

Acoustic Flow Measurement



Applications Overview
Customer Information



Wastewater



Hydropower



Irrigation / Channels



Hydrology



Water Supply



Innovative measurement solutions
for valuable resources



Introduction

Water is the most precious resource on our planet and its disparate distribution makes managing water a real challenge. To tackle this challenge, investments in automation of wastewater, hydropower, irrigation, hydrology and water supply systems have increased significantly. Today, most predictions and actions are derived from collected data. This requires higher data quality and granularity. Hence, the precise measurement of flow rates and consumption as well as the communication of data are becoming increasingly important.

Dr. Jürgen Skripalle, GWF's Executive Vice President for Acoustic Flow Measurement (AFM), looks back on numerous successful installations of water measurement systems across the globe. "We see a strong growth in demand for our systems based on our technical advantages and deep knowledge of ultrasonic technologies." GWF's products stand out with their accuracy and reliability, as well as their exceptional level of manufacturing quality. Continuous investments in further developing the portfolio make GWF an innovative solution provider. Applications range from simple non-contact measurement for wastewater to complete systems for penstock rupture monitoring.

Dr. Jürgen Skripalle (left) and Florian Strasser overlooking the Thornton Reservoir in Chicago, IL. In and outflow into this 7.9 billion US gallon reservoir is measured by the proprietary Ductus technology.

GWF is a Swiss family business with more than 220 employees and global reach. With over 120 years of experience in the field of gas and water measurement solutions, the company is the trusted partner of utilities, systems integrators, general contractors and hardware manufacturers. Florian Strasser, President of GWF, says: "GWF's mission is to build a future-oriented company that helps to reduce human's impact on the environment by using relevant data generated through highest quality measurement instruments. Our AFM portfolio and our successful projects in this field are prime examples on how we execute on this mission."

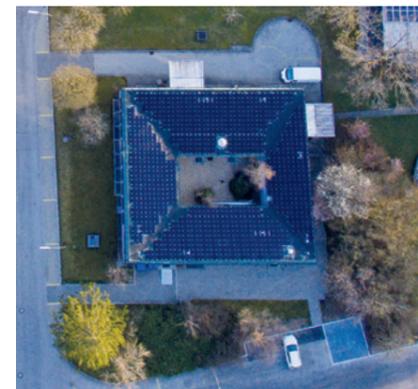
We encourage you to discover our products and services around Acoustic Flow Measurement on the following pages. Please contact us – we look forward to exchanging ideas on the challenges of water management, and to working with you to make your measurement a success.



Frontpage:
Grande Dixence, Val des Dix, Sion / VS, Switzerland



GWF MessSysteme AG in Lucerne CH



Production facility Kaufbeuren with solar panel roof

Products

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GWF is at the forefront of innovative flow technologies, products and solutions. In this brochure, we describe various applications for our portfolio. We measure anywhere: in rivers, channels, and partially filled or pressurized pipes.

Ultrasound propagates through fluid media as pressure waves. Our instruments are able to convert information gained from measuring the behaviour of these waves into flow speed. There are two main measurement principles on which our instruments are based.

Applying the Transit Time technique, we measure the time of flight with and against flow direction. When using the Pulse-Doppler or cross-correlation technology, our instruments record the change of the signal frequency reflected by a particle in the flow.



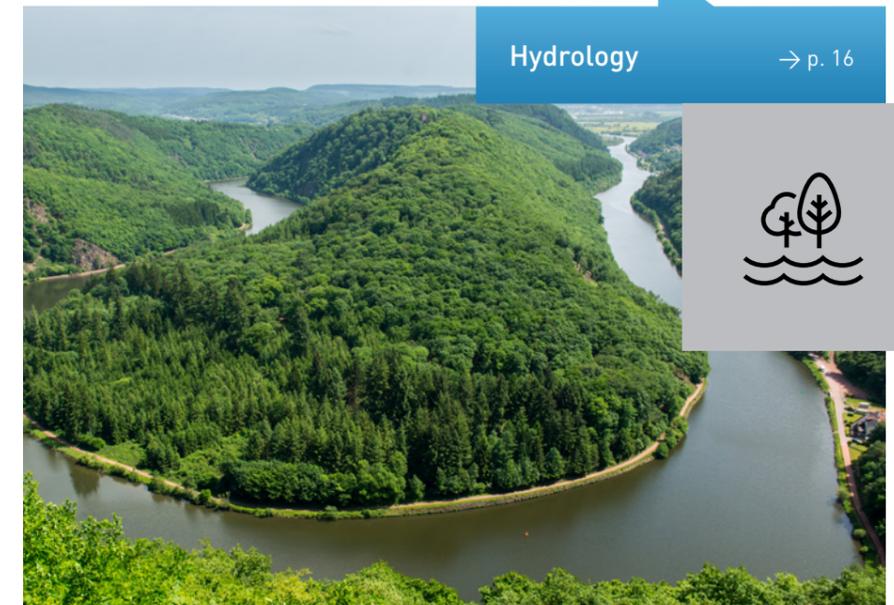
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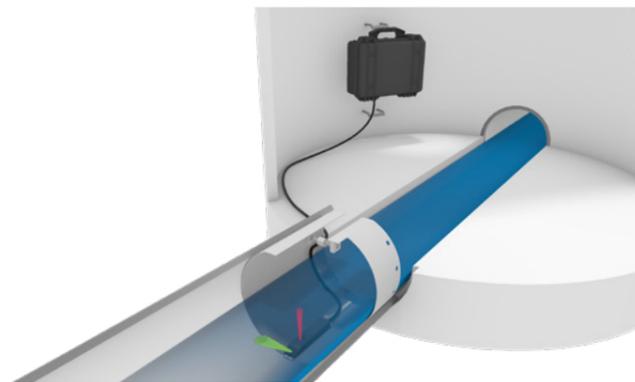
Fields of Application.



Water Supply → p. 18



The observation and control of wastewater is of highest importance. Today's civilization is unthinkable without functioning wastewater treatment plants. Wastewater contains a multitude of organic substances which are treated or removed and then discharged again into the environment. Advanced collection systems are required to transport wastewater to the right place at the right time in order to protect ecosystems. These collection systems are highly complex and consist of channels for wastewater flow, clarification plants and overflow basins. GWF solves flow measurement challenges in all of these areas globally.

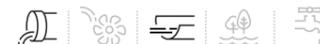


Installation in manhole

Wastewater



Products



For sewage treatment plants, flow measurements are primarily installed for internal reasons, for example to operate specific plant components depending on flow rate or for controlling additives. International regulations, such as the EU directive for handling municipal wastewater, require a continuous surveillance of wastewater flow. Defective flow measurements in sewage-treatment plants can therefore not only influence their operation, but also cause legal or environmental consequences.



