

CERTIFICATE OF CONFORMITY



1. **HAZARDOUS (CLASSIFIED) LOCATION ELECTRICAL EQUIPMENT PER US REQUIREMENTS**

2. **Certificate No:** FM17US0237
3. **Equipment:** PR-23 Series, Refractometer Sensor
(Type Reference and Name)
4. **Name of Listing Company:** K-Patents Oy
5. **Address of Listing Company:** Elannontie 5
FI-01510 Vantaa, Region of Uusimaa
Finland

6. The examination and test results are recorded in confidential report number:

3036400 dated 29th January 2010

7. FM Approvals LLC, certifies that the equipment described has been found to comply with the following Approval standards and other documents:

FM Class 3600:2011, FM Class 3610:2007, FM Class 3810:2005, ANSI/IEC 60529:2004, ANSI/ISA-60079-0:1999, ANSI/ISA-60079-11:2002, ANSI/ISA-61010-1:2004, NEMA 250:1991

8. If the sign 'X' is placed after the certificate number, it indicates that the equipment is subject to specific conditions of use specified in the schedule to this certificate.

9. This certificate relates to the design, examination and testing of the products specified herein. The FM Approvals surveillance audit program has further determined that the manufacturing processes and quality control procedures in place are satisfactory to manufacture the product as examined, tested and Approved.

10. **Equipment Ratings:**

Intrinsically safe apparatus for use in Class I, Division 1, Groups A, B, C and D, in accordance with manufacturer's Control Drawing; equipment protection by intrinsic safety AEx ia for use in Class I, Zone 0, Group IIC, in accordance with manufacturer's Control Drawing, hazardous (classified) locations; and ordinary (unclassified) locations with an ambient temperature rating of -20 °C to +45 °C, indoor and outdoor (Type 4X; IP67) environments.

Certificate issued by:

J. E. Marquedant
VP, Manager, Electrical Systems

11 July 2017

Date

To verify the availability of the Approved product, please refer to www.approvalguide.com

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11. The marking of the equipment shall include:

In type of protection intrinsically safe apparatus, the refractometer sensor equipment is labelled with the following marking(s).

Intrinsically Safe

Class I, Division 1, Groups A, B, C, D T4

Class I, Zone 0, AEx ia IIC T4

Ta = -20 °C to +45 °C

See Control Drawing WRG-478 (STR) or WRG-569 (MI)

Type 4X; IP67

12. **Description of Equipment:**

General – The PR-23 Series Refractometer Sensor is designed for industrial and hazardous (classified) location applications. They are intended to function as process measurement instruments which measure the concentration of process liquids by means of optical refractive index measurement. The refractometer sensors are a microcontroller-based instrument with several auxiliary measurement functions (internal temperature, humidity, etc.) in addition to the refractive index measurement. The refractive index measurement is based on the critical angle measurement. The measurement system consists of several optical parts, a light source (low-power light-emitting diode) and a charge-coupled device camera to capture the image. The sensor itself does not carry any milliampere outputs or relay outputs. All output functions are in a dual transmitter as well as part of the signal processing. The refractometer sensors communicate with the indicating transmitter by using a two-wire connection with both power supply and communication in the same wire pair. Because of the digital sensing technology, even large amounts of suspended solids, bubbles or color changes do not affect the measurement or the accuracy. Each sensor is provided with a calibration certificate comparing a set of standard liquids to the actual sensor output. The calibration and accuracy can be verified on-site with the certified Refractive Index liquids and K-Patents documented procedure.

The PR-23-AC Sanitary Compact Refractometer provides accurate means for measuring Brix and liquid concentrations in hygienic installations and in small pipe line sizes of 2.5 inch and smaller. The PR-23-AC sensor is installed in the pipe bend. It is angle mounted in the outer corner of the pipe bend directly or through a flow cell, a sanitary clamp or a Varivent® connection. This way the best flow conditions and self-cleaning effect can be achieved. The measurement range covers 0-100 Brix. The accuracy is ± 0.1 Brix and the measurement is automatically temperature compensated. Low and high concentration alarms can be configured.

The PR-23-AP Sanitary Probe Refractometer provides accurate means for measuring Brix and liquid concentrations for hygienic installations in large pipes, tanks, cookers, crystallizers and kettles and in higher temperatures up to +150 °C (+300 °F). The PR-23-AP sensor is installed in the pipe line or vessel through a 2.5 in. or 4 in. sanitary clamp. The PR-23-AP helps to control the concentration to assure the critical product quality attributes and to reduce costs. The measurement range covers 0-100 Brix. The accuracy is ± 0.1 Brix and the measurement is automatically temperature compensated. Low and high concentration alarms can be configured.

