   Note: The current assignment of the switch is shown at the bottom of the Switch menu display, e.g. Figure 6.9 Switch 1 is assigned to Sensor A with function Wash stop.

1	NOT DEFINED	Factory setting
2	HOLD	When used with a built-in wash relay, this function is useful for an intermittent process: the prism is washed when the

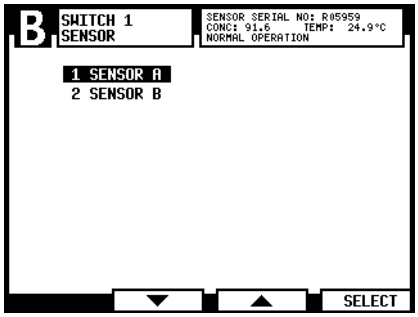


Figure 6.9 Arrival to Switch 1's sensor selection menu, sensor A selected

		process stops (as indicated by contact closure).The wash is repeated when the process restarts (if the stop lasts over 60 seconds). The signal is on hold between washes.When used with an external independent timer, contact closure holds the output signal.
3	WASH STOP	Switch closure prevents wash cycle. It can be used to prevent wash action when the process pipe is empty. The message WASH STOP will appear when a wash cycle is initiated.
4	REMOTE WASH	At switch closure the system waits for an external wash command before initiating wash.
5	SCALE SELECT	Any chemical curve and associated field calibration scale can be selected by switch closure. The scales assigned to each switch independently.
6	CALIBRATION SEAL	Contact closure prevents access to calibration and configuration ("external password"). Can be used to seal the calibration.

7. If you chose Scale select as switch function, return to the Switch menu (if not returned automatically) and choose 3 SCALE CHEMICAL to enter the parameters for the chemical curve assigned to the switch. See Section 6.4.1 for more information on chemical curves and chemical curve parameters.
8. If necessary, the chemical curve assigned to a switch can be adjusted by field calibration parameters. Select 4 SCALE FIELD in the Switch menu to enter the parameters.See Section 6.4.3 for more information on field calibration and field calibration parameters.

6.3.3 Configuring mA outputs

For the electrical properties of the two output signals, see Section 3.3.3, "Connecting the Indicating transmitter".

- First select 5 CALIBRATION in the Main menu and enter password if necessary. Then select 2 OUTPUTS in the Calibration menu. In the Outputs menu, select 5 mA OUTPUTS.
- Select the mA output, 1 or 2, to get to the Output menu (Figure 6.10 below) where the output can be configured.
  Note: The line at the bottom of the Output menu display indicates the current configuration of the selected mA output, e.g. in Figure 6.10 mA Output 1 has been configured to send the concentration reading of Sensor B.

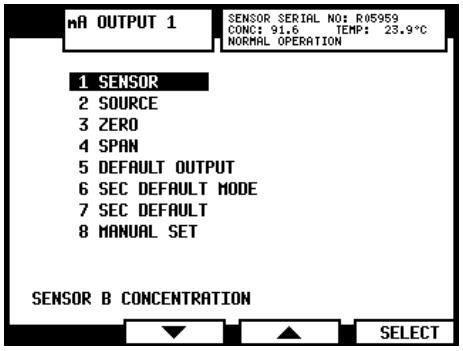


Figure 6.10 The Output menu for mA Output 1

- To change the sensor the selected output is assigned to, select 1 SENSOR in the Output menu.
- To change output source for the selected output, select 2 SOURCE.
  Note: Selecting 1 NOT DEFINED 'turns off' the selected output.
- The 3 ZERO value sets the value when the signal is 4 mA. The default zero value is 0.00, the unit depends on the source and display unit set for the sensor in question (and can thus be for example 0 BRIX or 0 °F).
- The 4 SPAN sets the range, i.e. the value given when the signal is 20 mA.

Example: If your measurement unit is CONC% and you want to measure the range 15–25 CONC%, first choose concentration as mA output source. Then set the zero value at 15 and span at 10. This means that the output signal is 4 mA at 15 CONC% and 20 mA at 15+10=25 CONC%. To change this output to range 10–30 CONC%, change zero to 10 and span to 20 (10+20=30).

- 5 DEFAULT OUTPUT sets a mA default output value that the instrument returns to in certain malfunction situations. The value can be set to a low or high mA value, e.g. 3.0 mA or 22 mA. The factory setting for default output is 3.4 mA. For a list of malfunctions that are affected, see section 8.4.

Note: NAMUR is an international association of users of automation in process industries. The association recommendation NE 43 promotes a standardization of the signal level for failure information. The goal of NE 43 is to set a basis for proactively using transmitter failure signals in process control strategies. Using these failure signals, instrument faults are separated from process measurements.

NAMUR NE 43 uses the 3.8 to 20.5 mA signal range for measurement information, with ≥21 mA or ≤3.6 mA to indicate diagnostic failures (see Figure 6.11). With that information, it is easier to detect a failure condition on a refractometer, for example, it clearly tells you whether you have an empty pipe or a failed instrument.

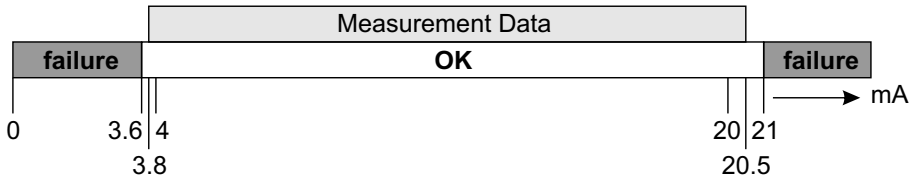


Figure 6.11 Default mA output values

- 6 SEC DEFAULT MODE and 7 SEC DEFAULT allow you to set a secondary mA output value for empty pipe (message NO SAMPLE) to differentiate it from the other messages that cause the measurement to revert to default mA. By default the secondary mA output is disabled.
- 8 MANUAL SET allows you to set different output values to check the output signal. Press the BACK key to return normal output function.

Note: If you want to 'turn off' the mA output, select NOT DEFINED in the Source menu.

6.4 Calibrating the concentration measurement

The concentration calibration of the PR-23 refractometer is organized in six layers.

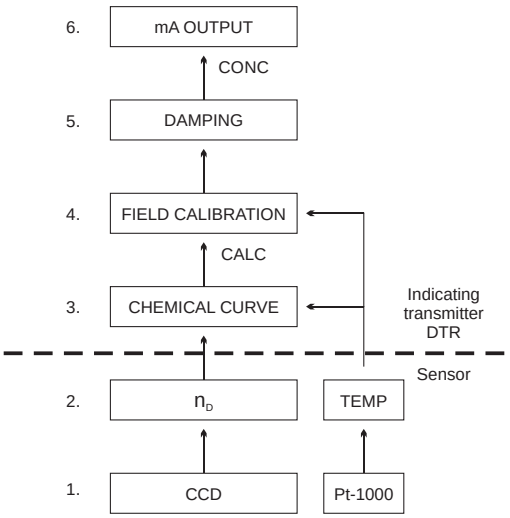


Figure 6.12 The six layers of concentration calibration

1. *The information from the CCD element and the Pt-1000 temperature element*. The position of the shadow edge (Figure 1.4, "Optical image detection") is described by a number called CCD and scaled from 0–100 %.

2. *The sensor calibration*: The actual refractive index n_D is calculated from the CCD value. The process temperature is calculated from the Pt-1000 resistance. The sensor output is n_D and temperature TEMP in Centigrade. Hence, the calibrations of all PR-23 sensors are identical, which makes sensors interchangeable. Furthermore, the calibration of each sensor can be verified using standard refractive index liquids, see Chapter 13.

3. *The chemical curve*: The Indicating transmitter DTR receives n_D and TEMP and calculates the concentration value according to chemical curves derived from available chemical literature and our expertise. The result is a temperature compensated calculated concentration value CALC.

4. *Field calibration*: Adjustment of the calculated concentration value CALC may be required to compensate for some process conditions or to fit the measurement to the laboratory results. The Field calibration procedure, Section 6.4.3, determines the appropriate adjustment to CALC. The adjusted concentration is called CONC. If there is no adjustment, CALC and CONC are equal. Thus the chemical curve is kept intact as a firm base for the calculation, the adjustment is merely additional terms.

5. *Damping*: See Section 6.1.

6. *Output signal*: The range of the 4 to 20 mA signal is defined by its two endpoints on the CONC scale, see Section 6.3.3.

6.4.1 The chemical curve

The chemical curve is the theoretical concentration curve based on $n_D$and TEMP. It is defined by a set of 16 parameters (Table 6.1, one set for each sensor).

C_{00}	C_{01}	C_{02}	C_{03}
C_{10}	C_{11}	C_{12}	C_{13}
C_{20}	C_{21}	C_{22}	C_{23}
C_{30}	C_{31}	C_{32}	C_{33}

Table 6.1 The chemical curve parameters

A chemical curve is specific to the given process medium, e.g. sucrose or sodium hydroxide. The set of parameters is given by Vaisala and should not be altered, except in case of changing to another process medium. The parameters can be changed by selecting first 5 CALIBRATION from the Main menu, then, in the Calibration menu, 1 CHEMICAL & FIELD PARAMETERS, and finally 1 CHEMICAL CURVE PARAMETERS.

6.4.2 Selecting display units and display decimals

The display units and display decimals are set separately for each sensor, so first go to the Calibration menu of the correct sensor. Then select 2 OUTPUTS in the Calibration menu and in the Outputs menu choose either 1 DISPLAY UNITS or 2 DISPLAY DECIMALS. For the display units, select either 1 CONCENTRATION or 2 TEMPERATURE and then the unit. For display decimals, enter the number of decimals you want to see on display by entering a number in the range 0–5 (0 meaning no decimals are shown).
Note: Change of concentration unit will not change the numerical value of the concentration. Change of temperature unit will recalculate the numerical temperature value according to selected scale (°C or °F).

6.4.3 Field calibration

Vaisala provides a *field calibration service* that adapts the calibration to the factory laboratory determinations based on the data supplied. The field calibration procedure should be made under normal process conditions using standard laboratory determinations of sample concentration.

Record the calibrating data on the PR-23 field calibration form (found in the end of this manual), also available by emailing a request to *<info@kpatents.com>*. Fax or email the completed Field calibration form to your local Vaisala KPATENTS® representative. A computer analysis of the data will be made at Vaisala and optimal calibration parameters will be sent to be entered in the Indicating transmitter DTR.

For a complete report, 10–15 valid data points (see below) are needed. A data point is of use for calibration only when the diagnostic message is NORMAL OPERATION. If prism wash is employed, do not take samples during the wash. Each data point consists of:

LAB%	Sample concentration determined by the user
From DTR display:	(see Figure 6.13)
CALC	Calculated concentration value
T	Process temperature measurement in Centigrade
nD	Actual refractive index n_D
CONC	Measurement in concentration units, the large size number

In addition to the calibration data, write down the Indicating transmitter serial number, the sensor serial number and the sensor position, i.e. whether it is installed as Sensor A or as Sensor B.

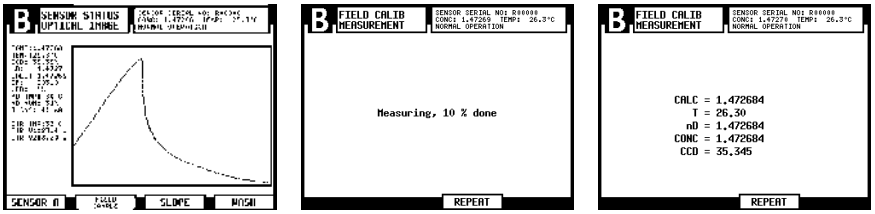
Accurate calibration is only achieved if the sample is taken correctly. Pay special attention to following details:

- The sampling valve and the refractometer should be installed close to each other in the process.

Warning! Wear protective clothing appropriate to your process when operating the sampling valve and handling the sample.

- Run the sample before starting to collect data points to avoid sampling old process liquid that has remained in the sampling valve.
- Read the values CALC, T(emp), nD and CONC in the DTR's display at exactly the same time with sampling.
  The easiest way of doing this is to use the FIELD SAMPLE soft key available through the Sensor status display (DTR program version 2.0 or newer). The value of each sample is the average of 10 consequent measurements to increase accuracy and reduce possible process noise.
- Use a tight container for the sample to avoid evaporation.

Important: Offline calibration using process liquid very seldom gives reliable results, as problems are caused by



Press the FIELD SAMPLE *soft key...*

...wait while DTR measures... (take sample for lab)

...and press REPEAT *for next data point or BACK to get to the Sensor status display.*

Figure 6.13 Using FIELD SAMPLE soft key

- low flow which makes sample to form an unrepresentative film on the prism
- sample evaporation at high temperature or undissolved solids at low temperature giving deviations from laboratory determinations
- an ageing sample which is not representative
- outside light reaching the prism

Thus *calibration using the process liquid should always be made inline*.

6.4.4 Entering field calibration parameters

The field calibration parameters supplied by Vaisala are entered by selecting 5 CALIBRATION from the Main menu, followed by first 1 CHEMICAL & FIELD PARAMETERS and then by 2 FIELD CALIBRATION PARAMETERS.

Important: If there is already a previous field calibration, it should be cleared (by setting all values to 0) before entering a new field calibration.

6.4.5 Direct BIAS adjustment

The concentration measurement value can also be directly adjusted by changing the field adjustment parameter f00.

The value of the bias parameter f00 will be added to the concentration value:
NEW CONC = OLD CONC + f00.

6.5 Configuring prism wash

In some applications the process flow does not keep the prism clean because of sticky process medium or low flow velocity. In these applications the prism can be automatically cleaned by installing a wash system (see Chapter 4).

The prism wash settings for sensors A and B are independent of each other. The wash system is active if a relay has been configured to be a wash relay (see Section 6.3.1) and the wash time is not zero. An automatic wash function can be configured so that both sensors have different parameters.

6.5.1 Wash cycle

The wash logic is shown in Figure 6.15 as a flow diagram. The automatic prism wash cycle (Figure 6.14) consists of three phases: *precondition*, *wash* and *recovery*. The optional preconditioning function is used to e.g. blow out the condensate before washing. After the preconditioning there is a one-second pause to avoid having both precondition and wash relays active at the same time.

The wash cycle is initiated when the wash interval has elapsed. The wash can also be started by closing an external switch (Remote wash, see Section 6.3.2) or manually from the user interface at the Sensor status display (see Section 5.1.3). The order of priority for these wash triggers is:

1. manual wash
2. remote wash request
3. wash interval timer

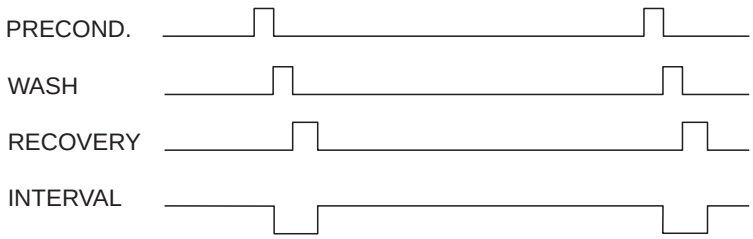


Figure 6.14 The automatic prism wash cycle

Note: For safety reasons two sensors never wash simultaneously. If the manual wash button for sensor A is pressed while sensor B is washing, the wash cycle for sensor A is started after B has finished. Similarly, if the interval time for sensor B elapses when A is washing, the wash for sensor B is delayed until A has finished.

In case of remote wash request the request is discarded if it arrives when the other sensor is washing. The request is honored only if the contacts are held closed until the other sensor has finished.

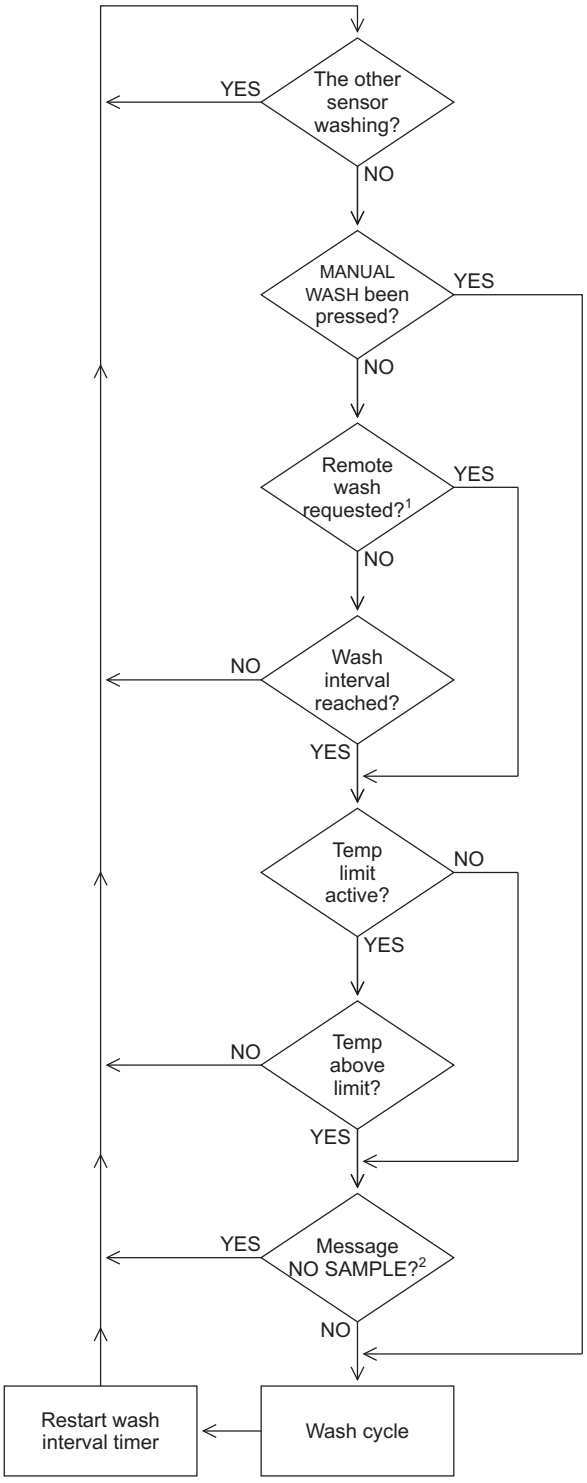
The wash relay is closed for the wash time specified in the wash settings. If the wash auto-cut functionality is active, the wash may be ended earlier (see Figure 6.16). The specified wash time is never exceeded.

After the wash phase is completed, a recovery time is spent. During the wash cycle (precondition, wash, recovery) the measurement result is in hold unless otherwise specified.

Preventing automatic wash:

The preconditioning and wash relays are never activated by the automatic wash control:

- Under the diagnostic message NO SAMPLE (see Section 8.2.6) as this indicates a clean prism in an empty process line. The diagnostic message is WASH STOP/NO SAMPLE.
- If a wash stop input switch is closed (see Section 6.3.2), indicating e.g. that there is no process flow. The diagnostic message is EXTERNAL WASH STOP.
- If the process temperature limit is activated and the temperature falls below the limit, indicating that the process is not running. The diagnostic message is LOW TEMP WASH STOP



NOTES

1. Remote wash is triggered at the closing of the switch. If the switch is held closed, only one wash cycle is carried out.
2. The wash is inhibited if there is no sample, no sensor or the sensor cannot measure correctly.

Figure 6.15 Wash logic

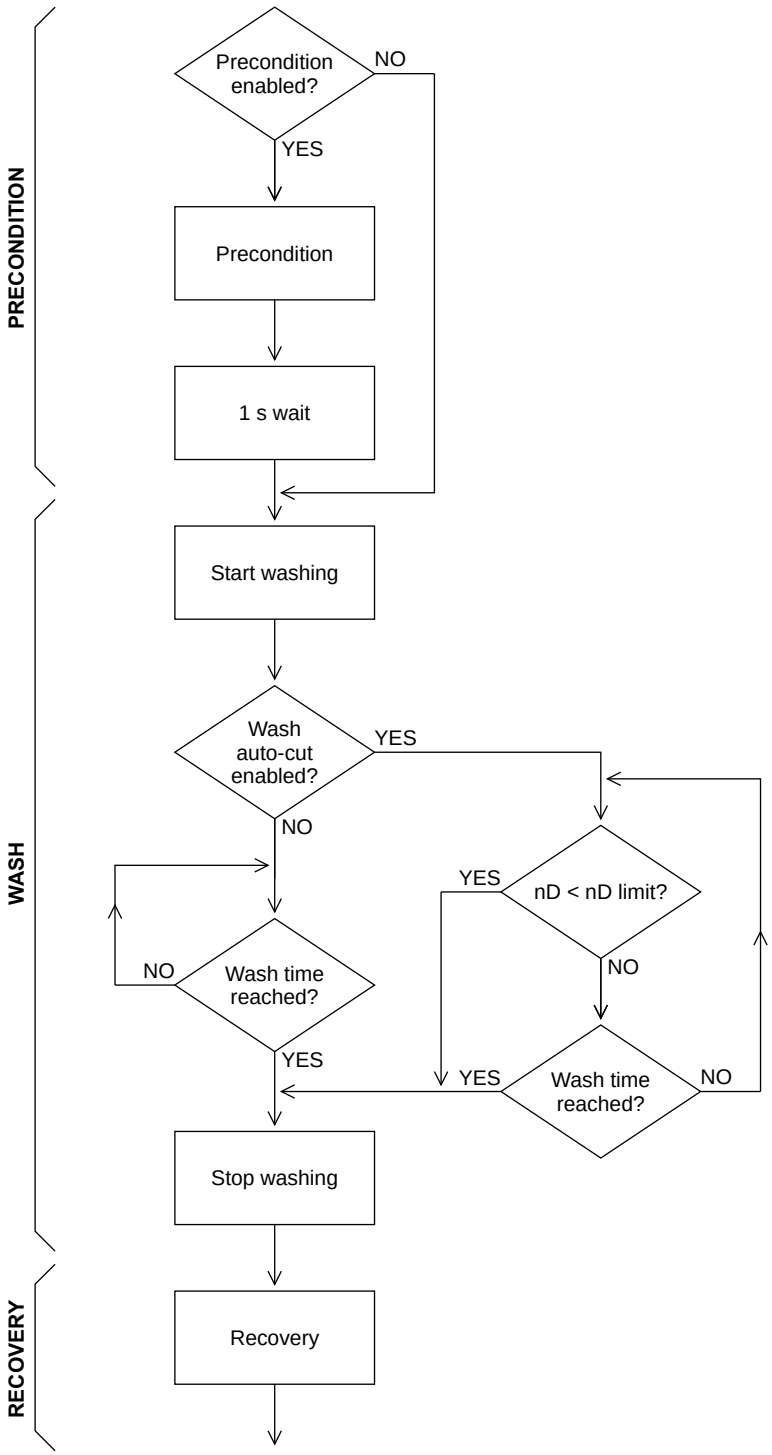


Figure 6.16 Wash cycle

6.5.2 Setting prism wash parameters

To set the prism wash parameters for a given sensor, first select the sensor, then select 5 CALIBRATION from the Main menu, and then 4 PRISM WASH. This menu contains the alternatives (factory settings are given in parentheses):

1	PRECONDITION TIME	0–30 s (0 s)
2	WASH TIME	0–30 s (3 s)
3	RECOVERY TIME	0–30 s (20 s)
4	WASH INTERVAL	0–1440 min (20 min)
5	WASH CHECK MODE	(Disabled)
6	HOLD DURING WASH	(Active)
7	TEMP LIMIT ACTIVATION	
8	TEMP LIMIT VALUE °C	
9	EMPTY PIPE CHECK	(Active)
0	MORE ...	
1	WASH nD LIMIT	
2	WASH TOLERANCE TIME	(0 min)

The prism wash cycle: See Figure 6.16 and Section 6.5.1. The timing of the wash cycle is controlled by the WASH INTERVAL, PRECONDITION TIME, WASH TIME and RECOVERY TIME settings. If the WASH INTERVAL is set to zero, the wash can be initiated only by using the manual wash or remote wash request.

If the PRECONDITION TIME is zero (or there is no relay configured for preconditioning), the preconditioning phase is skipped. If the WASH TIME is zero (or there is no relay for wash), the wash functionality is completely disabled.

The recommended wash times and wash medium pressures are given in Section 4.2.1, “Recommended wash pressures and times”.

Wash check: The prism wash check monitors automatically that the wash really has an effect on the prism. In the WASH CHECK STANDARD mode, prism wash is accepted if the refractive index $n_D$either falls below wash nD limit (default 1.34) at NORMAL OPERATION or NO SAMPLE occurs. This is the indication of a successful wash with water or steam.
If the wash is not accepted, the diagnostic message PRISM WASH WARNING (see Section 8.4) will appear. If no wash is accepted during wash tolerance time, the message becomes PRISM WASH FAILURE. Both messages and the wash tolerance counter are reset by a successful wash.
The WASH CHECK AUTOMATIC WASH CUT mode differs from the standard mode by stopping the wash 2 seconds after the $n_D$falls below the limit.

To stop the measurement for the duration of the prism wash, choose 6 HOLD DURING WASH and in that menu activate the hold function. The CONC reading and mA output are held in the value they had immediately before starting the wash cycle.

To activate (or deactivate) a temperature limit, choose 7 TEMP LIMIT ACTIVATION and then the appropriate command in the menu.

To set a low temperature limit, choose 8 TEMP LIMIT VALUE °C and enter the temperature (in °C!) where the limit should be.

The empty pipe check prevents washing if message is NO SAMPLE, i.e. there's no process liquid in the pipe. To deactivate (or active) the empty pipe check, choose 9 EMPTY PIPE CHECK and then the appropriate menu command.

To change the wash nD limit, select first 0 MORE … and then 1 WASH nD LIMIT to set the $n_D$value to be used with the wash check functionality.

To set wash tolerance time, select first 0 MORE … and then 2 WASH TOLERANCE TIME to set the time during which a wash has to be accepted. If no wash is accepted during wash tolerance time, the message becomes PRISM WASH FAILURE. The wash tolerance counter is reset by a successful wash.

7 Regular maintenance

The need for regular maintenance is minimal, due to the construction with no moving parts, no mechanical adjustementsand with a solid-state light source. The following rules apply:

- Keep the sensor head and the Indicating transmitter clean and dry.
- Check that the ambient temperature is not above +45 °C (113 °F). The sensor head should not be too hot to keep a hand on.
- If your refractometer has prism wash, check that it works, see Section 5.1.3.
- Follow preventive maintenance program, if any.

7.1 Checking the sensor humidity level

The PR-23 sensor head has an internal humidity detector. The humidity reading can be checked on the Indicating transmitter display, select 3 SENSOR STATUS from the Main menu. **Check the humidity reading once in every three months.**

Increasing humidity level indicates either condensate forming in the sensor head (if the process temperature is below ambient) or prism leakage. If the humidity reading exceeds 30 %, replace the dryer. If the reading exceeds 50 %, check the prism seals. Relative humidity exceeding 60 % will produce a diagnostic message HIGH SENSOR HUMIDITY (see Section 8.1.7). Contact service if internal humidity increases.

7.2 Checking the prism and prism gaskets

Once a year check that the prism surface is smooth and clean and free of erosion and small holes or digs. If the prism is scratched, eroded, or the gaskets seem to leak, contact service.

Important: In **3-A certified sensors**, prism gasket replacement and other repairs must be done **by authorized Vaisala K-PATENTS® service centers only**. If gaskets of 3-A certified sensors are replaced in the field, the certification is no more valid.

8 Troubleshooting

8.1 Hardware

To troubleshoot refractometer hardware problems, it is often important to localize the different cards inside the DTR. The Diagnostic LEDs on the cards help solve the problems and give an indication on whether a connection is good.

Warning! Hazardous voltage, contact may cause electric shock or burn. Beware of the live wires in the lower right-hand corner of the H1 interface card.

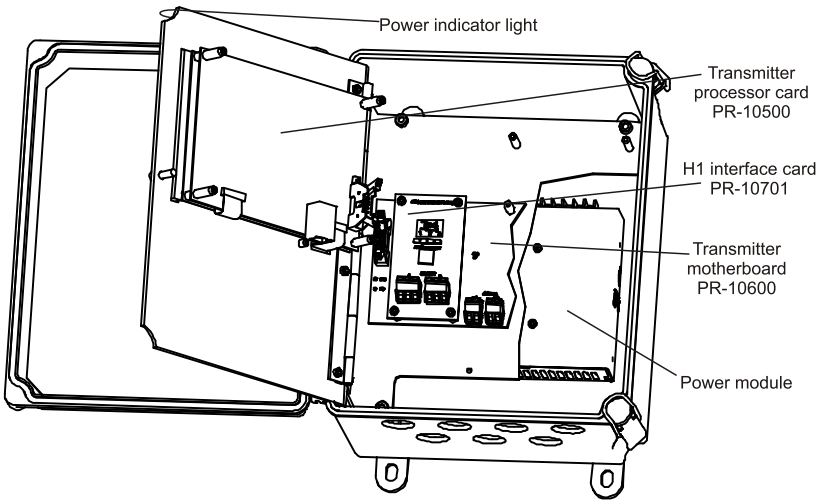


Figure 8.1 Positions of the transmitter cards

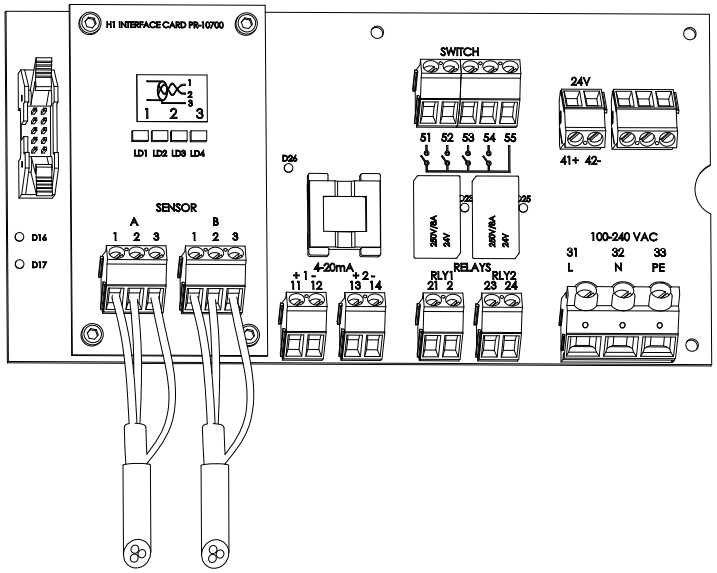


Figure 8.2 Motherboard PR-10600 and H1 interface card PR-10701 in detail.

8.1.1 Blank display

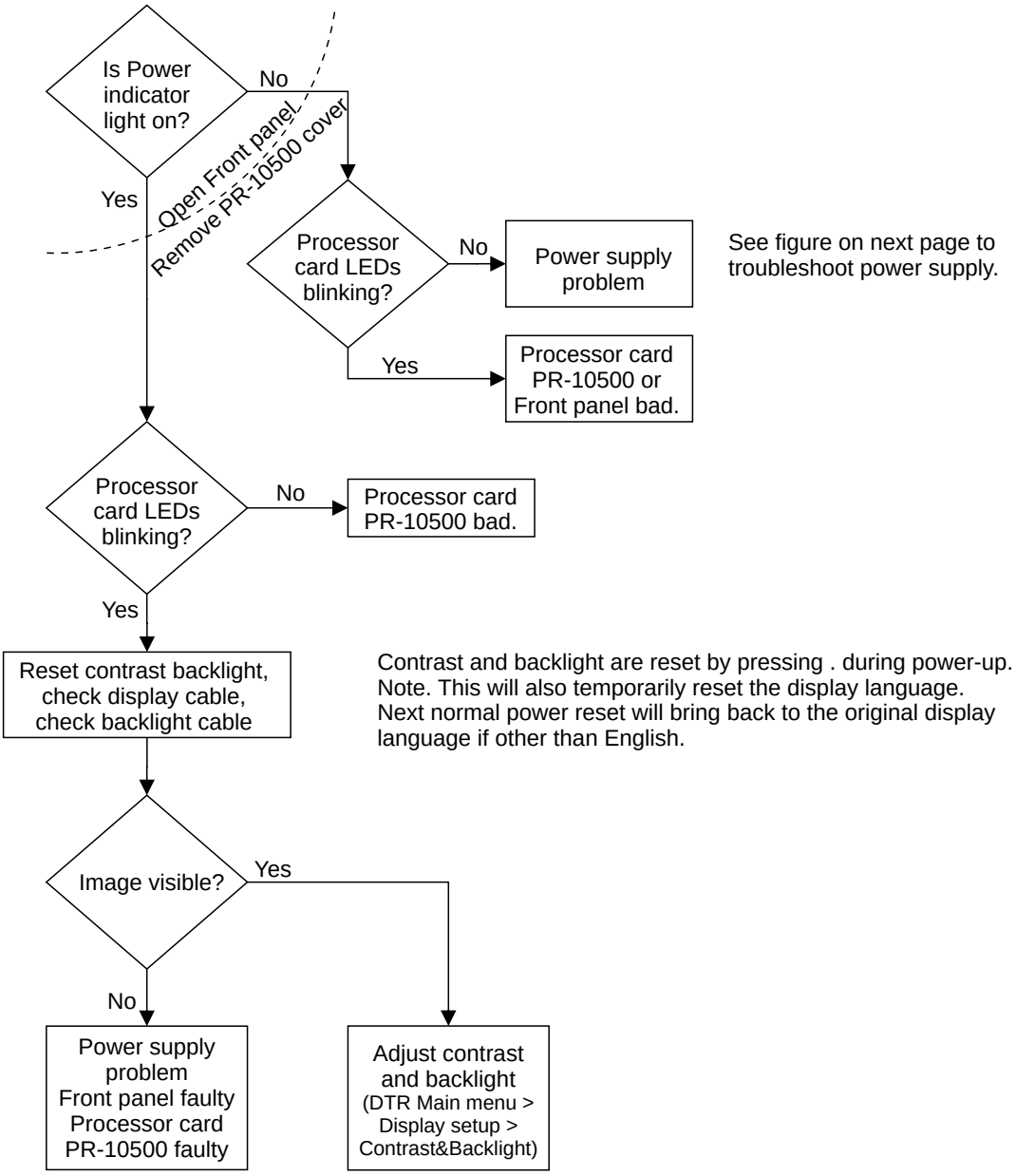


Figure 8.3 Troubleshooting a blank display.

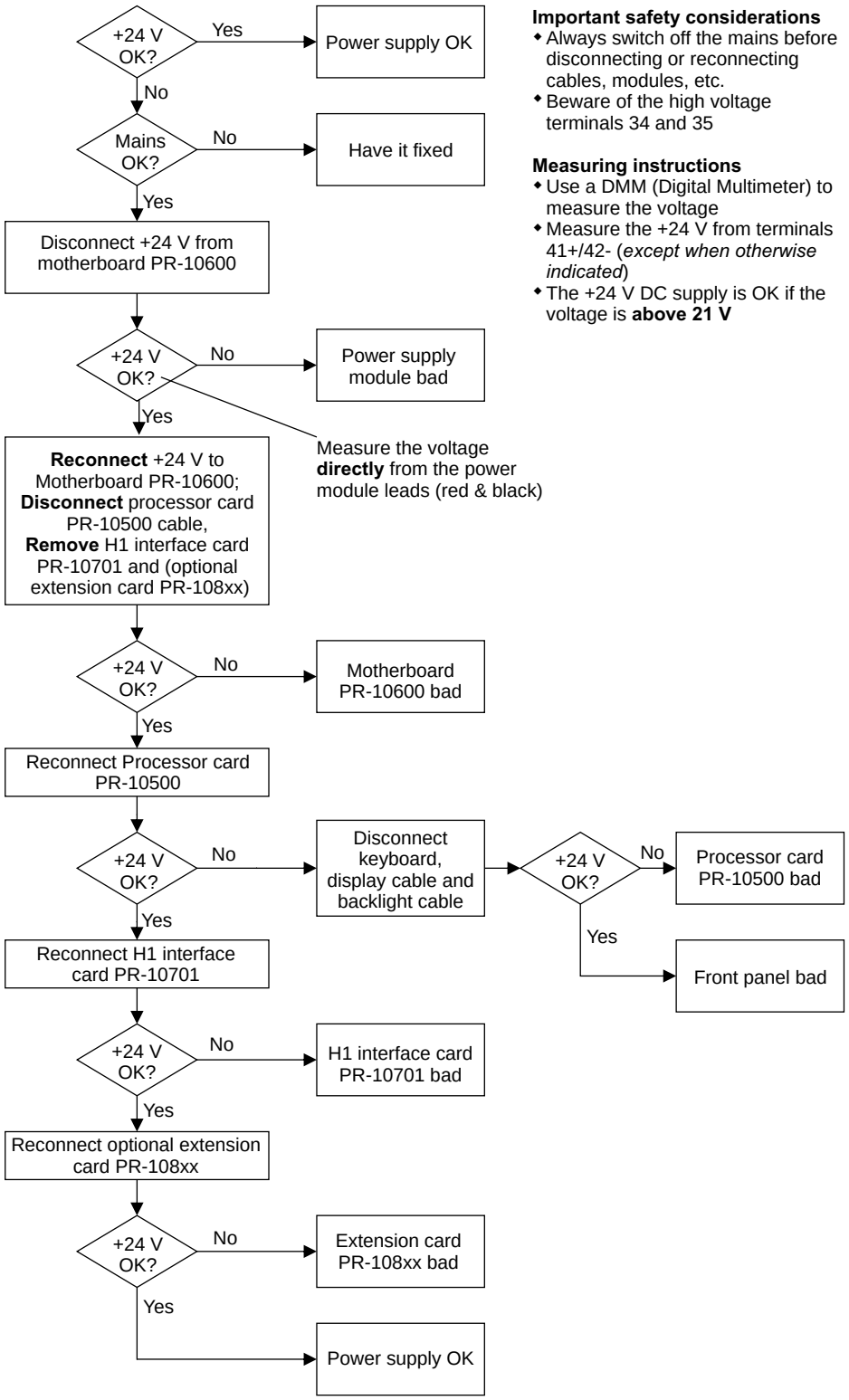


Figure 8.4 Checking the power supply.

8.1.2 Diagnostic LEDs

Figure 8.1 and Figure 8.2 assist to localize the diagnostic LEDs.

LED	**Status**	**Indication**	**See**
Front panel			
green LED	lit	DTR power is on; Processor card PR-10500 is active.	8.1.1
Transmitter processor card PR-10500			
2 yellow LEDs	blinking	Processor card ok.	
Transmitter motherboard PR-10600			
yellow LED (D17)	blinking	Motherboard processor working.	
green LED (D16)	lit	Processor card converts 24V/3V.	
green LED (D26)	lit	Isolating DC/DC conversion ok.	
2 green LEDs (D23, D25)	lit	Corresponding relay (RLY1/RLY2) has power.	
H1 interface card PR-10701			
green LED (LD1)	lit	Sensor A current correct, 20–60 mA.	
green LED (LD1)	blinking	Sensor A is being reset.	
red LED (LD2)	blinking	Sensor A current is too high and the card is trying to reconnect with correct current.	8.1.6
red LED (LD2)	lit	Sensor A current is too high and power supply to Sensor A has been switched off.	8.1.6
green LED (LD3)	lit	Sensor B current is correct, 20–60 mA	
green LED (LD3)	blinking	Sensor B is being reset.	
red LED (LD4)	blinking	Sensor B current is too high and the card is trying to reconnect with correct current.	8.1.6
red LED (LD4)	lit	Sensor B current is too high and power supply to Sensor B has been switched off.	8.1.6

Table 8.1 Diagnostic LEDs

Important: A lit red LED on PR-10701 always indicates a problem. Red LEDs are always turned off in normal operation, whether any sensors are connected or not.

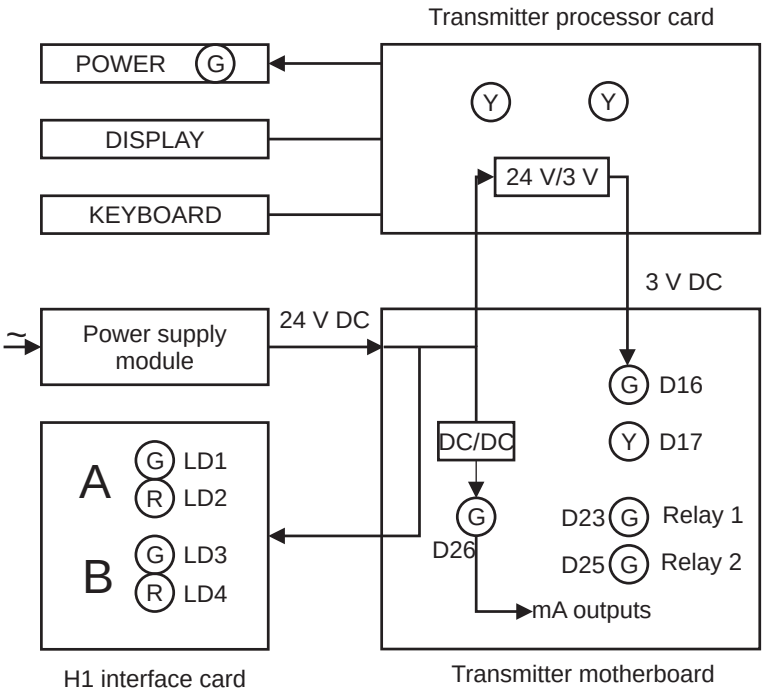


Figure 8.5 Diagnostic LED functions

8.1.3 Display unreadable

If the display is unreadable because of extreme display backlight and contrast settings or wrong display language, you can perform a **display reset**. A display reset will temporarily restore the display backlight and contrast to their factory settings and will return the display language to English.

For the display reset, you will need to access the DTR keyboard directly. Then do the following:

1. Switch off the DTR power.
2. Press (hold) down the dot (period/comma) key on the keyboard.
3. Switch on the DTR power.
4. Hold down the dot key until the DTR has started completely and you see the main display.

Note: The reset on the display language is temporary and the language will return to original next time the DTR is powered off, except if the language is permanently changed through the display settings menu.

8.1.4 Message NO SENSOR

Cause: The current in the cable to this sensor is below 20 mA. Normally this means that there's no sensor connected to the cable or that there's no cable to the DTR. If this message comes up while a sensor properly is connected, the most likely cause of this message is a fault in the sensor. It is also possible that the cable is totally dead for example if it is accidentally cut through.
See also Diagnostic LED LD1/LD3, Section 8.1.2 "Diagnostic LEDs". The concentration display will be a dashed line.

8.1.5 Message NO SIGNAL

Besides the message, the concentration display will be a dashed line although a sensor is connected.

Cause: The current in the cable to this sensor is in the correct range 20–60 mA, but no data is coming in from the sensor. This indicates that the Sensor processor card is faulty.
See also Diagnostic LED LD1/LD3, Section 8.1.2 "Diagnostic LEDs".

Action: Replace the Sensor processor card.

8.1.6 Message SHORT-CIRCUIT

The current in the cable to the sensor A/B exceeds 60 mA. First, the DTR attempts for a short time to reconnect with the sensor in question. If the short-circuit persists, the sensor in question is switched off completely to protect the Motherboard from overheating.
See also Diagnostic LED LD2/LD4, Section 8.1.2, "Diagnostic LEDs".

Note: If two sensors are connected to the DTR, a short-circuit in one of the cables may disturb the measurement of both sensors as DTR attempts to reconnect. The measurement of the non-affected sensor returns to normal as soon as the short-circuited sensor is switched off.

If the DTR detects a short-circuit that persists, the affected sensor is switched off to prevent further damage. The message SHORT-CIRCUIT will stay on the screen until the DTR is powered off and on.
See also Diagnostic LED LD2/LD4, Section 8.1.2, "Diagnostic LEDs".

Cause and action: The most likely cause of these messages is a problem in the cable connecting the sensor in question to the DTR. Check that the cable is undamaged and replace it if necessary, then turn the DTR off and back on.

8.1.7 Message HIGH SENSOR HUMIDITY

Tells that humidity measured at the Sensor processor card exceeds 60 % relative humidity. The reason may be moisture leaking in through prism seal or the cover being open. Also, check and, if necessary, replace prism seal.

8.1.8 Message HIGH SENSOR TEMP

The temperature on the Sensor processor card exceeds 65 °C (150 °F). To read this temperature, select 3 SENSOR STATUS from the Main menu. For action, see Section 2.2.1, “Choosing sensor mounting location”.

8.1.9 Message HIGH TRANSMITTER TEMP

The temperature of the Motherboard of the Indicating transmitter exceeds 60 °C (140 °F). To read this temperature, select 3 SENSOR STATUS from the Main menu and check DTR TMP. If the warning persists, the transmitter should be moved to a cooler place (for example out of sun).

8.1.10 Message LOW TRANSMITTER VOLT

The internal DC voltages of the transmitter are below specifications. Check the power supply input voltage. If the supply voltage is within specifications, replace power supply module, Figure 8.1.

8.1.11 Relays and switches not working

Check configuration, Section 5.3, “Viewing system information”, and for possible correction Section 6.3.2, “Configuring input switches”, Section 6.3.1 “Configuring relays”, and Section 6.5 “Configuring prism wash”.

Relay status is indicated by LEDs D23, D25 on the Motherboard, see Section 8.1.2 “Diagnostic LEDs”. For switches, check also LED D26 on the Motherboard indicating that the 3 V DC supply is correct, see Section 8.1.2 “Diagnostic LEDs”.

The wash function can be tested according to Section 5.1.3 “Testing prism wash”.

8.1.12 Output signal error during NORMAL OPERATION

If there is no output signal, check wiring (Section 3.3, “Electrical connections”) and the Diagnostic LED D26 (Section 8.1.2, “Diagnostic LEDs”).

If the mA signal does not correspond to the concentration display, check output signal configuration, Section 5.3, “Viewing system information”, and for possible correction Section 6.3.3, “Configuring mA outputs”. A low mA signal can also be caused by high resistance in the external current loop, see Section 3.3, “Electrical connections”.

A noisy signal can be damped, Section 6.1, “Configuring output signal damping”.

8.2 Measurement

8.2.1 Message OUTSIDE LIGHT ERROR

Cause: The measurement is not possible because too much outside light reaches the camera.

Action: Identify the light source (for example sun shining into an open tank or a translucent pipe) and block the light from getting to the prism at the sensor tip.

8.2.2 Message NO OPTICAL IMAGE

The optical image can be seen from selecting 3 SENSOR STATUS at the Main menu, Section 5.4.1. There are several possible causes:

1. The prism is heavily coated, Section 4.1. Perform prism wash if available, Section 5.1.3 “Testing prism wash”. Remove sensor from line and clean prism manually.
2. There is moisture condensation in the sensor head, see Section 8.1.7.
3. The sensor head temperature is too high, see Section 8.1.8.
4. The light source is faulty. When the sensor is removed from the process, the yellow flashing light can be seen through the prism. **Note:** The light is only visible at an oblique angle. Also check the LED value in the Sensor status display (select 3 SENSOR STATUS in the Main menu); if the value is clearly below 100, LED fault is not likely.
5. There are negative spikes in the optical image. The probable cause is dust or fingerprints on the CCD window.
6. The CCD card in the sensor is faulty.

8.2.3 Message PRISM COATED

Cause: The optical surface of the prism is coated by the process medium or impurities in the process medium.

Action: Perform prism wash if available, Section 5.1.3 “Testing prism wash”. Remove sensor from line and clean prism manually.

If the problem is recurrent, consider improving the flow conditions (see Section 2.2, “Mounting the sensor”) or, if prism wash is available, adjust the wash parameters, see Section 6.5, “Configuring prism wash”.

8.2.4 Message OUTSIDE LIGHT TO PRISM

Cause: Some light from the outside reaches the sensor and may disturb the measurement.

Action: Identify the light source (for example sun shining into an open tank or a translucent pipe) and block the light from getting to the prism at the sensor tip.

8.2.5 Message LOW IMAGE QUALITY

Cause: The most likely cause for this message is scaling on the prism. There still is a optical image available, but the measurement quality may not be optimal.

Action: Clean the prism, see Section 8.2.3 above.

8.2.6 Message NO SAMPLE

The operation of the equipment is OK but there is no process liquid on the prism. The optical image looks like the left image in Figure 5.8 or Figure 5.6.

8.2.7 Message TEMP MEASUREMENT FAULT

Indicates faulty temperature element. Replace the temperature element.

Note: A difference to some other process temperature measurement is not a fault. PR-23 measures the true temperature of the prism surface.

8.2.8 Concentration drift during NORMAL OPERATION

For drift upward, suspect prism coating, Section 4.1, “Prism coating”. Otherwise check calibration (Section 6.4, “Calibrating the concentration measurement”) and sensor verification (Chapter 13, “Sensor verification”).

8.3 Wash

8.3.1 Message EXTERNAL HOLD

The concentration measurement is on HOLD due to an external switch closure. For explanation, see Section 6.3.2, “Configuring input switches”.

8.3.2 Messages PRECONDITIONING, WASH, RECOVERING

- PRECONDITIONING: An optional preconditioning relay is closed, see Section 6.5 “Configuring prism wash”.
- WASH: The internal wash relay is closed, see Section 6.5 “Configuring prism wash”.
- RECOVERING: The concentration measurement is on HOLD during a preset time.

8.3.3 Message PRISM WASH WARNING

No dip of $n_D$value during prism wash. The accepted size of the dip is set as the WASH CHECK function, Section 6.5, “Configuring prism wash”. See also Section 5.1.3 “Testing prism wash”.

8.3.4 Message PRISM WASH FAILURE

No dip of n_D value during any prism wash during wash tolerance time. The wash tolerance time is set in wash parameters, see Section 6.5.2, “Setting prism wash parameters”. See also Section 5.1.3 “Testing prism wash”.

8.3.5 Message EXTERNAL WASH STOP

Tells that wash action is prevented because an EXTERNAL WASH STOP switch is closed, see Section 6.3.2 “Configuring input switches”.

- NO SAMPLE (Section 8.2.6) indicates empty pipe

8.3.6 Message LOW TEMP WASH STOP

Tells that wash action is prevented because of LOW TEMP: low process temperature indicates empty pipe. To set the limit, see Section 6.5 “Configuring prism wash”.

8.3.7 Message NO SAMPLE/WASH STOP

Tells that wash action is prevented because of NO SAMPLE: the process pipe is empty and the prism is clean.

8.4 Diagnostic messages table

Important: The messages are listed in descending order of priority. *Example:* If both NO OPTICAL IMAGE and TEMP MEASUREMENT FAULT are activated, only NO OPTICAL IMAGE will be shown. The wash related messages have priority only during the wash cycle (preconditioning–wash–recovery).

When a relay is configured with FUNCTION INSTRUMENT OK (see Section 6.3.1), it is closed when there's no equipment malfunction i.e. instrument is ok.

Certain malfunctions cause the mA measurement to return to the mA default output value (Section 6.3.3), see the table below.

			Returns to default mA	
Message	Section	Instrument ok	Conc	Temp
SHORT-CIRCUIT	8.1.6		X	X
NO SIGNAL	8.1.5		X	X
OUTSIDE LIGHT ERROR	8.2.1			
NO OPTICAL IMAGE	8.2.2		X	
TEMP MEASUREMENT FAULT	8.2.7		X	X
PRECONDITIONING	8.3	X		
WASH	8.3	X		
RECOVERING	8.3	X		
HIGH SENSOR HUMIDITY	8.1.7			
HIGH SENSOR TEMP	8.1.8			
HIGH TRANSMITTER TEMP	8.1.9			
LOW TRANSMITTER VOLT	8.1.10			
EXTERNAL WASH STOP	8.3.5	X		
LOW TEMP WASH STOP	8.3.6	X		
NO SAMPLE/WASH STOP	8.3.7	X		
EXTERNAL HOLD	8.3.1	X		
NO SAMPLE	8.2.6	X	X	
PRISM COATED	8.2.3	X	X	
OUTSIDE LIGHT TO PRISM	8.2.4	X		
LOW IMAGE QUALITY	8.2.5	X		
PRISM WASH FAILURE	8.3.4	X		
PRISM WASH WARNING	8.3.3	X		
NO SENSOR	8.1.4		X	X
NORMAL OPERATION		X		

9 Sensor specifications

Note: For the specifications of the PR-23-SD sensor for Safe-Drive™ system, see Sections 11.2 and 10.4.

