

# Slurry Process Analysers

with wear resistant ceramic probes



Slurry Massflow

Slurry Density

Slurry Flow

Slurry Electrical Conductivity

Temperature

Suspended solids

Production [t/h]

Cumulative production

# Mining & Dredging Technology

Arenal M&DT works closely with customers in mining, dredging, drilling and tunneling industries to increase the efficiency of their operation by offering accurate and high reliable real-time measuring data from ultrasonic slurry density, and thermal (mass)flow probes.

Ceramic sensors are required by our customers, because they do not wear, are more reliable, accurate and environmental safe. In addition, they do not require maintenance, have a longer lifespan and are readily available from stock.

The ongoing R&D and Quality Assurance Programs at Arenal Process Control Solutions BV, the mother organization of Arenal M&DT, guarantees a continuous improvement of measurement technology and the development of other new technologies and applications.



## Quality control

Each Arenal product is designed, manufactured and delivered according to the Quality Assurance Program ISO9001:2015 and tested at different production stages. After start-up and commissioning, the system will be monitored to ensure that the product delivers maximum performance and meets the (process) requirements of the client.



### Economic

Arenal offers density and combined (mass) flow monitoring solutions for a lower price than nuclear analysers and external flowmeters. In addition, the systems save costs by improving reliability, safety and accuracy while reducing maintenance needs.



### Fast delivery

New analysers are available from stock and generally have a short delivery time. An immediate response can be provided when old nuclear analysers break down and density or massflow measurement is critical for your process control.



### Local service

Our specialized and well trained sales and service teams offer world wide support with services like field calibration, training and start-ups commissioning. If needed, the systems can be remotely monitored and controlled through the internet.



## Slurry Analyser

Slurries can be found all over the industry. The common challenge is to measure the density and concentration of suspended solids real-time and as accurate as possible, without the need for sampling. Arenal Mining & Dredging Technology BV is solely focused on the development of sensors and analysers that contribute to the control and optimization of your slurry handling systems.

Arenal started in 2012 with the introduction of ceramic ultrasonic spectroscopy sensors for the determination of slurry density and suspended solids inside abrasive slurries.

During the previous generation of slurry density sensors, also a new accurate type of slurry flowmeter is introduced: the slurry mass flow sensor, based on transfer of heat into slurries. During the first prototypes it appeared that this technology was already as accurate as the magnetic flowmeters. Now the 4th generation of slurry massflow sensors are introduced, offering a guaranteed maintenance free and stable reading of the slurry density.

Our technology offers the following properties and benefits:

- All-in one slurry massflow analyser (Density+Flow)
- Wear resistant ceramic sensors
- Remote Monitoring Access
- Fast delivery
- Economic & best technology on market
- Non-nuclear and maintenance free
- Inline, Submersible & Open Channel probes
- Cross meter and production information for dredging
- Real-time, up to 1000 measurements per second
- High performance Accurate & Reproducible. No drift



## Applications

- Mining & Metal refining
- Dredging
- Tunneling
- Drilling
- All other slurries



# Slurry Massflow Monitoring

Up to now, real-time slurry density monitoring in the mining, dredging, tunneling and drilling industry is done with risky, expensive and often inaccurate nuclear density meters.

With the introduction of the Arenal Ultrasonic Slurry Density Analyser in 2012, the density measurement can now be performed in a more secure, user-friendly and highly accurate manner.

In addition, faster interventions are possible and the system ensures savings in operational costs while increasing control of the process.

Arenal is the first and only producer of ceramic ultrasonic spectroscopy sensors in the world for the determination of density, specific gravity, total suspended solids and temperature of abrasive and high concentration slurries. The ceramic sensor construction not only provides the best acoustical physical properties but it also provides the highest degree of hardness ensuring optimal wear-resistance for the most demanding applications in the industry. This makes the reliable ultrasonic technology in combination with the extremely durable sensor very suitable for monitoring a wide variety of mineral slurries.



