ACOUSTIC SUSPENDED SEDIMENT PROFILER RANGE

AQUAscat® - Buyer's Guide

AQUA*scat* ® 1000

Aquatec has a long history of innovation and was founded in 1990 by the current managing director as a specialist consultancy in oceanographic design. Since then, the company has established a diverse portfolio of products for the measurement of oceanographic and process parameters, as well as establishing a range of services including instrument and communication design. Suspended sediment measurement has been a core element of our product offering for over 20 years. The AQUAscat range are market leading instruments that use multi-frequency acoustics to observe profiles of suspended sediment concentration up to 10m in range.

KEY FEATURES

SEDIMENT SOLVED
- Observe profiles of mean particle size and suspended sediment concentration
- Uses acoustic backscatter method
- The instruments are most suitable for particle sizes between 20 μm and 500 μm radius and concentrations of 0.01 g/l to 20 g/l over 1 m, or more over a shorter range
- Profiles of <1 m to 10 m
- Vertical resolution of 2.5 mm to 4 cm

TRANSDUCERS
- Models with cabled and fixed transducers
- Transducers range from 300 kHz to 5 MHz
- All instruments feature at least 2 transducers

DEPLOYING THE LOGGER
- Deploy in fresh and seawater to 1000 m depth (field models), or in tanks and flumes (lab model)
- Custom instruments to 4000 m depth
- Integral temperature and pressure sensors
- Cabled turbidity sensor available on request
- Internal batteries and memory for autonomous deployment
- External battery packs for long term deployment or high frequency sampling
- Transducer clamps available for cabled models

ACCESING THE DATA
- 8 GB internal memory for logging data
- View the unprocessed acoustic backscatter in real time
- Post-process the backscatter data to give profiles of mean particle size and suspended sediment concentration

SEDIMENT SOLVED WITH AQUA*scat* ®

The AQUAscat 1000 profilers form a core part of the Sediment Solved range of instrumentation, observing suspended sediment concentration (SSC) in freshwater and marine environments. Measuring suspended sediment concentration is important for a wide range of applications and disciplines, from operational dredge monitoring or civil engineering activities, to understanding natural environments, as well as fundamental research into sediment transport processes.

ACOUSTIC BACKSCATTER METHOD

The AQUAscat transmits pulses of sound at various frequencies into the water and records the sound signal scattered back. The frequency of sound transmitted is typically between 300 kHz and 5 MHz. It is attenuated and absorbed to a lesser degree than light, and travels much more slowly through the water. As a result, the AQUAscat can provide profiles of backscatter, rather than single point measurements.

In order to calculate SSC from acoustic backscatter, multiple frequencies of sound are transmitted into the same body of water. The size dependent response from the same sediment particles scattering different frequencies of sound enables the mean particle size and SSC to be calculated for bins along the profile range.

TEMPERATURE, PRESSURE AND TURBIDITY

Field models of the AQUAscat feature integral temperature and pressure sensors, to provide useful contextual information. Cabled turbidity sensors are also available as accessories.
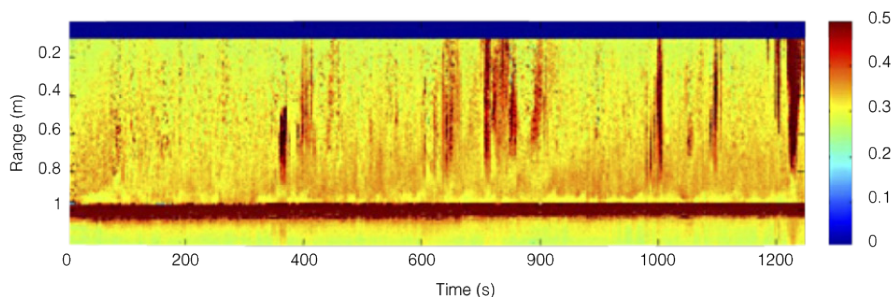
BENEFITS OF ACOUSTICS

