IM-EN-PR23-G

User Guide

Process Refractometer

PR-23 Series

VAISALA

PUBLISHED BY

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

Visit our Internet pages at www.vaisala.com.

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1. About this document

1.1 Version information

This document provides instructions for installing, using and maintaining Vaisala K-PATENTS® Process Refractometer PR-23.

Table 1 Document versions (English)

Document code	Date	Description
IM-EN-PR23, G	July 2021	Change in Ex protection type in Atex and IECEx. Style updates.
IM-EN-PR23, F	April 2021	Updates to chapters 4 and 13. DTR DC power supply fuse information added
IM-EN-PR23, E	February 2021	Structure and style updates, updates to sensor specifications.

1.2 Documentation conventions

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

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

Note highlights important information on using the product.

Tip gives information for using the product more efficiently.

Lists tools needed to perform the task.

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

1.3 Trademarks

Vaisala® and K-PATENTS® are registered trademarks of Vaisala Oyj.

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

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

1.4 Patent notice

This product is protected by the following patents and patent applications and their corresponding national rights:

Table 2 PR-23 patents

Product	Applicable patent
Process Refractometer PR-03/23/33	US 9063020 23.2.2032
Process Refractometer PR-03M/23M/MS/W	US 6760098 1.8.2021
	US 9028140 19.1.2032
SAFE-DRIVE™ Refractometer PR-23-SD	FI 118442 17.6.2026
	US 7631569 9.12.2027

Process Refractometer PR-23/33 also has the following additional patent applications pending:

- FI 20106065
- DE 102011084387.6
- US 13/273,907
- FI 20106066
- DE 102011094386.8
- US 13/274,000

2. Product overview

The PR-23 in-line 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.

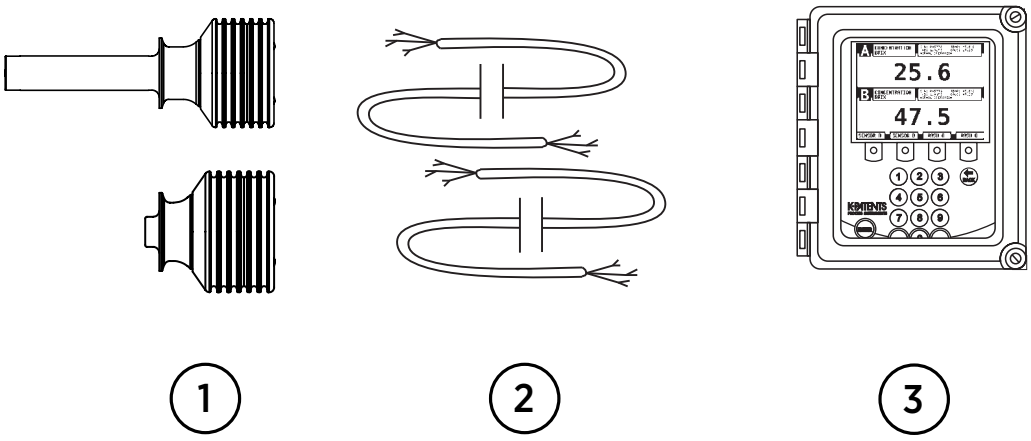


Figure 1 Refractometer equipment

1 Sensors
2 Interconnecting cables
3 Indicating transmitter

The in-line refractometer sensor (1) measures the refractive index n_D and the temperature of the process medium. This information is sent through the interconnecting cable (2) to the indicating transmitter (3). The indicating transmitter DTR calculates the concentration of the process liquid based on the refractive index and temperature, taking predefined 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 through an Ethernet cable.

The password for PR-23 is:

```
7 8 4 5 1 2
```

2.1 Safety

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

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

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 flange or 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.

For the Safe-Drive system safety rules, see Safe sensor insertion and removal for Safe-Drive generation 2.1 (page 185) and for additional precautions required by explosive atmosphere, see PR-23 process refractometers in potentially explosive atmosphere (page 213).

Wear protective eyewear.

Wear protective gloves.

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.

The process medium may be hot or otherwise hazardous. Use shields and protective clothing adequate for the process medium. Do not rely on avoidance of contact with the process medium.

2.2 Storage conditions, packaging and transportation

Soft shell packaging prevents damage to the refractometer. Transport the device in its original packaging.

Before storing, remove any dirt and grease from the refractometer and make sure that it is dry.

Storage conditions:

- Temperature: −40 ...+40 °C (−40 ... +104 °F)
- Humidity: No condensation

2.3 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 in-line 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 or a Nepsi certified PR-23-...-CX sensor a PR-23 process refractometer system can be used in potentially explosive atmosphere. Intrinsically safe process refractometer PR-23-...-IA/-IF/-CI can be used in hazardous locations in Zone 0 and Zone 1. The Safe-Drive system with a PR-23-SD sensor enables safe sensor insertion and removal also when process line is in full operation.

2.4 Refractometer sensor

The following figure shows a cutaway picture of a refractometer sensor. The measurement prism (6) is flush mounted to the surface of the probe tip. The prism (6) and all the other optical components are fixed to the solid core module (7), which is springloaded (9) against the prism gasket (5). The light source (3) is a yellow LED, and the receiver is a Charge Couple Device (CCD) element (10). The electronics is protected against process heat by a thermal isolator (8) and cooling fins (1). The sensor processor card (2) receives the raw data from the CCD element (10) and the Pt-1000 process temperature sensor (4), then calculates the refractive index n_D and the process temperature T. This information is transmitted to the indicating transmitter.

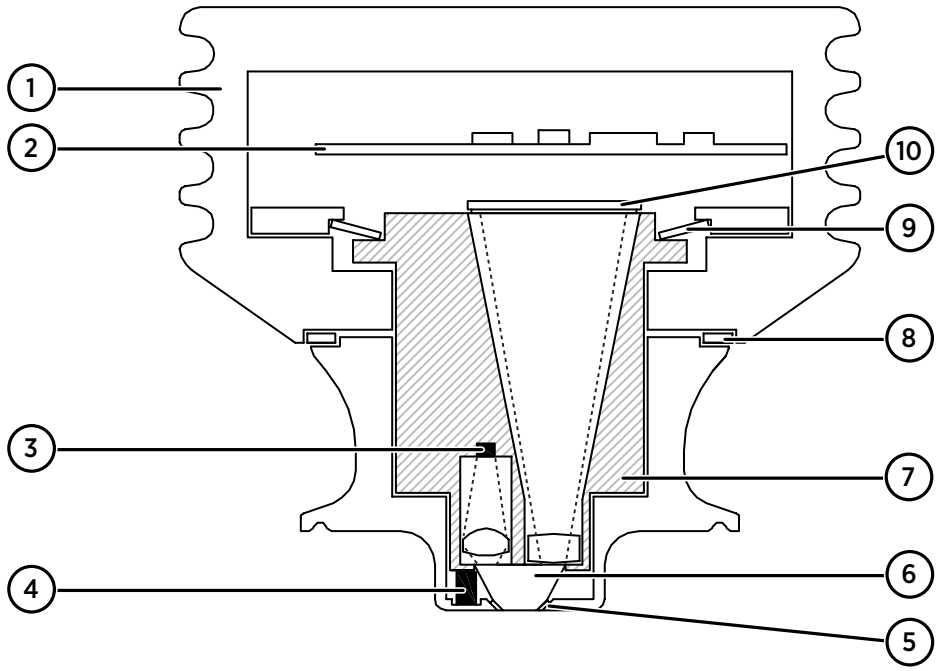


Figure 2 Sensor structure

1 Cooling fins
2 Sensor processor card
3 Light source
4 Temperature sensor
5 Prism gasket
6 Prism
7 CORE module
8 Thermal isolator
9 Disc spring
10 CCD element

2.5 Indicating transmitter DTR

The indicating transmitter DTR is a specialized computer designed to process data received from one or two sensors. The indicating transmitter enclosure contains a front panel with a backlit LCD and a keyboard. The front panel swings open to give access for connections and service. Both of the enclosure's cover latches include knockout padlock provisions to prevent unauthorized access.

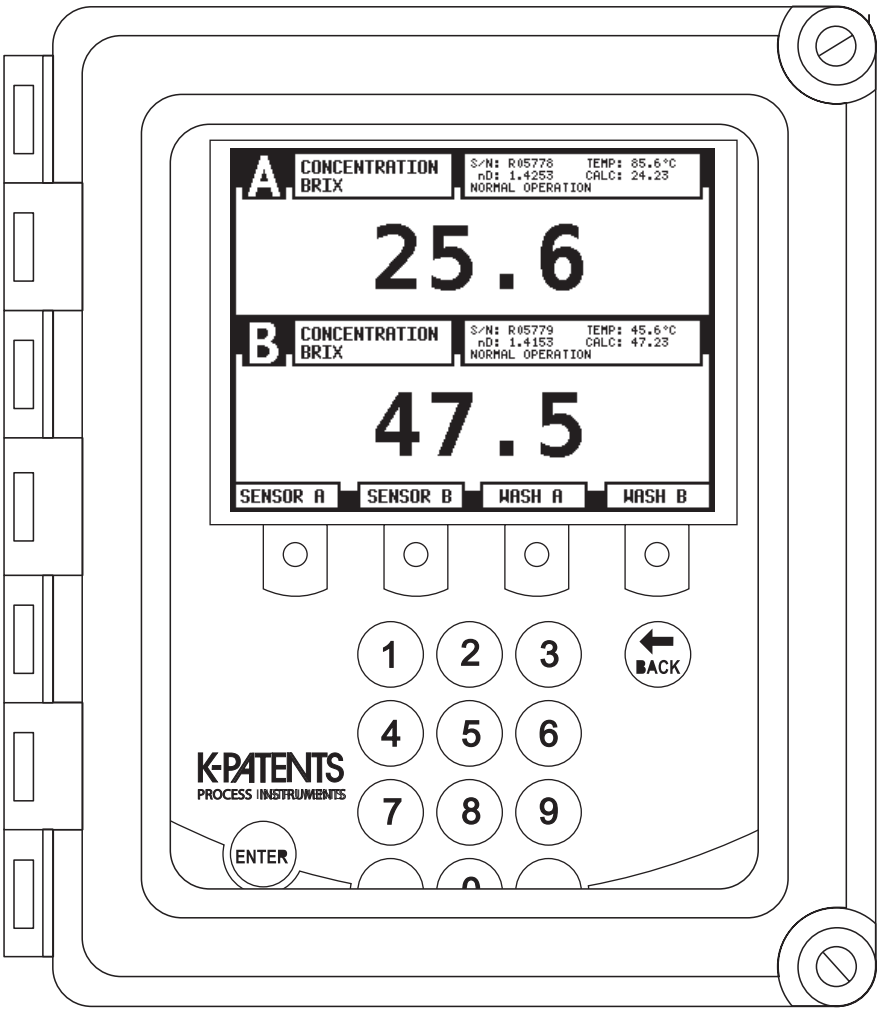


Figure 3 Indicating transmitter enclosure

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 as shown in the following example, and performs an automatic temperature compensation.

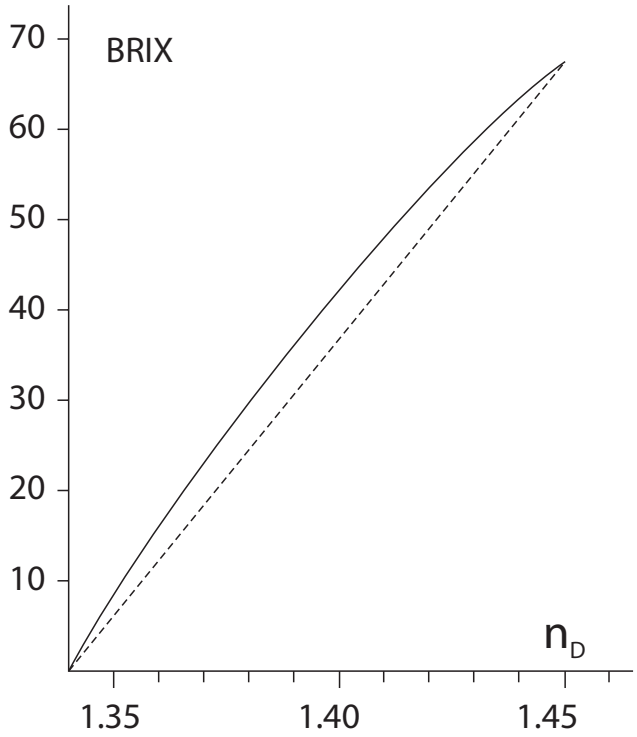


Figure 4 Linearized curve

3. Mounting

3.1 Mounting sensor

Choose the sensor mounting location 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 Sensor specifications (page 96).

- For the Sanitary compact refractometer PR-23-AC see Sanitary process refractometer PR-23-AC (page 97)
- For the Probe sanitary refractometer PR-23-AP see Sanitary probe refractometer PR-23-AP (page 110)
- For the Process probe refractometer PR-23-GP see Probe process refractometer PR-23-GP (page 128)
- For the Teflon body refractometer PR-23-M and Teflon body semicon refractometer PR-23-MS see Teflon body refractometer PR-23-M/MS (page 143)
- For the Saunders body refractometer PR-23-W see Saunders body refractometer PR-23-W (page 151)
- For mounting an ATEX/FM/CSA approved sensor in explosive atmosphere, see Installation (page 216)
- For mounting an intrinsically safe refractometer PR-23-...-IA/-CI, see Intrinsically safe refractometers PR-23-...-IA, PR-23-...-IF and PR-23-...-CI (page 158)
- For mounting of the Safe-Drive system with the PR-23-SD sensor, see Safe-Drive mounting (page 172)

3.1.1 Choosing sensor mounting location

A PR-23 refractometer sensor can be located either indoors or outdoors in most climates. However, when locating a sensor outdoors, make sure to provide some basic protection against direct exposure to sunlight and rain. Take special care if the pipe wall is translucent (for example made 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.

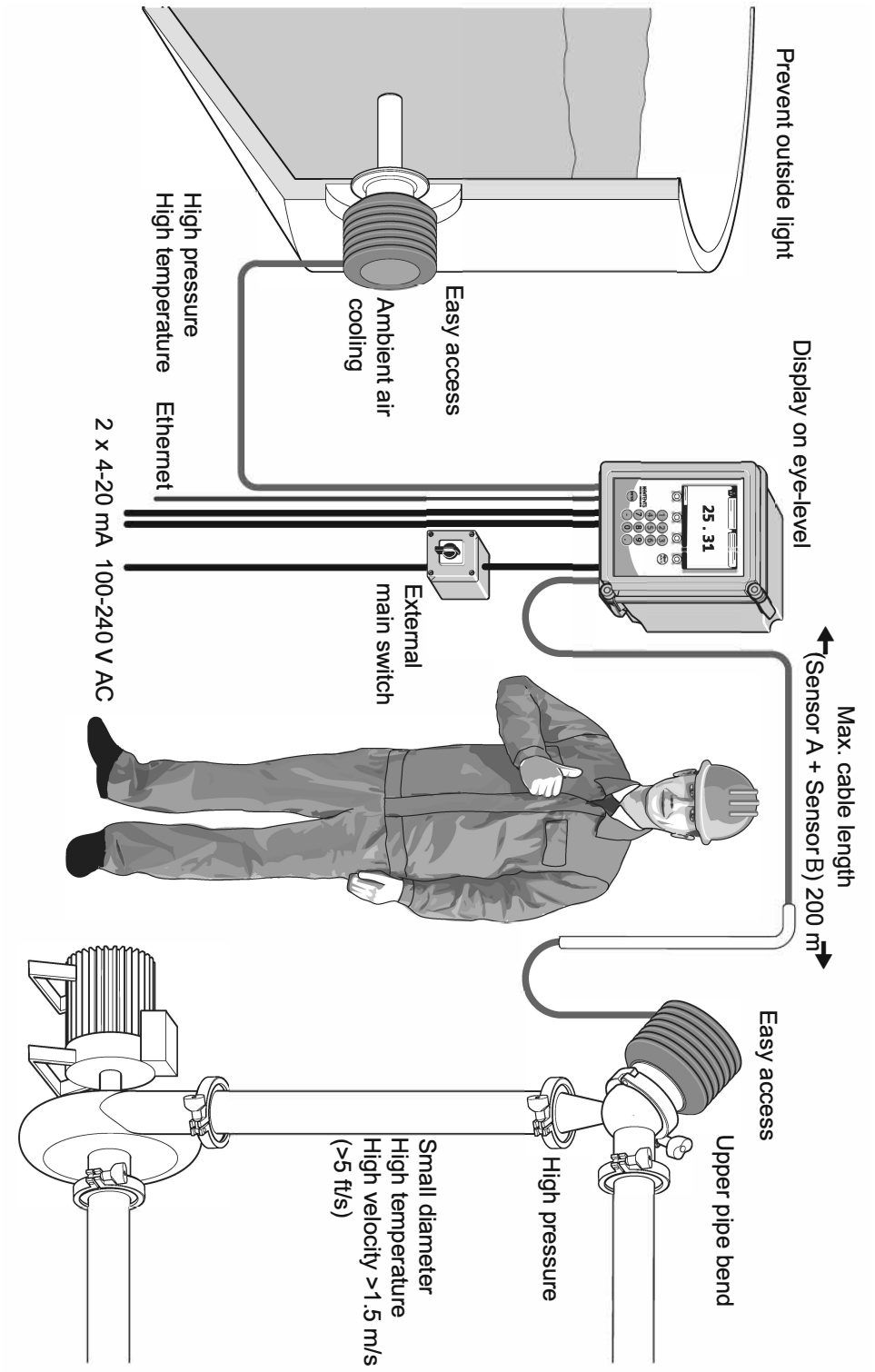
CAUTION! If the process pipe vibrates, support the pipe. A vibrating pipe might damage the in-line sensor mounted on it.

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).

CAUTION! Always mount the sensor so that the interconnecting cable points downwards from the sensor head.

3.1.2 PR-23 mounting guide



3.1.3 Pipe mounting checklist

Most in-line refractometer models are mounted in a pipe. The recommended minimum flow velocity is 1.5 m/s (5 ft/s). The diameter and form of the pipe and the process temperature 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. When a dilution valve is controlled, for example, 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 is accessible for service.

3.1.4 Checklist for mounting in tank, vessel or 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 do not have a scraper or where the mixer does not 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 is accessible for service.

3.2 Mounting indicating transmitter

Warning

Warning! The DTR does not have a built-in power switch. The system is always powered on when connected to a power source. It is recommended to mount an external power switch to control the DTR's power supply.

Varoitus! DTR:ssä ei ole sisäänrakennettua virtakytkintä. Järjestelmän virta on aina päällä, kun se on kytketty virtalähteeseen. DTR:n virransyötön ohjaamiseksi on suositeltavaa asentaa ulkoinen virtakytkin.

Varning! DTR har ingen inbyggd strömbrytare. Systemet är alltid påslaget när det är anslutet till en strömkälla. Rekommendationen är att montera en extern strömbrytare för att styra strömförsörjningen till DTR:er.

Advarsel! DTR har ikke nogen indbygget afbryder. Systemet er altid tændt, når det er tilsluttet en strømkilde. Det anbefales at montere en ekstern afbryder til styring af DTR'ens strømforsyning.

Hoiatus! DTR-il puudub sisseehitatud toitelüliti. Süsteem on alati pinge all, kui on toiteallikaga ühendatud. DTR-i toiteallika juhtimiseks on soovitatav paigaldada väline toitelüliti.

Внимание! DTR н е имеет встроенного переключателя питания. Если система подключена к источнику питания, она всегда включена. Для управления подачей питания на DTR рекомендуется установить внешний переключатель питания.

Įspėjimas! DTR ne turi įmontuoto maitinimo jungiklio. Sistema visada įjungiama, kai ji yra prijungta prie maitinimo šaltinio. DTR maitinimo šaltiniui valdyti rekomenduojama sumontuoti išorinį maitinimo jungiklį.

Ostrzeżenie! DTR nie zawiera wbudowanego wyłącznika zasilania. Zasilanie systemu jest włączone zawsze, gdy jest on podłączony do źródła zasilania. Wskazane jest wykonanie zewnętrznego wyłącznika zasilania do sterowania zasilaniem DTR.

Varování! DTR nemá vestavěný vypínač napájení. Po připojení ke zdroji napájení je systém vždy zapnutý. Pro ovládání napájení DTR se doporučuje namontovat externí vypínač.

Figyelmeztetés! A DTR nem rendelkezik beépített hálózati kapcsolóval. A rendszer mindig be van kapcsolva, ha áramforráshoz csatlakozik. A DTR tápellátásának vezérléséhez ajánlott egy külső tápkapcsolót felszerelni.

Warnung! Der DTR ist nicht mit einem eingebauten Netzschalter ausgestattet. Das System ist immer eingeschaltet, wenn es an eine Stromquelle angeschlossen ist. Es wird empfohlen, einen externen Netzschalter zu installieren, um die Stromversorgung des DTR zu steuern.

Waarschuwing! De DTR heeft geen ingebouwde voedingsschakelaar. Het systeem is altijd ingeschakeld wanneer het is aangesloten op een voedingsbron. Het wordt aanbevolen om een externe voedingsschakelaar te monteren om de voeding van de DTR te regelen.

Avertissement! Le DTR n'est pas équipé d'un interrupteur d'alimentation intégré. Le système est toujours sous tension lorsqu'il est connecté à une source d'alimentation. Il est recommandé de monter un interrupteur d'alimentation externe pour contrôler l'alimentation du DTR.

¡Advertencia! El DTR no tiene un interruptor de encendido integrado. El sistema siempre está encendido cuando está conectado a una fuente de alimentación. Se recomienda montar un interruptor de encendido externo para controlar la fuente de alimentación del DTR.

Avvertimento! Il DTR non dispone di un interruttore di alimentazione integrato. Il sistema è sempre acceso quando è collegato a una fonte di alimentazione. Si consiglia di montare un interruttore di alimentazione esterno per controllare l'alimentazione del DTR.

Mount the indicating transmitter indoors, preferably 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 4 mounting feet, see the following figure. The LCD is best viewed when approximately at 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, install it as remotely as practical from product areas or connections.

CAUTION! Do not drill mounting holes in the enclosure as that affect the protection class of the enclosure and damage the electronics.

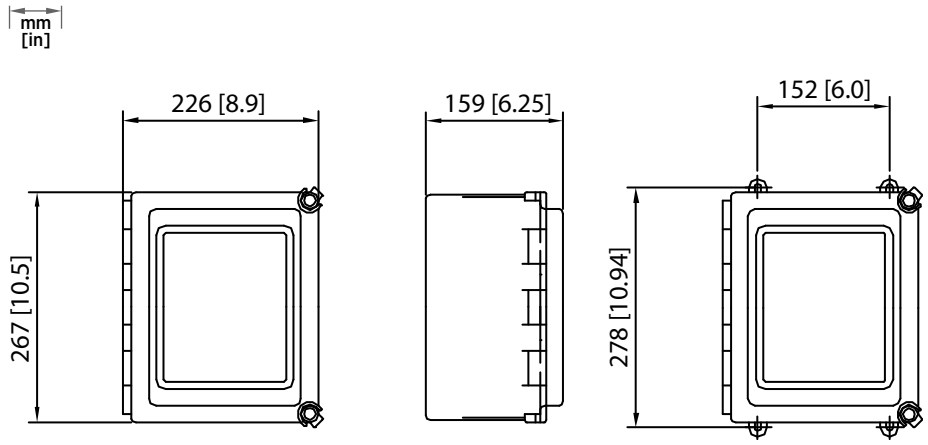


Figure 5 Indicating transmitter dimensions and mounting feet measures

4. Electrical connections

4.1 Interconnecting cable

The cable contains a pair of twisted signal wires and a cable shield. Standard delivery is 10 m (33 ft) of cable. The maximum length of an interconnecting cable is 200 m (660 ft). The signal wires are interchangeable (non-polarized). The cable shield is connected to the protective earth at the indicating transmitter.

If you have a junction box, you can use your own cable, as long as it meets IEC 61158-2 type A standard requirements. For more information, see Interconnecting cable specifications (page 223).

More information

- Connecting sensor (page 25)

4.2 Connecting the sensor to the indicating transmitter

4.2.1 Connecting sensor

CAUTION! Do not connect or disconnect the sensor connector 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 the sensor cable back to the sensor, you can switch power back on.

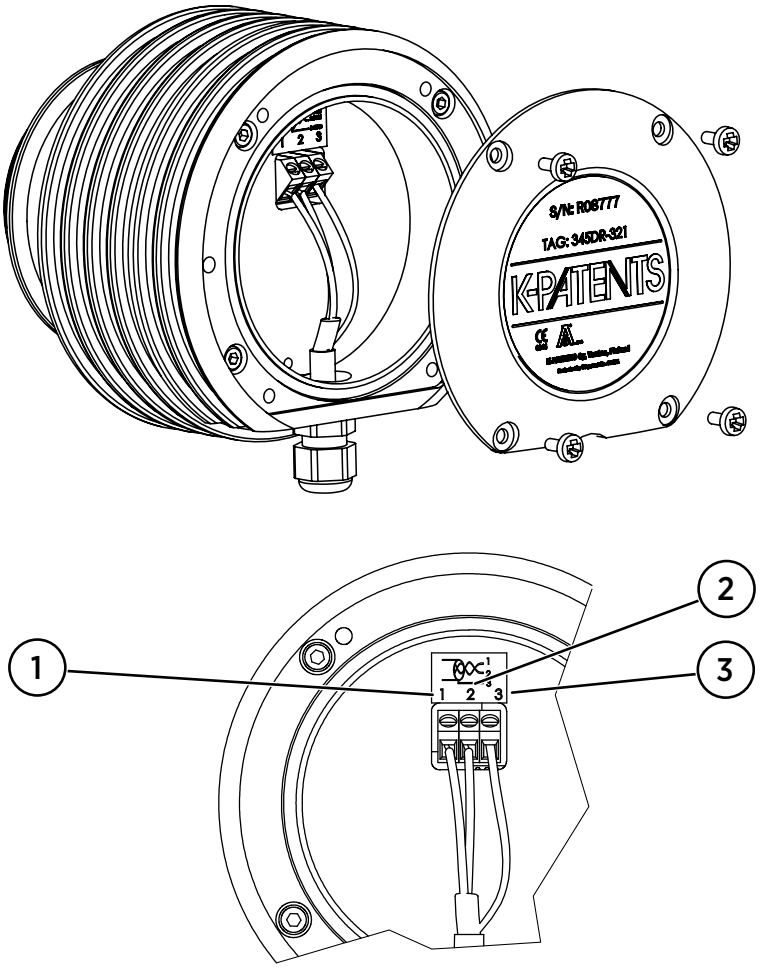


Figure 6 Sensor electrical connections

1. Remove the 4 screws holding the sensor nameplate. 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 the cable gland.
4. Screw the nameplate back on.

More information

- Interconnecting cable (page 25)

4.2.2 Connecting indicating transmitter

Warning

Warning! Check that the power is off before opening the front panel. If the green power indicator light is on, there is still power in the system.
Warning! Multiple power sources.

Varoitus! Tarkista, että virta on katkaistu, ennen kuin avaat etupaneelin. Jos vihreä virran merkkivalo palaa, järjestelmässä on edelleen virtaa.
Varoitus! Useita virtalähteitä.

Varning! Kontrollera att strömmen är avstängd innan du öppnar frontpanelen. Om den gröna indikatorlampan lyser är det fortfarande ström i systemet.
Varning! Flera strömkällor.

Advarsel! Kontroller, at strømmen er slukket, før frontpanelet åbnes. Hvis den grønne strømindikatorlampe er tændt, er der stadig strøm i systemet.
Advarsel! Flere strømkilder.

Hoiatus! Enne esipaneeli avamist kontrollige, et süsteem poleks pinge all. Kui roheline toitemärgutuli põleb, on süsteemis endiselt pinge all.
Hoiatus! Mitu toiteallikat.

Внимание! Перед открытием передней панели убедитесь, что питание отключено. Если горит зеленый индикатор питания, система находится под напряжением.
Внимание! Несколько источников питания.

Įspėjimas! Prieš atidarydami priekinį skydelį, patikrinkite, ar maitinimas išjungtas. Jei šviečia žalia maitinimo indikatoriaus lemputė, sistemoje vis dar veikia maitinimas.
Įspėjimas! Keli energijos šaltiniai.

Ostrzeżenie! Przed otwarciem panelu przedniego sprawdzić, czy zasilanie jest wyłączone. Dopóki świeci się zielona kontrolka zasilania, system znajduje się pod napięciem zasilania.
Ostrzeżenie! Wiecej niz jedno zródło zasilania.

Varování! Před otevřením předního panelu zkontrolujte, zda je napájení vypnuto. Pokud svítí zelená kontrolka napájení, je v systému stále přítomno napájení.
Varování! Více zdroju napájení.

Figyelmeztetés! Az előlap kinyitása előtt ellenőrizze, hogy a készülék ki van-e kapcsolva. Ha a zöld tápellátás jelzőfény világít, akkor a rendszer még áram alatt van.
Figyelmeztetés! Több áramforrás.

Warnung! Prüfen Sie, ob das Gerät ausgeschaltet ist, bevor Sie die Frontblende öffnen. Wenn die grüne Betriebsanzeige leuchtet, liegt noch Spannung an.
Warnung! Mehrere Stromquellen.

Waarschuwing! Controleer of de stroom is uitgeschakeld voordat u het voorpaneel opent. Als het groene stroomindicatielampje brandt, staat er nog stroom op het systeem.
Waarschuwing! Meerdere voedingsbronnen.

Avertissement! Vérifiez que l'alimentation est coupée avant d'ouvrir le panneau avant. Si le voyant d'alimentation vert est allumé, le système est toujours sous tension.
Avertissement! Sources d'alimentation multiples.

¡Advertencia! Verifique que la alimentación está desconectada antes de abrir el panel frontal. Si la luz indicadora de encendido de color verde está encendida, aún hay energía en el sistema.
¡Advertencia! Varias fuentes de alimentación.

Avvertimento! Verificare che l'alimentazione sia spenta prima di aprire il pannello anteriore. Se la spia di alimentazione verde è accesa, il sistema è ancora alimentato.
Avvertimento! Molteplici fonti di alimentazione.

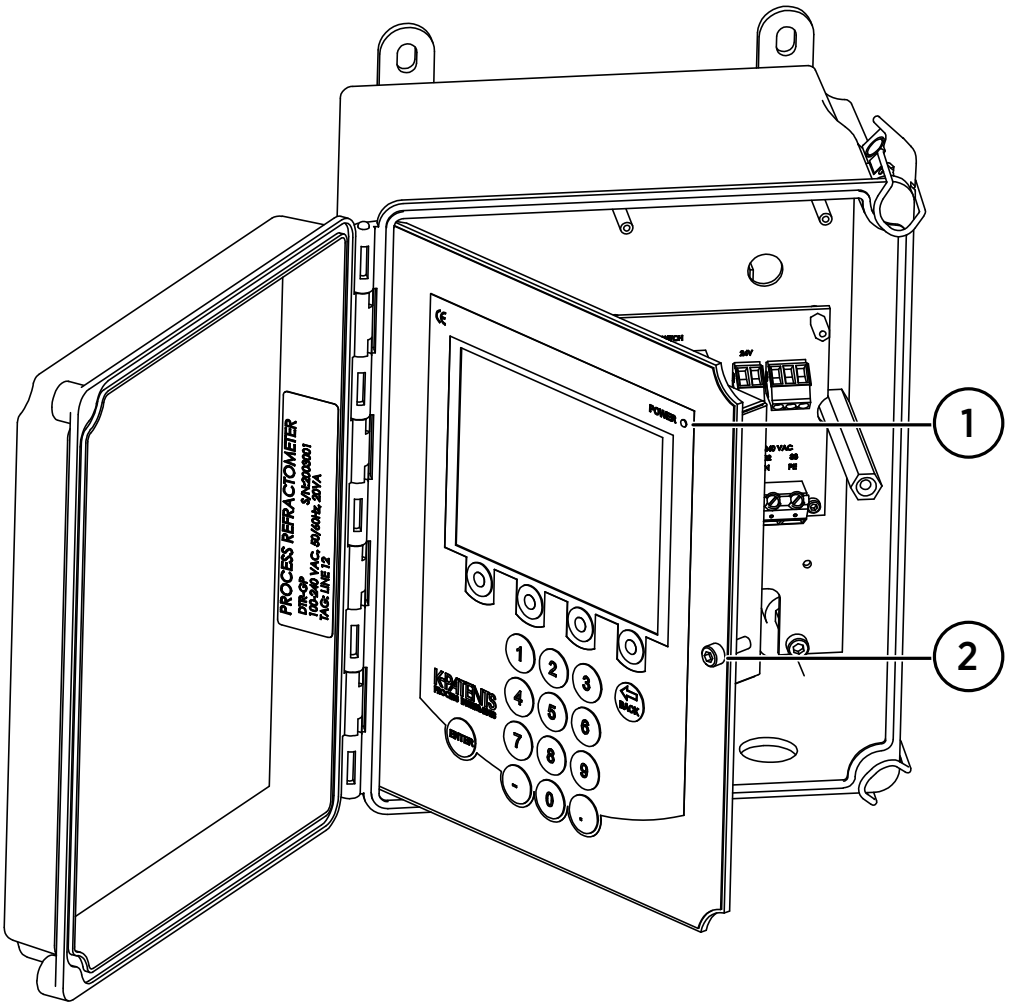
The following table describes the terminals on the H1 interface card PR-10701 and on the transmitter motherboard PR-10600.

Terminal	Usage
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 Ω, galvanically isolated.
13 14	4 ... 20 mA output 2, positive (13), negative (14), max. load 1000 Ω, galvanically isolated.
21 22[1)]	Relay 1, one contact output, max. 240 V AC, max. 3 A, fuse with voltage 250 V AC, max fuse size 3 A, speed slow.
23 24[1)]	Relay 2, one contact output, max. 240 V AC, max. 3 A, fuse with voltage 250 V AC, max fuse size 3 A, speed slow.
31 32 33[1)]	Power, L (31), N (32), protective earth (33), 100 ... 240 V AC, 50 ... 60 Hz, fuse with voltage 250 V AC, max. size 10 A and speed slow. An external power switch is mandatory. Power, + (31), - (32), protective earth (33), 24 V DC ± 10%, fuse with voltage min 48 V DC, max. size 4 A and speed fast.
41 42	24 V terminal for DTR internal use only. Connecting terminal to external 24 V supply voids the warranty. Connecting external devices to 24 V terminal voids the warranty.
51 52 53 54 55	Switch inputs: switch 1 (51), switch 2 (52), switch 3 (53), switch 4 (54) and common 3 V for all inputs (55). The switch terminals are galvanically isolated.

1) *Wiring to terminals should be min. 1.5 mm^2 (AWG 18). The fuse voltage should be 250 V, max. size 10 A and fuse speed slow. Torque used is 0.5 Nm ... 0.6 Nm. Stripping length is 8 mm for wires.*

1. To access the electrical terminals, open the enclosure cover.

2. Loosen the front panel screw (2), and open the front panel.
   All terminals are now accessible.

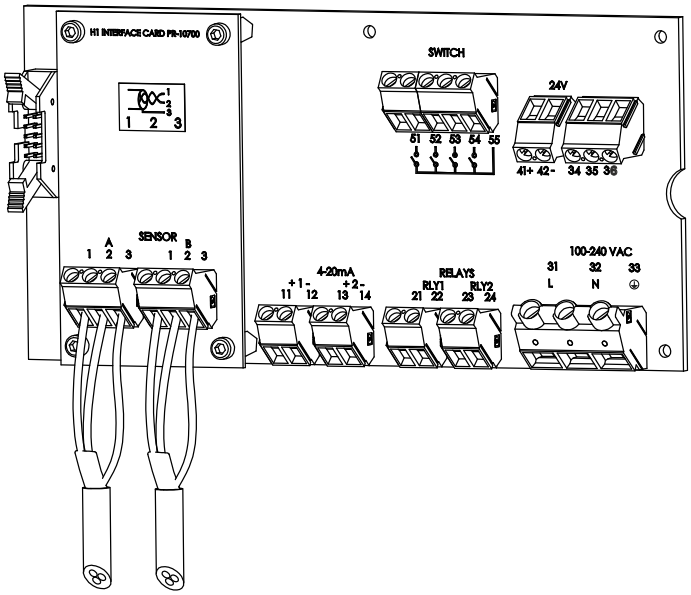


a. Power indicator light
b. Front panel screw

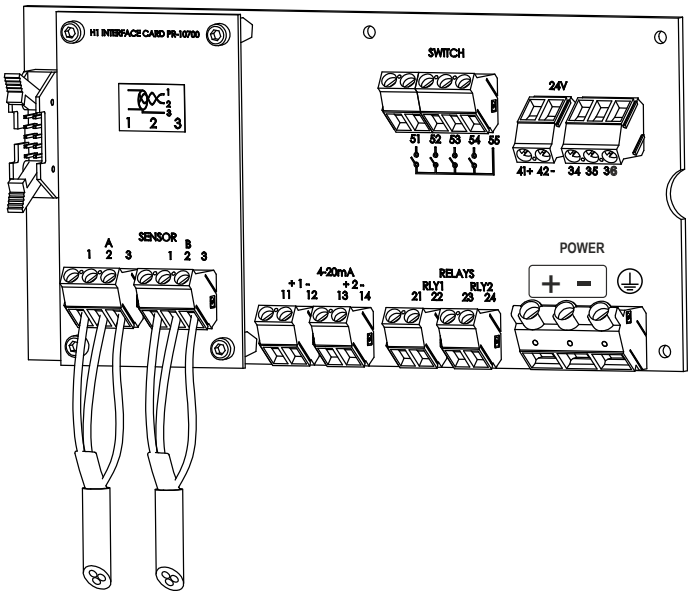
3. Connect the signal wires to terminal (1) and (2), and the cable shield to terminal (3).

> Make sure that you connect the signal wires in the sensor and in the indicating transmitter in the same order.

- The following figure shows the motherboard of the indicating transmitter for AC power.



- The following figure shows the motherboard of the indicating transmitter for 24 V DC power.



4.3 Connecting power terminals

4.3.1 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. The 3 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 must be of min. 1.5 mm^2. The fuse voltage should be 250 V, max. size 10 A and fuse speed slow. Make sure that the protective fuse in the building system complies with local requirements.

If you use an AC power terminal, Vaisala recommends that you install an external power switch. The ratings of the external power switch are 10 A and 250 V. Make sure that you mount the external power switch close to the indicating transmitter and that it is easily reachable. Make sure that you mark the external power switch as a disconnecting device.

Warning

Warning! Install the external power switch in accordance to the local installation requirements.

Varoitus! Asenna ulkoinen virtakytkin paikallisten asennusvaatimusten mukaisesti.

Varning! Installera den externa strömbrytaren i enlighet med lokala installationskrav.

Advarsel! Installer den eksterne afbryder i overensstemmelse med de lokale installationskrav.

Hoiatus! Paigaldage väline toitelüliti vastavalt kohalikele paigaldusnõuetele.

Внимание! Установите внешний переключатель питания в соответствии с местными требованиями к установке.

Įspėjimas! Išorinį maitinimo jungiklį sumontuokite laikydamiesi vietinių įrengimo reikalavimų.

Ostrzeżenie! Zewnętrzny wyłącznik zasilania musi być zamontowany zgodnie z miejscowymi wymaganiami dotyczącymi instalacji elektrycznych.

Varování! Externí vypínač nainstalujte v souladu s místními požadavky na instalaci.

Figyelmeztetés! A külső tápkapcsolót a helyi telepítési követelményeknek megfelelően kell felszerelni.

Warnung! Beachten Sie beim Installieren des externen Netzschalters die örtlichen Vorschriften.

Waarschuwing! Installeer de externe voedingsschakelaar conform de plaatselijke installatievereisten.

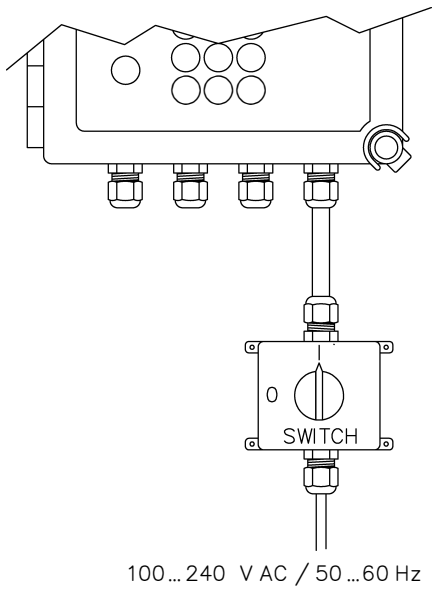
Avertissement! Installez l'interrupteur d'alimentation externe conformément aux exigences d'installation locales.

¡Advertencia! Instale el interruptor de encendido externo según los requisitos de instalación locales.

Avvertimento! Installare l'interruttore di alimentazione esterno in base ai requisiti di installazione locali.

The following figure shows the recommended external power switch, spare part PR-10900.

Figure 7 External power switch



4.3.2 Power terminals for 24 V DC power

The DC power is connected to a terminal stripe marked **POWER** in the lower right-hand corner of the motherboard. The 3 terminals are marked 31/+, 32/– and 33/(protective earth). The power terminal is directly connected to the exposed metal parts of the indicating transmitter DTR. Fuse voltage should be min. 48 V DC, max. size 4 A and fuse speed fast. Ensure that the protective fuse in the building system complies with local requirements.

The 24 V DC power to this terminal stripe must 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 IEC 61010-1.

4.4 Relay connections

Warning

Warning! Connect only AC **or** DC power to relays. You can connect AC power to both relays or DC power to both relays, but never connect AC in one and DC in the other relay.

Varoitus! Kytke releisiin vain vaihtovirta **tai** tasavirta. Voit kytkeä vaihtovirran molempiin releisiin tai tasavirran molempiin releisiin, mutta älä koskaan kytke yhteen releeseen vaihtovirtaa ja toiseen releeseen tasavirtaa.

Varning! Anslut endast en AC- **eller** DC-strömkälla till reläer. Du kan ansluta en AC-strömkälla till båda reläerna eller en DC-strömkälla till båda reläerna, men aldrig ansluta en AC-strömkälla till det ena reläet och en DC-strömkälla till det andra.

Advarsel! Tilslut kun vekselstrøm **eller** jævnstrøm til relæerne. Du kan slutte vekselstrøm til begge relæer eller jævnstrøm til begge relæer, men tilslut aldrig vekselstrøm til det ene og jævnstrøm til det andet relæ.

Hoiatus! Ühendage releed ainult vahelduvvoolu- **või** alalisvooluvõrku. Võite mõlemad releed ühendada kas vahelduvvooluvõrku või alalisvooluvõrku, ent mitte kunagi ühte releed vahelduvvooluvõrku ja teist alalisvooluvõrku.

Внимание! Подключайте к реле только питание переменным **или** постоянным током. К обоим реле можно подключить питание переменным или постоянным током, но никогда не подключайте к одному реле питание переменным током, а к другому ----- питание постоянным током.

Įspėjimas! Prijunkite tik AC **arba** nuolatinę srovę relėms. Galite prijungti kintamąją srovę prie abiejų relių arba nuolatinę srovę prie abiejų relių, bet niekada nejunkite kintamosios srovės vienoje ir nuolatinės srovės kitoje.

Ostrzeżenie! Do przekaźników podłączać tylko AC **lub** DC. Do obu przekaźników może być podłączone zasilanie AC lub zasilanie DC, ale nie wolno podłączać zasilania AC do jednego, a zasilania DC do drugiego przekaźnika.

Varování! K relé připojte pouze střídavé **nebo** stejnosměrné napájení. Můžete připojit střídavé napájení k oběma relé nebo stejnosměrné napájení k oběma relé, ale nikdy nepřipojujte k jednomu relé střídavé a k druhému stejnosměrné napájení.

Figyelmeztetés! Csak AC **vagy** csak DC tápellátást csatlakoztasson a relékhez. Csatlakoztathat AC tápellátást mindkét reléhez, vagy DC tápellátást mindkét reléhez, de soha ne csatlakoztasson az egyikhez AC, a másikhoz pedig DC tápellátást.

Warnung! Nur Wechselstrom **oder** Gleichstrom an die Relais anschließen. Sie können Wechselstrom an beide Relais oder Gleichstrom an beide Relais anschließen, dürfen aber keinesfalls Wechselstrom an ein und Gleichstrom an das andere Relais anschließen.

Waarschuwing! Sluit alleen AC- **of** DC-voeding aan op relais. U kunt AC-voeding aansluiten op beide relais of DC-voeding op beide relais, maar sluit nooit AC-voeding aan op het ene en DC-voeding aan op het andere relais.

Avertissement! Connectez uniquement une alimentation CA **ou** CC aux relais. Vous pouvez connecter une alimentation CA aux deux relais ou une alimentation CC aux deux relais, mais ne connectez jamais une alimentation CA à un relais et une alimentation CC à l'autre relais.

¡Advertencia! Conecte solo la alimentación de CA **o** de CC a los relés. Puede conectar la alimentación de CA a ambos relés o la alimentación de CC a ambos relés, pero nunca podrá conectar una alimentación de CA en un relé y una alimentación de CC en el otro relé.

Avvertimento! Collegare ai relè solamente l'alimentazione CA **o** CC. È possibile collegare l'alimentazione CA o CC a entrambi i relè, ma non collegare mai l'alimentazione CA in un relè e l'alimentazione CC nell'altro relè.

Warning

Warning! Multiple power sources. The relays are powered from external circuits.

Varoitus! Useita virtalähteitä. Releet saavat virtaa ulkoisista piireistä.

Varning! Flera strömkällor. Reläerna drivs från externa kretsar.

Advarsel! Flere strømkilder. Relæerne får strøm fra eksterne kredsløb.

Hoiatus! Mitu toiteallikat. Releed saavad toidet välistest vooluahelatest.

Внимание! Несколько источников питания. Реле питаются от внешних цепей.

Įspėjimas! Keli energijos šaltiniai. Relės maitinamos iš išorinių grandinių.

Ostrzeżenie! Więcej niż jedno źródło zasilania. Przekaźniki zasilane są z zewnętrznych obwodów.

Varování! Více zdrojů napájení. Relé jsou napájena z externích obvodů.

Figyelmeztetés! Több áramforrás. A relék táplálása külső áramkörökből történik.

Warnung! Mehrere Stromquellen. Die Relais werden über externe Stromkreise gespeist.

Waarschuwing! Meerdere voedingsbronnen. De relais worden gevoed door externe circuits.

Avertissement! Sources d'alimentation multiples. Les relais sont alimentés à partir de circuits externes.

¡Advertencia! Varias fuentes de alimentación. Los relés se alimentan de circuitos externos.

Avvertimento! Molteplici fonti di alimentazione. I relè sono alimentati da circuiti esterni.

4.5 Reset button

You can reset and restart both the indicating transmitter DTR and the sensor by pushing the reset button. You can access the button through the cable hole in the front panel shield as shown in the following figure. To reach the reset button, use a thin stick or similar utensil, preferably of non-conducting material. After pushing the reset button, the display blacks out for a few seconds. The instrument returns to full operation within 30 s.

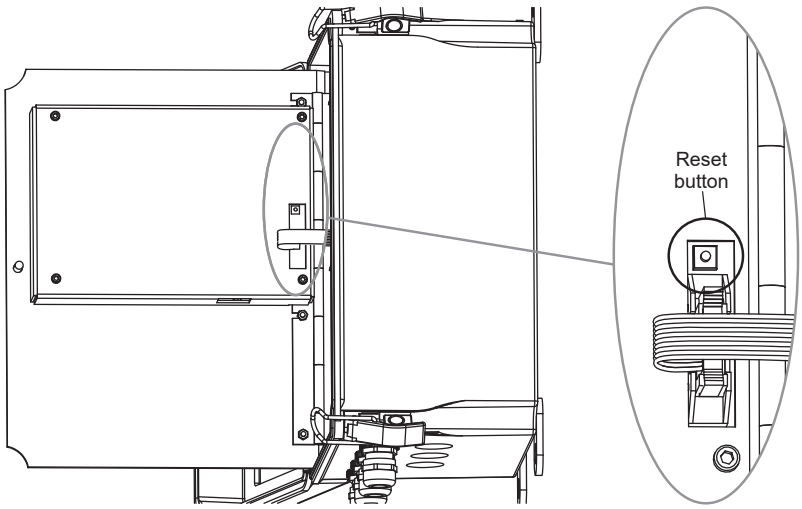


Figure 8 Location of reset button

5. Prism wash systems

5.1 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 keeps clean due to the self-cleaning effect. If coating occurs, check the following:

- Sufficient flow velocity, see Pipe mounting checklist (page 22).
- A temperature difference between process fluid and sensor probe can cause coating. This can happen with small flows if the thermal insulation is inadequate. In some cases it also helps to insulate the clamp connector.

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

Consider installing a wash nozzle, if increasing the velocity or using a flow booster does not provide a solution. See Prism wash (page 35).

5.2 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 Configuring relays (page 64).

CAUTION! 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.

Culinary Steam: 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: Water from a supply properly located, protected, and operated, and of safe, sanitary quality. The water must 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.

5.2.1 Recommended wash pressures and times

The following tables show the recommended wash pressures and times.

Table 3 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)	3 s	20 ... 30 s	20 ... 30 min
High pressure water (WP)	15 bar (220 psi)	40 bar (600 psi)	10 s	20 ... 30 s	10 ... 20 min

Table 4 Wash medium parameters for flow cell wash nozzle AFC

	Minimum above process pressure	Maximum above process pressure	Wash time	Recovery	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

Table 5 Wash medium parameters for Safe-Drive isolation valve nozzle SDI

	CONC % value	Minimum above process pressure	Maximum above process pressure	Wash time	Recovery	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)		25 bar (350 psi)	30 bar (435 psi)	10 ... 15 s	20 s	5 ... 20 min

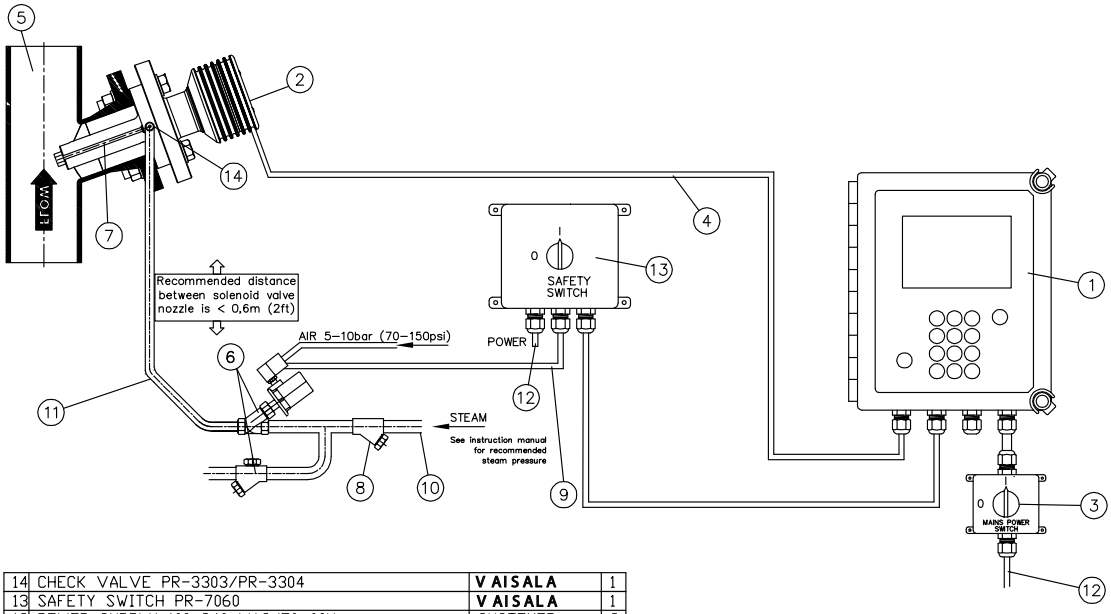
CAUTION! In steam wash, do not exceed the recommended wash times, because some process media can burn to the prism surface if steamed for longer time. In case of coating, shorten the wash interval.
For the Automatic wash cut parameter, see Setting prism wash parameters (page 79).

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

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

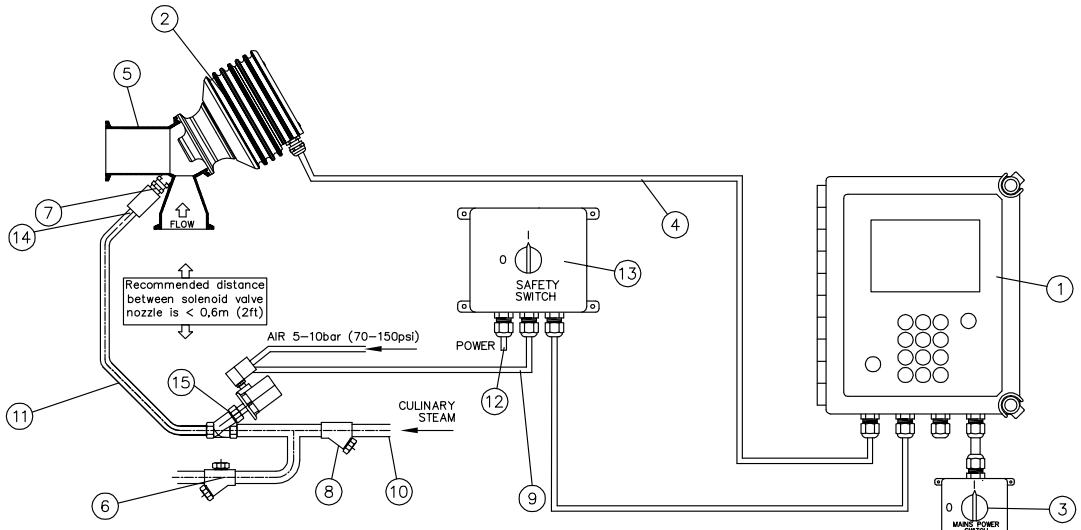
5.2.2 Prism wash systems

The following figures describe the prism wash systems for steam and for sanitary systems. Figure 14 (page 42) describes the prism wash system for high pressure water.



14	CHECK VALVE PR-3303/PR-3304	VAISALA	1
13	SAFETY SWITCH PR-7060	VAISALA	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	VAISALA	1
7	STEAM NOZZLE	VAISALA	1
6	SHUT-OFF VALVE&STEAM TRAP PR-3340-230/110	VAISALA	1
5	FLOW CELL/ PROCESS PIPE	VAI/CUSTOMER	1
4	CABLE BETWEEN DT-R AND SENSOR PR-8230-...	VAI/CUSTOMER	1
3	MAINS POWER SWITCH PR-10900	VAI/CUSTOMEP	1
2	SENSOR PR-23-G	VAISALA	1
1	INDICATING TRANSMITTER DTR	VAISALA	1
PART	PART SPECIFICATIONS	SUPPLIED BY	

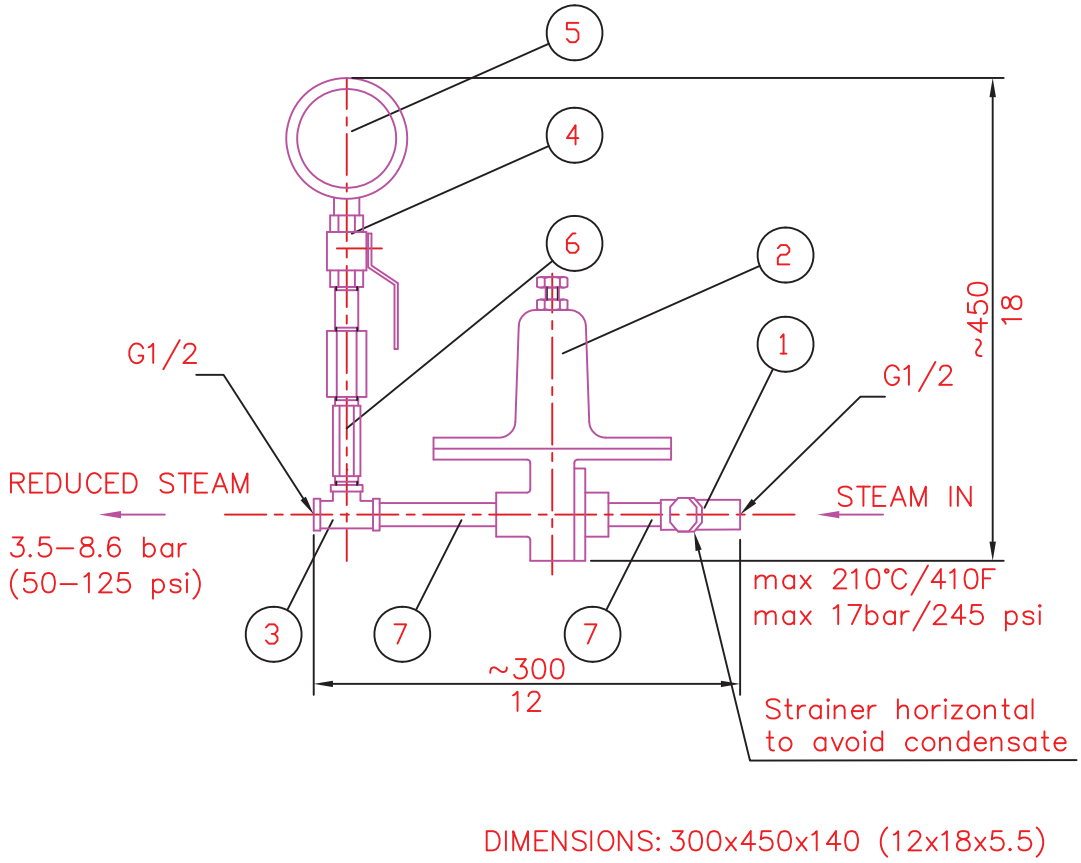
Figure 9 Prism wash system for steam (non-sanitary)



PART	PART SPECIFICATIONS	SUPPLIED BY	
15	SANITARY SHUT-OFF VALVE	CUSTOMER	1
14	SANITARY CHECK VALVE	CUSTOMER	1
13	SAFETY SWITCH PR-7060	VAISALA	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	VAISALA	1
6	STEAM TRAP	CUSTOMER	1
5	FLOW CELL AFC-HSS-H10/15/20/25 -SI/RI-NC	VAISALA	1
4	CABLE BETWEEN DT-R AND SENSOR PR-8230-...	CUSTOMER	1
3	MAINS POWER SWITCH PR-10900	VAI/CUSTOMER	1
2	SENSOR PR-23-A	VAISALA	1
1	INDICATING TRANSMITTER DTR	VAISALA	1

Figure 10 Sanitary prism wash system for steam

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



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 Pressure reducing valve PR-3341-J

Note the orientation of the strainer.

