Fully Reelable Towed Array Systems for SSK Submarines

Steven Ray, Product Manager, ATLAS ELEKTRONIK UK Ltd

Frank Bernhardt, Product Manager, ATLAS ELEKTRONIK GmbH

Abstract

A towed array sonar offers numerous operational benefits to a submarine platform over hull mounted sonar systems. The ability to isolate self-noise by separating the sensor from the platform significantly improves the ability to detect low frequency acoustic signals. Previously the diameter of the towed array has driven SSK platforms to use a clip-on configuration to provide a Towed Array capability. The clip-on configuration however comes with an impact to the platform manoeuvrability that limits the options available to the platform command.

The ATLAS ELEKTRONIK GmbH Thinline Towed Array coupled with the ATLAS ELEKTRONIK UK Electric Towed Array Handling System (eTAHS) offers the next generation of technology to submarine operating nations. The ATLAS ELEKTRONIK GmbH Thinline Towed Array uses a modular approach that enables different length array configurations to be built from unified modules. The ATLAS ELEKTRONIK UK eTAHS provides a low power, quiet, electric drive handling system that will safely deploy and recover the towed array on command.

These developments in both towed array technology and towed array handling systems now enable fully reelable towed array options to be conducted from SSK platforms

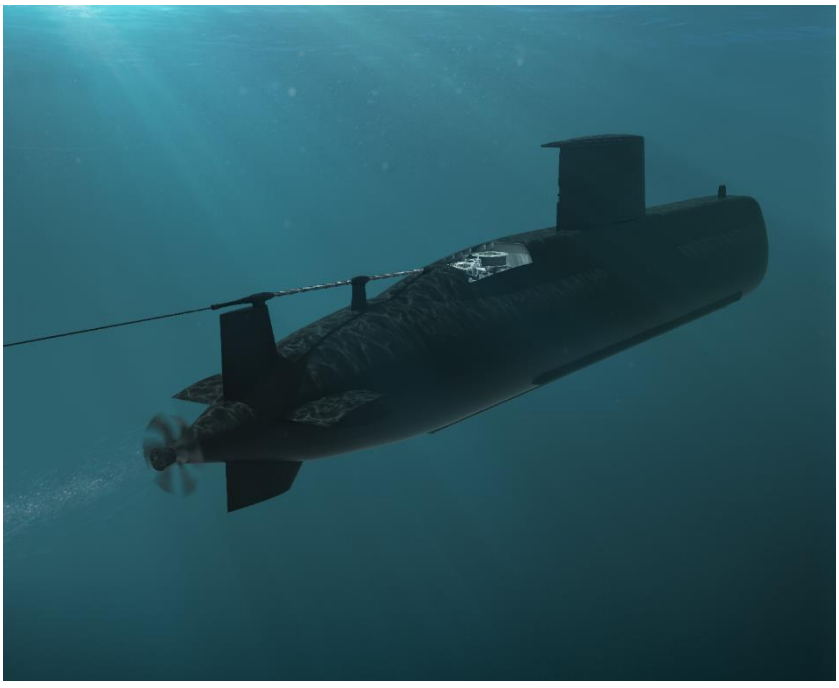

Figure 1 – HDW Class 209 SSK fitted with ATLAS ELETRONIK Thin Line Towed Array (TLTA) and Electric Towed Array Handling System (eTAHS)

Introduction

A Towed Array Sonar (TAS) is unique within a submarine's sonar suite, as it is not located on the hull of the submarine, but streamed astern of the towing vessel. This provides it with two distinct advantages over hull-mounted arrays:

- Its length is not constrained by that of the submarine, meaning that it can be designed to operate at lower frequencies providing long-range detection as well as low frequency classification;
- It is isolated from any self-noise of the submarine, reducing the noise level in which it operates and therefore providing an increase in detection performance in terms of signal to noise ratio.

The benefits achieved by the integration of a TAS, such as enhanced long-range detection capability, increased sensor gain and directivity, cannot be matched by other, hull-mounted sensors. This capability enhancement is especially beneficial for submarines that engage in both littoral and blue-water operations.

A towed array (TA) can be mounted in two different ways. Clip-on variants are the preferred option when there is only limited space available on the platform. Previously TAS refit solutions for small SSK platforms have been implemented as clip-on configurations for this reason; however, this configuration imposes operational and navigational limitations that are not always acceptable.

The preferred option is to install the TA on a fully reelable winch system.

