deltawave

Ultrasonic Flow Metering System for Water and Wastewater

- Partially and fully-filled channels, pipes and surface waters
- Multiple-path technology ensures highly precise measurement
- Virtually maintenance-free

deltawave
made by systec

systec
CONTROLS

deltawave provides precise measurement for all hydrological tasks and can be used in virtually any application: in filled and partially-filled pipes, open channels, canals and rivers. deltawave functions even under extreme conditions, maintenance and calibration-free and reliably. The measurement system continuously monitors itself, and its multi-channel design ensures redundant safety.

Using just one deltawave flow transmitter allows you to cover up to 4 independent measurement sites.

deltawave is in use in a wide variety of industrial settings:

Water and Wastewater Management
Special advantages: Maintenance-free, deposits of biomass and dirt on the transducers have virtually no effect on measurement quality. IDM accuracy in filled and partially-filled cross-section area or open channel! No culverts required. Back-ups and back flows are reliably detected and measured.

- **Treatment plants for industrial and municipal services**
  Applications include:
  - Monitoring of treatment plant inflow and outflow according to the (German) self-monitoring regulation (EkVO)
  - Monitoring of rainwater catchment basins
  - Feeding of parallel basins
  - Recirculation control and optimization

- **Wastewater treatment associations and public utilities**
  Metering of exact discharge quantities for accounting purposes
  - Detection of false water quantities
  - Checking and recording of canal hydrology

Thermal and Hydro Power Stations
Special advantages: IDM accuracy in pressurized piping with minimal construction effort. Reliable quantity detection in inflow for river-sited power plants, turbine acceptance measurements. Installation/removal possible under operating conditions. Exact calculation of cooling water volume with public authorities.

Accounting for cooling water, with IDM accuracy

- **Thermal Power Stations**
  Here, deltawave reliably carries out
  - monitoring of tapped and recycled cooling water volumes for accounting purposes
  - Energy balancing to avoid impermissible flow heating
  - Online efficiency measurement
  - District heating accounting measurements

- **Storage and Pumped Storage Power Stations**
  - Turbine and pump monitoring
  - Optimization of turbine efficiency
  - Turbine acceptance per IEC 60041 and ASME PTC 18
  - Monitoring of required water volumes
  - Leak detection, even under dynamic operating conditions
  - Measurements possible up to 100 bar – even in large pipes

Turbine acceptance and optimization

- **Run-of-the-river power stations**
  - Efficiency optimization and vane control
  - Monitoring of environmental protection requirements
  - Monitoring of fish ladders

Truly versatile, always precise and usable

Detect leaks quickly and accurately – even under dynamic operating conditions

General advantages:
- Flow measurement regardless of fluctuations in temperature, pressure, density and viscosity
- Virtually no loss of pressure
- Subsequent installation possible without disrupting piping
- Maintenance-free
- Standardized discharge equations per ISO6416, IEC 60041 and ASME PTC 18

Water management, environmental protection and hydrography
Special advantages: Continual discharge measurement, high accuracy, no maintenance required, detection of flooding events without the need for "rapid deployment troops", massive data storage, all communication interfaces (RS232, LAN, USB), detection of speed profiles.

- Flood monitoring
- Monitoring of adherence to environment regulations, e.g. for hydropower stations
- Discharge monitoring, e.g. from sewage treatment plants
- Monitoring of vessel navigability

Powerful leakage monitoring with the deltawave Leakage Master
Very often only the instantaneous (analog) measurement values for inflow and discharge are employed in leakage monitoring. However, in dynamic situations, e.g. in start-up / shut-down mode or in the event of a change in the performance of individual turbines, or even due to pipeline dynamics etc., instantaneous values can vary greatly. The operator is then faced with the dilemma of accepting potentially high leakage volume as part of leakage monitoring, or risking false emergency shutdowns. But both are disadvantageous for plant safety and uptime.

