VAISALA

Certified by EHEDG
46-04

Vaisala K-PATENTS® Sanitary Refractometer PR-43-A

For In-Line Brix and Concentration Measurement

SB: PR-43-A-9
October 2021

TYPICAL APPLICATIONS

BEVERAGES
Extraction, evaporation, brewing, distilling, sugar dissolving, blending, filling. Alcohol, rum, whiskey, brandy, vodka, molasses, liquors, cider and perry, alcoholic beverages, pre-mixed liquors. Beer and malt beverages, wort, cut beer, root beer. Juices, blended vegetable and fruit juices and nectars, still drinks, vegetable and juice concentrates, iced tea and coffee, instant coffee and tea. Soft drinks, energy and sport drinks, beverage base. Wines, grape must.

CEREALS
Sugar coating. Sugar syrup.

CONFECTIONARY
Sugar coating, topping, sugar dissolving, filling. Candies, jelly beans, caramel, chewing gum, flavors, syrup.

CULTURES, ENZYMES, YEAST
Fermentation, extraction, evaporation, filtration, separation. Enzymes, yeast.

DAIRY
Evaporation, spray drying. Condensed milk, skimmed milk, milk powder, casein, caseinate, yoghurt, ice cream, ice-cream mix, whey, whey cream, concentrated whey cream, whey powder, lactose, lactose powder, infant formula, non-dairy creamer.

EGG
Mixing, separation. Egg white, egg yolk, whole egg, mixes with added sugar or salt, egg powder, pasta with egg.

FINE BAKERY PRODUCTS
Sugar coating. Donuts, sweet rolls.

FLAVORS AND INGREDIENTS
Mixing, evaporation. Citric acid, sodium benzoate, natural and artificial flavors.

CASINGS
Extrusion. Synthetic sausage casings, polyamide, polyethylene, polypropylene, polyvinyl chloride, polyester, sodium hydroxide.

NUTRITIONAL FOOD SUPPLEMENTS
Esterification. Plant stanol ester.

FROZEN FOOD
Salinity of brined products, frozen vegetables, fruits and seafood.

FRUITS AND VEGETABLES

Blending, cooking, evaporation. Preserves, canned fruits and vegetables, vegetable extract, sauces, instant soups, jam, jellies, marmalades, juice concentrate. Soy, soy milk. Tomato based products, tomato purée, pulp, paste, ketchup.

PREPARED FOODS
Blending, cooking. Dairy desserts, rice-pudding, starch slurry.

SWEETENERS
Sugar, syrup, honey, table-top sweeteners, inulin, steviol.

SALTS, SPICES, SOUPS, SAUCES, PROTEIN PRODUCTS
Extraction, cooking, evaporation. Sodium chloride, salt substitutes, herbs, spices, seasonings, vinegar, soups and broths, sauces, yeast, protein, gelatin, agar-agar, soy drinks.

PRODUCT AND CIP INTERFACES
Product to product interfaces, product to CIP interfaces, CIP fluids.

CHROMATOGRAPHIC SEPARATION
Fractionation.

PERFORMANCE OVERVIEW

REFRACTOMETER TECHNOLOGY IN TRANSITION

We have used our expertise to develop the unique and innovative Sanitary refractometer PR-43-A to measure, refine, manage and indicate Brix and diagnostic information. The Sanitary refractometer PR-43-A is designed to meet the needs of end users in the beverage, dairy and food processing industries.

The Sanitary PR-43-A system consists of a compact or probe refractometer and a graphical user interface. The refractometer is a stand-alone device capable of operating independently. It has a measurement range of 0 to 100 Brix and provides an Ethernet or 4–20 mA output signal proportional to the temperature-compensated Brix value for real-time process control. Different user interface options range from a rugged, multichannel, industrial computer to a compact light-weight and a web-based version, and allow the user to select the most preferred way to access and use the refractometer measurement and diagnostics data.

The PR-43-A refractometer has a built-in web server with an instrument homepage. The homepage allows for configuring, monitoring, verifying and diagnosing the refractometer via an Ethernet connection. Every PR-43-A refractometer also provides an mA output signal for control purposes.

