TD 316 OPERATING MANUAL
Motus Wave Sensor
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Motus Wave Sensor 5729

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1st Edition	13 November 2017	New added parameters and new structure
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Introduction

Purpose and scope

This document is intended to give the reader knowledge of how to operate and maintain the Aanderaa Motus Wave Sensor 5729. The sensor is made for integration with either EMM 2.0 buoy or Motus DB 1750 buoys or used as stand-alone sensor with 3rd party buoys. The sensor is a part of the Aanderaa buoy package Aanderaa EMM 2.0 Motus buoy or the Aanderaa DB 1750 Motus Buoy. Both buoy package are standard solutions with a wide range of optional parameters available both for meteorological and hydrological measurements. The sensor is also available as Sensor Kit for mounting on existing EMM 2.0 or Motus DB 1750 buoys. The sensor and integrations on all buoys are described in a single manual since the measurement principle and operation of sensor are the same.

The sensor utilize common communication protocols at the RS-232 interface where the Smart Sensor Terminal protocol is a simple ASCII command string based protocol, AADI Real Time is an XML based protocol, AIS mode is a special output designed to transmit the Message 8 directly to an AIS transponder and the CAN bus based AiCaP communication protocol are mainly used when the sensor is connected to one of the Aanderaa Dataloggers.

In this Manual we will focus on connection to SmartGuard as this is the standard datalogger for use in buoy. We will also cover 3rd party loggers since this configuration will differ from the SmartGuard. However the sensor can also be connected to a SeaGuardII but then the configuration will be identical to SmartGuard since SeaGuardII is a watertight submerged version of SmartGuard. For SeaGuardII configurations follow ***CHAPTER 3.***

To configure and control the sensor we use sensor properties. A complete list of user accessible sensor properties is listed in ***chapter 1.7***. The sensor properties are divided in 4 groups with different access levels. Some properties may be set on or off when others may contain different values. To change these setting you can either use AADI Real-Time Collector, described in ***CHAPTER 3*** and ***CHAPTER 4*** or terminal software like Tera Term, described in ***CHAPTER 6***.

Note! Some settings are only visible when certain settings are enabled.

The sensor may be used on other 3rd party buoys of similar size and shape as Motus DB 1750 without any extra adjustment. If the size or shape of buoys is different an adjustment to the frequency response might be necessary. Please contact aanderaa.support@xyleminc.com for information about this adjustment.

Document Overview

CHAPTER 1 is a short description of the Motus including dimension, connections and properties.

CHAPTER 2 gives the theory of operation and list of all output parameters including calculations.

CHAPTER 3 is an overview of how to configure the sensor with AADI Real-Time Collector when connected via an Aanderaa logger such as SmartGuard.

CHAPTER 4 is an overview of how to configure the sensor with AADI Real-Time Collector when the sensor is used stand-alone.

CHAPTER 5 describes how to log data using AADI Real-time Collector.

CHAPTER 6 describes sensor configuration using terminal software such as Tera Term.

CHAPTER 7 describes the use of External Compass.

CHAPTER 8 describes the sensor electromagnetic compatibility (EMC) and cables.

CHAPTER 9 gives information about maintenance.

CHAPTER 10 describes installations of sensor on a buoy and information about all available accessories.

Applicable Documents

Form 858	**Test & Specification Sheet**
Form 856	**Calibration Certificate Motus**
D-417	**Data Sheet Motus Wave Sensor 5729**
TD 268	**AADI Real-Time collector operating manual**
TD 293	**Operating manual SmartGuard**

Abbreviations

AiCaP	Aanderaa Protocol: Automated idle Line CANbus Protocol
ASCII	American Standard Code for Information Interchange
BOOT ENABLE	Used to enable firmware upgrade.
CAN	Controller Area Network - sometimes referred to as CANbus
COM port	Communication port used for Serial communication RS232/RS422
Deg.M	Degrees Magnitude
EMC	Electromagnetic compatibility
EIA	Electronic Industry Alliance
ft	Feet
GND	Ground
hPa	Hectopascal unit for measuring pressure, 1hPa=1mbar
Hz	Hertz is the derived unit of frequency in the International System of Units (SI)
IMU	Inertial Measurement Unit
kPa	Kilopascal unit for measuring pressure
m	Meter
mA	Milli Amper
mbar	Millibar unit for measuring pressure, 1mbar=1hPa
NOAA	National Oceanic and Atmospheric Administration
RS-232	Recommended Standard 232 refers to a standard for serial communication of data
RS-422	Differential serial communication for longer cables
RXD	Serial communication Received data
s	Seconds
SD-Card	Secure Digital Card a storage device used to store data
TXD	Serial communication Transmitted data
USB	Universal Serial Bus
V	Volt
VPWR	Positive Supply
QA	Quality Assurance, how it establishes a set of requirements for creating reliable products.
QC	Quality Control, the operational techniques and activities used to fulfil requirements for quality

CHAPTER 1 Short description and specifications of the Motus Wave Sensor

1.1 Description

Motus Wave sensor is a directional sensor module for use on surface buoys. The sensor is tested and approved for use with YSI EMM 2.0 and Motus DB1750 buoys. The sensor can either be connected to an Aanderaa Datalogger using the AiCaP protocol or to any third party logger using RS-232. The sensor is using a build-in solid state 9-axis accelerometer/gyro/magnetometer to measure the movement of the buoy. These measurements are then processed inside the sensor and a wide range of parameters as well as wave spectrum are presented directly from the sensor in real-time. For maximum flexibility the sensor can handle off- center mounting and due to the 30 meter depth rating it can also be installed outside the buoy body. The senor is equipped with an internal compass in order to reference directional data to geographical or magnetic north. If the magnetic field is disturbed by the buoy structure or payload an optional external compass may be used. In order for the wave sensor to fully capture the required movements of the buoy a more flexible mooring is required. To obtain the required flexibility one section of the mooring should consist of a rubber cord. Guidelines for mooring design are available in ***CHAPTER 10***.

1.2 Sensor Dimension

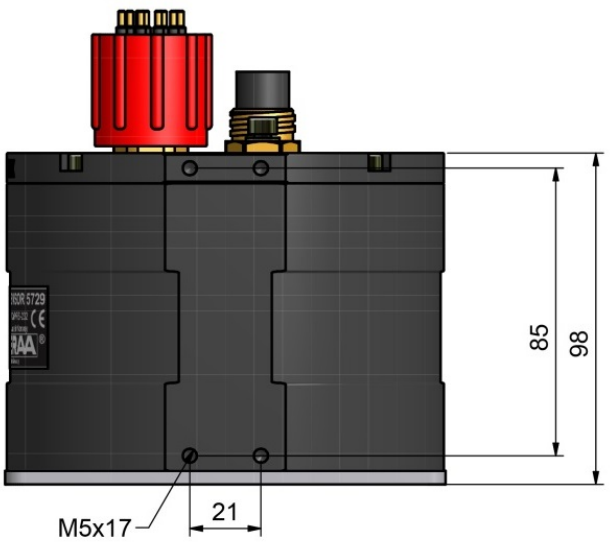


Figure 1-1: Sensor Dimension side view

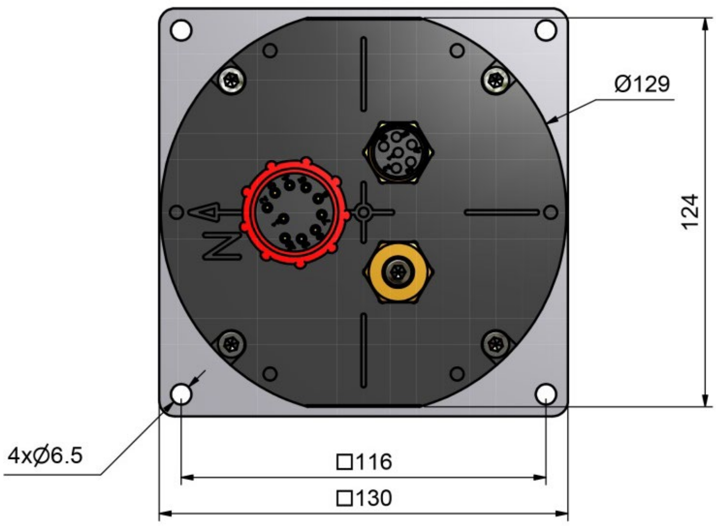


Figure 1-2: Sensor Dimension top view

1.3 Sensor pin configuration and data output

Motus are using a 10-pin underwater mateable connector, WET-CON MCBH10M from SeaCon for RS-232 and AiCaP communication between sensor and logger; see ***chapter 1.3.1*** for pin configuration. It also uses a 6-pin underwater mateable connector, WET-CON MCBH6F from SeaCon for RS-232/RS-422 connection to external compass; see ***chapter 1.3.2***

1.3.1 Sensor pin configuration RS-232 and AiCaP communication

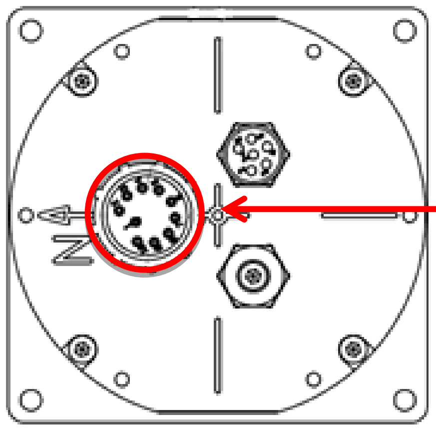
Sensor top view	
	- Sensor connector type: WET-CON MCBH10M - Recommended cable: WET-CON MCIL10F

Figure 1-3 Sensor communication port 10-pin plug

Sensor Signal name	Input (I) Output (O)	Sensor plug MCBH10M. Pin no:	Connecting Cable MCIL10F. Pin no:
TXD	O	1	1 Black
RXD	I	2	2 White
VPWR	I	10	10 Orange/ Black
GND	-	9	9 Green/Black
NCE		7	7 White/Black
NCR		6	6 Blue
CAN_GND	-	5	5 Orange
CAN_H		3	3 Red
CAN_L		4	4 Green
BOOT ENABLE	I	8	8 Red/Black

Table 1-1: Sensor pin configuration 10-pin plug

1.3.2 Sensor pin configuration external compass input

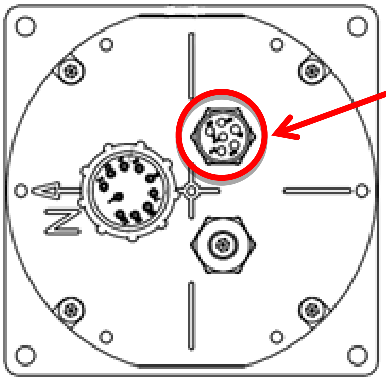
Sensor top view	
	- An external compass can be connected to the wave sensor via the sensors dedicated WET-CON MCBH6F connector. - Recommended cable: WET-CON MCIL6M - Output voltage: Sensor supply voltage, (VPWR) - Maximum Current Drain: 0.8A - Acceptable data format: NMEA 0183 “HDG” output

Figure 1-4 External compass input 6-pin plug

Signal name	Input (I) Output (O)	Sensor plug Pin no: MCBH6F	Connecting Cable Pin no: MCIL6M	Remarks
RX-	I	4	4 Green	
RXD/RX+	I	3	3 Red	
TXD/TX-	O	6	6 Blue	
TX+	O	5	5 Orange	
Compass GND	-	2	2 White	
Compass PWR	O	1	1 Black	Voltage =VPWR

Table 1-2: Sensor pin configuration for external compass 6-pin plug

1.3.3 Sensor Grounding

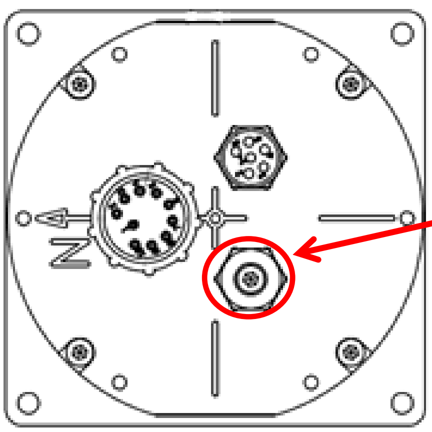
Sensor top view	
	Ground Terminal. Always connect to Ground

Figure 1-5: Sensor Grounding

1.4 Sensor Connection

Aanderaa offers a wide range of cables for different use of the sensors, both standard cables for use with loggers using AiCaP and RS-232 but also special customer specified cables for use in project. See ***chapter 10.3*** for an overview of standard cables or contact aanderaa.support@xyleminc.com for more info. To configure the sensor it either need to be connected to an Aanderaa logger using AiCaP, a real-time RS-232 cable or you need a RS-232 configuration cable.

1.4.1 Configure sensor using RS-232 configuration cable

The 5789 cable is a 1.5 meter configuration cable used for connection between sensor and PC.

The cable is supplied with a USB port providing power to the sensor but since the USB port on a computer normally gives 5V power and the Motus needs 6-14V the sensor cannot be powered from the computer like for most other Aanderaa Smart Sensors. A USB extension is supplied with the cable and we recommend connecting the free end to an external power (6-14V). An alternative solution is *to use a 9V alkaline battery (6LF22) to set the sensor up or log it in the laboratory.* Sensor Cable 5789 is also available in other lengths.

Cable 5789 do also consist of a read switch that is used for firmware upgrade. This can only be performed by trained and certified personal. Please contact aanderaa.support@xyleminc.com for more info.

To configure/communicate with the sensor you might either use AADI Real-time collector, refer to ***CHAPTER 3*** and ***CHAPTER 4*** or you might use terminal software like Tera Term or HyperTerminal, refer ***CHAPTER 6.***

This cable can be used to communicate with the sensor regardless of which mode the sensor is set to. An AiCaP cable can only be used to communicate with a cable set to AiCaP mode.

Pin configuration is shown in ***Table 1-3.***

Figure 1-6: Configuration Cable 5789

Signal name	Sensor plug MCIL10F	9-p D-Sub	USB
TXD	1	2	
RXD	2	3	
CAN_H	3		
CAN_L	4		
CAN_GND / NCG	5		
NCR	6		
NCE	7		
BOOT ENABLE	8	Read Switch	
GND	9	5 + Read Switch	4 (Black)
VPWR / Pos. Supply	10		1 (red)
RTS short to CTS		7-8	
DSR short to DTR		4-6	

Table 1-3: 5789 Cable pin configuration

1.5 User accessible sensor properties

All configuration settings that determine the behaviour of the sensor are called properties and are stored in a persistent memory block (flash). One property can contain several data elements of equal type (Boolean, character, integer etc.). The different properties also have different access levels.

To read the value of a certain properties you need to send ASCII string starting with the command get and then followed by the property name to the sensor, see example below.

To change the content of a property an ASCII string starting with set and then followed by the property name and new value in brackets need to be sent to the sensor.

For more information about sensor connection and configuration see ***CHAPTER 3, CHAPTER 4*** or ***CHAPTER 6***.

Get Interval //When sending this string to the sensor, it will then return the value stored in this property.

Interval 5729 19 100.000 //Returned from sensor, where 5729 is the product number, 19 is the serial number of the sensor and 100.000 is the value stored as interval in seconds.

To change the value you might send the following command:

Set Interval(300) //This will change the value for this property to 30 minutes

Save //Always end with save to store setting in flash

The interval will now be changed to 300 seconds.

1.6 Passkey for write protection

To avoid accidental change, most of the properties are write-protected. There are four levels of access protection, refer ***Table 1-4*** .

A special property called ***Passkey()*** must be set according to the protection level before changing the value of properties that are write-protected, refer ***Table 1-4***. After a period of inactivity at the serial input, the access level will revert to default. This period corresponds to the ***Comm TimeOut*** setting, or 1 minutes it the ***Comm TimeOut*** is set to ***Always On.***

The access level needed to Read or Write each property is given in the last column of each table in the following chapters. Please note that some properties are read only for operators, and only Aanderaa Service personal or trained users can write to these properties.

Output	Passkey	Description
No		No Passkey needed for changing property
Low	1	The Passkey must be set to 1 prior to changing property
High	1000	The Passkey must be set to 1000 prior to changing property This Passkey value also gives read access to some factory properties that usually are hidden
Read Only	Factory	The user have only read access

Table 1-4: Passkey protection

1.7 Sensor Properties

When using AADI Real-Time Collector you don't need to think about the command string sent to the sensor since this is fully controlled by the software, see ***CHAPTER 3*** and ***CHAPTER 4***.

Some properties of the 'AiCaP' sensor will not be applicable / visible when the sensor is connected to a SmartGuard Datalogger, as these properties will be controlled by the instrument. For older versions of Motus a hardware upgrade might also be needed. Please contact aanderaa.sales@xyleminc.com for assistance.

Please note that updating the Image might also require an Image update in the logger and update of AADI Real-Time Collector.

All sensor properties are listed in ***chapters 1.7.1*** through ***1.7.4.***

1.7.1 Factory Configuration

All properties in this section are Read Only, not possible to overwrite for the user. Only certified Aanderaa service personal can alter these settings. The access level for reading the status of this properties are however different for each property, see table for more details. In this group we find information about Software and hardware settings, Production, Service and Calibration dates.

ENUM=Enumeration, INT =Integer, BOOL=Boolean ('yes'/'no')

Property	Type	No of elements	Use	Configuration Category	Access Protection Read/Write
Product Name	String	31	AADI Product name, default Motus Wave Sensor	FC	No / Read Only
Product Number	String	6	AADI Product number, default 5729		
Serial Number	INT	1	Serial Number		
SW ID	String	11	Unique identifier for internal firmware		
SW Version	INT	3	Software version (Major, Minor, Built)		
SW ID 2	String	11	Unique identifier for internal firmware		
SW Version 2	INT	3	Software version (Major, Minor, Built)		
HW ID X	String	19	Hardware Identifier, X =1..2 unique identifier for hardware		High / Read Only
HW Version X	String	9	Hardware Identifier, X =1..2 (Rev. x)		
System Control	INT	3	For AADI service personnel only		
Production Date	String	31	AADI production date, format YYYY-MM-DD (Not in use)		
Last Service	String	31	Last service date, format YYYY-MM-DD, empty by default		
Last Calibration	String	31	Last calibration date, format YYYY-MM-DD (Not in use)		
Calibration Interval	INT	1	Recommended calibration interval in days (Not in use)		
Fe Image File Name	String	31	Front Image File Name		No / Read Only

Table 1-5: Factory Configuration sensor properties for Motus Wave Sensor 5729

1.7.2 Deployment Settings

Deployment Settings contains settings for instruments metadata like position and owner.

ENUM=Enumeration, INT =Integer, BOOL=Boolean ('yes'/'no')

Property	Type	No of elements	Use	Configuration Category	Access Protection Read/Write
Interval	ENUM	1	Set the output interval in seconds. Minimum available interval is dependent on configuration.	DS	No / No
Location	String	31	User setting for location		
Geographic Position	String	31	User setting for geographic position		
Vertical Position	String	31	User setting for describing sensors vertical position.		
Reference	String	31	User setting for describing sensor reference, user definable.		

Table 1-6: Deployment settings sensor properties for Motus Wave Sensor 5789

1.7.3 System Configuration

This group is used to control the sensor via properties for configuring communication with logger, sensor setup and parameter enabling and controlling the output from sensor. Some of the properties are only visible depending on the mode selected or if the function is enabled or not. These properties will either be grey or not visible at all.

ENUM=Enumeration, INT =Integer, BOOL=Boolean ('yes'/'no')

Property	Type	No of elements	Use	Configuration Category	Access Protection Read/Write
Mode	ENUM	1	Sets the sensor operation mode (AiCaP, Smart Sensor Terminal, AADI Real-Time and AIS Output). AiCaP is a CAN bus output only used with Aanderaa loggers, Smart Sensor Terminal is an ASCII output, AADI Real-Time is a XML output and AIS Output is a special NMEA output used when connected to an AIS transmitter.	SC	No / Low
Enable Sleep	BOOL	1	Enables sleep mode in Smart Sensor Terminal and AADI Real-Time operation to save power (In AiCaP the sensor always tries to sleep when not busy). Default is 'Yes'		
Enable Polled Mode	BOOL	1	Enables polled mode in Smart Sensor Terminal Mode. When set to 'no' the sensor will sample at the interval given by the *Interval* property. When set to 'yes' the sensor will start measurements at the time of power up. A *Do Sample* command triggers the end calculations and output of data. A *Do Output* command will repeat the output of the last calculated data. Default is 'No'		
Enable Text	BOOL	1	Controls the insertion of descriptive text in Smart Sensor Terminal mode, i.e. parameter names and units. Used to reduce message size.		
Enable Decimalformat	BOOL	1	Controls the use of decimal format in the output string in Smart Sensor Terminal mode. Default is scientific format (exponential format).		
Water Depth	Float	1	Water Depth surface to sea bed. [m]		No / No
Gravity	Float	1	Local Gravity constant [m/s²], default value are 9.81		
High Frequency Limit (Hz)	Float	1	Lower cut-off frequency in Hz. The default value is 0.7Hz= 1/0.7 = 1.42 second, this is also equal to the lowest wave period we can measure.		
Low Frequency Limit (Hz)	Float	1	Higher cut-off frequency in Hz. The default value is 0.03333Hz = 1/0.3333 = 30 seconds. The range is maximum 33 seconds = 0.03030Hz, this is also equal to the highest wave period the sensor can measure.		
Wave Integration Time	ENUM	1	Integration time used for wave calculation. 5 min,10 min,15 min,20 min,25 min,30 min,35 min,40 min,45 min,50 min,55 min,1 hour. Default is 30min.		
Time Series Record Length	Float	1	Length of each temeries.5 min,10 min,15 min,20 min,25 min,30 min,35 min,40 min,45 min,50 min,55 min,1 hour. Default is 30 min.		
Enable 2 Hz Output	BOOL	1	Enables 2Hz output for all Time Series. Default 'no' equal to 4HZ.		
Swell Wind Separation Frequency (Hz)	Float	1	Separation Frequency used to separate swell from wind generated sea. Default is 0,1Hz = 10 seconds		

Mean Spreading Angle Output	ENUM	1	Configuration of Mean Spreading Angle Output Alternative options are: Off, Storage, Output+Storage[1)]	SC	No / Low
First Order Spread Output	ENUM	1	Configuration of First Order Spread Output Alternative options are: Off, Storage, Output+Storage[1)]		
Long Crestedness Output	ENUM	1	Configuration of Long Crestedness Output Alternative options are: Off, Storage, Output+Storage[1)]		
Energy Spectrum Output	ENUM	1	Configuration of Energy Spectrum Output Alternative options are: Off, Storage, Output+Storage[1)]		
Directional Spectrum Output	ENUM	1	Configuration of Directional Spectrum Output Alternative options are: Off, Storage, Output+Storage[1)]		
Principal Dir Spectrum Output	ENUM	1	Configuration of Principal Dir Spectrum Output Alternative options are: Off, Storage, Output+Storage[1)]		
Orbital Ratio Spectrum Output	ENUM	1	Configuration of Orbital Ratio Spectrum Output Alternative options are: Off, Storage, Output+Storage[1)]		
Fourier Coeff Spectrum Output	ENUM	1	Configuration of Fourier Coeff Spectrum Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Peak Dir Wind Output	ENUM	1	Configuration of Wave Peak Dir Wind Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Peak Dir Swell Output	ENUM	1	Configuration of Wave Peak Dir Swell Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Mean Dir Output	ENUM	1	Configuration of Wave Mean Dir Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Height Wind Hm0 Output	ENUM	1	Configuration of Wave Height Wind Hm0 Output. Outputs Significant Wave Height Wind Hm0. Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Height Swell Hm0 Output	ENUM	1	Configuration of Wave Height Swell Hm0 Output. Outputs Significant Wave Height Swell Hm0. Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Height Hmax Output	ENUM	1	Configuration of Wave Height Hmax Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Height Max Trough Output	ENUM	1	Configuration of Wave Height Max Trough Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Height Max Crest Output	ENUM	1	Configuration of Wave Height Max Crest Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Period Tmax Output	ENUM	1	Configuration of Wave Period Tmax Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Mean Period Tz Output	ENUM	1	Configuration of Wave Mean Period Tz Output Alternative options are: Off, Storage, Output+Storage[1)]		

Wave Height H1/3 Output	ENUM	1	Configuration of Wave Height H1/3 Output. Outputs Significant Wave Height H1/3. Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Height H1/10 Output	ENUM	1	Configuration of Wave Height H1/10 Output. Outputs Significant Wave Height H1/10. Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Height H1/1 Output	ENUM	1	Configuration of Wave Height H1/1 Output. Outputs Significant Wave Height H1/1. Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Mean Period T1/3 Output	ENUM	1	Configuration of *Wave Mean Period* T1/3 Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Mean Period T1/10 Output	ENUM	1	Configuration of *Wave Mean Period* T1/10 Output Alternative options are: Off, Storage, Output+Storage[1)]		
Heave Vert. Time Series Output	ENUM	1	Configuration of Heave Vertical Time Series Output Alternative options are: Off, Storage, Output+Storage[1)]		
Heave Hor. Time Series Output	ENUM	1	Configuration of Heave Horizontal Time Series Output Alternative options are: Off, Storage, Output+Storage[1)]	SC	No / Low
Wave Mean Period Tm02 Output	ENUM	1	Configuration of Wave Mean Period Tm02 Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Peak Period Wind Output	ENUM	1	Configuration of Wave Peak Period Wind Output Alternative options are: Off, Storage, Output+Storage[1)]		
Wave Peak Period Swell Output	ENUM	1	Configuration of Wave Peak Period Swell Output Alternative options are: Off, Storage, Output+Storage[1)]		
Heading Output	ENUM	1	Configuration of Heading Output Alternative options are: Off, Storage, Output+Storage[1)]		
External Heading Output	ENUM	1	Configuration of External Heading Output Alternative options are: Off, Storage, Output+Storage[1)]		
Pitch and Roll Output	ENUM	1	Configuration of Pitch and Roll Output Alternative options are: Off, Storage, Output+Storage[1)]		
System Parameters Output	ENUM	1	Configuration of System Parameters Output Alternative options are: Off, Storage, Output+Storage[1)]		

Table 1-7: Sensor properties for Motus Wave Sensor 5729

[1)] The enumeration is Off or Output in Smart Sensor Terminal and AADI Real-Time mode. In AiCaP the enumeration is Off, Storage, Output+Storage, where Output+Storage means that the sensor instructs the Datalogger to send out a parameter in real-time in addition to saving the parameter to the SD card and Storage is only saving the data to the SD card.

1.7.4 User Maintenance

This group contains sensor settings that normally are not altered by the user. To access most of these properties you need to send passkey(1000) or with Real-Time Collector use password: 1000. These properties are used to configure serial port settings, communication to and from sensor in addition to some sensor settings.

ENUM=Enumeration, INT =Integer, BOOL=Boolean ('yes'/'no')

Property	Type	No of elements	Use	Configuration Category	Access Protection Read/Write
Node Description	String	31	User text for describing node, placement etc. Default is Motus Wave Sensor 5729#xxx where xxx is serial number	UM	No / Low
Owner	String	31	User setting for owner information, company name etc.		No / High
Interface	String	31	Factory use only, RS-232 for standard version.		High / High
Baudrate	ENUM	1	RS232 baudrate: 4800, 9600, 57600, or 115200. Default baudrate is 115200. The baudrate affects the minimum available Interval setting.		
Flow Control	ENUM	1	RS-232 flow control: 'None' or 'Xon/Xoff'. Default setting is Xon/Xoff'. To remove the "disturbance" on the receiver, select None. Be aware that this may also lead to missing characters when sending commands to the sensor.		
Enable Comm Indicator	ENUM	1	Enable communication sleep ('%') and communication ready ('!') indicators. After the last communication with the sensor, it normally outputs a '%' when the *Comm Timeout* time is over. When a character is sent to the sensor, it outputs a '!' to indicate that it is ready to communicate.		
Comm TimeOut	BOOL	1	Time communication is active (Always On, 10 s, 20 s, 30 s, 1min, 2 min, 5 min, 10 min). A short time means that the sensor is going to sleep faster after a communication input.		
Enable Off-centre Correction	BOOL	1	Enables the correction of displacement errors due to a sensor located off the buoys rotational origin. The errors in the vertical displacement will have impact on the calculated significant wave height.		
Off-centre XYZ (m)	Float	3	The sensors installation position (X,Y,Z) relative to the rotation origin of the buoy. Based on this position and the sensors orientation sampled at 4Hz, the added displacement for the X,Y and Z component are coherently subtracted to the IMU based displacement. By activating this function the wave height and the wave direction are more precisely calculated for a wave sensor installed off the buoys rotational origin.		

Enable Frequency Correction	BOOL	1	Enables frequency correction of the buoy frequency response.	UM	High / High
Correction Frequencies (Hz)	Float	15	Selects the center frequency for each frequency correction		
Correction Factors	Float	15	Selects the correction values for the center frequencies given in the Frequency Scale.		
Sensor Rotation Offset PRH (Deg)	Float	3	Sensor rotation offset Pitch, Roll, and Heading. These values is added to the IMU calculated Pitch, Roll and Heading. These values do not change the calculated wave direction, but only the reported Wave Sensor Orientation. When post processing the wave directions using an external compass as reference these values must be subtracted from the Sensor Orientation before the External compass corrections are performed.		No / No
Enable Magnetic Declination	BOOL	1	Enables use of magnetic declination angle input (see next property)[1)]		No / Low
Declination Angle (Deg.M)	Float	1	A value to correct for the magnetic variation on the site where the sensor is used. This is the angle in degrees between magnetic north and true north.[1)]		
Enable Ext Compass Input	BOOL	1	Enables external compass		High / High
Enable Ext Compass Correction	BOOL	1	Enables external compass correction.		
Ext Compass Alignment Offset (Deg.M)	Float	1	External Compass Offset that is added to the sensor Heading.		No / No
Compass Type	ENUM	1	Selectable compasses: HSC100 NMEA or Generic NMEA[2)]		High / High
Compass Warm-up Time (s)	Float	1	The time needed from power is switched on to the external compass until it is ready to output compass data. Check the manual for the compass used and set the correct time.		
Enable Compass Power Control	BOOL	1	Enables power switching of the compass to save power[3)]. If disabled, the compass is always on.		
Compass Start Offset Time (s)	INT	1	Offset time from the start of a recording interval until the first start of the external compass. This offset time starts again from every recording interval start. Only used when Enable Compass Power Control is activated.		
Compass Sampling interval (s)	INT	1	This is the interval between each new start of the external compass sampling. This interval has to be bigger than N/fs where N is the Compass Sample Average Number and fs are the Compass Sampling frequency. Only used when Enable Compass Power Control is activated.		
Compass Sample Average Number	ENUM	1	Number of samples to be taken from the external compass and averaged before the power to the external compass is switched off again. Selectable number of values is 4, 8, 16, 32, 64 and 128. Only used when Enable Compass Power Control is activated.		

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Compass Sampling Frequency (Hz)	Float	1	Only 1Hz supported, may be extended later	UM	High / High
Heading Sensor Id	ENUM	1	When the Wave Sensor is connected to AiCaP, a list of other available sensors connected to the SmartGuard/SeaGuard Datalogger is shown. This makes it possible to get a correct heading input from another sensor through the datalogger4) Only in AiCaP mode		No / High
Heading Parameter Id	ENUM	1	A list of all available Heading parameters with Deg.M as unit is shown in the dropdown menu. Also other directions like for example Current direction from Doppler sensors is shown if connected to the same logger. Make sure that the correct heading parameter is selected. Only in AiCaP mode.		
Heading Alignment Offset (Deg.M)	Float	1	Offset added to the AiCaP external heading. Only in AiCaP mode.		
Enable AiCaP Compass Correction	BOOL	1	Enables the use of AiCaP external compass correction for wave direction calculation. Only in AiCaP mode.		
Processing Time Output	ENUM	1	Configuration of Processing Time Output Off, Storage, Output+Storage. This is an advanced system output which can be enabled to give more information when testing the operation of the sensor. This is the time used for processing all the data from the last wave integration time. Default is 'Off'.		No / Low
FE State Parameters Output	ENUM	1	Configuration of FE State Output: Off, Storage, Output+Storage Two output parameters, FE State and FE Notifications are controlled by this setting. Default set to Off. The output FE State parameter is 0 if everything is ok. The FE Notifications parameter gives information about the last communications with the coprocessor.		
HW State Parameter output	ENUM	1	Configuration of HW State Output: Off, Storage, Output+Storage This is an advanced system setting which can be enabled to give more information about the internal electronic hardware. The output is 0 if everything is ok. Default set to Off.		

Table 1-8: Sensor properties for Motus Wave Sensor 5729

1) Magnetic declination (variation) is the angle between the magnetic north and the true north. This angle varies depending on the position on the Earth's surface and also varies over time. Declination is positive when magnetic north is east of true north and negative when it is to the west (input angle value ±180°). Magnetic declination at the deployment location can be found for i.e. on NOAA website: http://www.ngdc.noaa.gov/geomag-web/

2) A generic NMEA compass can be selected. This generic NMEA compass has to be pre-configured; it cannot be configured through the Motus Wave Sensor. The baud rate of this NMEA compass has to be set to 4800.

