



# ***Spherical Magnetic Compasses***

## ***Operation & Mounting***

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## How to Find and Read the Heading

### Attention!

A magnetic compass does not indicate the heading as to be found in the sea chart and as used for course planning. Read the following paragraph to be familiar with the different types of heading. Responsible navigation to grant maximum safety for crew and ship requires knowledge and consideration of the mentioned context.

### Glossary

- Compass heading: The heading as indicated by the magnetic compass.
- Magnetic heading: The direction of the earth's magnetic meridian. This is the compass heading after adjustment and applying of the residual deviation as shown in the steering table. The difference between compass and magnetic heading is the deviation. It reflects the influence of the vessel's interfering field.
- True heading: The direction as to be found in the sea chart and as used for navigation. This is the magnetic heading after applying the local variation and the drift. The difference between magnetic and true north is the local variation. It reflects the "north error" of the earth's magnetic field and depends on the position.
- Deviation: The compass indication error caused by interferences of the ship's own magnetic field.
- Local variation: The angle difference between geographic and magnetic north. Depends on the ships position.
- Compass adjustment: the correction of the ship's own interfering field.

The ship's heading has to be read at the main or ahead lubber mark of the compass. Additional lubber marks can be installed under 45°, 90° or ship's aft. When reading at these auxiliary lubber marks their direction (45° or 90°) has to be added (lubber mark on port side) or subtracted (lubber mark on starboard side). When reading the aft lubber mark add or subtract 180°.



Main (ahead) lubber mark

45° lubber mark: subtract 45° from 45° to get 000° ship's heading

Shadow pin

Groove within the compass cover ring for guidance of the hood

Each magnetic compass shows the direction of the magnetic field at the compass position. This direction can differ from the earth field direction because of the interfering magnetic field of the ship's hull or superstructure. The corresponding indication error is called deviation. The ship's interfering magnetic field has to be neutralised by the compass adjustment. A non-adjustable residual error of less than 2° may remain. This residual deviation differs from heading to heading, therefore a deviation or steering table comprises the numerical values or a graphic sketch of these errors. Applying these correction values to the adjusted compass heading gives the magnetic heading, the direction relative to magnetic north, to the direction of the earth field. The heading as required for navigation is the true or chart heading. This differs from the magnetic heading because magnetic north is different to geographic north. The difference depends on the actual position and is called local variation. One can find it in the sea chart of the operation region. For heading calculations the drift by stream and wind has to be applied additionally.

Detailed explanations how to calculate the true heading from the compass heading can be found in the relevant nautical literature.

## Shadow Pin

Only the yachting types of compasses with 5° card division are equipped with a shadow pin axial to the card assembly.

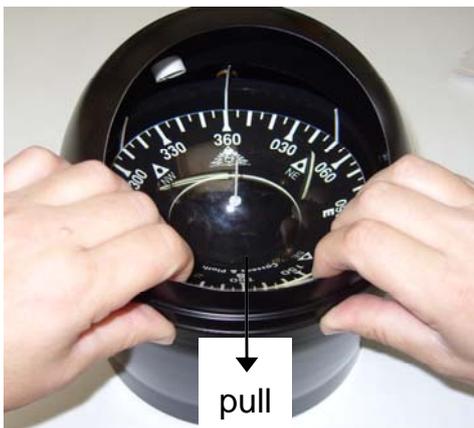
- This can be used for astronomical determination of the deviation. One has to compare the sun's azimuth (the direction to the sun) and the direction of the sun shadow on the compass card (minus 180°). A detailed description can be found in the relevant nautical literature.
- Rough bearings can be taken with it.

## Hood with Aperture

A hood with window is available as an option. It prevents glare on the polished glass surface and reduces heating of the compass fluid by direct sun radiation.

At the edge of the hood rivets are visible. These have to be caught by a corresponding groove in the upper ring of the compass (ref. to illustration above). To install the hood proceed as follows:

1. Snap the rivets opposite of the aperture into the groove of the compass cover ring.
2. Pull the lower edge of the aperture to your direction (as seen in the illustration below) and snap it into the groove of compass cover ring.



