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Electrical navigational appliances – the role of the Gyrocompass and interaction with other equipment in the control cabin

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Abstract. The paper presents the role of the gyrocompass in navigation equipment and systems, by considering a practical methodology and system framework that align the gyrocompass with autopilot, radar, ECDIS, and AIS through standardized interfaces, emphasizing error correction, alarm prioritization, and power efficiency. The proposed methodology and framework represent a comprehensive architectural framework are presented, enabling accurate gyrocompass integration, automated correction of operational errors, and harmonized data exchange with critical bridge systems.

The general and material laws of electromagnetic field theory have been considered to present the factors on which the strength of the magnetic field and the derived magnetization-magnitude of the magnetic moment depend. The gyro block diagram was used to show the usefulness of this equipment and the components that are in the composition. Gyro compass errors were calculated and how to remove them was shown. The analysis of equipment management was made, and the energy consumption was presented, comparing it with three other equipment (radar, Electronic Chart Display Information System (ECDIS); Automatic Identification System (AIS)) aimed at optimizing power consumption.

Keywords: gyrocompass; navigation equipment; electromagnetic field; optimization power; diagrams.

1. Introduction

In the naval research, the aim was to achieve an efficient transport system that reduces logistics costs and promotes competitiveness and integration. In the naval research, the coordination and connections for the construction of modern ships were pursued, linking transport strategies with action plans for the use of auto coordination. The analysis of the gyrocompass starts from the rotating ellipsoid, which is a perfectly mathematically defined surface and best corresponds to the general shape of the Earth. He is the mathematical model of our planet. The elements of the revolution ellipsoid (terrestrial ellipsoid) have been calculated over time by Everest, Bessel, Hayford, Krasovski, etc.). The dimensions agreed to be the ellipsoid were those of Hayford (International Geodesy and Geophysics Conference in Madrid, 1924) and since 1984 those of the World Geodesy System 1984 (WGS84).

The magnetic compass is used to determine directions on board ships, being an instrument based on the principle of orientation in the direction of the force lines of the magnetic field of a free magnetic needle suspended in its center of gravity, with the property of orienting toward the magnetic north. The magnetic compass is subject to the influence of two magnetic fields: The earth field and the vessel field magnetization is carried out based on the law of temporary magnetization, which shows that the magnetic intensity varies with the nature of the substance and can be expressed according to the strength of the magnetic field. The magnetic field of the ship has two components - the magnetic field generated by magnetizing of the hard iron - temporary magnetic field, and the magnetic field generated by magnetizing the hard iron - permanent magnetic field. By composing the two magnetic fields, the magnetic field of the ship is obtained. The strength of the ship's permanent magnetic field depends on the following factors: The orientation of the coil relative to the magnetic meridian; the geographical location of the construction site; the technological process used in the construction (welding, riveting, etc.), which can favor or slow the process of magnetization; the position of the ship after launching to water, during reinforcement; the size of the permanent magnetic fields of the installations to be mounted on board, their direction and direction in relation to the magnetic field of the body of the ship.

The magnetic compass determines directions at sea: courses or directions [1,2]

2. Use and role of components of the gyrocompass system

The gyrocompass is the navigation equipment used for the governance of the ship that does not depend on the earth's magnetic field, determines the direction north gyro very close to the true north direction, which measures the courses and gyro points. The gyrocompass is used in navigation because:

- find true north, determined by the Earth's axis of rotation, which is different from magnetic north;
- not affected by ferromagnetic materials - the body of the ship is steel, material that distorts the magnetic field.

The gyroscope of the gyrocompass is mounted so that it can move freely around the three perpendicular axes and is controlled to allow rotation around its axis, which is parallel to the true meridian and influenced by the rotation and gravity of the Earth. A GPS system is used to transmit data to the gyrocompass for error correction - see Figure 1.

The block diagram of a gyrocompass includes: The sensitive element; the tracking system; synchronous data transmission system; the electricity supply system; the signaling system; and cooling system. The electromotor and the motor unit are called the gyro motor. The tracking system (resistive or inductive) is used to convert the yaw angle of the ship into an electrical signal – the gyro signal, transmitted to the gyro repeaters through the synchronous data transmission system. The synchronous data transmission system shall transmit the master gyrocompass indications to the gyro repeaters at different points on board the ship and to other navigation equipment (autopilot, radars, ECDIS, AIS, conning etc.).