Which is why the deltawave Leakage Master employs a significantly more powerful monitoring concept:
the connected deltawaves continuously transmit time stamped meter readings from the individual measuring points to the Leakage Master – fully digital via ethernet. The Leakage Master balances the meter readings for inflows/discharges over freely definable time windows (integration periods), with up to four different integration periods able to be defined. A different leakage threshold can be established for each integration period, with an alarm activated in the event that the threshold is exceeded. Typically, higher leakage volumes are accepted for shorter integration periods – e.g. 10 seconds – in order to compensate for dynamic operating conditions, while smaller leakage volumes are accepted for longer integration periods, e.g. 60 seconds (steady-state operating conditions). This concept enables leakage monitoring to be individually and optimally adjusted for the respective plant. Even very small leakage quantities can be reliably detected – avoiding costly false shutdowns.

- Balancing and leak detection of up to 6 individual deltawave flow measurement stations
- 2 independent monitoring circuits
- Evaluation of digital meter readings avoids inexact comparison of simultaneous (analog) values
- Also suitable for dynamic conditions such as operational start-up and shutdown
- Better than 0.3% leakage uncertainty via calibration
- Automatic synchronization of the individual deltawave devices via ethernet
- Extensive fault monitoring
- Supports fiber-optic transmission for long transmission paths
- Fully digital measurement data acquisition and leakage analysis

Correlation method permits measurement under most difficult requirements

Ultrasonic signals are disturbed by a large number of influencing factors; this includes EMC radiation, gas or solid impurity loading, machine noise etc. For conventional ultrasonic devices to be able to reliably pick out the ultrasonic signals in this "ambient noise", the signal amplitude must be a multiple of the noise.

For deltawave, systec Controls has developed a new kind of evaluation method, which finds the ultrasonic signals even if the amplitude of the noise is a multiple of the signal amplitude. The benefits for the deltawave user are reliable and stable measurement data even under extremely unfavorable conditions.
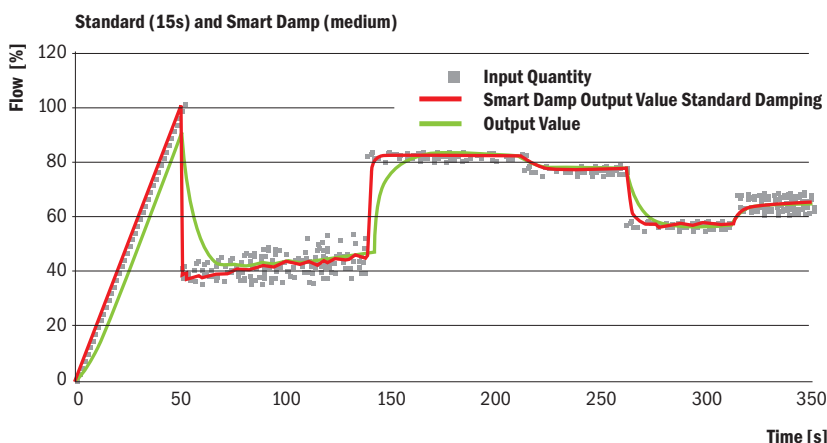
Smartdamp – reacts immediately and is damped as well

The problem in the case of normal damping of the first order is well known:

You "pay" for nicely smoothened measurement values in the form of a slow reaction of the measuring instrument to rapid spikes in measured values. The smoothened measured values are required for stable regulation, yet the realtime jump response is essential too. Consequently, with most measuring instruments the user's only choice remains a compromise between moderate control quality and only minimally adequate reaction to jerky changes in measured values.

Here, the new "Smartdamp" damping strategy developed by systec Controls offers a big advantage: Smartdamp quickly follows the measured value in case of sudden jumps, but reliably damps small measured value variations, to ensure high control quality of the downstream control elements.

High-Tech Ultrasonic Transducer

High Signal Exploitation

deltawave ultrasonic transducers provide excellent signal exploitation. Piezo, the housing, gluing and casting materials were optimized for the highest transmission of the sound energy. Therefore, the integration of the ultrasonic signals in the fluid takes place with the best possible signal exploitation. The high signal exploitation means that a significantly more stable signal is achieved compared to other ultrasonic transducers and clamp-on-systems. This also makes possible the measurement of media that are poor conductors of sound or under high solid and gas loading, – and that at path lengths of more than 100 m.