Positioned in the same process line as the density sensor, the thermal mass flowmeter is installed. Arenal is currently the first and only company in the world offering ceramic thermal mass flowmeters for abrasive slurries. After compensation of the slurry density, the flow is calculated with an accuracy of less than 0,03 m/s, which is by far better than any slurry flow meter available on the market. The flow meter is connected to the Slurry Density Analyser, which significantly reduces the cost of the massflow system.



# Benefits



## Non-nuclear

Ultrasonic spectroscopy relies on the determination of physical properties with ultrasonic waves, and does not require any nuclear sources.



## No maintenance

As the sensors are made from one of the hardest ceramic material on earth, silicon carbide, there is no requirement for maintenance.



## Drift free & accurate

By measuring different physical acoustical properties in the slurry and the sensor, drift in the density range from 0 to 4500 kg/m<sup>3</sup>, is physically not possible.



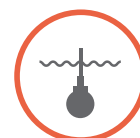
## Immediate response

The response-time is less than a second, so changes in the slurry density are observed immediately.



## In-line mounting

With a variety of in-line mounting solutions, like spool pieces, wafer cells and weldolets, the probes can be installed in new and existing situations without redesigning.



## Submersible mounting

Arenal also offers sensors for submersed mounting in tanks or vessels. The sensor can be fixed mounted or combined with an automatic winch.



## Open channel

For easy installation in open channels, the Arenal sensors are supplied with a basic set of pipe supplies and brackets.

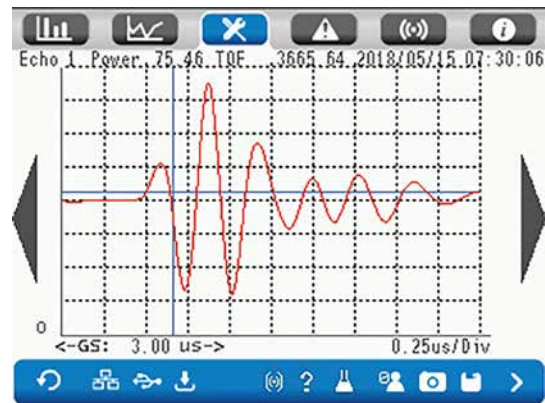
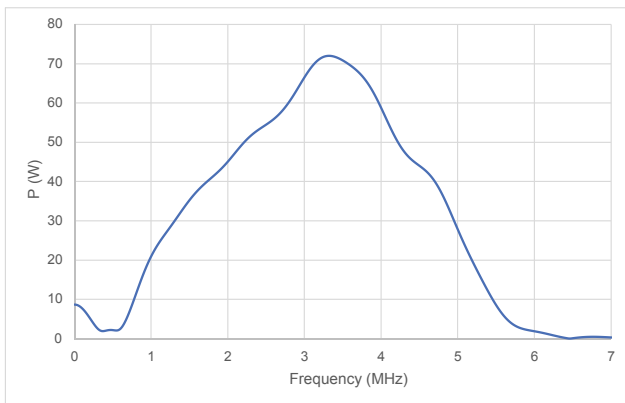
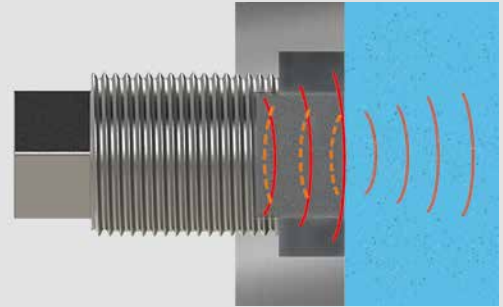


## Portable devices

Temporary monitoring needs? The portable analysers come with a strong watertight case and the sensor can be selected from the full range of products.


