# GYROPILOT 3 AUTOPILOT

## User Manual

**V1.4**


**This manual describes the installation and initialization of the GyroPilot 3 driver and explains its operation and settings.**



nke MARINE ELECTRONICS

# Contents





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# 1. INTRODUCTION

## 1.1. *OPERATING PRINCIPLE OF THE GYROPILOT 3 PROCESSOR*

The ***GyroPilot 3 processor*** is an aid to navigation and is designed to automatically maintain a course, ensure the boat's stability, assist the skipper during manoeuvres and can put the boat in a safe position if a man overboard is detected.

Each of these actions can be customised to adapt the operation of the GyroPilot 3 processor to suit the user's expectations and needs.

When you switch it on, it is necessary to power up the autopilot ***BEFORE*** starting the system, otherwise the autopilot will not be recognised on the installation.

## 1.2. *FUNCTIONALITIES*

The ***GyroPilot 3 processor*** offers several steering modes to automatically maintain a course:

- The steering mode
- The compass mode
- The Apparent Wind mode
- The True Wind mode
- The GPS mode
- The VMG mode (polar)

The processor also integrates control overlays called "SUPER" modes:

- gust mode
- heel mode

By using the GyroPilot 3 "Pilot Settings" menu, it is possible to customise various parameters that affect:

- The reaction time and precision of the steering
- The execution of manoeuvres such as instruction changes, tacking, gybe, etc.
- Management of downgraded modes in the event of a malfunction

**The GyroPilot 3 processor** can be installed in different environments without requiring any hardware modification: different types of hydraulic ram, rudder angle and clutch.

# 2. INSTALLATION

## 2.1. *EQUIPMENT SUPPLIED*

The ***GyroPilot 3 processor*** is supplied in its packaging with a ***GyroPilot 3 bus*** cable SF000455, a ***GyroPilot 3 Power Input*** cable SF000453 and a ***Gyro3 Actuator 1X*** cable SF000454.

## 2.2. *PROCESSOR ORIENTATION*

### 2.2.1. **Automatic detection of the case verticality**

The pilot must be installed on a vertical wall of the boat with its connectors downwards. The pilot constantly checks his orientation and will trigger a pilot alarm if he detects a lack of verticality.

The pilot also checks the coherence of the roll and pitch it receives from an external attitude sensor if there is one. The pilot is able to check the correct attitude coherence and to detect whether an attitude sensor is upside down. In effect, on some boats, compasses are simply fixed with a glued or a scratch plate bracket. The pilot will quickly detect whether it can be used for steering. In the event of a sensor inclination that is more than 25° in relation to the vertical position of the processor, the autopilot triggers an alarm indicating:

- A problem with the mounting of the case if the autopilot has the steepest inclination.
- A problem regarding the mounting of the external attitude sensor if the steepest inclination is that of the external attitude sensor.

### 2.2.2. **Automatic detection of the case orientation**

To use the full functionality of the autopilot, it is important to align the marking on the case with the marking on the boat.

Four positions are permitted:

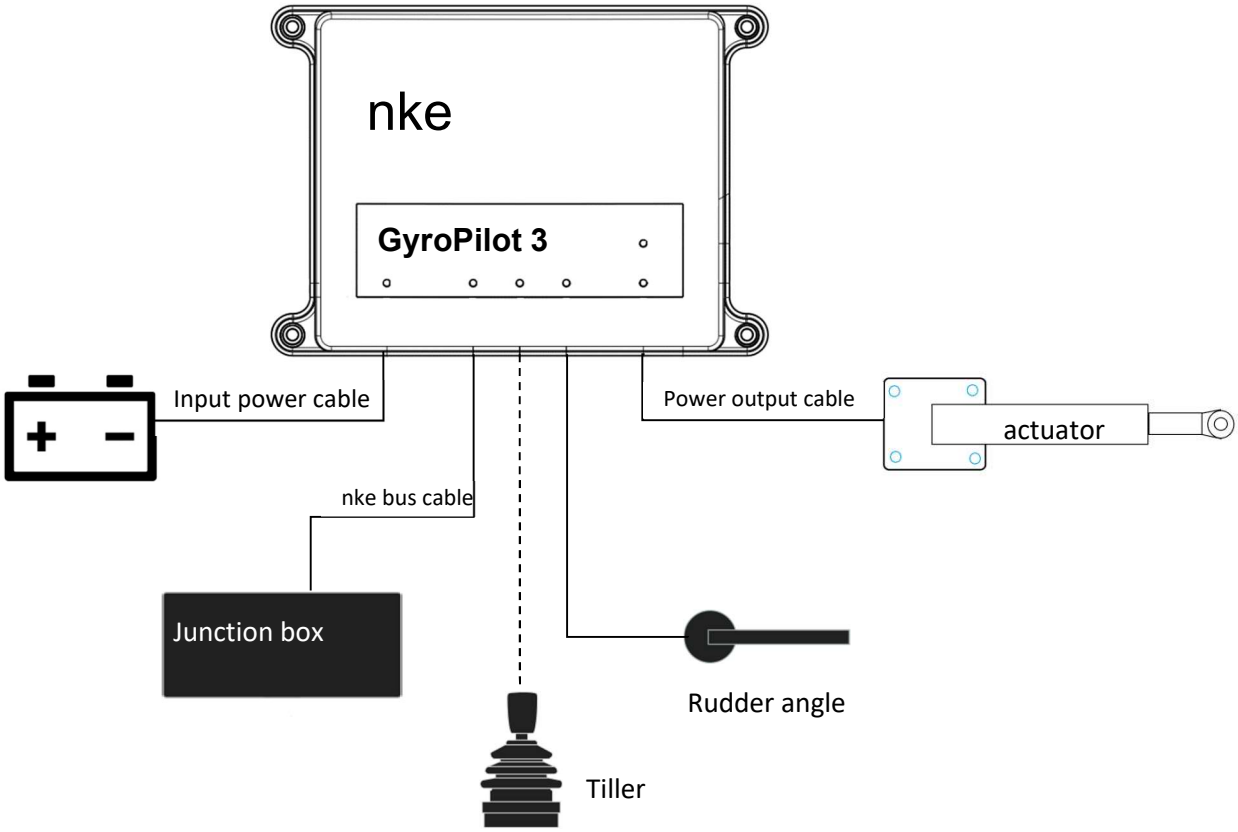
- The front of the case facing the starboard side of the boat
- The front of the case facing the port side of the boat
- The front of the case facing the bow of the boat
- The front of the case facing the stern of the boat

During the first commissioning of the autopilot, the processor considers that it has no set orientation. It will take a few minutes to estimate the orientation of the case if the boat heels more than 6°. Once the orientation of the case is determined, the autopilot will be able to use the attitudes to fine-tune the steering set-up and ensure that the loss of sensor information is minimised in the event of a problem.

During the next few navigation periods, the autopilot will confirm the orientation of the case at each start-up. As long as confirmation is not obtained, it relies on the old orientation found, to be able to use the full functionality of the autopilot within the first seconds.

# 3. CONFIGURATION

## 3.1. *CONNECTION*



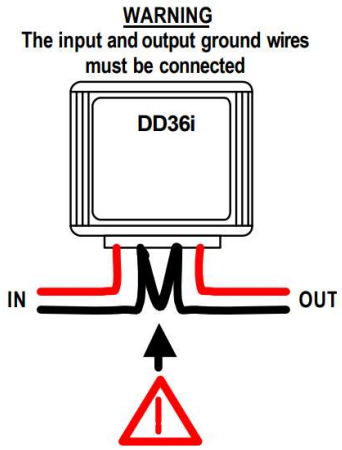

| Input power cable *(ref : SF000453 )* | | |
|---|---|---|
| Red cable | 12V/24V | |
| Black cable | ground | |
| **Nke bus cable (to junction box SF000455 )** | | |
| White | 12V | |
| Ground | Ground | |
| Black | Data bus | |
| **Output power cable (*ref SF000454* )** | | |
| | **RVP connection** | **CRP connection** |
| Red cable | Motor + | Solenoide valve 1 12V/24V |
| Black cable | Motor - | Solenoide valve 1 ground |

| | | |
|---|---|---|
| Red wire insulated cable | clutch | Solenoide valve 2 12V/24V |
| black wire insulated cable | clutch | Solenoide valve 2 ground |

## 3.2. *USAGE WARNING*

The GyroPilot 3 is connected with its bus cable to an nke installation allowing control of the autopilot. This bus is stabilized with a DC/DC converter in order to avoid voltage drops which would have the consequence of stopping the nke products and stopping the driver at each current draw on lightly charged batteries.