- Low maintenance
- High immunity to biofouling
- Provides profiles of up to 10m
- Suitable for unattended operation
- Non intrusive
- Flexible sampling


SEDIMENT CONCENTRATION (g/l)
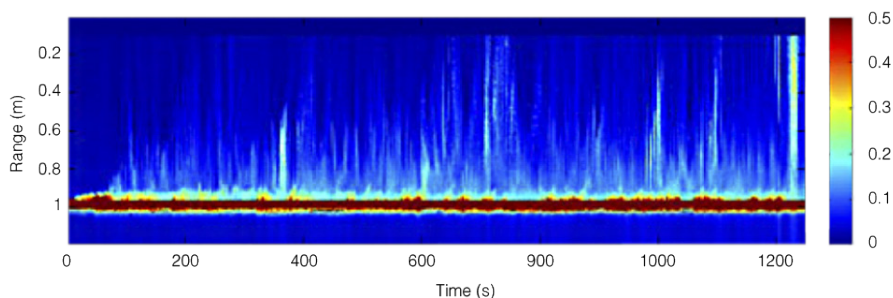
MEAN SEDIMENT D50 (mm)

USING THE AQUA*scat* ®

MULTIPLE FREQUENCIES

If a single frequency of sound is used, it's not possible to determine the load without knowledge of the mean particle size, as the response for a fixed load varies with it. In situ samples or independent analysis would be required. With multiple frequencies, the size dependent response to different frequencies can be used to determine particle size. The concentration can then be calculated using the particle size.

MEASURED SIGNAL AGAINST PARTICLE SIZE FOR A FIXED CONCENTRATION
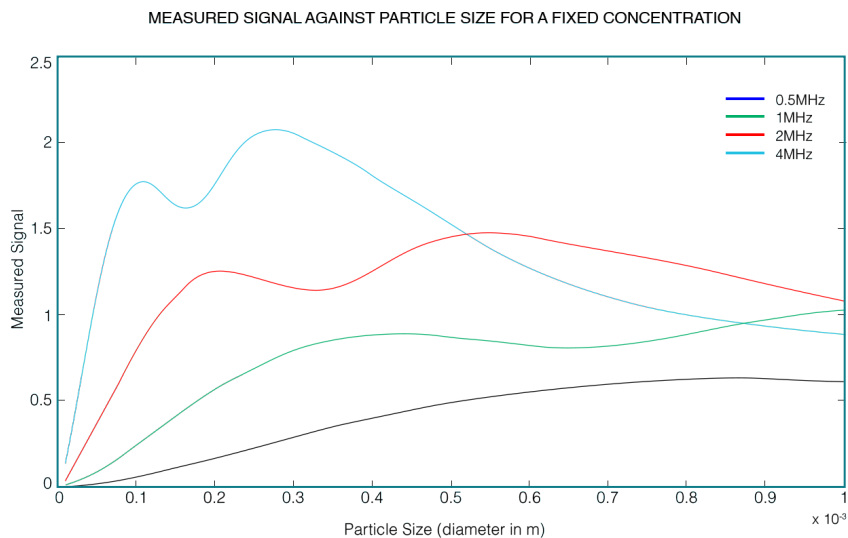

TRANSDUCER SELECTION

The selection of frequencies, typically between 300 kHz and 5 MHz, requires careful consideration: higher frequencies give higher spatial resolution (a function of transducer bandwidth) and the ability to detect finer particles, but at the cost of range, which is reduced due to higher attenuation. The lower frequencies give a longer range, but lower spatial resolution and the ability to preferentially detect the larger particles.