The assembly plate comes with standard impact protection which reliably protects the transducer from damage from floating debris.

Short Response and Reverberation Times

Fast response and short reverberation of the ultrasonic transducer has a number of advantages: The maximum signal amplitude is quickly available, hence the signal is more easily recognizable. An ingenious structural shape and special casting materials make this advantageous transducer behavior possible.

High pressure/high-temperature transducers

Our high-pressure transducers for pressures exceeding 100 bar can e.g. be used in storage power stations. For applications involving invoicing services for district heating networks, for example, we manufacture high-temperature transducers which operate at up to 140°C.

Standard (15s) and Smart Damp (medium)

Legend:
- Input Quantity
- Smart Damp Output Value Standard Damping
- Output Value

Die herkömmliche Standarddämpfung (grüne Linie) im Vergleich mit der neuen Smart damp. Die grauen Punkte sind die Messwertgrößen, auf die die Dämpfungen reagieren.
Bei t = 50 Sekunden gibt es z.B. einen Messwertsprung, dem Smart Damp weit schneller folgt als die Standarddämpfung.

Im Bereich von 50 bis 150 Sekunden ändert sich der Messwert kontinuierlich (Streuung).Wie die Darstellung zeigt, dämpft Smart damp genauso gut wie die Standarddämpfung, folgt aber Messwertsprüngen deutlich schneller, was letztlich zu höherer Regelgüte führt.

Maintenance-free, no culverts, no long approach paths

Intelligent Evaluation

Transit time measurement with highest resolution of flow speed

deltawave's electronics measure the transit time difference of the ultrasonic signals running with and against the direction of flow with astonishing precision. The evaluation technology developed by systec Controls boasts a resolution of up to < 30 psec.

Consequently, deltawave reliably measures even the smallest flow speeds. And because the transit time measurement is a purely digital time measurement, the electronics function in drift-free, maintenance-free manner.

Reliable signal detection by transmitting encoded signals

To exclude the possibility of wrong measurements with certainty, deltawave transmits encoded transmission signals – similar to Morse code. The digital signal processor then searches in the received signal for the transmitted Morse code. If a deviating signal is found, the signal is rejected. As a result, mismeasurements caused by noise are practically elimi-

nated. This becomes possible thanks to the extremely powerful ultrasonic transducers, which can cleanly convert such encoded transmission signals into ultrasonic signals.
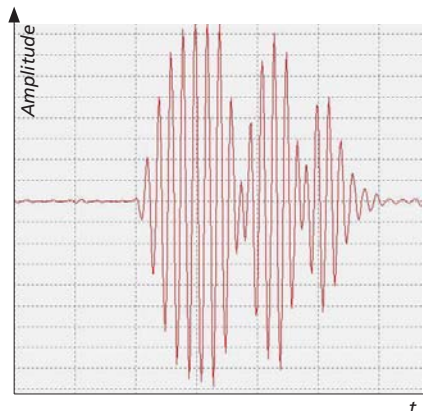
Encoded signals: typical signal packet with two 180° phase shifts for reliable signal recognition.

High-performance hardware architecture

Plug and Play Hardware

Multiboard Concept

The deltawave measurement transducer consists of a main computer, which enables the user to individually configure measurement cards. Plug&Play applies to all extension cards: simply open the housing, insert the new measurement card, close the housing and then use the new measurement card. The main computer recognizes new measurement cards automatically and immediately makes the hardware available, without any further steps being required.

