H5000 Pilot: Advanced User Information

About

This document provides further information on core setup features and also introduces detailed descriptions and use advisories for the features found under Advanced Mode which include the Performance Sailing (PS) algorithm and Expert Systems.

IMOCA 60 advisories are included for Vendee Globe 2016 teams.

This document should be used alongside the standard Operation and Installation manuals for advanced users only. Note that some features are only available if Advanced mode is enabled on the H5000 Pilot Keypad (Setup > Local > Advanced Mode).

Functions

The items covered by this document are:

Rudder Gain 2

Cruising Speed 3

Speed Source 4

AutoTrim 5

Adapt 6

Tack Time 7

Wind Mode (App or True) 8

Response Level 9

Auto Response 10

Recovery Mode 11

Heel Compensation 12

Gust Response 13

TWS Response 14

TWA Response 15

APPENDIX A: H5000 Pilot - Menu Structure 16

APPENDIX B: H5000 Pilot – Speed selection sequence 18

Rudder Gain

Type

Setup

What is it?

Rudder Gain controls the amount of rudder applied for a given amount of course error.

What does it do?

In simple terms, when the Rudder Gain is increased the Pilot will apply more rudder per degree of heading error.

Advanced User Notes

- Linked to cruising speed, Rudder Gain is used in Perf 1 response level, it is used with less effect in Perf 2-5 levels. Rudder gain is progressively faded out as the response level is increased, in favour of the PS algorithm which uses a fixed table with set gain parameters based on the performance boat mathematical model.

IMOCA 60 Advisory

Recommended settings are in the range **0.65-0.80**.

Control

Installation > Commissioning > Sea Trial > Rudder Gain

Cruising Speed

Type

Setup (and Failsafe)

What is it?

Cruising Speed is a set point at which all the standard Pilot setup parameters are used at 100% of the input value. It is recommended the cruising speed is set to a value close to the speed at which the AutoTune process is completed if possible. For most sailing boat this will be 5-8 Knots.

Cruising Speed is used as a failsafe boat speed input if Boat Speed, SOG or manual speed are all invalid.

What does it do?

In simple terms, if the Boat Speed is less than the Cruising Speed setting, the Pilot will apply more rudder for a given course error. If Boat Speed is greater than the Cruising Speed setting, the Pilot will use less rudder for the same course error.

Advanced User Notes

- Cruising Speed is used extensively in Perf 1 response level, but has less effect in Perf 2 -5 as the Performance Sail (PS) algorithm has a greater weighting as you move up the response levels, PS does not use the Cruising Speed parameter so the effect naturally becomes less.

IMOCA 60 Advisory

While it is normal to set the Cruising Speed to the speed at which AutoTune is carried out (recommended at high engine speed and flat water), in practice the best Cruising Speed for the IMOCA 60 is around **12 knots**.

Control

Steering > Limits > Cruising Speed

Speed Source

Type

Steering Algorithm control

What is it?

A manual control of boat speed input, to allow use in the case of unreliable speed reading.

What does it do?

Allows the user to select between automatic (boat speed, backed up by SOG) or a manually input speed.

Advanced User Notes

- 0 = Automatic
- 1-25 knots in manual setting
- Note that under-estimating the speed will tend to over-steer the boat, over-estimating the speed will tend to under-steer the boat.

IMOCA 60 Advisory

We recommend that this setting is left at the default of **0**. In the extreme case of speed failure (both boat speed and SOG) then you should attempt to match your estimate of the actual boat speed.

Control

Steering > Speed Source > Manual

AutoTrim

Type

Steering Algorithm control

What is it?

AutoTrim corrects for persistent course errors by continuously monitoring and learning the rudder offset.

What does it do?

When the vessel has a constant heading error due to external forces such as wind or trim the AutoTrim function corrects for this by dynamically adjusting rudder offset based on the most recent measurements from the rudder.

Advanced User Notes

- The AutoTrim value is reset every time the AUTO mode is entered or when a course change of greater than approximately 20° is made. The time period used in the AutoTrim function may be adjusted by the user, but it is advised that this is left at default settings
- The Performance Sail (PS) algorithm used in Perf 2-5 will progressively override this feature with the PS WeatherHelm feature.

IMOCA 60 Advisory

Recommended setting is **60 seconds**.

Control

Installation > Commissioning > Sea Trial > Auto Trim

Adapt

Type

Steering Algorithm control

What is it?

This is a software feature that continues to learn variables that are essential for steering performance.

What does it do?

