AUTONNIC

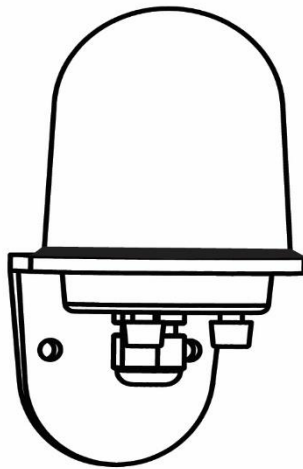# A5023 A5024 FLUXGATE COMPASS USER AND INSTALLATION MANUAL

A5023 A5024 manual 07.docx

Nov 2020

Software releases:

V017

Hardware versions:

7310-5

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Table of Contents

1. Introduction and description of fluxgate compass.

1.1 Description of compass.

The Autonnic NMEA IP68 compass unit is a complete component for a compass indicating system, RADAR 'North-up' input or autopilot. It is housed in a water-resistant enclosure, so it does not need to be protected from rain or spray. It delivers heading data in several industry-standard forms.

The A5023 and A5024 contain a fluxgate with floating core surrounded by high-precision interface circuits which, together with the special clockwise/anticlockwise and offset nulling sequence allow a microprocessor to acquire a binary value from two orthogonal sensors of the horizontal component of the Earth's magnetic field. The processor calculates the vector from these values, uses a calibration table to correct for local field disturbance errors, offsets the result and then presents the data in a manner which has been requested. Such requests alter the frequency of the data, the degree of filtering and the offset value. The devices feature auto-calibration.

1.2   Connections

1.2.1 A5024

Conductor	Colour	Type	Function
1	Red	P	+Supply 8-30v
2	Yellow	O	NMEA OUT+
3	Brown	I	NMEA IN-
4	White	I	NMEA IN+
5	Black	P	GND
6	Blue	O	Furuno AD-10 Clock
7	Violet	O	Furuno AD-10 Data
8	Green	P	GND
	Screen		Not connected
NOTE 1 Conductors 5 and 8 are connected together inside the A5024 NOTE 2 Wiring does not use the same colours as the A5023			

1.2.2 A5023

Conductor	Colour	Type	Function
1	Red	P	+ Supply 10-30V
2	Green	I	NMEA IN +
3	Yellow	I	NMEA IN -
4	Blue	O	NMEA OUT+
5	Screen	P	GND

1.2.3   Variants with suffix -CP

A5023

Conductor	Colour	Type	Function
1	Red	P	+ Supply
2	Green	I	NMEA IN +
3	Blue	P	GND and NMEA IN -
4	Yellow	O	NMEA OUT +
NOTE Cable foil and drain wire internally NOT connected to GND			

1.3   Switch Inputs
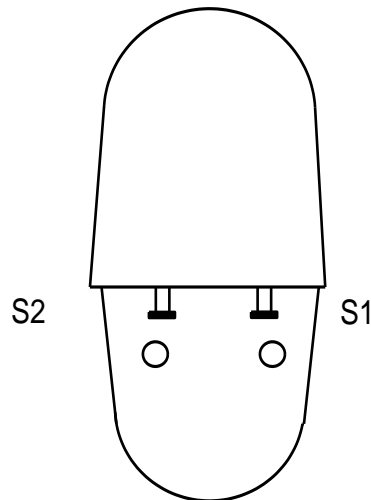

S2   S1

Fig 1

Except for variants with suffix -S, two push-button switches are provided for calibrating the compass in the field.

When the A5023-24 is viewed from the front face with the LED facing, then Switch 1 is on the right and Switch 2 is on the left.

1   Switch 1:   Start the auto-calibration process

2   Switch 2:   Set reference NORTH heading. The A5024/4 must be mounted upright but at any azimuth. Pressing S2 sets the heading to zero and so can be done when the whole installation is headed North.

3   Both together   Pressing both together for at least one second causes the auto-calibration process to halt and restores the previously saved calibration values.

1.4   Indicator light

A blue light indicates three states of the A5023-24.

State 1   Uncalibrated   long flash

State 2   In the process of calibration continuous

State 3   Calibrated   short flash

After the reset command, **$PATC,IIHDG,0CV<CR><LF>**, the compass is uncalibrated and will have a long flash.

Note that the LED can be turned off and on by the DLED command – see section 5.

1.5   Power supply

The compass is compatible with any DC power supply of between 8 and 30 Vdc. Typical supply current during operation is approx. 25mA. The compass is protected against reversed polarity.