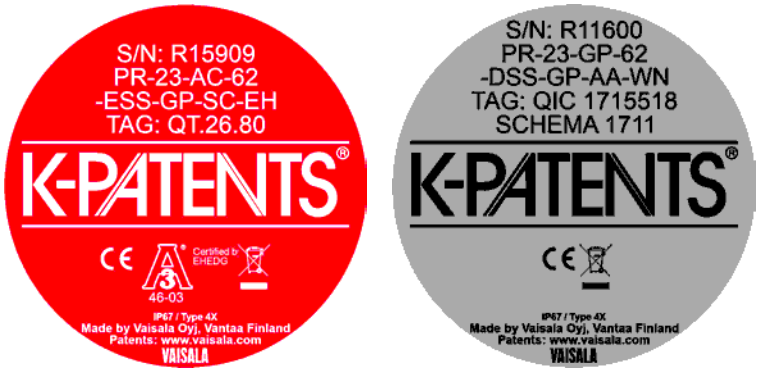


Figure 9.1 Sensor nameplates

9.1 Sensor compatibility

Electrically: All the PR-23 refractometer sensors are interchangeable. The PR-23 sensors are **not** interchangeable with the PR-01 and PR-03 range sensors. Furthermore, the PR-23 sensors are **not** compatible with the PR-01 / PR-03 indicating transmitter IT-R.

Mechanically: The sanitary process refractometer PR-23-AC-62-HSS fits the same 2 1/2" sanitary process connection as the sanitary refractometer PR-03-A62-HSS.

9.2 Sensor rangeability

The refractive index standard range of a PR-23 refractometer sensor is 1.320–1.530 (corresponds to 0–100 Brix), Figure 9.2.

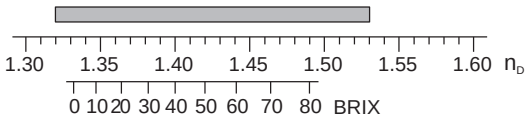


Figure 9.2 PR-23 rangeability

The refractometer models PR-23-M/MS and PR-23-W for aggressive solutions and ultra-pure fine chemicals can be equipped with a sapphire prism with a refractive index range 1.2600–1.4600, Figure 9.3.

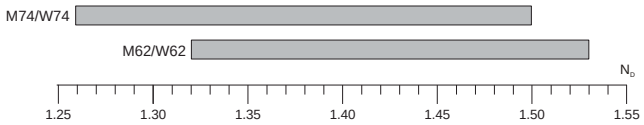


Figure 9.3 PR-23-M/MS/W rangeability with a sapphire prism (74) and with a standard prism (62)

9.3 Sanitary process refractometer PR-23-AC

Sanitary compact refractometer PR-23-AC is a 3A sanitary process refractometer for measuring concentrations *in a pipe line*. Easy to install in any pipe size directly or using a flowcell. The Sanitary compact refractometer is suitable for all food and beverage processing applications where on-line monitoring and control can help to improve product quality and reduce costs.

9.3.1 PR-23-AC sensor model code

SANITARY COMPACT REFRACTOMETER for pipelines

Model and description	Model
PR-23 = Refractometer	PR-23
Sensor model	
-A = 3-A Sanitary Standard 46-03 certified	-A
Sensor type	
C = Compact type for pipeline installations	C
Refractive index range limits	
-62 = R.I. 1.320–1.530 n_D(0-100 Brix) Spinel prism	-62
-73 = R.I. 1.320–1.530 n_D(0-100 Brix) Sapphire prism	-73
-74 = R.I. 1.260–1.470 n_DSapphire prism	-74
Process connection	
-H = Sanitary 3A-clamp, 2½inch, insertion length 14 mm **(A)**	-H
-E = Varivent® in-line access unit clamp DN65	-E
-N = Sanitary 3A-clamp, 2½inch, insertion length 14 mm, high pressure, 40 bar at 20°C	-N
-ZC = Sanitary I-line male (14 WI) 2½inch, insertion length 14 mm	-ZC
Sensor wetted parts material	
SS = AISI 316 L	SS
HC = Alloy C276 **(B)**	
Electrical classification	
-GP = General purpose	-GP
-AX = ATEX and IECEx certified Ex II 3G, Ex nA IIC T4 Gc (up to zone 2) (T_{amb} -20 ... +65°C)	-AX
-FM = FM certified Class I, Div.2, Groups A, B, C, D T6 (T_{amb} -20 ... +45°C)	-FM
-CS = CSA certified Class I, Div.2., Groups A, B, C, D, T4 (T_{amb} -20 ... +45°C)	-CS
-IA = ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0) (T_{amb} -20 ... +65°C **(C)**	-IA
-IF = FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D T4 (T_{amb} -20 ... +45°C) **(C)**	-IF
Sensor housing	
-AA = Anodized Aluminium	-AA
-SC = Stainless steel AISI 316	-SC
EHEDG option	
-EH = EHEDG Type EL Class I Certified Model **(D)**	-EH
Polishing option	
-EP = Electropolished sensor wetted parts (RA 0.38µ, 15 µ inch) **(A)**	

(A) For AISI 316 L / EN 1.4335 only

(B) Includes gasket Teflon 2.5" and Ferrule in Alloy C

(C) Available with STR Indicating Transmitter and IS isolator only

(D) for -H, -E, -N options

9.3.2 PR-23-AC mounting hardware model code

Elbow flow cells for PR-23-AC-62-HSS sensor

Model and description	Model
AFC = Elbow flow cell	AFC
Sensor connection	
-H = Sanitary 3A-clamp, 2½ inch	-H
Material of construction	
SS = AISI 316 L	SS
Process connection	
-H = Sanitary 3A-clamp	-H
Pipe section diameter	
10 = 25 mm (1 inch)	10
15 = 40 mm (1½ inch)	15
20 = 50 mm (2 inch)	20
25 = 65 mm (2½ inch) **(A)**	25
30 = 80 mm (3 inch) **(A)**	30
40 = 100 mm (4 inch) **(A)**	40
Flow cell inlet type	
-SI = Straight pipe	-SI
-RI = Reduced pipe (cone)	-RI
Polishing option	
-EP = Electropolished process wetted parts (RA 0.38µm, 15 µ inch)	-EP

(A) with -SI option only

EHEDG Certified Elbow Flow Cells, connection Sanitary 3A-clamp 2½ inch

Model and description	Model
AFC = Elbow flow cell	AFC
Sensor connection	
-H = for Sanitary 3A-clamp, 2½ inch	-H
Material of construction	
SS = AISI 316 L	SS
Process connection	
-H = Sanitary 3A-clamp	-H
Pipe section diameter	
20 = 50 mm (2 inch)	20
Flow cell inlet type	
-SI = Straight pipe	-SI

EHEDG	
-EH = EHEDG Type EL Class I Certified Model	-EH
Polishing option	
-EP = Electropolished process wetted parts (RA 0.38µm, 15 µ inch)	-EP

Elbow flow cells with prism wash nozzle for PR-23-AC-63-HSS

Model and description	Model
AFC = Elbow flow cell	AFC
Sensor connection	
-H = Sanitary 3A-clamp, 2½ inch	-H
Material of construction	
SS = AISI 316 L	SS
Process connection	
-H = Sanitary 3A-clamp	-H
Pipe section diameter	
10 = 25 mm (1 inch)	10
15 = 40 mm (1½ inch)	15
20 = 50 mm (2 inch)	20
25 = 65 mm (2½ inch) **(A)**	25
30 = 80 mm (3 inch) **(A)**	30
40 = 100 mm (4 inch) **(A)**	40
Flow cell inlet type	
-SI = Straight pipe	-SI
-RI = Reduced pipe (cone)	-RI
Wash nozzle connection	
-NC = Nozzle connection	-NC
Wash nozzles	
-SN = Steam nozzle, threads G ¼ inch female	-SN
-WN = Water nozzle, threads G ¼ inch female	-WN
-WP = Pressurized water nozzle, threads G ¼ inch female	-WP
-PG = Plug for nozzle connection	-PG

(A) with -SI option only

Mounting hardware for PR-23-AC-62-HSS sensor

Model and description	Model
MFC = Mini Flow Cell	MFC
Sensor connection	
-H = Sanitary 3A-clamp, 2½ inch	-H
Material of construction	
SS = AISI 316 L	SS
Process connection	
-H = Sanitary 3A-clamp	-H
Pipe section diameter	
05 = 15 mm (½ inch)	05

Mounting hardware for PR-23-AC-62-ESS sensor

Model and description	Model
TDN = Varivent® in-line access unit clamp DN65 Type N **(A)**	TDN
Pipe section diameter	
-40 = 40 mm (1½ inch)	-40
-50 = 50 mm (2 inch)	-50
-65 = 65 mm (2½ inch)	-65
-80 = 80 mm (3 inch)	-80
-100 = 100 mm (4 inch)	-100
-125 = 125 mm (5 inch)	-125
-150 = 150 mm (6 inch)	-150
Counter flange options	
-SN = Steam nozzle, G¼ thread female	-SN
-WP = Pressurized Water Nozzle, G¼ thread female	-WP
-WN = Water Nozzle, G¼ thread female	-WN
-PG = Varivent blind flange type N	-PG

(A) Includes one 1½ inch type N blind flange with 2½ inch EPDM gasket and 2½ inch Varivent clamp Type N

Side Flow Cells, connection Sanitary 3A-Clamp 2½ inch

Model and description	Model
SFC = Side Flow Cell **(A)**	SFC
Sensor connection	
-HH = Sanitary 3A-clamp, 2½ inch	-H
Material of construction	
SS = AISI 316 L	SS
Process connection	
-H = Sanitary 3A-clamp	
Pipe section diameter	
10 = 25 mm (1 inch)	10
15 = 40 mm (1½ inch)	15
20 = 50 mm (2 inch)	20
25 = 65 mm (2½ inch)	25
Flow cell inlet and outlet orientation	
-090 = Elbow, 90 degree bend	-90
-180 = Straight pipe, 180 degrees	-180

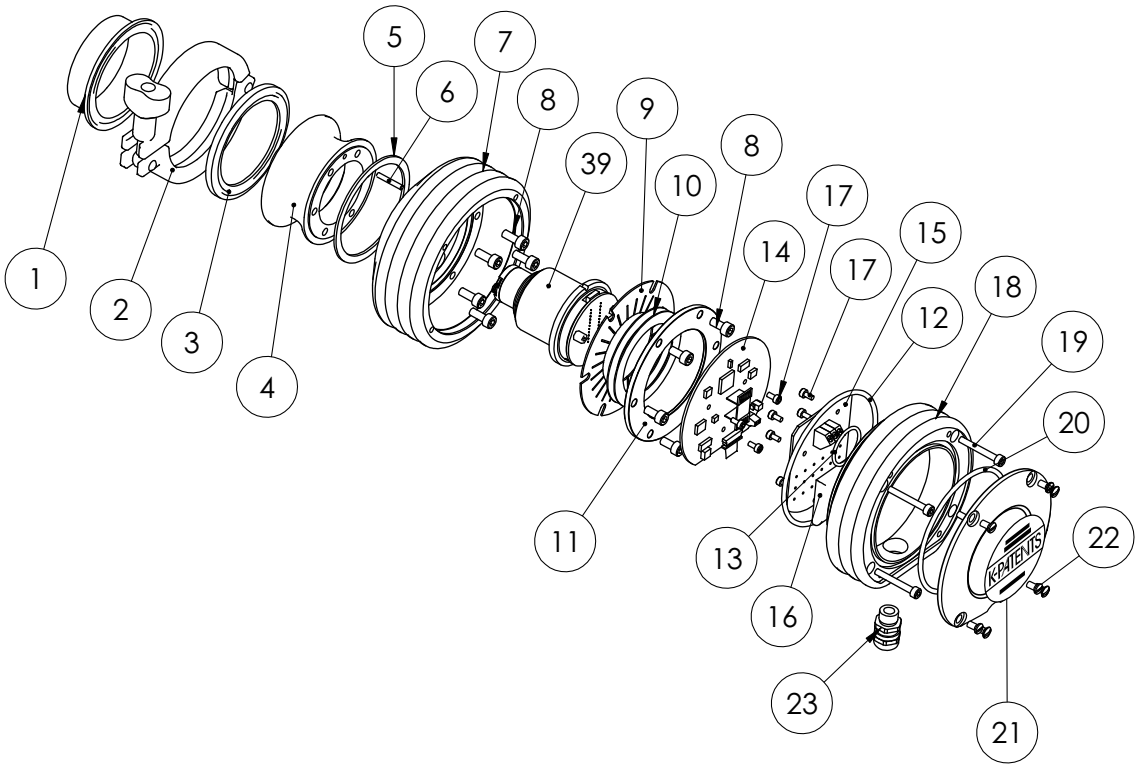
(A) Includes one 2½ inch EPDM gasket and 2½ inch sanitary clamp

9.3.3 PR-23-AC specifications

General specifications

Refractive Index range:	Full range n_D 1.3200–1.5300 (corresponds to hot water – 100 Brix)
Accuracy:	Refractive index n_D ± 0.0002 (corresponds typically to ± 0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Calibration:	With Cargille certified refractive index liquids over full range of n_D 1.3200–1.5300
CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED) 589 nm wavelength, sodium light
Temperature sensor:	Built-in Pt-1000
Temperature compensation:	Automatic, digital compensation
Instrument verification:	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature:	Sensor: max. 45 °C (113 °F), min. -20 °C (-4 °F) Indicating transmitter: max. 50 °C (122 °F), min. 0 °C (32 °F)
SENSOR PR-23-AC:	Compact sensor model for small pipe lines
Process connection:	Sanitary 3A-clamp 2.5"; Varivent® in-line access unit clamp DN65 or via elbow flowcell (for line sizes of 2.5" and smaller)
Sanitary design:	3-A Sanitary Standard 46-03 approved and EHEDG (European Hygienic Engineering & Design Group) certified (connections -H, -E, -N)
Process pressure:	Sanitary clamp max. 15 bar (200 psi) at 20 °C (70 °F)/9 bar (125 psi) at 120 °C (250 °F)
Process temperature:	-20 °C–+130 °C (-4 °F–+266 °F)
Process wetted parts, standard:	AISI 316L stainless steel, prism spinel, prism gaskets MTF (Modified Teflon)
Sensor protection class:	IP67, Nema 4X
Sensor weight:	2.0 kg (4.4 lbs)

9.3.4 PR-23-AC parts list



Item	Pcs.	Part No.	Description
1	1	PR-9205	2.5″ Sanitary ferrule
2	1	PR-9201	2.5″ Sanitary clamp
3	1	PR-9202	2.5″ Sanitary gasket EPDM
3	1	PR-9203	2.5″ Sanitary gasket NBR
3	1	PR-9204	2.5″ Sanitary gasket PTFE (Teflon®)
4	1	PR-10001	PR-23 H head (3A sanitary clamp connection)
4	1	PR-10021	PR-23 E head (Varivent®connection)
5	1	PR-10048	68x3 O-ring
6	1		Alignment pin
7	1	PR-10005	PR-23 base
8	6		Screw M5x12
	6		Locking spacer M5
9	1	PR-9011	Thermal conductor
*	1	PR-9010	Disc spring set
10	2		Disc spring
11	1		Disc spring holder
12	1	PR-10031	O-ring seal 89.5 x 3
13	1	PR-10032	O-ring seal 24 x 2
14	1	PR-10103	Sensor processor card
15	1	PR-10300	Bus terminator card

Item	Pcs.	Part No.	Description
16	1	PR-9108	Dryer sachet
17	8		Screw M3x6 DIN 912 A2
18	1	PR-10000	PR-23 cover
19	4		Screw M4x30 DIN 912 A4
20	1	PR-10002	O-ring seal 82x3
21	1		PR-23-A endplate with label
22	4		Screw M4x8 DIN 964 A4
23	1		Cable gland M16x1.5
39	1	PR-10012	PR-23 compact sensor CORE module

9.3.5 PR-23-AC mounting specifics

The sanitary process refractometer PR-23-AC is connected to the process by a 2 1/2" 3A sanitary clamp. The recommended mounting is *in a pipe bend, with a vertical flow upwards before the sensor, and a horizontal pipe after*. By this mounting is obtained

1. Self-cleaning of prism due to the flow directed against its surface.
2. Efficient drainage when the pipe is emptied.

For *pipe diameters of 3" or above*, a ferrule is welded directly to the pipe wall, Figure 9.4 (a ferrule, length 21.5 mm, is delivered with standard sensor delivery from Vaisala).

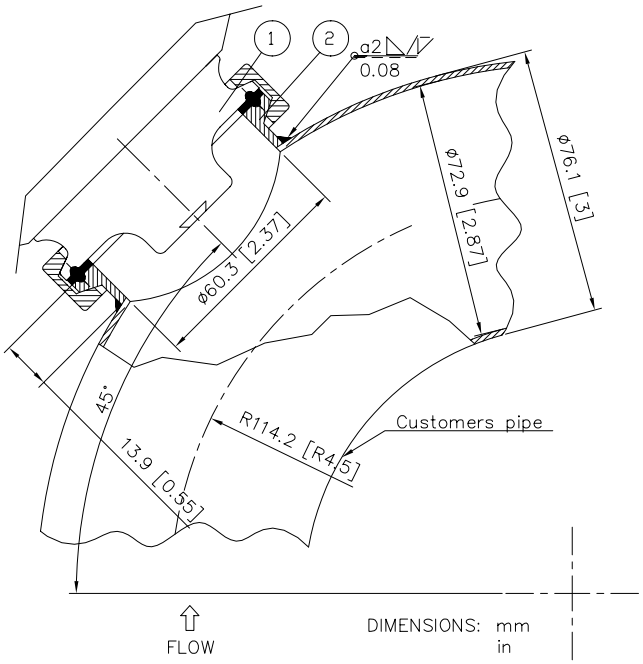
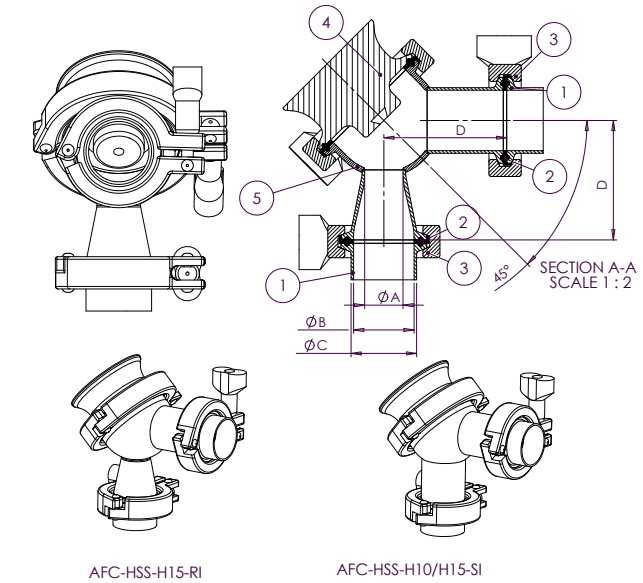


Figure 9.4 Mounting with sanitary ferrule
Pipe diameter 3" (80 mm) or more

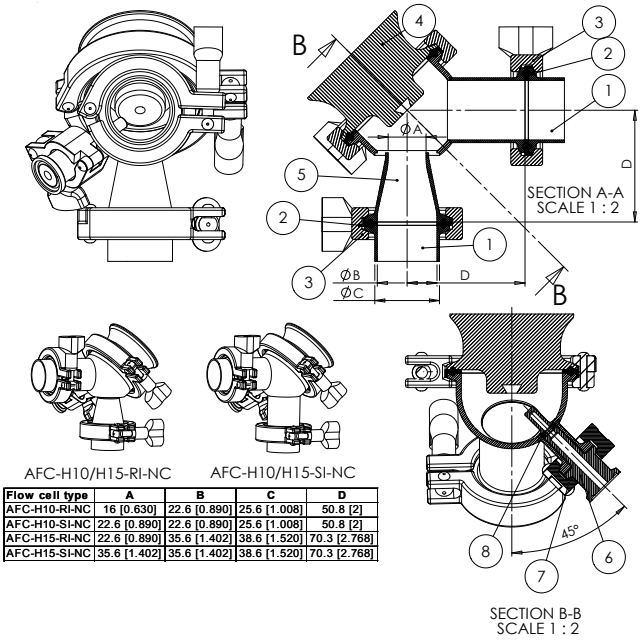
For smaller pipe diameters, flowcells are available from Vaisala, Figures 9.5, 9.6, 9.7 and 9.8, see also the tables in Section 9.3.2.

The flowcells are exchangeable with standard 90° bend pieces.



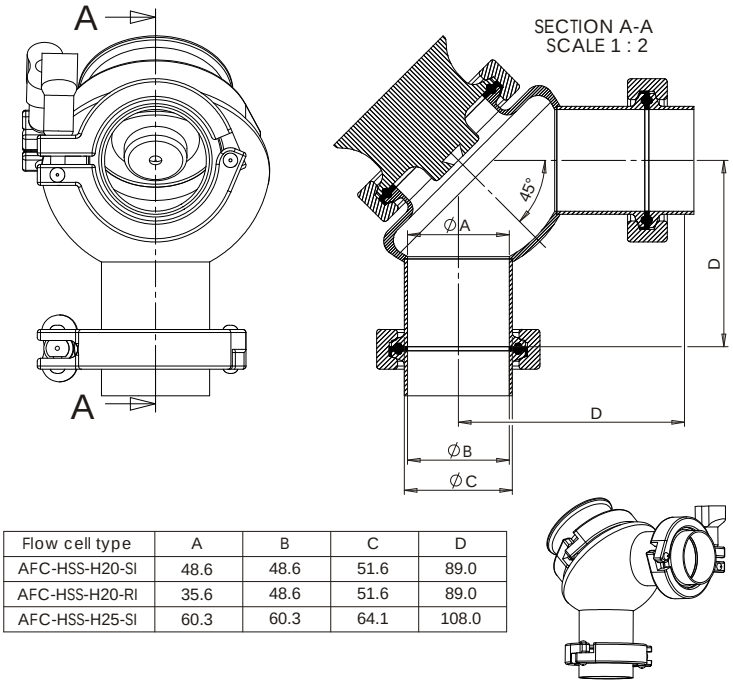
Flow cell type	A	B	C	D
AFC-H10-SI	22.6 [0.890]	22.6 [0.890]	25.6 [1.008]	50.8 [2]
AFC-H15-RI	22.6 [0.890]	35.6 [1.402]	38.6 [1.520]	70.3 [2.768]
AFC-H15-SI	35.6 [1.402]	35.6 [1.402]	38.6 [1.520]	70.3 [2.768]

Figure 9.5 Flowcell AFC-HSS-
H10 for pipe diameter 1" (25 mm) and H15 for pipe diameter 1 1/2" (40 mm)



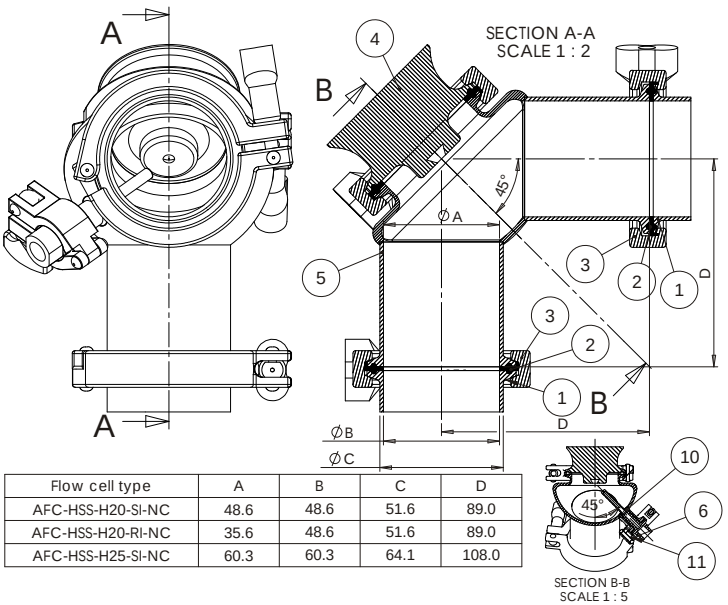
Flow cell type	A	B	C	D
AFC-H10-RI-NC	16 [0.630]	22.6 [0.890]	25.6 [1.008]	50.8 [2]
AFC-H10-SI-NC	22.6 [0.890]	22.6 [0.890]	25.6 [1.008]	50.8 [2]
AFC-H15-RI-NC	22.6 [0.890]	35.6 [1.402]	38.6 [1.520]	70.3 [2.768]
AFC-H15-SI-NC	35.6 [1.402]	35.6 [1.402]	38.6 [1.520]	70.3 [2.768]

Figure 9.6 Flowcell AFC-HSS- with wash nozzle connection (-NC)
H10 for pipe diameter 1" (25 mm) and H15 for pipe diameter 1 1/2" (40 mm)



Flow cell type	A	B	C	D
AFC-HSS-H20-SI	48.6	48.6	51.6	89.0
AFC-HSS-H20-RI	35.6	48.6	51.6	89.0
AFC-HSS-H25-SI	60.3	60.3	64.1	108.0

Figure 9.7 Flowcell AFC-HSS-
H20 for pipe diameter 2" (50 mm) and H25 for pipe diameter 2 1/2" (65 mm)



Flow cell type	A	B	C	D
AFC-HSS-H20-SI-NC	48.6	48.6	51.6	89.0
AFC-HSS-H20-RI-NC	35.6	48.6	51.6	89.0
AFC-HSS-H25-SI-NC	60.3	60.3	64.1	108.0

Figure 9.8 Flowcell AFC-HSS- with wash nozzle connection (-NC)
H20 for pipe diameter 2" (50 mm) and H25 for pipe diameter 2 1/2" (65 mm)

9.3.6 PR-23-AC I-Line fitting

Sanitary Refractometer PR-23-AC-ZC can be mounted using 3-A Sanitary approved 2.5 inch Cherry Burrell I-Line fittings that are made of interlocking flat face ferrules, a flat gasket and a clamp. This interlocking, metal-to-metal design eliminates over compression by the clamp not allowing the gasket to be extruded into the product contact side.

Sensor wetted parts material is AISI 316L or Alloy C, gaskets EPDM.

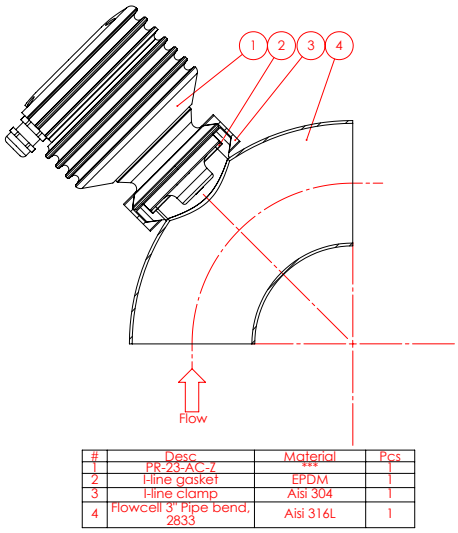


Figure 9.9 I-Line fitting for PR-23-AC

9.3.7 Mounting specifics for EHEDG certified PR-23-AC configuration

Vaisala offers certain PR-23-AC configurations which have been certified to fulfill the sanitary requirements published by EHEDG (European Hygienic Engineering & Design Group) organization. During this certification the hygienic characteristics of both the refractometer and the process connection were evaluated against the applicable requirements.

To ensure EHEDG compliant installation, follow the mounting specifics provided on the mounting drawing supplied by Vaisala with each PR-23-AC refractometer sensor ordered with the -EH option.

9.3.8 3A Sanitary Standard compliance

The user should ensure that the refractometer is not a source of contamination to product due to damaged or worn product contact surfaces. Misuse (e.g. too long prism wash time or too high wash pressure) or mishandling may result in metal scratches or roughened surfaces. Such surfaces may not stay clean in processing.

Vaisala offers a 3A Sanitary Standard Accepted repair and maintenance package in which all wetted parts, prism, gaskets and dryer are replaced. Note that this repair service can be completed only by a 3A authorized service center (Vaisala factory or regional headquarters).

9.4 Sanitary probe refractometer PR-23-AP

Sanitary probe refractometer PR-23-AP provides an accurate on-line BRIX measurement in cookers and tanks.

9.4.1 PR-23-AP model code

SANITARY PROBE REFRACTOMETER for large pipelines and vessels

Model and description	Model
PR-23 = Sensor	PR-23
Sensor model	
-A = 3A approved	-A
Sensor type	
P = Probe type for tank and large pipeline installation	P
Refractive Index range limits	
-62 = R.I. 1.320–1-530 n_D (0-100 Brix) Spinel prism	-62
-73 = R.I. 1.320–1.530 n_D (0-100 Brix) Sapphire prism	-73
-74 = R.I. 1.260–1.470 n_D Sapphire prism	-74
Process connection	
-T = Sanitary 3A-clamp, 2½ inch, insertion length 170 mm **(A)**	-T
-N = Sanitary 3A-clamp, 2½ inch, insertion length 14 mm, high pressure, 40 bar at 20°C **(A)**	-N
-I = Sanitary 3A-clamp, 2½ inch, insertion length 42 mm **(A)**	-I
-R = Sanitary 3A-clamp, 4 inch, insertion length 170 mm **(A)**	-R
-S = Sanitary 3A-clamp, 4 inch, insertion length 63 mm **(A)**	-S
-P = MT4 DN 25/1T APV Tank bottom flange, flush mounted **(B)**	-P
-B = MT4 DN25/1T APV Tank bottom flange, insertion length 170 mm **(C)**	-B
-V = Sanitary 3A-clamp, 2½ inch, insertion length 170 mm **(D)**	-V
-H = Sanitary 3A-clamp, 2½ inch, insertion length 14 mm **(A)**	-H
-Q = Sanitary 3A-clamp, 2½ inch for flush-mount adaptor, insertion length 140 mm **(C)**	-Q
-C = Varivent® in-line access unit clamp DN 65, insertion length 170 mm **(A)**	-C
-ZP = Sanitary I-line male (14 WI) 2½ inch, insertion length 178 mm **(B)**	-ZP
Sensor wetted parts material	
SS = AISI 316 L	SS

Electrical classification	
-GP = General purpose	-GP
-AX = ATEX and IECEx certified Ex II 3G, Ex nA IIC T4 Gc (up to zone 2) (T_{amb} -20 ... +65°C)	-AX
-FM = FM certified Class I, Div.2, Groups A, B, C, D T6 (T_{amb} -20 ... +45°C)	-FM
-CS = CSA certified Class I, Div.2, Groups A, B , C, D T4 (T_{amb} -20 ... +45°C)	
-IA = ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0) (T_{amb} -20 ... +65°C) **(E)**	-IA
-IF = FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D T4 (T_{amb} -20 ... +45°C) **(E)**	-IF
Sensor housing	
-AA = Anodized aluminium	-AA
-SC = Stainless steel AISI 316	-SC
Options	
-EH = EHEDG Type EL Class I Certified Model **(F)**	-EH

(A) EHEDG and Sanitary 3-A certified

(B) Sanitary 3-A certified

(C) Design according to Sanitary 3-A

(D) Requires mount adaptor VFME-23-VSS or VFMF-23-VSS, design according to Sanitary 3-A

(E) Available with STR-Indicating transmitter and IS isolator only

(F) For connections -T, -N, -I, -R, -S, -H, -C

SANITARY PROBE REFRACTOMETER PR-23-AP with prism wash for large pipelines and vessels

Model and description	Model
PR-23 = Sensor	PR-23
Sensor model	
-A = 3A approved	-A
Sensor type	
P = Probe type for tank and large pipeline installation	P
Refractive Index range limits	
-62 = R.I. 1.320–1-530 n_D (0-100 Brix) Spinel prism	-62
-73 = R.I. 1.320–1.530 n_D (0-100 Brix) Sapphire prism	-73
-74 = R.I. 1.260–1.470 n_D Sapphire prism	-74
Process connection	
-R = Sanitary 3A-clamp, 4 inch, insertion lenght 170 mm	-R
Sensor wetted parts material	
SS = AISI 316 L	SS
Electrical classification	
-GP = General purpose	-GP
-FM = FM certified Class I, Div.2, Groups A, B, C, D T6 (T_{amb} -20 ... +45°C	-FM
-CS = CSA certified Class I, Div.2, Groups A, B, C, D T4 (T_{amb} -20 ... +45°C	-CS

-AX = ATEX and IECEx certified Ex II 3G, Ex nA IIC T4 Gc (up to zone 2) (T_{amb} -20...+65°C)	-AX
-IA = Ex and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0) (T_{amb} -20...+65°C) **(A)**	-IA
-IF = IF certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D T4 (T_{amb}-20 ... +45°C **(A)**	-IF
Sensor housing	
-AA = Anodized Aluminium	-AA
-SC = Stainless steel AISI 316	-SC
Prism wash	
-SN = Integral steam nozzle, AISI 316 L	-SN
-WN = Integral water nozzle, AISI 316 L	-WN
-WP = Integral pressurized water nozzle, AISI 316 L	

(A) Available with STR Indicating transmitter and IS isolator only

9.4.2 PR-23-AP mounting hardware model code

Mounting hardware for PR-23-AP sensor

Part number and description	Part no.
VFMA-23-PSS = Tank bottom flange for PR-23-AP, MT4 DN 25/1T	VFMA-23-PSS
VFBP-23-PSS = Tank bottom blind flange for PR-23-AP, MT4 DN 25/1T	VFBP-23-PSS
VFME-23-VSS = Mount adaptor for PR-23-AP-62-VSS HEXNUT type	VFME-23-VSS
VFMF-23-VSS = Mount adaptor for PR-23-AP-62-VSS HEXNUT extended	VFMF-23-VSS

Model and description	Model
AP = Adapter for PR-23-AP	AP
Sensor type	
-T = Sanitary 3A-clamp, 2½ inch, insertion lenght 170 mm	-T
-ZP = Sanitary I-line male (14 WI) 2½ inch, insertion length 178 mm	-ZP
Material of construction	
SS = AISI 316 L	SS
Process connection	
-P = MT4 DN 25/1T Tank bottom flange, flush mounted	-P
Insertion length adapter	
30 = 30 mm	30
Prism wash	
-SN = Integral steam nozzle, AISI 316 L	-SN
-WP = Integral pressurized water nozzle, AISI 316 L	-WP
-WN = Integral water nozzle, AISI 316 L	-WN

Model and description	Model
WNA = Wash nozzle adapter	WNA
Sensor type	
-T = Sanitary 3A-clamp, 2½ inch, insertion lenght 170 mm	-T
-ZP = Sanitary I-line male (14 WI) 2½ inch, insertion length 178 mm	-ZP
Material of construction	
SS = AISI 316 L	SS
Process connection	
-H = For sanitary 3A-clamp, 2½ inch	-H
Insertion length adapter	
-30 = 30 mm	-30
-117 = 117 mm	-117
Prism wash	
-SN = Integral steam nozzle, AISI 316 L	-SN
-WP = Integral pressurized water nozzle, AISI 316 L	-WP
-WN = Integral water nozzle, AISI 316 L	-WN

Side Flow Cells, connection Sanitary 3A-clamp 2½ inch

Model and description	Model
SFC = Side Flow Cell **(A)**	SFC
Sensor connection	
-HH = Sanitary 3A-clamp, 2½ inch	-HH
Material of construction	
SS = AISI 316 L	SS
Pipe section diameter	
10 = 25 mm (1 inch)	10
15 = 40 mm (1½ inch)	15
20 = 50 mmm (2 inch)	20
25 = 65 mm (2½ inch)	25
Flow cell inlet and outlet orientation	
-090 = Elbow, 90 degree bend	-090
-180 = Straight pipe, 180 degrees	-180

(A) Includes one 2½ inch blind flange with 2½ inch EPDEM gasket and 2½ inch sanitary clamp

Aseptic Steam Valve for PR-23-AP-ISS

Model and description	Model
ASV = Aseptic Steam Valve	ASV
Sensor connection	
-H = Sanitary 3A-clamp, 2½ inch	-H
-E = Varivent® in-line access unit clamp DN65	-E
Material of construction	
SS = AISI 316 L	SS
Option	
-ASI = Adapter and Bürkert 8695 Control Head, Process Valve Mounting	-ASI

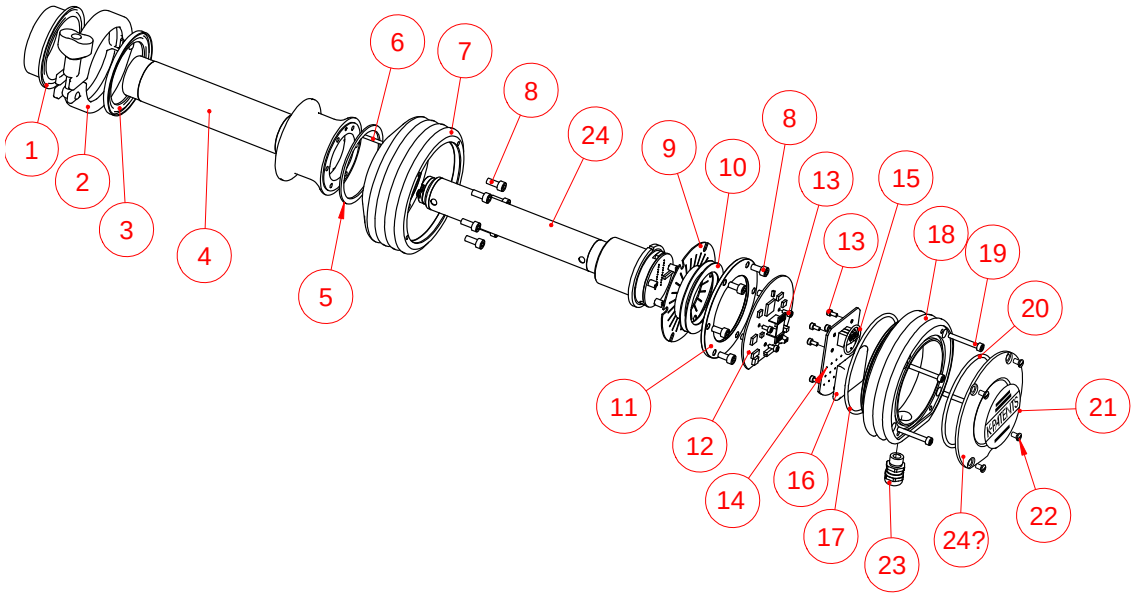
Steam connection ½ inch

9.4.3 PR-23-AP specifications

General specifications

Refractive Index range:	Full range n_D 1.3200–1.5300 (corresponds to hot water – 100 Brix)
Accuracy:	Refractive index n_D ± 0.0002 (corresponds typically to ± 0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Calibration:	With Cargille certified refractive index liquids over full range of n_D 1.3200–1.5300
CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED) 589 nm wavelength, sodium light
Temperature sensor:	Built-in Pt-1000
Temperature compensation:	Automatic, digital compensation
Instrument verification:	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature:	Sensor: max. 45 °C (113 °F), min. -20 °C (-4 °F) Indicating transmitter: max. 50 °C (122 °F), min. 0 °C (32 °F)
SENSOR PR-23-AP:	Probe sensor model for large pipe lines and vessels
Process connection:	Sanitary 3A-clamp 2.5"; Sanitary 3A-clamp 4" or MT4 DN 25/1T APV Tank bottom flange
Sanitary design:	3-A Sanitary Standard 46-03 approved and EHEDG (European Hygienic Engineering & Design Group) certified (connections -T, -N, -I, -R, -S, -H, -C)
Process pressure:	Sanitary clamp max. 15 bar (200 psi) at 20 °C (70 °F)/9 bar (125 psi) at 120 °C (250 °F)
Process temperature:	-20 °C–+150 °C (-4 °F–+302 °F)
Process wetted parts, standard:	AISI 316L stainless steel, prism spinel, prism gaskets MTF (Modified Teflon®)
Sensor protection class:	IP67, Nema 4X
Sensor weight:	3.0 kg (6.6 lbs)

9.4.4 PR-23-AP parts list



Item	Pcs.	Part No.	Description
1	1	PR-9205	2.5” sanitary ferrule
1	1	VFMA-23-PSS	MT4 DN25/1T APV tank bottom flange
1	1	PR-9275	4” sanitary ferrule
2	1	PR-9201	2.5” sanitary clamp
2	1	PR-9271	4” sanitary clamp
3	1	PR-9202	2.5” sanitary gasket EPDM
3	1	PR-9203	2.5” sanitary gasket NBR
3	1	PR-9204	2.5” sanitary gasket Teflon®
3	1	PR-9243	MT4 DN25/1T APV gasket EPDM
3	1	PR-9272	4” 3A sanitary gasket EPDM
3	1	PR-9273	4” 3A sanitary gasket NBR
3	1	PR-9274	4” 3A sanitary gasket Teflon®
4	1	PR-10008	PR-23-P-TSS head
4	1	PR-10006	PR-23-P-PSS head
4	1	PR-10007	PR-23-P-RSS head
5	1	PR-10048	68x3 O-ring
6	1		Alignment pin
7	1	PR-10005	PR-23 base
8	6		Screw M5x12
	6		Locking spacer M5
9	1	PR-9011	Thermal conductor

Item	Pcs.	Part No.	Description
*	1	PR-9010	Disc spring set
10	2		Disc spring
11	1		Disc spring holder
12	1	PR-10103	Sensor processor card
13	8		Screw M3x6 DIN 912 A2
14	1	PR-10300	Bus terminator card
15	1	PR-10032	O-ring seal 24x2
16	1	PR-9108	Dryer sachet
17	1	PR-10031	O-ring seal 89.5x3
18	1	PR-10000	PR-23 cover
19	1		Screw M4x30 DIN 912 A4
20	1	PR-10002	O-ring seal 82x3
21	1		PR-23-A endplate with label
22	4		Screw M4x8 DIN 964 A4
23	1		Cable gland M16x1.5
24	1	PR-10022	PR-23-P core

9.4.5 PR-23-AP mounting specifics

The Probe refractometer PR-23-AP is primarily designed for mounting in a tank wall. To ensure that the measurement is representative and that the prism stays clean, the probe should be installed close to a stirrer.

Probe refractometer type PR-23-AP-T is connected to the process by a 2 1/2" 3A sanitary clamp, Figure 9.10. PR-23-AP-R is connected by 4" sanitary clamp.

Note: For higher process (or ambient) temperatures, use instead a flush mounted sensor, where the electronics in the sensor head are farther away from the process heat, Figure 9.11.

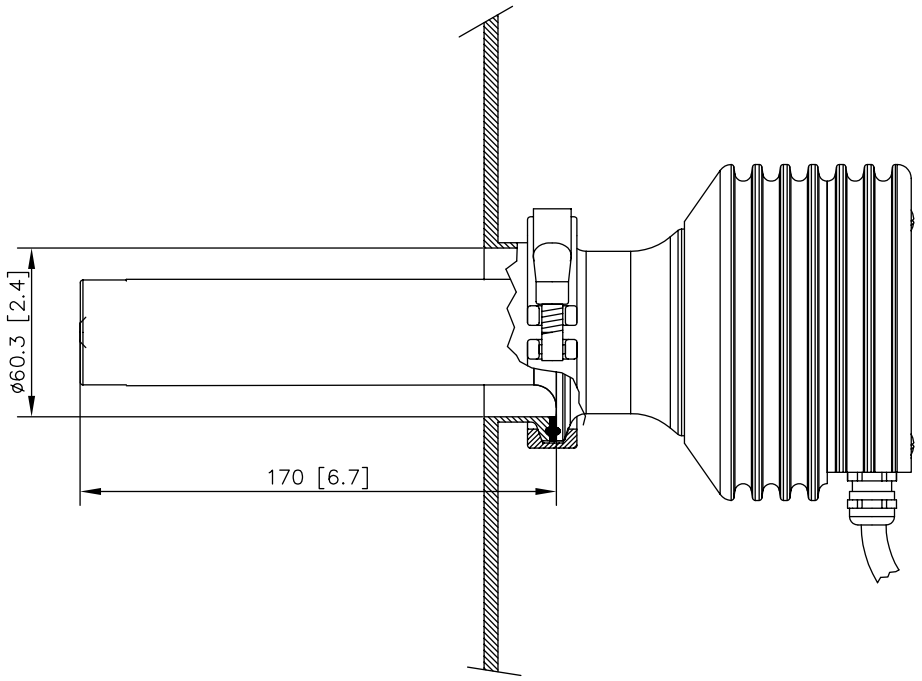


Figure 9.10 Insertion of Probe refractometer PR-23-AP62-TSS

The refractometer type PR-23-AP62-PSS is flush mounted, using a sanitary APV tank bottom flange, Figure 9.11. The sensor can be flush mounted in the side wall, which allows the use of a scraper. It is also easily installed through a steam jacket.

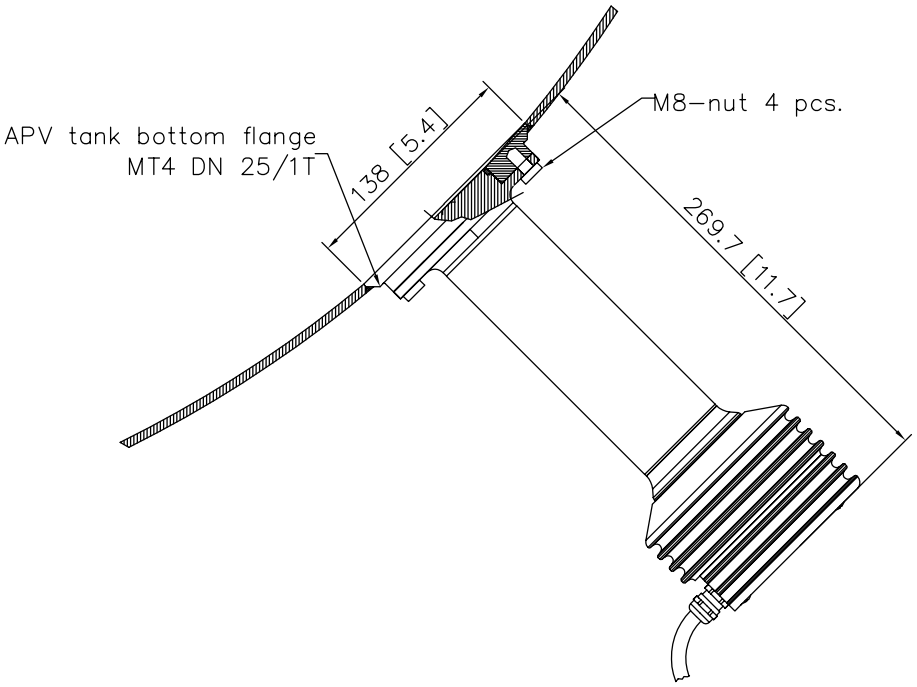


Figure 9.11 Flush mounting Probe refractometer PR-23-AP62-PSS

9.4.6 PR-23-AP I-Line fitting

Sanitary Refractometer PR-23-AP-ZP can be mounted using 3-A Sanitary approved 2.5 inch Cherry Burrell I-Line fittings that are made of interlocking flat face ferrules, a flat gasket and a clamp. This interlocking, metal-to-metal design eliminates over compression by the clamp not allowing the gasket to be extruded into the product contact side.

Sensor wetted parts material is AISI 316L or Alloy C, gaskets EPDM.

9.4.7 Mounting specifics for EHEDG certified PR-23-AP configuration

Vaisala offers certain PR-23-AP configurations which have been certified to fulfill the sanitary requirements published by EHEDG (European Hygienic Engineering & Design Group) organization. During this certification the hygienic characteristics of both the refractometer and the process connection were evaluated against the applicable requirements.

To ensure EHEDG compliant installation, follow the mounting specifics provided on the mounting drawing supplied by Vaisala with each PR-23-AP refractometer ordered with the -EH option.

9.4.8 3A Sanitary Standard compliance

The user should ensure that the refractometer is not a source of contamination to product due to damaged or worn product contact surfaces. Misuse (e.g. too long prism wash time or too high wash pressure) or mishandling may result in metal scratches or roughened surfaces. Such surfaces may not stay clean in processing.

Vaisala offers a 3A Sanitary Standard Accepted repair and maintenance package in which all wetted parts, prism, gaskets and dryer are replaced. Note that this repair service can be completed by 3A authorized service center only (Vaisala factory or regional headquarters).

9.5 Compact process refractometer PR-23-GC

Compact process refractometer PR-23-GC is designed for the general industry small pipeline and bypass line applications e.g. in chemical, oil, gas, petrochemical and kraft pulping processes.

