

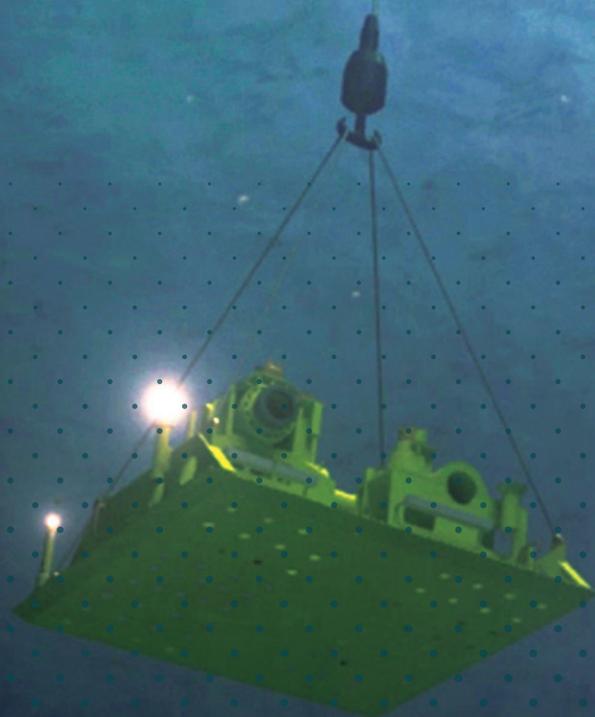


KONGSBERG

# HiPAP<sup>®</sup>

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HIGH PRECISION ACOUSTIC POSITIONING



# 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.

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# AN INTRODUCTION TO HiPAP®

The HiPAP family consists of the world's most successful underwater positioning systems. It was first developed with a focus on the Super Short Base Line (SSBL) principle, as this was a market requirement of trying to avoid the Long Base Line (LBL) principle in deep water and in accurate seabed survey applications. The main advantage of the SSBL principle is that it only requires installation of a single vessel-mounted transducer and one subsea transponder. The unique transducer technology and advanced digital signal processing was found to be the ideal solution for obtaining the optimal position accuracy required in any water depths.

The first HiPAP was introduced in 1996. This was followed by the second generation HiPAP (xx1 models) in 2007, and the third generation (xx2 models) were released in 2015.

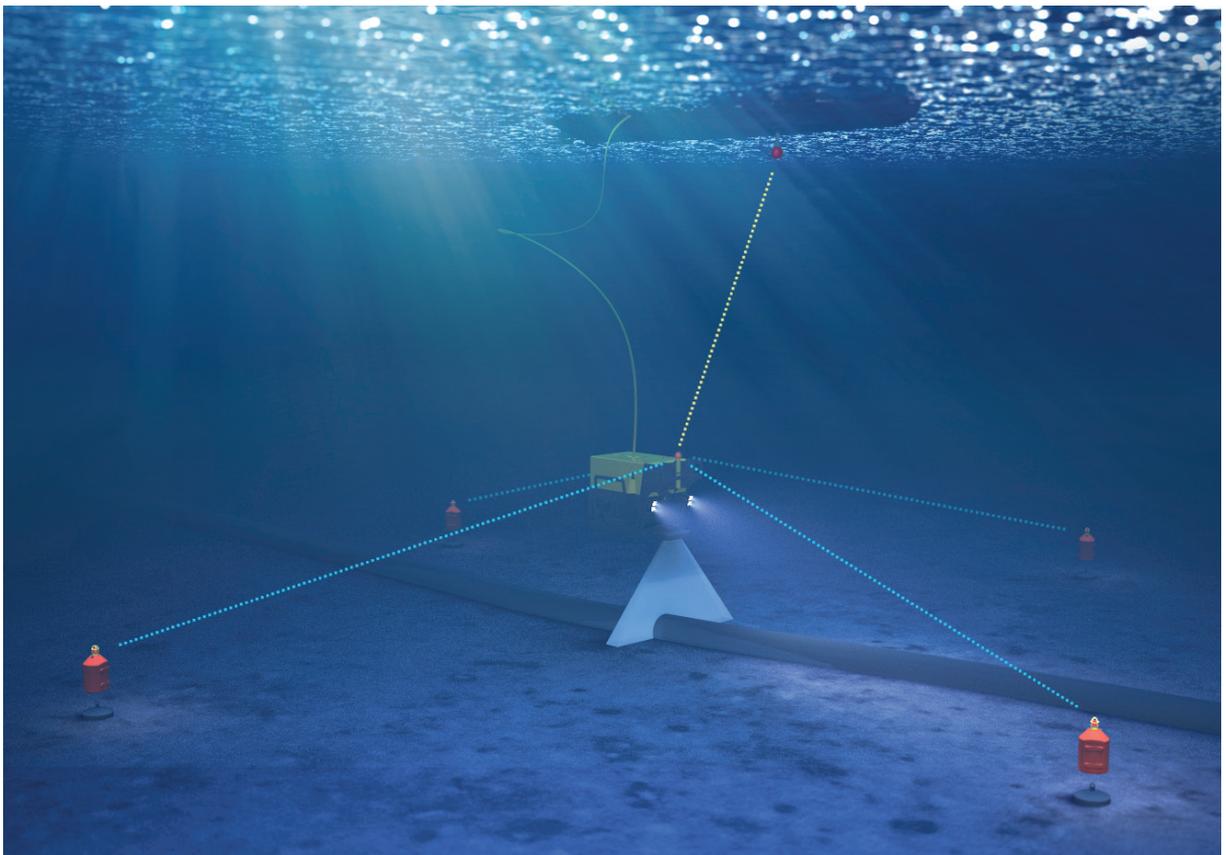
Newer models have been released due to the continuous development of electronic hardware and software, along with newly available electronic components.

The most recent improvements in the xx2 system range are:

- Smaller, lighter and less temperature sensitive transceiver unit built within a stainless steel cabinet
- New Low Power Transceiver (LPT) boards with better filtering and signal processing providing an additional 5-6 dB sensitivity
- The improved sensitivity gives better range and angle accuracy compared to previous generation HiPAPs
- The improved sensitivity allows for less source level in the transponder which leads to longer transponder battery endurance.

All HiPAP models operate the latest acoustic protocol for positioning and communication, Cymbal. All new generation HiPAP models are compatible with earlier generations of transponders.

*HiPAP in action: LBL and SSBL positioning of underwater vehicles and structures*



# THE POSITIONING PRINCIPLES

## SUPER (ULTRA) SHORT BASE LINE

SSBL (USBL) is the simplest underwater positioning principle in operation. The Super Short Base Line refers to the very short distance between the active piezo-electric elements in the transducer, which is lowered under the vessel. The SSBL principle has the obvious advantage that it requires no installation of calibrated array transponders on the seabed. Only the targets that are to be positioned must be equipped with a transponder. An SSBL system measures the horizontal and vertical angles together with the range to the transponder(s), giving a 3D position projection of the transponder(s) relative to the vessel. An error in the angle measurement causes the position error to be a function of the range to the transponder, so SSBL has an accuracy error that increases with range.

To obtain better position accuracy in deep water using an SSBL system it is necessary to increase the accuracy of the angle measurement.

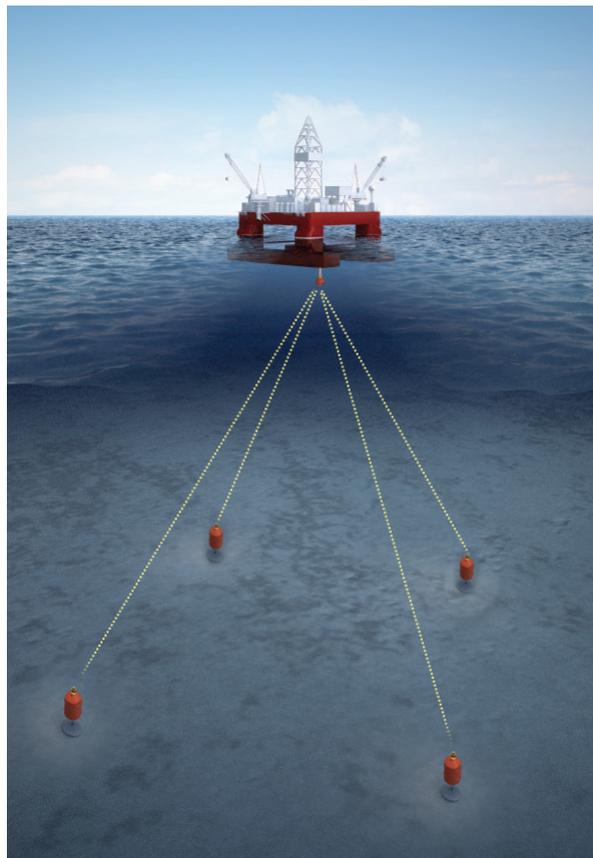
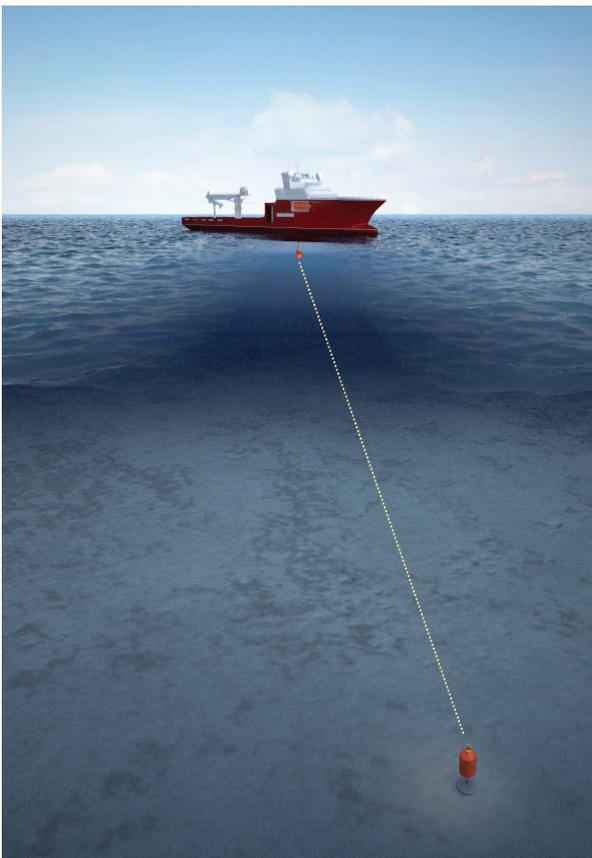
## LONG BASE LINE