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The PR-23-GC Compact Process Refractometer is an industrial, compact instrument for the general industry small pipeline and bypass line applications. The PR-23-GC sensor is easy to install in the process either directly in a pipe elbow by a Sandvik coupling connection or in a straight pipe via a Wafer flow cell or a Pipe flow cell. The flangeless Wafer flow cell is a compact alternative to traditional flanged pipe 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. If the harsh environments or aggressive process fluid require a better material grade against chemical corrosion, higher alloys and special wetted parts materials are available. The measurement range covers 0-100 % by weight. The accuracy is typically ± 0.1 % b.w. and the measurement is automatically temperature compensated. Low and high concentration alarms can be configured.

The PR-23-GP Process Refractometer is an ideal all-round instrument for measuring the concentrations of a wide range of chemicals. The PR-23-GP sensor is installed via a flange or clamp connection. The measurement range covers 0-100 % by weight. The accuracy is typically ± 0.1 % b.w. and the measurement is automatically temperature compensated. Low and high concentration alarms can be configured.

The PR-23-M Teflon Body Refractometer is designed to be used in chemically aggressive solutions and ultra-pure fine chemical processes. It 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 polytetrafluoroethylene (Teflon®) or polyvinylidene difluoride (Kynar®), and thus the PR-23-M sensor withstands corrosion well. The PR-23-M sensor is connected to the process by a G1/2 in. female or a 1/2 in. NPT process connection. The measurement range covers 0-100 % by weight. The accuracy is typically ± 0.1 % b.w. and the measurement is automatically temperature compensated. Low and high concentration alarms can be configured.

The PR-23-MS Semicon Process Refractometer has a built-in, ultra-pure, modified polytetrafluoroethylene flow cell designed to keep all metal and corroding parts from coming into contact with the process liquid. All the wetted parts are made of ultra-pure, modified polytetrafluoroethylene. The prism material is sapphire. The PR-23-MS is mounted directly in-line with a pillar or flare fitting. The compact design allows integration to a wet bench or to a cabinet, where the need for foot print area is very low. The dissolved solids concentration is determined by making an optical measurement of the solution's Refractive Index. The advantage of this principle is that the same instrument can be used to measure any chemical. The PR-23-MS provides a continuous 4-20 mA or digital measurement signal and immediate feedback to the control system, if the chemical is not within specifications. The PR-23-MS is physically small and easy to install in the bulk chemicals dispense, and in point of use chemical blending, spiking and monitoring applications.

The PR-23-RP Process Refractometer is a heavy-duty refinery model designed to meet the unique requirements of the refining and petroleum industries. Typical applications include accurate liquid concentration measurements, e.g. acid in alkylation, glycol or amines in gas processing and multi-product (crude oil, fuel oil, and diesel) interfaces in transfer operations. The Refractometer sensor is installed in the process, either directly by welding stud, or via 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 automatic 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. The PR-23-RP comes with user-specified supplementary tests and documents such as, metallurgical and material hardness certification (e.g. compliance with the NACE MR0103 or NACE MR0175/ ISO 15156 standard), API recommended tests and welding documents (e.g. WPS, PQR, WQR, NDE, radiographic test and hydrostatic shell test), material traceability certification and the positive material identification (PMI) test. A factory acceptance test, site acceptance test, and customized drawings stating client specific information are also available on request. The measurement range covers 0-100 % by weight. The accuracy is typically ± 0.1 % b.w. and the measurement is automatically temperature compensated. Low and high concentration alarms can be configured.

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The PR-23-SD Safe-Drive™ Process Refractometer is a retractable refractometer for measuring black liquor dry solids and green liquor density or TTA in kraft chemical recovery process. Safe-Drive™ Process Refractometer PR-23-SD system consists of Retractable Safe-Drive™ Process Refractometer Sensor, Safe-Drive™ Isolation Valve, Safe-Drive™ Retractor, Steam Wash System, and Indicating Transmitter. Safe-Drive™ design allows for safe and easy insertion and retraction of the sensor under full operating pressure without having to shut down the process (Patent No. 2051111). The measurement range covers 0-100 % by weight. The accuracy is typically ± 0.1 % b.w. and the measurement is automatically temperature compensated. Low and high concentration alarms can be configured.