The Sanitary refractometer PR-43-A is factory-calibrated to measure Brix and temperature in standard units. Each refractometer has identical calibration. For this reason, the refractometers can be freely interchanged without optical recalibration or parameter changes. The refractometer does not require any recalibration or regular maintenance. Furthermore, the calibration of each refractometer can be verified using standard refractive index liquids and a built-in verification procedure.

The Sanitary refractometer PR-43-A is Sanitary 3-A approved and EHEDG certified to meet the highest hygiene requirements of food production. It withstands the rigors of food processing such as high process temperatures (compact type up to 130°C (265°F) and probe type up to 150°C (300°F)), CIP and SIP processes and cleaning and rinsing of facilities.

3-A SANITARY APPROVAL

The 3-A Symbol assures that the Sanitary Refractometer PR-43-A conforms to 3-A Sanitary Standard Number 46-04 for Refractometers and Energy-Absorbing Optical Sensors for Milk and Milk Products and it has passed the independent Third Party Verification inspection for 3-A Symbol authorization.

EHEDG CERTIFICATION

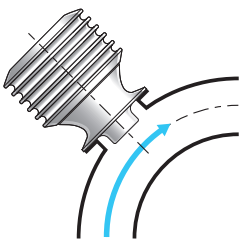
The certification of the EHEDG (European Hygienic Equipment Design Group) Type EL Class I is granted on fulfilment of the strict Hygienic Design Criteria. This is the decisive proof for the in-place cleanability, CIP/SIP capability and food contact materials safety of the Sanitary refractometers.

REFRACTOMETER INSTALLATION

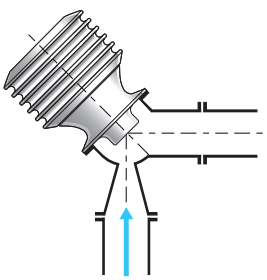
The Sanitary refractometer PR-43-A is installed in the main processing line or vessel and no by-pass arrangements are required. The user interface of the refractometer can be installed locally in the field, remotely in the control room or in both locations by connecting several user interfaces in a network.

COMPACT PROBE FOR SMALL PIPES

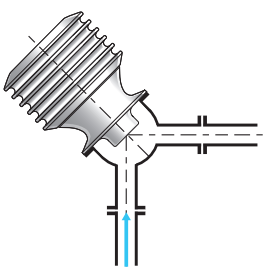
2.5 inch Sanitary or I-Line clamp



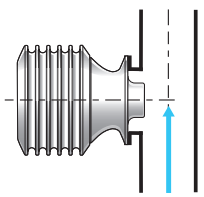
2.5 inch Sanitary or I-Line clamp and flow cell



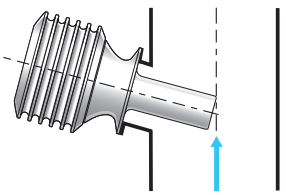
2.5 inch Sanitary or I-Line clamp and flow cell

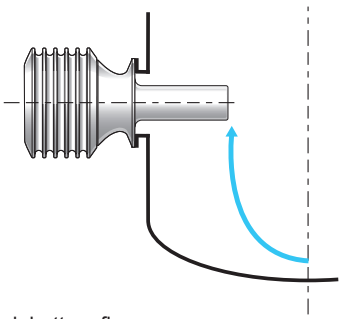


Varivent connection

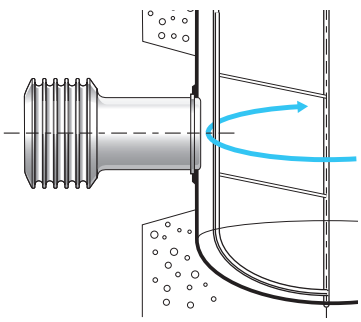


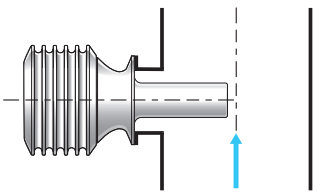
LONG PROBE FOR LARGE PIPES AND VESSELS





Tank bottom flange





STANDARD PACKAGES

REFRACTOMETER
PR-43-A

MULTICHANNEL USER
INTERFACE MI

SANITARY REFRACTOMETER PR-43-A AND MULTICHANNEL USER INTERFACE MI

A fully equipped system with refractometer, interconnecting cable and multichannel user interface with high performance industrial computing, wash control and high expandability capabilities and connectivity.