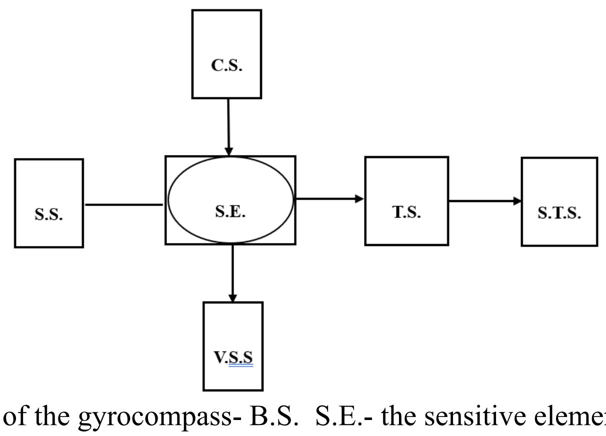

Figure 1. Block scheme of the gyrocompass- B.S. S.E.- the sensitive element; S.S. - supply system; T.S. - tracking system; S.T.S. - synchronous transmission system; C.S. - cooling system; V.S.S. - Voltage deviation signaling system [3]

The cooling and signaling systems ensure the constant working temperature of the gyrocompass installation and the incorrect signaling of some functional parameters [4]. The power supply system provides power to the gyro motors at frequencies that ensure their optimum speed. The gyro is the sensitive element and the main device of the gyrocompass. It consists of a three-phase asynchronous motor with the rotor in short circuit, of reverse construction (the rotor is outside the stator) is fed at a frequency between 330-500 Hz, being provided on the outside with a steel crown that constitutes the gyro's torus.

The gyro sphere can be fed in two phases, and the third phase is supplied by a capacitor. The electric motor and the motor assembly constitute the gyro motor. The tracking system converts the yaw of the ship into an electrical signal, amplifies the signal and supplies the yaw motor. The cooling system is designed to maintain constant temperature. The gyro compass shaft will no longer be oriented in the direction of the Earth's horizontal rotation component, in the first place, we will be able to find a way to obtain the true meridian, under the influence of the displacement of the ship at constant speed on the surface of the Earth.

The gyrocompass system has the following components: The gyroscopic unit (the rotating gyroscope represents the core of the system – it aligns with the true north using precession and concepts of stiffness in space); control panel (interface for steering, calibration and display information operation; it shows the direction in degrees from the true north); power unit (provides a reliable power supply with backup redundancy); repeater units (displays steering information in remote places, such as bridge wings or steering stand); Interface modules (connects the gyro console to integrated bridge systems, including radar, AIS, ECDIS and autopilot); feedback mechanism (guarantees error correction and real-time title updates) The gyroscopic compass interface helps in the process of digital/analog representation of signals when they are modulated using the Python programming language [5.6,7.8,9].

The interface can be represented as a computer service provided through a cloud computing platform (e.g., Microsoft Azure, Google Cloud Platform, etc.) and then called as a service for any electronic equipment. The implementation of the interface is carried out in accordance with standard IEC61162-1/2, so that all electronic requirements are met according to that standard. The interface contains the requirements for meeting the communication of data between maritime electronic instruments (gyroscopic compass, GPS, BNWAS and others), navigation, and radio communication equipment when interconnected through the information system.

3. Gyro compass errors

Main errors of the gyro compass [10,11,12,13]:

- inertial errors are caused by inertial acceleration produced by the variation of the velocity vector because of the manoeuvre of the ship.
- the balance error is due to the action of the waves on the ship during the voyage.

Speed error is the angle at which the gyrocompass axis deviates from the true meridian, under the influence of the ship moving at constant speed on the surface of the Earth. The axis of the gyro compass shall also be oriented in a resulting direction given by the sum of the horizontal velocity of the Earth and the angular rate of rotation of the horizon plane due to the speed of the ship [2].

Speed error in degrees, is:

$$\delta_v = \frac{V_N \cos D\,a}{\omega_t R_t cos\varphi + V_N \sin D\,a} 57^\circ.3$$

where: δ_v - speed error; δg- correction of speed error; ω_t-speed of rotation of the earth; φ- latitudinea navei; V_N - the actual speed of the ship.; R_t– earth radius.

The correction of the speed error is a sign contrary to the speed correction value as a function of the Gyro courses and is calculated with the formula:

$$\delta_g = -\frac{V_N \cos Dg}{\omega_t R_t cos\varphi} 57°.3$$

The speed error depends only on the speed, the ship's course and the geographical latitude of the ship. It is eliminated by the action of the automatic speed error corrector.

The waves act on the ship and therefore also on the gyrocompass by means of a periodic inertial type of acceleration, the vector of which is permanently perpendicular to the front of the wave:

$$\delta_b = \frac{B}{4K\omega_t cos\varphi} \frac{Ab_{max}^2}{g^2} \sin 2\,Q$$

where: δ_b - it is the correction of the balance error; Ab_{max} - the maximum amplitude of the swing acceleration; φ – the vessel's latitude; sin2Q - wave direction function error.

