Data Sheet

Acoustic Systems Trainer – SONAR Mk X

DESCRIPTION:

The study of sonar principles and techniques are as demanding as the study of radar. Sonar is the underwater equivalent of radar, and like radar its functions are many and varied. These include the detection, identification, location and speed indication of 'targets of interest'. There are basically two sonar modes of operation, 'passive' (receiving or listening) and 'active' (transmitting and receiving).

Until recently, the investigation of sonar principles has required large expensive test facilities, or costly commercial sonar systems requiring time consuming preparations. These facilities are not always oriented to hands-on work, leaving a great deal of practical study and research unaccomplished.

Introducing the Acoustic Systems Trainer (AST) for Education and Research. The AST is a fully instrumented system for use in the investigation of sonar principles, and exploration of under-water acoustics. The AST is an ideal test bed for acoustic studies, producing accurate results, and parameters representative of larger test facilities at a fraction of the cost and setup time. The AST includes a full set of courseware, and a range of application based hands-on exercises, covering-

- **Active SONAR**
- **Passive SONAR**
- **CTFM SONAR**
- **The Doppler effect**
- **Active target profiles**
- **Single element transducers**
- **Acoustic noise jamming (ASW)**
- **Thermal effects**
- **Beam formation and steering**
- **Passive target FFT spectrograms**
- **Resonant frequency responses**
- **Transducer beamwidth**
- **Volume scattering**
- **The speed of sound in water**

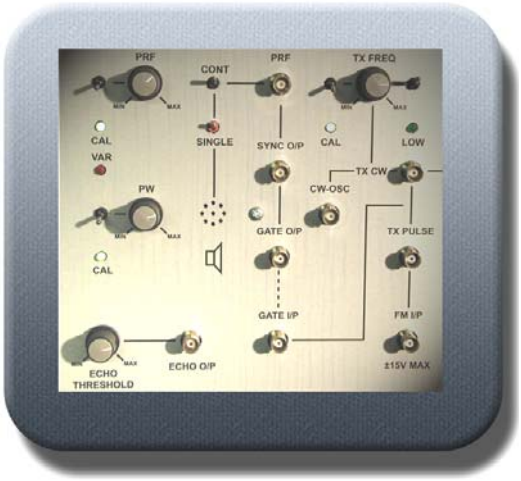
…and more

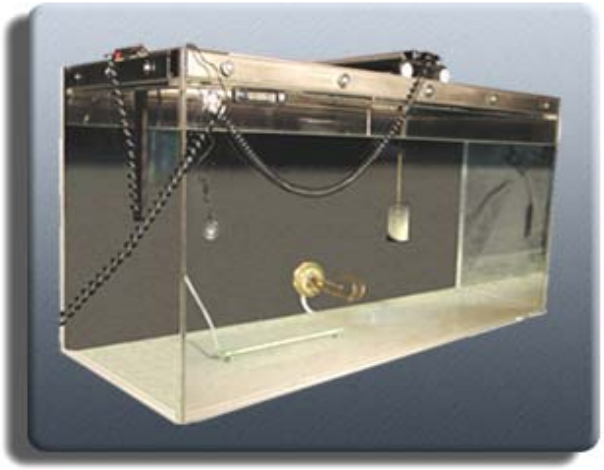
Originally designed to meet the hands-on training requirements of the Royal Navy's SONAR curriculum, the AST is now being used around the World in Physics and Marine laboratories, for underwater acoustics research and development.

For R&D work, a range of variable electronic parameters such as PRF, Pulse Width, TX frequency, and phase outputs, can all be adjusted to optimal settings for the task at hand. For education, calibrated settings, and menu driven assignments with default opening screens make the AST the perfect solution for your underwater acoustics training courses.

The AST's operational parameters have all been scaled to the appropriate specifications, such as and increase in frequency of operation (hence a shorter wavelength), and the subsequent reduction in the dimensions of the acoustic tank, lower power requirements in the active sonar mode, and a PC interface with software to perform the signal analysis.

The system is comprised of a control Console housing the CW and Pulse gating electronics, which can all be adjusted to the required parameters, or switched to a pre-calibrated mode. The console also includes full signal conditioning, and software processing (SONAR Signal Analyzer – SSA) interfaced with the computer through a parallel or USB port.