# Ultrasonic Spectroscopy

Ultrasonic spectroscopy is at the basis of all Arenal Ultrasonic Density Analysers. The field of ultrasonic spectroscopy looks at the behavior of propagation of ultrasonic waves, and changes of waves due to changes in process conditions. In most monitoring situations, ultrasonic pulses are transmitted into the sensor tip and the returning echo signals are analysed in a computer. The principle of ultrasonic spectroscopy is used in many industrial measurement applications like density, temperature, level, flow, particle size distribution, concentration and viscosity.



Frequency spectrum and Oscilloscope function in the SDA analyser

## Analysis & Recording of Ultrasonic signals

 Acoustic waves are generated after applying a high voltage pulse to a piezo element. By means of the piezoelectric effect, the element vibrates. This micro-movement of the element is transmitted into the ceramic part of the sensor and the wave then moves to the slurry. At the surface of the ceramic element and the slurry, the ultrasonic waves are transmitted and reflected. By measuring the reflected waves, Arenal can determine the Acoustical Physical Properties (APP's) of materials (like acoustic impedance, time of flight, speed of sound, attenuation, ultrasonic frequency spectrum). These APP's are related to their physical properties (density, temperature, dry solids concentration, viscosity, particle size). With Ultrasonic Spectroscopy we measure the APP's and by reverse modelling of physical laws, the physical properties of the liquid are determined. A measurement of acoustic impedance, flight times of echo's and temperature enables us to calculate specific gravity and density. The speed of sound and temperature are correlated to the concentration of dissolved solids.



## Thermal mass flow

The all-ceramic thermal mass flow sensor can be used in a wide range of industrial applications such as water, chemicals, oils and slurry mass flow measurement. To correct for thermal conductivity of the medium, the mass flow meter is embedded in the slurry density analyser or the chemical concentration analyser. The sensor is heated up a few degrees above the medium temperature. More heat is absorbed by the liquid when the thermal conductivity increases or when the flow velocity increases. The heat transfer coefficient is a function of, for example, viscosity, Reynolds numbers and the mass flux. This function is set in a single point field calibration. Dividing this mass flux by the ultrasonic slurry density or the concentration of the chemical, the velocity of the medium is accurately determined in m/s. It appears that this technology is more accurate and reproducible than other flow meters in the world.



## Temperature monitoring

Arenal offers a unique, all-ceramic temperature sensor for a variety of industry applications including high accuracy temperature measurement in water, chemicals, oils and slurries. The temperature of abrasive slurries or aggressive chemicals is determined by a 4-wire PT1000 element inside a ceramic sensor. Arenal offers connectivity to various transmitters, such as 4-20 mA and Hart.



## Conductivity

Arenal's unique all-ceramic high-precision 4-pole conductivity sensor can be used in a variety of industrial applications, like abrasive slurries and most demanding chemicals. The electrical conductivity of a liquid or slurry depends on its temperature, the concentrations of dissolved solids, like salts, acids or bases and the concentration of suspended solids. These parameters provide essential information about the state of the dissolved solids concentration. Arenal applies accurate 4-pole AC technology for the range 0-300 mS/cm.



# Slurry Massflow Analyser

Model MFA is designed to monitor Slurry Density and Mass Flow of highly abrasive slurries. The controller consists of an advanced industrial PLC based HMI, which offers great flexibility with advanced settings and clear screens and graphs for interaction with the user.

The standard measuring screen starts showing Specific Gravity, Density, Flow, Massflow, Total Suspended Solids, Temperature, Production and Accumulated Production. The user can select different start screens like a cross-meter in dredging applications. The controller communicates with the field transmitters.



## Mounting:

- Durable aluminum enclosure with powder coating.
- Remote mounting up to 200 meters from the measuring point.
- Wall mounting without opening lid.

## Connectivity:

- (2x) 4–20 mA output and 2x mA input
- Ethernet, Modbus TCP/IP
- Optional: Hart, Fieldbus, Profibus DP/PA







#### Features:

- Data logging of monitored data
- Control sample taking and ID tracking
- Time trend graphs
- Echo scope functions
- Alarm screens
- Network connectivity
- Control of ultrasonic and thermal transmitters

#### Portable version:

- Strong and weatherproof enclosure
- For fast and accurate inspection of the density inside tanks or monitoring of the settling process.