Nke installations with an isolated DC/DC without the masses connected tend to generate an electrical problem which can lead to deterioration of the GyroPilot 3 calculator. It is therefore imperative to wire the converter masses together. Failure to follow this assembly instruction may result in the warranty being voided.




## 3.3. *EQUIPMENT CONFIGURATION*

Once the GyroPilot 3 is properly installed and connected to the system, several settings are required prior to use:

- Setting the type of hydraulic ram
- Setting the type of clutch
- Setting the type of rudder angle
- Carrying out a steering initialisation

The GyroPilot 3 can control different types of servo systems: either CFP (Continuous Flow Pump) or RP (Reversible Pump). It only requires user action on a **nke** display and does not need any intervention on the installation.

In the "Pilot" menu of the display, select "maintenance" and then one of the following 3 menus:

- The type of hydraulic ram
- The type of circuit supply clutch
- The type of rudder angle

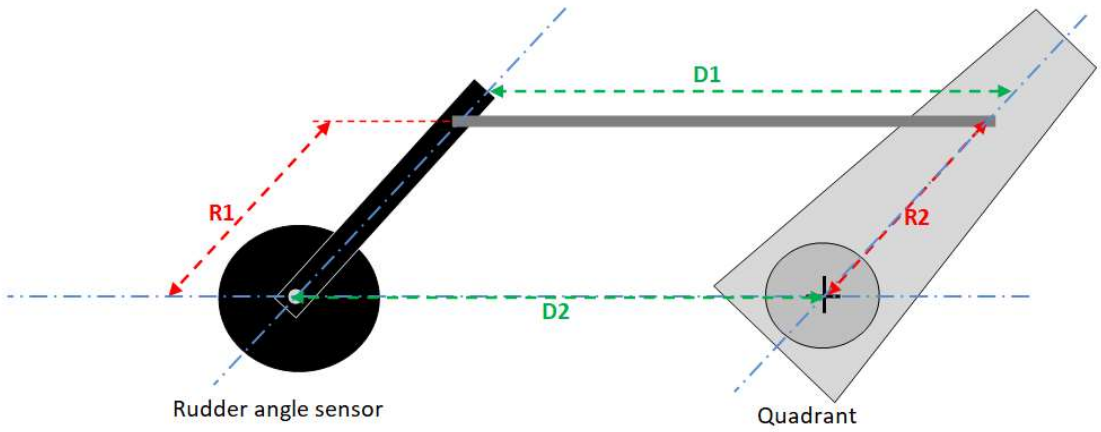
*Caution: any change to the configuration resets the rudder system. The pilot will no longer operate without a new rudder system initialisation. Starting the autopilot without prior initialisation will activate a message requesting an initialisation.*

### 3.3.1. ***The type of rudder angle***

There are two types of rudder angle sensors that can be connected to the GyroPilot 3: The **nke** rotary sensor or an analog linear sensor.

**nke** rotary rudder angle:

The sensor should be mounted in parallel with the rudder stock or false rudder stock. For the sensor to measure the rudder angle correctly, one degree of rudder rotation = one degree of sensor rotation. This requires that R1 = R2 = 10 cm and that D1 = D2 (see diagram below). This is called a perfect parallelogram.

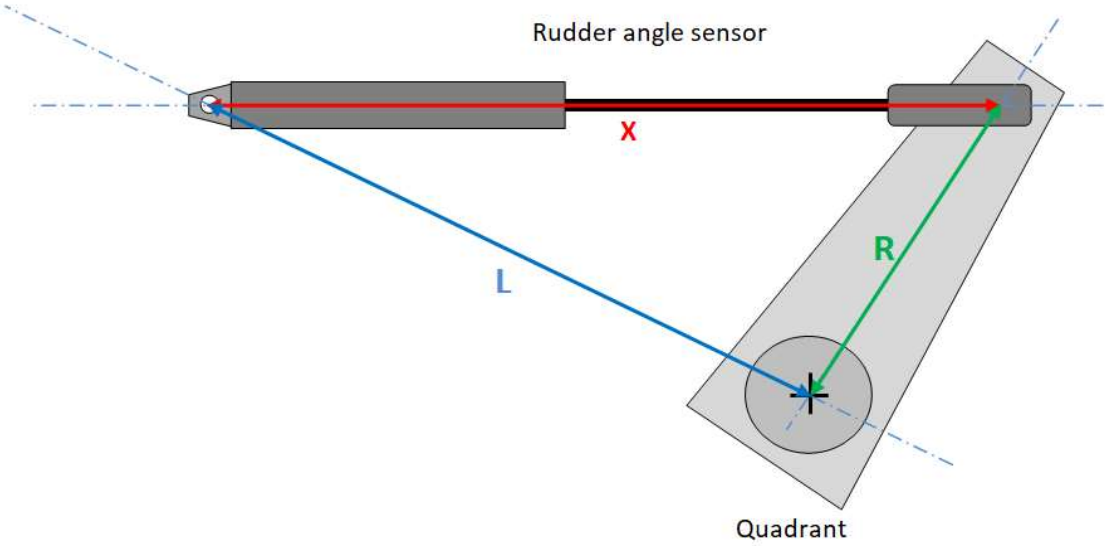



Picture1: installation of a nke rotary rudder angle sensor

Once the **nke** rotary rudder angle sensor is correctly installed, the measurement of one degree of rudder rotation will be automatically converted by the GyroPilot 3 calculator into one degree of rudder in the autopilot.

Analog linear rudder angle:

The GyroPilot 3 system also integrates linear rudder angles. To take such a sensor into account, it is necessary to measure the triangle of the steering system (see picture below). 5 measures are required:




- **Center R - rudder to amidship:** distance in mm between the rudder stock axle and the sensor mounting on the tiller arm
- **Center L - rudder to amidship:** distance in mm between the rudder stock and the sensor fastening to the boat
- **Center X - rudder to amidship:** size of the linear sensor (mm) corresponding to a centred rudder
- **Starboard X - rudder to starboard**: size of the linear sensor (mm) corresponding to the starboard stop position of the rudder
- **Port X - rudder to port**: size of the linear sensor (mm) corresponding to the port stop position of the rudder

Once these measurements have been completed, they must be entered in the "Measures" menu. To do this, the " rudder sensor " option must be changed to linear rudder. If this has not been done, then the " Measures " menu will be available just below.

*Note: These measurements should be done before the rudder initialisation is completed.* The same positions should be used during the rudder initialisation (rudder amidships, rudder to the starboard stop position and rudder to the port stop position). This is why it is necessary to take the most accurate benchmarks as possible.

### 3.3.2. *The type of hydraulic ram*

The GyroPilot 3 processor allows you to choose in the "Pilot-Maintenance" menu, the type of hydraulic ram used.

**RVP:** (reversible pump) The power voltage of the cylinder can be controlled by a PWM frequency modulated signal. This type of cylinder makes it possible to control the rudder speeds in one direction or the other. This type of power unit concerns most actuators on the market: RayMarine, Lecomble and Schmitt, JEFA.

**CRP:** This setting is intended to control the electro-distributors of a fixed flow hydraulic electro-pump group, generally mounted on large pleasure, fishing and utility boats.

**WARNING**:

*The CRP power unit type is incompatible with a PWM type clutch. Bar initialization will be impossible in this case, the GyroPilot 3 will report an error in this case.*

### 3.3.3. *The type of circuit supply clutch (PWM/DC)*

The type of clutch used can be selected by the user in the "Pilot-Maintenance" menu.

**PWM**: the clutch takes a PWM type signal as input. It is a niche signal which has a high level at the battery voltage value (12V or 24V depending on the power input voltage value) and a low level at 0V. The width of the pulse allows several values to be translated. Raymarine or Lecomble and Schmitt cylinders have this type of clutch.

**DC**: the clutch takes as input a continuous signal which is either at the value of the computer input voltage 12V or 24V when the cylinder is engaged, or at the voltage 0V in the case of a free bar. JEFA cylinders have this type of clutch.

## 3.4. *RUDDER INITIALIZATION*

The rudder initialisation is a procedure to take into account the settings needed to detect the direction of movement of the hydraulic ram and the rudder angle sensor. A wizard on the **nke** displays allows this procedure to be carried out. It is divided into 4 steps:

- **Step - rudder to amidship:** used to determine the 0° of the rudder angle.
- **Step - rudder to starboard end position:** sets the maximum rudder limit for heading to starboard. It also detects the direction of movement of the rudder angle sensor.
- **Step - rudder to starboard end position:** enables setting of the maximum rudder limit for heading to port.