The multichannel user interface MI provides the highest level of industrial computing, intelligence and sophisticated features as well as environmental protection.

REFRACTOMETER
PR-43-A

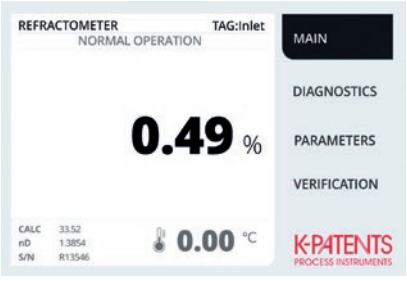
COMPACT USER
INTERFACE CI

SANITARY REFRACTOMETER PR-43-A AND COMPACT USER INTERFACE CI

A compact, single device connectivity system with refractometer, interconnecting cable and compact user interface for applications where a local or remote display and access is preferred and where no wash is required.

REFRACTOMETER
PR-43-A

WEB USER
INTERFACE WI



SANITARY REFRACTOMETER PR-43-A AND WEB USER INTERFACE WI

A stand-alone system with refractometer, interconnecting cable and web user interface designed particularly for direct control system integration in applications where no industrial computer (e.g. to control prism wash) or monitoring display is required.

USER INTERFACES

The Sanitary refractometer PR-43-A can be equipped with different user interface options for handling the user and refractometer as well as refractometer and control system interaction.

MULTICHANNEL USER INTERFACE MI

- High-performance, industrial computing system
- Expandable system and connectivity for up to four (4) PR-43-A refractometers and eight (8) I/O modules
- Environmentally sealed 316 stainless steel IP67 (door closed), IP66 (door open)/Type 4X enclosure that withstands the corrosive cleaning agents and frequent washes in food and beverage processing plants. In addition, the stainless steel enclosure has superior hygienic qualities and bacteria and germs have difficulty growing on it. Also for demanding field and outdoor conditions (-40−50°C, -40−122°F)
- Prism wash diagnostics and control
- Trend display that shows one or two graphs over a selected period of time.
- Embedded measurement apps: The apps are small programs that give different types of measurement data and functionality.
- Modules, e.g. mA-output and mA-input module
- 10” graphical touchscreen color display
- 21 CFR 11 compliant user identification and management, electronic data records and data-logging, event log/audit trail.

COMPACT USER INTERFACE CI

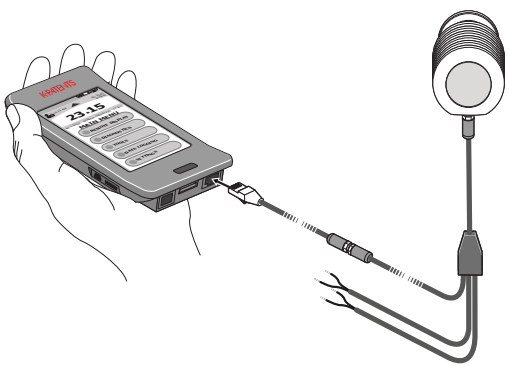
- Single device connectivity
- Local and/or remote display and access
- Light-weight, aluminum enclosure for control room conditions and epoxy coated, IP66, Type 4X enclosure with polycarbonate display shield for field conditions
- Trend display
- 10” graphical touchscreen color display.