The balance error increases with latitude, with the amplitude of the swing acceleration and by the term *sin2Q,* the error depends on the direction of wave propagation. The swing error can reach 300th values , which can cause the gyro compass to be unusable, so the sway error is canceled by construction. Two identical gyroscopes are used to eliminate the swing error, which are inserted into the gyro [2].

Gyrocompass system alarms are a feature of gyrocompass systems that inform the crew of any faults, deviations or hazardous situations. These can be [14,15,16,17,18,19]:

A. *Alarms associated with the direction*
   - The steering deviation alarm is triggered if the direction of the gyrocompass deviates from the predetermined limits, suggesting a potential problem.
   - Loss of steering signal notifies connected systems when the gyroconsole is unable to provide steering data.

B. *System failure alarms*
   - fault in the gyro compass signals a problem with the electrical or mechanical components of the gyro compass unit.
   - A fault in the power supply informs the user when the primary or backup power of the gyro compass is cut off.
   - Gyro alignment may be affected by speed or latitude input errors, which occur when information in speed logs or latitude input devices is incorrect or absent.

C. *Performance alarms*
   - The excessive drift alarm is triggered when the gyrocompass travel rate increases above the permitted limits
   - alignment error occurs when the gyroconsole does not align correctly with true north after power on or during calibration

D. *Integrated alarms*
   - The interface error is the one that informs users when there is a loss or deterioration of communication between the gyrocompass and connected systems (such as radar or autopilot)

Alarm Management includes:

1. *Display and confirmation*
- Alarms are displayed on the control panel/ integrated systems (ECDIS).
- Timely recognition and response are guaranteed by visual and auditory cues.
2. *Alarm priority*
- An example of a high priority alarm that requires a quick response is a gyro fault.
- Routine checks are important to manage low priority issues such as alignment errors during startup.
3. *Analysis and registration*

- For the sake of maintenance and compliance, critical alerts are recorded.
- Alarm logs are useful for troubleshooting and locating recurring problems.

Technical details:

- Accuracy: Depending on system calibration and sea conditions, accuracy is between ±0.1° and ±0.5°.
- Drift rate: Depending on the model and the manufacturer is less than 0.5° every hour.
- Depending on the features and size of the system, the power consumption varies from 50W to 150W.
- After starting the system to achieve maximum operational accuracy it takes approximately 1-2 hours.

Maintenance consists of two activities:

A) typical maintenance

- To check wear and damage, the components must be cleaned and examined.
- A backup compass or calibration facilities are used to confirm steering correctness.

b) Performance test

- Steering accuracy shall be tested during routine checks or sea tests.
- Alarms are tested to ensure functionality.

Safety points to remember:

- It is mandatory to integrate/correlate the gyrocompass equipment with other equipment

-Autopilot is the one that provides accurate navigation information for an exact route.
ECDIS is the information system that provides route control and head information for possible chart overlaps.

- Radar provides precise alignment of navigation direction and collision avoidance.

The AIS system improves knowledge of the ship's situation through an active exchange of direction data with other vessels.

4. Power consumption model for the gyrocompass

A gyrocompass powered at 115 V AC/ 400 Hz, accuracy of ±0.5°, compatible with autopilot systems shall be considered. The gyrocompass is based on the principles of gyroscope and Earth rotation to maintain its orientation. A mathematical model is based on the equations of motion of a gyroscope subject to the Coriolis force and precession. The basic equation for the precession of a gyroscope:

$$\vec{M} = \frac{d\vec{L}}{dt} = \vec{w} \times \vec{L}$$

where:

- $\vec{M}$ is the total moment acting on the gyroscope (including friction torques, restoring force, etc.);
- $\vec{L}$ $=I\omega g$ - is the angular momentum of the gyroscope (I– moment of inertia, ωg– angular rotational speed of the rotor);
- $\vec{\omega}$ - Is the angular velocity of the cardan frame or Earth (for the gyrocompass, the rotation speed of the Earth at that latitude is relevant).A detailed model includes: Latitude effect ϕ (Earth's angular Hourly velocity: $\Omega = 7.2921159 \times 10$. At$-5 rad/s$, and projection on the horizontal axis depends on $sin\,\phi$);damping torque (damping torque) required to prevent excessive oscillation; errors caused by ship accelerations, tangage, roll, etc.

The static error (offset) can be approximated to be within ± 0.5°. This offset can be modeled as a constant δ in the measured angle:

$$\theta_{measured} = \theta_{true} + \delta$$

Dynamic error can be modeled as a random walk or a Kalman filter that estimates angular deviation over time.

$$\theta_{error}(t+1) = \theta_{error}(t) + \omega_{ruido}(t)$$

where: $\omega_{ruido}\ (t)$ it is a white noise with a certain spectral density of power.