- **Step - activation of the hydraulic ram:** the hydraulic ram activates automatically. It moves the rudder in one direction and then comes back to the amidship position. This allows the autopilot to determine the polarity in order to go to one side or the other and to calculate the response parameters of the actuator allowing it to increase its performances.

### 3.4.1. *Results of the rudder initialisation*

Once initialisation has been completed, the autopilot sends the status of the rudder initialisation to the displays

If the initialisation has been successfully completed,

- The measured rudder-stop information and rotation speed are displayed
- The LED of the rudder angle sensor lights up in green
- The autopilot changes the rudder angle status to "valid" and the autopilot becomes operational.

If the procedure is invalid

- The display will show: "Invalid rudder initialisation".
- The LED of the rudder angle sensor will remain orange
- The autopilot sets the rudder angle status to "invalid" and the autopilot remains disabled.

In the case of an invalid procedure, the whole procedure must be carried out again. Rudder initialisation can be considered invalid in the following cases:

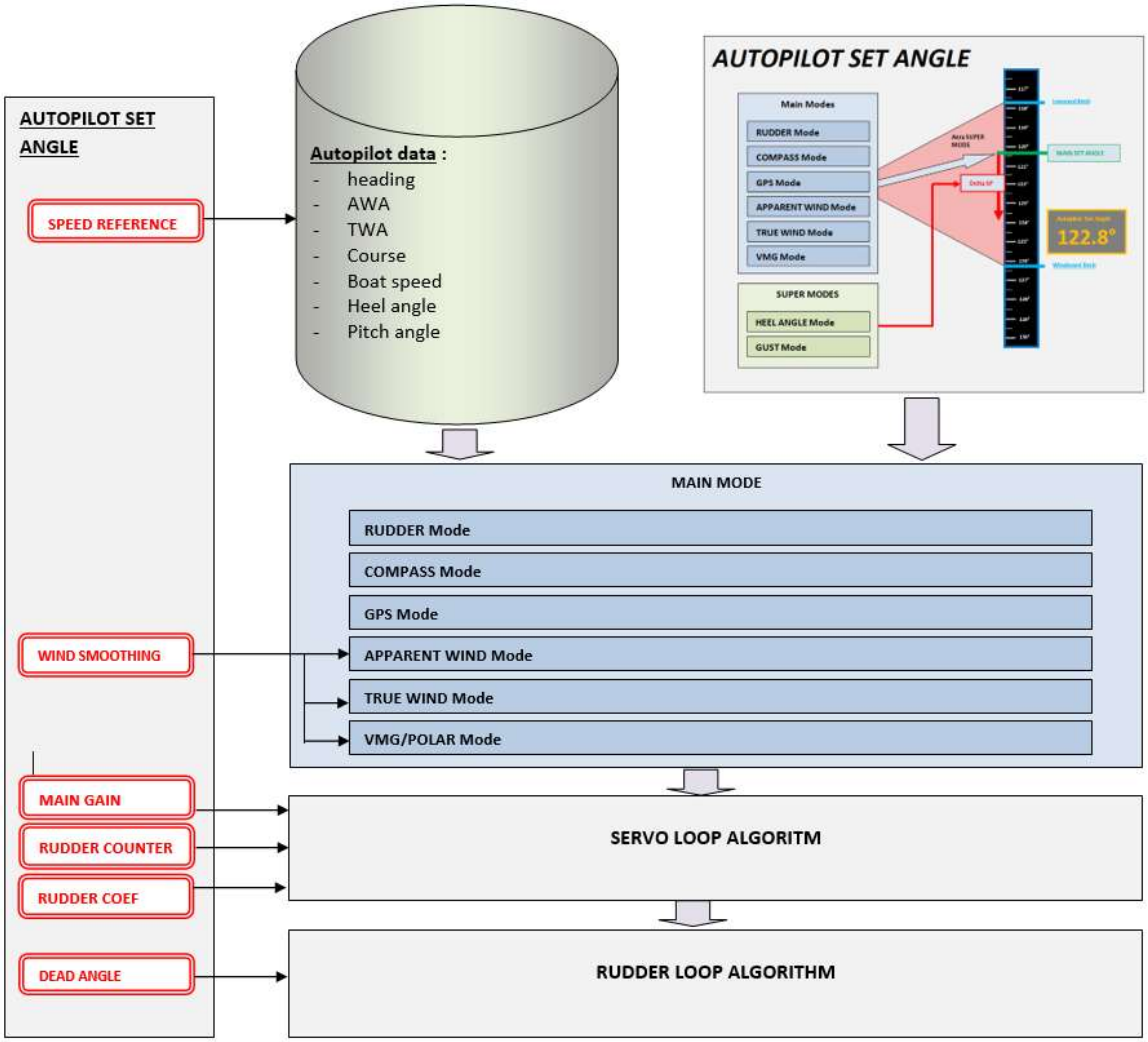
- The rudder angle sensor sends incorrect or missing information. The rudder angle sensor is immediately discarded and the rudder initialisation fails.
- The starboard and port rudder stops are within 4 degrees of each other. The amplitude of the rudder crosshead is too small for optimal use.
- The zero of the rudder is outside the range [starboard rudder stop, port rudder stop] (rudder stops have the same sign). In this case the initialisation procedure fails.
- The hydraulic ram cannot move the rudder faster than 0.2°/s. In this case, it considers that the hydraulic ram is not responsive enough and that the autopilot cannot be used efficiently.
- The combination of PWM and CRP is forbidden. In the Multidisplay, within the Menu -> Autopilot -> Maintenance, check the configuration of the ram and the clutch.
- During the initialisation of the rudder angle sensor, if the angle is beyond the already defined rudder angle stop position then the initialization procedure will be stopped.
- The user did not return the rudder to the center (+/- 2°) before the actuator activation step. The autopilot cannot correctly estimate the speed of movement of the cylinder.

## 3.5. *PILOT SPEED REFERENCE*

The speed used by the autopilot can result from different possible sources: GPS, **nke** SPEEDO. These elements provide the true speed and/or the ground speed of the boat. Based on all this information, it calculates the autopilot speed which is the boat speed data that the autopilot will consider. For the GyroPilot 3, the speed used by the autopilot is only a selection of the speed source (ground or surface) chosen by the skipper via a **nke** display.

# 4. OPERATION

## 4.1. *SETPOINT MONITORING ARCHITECTURE*




## 4.2. *THE MAIN MODES*

The steering modes available for the **GyroPilot 3 processor** can be selected from the "Pilot" menu and then "Mode select" or from a pilot page by pressing the OK button and then "Mode select".

The **GyroPilot 3 processor** has a total of 6 steering modes, but a display will only show the modes that can be used with the sensors available on the installation. If, for example, there is no wind speed/wind vane sensor, the wind modes will not be available. Only the rudder angle sensor is needed in all steering modes

- The **rudder mode**: requires a rudder angle sensor connected to the processor and configured.
- The **compass mode** requires heading data
- The **Apparent Wind mode** requires a wind speed/wind vane sensor.
- The **True Wind mode** requires a wind speed/wind vane sensor and boat speed data.
- GPS mode requires a compass sensor, as well as a GPS, or any other instrument that sends NMEA GPS sentences. The latter must be connected to an NMEA input on the **nke** installation.
- The **polar mode** requires an external processor that provides the optimal wind angle (VMG) calculated from a boat speed polar.