Specifications

Q-Eye PSC

Stationary area velocity flow meter

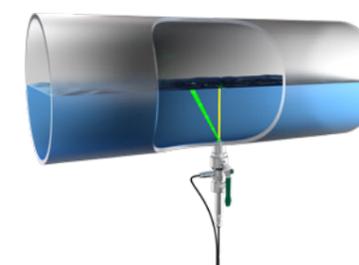
Q-Eye PSC Portable

Portable area velocity flow meter

Sensor	1 x velocity (up to 3 sensors) 1 x water level	1 x velocity 1 x water level
Pulse	1 MHz	1 MHz
Number of cells	up to 32 cells	up to 18 cells
Range	velocity ± 5.0 m/s water level 0.04-1.3 m expandable via external 4-20 mA sensor	velocity ± 5.3 m/s water level 0.04-1.3 m expandable via external 4-20 mA sensor
Uncertainty velocity/flow	velocity: ± 0.03 m/s from -1.5 m/s to +1.5 m/s $\pm 2\%$ of reading from -5.0 to -1.5 m/s and +1.5 to +5.0 m/s flow: typically $\pm 2\%$, depending on site conditions	velocity: ± 0.03 m/s from -1.5 m/s to +1.5 m/s $\pm 1\%$ of reading from -5.2 to -1.5 m/s and +1.5 to +5.2 m/s flow: typically $\pm 2\%$, depending on site conditions
Uncertainty level/temperature	mouse type level (ultrasonic): ± 2 mm temperature: ± 0.5 K for 4 °C to 57 °C insertion type level (pressure): max. 1.5% FS (0.2 bar) or 0.5% FS (10 bar)	mouse type level: $\pm 0.5\%$ FS (1.5 m)
Display	4 lines, 20 characters	4 lines, 20 characters
Keyboard	4 keys	4 keys
Datalogger	16 GB MicroSD card	16 GB MicroSD card
Communication	RS-485, Modbus (RS-232 or RS-485), Wireless LAN, 4G (LTE) / 3G (HSPA+) / 2G, Ethernet 10/100 Mbps	Wireless LAN, 4G (LTE) / 3G (HSPA+) / 2G
Inputs	max. 4 x 4-20 mA, 2 x digital	max. 2 x 4-20 mA
Outputs	max. 4 x 4-20 mA, 4 x Relay, 2 x Pulse	-
Power supply	9-36 V DC or 100-240 V AC (50/60 Hz)	2 x rechargeable batteries, hot swappable
Protection class housing	IP66 (NEMA 4)	IP67
Enclosure	aluminum, wall mounted	HPX® Resin

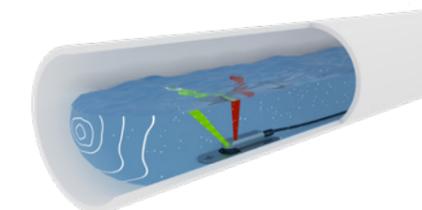
Typical Applications

Insertion type –
only for stationary PSC



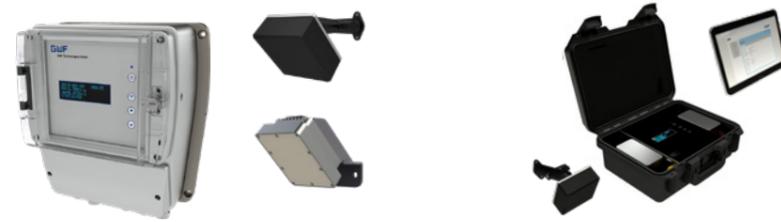
Full pipes or partially filled pipes
(with integrated pressure transducer)

Mouse type –
for both stationary and portable



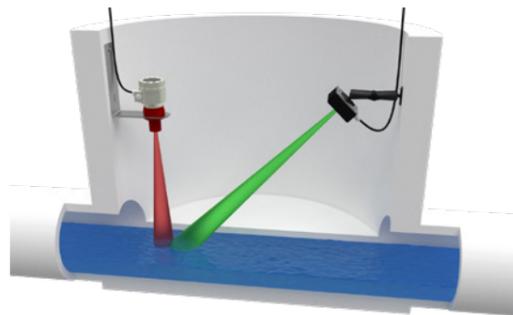
Open channels or closed pipes

Products



Specifications

	Q-Eye Radar Stationary non-contact flow meter	Q-Eye Radar Portable Mobile non-contact flow meter
Sensor	1 x velocity 1 x water level (external 4-20 mA sensor)	1 x velocity 1 x water level (external 4-20 mA sensor)
Frequency	24 GHz	24 GHz
Beam width	RV11: 11° (-3 dB) RV24: 12° Azimuth, 24° Elevation	11° (-3 dB)
Range	± 0.02 m/s to ± 15 m/s	± 0.05 m/s to ± 15 m/s
Uncertainty velocity	RV11: ± 0.5% of reading ± 0.01 m/s RV24: ± 1% of reading	± 0.5% of reading ± 0.01 m/s
Resolution	1 mm/s	1 mm/s
Display	4 lines, 20 characters	4 lines, 20 characters
Keyboard	4 keys	4 keys
Datalogger	16 GB MicroSD card	16 GB MicroSD card
Communication	RS-485, Modbus (RS-232 or RS-485), Wireless LAN, 4G (LTE) / 3G (HSPA+) / 2G, Ethernet 10/100 Mbps	Wireless LAN, 4G (LTE) / 3G (HSPA+) / 2G
Inputs	max. 4 x 4-20 mA, 2 x digital	max. 2 x 4-20 mA
Outputs	max. 4 x 4-20 mA, 4 x Relay, 2 x Pulse	-
Power supply	9-36 V DC or 100-240 V AC (50/60 Hz)	2 x rechargeable batteries, hot swappable
Protection class housing	IP66 (NEMA 4)	IP67
Enclosure	aluminum, wall mounted	HPX® Resin