Note that the operation of the LED adds another 10mA and that during auto-calibration the consumption can be as high as 60mA.

Care should be taken to make sure the compass is not situated too close to the power supply, as it's accuracy may be affected by either the iron in the mains transformer, or by magnetic field 'noise' from a switching power supply. It is not possible to cover all possible scenarios here, and it remains up to the user to determine the suitability of a possible location for the compass.

Note that the output takes several seconds to stabilize after a power is applied; the time taken depends on the damping settings. There is a command - see section 5 – which can be used to suppress the output after power-up.

1.6   Mounting

The compass is fixed to the chassis of the vessel or vehicle in the upright position using the fixing holes shown in the data sheet. It does not matter which way it faces as the azimuth can be set to North at any time the chassis is orientated North. Alternatively if the azimuth of the chassis is known, then the compass may be rotated before fixing to North using a protractor. S2 is then pressed and then the compass can be mounted on the chassis.

2 Connecting the compass to your application

2.1 Compass to a NMEA-0183 instrument

The hardware on which the NMEA-0183 standard is based on is a balanced serial protocol called RS422. This means that two wires are need for send and two for receive.

6 NMEA OUT +

5 GND

4 NMEA IN+

+

NMEA current
source

3 NMEA IN-

-

External NMEA device

Fig 2

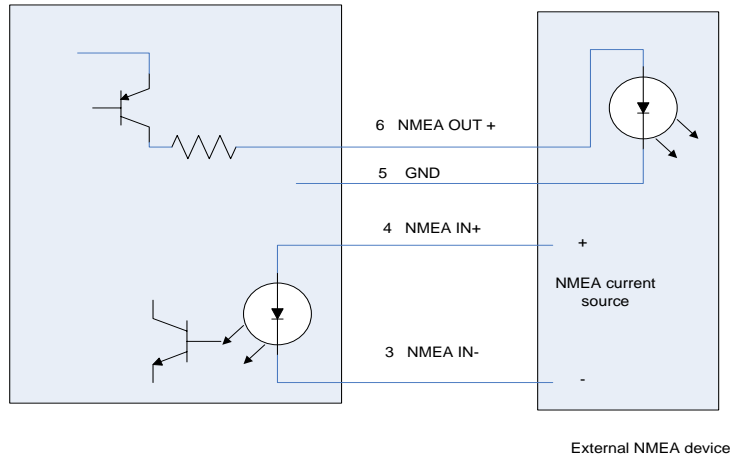Note that the GND wire is used for the current return path. This might be shared with the NMEA- wire in some installations.

2.2 Compass to a PC serial port

In many cases the wires can be joined directly as shown in Fig 2. Alternatively use the Autonnic A3036 serial interface unit.
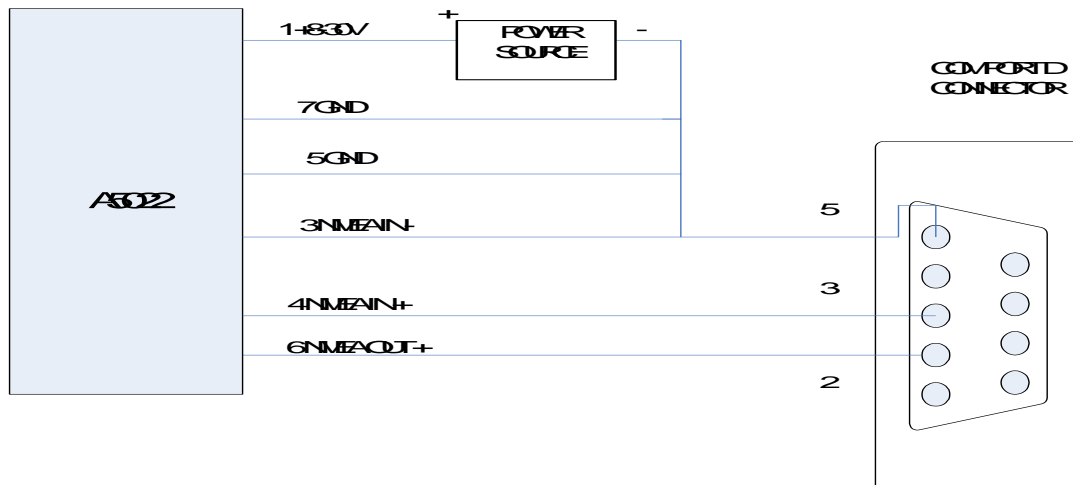

1 +8-30V

POWER
SOURCE

COMPORT D
CONNECTOR

7 GND

5 GND

A5022

3 NMEA IN-

5

3

4 NMEA IN+

6 NMEA OUT +

2

Fig 3

3 Output formats available from compass

3.1 NMEA-0183

The serial output format is: 4800 Baud, 8 data bits, 1 stop bit, no parity.