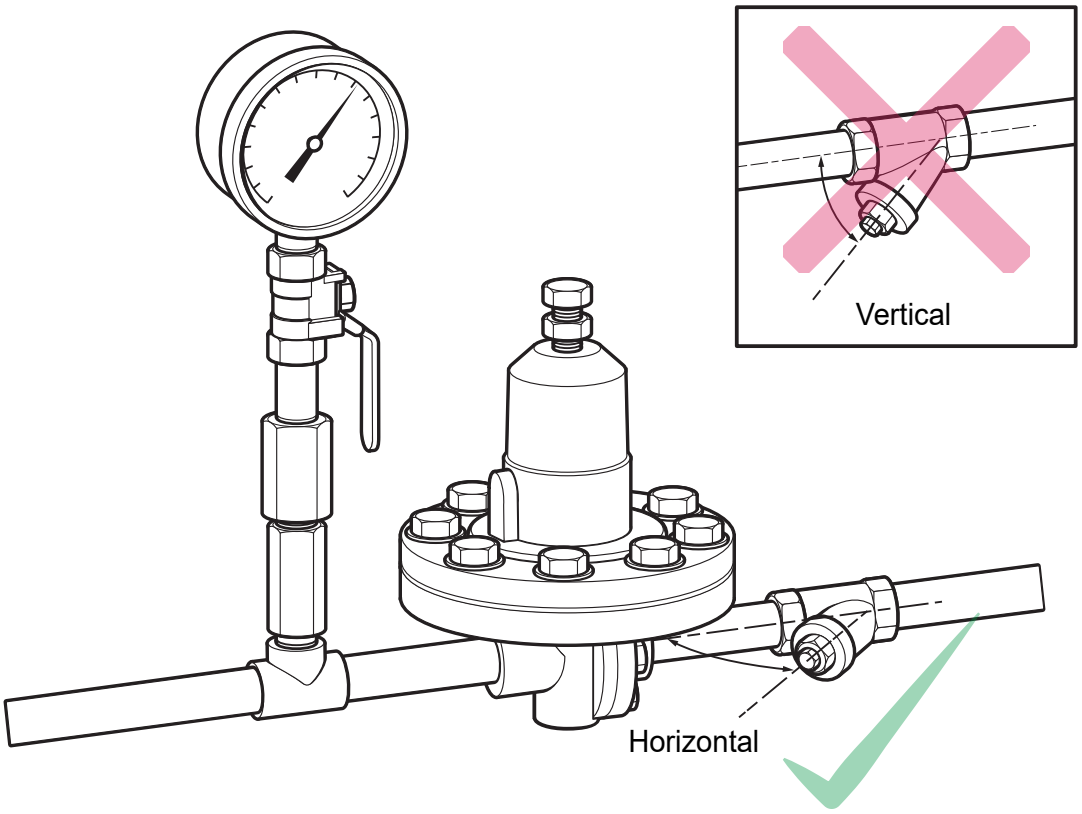


Figure 12 Install strainer horizontally

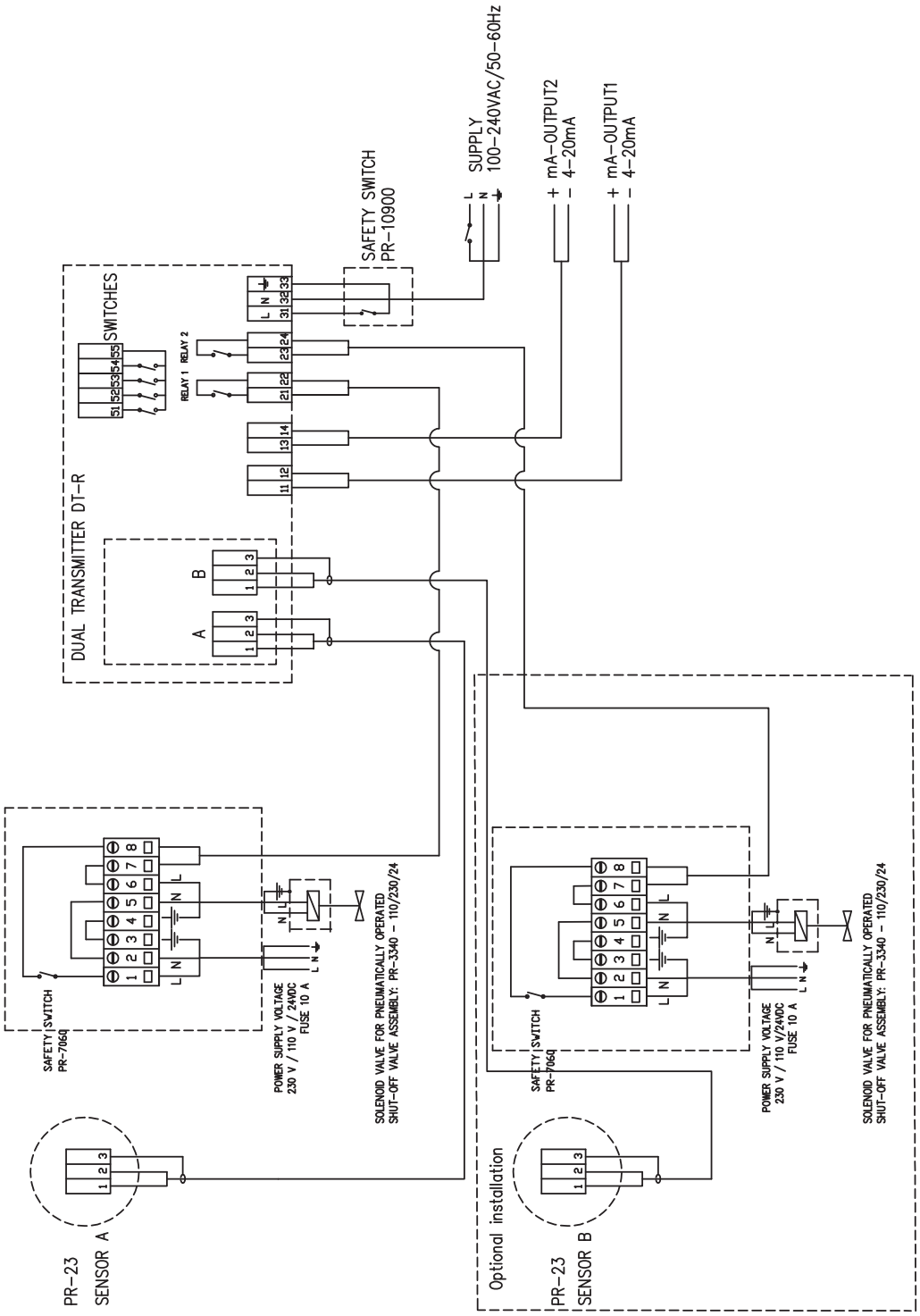
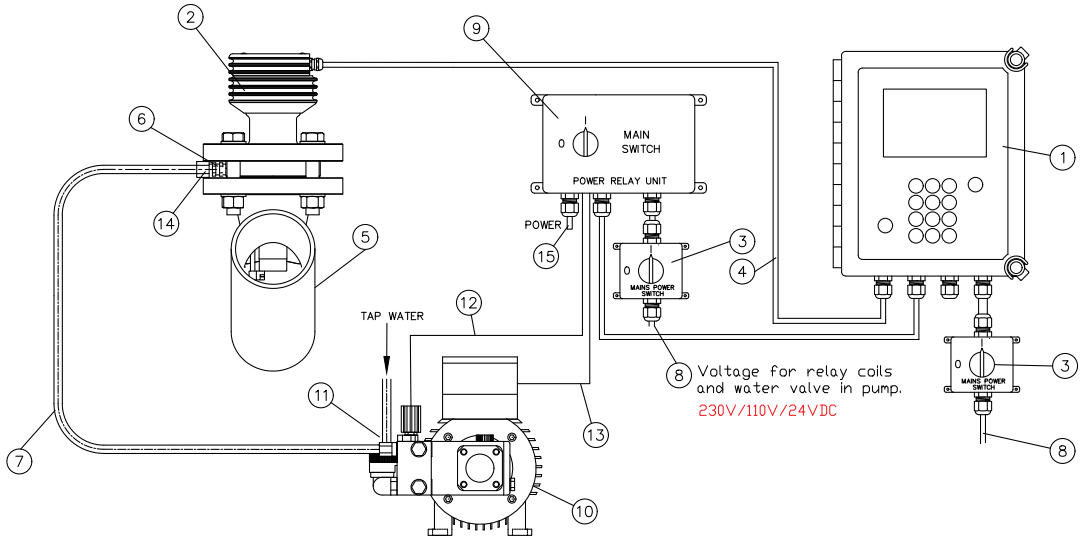


Figure 13 Wiring for a prism wash system for steam

WARNING! In high pressure wash systems, pressure increase can occur in a closed pipe section when the high pressure pump is operated. It is recommended to mount a pressure relief valve in the pipe section. Relief pressure must be according to pipe pressure rating.



15	POWER SUPPLY 3~ 400V/50Hz AC	CUSTOMER	1
14	CHECK VALVE R 1/4" PR-3303/PR-3304	VAISALA	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 230V/50Hz WITH INLET 3/8"	VAISALA	1
10	HP PUMP PR-3602-400-BR/SS-230/110	VAISALA	1
9	POWER RELAY UNIT PR-3603-400-U/M-230/110	VAISALA	1
8	POWER SUPPLY 100-240VAC/50-60Hz	CUSTOMER	2
7	HIGH PRESSURE HOSE 8 meter / high pressure piping	VAISALA	1
6	PRESSURIZED WATER NOZZLE	VAISALA	1
5	PROCESS PIPE/FLOW CELL	VAISALA	1
4	CABLE BETWEEN DT-R AND SENSOR PR-8230	VAISALA	1
3	MAINS POWER SWITCH PR-10900	VAISALA	2
2	SENSOR PR-23-GP	VAISALA	1
1	INDICATING TRANSMITTER DT-R	VAISALA	1
PART	PART SPECIFICATIONS	SUPPLIED BY	

Figure 14 Prism wash system for high pressure water

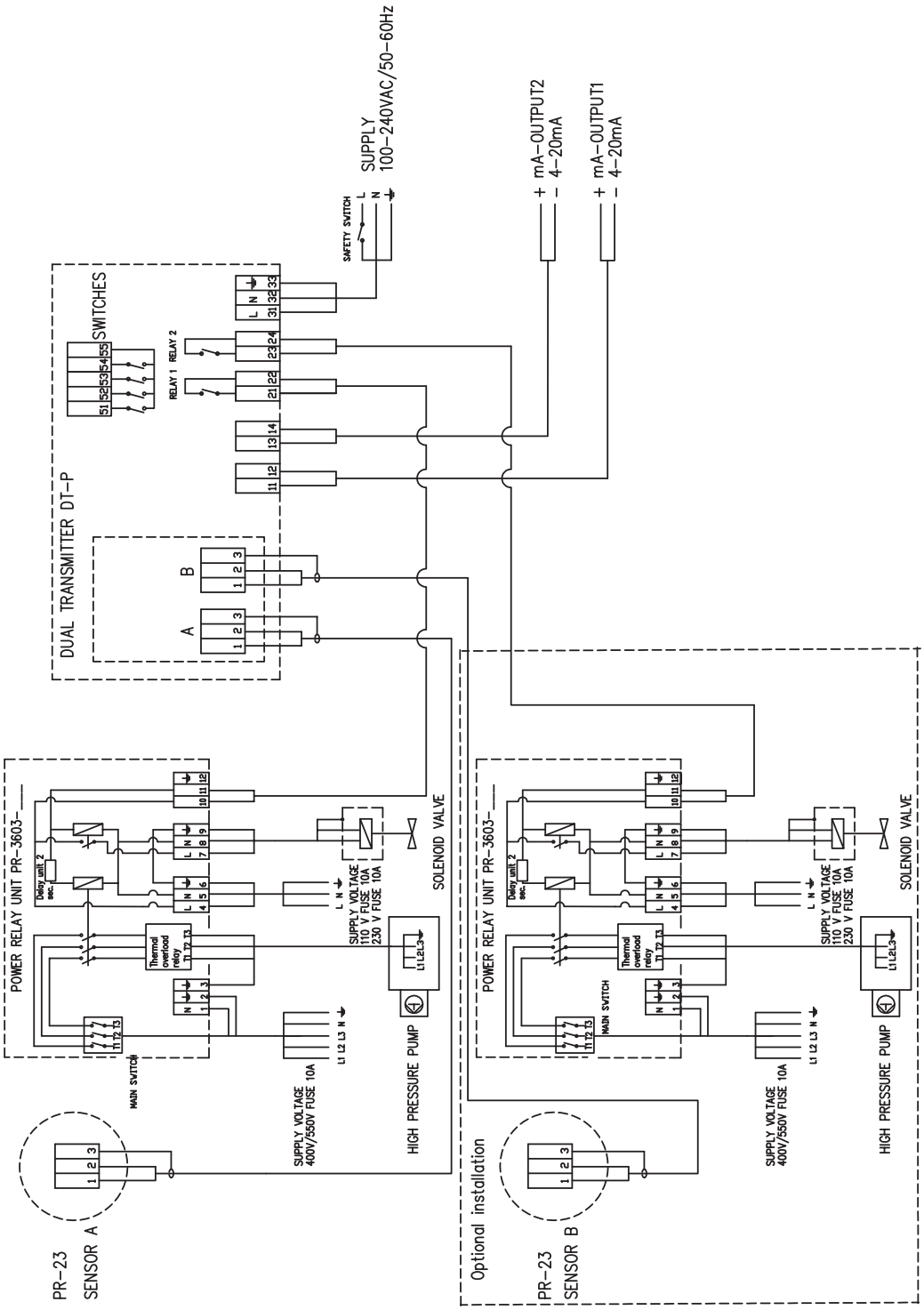


Figure 15 Wiring for prism wash system for high pressure water

5.2.3 Prism wash nozzles

When selecting a wash nozzle for a **compact refractometer**, take into account both the wash medium and the flow cell model: flow cells with larger pipe diameters need longer wash nozzles. The following figure shows a wash nozzle for a flow cell and gives the measurements and part numbers for each nozzle type.

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

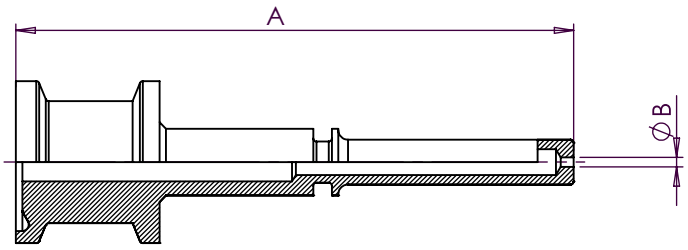


Figure 16 Wash nozzles for flow cell AFC-HSS-XXX-XX-NC

The following figure shows how the nozzle is mounted in a flow cell (-NC with stud for a wash nozzle).

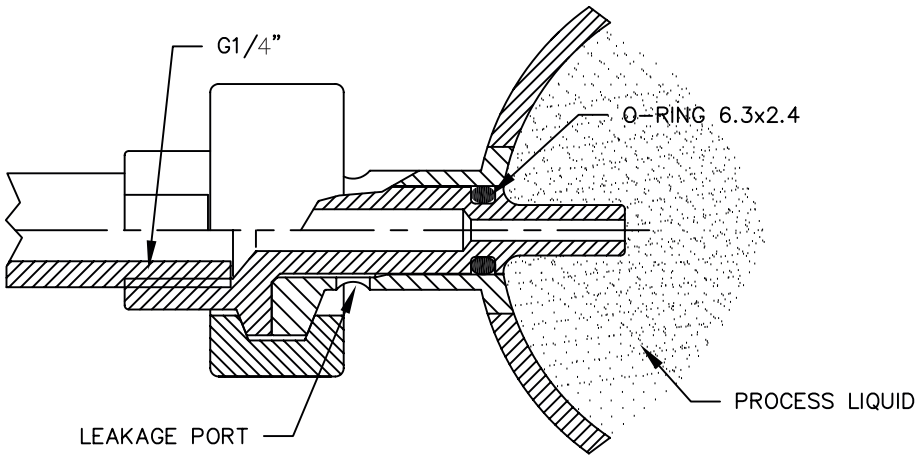


Figure 17 Process connection of wash nozzle in flow cell

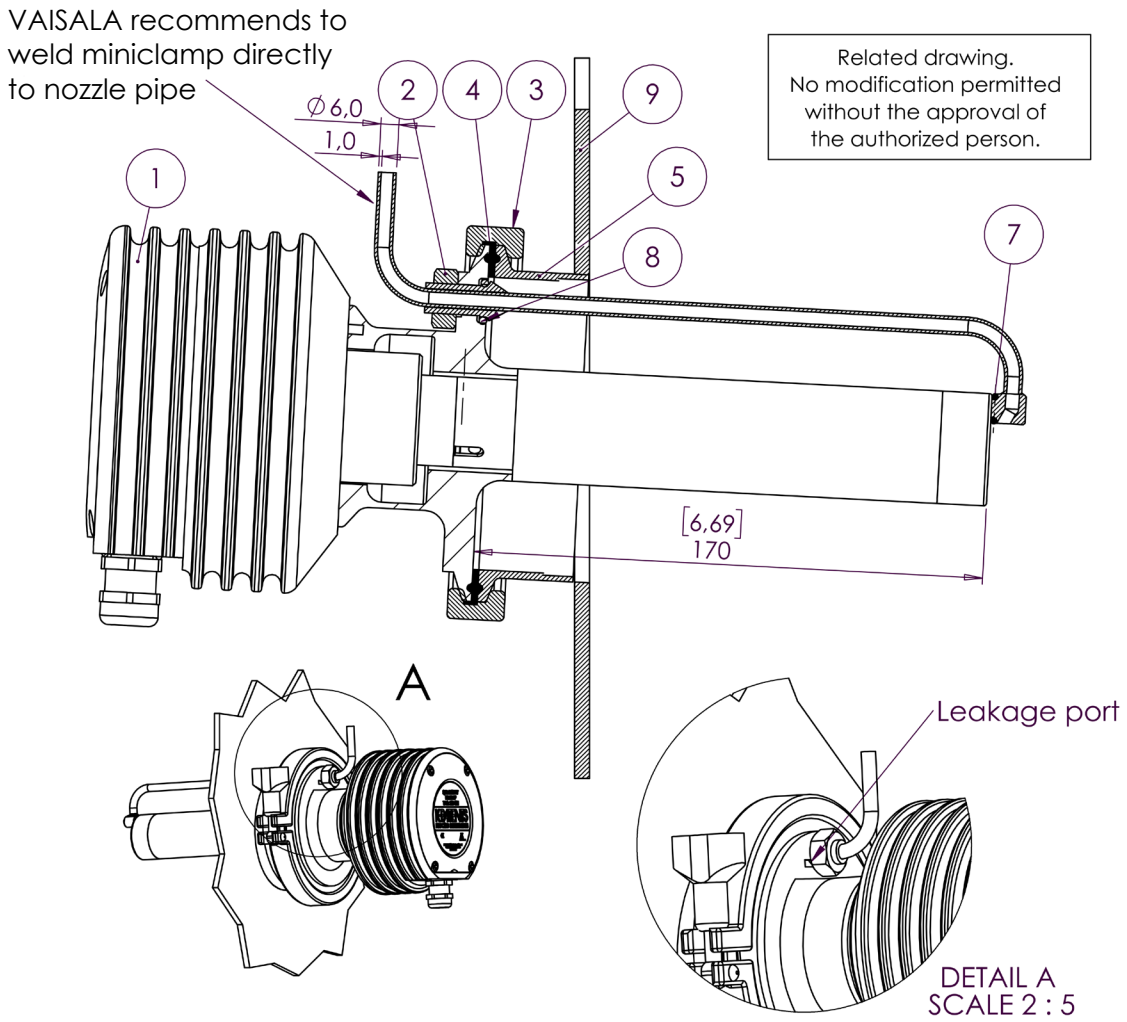
For more information on flow cells, see PR-23-AC mounting specifications (page 104).

The following table lists wash nozzles according to wash medium and refractometer model for probe refractometers.

Table 6 Prism wash nozzle selection

	PR23-AP	PR-23-GP
Steam nozzle	PR-9321	PR-9324
Water nozzle	PR-9320	PR-9323
Pressurized water nozzle	PR-9322	PR-9325

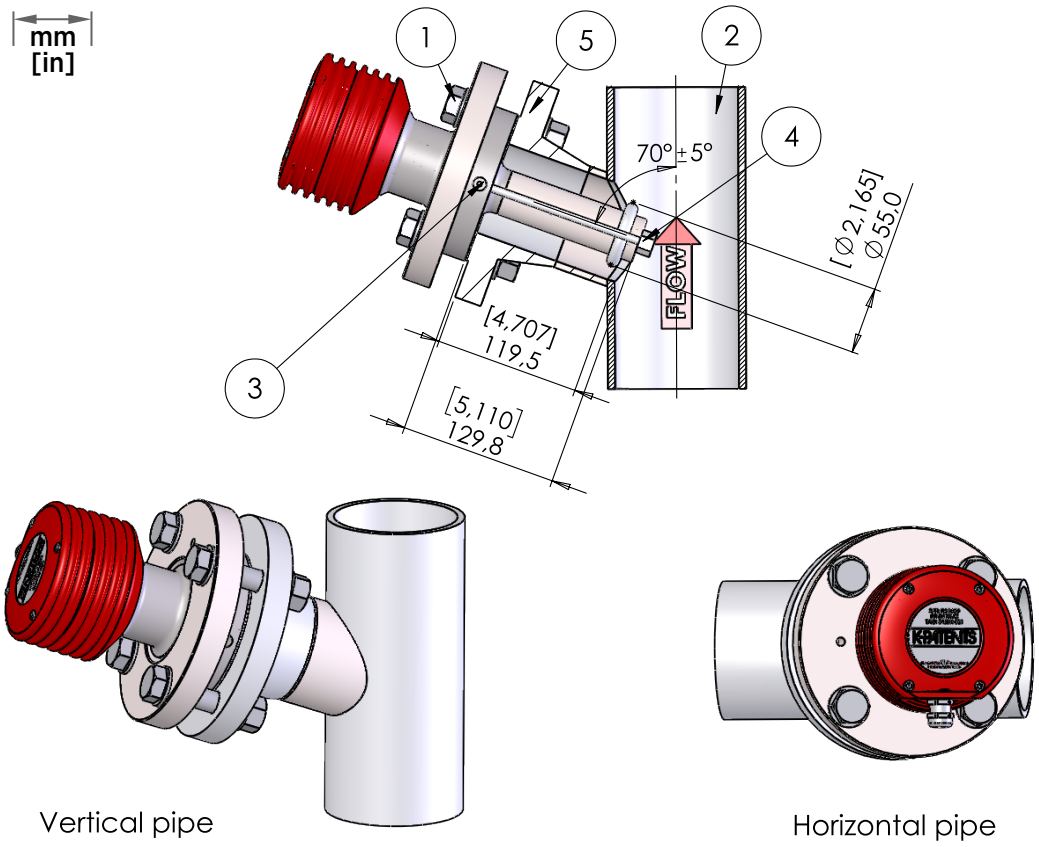
The following figure shows the mounting of the wash nozzle for sanitary probe refractometer PR-23-AP.



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

Figure 18 Mounting of wash nozzle for sanitary probe refractometer PR-23-AP

The following figure shows the mounting of the wash nozzle for process refractometer PR-23-GP.



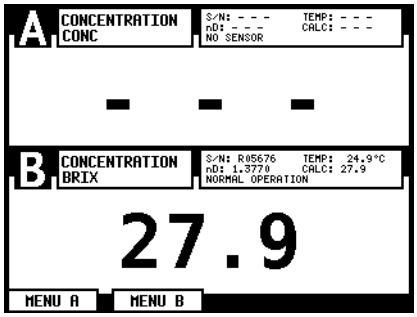
ITEM NO.	DESCRIPTION	MATERIAL	SUPPLIED BY	PCS.
1	Bolt, washer, nut	AISI316L	Customer	4/8
2	Customer Pipe DN80/3" or larger	AISI316L	Customer	1
3	Check valve PR-3303	AISI316L/Kalrez	VAISALA	1
4	PR-23-GP wash nozzle	AISI316L	VAISALA	1
4.1	Steam nozzle PR-9324	AISI316L	VAISALA	
4.2	Water Nozzle PR-9323	AISI316L	VAISALA	
4.3	Pressurized water nozzle PR-9325	AISI316L	VAISALA	
5	Welding flange		Customer	1

Figure 19 Mounting of wash nozzle for process refractometer PR-23-GP

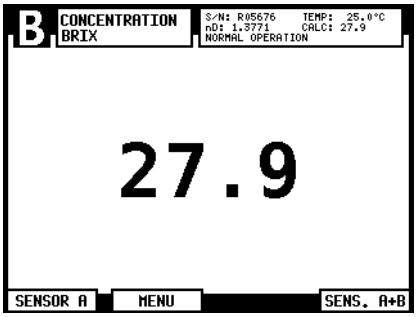
6. Startup and use

6.1 Startup

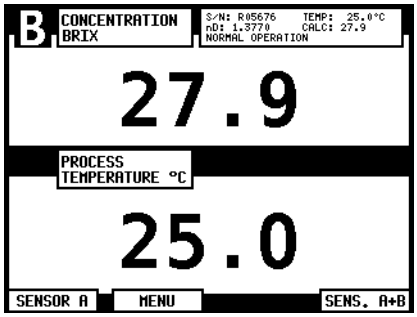
6.1.1 Initial check



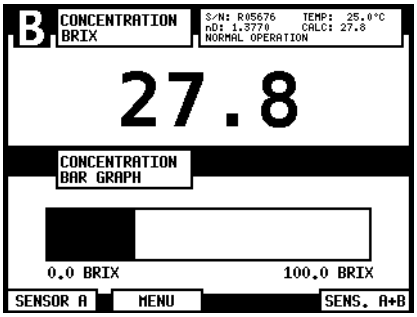
Main display for two sensors



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 20 Main display alternatives

1. Check the wiring, see Connecting the sensor to the indicating transmitter (page 25).
2. Connect the power. The power indicator light and the screen light up within a few seconds. The **Main** display comes up, as shown in Figure 20 (page 48).
3. If the display shows a row of dashes, there is no corresponding sensor (for example in the figure above, upper left, there is no sensor A, only sensor B is connected). The diagnostic message is **NO SENSOR** for that sensor.
4. Check the serial number of the sensor at the upper right corner in the display.

5. For a connected sensor, the diagnostic message at start-up is **Normal operation** or **NO SAMPLE** if the process pipe is empty. If another diagnostic message is shown instead, see Diagnostic message priorities (page 94).
6. The **TEMP** value shows the current process temperature.
7. To check the value and the correct setup of the two mA output signals, go to **Main > DESCRIPTION > mA OUTPUTS**. For more information, see Viewing system information (page 53).
8. If internal relays or switch inputs are used, check their settings through the **DESCRIPTION** menu. For more information, see Viewing system information (page 53).

6.1.2 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, see Calibrating concentration measurement (page 70).

6.1.3 Testing prism wash

1. Check that the steam or water washing parts are connected.
2. Go to **Main > SENSOR STATUS** and press **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.

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

More information

- Prism wash systems (page 37)

6.2 Using indicating transmitter

The indicating transmitter DTR receives the refractive index value n_D and the process temperature from the sensor. 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.

More information

- Configuration and calibration (page 57)

6.2.1 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: used to implement the selected (highlighted) menu command or to accept an entered value.

BACK key: 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. The figure below 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**).

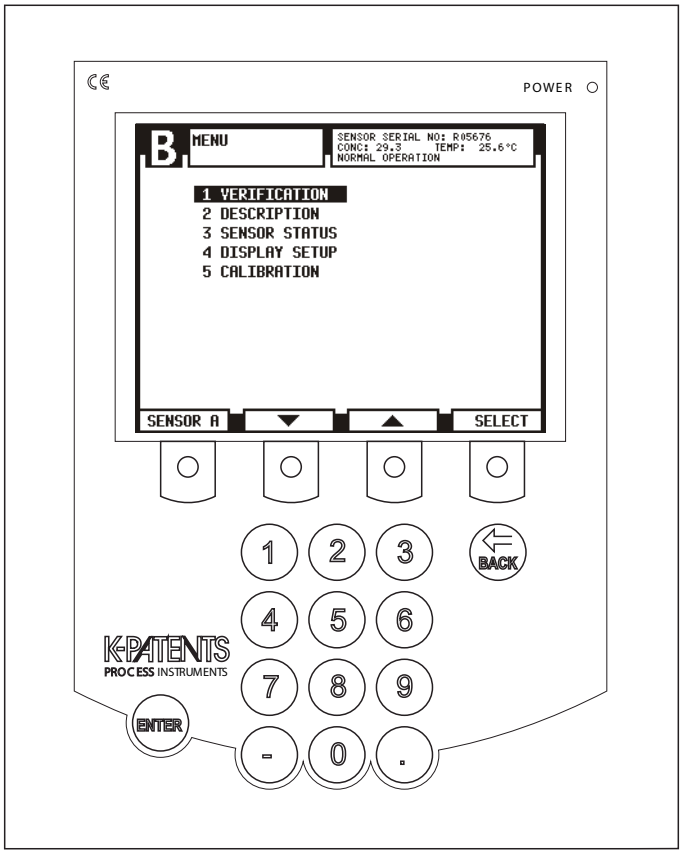


Figure 21 DTR keyboard and Main menu for sensor B

Press the key under the display. The display is not touch sensitive.

6.2.2 Display setup

To go to the menu display, select **MENU** / **MENU A** / **MENU B** or **SENSOR A** or **SENSOR B** (depending on your **Main** display format) in the **Main** display. Choose **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 22 Display setup menu

Main display format: The following figure shows the 4 different **Main** display formats. The dual sensor format shows information on both sensors while the 3 different single sensor formats show selected information on one sensor at a time. Choose **MAIN DISPLAY FORMAT** in the **Display** setup menu to change the **Main** display. The current format is shown on the display format selection display, as shown in the figure.

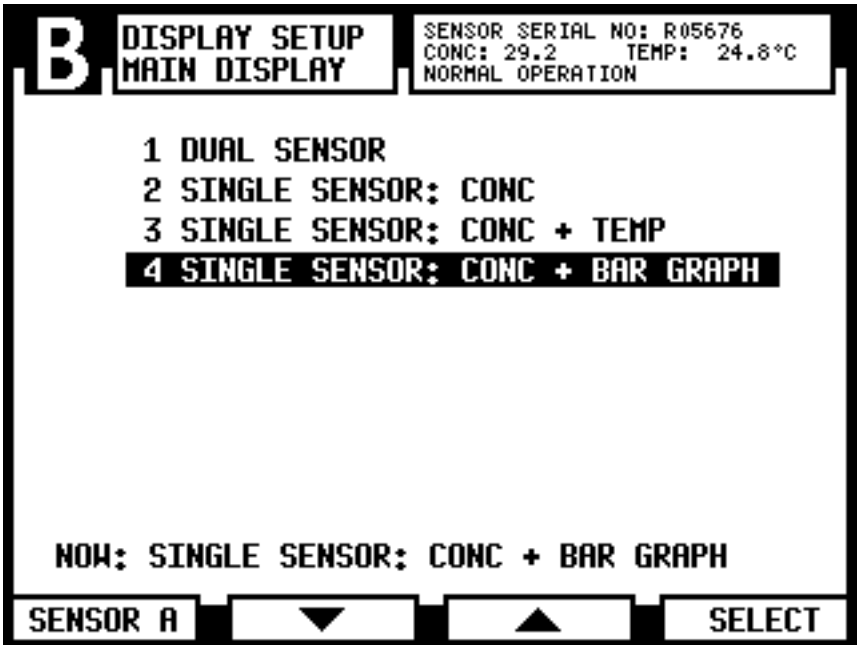


Figure 23 Main display format selection

An automatic 60 s (in verification 5 min) timeout makes backsteps from any display until the **Main** display is reached.

Display appearance: Go to **DISPLAY SETUP > DISPLAY BACKLIGHT & CONTRAST**. To change the values use the arrow soft keys or alternatively a one digit input, for example 8 designates 80 % when adjusting contrast.

DISPLAY INVERSION contains two choices. The default setting of the display is **POSITIVE DISPLAY**, which is a yellow background with black text. **NEGATIVE DISPLAY** is a black background with yellow text.

Bar graph settings: Go to **BAR GRAPH SETTINGS** to set the bar graph span and zero separately for sensors A and B.

Bar graph is only visible when **Main** display is in the bar graph format, see above.

Display language: Go to **DISPLAY LANGUAGE** to choose the DTR display language. The default language is English and it is always available. The order and number of languages in the language menu varies depending on what languages are loaded into the DTR. Language change through this menu is immediate.

6.3 Viewing system information

Go to **Main > DESCRIPTION** for information about the system and calibration. This path is risk-free in the sense that no values can be changed through this menu. To change the calibration, go to **Main > CALIBRATION**.

The **DESCRIPTION** menu, shows the following information:

1. **SYSTEM**: See Figure 24 (page 53), right side.
2. **mA OUTPUTS**: See Configuring mA outputs (page 69).
3. **RELAYS**: See Configuring relays (page 64).
4. **SWITCHES**: See Configuring input switches (page 66).
5. **PRISM WASH**: See Configuring relays (page 64) and Configuring prism wash (page 75).
6. **PARAMETERS**: See Calibrating concentration measurement (page 70).
7. **NETWORK**: The Ethernet address and card ID of the DTR.

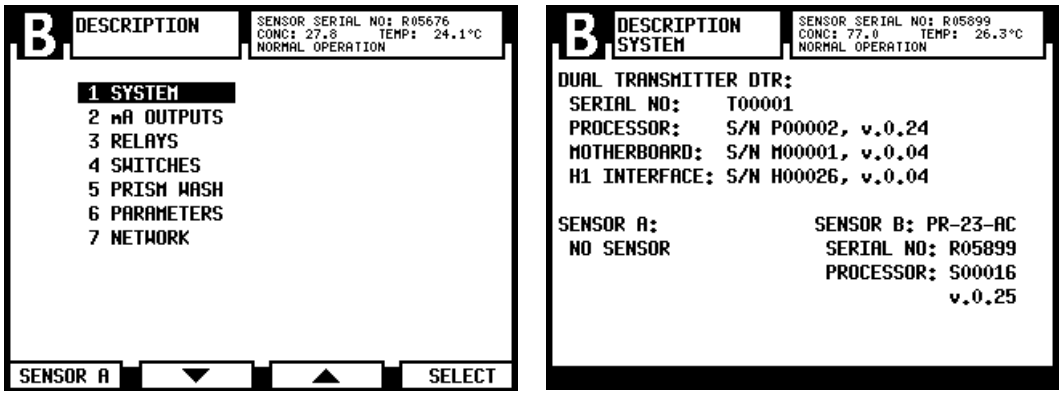


Figure 24 System description

More information

- Ethernet connection specification (page 224)
- Configuring input switches (page 66)

6.4 Viewing sensor status

Go to **Main > SENSOR STATUS**.

6.4.1 Optical image with IDS

Image Detection Stabilization (IDS) compensates for unwanted noise in the image. In the following figure, the vertical dotted line indicates the position of the shadow edge. For empty pipe, the optical image resembles the figure on the left side.

If there is no signal from the sensor, the image field is crossed over.

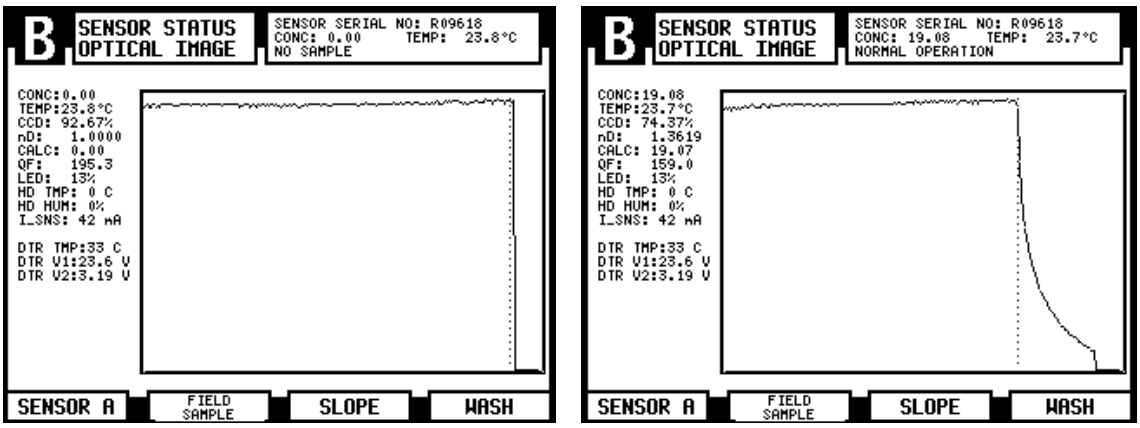


Figure 25 Optical images with IDS

The soft key SLOPE leads to a graph showing the slope (or first differential) of the optical image graph.

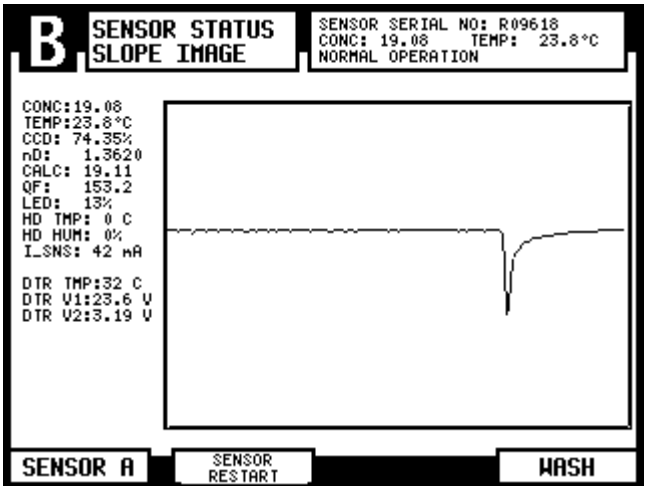
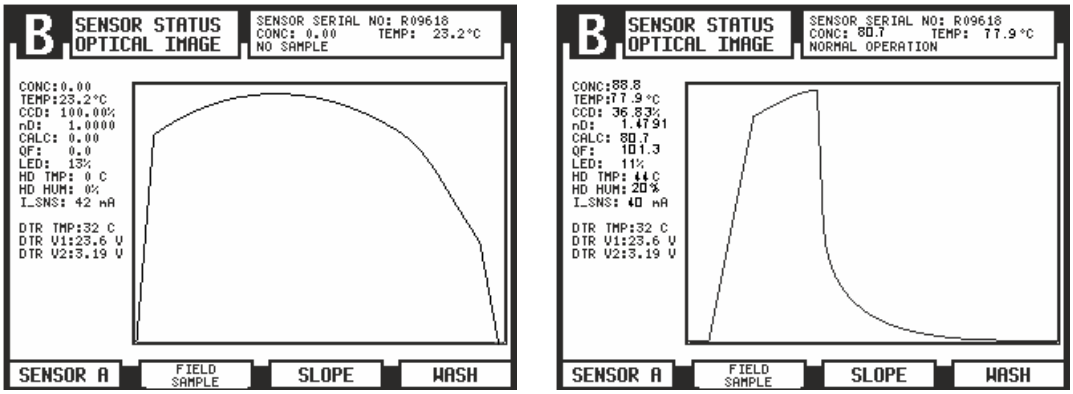


Figure 26 Slope graph with IDS

The "empty" optical image may have a vertical left and/or right edge close to the edge of the image. In the example, only the right edge is visible.

6.4.2 Optical image with VD

Vertical Borderline Image Detection (VD) is 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 27 Optical images with VD

6.4.3 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 36 (page 71).
- TEMP, see Temperature measurement (page 56).
- 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, Field calibration (page 73).
- QF or Quality Factor is a value in the range of 0 to 200. The QF value depends on process medium optical properties. A typical good value is 100, but there are process media where 50 is acceptable. The QF value should stay constant during the process. Falling QF value may indicate prism coating.
- LED is a measure of the amount of light from the light source in %.
- HD TMP is the sensor head temperature, see Temperature measurement (page 56).
- HD HUM is the sensor head humidity, see Sensor head humidity (page 56).
- I_SNS value shows the current to sensor, the nominal value is 40 mA.
- DTR TMP is the indicating transmitter temperature, see Temperature measurement (page 56).
- DTR V1 gives the voltage from the power module, the nominal value is 24 V.
- DTR V2 gives the DC supply voltage, the nominal value is 3.3 V.

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.

6.4.4 Temperature measurement

The system contains 3 different temperature measurements displayed to the left of the optical image graphs:

- TEMP is the process temperature used for automatic temperature compensation in the indicating transmitter.
- HD TMP measures the temperature on the sensor processor card PR-10100.
- DTR TMP measures the temperature on the motherboard of the indicating transmitter.

The sensor head temperature and DTR temperature are monitored by the built-in diagnostics program.

6.4.5 Sensor head humidity

The sensor processor card also contains a humidity sensor. The value **HD HUM** is the relative humidity inside the sensor. It is monitored by the diagnostics program.

6.5 Sensor verification

A company that maintains quality systems 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.

More information

‣ Sensor verification (page 239)

7. Configuration and calibration

All changes of configuration and calibration are made in **Main > CALIBRATION**.

Password

It may be necessary to enter a password before proceeding to the **CALIBRATION** menu. The password is shown in Product overview (page 13). You can activate and deactivate the password function using the **PASSWORD** command in the **CALIBRATION** menu.

By default the password is deactivated.

7.1 Configuring output signal damping

You can apply signal damping in the **OUTPUTS** display to diminish the influence of process noise. Damping is applied to the CONC value (and therefore the output signal) of the selected sensor (see upper edge of the display to check which sensor is selected). If necessary, you can change the sensor in the **CALIBRATION** display.

There are 3 types of signal damping:

- Exponential signal damping
- Linear signal damping
- Slew rate

You can select the type of signal damping in **CALIBRATION > OUTPUTS > Damping type**. The damping time depends on the damping type.

7.1.1 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 **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 s for the DTR to display concentration 55 %. A damping time of 5 ... 15 s works best in most cases, the factory setting is 5 s. Use the **Damping time** menu item to set the damping time.

The following figure shows how exponential damping time affects the measurement.

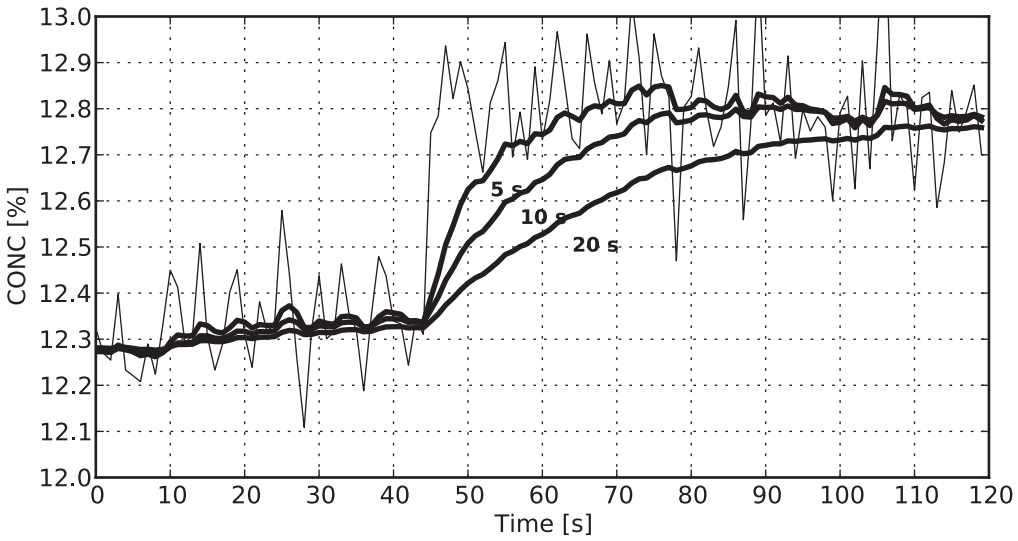


Figure 28 Exponential damping

7.1.2 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 **Damping time** menu item to set the damping time.

For similar noise suppression a longer damping time has to be specified than for the exponential damping.

The following figure shows how linear damping time affects the measurement.

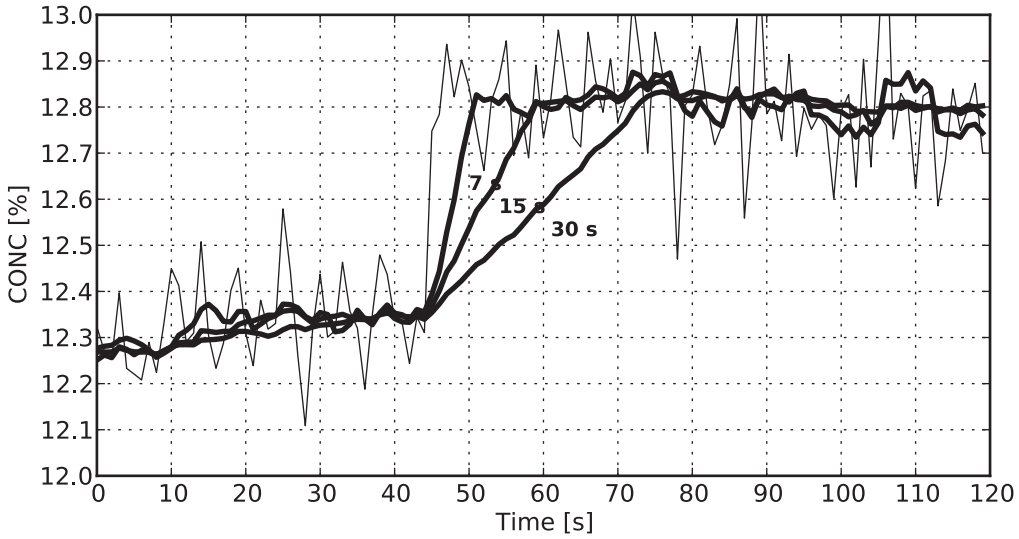


Figure 29 Linear damping

7.1.3 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 1 s. The slew rate limit damping is recommended for random noise suppression as it is non-linear.

You can set the slew rate limit in the menu item **Slew rate**. Typical values depend on the concentration unit but are typically 0.05 % to 1 % when the concentration is measured in %.

The following figure gives an example of different slew rate limits.

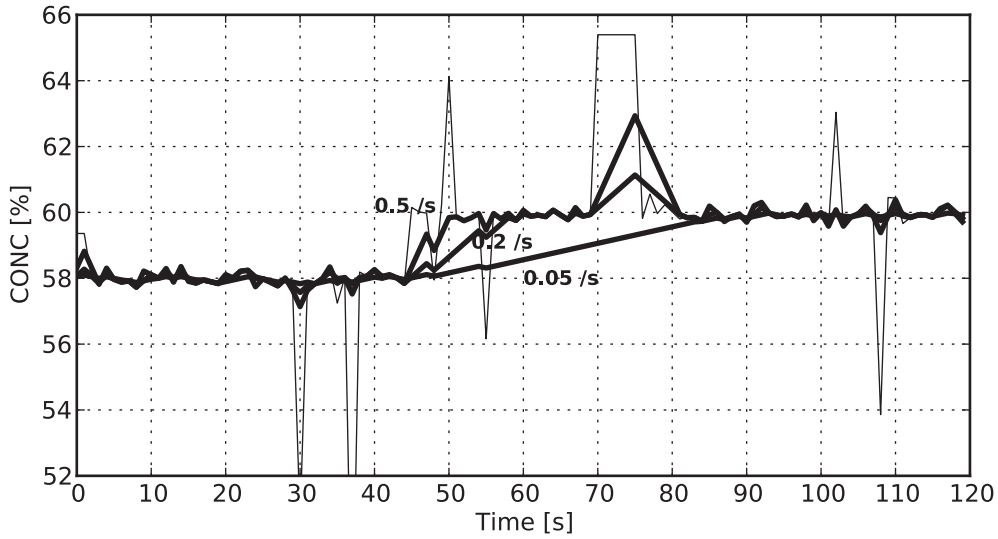


Figure 30 Slew rate damping

Avoid overdamping, the signal should not be made insensitive.

7.2 Configuring output signal hold functionality

The refractometer can be configured to temporarily hold its measurement result in 3 different cases:

1. By using an external hold switch, see Configuring input switches (page 66).
2. During prism wash, see Setting prism wash parameters (page 79).
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 (for example, **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 Calibrating concentration measurement (page 70). 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 (for example, no sample on the prism), there will be no measurement signal during the hold.

7.2.1 External hold

When a switch input is configured for external hold functionality 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. Status message **EXTERNAL HOLD** is displayed.

More information

- Configuring input switches (page 66)
- Hold source interactions (page 62)

7.2.2 Hold during wash

When **HOLD DURING WASH** is set to **ACTIVE**, the output signal is on hold when the instrument is washing. The signal is on hold during all 3 phases (preconditioning, wash, recovery) of the wash process. This setting can be used to avoid dips in the measurement signal during the prism wash.

More information

- Hold source interactions (page 62)
- Setting prism wash parameters (page 79)

7.2.3 Tolerance time

The tolerance time setting can be used in processes with 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, for example, **NO SAMPLE**, **NO OPTICAL IMAGE**, **PRISM COATED**), the measurement is held for the given number of seconds.

For example, a setting of 10 s ensures that any **NO SAMPLE** state which is shorter than 10 s does not make a dip into the output signal. The factory setting is 5 s. To se the tolerance time, go to **CALIBRATION > OUTPUTS > Tolerance time**.

The tolerance time counter is reset always when there is a representative sample on the prism (for example, the n_D can be determined). The following figure shows this behavior with an intermittent measurement signal. When the signal drop is shorter than the tolerance time (for example, 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 is a drop in the output signal (at t = 80 s in the figure).

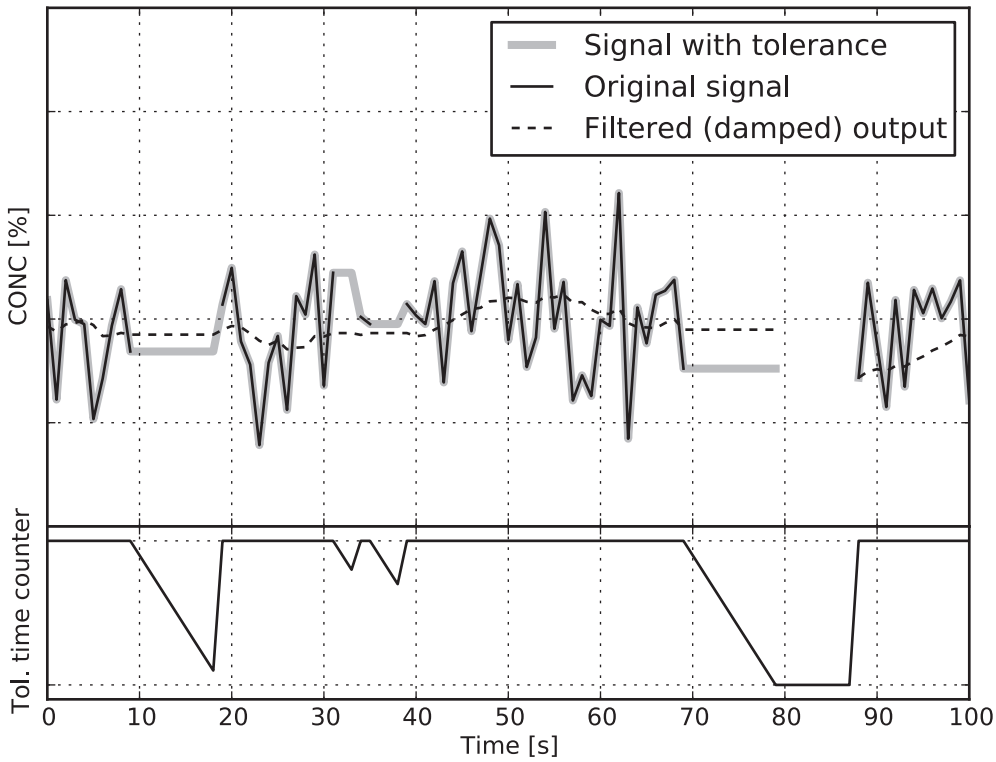


Figure 31 Effect of tolerance time on output

More information

- Hold source interactions (page 62)
- QF threshold (page 62)

7.2.4 QF threshold

QF Threshold can be used to prevent the instrument from measuring when the image quality is below a certain limiting value. When the QF value is lower than the defined value, the image status changes to **NO OPTICAL IMAGE** after the defined tolerance time.

By default the QF threshold value is -500.

More information

- Tolerance time (page 61)

7.2.5 Hold source interactions

There are 3 reasons why the measurement signal may be in hold. All 3 reasons result in the same behavior, but they also interact with each other.

Wash-related hold and external hold are connected in parallel. If at least one of them is active, the measurement result is in hold.

Tolerance time is independent of the wash-related hold and external hold, but the tolerance time is reset whenever there is another reason for the measurement hold. For example, if the tolerance time is set to 10 s, and wash hold becomes active after 7 s, the remaining tolerance time resets to 10 s After the wash is over, 10 s of tolerance time still remain.

More information

- Hold during wash (page 61)
- External hold (page 61)
- Tolerance time (page 61)

7.2.6 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). The following figure shows this behavior (gray areas represent the periods when the hold is active).

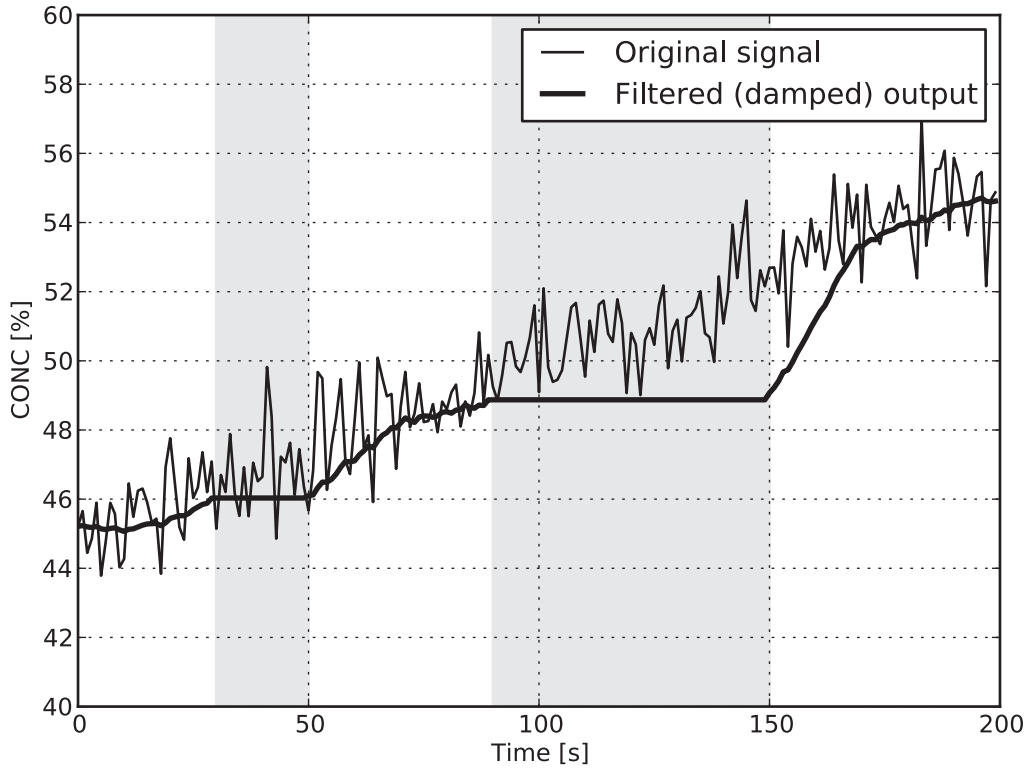


Figure 32 Damping stops during hold

7.2.7 Hold functions with DD-23

The Digital Divert Control System DD-23 uses the displayed concentration value in its decision logic.

CAUTION! Do not use the external hold functionality with a DD-23. It could render the system unsafe by freezing the measurement result.

HOLD DURING WASH must be used with DD-23. Otherwise the signal damping combined with low n_D 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**. However, it slows down the malfunction alarm in 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 s when a DTR is used in a DD-23 system.

7.3 Configuring refractometer system

The indicating transmitter has 2 built-in 4 ... 20 mA outputs (mA OUTPUT 1, mA OUTPUT 2), 2 relay contact outputs (RELAY 1, RELAY 2), and 4 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.

7.3.1 Configuring relays

For the electrical properties of the built-in relays, see Connecting indicating transmitter (page 27). You can configure each of the 2 relays individually to either sensor A or sensor B, meaning 0 to 2 relays can be assigned to a sensor. You can also open and close relays manually, mainly to test them.

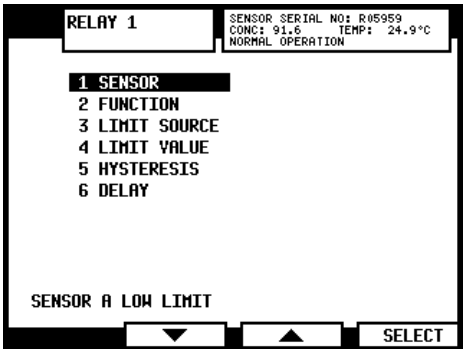


Figure 33 Relay menu for relay 1

1. Select **Main > CALIBRATION > RELAYS**.
2. Select the relay that you want to configure, either **RELAY 1** or **RELAY 2**.
3. To assign the current relay to either sensor A or sensor B, select **SENSOR**.

> The current assignment of the relay is shown at the bottom of the **Relay** menu display. In the figure, relay 1 is assigned to sensor A with function Low limit.

4. To set the relay function, select **FUNCTION**.

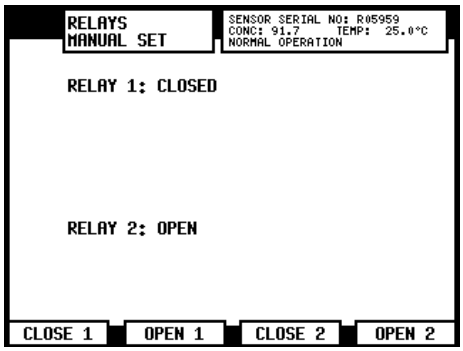
Function name		Description
1	**NOT DEFINED**	Factory setting
2	**NORMAL OPERATION**	Closed contact if diagnostic message is **Normal operation** during **HOLD**, see Configuring input switches (page 66). The contact is also closed when message is **NO SAMPLE**.
3	**INSTRUMENT OK**	Closed contact if there is no equipment malfunction. See also Diagnostic message priorities (page 94).
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 Wash cycle (page 75).
7	**WASH**	See Configuring prism wash (page 75).
8	**PRISM WASH FAILURE**	Closed contact if diagnostic message is **PRISM WASH FAILURE**, see Setting prism wash parameters (page 79).

5. If you choose either low limit or high limit as relay function, you must define a limit source. To set the limit source, select **Relay > LIMIT SOURCE**. Limit source selection:

Function name		Description
1	**NOT DEFINED**	Factory setting
2	**CONCENTRATION**	Measured concentration CONC
3	**PROCESS TEMPERATURE**	Process temperature

6. To set the limit value select **Relay > LIMIT VALUE**, and enter a numeral limit value.

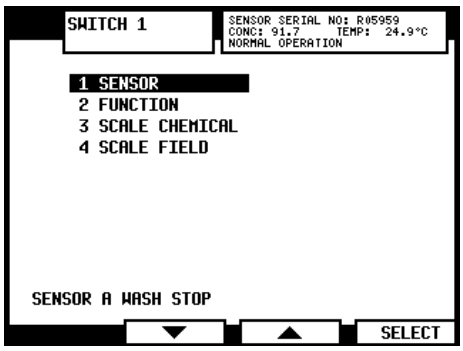
7. To set the hysteresis value select **Relay > HYSTERESIS**. The hysteresis value indicates how soon the relay opens after the process has temporarily gone over the high limit or under the low limit. For example, if high limit is 50 and hysteresis is 2, the relay opens only once the process drops to below 48.
8. To change the relay delay time, select **Relay > DELAY**. The delay is given in seconds, factory setting is 10 s.
9. For **manual set**, go back to the **Select relay** menu and choose **MANUAL SET**.
   In the manual set display you can open and close any relay by pressing the appropriate soft key. The current status of the relay (open or closed) is displayed next to the relay name.



7.3.2 Configuring input switches

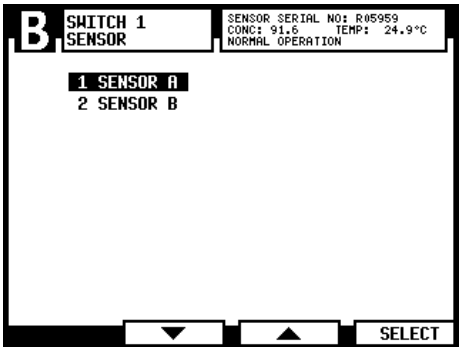
For information on the electrical properties of the 4 input switches, see Connecting the sensor to the indicating transmitter (page 25). To see which switches are closed, check the **DESCRIPTION** menu. To configure the switches, follow the instructions below.

1. Select **Main > CALIBRATION > SWITCHES**.
2. Select switch, 1, 2, 3 or 4, to be configured. The **Switch** menu shows the following options.



3. Select **SENSOR** to assign the chosen switch to a given sensor.

The selection line automatically goes to the currently valid setting. In the following figure, switch 1 has been assigned to sensor A.



4. To set the switch function, select **Switch > FUNCTION**.

> The current assignment of the switch is shown at the bottom of the **Switch** menu display. For example, in the previous figure, switch 1 is assigned to sensor A with function **WASH STOP**.

Function name		Description
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 process stops (as indicated by contact closure). The wash is repeated when the process restarts (if the stop lasts over 60 s). 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** displays 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 are 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.

5. If you chose **SCALE SELECT** as switch function, select **Switch > SCALE CHEMICAL** to enter the parameters for the chemical curve assigned to the switch. For more information on chemical curves and chemical curve parameters, see Chemical curve (page 72).
6. If necessary, the chemical curve assigned to a switch can be adjusted by field calibration parameters. Select **Switch > SCALE FIELD** to enter the parameters. For more information on field calibration and field calibration parameters, see Field calibration (page 73).

More information

- External hold (page 61)
- Viewing system information (page 53)

7.3.3 Configuring mA outputs

For the electrical properties of the 2 output signals, see Connecting indicating transmitter (page 27).

- Go to **Main > CALIBRATION**. Enter a password if necessary. Go to **CALIBRATION > OUTPUTS > mA Outputs**.
- Select the mA output, 1 or 2, to get to the **Output** menu (as shown in the following figure) where the output can be configured.

The line at the bottom of the **Output** menu display indicates the current configuration of the selected mA output, for example, in the following figure the mA Output 1 has been configured to send the concentration reading of Sensor B.

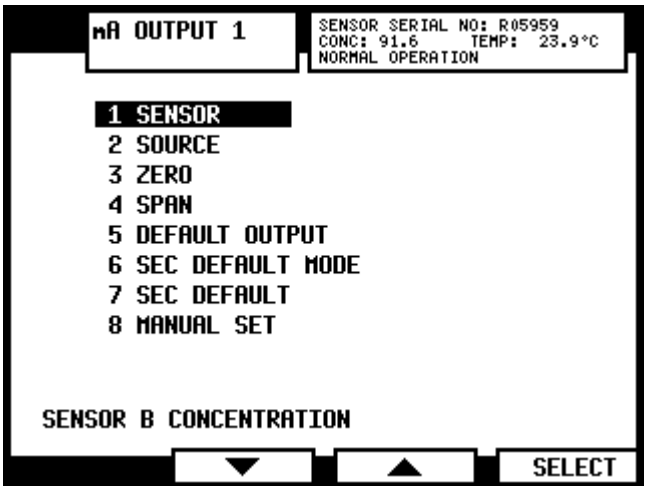


Figure 34 Output menu for mA Output 1

- To change the sensor the selected output is assigned to, select **SENSOR** in the **Output** menu.
- To change output source for the selected output, select **SOURCE**.

Selecting **NOT DEFINED** 'turns off' the selected output.