A table with the consumption electric power values of the mandatory on-board equipment has been drawn up, see Table 1, assuming that the consumption values for the continuously operating equipment (ECDIS, AIS, Gyro) remain constant and the radar is switched on in the ranges 0–2h, 4–6h and 6–9h (see Table 1).

Table 1. Power consumption of navigation equipment (simulated)

Time interval	Radar (kW)	ECDIS (kW)	AIS (kW)	Gyro (kW)	Total (kW)
0–1h	2,00	0,15	0,05	0,05	2,25
1–2h	2,00	0,15	0,05	0,05	2,25
2–3h	0,00	0,15	0,05	0,05	0,25
3–4h	0,00	0,15	0,05	0,05	0,25
4–5h	2,00	0,15	0,05	0,05	2,25
5–6h	2,00	0,15	0,05	0,05	2,25
6–7h	2,00	0,15	0,05	0,05	2,25
7–8h	2,00	0,15	0,05	0,05	2,25
8–9h	2,00	0,15	0,05	0,05	2,25
9–10h	0,00	0,15	0,05	0,05	0,25
10–11h	0,00	0,15	0,05	0,05	0,25
11–12h	0,00	0,15	0,05	0,05	0,25

In the ASCII scheme using the column chart (Bar Chart) where the columns represent the total consumption (kW) every hour. On the horizontal-X axis the time intervals appear, and on the vertical-Y axis the value of the active power (kW). Each # symbol represents 0.25 kW, see Figure 2.

```
3    |
2    |    ##########  (2.25) < - radar consumption  + ECDIS + AIS + Gyro
1    |    ##########
0,5  |    ##########
0,25 |    ###         (0.25) < - only consumption ECDIS + AIS + Gyro
0    |________________________________________
       0-1  1-2  2-3  3-4  4-5  5-6  6-7  7-8  8-9  9-10  10-11  11-12 (hours)
```

Figure 2. Power consumption of navigation equipment

- Intervals with **2,25 kW** (ex. 0–1h, 1–2h, 4–9h) have the radar on.
- **0.25 kW intervals** (ex 2–3h, 3–4h, 9–12h) have only the AIS ECDIS and the Gyrocompass (see Figure 3).

```
2,5|              ■■ Radar + ECDIS + AIS + Gyro
2,0|         ▲▲▲▲ Radar
1,5|         ■■■■  ECDIS
1,0|         ■■■■   AIS
```

0,5| ■■■■   Gyro
0,0| ______________________________

0-1 1-2 2-3 3-4 4-5 5-6 6-7 7-8 8-9 9-10 10-11 11-12 (hours)

Figure 3. Power consumption of individual and collective navigation equipment

The graphs show us peak consumption periods (radar is on), minimum consumption intervals (ECDIS, AIS and Gyrocompass are active), how we can optimize energy consumption.Simulations and mathematical models for power consumption for radar, ECDIS, AIS and gyrocompass.

The Gyrocompass and other equipment on board the ship shall comply with the resolutions of the International Conventions [20-22].

5. Methodology and the proposed framework

Modern maritime navigation demands highly reliable and integrated systems that provide accurate heading information under all sea and operational conditions. The gyrocompass, unlike the magnetic compass, determines true north based on Earth’s rotation and is immune to ferromagnetic interference from the ship’s steel structure. Its role goes beyond heading indication—it acts as a central reference for autopilot, ECDIS, radar, AIS, and repeaters, ensuring coordinated situational awareness and safe navigation.

However, the effectiveness of the gyrocompass depends not only on its internal design (sensitive element, tracking, synchronous transmission, power and cooling systems) but also on its integration with other equipment. Correcting errors (speed, balance, and inertial), managing alarms, and optimizing energy consumption are essential for operational reliability. To achieve this, a structured methodology and well-defined architecture must be implemented, enabling seamless commissioning, error handling, and ongoing operations.

The proposed methodology follows a systematic lifecycle approach, from setup to continuous monitoring:

1. **Assessment & Design**
   - Evaluate existing bridge systems, available power sources (115VAC/400Hz + UPS), and network infrastructure.
   - Map integration points for autopilot, ECDIS, radar, AIS, and repeaters using IEC 61162-1/2 standards.
2. **Installation & Configuration**
   - Install the gyrocompass unit, power module, and repeaters.
   - Configure interface gateways to distribute heading (HDG/THS) and diagnostic data.
   - Align the gyrocompass physically and configure calibration parameters.
3. **Calibration & Correction**
   - Compare gyro heading with GPS-derived Course Over Ground and magnetic compass to fine-tune alignment.
   - Apply automatic speed and latitude error corrections using GPS and speed log inputs.
   - Conduct drift checks during warm-up (1–2 hours) to establish baseline accuracy.
4. **Alarm Setup & Prioritization**
   - Define thresholds for high-priority alarms (gyro fault, power failure, excessive drift).
   - Configure alarm distribution to ECDIS and integrated panels with visual/auditory cues.
   - Establish alarm acknowledgment procedures and logging for compliance and troubleshooting.
5. **System Integration Testing**
   - Validate heading distribution to autopilot, radar, ECDIS, AIS, and repeaters.
   - Test failover scenarios (loss of signal, power cut, or interface error).