WEB USER INTERFACE WI

- Web browser interface via Ethernet connection to a control system or any type of computer
- Output values are transmitted through 4-20 mA output and output values, diagnostic information and trends are transmitted via an Ethernet connection using a UDP/IP protocol

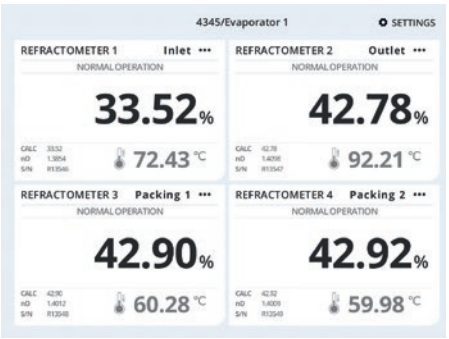
FIELD COMMUNICATOR FC-11

The user can remotely operate and configure the refractometer using the hand-held Field Communicator FC-11. The FC-11 provides an identical window into the process, showing measurement and diagnostic data including the optical image, and facilitating real time analysis and configuration directly at the refractometer.

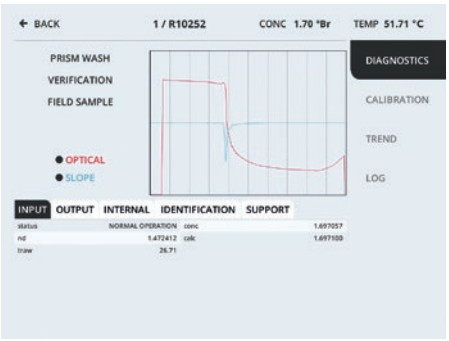


MI AND CI DISPLAYS

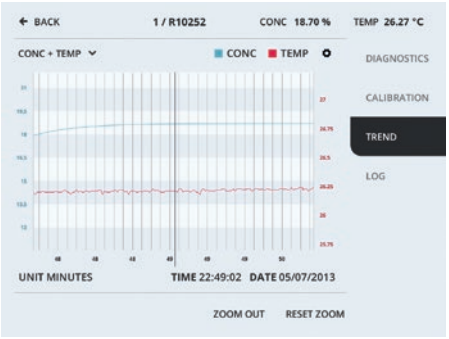
Main output display for four (4) measurement apps



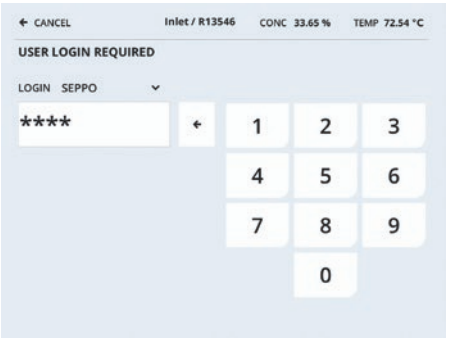
Diagnostics display



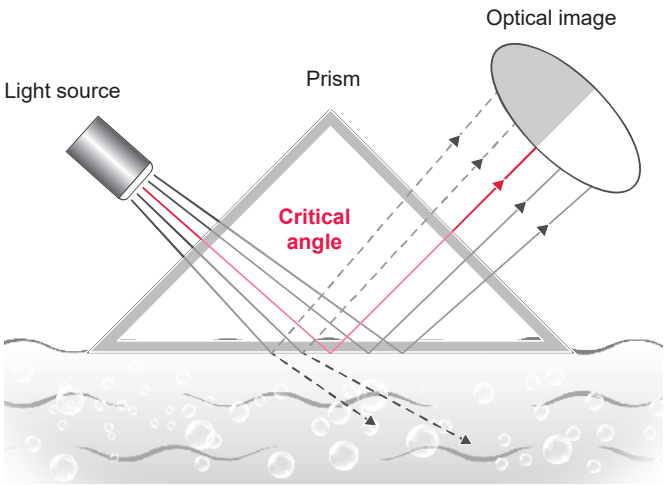
Trend display



User authentication with user ID and password



PRINCIPLE



DIGITAL MEASUREMENT PRINCIPLE

The light source sends light to the interface between a prism and the process solution, where the rays meet the surface at different angles. Depending on the angle, some rays undergo a total internal reflection. The rest of the light is refracted into the process solution.

