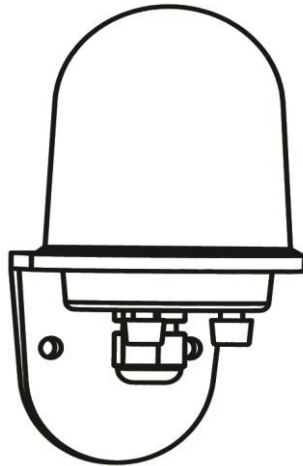


# AUTONNIC



## A5041 NMEA 0183 FLUXGATE GYRO COMPASS USER MANUAL

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# 1. Introduction and description of fluxgate compass.

## 1.1 Description of compass.

The Autonnac NMEA 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 can be mounted outside a steel hull. It delivers heading data in two industry-standard forms.

The A5041 contains 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 and then uses a calibration table to correct for local field disturbance errors so as to derive a value for Magnetic Heading.

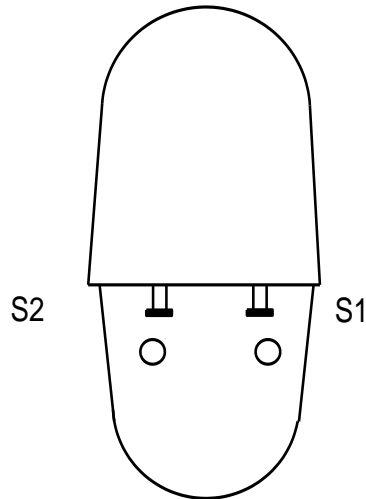
But the A5041 also contains a rotary accelerometer the output of which is a value of the rate-of-turn. The A5041 integrates this value so as to obtain a heading – but this heading has no absolute value and is subject to drift. Under steady conditions this value is ignored as having no validity but when the value is high it is taken as being the heading so that certain magnetic errors are corrected. These errors can occur at high rates-of-turn because the magnetic sensor is referenced to horizontal by gravity; but any sense of gravity is easily disturbed by rapid rotary movement when the centrifugal force makes the 'down' force vector point away from directly down.

By combining of magnetic long-term sensing and accelerometer sensing at high turn speed, the A5041 is able to present the most precise Heading Value and it does so in the manner which has been requested. Such requests alter the frequency of data presentation, the degree of filtering and the offset value. Calibration sequences can also be commanded.

## 1.2 Connections

1	Red	+10-30v
2	White	NMEA IN+
3	Brown	NMEA IN-
4	Black	GND
5	Green	GND
6	Yellow	NMEA OUT+
7	Blue	No Connection
8	Violet	No Connection
9		No Connection

### 1.3 Switch Inputs



**Fig 1**

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

When the A5041 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 A5041 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. (Equivalent to sending the XCL command – see section 5.2.)

### 1.4 Indicator light

A blue light indicates four states of the A5041 by the patterns of its flashing.

After the reset command, \$PATC,IIHDG,0CV<CR><LF>, the A5041 is uncalibrated and the blue indicator will show a VQF3 flash.

Note that the LED can be turned off and on by the DLED command – see section 5. The indicator can show the following patterns:

- 1 A double flash repeated means that the Fluxgate is calibrated
- 2 During the time it is calibrating it flashes
- 3 The flashes are grouped in threes when the Fluxgate is not calibrated. The A5041 is delivered uncalibrated because the prime source of error is the magnetic environment where it is installed.
- 4 A group of 4 flashes means that there is a fault; contact Autonnic if this occurs.

## 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 from the A5041 takes several seconds to stabilize after a power is applied; the time taken depends on the damping settings. We advise waiting 10s for the output to be reliable.

## 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 A5041 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 NMEA-0183 standard is a balanced serial protocol which means that two wires are needed for send and two for receive. But many installations use the Ground wire(s) for one of the pair. Autonic provides only NMEA OUT+ so all connections which involve the other wire need to be connected to Ground – as shown in Fig 2.