### 4.2.1. *Rudder mode*

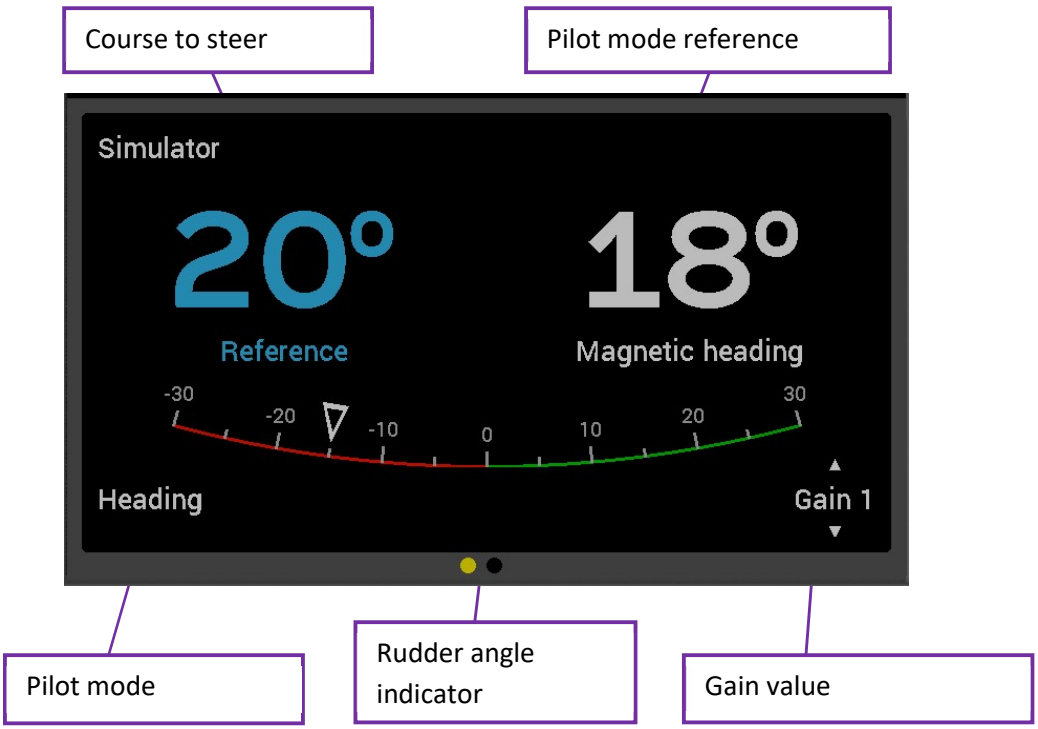
The rudder mode is the most basic mode of the autopilot. The set value is a rudder angle. The rudder mode allows you to set a rudder angle and lock the rudder at the selected value. The pilot gives the selected rudder angle as a set value, within the limits of the stops detected during the rudder initialisation procedure. This mode is a distinct mode because it acts directly on the steering circuit.

*Note: This mode is very useful when looking for a malfunction. If the mode is operating, the possibility that the hydraulic ram or the rudder angle is the cause of the problem is excluded.*

### 4.2.2. *Compass mode*

In compass mode, the **GyroPilot 3 processor** steers the boat by following the **magnetic heading** given by the **compass**.

The **compass mode** screen below is displayed on a multi-display:




- The set value indicates the reference heading to be reached, selected by the user. This screen displays "---" or "**OFF**" when the autopilot is disengaged.
- The steering mode reference indicates the current course of the boat; it is the **magnetic heading** channel,
- The pilot gain window is common to the six modes.
- The rudder angle indicator is common to the six modes.

To use the **Compass mod**e at sea:

- Select "Compass" in the steering mode.
- Steer your boat and press the **Auto** button to activate the **GyroPilot 3**.
- The pilot then takes the heading as a reference. The GyroPilot 3 is then activated and steers the boat.
- You can use the +/-1 and +/-10 keys on a PAD, a remote control or a display to adjust the set-point.
- To switch off the GyroPilot 3, take over the steering and press the stop button.

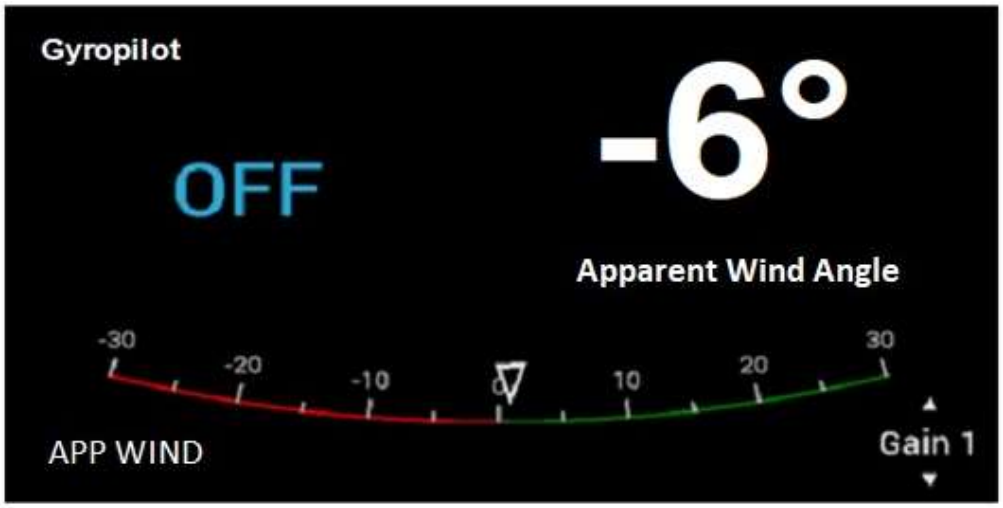
**WARNING**:

The **Auto** button is used to activate the autopilot, i.e. to turn it on.

The **Stop** button is used to deactivate the autopilot, i.e. to turn it off.

### 4.2.3. *Apparent Wind mode*

In apparent wind mode, the GyroPilot 3 steers the boat by following the ***apparent wind*** angle, given by the wind speed and wind direction sensor. It is mainly used upwind. The page displayed is identical to that of the compass, except that the steering mode label is replaced by the apparent wind angle.




### 4.2.4. *True Wind Mode*

In true ***wind mode***, the ***GyroPilot 3*** steers the boat according to the ***true wind*** angle given by the system.

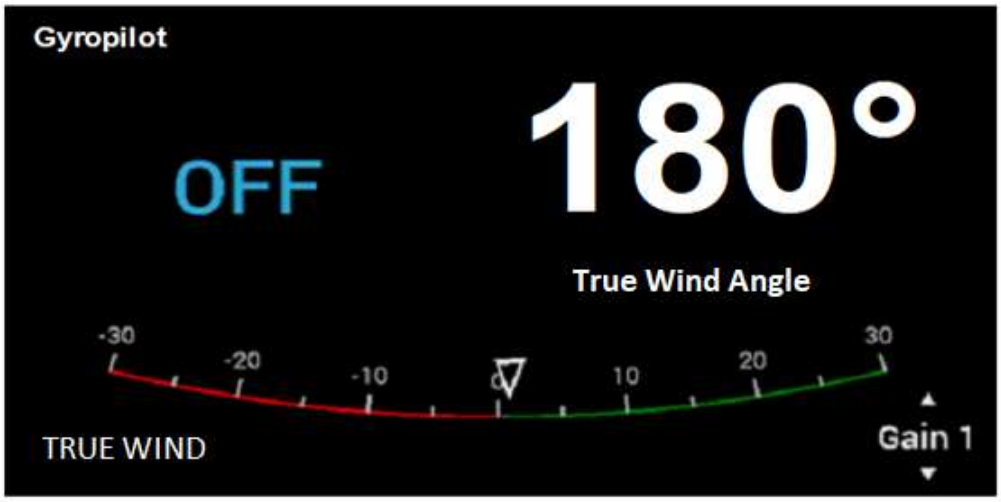
**Why use the True Wind mode?**

The ***true wind*** mode is particularly effective when sailing downwind in heavy swell: In these conditions, the **GyroPilot 3** shows its potential. If you use the **apparent wind** mode downwind and in swell, you will observe this:

- As the boat descends the wave, the apparent wind speed increases, the apparent wind angle decreases and therefore, the wind heads. Action of the autopilot: it makes the boat bear away.
- As the boat climbs the wave, the apparent wind speed decreases, the apparent wind angle increases and therefore the wind lifts. Action of the autopilot: it makes the boat luff up.

In swell, the **apparent wind** mode does not allow for perfect heading control and you have to switch to compass mode to descend the wave with a straight trajectory.

**The true wind mode** allows you to go straight down the wave and keep the optimum descending angle. The true wind angle does not vary with boat speed.




4.2.5. ***GPS mode***

In **GPS** mode, the **GyroPilot 3** steers the boat by following the route given by the GPS. To do this, a GPS or other instrument that delivers NMEA GPS sentences must be connected to an NMEA input on your installation.

**CTW** (Course to Waypoint), **COG** (Course Over Ground in °), **DTW** (Distance to Waypoint in Km or M) information is displayed.

The GyroPilot 3 processor follows the route to the Waypoint. On arrival at WAYPOINT < 0.1NM, the NKE displays beep and the autopilot switches to compass mode. If the user enters a new waypoint, the GyroPilot 3 automatically switches back to GPS mode.