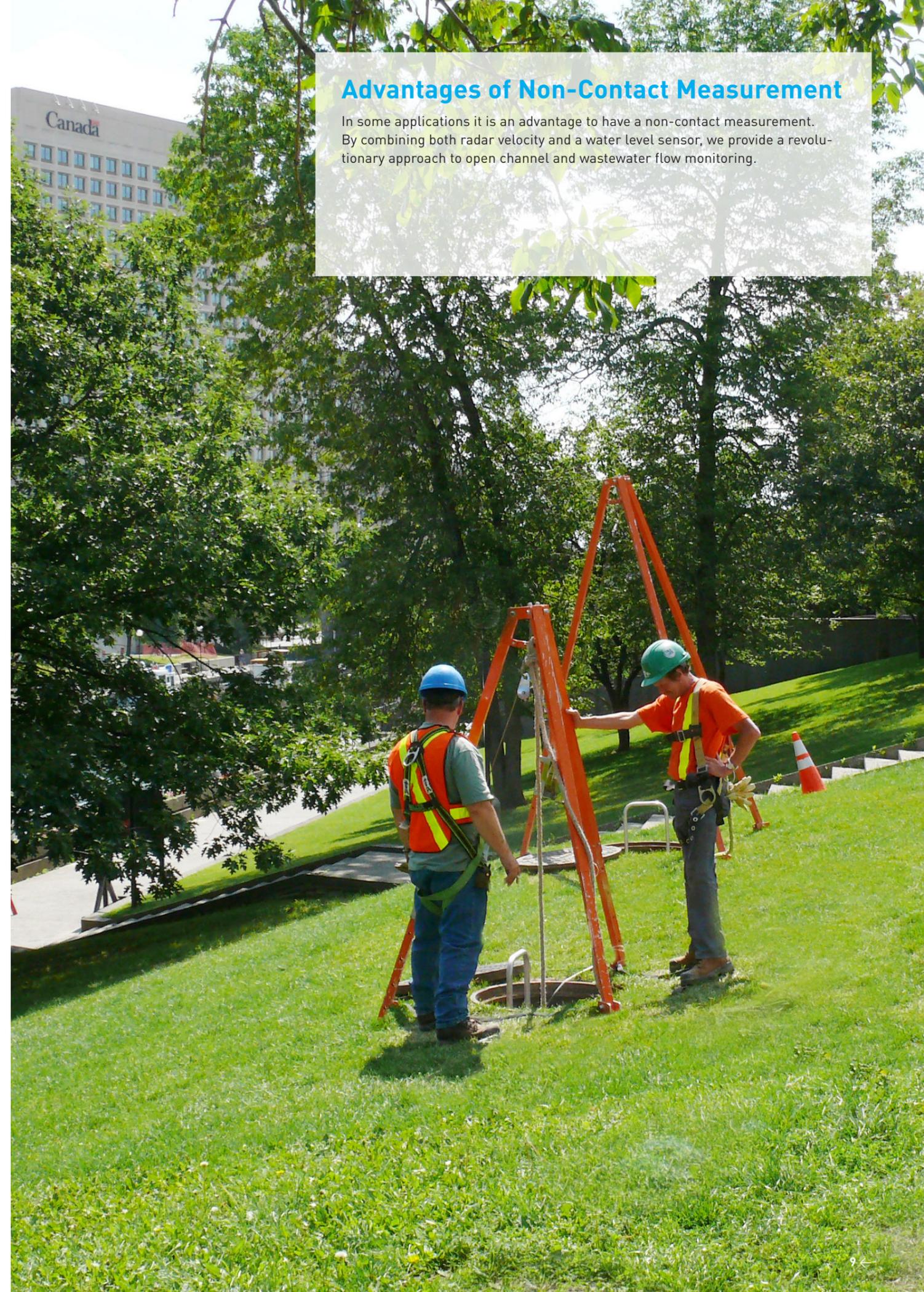
Application

Q-Eye Radar is an exceptionally versatile flow measurement system designed for continuous operation and suitable for application not only in open channels, but also in municipal wastewater and storm water sewers. Compact construction combined with the non-contact measurement principle enables an easy installation and use. The Q-Eye Radar is designed to accept any level sensor (ultrasonic, radar and pressure) with an analog input (4-20 mA). Our Q-Eye Radar transmitter offers the best in wastewater measurement.

As the system is installed outside of the medium, your personnel will not get in contact with the polluted fluid during installation. Furthermore, the need for maintenance caused by sensor fouling or deposits is eliminated.

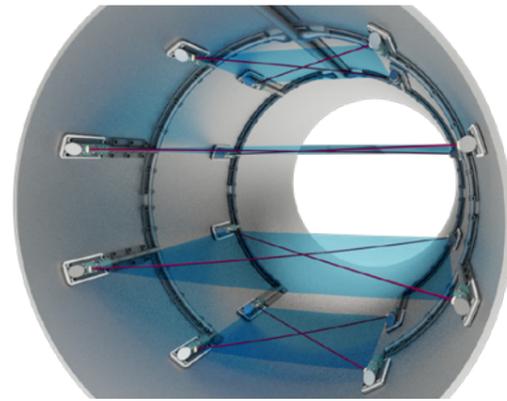
Advantages of Non-Contact Measurement

In some applications it is an advantage to have a non-contact measurement. By combining both radar velocity and a water level sensor, we provide a revolutionary approach to open channel and wastewater flow monitoring.



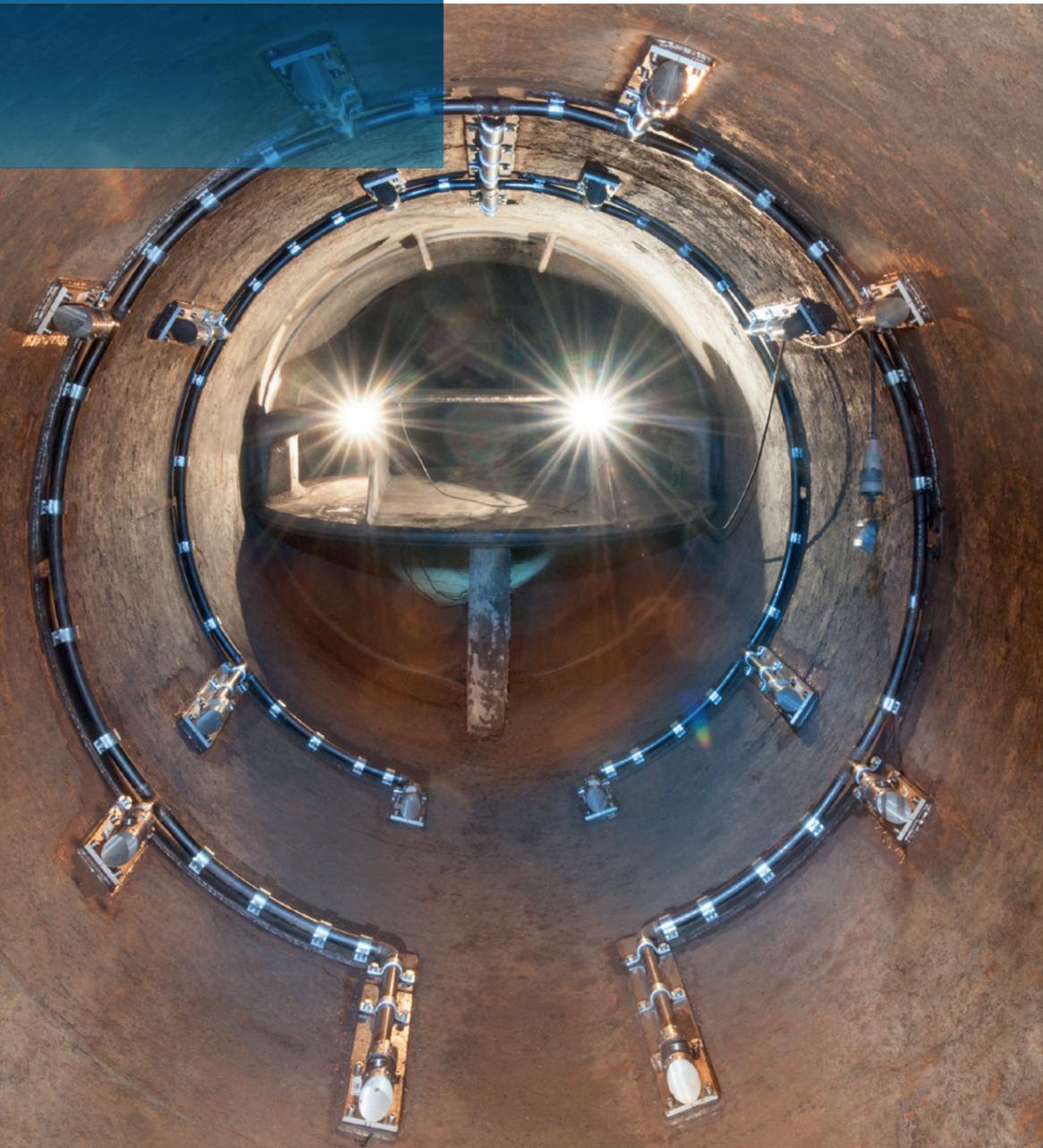
Hydropower is an important source of energy which is able to cater to the increased need for power supply to the earth's population. Today, hydropower plants deliver approximately 3.5 per cent of electric energy generated worldwide. Their share in power generation from renewable resources comes to 18 per cent. This share is continuing to grow as resources of fossil fuels are depleted and investments in alternative energy sources grow.

