



Anton Paar

Concentration, Density and
Sound Velocity Measurement
in Industrial Processes

::: Unique Density & Concentration Meters



Anton Paar Introduction

Anton Paar GmbH, founded in 1922, is a family-owned, highly innovative company with more than 400 employees worldwide. Using the latest technologies, Anton Paar GmbH is a renowned producer of a variety of high-quality, high-performance instruments and a contract manufacturer of high-precision parts and system components.

Tools such as CNC machining, SMD electronics, orbital welding and laser technologies are used at Anton Paar according to strict ISO 9001 guidelines.

Worldwide partnerships and a reliable distribution network in over 80 countries with well-trained sales and service engineers provide fast and efficient support to all Anton Paar customers.



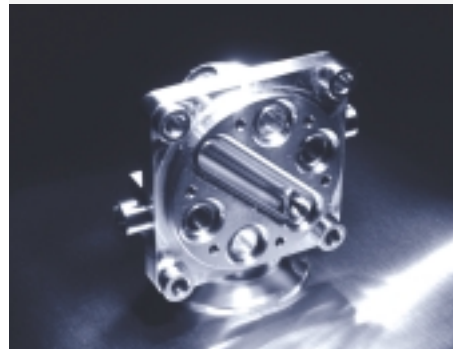
Anton Paar and the oscillating U-tube principle

In 1967, Anton Paar introduced a revolutionary new method of density measurement based on the law of harmonic oscillation. Due to its accuracy and versatility, the oscillating U-tube has since become the principle method of density measurement worldwide.

Anton Paar's instruments for process applications

Anton Paar has supplied process instruments to industry for over 30 years. We offer a wide range of instruments and accessories to meet the requirements of customers in a variety of industrial branches.

These products have gained a great reputation for their quality, reliability and accuracy, especially when used in highly demanding applications.



Applications

Anton Paar's online instrumentation ensures the continuous control of product quality and product specifications within tight tolerance limits.

A variety of wetted parts, materials and process connections are available to suit each application. A team of application specialists offer advice based on long experience and assists in solving new application tasks.



Density measurement



Precise density and concentration measurement of ...

- ▶ food
- ▶ beverages (extract, alcohol, °Brix, etc.)
- ▶ sugar
- ▶ oleum
- ▶ hydrochloric acid
- ▶ phosphoric acid
- ▶ nitric acid
- ▶ boric acid
- ▶ sodium hydroxide
- ▶ ammonia
- ▶ HES
- ▶ sulfuric acid up to 90%
- ▶ potassium hydroxide solution
- ▶ hydrogen peroxide
- ▶ glucose
- ▶ hydrocarbons
- ▶ fuels
- ▶ lubricants
- ▶ liquefied petroleum gas
- ▶ MEK in toluene

Velocity of sound measurement



Precise sound velocity and concentration measurement of ...

- ▶ food
- ▶ beverages (extract, alcohol, °Brix, etc.)
- ▶ sugar
- ▶ alkalis
- ▶ solvents
- ▶ emulsions
- ▶ reaction monitoring
- ▶ sulfuric acid above 90%
- ▶ oleum
- ▶ acetic acid
- ▶ sodium hydroxide
- ▶ oil in cooling plants
- ▶ acids in previously ambiguous measuring ranges
- ▶ material and phase recognition

Combined density and velocity of sound measurement



Precise concentration measurement of ...

- ▶ food
- ▶ beverages (extract, alcohol, °Brix, etc.)
- ▶ sucrose/inverted sugar/water
- ▶ formaldehyde/methanol/water
- ▶ sodium chloride/sodium hydroxide/water
- ▶ sulfuric acid/oleum concentrations
- ▶ emulsions
- ▶ reaction monitoring

Density Measurement

The Anton Paar oscillating U-tube method

A U-shaped metal or glass tube is electromagnetically forced into harmonic oscillation. The period of oscillation is dependent on the density of the sample in the tube. Therefore, by measuring the period of oscillation, the density or density-related values can be calculated to a high level of accuracy.



