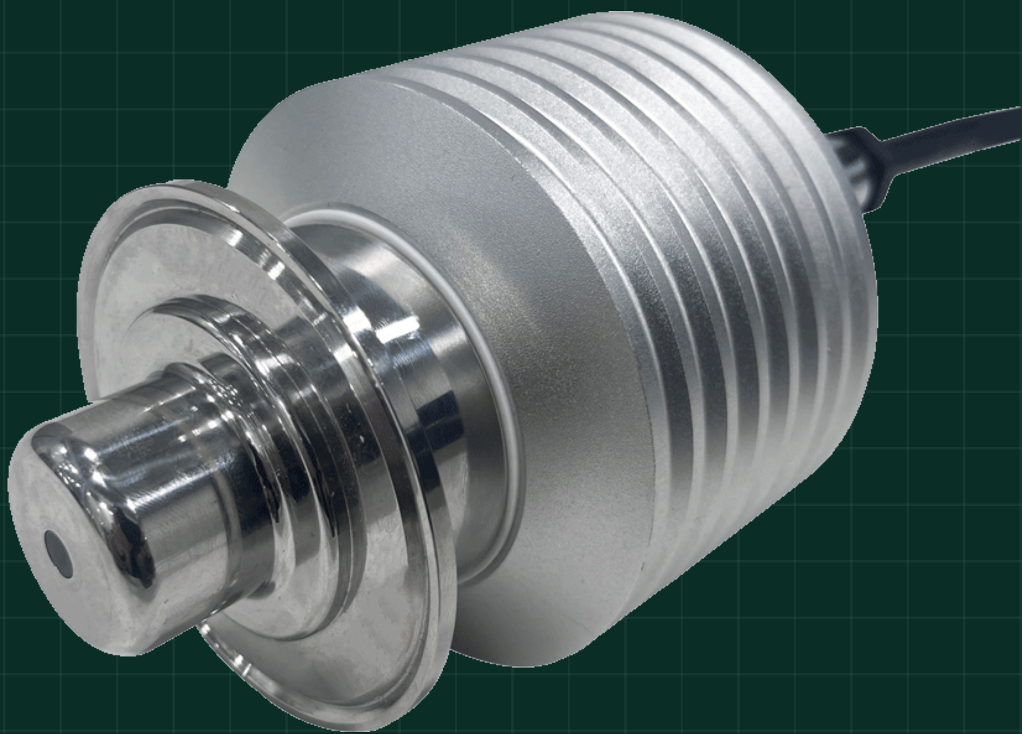
PS7110 Series · Xi'an PISONICS

Inline Process Refractometer

TECHNICAL SPECIFICATION

Critical-angle method · interface-layer measurement · insensitive to colour and turbidity

PS7110-DS-EN-A · Rev.A · 2026-09 · specifications subject to change without notice



▲ PS7110 tri-clamp sensor: prism face and integral transmitter

REVISION

Revision A · 2026-09

WEB

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Contents

CONTENTS

The PS7110 series inline process refractometer measures the refractive index of the medium by the critical-angle method and converts it to concentration through a scale. The measurement takes place in a thin layer at the prism face, which makes it insensitive to the colour, turbidity and entrained gas of the medium. An integral temperature sensor provides compensation; refractive index and temperature are calibrated before delivery.

01 Product overview

The PS7110 measures the refractive index of the medium. Light travels from a prism towards the liquid; at the interface, the part arriving above the critical angle is totally reflected while the part below it refracts into the liquid. A CCD array reads the position of the resulting shadow line, which maps to exactly one refractive index, and a scale converts that index to concentration.

1.33299 nD	0–100 %Brix	±0.0001 nD	IP68
refractive index, lower limit	concentration (B / C)	refractive index accuracy	protection, wetted parts

The measurement takes place in a thin layer at the prism face; the light does not have to cross the bore. That gives the method one of its defining properties — the colour, turbidity, entrained gas and suspended solids of the medium never enter the optical path, so none of them disturbs the reading. It also fixes its main constraint: the prism face must stay clean. Coating, crystallisation or abrasion change the reading directly, and none of them raises an alarm.

An integral temperature sensor measures the medium temperature at the interface and feeds the compensation. Refractive index and temperature are calibrated in standard units before delivery; RI verification and adjustment, self-service modelling and multi-point temperature compensation can all be carried out on site.

