

**CIVIL GPS SERVICE INTERFACE COMMITTEE
INTERNATIONAL INFORMATION SUBCOMMITTEE
(CGSIC/IISC)**

NATIONAL REPORT OF POLAND 2000
Concise outline of selected GPS projects realised in Poland
with particular consideration of marine applications

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**Report presented to the 9th European Meeting
of the Civil GPS Service Interface Committee,
International Information Subcommittee
(CGSIC/IISC)**

Monaco
30 November - 1 December 2000

NATIONAL REPORT OF POLAND 2000

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This National Report of Poland meets the requirement of the organisers of the European Meeting of the Civil GPS Service Interface Committee International Information Subcommittee (CGSIC/IISC) to adopt mainly the maritime theme and places a special emphasis on basic activities of the Polish maritime institutions.

There are two main centres of maritime institutions in Poland: Gdynia in the eastern part of the Polish coast of the Baltic Sea and Szczecin in the western part.

The most important educational and administrative civil and military institutions in the Gdynia region are: Polish Naval Academy Gdynia (military), Gdynia Maritime Academy (civil) and Maritime Office Gdynia. In the Szczecin region we have: Maritime University Szczecin (civil) and Maritime Office Szczecin.

1. ACTIVITIES OF THE POLISH MARITIME ADMINISTRATION

Polish Maritime Administration provides the access to all harbours of major importance for the national economy, by establishing of fairways, anchorages and study of the shipping conditions in approach areas of the harbours and marinas. These are duties of the maritime administration and result from the Act on Sea Areas of the Republic of Poland and Maritime Administration. Fairways with buildings, equipment and installations – including navigation and positioning systems, which are connected with marine fairway's functionality, are an infrastructure providing the access to harbours and marinas.

The above mentioned infrastructure is the property of the State Treasury and is out of turnover; the buildings, their modernisation and maintenance are financed from the state budget.

Basic maritime surveys, which are made using the positioning RTK/ DGPS systems with the aim to estimate shipping conditions of the waterways, are:

1. Surveys of the relief of sea bottom, by executing the bathymetrical surveys using one or multi-beam hydro-sounding systems and RTK/DGPS;
2. Hydro-sounding (sonar) surveys of the sea bottom for purpose of detection of the underwater objects and obstructions to navigation;
3. Magneto-metric surveys of the sea bottom for purpose of detection of the steel objects;
4. TV inspection of the sea bottom recording underwater obstructions to navigation;

5. Execution of the geological surveys.
6. Defining of the navigational marks position.
7. Executing the hydrological surveys, as well as making inspections and calibration procedures of hydro-sounding equipment, including:
 - defining the sound speed in sea water;
 - recording the vertical oscillation of the sea level.
8. Geodetic and/or hydrographical measurements to evaluate WGS-84 positions of lighthouses, floating and permanent objects (buoys, leading lines), lights and other aids to navigation.

To provide the efficient and safety service, maritime administration is obliged to develop standards according to the requirements of IHO (International Hydrographical Organisation), IMO and IALA, on technical and operational requirements of applied systems.

These are:

1. Two fully operational, monitored, internationally coordinated DGPS marine stations (some technical data see Table 1. below)

Table 1. Polish maritime DGPS reference stations

Name	Position Latitude Longitude	Nominal range [km] at 34dBuV	Frequency [kHz]	Emission	RTCM type Ver.2.1	Signal availability	Accuracy 2σ	ID
DZIWNÓW	54°01' 18" N 14°43' 51" E	90	288.0	MSK, 100Bd	- 1,3,7,16	99.7% at 38dB	2-5m	481
ROZEWIE	54°49' 50" N 18°20' 07" E	90	311.0	A1 MSK, 100Bd	- 1,3,7,16	99.7% at 38dB	2-5m	482

2. Mobile reference Real Time Kinematic – GPS 12 channel system with geodetic accuracy.
3. Short range laser system Polartrack, with UHF data link.
4. Multi-beam ultrasonic integrated system, with the options presented below in Fig. 1.

Polish maritime administration is represented in the following maritime international organisations, which deal with GNSS systems:

- ❖ IMO,
- ❖ IALA (Radionavigation, Vessel Traffic Systems, Operations Committee),
- ❖ European Radionavigation Advisory Forum, and
- ❖ IHO (through Polish Navy).