DPRn Density Transducers - Measuring principle

Sample flows continuously through the vibrating U-tube sensor. The characteristic frequency of vibration is measured and the separate mPDS Evaluation Unit instantly translates the signal into a density or concentration value. Each DPRn Transducer is paired with an mPDS Evaluation Unit. Temperature compensation is achieved using an integrated Pt1000 temperature sensor.

DPRn 417/DPRn 427 Density Transducer

- ▶ Inner diameter: 6.6 mm
- ▶ Materials (wetted parts): Hastelloy, Stainless Steel 316Ti or Incoloy 825
- ▶ Recommended transducer for beverage processes, extremely accurate
- ▶ Typical applications: Beer, soft drinks, alcoholic lemonades, distillates, milk and other applications requiring the highest precision
- ▶ Meets sanitary requirements



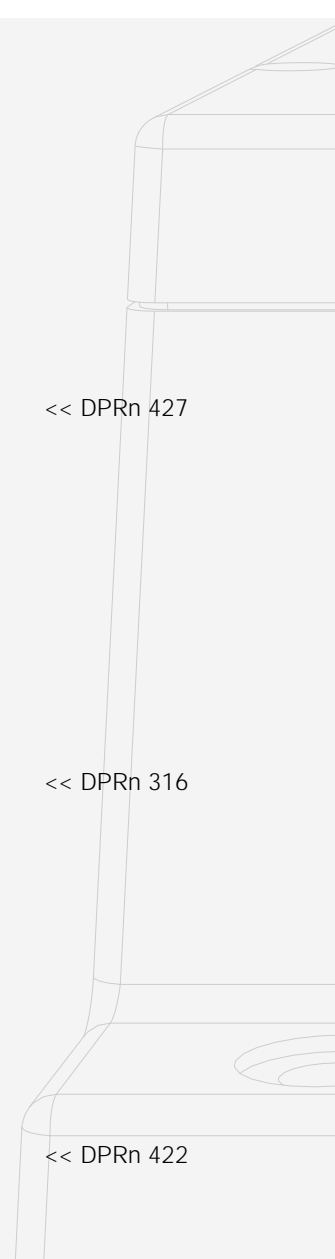
<< DPRn 427