Hydroelectric performance depends essentially on the usable altitude difference between upper reservoir and lower reservoir. In order to use the potential energy in an optimal way, flow should be accurately monitored over the long term.



4 planes crossed according to IEC 41 / ASME PTC 18

Hydropower



Products



Acoustic flow measurement systems have long established themselves as a reliable and convenient method of determining turbine efficiency. Measurements in several planes according to international standards are recommended for this task. With this method, there is no need for calibration and a deterioration of turbine or hydraulic efficiency can be detected at an early stage. A further area of application is the detection of leaks, where at least two systems are permanently installed. Because of the accuracy of the Ductus system, even small leakages can be detected instantaneously.

Specifications

Ductus M

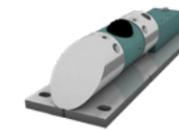
Time of flight system with digital signal processing

Acoustic paths	1 to 8
Accuracy	up to ± 0.5% (8 paths)
Range	± 20 m/s
Pipe diameter	> 3000 mm
Display	4 lines, 20 characters
Datalogger	internal, user-selectable sampling interval
Communication	2 x RS-232, FTP, Modbus TCP (optional)
Inputs	max. 8 x 4-20 mA
Outputs	max. 4 x 4-20 mA, 2 x Relay, 2 x Pulse
Power supply	24 V DC
Battery backup	integrated, 2 Ah
Protection class	IP65 (NEMA 4)
Enclosure	powder-coated sheet steel, wall mounted

Transducers

A variety of transducers is available – depending on your requirements

Internal mount sensors can be fixed directly to the wall. The transducers are aligned by rotating them in their mounting into a predefined position and then fixed in place by tightening. When combining the Ductus system with Clamp-On transducers, the flow measurement becomes non-intrusive. The transducers are installed with little technical effort and without process interruption on the pipeline. Clamp-On transducers require no modification of the conduit or plant shutdown. This non-invasive measurement method is suitable for various media such as wastewater, salt water and glycol.



Specifications

TD-IM

Frequency	200 kHz
Beam width	18° (-3 dB)
Configuration	IEC41 / ASME PTC 18
Pipe diameter	1.0 m to 10 m
Mounting	–
Pressure rate	60 bar (other rates on request)
Material	stainless steel / polyamide
Cable	twisted pair with shield
Operating temperature	0 °C to +40 °C
Dimensions	320 x 100 x 70 mm (L x W x H)
Installation	from the inside



Specifications

CO-L

Frequency	200 kHz
Beam width	8° (-3 dB)
Pipe diameter	0.4 m to 15 m (for < 3 m use Ductus S system)
Pipe wall thickness	up to 100 mm (steel, plastic, glass fiber)
Material	stainless steel / POM
Operating temperature	-20 °C to +60 °C
Dimensions	270 x 115 x 100 mm
Mounting	non-intrusive, from the outside of the pipe

Products



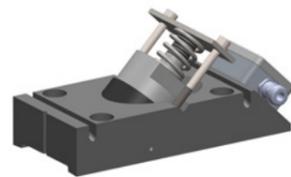
Ductus M Portable is available exclusively for measurement campaigns or as a rental device. Contact us – we would be happy to explain the possibilities of portable contactless measurement.

Specifications

Ductus M Portable

Mobile time of flight system with digital signal processing

Acoustic paths	1 to 8
Accuracy	up to $\pm 0.5\%$ (8 paths)
Range	± 20 m/s
Power supply	12 V DC
Display	4 lines, 20 characters
Keyboard/LED's	4 LED control lights, 2 keys
Housing material	aluminum
Communication	2 x RS232, 4 x USB, 2 x Ethernet (100 Mbit)