Since all the measurement cards have their own processors, system performance is always assured, regardless of whether 4, 8, 12 or 16 ultrasonic paths are used. The powerful 64-bit Linux main computer simply assigns the relevant tasks to the measurement cards, after which the respective cards then perform their measurement function fully independently. Thus, depending on the configuration, the individual measurement path is measured up to more than 100 times per second. This ensures not only measurement performance, but also a high degree of redundancy and system stability. All boards are equipped with a separate self-monitoring system.
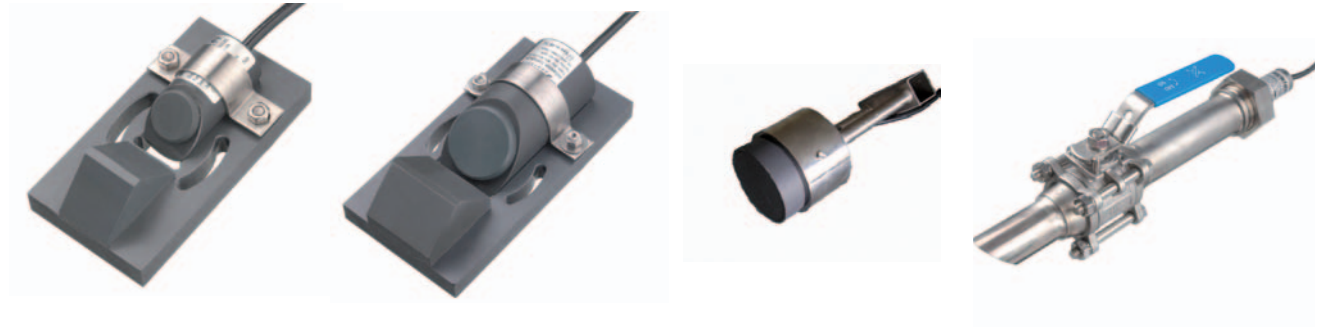
Description	deltawave flow transmitter Ultrasonic multimeter flow-meter	deltawave Leakage Master Leakage monitoring and alarms	High pressure / High temperature transducer for external mounting on pipes and under operating conditions (optional)
Technical Data	**Number of acoustic paths:** typically up to 12 (max. 16) **Number of independent measuring stations:** 1 - 4 **Power Supply:** 90 - 230V AC (24V DC upon request) **Protection Degree:** IP65, optional Eexd **Display:** Touchscreen, graphics, 320 x 240 pixels, LED backlit **Interfaces:** USB, RS232, LAN **Measurement Type:** Multiple-path ultrasonic transit time difference (bidirectional) **Outputs:** 4 x 4...20mA, 2 x pulse, 2 x relays Number of outputs can be doubled with additional IO card **Inputs:** 8 x 4...20 mA expandable up to 16 x 4...20 mA with additional IO card **Output Signals:** flow, mean flow velocity, level, temperature, function alarm, threshold alarms, volume meter **Data Logger:** Integrated, 1 GB **Remote Data Transmission:** via LAN modem (optional) or GSM modem (optional) **Dimensions (wxhxd):** 300 x 400 x 210 mm **Weight:** ca. 6 kg **Mounting:** Wall-mounted, M8/M10	**Number of independent monitoring circuits:** 2 **Number of connected deltawave flowmeters:** Up to 6 **Communication with flowmeters:** http protocol (LAN) **Accuracy of leakage detection:** Up to 0.3% via synchronization of the deltawave flowmeters employed **Inputs:** LAN for connected deltawave flowmeter **Outputs:** Digital outputs for leakage alarm Consideration of dynamic operating conditions by setting up to 4 integration periods and alarm thresholds Automatic synchronization of the connected deltawave flowmeters Extensive error recognition(e.g. broken cable) **Power Supply:** 90 - 230 V AC (24 V DC upon request) **Protection Degree:** IP65, optionally Eexd **Display:** Touchscreen, graphics, 320 x 240 pixels, LED backlit **Dimensions (wxhxd):** 300 x 400 x 210 mm **Weight:** ca. 6 kg **Mounting:** Wall-mounted, M8/M10	**Frequency:** 1 MHZ / 500 kHZ **Path Lengths:** 0.1 - 7 m (Type 1 MHz) 0.5 - 40 m (Type 500 kHz) **Pressure Range:** High-pressure version: Up to 100 bar High-temperature version (only 1 MHz): up to 28 bar **Temperature Range:** High-pressure version: -40...80°C **High-temperature Version:** (only 1 MHz): -40...140°C **Pipe Size:** DN800 and higher **Cable Length:** 10 - 150 m **Accessories:** Exchange armature (Exchange Kit) for switching out transducers under operating conditions
Certifications	CE, Exd	CE	CE, Eexm

