HEADING TRANSDUCER

Type 132 - 620 NG125

1 Description
2 Operating Instructions
3 Construction and Principle of Operation
4 Maintenance and Behaviour in Case of Errors

Copying of this document, and giving it to others and the use or communication of the contents thereof, are forbidden without express authority. Offenders are liable to the payment of damages.

Toute communication ou reproduction de ce document, toute exploitation ou communication de son contenu sont interdites, sauf autorisation expresse. Tout manquement à cette règle est illicite et expose son auteur au versement de dommages et intérêts.

Toute communication ou reproduction de ce document, toute exploitation ou communication de son contenu sont interdites, sauf autorisation expresse. Tout manquement à cette règle est illicite et expose son auteur au versement de dommages et intérêts.

Sin nuestra expresa autorización, queda terminantemente prohibida la reproducción total o parcial de este documento, así como su uso indebido y/o su exhibición o comunicación a terceros. De los infractores se exigirá el correspondiente resarcimiento de danos y perjuicios.
# Heading Transducer for Gyro Compass Equipment

## Contents

### Safety Regulations

<table>
<thead>
<tr>
<th>Declaration of Conformity acc. to EC Directive 96/98/EC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Description ................................................................ 1 - 1</td>
</tr>
<tr>
<td>1.1 General .................................................................... 1 - 1</td>
</tr>
<tr>
<td>1.2 Technical Data ..................................................... 1 - 2</td>
</tr>
<tr>
<td>1.2.1 Dimensions and Weight ........................................ 1 - 2</td>
</tr>
<tr>
<td>1.2.2 Connection to Mains ........................................... 1 - 2</td>
</tr>
<tr>
<td>1.2.3 Environmental Conditions ..................................... 1 - 2</td>
</tr>
<tr>
<td>1.2.4 Interfaces ....................................................... 1 - 2</td>
</tr>
</tbody>
</table>

### Operating Instructions

| 2 Operating Instructions ............................................. 2 - 1 |
| 2.1 Alarms .................................................................. 2 - 1 |
| 2.2 Signalling ........................................................... 2 - 2 |
| 2.2.1 Signalling with Normal Operation ......................... 2 - 2 |
| 2.2.2 Signalling of Errors .......................................... 2 - 3 |

### Construction and Principle of Operation

| 3 Construction and Principle of Operation ..................... 3 - 1 |
| 3.1 Construction ......................................................... 3 - 1 |
| 3.2 Principle of Operation ........................................... 3 - 2 |
| 3.3 Making Use of the Heading Transducer in Various Systems 3 - 3 |
| 3.3.1 Gyro Compass STANDARD 20 COMPACT - Stand-alone Version 3 - 3 |
| 3.3.2 Gyro Compass STANDARD 20 PLUS Stand-alone Version ........................................ 3 - 5 |
| 3.3.3 Gyro Compass STANDARD 20 COMPACT Twin Equipment ....................................... 3 - 7 |

### Care and Maintenance and Behaviour in Case of Errors

| 4 Care and Maintenance and Behaviour in Case of Errors .......... 4 - 1 |
| 4.1 Care and Maintenance ............................................... 4 - 1 |
| 4.2 Behaviour in Case of Errors ..................................... 4 - 3 |
| 4.2.1 Description of the Signal Electronics ....................... 4 - 4 |
| 4.2.1.1 Function of the Signal Electronics ....................... 4 - 4 |
| 4.2.1.2 Construction of the Signal Electronics .................. 4 - 4 |
| 4.2.1.3 Principle of Operation of the Signal Electronics .......... 4 - 5 |
| 4.2.1.4 Technical Data of the Signal Electronics ................ 4 - 6 |
| 4.2.1.5 Test List ................................................................ 4 - 7 |
| 4.2.1.6 Jumper Assignment ........................................... 4 - 9 |
### Heading Transducer for Gyro Compass Equipment

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.2</td>
<td>Description of the Serial Interface Module</td>
<td>4-10</td>
</tr>
<tr>
<td>4.2.2.1</td>
<td>Construction of the Module</td>
<td>4-10</td>
</tr>
<tr>
<td>4.2.2.2</td>
<td>Principle of Operation of the Module</td>
<td>4-10</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Description of the MC Module</td>
<td>4-11</td>
</tr>
<tr>
<td>4.2.3.1</td>
<td>Principle of Operation</td>
<td>4-11</td>
</tr>
<tr>
<td>4.2.4</td>
<td>Description of the Power Supply PCB</td>
<td>4-12</td>
</tr>
<tr>
<td>4.2.4.1</td>
<td>Construction of the Power Supply PCB</td>
<td>4-12</td>
</tr>
<tr>
<td>4.2.4.2</td>
<td>Principle of Operation</td>
<td>4-12</td>
</tr>
<tr>
<td>4.2.4.3</td>
<td>Technical Data</td>
<td>4-14</td>
</tr>
<tr>
<td>4.2.4.4</td>
<td>Test List</td>
<td>4-14</td>
</tr>
<tr>
<td>4.2.5</td>
<td>Description of the Amplifier PCB (Booster)</td>
<td>4-15</td>
</tr>
<tr>
<td>4.2.5.1</td>
<td>Function of the Amplifier PCB (Booster)</td>
<td>4-15</td>
</tr>
<tr>
<td>4.2.5.2</td>
<td>Construction of the Amplifier PCB (Booster)</td>
<td>4-15</td>
</tr>
<tr>
<td>4.2.5.3</td>
<td>Principle of Operation of the Amplifier PCB (Booster)</td>
<td>4-15</td>
</tr>
<tr>
<td>4.2.5.4</td>
<td>Functions of the Amplifier PCB (Booster)</td>
<td>4-16</td>
</tr>
<tr>
<td>4.2.5.5</td>
<td>Mains Supply</td>
<td>4-16</td>
</tr>
<tr>
<td>4.2.5.6</td>
<td>Two-channel Proportional Power Amplifier</td>
<td>4-18</td>
</tr>
<tr>
<td>4.2.5.7</td>
<td>Monitoring &quot;1&quot;</td>
<td>4-18</td>
</tr>
<tr>
<td>4.2.5.8</td>
<td>Monitoring &quot;2&quot;</td>
<td>4-19</td>
</tr>
<tr>
<td>4.2.5.9</td>
<td>Measures to be taken after Monitoring Systems &quot;1&quot; or &quot;2&quot; have responded</td>
<td>4-20</td>
</tr>
<tr>
<td>4.2.5.10</td>
<td>Technical Data of the Amplifier PCB</td>
<td>4-21</td>
</tr>
<tr>
<td>4.2.6</td>
<td>Synchronization with STANDARD 20 Equipment</td>
<td>4-26</td>
</tr>
</tbody>
</table>