The compass sends information using the standard NMEA-0183 sentence 'HDG': Magnetic Heading, Deviation, and Variation. But note that the information of Deviation and Variation is not sent and so blank fields are defined by consecutive commas. In the A5024/4 the sentence may have one of several forms typically of the general form:

$HCHDG,hhh.h etc

Where hhh.h is the magnetic heading from 000.0 to 359.9 degrees

Also the Rate-of-turn data is sent either with or without the heading sentence.

For a complete list of output formats available see Section 5.11

3.2 Furuno AD-10 - A5024 only

The compass has a separate, dedicated output in Furuno AD-10 format. This is a proprietary 4 character serial format, which gives heading in degrees and tens of minutes. The string 0872 represents the heading 87° 20' so that the precision is to 1/6 of a degree. At the same time the A5024 would be also sending the NMEA data to a precision of 1/10 of a degree.
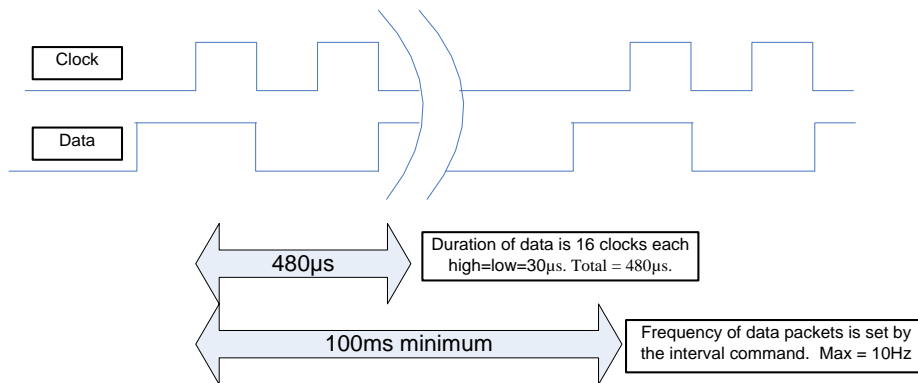

Clock

Data

480µs

Duration of data is 16 clocks each high=low=30µs. Total = 480µs.

100ms minimum

Frequency of data packets is set by the interval command. Max = 10Hz

Fig 4

4   Calibration

4.1   Why the compass needs calibrating

When any compass is installed the magnetic characteristics of the whole installation affect the way the Earth's field reaches the detector inside the device. Each individual installation will be different and so the A5023 and A5024 are equipped with an auto-calibration routine which corrects for these installation distortions.

4.2   Starting calibration

- A NMEA-0183 command can be sent to initiate the process – section 5.2.9

OR

- Switch 1 can be pressed.

There are two compass calibration techniques in common use:

1   Constant angular velocity

2   Double rotation without constant velocity.

The Autonnic compasses use the first method. The process consists of rotating the whole installation in the Earth's field so that both permanent magnets and induced magnets are corrected. The method used is the single turn at a constant rate and this rate should be in range 60 to 180 seconds for the full 400 degrees needed. The whole arrangement is turned at constant angular velocity because the method relies on applying a correction when the heading measured is uneven with time.

The second method is not used by us. Autonnic has evaluated the method which uses a mathematical model of an ideal compass and treats errors as arising from distortion due to magnetic objects. The ideal error plot of the field vector would be a circle with no offset from the origin. Permanent magnets ('hard') have the effect of shifting the centre from the origin and induced magnets ('soft') modify the circle into an ellipse. The results of

our investigation show that there is always a residual error due to the fact that real magnetic objects do not behave exactly according to the model outlined. Autonnic is aware that the need for a constant angular velocity is onerous but the benefit is that it provides a very low residual error – less than 0.5°.

Note that the calibration is different if the unit is mounted upside-down.