Allows to Pilot to learn steering variables for the current conditions. The Pilot will continue to adjust internal variables that are essential for steering performance, e.g. rudder/turn-rate ratio. Every 30 minutes the Pilot will save the latest values into stored memory.

Advanced User Notes

- When enabled these internal variables are optimised during the session in response to the yacht's behaviour
- Disabling this feature will lock the variables.

IMOCA 60 Advisory

We recommend that this setting is **Enabled.**

Control

Installation > Commissioning > Sea Trial > Adapt

Tack Time

Type

Steering Algorithm control

What is it?

A control that allows the user to control the speed of a Tack or Gybe manoeuvre.

What does it do?

Adjusts the rudder control during a tack to allow faster or slower tack/gybe manoeuvres.

Advanced User Notes

- If the boat fails to complete a tack by due to stalling close to head-to-wind, try reducing the tack time
- Consider tack time to be equivalent to “use more rudder” (lower tack time), or “use less rudder” (higher tack time) as opposed to a definitive controlled timing of a tack or gybe. The actual time will be dictated by tacking/gybing angles, sea-state, wind speed and boat speed among other variables.

IMOCA 60 Advisory

We recommend that a range of **5-10 seconds** is used as a starting point.

Control

Sailing > Tack Time

Wind Mode (App or True)

Type

Steering Algorithm control

What is it?

The Wind steering mode can use TWA or AWA, depending on user selection or system criteria.

What does it do?

When the user engages wind steering mode. The Pilot will use the wind mode to select either AWA or TWA angle as the current target, depending on the settings below:

1) AWA – steers exclusively to a set Apparent Wind Angle
2) TWA – steers exclusively to a set True Wind Angle
3) Auto – switches wind angle mode, using AWA upwind and TWA downwind

Advanced User Notes

- If the user has enabled wind mode to be “auto” the Pilot will select either AWA or TWA appropriately. The change-over point is at 70 degrees TWA. At angles less than 70 degrees TWA the Pilot will select AWA and at angles greater than 70 degrees TWA the Pilot will select TWA.
- The Pilot will not auto switch between AWA and TWA whilst it is engaged, it only sets this feature when initially engaged.

IMOCA 60 Advisory

Recommended setting is to use **AWA** for upwind work and **TWA** for downwind work. This may be achieved by using the **Auto** selection, but remember to disengage/re-engage the Pilot if you have a significant change in wind angle – this reselects the mode.

Control

Sailing > Wind Mode

Response Level

Type

Steering Algorithm control

What is it?

Provides the user a simple control to trade off course keeping performance vs. power use.

What does it do?

Adjusts the settings of multiple functions (deadbands, gain, velocity control etc.) to increase course keeping performance as the response level is increased from Perf 1 up to Perf 5. Think of it as a volume control: loud and powerful? or quiet and economic? Typically, a user should run the lowest Response level they are happy with.

Advanced User Notes

- Setting the Response level too high can be counter-productive - the rudder will be adjusted all the time for minor course errors, consuming a lot of power and putting unnecessary wear and strain on steering components.
- The user may choose to use the Auto Response feature to allow the Pilot to increase (but not decrease) the user set response level based on measured course keeping performance (see Auto Response).
- Perf 1 uses a traditional PID control algorithm, Perf 2-5 levels implement greater weighting of the B&G Performance Sail algorithm.

IMOCA 60 Advisory

Conditions dependent. Response mode should be adjusted based on wind conditions (strength and stability) and sea state (flat vs. rough). In stable winds on flat water you should be able to run the minimum level.

Note that **Perf 3** has good all-round performance, though you will likely use **Perf 4** or **Perf 5** in the more serious conditions. Do not be afraid to use **Perf 1**, this setting provides good steering in all non-extreme conditions.

Control

Response > Rate

Auto Response

Type

Expert System

What is it?

Allows the Pilot to increase response Perf level to improve course keeping.

What does it do?

Automatically increases Perf level to reduce heading error. The response setting will be increased slowly from the user's Perf level setting to maintain course if conditions change requiring more response from the Pilot. The Perf level setting will automatically return to the user's response setting once conditions have improved.

Advanced User Notes

- User limit setting: Set to Economy, Normal or Sport to control the course error sensitivity used by the Pilot to determine when it increases the response mode
- The Pilot will slowly increase the user set response level until the conditions have improved where it will return to the user set level. The mode will not reduce the response level below the user set level.

IMOCA 60 Advisory

If you elect to use this feature we recommend the **Normal** setting, the Sport setting can be too sensitive on an IMOCA 60 causing the Pilot to increment the response to Perf 5 quite quickly.