**How to remove or install the hood**

## Location of Compass - Magnetic Aspects

The indication of magnetic compasses is deflected by the interfering fields of the vessel. Contrary to a popular opinion there is no way to shield these interfering fields by metal sheets or similar gadgets.

One has to distinguish between two sources of interfering fields:

1. The ship's own magnetic field from hull or superstructure,
2. the field of electric/electronic instruments.

Ad 1. The distance to any magnetic iron should be not less than 50 cm. Higher values of 1 m or 1.5 m are valid for professional ships. Furthermore, magnetic compasses cannot be installed within the closed shielding iron superstructure or hull.

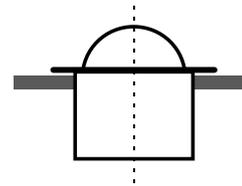
Even if both conditions are fulfilled interfering fields may deflect the compass card. This deviation has to be adjusted by magnets suitably arranged in the neighbourhood of the compass to neutralize the interfering fields.

Ad 2. These are generally variable fields caused by electric motors of the window wipers, radar antennas, echo sounders or similar instruments. So an adjustment with (fixed) magnets is not possible. The only way to avoid deflection is to keep a suitable distance. In professional navigation each type instrument of the bridge inventory has to be measured magnetically and marked with the magnetic compass safe distance. If this is not done as often for yachting instruments, contact the manufacturer.

To give general distances is very difficult because of the large number of the various instruments. To electric motors, for example, a distance between 1.5 ... 2 m is necessary and to loudspeakers, 1 m.

## Installation

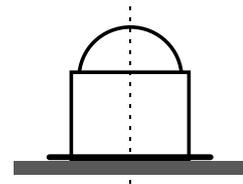
**Built-in Compass:** Cut a hole into the deck or desk to insert the compass. Choose a hole diameter as follows: ZETA 1: 146 mm; DELTA 1: 182 mm; BETA 1 and T12: 210 mm. Insert the compass, main or ahead lubber mark in ahead direction. Fix it temporarily by using the oblong holes of the flange outside the binnacle.



The screws are not included in the range of delivery. Use nonmagnetic screws only! Now adjust the ahead lubber mark to show exactly in ahead direction of the vessel by bearing. This alignment (also called A-error adjustment) alternatively can be done during compass adjustment (ref. to paragraph "Deviation & Compass Adjustment"). Finally fix the compass.

**Set-up compass with flange inside:** Remove the compass from compass binnacle by loosening the screws as illustrated below. **The screws visible from above the compass are to close the compass. Unscrewing will cause leakage and loss of compass fluid!** Mark ahead orientation of compass and binnacle and fix the binnacle temporarily by using the oblong holes inside the binnacle. The screws are not included in the range of delivery. Use nonmagnetic screws only! Now adjust the main or ahead lubber mark to show exactly in ahead direction of the vessel by bearing. This alignment (also called A-error adjustment) alternatively can be done during compass adjustment (ref. to paragraph "Deviation & Compass Adjustment"). Finally fix the binnacle.

Set-up compass with flange outside: Orientate the compass so that the main lubber mark points in ahead direction of the vessel. Fix it temporarily by using the oblong holes in the outside flange. Now adjust the ahead lubber mark to show exactly in ahead direction by bearing. This alignment (also called A-error adjustment) can alternatively be done during compass adjustment (ref. to paragraph "Deviation & Compass Adjustment"). Finally fix the binnacle.



