H5se7 side scan sonar

User's manual

IVYUT.416219.012RE

Revision 6

Table of contents

Annotation

This document provides user's manual (hereinafter UM) for technical operation on side scan sonar H5se7 different versions (hereinafter SSS or sonar) with a built-in echosounder (hereinafter ES).

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revision 3 (r3) — editorial changes (March, 2018)
revision 4 (r4) — editorial changes (May, 2018)
revision 5 (r5) — editorial changes (Jun, 2018)
revision 6 (r6) — editorial changes (Jul, 2018)

1. About this document

For information about the manufacturer of the SSS, see section 11.

The list of abbreviations used — see APPENDIX A.

This manual describes how to install and use the SSS. It is divided into a hardware orientated part and a description of the SSS control and data acquisition software “HyScan base” (hereinafter HS).

This manual is intended for acquaintance of the Consumer with completeness, technical characteristics, the operating principle, design features and operation rules of SSS. The list of versions and a complete set of SSS – see Table 1. For any questions regarding the use of the SSS, please contact the Manufacturer (see section 11).

NOTE. Before you start working with the SSS, carefully review this UM, the requirements for service personnel, operational restrictions and safety rules when working with the SSS.

Table 1 - SSS versions

Model	Designation	Notes
H5se7	H5se7 side scan sonar IVYUT.416219.012	Built-in ES, 10-17DC power supply
H5se7-1	H5se7 side scan sonar IVYUT.416219.012-01	Built-in ES, 10-30DC power supply
H5se7-bs	H5se7 basic set IVYUT.416929.014	Basic set for H5se7
H5se7-1-bs	H5se7 basic set IVYUT.416929.014-01	Basic set for H5se7-1

NOTES. The electronic version of the UM is located on the optical disk, which is included in the package of SSS or complex that includes SSS.

2. Description and operation

2.1. Intended use and performed tasks

SSS is intended for creation of portable sonar hardware and software system mounted on a small vessel, boat or self-contained apparatus. The system is used for automated visual high-quality underwater surveillance at waters with the depth from 0,5 to 50m, its analysis, archiving, and further processing with the purpose of:

- detection of submerged objects, determining of their coordinates and dimensions;
- surveying of condition of bed, underwater surfaces of waterworks (hereinafter WW) and floating objects;
- conduction of surveying works

NOTE. SSS is not self-sustainable for system operation, it requires additional equipment (computer, navigation receiver, battery, mounting etc.), either optional or pertinent to the system in which the SSS is used.

SSS contains two sonar systems — side scan sonar (hereinafter SSS) and surveying echosounder (hereinafter ES) integrated into a single SSS body.

Underwater surveillance and surveying of waters is provided by water sonar survey (hereinafter survey). Survey is conducted by means of SSS mounted onto a carrier.

NOTE. Hereinafter carrier implies for any vessel or self-contained apparatus, on which the SSS is mounted.

SSS-based system may be either portable or stationary one. For SSS operation at a small vessel (inflatable boat) different on-board fixtures are used.

During survey the following is provided:

- detection by the operator of underwater surfaces and objects from the images obtained by the SSS at large distances with high resolution in real time;
- measuring of depth of investigated water area simultaneously with acquisition of the acoustic image (hereinafter AI);
- determination of the coordinates of detected objects and other en route points by means of navigation aids (if any).

All information obtained during the survey is stored for further office processing. During office processing the following capabilities are available:

- plotting of AI mosaic of surveyed polygon of water area;
- measuring of object parameters;
- plotting of bathymetric chart of surveyed polygon of water area;
- overlapping of AI mosaic onto bathymetric chart;
- reporting

When using the option all-around looking (SSU003 or other), SSS can be used to capture the image from the surface of the ice or fixed base in the sonar mode of the all-around looking sonar (ALS)— see APPENDIX L.

Sonar information obtained during the survey and from the SSS is recorded in the system computer synchronously with the navigational data (coming from the navigation receiver) and may be further reviewed any number of times.

2.2. Scope of supply

SSS may be supplied as a part of a complex, or of basic set, or separately.

Obligatory item in the delivery is the SSS, which, upon customer's request, may be provided with options and completed with different accessories.

In the case of delivery as a part of basic set (see fig. 2.1), SSS is supplied in a case along with the following equipment:

- CPL002 cable coupler (hereinafter CPL002)
- terminals for connecting to car battery
- mounting kit
- optical disc Hydra Complexes. IVYuT.467369.006 (hereinafter OD) containing operation and maintenance manual and the software (SW) — HyScan base program (hereinafter HS);

NOTE. You may find electronic versions of UM on OD.

Figure 2.1. SSS basic set

2.2.1. Options

SSS may be supplied with an integrated spatial orientation sensor system (ISOSS) including heading, roll and pitch sensors.

Optionally the delivery set may contain:

- spare parts, tools and accessories;
- additional accessories;
- additional SW

2.3. Specifications of SSS

Specification for monoblock includes acoustic, electrical, mechanical, operational and environmental characteristics.

NOTE: All specifications are subject to change without notice.

Acoustic specification	
Parameter	**Value**
Sonar channels	3 (port, starboard, ES)
*Operating frequency, kHz	530-840 (SSS) 900-1200 (ES)
Transducers	2 (port & starboard of SSS) 1 (ES)

Acoustic specification	
Operating modes	Port only; starboard only; port+starboard; Port + ES; starboard +ES; port+starboard + ES
Max. SSS slant range, m	Up to 120 (actual range varies with environmental conditions)
SSS swath width, depths	Up to 10
SSS total swath width (port+starboard), m	Up to 200
**Slant range resolution, mm	10
SSS transducer angle	Tilted down 25° from horizontal
***Beam width, degree	0,5 horizontal x (45-50) vertical for SSS; 3 for ES
Pulse types	CW (Tone burst), CHIRP (independent pulse controls for each sonar channel)
Pulse duration, ms: CW (ES); CW (SSS); CHIRP	 0,012..0,009; 0,024..0,014; 1,2,4,8,12
ES maximum depth, m, not less than	30
Sweep period, ms	12-400
Recommended range of surveyed depths, m	1-20 (SSS) 1-30 (ES)
ES instrumental error, mm	10
ES accuracy of depth measurement: • for depths < 20 m • for depths >20 m	 1 cm 1 cm +0,07*depth
Range of measured depths ES, m	0,5-50
NOTES: * *The specific value of the parameter is given in the passport on monoblock.* ** *Slant range resolution is the smallest distinguishable distance between the*	

Acoustic specification
peaks of two reflections that can be displayed on the screen as separate reflectors. Sound energy is reflected back to the sonar system when the transmitted pulse encounters a change in density. The resolution of a sonar system is measured by its ability to distinguish between two adjacent targets. The resolution is dependent on the transmitted chirp pulse bandwidth. It is theoretically calculated by the product of the transmitted pulse length (inverse of the bandwidth) and half the speed of sound in water (approximately 750 m/s). For example, a full bandwidth pulse from an SSS has a resolution ~1 cm (750 x 1/70000). **** At -3 dB points.*

Mechanical , electrical & environmental specification	
Parameter	**Value**
Construction	Monoblock
Immersion, m	0,3 — 5
Accuracy of in-built ISOSS sensors, deg	2 (heading) 0,2 (roll, pitch)
Weight, kg	0,8 (on air)
Weight of basic set case, kg, not more than	Net: 2 Gross: 2,1
Electrical	
Interface with computer	Ethernet 100 Tx
*DC power supply, V	10..17 (for H5se7) 10..30 (for H5se7-1)
Max. impulse power, Wt	150 (SSS) 100 (ES)
Power consumption Power consumption, W, not more than Average power consumption in W, not more than: PP type — Tone; PP type - CHIRP	2,2 12
Synchronization mode	Internal, external
Synchronization type	Pulse
Synchronization pulse levels, V	0-0,4 (low) 2,2-3,3 (high)
Synchronization pulse polarity	Positive or negative
Synchronization pulse duration, ms	0,01-10

Mechanical , electrical & environmental specification	
Operational	
Readiness time after powering on, s	Up to 5
Mean time before failure, h, not less than	2000
Mean lifetime, not less than	10 years
Max. survey velocity, knots (m/s)	Up to 9 (4,5)
Waves at water area during the survey, points, not more than	3
Uncompressed acoustic raw data stream, Gb/h	6,5 (SSS) 3 (ES)
Environmental	
**Temperature, ºC: - working (on air) - working (in water) - transportation - storage	 -15..+50 -10..+40 -25..+50 +5..+40
* The specific value of the parameter is given in the passport on monoblock. ** The working temperature of the air is indicated for the elements used in the air. The working temperature of the water is indicated for the elements used in the water.	

2.4. Structure and function

2.4.1. Monoblock

SSS structure (see fig.2.2) is a monoblock consisting of aluminum body and cover. Streamlined shape of body and cover give additional strength and good fluid dynamics. Cover is attached to the body with M3 screws. In order to provide tightness between the cover and the body a seal gasket is used. A cable is embedded in the cover and filled with compound. Cable ends with the SSS sure-seal connector. SSS connector is used for connecting to the PC via Ethernet and power supply to SSS via CPL002 cable coupler (hereinafter CPL002) or cable network of the complex – see APPENDIX D. Body upper part is provided with a bracket for pole mounting.

Body lower part embeds:

- two similar transmit/receive antennas — piezoelectric modules of SSS port and starboard installed relative to horizontal at an angle of 40 deg (SSS antenna beam angle);
- one transmit/receive antenna – ES piezoelectric modulus directed vertically down.

At the body left side an identification plate (nameplate) is mounted specifying SSS number, date of production, name and designation.

During operation SSS must move with its cover frontwards.

While operating from the boat sides in order to fix SSS a KIT006 is used or similar.

SSS outline drawings – see APPENDIX K.

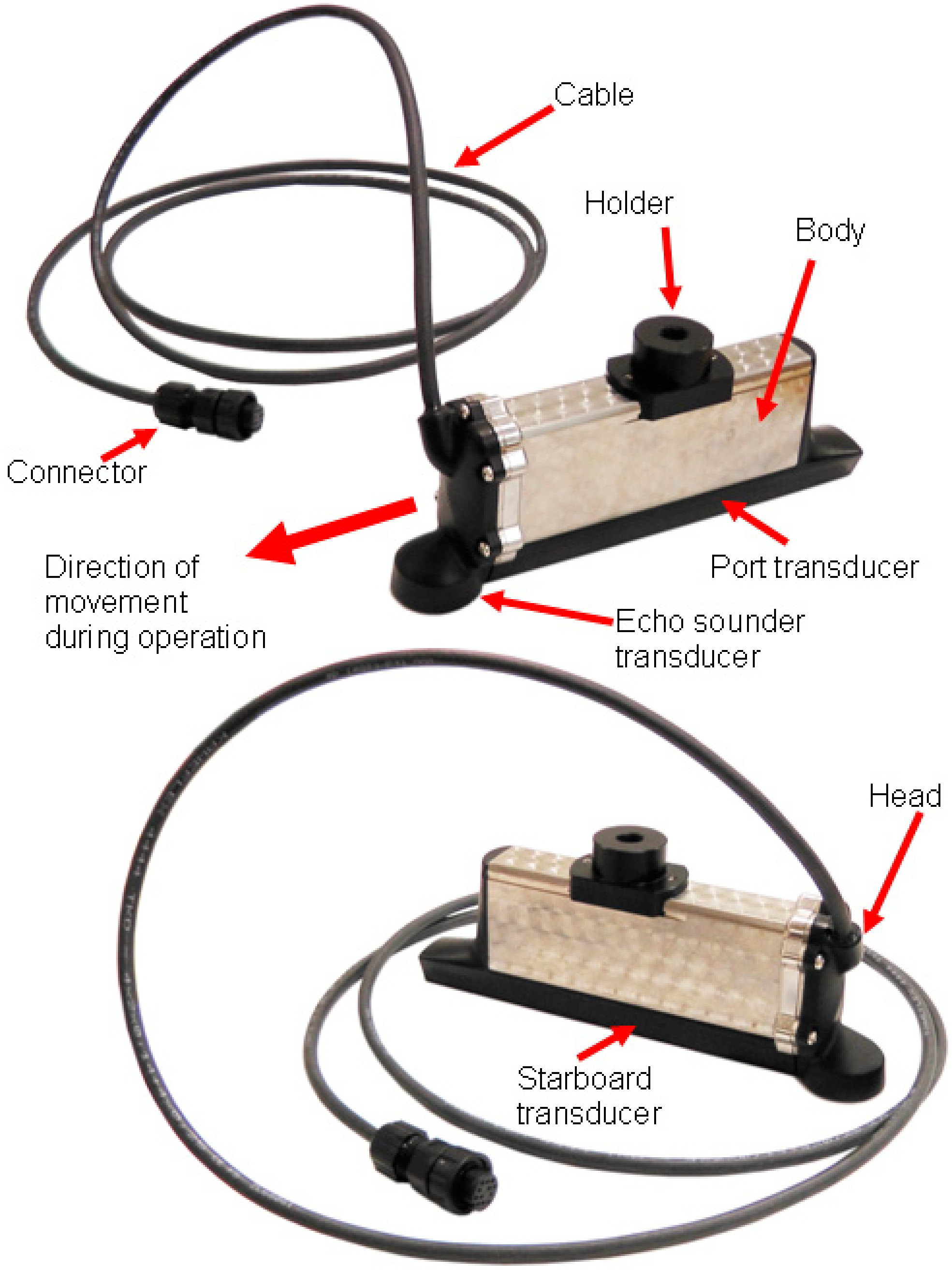


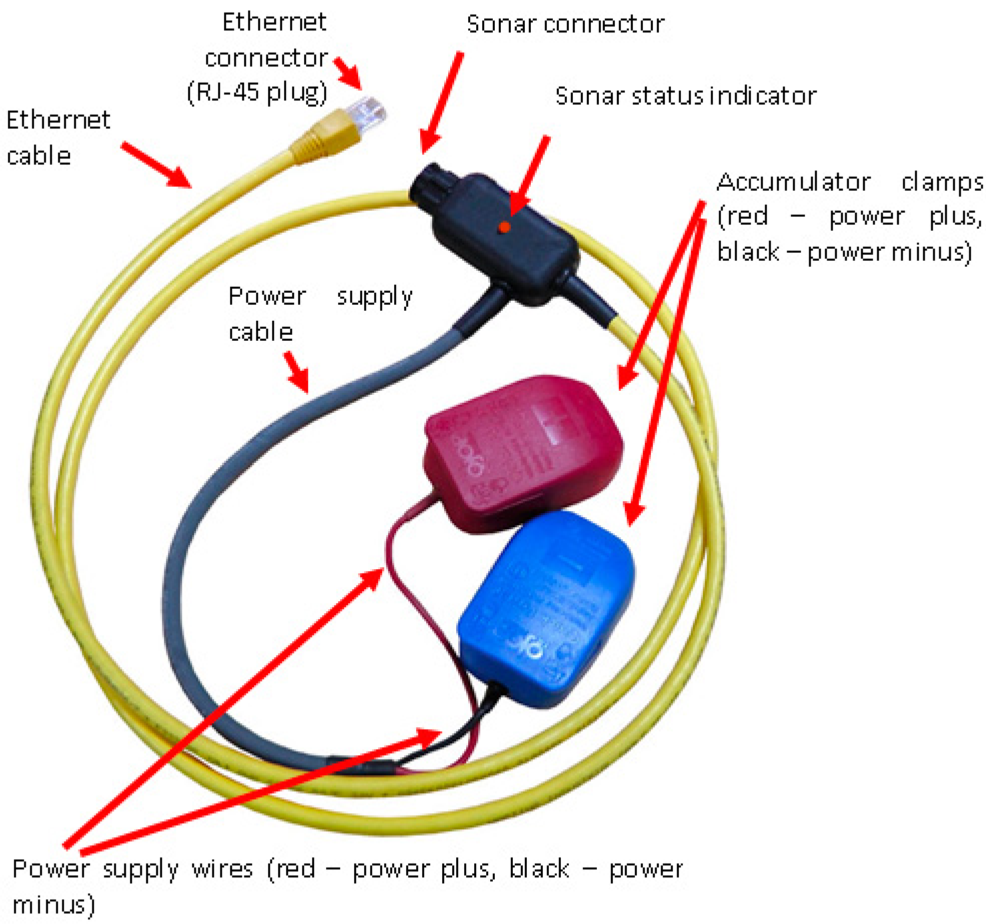
Figure 2.2. Appearance and arrangement of SSS elements

2.4.2. CPL002 cable coupler

For SSS connection to the computer, SSS power supply, and SSS current status indication a CPL002 cable coupler (see fig. 2.3) is used, which is included to basic delivery set.

SSS powering on/off is provided at the expense of energizing/deenergizing of CPL002-2, CPL002-4 power leads. SSS status indicator is built in the power button. Status indication description is given in APPENDIX F.

CPL002



CPL002 with accumulator clamps

Figure 2.3. CPL002 cable coupler

2.4.3. Power supply

SSS is powered with an accumulator battery (see table 2) or an on-board DC power source. Supply voltage range is given in technical specifications. SSS powering on/off is provided by means of connecting/disconnecting of SSS connector or power switching with external devices.

NOTE. Though average power (current) consumption of SSS is imperceptible, pulse current consumption may reach 10A while transmitting. SSS battery (power supply) must provide operation at pulse current.

Table 2 - Accumulators for SSS power supply

Model	Accumulator variations
H5se7	12V (Pb; 11,6..12,7V) 14,8V (Li-ion, 4S; 10..16,8V)
H5se7-1	12V (Pb; 11,6..12,7V) 14,8V (Li-ion, 4S; 10..16,8V) 18,5V (Li-ion, 5S; 12,5..21V) 22,2V (Li-ion, 6S; 15..25,2V) 24V or 2x12V (Pb; 23,2..25,4V) 25,9V (Li-ion, 7S; 17,5..29,4V)

2.4.4. Probing pulses. Types, parameters

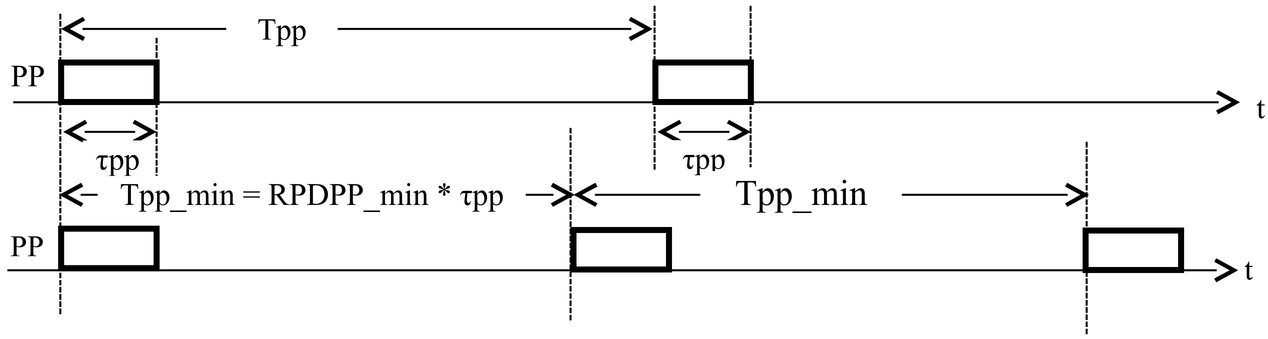
Choice of PP is defined with the number of factors including depth, bed ground type and its topography, and swath.

Tone PP gives essentially clearest (noise-free) acoustic image. In complicated jamming environment, at great depths or in the case of muck bottom it is recommended to apply a PP with high energy – CHIRP signal. The only restriction for application of CHIRP signal is the skip distance.