- The **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 **SPAN** sets the range, which is 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).

- **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, for example, 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 Diagnostic message priorities (page 94).

> 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 ... 20.5 mA signal range for measurement information, with ≥21 mA or ≤3.6 mA to indicate diagnostic failures (see the following figure). 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.

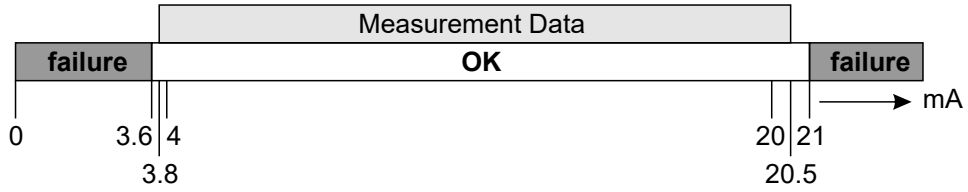


Figure 35 Default mA output values

- **SEC DEFAULT MODE** and **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.
- **MANUAL SET** allows you to set different output values to check the output signal. Press **BACK** to return normal output function.

> If you want to turn off the mA output, select **NOT DEFINED** in the **SOURCE** menu.

7.4 Calibrating concentration measurement

The concentration calibration is organized in 6 layers.

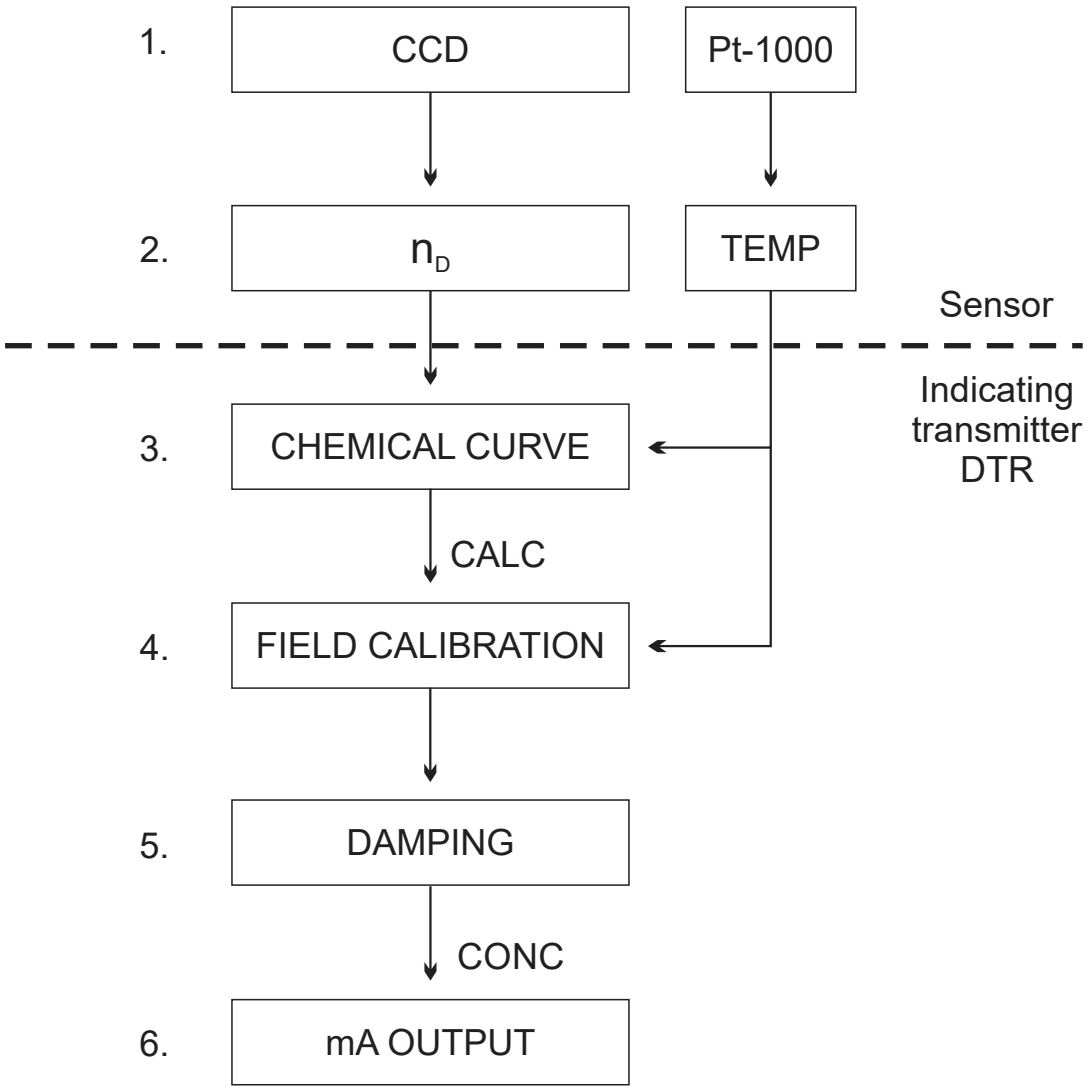


Figure 36 Concentration calibration layers

1 The information from the CCD element and the Pt-1000 temperature element. The position of the shadow edge is described by a number called CCD and scaled 0 ... 100 %. For more information, see Figure 133 (page 251)

2 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 degrees Celsius. The calibrations of all sensors are identical, which makes sensors interchangeable. The calibration of each sensor can be verified using standard refractive index liquids.

3 Chemical curve: The indicating transmitter DTR receives n_D and TEMP and calculates the concentration value according to chemical curves. 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 determines the appropriate adjustment to CALC. The adjusted concentration is called CONC. If there is no adjustment, CALC and CONC are equal. Therefore the chemical curve is kept intact as a firm base for the calculation, the adjustment is merely additional terms. For more information, see Field calibration (page 73).
5 Damping: For more information, see Configuring output signal damping (page 57).
6 Output signal: The range of the 4 ... 20 mA signal is defined by its 2 endpoints on the CONC scale. For more information, see Configuring mA outputs (page 69).

7.4.1 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 7 Chemical curve parameters

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}

A chemical curve is specific to the given process medium, for example, sucrose or sodium hydroxide. The set of parameters is given by Vaisala. Do not alter the chemical curve parameters, except in case of changing to another process medium. You can change the parameters in **Main > CALIBRATION > CHEMICAL & FIELD PARAMETERS > CHEMICAL CURVE PARAMETERS**.

7.4.2 Selecting display units and display decimals

The display units and display decimals are set separately for each sensor.

1. Go to the **CALIBRATION** menu of the correct sensor.
2. Select **OUTPUTS** and choose either **Display units** or **Display decimals**.
   - For the display units, select either **Concentration** or **Temperature** and then the unit.

     Changing the concentration unit does not change the numerical value of the concentration. Changing the temperature unit recalculates the numerical temperature value according to selected scale (°C or °F).

   - For display decimals, enter the number of decimals you want to see on display by entering a number in the range of 0 to 5 (0 meaning no decimals are shown).

7.4.3 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 field calibration form found in Field calibration form (page 253), also available by emailing a request to helpdesk@vaisala.com. Email the completed field calibration form to your local Vaisala representative. Vaisala makes a computer analysis of the data and sends optimal calibration parameters 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 37 (page 74).
- 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, meaning whether it is installed as Sensor A or as Sensor B.

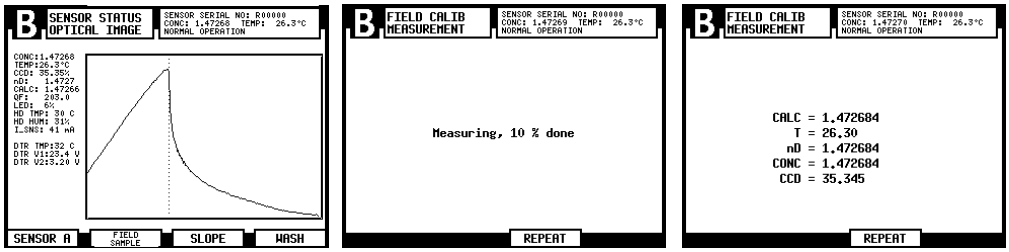
Accurate calibration is only achieved if the sample is taken correctly. Pay special attention to following details:

- 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, 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.



1 Press the FIELD SAMPLE soft key

2 Wait while DTR measures (take sample for lab)

3 Press REPEAT for next data point or BACK to get to the Sensor status display.

Figure 37 Using FIELD SAMPLE soft key

- Use a tight container for the sample to avoid evaporation.

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

Calibration using the process liquid must always be made in-line.

7.4.4 Entering field calibration parameters

To enter the field calibration parameters supplied by Vaisala, go to **Main > CALIBRATION > CHEMICAL & FIELD PARAMETERS > FIELD CALIBRATION PARAMETERS**.

CAUTION! If there is already a previous field calibration, clear it by setting all values to 0 before entering a new field calibration.

7.4.5 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 is added to the concentration value:

NEW CONC = OLD CONC + f00.

7.5 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.

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 Configuring relays (page 64), and the wash time is not zero. An automatic wash function can be configured so that both sensors have different parameters.

More information

- Prism wash systems (page 37)

7.5.1 Wash cycle

The automatic prism wash cycle consists of 3 phases: **precondition**, **wash** and **recovery**. The optional preconditioning function is used to, for example, blow out the condensate before washing. After the preconditioning there is a 1 s 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, see Configuring input switches (page 66), or manually on the **SENSOR STATUS** display, see Testing prism wash (page 49).

The order of priority for these wash triggers is as follows:

1. Manual wash
2. Remote wash request
3. Wash interval timer

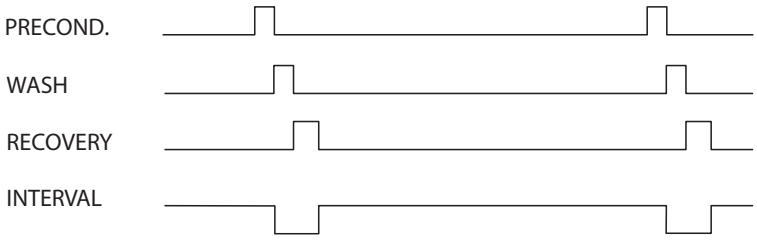


Figure 38 Automatic prism wash cycle

For safety reasons 2 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. 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. The specified wash time is never exceeded. For more information, see Figure 40 (page 78).

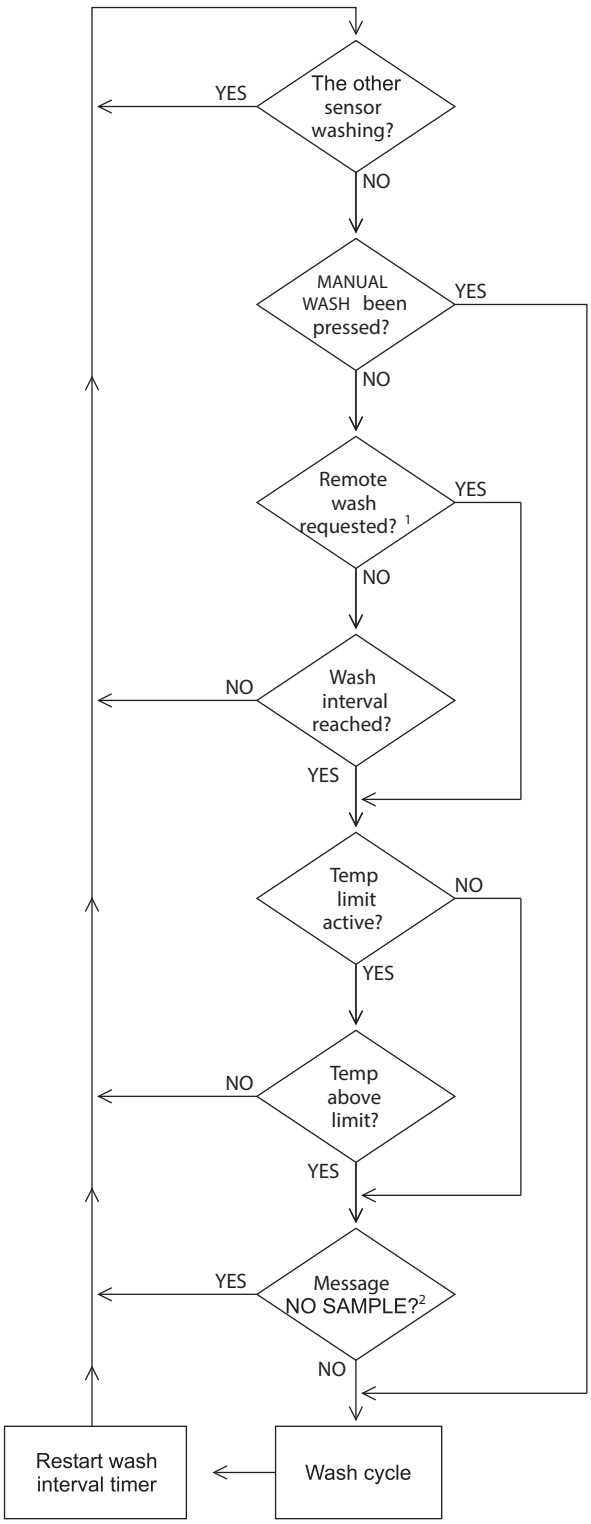
After the wash phase is completed, a recovery time is spent. During the wash cycle (precondition, wash, recovery) the measurement result is in hold unless otherwise specified.

Preventing automatic wash

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

- The diagnostic message **NO SAMPLE** is shown, as it 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, indicating, for example, that there is no process flow. The diagnostic message is **EXTERNAL WASH STOP**. For more information, see Configuring input switches (page 66).
- 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**.

The following figure shows the wash logic as a flow diagram.



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 39 Wash logic

The following figure shows the wash cycle as a flow diagram.

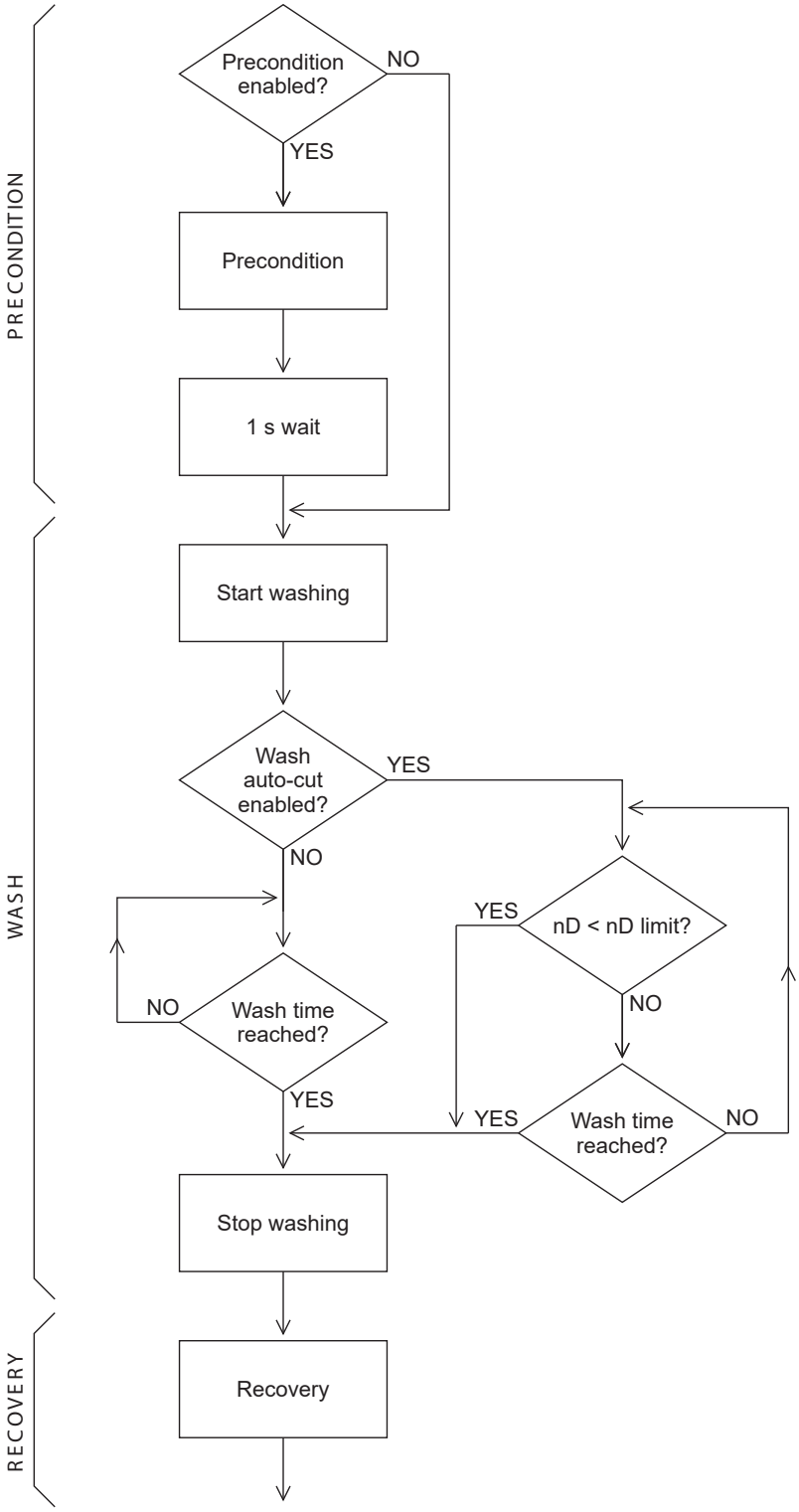


Figure 40 Wash cycle

More information

- Troubleshooting messages (page 89)

7.5.2 Setting prism wash parameters

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

	Parameter	Value
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: 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 0, the wash can be initiated only by using the manual wash or remote wash request. For more information, see Figure 40 (page 78) and Wash cycle (page 75).

If the **PRECONDITION TIME** is 0 (or there is no relay configured for preconditioning), the preconditioning phase is skipped. If the **WASH TIME** is 0 (or there is no relay for wash), the wash functionality is completely disabled.

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 n_D 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** is shown. 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. For more information, see Diagnostic message priorities (page 94).

The **WASH CHECK AUTOMATIC WASH CUT** mode differs from the standard mode by stopping the wash 2 s after the n_D falls below the limit.

To stop the measurement for the duration of the prism wash, choose **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 **TEMP LIMIT ACTIVATION** and then the appropriate command in the menu.

To set a low temperature limit, choose **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, meaning there is no process liquid in the pipe. To deactivate (or active) the empty pipe check, choose **EMPTY PIPE CHECK** and then the appropriate menu command.

To change the wash n_D limit, select **MORE...** and then **WASH nD LIMIT** to set the n_D value to be used with the wash check functionality.

To set wash tolerance time, select **MORE...** and then **WASH TOLERANCE TIME** to set the time during which a wash must 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.

More information

- Recommended wash pressures and times (page 35)
- Hold during wash (page 61)

8. Regular maintenance

The need for regular maintenance is minimal, due to the construction with no moving parts, no mechanical adjustments and 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 must not be too hot to keep a hand on.
- If your refractometer has prism wash, check that it works. For more information, see Testing prism wash (page 49).
- Follow preventive maintenance program, if any.

8.1 Checking sensor humidity level

The PR-23 sensor head has an internal humidity detector. To check the humidity reading, go to **Main > SENSOR STATUS**. **Check the humidity reading once in every 3 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. If the relative humidity exceeds 60 %, the diagnostic message **HIGH SENSOR HUMIDITY** appears, see Troubleshooting messages (page 89). Contact service if internal humidity increases.

8.2 Checking 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.

CAUTION! In 3-A certified sensors, only authorized Vaisala service centers can perform prism gasket replacement and other repairs. If gaskets of 3-A certified sensors are replaced in the field, the certification is no more valid.

9. Troubleshooting

9.1 Hardware

Warning

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.

Varoitus! Vaarallinen jännite – kosketus voi aiheuttaa sähköiskun tai palovammoja. Varo jännitteisiä johtoja H1-liitäntäkortin oikeassa alakulmassa.

Varning! Farlig spänning. Kontakt kan leda till elstöt eller brännskador. Var försiktig med de strömförande kablarna i det nedre högra hörnet på H1-gränssnittskortet.

Advarsel! Farlig spænding, kontakt kan forårsage elektrisk stød eller forbrænding. Vær opmærksom på de strømførende ledninger i nederste højre hjørne af H1-interfacekortet.

Hoiatus! Ohtlik pinge, kokkupuutel võite saada elektrilöögi või põletuse. Ettevaatust voolu all olevate juhtmetega H1-liidesekaardi all paremas nurgas.

Внимание! Опасное напряжение, при контакте можно получить удар электрическим током или ожог. Остерегайтесь проводов под напряжением в правом нижнем углу интерфейсной платы H1.

Įspėjimas! Pavojinga įtampa, kontaktas gali sukelti elektros smūgį arba užsidegimą. Saugokitės įtampos laidų, esančių apatiniame dešiniajame H1 sąsajos kortelės kampe.

Ostrzeżenie! Niebezpieczne napięcie, dotknięcie grozi porażeniem prądem lub oparzeniem. Uważać na przewody pod napięciem w prawym dolnym rogu karty interfejsu H1.

Varování! Nebezpečné napětí, kontakt může způsobit úraz elektrickým proudem nebo popálení. Dejte si pozor na vodiče pod napětím v pravém dolním rohu karty rozhraní H1.

Figyelmeztetés! Veszélyes feszültség, érintése áramütést vagy égési sérülést okozhat. Óvakodjon a feszültség alatt lévő vezetékektől a H1 interfészkártya jobb alsó sarkában.

Warnung! Gefährliche Spannung, Kontakt kann Stromschlag oder Verbrennungen verursachen. Halten Sie sich von den stromführenden Kabeln unten rechts an der H1 Schnittstellenkarte fern.

Waarschuwing! Gevaarlijke spanning, contact kan elektrische schokken of brandwonden veroorzaken. Pas op voor de spanningvoerende draden in de rechterbenedenhoek van de H1-interfacekaart.

Avertissement! Tension dangereuse, un contact peut provoquer un choc électrique ou des brûlures. Prenez garde aux fils sous tension dans le coin inférieur droit de la carte d'interface H1.

¡Advertencia! El contacto con voltaje peligroso puede causar descargas eléctricas o quemaduras. Tenga cuidado con los cables activos en la esquina inferior derecha de la tarjeta de interfaz H1.

Avvertimento! Tensione pericolosa, il contatto può causare scosse elettriche o ustioni. Attenzione ai fili sotto tensione nell'angolo inferiore destro della scheda di interfaccia H1.

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.

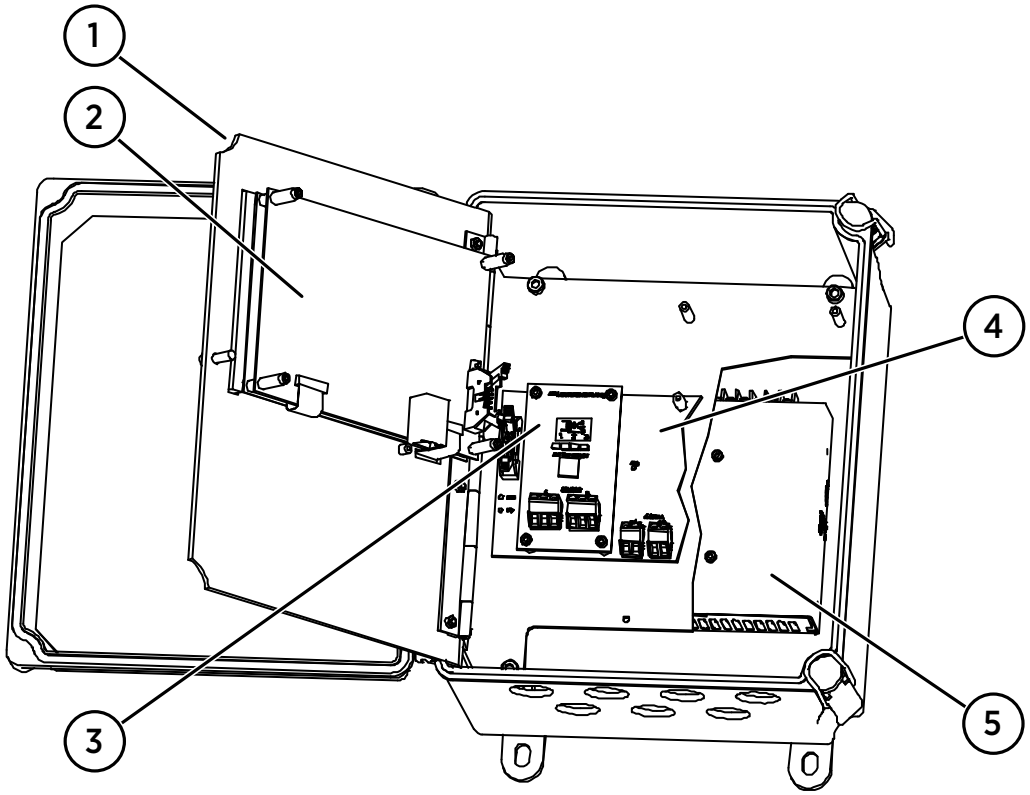


Figure 41 Transmitter card positions

1 Power indicator light
2 Transmitter processor card PR-10500
3 H1 interface card PR-10701
4 Transmitter motherboard PR-10600
5 Power module

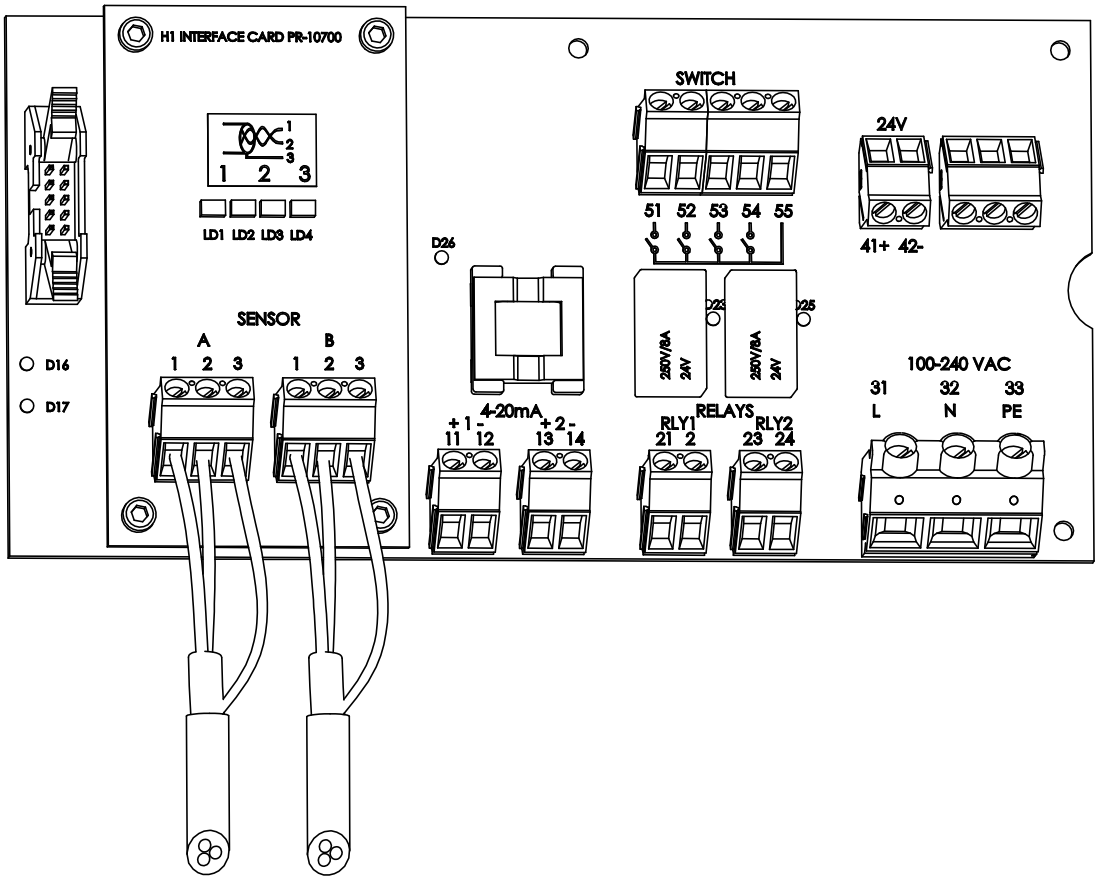


Figure 42 Motherboard PR-10600 and H1 interface card PR-10701

9.1.1 Blank display

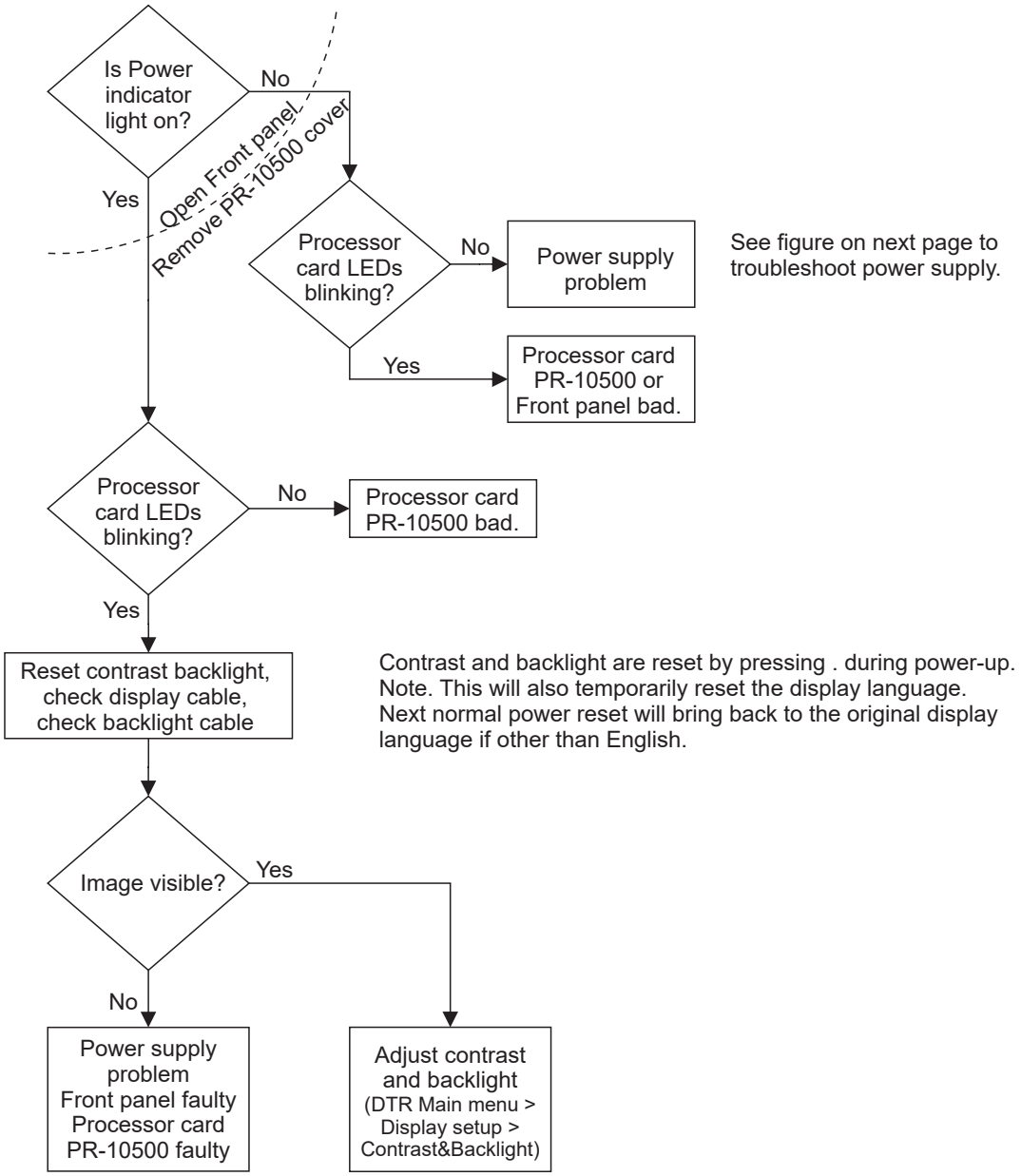


Figure 43 Troubleshooting blank display

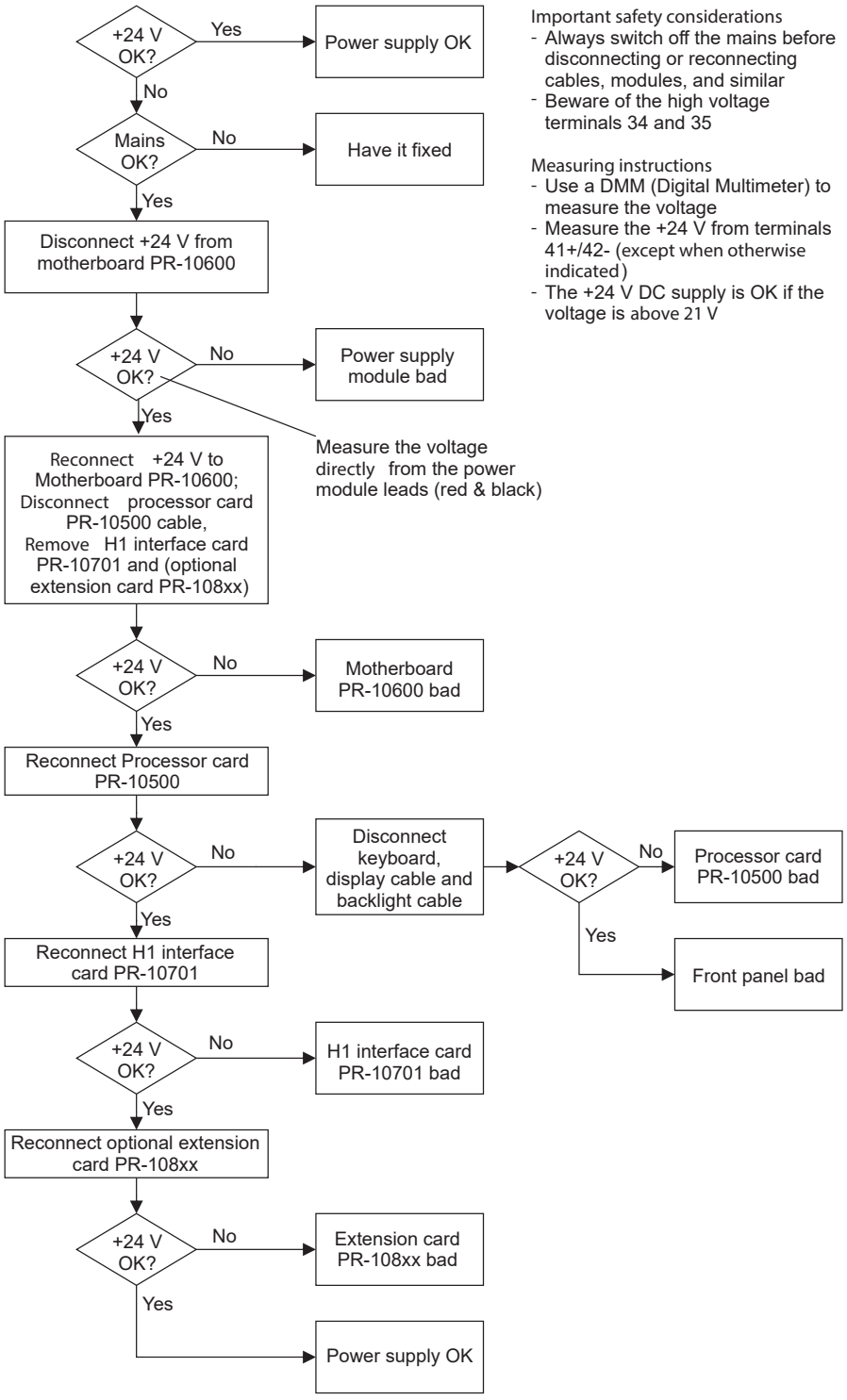


Figure 44 Checking power supply

9.1.2 Diagnostic LEDs

Figure 41 (page 83) and Figure 42 (page 84) assist in locating the diagnostic LEDs.

Table 8 Diagnostic LEDs

LED	Status	Indication	See section
Front panel			
Green LED	Lit	DTR power is on; processor card PR-10500 is active.	Blank display (page 85)
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 24 V / 3 V.	
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.	Troubleshooting messages (page 89)
Red LED (LD2)	Lit	Sensor A current is too high and power supply to Sensor A has been switched off.	Troubleshooting messages (page 89)
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.	Troubleshooting messages (page 89)
Red LED (LD4)	Lit	Sensor B current is too high and power supply to Sensor B has been switched off.	Troubleshooting messages (page 89)

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.

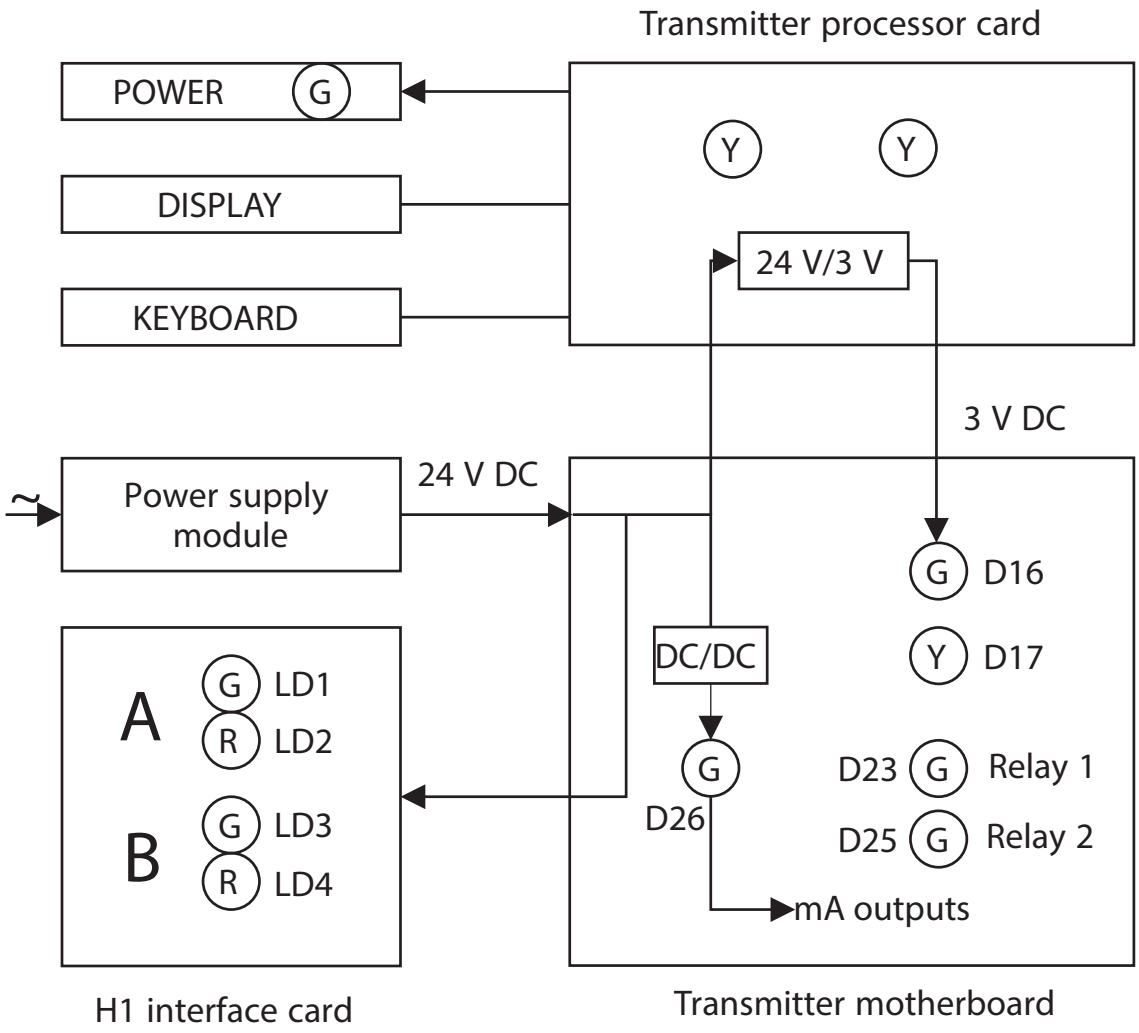


Figure 45 Diagnostic LED functions

9.1.3 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 temporarily restores the display backlight and contrast to their factory settings and returns the display language to English.

For the display reset, access the DTR keyboard directly. Then perform the following steps.

1. Switch off the DTR power.
2. Press and hold the decimal point key on the keyboard.
3. Switch on the DTR power.

4. Hold down the decimal point key until the DTR has started completely and you see the main display.

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

9.1.4 Troubleshooting messages

Table 9 Hardware troubleshooting

Problem	Cause	Corrective action
Message **NO SENSOR**	The current in the cable to this sensor is below 20 mA. Normally this means that there is no sensor connected to the cable or that there is 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, Diagnostic LEDs (page 86). The concentration display is a dashed line.	
Message **NO SIGNAL** Besides the message, the concentration display is a dashed line although a sensor is connected.	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, Diagnostic LEDs (page 86).	Replace the sensor processor card.

<table>
<tr><th>Problem</th><th>Cause</th><th>Corrective action</th></tr>
<tr><td>Message SHORT-CIRCUIT
The current in the cable to the sensor A/B exceeds 60 mA. First, the DTR attempts fora 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, Diagnostic LEDs (page 86)
 
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 stays on the screen until the DTR is powered off and on.
See also Diagnostic LED LD2/LD4, Diagnostic LEDs (page 86)</td><td colspan="2">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.</td></tr>
<tr><td>Message HIGH SENSOR HUMIDITY</td><td colspan="2">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.</td></tr>
<tr><td>Message HIGH SENSOR TEMP</td><td>The temperature on the sensor processor card exceeds +65 °C (+150 °F). To read this temperature, go to Main > SENSOR STATUS.</td><td>For action, see Choosing sensor mounting location (page 19).</td></tr>
</table>

Problem	Cause	Corrective action
Message **HIGH TRANSMITTER TEMP**	The temperature of the motherboard of the indicating transmitter exceeds +60 °C (+140 °F). To read this temperature, go to **Main > SENSOR STATUS** and check DTR TMP. If the warning persists, move the transmitter to a cooler place (for example out of the sun).	
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 41 (page 83).
Relays and switches not working	Check configuration, see Viewing system information (page 53), and for possible correction see Configuring input switches (page 66), Configuring relays (page 64), and Configuring prism wash (page 75). Relay status is indicated by LEDs D23, D25 on the Motherboard, see Diagnostic LEDs (page 86). For switches, check also LED D26 on the Motherboard indicating that the 3 V DC supply is correct, see Diagnostic LEDs (page 86). The wash function can be tested according to Testing prism wash (page 49).	
Output signal error during **Normal operation**	If there is no output signal: • Check wiring, see Connecting the sensor to the indicating transmitter (page 25). • Check Diagnostic LED D26, see Diagnostic LEDs (page 86). If the mA signal does not correspond to the concentration display, check output signal configuration, see Viewing system information (page 53), and for possible correction see Configuring mA outputs (page 69). A low mA signal can also be caused by high resistance in the external current loop, see Connecting the sensor to the indicating transmitter (page 25). A noisy signal can be damped, see Configuring output signal damping (page 57).	

Table 10 Measurement troubleshooting

Problem	Cause	Corrective action
Message **OUTSIDE LIGHT ERROR**	The measurement is not possible because too much outside light reaches the camera.	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.

<table>
<tr><th>Problem</th><th>Cause</th><th>Corrective action</th></tr>
<tr><td>Message NO OPTICAL IMAGE</td><td colspan="2">To see the optical image, go to Main > SENSOR STATUS. For more information, see Optical image with IDS (page 53) and Optical image with VD (page 55). There are several possible causes:
The prism is heavily coated, see Prism coating (page 35). Perform prism wash if available, see Testing prism wash (page 49). Remove sensor from line and clean prism manually.
There is moisture condensation in the sensor head.
The sensor head temperature is too high.
The light source is faulty. When the sensor is removed from the process, the yellow flashing light can be seen through the prism.

The light is only visible at an oblique angle. Also check the LED value in the Sensor status display (go to Main > SENSOR STATUS); if the value is clearly below 100, LED fault is not likely.
There are negative spikes in the optical image. The probable cause is dust or fingerprints on the CCD window.
The CCD card in the sensor is faulty.</td></tr>
<tr><td>Message PRISM COATED</td><td>The optical surface of the prism is coated by the process medium or impurities in the process medium.</td><td>Perform prism wash if available, see Testing prism wash (page 49). Remove sensor from line and clean prism manually.

If the problem is recurrent, consider improving the flow conditions, see Mounting sensor (page 19). If prism wash is available, adjust the wash parameters, see Configuring prism wash (page 75).</td></tr>
<tr><td>Message OUTSIDE LIGHT TO PRISM</td><td>Some light from the outside reaches the sensor and may disturb the measurement.</td><td>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.</td></tr>
<tr><td>Message LOW IMAGE QUALITY</td><td>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.</td><td>Clean the prism.</td></tr>
<tr><td>Message NO SAMPLE</td><td colspan="2">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 25 (page 54).</td></tr>
</table>

Problem	Cause	Corrective action
Message **TEMP MEASUREMENT FAULT**	Indicates faulty temperature element.	Replace the temperature element. A difference to some other process temperature measurement is not a fault. PR-23 measures the true temperature of the prism surface.
Concentration drift during **Normal operation**	For drift upward, suspect prism coating, see Prism coating (page 35). Otherwise check calibration, see Calibrating concentration measurement (page 70), and sensor verification, see Sensor verification (page 239).	

Table 11 Wash troubleshooting

Problem	Cause	Corrective action
Message **EXTERNAL HOLD**	The concentration measurement is on HOLD due to an external switch closure. For explanation, see Configuring input switches (page 66).	
Messages **PRECONDITIONING**, **WASH**, **RECOVERING**	**PRECONDITIONING**: An optional preconditioning relay is closed.	See Configuring prism wash (page 75).
	WASH: The internal wash relay is closed.	Configuring prism wash (page 75).
	RECOVERING: The concentration measurement is on HOLD during a preset time.	
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, see Configuring prism wash (page 75). See also Testing prism wash (page 49).	
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 Setting prism wash parameters (page 79). See also Testing prism wash (page 49).	
Message **EXTERNAL WASH STOP**	Tells that wash action is prevented because an **EXTERNAL WASH STOP** switch is closed, see Configuring input switches (page 66). • **NO SAMPLE** indicates an empty pipe.	
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 Configuring prism wash (page 75).
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.	

More information

- Wash cycle (page 75)

9.1.5 Diagnostic message priorities

The messages are listed in descending order of priority. For example, if both **NO OPTICAL IMAGE** and **TEMP MEASUREMENT FAULT** are activated, only **NO OPTICAL IMAGE** displays.

When a relay is configured with **FUNCTION INSTRUMENT OK**, see Configuring relays (page 64), it is closed when there is no equipment malfunction.

Certain malfunctions cause the mA measurement to return to the mA default output value, see Configuring mA outputs (page 69). For more information, see the following table.

Message	Instrument OK	Returns to default mA	
		Conc	Temp
SHORT-CIRCUIT		X	X
NO SIGNAL		X	X
OUTSIDE LIGHT ERROR			
NO OPTICAL IMAGE		X	
TEMP MEASUREMENT FAULT		X	X
PRECONDITIONING	X		
WASH	X		
RECOVERING	X		
HIGH SENSOR HUMIDITY			
HIGH SENSOR TEMP			
HIGH TRANSMITTER TEMP			
LOW TRANSMITTER VOLT			
EXTERNAL WASH STOP	X		
LOW TEMP WASH STOP	X		
NO SAMPLE / WASH STOP	X		
EXTERNAL HOLD	X		
NO SAMPLE	X	X	
PRISM COATED	X	X	
OUTSIDE LIGHT TO PRISM	X		
LOW IMAGE QUALITY	X		

Message	Instrument OK	Returns to default mA	
		Conc	Temp
PRISM WASH FAILURE	X		
PRISM WASH WARNING	X		
NO SENSOR		X	X
NORMAL OPERATION	X		

10. Sensor specifications

For the specifications of the PR-23-SD sensor for Safe-Drive system, see PR-23-SD specifications (page 167) and Indicating transmitter parts list (page 222).

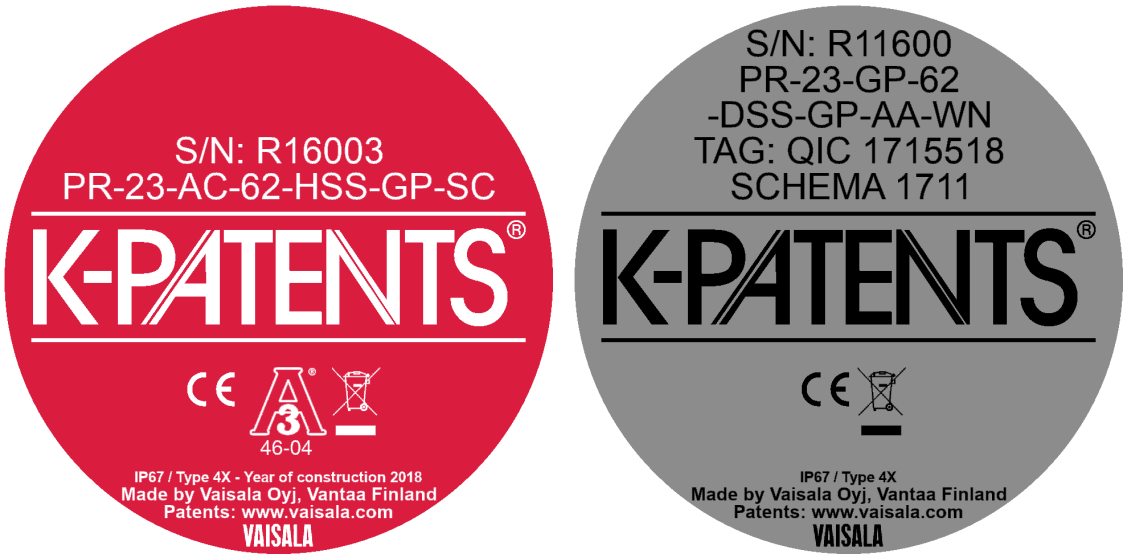


Figure 46 Sensor nameplates

10.1 Sensor compatibility

Electrically: All PR-23 sensors are interchangeable. The PR-23 sensors are **not** interchangeable with the PR-01 and PR-03 range sensors. 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 2.5 in sanitary process connection as the sanitary refractometer PR-03-A62-HSS.

10.2 Sensor rangeability

The standard refractive index range of a PR-23 sensor is 1.320 ... 1.530 (corresponds to 0 ... 100 Brix), shown in the following figure.

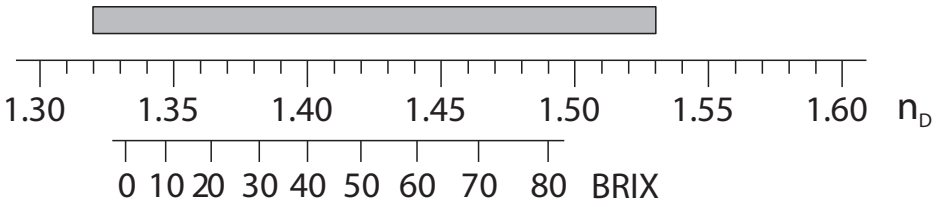


Figure 47 PR-23 rangeability

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 ... 1.4700, shown in the following figure.

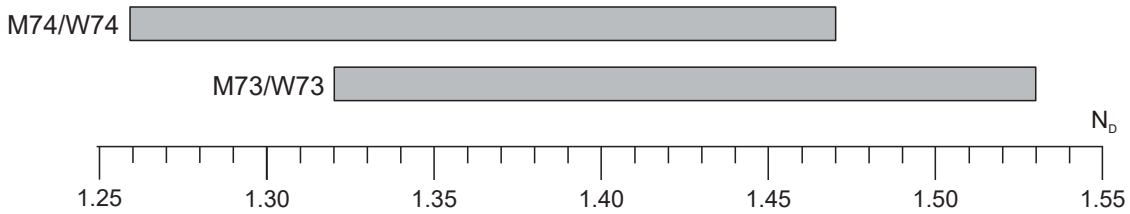


Figure 48 PR-23-M/MS/W rangeability with a sapphire prism (74) and with a standard prism (73)

10.3 Sanitary process refractometer PR-23-AC

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

10.3.1 PR-23-AC sensor model code

Table 12 Sanitary compact refractometer for pipelines

Model	Description
PR-23	Sensor
Sensor model	
-A	3-A Sanitary Standard 46-04 certified
Sensor type	

Model	Description
C	Compact type for pipeline installations
Refractive index range limits	
-62	R.I. 1.320–1.530 n_D (0 ... 100 Brix) spinel prism
-73	R.I. 1.320–1.530 n_D (0 ... 100 Brix) sapphire prism
-74	R.I. 1.260–1.470 n_D sapphire prism
Process connection	
-H	Sanitary clamp, 2.5 in, insertion length 14 mm 1)
-E	Varinline® in-line access unit clamp 2 in (DN 50/40)
-N	Sanitary clamp, 2.5 in, insertion length 14 mm, high pressure, 40 bar at +20 °C (+68 °F)
Sensor wetted parts material	
-SS	AISI 316 L
-HC	Alloy C276 2)
Electrical classification	
-GP	General purpose
-AX	ATEX and IECEx certified Ex II 3G, Ex ec IIC T4 Gc (up to zone 2). T_{amb} −20 ... +65 °C (−4 ... +149 °F)
-FM	FM certified Class I, Div.2, Groups A, B, C, D, T6 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-CS	CSA certified Class I, Div.2, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-IA	ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0), T_{amb} −20 ... +65 °C (−4 ... +149 °F) 3)
-IF	FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F) 3)
-CX	NEPSI Certified for use in Ex nA IIC T4 Gc
-CI	NEPSI Certified for use in Ex ia IIC T4 Ga
Sensor housing	
-AA	Anodized Aluminum
-SC	Stainless steel AISI 316
EHEDG option	
-EH	EHEDG Type EL Class I Certified Model 4)

Model	Description
Polishing option	
-EP	Electropolished sensor wetted parts (RA 0.38 µm, 15 µin) 1)

1) *For AISI 316 L / EN 1.4335 only.*
2) *Includes gasket Teflon 2.5 in and Ferrule in Alloy C.*
3) *Available with STR Indicating Transmitter and IS isolator only.*
4) *For -H, -E, -N options.*

10.3.2 PR-23-AC mounting hardware model code

Table 13 Elbow flow cells for PR-23-AC-xx-HSS sensor

Model	Description
AFC	Elbow flow cell
Sensor connection	
-H	Sanitary clamp, 2.5 in
Material of construction	
SS	AISI 316 L
Process connection	
-H	Sanitary clamp
Pipe section diameter	
10	25 mm (1 in)
15	40 mm (1.5 in)
20	50 mm (2 in)
25	65 mm (2.5 in) 1)
30	80 mm (3 in) 1)
40	100 mm (4 in) 1)
Flow cell inlet type	
-SI	Straight pipe
-RI	Reduced pipe (cone)
Polishing option	
-EP	Electropolished process wetted parts (RA 0.38 µm, 15 µin)

1) *With -SI option only.*

Table 14 EHEDG certified elbow flow cells, connection sanitary clamp 2.5 in

Model	Description
AFC	Elbow flow cell
Sensor connection	
-H	Sanitary clamp, 2.5 in
Material of construction	
SS	AISI 316 L
Process connection	
-H	Sanitary clamp
Pipe section diameter	
20	50 mm (2 in)
Flow cell inlet type	
-SI	Straight pipe
EHEDG	
-EH	EHEDG Type EL Class I Certified Model

Table 15 Elbow flow cells with prism wash nozzle for PR-23-AC-xx-HSS

Model	Description
AFC	Elbow flow cell
Sensor connection	
-H	Sanitary clamp, 2.5 in
Material of construction	
SS	AISI 316 L
Process connection	
-H	Sanitary clamp
Pipe section diameter	
10	25 mm (1 in)
15	40 mm (1.5 in)
20	50 mm (2 in)
25	65 mm (2.5 in) 1)
30	80 mm (3 in) 1)

Model	Description
40	100 mm (4 in) 1)
Flow cell inlet type	
-SI	Straight pipe
-RI	Reduced pipe (cone)
Wash nozzle connection	
-NC	Nozzle connection
Wash nozzles	
-SN	Steam nozzle, G¼ thread female
-WN	Water nozzle, G¼ thread female
-WP	Pressurized water nozzle, G¼ thread female
-PG	Plug for nozzle connection

1) With -SI option only.

Table 16 Mounting hardware for PR-23-AC-xx-HSS sensor

Model	Description
MFC	Mini flow cell
Sensor connection	
-H	Sanitary clamp, 2.5 in
Material of construction	
SS	AISI 316 L
Process connection	
-H	Sanitary clamp
Pipe section diameter	
05	15 mm (0.5 in)

Table 17 Mounting hardware for PR-23-AC-xx-ESS sensor

Model	Description
TDN	Varinline® in-line access unit clamp DN65 Type N 1)
Pipe section diameter	
-40	40 mm (1.5 in)
-50	50 mm (2 in)

Model	Description
-65	65 mm (2.5 in)
-80	80 mm (3 in)
-100	100 mm (4 in)
-125	125 mm (5 in)
-150	150 mm (6 in)
Counter flange options	
-SN	Steam nozzle, G¼ thread female
-WP	Pressurized water nozzle, G¼ thread female
-WN	Water nozzle, G¼ thread female
-PG	Varivent blind flange type N

1) *Includes one 1.5 in type N blind flange with 2.5 in EPDM gasket and 2.5 in Varivent clamp Type N*

Table 18 Side flow cells, connection sanitary clamp 2.5 in

Model	Description
SFC	Side flow cell 1)
Sensor connection	
-H	Sanitary clamp, 2.5 in
Material of construction	
SS	AISI 316 L
Process connection	
-H	Sanitary clamp
Pipe section diameter	
10	25 mm (1 in)
15	40 mm (1.5 in)
20	50 mm (2 in)
25	65 mm (2.5 in)
Flow cell inlet and outlet orientation	
-90	Elbow, 90° bend
-180	Straight pipe, 180°

1) *Includes one 2.5 in EPDM gasket and 2.5 in sanitary clamp.*

10.3.3 PR-23-AC specifications

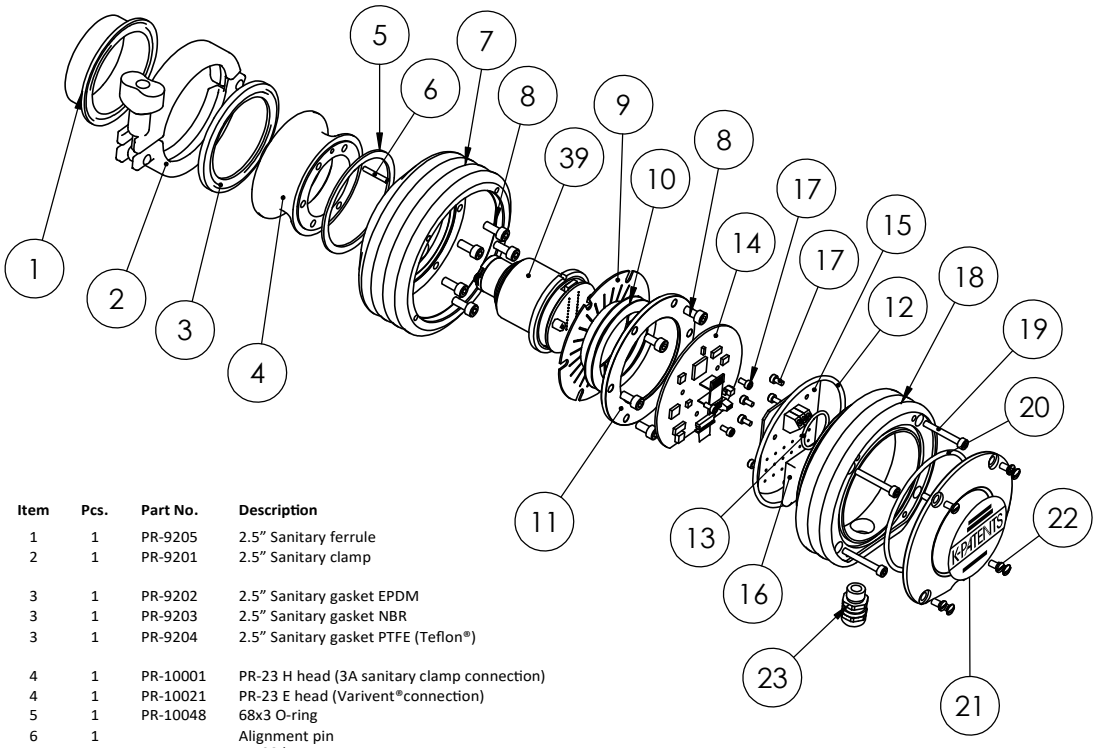
Table 19 General specifications

Feature	Specification
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
Digital measurement	3648 pixel CCD element
Light source	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	−20 °C ... +45 °C (−4 °F ... +113 °F)

Table 20 Sensor PR-23-AC specifications

Feature	Specification
Sensor PR-23-AC	Compact sensor model for small pipelines
Process connection	Sanitary clamp 2.5 in; Varinline® in-line access unit clamp DN65 or using elbow flow cell (for line sizes of 2.5 in and smaller)
Sanitary design	3-A Sanitary Standard 46-04 approved and EHEDG (European Hygienic Engineering & Design Group) certified (connections -H, -E)
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 316 L stainless steel, spinel prism, prism gaskets MTF (Modified Teflon)
Sensor protection class	IP67, Nema 4X
Protection class	Protection class 3
Sensor weight	2.0 kg (4.4 lbs)

10.3.4 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

Figure 49 PR-23-AC parts list

10.3.5 PR-23-AC mounting specifications

The sanitary process refractometer PR-23-AC is connected to the process by a 2.5 in sanitary clamp. The recommended mounting is in a pipe bend, with a vertical flow upwards before the sensor, and a horizontal pipe after. This mounting enables the following:

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 in or above, a ferrule is welded directly to the pipe wall (a ferrule, length 21.5 mm, is delivered with standard sensor delivery from Vaisala).

