

# ELECTRONIC NAVIGATION CONSOLE

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**Quick User Guide** 

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# 1. Introduction

The new version of the firmware for the ENC consoles, released in January 2021, introduces series of new features, allowing for even easier and more precise usage of ENC.

Relevant software versions described in this document are: ENC2- 1.6.6, ENC3- 1.7.6

This document **only describes new and changed software components** and is a **supplement** to the instructions for the previous firmware versions, and general ENC2 and ENC3 manuals.

# 2. Changes list

Compared previous firmware, the new versions introduces the following changes:

#### Changed elements :

- Improved efficiency and accuracy of compass calibration
- Changed appearance of the speed sensor/ "log" settings screen
- The declination and deviation of the compass are set with an accuracy of 0.1 degree
- Minor bugs found in connection between the console and the PC / Android program have been fixed

#### New added elements :

- Auto-REC option automatic recording activation while swimming
- Auto-HOLD option automatic stopping of recording while movement stops
- Auto + marker option automatic adding of a marker (marker) when Auto-HOLD is on
- Deep sleep option saving battery when the device is not used for a long time
- Disable GPS option resignation from using the built-in GPS receiver
- Option to manually enter the log calibration factor

- Precise **setting of the angle** at which the ENC console is mounted relative to the scooter hull (Install angle parameter). This parameter has to be set in order to allow for ENC precise navigation.

- The ability to display data directly from the sensors of the device: **accelerometer**, **magnetometer** and **gyroscope** - for diagnostic purposes.

# 3. New settings (Other options)

The additional settings screen (MENU  $\rightarrow$  SETUP  $\rightarrow$  Other) is divided into 2 parts.

The first part of the screen shows the current settings: Backlight, Record every, Depth tresh. (...old), Auto-ON and Auto-OFF.

Their meaning has not changed. The upper button goes through all these options one after the other, and then the next screen is displayed.

The lower button allows - as on the previous screen - to cyclically change the highlighted value.

The second part of the additional settings includes newly introduced options that will be discussed later in this manual.



First part of settings screen

Other options 2	2/2
Auto-REC	yes
Auto-HOLD	yes
Auto+marker	no
Deep sleep	no
Disable GPS	no
	ł

Second part of settings screen

# 4. 'Auto-REC' option

Possible settings: enabled (yes) or disabled (no).

The option is enabled by default.

When Auto-REC is off, the ENC console functions as it did in the previous software version. User must manually start data recording (lower button on the main screen with compass) to save information.

When Auto-REC is enabled, the ENC console will automatically detect when data recording should begin

Automatic start of data recording will start if **all** of the following conditions are met **simultaneously**:

- the ENC console is submerged to a depth at least equal to **Depth tresh.** (available on the first screen of additional settings)

- Speed sensor detects water flow of at least 8 m / min for a minimum duration of 1.2 seconds. The flow must not be interrupted (no velocity decays)

- the main console screen is currently displayed (the one with the large arrow)

The Auto-REC option is responsible only for starting data recording automatically.

# 5. 'Auto-HOLD' option

Possible settings: enabled (yes) or disabled (no).

The option is enabled by default.

When Auto-HOLD is off, the ENC console functions as before. Requires manual stopping of data recording by the user (lower button on the main screen with compass)

When Auto-HOLD is turned on, the ENC console will automatically stop writing data.

Automatic interruption of data recording will occur if at least one of the following conditions is met:

- the depth measured by the ENC console has decreased to 0.2 meters or less

- speed measured by speed sensor has dropped **below 6 m / min** and remains so for at least 1.2 seconds (without momentary speed increases)

The Auto-HOLD function is responsible **only for stopping the recording** and works regardless of the current content of the device screen.

#### Warning



The Auto-REC and Auto-HOLD options have lower priority than the REC and HOLD commands issued by the user. Thus, any REC / HOLD command activated by pressing a button on the ENC console will lock Auto-REC and Auto-HOLD for only 15 seconds. During these 15 seconds, the REC or HOLD state will remain as manually set by the user. After 15 seconds, if the Auto-REC and Auto-HOLD functions are not turned off, the data recording status will be determined automatically again.

#### Warning



When recording (REC mode) is turned on - by user command or automatic mechanism - the device continuously calculates position and displacement based on information from the compass and log. When the recording is not started or when it is interrupted (HOLD mode), calculations are stopped (the position in space does not change). When at this point the user moves, the memory of the device will no longer correspond to the actual course of the dive. This can cause errors that are difficult to detect, including the inability to return to the starting point basing on ENC console readings.

