SUBSEA CONSTRUCTION

APOS, SUBSEA CONSTRUCTION AND SURVEY

KONGSBERG

MAXIMIZING PERFORMANCE BY PROVIDING

THE FULL PICTURE

OUR MISSION

We shall earn the respect and recognition for our
dedication to provide innovative and reliable marine
electronics that ensure optimal operation at sea.
By utilising and integrating our technology, experience
and competencies in positioning, hydroacoustics,
communication, control, navigation, simulation, and
automation, we aim to give our customers
The Full Picture.

The Full Picture yields professional solutions and global
services that make a difference enabling you to stay ahead
of the competition.

OUR PHILOSOPHY

Our success depends on the success of our customers.
Actively listening to our customers and truly understanding
their needs, and then translating these needs into
successful products and solutions is central to achieving
our goal.

Our people are the key to our success and we empower
them to achieve. Working together in a global network of
knowledge, guided by our values, engenders innovation
and world class performance. Every day we have to think
a little differently, because every client is unique. We aspire
to translate the imagination and dedication of our staff into
successful technologies and solutions. Our commitment is
to add value to your operations by providing you with The
Full Picture.

CONTENTS

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SUBSEA CONSTRUCTION AND SURVEY

HIGH PRECISION SUBSEA POSITIONING SYSTEM
KONGSBERG provides surveyors with a Full Picture suite of integrated acoustic and inertial positioning solutions including SSBL, optimized SSBL, Sparse LBL, LBL, Multi user LBL and Inertial with HAIN. KONGSBERG have addressed the challenge to position more accurately in deep water, extending the limits of SSBL, before reverting to full LBL. This affords extremely efficient use of vessel time and gives real operational costs savings.

By maximising the capability of the vessels HiPAP and realizing the cost benefits of using the permanent fit acoustic system, all positioning and subsea construction tasks have been made easier, negating the need and cost of installing an independent, dedicated survey pole over the side of the ship. For vessels of opportunity Kongsberg have a range of portable SSBL/LBL transducers. These include the calibration free HiPAP 351P and µPAP with built in heading and attitude sensors, through to simpler LBL only transceivers.

LBL structure positioning
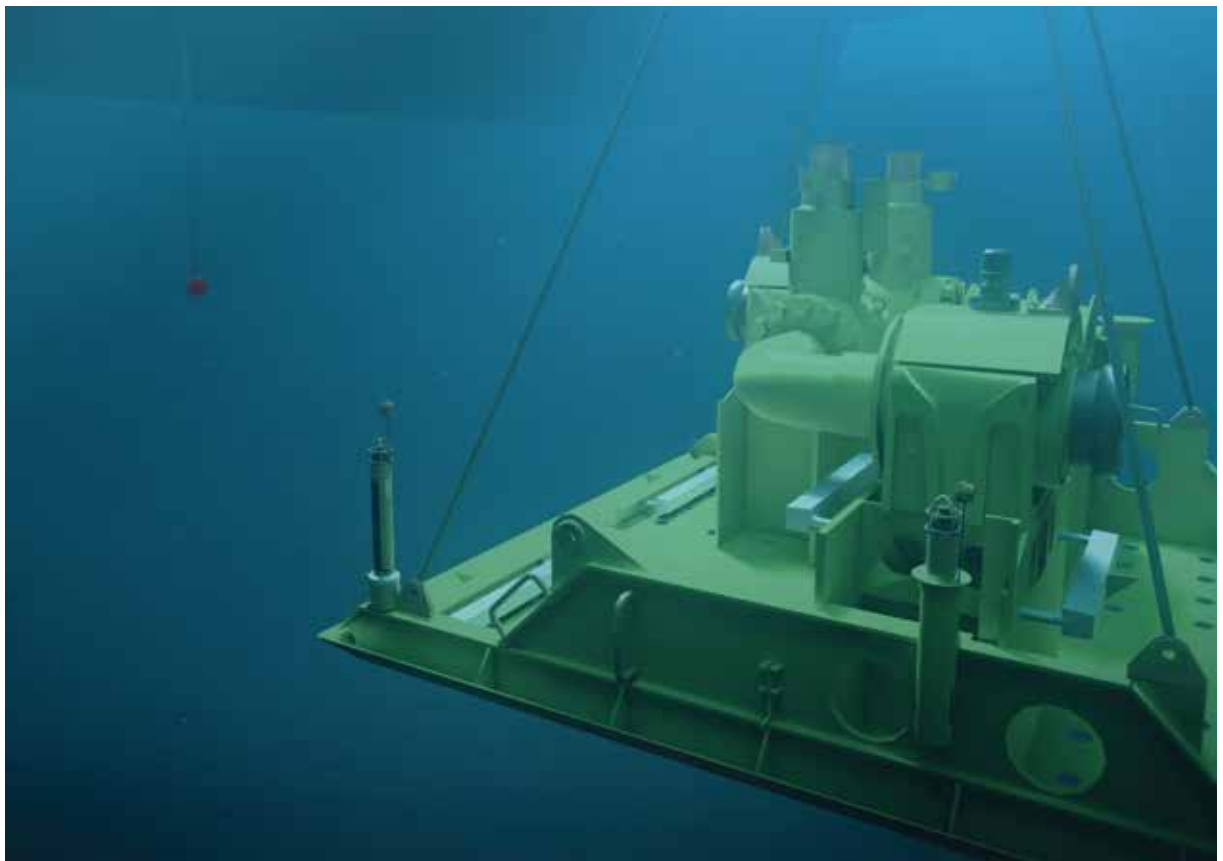
APOS - ACOUSTIC POSITIONING OPERATOR STATION