#### Specifications under ideal laboratory conditions::

Density range:	0–4500 kg/m <sup>3</sup>
Density accuracy:	3 g/l
Flow range:	0–10 m/s
Flow accuracy:	3 cm/s
Temperature range:	0–65°C and 0–110°C
Temperature accuracy:	0,01 °C



# Transmitter & Modules

Arenal offers a wide range of electronic circuit boards to convert analog or digital data into another format and to control sensors or actuators.

Transmitters (QT range) control sensors and convert analog measurements into digital information to send over the Modbus RTU bus to the analyser, like:

- QT0161-UDT: Ultrasonic Density Transmitter controls the ultrasonic density probes and converts echo information into digital values.
- QT654-TMT: Thermal Massflow Transmitter controls the thermal massflow probe and converts energy and temperature information into digital values.
- QT104-CCT: Contacting Conductivity Transmitter controls the Contacting Conductivity Probes and converts the conductivity and temperature information to digital information. Also to a mA output.
- QT124-PTT: PT1000 Temperature Transmitter controls the temperature probe and converts electrical resistance information from the PT1000 to digital values and 4–20 mA.

Modules (QM range) convert digital information to other digital information, like:

- QM05-PSM: Power Supply Module to convert and regulate power supplies.
- QM101-MPC: Modbus Protocol Convertors to Hart or Profibus or any other communication method.
- QM131-IOM: IO Module to offer remote 4–20 mA input and output signals and relay contacts.
- QM146-RMM: Remote Monitoring Module to give access to our analyser from a remote location by LAN, VPN, WIFI or GSM.





# Remote monitoring Services

Arenal offers safe and secure remote monitoring solutions for our analysers in the industrial and environmental monitoring applications. Installed GPRS/GSM modems decrease the commissioning and service time significantly. The objective is to take over the control of our analyser systems when requested. After powering up, the gateway will connect to our server on the internet by means of a VPN tunnel. We connect to this server with a VPN connection as well and from that moment we can take over control of all analysers that are connected in the underlying network of the gateway.



Model: QM146-RMM

## Remote monitoring Module

The RMM (Remote Monitoring Module) consists of a strong aluminum enclosure with pre-fixed waterproof antenna and an additional connector for our extended antenna. The unit is powered by PoE from the analyser.





# Ceramic Probes

## In-line probes

All ceramic probes from Arenal are designed to fit in abrasive and high massflow slurry applications. The ceramic sensor is made from one of the toughest materials on earth: Silicon Carbide (SiC). They are much more wear resistant compared to all other ceramics. Secondly the acoustical, thermal and physical properties of SiC are perfect for the applications in abrasive slurry massflow monitoring.



Model: QP014-UDP-WFC-SiC



Model: QP014-UDP-SPC-SiC



Model: QP014-UDP-PRC-SiC



Model: QP654-TMP-WFC





## Submersible and Diver Probes

The submersible ultrasonic probe (SUB and SUBR) is often used in applications where the density of a slurry in a tank or has to be determined. The probe is fixed with an assembly to the top of the tank and will determine the density on that specific point.

The diver probe (DIV and DIVR) is similar to the SUB and SUBR, except that it is fixed to cable, not to a pipe. This model is used in winch systems to monitor the settling process, by measuring the density on the complete height of the tank. The SS316 housing is heavy enough to reach the bottom of the thickening tank. Arenal supplies a strong wear, chemical and high temperature resistant cable for winch systems. During his flight, the probe monitors the settling process accurately for display on the screen or on digital outputs.

Arenal offers sensors for density only as well as for a combination with attenuation and speed of sound.