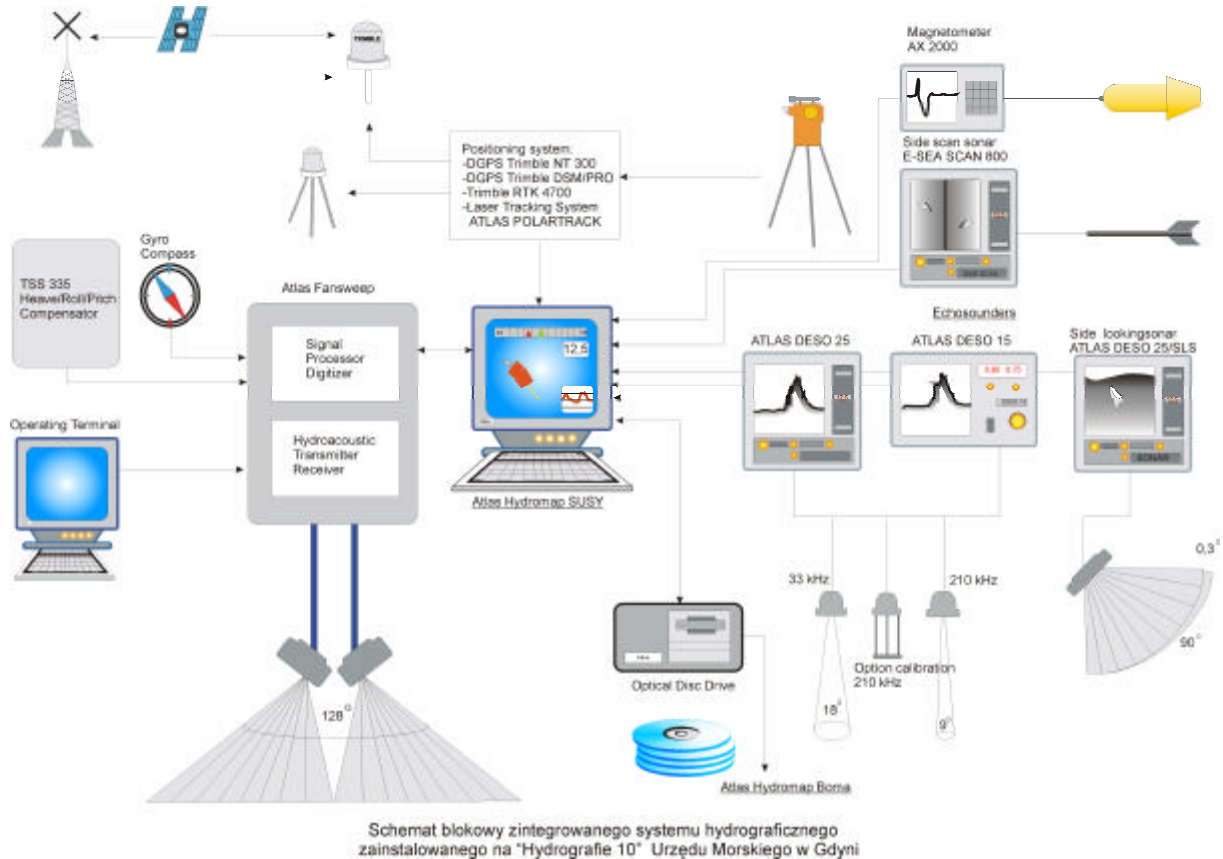


Fig. 1 Diagram of multibeam integrated hydrographic system organisation

The Maritime Office Szczecin performs the similar activities as Gdynia Centre in the Polish responsibility area but owns some different equipment. Generally, the Office uses GPS/DGPS positioning technique in dynamic mode; no GLONASS receivers are available. All GPS-DGPS receivers are installed onboard of hydrographic ships except of two receivers remaining at the Office for remote monitoring of reference stations. DGPS signals used by Maritime Office Szczecin cover whole area of responsibility. Typical operation areas are: Pomorska Bay, Zalew Szczeciński, harbour and all fairways areas close to Swinoujście and Szczecin main ports.

The Polish reference DGPS station Dziwnów is maintained and managed by the hydrographic department of the Maritime Office Szczecin. The station is equipped to conform IALA beacon performance standard.

Another UHF reference station is dedicated for precise hydrographic or docking operations.

New IMO resolutions and updated techniques press the administration to upgrade equipment to improve navigation and hydrographic services.

There are also plans to employ RTK techniques and GPS pocket-size receivers with possibility to check floating or land based aids to navigation position.

2. ACTIVITIES OF THE POLISH NAVAL ACADEMY IN GDYNIA

The activities of the Polish Naval Academy in Gdynia include theoretical, practical and educational subjects. Some of them are shortly reported below.