9.5.1 PR-23-GC sensor model code

MODEL AND DESCRIPTION	MODEL
PR-23 = Sensor	PR-23
Sensor model	
-GC = General purpose compact	-GC
Refractive Index range limits	
-73 = n_D 1.320–1.530 (0–100 Brix) Sapphire prism	-73
-74 = n_D 1.260–1.470, Sapphire prism	-74
-82 = n_D 1.410–1.620, YAG prism	-82
-92 = n_D 1.520–1.730, GGG prism	-92
Process connection	
-K = Sandvik L coupling 76.1, insertion length 14 mm	-K
Sensor wetted parts material	
SS = AISI 316 L	SS
HA = Alloy 20	HA
HC = Alloy C276 / ASTM C276	HC
NI = Nickel 200/201	NI
TI = Titanium ASTM B348 GR 2	TI
SU = AISI 904L	SU
XS = Duplex 2205 / SAF2205	XS
Electrical classification	
-GP = General Purpose	-GP
-AX = ATEX and IECEx certified Ex II 3 G, Ex nA IIC T4 Gc (up to Zone 2) (T_{amb} -20 ... +65°C)	-AX
-IA = ATEX and IECEx certified Ex II 1 G, Ex ia IIC T4 Ga (up to Zone 0) (T_{amb} -20 ... +65°C) **(A)**	-IA
-CS = CSA certified Class I, Div.2, Groups A, B, C, D T4 (T_{amb} -20 ... +45°C)	-CS
-FM = FM certified Class I, Div.2, Groups A, B, C, D T6 (T_{amb} -20 ... +45°C)	-FM
-IF = FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D T4 (T_{amb} -20 ... +45°C) **(A)**	-IF
Sensor housing	
-SC = Stainless steel AISI 316	-SC

(A) Available with STR Indicating Transmitter and IS isolator only

Wafer flowcell model code

MODEL AND DESCRIPTION	MODEL
WFC = Wafer flowcell	WFC
Sensor connection -K = Sandvik L coupling 76.1 mm (insertion length 14 mm)	-K
Construction material -SS = AISI 316 L -HA = Alloy 20 -HC = Alloy C276 -NI = Nickel 200 -TI Titanium ASTM B248 -SU = AISI 904L (A) -XS = SAF2205 (A)	 SS HA HC NI TI SU XS
Process connection -A = ANSI flange 150 psi -D = DIN flange PN40 -J = JIS flange10K	 -A -D -J
Pipe section diameter 05 = 15 mm (1/2 inch) 10 = 25 mm (1 inch) 15 = 40 mm (1 1/2 inch)	 05 10 15
Wash nozzle connection -NC = Nozzle connection	-NC
Wash nozzle options -SN = Steam nozzle (A) -WN = Water nozzle (A) -WP = Pressurized water nozzle (A) -PG = Plug for nozzle connection (A)	 -SN -WN -WP -PG

(A) threads G 1/4 inch female

Pipe flowcell model code

MODEL AND DESCRIPTION	MODEL
PFC = Pipe flowcell	PFC
Sensor connection -K = Sandvik L coupling 76.1 mm (insertion length 14 mm)	-K
Construction material -SS = AISI 316 L Other materials on request	SS
Process connection -A = ANSI flange 150 psi -D = DIN flange PN40 -J = JIS flange10K	 -A -D -J
Pipe section diameter 05 = 15 mm (1/2 inch) 10 = 25 mm (1 inch) 15 = 40 mm (1 1/2 inch)	 05 10 15
Wash nozzle connection -NC = Nozzle connection	-NC
Wash nozzle options -SN = Steam nozzle (A) -WP = Pressurized water nozzle (A)	 -SN -WP

(A) threads G 1/4 inch female

9.5.2 PR-23-GC specifications

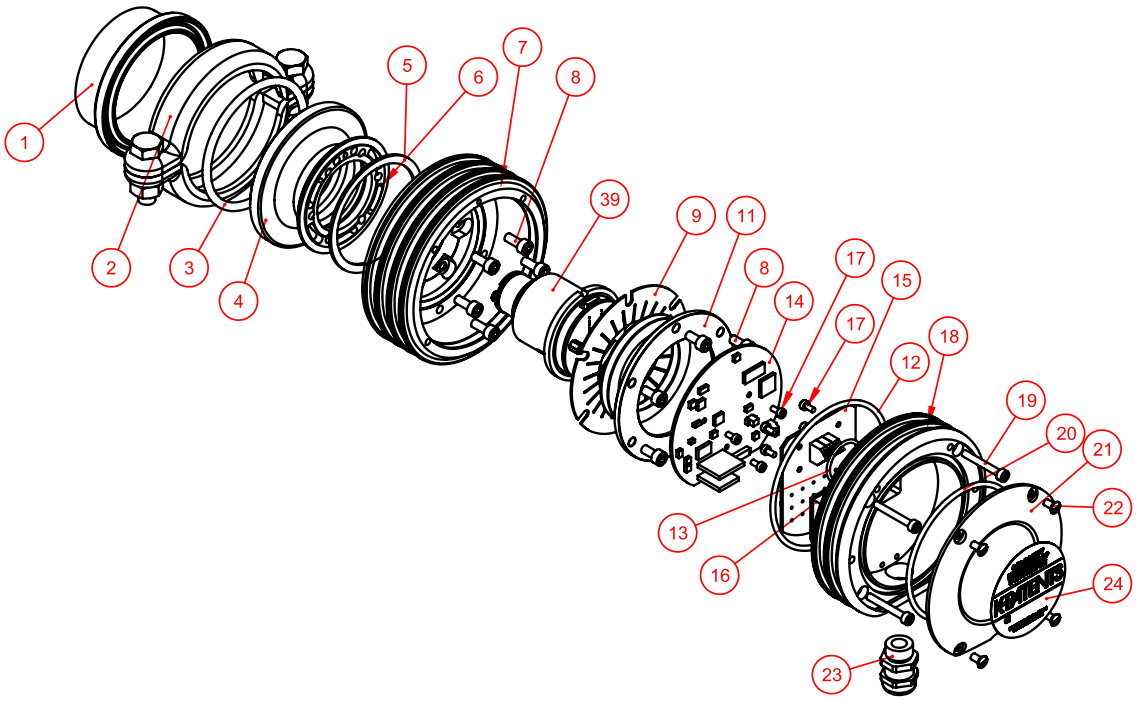
General specifications

Refractive Index range:	Full range n_D 1.3200–1.5300 (corresponds to 0–100 % b.w.), Sapphire prism
Accuracy:	Refractive index n_D ± 0.0002 (corresponds typically to ± 0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Calibration:	With Cargille certified refractive index liquids over full range of n_D 1.3200–1.5300
CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED) 589 nm wavelength, sodium light
Temperature sensor:	Built-in Pt-1000
Temperature compensation:	Automatic, digital compensation
Instrument verification:	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature:	Sensor: max. 45 °C (113 °F), min. -20 °C (-4 °F) Indicating transmitter: max. 50 °C (122 °F), min. 0 °C (32 °F)

SENSOR PR-23-GC:

Process connection (in upper elbow of pipe):	by Sandvik coupling L 76.1 mm (2.5 inch) for pipe line sizes of 2.5 inch and larger; via reducing ferrule PR-9283 for 2 inch pipes
Wafer flow cell WFC connection (in straight pipe):	via Wafer flow cell WFC for pipe line sizes 15 mm (0.5 inch), 25 mm (1 inch) and 40 mm (1.5 inch); Wafer flow cell body mounts between ANSI 150 psi, DIN PN 25 or JIS
Pipe flow cell PFC connection (in straight pipe)	via a Pipe flow cell PFC for pipe line sizes 15 mm (0.5 inch), 25 mm (1 inch) and 40 mm (1.5 inch); Pipe flow process connection ANSI 150 psi, DIN PN 25 or JIS
Process pressure:	up to 15 bar (200 psi) at 20 °C (70 °F)
Process temperature:	-40 °C–+130 °C (-40 °F–+266 °F)
Process wetted parts, standard:	AISI 316L stainless steel, prism sapphire, prism gaskets PTFE (teflon)
Process wetted parts, options:	AISI 904L stainless steel, Alloy 20, Alloy C276, Nickel 200, Titanium ASTM B348 or SAF 2205
Sensor protection class:	IP67, Nema 4X
Sensor weight:	2.0 kg (4.4 lbs)

9.5.3 PR-23-GC parts list



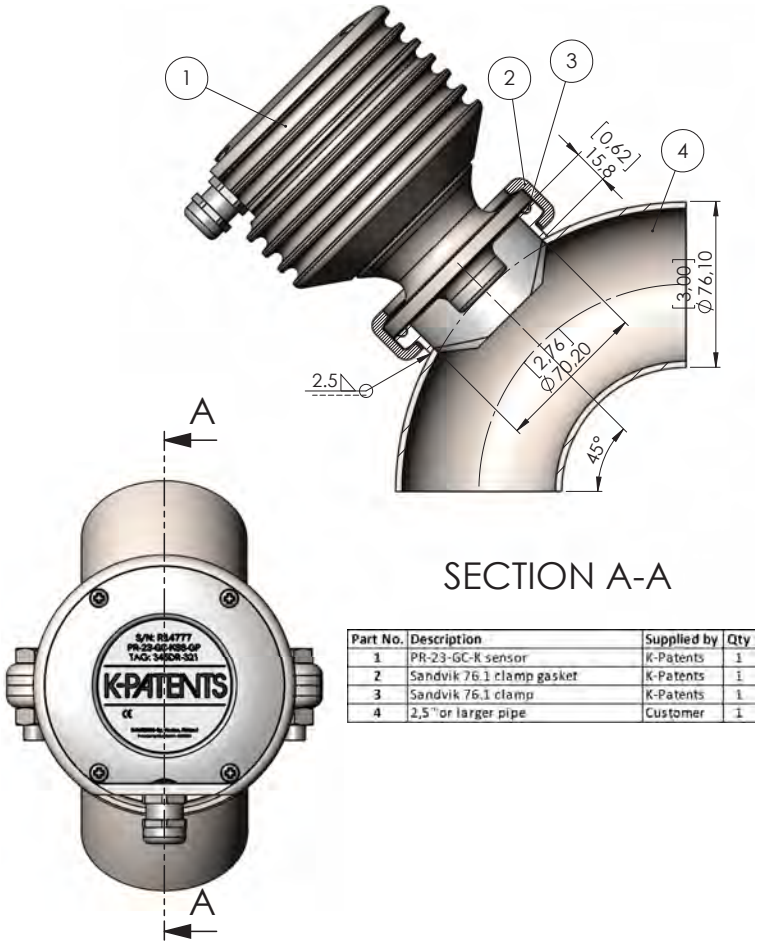
Item	Pcs.	Part No.	Description
1	1	PR-9280	Sandvik ferrule 76.1
1	1	PR-9283	Sandvik 76.1 reducing ferrule
2	1	PR-9282	Sandvik clamp FCLC-76.1
3	1	PR-9281	Sandvik O-ring FCLG-T-76.1 Teflon®
3	1	PR-9291	Sandvik O-ring FCLG-V-76.1 Viton
4	1	PR-9284	PR-23/33-GC head
5	1	PR-10048	68x3 O-ring
6	1		Alignment pin
7	1	PR-10005-SC	PR-23 base
8	6		Screw M5x12
	6		Locking spacer M5
9	1	PR-9011	Thermal conductor
*	1	PR-9010	Disc spring set
10	2		Disc spring
11	1		Disc spring holder
12	1	PR-10031	O-ring seal 89.5 x 3
13	1	PR-10032	O-ring seal 24 x 2
14	1	PR-10103	Sensor processor card
15	1	PR-10300	Bus terminator card

Item	Pcs.	Part No.	Description
16	1	PR-9108	Dryer sachet
17	8		Screw M3x6 DIN 912 A2
18	1	PR-10000-SC	PR-23 cover
19	4		Screw M4x30 DIN 912 A4
20	1	PR-10002	O-ring seal 82x3
21	1	PR-10047-SC	PR-23 endplate with label and screws
22	4		Screw M4x8 DIN 964 A4
23	1		Cable gland M16x1.5
39	1	PR-10036	H73 compact sensor CORE module

9.5.4 PR-23-GC mounting specifics

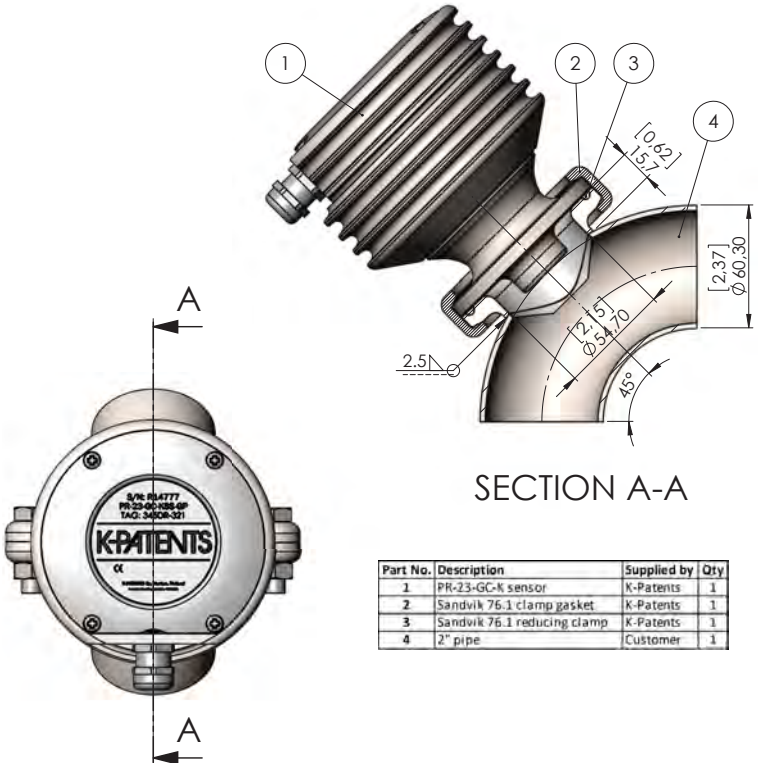
The Compact refractometer is mounted either in a pipe elbow by a Sandvik coupling connection or in a straight pipe via a Wafer flow cell or a Pipe flow cell. Both flow cell mounting designs create optimum flow velocity on the measurement surface providing a good self-cleaning effect. The Wafer flow cell has also an optional automatic wash system capability.

In a pipe at least 2.5" in diameter the sensor is mounted in a pipe elbow with a Sandvik coupling. In a 2" pipe the sensor is mounted in a pipe elbow via reducing ferrule PR-9283. In 0.5, 1 and 1.5 inch pipes a flow cell is installed in a straight pipe. The flangeless Wafer flow cell is a compact alternative to traditional flow cells. The Wafer refers to a flow cell body that is installed between DIN, ANSI or JIS piping flanges with bolts and nuts. The Wafer flow cell is a one-piece body construction with no welds. A Pipe flow cell is also available for 0.5 and 1 inch pipes.



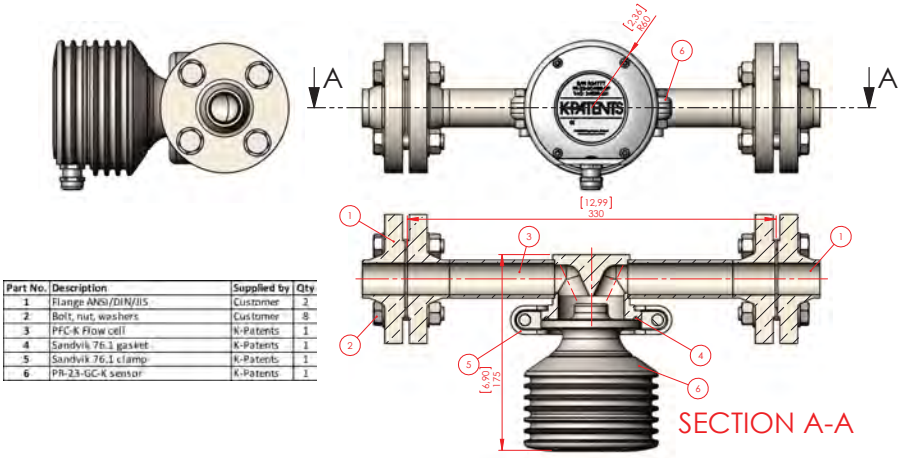
Part No.	Description	Supplied by	Qty
1	PR-23-GC-K sensor	K-Patents	1
2	Sandvik 76.1 clamp gasket	K-Patents	1
3	Sandvik 76.1 clamp	K-Patents	1
4	2,5 "or larger pipe	Customer	1

Figure 9.12 Mounting the sensor in a pipe 2 1/2" or larger



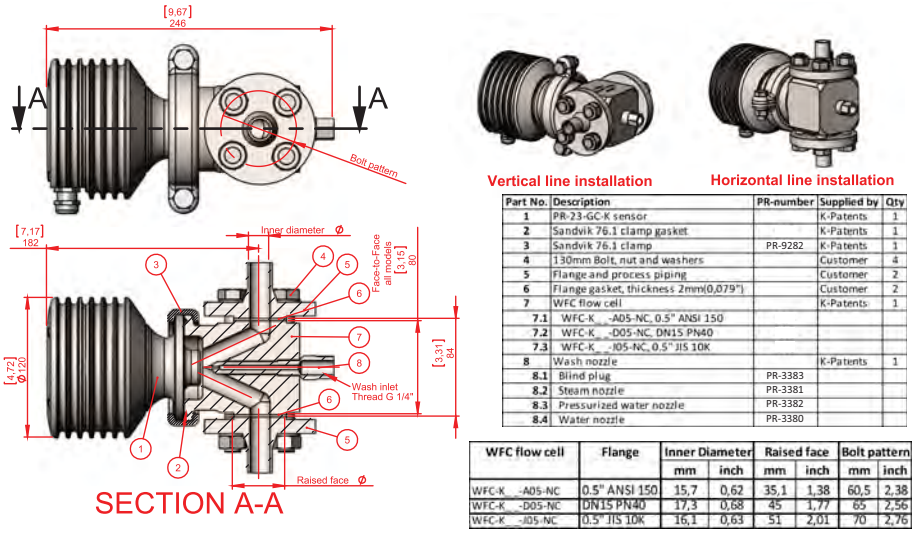
Part No.	Description	Supplied by	Qty
1	PR-23-GC-K sensor	K-Patents	1
2	Sandvik 76.1 clamp gasket	K-Patents	1
3	Sandvik 76.1 reducing clamp	K-Patents	1
4	2" pipe	Customer	1

Figure 9.13 Mounting the sensor in a 2" pipe



Part No.	Description	Supplied by	Qty
1	Flange ANSI/DIN/JIS	Customer	2
2	Bolt, nut, washers	Customer	8
3	PFC-K Flow cell	K-Patents	1
4	Sandvik 76.1 gasket	K-Patents	1
5	Sandvik 76.1 clamp	K-Patents	1
6	PR-23-GC-K sensor	K-Patents	1

Figure 9.14 Mounting the sensor with a pfc flow cell



Part No.	Description	PR-number	Supplied by	Qty
1	PR-23-GC-K sensor		K-Patents	1
2	Sandvik 76.1 clamp gasket		K-Patents	1
3	Sandvik 76.1 clamp	PR-9282	K-Patents	1
4	130mm Bolt, nut and washers		Customer	4
5	Flange and process piping		Customer	2
6	Flange gasket, thickness 2mm(0,079")		Customer	2
7	WFC flow cell		K-Patents	1
7.1	WFC-K__-A05-NC, 0.5" ANSI 150			
7.2	WFC-K__-D05-NC, DN15 PN40			
7.3	WFC-K__-J05-NC, 0.5" JIS 10K			
8	Wash nozzle		K-Patents	1
8.1	Blind plug	PR-3383		
8.2	Steam nozzle	PR-3381		
8.3	Pressurized water nozzle	PR-3382		
8.4	Water nozzle	PR-3380		

WFC flow cell	Flange	Inner Diameter		Raised face		Bolt pattern	
		mm	inch	mm	inch	mm	inch
WFC-K__-A05-NC	0.5" ANSI 150	15,7	0,62	35,1	1,38	60,5	2,38
WFC-K__-D05-NC	DN15 PN40	17,3	0,68	45	1,77	65	2,56
WFC-K__-J05-NC	0.5" JIS 10K	16,1	0,63	51	2,01	70	2,76

Figure 9.15 Mounting the sensor with a wfc flow cell

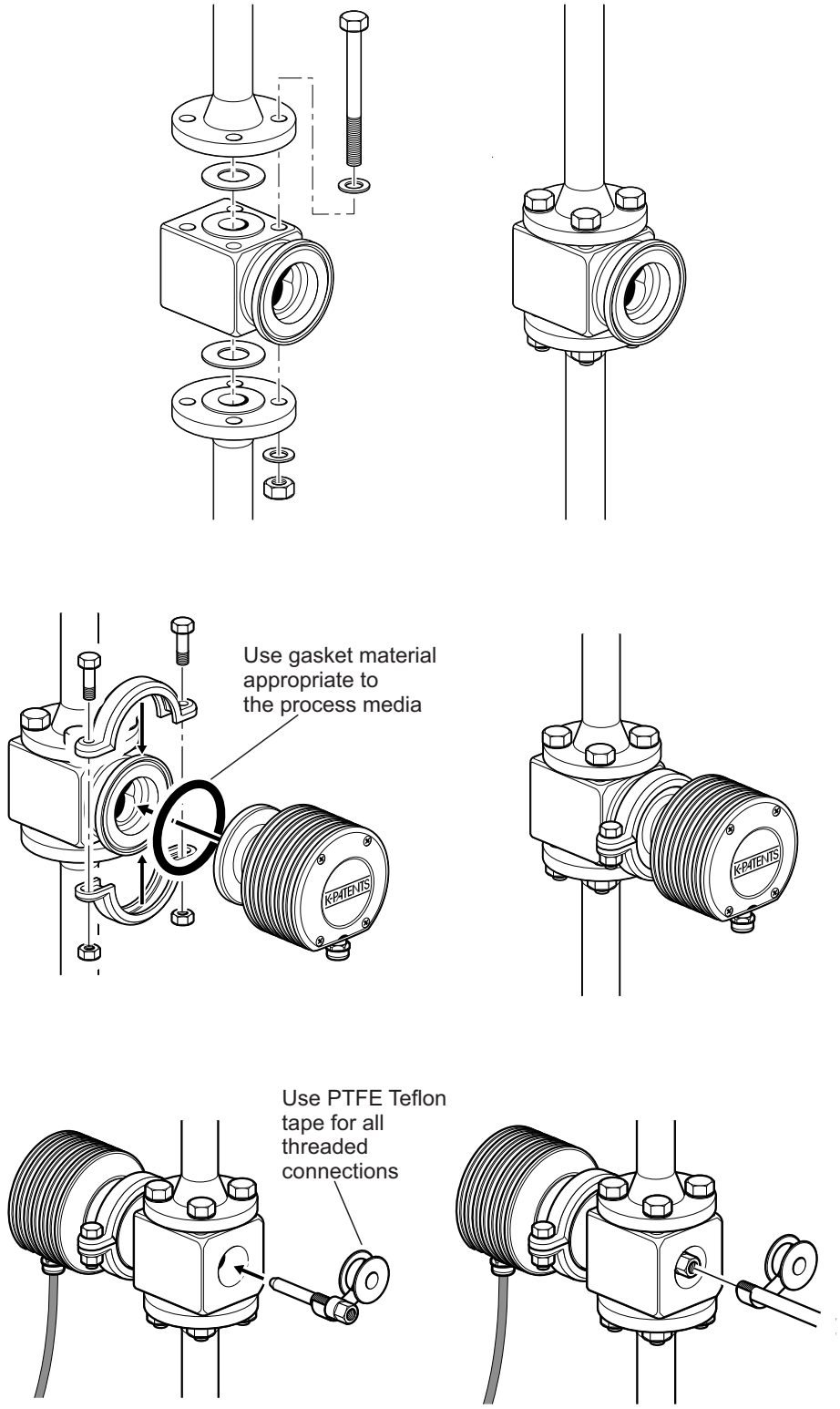


Figure 9.16 Mounting the Wafer flow cell and sensor in a vertical pipe

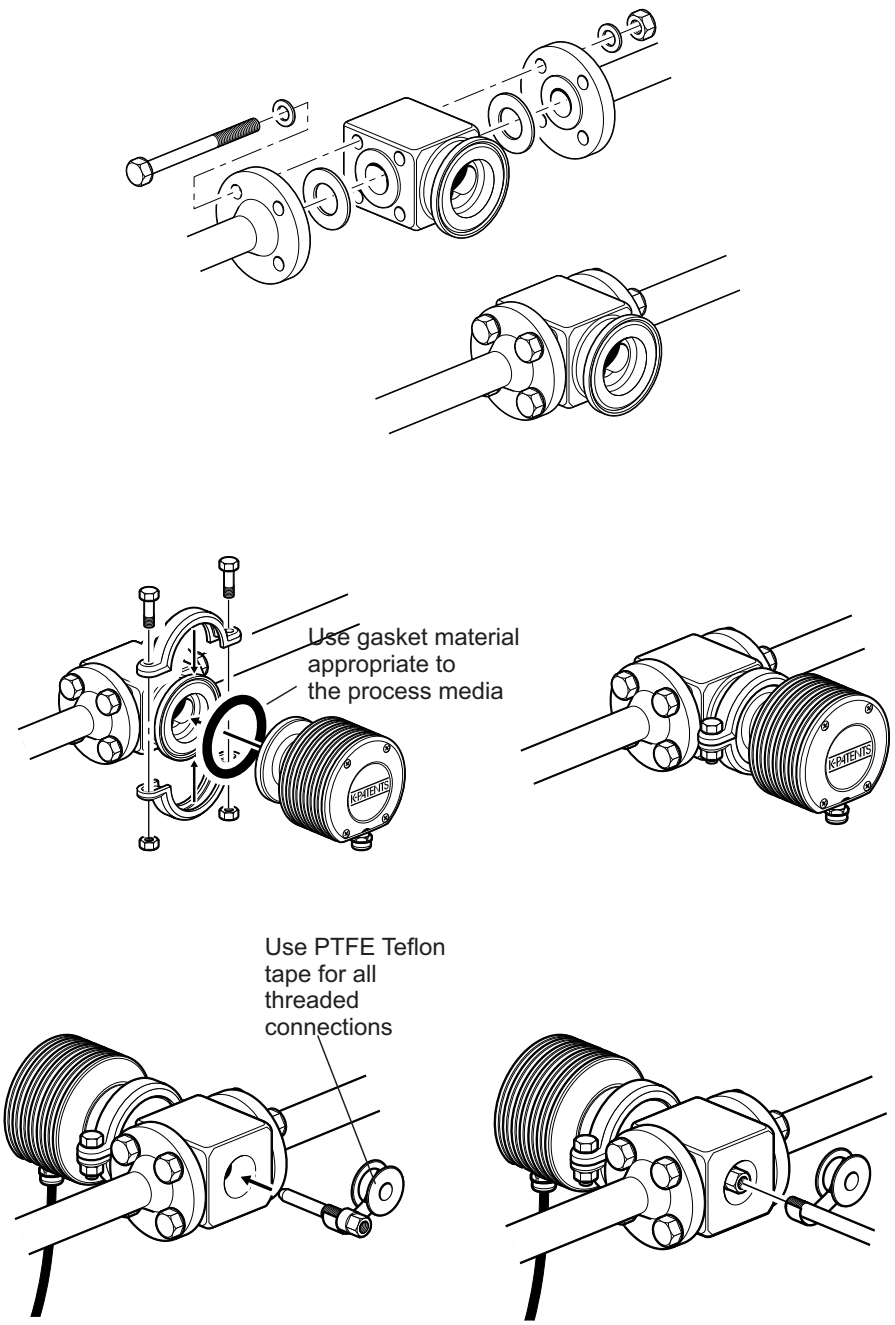


Figure 9.17 Mounting the Wafer flow cell and sensor in a horizontal pipe

9.6 Probe process refractometer PR-23-GP

Probe process refractometer PR-23-GP is a general industry model for measuring liquid concentrations in various in-line applications, like chemicals, fibers, plastics, salts and sodium components. It is typically installed in large pipes and vessels.

9.6.1 PR-23-GP sensor model code

MODEL AND DESCRIPTION	MODEL
PR-23 = Sensor	PR-23
Sensor model	
-G = General	-G
Sensor type	
P = Probe type for tanks and large pipes	P
Refractive Index range limits	
-62 = n_D 1.320–1.530 (0–100 Brix) Spinel prism	-62
-73 = n_D 1.320–1.530 (0–100 Brix) Sapphire prism	-73
-74 = n_D 1.260–1.470, Sapphire prism	-74
-82 = n_D 1.410–1.620, YAG prism	-82
-92 = n_D 1.520–1.730, GGG prism	-92
Process connection	
-A = ANSI-flange 150 lbs, 3 inch, insertion length 130 mm	-A
-D = DIN-flange 2656, PN25 DN80, insertion length 130 mm	-D
-DA = DIN-flange 2656, PN25 DN100, insertion length 130 mm	-DA
-J = JIS-flange 10k 80A, insertion length 130 mm	-J
-L = Sandvik L clamp, 88 mm, insertion length 130 mm	-L
-M = ANSI-flange 300 lbs, 3 inch, insertion length 130 mm	-M
-O = ANSI-flange 150 lbs, 4 inch, insertion length 130 mm	-L
-U = ANSI-flange 300 lbs, 4 inch, insertion length 130 mm	-U
-JA = JIS-flange 10k 100A, insertion length 130 mm	-JA
Sensor wetted parts material	
SS = AISI 316 L	SS
RS = Stainless steell AISI 304 L	RS
HA = Alloy 20	HA
HC = Alloy C276	HC
HD = Alloy C22	HD
NI = Nickel 200/201	NI
TI = Titanium ASTM B348 GR 2	TI
XS = Duplex 2205 / SAF2205	XS
Electrical classification	
-GP = General Purpose	-GP
-AX = ATEX and IECEx certified Ex II 3 G, Ex nA IIC T4 Gc (up to Zone 2) (T_{amb} -20 ... +65°C)	-AX
-FM = FM certified Class I, Div. 2, Groups A, B, C, D, T6 (T_{amb} -20 ... +45°C)	-FM
-CS = CSA certified Class I, Div. 2, Groups A, B, C, D, T4 (T_{amb} -20 ... +45°C)	-CS
-IA = ATEX and IECEx certified Ex II 1 G, Ex ia IIC T4 Ga (up to Zone 0) (T_{amb} -20 ... +65°C) **(A)**	-IA
-IF = FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D T4 (T_{amb} -20 ... +45°C) **(A)**	-IF
Sensor housing	
AA = Anodized aluminium	-AA
-SC = Stainless steel AISI 316	-SC
Prism wash	
-SN = Integral steam nozzle	-SN
-WN = Integral water nozzle	-WN
-WP = Integral pressurized water nozzle	-WP
-NC = Integral nozzle connection	-NC
-YC = without nozzle connection	-YC
Option	
-VD = Vertical Borderline Image Detection (e.g. sugar vacuum pan)	-VD

(A) Available with STR Indicating Transmitter and IS isolator only

9.6.2 PR-23-GP specifications

General specifications

Refractive Index range:	Full range n_D 1.3200–1.5300 (corresponds to hot water – 100 Brix)
Accuracy:	Refractive index n_D ± 0.0002 (corresponds typically to ± 0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Calibration:	With Cargille certified refractive index liquids over full range of n_D 1.3200–1.5300
CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED) 589 nm wavelength, sodium light
Temperature sensor:	Built-in Pt-1000
Temperature compensation:	Automatic, digital compensation
Instrument verification:	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature:	Sensor: max. 45 °C (113 °F), min. -40 °C (-40 °F) Indicating transmitter: max. 50 °C (122 °F), min. 0 °C (32 °F)
SENSOR PR-23-GP:	Probe sensor for large pipe line and vessel installation
Process connection:	Flanges: ANSI 3'' 150 lbs or DIN 80 PN 25 or JIS 10K 80A; or Sandvik L clamp 88 mm
Process pressure:	Flange connections up to 25 bar (350 psi)
Process temperature:	-20 °C–+150 °C (-4 °F–+302 °F)
Process wetted parts, standard:	AISI 316L stainless steel, prism spinel, prism gaskets MTF (Modified Teflon)
Sensor protection class:	IP67, Nema 4X
Sensor weight:	Aluminium sensor with clamp/flange 4.0–9.0 kg (8.8–19.8 lbs), stainless steel sensor with clamp/flange 5.9–10.9 kg (13.0–24.0 lbs)

9.6.3 PR-23-GP thermal cover

The thermal cover prevents heat flow between process and ambient surroundings. It helps maintain the sensor tip and the prism surface at process temperature and may reduce prism coating. Use thermal cover when the temperature difference between the process and the ambient is more than 30°C or when the process temperature is over 60°C.

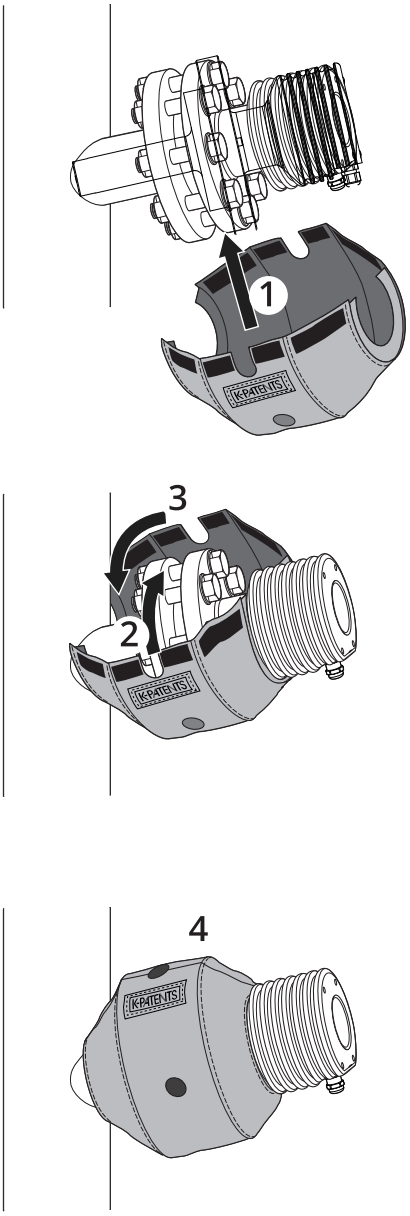
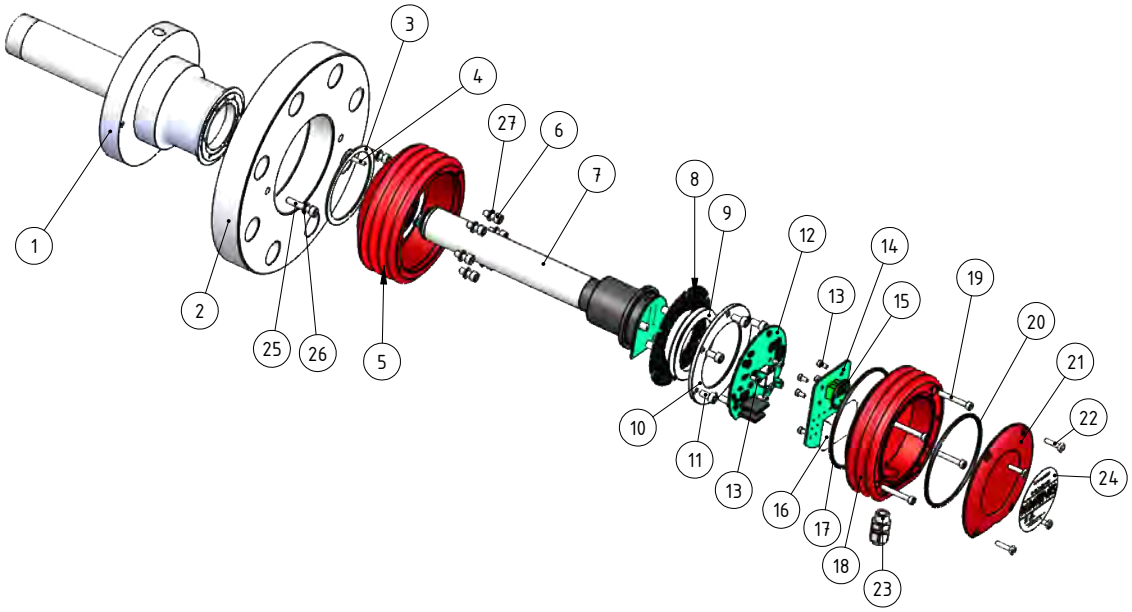


Figure 9.18 Mounting thermal cover on PR-23-GP

9.6.4 PR-23-GP parts list



Item	Pcs.	Part No.	Description
1.1	1	PR-10009	PR-23-GP-L head
1.2	1	PR-10010	PR-23-GP-D head
1.3	1	PR-10011	PR-23-GP-D-NC head
2	1		ANSI 3" 150 lbs flange
2	1		DIN 80 PN 25 flange
2	1		JIS 80A 10k flange
3	1	PR-10048	68x3 O-ring
4	1		Alignment pin
5.1	1	PR-10005	PR-23 base
5.2	1	PR-10005-SC	PR-23 base SS
5.3	1	PR-10005-EC	PR-23 base EC
6	6		Screw M5x12
	6		Locking spacer M5
7	1	PR-10022	PR-23-P core
8	1	PR-9011	Thermal conductor
*	1	PR-9010	Disc spring set
9	2		Disc spring
10	1		Disc spring holder
11	6		Screw M5x10 DIN 912 A2

Item	Pcs.	Part No.	Description
12	1	PR-10103	Sensor processor card
13	8		Screw M3x6 DIN 912 A2
14	1	PR-10300	Bus terminator card
15	1	PR-10032	O-ring seal 24x2
16	1	PR-9108	Dryer sachet
17	1	PR-10031	O-ring seal 89.5x3
18.1	1	PR-10000	PR-23 cover
18.2	1	PR-10000-SC	PR-23 cover SS
18.3	1	PR-10000-EC	PR-23 cover EC
19	4		Screw M4x30 DIN 912 A4
20	1	PR-10002	O-ring seal 82x3
21	1		PR-23 endplate with label
22	4		Screw M4x8 DIN 964 A4
23	1		Cable gland M16x1.5
24	1		Label
25	2		Screw M6x30 A4 DIN912
26	2		Washer M6 A4 DIN125
27	6		Lock washer M6

9.6.5 PR-23-GP mounting specifics

Model	
PFC-23-GP-ASS-Y-NC	190.5 [7.5]
PFC-23-GP-DSS-Y-NC	200 [7.874]
PFC-23-GP-JSS-Y-NC	185 [7.283]

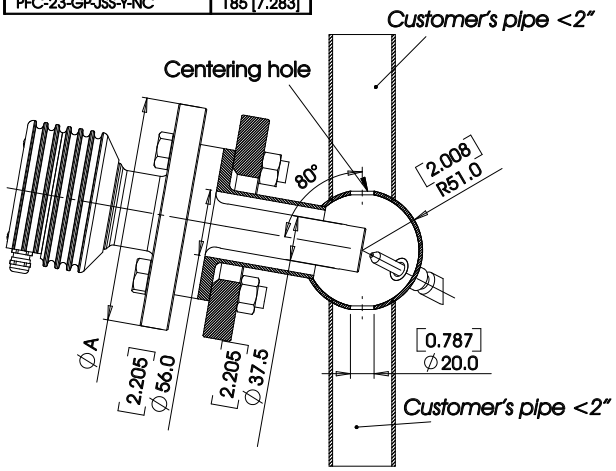
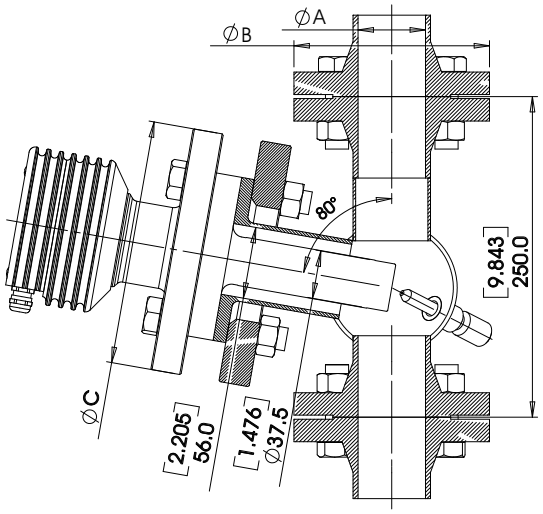


Figure 9.19 PR-23-GP-A/D/JSS Y flowcell



Model	A	B	C
PFC-23-GP-ASS-A10-NC	26.7 [1.051]	108 [4.252]	190.5 [7.5]
PFC-23-GP-ASS-A20-NC	52.6 [2.071]	152.3 [6]	190.5 [7.5]
PFC-23-GP-DSS-D10-NC	25 [1]	115 [4.528]	200 [7.874]
PFC-23-GP-DSS-D20-NC	51 [2]	165 [6.496]	200 [7.874]
PFC-23-GP-JSS-J10-NC	25 [1]	125 [4.921]	185 [7.283]
PFC-23-GP-JSS-J20-NC	51 [2]	155 [6.102]	185 [7.283]

Figure 9.20 PR-23-GP-A/D/JSS flowcell

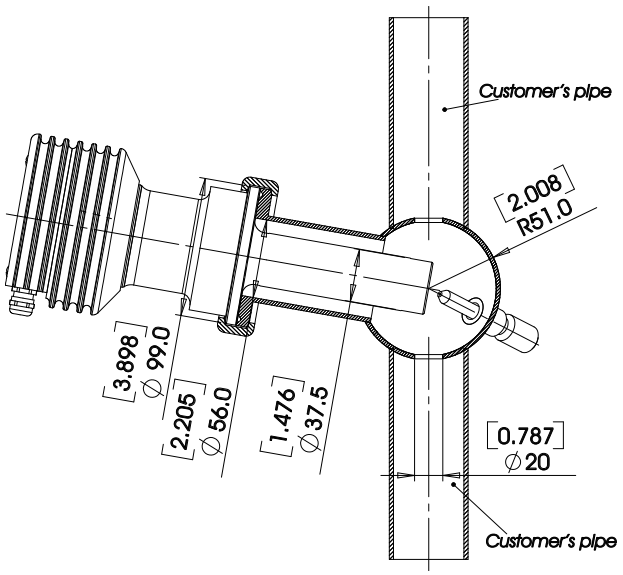
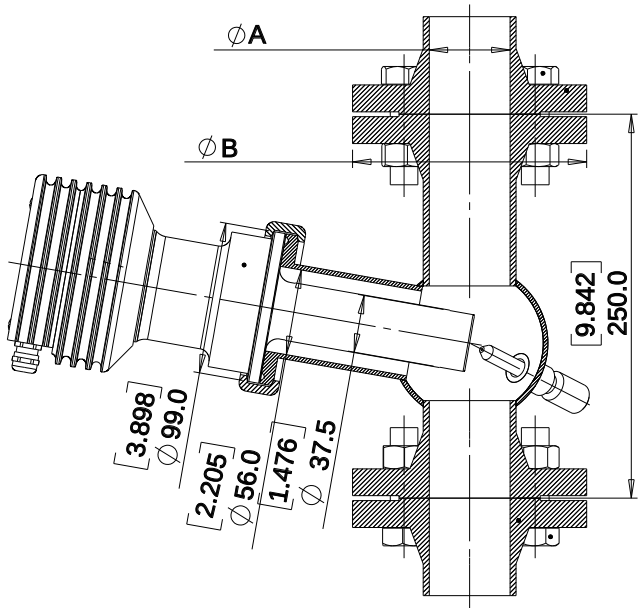


Figure 9.21 PR-23-GP-LSS Y flowcell



Model	A	B
PFC-23-GP-LSS-A10-NC	26.7 [1.051]	108 [4.252]
PFC-23-GP-LSS-A20-NC	52.6 [2.071]	152.4 [6]
PFC-23-GP-LSS-D10-NC	25 [1]	115 [4.528]
PFC-23-GP-LSS-D20-NC	51 [2]	165 [6.496]
PFC-23-GP-LSS-D20-NC	25 [1]	125 [6.102]
PFC-23-GP-LSS-J20-NC	51 [2]	155 [6.102]

Figure 9.22 PR-23-GP-LSS flowcell

9.7 Process refractometer PR-23-RP

Process Refractometer PR-23-RP is a heavy-duty refinery model that is designed to support the unique requirements of the refining and petroleum industries. Typical applications are in accurate liquid concentration mesurements, e.g. acid in alkylation, glycol or amines in gas processing and multi-product (crude oil, fuel oil, diesel) interfaces in transfer operations. The main physical properties have been designed in accordance with ASME VIII Div1 and Div2.

The PR-23-RP comes with user-specified supplementary tests and documents. The following items can be specified and ordered: metallurgical and material hardness certification (e.g. compliance with the NACE MR0103 or NACE MR0175/ ISO 15156 standard), API recommended tests and welding documents (e.g. WPS, PQR, WQR, NDE, radiographic test and hydrostatic shell test), material traceability certification and the positive material identification (PMI) test. A factory acceptance test (FAT), site acceptance test (SAT), and customized drawings stating client specific information are also available on request.

9.7.1 PR-23-RP sensor model code

MODEL AND DESCRIPTION	MODEL
PR-23 = Sensor	PR-23
Sensor model -R = Refinery	 -R
Sensor type P = Probe type, wetted materials single piece no weldings	 P
Refractive Index range limits -73 = n_D 1.320–1.530 (0–100 Brix)	 -73
Process connection -M20 = ANSI-flange 300 lbs, 2 inch, insertion length 130 mm -J20 = JIS-flange 10k 50A, insertion length 130 mm	 -M20 -J20
Sensor wetted parts material -SS = AISI 316 L -HA = Alloy 20 -HC = Alloy C276	 -SS -HA -HC
Electrical classification -GP = General Purpose -AX = ATEX and IECEx certified Ex II 3 G, Ex nA IIC T4 Gc (up to Zone 2) (T_{amb} -20 ... +65°C) -IA = ATEX and IECEx certified Ex II 1 G, Ex ia IIC T4 Ga (up to Zone 0) (T_{amb} -20 ... +65°C) -FM = FM Class I, Div. 2, Groups A, B, C & D, T6 (T_{amb} -20 ... +45°C) -IF = FM Class I, Div. 1, Groups A, B, C & D, T4 (T_{amb} -20 ... +45°C) -CS = CSA Class I, Div. 2, Groups A, B, C & D, T4 (T_{amb} -20 ... +45°C)	 -GP -AX -IA -FM -IF -CS
Sensor housing -SC = Stainless steel	 -SC
Prism wash See flowcell	

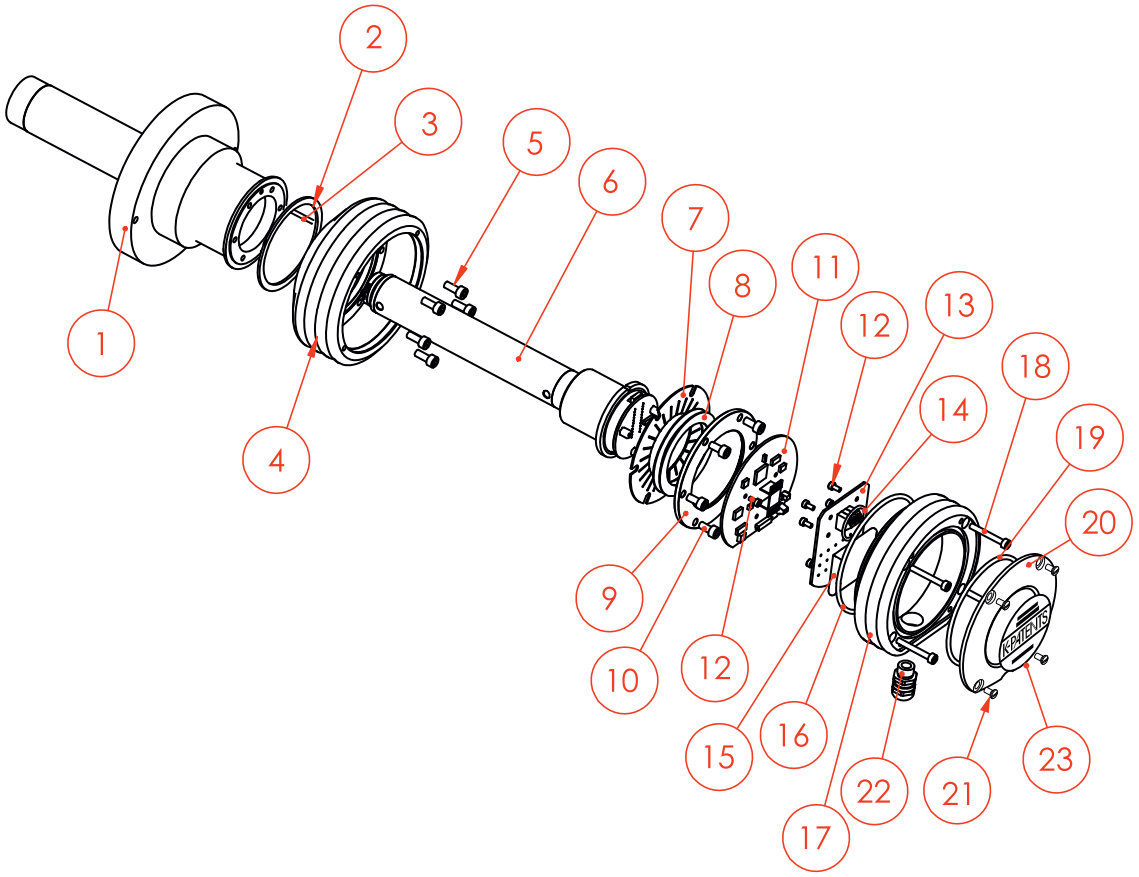
Example: Sensor: PR-23-RP-73-M20-SS-AX-SC

9.7.2 PR-23-RP specifications

General specifications

Refractive Index range:	Full range n_D 1.3200–1.5300 (corresponds to hot water – 100 Brix)
Accuracy:	Refractive index n_D ± 0.0002 (corresponds typically to ± 0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Calibration:	With Cargille certified refractive index liquids over full range of n_D 1.3200–1.5300
CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED) 589 nm wavelength, sodium light
Temperature sensor:	Built-in Pt-1000
Temperature compensation:	Automatic, digital compensation
Instrument verification:	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature:	Sensor: max. 45 °C (113 °F), min. -20 °C (-4 °F) Indicating transmitter: max. 50 °C (122 °F), min. 0 °C (32 °F)
SENSOR PR-23-RP:	Probe type, seamless one-piece wetted parts construction with no welds
Process connection:	Flanges: ANSI 2'' 300 lbs
Process pressure:	up to 25 bar (350 psi)
Process temperature:	-40 °C–+150 °C (-40 °F–+302 °F)
Process wetted parts, standard:	AISI 316L Stainless steel, Alloy 20 or Alloy C276; prism sapphire, prism gaskets PTFE
Sensor protection class:	IP67, Nema 4X
Sensor weight:	7.89 kg (17.4 lbs)

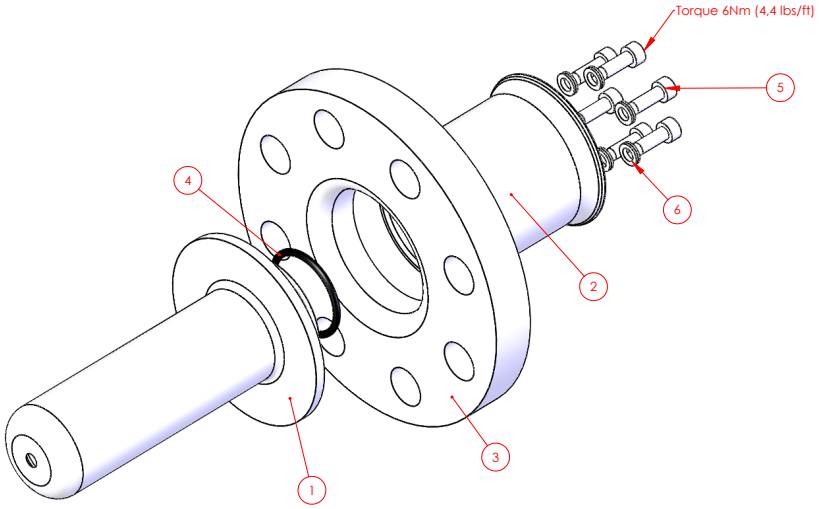
9.7.3 PR-23-RP parts list



Item	Pcs.	Part No.	Description
1.1	1	PR-10043	PR-23-RP-SS head
1.2	1	PR-10043-HC	PR-23-RP-SS Hastelloy® C 276
1.3	1	PR-10043-HA	PR-23-RP-SS Alloy® 20 head
2	1	PR-10048	68x3 O-ring
3	1		Alignment pin
4	1	PR-10005-SC	PR-23 base SS
5	6		Screw M5x10 DIN 912 A2
6	1	PR-10041	H73 CORE-Optics module PR-23 P
7	1	PR-9011	Thermal conductor
*	1	PR-9010	Disc spring set
8	2		Disc spring
9	1		Disc spring holder
10	6		Screw M5x13 DIN 912 A2
	6		Locking spacer M5

Item	Pcs.	Part No.	Description
11	1	PR-10103	Sensor processor card
12	8		Screw M3x6 DIN 912 A2
13	1	PR-10300	Bus terminator card
14	1	PR-10032	O-ring seal 24x2
15	1	PR-9108	Dryer sachet
16	1	PR-10031	O-ring seal 89.5x3
17	1	PR-10000-SC	PR-23 cover SS
18	4		Screw M4x30 DIN 912 A4
19	1	PR-10002	O-ring seal 82x3
20	1		PR-23 endplate with label
21	4		Screw M4x8 DIN 964 A4
22	1		Cable gland M16x1.5

9.7.4 PR-23-RP head parts list



PR-10043
PR-10043-HC
PR-10043-HA

Item	Pcs.	Part No.	Description	Item	Pcs.	Part No.	Description
1.1	1		PR-23-RP head	3	1		2" ANSI 300 flange
1.2	1		PR-23-RP head Hastelloy C	4	1	PR-10049	O-ring 50x3 FPM
1.3	1		PR-23-RP head Alloy 20	5	6		M6x16 DIN912 A4
2	1		PR-23-RP outer head	6	6		M6 Nord lock washer

9.7.5 PR-23-RP dimensions

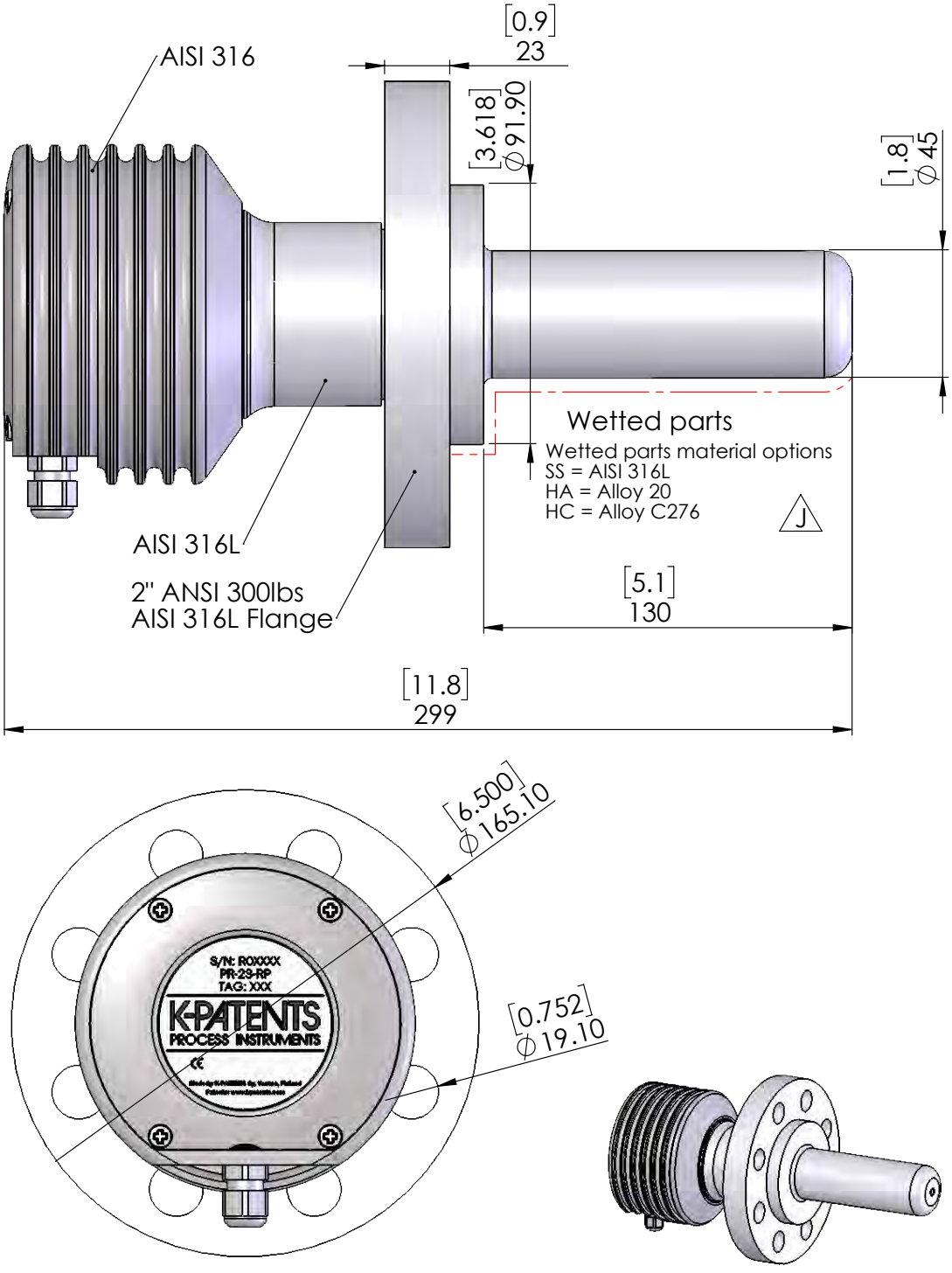
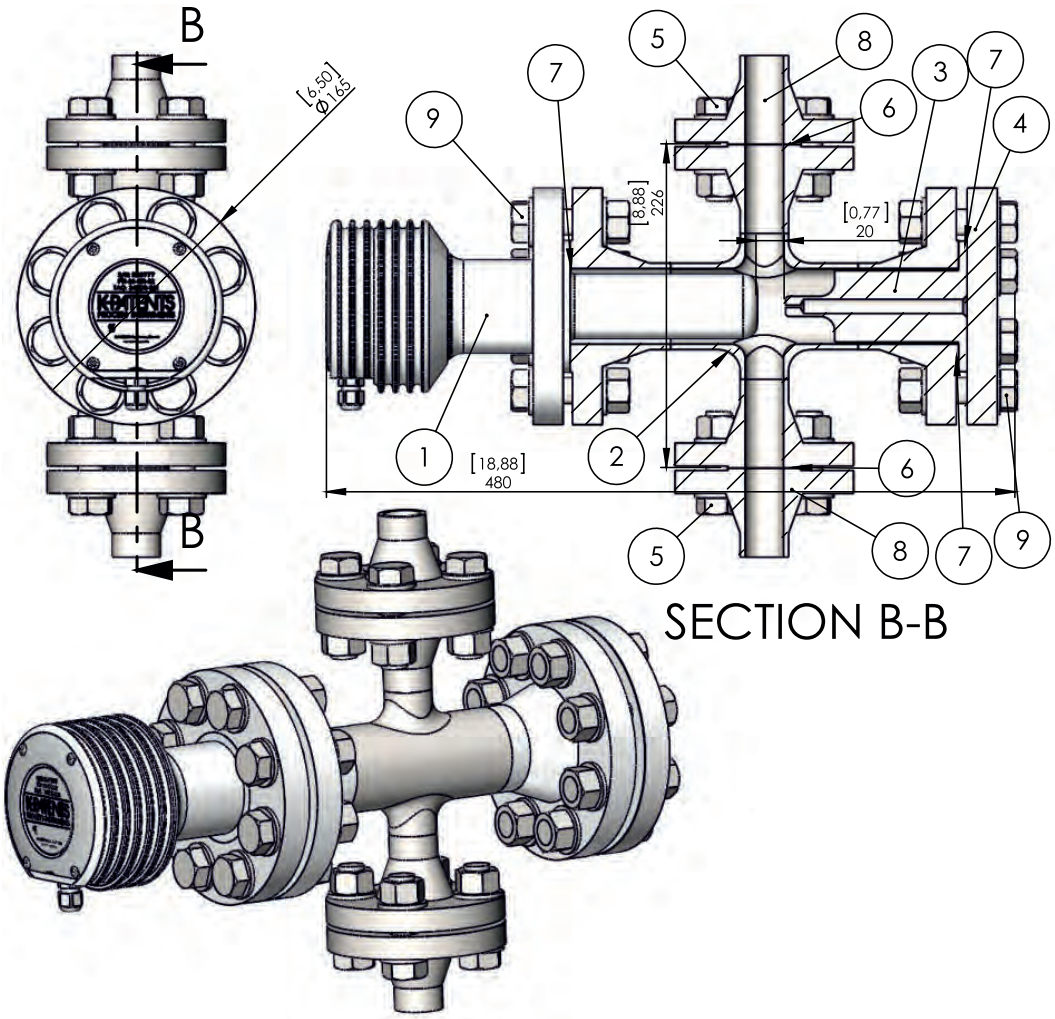


Figure 9.23 PR-23-RP-73-M20

9.7.6 PR-23-RP mounting specifics

The Refractometer sensor is installed in the process, either directly by welding a mounting flange to 2 inch or larger pipes or vessels, or via a 1 inch, 2 inch or 3 inch cross flowcell. Due to the sensor's rugged, innovative non-weld sensor body, and self-cleaning or optional wash system capabilities, the PR-23-RP functions accurately and reliably in harsh refinery conditions. Intrinsically safe and hazardous area certification is provided for hazardous areas.