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APOS runs a windows based software package at the heart of KONGSBERGs LBL and SSBL positioning system. Installed on the majority of Subsea and Survey Vessels worldwide, APOS provides the Full Picture of positioning techniques from simple SSBL, through to more advanced LBL, tracking structures, ROVs and vessels in one versatile software package. APOS can be connected to a single or multiple permanently mounted transducers within the HiPAP family, through to portable systems including the HiPAP 351P and μPAP.
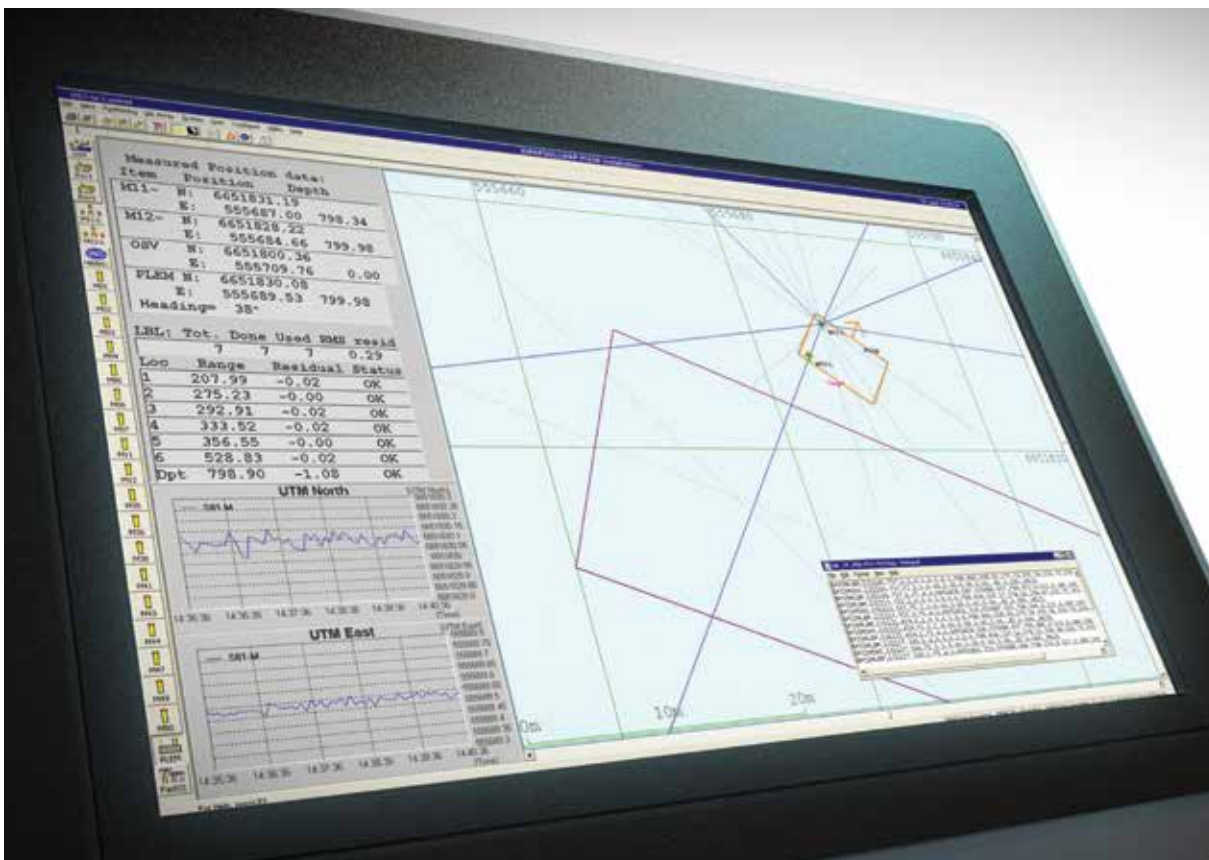
POSITIONING TECHNIQUES

Long Baseline is a well proven positioning technique for accurate positioning of structures and ROVs, using 'range-range' or trilateration. Relative positional accuracies of better than a decimeter are achievable within an LBL array. In order to provide an indication of quality, an LBL array should consist of at least four transponders on the seabed, which are calibrated by measuring baselines between them and performing a least squares adjustment.

SSBL is a range and bearing positioning technique. The system measures the two way acoustic travel time and phase differences over the super short baseline between the active piezo-electric elements in the transducer below the hull, from a mobile transponder(s).
A 3D position of the transponder(s) relative to the vessel SSBL hull transducer is computed. The accuracy of SSBL is a function of the accuracy of the bearing measurement and the range.

Sparse LBL used for ROV positioning, combines the convenience of SSBL positioning with just one or more sparse LBL ranges, to reduce the positional error. When specified project, positioning accuracies fall between full LBL and SSBL, sparse LBL can save significant vessel time over full LBL.