Energy of a transmitted PP depends only on its type and on monoblock supply voltage. Variation of PP period does not cause any changes in radiated energy.

SSS sweep period (PP generation) is defined with the preset slant distance (depth). Slant distance (depth) is set by the operator in HS program. The greater is the slant distance (depth), the greater is the period. Minimum sweep period is defined with the minimum PP duty ratio (see fig.2.4).

Restriction of minimum duty ratio is necessary in order to prevent PEM overheating.



TPP – period of PP generation

τPP – PP duration

PP pulse ratio = RPDPP = TPP/ τPP >=RPDPP_min,

RPDPP min — minimum allowable pulse ratio of PP

Figure 2.4. PP generation

SSS swath directly depends on PP radiated energy – energy increase allows obtaining information from greater range at the same external conditions (swath increase), while energy reduction decreases the swath. Energy reduction is useful in the following cases:

- for reduction of reverberation in shallow body of water;
- for reduction of power consumption and thus the increase of battery life.

The greater is the supply voltage, the greater is the radiated energy. Radiating energy is also directly proportional to the PP duration. Variation of PP duration is only possible for CHIRP signals. Duration is given with the number of CHIRP signal, the number may take the values 1, 2, 4, 8, 12,16, and means its duration in ms. For example, duration of PP of CHIRP8 is 8ms, CHIRP1 - 1ms. For tone PP, energy is adjusted at the expense of PWM (pulse-width modulation). There exist two types of tone PP: Tone1 and Tone2. PP energy of Tone1 is less than PP energy of Tone2.

Recommendations for PP selection - APPENDIX G.

2.4.5. Synchronization

SSS may operate in standalone or synchronous mode; accordingly, there exist two types of complex synchronization:

- internal synchronization;
- external synchronization.

External synchronization is used in the cases when it is necessary to synchronize radiation duration of PP used by SSS with any other process (e.g., with radiation duration of PP from another sonar).

At simultaneous operation of two and more different sonar complexes at a single vessel mutual synchronization of complexes may be required in order to reduce mutual influence of these complexes operation. In this case PPs in all synchronized complexes are emitted synchronously and sweep periods for all complexes are the same.

When using external synchronization one of the complexes is a master one (defines sweep period), and the others are the slave ones (they synchronize emission of their PPs with the master one). Below (table 3) are given the recommendations on synchronization at operation of different sonar complexes developed by Screen LLC.

Table 3 – Mutual synchronization of complexes

Synchronized complexes	Settings
SSS, SSS	Master – SSS, slave – SSS
SSS, sub-bottom profiler	Master – sub-bottom profiler, slave – SSS

Setting of the parameters of signals of complex synchronization is performed by the Operator by means of HS program. Timing diagram of generation of synchronizing pulses (SP) – see fig.2.5.

At complex operation from external synchronization, if SP duty ratio turn out to be less than PP minimum duty ratio, then SSS automatically skips a necessary amount of SPs in order to achieve minimum allowable PP duty ratio (see fig.2.6).

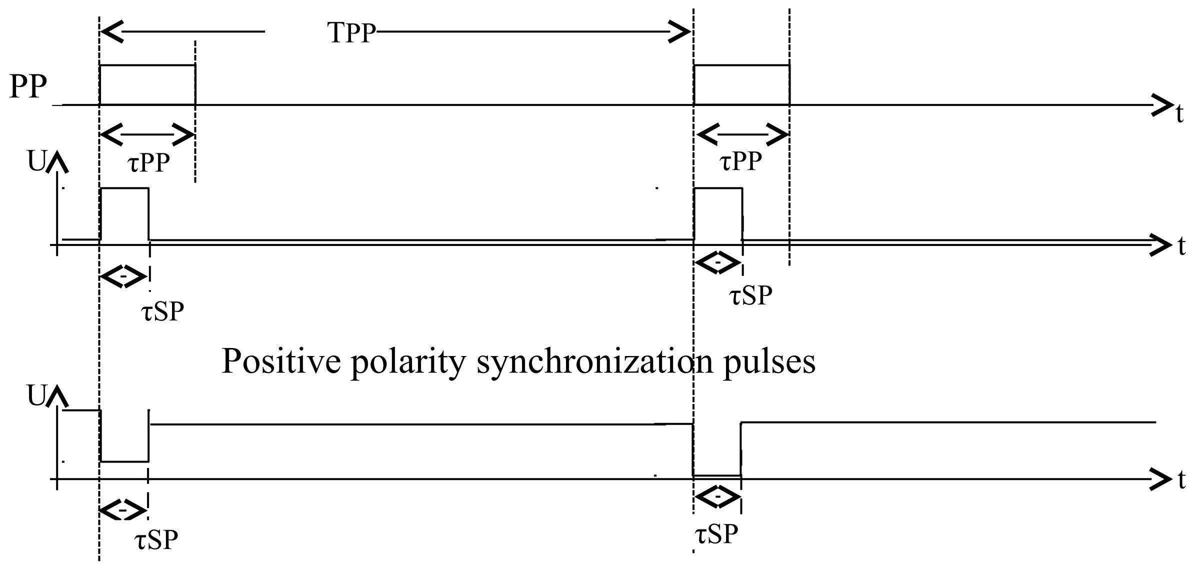


Figure 2.5. Generation of synchronization output pulse

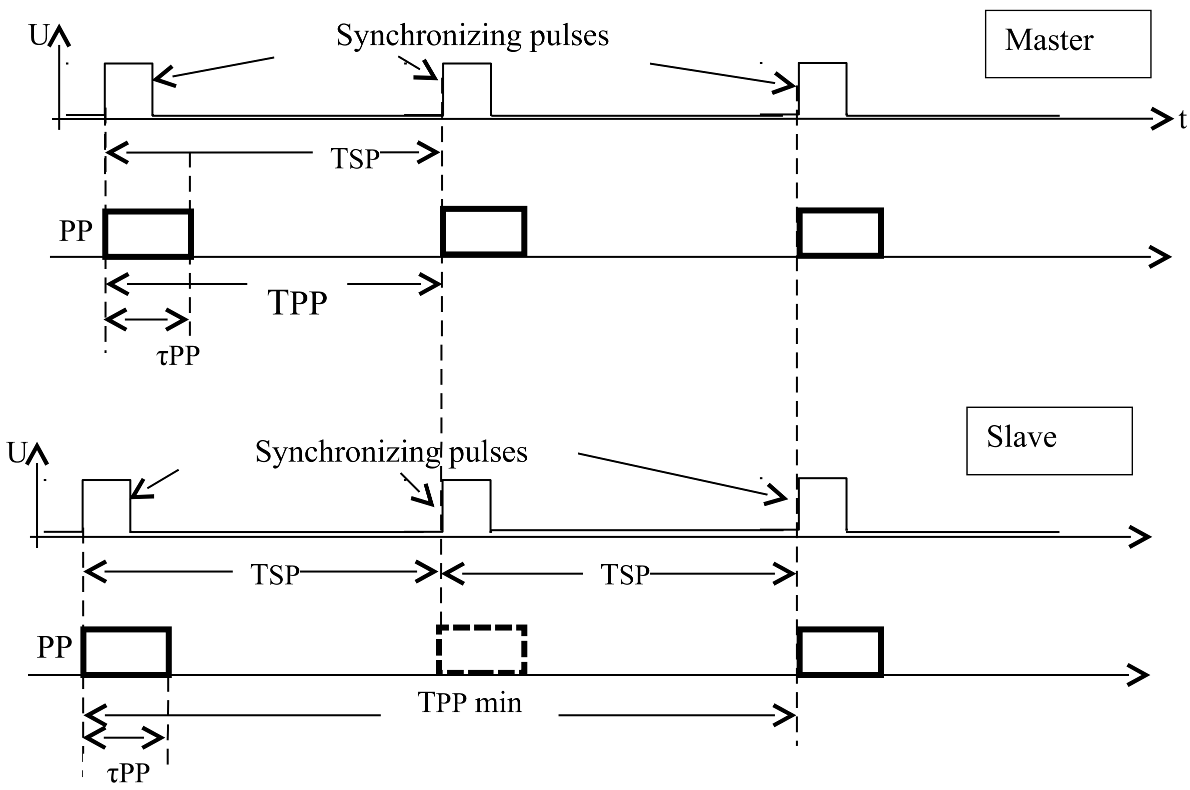


Figure2.6. Control of SP duty ratio

2.4.6. TVG

Back-scattering echoes decay differently depending on the distance that they have passed to the seabed and back. As the result of decaying and scattering, these echoes are by several times less than the initial one – emitted signal. For a wave from a spherical source this decay varies according to the inverse square law from the distance to target, and thus, will be different for every echo. Therefore, for signal decay compensation TVG is applied. In the most simplified case the algorithm of automatic or semi-automatic TVG is used – for amplification of every echo in compliance with the time of its arrival. However, it should be noted that TVG algorithm does not account for variations of characteristics of seabed reflectivity. More advanced users of complex use straight-line or exponential TVG algorithms. User chooses which TVG algorithm is used by means of HS program.

2.4.7. Forming of acoustic image

Reflected signal is received from all the directions within the SSS beam. For every range interval (equidistant point inside the beam relatively to its origin) reflected signals from all the directions are summed. SSS does not distinct the objects, from which the reflected signal comes equidistantly – these objects will be combined in a single point (visually superimposed) in the AI.

Realistic image of the bottom shall be generated upon the condition that the reflected signal from every point of the bottom along the beam will arrive with a delay.

Let us consider an example of forming of line of AI of port and starboard (see fig.2.7):

Point 1: port – reflection from water column (weak signal), starboard - reflection from the object in water column (strong signal).

Point 2: starboard – reflection from water column (weak signal), starboard - reflection from the object in water column (strong signal).

Point 3: port and starboard – reflection from water column only (weak signal).

Point 4: port – reflection from the object in water column (strong signal), starboard - reflection from water column (weak signal).

Point 5: port and starboard – reflection from water column only (weak signal).

Point 6: port – reflection from the object in water column and from the bottom (strong signal), starboard - reflection from the bottom (strong signal).

Point 7: port – reflection from the bottom (strong signal), starboard - reflection from the bottom (strong signal).

Point 8: port – reflection from the bottom (strong signal), starboard - reflection from the bottom (strong signal).

Point 9: port – reflection from the bottom (strong signal), starboard - reflection from the bottom (strong signal).

Point 10: port – reflection from the bottom (strong signal), starboard - reflection from the bottom (strong signal).

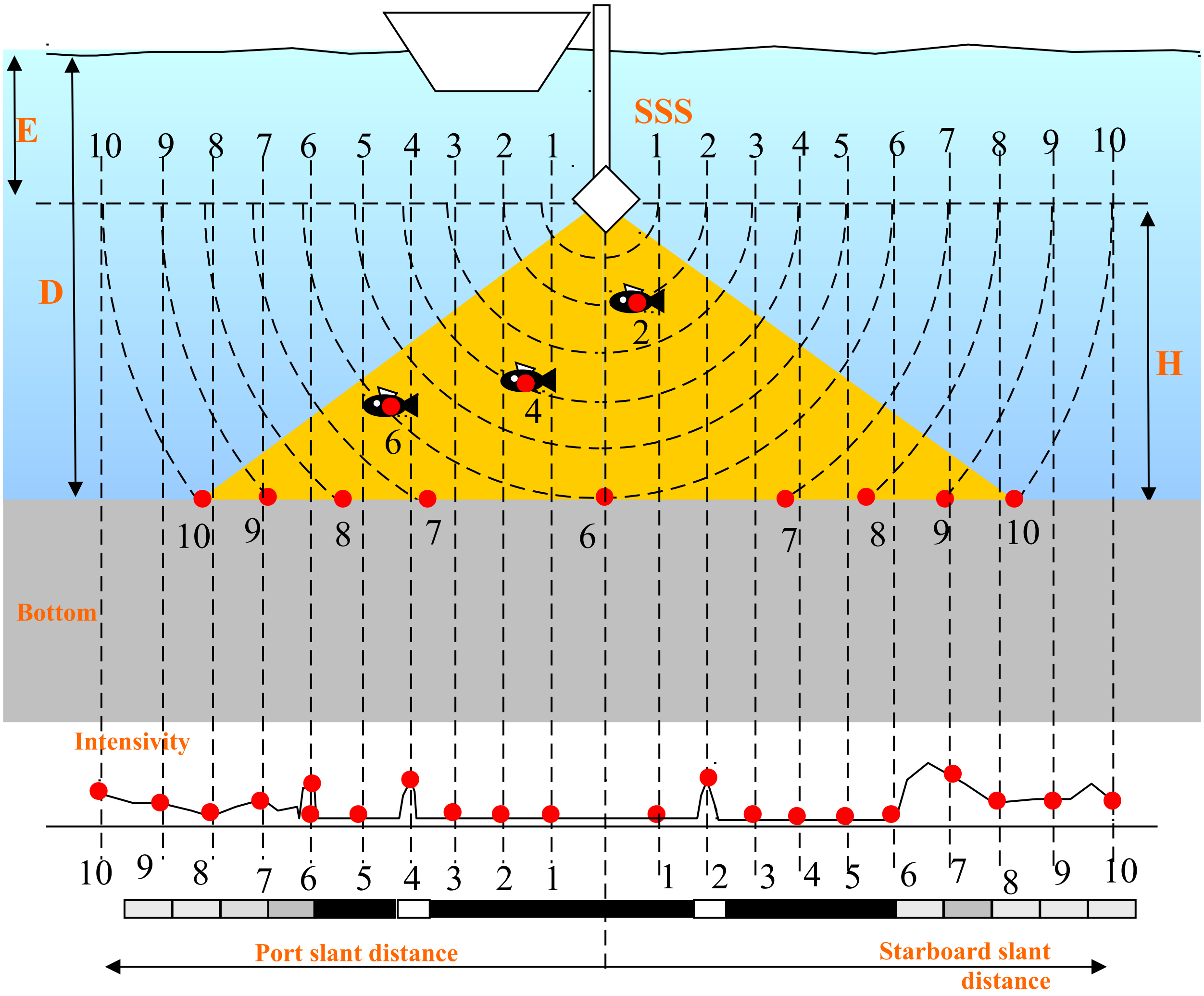


Figure 2.7. AI generation

Reflected signal from the bottom arrives in point 6 (minimum distance from the SSS to bottom under condition that the bottom is flat).

In points 1-5 the reflection from water column is minimum, so this area will be dark in the AI. In point 2 from the port the reflected signal from the object will be higher than the signal from water column, so this are will be bright in the AI.

Reflection from the object in point 6 from the port coincides with the first reflection from the bottom. Point 6 in the AI reflects SSS height above the bottom H and is called the bottom point (sometimes it is also called initial appearance point). Image in this point changes from dark (water column) to more bright (reflection from the bottom).

In points 7-10 reflection will come from the bottom areas with different intensity, so these areas shall have different brightness in the AI.

During vessel movement consecutive bottom points form in the AI a borderline between the water column and the bottom, thus forming bottom line (bottom entrance line).

Points 1-10 reflect the range increase within the beam, forming the slant distance.

Generated AI is raw and contains geometric distortions. Due to the geometry the same distances between the bottom points will be displayed as different distances in the AI.

Depth (D) is the distance from water surface to bottom, which is defined as a sum of SSS antenna height above the bottom (H) and the value of SSS antenna depth relatively to water surface (E):

$$\mathbf{D = H+E}$$

Interpretation of initial AI is based on the following hypotheses:

- sound beam spreads rectilinearly;
- the bottom is relatively flat;
- sound velocity in water is the same for all depths;
- vessel with SSS on board moves uniformly and rectilinearly.

It should be borne in mind that the hypotheses used for interpretation are not always fulfilled, which causes AI distortion and appearing of artifacts.

During image interpretation crucial role is played by the obtained image of object shadow.

Presence and position of a shadow helps to decide whether the object rises above the bottom (prominence) or is below the bottom (hollow, pit).

On the basis of geometry of side scan method the same object being at different distance from the SSS gives different shadow length.

Depending on object geometry and reflectivity, irradiation from different sides and with different angles may give different reflection factor (and, respectively, brightness).

AI contains the following basic elements (see fig.2.8):

- Water column
- Bottom line
- Acoustic shadows
- Objects
- Relief flexes (edges), pits

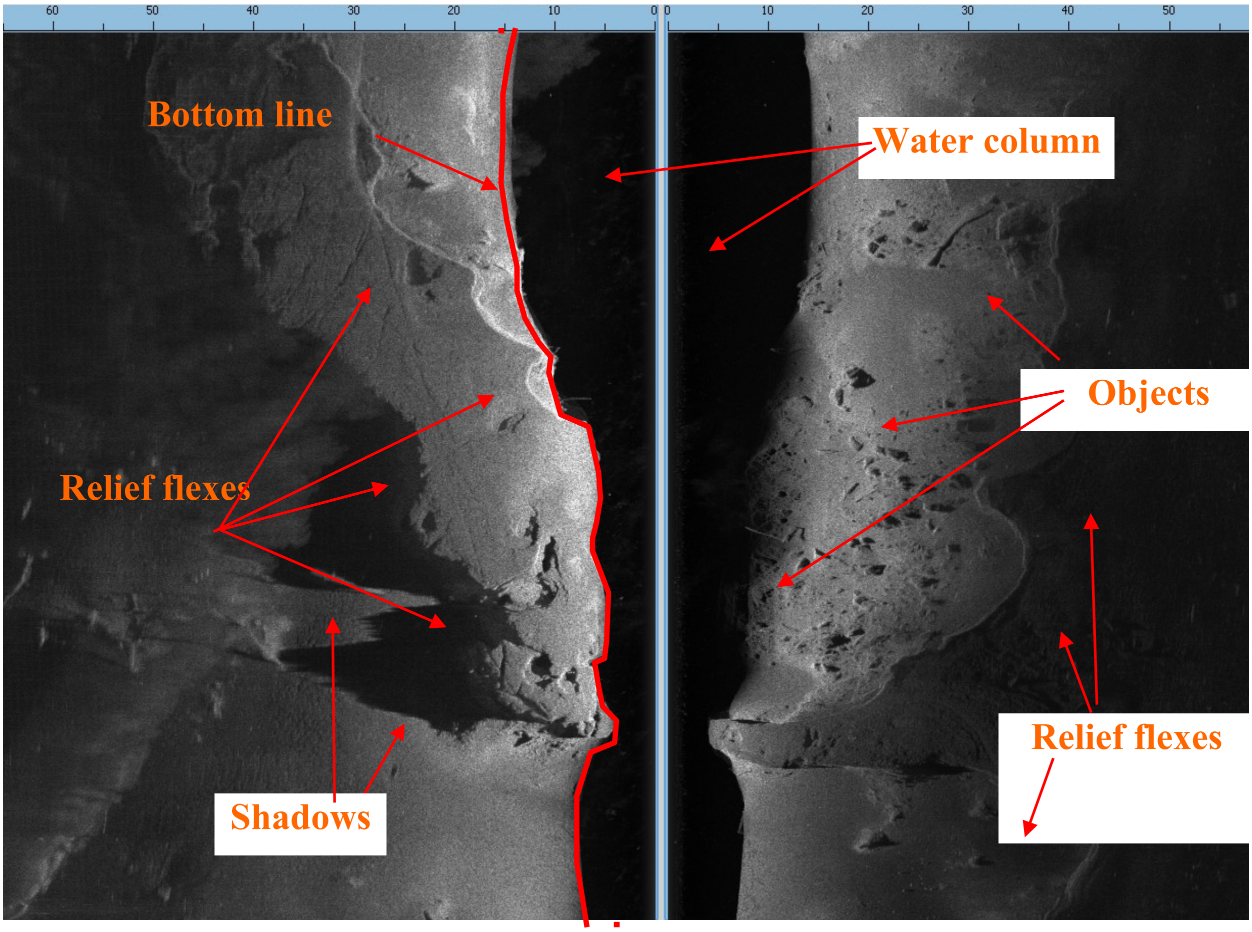


Figure 2.8. AI elements

AI may be distorted due to different factors; these distortions are called artifacts. Presence of artifacts may cause misinterpretation and distortion of the results.