1. Application of the least square method for determining the magnetic compass deviation. The research consists in the use of a ship DGPS receiver as a source of reference direction for an algorithm for evaluation of the magnetic compass deviation based on the least square method. An experimental automatic system, coupled with a magnetic compass recording device, for fine estimation of the deviation curve on the basis of incomplete circulation was built.
2. Measurement of ship's orientation by means of set of different GPS receivers. The study discusses the possibilities of adoption of fix measurements taken by sets of DGPS or RTK receivers installed on the same ship to determine her heading and attitude. The main goal of the research is to make some reference system for investigation of different ships' sensors like compasses or for identification of the dynamic ship characteristics.
3. Research on analytical methods of prediction of the availability of the DGPS radiobeacon signals. The aim is to make computer tools for prediction of the availability of corrections receiving from a DGPS reference station for such tasks like hydrographic measurements.
4. The Inverse DGPS Reference Station Application in the VTS System. The works consist in tests of the possible benefits of supplements to VTS with software realising functions of DGPS in an inverse variant. It includes equipping a VTS dispatcher with own GPS reference station and calculating ship's position with the DGPS method. It is possible to radically improve the precision in monitoring ships in VTS.
5. Validation of GPS receivers by means of GPS simulator
Project aims at the establishment of the nation certified laboratory for examination of GPS receivers' quality.

3. PERMANENT GPS STATIONS IN POLAND

Six permanent geodetic GPS stations are operating in Poland. They are:

- Borowiec (managed by the Space Research Centre, Polish Academy of Sciences),
- Borowa Gora (managed by the Institute of Geodesy and Cartography),
- Gdansk (station established by the Chair of Satellite Geodesy and Navigation of the Warmia and Masury University Olsztyn),
- Jozefoslaw (managed by the Institute of Geodesy and Geodetic Astronomy of the Warsaw University of Technology),
- Lamkowko-Olsztyn (managed by the Institute of Geodesy of the Warmia and Masury University Olsztyn),
- Wroclaw (managed by the Department of Geodesy and Photogrammetry of the Agriculture University Wroclaw).

Next permanent geodetic station will be soon established by the University of Mining and Metallurgy, Faculty of Mining Surveying and Environmental Engineering Cracow. Now the station is in a final stage of installation.

Three Polish permanent stations are incorporated to the International GPS Service IGS (Borowiec, Jozefoslaw, Lamkowko-Olsztyn). Five stations are included to the EUREF permanent network (Borowa Gora, Borowiec, Jozefoslaw, Lamkowko-Olsztyn, Wroclaw).

Some stations maintain also other permanent services:

- | | | |
|------------------|---|--|
| Borowiec | - | SLR (Satellite Laser Ranging) and time service, |
| Borowa Gora | - | time service, |
| Jozefoslaw | - | gravimetric tidal monitoring, astrometric observations,
TEC ionosphere variation, |
| Lamkowko-Olsztyn | - | TEC ionosphere variation. |

Two stations at the Baltic Sea coast (Rozewie and Dziwnow) are operating permanently as maritime navigation stations (see section 1).

4. TIME METROLOGY ACTIVITIES IN POLAND

The institutions involved in time metrology report on

- * development of the national independent atomic time scale, TA(PL), and
- * development of the high-accuracy multi-channel GPS time transfer receiver.

Several Polish scientific and commercial institutions are equipped with caesium frequency standards, which can be used for the establishment of a National Atomic Time Scale. Among them are:

- Time and Frequency Laboratory of the Central Office of Measures (GUM): four Cs clocks;
- Institute of Communication, two Cs clocks;
- Central Laboratory of the Polish Telecommunication Company (TPSA), one Cs clock;
- Astrogeodynamical Observatory of the Polish Academy of Sciences (AOS), two Cs clocks.

The Polish Atomic Time Scale is computed from the readings of the clocks of the above-listed laboratories according to a special algorithm developed in cooperation with the BIPM.

All participating laboratories are equipped with the TTS-2 GPS time receiver, based on the Motorola VP Oncore module (general diagram of the receiver – see below)