---

Drawings:

**Dimensional Diagram:** NB08 C 012.00-054

**Wiring Diagram:** 132 C 620 HP 008

**Circuit Diagrams:**
- Wiring PCB 132 C 620 HP 015
- (incl. Power Supply PCB)

**Connection Diagram:**
- for Gyro Compass STD 20 1100 D 5209

**Assembly Drawing (Jumper Assignment):**
- Signal Electronics 132 D 620 HP104, Sheet 1 + 2
Alarm outputs must be connected to a central Alarm Panel/Signal Unit. Alarm Panel or Signal Unit must have an acoustical and optical alarm indication.

A heading from a THD (transmitting heading device) is only allowed for ships up to 500GT.

It is not allowed to connect/distribute a heading which is generated by a magnetic compass (according to SOLAS regulations).

**WARNING**

This equipment is not fitted with safety interlocks lethal voltages are present when the units are open and exposed. Before removing any sub-unit or PCB, all supplies must be switched off.
ATTENTION
Observe Precautions for Handling Electrostatic Sensitive Devices

CAUTION

Handling of Electrostatic-sensitive Semiconductor Devices

Certain semiconductor devices used in the equipment are liable to damage due to static voltage. Observe the following precautions when handling these devices in their unterminated state, or sub-units containing these devices:

1) Persons removing sub-units from an equipment using these devices must be earthed by a wrist strap and a resistor at the point provided on the equipment.

2) Soldering irons used during the repair operations must be low voltage types with earthed tips and isolated from the mains voltage by a double insulated transformer.

3) Outer clothing worn must be unable to generate static charges.

4) Printed Circuit Boards (PCBs) fitted with these devices must be stored and transported in anti-static bags.
Heading Transducer for Gyro Compass Equipment

Intentionally left blank
1 Description

1.1 General

Transducers are interface sub-assemblies mounted between the signal generators and the connected reference receivers, and intended for navigational purposes.

The Heading*) Transducer, Type 132–620, converts the serial heading signal generated by the gyro compass – into a synchro signal required for the loads (repeater compasses). 12 repeater compasses with synchro receivers can be connected as a maximum.

*) designation acc. to IMO and MSC definitions

By making use of the control unit, there exists the possibility of transmitting a speed-error-corrected 1° synchro signal as well as receiving the heading value from a magnetic compass with magnetic sonde.

A power supply unit provided in the heading transducer produces from the AC ship’s mains the supply voltage for the transducer itself as well as for the connected repeater compasses.

A DC voltage with a rated value of 28V – produced as well – can be used as a supply voltage for a gyro compass, if required.

Fig. 1: Heading Transducer, Type 132–620 NG125
1.2 Technical Data of the Transducer

1.2.1 Dimensions and Weight

Weight: approx. 16 kg

1.2.2 Connection to Mains

Input voltage: 110/220/380/440V_{AC}
Voltage tolerance: \( \pm 10\% \)
Frequency: 50/60Hz
Frequency tolerance: \( \pm 5\% \)
Power consumption: approx. 350VA
Output voltage: 28V_{DC} (from power supply unit)
Power output: max. 110W
Permissible needle pulses: 660V, rise 1.2 \( \mu \)s
decay in 50 \( \mu \)s
Overvoltage protection: voltage peaks acc. to GL
\( \overset{\text{\( \approx \)}}{\text{2.5 x } U_{N}} \)
1ms duration

1.2.3 Environmental Conditions

Permissible ambient temperature:
- Operation: -10 °C to +55 °C
- Storage: -25 °C to +70 °C
Type of enclosure:
- IP 23 (with casing)
- IP 00 (without casing)
EMC: see Declaration of conformity

1.2.4 Interfaces

Input interface
- Serial input "HEADING" from Gyro Compass STANDARD 20 via the RS 422 module configured on the signal electronics

Output interface
- 1° synchro signal *) power for 12 receivers (torque transmitters) (S_1, S_2, S_3 with max. 20V_{AC})
Reference voltage (R_1, R_2): 50V
Frequency: 50 / 60Hz
7 terminals for repeater compasses in the heading transducer and a distribution for further 5 peripherals
Floating contact Booster defective

*) Limiter of the turn rate to max. \(10^\circ/s\) for heading signal adaptation to the dynamic transmission conditions of the electromechanical heading receivers.

Output alarms (Terminal board L6.1 ..... L6.3)
- System error
- Overtemperature
- Booster errors
- Serial input invalid/lost
2 Operating Instructions

For switching on the heading transducer, set the switch to "1". The gyro compass supply – if used – is activated by this switch as well.

Only for carrying out maintenance and repair work, the switch must be set to "0". If an emergency supply is connected to the gyro compass, the compass will even now remain active.

2.1 Alarms

Alarm outputs must be connected to a central Alarm Panel/Signal Unit. Alarm Panel or Signal Unit must have an acoustical and optical alarm indication.

