# INSTRUMENTS

# A+T Pilot user guide and Pilot Controller installation

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#### Conformity.

The A+T Pilot Control, interface cards and displays comply with the CE EMC directive 2004/108/EC and Level 2 of the Radio communications (Electromagnetic Compatibility) standard 2008

CE



# 1. Introduction

This user guide assumes familiarity with marine electronic navigation systems and basic PC software tools.

This guide covers:

- The A+T Pilot system and aspects of the Web-server interface which is needed to set up, commission, calibrate and carry out diagnostics.
- Installation of the A+T Pilot Controller and connection to pilot drive systems.

For installation of the Pilot Processor unit, see the **A+T ATP2\_Pilot Processor user guide**. The ATP2 and Pilot Processor are common hardware platforms.

For installation of the Pilot Head Display, see the A+T MFD\_PHD user guide

GNSS (Global Navigation Satellite System) is used to refer to GPS, Galileo, GLONASS and the other such positioning systems.

This document provides the background and explanation of how the Pilot works. Detailed 'how to' is not provided as this is generally intuitive from the web-server. Updates are continually produced reflecting feedback and system development.

Please visit: - <u>www.AandTinstruments.com/downloads</u> for the latest version of the manual and the Pilot software.



## 2. A+T Pilot features

The A+T Pilot is engineered to the highest standards and designed for racing yachts, superyachts and large cruising and classic yachts (motor and sail). There are three key components to the A+T Pilot:

#### **1. Pilot Processor**

The Pilot Processor is the 'brains' of the A+T Pilot and communicates via ethernet with the Pilot Control unit. The Pilot Processor utilises a web-server to setup and commission sensors and drives, and to manage advanced settings ensuring superior pilot performance

#### 2. Pilot Control unit

The Pilot Control unit, on command from the Pilot Processor, delivers drive power of up to 50A to reversible DC motor drive units, as well as drive signals for proportional valve and clutched/braked systems.

#### 3. Pilot Head Display (PHD)

At least one A+T Pilot Head Display is required to Start and Stop the pilot, and to send steering commands to the Pilot Processor

#### **Typical system structure**





# 3. Connectivity

The A+T Pilot system may be installed to operate as a stand alone system, however it is compatible with most common systems and data buses including:

- A+T ethernet
- Fastnet for compatibility with B&G H2000, H3000 and WTP2/3 instrument systems
- CANbus N2k compatible for use with N2k Pilot displays and chart plotters
- NMEA0183

# 4. Pilot commands

The A+T Pilot Processor will receive commands from:

- A+T PHD
- B&G H2000 & H3000 pilot displays
- N2k compatible systems with Pilot controls (displays and Chart plotter units)
- Web-server
- Tiller control NFU and FU

# 5. Pilot drives

The A+T Pilot Controller unit will drive:

- 9-32V DC electric motors (peak 50A)
- Hydraulic Proportional Valve (+/-10V or 4-20mA)
- Constant running Hydraulic Valve
- Reversible DC motor i.e. Rotary or Hydraulic Linear
- Clutch and Brake controlled systems

# 6. Web-server

Setup and commissioning of the A+T Pilot is via the web-server. The Pilot may also be controlled from the web-server. See the A+T ATP2 and Pilot Processor Manual for web-server connection instructions.

Connect to the Pilot web-server by entering the relevant IP address as described in the **A+T ATP2\_Pilot Processor user guide** in any web browser.

A+T Autop	pilot × +				-		×
← → ⊂	🛈 🛛 🔏 192.168.1.229	/autopilot/home		… ⊠ ☆	II\ E	] 📽	≡
🗮 Menu		1	Start			4	
	Pilot Home			ATP	ilot	ŀ	lold
	This webserver provides confi the A+T Autopilot (ATPilot) sy	guration, perforr stem.	nance and diagnostic informa	ation on all aspect	s of		
	Pilot Status	STBY	Pilot Control	OK			
	Processor Temp	43.5°C	Supply Voltage	11.7V			
	Enclosure Temp	38.3°C	Supply Current	1.1A			
	Pilot Control Voltage	12.1V	Drive Current	A0.0			
	Drive Temperature	20.2°C	Clutch Current	A0.0			
	Contact						
	Phone: +44 1590 718182 (2	4/7)	Email: support@A	AandTInstruments.	com		

The Pilot banner is always at the top of the web-server page.





The Alarm Icon will be Amber if there are active Warnings and Red for active Alarms



Clicking on the A+T logo will return you to the Pilot web-server Home Page.