Control

Turn feature On/Off:	> Steering > Auto Response >
Adjust sensitivity:	> Steering > Auto Response > (Economy, Normal or Sport)

Recovery Mode

Type

Expert System

What is it?

Allows the Pilot to return to course quickly after one-off wave impact knocks the boat off-course.

What does it do?

Automatically Increases response to the maximum (Perf 5) setting for a short period, providing maximum response to regain desired course. Allows the user to save power by running a response level relevant to the typical conditions rather than the worst case conditions expected.

Advanced User Notes

- User limit setting: May be set to Wide, Medium or Narrow to control when the feature is activated
- Recovery Mode will override the Auto Response algorithm.

IMOCA 60 Advisory

If you elect to use this feature, we recommend the **Medium** setting.

Control

Turn feature On/Off:	> Steering > Recovery >
Adjust Off Course value at activation:	> Steering > Recovery > [Narrow, Medium or Wide]

Heel Compensation

Type

Expert System

What is it?

To react rapidly and proportionately to any change in heel angle before it causes a course error.

What does it do?

Applies a pre-emptive rudder correction before any significant off course error occurs. Calculated by the real-time boat model and based on multiple inputs including: wind speed, gust factor, apparent wind angle, heel angle etc.

Advanced User Notes

- User gain control: If in doubt apply a lower gain (the weather helm algorithm will correct for longer term effects)
- Allow ~1 minute after engaging Pilot for weather helm to stabilise prior to adjusting Heel Gain.
- Heel Compensation is scaled progressively to 0 as TWA get towards Max TWA to reduce rudder movement at low angles.
- No course change that will exceed the safety limits will be commanded by this feature.

IMOCA 60 Advisory

If you elect to use this feature, we recommend the Response Rate is set to **1**.

Control

Turn feature On/Off:	> Sailing > Heel Compensation > Enable
Heel response level [1 low - 10 high]:	> Sailing > Heel Compensation > Response Rate

Gust Response

Type

Expert System

What is it?

To react rapidly and proportionately to any change in wind speed before it causes a course error or broach.

What does it do?

Applies a temporary change (bear-away) to the TWA target during a gust. The target will return to the original target after a short time.

Applies a 'fast' bear away and a 'slow' return to target TWA.

Advanced User Notes

- User gain control: start with a low value and increase. This setting should be adjusted so that the boat *just* applies enough rudder during gusts to prevent the boat being over-powered.
- "Gust" is defined as a deviation from the average wind speed. If any increase in wind speed remains in place (i.e. the average wind speed increases) then the Gust Response will slowly reduce to zero. For changing conditions where the wind is increasing and decreasing in longer periods then we recommend the use of the Adaptive Wind Control ("TWS Response") function instead of, or as well as, Gust Response.
- If you use TWS Response it is recommended that you set the gain level for that feature first, then set the Gust Response gain
- Only applied between min TWA and Max TWA parameters (Menu > Steering > Limits > [TWA Minimum, TWA Maximum])
- No course change that will exceed the safety limits will be commanded by this feature
- Excessive gain can cause a temporary bear away (within the safety limits)

IMOCA 60 Advisory

We have experienced mixed results using Gust Response on IMOCA 60s. Using the TWS Response feature seems more effective for this class. If you use Gust Response, we recommend you use it with TWS Response. If you elect to use the feature we recommend: Gust Limit = **5kt**, Response Rate **between 3 and 5**.

Control

Turn Gust Response On/Off:	> Sailing > Gust Response > Enable
Set the minimum Gust to activate feature:	> Sailing > Gust Response > Gust MIN [knots]
Adjust Gust Response level (1 slow, 10 fast):	> Sailing > Gust Response > Response Rate

System-wide settings relevant to this feature:

Adjust TWS Response based on TWA:	see "TWA Response"
Set TWA Limits:	> Sailing > Limits > TWA Minimum [default 110 TWA]
	> Sailing > Limits > TWA Maximum [default 165 TWA]

TWS Response

Type

Expert System

What is it?

TWS Response allows the Pilot to automatically bear-away to a lower target angle if the wind speed increases above the level it was when the Pilot was engaged.

What does it do?

Applies a semi-permanent change (bear-away) to the TWA target if the TWS has increased since the Pilot was engaged. If the TWS drops back to the initial mean TWS value (or below) then the Pilot target will come back to the originally commanded TWA value. This allows the boat to be driven faster and also assists in broach prevention.