An alarm contact “normally closed” at the terminal board L6.2 - L6.3 shows below mentioned errors at an external alarm device:
- System error
- No supply voltage
- Fuse F1 (Booster) defect
- Coursebus error or lost
- Overtemperature at the booster
2.2 Signalling

The following LEDs have been arranged on the signal electronics (view of the signal electronics with opened casing):

![Arrangement of LEDs on the Signal Electronics](image)

**Fig. 2 – 1:** Arrangement of LEDs on the Signal Electronics

- = LED is lighting
- = LED is blinking
- = LED is blinking with double frequency
- = LED does not light

### 2.2.1 Signalling with Normal Operation

<table>
<thead>
<tr>
<th>red green yellow yellow red green</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="LEDs Arrangement" /></td>
<td>Gyro Compass in heating phase</td>
</tr>
<tr>
<td><img src="image" alt="LEDs Arrangement" /></td>
<td>Gyro compass and heading transducer are available</td>
</tr>
</tbody>
</table>

- = LED is lighting
- = LED is blinking
- = LED is blinking with double frequency
- = LED does not light
2.2.2 Signalling of Errors

<table>
<thead>
<tr>
<th>red</th>
<th>green</th>
<th>yellow</th>
<th>yellow</th>
<th>red</th>
<th>green</th>
<th>Cause</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Failure of microprocessor on the signal electronics</td>
<td>The status of the other LEDs is not essential</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No valid heading value from gyro compass</td>
<td>The first yellow LED flashing with double frequency</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Serial input signal invalid</td>
<td>The first yellow LED flashing with double frequency</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Amplifier (Booster) defective</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Current limitation on the amplifier is active</td>
<td>Warning only!</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>MC module not existing on the signal electronics</td>
<td>see Section 4.2.3</td>
</tr>
</tbody>
</table>

In case of warnings: Cancel warning by releasing a short-circuit on the RESET jumper.

In case of error message: Perform trouble shooting (see Chapter 4), eliminate error and release RESET procedure; then carry out synchronization acc. to Section 4.2.6.

= LED is lighting  
= LED is blinking  
= LED is blinking with double frequency  
= LED does not light
Heading Transducer for Gyro Compass Equipment

Intentionally left blank
3 Construction and Principle of Operation

3.1 Construction

(Fig. 3–1)

The casing of the heading transducer is made of metal and is intended for bulkhead mounting. On its bottom side, it carries a cable entry plate and a ground connection accessible from outside. The electric modules are arranged in the casing on the wiring PCB (3–1/4). There are also provided the terminals for the hull-bound cable installation as well as three plug-and-socket connections for the signal electronics (3–1/3), amplifier PCB (booster) (3–1/2) and power supply unit (3–1/1). The power supply unit is fastened on the top of the wiring PCB. The wiring PCB is screwed onto a mounting plate. The casing door carries the ON / OFF switch (B5) and the fuses E1 and E2.

![Diagram of Heading Transducer, Casing opened](image)
3.2 Principle of Operation (concerning to Gyro compass STD 20)  
(Fig. 3–2)
The heading transmission system of the gyro compass equipment STANDARD 20 is 
based upon the interface RS 422 HEADING SERIAL\(^\text{1}\). The heading transducer is acti-
vated with this signal in a self-synchronizing way from the gyro compass STANDARD 20 
via the Distributor COMPACT, Type 110–224, or from the control unit of the gyro compass 
equipment STANDARD 20 PLUS.

The heading signal is fed in the heading transducer first to the signal electronics. On this 
PCB, the heading information is converted into a synthetic synchro signal and then fed to 
the amplifier PCB (booster). Here, the synchro signal is amplified and is then used for the 
activation of max. 12 repeater compasses with synchro receivers.

Fig. 3–2: Heading Transducer – Block Diagram

For a twin equipment with two gyro compasses, heading selection is performed in con-
junction with the control unit (STANDARD 20 PLUS). (See also Fig. 3–5: Heading Trans-
ducer with Gyro Compass STANDARD 20 PLUS Twin Equipment, Page 3 – 8.)

The serial interface is led via a small additional PCB (piggy back) referred to in the follow-
ing block diagrams as SCI (serial communication interface).

For the sake of simplicity, the signal electronics is shown in the following block diagrams 
with a dark background.

\(^{1}\) Raytheon Marine specific
3.3 Making Use of the Heading Transducer in Various Systems

3.3.1 Gyro Compass STANDARD 20 COMPACT - Stand-alone Version

(Fig. 3-3)

A single gyro compass equipment STANDARD 20 COMPACT with distributor COMPACT (but also without distributor COMPACT) activates the heading transducer via the interface RS 422 HEADING SERIAL\(^1\). The amplifier (booster) integrated in the course transducer supplies the synchro signal for a maximum of 12 repeater compass loads. A self-synchronization will be required after an AC voltage failure, as without AC mains the synchro supply is missing, and no follow-up of the synchro periphery takes place. During the failure time, the heading value is stored; after voltage recovery, the new heading value will be recognized and the synchronization difference eliminated. During the failure time, the STANDARD 20 gyro compass equipment is operating on the 24V ship’s mains without disturbance. The output signals of the distributor COMPACT remain on heading.

\(^1\) Raytheon Marine specific

---

*[Diagram showing the connections between the gyro compass STD 20 unit, power supply, distributor COMPACT Type 110-224, and the heading transducer Type 132-620]*

**Fig. 3-3:** Heading Transducer with Gyro Compass STD 20 (Stand-alone Version)
A slight heading uncertainty of the mechanical synchro periphery may originate when the AC supply breaks down during a fast rate of turn. Therefore, a heading control of the mechanical synchro repeaters should be made now and then.

7 interfaces for repeater indications are available directly in the heading transducer and, in addition, a distribution interface for 5 further devices.
3.3.2 Gyro Compass STANDARD 20 PLUS Stand-alone Version
(Fig. 3–4)
The heading information from the gyro compass STANDARD 20 PLUS undergoes a speed-error correction in the appertaining control unit.

When the ship is making way, a compass error occurs, referred to as speed error. The latter is independent from the construction of the gyro compass and its installation on board ship. The magnitude of the speed error depends on the heading, speed and latitude.

For speed-error correction, the control unit – in addition to the heading telegram of the RS 422 HEADING SERIAL interface – requires the values for speed and latitude. The speed value is received by the system from the connected log, but the value can also be input manually via the operator unit for STANDARD 20 PLUS equipment. On the basis of these values for speed and latitude, the heading telegram in the control unit is varied and provided with an extra bit as a symbol for speed-error and oil-damping-residual-error-corrected heading value.