Typical industries

- Food and beverage
- Sugar and juice
- Brewing
- Dairy
- Chemical and petrochemical
- Cutting and cooling fluids
- Pharmaceutical
- Herbal extraction
- Semiconductor and electronic chemicals
- Surface treatment

02 Why the refractive-index method

Each of the mainstream routes to inline concentration measurement has its own boundary. The table below compares them by how they actually fail in the field, which is what should decide the route for a duty.

Method	Principal limitation
Refractive index (PS7110)	Reads a thin layer at the prism only. Coating, crystallisation or abrasion of the prism change the reading directly; components with similar refractive indices cannot be told apart
Sonic velocity (PS7020)	Reads sonic velocity across the bore. High resolution, but a range spanning a velocity turning point has to be split, and it is sensitive to entrained gas
Absorption spectroscopy (PS7100)	Can quantify several components and confirm the identity of the medium, but the target must have a usable absorption band, and it is sensitive to bubbles and to films on the window
Vibrating fork density (PS7400)	Reads density, a single scalar. Insufficient resolution where the density-to-concentration slope is flat
Conductivity	Responds only to conductive components; no response to non-electrolytes

What the PS7110 trades

Strengths

Insensitive to colour and turbidity	The light never crosses the bore, it reflects at the prism interface; dark, turbid or gas-bearing media can be measured
Thin-layer measurement	Unaffected by flow velocity, turbulence or flow regime; the bore does not have to run full, only the prism face has to stay submerged
Sanitary construction	Tri-clamp connection, CIP and SIP capable
Calibrated before delivery	Refractive index and temperature are calibrated in standard units, so the instrument can be put into service directly; a concentration scale is then built for the medium when one is needed
No reagents or consumables	No chemicals introduced and no waste liquid produced

Limitations

A clean prism is a precondition	Coating, crystallisation and abrasion change the reading directly and the instrument does not flag it. Fouling media need automatic cleaning

Similar indices cannot be separated	Components with close refractive indices cannot be told apart; multi-component systems should use the spectroscopic method
A scale is medium-specific	A scale built for one medium cannot be used to measure another liquid
The face must not point downwards	On pipe or vessel alike, a downward-facing prism collects deposits
Abrasive particles	Grit and abrasive particles must be filtered out upstream, otherwise they wear the prism

> The refractive-index and sonic-velocity methods often reach the shortlist together. The test is simple: a dark, turbid or gas-bearing medium whose concentration to refractive-index relationship is monotonic — take the refractometer; a clean medium that needs higher resolution and carries no fouling risk — take sonic velocity.

03 Measuring principle

CRITICAL ANGLE

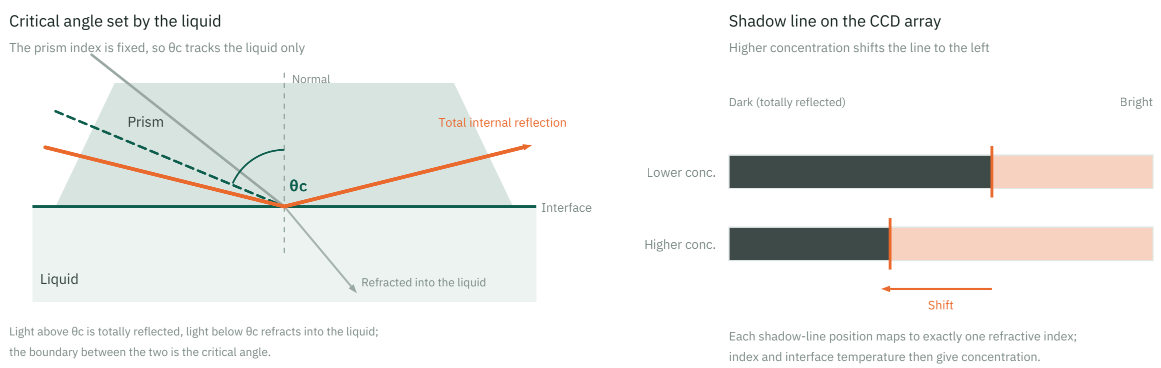
$$\sin \theta_c = n_2 / n_1$$

θ_c critical angle n_1 prism index, known and fixed n_2 index of the liquid

When light passes from the denser medium (the prism) towards the less dense one (the liquid), light arriving above the critical angle is totally reflected and light below it refracts into the liquid. The index of the prism is fixed, so the critical angle tracks the index of the liquid alone — measuring the critical angle gives the refractive index.