A fully reelable eTAHS allows a submarine to leave its berth and submerge before transiting to its operational area. During the mission, it can deploy and recover its TA without suspending other operational tasks. The submarine can then benefit from the superior detection capabilities of the TLTA, providing a significant enhancement to its situational awareness, with the accompanying tactical advantages over less well-equipped adversaries.

Upon transit phases or operation within constrained shallow water environments, it is possible for a fully reelable TAS to be quickly and easily recovered at the discretion of the submarine commander. The flexibility of deploying and recovering the TA depending on the operational requirements bring out the true benefit of a TAS combined with the versatility of a SSK.

The new **ATLAS ELEKTRONIK Thinline Towed Array (TLTA)** in combination with **the Electric Towed Array Handling System (eTAHS)** now provides a compact TAS solution to equip class 209 submarines with state-of-the-art sonar capabilities; a challenge that was previously not thought achievable due to the small size of the platform. This capability can be integrated at build or as part of a re-fit/upgrade programme.

ATLAS ELEKTRONIK GmbH Thinline Towed Array

The ATLAS ELEKTRONIK Thinline Towed Array (TLTA) is a new design of modular linear array with approx. 38 mm in diameter. It is composed of multiple unified sections (US) of approx. 40 m length each, which can be connected to assemble arrays of various acoustic lengths.

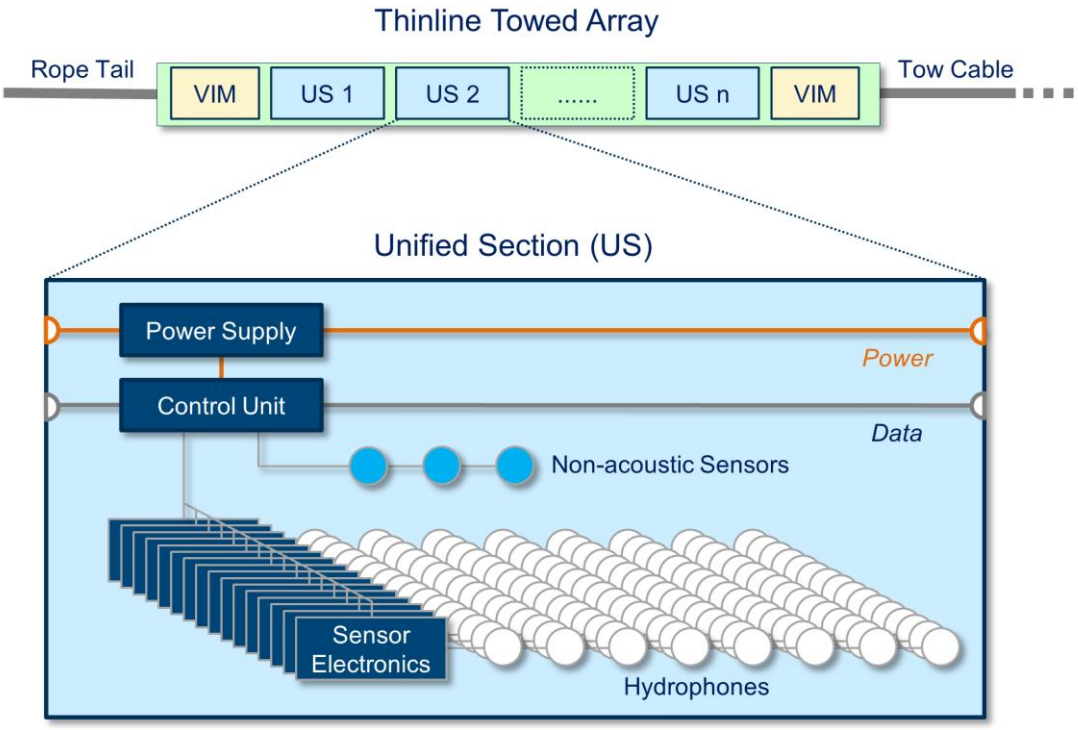

Figure 2 – The Thinline Towed Array holds a configurable number of Unified Sections

All unified sections are identical and equipped as linear arrays with equidistant hydrophone spacing. The individual sampling of every single channel enables the highest flexibility in the beamforming process and enhances especially the high frequency directivity in contrast to nested array designs. The modular concept of unified sections allows easy maintainability and high availability of the array.

