# Sailing under H5000 Autopilot

PID: Proportional Integral and Derivative | ExpS : Expert System
SAC: Steering Algorithm Control | PS: Performance Sail algorithms

Heel & Motion correction for Wind **ON.** Leeway-corrected wind **OFF.** Strong/max **TWD** damping

*KaliX*

| Settings | Type | Description | KaliX |
|---|---|---|---|
| **Rudder Gain** *(Use tuning chart)* | PID | **Reduce when running & at higher speeds**. Said to be less important at higher Performance levels. KaliX 0.4-0.9. [0.35-0.45 for 12-m Racing yacht, 0.65-0.80 IMOCA 60] | **0.43** (0.43) 0.37-0.60 > 0.90 |
| **AutoTrim** *(Use tuning chart)* | PID | Could provoke oscillating turns that increased over time. Was removed from SAC (v2.0.0.2); only controls time period for Weather Helm learning routine to achieve steady heading by correcting persistent course errors. Recommended setting: boat length in feet. Reduce for more responsive WH, increase if WH varies up & down. | <u>043</u> (067) |
| **Counter Rudder** *(Use tuning chart)* | PID | Adjust to avoid overshooting & creeping in turns, to keep on course in waves. [0.9 for 12-m Racing yacht] | 01.1 0.9-1.3 |
| **Deadband** *(Use tuning chart)* | SAC | Use as a **sea-state parameter: increase to follow the waves** & avoid excessive corrections. | AUTO [0.5-2.0 |
| Cruising Speed | Setup Failsafe | The Boat Speed at which Autopilot parameters are applied at **100% (more at low Boat Speed, less at higher)**. Can be used to tune the Autopilot by shifting the response curve (Perf 1 mainly): lower CS strengthens response; higher CS weakens response. Perform Sea Trials at or near that speed. Also Failsafe for Boat Speed. | 8 |
| Adapt | SAC | Allows the Pilot to continuously learn steering variables for current conditions. Values are **stored every 30'**. | **Disabled** |
| **Wind Mode** | SAC | The Wind Steering Mode can use TWA or AWA, depending on user selection (AWA or TWA) or system criteria (Auto: AWA if TWA<70°; TWA if TWA≥70°). **The Pilot will not auto-switch whilst it is in use!** The Auto setting simply selects AWA or TWA when the Pilot is activated. Do check the Wind Angle that is actually selected. | Auto *AWA upwind TWA downwind* |
| **Response** (Perf Level) | SAC | Adjusts **settings** (DB, RG, RS…) to increase course-keeping performance, using more power. Use lowest level that provides good steering results. In light conditions, Perf 1 (traditional PID control algorithm only) can give good results. Levels 2 to 5 implement greater weighting of B&G's PS algorithm. Perf 3 good all-round level. | **3** 1 to 4, 5 |
| *Auto Response* | ExpS | Allows the Pilot to increase Performance level to improve course keeping. The Response will increase **slowly** from the user's Perf Level setting to adjust to environmental influence requiring more response from the Pilot. The Perf Level will automatically return to the user's Response setting once conditions have improved. | Normal *(if used) economy, sport* |
| *Recovery Function* | ExpS | **Instantaneously** increases Response to **Perf 5** to quickly recover from one-off event (e.g. wind shift, wave). Returns to user setting after 15" or when heading error has been corrected. Overrides Auto Response. | Medium *(if used)* |
| Limits | | Set TWA min, TWA max, Bear Away max, Cruising Speed, Rudder Limit, Off course, Low Boat Speed | 110/155/5/7/35/20/0.5 |
| **TWS Response** | ExpS | Compensates for **long-term changes** in wind speed. Applies a semi-permanent bear-away if the TWS has increased since the Pilot was engaged. Turn Gust Response off to set the gain initially. Max bear-away is 20°. | Enabled *Gain b/w 3 & 5* |
| **Gust Response** | ExpS | **Rapid reaction** to heel changes caused by gusts. Applies a pre-emptive temporary bear-away (on TWA target) during a gust, before it creates a course error. "Fast" bear-away and "slow" return to target TWA. Gust Limit: use 5 kts. **If Gust Response is used**, use TWS Response as well and set the gain for the TWS response first. | *Gain: start w/ 1 increase up to 5 Gust Limit: 5 kts* |
| *TWA Response* | ExpS | Multiplying factor that allows varying the amount of bear-away in response to Gusts b/w reaching & downwind | Enabled, 1.5 |
| **Heel Compensati** | ExpS | Protection against roll-induced broaching in heavy seas or high gust conditions by applying the correct amount of rudder compensation before adverse events become dangerous. Allow ~1 minute after engaging the Pilot for the weather helm to stabilise **prior to adjusting Heel gain**. | 0 (off) *If used: 1 (Low)* |
| **Tack Time Tack Angle** | SAC | The rudder control will be adjusted to enable faster or slower tacks and gybes. Try a value in the range 5-10 s as a starting point. Tack angle: applied in Auto Mode only; use 80°. **Adjust values for gybes**, or solo. | T: 8 s 80° G: 12 s 50° |

*Side label (Rudder Gain / AutoTrim / Counter Rudder / Deadband):* Use tuning chart

*Side label (TWS/Gust/TWA/Heel):* Between TWA$_{min}$ & TWA$_{max}$

**Boat Speed**: leave at 0 [automatic source selection]. In case of speed failure (STW and SOG), then try to match the speed manually. Over-estimating speed will under-steer and vice versa.

v6.3 CHECKED

*Left vertical margin:* **Autopilot Modes:** Standby (S) | Auto (A) | Wind (W) | NoDrift (ND) | Navigation (N) | Non Follow Up (NFU) – to steer the boat manually

# H5000 Autopilot Commissioning

PID: Proportional Integral and Derivative | ExpS : Expert System
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<u>Prerequisites</u>: carefully installed system, meticulously calibrated sensors.