FREQUENCIES	300 kHz	FINER PARTICLES	DECREASING RESOLUTION	DECREASING RANGE
	500 kHz			
	1 MHz			
	2 MHz			
	2.5 MHz			
	4 MHz			
	5 MHz			

RANGE

Depending on the model and resolution option selected, the AQUAscat can collect profiles of up to 10m. Profiling can be done horizontally or vertically. The operating range is dependent on both the mean particle size and the suspended sediment concentration. Particles below a certain size, related to the transmitted frequency, exhibit decreasing backscatter levels, tending to zero with particle size. More suspended material causes higher levels of backscatter but also attenuates the acoustic signal, which causes backscatter at longer ranges to be reduced. The effect varies with frequency, with higher frequencies being attenuated more. To assist with understanding this complex balance, Aquatec can run range simulations for you.

RESOLUTION	MAXIMUM RANGE	MINIMUM FREQUENCY
0.25 cm	0.64 cm	2 MHz
0.5 cm	1.28 m	1 MHz
1 cm	2.56 m	500 kHz
2 cm	5.12 m	None
4 cm	10.24 m	None

MAX RANGE WITH 2 FREQUENCIES
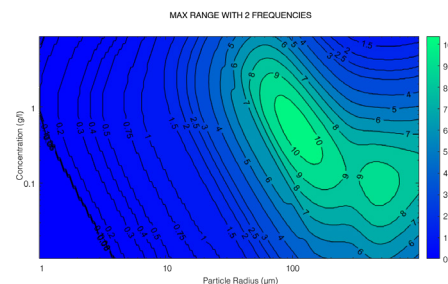
DEPLOYING THE AQUA*scat* ®

AQUA*talk*

The AQUAscat is set up for deployment using the supplied AQUAtalk software. You can select the sampling regime, set the channels and choose the bin size, depending on the model. The battery life calculator shows how long your instrument can monitor in your preferred settings, and allows you to plan accordingly.

Mean particle size and suspended sediment concentration is calculated after the deployment using the AQUAscat Toolkit, also supplied with the instrument.
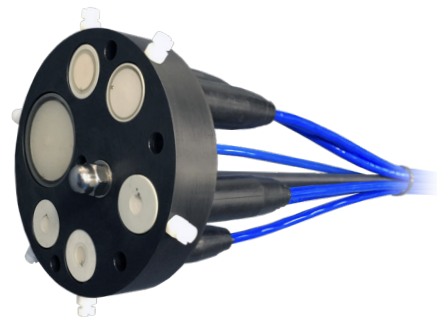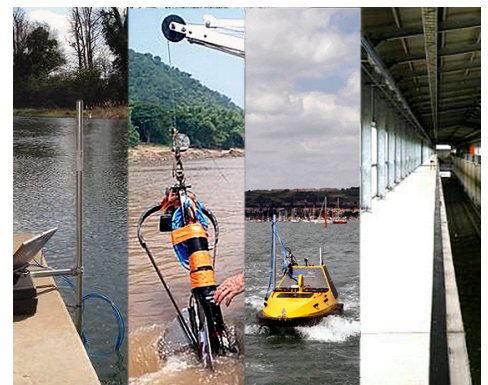
DEPLOYMENT METHODS

The AQUAscat can be deployed in a number of ways:

- From a boat
- On a subsea frame
- Attached to a structure
- On a mooring line
- On a buoy
- In a tank or flume

To aid deployment, a transducer clamp that can hold in place the cabled transducers of the research model is available. It can fit all sizes of transducer and custom versions are available for a variety of different transducer arrangements.

MOUNTING ARRANGEMENTS

As with any acoustic instrument, there are a number of factors to consider when deciding on mounting arrangements:

- Interference - Interference from other acoustic instruments with similar frequencies is possible, e.g. ADCPS.
- Blanking distance - For each transducer, there is a 'blanking distance' that extends typically 10-15cm from the transducer face, where readings will be less accurate - the backscatter readings in this region may be contaminated by ringing from the transducer after the initial pulse transmission.
- Bubbles - Entrained air bubbles may affect readings, so the AQUA*scat* should not be deployed in the surf zone. In addition, the AQUA*scat* should remain under water, so air bubbles do not attach to the face of the transducers upon submersion.
- Hard reflectors - care should be taken when deployment the AQUA*scat* close to hard surfaces that may cause reflections

Advice on deployment arrangements is available on request.