# 7. Pilot Operation

The A+T Pilot may be Started or Stopped from any PHD, the web-server, H2000/H3000 pilot displays or N2k pilot displays and pilot compatible plotters.

#### Web-server

- Select Menu > Pilot Control
- Select Pilot mode and send course and rudder commands



#### PHD

- Press Menu and scroll to Pilot Mode to change Pilot Mode
- In Power Steer mode <1 and 1 ▶ will command 10 degrees</li>



#### **Tiller Control**

Follow up and non-Follow up type levers in Power Steer mode



# **APPENDIX A - Pilot Control unit Installation**

#### 1. Mounting

The Pilot Control unit may be mounted in any location convenient to the Pilot drive power supply cable run, clutch/valve and Rudder sensors as required. It is recommended to orient the cable glands either vertically down or horizontally to reduce the risk of water ingress.

2. Pilot Control connections



#### 3. Power supply

The Pilot Controller requires one independent DC power input

- DRIVE SUPPLY 12 or 24v power with a fuse or circuit breaker per your drive specification, but not larger than 50A
  - When power is supplied to **DRIVE SUPPLY** the DRIVE SUPPLY LED will illuminate
- PILOT CONTROL SUPPLY The Pilot Control unit must receive power from the ethernet connection to the Pilot Processor. See 4. below. When power is supplied to the Pilot Control, the CONTROL SUPPLY LED will illuminate

#### 4. Ethernet network connection

There is one on-board ethernet connection. This must be connected to the Pilot Processor either via the A+T Instrument ethernet network, or preferably to Net1 or Net2 on the Pilot Processor.

When the ethernet network is connected and active the NET LED will illuminate.

Terminal	A+T Colour	Cat5e screened cable
TX+	Brown	White/Orange
TX-	Blue	Orange
RX+	White	White/Green
RX-	Green	Green
SCRN	Bare	Screen
+V	Red	White/Brown & Brown
0V	Black	White/Blue & Blue

**Note:** The +V and 0v connections use spare wires within cat5e cable. Twist together the White/Brown and Brown pair, and the White/Blue and Blue pair for connection to the +V and 0V terminals.

	NET	
	ТХ+	
	тх- 🕰	
	RX+ <b>  O</b> _)	
ETHERNET	RX- 🗛	
SC	REEN 🖁 🖸	
CONTROL +12	/240 🗛	
SUPPLY	0V <b>+Q</b> )	







#### 5. Rudder angle sensor

The Rudder angle input may be from either Potentiometer or Frequency type sensors.

Select your sensor output type by moving the header to the **FREQ** or **POT** position.



For A+T Rudder Reference Unit (ATRRU01)

- Wiring:
- Move the header to the **POT** position

SCREEN	Screen
RUDDER	Green
0V	Blue
POT V+	Red

Other sensors such as linear displacement and string pot potentiometer/voltage dividers may be used.

#### 6. Pilot Drive Connections

The A+T Pilot can drive most common drive types. See the relevant appendix for your drive type

APPENDIX B - Reversible DC motor i.e. Rotary drive or Hydraulic Linear APPENDIX C - Hydraulic Proportional Valve (+/-10v and 4-20mA types), and constant running or on demand hydraulic pumps

#### 7. Specifications

Power consumption	Watts
Weight	0.81kg
Operating temperature	-10 to +70 deg C



### 8. Mounting Template





# **APPENDIX B - Reversible DC motor drives**

Refer in the first instance to your Pilot Drive specifications.

VALVE/MOTOR 1	Drive A
VALVE/MOTOR 2	Drive B
VALVE 0V	Not used

Hydraulic Valve drives:

VALVE/MOTOR 1	Valve A
VALVE/MOTOR 2	Valve B
VALVE 0V	Valve A & B 0V



**Note:** The Pilot will discover the direction the rudder moves when power is supplied to VALVE/MOTOR 1 or 2 in dockside commissioning.

When VALVE/MOTOR 1 or 2 is activated the associated LED will illuminate.



# **APPENDIX C - Proportional Valve Drive Outputs**

Refer in the first instance to your Pilot Drive specifications.

These outputs are isolated low current signals designed to drive proportional valve controllers with either

- +/- 10V (Bosch/Rexroth)
- 2.5 to 7.5V (Danfoss)
- 4-20mA which provides the current loop power.



Depending on settings, the proportional valve outputs will output:

	100% direction 1	Stopped	100% direction 2
Bosch	-10V	0V	+10V
Danfoss	2.5V	5V	7.5V
4-20mA	4mA	12mA	20mA

The Clutch output can be used to control either a constant running pump or 'on demand' pump up with 10A continuous to 20A peak.