The LBL underwater positioning principle is in general more complex in operation. However, the HiPAP LBL mode is as simple as SSBL to operate, except for the need for at least 4 transponders in an array. The Long Base Line refers to the base lines between the transponders spread out on the seabed.

This array of transponders needs to be calibrated, i.e. all ranges between them need to be measured. HiPAP systems have automated and advanced functionalities working on acoustic ranging and telemetry to find these ranges. Normally LBL gives more accurate positioning within the range of the transponder array, and the LBL position accuracy is almost independent of depth.

The High Precision Acoustic Positioning (HiPAP) family can utilise software for both SSBL and LBL principles.

Below (left) an example of SSBL vessel positioning  
Below (right) an example of LBL rig positioning



# HiPAP® SYSTEM ADVANTAGES

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## EXTREME POSITIONING ACCURACY

The HiPAP system establishes subsea positioning so accurate in SSBL mode that the more complex LBL principle is made redundant within reasonable depths. The time and cost of survey operations are therefore reduced to a minimum.

The HiPAP system is a quantum leap in technology, with hundreds of elements in a spherical transducer. These elements enable an extremely high internal redundancy reliability and a high degree of directivity. The same advanced transducer technology is utilised across the entire HiPAP family, together with digital acoustic signal processing, making HiPAP the most accurate and reliable SSBL system available.

## BEAM FORMING TECHNOLOGY

The beam-former in HiPAP is digital. All transducer elements are individually interfaced to the Digital Signal Processor (DSP) which measures the phase and amplitude of the incoming signal to calculate the horizontal and vertical angle to the transponder. All HiPAP models use a unique and automated focussing of narrow transmitting and listening beams technology. The beams are formed by the DSP in the direction decided by the position-tracking algorithm towards the transponder. Data from the vessels compass and roll pitch sensors is inputted into the tracking algorithm to direct the beam in correct horizontal direction and stabilise the beam. The narrow beams provide improved Signal to Noise ratio (S/N) which is essential to obtain improved angle measurement accuracy and longer range capabilities. Additionally it suppresses the negative effect of acoustic reflections and noise coming from other directions.

The HiPAP® family transducers, from left; HiPAP® 500, HiPAP® 350 and HiPAP® 100.



# HiPAP® SYSTEM MODULES

## OPERATOR UNIT WITH APOS

All HiPAP systems use the same Acoustic Positioning Operator Station (APOS) and Man Machine interface. The APOS consists of a colour display, computer, keyboard and tracker-ball. The APOS performs all user interfaces and controls the transceiver data. The APOS runs with Windows software, which enables the operation of the HiPAP in a familiar fashion. Multiple Operator Stations are possible with no limit to how many are onboard a vessel. One Operator Station will always be primary and all the others will be secondary. A secondary station may take primary control at any time.

## THE HiPAP FAMILY UNIQUE TRANSDUCERS

There is a clear connection between system performance and the number of elements within a transducer, and the HiPAP series of transducers have more elements than any of its competitors. Acoustical redundancy, mathematical redundancy and improvement of the Signal to Noise level are all factors in the high system performance of the HiPAP family. Except for the HiPAP 351P Portable transducer all the

transducers are purely mechanical devices with internal ceramic elements which maximize the reliability when compared to systems that also have electronics inside.

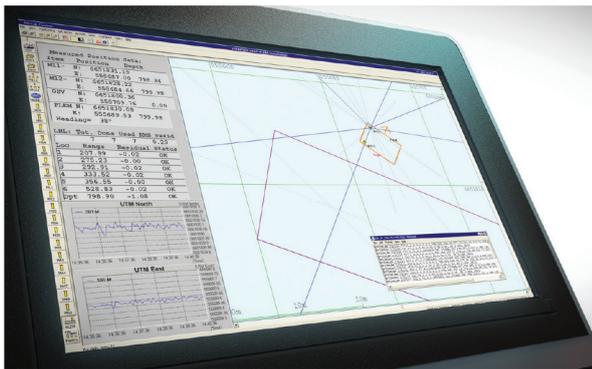
## HULL UNIT

The HiPAP system operates with the transducer mounted on the hull unit, allowing it to be lowered several meters below the vessel hull until it is below the critical surface water layers as well as the aerated water created by the vessel. The hull unit is mounted on a certified gate valve. KONGSBERG hull units are guaranteed to withstand water forces up to 10 knots. The hull unit is the same for all HiPAP transducers and can be supplied in different lengths.

## TRANSCEVER

The transceiver unit is mounted close to the hull unit and contains advanced digital transmitters, preamplifiers and beam-forming electronics. The transceiver communicates with the APOS via fiber optic cables.

Clockwise from top left: APOS screenshot, hull unit with HiPAP transducer, hoist control unit, the transceiver unit X82 and the HiPAP family transducers.



## EXTERNAL INTERFACES

A standard HiPAP system is interfaced to both heading and vertical reference sensors. A GNSS surface navigation system may also be interfaced in order to refer the subsea position data to absolute geographical coordinates.

## TRANSPONDERS AND RESPONDERS

The underwater target to be positioned must have a transponder or a responder installed. The transponder operates acoustically while the responder requires a cable for triggering.

A cNODE transponder is built up by modules;

- The main body with electronics and battery. 3 different housing sizes are available (Maxi, Midi and Mini) which determine the battery size and capacity.
- The transducer with different beam patterns available
- The modular end cap which can have an acoustic release mechanism, a variety of built-in sensors or a sensor interface connector

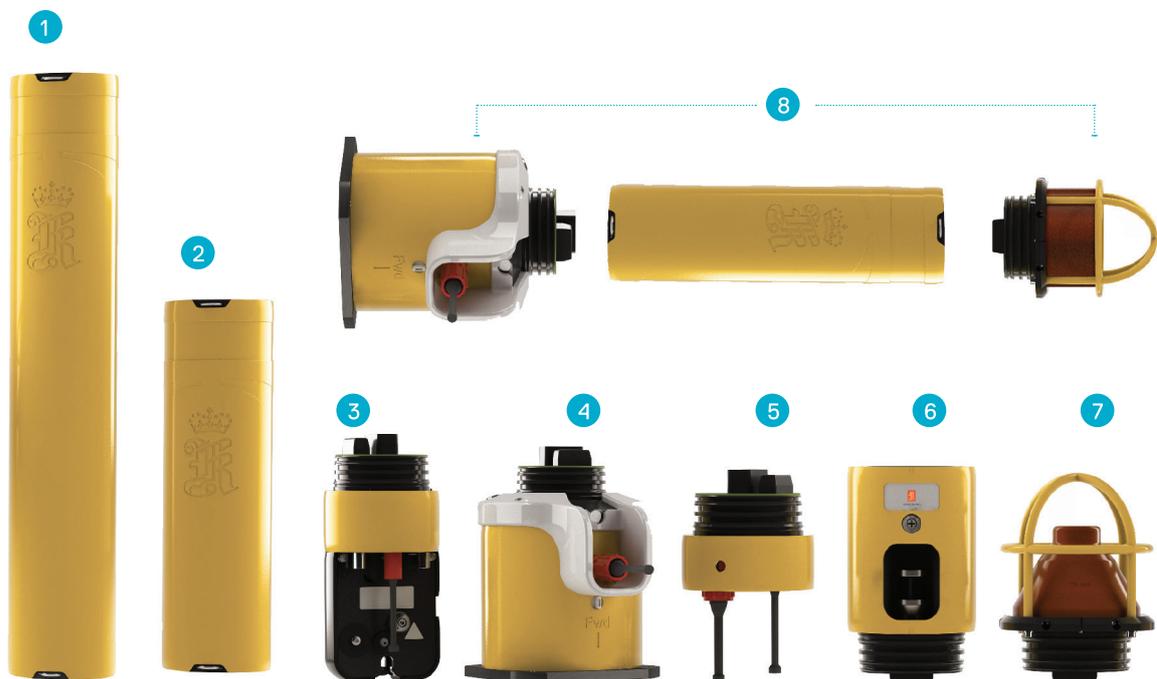
- The optional Modular Top Section (main body extension section between the transducer and main body) This sections can also have a variety of built-in sensors, i.e. high accuracy Depth Sensor, Sound Velocity Sensor, Inclometers, etc.