APOS Survey Operator Station

Multi-User LBL mode provides simultaneous positioning of an unlimited number of vessels or ROV's within one LBL array. The technique uses time differences of arrival at the transceivers from each of the array transponder replies.
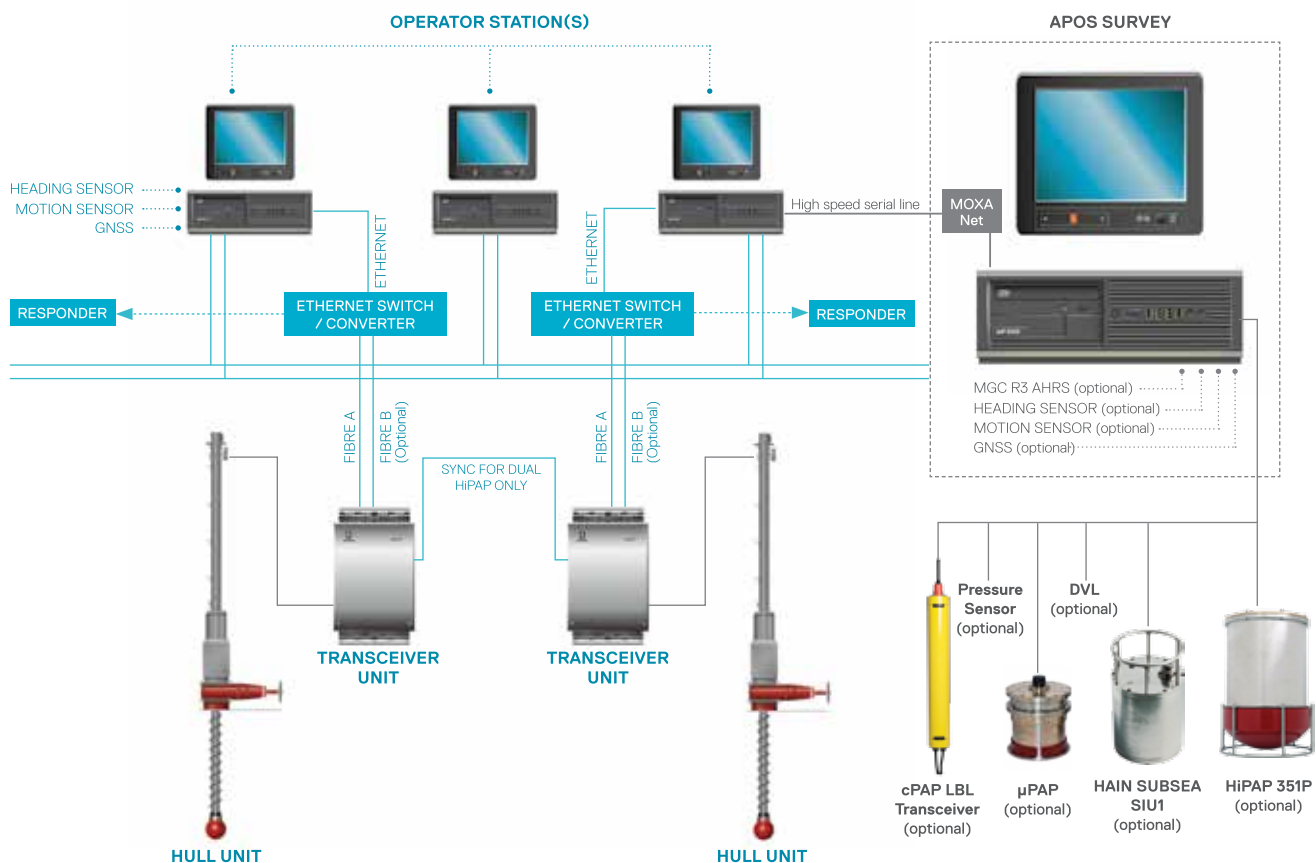
HAIN Subsea for ROV positioning is an aided inertial navigation system, that improves subsea positioning accuracy and update rates. HAIN is aided by SSBL and/ or LBL data from APOS, and can also be interfaced to a doppler velocity log and pressure sensor.

APOS SURVEY - THE THIRD PARTY VESSEL SOLUTION
APOS Survey is a cost effective way to maximize the use of HiPAP, particulary on a third party vessel without the need for software updates or configuration changes.

The independent APOS Survey computer connects to the vessel system and interleaves the use of the HiPAP without sharing a common database. The surveyor can define an independent set of lever arms and alignment offsets, interface dedicated attitude and GNSS sensors and import a velocity profile without any changes being replicated on the vessel system. The APOS Survey computer allows SSBL positioning, telemetry, full LBL mobile structure positioning, interfacing of the cPAP ROV transceiver and HAIN. Both the vessels APOS and APOS Survey can compute position from the same SSBL transponders with independent calculations, and HiPAP transducer alignment for both the vessel and APOS Survey system can be run simultaneously off the same seabed transponder.

A simplified diagram illustrating the APOS Survey system configuration (not to scale)

OPERATOR STATION(S)

APOS SURVEY

HEADING SENSOR
MOTION SENSOR
GNSS

High speed serial line

MOXA Net

ETHERNET

ETHERNET

RESPONDER

ETHERNET SWITCH / CONVERTER

ETHERNET SWITCH / CONVERTER

RESPONDER

MGC R3 AHRS (optional)
HEADING SENSOR (optional)
MOTION SENSOR (optional)
GNSS (optional)

FIBRE A
FIBRE B (Optional)

FIBRE A
FIBRE B (Optional)

SYNC FOR DUAL HiPAP ONLY

TRANSCEIVER UNIT

TRANSCEIVER UNIT

Pressure Sensor (optional)

DVL (optional)

cPAP LBL Transceiver (optional)

µPAP (optional)

HAIN SUBSEA SIU1 (optional)

HiPAP 351P (optional)

HULL UNIT

HULL UNIT

SSBL CALIBRATION – TRANSDUCER ALIGNMENT

APOS includes an integrated calibration tool for calculation of the transducer attitude and lever arms, MRU and Gyro alignment, seabed transponder position (boxed-in) and sound velocity.