Advanced User Notes

- User gain control: start with a low value and increase
- It is recommended that you set up TWS Response gain with the Gust Response turned off initially
- This feature takes longer to effect the boat's TWA angle than Gust Response
- Maximum bear away is 20 degrees
- Only applied between Min & Max TWA parameters, no course change that will exceed the safety limits will be commanded by this feature.

IMOCA 60 Advisory

We recommend that this feature is **Enabled**, with a Response Rate **between 3 and 5**

Control

Turn TWS Response On/Off:	> Sailing > TWS Response > Enable
Adjust TWS Response level:	> Sailing > TWS Response > Response Rate [1 slow - 10 fast]

System-wide settings relevant to this feature:

Adjust TWS Response based on TWA:	see “TWA Response”
Set Maximum Bear Away Angle:	> Sailing > Limits > Bear Away MAX
Set TWA Limits:	> Sailing > Limits > TWA Minimum [default 110 TWA]
	> Sailing > Limits > TWA Maximum [default 165 TWA]

TWA Response

Type

Expert System settings

What is it?

Allows the user to vary the amount of the amount of Gust bear away effect between reaching and downwind angles.

What does it do?

It is normal to require a larger bear-away for a given gust at higher wind angles (reaching) than lower angles (broad reaching). TWA Response allows the user to adjust the variation between the two extremes of the wind range between the Max TWA limit and the Min TWA limit.

Advanced User Notes

- User gain control: start with a low value and increase
- The setting is a simple multiplier – so if the setting is “1.5” then the bear-away at the Min TWA (110 by default) will be 1.5 times the bear-away applied at Max TWA (165 by default)
- Used in Gust Response and TWS Response features

IMOCA 60 Advisory

We recommend that this setting is left at, or close to, the default of **1.5**.

Control

Sailing > Gust Response > TWA Response

APPENDIX A: H5000 Pilot - Menu Structure

MENU				VALUE
Response				Perf 1
				Perf 2
				Perf 3
				Perf 4
				Perf 5
Sailing	Wind Mode			Auto
				Apparent
				True
	Gust Response	Enable		On / Off
		Gust Minimum		1 - 10
		Response Rate		1 - 10
		TWA Response		0 - 5
	TWS Response	Enable		On / Off
		Response Rate		1 - 10
	Tack Time			2 - 50 seconds
	Tack Angle			50 - 150 degrees
	Heel Compensation	Enable		On / Off
		Response Rate		1 - 10
Steering	Auto Response			Off
				Economy
				Normal
				Sport
	Recovery			Off
				Narrow
				Medium
				Wide
	Limits	TWA Minimum		110 - 165 degrees
		TWA Maximum		110 - 165 degrees
		Bear Away Max		1 - 20 degrees
		Cruising Speed		2 - 50 knots
		Rudder Limit		10 - 45 degrees
		Off Course		5 - 35 degrees
		Low Boat Speed		0.0 - 3.0 knots
	Speed Source	Manual		0 [auto] - 25 knots
Installation	Commissioning	Dockside	Rudder Feedback	Internal Frequency
				Internal Voltage
				Internal Current
				External
			Boat Length	6 - 50 meters
			Drive Voltage	12 Volts
				24 Volts
			Rudder Calibration	Set Port End
				Set Starboard End
				Set Mid-Point
			Rudder Test	
		Sea Trial	Auto Tune	
			Rudder Gain	0 - 4
			Auto Trim	10 - 800 seconds

			Counter Rudder		0.5 - 16
			Adapt	Enable	On / Off
			Mid-Point		
	Rudder Drive	Drive Voltage			12 Volts
					24 Volts
		Drive Engage			Auto
					Clutch
		Motor Output			10 - 100 %
		Rudder Deadband			Auto
					Manual
		Manual Deadband			0.1 - 4.0 degrees
Installation (cont.)	Reset Pilot				Yes / No
	Source Selection				Auto Selection
					Compass
					Navigation
					Position
					Boat Speed
					Apparent Wind Angle
					True Wind Angle
					Heel Angle
					Rudder Feedback
Setup	Display	Day Mode	Red Backlight		On / Off
			Inverse Display		On / Off
			Contrast		1 - 10
		Night Mode	Red Backlight		On / Off
			Inverse Display		On / Off
			Contrast		1 - 10
		Lighting Group			Local
					Network
					1
					2
					3
					4
	Alarm buzzer				On / Off
	Language				English
					German
					French
					Spanish
					Italian
					Dutch
					Swedish
					Norwegian
	Local	Reset			Yes / No
		Advanced Mode	Enable		On / Off
	Key Beeps	Enable			On / Off
	Software Information				

APPENDIX B: H5000 Pilot – Speed selection sequence

