

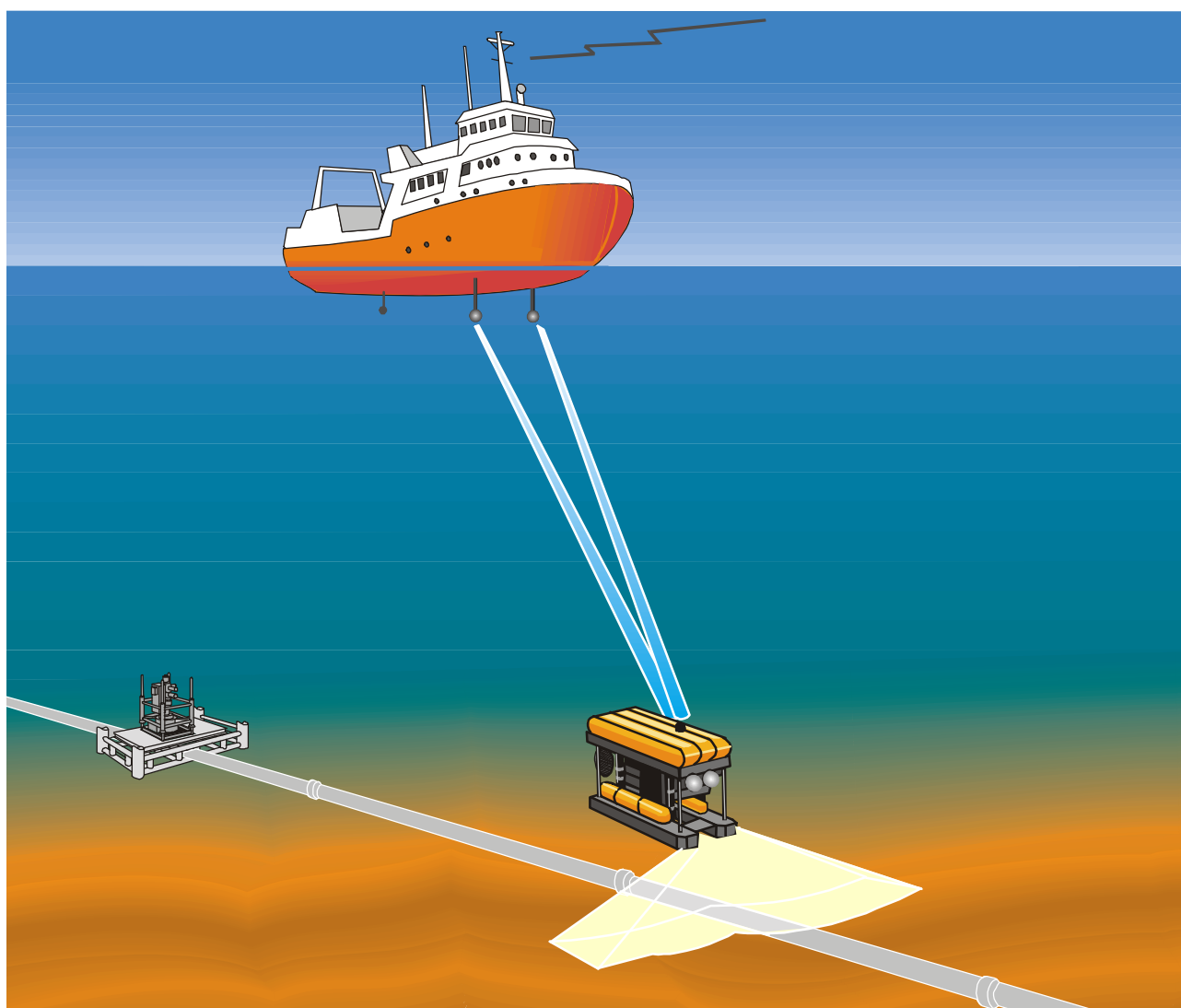


KONGSBERG

# Product description

## HiPAP 350 system

High Precision Acoustic Positioning system





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# ***HiPAP 350 system***

## High Precision Acoustic Positioning system

This document describes the HiPAP 350 system. The HiPAP 350 system is designed for positioning of subsea targets on both shallow and deep water.

The system uses both Super Short Base Line (SSBL) and Long Base Line (LBL) positioning techniques.

## Document logistics

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## Table of contents

<b>1</b>	<b>INTRODUCTION.....</b>	<b>5</b>
	Contents .....	5
	List of abbreviations .....	5
	HiPAP 350 system .....	5
	Sensors .....	6
<b>2</b>	<b>POSITIONING PRINCIPLES.....</b>	<b>7</b>
	Introduction.....	7
	SSBL positioning.....	7
	LBL positioning.....	9
<b>3</b>	<b>MEASUREMENT COMPENSATION.....</b>	<b>13</b>
	Roll - pitch - heading compensation .....	13
<b>4</b>	<b>APPLICATIONS.....</b>	<b>17</b>
	Dynamic Positioning (DP) reference.....	17
	Subsea survey and inspection .....	17
	Rig and Riser monitoring.....	17
	Acoustic Blow Out Preventer (BOP) control .....	17
	Construction work and metrology .....	18
<b>5</b>	<b>SYSTEM UNITS .....</b>	<b>19</b>
	General.....	19
	Operator Station .....	19
	Transceiver unit .....	22
	Transducer .....	23
	Hull units.....	23
	Hoist Control Unit .....	24
	Remote Control Unit.....	24
	Gate valve .....	24
	Mounting flange.....	24
<b>6</b>	<b>EXTERNAL INTERFACES.....</b>	<b>25</b>
	Position outputs.....	25
	Surface navigation .....	25
	Vertical Reference Unit (VRU) .....	25
	Gyro compass .....	25
	Integrated attitude sensors .....	25
	Interface specification.....	26

<b>7</b>	<b>SYSTEM CONFIGURATIONS .....</b>	<b>27</b>
	General.....	27
	Single HiPAP system.....	27
	Redundant HiPAP system.....	27
<b>8</b>	<b>TRANSPONDERS .....</b>	<b>30</b>
	General.....	30
	MPT series .....	31
	SPT series .....	32
	RPT series .....	33
<b>9</b>	<b>SYSTEM FUNCTIONS.....</b>	<b>34</b>
	Introduction.....	34
	Main functions .....	34
<b>10</b>	<b>TECHNICAL SPECIFICATIONS.....</b>	<b>40</b>
	SSBL accuracy.....	40
	LBL accuracy.....	43
	Range capabilities .....	44
	Unit specifications .....	45
	Outline dimensions .....	52
	HiPAP 350 hull units .....	60

# 1 INTRODUCTION

## Contents

This description covers the HiPAP 350 system. It provides a general description of the systems, each module, the functions and technical specifications.

## List of abbreviations

ACC	Acoustic Control Commander
ACS	Acoustic Control Subsea
APC	Acoustic Positioning Computer
APOS	Acoustic Positioning Operator Station
BOP	Blow Out Preventer
DGPS	Differential Global Positioning System
DP	Dynamic Positioning
GPS	Global Positioning System
HiPAP	High Precision Acoustic Positioning
HPR	Hydroacoustic Position Reference
LBL	Long Base Line
MPT	Multifunction Positioning Transponder
MULBL	Multi-User Long Base Line
ROV	Remotely Operated Vehicle
RPT	ROV Positioning Transponder
SPT	SSBL Positioning Transponder
SSBL	Super Short Base Line
VRU	Vertical Reference Unit

## HiPAP 350 system

The system is designed to provide accurate positions of subsea targets such as Remotely Operated Vehicles (ROVs), towed bodies or fixed transponders. To achieve the accuracy, it uses a spherical shaped transducer design and a new signal processing technique. This new technique enables narrow beams to be generated in all directions within the lower half of the transducer using only electronic beam control.

The HiPAP 350 operates as an SSBL system, measuring angles and range by using a unique processing technique that provides very high accuracy. For LBL operation the system can simultaneously position several seabed transponders and compute the vessel's position.

The HiPAP 350 has a spherical transducer with a cylindrical body including 46 transducer elements. This model has good accuracy in the +/- 60° coverage sector and is suited for operations where the major positioning targets are within this sector.

The use of *narrow beams* provides:

- High accuracy
- long range
- good noise reduction capabilities.

The HiPAP 350 transducer has a diameter of 320 mm and will be installed with a 350 mm gate valve. Installing the system with a 500 mm gate valve will enable an easy upgrade to a HiPAP 500 system.

## **Operating modes**

The HiPAP system has the following main operating modes:

- SSBL - This mode positions various targets by directional and range measurements.
- LBL - This mode positions the surface vessel by simultaneously use of combined directional and range measurements to transponders in an LBL array.
- MULBL - This mode positions the surface vessel in an MULBL transponder array.
- Telemetry mode - This mode communicates to transponders for LBL calibration or metrology measurements.
- Telemetry mode - This mode communicates to instrument units and BOP systems.

## **APOS**

The HiPAP system is operated from the APOS, which is a Windows NT based software. The system can be operated from one single APOS station or from a wide number of APOS operator stations connected on a network.

The APOS software can also be integrated with the Kongsberg Simrad DP system.

## **Sensors**

The HiPAP system has a wide range of interfaces to sensors from different manufacturers.

A gyro compass and a vertical reference sensor will normally be interfaced to a HiPAP system.



## 2 POSITIONING PRINCIPLES

### Introduction

The HiPAP system uses two different principles for positioning. These two principles have different properties that make the system flexible for different applications.

- The SSBL principle is based on a range and direction measurement to one transponder, while the LBL principle is based on range measurements to minimum three transponders on the seabed.
- The position accuracy in SSBL is proportional to the slant range to the transponder, while the LBL accuracy is determined of the geometry of the seabed transponders and the vessel that is being positioned.
- The SSBL principle, due to its simple operation, is the obvious choice if the accuracy is good enough for the application being done. The LBL principle is the obvious choice if the SSBL accuracy is not good enough for the application being done, though it requires a more complex operation.

### SSBL positioning

In SSBL, the system calculates a three-dimensional subsea position of a transponder relative to a vessel-mounted transducer. The position calculation is based on range and direction measurements to one transponder. The onboard transducer transmits an interrogation pulse to a subsea transponder, which then answers with a reply pulse. When using a responder the interrogation is replaced by a hard wire trigger connection.

- The onboard system will measure the time from interrogation to the reply pulse is detected and use the sound velocity to compute the range.
- The transponder position is presented both numerical and graphically on the operator station. Only one onboard SSBL type transducer is necessary to establish this position.

Using a pressure sensor in the subsea transponder can increase position and depth accuracy. The pressure is measured and transmitted to the surface HiPAP system using acoustic telemetry. The depth is then used in the algorithms for establishing the 3D position. The system can also read the depth via a serial line input from a pressure sensor. Simultaneous use of many transponders is made possible by using individual interrogation and reply frequencies.

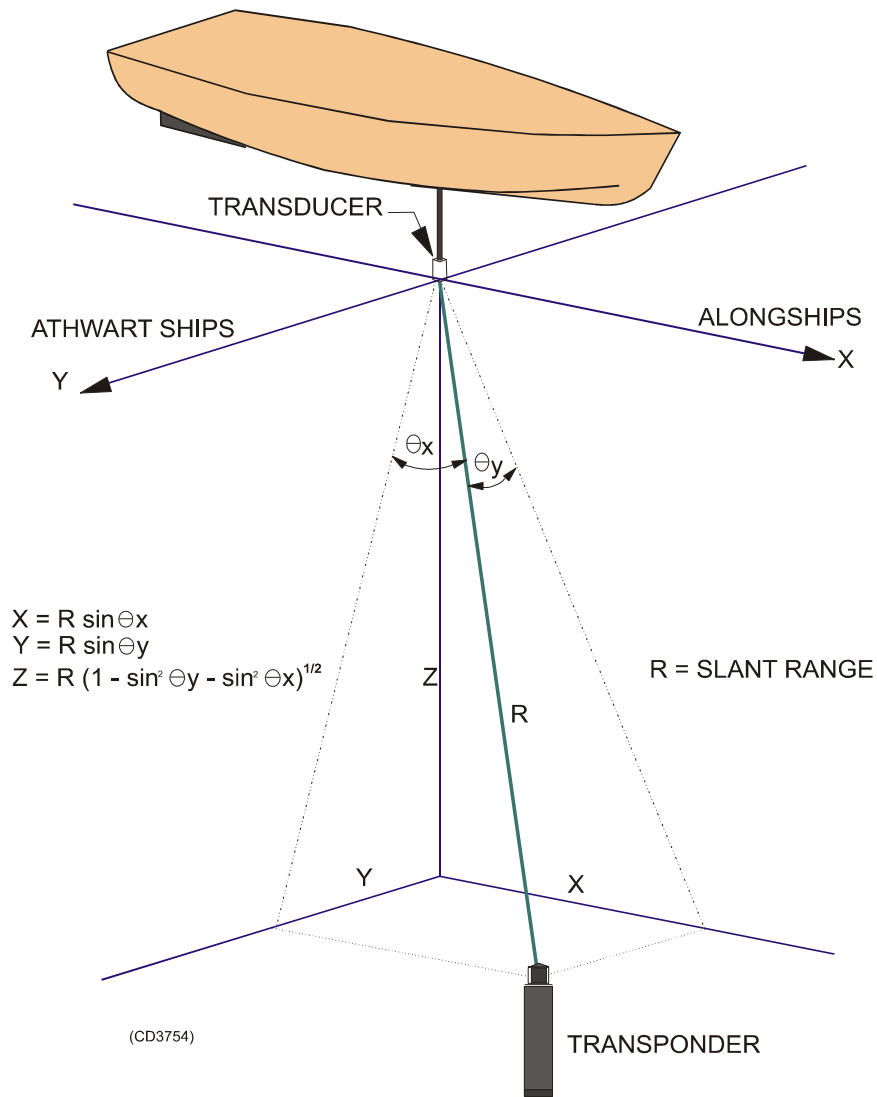


Figure 1 SSBL principle

## **LBL positioning**

### **Calibration**

The LBL principle is based on one vessel-mounted transducer, and normally 4 - 6 transponders on the seabed. This seabed transponder array must be calibrated before LBL positioning operations can begin. The calibration shall determine the transponder's positions in a local geographical co-ordinate frame. The HiPAP system supports two calibration techniques:

#### **Baseline measurements**

This technique uses automatic calibration functions in the HiPAP system. This allows all the ranges to be measured and made available by acoustic telemetry communication between the transponders and the vessel's system. Based on the baseline measurements and initial positions of the transponders, the calibrated transponder positions are computed.

#### **Runtime calibration**

To use this technique, the system is run in LBL positioning mode, using the SSBL positions of the seabed transponders for the vessel LBL position calculation. The runtime calibration function logs the measurements, and based on this, new optimised seabed transponder positions will be computed. This technique makes the baseline measurements redundant. If the baselines measurements are done, they are also used in the calculations.