CLUTCH 1	+ V
CLUTCH 2	0 V





# **APPENDIX D – Set-up, Commissioning and Diagnostics**

#### Settings

Prior to commissioning, the A+T requires Setup of sensors, inputs and outputs on the webserver

#### 1. General Settings

Set your Instrument System Processor

- Standalone: No processor
- A+T: ATP1 and ATP2
- Legacy: B&G H2000/H3000, WTP2/3

Set System Bearing Mode to True or Magnetic



Obtain an IP address from a DHCP server or set a fixed IP





#### 3. Interfacing

#### 3.1 GNSS

Select Input Type and Source

#### 3.2 Heading

- Select Input Type and Source
- An Offset may be input if required

#### 3.3 Rudder

Calibrate Rudder sensor input parameters and Drive Limits

**NOTE:** Establish the actual degrees of rudder angle at the maximum physical limits that the rudder can be moved to and the position of 0 deg rudder angle before starting this calibration process.

A+TAutopilot → C <sup>4</sup> ∰ 0 ≝	× + 92.168.1.229/autopilot/rudder.php	)		•
Menu		Start		4
Rudder				
Set-up and calibrati carried out <u>here</u> . If the configuration	on for rudder input. This must on this page is changed, the ru	be done before docksio idder must be re-comm	le commissioning is issioned.	
Input Type:	A+T Pilot Control			
Live Rudder	Port Endstop @ 1509	<b>Centre</b> 2063	Stbd Endstop 2647	
OFF	-30.0 *	0 *	30.0 *	
Port Drive Limit	0		-27.00	
Stbd Drive Limit Autopilot Limit	0		27.00 15.0 *	
	OK	Cancel		

- 1. Enter the rudder angle in degrees to the Port Endstop, move the rudder to the maximum physical position to Port then press **Set Port Endstop**
- 2. Centre the rudder and press Set Centre
- 3. Enter the rudder angle in degrees to the Stbd Endstop, move the rudder to the maximum physical position to Port then press **Set Stbd Endstop**
- 4. The Pilot Processor will calculate and display the Port and Starboard Drive Limits that the Pilot will never exceed. This is to prevent driving against physical stops and vessel structure.
- 5. You may set the Autopilot Limit which is the maximum angle the Pilot will drive the Rudder while under way. This is to prevent violent vessel motion when large course change instructions are sent to the Pilot Processor.



#### 3.4 Tiller Control

- **Follow-up** non-spring loaded. Moving the lever commands a desired rudder angle that the Pilot will drive the rudder to, and stop when the desired angle is achieved
- Non follow-up spring loaded. Moving the lever commands the direction to move the rudder. When released and centred the Pilot will stop driving the rudder

#### 4. Commissioning

#### 4.1 Dockside Commissioning

This process measures the maximum rate at which the Pilot drives the rudder with no resistance due to vessel speed. The rate of change of rudder angle is continually monitored by the Pilot Processor and if, when the Pilot is running, the rate of change of Rudder angle is less than 25% of the calculated maximum a Warning is triggered.

Rudder Drive Type and Clutch Control Modes must be set before commissioning.

- Rudder Drive Type 5 options:
  - 1. Not Set Factory default only
  - 2. **Bang Bang** Pilot Drive power is ON or OFF only
  - 3. Variable Pilot Drive power is variable and tuneable
  - 4. Proportional (+/-10V, 4-20mA)
  - 5. Proportional (2.5 7.5V)
- Clutch Control Modes:
  - 1. Disabled
  - 2. Enabled drive system dependent
  - 3. Demand drive system dependent



#### **4.1.1 Variable Drive Settings**

Traditional **Bang Bang** systems instantly apply 100% power when commanded to move the rudder and instantly stop when commanded.

**Variable** and **Proportional** drive settings manage the drive system in order to reduce shock on the steering hardware and improve pilot performance. The **Variable** settings may also be set to limit high powered drive systems to improve performance, comfort and economy.

- For reversible DC motor type drives, the amount of power the Pilot applies to the drive system is adjusted
- For proportional valve drive systems, the Pilot will manage the valve position

Three parameters must be set to tune the pilot Variable Drive Settings.

- Max Drive % The proportion of the maximum possible drive rate to be used
- Min Drive % The proportion of the maximum possible drive rate to be instantly used when the drive system is commanded to move the rudder
- Run-Up Time the time taken for the pilot to get from Min Drive Rate to Max Drive Rate and from Max Drive % to Min Drive %



Figure 1 demonstrates the power supplied to a pilot drive for 10 seconds with a **Bang Bang** drive type and a **Variable** drive type with the **Max Drive %** = 90%, **Min Drive %** = 60% and a **Run-Up Time** = 4 seconds.