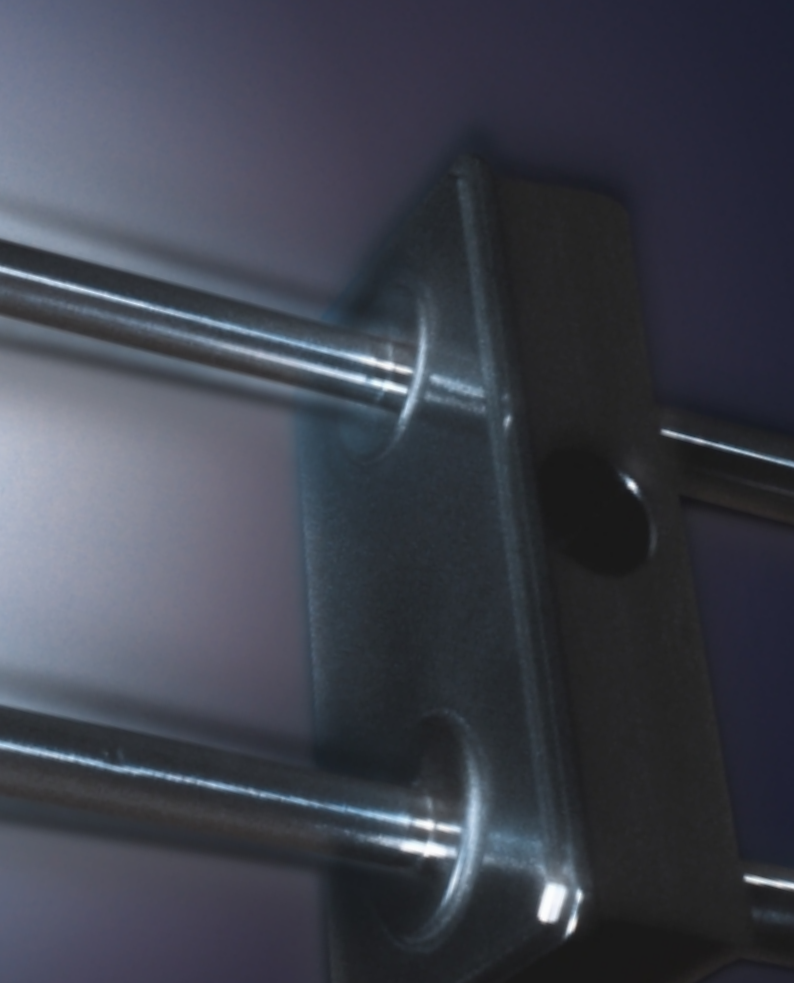


<< DPRn 316



<< DPRn 422





Features and benefits

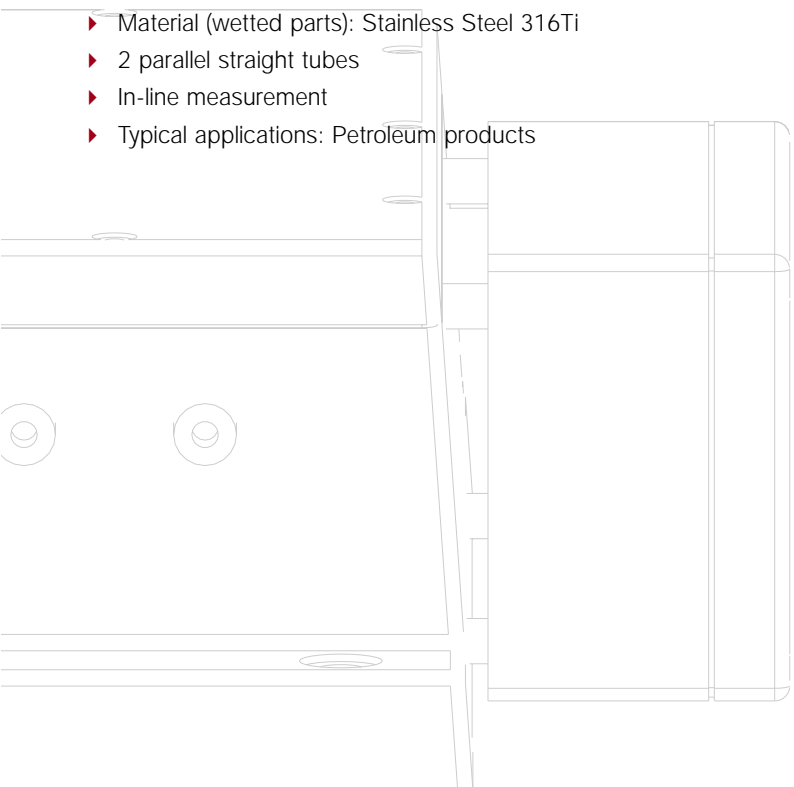
- ▶ The most accurate measurement on the market
- ▶ The high linearity provides exceptional accuracy over a wide density range
- ▶ Rapid response to changes in concentration or temperature provides real-time results and drift-free measurement
- ▶ Extremely high resolution and repeatability
- ▶ Legendary robust design, long life
- ▶ Variety of wetted parts materials to suit most applications
- ▶ Automatic conversion into specific gravity, °Brix, % alcohol, % H₂SO₄, API gravity and many other concentration readings by the mPDS 1000/ mPDS 2000V3 Evaluation Unit

DPRn 427 Tantalum Density Transducer

- ▶ Inner diameter: 7 mm
- ▶ Material (wetted parts): Tantalum
- ▶ Typical applications: Most aggressive samples, concentrated sulfuric acid, other acids, etc.