The PR-23-W Saunders Body Refractometer is designed for use in chemically aggressive solutions and ultra-pure fine chemical processes in large-scale production and in large pipelines (diameter 50, 80 or 100 mm; 2, 3 or 4 in., respectively). The PR-23-W is delivered with a Saunders (diaphragm) valve body and can be mounted either in a vertical or horizontal pipe. The Saunders body material is graphite cast iron, which provides a solid mechanical base. A PFA-lining ensures the chemical resistance. The sensor wetted parts materials are Spinell or Sapphire (prism), polytetrafluoroethylene (prism gasket), polyvinylidene difluoride or polytetrafluoroethylene (Teflon®). The sensor cover is stainless steel AISI 316L. The measurement range covers 0-100 % by weight. The accuracy is typically ± 0.1 % b.w. and the measurement is automatically temperature compensated. Low and high concentration alarms can be configured.

Construction – The PR-23 Series Refractometer Sensors are constructed of three main elements, including the sensor head, the sensor cover, and the core-module. The sensor head is interfaced between process liquid to be measured and instrument itself. There are different types and sizes of sensor heads depending on application, pipe size and material. The instrument is connected to the process pipe through the process connection, such as a clamp or flange, in the sensor head. The sensor cover is part of the enclosure for the electronics. It is mechanically and chemically resistant to ambient atmospheres and it also acts as a cooling fin for the electronics. Also a junction box is inside the sensor cover. The core-module contains all components needed for refractive index measurement and it is mechanically isolated from the sensor head and sensor cover to avoid any changes to optics caused by vibration, pressure shocks or temperature changes.

In addition to a passive resistive temperature sensor, Pt1000, connected to the process sensor, the Refractometer PR-23 Sensor contains four interconnected printed circuit boards, housed in a standard dimensioned housing. Due to the construction of the device, there are no polarity requirements; where both polarities are acceptable.

For more specifics concerning construction and description details of the refractometer sensors, reference the manufacturer's sales literature and specification sheets.

Ratings – The equipment is certified to the following ratings.

The ambient operating temperature range is -20 °C to $+45$ °C when properly mounted and installed.

The process temperature range of the media is -20 °C to $+180$ °C, each depending on the model configuration and process fitting, with a maximum working pressure range of 0 to 2.5 MPa (0 to 363 psig). The sensor has a Refractive Index measurement range of 1.3200 to 1.5300, which corresponds to 0 to 100 % by weight concentration at $+100$ °C, or an optional range of 1.2600 to 1.4700 for strong HF, depending upon model configuration.

The equipment is designated for installation transient overvoltages up to levels of Overvoltage Category II and environmentally classified as Pollution Degree 2.

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In type of protection intrinsically safe apparatus, the equipment is connected to a certified intrinsically safe linear circuit with the following maximum entity parameter values.

Supply and Signal Terminals (1, 2), $V_{max}(U_i) = 24$ VDC, $I_{max}(I_i) = 250$ mA, $C_i = 0$, $L_i = 0$, $P_i = 1.3$ W

Model Codes – The equipment is identified with the following model code structure.

PR-23-AC-a-bc-d-e, Sanitary Compact Process Refractometer Sensor.

Reference Control Drawing No. WRG-478 (STR) for Entity Parameter values

Reference Control Drawing No. WRG-569 (MI) for Entity Parameter values

- a = Refractive Index Range Limits: 62, 73, 74, 82, 83 or 92
- b = Process Connection: E, H or N
- c = Sensor Wetted Parts Material: FZ, HA, HC, MO, NI, RS, SM, SS, SU or TI
- d = Electrical Classification: IF
- e = Sensor Housing: AA, EC or SC

PR-23-AP-a-bc-d-e-f, Sanitary Probe Process Refractometer Sensor.

Reference Control Drawing No. WRG-478 (STR) for Entity Parameter values

Reference Control Drawing No. WRG-569 (MI) for Entity Parameter values

- a = Refractive Index Range Limits: 62, 73, 74, 82, 83 or 92
- b = Process Connection: B, H, I, N, P, Q, R, S, T or V
- c = Sensor Wetted Parts Material: FZ, HA, HC, MO, NI, RS, SM, SS, SU or TI
- d = Electrical Classification: IF
- e = Sensor Housing: AA, EC or SC
- f = Prism Wash: SN, WN or WP

PR-23-GC-a-bc-d-e, Compact Process Refractometer Sensor.