Light from a high-brightness LED is led into one side of the prism through an optical fibre and reaches the interface between prism and liquid along a designed path. The interface therefore carries an optical image made of a bright region and a dark region, and the angle at which they meet is the critical angle.

A CCD array reads the position of that shadow line. Each position maps to exactly one refractive index; as the concentration of the liquid rises so does the index, and the shadow line shifts. From the index nD and the interface temperature T, the transmitter computes and displays the concentration through the scale and the temperature-compensation model.



▲ PS7110 critical-angle measurement

Why colour, turbidity and bubbles do not disturb it

Transmission-based optical methods require the light to cross the whole bore, so colour, turbidity and bubbles all attenuate or scatter the path. The refractive-index method is different: the light turns back at the prism-to-liquid interface, and the optical path is only the thin layer at that interface. Suspended particles, bubbles and colour never enter that path, so they do not shift the shadow line.

> The price of that property is this: the reading represents only the thin layer at the prism face. When the face is covered by coating or crystals, the instrument measures the deposit rather than the medium — and that condition raises no alarm, it appears as a slow one-way drift. Fouling media should be given automatic cleaning at the design stage.

Key differences from the other inline methods

Aspect	PS7110 refractive index	Sonic / spectroscopic / density
Optical path	Thin layer at the prism face	Across the bore or the full section
Colour and turbidity	Insensitive	Spectroscopy is sensitive
Bubbles	Outside the path, little effect	Both spectroscopy and sonic velocity are sensitive
Flow regime and velocity	Insensitive; the face only has to stay wetted	Most methods require a full bore and a minimum velocity
Face cleanliness	Decisive precondition	Not relevant to density methods
Multiple components	Cannot separate similar indices	Spectroscopy can quantify each where the matrix is stable

04 Scales and calibration

Refractive index is what the instrument measures directly; concentration is what a scale converts it into. Refractive index and temperature are calibrated before delivery, while the concentration scale depends on the medium.

4.1 Factory calibration

Calibrated quantities	Refractive index nD and temperature T, in standard units
Calibration span	nD = 1.31 to 1.54 (0 to 100 Brix)
Consistency	Every sensor is calibrated individually before delivery, so readings are consistent from unit to unit
Built-in scale	Brix, temperature-compensated for sucrose

4.2 Concentration scales

Brix is a scale referenced to aqueous sucrose. Where the medium is not a sucrose solution, a concentration-to-index relationship has to be built for that medium, together with multi-point temperature compensation. This can be done by Pisonics before delivery or by the user on site through the self-service modelling function.

> A scale built for one medium cannot be used to measure another liquid — the same refractive index does not mean the same concentration. Where one instrument serves several media in turn, a scale has to be built for each and selected when the medium changes.

4.3 Adjustments available on site

RI verification and adjustment	Check and correct the index reading against a standard of known refractive index
Self-service modelling	Build a concentration curve on site from sampled laboratory values
Scale correction	Apply correction coefficients to an existing curve
Multi-point temperature compensation	Set compensation values at several temperatures for the medium

Note: Before adjusting anything, confirm that the prism face is clean, that the medium fully covers it and that the temperature is steady. Adjusting coefficients while the face is fouled fixes the error into the instrument.

05 Technical specifications

The PS7110 comes in three variants, A / B / C. They differ in prism material and process temperature; everything else is common. The table below lists the differences first, then the shared specifications.

Item	PS7110-A	PS7110-B	PS7110-C
Concentration range	0.0 – 90 %Brix	0.0 – 100 %Brix	0.0 – 100 %Brix
Refractive index range	1.33299 – 1.51782	1.33299 – 1.57041	1.33299 – 1.57041
Process temperature	0 – 60 °C	0 – 70 °C	−10 – 100 °C
Prism material	High-strength optical glass	Sapphire	Sapphire
Optional wetted materials	—	PTFE / Hastelloy / titanium / tantalum	PTFE / Hastelloy / titanium / tantalum