    - Verify redundancy with magnetic compass and GPS inputs.
6. **Crew Training & Operationalization**
    - Train operators in alarm handling, cross-checking headings, and emergency fallback.
    - Conduct drills for manual reversion when the gyro is offline.
    - Provide documentation of error correction formulas and operating procedures.
7. **Monitoring & Maintenance**
    - Implement log analysis for drift, accuracy deviations, and error trends.
    - Perform routine inspections and performance tests during sea trials.
    - Schedule proactive maintenance, including cooling system checks and alarm testing.

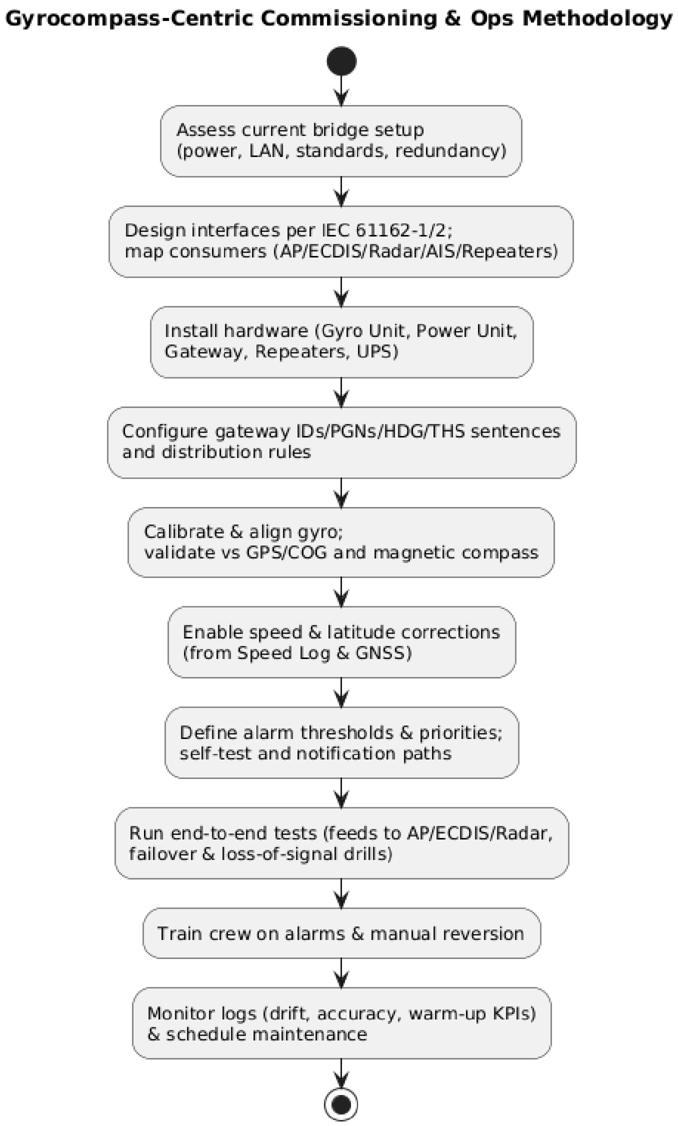

Figure 4. The step-by-step lifecycle for deploying and operating a gyrocompass

The activity diagram (see Figure 4) illustrates the step-by-step lifecycle for deploying and operating a gyrocompass as the central navigation reference in an integrated bridge system.

- **Assessment & Design**: The process begins with an evaluation of the existing bridge integrated setup, including power sources, network capabilities, and redundancy needs. This ensures that integration requirements (IEC 61162-1/2, consumer mapping for autopilot, radar, ECDIS, AIS, and repeaters) are clearly defined.

- **Installation & Configuration**: Hardware such as the gyro unit, repeaters, gateway, and UPS is installed. Interfaces are configured so that heading data and diagnostics can be properly distributed across the bridge network.
- **Calibration & Error Correction**: Once installed, the gyrocompass is calibrated and aligned. GPS and magnetic compass inputs are used for cross-checking, while automatic correction mechanisms handle speed and latitude errors.
- **Alarm Management**: Alarm thresholds and priorities are defined. The diagram emphasizes self-tests, fault detection, and notification pathways so the crew can quickly respond to drift, power faults, or misalignment.
- **System Testing**: End-to-end validation is performed by simulating live operations. Heading data is checked against autopilot, radar, and ECDIS, while failover drills test system robustness in case of signal or power loss.
- **Crew Training & Handover**: Operators are trained on alarm recognition, manual fallback, and the use of backup navigation systems. This ensures human readiness complements technological safeguards.
- **Monitoring & Maintenance**: The final steps involve log analysis (drift rate, accuracy, warm-up time) and scheduling preventive maintenance. These routines guarantee long-term reliability and compliance with maritime standards.