Model: QP013-UDP-SUBR-SiC-LT-ASSY



Model: QP013-UDP-OCP-SiC-SS316-LT-XXX-ASSY-A

## Open Channel Probes

The open channel ultrasonic probe (OCP) is mounted in the open channel flow, facing upstream. It consists of a strong SS316 body and a ceramic SSiC element, which is wear resistant. Additionally, the flow speed as well as the height of the slurry is measured to determine the massflow. When the massflow needs to be determined, Arenal includes a level transmitter to the analyser. The Massflow analyser determines the slurry and the solids massflow in t/h.

# Mounting configurations



Model: QB063-SPC

## Spool piece

To measure the massflow of abrasive slurries in pipes, Arenal offers complete steel, stainless steel or HDPE spool pieces with PU lining and sampling valves. The SPC sensor is flush mounted from the inside to outside of the pipe and fixed in a cone or weldolet assembly.

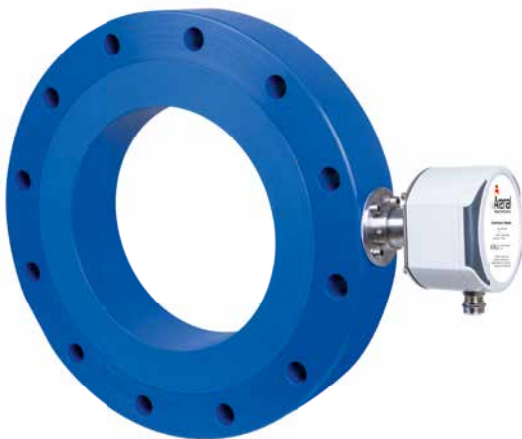
Arenal also offers spool pieces without lining for any pipe size and flange reference. In this case and also in the situation above, the WFC probe is used and mounted from the outside to the inside of the pipe and fixed in a saddle type flange. These flanges can be welded locally to existing pipes as well.



Model: QB051-SWC

## Sensor Wafer Cell

The Sensor Wafer Cell is a Wafer Cell in which the wafer material is also the sensor. From the inside from the wafer, no sensor is visible. Mounting is between the two flanges of the pipe. It is our latest technology with sensor-less configuration: there is no sensor in contact with the medium. The SS316 SWC is designed for high pressure (up to 600 bar) and paste applications. It has a tungsten carbide coating on the inside. Optionally, this system can be used to measure the wear in pipes, when it is assumed that the erosion of the pipes is similar to the erosion of the wafer cell.



Model: QB031-WFC

## Wafer cell

The wafer cell is made from UPE-1000 (high molecular weight polyethylene) steel or stainless steel. It is clamped between two flanges of the pipe and the ceramic sensor penetrates through the wafer cell body to the medium. It is designed to fit the pressure rating and temperature range of your process. Wafer Cells are designed for each pipe individually, as the inner diameter and the flange size must correspond to the dimensions of the wafer cell. A well designed wafer is very durable.



Mounting configurations	Method/description	Probe type	Ultrasonic density	Thermal mass flow	Temperature	Electrical conductivity
QB01	Flow through block	FTB	●	-	●	●
QB02	QB021	Weldolet Assemblies	SPC/WFC	●	●	●
	QB022	Process Flange Assemblies	SPC/WFC	●	-	●
	QB023	Open Channel Pipe Assemblies	OPC	●	●	●
	QB024	Submersible Pipe Assemblies	SUB/SUBR	●	-	●
QB03	Wafer Cell	WFC	●	●	●	●
QB04	Submersible blocks for river bed contamination monitoring	FTB	●	●	●	●
QB05	Sensor Wafer Cell	SWC	●	-	●	-
QB06	Steel Spool piece with or without lining	SPC/WFC/PRC	●	●	●	●
QB07	HDPE Spool piece with or without lining	SPC/WFC/PRC	●	●	●	●
QB08	SS316 Spool piece or without lining	SPC/WFC/PRC	●	●	●	●
QB09	Diver on winch system	DIV/DIVR	●	-	●	●



Model: QB013-FTB



# Sales & Partner network

Mining, dredging, tunneling and drilling



● Head office

● Agency

● Distributor

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