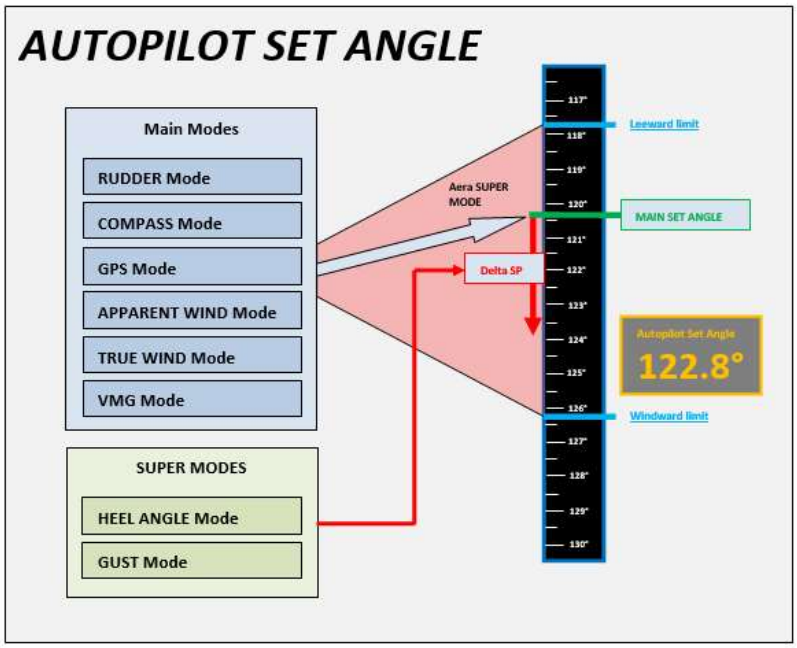
A change of setpoint (+1 / -1 / +10 / - 10) automatically switches the pilot back to compass mode with the variation in direction requested.

4.2.6. ***VMG mode***

The VMG mode enables the boat to follow an optimal wind angle. This angle is the best upwind angle when heading into the wind: VMG up, or the best angle when heading down the wing in downwind conditions: VMG down. Apart from the set-point change in relation to the wind speed, this mode functions like a true wind mode.

## 4.3. *THE SUPER MODES*

The SUPER modes are used in addition to the main modes. They allow the autopilot's set point to be adjusted slightly in response to a temporary phenomenon: heel variation, gust




In the GyroPilot 3, only one SUPER mode can be activated at one time. There are 3 states in a SUPER mode:

- **Status: OFF.** The skipper has not selected SUPER mode.
- **Status: Standby.** SUPER mode is ready to be used, but it is not active yet:
  - a piece of data is missing,
  - the autopilot is not activated,
  - the SUPER mode has deactivated itself due to a manoeuvre or change in the main mode.
- **Status: ON.** The SUPER mode is activated.

The “Delta SP” variable allows you to clearly understand the contribution of super mode. It corresponds to the setpoint variation made either to respect a heeling setpoint or to counter a gust of wind. “Delta SP” is negative when the set variation seeks to make the boat upwind and positive when the variation seeks to make the boat downwind.

### 4.3.1. *Heel angle mode*

This mode allows you to maintain a constant heel angle. It can be activated when following a set-point in compass, apparent wind, true wind or polar mode. This mode can be set on the displays:

- **Leeward limits:** maximum leeward set point deviation in degrees that the skipper allows to follow the heeling angle instruction.
- **Windward limits:** maximum windward set point deviation in degrees that the skipper allows to follow the heeling angle instruction.
- **Gain**: value given to the heel angle instruction follow-up. The higher the gain, the less the autopilot is tolerant to heel angle variations. Caution: a very precise follow-up of the heel variation can have consequences on the regularity of the boat's trajectory. It is, therefore, a matter of finding the best gain compromise.

**WARNING**:

- The heel mode gain should not be confused with the “pilot gain”. The pilot gain adjusts the amplitude of the helm to follow a pilot setpoint while the gain of the heel mode will manage the amplitude of variation of the pilot setpoint to stabilize the heel of the boat.

- The heel mode only works if the pilot has detected its orientation. During a first start, you must wait a few heeled edges to unlock the heeling mode.

#### 4.3.2. *Gust mode*

The gust mode allows you to react at the helm during a gust. It can be activated when following a set-point in compass, apparent wind, true wind or polar mode. This mode can be set on the displays:

- **Limit:** the maximum set point variation in degrees that the skipper allows to counter a gust.
- **Gain**: value given to counter a gust The higher the gain, the less tolerance the autopilot has to variations of wind speed and the faster he responds to a gust. Caution: a very precise follow-up can have consequences on the regularity of the boat's trajectory. It is, therefore, a matter of finding the best gain compromise.
- **Filter:** period of time over which the gusts are detected. The larger the time window, the more the gust mode will react to long gust periods.

**WARNING**:

Gust mode gain should not be confused with “pilot gain”. The pilot gain adjusts the bar amplitude to follow a pilot setpoint while the burst gain will manage the amplitude of variation of the pilot setpoint to counter a burst.

- The gust mode needs to know an average wind force. You must wait the time defined in the "filter" setting after starting the nke control unit to be able to start detecting the first gusts.

## 4.4. *THE TILLER*

The tiller is a pilot operating mode using a joystick. To use it, the autopilot must be activated. If the joystick is activated, the autopilot automatically switches to TILLER mode. If the joystick is deactivated, the autopilot automatically switches back to the previous mode.

There are 5 types of tiller mode operation. These types can be selected through the “Tiller type” field in the GyroPilot 3 configuration page of the TopSailor software.

| Type tiller value | Type of operation |
|---|---|
| 0 | The tiller is position-controlled:<br>- When activating the tiller, the pilot switches to rudder mode<br>- The tiller angle corresponds to a rudder angle.<br>- The centered value is the centered helm angle estimated by the pilot<br>- The commands +1/-1/+10/-10 do not cause any setpoint change when the tiller is activated<br>- When deactivating the tiller, the pilot automatically switches to the mode in which it was previously<br>- |
| 1 | The tiller is speed-controlled:<br>- When activating the tiller, the pilot switches to rudder mode<br>- The tiller angle corresponds to a bar variation speed.<br>- Centered value is zero rudder variation<br>- The commands +1/-1/+10/-10 do not cause any setpoint change when the tiller is activated<br>- When deactivating the tiller, the pilot automatically switches to the mode in which it was previously |
| 2 | The tiller input allows external activation/deactivation:<br>- When the tiller is activated, the pilot switches to AUTO.<br>- The tiller has no impact on helm or setpoint variations<br>- If the tiller is activated, you can change the setpoint, stop the pilot<br>- When deactivating the tiller, the pilot stops<br>- The AUTO, +1/-1/+10/-10 setpoints are deactivated |
| 3 | The tiller allows setpoint changes:<br>- When the tiller is activated, nothing happens, we stay in the same operating mode<br>- A punctual tiller movement, allows the pilot setpoint to be changed by 1° or -1°<br>- A tiller movement prolonged by 1 sec allows a setpoint variation of +10°/-10°<br>- The commands on the displays are still functional |
| 4 | The tiller is controlled in position:<br>- When activating the tiller, the pilot switches to compass mode<br>- When the tiller is given an angle, it corresponds to a rudder angle. The compass setpoint evolves at the speed of the heading variation and when the tiller is centered again the heading setpoint becomes the current heading reached and it continues in compass mode<br>- The commands +1/-1/+10/-10 do not cause any setpoint change when the tiller is activated<br>- When deactivating the tiller, the pilot automatically switches to the mode in which it was previously |

There is an internal parameter "Tiller Coefficient" accessible in the TopSailor software which allows to adjust the amplitude of the tiller to the bar amplitude. Its default value is 1.

## 4.5. *AUTOPILOT SETTINGS*

### 4.5.1. *Autopilot gain*

The pilot gain allows the boat to be more responsive. Gain increase is often used in the following circumstances:

- In rough sea conditions, the increase of the gain allows to counter more efficiently the strong waves which cause lurches.
- When sailing downwind, with powerful sails such as a spinnaker, the increase in gain helps to avoid excessive set-up variations which can cause into the wind or down the wind runs.

The setting range is between 1 and 9.

### 4.5.2. *Rudder coefficient*

The rudder coefficient controls the amplitude and acceleration of the rudder movements according to the speed of the boat. Its value is increased in proportion to the speed of the boat.

The setting range is between 1 and 53.