Fig. 3–4: Heading Transducer with Gyro Compass STANDARD 20 PLUS
By means of a DIP switch on the processor module of the signal electronics, it will be defined which heading is made available by the control unit to the signal electronics. The following configurations can be realized with this switch:
- Heading from gyro compass only
- Heading from gyro compass selection by:
  - Operator unit for gyro compass equipment STANDARD 20 PLUS
    (see respective Description)
3.3.3 Gyro Compass STANDARD 20 COMPACT Twin Equipment

(Fig. 3–5)

The function of any gyro compass system component corresponds to that described in Section 3.4.1. The two systems are connected to each other in such a way that the synchro output signal of equipment 2 acts as an emergency input signal to the booster of equipment 1. The emergency change-over function integrated in the booster of equipment 1 performs in this system configuration also as a normal compass change-over function; therefore, at the output of equipment 1 the 1° synchro signal is made available either from gyro compass 1 or from gyro compass 2.

Fig. 3–5: Heading Transducer with Gyro Compass STANDARD 20 COMPACT Twin Equipment
Change-over is automatical in case of failure of the booster in system 1.

**Note:**
Each system part – heading transducer with gyro compass STANDARD 20 COMPACT – is self-synchronizing (see Page 3–5). The synchro periphery is generally connected to system 1. Only by means of emergency change-over, the signals are fed from system 2 to the periphery. Due to differences with several change-over actions or by faulty follow-up operation, the periphery may be desynchronized. Therefore, it is advisable to check the heading values of the synchro periphery frequently and to correct them, if necessary.
4  Care and Maintenance and Behaviour in Case of Errors

4.1  Care and Maintenance
The heading transducer requires no special care.

The front panel of the heading transducer carries two fuses which can easily be re-
placed; in addition, two fuses are located inside the casing, in the upper part, immedi-
ately beside the transformer, and which are easy to replace as well.

Fig. 4-1:  Fuses between Transformer and Wiring PCB *)

- Loosen fuse cap by means of a screw driver, size 6
- Exchange the defective fuse for a new one (T 6.3 A)

**Attention!**
Never insert fuses of other values than the indicated values.

- Screw on the fuse cap again.

*) **Attention:**
With previous devices, these fuses are not provided!
Fuses located on the amplifier PCB (booster):
The amplifier PCB contains 8 fuses (see Fig. 4-2). The fuses E2 to E8 (T 1 A) are directly accessible; the fuse E1 (T 4 A) is located on the rear of the amplifier PCB. The fail of the fuses is indicated by lighting up of the corresponding LED (H1 with E1 etc.) (in booster 132 – 361 only). For exchanging this fuse, the amplifier PCB must be drawn out.

Exchange of fuses see above.

![Diagram of fuses on amplifier PCB](image-url)
### 4.2 Behaviour in Case of Errors

On the signal electronics, the following errors and failures are signalized by lighting-up or flashing of LEDs:

<table>
<thead>
<tr>
<th>Red</th>
<th>Green</th>
<th>Yellow</th>
<th>Yellow</th>
<th>Red</th>
<th>Green</th>
<th>Cause</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>☀</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
<td>☐</td>
<td>☑</td>
<td>Failure of microprocessor on the signal electronics</td>
<td>The status of the other LEDs is not essential</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☐</td>
<td>☑</td>
<td>☐</td>
<td>No valid heading value from gyro compass</td>
<td>The first yellow LED flashing with double frequency</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
<td>☑</td>
<td>☐</td>
<td>Serial input signal invalid</td>
<td>The first yellow LED flashing with double frequency</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
<td>☐</td>
<td>☐</td>
<td>Amplifier (Booster) defective</td>
<td></td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
<td>☐</td>
<td>☐</td>
<td>Current limitation on the amplifier is active</td>
<td>Warning only!</td>
</tr>
<tr>
<td>☐</td>
<td>☐</td>
<td>☑</td>
<td>☑</td>
<td>☐</td>
<td>☐</td>
<td>MC module not existing on the signal electronics</td>
<td>see Section 4.2.3</td>
</tr>
</tbody>
</table>

- ☀ = LED is lighting
- ☐ = LED is blinking or LED is blinking with double frequency
- ☐ = LED does not light

In case of warnings:
- Check the possibly concerned wiring (defective contact, bad soldering)
- Cancel warning by releasing a short circuit on the reset jumper of the signal electronics.
- If the warning occurs repeatedly, eliminate cause.

In case of error messages:
- Perform trouble shooting and eliminate error, release reset procedure and then perform synchronization acc. to Section 4.2.6.
4.2.1 Description of the Signal Electronics
(Cf. marked diagrams at the end of Part 4; for relevant circuit diagrams see Annex)

4.2.1.1 Function of the Signal Electronics
The signal electronics receives the heading signals from the gyro compass and converts them into corresponding torque synchro signals (phases $S_1$ and $S_3$) used as input signals for the amplifier PCB (booster). The heading signals are monitored for plausible static and dynamic values. If errors occur, warnings will be signalized and further status messages and function controls will be indicated.

The signal electronics makes available the synchro heading signal in a self-synchronizing way, i.e. if the AC supply voltage should fail, the heading value will be stored. On voltage recovery, the signal electronics compares the stored heading value with the new heading value and compensates a heading difference by immediate follow-up action.

4.2.1.2 Construction of the Signal Electronics
The signal electronics has been designed as a printed-circuit module to be used in course transducers.
The PCB carries a cooling bar for the voltage regulator. This bar dissipates heat and simultaneously represents the mechanical fastening of the PCB in the transducer.
Electrical connection is via a pin-and-socket connector (DIN 41 612, type D). The processor electronics is connected as a plug-in module via plug-and-socket connectors (DIN 41 612, type B/2) with the printed-circuit module and also held in position in this way. Via a function extension module – contacted via plug-and-socket connectors (DIN 41 612, type B/3) as well – the serial heading interface is retrofitted.