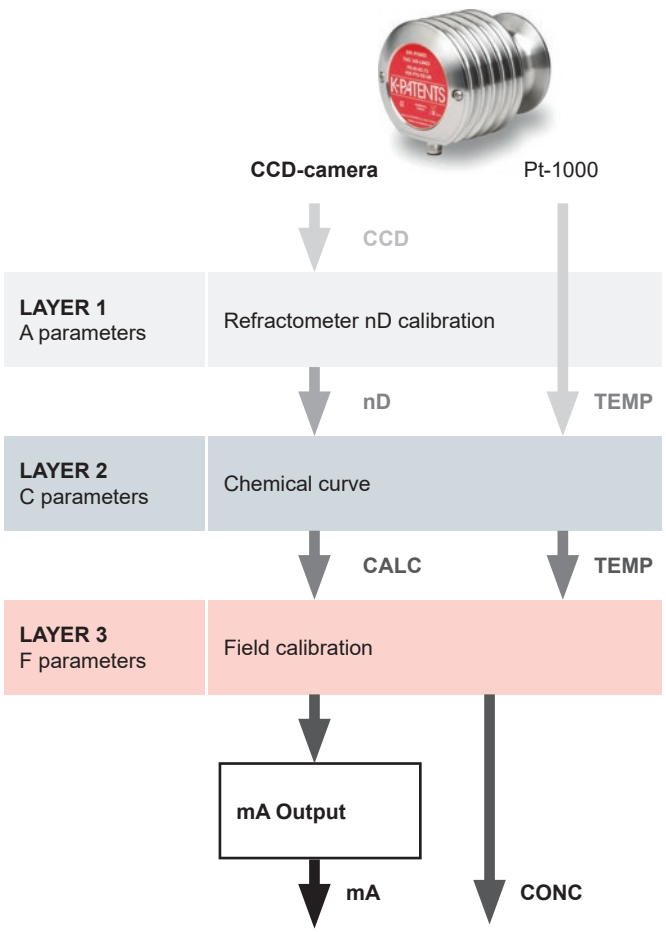
Thus, an optical image with a dark sector and a light sector is created. The angle corresponding to the shadow line is called the critical angle of total internal reflection.

This angle is a function of the refractive index and therefore the concentration of the solution. A CCD-camera detects the optical image. The image is transformed point-by-point into a digital signal. Digital signal processing is used to locate the exact shadow line position and to determine the refractive index nD.

A built-in temperature sensor measures the temperature T on the interface of the process liquid. The sensor converts the refractive index nD and temperature T into Brix units.

The diagnostics program ensures that the measurement is reliable.

CALIBRATION



UNIQUE 3-LAYER CALIBRATION

The concentration calibration of the PR-43-A refractometer is organized in three (3) layers: the Refractometer nD calibration, chemical curve and field calibration. The advantages of the layer feature are free interchangeability of refractometers, applications and recipes without any need for mechanical calibration adjustment in the field.

The optical image information is detected by the CCD-element and transformed into a number (CCD). The process temperature T is measured by a Pt-1000 resistance.

LAYER 1:
The refractometer calibration: The actual refractive index nD is calculated from the CCD.