Autonomous Components, Highest Reliability

deltawave 1.0 MHz ultrasonic transducer	deltawave 0.5 MHz ultrasonic transducer	deltawave 0.2 MHz ultrasonic transducer	deltawave quicklock
For wall mounting in pipes, channels and surface waters	For wall mounting in pipes, channels and surface waters	For installation in larger canals and surface waters	For external mounting on pipe, optionally under operating conditions
Frequency: 1 MHz	**Frequency:** 0.5 MHz	**Frequency:** 0.2 MHz	**Frequency:** 1 MHz
Path Lengths: 0.1..7 m	**Path Lengths:** 0.5..40 m	**Path Lengths:** 3..150 m	**Path Lengths:** 0.1..7 m
Temperature Range: -40..80°C Ex to 60°C	**Temperature Range:** -40..80°C Ex -20...60°C	**Temperature Range:** -40..80°C	**Temperature Range:** -40..80°C
Pressure Range: max. 10 bar(g)	**Pressure Range:** max. 3 bar(g)	**Pressure Range:** max. 2 bar(g)	**Pressure Range:** PN 6 / PN100
Material (contact with medium): PVC / PU / V4A (others upon request)	**Material (contact with medium):** PVC / PU / V4A (others upon request)	**Material (contact with medium):** PVC / PU / V4A (others upon request)	**Material (contact with medium):** PVC / V4A (others upon request)
Cable Length: 10 – 150 m	**Cable Length:** 10 – 150 m	**Cable Length:** 10 - 300 m	**Cable Length:** 10 - 150 m
Cable Type: RG 58	**Cable Type:** RG 58	**Cable Type:** RG 58	**Cable Type:** RG 58
Sensor delivered with standard wall mounting, other mounting systems available, e.g. mounting rails or locking rings.	Sensor delivered with standard wall mounting, other mounting systems available, e.g. mounting rails or locking rings.	Sensor assembly is specifically configured and manufactured depending on application.	Sensor can be delivered in different installation configurations. Optionally, installation and removal possible under operating conditions (Quicklock version).
Ex Zone 2 und Zone 1	Ex Zone 2 und Zone 1		

Basis of Calculation

The calculation of flow speed is based on the ultrasonic transit time process: two ultrasonic transducers emit sound waves into the medium at an angle α (15 - 75°). The two transducers function reciprocally as receiver and transmitter, and together form a so-called acoustic path. This type of transducer pair combines to form an acoustic path. The ultrasonic signals (T1) emitted by the transducer positioned upstream are accelerated by the flow, while the ultrasonic signals (T2) from the transducer located downstream are delayed. The transit time difference (T2-T1) between the pair is a direct measurement of the mean flow speed over the path length. Given a known geometry, this allows the flow to be calculated according to the formula $Q = A \times v_m$,

whereby:
• A= the cross-sectional area or so-called hydraulic surface
• v_m = mean flow speed over the cross-section

deltawave calculates the transit time difference with an extremely high resolution of less than 1 mm/s. The calculation of the flow and discharge conforms to international standard, and of course in addition to (rectangular) channels is also suitable for drains and surface waters with virtually any cross-section geometry.

High accuracy via multiple-path measurement

Even with just a single acoustic path, under ideal conditions a reproducible and reliable determination of the discharge is possible. At the same time, the flow conditions in large pipes and open or partially filled channels are very com-
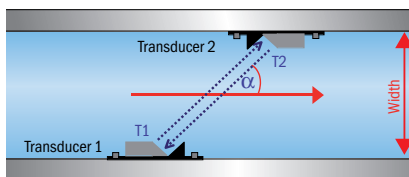