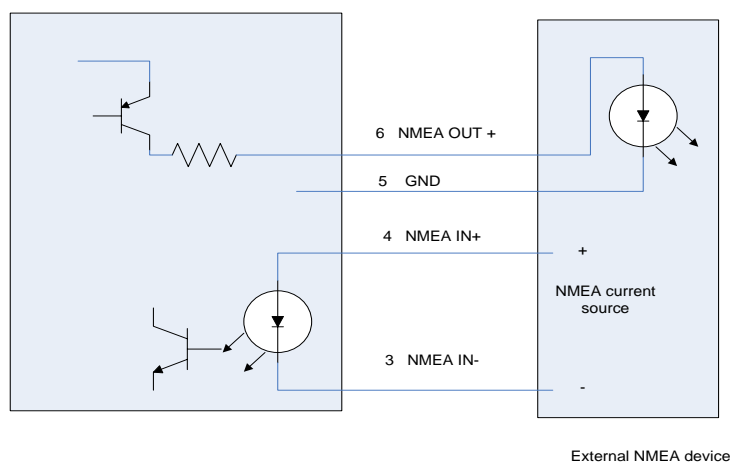


Fig 2

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.

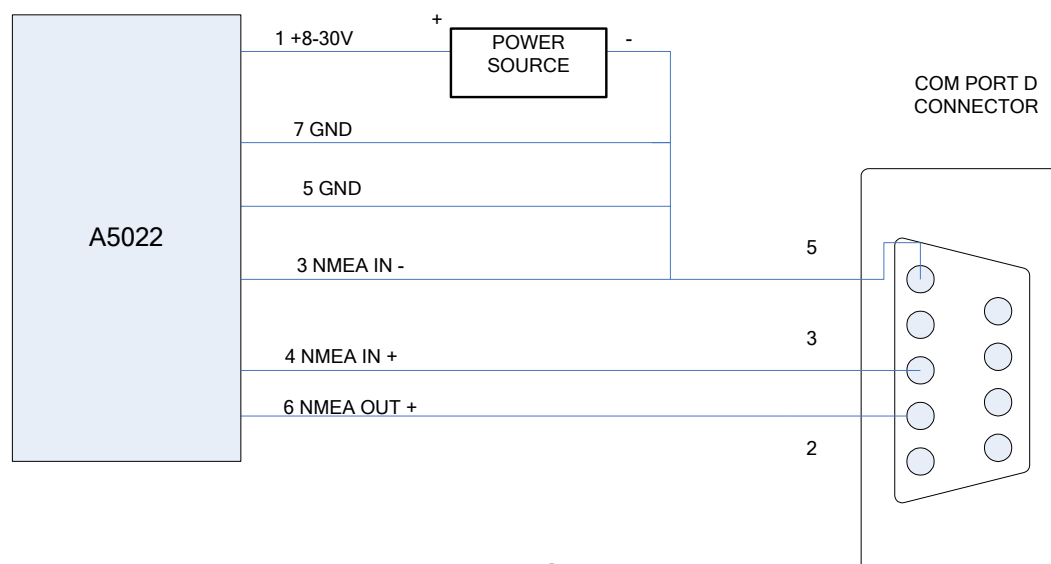


Fig 3

## 3 Output formats available from compass

### 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 A5041 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**

### 3.2 Furuno AD-10

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  $87^{\circ} 20'$  so that the precision is to 1/6 of a degree. At the same time the A5041 would be also sending the NMEA data to a precision of 1/10 of a degree.

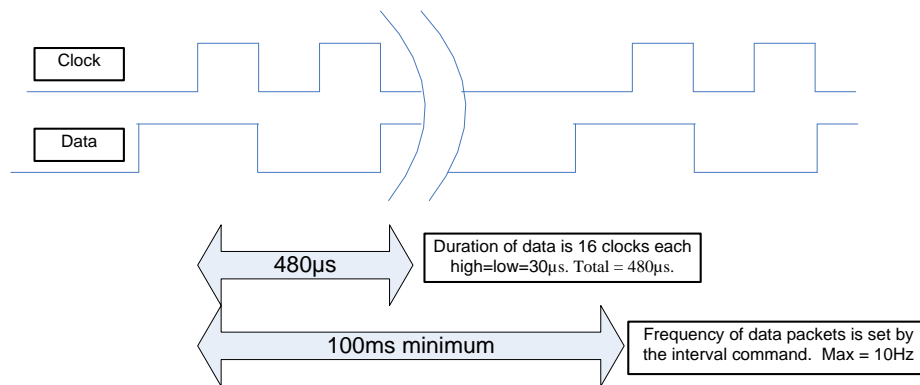


Fig 4

## 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 A5041 is equipped with an auto-calibration routine which corrects for these installation distortions.