#### **Commissioning notes**

- Variable settings may be tested in the Dockside Commissioning process to observe behaviour of the drive system with different settings.
- It is important to note when setting Max, Min and Run-Up that a fully loaded rudder with Pilot engaged will behave differently to an unloaded rudder under Dockside Commissioning settings.
- It is recommended to **NOT** set the **Min Drive %** below 60% for this reason.

#### 4.1.2 Running Dockside Commissioning

#### WARNING: RISK OF SERIOUS INJURY OR DAMAGE

Dockside Commissioning will drive your steering system through its full range to establish drive direction and drive rates. Ensure the steering system is clear of all obstructions. This procedure must be undertaken at the dock or with the vessel stopped in open water.

Pressing **Start** will initiate the Commissioning procedure. A progress bar will indicate the status of the rudder timing procedure, and will indicate a pass if completed successfully.

If the procedure fails a Warning will be displayed with a description of the failure. Correct the cause of the error and repeat the procedure.

You may observe the rudder angle and rates in the time series graphs at the bottom of the page.

- Bang Bang centre the rudder and press Start. When completed successfully, press OK
- Variable and Proportional
  - 1. Enter values for Max Drive % and Min Drive %, and for Run-Up Time
  - 2. The **Rudder Timing Procedure** must be completed for all three **Variable** drive parameters.
    - 2.1. Select the first radio button and press Start.
    - 2.2. Repeat for the second and third radio button, then press OK.

Rudder Drive Type	:		Variable	~	
Adjust min and max drive percentages until satisfactory, then set the run-up time. Drive behaviour can be checked by clicking the rudder timing start button.					
Max Drive % 🕜	90 %	۲	Drive Rate	6.86°/s	
Min Drive % 🕜	60 %	0	Drive Rate	0.25°/s	
Run-Up Time 🚱	1 s	0			



#### 4.3 Sea Trial

The sea trial process will analyse the vessels response to changes of rudder angle while under way to establish the **Proportional**, **Differential** and **Integral** factors. These determine how the pilot applies rudder to steer the vessel.

#### Proportional factor

The amount of rudder to be applied for a given course change command (sometimes called Gain)

#### Differential factor

The amount of rudder required to reduce the rate of turn of the vessel (sometimes called counter rudder)

#### Integral factor

The amount of rudder required to maintain a steady course in an unbalanced system, for example on a single propellor motor yacht or weather helm of a sailing yacht.

C' û	🛛 🔏 192.168.1.229/autopik	ot/sea-trial.php		… ⊠ ☆	lii\ C
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Rate of C	Change of RoT :				OFF
Rudder:					OFF
Sea Trial				5.0 °	Start
	R	udder <b>E Ro</b> T	RoT'		
20					1.0
15					0.6
10					0.4
5					0.2
0					-0
-5					-0.2
-10					-0.4
					-0.8
-15					



#### **4.3.1 Running the Sea Trial**

You must set the number of degrees that the sea trial process will use.

#### WARNING: RISK OF SERIOUS INJURY OR DAMAGE

This process drives the steering system to predetermined rudder angles initiating turns. Ensure you have adequate safe navigable sea room, that the steering system is free of any obstacles, and all personnel are clear of all moving parts including wheels and tillers before proceeding.

- 1. At your chosen sea trial speed, steer a steady course and press Start.
- 2. You may observe the variables during the sea trial both in the text boxes and on the time series graph.
- 3. Once complete, your Pilot is ready for use.

#### 4.4 Advanced

You may adjust the **Proportional, Differential** and **Integral** factors from the sea trial based values.

These three variables are interrelated and caution must be used in adjusting these as some combinations may result in undesirable or unpredictable behaviour.

Any changes should be fully tested in open water before being relied upon for general use.



#### 5. Diagnostics

#### 5.1 All, CANbus, Statistics

View live raw data as used by the pilot for diagnostic purposes.