3) The "on" time of the external compass is controlled by the Warm-up Time, the Compass Sample Average Number and the Compass Sampling Frequency. The on/off duty cycle is also dependent on the Compass Sampling Interval which gives the time between each start (power on) of the external compass.

4) The Motus Wave Sensor is also shown in this list. Make sure that an external sensor is selected and not the Wave Sensor itself.

1.8 Motus Wave Sensor 5729 Specifications

Motus Wave Sensor 5729 Specifications Refer Datasheet D 417 which is available on our web site http://www.aanderaa.com or contact aanderaa.support@xyleminc.com

You will find the latest versions of our documents on Aanderaa website.

1.9 Manufacturing and Quality Control

Aanderaa Data Instruments products have a record for proven reliability. With over 50 years' experience producing instruments for use in demanding environments around the globe you can count on our reputation of delivering the most reliable products available.

We are an ISO 9001, ISO 14001 and OHSAS 18001 Certified Manufacturer. As a company we are guided by three underlying principles: quality, service, and commitment. We take these principles seriously, as they form the foundation upon which we provide lasting value to our customers.

CHAPTER 2 Theory of Operation

2.1 Wave Measurement

The wave measurement is based on an IMU with 9-axis accelerometer/gyro/magnetometer, The IMU operates at 1 kHz internally – 100Hz output for low pass filtering with 4Hz for wave calculation. Mechanical dampening acts as a low pass filter for the IMU-accelerometer in order to avoid aliasing and reduce low frequency noise. Due to coherent offset compensation the wave sensor can be installed off rotational origin for the buoy without introducing errors. The user enters the offset coordinates (x/y/z) for the installation. A user selectable buoy transfer function can be modified and activated. User selectable compass input. IMU compass, in-run IMU calibration or external compass are also available.

2.2 Sensor Integrated Firmware

The main tasks of the sensor's integrated firmware are to control the different sensor parts and calculate all parameters.

All the user configurable properties that can be changed for each individual sensor, i.e. calibration coefficients, parameter outputs and configurations parameters are called sensor properties, see **chapter 1.7**. When the sensor is connected to an Aanderaa logger the AiCaP mode is normally used. If connected to an Aanderaa logger like SmartGuard and using AiCaP the properties can be displayed and changed by using the AADI Real-Time Collector software, see ***CHAPTER 3***. For a stand-alone sensor the properties may be displayed and changed either via the AADI Real-time Collector software, see ***CHAPTER 4*** or using a terminal communication program, refer ***CHAPTER 6*** via the RS-232 port. Examples of typical terminal emulation programs are Hyper Terminal and Tera Term.

The sensor will always output a minimum of 3 wave parameters, ***Significant Wave Height H_{m0}, Wave Peak Direction and Wave Peak Period.*** The rest of the parameters can be switch on in the ***Sensor Configuration*** menu. If used with an Aanderaa Logger each parameter can be transmitted in real-time and/or stored in the logger.

In RS-232 mode the Motus sensor will perform a measurement sample and present the result within the first 1.5 seconds after the Motus has been powered up. However some of the parameter needs a number of samples before they can be calculated.

The higher the number of samples in your ***Wave Integration Time*** is the better Standard Deviation you will obtain. You also need a longer ***Wave Integration Time*** to make sure more repetitions of especially the long period waves. Standard ***Wave Integration Time*** is normally set to 20 or 30 minutes.

The recording interval might be set to a shorter time than the ***Wave Integration Time***. But the output will always be a calculation using data from the last Wave integration Time. For example if the interval is set to 5 minutes and ***Wave Integration Time*** is set to 20 minutes. The sensor will present data every 5 minutes based on data collected the last 20 minutes. After power up the sensor will not calculate any parameters before a full ***Wave Integration Time*** has passed.

2.3 Sensor offset compensation

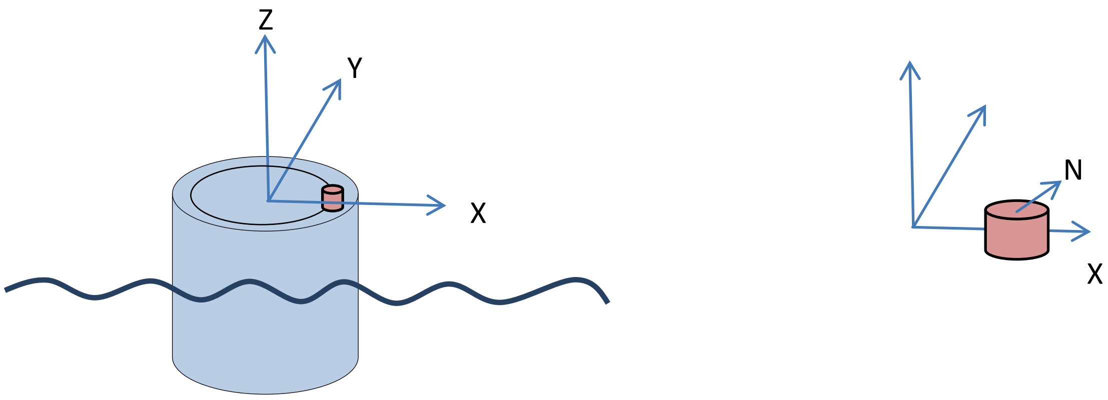
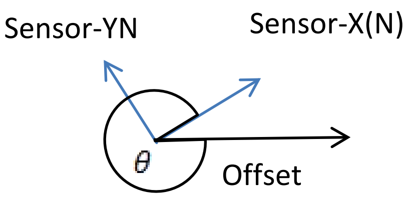


Figure 2-1: Buoy sensor offset geometry

The sensors axis system is defined by the orientation of the North mark of the sensor. This mark is aligned with the IMU x-axis. The sensor offset installation on the buoy has to be described relative to the sensor axis system. The easiest way to do this is to rotate the sensor such that the North mark on the buoy points directly away from the center of the buoy. By doing this the sensor offset will be aligned with the sensor x-axis. In this case the radius offset will be the x-axis offset, and the y-axis offset will be 0. The vertical offset is the height above the rotation origin. Normally the buoy water line would be sufficient accurate as reference for the vertical component (Z) of the rotation origin.

In case the installation prevents the sensor x-axis orientation to be aligned with the installation offset vector, the offset vector has to be decomposed into the sensor coordinate system according to ***Figure 2-1*** and ***Figure 2-2.***



$$X = \cos(\theta)$$
$$Y = -\sin(\theta)$$

Figure 2-2: Offset vector decomposition

The IMU pitch and roll is used together with the installation offset of the sensor in order to calculate the additional displacement of the sensor on a sample by sample basis and coherently subtract this value from the sensors reported values. Sea trials in Norwegian fjords indicate that the error introduced when not compensating for this effect can be in the order of 10 -15 % (40cm installation offset) depending on the sea state and spectral distribution of the waves.

2.4 Offset settings and use of External compass

Figure 2-3 shows how the different Offset settings and External compass is used inside the sensor to improve the measurement. White coloured boxes are sensor input either from External compass or internal measurements. Yellow coloured boxes are property setting set by the operator if enabled. Blue boxes are the internal processing and green boxes are Data Output from the sensor. See ***CHAPTER 7*** for how to use external compass. Offset settings and external compass settings are listed in ***chapter 1.7*** and description are found in ***chapter 3.7.4*** to ***3.7.6*** or ***chapter 4.6.4*** to ***4.6.5***.

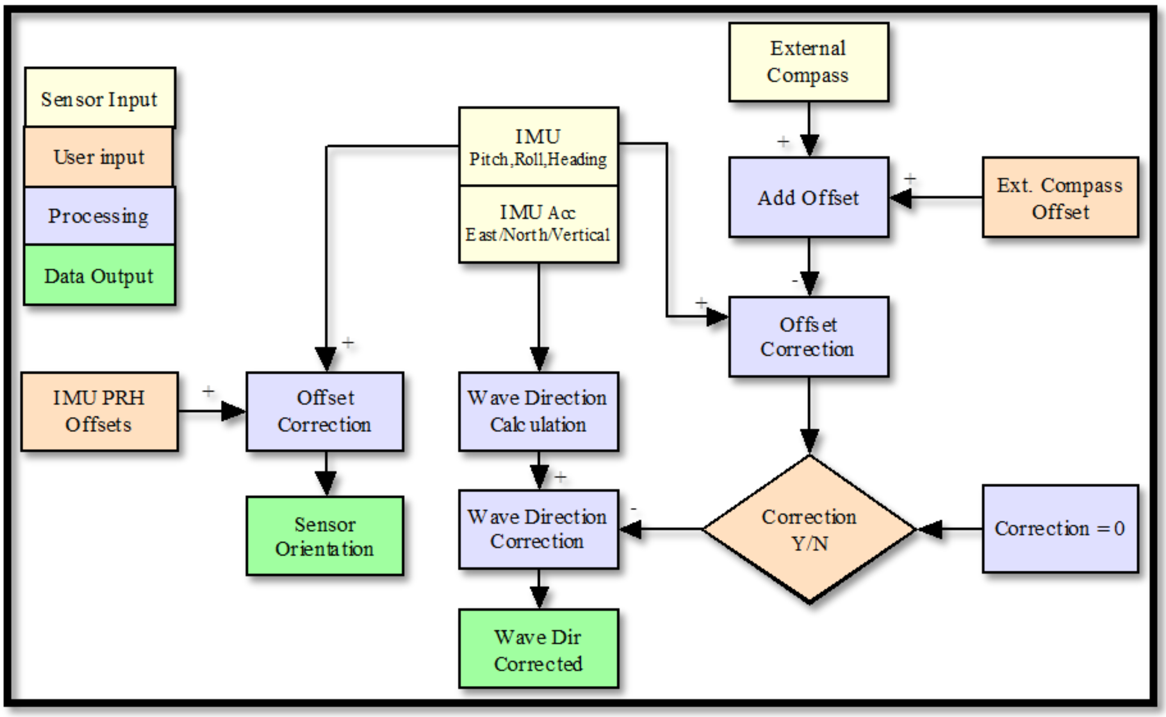


Figure 2-3: Offset settings and use of External compass

2.5 Parameter Output

The sensor will always output at least 3 wave parameters ***Significant Wave Height H_{m0}, Wave Peak Direction and Wave Peak Period***. These three parameters cannot be switched off. The rest of the parameters can be configured by the user by selecting the corresponding property. If using AADI Real-Time Collector each property can be selected or deselected in the ***Sensor Configuration*** menu. If using terminal software each parameter can be selected by sending the corresponding property and value to the sensor using a set Property(Value) command. The alternative for value depends on the mode.

To enable output of ***Mean Spreading Angle*** we need to send the following command:

In ***AiCaP mode:*** ***set Mean Spreading Angle Output(Output + Storage)***

In ***Smart Terminal*** and ***AADI Real-Time mode:*** ***set Mean Spreading Angle Output(Output)***

2.6 Parameter list

Table 2-1: Parameter list. Frequency Based Parameters

Output parameters	*Symbol*	*Unit*	*Type*
Significant Wave Height H_{m0} 1)2)	H_{m0}	m	Operational
Wave Peak Direction 2)	θ	Deg.M	Operational
First Order Spread	σ	Deg.M	Operational
Mean Spreading Angle	θ_k	Deg.M	Operational
Long Crestedness	τ	-	Operational
Wave Peak Period 2)	T_p	s	Operational
Wave Mean Period T_{m02}	T_{m02}	s	Operational
Wave Mean Direction	θ_{avg}	Deg.M	Operational
Energy Spectrum	E(f)	m^2/Hz	Research
Directional Spectrum	$DWS_m(f)$	Deg.M	Research
Principal Directional Spectrum	$DWS_p(f)$	Deg.M	Research
Orbital Ratio Spectrum	K(f)	-	Research
Fourier Coefficients Spectrum	A1(f),B1(f),A2(f),B2(f)	-	Research

1) *Significant Wave Height is equivalent to Wave Height*
2) *Available as standard, Wind and Swell*

Table 2-2: Parameter list. Time Based Parameters

Output parameters	*Symbol*	*Unit*	*Type*
Significant Wave Height $H_{1/3}$, $H_{1/10}$, $H_{1/1}$, 1)2)	$H_{1/3}$, $H_{1/10}$, $H_{1/1}$	m	Operational
Wave Mean Period T_z, $T_{1/3}$, $T_{1/10}$	T_z , $T_{1/3}$, $T_{1/10}$	s	Operational
Wave Height H_{Max}	H_{Max}	m	Operational
Wave Period Tmax	T_{Max}	s	Operational
Wave Height Max Crest	C_{max}	m	Operational
Wave Height Max Trough	Tr_{max}	m	Operational
Heave Timeseries	H(t)	m	Operational/ Research

1) *Significant Wave Height is equivalent to Wave Height*
2) *Available as standard, Wind and Swell*

See description and calculation of all parameters in following chapter

MOTUS can be setup to define a range of parameters as Wind or as Swell driven. The threshold between Wind driven waves and Swell are given by ***Swell Wind Separation Frequency (Hz)*** where the default value is 0.1Hz=10second.

2.7 Parameter calculation

Three different spreading parameters are calculated.

1. ***Mean Spreading Angle, θ_k*** is the spreading function based on the first and second order Fourier coefficients, calculated for the frequency corresponding to the peak in the directional energy spectrum.

$$\theta_k = atan\left[\frac{0.5b_1^2(1+a_2) - a_1b_1b_2 + 0.5a_1^2(1-a_2)}{a_1^2 + b_1^2}\right]$$

2. ***First Order Spread, σ*** (Directional width) is a measure of directional spreading based on the first order Fourier coefficients, calculated for the frequency corresponding to the peak in the directional energy spectrum Kuik et al. (1988).

$$\sigma = \sqrt{2(1-\mathrm{r}_1)}, \mathrm{r}_1 = \sqrt{a_1^2 + b_1^2}$$

3. ***Long Crestedness Parameter, τ*** gives the normalized spreading function, calculated for the frequency corresponding to the peak in the directional energy spectrum.

$$\tau = \sqrt{\frac{1-\sqrt{a_1^2+b_1^2}}{1+\sqrt{a_1^2+b_1^2}}}$$

For long-crested waves the direction of all wave fronts are the same and the spreading function reaches 0. When the wave fronts no longer are uniform and then become more spread, the length of the wave crests will be shorter and the Long Crestedness parameter will increase.

The ***Energy Spectrum, E(f)*** gives the vertical wave energy density for each frequency bin, accumulated from all directions.

Two different directional Spectrums are calculated

1. ***Direction Spectrum, $DWS_m(f)$*** is calculated as mean wave direction for each frequency bin in the spectrum based on the first order Fourier Coefficients.

$$\theta_1(f) = atan(b_1(f_i)/a_1(f_i))$$

2. ***Principal Direction Spectrum, $DWS_p(f)$*** is calculated based on the second order Fourier Coefficients. The principal wave direction has an ambiguity direction of 180 degree, but is forced to be in the same interval as the mean wave direction.

$$\theta_2(f) = 0.5 \cdot atan(b_2(f_i)/a_2(f_i))$$

Orbital Ratio Spectrum, K(f) gives the ratio of vertical to horizontal motions corrected for the wavenumber and water depth

$$K(f) = \left\{\frac{1}{\tanh(k(f) \cdot h)}\right\} \cdot \sqrt{\frac{C_{11}(f)}{C_{22}(f) + C_{33}(f)}}$$

where:

C11(f), C22(f), and C33(f), are the cross-spectra of displacement in Vertical, East and North direction. k(f), is the wave number and h is the water depth.

Fourier Coefficients Spectrum, A1(f), B1(f), A2(f), B2(f) are used to calculate all frequency based parameters

Wave Peak Direction, θ gives the direction of the peak wave period. The wave peak direction is calculated as;

$$\theta = atan2(b_1(f_{max}), a_1(f_{max})) \text{ ,}$$

where:

f_{max} is the frequency that gives the maximum energy in the specter E(f).

Wave Peak Direction Wind is calculated using the waves defined as Wind. The range of Wind and Swell are configurable using the ***Swell Wind Separation Frequency (Hz)*** parameter.

Wave Peak Direction Swell is calculated using the waves defined as Wind. The range of Wind and Swell are configurable using the ***Swell Wind Separation Frequency (Hz)*** parameter.

Wave Mean Direction θ_{avg} is the energy weighted mean direction over all frequency bins.

$$\theta_{avg} = atan\left(\sum_i E(f_i) \cdot b_1(f_i)/a_1(f_i)\right)$$

The spreading angle is a measure of how wide the directional cone is over which the wave direction is distributed (Kumar and Anoop, 2013).

Significant Wave Height is defined either as H_{m0}, $H_{1/3}$, $H_{1/10}$ or $H_{1/1}$; the difference in magnitude between the four definitions is only a few percent. See definition of each parameter below. ***Significant Wave Height*** is equivalent to ***Wave Height.***

Wave Height Wind/Swell H_{m0} is a modern definition of significant wave height defined as four times the standard deviation of the surface elevation. Full name is ***Significant Wave Height, Wind/Swell*** H_{m0}

Wave Height Wind H_{m0} is calculated using the waves defined as Wind. The range of Wind and Swell are configurable using the ***Swell Wind Separation Frequency (Hz)*** parameter. Full name is ***Significant Wave Height Wind*** H_{m0}

Wave Height Swell H_{m0} is calculated using the waves defines as Swell. The range of Wind and Swell are configurable using the ***Swell Wind Separation Frequency (Hz)*** parameter. Full name is ***Significant Wave Height Swell*** H_{m0}

Wave Height Max, H_{max} is the vertical distance between the highest (crest) and lowest (trough) parts of a wave.

Wave Height Max Trough, Tr_{max} is the highest negative wave amplitude below average water level within a record of waves.

Wave Height Max Crest, C_{max} is the highest positive wave amplitude above average water level within a record of waves.

Wave Period, T_{max} is the corresponding wavelength of the wave that is identified as ***Wave Height Max, H_{max}***.

Wave Mean Period, T_z gives the wave mean period of all wave periods in a time-series representing a certain sea state. ***T_z*** can also be named ***$T_{1/1}$.***

Wave Height, $H_{1/3}$ is the mean of the highest third of the all waves (trough to crest) in current record, based on time series analysis. A single wave is defined by the difference of between maximum (crest) and minimum waver level (trough) in between two zero up-crossing values. The zero value is defined by the average water level of the whole record. Full name is ***Significant Wave Height, $H_{1/3}$.******Wave Height, $H_{1/10}$*** is the mean wave height of the highest 10% of the all waves (trough to crest) in current record, based on time series analysis. A single wave is defined by the difference of between maximum (crest) and minimum waver level (trough) in between two zero up-crossing values. The zero value is defined by the average water level of the whole record. Full name is ***Significant Wave Height, $H_{1/10}$.***

Wave Height, $H_{1/1}$ is the mean wave height of the all waves (trough to crest) in current record, based on time series analysis. A single wave is defined by the difference of between maximum (crest) and minimum waver level (trough) in between two zero up-crossing values. The zero value is defined by the average water level of the whole record. Full name is ***Significant Wave Height, $H_{1/1}$.***

Wave Mean Period, $T_{1/3}$ is the mean period of the waves defined by ***Significant Wave Height, $H_{1/3}$.***

Wave Mean Period, $T_{1/10}$ is the mean period of the waves defined by ***Significant Wave Height, $H_{1/10}$.***

Heave Vertical Timeseries, H(t) is the vertical displacement time series sampled at 2Hz or 4 Hz (configurable), the signal is bandwidth limited to cover the wave frequency range from [0.033 – 0.7] Hz, or equivalent to wave period from 30seconds to 1.42 seconds.

Heave Horizontal Timeseries, H(t) is the horizontal displacement time series. It's divided into to outputs, North and East.

1. ***Heave Timeseries, North(t)***, is the north component of the horizontal displacement time series sampled at 2Hz or 4 Hz (configurable), the signal is bandwidth limited to cover the wave frequency range from [0.033 – 0.7] Hz, or equivalent to wave period from 30seconds to 1.42 seconds. If the horizontal timeseries is activated, the sensor will provide both North and East component of the horizontal timeseries.

2. ***Heave Timeseries East(t)***, is the east component of the horizontal displacement time series sampled at 2Hz or 4 Hz (configurable), the signal is bandwidth limited to cover the wave frequency range from [0.033 – 0.7] Hz, or equivalent to wave period from 30seconds to 1.42 seconds. If the horizontal timeseries is activated, the sensor will provide both North and East component of the horizontal timeseries.

Wave Mean Period, T_{m02} is the mean wave period calculated from the spectrum.

$$T_{m02} = \sqrt{\frac{m_2}{m_0}},$$

where:

m_n is the n order moment calculated from the Energy spectrum as;

$$m_n = \int_0^\infty f^n E(f) df$$

Wave Peak Period, Tp is the wave period with the highest energy. ***Tp*** can be calculated as;

$$T_p = \frac{1}{f_{max}},$$

where:

f_{max} is the frequency that gives the maximum energy in the specter E(f).

Wave Peak Period Wind, Tp, is calculated based on the frequency band defining the wind generated waves, typically 0.1 – 0.7 Hz. The crossover frequency between swell and wind can be modified.

Wave Peak Period Swell, Tp is calculated based on the frequency band defining the swell, typically 0.033-0.1 Hz. The crossover frequency between swell and wind can be modified.

2.8 Other wave descriptions

Wave Crest is the point on a wave with the maximum value or upward displacement within a cycle

Wave Troughs is the point on a wave with the minimum or lowest point in a cycle

Wavelength *is the distance from a certain point on one wave to the same point on the next wave (e.g. distance between two consecutive wave crests or between two consecutive wave troughs).*

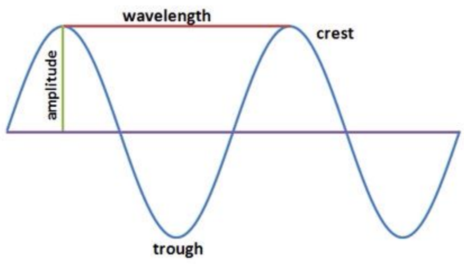


Figure 2-4: wave descriptions

Wave amplitude is one half the distances from the crest to the trough. Wave amplitude is a more technical term for wave height and is used in engineering technology.

Wave frequency is the number of waves passing a fixed point in a specified period of time. Frequency has units of waves per second or cycles per second. Another unit for frequency is the Hertz (abbreviated Hz) where 1 Hz is equivalent to 1 cycle per second.

Wave period are the time it takes for two successive crests (one wavelength) to pass a specified point.

Wave speed is the distance the wave travels divided by the time it takes to travel that distance. Wave speed is determined by dividing the wavelength by the wave period. In symbols $c = \lambda / T$ or $c = \lambda f$, where c is the wave speed, λ (lambda) is the wavelength, T is the wave period and f is the wave frequency

Wave Steepness is the ratio of height to wavelength. When wave steepness exceeds 1:7, breakers are formed. If a wave has height of 1 meter and a length from crest to crest of 8 meter, then the ratio is 1:8 and this wave is not going to break. But if the height is 1 meter and the length decreases to 5 meter, then the ratio is 1:5 and this wave has now become so steep that the crest topples and the wave breaks.

CHAPTER 3 Configuration via Aanderaa data logger

3.1 Introduction

The Motus Wave Sensor 5729 can easily be installed on a buoy using the Aanderaa SmartGuard to configure and collect data. The Motus Wave Sensor need to be in AiCaP mode before it is connected to the SmartGuard.

3.2 Installation of the Sensor to SmartGuard

This chapter only describes the software and configuration of sensor. For more information about the SmartGuard refer to TD 293 Operating manual for SmartGuard.

3.2.1 Starting up with Real-Time collector

- Connect the Motus Wave sensor to your SmartGuard using the cable shown in ***chapter 10.3***. Connect the SmartGuard to your PC's USB port using a USB Cable.
- If the logger is connected via a RS-232 real-time connection or via the LAN connection all configuration may also be done using this connection instead of the USB.
- Install and start the AADI Real-Time Collector software on your PC (provided on the memory stick delivered with the instrument). For more information about the AADI Real-Time Collector, refer TD 268 AADI Real-Time Collector Operating Manual
- Switch on the instrument by turning the power button to ***On.*** The startup procedure will take approximately 60 seconds.
- Please note that the SmartGuard needs a power reset after connection to find the sensor.

NOTE!

When using a USB connection, you also need to install Windows Mobile Device Center (Windows Vista, and Microsoft Windows 7) if not already installed on your computer. It can be downloaded from Microsoft website.

Windows Mobile Device Center acts as device management and data synchronization between a Windows Mobile-based device and a computer.

If using windows 10 please see ***chapter 10.2***

Once the USB connection has been established, Windows Mobile Device Center will start automatically:

For other operating system please refer to user manual or contact aanderaa.support@xyleminc.com

Figure 3-1: Windows Mobile Device Center

3.3 Establish a new connection to SmartGuard

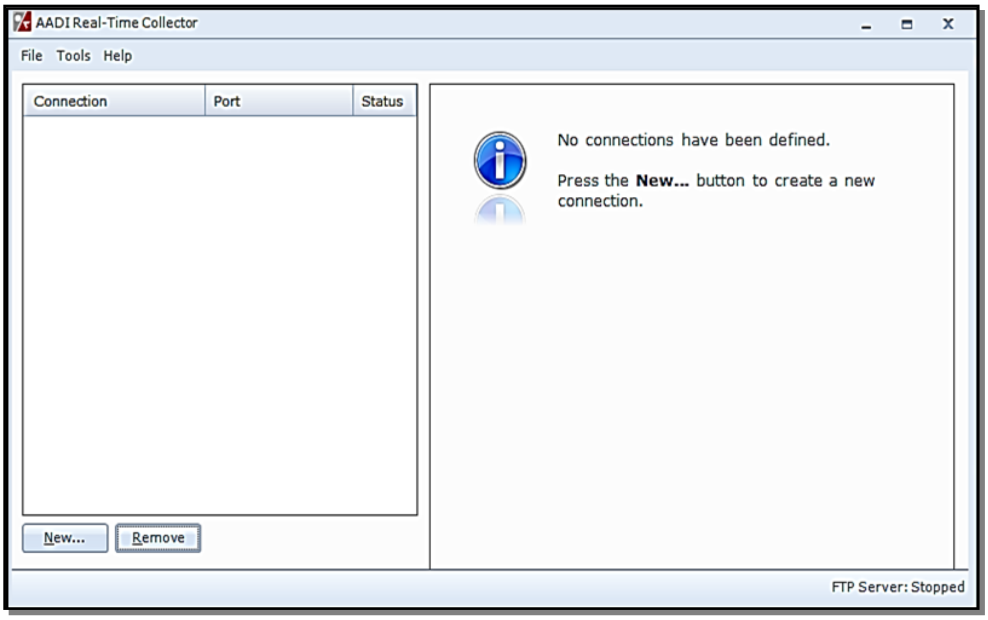


Figure 3-2: AADI Real-Time Collector start up menu

If the AADI Real-Time Collector program is being used for the first time, the connection list will be empty. Click on the ***New*** button in the lower left corner to create a new connection.

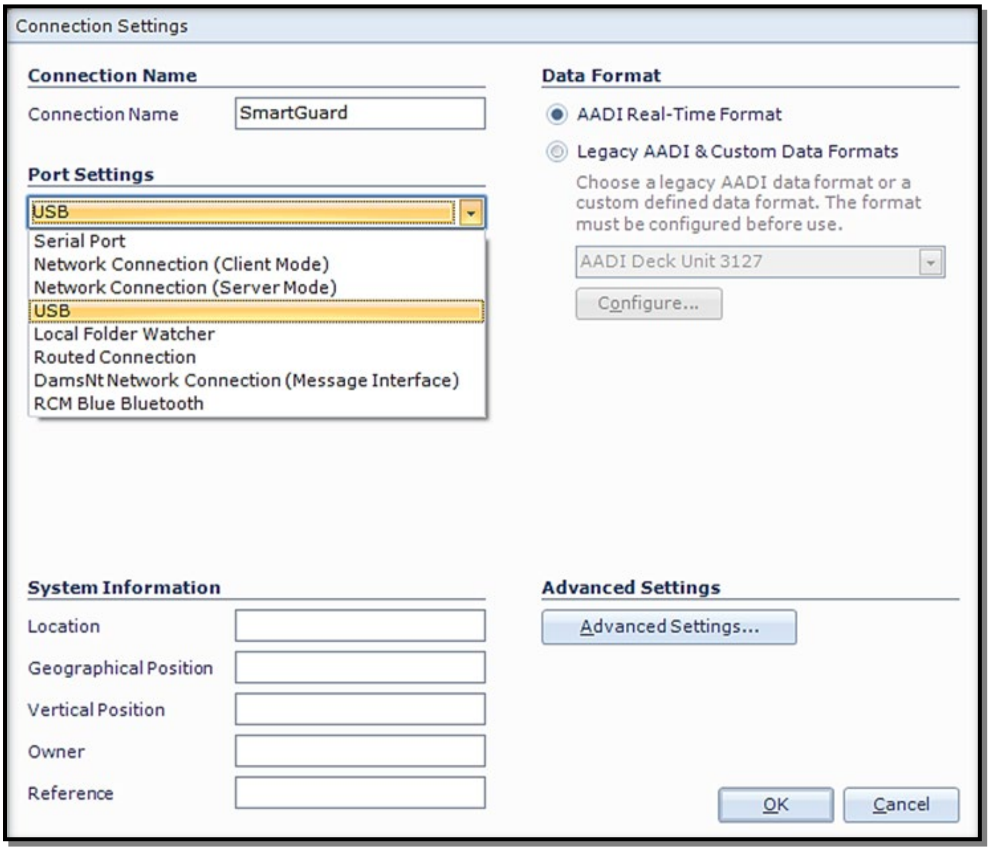


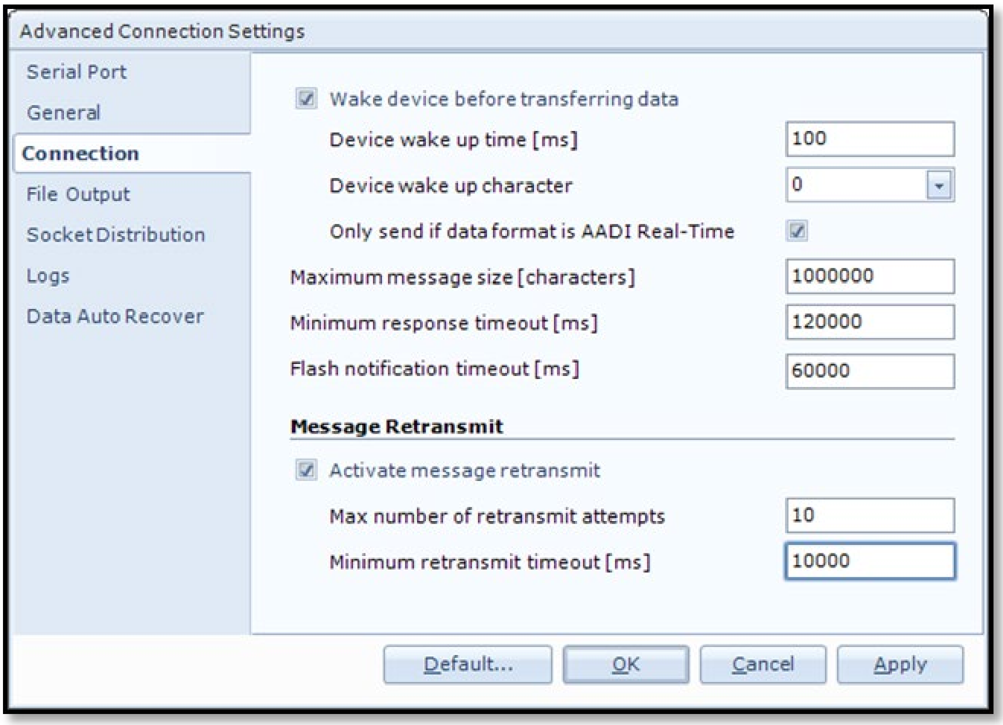
Figure 3-3: AADI Real time Collector connection settings

In the ***Connection Name*** box write a name specific for this connection (e.g. SmartGuard and #serial number)

Select ***USB*** from the ***Port Settings*** drop down menu if using USB connection, ***Serial Port*** if using the serial real-time connection or ***Network Connection*** if using LAN.

Then click on the ***Advanced Settings*** on the lower right side and in the ***Advanced Connection Settings*** window select ***Connection*** in the list on the left side, refer ***Figure 3-4***.