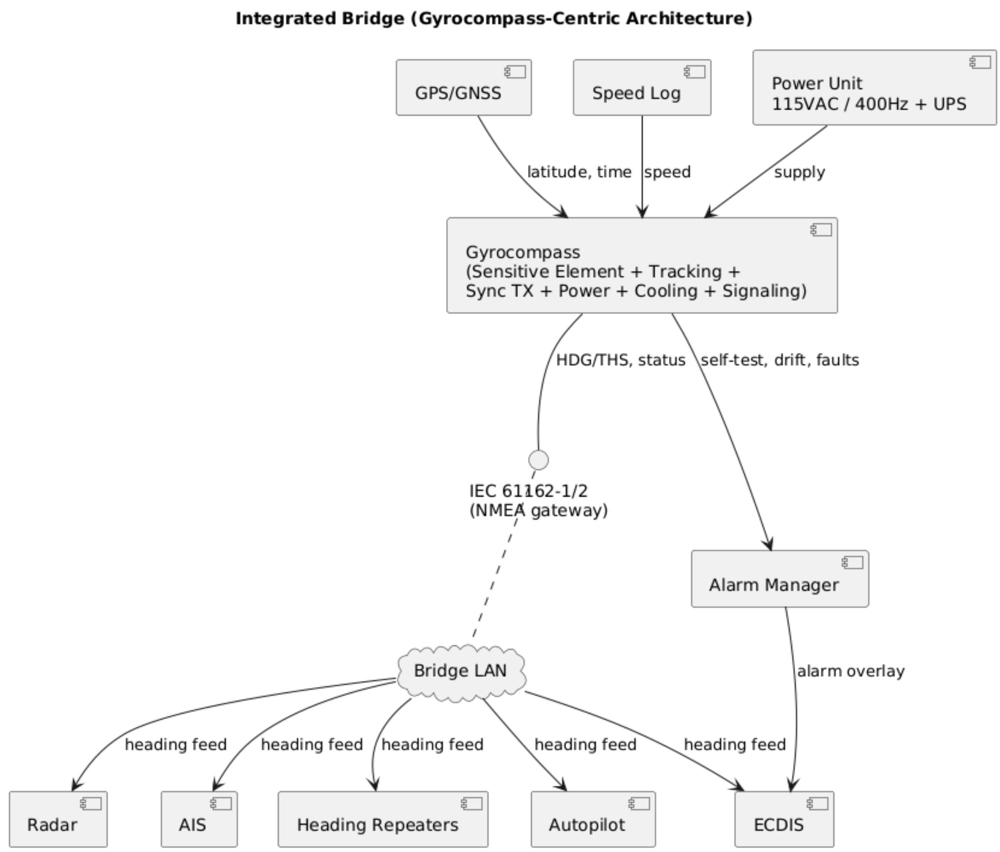

Figure 5. The architecture of an integrated bridge system centered around the gyrocompass

The component diagram (see Figure 5) depicts the architecture of an integrated bridge system centered around the gyrocompass. It shows how the gyrocompass acts as the primary source of true heading and distributes this information across multiple navigation and control devices.

- **Core System (Gyrocompass Unit).** The gyrocompass includes its sensitive element, tracking system, synchronous transmission, power supply, and cooling/signaling subsystems. GPS/GNSS provides latitude and timing data, while the speed log delivers ship speed for automatic error correction. A dedicated power unit (115 VAC / 400 Hz with UPS backup) ensures continuous operation.
- **Interface and Communication.** The gyro feeds heading (HDG/THS) and status signals into an IEC 61162-1/2 gateway. This serves as the standardized communication layer, ensuring compatibility and integration with other bridge equipment.
- **Consumers of Heading Data.** Through the bridge LAN, the autopilot, ECDIS, radar, AIS, and heading repeaters receive synchronized gyro data. This guarantees a unified heading reference across steering, charting, collision avoidance, and vessel tracking functions.
- **Alarm Management.** A dedicated alarm manager collects self-test results, drift detection, power faults, and alignment errors from the gyro. Alerts are then routed to the ECDIS or integrated displays, where they are visualized for immediate operator response.
- **System Integration.** The architecture emphasizes modularity and interoperability: the gyrocompass provides accurate heading; the gateway standardizes communication; the LAN distributes data; and each subsystem (autopilot, radar, AIS, ECDIS, repeaters) uses the same reliable input.