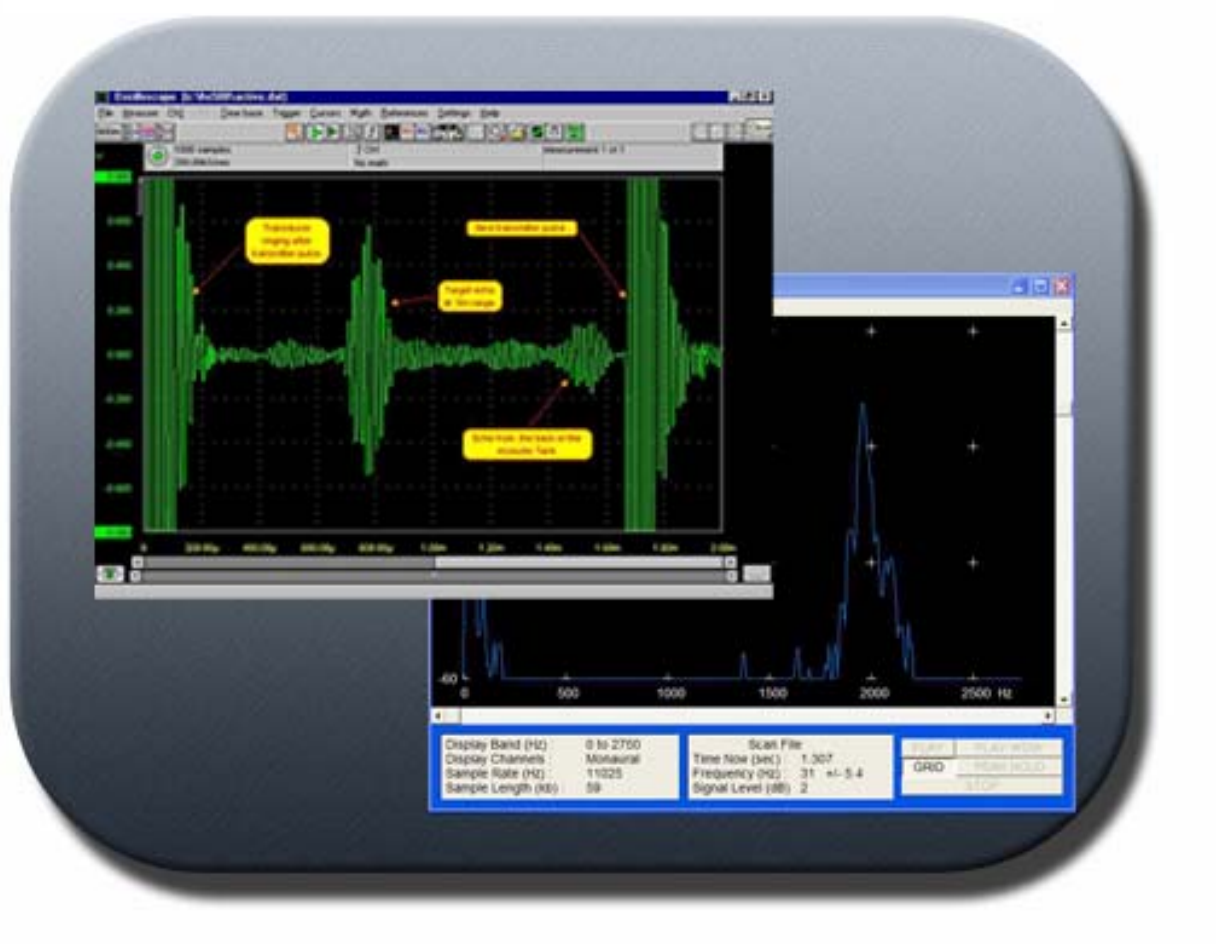




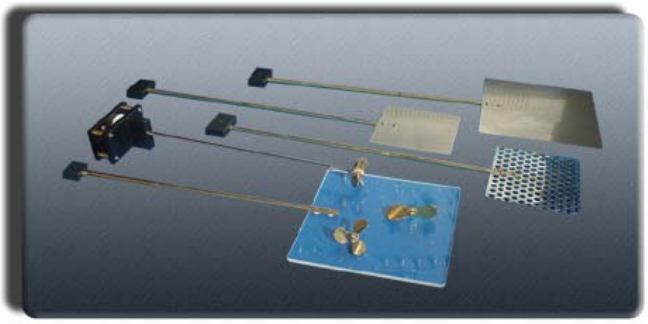
The bench mounted, transparent acoustic tank, is constructed from acrylic material measuring just over 4' in length, 2' wide, 2' deep (120 x 60 x 60 cms) and can hold more than 85 gallons (approx 380 liters) of water. An integral heating element allows the temperature to be raised to allow a demonstration of sound speed vs. temperature. The active and passive targets are removable, reconfigurable, and are mounted on an automated target transport system with protective electronics, for the safety of the operator and the system.