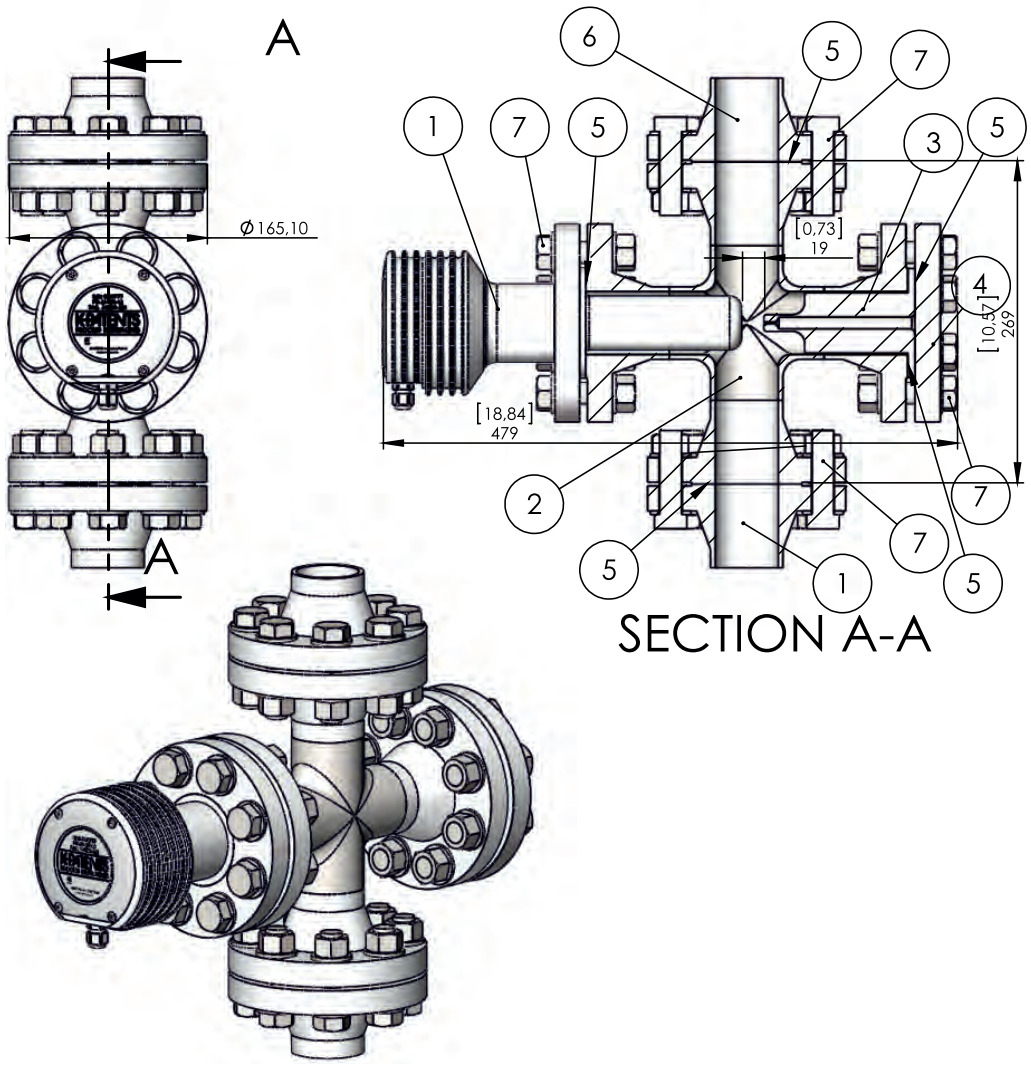
PR-23-RP mounting in CFC 1” line



Item.	Description	Supplied by	Pcs.	Item.	Description	Supplied by	Pcs.
1	Sensor PR-23-RP-73-M20	K-Patents	1	5	Bolt, washer and nut for 1”flange	Customer	8
2	CFC-RP-M20-M10-NC-PG/SN/WP	K-Patents	1	6	1’’ flange gasket	Customer	2
3	2”ANSI 300 Wash nozzle	K-Patents	1	7	2’’ flange gasket	Customer	3
4	1”ANSI 300 blind flange	K-Patents	1	8	1’’ ANSI 300 Welding neck flange	Customer	2
				9	Bolt, washer and nut for 2”flange	Customer	16

Figure 9.24 CFC-RP-M20-SS/HC/HA-M10-NC-PG/SN/WP flowcell

PR-23-RP mounting in 2” line

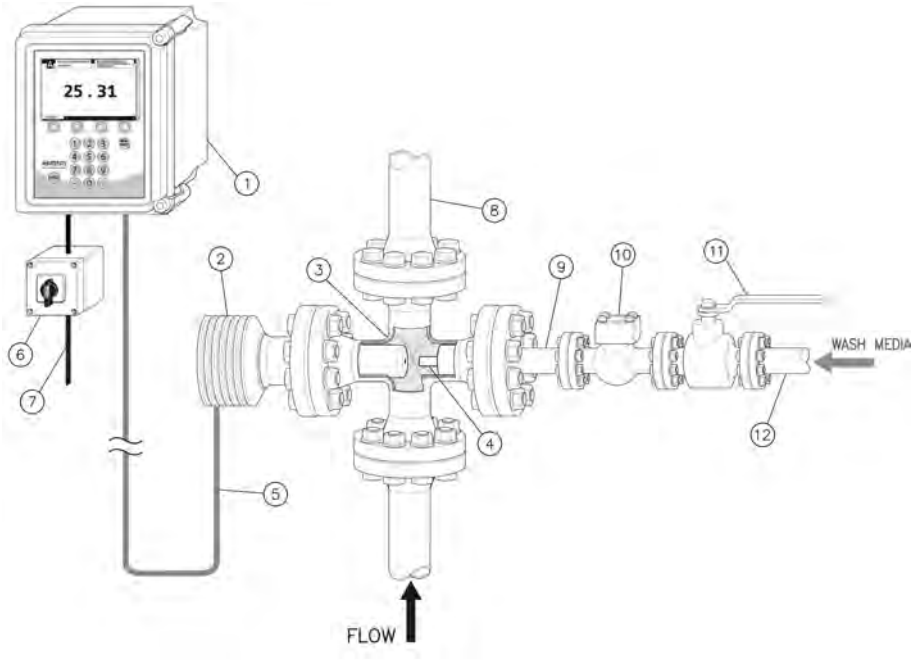


Item.	Description	Supplied by	Pcs.	Item.	Description	Supplied by	Pcs.
1	Sensor PR-23-RP-73-M20	K-Patents	1	5	2”flange gasket	Customer	5
2	CFC-23-RP-M20-M20-NC-PG/SN/WP	K-Patents	1	6	2”ANSI 300 Welding neck flange	Customer	2
3	2’’ ANSI 300 Wash nozzle	K-Patents	1	7	Bolt, washer and nut for 2”flange	Customer	32
4	1’’ ANSI 300 blind flange	K-Patents	1				

Figure 9.25 CFC-RP-M20-SS/HC/HA-M20-NC-PG/SN/WP flowcell

9.7.7 PR-23-RP prism wash system

A prism wash system is available for the PR-23-RP. This requires the use of a CFC-RP-M20 flow-cell in combination with a 2" ANSI 300 CFC wash nozzle. Both of these components are available from Vaisala. All the further components specifically required for the wash system installation, are obtained independently by the customer. These include a 2" ANSI 300 to ½" ANSI 300 adapter, ½" ANSI check valve, ½" ANSI 300 shut-off valve, ½" supply piping for the wash media. See Figure 9.26



Item.	Description	Supplied by	Pcs.	Item.	Description	Supplied by	Pcs.
1	Indicating transmitter DTR	K-Patents	1	7	Power supply 100-240 VAC/50-60Hz	Customer	1
2	Sensor PR-23-RP	K-Patents	1	8	Process pipe	Customer	1
3	CFC-RP-M20 flow cell	K-Patents	1	9	2'' ANSI 300 to 1/2"ANSI 300 adapter	Customer	1
4	2'' ANSI 300 CFC wash nozzle	K-Patents	1	10	Check valve ANSI 1/2"	Customer	1
5	Cable between DTR and sensor	K-P/Customer	1	11	1/2'' ANSI 300 Valve	Customer	1
6	Main switch PR-10900	Customer/K-P	1	12	Wash supply 1/2"	Customer	1

Figure 9.26 A prism wash system for PR-23-RP

9.8 Teflon body refractometer PR-23-M/MS

Teflon body refractometer PR-23-M/MS is designed for use in chemically aggressive solutions and ultra-pure fine chemical processes.

PR-23-M is an all-purpose model, PR-23-MS is designed especially for the semiconductor industry. The sensor has a built-in flowcell designed to keep all metal and other easily corroding parts from coming into contact with the process liquid. All the wetted parts are made of non-metallic materials, either PTFE (Teflon®) or PVDF (Kynar®), and thus the PR-23-M/MS sensor withstands corrosion very well.

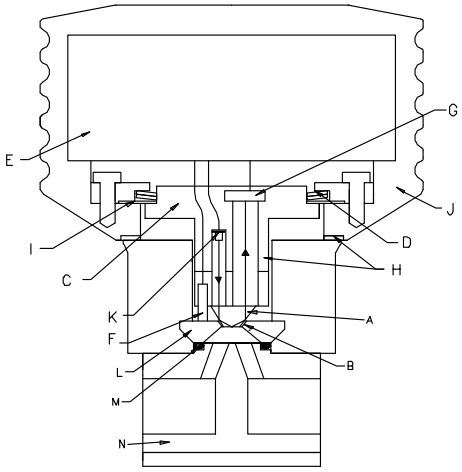


Figure 9.27 The PR-23-M/MS sensor

Figure 9.27 shows the structure of the sensor. The flowcell (N) and the sapphire plate (L) are fixed to the stainless steel sensor with four screws. The flowcell (N) is sealed by a Kalrez O-ring (M). The flowcell prevents any leakage reaching the metal parts, because there is a circular leakage chamber behind the O-ring (M). The chamber connects to a checkport, which has a 1/8" female thread connection.

9.8.1 PR-23-M sensor model code

MODEL AND DESCRIPTION	MODEL
PR-23 = Sensor	PR-23
Sensor model -M = Aggressive medium adapter	 -M
Refractive Index range limits 73 = n_D 1.320–1.530 (0–100 Brix) Sapphire prism 74 = n_D 1.260–1.470 Sapphire prism	 73 74
Electrical classification -GP = General purpose -AX = ATEX and IECEx certified Ex II 3 G, Ex nA IIC T4 Gc (up to Zone 2) (T_{amb} -20 ... +65°C) -FM = FM certified Class I, Div. 2, Groups A, B, C, D, T6 (T_{amb} -20 ... +45°C) -CS = CSA certified Class I, Div. 2, Groups A, B, C, D, T4 (T_{amb} -20 ... +45°C) -IA = ATEX and IECEx certified Ex II 1 G, Ex ia IIC T4 Ga (up to Zone 0) (T_{amb} -20 ... +65°C) **(A)** -IF = FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D T4 (T_{amb} -20 ... +45°C) **(A)**	 -GP -AX -FM -CS -IA -IF
Sensor housing -SC = Stainless steel	 -SC

(A) Available with STR Indicating Transmitter and IS isolator only

Example: Sensor: PR-23-M73-GP-SC

FLOWCELL FOR SENSOR PR-23-M	MODEL
Process connection FR = Flowcell with G 1/2 inch thread inlet/outlet connection (female) FN = Flowcell body with 1/2 inch NPT thread inlet/outlet (female)	 FR FN
Line size connection diameter -050 = 1/2 inch (flow volume 2-8 l/min (0.5-2.1 GPM))	 -050
Flowcell wetted parts material -PV = Kynar® (PVDF=Polyvinylidenefluoride) -TF = Teflon® (PTFE=Polytetrafluoroethylene)	 -PV -TF

Example: Flowcell: FR-050-PV/TF, FN-050-PV/TF

9.8.2 PR-23-M specifications

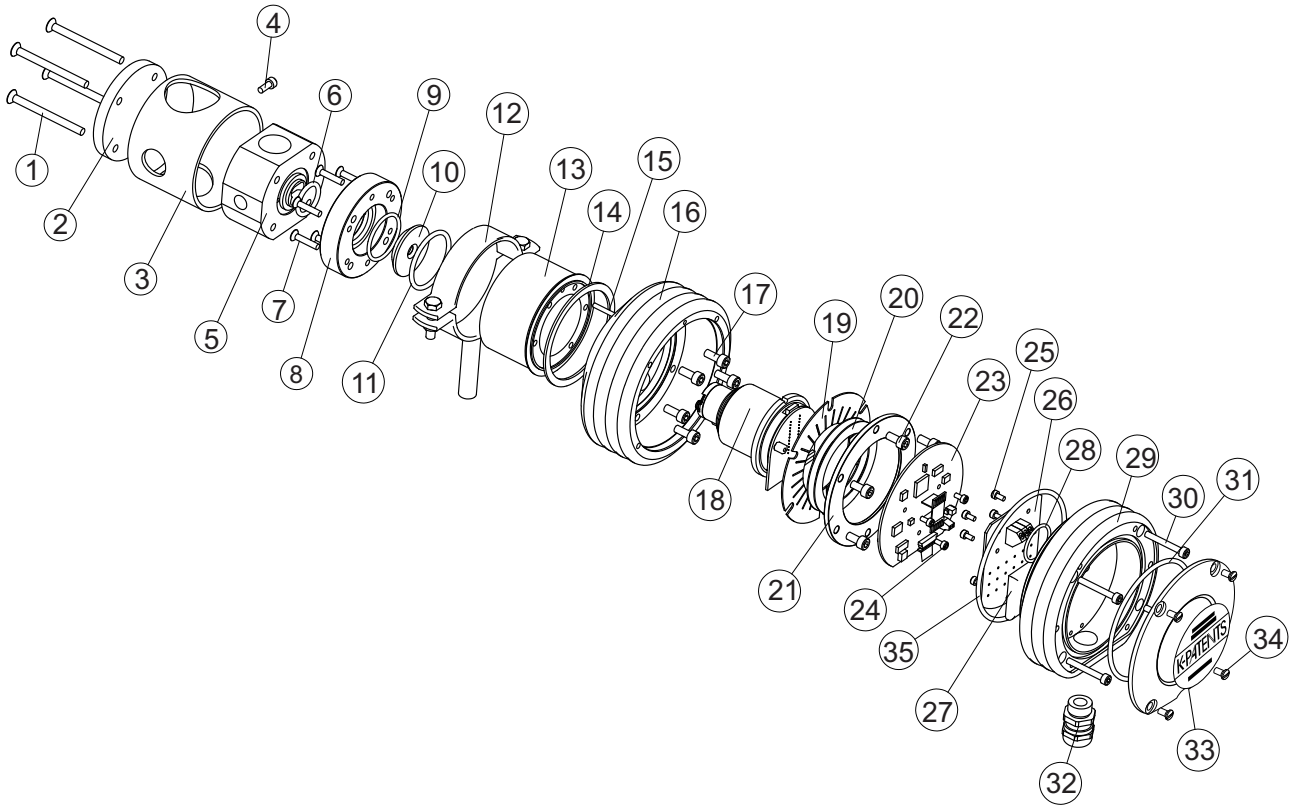
General specifications

Refractive Index range, standard:	Full range n_D 1.3200–1.5300 (corresponds to hot water – 100% b.w.) with Spinel prism H62 and Sapphire prism H73 starting Nov. 1, 2012
Refractive Index range, option	With sapphire prism H74 n_D1.2600–1.4700
Accuracy:	Refractive index n_D ± 0.0002 (corresponds typically to ± 0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Calibration:	With Cargille certified refractive index liquids over full range of n_D 1.3200–1.5300
CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED) 589 nm wavelength, sodium light
Temperature sensor:	Built-in Pt-1000
Temperature compensation:	Automatic, digital compensation
Instrument verification:	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature:	Sensor: max. 45 °C (113 °F), min. -20 °C (-4 °F) Indicating transmitter: max. 50 °C (122 °F), min. 0 °C (32 °F)
SENSOR PR-23-M:	Teflon body sensor model for aggressive medium
Sensor protection class:	IP67, Nema 4X
Sensor weight:	5.0 kg (12.1 lbs)

FLOW CELL FOR PR-23-M

Process connection:	Thread G 1/2" or 1/2" NPT female
Process pressure:	max. 10 bar (145 psi)
Process temperature:	max. 130 °C (266 °F)
Process wetted parts, standard:	Teflon® (PTFE) or Kynar® (PVDF), prism gaskets MTF (Modified Teflon®), prism Spinel, O-ring Kalrez, adaptor sapphire
Process wetted parts, option:	prism sapphire

9.8.3 PR-23-M parts list



Item	Pcs.	Part No.	Description	Item	Pcs.	Part No.	Description
1	4		Screw DIN 7991 M5x70 A4	18	1	PR-10036	PR-23 compact sensor CORE module
2	1		PR-23-M endplate	19	1	PR-9011	Thermal conductor
3	1	PR-9129	PR-03/23-M protection cover	*	1	PR-9010	Disc spring set
4	1		Screw DIN 912 M4x10 A4	20	2		Disc spring
5	1	PR-9120	PR-03/23-M-PV-R05 flow cell (PVDF)	21	1		Disc spring holder
5	1	PR-9121	PR-03/23-M-TF-R05 flow cell (PTFE)	22	6		Screw DIN 912 M5x12 A2
6	1	PR-9252	O-ring 20.2 x 3 Kalrez 6375UP	23	1	PR-10103	Sensor processor card
7	6		Screw M4 x 20 DIN 7991 A4	24	4		Screw M3x6 DIN 912 A2
8	1		PR-03/23-M headring (PVDF)	25	4		Screw M3x6 DIN 912 A2
9	1	PR-9112	O-ring seal 30.3 x 2.4 FPM	26	1	PR-10300	Bus terminator card
10	1	PR-9126	Sapphire plate for PR-03/23-M	27	1	PR-9108	Dryer sachet
11	1	PR-9113	O-ring seal 37.3 x 3 FPM	28	1	PR-10032	O-ring seal 24 x 2
12	1	PR-9100	Sensor support	29	1	PR-10000	PR-23 cover
13	1	PR-11101	PR-23-M head	29	1	PR-10000-EC	PR-23-EC cover
14	1	PR-10048	68x3 O-ring	30	4		Screw M4x30 DIN 912 A4
15	1		Alignment pin	31	1	PR-10002	O-ring seal 82x3
16	1	PR-10005	PR-23 base	32	1		Cable gland M16x1.5
16	1	PR-10005-EC	PR-23-EC base	33	1		PR-23-M endplate with label
17	6		Screw M5x12 DIN 912 A2	34	4		Screw M4x8 DIN 964 A4
	6		Locking spacer M5	35	1	PR-10031	O-ring seal 89.5 x 3

9.8.4 PR-23-MS sensor model code

MODEL AND DESCRIPTION	MODEL
PR-23 = Sensor	PR-23
Sensor model	
-MS = Aggressive medium adapter, semiconductor industry	-MS
Refractive Index range limits	
73 = n_D 1.320–1.530 (0–100 Conc% b.w.) Sapphire prism	73
74 = n_D 1.260–1.470 Sapphire prism	74
Electrical classification	
-GP = General purpose	-GP
-AX = ATEX and IECEx certified Ex II 3 G, Ex nA IIC T4 Gc (up to Zone 2) (T_{amb} -20 ... +65°C)	-AX
-FM = FM certified Class I, Div. 2, Groups A, B, C, D, T6 (T_{amb} -20 ... +45°C)	-FM
-CS = CSA certified Class I, Div. 2, Groups A, B, C, D, T4 (T_{amb} -20 ... +45°C)	-CS
-IA = ATEX and IECEx certified Ex II 1 G, Ex ia IIC T4 Ga (up to Zone 0) (T_{amb} -20 ... +65°C) **(A)**	-IA
-IF = FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D T4 (T_{amb} -20 ... +45°C) **(A)**	-IF
Sensor housing	
-EC = Epoxy coated stainless steel	-EC

(A) Available with STR Indicating Transmitter and IS isolator only

Example: Sensor: PR-23-MS73-GP-EC

FLOWCELL FOR SENSOR PR-23-MS	MODEL
Process connection	
-F2 = Flowcell body with Flare fitting	-F2
-P2 = Flowcell body with Pillar fitting	-P2
Line size connection diameter	
025 = 1/4 inch	-025
050 = 1/2 inch	-050
075 = 3/4 inch	-075
100 = 1 inch	-100
Flowcell wetted parts material	
-TM = Modified PTFE Ultra-Pure (PTFE=Polytetrafluoroethylene)	-TM

Flowcell is integrally mounted to the PR-23-MS sensor

Example: Flowcell: F2-025-TM

9.8.5 PR-23-MS specifications

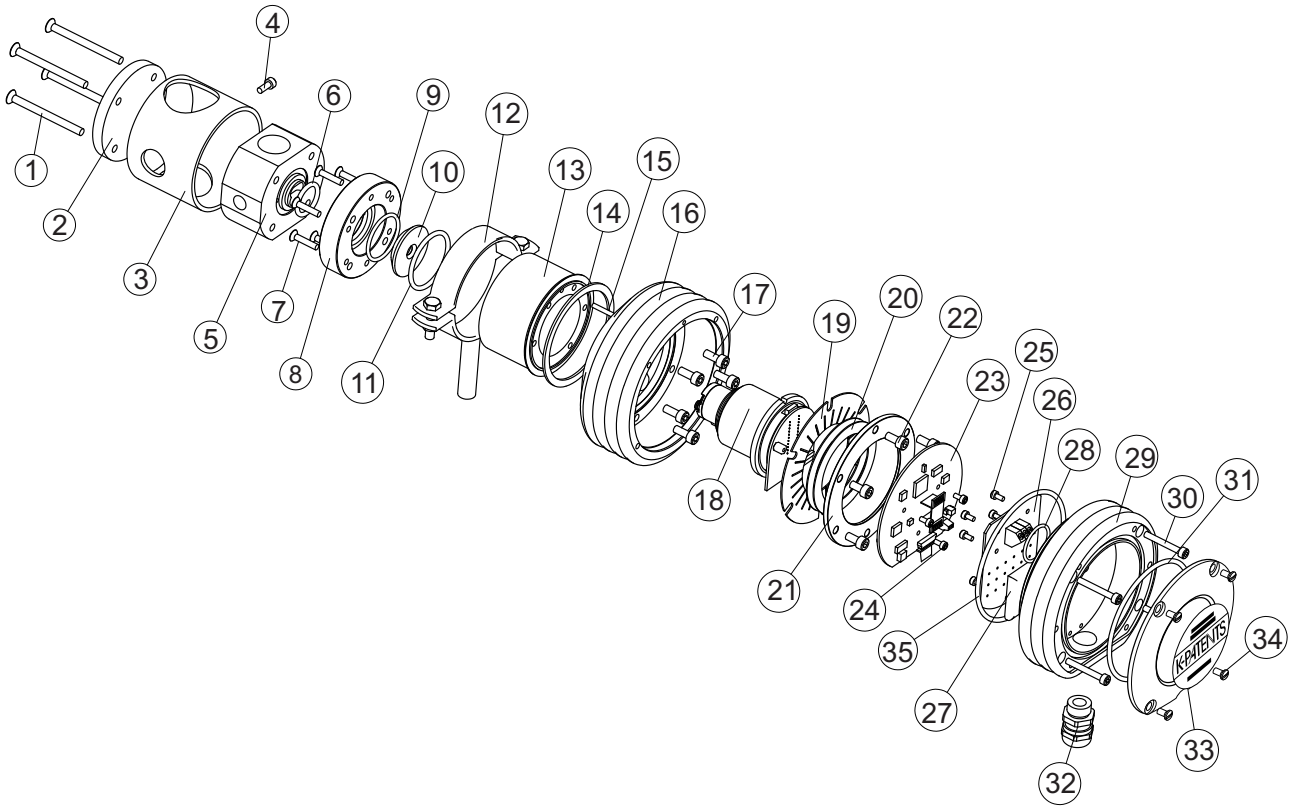
General specifications

Refractive Index range, standard:	Full range n_D 1.3200–1.5300 (corresponds to hot water – 100% b.w.) with Sapphire prism H73
Refractive Index range, option	With sapphire prism H74 n_D1.2600–1.4700
Accuracy:	Refractive index n_D ± 0.0002 (corresponds typically to ± 0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Calibration:	With Cargille certified refractive index liquids over full range of n_D 1.3200–1.5300
CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED) 589 nm wavelength, sodium light
Temperature sensor:	Built-in Pt-1000
Temperature compensation:	Automatic, digital compensation
Instrument verification:	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature:	Sensor: max. 45 °C (113 °F), min. -20 °C (-4 °F) Indicating transmitter: max. 50 °C (122 °F), min. 0 °C (32 °F)
SENSOR PR-23-MS:	Teflon body sensor model for aggressive medium
Sensor protection class:	IP67, Nema 4X
Sensor weight:	5.0 kg (12.1 lbs)

FLOW CELL FOR PR-23-MS

Process connection:	Thread G 1/2" or 1/2" NPT female
Process pressure:	max. 10 bar (145 psi)
Process temperature:	max. 130 °C (266 °F)
Process wetted parts, standard:	Teflon® (PTFE) or Kynar® (PVDF), prism gaskets MTF (Modified Teflon®), prism Spinel, O-ring Kalrez, adaptor sapphire
Process wetted parts, option:	prism sapphire

9.8.6 PR-23-MS parts list



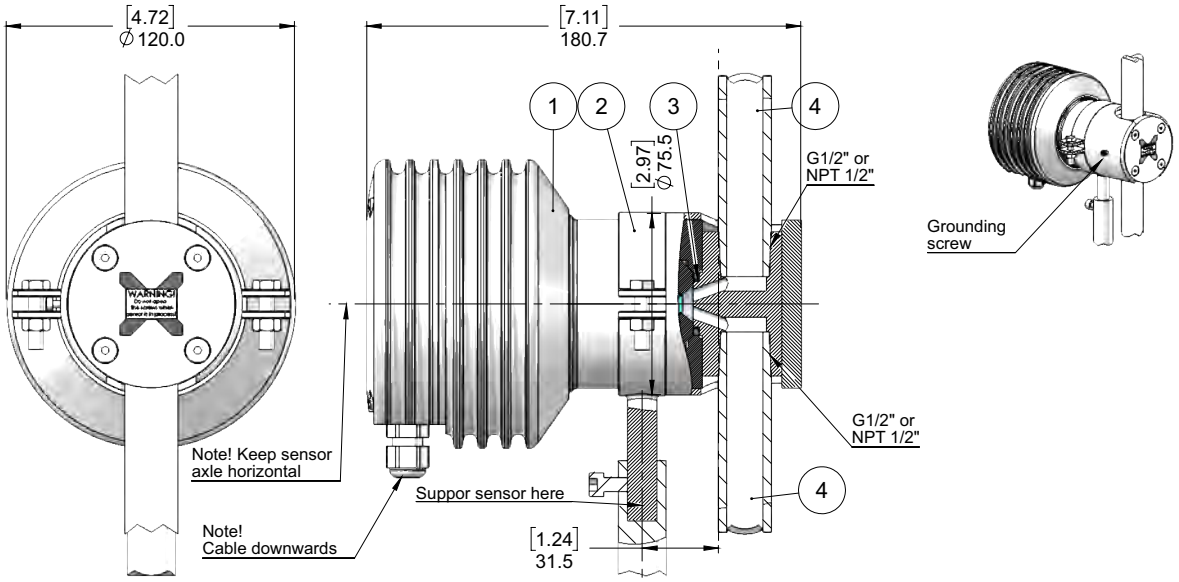
Item	Pcs.	Part No.	Description
1	4		Screw DIN 7991 M5x70 A4
2	1		PR-23-MS endplate
3	1	PR-9129-EC	PR-23-MS protection cover
4	1		Screw DIN 912 M4x10 A4
5	1	PR-9120	PR-03/23-M-PV-R05 flow cell (PVDF)
5	1	PR-9121	PR-03/23-M-TF-R05 flow cell (PTFE)
6	1	PR-9252	O-ring 20.2 x 3 Kalrez 6375UP
7	6		Screw M4 x 20 DIN 7991 A4
8	1		PR-03/23-M headring (PVDF)
9	1	PR-9112	O-ring seal 30.3 x 2.4 FPM
10	1	PR-9126	Sapphire plate for PR-03/23-M
11	1	PR-9113	O-ring seal 37.3 x 3 FPM
12	1	PR-9100-EC	MS Sensor support
13	1	PR-11101-EC	PR-23-MS head
14	1	PR-10048	68x3 O-ring
15	1		Alignment pin
16	1	PR-10005	PR-23 base
16	1	PR-10005-EC	PR-23-EC base
17	6		Screw M5x12 DIN 912 A2
	6		Locking spacer M5
18	1	PR-10036	PR-23 compact sensor CORE module
19	1	PR-9011	Thermal conductor

Item	Pcs.	Part No.	Description
*	1	PR-9010	Disc spring set
20	2		Disc spring
21	1		Disc spring holder
22	6		Screw DIN 912 M5x12 A2
23	1	PR-10103	Sensor processor card
24	4		Screw M3x6 DIN 912 A2
25	4		Screw M3x6 DIN 912 A2
26	1	PR-10300	Bus terminator card
27	1	PR-9108	Dryer sachet
28	1	PR-10032	O-ring seal 24 x 2
29	1	PR-10000	PR-23 cover
29	1	PR-10000-EC	PR-23-EC cover
30	4		Screw M4x30 DIN 912 A4
31	1	PR-10002	O-ring seal 82x3
32	1		Cable gland M16x1.5
33	1		PR-23-M endplate with label
34	4		Screw M4x8 DIN 964 A4
35	1	PR-10031	O-ring seal 89.5 x 3

9.8.7 PR-23-M/MS mounting specifics

Teflon body refractometer PR-23-M/MS is connected to the process by a G1/2" female or a 1/2" NPT process connection, Figure 9.28 below.

Important: Always install PR-23-M/MS with **sensor support** to prevent the sensor weight from pulling at the non-metallic piping. See Figure 9.28 for support placement.



Item no.	Name	Material	Supplied by	Pcs.
1	Sensor PR-23-M		K-Patents	1
2	Sensor support	AIS304	K-Patents	1
3	O-ring 20.2x3	Kalrez 6375	K-Patents	1
4	Process pipe		Customer	2

Figure 9.28 G1/2" female process connection (mm [in])

9.9 Saunders body refractometer PR-23-W

Saunders body refractometer PR-23-W is a heavy-duty instrument designed for chemically aggressive liquids and ultra-pure fine chemicals in *large-scale production* and in *large pipelines*. The materials and design of the sensor are similar to the Teflon body refractometer PR-23-M, but the Saunders body makes it possible to fit this refractometer into 50, 80 or 100 mm (2", 3" or 4") pipelines.

The Saunders body material is graphite cast iron lined with 3 mm PFA (Fluorinated ethylene propylene) or ETFE (Ethylene tetrafluoroethylene) fluoroplastic. The cast iron provides a solid mechanical base and the PFA/ETFE lining ensures the chemical resistance.

The sensor itself is built just like the PR-23-M sensor (see Section 9.8) and it is fixed to the Saunders body in the same way, with a sapphire plate and a Kalrez O-ring to keep all the metallic parts away from the process liquid.

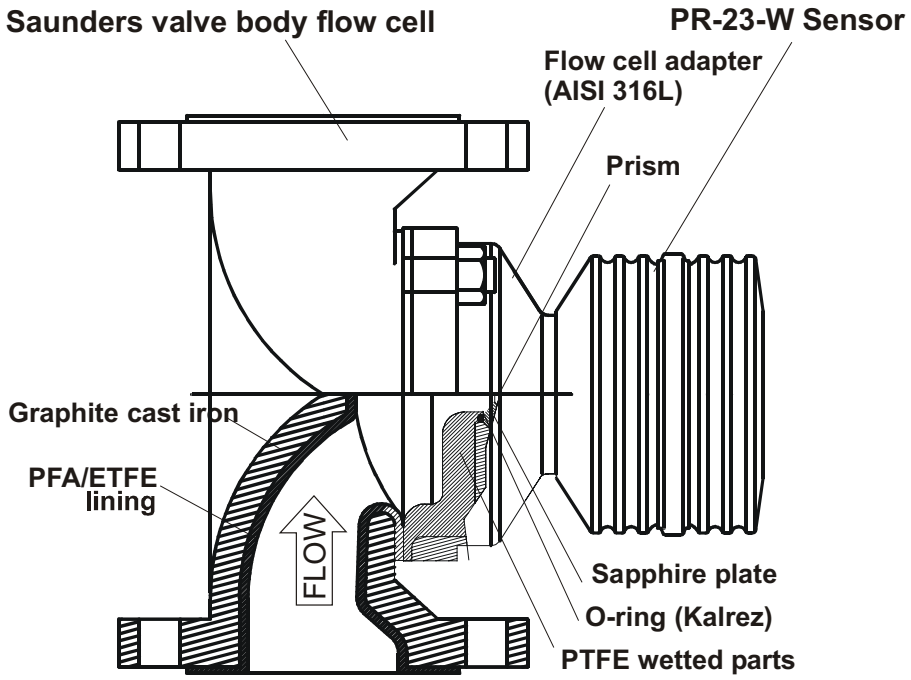


Figure 9.29 PR-23-W Saunders body sensor

9.9.1 PR-23-W sensor model code

MODEL AND DESCRIPTION	MODEL
PR-23 = Sensor	PR-23
Sensor model -W = Aggressive medium Saunders body flowcell	 -W
Refractive Index range limits 73 = n_D 1.320–1.530 Sapphire prism 74 = n_D 1.260–1.4700 Sapphire prism	 73 74
Sensor wetted parts material -2TF = Teflon® (PTFE=Plytetrafluoroethylene)	 -2TF
Sensor/diaphragm valve body connection 4 = Adapter for 4 inch/DN 100 valve body 3 = Adapter for 3 inch/DN 80 valve body 2 = Adapter for 2 inch/DN 50 valve body	 4 3 2
Electrical classification -GP = General Purpose -AX = ATEX and IECEx certified Ex II 3 G, Ex nA IIC T4 Gc (up to Zone 2) (T_{amb} -20 ... +65°C) -FM = FM certified Class I, Div. 2, Groups A, B, C, D, T6 (T_{amb} -20 ... +45°C) -CS = CSA certified Class I, Div. 2, Groups A, B, C, D, T4 (T_{amb} -20 ... +45°C) -IA = ATEX and IECEx certified Ex II 1 G, Ex ia IIC T4 Ga (up to Zone 0) (T_{amb} -20 ... +65°C) **(A)** -IF = FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D T4 (T_{amb} -20 ... +45°C) **(A)**	 -GP -AX -FM -CS -IA -IF
Sensor housing -SC = Stainless steel	 -SC

(A) Available with STR Indicating Transmitter and IS isolator only

Example: Sensor: PR-23-W62-2TF4-GP-SC

SAUNDERS VALVE BODY FOR SENSOR PR-23-W	MODEL
SVB = Saunders valve body	SVB
Process line connection -A040 = ANSI flange 4 inch 150 lbs -A030 = ANSI flange 3 inch 150 lbs -A020 = ANSI flange 2 inch 150 lbs -D100 = DIN flange DN 100 PN 16 -D080 = DIN flange DN 80 PN 16 -D050 = DIN flange DN 50 PN 16 -J100 = JIS flange 10K 100A -J080 = JIS flange 10K 80A -J050 = JIS flange 10K 50A	 -A040 -A030 -A020 -D100 -D080 -D050 -J100 -J080 -J050
Valve body material -GC = Graphite cast iron	 -GC
Valve body lining material -PFA = PFA (= Fluorinated ethylene propylene)/ -ETFE = ETFE (= Ethylene tetrafluoroethylene)	 -PFA/-ETFE

Example: Valve body: SVB-A040-GC-ETFE

9.9.2 PR-23-W specifications

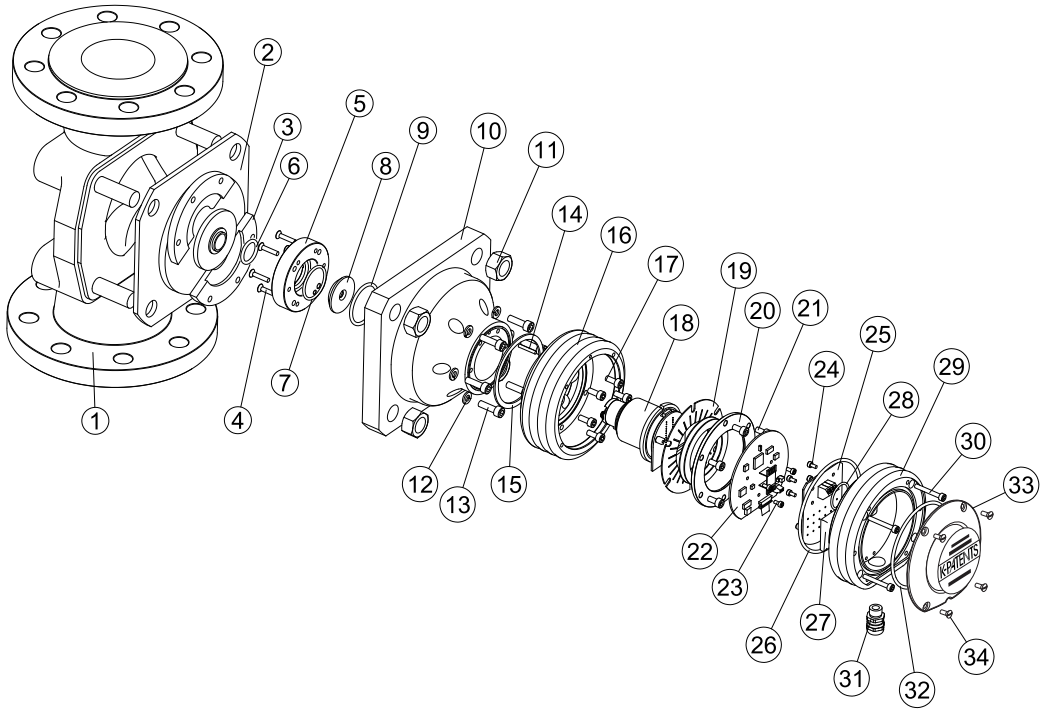
General specifications

Refractive Index range, stand.:	Full range n_D 1.3200–1.5300 (0–100 Conc% b.w.) with Spinel prism H62 and Sapphire prism H73
Refractive Index range, option:	n_D 1.2600–1.4700 with Sapphire prism H74
Accuracy:	Refractive index n_D ± 0.0002 (corresponds typically to ± 0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Calibration:	With Cargille certified refractive index liquids over full range of n_D 1.3200–1.5300
CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED) 589 nm wavelength, sodium light
Temperature sensor:	Built-in Pt-1000
Temperature compensation:	Automatic, digital compensation
Instrument verification:	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature:	Sensor: max. 45 °C (113 °F), min. -20 °C (-4 °F) Indicating transmitter: max. 50 °C (122 °F), min. 0 °C (32 °F)
SENSOR PR-23-W:	Saunders body sensor for aggressive process medium
Process connection:	With PFA (Fluorinated ethylene propylene) or ETFE (Ethylene tetrafluoroethylene) lined Saunders valve body 2", 3" or 4"
Process pressure:	max. 10 bar (145 psi)
Process temperature:	-20 °C–+130 °C (-4 °F–+266 °F)
Process wetted parts, stand.:	Teflon® (PTFE), prism spinel or sapphire, prism gaskets MTF (Modified Teflon)
Sensor protection class:	IP67, Nema 4X
Sensor weight:	Sensor and 2" Saunders body 15 kg (33 lbs), sensor and 3" Saunders body 26 kg (57 lbs), sensor and 4" Saunders body 33 kg (73 lbs)

SAUNDERS VALVE BODY

Valve body material	Graphite cast iron
Valve body lining material	PFA (Fluorinated ethylene propylene) / ETFE (Ethylene tetrafluoroethylene)
Process connection	ANSI flange 4 inch 150 lbs / ANSI flange 3 inch 150 lbs / ANSI flange 2 inch 150 lbs / DIN flange DN 100 PN 16 / DIN flange DN 80 PN 16 / DIN flange DN 50 PN 16

9.9.3 PR-23-W parts list

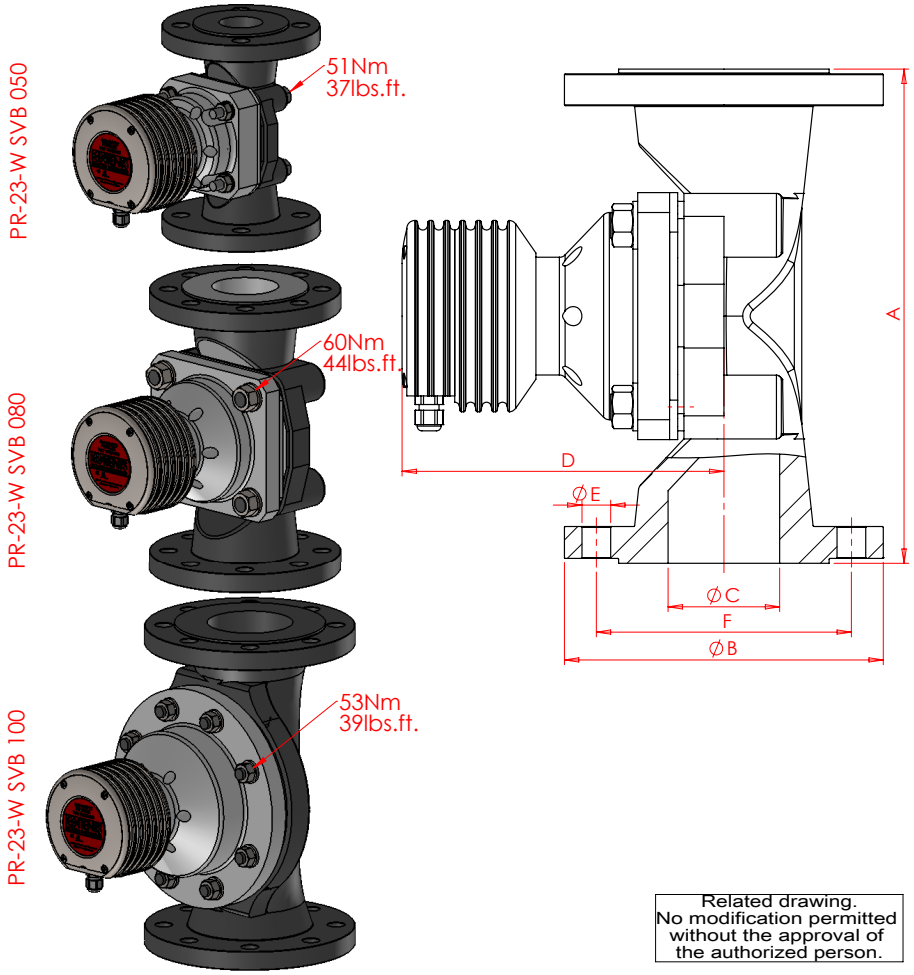


Item	Pcs.	Part No.	Description
1	1		Saunders valve body PFA/ETFE lining ANSI 2”/DIN 50/JIS 50
1	1		Saunders valve body PFA/ETFE lining ANSI 3”/DIN 80/JIS 80
1	1		Saunders valve body PFA/ETFE lining ANSI 4”/DIN 100/JIS 100
2	1		Facing for 2” valve body
2	1		Facing for 3” valve body
2	1		Facing for 4” valve body
3	2		Split disc
4	6		Screw M4x20 DIN 7991 A4
5	1		PR-03/23-W headring (PVDF)
6	1	PR-9252	O-ring seal 20.2 x 3.0 Kalrez 6375UP
7	1	PR-9112	O-ring seal 31.6 x 2.4 FPM
8	1	PR-9122	Sapphire plate for PR-03/23-W
9	1	PR-9113	O-ring seal 37.2 x 3 FPM
10	1	PR-11019	PR-23-W 2” head
10	1	PR-11020	PR-23-W 3” head
10	1	PR-11021	PR-23-W 4” head
11	4		Nuts DIN 934 M16 A4
12	6		Washers DIN 127 M6 A4
13	6		Screws DIN 912 M6x20 A4
14	1	PR-10048	68x3 O-ring
15	1		Alignment pin
16	1	PR-10005	PR-23 base
17	6		Screw M5x12 DIN 912 A2
	6		Locking spacer M5
18	1	PR-10012	PR-23 compact sensor CORE module
19	1	PR-9011	Thermal conductor

Item	Pcs.	Part No.	Description
*	1	PR-9010	Disc spring set
	2		Disc spring
20	1		Disc spring holder
21	6		Screw M5x10 DIN 912 A2
22	1	PR-10103	Sensor processor card
23	4		Screw M3x6 DIN 912 A2
24	4		Screw M3x6 DIN 912 A2
25	1	PR-10300	Bus terminator card
26	1	PR-10031	O-ring seal 89.5 x 3
27	1	PR-9108	Dryer sachet
28	1	PR-10032	O-ring seal 24 x 2
29	1	PR-10000	PR-23 cover
30	4		Screw M4x30 DIN 912 A4
31	1		Cable gland M16x1.5
32	1	PR-10002	O-ring seal 82x3
33	1		PR-23-W endplate with label
34	4		Screw M4x8 DIN 964 A4

9.9.4 PR-23-W mounting specifics

PR-23-W Saunders valve body flowcell can be mounted either vertically or horizontally. Special sensor support is not needed as the valve body (piping) supports the sensor. Either way sensor cover should always be horizontal to avoid sedimentation or gas/air pocket on the prism. Also installation after pump, before valve and low installation point will reduce risk of air/gas pocket. Recommended flow velocity is 1.5–6m/s (5–20ft/s).



Saunders valve body	Flange size	A	B	C	D	E	F
SVB-A020	ANSI 2" 150psi	196 [7.72]	152.4 [6]	47 [1.85]	189 [7.40]	19.1 [0.75]	120.7 [4.75]
SVB-D050	DN50 10bar	230 [9.06]	165 [6.50]	50 [1.97]	189 [7.40	18 [0.71]	125 [4.92]
SVB-J050	JIS 10k 50A		155[6.1]	61.1[2.4]		19[0.75]	120[4.72]
SVB-A030	ANSI 3" 150psi	260 [10.24]	190.5 [7.5]	78 [3.07]	205 [8.07]	19.1 [0.75]	152.4 [6]
SVB-D080	DN80 10bar	310 [12.2]	200 [7.87]	80 [3.15]	205 [8.07]	18 [0.71]	160 [6.30]
SVB-J080	JIS 10k 80A		185[7.28]	90[3.54]		19[0.75]	150[5.90]
SVB-A040	ANSI 4" 150psi	311 [12.24]	228.6 [9]	92 [3.62]	256 [10.08]	19.1 [0.75]	190.5 [7.5]
SVB-D100	DN100 10bar	350 [13.78]	220 [8.66]	100 [3.94]	256 [10.08]	18 [0.71]	180 [7.09]
SVB-J100	JIS 10k 100A		210[8.27]	115.4[4.54]		19[0.75]	175[6.89]

Figure 9.30 PR-23-W mounting

9.10 PR-23 process refractometers in potentially explosive atmosphere

The PR-23 refractometer series can be used in locations with potentially explosive atmosphere *with following modifications, made by Vaisala Oyj*. The refractometer sensor's compliance with the Essential Health and Safety Requirements is assured by complying with standard EN 50 021:1999.

The PR-23-...-AX refractometers have been certified by DEKRA Certification B.V. under the European ATEX directive 2014/34/EU for ATEX Ex II 3G / Ex nA IIC T4 Gc and under the IECEx scheme for Ex nA IIC T4 Gc. The Type-examination Certificate number is KEMA 05ATEX1183X and the IECEx Certificate number is IECEx KEM 10.0033X. These certifications cover the following Ex standards: EN 60079-0:2012 / IEC 60079-0:2011, EN 60079-15:2010 / IEC 60079-15:2010.

The PR-23-...-FM refractometers are certified by Factory Mutual Research Corporation, Approval ID 3026104. Equipment Ratings: Nonincendive for use in Class I, Division 2, Groups A, B, C & D, Hazardous (Classified) Locations. Temperature identification rating for PR-23-...-FM is T6 (T_{amb} = 45 °C).