Image of water column represents a dark area at the distance beginning.

Within the water column brighter images of objects (fish, contrail, suspensions etc.) may appear.

Bottom line is the boundary between the water column and the bottom. Shadows appear as the result of depth reduction along the SSS beam. By the size of a shadow one may judge on the height difference (change in depth). Objects appear in the AI as image areas, which brightness differs from the background brightness; as a rule, these areas have shadows. Object is visible if its brightness differs from the background brightness or if it has a shadow. It is possible to judge on the object type by the geometry of an area of its image and/or from the geometry of its shadow image. Relief flexes (edges) appear due to the variation in depth along the SSS beam.

Reliable determination of depth for SSS is only possible along the vessel movement trajectory from the bottom line image.

2.4.8. Echosounder operation

ES operation is based on indirect method of distance measurement.

ES measures time (delay) that passed between the PP emission and the moment of arrival of the signal reflected from the bottom. The distance to the bottom is computed in software by means of multiplication of measured delay by the known velocity of sound propagation in water. By default, the velocity of sound propagation in water is considered as equal to 1500 m/s (at signal passing to the bottom and back).

For depth is taken a computed distance to the bottom with due account of corrections for ES antenna depth relatively to water level.

AI generated by the ES is displayed in HS program and contains the following basic elements (see fig. 2.9):

- Water column
- Bottom (first reflection)
- Bottom line
- Second and subsequent reflections

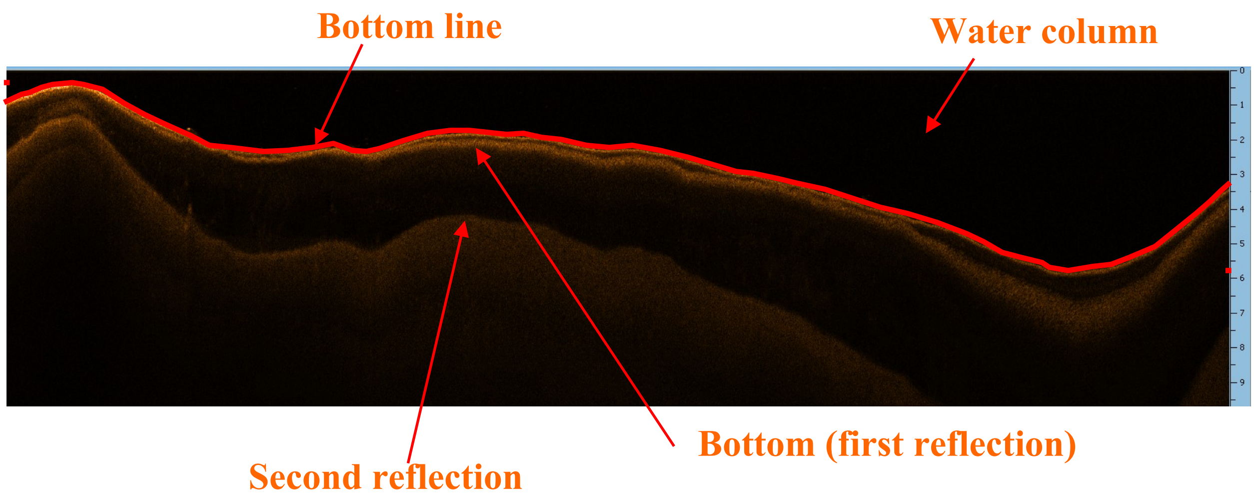


Figure 2.9. ES AI elements

Image of water column represents a dark area at the distance origin. Within the water column brighter images of objects (fish, contrail, suspensions etc.) may appear.

For every probing the program calculates the point of bottom begin (first reflection). During vessel movement consecutive bottom points form in the AI a borderline between the water column and the bottom, thus forming bottom line (bottom entrance line).

AI may be distorted due to different factors; these distortions are called artifacts. Presence of artifacts may cause misinterpretation and distortion of the results of depth measurement.

The accuracy of depth measurement depends on:

- the accuracy of bottom line allocation
- the accuracy of measurement of sound velocity in water (sound velocity profile)

Control of ES depth calculation is performed by the Operator. If necessary, bottom line allocated by the ES may be manually corrected by the Operator.

2.4.9. Monoblock placement

SSS may be mounted on any vessel. SSS installation on vessel may be portable (detachable) or stationary one (see fig.2.10).

The greatest attention must be paid to choice of place of SSS installation and mounting, as it affects SSS operating quality. For SSS typical mounting options see APPENDIX J. When using user’s mounting configuration, it is necessary to observe the following recommendations:

- select mounting points in the spots with the least swinging amplitude;
- it is recommended to provide two options of mounting stable position: operating position – vertically, and field position (non-operating). In operating position monoblock must be submerged in such a way that it does not leap out of water at swinging. Field position is intended for vessel movement from one point to another (lashing) without performing a survey. It is desirable that a swift transition from field position to operating position and vice versa is possible;

- for pole mounting, the SSS body must not touch the watercraft hull in order to prevent the vibration transfer from the last-mentioned to the SSS;
- it is necessary to locate SSS as far from engines and as close to vessel center as possible;
- mounting must provide for SSS levelness in operating position at vessel's level position; SSS fore-and-aft axis must be parallel to the vessel fore-and-aft axis;
- back up SSS mounting with halyards against the possibility of break-off;
- clamp the cables securely with a pace of 20-30 cm;
- in operating position SSS must be completely submerged. Immersion depth is defined with the particular conditions of survey and may vary within the range from 25 cm to 150 cm. Recommended SSS immersion is not less than 30 cm. When working in shallow waters it is forbidden to immerse SSS deeper than the watercraft keel in order to prevent accidental contact of the SSS with the bottom. However, immersion depth must be sufficient for SSS to remain in water during movement at vessel swinging;
- it is allowed to mount SSS on vessel keel or body; however, no acoustic shadows may be present. Reflections from the bottom or boards may cause mirror or multiple imaging. SSS mounting to bottom or keel must be such that at water flowing around the SSS body no swirling or cavitation is observed.

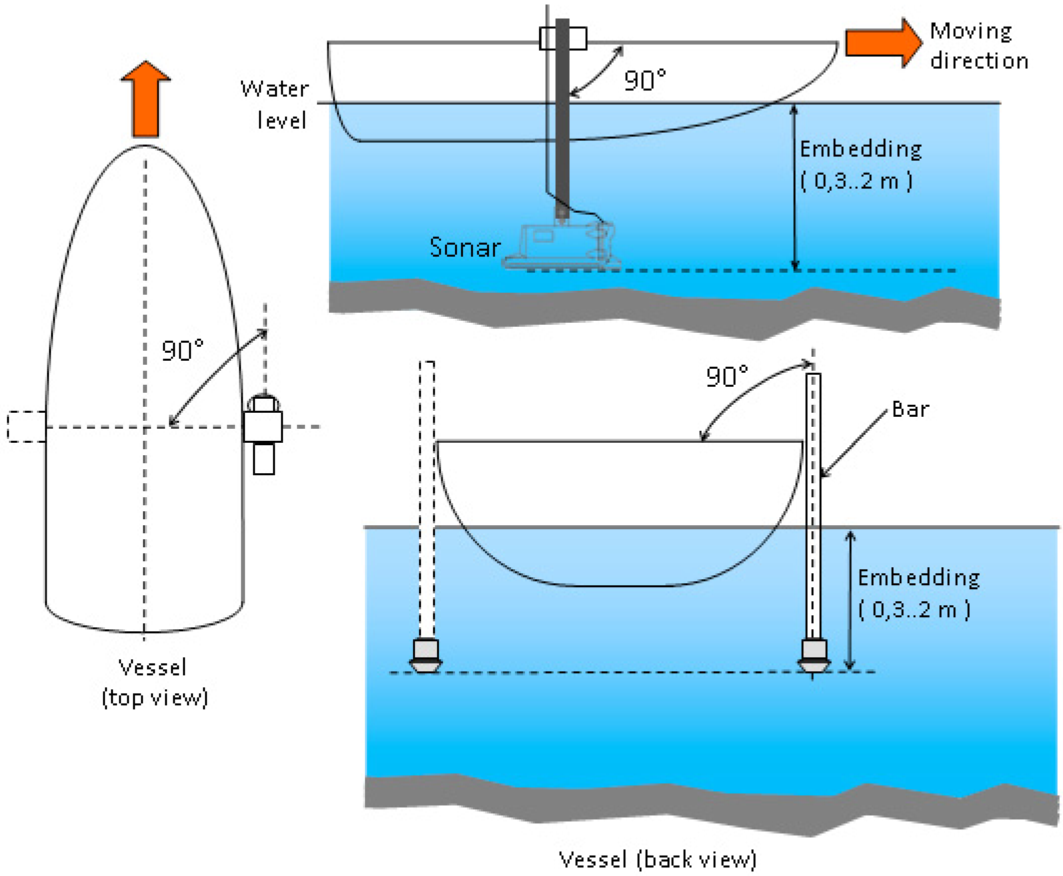


Figure 2.10. Mounting on boat

2.4.10. Using software

SW for work with the SSS is divided into two parts:

- survey SW
- office processing SW.

Survey SW is intended for:

- performing of survey;
- determination of object parameters (coordinates, dimensions);
- review and analysis of data recorded during survey;
- compilation of reports on survey;
- survey data conversion for further processing

As survey SW is used HS program, which is included to the delivery set. HS program is installed on the laptop.

Office processing SW is intended for:

- plotting of AI mosaic;
- plotting of bathymetric chart upon the results of echosounding;

- overlapping of AI mosaic onto bathymetric chart;
- analysis of obtained data;
- reporting.

As post-processing SW are used dedicated packages for SSS, ES data processing, which may be included to the scope of supply or bought individually by the Customer. Post-processing SW is installed on the laptop included to the scope of supply or other computer used for post-processing.

If necessary, SW may be reinstalled from the corresponding installation software, which may be found on the OD.

Work with SW is conducted according to the corresponding OM.

3. Intended use

Prior to use of SSS carefully read and observe below-mentioned requirements to operating personnel, operating restrictions and safety precautions.

Concerning the issues on storage, maintenance and transportation refer to corresponding sections of the present OM. If you have any other issues, consult the Manufacturer.

3.1. Requirements to operating personnel

Persons operating SSS must:

1) know the structure, operating principle and features of SSS operation;
2) observe operating restrictions and safety precautions when operating SSS;
3) have knowledge and experience in operating computer OS at advanced user level;
4) know operation and features of implemented SW to the extent of corresponding operator’s manuals; complete (if necessary) corresponding training in use of SW
5) ave knowledge and experience in conduction of works by means of SSS, complete (if necessary) corresponding training
6) observe safety requirements when working on water

7) account for design features and marine navigation features for used boat during installation and operation of SSS

3.2. Operating restrictions

It is forbidden to operate SSS, if the conditions on operating temperature are not satisfied.

It is necessary to agree with the Manufacturer the use of ancillary equipment used jointly with SSS during survey.

SSS is oriented to operation from the carrier board, which was prepared for operation with SSS (fixture mounting is required). In the case of changing of a carrier it is necessary to repeat all preparatory operations (see 3.5).

When using KIT006, it may be only used for certain type of boats, if it is necessary to use the boat of other type check the possibility of using KIT006 for this boat type, if necessary, consult the Manufacturer.

3.3. Safety precautions

SSS is not intended for provision of vessel safe navigation, vessel protection from running aground, avoiding collisions with submerged, floating or other dangerous objects. If you are in doubt about any of these hazards, always carry put the survey at reduced speeds, and proceed according to the situation.

Note: When you are on the vessel, your own safety is of the highest priority.

IT IS FORBIDDEN to use batteries and power supplies not intended for operation with the SSS (complex components).

Cables from power supply (network) are connected in the last turn.

When laying the cables, they must not be strained or experience mechanical stress.

While connecting the cables, the forces are applied to rigid parts of connectors, and not to the wire connections.

Cables must be clamped along the cable route to avoid their unauthorized displacement. Clamp the cables with a pace of 20-30 cm.

SSS is intended for operation in water only. Testing in the air is only allowed during maintenance (dry testing).

During operation it is FORBIDDEN TO:

EXPOSE SSS TO IMPACTS AND HIGH MECHANICAL LOADS;

SWITCH SSS THAT IN NOT SUBMERGED TO OPERATING MODE (BESIDE DRY TESTING);

MOVE SSS WHILE HOLDING IT BY ITS EMBEDDED CABLES;

INSTALL SSS IN SUCH A WAY THAT ITS CONNECTING CABLES ARE STRAINED;

SUBMERGE SSS WITH LOOSE MOUNTING HARDWARE

During mounting and operation of SSS it is necessary to take the following precautions:

- Handle antennas radiation surfaces with care. They are covered with soft hermetic and may be damaged when contacting with rigid objects.
- SSS body temperature higher 50 degrees centigrade is NOT ALLOWED.
- NEVER LEAVE SSS under direct sunlight for a long period of time, as it may cause damage of antennas covering and of rubber seals of the SSS body;
- While operating in shallow waters monitor the depth to avoid accidental contact of the SSS body with the bottom or objects in close proximity to water surface.

The most dangerous situation during the survey is fouling of the SSS body (SSS pole mounting) by the obstacle, which may cause the loss of SSS. In this case it is NECESSARY TO:

- immediately stop the vessel and look around;

- free SSS (pole) from fouling.

Additional information on safety precautions of set components is given in the corresponding UM.

NOTES.

1) Do not insert foreign metal objects or other objects into SSS and CPL002 connectors;
2) avoid bending and (or) kinking of the SSS cable with the radius less than 50 mm, as it may reduce its operational life;
3) avoid substantial temperature fluctuations during SSS operation;
4) in order to prevent corrosion wash away the sea salt from the SSS body immediately upon the survey completion;
5) store SSS in its intended case

3.4. Survey technology & Workflow

The following basic stages of work with SSS are distinguished (see fig.3.1):

- task definition
- preparation to survey
- Survey (data collection)
- Post-processing (may be absent)
- compiling of reports (may be absent)

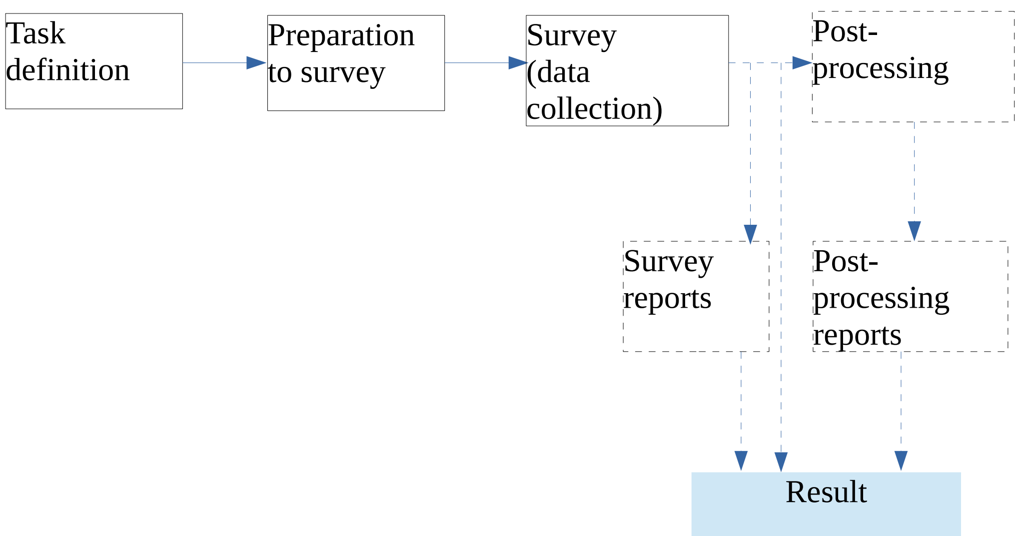


Figure 3.1. Workflow

3.4.1. Task definition and survey types

During task definition the following is defined:

- survey type
- data and place, and survey polygon
- used vessel
- features of polygon, approach spots etc.
- results data sheet (reporting form and composition)

Depending on set goal and on solution of a particular problem the following survey types are distinguished:

- observation survey;
- search survey;
- engineering survey (engineering monitoring);
- echosounding;
- echosounding with instrument evaluation.

It is possible to combine several types in a single survey.

Observation survey is intended for evaluation of condition of water area and bottom relief. It may be performed at high speed (up to 10 knots). It is used for:

1) evaluation of unknown water area prior to search survey or surveying works

2) evaluation of bottom surface condition and depths prior to conduction of diver inspection.

Search survey is intended for search of different objects on the bottom and in water column. In the case of small objects it is performed at low speed (up to 3 knots). In the case of of large objects it is performed at high speed (up to 10 knots).

Engineering survey is intended for evaluation of WW underwater part and walls. It is performed at low speed (up to 3 knots).

Echosounding is intended for plotting of water area bathymetric chart. It is performed by means of ES at low speed (up to 3 knots).

3.4.2. Survey preparation

At preparation stage all necessary activities providing qualitative survey are conducted.

Technically speaking (business activities are not considered), preparation stage includes:

- generation of initial data;
- tack planning;
- carrier preparation;
- equipment preparation

Recommendations on tack planning - APPENDIX I..

Carrier preparation includes:

- mounting of all necessary fixtures for used equipment (if the vessel is used for the first time or other vessel is used);
- measuring of offsets of equipment mounting points and their recording to survey log;

Equipment preparation includes:

- charging of used batteries;
- functional check of used equipment;
- check of equipment arrangement on vessel (at first use);
- check of completeness of installed SW, SW installation (if necessary)

SSS and complex elements are connected in compliance with the standard connection diagrams – see APPENDIX C. Computer (laptop) is installed into a portable set case or at any other place suitable for work.

3.4.3. Survey (data collection)

During data collection a direct sonar areal survey with recording of obtained data is carried out, data visual interpretation and primary analysis is conducted. During data collection the following is conducted:

- real-time correction of survey parameters;
- keeping of marking and tacking logs;
- SI recording;

- sonar status control
- control of velocity and motion trajectory in compliance with tack planning

During data collection the following SSS operating modes are possible:

- SSS only (one or two boards) – for observation, search or engineering survey;
- Only ES to perform sounder measurement;
- SSS (one or two boards) + ES to perform echosounder measurements with instrumental evaluation.

NOTE. It is recommended to include ES for any type of shooting for more accurately determine the depth.

For survey HS program is used. Other ancillary programs may also be used in order to provide survey convenience. Modes are switched in HS program.

The smaller is the searched object, the lower must be the motion velocity.

In general case average motion velocity during a survey is usually within the limits from 1 to 10 knots (0,5..5 m/s). At detection of objects and large roll and pitch angles it is also necessary to reduce the velocity.

During survey periodically check:

- SSS supply voltage in HS program;
- computer powering mode (internal battery or external accumulator battery);

Upon completion of data collection primary processing of collected data is performed (if necessary). Primary processing of survey data includes:

- SI analysis;
- compilation of reports (an example of a survey report see in APPENDIX B.).