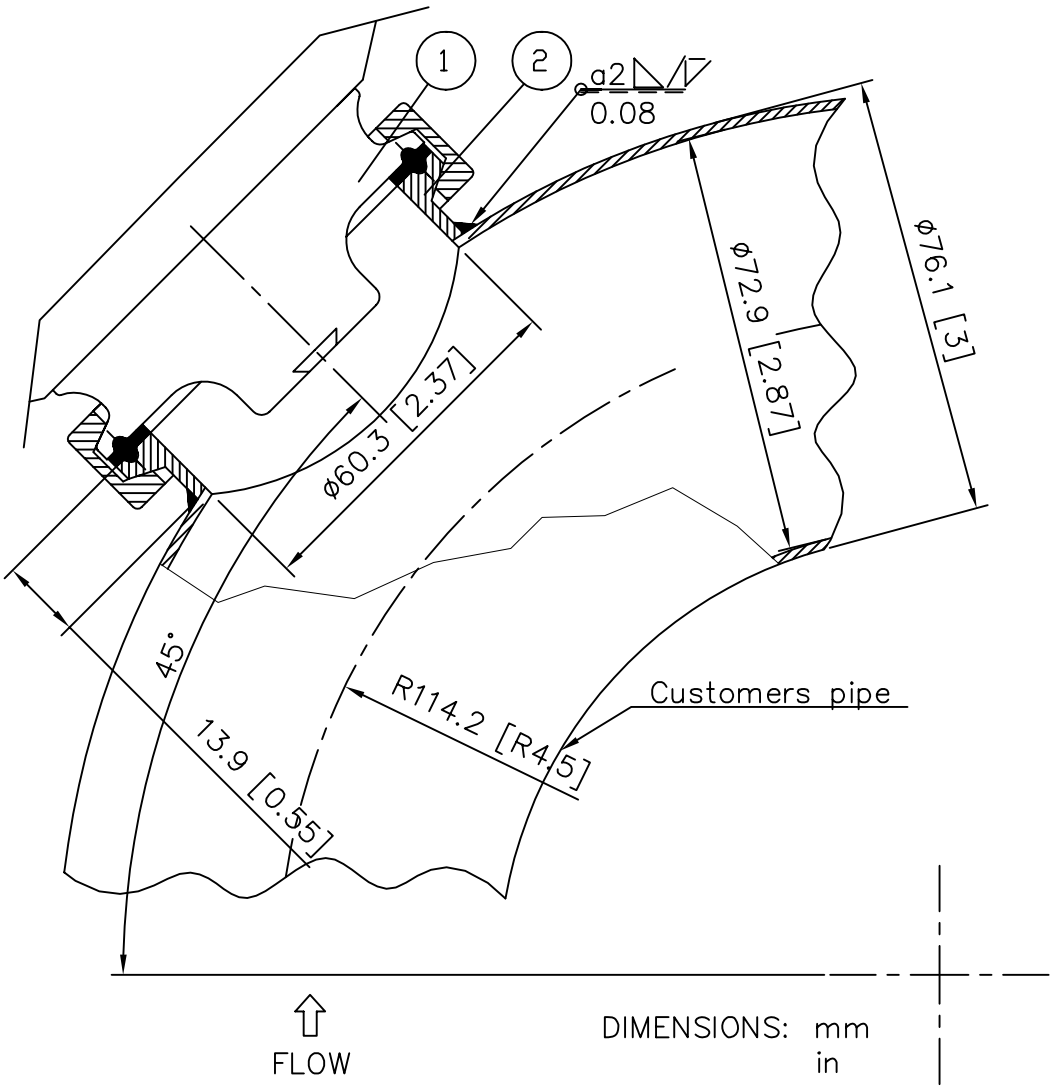
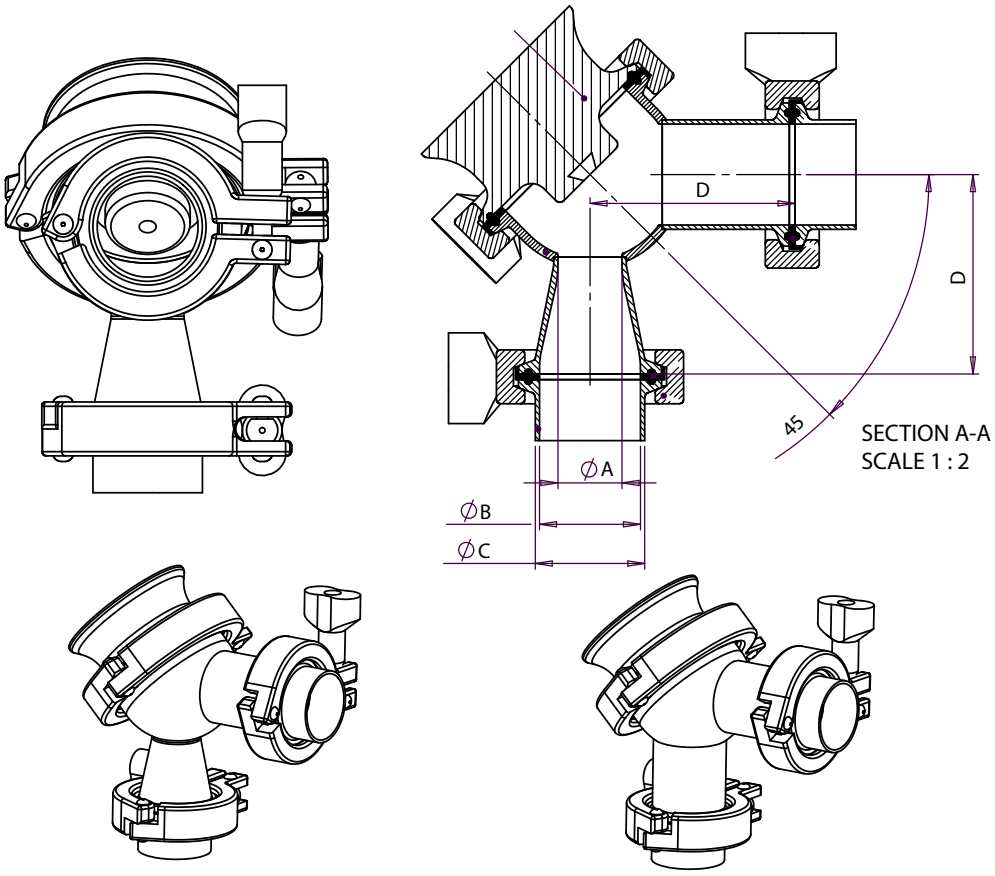


Figure 50 Mounting with sanitary ferrule pipe diameter 3 in (80 mm) or more

For smaller pipe diameters, flow cells are available from Vaisala, see Figure 51 (page 106), Figure 52 (page 107), Figure 53 (page 108) and Figure 54 (page 109), see also the tables in PR-23-AC mounting hardware model code (page 99).

The flow cells are exchangeable with standard 90° bend pieces.



AFC-HSS-H15-RI AFC-HSS-H10/H15-SI

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 51 Flow cell AFC-HSS- H10 for pipe diameter 1 in (25 mm) and H15 for pipe diameter 1.5 in (40 mm)

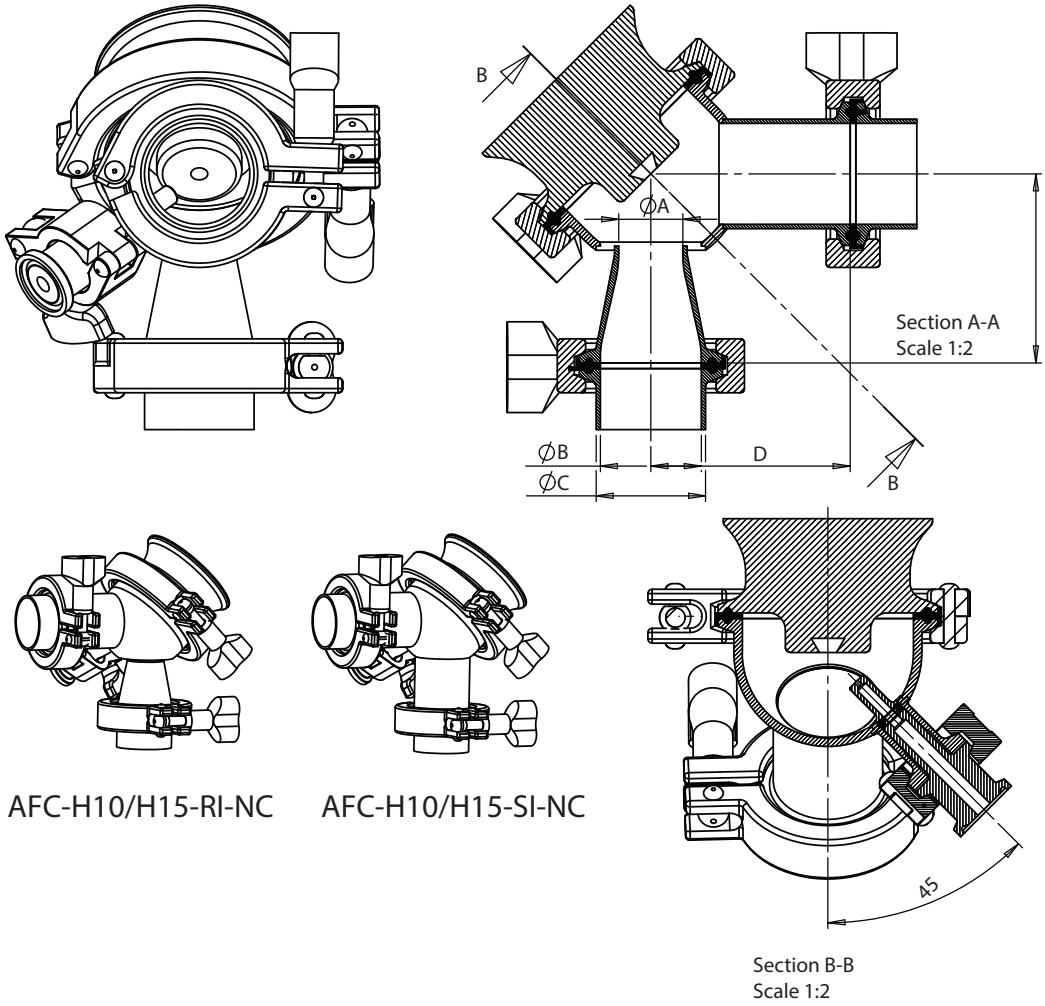
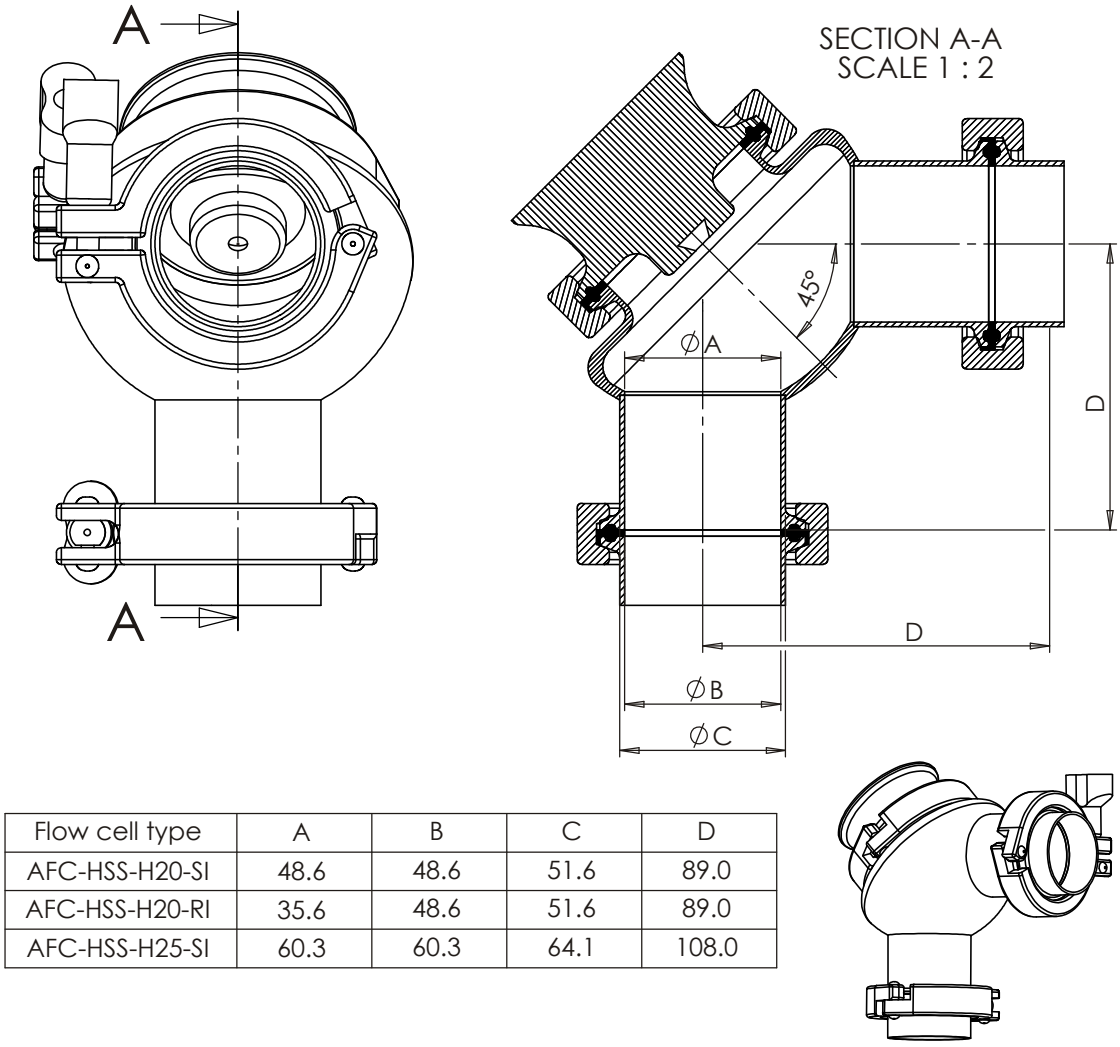


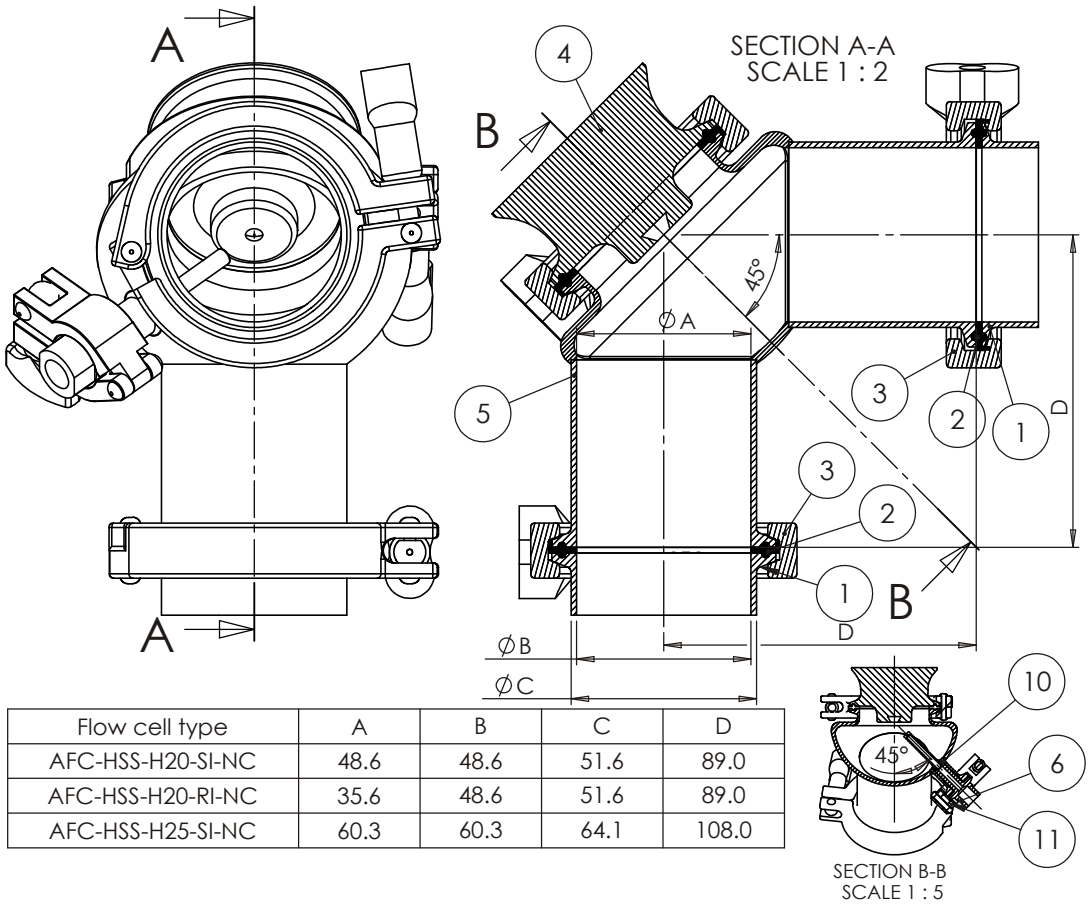
Figure 52 Flow cell AFC-HSS- with wash nozzle connection (-NC) H10 for pipe diameter 1 in (25 mm) and H15 for pipe diameter 1.5 in (40 mm)

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



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 53 Flow cell AFC-HSS- H20 for pipe diameter 2 in (50 mm) and H25 for pipe diameter 2.5 in (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 54 Flow cell AFC-HSS- with wash nozzle connection (-NC) H20 for pipe diameter 2 in (50 mm) and H25 for pipe diameter 2.5 in (65 mm)

10.3.6 Mounting specifications for EHEDG-certified PR-23-AC configuration

Vaisala offers certain 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 specifications provided on the mounting drawing supplied by Vaisala with each refractometer sensor ordered with the -EH option.

10.3.7 3-A Sanitary Standard compliance

Ensure that the refractometer is not a source of contamination to the product due to damaged or worn product contact surfaces. Misuse (for example, excessive prism wash time or wash pressure) or mishandling may result in metal scratches or roughened surfaces. Such surfaces may not stay clean in processing.

Vaisala offers a 3-A Sanitary Standard Accepted repair and maintenance package in which all wetted parts, prism, gaskets and dryer are replaced.

This repair service can be completed only by a 3-A authorized service center (Vaisala factory or regional headquarters).

10.4 Sanitary probe refractometer PR-23-AP

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

10.4.1 PR-23-AP model code

Table 21 Sanitary probe refractometer for large pipelines and vessels

Model	Description
PR-23	Sensor
Sensor model	
A	3-A approved
Sensor type	
P	Probe type for tanks and large pipes
Refractive index range limits	
-62	R.I. 1.320–1.530 n_D (0 ... 100 Brix) spinel prism
-73	R.I. 1.320–1.530 n_D (0 ... 100 Brix) sapphire prism
-74	R.I. 1.260–1.470 n_D sapphire prism
Process connection	
-T	Sanitary clamp, 2.5 in, insertion length 170 mm [1)]
-N	Sanitary clamp, 2.5 in, insertion length 14 mm, high pressure, 40 bar at +20 °C (+68 °F) [1)]
-R	Sanitary clamp, 4 in, insertion length 170 mm [1)]
-S	Sanitary clamp, 4 in insertion length 63 mm [1)]
-P	MT4 DN 25/1T APV Tank bottom flange, flush mounted [2)]
-B	MT4 DN25/1T APV Tank bottom flange, insertion length 170 mm [3)]
-V	Sanitary clamp, 2.5 in, insertion length 170 mm

Model	Description
-H	Sanitary clamp, 2.5 in, insertion length 14 mm 1)
-Q	Sanitary clamp, 2.5 in for flush-mount adaptor, insertion length 140 mm 3)
-C	Varinline® in-line access unit clamp 2 in (DN 50/40) insertion length 170 mm 1)
Sensor wetted parts material	
SS	AISI 316 L
Electrical classification	
-GP	General purpose
-AX	ATEX and IECEx certified Ex II 3G, Ex ec IIC T4 Gc (up to zone 2). T_{amb} −20 ... +65 °C (−4 ... +149 °F)
-FM	FM certified Class I, Div.2, Groups A, B, C, D, T6 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-CS	CSA certified Class I, Div.2, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-IA	ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0), T_{amb} −20 ... +65 °C (−4 ... +149 °F) 4)
-IF	FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F) 4)
-CX	NEPSI Certified for use in Ex nA IIC T4 Gc
-CI	NEPSI Certified for use in Ex ia IIC T4 Ga
Sensor housing	
-AA	Anodized Aluminum
-SC	Stainless steel AISI 316
EHEDG option	
-EH	EHEDG Type EL Class I Certified Model 5)

1) *EHEDG and Sanitary 3-A certified.*
2) *Sanitary 3-A certified.*
3) *Design according to Sanitary 3-A.*
4) *Available with STR indicating transmitter and IS isolator only.*
5) *For connections -T, -N, -R, -S, -H, -C.*

Table 22 Sanitary probe refractometer PR-23-AP with prism wash for large pipelines and vessels

Model	Description
PR-23	Sensor

Model	Description
Sensor model	
-A	3-A approved
Sensor type	
P	Probe type for tanks and large pipes
Refractive index range limits	
-62	R.I. 1.320–1.530 n_D (0 ... 100 Brix) spinel prism
-73	R.I. 1.320–1.530 n_D (0 ... 100 Brix) sapphire prism
-74	R.I. 1.260–1.470 n_D sapphire prism
Process connection	
-R	Sanitary clamp, 4 in, insertion length 170 mm
Sensor wetted parts material	
SS	AISI 316 L
Electrical classification	
-GP	General purpose
-FM	FM certified Class I, Div.2, Groups A, B, C, D, T6 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-CS	CSA certified Class I, Div.2, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-AX	ATEX and IECEx certified Ex II 3G, Ex ec IIC T4 Gc (up to zone 2). T_{amb} −20 ... +65 °C (−4 ... +149 °F)
-IA	ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0), T_{amb} −20 ... +65 °C (−4 ... +149 °F) [1)]
-IF	IF certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F) [1)]
-CX	NEPSI Certified for use in Ex nA IIC T4 Gc
-CI	NEPSI Certified for use in Ex ia IIC T4 Ga
Sensor housing	
-AA	Anodized Aluminum
-SC	Stainless steel AISI 316
Prism wash	
-SN	Integral steam nozzle, AISI 316 L
-WN	Integral water nozzle, AISI 316 L
-WP	Integral pressurized water nozzle, AISI 316 L

1) Available with STR Indicating transmitter and IS isolator only.

10.4.2 PR-23-AP mounting hardware model code

Table 23 Mounting hardware for PR-23-AP sensor

Part number	Description
VFMA-23-PSS	Tank bottom flange for PR-23-AP, MT4 DN 25/1T
VFBP-23-PSS	Tank bottom blind flange for PR-23-AP, MT4 DN 25/1T

Model	Description
AP	Adapter for PR-23-AP
Sensor type	
-T	Sanitary clamp, 2.5 in, insertion length 170 mm
Material of construction	
SS	AISI 316 L
Process connection	
-P	MT4 DN 25/1T tank bottom flange, flush mounted
Insertion length adapter	
30	30 mm
Prism wash	
-SN	Integral steam nozzle, AISI 316 L
-WP	Integral pressurized water nozzle, AISI 316 L
-WN	Integral water nozzle, AISI 316 L

Model	Description
WNA	Wash nozzle adapter
Sensor type	
-T	Sanitary clamp, 2.5 in, insertion length 170 mm
Material of construction	
SS	AISI 316 L
Process connection	
-H	Sanitary clamp, 2.5 in
Insertion length adapter	
-30	30 mm
-117	117 mm
Prism wash	

Model	Description
-SN	Integral steam nozzle, AISI 316 L
-WP	Integral pressurized water nozzle, AISI 316 L
-WN	Integral water nozzle, AISI 316 L

Table 24 Side flow cells, connection sanitary clamp 2.5 in

Model	Description
SFC	Side flow cell [1)]
Sensor connection	
-HH	Sanitary clamp, 2.5 in
Material of construction	
SS	AISI 316 L
Pipe section diameter	
10	25 mm (1 in)
15	40 mm (1.5 in)
20	50 mm (2 in)
25	65 mm (2.5 in)
Flow cell inlet and outlet orientation	
-090	Elbow, 90° bend
-180	Straight pipe, 180°

1) Includes one 2.5 in blind flange with 2.5 in EPDEM gasket and 2.5 in sanitary clamp.

Table 25 Aseptic steam valve for PR-23-AP-ISS

Model	Description
ASV	Aseptic steam valve [1)]
Sensor connection	
-H	Sanitary clamp, 2.5 in
-E	Varinline® in-line access unit clamp 2 in (DN 50/40)
Material of construction	
SS	AISI 316 L
Option	
-ASI	With AS interface control head (30 V DC)

Model	Description
-24VDC	With electrical installation 24 V DC, PR-9298

1) *Steam connection: Tri-Clamp DIN10 DIN32676.*

10.4.3 PR-23-AP specifications

Table 26 General specifications

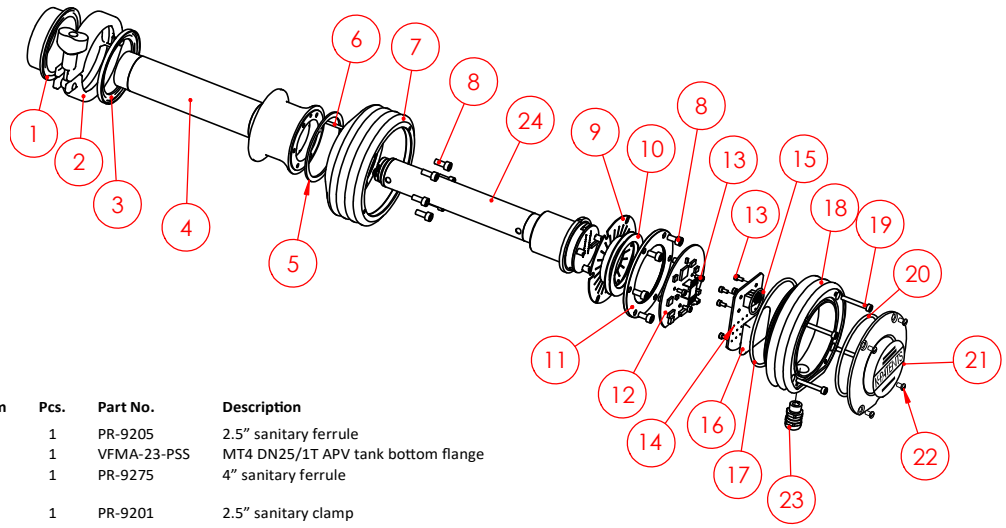
Feature	Specification
Refractive index range	Full range n_D 1.3200 ... 1.5300 (corresponds to hot water – 100 Brix)
Accuracy	Refractive index n_D ±0.0002 (corresponds typically to ±0.1 % by weight) Repeatability and stability correspond to accuracy
Speed of response	1 s undamped, damping time selectable 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
Digital measurement	3648 pixel CCD element
Light source	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	–20 °C ... +45 °C (–4 °F ... +113 °F)

Table 27 Sensor PR-23-AP specifications

Feature	Specification
Sensor PR-23-AP	Probe sensor model for large pipe lines and vessels
Process connection	Sanitary clamp 2.5 in; sanitary clamp 4 in or MT4 DN 25/1T APV Tank bottom flange
Sanitary design	3-A Sanitary Standard 46-04 approved and EHEDG (European Hygienic Engineering & Design Group) certified (connections -T, -N, -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, spinel or sapphire prism, prism gaskets MTF (Modified Teflon®)

Feature	Specification
Sensor protection class	IP67, Nema 4X
Protection class	Protection class 3
Sensor weight	3.0 kg (6.6 lbs)

10.4.4 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

Figure 55 PR-23-AP parts list

10.4.5 PR-23-AP mounting specifications

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, install the probe close to a stirrer.

Probe refractometer type PR-23-AP-T is connected to the process by a 2.5 in sanitary clamp. PR-23-AP-R is connected by a 4 in sanitary clamp.

CAUTION! 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, see Figure 57 (page 118).

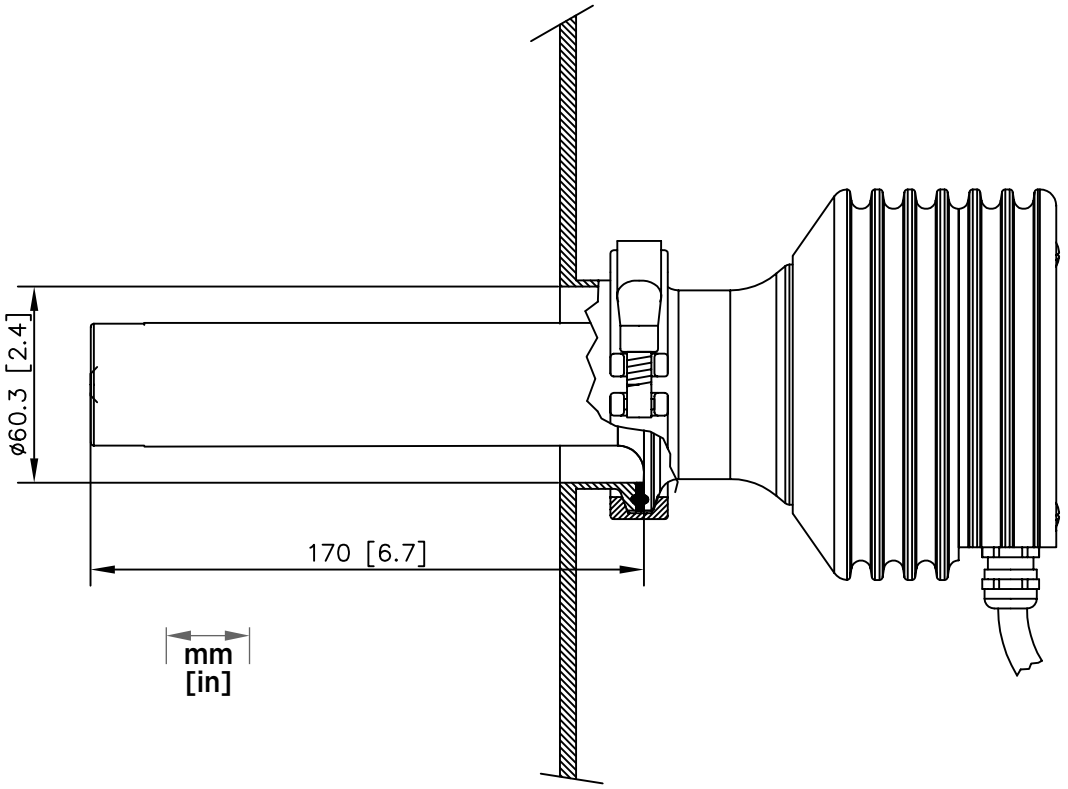


Figure 56 Insertion of probe refractometer PR-23-AP-XX-TSS

The refractometer type PR-23-AP-XX-PSS is flush mounted, using a sanitary APV tank bottom flange. 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.

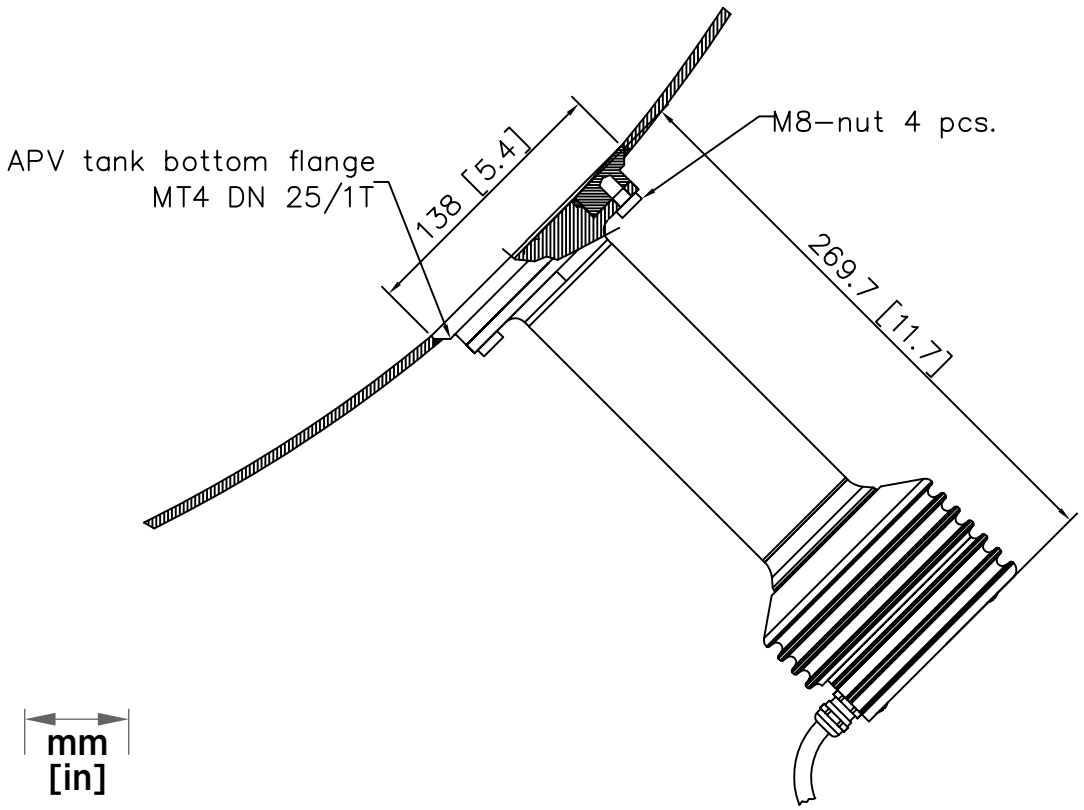


Figure 57 Flush mounting probe refractometer PR-23-AP-XX-PSS

10.4.6 Mounting specifications for EHEDG-certified PR-23-AP configuration

Vaisala offers certain 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 specifications provided on the mounting drawing supplied by Vaisala with each refractometer sensor ordered with the -EH option.

10.4.7 3-A Sanitary Standard compliance

Ensure that the refractometer is not a source of contamination to the product due to damaged or worn product contact surfaces. Misuse (for example, excessive prism wash time or wash pressure) or mishandling may result in metal scratches or roughened surfaces. Such surfaces may not stay clean in processing.

Vaisala offers a 3-A Sanitary Standard Accepted repair and maintenance package in which all wetted parts, prism, gaskets and dryer are replaced.

This repair service can be completed only by a 3-A authorized service center (Vaisala factory or regional headquarters).

10.5 Compact process refractometer PR-23-GC

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

10.5.1 PR-23-GC sensor model code

Table 28 PR-23-GC sensor model code

Model	Description
PR-23	Sensor
Sensor model	
-G	General
C	Compact type for pipeline installations
Refractive index range limits	
-73	R.I. 1.320–1.530 n_D sapphire prism
-74	R.I. 1.260–1.470 n_D sapphire prism
-82	R.I. 1.410–1.620, YAG prism
-92	R.I. 1.520–1.730, GGG prism
Process connection	
-K	L coupling 76.1, insertion length 14 mm
Sensor wetted parts material	
SS	AISI 316 L
HA	Alloy 20
HC	Alloy C276 / ASTM C276
NI	Nickel 200/201
TI	Titanium ASTM B348 GR 2
Electrical classification	
-GP	General purpose

Model	Description
-AX	ATEX and IECEx certified Ex II 3G, Ex ec IIC T4 Gc (up to zone 2). T_{amb} −20 ... +65 °C (−4 ... +149 °F)
-IA	ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0), T_{amb} −20 ... +65 °C (−4 ... +149 °F) 1)
-CS	CSA certified Class I, Div.2, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-FM	FM certified Class I, Div.2, Groups A, B, C, D, T6 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-IF	FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F) 1)
-CX	NEPSI Certified for use in Ex nA IIC T4 Gc
-CI	NEPSI Certified for use in Ex ia IIC T4 Ga
Sensor housing	
-SC	Stainless steel AISI 316

1) Available with STR Indicating Transmitter and IS isolator only.

Table 29 Wafer flow cell model code

Model	Description
WFC	Wafer flow cell
Sensor connection	
-K	L coupling 76.1 mm (insertion length 14 mm)
Material of construction	
SS	AISI 316 L
Process connection	
-A	ANSI flange 150 psi
-D	DIN flange PN40
-J	JIS flange 10K
Pipe section diameter	
05	15 mm (0.5 in)
10	25 mm (1 in)
15	40 mm (1.5 in)
Wash nozzle connection	
-NC	Nozzle connection
Wash nozzles	

Model	Description
-SN	Steam nozzle, G¼ thread female
-WN	Water nozzle, G¼ thread female
-WP	Pressurized water nozzle, G¼ thread female
-PG	Plug for nozzle connection

Table 30 Pipe flow cell model code

Model	Description
PFC	Pipe flow cell
Sensor connection	
-K	L coupling 76.1 mm (insertion length 14 mm)
Material of construction	
SS	AISI 316 L
Process connection	
-A	ANSI flange 150 psi
-D	DIN flange PN40
-J	JIS flange 10K
Pipe section diameter	
05	15 mm (0.5 in)
10	25 mm (1 in)
15	40 mm (1.5 in)
Wash nozzle connection	
-NC	Nozzle connection
Wash nozzles	
-SN	Steam nozzle, G¼ thread female
-WP	Pressurized water nozzle, G¼ thread female

10.5.2 PR-23-GC specifications

Table 31 General specifications

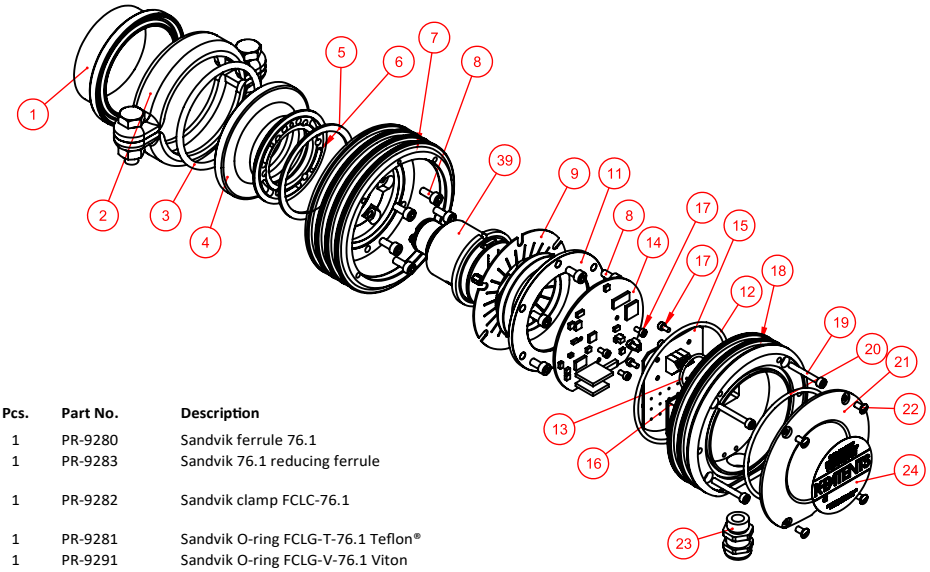
Feature	Specification
Refractive index range	Full range n_D 1.3200 ... 1.5300, sapphire prism

Feature	Specification
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
Digital measurement	3648 pixel CCD element
Light source	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	−20 °C ... +45 °C (−4 °F ... +113 °F)

Table 32 Sensor PR-23-GC specifications

Feature	Specification
Process connection (in upper elbow of pipe)	L coupling 76.1 mm (2.5 in) for pipeline sizes of 2.5 in and larger; using reducing ferrule PR-9283 for 2 in pipes
Wafer flow cell WFC connection (in straight pipe)	Using wafer flow cell WFC for pipe line sizes 15 mm (0.5 in), 25 mm (1 in) and 40 mm (1.5 in); wafer flow cell body mounts between ANSI 150 psi, DIN PN 25 orJIS
Pipe flow cell PFC connection (in straight pipe)	Using pipe flow cell PFC for pipe line sizes 15 mm (0.5 in), 25 mm (1 in) and 40 mm (1.5 in); pipeflow process connection ANSI 150 psi, DIN PN 25 or JIS
Process pressure	Up to 25 bar (350 psi) at +20 °C (+70 °F)
Process temperature	−40 °C ... +130 °C (−40 °F ... +266 °F)
Process wetted parts, standard	AISI316L stainless steel, prism sapphire, prism gaskets PTFE (teflon)
Sensor protection class	IP67, Nema 4X
Protection class	Protection class 3
Sensor weight	2.0 kg (4.4 lbs)

10.5.3 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

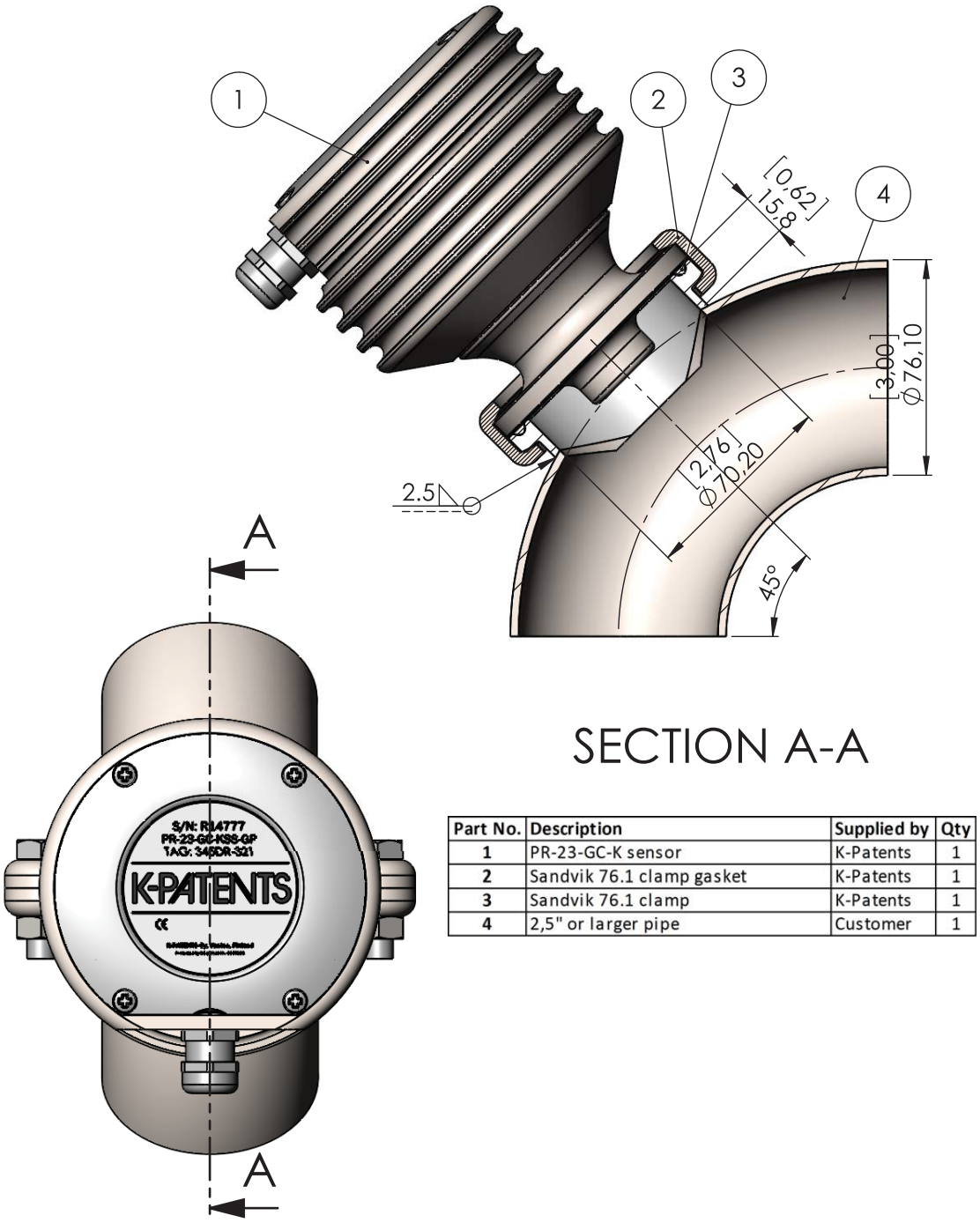
Item	Pcs.	Part No.	Description
16	1	PR-9108	Dryer sachet
17	8		Screw M3x6 DIN 912 A2
18	1	PR-10000-SC	PR-23 cover
19	4		Screw M4x30 DIN 912 A4
20	1	PR-10002	O-ring seal 82x3
21	1	PR-10047-SC	PR-23 endplate with label and screws
22	4		Screw M4x8 DIN 964 A4
23	1		Cable gland M16x1.5
39	1	PR-10036	H73 compact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

Figure 58 PR-23-GC parts list

10.5.4 PR-23-GC mounting specifications

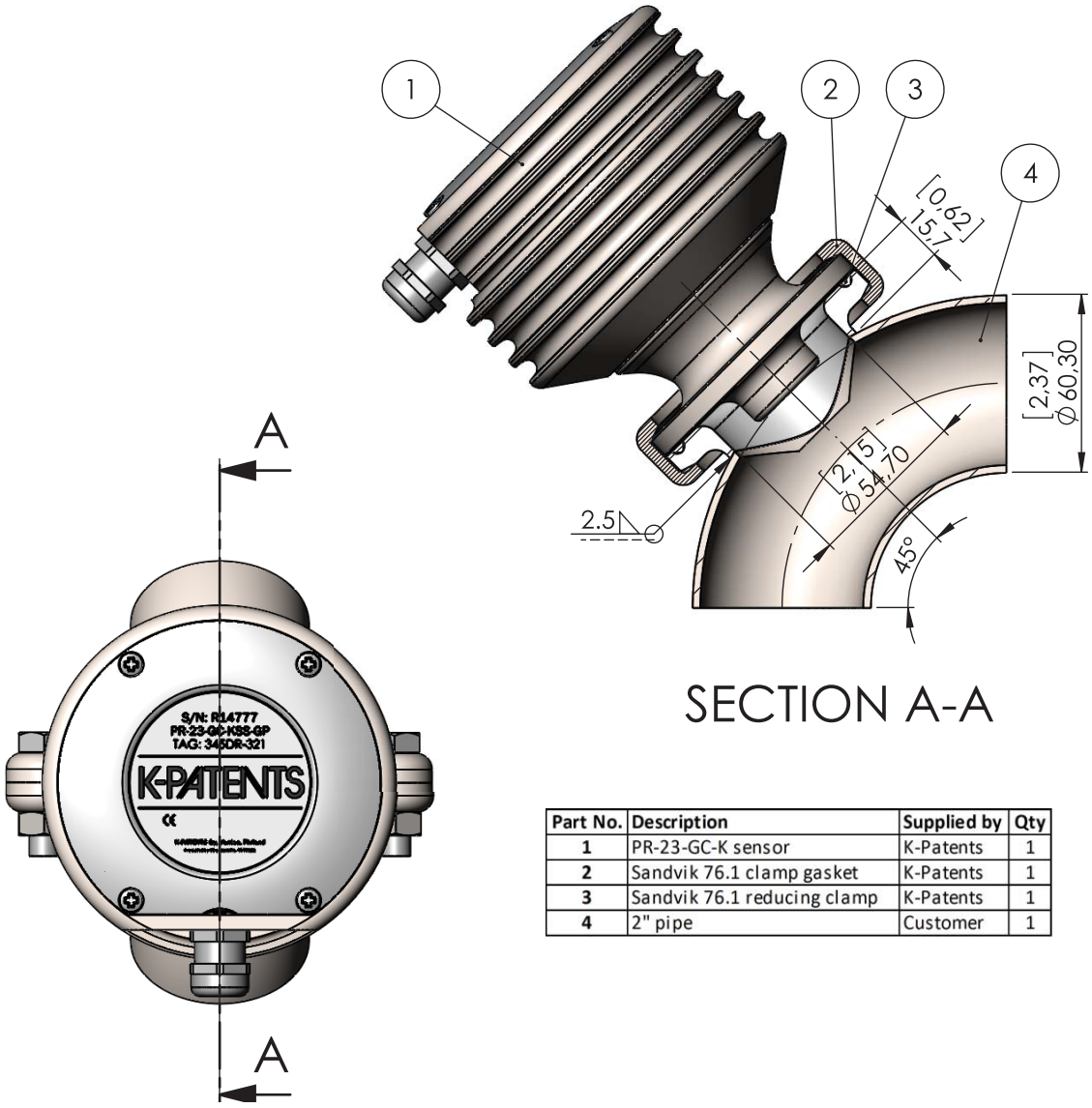
The compact refractometer is mounted either in a pipe elbow by an L coupling connection or in a straight pipe using a wafer flow cell or a pipe flow cell. Both flow cell mounting designs create optimum flow velocity on the measurement surface providing a good self-cleaning effect. The wafer flow cell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

In a pipe of at least 2.5 in diameter the sensor is mounted in a pipe elbow with an L coupling. In a 2 in pipe the sensor is mounted in a pipe elbow using reducing ferrule PR-9283. In 0.5 in, 1 in and 1.5 in 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 in and 1 in pipes.



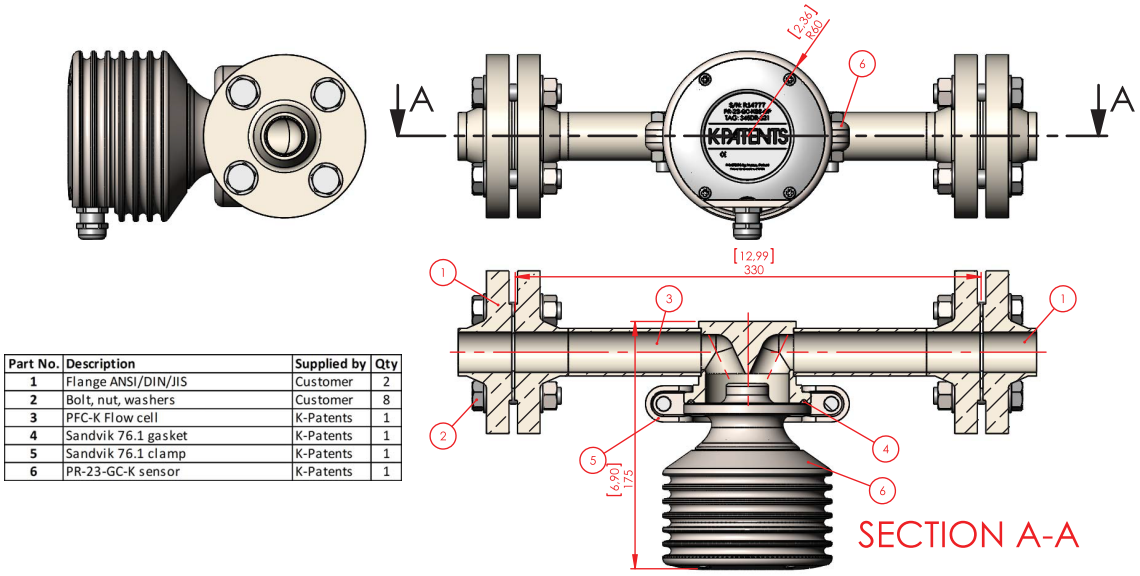
Part No.	Description	Supplied by	Qty
1	PR-23-GC-K sensor	K-Patents	1
2	Sandvik 76.1 clamp gasket	K-Patents	1
3	Sandvik 76.1 clamp	K-Patents	1
4	2,5" or larger pipe	Customer	1

Figure 59 Mounting sensor in pipe 2.5 in or larger



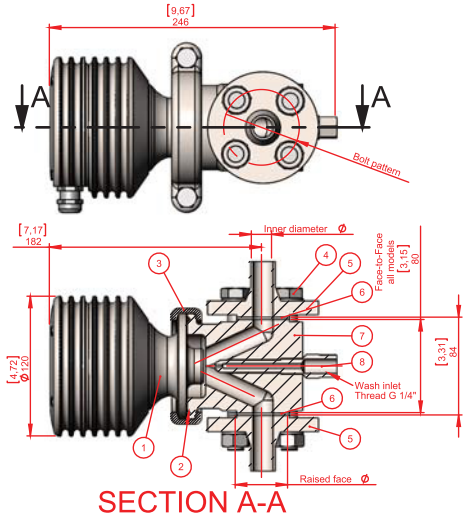
Part No.	Description	Supplied by	Qty
1	PR-23-GC-K sensor	K-Patents	1
2	Sandvik 76.1 clamp gasket	K-Patents	1
3	Sandvik 76.1 reducing clamp	K-Patents	1
4	2" pipe	Customer	1

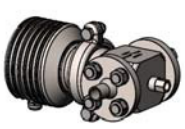
Figure 60 Mounting sensor in 2 in pipe



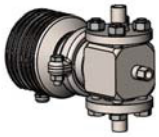
Part No.	Description	Supplied by	Qty
1	Flange ANSI/DIN/JIS	Customer	2
2	Bolt, nut, washers	Customer	8
3	PFC-K Flow cell	K-Patents	1
4	Sandvik 76.1 gasket	K-Patents	1
5	Sandvik 76.1 clamp	K-Patents	1
6	PR-23-GC-K sensor	K-Patents	1

Figure 61 Mounting sensor with PFC flow cell





Vertical line installation



Horizontal line installation

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 62 Mounting sensor with WFC flow cell

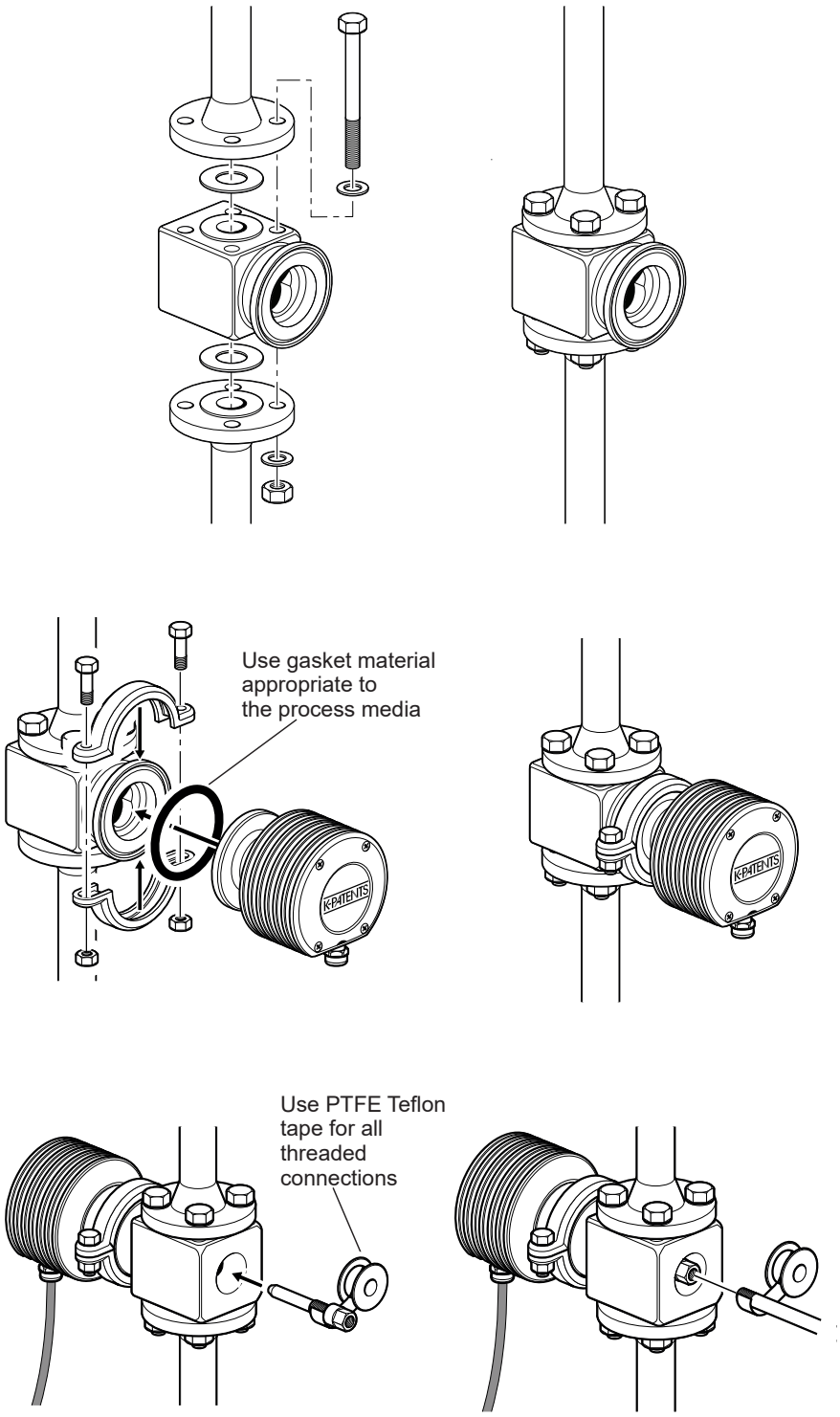


Figure 63 Mounting wafer flow cell and sensor in vertical pipe

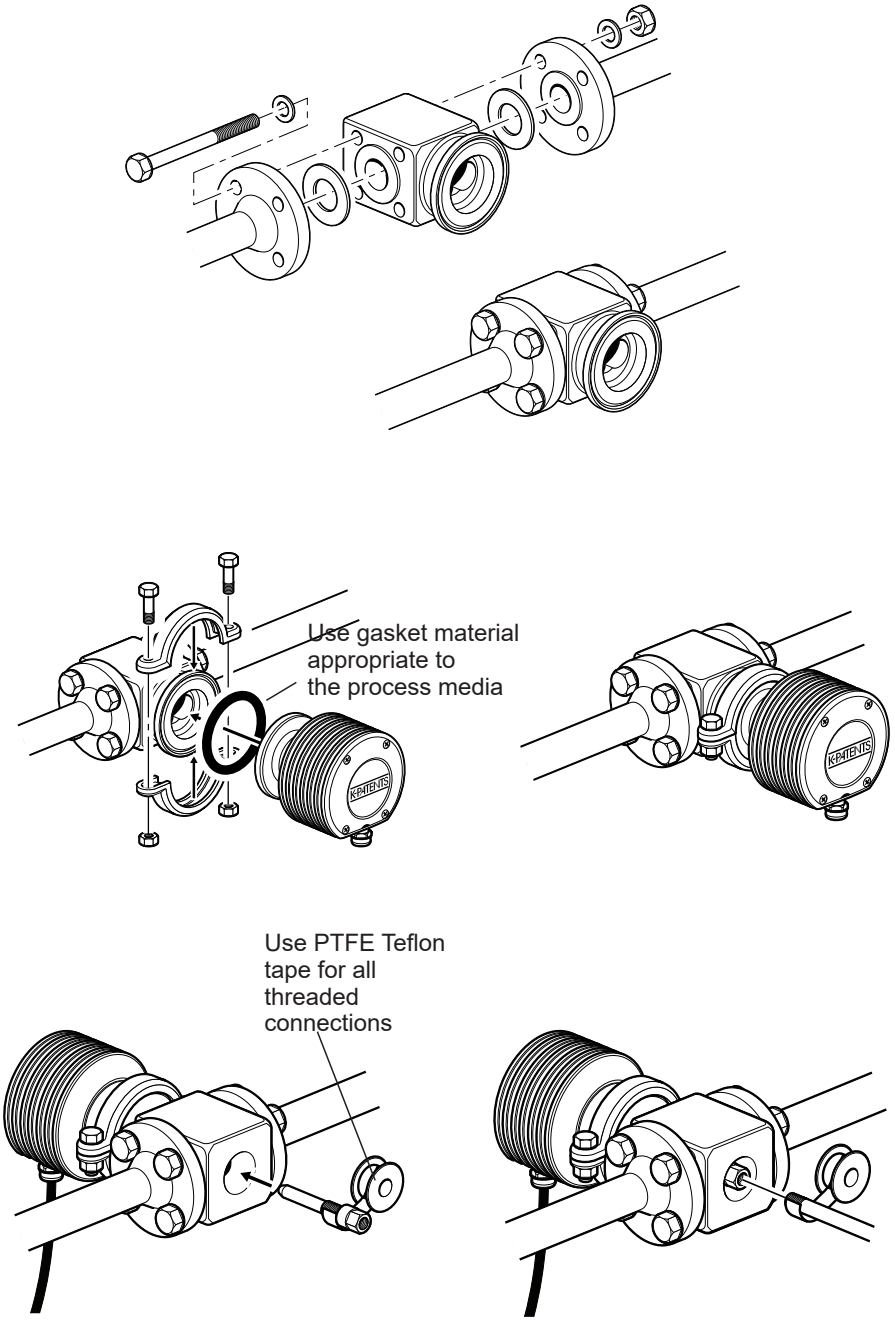


Figure 64 Mounting wafer flow cell and sensor in horizontal pipe

10.6 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.