The PR-23-...-CS refractometers are certified by Canadian Standards Association for Class I, Division 2, Groups A-D. The Certificate Number is 1706327. Equipment Ratings: Nonincendive for use in Class I, Division 2, Groups A, B, C & D, Hazardous (Classified) Locations. Temperature identification rating for PR-23-...-CS is T4 (T_{amb} = 45 °C).

9.10.1 Equipment

The refractometer system (Figure 9.31) for potentially explosive atmosphere locations consists of a modified refractometer sensor PR-23-...-AX/FM/CS, a standard Indicating transmitter DTR and a sensor cable PR-8230-...

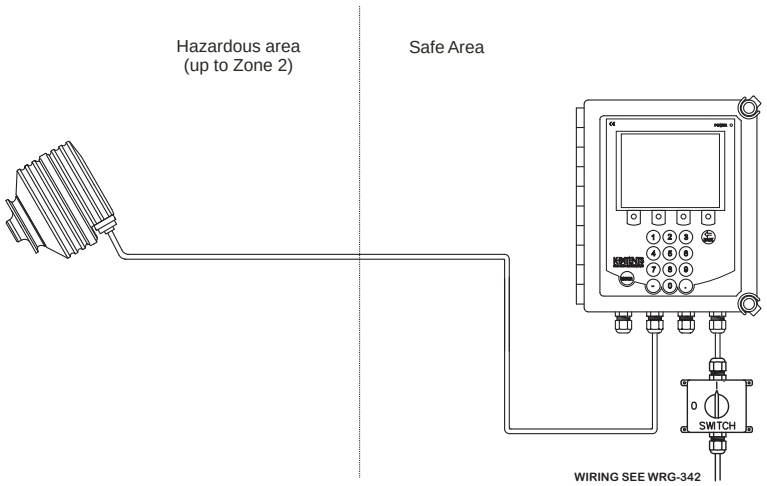


Figure 9.31 Refractometer system PR-23-...-AX/FM/CS

The ATEX/FM/CSA approved sensors PR-23-...-AX/FM/CS are identified by the sensor nameplate, see Figure 9.1. The Indicating transmitter is a standard DTR.

The approvals are valid for sensors PR-23-AC, PR-23-AP, PR-23-GP, PR-23-M, PR-23-MS, PR-23-SD, PR-23-W and PR-23-RP.

PR-23-AC/AP-...-AX nameplate

-AX nameplate, all other models

EX approval symbol

PR-23-AC/AP-...-FM nameplate

-FM nameplate, all other models

FM approval symbol

PR-23-AC/AP-...-CS nameplate

-CS nameplate, all other models

CSA approval symbol

Figure 9.32 PR-23-...-AX/FM/CS sensor nameplates

9.10.2 Installation

Sensor wiring must follow drawing WRG-367 or WRG-350, see Figure 9.33 on next page. See also Figure 4.5 on page 22 and Figure 4.8 on page 25.

Important: The FM unit installations must comply with the relevant requirements of National Electrical Code (ANSI/NFPA 70) for Division 2 Hazardous (Classified) Locations and all instructions in this manual. **All wiring of PR-23-...-FM systems must run in a conduit.**

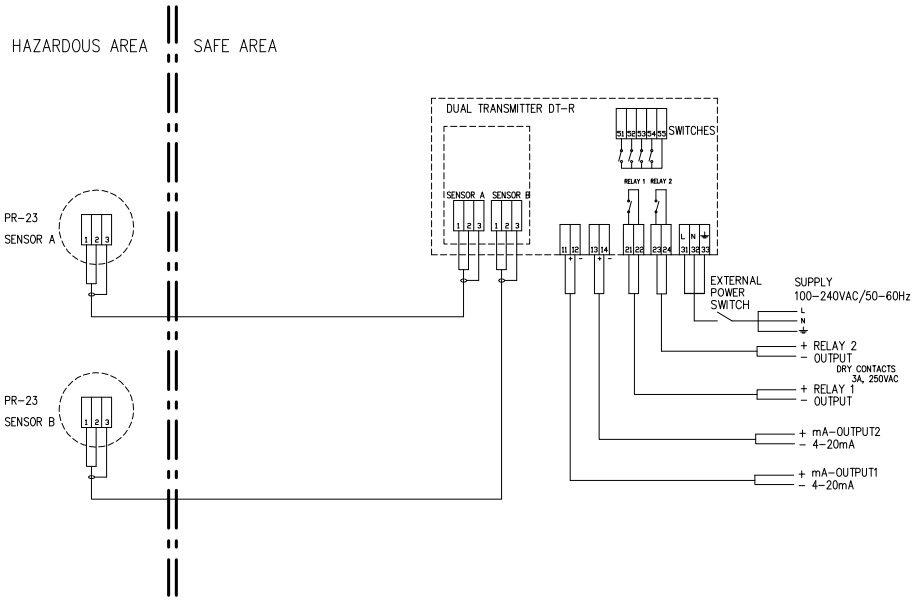
Important: Tampering and replacement with other than original Vaisala K-PATENTS® components is not allowed because this may affect adversely the safe use of the system.

Note: Sensor connector shall not be connected or disconnected when the circuits are energized. Switch OFF the power from Indicating transmitter DTR external power switch before disconnecting sensor cable from sensor. After connecting sensor cable back to the sensor you can switch power on again.

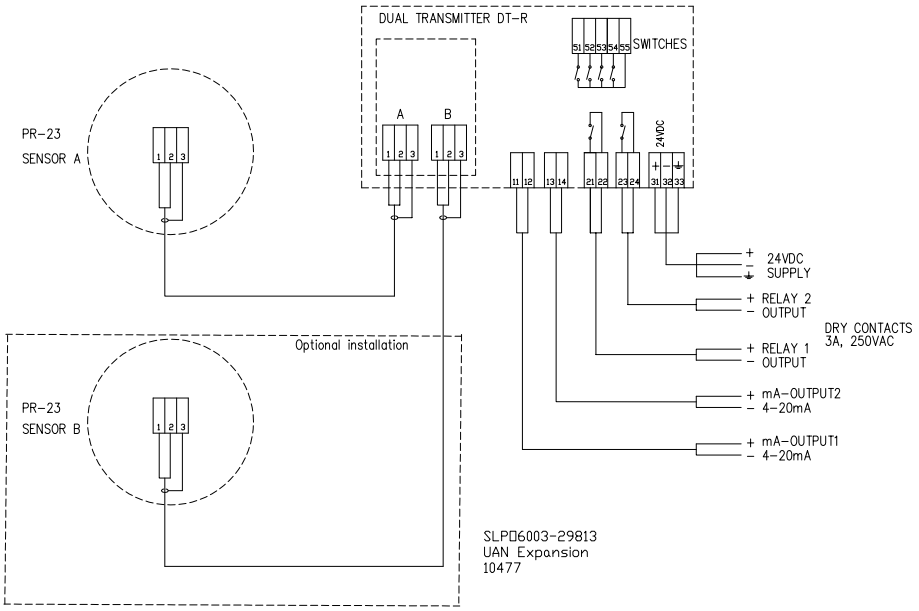
Important: Provisions shall be made to prevent the rated voltage from being exceeded by transient disturbances of more than 119V.

Important: The refractometer models PR-23-M, PR-23-MS and PR-23-W contain parts made of PTFE in sensor heads. These parts are subject to electrostatic hazard. The refractometer models PR-23-M, PR-23-MS and PR-23-W shall only be used for measuring liquids with high conductivity (> 10000 pS/m) in the presence of hazardous atmospheres.

Important: The painted surface of the enclosure of PR-23-MS refractometer is subject to electrostatic hazard and therefore the cleaning shall be done only with a damp cloth in the presence of hazardous atmospheres.



Safe sensor wiring according to WRG-367 (100-240 VAC)



Safe sensor wiring according to WRG-350 (24 VDC)

Figure 9.33 Safe sensor wiring

9.11 Intrinsically safe refractometers PR-23-...-IA and PR-23-...-IF

Hazardous locations are places where a possibility of fire or explosion exists because of flammable gases, vapors or fine dust.

Zone 0: An area in which an explosive gas-air mixture is continuously present or present for long periods of time.

Zone 1: An area in which an explosive gas-air mixture is likely to occur in normal operation.

Intrinsically Safe Process Refractometer PR-23-...-IA/-IF can be used in hazardous locations in Zone 0 and Zone 1 areas.

The PR-23-...-IA refractometers have been certified by Eurofins Expert Services Oy under the European ATEX directive 2014/34/EU **for ATEX Ex II 1G and Ex I M1 / Ex ia IIC T4 Ga and Ex ia I Ma (T_{amb}= -20 – + 65°C)** and under the IECEx scheme **for Ex ia IIC T4 Ga and Ex ia I Ma (T_{amb}= -20 – +65°C)**. The EU Type-examination Certificate number is EESF 19 ATEX 028X and the IECEx Certificate number is IECEx EESF 19.0010X. These certifications cover the following Ex standards: EN 60079-0:2012 / IEC 60079-0:2011 and EN 60079-11:2012 / IEC 60079-11:2011.

The PR-23-...-IF refractometer is certified by FM under the United States standards **for IS/I/1/ABCD/T4 and I/0/AEx ia/IIC/T4 (T_{amb} = -20 – +45 °C)** The certificate ID Number is 3036400. This certification covers the following US standards: class 3600 1998, class 3610:2007, class 3810:2005, ANSI/ISA-12.00.01:1999, ANSI/ISA-12.02.01:2002, ANSI/ISA-82.02.01:2004, ANSI/NEMA 250:1991 and ANSI/IEC 60529:2004.

The PR-23-...-IF refractometer is certified by FM under the Canadian standards **for IS/I/1/ABCD/T4 and I/0/Ex ia/IIC/T4 (T_{amb} = -20 – +45 °C)**. The certificate ID Number is 3036400C. This certification covers the following Canadian standards: CSA C22.2 No. 94:1999, CSA C22.2 No. 142:2004, CSA C22.2 No. 157:2006, CSA C22.2 No. 60529:2005, CSA C22.2 No. 61010.1-1:2004, CSA E60079-0:2007 and CSA E60079-11:2002.

Note: Servicing of the intrinsically safe PR-23-...-IA/-IF refractometer is only allowed for trained service personnel of Vaisala and its representatives. Servicing must be done according to separate instructions defined by Vaisala and must be reported to Vaisala.

9.11.1 Equipment

Intrinsically Safe Process Refractometer consists of: a modified refractometer sensor PR-23-...-IA/-IF, an Indicating transmitter STR with single sensor connectivity, and IS Isolator and cabling between the refractometer sensor and the transmitter (Figure 9.34).

The equipment is intrinsically safe only if **all** mounting instructions in Section 9.11.2 are followed. If the instrument has been in any way damaged during transportation, return it to your nearest Vaisala service point for checkup before installation. Never install a damaged instrument into the process line.

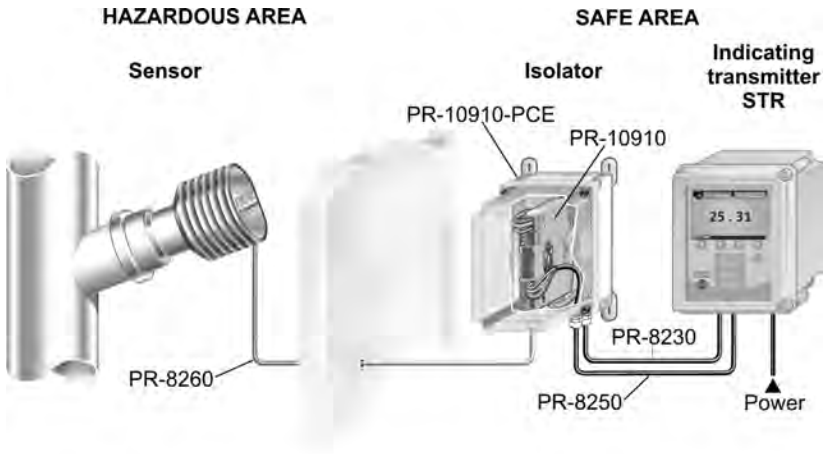


Figure 9.34 Refractometer system PR-23-...-IA/-IF with an STR

3-A approved intrinsically safe -IA sensor

Other intrinsically safe -IA sensor

3-A approved intrinsically safe -IF sensor

Other intrinsically safe -IF sensor

Figure 9.35 Intrinsically safe sensor nameplates

The intrinsically safe sensor PR-23-...-IA/-IF is identified by the nameplate, see Figure 9.35. The Indicating transmitter is of model STR, for single sensor connection.

An intrinsically safe sensor has a different processor card and a different terminator card than a standard sensor, other parts are as in standard sensor (see earlier in this chapter for full parts list).

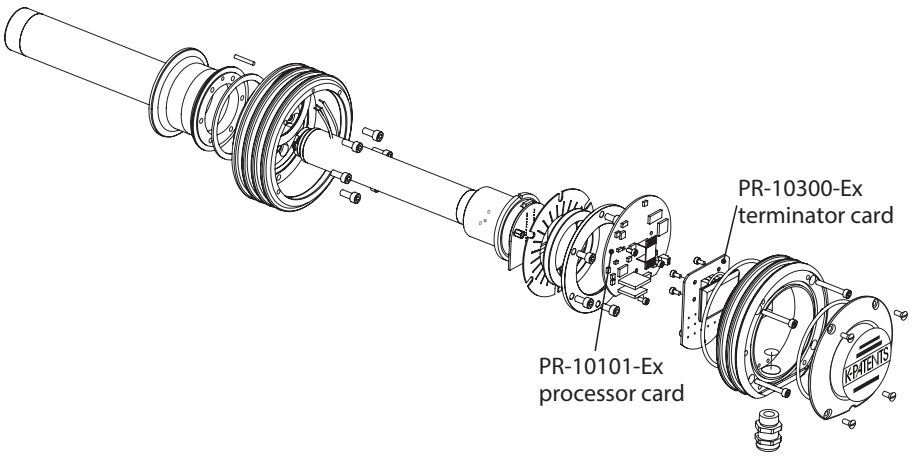


Figure 9.36 Intrinsically safe parts

Warning! Do not replace any part of an intrinsically safe sensor with a standard sensor part.

Important: If the sensor cover is made of aluminium, the refractometer sensor can cause ignition if it hits other metal parts during the installation. An aluminium sensor cover must have a sticker warning about this possibility.

Contains lightmetals
Ignition hazard!
Avoid impact!

Figure 9.37 Warning sticker

Important: The refractometer models PR-23-M, PR-23-MS and PR-23-W contain parts made of PTFE in sensor heads. These parts are subject to electrostatic hazard. The refractometer models PR-23-M, PR-23-MS and PR-23-W shall only be used for measuring liquids with high conductivity (> 10000 pS/m) in the presence of hazardous atmospheres.

Important: The painted surface of the enclosure of PR-23-MS refractometer is subject to electrostatic hazard and therefore the cleaning shall be done only with a damp cloth in the presence of hazardous atmospheres.

9.11.2 Intrinsically safe mounting

Choose the mounting location of the sensor, the isolator/barrier unit and the indicating transmitter so that they are protected from sudden impact and friction. If any of the system parts are affected by a sudden impact, power off immediately and have the system checked by trained Vaisala service personnel before it is used again.

The electrical connections for PR-23-...-IA are described in Figure 9.38. The electrical connections for PR-23-...-IF are described in Figure 9.39.

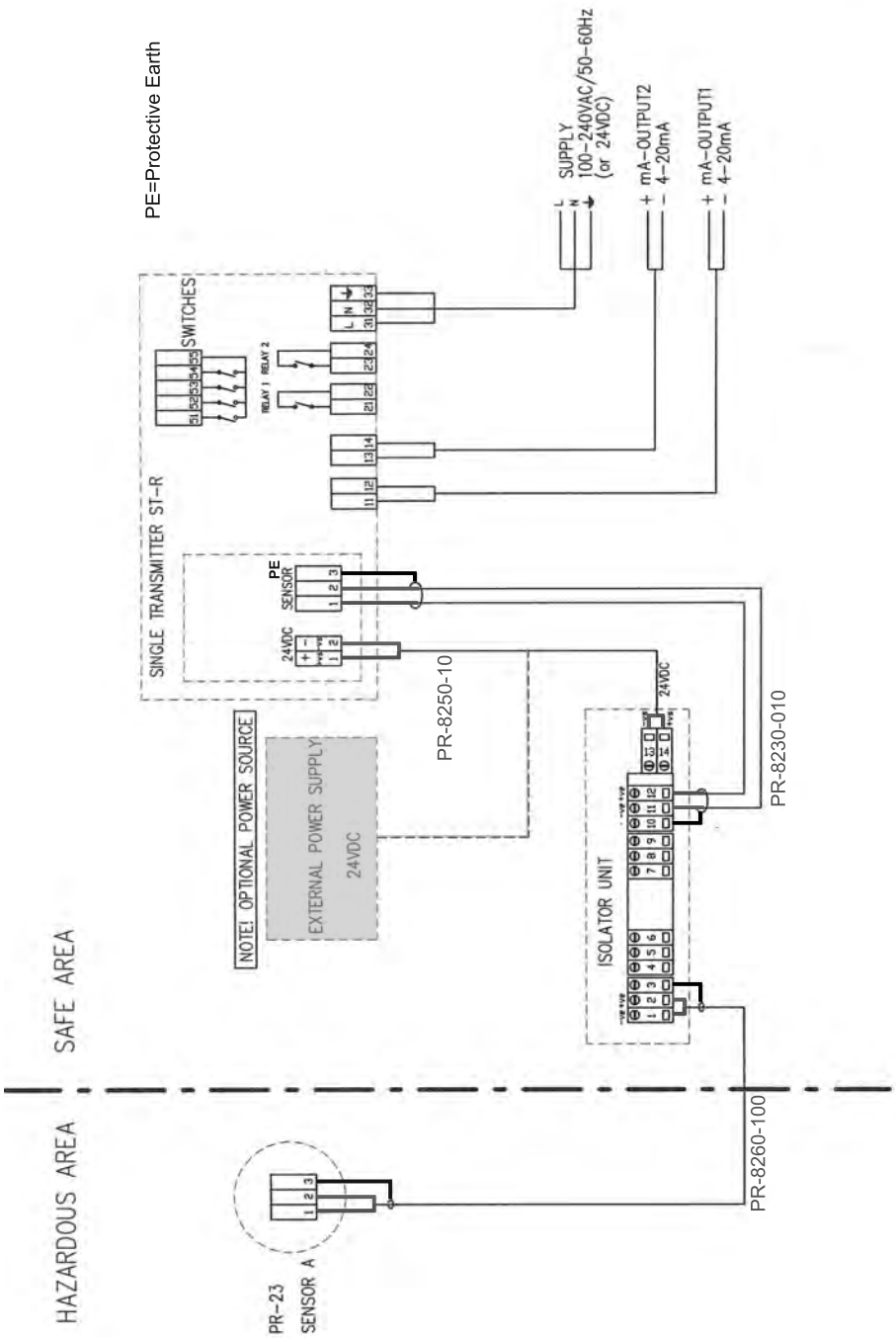


Figure 9.38 Intrinsically safe wiring, PR-23-...-IA according to WRG-362

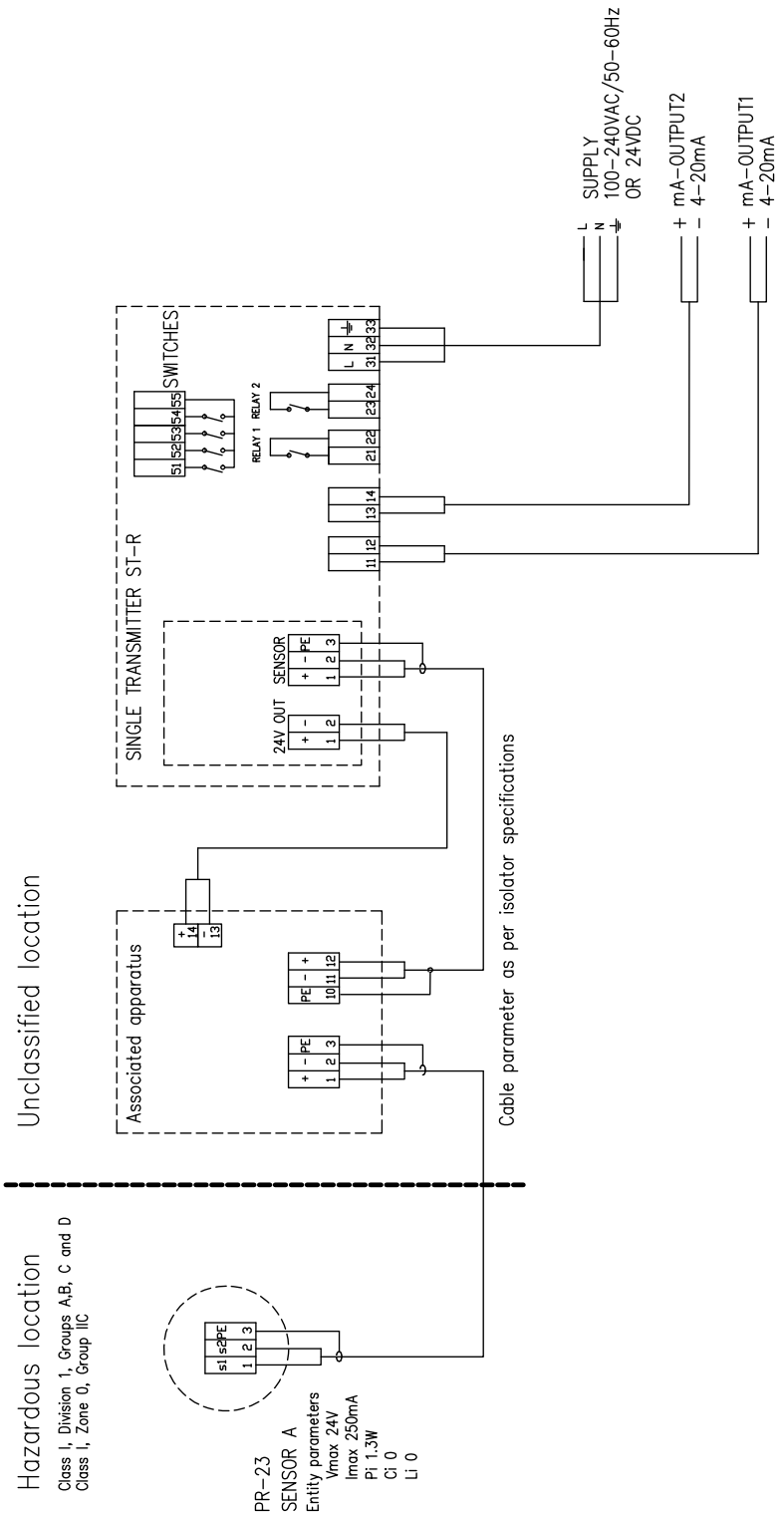


Figure 9.39 Intrinsically safe wiring,
PR-23-...-IF with STR according to WRG-478

Notes:

In the United States, installation must be in accordance with the applicable requirements of ANSI/ISA RP12.6 and the national electrical code (ANSI/NFPA 70). In Canada installation must be in accordance with the applicable requirements of Canadian electrical code part I C22.2.1 section 18 and appendix F. Associated Apparatus manufacturer's installation drawing shall be followed when installing this equipment.

Ex ia is defined as Intrinsically Safe. The intrinsic safety concept allows the interconnection of two intrinsically safe devices. FM approved and CSA certified entity parameters are not specifically examined in combination as a system when:

Uo or Voc or Vt <= Vmax,
Io or Isc or It <= Imax
Ca or Co >= Ci + Ccable or
La or Lo >= Li + Lcable, Po < Pi.

Control equipment connected to the Associated Apparatus shall not use or generate more than 250 Vrms or Vdc. **Important:** Use supply wires suitable for 5 K above surrounding environment.

For Division 1 installations, the configuration of Associated Apparatus shall be FM Approved/CSA Certified under Entity Concept.

Cables for intrinsically safe installation:

- 10 m (33 ft) cable, part number PR-8230-010, connecting the Indicating transmitter STR and the Isolator unit.
  The maximum cable length is 100 m (330 ft).
- 10 m (33 ft) power cable, part number PR-8250-010, connecting the Indicating transmitter STR and the Isolator unit, part number PR-8250-010. The maximum length is 100 m (330 ft).
- The intrinsically safe cable between Isolator unit and sensor, part RP-8260-xxx, where xxx is the cable length in meters. The maximum length is 200 m (660 ft).
  For cable connections see Figures 9.38 and 9.40.

Note: Isolator/Barrier Unit can also use an optional *external* +24V DC power supply instead of the +24V DC power supply from the transmitter. +24V DC is connected to terminals 13 and 14. (If +24V DC is used, the PR-8250 power cable is not used at all.)

9.11.3 Isolator/barriers

Isolator unit wiring is explained below in Figure 9.40.

Note: If the power to Isolator unit terminals is not correctly connected, +24V DC to terminal 14 (+vs) and zero to terminal 13 (-vs), the transmitter STR will give the message No signal. Also if terminals 11 and 12 are not correctly connected, sensor cable connecting terminal 2 of the Indicating transmitter STR to the Isolator unit terminal 11 (-ve) and terminal 1 of the STR to Isolator unit terminal 12 (+ve) , the message No signal will appear.

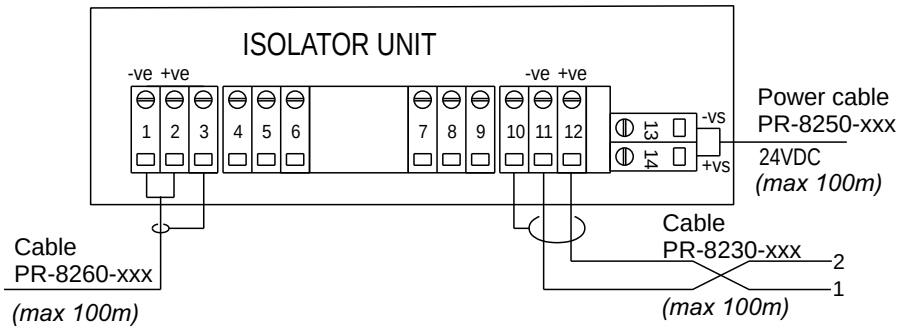
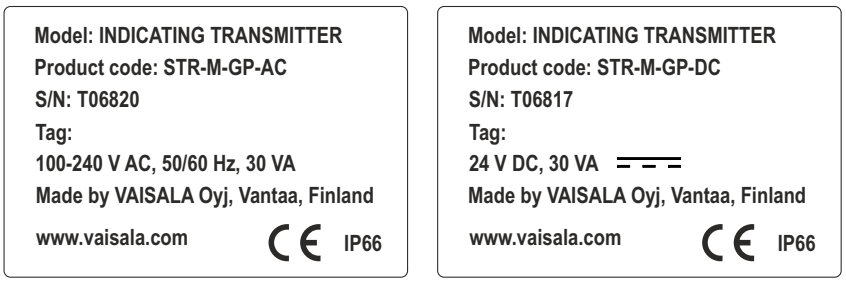


Figure 9.40 Isolator unit wiring

10 Indicating transmitter DTR specifications

AC label *DC label*

Figure 10.1 Indicating transmitter DTR serial number label



AC label *DC label*

Figure 10.2 Indicating transmitter STR serial number label

10.1 Compatibility

The Indicating transmitter DTR is only compatible with the PR-23 refractometer range. Any one or two PR-23 refractometer sensors can be connected to the DTR. *PR-01 and PR-03 refractometer sensors are not compatible with an Indicating transmitter DTR.*

For intrinsically safe installations (see Section 9.11) there is a single-sensor version of the transmitter (STR). The information given in this chapter applies to STR as well, unless otherwise indicated.

10.1.1 Transmitter program versions

The DTR program version can be updated over the Ethernet connection (see Chapter 12). Contact your nearest representative for more information on how to update your DTR program version.

Program version 4.07:
The DTR program version 4.07 is compatible with any DTR and any PR-23 sensor with program version 1.00 or higher. This DTR program version contains following new features:

- **DD-23 Divert Control Unit:** protocol versions 2 and 3.
- **Network booting for sensors:** Network booting of sensors from DTR files.
- **mA output:** Support for negative span for mA output.
- **Temperature bias:** Parameter for temperature bias.
- **Temperature hold:** An ability to hold temperature when concentration is held for wash or external hold.
- **Slew rate limit filter:** New output filter method to limit the maximum change from a measurement to the next.
- **Support for advanced http interface**
- **Instrument tags:** An option to add instrument tags (max. 16 characters) to transmitter and sensor information.
- **Wash fail status handling:** Wash recovery handling changed so that a wash failure status is not cleared if wash check was not passed. The error status will be cleared when the wash check is passed.

Program version 3.0:
The DTR program version 3.0 is compatible with any DTR and any PR-23 sensor with program version 1.00 or higher. This DTR program version contains following new features:

- **Single sensor mode** for the intrinsically safe PR-23-...-IA refractometer system (see Section 9.11). This mode combined with a special single connection H1 interface card PR-10705 creates an Indicating transmitter STR.
- **Divert functionality** enables the DTR to function as a part of a Divert Control System used to control black liquor concentration in paper and pulp applications. Divert mode only allows for one sensor per transmitter, but a standard DTR is used.

Program version 2.0:
The DTR program version 2.0 is compatible with any DTR and any PR-23 sensor with program version 1.00 or higher. This DTR program version contains following new features:

- Instrument homepage and printable verification certificate
- Multi-lingual user interface
- Linear damping
- Field sample soft key

10.2 Model code

10.2.1 Transmitter model code

MODEL AND DESCRIPTION	MODEL
DTR = Indicating transmitter (connectivity for two sensors)	DTR
STR = Indicating transmitter (connectivity for one -IA/-IF sensor)	STR
Cable connection	
-U = ½ inch NPT type conduit hubs for CSA certified Transmitter	-U
-M = M20x1.5 metric cable glands for general purpose Transmitter	-M
Electrical classification	
-GP = General purpose	-GP
-CS = CSA certified for use in general purpose (ordinary) locations Applicable to CSA and ANSI/UL standards **(A)**	-CS
Power supply	
-AC = Power supply 100-240 VAC 50/60 Hz	-AC
-DC = Power supply 24 V DC **(B)**	-DC

(A) Available only with cable connection code -U, ½ NPT type conduit hubs and -AC power supply
(B) With -GP option only

Table 10.1 Transmitter model code

10.2.2 Interconnecting cable model code

PART NUMBER AND DESCRIPTION		PART NO.
PR-8230 =	Interconnecting cable between transmitter and sensor	PR-8230
Cable length		
-010 =	10 meters (33 feet), standard length	-010
-_ _ _ =	Specify cable length in meters with 10 meter increments. Max. length is 200 meters (660 feet)	-_ _ _

Table 10.2 Interconnecting cable model code

10.3 Specifications

10.3.1 Indicating transmitter specifications

Display:	320x240 pixel graphical LCD with LED backlight
Keypad:	18 membrane keys
Current output:	Two independent current sources, 4-20 mA, max. load 1000 Ohm, galvanic isolation 1500 VDC or AC (peak), hold function during prism wash
Power:	AC input 100-240 VAC, ±10%, 50/60 Hz/30 VA, optional 24 VDC, Overvoltage Category II, Pollution Degree 2 (DTR), Pollution Degree 3 (sensor)
Alarms/Wash relays:	Two built-in signal relays, max. 250 V/3 A
Input switches:	Four switch inputs.
Current outputs:	Two current outputs configurable independently to indicate process concentration or temperature of either sensor.
Sensor connectivity, DTR:	One or two sensors can be connected to the transmitter. Sensors independent of each other: own parameter sets and usable in different applications.
Sensor connectivity, STR:	Only one sensor can be connected to the transmitter. Used with the Intrinsically safe sensor PR-23-...-IA.
Transmitter protection class:	Enclosure IP66, Nema 4X
Installation:	Transmitter indoor, sensor indoor/outdoor, relative humidity 80% max
Indicating transmitter weight:	4.5 kg (10 lbs)

10.3.2 Interconnecting cable specifications

Cable:	IEC 61158-2 compliant two-wire cable: two signal wires and shield copper area 0.8 mm^2 (18 AWG) cable resistance 24 Ohm/km (per wire) cable attenuation 3.0 dB/km @ 28 kHz
Cable length:	Standard 10 m (33 ft), max. total length 200 m (660 ft)

Note: For information on the *intrinsically safe cabling* for PR-23-...-IA, see Section 9.11.2 on page 140.

10.4 Transmitter parts list

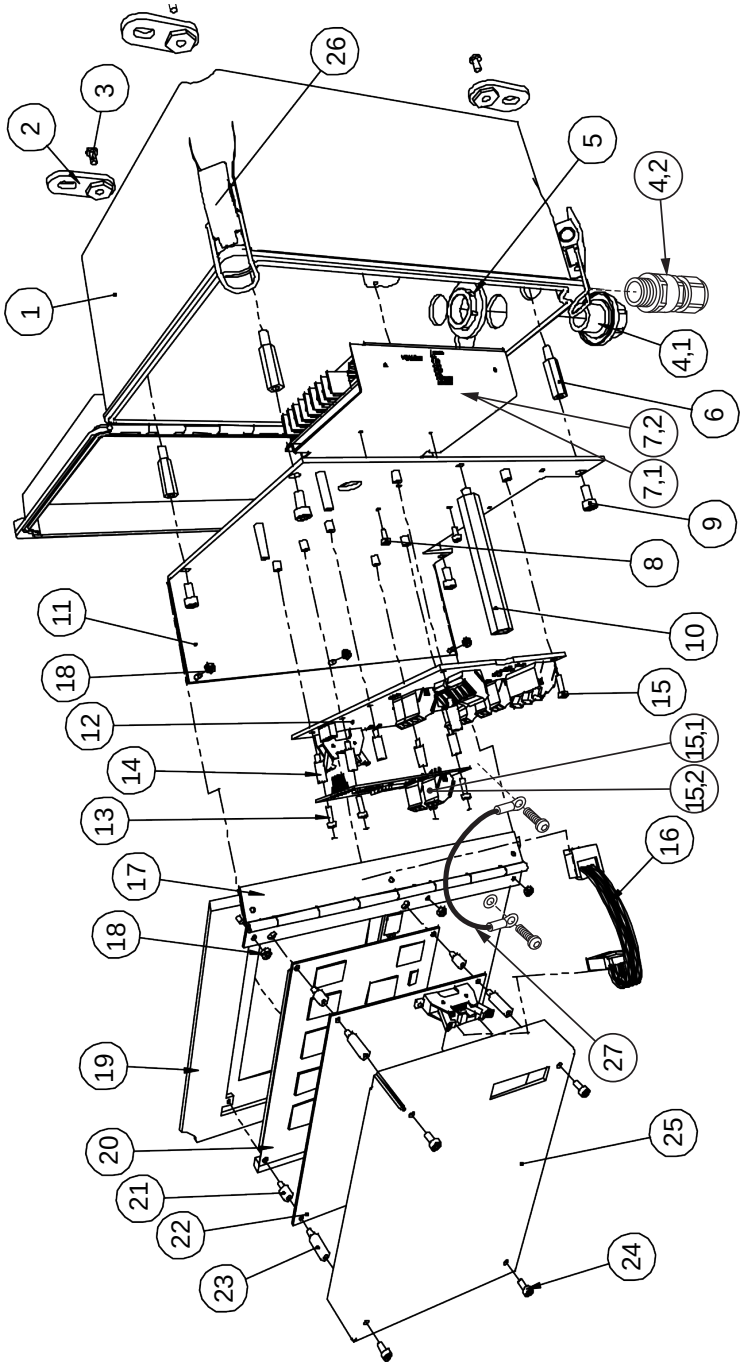


Figure 10.3 Indicating transmitter DTR (*STR*) parts

Item	Pcs.	Part No.	Description
1	1	PR-7602	Enclosure
2	4		Mounting feet
3	4		Screw 10-32 pan head
4.1	7		Conduit hub 1/2 NPT-type ST-1 (US)
4.2	7		Cable gland M20x1.5 (European) with adapter
5	7		Conduit hub nut
6	4		Tower screw 10-32/M4
7.1	1	PR-10810	Power supply module 100-240 V AC 50-60 Hz
7.2	1	PR-10820	Power supply module 24 V DC
8	2		Screw M3x6 DIN 912 A2
9	4		Screw M4x10 DIN 912 A2
10	1		Tower screw M4x10
11	1		Frame plate
12	1	PR-10600	Transmitter motherboard
13	1		Screw M3x6 DIN 912 A2
14	6		Tower screw M3x13

Item	Pcs.	Part No.	Description
15.1	1	PR-10701	H1 interface card
15.2	1	*PR-10705*	*Single sensor H1 interface card* *For intrinsically safe system PR-23-...-IA*
16	1	PR-12109	Ribbon cable
*	1	PR-10830	DTR door complete (incl. PR-10500)
17	1		Piano hinge
18	6		M3 Nut A2
19	1		Keyboard panel
20	1		Display card
21	1		Tower screw M3x6
22	1	PR-10500	Transmitter processor card
23	1		Tower screw
24	4		Screw M3x6 DIN 912 A2
25	4		DTR door protecting plate
26	2	PR-7340	Door latch

10.5 Flame proof DTR/STR enclosures

The flame proof enclosures embedding a DTR or a STR have aluminium enclosures with ATEX and IECEx options and with or without Isolator for hazardous Zone 1 and 2 installations.

The Ex type junction box is intended for hazardous areas where flammable gases are present in the environment and can be ignited by an electrical spark or hot surfaces. In these environments, all equipment manufacturers work from the assumption that it is impossible to prevent gases from penetrating all areas. Instead the design is based on confining the explosion by guiding the flames to follow a path long and narrow enough to guarantee the cooling of the gases and avoiding an external explosion. This method of protection is the oldest used to prevent explosions and remains still one of the safest because it is based on a very simple and, therefore, unlikely fallible technology.

The EJB type junction box covers the design for ethylene gas from the gas group IIB and hydrogen gas from the gas group IIC. The GUB type junction box covers the design for gases from the gas group IIC. Both Ex type junction boxes have a window allowing the user to read the DTR/STR display.

10.5.1 Model code

Model and description	Model
DTR = Indicating transmitter (connectivity for two sensors)	DTR
STR = Indicating transmitter (connectivity for one -IA/-IF sensor)	STR
Cable connection	
-R = ½" ISO 7/1 RC threads	-R
Electrical classification	
-B1 = Atex Ex d IIB+H2 T6 Gb, for -AX model T_{amb} -25 ... +45°C, type EJB	-B1
-B2 = IECEx Ex d IIB+H2 T6 Gb, for -AX model T_{amb} -25 ... +45°C, type EJB	-B2
-B3 = Atex Ex d[ia Ga] IIB+H2 T6 Gb, for -IA model T_{amb} -25 ... +45°C, type EJB **(A)**	-B3
-B4 = IECEx Ex d[ia Ga] IIB+H2 T6 Gb, for -IA model T_{amb} -25 ... +45°C, type EJB **(A)**	-B4
-C1 = Atex Ex d IIC T6 Gb, for -AX model T_{amb} -25 ... +45°C, type GUB	-C1
-C2 = IECEx Ex d IIC T6 Gb, for -AX model T_{amb} -25 ... +45°C, type GUB	-C2
-C3 = Atex Ex d[ia Ga] IIC T6 Gb, for -IA model T_{amb} -25 ... +45°C, type GUB **(A)**	-C3
-C4 = IECEx Ex d[ia Ga] IIC T6 Gb, for -IA model T_{amb} -25 ... +45°C, type GUB **(A)**	-C4
Enclosure material	
-AL = Aluminium junction box	-AL
Power supply	
-AC = Power supply 100 - 240 VAC 50/60 Hz	-AC
-DC = Power supply 24 VDC	-DC
Option	
-MX = with Fieldbus converter, for EJB box only	-MX

(A) Includes isolator PR-10910 or PR-10910-RH

10.5.2 Dimensions

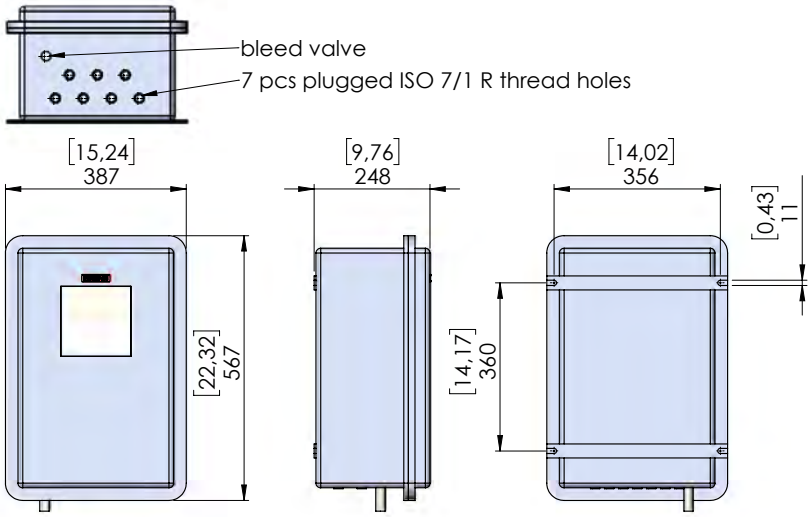


Figure 10.4 EJB enclosure dimensions

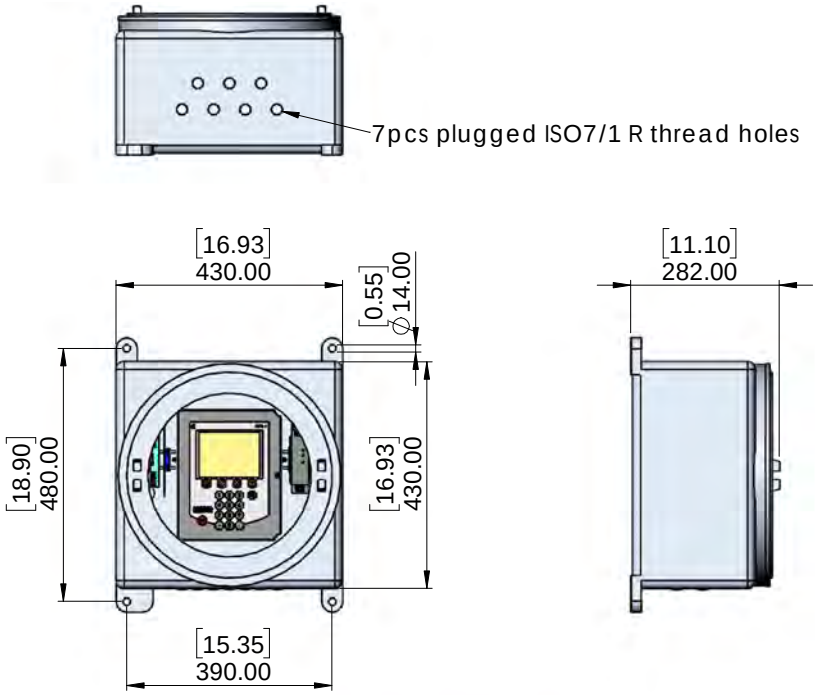
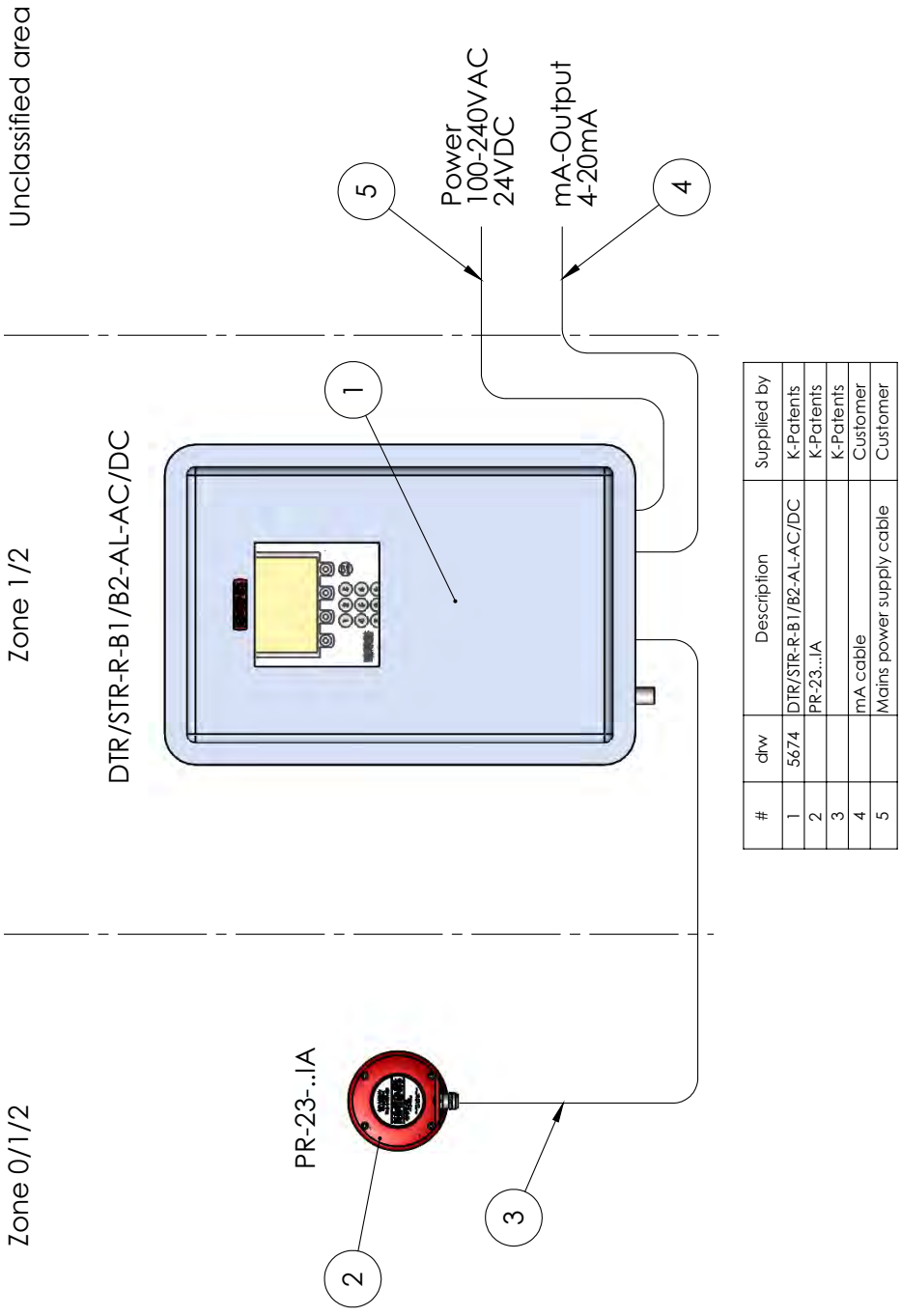


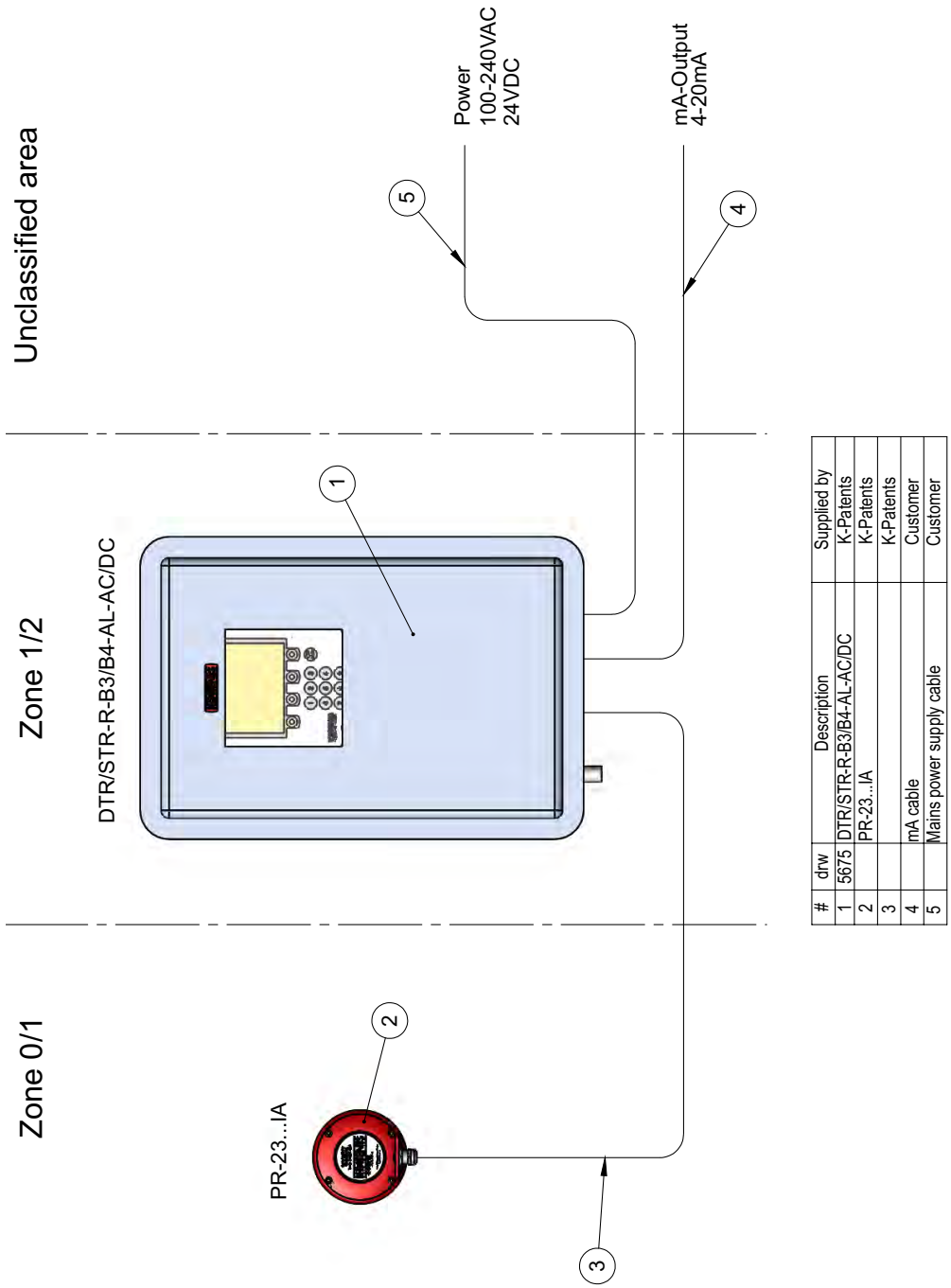
Figure 10.5 GUB enclosure dimensions

10.5.3 Refractometer system with flame proof enclosure



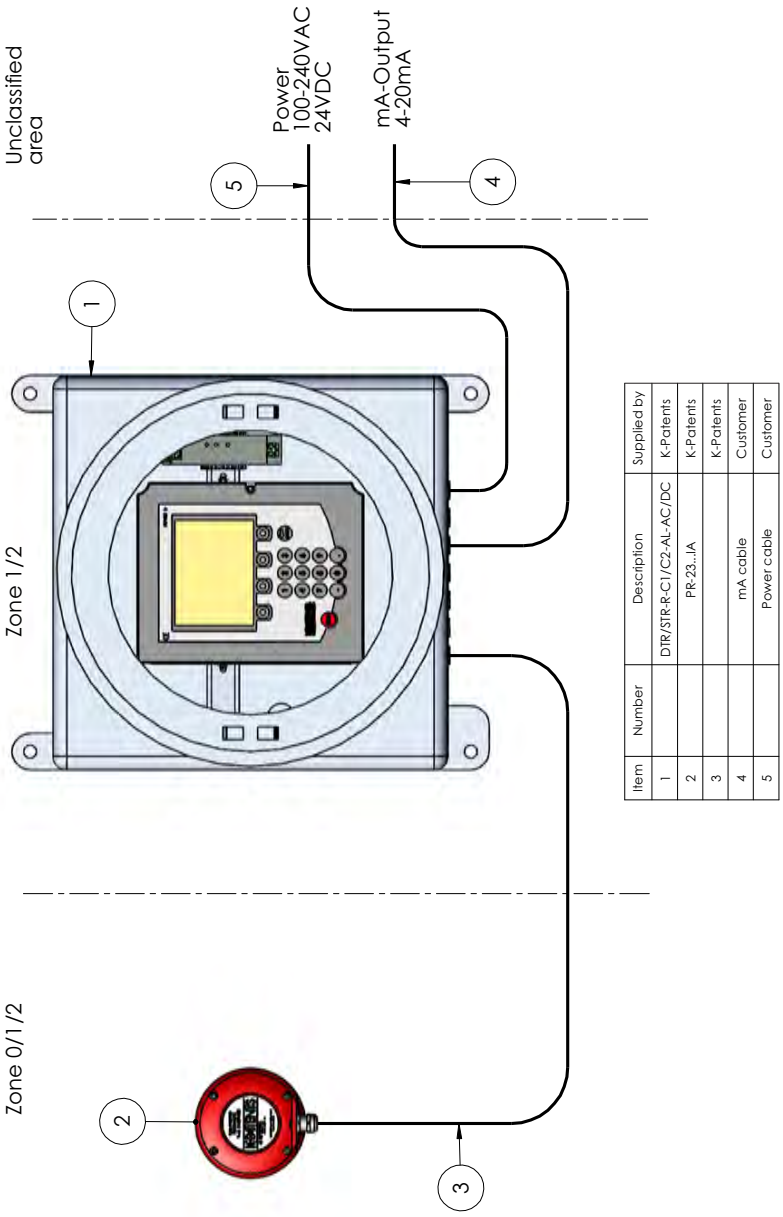
#	drw	Description	Supplied by
1	5674	DTR/STR-R-B1/B2-AL-AC/DC	K-Patents
2		PR-23...IA	K-Patents
3			K-Patents
4		mA cable	Customer
5		Mains power supply cable	Customer