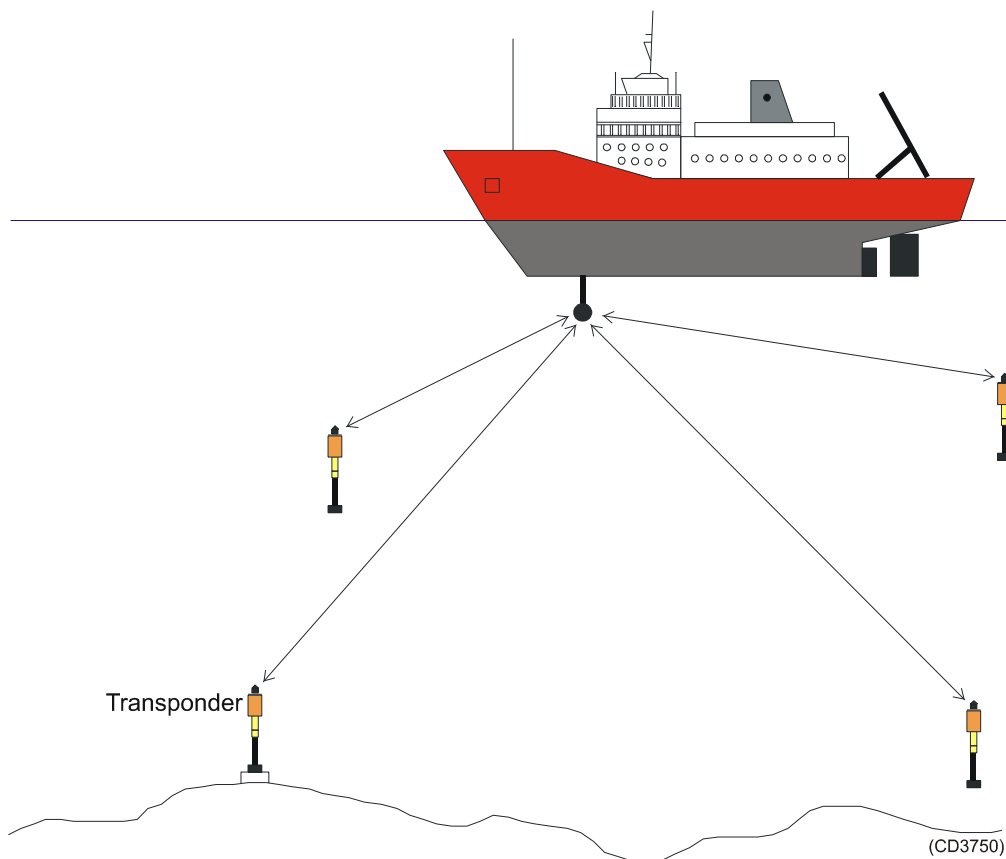
The calibration is performed only once prior to positioning operation, since the transponders will remain in the same location during the operation.

### **Positioning**

When the transponder positions are known, positioning of the surface vessel can begin. All the seabed transponders will be interrogated simultaneously, and each will respond with its specific reply signal. The LBL system will then calculate the ranges from the individual transponders. By using the calibration data together with the calculated ranges in software algorithms, the vessel or an ROV can be positioned. ROV positioning requires an HPR 400S transceiver to be mounted on the ROV..

- The system can take the depth from an ROV-mounted pressure sensor via a serial line. By using this depth in the computation, it will increase the position accuracy of the ROV.

- The range capabilities of a medium frequency LBL system will be approximately the same as those of an SSBL system.
- LBL positioning will give better position accuracy at greater water depths, but is more complex to operate, and it needs more transponders than the SSBL.
- LBL TP positioning method uses one transponder to measure the ranges to the transponders in the array and telemetry the data to the surface vessel which computes the position of the transponder.



**Figure 2 LBL principle**

## **Combined SSBL and LBL positioning**

The combined SSBL/LBL system uses an onboard multi-element transducer. The system may operate as an SSBL system and as an LBL system simultaneously.

As an example, the vessel may be positioned relative to the seabed using LBL while an SSBL transponder/responder on an ROV is positioned relative to the vessel. The vessel is displayed relative to the array origin and the ROV relative to the vessel.

The combined system will also use the measured directions in 2D together with the measured ranges in the LBL positioning. The combined measurement gives a robust system with increased accuracy. An LBL solution is achievable when only two transponder replies are detected.

## **Multi-User LBL positioning**

Several individual vessels and ROV units can now position themselves using the same seabed transponder array. The system and principle has the following main advantages:

- Provides high position accuracy (comparable to standard LBL).
- A small number of transponders serve all vessels and ROVs.
- Secures high position update rate (down to approx. 2 seconds), which is essential in DP operations.
- Avoids transponder frequency collisions when vessels are working in the same area (all vessels are "listening" only).

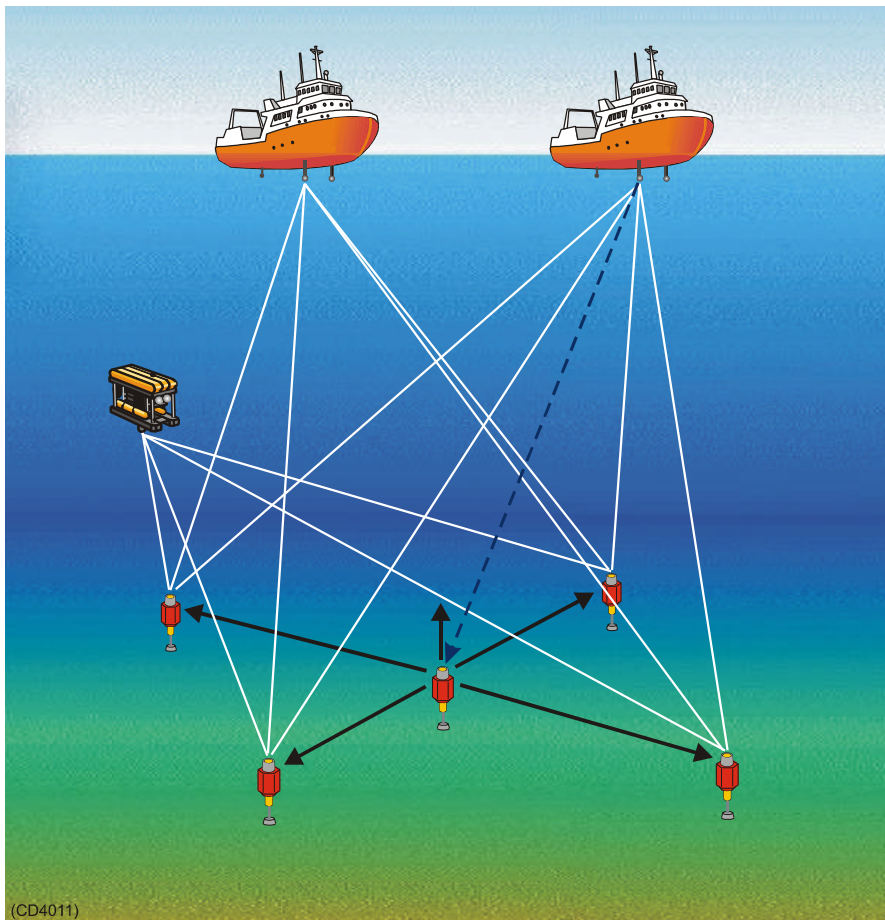
A transponder array is deployed and calibrated by use of subsea baseline measurements. One transponder is used as the Master in the positioning phase. The other transponders are called the Slaves.

The Master transponder acts as a beacon. It starts a positioning sequence by doing the steps described below. This is done regularly with an interval set by telemetry from one of the vessels.

- 1 The Master interrogates the Slaves.
- 2 The Master transmits its individual transponder channel to be received by the vessels/ROVs positioning in the array.
- 3 Each Slave transponder receives the interrogation from the Master and transmits its individual reply channels after a turnaround delay.

A MULBL system positioning in the array listens for the individual channels transmitted by the master beacon, and by the Slave transponders. When they are received, the system uses its knowledge about their positions in the TP array to calculate the differences in range to the transponders in the TP array. The time difference between the Master interrogation and the start of the reception of the pulses at the system is unknown. It has to be calculated together with the position of the vessel or ROV.

All vessels to use the MULBL array need the coordinates of the transponders and the channel numbers, which will be distributed of a file.



**Figure 3 Multi-User LBL positioning**

## **3 MEASUREMENT COMPENSATION**

### **Roll - pitch - heading compensation**

In order to compensate for the vessels roll/pitch/heading movements, vertical reference sensors and heading sensors are interfaced. Data from these sensors are used to compute position data that is relative to horizontal level and to north.

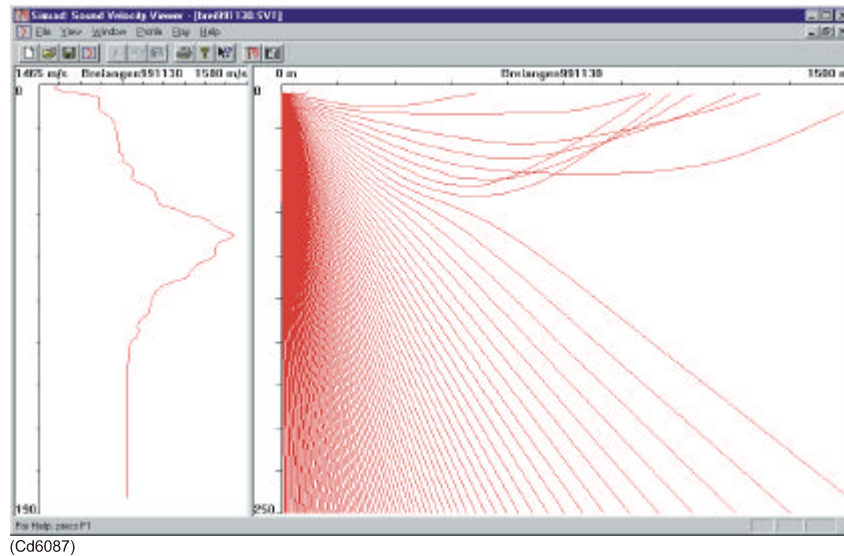
The absolute accuracy and the standard deviation of the position are very dependent of the roll/pitch/heading sensors performance. Specially when working at great waterdepths the roll/pitch/heading error contribution is significant and when working at long horizontal range the heading error contribution is significant. This compensation is used in all positioning modes.

The accuracy of the attitude data is of crucial significance for the total accuracy of the HiPAP system, and the error from the attitude sensor will add to the error of the HiPAP system.

As an example an roll or pitch error of 0.25 degrees will give an error of 4.4 meters at 1000 m depth, and an error of 13 at 3000 m depth, while a roll or pitch error of 0.05 degree will give respectively 0.9 m and 2.6 m.

## Ray bending compensation

Positions calculated from the raw measurements are influenced by variable sound velocity through the water column. The variable sound velocity causes an error in both range measurements and the angular measurements. By use of a sound profile the system can correct these errors.



**Figure 4 Sound profile – APOS presentation**

The sound velocity values may be measured by a probe and transferred to the system. If the depth of the target (transponder) is known either by depth sensor in the transponder or by an ROV depth sensor, these data can be transferred to the system and they will be used in the compensation.

The range calculation is compensated for the error caused by different sound velocities in the water column, and for the extra propagation path caused by the ray bending. The angular measurements are compensated for the ray bending.

The compensation is used in all positioning modes.

## Transducer alignment

After the HiPAP installation, it is necessary to determine a number of offsets between various sensor reference points and axes. These are:

- Vertical angular - The offset between transducer axis and roll/pitch sensor axis.
- Horizontal angular - The offset between roll/pitch sensor and heading reference.

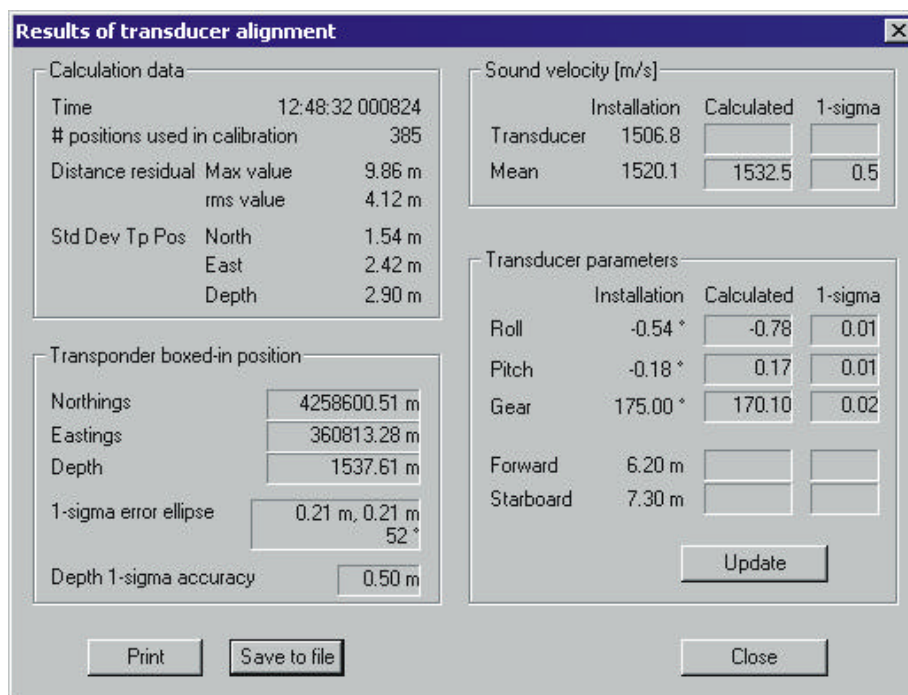


- Horizontal angular - The offset between transducer axis and heading reference.
- Horizontal distance - The offset between transducer location and reference point.

The principles for these alignment adjustments are based on the position of a fixed seabed transponder relative to the vessel and the geographical position of the vessel.

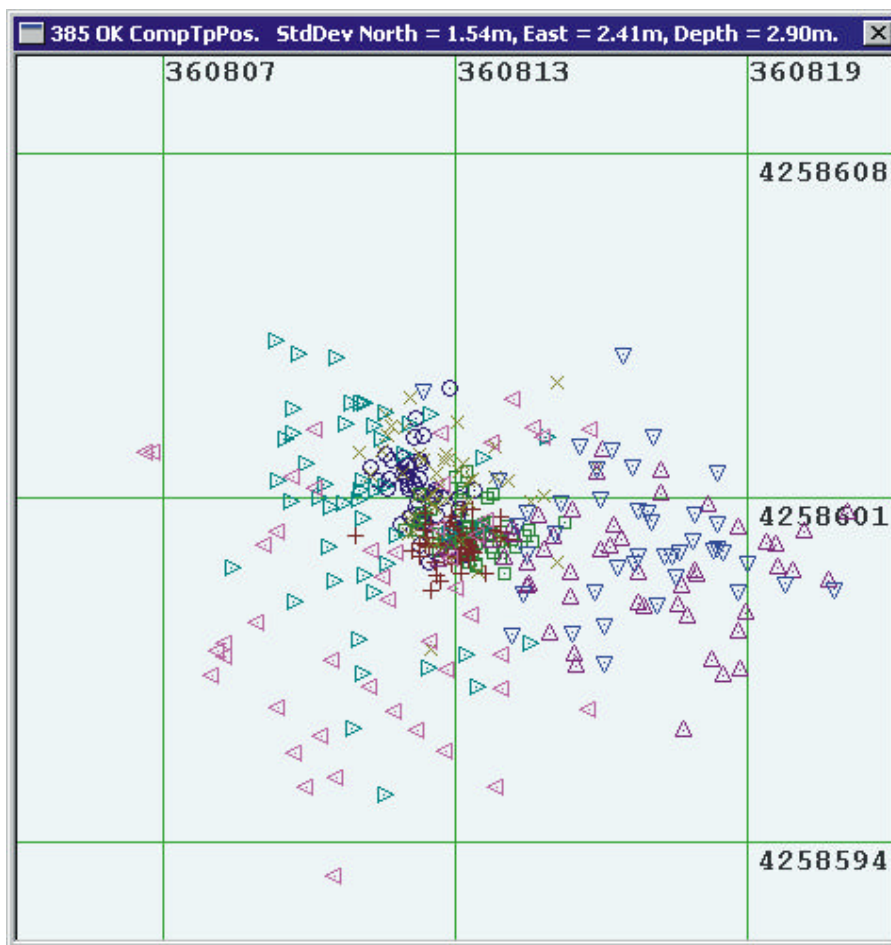
In order to simplify and improve the quality of the alignment scenario, the alignment function in APOS is used. By logging the vessel position from DGPS along with the measured HiPAP position of a seabed transponder, the program computes the alignment parameters. The normal procedure is to locate the vessel at four cardinal points and on top of the transponder with four headings.