### 4.5.3. *The counter rudder*

The counter rudder prevents trajectory fluctuations from occurring around the set point. The boat's motion expectation is preset. Anticipation is necessary in the following cases:

- Boats with high inertia. Naturally, the counter-rudder value will be high.
- The delay of pilot data is sometimes intentional for filtering reasons.
- Trajectory fluctuations around the set point

The setting range is between 1 and 9.

### 4.5.4. *Wind damping*

Wind smoothing is used in apparent wind, true wind or polar mode. This setting is used to stabilise the steering when the wind measurement fluctuates. The setting range is between 1 and 9.

The correspondence of the wind damping value in relation to the filtering time window is expressed in the table below:

| Filtering time window | |
|---|---|
| **WIND DAMPING** | **Time window (s)** |
| 1 | 2.0 |
| 2 | 4.0 |
| 3 | 8.0 |
| 4 | 12.0 |

| | |
|---|---|
| 5 | 18.0 |
| 6 | 25.0 |
| 7 | 35.0 |
| 8 | 60.0 |
| 9 | 100.0 |

4.5.5. ***Tacking angle***

This is the auto-tacking angle in compass mode, adjustable from 70 to 115° with increments of 5°.

4.5.6. ***Tacking velocity***

The tacking speed is adjustable from 1° to 32°/s.

4.5.7. ***Man Overboard (MOB)***

In the autopilot settings, it is possible to select the "Man Over Board" menu among two sub-menus: MOB crew and MOB single-handed (see. §MOB )

4.5.8. ***Speed reference***

The speed source is used to select the type of speed that the autopilot will choose to adjust the servo and to calculate the true wind.

4.5.9. ***Time before cut-off***

There are extremely downgraded configurations in which the autopilot is no longer able to steer. In this case, the autopilot triggers a pilot alarm and releases the steering after a period of time: This is "the time before cut-off" if the situation has not changed favourably. The setting range varies from 20 seconds to 300 seconds.

4.5.10. **Rudder offset**

There is a rudder offset that can be used in some special circumstances. In the event of a rudder angle sensor failure, while sailing in difficult conditions, it is often impossible to perform a rudder initialisation procedure. The rudder offset can, therefore, be used temporarily to allow steering with a second rudder angle already set. The setting range is between -3° to 3°.

4.5.11. ***Dead angle***

The dead angle takes into account the mechanical looseness that exists in the steering systems of boats. The setting range is between 0 and 3°.

#### 4.5.12. *Upwind and downwind limit*

The upwind and downwind limit limit is a true wind angle. If the actual wind angle is less than this limit, the autopilot is said to be “upwind type” and if it is above the autopilot is said to be “downwind type”.

Let us consider that this limit is 85°. If the actual wind angle is below this value (for example 75°), the pilot's change of tack will be a tack and the super activated mode will act as "near type": the pilot will luff in a gust or list. too important. Conversely, if the real wind angle is greater than the limit (for example 115°) the pilot will initiate a jibe as part of a change of tack and the super activated mode will act in "bearing type": pilot will bear down in a gust or excessive list if a super mode is activated.

This setting is particularly important when using super modes in side wind conditions. Depending on the sails used, we will prefer to go upwind in a strong gust or too high list. In other case we will want to go downwind with a same true wind angle.

The setting range is 50° to 140°. Default value is 90°.

## 4.6. *SETTING OF THE AUTOPILOT ALARMS*

The GyroPilot 3 processor has two configurable alarms:

- The wind direction alarm
- The battery voltage alarm

### 4.6.1. *The wind direction alarm*

The wind direction alarm, called "**wind/heading**", monitors a change in wind direction. It only works if the autopilot is operating in compass mode, apparent wind mode, true wind mode or VMG mode. The “wind/heading setting” in the displays corresponds to a range in degrees representing a sector around the direction of the true wind. When activating the alarm, the autopilot saves the true wind direction. If it leaves the predefined sector, an alarm is triggered.

The alarm is automatically deactivated when the autopilot stops.

### 4.6.2. *The battery voltage alarm*

The alarm is triggered if the pilot power supply voltage drops below the threshold configured in the pilot displays. Default setting is 10V.

## 4.7. *TACKING*

The GyroPilot 3 allows you to tack in any mode: compass, apparent wind, true wind or polar. Tacking or gybing is executed by a long press on the +/-10 key of a pilot control box.

The GyroPilot 3 analyzes each tacking/jibe made if it has not been interrupted or modified by a change of instructions within one minute following the end of the procedure. The GyroPilot 3 will optimize tacking and jibes gradually.

## 4.8. MOB

The radio transmitter must first be activated in scan mode (see transmitter manual).

Man over board (MOB) is a safety manoeuvre. When the receiver no longer receives messages from the radio transmitter (this is called a radio loop break), the autopilot initiates a MOB procedure.

Depending on the settings of the "Man over board" parameter of the autopilot there are 2 procedures:

- Crew mode: the navigation system triggers an audible alarm but does not cause any steering changes.
- Solo mode: the navigation system triggers an audible alarm and then takes the control in order to is hove to. It uses all the data available to it to carry out the manoeuvre as accurately as possible.

## 4.9. *DOWNGRADED MODES*

In the event of a sensor failure, the autopilot keeps control of the helm during the "Time before cut-off" or temporarily changes the steering mode.

### 4.9.1. *Lost of speedometer sensor*

The autopilot no longer has a sensor to calculate surface speed. If the skipper has selected a surface speed reference, the autopilot automatically switches to the “ground reference” speed if this is available.

The GyroPilot 3 constantly monitors the state of the water speed. If it detects a new availability of the speedo, the pilot automatically switches back to the surface speed reference previously chosen by the sailor.

If the autopilot no longer has ground reference speed, the pilot will trigger a “loss of pilot speed” alarm. If the autopilot is in true wind mode, it will automatically switch to apparent wind mode. Likewise, it will automatically switch back to true wind mode if speed information returns.

### 4.9.2. *Lost of GPS signal*

The autopilot no longer has a sensor to calculate SOG. If the skipper has selected a ground reference speed, the autopilot automatically switches to the “surface” speed reference if this is available.

The GyroPilot 3 constantly monitors the SOG status. If it detects a new GPS availability, the pilot automatically returns to the ground reference speed previously chosen by the sailor.

GPS mode will not be available during signal loss. The autopilot will automatically switch to compass mode.

### 4.9.3. *Lost of anemometer sensor*

The autopilot no longer has a sensor to measure the apparent wind speed. The calculation of the true wind will no longer be possible, the GyroPilot 3 will trigger an alarm: "loss of true wind".

When navigating under pilot in true wind mode, the GyroPilot 3 will automatically switch to apparent wind mode. The GyroPilot 3 continuously monitors the apparent wind speed status. If it detects a new availability of the anemometer sensor, the autopilot automatically switches back to true wind mode.

### 4.9.4. *Lost of wind direction mast head unit*

The autopilot no longer has a sensor for measuring the apparent wind angle. True wind calculation will no longer be possible and apparent wind, true wind and VMG pilot modes will no longer be available. The GyroPilot 3 will trigger an alarm: “loss of wind”.

When navigating under pilot in apparent wind, true wind or VMG mode, the GyroPilot 3 and will automatically switch to compass mode. The GyroPilot 3 constantly monitors the status of the apparent wind angle. If it detects a new availability of the wind vane sensor, the autopilot automatically returns to its old piloting mode.

### 4.9.5. *Lost of compass sensor*

The autopilot no longer has a sensor to measure the heading of the boat. The GyroPilot 3 will trigger an alarm: "loss of compass".

When navigating under autopilot in compass mode, the autopilot will automatically switch to true wind mode. The GyroPilot 3 continuously monitors the heading status. If it detects a new availability of the compass, the autopilot automatically switches back to its old piloting mode.

If there is no wind sensor, the pilot will remain in compass mode. It will calculate an inertial heading that can be used for a few minutes. At the end of the time before cut-off, the pilot will stop.

### 4.9.6. *Lost of feedback sensor*

The pilot no longer has a rudder angle sensor, the GyroPilot 3 will trigger an alarm: "loss of rudder angle".

In the event of navigation under pilot, the pilot will hold the helm in the center for the time before stopping.

### 4.9.7. *Navigation bus stop*

The pilot no longer has piloting data, the pilot continues to operate in compass mode in pure inertia during the time before cut-off before stopping.

If the skipper wants to regain control, just restart the nke bus and the pilot will stop automatically. The other possibility is to turn off the pilot power.