Figure 10.6 DTR/STR-R-B1/B2-AL-AC/DC



#	drw	Description	Supplied by
1	5675	DTR/STR-R-B3/B4-AL-AC/DC	K-Patents
2		PR-23...IA	K-Patents
3			K-Patents
4		mA cable	Customer
5		Mains power supply cable	Customer

Figure 10.7 STR-R-B3/B4-AL-AC/DC



Item	Number	Description	Supplied by
1		DTR/STR-R-C1/C2-AL-AC/DC	K-Patents
2		PR-23...IA	K-Patents
3			K-Patents
4		mA cable	Customer
5		Power cable	Customer

Figure 10.8 DTR/STR-R-C1/C2-AL-AC/DC

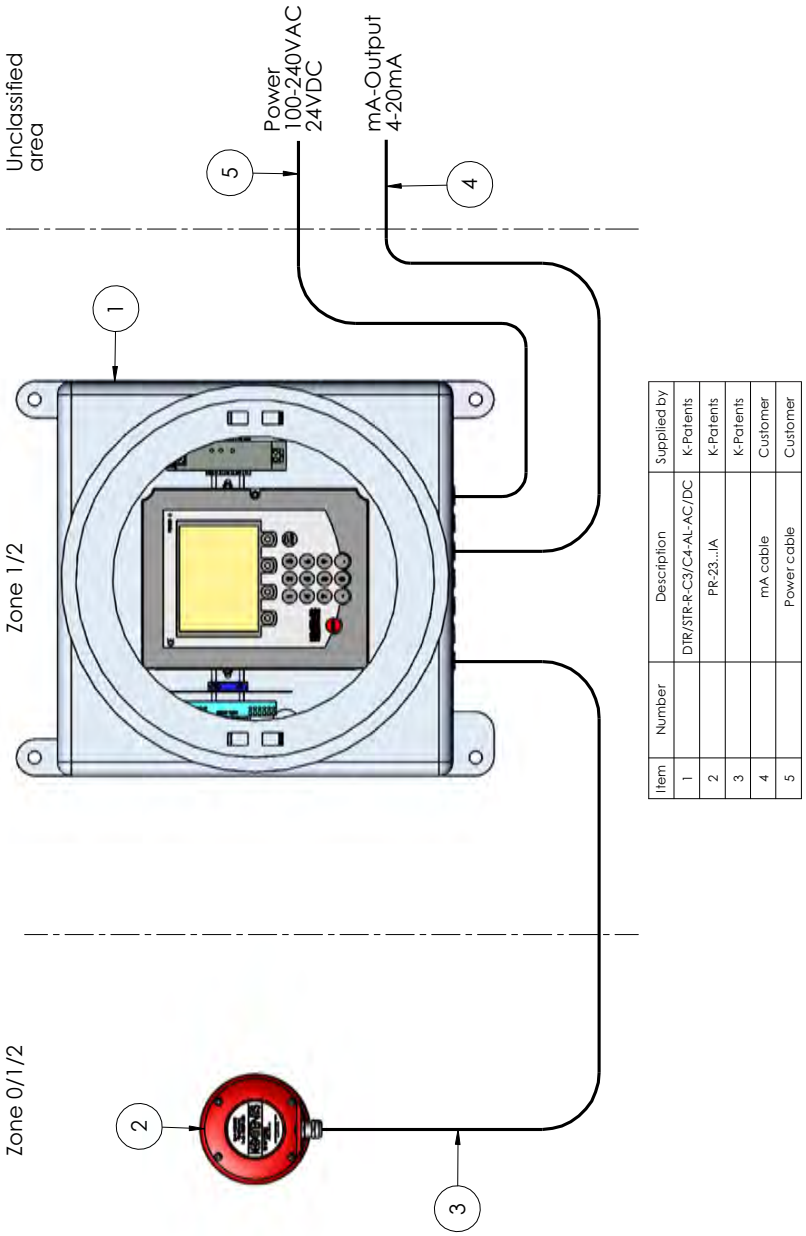


Figure 10.9 STR-R-C3/C4-AL-AC/DC

10.5.4 Wiring

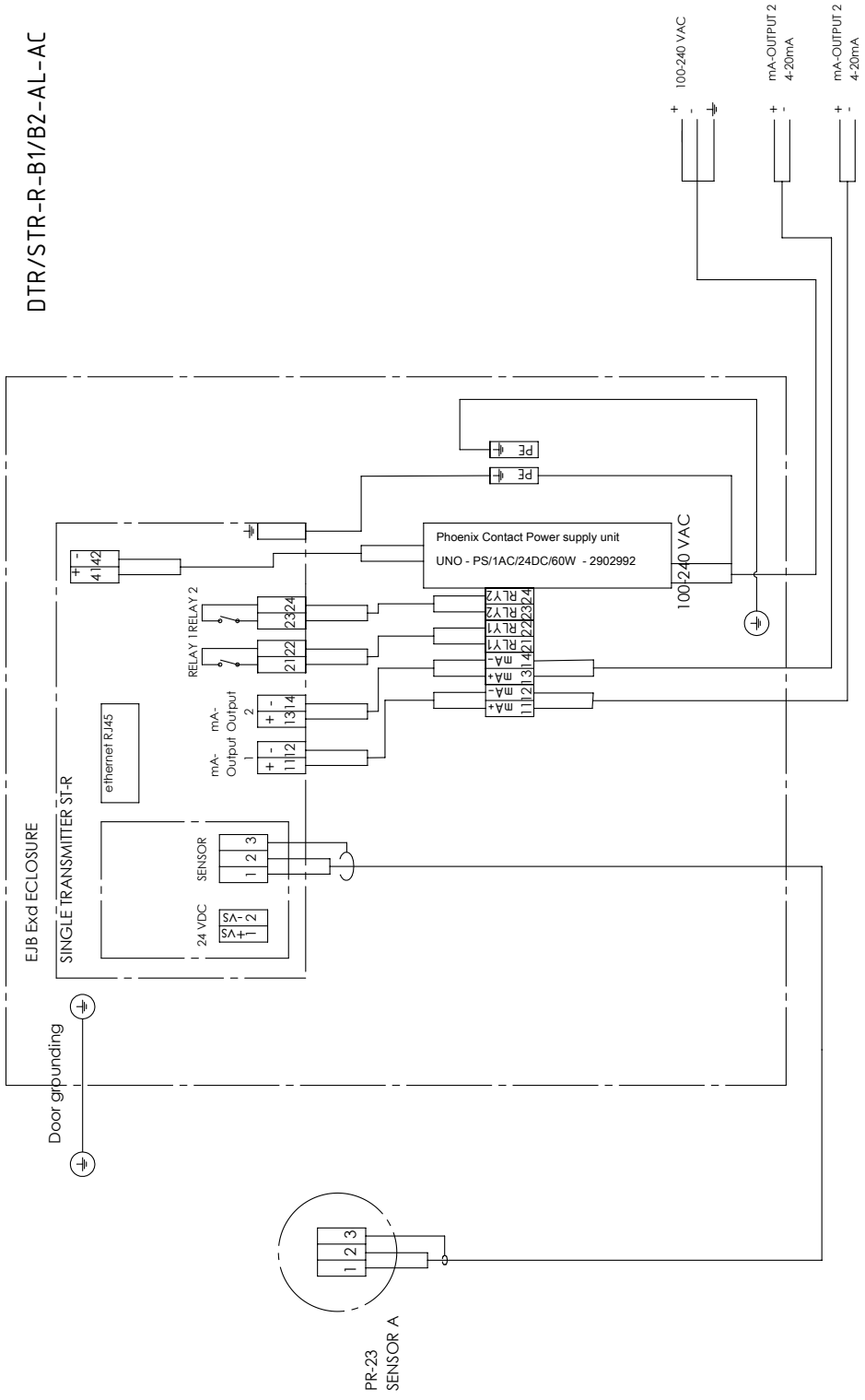


Figure 10.10 EJB enclosure wiring without an isolator (DTR/STR-R-B1/B2-AL-AC)

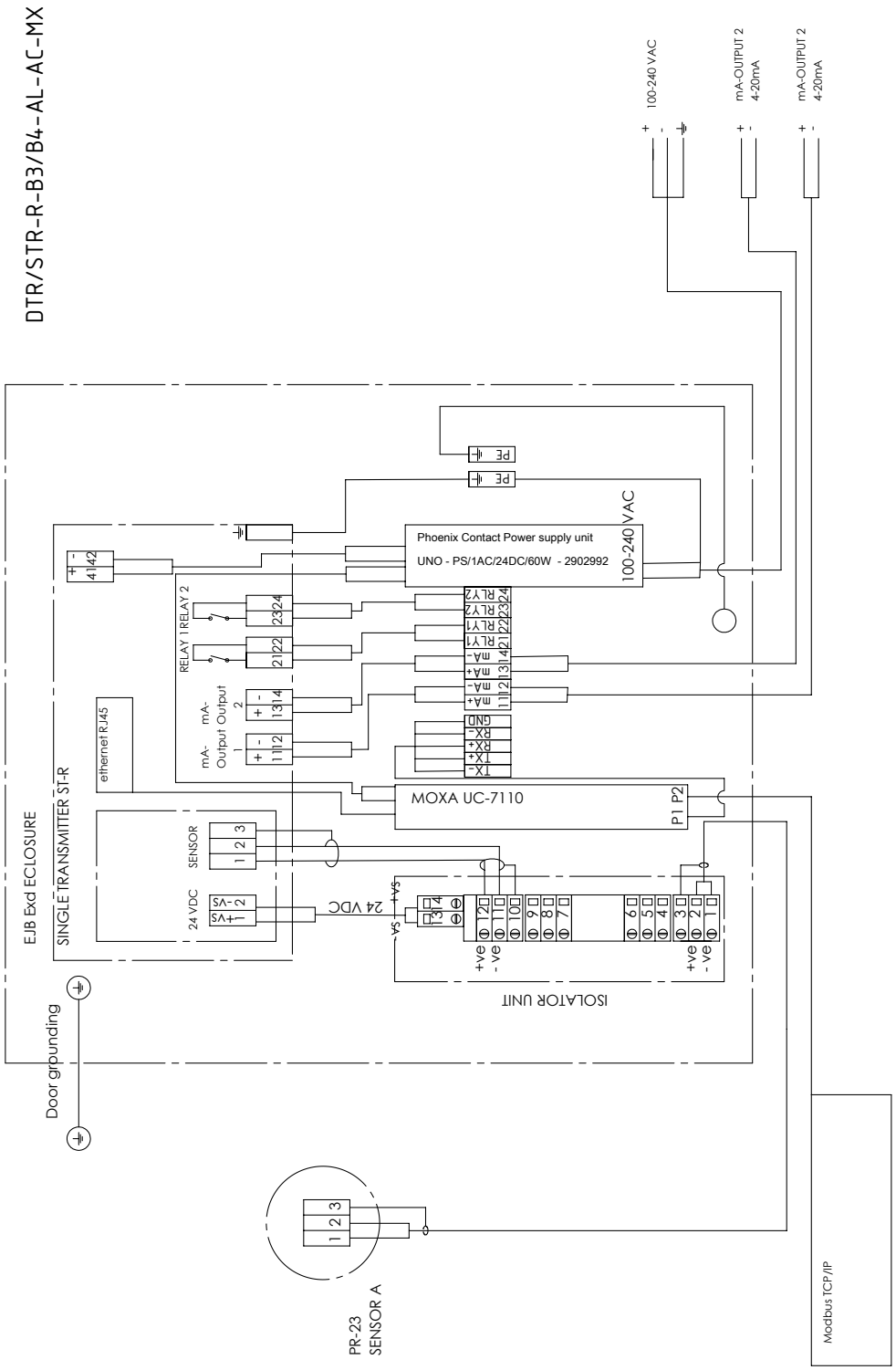


Figure 10.11 EJB enclosure wiring with an isolator and fieldbus converter (STR-R-B3/B4-AL-AC-MX)

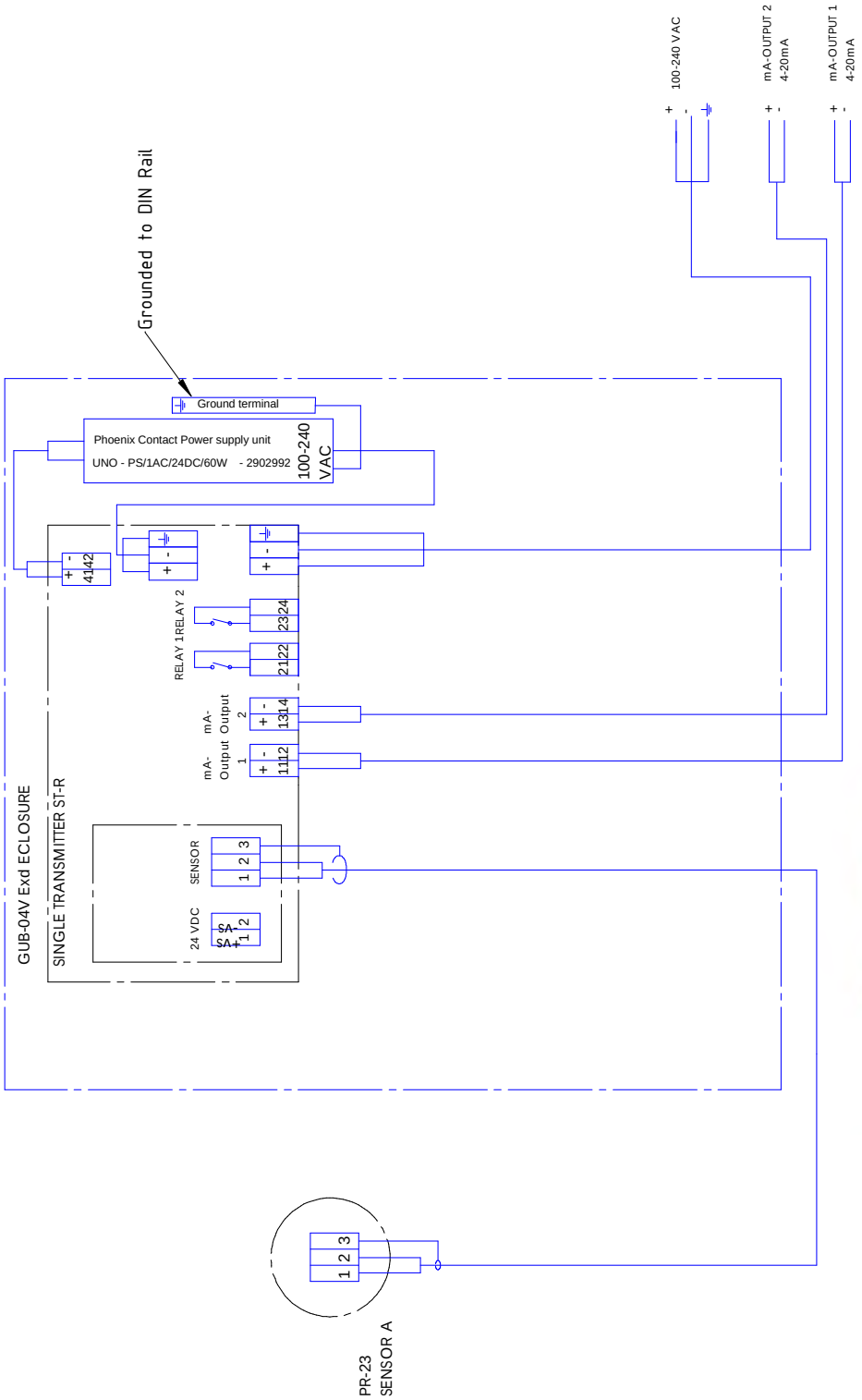


Figure 10.12 GUB enclosure wiring without an isolator (DTR/STR-R-C1/C2-AL-AC)

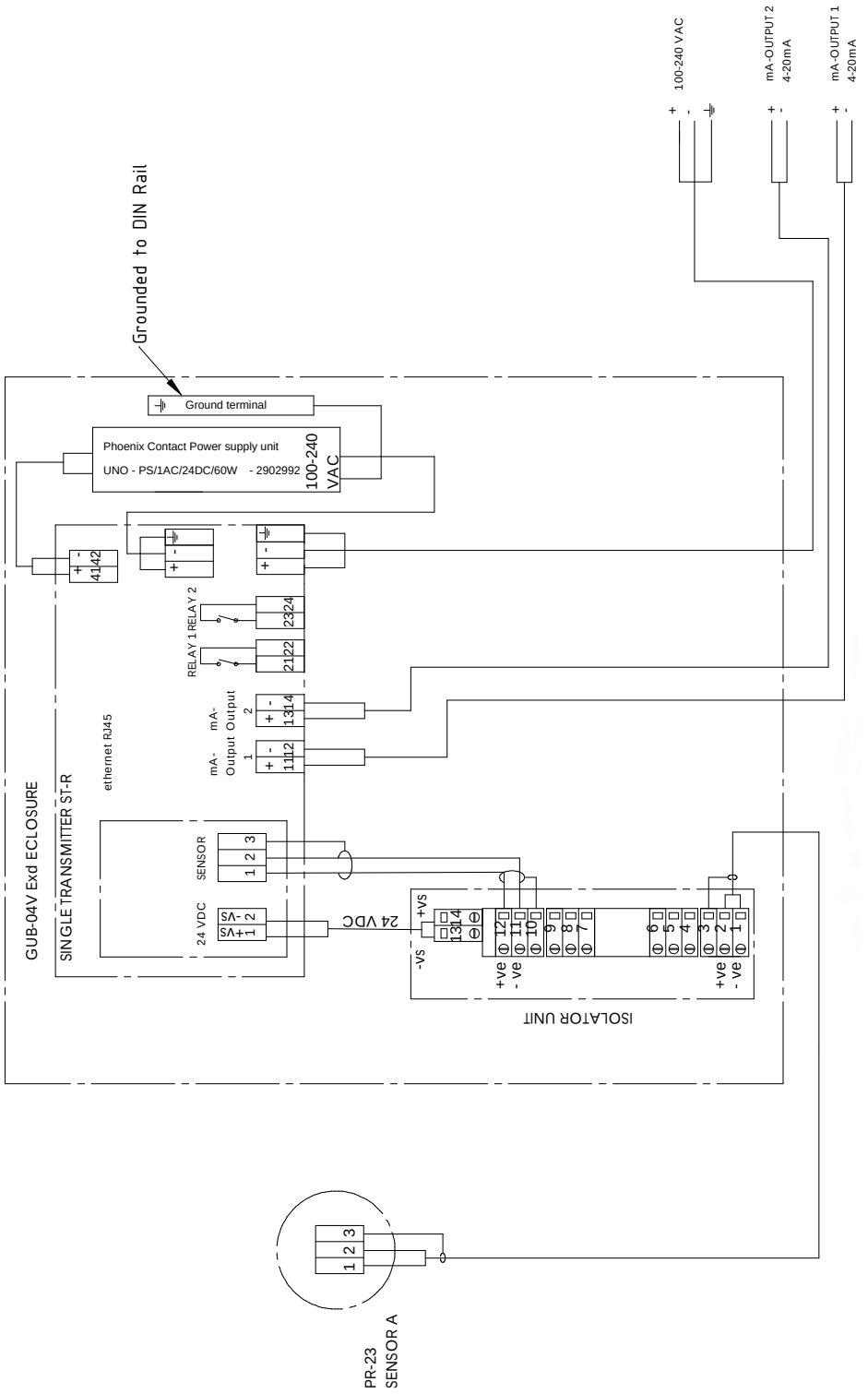


Figure 10.13 GUB enclosure wiring with an isolator (STR-R-C3/C4-AL-AC)

10.5.5 Specifications

Specifications for DTR/STR in EJB or GUB type enclosure	
Electrical specifications	
EJB type enclosure with AC power source	
Nominal input voltage range	100 V AC ... 240 V AC
Current consumption	1.3 A (100 V AC) 0.6 A (240 V AC)
Nominal power consumption	60 W
Input fuse	2.5 A (slow-blow, internal)
Choice of suitable circuit breakers	6A ... 16 A (Characteristics B, C, D, K)
EJB type enclosure with DC power	
Nominal input voltage range	10 V DC ... 32 V DC Input polarity reversial protection
Input current	2.1 A (typical); 5.0 A (max)
Input protection	6.3A/125 VDC internal fuse
Nominal power consumption	40 W
GUB type enclosure with AC power source	
Nominal input voltage range	100 V AC ... 240 V AC
Current consumption	0.4 A (100 V AC) 0.2 A (240 V AC)
Inrush current	14 A @10 V, 28 A @200 V
Over current protection	Operate at 105% min rated current, automatic return
Over voltage protection	Input retry at shutdown
Nominal power consumption	30 W
GUB type enclosure with DC power source	
Nominal input voltage range	19 V DC ... 32 V DC Input polarity reversial protection by internal fuse
Input current	1.1 A typical
Internal DC power source output protection	Over voltage protection ≥26.4VDC. Output shutdown (to reset, leave 1 minute after shutdown) Output current with automatic recovery current limiting 1.21A
Nominal power consumption	25 W
Hazardous area classifications	
Installation (EN 60079.14)	Zone 1, 2, 21, 22
ATEX CE 0772 Ex	*EJB type enclosure* II 2 GD Ex d IIB+H2 T6 Gb IP66/67 Ta -25 ... +45°C (without isolator) II 2(1)GD Ex d[ia Ga] IIB+H2 T6 Gb IP66/67 Ta-25 ... +45°C (with isolator) *GUB-type enclosure:* II 2GD Ex d IIC T6 Gb IP66 Ta -25 ... +45°C (without isolator) II 2(1)GD Ex d[ia Ga] IIC T6 Gb IP66 Ta -25 ... +45°C (with isolator)

IECEx	*EJB type enclosure* Ex d IIB+H2 T6 Gb IP66/67 Ta -25 ... +45°C (without isolator) Ex d[ia Ga] IIB+H2 T6 Gb IP66/67 Ta-25 ... +45°C (with isolator) *GUB type enclosure* Ex d IIC T6 Gb IP66 Ta -25 ... +45°C (without isolator) Ex d[ia Ga] IIC T6 Gb IP66 Ta -25 ... +45°C(with isolator)
Ambient temperature	-25 ... +45°C
Enclosure material	Aluminium
Weight	*EJB type enclosure*: 37 kg *GUB type enclosure*: 42 kg
Degree of protection	EJB: IP66/67 GUB: IP66

11 Safe-Drive™

The Safe-Drive™ system is used for safe insertion and removal of a refractometer sensor while the process line is under full process flow and pressure. The Safe-Drive™ system is typically used in a continuous process with infrequent shutdowns and large pipe size, diameter 50 mm (2") or above, e.g. in wood pulp industry.

11.1 System description

The Safe-Drive™ system consists of a Safe-Drive™ isolation valve welded to the process pipe, a PR-23-SD refractometer sensor and a Safe-Drive™ retractor used for sensor insertion and removal. The two-part Retractor can be kept separately in clean storage and all installed PR-23-SD sensors can be inserted and removed with one and same tool.

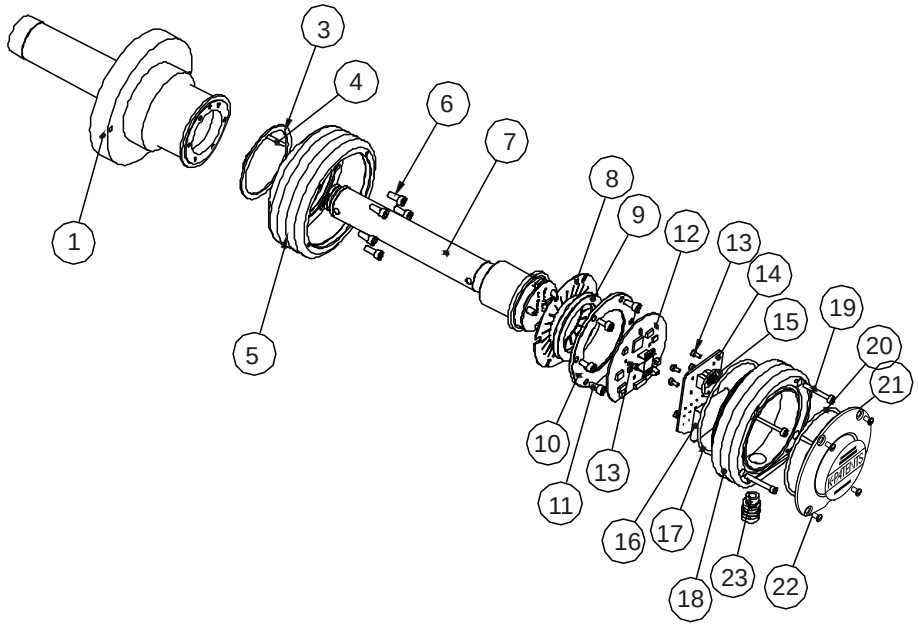
Figure 11.1 The Safe-Drive™ system:
Isolation valve, PR-23-SD sensor, Retractor

11.2 Specifications

Refractive Index range:	Full range n_D1.3200–1.5300 (corresponds to hot water – 100 Brix)
Accuracy:	Refractive index n_D± 0.0002 (corresponds typically to ± 0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response:	1 s undamped, damping time selectable up to 5 min
Calibration:	With Cargille certified refractive index liquids over full range of n_D1.3200–1.5300
CORE-Optics:	No mechanical adjustments (US Patent No. US6067151)
Digital measurement:	3648 pixel CCD element
Light source:	Light emitting diode (LED) 589 nm wavelength, sodium light
Temperature sensor:	Built-in Pt-1000
Temperature compensation:	Automatic, digital compensation
Instrument verification:	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature:	Sensor: max. 45 °C (113 °F), min. -20 °C (-4 °F); Indicating transmitter: max. 50 °C (122 °F), min. 0 °C (32 °F)
SAFE-DRIVE™ SENSOR PR-23-SD AND ISOLATION VALVE SDI-23	(Patent Pending)
Isolation valve connection:	Safe-Drive™ flange DN 40 PN25 (Patent pending)
Process pressure:	Static pressure up to 20 bar (300 psi), operational pressure up to 10 bar (150 psi)
Process temperature:	-20 °C–170 °C (-4 °F–340 °F)
Sensor process wetted parts, standard:	SAF 2205, Duplex steel SS 2377, Werkstoff-Nr. 1.4462, UNS S31803, prism spinel, prism gaskets MTF (Modified Teflon)
Sensor protection class:	IP67, Nema 4X
Isolation valve, process wetted parts:	SAF 2205, Duplex steel SS 2377, Werkstoff-Nr. 1.4462, UNS S31803, AISI 316 L, flange gasket Viton®, lip seals Bronze Teflon® and ELGILOY, AISI 301 spring
Isolation valve, process connection:	By welding to pipe sizes of 2"–24", for both vertical and horizontal pipe lines
Prism wash:	Retractable steam wash nozzle with check valves
Sensor and valve weight:	10.5 kg (23 lbs)
SAFE-DRIVE™ RETRACTOR SDR-23	(Patent pending)
Retractor weight:	7.7 kg (17 lbs)

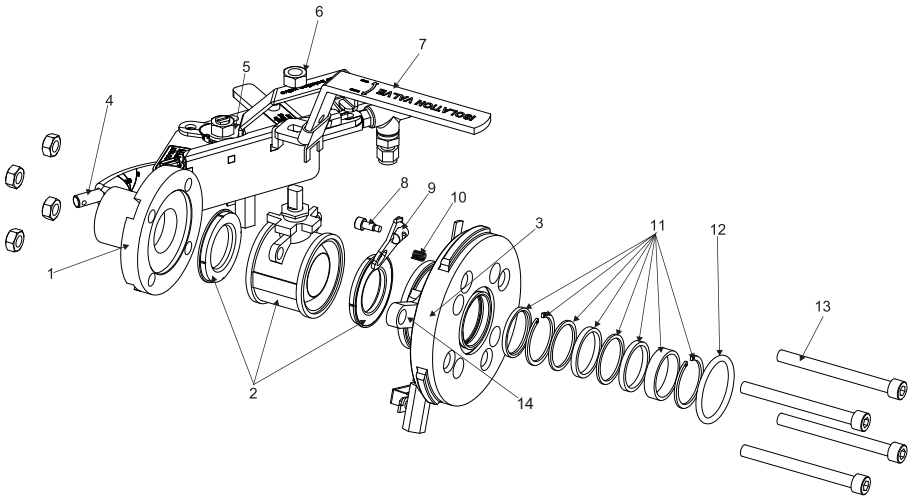
11.3 Parts lists

11.3.1 PR-23-SD sensor



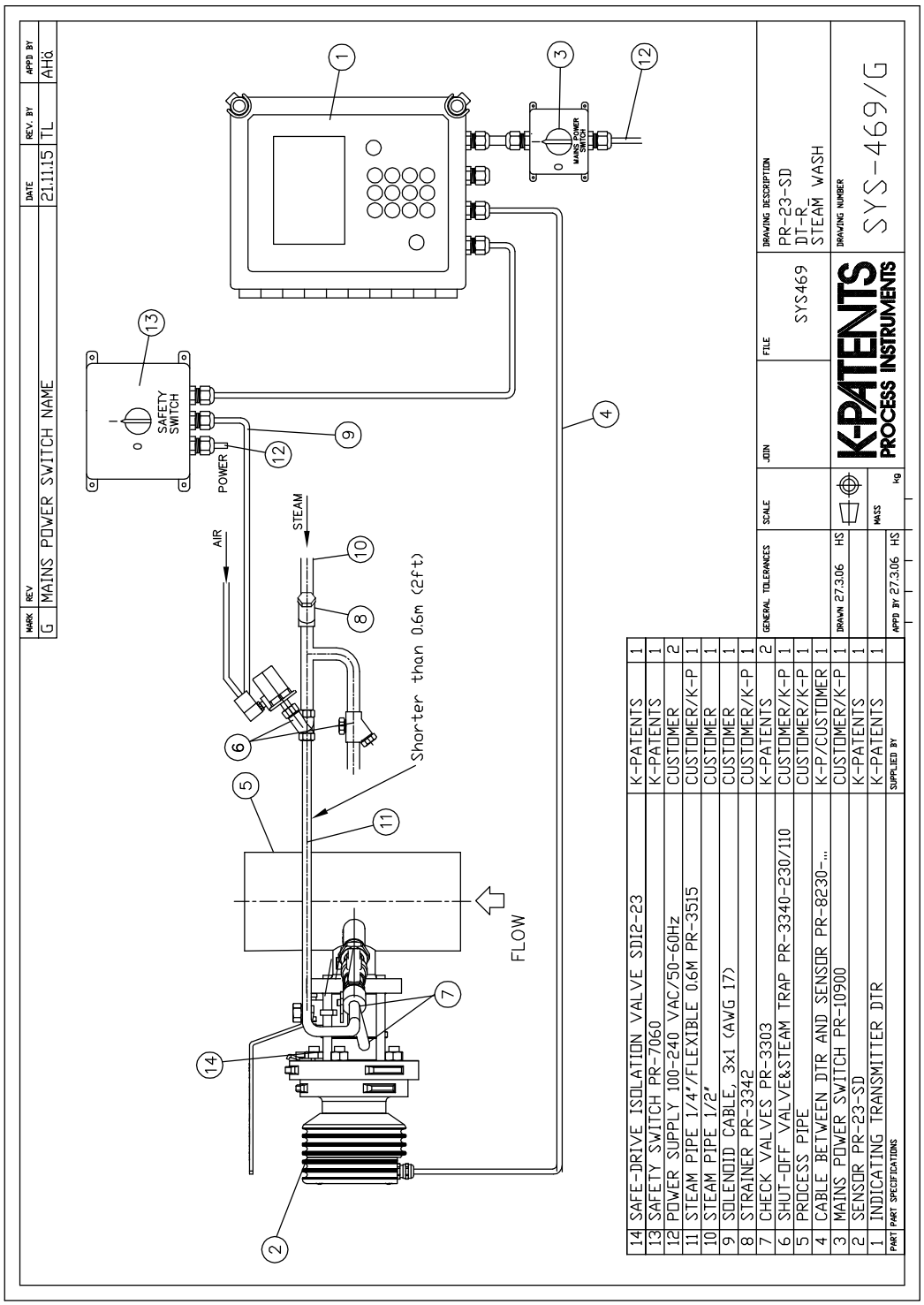
Item	Pcs.	Part No.	Description
1	1	PR-10015	PR-23-SD head
2	1		Safe-Drive™ flange
3	1	PR-10048	68x3 O-ring
4	1		Alignment pin
5	1	PR-10005	PR-23 base
6	6		Screw M5x10 DIN 912 A2
7	1	PR-10022	PR-23-P core
8	1	PR-9011	Thermal conductor
*	1	PR-9010	Disc spring set
9	2		Disc spring
10	1		Disc spring holder
11	6		Screw M5x10 DIN 912 A2
12	1	PR-10101	Sensor processor card
13	8		Screw M3x5 DIN 7380 A4
14	1	PR-10300	Bus terminator card
15	1		O-ring seal 24x2
16	1	PR-9108	Dryer sachet
17	1		O-ring seal 89.5x3
18	1	PR-10000	PR-23 cover
19	4		Screw M4x30 DIN 912 A4
20	1	PR-10002	O-ring seal 82x3
21	1		PR-23-SD endplate with label
22	4		Screw M4x8 DIN 964 A4
23	1		Cable gland M16x1.5

11.3.2 Safe-Drive™ Isolation valve



Item	Pcs.	Part No.	Description	Item	Pcs.	Part No.	Description
1	1	PR-11000	SDI flange and nozzle weld assembly SAF 2205	6	1		M12 nut A4
				7	1		SDI isolation valve handle
*	1	PR-11001	DN 40 ball valve assembly: parts 2, 6, 7	8	1		Safety lock screw
2	1		DN 40 ball valve	9	1		Safety lock
*	1	PR-11009	SDI body assembly: parts 3, 8, 9, 10	10	1		Spring 1.5x14x20 Lesjöfors no. 2371
3	1		SDI body	11	1	PR-11002	SDI box packing set
4	1	PR-11023	SDI steam wash nozzle SN	12	1	PR-11003	O-ring 50x5 EPDM
4	1	PR-11024	SDI high pressure wash nozzle WP	13	4	PR-11008	DIN 912 M10 x 110 screw + nut
5	1	PR-11025	Nozzle isolation valve assembly for SDI2	14	1	PR-11026	Locking bracket for isolation valve

11.3.3 Safe-Drive™ steam wash system parts



11.3.4 Safe-Drive™ Retractor

The Safe-Drive™ Retractor consists of Inner casing and Outer casing. The Inner casing is attached to the sensor flange with bayonet mounting. The Outer casing is attached to the isolation valve body with bayonet mounting. When the hand-wheel is turned, the Inner casing moves inside the Outer casing along the screw thread.

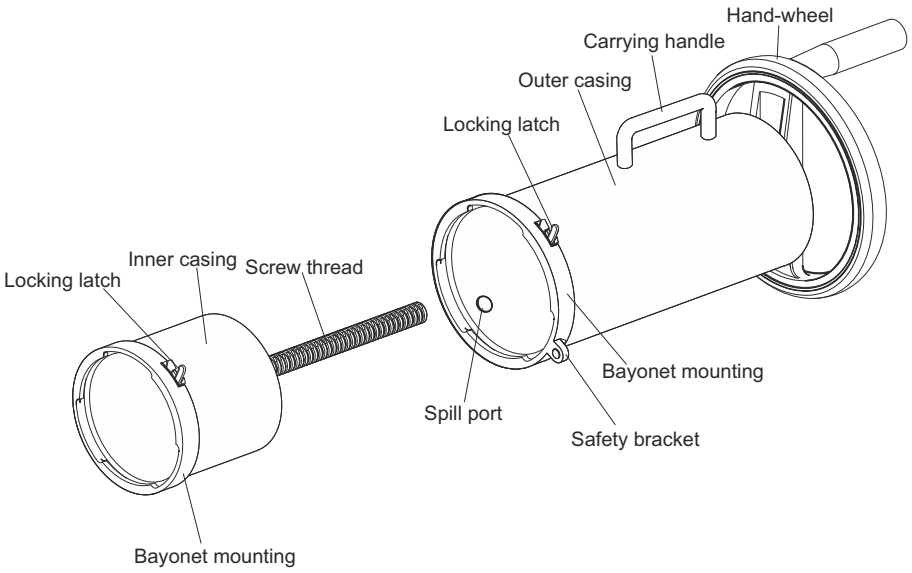


Figure 11.2 The Safe-Drive™ Retractor

11.4 Mounting

A standard Safe-Drive™ system delivery contains a Safe-Drive™ Sensor (PR-23-SD) with a Indicating transmitter DTR, a Safe-Drive™ Isolation valve to be welded onto customer's pipe and a Safe-Drive™ Retractor for sensor insertion and removal. A welding guide sticker is also provided for accurate cutting and welding.
By special order the Safe-Drive™ Isolation valve can also be welded to a suitable length of pipe at the Vaisala factory to be part of the piping on site.

Warning! Hard-scale removal in green liquor handling systems: Make sure that the sensor and wash nozzle materials are suitable for the hard-scale removal chemicals.

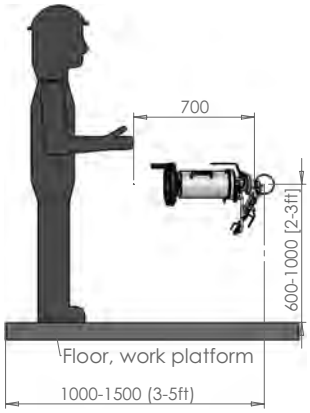


Figure 11.3 Selecting the mounting location

The Safe-Drive™ system is mounted on a vertical pipe or horizontal pipe. When choosing mounting location, keep in mind that you have to be able to lift the Retractor with sensor inside over and off the isolation valve for sensor insertion and removal.

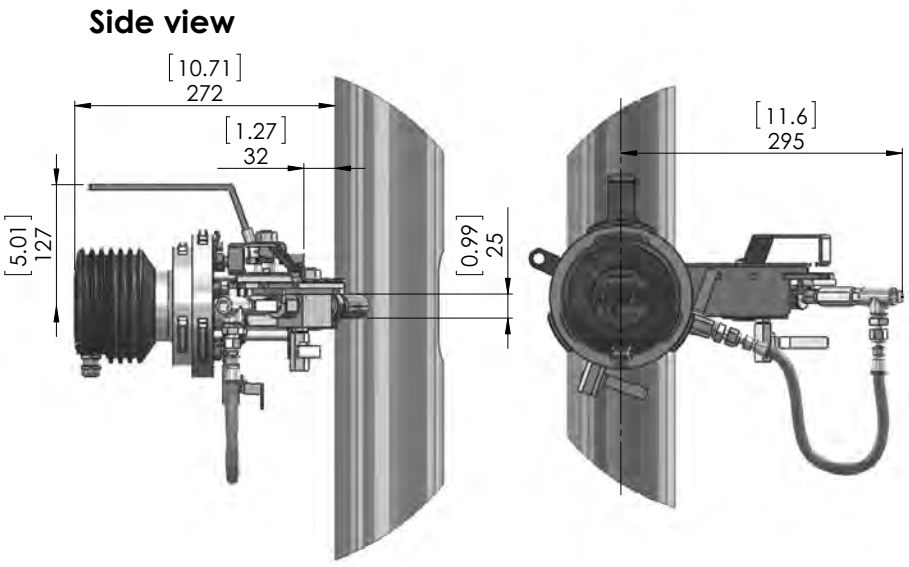


Figure 11.4 Mounting on a vertical pipe

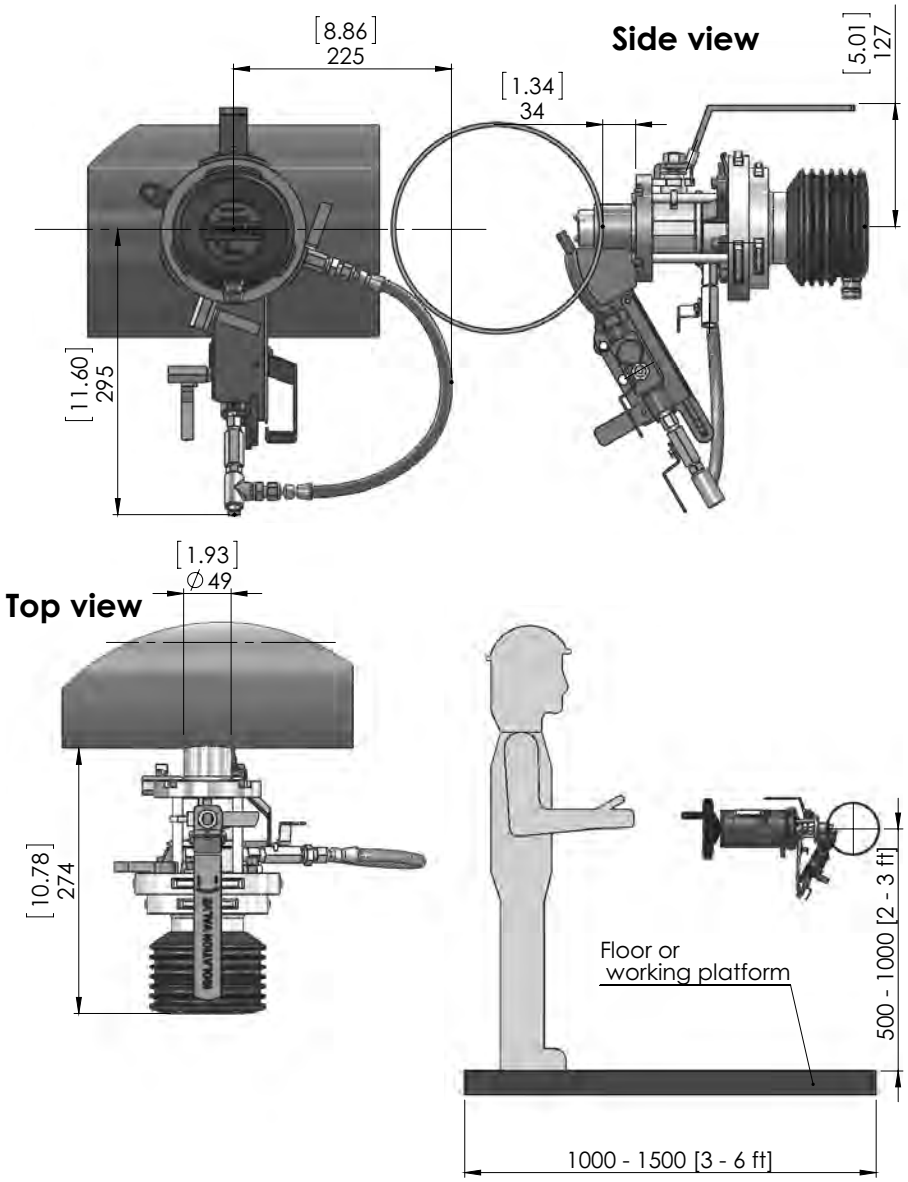


Figure 11.5 Mounting on a horizontal pipe

11.4.1 Welding isolation valve to pipe

For the Safe-Drive™ Isolation valve, two holes – 50 mm (2") and 25 mm (1") – are drilled to the pipe and the bridge between the holes is then removed. To help you place the holes correctly, Vaisala delivers with the valve an installation guide sticker (see Figure 11.6).

Welding steps (see Figure 11.7 or Figure 11.8):

1. Clean the surface of the pipe around the installation area and place the guide sticker across the pipe. Make sure that the flow marker is parallel to the pipe and points to the correct flow direction.

2. Disassemble the isolation valve for welding to avoid thermal damage to the isolation valve sealing.

3. Drill 50mm(2") and 25mm (1") holes to pipe and cut the metal away between the holes.

4. Weld the isolation valve according to MTG472 or MTG2149 (Figure 11.7 or Figure 11.8)

5. Reassemble the isolation valve. Note! The isolation valve handle and the large bayonet tooth must be on the top.

6. Tighten the four M10 nuts to the correct torque.

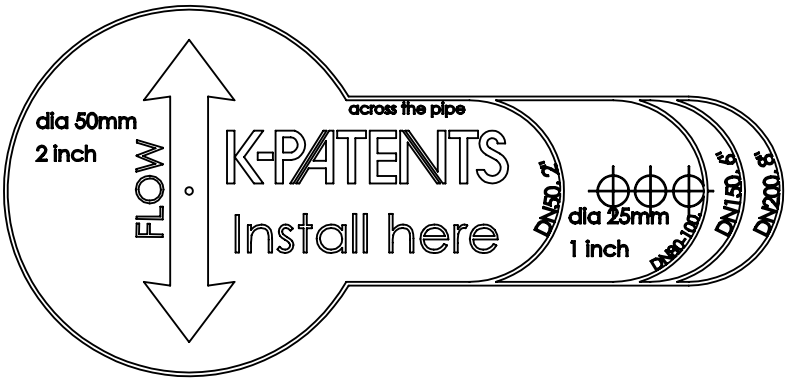
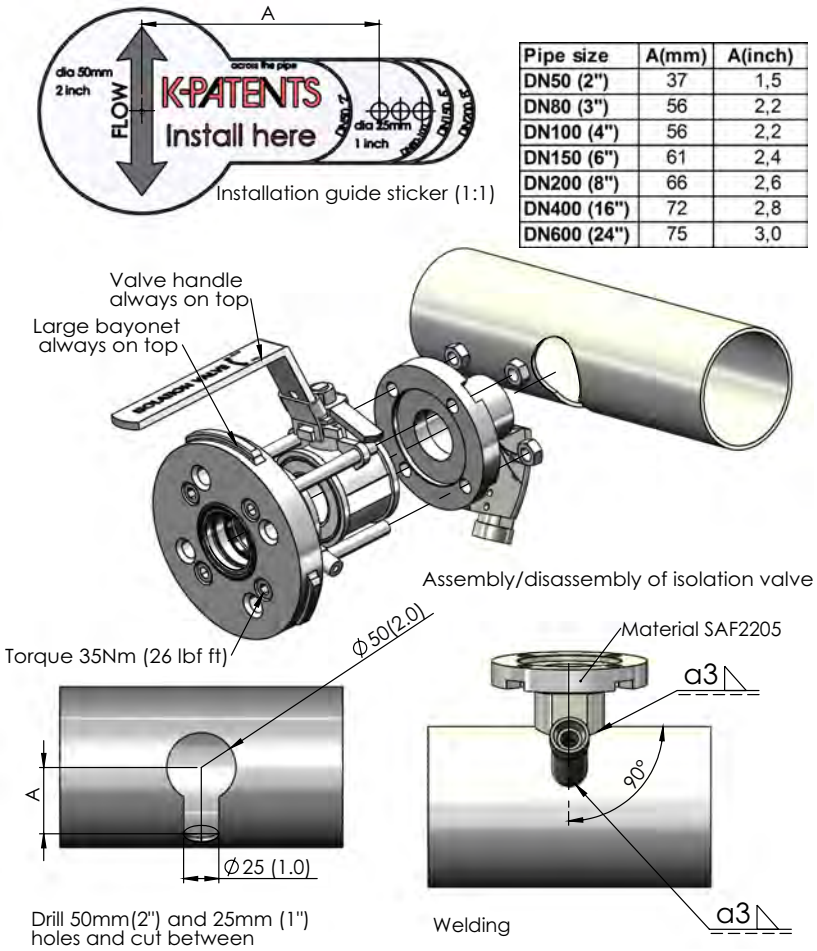
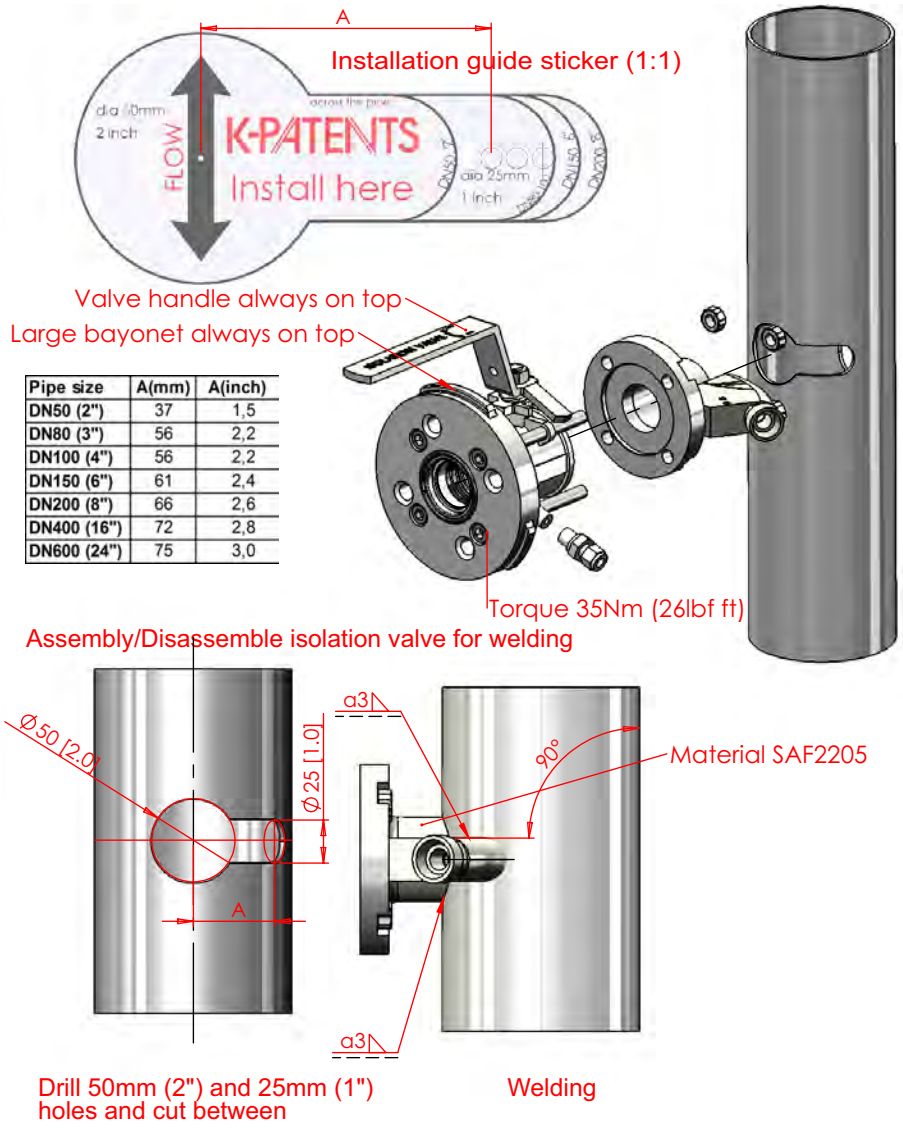


Figure 11.6 A Safe-Drive™ isolation valve installation guide sticker



Pipe size	A(mm)	A(inch)
DN50 (2")	37	1,5
DN80 (3")	56	2,2
DN100 (4")	56	2,2
DN150 (6")	61	2,4
DN200 (8")	66	2,6
DN400 (16")	72	2,8
DN600 (24")	75	3,0

Figure 11.7 Welding the Safe-Drive™ isolation valve to a horizontal pipe



Pipe size	A(mm)	A(inch)
DN50 (2")	37	1,5
DN80 (3")	56	2,2
DN100 (4")	56	2,2
DN150 (6")	61	2,4
DN200 (8")	66	2,6
DN400 (16")	72	2,8
DN600 (24")	75	3,0