If you want to return to this menu later please close the port and then press ***Settings..*** in the main menu, refer ***Figure 3-5.***

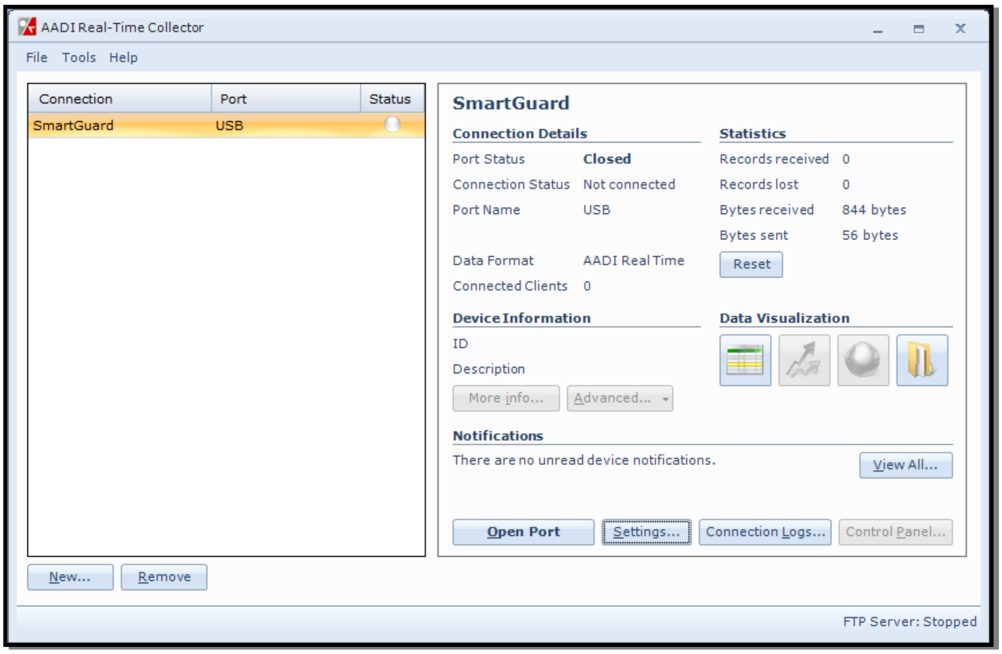


AADI Real-Time Collector uses a default setting that fits for most Smart Sensors. However the SmartGuard with Motus Wave Sensor outputs a large amount of data and might have much longer response time (depending on the configuration) than other smart sensors. Some of the connection settings might need to be changed. We recommend using the settings as shown in ***Figure 3-4.***

After updating the ***Advanced Connection Settings***, click on ***Apply*** and ***OK*** and then ***OK*** to go back to the start screen.

Figure 3-4: Advanced connection setting

The ***Advanced Settings*** are only accessible to change when the port is closed. If the settings are grey then you first need to close the port.

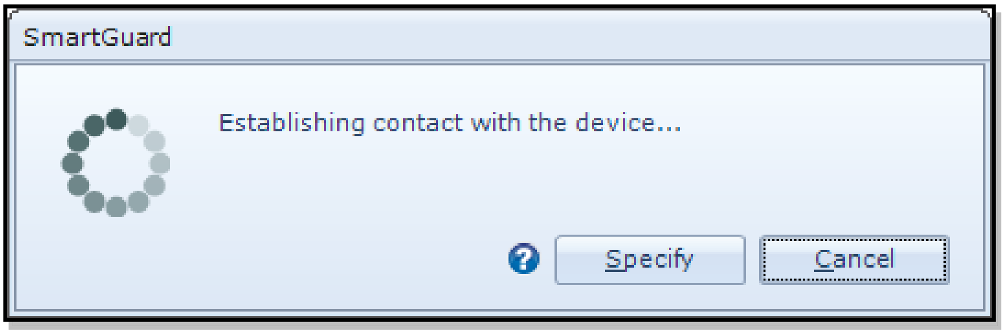


The new connection is now shown in the AADI Real-Time Collector connection list. Choose the new connection and click on the ***Open Port*** button.

The connection list might contain different connection to other sensors as well. Then highlight the SmartGuard connection to proceed.

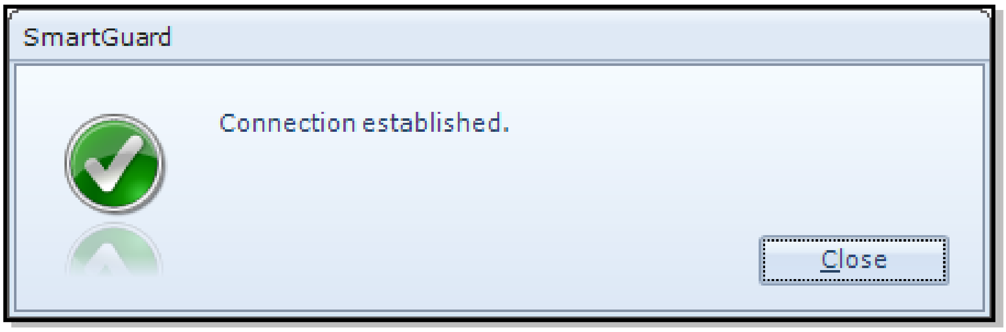
NOTE: This procedure only needs to be done once. This connection will be in the connection list at next start-up.

Figure 3-5: Connection list



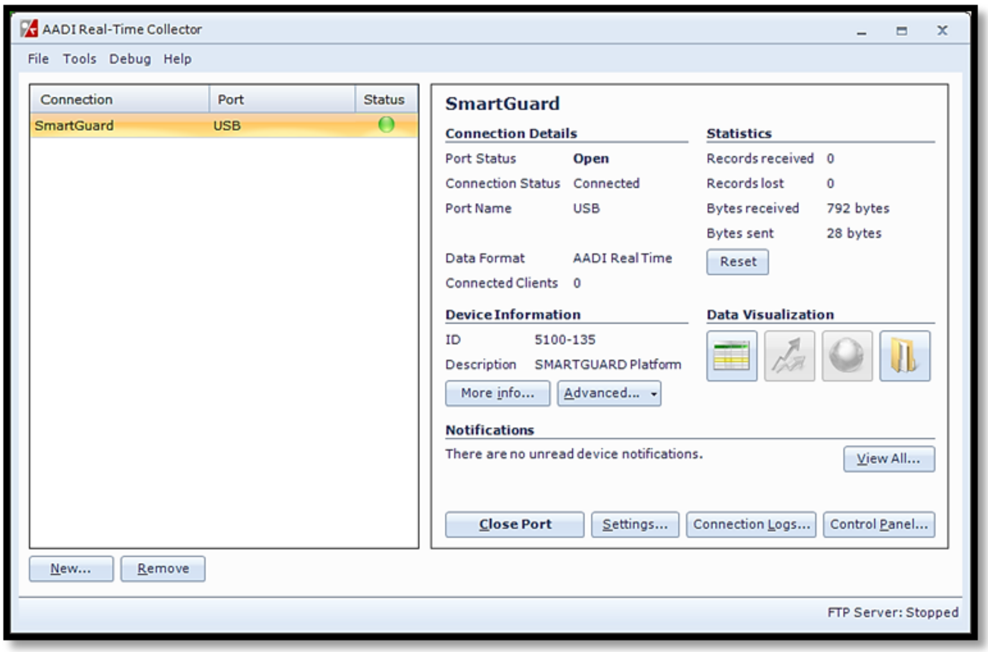
A new window with a turning wheele will then show up waiting for contact. This might take a couple of seconds depending on the SmartGuard configuration.

Figure 3-6: Establishing contact



When connection is established the status light will turn green.

Figure 3-7: Connection established



The selected connection has now changed to green status

*Press **Control Panel** to continue.*

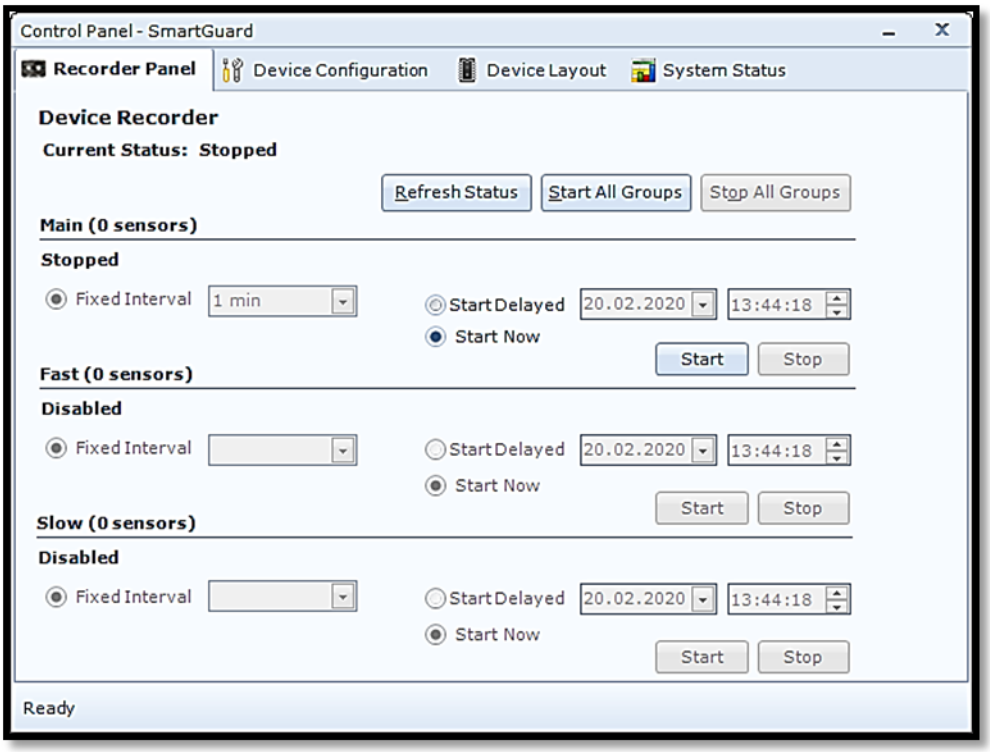
Figure 3-8: AADI Real-Time Collector main menu

3.4 Control Panel

In the ***Control Panel*** window you will find four tabs, ***Recorder Panel***, ***Device Configuration, Device Layout*** and ***System Status.*** Please note that these tabs are controlling the SmartGuard and the sensor is controlled by the SmartGuard together will all other sensors and equipment connected to the same logger. Under ***Recorder Panel*** you can start and stop recordings. If the recorder is running first click on the ***Stop Recorder*** as you are not allowed to configure the sensor when recording. In ***Device Configuration*** you will be able to perform all configurations on the Motus, SmartGuard and all other sensors connected. ***Device Layout*** is used to configure input from Non Smart Sensors such as analog sensors and also to configure output from the SmartGuard. Motus is a smart sensor and you don't need to configure this under ***Device Layout*** , but if you using an external compass this need to be configured her. ***System Status*** gives information about SmartGuard status including battery voltage, SD card status and Memory used. For more information about ***Device Layout*** and ***System Status*** please refer to TD293 Manual for SmartGuard.

3.5 Recorder Panel

In the ***Recorder Panel*** you will find 3 groups that are all controlled by the SmartGuard. Each group might have a different recording interval. Each group can contain different kind of sensors with different outputs. Also 3rd party sensors connected to the SmartGuard can be controlled by the logger. Each group can individually be either set to ***Start Now*** or ***Start Delayed***. To check in which group the Motus sensor is placed, or move it to another group select the ***Device Configuration*** folder and then ***Get Current Configuration***, then click on the ***Edit*** button under ***Deployment Setting***, select ***Multi Group Recorder*** under ***Device Nodes*** and then check ***Add/Remove Sensors*** for each group. See SmartGuard Manual TD293 for more information about ***Multi Group Recorder*** and how to place sensors in each group. The ***Fixed Interval*** or recording interval can be configured individual for each group either in ***Recorder Panel*** or in the ***Multi Group Recorder*** menu.



Select ***Recorder Panel.***

Note! *The configuration cannot be changed during a recording session.*

If the instrument is recording, under ***Recorder Panel***, press ***"Stop All Groups".***

Each recording group may be set to either ***Start Now*** or ***Start Delayed.***

Please note that the recorder panel controls the SmartGuard recording and each sensor connected are controlled by the SmartGuard

Figure 3-9: Recorder panel

3.6 Changing Values

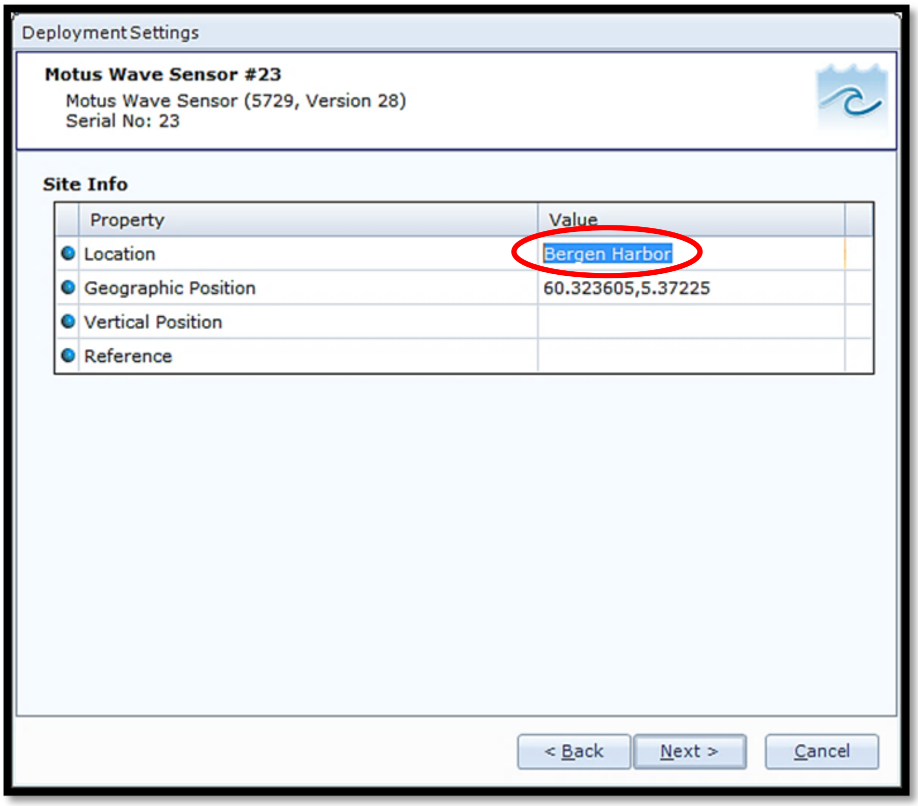


Figure 3-10 Change value

In the following chapters we will learn more about the Motus configuration. Sometimes you will need to change the value of a property.

First select the tab where the property is located. In this example: ***Device Configuration***.

Then press ***Get Current Configuration*** and ***Edit,*** located under ***Deployment Setting.***

Select by double clicking on the ***Motus Wave Sensor*** icon.

Then select the property you want to change by clicking in the value box.

To change values enter the text or number in the value box and press ***Next.***

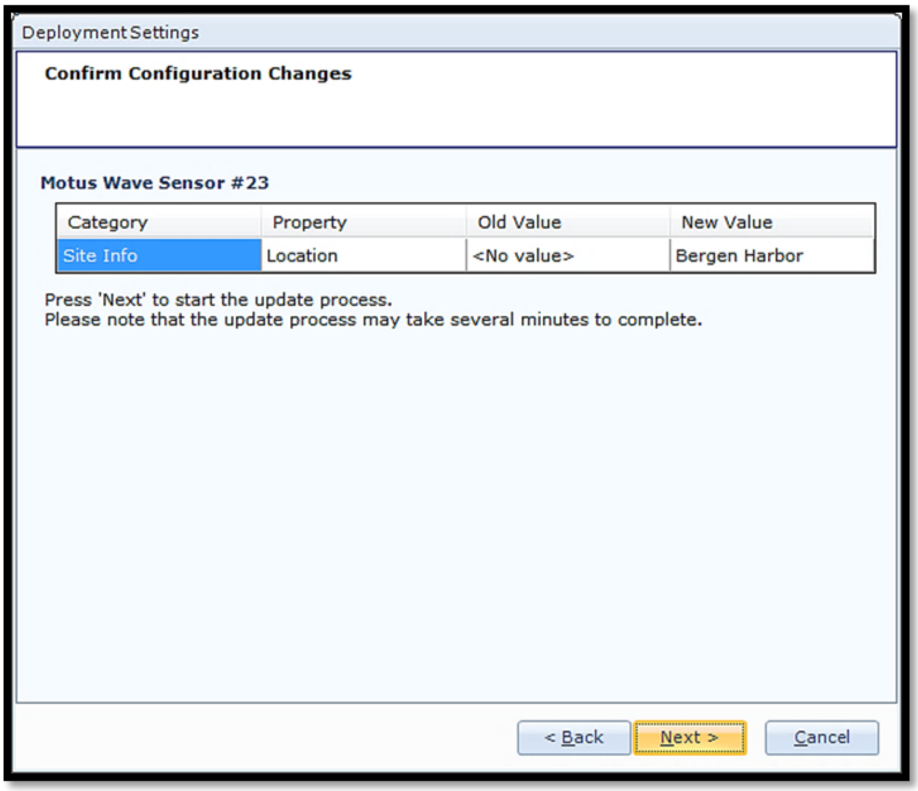
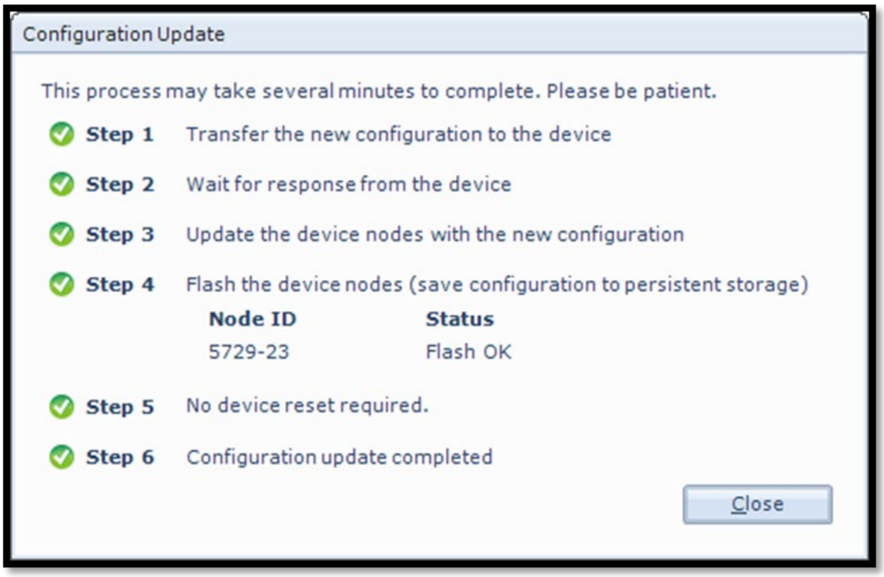


Figure 3-11 Confirm Configuration Changes

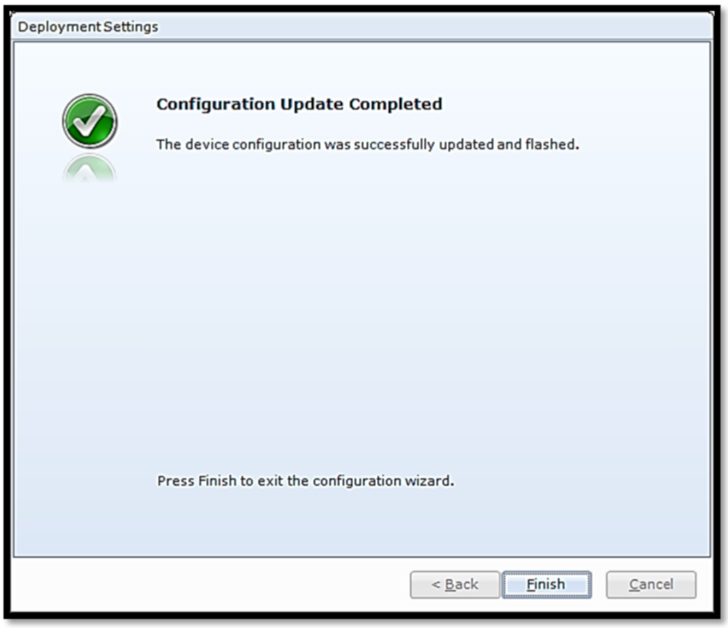
In the next window called ***Confirm Configuration Changes*** you will find a list of all changed properties with old and new values.

If the list of configuration changes is correct press ***Next*** to start the update process.



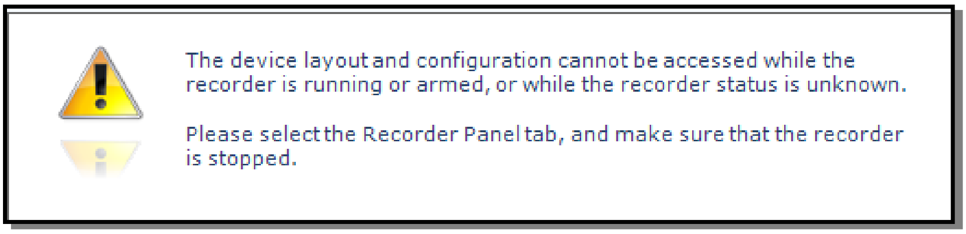
An automatic process will start with 6 steps transferring and storing the new settings in the sensor Flash. If necessary a reset will be executed. Do not switch off before the entire process is completed.

Figure 3-12 Configuration Update



When the updating process is finished a confirmation will show up. Press ***Finish*** to continue.

Figure 3-13 Configuration Update Completed



When you click finish the following warning may show up. Then you need to open the ***Recorder Panel*** and select ***Stop*** or ***Stop All Groups*** and/or press the ***Refresh Status*** button.

Figure 3-14: Warning after changing values

3.7 Device Configuration

Click on the ***Device Configuration*** tab in the top row of the ***Control Panel*** to access the sensor property configuration.

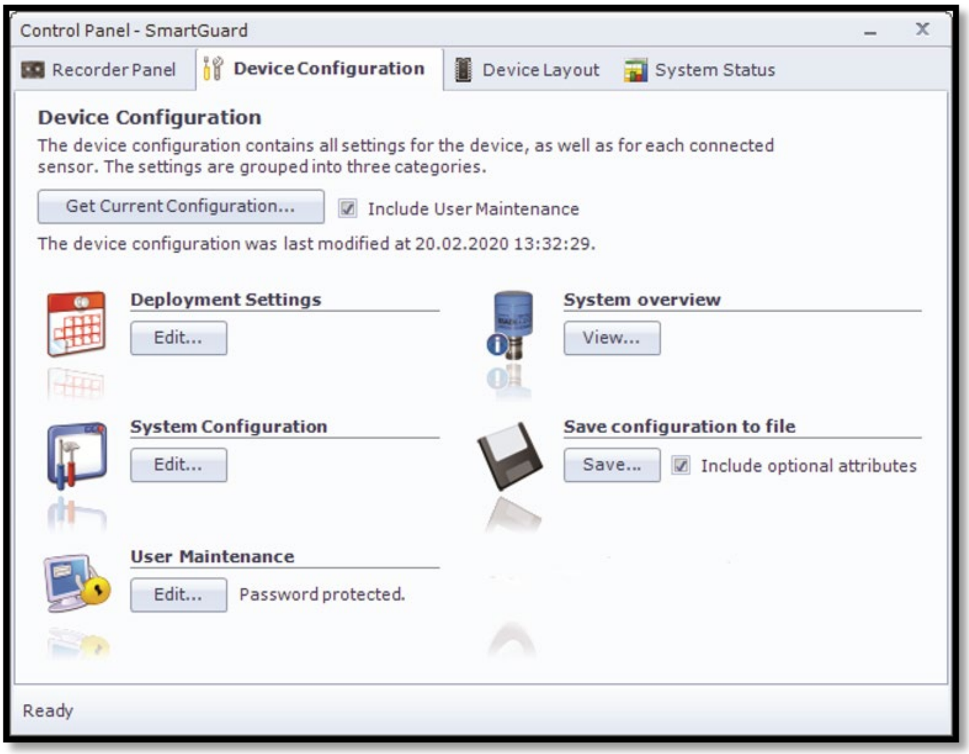


Figure 3-15: Device configuration

Click on ***Get Current Configuration...*** in order to receive the current configuration from the sensor. Check ***Include User Maintenance*** to view user maintenance settings. This group is password protected. ***The password is 1000***.

The ***Device Configuration*** is separated into five sections:

- ***Deployment settings***
- ***System Configuration***
- ***User Maintenance***
- ***System overview***
- ***Save configuration to file***

*User accessible sensor properties that are used to configure the sensor are found in the first three sections. **Deployment Settings** are described in **chapter 3.8**, **System Configuration** in **chapter 3.9**, **User Maintenance** in **chapter 3.10**. **System overview** in **chapter 3.11** and **Save configuration to file** in **chapter 3.12**.*

3.8 Deployment Settings

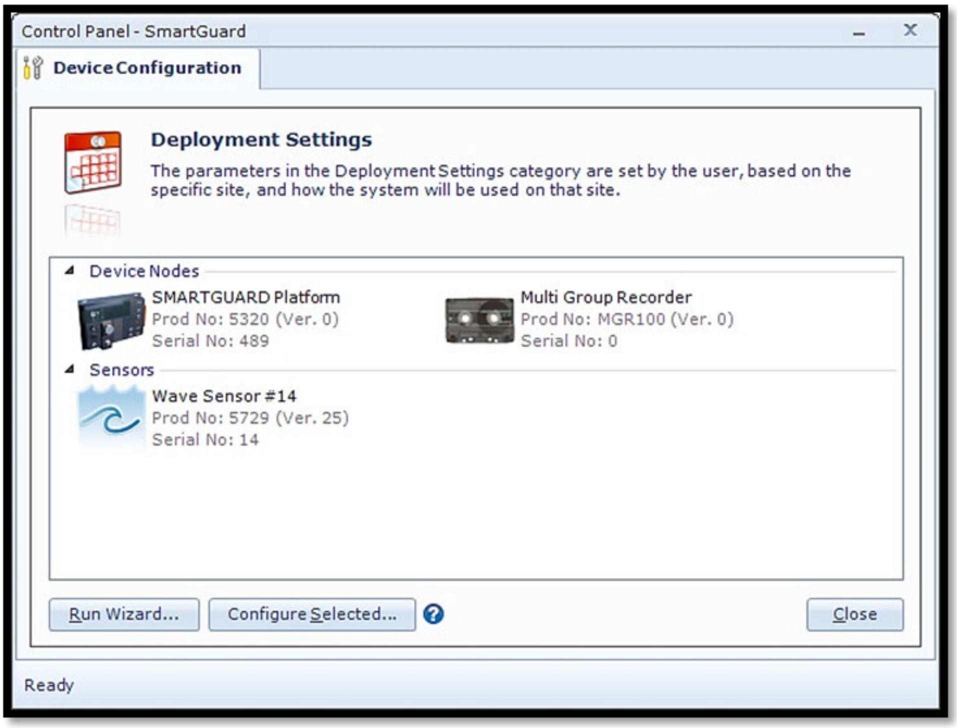


Figure 3-16: Deployment settings main

Select ***Deployment Settings*** by pressing the ***Edit*** button under ***Deployment Settings***

Under the ***Sensors*** section you will find a list of all sensors connected to the logger.

Double-click on the ***Wave sensor*** icon to select the sensor.

If you don't find the sensor check connection and make sure the sensor are set to ***AiCaP mode***.

If you still can't find the sensor check that the AiCaP termination is as recommended.

Please note that you need a power reset after connecting the sensor.

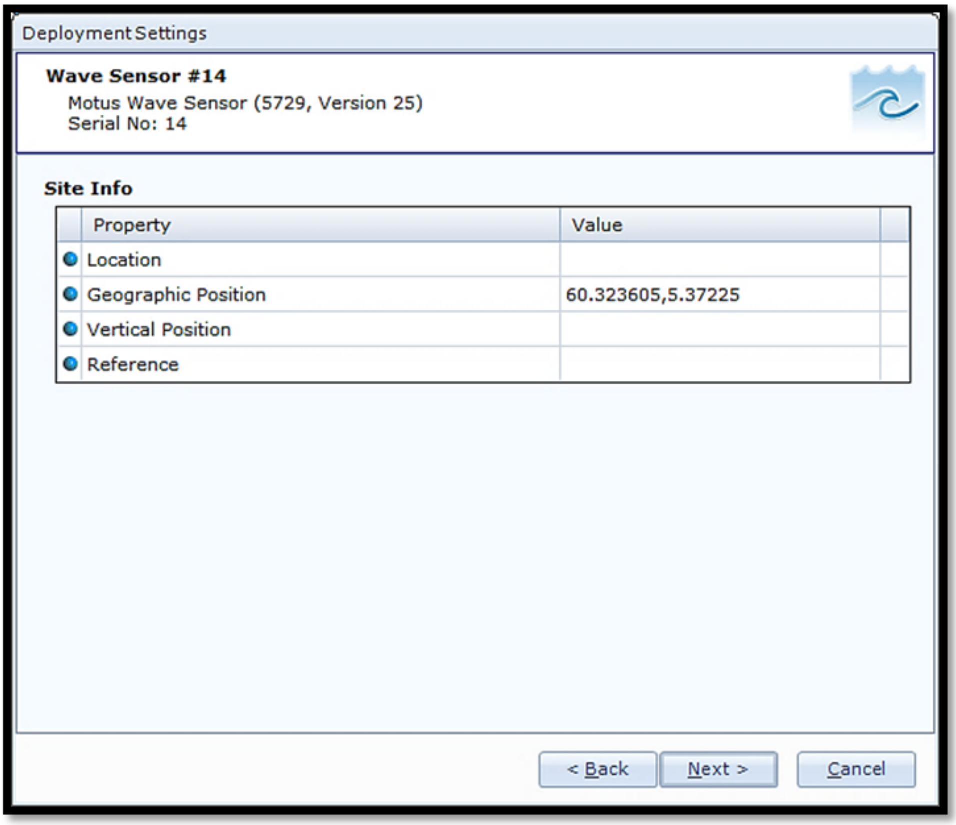


Figure 3-17: Wave sensor Deployment Settings

Deployment Settings consist of only one session; ***Site Info*** containing four properties:

3.8.1 Site Info

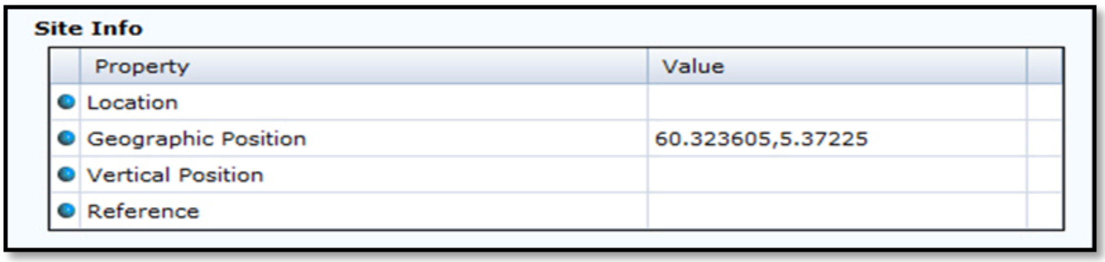


Figure 3-18: Site Info

Site Info containing four properties:

- ***Location***
- ***Geographic Position***
- ***Vertical Position***
- ***Reference***

All these settings are optional information where you can enter and store information about the deployment. This can be useful information to store together with a data set. These setting are not used in calculation. ***Geographical Position*** is used to give the map coordinates unless a GPS input is connected to the logger