SSBL MULTI FAST TRACK (SIMULTANEOUS POSITIONING AND SENSOR DATA)

Fast Track simultaneously positions multiple SSBL mobile transponders with one interrogation, rather than individually interrogating each transponder.
In addition to simultaneous position updates, sensor data, inclinometer or gyro for example may be transmitted on the back of the transponders position pulses without any additional telemetry.

LBL FAST BATCHED BASELINE COLLECTION

APOS can compute large array adjustments using a 'Super Array' which processes baseline measurements from 100 + transponders. Baseline calibrations are carried out in batches, this allows for rapid collection of baseline data, eliminating the need for repetitive sequential commands between the surface vessel and transponders.
Raw millisecond ranges are made available and converted to baselines in APOS using average speed of sound between the sensors installed on the transponders and ROV, or from an imported profile. Baselines can be QC'd using the graphical histogram editing tool, which shows the direction each baseline was measured, calculated baseline length and standard deviation of the observations. The baseline adjustment can be processed and reprocessed in 2D or 3D, holding one or more transponders fixed or weighted. Baseline data can also be exported for processing in an offline QC package.

LBL structure placement via ROV cPAP transceiver
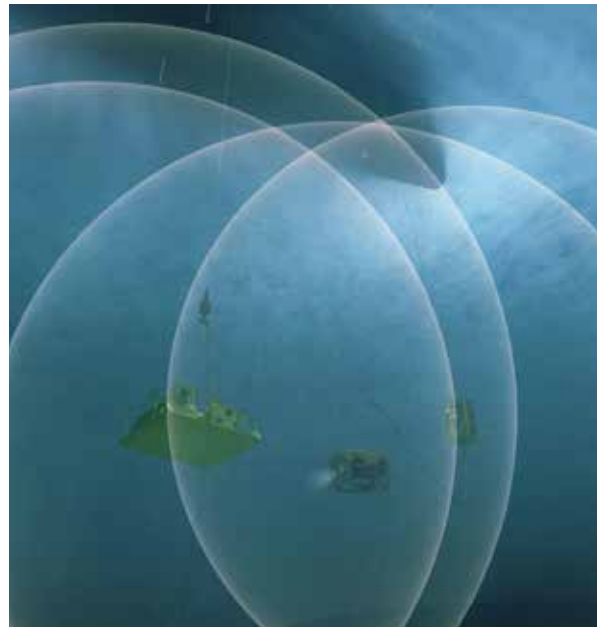
LBL ABSOLUTE ARRAY CALIBRATION

APOS supports several methods for absolute calibration:
- Boxin
- Geographical also known as grid on grid
- Manual Entry from previous calibration

In the case of the Boxin or manual entry the Transponder position and accuracy is used as part of the overall array adjustment. APOS allows the surveyor to fix the orientation of the array when adjusting the network, weight the boxed in coordinates and also includes block shift and array rotation functions.

The geographical or grid on grid calibration technique is useful where it is not possible to sail around the transponders, due to obstruction from a structure or anchor lines for example. The vessel will be positioned by GNSS and LBL simultaneously, collecting data at several points around the array to compute a block shift and rotation

SERIAL INPUT & OUTPUT

APOS supports a number of industry standard NMEA messages for interfacing GNSS and attitude sensors. Kongsberg propriety messages provide output of both computed positions and raw data, including LBL ranges and sensor data. Fully corrected and raw SSBL positions can be output, the latter uncompensated for lever arms, attitude or transducer alignment, to allow final computation in an independent survey suite.

*A screenshot of the LBL Baseline editor*
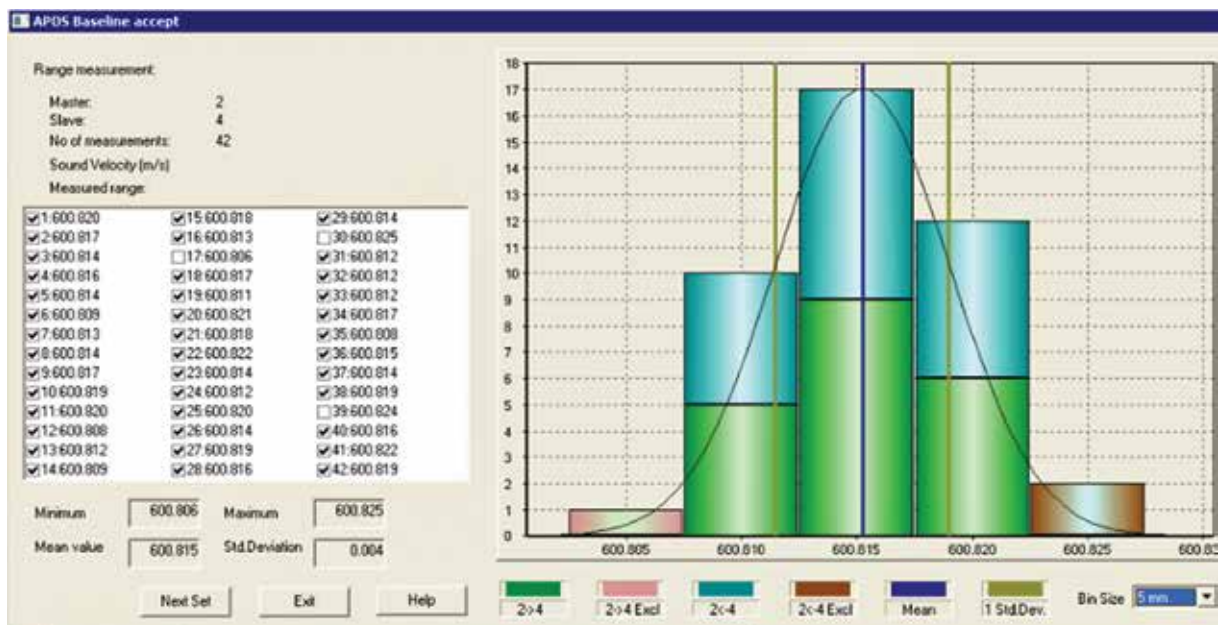
ACOUSTIC POSITIONING HARDWARE