PROCESSING YOUR DATA

REAL-TIME VIEW

The AQUA*scat* is typically used as a logging instrument. The instruments have a USB interface allowing you to view the acoustic backscatter in real-time. However, the sediment load is calculated in post-processing.

MEAN PARTICLE SIZE AND SEDIMENT LOAD

The backscatter data collected by the AQUA*scat* can be post-processed using dedicated software supplied with the instrument, the AQUA*scat* Toolkit, to obtain the mean particle size and profiles of suspended sediment concentration.
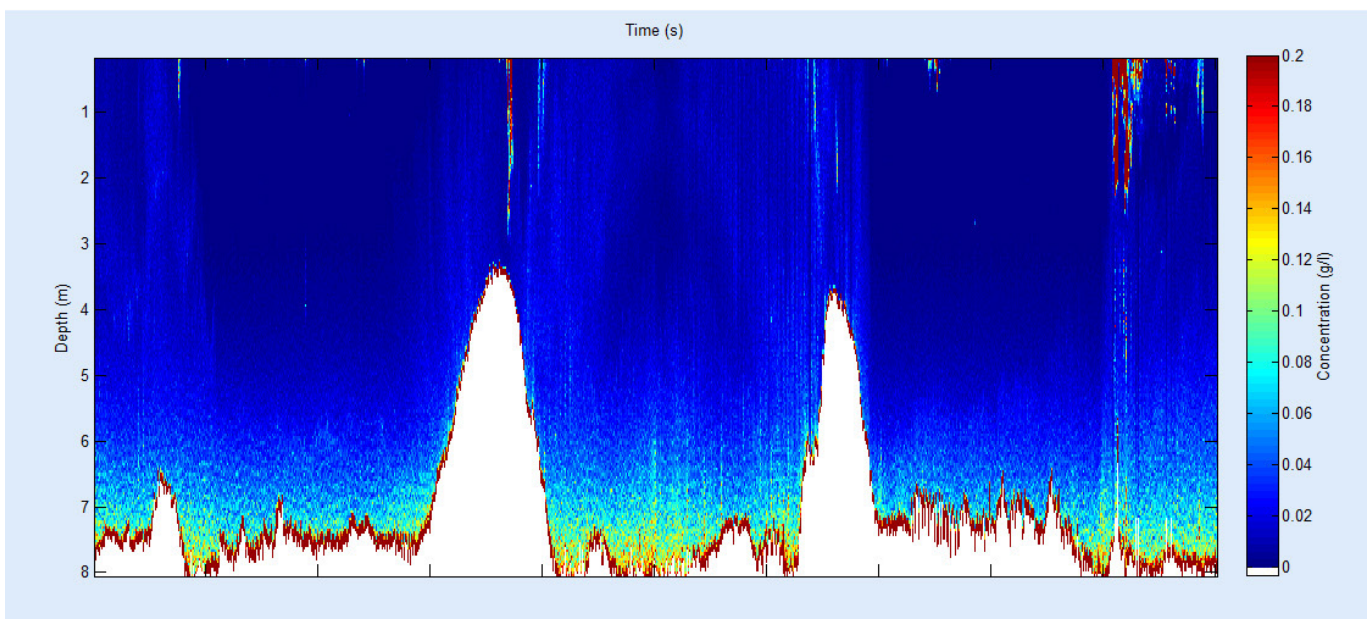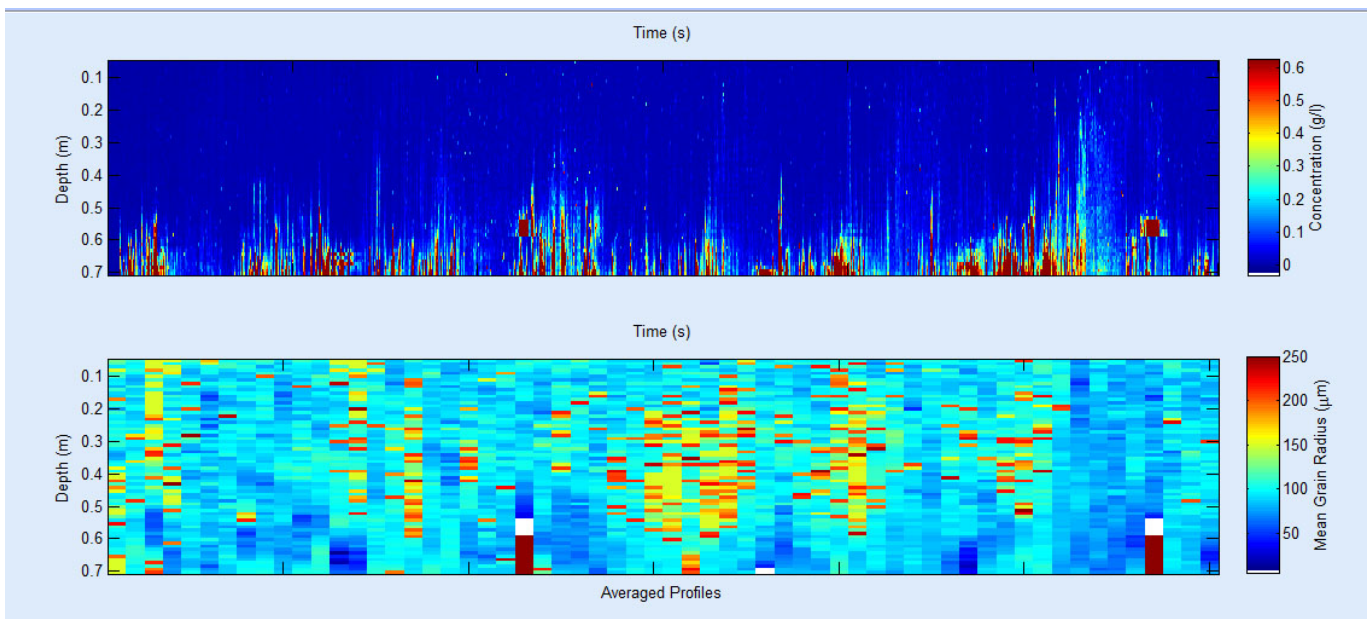
SELECTING YOUR INSTRUMENT