Schema Kanal (Draufsicht)

plex. Short inlet runs, changing water levels, back flow, channel roughness, wind and waves represent just some of the many disrupting factors in performing such measurements. Multiple-path measurement is necessary to precisely determine the relevant mean flow velocity under such difficult conditions. By arranging multiple acoustic paths – typically 4 – flow speeds are measured at different heights, the flow profile is optimally calculated and the mean flow velocity is precisely determined. The table below provides an overview of which deltawave equipment achieves the relevant accuracies.
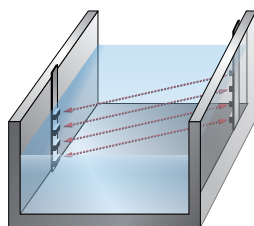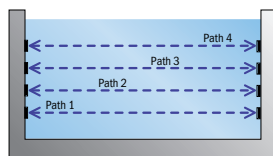
Large channel widths commonly lack the necessary inlet conditions, leading to significantly reduced measurement accuracy when using other measurement methods due to the subsequently

distorted flow profile (turbulences). deltawave supports crosswise measurement, in which two acoustic paths are installed at each measuring level and whose measured speed values are then determined. Disruptive influences and turbulences are thus fully compensated for – and use is possible virtually without any inlet length.
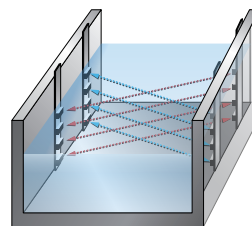
Among others, measuring accuracy was calculated and verified at the Authority for Environmental Engineering and Water Engineering (VPUW) at the University of Kassel.

Installation Options

Regardless of whether there is a rectangular cross-section involved, or partially or fully filled pipes or naturally running water, the location of the measurement point considerably influences the measurement result.
On the basis of the isometric view or drawing of the application, systec Controls recommends the best possible installation location and specifies the expected accuracy free of cost. If desired, and for reimbursement of the small charges that will be incurred, your systec Controls agent can also perform the measurement recording on-site.

The design and mounting of the transducer is individually customized to the measurement environment.

	Accuracies*					
Inlet Path	> 10D			< 5D		
Paths / Crosswise Measurements	2	4	6	2x2	4x2	6x2
Filled pipes and filled rectangular cross-sections	< 2%	0,5%	0,3%	< 2%	0,5%	0,3%
Open channels Partially filled pipes, running water	3%	2%	1%	3%	2%	1%

*Accuracies effective starting at v = 0.1 m/s

Installation in open channels

The transducers can be installed directly on the surface of the channel or on special mounting rails which enables them to be pulled under operational conditions. Connecting a level measurement device (4..20 mA) makes possible correct discharge calculation under changing level values.

Installation in piping

In filled pipes, the transducers are either introduced into the inside of the tube through welding sockets or installed internally, e.g. by means of a clamping ring. Using welding sockets in the Quick-lock construction form or an external exchange armature, the transducers can be installed and replaced while operations are running and at operating pressures up to 100 bar and – all entirely without interrupting operations.
In the case of partially filled pipes, the measurement system is only augmented by a single additional level meter.


Installation Examples for Surface Waters

Installation is possible on bridges and dams, as well as at a distance from the banks. In channels where the banks are not uniform in cross-section or are covered by vegetation, international standards permit the transducers to be mounted on stakes that must be inserted at a certain distance from the banks. In particular, when the ratio between "unmeasured" and "measured" flow is low, the correction (calibration) to be carried out is also less and the generated measurement inaccuracies are within tolerance.

Even complex channel configurations can be recorded in the deltawave via up to 256 plotting points.

In cooperation with the measurement point operator, systec Control develops customized and easy-to-assemble fastenings adapted to the flow channel.

Mounting stakes

Transducer
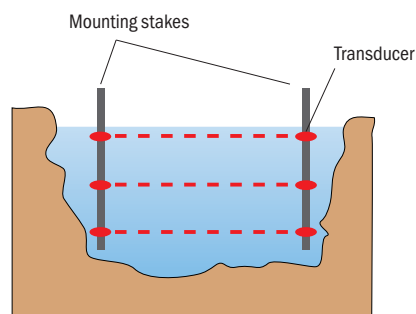
Self-explanatory, convenient, safe and able to be monitored over the internet

Parameterization

deltawave can be conveniently and easily prepared for measurement, even for very complex applications.

The accompanying Windows software enables intuitive and largely self-explanatory parameterization.

After finalizing the parameters, the latter can be stored via a workplace PC or laptop on a common memory stick and loaded to the device. Simply insert the stick into deltawave – the parameters are then copied fully automatically. Irksome maneuvering of the laptop under often rough conditions at the measurement location is thus eliminated. Even updates, software enhancements or display layout changes are easily possible with this tool.