Immediately the alignment parameters can be computed and automatically be transferred to the APOS alignment parameters. No manual transfer is needed. The results from the alignment are shown both numerical and graphically on the APOS. An example is shown in the two figures below.



(Cd5886)

**Figure 5 Result of transducer alignment – APOS presentation**



(Cd5885)

**Figure 6 Transponder positioning - APOS presentation**

The figure shows the positions at the seabed transponder in UTM coordinates after the compensation values are determined and applied. The various symbols are used so readings from different locations easy can be separated from each other.

## **4 APPLICATIONS**

### **Dynamic Positioning (DP) reference**

The position data can be used by a DP system as the reference signals for keeping the vessel in the desired position. High position accuracy and reliability ensure a secure and stable reference input to the DP systems. SSBL and LBL systems may be used.

### **Subsea survey and inspection**

Positioning of ROVs carrying instruments for survey and inspection is another important application for the HiPAP system. The ROV position relative to the vessel is integrated with the position from surface navigation to provide a geographical position of the ROV. In this application a responder is suitable.

Tracking towed bodies for similar applications may also be done. In survey applications, a best possible geographic position is wanted. To obtain this, sound velocity and depth (pressure) sensor input to the HiPAP system may be used.

### **Rig and Riser monitoring**

The HiPAP system can be used to monitor the drill rig position relative to the well/Blow Out Preventer (BOP). It can also be used with inclinometer transponders to monitor the BOP and riser inclination. Interface to electrical riser angle measurement is also available. Used with the Acoustic Control Subsea (ACS 400) it can be used for BOP.

### **Acoustic Blow Out Preventer (BOP) control**

The HiPAP system is also used for transmitting and receiving acoustic telemetry command with high security. This is used for acoustic BOP control, which includes BOP valve operation and monitoring critical functions by reading subsea status information and sending this information to the operator onboard the vessel.

A separate unit, the ACS 400, is required on the BOP stack. The ACS 400 contains electronics and batteries for interfacing the BOP.

A portable control unit, the Acoustic Control Commander (ACC 400), is also available. The ACC 400 contains electronics and batteries for operating the BOP functions.

## **Construction work and metrology**

### **LBL Transponder positioning**

A feature in the HiPAP system is to position one transponder relative to an LBL array. One Multifunction Positioning Transponder (MPT) is used to measure the range to other MPTs in an LBL array, and to transmit the ranges via telemetry to the surface HiPAP system. The HiPAP system computes the position of the transponder in the array.

The transponders may be interrogated simultaneously or in sequence. The ranges can be transmitted automatically after the measurement or on a controlled sequence from the surface HiPAP system.

The operator can control the speed of the telemetry link. A position update rate of 4 seconds is achievable. This function is ideal in applications like subsea construction and other object positioning where high accuracy is required and where there is no possibility to have an umbilical.

### **LBL High Accuracy Metrology**

The MPT transponders have a High Accuracy mode, which has a very good range accuracy performance. It is possible to measure baselines with accuracy better than 0.05 m. The MPT's are standard units that are operated by the HiPAP system.

The high accuracy and range capabilities obtained using MPTs in medium frequency mode reduce the need for high frequency transponders. High frequency transponders often need additional equipment to be installed onboard.

## 5 SYSTEM UNITS

### General

The HiPAP 350 system consists of four main units:

- Operator Station
- Transceiver Unit
- Hull Unit with transducer and hoist control
- Gate valve and mounting flange

Each transducer requires a dedicated hull unit arrangement and transceiver unit. One operator station can control several transceiver units.

→ *The units are shown in the system diagrams on page 28 and 29.*

### Operator Station

#### General

The Operator Station consists of:

- APC 10 computer
- WinKeyboard
- Colour monitor

The computer runs on the Microsoft Windows NT operating system. The user interface is a graphical user interface, designed as a standard Windows NT application.

A WinKeyboard with numerical keys and a trackball, controls the operation.

The screen is divided into 3 windows in which the operator can select several different views. Typical views are graphical position plot, numerical data, inclination and roll, pitch and heading. A normal display configuration is shown in the following figure.

One system may have one or several operator stations, which communicates on an Ethernet. One of the operator stations will be the Master. This is selected by the operator(s).

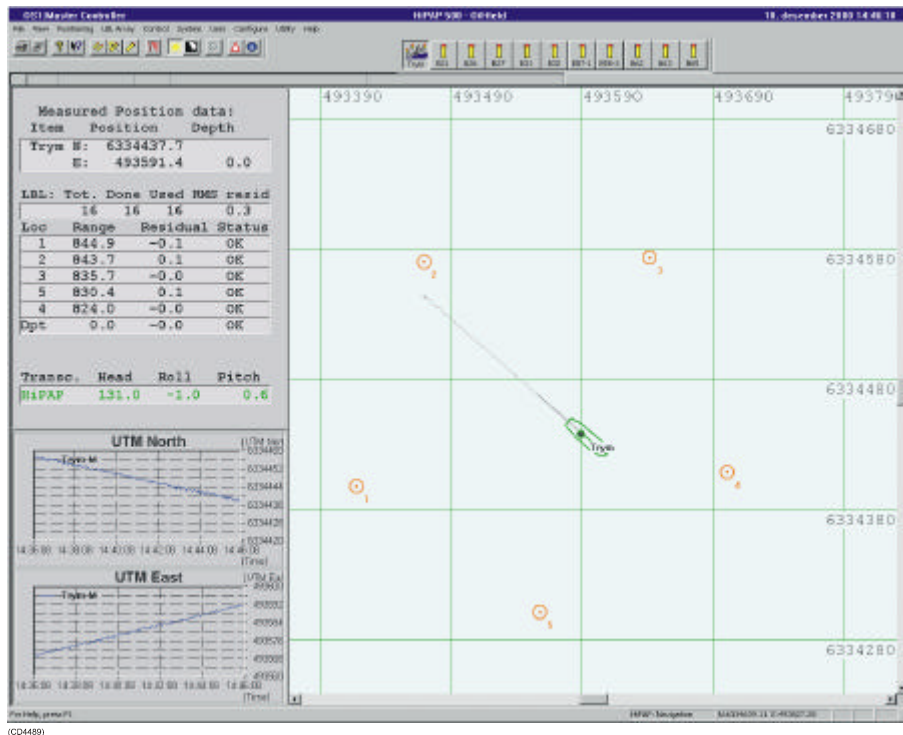


Figure 7 APOS presentation

## Operator Station configuration

A HiPAP system may be configured with the Operator Station in two ways:

- Stand alone APC 10 computer, monitor and WinKeyboard.
- Operator Console, integrated with the Simrad Dynamic Positioning (SDP) 70X series DP.

## Standard Operator Station

### APC 10 - Acoustic Positioning Computer

The Kongsberg Simrad APC 10 is the computer in the HiPAP Operator Station. It holds all the operational software and interfaces to display, keyboard, printers, network and other peripheral devices as required. The unit is normally fitted with a 3.5" floppy drive and a CD-read/write unit.

The APC 10 may be mounted desktop attached to the colour monitor, or in a 19" rack.

### ***LCD colour monitor***

LCD display is a general purpose, micro-processor based and digitally controlled display unit. The following models are available:

- LCD 151 - a 15" LCD display
- LCD 181 - a 18" LCD display
- LCD 201 - a 20" LCD display

The LCD displays can be installed in several ways; desktop, roof, panel or 19" rack.

### ***Keyboard***

The keyboard is designed for easy use. It includes numerical keys, function keys and a trackball with three buttons.

The keyboard can be mounted on the APC 10 or be placed on a desktop.

### ***Operator console***

The stand alone operator console integrates a 21" monitor, system controller and a keyboard. The console is identical to consoles used with the Kongsberg Simrad DP systems. The console is to be mounted on the deck and normally in line with the DP consoles.

### ***Operator console integrated with SDP XX***

The integrated HiPAP and DP operation is available as two different solutions.

### ***HiPAP and DP - multiple integrated operator stations***

When several operator stations are available, the operator can select to vie and operate the DP and the HiPAP on any station.

The operation is the same as for a single operator console.

### ***HiPAP and DP - multiple operator stations***

When several operator stations are available, it is also possible to dedicate one of the SDP consoles for the HiPAP operator station, and in addition, use other consoles as integrated operator stations for both DP and HiPAP use.

The operation is the same as for a single operator console.

## Transceiver unit

### General

The HiPAP 350 transceiver unit is interfaced to the spherical transducer array. The transceiver contains transmission amplifiers, A/D conversion circuits and a signal-processing computer. It is interfaced to one HiPAP transducer, attitude sensor(s), and controls the triggering of up to 4 responders. The transceiver outputs the transponder position to the APC 10. The unit is designed for bulkhead mounting close to the hull unit.

### Transceiver functions

- **HiPAP SSBL processing**
  - The HiPAP system determines the position of a subsea target (transponder or responder) by controlling a narrow reception beam towards its location. The system uses a digital beam-former, which takes its input from all the transducer elements.
  - The system uses a number of wide fixed beams to generate an approximate position for the target. Once this is achieved, it uses data from all the elements on the hemisphere facing the target to compute the narrow reception beam and optimise the directional measurement.
  - The range is measured by noting the time delay between interrogation and reception. The system will control the beam dynamically so it is always pointing towards the target. The target may be moving, and the vessel itself is affected by pitch, roll and yaw. Data from a roll/pitch sensor is used to stabilise the beam for roll and pitch, while directional data from a compass is input to the tracking algorithm to direct the beam in the correct horizontal direction.
  - The HiPAP transceiver can operate with up to 56 transponders simultaneously. The data is sent to the APC 10.



- **HiPAP LBL processing**
  - This mode is similar to the HiPAP SSBL processing, but the transceiver positions up to 8 LBL transponders for each single LBL interrogation. Both ranges and directions to the transponders are measured.
- **HiPAP MULBL processing**
  - This mode is similar to the HiPAP LBL processing, but the transceiver does not interrogate the MULBL transponder array, it only listen for the replies from the array. The transceiver can listen for to 8 LBL transponders. The direction to the transponders and the time difference between the received replies is transmitted to the APC 10.
- **HiPAP Telemetry processing**
  - The unit transmits acoustic telemetry messages, and receives and decodes the acoustic telemetry message from the transponder. The data is sent to the APC 10.

## Transducer

The HiPAP 350 has a spherical transducer with a cylindrical body including 46 transducer elements, the elements covers its +/- 60° cone pointing downwards. The large number of elements enables narrow receiver beams to be generated. The transducer is mounted on the hull unit.

## Hull units

The hull unit enables the transducer to be lowered, under either local or remote control, through the vessel's hull to a depth sufficient to minimise the effects of noise and air layers below the vessel. The hull unit is installed on top of a gate valve, which can be closed during maintenance (cleaning) of the transducer.

The hull unit also holds the guide-rail arrangement for keeping the transducer exactly aligned with the vessels reference line.

The following HiPAP 350 hull units are available:

### **HL 3770 with HiPAP 350 transducer for 350 mm gate valve**

This is the normally supplied hull unit for the HiPAP 350. It is supplied with a 350 mm transducer dock to fit on a 350 mm gate valve.

### **HL 3770 with HiPAP 350 transducer for 500 mm gate valve**

This is a hull unit for HiPAP 350. It is supplied with a 500 mm transducer dock to fit on a 500 mm gate valve.

### **HL 2180 with HiPAP 350 transducer for 350 mm gate valve**

This hull unit has reduced length for HiPAP 350. It is supplied with a 350 mm transducer dock to fit on a 350 mm gate valve.

**HL 2180 with HiPAP 350 transducer for 500 mm gate valve**

This hull unit has reduced length for HiPAP 350. It is supplied with a 500 mm transducer dock to fit on a 500 mm gate valve.

**HL 6120 with HiPAP 350 transducer for 350 mm gate valve**

This hull unit has extended length for HiPAP 350. It is supplied with a 350 mm transducer dock to fit on a 350 mm gate valve.

**HL 6120 with HiPAP 350 transducer for 500 mm gate valve**

This hull unit has extended length for HiPAP 350. It is supplied with a 500 mm transducer dock to fit on a 500 mm gate valve.

A HiPAP hull unit is equipped with the following sub units:

## **Hoist Control Unit**

This unit holds the power supplies and control logic for the hoist and lower operation of the hull unit. It also has a local control panel for local control of the hoist/lower operation.

## **Remote Control Unit**

This unit is normally mounted close to the display unit in the operation room. It allows remote control of the hoist and lower operation of the hull unit.

## **Gate valve**

There are two different gate valves available with 500 mm aperture and 350 mm aperture. The valve is hand-wheel operated delivered with electrical interlock for prevention of lowering the transducer into the gate.

As an option the gate valve can be delivered with an electrical actuator (electrical gate valve operation).

## **Mounting flange**

There are two different flanges available with 500 mm aperture and 350 mm aperture. Standard height is 600 mm.

## 6 EXTERNAL INTERFACES

### Position outputs

The HiPAP 350 system can be interfaced to other computers allowing them to process the position data for various applications. The system is flexible in the way it interfaces other computers. Several binary and ASCII formats are available on serial line and Ethernet using UDP protocol. A dual Ethernet is available for secure DP operations. An accurate time-tagged position output is available if the system is interfaced to a DGPS and synchronised to 1PPS.

→ *Refer to the NMEA 0183 sentences description, doc no. 850-160045.*

### Surface navigation

The HiPAP 350 system can be interfaced to a surface navigation system, as standard the system uses DGPS. When DGPS is interfaced, a number of features will become available, UTM grid on display, UTM position of transponders, transducer alignment and geographical calibration of LBL arrays.

### Vertical Reference Unit (VRU)

The Vertical Reference Unit (VRU) is interfaced to the HiPAP system transceiver unit. The system can thereby automatically compensate for the vessel's roll and pitch movements. The HiPAP system can use the same VRU as the Dynamic Positioning (DP) system (if one is fitted).

The VRU may or may not be a part of the Kongsberg Simrad delivery. In any case, the unit is documented separately by the applicable manufacturer.

### Gyro compass

The gyro compass supplies the HiPAP system with the vessel's heading relative to north. The HiPAP system may then provide transponder coordinates relative to north. It is also used to update the position filter as the vessel changes heading.

### Integrated attitude sensors

These sensors integrate rate gyros, accelerometer and GPS to provide an accurate roll, pitch, heave and heading output. These sensors are superior to traditional gyros and VRUs. The HiPAP system may be interfaced to such sensors.

## **Interface specification**

The HiPAP system has several interface formats available. These are described in the *Attitude formats description* document.

→ *Refer to the Attitude formats description, doc no. 853-201392.*

## **7 SYSTEM CONFIGURATIONS**

### **General**

A HiPAP 350 system may be configured in several different ways, from a single system to a redundant system with several operator stations. Some configurations are described below.