In addition to the unified sections, the array comprises: a rope tail to stretch the array; two Vibration Isolation Modules (VIM) fore and aft of the acoustic section to reduce mechanical vibrations; and a neutrally buoyant tow cable for power supply, optical data transfer and connection to the platform. The distance from the towing platform ensures separation from any noise generated by the own boat, maximising SNR and thus enabling detection even of quiet targets such as opposing SSKs or airborne threats like MPAs or helicopters.

The TLTA can, due to its modularity be equipped to almost any submarine, whether new build or retrofitted, matching different customer demands. It can be installed either as a clip-on solution or on a fully reelable towed array handling system such as eTAHS. For HDW Class 209 submarines, acoustic lengths of more than 150 m are achievable on eTAHS, depending on the individual platform type and design. Larger submarines such as HDW Classes 212A or 214 can in fact accommodate larger arrays with acoustic lengths of more than 300 m to achieve an even higher directivity and signal-to-noise in the low frequency domain.

Within the signal processing, a Towed Array Shape Estimation (TASE) is implemented to address any non-linear shape within the TLTA caused by own boat manoeuvres. With the aid of TASE, detection is still possible during own boat manoeuvres. Adaptive Beamforming ensures detection of weak signals even in the presence of strong noise sources and significantly improves target separation in high traffic areas. Additionally, data from hull-mounted sensors such as cylindrical array (CAS) or flank array (FAS) can be combined with TAS bearings in the sonar track management, resulting in a much faster and more reliable cross-bearing target motion analysis (X-TMA).

ATLAS ELEKTRONIK UK electric Towed Array Handling System (eTAHS)

The purpose of a Towed Array Handling System is to safely store, deploy, tow and recover a TA. To achieve this precise control and synchronisation of the system elements, particularly the winch, spooler and deployer is required. Unlike other systems that suffer hysteresis or lag and rely on external sensors, the ATLAS ELEKTRONIK electric Towed Array Handling System (eTAHS) uses direct drive electric motors coupled with a closed loop control system. This provides the precision control and feedback necessary to deliver a compact eTAHS that can deploy and recover a TA safely under all conditions on platforms as small as the HDW Class 209 submarine.