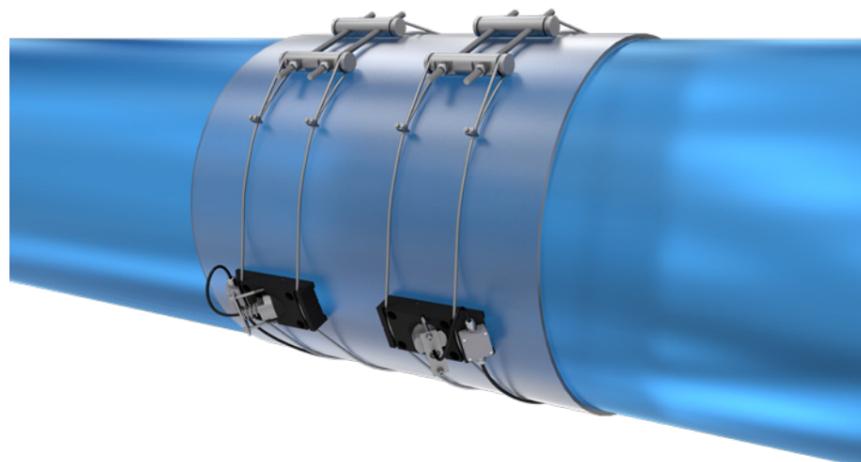
Transducers

Specifications

CO-L

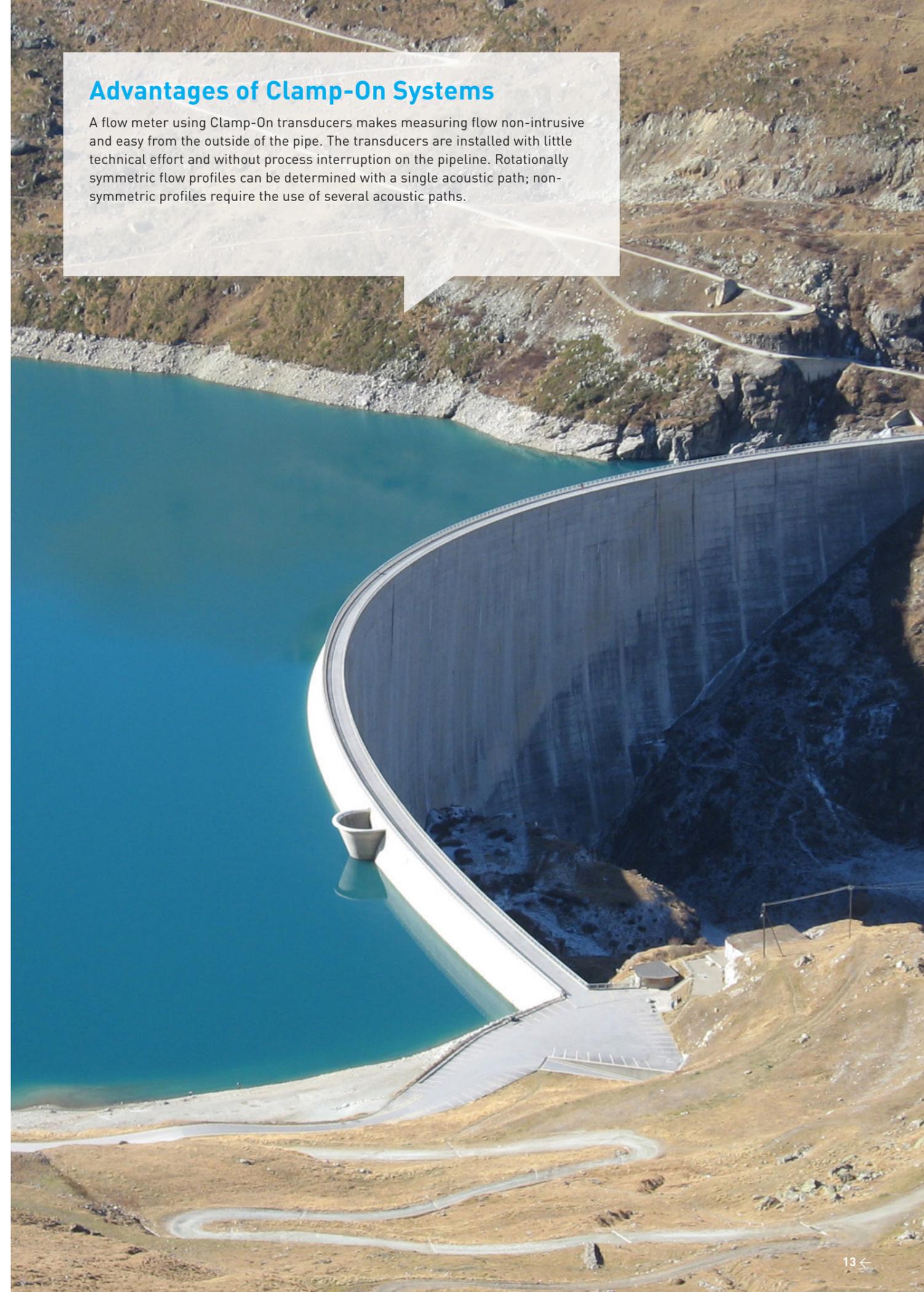
Pipe diameter	0.4 m to 15 m (for < 3 m use Ductus S system)
Pipe wall thickness	up to 100 mm (steel, plastic, glass fiber)
Frequency	200 kHz
Beam width	8° (-3 dB)
Material	stainless steel / POM
Operating temperature	-20 °C to +60 °C
Dimensions	270 x 115 x 100 mm
Mounting	non-intrusive, from the outside of the pipe

Clamp-On with 2 acoustic paths



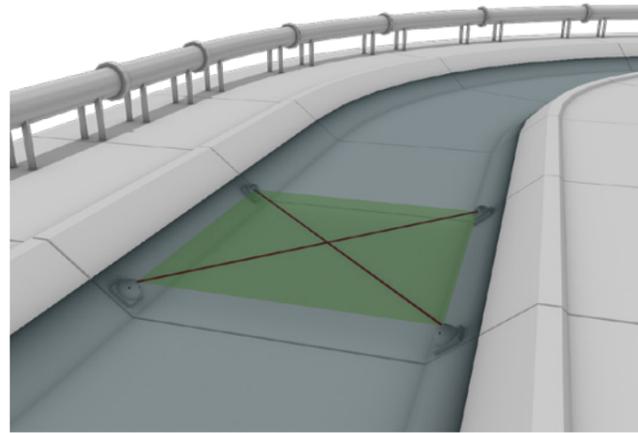
Advantages of Clamp-On Systems

A flow meter using Clamp-On transducers makes measuring flow non-intrusive and easy from the outside of the pipe. The transducers are installed with little technical effort and without process interruption on the pipeline. Rotationally symmetric flow profiles can be determined with a single acoustic path; non-symmetric profiles require the use of several acoustic paths.



Channels are artificially created waterways used, among others, for transportation, irrigation, drainage, drinking water supply and water extraction for power.

Especially for applications in the supply of drinking water, it is crucial to detect leakages at an early stage. Our instruments measure man-made channels, tunnels and aqueducts precisely in order to prevent long term water losses and support process stability.