### **Single HiPAP system**

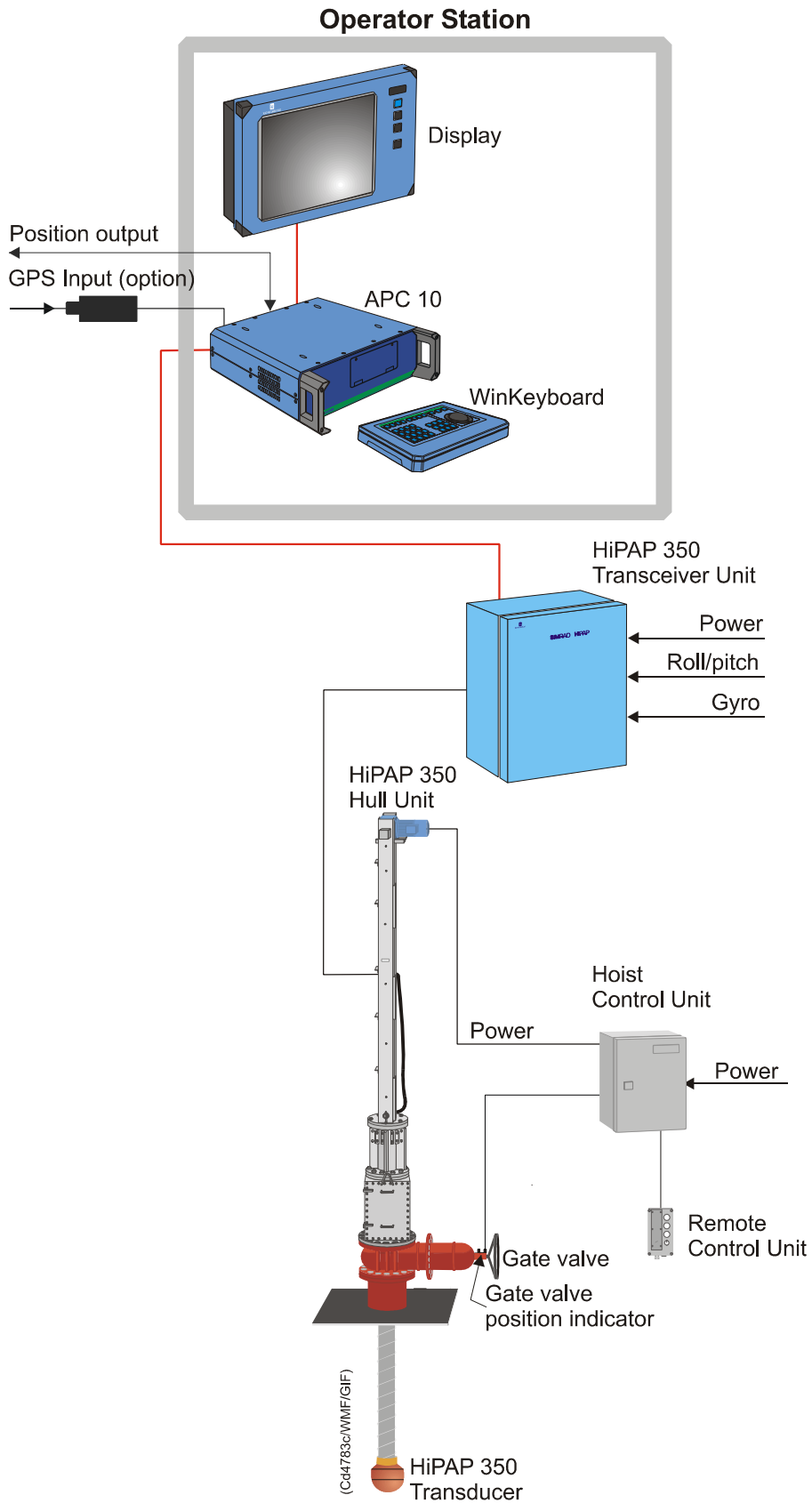
The single HiPAP 350 system has one transceiver and hull unit, but it may have one or more operator stations.

→ *See the system diagram on page 28.*

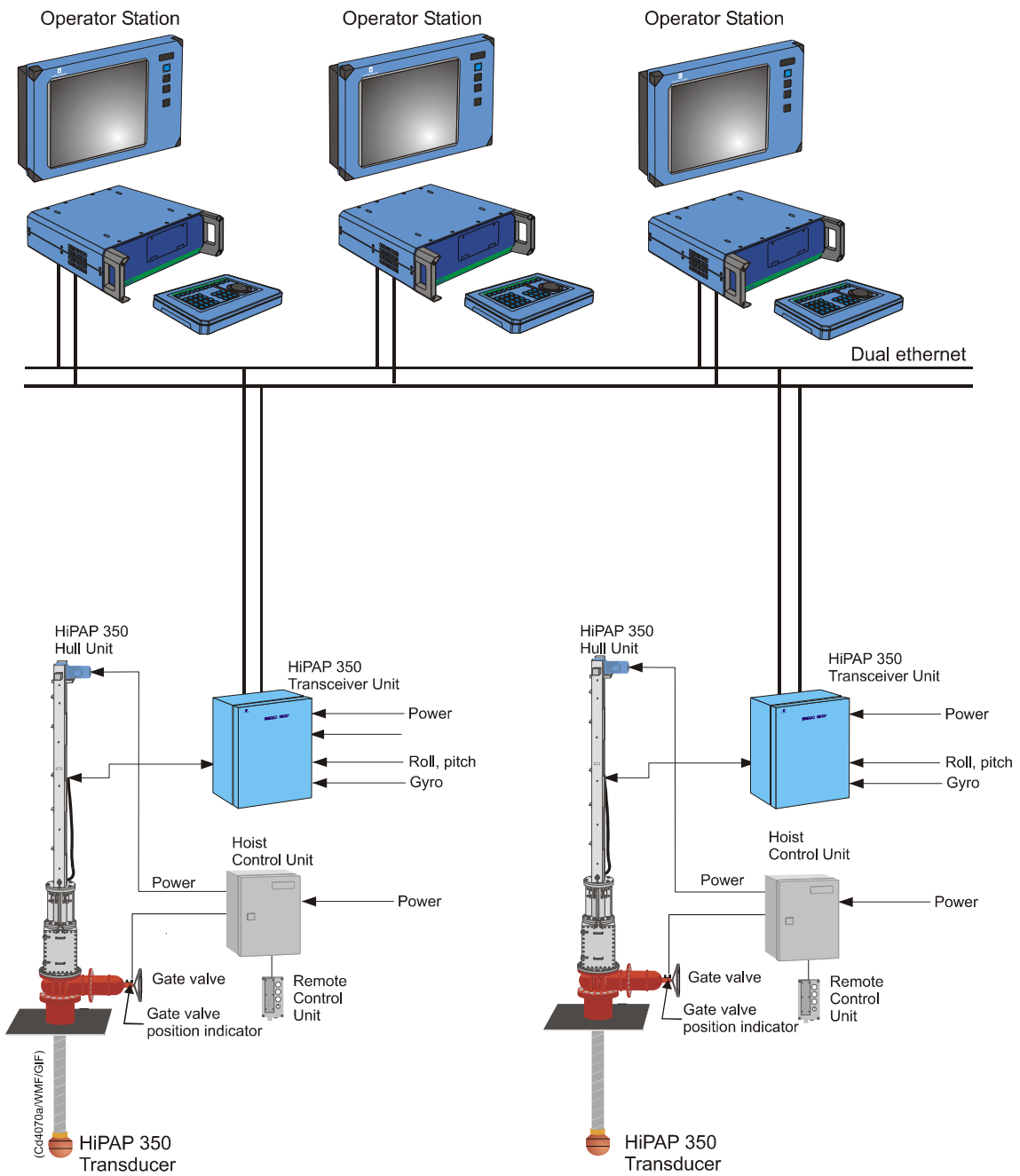
### **Redundant HiPAP system**

The redundant HiPAP 350 system has two or more operator stations and two or more transceivers and hull units. All transceivers are accessible from all operator stations. The redundant system will operate with 2 transponders, one on each transducer. The redundant system shall still be operational after one single failure in the system.

### Single HiPAP 350 – System Diagram



## Redundant HiPAP 350 – System Diagram



## 8 TRANSPONDERS

### General

The position calculation is based on range and/or direction measurements from the onboard transducer to the subsea transponder(s). For the HiPAP 350 system, there is a wide range of transponders available. The various transponders models have different depth rating, source level, lifetime, beam pattern and function. The transponder models consists of three series:

- MPT - Multifunction Positioning Transponders
- SPT - SSBL Positioning Transponders
- RPT - ROV Positioning Transponders

The MPT/SPT transponders are available with 1000 and 3000 m depth rating, while the RPT is available with 1000 and 2000 m depth rating.

The MPT and SPT transponders do all have acoustic telemetry included. By use of acoustic telemetry from the HiPAP system several parameters can be controlled:

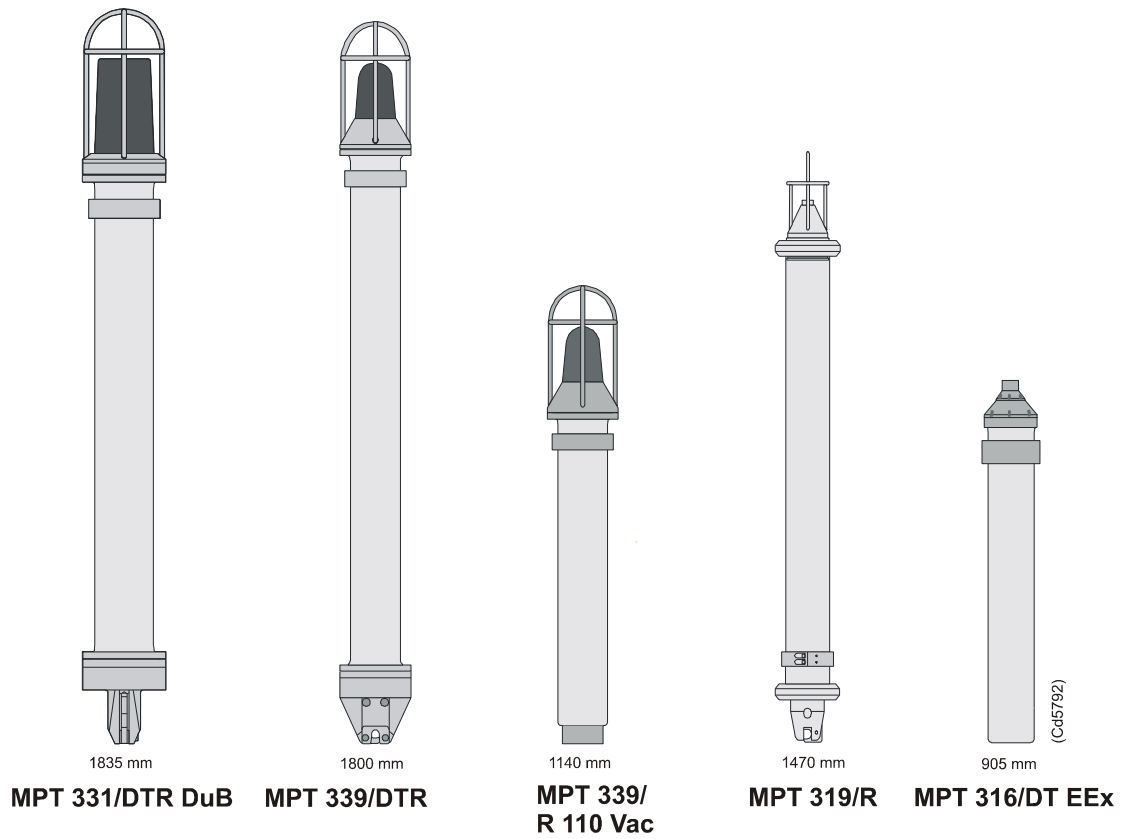
- Read battery status
- Enable/disable
- Transmitter power
- Receiver sensitivity
- Change channel - frequency
- Read sensors, if any
- Acoustic release

For full details, please see the *Product Specification* for each of the models.



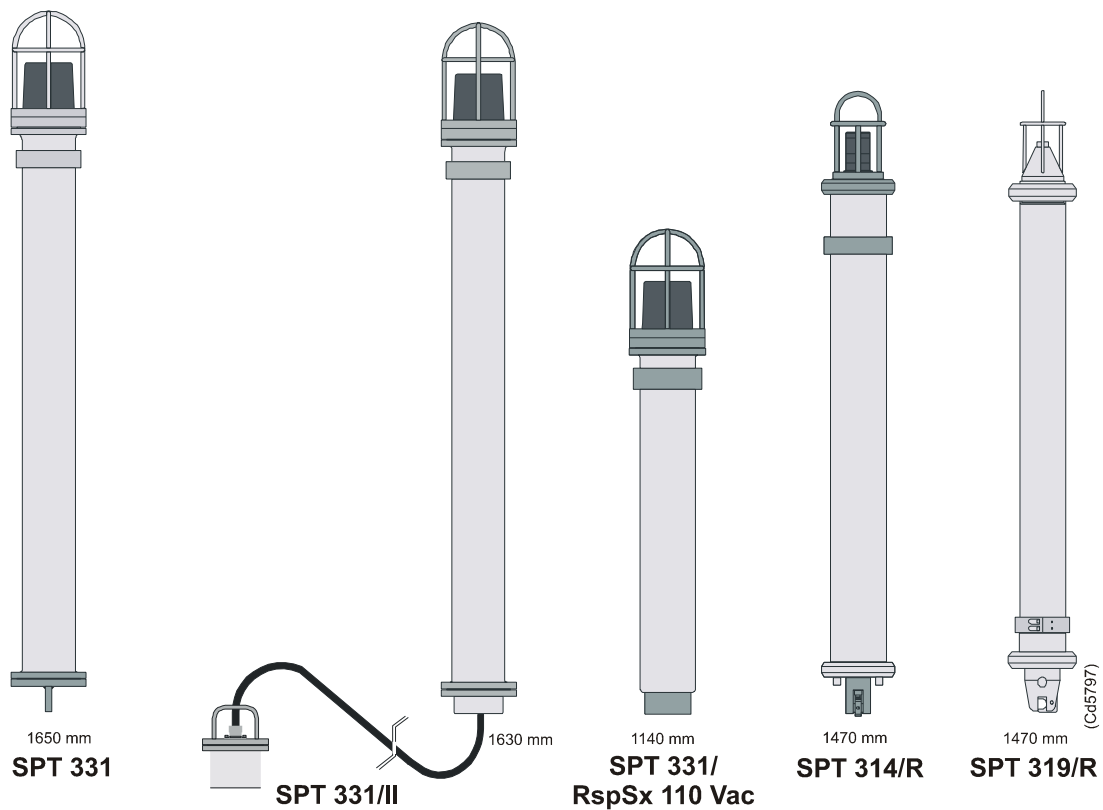
## MPT series

The MPT series consists of a wide number of transponders all suited for SSBL and LBL use. Depth rating, beam pattern, release mechanism, pressure and temperature sensor are among the options/choices available.



## SPT series

The SPT series consists of a wide number of transponders. All suited for SSBL use. The SPT has the same hardware as the MPT, but only the SSBL functionality. Depth rating, beam pattern, release mechanism, inclinometers, pressure and temperature sensor are among the options/chooses available.



## RPT series

The RPT is an SSBL mini transponder suited for ROV operation and where the size of the transponder can be a limiting factor. The transponder models cover various water depths. The RPT series consists of the following two models:

- RPT 319 - rated for 1000 m water depth
- RPT 324 - rated for 2000 m water depth

Both units have a rechargeable battery, can operate in responder mode and be externally powered.



330 mm

**RPT 319**

350 mm

**RPT324**

(C-d5798)

## **9 SYSTEM FUNCTIONS**

### **Introduction**

The HiPAP system consists of a wide range of functions. A function is selected by the operator. The basic systems have standard functions included, to ensure normal operation. The systems may be delivered with additional options selected from the system option list.

### **Main functions**

#### **General**

The main functions in the HiPAP system are described below. The system may be configured with one or several of these functions. They will appear in the systems main menu.

## List of main functions

The list below shows which functionality each of the functions includes. The "reg. no" is the unique identification for this function.

Example; the reg. no for APOS Base version is 886 - 212745.