3.4.4. Post-processing

The necessity of office processing is defined with the initial requirements. Office processing is conducted upon survey completion and not in real time. At office processing the following may be created:

- field sheet with AI mosaic and target markers;

- bathymetric chart;

Office processing is conducted by means of office processing SW (see 2.4.10)

3.4.5. Reports

The necessity of compilation of reports is defined with the initial requirements. Usually, reports are compiled upon the results of survey and office processing. It is also possible to compile a final report on the results of performed works.

For report form a text file with all necessary explanations and illustrations may be used. Additionally, video records, screenshots, results of office processing in different formats etc. may be enclosed.

Recommended data set for a report on survey and office processing is given in the appendix (APPENDIX B.).

For creation of the report data the HS or other corresponding system SW may be used.

3.5. Preparation to first use

Prior to the SSS first use it is necessary to perform the following setup operations:

1) depreservation

2) fixture mounting to carrier

KIT006 is mounted on tube on port or starboard. Mounting instructions are given in ED for KIT006.

3.6. SSS preparation to work

Before starting:

- thoroughly read section 2.4.;
- check the condition and completeness according to the accompanying documents;
- charge used batteries;

- install SSS fixture (KIT006 or other) on boat in compliance with the ED for fixture;
- mount SSS on boat by means of fixture with due regard to recommendations in p.3.2 and 3.3;
- clamp SSS cable to mounting pole;
- make all necessary settings for network connection in computer OS;
- connect the complex according to the connecting diagram (see Ошибка: источник перекрёстной ссылки не найден);
- power SSS on;
- check data acquisition from navigation receiver and other sensors (if they are used) in compliance with the ED for sensors;
- conduct complex functional check (see p. 5.2)

Now complex is ready for operation.

NOTES.

1) At SSS mounting to board it is recommended to provide two options of pole stable position:

a) operating – SSS is immersed for 0,3..2 m in such a way that it does not leap out of water at swinging;

b) field (non-operating) - SSS is fixed on pole in such a way that it is above the waterline. Field position is intended for vessel movement from one point to another without performing a survey. In both positions the mounting must provide stable position of monoblock. It is desirable that a swift transition from field position to operating position and vice versa is possible.

2) SSS mounting must provide for SSS levelness in operating position when the vessel is on even keel.

3) It is recommended to back up the SSS on pole with a thin halyard against the possibility of break-off at collision with an obstacle.

4) It is recommended to clamp the SSS cable securely along the pole with a pace of 20-30 cm.

5) SSS may be moved away from the computer for a distance not exceeding the length of respective cables (accounting for extension cords).

IT IS FORBIDDEN TO SWITCH SSS FROM OPERATING POSITION TO FIELD POSITION AND VICE VERSA DURING VESSEL MOVEMENT. THESE OPERATIONS MUST BE CONDUCTED ONLY DURING VESSEL DRIFT.

Below are given the recommendations on SSS placement and fixing to board:

1) SSS mounting to pole must be conducted when the SSS is turned off;
2) During mounting to pole SSS body must not touch the watercraft hull in order to prevent the vibration transfer from the last-mentioned to the SSS.
3) Prior to operation it is necessary to check whether all SSS mounting bolts and nuts are securely tightened.
4) In the case of unprotected connector joints (when using extension cords or adapters) it is necessary to protect the joints from water ingress.
5) Do not bend the cables with the radius less than 50 mm
6) Do not allow any acoustic shadows. Acoustic shadows may occur and cause the reduction of maximum coverage range. Reflections from the vessel bottom or boards may cause mirroring or multiple imaging.
7) Location relative to the engine. For SSS pole-mounting mount the SSS in front of the engine in such a way that SSS does not get into air-bubble jet created by the propeller. Provide minimum distance of not less than 0,4 m between the SSS and the propeller in order to minimize mechanical interference (noise).
8) Do not allow cavitation or whirling. SSS mounting must be such that at water flowing around the SSS body no swirling or cavitation is observed.

3.7. Surveying

Prior to conduction of survey:

- define the goals and tasks of a survey;
- examine the survey area, determine the survey area and the ranges of surveyed depths;
- prepare the vessel, fixture, SSS and other implemented equipment to use;

For surveying:

- power the laptop on, wait until the OS is loaded;

- power SSS on;
- switch the pole of SSS mounting to operating position (plunge SSS into water);
- start the HS program;
- check connection to SSS, data acquisition from navigation receiver and other sensors in HS;
- conduct survey in compliance with the survey plan;
- during survey control monoblock supply voltage in HS program

After survey:

- close HS program;
- close the OS, turn the computer off;
- switch the pole of SSS mounting to field position (pull SSS out of the water);
- power SSS off;
- dismantle the workplace;
- desalt the SSS body (in the case of operation in salt water);
- wipe off the moist from SSS body;
- if further operation of monoblock is not planned, prepare SSS for placing into case after work and put all components to their respective places.

Possible malfunctions during SSS operation and troubleshooting are described in p. 4. In the case of unrecoverable failure send SSS for repairs to the Manufacturer specifying all symptoms of detected failure.

3.7.1. Features of SSS application

During survey keep a constant speed of the vessel in the range from 1 to 10 knots. Slow speed provides higher-quality AI.

During survey in water area with the current its speed must be accounted for. E.g., at current speed of 3 knots at vessel motion upstream with the speed of 6 knots sailing speed will amount 3 knots, and at vessel motion downstream – 9 knots.

If possible, mount SSS as far from the propeller as possible. Wake from the propeller contains air bubbles and interferes with SSS operation, which is clear from the AI.

In order to prevent SSS damage one must avoid two main sources of danger:

- sudden changes in bottom height;
- appearing of submerged objects in the vessel's way.

AI image displays in computer the distance not from the surface, but below the SSS downwards, and does not show the depth ahead on course. For this reason, if you operate SSS in close proximity from the bed, you must continuously and attentively monitor generated AI and always be prepared to stop and take SSS out of the water to prevent SSS collision with the bottom. This also pertains to appearing of submerged objects, e.g., of a blockship, which may suddenly appear in the direction of towing.

If you have any concerns relative to the nature of underwater terrain, or possible presence of obstacles on bottom, in order to prevent collisions always take timely precautions, reduce the speed.

Depending on the underwater terrain, a minimum altitude of SSS above the bottom of 1 to 5m should be considered safe.

3.7.2. Waves, Wake and Surface Chop

While operating from the vessel board SSS is located close to the water surface, so the resulting AI can be distorted by the vessel swinging (the brightness of the neighboring image lines and/or the depth changes in time with swinging).

SSS is able to work at up to 3 force waves. At increment of swinging the quality of generated AI will be reduced. SSS will not operate qualitatively at high sea.

3.7.3. Survey velocity

When surveying, remember that it is “pinging” at a fixed rate (depending on range). The faster you tow the fish, the more compressed images will appear on the display, and its towing depth may become shallower as the drag on the sonar transducer head and towing cable increases.For long ranges, try to tow at speeds between 1 and 3 knots, while shorter ranges can be used with speeds of 3 to 6 knots.

3.7.4. Height above the bottom

SSS height above the bottom is an important factor used at consideration and interpretation of height of objects on the bed by their acoustic shadows. Survey at small heights from the bottom makes object shadows are too elongated, whereas the survey at large heights from the bottom causes generating of AI with minimum shadows that cannot be analyzed.

3.7.5. SSS location relative to the vessel

SSS location at depths greater than the draft of towing vessel minimizes receiving of echoes from the vessel hull, which appear as mirroring or ghosting in AI.

3.7.6. Prevention of collision with the object in water column

When passing by the buoy or other object, which may be at anchor, it is necessary to assume that the cable or rope under the buoy (or other object at anchor) may straddle. Current may cause the slope of cable or rope or partial laying on the seabed, and, if a sufficient distance between the SSS and an obstacle in the form of cable or rope is not provided, this may cause SSS damage.

In order to determine the required distance you must not rely on SSS as on navigation system for your ship, or as on source of information for prevention of grounding collisions with submerged objects or objects within the water column.

3.7.7. Survey planning

At planning of areal survey lay the course in straight tacks, with turnarounds by 180° at the tack end. Remember that when the ship turns around at the tack end, AI will seem distorted and cannot be used for processing. In order to prevent collisions provide a sufficient distance between the carrier vessel and other vessels or objects within the water column. If possible, avoid operating in the wake of ships and vessels passing by, due to essential interference.

3.7.8. Navigation

During water area survey hold the vessel heading as straight as possible. Perform polygon survey in parallel tacks. Remember that at vessel turning or turning around AI is distorted. It should be reckoned that AI, obtained at turning motion is not to be processed. If the surveyed object appeared in AI during a turn, turnaround or about-turn, in order to specify object parameters it is necessary to make and additional tack. Besides, it is necessary to account for features of carrier operation – when turning motion is complete, carrier does not get on the straight course right away. For this reason, tack origin must be planned with a certain allowance.

3.8. Carrying out of measurements by AI

The following measurements by AI data are available to the operator:

- object coordinates
- object dimensions
- distance between objects
- object height by its shadow

NOTE. First three types of measurements are available only upon availability of data from the navigation receiver.

Measurements are available during survey, data playing, or office processing.

During survey and data playing measurements are made in HS, at office processing they are carried out in office processing software.

Measuring of object height by its shadow is conducted only in HS.

3.9. Data playing

Data recorded during survey are reproduced in HS. At reproduction the measurements by the AI data are available (see p. 3.8).

3.10. Post-processing

Office processing of survey recorded data is performed upon completion of a survey by means of office processing SW (see p. 2.4.10).

Processing may be carried out on a system laptop or any other computer (provided that office processing SW is installed).

The results of SSS data office processing:

- AI mosaics;
- different forms of reports (information on detected objects, fairway condition, condition of underwater part of WW etc.)

For more detailed information on office processing see respective OM.

4. Troubleshooting

Failure	Possible causes	Finding faulty element	Corrective action
No connection via control interface from the control computer	Absence of primary power for Ethernet interface	Measure voltage at PS	replace PS
		Check power line for continuity	replace cable
	Communication line breakdown	Check comm line for continuity	
	Faulty control computer		Replace computer
Image at both boards is absent or dark image	Insufficient amplification		Increase amplification
	SSS is incorrectly installed	check SSS installation	Observe recommendations on installation in p. 2.4.9
	Antenna transducing surface is contaminated or blocked by foreign object	Check antennas condition	
Image is low in contrast	Amplification is too strong		Decrease amplification
	PP with high energy is used		use PP with lower energy (use tone signal)
	Brightness or contrast is not adjusted		Set required brightness and contrast
Bottom line is not identified or bottom line is blurred	CHIRP signal is used at shallow depths		Switch to CHIRP signal of shorter duration or use tone signal
	range less than the actual depth is set		Increase the range
Repeatable interference (stripes) in AI	Emission from other sonar complexes (echosounders) operating with the frequency close to yours	Make sure that no vessels are nearby that use sonar devices	If any other sonar devices are present at your vessel perform synchronization
	Electric pickup from computer adapter	Check the influence of computer adapter on complex operation	Replace power adapter

Failure	Possible causes	Finding faulty element	Corrective action
	Pickup from vessel engine	Check the influence of engine on sonar operation	Use engine rpm speed with minimum interference
AI with rereflection	PP with high energy is used at shallow depths		use PP with lower energy (use tone signal)
	Sonar is incorrectly installed	Check sonar installation	Observe recommendations on installation in OM
Insufficient swath	PP with low energy is used		use PP with higher energy (CHIRP signal)
	insufficient final gain when using TVG		check TVG settings
Different swath at port and starboard	bottom has a slope		
	Sonar is incorrectly installed	Check sonar installation	Observe recommendations on installation in OM
Different brightness (contrast) of AI t port and starboard	signal energies (modes) used for boards are different		Set the same (close) operating modes for both boards
	Different settings of gain, brightness, contrast for boards		Adjust gain, brightness, contrast
AI at one of the boards is absent or dark	signal energies (modes) used for boards are different		Set the same (close) operating modes for both boards
	Different settings of gain, brightness, contrast for boards		Adjust gain, brightness, contrast
	Antenna transducing surface is contaminated or blocked by foreign object	Check antennas condition	
Interference (stripes), high level of noise in AI	Electromagnetic pickup from power supply of consumer or consumer itself		Remove consumer power supply and (or) consumer to the maximum possible distance from sonar
At SSS connection HS	Settings for computer network		Set up the computer network

Failure	Possible causes	Finding faulty element	Corrective action
program does not display connection to sonar	connection are not set or are set incorrectly		connection

5. Service technology

In order to provide continuous functionality and availability of SSS for its intended use, as well as after storage, it is necessary to observe the procedure and the rules of maintenance specified in this section.

The following maintenance types are provided:

- Line maintenance. It is performed before and after the intended use and after transportation.
- Routine maintenance.

5.1. Safety precautions

There are no potentially lethal voltage in SSS.

5.2. Maintenance procedure

5.2.1. Line maintenance

Line maintenance provides for:

- visual inspection for absence of mechanical damage to SSS body, cables; condition of inscriptions;
- removal of dust and moist from outer surfaces

5.2.2. Routine maintenance

Forms of routine maintenance see in Таблица 4.

Таблица 4 - Forms of routine maintenance

Name of maintenance and operation object	Routine maintenance frequency at operation
Cleaning of outer surfaces from dirt. 1 Disconnect the cable. 2 Switch the complex to non-operating position. 3 Clean with soapy water using a brush. 4 Wash the connector contacts using brush and alcohol. ATTENTION. Plastic elements of the SSS body rapidly deterioration under action of toluene, phosphoric acid, formic acid and nitric acid, formaldehyde, turpentine, acetons, as well as compounds with high chlorine content (liquid chlorine, hydrochloric acid etc.).	1 year ± 1 month or if necessary.

Functional check without immersion 1 Assemble workplace in compliance with complex connection diagram 2 Power complex on 3 In HS program establish connection to sonar 4 In HS program run test “Dry test” 5 By applying light pressure intensely rub operating surfaces of sonar antennas; while affecting every antenna monitor the signal in respective field of AI program. Signal must be clearly detected. 6 Stop test “Dry test”. 7 Power complex off	When necessary at operation
Replacing of rubber gaskets, leak check and angular sensors of SSS	2 years ± 1 month or if necessary. It is performed at manufacturing facility

6. Repair

Routine repairs of SSS are made at the manufacturing facility.

Replacement of components of SSS basic set from spare parts fixture tools by the Consumer is possible.

If you have any issues on repairs and purchasing of spare parts please contact the Manufacturer (see p. 11).

7. Storage

Storage room air must be free of aggressive vapors and gases causing corrosion.

When not in use, SSS and all other components should be packed in their original shipping containers, in the same manner in which they were originally shipped, and stored in a dry area.

8. Transportation

During transportation it is necessary to observe shipping rules effective for this transportation mode.

During loading, transportation, and unloading it is FORBIDDEN to drop and tilt the case.

9. Disposal

SSS and basic set components after end of life or broken down and beyond repair after disposition are to be disposed by the Consumer.

10. Warranty liability

Manufacturer ensures compliance of SSS with the requirements of effective technical documents provided that operation, transportation and storage conditions are observed.

SSS guaranteed service life is 12 months since placed in service, but not more than 24 months since the date of SSS shipment to the Consumer.

SSS, for which noncompliance with the requirements of effective technical documents was detected during warranty period, is replaced or repaired by the manufacturing facility free of charge.

For all issues on warranty and post-warranty servicing please contact the Manufacturer.

11. About Manufacturer

SCREEN traces its history in underwater data acquisition and processing back to 1998. SCREEN has designed, developed, and manufactured sonars, instruments, and systems—for acquisition of underwater data, including marine, and coastal applications—for over 20 years.

Scientific and production firm “Ekran”

Zhukovsky city, Moscow region, Russia

Web: www.hydrasonars.ru, E-mail: support@hydrasonars.ru

See mailing address and contact phone number in website.

12. Product support

Website

Visit www.hydrasonars.ru for the on-line home of the SSS product family. From here you can get the latest news, software and firmware updates. Additionally, you can see sonar imagery from other SSS customers, and submit any interesting images you collect.

Technical support

If your SSS is not operating properly, we would suggest that your first try the ‘Troubleshooting’ section of this manual and the electronic documentation provided with the product to see if the problem can be easily remedied.

If you need further support, you can contact us at…

Web: www.hydrasonars.ru E-mail: support@hydrasonars.ru

Call: +7-495-790-7178 (9:00 am to 6:00 pm, Monday to Friday, GMT+3)

For all of the above please provide the following information, where appropriate and if possible, to help us with your technical support request…

- Part and Serial Numbers of the system components. These are located on the labels of each item.
- Version number of the HS software you are using.
- The operating system name, version, type (32 bit or 64 bit) and service

pack upgrade your computer is using.

- Brand and model of your computer (processor type and memory configuration is also useful if known). Name of the stockist, supplier or retailer where you purchased your SSS system.

If you have to return your SSS product for servicing, please…

- Contact us (using the details above) before sending your SSS.
- Pack your SSS back in the original packaging (or other suitable container), and enclose written documentation with your contact details (including contact phone number), description of the problem and any symptoms occurring.
- If your product is still under warranty, please include a copy of your receipt (showing proof and date of purchase).
- Please return the product back to SCREEN using an insured courier and delivery confirmation.

NOTE: *Due to the expansion of equipment capabilities and the fact that new products are continually being introduced, this manual cannot detail every aspect of the product operation.*

13. Limited warranty policy

SCREEN warrants that at the time of shipment all products shall be free from defects in material and workmanship and suitable for the purpose specified in the product literature.

System warranty commences immediately from the date of customer acceptance and runs for a period of 365 days.

APPENDIX A. Abbreviation

AI	Acoustic image
ALS	Around locking sonar
AUSV	Autonomous unmanned surface vehicle
CHIRP	Linear frequency modulation
CPL002	cable coupler CPL002
CW	Toneburst pulse
ES	Echosounder
Ethernet	Ethernet interface
HS	HyScan software
ISOSS	Integrated spatial orientation sensor system
KIT006	KIT006 mounting set
MS003	MS003 mobile set
MS004	MS004 mobile set
OD	Optical disk
OM	Operator manual
OS	Operational system
PA	Power amplifier
PP	Probing pulse
PWM	Pulse-width modulation
ROV	Remotely Operated Underwater Vehicle
SI	Sonar information
SP	Synchronizing pulse
SSS	Side scan sonar

SSSE	SSS with build in ES
SW	Software
TVG	Time variable gain
US	User manual
USB	USB interface
Wi-Fi	Wi-Fi interface

APPENDIX B. Survey report

Recommended contents of the report on conducted survey is given below.

1) Survey purpose (type)
2) Survey area, polygon
3) Date and time of survey
4) Survey weather conditions
5) Used vessel and equipment
6) Use navigation system
7) Tack plan
8) Information on contacts (detected objects) – screen shots, coordinates, dimensions, height etc.