10.6.1 PR-23-GP sensor model code

Table 33 PR-23-GP sensor model code

Model	Description
PR-23	Sensor
Sensor model	
-G	General
Sensor type	
P	Probe type for tanks and large pipes
Refractive index range limits	
-62	R.I. 1.320–1.530 n_D spinel prism
-73	R.I. 1.320–1.530 n_D sapphire prism
-74	R.I. 1.260–1.470 n_D sapphire prism
-82	R.I. 1.410–1.620, YAG prism
-92	R.I. 1.520–1.730, GGG prism
Process connection	
-A	ANSI-flange 150 lbs, 3 in, insertion length 130 mm
-D	DIN-flange 2656, PN25 DN80, insertion length 130 mm
-J	JIS-flange 10k 80A, insertion length 130 mm
-L	L clamp, 88 mm, insertion length 130 mm
-M	ANSI-flange 300 lbs, 3 in, insertion length 130 mm
Sensor wetted parts material	
SS	AISI 316 L
RS	Stainless steel AISI 304 L
HA	Alloy 20
HC	Alloy C276
XS	Duplex 2205 / SAF2205
Electrical classification	
-GP	General purpose
-AX	ATEX and IECEx certified Ex II 3G, Ex ec IIC T4 Gc (up to zone 2). T_{amb} −20 … +65 °C (−4 … +149 °F)
-FM	FM certified Class I, Div.2, Groups A, B, C, D, T6 T_{amb} −20 … +45 °C (−4 … +113 °F)
-CS	CSA certified Class I, Div.2, Groups A, B, C, D, T4 T_{amb} −20 … +45 °C (−4 … +113 °F)

Model	Description
-IA	ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0), T_{amb} −20 … +65 °C (−4 … +149 °F) [1]
-IF	FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D, T4 T_{amb} −20 … +45 °C (−4 … +113 °F) [1]
-CX	NEPSI Certified for use in Ex nA IIC T4 Gc
-CI	NEPSI Certified for use in Ex ia IIC T4 Ga
Sensor housing	
-AA	Anodized Aluminum
-SC	Stainless steel AISI 316
Prism wash	
-SN	Integral steam nozzle
-WN	Integral water nozzle
-WP	Integral pressurized water nozzle
-NC	Integral nozzle connection
-YC	Without nozzle connection option
Option	
-VD	Vertical Borderline Image Detection (for example, sugar vacuum pan)

1) *Available with STR Indicating Transmitter and IS isolator only.*

10.6.2 PR-23-GP specifications

Table 34 General specifications

Feature	Specification
Refractive index range	Full range n_D 1.3200 … 1.5300, 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
Digital measurement	3648 pixel CCD element
Light source	LED 589 nm wavelength, sodium light

Feature	Specification
Temperature sensor	Built-in Pt-1000
Temperature compensation	Automatic, digital compensation
Instrument verification	With certified refractive index liquids and Vaisala documented procedure
Ambient temperature	−40 °C ... 45 °C (−40 °F ... 113 °F)

Table 35 Sensor PR-23-GP specifications

Feature	Specification
Sensor PR-23-GP	Probe sensor for large pipe line and vessel installation
Process connection	Flanges: ANSI 3 in 150 lbs or DIN 80 PN 25 or JIS 10K 80A; or 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 316 L stainless steel, spinel prism, prism gaskets MTF (Modified Teflon)
Sensor protection class	IP67, Nema 4X
Protection class	Protection class 3
Sensor weight	Aluminum sensor cover with clamp/flange 4.0 ... 9.0 kg (8.8 ... 19.8 lbs) Stainless steel sensor cover with clamp/flange 5.9 ... 10.9 kg (13.0 ... 24.0 lbs)

10.6.3 PR-23-GP thermal cover PR-7062

The thermal cover prevents heat flow between process and ambient surroundings. It helps to 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.

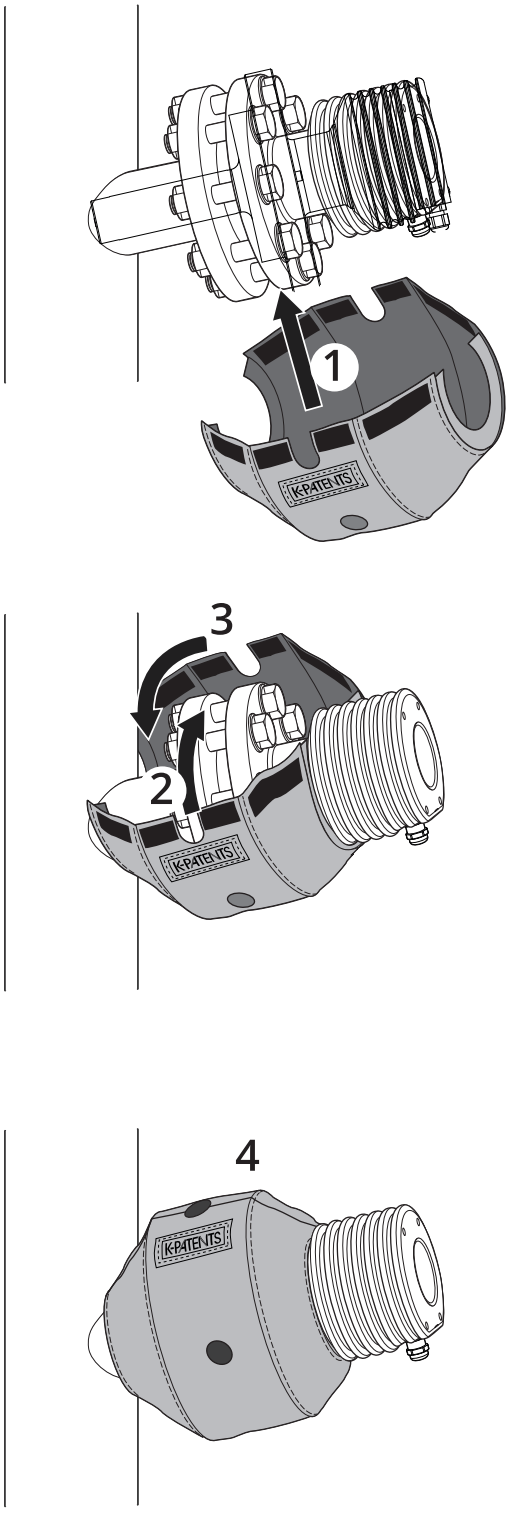
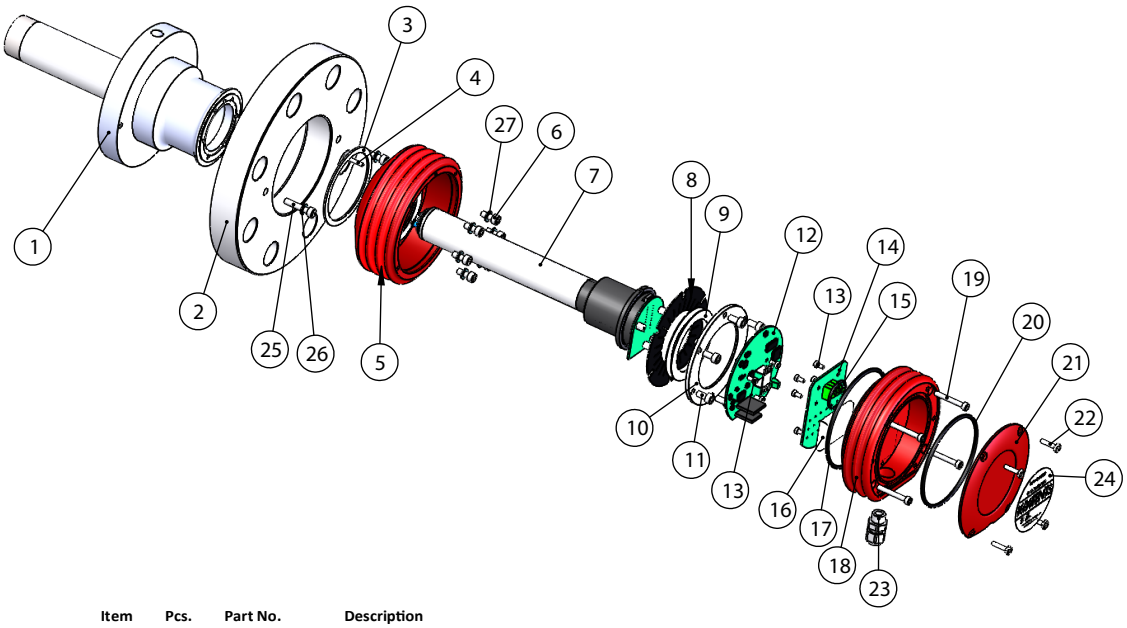


Figure 65 Mounting thermal cover on PR-23-GP

10.6.4 PR-23-GP parts list

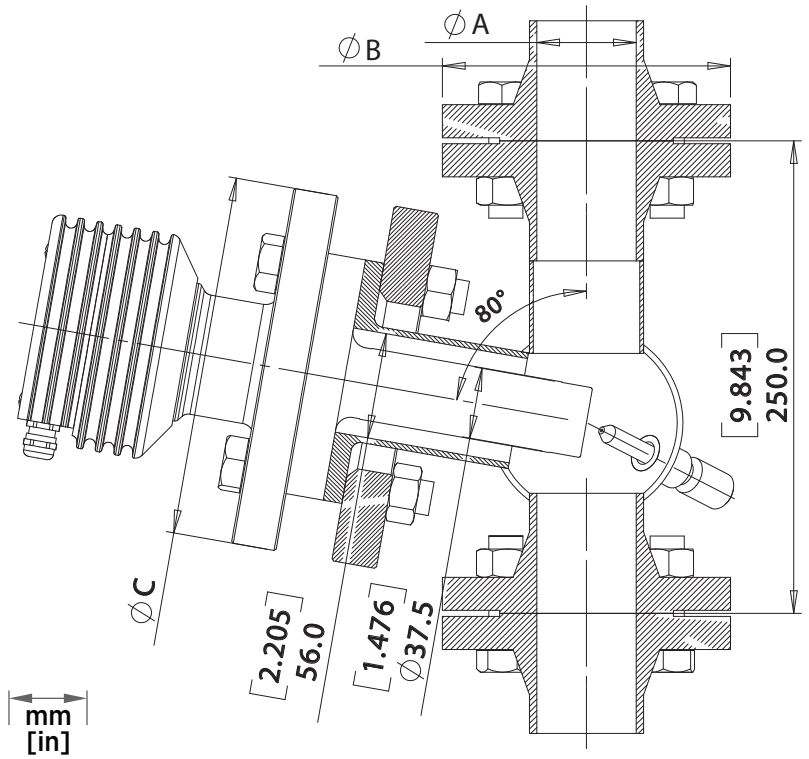


Item	Pcs.	Part No.	Description
1.1	1	PR-10009	PR-23-GP-L head
1.2	1	PR-10010	PR-23-GP-D head
1.3	1	PR-10011	PR-23-GP-D-NC head
2	1		ANSI 3” 150 lbs flange
2	1		DIN 80 PN 25 flange
2	1		JIS 80A 10k flange
3	1	PR-10048	68x3 O-ring
4	1		Alignment pin
5.1	1	PR-10005	PR-23 base
5.2	1	PR-10005-SC	PR-23 base 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

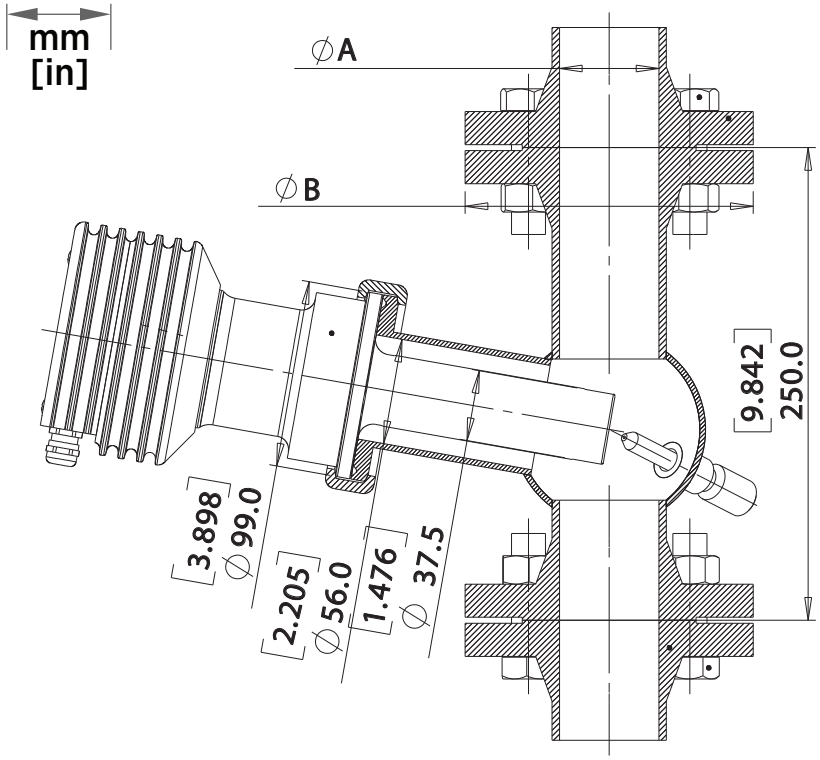
Figure 66 PR-23-GP parts list

10.6.5 PR-23-GP mounting specifications



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 67 PR-23-GP-A/D/JSS flow cell



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 68 PR-23-GP-LSS flow cell

10.7 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, for example, 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.

PR-23-RP comes with user-specified supplementary tests and documents. Sensor wetted parts are made from 1 piece of metal and no welds are in sensor construction. The following items can be specified and ordered: API recommended tests hydrostatic test, material traceability certification compliance with the NACE MR0103 or NACE MR0175/ ISO 15156 standard and the positive material identification (PMI) tests are available on request.

A factory acceptance test (FAT), and customized drawings stating client specific information are also available on request.

10.7.1 PR-23-RP sensor model code

Table 36 PR-23-RP sensor model code

Model	Description
PR-23	Sensor
Sensor model	
-R	Refinery
Sensor type	
P	Probe type, wetted materials single piece no weldings
Refractive index range limits	
-73	R.I. 1.320–1.530 n_D (0 ... 100 Brix) sapphire prism
Process connection	
-M20	ANSI-flange 300 lbs, 2 in, insertion length 130 mm
-J20	JIS-flange 10k 50A, insertion length 130 mm
Sensor wetted parts material	
-SS	AISI 316 L
-HA	Alloy 20
-HC	Alloy C276
Electrical classification	
-AX	ATEX and IECEx certified Ex II 3G, Ex ec IIC T4 Gc (up to zone 2). T_{amb} −20 ... +65 °C (−4 ... +149 °F)
-IA	ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0), T_{amb} −20 ... +65 °C (−4 ... +149 °F) [1)]
-CX	NEPSI Certified for use in Ex nA IIC T4 Gc
-CI	NEPSI Certified for use in Ex ia IIC T4 Ga
Sensor housing	
-SC	Stainless steel AISI 316

1) Available with STR- indicating transmitter and IS isolator only.

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

10.7.2 PR-23-RP specifications

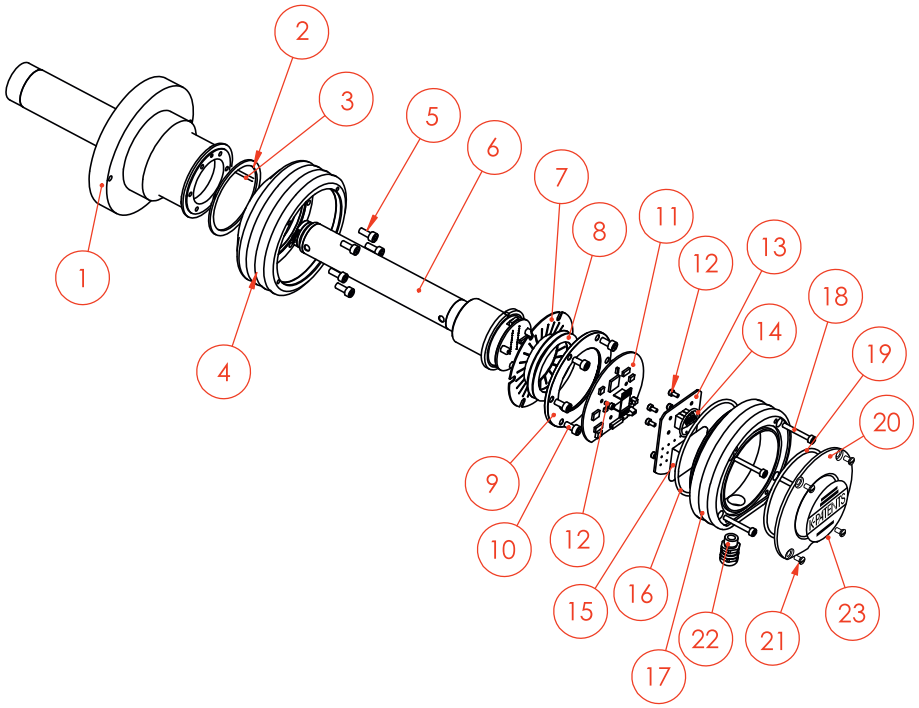
Table 37 General specifications

Feature	Specification
Refractive index range	Full range n_D 1.3200 ... 1.5300, 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
Digital measurement	3648 pixel CCD element
Light source	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	−20 °C ... +45 °C (−4 °F ... +113 °F)

Table 38 Sensor PR-23-RP specifications

Feature	Specification
Sensor PR-23-RP	Probe type, seamless one-piece wetted parts construction with no welds
Process connection	Flanges: ANSI 2 in 300 lbs
Process pressure	Up to 25 bar (350 psi)
Process temperature	−40 °C ... +150 °C (−40 °F ... +302 °F)
Process wetted parts, standard	AISI316L Stainless steel, Alloy 20 or Alloy C276; prism sapphire, prism gaskets PTFE
Sensor protection class	IP67, Nema 4X
Protection class	Protection class 3
Sensor weight	7.89 kg (17.4 lbs)

10.7.3 PR-23-RP parts list

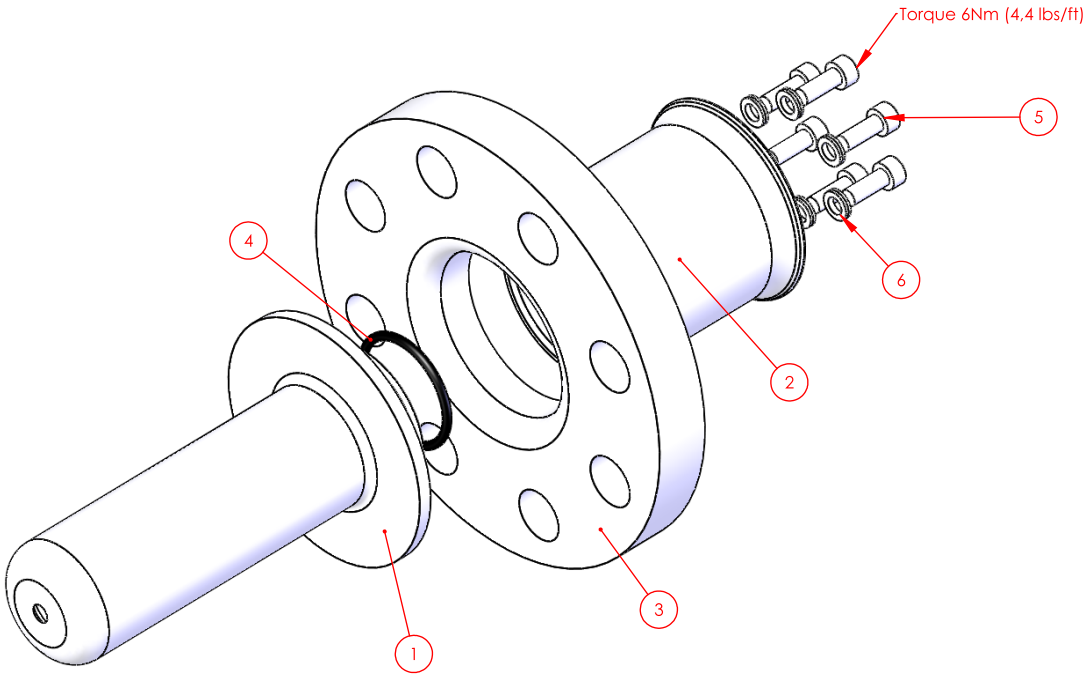


Item	Pcs.	Part No.	Description
1.1	1	PR-10043	PR-23-RP-SS head
1.2	1	PR-10043-HC	PR-23-RP-SS Hastelloy® C 276
1.3	1	PR-10043-HA	PR-23-RP-SS Alloy® 20 head
2	1	PR-10048	68x3 O-ring
3	1		Alignment pin
4	1	PR-10005-SC	PR-23 base SS
5	6		Screw M5x10 DIN 912 A2
6	1	PR-10041	H73 CORE-Optics module PR-23 P
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

Figure 69 PR-23-RP parts list

10.7.4 PR-23-RP head parts list



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

Figure 70 PR-23-RP head parts list

10.7.5 PR-23-RP dimensions

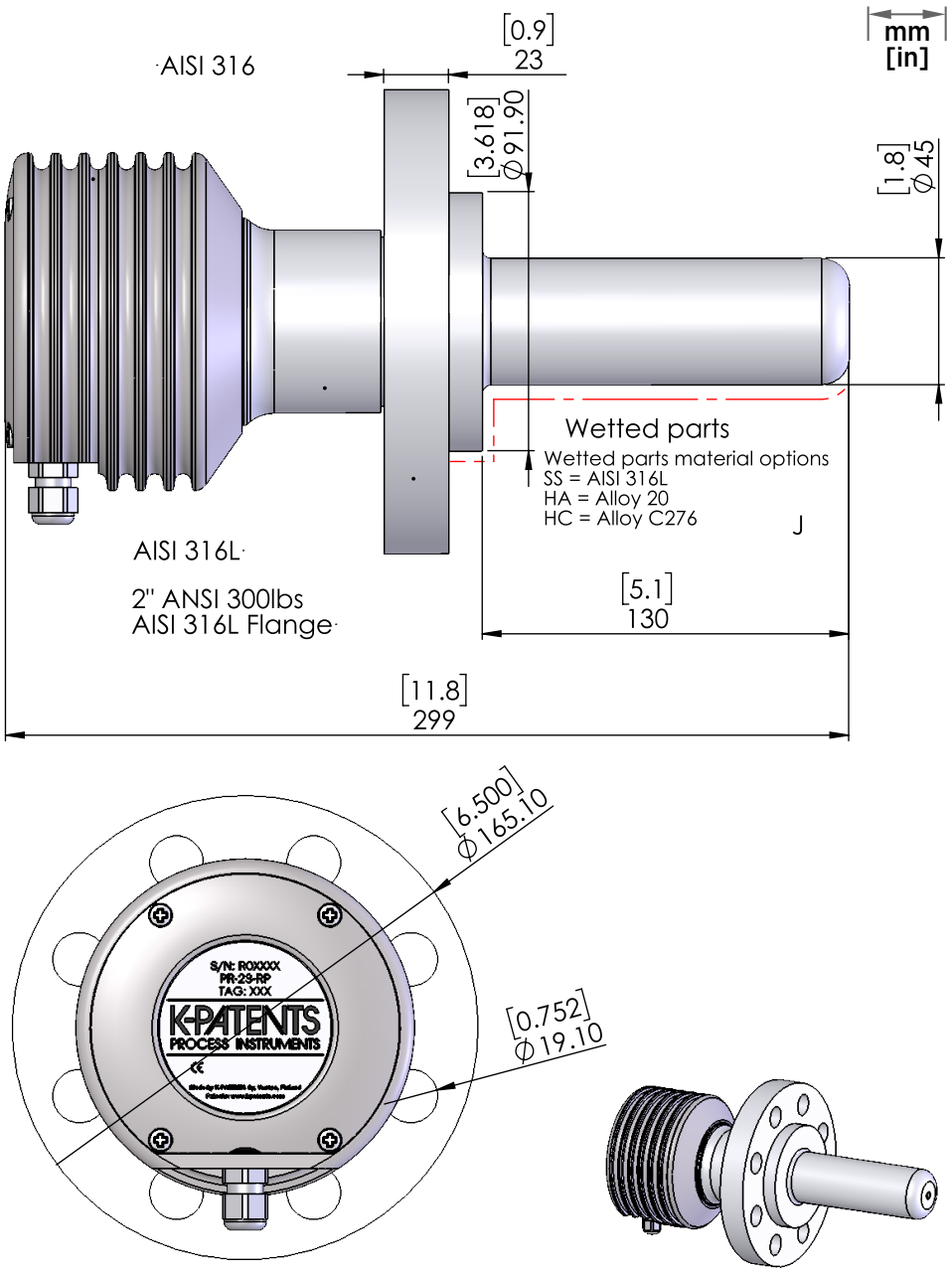
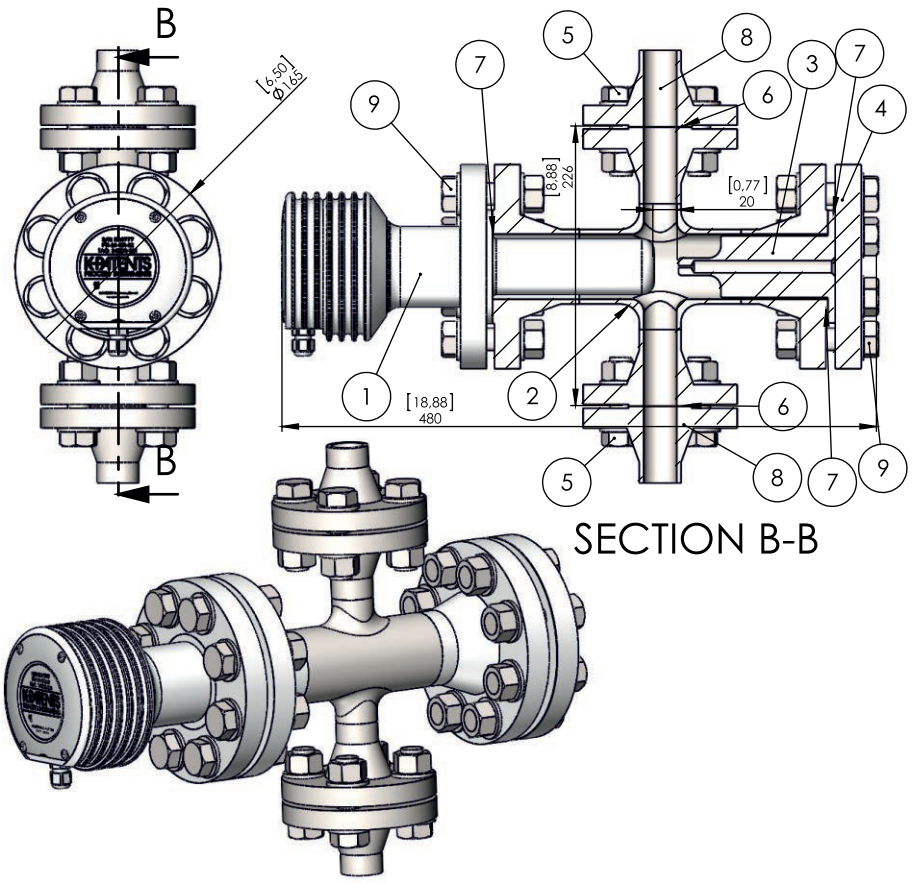


Figure 71 PR-23-RP-73-M20

10.7.6 PR-23-RP mounting specifications

The refractometer sensor is installed in the process, either directly by welding a mounting flange to 2 in or larger pipes or vessels, or using a 1 in, 2 in or 3 in cross flow cell. 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.

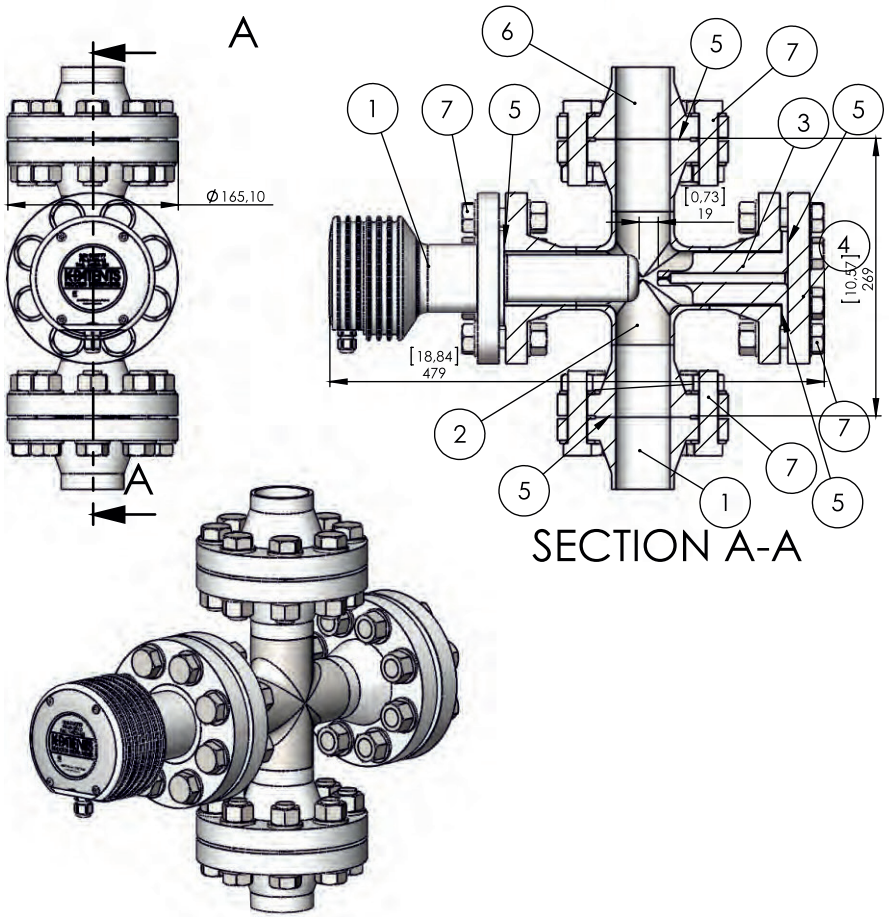
PR-23-RP mounting in CFC 1 in line



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

Figure 72 CFC-RP-M20-SS/HC/HA-M10-NC-PG/SN/WP flow cell

PR-23-RP mounting in 2 in line

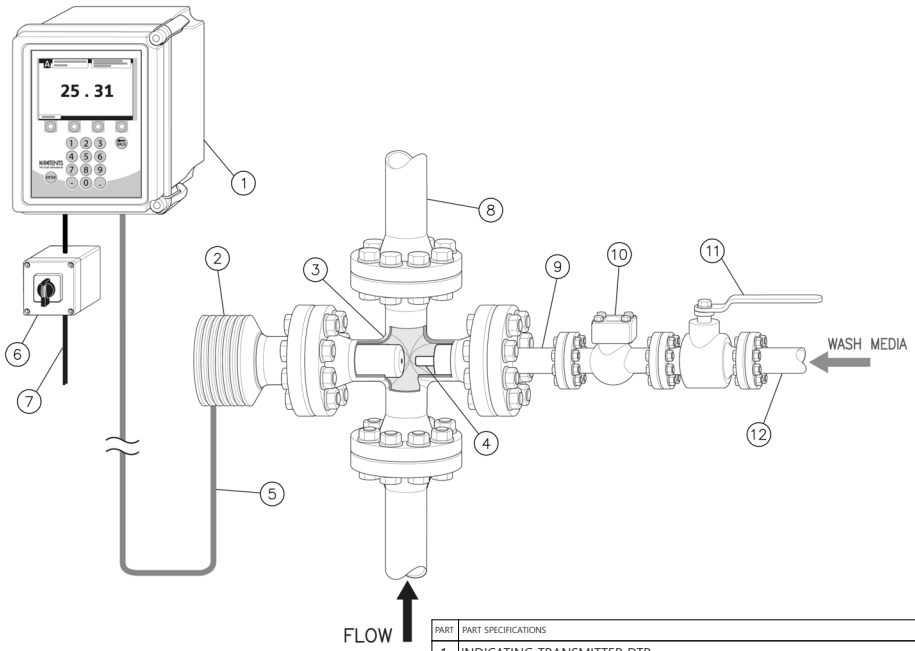


Item.	Description	Supplied by	Pcs.	Item.	Description	Supplied by	Pcs.
1	Sensor PR-23-RP-73-M20	Vaisala	1	5	2"flange gasket	Customer	5
2	CFC-23-RP-M20-M20-NC-PG/SN/WP	Vaisala	1	6	2"ANSI 300 Welding neck flange	Customer	2
3	2'' ANSI 300 Wash nozzle	Vaisala	1	7	Bolt, washer and nut for 2"flange	Customer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

Figure 73 CFC-RP-M20-SS/HC/HA-M20-NC-PG/SN/WP flow cell

10.7.7 PR-23-RP prism wash system

A prism wash system is available for PR-23-RP. This requires the use of a CFC-RP-M20 flow cell in combination with a 2 in ANSI 300 CFC wash nozzle. Both of these components are available from Vaisala. All further components specifically required for the wash system installation, are obtained independently by the customer. These include a 2 in ANSI 300 to 0.5 in ANSI 300 adapter, 0.5 in ANSI check valve, 0.5 in ANSI 300 shut-off valve, 0.5 in supply piping for the wash media.



PART	PART SPECIFICATIONS	SUPPLIED BY	
1	INDICATING TRANSMITTER DTR	VAISALA	1
2	SENSOR PR-23-RP	VAISALA	1
3	CFC-RP-M20 FLOW CELL	VAISALA	1
4	2" ANSI 300 CFC WASH NOZZLE	VAISALA	1
5	CABLE BETWEEN DTR AND SENSOR PR-8230-..	VAI/CUSTOMER	1
6	MAIN SWITCH PR-10900	CUSTOMER/VAI	1
7	POWER SUPPLY 100-240 VAC/50-60Hz	CUSTOMER	1
8	PROCESS PIPE	CUSTOMER	1
9	2" ANSI 300 TO ½" ANSI 300 ADAPTER	CUSTOMER	1
10	CHECK VALVE ANSI 1/2"	CUSTOMER	1
11	½" ANSI 300 VALVE	CUSTOMER	1
12	WASH SUPPLY 1/2"	CUSTOMER	1

Figure 74 Prism wash system for PR-23-RP

10.8 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 flow cell 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®), so the PR-23-M/MS sensor withstands corrosion very well.

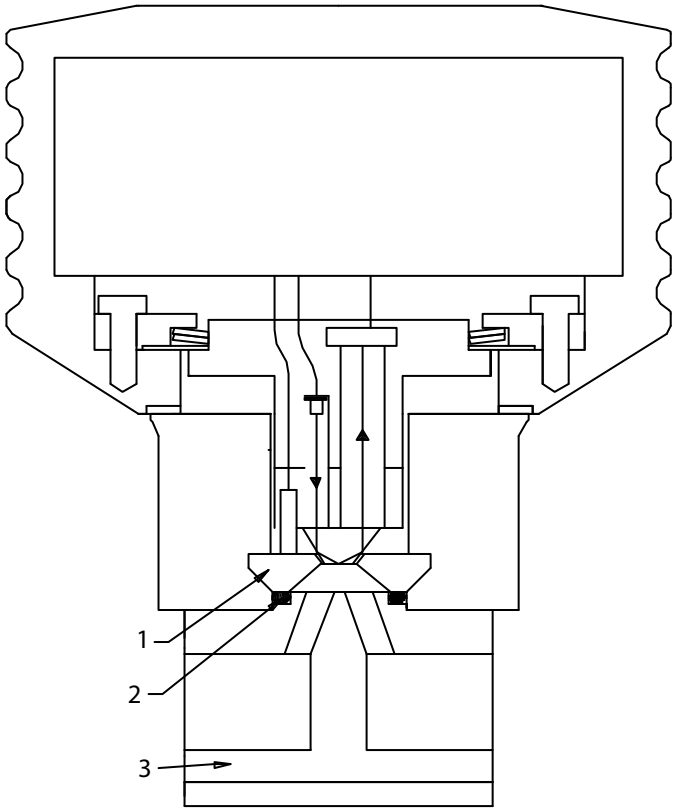


Figure 75 PR-23-M/MS sensor

The previous figure shows the structure of the sensor. The flow cell (3) and the sapphire plate (1) are fixed to the stainless steel sensor with 4 screws. The flow cell (3) is sealed by a Kalrez O-ring (2). The flow cell prevents any leakage reaching the metal parts, because there is a circular leakage chamber behind the O-ring (2). The chamber connects to a checkport, which has a 1/8 in female thread connection.

10.8.1 PR-23-M sensor model code

Table 39 PR-23-M sensor model code

Model	Description
PR-23	Sensor
Sensor model	
-M	Aggressive medium adapter
Refractive index range limits	
73	R.I. 1.320–1.530 n_D sapphire prism
74	R.I. 1.260–1.470 n_D sapphire prism

Model	Description
Electrical classification	
-GP	General purpose
-AX	ATEX and IECEx certified Ex II 3G, Ex ec IIC T4 Gc (up to zone 2). T_{amb} −20 … +65 °C (−4 … +149 °F)
-FM	FM certified Class I, Div.2, Groups A, B, C, D, T6 T_{amb} −20 … +45 °C (−4 … +113 °F)
-CS	CSA certified Class I, Div.2, Groups A, B, C, D, T4 T_{amb} −20 … +45 °C (−4 … +113 °F)
-IA	ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0), T_{amb} −20 … +65 °C (−4 … +149 °F) [1]
-CX	NEPSI Certified for use in Ex nA IIC T4 Gc
-CI	NEPSI Certified for use in Ex ia IIC T4 Ga
-IF	FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D, T4 T_{amb} −20 … +45 °C (−4 … +113 °F) [1]
Sensor housing	
-SC	Stainless steel AISI 316

1) *Available with STR indicating transmitter and IS isolator only.*

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

Table 40 Flow cell for sensor PR-23-M

Model	Description
Process connection	
FR	Flow cell with G 0.5 in thread inlet/outlet connection (female)
FN	Flow cell body with 0.5 in NPT thread inlet/outlet (female)
Line size connection diameter	
-050	0.5 in (flow volume 2 … 8 l/min (0.5 … 2.1 GPM))
Flow cell wetted parts material	
-PV	Kynar® PVDF (Polyvinylidenefluoride)
-TF	Teflon® PTFE (Polytetrafluoroethylene)

Example: Flow cell: FR-050-PV/TF, FN-050-PV/TF

10.8.2 PR-23-M specifications

Table 41 General specifications

Feature	Specification
Refractive index range, standard	Full range n_D 1.3200 ... 1.5300, sapphire prism
Refractive index range, option	n_D 1.2600 ... 1.4700 , 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
Digital measurement	3648 pixel CCD element
Light source	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	−20 °C ... +45 °C (−4 °F ... +113 °F)

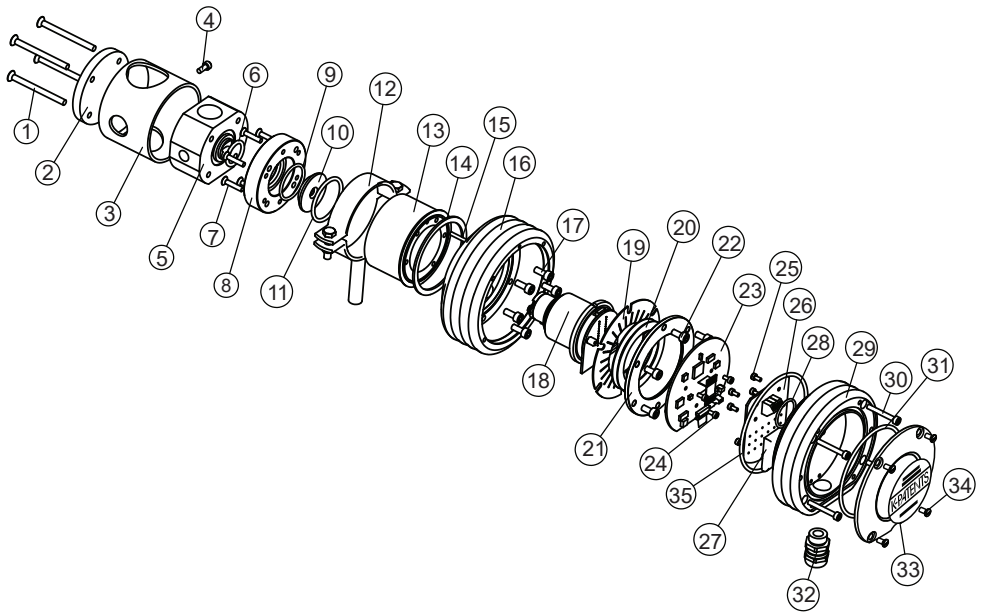
Table 42 Sensor PR-23-M specifications

Feature	Specification
Sensor PR-23-M	Teflon body sensor model for aggressive medium
Sensor protection class	IP67, Nema 4X
Protection class	Protection class 3
Sensor weight	5.0 kg (12.1 lbs)

Table 43 Flow cell for PR-23-M specifications

Feature	Specification
Process connection	Thread G½ in or ½ in 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®), sapphire prism, O-ring Kalrez®, adaptor sapphire

10.8.3 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

Figure 76 PR-23-M parts list

10.8.4 PR-23-MS sensor model code

Table 44 PR-23-MS sensor model code

Model	Description
PR-23	Sensor
Sensor model	
-M	Aggressive medium adapter
S	Semiconductor industry

Model	Description
Refractive index range limits	
73	R.I. 1.320–1.530 n_D sapphire prism
74	R.I. 1.260–1.470 n_D sapphire prism
Electrical classification	
-GP	General purpose
-AX	ATEX and IECEx certified Ex II 3G, Ex ec IIC T4 Gc (up to zone 2). T_{amb} −20 ... +65 °C (−4 ... +149 °F)
-FM	FM certified Class I, Div.2, Groups A, B, C, D, T6 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-CS	CSA certified Class I, Div.2, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F)
-IA	ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0), T_{amb} −20 ... +65 °C (−4 ... +149 °F) 1)
-IF	FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D, T4 T_{amb} −20 ... +45 °C (−4 ... +113 °F) 1)
-CX	NEPSI Certified for use in Ex nA IIC T4 Gc
-CI	NEPSI Certified for use in Ex ia IIC T4 Ga
Sensor housing	
-EC	Epoxy coated stainless steel

1) *Available with STR indicating transmitter and IS isolator only.*

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

Table 45 Flow cell for sensor PR-23-MS

Model	Description
Process connection	
F2	Flow cell body with flare fitting
P2	Flow cell body with Pillar® fitting
Line size connection diameter	
-025	¼ in
-050	½ in
-075	¾ in
-100	1 in
Flow cell wetted parts material	

Model	Description
-TM	Modified PTFE Ultra-Pure PTFE (Polytetrafluoroethylene)

The flow cell is integrally mounted to the PR-23-MS sensor.

Example: Flow cell: F2-025-TM

10.8.5 PR-23-MS specifications

Table 46 General specifications

Feature	Specification
Refractive index range, standard	Full range n_D 1.3200 ... 1.5300, sapphire prism
Refractive index range, option	n_D 1.2600 ... 1.4700, 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
Digital measurement	3648 pixel CCD element
Light source	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	−20 °C ... +45 °C (−4 °F ... +113 °F)

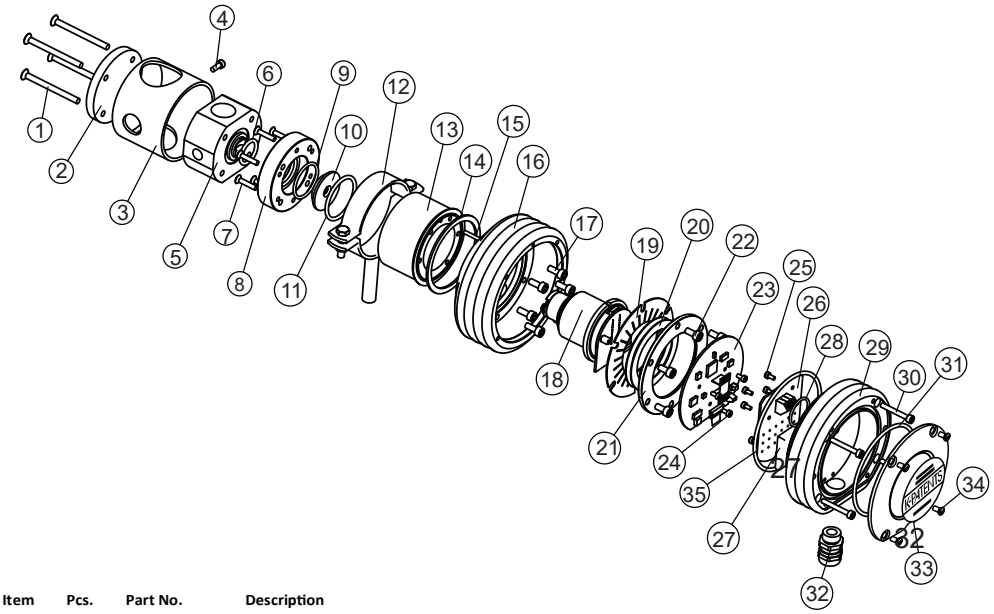
Table 47 Sensor PR-23-MS specifications

Feature	Specification
Sensor PR-23-MS	Teflon® body sensor model for aggressive medium
Sensor protection class	IP67, Nema 4X
Protection class	Protection class 3
Sensor weight	5.0 kg (12.1 lbs)

Table 48 Flow cell for PR-23-MS specifications

Feature	Specification
Process connection	Thread G ½ in or ½ in 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®), sapphire prism, O-ring Kalrez, adaptor sapphire

10.8.6 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

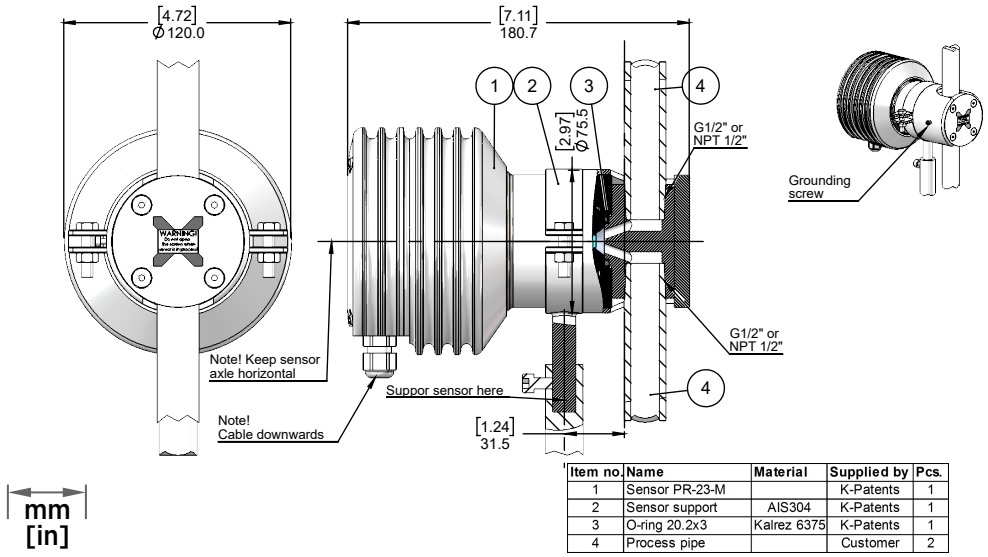
Item	Pcs.	Part No.	Description
*	1	PR-9010	Disc spring set
20	2		Disc spring
21	1		Disc spring holder
22	6		Screw DIN 912 M5x12 A2
23	1	PR-10103	Sensor processor card
24	4		Screw M3x6 DIN 912 A2
25	4		Screw M3x6 DIN 912 A2
26	1	PR-10300	Bus terminator card
27	1	PR-9108	Dryer sachet
28	1	PR-10032	O-ring 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

Figure 77 PR-23-MS parts list

10.8.7 PR-23-M/MS mounting specifications

Teflon® body refractometer PR-23-M is connected to the process by a G ½ in female or a ½ in NPT process connection, see the figure below. PR-23-MS is connected to the process by a ¼ ... 1 in G/NPT process connection.

CAUTION! Always install PR-23-M/MS with sensor support to prevent the sensor weight from pulling at the non-metallic piping. See the figure below 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 78 PR-23-M with ½ in G/NPT process connection

10.9 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 mm, 80 mm or 100 mm (2 in, 3 in or 4 in) pipelines.

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 Teflon body refractometer PR-23-M/MS (page 143), 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.

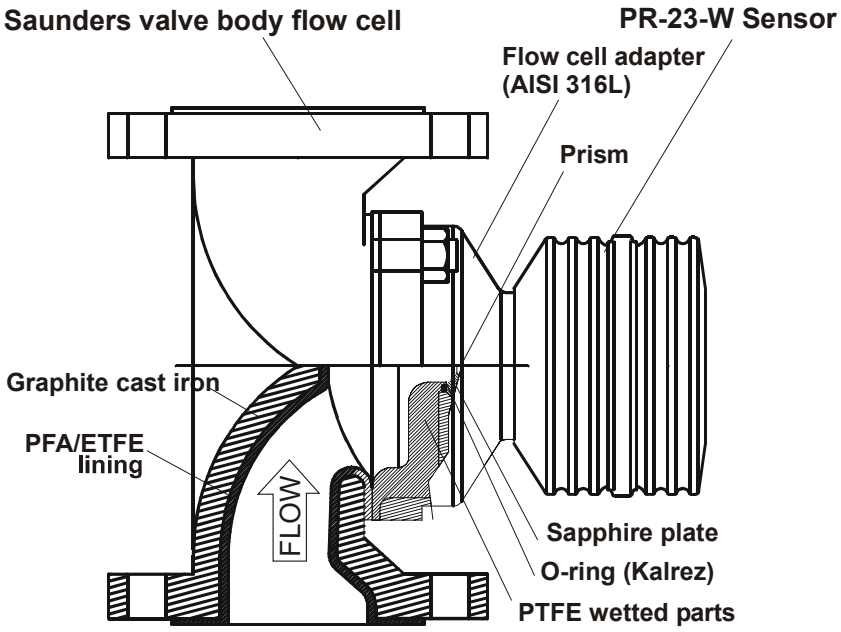


Figure 79 PR-23-W Saunders® body sensor

10.9.1 PR-23-W sensor model code

Table 49 PR-23-W sensor model code

Model	Description
PR-23	Sensor
Sensor model	
-W	Aggressive medium Saunders® body flow cell
Refractive index range limits	
-73	R.I. 1.320–1.530 n_D sapphire prism
-74	R.I. 1.260–1.470 n_D sapphire prism
Sensor wetted parts material	
-2TF	Teflon® PTFE (Plytetrafluoroethylene)
Sensor/diaphragm valve body connection	
2	Adapter for 2 in/DN 50 valve body

Model	Description
3	Adapter for 3 in/DN 80 valve body
4	Adapter for 4 in/DN 100 valve body
Electrical classification	
-GP	General purpose
-AX	ATEX and IECEx certified Ex II 3G, Ex ec IIC T4 Gc (up to zone 2). T_{amb} −20 … +65 °C (−4 … +149 °F)
-FM	FM certified Class I, Div.2, Groups A, B, C, D, T6 T_{amb} −20 … +45 °C (−4 … +113 °F)
-CS	CSA certified Class I, Div.2, Groups A, B, C, D, T4 T_{amb} −20 … +45 °C (−4 … +113 °F)
-IA	ATEX and IECEx certified Ex II 1G, Ex ia IIC T4 Ga (up to zone 0), T_{amb} −20 … +65 °C (−4 … +149 °F) 1)
-IF	FM certified to US and Canadian standards Class I, Div.1, Groups A, B, C, D, T4 T_{amb} −20 … +45 °C (−4 … +113 °F) 1)
-CX	NEPSI Certified for use in Ex nA IIC T4 Gc
-CI	NEPSI Certified for use in Ex ia IIC T4 Ga
Sensor housing	
-SC	Stainless steel AISI 316

1) *Available with STR indicating transmitter and IS isolator only*

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

Table 50 Saunders® valve body flow cell for sensor PR-23-W

Model	Description
SVB	Saunders®valve body flow cell
Process line connection	
-A020	ANSI flange 2 in 150 lbs
-A030	ANSI flange 3 in 150 lbs
-A040	ANSI flange 4 in 150 lbs
-D050	DIN flange DN 50 PN 16
-D080	DIN flange DN 80 PN 16
-D100	DIN flange DN 100 PN 16
-J050	JIS flange 10K 50A
-J080	JIS flange 10K 80A
-J100	JIS flange 10K 100A

Model	Description
Valve body material	
-GC	Graphite cast iron
Valve body lining material	
-ETFE	ETFE (ethylene tetrafluoroethylene)
-PFA	PFA (fluorinated ethylene propylene)

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

10.9.2 PR-23-W specifications

Table 51 General specifications

Feature	Specification
Refractive index range, standard	Full range n_D 1.3200 ... 1.5300, sapphire prism
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
Digital measurement	3648 pixel CCD element
Light source	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	−20 °C ... +45 °C (−4 °F ... +113 °F)

Table 52 Sensor PR-23-W specifications

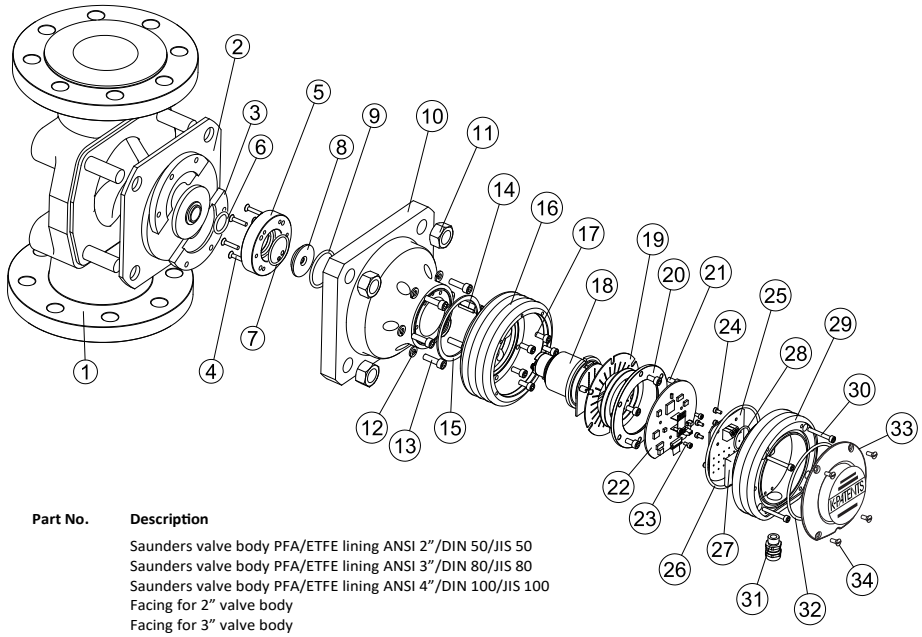
Feature	Specification
Sensor PR-23-W	Saunders® body sensor for aggressive process medium
Process connection	With PFA (Fluorinated ethylene propylene) or ETFE (Ethylenetetrafluoroethylene) lined Saunders valve body 2 in, 3 in or 4 in

Feature	Specification
Process pressure	Max. 10 bar (145 psi)
Process temperature	–20 °C ... +130 °C (–4 °F ... +266 °F)
Process wetted parts, standard	Teflon® (PTFE), sapphire prism, prism gaskets MTF (Modified Teflon)
Sensor protection class	IP67, Nema 4X
Protection class	Protection class 3
Sensor weight	Sensor and 2 in Saunders® body 15 kg (33 lbs), sensor and 3 in Saunders® body 26 kg (57 lbs), sensor and 4 in Saunders® body 33 kg (73 lbs)

Table 53 Saunders® valve body specifications

Feature	Specification
Valve body material	Graphite cast iron
Valve body lining material	PFA (Fluorinated ethylene propylene) / ETFE (Ethylene tetrafluoroethylene)
Process connection	ANSI flange 2 in 150 lbs ANSI flange 3 in 150 lbs ANSI flange 4 in 150 lbs DIN flange DN 50 PN 16 DIN flange DN 80 PN 16 DIN flange DN 100 PN 16 JIS flange 10K 50A JIS flange 10K 80A JIS flange 10K 100A

10.9.3 PR-23-W parts list



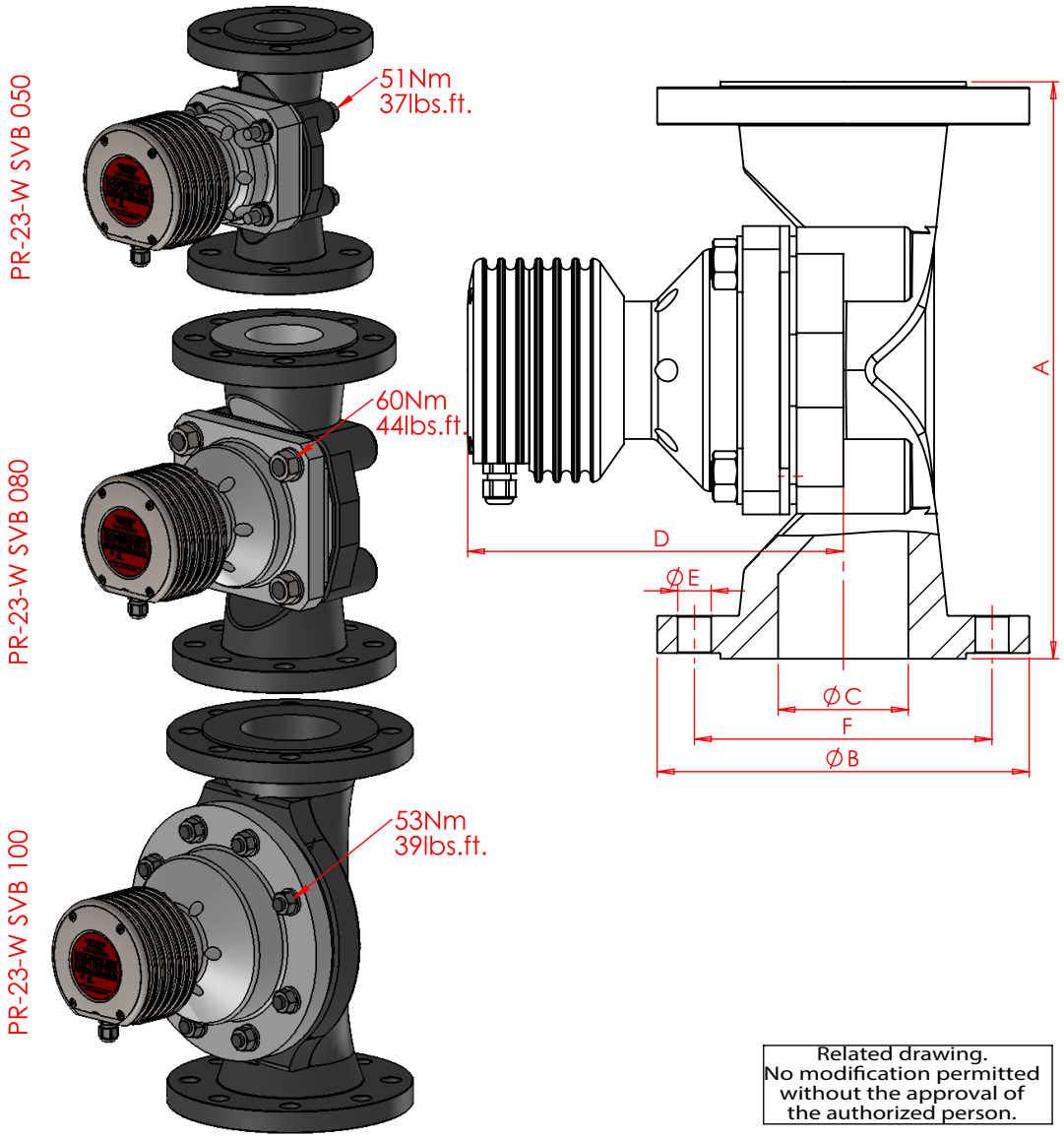
Item	Pcs.	Part No.	Description
1	1		Saunders valve body PFA/ETFE lining ANSI 2”/DIN 50/JIS 50
1	1		Saunders valve body PFA/ETFE lining ANSI 3”/DIN 80/JIS 80
1	1		Saunders valve body PFA/ETFE lining ANSI 4”/DIN 100/JIS 100
2	1		Facing for 2” valve body
2	1		Facing for 3” valve body
2	1		Facing for 4” 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 M6x25 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

Figure 80 PR-23-W parts

10.9.4 PR-23-W mounting specifications

PR-23-W Saunders® valve body flow cell 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 must always be horizontal to avoid sedimentation or gas/air pocket on the prism. Also installation after pump, before valve and low installation point reduces risk of air/gas pocket. Recommended flow velocity is 1.5 ... 6 m/s (5 ... 20 ft/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 81 PR-23-W mounting

10.10 Intrinsically safe refractometers PR-23-...-IA, PR-23-...-IF and PR-23-...-CI

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

Zone0: An area in which an explosive gas-air mixture is continuously present or present for long periods of time.