Reg. no	Description
886-212745	<p><b>APOS Base Version</b></p> <p><i>APOS - Acoustic Position Operator Station</i></p> <p>Base for running all applications, includes:</p> <ul style="list-style-type: none"> <li>• Sound velocity profile function</li> <li>• Ethernet interface for position data</li> <li>• Serial line, RS-422 for transceiver interface</li> <li>• Serial line, RS-422 for position data</li> </ul> <p>Transponder telemetry for SPT/MPT transponders including:</p> <ul style="list-style-type: none"> <li>• Set transmit power level</li> <li>• Set receive sensitivity</li> <li>• Set Pulse length</li> <li>• Change channel</li> <li>• Enable/Disable</li> <li>• Transponder release</li> <li>• Read battery status</li> <li>• Read sensor data, if any</li> </ul> <p>Position and angle alarm:</p> <ul style="list-style-type: none"> <li>• APOS software for HiPAP or HPR 400 providing alarm for transponder position and riser angle alarm.</li> </ul> <p>APOS Depth sensor interface:</p> <ul style="list-style-type: none"> <li>• APOS software for interfacing a depth sensor for depth compensation of position. Suitable for ROV or Tow fish positioning.</li> </ul> <p>Interface to DGPS for providing data to transducer alignment:</p> <ul style="list-style-type: none"> <li>• An SSBL transponder position can be presented in geographical coordinates.</li> <li>• The clock may be synchronised to 1PPS from the DGPS receiver.</li> </ul>

Reg. no	Description
886-212746	<p><b>HiPAP SSBL function</b></p> <p>APOS software for HiPAP SSBL operation includes:</p> <ul style="list-style-type: none"> <li>• Transponder positioning</li> <li>• Responder positioning</li> <li>• Serial interface for gyro and vru or attitude sensor. maximum 3 units</li> <li>• SSBL simulator for training</li> </ul>
886-212748	<p><b>LBL function</b></p> <p>APOS software for LBL operation using HPR 400 or HiPAP, includes:</p> <ul style="list-style-type: none"> <li>• Calibration of transponder array in local grid</li> <li>• Positioning of vessel/ROV in LBL array</li> <li>• Necessary transponder telemetry</li> <li>• LBL simulator for training</li> <li>• Geographical position output if tp origin is entered in geo coordinates</li> </ul> <p>On HiPAP it requires HiPAP SSBL function reg. no: 212746. Positioning of an ROV in LBL requires an HPR 400 Subsea Unit.</p>
886-212750	<p><b>HiPAP MULBL function</b></p> <p>APOS software for HiPAP MULBL operation includes:</p> <ul style="list-style-type: none"> <li>• Calibration of transponder array in local grid</li> <li>• Positioning of vessel in MULBL array</li> <li>• Necessary transponder telemetry</li> </ul> <p>It requires HiPAP SSBL and LBL, reg. no.: 212746 and 12748.</p>
886-212751	<p><b>MULBL transponder array data</b></p> <p>APOS files containing transponder array data for MULBL.</p>

Reg. no	Description
<b>ADDITIONAL OPTIONS</b>	
886-212752	<p><b>Beacon Mode</b></p> <p>APOS software for HiPAP or HPR 400 beacon and depth beacon operation.</p>
886-212753	<p><b>Inclinometer Mode</b></p> <p>APOS software for HiPAP or HPR 400 inclinometer transponder operation.</p>
886-212754	<p><b>Compass Transponder</b></p> <p>Mode APOS software for HiPAP or HPR 400 compass transponder operation.</p>
886-212755	<p><b>GEO LBL Calibration</b></p> <p>APOS software for HiPAP or HPR 400 for calibration of LBL array in geographical coordinates. In positioning mode the position may be reported in geographical coordinates.</p>
886-212757	<p><b>LBL Transponder Positioning Mode</b></p> <p>APOS software for HiPAP or HPR 400 for use of MPT transponders to be positioned in an LBL network. (old name was Tp Range Pos).</p>
886-212758	<p><b>DUAL HiPAP SSBL function</b></p> <p>APOS and HiPAP software for dual SSBL operation. Provides simultaneous measurement of transponder position by use of two HiPAP transducers, includes:</p> <ul style="list-style-type: none"> <li>• Dual HiPAP provides increased accuracy</li> <li>• Transponder positioning</li> <li>• Responder positioning</li> <li>• Provides two separate and one integrated position</li> </ul> <p>Requires two HiPAP transceivers/transducers for SSBL operation.</p>
886-212759	<p><b>APOS Master Slave function</b></p> <p>An extra copy of the functionality of the master operator station for installation on additional operator stations.</p> <p>The operator can select which station shall be the master. Can be used for both HiPAP and HPR 400 systems.</p>

Reg. no	Description
886-212760	<p><b>APOS Upgrade software</b></p> <p>Upgrade from HSC400 software to APOS software, including old functionality. This may require an new monitor and a APC 10 computer and keyboard.</p>
886-212761	<p><b>APOS External synch.</b></p> <p>APOS software for synchronising HiPAP or HPR 400 transceivers to external equipment.</p>
886-212762	<p><b>APOS DUAL Ethernet</b></p> <p>APOS software and hardware for use of SDP dual Ethernet.</p> <p>Requires one Ethernet PCB.</p>
886-212763	<p><b>HiPAP Transceiver DUAL Ethernet</b></p> <p>An SDN 400 module mounted in HiPAP transceiver cabinet for interface to dual Ethernet.</p>
886-212765	<p><b>APOS ACS BOP function</b></p> <p>APOS software for telemetry to ACS 400 or ACS 300 system used on BOP.</p> <p>Telemetry to ACS 300 only available on HPR 400 systems.</p>
886-212766	<p><b>APOS ACS OLS function</b></p> <p>APOS software for telemetry to ACS 300 system used on OLS.</p> <p>Telemetry to ACS 300 only available on HPR 400 systems.</p>
886-212767	<p><b>APOS STL function</b></p> <p>APOS software for HiPAP or HPR 400 systems for STL fields special functions including:</p> <ul style="list-style-type: none"> <li>• Scanning of MLBE depth and position</li> <li>• Positioning of STL buoy</li> <li>• Scanning of transponder battery status</li> <li>• Graphics showing STL connection point</li> </ul>
886-215836	<p><b>APOS Anchor Line Monitoring function</b></p> <p>APOS software for HiPAP and HPR 400 systems.</p> <p>Scanning of up to 9 transponder(s) installed on Anchor Lines/Anchor Line Buoys, presenting individual:</p> <ul style="list-style-type: none"> <li>• Depth</li> <li>• Position</li> <li>• Scanning of transponder battery status.</li> </ul>



Reg. no	Description
886-215837	<p><b>HiPAP Transponder Relay Function</b></p> <p>Enables use of relay-function, relay-transponder frequency allocation, operator interfaces and displays functionality.</p>
886-215939	<p><b>SAL Tension &amp; Yoke monitoring</b></p> <p>APOS software HiPAP or HPR 400 systems for showing Tension and Yoke including:</p> <ul style="list-style-type: none"> <li>• Graphical presentation of yoke-angle.</li> <li>• Graphical presentation of tension.</li> <li>• Table for converting inclination angle to tension.</li> </ul>
886-212768	<p><b>APOS Field transponder array data</b></p> <p>APOS files containing transponder array data for offshore loading fields.</p>
886-212769	<p><b>APOS Training version</b></p> <p>A CD containing the APOS software and a copy of the APOS manual. This is suitable for demonstrations and training purposes. The APOS can be operated as normal and a simulator replaces transceiver and transponders. It can also be used to check telegram interfaces.</p> <p>This requires a computer with CD-ROM player, running NT40, and a monitor with 1024 x 768 resolution.</p>

## 10 TECHNICAL SPECIFICATIONS

### SSBL accuracy

HiPAP 350 Single system	S/N [dB rel. 1mPa]		
	20	10	0
Angular Accuracy, $1\sigma$ [°] (At 0° elevation)	0.18	0.23	0.4
Range Accuracy, $1\sigma$ [m]	0.1	0.15	0.2
Receiver beam [°]	15		
Coverage [°]	+/-80		

The angular figures are errors in both axis, elevation and orthogonal.

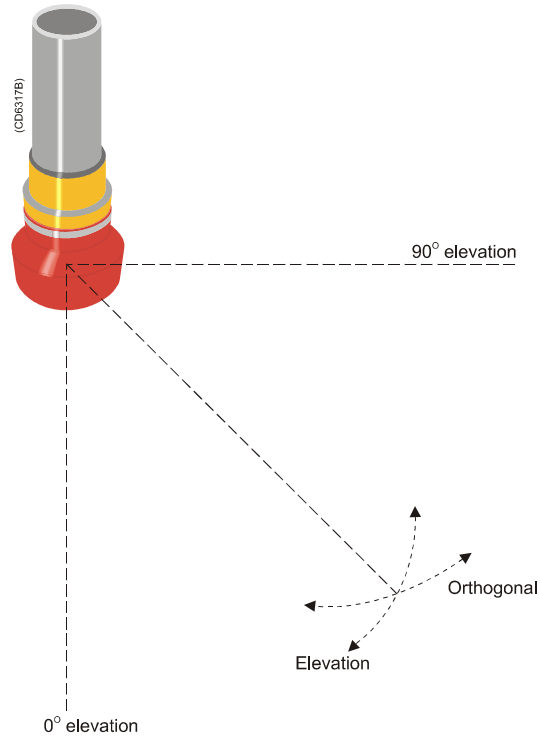
**The specification is based on:**

Note

Note ! *The specification is based on:*

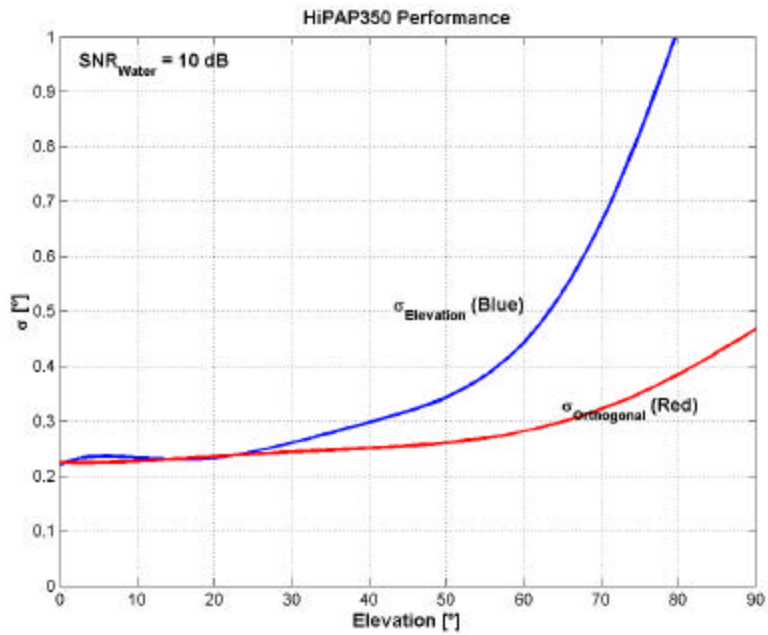
- Free line of sight from transducer to transponder.
- No influence from ray bending.
- Signal to Noise ratio in water in the 250 Hz receiver band.
- No error from heading and roll/pitch sensors.

## Definition of elevation and orthogonal

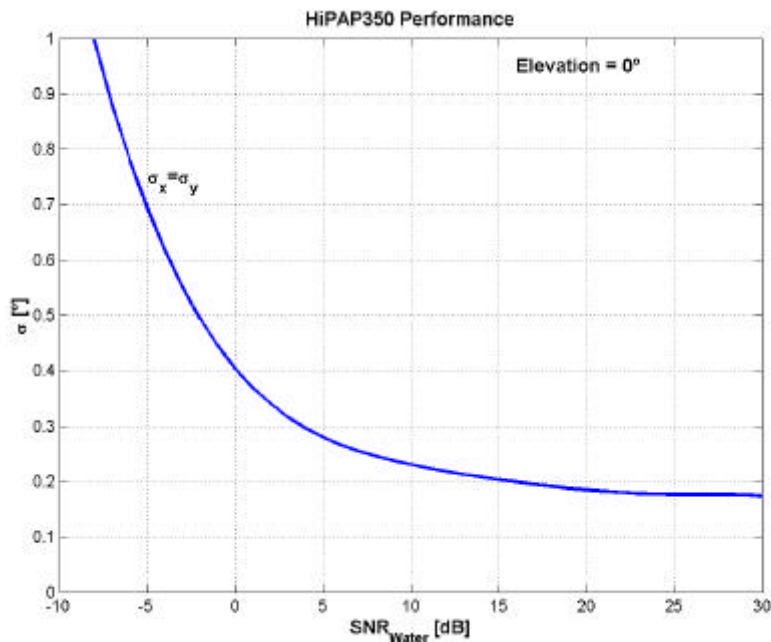


The elevation and orthogonal angles are used in the accuracy curves.

### Accuracy curves – HiPAP 350



The above figure shows the accuracy as a function of elevation angle. The signal to noise ratio 10 dB is in the bandwidth.



The above figure shows the accuracy as a function of signal to noise ratio. The elevation and the orthogonal angles are 0° (at vertical).

## LBL accuracy

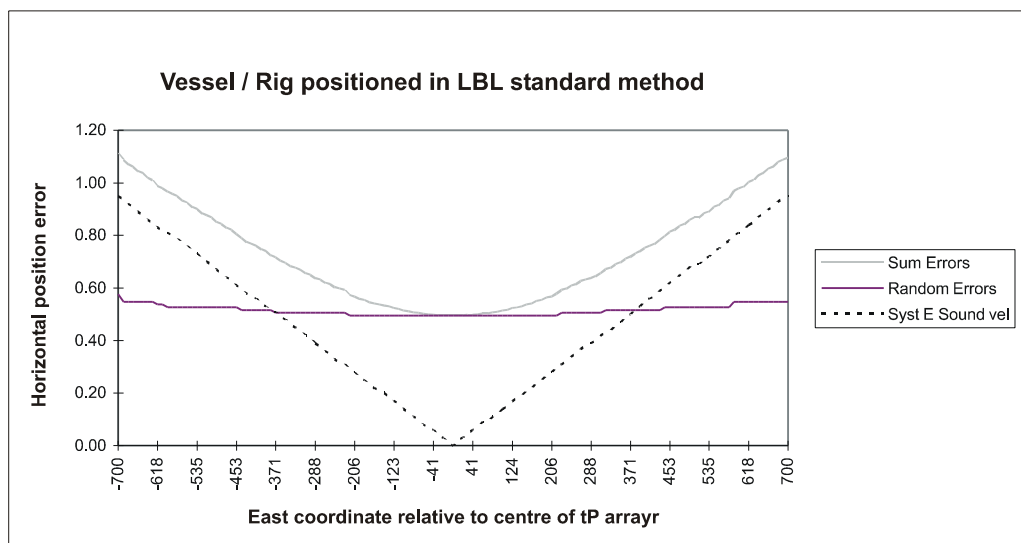
The position accuracy for LBL operation is very dependent on the transponder array geometry, sound velocity errors and signal to noise ratio. However, the accuracy can be shown by simulations.

Range accuracy's down to a few centimetres can be obtained, while ROV and vessel positions can be calculated to within a few decimetres.

The following "one sigma" error contribution to the range measurements are assumed (20-30 kHz system):

- Range reception with 20 dB S/N: 0.15 m
- Range reception in the transponder: 0.15 m
- Range error due to TP movement: 0.10 m
- Range error due to rig movement: 0.20 m

The random errors are added as Gaussian noise to the measurements.



(Cd5534)

**Figure 8 Error in the horizontal position**

The figure shows the error in the horizontal position when the Rig moves within the transponder array. The simulations are done with the following parameters:

- Four LBL transponders placed on the seabed in a circle with radius 636 m.
- The water depth is 1200 m.

The error is showed as a function of the East coordinate. The north coordinate is retained at zero, and the East coordinate zero is consequently the centre of the array. We have assumed that the wide beam of the transducer is used, and that the S/N when receiving the transponder replies is 20 dB. The effect of a systematic error in the Sound velocity of 1 m/s is also showed. When being in the centre of the array, that error causes no position error. When being in the outer parts of the array, that error causes a significant systematic error in the position.

## Range capabilities

The range capabilities are very dependent of the vessels noise level and attenuation of the transponder signal level due to ray bending.

- The HiPAP system will in most cases have longer range capabilities that specified below due to its narrow receiving beam.
- The figures are based on 20-32 kHz systems and are approximate values for guidance.