The key outboard components for the eTAHS are shown in Figure 3

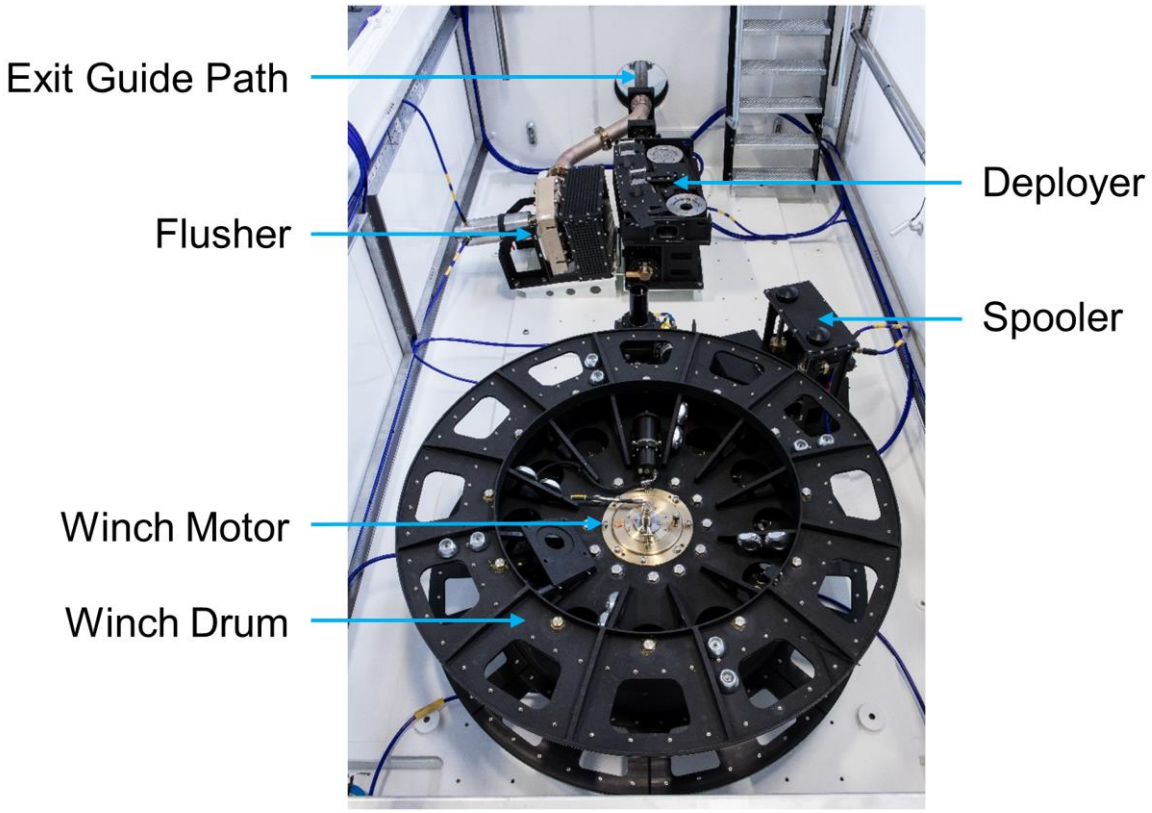

Figure 3 – eTAHS Outboard System Components

Winch Motor and Winch Drum – provide the main system elements that deploy or recover the TAS. The TAS is layered onto the winch drum for storage. The size of the winch drum is optimised for the space under the casing of the HDW Class 209 submarine; depending on the respective type of 209, it can hold a tow cable of approximately 200 m plus a TLTA with an acoustic aperture of more than 150 m.

Spooler – controls the layering of the TAS on the Winch Drum during both deployment and recovery operations. The spooler is synchronised to the Winch operation to ensure that the packing arrangement on the drum will accommodate the full length of the TAS without any slack.

Deployer – manages the tension in the TAS. The deployer controls the tension between the winch and the outboard drag. It is the key system element to ensure a safe reeling operation with a minimum of mechanical stress to the TAS.

Flusher – provides a water flow through the exit guide path to reduce the friction within the guide path during deployment operations.

Exit Guide Path – provides a low friction route from the winch space to the top of the rudder on the platform to allow deployment of the TAS into the sea. The end of the exit guide path has a bend limiter fitted to prevent TAS damage during platform manoeuvres when the TAS is deployed.

Operator control - is provided inboard of the platform from either a standalone Display and Control Unit (DCU) or the platform command and control system. The standalone option can be either a dedicated operator station or a laptop based solution. Different operating modes are available to the operator (automatic, semi-automatic, manual) to allow increasing level of operator interaction.