The cNODE transponder family can use the Cymbal acoustic protocol (PSK) or the traditional frequency shift (FSK) modulation technique. The transponders are depth rated down to 4000 or 7000 meters and are able to perform any positioning task. The built in Cymbal acoustic protocol allows for high speed, two-way, data telemetry. Customers may also use the transponders as a transparent modem when data needs to be sent wirelessly. Floating collars are also available.

The HiPAP Medium Frequency (MF) systems, excluding HiPAP 102, may also position Diver Emergency Channels A and B, but at a reduced range (typical max range 1000m). More detailed information can be found in the Transponder product sheets.

The modular family of cNODE® transponders:

1. Maxi housing
2. Midi housing
3. Release end cap
4. Gyro end cap module (Heading, Roll and Pitch)
5. Serial interface end cap
6. Top Section module (Sound Velocity, Pressure and Inclometers)
7. Omni directional transducer
8. The modular nature of cNODE®



# CYMBAL® ACOUSTIC PROTOCOL

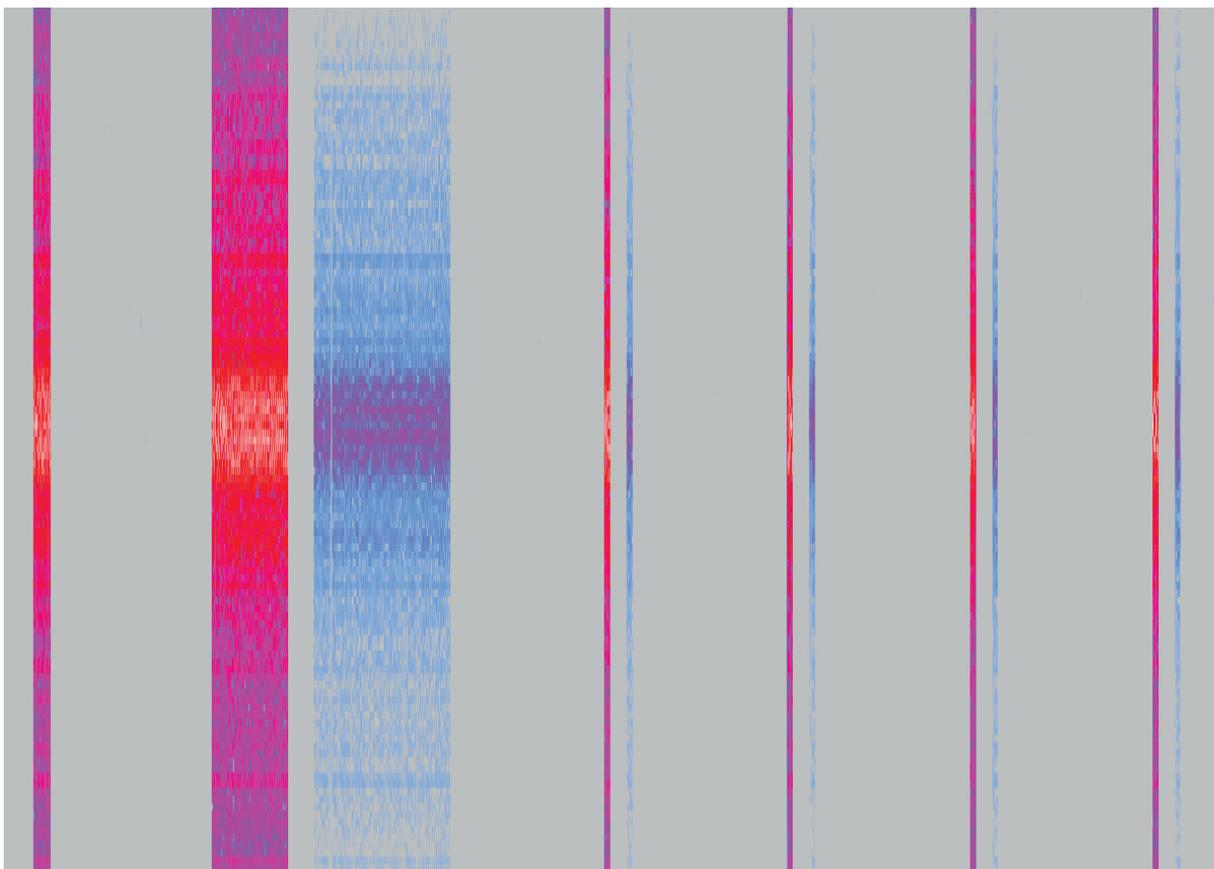
HiPAP Model 502/452/352/102 systems are the third generation HiPAP systems which have a new transceiver unit. The Cymbal acoustic protocol utilizing the wideband Direct Sequence Spread Spectrum (DSSS) signals is a standard feature.

The Cymbal protocol transmits more energy into the water, and together with the uniqueness coding, new filtering and acoustic processing techniques.

Improved specifications with Cymbal:

- Angular accuracy specification improvement of 100% - up to 0,06°
- Longer range capability with MF systems (5000m)
- Range accuracy is in the order of 0.02m.
- Range repeatability is in the order of 0.01m between cNODE transponders
- Allows higher position update rate through Fast Track
- Automatic adjustment of transponder TX power for increased battery endurance
- High speed telemetry data rate
- Supports variable telemetry data rate at a high reliability level
- Telemetry data will be interleaved between the positioning signals
- Enables modeless change of transponders from SSBL and LBL and vice versa.

Example of a time-frequency plot of Cymbal signals for navigation and communication. High intensity signals are from HiPAP, followed by weaker replies from a remote cNODE®





# APPLICATIONS AND FUNCTIONS

## RELIABLE UNDERWATER REFERENCE FOR DP SYSTEMS

No other acoustic positioning system has more built-in experience than KONGSBERG's HiPAP. The system always sends raw position data to the Dynamic Positioning (DP) system, allowing the DP itself to perform the evaluation, weighting and filtering of its references. As KONGSBERG is also one of the world's major suppliers of DP systems, we know the challenges of the tough and noisy environment onboard vessels controlled by a DP. All HiPAPs can be integrated with HAIN Reference system to enhance the performance of the acoustic reference.

## SURVEY INDUSTRY APPROVED UNDERWATER POSITIONING

A major survey and construction company has described the HiPAP series as a "quantum leap" in the area of underwater positioning. Due to continuous further developments and enhancements of the HiPAP