3.9 System Configuration

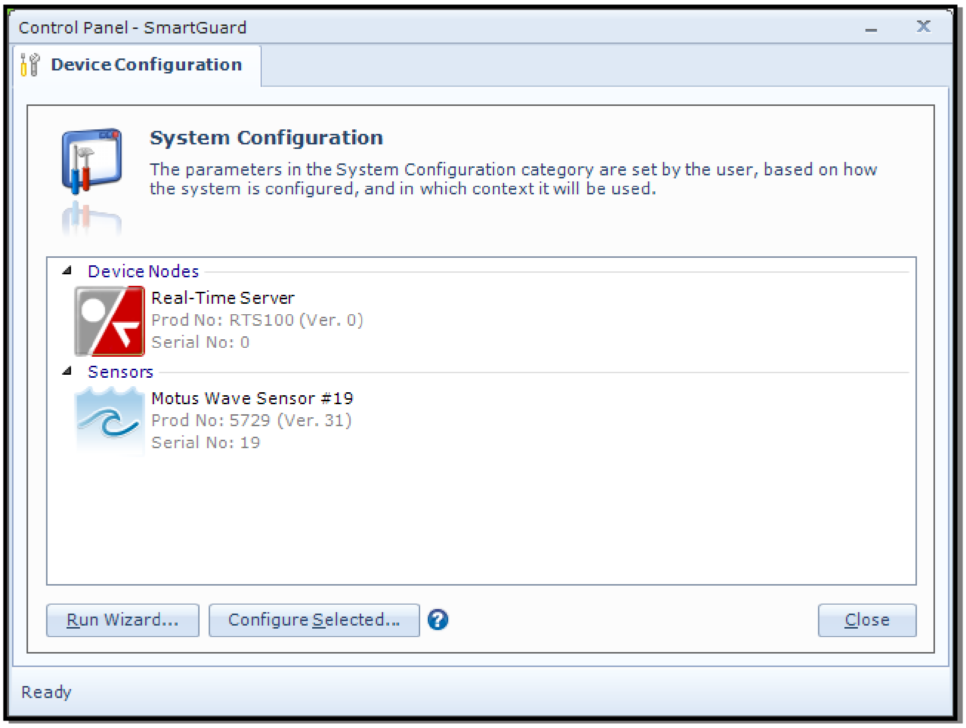
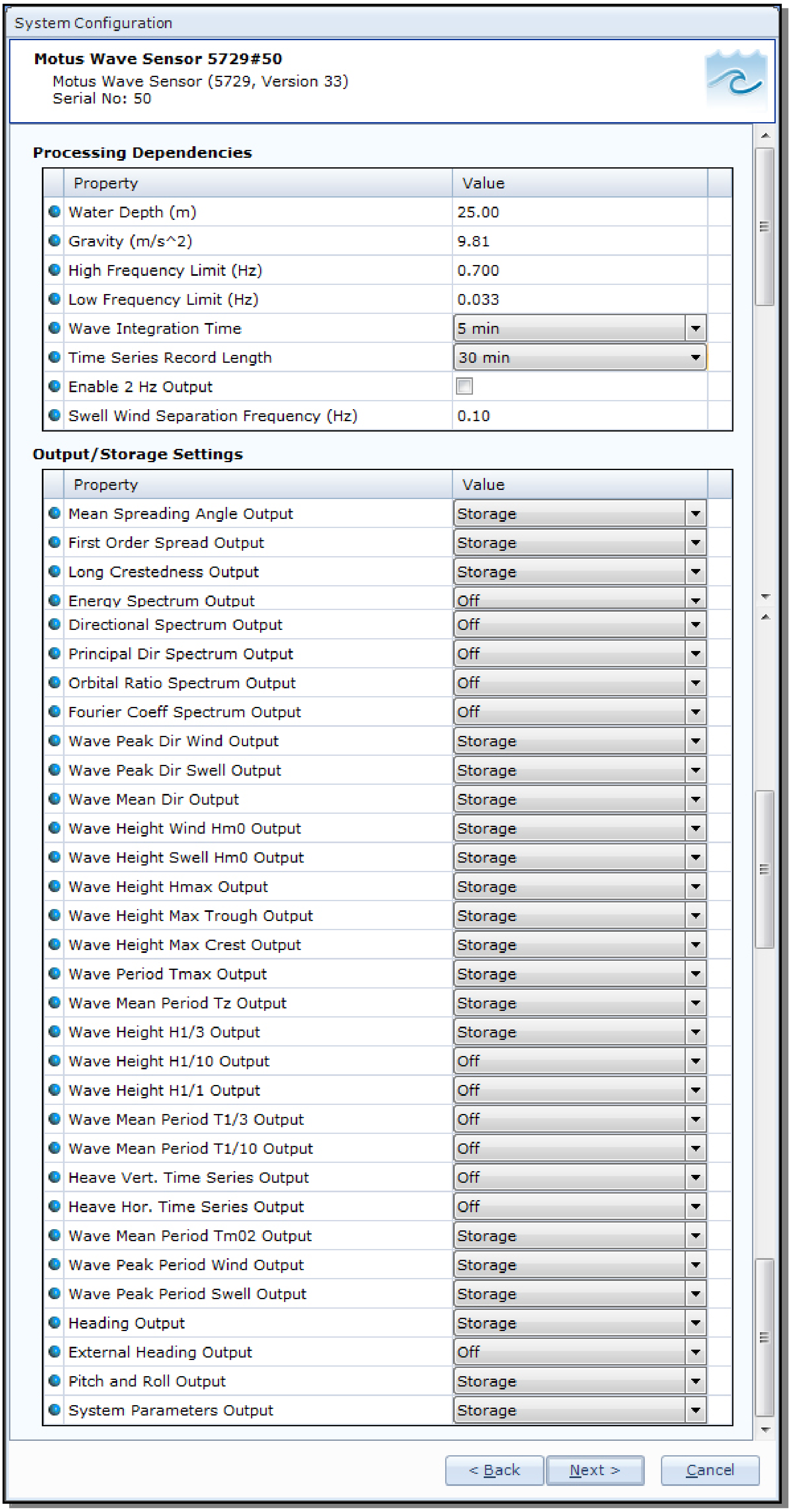


Figure 3-19: System configuration main

Select ***System Configuration*** by pressing the ***Edit*** button under ***System Configuration,*** refer ***Figure 3-15.***

The different sensors connected to the same Datalogger will show up as selectable items.

Double-click on the ***Wave Sensor.***



System Configuration

Motus Wave Sensor 5729#50
Motus Wave Sensor (5729, Version 33)
Serial No: 50

Processing Dependencies

Property	Value
Water Depth (m)	25.00
Gravity (m/s^2)	9.81
High Frequency Limit (Hz)	0.700
Low Frequency Limit (Hz)	0.033
Wave Integration Time	5 min
Time Series Record Length	30 min
Enable 2 Hz Output	☐
Swell Wind Separation Frequency (Hz)	0.10

Output/Storage Settings

Property	Value
Mean Spreading Angle Output	Storage
First Order Spread Output	Storage
Long Crestedness Output	Storage
Energy Spectrum Output	Off
Directional Spectrum Output	Off
Principal Dir Spectrum Output	Off
Orbital Ratio Spectrum Output	Off
Fourier Coeff Spectrum Output	Off
Wave Peak Dir Wind Output	Storage
Wave Peak Dir Swell Output	Storage
Wave Mean Dir Output	Storage
Wave Height Wind Hm0 Output	Storage
Wave Height Swell Hm0 Output	Storage
Wave Height Hmax Output	Storage
Wave Height Max Trough Output	Storage
Wave Height Max Crest Output	Storage
Wave Period Tmax Output	Storage
Wave Mean Period Tz Output	Storage
Wave Height H1/3 Output	Storage
Wave Height H1/10 Output	Off
Wave Height H1/1 Output	Off
Wave Mean Period T1/3 Output	Off
Wave Mean Period T1/10 Output	Off
Heave Vert. Time Series Output	Off
Heave Hor. Time Series Output	Off
Wave Mean Period Tm02 Output	Storage
Wave Peak Period Wind Output	Storage
Wave Peak Period Swell Output	Storage
Heading Output	Storage
External Heading Output	Off
Pitch and Roll Output	Storage
System Parameters Output	Storage

< Back | Next > | Cancel

Figure 3-20 Wave Sensor System Configuration

System Configuration are divided in two section

- ***Processing Dependencies***
- ***Output/Storage Settings***

Processing Dependencies are settings used in the wave calculation.

Please note that the time settings here are controlling the sensor wave calculation time and the time series length, not the output ***interval***. The SmartGuard are controlling the Output ***Interval***, how often the data is presented on the output or alternatively stored to the SD-card.

Output ***Interval*** is configured in ***Device Configuration>Deployment Settings>Multi Group Recorder***, see ***chapter 3.5*** or in the ***Recorder Panel*** see ***chapter 3.4.1***

Output/Storage Settings are controlling the output from the sensor. Except from ***Significant Wave Height H_{m0}, Wave Peak Direction and Wave Peak Period*** that always will be presented all other parameters can either be set to ***Off, Storage*** or ***Storage+Output***.

Where ***Off*** means that the parameter is not calculated, ***Storage*** means that the parameter is stored on SmartGuard SD-card and ***Storage+Output*** means that the parameter is both stored and transmitted on the SmartGuard output lines.

All parameters are calculated based on data collected the last ***Wave Integration Time***

3.9.1 Processing Dependencies

Processing Dependencies

Property	Value
Water Depth (m)	25.00
Gravity (m/s^2)	9.81
High Frequency Limit (Hz)	0.700
Low Frequency Limit (Hz)	0.033
Wave Integration Time	5 min
Time Series Record Length	30 min
Enable 2 Hz Output	☐
Swell Wind Separation Frequency (Hz)	0.10

Figure 3-21: Processing Dependencies

Water Depth (m) is the total water depth where the buoy is located in meter. The default setting is 25 meter.

Gravity (m/s^2) is the local gravity constant in m/s^2. The default value is 9.81m/s^2

High Frequency Limit (Hz) is the lower cut-off frequency in Hz. The default value is 0.7Hz= 1/0.7 = 1.42second, this is also equal to the lowest wave period we can measure.

Low Frequency Limit (Hz) is the higher cut-off frequency in Hz. The default value is 0.03333Hz = 1/0.3333 = 30seconds. The range is maximum 33seconds = 0.03030Hz.

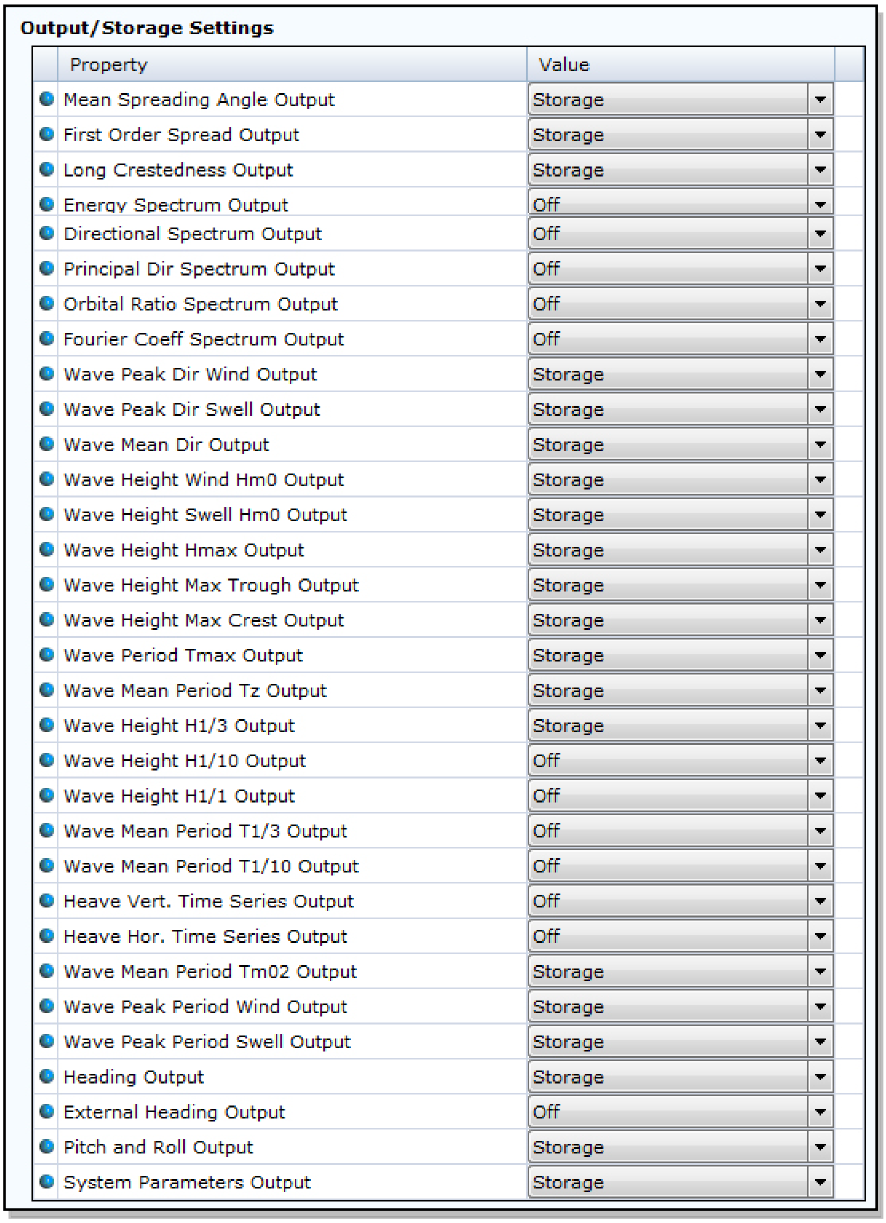
Wave Integration Time is the period the sensor use to calculate all wave parameters. Range is 5 minutes to 60 minutes and default is 30 minutes.

Timeseries record length is the length of each timeseries. Range is 5 minutes to 60 minutes and default is 30 minutes.

Enable 2 Hz Output sets the output for all Time Series to 2Hz. Default is 'no' equal to 4HZ.

Swell Wind Separation Frequency (Hz) is the frequency that separates wind from swell. Default value is 0.1Hz =10s. Waves with period bellow 10s are then considered as wind generated sea and waves above 10s are considered as swell.

3.9.2 Output/Storage Settings


Output/Storage Settings

Property	Value
Mean Spreading Angle Output	Storage
First Order Spread Output	Storage
Long Crestedness Output	Storage
Energy Spectrum Output	Off
Directional Spectrum Output	Off
Principal Dir Spectrum Output	Off
Orbital Ratio Spectrum Output	Off
Fourier Coeff Spectrum Output	Off
Wave Peak Dir Wind Output	Storage
Wave Peak Dir Swell Output	Storage
Wave Mean Dir Output	Storage
Wave Height Wind Hm0 Output	Storage
Wave Height Swell Hm0 Output	Storage
Wave Height Hmax Output	Storage
Wave Height Max Trough Output	Storage
Wave Height Max Crest Output	Storage
Wave Period Tmax Output	Storage
Wave Mean Period Tz Output	Storage
Wave Height H1/3 Output	Storage
Wave Height H1/10 Output	Off
Wave Height H1/1 Output	Off
Wave Mean Period T1/3 Output	Off
Wave Mean Period T1/10 Output	Off
Heave Vert. Time Series Output	Off
Heave Hor. Time Series Output	Off
Wave Mean Period Tm02 Output	Storage
Wave Peak Period Wind Output	Storage
Wave Peak Period Swell Output	Storage
Heading Output	Storage
External Heading Output	Off
Pitch and Roll Output	Storage
System Parameters Output	Storage

Figure 3-22: Output/Storage Settings

The second session is ***Output/Storage Settings***. The alternatives in the drop down menu for each parameter are ***Off, Storage*** and ***Output+Storage***, where ***Off*** means that the parameter is not calculated, ***Output+Storage*** means that the sensor instructs the Datalogger to send out a parameter in real-time in addition to saving the parameter to the SD card and ***Storage*** *are used* for only saving the data to the SmartGuard SD card.

All parameters except from ***Significant Wave Height H_{m0}, Wave Peak Direction and Wave Peak Period*** may be switched on or off.

Some of the Properties are enabling only one parameter and others can enable multiple parameters. Please also notice that the order and name of the properties do not match with the order and name of the output parameters.

Wave Properties in this section are listed in ***Table 3-1*** with corresponding parameter and unit. For more information about parameter calculation see ***chapter 2.7***

Property	Parameter	Unit
Mean Spreading Angle Output	*Mean Spreading Angle*	Deg.M
First Order Spread Output	*First Order Spread*	Deg. M
Long Crestedness Output	*Long Crestedness*	
Energy Spectrum Output	*Energy Spectrum*	m^2 / Hz
Directional Spectrum Output	*Directional Spectrum*	Deg. M
Principal Dir Spectrum Output	*Principal Directional Spectrum*	Deg. M
Orbital Ratio Spectrum Output	*Orbital Ratio Spectrum*	
Fourier Coeff Spectrum Output	*Fourier Coeff A1* *Fourier Coeff A2* *Fourier Coeff B1* *Fourier Coeff B2*	
Wave Peak Dir Wind Output	*Wave Peak Direction Wind*	Deg. M
Wave Peak Dir Swell Output	*Wave Peak Direction Swell*	Deg. M
Wave Mean Dir Output	*Wave Mean Direction*	Deg. M
Wave Height Wind H_{m0} Output	*Wave Height Wind H_{m0}*	m
Wave Height Swell H_{m0} Output	*Wave Height Swell H_{m0}*	m
Wave Height H_{max} Output	*Wave Height H_{max}*	m
Wave Height Max Trough Output	*Wave Height Trough*	m
Wave Height Max Crest Output	*Wave Height Crest*	m
Wave Period T_{max} Output	*Wave Period T_{max}*	s
Wave Mean Period T_z Output	*Wave Period T_z*	s
Wave Height $H_{1/3}$ Output	*Significant Wave Height $H_{1/3}$*	m
Wave Height $H_{1/10}$ Output	*Significant Wave Height $H_{1/10}$*	m
Wave Height $H_{1/1}$ Output	*Significant Wave Height $H_{1/1}$*	m
Wave Mean Period $T_{1/3}$ Output	*Wave Mean Period $T_{1/3}$*	s
Wave Mean Period $T_{1/10}$ Output	*Wave Mean Period $T_{1/10}$*	s
Heave Vert. Time Series Output	*Last Heave Sample Index* *Heave Time Series Vertical*	 m
Heave Hor. Time Series Output	*Heave Time Series North* *Heave Time Series East*	m m
Wave Mean Period T_{m02} Output	*Wave Mean Period T_{m02}*	s
Wave Peak Period Wind Output	*Wave Peak Period Wind*	s
Wave Peak Period Swell Output	*Wave Peak Period Swell*	s

Table 3-1: Output Properties and corresponding Parameters

Other non-wave parameters in this section are listed in ***Table 3-2*** with corresponding parameter and unit.

Property	Parameter	Unit
Heading Output	**Heading**	Deg. M
	StDev Heading	Deg. M
External Heading Output	**External Heading**	Deg. M
Pitch and Roll Output	**Pitch**	Deg
	Roll	Deg
	StDev Pitch	Deg
	StDev Roll	Deg
System Parameters Output	**Input Voltage**	V
	Input Current	mA
	Memory Used	Bytes

Table 3-2: Output Properties and corresponding Parameters

3.10 User Maintenance

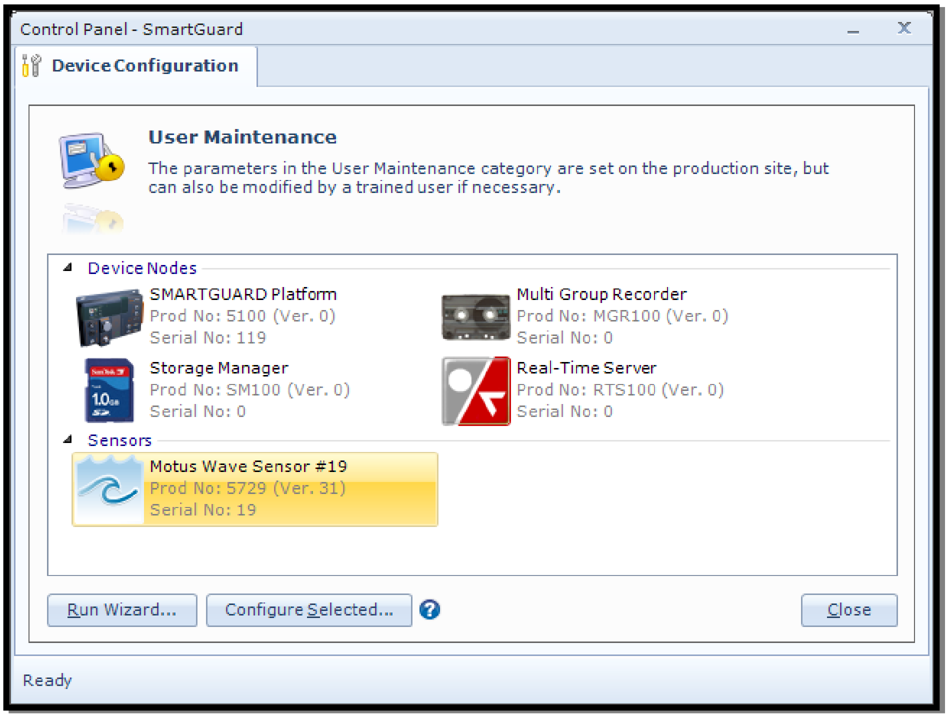


Figure 3-23: User Maintenance main

In ***User Maintenance*** you will find properties that are password protected and are normally set / altered by a trained user. It is not recommended to change properties unless instructed. To access this menu check the ***"Include User Maintenance"*** box in the ***Device Configuration*** before clicking on the ***"Get Current Configuration…"*** button. The password is: **1000**.

Then click on the ***Edit*** button under ***User Maintenance*** and double click on the ***Wave Sensor*** icon in the sensor list.

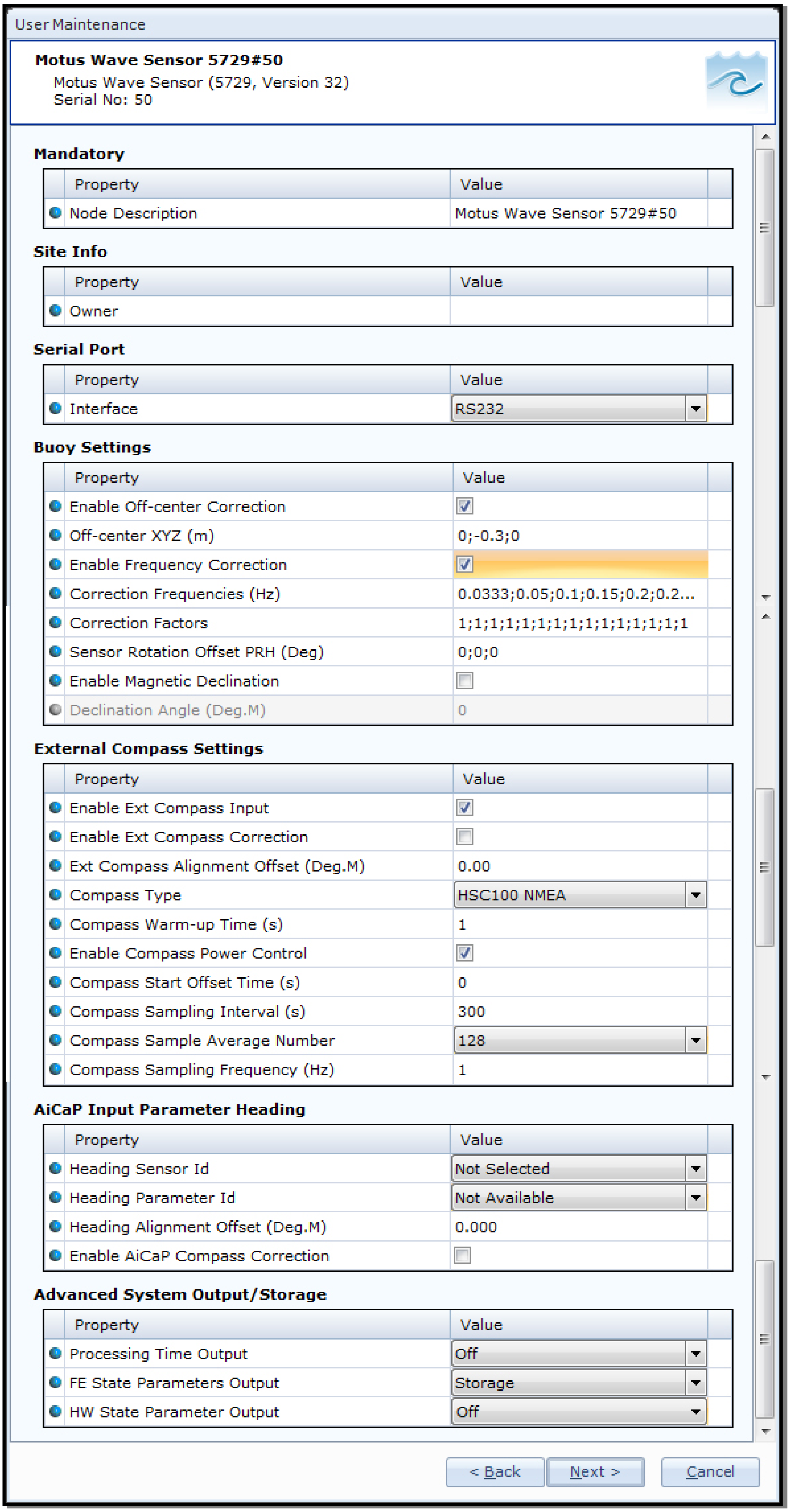


Figure 3-24: Wave Sensor User Maintenance

User Maintenance holds 7 different sections:

- ***Mandatory***
- ***Site Info***
- ***Serial Port***
- ***Buoy Settings***
- ***External Compass Settings***
- ***AiCaP Input Parameter Heading***
- ***Advanced System Output /Storage***

The settings here are mainly used to compensate for influence from the sensor surroundings like off-center mounting and magnetic influence on the internal compass. The adjustment for use on other buoys that Motus DB 1750 and EMM 2.0 can also be entered here by using the ***Enable Frequency Correction***.

See *chapter 3.7.1* through *3.7.7* for a description of each parameter in each sections.

AiCaP Input Parameter Heading is only available when in ***AiCaP mode***. Not visible when used in other applications.

3.10.1 Mandatory

Mandatory

Property	Value
Node Description	Motus Wave Sensor 5729#50

Figure 3-25: Mandatory in User Maintenance

All sensors are given a ***Node Description*** text like ***Motus #xxx*** (where xxx is the serial number of the sensor). The user can modify this node description text if required. Be aware that the node description changes to ****Corrupt Configuration*** if it has lost the configuration in flash. Contact the factory if this happens. The configuration is saved in two sectors in flash memory. A flash sector can be corrupted if the power is lost during the saving of new configuration. The double flash sector saving ensures that it does not lose the configuration. If one of the sectors is corrupted, the other sector is used and also saved to the corrupt sector.

3.10.2 Site Info

Site Info

Property	Value
Owner	

Figure 3-26; Site Info in User Maintenance

Site Info is optional information to be entered to store information about the ***Owner***. This setting is not used in calculation.

3.10.3 Serial Port

Serial Port

Property	Value
Interface	RS232

Figure 3-27: Serial Port settings in User Maintenance

The ***Serial Port*** group contains setting that deals with the serial port setting***. Interface*** is only available as RS-232.

3.10.4 Buoy Settings

Buoy Settings

Property	Value
Enable Off-center Correction	☑
Off-center XYZ (m)	0;-0.3;0
Enable Frequency Correction	☑
Correction Frequencies (Hz)	0.0333;0.05;0.1;0.15;0.2;0.2...
Correction Factors	1;1;1;1;1;1;1;1;1;1;1;1;1;1;1
Sensor Rotation Offset PRH (Deg)	0;0;0
Enable Magnetic Declination	☐
Declination Angle (Deg.M)	0

Figure 3-28: Buoy Settings in User Maintenance

If the sensor is positioned off-center you will be able to compensate for this offset by enabling ***Enable Off-center Correction***. The sensor will then use the xyz coefficients given in ***Off-center XYZ (m)*** to compensate for any off-center positioning. Refer to ***chapter 2.3*** for calculation of the off-center coefficients. Sea trials indicate that the error introduced when not compensating for this effect can be in the order of 10 -15 % (40cm installation offset) depending on the sea state and spectral distribution of the waves.

If ***Enable Frequency Correction*** is set then ***Correction Frequencies (Hz)*** and ***Correction Factors*** are enabled and used in calculations. ***Correction Frequencies (Hz)*** set a total number of 15 frequencies and each frequency has a corresponding ***Correction Factors.*** These setting are used to correct for different frequency response of different buoys. The default settings are according to the Motus DB 1750 buoy and can also be used for similar buoys. If you want to use the sensor on another buoy with different frequency response then please contact aanderaa.support@xyleminc.com for further instructions.

Sensor Rotation Offset PRH (Deg) sets a compensation value for ***Pitch***, ***Roll*** and ***Heading***. These values is added to the IMU calculated Pitch, Roll and Heading. These values do not change the calculated wave direction, but only the output parameters ***Pitch***, ***Roll*** and ***Heading***. When post processing the wave directions using an external compass as reference these values must be subtracted from the Sensor Orientation before the External compass corrections are performed.

Enable Magnetic Declination is normally used when sensor is used close to South Pole or North Pole. ***Declination Angle (Deg.M)*** is a value to correct for the magnetic variation on the site where the sensor is used. This is the angle in degrees between magnetic north and true north. Magnetic declination (variation) is the angle between the magnetic north and the true north. This angle varies depending on the position on the Earth's surface and also varies over time. Declination is positive when magnetic north is east of true north and negative when it is to the west (input angle value ±180°). Magnetic declination at the deployment location can be found for i.e. on NOAA website: http://www.ngdc.noaa.gov/geomag-web/

3.10.5 External Compass Settings

External Compass Settings

Property	Value
Enable Ext Compass Input	☑
Enable Ext Compass Correction	☐
Ext Compass Alignment Offset (Deg.M)	0.00
Compass Type	HSC100 NMEA
Compass Warm-up Time (s)	1
Enable Compass Power Control	☑
Compass Start Offset Time (s)	0
Compass Sampling Interval (s)	300
Compass Sample Average Number	128
Compass Sampling Frequency (Hz)	1

Figure 3-29: External Compass Settings in User Maintenance

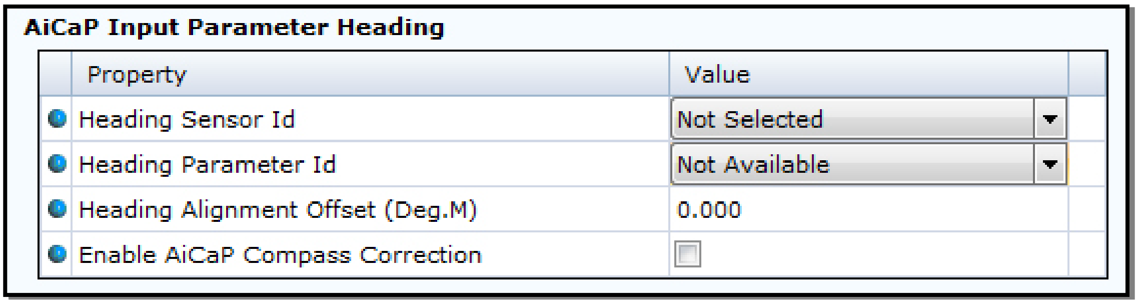
To use an external compass you need to select ***Enable Ext Compass Input*** but then to use this compass reading in calculation you also need to select the ***Enable Ext Compass Correction*** otherwise it will only store and/or output the reading as external compass. ***Ext Compass Alignment Offset (Deg.M)*** is the angle in Degrees Magnitude used to compensate for a compass misalignment. The value is added to the parameter ***External Heading***.

Two different alternatives are available in ***Compass Type*** as external compass:

- ***HSC100 NMEA***
- ***Generic NMEA***

Compass Warm-up Time (s) is the time in seconds needed from power is switched on to the external compass until it is ready to output compass data. To save power the ***Enable Compass Power Control*** might be set. If disabled, the compass is always on. ***Compass Start Offset Time (s)*** is the Offset time from the start of each recording interval until the start of the external compass. Only used when ***Enable Compass Power Control*** is activated. ***Compass Sampling Interval (s)*** is the interval between each new start of the external compass sampling. This interval has to be bigger than N/fs where N is the ***Compass Sample Average Number*** and fs are the ***Compass Sampling frequency (Hz)***. Only used when ***Enable Compass Power Control*** is activated. ***Compass Sample Average Number*** is the number of samples to be taken from the external compass and averaged before the power to the external compass is switched off again. Selectable number of values is 4, 8, 16, 32, 64 and 128. Only used when ***Enable Compass Power Control*** is activated. ***Compass Sampling Frequency (Hz)*** is the frequency which the sensor is sampling the compass, 1Hz is the only alternative yet.

3.10.6 AiCaP Input Parameter Heading


AiCaP Input Parameter Heading

Property	Value
Heading Sensor Id	Not Selected
Heading Parameter Id	Not Available
Heading Alignment Offset (Deg.M)	0.000
Enable AiCaP Compass Correction	☐

Figure 3-30: AiCaP Input Parameter Heading in User Maintenance

All these settings are only visible if the sensor is set to AiCaP mode and they are then used to select and configure an external AiCaP compass connected to the AiCaP-bus on the SmartGuard. In the ***Heading Sensor Id*** dropdown list you will find all heading sensors connected to the SmartGuard logger. If no external compass with less magnetic influence are in use select ***"Not Selected"***

NOTE! Make sure you don't select the Motus as its own external compass.

In the ***Heading Parameter Id*** drop down list all available Heading parameters with Deg.M as unit from the sensor selected in ***Heading Sensor Id*** are shown. Also other directions like for example Current direction from Doppler sensors is shown if connected to the same logger. Make sure that the correct heading parameter is selected.