RESEARCH MODEL - AQUAscat® 1000R
Field Instrument - 1000 m rated
4 Cabled transducers - rom 300 kHz to 5 MHz
Variable resolution - 2.5 mm to 4 cm
Internal alkaline battery and 8GB memory

SURVEY MODEL - AQUAscat® 1000S
Field instrument - 1000 m rated
4 fixed transducers - 0.5, 1, 2, 4 MHz
Variable resolution - 2.5 mm to 4 cm
Variable range - 0.64 m to 10 m
Internal alkaline battery and 8 GB memory

LITE MODEL - AQUAscat® 1000LT
Field instrument - 200 m rated
2 fixed transducers - 1.4 MHz
Fixed resolution - 10 mm
Fixed maximum range - 2.56 m
Internal rechargeable battery and 8 GB memory

LAB MODEL - AQUAscat® 1000L
Lab instrument
4 cabled transducers - from 500 kHz to 5 MHz
Fixed resolution - 10 mm
Fixed maximum range - 2.56 m
8 GB memory

UPGRADES

External battery packs
For high frequency sampling or long autonomous deployment, external alkaline battery packs in 1000 m rated housing are available.

Rechargeable battery upgrade
If rechargeable internal batteries are preferred, AQUAscat instruments can be upgraded pre or post delivery.

Additional transducers
For research and lab instruments, additional transducers can be purchased. The research model is supplied with 4 transducers and the lab model 3. A maximum of 4 can be used at any one time but a total of 7 different frequencies are now available.

Cabled turbidity sensor
Cabled turbidity sensors can be added to any of the instruments, to deploy a different method of measuring sediment.

