The AQUAscat 1000 Acoustic Backscatter System

The AQUAscat 1000 represents a new generation of high frequency acoustic instrumentation. It has applications in sediment transport studies, including measurement of suspended sediment profiles, ripple bed morphology, precision altimetry, dredge plumes and turbulence.

The AQUAscat transmits pulses of high frequency sound on up to four transducers, each of which may operate at a different frequency. It measures the sound scattered by sediment or other suspended materials at discrete spatial intervals programmable from around 2½ millimetres to several centimetres. For altimetry, this may span a few tens of centimetres; for monitoring sediment suspension profiles, a total range of around 1-2 metres is typical; while dredge plume estimation may extend to 20 metres.

The instrument may be supplied in a subsea housing suitable for long-term unattended deployments. There is also a laboratory version of the instrument, supplied in a bench-top instrument case. Batteries for various deployment schedules are available to order.
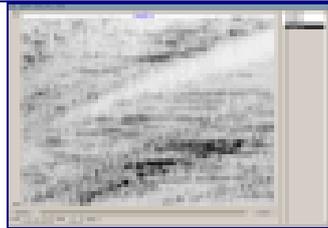
Specification

Sediment Range	Typically 20 μm to 2000 μm radius 0.1 g/l to 20 g/l over 1 m, or more over shorter range
Frequencies	Up to 4 frequencies, from 500 kHz to 5 MHz
Transducers	Typically Ø10-20mm ceramic discs (beam width according to frequency), with other optional configurations.
Transducer Arrangement	AQUAscat 1000S: 4-frequency transducer head integral to housing; Other models: individual cabled transducers
Gain	Software controlled gain adjustment and various TVG gain profiles
Range	150 cm (typical), up to 20 m below 2MHz depending on model.
Transmitted Signal	1 W rms typical transmit CW pulse, pulse length to match cell size.
Transmission Rate	100 Hz max pulse rate for each frequency (i.e. 400 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, 20mm 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 2 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 10 days continuous use. External battery packs available according to deployment needs.
Additional Sensors	Temperature: 0-25°C standard, ±0.05°C, resolution <0.0015°C Pressure: Choices to 100 bar, ±0.2%FS, resolution 0.005%FS Turbidity: Optional remote turbidity sensor Other: Connect up to two external sensors.
Disk Storage	Compact Flash (proprietary format). 4GB standard. Up to 8GB option.
Data Comms	RS232 up to 115 kbaud; USB 1.1 typically 2-3 Mbaud
Housing Options	1000m aluminium alloy housing for subsea systems Steel bench-top instrument case for AQUAscat 1000L

AQUAscat transducer head

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Software and Services

AQUA*talk* Software	AQUA*talk* is a Windows application included with the system at no additional cost. It provides a control and data transfer interface to the ABS data logger. It provides the following functions: ● *Review and set logging parameters* ● *Review and set internal logger clock* ● *Control logging applications* ● *Upload stored data* ● *Display real time data*
AQUA*view* Software	AQUA*view* is a Windows application, also included at no additional cost. It provides the following functions: ● *Graphical display of profiles (sets of echo sounder traces)* ● *View the auxiliary channels.* ● *Export of data to spreadsheet compatible formats*
MATLAB® Toolkit	Set of MATLAB® functions for importing, calibrating and processing AQUA*scat* data. These can be customised by the user to meet their requirements.
Training	We can provide technical training sessions either at our UK facilities or at customers' sites.

Ordering Guide

For full details of the various options available, please refer to our application note AN3: Specifying the AQUA*scat* System. There are 3 basic models – the 1000L **L**aboratory model, the 1000S **S**urvey model, and the 1000R **R**esearch model. The table below highlights the main differences.

Feature	AQUA*scat* 1000R	AQUA*scat* 1000S	AQUA*scat* 1000L
4-frequency electronics	✔	✔	✔
1000 m pressure housing	✔	✔	✘
Bench housing	✘	✘	✔
3 individual transducers	✔	✘	✔ (BNC Connectors)
4-frequency uni-directional transducer head	✘	✔	✘
4th transducer	Option	N/A	Option
Calibrated temperature sensor	✔	✔	✘
Calibrated precision pressure sensor	✔	✔	✘
Medium capacity internal battery	✔	✔	✘
Mains power supply	✔	✔	✔
Range/resolution combinations	All	1 + Options	1 + Options
Storage (Compact flash card, proprietary format)	8GB	4GB or Options	Option
USB cable	✔	✔	✔
Trigger cable	Option	Option	BNC
Power cable (external battery)	Option	Option	N/A
RS232 cable	Option	Option	✔ (lab)
1 year parts & labour return-to-base warranty	✔	✔	✔
30 days limited support contract (conditions apply)	N/A	✔	✔
1 year technical support contract (conditions apply)	✔	Option	Option
AQUA*talk* software	✔	✔	✔
AQUA*view* software	✔	✔	✔
Matlab Toolkit	✔	Option	Option
Transit case	✔	✔	✘
Spares kit	✔	✔	✘

Background

The use of acoustic backscatter (ABS) techniques to measure suspended sediment dates back to the 1980s (Young *et al*, 1982 and Hay, 1983). In 1992, a method of particle size measurement by combining data from a 3-frequency ABS instrument was described (Hay and Sheng, 1992). Also from the early 1990s, detailed analyses of the acoustic backscatter properties of various suspended sediments were carried out by Thorne and others (various dates), allowing more accurate approaches to instrument calibration.   In 1992, Aquatec first started developing data logging systems to cope with the high data volume produced by the ABS instrument. Since 1996, we have manufactured ABS instruments (AQ174, AQ278) based on electronics developed by the UK Ministry of Agriculture, Fisheries and Food (Pearson and Thomas, 1991). In 2001, with obsolescence of the original electronics, we returned to first principles, to design a new acoustic instrument capable of dramatically improved performance.

The AQUA*scat* 1000 is the latest evolution of this technology. It has a broad band signal input, which is acquired digitally at a very high sampling rate. It is then digitally down-converted to the bandwidth of interest. This data contains amplitude information and may also be analysed for frequency (e.g. Doppler shift) information. The ABS has greater sensitivity to coarser, sandy suspensions than optical back scatter (OBS) instruments such as the AQUA*logger* 210TY, which are more sensitive to fine, muddy material. Neither instrument directly establishes the sediment concentration because the backscatter is also a function of grain size and shape. However, the use of multiple frequencies allows good estimates of particle size distribution to be made. Calibrations may be carried out in laboratory conditions using samples of actual seabed material from a deployment site.