Heading Alignment Offset (Deg.M) is used to enter any misalignment in the external AiCaP compass.The value in ***Heading Alignment Offset (Deg.M)*** is added to ***Heading***.

If ***Enable AiCaP Compass Correction*** are selected then the value from the external AiCaP source will be used in wave calculation.

3.10.7 Advanced System Output

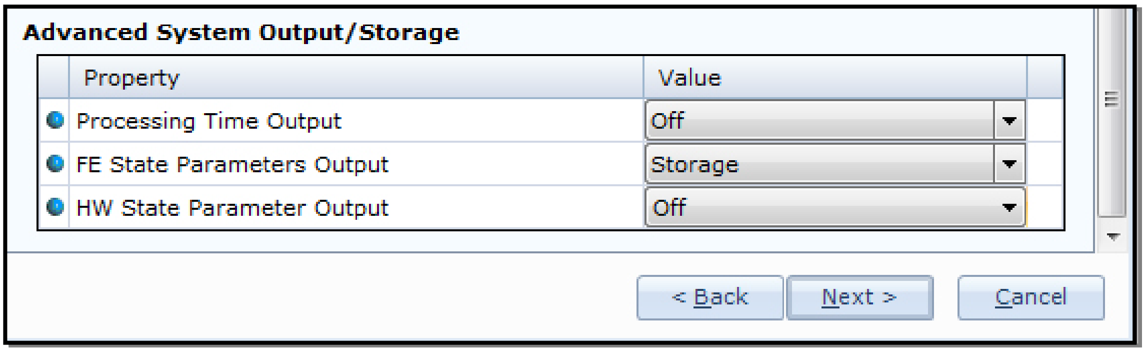


Figure 3-31: Advanced System Output in User Maintenance

The properties in this section may be set to one of the tree options: ***Off, Storage*** and ***Output + Storage*****.**

Off: Parameter is turned off

Storage: Parameter is stored in logger but not presented on real-time output

Output + Storage**:** Parameter is both stored in logger and presented through the real-time output

The parameters in this section are useful parameters for troubleshooting purpose. ***Processing Time Output*** is the time used for processing all the data from the last wave integration time.

FE State Parameters Output is an advanced system output which can be enabled to give more information about the internal coprocessor and communication between the host processor and the coprocessor. Two output parameters, ***FE State*** and ***FE Notifications*** are controlled by this setting. The ***FE State*** parameter is 0 if everything is ok. The ***FE Notifications*** parameter gives information about the last communications with the coprocessor.

HW State Parameter Output is an advanced system setting which can be enabled to give more information about the internal electronic hardware. The output is 0 if everything is ok.

3.11 System Overview

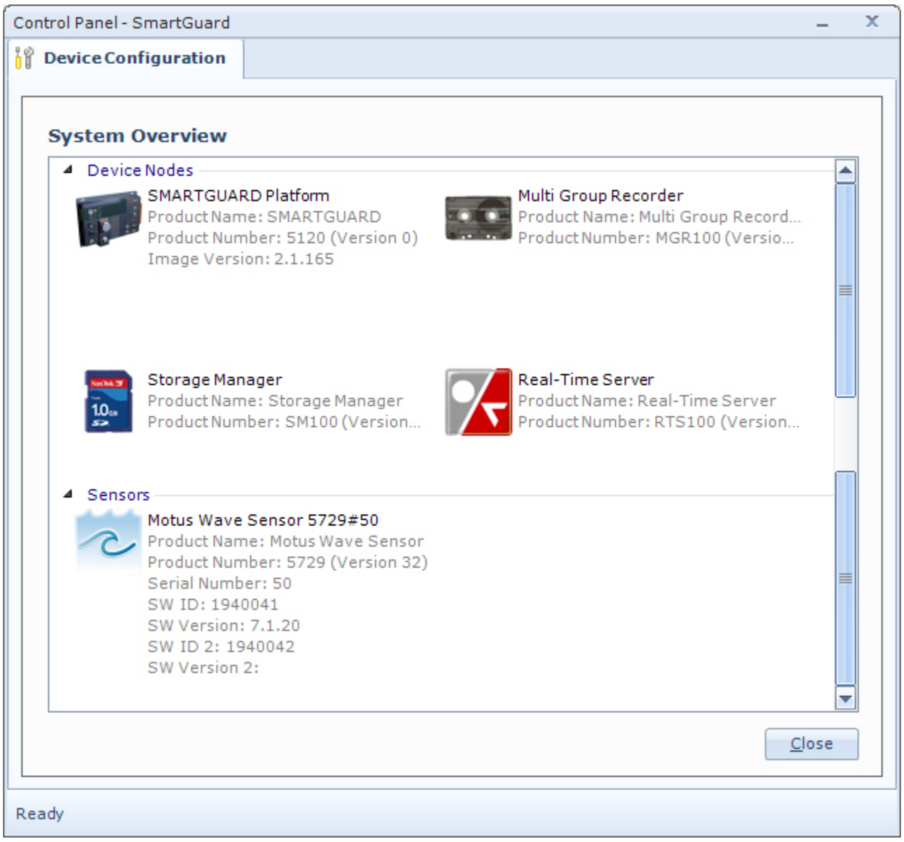


Figure 3-32: System Overview

When you select ***System Overview*** under the ***Device Configuration*** tab you will get a short list of the SmartGuard Device Nodes with info like ***Product Name, Product Number*** and ***Image Version***. If you scroll down using the bar on the right side you will also see a list of all connected sensors with ***Product Name, Product Number, Serial Number*** and ***Software Version***.

3.12 Save Configuration to file

The example below shows a small excerpt of a saved co0024nfiguration. All information and settings related to both SmartGuard and all connected sensor are found in the full file.


```
<?xml version="1.0" encoding="UTF-8"?>
- <Config xmlns="http://www.aadi.no/RTConfigSchema" ID="5120-488-2020-04-24T07:39:27Z" Time="2020-04-24T07:39:27.982Z">
  - <NodeConfig ID="5120-488" ProdName="SMARTGUARD" Descr="SMARTGUARD Platform" ProdNo="5120" SerialNo="488" ConfigVer="0" NodeTypeID="101" ProtocolVer="4">
    - <ConfigCategory ID="0" Descr="Factory Maintenance">
      - <PropertyCategory ID="0" Descr="Mandatory">
          <Property ID="0" Descr="Product Name" Type="VT_BSTR" Access="R1">SMARTGUARD</Property>
          <Property ID="1" Descr="Product Number" Type="VT_BSTR" Access="R1">5120</Property>
        </PropertyCategory>
      - <PropertyCategory ID="1" Descr="Mainboard">
          <Property ID="0" Descr="Product Number" Type="VT_BSTR" Access="R1">3969691</Property>
          <Property ID="1" Descr="Serial Number" Type="VT_I2" Access="R1">488</Property>
          <Property ID="2" Descr="Version" Type="VT_BSTR" Access="R1">8</Property>
          <Property ID="3" Descr="Last Service" Type="VT_BSTR" Access="R1W4"/>
        </PropertyCategory>
      - <PropertyCategory ID="3" Descr="SR10VR22 Logger">
          <Property ID="0" Descr="Product Number" Type="VT_BSTR" Access="R1">3969047A</Property>
          <Property ID="1" Descr="Serial Number" Type="VT_I2" Access="R1">381</Property>
          <Property ID="2" Descr="Version" Type="VT_BSTR" Access="R1">D</Property>
          <Property ID="3" Descr="Last Service" Type="VT_BSTR" Access="R1W4"/>
        </PropertyCategory>
      - <PropertyCategory ID="4" Descr="Software">
          <Property ID="0" Descr="Image Name" Type="VT_BSTR" Access="R1">SSH20</Property>
          <Property ID="1" Descr="Image Version" Type="VT_ARRAY | VT_I2" Access="R1">2;1;165</Property>
        </PropertyCategory>
      </ConfigCategory>
    - <ConfigCategory ID="1" Descr="User Maintenance">
      - <PropertyCategory ID="0" Descr="Mandatory">
          <Property ID="0" Descr="Node Description" Type="VT_BSTR" Access="R1W3">SMARTGUARD Platform</Property>
```


Figure 3-33: Example of saved .xml

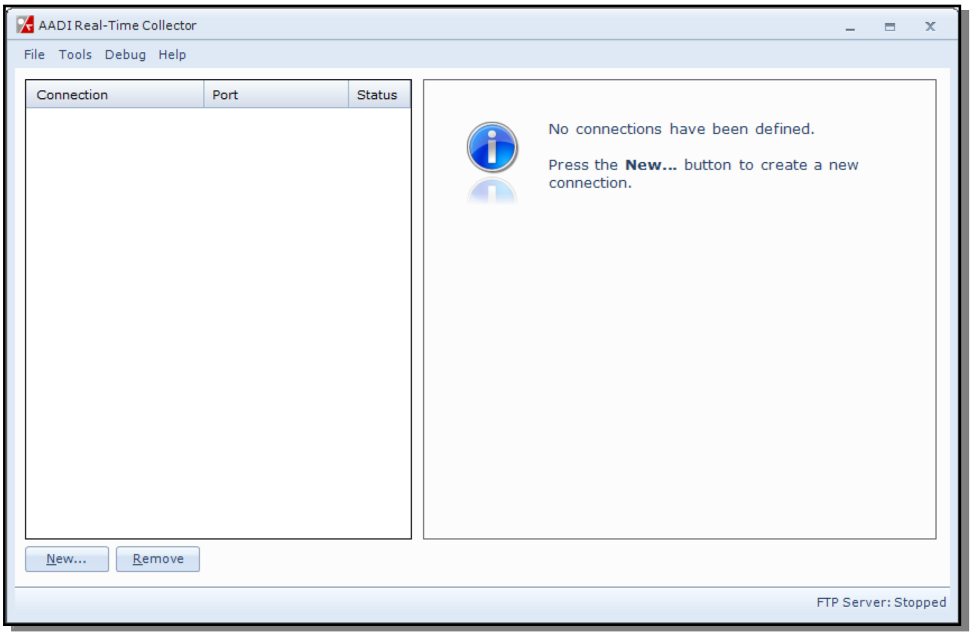
CHAPTER 4 Stand-alone sensor configuration using AADI Real-Time Collector

This chapter describes the sensor configuration using AADI Real-Time Collector when the sensor is used stand-alone with serial communication via the PC COM-port. The sensor might be set to any mode when configured using AADI Real-Time Collector but if you want to use the included real-time display function then the sensor needs to be in AADI Real-Time mode, refer ***chapter 4.5.1*** for changing the mode. The menus shown here are slightly different from the menus shown when the sensor is set to AiCaP mode and configured either stand-alone or through a SmartGuard Datalogger (described in ***CHAPTER 3***).

See ***chapter 1.4*** for sensor connection and ***chapter 10.4.3*** for available cables between sensor and PC. Please note that the sensor need a steady power supply with 6-14VDC. Our standard stand-alone cables are normally supplied with a 9 pin D-sub plug for connection to PC. If your PC has no Serial Port we recommend to use Keyspan Serial to USB adapter, see ***Figure 4-1***: This adapter can also be ordered from Aanderaa. After the sensor is connected and power are supplied then install and start the AADI Real-Time Collector software on your PC (license and software delivered on memory stick with the sensor). For more info refer TD 268 AADI Real-Time Collector Operation Manual.

Figure 4-1: Keyspan serial-USB adapter

4.1 Establishing a new connection



If the AADI Real-Time Collector program is being used for the first time, the connection list will be empty. Click on the ***New*** button in the lower left corner to create a new connection.

Figure 4-2: AADI Real-Time Collector start up menu

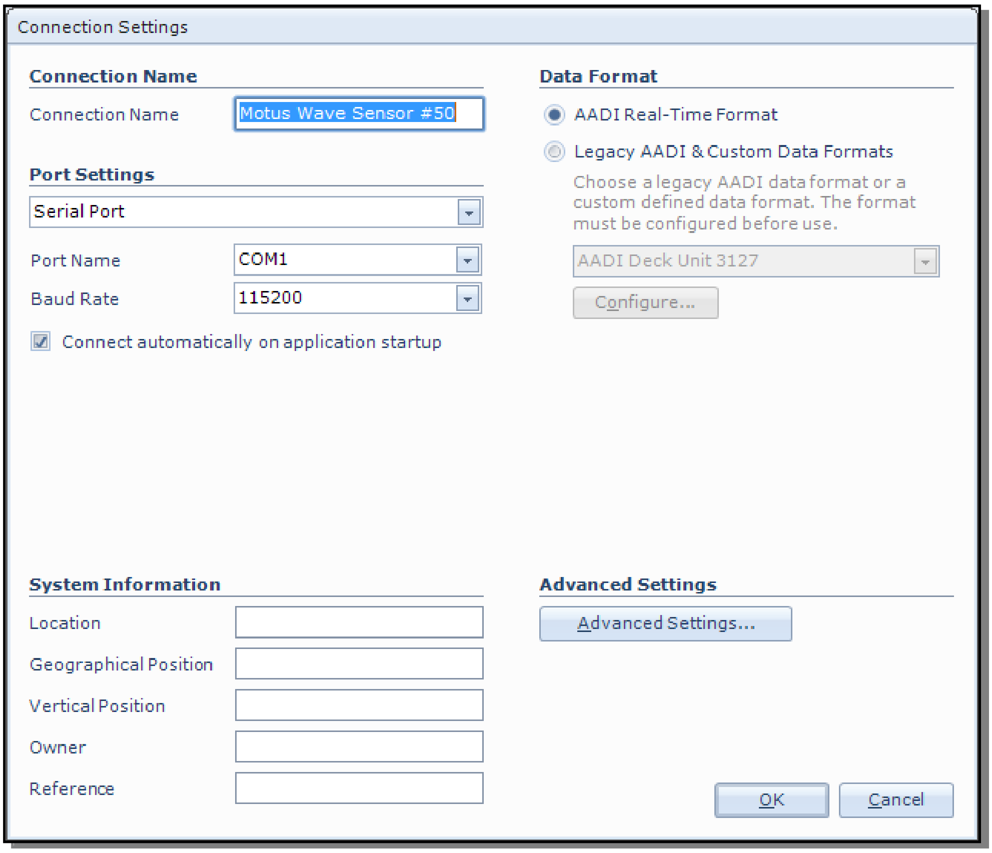


Figure 4-3: AADI Real Time Collector connection settings

Type a descriptive name in the ***Connection Name*** box (e.g. Motus and #serial number).

Select ***Serial Port*** as ***Port Settings*** even if you use the serial to USB adapter, selects the correct ***COM#*** as ***Port Name*** and ***115200*** as ***Baud Rate***. This is the default baud rate set at factory on all Motus Wave sensors. ***Baud rate*** needs to be the same as set in sensor to obtain connection.

Then click on the ***Advanced Settings*** on the lower right side and in the ***Advanced Connection Settings*** window select ***Connection*** in the list on the left side, refer ***Figure 4-4.***

If you want to return to this menu later please close the port and then press ***Settings..*** in the main menu, refer ***Figure 4-5.***

If ***Connect automatically on application startup*** is selected then this connection will automatically open every time you start AADI Real-Time Connector.

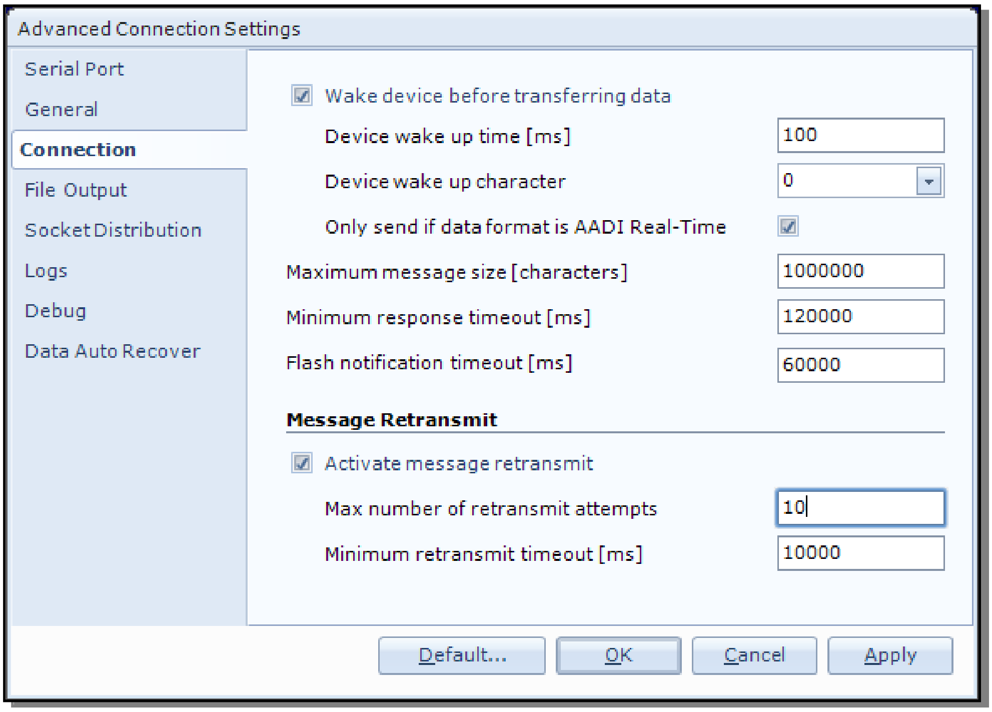
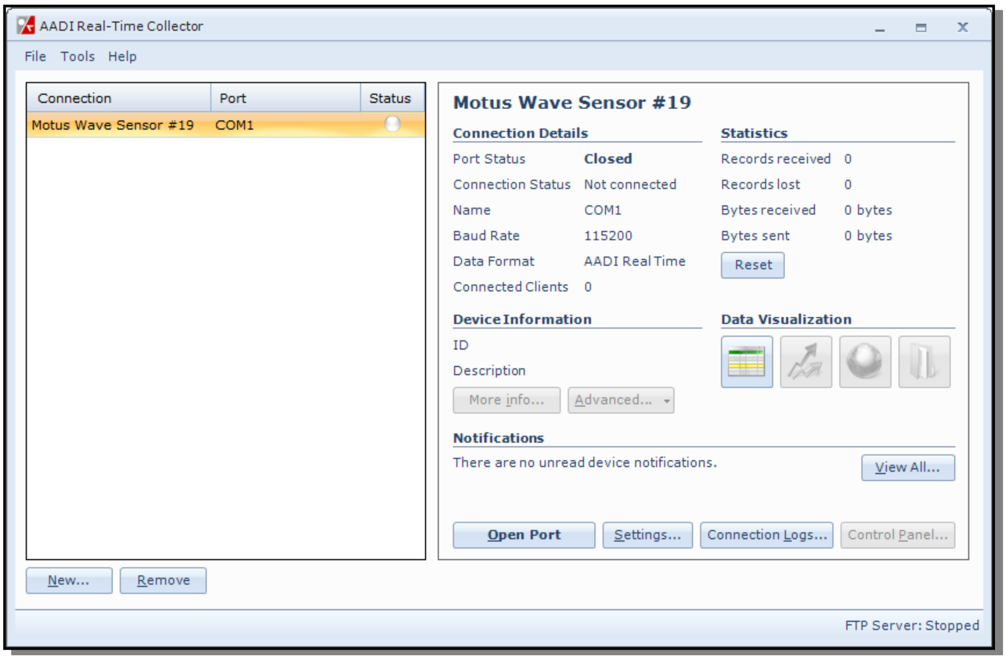


Figure 4-4: Advanced connection settings

AADI Real-Time Collector uses a default setting that fits for most Smart Sensors. However the Motus Wave Sensor outputs a large amount of data and might have much longer response time (depending on the configuration) than other smart sensors. Some of the connection settings might need to be changed. We recommend using the settings as shown in ***Figure 4-4.***

After updating the ***Advanced Connection Settings***, click on ***Apply*** and ***OK*** and then ***OK*** to go back to the start screen.

The ***Advanced Settings*** are only accessible to change when the port is closed. If the settings are grey then you first need to close the port, refer ***Figure 4-5*** and press ***Close Port.***

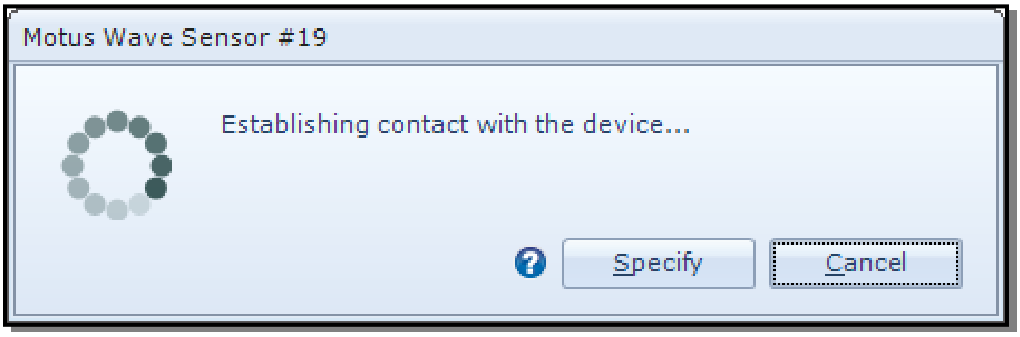


The new connection is now shown in the AADI Real-Time Collector connection list. Choose the new connection and click on the ***Open Port*** button.

The connection list might contain different connections to other sensors as well. Then highlight the Motus connection before pressing the ***Open Port*** button.

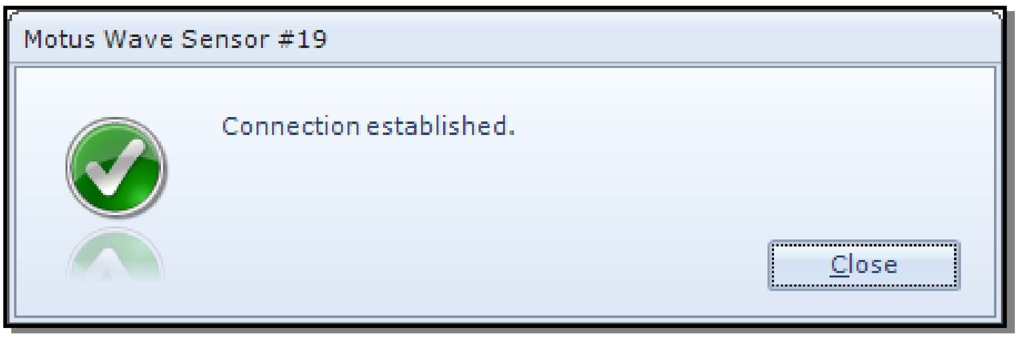
NOTE: This procedure only needs to be done once. This connection will be in the connection list at next start-up.

Figure 4-5: Connection list



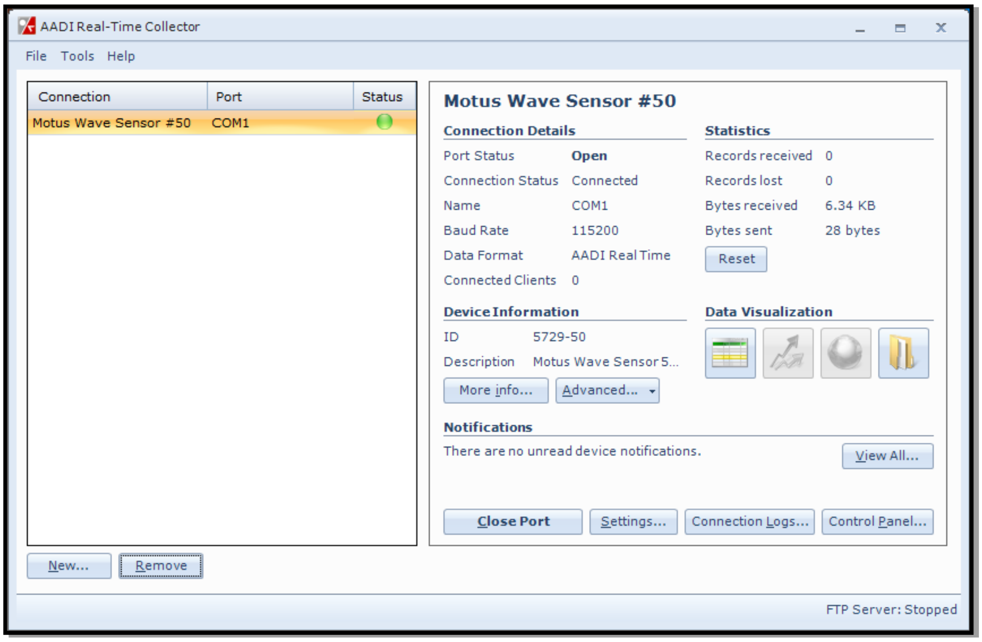
A new window with a turning wheele will then show up waiting for contact. This might take a couple of seconds depending on the sensor configuration.

Figure 4-6: Establishing contact



When connection is established the status light will turn green

Figure 4-7: Connection established



The selected connection has now changed to green status.

Press ***Control Panel*** *in the right lower corner to continue.*

Figure 4-8: AADI Real-Time Collector main menu

4.2 Control Panel

In the ***Control Panel*** window you will find three tabs, ***Recorder Panel, Device Configuration*** and ***System Status.*** In ***Recorder Panel*** you can start and stop recordings if the sensor is set to AADI Real-Time mode. If the recorder is running first click on the ***Stop Recorder*** as you are not allowed to configure the sensor when recording. In ***Device Configuration*** you will be able to perform all configurations of the Motus . ***System Status*** gives information about

4.3 Recorder Panel

In the recorder panel you will be able to start and stop the recorder as long as the sensor is set to AADI Real-Time mode. If the sensor is set to another mode the sensor will not be controlled by the ***Recorder Panel*** and therefore all setting will be grey and not selectable. In AiCaP mode you need an Aanderaa logger to control the sensor. In all other mode the sensor will either start at power up in non-polled mode or when a ***do sample*** message is sent to the sensor in polled mode.

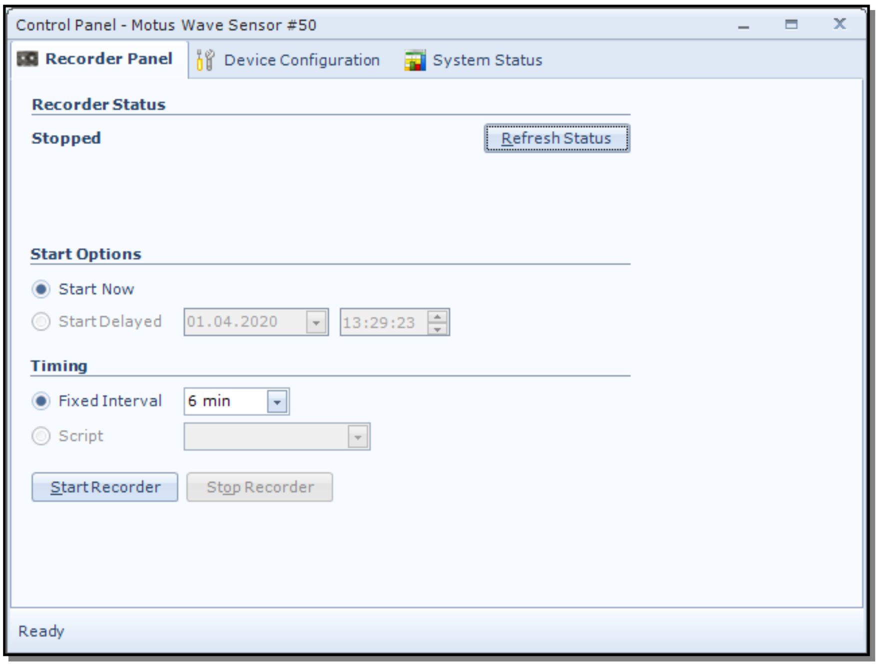


Figure 4-9: Control Panel for the Motus Wave Sensor

Select ***Recorder Panel.***

This is only applicable if sensor is in AADI Real-Time mode. For all other modes the alternatives will be grey.

Click on the ***Stop Recorder*** button if the sensor is running as you are not allowed to configure the sensor when recording.

Under ***Start Option*** the only selectable choice is ***Start Now***.

Under ***Timing*** the only selectable choice is ***Fixed Interval*** where you might set the recording interval. This setting is also available in the ***Deployment Setting*** menu as ***interval(s)***, refer ***chapter 4.4.***

4.4 Changing Values

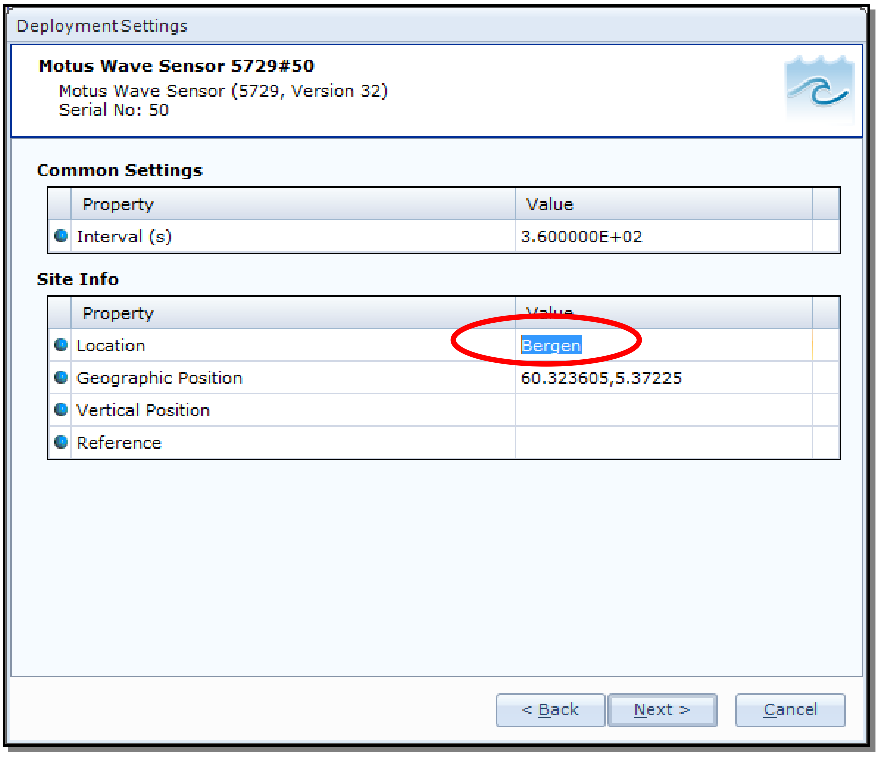


Figure 4-10: Change value

In the following chapters we will learn more about the Motus configuration. Sometimes you will need to change the value of a property.

First select the tab where the property is located. In this example: ***Device Configuration***.

Then press ***Get Current Configuration*** and ***Edit,*** located under ***Deployment Setting.***

Select by double clicking on the ***Motus Wave Sensor*** icon.

Then select the property you want to change by clicking in the value box.

To change values enter the text or number in the value box and press ***Next.***

In the next window called ***Confirm Configuration Changes*** you will find a list of all changed properties with old and new values.

If the list of configuration changes is correct press ***Next*** to start the update process.

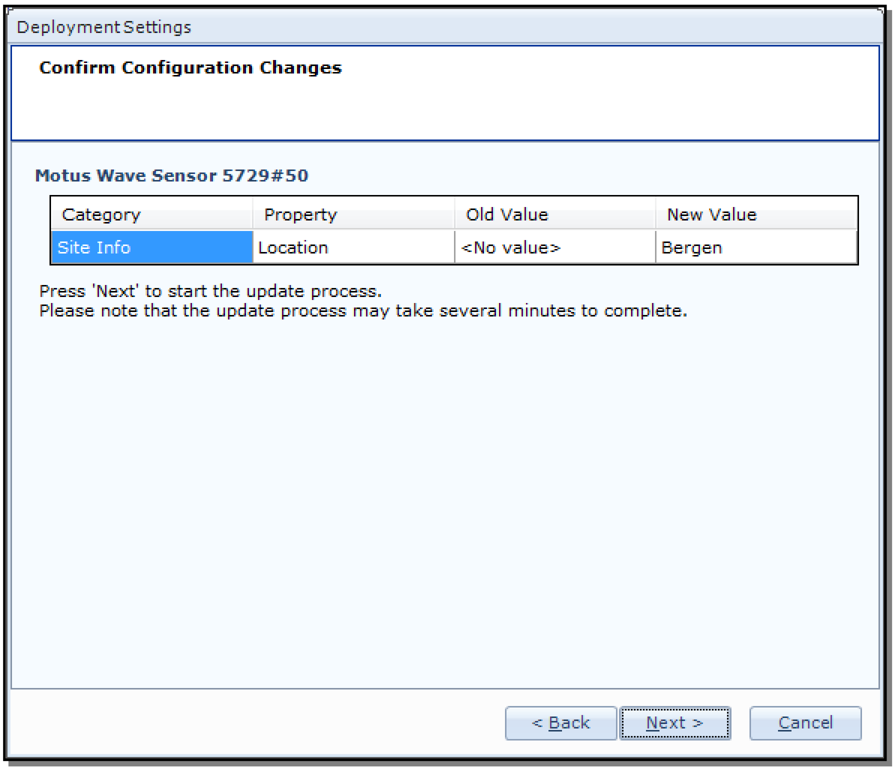


Figure 4-11 Confirm Configuration Changes

An automatic process will start with 6 steps transferring and storing the new information/setting in the sensor Flash. If necessary a reset will be executed. Do not switch off before the entire process is completed.