### Standard transponder:

w/ 188 dB rel.1μPa ref.1m	Typical max. 1350 m
---------------------------	---------------------

### High power transponder:

w/ 195 dB rel.1μPa ref.1m	Typical max. 2000 m
---------------------------	---------------------

### High power transponder:

w/ 206 dB rel.1μPa ref.1m	Typical max. 3000 m
---------------------------	---------------------

## Note

Note ! *The specification is based on:*

- Free line of sight from transducer to transponder
- No influence from ray bending
- Signal to Noise ratio  $\geq$  20 dB. rel. 1μPa

## Unit specifications

### APC 10 computer

#### Power supply:

Voltage	180-264 Vac/ 90-132 Vac
Frequency	50-60 Hz
Max Inrush current	80 A
Nominal	80 W

#### Temperature:

Storage	-40° C to +70° C
Operating	+10° C to +55° C

#### Humidity:

Storage	95% relative
Operating	85% relative

#### Vibration:

Range	5-100 Hz
Excitation level	5-13.2 Hz $\pm 1.5$ mm, 13.2-100 Hz 1 g

#### General:

Unit for desktop installation	Approximately 17 kg
Unit for rack installation (including rails and side plates)	Approximately 17 kg
Colour graphics resolution	Eligible max. 1600 x 1200
Video output	15 pin, analogue VGA
Floppy drive	3.5"
Printer interface	parallel
Electrical interfaces	RS-422, RS-232, Ethernet

#### Telegram formats:

Serial lines	Ethernet
- Proprietary NMEA	- Proprietary NMEA

## WinKeyboard

Weight	3 kg
Cable length	2 m

## LCD displays

The following specifications are common for all the LCD models.

### Power supply unit:

Input voltage	90 - 264 Vac
Output voltage to LCD	12.4 Vac + 0.2 V

### Power supply LCD:

Supply voltage	12.4 Vdc
----------------	----------

### Humidity:

Storage	10 - 90% relative
Operating	20 - 80% relative

### Temperature:

Operating temperature	0° C to +70° C
-----------------------	----------------

### Frequency:

Vertical frequency range	40 - 150 Hz
Horizontal frequency range	5 - 80 kHz

## LCD 151

Supply current	0.7 - 1.7 A
Resolution	640 x 400 pixels (min) 1024 x 768 pixels (max)
Weight	4.1 kg
Dimensions (W x H x D)	400 x 290 x 47 mm

## LCD 181

Supply current	20 mA
Resolution	640 x 400 pixels (min) 1600 x 1280 pixels (max)
Weight	6.5 kg
Dimensions (W x H x D)	450 x 410 x 53 mm



**LCD 201**

Supply current	320 mA
Resolution	640 x 400 pixels (min) 1600 x 1280 pixels (max)
Weight	8 kg
Dimensions (W x H x D)	540 x 410 x 58 mm

**Transceiver unit****Power supply:**

Voltage	230 Vac +/-10%
Frequency	50-60 Hz
Inrush max	350 W
Nominal	250 W

**Temperature:**

Storage	-20° C to + 65° C
Operating	0° C to + 35° C

**Protection:**

Degree of protection	IP 44
----------------------	-------

**Humidity:**

Storage	90% relative
Operating	80% relative

Weight	Approximately 47 kg
--------	---------------------

**Heading reference**

- Serial RS-422 SKR format
- Serial RS-422 STL format
- Serial RS-422 NMEA format
- Serial RS-422 Seatex MRU or Seapath
- Serial RS-422 DGR format (Tokimec DGR 11)
- Serial RS-422 NMEA HDT, VHW

**Roll and pitch reference**

- Serial RS-422 Seatex MRU or Seapath

## Hull units

Common specifications for all the HiPAP 350 hull units.

### Power supply:

Voltage	230/440 Vac 3-phase
Frequency	50-60 Hz
Consumption max.	1100 W

### Temperature:

Storage	-20° C to +60° C
Operating	0° C to +55° C

### Humidity:

Storage	90% relative
Operating	80% relative

### Protection:

Degree of protection	IP 54
----------------------	-------

### Weight:

HL 3770 (standard with 500 mm dock)	1225 Kg
HL 3770 (standard with 350 mm dock)	1200 Kg
HL 2180 (without transducer dock)	950 Kg
HL 6120 (extra long transducer shaft)	1575 Kg

## Hoist Control Unit

### Power supply:

Voltage	230/440 Vac 3 Phase
Frequency	50-60 Hz
Consumption max.	1100 W

### Temperature:

Storage	-20° C to +60° C
Operating	0° C to +55° C

**Humidity:**

Storage	90% relative
Operating	80% relative

**Protection:**

Degree of protection	IP 54
----------------------	-------

Weight	12 kg
--------	-------

**Remote Control Unit****Power supply:**

The Remote Control Unit is supplied with 24 Vdc from the Hoist Control Unit.

Voltage	240 Vdc
Frequency	50-60 Hz
Consumption	6 W

**Temperature:**

Storage	-20° C to +60° C
Operating	0° C to +55° C

**Humidity:**

Storage	10 - 90% relative
Operational	30 - 80% relative

**Protection:**

Degree of protection	IP 54
----------------------	-------

Weight	1.5 kg
--------	--------

## **Flanges**

### ***Certificates***

Lloyd's and DNV certifications are standard, others on request.

### ***500 mm mounting flange***

Standard height	600 mm
Optional height	Specified by customer
Internal diameter	500 mm
Flange diameter	670 mm
Wall thickness	20 mm
Weight, standard	Approximately 90 Kg

### ***350 mm mounting flange***

Standard height	200 mm
Optional heights	Specified by customer
Internal diameter	350 mm
Flange diameter	505 mm
Wall thickness	28 mm
Weight, standard	Approximately 70 Kg

## Gate valves

### *Certificates*

Lloyd's and DNV certifications are standard, others on request.

### **500 mm gate valve**

Type	DN500
Height	350 mm
Length (from centre)	1335 mm
Internal diameter	500 mm
Flange diameter	670 mm
Weight	510 Kg

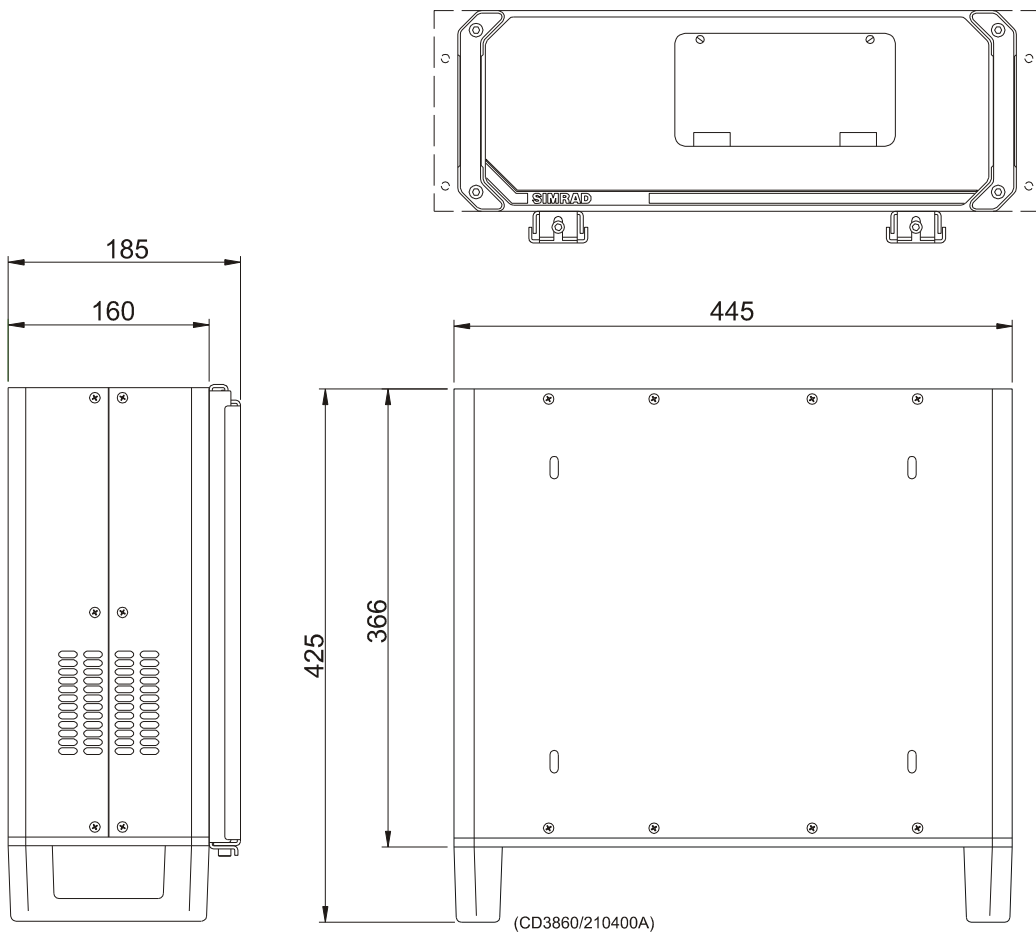
### **350 mm gate valve**

Type	DN350
Height	290 mm
Length (from centre)	940 mm
Internal diameter	350 mm
Flange diameter	505 mm
Weight	225 Kg

## Outline dimensions

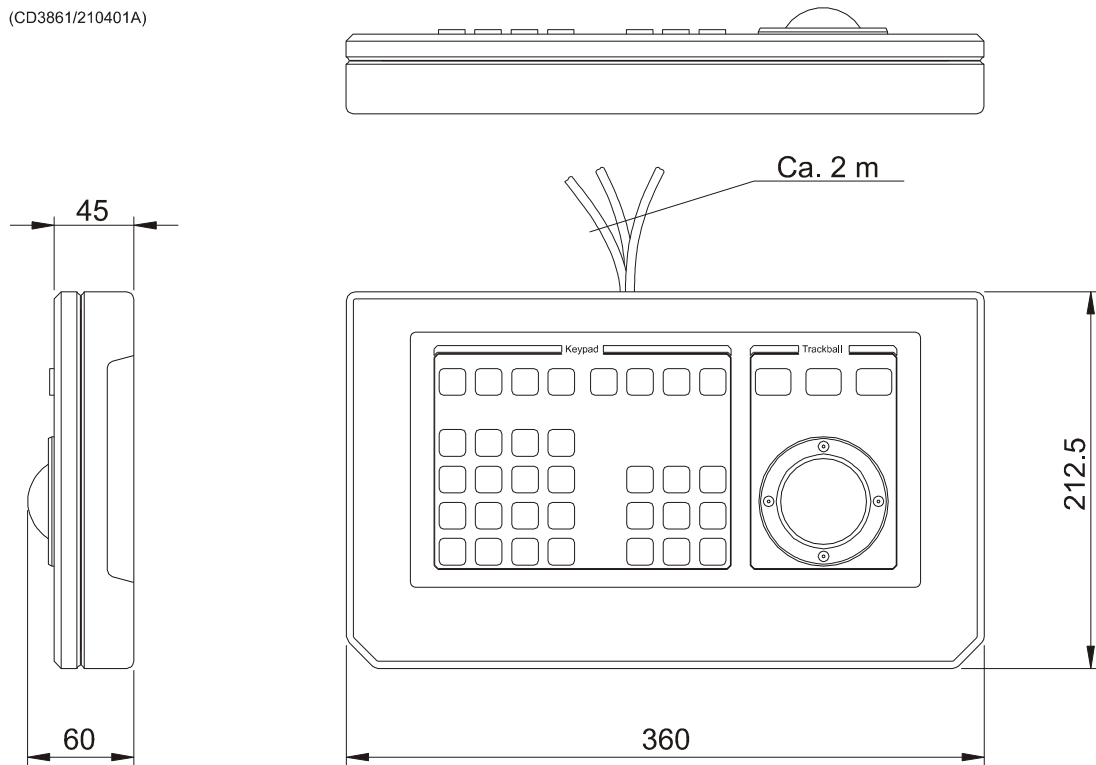
The outline dimensions shown in this section are for information only and must not be used for installation or manufactory purposes. For exact information, please use the installation manuals.

### APC 10 computer

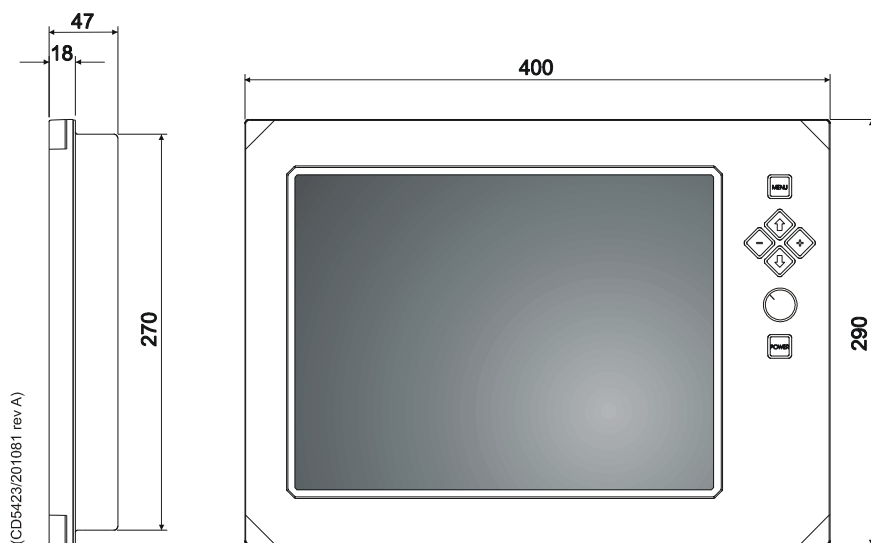


## WinKeyboard

(CD3861/210401A)

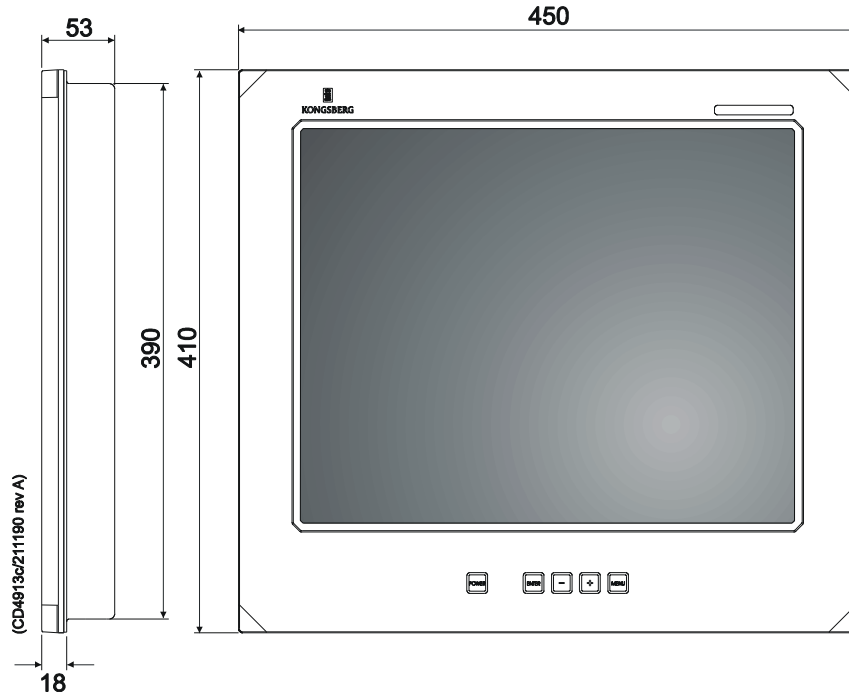


## LCD 151 display

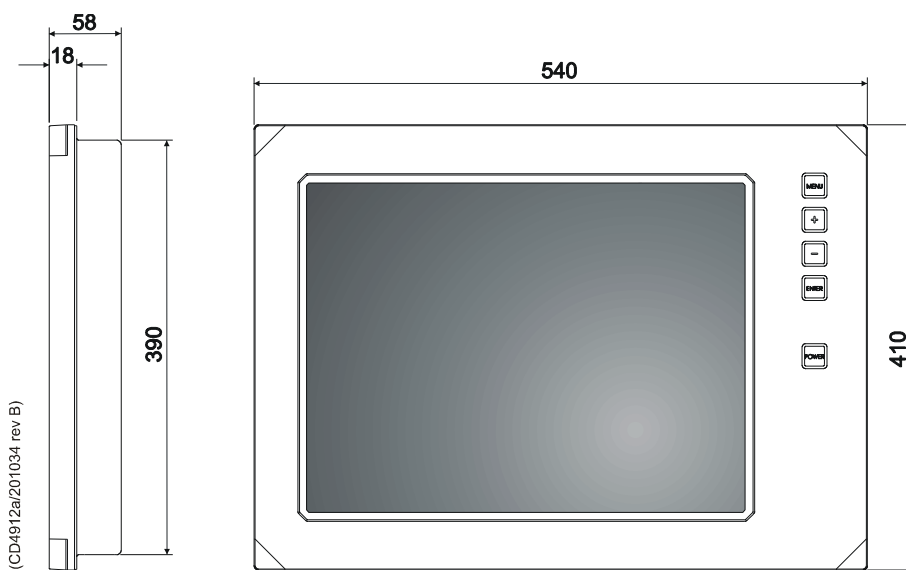


(CD5423/201081 rev.A)