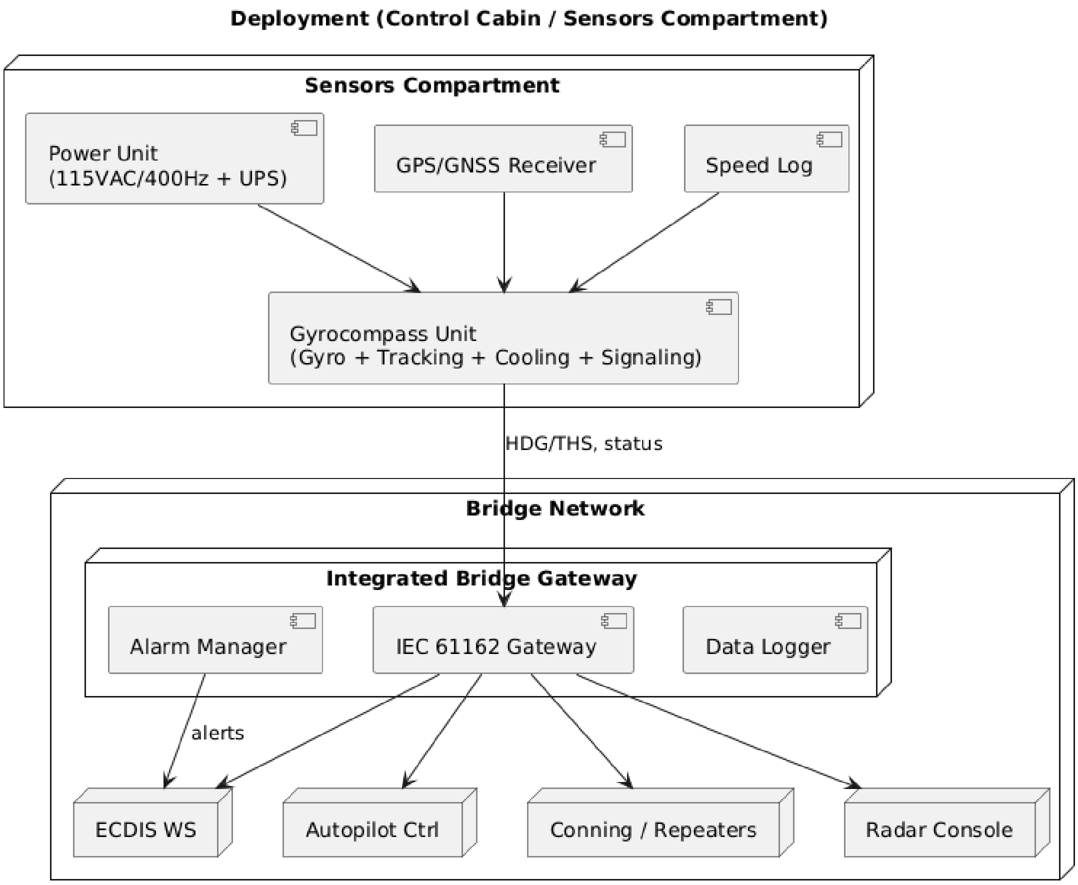

Figure 6. Physical and network-level arrangement of the gyrocompass

The deployment diagram (see Figure 6) represents the physical and network-level arrangement of the gyrocompass and its connected systems on board the vessel. It highlights the separation between the

Sensors Compartment (equipment generating navigation data) and the Bridge Network (equipment consuming and displaying navigation information).

- **Sensors Compartment.** This section houses the gyrocompass unit (sensitive element, tracking, cooling, signaling), its dedicated power unit (115 VAC / 400 Hz with UPS for redundancy), as well as the GPS/GNSS receiver and speed log. Together, these provide the essential inputs—heading, latitude, time, and ship speed—that feed into the navigation system.
- **Bridge Network.** At the bridge level, an IEC 61162 gateway connects the gyrocompass outputs to all navigation consumers. Supporting modules like the alarm manager and data logger monitor faults, drift, and performance, while distributing alerts. Heading data is then made available to the ECDIS workstation, radar console, autopilot control unit, and conning/repeaters for synchronized navigation.
- **Integration Path.** The diagram shows how signals flow from the sensors compartment to the bridge network: the gyrocompass processes input data, applies corrections, and transmits heading through the gateway. The network then distributes this data across critical navigation systems, ensuring consistent and reliable situational awareness.