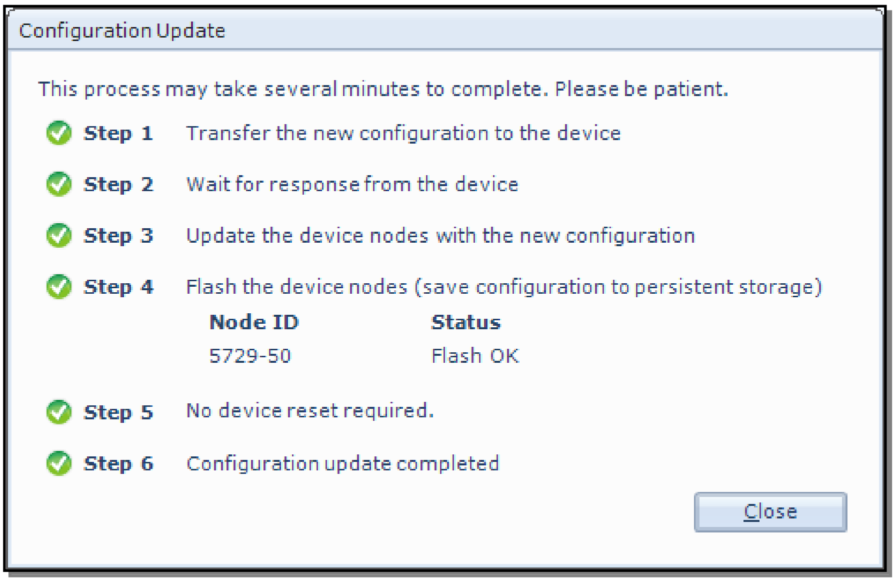
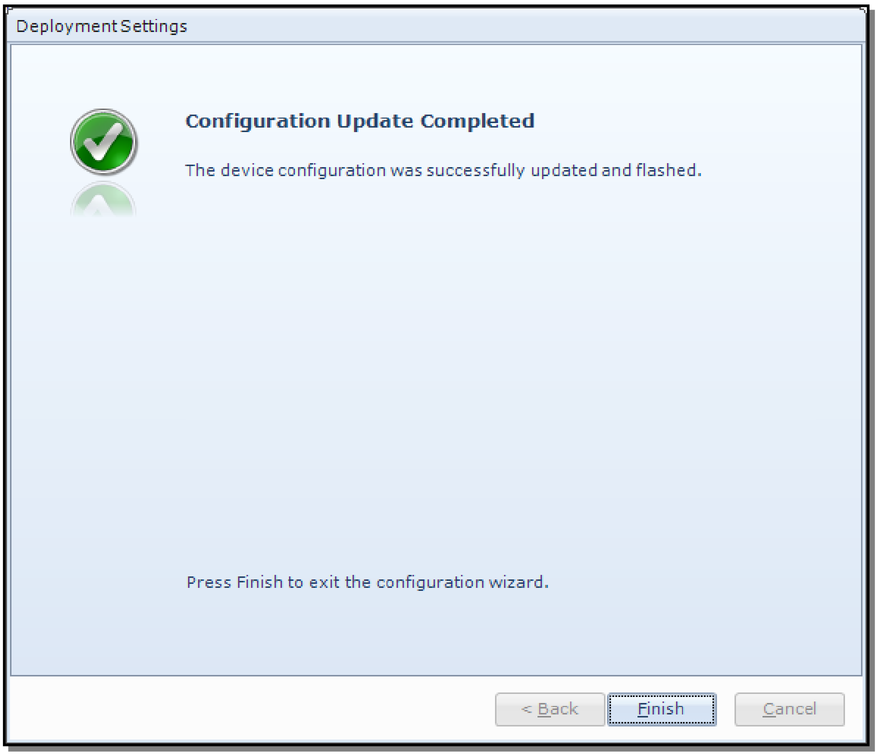
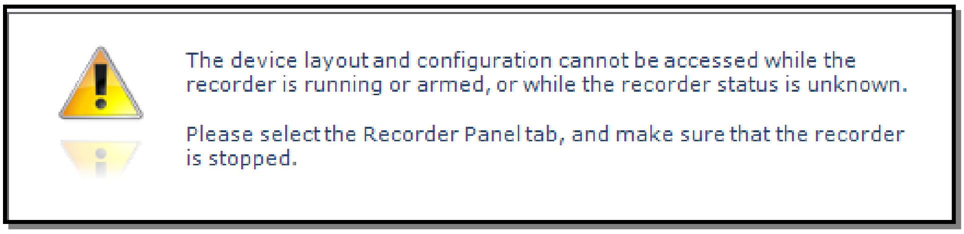


Figure 4-12 Configuration Update



When the updating process is finished a confirmation will show up. Press ***Finish*** to continue.

Figure 4-13 Configuration Update Completed



When you click ***Finish*** the following warning may show up. Then you need to open the ***Recorder Panel*** and select ***Stop Recorder*** and/or press the ***Refresh Status*** button.

Figure 4-14: Warning after changing values

4.5 Device Configuration

Click on the ***Device Configuration*** tab in the top row of the ***Control Panel*** to access the sensor property configuration.

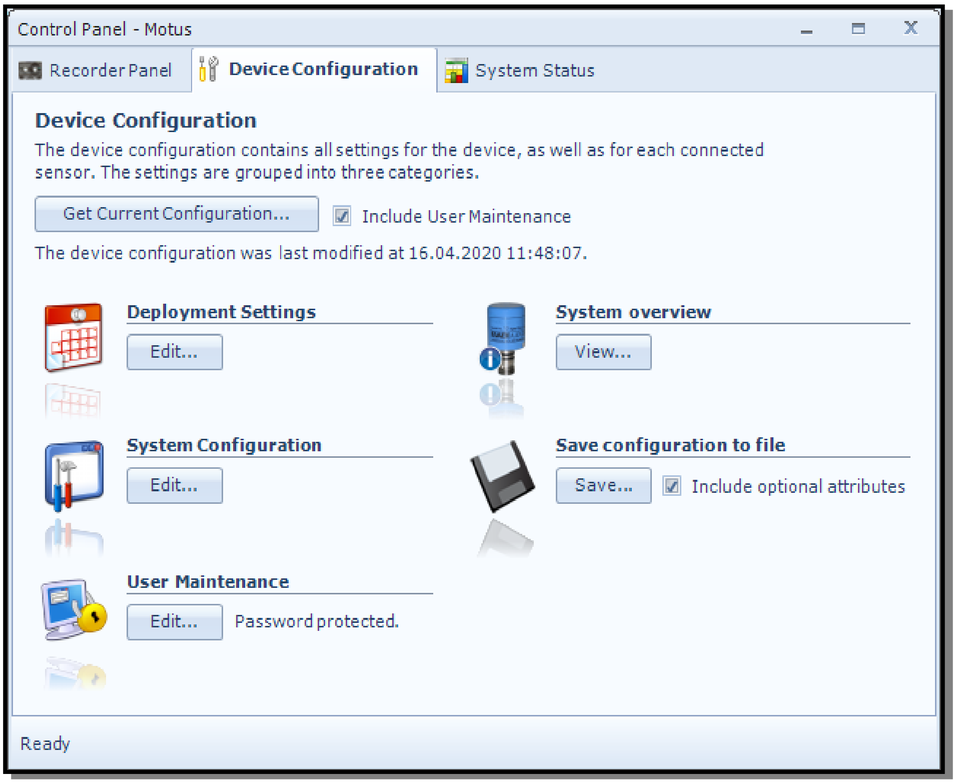


Figure 4-15: Device Configuration

Click on ***Get Current Configuration...*** in order to receive the current configuration from the sensor. Check ***Include User Maintenance*** to view user maintenance settings. This group is password protected. ***The password is 1000***.

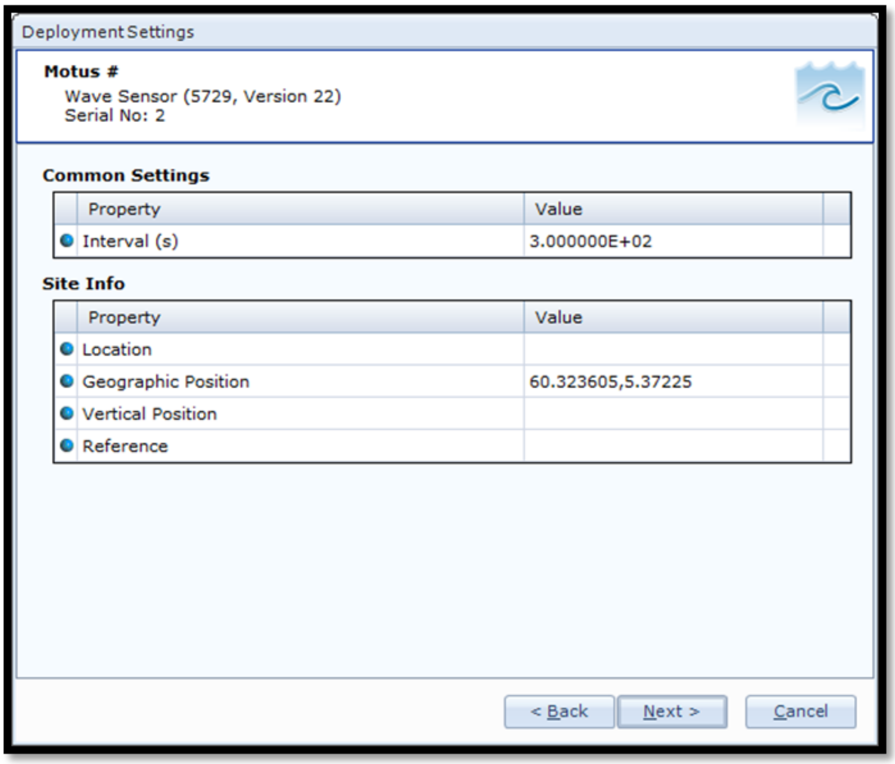
The ***Device Configuration*** is separated into five sections:

- ***Deployment settings***
- ***System Configuration***
- ***User Maintenance***
- ***System overview***
- ***Save configuration to file***

User accessible sensor properties that are used to configure the sensor are found in the first three sections. ***Deployment Settings*** *are described in* ***chapter 4.5***, ***System Configuration*** *in* ***chapter 4.6***, ***User Maintenance*** *in* ***chapter 4.7. System overview*** *in* ***chapter 4.8*** *and* ***Save configuration to file*** *in* ***chapter 4.9***.

4.6 Deployment Settings

Select the ***Deployment Settings*** by pressing the ***"Edit…"*** button ***under Deployment Settings,*** see ***Figure 4-15.***



This menu holds two different sections, ***Common Settings*** and ***Site Info.***

For detail on each property refer to ***chapter 4.4.1*** through ***4.4.2.***

Figure 4-16: Deployment Settings

4.6.1 Common settings

Figure 4-17: Common Settings in System Configuration

This setting is used to control the sensors recording interval, the number of seconds between each output. Please note that this setting will act different depending on mode.

The interval may also be set from ***Recorder Panel*** if sensor is set to ***AADI Real-Time*** mode. The last entered value will be the valid one if properly stored to flash.

4.6.2 Site Info

Site Info

Property	Value
Location	
Geographic Position	60.323605,5.37225
Vertical Position	
Reference	

Figure 4-18: Site Info

Site Info containing four properties:

- ***Location***
- ***Geographic Position***
- ***Vertical Position***
- ***Reference***

All these settings are optional information to be entered to store information about the deployment. These setting are not used in calculation. ***Geographical Position*** can be used to give the map coordinates either under the Data Visualization using AADI Real-Time connector and sensor in AADI Real-Time mode or it can be used in a display software to display position of sensor..

4.7 System Configuration

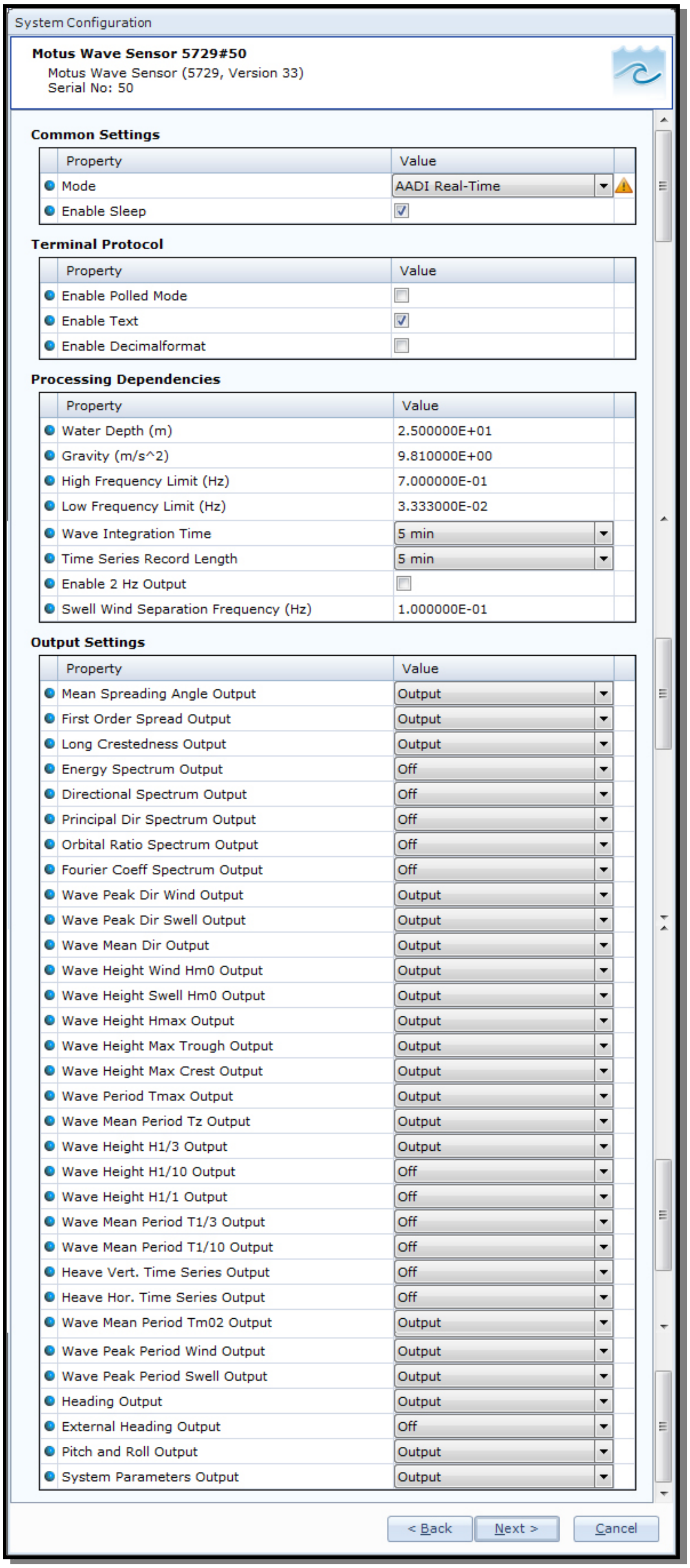


Figure 4-19: System Configuration

System Configurations holds four different sections that are mainly controlling the output from the sensor. The sections are:

- ***Common Settings***
- ***Terminal Protocol***
- ***Processing Dependencies***
- ***Output Setting***

Common Settings are used to set the ***mode*** and to save power by allowing the sensor to go to sleep between meassurements.

Processing Dependencies are settings used in the wave calculation.

Please note that the time settings here are controlling the sensor wave calculation time and the time series length, not the Output ***Interval***. ***Interval(s)*** are controlling the Output ***Interval***, how often the data is presented on the output line.

Interval(s) is configured in ***Device Configuration>Deployment Settings*** see ***chapter 4.4.1*** or in the ***Recorder Panel*** see ***chapter 4.2.1.***

Output/Storage Settings are controlling the output from the sensor. Except from ***Significant Wave Height H_{m0}, Wave Peak Direction and Wave Peak Period*** that always will be presented all other parameters can either be set to ***Off*** or ***Output***.

For configuration details, refer to ***chapter 4.5.1*** through ***4.5.4.***

4.7.1 Common settings

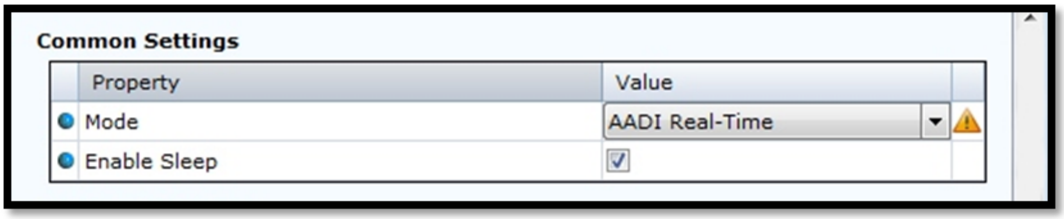


Figure 4-20: Common Settings in System Configuration

Mode: The communication protocol need to be defined under "***Mode".*** There are four different choices:

- ***AADI Real-Time*** is the correct mode (protocol) when used together with Real-Time Collector. This is an xml based protocol which includes more metadata in the data messages.
- The ***Smart Sensor Terminal*** protocol is a simplified ASCII protocol which is easier to use together with a PC terminal program. This protocol is described more detailed in CHAPTER 8. It is possible to configure the sensor even if it is set to AiCaP or Smart Sensor Terminal mode when it is connected via RS-232 to the PC, but it is not possible to run and log data with Real-Time Collector unless the sensor is set to AADI Real-Time. Notice that the sensor always has to be reset when the protocol/mode has been changed.
- If the sensor is going to be used with an Aanderaa logger such as SmartGuard, the mode has to be changed to ***AiCaP*** mode first and saved before connecting it to the logger.
- ***AIS mode*** is specially made for feeding the AIS directly with a standard output following the AIS Message 8 format.

Enable Sleep: *This setting gives lower power consumption in AADI Real-Time and Smart Sensor Terminal mode when the sensor is able to go to sleep between measurements. In AiCaP mode this is controlled by the logger.*

4.7.2 Terminal Protocol settings

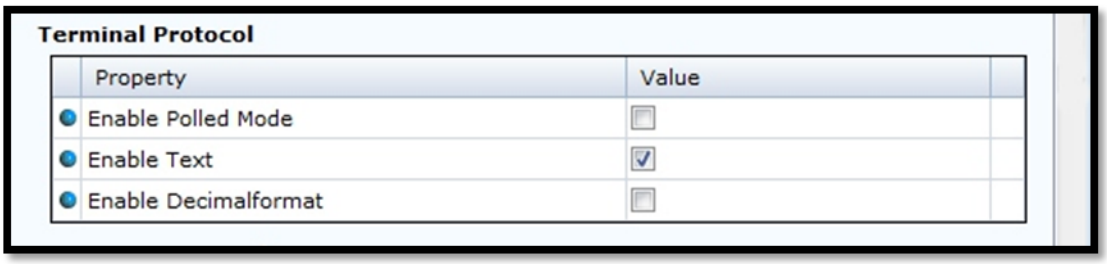


Figure 4-21: Terminal Protocol settings in System Configuration

The ***Terminal Protocol*** settings are only used if the sensor is set to Smart Sensor Terminal protocol. See CHAPTER 6for more details. This protocol opens up for an ***Enable Polled Mode*** where the sensor outputs data when the user/system polls for data (***Do Sample ()*** command). ***Enable Text*** and ***Enable Decimalformat*** control the output string in Smart Sensor Terminal. With ***Enable Text*** enabled the sensor will put out a string with parameter name together with each reading, refer Figure 6-2 for an example where this command is toggled. ***Enable Decimalformat*** toggle between decimal format like 0.10 and Engineering format like 1.000E-01.

4.7.3 Processing Dependencies

Processing Dependencies

Property	Value
Water Depth (m)	2.500000E+01
Gravity (m/s^2)	9.810000E+00
High Frequency Limit (Hz)	7.000000E-01
Low Frequency Limit (Hz)	3.333000E-02
Wave Integration Time	5 min
Time Series Record Length	5 min
Enable 2 Hz Output	☐
Swell Wind Separation Frequency (Hz)	1.000000E-01

Figure 4-22: Processing Dependencies in System Configuration

Water Depth (m) is the total water depth where the buoy is located in meter. The default setting is 25 meter.

Gravity (m/s²) is the local gravity constant in m/s^2. The default value is $9.81 m/s^2$

High Frequency Limit (Hz) is the lower cut-off frequency in Hz. The default value is 0.7Hz= 1/0.7 = 1.42second, this is also equal to the lowest wave period we can measure.

Low Frequency Limit (Hz) is the higher cut-off frequency in Hz. The default value is 0.03333Hz = 1/0.3333 = 30seconds. The range is maximum 33seconds = 0.03030Hz.

Wave Integration Time is the period the sensor use to calculate all wave parameters. Range is 5 minutes to 60 minutes and default is 30 minutes.

Timeseries record length is the length of each timeseries. Range is 5minutes to 60 minutes and default is 30 minutes.

Swell Wind Separation Frequency (Hz) is the frequency that separates wind from swell. Default value is 0.1Hz =10s. Waves with period bellow 10s are then considered as wind generated sea and waves above 10s are considered as swell.

4.7.4 Output Settings

Output Settings

Property	Value
Mean Spreading Angle Output	Output
First Order Spread Output	Output
Long Crestedness Output	Output
Energy Spectrum Output	Off
Directional Spectrum Output	Off
Principal Dir Spectrum Output	Off
Orbital Ratio Spectrum Output	Off
Fourier Coeff Spectrum Output	Off
Wave Peak Dir Wind Output	Output
Wave Peak Dir Swell Output	Output
Wave Mean Dir Output	Output
Wave Height Wind Hm0 Output	Output
Wave Height Swell Hm0 Output	Output
Wave Height Hmax Output	Output
Wave Height Max Trough Output	Output
Wave Height Max Crest Output	Output
Wave Period Tmax Output	Output
Wave Mean Period Tz Output	Output
Wave Height H1/3 Output	Output
Wave Height H1/10 Output	Off
Wave Height H1/1 Output	Off
Wave Mean Period T1/3 Output	Off
Wave Mean Period T1/10 Output	Off
Heave Vert. Time Series Output	Off
Heave Hor. Time Series Output	Off
Wave Mean Period Tm02 Output	Output
Wave Peak Period Wind Output	Output
Wave Peak Period Swell Output	Output
Heading Output	Output
External Heading Output	Off
Pitch and Roll Output	Output
System Parameters Output	Output

Figure 4-23: Output settings in System Configuration

The alternatives in the ***Output/Storage Settings*** drop down menu for each parameter are ***Off* or *Output,*** where ***Off*** means that the parameter is not calculated and ***Output*** means that the sensor in real-time output from the sensor either in XML or ASCII. All parameters except from ***Significant Wave Height H_{m0}, Wave Peak Direction and Wave Peak Period*** may be switched on or off.

Some of the Properties are enabling only one parameter and others can enable multiple parameters. Please also notice that the order of the properties do not match with the order of the output parameters.

Wave Properties in this section are listed in *Table 4-1*with corresponding parameter and unit. For more information about parameter calculation see *chapter 2.7*

Property	Parameter	Unit
Mean Spreading Angle Output	*Mean Spreading Angle*	Deg.M
First Order Spread Output	*First Order Spread*	Deg. M
Long Crestedness Output	*Long Crestedness*	
Energy Spectrum Output	*Energy Spectrum*	m^2 / Hz
Directional Spectrum Output	*Directional Spectrum*	Deg. M
Principal Dir Spectrum Output	*Principal Directional Spectrum*	Deg. M
Orbital Ratio Spectrum Output	*Orbital Ratio Spectrum*	
Fourier Coeff Spectrum Output	*Fourier Coeff A1* *Fourier Coeff A2* *Fourier Coeff B1* *Fourier Coeff B2*	
Wave Peak Dir Wind Output	*Wave Peak Direction Wind*	Deg. M
Wave Peak Dir Swell Output	*Wave Peak Direction Swell*	Deg. M
Wave Mean Dir Output	*Wave Mean Direction*	Deg. M
Wave Height Wind H_{m0} *Output*	*Wave Height Wind* H_{m0}	m
Wave Height Swell H_{m0} *Output*	*Wave Height Swell* H_{m0}	m
Wave Height H_{max} *Output*	*Wave Height* H_{max}	m
Wave Height Max Trough Output	*Wave Height Trough*	m
Wave Height Max Crest Output	*Wave Height Crest*	m
Wave Period T_{max} *Output*	*Wave Period* T_{max}	s
Wave Mean Period T_z *Output*	*Wave Period* T_z	s
Wave Height $H_{1/3}$ *Output*	*Significant Wave Height* $H_{1/3}$	m
Wave Height $H_{1/10}$ *Output*	*Significant Wave Height* $H_{1/10}$	m
Wave Height $H_{1/1}$ *Output*	*Significant Wave Height* $H_{1/1}$	m
Wave Mean Period $T_{1/3}$ *Output*	*Wave Mean Period* $T_{1/3}$	s
Wave Mean Period $T_{1/10}$ *Output*	*Wave Mean Period* $T_{1/10}$	s
Heave Vert. Time Series Output	*Last Heave Sample Index* *Heave Time Series Vertical*	 m
Heave Hor. Time Series Output	*Heave Time Series North* *Heave Time Series East*	m m
Wave Mean Period T_{m02} *Output*	*Wave Mean Period* T_{m02}	s
Wave Peak Period Wind Output	*Wave Peak Period Wind*	s
Wave Peak Period Swell Output	*Wave Peak Period Swell*	s

Table 4-1: Output Properties and corresponding Parameters

Other non-wave parameters in this section are listed in ***Table 4-2*** with corresponding parameter and unit.

Property	Parameter	Unit
Heading Output	Heading	Deg. M
	StDev Heading	Deg. M
External Heading Output	External Heading	Deg. M
Pitch and Roll Output	Pitch	Deg
	Roll	Deg
	StDev Pitch	Deg
	StDev Roll	Deg
System Parameters Output	Input Voltage	V
	Input Current	mA
	Memory Used	Bytes

Table 4-2: Output Properties and corresponding Parameters

Name with unit	Type	Explanation
Heading[Deg.M]	Float	Averaged heading from one interval, one heading measurement per ping, vector averaged.
Std Dev Heading[Deg.M]	Float	Standard deviation calculation on all heading values from one interval. Indicates how much the sensor rotates around the vertical axis during a measurement interval.
External Heading[Deg.M]	Float	
Pitch[Deg]	Float	Pitch angle, average from one interval, one tilt measurement per ping. Pitch is the rotation angle around the x-axis of the sensor (same axis as Transducer 1 and 3)
Roll[Deg]	Float	Roll angle, average from one interval, one tilt measurement per ping. Roll is the rotation angle around the y-axis of the sensor (same axis as transducer 4 and 2)
Std Dev Pitch[Deg]	Float	Standard deviation Pitch from all values of the pitch in the interval. Indicates if the sensor is moving around with variable tilt during the measurement interval.
Std Dev Roll[Deg]	Float	Standard deviation Roll from all values of the roll in the interval. Indicates if the sensor is moving around with variable tilt during the measurement interval.
Input Voltage[V]	Float	The minimum input voltage measured while charging the capacitor bank. It should normally be >6.0V
Input Current[mA]	Float	The current measured when not charging while awake, averaged.
Memory Used[Bytes]	Integer	Used heap memory.

Table 6-3: Sensor parameter details and explanation

Mandatory

Property	Value
Node Description	Motus Wave Sensor 5729#50

Site Info

Property	Value
Owner	

Serial Port

Property	Value
Interface	RS232
Baudrate	115200
Flow Control	Xon/Xoff
Enable Comm Indicator	☑
Comm Timeout	1 min

Buoy Settings

Property	Value
Enable Off-center Correction	☑
Off-center XYZ (m)	0.000000E+00;0.000000E+00...
Enable Frequency Correction	☑
Correction Frequencies (Hz)	3.330000E-02;5.000000E-02;...
Correction Factors	1.000000E+00;1.000000E+00...
Sensor Rotation Offset PRH (Deg)	0.000000E+00;0.000000E+00...
Enable Magnetic Declination	☑
Declination Angle (Deg.M)	0.000000E+00

External Compass Settings

Property	Value
Enable Ext Compass Input	☑
Enable Ext Compass Correction	☐
Ext Compass Alignment Offset (Deg.M)	0.000000E+00
Compass Type	HSC100 NMEA
Compass Warm-up Time (s)	1.000000E+00
Enable Compass Power Control	☑
Compass Start Offset Time (s)	0
Compass Sampling Interval (s)	300
Compass Sample Average Number	128
Compass Sampling Frequency (Hz)	1.000000E+00

Advanced System Output

Property	Value
Processing Time Output	Off
FE State Parameters Output	Off
HW State Parameter Output	Off

< Back | Next > | Cancel

4.8 User Maintenance settings

Under ***User Maintenance***, you find properties that are password protected and are set / altered by a trained user. It is not recommended to change properties unless instructed. To access this menu, check the "***Include User Maintenance***" box in the ***Device Configuration*** before clicking on the "***Get Current Configuration…***" button. The password is: **1000**. Then click on the ***Edit*** button under ***User Maintenance*** , This menu consists of six sessions:

- **Mandatory**
- **Site Info**

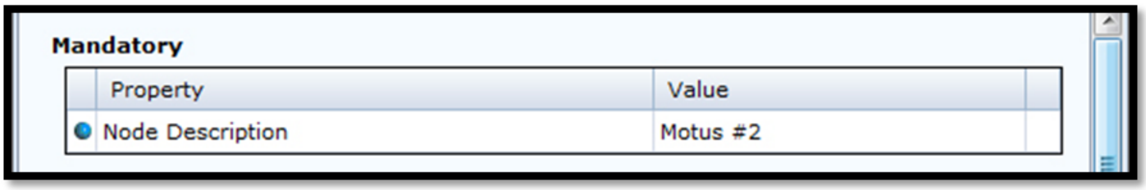
- **Serial Port**
- **Buoy Settings**
- **External Compass Settings**
- **Advanced System Output**

The settings here are mainly used to compensate for influence from the sensor surroundings like off-center mounting and magnetic influence on the internal compass. The adjustment for use on other buoys that Motus DB 1750 and EMM 2.0 can also be entered here.

For a full description of each property please refer to ***chapter 4.6.1*** through ***4.6.6.***

Figure 4-24: User maintenance

4.8.1 Mandatory



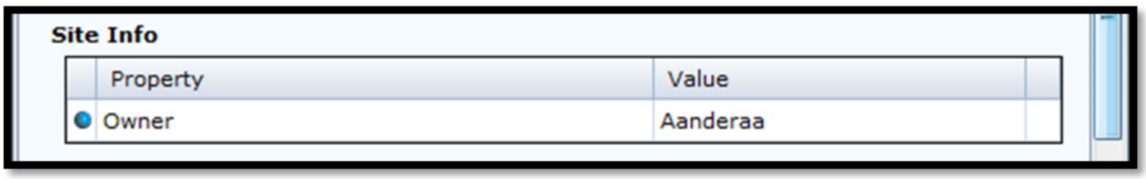
Mandatory

Property	Value
Node Description	Motus #2

Figure 4-25: Mandatory in User Maintenance

All sensors are given a ***Node Description*** text like Motus #xxx (xxx is the serial number of the sensor). The user can modify this ***Node Description*** text if required. Be aware that the ***Node Description*** changes to ****Corrupt Configuration*** if it has lost the configuration in flash. Contact the factory if this happens. The configuration is saved in two sectors in flash memory. A flash sector can be corrupted if the power is lost during the saving of new configuration. The double flash sector saving ensures that it does not lose the configuration. If one of the sectors is corrupted, the other sector is used and also saved to the corrupt sector.

4.8.2 Site Info



Site Info

Property	Value
Owner	Aanderaa

Figure 4-26; Site Info in User Maintenance

Site Info is optional information to be entered to store information about the ***Owner.*** This setting is not used in calculation.