TRANSDUCERS

Communication and positioning within the LBL array is provided through the full range of HiPAP, µPAP and cPAP (for ROV) transducers, all operate through the same APOS software.

cPAP – ROV POSITIONING

cPAP is an ROV LBL and telemetry transceiver for accurate ROV positioning, but also comes in a dunking transducer variant for vessels of opportunity. cPAP is versatile, operating in both LBL and SSBL (transponder/responder). One or two remote transducers may be fitted and they may be directional, omni directional or donut horizontal. This provides the ability to position the ROV through the water column, using SSBL with a directional transducer and then switch to LBL positioning with the omni directional or donut in deep water.

cPAP LBL transceiver on ROV
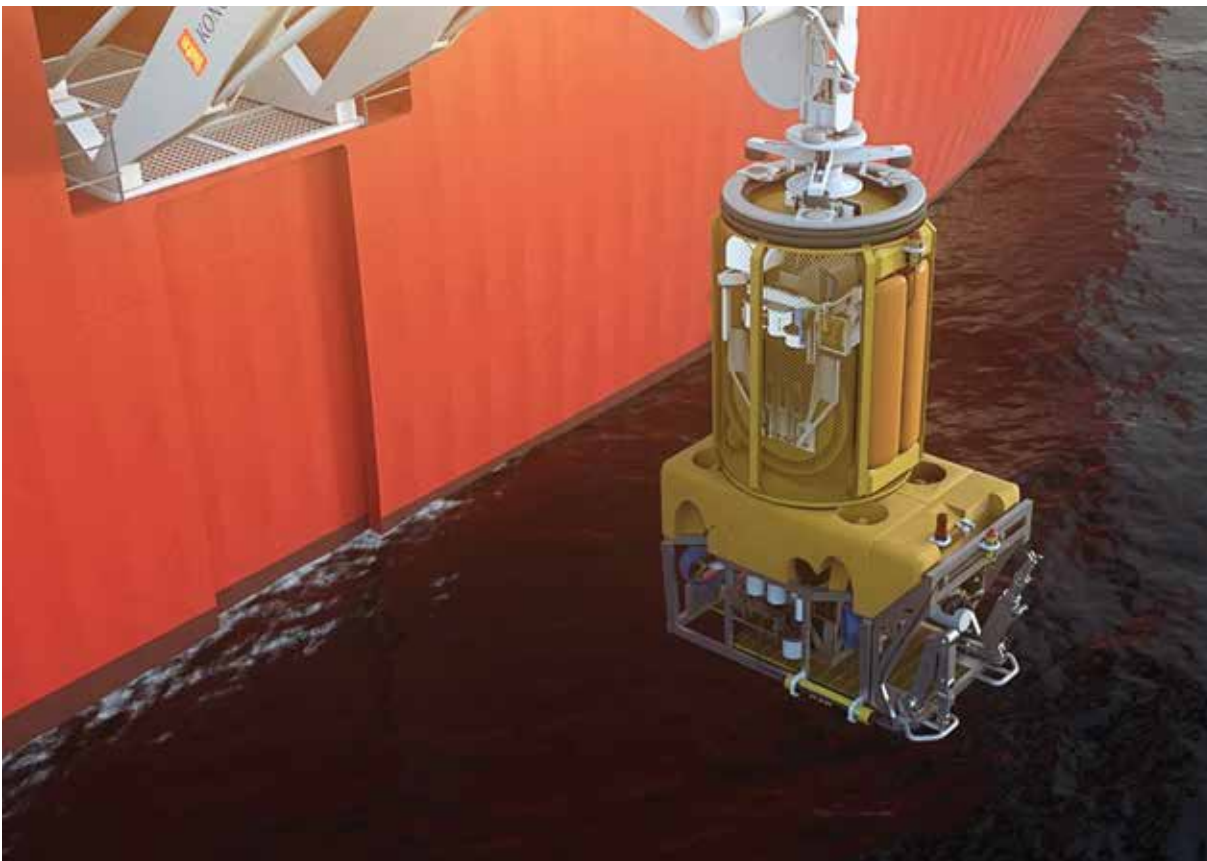
cNODE TRANSPONDERS

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The cNODE family of transponders provide extremely accurate LBL positioning with range accuracies of better than 2cm. Flexibility comes as standard in cNODE, the Maxi, Midi, Mini all come with the following functions:
- LBL
- SSBL
- Responder
- 560+ Cymbal Navigation Codes
- Configurable acoustically & via serial interface
- Modular components

The cNODE transponders are deployed in floating collars or in seabed frames, to form an LBL array.

Additional transponders fitted to subsea structures are positioned within the array during deployment, the range measurements and sensor data are used to calculate precise position, heading, depth and inclination.

ROV deploying cNODE transponders with sensor module

cNODE MODULES

cNODE modular design allows sensor modules and transducers to be easily fitted or swapped in the field or workshop. The flexibility allows modules to be shipped between projects and fitted to existing onboard cNODE transponders.

GYRO ENDCAP MODULE

Designed to operate both with a transponder or standalone as a survey grade gyro, the endcap module is equipped with a Kongsberg MGC ring laser gyro. The module can be fitted to either a cNODE Maxi or Midi and provides high accuracy heading pitch and roll, for LBL and SSBL positioning operations, when installing subsea structures.