#### Warning



The Auto-REC and Auto-HOLD options control recording only when the ENC console is enabled to use a speed sensor to measure the distance traveled (MENU  $\rightarrow$  SETUP  $\rightarrow$  Log / Speed = External log). If the external log is turned off (MENU  $\rightarrow$  SETUP  $\rightarrow$  Log / Speed = Const. Speed), then the Auto-REC, Auto-HOLD and Auto + marker settings will be kept, but their description will be displayed in gray, and an attempt to change them will trigger the message " Option currently not available "

# 6. 'Auto+marker' option

Possible settings: enabled (yes) or disabled (no).

The option is disabled by default.

The ENC console has a built-in mechanism for writing markers. A marker is an additional "highlight" associated with a point on a recorded route. By default, each time you stop recording manually (with the button on the console), the device saves the current marker number in the memory and increases its number by a value of 1 until it reaches 99.

If Auto + marker is turned off, markers will only be saved when you stop recording manually.

When the Auto + marker option is turned on, stopping the recording due to the Auto-HOLD option will cause saving and increasing the marker number. If Auto-HOLD is turned off, Auto + Marker does not work.

# 7. 'Deep sleep' option

Possible settings: enabled (yes) or disabled (no).

The option is disabled by default.

The ENC console periodically measures barometric pressure, even when turned off. This is necessary for the precise calculation of the underwater depth. However, even brief partial wake-ups of the console causes the drain on internal battery power, so even a fully charged ENC console needs to be recharged after about 3-4 months of non-use.

When we enable the **Deep sleep** option, periodic measurements of atmospheric pressure will not be performed.

It should be remembered that in a few unfavorable cases, the accuracy of the depth calculations may deteriorate. The maximum error of the depth calculation may increase to even 0.8 m, while without saving energy, this error remains in the range of 0.2-0.4 m.

Thanks to the **Deep sleep** option, the energy consumption of the ENC console during shutdown decreases about 2.5 times, so a fully charged device will maintain the state of charge for up to about 9 months (estimated).

### Warning



If you plan to stop diving for a long time, it is recommended that this option be turned on (yes). If you are moving to a different geographic area and intending to dive there, it is recommended that **Deep sleep** be set to 'no'.

# 8. 'Disable GPS' option

The ENC console has a built-in GPS receiver that works continuously on the surface (when the calculated depth is 0.1 meters or less). The operation of the GPS receiver increases the consumption of battery power while it is **on** (active).

There are cases where receiving a GPS signal is inherently impossible (e.g. inside caves), so keeping the receiver on is an unnecessary waste of energy.

If **Disable GPS** is set to **yes**, the GPS receiver will remain off all the time, regardless of the depth. This will allow the ENC console to work on the surface for approx. 20% longer.

#### Warning



Turning off the GPS receiver completely causes its icon to disappear from the main navigation screen.

Attempting to enter the detailed information on GPS status (MENU  $\rightarrow$  SETUP  $\rightarrow$  GPS) will display the message "Option currently not available"

# 9. New compass settings screen

The ENC compass settings screen, accessible by selecting  $MENU \rightarrow SETUP \rightarrow Compass$ , looks like the picture below :



Compass settings screen

White text highlighting indicates the currently selected item.

On the left side there is a text description of the function or parameter.

The right side shows information about the function or the parameter value.

**Calibration** - these are functions related to compass calibration. The information on the right is the time that has elapsed since the last calibration (in minutes, hours, days or '> 1y' if the time is greater than 1 year). The exact content of the compass calibration menu is shown in the next section of the manual.

**Geometry** - is a screen of precise compass readings corrections. The operation of this function has not changed compared to the previous version of the program.

**Install angle** - is the value of the ENC console installation angle relative to the scooter hull. Details on this setting will be described in the next section of this manual.

**Declination** - the compass declination value expressed in degrees. Alignment accuracy has been increased to tenths of a degree. A positive value of this coefficient means eastern (E) declination, and negative - western (W).

Deviation - compass deviation (constant error) expressed in degrees.

# 10. New compass calibration menu

After selecting **MENU**  $\rightarrow$  **SETUP**  $\rightarrow$  **Compass**  $\rightarrow$  **Calibration**, we will be moved to the next menu, containing information and commands for calibrating the compass. The screen is shown on the pictures below: :



Compass calibration - current values



Compass calibration – previous calibration values

The compass calibration current values contain the following information:

Age - calibration age (time elapsed since the last calibration). NOTE - if the clock is or was incorrectly set during calibration, the indication may be incorrect.