Measurement

Measuring principle	Critical-angle refractometry; CCD array reads the shadow-line position
Measured quantities	Refractive index, temperature, concentration, Brix (or another scale)
Displayed values	Refractive index nD, Brix (temperature-compensated for sucrose), concentration Conc, temperature °C
Available outputs	Beyond the displayed values, mass concentration, solids content and density can be derived through the scale; refractive index nD can also be output directly
Accuracy	Concentration ±0.1 %; refractive index ±0.0001; temperature ±0.5 °C
Resolution	Concentration 0.01 %; refractive index 0.00001; temperature 0.1 °C
Factory calibration span	nD = 1.31 to 1.54 (0 to 100 Brix)
Data processing	Sensor status diagnostics, RI verification and adjustment, self-service modelling, multi-point temperature compensation, scale correction
Custom scales	Built to order from a model for the specified medium

Process conditions

Cleaning temperature	−30 to 120 °C; CIP (clean-in-place) and SIP (sterilise-in-place) capable
Pressure rating	⩽ 1.5 MPa at the prism face

Ambient temperature	−10 to 100 °C

Electrical and output

Power supply	DC 24 V standard; AC 100–240 V, 50/60 Hz, 30 VA optional
Supply tolerance	Within ±10 % of rated voltage
Signal output	4–20 mA / RS485 / RS232 / USB
Cable length	2 m standard, extendable to 200 m
Display	1.4-inch on-board display

Construction and protection

Wetted materials	SS316L plus prism (material per the table above)
Process connection	Compact tri-clamp; flange DN25 / DN50 / DN65 / DN80 optional
Ingress protection	IP68 for the wetted parts
Hazardous area	Ex ia IIC T6 Ga
Net weight	Approx. 1.0 kg

Note: Overall dimensions depend on the process connection; the order drawing governs.

06 Measurement and diagnostics

Failures of the refractive-index method rarely stop the instrument. They usually appear as a reading that is still there but now describes the deposit rather than the medium. The instrument therefore provides sensor status diagnostics and hands the readable state to the operator.

Capability	Description
Sensor status diagnostics	Continuous self-monitoring; on failure the cause is reported so it can be located quickly on site
RI verification and adjustment	Check and correct the index reading against a standard; can be done at any time on site
Self-service modelling	Build a concentration curve on site from sampled laboratory values
Scale correction	Apply correction coefficients to an existing curve
Multi-point temperature compensation	Set compensation values at several temperatures to cover the process range
On-board display	Refractive index, Brix, concentration and temperature are all readable on the instrument

6.1 Reading the symptoms on site

The following conditions do not normally raise a fault code, but their signatures are distinctive enough to locate the problem quickly.

Symptom	Most likely cause
Slow one-way drift, unusually smooth curve	Coating, scale or crystals on the prism — the instrument is reading the deposit, not the medium
Sudden step, then no longer follows the process	The face is covered by gas, or the level has dropped and no longer covers the prism
Whole reading offset by a constant amount	The scale does not match the current medium, or the index zero needs RI verification
Reading swings with temperature	Compensation points do not cover the present temperature range, or the temperature is swinging sharply
Noise increasing and not recovering	The prism face is being abraded; check the upstream filtration

> The condition of the prism face is the single precondition for a trustworthy reading. Putting "look at the face" into the routine inspection is worth more than any coefficient correction applied afterwards.

07 Interfaces and output

The instrument provides a 4–20 mA analogue output together with RS485, RS232 and USB digital interfaces, so a DCS or PLC and a host computer can be connected at the same time.

Output and interfaces

Analogue output	4–20 mA
Digital communication	RS485 / RS232 / USB
Transmission distance	Standard cable 2 m, extendable to 200 m

Note: Beyond about 5 m, use the RS485 digital signal rather than running a long analogue loop. A shielded cable or an enclosure earth connection is required for a stable analogue output.

Note: System-level options — multi-point management, remote display and wireless transmission — are listed in chapter 08, Cleaning and accessories.

08 Cleaning and accessories

A clean prism face is the precondition for a trustworthy reading. Media that coat or crystallise need a cleaning strategy decided at the design stage, not added after the reading has started to drift.