4.8.3 Serial Port

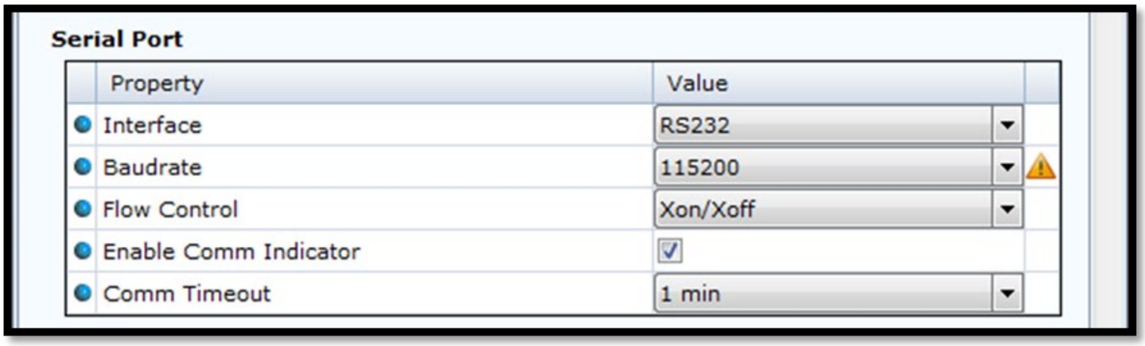


Figure 4-27: Serial Port settings in User Maintenance

The ***Serial Port*** group contains setting that deals with the RS-232 setup. ***Interface*** is only available as RS-232. When using Smart Sensor Terminal make sure that the sensor setting is the same as terminal set-up. The default setting from factory for ***Baudrate*** and ***Flow Control*** is 115200 and Xon/Xoff. ***Enable Comm Indicator*** is enabling communication sleep ('%') and communication ready ('!') indicators, when set to ***Smart Sensor Terminal*** mode. '!' indicates that the sensor is ready to communicate after sleep and '%' indicates that the sensor is going to sleep due to inactivity longer than the value/time set in ***Comm Timeout*** **.**

4.8.4 Buoy Settings

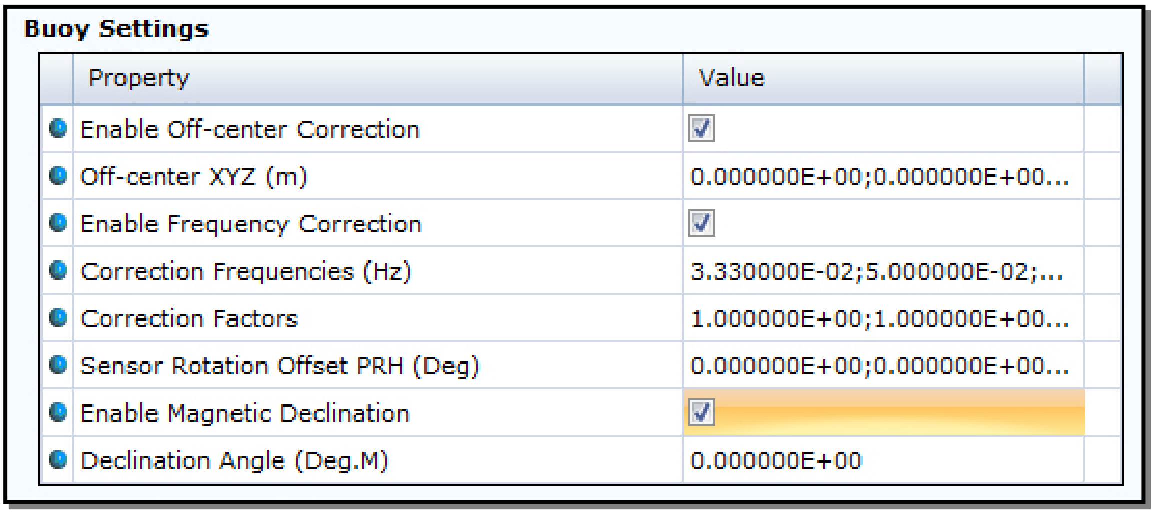


Figure 4-28: Buoy Settings in User Maintenance

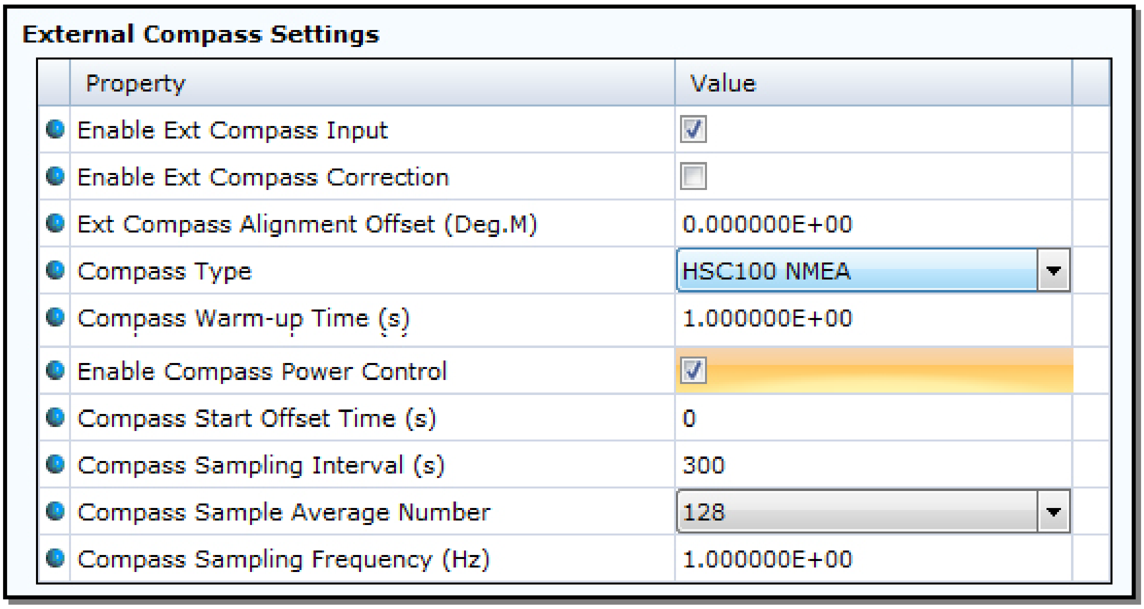
If the sensor is positioned off-center by enabling ***Enable Off-center Correction*** you will compensate for this offset. The sensor will then uses the xyz coefficients given in ***Off-center XYX (m),*** refer Figure 2-2 to calculate the off-center coefficients. Sea trials indicate that the error introduced when not compensating for this effect can be in the order of 10 - 15 % (40cm installation offset) depending on the sea state and spectral distribution of the waves.

If ***Enable Frequency Correction*** is set then ***Correction Frequencies (Hz)*** and ***Correction Factors*** are enabled and used in calculations. ***Correction Frequencies (Hz)*** set a total number of 15 frequencies and each frequency has a corresponding correction factor.

Sensor Rotation Offset PRH (Deg) sets a compensation value for Pitch, Roll and Heading. These values is added to the IMU calculated Pitch, Roll and Heading. These values do not change the calculated wave direction, but only the reported Wave Sensor Orientation. When post processing the wave directions using an external compass as reference these values must be subtracted from the Sensor Orientation before the External compass corrections are performed.

Enable Magnetic Declination is normally used when sensor is used close to South Pole or North Pole. ***Declination Angle (Deg.M)*** is a value to correct for the magnetic variation on the site where the sensor is used. This is the angle in degrees between magnetic north and true north. Magnetic declination (variation) is the angle between the magnetic north and the true north. This angle varies depending on the position on the Earth's surface and also varies over time. Declination is positive when magnetic north is east of true north and negative when it is to the west (input angle value ±180°). Magnetic declination at the deployment location can be found for i.e. on NOAA website: http://www.ngdc.noaa.gov/geomag-web/

4.8.5 External Compass Settings


External Compass Settings

Property	Value
Enable Ext Compass Input	☑
Enable Ext Compass Correction	☐
Ext Compass Alignment Offset (Deg.M)	0.000000E+00
Compass Type	HSC100 NMEA
Compass Warm-up Time (s)	1.000000E+00
Enable Compass Power Control	☑
Compass Start Offset Time (s)	0
Compass Sampling Interval (s)	300
Compass Sample Average Number	128
Compass Sampling Frequency (Hz)	1.000000E+00

Figure 4-29: External Compass Settings in User Maintenance

To use an external compass you need to set ***Enable Ext Compass Input*** but to use the compass reading in calculation also the ***Enable Ext Compass Correction*** must be set. ***Ext Compass Alignment Offset (Deg.M)*** is used to compensate for a compass misalignment. The value is added to the sensor Heading.

Two different alternatives are available in ***Compass Type***:

- ***HSC100 NMEA***
- ***Generic NMEA***

Compass Warm-up Time (s) is the time in seconds needed from power is switched on to the external compass until it is ready to output compass data. To save power the ***Enable Compass Power Control*** might be set. If disabled, the compass is always on. ***Compass Start Offset Time (s)*** is the Offset time from the start of each recording interval until the start of the external compass. Only used when ***Enable Compass Power Control*** is activated. ***Compass Sampling Interval (s)*** is the interval between each new start of the external compass sampling. This interval has to be bigger than N/fs where N is the ***Compass Sample Average Number*** and fs are the ***Compass Sampling frequency***. Only used when Enable ***Compass Power Control*** is activated. ***Compass Sample Average Number*** is the number of samples to be taken from the external compass and averaged before the power to the external compass is switched off again. Selectable number of values is 4, 8, 16, 32, 64 and 128. Only used when ***Enable Compass Power Control*** is activated. ***Compass Sampling Frequency*** is the frequency which the sensor is sampling the compass, 1Hz is the only alternative yet.

4.8.6 Advanced System Output

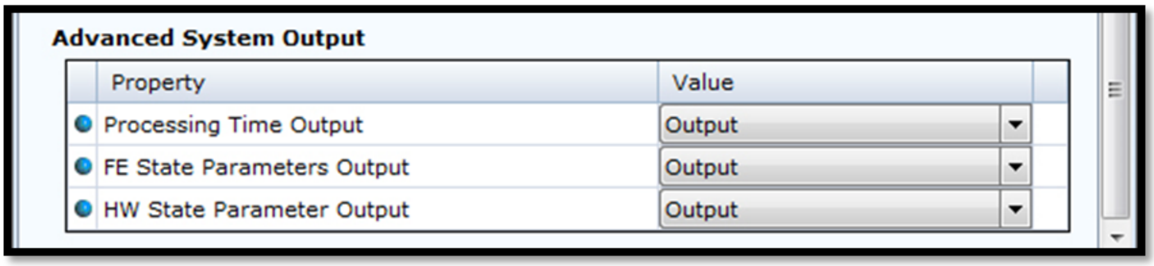


Figure 4-30: Advanced System Output in User Maintenance

In ***AADI Real-Time*** and ***Smart Sensor Terminal*** mode the alternatives are either ***Off*** or ***Output*****.**

Off: Parameter is turned off.

Output: Parameter is included in the xml or the ASCII output.

The parameters in this section are useful parameters for troubleshooting purpose. ***Processing Time Output*** is the time used for processing all the data from the last wave integration time.

FE State Parameters Output is an advanced system output which can be enabled to give more information about the internal coprocessor and communication between the host processor and the coprocessor. Two output parameters, ***FE***

State and ***FE Notifications*** are controlled by this setting The ***FE State Parameter*** is 0 if everything is ok. The ***FE Notifications parameter*** gives information about the last communications with the coprocessor.

HW State Parameter Output is an advanced system setting which can be enabled to give more information about the internal electronic hardware. The output is 0 if everything is ok.

4.9 System Overview

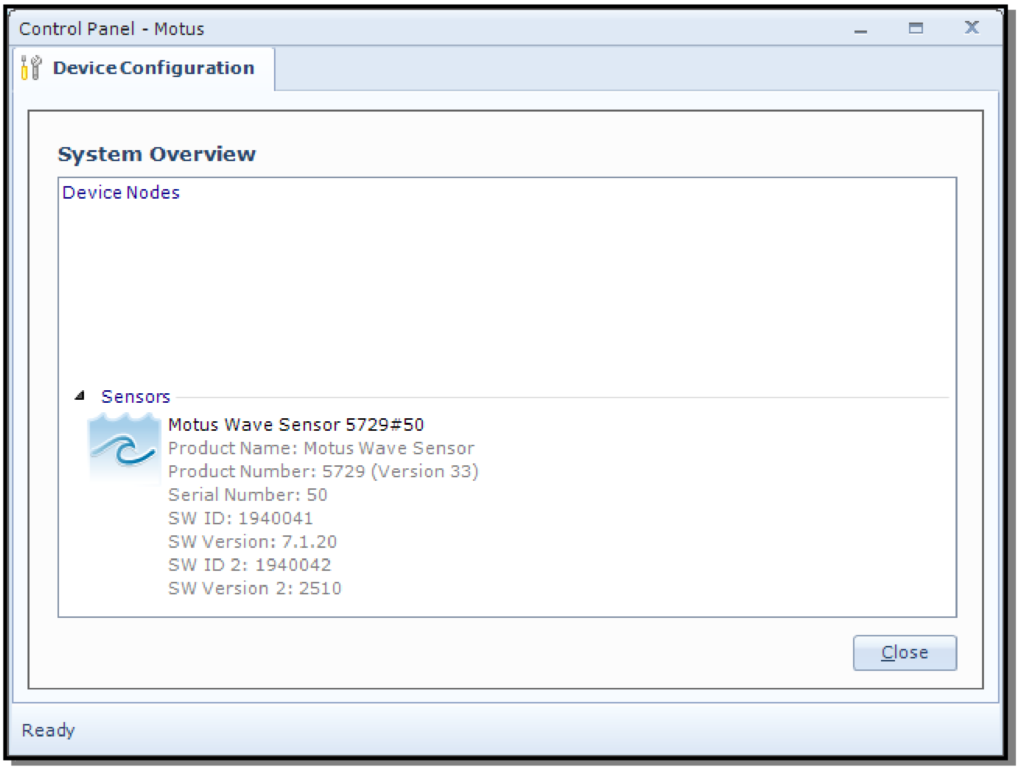


Figure 4-31: System overview

When you select ***System Overview*** under the ***Device Configuration*** tab you will get a short list of sensor information with ***Product Name, Product Number, Serial Number*** and ***Software Version***.

4.10 Save Configuration to file

Figure 4-32: Example of saved configuration file in .xml format


```
<?xml version="1.0" encoding="UTF-8"?>
- <Config xmlns="http://www.aadi.no/RTConfigSchema" ID="5729-50-7.1.20-0-5" Time="2020-05-08T12:37:41.325Z">
  - <NodeConfig ID="5729-50" ProdName="Motus Wave Sensor" Descr="Motus Wave Sensor 5729#50" ProdNo="5729" SerialNo="50" ConfigVer="33" NodeTypeID="2030" ProtocolVer="6" Adr="4190720"
    IsSensor="true">
    - <ConfigCategory ID="0" Descr="Factory Maintenance">
      - <PropertyCategory ID="0" Descr="Mandatory">
          <Property ID="0" Descr="Product Name" Type="VT_BSTR" Access="R1W4">Motus Wave Sensor</Property>
          <Property ID="1" Descr="Product Number" Type="VT_BSTR" Access="R1W4">5729</Property>
          <Property ID="2" Descr="Serial Number" Type="VT_I2" Access="R1W4">50</Property>
          <Property ID="6" Descr="SW ID" Type="VT_BSTR" Access="R1">1940041</Property>
          <Property ID="3" Descr="SW Version" Type="VT_ARRAY|VT_I2" Access="R1">7;1;20</Property>
          <Property ID="8" Descr="SW ID 2" Type="VT_BSTR" Access="R1">1940042</Property>
          <Property ID="7" Descr="SW Version 2" Type="VT_BSTR" Access="R1">2510</Property>
        </PropertyCategory>
      - <PropertyCategory ID="4" Descr="Hardware">
          <Property ID="0" Descr="HW ID 1" Type="VT_BSTR" Access="R3W4"/>
          <Property ID="1" Descr="HW Version 1" Type="VT_BSTR" Access="R3W4"/>
          <Property ID="2" Descr="HW ID 2" Type="VT_BSTR" Access="R3W4"/>
          <Property ID="3" Descr="HW Version 2" Type="VT_BSTR" Access="R3W4"/>
        </PropertyCategory>
      - <PropertyCategory ID="1" Descr="System Control">
          <Property ID="0" Descr="System Control" Type="VT_ARRAY|VT_I2" Access="R3W4">0;0;0</Property>
        </PropertyCategory>
      - <PropertyCategory ID="2" Descr="Service Info">
          <Property ID="0" Descr="Production Date" Type="VT_BSTR" Access="R3W4"/>
          <Property ID="1" Descr="Last Service" Type="VT_BSTR" Access="R3W4"/>
          <Property ID="2" Descr="Last Calibration" Type="VT_BSTR" Access="R3W4"/>
          <Property ID="3" Descr="Calibration Interval" Type="VT_I4" Access="R3W4" Unit="Days">0</Property>
        </PropertyCategory>
      - <PropertyCategory ID="16" Descr="Processing Dependencies">
          <Property ID="1" Descr="Wave Height Unit" Type="VT_I4" Access="R1W2" Enum="Metric [m]=1;Imperial [Feet]=0">1</Property>
        </PropertyCategory>
      - <PropertyCategory ID="50" Descr="Storage">
          <Property ID="11" Descr="Fe Image File Name" Type="VT_BSTR" Access="R1W4">WaveFront.bin</Property>
        </PropertyCategory>
      </ConfigCategory>
    - <ConfigCategory ID="1" Descr="User Maintenance">
      - <PropertyCategory ID="0" Descr="Mandatory">
          <Property ID="0" Descr="Node Description" Type="VT_BSTR" Access="R1W2">Motus Wave Sensor 5729#50</Property>
        </PropertyCategory>
      - <PropertyCategory ID="1" Descr="Site Info">
          <Property ID="0" Descr="Owner" Type="VT_BSTR" Access="R1W3"/>
        </PropertyCategory>
```


4.11 System Status

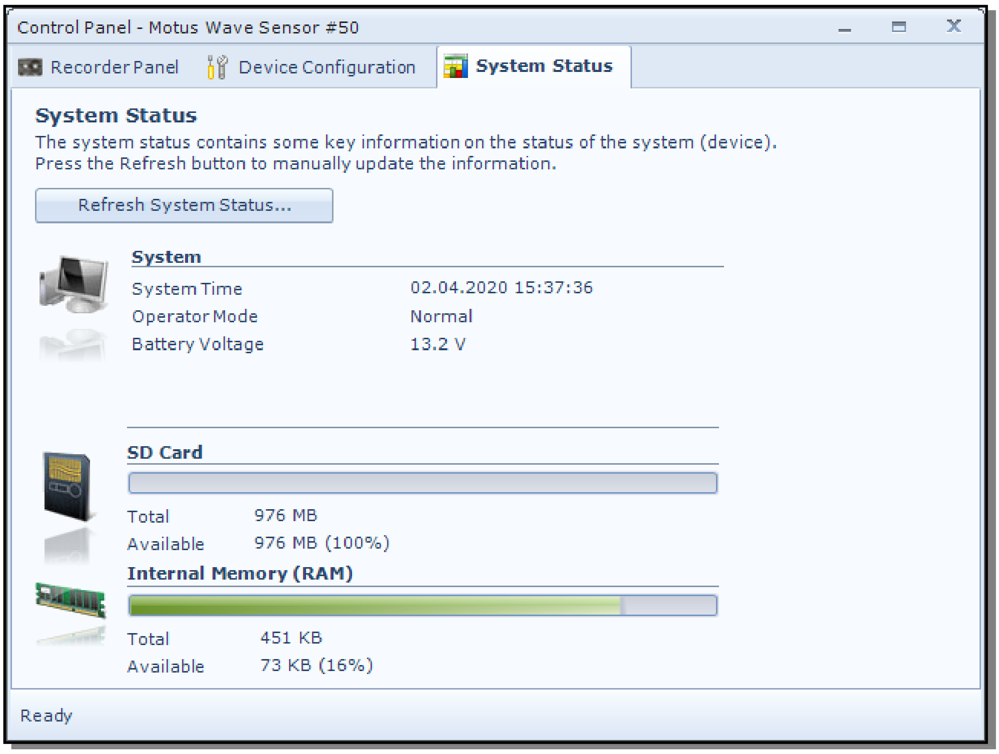


Figure 4-33: System Status

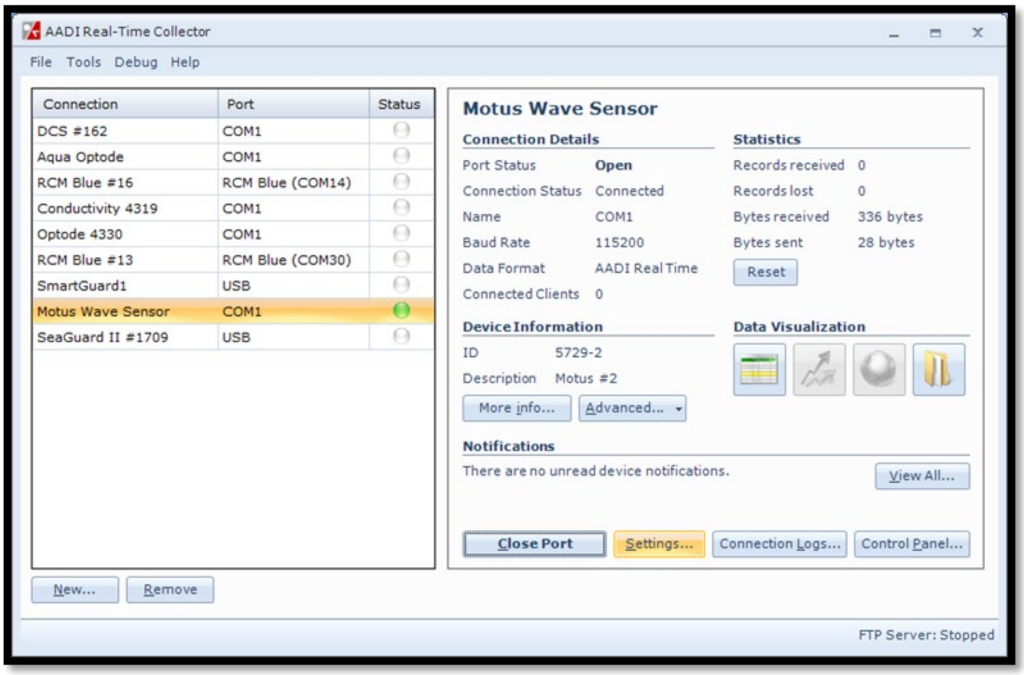
System Status is the last tab in the ***Control Panel*** and holds information about the sensor such as ***System Time, Battery Voltage*** and ***Internal Memory***.

CHAPTER 5 Logging data via AADI Real-Time Collector

5.1 Logging data on PC

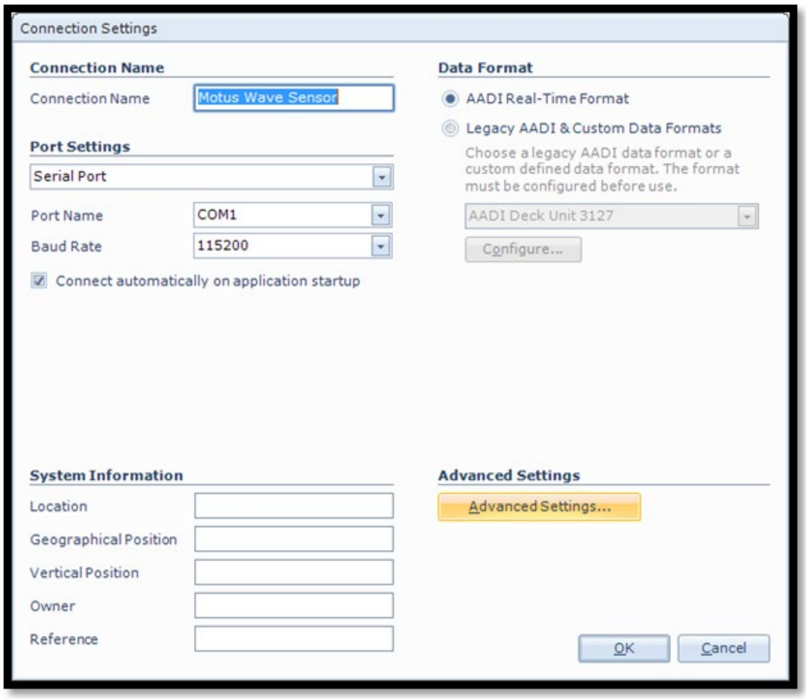
The Real-Time Collector can save the incoming data to file, either to a txt-file or to xml-files. For instructions refer to Chapter 2.2.1 to 2.2.2.

5.1.1 Enabling file output



If your connection is open (status green in the AADI Real Time Collector main menu) then first press ***Close Port***. When the port is closed then highlight the Motus connection and. click on the "***Settings…***" button next to ***Close Port/Open Port***, as shown in ***Figure 5-1***.

Figure 5-1: AADI Real-Time Collector start up menu



Click on the "***Advanced Settings…"*** button in the ***Connection Settings*** window; refer ***Figure 5-2.***

Figure 5-2: Connection settings menu

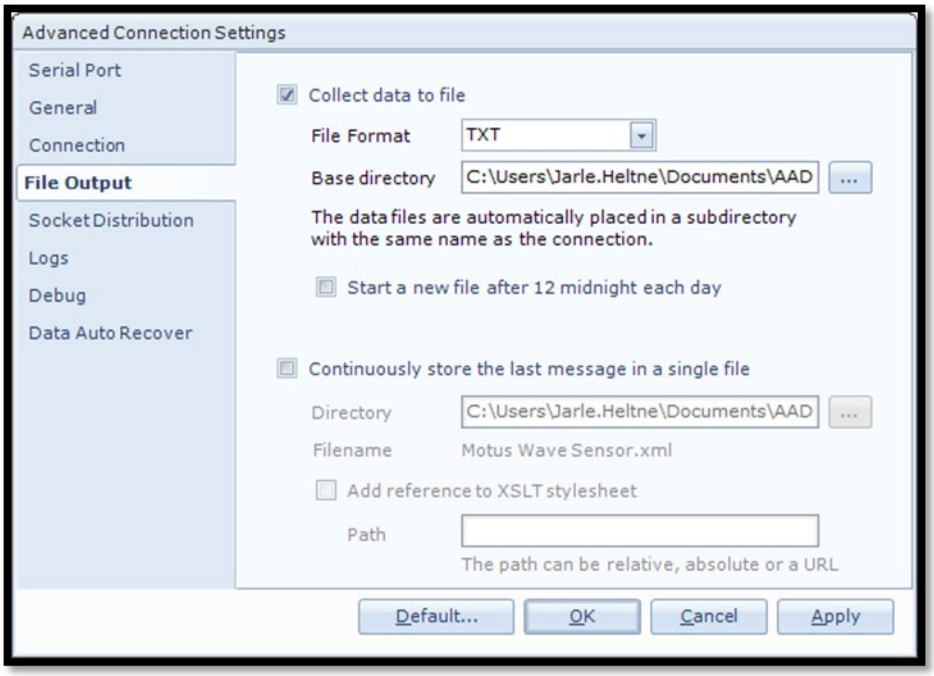


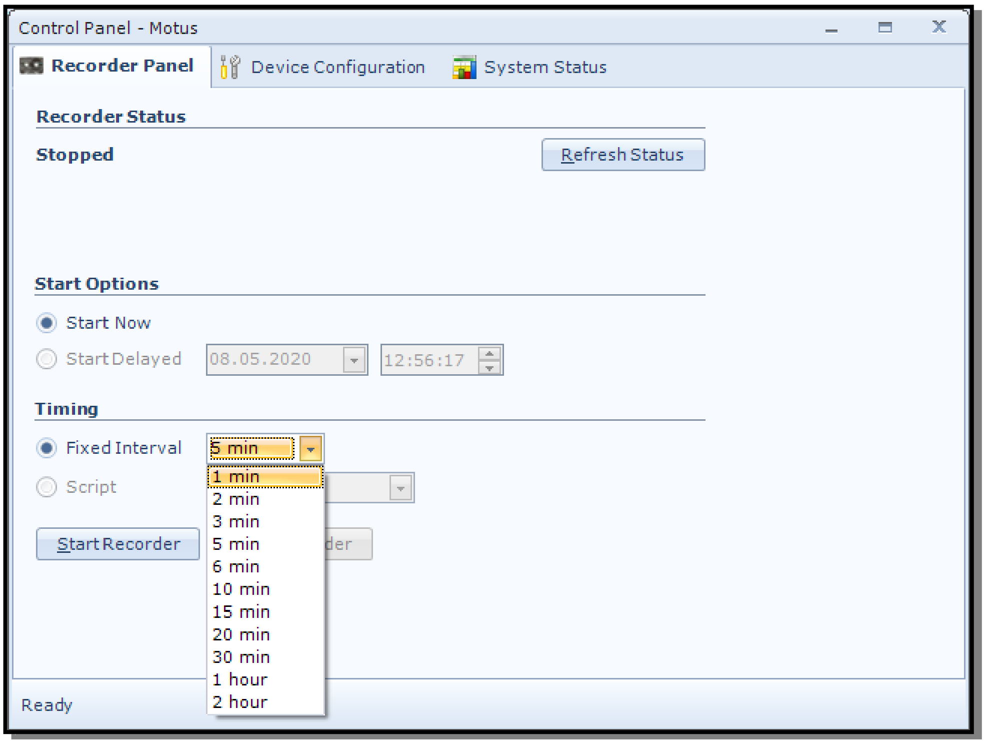
Figure 5-3: Advanced connection settings / File Output

Choose ***File Output*** from the list on the left side. Check the ***"Collect data to file"*** box to enable file output. Select a file format and choose a base directory where you want the file to be saved.

Click "***OK"*** in the Advanced Connection Settings window, and ***"OK"*** in the Connection Settings window.

5.1.2 Starting the sensor and logging to file

In AADI Real-Time Collector start menu, see ***Figure 5-1*** click on the selected connection and ***"Open Port"***. The Status turns green when the port is opened and connected. Click on the ***"Control Panel…"*** button in the lower right corner.



In the Control Panel you will find four alternatives:

- ***Recorder Panel***
- ***Device Configuration***
- ***System Status***

In the ***Recorder Panel*** window select ***Start Now,*** then select ***Fixed Interval*** and click the ***"Start Recorder"*** button. The shortest interval available depends on the sensor configuration.

Figure 5-4: Recorder panel

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Description	Motus Wave Sensor 5729#50											
2	Product Name	Motus Wave Sensor											
3	Product Number	5729											
4	Serial Number	50											
5	Device ID	5729-50											
6	Session ID	5729-50-7.1.20-0-7											
7	Location												
8	Geographic Position	60.323605,5.37225											
9	Vertical Position												
10	Owner												
11	Reference												
12													
13													
14			Motus Wave Sensor 5729#50										
15	Record Time	Record Nu	Sensor Sta	Significan	Status	Wave Pea	Status	Wave Pea	Status	Wave Hei	Status	Wave Hei	Status
16	08.05.2020 13:42	1	(0) OK	3.65E-02		8.07E+01		2.84E+01		6.16E-03		3.60E-02	
17	08.05.2020 13:47	2	(0) OK	6.48E-02		2.52E+01		2.56E+01		7.68E-03		6.44E-02	
18	08.05.2020 13:52	3	(0) OK	4.85E-02		3.47E+02		2.13E+01		6.96E-03		4.80E-02	
19	08.05.2020 13:57	4	(0) OK	7.23E-02		2.88E+02		2.84E+01		6.34E-03		7.20E-02	
20	08.05.2020 14:02	5	(0) OK	4.11E-02		1.07E+02		2.84E+01		5.36E-03		4.08E-02	
21	08.05.2020 14:07	6	(0) OK	3.29E-02		2.24E+02		2.84E+01		7.29E-03		3.21E-02	
22	08.05.2020 14:12	7	(0) OK	3.18E-02		6.79E+01		2.56E+01		5.42E-03		3.13E-02	
23	08.05.2020 14:17	8	(0) OK	3.72E-02		3.55E+02		1.97E+01		7.93E-03		3.63E-02	
24	08.05.2020 14:22	9	(0) OK	3.68E-02		1.29E+02		2.13E+01		6.64E-03		3.62E-02	
25	08.05.2020 14:27	10	(0) OK	2.56E-02		2.45E+02		2.33E+01		6.56E-03		2.48E-02	
26	08.05.2020 14:32	11	(0) OK	2.50E-02		2.32E+02		2.33E+01		7.95E-03		2.37E-02	
27													

Data will start logging in the defined directory. If it is a txt-file, the easiest way to view it is in Excel. *Figure 5-5* gives an example of obtained data file. The different parameters are organized in columns.

Figure 5-5: Example of a txt-file obtained from the sensor using RT Collector

5.2 Viewing incoming data in real-time

When the sensor is running, the incoming data can be viewed by selecting ***"Connection Logs…"*** in the AADI Real-Time Collector start menu, refer *Figure 5-1* and *Figure 5-6*. Each Record number contains data from one recording period.

