The AQUA*scat* Acoustic Backscatter System

The AQUA*scat* represents a new generation of high frequency acoustic instrumentation. It has applications throughout the field of particle transport studies, including measurement of suspended sediment profiles, ripple bed morphology, precision altimetry, biomass and turbulence.

The AQUA*scat* transmits pulses of high frequency sound on up to four different 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 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 metre is typical; while ripple bed monitoring or biomass estimation may extend to many 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 watertight briefcase. Batteries for various deployment schedules are available to order.

AQUA*scat* Technical Specification

Frequencies	Up to 4 frequencies, up to 5 MHz
Transducers	Typically Ø10mm ceramic discs (beam width according to frequency), with other diameters available for narrower or wider beam width, and rectangular elements for 'sidescan' use
Gain	Software controlled – overall gain adjustment and various TVG gain profile selections
Range	128 cm standard. Other ranges optional
Transmitted Signal	1W transmitted pulse, various pulse lengths and types optional
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 4Hz, or optionally 1Hz for calibration
Data Averaging	Cell ensembles averaged over time by powers of 2 up to 64 before storage
Range Cells	10mm standard. Options include 5mm, 2.5mm, and from 20mm to 160mm. Start and end range cell set by software
Trigger	Either external hardware trigger when required or internal software trigger at regular intervals
Logging Period	From 1 to 60 minutes
Automatic Logging	From once every 2 to once every 255 minutes
Trigger Source	A digital input allows logging of different trigger events
Power Requirement	10V to 28V dc. Typically 2W when logging, 4W when writing to disk, and with standby current of typically 400µA when not logging. Battery packs can be supplied according to deployment characteristics
Extra Channels	Up to six additional analogue channels and temperature may optionally be monitored
Data Acquisition	16-bit storage resolution; 75ksps (~1cm) standard spatial resolution 300ksps (~2.5mm) highest spatial resolution
Memory	1Mb x 16, representing approximately 2500 averaged three-frequency profiles at 1cm resolution
Disk Storage	Any 2.5" notebook style IDE hard disk – typically 10GB minimum
Data Comms	RS422 up to 115kbaud; USB typically 2-3 Mbaud
Housing Options	100m plastic housing, 1000m Al alloy housing or IP68 briefcase-style lab housing. Batteries or external power supplies in separate housing. Transducers on individual cables.

3 frequency AQUA*scat*

AQUA*scat* transducer

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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*

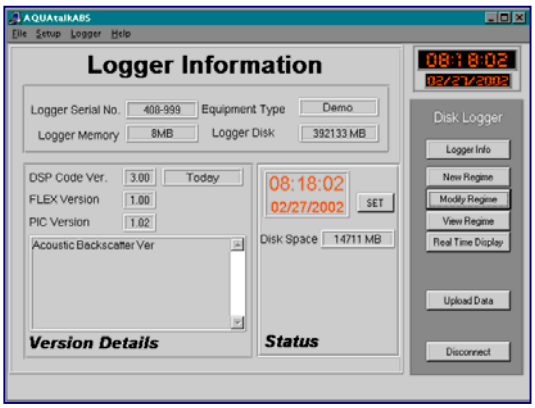
AQUA*view* Software

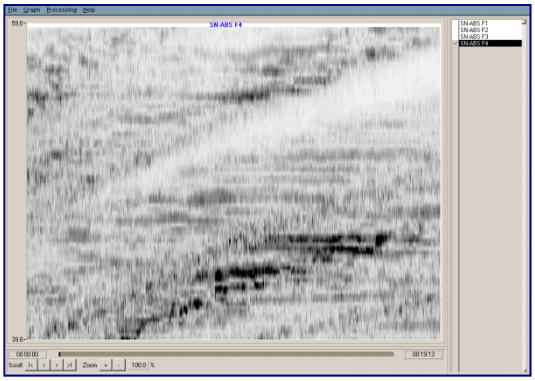
AQUA*view* is a Windows application also included at no additional cost. It provides the following functions:

- *Display of data file header, containing configuration*
- *Graphical display of profiles (sets of echo sounder traces)*
- *Export of data to spreadsheet compatible formats*

Analysis Software and Calibration

Some users have developed analysis software. Analysis modules to operate with AQUA*view* are also currently under development. Calibration facilities are also available through other users, and Aquatec can provide calibration of instruments with standard sand, or customers own samples if required.





AQUA*talk* (top) and AQUA*view* with Sidescan display

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. Around this time, Aquatec first became involved in developing data logging systems to cope with the high data volume produced by the ABS instrument. Since 1996, Aquatec has manufactured ABS instruments (the AQ59, and then the AQ278) based on electronics technology 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 new AQUA*scat* 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. So for the traditional backscatter approach, where the signal is monitored in 1cm spatial increments, the data is down-converted to a 75 ksps base-band data stream. This contains the same amplitude information as the original rectified and filtered signal, which may also be analysed for frequency (e.g. Doppler shift) information. However, the signal may also be down-converted to much higher rate data streams, allowing for sub-centimetre spatial resolution.

The ABS has greater sensitivity to coarser, sandy suspensions than optical back scatter (OBS) instruments such as the AQUA*logger* 200TY, 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.

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