**Separate set-up type compass from binnacle with inside flange**

**8 Screws to open the compass.  
Do not unscrew!**

4 Screws to separate compass from binnacle



**Separate set-up type compass from binnacle with inside flange**

Main or ahead lubber mark

Compass bowl

Inside mounting flange

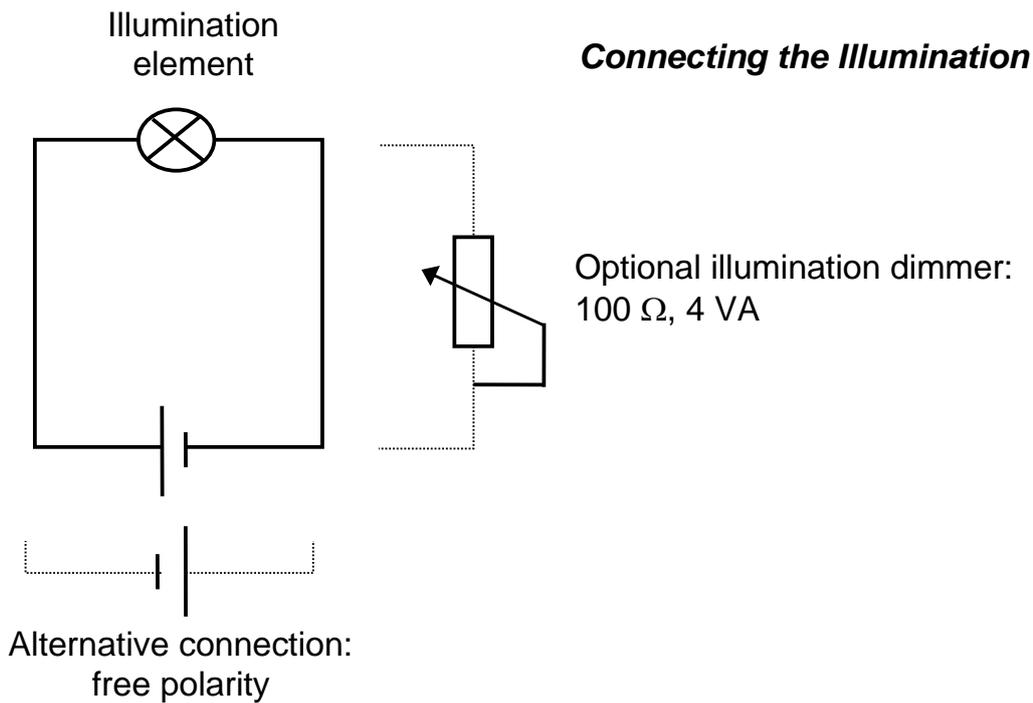
B-corrector bar, optional

Compass binnacle or external bowl

## Illumination

Required voltage: 12 or 24 VDC (as stated with order). The 24 V element is marked by a red dot. Connect cable and battery according to scetch below. The choice of polarity is free because a glow lamp is used. For dimming a rheostat potentiometer can be switched into the circuit.

A spare illumination element consists of a watertight capsuled bulb with cable. This can be fixed on the glass dome by a glue tape at a position most convenient. In case of order of a spare illumination element indicate type of compass and ship's voltage.



## Replacement of the Illumination Element

Glue light element at a position most convenient for your reading

## Deviation & Compass Adjustment

Correctors are not included in the standard range of delivery. They have to be ordered separately with the compass, because they have to be fixed at the compass in our workshop. A detailed description how to use the correctors will be included in the delivery.

The heading indication of magnetic compasses on steel ships is deflected from magnetic north by the magnetic iron in the neighbourhood of the compass. This error -the deviation- depends on the heading: on some headings the deviation is large and on others small, on some it is negative and on others positive. For correction the compass adjustment has to be carried out. This cannot be done at the factory because the error reflects the influence of the vessel only.

For compass adjustment the following correctors are used:

- B+C neutralise the permanent longitudinal and cross ship magnetic field,
- the heeling corrector neutralise the permanent vertical field (errors are only visible under heeling)
- and the the D-corrector neutralise the weak iron influence.

On private motor and sailing yachts with magnetic iron steel hull or superstructure B+C-correctors are recommended, heeling correctors are additionally recommended on sailing yachts. D-correctors on private yachts are not so often used although the deviation can amount up to 10°. On professional ships all correctors have to be installed. The responsible authority will give further details.