Figure 11.8 Welding the Safe-Drive™ isolation valve to a vertical pipe

11.4.2 Wiring

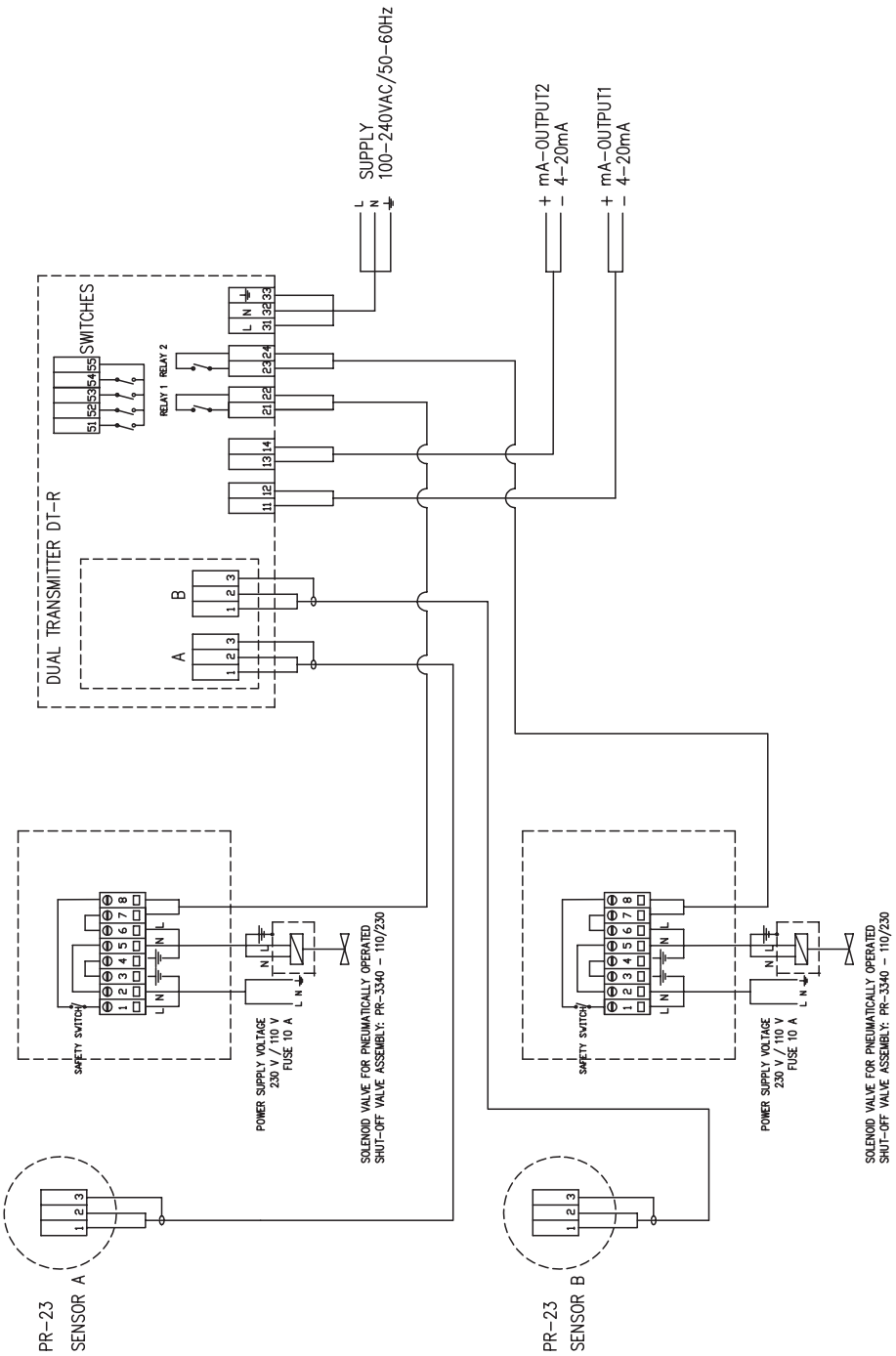
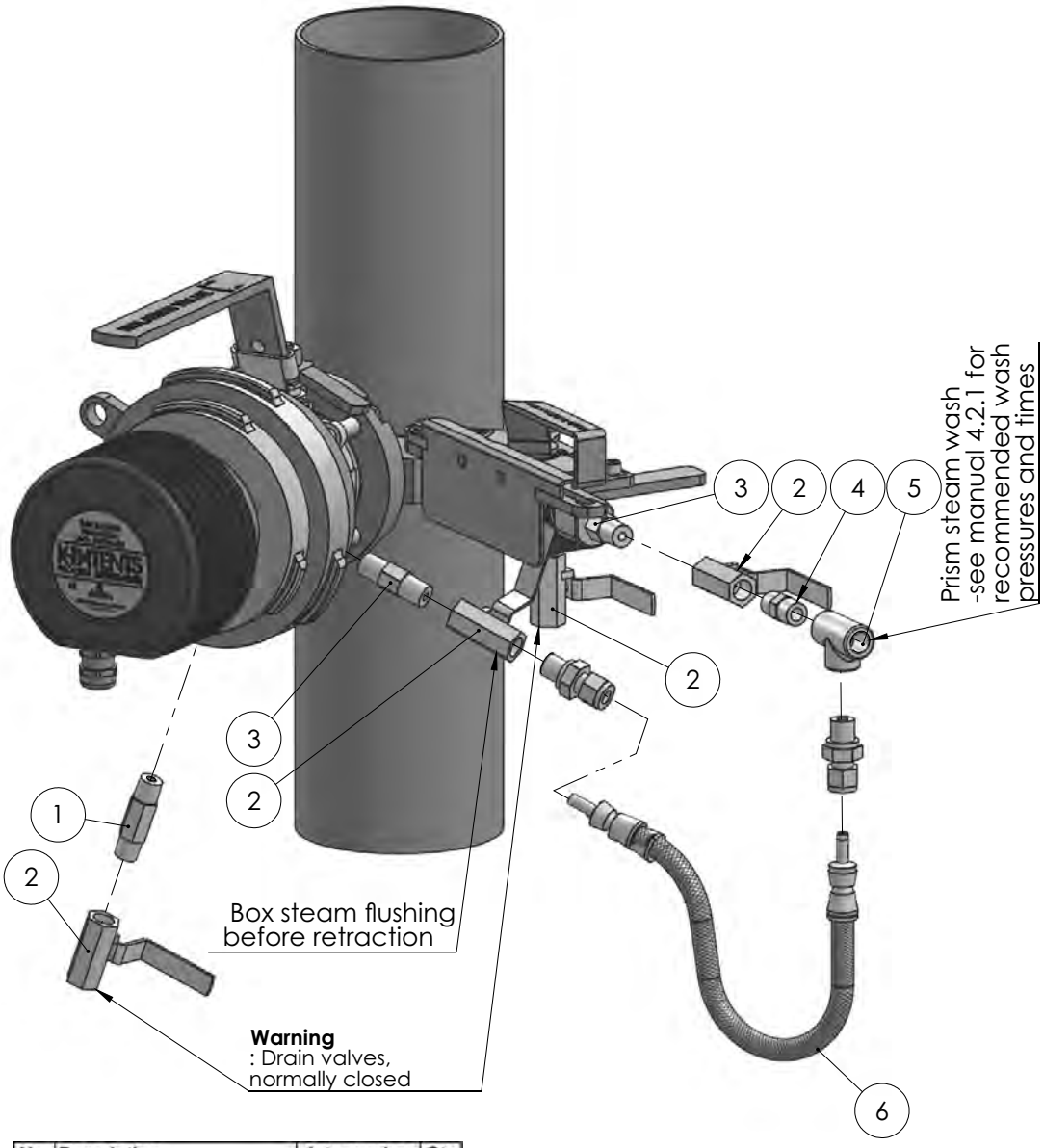


Figure 11.9 PR-23-SD system wiring

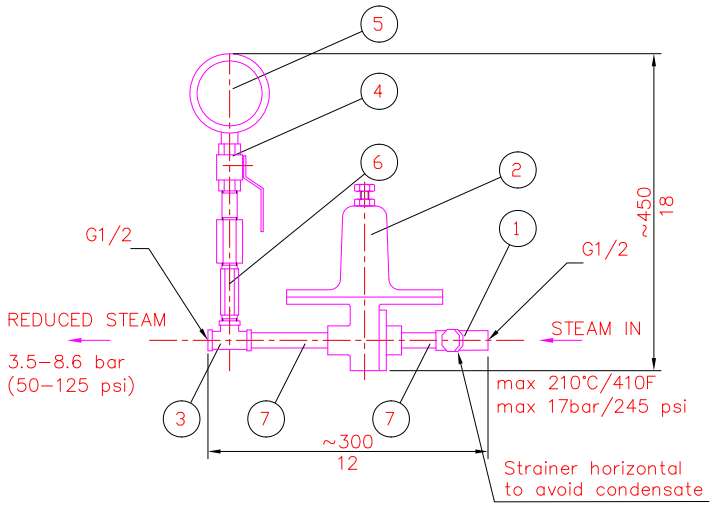
11.4.3 Steam piping for SDI2 (eg weak and black liquor)



No.	Description	Art. number	Qty
1	Nipple for HIMP		1
2	1/4" ball valve	PR-3516	3
3	Check valve	PR-3304	2
4	1/4" hexagon nipple		2
5	1/4" T-piece		1
6	Flexible pipe SS-4BHT-18	PR-3517	1

Figure 11.10 Mounting steam wash to isolation valve

In case of excessive pressure: If the steam pressure exceeds to maximum pressure differential, a pressure reducing valve PR-3341-J needs to be installed to reduce the steam pressure to optimal design.



DIMENSIONS: 300x450x140 (12x18x5.5)

7	SEAMLESS PIPE NIPPLE 1/2"		AISI 316	2
6	HEX VALVE SYPHOUS			1
5	PRESSURE METER			1
4	BALL VALVE			1
3	T-COUPLING 1/2"			1
2	PRESSURE REGULATOR			1
1	STRAINER			1

Figure 11.11 Pressure reducing valve PR-3341-J

Note the orientation of the strainer.

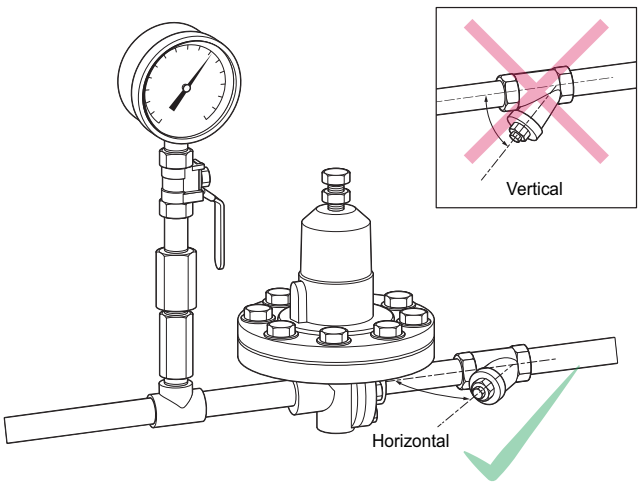
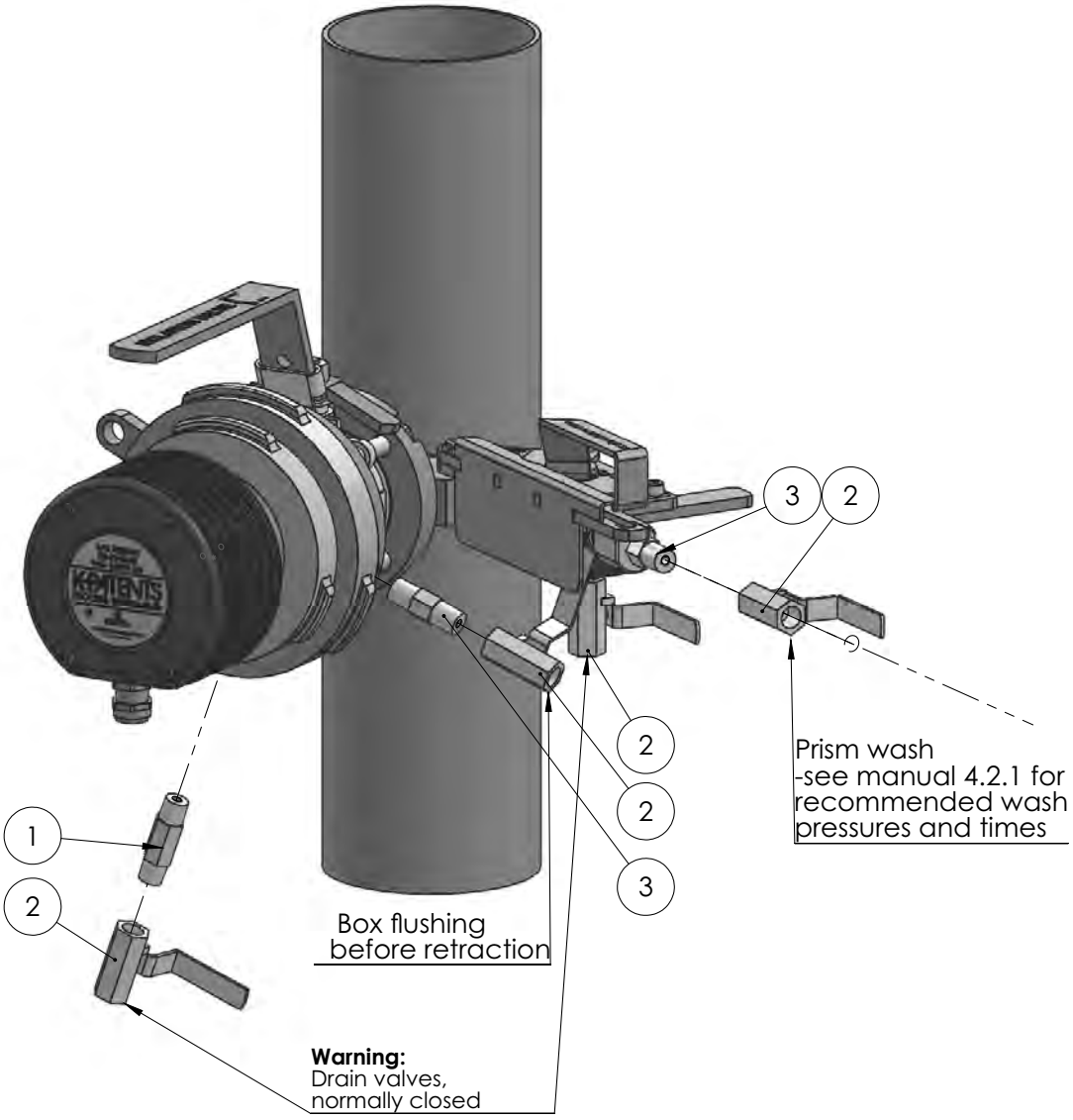


Figure 11.12 Install strainer horizontally

11.4.4 High pressure water piping for SDI2 (eg green liquor)



No.	Description	MRP	Qty
1	Extended nipple	5344	1
2	1/4" ball valve	PR-3516	4
3	Check valve	PR-3304	2

Figure 11.13 Mounting high pressure water wash to isolation valve

11.4.5 Water consumption of the high pressure wash system

	Water add		
Pressure	**10 s wash**	**10 s wash every 15 min**	**Nozzle flow**
17 bar (250 psi)	1.5 l (0.40 gal)	6 l (1.6 gal)/h	0.15 l (0.04 gal)/s
34 bar (500 psi)	2.2 l (0.58 gal)	8.8 l (2.3 gal)/h	0.22 l (0.06 gal)/s
41 bar (600 psi)	2.5 l (0.66 gal)	10 l (2.6 gal)/h	0.25 l (0.07 gal)/s

Table 11.1 Nozzle flow at various pressures with 2 mm (0.080 inch) nozzle orifice diameter

11.4.6 Non retractable wash nozzle SDI2-23-WPR/WPN-XS

The non retractable high pressure water wash nozzle SDI2-23-WPR/WPN-XS must be inserted before the line is pressurized and it may not be removed while line is under pressure.

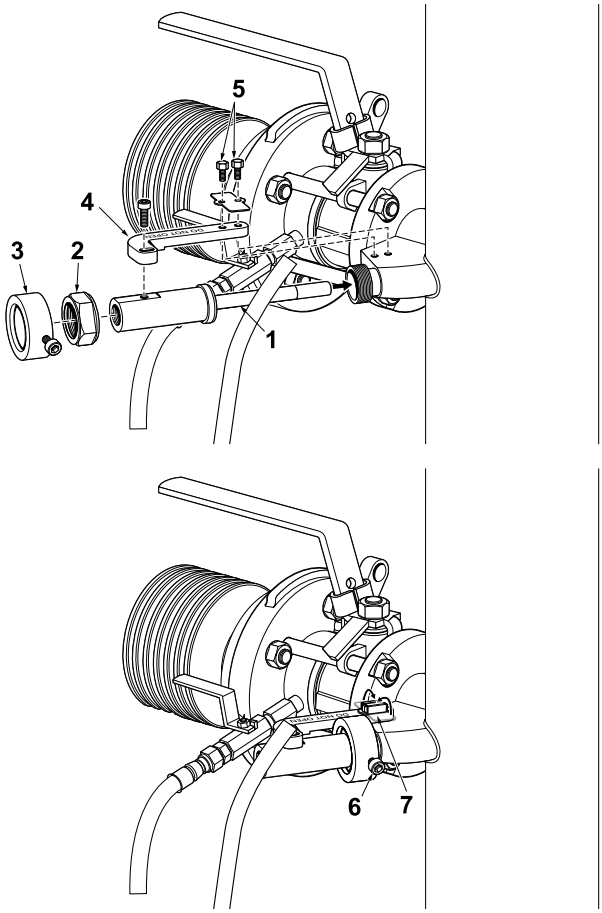


Figure 11.14 Installing non retractable wash nozzle

11.5 Safe sensor insertion and removal for Safe-Drive™ Generation 2.1

Important: These instructions are for Safe-Drive™ generation 2.1. If you have Generation 1 or Generation 2 Safe-Drive™ , consider upgrading to 2.1. Upgrade from Generation 1 requires shutdown, upgrade from Generation 2 can be done any time. See *http://www.kpatents.com/support/product-upgrades-and-notifications/documentation-upgrade-for-safe-drive* for more information on how to upgrade.

Warning! Always use the Safe-Drive™ Retractor for sensor insertion and removal! Safe sensor insertion and removal can only be guaranteed when the Retractor tool is used and these instructions are carefully followed. Removing the sensor without the Retractor tool may cause a life-threatening situation if there's any pressure in the pipe. Also, the lip seal damages easily if Retractor is not used.

Important: Safe-Drive™ is designed to protect user from process liquid and to safely insert and remove the sensor. However, do not underestimate or neglect the factory safety requirements:



- Wear long-sleeved safety clothing since the process liquid can be either hot, corrosive or both
- Use protective gloves
- Use safety glasses and/or goggles
- Use ear protectors
- Use a hard hat or helmet
- Use face visor
- Wear hard-cap safety boots
- Before you start, locate the nearest emergency shower and eye wash
- Never operate the system alone: It is recommended for one operator to read the instructions and guide the second operator performing the step

Warning! The drain valves (see Figures 11.10 and 11.13) should always be closed unless otherwise indicated. If the valves are left open, process liquid will leak out through them.

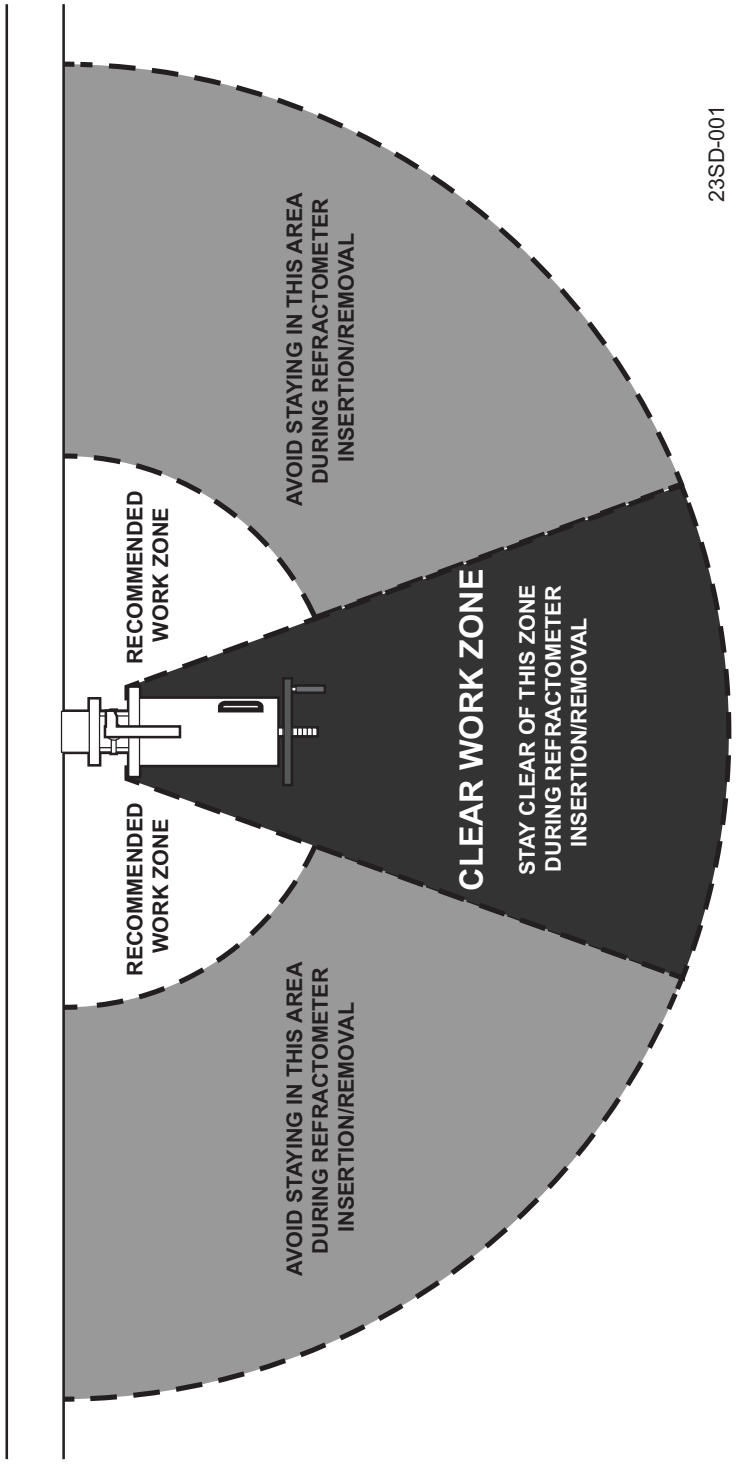
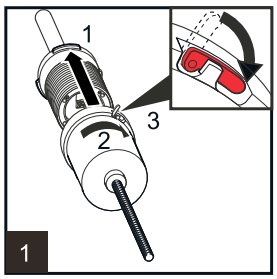
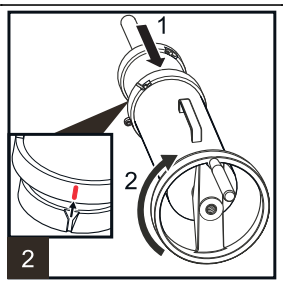
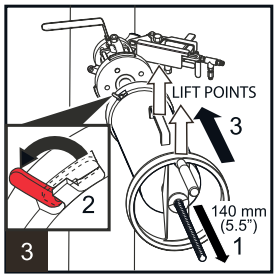
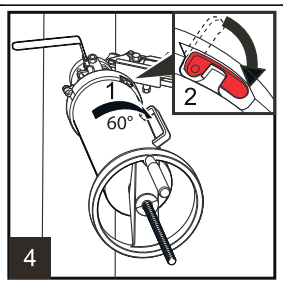


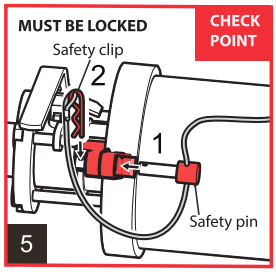
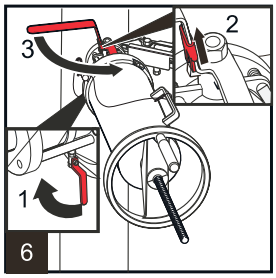
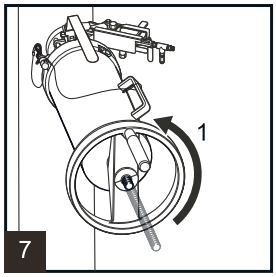
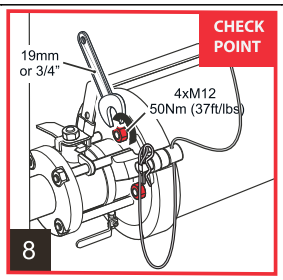
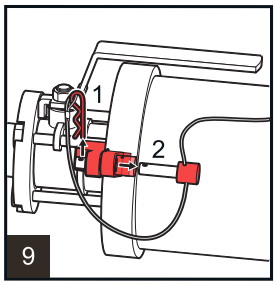
Figure 11.15 The recommended work zone is by the side of the SD

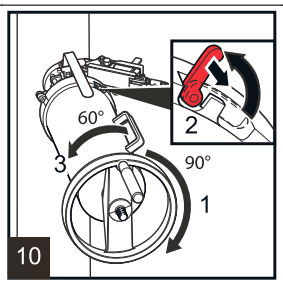
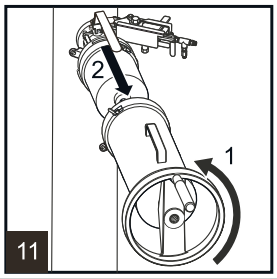
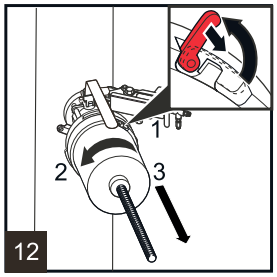
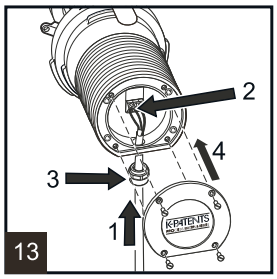
11.5.1 Sensor insertion

Before you start

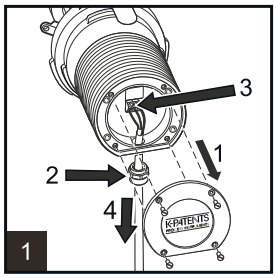
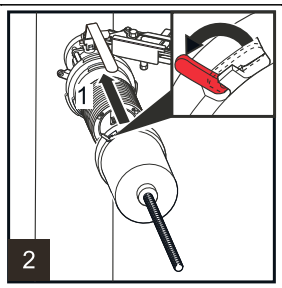
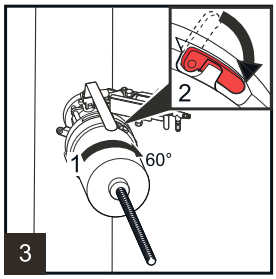
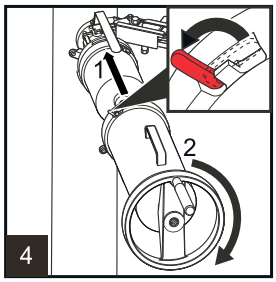
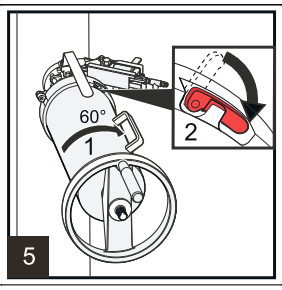
- check that the gaskets and gasket surfaces are clean and undamaged
- remove the sensor cable gland and unlock Inner casing

1		1. Insert the sensor into Inner casing. Make sure that the sensor cable gland has been taken off. Match the bayonet closing with sensor flange so that the latch is slightly to the left of the top and the sensor cable passage is straight down. 2. When sensor flange is flush with the bottom of Inner casing, rotate Inner casing 60 degrees clockwise to lock it to the flange. 3. Push down locking latch to secure the connection.
2		1. Fit Outer casing over Inner casing. To match the casings, check that the rail on the Inner casing matches the groove on Outer casing. The latch of Inner casing should be slightly to the right from the top and the handle of Outer casing should point up. 2. Turn the hand-wheel clockwise until it stops to draw the Inner casing with sensor into Outer casing.
3		1. The sensor should now be inside Retractor and about 140 mm (5.5”) of the screw thread should stick out of the middle of the wheel. 2. Unlock the latch on Outer casing. 3. Take a firm hold of the hand-wheel and handle and lift Retractor (with sensor) over the isolation valve flange. Keep handle up.
4		1. Rotate Outer casing 60° clockwise to lock the bayonet. 2. Lock Outer casing latch.

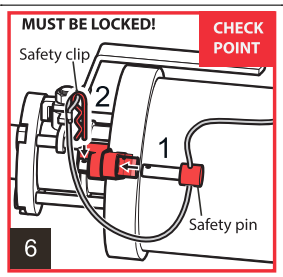
5		1. Insert the safety pin. 2. Lock the safety pin with safety clip. **DO NOT PROCEED UNTIL YOU HAVE COMPLETED THIS STEP!**
6		1. Close the blow-out ball valve under Isolation valve. 2. Lift up the Isolation valve handle locking plate. 3. Open Isolation valve by turning the valve handle 90°. The valve is open when the ball valve handle is parallel to Retractor and sensor.
7		Now the sensor can be inserted into the process. 1. Turn the hand-wheel counterclockwise until it stops, i.e. until the sensor flange connects with Isolation valve and only the end of the screw thread is visible. **Warning! If you detect leaking, revert immediately to the previous step. Do not continue the installation until the reason for leakage has been cleared and fixed.**
8		Fit the four M12 nuts to the bolts holding the sensor to Isolation valve and screw them on with a 19 mm or ¾" wrench. Important: Do not overtighten the nuts, set the torque at 50 Nm (37 ft/lbs). **DO NOT PROCEED UNTIL YOU HAVE COMPLETED THIS STEP!**
9		1. Remove the safety clip. 2. Remove the safety pin.

10		1. Turn the wheel 90° clockwise. 2. Open the locking latch on Outer casing. 3. Rotate Outer casing handle 60° counterclockwise.
11		1. Turn the hand-wheel counterclockwise to drop the thread. 2. Lift off Outer casing.
12		1. Lift up the latch of Inner casing to unlock it. 2. Rotate the casing 60° counterclockwise to release it from the flange. 3. Lift Inner casing away from the sensor head.
13		Ensure the DTR is switched off. Connect the sensor cable to the DTR. 1. Push the interconnecting cable through the cable gland and into the sensor. 2. Connect the interconnecting cable to the sensor. 3. Tighten the cable gland onto the sensor 4. Fit the nameplate onto the sensor and screw it on. Turn on DTR power to power up the Safe-Drive™ system. Open wash valve.

11.5.2 Sensor removal

1		Switch off the DTR to cut off power from the sensor. Close wash valve. 1. Unscrew and remove sensor nameplate 2. Loosen the cable gland 3. Unscrew the wires 4. Remove the sensor cable and cable gland **Note:** If another in-line sensor is connected to the same DTR, disconnect the loose cable from the DTR and turn on power again.
2		1. Lift up the latch of Inner casing to unlock it. Lift Inner casing over the sensor head. The latch of Inner casing should be slightly to the left.
3		1. Rotate Inner casing 60° clockwise to lock it onto the flange. 2. Lock Inner casing latch.
4		1. Open the locking latch on Outer casing. Grab Outer casing with one hand on the handle and the other hand on the wheel. Fit Outer casing over Inner casing. 2. Turn the hand-wheel clockwise to get the thread of Inner casing running through the hand-wheel.
5		1. Rotate Outer casing 60° clockwise to lock the bayonet. 2. Lock Outer casing latch.

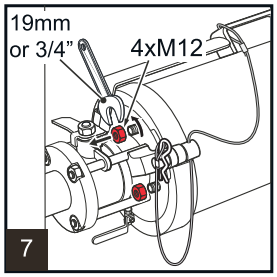
6



1. Insert the safety pin.
2. Lock the safety pin with the safety clip.

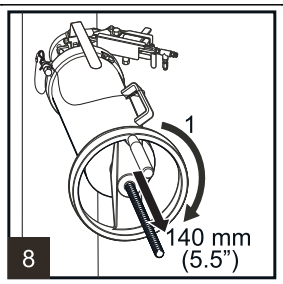
DO NOT PROCEED UNTIL YOU HAVE COMPLETED THIS STEP!

7



Open and remove the four M12 nuts on the bolts holding the sensor to Isolation valve using a 19 mm or ¾” wrench.

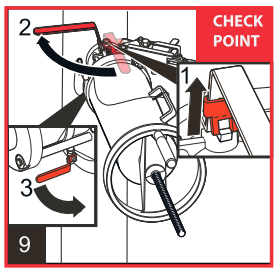
8



1. To remove the sensor from the process, turn the hand-wheel clockwise until it stops. At this stage about 140 mm (5.5”) of the thread should stick out from the middle of the wheel.

Warning! If you detect leaking, revert immediately to the previous step. Do not continue removal until the reason for leakage has been cleared and fixed.

9



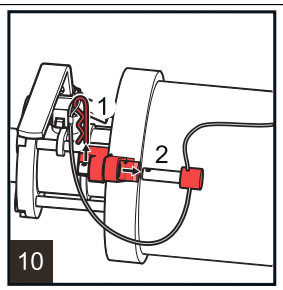
1. Lift up Isolation valve handle locking plate.
2. Close Isolation valve by turning the handle 90°.

Important: Isolation valve is properly closed when the handle points away from the sensor and the locking plate drops down over the handle.

3. Open the blow-out valve under Isolation valve for box cleaning to get rid of any process liquid inside Isolation valve. Warning! Some process liquid will leak out through the small ball valve, beware of splashing!

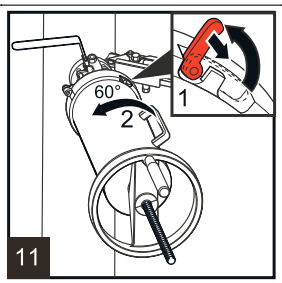
DO NOT PROCEED UNTIL YOU HAVE COMPLETED THIS STEP!

10



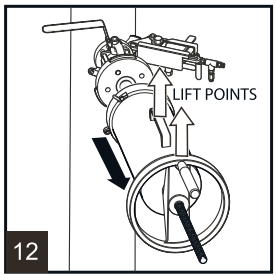
1. Remove the safety clip.
2. Pull out the safety pin.

11



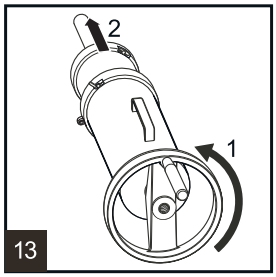
1. Lift open Outer casing locking latch.
2. Rotate Outer casing 60° counterclockwise so that the handle comes up on top.

12



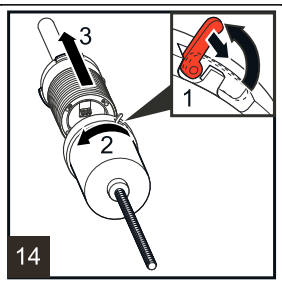
Take a firm hold on the hand-wheel and the handle and pull out Retractor with sensor inside.
Warning! A firm hold of the tool is essential as the combination of the tool and the sensor is noticeably heavier than Retractor alone.
Note: To ensure Isolation valve after the Safe-Drive tool with the sensor has been removed, you can bolt a standard ANSI 1.5” 105 lbs blind flange to Isolation valve with ½” (M12) bolts and nuts.
A lock can be added to Isolation valve handle.
Warning! The sensor tip is hot and may be covered with liquor. It is recommended to rinse the sensor tip and Isolation valve with hot water.

13



Put Retractor with sensor onto a table or similar surface so that the hand-wheel has space to turn.
1. Turn the hand-wheel counterclockwise to drop the thread, i.e. until Outer casing is no longer connected to the parts inside.
2. Pull off Outer casing.

14



1. Open the latch on Inner casing.
2. Keep sensor steady with one hand and rotate Inner casing counterclockwise with the other hand to unlock Inner casing from sensor.
3. Pull off the sensor.

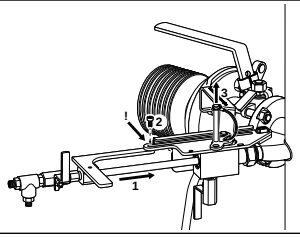
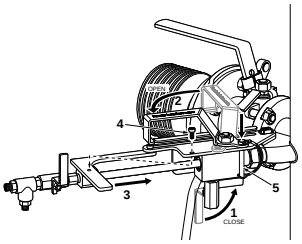
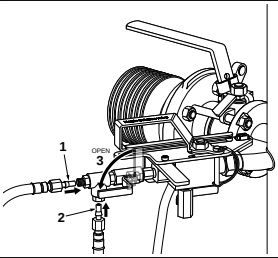
11.6 Wash nozzle insertion and removal

Warning! Non retractable wash nozzle SDI2-23-WPR/WPN-XS for high pressure water can only be inserted or removed when the process pipe is empty. Insertion and retraction instructions below are valid only for wash nozzles SDI2-23-SN2 for steam and SDI2-23-WP2 for high pressure water. For installation of the non retractable wash nozzle see Section 11.4.6.

11.6.1 Wash nozzle insertion

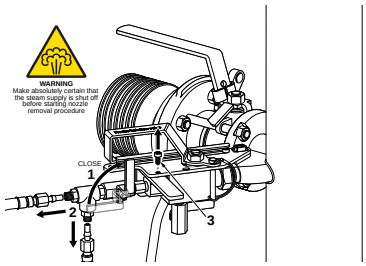
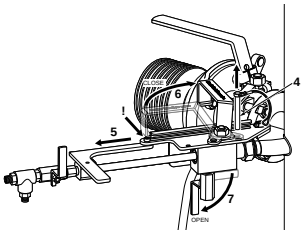
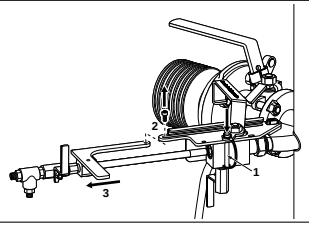
Check the nozzle and the valve before installing the wash nozzle. Use thread seal tape for all thread connections.

Warning! Always shut the main steam valve before performing any work on the wash nozzle.

1		1. Insert the nozzle into the isolation valve (1). 2. Attach the nozzle to the nozzle guide with one special M5x10 screw (2) using a 5 mm allen key. 3. Remove the safety pin (3).
2		1. Close the 1/4'' check port valve under the nozzle isolation valve (1). 2. Open the isolation valve (2) by turning the handle counterclockwise. 3. Push the nozzle to the process (3). 4. Attach the nozzle to the nozzle guide with one special M5x10 screw (4) using a 5 mm allen key. 5. Lock the isolation valve handle with the safety pin (5).
3		1.1 **STEAM**: Connect the steam line and sensor flush flexible line to the nozzle T-piece (1,2). 1.2 **WATER**: Connect the water line to 1/4" valve (1,2). 2. Open the steam supply line valve (3). 3. Check the functionality of washing from the optical image window in DTR.

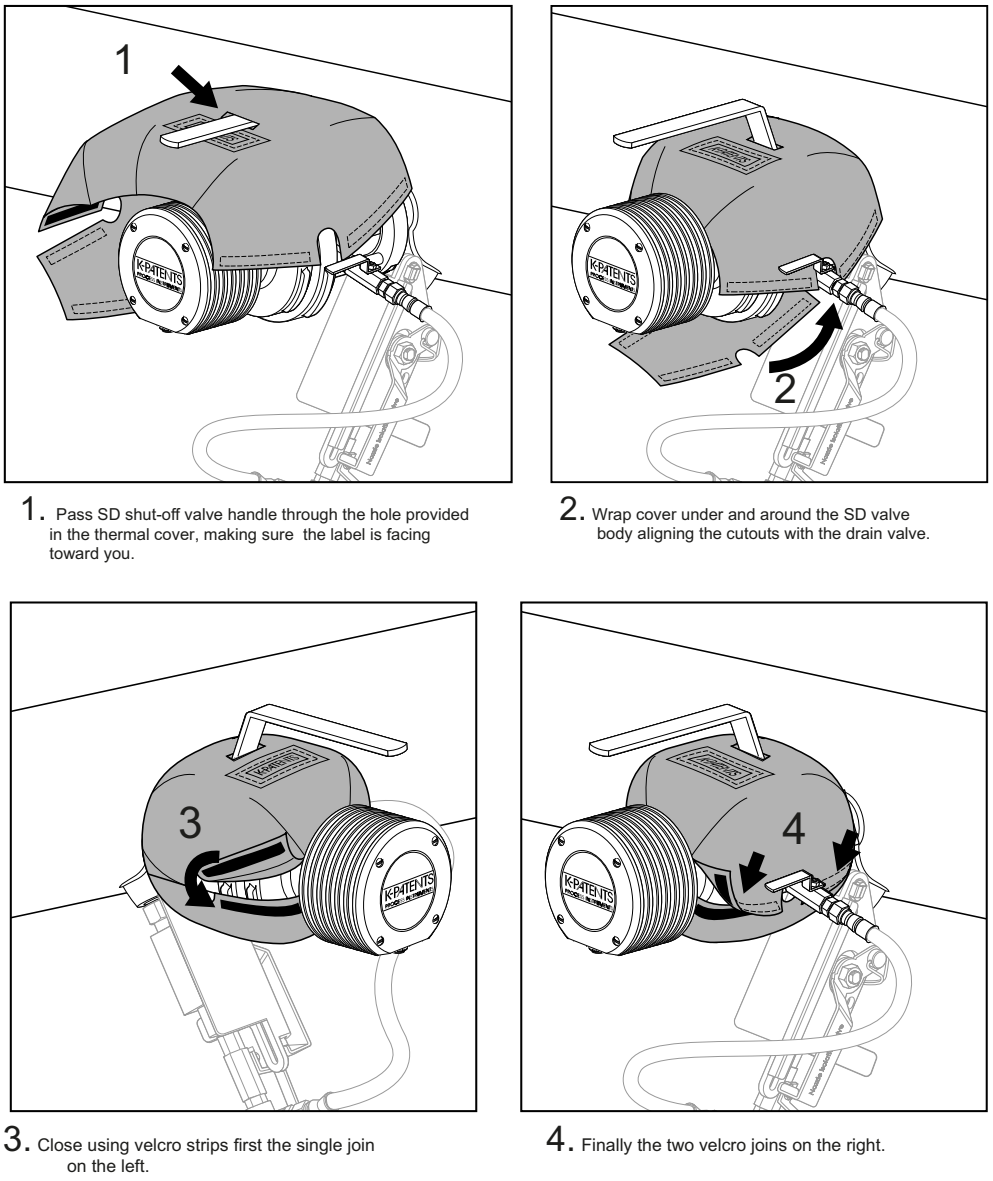
11.6.2 Wash nozzle removal

Warning! Always shut the main steam valve before performing any work on the wash nozzle.

1		**WARNING**: Make absolutely certain that the steam or water supply is shut off before starting nozzle removal procedure. 1 Close the steam line supply valve (1). 2.1 **STEAM**: Remove the steam supply line (2) and the sensor flush flexible line (2) from the nozzle T-piece. 2.2 **WATER**: Remove the water supply line (2) from the nozzle. Remove the special M5x10 nozzle guide locking screw (3) using a 5mm allen key. Be careful, process pressure will try to push the nozzle out from the process!
2		4 Remove the safety pin (4). 5 Slide the nozzle out from the process (5) until the guide plate stops it. 6 Close the nozzle isolation valve (6) by turning the handle clockwise. 7 Open the 1/4'' check port valve under the nozzle isolation valve (7). **Note:** Only little process liquid should flow from the nozzle. If process liquid keeps on flowing, the nozzle isolation valve is damaged and it is not safe to remove the nozzle. Do not proceed with nozzle removal.
3		1 Lock the isolation valve handle with the safety pin (1). 2 Remove the special 5x10 guide plate screw (2) using a 5mm allen key. 3 Remove the nozzle from the isolation valve completely (3).

11.7 Thermal cover for PR-23-SD

The thermal cover prevents heat flow between process and ambient surroundings. It helps maintain the sensor tip and the prism surface at process temperature and may reduce prism coating. Use thermal cover when the temperature difference between the process and the ambient is more than 30°C or when the process temperature is over 60°C.



1. Pass SD shut-off valve handle through the hole provided in the thermal cover, making sure the label is facing toward you.

2. Wrap cover under and around the SD valve body aligning the cutouts with the drain valve.

3. Close using velcro strips first the single join on the left.

4. Finally the two velcro joins on the right.

Figure 11.16 Mounting the thermal cover

To remove the thermal cover, first open the two velcro fasteners on the right. Then open the velcro fastener on the left, unwrap the cover underneath the sensor and then remove the cover.

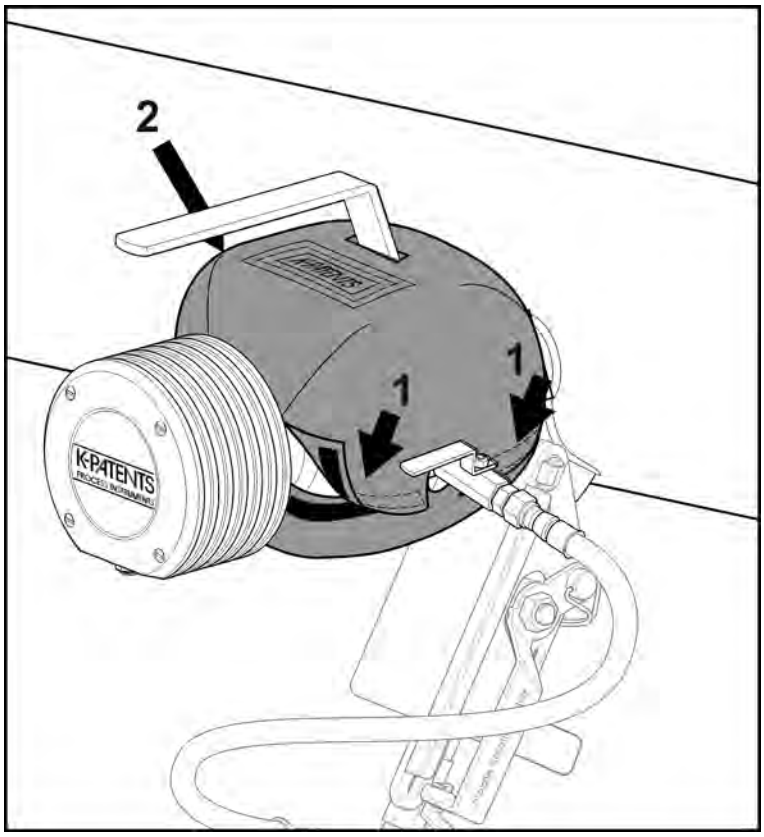
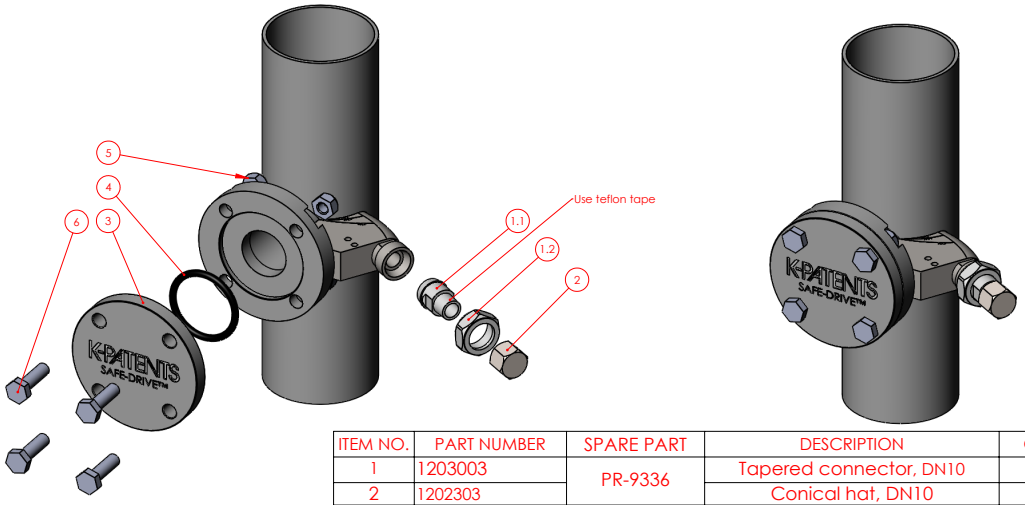


Figure 11.17 Removing the thermal cover

11.8 Blinding the Safe-Drive™ system

A Safe-Drive™ connection that is no longer used can be secured with blind plugs.



ITEM NO.	PART NUMBER	SPARE PART	DESCRIPTION	QTY.
1	1203003	PR-9336	Tapered connector, DN10	1
2	1202303		Conical hat, DN10	1
3	3825	PR-9335	PR-23-SD-PG	1
4	-		O-ring	1
5	DIN985, A4, M10		Stainless nylon insert lock nut	4
6	DIN933		Hexagonal bolt DIN933 x 35 A4	4

Figure 11.18 SDI mounting flange plug system

11.9 Identifying your refractometer generation

These instructions are written for **Safe-Drive™ Generation 2.1**. If you downloaded the instructions online or ordered a manual as a spare part, it is possible that your Safe-Drive™ system is of different generation and a different set of instructions is needed. Vaisala strongly recommends upgrading the system to Generation 2.1, for more information see `http://www.kpatents.com/support/product-upgrades-and-notifications/documentation-upgrade-for-safe-drive` on K-Patents website.

The first place to look for the generation information the retractor handle. If your retractor is Generation 2, the handle will have the code G2. If your retractor is Generation 2.1, the handle will have code G2.1 (see Figure 11.19). But the difference between the generations is visible also when looking at the retractor and the isolation valve, see Table 11.2 on page 195.

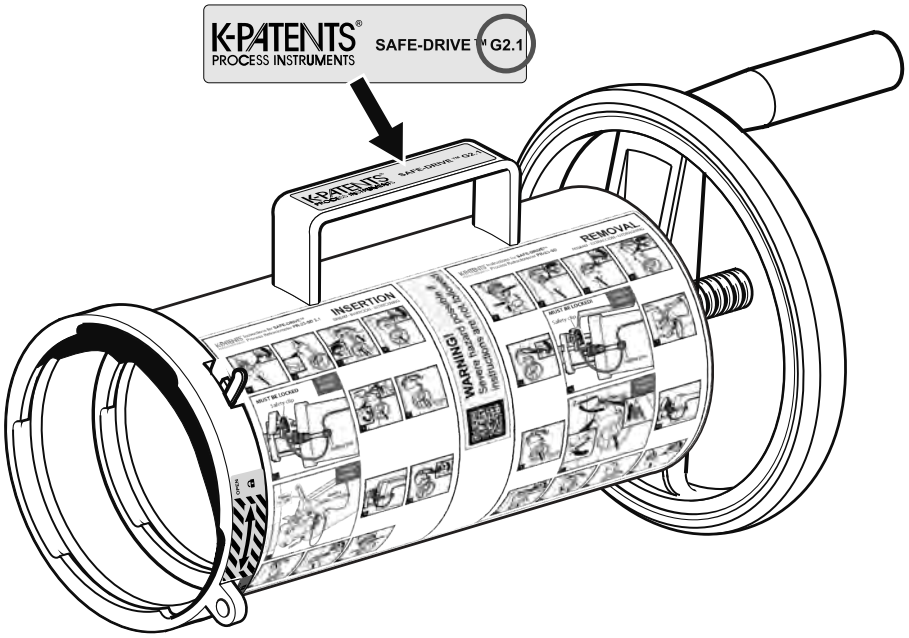


Figure 11.19 Markings on the retractor handle

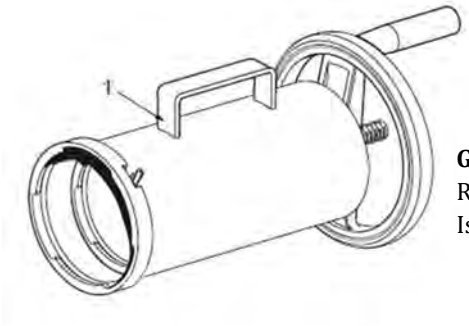
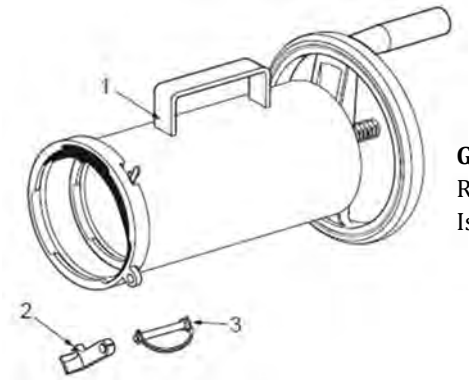
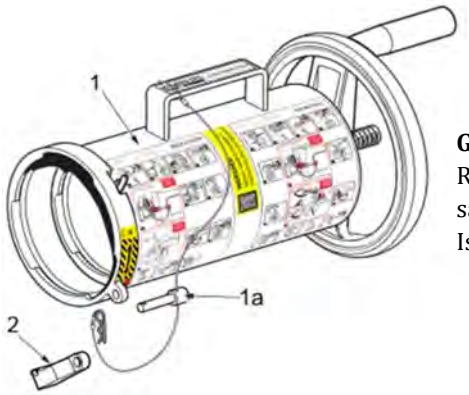
	**Generation 1** (2006-2014) Retractor *without* safety bracket. Isolation valve *without* safety bracket.
	**Generation 2** (2014-2017) Retractor *with* safety bracket. Isolation valve *with* safety bracket.
	**Generation 2.1** (2017-) Retractor *with* safety bracket and integrated safety clip and pin. Isolation valve *with* safety bracket.