In addition, the gyro compass needs to have its gyro calibrated as sensitivity differs from device to device.

### 4.2 Starting magnetic calibration

- A NMEA-0183 command can be sent to initiate the process.
- OR
- Switch 1 can be pressed to start it.

There are two compass calibration techniques in common use:

- 1 Constant angular velocity
- 2 Double rotation without constant velocity.

The A5041 uses 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 in the A5041. 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 listed 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 is provided to set 'zero'. The A5041 should

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

There is also a NMEA command which can set any angle – including zero – which is detailed in 5.1.

### **4.5 Set-up suggestions**

When the A5041 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.

### **4.6 Gyro Calibration**

There is a factory only command to calibrate the gyro and it is not published.

## 5 NMEA-0183 Command List

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 following input sentences are received the A5041 will reply with an 'acknowledge' output sentence of the format:

**\$PATC,HCHDG,ACK<CR><LF>**

except where noted to be different.

### 5.1 AHD - Set heading in degrees

**\$PATC , I IHDG , AHD , f f f . f <CR><LF>**

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.

### 5.2 DHD - Set heading damping

**\$PATC , I IHDG , DHD , d d d . d <CR><LF>**

The valid range for ddd.d is 0 to 100.0

### 5.3 TXP - Set the Output data transmission period in mS

**\$PATC , I IHDG , TXP , u u u u <CR><LF>**

where uuuu= Range - 0100 to 2500ms Note: The minimum resolution -is 10ms so the last digit must always be 0.

### 5.4 IAC - Start auto direction calibration

**\$PATC , I IHDG , IAC <CR><LF>**

This command has the same result as pressing Button 1

### 5.5 XCL - Abort auto direction calibration

**\$PATC , I IHDG , XCL<CR><LF>**

### 5.6 0CV – Restore all Factory Data

This command should never be used. It is for factory use only and we show what it does because other instruments have this command and someone might try it. It is strongly NOT advised because it reset all parameters including the gyro calibration which is difficult to reset.

**\$PATC , I IHDG , 0CV<CR><LF>**

### 5.7 RID - Reads the Serial number

**\$PATC , I IHDG , RID<CR><LF>**

The response is

**\$PATC , I IHDG , RID , sssss<CR><LF>**

where sssss is the serial number in ASCII decimal.

Note: if no Serial Number has been set the unit will return 00000.

### 5.8 CFG - Configure Output sentences

**\$PATC , I IHDG , CFG , abc<CR><LF>**

Note:

There must be three characters

Ranges:     a = 0 to 5  
              b = 0 to 2  
              c = 0 to 4

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

Where 'a' is heading sentence type 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 , , , , \*sssss <CR><LF>* (sssss is the unit's serial number)

and where 'c' has the following significance about Rate of Turn information (ROT):

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  
c = 4 ROT with 64s average

The form of the transmitted sentence is:

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

Except when a=4 when the form is

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

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

## 5.9 ELED - Enable LED Flash

**\$PATC , I IH DG , ELED <CR><LF>**

Replies with the standard acknowledge sentence (**\$PATC , HCH DG , ACK <CR><LF>**).  
Default: LED enabled.

## 5.10 DLED - Disable LED Flash

**\$PATC , I IH DG , DLED <CR><LF>**

Replies with the standard acknowledge sentence (**\$PATC , HCH DG , ACK <CR><LF>**).

## 5.11 SR - Read device firmware version

**\$SR <CR><LF>**

The unit responds as follows:

**\$SR , A5041 , 016 , 02 <CR><LF>** .

## 6 References

- 1 A5041 data sheet
- 2 NMEA-0183 specification

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