Zone1: An area in which an explosive gas-air mixture is likely to occur in normal operation.

Intrinsically Safe Process Refractometer PR-23-...-IA/-IF/-CI 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 (−4 ... +149 °F)** and under the IECEx scheme **for Ex ia IIC T4 Ga and Ex ia I Ma, T_{amb} = −20 ... +65 °C (−4 ... +149 °F)**. 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 (−4 ... +113 °F)**. 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 (−4 ... +113 °F)**. 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.

The PR-23--...-CI refractometer is certified by Nepsi under Chinese standards under the **IECEx scheme for Ex ia IIC T4 Ga**. The certificate number is GYJ19.1133X. This certification covers the following Ex standards: GB 3836.1-2010, GB 3836.4-2010 and GB 3836.20-2010.

Only trained service personnel of Vaisala and its representatives are permitted to service the intrinsically safe PR-23-...-IA/-IF/-CI refractometer. Servicing must be performed according to separate instructions defined by Vaisala and must be reported to Vaisala.

10.10.1 Intrinsically safe refractometer equipment

The intrinsically safe process refractometer consists of the following:

- A modified refractometer sensor PR-23-...-IA/-IF/-CI
- An indicating transmitter STR with single sensor connectivity

- IS isolator and cabling between the refractometer sensor and the transmitter

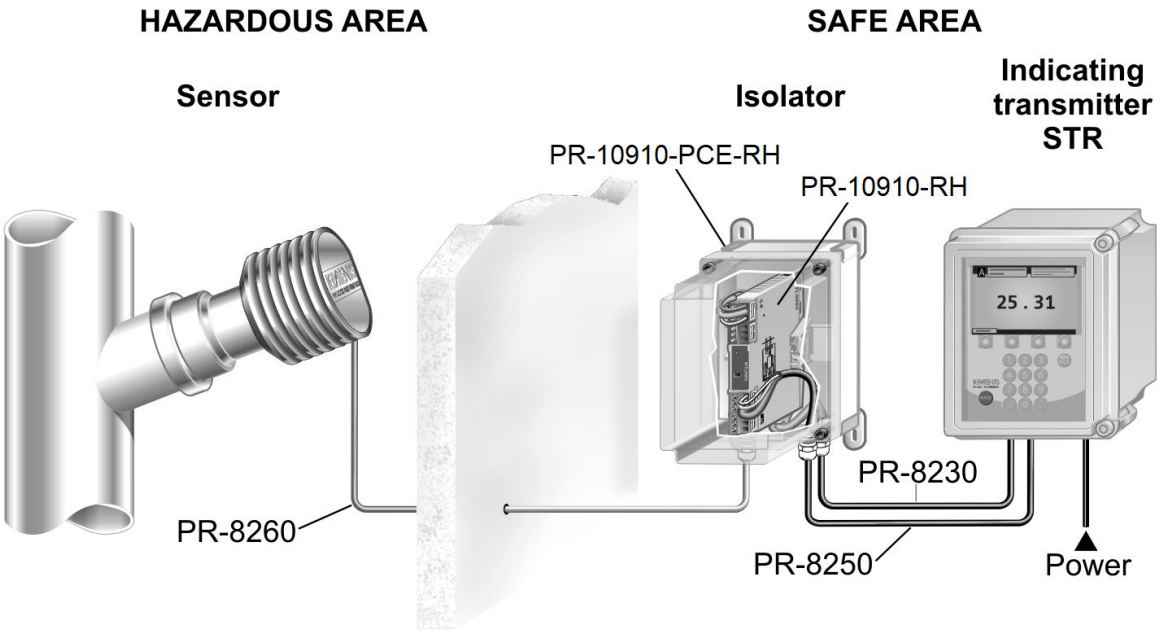
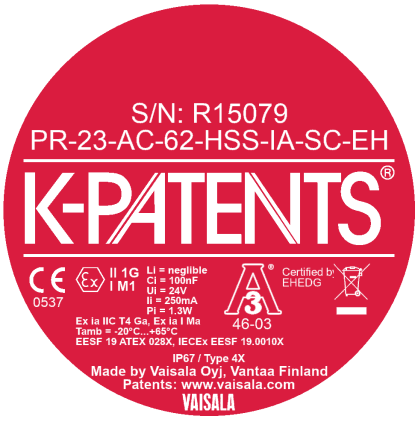


Figure 82 Refractometer system PR-23-...-IA/-IF/-CI with STR

The equipment is intrinsically safe only if **all** mounting instructions in Intrinsically safe mounting (page 162) 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.

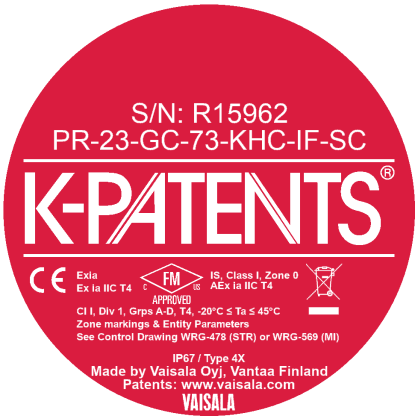
The intrinsically safe sensor PR-23-...-IA/-IF/-CI is identified by the nameplate, see the following figure. The Indicating transmitter is of model STR, for single sensor connection.



3-A approved intrinsically safe -IA sensor

Other intrinsically safe -IA sensor

3-A approved intrinsically safe -IF sensor



Other intrinsically safe -IF sensor

3-A approved intrinsically safe -CI sensor

Other intrinsically safe -CI sensor

Figure 83 Intrinsically safe sensor nameplates

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).

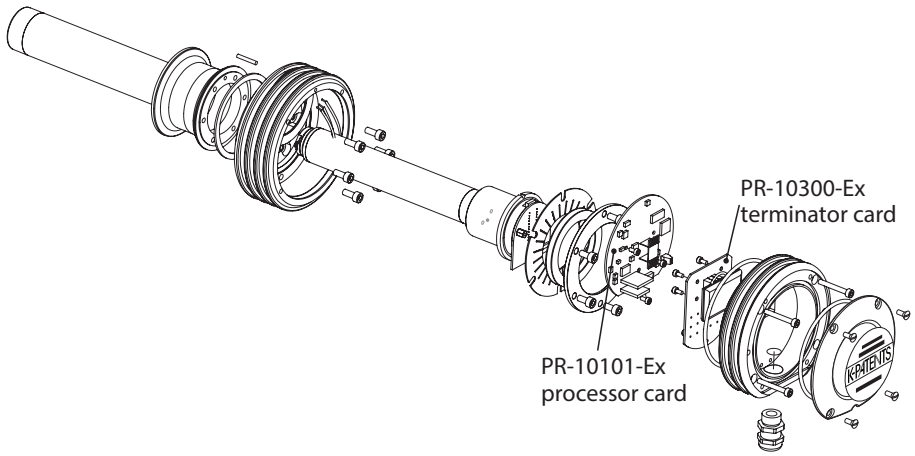


Figure 84 Intrinsically safe parts

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

Contains lightmetals

Ignition hazard!

Avoid impact!

Figure 85 Warning sticker

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

WARNING! 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.

WARNING! 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.

10.10.2 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.

CAUTION! 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 following figures describe the electrical connections for PR-23-...-IA/-CI and the electrical connections for PR-23-...-IF.

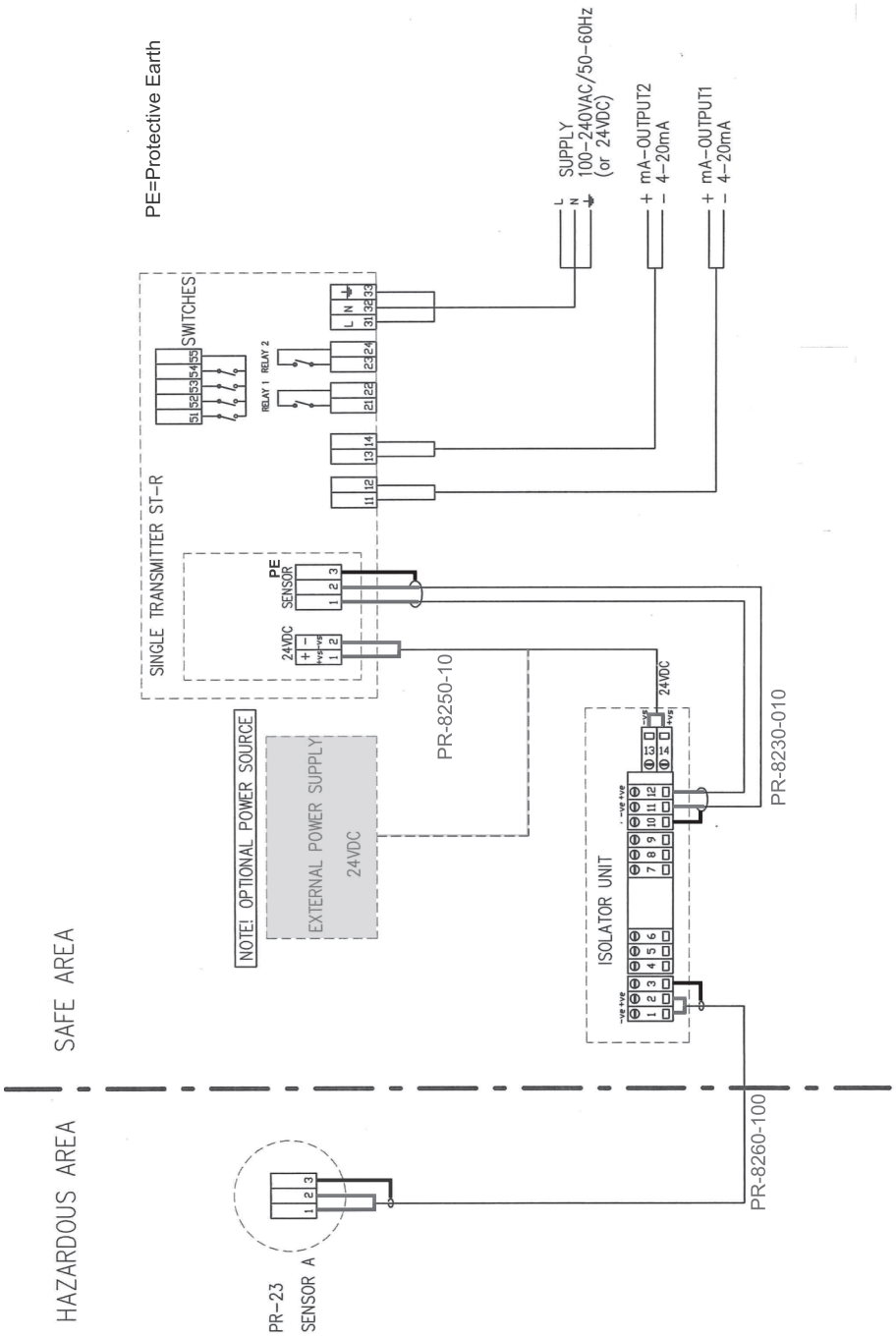


Figure 86 Intrinsically safe wiring, PR-23-...-IA/-CI according to WRG-362

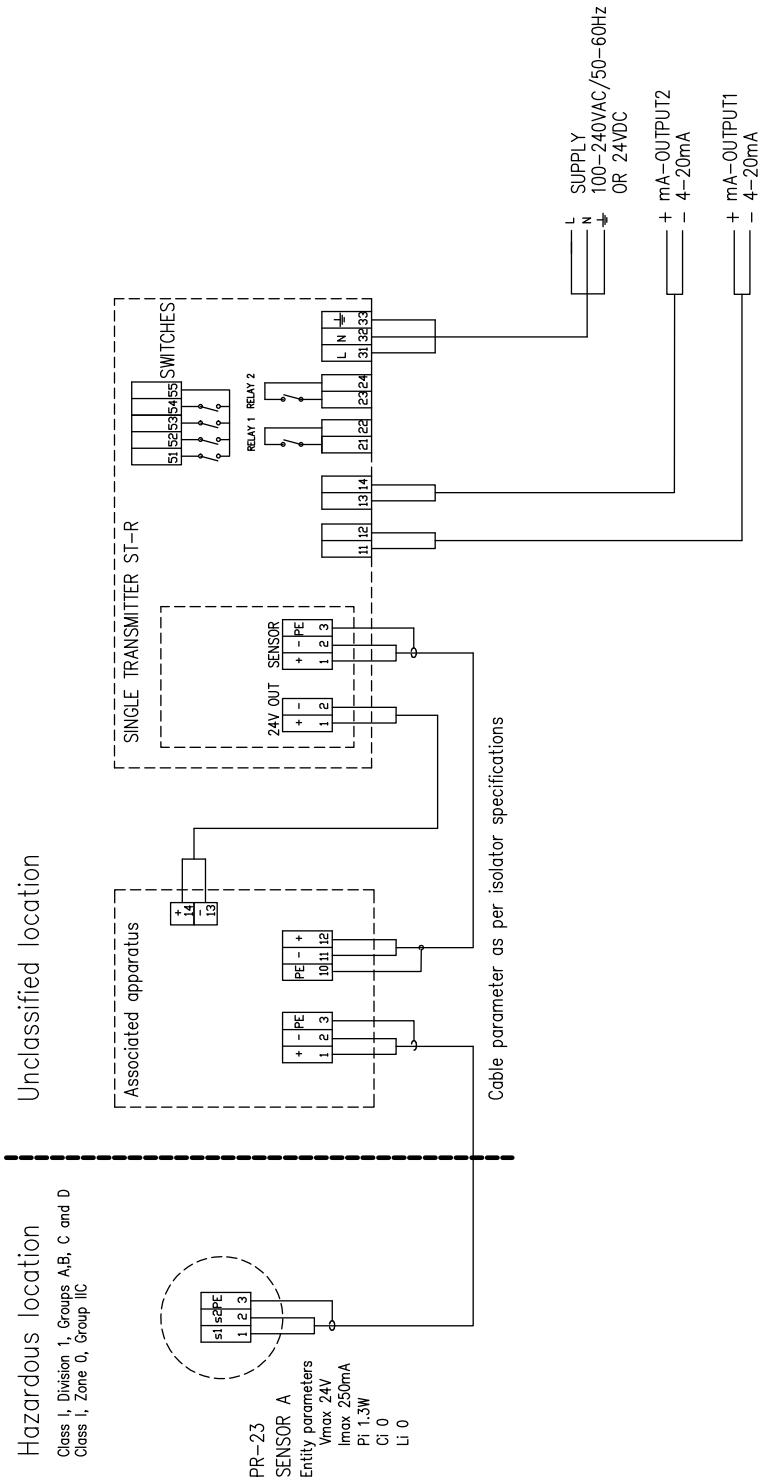


Figure 87 Intrinsically safe wiring, PR-23-...-IF with STR according to WRG-478

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 2 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
- La or Lo >= Li + Lcable, Po < Pi

CAUTION! Control equipment connected to the Associated Apparatus shall not use or generate more than 250 Vrms or V DC. 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 Figure 86 (page 163) and Figure 88 (page 166).

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

10.10.3 Isolator/barriers

The following figure shows the isolator unit wiring.

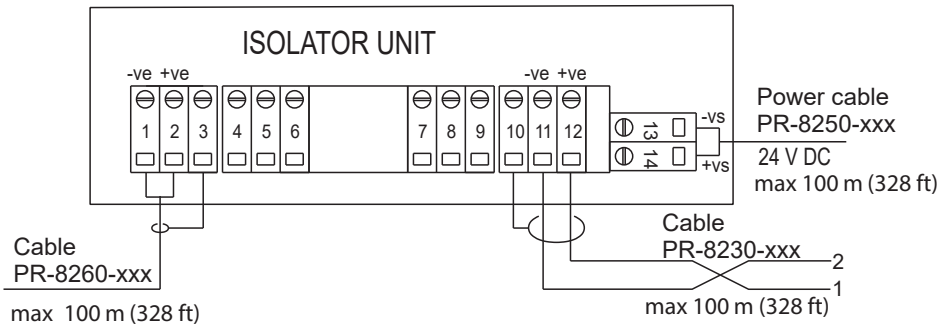


Figure 88 Isolator unit wiring

If the power to isolator unit terminals is not correctly connected, +24 V DC to terminal 14 (+vs) and zero to terminal 13 (-vs), the transmitter STR displays the message **NO SIGNAL**. 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** displays.

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 in) or above, for example in wood pulp industry.

11.1 Safe-Drive 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 2-part retractor can be kept separately in clean storage and all the installed PR-23-SD sensors can be inserted and removed with one the and same tool.

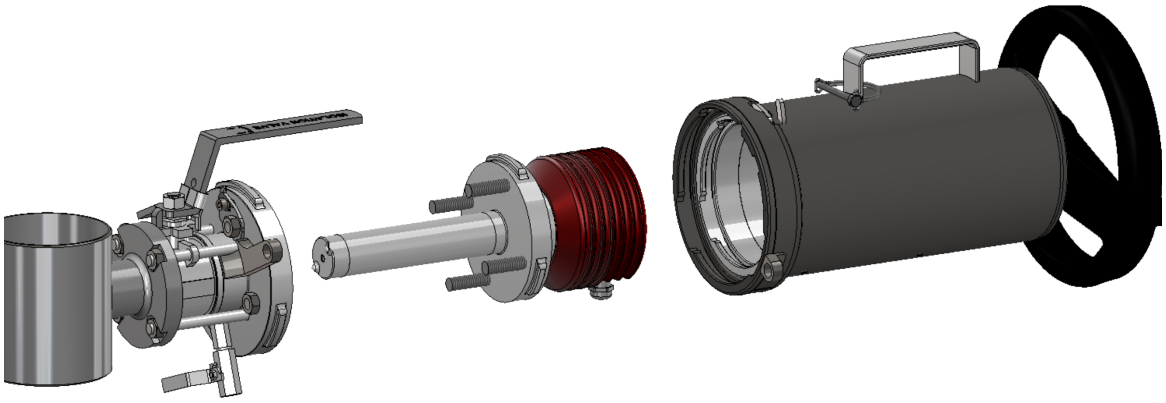


Figure 89 Safe-Drive system: isolation valve, PR-23-SD sensor, retractor

11.2 PR-23-SD specifications

Table 54 PR-23-SD specifications

Feature	Specification
Refractive index range	Full range n_D 1.3200 ... 1.5300, 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

Feature	Specification
Digital measurement	3648 pixel CCD element
Light source	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	-20 °C ... +45 °C (-4 °F ... +113 °F)

Table 55 PR-23-SD and isolation valve SDI-23 specifications

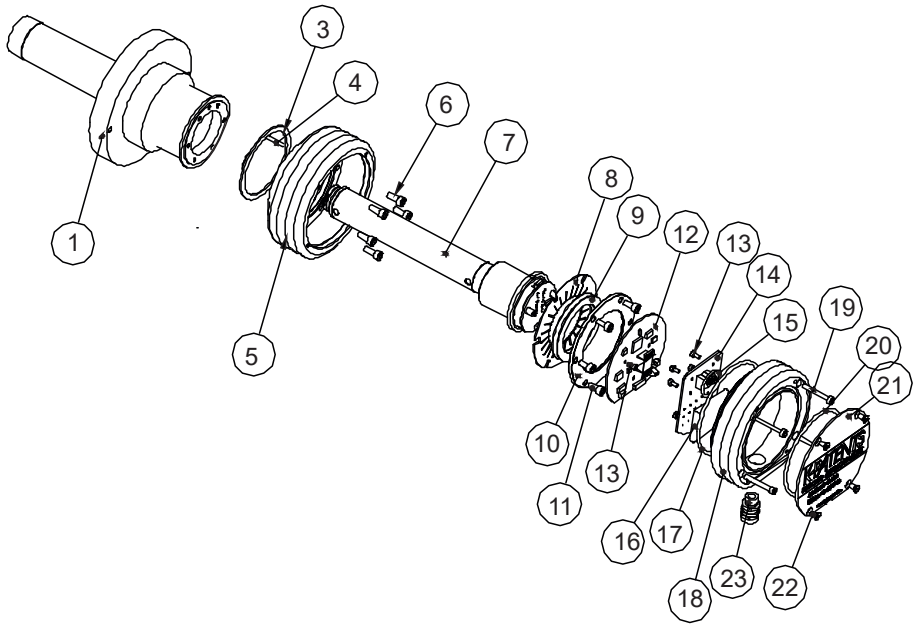
Feature	Specification
Isolation valve connection	Safe-Drive flange DN 40PN25
Process pressure	Static pressure up to 20 bar (300 psi), operational pressure up to 10 bar (150 psi)
Process temperature	-20 ... +170 °C (-4 ... +340 °F)
Process wetted parts, standard	SAF 2205, Duplex steel SS 2377, EN 1.4462, UNS S31803, spinel or sapphire prism, prism gaskets MTF (Modified Teflon®)
Sensor protection class	IP67, Nema 4X
Protection class	Protection class 3
Isolation valve, process wetted parts	SAF 2205, Duplex steel SS 2377, EN 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 in, for both vertical and horizontal pipelines
Prism wash	Retractable steam wash nozzle with check valves, high-pressure water wash nozzle.
Sensor and valve weight	10.5 kg (23 lbs)

Table 56 Safe-Drive retractor SDR-23 specifications

Feature	Specification
Safe-Drive retractor SDR-23	
Retractor weight	7.7 kg (17 lbs)

11.3 Safe-Drive component parts lists

11.3.1 PR-23-SD sensor

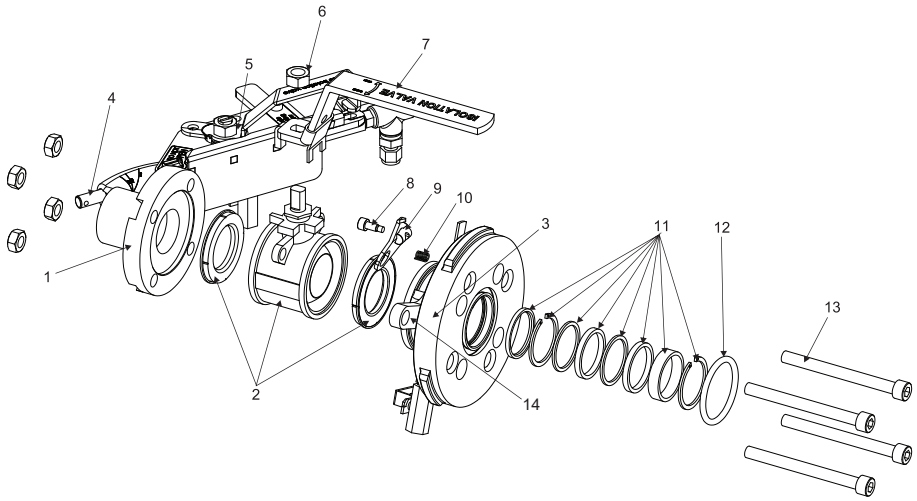


Item	Pcs.	Part No.	Description
1	1	PR-10015	PR-23-SD head
2	1		Safe-Drive™ flange
3	1	PR-10048	68x3 O-ring
4	1		Alignment pin
5	1	PR-10005	PR-23 base
6	6		Screw M5x10 DIN 912 A2
7	1	PR-10022	PR-23-P core
8	1	PR-9011	Thermal conductor
*	1	PR-9010	Disc spring set
9	2		Disc spring
10	1		Disc spring holder

Item	Pcs.	Part No.	Description
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

Figure 90 PR-23-SD sensor parts

11.3.2 Safe-Drive isolation valve SDI2-23



				Item	Pcs.	Part No.	Description
1	1	PR-11000	SDI flange and nozzle	6	1		M12 nut A4
			weld assembly SAF 2205	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

Figure 91 Safe-Drive isolation valve parts

11.3.3 Safe-Drive steam wash system parts

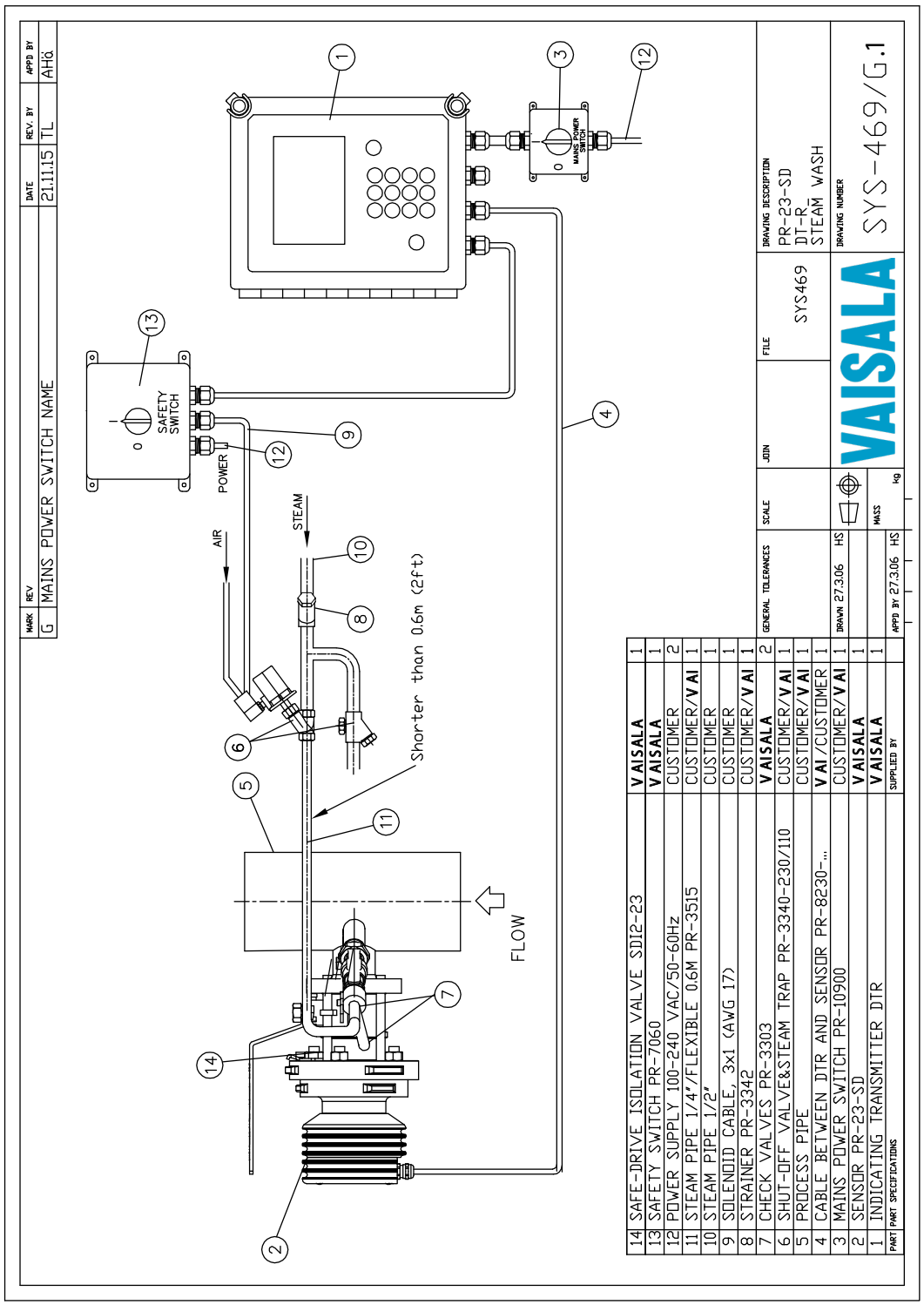


Figure 92 Safe-Drive steam wash system parts

11.3.4 Safe-Drive retractor SDR2-23

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 handwheel is turned, the inner casing moves inside the outer casing along the screw thread.

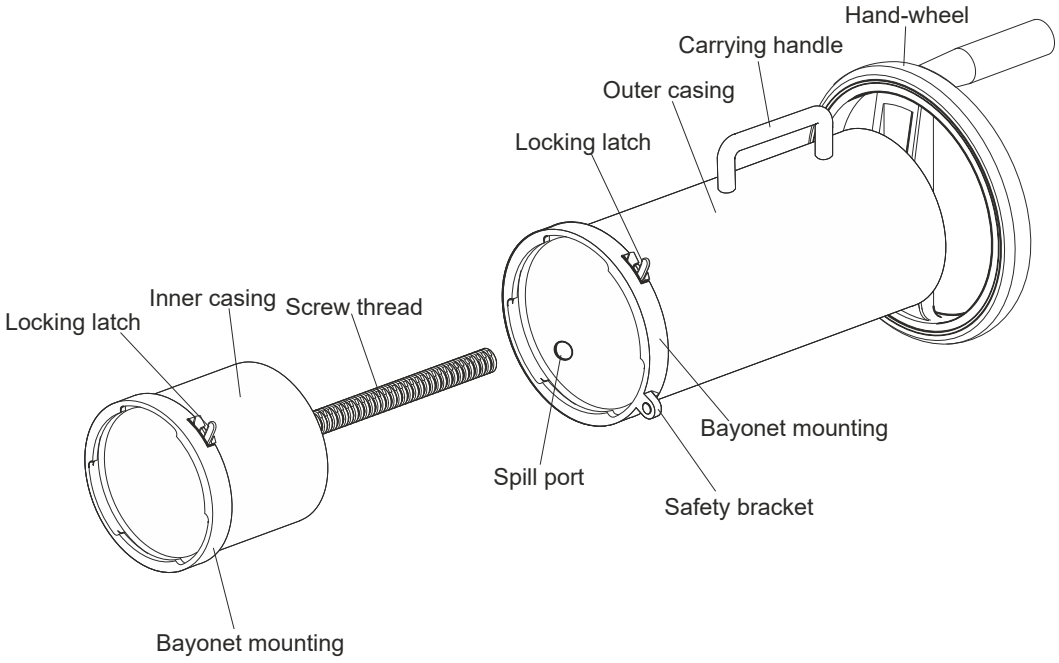


Figure 93 Safe-Drive retractor

11.4 Safe-Drive mounting

A standard Safe-Drive system delivery contains a Safe-Drive sensor (PR-23-SD) with an indicating transmitter DTR, a Safe-Drive isolation valve to be welded onto the 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.

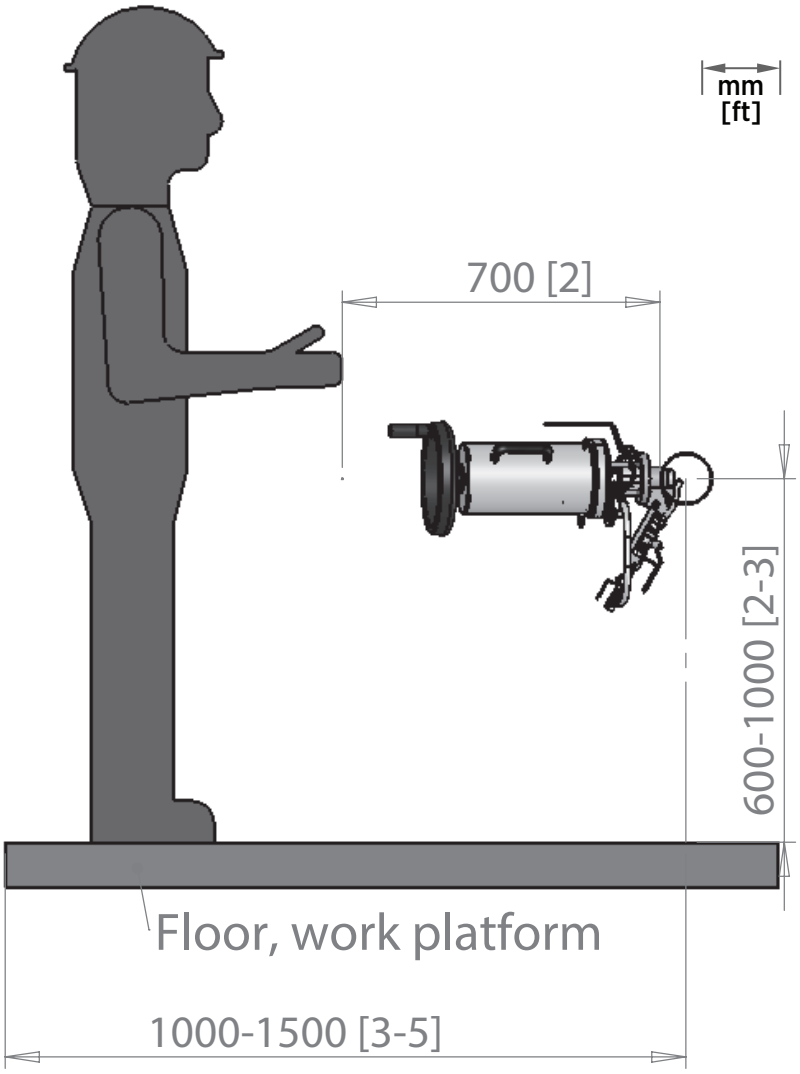


Figure 94 Selecting mounting location

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.

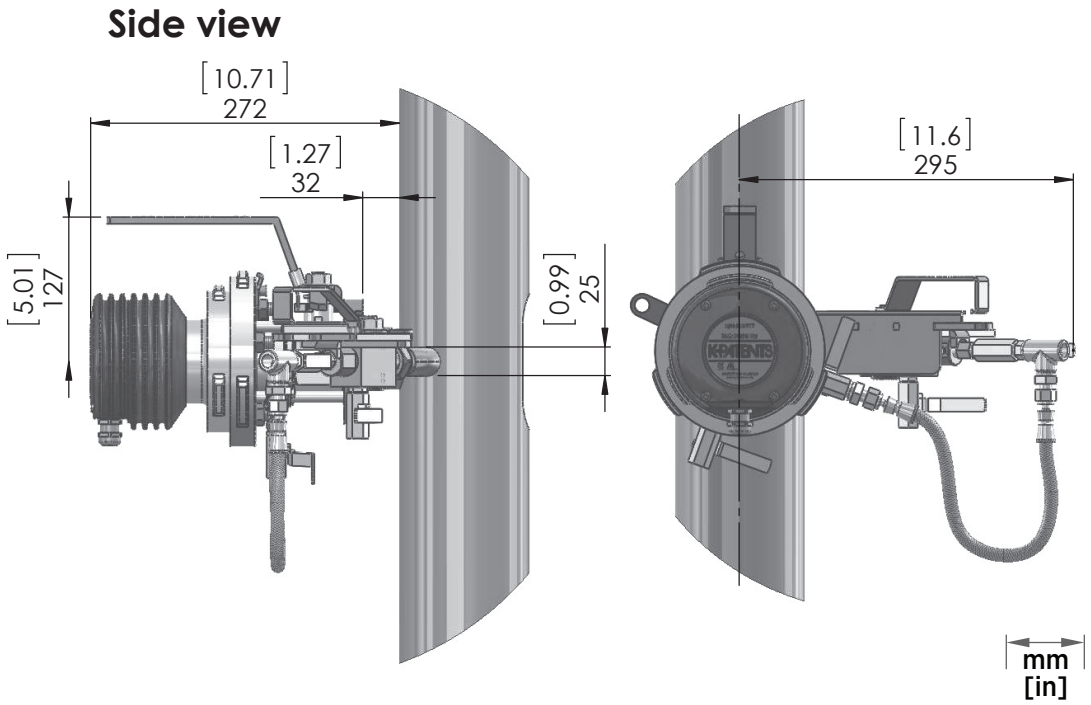


Figure 95 Mounting Safe-Drive on vertical pipe

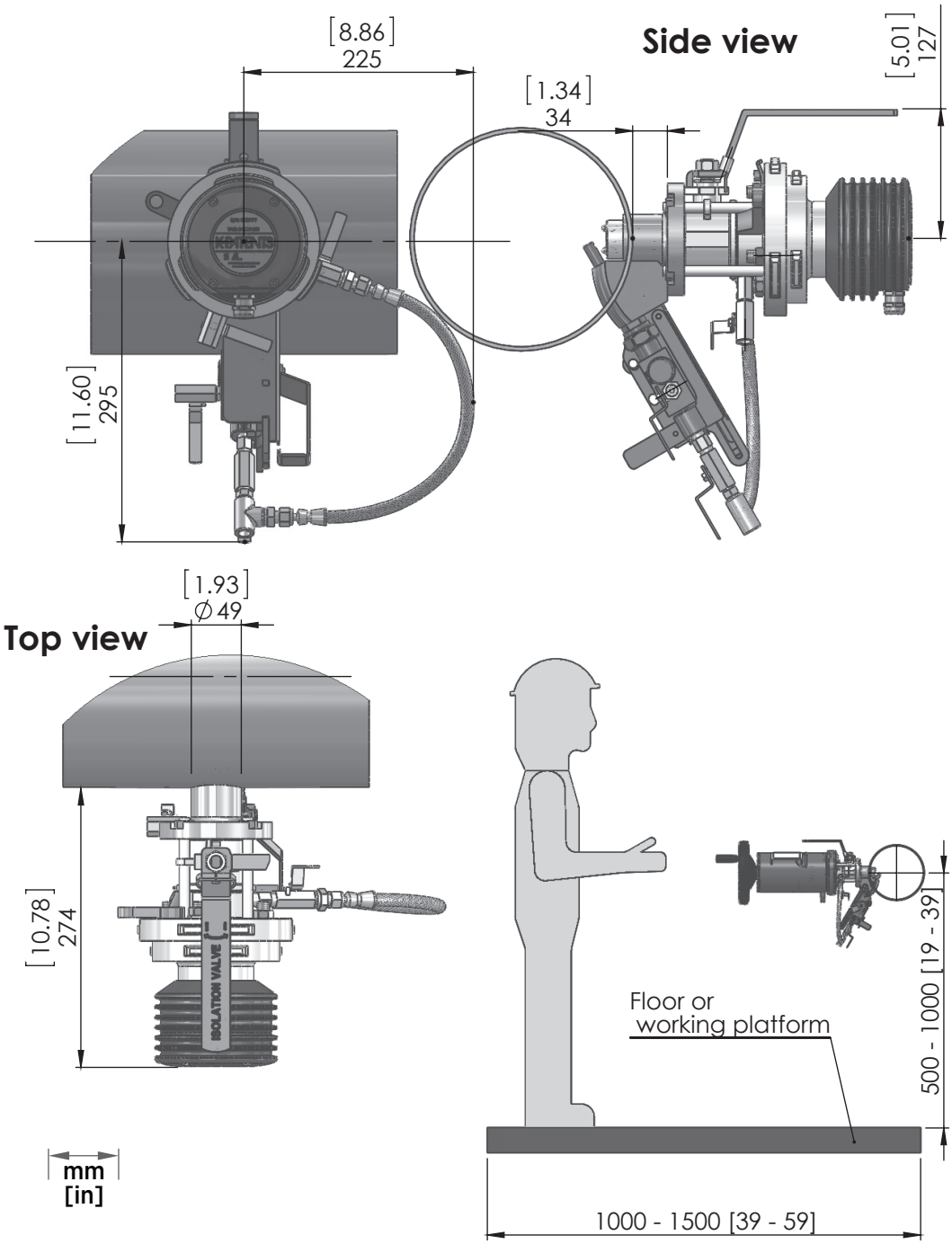


Figure 96 Mounting Safe-Drive on horizontal pipe

11.4.1 Welding isolation valve to pipe

For the Safe-Drive isolation valve, drill one 50 mm (2 in) hole and one 25 mm (1 in) hole to the pipe. Then, remove the bridge between the holes. To help you place the holes correctly, Vaisala delivers an installation guide sticker with the valve.

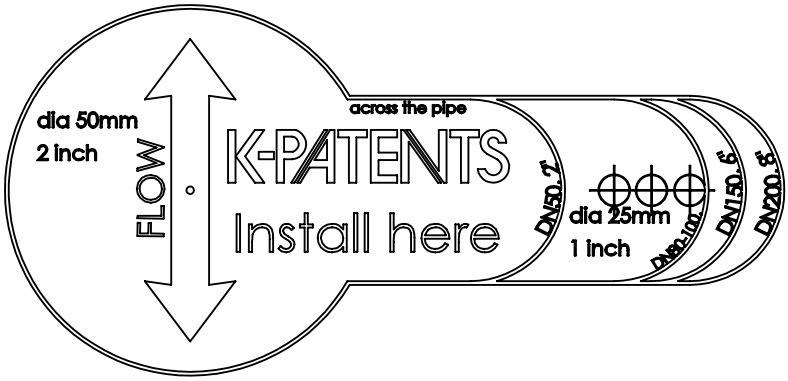
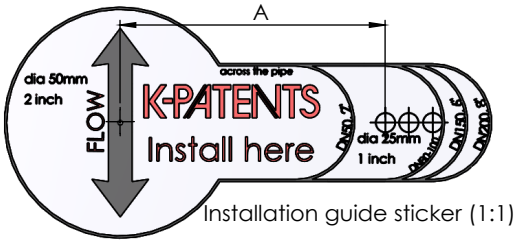


Figure 97 Safe-Drive isolation valve installation guide sticker

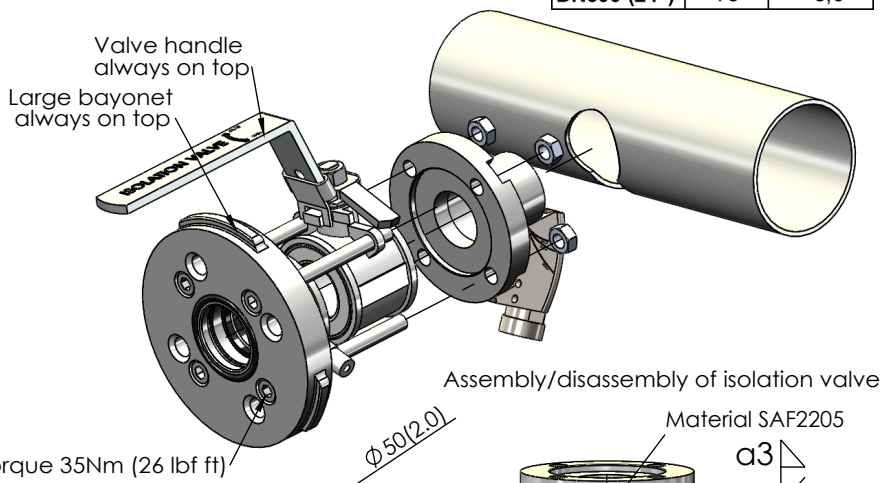
1. Clean the surface of the pipe around the installation area and place the guide sticker across the pipe. Make sure that the flow marker is parallel to the pipe and points to the correct flow direction.
2. Disassemble the isolation valve for welding to avoid thermal damage to the isolation valve sealing.
3. Drill 50 mm (2 in) and 25 mm (1 in) holes to the pipe and cut the metal away between the holes.

4. Weld the isolation valve to the pipe.
   - The following figure shows welding instructions to a horizontal pipe.



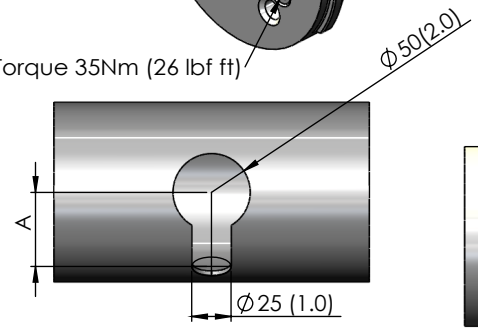
Installation guide sticker (1:1)

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

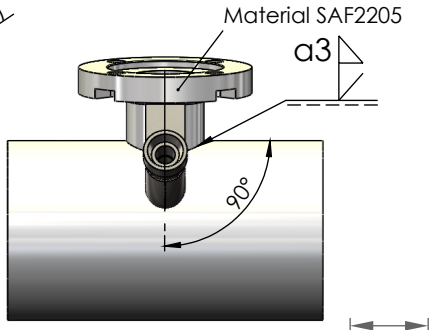


Assembly/disassembly of isolation valve

Torque 35Nm (26 lbf ft)



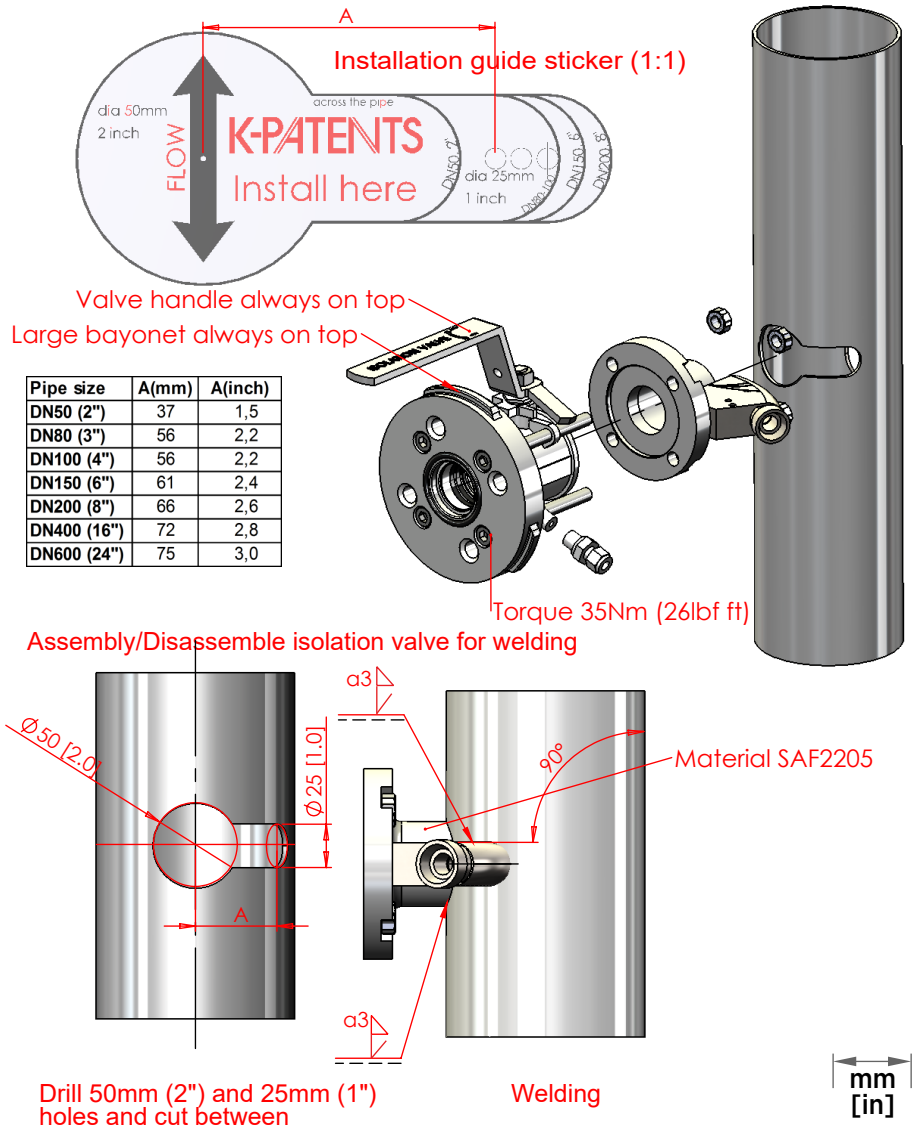
Drill 50mm(2") and 25mm (1") holes and cut between



Welding

mm
[in]

- The following figure shows welding instructions to a vertical 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

5. Reassemble the isolation valve.

> Make sure that you position the isolation valve handle and the large bayonet tooth so that they are on top.

6. Tighten the four M10 nuts to the torque 35 Nm (26 lbf ft).

11.4.2 PR-23-SD system wiring

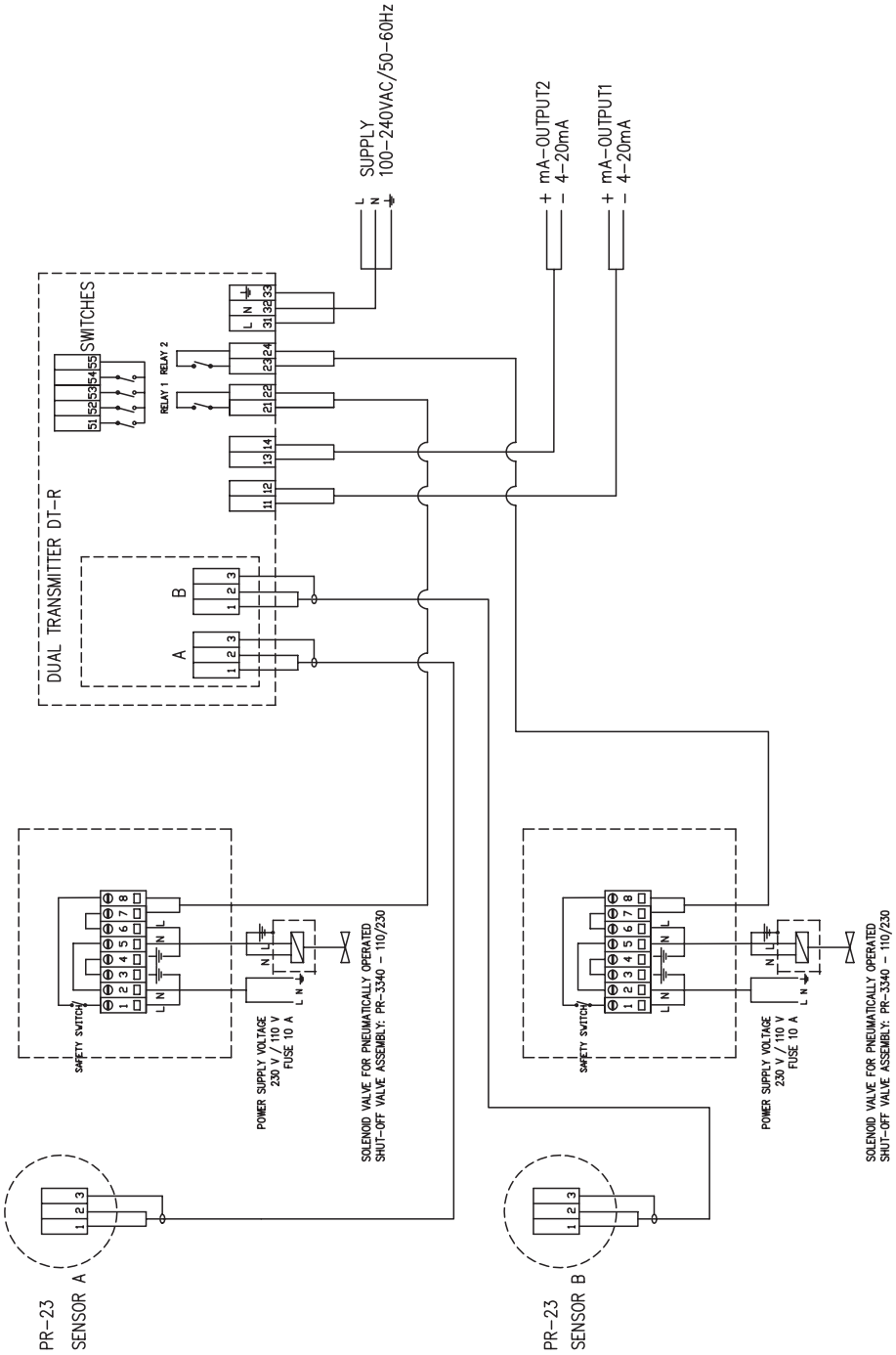
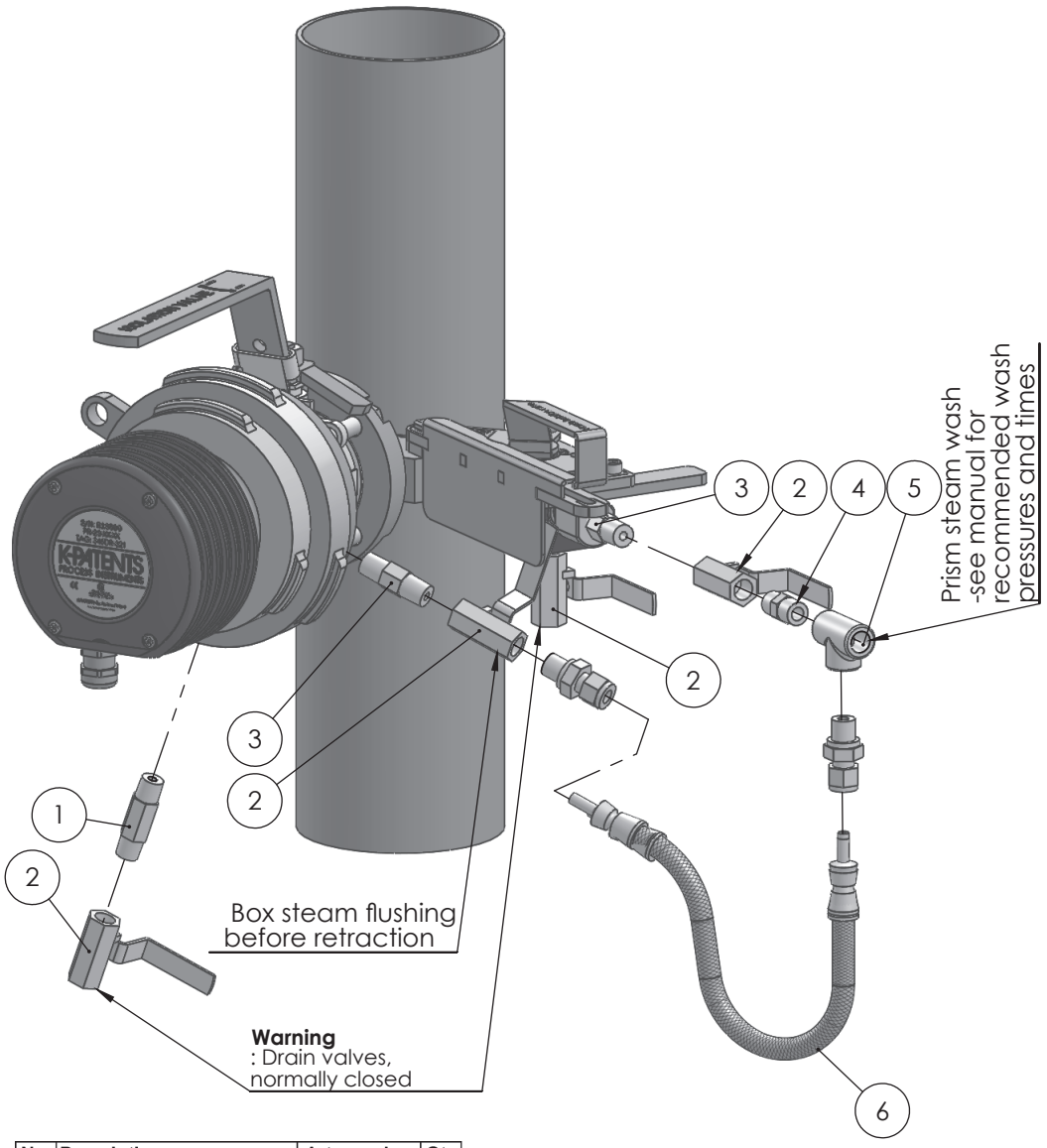


Figure 98 PR-23-SD system wiring

11.4.3 Steam piping for SDI2

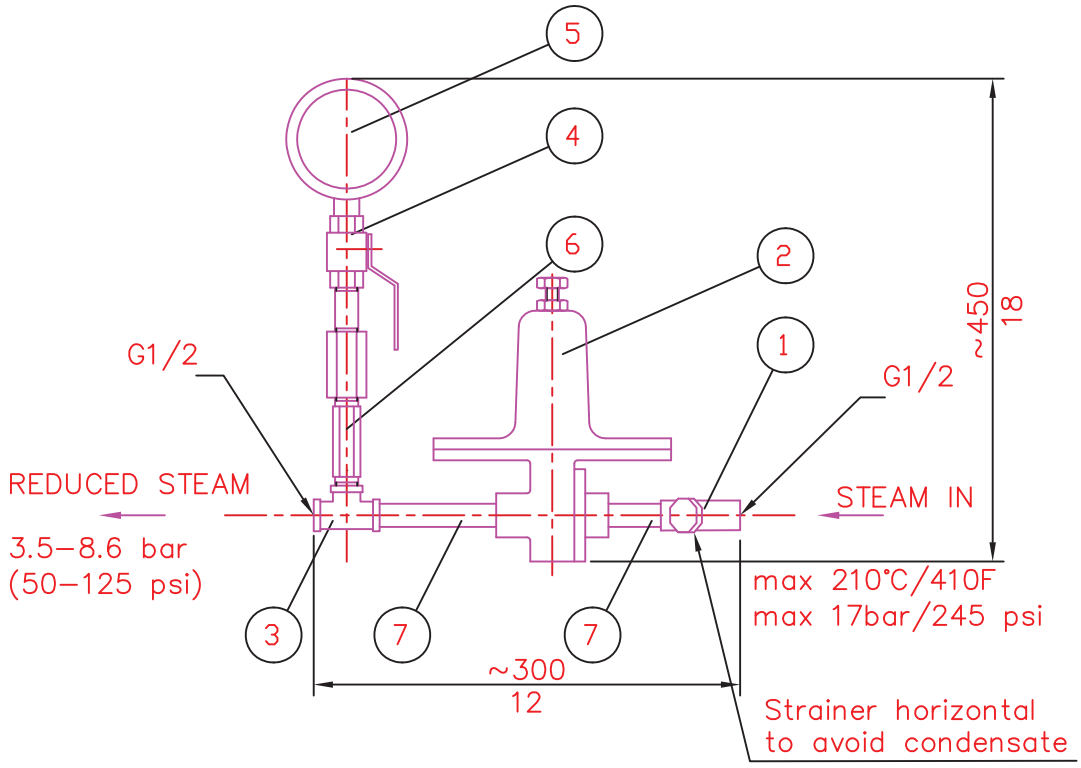
This section describes the steam piping system for SDI2, for example for weak liquor and black liquor.



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 99 Mounting steam wash to isolation valve

If the steam pressure exceeds the maximum pressure differential, a pressure-reducing valve PR-3341-J must 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 100 Pressure-reducing valve PR-3341-J

Note the orientation of the strainer.

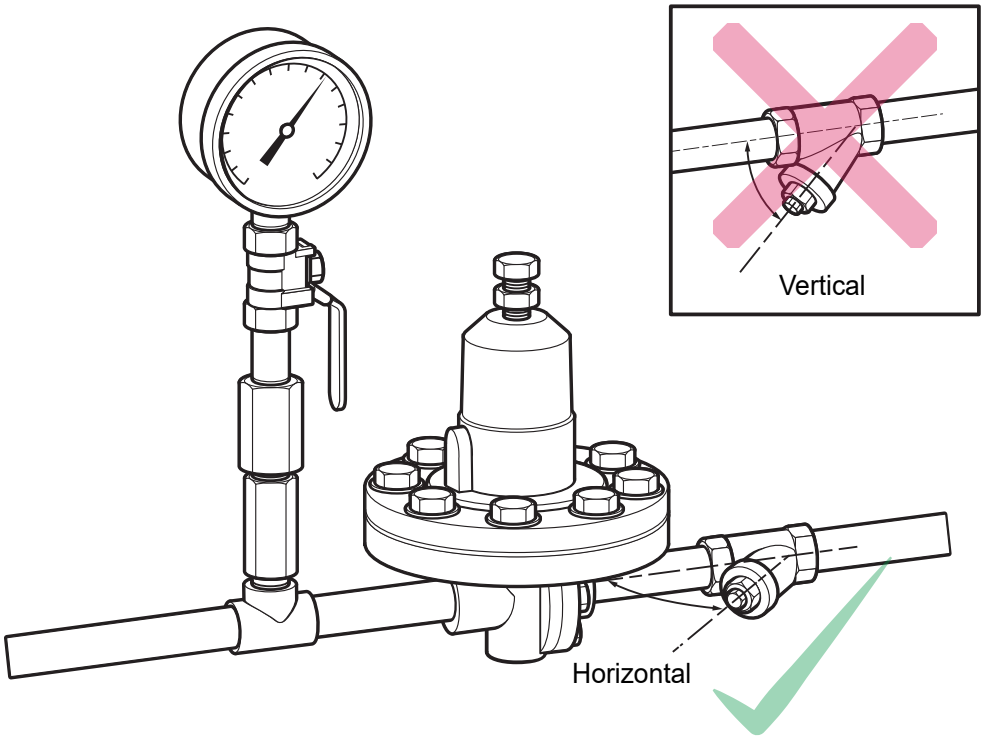
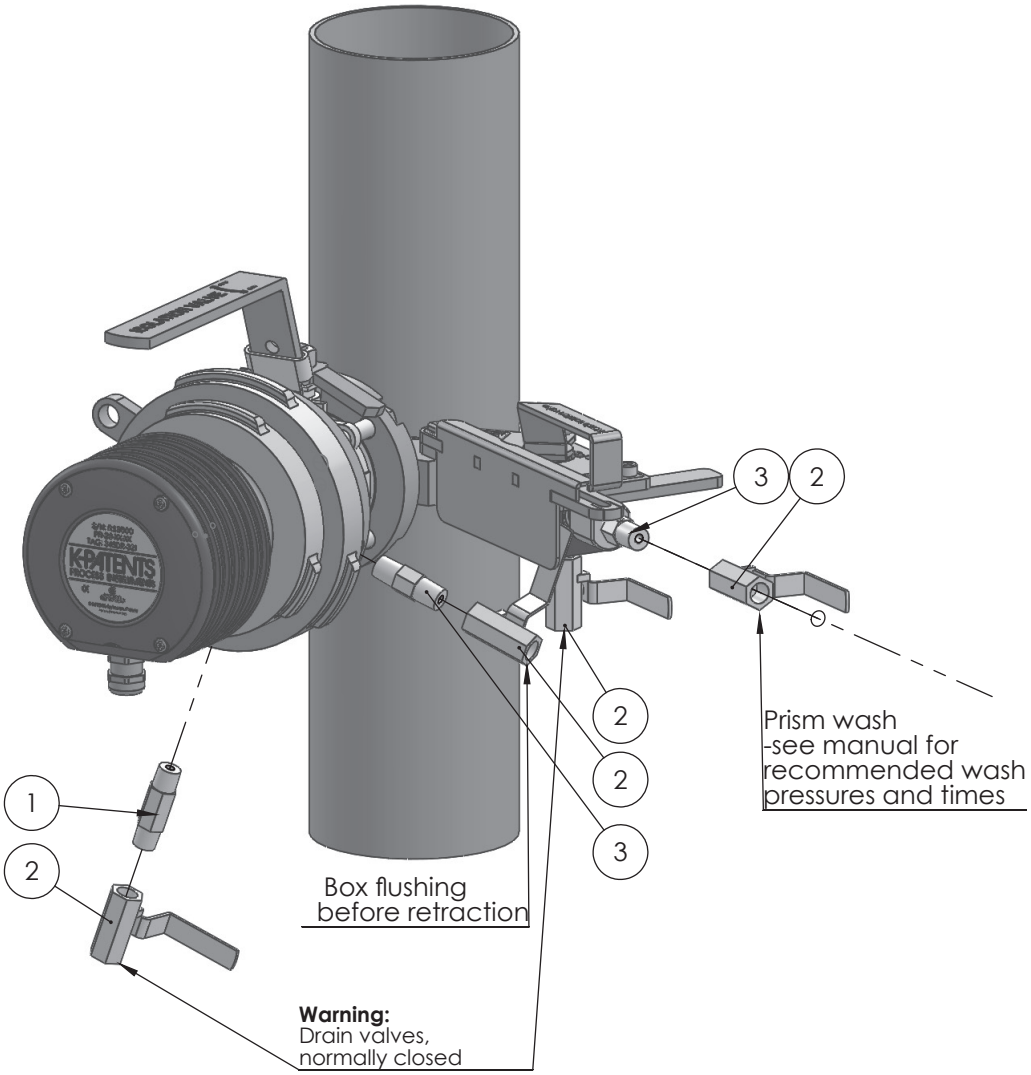


Figure 101 Install strainer horizontally

11.4.4 High pressure water piping for SDI2

The following section describes the high pressure water piping system for SDI2, for example for green liquor.