Internal or external power may be used and serial data output is provided to display attitude data on an external ROV LED text display.

TOP SECTION MODULE

The top section module may be fitted with up to three sensors, high accuracy pressure, high accuracy dual axis inclinometers and sound speed. The module may be fitted to either the cNODE Maxi or Midi

SERIAL INTERFACE ENDCAP

The serial interface endcap with logging capability for Midi and Maxi transponders can connect up to three external serial devices, including pressure, sound speed and current. In addition the end cap may be used to connect to other third party sensors and the transponder may be used as a modem to collect external data via the vessels HiPAP modem option.

MODULAR ENDCAP FOR METROLOGY

Fitted with a Digiquartz pressure and high accuracy dual axis inclinometers, the flat moduler endcap is designed to fit industry standard metrology stab plates .

The modular family of cNODE® transponders:
1. *Maxi housing*
2. *Midi housing*
3. *Release endcap*
4. *Gyro endcap module (Heading, Roll and Pitch)*
5. *Serial Interface endcap*
6. *Top Section module SVPI (Sound Velocity Pressure Inclinometers)*
7. *Omni directional transducer*
8. *The modular nature of cNODE®*
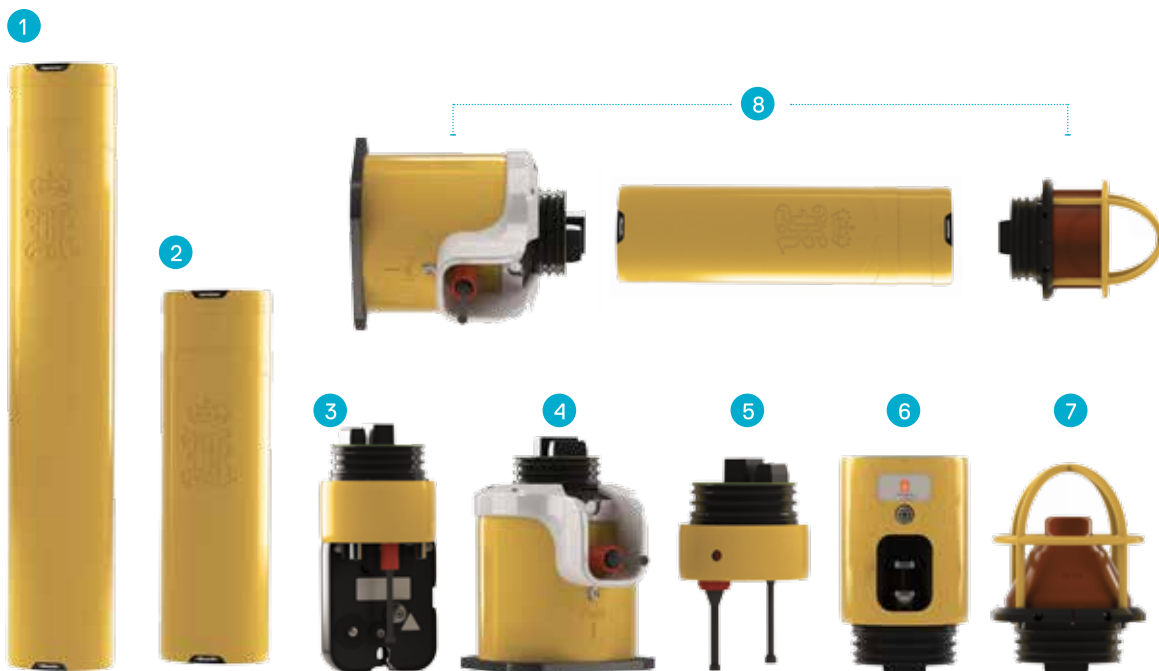
AUTONOMOUS MONITORING AND LOGGING WITH cNODE

All cNODE sensor modules are fitted as standard with SD storage cards. Using the APOS logging software option, the cNODE can be configured to autonomously log sensor data, such as pressure, inclination and sound speed as wells as baselines at predetermined wake up intervals.

Data may be recovered at a later date by any HiPAP or cPAP system using the Cymbal telemetry. The same cNODES used for structure positioning may therefore be used for applications including monitoring of seabed deformation, pipeline expansion and structure settlement.