The signal electronics comprises the following functional groups:
- Feeding
- Status inputs
- MC module
- Interface module
- Watchdog
- Signalling
- Digital-synchro converter (DSC)
- Course memory
4.2.1.3 **Principle of Operation of the Signal Electronics**

Note: Underlined terms in the following text correspond to the marked areas in the circuit diagrams at the end of Part 4; relevant circuit diagrams see Annex.

The signal electronics in the heading transducer works together with the power supply PCB and the amplifier PCB (booster). A wiring PCB establishes the connection for this PCBs among each other and to external interfaces.

The **MC module** (microcontroller) is responsible for the complete input and output management and computation.

The **watchdog** monitors the processor environment on switching on, during operation and on switching off. Monitoring is performed of the internal processor supply voltage as well as – derived from the power supply PCB – of the AC voltage.

**Status inputs** – edited by optocouplers – lead directly to the MC module. Here, the over-current message as well as the aggregate error which releases emergency operation are coupled in from the amplifier PCB (booster). Two further inputs are not yet used.

It is via the **signalling** that the system function is internally and externally signalized via floating contacts or the amplifier (booster) is enabled, resp. Six luminous diodes permit status and error messages to be recognized (see Sections 4.2 and 4.2.1.5)

Fixed-voltage regulators in the **feed part** stabilize the unregulated voltages generated on the power supply PCB.

The **digital-synchro converter** converts the digital heading information computed in the MC module into the signals S₁ and S₃ required for the amplifier (booster). Two reference branches, REF 0 and REF 90, are available for modulation so that the position-dependent 0° signals and the rate-of-turn-dependent 90° signals can be prepared for the two channels. It is via the coupling capacities that the synchro select signals are transmitted to the amplifier PCB (booster).

An EEPROM is made available as a **heading memory** to fulfill the tasks for the self-synchronizing functions. In case of voltage failure, the controller here reads in the absolute heading with serial data transfer. On voltage recovery, the heading is read out again and used for synchronizing follow-up action.
### 4.2.1.4 Technical Data of the Signal Electronics

#### Input voltages:
- Reference for torque synchro: 2 x 25V, 50Hz or 60Hz, centre at signal ground
- Analog supply: +/- 16V unstabilized
- Digital supply: + 9V unstabilized
- Relay supply: + 24V

#### Signal inputs:
- RS 422 HEADING SERIAL*)
- 24V booster monitoring
  - (0V = booster error)
- 24V booster current
  - (0V = current limitation)

#### Signal outputs:
- S$_1$ / S$_3$ max. 5V, 50 / 60Hz
- 1° shaft signal for booster

*) Raytheon Marine specific (Coursebus)

- Alarm contact for “System disturbed” (for external alarms – L6)
- Monitoring contact (N–INI) for booster enable
- Status input (open collector) for heading input monitoring
- Status output 12V for system ON (0V = OFF)
4.2.1.5 Test List

(See also Fig. 4-3 and Fig. 4-4).

In case of faulty synchro signal transmission, first of all check the voltage values on the signal electronics.

The following voltage values must be available:

- TPA 5 → TPA 6 \(12V_{DC}\)
- TPA 4 → TPA 7 \(+12V_{DC}\)
- TPA 3 → TPA 7 \(-12V_{DC}\)
- TPA 2 → TPA 1 \(+5V_{DC}\)
- TPB 2 → TPB 1 approx. \(5V_{AC}\) 50 / 60Hz reference

**Trimming potentiometer**

**Fig. 4-3:** Location of Test Point Fields on the Signal Electronics

Further trouble shooting:

- Due to excessiv heating, the thermic circuit breaker has switched off the connected periphery.

  **Adjustment of the trimming potentiometer R 93 (Fig. 4-3, Fig. 4-4 and Fig. 4-5):**
  Connect an ammeter - range 4A (with connection of a few repeaters also < 4A) - to one of the fuses (E3 or E4). After removing the fuse, the alternating current can be measured in the reference circuit. By varying the adjustment of the trimming potentiometer R 93 on the signal PCB, bring this alternating current to a minimum!
  After termination of the measuring insert the fuse again.

- Fuses defective?
  - Voltage at \(R_1 / R_2\): 50V
  - Voltage between \(S_1 - S_2 - S_3\): 0...20V

After performing repair work or exchange of the signal electronics, it is indispensable to check the jumper position acc. to Section 4.2.1.6 and to perform the above-mentioned minimization of the alternativ current!
**Fig. 4-4:** Measuring the AC at a Fuse

**Fig. 4-5:** Signal Electronics - Components Diagram
4.2.1.6 Jumper Assignment

For test purposes

Selection of relay contact (monitoring)
- Status at L6.1 and system disturbed at L6.2
- System disturbed at L6.1 and status at L6.2

Normally LED N54 alight when system disturbed

LED N54 not alight when system disturbed

For function RESET by short-circuit of the pins

Note:
Current jumper assignment see assembly drawing in the annex.
4.2.2 Description of the Serial Interface Module

4.2.2.1 Construction of the Module
The input interface (RS 422) has been provided with a module (piggy back). The module – located on a 45 mm wide PCB – is equipped with the adequate electronic components and carries two plug connectors (DIN 41 612, Type B/3), by which the mechanical and electrical connection to the mother PCB is established.

4.2.2.2 Principle of Operation of the Module
By the inserted module acc. to RS422 standard there exists the possibility of receiving serial data. The driver / receiver ICs N4 and N5 are activated via optocouplers for the purpose of electric isolation and separately supplied by the DC / DC converter N2, which converts 5V into isolated 5V.
4.2.3 Description of the MC Module

4.2.3.1 Principle of Operation

Definition: Synchro zero position
Definition: Synchro max. position

Heading signal from gyro compass
Not allowed (magnetic compass)
Not allowed (magnetic compass possible)
4.2.4 Description of the Power Supply PCB
(see also Circuit Diagram 132 C 620 HP 015 and Fig. 4–6)

4.2.4.1 Construction of the Power Supply PCB
The power supply PCB is designed as a printed circuit board to be used in heading transducers. A rail has been mounted on a PCB to ensure the mechanical fastening in the transducer. Electric connection to the wiring PCB is provided via a plug connector (DIN 41 612, Type D); connection to the transformer or rectifier is ensured via separable plug-in terminals with cable looms. The power supply PCB carries components for rectification and filtering as well as a monitoring circuit.

