

UDC 681.883.41

© **Albert K. Dolzhikov**, doctor in technical science

"RIF-ACVAAPARAT" RI JSC, Balti (Republic of Moldova)

THE SECTOR-SCANNING SONAR FOR ENSURING OF THE SURFACE DISPLACEMENT HIGH-SPEED SHIPS' MOVEMENT SECURITY

In the article are considered certain new hydroacoustic facilities for the underwater conditions illumination in order to protection of the surface displacement high-speed ships' movement. The scanty depth under the ship's keel and collision with free-drifting and fixed underwater objects apply to number of basic navigation dangers. It is considered the sector-scanning sonar of underwater space in front of ship, in which composition a depth sounding channel is taking part. The developed specially designed signal processors, which are realized on the basic of modern soft-hardware features, the usage of complex sounding signals, enabled us to increase sonar surveying efficiency in conditions of the high-speed displacement ships considerably.

HYDROACOUSTICAL FACILITIES, UNDERWATER SITUATION, NAVIGATION DANGERS, SECTOR-SCANNING SONAR, DISPLACEMENT SHIPS

The sector-scanning sonar (pic. 1) is served for the navigation protection of displacement high-speed transport and passenger ships sailing, including Arctic voyages.

The sonar ensures the illumination of underwater situation in front of the ship at a distance to 2000 m for the purpose of objects detection which are navigation danger.

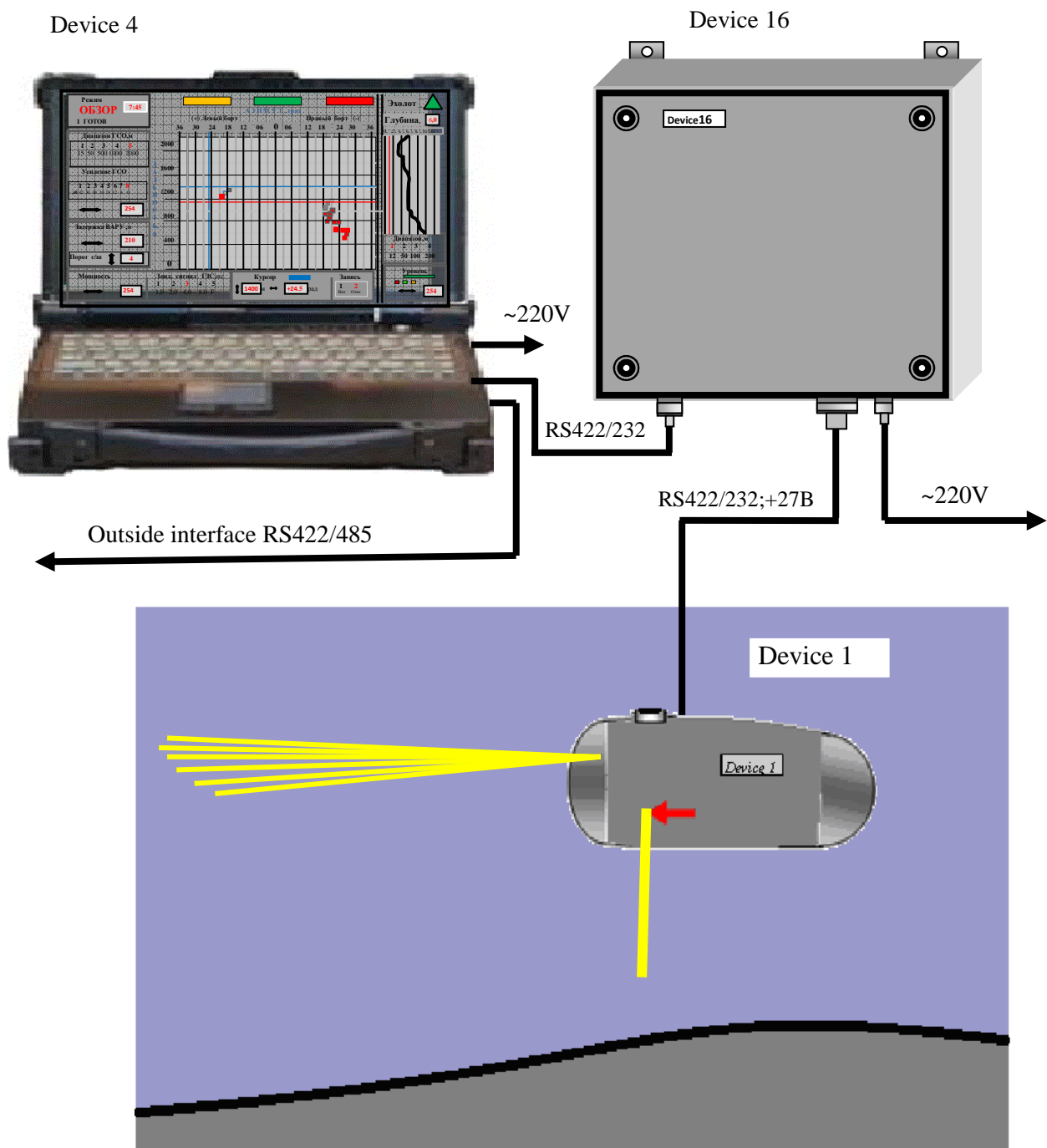
The surveying sector:

- azimuth, deg - ± 33 ; (relative to ship's diametral plane);
- angle of elevation, deg - 20; 8 (of operator's choice);

The number of headed rays in azimuthal plane is 24.

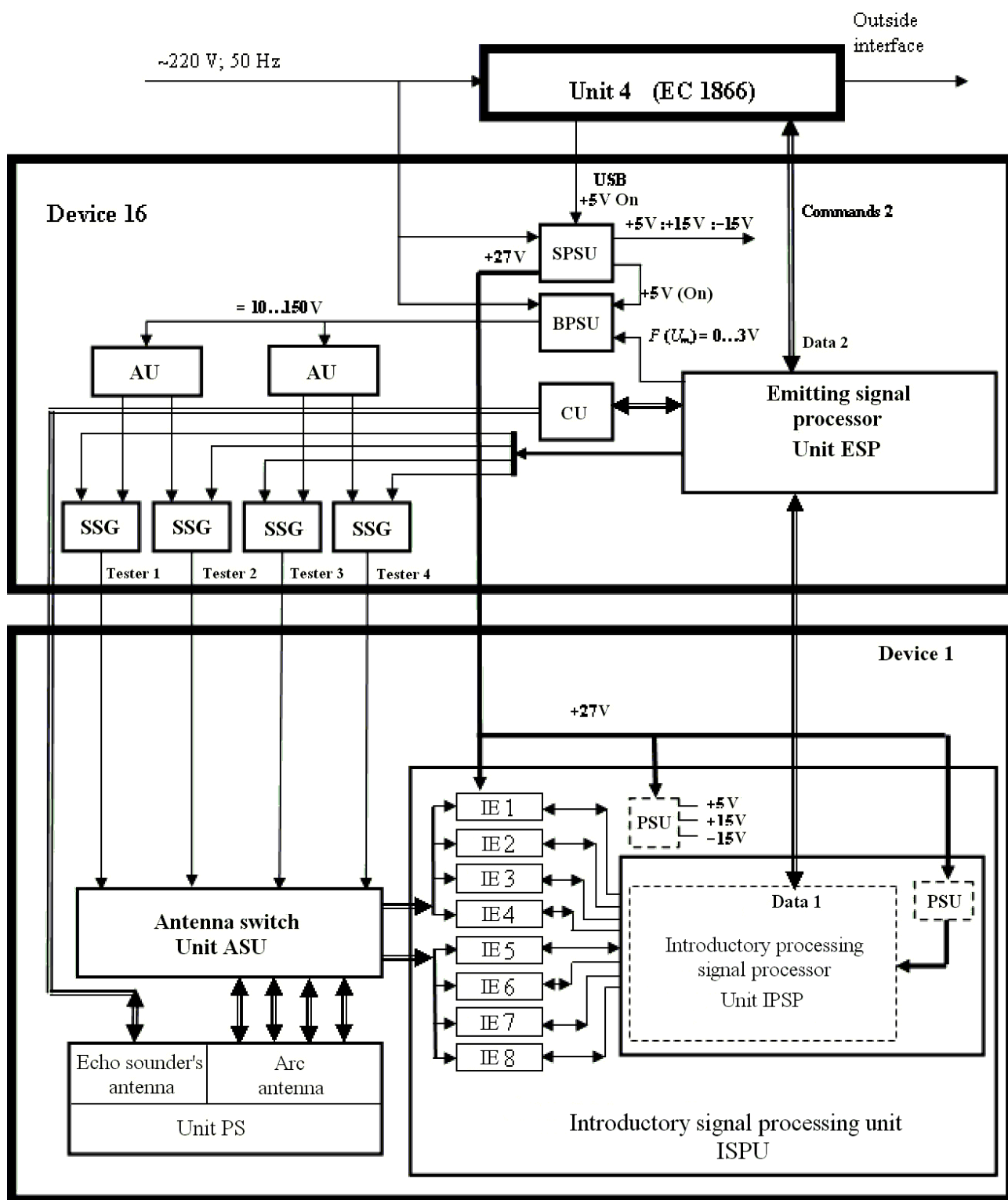
In the composition of sonar also are realized:

- bathymetric channel, which is ensuring a depth sounding under the ship's keel within 0,5-200 m with visual displaying current relief on the screen and automatic signaling about dangerous value of the depth under the ship's keel;
- system of automatic rating of the dangerous approaching of ship with localizing object and classification of objects on the basis of navigation danger;
- system of the visual, voice and sound signaling of the navigator about the navigation dangers and dangerous depths in surveying sector of the underwater space on the ship head;
- system of the automatic adaptation of working conditions to the current hydrolocation conditions;
- the sonar functionality diagnostic;
- the noninterruptible recording of hydrolocation and bathymetrical files and current values of the control commands during no less than 250 hours with next possibility of the playing on the sonar's display.



Pic. 1 - The sector-scanning sonar for the displacement high-speed ships

The structure of the hardware features of the modern sector-scanning sonar “HYDRA”, which was developed in 2010-2011, is represented on the pic. 2.



Pic. 2 - The structure of hardware features of the sector-scanning sonar «HYDRA»

The composition of the sector-scanning sonar's hardware features, which structure chart is painted on the picture 2, includes next units:

The device 1 includes:

- 1) unit PS:

- arc multiunit horizontal surveying combined antenna is represented in arc plane with 26 active components each is produced with 12 active half-wave components on the generatrix of arc sector;

- the transceiver converter of the echo sounder which directional characteristic (DC) is directed to the bottom;

2) unit ASU – multi-channel antenna switches unit to the switching of active acoustical components of the arc antenna in the time of transition from remission mode of sounding signal to the echo-sounds reception mode:

- in the remission mode – to sounding signals oscillators' SSO outputs;

- in the reception mode – to suitable inputs of introductory enhancers IE;

3) unit ISPU – introductory signal processing unit consists of:

a) 48 introductory enhancers IE which are used for the echo signals enhancement, introductory frequency filtering, conversion of their current values to 10-digit binary code and the codes' delivery onto suitable inputs of introductory processing signal processor IPSP;

b) introductory processing signal processor for echo signals IPSP is realized on the basic of EPLD series "Cyclone 3" which is implementing algorithms:

- multi-channel transversal filter for the forming in the azimuthal plane 24 spatial rays and conformed filtration of echo signals are received in these rays;

- command forming for the optimization of the working conditions of transceiver path on the basic of the current hydrolocation conditions ratings;

- finding (evaluation) of the underwater objects' spatial location;

- forming of device's 1 interface with devices 16 and 4.

On the high-speed ship the device 1 must be installed into fairwater for the purpose of hydrodynamic frontal resistance, cavitation effects and running noises decrease.

The fairwater can be installed on the outboard device and be fasted to board, head or ship's stern on hydrojet ships. The fairwater can be installed on the pulling-and-running equipment which is pulled out ship's bottom borders when sonar is working.

The device 1 can be installed also on the head's bulb of the ship.

The device 16 consists of:

1) emitting path signal processor (ESP) which is realized on the basic of EPLD series "Cyclone 3" which is implementing algorithms:

- forming of emission signals with fixed frequency of filling temporal and phase structure for the running the four sounding signals generators SSG1...SSG4;

- echo sounder running and processing of echo sounder's signals;

2) four sounding signals generators SSG1...SSG4 which are feeding components of suitable modules of arc antenna;

3) manageable rectifier BPSU, is regulated within +10 to +150V with help of commands which are arriving from suitable outputs of signal processor ESP.

Output voltage BPSU is in keeping with fixed emitted capability of sounding signals and is used for the accumulator charging (AU1 and AU2), which energy ensures fixed energy parameters of sounding signals in output of generators SSG1...SSG4.

The device 4 is realized on the basic of laptop computer EC1866 and ensures:

- panoramic displaying of underwater conditions in surveying sector;

- detected targets rating by navigation danger criterion;

- displaying of the bottom relief and the value of current depth under ship's keel;

- automatic sonar's functionality diagnostics;
- sonar's working conditions choice by operator.

The navigation danger's band edges are assigned around the ship to realize algorithm of automatic rating of spotted targets by navigation danger criterion by operator (navigator):

- the edge which locates minimal permissible distance is enough to deviation from collision between sheep and spotted underwater object;
- permissible minimal value of dangerous depth under keel which protects ship's movement.