A+T Autopilet	× +				- a ×	A	l'Autopilet	× +					- a ×	A+T Auto	siet	× +					- 1
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Field Id Descr	iption Sender	Instance	Value	String	System Time	Devi	Data	PGN's	Unique	• Serial	Version	Can	Last Update	Device Uni	Id Version	Up Time Ne	(Rxd (/min) N	et Sent (/mir	a) Dropped	min) Corrupt	ed (/min) Sy
0x0500 Heading *T	CanBus	Address 1	225.585	225.58°T	15:57:58.378		Source		ID	Mmbor		Addross	Timo (UT)	ATPilot Inter	nal Version : 1.03	0d 04:20:13	\$761	1301	10	0	0 16
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x0711 Rudder Angle *	Drive Unit	Internal	-0.974729	-1.0°	11:48:06.760			of Turn						Drive Unit	Internal 2.1	1.05	17:62:29	3 0	0	- 0 - U	1 915
x0711 Rudder Angle "	Autopilot	Internal	-0.974729	-1.0*	11:48:07.251			Apple 12/207						Pilot Interfac	e Version	: Ldr Ver:	24				
e0720 Barometer (mba	r) Pilot Interface Board	Internal	103257	1032.6 mb	15:57:57.636			W20126003						Board	Internal 0.51	1.00	01:47:31	16 142	0	12 0	0 16
0730 CPU Temperatu	re °C Autopilot	Internal	45.25	45.2°C	15:57:58.079			(Unknown PGN) *													
0731 Enclosure Temp	"C Pilot Interface Board	Internal	4016	40.2°C	15:57:57:636			PGN130311													
0710 Raw Accelerous	eter X Pilot Interface Board	Internal	-31	-31	15:57:58.383			Environment*			71-100227										
0741 Raw Acceletom	eter Y Pilot Interface Board	Internal	-83	-83	15:57:58.383	1/7 5	0	PGN130312	2089	00004604	1.05R/70-100394	2	n/a								
0742 Raw Accelerom	eter Z Pilot Interface Board	Internal	-16918	-16918	15:57:58.383	10000		CONTROLL (CONTROLL)			1.008										
0746 BMI160 Raw Te	emp Pilot Interface Board	Internal	9550	9550	15:57:58.383			(Unknown PGN) *													
0760 Raw Gyro X	Pilot Interface Board	Internal	-108	-108	15:57:58 383			PGN130316													
0761 Raw Gyro Y	Pilot Interface Board	Internal	-24	-24	15:57:58.383			(Unknown FGN)*													
0762 Raw Gyto Z	Pilet Interface Board	Internal	13	13	15.57.58.383																
1801 Raw Analogue V	Val 1 Drive Unit	Internal	2045	2045	11:48:06.760	Note: J	GN's marked	with an * are not proce	issed by the	e AlPilot											
0806 Raw Analogue V	Val 6 Pilot Interface Board	Internal	943	943	15:57:58.382																
0807 Raw Analogue V	Val 7 Pilot Interface Board	Internal	170	170	15:57:58.382																
0818 Analogue Seque	nce Pilot Interface Board	Internal	142	142.0000	15:57:58.382																
0819 Analogue Timer	Pilot Interface Board	Internal	0	0.0000	15.57.58.382																
1145 System Time	Autopilot	Internal	1.6185E-09	15:57:58	15:57:58.079																
1500 Heading 'T	Autopilot	Internal	225.5E5	225.58°T	15:57:58.340																
(1501 Heading "M	Autopilot	Internal	225.585	225.58°M	15:57:58.340																
1502 System Variation	a Aotopilot	Internal	0	60.0°E	15:57:58.246																
1806 Analogue Val Cl	h 6 Pdat Interface Board	Internal	11.6649	11.66	15:57:58.383																
1807 Analogue Val Cl	h 7 Pilot Interface Board	Internal	1.10503	1.11	15:57:58.383																
1836 ATP Supply Vol	tage Pdot Interface Board	Internal	11.6649	11.7V	15:57:58.383																
x1837 ATP Supply Cur	rent Pilot Interface Board	Internal	1.10503	1.1A	15:57:58.383																
alA10 Pilot Rodder De	mand Autopilot	Internal	-0.974729	-1.0*	11:48:06.868																
				A 4646	11 10 AV AVA																

#### 5.2 Data Logs

The Pilot Processor may internally log data for diagnostic purposes, not for general use.

- The Log Frequency may be adjusted
- Press Start to begin logging.
- You may delete or export logs to your PC

#### 5.3 Event Logs

You may view and download system event logs within the Pilot Processor for diagnostic purposes.

#### 6. Saved Configurations

The Pilot settings and Sea Trial results may be saved as backups in case of a system reset, and may be exported for diagnostic purposes.

#### 7. Software Update

To update Pilot Software, select the update file and press **Update**.

Manage saved ATPitit configurations. Can be used to restore backups in case of accidental changes, or to maintain configurations for different situations. Saved configurations can also be exported for diagnostic purposes.
Save Current Configuration Configuration Name: Sov
Existing Saved Configurations Select Configuration: Colds Colds
Restore from File Locate Configuration File: Browse No file selected. Resources from File
Reset to Factory Default Reset Configuration



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