APPENDIX C. Connection diagrams

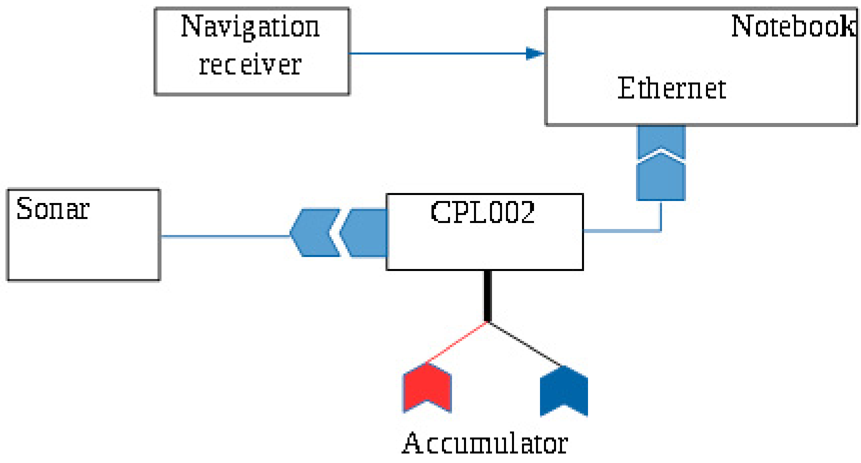


Figure C.1. Complex connection diagram

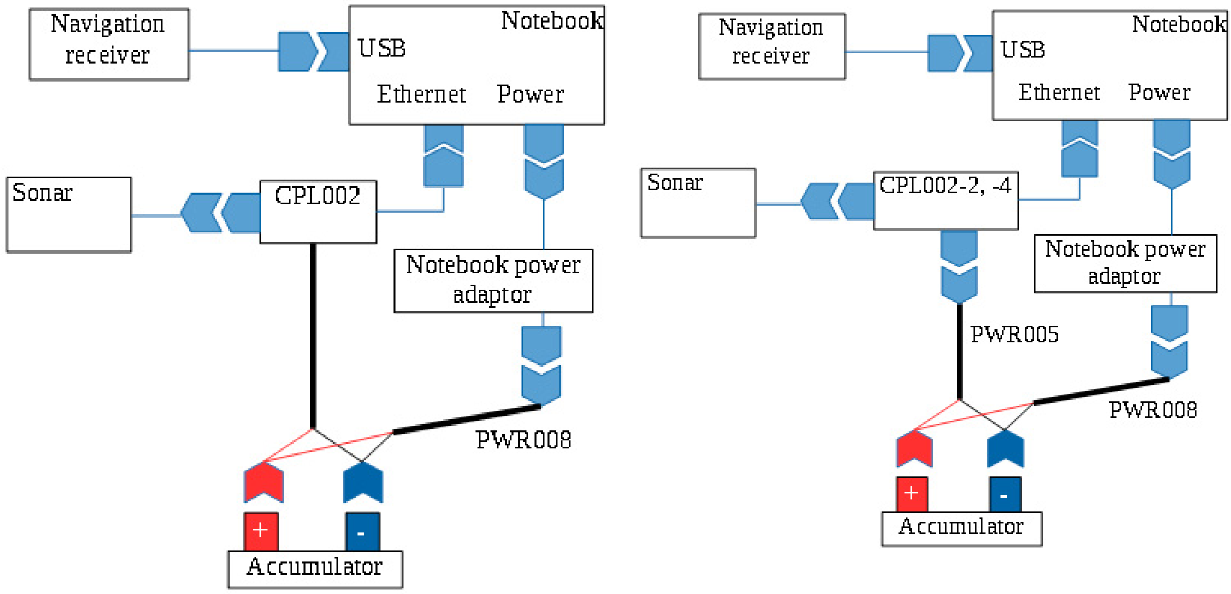


Figure C.2. Complex connection diagram (power supply of monoblock and laptop from the same battery)

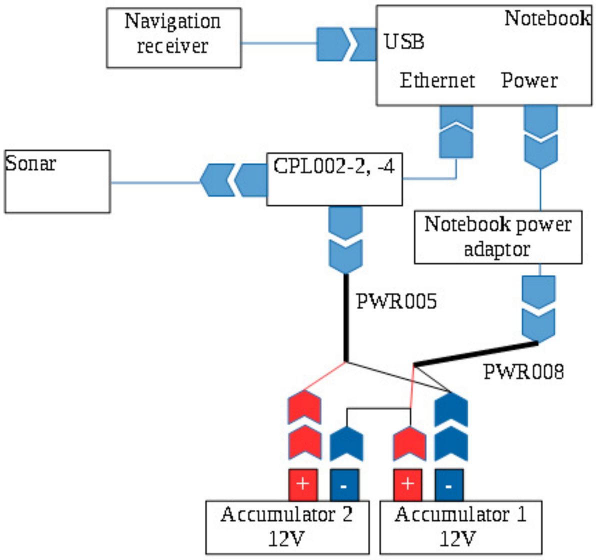


Figure C.3. Complex connection diagram (power supply from 2x12V batteries)

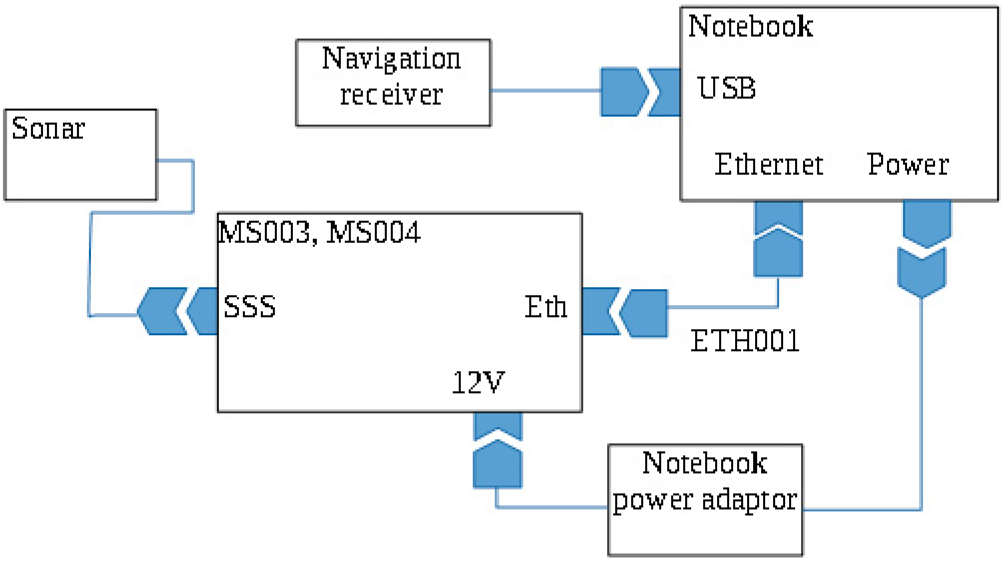


Figure C.4. Complex connection diagram at using of MS003, MS004

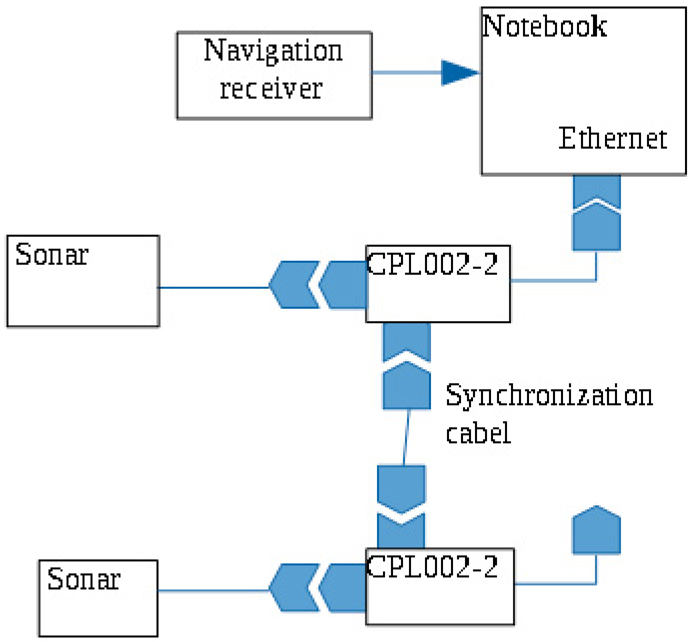


Figure C.5. Connection diagram at synchronization of Hydra complexes

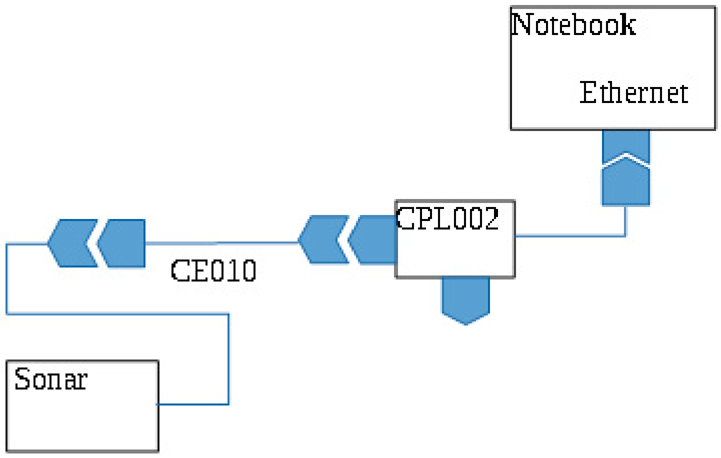


Figure C.6. Diagram of monoblock cable growth by means of CE010

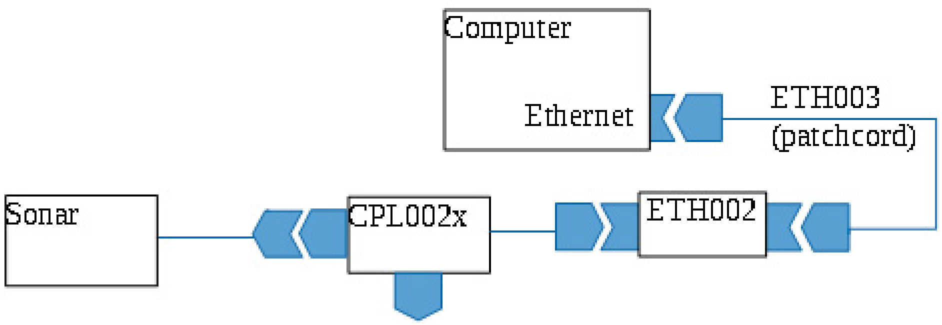


Figure C.7. Diagram of Ethernet cable growth by means of spacer ETH002 and cable ETH001 (or patch cord)

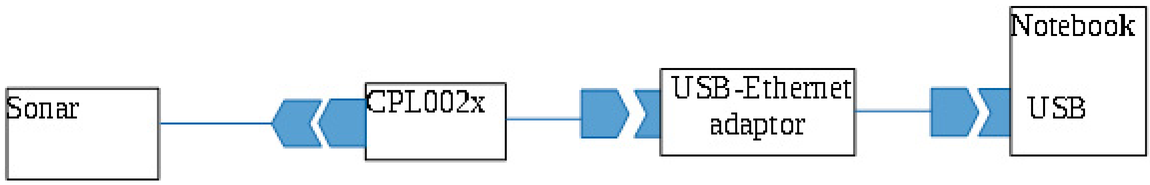


Figure C.8. Diagram of Ethernet line connection to the computer at using of USB-Ethernet adapter

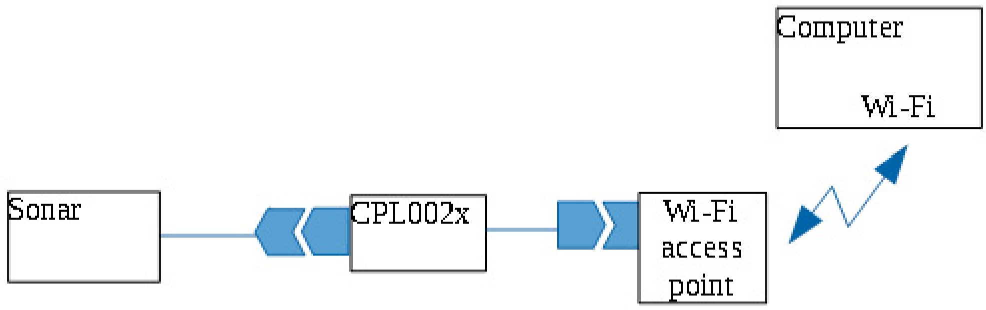


Figure C.9. Diagram of Ethernet line connection to the computer at using of Wi-Fi

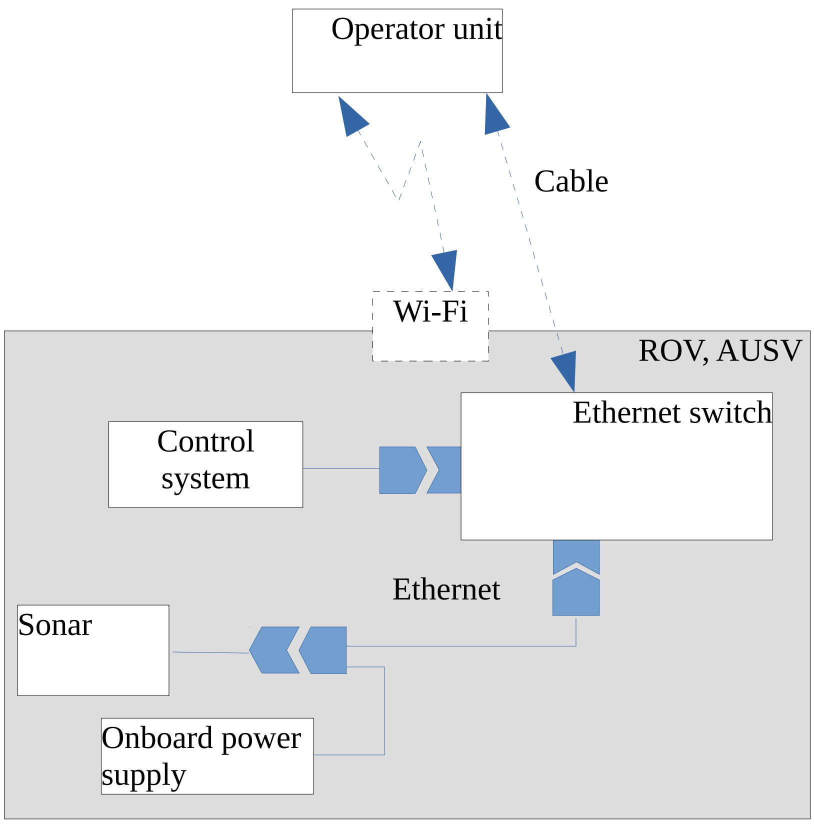
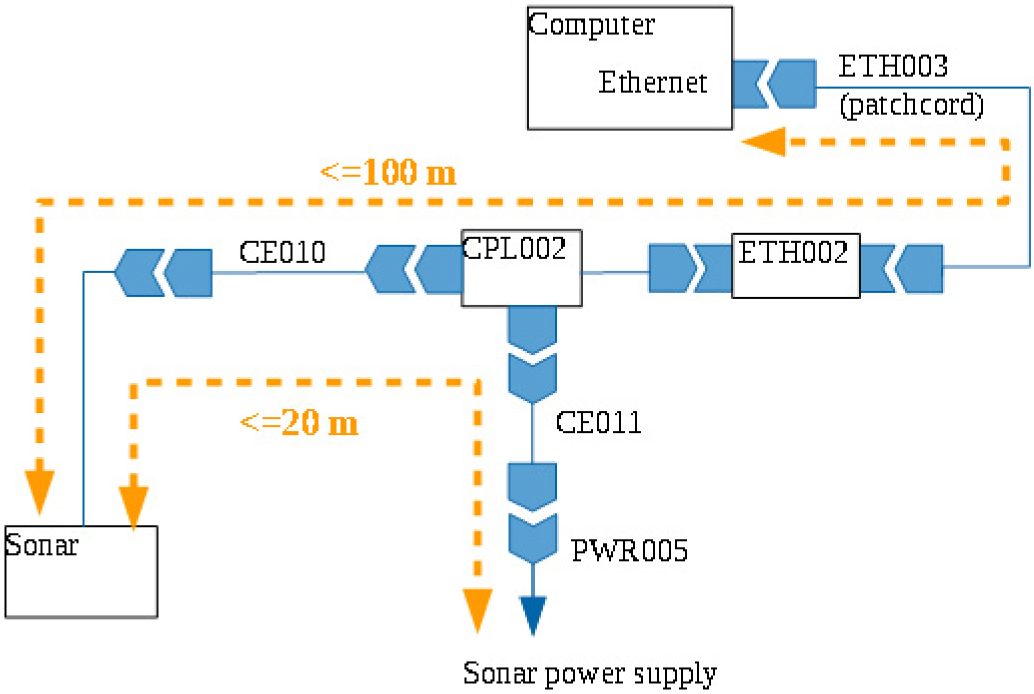
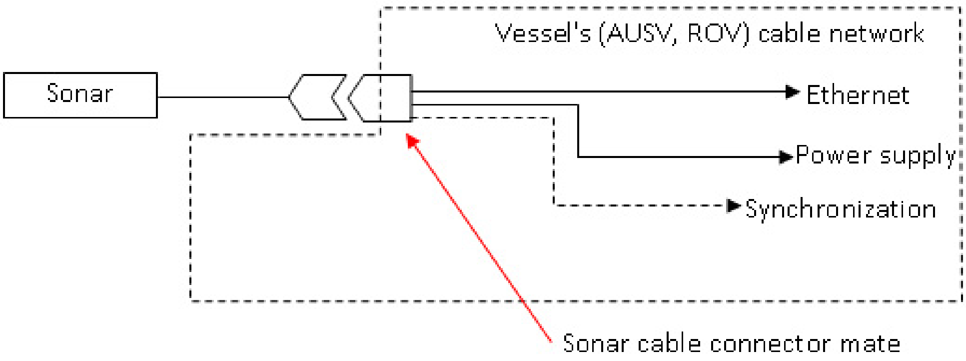


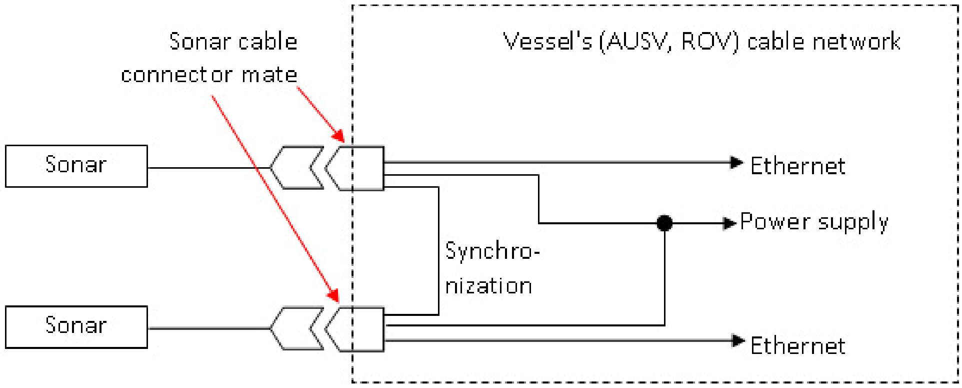
Figure C.10. Connection diagram (SSS on ROV, AUSV)