**Match** - estimated quality of performed calibration. A value below 80% may indicate a device fault or external interference during calibration. The ideal calibration should be 92-95% of this parameter.

**Field** - the length of the magnetic field vector at the calibration site. The value is expressed in microtesla (uT). The correct value of the magnetic field strength can be found using, for example, this website:

https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml#igrfwmm

If the value given by the ENC in this field differs by more than 10% from the expected value of the field strength (given by the online calculator), we have reason to assume that the calibration has been disturbed or there are local magnetic anomalies at the calibration site.

X, Y, Z - exact values of the magnetometer calibration coefficients. You can use them for comparison purposes (for subsequent calibrations)

The values in the factory calibration screen have the same meaning but refer to the settings that the device received at the time of manufacture (can be used for comparison).

#### Warning



Factory calibration may or may not be effective for the user's current location. In the lowest line of the screen, in green, hints for each highlighted function are displayed.

When Current is highlighted, pressing the new button starts the compass calibration process.

When the **Previous** field is highlighted, we can see the calibration settings that the console had previously. The device stores one previous compass calibration in its memory. Pressing the lower button when the Previous field is highlighted will cause the current compass calibration to take the values saved previously (e.g. from a month or a week ago)

When the **Factory** field is highlighted, we see the factory calibration properties. These are the parameters that the device had when the factory tests were carried out. Pressing the console's lower button while Factory is highlighted will restore the compass to factory calibration.

## Warning



Restoring the factory calibration of the compass makes sense only in one case - if our device does not work properly and we cannot deal with it ourselves.

Factory calibration is correct for the place where the device was manufactured. In another part of the world, the readings of such a calibrated compass may differ significantly from the correct values.

If the compass still does not work after factory calibration has been restored - e.g. shows only one value or it only changes by a few degrees - it means a defect in the device that can only be diagnosed by factory service.

If a factory reset of the compass has made it unblocked, try a regular calibration to get the best readings.



While calibrating the compass, you should slowly- without rapid movements- turn it in all possible directions ("tilting the eighths while turning around"). The screen displayed during this operation has not changed from the previous version. The only addition is the digital "calibration progress percentage" indicator that appears at the bottom left of the screen.

However, the internal procedure for obtaining compass calibration data completely changes.

Previously, calibration was simply measured by its duration. It was up to the diligence of the user whether after the calibration was completed its result would be good or not.

In the current software version, an advanced algorithm analyzes the operations performed by the user while calibrating the device. The progress bar and digital indicator on the screen reflect the actual operation progress.

If the user does not rotate the device as it should, or rotates it only in one axis all the time, the progress bar and digital indicator will remain unchanged and may even roll back after 5 minutes of inactivity.

Calibration is successful when the progress bar turns green and the digital indicator is at least 70%. At this point, the text in the lower right corner of the screen will change to **APPLY**, and the user by pressing the lower navigation button will save the new calibration values to the device memory.

The top navigation button during the entire calibration process is used to abort the operation without saving the data.

The maximum value shown in the digital progress indicator field is 120%. This means that 20% more data has been collected than is necessary to accurately calculate the compass calibration.

# 11. Preview of current values from sensors

The last function available in the compass calibration menu is the function of displaying the current values measured by the sensors of the ENC console. We activate this function by highlighting **Raw data** on the compass calibration screen. By pressing the lower button of the console, we change the view of the previewed data, as shown in the figures below::



Magnetometer raw data

Accelerometer raw data



Gyroscope raw data

Euler angles

The data of the magnetometer (**Mag**) can be used, for example, when looking for a good place to mount the ENC console. If the total value of the magnetic field (**Field**) oscillates, for example, around the number 47.7uT (as in the picture above) and we bring our ENC console closer to the scooter, we can observe a change in the **Field** value. If this change is large (above 10%), then the place where we placed the ENC console is not suitable for mounting it, as it is under the influence of some disturbing magnetic interference. Similarly, we can test equipment elements by bringing them closer to the ENC console. Changing the Field value will show us what objects generate or change the magnetic field and should be placed away from our ENC.

Accelerometer (ACC) data is needed to determine console tilt. The values on this screen are accelerations expressed in m /  $s^2$ . If we place the console perfectly vertical, the value on one of the axes (X, Y or Z) should be close to 9.81 (this is the average acceleration due to gravity), and the other values should be close to 0. If the acceleration due to gravity cannot be observed, or when the vertically positioned device does not show zero on at least 2 axes, it may indicate its damage (e.g. due to a very strong impact). The compass may not be correct in this case.