DPRn 316 Density Transducer

- ▶ Material (wetted parts): Stainless Steel 316Ti
- ▶ 2 parallel straight tubes
- ▶ In-line measurement
- ▶ Typical applications: Petroleum products



DPRn 4122 Density Transducer

- ▶ Inner diameter: 22 mm
- ▶ Material (wetted parts): Stainless Steel 316Ti
- ▶ Large inner diameter for high flow rate or less homogeneous samples
- ▶ SF Special Flange version with various flanges and clamps available
- ▶ Typical applications: Extreme sanitary requirements, high flow rates

DPRn 407 Density Transducer

- ▶ Inner diameter: 7 mm
- ▶ Material (wetted parts): Borosilicate glass and PVDF [Poly(vinylidene fluoride)]
- ▶ Typical applications: Aggressive or extremely pure liquids

DPRn 422 Density Transducer

- ▶ Inner diameter: 2.8 mm
- ▶ Material (wetted parts): Hastelloy
- ▶ Typical applications: High pressure up to 200 bar and/or low flow rates

Sound Velocity Measurement

For many liquid mixtures, the speed of sound is directly proportional to the concentration of the components. Therefore, sound velocity measurement can often be used for concentration measurement of 2-component mixtures. The sound velocity is also a characteristic property of a liquid and can be used for material characterization.

Features and benefits

- ▶ High resolution and repeatability
- ▶ Fast response to changes in concentration or temperature provides accurate drift-free measurement
- ▶ Robust design
- ▶ Automatic conversion into concentration readings by the mPDS 1000/mPDS 2000V3 Evaluation Unit

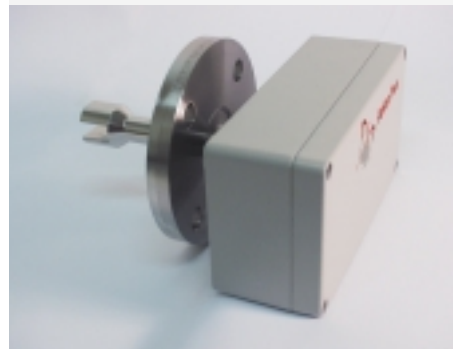


SPRn Sound Velocity Transducers – Working principle

The sample flows perpendicular to a sound signal. The speed of sound is measured between a transmitter and a receiver and temperature compensation is achieved using an integrated Pt1000 temperature sensor.

SPRn 4115 Sound Velocity Transducer

- ▶ Material (wetted parts): Stainless Steel 316Ti, other materials possible
- ▶ In-line installation, fork-type sensor
- ▶ LI version (long shaft 100 mm, intrinsically safe) for installation in containers and tanks
- ▶ Connections for extreme sanitary requirements
- ▶ Typical applications: Original extract of beer, purity of liquids, interface detection, concentration of bulk chemicals, etc.



<< SPRn 4115 Li

SPRn 4214 Sound Velocity Transducer

- ▶ Material (wetted parts): Hastelloy or Incoloy 825
- ▶ Bypass installation, tube-type sensor
- ▶ LS version for samples with low sound velocity i.e. coolants (Freon, etc.)
- ▶ Typical applications: Concentration determination of alcohol, liquid foods, chemicals, solvents in paints, coolants



<< SPRn 4214

Combined Density and Sound Velocity Measurement

It is possible to measure three concentrations in a 3-component mixture by determining the density and sound velocity simultaneously and then processing the data using sophisticated polynomial formulas. For example: Beer (alcohol/extract/water), formaldehyde/methanol/water. The density/sound velocity concept is also applied for product characterization and purity control.

Features and benefits

- ▶ High resolution and repeatability, rapid response and accurate measuring results
- ▶ Designed to withstand the rough conditions of the industrial environment
- ▶ Requires the mPDS 2000V3 Evaluation Unit



DSRn Density & Sound Velocity Transducers – Working principle

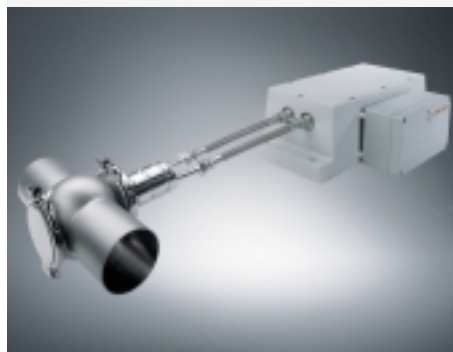
The sample flows continuously through a single combined sensor measuring the speed of sound and the density simultaneously. Temperature compensation is achieved using a Pt1000 temperature sensor.