*KaliX*

| | Parameter | Type | Description | KaliX |
|---|---|---|---|---|
| **Dockside** | Rudder Feedback | Setup | Select *External* for network sources or *Internal frequenc*y for RF300 sensors. KaliX is equipped with the RF25 feedback unit: use "External". | External |
| | Boat Length | Setup | Used to assign a set of initial Autopilot parameters. Not critical. Use 13.10 m on KaliX for consistency with other Boat Length inputs elsewhere in the B&G system. | 13.10 m |
| | Drive Voltage | Setup | Set the *Drive Voltage* to 12 V or 24 V depending on the onboard electrical system. 12 V on KaliX. | 12 V |
| | Max Rudder | Setup | During Dockside commissioning, set the values of *max starboard* and *max port* angles for the rudder as close as possible to reality for optimum AP performance. 45° on KaliX *(system uses -42° to +42° in "Follow Up" mode)* | +45° -45° |
| | Speed Source | SAC | Allows selecting input for Boat Speed between *Automatic* (0) and a *Fixed* value (specify speed in kts), overriding other sources. Keep at 0. In case of speed failure (STW and SOG), then try to match the speed manually. | 0 |
| **Rudder Drive** | Drive Voltage | Setup | *Don't know why it shows up again after Dockside Commissioning* | 12 V |
| | Drive Engage | Setup | The *Auto* setting is for future applications. Always use *Clutch*: it allows steering manually from the helm in Standby mode. When engaging the Autopilot, the clutch yields control to the ram and locks out the steering. | Clutch |
| | **Motor Output** | Setup PID | Amount of available power to achieve correct rudder speed (8°/s preferred, see Rudder Test). The setting allows the user to change the **Rudder Speed** learned during Dockside commissioning. Increase Rudder Speed sailing downwind. Always perform a new Autotune after adjusting Rudder Speed. | **90%-100%** |
| | **Rudder Deadband** | SAC | Prevents rudder from hunting. Adaptive function; optimizes Deadband for boat speed and rudder load. Manually adjustable (use lowest possible value); wide deadband ⇒ inaccurate steering; narrow deadband ⇒ instability. A **sea-state parameter: increase to follow the waves** & avoid excessive corrections. Check Rudder stability in Auto. | Auto: MIN<br>Min 0°<br>Max 4° |
| | Rudder Feedback | Setup | The rudder feedback calibration will set the correct relationship between the physical rudder movement and the rudder angle readout. *Make sure the RF unit is perfectly installed to obtain a linear and symmetric response.* | Perfect |
| | Cruising Speed | Setup Failsafe | Set point at which all the standard Pilot setup parameters are used at 100% of their input value. Use a value close to actual CS [for KaliX, 7 kts; if possible 8 to match setting]. B&G now (v2.0.0.2) recommends using 8 (from 12). | 8 |
| | Rudder Test | Setup | A timing test that detects minimum power to drive the rudder [**Motor Output**] and reduces the rudder speed if it exceeds the maximum preferred speed (**8°/s**) for autopilot operation. Manually centre the rudder before the test. | **95%** (10.5°/s) 8°/s: 76% |
| **Autotune** | **Cruising Speed** | **Setup** | Perform Autotune at this speed [KaliX: 7 kts; 8 kts if possible]. *In Perf 1, can be used as a Pilot **tuning parameter*** | 8 |
| | **Rudder Gain** | Setup PID | **Critical** parameter (w/ CR). **Ability to maintain the course**. Changes the magnitude of the rudder angle that is used, and how quickly it is applied, to get back onto course. Autotune: starting value. | 0.43 (0.37) 0.37-0.60 > 0.9 |
| | **Counter Rudder** | Setup PID | **Ability to make the turn** (Boat Lag); briefly superimposed on the proportional response caused by the heading error in order to stop it overshooting the required heading. AT: starting value. | **01.1** (1.0) 0.9-1.3 |
| | *Advice* | Setup | Before AT: Performance Level at 1; turn off all options; check Rudder zero; complete series of large (≥ 90°) turns using 10° key. During AT: if rudder aggressive, reduce Motor Output. After AT: **HOLD HELM**! Head on cardinal headings in Auto, check all modes; engage AP at different wind angles. | *Boat Speed for AT: Calibrate Speed & Compass. Verify Rudder zero. Sea Trial at BS close to average cruising speed, 7-8 kts for KaliX.* |

*"Mast height" = distance b/w 3D Motion & Wind sensor [22.30 m for WS730S]. Boat Speed: if adjusted manually, over-estimating speed will under-steer and vice versa.*

v6.3 CHECKED | Do not change