Table 11.2 Identifying the different Safe-Drive™ generations

12 Ethernet connection specification

The Ethernet connection enables data download from a DTR to a computer. The connection works both directly between DTR and computer or via a hub or switch, local area network (LAN), wireless network (WLAN) or fiber Ethernet.

Any type of computer (PC, Mac, PDA, mainframe...) with a compatible network connection can be configured to download data from the DTR. This document gives all the specifications necessary to write a communications program for downloading purposes. It is also possible to get a ready-to-install communications software from Vaisala.

12.1 Cable requirements and connection

12.1.1 Ethernet cable specification

The DTR uses a standard Ethernet cable (10/100BASE-T Cat 5e UTP cable with RJ45 connectors). The maximum cable length is 100 m.

Ethernet connection is similar to that of a computer/PC:
Use cross-over Ethernet cable to connect the DTR directly to a computer (Figure 12.1). If you are connecting the DTR to a LAN (Local Area Network) via a wall socket, use straight-through Ethernet cable (Figure 12.2).

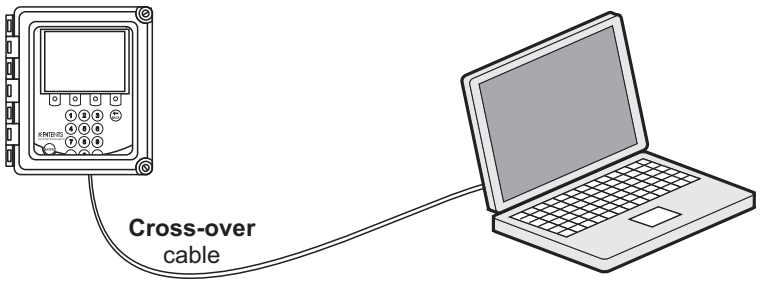


Figure 12.1 Connecting DTR to a computer.

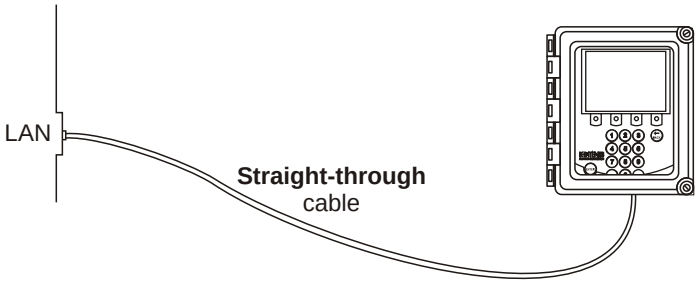


Figure 12.2 Connecting DTR to LAN.

If you are connecting the DTR to a hub or switch or WLAN access point, please consult the user's guide of your hub/switch/access point for the correct cable type (Figures 12.3 and 12.4).

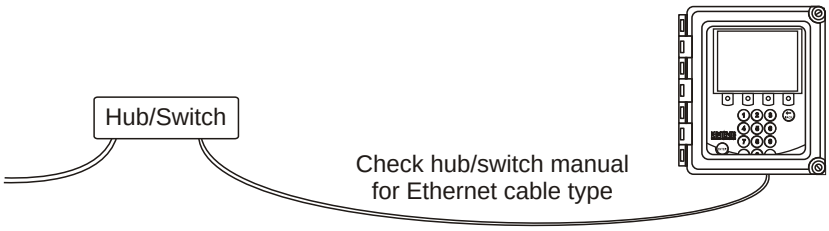


Figure 12.3 Connecting a DTR to a hub or a switch.

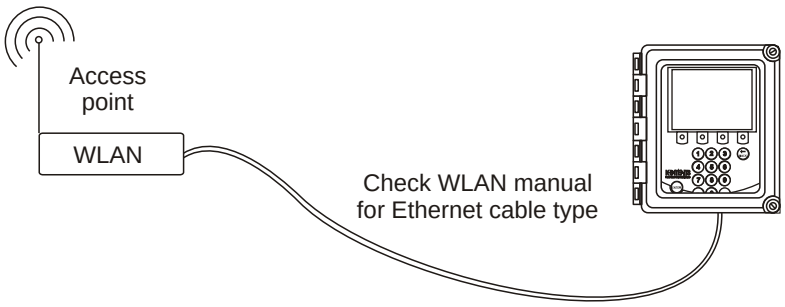


Figure 12.4 Connecting DTR to WLAN.

If you need a longer cable or the environment is electrically noisy, use fiber optics Ethernet with media converters (Figure 12.5).

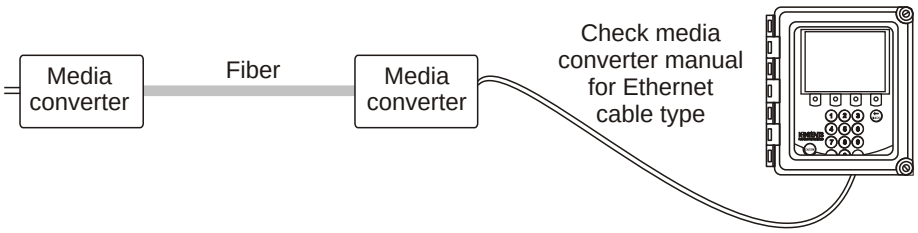


Figure 12.5 Using fiber optics Ethernet.

12.1.2 Connecting the Ethernet cable

To connect the Ethernet cable to the DTR, open the DTR's enclosure cover, loosen the front panel screw and open the front panel. The Ethernet connector is **behind the front panel**, see Figure 12.6. Plug one end of an appropriate Ethernet cable into the connector. Plug the other end into your PC/LAN socket/hub/switch/access point.

Warning! While it is possible to connect and disconnect the Ethernet cable when the DTR is powered on, for your safety we recommend that you turn off the power (by using the external power switch) before opening the DTR's front panel.

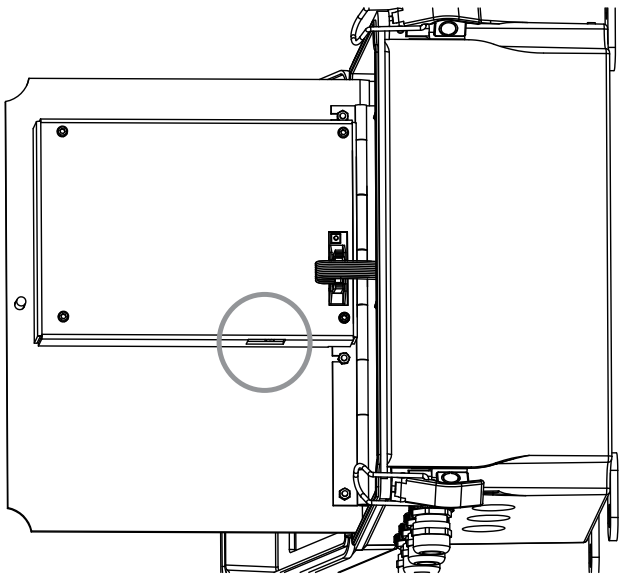


Figure 12.6 Ethernet connector on the underside of the Front panel.

Note: The DTR has automatic speed negotiation, i.e. it will automatically find out what the optimal speed for the connection is and choose accordingly either 10 Mbit/s or 100 Mbit/s speed.

12.2 Connection settings

12.2.1 IP settings for DTR

The DTR uses the IP protocol to communicate over the Ethernet. The **factory setting** for the DTR's IP address is **192.168.23.254** (a private network address).

Note: If you connect the DTR to an existing network, the address must be changed to fit the network before making the connection. To prevent conflicts, consult your network administration to find a suitable IP address for the DTR in question.

The DTR address is changed manually through the Calibration menu via the following path: 5 Calibration – 2 Outputs – 6 Network. Type the new IP address and press the Enter button to change the address.

12.2.2 IP settings for stand-alone computer

If you connect a non-networking (stand-alone) computer directly to a DTR with a cross-over cable, the easiest solution is to check the computer's network settings and conform the DTR's settings to it.
Note: If the DTR is in a factory network, contact the system admin on how to connect to the DTR. The stand-alone method may not be the best one in this kind of case.

If you are using Windows (or Mac OS X 10.3 or newer or any recent Linux distribution) and the computer has the default network settings, change the **DTR IP address** to 169.254.x.y, where x=1–254 and y=1–254, for example 169.254.100.100 or 169.254.123.1. This way the DTR address will be suitably paired with the address your computer automatically generates for itself.

If in doubt, you can get your Windows computer's network settings by opening the command window (command prompt) and by typing the command `ipconfig` at the command prompt (press Enter to give the command), see figure 12.7 (in Mac OS X and Linux the same command is called `ifconfig`). The result will give you your computer's IP address, so you can change the DTR to match; the connection should always work if you match the first three groups of numbers and just change the last number.

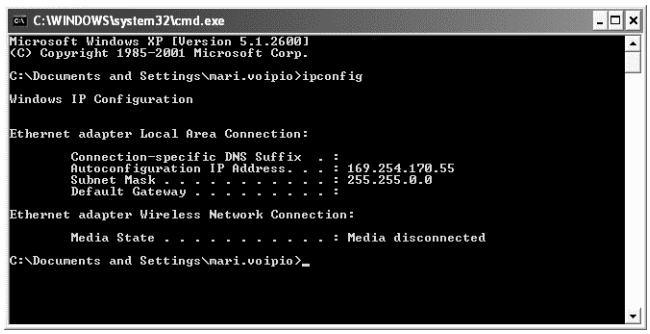


Figure 12.7 Typical IP configuration for a stand-alone laptop when connected to a DTR; laptop wireless (WLAN) is turned off

Note: You may have to connect the cross-over cable and power on the DTR before your computer generates an IP address for the ethernet connection (computer reboot may also be required). Note also that the connection will not work if the computer and the DTR have exactly the same IP address.

Note: Please make sure that your WLAN (Wireless network connection) is not active when you connect to the DTR. If the WLAN is active, the computer's Ethernet connection may not function as expected.

When you have set the DTR (and/or the computer) according to instructions above, you can proceed to test the connection as instructed below in Section 12.3.

12.3 Testing the Ethernet connection

On the Ethernet connector inside the DTR there are two **diagnostic LEDs**. The **green LED indicates that the physical connection is working**, i.e. that both ends of the Ethernet cable are plugged in, the device in each end is powered and the cable is of correct type. The **orange LED indicates traffic in the cable**, i.e. that DTR receives data.

The IP address can be tested with a *ping* command after the physical Ethernet connection has been set up and the DTR is powered. In Windows systems *ping* is available by using the Command Prompt (usually found in the Accessories). The usage of *ping* is

very simple: go to the command interface (for example the Command Prompt), type the name of the command and the IP address you want to check and press Enter. If the Ethernet connection is good, the DTR is powered on and the address given to ping is correct, the DTR will answer to ping and return any data packets sent to it, see Figure 12.8.

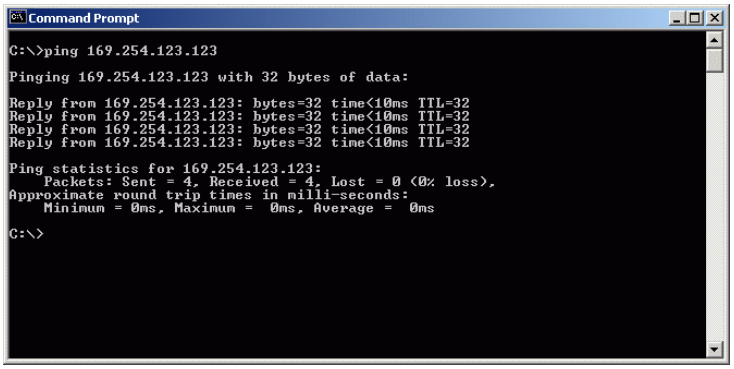


Figure 12.8 Ping OK.

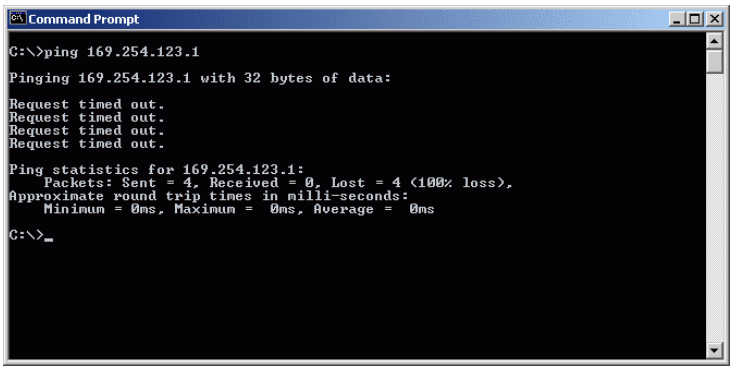


Figure 12.9 Ping error message.

12.3.1 Troubleshooting the connection

If you get an error message from a *ping* command (for example Request timed out like in Figure 12.9), check your connections.

First open the DTR cover and front panel and check the diagnostic LEDs of the Ethernet connector (see Section 12.1.2). **Note:** Keep both the DTR and your computer powered while you check the diagnostic LEDs.

If you cannot see any LED lights, something is physically wrong with your connection. Check the following

- both the DTR and the device in the other end of the cable are powered on
- the Ethernet cable is properly inserted in both ends
- the Ethernet cable is of the correct type (cross-over cable for direct DTR-to-computer connection)

If the green LED is lit, your Ethernet connection is made correctly with the right type of cable. In this case, try *ping*ing the DTR and check if the orange LED flashes during ping.

If the LED does not flash, re-check the IP address (so that you are really pinging the DTR in question). In case the DTR is not connected directly to the computer, there may be a routing problem. Please consult your network administrator to solve the problem.

Note: A firewall software (especially that of Windows XP) with tight settings may stop you from connecting to a DTR. If you are connecting directly to the DTR (and not in a network), the easiest way of solving this problem is to turn off the firewall temporarily while working with the DTR. Remember to turn on the firewall before connecting to a network again!

12.4 Instrument homepage

From DTR program version 2.0 onwards every DTR has its own built-in instrument homepage that contains information about the instrument and a remote panel with full functionality. The instrument functions just like a web server, so you only need a working ethernet connection to the DTR and any web browser to access the instrument homepage.

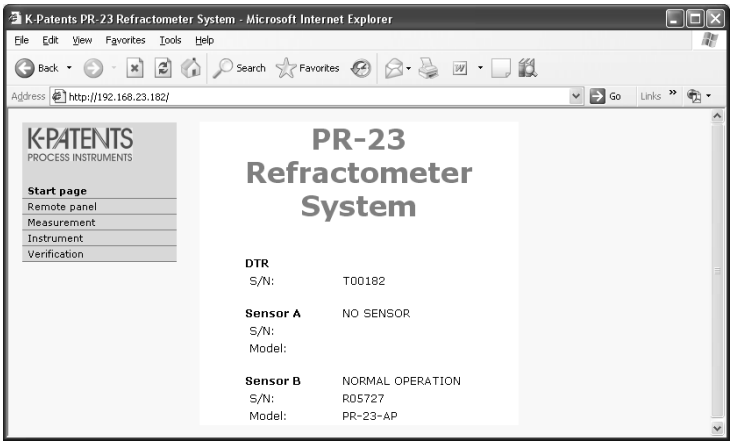


Figure 12.10 Instrument homepage open in a browser

Opening the instrument homepage:

1. Establish a working Ethernet connection (see above) to the DTR.
2. Start your preferred web browser (for example Internet Explorer, Mozilla Firefox, Safari, Opera or Chrome).
3. The address (URL) of the instrument homepage is the DTR's IP address, for a factory set DTR it is http://192.168.23.254/ (the figure 12.10 above uses a different address, not the default). Give the address to the browser just like you'd enter any other address (for example http://www.vaisala.com/)
4. Wait until the homepage is loaded, this may take a few seconds.
   If the page looks strange in the first try, refresh/reload the page and it should settle to look approximately like in Figure 12.10; the exact look of the page depends on your browser and screen settings so slight variation can be expected.
5. Use the links in the link bar on the left side of the page to find more extensive information on the instrument.

12.4.1 Remote panel

The instrument remote panel is a fully functional virtual DTR where keys on the keyboard are clicked with a mouse. The DTR doesn't make any difference between commands coming from the actual keyboard and from a remote panel. All commands are executed in the order the DTR gets them, independent of where they come from.

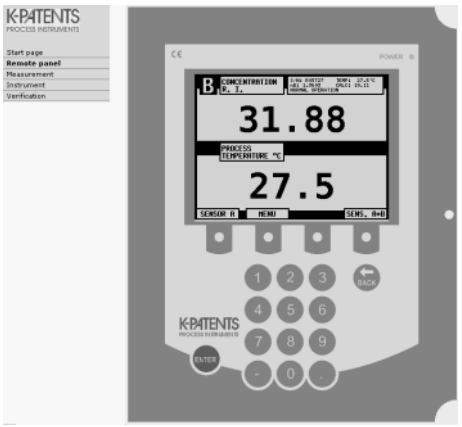


Figure 12.11 DTR remote panel

Note: The DTR display picture on the remote panel sometimes has a slight lag (of few seconds) before it refreshes. This depends on many factors like the computer and network used. If the DTR seems to 'skip' displays, it may be that it is executing mouse-click keyboard commands faster than your browser updates the picture.

12.4.2 Sensor verification certificate

A sensor verification certificate can be viewed and printed by following the Verification link on the link bar. For more information on instrument verification, see Chapter 13.

12.5 Collecting data via Ethernet

The main purpose of the Ethernet connection is to collect measurement data from the instrument. You can program a downloading facility yourself following the specifications below.

Note: Vaisala guarantees that the specifications are correct, but cannot assume any responsibility or provide support for software.

12.5.1 Communication protocol

The communications protocol is based on **UDP/IP** to **port 50023**. It is a client/server protocol, where the DTR is the server and thus only sends information when the client (i.e. your computer) requests it. The server should answer to all requests within five seconds (5000 ms) from the request, usually the response time is below 100 ms.

Request format

The client to server communication, i.e. the requests sent from your computer to the DTR, is in binary format. The request packets contain the following binary data (all integers are in the network order, MSB first):

- 32-bit integer: packet number
- 32-bit integer: request ID
- (any): request data (depends on the request)
- (any): fill-in data

Important: The maximum size of the message is 1472 octets (bytes).

The **packet number** is echoed back by the DTR, but not processed in any way. The packet numbers do not have to be sequential, any 32-bit value is valid.

The **request ID** is a 32-bit value that identifies the requested function, for example sensor information. See Section 12.5.2 for request IDs.

The **request data** consists of 0 to 1464 octets of additional data associated with the request.

The **fill-in data** can be used to increase the number of octets in a message. Any number of NULL characters (0x00) may be added to the end of the request as long as the total size of the message does not exceed the maximum of 1472 octets. This may be useful, for example, if the client implementation uses fixed-length packets.

Response format

The response data sent by the DTR is in ASCII format. With the exception of the packet number, the data is human-readable. The data structure is very simple:

- packet number (32-bit integer)
- zero or more lines of ASCII (text) keys and values associated with these keys (for example temperature key and process temperature in Celsius)

The **packet number** is echoed back without change. The client (software on computer) can use the packet number to check the response against the packet number of the request.

The **message text** consists of lines of text, each line a single key (of one word) and its value or values. The values are separated from the key by an equal sign (=) and multiple values are separated by a comma. White space (space or tabulator) is allowed anywhere except within a single value or key name.

If the response consists of a character string, it is enclosed in double quotes (").

For example all these are valid message text lines:

```
ok
temp=23.45
headhum = 13.32
LEDcnt = 8341
ChemCurve = 1.234, 3.21, 0.00, 4.37, 1.11, 0.00002, 2.1345
StatusMessage = "Normal Operation"
```

Note: All the key identifiers (see Section 12.5.2 for additional information) are case-insensitive. However, it is recommended that they are written as in this specification.

The server (DTR) may send the response keys in any order. It will send the mandatory keys (marked with an asterisk in Section 12.5.2) of the specific request, but it may omit any other keys. The server may also send keys that are not specified in this document, but the client (computer) may ignore them.

Request and response errors

When the server (DTR) detects an error, it responds with an error message (for more information see Section 12.5.3). An error message can be caused for example by an unknown request or inability to collect data for the mandatory keys of a response.

12.5.2 Request-response pair specification

The list below describes the *query messages*, i.e. request-response pairs, used for data collection via Ethernet. **Mandatory response keys are preceded by an asterisk (*).**
Note: Even when multiple request data options are available, only one can be used at a time. For example each sensor status request must be directed to either sensor A or sensor B, not both.

NULL message

The null message is included in the query messages for debugging purposes as it can be used to check whether the server is listening. The message gives a high-level 'ping' functionality.

Request ID `0x00000000`
Request data `(none)`
Response key `IP` : IP address
`MAC` : Ethernet MAC address

Protocol version

The version query is responded with a value representing the server (DTR) protocol version.

Request ID `0x00000001`
Request data `(none)`
Response key `*Version` : integer, the server protocol version (currently 3)

DTR information

The DTR information query gives the basic information of the DTR assembly.

Request ID `0x00000002`
Request data `(none)`
Response keys
`*DTRserial` : string, DTR serial number
`*ProcessorSerial` : string, processor card serial number
`*ProgramVersion` : string, main program version
`*MBSerial` : string, motherboard serial number
`*MBVersion` : string, motherboard program version
`IFSerial` : string, sensor interface serial number
`IFVersion` : string, sensor interface card program version

The IFSerial and IFVersion are only supplied if the information is available.

Sensor information

The sensor information query gives the basic information of the chosen sensor.

Request ID `0x00000003`
Request data `0x00000000` : sensor A
Request data `0x00000001` : sensor B
Response keys
`*SensorSerial` : string, sensor serial number
`*SProcSerial` : string, sensor processor card serial number
`*SensorVersion` : string, software version number
`SensorCurrent` : integer, sensor current in milliamps

Measurement results

The measurement result query gives the measured and calculated measurement values from the chosen sensor.

Request ID	`0x00000004`	
Request data	`0x00000000`	: sensor A
Request data	`0x00000001`	: sensor B
Response keys	`Status`	: string, sensor status message
	`Slope`	: float, image quality factor (QF)
	`PTraw`	: integer, PT1000 value
	`LED`	: float, sensor led value
	`RHsens`	: float, sensor internal humidity
	`nD`	: float, calculated $n_D$value
	`CONC`	: float, final concentration value
	`Tsens`	: float, sensor internal temperature
	`T`	: float, process temperature (with temperature bias)
	`Traw`	: float, process temperature (without bias)
	`CCD`	: float, image shadow edge
	`CALC`	: float, calculated concentration value

DTR status

Request ID	`0x00000006`	
Request data	`(none)`	
Response key	`*Volt1`	: float, DTR internal voltage 1
	`*Volt2`	: float, DTR internal voltage 2
	`*DTRtemp`	: float, DTR internal temperature
	`Out1uA`	: integer, mA output 1 in uA
	`Out2uA`	: integer, mA output 2 in uA
	`Switches`	: hex string (e.g. "0x00"), switch status as a bit field

12.5.3 Error message specification

If the server (DTR) does not recognize the request or cannot fulfill it, it responds with an error message. The error message has the following keys:

`*Error`	: integer, error code	`0x00000000`	: Unknown request
`*Error`	: integer, error code	`0x00000001`	: Invalid request (request recognized, invalid request data)
`*Error`	: integer, error code	`0x00000002`	: No sensor (sensor(s) not connected to DTR)
`ErrorMsg`	: string, error details		

There may also be error-dependent extra keys. Other error codes may be returned. `0x00000003` is to be handled as unknown request. Codes with higher numbers refer to internal errors; contact Vaisala for more information on these.

13 Sensor verification

A company maintaining quality system according to ISO 9000 quality standards must have defined procedures for controlling and calibrating its measuring equipment. Such procedures are needed to demonstrate the conformance of the final product to specified requirements. The company should

- Identify the required accuracy and select appropriate equipment for measurements.
- Establish calibration procedures including a check method and acceptance criteria.
- calibrate the equipment at prescribed intervals against certified equipment having a known valid relationship to nationally recognized standards. In cases where no such standards exist, the basis used for calibration must be documented.

Vaisala verifies the calibration of all delivered instruments according to a procedure similar to the one described Section 13.1. Vaisala K-PATENTS® quality system is ISO 9001 certified by Det Norske Veritas.

13.1 Refractive index n_D verification

Before starting the verifications procedures, make sure that you have a sample holder at hand. Also check the condition of your standard refractive index liquids. You'll also need a cleaning solution (ethanol or IPA) and tissues to clean the sensor prism and the sample holder between the samples.

The sample holder keeps the sample on the prism surface and also keeps the ambient light out. The universal sample holder PR-1012 (Figure 13.1) can be used with any PR-23 sensor (in PR-23-M only the top part of the sample holder is needed).

Figure 13.1 The universal sample holder PR-1012

The verification of the PR-23 sensor calibration is made using a set of standard refractive index liquids with the nominal values at 25 °C:

- 1.330
- 1.370
- 1.420
- 1.470
- 1.520

The accuracy of the certified standard refractive index liquids is ±0.0002 and they can be traced back to national standards: N.I.S.T Standards # 1823 and # 1823 II.

The repeatability of PR-23 sensor, i.e. the deviation from the latest n_D calibration, is within ±0.0002.

As the specified accuracy of PR-23 is ±0.0002, then the representative level is the sum of the three accuracy specifications, that is ±0.0004.

Vaisala provides a set of standard R.I. liquids, PR-2300, containing these five liquids. The set can be ordered directly from Vaisala or through your nearest representative.

13.1.1 Handling the R.I. liquids

Use gloves and safety glasses or goggles. Make sure the ventilation is good, local ventilation is preferable. Please review the safety instructions and the MSDS shipped with the liquids (valid inside R.I. range 1.30-1.57, safety markings valid in EU/EEA areas). Do not put tissues or liquid bottles in household waste, dispose of waste according to local regulations for chemical waste.

13.2 Verification procedure

To start the verification process, select 1 VERIFICATION in the Main menu of your sensor. The first verification display instructs you on the pre-verification procedure:

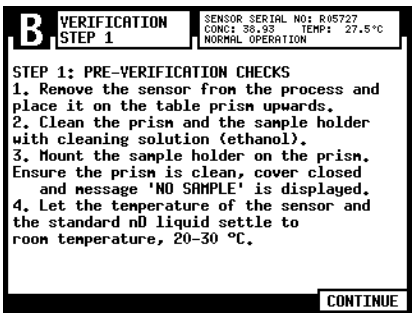


Figure 13.2 Verification, pre-verificaton checks

When you are finished with the preparations, press CONTINUE (right-most soft key) to start the verification process.

The verification itself is done by the refractometer system, you only have to follow the instructions on screen and apply one RI liquid at a time on the sensor and press VERIFY (right-most soft key). See Figure 13.3.

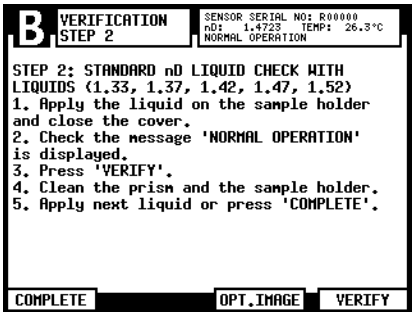
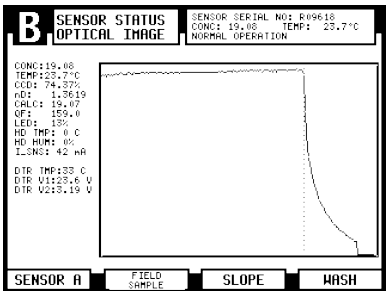


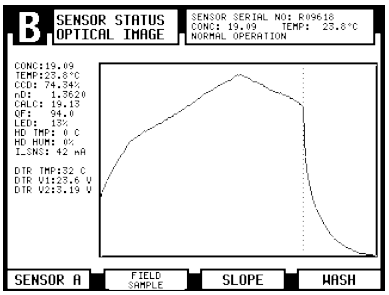
Figure 13.3 Verification display

Important: Clean and dry the prism and the sample holder very carefully between the RI liquids. Use a suitable solvent, e.g. ethanol or IPA (Isopropyl alcohol).

To check that the standard liquid is properly wetting the prism, it is possible to press soft key OPT. IMAGE. The optical image should show a sharp shadow edge, as e.g. in Figure 13.4. For more information on the optical image, please see Section 5.4.1.



Sharp optical image (with IDS)



Sharp optical image (without IDS)

Figure 13.4 Typical optical images

A verification data collection method is implemented in the DTR. The instrument measures each verification data point ten times and uses the average of these measurements. Measuring each verification liquid takes approximately ten seconds, during which the measurement progress display (Figure 13.5) is shown. Please wait until the verification step 2 display reappears before proceeding to next verification liquid.

The sample holder keeps the sample on the prism surface and also blocks the ambient light from reaching the prism.

Pressing COMPLETE in the verification display finishes the verification procedure and calls up the verification results.

If verification is successful, i.e. all measurements are within ±0.0004 of the nominal values, you get the message VERIFICATION OK, see Figure 13.6 below.

Note: The sensor verification concerns only the refractive index $n_D$measurement. The calculation of concentration from n_D and process temperature TEMP is not included, see Section 6.4, “Calibrating the concentration measurement”.

Figure 13.5 Verification in process

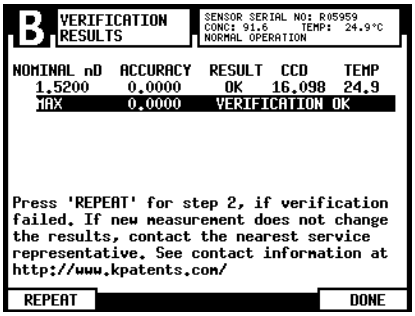


Figure 13.6 Verification completed successfully (here only with one RI liquid)

If the verification fails, please see section 13.4 for corrective action.

13.3 Sensor verification certificate

The DTR stores the most recent verification done on the DTR and the results of that verification can be viewed and printed on the instrument homepage by following the Verification link on the link bar. (For more information on the instrument homepage, see Chapter 12.)

Important: When you have performed a verification on a sensor, reload/refresh the verification page to view the newest results. **The date given on the verification page is the page load date**, not necessarily the verification date.

The date and time settings are taken from the browser, i.e. the computer used to view the verification certificate. The DTR doesn't have timekeeping functionality.

To print the verification certificate, simply use your browser's print function. The page is designed so that with browser default settings it normally fits onto a single sheet of A4 or letter sized paper; the navigation bar is omitted for cleaner printout (Figure 13.8).

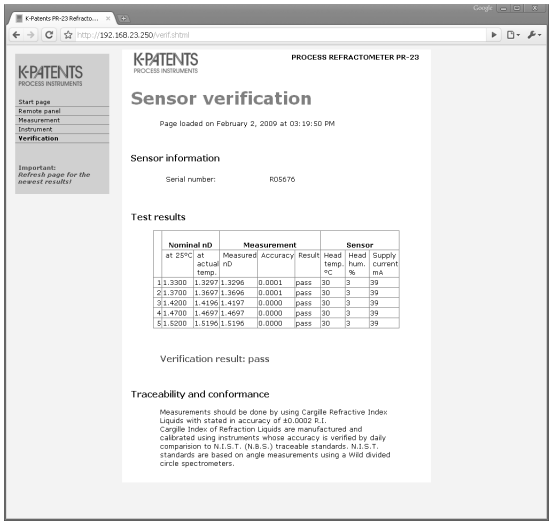


Figure 13.7 Instrument verification page open in a browser

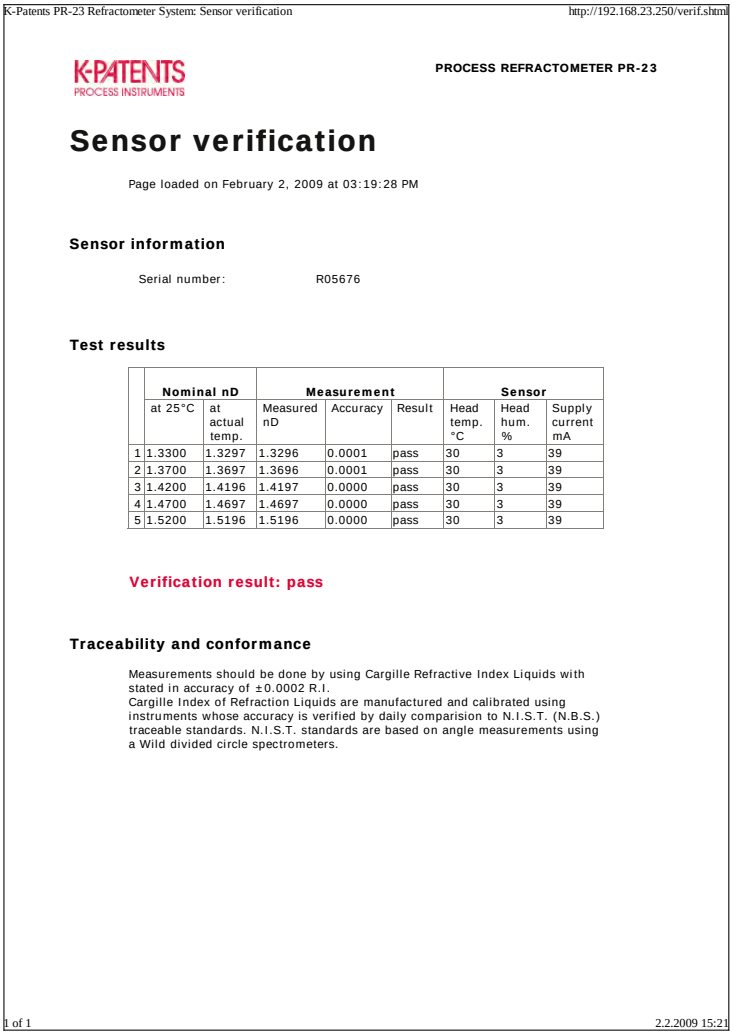
Note: If you need to verify two sensors connected to one DTR, you need to verify one and then to save or print the certificate, as the results from the verification of the second sensor will overwrite the results of the first sensor. Check the sensor serial number on the certificate to see that you have correct results on screen and reload/refresh if needed.

13.4 Corrective action

If you get the message VERIFICATION FAILED (Figure 13.9), first check that the prism **and** the sample holder are absolutely clean and the sample holder sits tightly on the sensor tip before a standard liquid is applied. Make sure the standard liquids are in good condition and not past their expiration date. Also, inspect the prism surface, checking that it is smooth and glossy without any scratches. Then go back to the Verification step 2 by pressing soft key REPEAT and repeat the whole verification procedure.

You may want to double-check the following, as they are the most common reasons for a failure of the verification:

- Insufficient cleaning of the prism.
- Too old calibration liquids
- Bad temperature control (changing temperature)



K-Patents PR-23 Refractometer System: Sensor verification http://192.168.23.250/verif.shtml

K-PATENTS PROCESS INSTRUMENTS

PROCESS REFRACTOMETER PR-23

Sensor verification

Page loaded on February 2, 2009 at 03:19:28 PM

Sensor information

Serial number: R05676

Test results

	Nominal nD		Measurement			Sensor		
	at 25°C	at actual temp.	Measured nD	Accuracy	Result	Head temp. °C	Head hum. %	Supply current mA
1	1.3300	1.3297	1.3296	0.0001	pass	30	3	39
2	1.3700	1.3697	1.3696	0.0001	pass	30	3	39
3	1.4200	1.4196	1.4197	0.0000	pass	30	3	39
4	1.4700	1.4697	1.4697	0.0000	pass	30	3	39
5	1.5200	1.5196	1.5196	0.0000	pass	30	3	39

Verification result: pass

Traceability and conformance

Measurements should be done by using Cargille Refractive Index Liquids with stated in accuracy of ±0.0002 R.I.
Cargille Index of Refraction Liquids are manufactured and calibrated using instruments whose accuracy is verified by daily comparision to N.I.S.T. (N.B.S.) traceable standards. N.I.S.T. standards are based on angle measurements using a Wild divided circle spectrometers.

1 of 1 2.2.2009 15:21

Figure 13.8 Instrument verification certificate

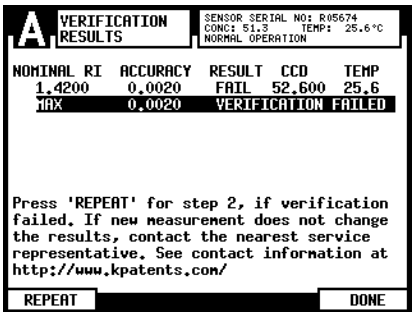


Figure 13.9 Verification failed

If verification fails even on the repetition of the verification procedure, fill in the **PR-23 sensor verification form** (available in Appendix C) and send it to your nearest representative or email the collected information to <info@kpatents.com> and wait for further instructions.

For the sensor verification form, you need to collect data from the Verification step 2 display and the Verification results display. The sensor's serial number is shown in the upper right corner of each display. The measured n_D(RI) is given when VERIFY has been pressed in Verification step 2. The list of CCD and TEMP values are found on the verification results display, see (Figure 13.10)

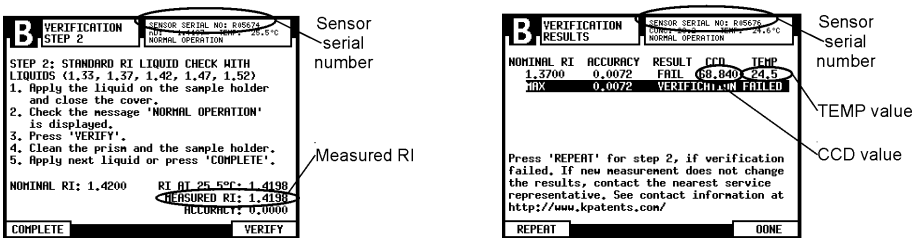


Figure 13.10 Finding verification information for PR-23 sensor verification form

14 Regulatory compliance and certifications

14.1 Declaration of Conformity for PR-23 series of refractometers

The following Declaration of Conformity confirms compliance with the applicable EU/EEA requirements and applies to all PR-23 refractometer models:

VAISALA **2019-09-01G/JAMO** 1 (1)

EU DECLARATION OF CONFORMITY

Manufacturer: Vaisala Oyj

Mail address: P.O. Box 26, FI-00421 Helsinki, Finland
Street Address: Vanha Nurmijärventie 21, Vantaa, Finland

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration:

K-Patents Process Refractometer PR-23 series
with Transmitter DTR / STR

The object of the declaration described above is in conformity with Directives:

RoHS Directive (2011/65/EU)
EMC Directive (2014/30/EU)
Low Voltage Directive (2014/35/EU)

The conformity is declared using the following standards:

EN 50581:2012 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements

EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use – EMC requirements – intended for use in industrial locations

Signed for and on behalf of Vaisala Oyj, in Vantaa, on 1st September 2019

Jukka Lyömiö
Standards and Approvals Manager

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Phone +358 9 894 91 | Fax +358 9 8949 2227
Email firstname.lastname@vaisala.com | www.vaisala.com
Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

14.2 Declaration of Conformity for PR-23-...-AX models (ATEX)

The following Declaration of Conformity confirms compliance with the European ATEX requirements and applies to PR-23-...-AX refractometer models:

VAISALA **2019-09-01E/JAMO** 1 (1)

EU DECLARATION OF CONFORMITY

Manufacturer: Vaisala Oyj

Mail address: P.O. Box 26, FI-00421 Helsinki, Finland
Street Address: Vanha Nurmijärventie 21, Vantaa, Finland

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration:

K-Patents Process Refractometer PR-23-...-AX

The object of the declaration described above is in conformity with Directives:

RoHS Directive (2011/65/EU)
EMC Directive (2014/30/EU)
ATEX Directive (2014/34/EU)
Low Voltage Directive (2014/35/EU)

The conformity is declared using the following standards:

EN 50581:2012 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

EN 60079-0:2012 + A11:2013 Explosive atmospheres - Part 0: Equipment - General requirements

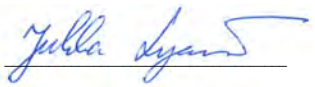
EN 60079-15:2010 Explosive atmospheres - Part 15: Equipment protection by type of protection "n"

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements

EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use – EMC requirements – intended for use in industrial locations

Notified body DEKRA Certification B.V. has issued type examination certificate KEMA 05ATEX1183 X for this product.

Signed for and on behalf of Vaisala Oyj, in Vantaa, on 1st September 2019



Jukka Lyömiö
Standards and Approvals Manager

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14.3 Declaration of Conformity for PR-23-...-IA models (ATEX)

The following Declaration of Conformity confirms compliance with the European ATEX requirements and applies to PR-23-...-IA refractometer models:

VAISALA **2019-09-01F/JAMO** 1 (1)

EU DECLARATION OF CONFORMITY

Manufacturer: Vaisala Oyj

Mail address: P.O. Box 26, FI-00421 Helsinki, Finland
Street Address: Vanha Nurmijärventie 21, Vantaa, Finland

This declaration of conformity is issued under the sole responsibility of the manufacturer.

Object of the declaration:

K-Patents Process Refractometer PR-23-...-IA

The object of the declaration described above is in conformity with Directives:

RoHS Directive (2011/65/EU)
EMC Directive (2014/30/EU)
ATEX Directive (2014/34/EU)
Low Voltage Directive (2014/35/EU)

The conformity is declared using the following standards:

EN 50581:2012 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

EN 60079-0:2012 + A11:2013 Explosive atmospheres - Part 0: Equipment - General requirements

EN 60079-11:2012 Explosive atmospheres - Part 11: Equipment protection by intrinsic safety "i"

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements

EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use – EMC requirements – intended for use in industrial locations

Notified body Eurofins Expert Services Oy (number 0537) has issued EU-type examination certificate EESF 19 ATEX 028X for this product.

Signed for and on behalf of Vaisala Oyj, in Vantaa, on 1st September 2019

Jukka Lyömiö
Standards and Approvals Manager

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Domicile Vantaa, Finland | VAT FI01244162 | Business ID 0124416-2

A Glossary and abbreviations

- CCD = **C**harge **C**ouple **D**evice, sensor optical element
- CORE, CORE Optics = **C**ompact **O**ptical **R**igid **E**lement: All measuring components are in one solid module, the CORE (Optics) module.
- DTR = Indicating transmitter DTR, Dual sensor indicating transmitter of a PR-23 refractometer system.
- LCD = **L**iquid **C**rystal **D**isplay, used as transmitter display.
- LED = **L**ight **E**mitting **D**iode, the light source in a PR-23 refractometer sensor.
- n_D= Refractive index (of a liquid), see Section 1.2.
- Sensor code:
  -AC = 3A approved, Compact model
  -AP = 3A approved, Probe model
  -GP = General purpose, Probe model
  -M = Teflon body refractometer for chemically aggressive liquids in small pipes
  -MS = Teflon body refractometer for semiconductor liquid chemical processes -SD = Safe-Drive™ sensor for the Safe-Drive™ system for safe sensor insertion and removal
  -W = Saunders body refractometer for chemically aggressive liquids in large pipes
  -...-AX = ATEX approved sensor, modified for use in potentially explosive atmosphere
  -...-CS = CS approved sensor, modified for use in potentially explosive atmosphere
  -...-FM = FM approved sensor, modified for use in potentially explosive atmosphere
  -...-IA = ATEX approved sensor for hazardous locations in Zone 0 and Zone 1
- STR = Indicating transmitter STR, Single sensor indicating transmitter for hazardous locations and divert control systems

B Index

C PR-23 sensor verification form

Fill in this email it to <info@kpatents.com> or to your local service representative.

Sensor serial no: _____

Customer: _____

Address: _____

Fax: _____

Email: _____

Date: _____

Verification made by: _____

	VERIFICATION RESULTS DISPLAY			
Sample no	Nominal n_D	Measured n_D	CCD	Temp
1	1.3300			
2	1.3700			
3	1.4200			
4	1.4700			
5	1.5200			

D PR-23 field calibration form

Fill in this form and email it to <info@kpatents.com> or to your local service representative.

Sensor serial no: _____

Customer: _____

Address: _____

Fax: _____

Email: _____

Sample description: _____

Solvent (water/other): _____

Laboratory method: _____

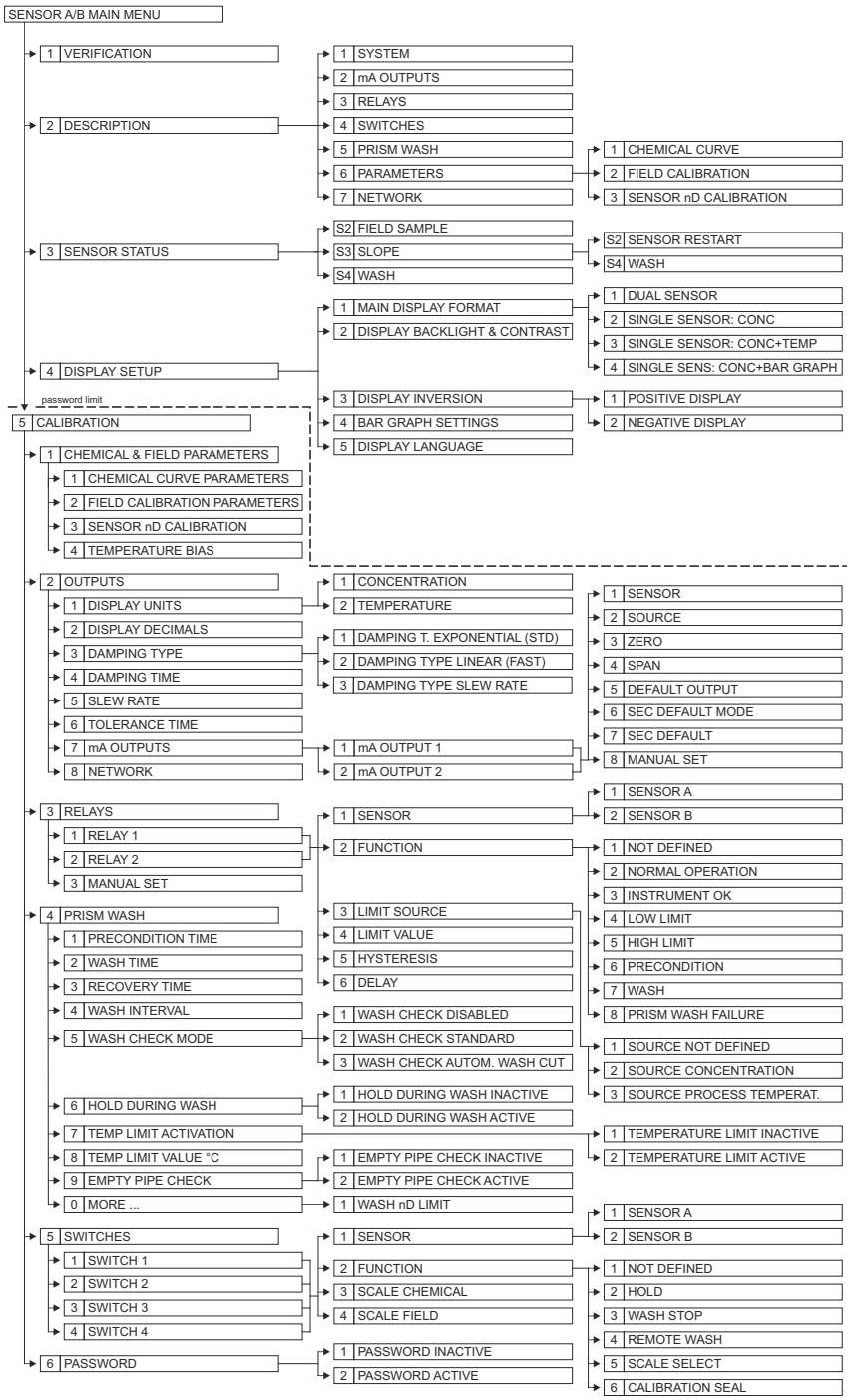
Date: _____

Data collected by: _____

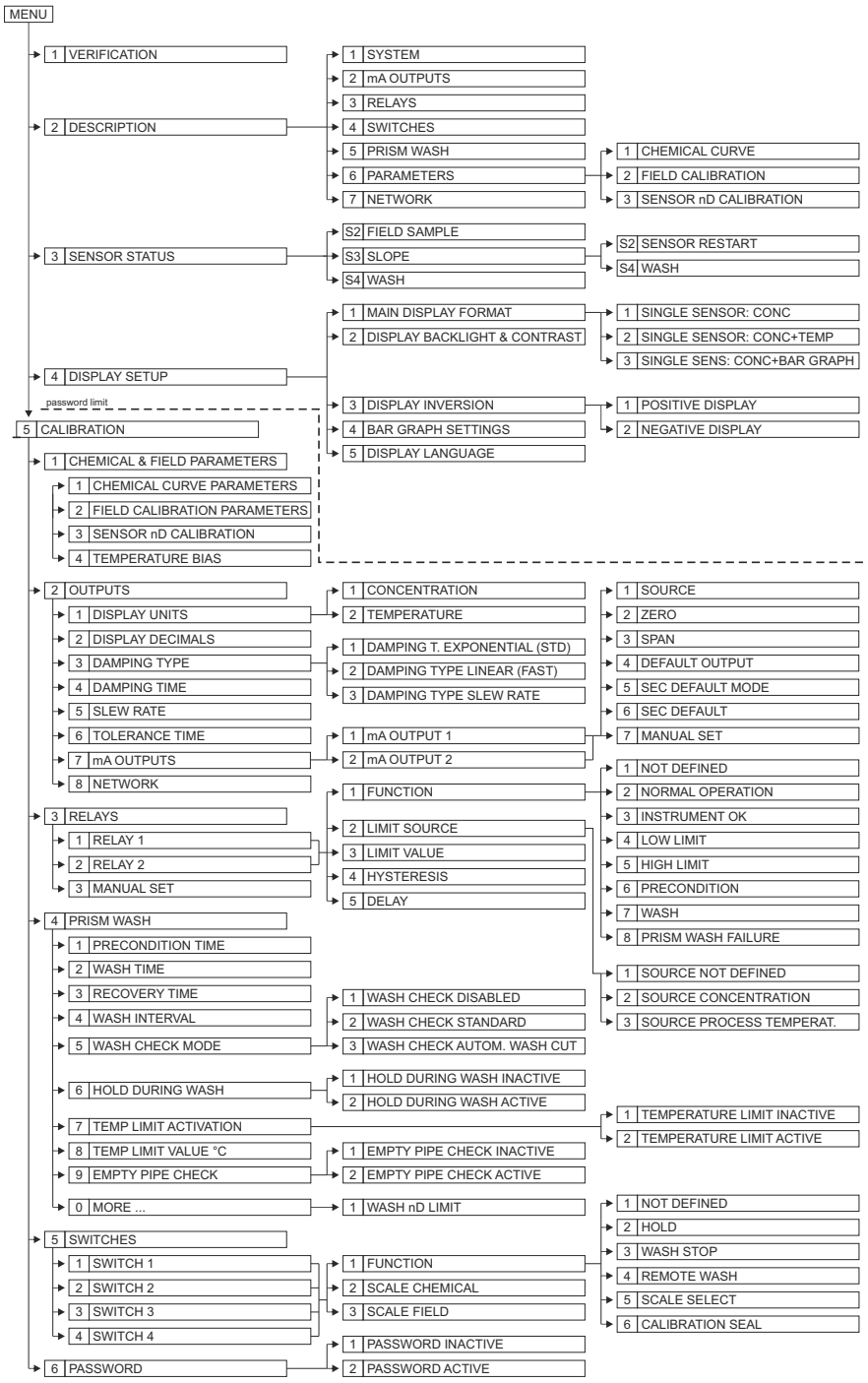
		DTR DISPLAY VALUES			
Sample no	LAB%	CALC	T	n_D	CONC

For instructions on field calibration, see PR-23 instruction manual, Chapter 6.

E DTR command selection tree



F STR/Divert mode command selection tree



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