Every spotted underwater object including bottom surface within the navigation danger band evaluates as navigation danger automatically. With the appearance of navigation danger or her risk the navigator signaling is switched on automatically.

The sector-scanning sonar ensures near underwater environment's illumination and has performance characteristics is given in table 1.

Table 1

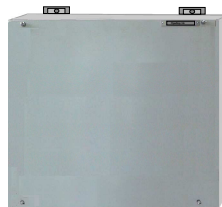
Specifications	Sonar's data	
Sector of scanning		
- in vertical plane, deg	20;8	At the command from panel
- in azimuthal plane, deg	$\pm 33; \pm 4^*$	relative to DP *) At the command from panel
Maximal detection distance, m (Req>5m; Pпо $\geq 0,9$)	to 2000;	It is specified at the running tests for each ship
Amount of rays at the reception	24	
Instrumental error of distance rating, %	$\pm 0,25$	
Distance scales, m	15; 250; 500; 1000; 2000	
Instrumental resolving ability by distance, m	0,25; 0,5; 1; 2; 5	
Instrumental error of angular coordinate rating, deg	$\pm 1,5$	
Weight and overall dimensions of sonar's devices		
Device's name	Dimension,mm	Weight, kg
Device 1	300x390x508	in air - 53 in water - 5,0
Device16	546x500x289	42,5
Device 4	352x294x79	5,7

The maximum medium's movement speed (to 40 knots) which is permissible to ensure sector-scanning sonar's performance characteristics is determined with ship-medium's noise level is reduced to arc antenna's surface and her value is specified for each ship at the stage of running tests.

The photos of sonar's devices are given on the pictures 3-4.



Pic. 3 - Device 1



Device 16



Device 16 with opened cover

Pic. 4

Bibliography

1. Bogorodskiy A.W. The hydroacoustic ocean researching and developing technology / Bogorodskiy A.W., Yakovlev G.W., Corepin E.A., Dolzhikov A.K. - L.: Hydrometizdat, 1984. – 264 p.
2. Bogachev A.S., Tolstov E.P. The compensation of signal's trajectory distortions in radiolocating stations with synth aperture. The foreign radio electronics, 1981, №3.
3. Edited by Kazarinov Y.M. Radio engineering systems. - M.: Soviet radio, 1969. – 496 p.

Стаття надійшла до редакції 04 грудня 2012 р. англійською мовою

© А.К. Должиков

ГІДРОЛОКАТОР СЕКТОРНОГО ОГЛЯДУ ДЛЯ ЗАБЕЗПЕЧЕННЯ БЕЗПЕКИ РУХУ НАДВОДНИХ ВОДОТОННАЖНИХ ШВИДКОХІДНИХ СУДЕН

У статті розглянуті деякі нові гідроакустичні засоби висвітлення підводної обстановки для забезпечення безпеки руху надводних швидкісних водотоннажних суден. Недостатня глибина під кілем судна й зіткнення з вільно дрейфуючими й стаціонарними підводними об'єктами належать до основних навігаційних небезпек. Розглядається гідролокатор секторного огляду підводного простору поперед судна, до складу якого включений канал виміру глибини. Розроблені сигнальні спецпроцесори, що виконані на основі сучасних програмно-апаратних засобів, використання складних зондувальних сигналів дозволило суттєво підвищити ефективність гідролокаційного огляду в умовах швидкісних водотоннажних судів.

© А.К. Должиков

ГИДРОЛОКАТОР СЕКТОРНОГО ОБЗОРА ДЛЯ ОБЕСПЕЧЕНИЯ БЕЗОПАСНОСТИ ДВИЖЕНИЯ НАДВОДНЫХ ВОДОИЗМЕЩАЮЩИХ БЫСТРОХОДНЫХ СУДОВ

В статье рассмотрены некоторые новые гидроакустические средства освещения подводной обстановки для обеспечения безопасности движения надводных скоростных водоизмещающих судов. Недостаточная глубина под килем судна и столкновение со свободно дрейфующими и стационарными подводными объектами относятся к числу основных навигационных опасностей. Рассматривается гидролокатор секторного обзора подводного пространства впереди судна, в состав которого включен канал измерения глубины. Разработанные сигнальные спецпроцессоры выполненные на основе современных программно-аппаратных средств, использование сложных зондирующих сигналов позволило существенно повысить эффективность гидролокационного обзора в условиях скоростных водоизмещающих судов.