8.1 Cleaning methods

Code	Method	Application
—	CIP / SIP	Routine cleaning in sanitary processes; cleaning temperature −30 to 120 °C
PS7110-CL1	Ultrasonic cleaning unit	Keeps the prism face clean continuously; for media that form films or coatings
PS7110-CL2	High-pressure flushing unit	Periodic flushing of the face with high-pressure gas or liquid; for crystallising or particle-depositing duties

8.2 Mounting accessories

Code	Accessory	Application
PS7110-MT1	Small-bore adapter	Lines of 2 inch and below
PS7110-MT2	Tee with sight glass	Where the face has to be checked visually
PS7110-MT3	Cross with sight glass	Where a flushing or sampling branch is needed as well
PS7110-MT4	Sanitary adapter	Food, dairy and pharmaceutical processes
—	Others	Built to the installation conditions

8.3 System accessories

Code	Accessory	Description
PS7110-SY1	Remote display controller	Separates display from sensor for points that are hard to reach
PS7110-SY2	Multi-channel acquisition system	Up to 120 channels for centralised management of several points
PS7110-SY3	Terminal data acquisition system	Central acquisition and archiving of field data
PS7110-SY4	Wireless transmission module	For points where cabling is impractical

Note: Accessory codes use two functional letters plus a serial number: CL for cleaning, MT for mounting, SY for system. They do not collide with the single-letter variant codes (PS7110-A / -B / -C) and can be listed alongside them on an order, for example PS7110-B + PS7110-CL1 + PS7110-MT4.

09 Requirements on the medium and the installation

The PS7110 reads the refractive index of the thin layer of liquid at the prism face. The reading is therefore only as trustworthy as two things: whether that face stays covered by liquid representative of the process, and whether it stays clean. Confirm the conditions below during selection and installation.

9.1 Requirements on the medium

Refractive index range	The index corresponding to the working concentration range must fall within the range of the chosen variant
Monotonicity	The relationship between concentration and refractive index must be monotonic across the working range; a range containing a turning point has to be split
Components	Components with similar refractive indices cannot be separated; systems in which several components vary independently should use the spectroscopic method
Abrasive particles	Grit, abrasive particles and anything else that could wear the prism must be filtered out upstream
Coating and crystallisation	Media that foul the prism require automatic cleaning; crystallisation on the window must be avoided while the plant is down
Temperature limit	Do not measure samples above 100 °C
Pressure limit	Pressure at the prism face must not exceed 1.5 MPa

9.2 Requirements on the installation

Face covered by liquid	Under every condition the sample must fill the flow line and cover the prism face
Face orientation	On pipe or vessel alike, the prism face must not point downwards — a downward-facing prism collects deposits
Riser flow direction	On a vertical line the flow must run upward; a down-flow riser drains and stops running full, leaving the prism uncovered
Vessel installation	The liquid in the vessel must circulate continuously, and the agitator must not touch the measuring window
Mechanical protection	Keep sharp objects away from the prism face; do not rest anything on the sensor
Vibration	Do not install where there is heavy vibration
Environment	Avoid direct sunlight, rain and heavy dust; ambient −10 to 100 °C

Earthing and shielding	A safe and reliable earth is required; the analogue output needs a shielded cable or an enclosure earth
Storage	When out of service for a long period, switch off the supply, keep the window free of crystals and keep it clean

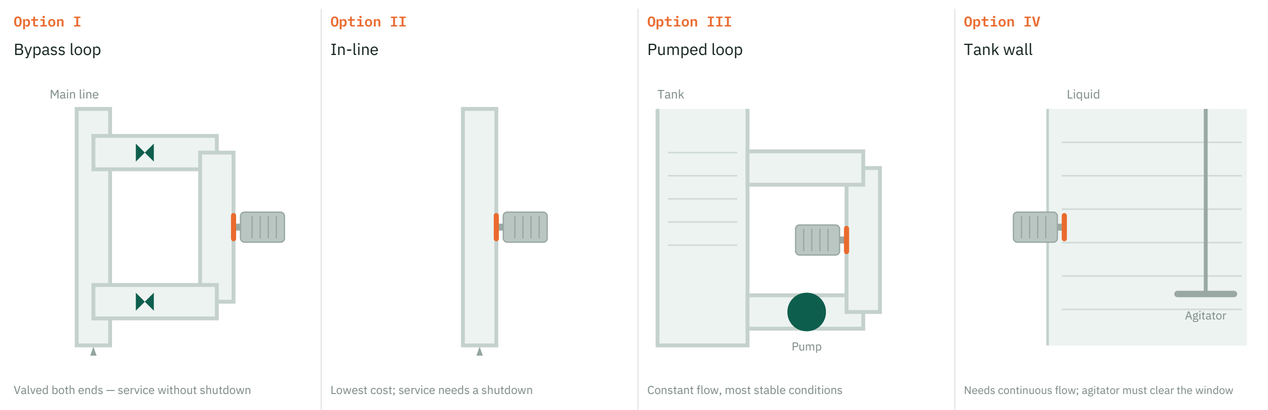
Note: An inline instrument is for process monitoring and trend assessment. Conclusions about compliance with a standard, or release of a product, should be made by laboratory methods.