Calibration must always be done with the unit in its final mounted position. The essential point of the calibration is remove the influence of external magnetic components in the vicinity – the nearby pieces of iron and steel –so it is essential that these remain unchanged after calibration. If any significant iron component is altered – such as the installation of new equipment or replacement of equipment such as winches or engines – then the calibration must be re-done.

4.3   Terminating a bad calibration

If the process is faulty in any way – such as would happen if the manoeuvre cannot be completed, the process can be terminated by the NMEA command (see 5.2.17) and the original factory default (linear) table is restored. Alternatively, this can be done by pressing both Switches together for at least 1 second.

NOTE that there should be a delay of at least 5 seconds after termination before a new calibration process is initiated.

4.4   Setting reference NORTH heading

Switch 2 (and also a NMEA command) is provided to set 'zero'. The compass should

  a.   first be auto-calibrated
  b.   then be aligned to North

4.5   Set-up suggestions

When the device is fixed in place and connected it can be calibrated as described above. Choose a calm day and a region of water where there are no currents. Set the boat turning to left or right at a slow rate and fix the wheel or tiller. Then, when the turning is steadily under way, press the auto-calibrate button and watch the LED.

When calibration is completed the boat can be on its way and the next task is to set North. This is best done by identifying transits on a chart and heading the boat on the transit. Again, this should be done in the same conditions so that the heading can be lined up on the transit and maintained while the set-zero button is pressed.

5   NMEA-0183 commands

The compass can be configured by sending various proprietary sentences to its NMEA-0183 input. Once configured, the compass will remember those settings every time it is powered up.

Response:

When any of the input sentences are received the A5023 and A5024 will reply with an 'acknowledge' output sentence of the format:

$$\textbf{\$PATC,HCHDG,ACK<CR><LF>}$$

Unless the command results in response which contains data.

5.1 List of Commands

Section	Command	Function
5.2.1	0CV	Factory default: calibration values; fluxgate heading output rate; fluxgate damping factor; last calibration error code
5.2.2	AHD	Set heading offset
5.2.3	CEC	Read calibration error code
5.2.4	CFG	Configure NMEA sentence output format
5.2.5	DHD	Set heading damping value
5.2.6	DLED	Disable LED(s)
5.2.7	DLY	Set power up delay
5.2.8	ELED	Enable LED(s)
5.2.9	IAC	Initialise autocalibration
5.2.10	RCV	Read calibration values
5.2.11	RHD	Read heading damping value
5.2.12	RHO	Read heading offset
5.2.13	RID	Read device serial number
5.2.14	SR	Read software version
5.2.15	TXP	Set NMEA output period
5.2.16	UPLOAD	Enter bootloader
5.2.17	XCL	Abort autocalibration

5.2.1 $PATC,IIHDG,0CV<CR><LF>

Sets the following:

Output rate	u= 100 milliseconds (10 updates/second),
output damping	d= 50 percent
heading offset	f= 0 degrees.

5.2.2 $PATC,IIHDG,AHD,fff.f<CR><LF>

Set heading:

Forces the heading to a certain value by supplying an offset which is stored and used thereafter.

Where f is in degrees with a valid range of 000.0 to 359.9

When f = 000.0 the result is the same as pressing switch 2 – see 1.3.

5.2.3 $PATC,IIHDG,CEC<CR><LF>

Read calibration code

The response is a proprietary sentence containing a code, k, for the status:

$PATC,HCHDG,CEC,k<CR><LF>

Where k has the following values:

k=0   the last auto-calibration was successfully completed.

k=1   Resetting the calibration data to factory default was completed successfully.

k=2   The autocalibration has been aborted internally due to the rotation being too slow.

k=3   The autocalibration has been aborted internally due to the rotation being too fast.

k=4   The autocalibration has been aborted internally because of rotation inconsistency.

k=5   The autocalibration has been aborted by an external command.

5.2.4 $PATC,IIHDG,CFG,abc<CR><LF>

Configures the output sentence structure and type.