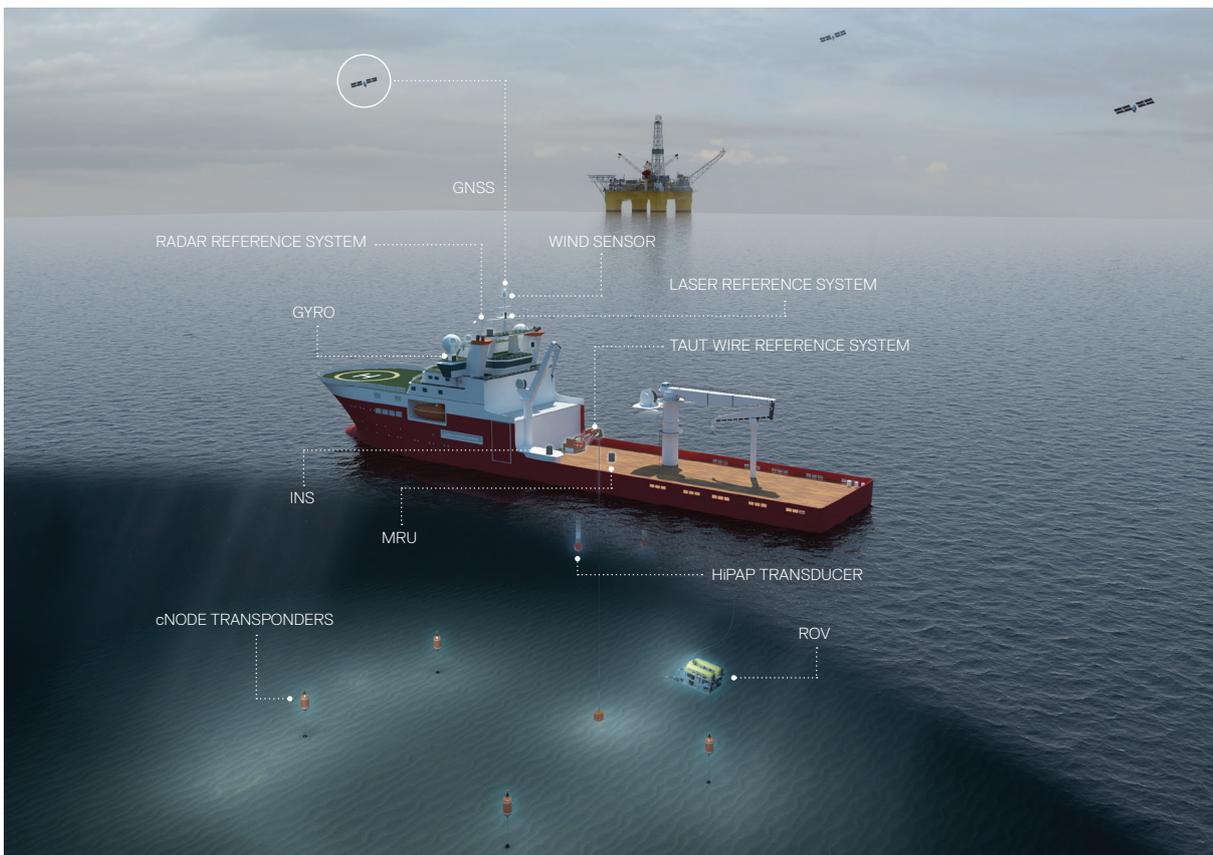
technology, customers continue to find the system unprecedented and extremely reliable. Many oil companies use the HiPAP specifications as precedent in their requirements when issuing tender documents.

## SUPER SHORT BASE LINE (SSBL)

A transponder is deployed at the seabed, on a submerged structure or on an underwater vehicle. Vessel operators then want to know the position of this transponder. The HiPAP system operating in SSBL mode gives the operator this information with the simple push of a button.

The HiPAP system will then display the transponder position relative to the vessel or geographically, in numerical coordinates. It will also send the coordinates via serial line or ethernet to external equipment. Simple and easy – it's no wonder operators prefer this principle.

Dynamic Positioning: Maximizing performance by providing THE FULL PICTURE



**LONG BASE LINE – WHEN NECESSARY FOR DP**  
 KONGSBERG introduced the LBL system in 1992, and has since become the market leader for supply of LBL and combined LBL/SSBL systems for vessel positioning. At some point of range, depending on the application, the SSBL principle can have limitations within DP reference due to the angle accuracy; deviation increases with the range. The HiPAP with optional LBL features is a flexible solution combining the advantages of both SSBL and LBL. The HiPAP has better long range performance than traditional wide beam systems.

**LONG BASE LINE – FOR POSITIONING OF UNDERWATER VEHICLES**

The HiPAP systems have fully integrated LBL functionality and are very flexible when combining the advantages of both SSBL and LBL principles. A vessel's HiPAP Operator Station can also be interfaced to, and control a subsea vehicle mounted LBL system (see cPAP product information).

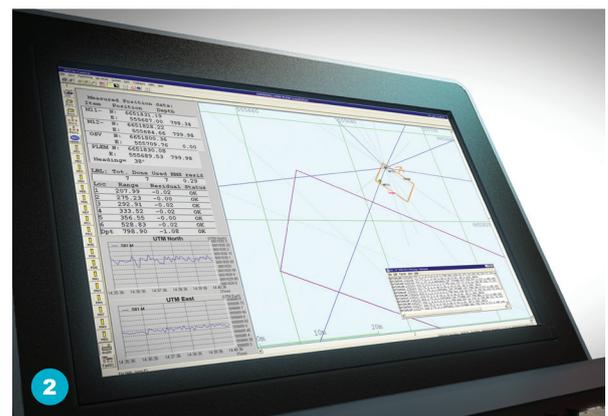
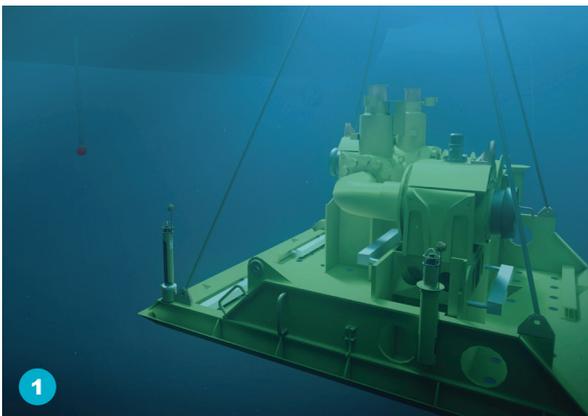
**LONG BASE LINE – FOR SUBSEA CONSTRUCTION**

A HiPAP operator station can position cNODE transponders on mobile structures, such as a manifold within a seabed LBL array. High accuracy is achieved in position, orientation, attitude and depth using instrumented cNODE transponders fitted with modules including a gyro, inclinometers, high accuracy pressure and sound velocity sensors.

**LONG BASE LINE POSITION ACCURACY**

LBL accuracy is independent of range, but only within an array of seabed transponders. The position accuracy for LBL operation depends on the transponder array geometry, sound velocity errors and signal to noise ratio. Range accuracy down to a few centimetres can be achieved, while ROV and vessel dynamic positions can be calculated to within a few decimetres.

1. The HiPAP spherical transducer permits horizontal communication and positioning
2. Real-time, raw data is exportable for QC and reporting
3. Precise LBL positioning of underwater vehicles/structures



## DUAL ACCURACY MODE

The use of two transducers will increase the electrical and also acoustic redundancy, as one transducer may have a better location with respect to noise environments and reflections. With optional dedicated software the SSBL accuracy will improve with 30% based on the statistical improvements of using a dual system.

## MULTI-USER LONG BASE LINE FOR THE POSITIONING OF MANY VESSELS AND SUBSEA VEHICLES

The Multi-User LBL (MULBL) function enables several individual vessels and ROV units to position themselves using the same seabed transponder array.

## MULTI-LBL FUNCTION FOR MULTIPLE SYSTEMS

The HiPAP Multi-LBL function option enables two, three or four HiPAP systems on-board one vessel to utilize one LBL transponder array to provide several separate independent position inputs to the DP system.

## ERROR COMPENSATION CAUSED BY SOUND VELOCITY VARIANCES

APOS has the ability to take use of a sound velocity profile to make real time corrections for errors introduced

to angular ray bending and distance in all measurements (SSBL and LBL). The profile can either be in the form of a digital text table, or it can be sent via serial line for online compensation.