DSRn 427 Density/Sound Velocity Transducer

- ▶ Material (wetted parts): Hastelloy C 276
- ▶ Typical applications: Fresh °Brix and degree of inversion of soft drinks, alcohol, real and original extract of beer, concentration of bulk chemicals such as formaldehyde/methanol/water



<< DSRn 427



<< DSRn 427 with online fitting

Density and Sound Velocity Transmitters

DTR and STR Transmitters use the same measuring technology as the DPRn and SPRn Transducers. An integrated processor board provides a direct 4 to 20 mA analog output signal. An mPDS Evaluation Unit is therefore not required.

These transmitters offer a much lower cost solution when only a 4 to 20 mA output is needed.



Features and benefits

- ▶ Calculates temperature-compensated density and concentration and provides a 4 to 20 mA output signal
- ▶ Requires no mPDS Evaluation Unit so costs are lower
- ▶ The same high-quality, highly reliable design as all other Anton Paar products

DTR 417/DTR 427 Density Transmitter

- ▶ Materials (wetted parts): Stainless Steel, Hastelloy or Incoloy
- ▶ Typical applications: Beverage syrups, juices, acids, bases, etc.



<< DTR 417

DTR 4122 Density Transmitter

- ▶ Material (wetted parts): Stainless Steel 316Ti
- ▶ SF version with various flanges and clamps available



<< DTR 4122

STR 4115 Sound Velocity Transmitter

- ▶ Material: Stainless Steel 316Ti, other materials possible
- ▶ SF version with various flanges and clamps available



<< STR 4115

Systems – The Complete Solutions

Anton Paar's process instruments can be used in various combinations. We have optimal standard solutions configured for many applications, adaptable to suit individual requirements.

A complete monitor combines the transducer with an mPDS Evaluation Unit and an application-specific software program.

Typical applications

The following are standard setups consisting of a combination of the units listed in this booklet.



Density Monitor

- ▶ Density at measuring temperature and temperature-compensated density

Gas Density Monitor

- ▶ Standard Density and Specific Gravity of gases

API Petroleum Monitor

- ▶ Specific Gravity, API Gravity and Density at 15 °C/60 °F

Rolling Oil Monitor

- ▶ Measures oil concentration continuously
- ▶ Optional pressure compensation

Phase Change Monitor

- ▶ Detection of phase changes and liquid/liquid interfaces

Formaldehyde Monitor

- ▶ Measures formaldehyde and methanol concentration

Sulfuric Acid Monitor

- ▶ Measures sulfuric acid concentration from 0 to 100%
- ▶ Fully resistant Tantalum or gold-plated sensor

Oleum Monitor

- ▶ Measures oleum concentration from 0 to 65% free SO₃
- ▶ Fully resistant gold-plated sensor

Cobrix 3 Beverage Analyzer

- ▶ Measures °Brix, % Diet, CO₂, parameters in beer, wine and alcoholic lemonades continuously

Brix Monitor

- ▶ High-precision °Brix measurement of soft drinks, syrups and fruit juices

Beer Monitor

- ▶ High-precision measurement of alcohol, real and original extract
- ▶ Optional CO₂ measurement for maximum system accuracy

mPDS Evaluation Units and Software

The mPDS Evaluation Units process measuring signals from DPRn Density Transducers, SPRn Sound Velocity Transducers and DSRn Density/Sound Transducers.

Concentration conversions are carried out by the powerful software. The flexible hardware provides analog and digital inputs, analog outputs, alarm capabilities, large displays, etc.

The optionally available PC software DAVIS is a custom-tailored tool for data acquisition and control.



mPDS 1000 Evaluation Unit

- ▶ Connects to a DPRn Density or SPRn Sound Velocity transducer
- ▶ Concentration conversions for common applications such as °Brix, °Plato, % alcohol, API gravity, specific gravity, etc.
- ▶ Determines the density and concentration of 2-component liquids
- ▶ Option: Intrinsically safe DPRn/SPRn input

mPDS 2000V3 Evaluation Unit

- ▶ Connects to a DPRn, SPRn or DSRn transducer
- ▶ Possible additional connection of an Anton Paar Carbo CO₂ transducer
- ▶ Wide range of application programs
- ▶ Allows customized programming
- ▶ Determines the density and concentration of 2-component liquids or 3-component liquids with a DSRn transducer
- ▶ Intrinsic safety: IPS 501 isolation transformer required for connecting a DPRn/SPRn/DSRn transducer

Accessories

On-line fitting for easy installation of:

DPRn 417/427, DSRn 427, DTR 427, CARBO 2100.