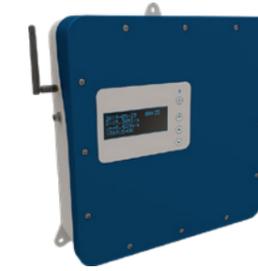


Crossed-path system, irrigation channel

Irrigation / Channels



Products



Specifications

Kanalis

Time of flight system with digital signal processing

Acoustic paths	1 to 10 (more upon request)
Channel width	1 to 20 m
Accuracy	± 2% (typical, depending on number of installed paths)
Display	4 lines, 20 characters
Datalogger	16 GB MicroSD card
Communication	RS-485, Modbus RTU/TCP, Wireless LAN, Ethernet 10/100 Mbps, optional 4G/3G Router
Inputs	max. 4 x 4-20 mA, 2 x digital
Outputs	max. 4 x 4-20 mA, 4 x Relay, 2 x Pulse
Power supply	9-36 V DC or 100-240 V AC (50/60 Hz)
Protection class	IP65 (NEMA 4)
Enclosure	ABS, wall mounted

Transducers



Specifications

TD-200/8

TD-200/18

Frequency	200 kHz	200 kHz
Typical channel width	20 m	5 m
Dimensions	Ø 218 mm, height 109 mm	Ø 140 mm, height 70 mm

Mounting Assembly Standardized mounting devices are available for any kind of channel geometry like rectangular, trapezoid or natural river banks. The flow optimized design protects the transducers against moving objects suspending in the flow stream. It also provides room for connections and protective conduits.

Single-path system

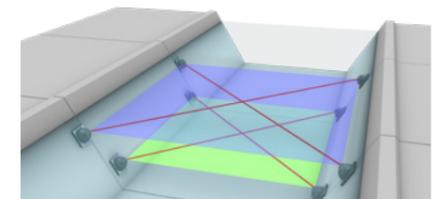
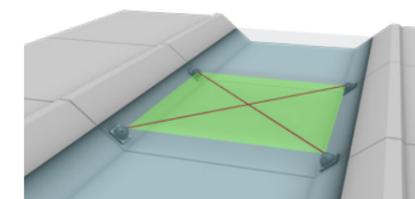
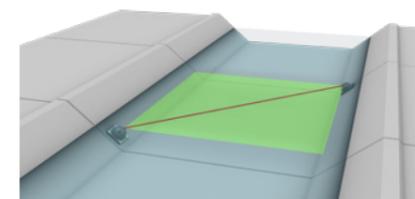
In its most basic form, the system operates with a single pair of transducers. This measurement relies upon a stable velocity profile unaffected by changes in the relation between water level and flow. The main flow must be parallel to the bank. The relationship between measured velocity and flow is established by hydrometric calibration.

Crossed-path system

Ideal for channels with cross-flow conditions. This depends mainly on the channel's geometry and whether there is an upstream bend in the conduit. Although cross-flows do not influence the total flow volume, they may affect the measurement accuracy. A second pair of transducers is required to capture these variances in velocity profiles. By cross-wise arrangement of four transducers, effects of changing flow direction can be eliminated.

Multi-path system

An even more accurate measurement can be obtained through systems using several planes. The measured result can be further improved by using a multi-path system layering each of the acoustic paths in parallel planes one above the other. This removes the need for an expensive hydrometric calibration. Such a system is suitable for applications with large water level fluctuations, reverse flow or a vertical velocity distribution outside the theoretical normal.



Numerous rivers intersect our landscape from small brooks up to huge river networks. Some of them form a natural border between two countries.

Since early times, man has preferred to live near rivers. Clean water, transportation, power generation and scenic beauty are amongst the reasons. However, our actions have more and more influence on water quantity and quality. In many regions, depletion of water for irrigation or human consumption are the reasons. More than half of all big rivers around the world have been polluted during the course of time and their stewardship is essential for the future survival of ecosystems.

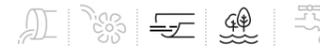
Observations of water levels have been used since ancient times, systematic flow measurements go back to the middle of the 19th century. This historical data has been used as the basis for various applications, for example flood protection and flood forecasting. They also form the foundation for the design of hydro-engineering constructions.

In recent years, acoustic flow measurement has established itself as a standard method for measurement in many hydrological stations. With this technology, data can be recorded continuously, thus providing 24/7 monitoring.

Hydrology



Products



The range of application for Fluvius runs from small waterways to huge river systems with high suspended solids concentration. A coded acoustic signal is sent through the water and the transit time is calculated, which provides the speed of flow. When an acoustic wave propagates in water, part of the energy is damped by friction and suspended solids. This procedure is frequency-related. The higher the frequency, the bigger the damping. Therefore, low frequencies allow for a considerably better receiver signal for wide distances.

Specifications

Fluvius

Time of flight system with digital signal processing

Acoustic paths	1 to 8
Channel width	20 to 1000 m
Accuracy	± 2% (typical, depending on number of installed paths)
Display	4 lines, 20 characters
Datalogger	internal, sampling interval user selectable
Communication	RS-232, Modbus, Ethernet, USB
Inputs	max. 8 x 4-20 mA
Outputs	max. 4 x 4-20 mA, 2 x Relay, 2 x Pulse
Power supply	24 V DC
Battery backup	integrated 2 Ah
Protection class	IP65 (NEMA 4)
Enclosure	powder-coated sheet steel, wall mounted