### LCD 181 display

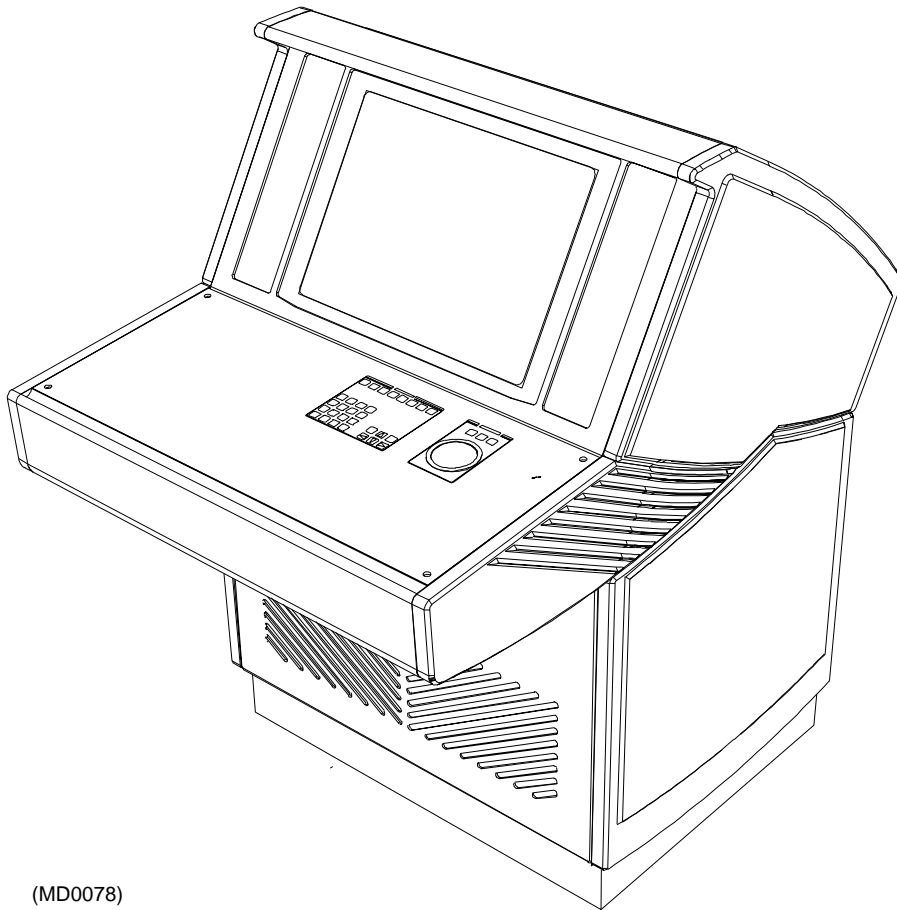


### LCD 201 display



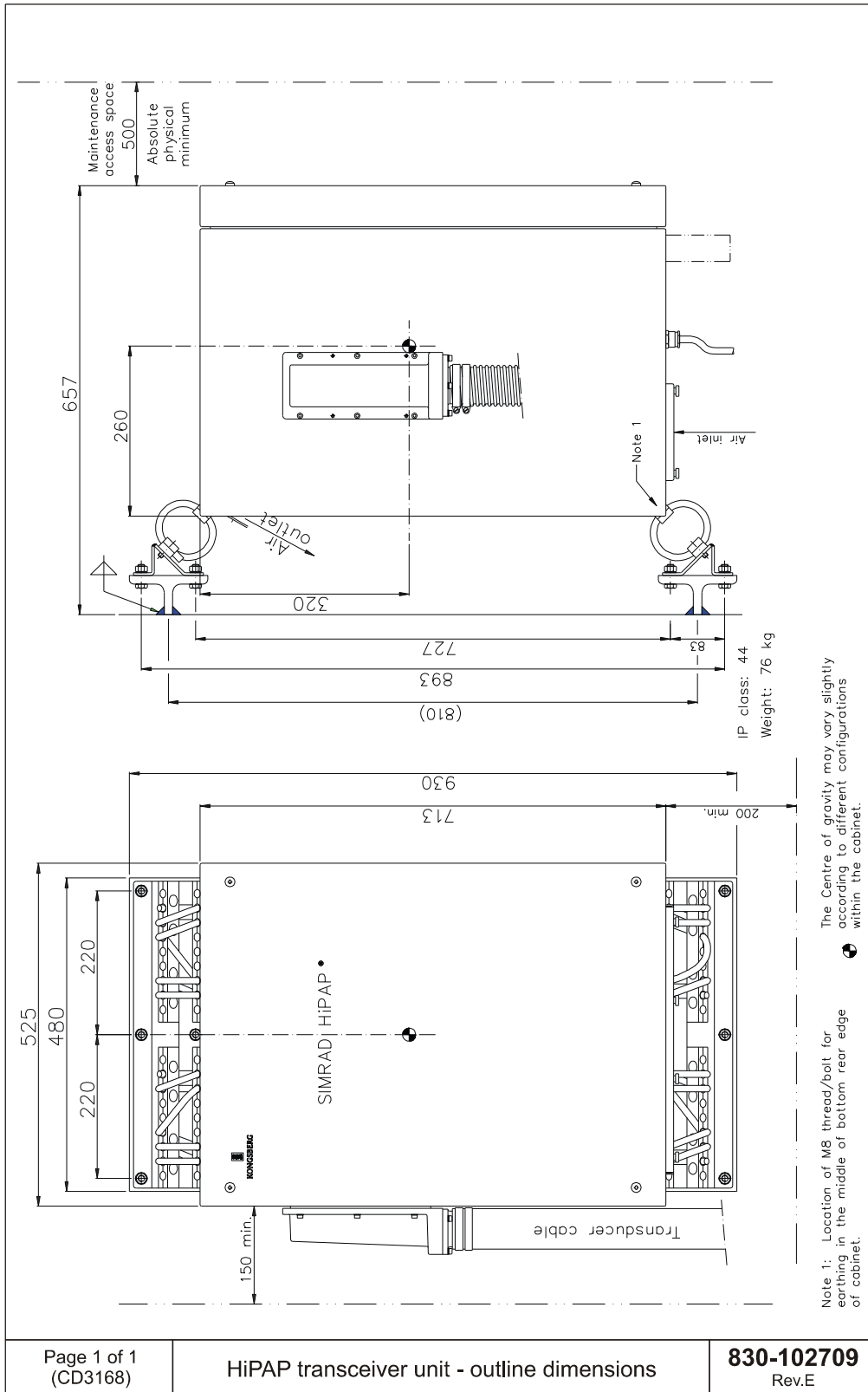


## Operator console

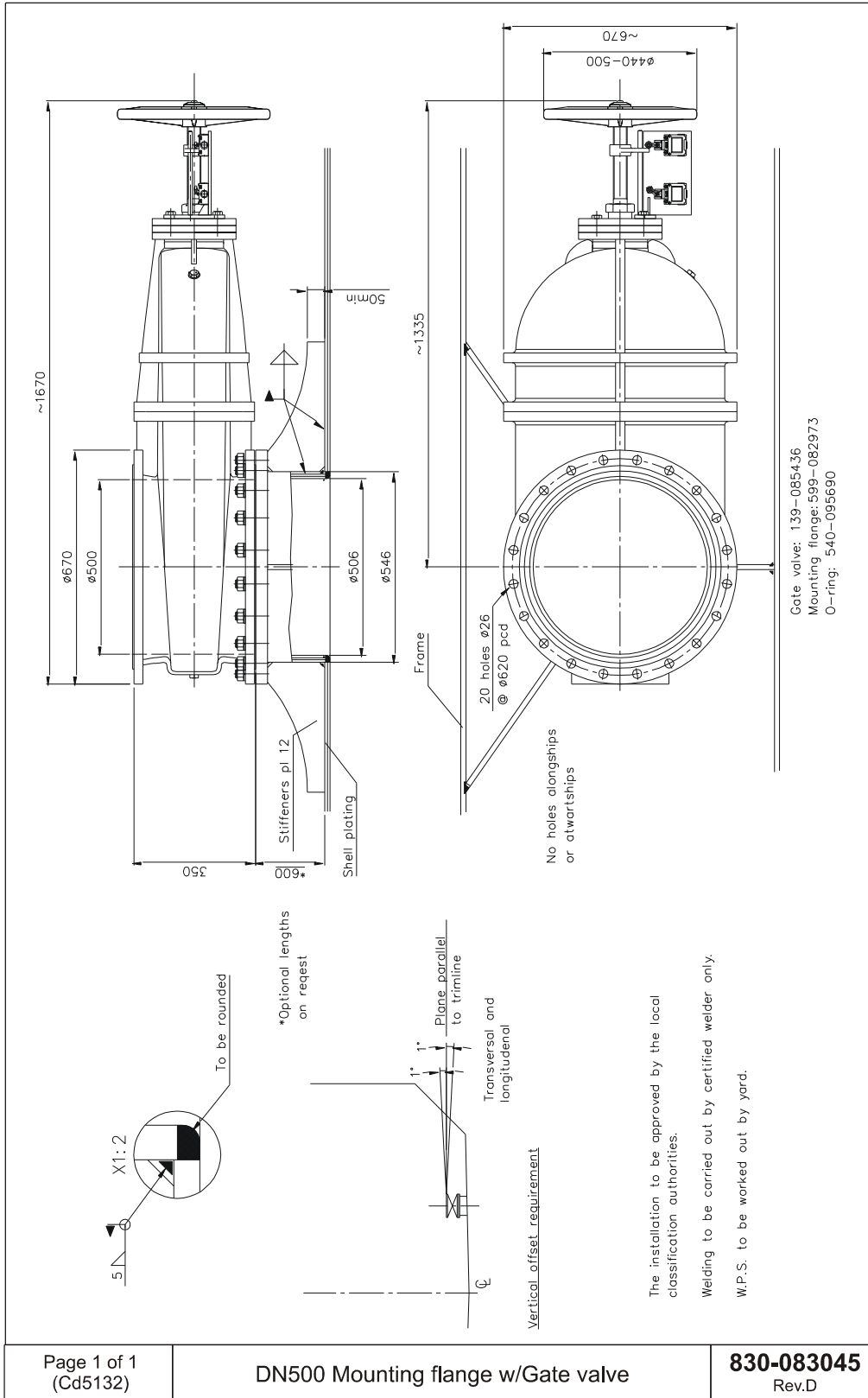


(MD0078)