## FULL INTEGRATION WITH HYDROACOUSTIC AIDED INERTIAL NAVIGATION - HAIN

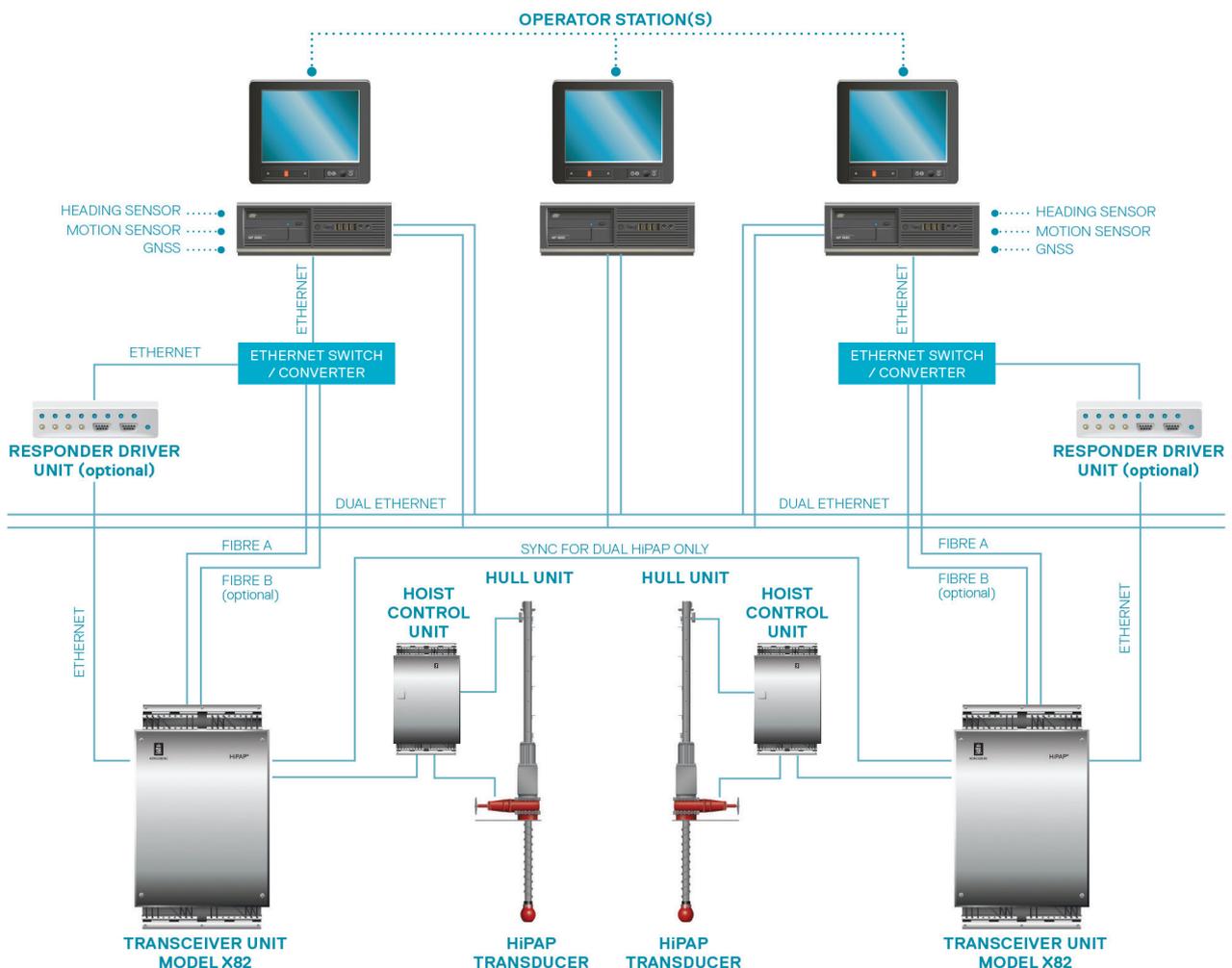
Acoustic and Inertial positioning principles in combination is ideal, since they have complementary qualities. Acoustic positioning is characterised by relatively high and evenly distributed noise and no drift in the position, whilst inertial positioning has very low short-term noise and relatively large drift in the position over time.

HAIN provides;

- improved acoustic position accuracy
- higher position update rate
- extends operational depth capabilities
- longer transponder-battery lifetime
- position update during acoustic drop-out

All HiPAP systems can be integrated with HAIN Subsea system for ROV's and HAIN Reference system for rigs and vessels. For more information on HAIN, see the separate HAIN brochures.

Below: A simplified diagram illustrating the double HiPAP system configuration (not to scale)



### HIPAP FOR DRILLING RIGS AND SHIPS

The HiPAP system can operate more than 500 transponders, providing all coordinates on the display. Position data output is also available. The system can denote transponder- locations at horizontal distances of up to 5-6 times the water depth, with increasing accuracy as the vessel gets closer to the required location. Vessel position will be given relative to any of the active reference transponders chosen by the operator, and all may be used with individual offsets in three dimensions. You can find the position of your template, stack, riser foot, ROV, Camera tool etc.

HiPAP used for underwater navigation is cost and time efficient when positioning the drill-bit to its first specified geographical position or when re-entering an existing well marked with a transponder.

Positioning of underwater vehicles and subsea tools relative to a fixed reference is performed simultaneously using transponders, responders or a combination of both.

In summary:

- Underwater navigation
- Underwater positioning
- Riser angle and differential angle measurements
- Acoustic Back-up Control of BOP

### LOWER ACOUSTIC RISER ANGLE (ARA) MEASUREMENTS

The HiPAP system is also capable of monitoring the riser angle by using an Inclinator Transponder, which measures both the X and the Y angle of the riser and sends the information by acoustic telemetry to the surface vessel. The Differential Tilt Transponder can be used to monitor the relative angle between the BOP/stack and the riser (in the flex joint). Operator selected alarm limits for visual as well as audible alarms for BOP position and riser angle are available.

### UPPER ELECTRICAL RISER ANGLE (ERA) MODE

An Ex Proof Motion Reference Unit (MRU) mounted on the riser below the drill floor and below the flex-joint. This MRU is hard wired to the APOS and will provide angle readings. The APOS will process and display the actual differential angle measurements between the rig's roll/pitch values, taken from the vessel mounted MRU, and the riser mounted MRU values.

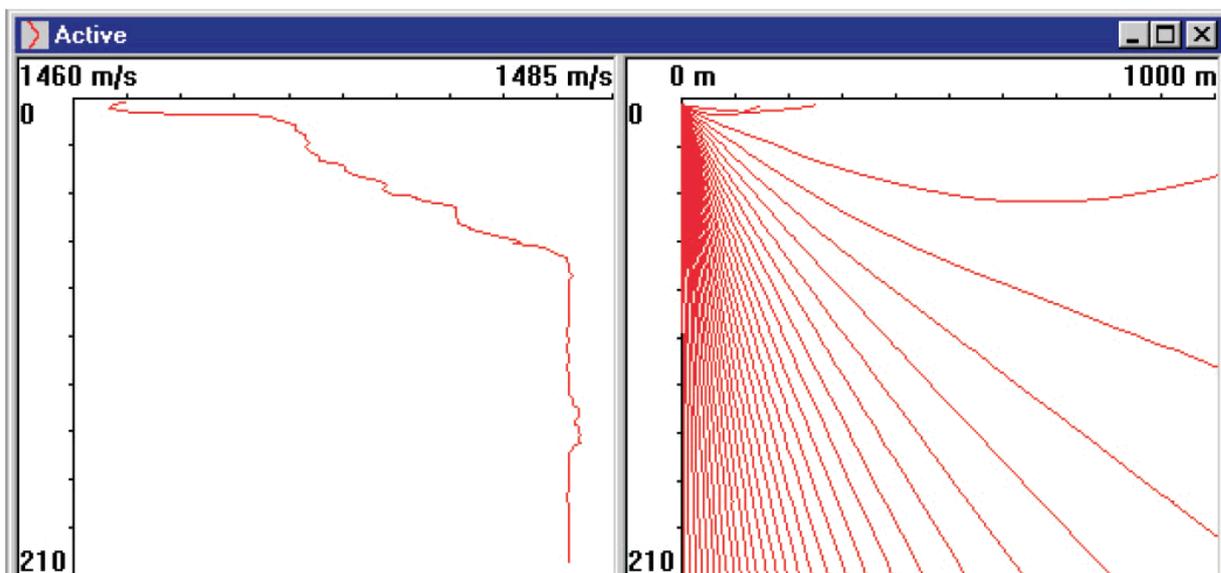
Both the ARA and ERA data are available on serial line or Ethernet outputs.

### SEA CURRENT MONITORING

The HiPAP system can be used to read sea current speed and direction at given points on a drilling riser by reading transponders interfaced to DVL (Doppler Velocity Log) sea current sensors.