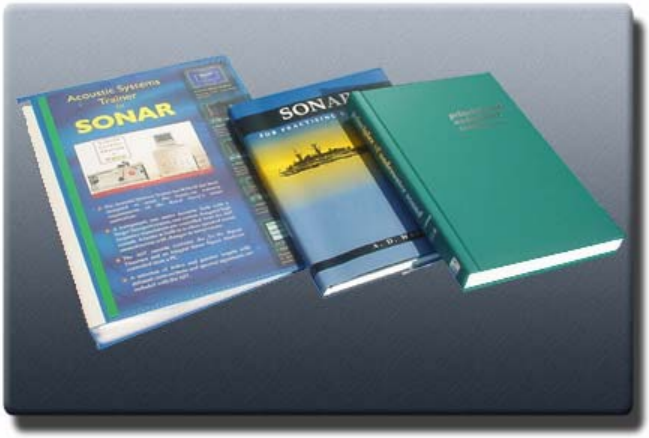
Narrow beam width, high frequency transducers are used, all calibrated by the National Physical Laboratory in the UK. A transducer array allows for beam interaction to be clearly shown.

The powerful PC based virtual instrumentation, which is an integral component of the Sonar Signal Analyzer, incorporates conventional instrument controls for an Oscilloscope, Spectrum Analyzer, Transient Recorder, Digital Multi-meters and an Arbitrary Waveform Generator. All optimal settings are pre determined during start up of the menu driven assignments. Extra drivers can be provided to interface this instrument to LabVIEW from National Instruments.



Several target profiles are included with the AST for demonstrations of Target Echo response, Stealth Techniques, Beam Deflection, and Propeller Target Signatures, in both Active and Passive Modes. Targets are easily positioned at various ranges and angles in the Acoustic Tank.





A full set of curriculum course material is provided, with examples of typical system responses, and technical notes related to the hands-on experiments. A recommended list of published material is also included, to enhance learning, and research.

FEATURES:

The AST features real-time operation of a SONAR system, and uses an Integral Sonar Signal Analyzer, specially designed to provide full interaction between the operator, and the signals produced by the AST.

Software: Signals are monitored via two, menu driven, software applications providing time and frequency responses, showing Active and Passive Sonar signals simultaneously. Signals can be annotated, saved, printed and analyzed.

Transducers: High frequency transducers can be reconfigured to meet the needs of the experiment at hand. For development work, drive circuits on the AST Console provide variable settings of Frequency, PRF, Pulse Width, Phase Control and Transport System speed.

Targets: A selection of passive and active targets is supplied to demonstrate target signature responses when processed by the software.

Acoustic Tank and Console: The bench top, transparent acoustic tank, and AST console are of robust construction, using quality components to withstand the wear and tear of lab use.

CURRENT USERS:

The AST was officially launched into the US market during the IEEE sponsored Oceans conference in October of 2002. This conference was a meeting of Oceanographic instructors and officials from Universities, Military and Commercial institutions around the world. The AST drew interest from many officials and educators as a unique and innovative product. As a result of this event the list of users is still growing, below is a condensed list of several establishments. If you would like contact information please let us know, a number of these users have very kindly agreed to act as a reference.

- Royal Navy - HMS Daedalus at Sultan, UK
- Royal Navy - HMS Collingwood , UK
- Britannia Royal Naval College – Dartmouth, UK
- University of Texas – Galveston, USA
- United States Naval Academy
- Royal Saudi Naval Academy - KSA
- Singapore Navy ASW Training
- Royal Norwegian Navy

REFERENCES:

Military Training and Simulation News: Training for ASW Operations

"One of the most innovative basic ASW training systems to appear on the market over recent years has been the Acoustic Systems Trainer (AST) for SONAR"

HMS Collingwood, Systems Engineering Group

"The Acoustic System Trainer is now a highly valued and productive training aid within our facility and we would strongly recommend it to any training organization."