Compass adjustment should be carried out by professional compass adjuster only. One can find one in all major harbours. In case of problems ask the port captain or the maritime authority.

Adjustment should not be done by laymen, because the knowledge of the magnetic influences is very complex and the life of the crew and the safety of the ship depends on reliable adjustment.

A straight line between main lubber mark and card centre of the compass must be parallel to the centre line of the vessel. This means that the lubber mark must be adjusted exactly in ahead direction. If this alignment adjustment is not possible visually, an analysis of the deviation or steering table will reveal this so-called A-error. It can be found as the averaged deviation on all cardinal and intercardinal headings. The A-error alignment correction is part of the compass adjustment.

Since the deviation alters with time it has to be checked from time to time. If necessary, a re-adjustment has to be carried out. Also melting works, lightning struck, collision and grounding change the ship's field and may make necessary a re-adjustment.

An outline of the adjustment procedure will be found in: U.S. Defense Mapping Agency Pub. 226, "Handbook of Compass Adjustment".

### Errors and Maintenance

The card assembly of magnetic compasses rests on a jewel with its pivot. The contact area is very small to reduce any friction. Strong vibrations or long term use may wear out the pivot's point. Then it has to be replaced by a new one in a special compass work shop. This is a routine service.

- One can recognize a defective pivot as follows: Place the compass in front of you and allow the card assembly to stabilize its movement. Read the heading. Now take a small piece of magnetic material like a key and deflect the card by approximately  $2^\circ$ . Stabilize the card in this new direction. Now quickly pull away the deflecting piece from the compass. Watch the settling of the card on the original undeflected direction. If the original direction is reached within a tolerance of  $\pm 0.5^\circ$ , the pivot/jewel suspension is intact. Carry out this test in different orientations, the tolerance has to be kept in all directions. If not, replace the pivot in a qualified compass work shop.

**Repeat this check periodically to assure accurate operation of the compass!**

- Bubbles in the compass fluid can be caused by a leaking compass bowl, defective gaskets etc. Air transportation may also cause bubbles because of the low atmospheric pressure. These bubbles will usually disappear after some time. Bubbles do not disturb the indication of the compass as long as their volume is less than approximately  $1 \dots 2 \text{ cm}^3$ . If the bubbles are of larger volume a work shop should be contacted. As a temporary measure, the fluid can be completed on board as follows: Remove the compass binnacle (ref. to illustration "Separate set-up type compass from binnacle with inside flange"). The binnacle of built-in compasses can be removed in the same way. Now the filling screw will be visible at the compass bowl. It has a 10 mm head. Orientate the filling screw upside. Open it and complete the missing fluid by using **distilled water or ethanol. Don't use oil or any other fluid!** This may destroy the compass or influence its dynamic behaviour! After such measure, contact a qualified compass work shop as soon as possible. If more than 20% of the fluid is missing use only the original Cassens & Plath compass fluid #39012.
- Cruising under different magnetic latitudes will cause different tilt of card assembly because of the different vertical field strength. A compass bought in the northern hemisphere will show a tilt of  $5^\circ$  in Australian waters. The south mark will be suppressed. Because of the magnifying glass dome this dip is visible especially on east or west headings. This tilt is only a cosmetic effect and does not impair the function of the compass.  
Furthermore a tilt can result from a strong unadjusted vertical field of the hull or a strong unadjusted heeling magnet below the compass. Remove the compass from its place or take out the heeling magnet. If the card returns to horizontal balance, carry out the heeling correction.  
Directional systems with a leaking float may also be inclined. If a tilt cannot be explained by different magnetic latitudes or a strong vertical field from the ship one has to assume a leakage. A leaking float also may be recognized by an extra strong inclination, by a moving of the lowest point, or if on the northern hemisphere, the north mark, and on the southern hemisphere, the south mark are not suppressed. A bubble in the fluid often shows a leaking card assembly. Call the next compass work shop for repair.



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