*Below (left): An example of sound velocity profile from 0 - 210m depth.*

*Below (right): Ray bending effect from the profile.*



## ACOUSTIC CONTROL SYSTEM (ACS) FOR OPERATING THE VALVE FUNCTIONS ON THE BOP

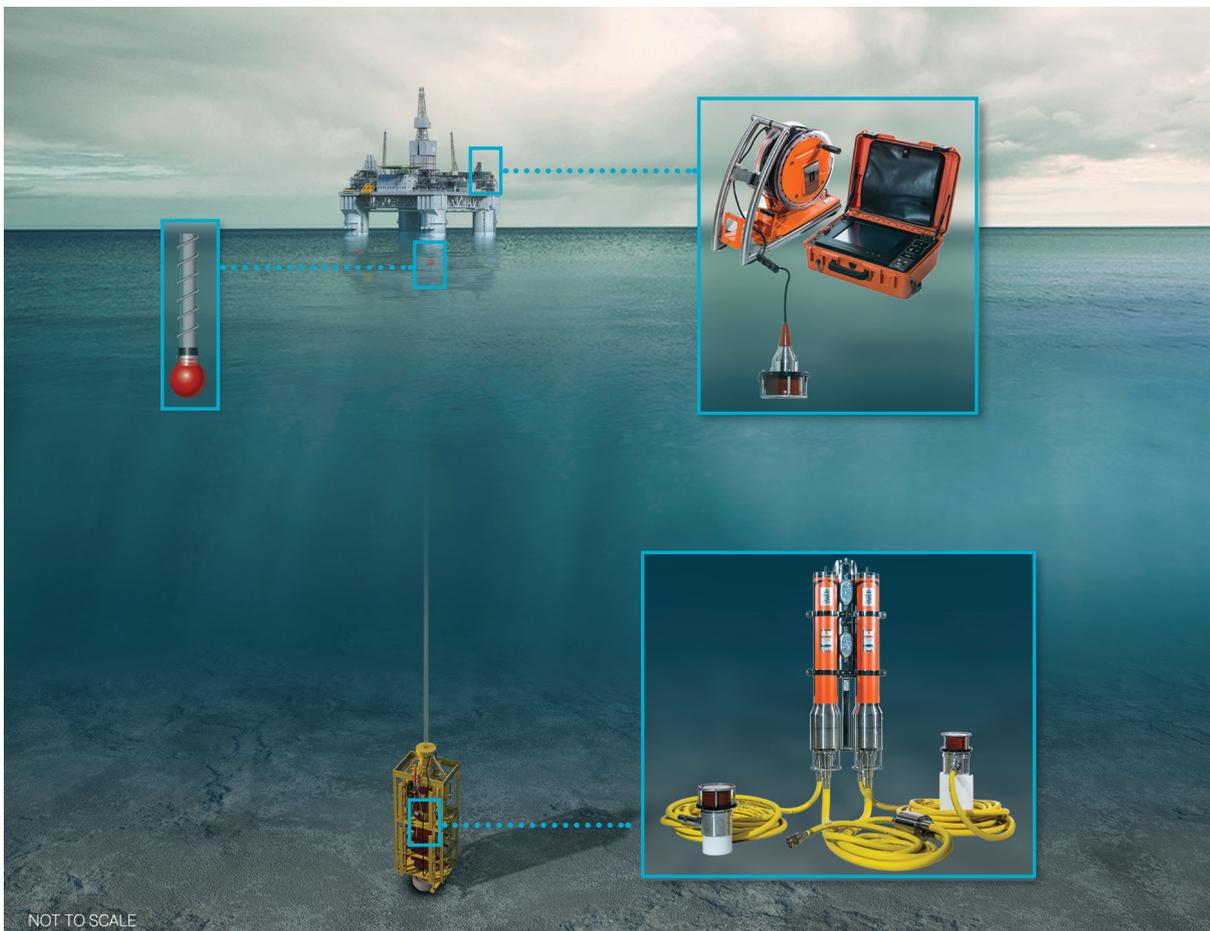
The valves on a Blow-Out-Preventer (BOP) are activated to operate by either using a hydraulic primary system or by using an acoustic system where signals from above are transmitted through the water column. The type approved ACS system is always delivered with a small command unit connected to a portable over-the-side dunking transducer. These units are designed for taking onto a lifeboat, a standby vessel, or into a helicopter in emergency situations, such as a Blow-Out, so that the operator can close down the BOP. The system plays an important role in environmental protection.

The HiPAP can also have software for operating with the Kongsberg ACS, which can operate the valves on the BOP. The HiPAP's hull mounted transducer is then used to perform telemetry to the Subsea parts in combination with the positioning tasks. Hull mounted transducers are mandatory in some countries.

For maintenance routine testing it is much more convenient to use HiPAP than performing the testing from the deck with a portable system.

For more information on Acoustic Control System, see the separate ACS brochure.

*Clockwise from top left: (in blue boxes) Hull mounted HiPAP transducer, portable control unit and subsea control unit with transducers*





# MODELS OF THE HiPAP® FAMILY

## THE HiPAP 502 – FULLY OMNI DIRECTIONAL

With its impressive transducer array of 241 computer controlled elements assembled in a sphere, no other system beats its performance. Accuracy is always dependent on the beam width, and the active area of a transducer gives HiPAP 502 the best accuracy in the market.

The HiPAP 500's spherical transducer allows the system to form narrow listening beams of 10° for reception of signals from the transponder. This beam can be pointed in any direction below the vessel, also horizontally and even upwards to the surface, as the transducer has the shape of a sphere and operating area of 200°.

## HiPAP 452

Except for a shortage of 6 of the advanced 32 channel Transmitter/Receiver Boards and Software, the HiPAP 452 system configuration is identical to the HiPAP 502. This means that the HiPAP 452 system's transducer is the same as the HiPAP 502 system's transducer, with its unique and advanced spherical shaped transducer. It has the same amount of elements as the HiPAP 502, but only the 46 lower sector elements of the sphere are activated and in use.

The HiPAP 452 uses medium-narrow listening beams of 15° for reception of signals from the transponder(s). For the interrogation of the transponder(s) a wide beam is used. The operating area below the vessel is 120°, as with the HiPAP 352 system, and the total coverage is 160°.

The HiPAP 452 system has the same operational and technical performance as the HiPAP 352. It can be easily upgraded within hours to the full HiPAP 502 performance at any time.

## HiPAP 352

The HiPAP 352 has many times more active transducer elements than our HPR systems and our competitors' systems. With its smaller transducer head, 320mm diameter, it can penetrate all existing HPR's 350mm gate valves. That means easy and inexpensive upgrades. The transducer is simply identical with the 46 lowest elements of the HiPAP 500 spherical transducer and the total coverage is 160°. It will typically be used for positioning within a cone sector of 120° below the vessel and where the extreme HiPAP 502 accuracy is not needed.

Below: (From left to right) HiPAP 502/452/352/102.  
A simplified drawing demonstrating the beam coverage capabilities of the HiPAP family transducers.  
Note: The orange dotted line shows the maximum coverage, and the blue dotted line shows the recommended operating area.



### HiPAP 102 –ULTRA DEEP WATER POSITIONING

HiPAP 102 is the Low Frequency member of the HiPAP system family. With high accuracy, good repeatability and high reliability, the HiPAP 102 system is the multi-purpose acoustic positioning system for ultra-deep water operations. The system is supplied as a multi-purpose “ultra-deep water” acoustic positioning system using transponders with depth rating down to 7000m (deeper on demand). The transducer can also be 30° mechanically tilted to maximize performance in the wanted area. The tilted transducer will still penetrate a 500mm valve.

The HiPAP 102 is well proven, and it provides the simplest way to position ROVs and other objects in very deep water and at long ranges using either or both SSBL and LBL principles.

The HiPAP 102 deep water system can also be combined with the medium depth HiPAP 352 and HiPAP 502 systems and operated from the same operator station.

### HIPAP 351P – PORTABLE FOR VESSELS OF OPPORTUNITY

This is the portable member of the HiPAP family. With its unique, compact transducer containing a complete transceiver and an accurate Motion Reference Unit, it will bring a new era into the underwater positioning services for vessels of opportunity. It is the only automatic beam steering portable transducer in the market.

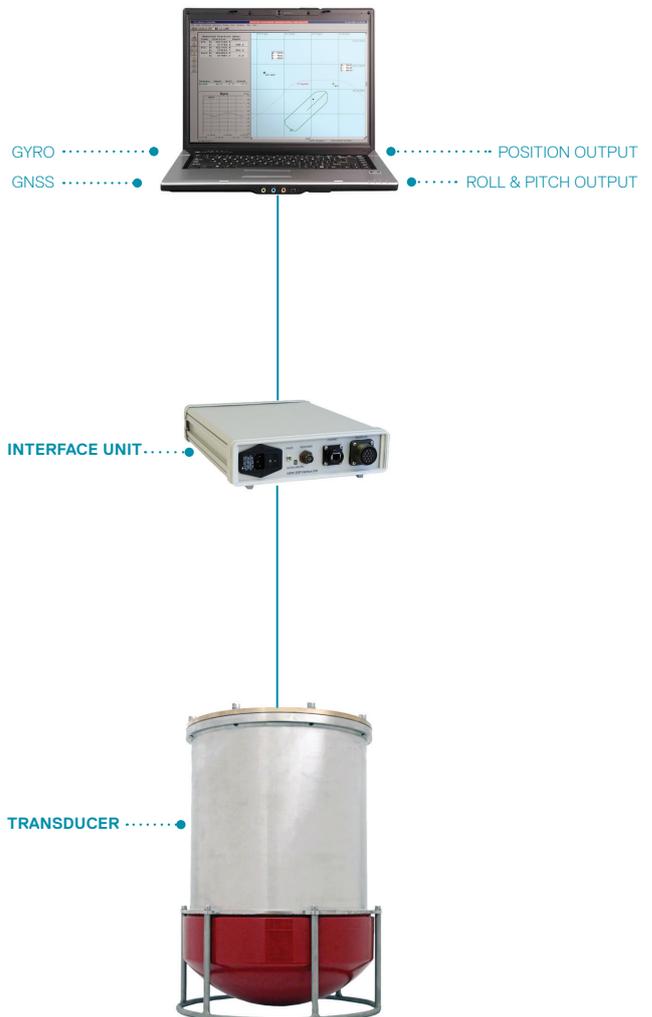
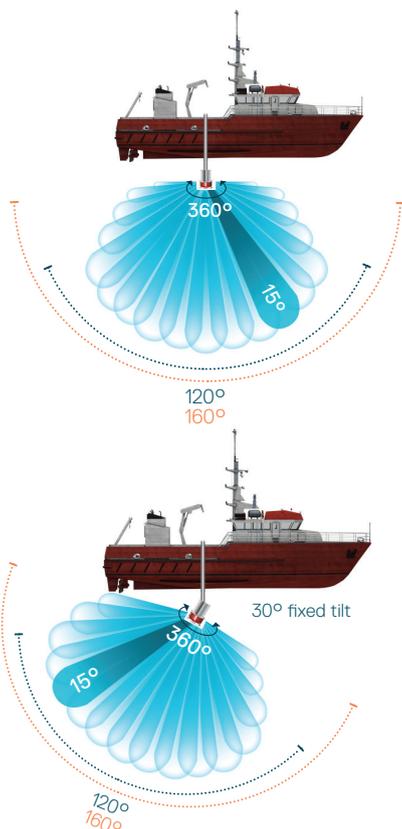
The transducer is designed to be mounted on a shaft to be installed over-the-side or through a moon-pool of a vessel.