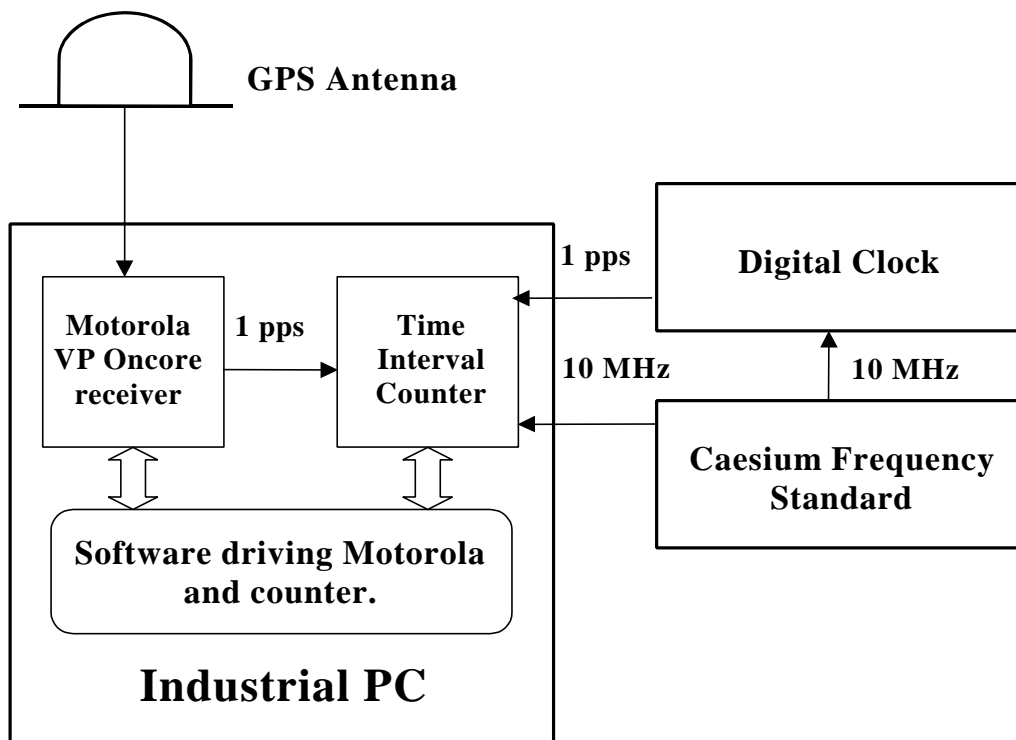


Diagram of the TTS-2 multi-channel GPS time transfer receiver

Some technical specifications related to the adopted time transfer system TTS-2 are summarised below:

UNCERTAINTY:

- ❖ For 1-channel observations: rms ~3 ns.
- ❖ According to new schedule: 96 observations, at up to 8 channels.
- ❖ Average at Borowiec is about 650 passes per day.
- ❖ Uncertainty obtained for multichannel observations AOS Borowiec – BIPM Sevres: rms: 1-2 ns.

ADVANTAGES:

- ❖ Use of receiver independent, raw satellite observation data.
- ❖ Compatibility with previous versions of data exchange format.
- ❖ Low cost, high accuracy.

TTS-2 receivers are currently working at:

- Astrogeodynamical Observatory (AOS), Borowiec Poland, 2 rcvs.
- United States Naval Observatory (USNO), 2 rcvs.
- Bureau International des Poids et Mesures (BIPM), 2 rcvs.
- Metrology Department of Semiconductor Physics Institute (SPI), Lithuania, 1 rcv.

- National Institute of Standards (NIS), Egypt, 1 rev.
- Observatorio Naval Buenos Aires (ONBA), Argentina, 1 rev.
- Swiss Office of Metrology, (SOM), Bern, 1 rev.
- Observatoire des Cote d'Azur (OCA) , France, 1 rev.
- Main Office for Measurements (GUM), Warsaw , 2 revs.
- Institute of Communication (IL), Warsaw, Poland, 2 revs.
- Central Laboratory of the Polish Telecommunication Company (CBR), Warsaw, Poland, 1 rev.
- Military Centre for Metrology, Zielonka, Poland, 1 rev.

More details on the activities related to the time transfer in Poland – contact: Jerzy Nawrocki, Astrogeodynamical Observatory, Space Research Centre, Polish Academy of Sciences, Borowiec, Poland (e-mail address see below).

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The following acronyms and abbreviations of names of Polish institutions involved in realisation of GPS projects are usually used in the National Reports:

AUW	Agriculture University of Wroclaw
DG	Department of Geodesy
DGP	Department of Geodesy and Photogrammetry
FMSEE	Faculty of Mining Surveying and Environmental Engineering
GMA	Gdynia Maritime Academy
GSP	General Surveyor of Poland
HOGC	Head Office of Geodesy and Cartography
IG	Institute of Geodesy
IGC	Institute of Geodesy and Cartography
IGGA	Institute of Geodesy and Geodetic Astronomy
MOG	Maritime Office Gdynia
MUS	Maritime University Szczecin
PAFA	Polish Air Force Academy Deblin
PAS	Polish Academy of Sciences
PNAG	Polish Naval Academy Gdynia
SGN	Chair of Satellite Geodesy and Navigation WMUO
SRC	Space Research Centre
UMMC	University of Mining and Metallurgy Cracow
WMUO	Warmia and Masury University Olsztyn
WUT	Warsaw University of Technology

In order to organise a quick transmission of information necessary for preparation of this and all subsequent National Reports for CGSIC there was established a network of correspondents of Polish institutions involved in realisation of GPS scientific and practical projects. Below you can find the names of the correspondents and their contact e-mail addresses. For further detailed information please contact directly the correspondents of particular institutions.

The author of this Report would like to express his sincere thanks to all correspondents for their help in prompt providing all necessary data.

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