Lab model upgrade
The lab model can be upgraded to include multiple range and resolution.

AQUA*scat* ® 1000R SPECIFICATIONS

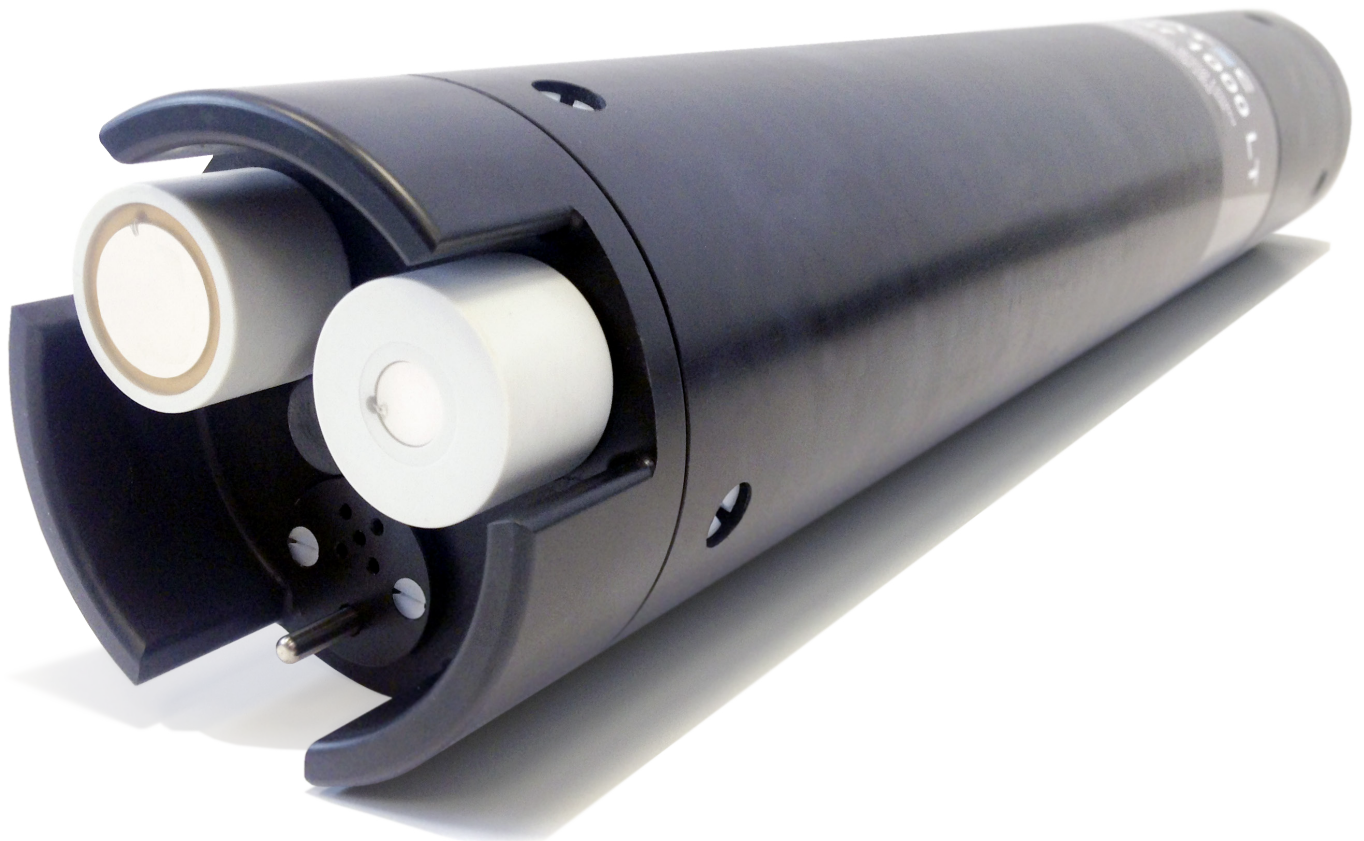|	
Sediment range	Sensitive to a wide range of grain sizes Size inversion typically feasible for 20 μm to 500 μm radius Typically 0.01 g/l to 20 g/l over 1 m, or more over shorter range
Frequencies	Up to 4 frequencies, from 300 kHz to 5 MHz
Transducers	Typically Ø10-25mm ceramic discs (beam width according to frequency), with other optional configurations
Transducer arrangement	Individual cabled transducers
Gain	Software controlled transmitter and receiver gain adjustment
Range	150 cm (typical), up to 10 m at frequencies below 2MHz depending on options
Transmitted signal	1 W rms typical transmit CW pulse, pulse length to match cell size
Transmission rate	128 Hz max pulse rate for each frequency (i.e. 512 pulses per second for four), subject to acoustic range limits. Minimum rate 1 Hz for calibration
Data averaging	Cell ensembles averaged over time by powers of 2 up to 64 before storage
Range cells	256 cells. 2.5 mm, 5 mm, 10 mm, 20 mm and 40 mm at 1500 m/s speed of sound. Start/end range set by software
Burst duration	Defined by number of profiles requested
Burst trigger	Either external hardware trigger when required or internal software trigger at regular intervals
Burst interval	Internally generated from once every minute to once every 255 minutes, user definable start time of first burst
Trigger output	A digital output allows triggering of external instruments
Power requirement	8 V to 24 V dc. Typically 1 W when logging, and with standby of typically 1 mW when not logging
Battery packs	Internal alkaline battery pack gives up to 10 days typical deployment. External battery packs available according to deployment needs
Additional sensors	Built-in temperature and pressure, optional turbidity
Disk storage	Compact Flash (proprietary format). 8 GB standard
Data comms	RS232 up to 115 kbaud; USB 1.1 typically 2-3 Mbaud
Housing options	1000m rated aluminium alloy housing. Greater depths available as custom instruments
Software	AQUA*talk* ® for AQUA*scat* ® for logger interaction AQUA*scat* ® toolkit for data processing