The gyro data (**GYRO**) is used to determine the compass direction when there is a sharp change in speed or direction. When at rest, the measurements of this sensor should be very close to 0 (acceptable values 0 ... 0.02). If it is not, the gyroscope may be damaged, which can negatively affect compass calculations.

The last screen (**EULER**) is the result of the direct operation of the ENC console's computational algorithms. The given angles are: H - Heading = compass heading without declination and deviation corrections), P - Pitch = ascent or descent grade, for ascent the values are positive, for descent - negative, R - Roll = side to side, a positive value means tilt to the right, negative - to the left. If the Euler angle indications do not work as described, the device must be reset to factory settings and then carefully calibrated from the beginning. When that doesn't help, the ENC console should be returned for service.

# **12.** ENC installation angle (Install angle).

The last new feature available in the compass calibration menu is the **Install angle** feature. This feature significantly increases the accuracy and repeatability of compass readings.

The electronic compass built into the ENC console will work properly only if the console is mechanically connected to the body of the underwater vehicle (scooter) in a permanent manner (unchanged throughout the entire dive). In addition, it is required that the angle formed by the screen of the device with the axis of the scooter is known and constant.

In the previous version of the ENC console software, we assumed that the user could attach the ENC console to the scooter in a certain way (fig. Below), and the installation angle would be within a small range of values (0 ...- 35 degrees):



Analyzing some less typical cases, we concluded that for some divers, due to their specific habits or specific diving conditions - this simplified system is insufficient and may lead to errors in determining the direction of flow, which also tend to accumulate.

Therefore, in the current software version, the installation angle issue has its own configuration section and **it is required** that the user **correctly configure this parameter.** 

#### What is an installation angle and why is it important

Ideally, the ENC console could be installed exactly perpendicular to the scooter hull. Such a case means that **Install angle = 0** (Fig. below)

However, such a case is extremely rarely possible in practice. Due to the convenience of use, it is easier to read the ENC console's



indications when its screen is slightly tilted "forward". This means that Install angle is negative. Additionally, the value of this angle

may vary depending on user requirements. If we tilt the console a bit, then when our scooter is set differently than straight, the compass direction measured by the ENC console does not coincide with the direction of the scooter movement.



The error will occur in case the ENC console does not compensate its indications.

In the previous version of the console software, this compensation was only possible in a narrow range of installation angle and tilt angle. The ENC console selected the correct values automatically and the user could not influence them.

The new software version allows the user to fully control all the necessary parameters. To set this parameter, go to **MENU**  $\rightarrow$  **SETUP**  $\rightarrow$  **Compass**  $\rightarrow$  **Install angle**. The ENC console display will show the following::



The current value of Install angle is shown

The lower button allows you to cyclically change the installation angle: 0 ...- 15 ...- 30 ...- 45 ...- 60 ... 0 ... -15 ...

The green text at the bottom tells you what the next value will be

The upper button allows you to go to the next option - angle measurement (MEASURE)



Measurement of **non-standard Install angle** value - first stage. Attach the ENC console perfectly perpendicular to the scooter hull and press the lower button once. This is how we measure the reference position (that is where the angle is 0).

The scooter should be kept as still as possible during the entire measurement. However, it does not have to be set in any particular way.

# Install angleSet final<br/>positionCHANGEposition<br/>& pressMEASURE& press<br/>ENTERTEST<br/>EXITHold vehicle stillImage: test still

Second stage of Install angle measurement.

Tilt the ENC console to the position that is most comfortable for the user. Then press the lower key again.



If during the **Install angle** measurement our scooter moves, the measurement will be rejected. The measurement can be started from the beginning with the lower button.

The installation angle measurement procedure allows you to set any angle that is convenient from the user's point of view.

The second option is to choose **the Install angle** from the available values (0, -15, -30, -45, -60), and then test if the selected value corresponds to our case.

To do this:

- attach the ENC console to the scooter body in the most convenient way for the user
- set one of the available Install angle, e.g. -30 degrees
- place the body of the scooter as horizontal as possible, e.g. parallel to the water surface

- go to the TEST option and check that the white dot is inside the green circle:



If so, our Install angle has been set correctly.

By tilting the scooter to the right or left, we will see that the white dot is moving in the opposite direction.

If the white dot is low, the Install angle selected by us is too small (e.g. we set -15 and it should be -30 degrees)

The reverse is true if the white dot is too high.



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