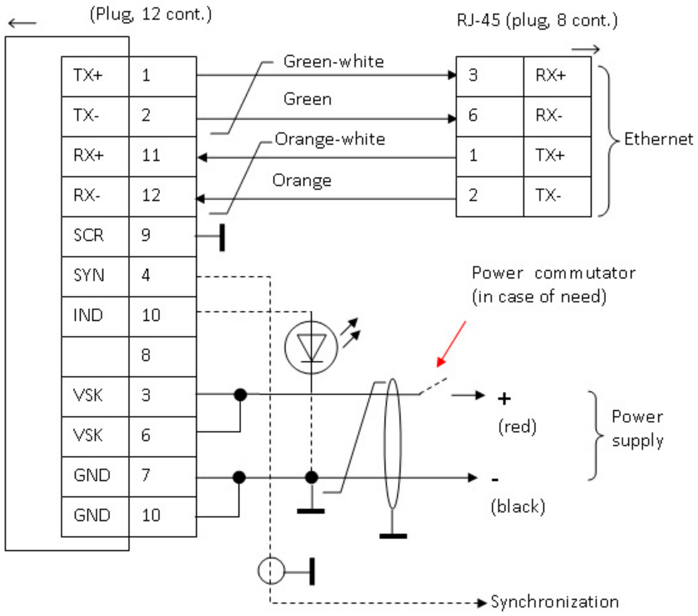
Picture C.11. Maximum cable length



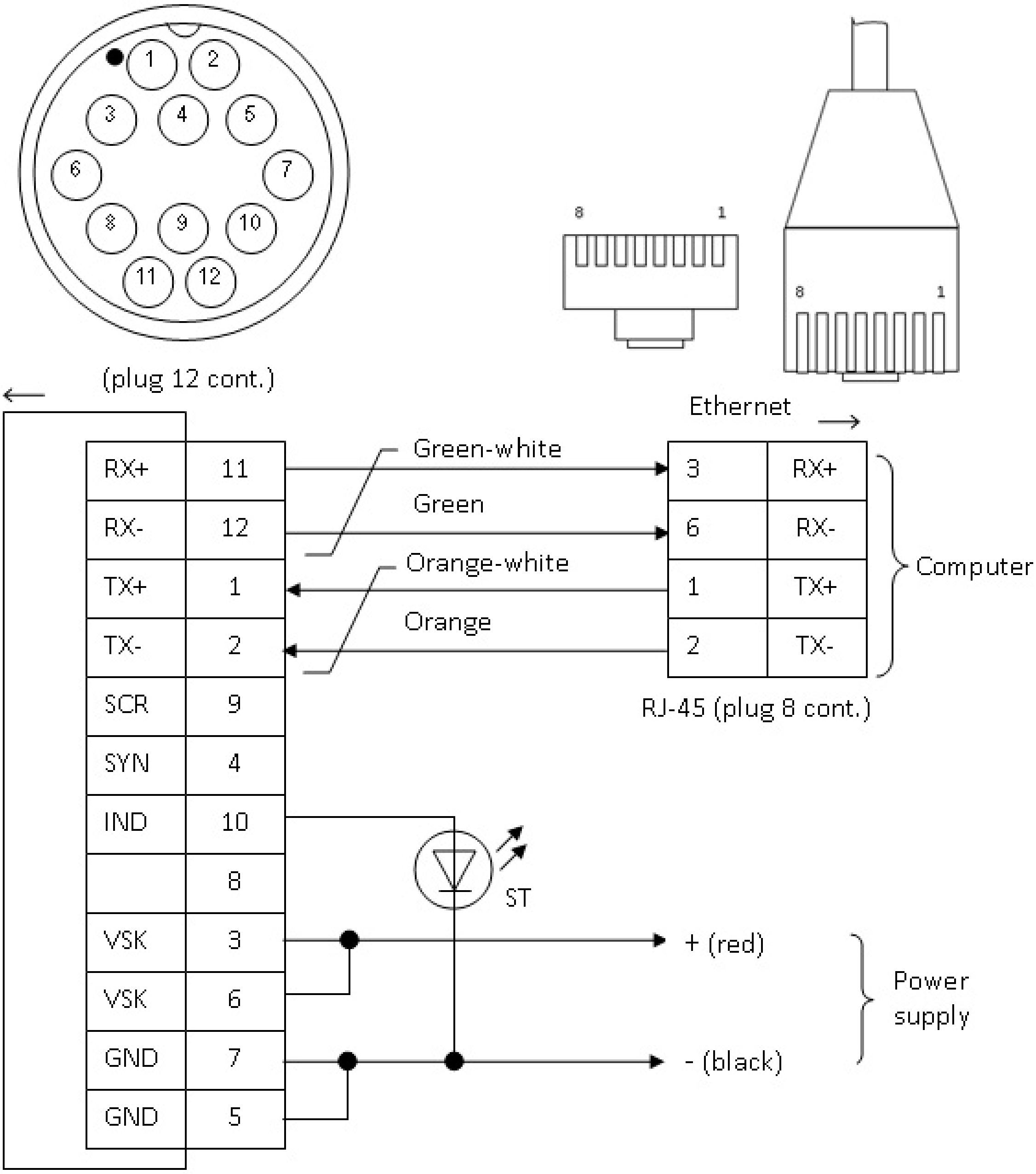
Sonar connection as part ROV, AUSV



Two sonar as part ROV, AUSV



Picture C.12. Connection diagram for SSS as part ROV, AUSV

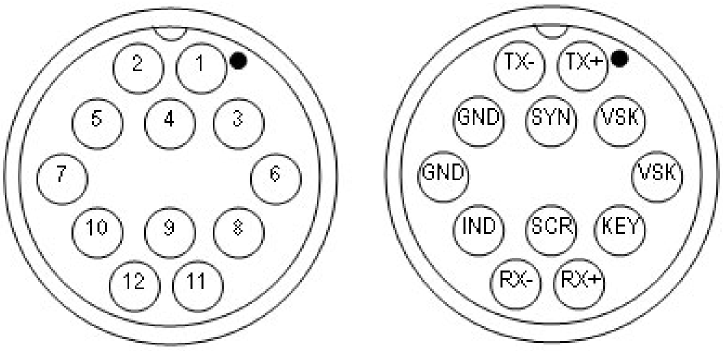


Picture C.13. CPL002 connection diagram

APPENDIX D.Wiring and connector pin out drawings

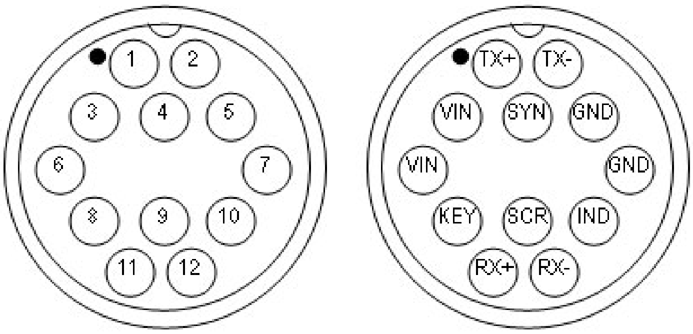
Below is given a connector pin out for monoblock and complex cable network connectors.

SSS connector (socket, 12 contacts)



Contact	Name	Description
1	TX+	+ phase of monoblock Ethernet transmitter (output)
2	TX-	- phase of monoblock Ethernet transmitter (output)
3,6	VSK	External power supply (+)
4	SYN	Synchronization input/output
5,7	GND	common and – of external power
10	IND	Status indicator (output)
11	RX+	+ phase of monoblock Ethernet receiver (input)
12	RX-	- phase of monoblock Ethernet receiver (input)
8	KEY	Not used

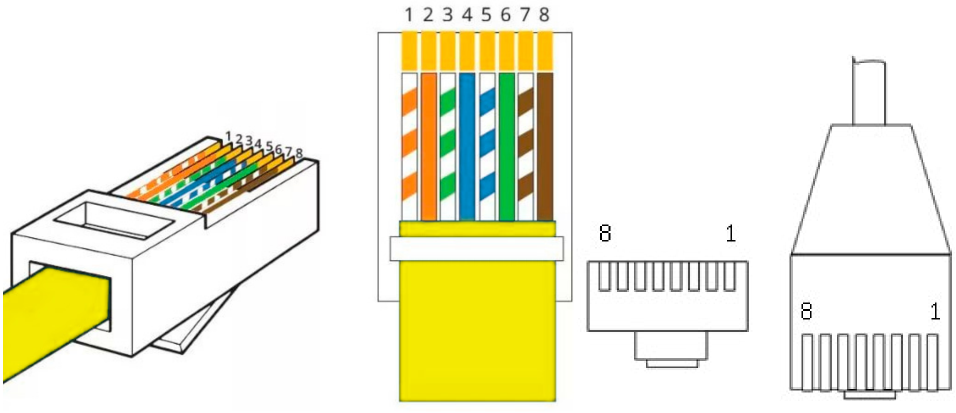
Sonar connector in CPL002x (male, 12 contacts)



View from the side of connection of monoblock cable

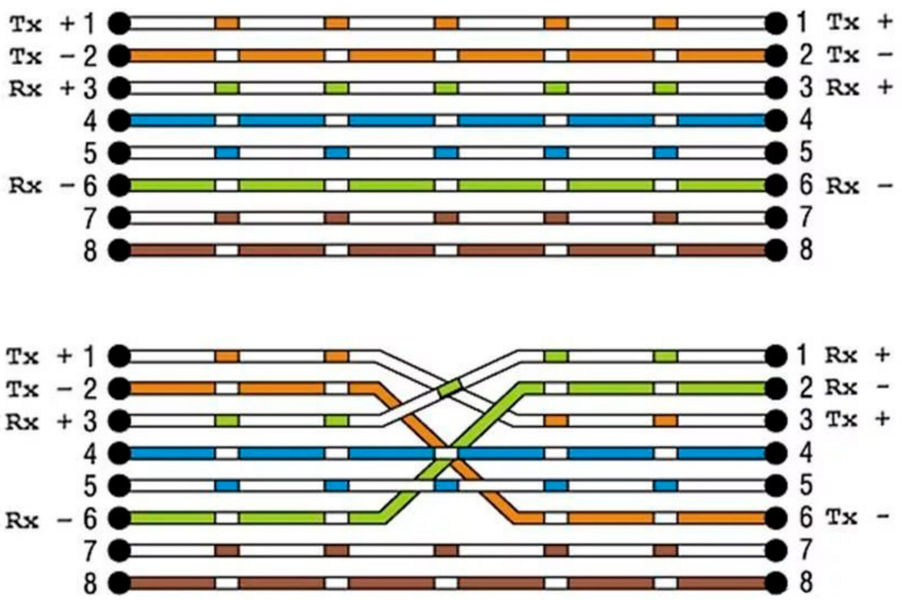
Contact	Name	Description
11	RX+	Input of Ethernet received data (phase +)
12	RX-	Input of Ethernet received data (phase -)
1	TX+	Output of Ethernet transmitted data (phase +)
2	TX-	Output of Ethernet transmitted data (phase -)
4	SYN	Synchronization input/output
8	KEY	Not used
10	IND	Status indicator input
3,6	VIN	Plus power output
5,7	GND	Common (minus) power output

Ethernet connector in CPL002x (RJ-45 plug, 8 contacts)



Contact	Wire color	Name	Description
1	Orange-White	TX+	Output of Ethernet transmitted data (phase +)
2	Orange	TX-	Output of Ethernet transmitted data (phase -)
3	Green-White	RX+	Input of Ethernet received data (phase +)
6	Green	RX-	Input of Ethernet received data (phase -)
4	Blue	-	Not used
5	Blue-White	-	
7	Brown-White	-	
8	Brown	-	

Patchcord



Picture D.1. Patchcord connection -direct (up) and cross (down)

NOTE. Only two pairs are enough for the sonar to work (1-2 & 3-6 pairs).

APPENDIX E. Network setting in OS

A monoblock with an Ethernet interface connects to the computer via a single 10/100 TX or 10/100/1000 TX Ethernet port. Monoblock has its own IP address and UDP port number (hereinafter UDP port), which is specified in the passport and on the label on the monoblock body.

The IP address is set in the OS network connection settings and when connecting to the sonar in the HS program.

UDP port is a decimal number in the range from 1 to 65535, for example: 4444. UDP port is specified only when connecting to the sonar in HS program.

To access the sonar, you must configure network connections in the OS on the computer to be used when working with the monoblock when shooting.

NOTES.

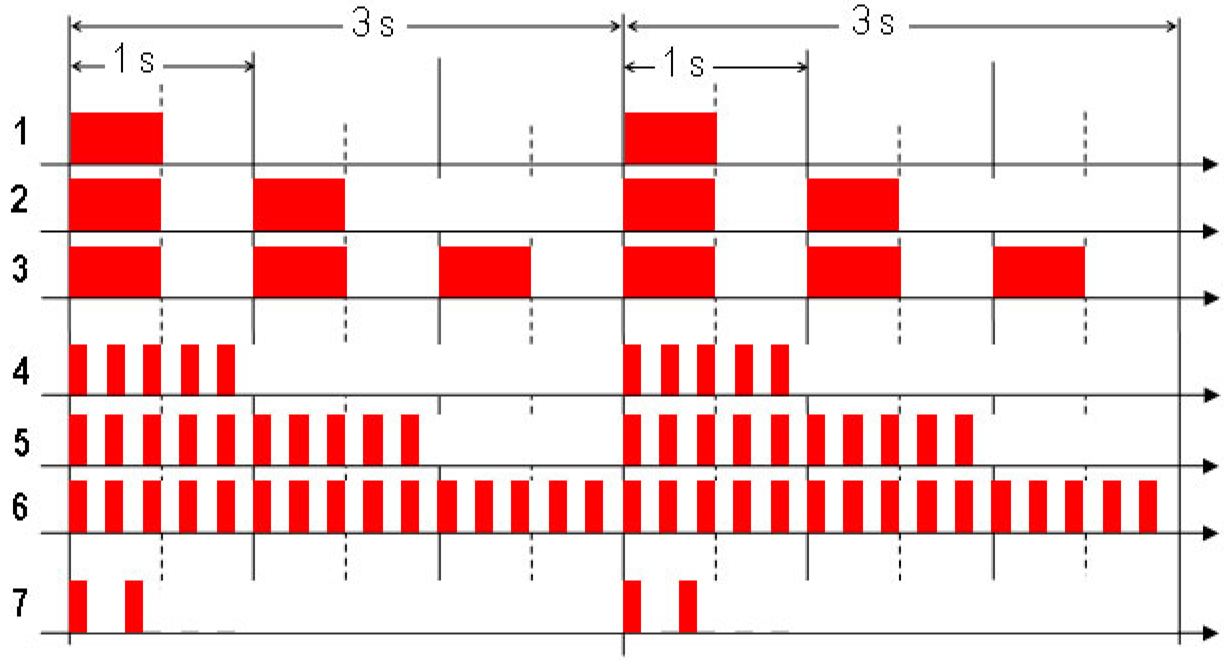
1. *If the UDP port number is not specified, it is 4444*
2. *By default, in the HS program, when connecting to the sonar, the IP address 192.168.13.3 and UDP port 4444 are used.*
3. *If the computer has several Ethernet ports, it is recommended to use a free (unoccupied) Ethernet port to connect to the SSS.*
4. *If your computer does not have an Ethernet port, you can connect the HBO to the computer via an Ethernet-USB adapter.*
5. *When connected to one computer several sonar, each of sonar must have a unique IP address.*
6. *If the computer will not be used for shooting (connection to HBO), then the network connections do not need to be configured.*
7. *If the Ethernet port is used for several tasks, it is recommended to install the program for quick switching of network connection settings*

APPENDIX F. SSS status indicator

The monoblock status indicator shows the current status of the sonar (see table below). The indicator is located in the CPL002 housing or is connected to the cable network of the complex

Indication modes

Monoblock state	Indication mode (chart number in the figure below)
Power off	Not lighted
Internal fault	Lights continuously
BOOT mode	Two short blinks with ~3s period (7)
Idle, power supply voltage of monoblock is very low	One blink with ~3s period (1)
dle, power supply voltage of monoblock is in middle range	Two blinks with ~3s period (2)
Idle, power supply voltage of monoblock is in upper range	Three blinks with ~3s period — blinking with 1 Hz frequency(3)
Scanning, power supply voltage of monoblock is very low	Five short blinks with ~3s period (4).
Scanning, power supply voltage of monoblock is in middle range	Ten short blinks with ~3s period (5)
Scanning, power supply voltage of monoblock is in upper range	Fifteen blinks with ~3s period — blinking with 5 Hz frequency (6)



Picture F.1. Timing diagrams of SSS status indicator

APPENDIX G. Choice of PP depending on survey conditions

PP used list

Number	PP name	PP description	PP energy
1	CW1	CW, power ~25%	Min
2	CW2	CW, power ~50%	
3	CW3	CW, power ~100%	
4	CHIRP1	CHIRP, duration ~1 ms, power ~100%	
5	CHIRP2	CHIRP, duration ~2 ms, power ~100%	
6	CHIRP4	CHIRP, duration ~4 ms, power ~100%	
7	CHIRP8	CHIRP, duration ~8 ms, power ~100%	
8	CHIRP12	CHIRP, duration ~12 ms, power ~100%	Max

Below are given the recommendations on setting of PP for SSS and ES depending on surveyed depth.

Surveyed depths, m	Applied PP
<2	CW1, CW2 (SS) CW1 (ES)
2-10	CW3 (SSS) CW1 -CW3(ES)
10-20	CW3, CHIRP1 (SSS) CW2-CW3 (ES)
20-40	CHIRP2, CHIRP4 (ГБО) CW3, CHIRP1 (ES)
40-50	CHIRP1, CHIRP2 (ES)

NOTES:

1) *depending on the hydrology of the shooting location, use the PP that provides the required detection range.*
2) *if the brightness of the AI SSS in the middle or end of the distance is small or not provided by the identification of objects, increase the energy of used PP SSS.*
3) *with unknown hydrology, start with CW3*
4) *when using CW signal, the maximum detection range for SSS is usually less than 60 m when operating in a sandy ground area*

Options used SSS working ranges depending on the type of shooting are shown in the table below.

Surveyed depths, m	**SSS slant distance, m**	
	Observing	**Searching**
<2	20-40	10-15
2-10	50-100	25-40
10-20	75-120	40-75
20-40	75-120	50-100

APPENDIX H. Recommended accessories and optional equipment

Below is the list of accessories, optional equipment and spare parts that can be used jointly with the SSS. For all questions about the use and purchase of these products, please contact the Manufacturer.

CE010 extender. Monoblock cable extension

CPL002 cable coupler. Connection to computer, power supply to monoblock.

Terminals for connecting car battery.

Cable PWR008. Connection of laptop power adapter to car battery.

Ethernet spacer ETH002. Ethernet cable extension.

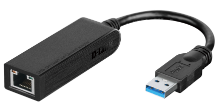
ETH003 Ethernet cable. Ethernet cable extension for CPL002 coupler.

GPS/GLONASS navigation receiver with 10 m positioning accuracy.

NAV002 GPS/GLONASS navigation receiver with 3 m positioning accuracy.

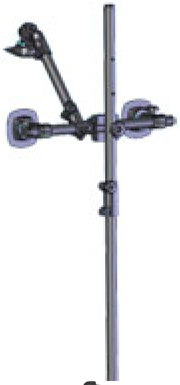
ACU002-5, ACU002-7 li-ion accumulator. Power supply for monoblock.

PWR010-3 charging adapter for ACU002-5, ACU002-7.



USB to Ethernet adapter. Ethernet line connection to the computer without Ethernet port.

Laptop power adapter. Laptop power supply from the car battery.



KIT006 mounting set. Monoblock mounting to inflatable boat board.

MS003 or MS004 mobile sets. Creation of portable complex on the set basis.

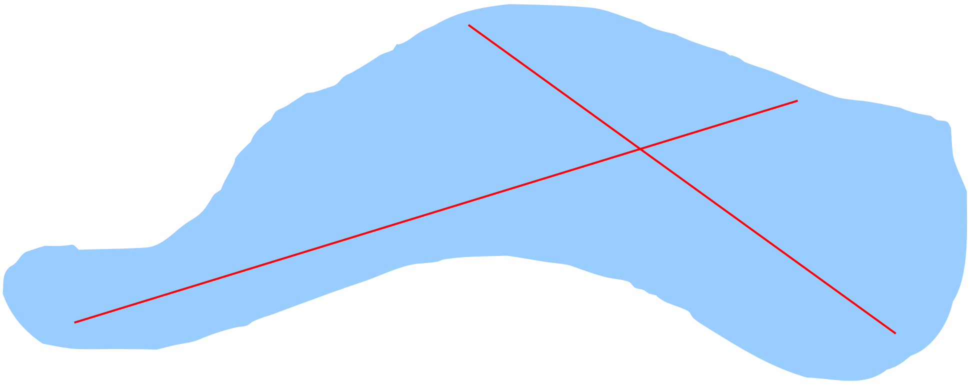
Protected laptop. Creation of portable complex.