10 Product make-up and installation

The instrument comprises the refractometer sensor (light source, prism, CCD array and temperature sensor), the tri-clamp or flange process connection, the connecting cable and the supplied accessories. A standard shipment contains the instrument, the clamp, the twelve-core cable, the PTFE quick-clamp gasket and the weld-on quick-clamp ferrule.

10.1 Four installation arrangements

The four arrangements do not differ in the measurement itself but in maintenance cost and in how stable the measuring conditions are. Which one to take depends on whether this line can be shut down, and on how stable the reading has to be.



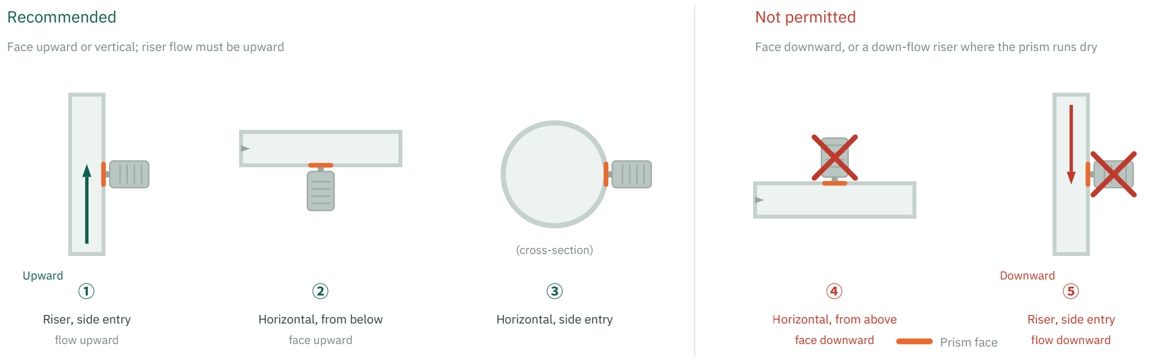
▲ PS7110 four installation arrangements

Arrangement	Method	Trade-off
Option I Bypass loop	A bypass branch off the main line with a valve at each end; the sensor sits in the branch	Can be isolated and serviced without shutting the main line; recommended, at the cost of extra pipework and valves

Arrangement	Method	Trade-off
Option II In-line	The sensor is fitted directly in the main line	Lowest installation cost; cleaning, calibration and service all require a shutdown
Option III Pumped loop	A pump draws from the tank and returns through a loop; the sensor sits downstream of the pump	Constant flow and the most stable measuring conditions, giving the best reading; highest cost
Option IV Tank wall	The sensor is fitted in the tank wall with the prism face immersed	Simplest arrangement; the liquid must circulate continuously and the agitator must clear the measuring window

10.2 Sensor orientation

There are only two rules on orientation, and both are absolute. First, the prism face must not point downwards — a downward face collects deposits, and a deposit raises no alarm, it simply makes the reading drift one way. Second, on a vertical line the flow must run upward; a down-flow riser drains when the pump stops or the flow falls, stops running full, and the prism is no longer covered.



▲ PS7110 sensor orientation: recommended and not permitted

Arrangement	Verdict	Reason
① Riser, side entry (flow upward)	Recommended	Face vertical; upward flow is stable and always runs full
② Horizontal line, entry from below (face upward)	Recommended	Face points upward and stays covered by liquid
③ Horizontal line, side entry	Recommended	Face vertical, which also satisfies the orientation rule
④ Horizontal line, entry from above (face downward)	Not permitted	A downward face collects deposits, and it raises no alarm
⑤ Riser, side entry (flow downward)	Not permitted	A down-flow riser drains and stops running full; the prism is left uncovered

> ① and ⑤ are the same arrangement; only the flow direction differs. When reusing existing pipework in a retrofit this is the easiest requirement to miss — the tapping is in the right place, the flow runs the wrong way, and the instrument still reads wrong.