Texas A & M University at Galveston,TX. Marine Systems Engineering

"The AST is an excellent demonstrator of underwater acoustics in a controlled and safe laboratory setting. My students appreciate having the ability of seeing the theory from the lectures demonstrated in the lab."

University of Plymouth, England. Marine Engineering-Extract from Degree Dissertation

Publication in The Hydrographic Journal, issue No.99, January 2001. Using AST Reflection of Sound from Submerged Plates and Bottom Backscatter in Shallow Water.

Acoustic Systems Trainer-SONAR

Ordering Specifications

The equipment should be of bench top design complete with, Acoustic Systems Trainer (AST) console, PC Sonar Signal Analyzer (SSA) virtual instruments, PC software, acrylic acoustic tank, target transport system, a selection of active/passive targets, reversible conical beam transducers, detector, cables, connectors and accessories.

The AST should be a two-student station, or configurable as an instructional demonstrator, or an underwater development platform for degree level studies at university.

The following system features should be incorporated in the AST:

- Real-time operation
- Safe, low power, low voltage operation
- Two channel Integral Sonar Signal Analyzer, digital oscilloscope, spectrum analyzer, multi-meters, transient recorder, arbitrary waveform generator
- All signals to be available at monitor points
- Menu driven software
- Print out of captured signals
- High frequency, narrow beamwidth transducers
- Active and Passive targets
- Variable speed, auto/manual reversing, target transport system
- Bench top transparent, acrylic, acoustic tank with heater

The minimum topic coverage should include:

- Familiarization with the SSA PC data acquisition virtual instruments.
- Passive SONAR
- Active SONAR
- Temperature effect on the speed of sound in water
- Single Transducer Beamwidth measurement
- Single Transducer Beam Plot
- Three Element Transducer Array
- The Doppler effect
- Volume Scattering
- Acoustic Noise Jamming

Acoustic Systems Trainer (AST) Console

The AST console should provide access to the Sonar Signal Analyzer (SSA), CH1, CH2, and the signal Generator via BNC connectors. The SSA should operate as an 8bit resolution, dual channel digital sampling oscilloscope with 1µsec to 600sec timebase, a spectrum analyzer with .001Hz to 50MHz range, and 100 harmonics measuring feature, six programmable digital meters, a transient recorder with >30,000 measuring points, and should include a 14-bit resolution arbitrary waveform generator with sweep capability.

It should also contain the CW oscillator with switchable High and Low frequency ranges, the high range must be variable across the resonant frequency of the reversible transducers at 192 kHz, with a variable amplitude gain control

The AST must have a variable and calibrated PRF/PW output, IN/OUT GATE, SYNC, and TX CW output, all on BNC type connectors. The PRF, PW, CW OSC should be available at BNC monitor points.

Three outputs should be provided for driving the transducers from TX1, TX2, TX3, with variable gain controls on each BNC output. TX2, and TX3 should have independent variable phase controls over the range 0-140 degrees minimum, and should be switch configurable in tandem, to allow beam steering experiments.

The CW OSC should be able to operate in the continuous or the single shot mode, with audible indication of single shots.

An FM input should be provided to enable the CW OSC output to be controlled by an input voltage between +15 and –15 volts dc, or by a variable frequency input drive.

A three input aux amplifier with BNC connectors is required to amplify the Doppler signals and to drive a detector module. This amplifier should have a variable gain control.

Three independent fixed gain amplifiers are required for transducer buffering and development studies.

A variable target speed control should produce the required dc drive power for an auto reversing target transport system.

A block diagram of the system electronics should be silk screened on the AST panel.

Provision should be made for the SSA to connect via a USB2 to a PC with Windows XP/VISTA O/S.

The Acoustic Tank

The acoustic tank should be constructed of 15mm and 12 mm acrylic material, with re-enforced stainless steel rails around the top, inside perimeter.

The tank dimensions should be 1,200mm (L), 600mm (W), 600mm (D).

The tank should have an integral 3kW heater, thermostatically controlled and positioned at the center, bottom, back of the tank.

Transducer slide rails should be secured on the left and the right sides of the tank and these should be of Delrin composition.

Two traction, guide rails should be provided to accommodate the target transport system.

The Target Transport System

The variable speed target transport system must be able to support at least two active targets, one passive target, or one beamplot transducer, it should be driven by a low voltage, 12v dc motor, with manual and auto reversing electronics, and a power off/on switch.

The target transport system should be constructed mainly of Delrin composition material.