4.2.4.2 Principle of Operation
For the gyro compass supply (28 VDC), the power supply PCB includes the filter capacities C9 ... C12, complemented by the discharging resistor R6 and EMC protection elements.

For supplying the signal PCB, three voltages are available (rectified via N11, N12, N13 and N14 and filtered by C10, C17, C19 and C20): +9V, +16V and -16V, with a common 0V reference. In addition, isolated 12 V are fed to the signal PCB (via N1 and C17). Merely connected through: 50 VAC with the centre tap referred to signal ground. These 50VAC voltage serves the signal PCB as a reference to modulation and is fed to the synchro booster as a supply voltage and there connected through to the booster periphery as a reference voltage.

A comparator (N6) monitors the AC supply. For self-supply, the comparator requires a 24V DC voltage from the compass supply unit. In case of error, its output (open collector) as signal ”AC ON” is switched to logic zero. It is internally fed to the signal PCB and there organizes self-synchronization.

The basic assembly of the heading transducer includes the mains transformer (M1) as well as the rectifier (N4) for the compass supply.

Via the cable loom, the mains transformer has voltage alternatives at L20 for the primary side:

110V, 220V, 380V and 440V.

The heading transducer carries in the casing cover the fuses (E1 and E2) and the switch (B5) of the primary input.
Fig. 4-6: Power Supply PCB – Components Diagram
4.2.4.3 Technical Data

In connection with transformer (M1) and rectifier (N4), the following output voltages are available:

- **Compass supply:** $28 \text{V}_{\text{DC}}, 110 \text{W}$
- **Synchro booster supply:** $50 \text{V}_{\text{AC}}, 4 \text{A}$ (with centre point as reference ground)
- **Signal PCB supply:**
  - $\pm 16 \text{V}, \pm 0.2 \text{A}$
  - $\pm 9 \text{V}, \pm 0.4 \text{A}$
  - $16 \text{V}, 0.1 \text{A}$ (floating)
- **Relay supply:** $+24 \text{V}, 0.2 \text{A}$
- **Signal output “AC ON”:** open collector, monitored

**AC supply:**
- high: AC supply available
- low: AC supply missing

4.2.4.4 Test List

Voltage values cannot directly be measured on the power supply PCB. There are checking possibilities, however, by making use of the test list of the signal electronics (see Section 4.2.1.5).
4.2.5 Description of the Amplifier PCB (Booster)
Fig. 4–7, Fig. 4–8 and Fig. 4–9

4.2.5.1 Function of the Amplifier PCB (Booster)
The amplifier PCB amplifies a torque synchro signal (phases S1 and S3) for the operation of synchro repeaters. Furthermore - with a connected, but mechanically blocked repeater -, a troublefree synchro operation of all further connected repeaters is ensured.

4.2.5.2 Construction of the Amplifier PCB (Booster)
The amplifier PCB has been designed as a PCB module for being used in course transducers.

It consists of a PCB with a heat sink mounted on it for the power semiconductors and for the thermal protection switch. The heat sink simultaneously serves for mechanical fixation of the electronics PCB as well as for heat dissipation to the casing of the heading transducer. Electrical connection is via 2 plug connectors (DIN 41 612, type D).

- **Functional groups of the amplifier PCB**
The amplifier PCB is divided into the following functional groups:
  - Mains supply
  - 2-channel proportional power amplifier
  - Monitoring "1"
  - Monitoring "2"

4.2.5.3 Principle of Operation of the Amplifier PCB (Booster)
The amplifier PCB operates in conjunction with the signal electronics.

In the signal electronics, the serial heading values of the gyro compass are converted into synchro select signals for the amplifier PCB. Here, these select signals are amplified in a 2–channel proportional power amplifier in order that up to 7 repeater compasses (with synchro torque receivers) may be connected. The 7 repeater compasses can be connected to the corresponding output terminals; further 5 repeater compasses, however, can be connected via an additional distribution terminal.
4.2.5.4 Functions of the Amplifier PCB (Booster)
1. Amplification of a synchro signal
2. Monitoring the temperature of the two power final stages
3. Monitoring of N–INI (approx. +12VDC from signal electronics)
4. Monitoring of $U_{\text{excit.}}$ (25V$_{1-}$)
5. Monitoring of $I_{\text{output}}$ ($S_1, S_3$)
6. Monitoring of $E_1$ (fuse)
7. Monitoring of $U_{\text{input}}$ ($S_1, S_3$)

4.2.5.5 Mains Supply
The mains voltage (50/60Hz) is converted via a bridge-connected rectifier and a subsequent filter circuit into a DC voltage. Via a stabilizing circuit - consisting of 2 Zener diodes etc. - the IC components are supplied.
A controller stabilizes the voltage at 24 VDC for the relays D1 and D2.

The electric supply of the power stages is unstabilized with ± 34VDC.
Suppressor chokes and varistors protect the amplifier PCB from mains-side over-voltage peaks as well as from energy return into the final stage.
Fig. 4-7: Synchro Booster - Block Diagram
4.2.5.6 Two–channel Proportional Power Amplifier

Both proportional power amplifier channels are identical in construction. Each channel consists of a pre–stage and a driver–controlled final stage.

Pre–stage
The pre–stage of each proportional power amplifier channel consists of an operational amplifier which is activated by means of a synthetic rotary–phase signal (S₁ and S₃). The inverting input of the operational amplifier is provided for activation via the synthetic rotary–phase signal from the signal electronics.

Driver stage
The driver stage of each proportional power amplifier channel consists of a push–pull stage with emitter resistor. The emitter resistor limits the current of the driver stage.