PKG008 case. Basic set transportation and storage.

SSU003 all-round view drive set. Using SSS as rotation-type scanning sonar.

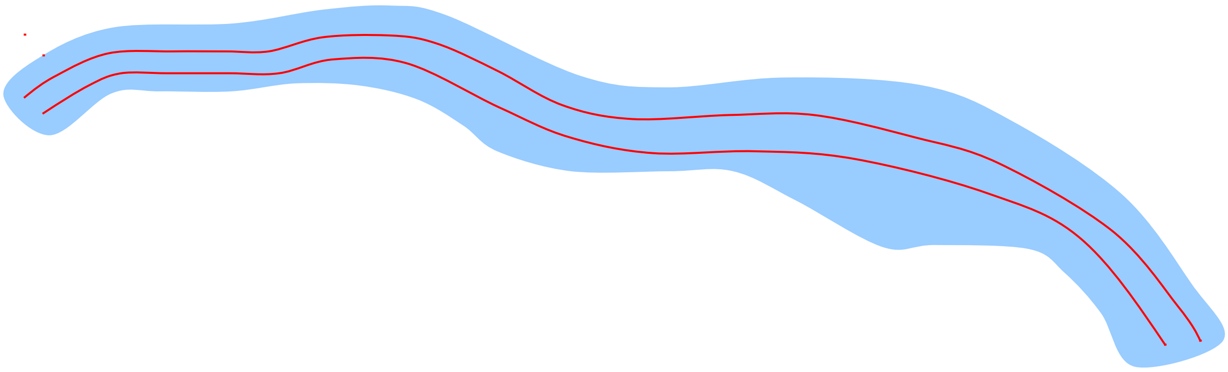
APPENDIX I. Recomendations for tacks planning

Below are given the examples on tacking for resolving of different tasks.

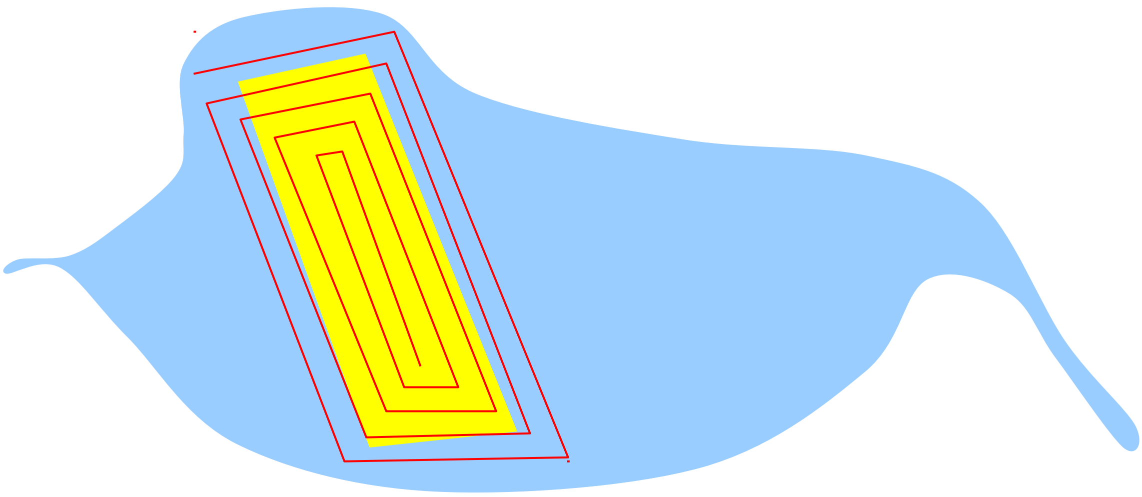


Example of two crossing tacks to assess the depths of unknown waters

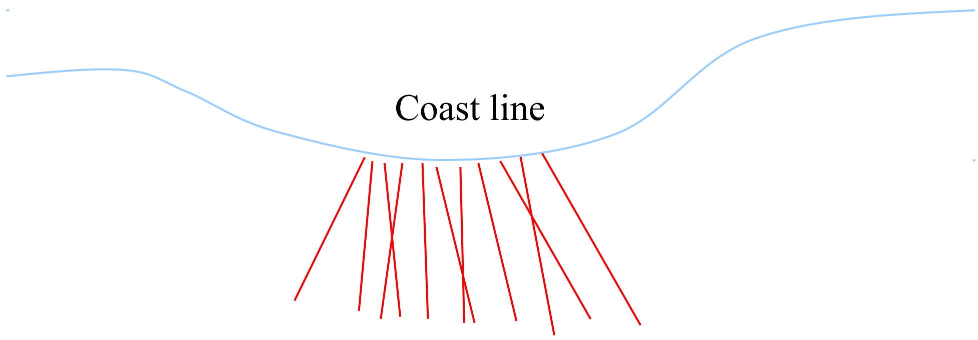
When working on rivers, it is recommended to make tacks along the riverbed (downstream or upstream). If the river is not wide, it may be enough to make one tack near the center of the riverbed.



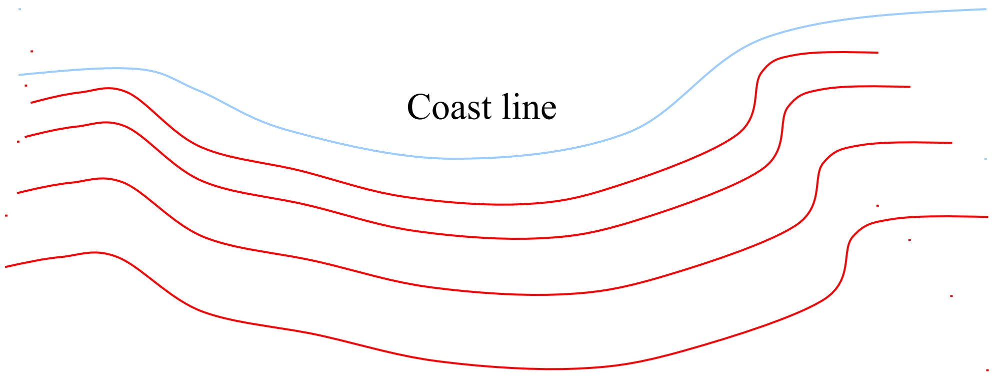
Tracking along the river bed



Example of tracking during search of object (yellow means an approximate region of object possible location)

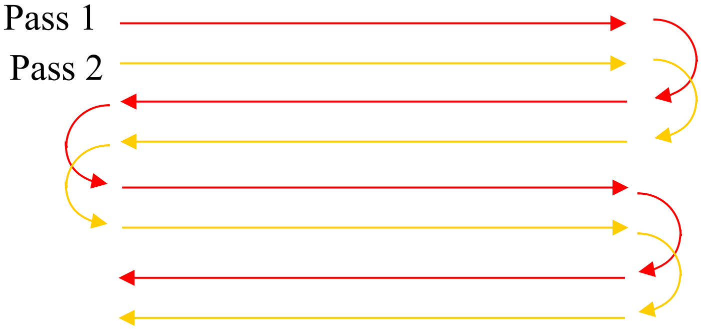


Example of tracking perpendicular to isobathic lines



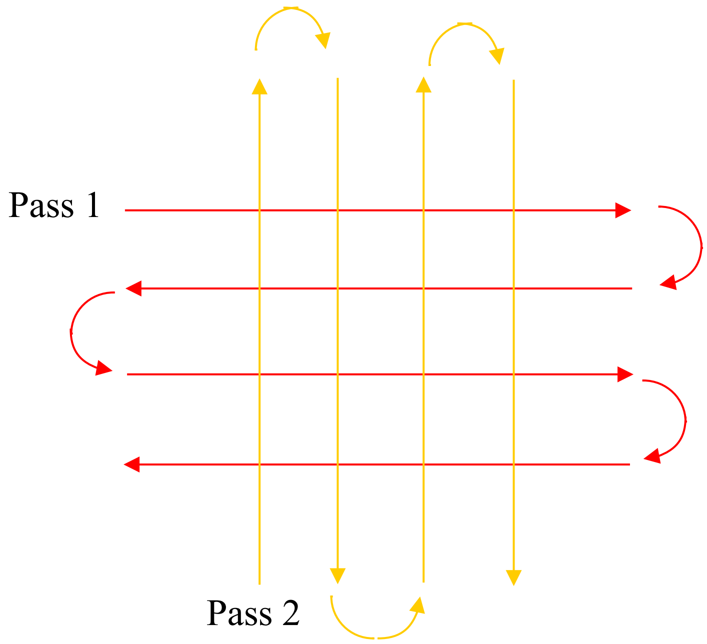
Example of tracking parallel to isobathic lines

Below is given an example of two independent surveys with tack parallel direction. Tacks in the second survey pass between the tacks of the first survey. This allows "illumination" of the same bottom area at different angles at each pass.



Example of parallel tracks in two independent surveys

Below is given an example of f two independent surveys with tack perpendicular direction. This allows "illumination" of bottom from two mutually perpendicular directions.



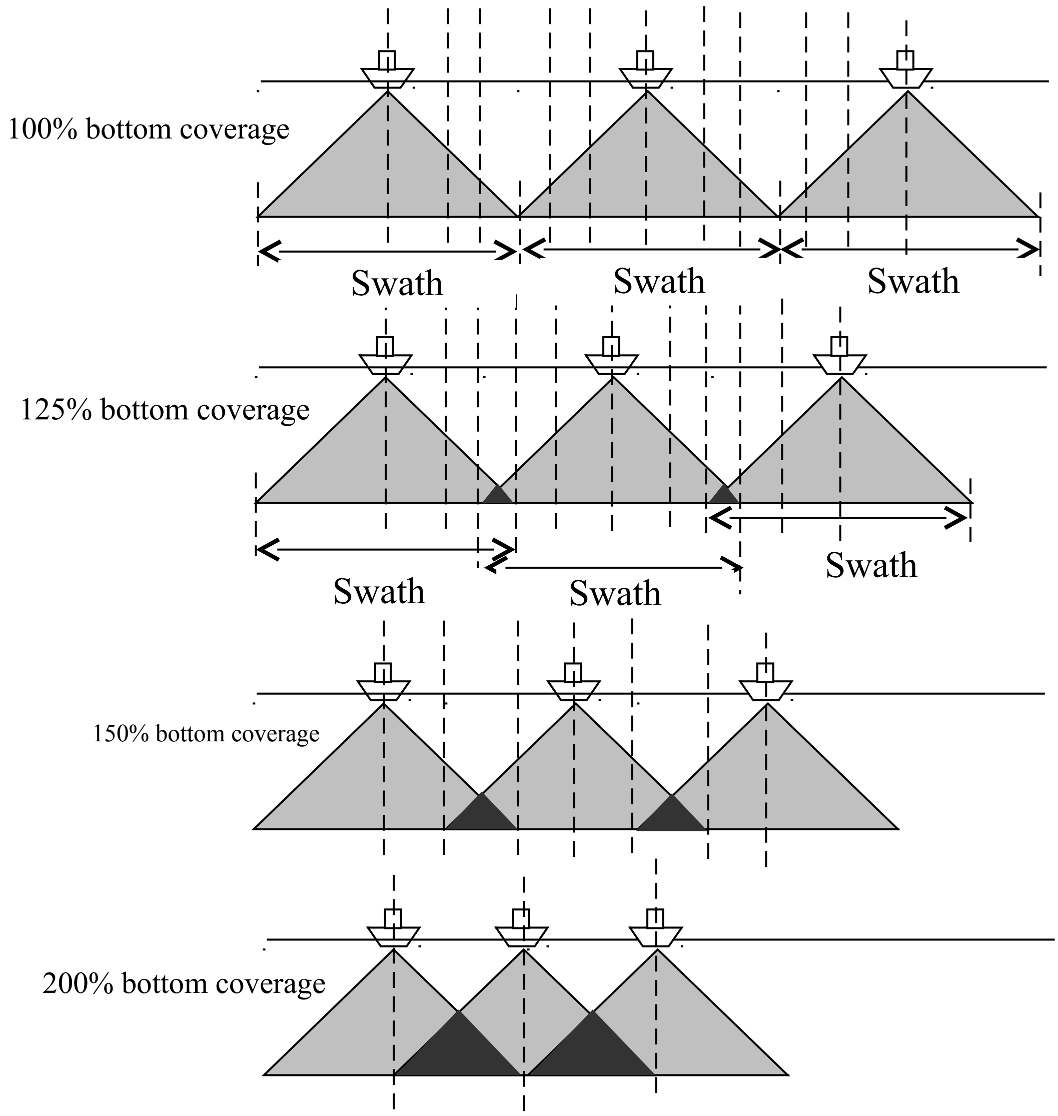
Example of orthogonal tracks in two independent surveys

Bottom coverage with acoustic energy is the function of irradiation spot size (SSS antenna directional pattern), probing frequency, values of roll and pitch angles. In order to achieve full coverage it is necessary that the irradiated areas of subsequent probings overlap in such a way that every bottom point is irradiated by at least one probing. For search tasks it is recommended that the object is irradiated by at least three subsequent probings. Field experience demonstrates that the object may be identified in the case if the irradiation spot from one probing covers it for 70% or more.

SSS total swath reaches 20 depths (depending on hydrology, SSS antenna directional pattern and mounting angle), however, for search it is recommended to use the swath of up to 7..8 depths. At roll the effective swath is reduced, so, with due regard to roll, recommended swath is reduced to 5..6 depths.

Degree of coverage defines overlapping of survey adjacent swaths (see figure below). The degree of 100% coverage does not provide for overlapping of adjacent swaths (tacking distance = swath). At coverage of 125% is provided swath overlapping for 25% (tacking distance = 7/8 of swath), at coverage of 150% is provided swath overlapping for 50% (tacking distance = 3/4 of swath), at coverage of 200% is provided swath overlapping for 100% (double overlapping, tacking distance = 1/2 of swath) etc.

At 100% overlapping of side swaths a solid acoustic image (mosaic) of bottom surface of surveyed area may be obtained by the swaths for every board separately. Degree of coverage greater than 200% usually is not used.