The transducer can be tilted to have the 120° cone operating area in the sector of the required area. The total coverage is 160°. There will be no need for extra calibration, or mechanical fine adjustments, as the internal Motion Reference Unit will automatically compensate for the tilt. A built in north seeking heading sensor is also available. This is based on an inertial measurement unit.

Below (left) A simplified drawing demonstrating the beam coverage capabilities of the HiPAP 351P.

Note: The orange dotted line shows the maximum coverage, and the blue dotted line shows the recommended operating area.

Below (right) A simplified system diagram showing the HiPAP 351P set up.



# APOS TRAINER AND APOS SURVEY

## APOS TRAINER

The HiPAP Acoustic Positioning Operator Station (APOS) is now available in a Trainer version for customers. The APOS Trainer is supplied on a USB stick for installation on a PC along with a simulator which replaces the transceiver and the transponders.

The APOS Trainer is operated as a normal HiPAP system, and is therefore suitable for training, planning and demonstration purposes.

### APOS TRAINER FEATURES:

- A USB Stick containing full APOS software with most options
- APOS instruction manual
- Includes Sound Velocity ray trace calculation with displaying of deflection based on velocity profile input
- Includes Long Base Line array planning tool
- Includes data output for testing telegram interfaces to external computers (transmits standard HPR/HiPAP telegrams)
- Includes simulators for GNSS, depth sensors, sound velocity sensor etc.

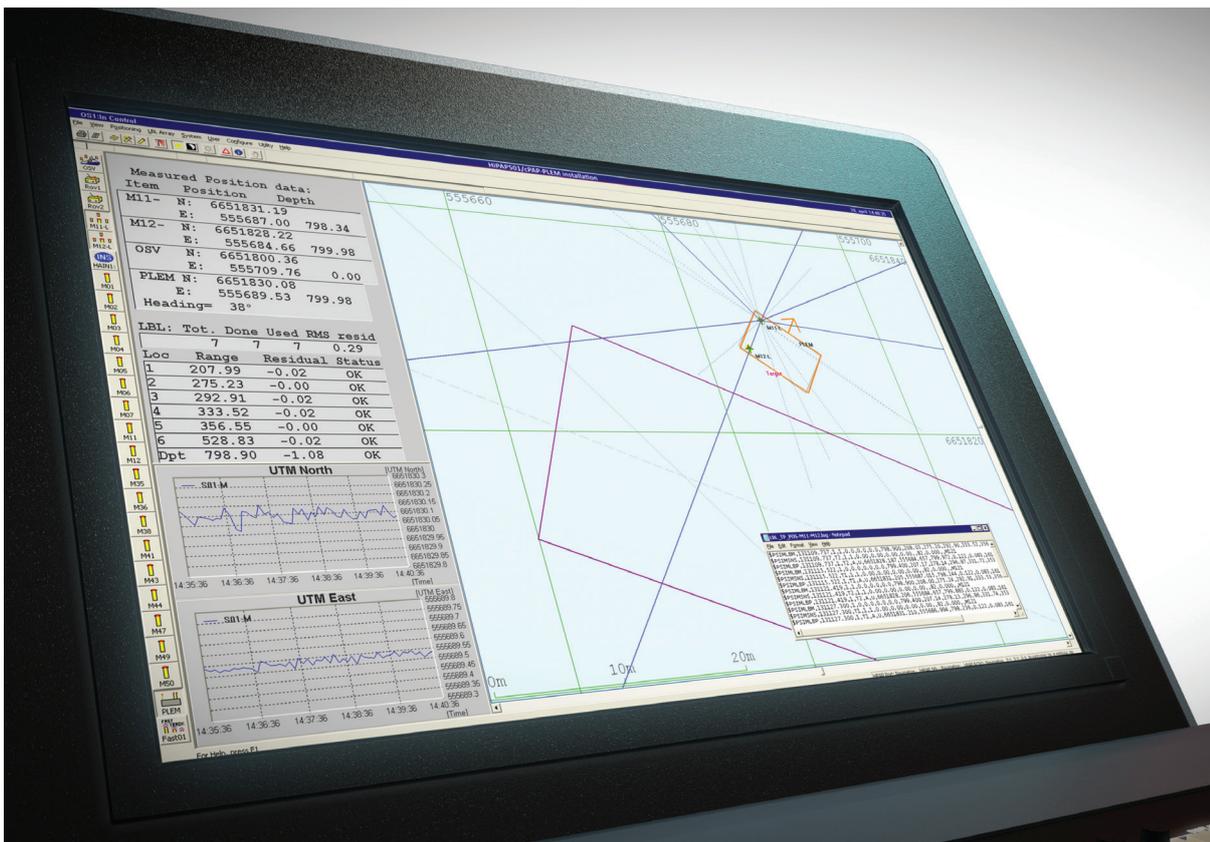
## APOS SURVEY - THE THIRD PARTY VESSEL SOLUTION

APOS Survey is simply an extra computer that a surveyor brings onboard to connect to the vessel's HiPAP. The APOS Survey computer will operate in parallel with the vessels normal use of HiPAP, i.e for DP reference and surveyors acoustic use will be interleaved in between the vessels acoustics 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. APOS SURVEY computer allows SSBL positioning, telemetry, full LBL mobile structure positioning, interfacing of the cPAP ROV transceiver and HAIN.

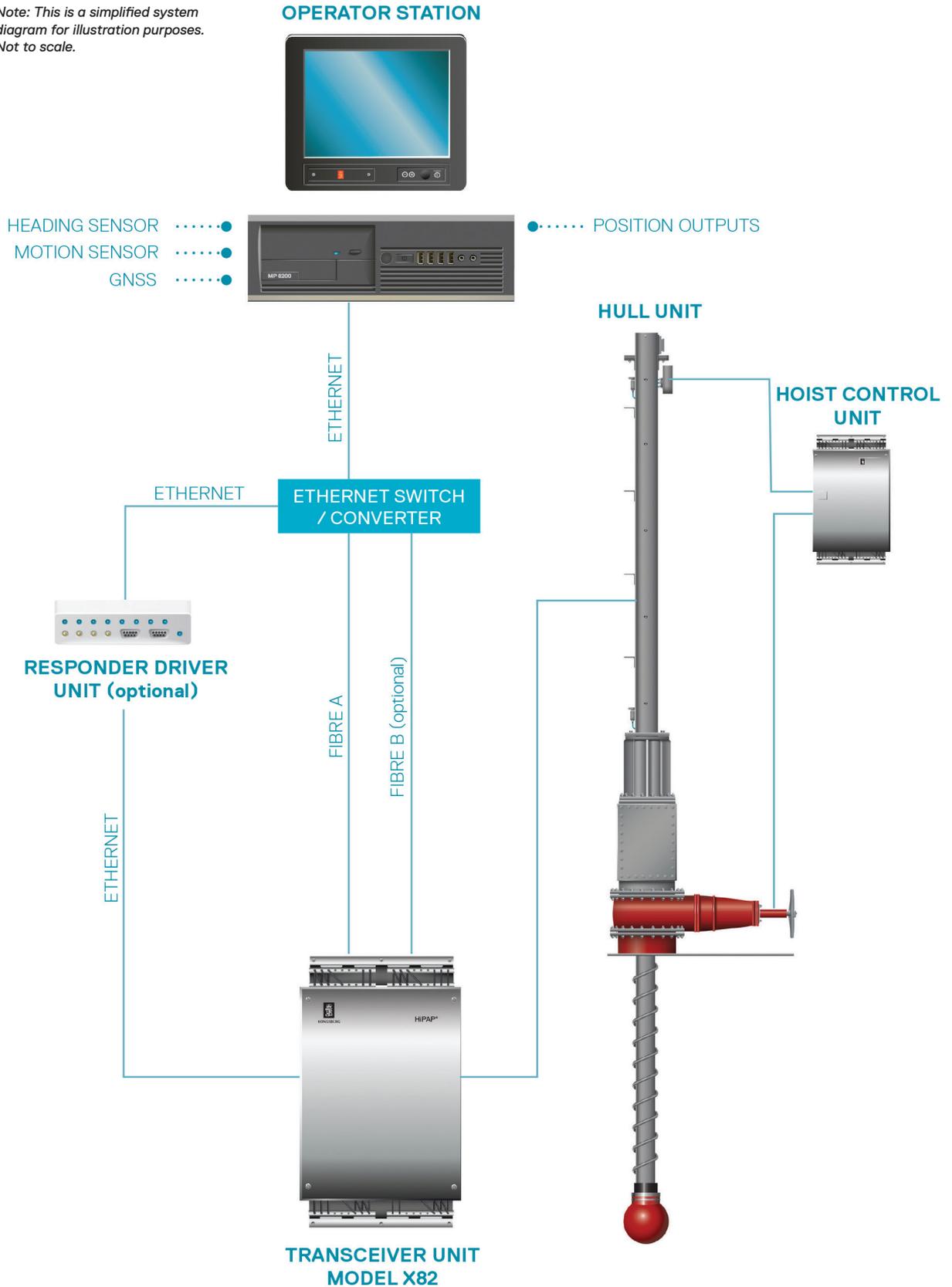
Both the vessels APOS and APOS Survey can compute position from the same SSBL transponders with independent calculations, and HiPAP transducer alignment for both the vessel and APOS Survey system can be run simultaneously off the same seabed transponder.