Platform Integration

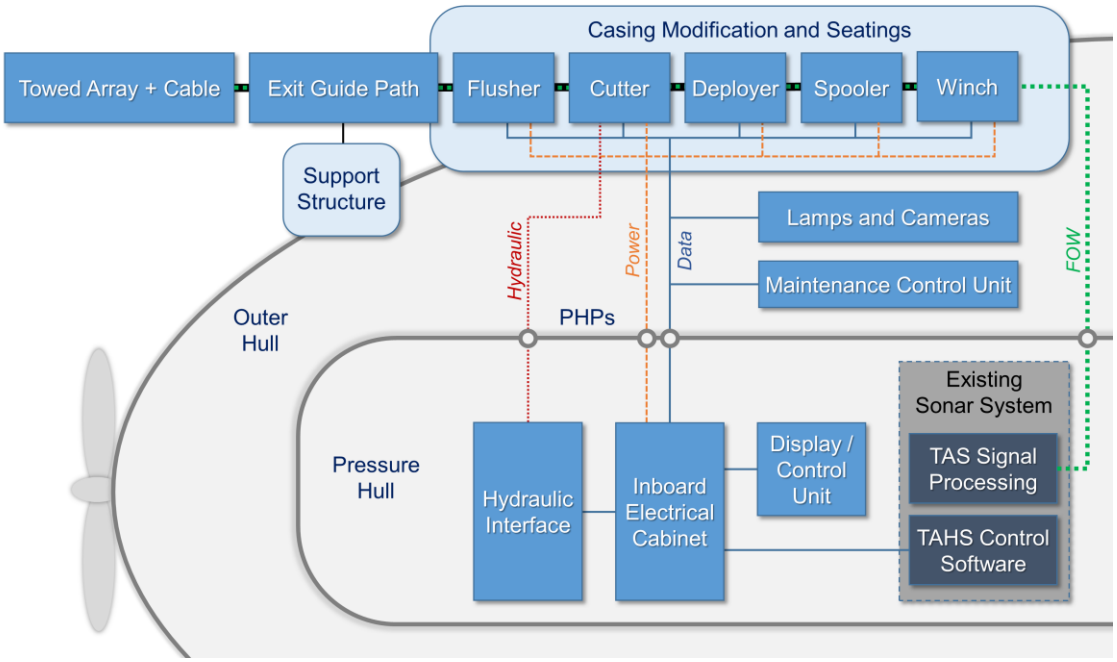

Figure 4 – Block Diagram showing Equipment Configuration on the Platform

The eTAHS comprises of inboard, outboard and deployment path components. The Inboard components are located within the Pressure Hull and include an Inboard Electronics Cabinet (IEC) and an interface to the hydraulics supply. Command and control is provided either from the host platform command and control system or a standalone eTAHS control unit. The Outboard components are mounted on the Pressure Hull in the free flood Winch Space under the Casing. The Deployment Path components are mounted above the Casing and provide a safe deployment route for the TA.

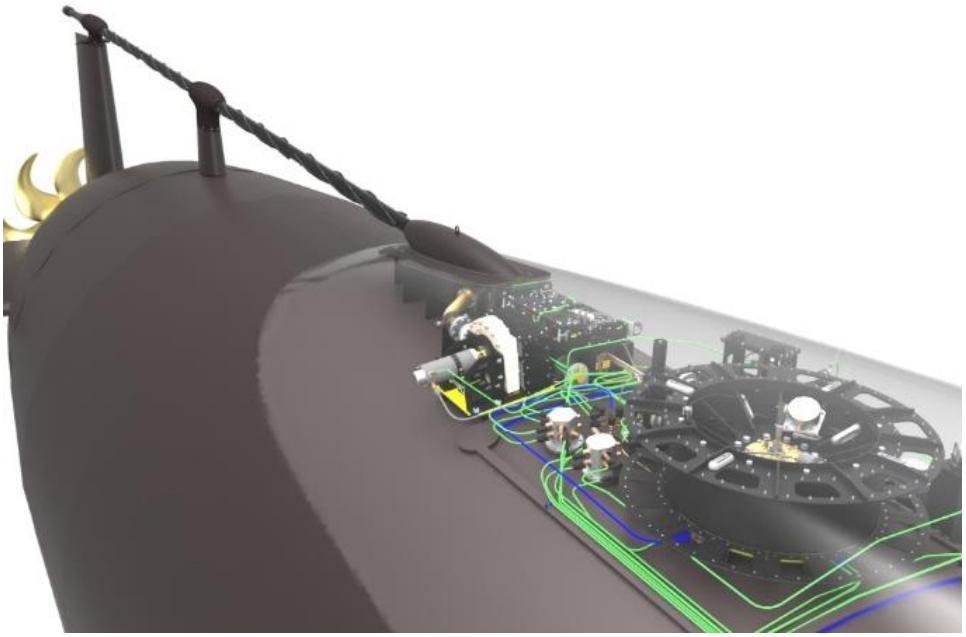

Figure 5 – Outboard Equipment Installation on the HDW Class 209 SSK

The eTAHS and TLTA are installed in 3 phases:

1. Hot work for mountings and casing modification
2. Equipment Installation of eTAHS
3. Set To Work (STW) and Loading of the TAS

During the hot work phase of the installation all equipment mounting are installed and the necessary modifications to the casing structure are completed. After the equipment installation, all of the eTAHS and Sonar systems are tested during the STW and loading phase tests. The eTAHS is operated through a simulated loading operation and deployment before the actual TLTA installation. This phase culminates in the loading of the TLTA and testing of the sonar data path through to the command and control console. At this point the ATLAS ELEKTRONIK TLTA and eTAHS system are ready for at sea operations.

PICTURE

Figure 6 – eTAHS Installation on a HDW Class 209 SSK

Conclusion

Many Naval operations have clearly demonstrated the operational advantages and through-life cost benefits of fully reelable towed array systems. The new designed TLTA and eTAHS by ATLAS ELEKTRONIK build on the solid experience of more than 40 delivered towed array systems to various customers in the past 20 years. The successful miniaturisation and modularisation of sea proven technology provides a new towed array capability for upgrade and modernization of HDW Class 209 submarines as well as new build projects.

This highly effective upgrade results in a significant enhancement of operational performance against quiet targets such as opposing SSKs or airborne threats.