[Replies with the standard acknowledge sentence
$PATC,HCHDG,ACK<CR><LF>]

Where 'a' specifies the heading of the output sentence as follows:

a=0 : *$HCHDG,hhh.h,,,,,<CR><LF>*

a=1 : *$HCHDT,hhh.h,T<CR><LF>*

a=2 : *$HCHDM,hhh.h,M<CR><LF>*

a=3 : *$HCHCC,hhh.h<CR><LF>*

a=4 : *$HEHDT,hhh.h<CR><LF>*

a=5:   no heading data sent

hhh.h is the compass heading in degrees

(this compass heading field will be omitted when auto-calibration is in process)

and 'b' is sentence end structure as follows:

b=0 : direction sentence will NOT include checksum nor unit ID serial number.

      e.g. *$HCHDG,hhh.h,,,,,<CR><LF>*

b=1 : direction sentence will include a checksum.

      e.g. *$HCHDG,hhh.h,,,,,*cc<CR><LF>*   (cc is the checksum)

b=2 : include the serial number.

      e.g. *$HCHDG,hhh.h,,,,,*ssss<CR><LF>*   (ssss is the unit's serial number)

and where 'c' has the following significance:

c = 0 or is missing means   no ROT

c = 1   ROT with 8s average

c = 2   ROT with 16s average

c = 3   ROT with 32s average

The form of the transmitted sentence is:

$HFROT,zxxx.x,A*cc<CR><LF>

c = 4   ROT with 64s average

The form of the transmitted sentence is:

$HEROT,zxxx.x,A*cc<CR><LF>   (note the E)

 and where z = sign as follows:

        + (or missing) turning to starboard (i.e. heading value is increasing)

        -                        turning to port (i.e. heading value is decreasing)

and **cc** = checksum

xxx.x = Rate of Turn in degrees per minute

NOTE: The HEROT (or HFROT) sentence is transmitted every 2s regardless of the sentence rate set using the TXP command

5.2.5   **$PATC,IIHDG,DHD,ddd.d<CR><LF>**

Set the internal filtering: ('damping')

Valid range for d is 0 to 100.0%

5.2.6 $PATC,IIHDG,DLED<CR><LF>

Disable LED:

Replies with the standard acknowledge sentence ($PATC,HCHDG,ACK<CR><LF>).

Note : LED will be automatically enabled during calibration process.

5.2.7 $PATC,IIHDG,DLYn.n<CR><LF>

Startup Delay

Sets a delay from Power-up to the transmission of the first output sentence where n.n is in seconds with a maximum of 6.5

5.2.8 $PATC,IIHDG,ELED<CR><LF>

Enable LED:

Replies with the standard acknowledge sentence ($PATC,HCHDG,ACK<CR><LF>).

Default: LED enabled.

5.2.9 $PATC,IIHDG,IAC<CR><LF>

Start Auto-Calibration

Refer to section 4.2. Same as pressing Switch 1 – see 4.4.

5.2.10 $PATC,IIHDG,RCV<CR><LF>

This command is to read the calibration table values and the response is in the form of the example shown below:

$TCF,0,0000,071C,0E38,1554,
$TCF,1,1C70,238C,2AA8,31C4,
$TCF,2,38E0,3FFC,4718,4E34,
$TCF,3,5550,5C6C,6388,6AA4,
$TCF,4,71C0,78DC,7FF8,8714,
$TCF,5,8E30,954C,9C68,A384,
$TCF,6,AAA0,B1BC,B8D8,BFF4,
$TCF,7,C710,CE2C,D548,DC64,
$TCF,8,E380,EA9C,F1B8,F8D4,

5.2.11 $PATC,IIHDG,RHD,nn<CR><LF>

Internal filter response

Where nn is the damping value within the range 0 to 99

5.2.12 $PATC,IIHDG,RHO<CR><LF>

$PATC,IIHDG,RHO,nnn.n<CR><LF>

Where nnn.n is the heading offset **Note** that leading zeros are suppressed eg 0.0

5.2.13 $PATC,IIHDG,RID<CR><LF>

Request the serial number:

A special proprietary reply sentence follows:

$PATC,IIHDG,RID,ssss<CR><LF> where ssss is the serial number in ASCII decimal.

5.2.14 $SR <CR><LF>

Read device firmware release

A typical response from a unit is as follows:

$SR,A5024,016,02<CR><LF>

showing the release is 016.

5.2.15   **$PATC,IIHDG,TXP,uuuu<CR><LF>**

Set the Output update period:

Valid range is u=100 to 2500 milliseconds. This is limited by the maximum data rate of NMEA-0183 output at 4800 baud.

5.2.16   **UPLOAD**

This command is used by Autonnic's updater software which runs under Microsoft Windows. It is used to send **.aeh** files to install a new version of firmware.

5.2.17   **$PATC,IIHDG,XCL<CR><LF>**

Abort Auto-Calibration.

Refer to section 1.3.

6   References

1   A5023-24 data sheet
2   NMEA-0183 specification

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