Remote Service

Alternatively, deltawave can also be connected to an intranet or the internet via a LAN and comfortably parameterized and updated via FTP – even wirelessly via the mobile phone network if a LAN modem is present. Reading the current measurement values is easy using deltawave's integrated webserver.

Alternatively, data transmission can also easily be effected via GSM modem by using the digital and analog signal outputs.
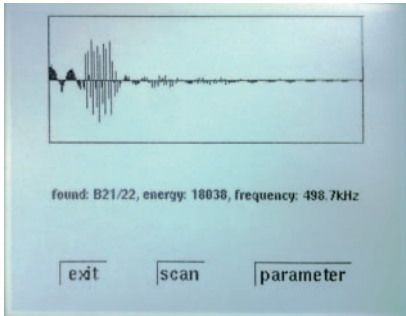
Oscilloscope Function
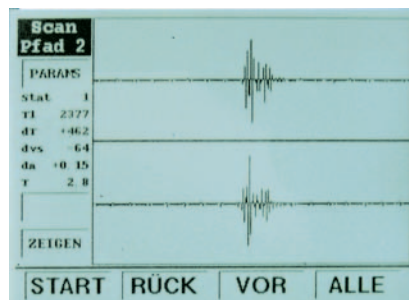
The integrated oscilloscope function allows for rapid verification of signal quality directly within the device.
This function makes it possible to visually display the signals, as well as the simple and quick check of all acoustic paths.

Transducer Testing

found: B21/22, energy: 18038, frequency: 498.7kHz

exit   scan   parameter
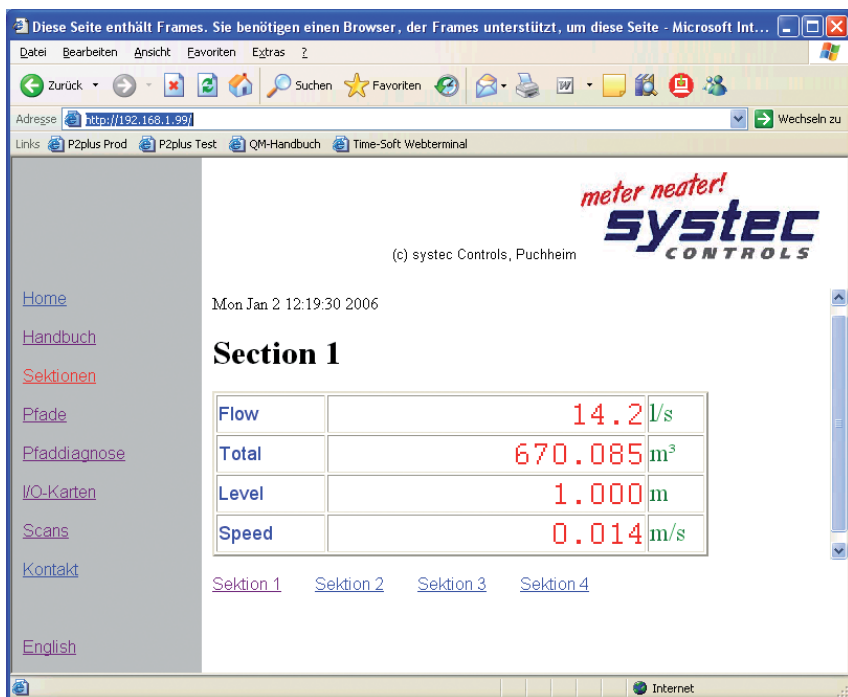
Using the transducer verification function, individual transducers can be tested in dry conditions (e.g. function checking prior to installation and/or after installation and prior to flooding). Simply hold the small plexiglass testing block against the transducer and initiate the transducer test via deltawave's touchscreen. The signals reflected from the testing block are then evaluated by deltawave. The optical display makes it a simple task to determine at a glance whether the transducer is functioning fully correctly. Costly dewatering/dismantling of the transducers is thus avoided. A pleasant side effect: deltawave also displays the terminal numbers of the transducer just checked. Consequently, the transducer checking function is also well-suited for quickly determination and documentation of the individual transducer positions.