# 5. DIAGNOSTIC

## 5.1. *LEDS IN NORMAL OPERATION*

The GyroPilot 3 is equipped with 6 LEDS allowing to carry out a first rapid diagnosis on is state.

| LEDS name | Color | Signification |
|---|---|---|
| STATUS | Green | Autopilot power ON |
| | OFF | Autopilot OFF |
| POWER INPUT | Green | Power input is valid |
| | Red | The voltage is too low |
| | OFF | The voltage is not valid, check that the power connector is well connected and that the Autopilot power switch is on |
| TOPLINE BUS | Green | Bus voltage and TOPLINE data reception are valid |
| | Orange | The Autopilot has detected in the last minute a collision bus, a loss of echo or has a full fifo bus. The bus is unstable. |
| | Red | The voltage is invalid or data from the Topline bus is not received. Check Topline connector |
| TILLER INPUT | Green | The tiller is detected and activated |
| | OFF | Tiller is not activated |
| RUDDER FEEDBACK | Green | The rudder angle sensor is detected, and the rudder angle value is within the rudder operating range |
| | Orange | The rudder initialization is not carried out or incorrect. Rudder initialization must be performed to use the autopilot. If the LED remains orange after this procedure, check the rudder angle sensor and its connection and start the rudder initialization again. |
| | Red | Rudder angle is outside the range or sensor is disconnected |
| POWER OUTPUT | OFF | Rudder is free and there are no engine errors detected |
| | Green | The pilot is activated and working |
| | Red | Engine error detected during navigation. However, the driver can continue to operate |

## 5.2. *LEDS IN PARTICULAR PROCEDURE*

- The LEDs flash red at the same time: the driver is being updated.
- The LEDs are all fixed orange: the driver in “boot” mode, it did not start correctly. Run a driver update.

## 5.3. *AUTOPILOT MESSAGES ON DISPLAYS*

| Message | Description |
|---|---|
| Heading alarm in wind mode | When the wind direction alarm is activated, the autopilot detects that the boat has changed its course significantly and has left the limits defined by the skipper |
| Wind alarm in compass mode | When the wind direction alarm is activated, the autopilot detects that the wind has changed direction and has left the limits defined by the skipper |
| WayPoint Arrival | In GPS mode, the autopilot has reached the waypoint, the GyroPilot 3 switches to compass mode |
| Battery discharged | The "Power battery" autopilot alarm is triggered when the power supply voltage of the GyroPilot 3 falls below the threshold defined by the skipper |
| Rudder feedback lost | The autopilot lost his rudder angle.<br>If the pilot is engaged, the autopilot keeps the rudder until the end of the "time before cut-off" |
| Rudder in oprating limit | The driver is activated. It is neither in change of setpoint, nor in change of tack, nor in MOB and the rudder has been at a stop for 30 seconds. |
| Blocked rudder | The actuator does not seem to reacts to GyroPilot 3 commands. Check :<br>- is the “Power output” connector properly connected?<br>- is the rudder angle correctly connected?<br>- is the rudder angle feedback correctly connected to the rudder sector (rudder saffron) ? |
| Lost of compass | The autopilot no longer receives compass data.<br>1 – if true wind is available and the pilot is activated, the autopilot will automatically switch to degraded true wind mode<br>2 – if true wind is not available but apparent wind angle is available, the pilot will automatically switch to apparent wind mode.<br>3 – if there is no wind source available, the pilot continues to operate in compass mode with the calculation of a heading with these internal gyroscopes until the end of the “time before cut-off” before stopping |
| Pure inertia navigation | The autopilot no longer receives heading information, he uses his internal gyroscopes for a few seconds to calculate a heading and continue to steer during the "time before cut-off" |
| Lost of heel angle | The autopilot has lost his external source of heel information but still has a heading. |
| Lost of pich angle | The autopilot has lost his external source of pitch information but still has heading and heel. |
| Retuned compass | The autopilot observed an inclination of the compass which seemed to him incoherent. The reasons are as follows:<br>- The compass fell from its partition<br>- The installation of the compass has a horizontality which differs by more than 25° from that of the computer. The computer has a horizontality that is too different for piloting<br>In all cases check if the compass is well fixed, check the installation of the compass and that of the GyroPilot 3 |

| | |
|---|---|
| Lost of wind | The autopilot no longer receives an apparent wind angle or speed.<br>Apparent wind, true wind, VMG and SUPER modes no longer work:<br>- The pilot switches to compass mode automatically if it is in apparent wind, true wind or VMG mode.<br>- GyroPilot 3 disables SUPER modes automatically |
| Lost of wind direction mast head unit | The autopilot no longer receives an apparent wind angle<br>Apparent wind modes, true wind mode, VMG mode and SUPER modes no longer work:<br>- The pilot switches to compass mode automatically if it is in apparent wind, true wind or VMG mode.<br>- GyroPilot 3 disables SUPER modes automatically |
| Lost of apprent wind speed | The autopilot no longer receives an apparent wind speed source,<br>True wind mode and SUPER modes no longer work:<br>- The pilot switches to apparent wind mode automatically if it is in true wind mode<br>- GyroPilot 3 disables SUPER modes automatically |
| Lost of VMG angle | The pilot no longer detects an optimal angle in VMG mode, it automatically switches to true wind mode |
| Lost of boat speed | There is no longer a source of speed for piloting or calculating the true wind. True wind and SUPER modes no longer work<br>- The pilot switches to apparent wind mode automatically if it is in true wind mode<br>- GyroPilot 3 disables SUPER modes automatically |
| Autopilot stop | The autopilot stops without action from the skipper. The autopilot stops by itself if:<br>- A motor driver is faulty<br>- The GyroPilot 3 temperature is too high<br>- The motor current exceeds 60A<br>- The rudder has been at a stop for more than 1 minute<br>- The requested pilot instruction is aberrant<br>- Loss of communication with the control for a period greater than "Time before cut-off" seconds. Loss of compass for longer than “Time to power off” seconds.<br>- Loss of rudder angle for a period greater than "Time before cut-off" seconds. |
| Command refused, tiller activated | When using a tiller, several situations prohibit setpoint changes when using this mode. |
| Gyrometer drift too high | The autopilot's internal IMU seems to be faulty and does not respect the performance requirements to allow quality piloting. Have the driver checked by the after-sales service. |
| Driver initialization to be performed | This is the first time the driver has been used. The pilot needs to test the cylinder and the behavior of the rudder angle before any use. Follow the procedure ($ Rudder initialization )<br><br>The pilot also requests a rudder initialization again after a modification of the actuator, clutch or rudder angle settings. |
| case orientation fault | Detection of a pilot unit orientation fault! The pilot must be fixed on a vertical wall of the boat, the connectors pointing downwards($ Automatic detection of the case verticality ) |

| | |
|---|---|
| | It is necessary to check if the GyroPilot 3 has not come off the wall |
| Defining a navigation sector | There is no true wind angle, therefore the pilot does not know its pace or its tack. It does not know which way to act during a SUPER mode setpoint correction.<br><br>SUPER modes cannot be used |
| heel angle unavailable | Case 1: the autopilot does not detect a heel source to activate the heel mode<br>Case 2: the autopilot has just been installed, he locks the list angle mode for a few moments to find its orientation in relation to the boat as a priority ($ Automatic detection of the case orientation ). |
| Gust mode unavailable | There is no true wind speed, we cannot activate the gust mode. |
| Autopilot temperature too high | If the temperature of the autopilot exceeds 80°C the alarm is triggered. If the temperature exceeds 110°C the pilot stops. |
| Electrical intensity too high | If the intensity of the average pilot exceeds 25A the alarm is triggered. The pilot try reduces the intensity sent to the actuator. If the average current exceeds 30A. the pilot stops to avoid its deterioration. |
| Faulty left low transistor | Low left transistor out of order. If the error is repeated, the computer must be checked by after-sales service |
| Faulty right low transistor | Low right transistor out of order. If the error is repeated, the computer must be checked by after-sales service |
| Faulty left upper transistor | Upper left transistor out of order. If the error is repeated, the computer must be checked by after-sales service |
| Faulty right upper transistor | right upper transistor out of order. If the error is repeated, the computer must be checked by after-sales service |
| Clutch fault | Clutch fault. If the error is repeated, the computer must be checked by after-sales service |

Several alarms can potentially be triggered at the same time. In the GyroPilot 3, a prioritization logic avoids having several alarms at the same time.

The acknowledgment of the alarm on a display is done manually by pressing: "OK" on the nke display or automatically after 20 seconds. Each acknowledgment suspends the alarm for several minutes. The suspension time is dependent on each alarm.