AQUA*scat* ® 1000S SPECIFICATIONS

Sediment range	Sensitive to a wide range of grain sizes Size inversion typically feasible for 20 μm to 500 μm radius Typically 0.01 g/l to 20 g/l over 1 m, or more over shorter range
Frequencies	4 frequencies - 500 kHz, 1 MHz, 2 MHz, 4 MHz
Transducers	Ø10-25mm ceramic discs (beam width according to frequency)
Transducer arrangement	4 fixed transducers
Gain	Software controlled transmitter and receiver gain adjustment
Range	150 cm (typical), up to 10 m at frequencies below 2 MHz depending on options
Transmitted signal	1 W rms typical transmit CW pulse, pulse length to match cell size
Transmission rate	128 Hz max pulse rate for each frequency (i.e. 512 pulses per second for four), subject to acoustic range limits. Minimum rate 1 Hz for calibration
Data averaging	Cell ensembles averaged over time by powers of 2 up to 64 before storage
Range cells	256 cells. 2.5 mm, 5 mm, 10 mm, 20 mm and 40 mm at 1500 m/s speed of sound. Start/end range set by software
Burst duration	Defined by number of profiles requested
Burst trigger	Either external hardware trigger when required or internal software trigger at regular intervals
Burst interval	Internally generated from once every minute to once every 255 minutes, user definable start time of first burst
Trigger output	A digital output allows triggering of external instruments
Power requirement	8 V to 24 V dc. Typically 1 W when logging, and with standby of typically 1 mW when not logging
Battery packs	Internal alkaline battery pack gives up to 10 days typical deployment. External battery packs available according to deployment needs
Additional sensors	Built-in temperature and pressure, optional turbidity
Disk storage	Compact Flash (proprietary format). 8 GB standard.
Data comms	RS232 up to 115 kbaud; USB 1.1 typically 2-3 Mbaud
Housing options	1000m rated aluminium alloy housing. Greater depths available as custom instruments
Software	AQUA*talk* ® for AQUA*scat* ® for logger interaction AQUA*scat* ® toolkit for data processing