Autonomous monitoring of structure movement with cNODE
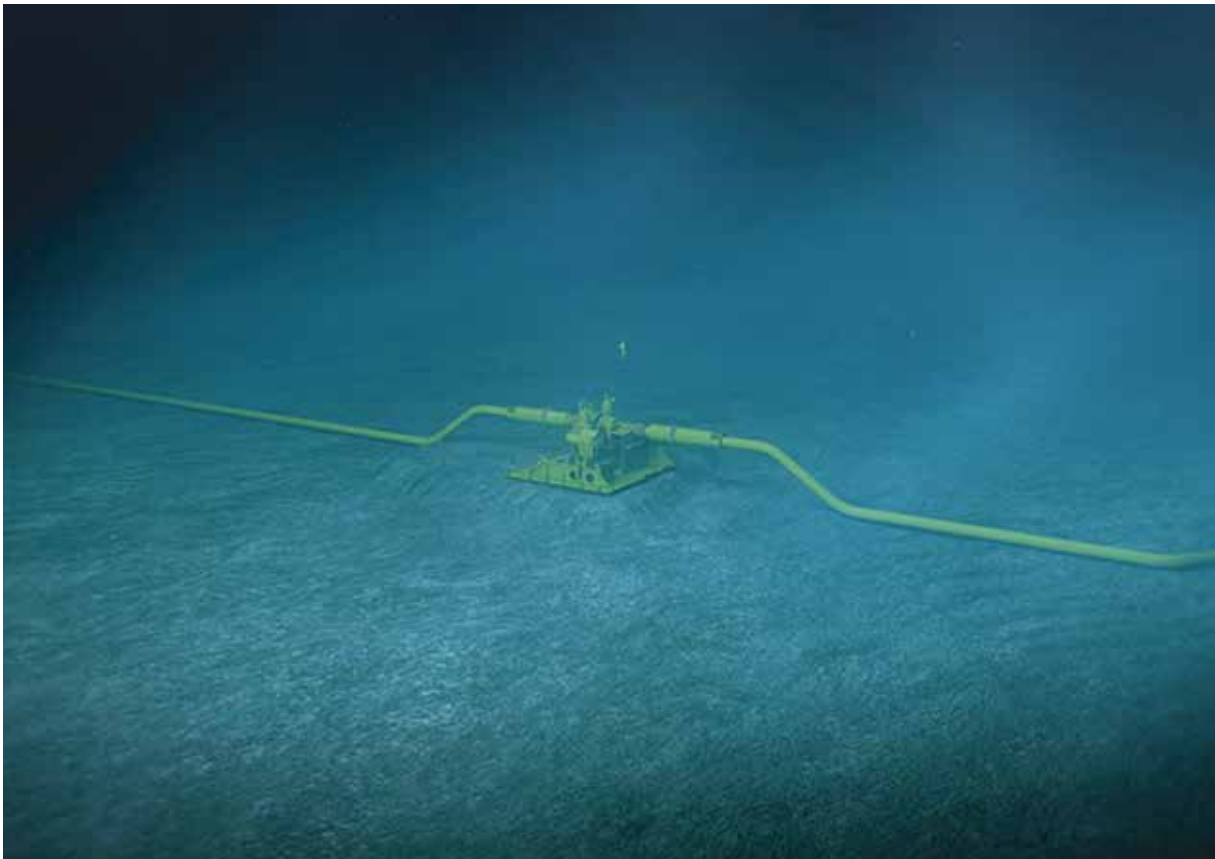
ACOUSTIC PROTOCOLS

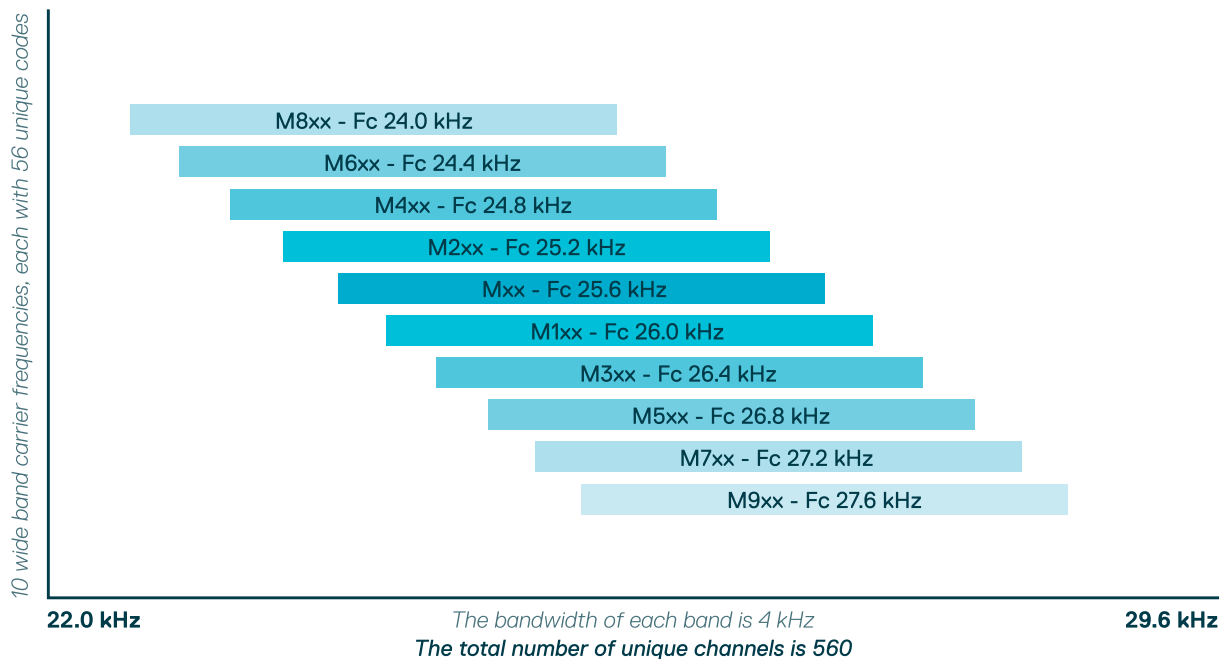Cymbal is the new acoustic protocol used for both positioning of subsea transponders in SSBL/LBL mode and data communication to and from transponders. The Cymbal technology utilises Direct Sequence Spread Spectrum (DSSS) signals for positioning and data communication. The data communication speed is variable and can be adapted to the acoustic communication conditions; noise and multi-path. DSSS is a wide band signal. The Cymbal protocol provides higher position accuracy, more accurate range measurements, longer range capabilities and higher data rate communication due to the higher energy in its pulses.