- ▶ A cylindrical insert is immersed into the main line. Sample is forced to flow through a short bypass to the transducer. The required pressure gradient is caused by the dynamic pressure on the sample inlet in the main flow (minimum flow of 1 m/s is required).

DAVIS Data Visualization Software

The DAVIS software is a Windows™-based software for data acquisition and control.

Features and benefits

- ▶ graphical real-time trend indication
- ▶ storage of all data and alarms
- ▶ statistical analysis
- ▶ network capability
- ▶ protocol reporting and printing

Transducer		DPRn 316	DPRn 407	DPRn 4122	DPRn 417 DPRn 427	DPRn 427 ta	DPRn 422	DSRn 427	SPRn 4115 A	SPRn 4115 SF	SPRn 4115 L	SPRn 4214 (LS)
Wetted parts (other materials on request)		SS 1.4571, 316Ti	Borosilicate glass	SS 1.4571, 316Ti	SS 1.4571, 316 Ti Hastelloy C276 Incoloy 825	Tantalum	Hastelloy C276	Hastelloy C276	SS 1.4571, 316Ti	SS 1.4571, 316Ti	SS 1.4571, 316Ti	Hastelloy C276 Incoloy 825
Tube inner diameter/ Sound distance	mm	6.6	7	22	6.6	7	2.8	6.6	13			14/6.5-LS 2.5
Tube length (inlet to outlet)	mm	Approx. 210 (2 x parallel)	Approx. 1400	Approx. 1000	Approx. 500				N/A			162
Process connection		Flange DIN 2633 (PN16DN25)	Hose connectors OD 10 mm PVDF	Tube ends 1"; flanges on request	Threads (parallel) R3/8" DIN259/1 G3/8" ISO 228	Hose connectors OD 10 mm	Fittings 1/8	Threads (parallel) R3/8" DIN259/1 G3/8" ISO 228	Threads fitting DIN 11851 NW 65	Special flanges on request	Flange DIN 2527 NW50 ND16	Threads (parallel) R3/4" DIN259/1 G3/4" ISO 228
Measuring range	g/cm ³ m/s	0.5 to 2.5 g/cm ³	0 to 3 g/cm ³					0 to 3 g/cm ³ 800 to 3000 m/s	800 to 3000 m/s LS: 200 to 1600 m/s			800 to 3000 m/s LS: 200 to 1600 m/s
Measurement repeatability	g/cm ³ m/s	5 x 10-5	1 x 10-5 Hast: 5 x 10-6					5 x 10-6 0.01 m/s	0.01 m/s			
Accuracy in the adjusted range (with best measuring conditions)	g/cm ³ m/s	2 x 10-4	1 x 10-4		1 x 10-4 Hast: 5 x 10-5	1 x 10-4		5 x 10-5 0.1 m/s	0.1 m/s			
Temperature range (sample)	°C, °F	-25 to 125 °C, -13 to 257 °F										
Pressure range	bar, psi	0 to 15, 0 to 217.5	0 to 10, 0 to 145	0 to 50, 0 to 725			0 to 200, 0 to 2900	0 to 60, 0 to 870	0 to 10, 0 to 145	0 to 25, 0 to 362.5	0 to 16, 0 to 232	0 to 15, 0 to 217.5
Flow rate (water)	l/h, gal/h	x	100 to 500, 25 to 125 (1000 max., 250 max.)	350 to 6000, 100 to 1600 (10000 max., 2500 max.)	100 to 500, 25 to 125 (1000 max., 250 max.)		20 to 50, 5 to 12.5 (100 max., 25 max.)	100 to 500, 25 to 125 (1000 max., 250 max.)	1 to 6 m/s velocity			200 to 1500, 50 to 375 (2500 max., 625 max.)
Dimensions	mm	30 x 330 D x L	555 x 274 x 139	560 x 330 x 105	470 x 274 x 139		280 x 258 x 101	470 x 274 x 139	220 x 120 x 195			
Weight	kg	14.5	18.5	17	28		6	28	3		4	3
EX-classification (optional)		EEx ia IIC T6						EEx ia IIB T6				