AQUA*scat*® 1000LT SPECIFICATIONS

Sediment range	Sensitive to a wide range of grain sizes Size inversion typically feasible for 20 μm to 500 μm radius Typically 0.01 g/l to 20 g/l over 1 m, or more over shorter range
Frequencies	2 frequencies - 1 MHz, 4 MHz
Transducers	Ø10-20mm ceramic discs (beam width according to frequency)
Transducer arrangement	2 fixed transducers
Gain	Software controlled transmitter and receiver gain adjustment
Range	150 cm (typical) at 4 MHz, 255 cm at 1 MHz
Transmitted signal	1 W rms typical transmit CW pulse, pulse length to match cell size
Transmission rate	128 Hz max pulse rate for each frequency (i.e. 256 pulses per second for two), subject to acoustic range limits. Minimum rate 1 Hz for calibration
Data averaging	Cell ensembles averaged over time by powers of 2 up to 64 before storage
Range cells	256 cells. 10 mm (at 1500 m/s speed of sound)
Burst duration	Defined by number of profiles requested
Burst trigger	Either external hardware trigger when required or internal software trigger at regular intervals
Burst interval	Internally generated from once every minute to once every 255 minutes, user definable start time of first burst
Trigger output	A digital output allows triggering of external instruments
Power requirement	8 V to 24 V dc. Typically 1 W when logging, and with standby of typically 1 mW when not logging
Battery packs	Internal rechargeable Nickel Metal Hydride battery pack gives up to 5 days typical burst deployment. External battery packs available according to deployment needs
Additional sensors	Built-in temperature and pressure
Disk storage	Compact Flash (proprietary format). 8 GB standard
Data comms	USB 1.1 typically 2-3 Mbaud
Housing options	200m rated acetal housing
Software	AQUA*talk*® for AQUA*scat*® for logger interaction AQUA*scat*® toolkit for data processing

AQUA*scat* ® 1000L SPECIFICATIONS

Sediment range	Sensitive to a wide range of grain sizes Size inversion typically feasible for 20 µm to 500 µm radius Typically 0.01 g/l to 20 g/l over 1 m, or more over shorter range
Frequencies	Up to 4 frequencies - from 500 kHz to 4 MHz
Transducers	Typically Ø10-25mm ceramic discs (beam width according to frequency), with other optional configurations
Transducer arrangement	4 fixed individual 4-metre cabled transducers
Gain	Software controlled transmitter and receiver gain adjustment
Range	150 cm (typical), up to 10 m below 2 MHz depending on options
Transmitted signal	1 W rms typical transmit CW pulse, pulse length to match cell size
Transmission rate	128 Hz max pulse rate for each frequency (i.e. 512 pulses per second for four), subject to acoustic range limits. Minimum rate 1 Hz for calibration
Data averaging	Cell ensembles averaged over time by powers of 2 up to 64 before storage
Range cells	256 cells. 10 mm standard (at 1500 m/s speed of sound). Options for 2.5 mm, 5 mm, 20 mm and 40 mm. Start/end range set by software
Burst duration	Defined by number of profiles requested
Burst trigger	Either external hardware trigger when required or internal software trigger at regular intervals
Burst interval	Internally generated from once every minute to once every 255 minutes, user definable start time of first burst
Trigger output	A digital output allows triggering of external instruments
Power requirement	12 V power supply.
Additional sensors	Cabled temperature, pressure, turbidity
Disk storage	Compact Flash (proprietary format). 8 GB standard
Data comms	RS232 up to 115 kbaud, USB 1.1 typically 2-3 Mbaud
Housing options	Plastic IP68 weatherproof instrument case
Software	AQUA*talk* ® for AQUA*scat* ® for logger interaction AQUA*scat* ® toolkit for data processing

AQUATEC