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.



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

Figure 102 Mounting high pressure water wash to isolation valve

11.4.5 Water consumption of high pressure wash system

Table 57 Nozzle flow at various pressures with 2 mm (0.080 in) nozzle orifice diameter

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

	Water add		
Pressure	**10 s wash**	**10 s wash every 15 min**	**Nozzle flow**
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

11.4.6 Installing the non-retractable wash nozzle

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 the line is under pressure.

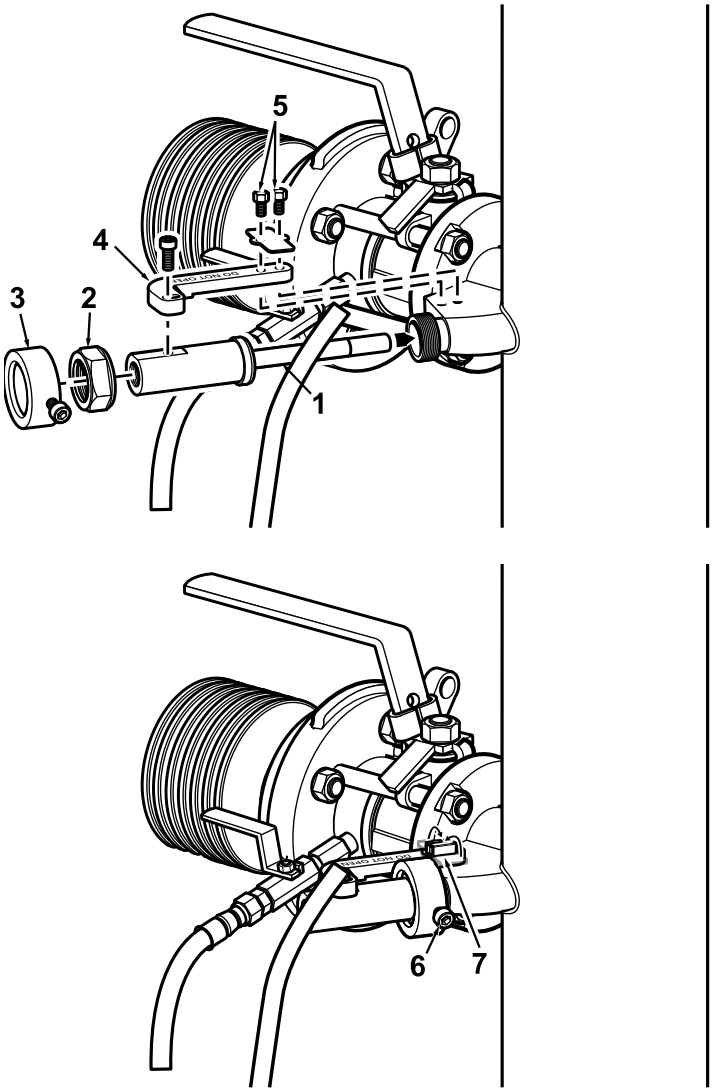


Figure 103 Installing non-retractable wash nozzle

1. Install the wash nozzle (1) into the SDI valve. The flat surface of the wash nozzle must be on top.
2. Insert the nut (2) and hand tighten it to the thread.
3. Slide the protective sleeve (3) onto the wash nozzle.
4. Place the nozzle guide plate (4) on the wash nozzle.
5. Fix the nozzle guide plate to the SDI isolation valve with 2 M5 screws (5). Fix the nozzle guide plate to the wash nozzle with an M5 socket screw.
6. Tighten the wash nozzle nut (2) to 80 Nm. Place the protective sleeve (3) over the nut (2). Tighten the M5 socket screw (6) to secure the protective sleeve.
7. Fold the locking plate (7) over the screws (5).

11.5 Safe sensor insertion and removal for Safe-Drive generation 2.1

These instructions are for Safe-Drive generation 2.1. If you have Safe-Drive generation 1 or generation 2, consider upgrading to generation 2.1. Upgrade from generation 1 requires shutdown, upgrade from generation 2 can be done at any time. See https://www.vaisala.com/en/safe-drive-refractometer-pr-23-sd-manuals-safety-instructions-and-safety-videos 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 is any pressure in the pipe. Also, the lip seal damages easily if the retractor is not used.

WARNING! 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 Figure 99 (page 180) and Figure 102 (page 183), should always be closed unless otherwise indicated. If the valves are left open, process liquid will leak out through them.

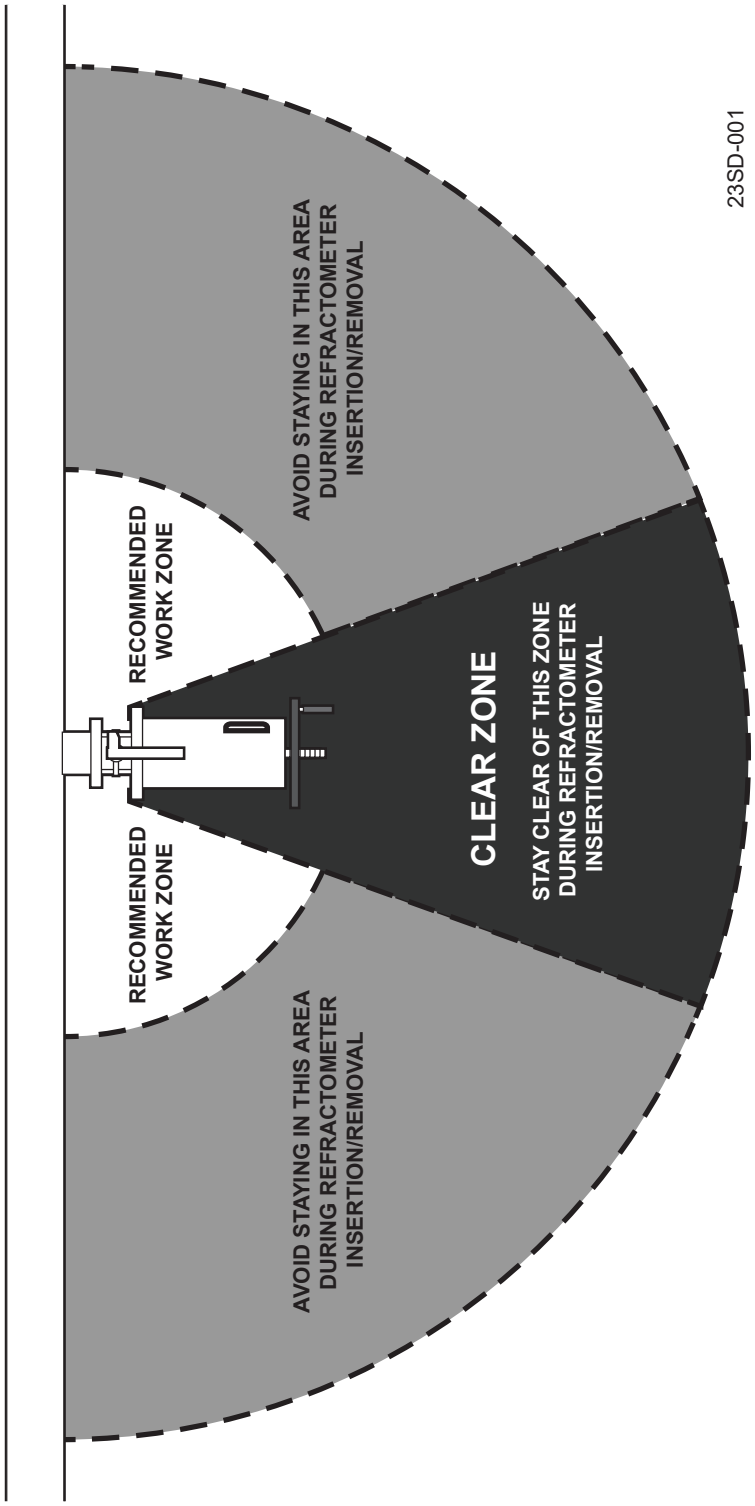


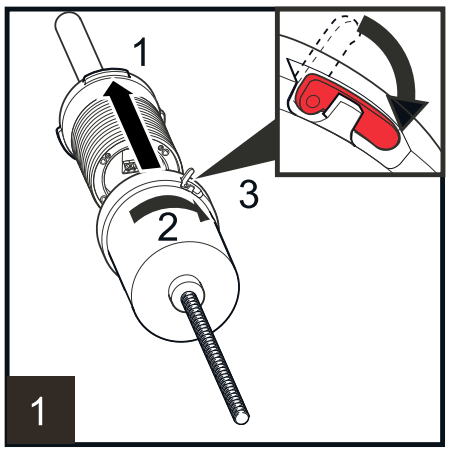
Figure 104 Recommended work zone by side of SD

11.5.1 Inserting Safe-Drive sensor

- Check that the gaskets and gasket surfaces are clean and undamaged

- Remove the sensor cable gland and unlock the inner casing

1. Insert the sensor into inner casing.

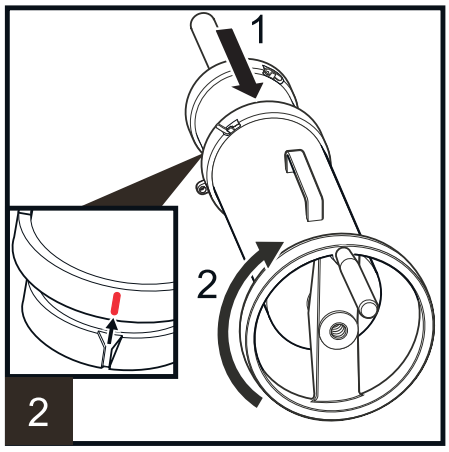


   a. Make sure that the sensor cable gland has been taken off. Match the bayonet closing with sensor flange so that the latch is slightly to the left of the top and the sensor cable passage is straight down.

   b. When sensor flange is flush with the bottom of inner casing, rotate inner casing 60° clockwise to lock it to the flange.

   c. Push down locking latch to secure the connection.

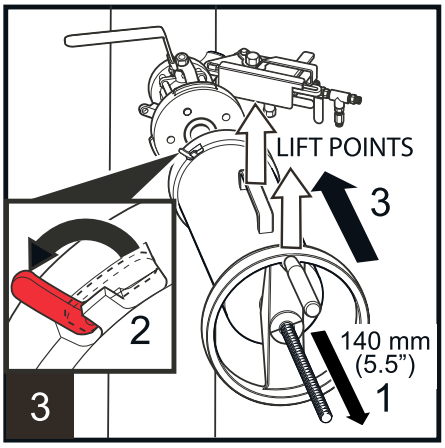
2. Fit outer casing over inner casing.



   a. To match the casings, check that the rail on the inner casing matches the groove on the outer casing. Make sure that the latch of the inner casing is slightly to the right from the top and the handle of the outer casing points up.

   b. Turn the handwheel clockwise until it stops to draw the inner casing with sensor into outer casing.

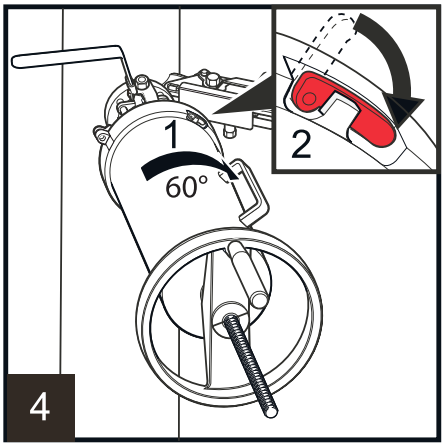
3. The sensor should now be inside retractor and about 140 mm (5.5 in) of the screw thread should stick out of the middle of the wheel.



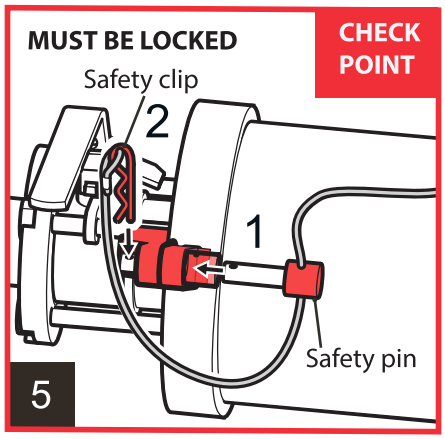
   a. Unlock the latch on outer casing.

   b. Take a firm hold of the handwheel and handle and lift retractor (with sensor) over the isolation valve flange. Keep handle up.

4. Rotate outer casing 60° clockwise to lock the bayonet (1), and lock the outer casing latch (2).



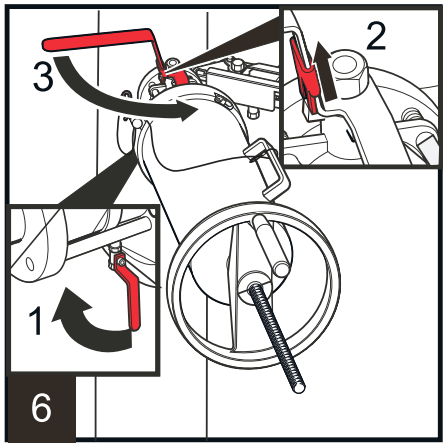
5. Insert the safety pin.



Lock the safety pin with safety clip.

> **WARNING!** Do not proceed until you have completed this step.

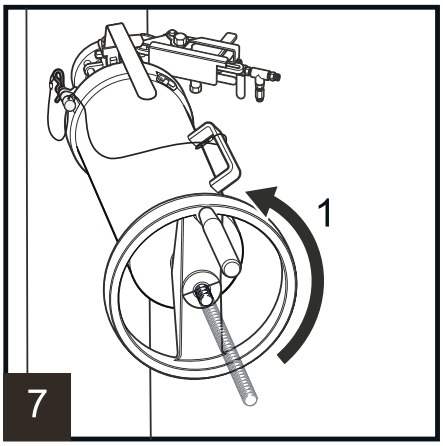
6. Close the blow-out ball valve under isolation valve.



a. Lift up the isolation valve handle locking plate.

b. Open the isolation valve by turning the valve handle 90°. The valve is open when the ball valve handle is parallel to the retractor and sensor.

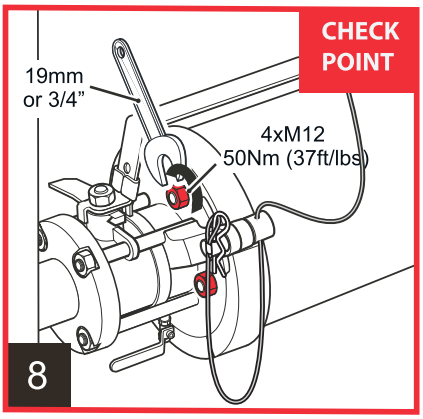
7. Now the sensor can be inserted into the process.



a. Turn the handwheel counterclockwise until it stops, that is 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 proceed with the installation until the reason for leakage has been cleared and fixed.

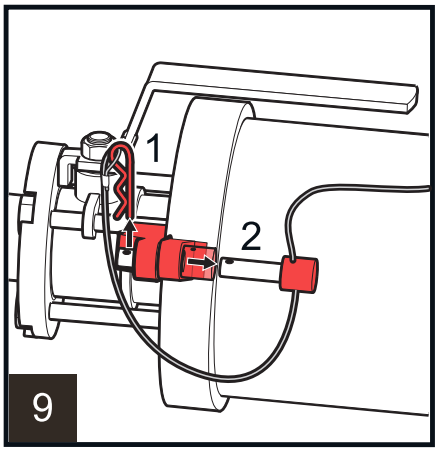
8. Fit the four M12 nuts to the bolts holding the sensor to isolation valve and screw them on with a 19 mm or ¾ in wrench.



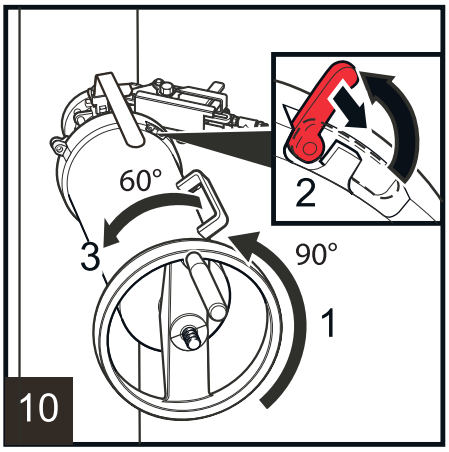
CAUTION! Do not overtighten the nuts, set the torque at 50 Nm (37 ft/lbs).

WARNING! Do not proceed until you have completed this step.

9. Remove the safety clip (1) and the safety pin (2).

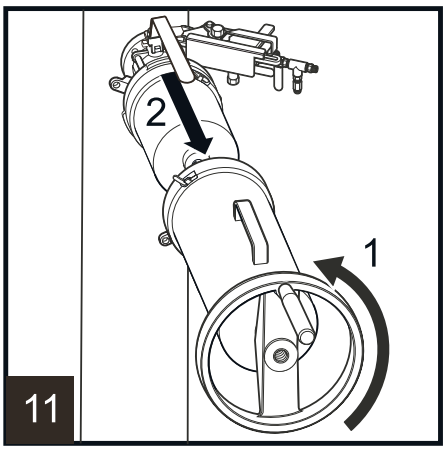


10. Turn the wheel 90° counterclockwise.

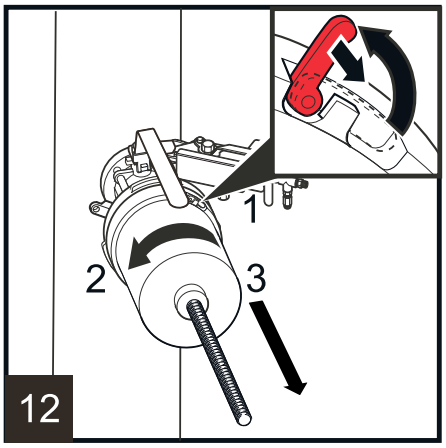


    a. Open the locking latch on outer casing.
    b. Rotate outer casing handle 60° counterclockwise.

11. Turn the handwheel counterclockwise to drop the thread (1), and lift off outer casing.

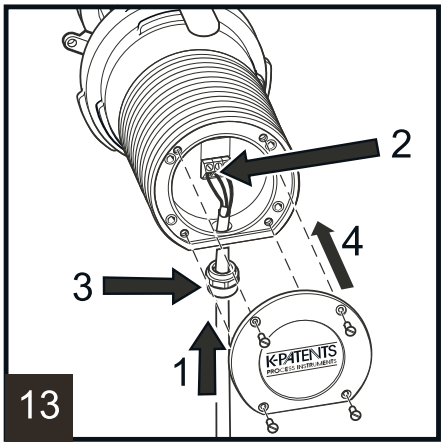


12. Lift up the latch of inner casing to unlock it.



   a. Rotate the casing 60° counterclockwise to release it from the flange.
   b. Lift inner casing away from the sensor head.

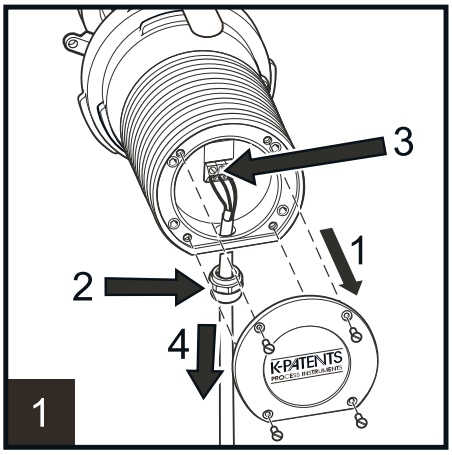
13. Ensure the DTR is switched off. Connect the sensor cable to the DTR.



   a. Push the interconnecting cable through the cable gland and into the sensor.
   b. Connect the interconnecting cable to the sensor.
   c. Tighten the cable gland onto the sensor.
   d. 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 Removing Safe-Drive sensor

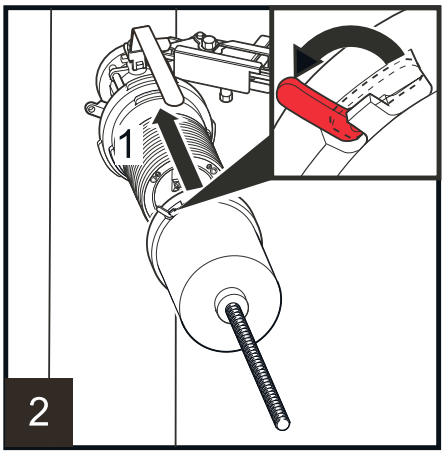
1. Switch off the DTR to cut off power from the sensor. Close wash valve.



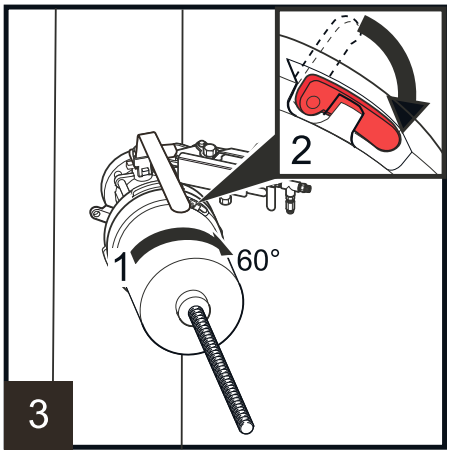
   a. Unscrew and remove sensor nameplate.
   b. Loosen the cable gland.
   c. Unscrew the wires.
   d. Remove the sensor cable and cable gland.

> If another in-line sensor is connected to the same DTR, disconnect the loose cable from the DTR and turn on power again.

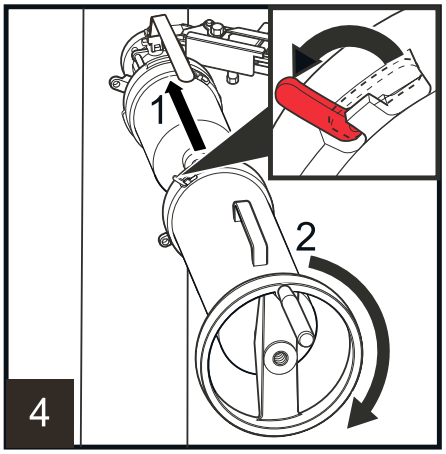
2. Lift up the latch of Inner casing to unlock it. Lift inner casing over the sensor head. The latch of inner casing should be slightly to the left.



3. Rotate Inner casing 60° clockwise to lock it onto the flange (1) and lock inner casing latch (2).



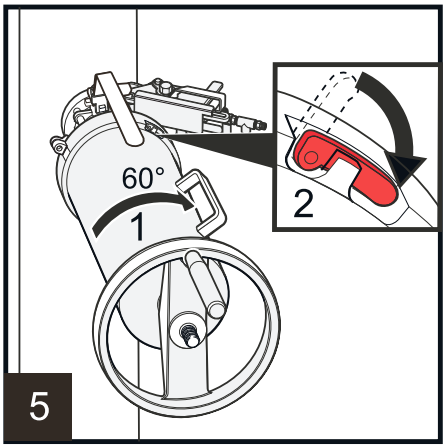
4. Open the locking latch on outer casing. Grab outer casing with one hand on the handle and the other hand on the wheel.



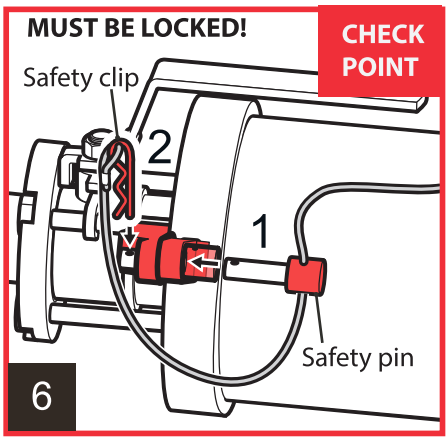
   a. Fit outer casing over inner casing.

   b. Turn the handwheel clockwise to get the thread of inner casing running through the handwheel.

5. Rotate outer casing 60° clockwise to lock the bayonet (1) and lock the outer casing latch (2).

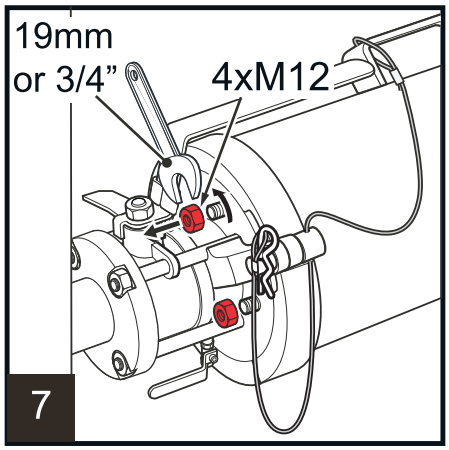


6. Insert the safety pin (1) and lock the safety pin with the safety clip (2).

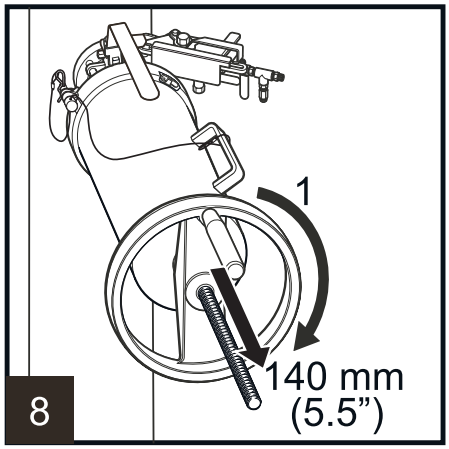


WARNING! Do not proceed until you have completed this step.

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

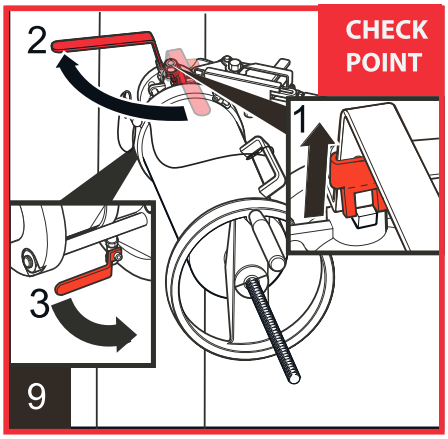


8. To remove the sensor from the process, turn the handwheel clockwise until it stops. At this stage about 140 mm (5.5 in) of the thread should stick out from the middle of the wheel.



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

9. Lift up Isolation valve handle locking plate.



a. Close Isolation valve by turning the handle 90°.

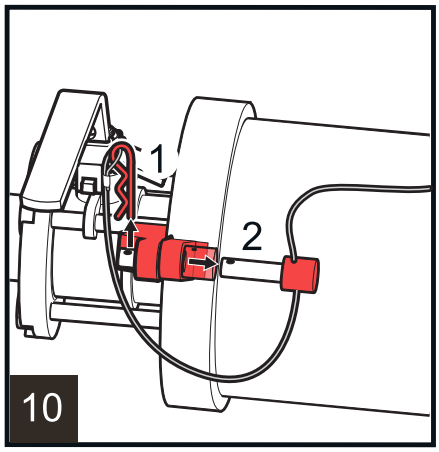
Isolation valve is properly closed when the handle points away from the sensor and the locking plate drops down over the handle.

b. Open the blow-out valve under Isolation valve for box cleaning to get rid of any process liquid inside the Isolation valve.

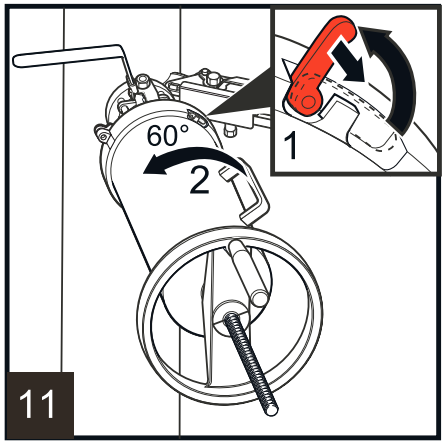
WARNING! Beware of splashing. Some process liquid will leak out through the small ball valve.

WARNING! Do not proceed until you have completed this step.

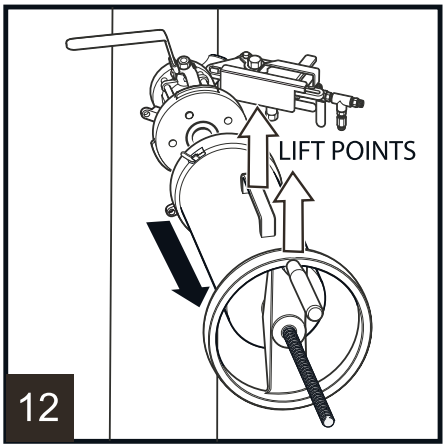
10. Remove the safety clip (1) and pull out the safety pin (2).



11. Lift open outer casing locking latch (1), and rotate outer casing 60° counterclockwise so that the handle comes up on top (2).



12. Take a firm hold on the handwheel and the handle and pull out retractor with sensor inside.

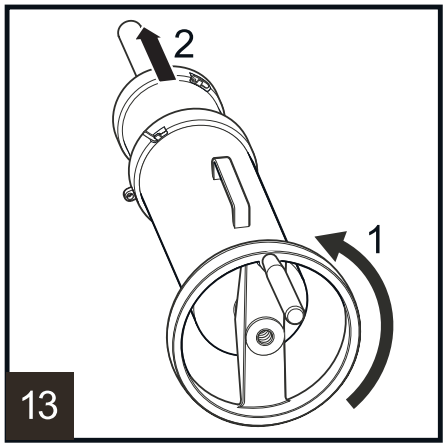


WARNING! A firm hold of the tool is essential as the combination of the tool and the sensor is noticeably heavier than retractor alone.

To ensure isolation valve after the Safe-Drive tool with the sensor has been removed, you can bolt a standard ANSI 1.5 in 105 lbs blind flange to Isolation valve with ½ in (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.

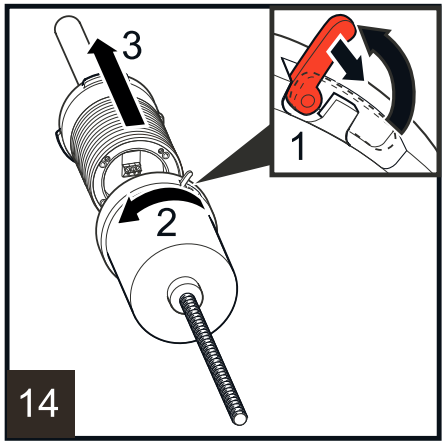
13. Put retractor with sensor onto a table or similar surface so that the handwheel has space to turn.



    a. Turn the handwheel counterclockwise to drop the thread, that is until outer casing is no longer connected to the parts inside.

    b. Pull off outer casing.

14. Open the latch on inner casing (1).



    a. Keep sensor steady with one hand and rotate inner casing counterclockwise with the other hand to unlock inner casing from sensor (2).

    b. Pull off the sensor (3).

11.6 Wash nozzle insertion and removal

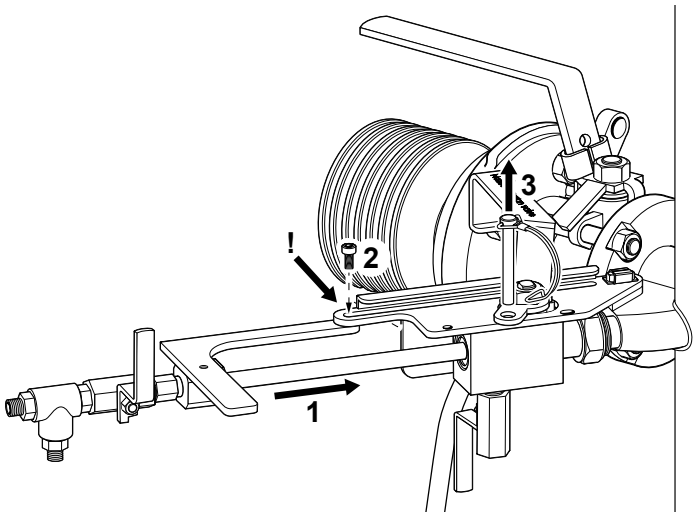
WARNING! Non-retractable wash nozzle SDI2-23-WPR/WPN-XS for high pressure water can only be inserted or removed when the process pipe is empty. Insertion and retraction instructions below are valid only for wash nozzles SDI2-23-SN2 for steam and SDI2-23-WP2 for high pressure water. For installation of the non retractable wash nozzle see Installing the non-retractable wash nozzle (page 184).

11.6.1 Inserting wash nozzle

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.

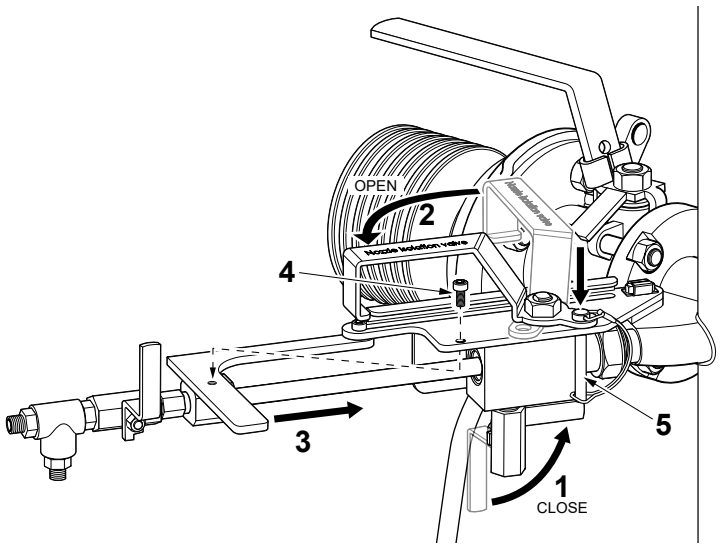
1. Insert the nozzle into the isolation valve (1).



   a. Attach the nozzle to the nozzle guide with one special M5x10 screw (2) using a 5 mm Allen key.

   b. Remove the safety pin (3).

2. Close the 1/4 in check port valve under the nozzle isolation valve (1).



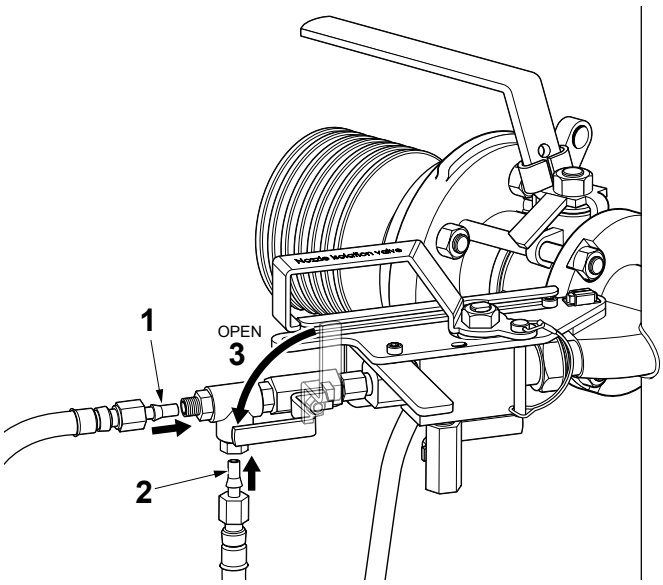
a. Open the isolation valve (2) by turning the handle counterclockwise.

b. Push the nozzle to the process (3).

c. Attach the nozzle to the nozzle guide with one s pecial M5x10 screw (4) using a 5 mm Allen key.

d. Lock the isolation valve handle with the safety pin (5).

3. Connect the lines in the following order.

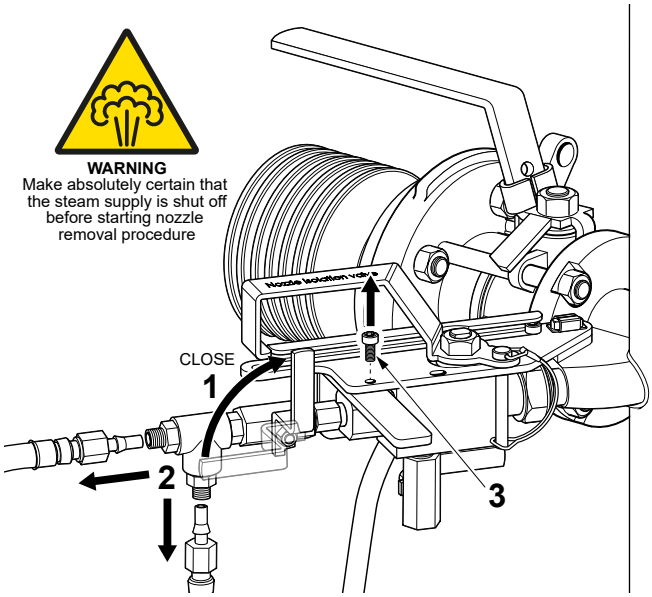


   a. STEAM: Connect the steam line and sensor flush flexible line to the nozzle T-piece (1,2).
   b. WATER: Connect the water line to 1/4 in valve (1,2).
   c. Open the steam supply line valve (3).
   d. Check the functionality of washing from the optical image window in DTR.

11.6.2 Removing wash nozzle

WARNING! Always shut the main steam valve before performing any work on the wash nozzle. Make certain that the steam or water supply is shut off before starting nozzle removal procedure.

1. Close the steam line supply valve (1).

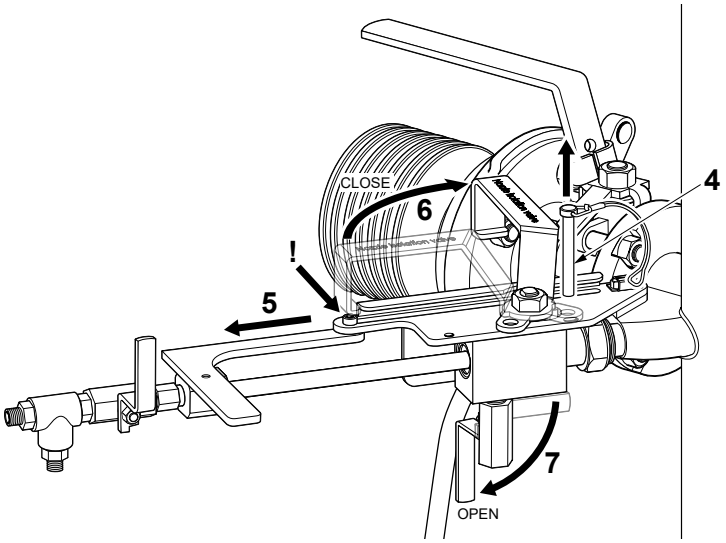


a. STEAM: Remove the steam supply line (2) and the sensor flush flexible line (2) from the nozzle T-piece.

b. WATER: Remove the water supply line (2) from the nozzle.

c. Remove the special M5x10 nozzle guide locking screw (3) using a 5 mm Allen key. Be careful, process pressure will try to push the nozzle out from the process.

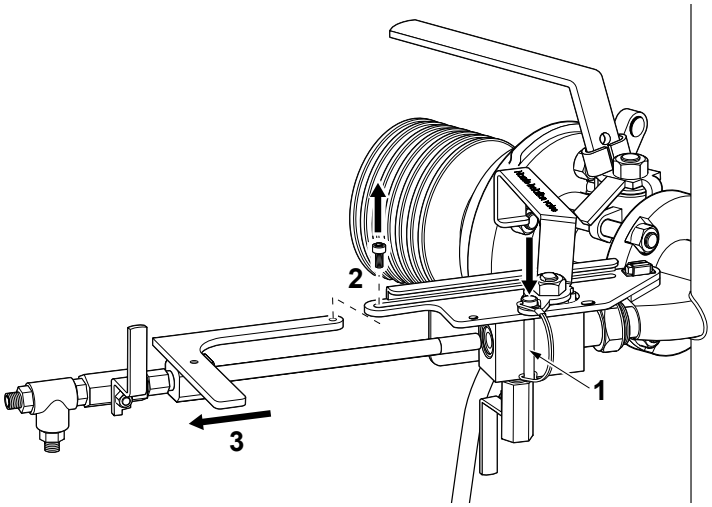
2. Remove the safety pin (4).



a. Slide the nozzle out from the process (5) until the guide plate stops it.
b. Close the nozzle isolation valve (6) by turning the handle clockwise.
c. Open the 1/4 in check port valve under the nozzle isolation valve (7).

WARNING! 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.

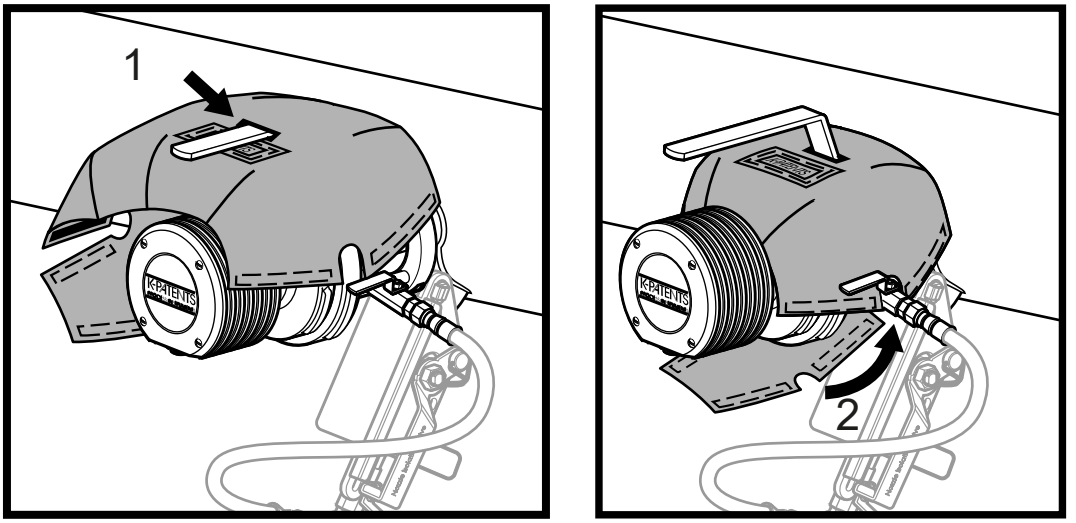
3. Lock the isolation valve handle with the safety pin (1).



   a. Remove the special 5x10 guide plate screw (2) using a 5 mm Allen key.
   b. Remove the nozzle from the isolation valve completely (3).

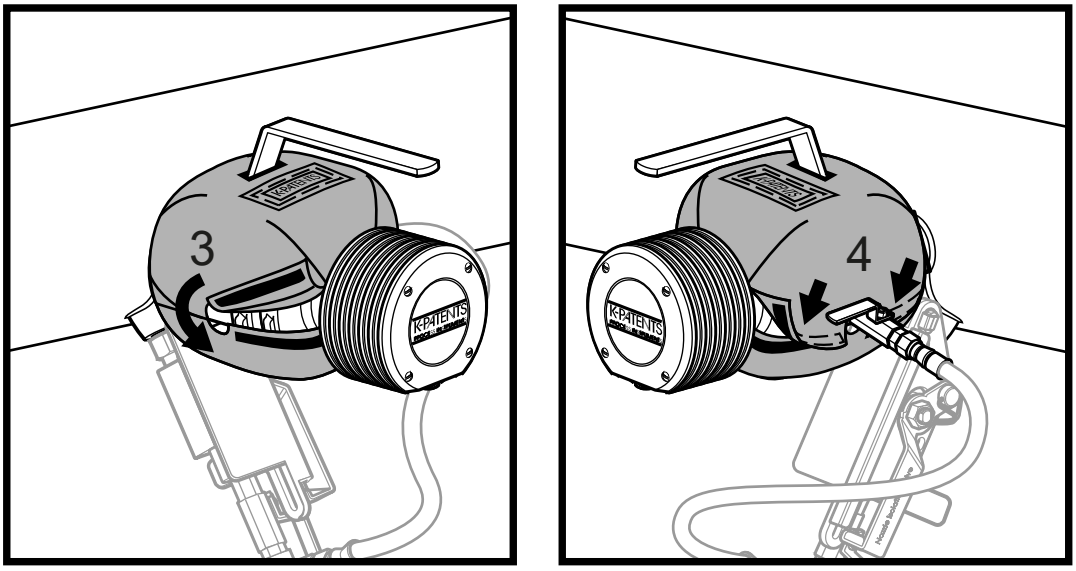
11.7 Thermal cover for SDI2-23

Thermal cover PR-7064 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 (86 °F) or when the process temperature is over +60 °C (+140 °F).



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

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



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

4. Finally the 2 velcro joins on the right.

Figure 105 Mounting thermal cover

To remove the thermal cover, first open the 2 velcro fasteners on the right. Then open the velcro fastener on the left, unwrap the cover underneath the sensor and then remove the cover.

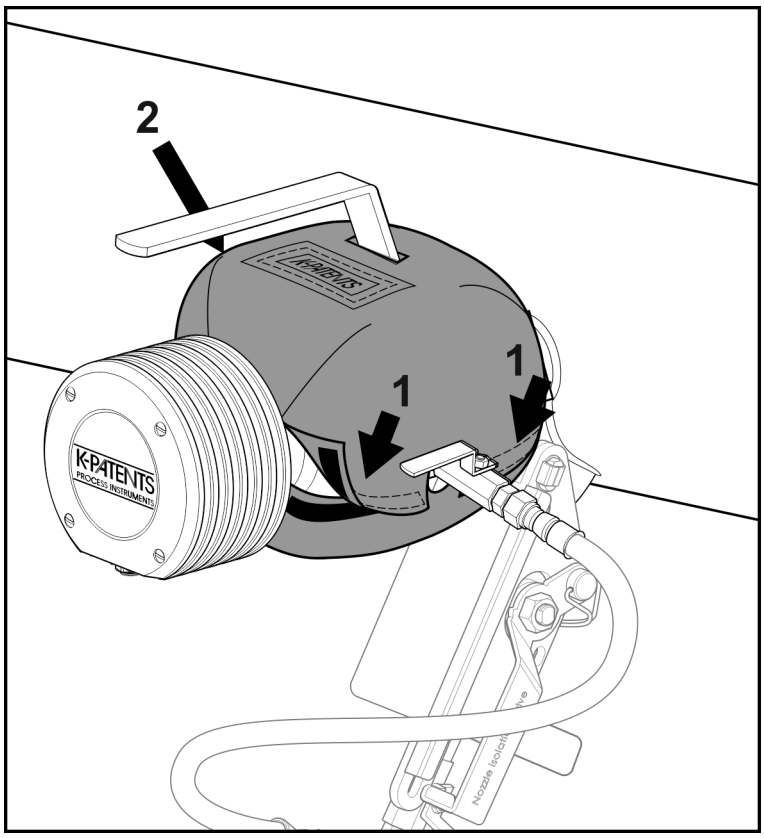
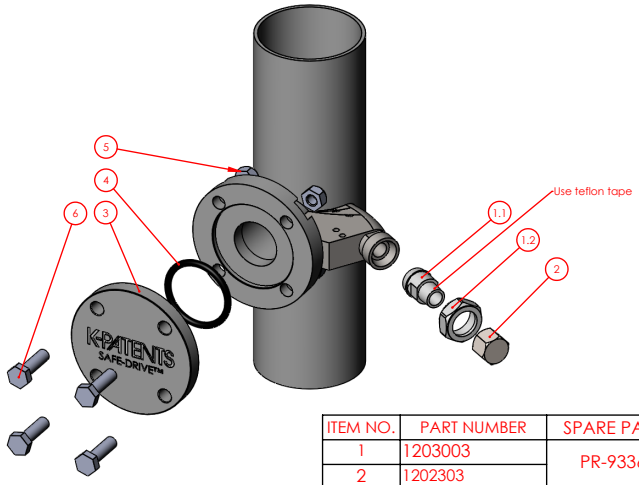


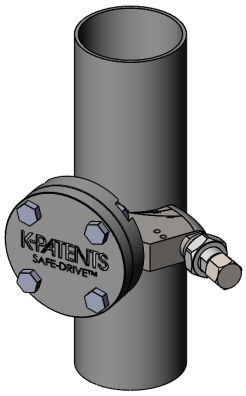
Figure 106 Removing thermal cover

1 Right hand fasteners
2 Left hand fasteners

11.8 Blinding Safe-Drive system

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





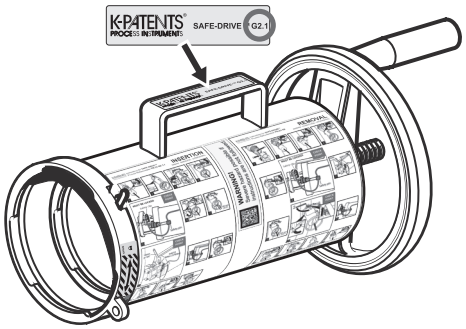
ITEM NO.	PART NUMBER	SPARE PART	DESCRIPTION	QTY.
1	1203003	PR-9336	Tapered connector, DN10	1
2	1202303		Conical hat, DN10	1
3	3825	PR-9335	PR-23-SD-PG	1
4	-		O-ring	1
5	DIN985, A4, M10		Stainless nylon insert lock nut	4
6	DIN933		Hexagonal bolt DIN933 x 35 A4	4

Figure 107 SDI mounting flange plug system

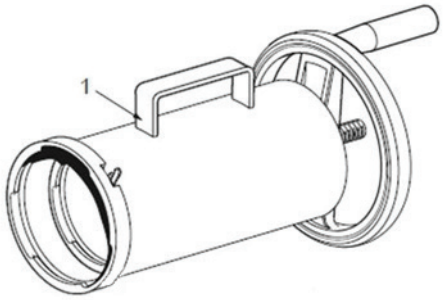
11.9 Identifying your refractometer generation

The following instructions about inserting and removing Safe-Drive 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.

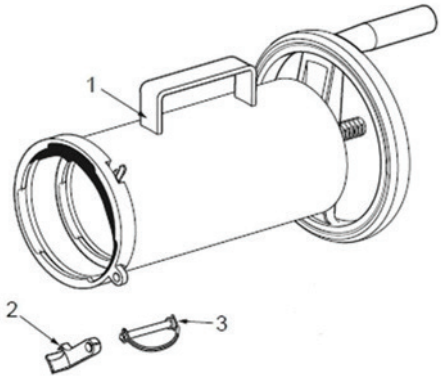
The first place to look for the generation information is the retractor handle. If your retractor is generation 2, the handle has the code G2. If your retractor is generation 2.1, the handle has code G2.1. The difference between the generations is visible also when looking at the retractor and the isolation valve. For more information, see the following figure.



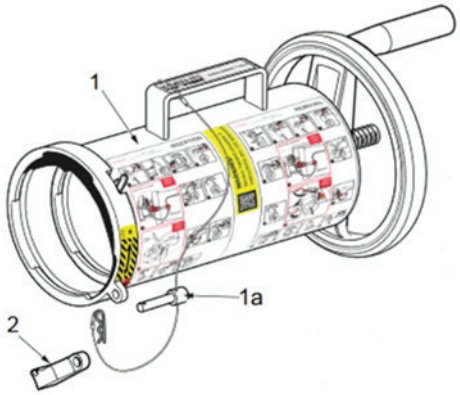
Markings on retractor handle



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.

Figure 108 Identifying different Safe-Drive generations

12. PR-23 process refractometers in potentially explosive atmosphere

The PR-23 refractometer series can be used in locations with potentially explosive atmosphere with the 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 Eurofins Expert Services Oy, under the European ATEX directive 2014/34/EU for ATEX Ex II 3G / Ex ec IIC T4 Gc and under the IECEx scheme for Ex ec IIC T4 Gc. The EU-Type examination Certificate number is EESF 21 ATEX 013X and the IECEx Certificate number is IECEx EESF 21.0008X. These certifications cover the following Ex standards: EN IEC 60079-0:2018 / IEC 60079-0:2017 and EN IEC 60079-7:2015/A1:2018 / IEC 60079-7:2017.

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. The temperature identification rating for PR-23-...-FM is T6, T_{amb} = −20 °C ... +45 °C (−4 °C ... +113 °F).

The PR-23-...-CS refractometers are certified by Canadian Standards Association for Class I, Division 2, Groups A, B, C & D. The Certificate Number is 1706327. Equipment Ratings: Nonincendive for use in Class I, Division 2, Groups A, B, C & D, Hazardous (Classified) Locations. The temperature identification rating for PR-23-...-CS is T4, T_{amb} = −20 °C ... +45 °C (−4 °C ... +113 °F).

The PR-23-...-CX refractometer is certified by Nepsi under Chinese standards under the IECEx scheme for Ex nA IIC T4 Gc. The type-examination certificate number is GYJ19.1134X. This certification covers the following Ex standards: GB 3836.1-2010 and GB 3836.8-2014.

12.1 Equipment

The refractometer system, in the following figure, for potentially explosive atmosphere locations consists of a modified refractometer sensor PR-23-...-AX/FM/CS/CX, a standard Indicating transmitter DTR and a sensor cable PR-8230-...

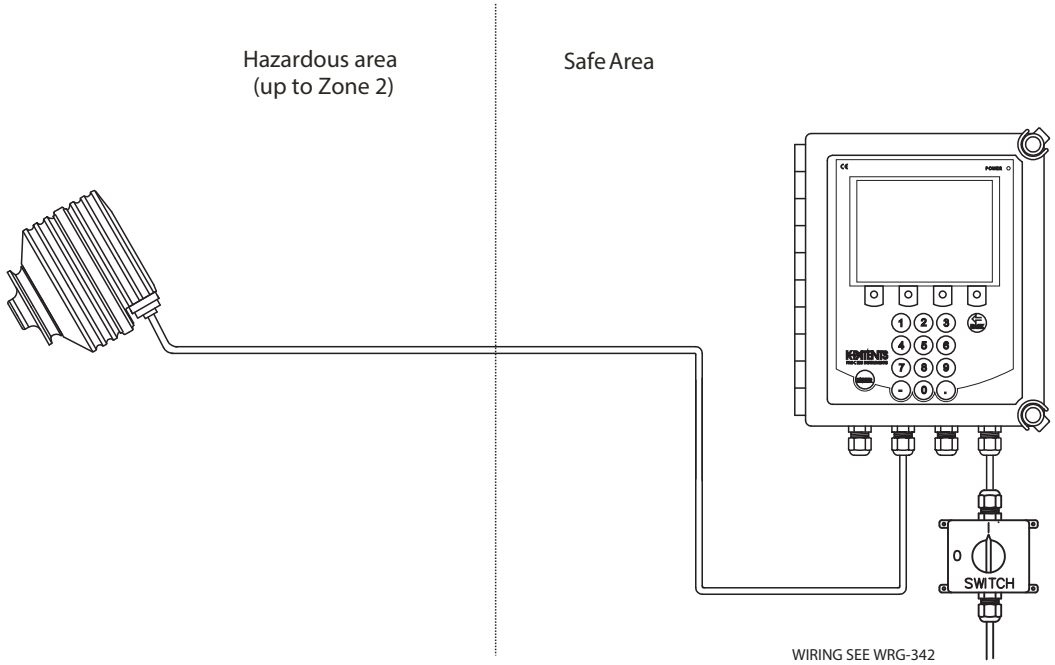


Figure 109 Refractometer system PR-23-...-AX/FM/CS/CX

The ATEX/FM/CSA approved sensors PR-23-...-AX/FM/CS/CX are identified by the sensor nameplate, see the following figure. The indicating transmitter is a standard DTR.

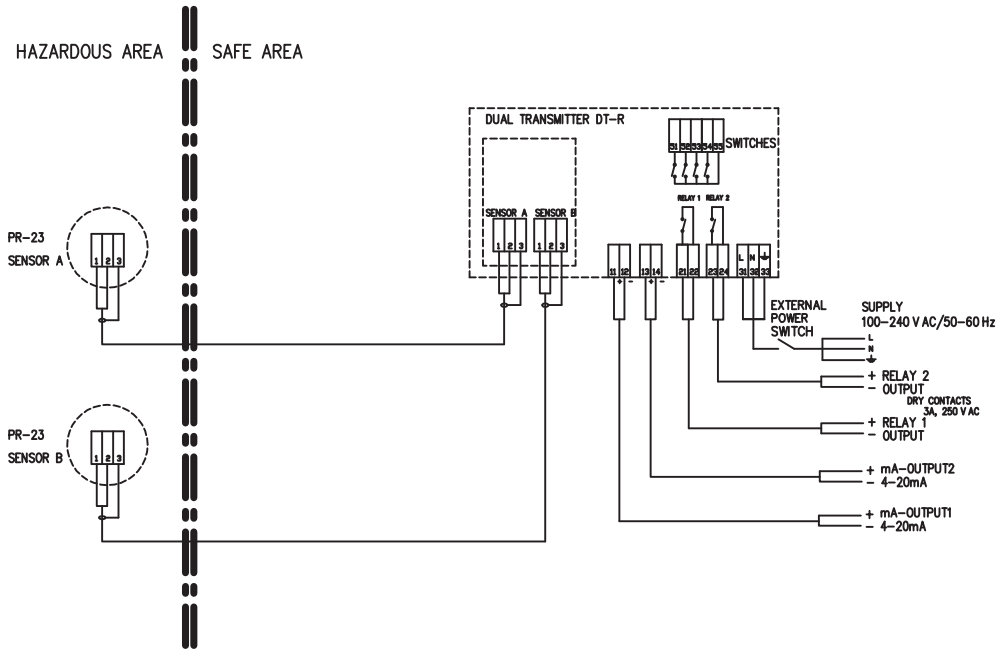
The approvals are valid for sensors PR-23-AC, PR-23-AP, PR-23-GC, PR-23-GP, PR-23-M, PR-23-MS, PR-23-SD, PR-23-W and PR-23-RP.

Figure 110 PR-23-...-AX/FM/CS/CX sensor nameplates

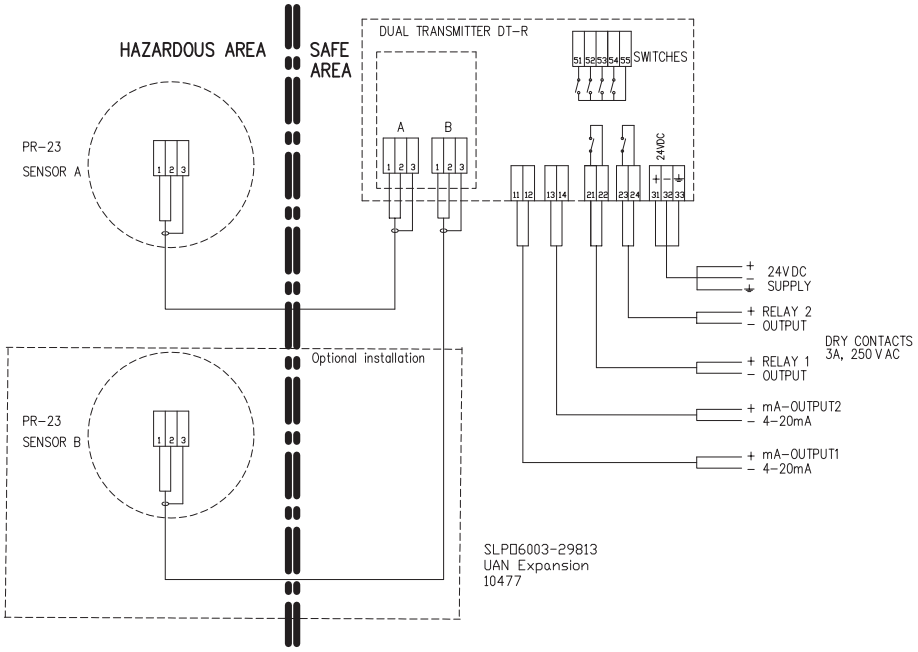
12.2 Installation

Sensor wiring must follow drawing WRG-367 or WRG-350, see Figure 111 (page 217). See also Figure 13 (page 41) and Figure 15 (page 43).