Discharge Method

Depending on your application, there are a large number of ISO-standardized discharge models that ensure optimum accuracy and traceability of measurement results. ISO6416 is followed for measurement of discharge flow in partially filled channels, with IEC41 and ASME PTC 18 observed for filled channels. For alternately wholly filled / partially filled channels deltawave automatically switches to the correct standard.

Convenient Expansion Options

With one deltawave measurement transducer, it is possible to realize up to four different measurement sites (sections) with a total maximum of 16 paths. Naturally, deltawave can be retroactively expanded: simply insert additional ultrasonic or I/O boards into the evaluation unit, switch on – and done! Recognition is automatic, simply plug and play.

Safety

With deltawave, safety is first and foremost. deltawave's main computer operates based on a highly secure embedded Linux operating system with a hierarchical security schema. Without a password, only the display of the current operations data and reading the data logger are possible. For other tasks, there are different access rights - "User / Service /Administrator" - which are password protected. This makes unintentional or malicious interference in the measurement task practically impossible.

Remote Operation

If deltawave is integrated into a computer network, parameters can be changed directly via any PC running Windows, the device status can be queried and stored measurement values can be read. deltawave can internally store the measured values for 40 (!) years. Therefore, repeatedly searching for the measurement point is eliminated. deltawave works fully automatically in the background without disturbing the work flow of the measurement technician

Flow metering technology "by systec"

deltaflowC

The deltaflowC measures the mass flow of gases in pipes and channels. Thanks to the integrated differential pressure, pressure and temperature sensors and patented microprocessor technology, measurement accuracies of greater than 2% can be achieved. The deltaflowC is particularly impressive on the strength of its high dynamic performance, zero-point stability and ease of operation. Practical, maintenance-free and available at good value for money, deltaflowC enables you to keep your process costs under control.

deltaflow for flow metering of gas, steam and liquids

The deltaflow pitot tube has proven its effectiveness a thousand times over for measuring the flow and volume measurement of gas, steam and liquids in pipes. Pitot tubes induce the lowest pressure loss of all differential pressure elements, which means that many applications can look forward to energy savings of several thousand Euros per year. With an accuracy of up to 0.4% of the measured value as tested by the Physikalisch-Technische Bundesanstalt (PTB), the deltaflow probe can also be reliably used in the most adverse conditions.
deltaflow is extremely robust and TÜV (German Technical Inspection Agency) tested for use in condensing, aggressive and dirty flue gases. deltaflow is available for pipe diameters from 1 mm – 15 m and a pressure level of up to 690 bar and can thus be used for the vast majority of flow applications.
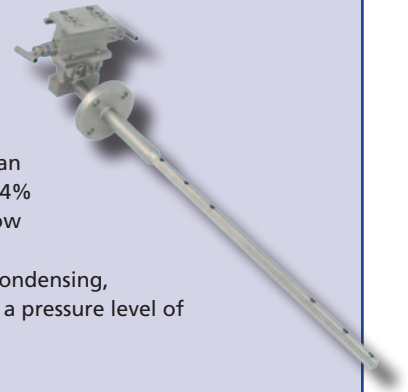
deltawaveC

deltawaveC devices are available in two different series: the deltawaveC-P for mobile / sampling measurements, and the deltawaveC-F, used for continuous measurements in fixed installations. Both units use the proven and highly precise ultrasonic transit time difference method. By using the latest digital signal processors, these robust gauges are extremely accurate and drift-free. Thanks to clamp-on technology, the ultrasonic transducers can be installed in a matter of minutes. No time-consuming work is required to cut or penetrate your pipes. This option, and the elimination of process interruptions, mean that deltawaveC devices are key to optimizing operating costs.

The head office of systec Controls is located in Puchheim, near Munich. Here, we develop and manufacture our products according to DIN EN ISO 9001. But innovation and product quality alone are not enough for us. We have also had our systems tested by independent institutes – with clear, proven success. And of course, we are there for you even after the installation of your system. Our service-crew will assist you at your plant.
systec Controls – the specialist in flow measurement technology.

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