Transducers

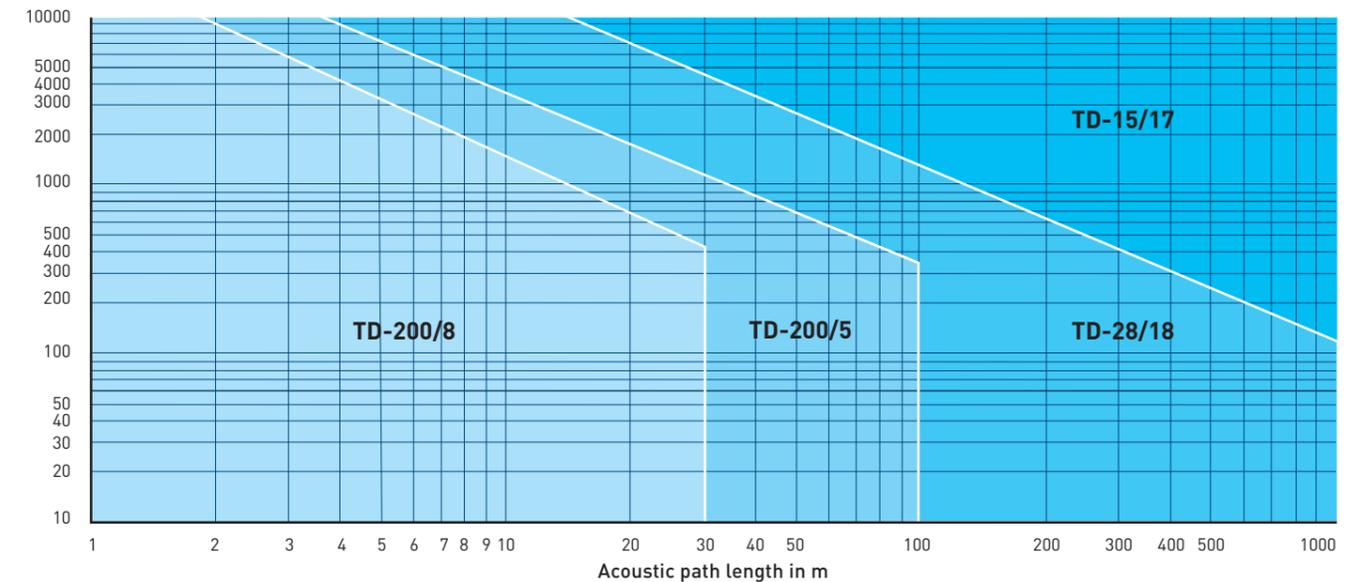


Specifications

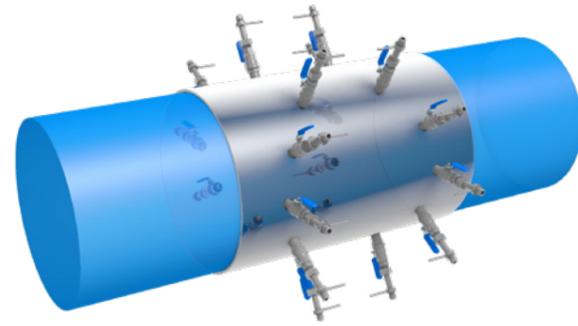
	TD-15/17	TD-28/18	TD-200/5	TD-200/8
Frequency	15 kHz	28 kHz	200 kHz	200 kHz
Typical channel width	> 400 m	< 400 m	< 100 m	< 30 m
Dimensions	Ø 368 mm, height 121 mm	Ø 183 mm, height 142 mm	Ø 340 mm, height 170 mm	Ø 218 mm, height 109 mm

Commonly used transducer frequencies for various path lengths and sediment loads

Sediment load in g/m³

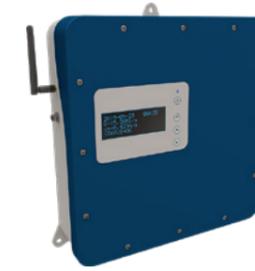


Although there is enough water on earth and it is not consumed but merely used, access to a reliable supply of clean, safe, potable water is becoming scarcer. Uneven distribution of water amongst regions and the planet's rising population lead to a global shortage of fresh potable water. More and more aqueducts for drinking water are being built all over the world. In order to operate large and complex piping networks efficiently, flow measurement is necessary for long term reliability and control.



Ductus S with 5 layers installed into existing pipeline

Products



Specifications

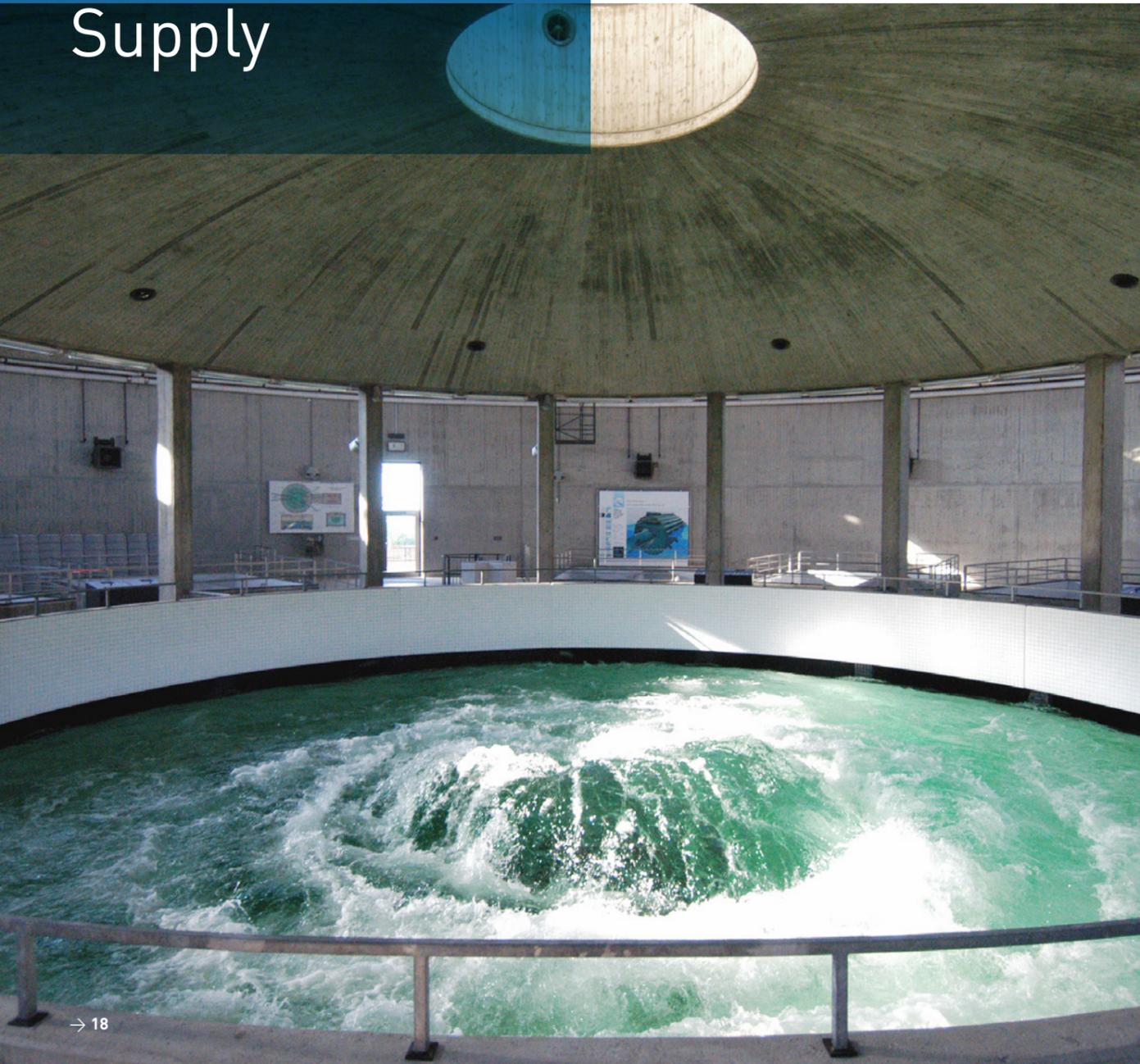
Ductus S

Time of flight system with digital signal processing

Acoustic paths	1 to 10 (more upon request)
Pipe diameter	up to 5000 mm
Accuracy	up to $\pm 0.15\%$ (10 paths)
Range	± 20 m/s (bidirectional)
Repeatability	$< \pm 0.02\%$
Zero stability	< 1 mm/s
Communication	RS-485, Modbus RTU/TCP, Wireless LAN, Ethernet 10/100 Mbps, optional 4G/3G Router
Inputs	max. 4 x 4-20 mA, 2 x digital
Outputs	max. 4 x 4-20 mA, 4 x Relay, 2 x Pulse
Power supply	9-36 V DC or 100-240 V AC (50/60 Hz)
Protection class	IP65 (NEMA 4)
Enclosure	ABS, wall mounted

Ductus S flow meter is a fully integrated time of flight metering solution with up to 10 acoustic paths for liquid fluids. It increases your profitability with exceptional repeatability and linearity throughout the flow range. Due to the patented velocity profile compensation, no flow straighteners or on-site calibration are required. Ductus S can be used with either wetted or external Clamp-On sensors.