WARNING! 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.



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



Safe sensor wiring according to WRG-350 (24 V DC)

Figure 111 Safe sensor wiring

CAUTION! Do not modify the unit or use it in ways not described in the documentation. Improper modification or use may lead to safety hazards, equipment damage, failure to perform according to specification, or decreased equipment lifetime.

CAUTION! Do not connect or disconnect the sensor connector 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 the sensor cable back to the sensor, you can switch power back on.

CAUTION! Make sure that the rated voltage is not exceeded by transient disturbances of more than 119 V.

WARNING! 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 must only be used for measuring liquids with high conductivity (> 10000 pS/m) in the presence of hazardous atmospheres.

WARNING! The painted surface of the enclosure of PR-23-MS refractometer is subject to electrostatic hazard. Clean only with a damp cloth in the presence of hazardous atmospheres.

13. Indicating transmitter DTR and STR specifications

Figure 112 Indicating transmitter DTR serial number label

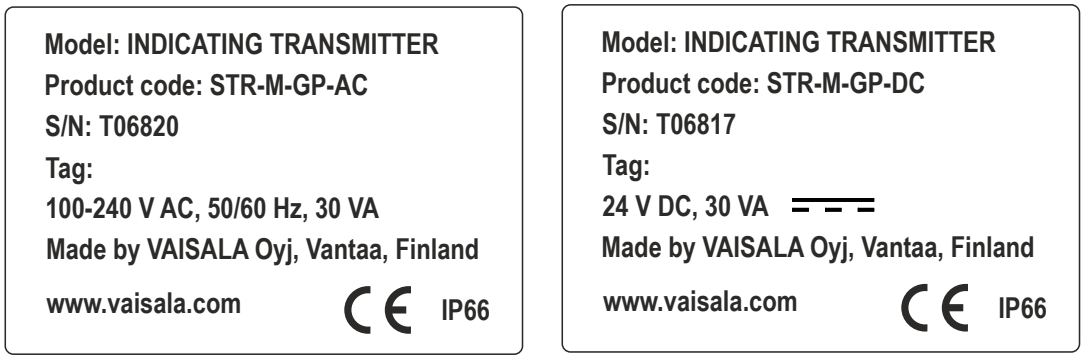


Figure 113 Indicating transmitter STR serial number label

13.1 Compatibility

The indicating transmitter DTR is only compatible with the PR-23 refractometer range. One or two PR-23 refractometer sensors can be connected to the DTR.

For intrinsically safe installations (see Intrinsically safe refractometers PR-23-...-IA, PR-23-...-IF and PR-23-...-CI (page 158)) there is a single-sensor version of the transmitter (STR). The information given in this chapter applies to STR as well, unless otherwise indicated.

13.2 Indicating transmitter model codes

Table 58 Indicating transmitter DTR and STR model codes

Model	Description
DTR	Indicating transmitter (connectivity for 2 sensors)
STR	Indicating transmitter (connectivity for one -IA/-IF/-CI sensor)
Cable connection	
-U	½ in NPT type conduit hubs for CSA certified transmitter
-M	M20 x 1.5 metric cable glands for general purpose
Electrical classification	
-GP	General purpose
-CS	CSA certified for use in general purpose (ordinary) locations Applicable to CSA and ANSI/UL standards [1]
Power supply	
-AC	Power supply 100-240 V AC 50/60 Hz, fuse with voltage 250 V AC, max. size 10 A and speed slow
-DC	Power supply 24 V DC, fuse with voltage min. 48 V DC, max. size 4 A and fuse speed fast. [2]

1) *Available only with cable connection code -U, ½ NPT type conduit hubs and -AC power supply.*
2) *With -GP option only.*

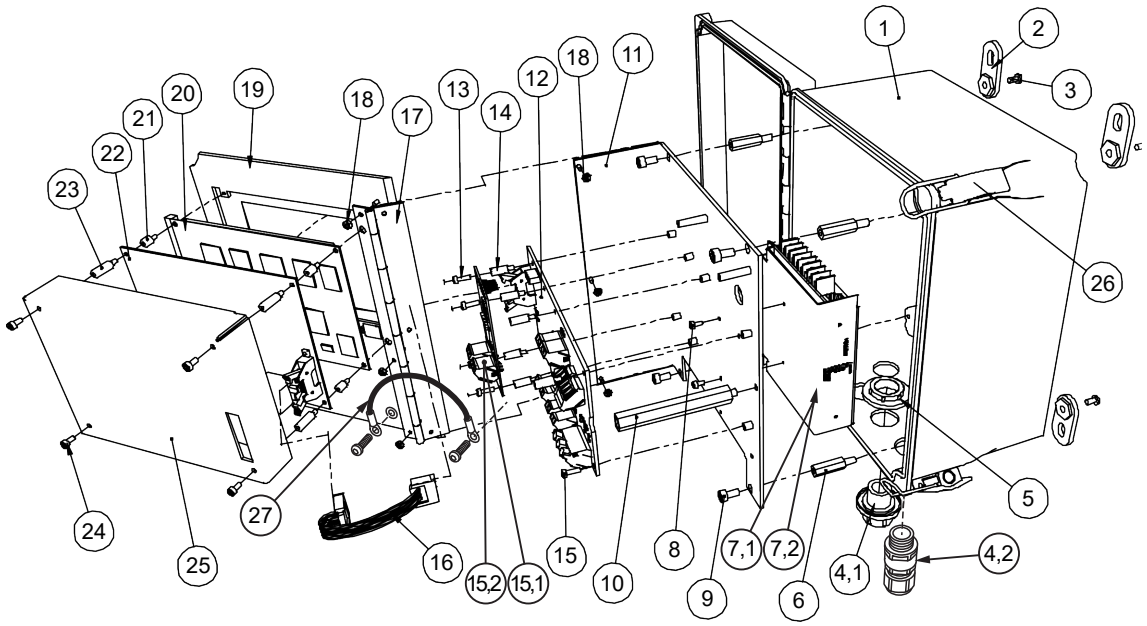
13.3 Indicating transmitter specifications

Table 59 Indicating transmitter specifications

Feature	Specification
Display	320 x 240 pixel graphical LCD with LED backlight
Keypad	18 membrane keys
Current output	Two independent current sources, 4 ... 20 mA, max. load 1000 Ω, galvanic isolation 1500 V DC or AC (peak), hold function during prism wash.
AC power supply	AC input 100 ... 240 V AC, ±10%, 50/60 Hz / 30 VA, fuse voltage 250 V AC, fuse max. size 10 A, fuse speed slow.
DC power supply	DC input 24 V DC, ±10%, fuse voltage min. 48 V DC, fuse max. size 4 A, fuse speed fast.
Overvoltage category	Overvoltage category II
Alarms/Wash relays	Two built-in signal relays, max. 240 V/3 A, fuse with voltage 250 V AC, max. size 10 A and speed slows.

Feature	Specification
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/-IF/-CI.
Transmitter protection class	Enclosure IP66, Nema 4X
Pollution degree	Pollution degree 2
Installation	Indoor
Indicating transmitter weight	4.5 kg (10 lbs)
Altitude	Max. altitude 2000 m (6561.68 ft)
Ambient temperature	0 ... +45 °C (+32 ... +113 °F) Display operating temperature 0 ... +50 °C (+32 ... +122 °F), display storage temperature -20 ... +60 °C (-4 ... +140 °F).
Relative humidity	0 ... 100 %
Wet location	Not applicable

13.4 Indicating transmitter parts list



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

Figure 114 Indicating transmitter DTR and STR parts (STR-specific parts in italics)

14. Interconnecting cable

14.1 Interconnecting cable model code

Table 60 Interconnecting cable model code

Part number	Description
PR-8230	Interconnecting cable between transmitter and sensor
Cable length	
-010 -_ _ _	• 10 m (33 ft), standard length • Specify cable length in meters with 10 meter increments Max. length is 200 m (660 ft)

14.2 Interconnecting cable specifications

Table 61 Interconnecting cable specifications

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

For information on the intrinsically safe cabling for PR-23-...-IA/-CI, see Intrinsically safe mounting (page 162).

15. 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 through a hub or switch, local area network (LAN), wireless network (WLAN) or fiber Ethernet.

Any type of computer (for example 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.

More information

- Sensor verification certificate (page 243)

15.1 Cable requirements and connection

15.1.1 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 50 m (164 ft).

Ethernet connection is similar to that of a computer/PC: Use a cross-over Ethernet cable to connect the DTR directly to a computer, as shown in the figure below. If you are connecting the DTR to a LAN (Local Area Network) through a wall socket, use straight-through Ethernet cable, as shown in the following figure.

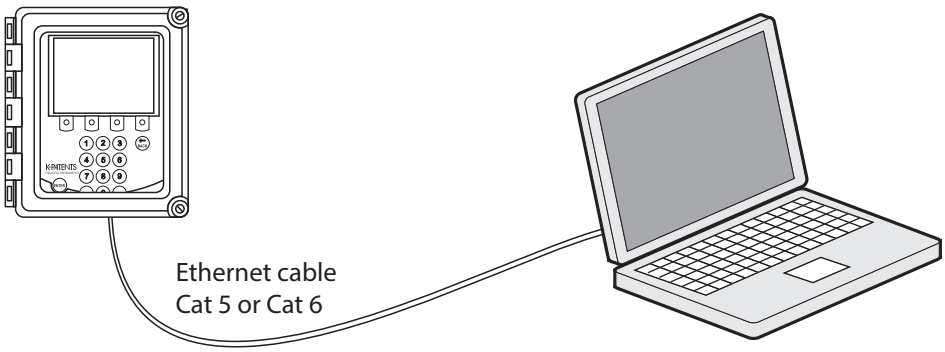


Figure 115 Connecting DTR to computer

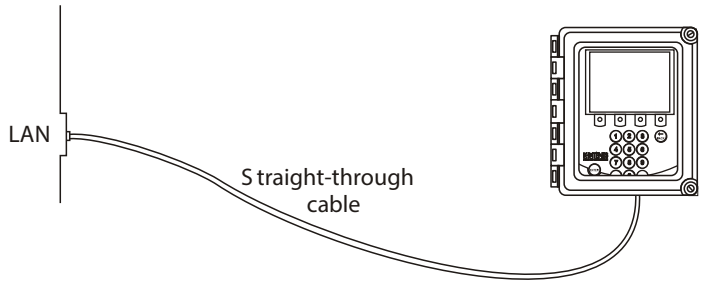


Figure 116 Connecting DTR to LAN

If you are connecting the DTR to a hub or switch or WLAN access point, please consult the user guide of your hub/switch/access point for the correct cable type, as shown in the following figures.

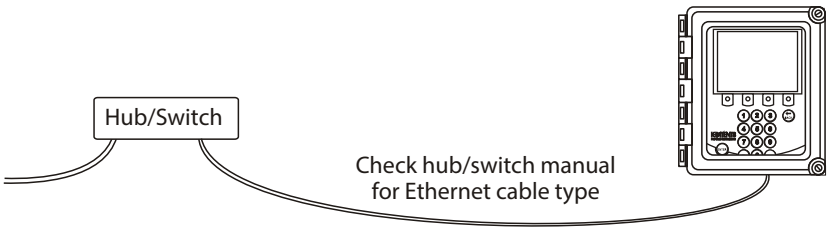


Figure 117 Connecting DTR to hub or switch

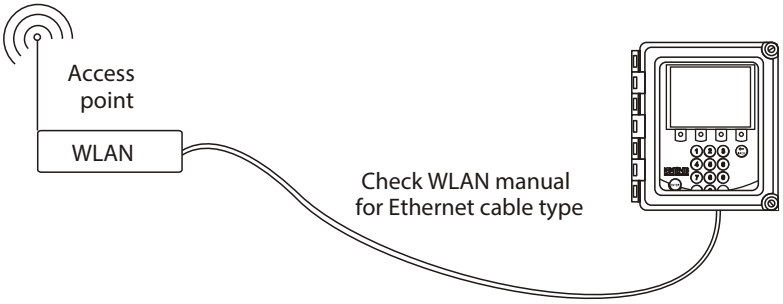


Figure 118 Connecting DTR to WLAN

If you need a longer cable or the environment is electrically noisy, use fiber optics Ethernet with media converters as shown in the following figure.

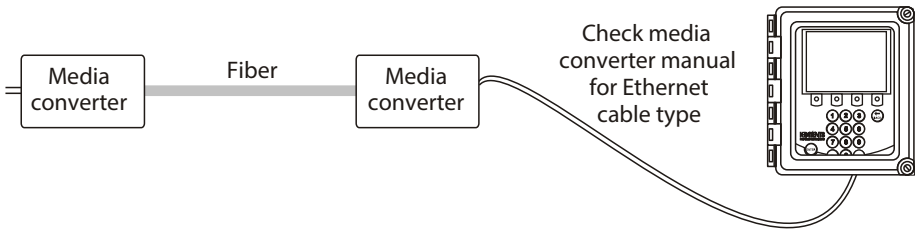


Figure 119 Using fiber optics Ethernet

15.1.2 Connecting 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 the following figure. 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

Warning! Check that the power is off before opening the front panel. If the green power indicator light is on, there is still power in the system.
Warning! Multiple power sources.

Varoitus! Tarkista, että virta on katkaistu, ennen kuin avaat etupaneelin. Jos vihreä virran merkkivalo palaa, järjestelmässä on edelleen virtaa.
Varoitus! Useita virtalähteitä.

Varning! Kontrollera att strömmen är avstängd innan du öppnar frontpanelen. Om den gröna indikatorlampan lyser är det fortfarande ström i systemet.
Varning! Flera strömkällor.

Advarsel! Kontroller, at strømmen er slukket, før frontpanelet åbnes. Hvis den grønne strømindikatorlampe er tændt, er der stadig strøm i systemet.
Advarsel! Flere strømkilder.

Hoiatus! Enne esipaneeli avamist kontrollige, et süsteem poleks pinge all. Kui roheline toitemärgutuli põleb, on süsteemis endiselt pinge all.
Hoiatus! Mitu toiteallikat.

Внимание! Перед открытием передней панели убедитесь, что питание отключено. Если горит зеленый индикатор питания, система находится под напряжением.
Внимание! Несколько источников питания.

Įspėjimas! Prieš atidarydami priekinį skydelį, patikrinkite, ar maitinimas išjungtas. Jei šviečia žalia maitinimo indikatoriaus lemputė, sistemoje vis dar veikia maitinimas.
Įspėjimas! Keli energijos šaltiniai.

Ostrzeżenie! Przed otwarciem panelu przedniego sprawdzić, czy zasilanie jest wyłączone. Dopóki świeci się zielona kontrolka zasilania, system znajduje się pod napięciem zasilania.
Ostrzeżenie! Wiecej niz jedno zródło zasilania.

Varování! Před otevřením předního panelu zkontrolujte, zda je napájení vypnuto. Pokud svítí zelená kontrolka napájení, je v systému stále přítomno napájení.
Varování! Více zdroju napájení.

Figyelmeztetés! Az előlap kinyitása előtt ellenőrizze, hogy a készülék ki van-e kapcsolva. Ha a zöld tápellátás jelzőfény világít, akkor a rendszer még áram alatt van.
Figyelmeztetés! Több áramforrás.

Warnung! Prüfen Sie, ob das Gerät ausgeschaltet ist, bevor Sie die Frontblende öffnen. Wenn die grüne Betriebsanzeige leuchtet, liegt noch Spannung an.
Warnung! Mehrere Stromquellen.

Waarschuwing! Controleer of de stroom is uitgeschakeld voordat u het voorpaneel opent. Als het groene stroomindicatielampje brandt, staat er nog stroom op het systeem.
Waarschuwing! Meerdere voedingsbronnen.

Avertissement! Vérifiez que l'alimentation est coupée avant d'ouvrir le panneau avant. Si le voyant d'alimentation vert est allumé, le système est toujours sous tension.
Avertissement! Sources d'alimentation multiples.

¡Advertencia! Verifique que la alimentación está desconectada antes de abrir el panel frontal. Si la luz indicadora de encendido de color verde está encendida, aún hay energía en el sistema.
¡Advertencia! Varias fuentes de alimentación.

Avvertimento! Verificare che l'alimentazione sia spenta prima di aprire il pannello anteriore. Se la spia di alimentazione verde è accesa, il sistema è ancora alimentato.
Avvertimento! Molteplici fonti di alimentazione.

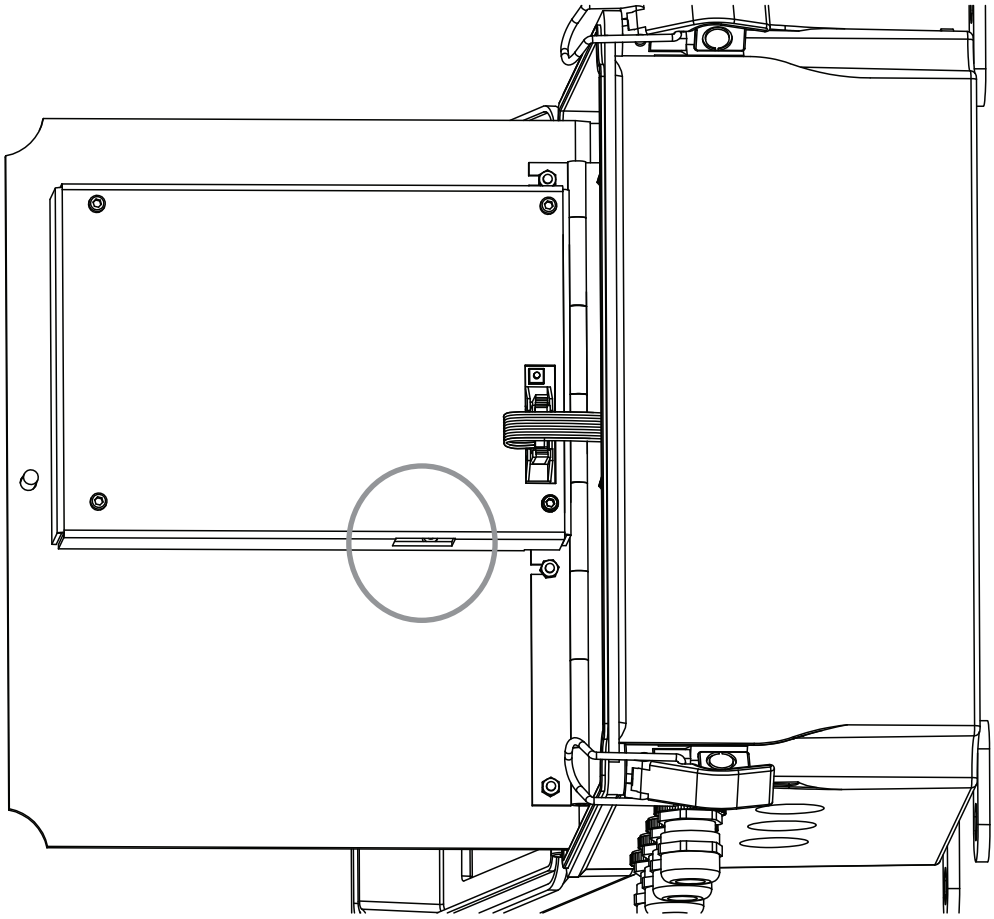


Figure 120 Ethernet connector on underside of front panel

The DTR has automatic speed negotiation, and automatically finds out what the optimal speed for the connection is and chooses accordingly, either 10 Mbit/s or 100 Mbit/s speed.

15.2 Connection settings

15.2.1 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).

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 through the following path:

5 Calibration > 2 Outputs > 6 Network

Type the new IP address and press **Enter** to change the address.

15.2.2 IP settings for standalone computer

If you connect a non-networking (standalone) computer directly to a DTR with a cross-over cable, check the computer's network settings and conform the DTR's settings to it.

If the DTR is in a factory network, contact the system admin on how to connect to the DTR. The standalone method may not be the best one in this 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 is suitably paired with the address that your computer automatically generates for itself.

You can access 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 following figure (in Mac OS X and Linux the same command is called **`ifconfig`**). The result is your computer's IP address, so you can change the DTR to match. The connection works if you match the first 3 groups of numbers and just change the last number.

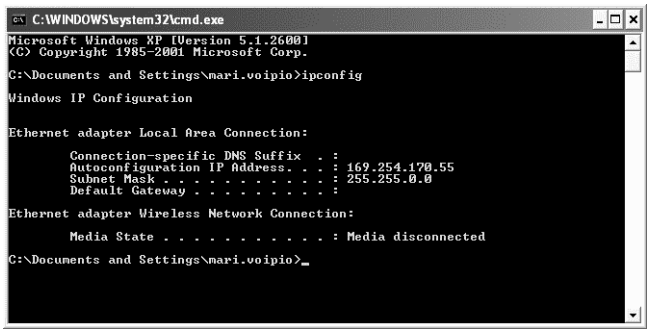


Figure 121 Typical IP configuration for standalone laptop when connected to DTR. Laptop wireless (WLAN) is turned off.

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). The connection does not work if the computer and the DTR have exactly the same IP address.

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 the computer), you can proceed to testing the connection. For more information, see Testing Ethernet connection (page 230).

15.3 Testing Ethernet connection

On the Ethernet connector inside the DTR there are 2 diagnostic LEDs.

- The green LED indicates that the physical connection is working. 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, DTR receives data.

You can test the IP address with a **`ping`** command after you have set up the physical Ethernet connection and the DTR is powered. To use **`ping`**:

1. Go to the command interface (for example, Command Prompt in Windows).
2. Type **`ping`** and the IP address you want to check.
3. Press **ENTER**.

If the Ethernet connection is good, the DTR is powered on, and the address is correct, the DTR answers to ping and returns any data packets sent to it. If DTR returns and error message. For more information, see Troubleshooting connection (page 231).

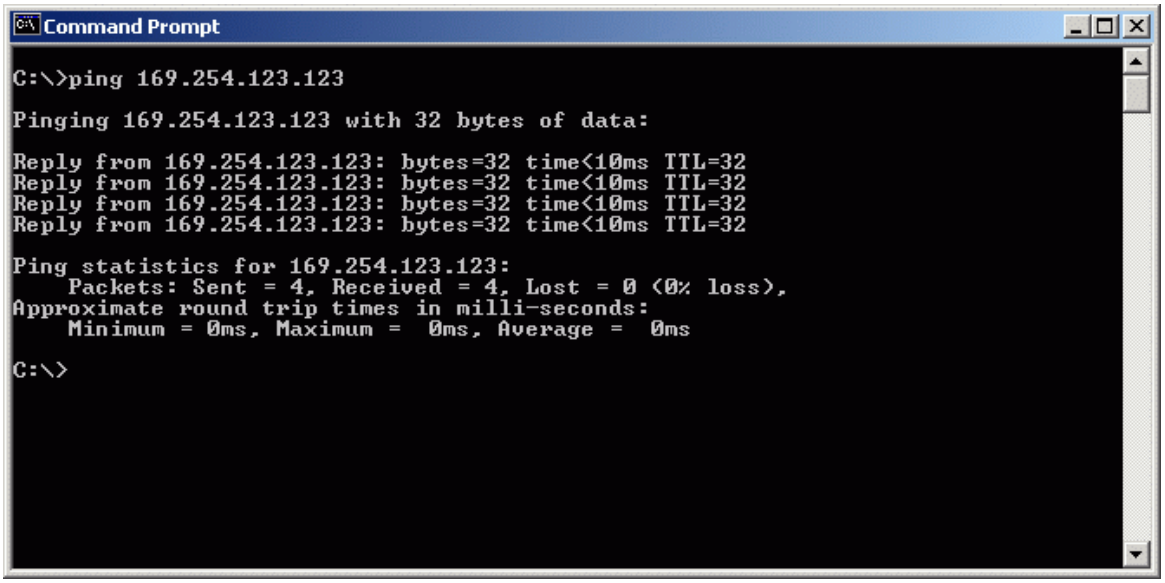


Figure 122 Ping OK

15.3.1 Troubleshooting connection

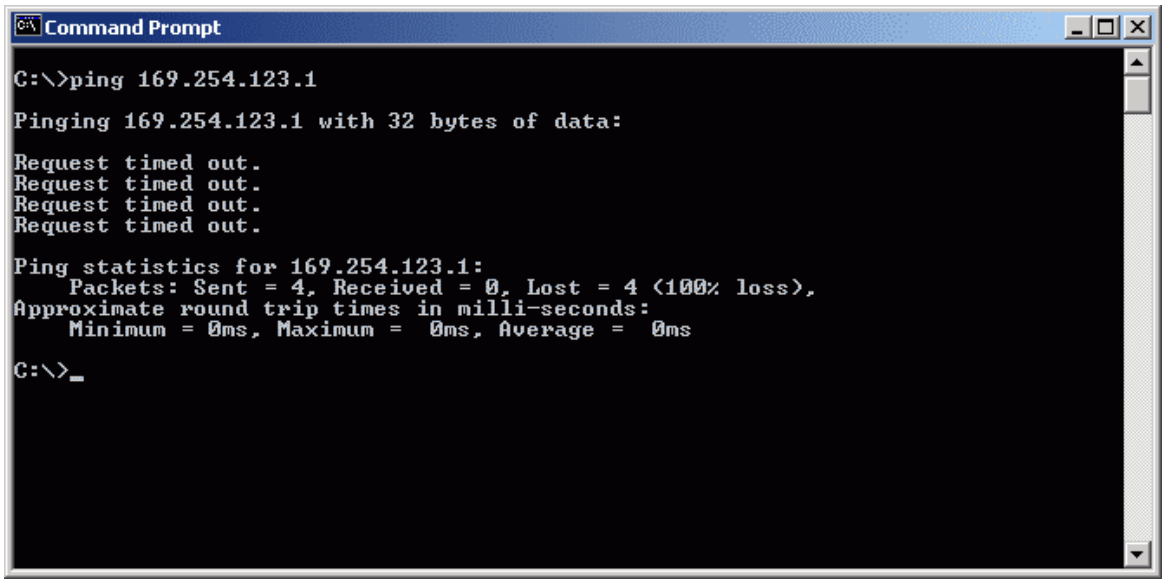


Figure 123 Ping error message

If you get a **ping** error message, check your connections.

Open the DTR cover and front panel and check the diagnostic LEDs of the Ethernet connector, see Connecting Ethernet cable (page 226).

Keep both the DTR and your computer powered while you check the diagnostic LEDs.

If both LED lights are turned off, 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 pinging the DTR and check if the orange LED flashes during ping.

If the orange LED does not flash, check that the IP address matches the IP address of the DTR. 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.

A firewall software with tight settings may stop you from connecting to a DTR. If you are connecting directly to the DTR and you are not in a network, turn off the firewall temporarily while working with the DTR. Remember to turn on the firewall before connecting to a network again.

15.4 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 works like a web server, so you only need a working Ethernet connection to the DTR and any web browser to access the instrument homepage.

15.4.1 Opening the instrument homepage

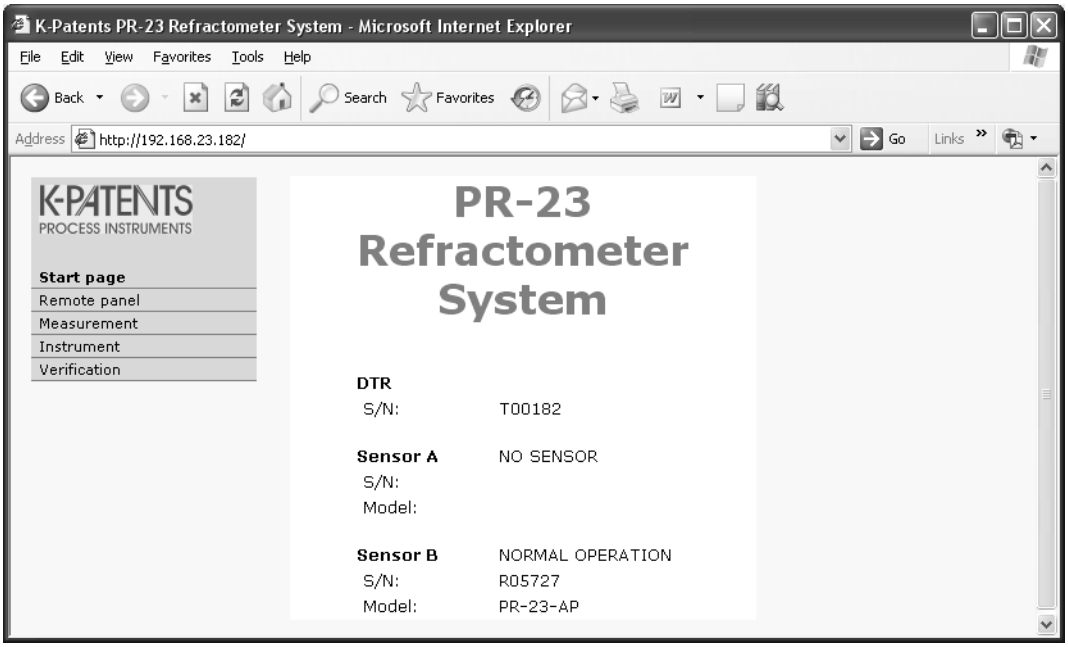


Figure 124 Instrument homepage open in browser

1. Establish a working Ethernet connection to the DTR.
2. Start your preferred web browser (for example Firefox, Edge, Safari, Opera or Chrome).
3. Type the DTR IP address to the address bar. The DTR IP address for a factory-set DTR it is http://192.168.23.254/ (the address used in the figure is not the default).
4. Wait until the homepage is loaded. This may take a few seconds. If the page looks strange, try refreshing the page. 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.

15.4.2 Remote panel

The instrument remote panel is a fully functional virtual DTR where keys on the keyboard are clicked with a mouse. The DTR does not 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.

The DTR display picture on the remote panel sometimes has a 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.

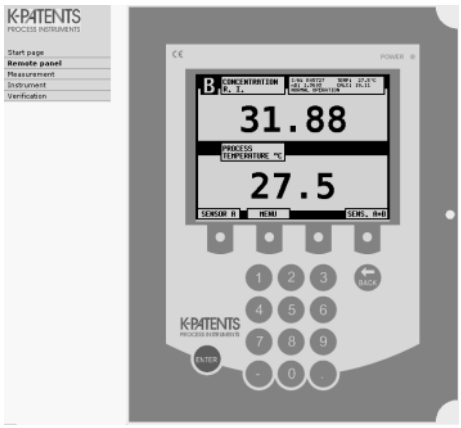


Figure 125 DTR remote panel

15.4.3 Sensor verification certificate

A sensor verification certificate can be viewed and printed by following the **Verification** link on the link bar.

More information

- Sensor verification (page 239)

15.5 Collecting data using Ethernet

The main purpose of the Ethernet connection is to collect measurement data from the instrument. To program a downloading facility, see the specifications in the following sections.

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

15.5.1 Communication protocol

The communication protocol is based on **UDP/IP** to **port 50023**. It is a client/server protocol, where the DTR is the server and therefore only sends information when the client (your computer) requests it. The server answers requests within 5 s (5000 ms), usually the response time is below 100 ms.

Request format

The client to server communication (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

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 Request-response pair specification (page 235) 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 consists of:

- 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"
```

All the key identifiers are case-insensitive, see Request-response pair specification (page 235). 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 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.

Mandatory keys are marked with an asterisk in Request-response pair specification (page 235).

Request and response errors

When the server (DTR) detects an error, it responds with an error message. For more information see Error message specification (page 237). Error messages can be caused by an unknown request, or inability to collect data for the mandatory keys of a response.

15.5.2 Request-response pair specification

The list below describes the request-response pairs (query messages), used for data collection through Ethernet. Mandatory response keys are preceded by an asterisk (*).

When multiple request data options are available, only one can be used at a time. Each sensor status request must be directed to either sensor A or sensor B, not both.

Table 62 Request-response pair specification

Specification	Description	Request ID	Request data	Response key
NULL message	The null message is included in the query messages for debugging purposes as it is used to check whether the server is listening. The message gives a high-level 'ping' functionality.	0x00000000	(none)	• IP: IP address • MAC: Ethernet MAC address
Protocol version	The version query is responded with a value representing the server (DTR) protocol version.	0x00000001	(none)	*Version: integer, the server protocol version (currently 3)

Specification	Description	Request ID	Request data	Response key
DTR information	The DTR information query gives the basic information of the DTR assembly.	0x00000002	(none)	• *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 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.	0x00000003	0x00000000 (sensor A) 0x00000001 (sensor B)	• *SensorSerial: string, sensor serial number • *SProcSerial: string, sensor processor card serial number • *SensorVersion: string, software version number • SensorCurrent: integer, sensor current in milliamps

Specification	Description	Request ID	Request data	Response key
Measurement results	The measurement result query gives the measured and calculated measurement values from the chosen sensor.	0x00000004	0x00000000 (sensor A) 0x00000001 (sensor B)	• 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		0x00000006	(none)	• *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 (for example, "0x00"), switch status as a bit field

15.5.3 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.

16. Sensor verification

A company maintaining quality systems 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 Refractive index n D verification (page 239). Vaisala K-PATENTS® quality system is ISO 9001 certified by Det Norske Veritas.

16.1 Refractive index n_D verification

Before starting the verification procedures, make sure that you have a sample holder at hand. Check the condition of your standard refractive index liquids. You 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 can be used with any PR-23 sensor (in PR-23-M only the top part of the sample holder is needed).

Figure 126 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 (+77 °F):

- 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, that is the deviation from the latest n_D calibration, is within ±0.0002.

As the specified accuracy of PR-23 is ±0.0002, the representative level is the sum of the 3 accuracy specifications, ±0.0004.

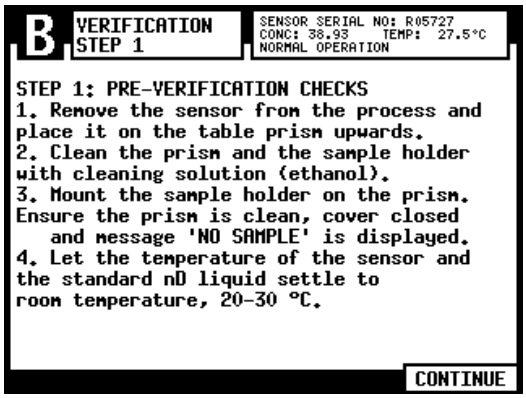
Vaisala provides a set of standard R.I. liquids, PR-2300, containing these 5 liquids. You can order the set directly from Vaisala or your nearest representative.

16.1.1 Handling 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.

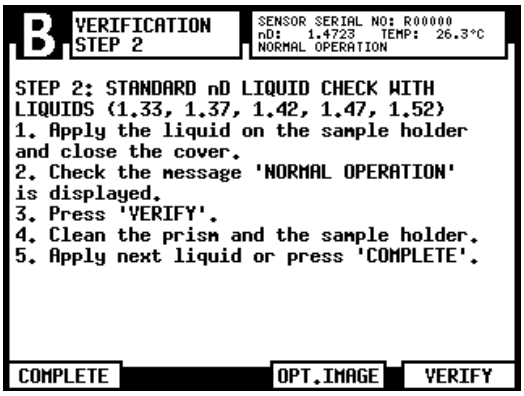
16.2 Verification procedure

1. To start the verification process, select **Main > VERIFICATION**.
   The first verification display instructs you on the pre-verification procedure:



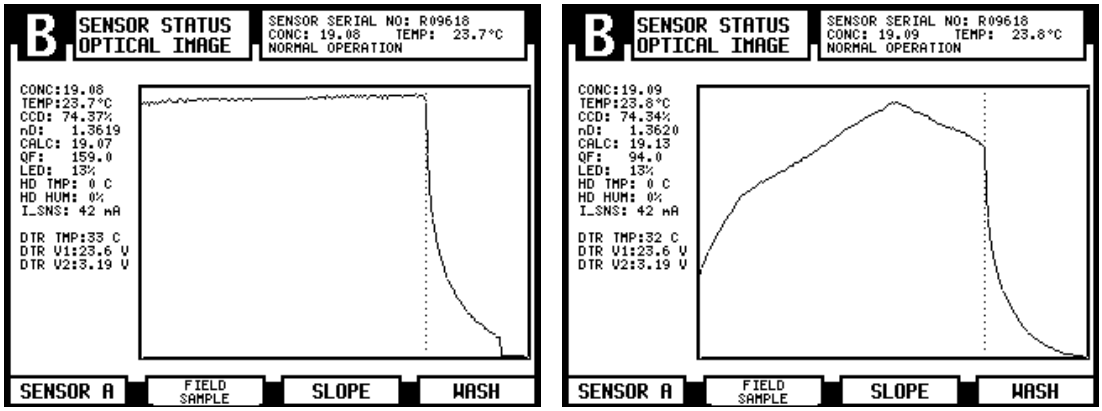
2. When you are finished with the preparations, press **CONTINUE** (rightmost soft key) to start the verification process.

3. The verification itself is done by the refractometer system. Follow the instructions on screen and apply one R.I. liquid at a time on the sensor and press **VERIFY** (rightmost soft key).

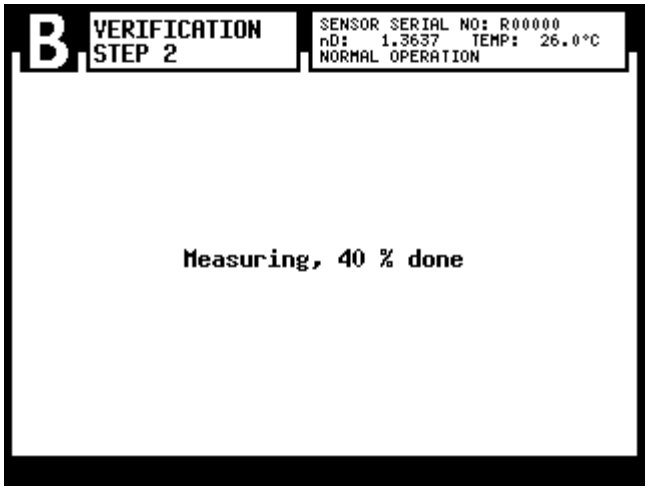


Clean and dry the prism and the sample holder very carefully between the R.I. liquids. Use a suitable solvent, for example ethanol or IPA (isopropyl alcohol).

4. To check that the standard liquid is properly wetting the prism, press soft key **OPT. IMAGE**. The optical image should show a sharp shadow edge, see the following figure.



5. A verification data collection method is implemented in the DTR. The instrument measures each verification data point 10 times and uses the average of these measurements. Measuring each verification liquid takes approximately 10 s, during which the measurement progress display is shown. Wait until the **VERIFICATION STEP 2** display reappears before proceeding to the next verification liquid.



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

6. Press **COMPLETE** in the verification display to finish the verification procedure and to call up the verification results.

If verification is successful, meaning that all measurements are within ±0.0004 of the nominal values, message **VERIFICATION OK** is shown.

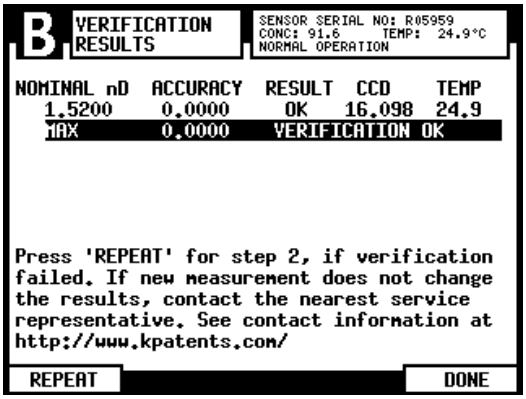


Figure 127 Verification completed successfully (here only with one R.I. liquid)

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. For more information, see Calibrating concentration measurement (page 70).

If the verification fails, see Troubleshooting sensor verification (page 245).

16.3 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.

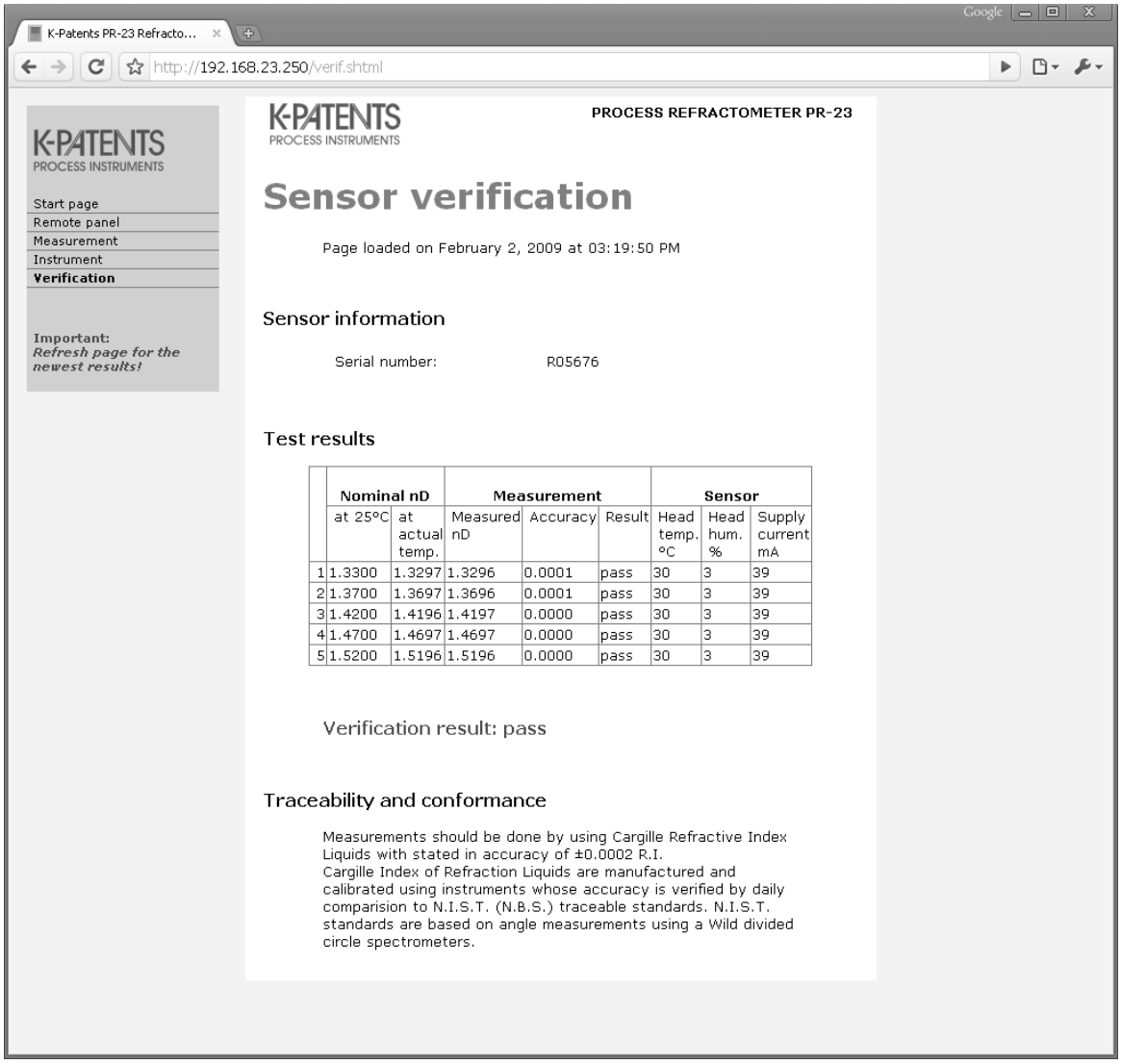


Figure 128 Instrument verification page open in browser

When you have performed a verification on a sensor, 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 computer used to view the verification certificate. To print the verification certificate, use your browser's print function. The page is designed so that it fits onto a single A4 or letter sized sheet.

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 129 Instrument verification certificate

When verifying two sensors connected to one DTR, verify one sensor and then save or print the certificate, as the results from the verification of the second sensor overwrites the results of the first sensor. Check the sensor serial number on the certificate to see that you have correct results on screen and refresh if needed.

More information

- Ethernet connection specification (page 224)

16.4 Troubleshooting sensor verification

The following are the most common reasons for verification failure:

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

The following figure shows the **VERIFICATION FAILED** message. If you get this message, perform the following checks.

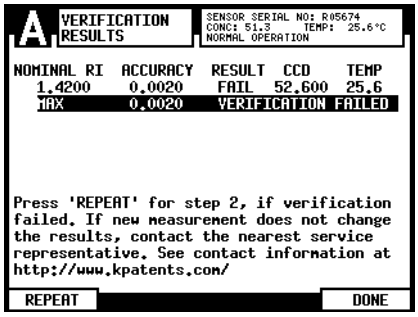
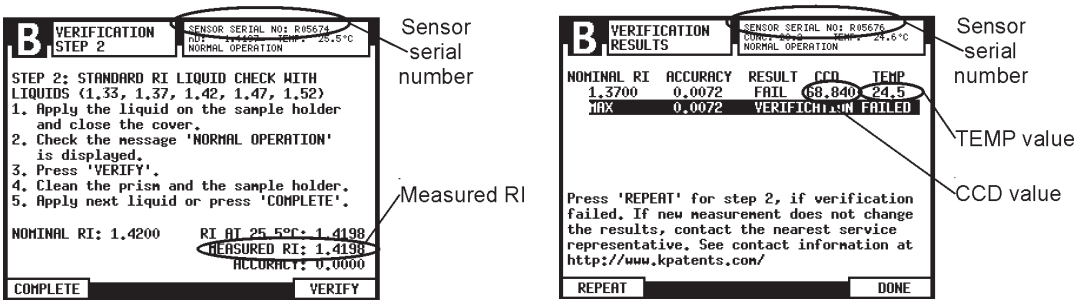


Figure 130 Verification failed

1. Check that the prism and the sample holder are clean and the sample holder sits tightly on the sensor tip before a standard liquid is applied.
2. Make sure the standard liquids are in good condition and not past their expiration date.
3. Inspect the prism surface, make sure that it is smooth and glossy without any scratches.
4. Go back to **VERIFICATION STEP 2** by pressing **REPEAT** in the verification procedure.

5. If verification fails even when repeating the verification procedure, fill in PR-23 sensor verification form (page 252) and send it to your nearest representative or email the collected information to helpdesk@vaisala.com and wait for further instructions.
   For the sensor verification form 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. To see the measured n_D (R.I.), press **VERIFY** in **VERIFICATION STEP 2**. The list of CCD and TEMP values are on the verification results display, see the following figure.



17. Regulatory compliance and certifications

17.1 Declaration of conformity for PR-23 series 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

Vaisala Oyj | PO Box 26, FI-00421 Helsinki, Finland
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

Appendix A. Glossary and abbreviations

Term	Definition
CCD	Charge Couple Device, sensor optical element.
CORE, CORE Optics	Compact Optical Rigid Element: 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	Liquid Crystal Display, used as transmitter display.
LED	Light Emitting Diode, the light source in a PR-23 refractometer sensor.
n_D	Refractive index (of a liquid), see Principle of measurement (page 250).
Sensor Code -AC	3-A approved, compact model
Sensor Code -AP	3-A approved, probe model
Sensor Code -GP	General purpose, probe model
Sensor Code -M	Teflon body refractometer for chemically aggressive liquids in small pipes
Sensor Code -MS	Teflon body refractometer for semiconductor liquid chemical processes
Sensor Code -SD	Safe-Drive sensor for the Safe-Drive system for safe sensor insertion and removal
Sensor Code -W	Saunders body refractometer for chemically aggressive liquids in large pipes
Sensor Code -...-AX	ATEX approved sensor, modified for use in potentially explosive atmosphere
Sensor Code -...-CS	CS approved sensor, modified for use in potentially explosive atmosphere
Sensor Code -...-FM	FM approved sensor, modified for use in potentially explosive atmosphere
Sensor Code -...-CX	Nepsi certified sensor, modified for use in potentially explosive atmosphere
Sensor Code -...-IA	ATEX approved sensor for hazardous locations in Zone 0 and Zone 1
Sensor Code -...-IF	FM approved sensor for hazardous locations in Zone 0 and Zone 1
Sensor Code -...-CI	Nepsi certified 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.

Appendix B. Principle of measurement

The Vaisala K-PATENTS® in-line refractometer 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 (589 nm) as the sodium D line (hence n_D). Light from the light source (L) in the figure below 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.

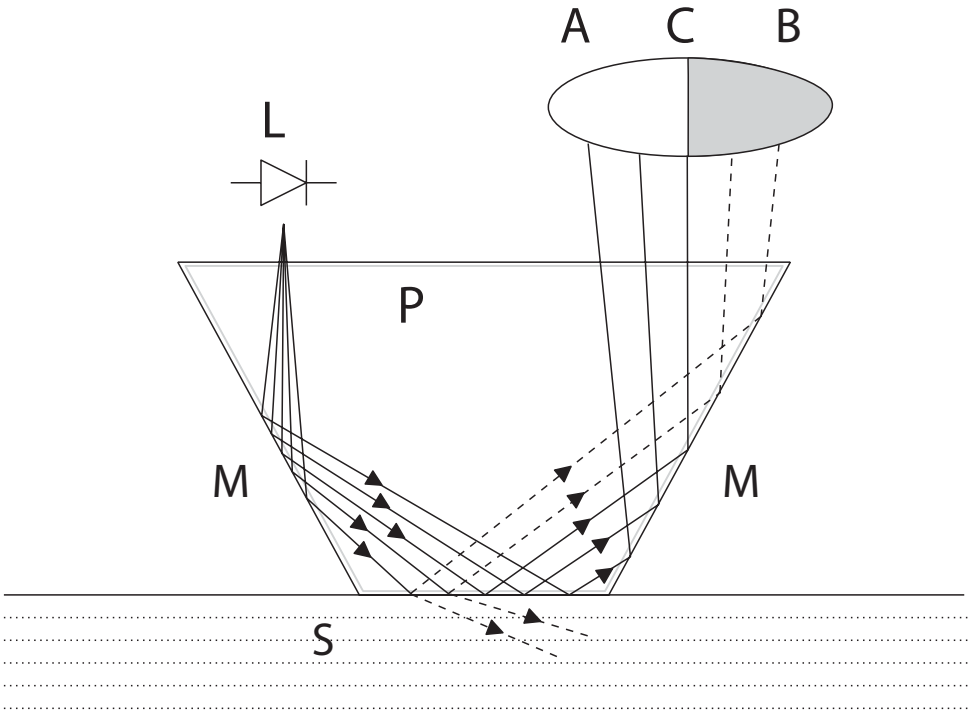


Figure 131 Refractometer principle

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. For most solutions the refractive index 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 the figure below. The color of the solution, gas bubbles or undissolved particles do not affect the position of the shadow edge (C).

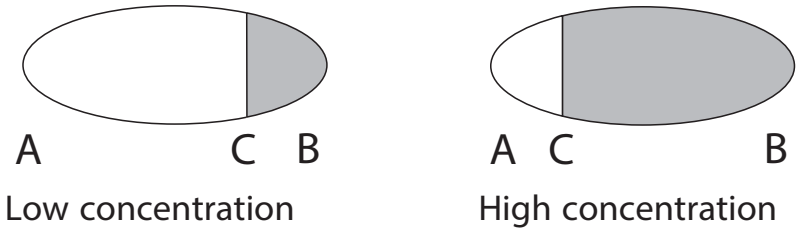


Figure 132 Optical images

The position of the shadow edge is measured digitally using a CCD element and is converted to a refractive index value n_D by a processor inside the instrument. This value is used together with the measured process temperature to calculate the concentration.

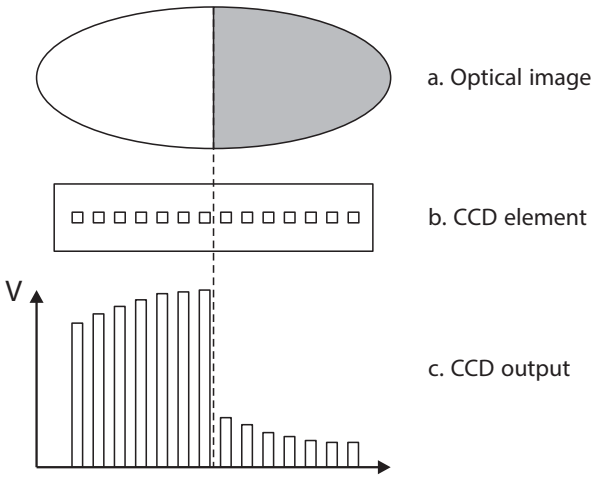


Figure 133 Optical image detection

Appendix C. PR-23 sensor verification form

Fill in this form and email it to helpdesk@vaisala.com or to your local service representative.

Sensor serial no:

Customer:

Address:

Email:

Date:

Verification made by:

Table 63 Verification results display

Sample number	Nominal n_D	Measured n_D	CCD	Temp
1	1.330			
2	1.370			
3	1.420			
4	1.470			
5	1.520			

Appendix D. Field calibration form

Fill in this form and email it to helpdesk@vaisala.com or to your local service representative.

Refractometer serial no:

Refractometer model:

Customer:

Address:

Email:

Sample description:

Solvent (water/other):

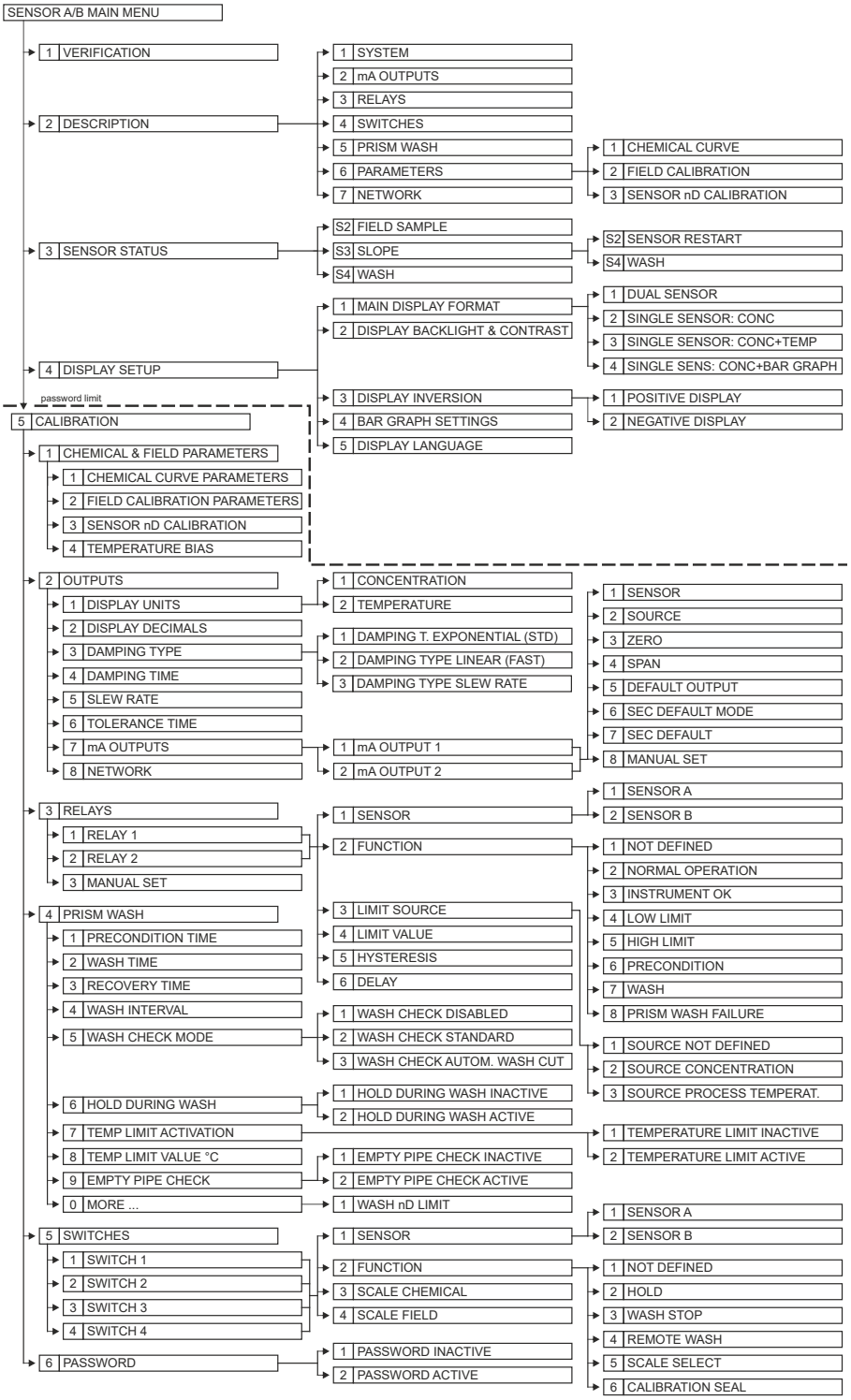
Laboratory method:

Date:

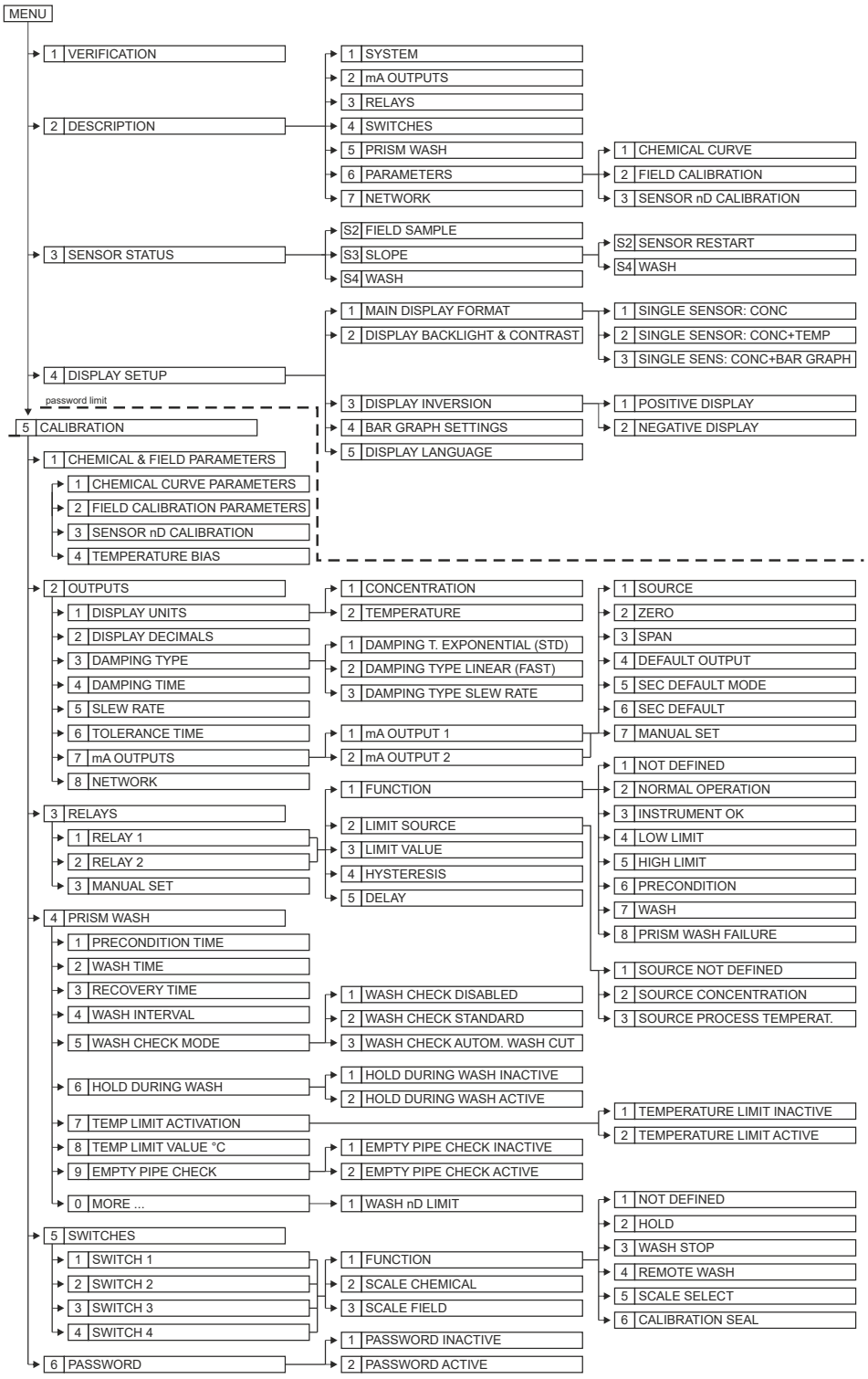
Data collected by:

		DTR DISPLAY VALUES			
Sample no.	**LAB%**	**CALC**	**T**	**n_D**	**CONC**

Appendix E. DTR command selection tree



Appendix F. STR/Divert mode command selection tree



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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.

Technical support

Contact Vaisala technical support at helpdesk@vaisala.com. Provide at least the following supporting information as applicable:

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

For more information, see www.vaisala.com/support.

Recycling

Recycle all applicable material.

Follow the statutory regulations for disposing of the product and packaging.

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