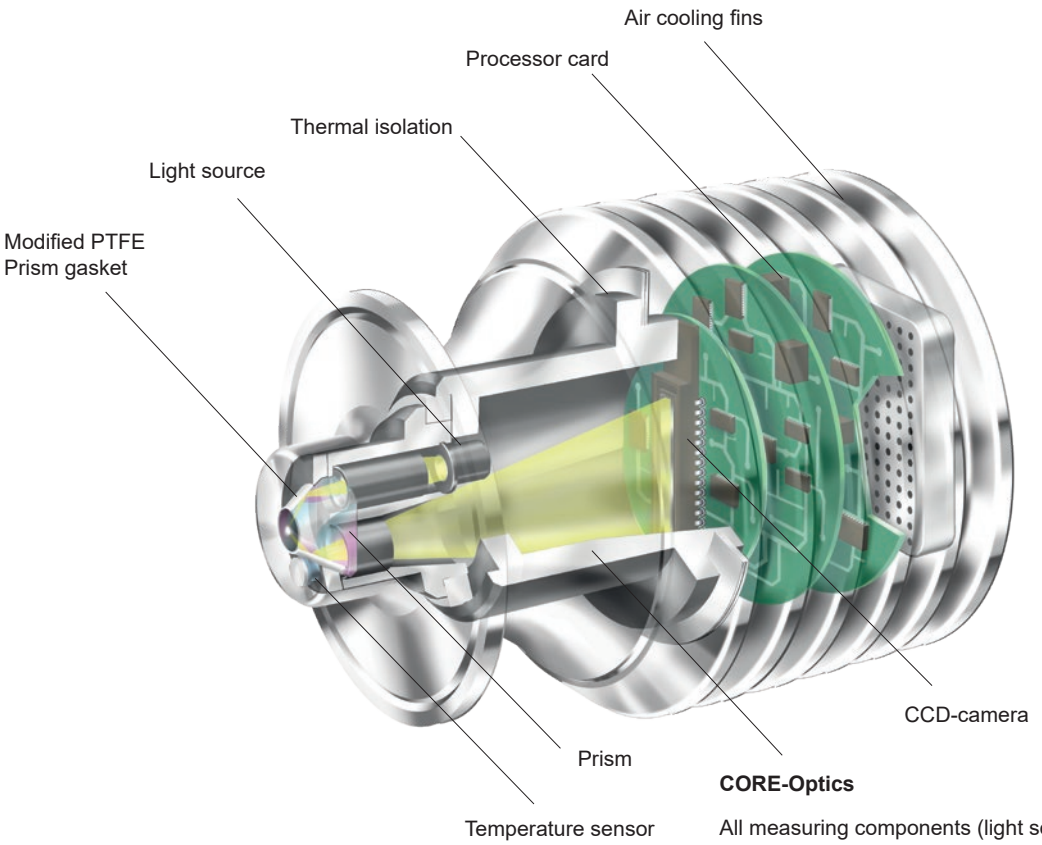
LAYER 2:

The chemical curve: The refractometer calculates the Brix or concentration value based on nD and TEMP. The result is a temperature compensated calculated concentration value CALC.

LAYER 3:
Field calibration: Adjustment of the calculated concentration value CALC may be required in order 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.

Output signal: The output signal is transmitted over the 4–20 mA current output or through the Ethernet connection.

DESIGN



CORE-Optics

All measuring components (light source, prism, temperature sensor and CCD-camera) are in one solid CORE-optics module.

The CORE-optics is mechanically isolated from the influence of external forces and vibrations. The CORE-optics contains no mechanical adjustments.