Water Supply

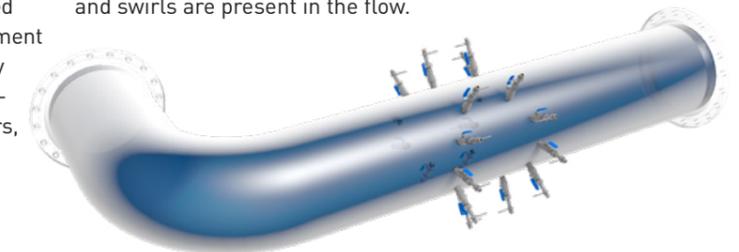


Concept Innovation

Space constraints and application configurations lead to complex flows in pipes which contain elbows, tees or other disturbing and non-uniform elements. This leads to difficulties in installing flow meters at an optimum location; which is defined by a minimum distance upstream or downstream of known disturbances at which a fully developed velocity profile is present. For traditional flow meters, significant errors may be caused by these adverse installation conditions.

In contrast to conventional systems, Ductus S provides detailed information on the flow velocity profile. An accurate measurement of the flow rate can be achieved by replicating the flow velocity profile across the pipe. Accuracy is maximized using predetermined conduit configuration parameters and correction factors, which incorporate the specific local installation conditions.

Conventional flow meters are also sensitive to velocity profiles with a large rotational component (swirl). Swirl can be caused by pumps or multiple out-of-plane changes in flow direction. It is present to some extent in almost every application and can generate significant transverse velocity components; and it takes a long distance to dissipate. If the swirl is not accounted for, it can cause significant errors. Ductus S can quantify and correct these disrupting factors without difficulty. The Ductus S system keeps its measurement accuracy even when asymmetric profiles and swirls are present in the flow.



Measurement after a 90° elbow

Products



Transducers



Specifications	FT-S	FT-L1000	TD-IM
Frequency	1 MHz	1 MHz	200 kHz
Beam width	5° (-3 dB)	10° (-3 dB)	18° (-3 dB)
Configuration	IEC41 / ASME PTC 18	IEC41 / ASME PTC 18	IEC41 / ASME PTC 18
Pipe diameter	0.1 m to 2 m	0.3 m to 5 m	1.0 m to 10 m
Mounting	welding socket or thread	welding socket or thread	–
Pressure rate	20 bar (other rates on request)	20 or 40 bar	60 bar
Material	stainless steel	stainless steel	stainless steel / polyamide
Cable	twisted pair with shield	twisted pair with shield	twisted pair with shield
Operating temperature	0 °C to +40 °C (up to +150 °C on request)	0 °C to +40 °C	0 °C to +40 °C
Dimensions	Ø 1", length: 293 mm	Ø 1½", length: 186 mm	320 x 100 x 70 mm (L x W x H)
Installation	incl. fixing device, ball valve and welding socket pipe needs to be dewatered only for the time of initial installation. Designed to allow removal of the entire transducer for repair, replacement or cleaning without the need to dewater the pipe lation.	removal of the transducer for repair, replacement or cleaning by means of a special jacking tool.	from the inside



Specifications	CO-L	CO-S
Pipe diameter	0.4 m to 15 m (> 3 m we recommend Ductus M system)	0.025 m to 1 m
Pipe wall thickness	up to 100 mm (steel, plastic, glass fiber)	up to 25 mm
Frequency	200 kHz	1 MHz
Beam width	8° (-3 dB)	5°
Material	stainless steel, POM	zinc alloy
Operating temperature	-20 °C to +60 °C	-20 °C to +60 °C
Dimensions	270 x 115 x 100 mm (L x W x H)	56 x 32 x 25 mm (L x W x H)
Installation	from the outside of the pipe	from the outside of the pipe

When combining the Ductus S with Clamp-On transducers, the flow measurement becomes non-intrusive. The transducers are installed with little technical effort and without process interruption on the pipeline. Clamp-On transducers require no modification of the conduit or plant shutdown. This non-invasive measurement method is suitable for various media such as wastewater, salt water and glycol.

Transducer Replacement

In the unlikely event that a transducer should fail, Ductus S can be programmed to automatically compensate for the loss in path information with little reduced accuracy. Additionally, the operator is advised that an alarm is present. The feedthrough transducer housings are separate from the transducers, and are designed to allow removal of the entire transducer for repair, replacement or cleaning without the need to dewater the pipe or shut down the process.



Look at him! The short target deadline was met once again. The acoustic flow measurement system for a hydropower plant has passed its final test. Everything works fine – this is the best moment a project engineer can experience.

Our professional and competent service department manages projects all over the world. Skilled technicians, engineers, and training staff provide advice and support from project planning all the way to the turnkey installation.

Prior to project planning we review the site data with our clients in order to submit a customized solution. We provide excellent and rapid support as well as installation services. Contact your local representative to see what our engineering department can do for you.

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Service



In operation worldwide



CANADA
 Location > Wastewater Treatment Plant
 System > Kanalis
 Transducer > TD-200/8



ICELAND
 Location > Hydropower
 System > Ductus M
 Transducer > Clamp-On



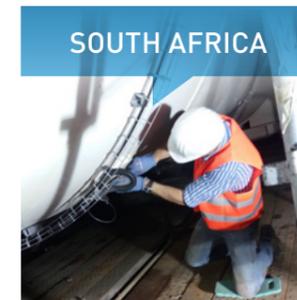
SWITZERLAND
 Location > Water Supply
 System > Ductus S
 Transducer > Feedthrough



TURKEY
 Location > Hydropower
 System > Ductus M
 Transducer > Feedthrough



USA
 Location > Wastewater Treatment Plant
 System > Kanalis
 Transducer > TD-200/8



SOUTH AFRICA
 Location > Hydropower
 System > Ductus S
 Transducer > Feedthrough



POLAND
 Location > Wastewater
 System > Q-Eye Radar
 Transducer > RV11



JAPAN
 Location > River
 System > Fluvius
 Transducer > TD-28/18



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