Final stage
The final stage of each proportional power amplifier channel consists of two Darlington transistors in a collector circuit. The emitter resistors limit the current. The transistors, lying in parallel with the emitter resistors, are actuated in the event of an overcurrent (e.g. electric short–circuit of the repeater lines) and short–circuit the drive signals of the driver stage via a comparator. The LC combination and the varistor at the final stage output provide protection against overvoltage peaks.

4.2.5.7 Monitoring "1"

Monitoring "1" is activated by 4 sensors:
- Temperature switch (on the heat sink of the power semi–conductors)
- N–INI input (from signal electronics)
- Optocoupler (on input $U_{\text{excit.}}$ (25V₁...))
- Optocoupler (in parallel to fuse E1)
Monitoring values can be measured at L19.1 / 2.

All 4 monitoring sensors control the relays D1 and D2 via a transistor. In case of disturbance, the connected repeaters are separated at the rotor and stator sides from the amplifier PCB by these relays and, if available, switched over to the torque synchro transmitter or to a second heading transducer, resp., for emergency operation.
Monitoring "1" is released:
- In case of overtemperature of the final transistors, e.g. in the event of a short-circuit in the feed line from the amplifier PCB to the repeaters.
- If an external fault is indicated via input N-INI.
- If $U_{\text{excit}}$ fails.
  (By means of an optocoupler, the input N-INI is interrupted to ensure reliable switching-off of relays D1 and D2.)
- If the mains fuse (E1) of the amplifier PCB fails.

Signalling of the monitoring function:
"TEMP. AND N-INI MONITORING EXT. ARRANGED"
is ensured by a $24\text{V}_{\text{DC}} / 100\text{mA}$ output.

A free-wheeling diode is arranged in parallel with the two relays D1 and D2. Connection of a relay with floating contacts, for instance, can be made for operating a visual or an audible signal transmitter.

4.2.5.8 Monitoring "2"
Monitoring "2" fulfills two monitoring functions:
- Monitoring of $U_{\text{input}}$ ($S_1 / S_3$, zero voltage monitoring).
- Monitoring of $I_{\text{output}}$ ($S_1 / S_3$, final stage output).

Values to be measured at L19.3 (overcurrent).

Monitoring "2" is released:
- When, due to disturbance, both the drive signals, $S_1$ and $S_3$, are simultaneously at zero potential. In this case, no activation of the final stages takes place. By this, thermal overload of the power transistors is prevented which might result from energy return of the connected and voltage-excited repeaters.

- When a short-circuit is present at the output terminals of the amplifier PCB. The monitoring, described together with the final stage function, prevents the short-circuit current from rising by $\geq 15\text{A}$, thus preventing the final stage transistors from being endangered.
The monitoring branch consists of a comparator comparing the input signals $S_1$ and $S_3$ of a reference voltage.

In case of disturbance, 2 analog switches are activated by the comparator, whereby the input signals of the driver stages are connected to ground.
Signalling of the monitoring function:
"OVERCURRENT MONITORING"
is ensured by a $24V_{DC}/60mA$ output. Connection of a relay with floating contacts, for instance, can be made for operating a visual or an audible signal transmitter.

**4.2.5.9 Measures to be taken after Monitoring Systems "1" or "2" have responded**

After a fault has been signalized via one of the floating relay contacts, the cause of the disturbance must be found out. If the fault is found to be e.g. in one of the synchro repeater compasses (fault diagnosis: short-circuit due to humidity), first the fault is to be eliminated. Subsequently, the heading indications of all connected synchro repeaters are to be checked and, if required, synchronized with the course indication of the gyro compass.
### Technical Data of the Amplifier PCB

**Mains supply:** Centre feed, 2 x 25V, 50Hz or 60Hz

**Distortion factor:** ≤10%

**Tolerance:** in accordance with GL regulation

**Ambient temperature:** -10°C ... +55°C

2 amplifier inputs
(for synthetic drive signal S1 + S3)

- **Input:** 5V, 50Hz or 60Hz (signal from signal electronics)

**Amplifier output**

- **Output:** 20V, 50Hz or 60Hz, short-circuit-proof

**Input N–INI**

- **Input:** 10V ... 12V ... 24VDC (undisturbed)
- **Input:** 0V ... 0,1VDC (disturbed operation)
  (voltages referred to ground)

**Monitoring "1"**

- **Signalling:**
  a) Overtemperature
  b) External fault signal via N–INI
  c) Fuse failure E1

**Signalling output**

- **Output:** 24VDC / 100mA (no separate potential)

**Monitoring "2"**

- **Signalling:** Overcurrent of final stage transistor

**Signalling output**

- **Output:** 24VDC / 60mA (no separate potential)

**Load capacity:**

A maximum of 12 repeater compasses (for synchro course signal) can be connected; 7 are individually fused with their rotor sides via 1 fuse (E2 ... E8) each, and further 5 can be connected to the distribution.
### Test List for the Amplifier PCB (Booster), Type 132–338

**Meters:**
- Multimeter, internal resistance $R_i \geq 20\text{kOhm/V}$
- Oscilloscope, probe 10:1 ($C \leq 10\text{ pF}$)

<table>
<thead>
<tr>
<th>Test Point: TP</th>
<th>Measurement</th>
<th>Measured Value</th>
<th>Conditions/Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ 4</td>
<td>Supply</td>
<td>+34V DC</td>
<td></td>
</tr>
<tr>
<td>- 5</td>
<td>Supply</td>
<td>+15V DC</td>
<td></td>
</tr>
<tr>
<td>+ 6</td>
<td>Supply</td>
<td>-15V DC</td>
<td></td>
</tr>
<tr>
<td>- 7</td>
<td>Supply</td>
<td>-34V DC</td>
<td></td>
</tr>
<tr>
<td>+ 3</td>
<td>Status of monitoring</td>
<td>+8V DC to +14V DC</td>
<td>approx. +1V DC</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No fault</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fault; e.g.: signal electronics drawn out, overcurrent of outputs</td>
</tr>
<tr>
<td>+ 1, 2</td>
<td>Pre-stage outputs</td>
<td>2V AC to 10V AC</td>
<td>Voltage level dependent on angular value and on output load</td>
</tr>
<tr>
<td>+ 8 or 9 or 8</td>
<td>Rotary-phase output voltages of the booster</td>
<td>14V AC mean value</td>
<td>Follow-up switch of compass at Pos. &quot;T&quot;, follow-up system is turning quickly</td>
</tr>
<tr>
<td>+ 9</td>
<td></td>
<td></td>
<td>Dependent on course value: 0V AC up to 20V AC</td>
</tr>
<tr>
<td>+ 8</td>
<td></td>
<td></td>
<td>Follow-up system not turning or turning very slowly</td>
</tr>
</tbody>
</table>
## Test List for the Amplifier PCB (Booster), Type 132-361