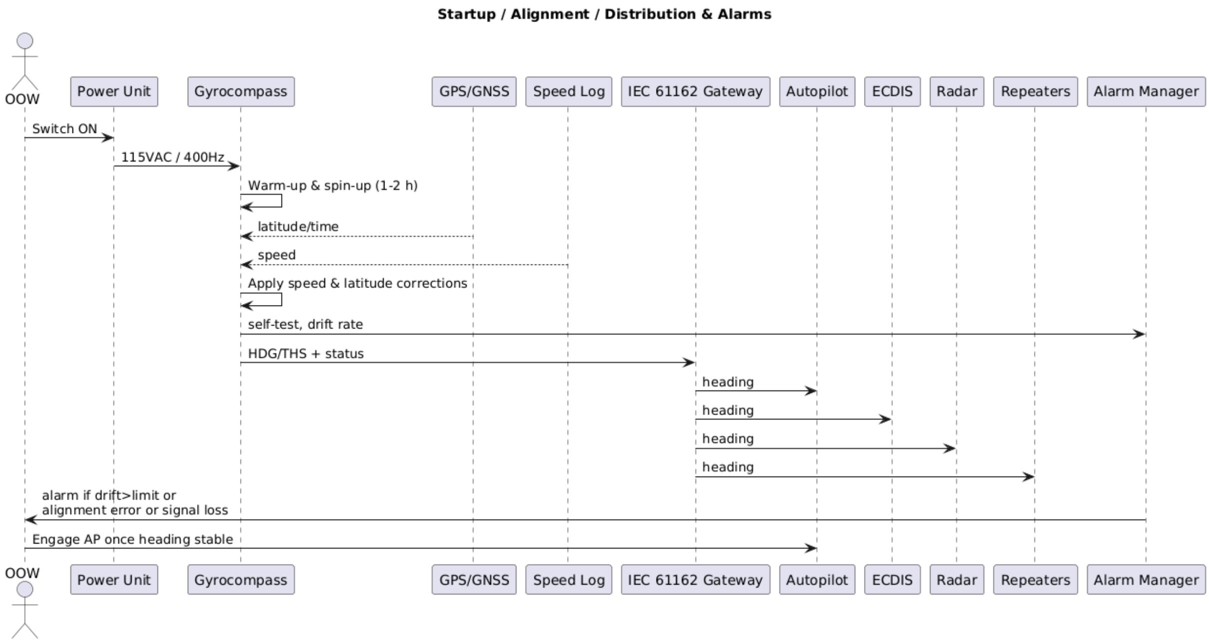

Figure 7. The operational flow of the gyrocompass

The sequence diagram (see Figure 7) illustrates the operational flow of the gyrocompass from startup to heading distribution and alarm handling. It shows how power, input, and data move step by step across the system until navigation equipment receives a stable heading reference.

- **Startup Phase.** The operator (OOW) powers on the system through the power unit, which supplies 115 VAC / 400 Hz to the gyrocompass. The gyro enters a warm-up and spin-up phase (typically 1–2 hours) before achieving operational accuracy.
- **Input Integration.** The GPS/GNSS receiver provides latitude and timing, while the speed log supplies ship speed. The gyrocompass processes these inputs to apply automatic speed and latitude error corrections, reducing deviations caused by motion and geographical position.
- **Heading Distribution.** Once stable, the gyro sends heading and status signals to the IEC 61162 gateway, which standardizes them (HDG/THS) and distributes them across the autopilot, ECDIS, radar, and repeaters. This ensures all bridge equipment receives synchronized and consistent heading data.

- **Alarm Handling.** The gyro continuously performs self-tests, monitoring drift and alignment. Detected faults (e.g., excessive drift, alignment error, loss of signal, or power failure) are sent to the alarm manager, which relays visual and auditory alerts to the operator and integrated systems such as ECDIS.
- **Operational Engagement.** Once the heading stabilizes, the OOW engages the autopilot, confident that corrected and verified gyro data is being reliably distributed.

6. Conclusions

The gyrocompass is a type of nonmagnetic compass that relies on a fast-rotating disc and the rotation of the Earth (or another planetary body, if used elsewhere in the universe) to automatically find geographic direction. Although an important component of a gyrocompass is a gyroscope, they are not the same devices; a gyroscope is built to use the effect of gyroscopic procession, which is a distinctive aspect of the overall gyroscopic effect. The advantages of the gyro-compass are: digital control of operation; it can transmit and receive information to/from other navigation equipment; it can work coupled with an automatic pilot; it is not affected by terrestrial magnetism; it allows measurement of precise gyro-references; it can be coupled with several repeaters; it can be installed anywhere on board the ship; automatic correction of speed and latitude error; superior accuracy of the magnetic compass; allows accurate holding of the gyro courses; automatic electronic correction of alignment of the master gyro with the gyro repeaters; displays: the gyro courses, the compass courses, the turning speed, the position, information about their operation and the gyro repeaters, alarms and indications; automatic synchronization of the repeaters.

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