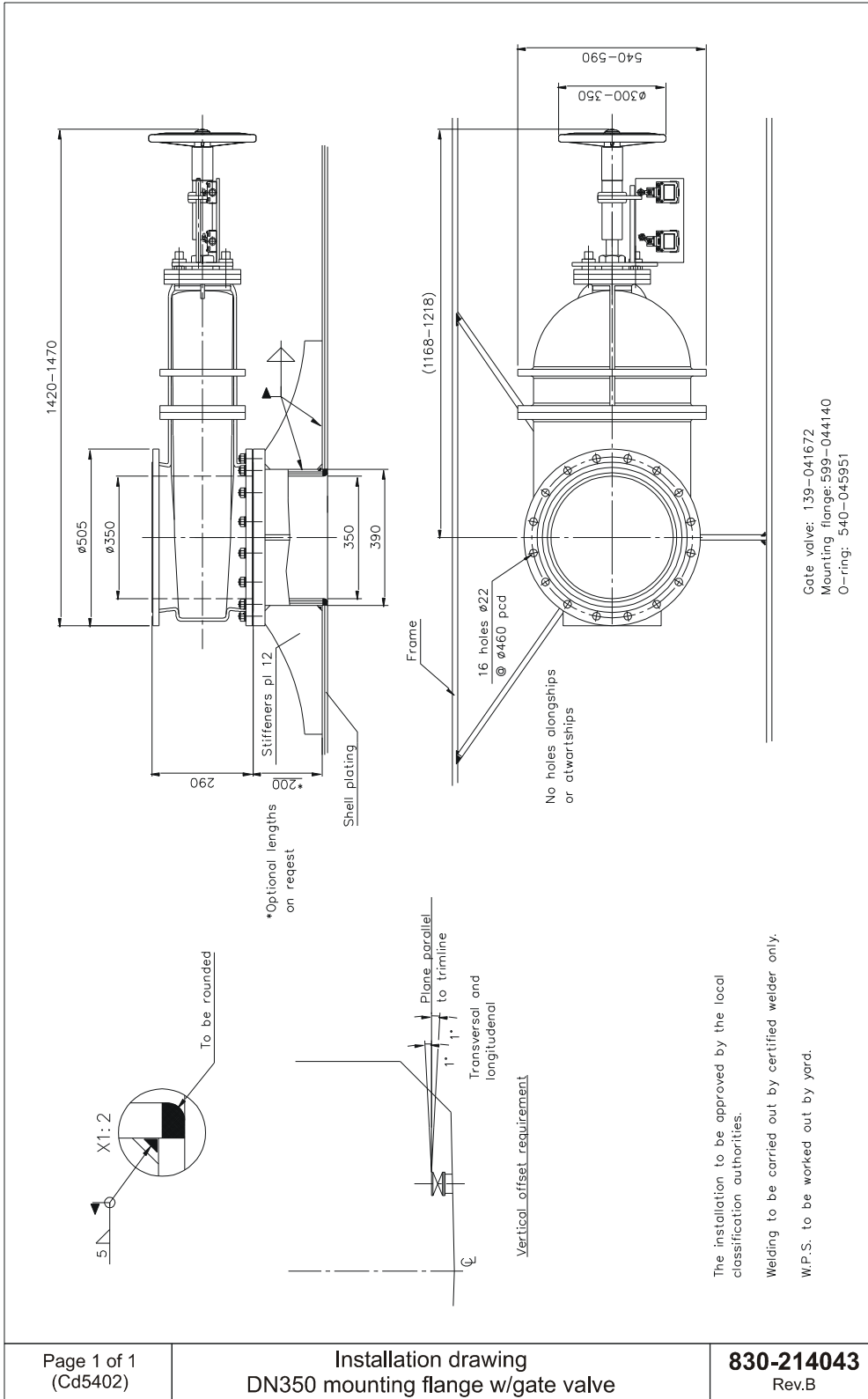
### Transceiver unit



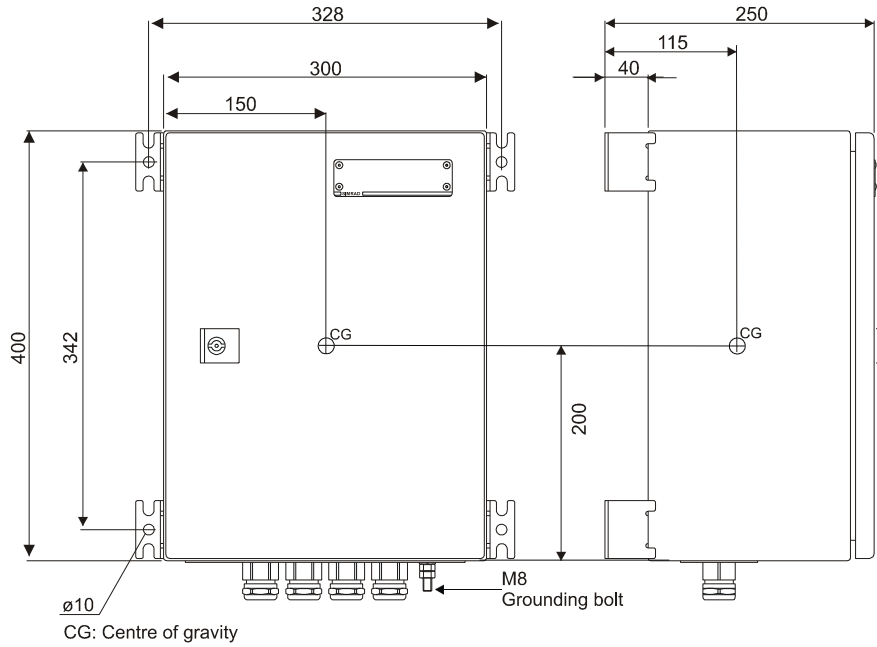
### Gate valve and flange – 500 mm



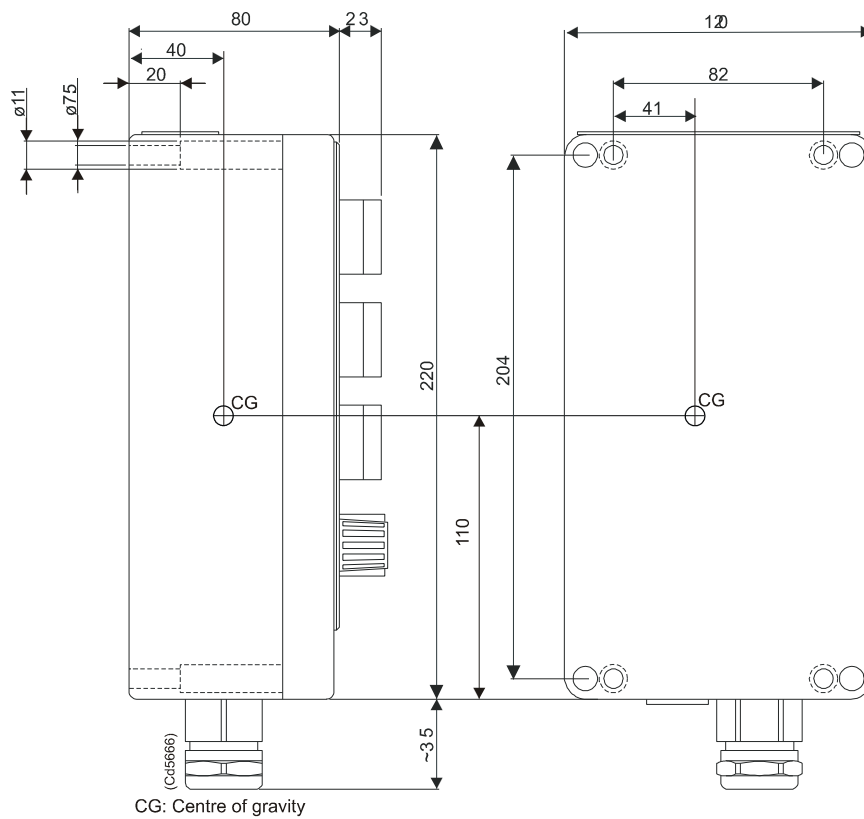
### Gate valve and flange – 350 mm



## Hoist Control Unit



## Remote Control Unit

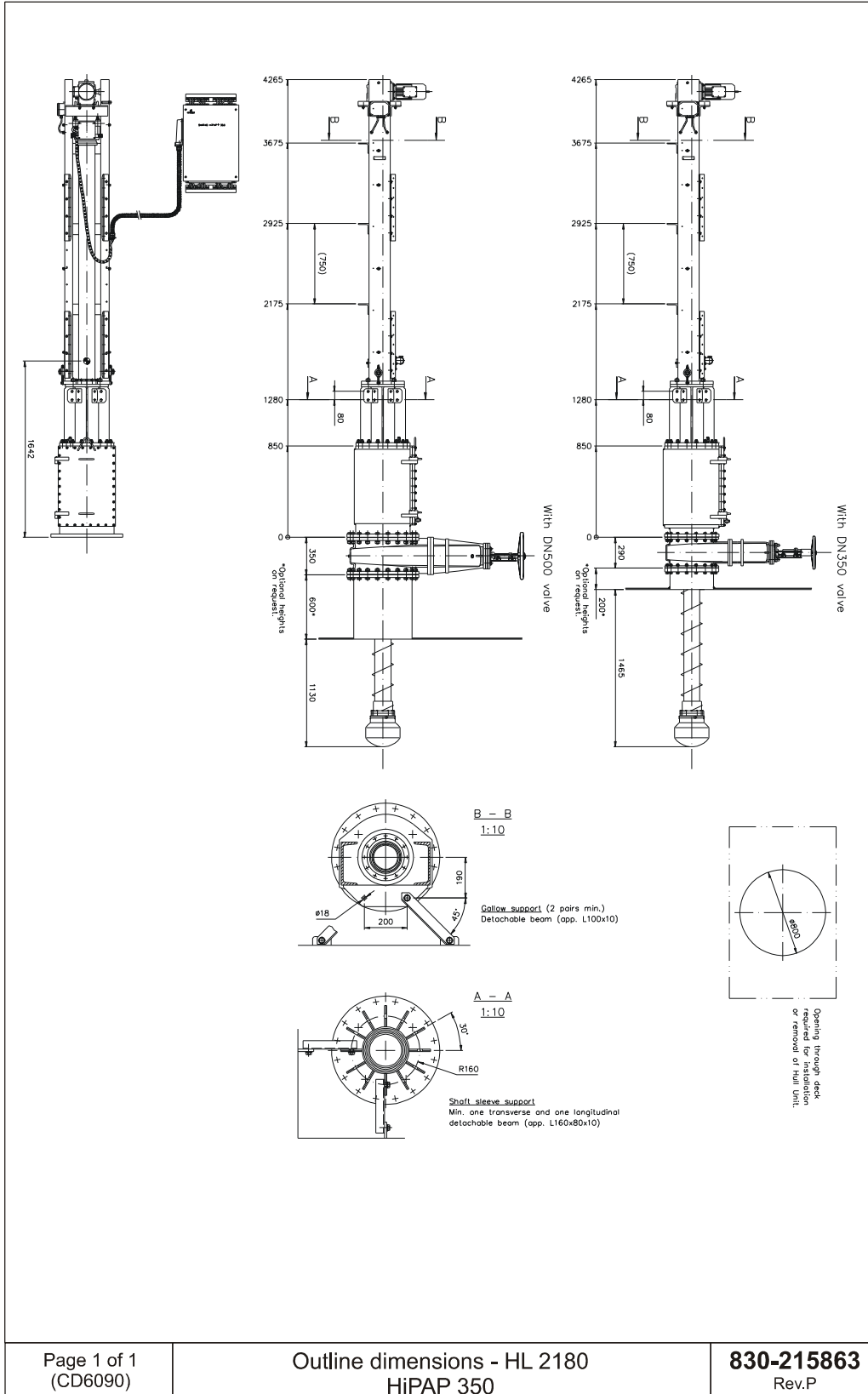


## **HiPAP 350 hull units**

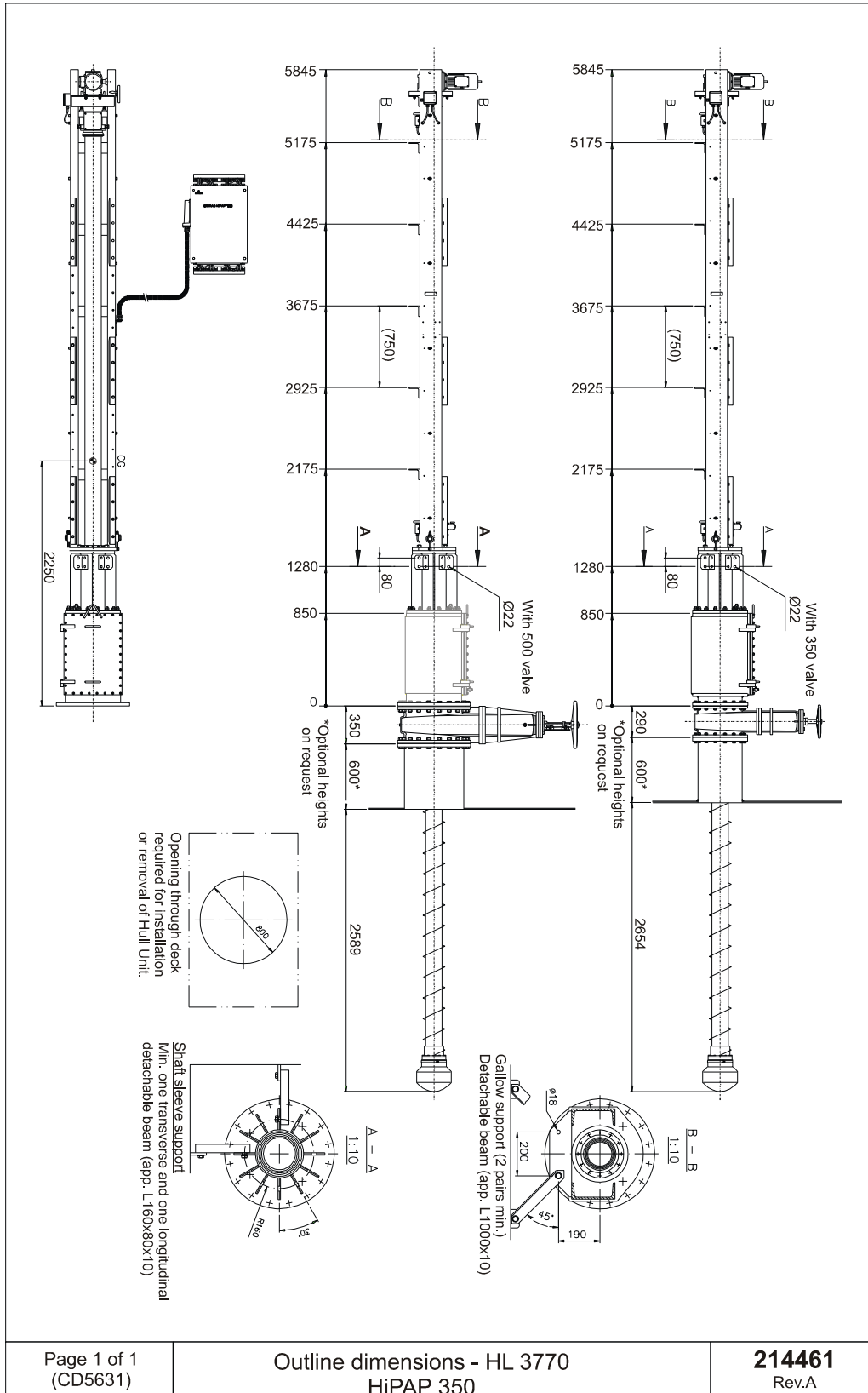
The following hull units outline dimensions are included:

- HiPAP 350 HL 2180, see page 61.
- HiPAP 350 HL 3770, see page 62.
- HiPAP 350 HL 6120, see page 63.

# HiPAP 350 HL 2180

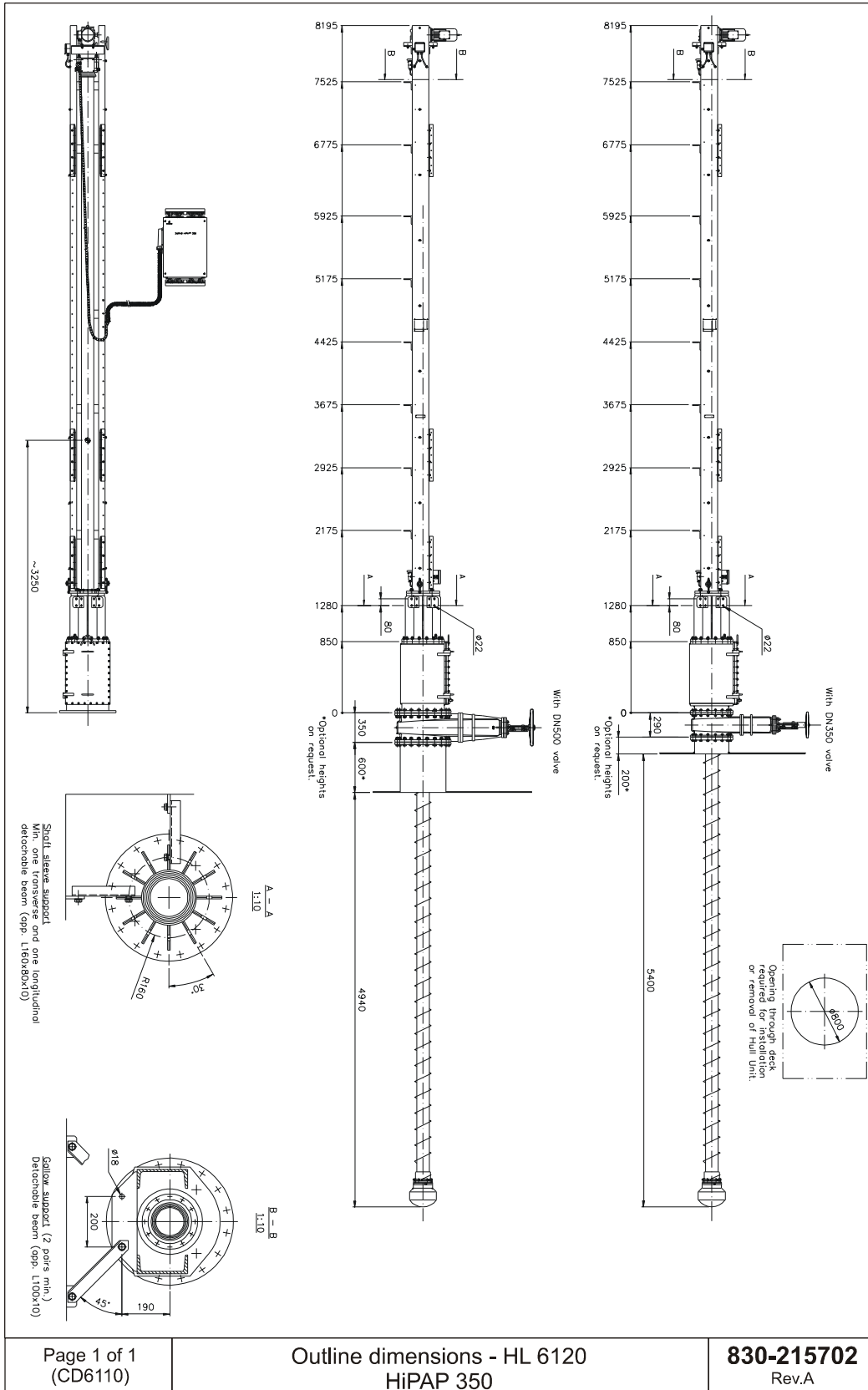


### HiPAP 350 HL 3770





# HiPAP 350 HL 6120



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