If the same alarm returns, the suspension duration doubles with each acknowledgment. For example, if you lose the compass, the alarm will ring for the first time. It will be repeated a first time 5 minutes later, then again 10 minutes after the first repetition, then 20 min, 40 min, 80 min etc... The compass loss alarm will therefore be repeated 15 times over 90 days of navigation without having stopped the autopilot.

## 5.4. *INTERNAL DRIVER PARAMETERS*

The GyroPilot 3 internal memory is used to store all the information which allows for a more complete diagnosis to improve its behaviour or to store settings data. Access to the memory is via the nke TopSailor software. The latter can be downloaded free of charge from the nke marine electronics website : https://nke-marine-electronics.com/software/

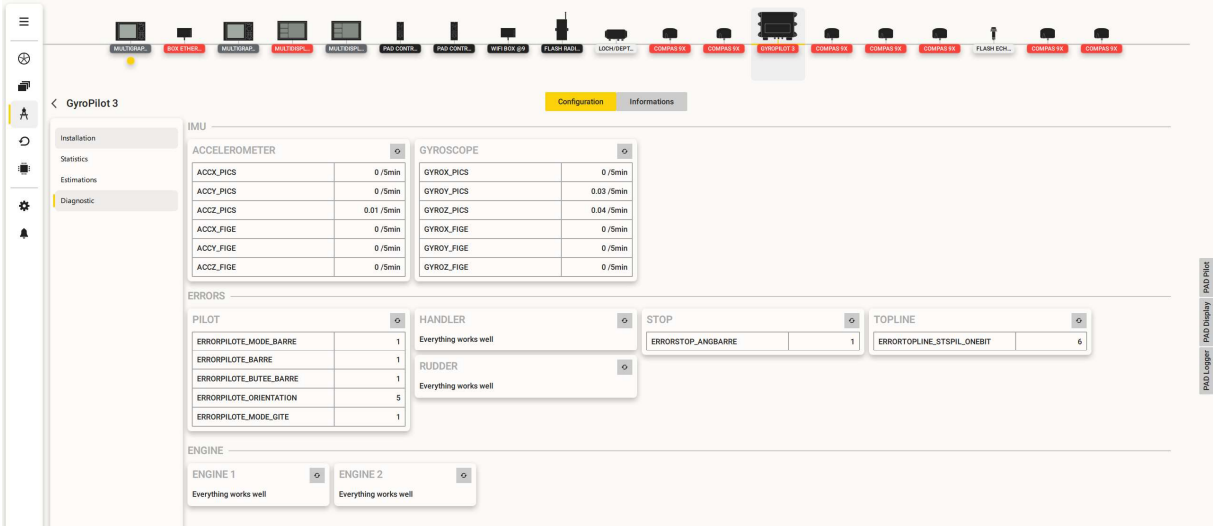



**Figure 2 : TopSailor view of GyroPilot 3 diagnostics**

# 6. EVOLUTION OF THE AUTOPILOT

## 6.1. *GYROPILOT2 / GYROPILOT3 IMPROVEMENT*

- CFP/RP configuration without hardware modification.
- 6 LEDs on the front panel to indicate the status of the autopilot.
- New high-performance electronic components.
- Faster algorithm with more accurate steering control.
- Enhanced pilot problem diagnosis.
- Securing of the steering system.
- Improvement of the tacking algorithm.
- Improved MOB algorithm with gybe "heave to" logic and logic for use of all sensors regardless of the configuration preceding the new order.
- Suppression of the rudder stroke if the rudder angle sensor is no longer available.
- Wind tables are taken into account in the autopilot's calculations.
- Message on bus when none execution of initialisation is detected.
- In case of overload, the processor keeps steering. It limits the intensity to 25A for the duration of the overload. However, if this lasts longer than 10 minutes, the GyroPilot 3 stops steering.
- Linear rudder sensor management.
- Improved Tiller algorithm with speed feedback control.
- Polar mode.
- Heel angle mode.
- Gust mode.

## 6.2. *IMPROVEMENT OF GYROPILOT 3 VERSIONS*

### 6.2.1. *GyroPilot 3 v1.1 version*

The improvements compared to the GyroPilot 3 v1.0 version are as follows:

- Resolution of the problem on the management of autopilot instructions coming from different command pilot.

### 6.2.2. *GyroPilot 3 v1.2 version*

The improvements compared to the GyroPilot 3 v1.1 version are as follows:

- Added internal IMU control module.
- Addition in memory of the duration of operation since the last change of estimated case orientation.
- Compatibility with CRP type actuator and DC type clutches
- Improved apparent wind mode and true wind mode.
- Improved heel angle mode: no more variation of heel target with a principal mode instruction change.

### 6.2.3. *GyroPilot 3 v1.3 version*

The improvements compared to the GyroPilot 3 v1.2 version are as follows:

- Improved driver LED management
- Modification of the pilot speed alarm activated only pilot activated: no more triggering at anchor.
- Improved prioritization of pilot alarms and automatic acknowledgment
- Activation of the box orientation control alarm
- Fixed the heading alarm bug in pure inertia
- Improvement of the tacking and jibe algorithm
- Improved real wind calculation.
- Integration of processor X wind and speed data
- Improved GPS mode
- Improved tiller, 5 different operating modes
- Reading of the "*Delta SP*" value always negative when the autopilot comes upwind and positive when the autopilot goes downwind.
- Improved bar initialization to learn about the behavior of the actuator.

#### 6.2.4. ***GyroPilot 3 v1.4 version***

The improvements compared to the GyroPilot 3 v1.3 version are as follows:

- Fixed the issue of lost connection between driver and control
- Product traceability with the Hardware identifier
- Added a 1° tolerance on the rudder limits for the color of the feedback LED
- Improved Battery/power alarm

# 7. SPECIFICATIONS

## 7.1. *TECHNICAL SPECIFICATIONS*

| Parameter | Value |
|---|---|
| Dimensions | 210 x 150 x 72 mm / 8.26’ x 5.90’ x 2.83’<br>(length x height x thickness) |
| Weight | 650g, case only / 1.43 lbs<br>3.2 kg / 7.04 lbs with cable (3 x 6m) |
| Power supply | 9V – 32V DC |
| Power consumption at 12 volts | <100mA without hydraulic ram in Auto |
| Waterproofing | Protection rate: IP 67 |
| Power cable | ***Gyro3 Power Input cable*** (SF000453) length 6m / 20ft |

## 7.2. *DEFAULT VALUES*

| **Parameter** | **Default value** |
|---|---|
| Steering mode | Compass |
| SUPER mode | OFF |
| Gain | 3 |
| Rudder coef. | 12 |
| Counter rudder | 3 |
| Wind smoothing | 4 |
| Tacking angle | 100° |
| Tacking speed | 12° / second |
| Shut-off delay | 20 seconds |
| Dead angle | 1.0° |
| Rudder offset | 0° |

| | |
|---|---|
| Speed reference | Surface speed |
| Man over board | Crew mode |
| Upwind/downwind limit | 90° |
| Heel angle gain | 1 |
| Wind limit heel angle mode | 5° |
| Leeward limit heel mode | 5° |
| Gust gain | 1 |
| Gust limit | 10° |
| Gust filtering | 100 seconds |
| Heading/Wind alarm | OFF |
| Battery alarm | 10 Volts DC |

# 8. LIABILITY

NKE MARINE ELECTRONICS liability can only be engaged if there is proof of its responsibility in the event of a fault. With regard to the supply prototypes or pilot products, the customer acknowledges that NKE is only bound by a simple obligation of means; that the risk of malfunctions of these products is inherent in their nature, and that NKE can, therefore, not be held liable in this respect.

NKE MARINE's liability is in any case expressly excluded in the event of (1) force majeure, (2) fault, negligence, violation or failure by the customer to fulfil their own legal, regulatory or contractual obligations resulting from the application of the general conditions of sale and (3) in the case of use of the products for purposes other than those for which the product is intended or due to storage or use that does not comply with the instructions and recommendations for use.

NKE MARINE can under no circumstances be held liable for compensation related to indirect and/or immaterial damage incurred by the customer or the latter's customers, such as turnover, margin, or customer loss, and harm to image, nor in the event of non-attainment of the return on investment expected or anticipated by the customer or the latter's customers, as a result of the use of the products.

In all cases, should NKE MARINE be held liable, the maximum amount of compensation due by NKE, all sums combined, cannot exceed the lowest of the following amounts: (1) twice the amount of the related order before tax, (2) €15,000 (fifteen thousand euros).