Transmitter		DTR 316	DTR 407	DTR 4122	DTR 427	DTR 427 ta	DTR 422	STRn 4115 A	STRn 4116 SF	STRn 4115 L	STRn 4214 (LS)	
Wetted parts (other materials on request)		SS 1.4571, 316Ti	Borosilicate glass	SS 1.4571, 316Ti	Hastelloy C276 Incoloy 825	Tantalum	Hastelloy C276	SS 1.4571, 316Ti	SS 1.4571, 316Ti	SS 1.4571, 316Ti	Hastelloy C276 Incoloy 825	
Tube inner diameter/ Sound distance	mm	6.6	7	22	6.6	7	2.8	13			14/6.5-LS 2.5	
Tube length (inlet to outlet)	mm	Approx. 210 (2 x parallel)	Approx. 1400	Approx. 1000	Approx. 500				N/A			162
Process connection		Flange DIN 2633 (PN16DN25)	Hose connectors OD 10 mm PVDF	Tube ends 1"; flanges on request	Threads (parallel) R3/8" DIN259/1 G3/8" ISO 228	Hose connectors OD 10 mm	Fittings 1/8	Threads fitting DIN 11851 NW 65	Special flanges on request	Flange DIN 2527 NW50 ND16	Threads (parallel) R3/4" DIN259/1 G3/4" ISO 228	
Measuring range	g/cm ³ m/s	0.5 to 2.5 g/cm ³	0 to 3 g/cm ³					800 to 3000 m/s			800 to 3000 m/s LS: 200 to 1600 m/s	
Measuring repeatability	g/cm ³ m/s	5 x 10-5						0.1 m/s				
Accuracy in the adjusted range (with best measuring conditions)	g/cm ³ m/s	2 x 10-4, 0.1%						0.2 m/s, 0.1%	0.2 m/s, 0.1%	0.2 m/s, 0.1%	0.2 m/s, 0.1%	
Temperature range (sample)	°C, °F	0 to 100, 32 to 212										
Pressure range	bar, psi	0 to 15, 0 to 217.5	0 to 10, 0 to 145	0 to 50, 0 to 725			0 to 200, 0 to 2900	0 to 10, 0 to 145	0 to 25, 0 to 362.5	0 to 16, 0 to 232	0 to 15, 0 to 217.5	
Flow rate (water)	l/h, gal/h	x	100 to 500, 25 to 125 (1000 max., 250 max.)	350 to 6000, 100 to 1600 (10000 max., 2500 max.)	100 to 500, 25 to 125 (1000 max., 250 max.)		20 to 50, 5 to 12.5 (100 max., 25 max.)	1 to 6 m/s velocity			200 to 1500, 50 to 375 (2500 max., 625 max.)	
Dimensions	mm	30 x 330 D x L	555 x 274 x 139	560 x 330 x 105	470 x 274 x 139	470 x 274 x 139	280 x 258 x 101	220 x 120 x 80				
Weight	kg	14.5	18.5	17	28	28	6	3		4	3	
EX-classification (optional)		EEx ia IIB T5						x	x	x	x	



Anton Paar

Anton Paar® GmbH
Anton-Paar-Str. 20
A-8054 Graz
Austria - Europe
Tel: +43 (0)316 257-0
Fax: +43 (0)316 257-257
E-mail: info@anton-paar.com
Web: www.anton-paar.com



Instruments for:

Density and concentration
measurement

Rheometry and viscometry

Sample preparation

Colloid science

Microhardness testing

X-ray structure analysis

CO₂ measurement

High-precision temperature
measurement



Specifications
subject to change
without notice

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