Bottom coverage

APPENDIX J. SSS mounting examples

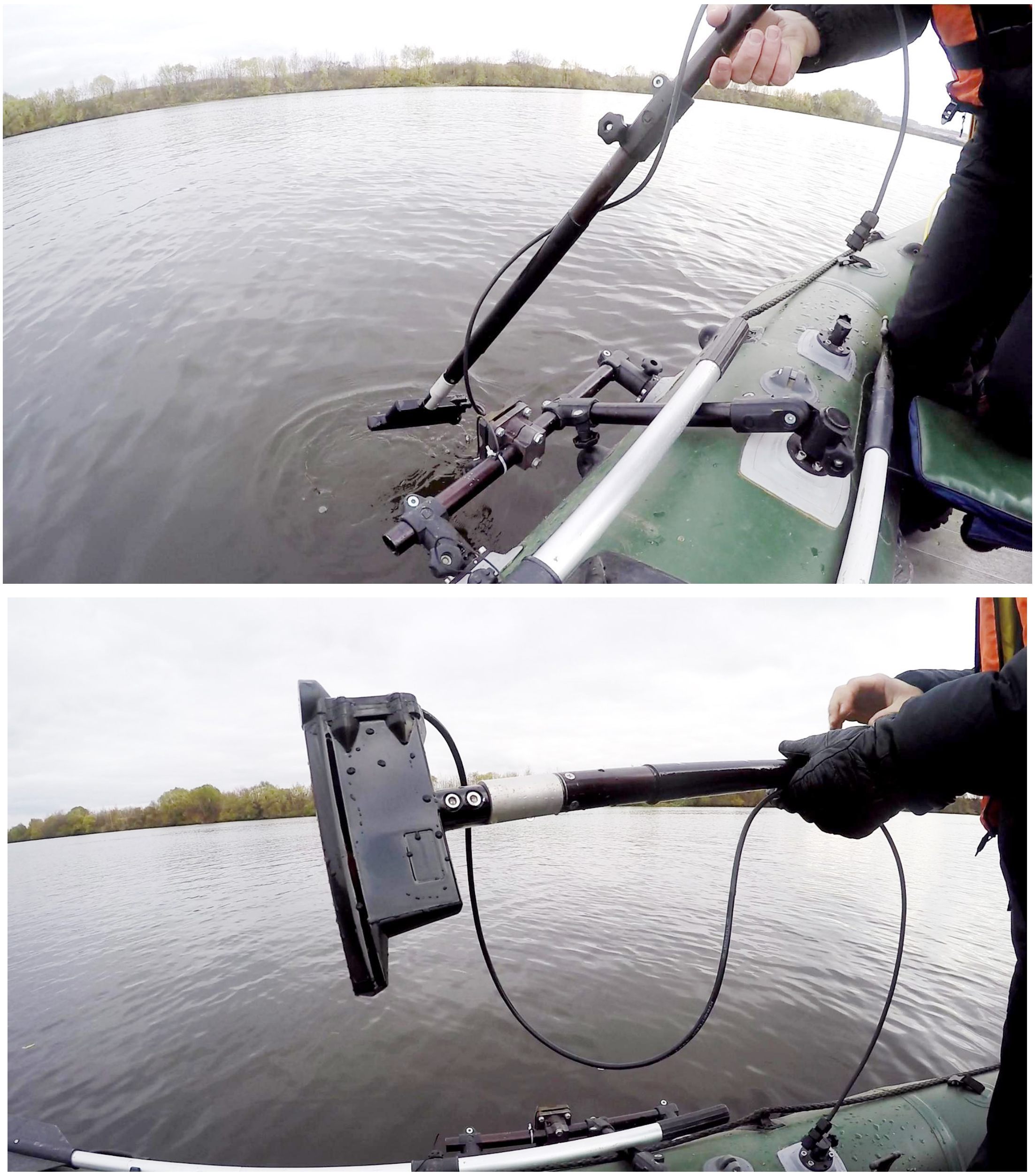


Figure J.1. Monoblock mount with KIT006

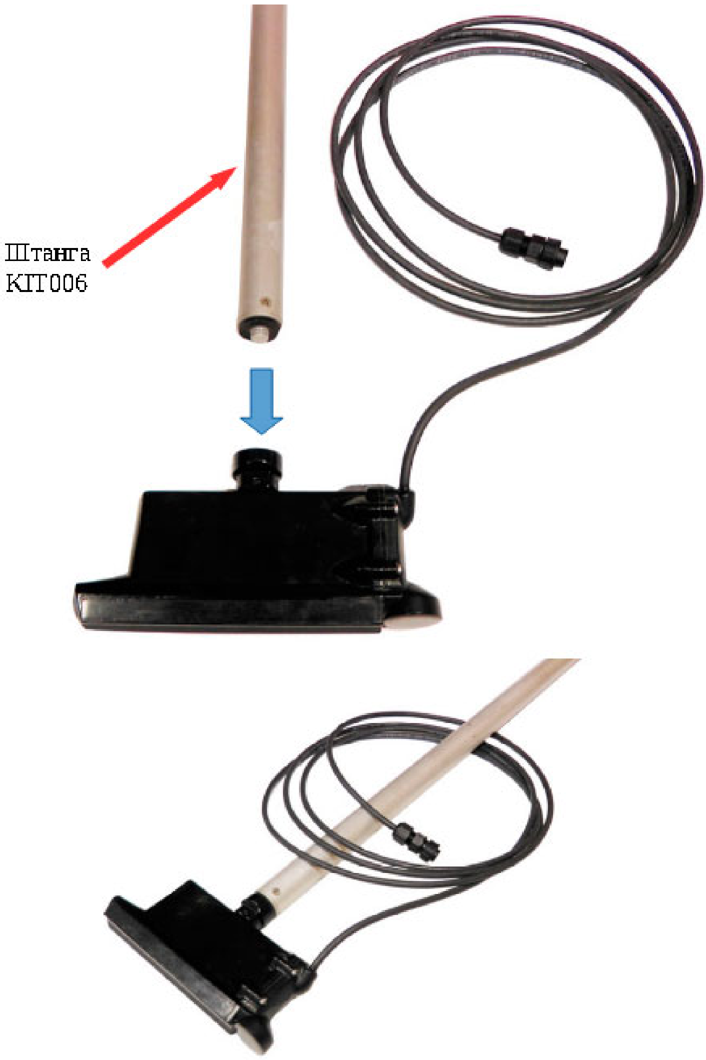


Figure J.2. SSS mounting to pole KIT006

Figure J.3. Variant for AUSV mounting

APPENDIX K. Monoblock outline drawings

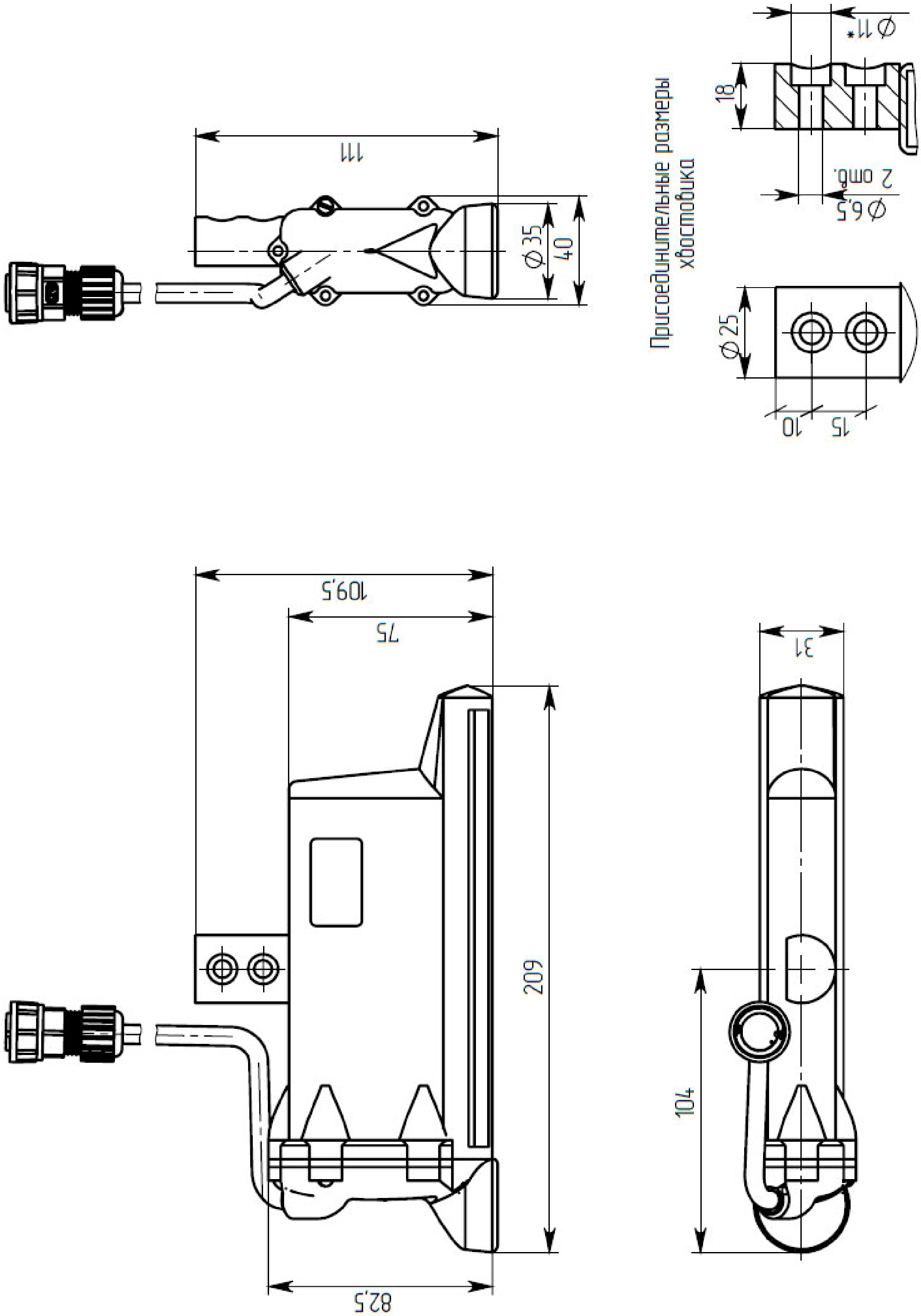


Figure K.1. Monoblock outline drawing (version for mounting via shank)

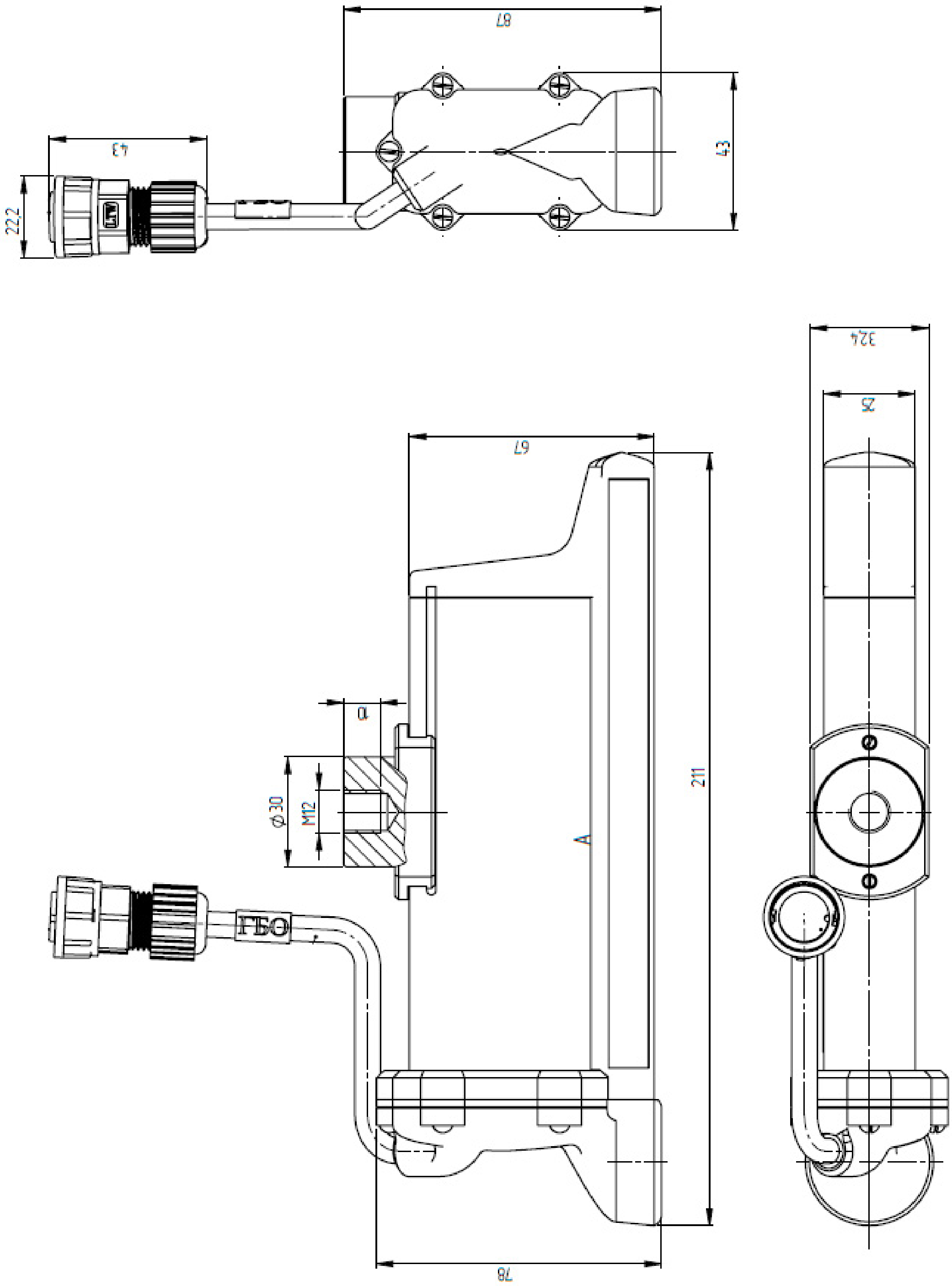


Figure K.2. Monoblock outline drawing
(version with bracket for mounting to pole d30 of KIT006 set)

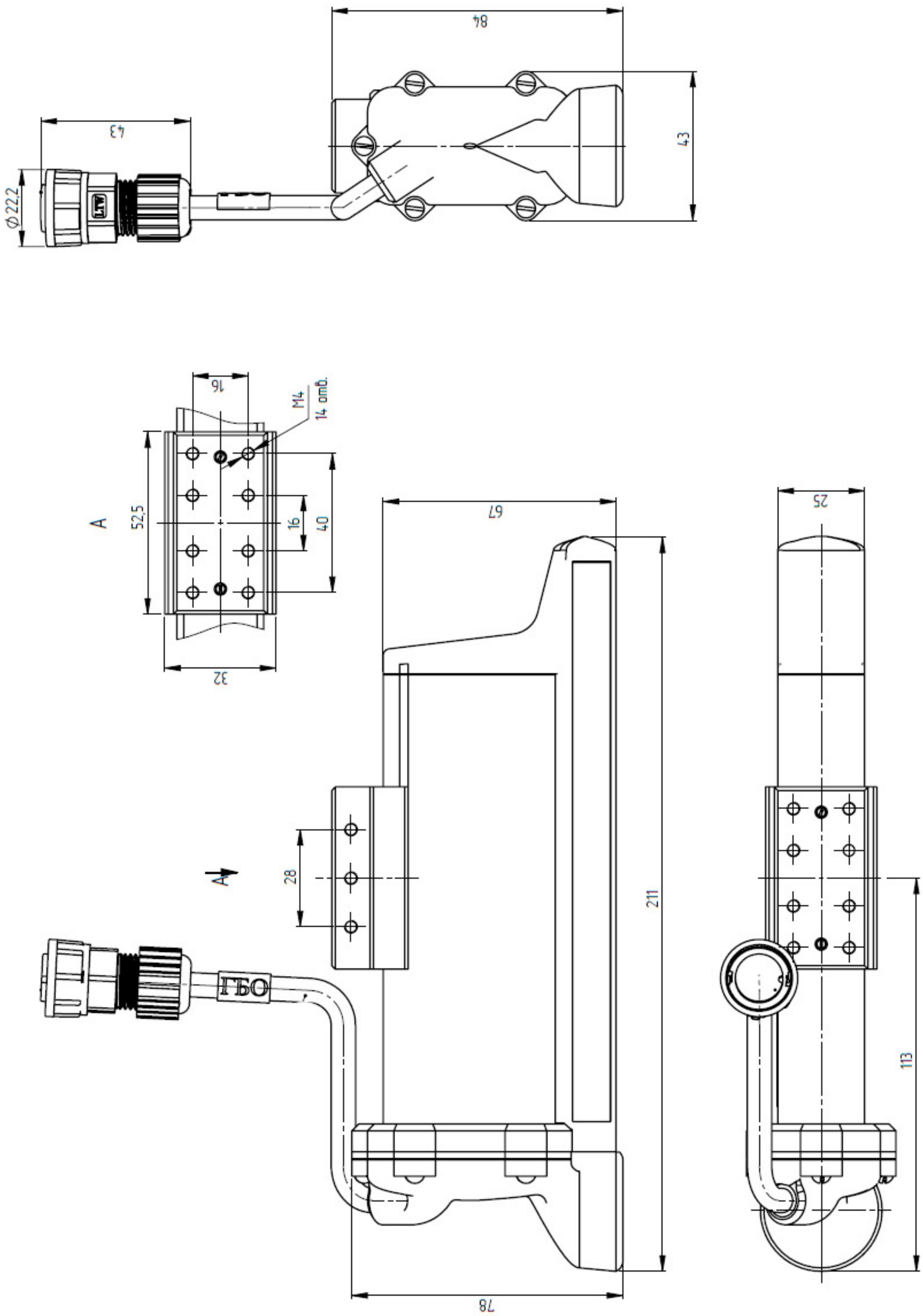


Figure K.3. Monoblock outline drawing (version with bracket for AUSV)

APPENDIX L. Examples for ALS

Option to install SSS on the SU003. A survey of the lake ice (fig L.1) received AI the bottom of the lake in the ALS mode — fig L.2.

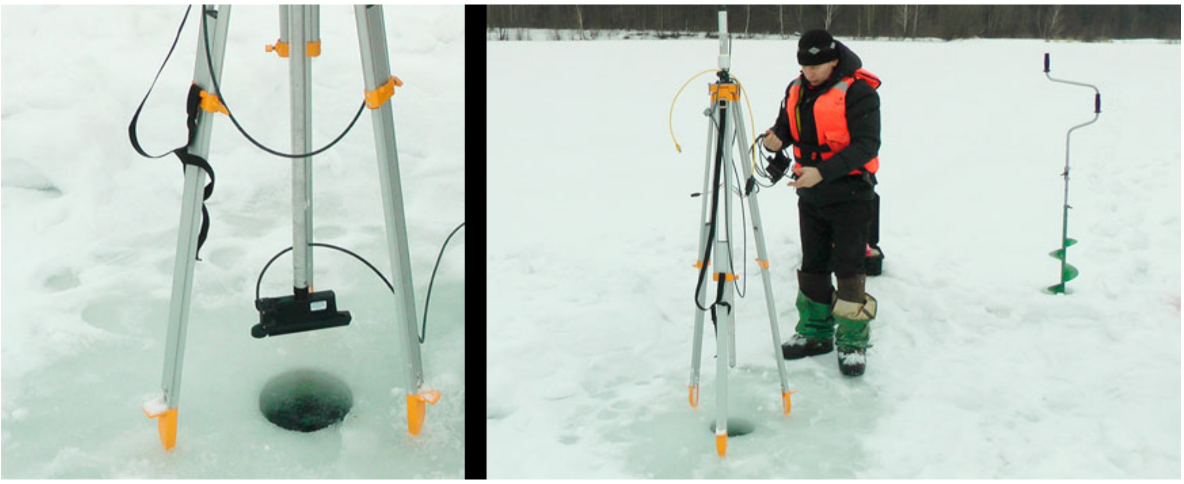


Figure L.1

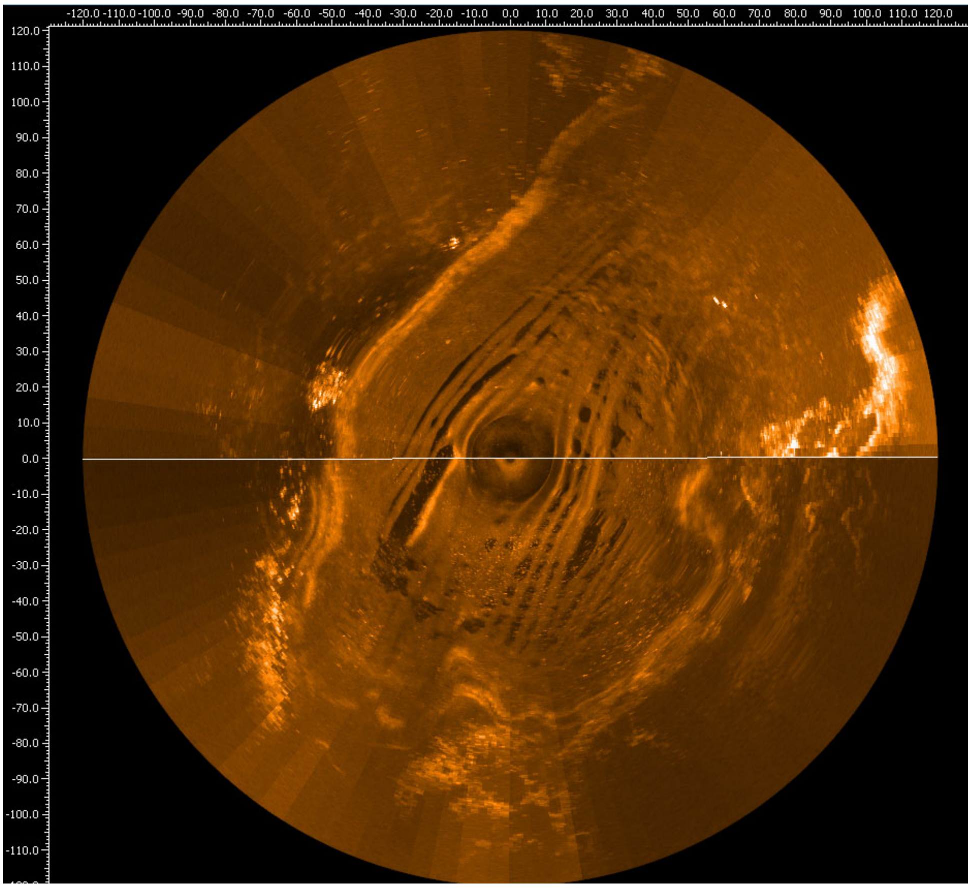


Figure L.2

Inspection of the bottom near the pier from the boat (see fig. L.3, L.4).

Fig L.3

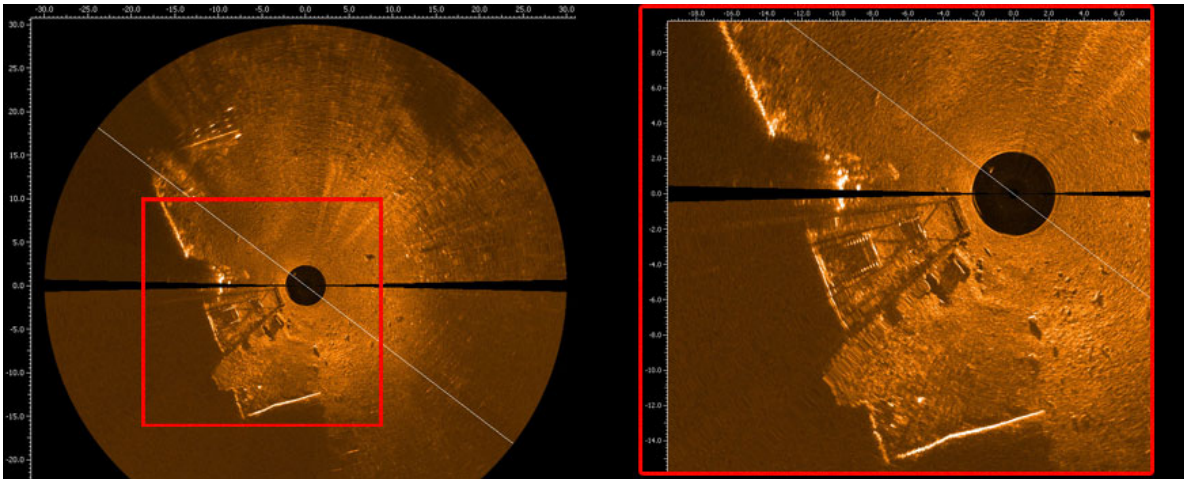


Figure L.4. An example of AI the bottom of the river near the pier, obtained in ALS mode