CYMBAL protocol 560+ unique navigation channels

10 wide band carrier frequencies, each with 56 unique codes

M8xx - Fc 24.0 kHz
M6xx - Fc 24.4 kHz
M4xx - Fc 24.8 kHz
M2xx - Fc 25.2 kHz
Mxx - Fc 25.6 kHz
M1xx - Fc 26.0 kHz
M3xx - Fc 26.4 kHz
M5xx - Fc 26.8 kHz
M7xx - Fc 27.2 kHz
M9xx - Fc 27.6 kHz

22.0 kHz   *The bandwidth of each band is 4 kHz*   **29.6 kHz**

The total number of unique channels is 560

TECHNICAL SPECIFICATIONS

APOS LBL PERFORMANCE

LBL ARRAY CALIBRATION	· Fast batched baselines / 2D and 3D adjustment · Absolute Calibration with 'Box-in' and Geographical (grid on grid)
SUPER ARRAY SIZE	100+ transponders
GEODESY	Blue Marble geodetic library
SOUND SPEED	Real time sound speed compensation from transponder SV sensors
SURVEY I/O	Industry standard survey telegrams and Kongsberg propriety NMEA
POSITIONING	ROVs and mobile structures with target transponders
STRUCTURE TRACKING	Up to 4 transponders installed on a structure, with precision sensors
SUPPORTED METHODS	LBL, Sparse LBL, MULBL and HAIN
RANGE ACCURACY	< 2cm
SOFTWARE	Windows 7 and XP
ACOUSTIC PROTOCOL	Cymbal: 560+ non interfering wideband navigation codes

cNODE SENSOR SPECIFICATIONS

SENSOR OPTIONS:	ACCURACY
High accuracy dual axis inclinometers (Top Section module)	+/- 0.05° (+/- 90° range)
High accuracy dual axis inclinometers (Modular endcap)	+/- 0.05° (+/- 30° range)
Digiquartz pressure sensor · 1400m · 2000m · 4000m	+/- 0.01% (full scale) +/- 0.01% (full scale) +/- 0.01% (full scale)
Gyro module (ring laser) · Heading (GNSS aided) · Heading (unaided) · Pitch and roll	· 0.08° RMS sec. lat · 0.15° RMS sec. lat · 0.01° RMS
Sound speed sensor	+/- 0.02 m/s
SD storage	Logging of sensor data

LIFE CYCLE SUPPORT

Designed to purpose – maintained to last

Our life cycle management service will assist our customers throughout all the phases, from design to commissioning and during the operational life time.

Solid in-house competence, both in system design and user competence enables us to provide solutions that are fit to purpose and thus yields efficiency in operation. Our common base technology provides robust designs, with few and reliable parts, an execellent foundation to maximize the output at competitive costs.

The distributed and open system design employs an industry standard communication network. Standard hardware components used for various applications and the open network approach results in:

· Increased reliability
· Competitive life-cycle support
· Easy up-grade solutions

Evergreen

We offer continuous hardware and software upgrade to keep your vessel at maximum efficiency. Our system is designed with consistent boundaries between individual systems and control segments. This design strategy makes it easy to add new functionality or complete new control segments thus enable us to offer up-grades step by step to keep your system evergreen.

Training

Qualified personnel are one of your major assets in efficient and safe operations. Thus, we offer modular training courses for all major subjects – from operator training to technical training that keeps your crew fit on the job.

PLANNING & DESIGN	PROJECT ENGINEERING & DEVELOPMENT	INSTALLATION & COMMISSIONING	OPERATION & MAINTENANCE	MODERNISATION
		On-line support »		
		Technical	support »	
Technical consulting »				
	Design and	software engineering »		
			Field service »	
			Repairs	and spare parts »
			Optimization	and modernization »

Supported by professionals
Our systems are easy to install and maintain – supported by professionals either on-site or through remote connectivity. They are designed for optimal operational availability and allow for favourable lifecycle expenditure

GLOBAL SUPPORT 24/7

We are always there, wherever you need us
KONGSBERG customer services organisation is designed
to provide high-quality, global support, whenever and
wherever it is needed. We are committed to providing
easy access to support and service, and to responding
promptly to your needs. Support and service activities are
supervised from our headquarters in Norway, with service
and support centres at strategic locations around the
globe – where you are and the action is.

As part of our commitment to total customer satisfaction,
we offer a wide variety of services to meet individual
customers' operational needs. KONGSBERG support 24
is a solution designed to give round-the-clock support.
For mission-critical operations, KONGSBERG support 24
can be extended to include remote monitoring.
We can adapt the level of support needs by offering
service agreements, on-site spare part stocks and quick
on-site response arrangements.

Svalbard

Norway (35)   Finland
Russia
Canada (5)   UK (11) Denmark
                        Ireland   Poland (2)
                        Germany
                        Netherlands   Hungary
                        France
USA (14)   Spain Italy (2)
                        Greece   South Korea (6)
                              UAE (3)   China (4)
Mexico (2)   Saudi Arabia   India (4)

Venezuela   Nigeria   Malaysia
                                              Singapore (4)
Brazil (3)

                                              Australia (2)

South Africa

Antarctica

Global and local support
We provide global support from local service and
support facilities at strategic locations world wide.
Service and support work is carried out under the
supervision of your personal account manager, who will
ensure that you receive high-quality service and support
where and when you need it.
Your account manager will ensure continuity and
work closely with your personnel to improve and
optimise system availability and performance.
Under the direction of your account manager, and
with a local inventory of spare parts, our wellqualified
field service engineers will be able to
help you quickly and effectively.

SALES
Call +47 33 03 41 00
E-mail: subsea@kongsberg.com

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Call +47 33 03 24 07
E-mail: km.support@kongsberg.com