Reference Control Drawing No. WRG-478 (STR) for Entity Parameter values

Reference Control Drawing No. WRG-569 (MI) for Entity Parameter values

- a = Refractive Index Range Limits: 73, 74, 82 or 92
- b = Process Connection: K
- c = Sensor Wetted Parts Material: HA, HC, NI, RS, SS, SU, TI or XS
- d = Electrical Classification: IF
- e = Sensor Housing: SC

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PR-23-GP-a-bc-d-e-f-g, General Probe Process Refractometer Sensor.

Reference Control Drawing No. WRG-478 (STR) for Entity Parameter values

Reference Control Drawing No. WRG-569 (MI) for Entity Parameter values

- a = Refractive Index Range Limits: 62, 73, 74, 82, 83 or 92
- b = Process Connection: A, D, E, G, J, K, L, M, N, O or W
- c = Sensor Wetted Parts Material: FZ, HA, HC, MO, NI, RS, SM, SS, SU or TI
- d = Electrical Classification: IF
- e = Sensor Housing: AA or SC
- f = Prism Wash: NC, SN, WN, WP or YC
- g = Vertical Borderline Image Detection: VD

PR-23-Ma-e-f, Teflon Body Process Refractometer Sensor.

Reference Control Drawing No. WRG-478 (STR) for Entity Parameter values

Reference Control Drawing No. WRG-569 (MI) for Entity Parameter values

- a = Refractive Index Range Limits: 62, 73, 74, 82, 83 or 92
- e = Electrical Classification: IF
- f = Sensor Housing: SC

PR-23-MSa-e-f, Semicon Process Refractometer Sensor.

Reference Control Drawing No. WRG-478 (STR) for Entity Parameter values

Reference Control Drawing No. WRG-569 (MI) for Entity Parameter values

- a = Refractive Index Range Limits: 62, 73, 74, 82, 83 or 92
- e = Electrical Classification: IF
- f = Sensor Housing: EC

PR-23-RP-a-bc-d-e, Heavy Duty Process Refractometer Sensor.

Reference Control Drawing No. WRG-478 (STR) for Entity Parameter values

Reference Control Drawing No. WRG-569 (MI) for Entity Parameter values

- a = Refractive Index Range Limits: 62, 73, 74, 82, 83 or 92
- b = Process Connection: A20, D20, J20 or M20
- c = Sensor Wetted Parts Material: FZ, HA, HC, MO, NI, RS, SM, SS, SU or TI
- d = Electrical Classification: IF
- e = Sensor Housing: AA, EC or SC

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PR-23-SD-a-bc-d-e, Safe-Drive™ Retractable Process Refractometer Sensor.

Reference Control Drawing No. WRG-478 (STR) for Entity Parameter values

Reference Control Drawing No. WRG-569 (MI) for Entity Parameter values

a = Refractive Index Range Limits: 62, 73, 74, 82, 83 or 92

b = Isolation Valve Connection: F

c = Sensor Wetted Parts Material: XS

d = Electrical Classification: IF

e = Sensor Housing: AA, EC or SC

PR-23-Wa-bc-d-e, Aggressive Valve Body Process Refractometer Sensor.

Reference Control Drawing No. WRG-478 (STR) for Entity Parameter values

Reference Control Drawing No. WRG-569 (MI) for Entity Parameter values

a = Refractive Index Range Limits: 62, 73, 74, 82, 83 or 92

b = Sensor Wetted Parts Material: TF

c = Sensor / Diaphragm Valve Body Connection: 2, 3 or 4

d = Electrical Classification: IF

e = Sensor Housing: SC

13. Specific Conditions of Use:

NONE

14. Test and Assessment Procedure and Conditions:

This Certificate has been issued in accordance with FM Approvals US Certification Requirements.

15. Schedule Drawings:

A copy of the technical documentation has been kept by FM Approvals.

16. Certificate History:

Details of the supplements to this certificate are described below:

Date	Description
29 th January 2010	Original Issue.
11 th July 2017	Supplement 4: Report Reference: RR210180, dated 11 th July 2017. Description of the Change: Assembly documents update, original certificate of compliance updated to new format – the actual change is made to the entire certificate and the full document is issued to the holder.

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