10.3 Three connection cases

Case	Method
Medium and large bore	Connected directly by tri-clamp or flange, with the face inside the bore and not pointing downwards
2 inch and below	Connected through the small-bore adapter (PS7110-MT1) so that the liquid fully covers the face
Vessel or tank wall	Fitted in the tank wall with the face immersed; the liquid must circulate continuously and the agitator must clear the window

10.4 Before deployment

- Settle the installation arrangement and the cable routing first, then select and order against them
- Confirm that the mechanical, electrical and communication interfaces match the pipework or vessel at the chosen point
- Install the cable trays or overhead runs according to the routing plan
- Confirm that the host is in place and that its interface and protocol match
- Confirm that the supply matches and that a safe, reliable earth is available

Note: Connecting the cable while the supply is live can cause electric shock; wiring must be carried out with the power off.

11 Typical applications

Food and beverage

Sucrose, fruit purée, jelly, soft drinks, fructose, juice and bone broth concentration during production

Sugar and brewing

Syrup concentration, glucose, beer process concentration

Dairy

Solids content of milk and dairy products

Chemical and petrochemical

Sulfuric acid, hydrochloric acid, phosphoric acid, sodium hydroxide, ammonia, urea, surfactants, glycol, hydrogen peroxide, sodium hypochlorite, methanol and ethanol

Cutting and cooling fluids

Mixing ratio of cutting fluids, coolants and emulsions

Pharmaceutical and herbal

DMF, DMAC, herbal concentrates and alcohol-extraction stages

Polymers and materials

PVOH, polyurethane, slurries, gelatin and collagen peptides

Others

Sodium carbonate, glycerol and similar solutions

Note: For duties not listed, please provide the composition, concentration range, working temperature and pressure, and whether the medium coats the prism or carries abrasive particles, so that suitability and the scale approach can be assessed.

12 Selection and customisation

The PS7110 can be specified by variant, process connection, wetted material, cleaning method and system accessories. At the selection stage please provide the composition, concentration range, working temperature and pressure, the bore and mounting position, and whether the medium coats, crystallises or carries abrasive particles.

Variants A / B / C · Tri-clamp / flange DN25–DN80 · Sapphire prism · PTFE / Hastelloy / Ti / Ta · Ultrasonic or high-pressure cleaning · Ex ia IIC T6 Ga

Choosing a variant

Deciding factor	Variant
Process temperature 0 – 60 °C, up to 90 Brix, non-corrosive medium	PS7110-A
Full 0 – 100 Brix range needed, or the medium may attack optical glass	PS7110-B
Process temperature below 0 °C or above 70 °C	PS7110-C
Medium may attack SS316L	B or C with PTFE, Hastelloy, titanium or tantalum

Pisonics inline density and concentration range

Model	Principle	Typical use
PS7000	Ultrasonic · acoustic impedance	Slurry density with entrained air or high solids (mineral, FGD)
PS7010	Ultrasonic · attenuation	Clamp-on duties with no pipe penetration; retrofits
PS7020	Ultrasonic · sonic velocity	Concentration of clean liquids (food, brewing, sugar)
PS7100	Optical · absorption spectroscopy	Multi-component concentration; identifying the medium
PS7110	Optical · refractive index	Concentration of dark or turbid media; sanitary and CIP processes
PS7200	Coriolis	High-accuracy density of clean liquids; custody transfer
PS7300	Differential pressure	Density on large-bore mains (DN200 and above)

Model	Principle	Typical use
PS7400	Vibrating fork	Density of fouling and corrosive chemical liquids
PS7600	Microwave	Density and concentration of aqueous suspensions

Note: Where the medium is clean, needs higher concentration resolution and carries no fouling risk, the PS7020 sonic-velocity method is usually the better fit; where several components have to be told apart, or the identity of the medium confirmed, use the PS7100 spectroscopic method.

13 Warranty and service

The instrument carries a one-year warranty from the date of despatch, with six months on repair and maintenance work. The warranty covers the original purchaser or a user supplied by an appointed distributor, and does not extend to damage caused by misuse, modification, negligence, accident or operation outside the specified conditions. Faulty instruments are repaired free of charge within the warranty period; please contact the service department with a description of the fault.