**Meters:**
- Multimeter, internal resistance $R_i \geq 20\, \text{kOhm/V}$
- Oscilloscope, probe 10:1 ($C \leq 10\, \text{pF}$)

<table>
<thead>
<tr>
<th>Test Point: TP</th>
<th>Measurement</th>
<th>Measured Value</th>
<th>Conditions/Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>+  5   4</td>
<td>Supply</td>
<td>$+34, \text{V}_{\text{DC}}$</td>
<td></td>
</tr>
<tr>
<td>6  4</td>
<td>Supply</td>
<td>$+24, \text{V}_{\text{DC}}$</td>
<td></td>
</tr>
<tr>
<td>7  4</td>
<td>Supply</td>
<td>$+15, \text{V}_{\text{DC}}$</td>
<td></td>
</tr>
<tr>
<td>8  4</td>
<td>Supply</td>
<td>$-15, \text{V}_{\text{DC}}$</td>
<td></td>
</tr>
<tr>
<td>9  4</td>
<td>Supply</td>
<td>$-34, \text{V}_{\text{DC}}$</td>
<td></td>
</tr>
<tr>
<td>-  1  4</td>
<td>Status of monitoring</td>
<td>$+8, \text{V}<em>{\text{DC}}$ to $+14, \text{V}</em>{\text{DC}}$</td>
<td>No fault</td>
</tr>
<tr>
<td></td>
<td>approx. $+1, \text{V}_{\text{DC}}$</td>
<td></td>
<td>Fault; e.g.: signal electronics drawn out, overcurrent of outputs</td>
</tr>
<tr>
<td>+ or -  2  4</td>
<td>Rotary-phase output voltages of the booster</td>
<td>$14, \text{V}_{\text{AC}}$ mean value</td>
<td>Follow-up switch of the gyro compass in pos. 'T', follow-up system is turning quickly</td>
</tr>
<tr>
<td>or       3  4</td>
<td></td>
<td></td>
<td>Follow-up system not turning or turning very slowly</td>
</tr>
<tr>
<td>or       2  3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Fig. 4–8: Amplifier PCB (Booster), Type 132–338 - Components Diagram
Fig. 4–9: Amplifier PCB (Booster), Type 132–361 – Components Diagram
4.2.6 **Synchronization with STANDARD 20 Equipment**

Synchronizing corrections during operation are to be carried out on each repeater compass (see description of repeater compasses).
JUMPER PANELS ON POS.1

OPERATION
TEST FUNCTION SWITCHES LED NS1,52,53,55 ON; LED NS4 OFF

IN COURSE CONTACT 'SYSTEM DISTURBED', NORMALLY-OPEN CONTACT LEADS TO L6.1, STATUS TO L6.2
TRANSUDER CONTACT 'SYSTEM DISTURBED', NORMALLY-OPEN CONTACT LEADS TO L6.2, STATUS TO L6.1

OPERATION, LED NS4/REDI LIGHTS UP IN CASE OF DISTURBANCE (COARSE SIGNAL ERROR OR BOOSTER ERROR)
TEST, LED NS4 LIGHTS UP WITHOUT DISTURBANCE

OPERATION
RESET FUNCTION FOR RESETTING WARNINGS OR ERROR MESSAGES (PINS TO BE BRIDGED OVER AND TO BE OPENED AGAIN)

SPECIAL MEASURE

 Hierzu Pos. 15+16
Pos. 18+19 in Pos. 20 eingetötet

ACHTUNG

ZUR VERMEIDUNG BEI MANUELLER ELEKTRODOSIERSYSTEM ASSEMBLY DRAWING WITH CONFIGURATION/ ASSEMBLY DRAWING WITH CONFIGURATION/ ASSEMBLY DRAWING WITH CONFIGURATION/
COMPONENTS SIDE MODULE POS.2

JUMPER PANELS ON MODULE POS.2

- JUMPER INSERTED
- PANELS NOT FILLED IN
- NO JUMPER INSERTED
- SETTINGS DEPENDING ON ORDER
- STANDARD SETTINGS

RESET JUMPER, MUST ALWAYS BE INSERTED
RELEASE STATUS
TEST OPERATION, NO RELEASE

- DIP SWITCH ON
- PANELS NOT FILLED IN
- DIP SWITCH OFF
- SETTINGS DEPENDING ON ORDER
- STANDARD SETTINGS

DIP SWITCHES ON MODULE POS.2

OPERATION
- COURSE READ-IN, SERIAL, MAGN. ONLY
- COURSE READ-IN, SERIAL, SELECTION VIA OPERATOR UNIT
- COURSE READ-IN, SERIAL, SEQUENTIAL VIA OPERATOR UNIT
- DEFINES: GYRO OR MAGN.

TEST
- TEST FOR BALANCING, DEFINES SYNCHRO ZERO POSITION
- OUTPUT OF A RATE OF TURN FOR TESTING THE SYNCHRO OUTPUT

Raytheon Marine GmbH
Germany

132-620.HP104

AUTRAGS-NR.
FÜR SERVICE-GR.
ORDER NO.
FOR SERVICE GROUP:
132-620.104

CAD
HP 5042 2D

ALLGEMEINTEILE
ZU 2708
EINHEITEN

DATE
BEZEICH

1995
KEMMANN

D 3262-02 185805 KO
C 3165-02 01256 KE
B 2374-03 041065 KE
A 2342-09 218395 STE

CAD

AAC 2

ERS FÜR
ERS DURCH