SPECIFICATIONS

	Standard	Optional
REFRACTOMETER PR-43-A Models	PR-43-AC Compact model for small pipe lines; PR-43-AP Probe model for large pipe lines and vessels.	
Refractive Index range	Full range, nD = 1.3200...1.5300 corresponds to hot water...100 Brix or % by weight.	nD = 1.2600…1.4700.
Accuracy	Across the full range of 0−100 Brix: Refractive index nD ±0.0002 corresponds typically to ±0.1 Brix or % by weight.	High accuracy version -HAC in the range of 0−30 Brix and 4−30°C: ±0.05 Brix or % by weight. ±0.02 Brix or % by weight (in set-point applications).
Repeatability	Across the full range of 0−100 Brix: nD ±0.00004 (corresponds typically to ± 0.02 Brix or % by weight).	
Speed of response	1 s undamped, damping time selectable up to 5 min.	
Calibration	With NIST traceable Cargille standard R.I. liquids over full range.	
CORE-Optics	No mechanical adjustments and digital measurement with 3648 pixel CCD element, sodium D-line light emitting diode (LED), built-in Pt-1000 temperature sensor (linearization according to IEC 751).	
Temperature compensation	Automatic, digital compensation.	
Instrument verification	With NIST traceable Cargille standard R.I. liquids and guided procedure, including a printable verification report.	
Process connection	PR-43-AC: Sanitary 3A-clamp 2.5”; Varivent in-line access unit clamp DN65 or via elbow flowcell (for line sizes of 2.5” and smaller); 2.5” Cherry-Burrell I-clamp. PR-43-AP: Sanitary 3A-clamp 2.5”; Sanitary 3A-clamp 4” or MT4 DN 25/1T APV Tank bottom flange; 2.5” Cherry-Burrell I-clamp.	
Hygienic design certification	3-A Sanitary Standard 46-03 certified and EHEDG (European Hygienic Equipment Design Group) Type EL Class I certified.	
Process pressure	Sanitary 3A and I-clamp max. 15 bar (200 psi) at 20°C (70°F)/9 bar (125 psi) at 120°C (250°F). High pressure Sanitary 3A clamp HP 40 bar.	
Process temperature	PR-43-AC: -40°C...130°C (-40°F...266°F), PR-43-AP: -40°C...150°C (-40°F...302°F).	
Ambient temperature	Refractometer: min. -40°C (-40°F), max. 45°C (113°F); Multichannel user interface MI: min. -40°C (-40°F), max. 50°C (122°F); Compact user interface CI: min. 0°C (32°F), max. 50°C (122°F).	
Process wetted parts	For compact probe Stainless steel 1.4435 (AISI 316L), for long probe Stainless steel AISI 316L, prism sapphire, prism gasket modified PTFE (Teflon), sanitary process connection gasket EPDM for Sanitary 3A-clamp, I-line clamp and Varivent connection; EHEDG certified process connection gasket for EHEDG compliant installation.	Hastelloy C ASTM C276
Sensor cover	AISI 316L stainless steel.	
Refractometer protection class	IP67, Type 4X.	
Refractometer weight	PR-43-AC: 1.6 kg (3.5 lbs), PR-43-AP: 2.9 kg (6 lbs).	
Current output	Isolated 4-20 mA, max. load 1000 Ohm, galvanic isolation 1000 VDC or AC (peak), hold function during prism wash.	
Fieldbus and industrial Ethernet connectivity	Through Fieldbus converter to Modbus/TCP, Modbus RTU and Ethernet/ IP networks.	
INTERCONNECTING CABLES	Standard length 10 m. Interconnecting cable length is field-adjustable with Platform 4 Cable extender for up to 100 m.	
USER INTERFACE Models	Multichannel user interface MI, Compact user interface CI, Web user interface WI	
Multichannel user interface MI	Environmentally sealed 316 stainless steel IP67 (door closed), IP66 (door open), Type 4X enclosure. Prism wash diagnostics and control. Trends, Apps. Eight (8) module slots. 10” graphical touchscreen color display with door. 21 CFR 11 compliant user authentication with user ID and password, electronic records and data-logging, event log/audit trail. Expandable system and I/O options: connect up to four (4) PR-43-A refractometers and up to eight (8) I/O modules. Wall and table-top mount.	
Compact user interface CI	Light-weight aluminum enclosure for control room conditions; Epoxy coated enclosure with polycarbonate display shield for field conditions, IP66/Type 4X. Trends. 10” graphical touchscreen color display. Wall, table-top and panel mount.	
Web user interface WI	Output values are transmitted through 4-20 mA output and output values, diagnostic information and trends are transmitted via Ethernet connection using a UDP/IP protocol.	
User interface weight	Multichannel user interface MI: 13.6 kg (29 lbs), Compact user interface CI: 5.4 kg (11 lbs)	
POWER SUPPLY	Refractometer: +24 VDC +/-10%, Max 2 VA; Multichannel user interface MI: AC input 100-240 VAC/50-60HZ or 24 VDC, 60W; Compact user interface CI: +24 VDC +/-10%, Max. 8.5W.	
OPTIONS	Prism wash, Hazardous and intrinsic safety approvals for hazardous area installations.	
SERVICES	To ensure continuous support before and after purchase of our products, we offer local application consultation, training, maintenance and support expertise via our authorized sales representative network. Please refer to www.vaisala.com to contact your nearest representative.	
PATENTS	See www.vaisala.com	

VAISALA

Please contact us at
www.vaisala.com/requestinfo

www.vaisala.com