APOS Screen



# HiPAP® SYSTEM DRAWING

*Note: This is a simplified system diagram for illustration purposes. Not to scale.*



# HiPAP® SYSTEM FEATURES

## STANDARD FEATURES

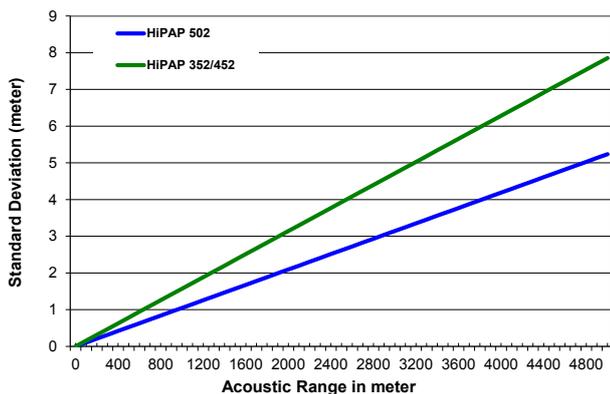
- SSBL function
- Online help function
- Automatic transducer alignment calibration
- Error compensation for ray bending
- Display of ray bending
- External Depth Sensor interface
- Position and angle alarm limits
- Noise spectrum analyser
- Emergency channels A & B
- Telegram output to DP system
- Telegram output to survey system
- Transponder telemetry for full utilisation
- GNSS interface
- Cymbal mode (wideband PSK)
- Continuous wave (FSK)
- APOS trainer
- Display a history track in the graphical view
- Operates on Windows
- 500+ PSK channels
- 56 FSK channels
- Automatic beam steering
- Interface to multiple heading/roll/pitch sensors.

## OPTIONAL FEATURES

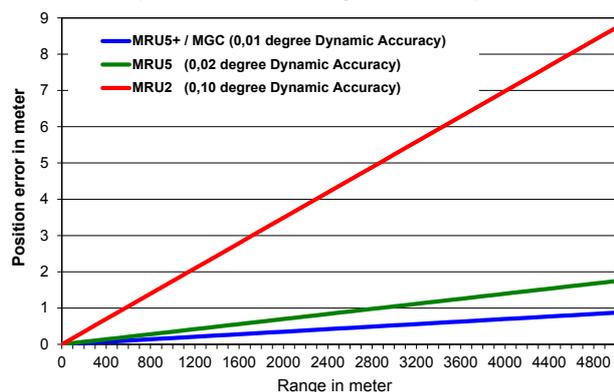
- Responder mode
- Beacon mode
- Compass Transponder mode
- Depth Sensor Transponder mode
- Inclinometer Transponder mode
- Long Base Line (LBL) functionality
- Fast LBL Transponder Positioning mode
- LBL Accurate Metrology mode
- Geographical LBL calibration
- Multi User LBL functionality
- Multi LBL functionality
- Multiple Operator Station function
- ACS BOP Telemetry function
- Offshore Loading Telemetry function
- Submerged Turret Loading function
- APOS transparent modem function
- APOS 3D current meter option
- Survey OS option
- FastTrack option
- Dual HiPAP increased SSBL accuracy function
- Lower Acoustic Riser Angle (ARA) mode
- Upper Electrical Riser Angle (ERA) mode
- Anchor Line Monitoring function
- Transponder Relay function
- Extension for Audible Alarm
- 3D Current Meter option
- Read Transponder External Sensor.

From the below curves one can see that the quality of the MRU is most important to the overall positioning of the underwater target as the total position error will be the sum of the HiPAP and the MRU error budgets.

**HiPAP Accuracy**



**Position Error from Pitch / Roll sensor  
(Values are within +/- 5 degree movements)**



# TECHNICAL SPECIFICATIONS

SYSTEM	HiPAP 502	HiPAP 452	HiPAP 352	HiPAP 351P series	HiPAP 102
TRANSDUCER OUTLINE					
NUMBER OF ACTIVE ELEMENTS	241	46	46	46	31
MAX / RECOMMENDED ACOUSTIC OPERATING AREA BELOW VESSEL	200° / 200°	160° / 120°	160° / 120°	160° / 120°	120° / 120°
MINIMUM GATE VALVE SIZE REQUIRED	20in / 500mm	20in / 500mm	14in / 350mm	-	20in / 500mm
TRANSDUCER DIAMETER	400mm	400mm	320mm	345mm	460mm
ANGULAR ACCURACY* OF X/Y DIRECTIONS (1 SIGMA FIGURES)	20 dB S/N: 0,06° 10 dB S/N: 0,10° 0 dB S/N: 0,30°	20 dB S/N: 0,10° 10 dB S/N: 0,15° 0 dB S/N: 0,40°	20 dB S/N: 0,10° 10 dB S/N: 0,15° 0 dB S/N: 0,40°	20 dB S/N: 0,18° 10 dB S/N: 0,23° 0 dB S/N: 0,40°	20 dB S/N: 0,14° - -
ACCURACY DUAL MODE OPTION, TWO-TD SYSTEM*	20 dB S/N: 0,042°	-	-	-	-
NARROW POINTING RECEIVING BEAM	10°	15°	15°	15°	15°
OPERATING RANGE*	1-5000m	1-5000m	1-5000m	1-4000m	1 – 10000 m
NUMBER OF TRANSPONDER CHANNELS, CW / CYMBAL	56 / 500+	56 / 500+	56 / 500+	56 / 500+	30 / 50
FREQUENCY BAND	21 – 31 kHz	21 – 31 kHz	21 – 31 kHz	21 – 31 kHz	10 – 15 kHz
RANGE DETECTION ACCURACY*	0,02 m	0,02 m	0,02 m	0,02 m	0,02 m
HULL UNIT FOR TRANSDUCER DEPLOYMENT	Available	Available	Available	-	Available

\*Position accuracy [°] can be calculated by  $\sqrt{X^2 + Y^2}$ . Values are based on; use of Cymbal mode, free line of sight from transducer to transponder, no influence from ray bending, Signal to Noise ratio as specified in water in the 250 Hz receiver band, no error from heading/roll/pitch sensors. Operating ranges are typical and conservative, and are assumed by using Kongsberg Transponders with sufficient source level.

All HiPAP 351P models includes attitude sensors with different accuracies. HiPAP 351P includes MRU-H, HiPAP 351P-5 includes MRU-5, HiPAP 351P-MGC includes MGC IMU and HiPAP 351P-I includes HG9900 IMU.

# 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 excellent 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

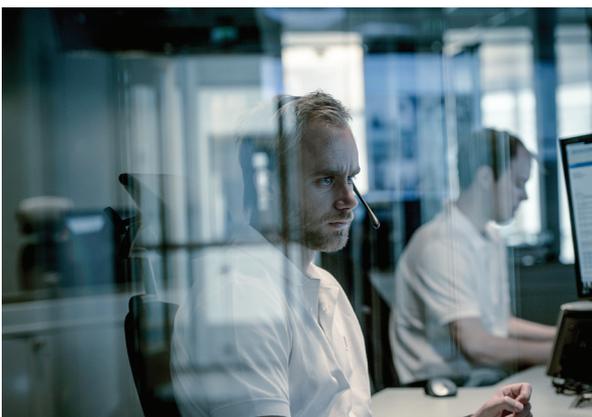
## Evergreen

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

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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.



## 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

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E-mail: [subsea@kongsberg.com](mailto:subsea@kongsberg.com)

## GLOBAL SUPPORT 24/7

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