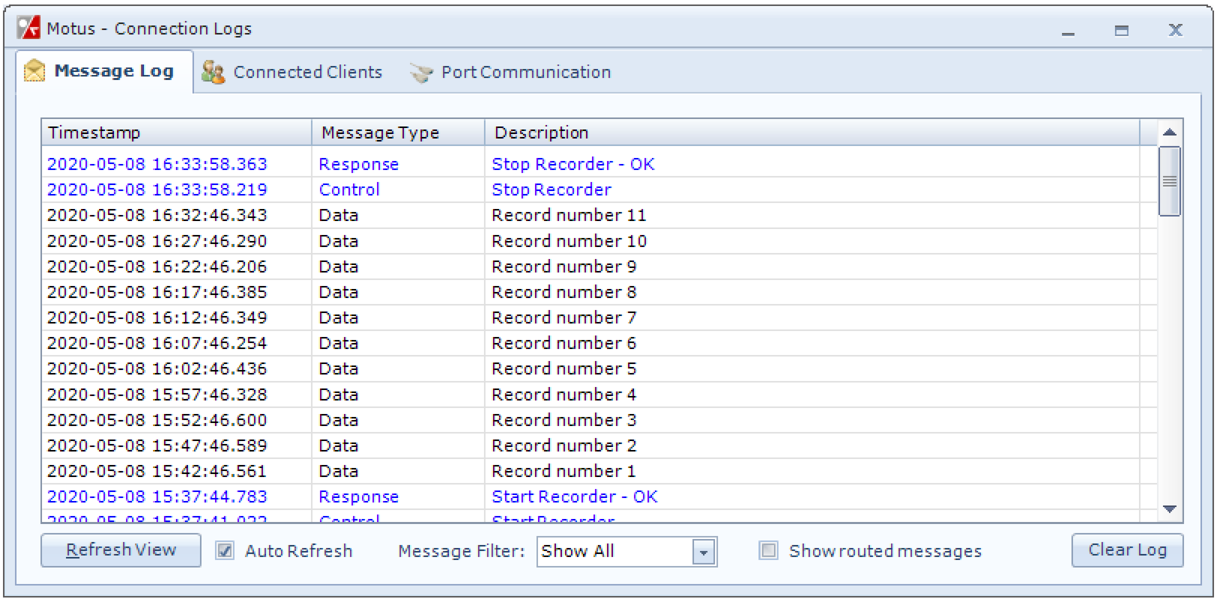
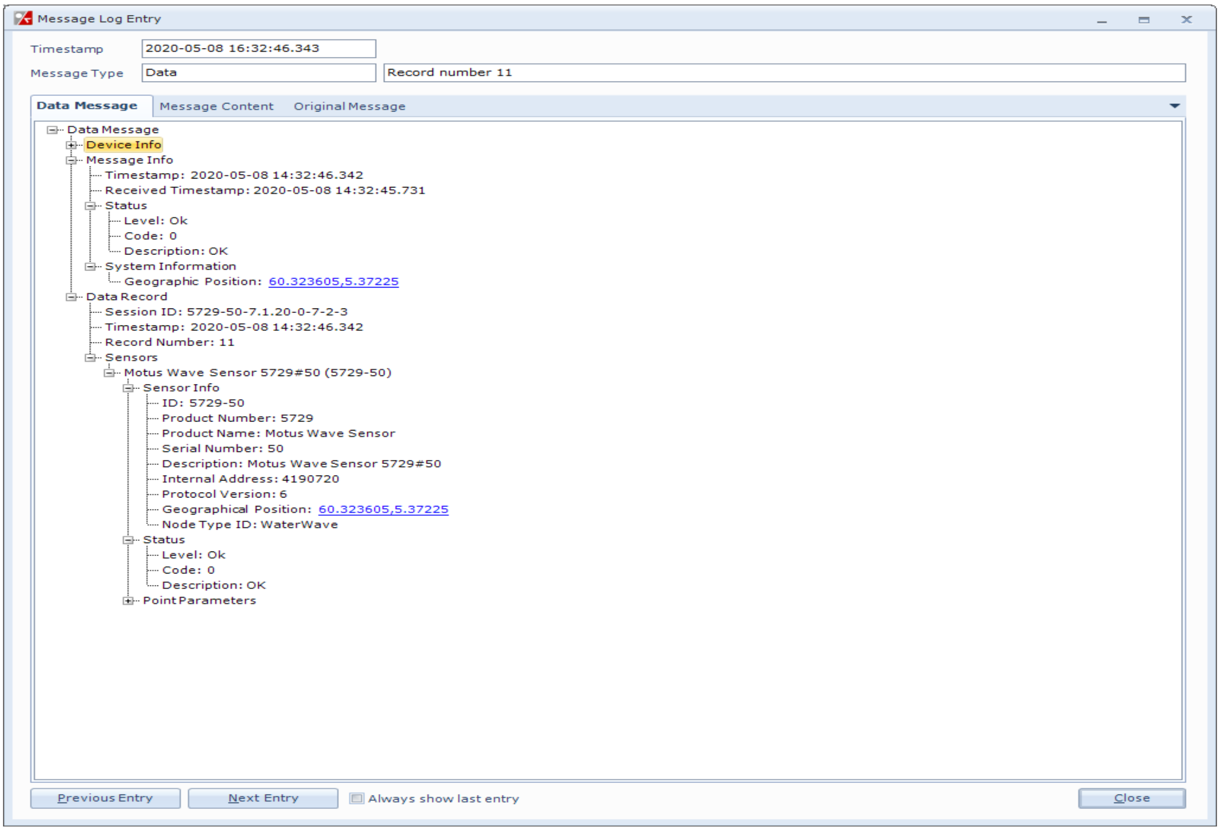
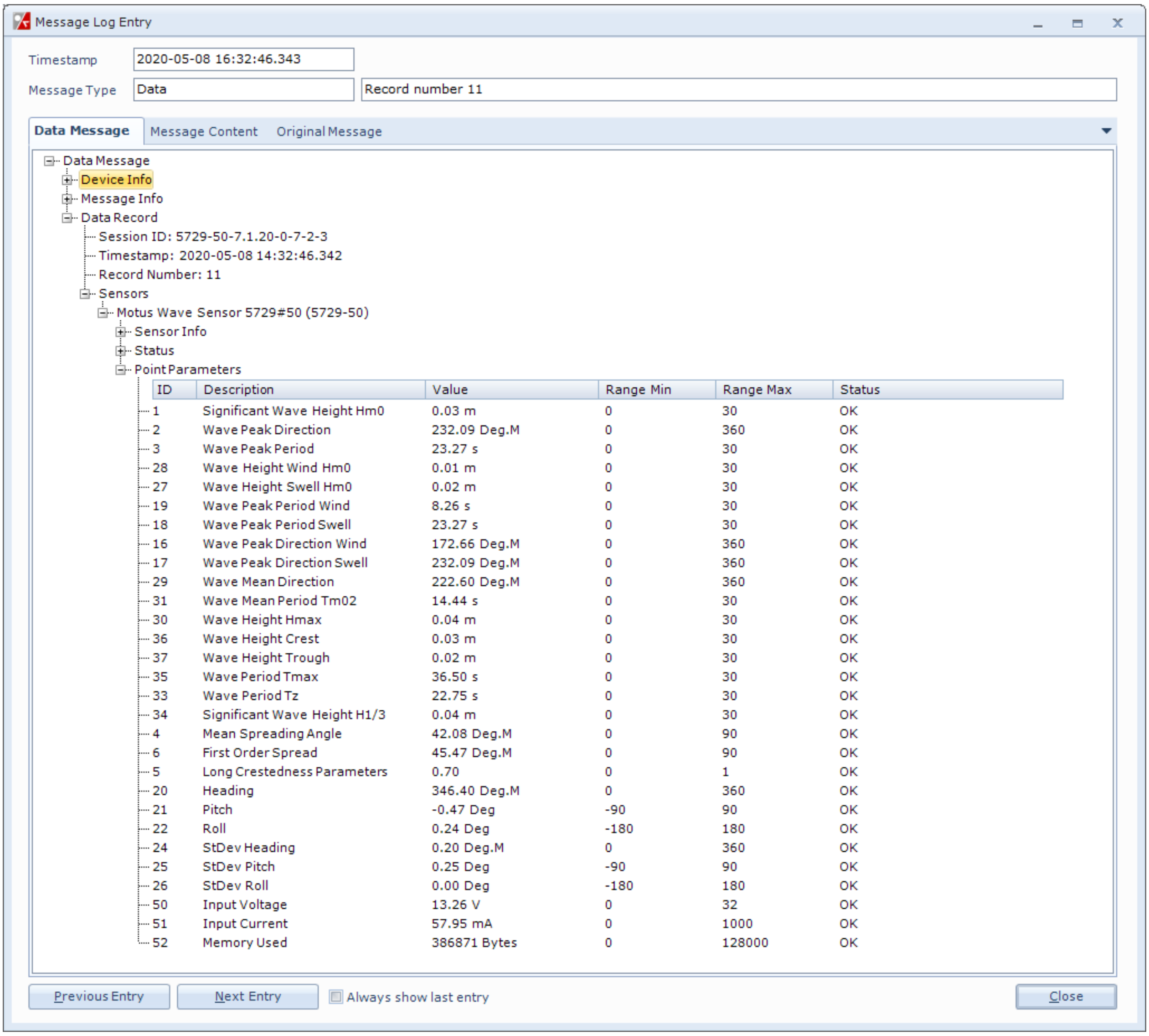


Figure 5-6: Connection Logs



Double-click on one of the Record numbers to look at the data.

Click on the + signs to open and see all the data in the message.



ID	Description	Value	Range Min	Range Max	Status
1	Significant Wave Height Hm0	0.03 m	0	30	OK
2	Wave Peak Direction	232.09 Deg.M	0	360	OK
3	Wave Peak Period	23.27 s	0	30	OK
28	Wave Height Wind Hm0	0.01 m	0	30	OK
27	Wave Height Swell Hm0	0.02 m	0	30	OK
19	Wave Peak Period Wind	8.26 s	0	30	OK
18	Wave Peak Period Swell	23.27 s	0	30	OK
16	Wave Peak Direction Wind	172.66 Deg.M	0	360	OK
17	Wave Peak Direction Swell	232.09 Deg.M	0	360	OK
29	Wave Mean Direction	222.60 Deg.M	0	360	OK
31	Wave Mean Period Tm02	14.44 s	0	30	OK
30	Wave Height Hmax	0.04 m	0	30	OK
36	Wave Height Crest	0.03 m	0	30	OK
37	Wave Height Trough	0.02 m	0	30	OK
35	Wave Period Tmax	36.50 s	0	30	OK
33	Wave Period Tz	22.75 s	0	30	OK
34	Significant Wave Height H1/3	0.04 m	0	30	OK
4	Mean Spreading Angle	42.08 Deg.M	0	90	OK
6	First Order Spread	45.47 Deg.M	0	90	OK
5	Long Crestedness Parameters	0.70	0	1	OK
20	Heading	346.40 Deg.M	0	360	OK
21	Pitch	-0.47 Deg	-90	90	OK
22	Roll	0.24 Deg	-180	180	OK
24	StDev Heading	0.20 Deg.M	0	360	OK
25	StDev Pitch	0.25 Deg	-90	90	OK
26	StDev Roll	0.00 Deg	-180	180	OK
50	Input Voltage	13.26 V	0	32	OK
51	Input Current	57.95 mA	0	1000	OK
52	Memory Used	386871 Bytes	0	128000	OK

Figure 5-7: Visualization of incoming data from the sensor in real time

Previous records or newer records (Figure 4-25) can be viewed by clicking on ***Previous Entry*** button or ***Next Entry button***. An automatic update to the last data message can be enabled by checking the Always show last entry check box.

The original message content can be seen if clicking on the ***Original Message*** tab.

CHAPTER 6 Stand-alone Sensor configuration using Terminal Software

This chapter describes how to communicate with the Motus Wave Sensor using the RS-232 Smart Sensor Terminal protocol or AADI Real Time

6.1 Communication setup

The 5729 Motus Wave Sensor can be used on a SmartGuard or SeaGuardII (AiCaP) Dataloggers or connected to a RS-232 com-port (PC or other devices with RS232 com-port).

Most terminal programs can be used for communication with the sensor when connected to a PC. For this description we have used TerraTerm

The following setup is recommended:

115200 Baud
8 Data bits
1 Stop bit
No Parity
Xon/Xoff Flow Control

IMPORTANT! The terminal program must send a Line Feed after each Carriage Return.

6.2 Sensor startup

When property ***Enable Text*** is set to ***Yes, StartupInfo*** is displayed at sensor power up or after ***Reset***. ***StartupInfo*** contains information about ***Product Number, Serial Number, Mode, Protocol Version*** and ***Config Version*** (Refer to Figure 6-1).

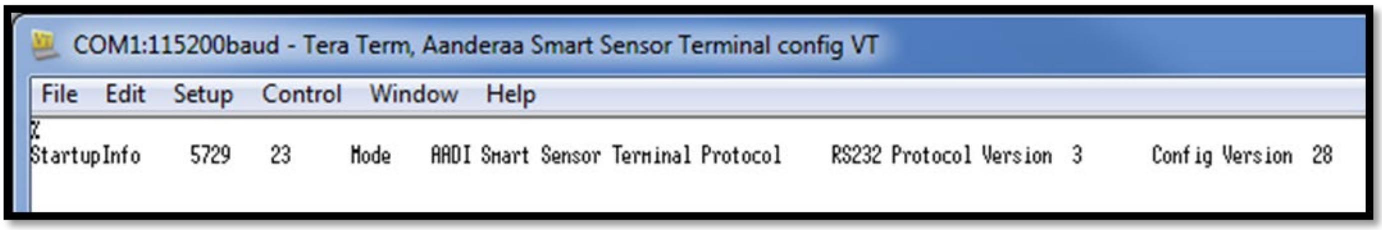


Figure 6-1: Start up info: communication using Tera Term

In order to minimize the current drain the sensor normally enters a power down mode after each sampling; the sensor can be awakened by any characters on the Smart Sensor Terminal input, and will then after receiving the last character stay awake for a time set by the ***Comm TimeOut*** property.

If the property ***Comm TimeOut*** is set to other than '***Always On'*** the serial interface will not be activated after power-up (or the ***Reset*** command).

Any character will activate the serial interface, but a Carriage Return (CR or CR+LF), '/' or ';' are often preferred since these characters do not interfere with the command syntax. The serial interface will then be active until a period of input inactivity specified by the ***Comm TimeOut*** value (10 s,20 s,30 s,1 min,2 min,5 min,10 min).

The ***Communication Sleep Indicator***, '***%***', will be transmitted when the serial communication is deactivated, and the ***Communication Ready Indicator***, '***!***' is outputted subsequent to activation (electronics require up to 500ms start up time).

If ***Comm TimeOut*** is set to '***Always On'*** the communication (and microprocessor) will be kept active all time.

The ***Communication Sleep Indicator*** '***%***' and the ***Communication Ready Indicator*** '***!***' are not followed by Carriage Return and Line Feed.

When communicating with the sensor, you may start by pressing *Enter*. The sensor will respond in two ways (***Comm TimeOut*** is 1 minute by default in the following description):

- If the sensor is ready for communication, it will not send any response indicator. The sensor will stay awake and ready to receive commands for 1 minute (controlled by the ***Comm TimeOut***) since the last command.
- If the sensor is in sleep mode and not ready for communication, the sensor will send a ***Communication Ready indicator*** (***!***) when awakened (within 500ms). The sensor will then be ready for communication.

6.3 Description of protocol

All inputs to the sensor are given as commands with the following format:

- ***MainCmd SubCmd*** or ***MainCmd Property(Value, ..., Value)***

Description of ASCII coded communication rules:

- The main command***, MainCmd,*** is followed by an optional subcommand (***SubCmd)*** or sensor property (***Property***).
- The ***MainCmd*** and the ***SubCmd/Property*** must be separated with the space ' ' character.
- When entering new settings the *Property* is followed by a parenthesis containing comma-separated values.
- The command string must be terminated by Carriage Return and Line Feed (ASCII code 13 & 10).
- The command string is not case sensitive (UPPER/lower-case).
- The ENUM property settings are case sensitive. E.g. "***Set Mode(AiCaP)"*** Here AICAP will result in argument error.
- A valid command string is acknowledged with the character '#' while character '*' indicates an error. Both are followed by Carriage Return/ Line Feed (CRLF).
- For most errors a short error message is also given subsequent to the error indicator.
- There are also special commands with short names and dedicated tasks, as ***save, reset***, and ***help.***
- All names and numbers are separated by tabulator spacing (ASCII code 9).
- The string is terminated by Carriage Return and Line Feed (ASCII code 13 & 10).

Note! Losing power during the flashing process can cause corruption of vital settings, such as coefficients, serial number, model number etc. If losing settings, contact AADI Service department for new setting file for the specific sensor with further instructions.

6.4 Passkey for write protection

To avoid accidental change, most of the properties are write-protected. There are four levels of access protection, refer Table 6-1.

A special property called ***Passkey*** must be set according to the protection level before changing the value of properties that are write-protected. After a period of inactivity at the serial input, the access level will revert to default. This period corresponds to the ***Comm TimeOut*** setting, or 1 minutes it the ***Comm TimeOut*** is set to ***Always On.***

Output	Passkey	Description
No		No Passkey needed for changing property
Low	1	The Passkey must be set to 1 prior to changing property
High	1000	The Passkey must be set to 1000 prior to changing property. This Passkey value also gives read access to factory properties that usually are hidden
Read Only		The user have only read access

Table 6-1: Passkey protection

6.5 Save and Reset

When the required properties are set, you should send a ***Save*** command to make sure that the new configuration is saved internally in the flash memory. The sensor always reads the configuration from the internal flash memory after reset and power up. The ***Save*** command takes about 20 seconds to complete (indicated with the character '#').

Always send a ***Reset*** command when a new configuration has been saved (or switch the power OFF and then back ON), or else calculated parameters may be corrupted. This forces the sensor to start up with the new configuration input. If the ***Enable Sleep*** property is set to ***Yes*** and the ***Comm TimeOut*** property is not set to ***Always On*** the sensor enters sleep mode after reset.

At startup/reset the sensor performs measurements according to the interval setting if the mode is ***Smart Sensor Terminal.***

If ***Enable Text*** is set to ***Yes***, the ***Startup Info*** is presented.

If the ***Save*** command is executed the new setting will be stored in the internal Flash memory.

Property changes will be lost when the sensor is reset or loses power unless you type the ***Save*** command.

Refer to Figure 6-2. The number of parameters in the list depends on which parameters are enabled.

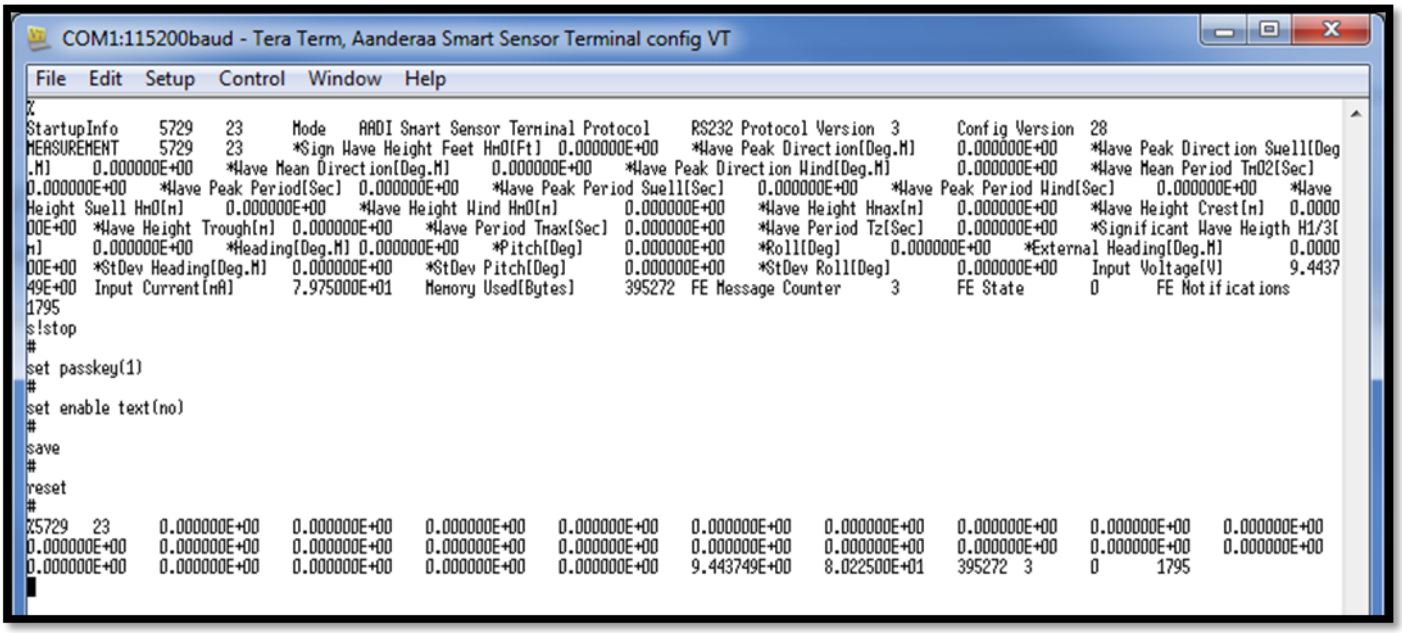


Figure 6-2: Save and reset in Tera Term

6.6 Available commands

Available commands and properties for the sensors are given in ***Table 6-2*** and ***chapter 1.7*** respectively.

Table 6-2 Available RS-232 commands.

Command	**Description**
Start	Start a measurement sequence according to current configuration
Stop	Stop a measurement sequence
Do Sample	Calculates and presents a new single set of measurement data. (used in polled mode).
Do Output	Presents the last set of calculated measurement data (normally only used in polled mode).
Get *ConfigXML*	Outputs information about the configuration properties in XML format
Get *DataXML*	Outputs information about available(enabled) parameters in XML format
Get *Property*	Output Property value (refer table 1-1), e.g get interval.
Get All	Output information about the configuration properties (same as shown on Get ConfigXML but without all the metadata)
Get All Parameters	Output information about all parameters value
Set *Property(Value,…, Value)*	Set Property to Value,…, Value (refer table 1-1), eg set interval(60)
Set *Passkey(Value)*	Set passkey to change access level
Save	Store current settings
Load	Reloads previous stored settings
Reset	Resets the sensor with last saved new configuration
Help	Print help information
;	Comment string, following characters are ignored
//	Comment string, following characters are ignored

6.6.1 The Get command

The ***Get*** command is used to read the value/values of a property and to read the latest value of a parameter.

The command name ***Get*** followed by a ***Property*** returns a string in the following format:

> ***Property ProductNo SerialNo Value, ..., Value***

The string starts with the name of the property, the product number and serial number of the sensor, and finally the value of the property.

The command name ***Get*** followed by a parameter returns the name and unit of the parameter, the product and serial number of the sensor, and finally the latest parameter reading.

A special version, ***Get All***, reads out all available properties in the sensor. Some properties are passkey protected and will not be shown without first writing the passkey. To see all user accessible properties, use ***passkey(1000).***

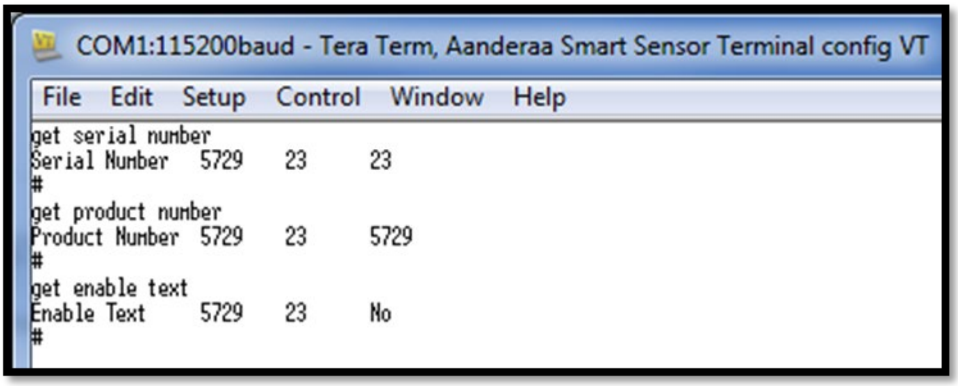


Figure 6-3: The Get Command

6.6.2 The Set command

The ***Set*** command is used for changing a property. The corresponding ***Get*** command can be used to verify the new setting, as shown in Figure 6-4. Please note depending on the configuration a too short interval will give an error message.

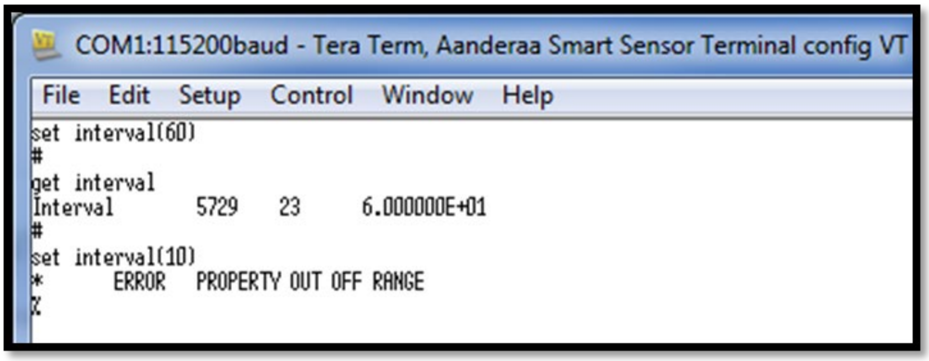


Figure 6-4: The Set Command

Use the ***Save*** commands to permanently store the new property value. Remember to always wait for the acknowledge character '#' after a save before switching off power to the sensor. If the power is lost while saving, the previous configuration saved to flash is used by the sensor.

The ***Mode*** and ***Baudrate*** property will require a ***Reset*** before the change is executed. All other property changes will be executed immediately.

Some properties are passkey protected and will not be accessible without first writing the passkey. If the passkey is needed you get the error message***: "ERROR PROTECTED PROPERTY".*** Using ***passkey 1000*** opens up all user accessible property settings. Refer Table 6-1 for more info

6.6.3 XML commands

The ***Get ConfigXML*** command outputs all available sensor properties in XML-format.

The ***Get DataXML*** command outputs all available sensor parameters in XML-format.

The ***XML-output*** is a general format shared by all Aanderaa smart sensors; the output from different types of smart sensors can be read and presented as e.g. in a general smart sensor setup program.

6.7 Example – How to configure sensor in Smart Sensor Terminal mode

In the following examples several configuration changes are shown. The command ***Stop*** is recommended to avoid output strings while configuring the sensor. If the sensor has started to transmit data when the user tries to communicate, it may take a while before the command response is sent from the sensor. This depends on configuration, timing and number of output parameters etc.

Example 1: Configure sensor for stand-alone use

//Press Enter to start communicating with the sensor, refer chapter 6.2
↵ //press Enter
Stop ↵//Wait for ack #. Repeat if necessary
Set Passkey(1000) ↵
Set Mode(Smart Sensor Terminal) ↵//wait for ack #
Set Enable Text(Yes) ↵//wait for ack #
Set Wave Integration Time(10min) ↵//wait for ack #
Set Wave Height Wind Hm0 Output(Output)↵//wait for ack #
Set Wave Height Swell Hm0 Output(Output)↵//wait for ack #
Set Wave Period Tmax Output(Output)↵//wait for ack #
Set Wave Height H1/3 Output(Off) ↵//wait for ack #
Set Heading Output(Output) ↵//wait for ack #
Set Pitch and Roll Output(Output) ↵//wait for ack #
Set Interval(300s) //an error message is sent from the sensor if the interval is too short
Save ↵// wait for ack #
Reset ↵// the sensor will restart with new settings

Comments to example 1:

The output string from sensor depends on the original configuration. The available/selectable values for each property can be found by sending the command ***Help***. This gives a printout from the sensor showing a short help text from the sensor. Setting a value which is not shown here for enumerated properties gives an error message (*ERROR ARGUMENT ERROR).The output from the ***Help*** command is shown in chapter 6.4 .

All parameters except from ***Significant Wave Height H_{m0}, Wave Peak Direction and Wave Peak Period*** may be switched on or off.

Some of the properties are enabling only one parameter and others can enable multiple parameters. Please also notice that the order and name of the properties do not match with the order and name of the output parameters.

If you want to add or remove any parameters from the output see ***Table 6-3*** for information about available parameters and the corresponding Property. For more information about parameter calculation see ***chapter 2.7***

One possible output from example 1 is shown in **Figure 6-5.** Please note that the number of parameters may differ if other parameters were turned on before starting. To switch these off find the corresponding and send the set command e.g. Set Fourier Coeff Spectrum Output(Off) if the four Fourier Coeff is displayed.

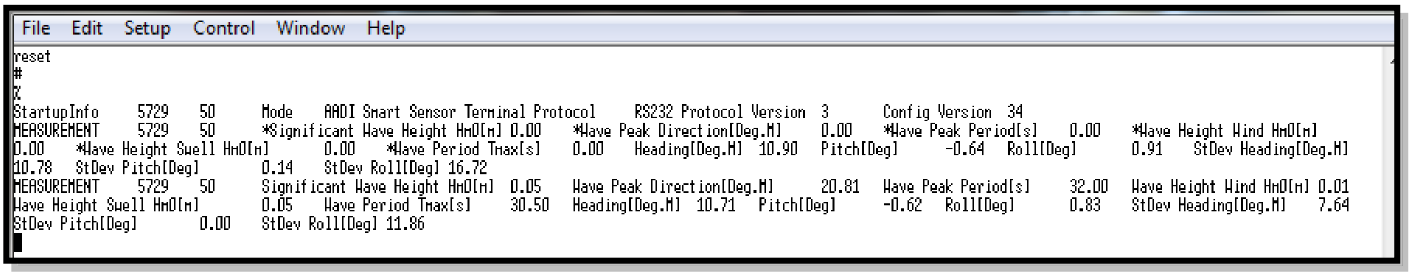


Figure 6-5: Output from Example 1

In Example 1 the first data set is showing a * before the parameter text. This indicates that the parameter is not ready because it has not enough samples to do the calculation. After reset at least a period equal to the ***Wave Integration Time*** is needed to calculate the wave parameters.

6.8 Output Parameters and corresponding Properties

Property	Parameter	Unit
Mean Spreading Angle Output	*Mean Spreading Angle*	Deg.M
First Order Spread Output	*First Order Spread*	Deg. M
Long Crestedness Output	*Long Crestedness*	
Energy Spectrum Output	*Energy Spectrum*	m^2 / Hz
Directional Spectrum Output	*Directional Spectrum*	Deg. M
Principal Dir Spectrum Output	*Principal Directional Spectrum*	Deg. M
Orbital Ratio Spectrum Output	*Orbital Ratio Spectrum*	
Fourier Coeff Spectrum Output	*Fourier Coeff A1* *Fourier Coeff A2* *Fourier Coeff B1* *Fourier Coeff B2*	
Wave Peak Dir Wind Output	*Wave Peak Direction Wind*	Deg. M
Wave Peak Dir Swell Output	*Wave Peak Direction Swell*	Deg. M
Wave Mean Dir Output	*Wave Mean Direction*	Deg. M
Wave Height Wind H_{m0} Output	*Wave Height Wind H_{m0}*	m
Wave Height Swell H_{m0} Output	*Wave Height Swell H_{m0}*	m
Wave Height H_{max} Output	*Wave Height H_{max}*	m
Wave Height Max Trough Output	*Wave Height Trough*	m
Wave Height Max Crest Output	*Wave Height Crest*	m
Wave Period T_{max} Output	*Wave Period T_{max}*	s
Wave Mean Period T_z Output	*Wave Period T_z*	s
Wave Height $H_{1/3}$ Output	*Significant Wave Height $H_{1/3}$*	m
Wave Height $H_{1/10}$ Output	*Significant Wave Height $H_{1/10}$*	m
Wave Height $H_{1/1}$ Output	*Significant Wave Height $H_{1/1}$*	m
Wave Mean Period $T_{1/3}$ Output	*Wave Mean Period $T_{1/3}$*	s
Wave Mean Period $T_{1/10}$ Output	*Wave Mean Period $T_{1/10}$*	s
Heave Vert. Time Series Output	*Last Heave Sample Index* *Heave Time Series Vertical*	 m
Heave Hor. Time Series Output	*Heave Time Series North* *Heave Time Series East*	m m
Wave Mean Period T_{m02} Output	*Wave Mean Period T_{m02}*	s
Wave Peak Period Wind Output	*Wave Peak Period Wind*	s
Wave Peak Period Swell Output	*Wave Peak Period Swell*	s

Table 6-3: Output Properties and corresponding Parameters

Other non-wave parameters in this section are listed in ***Table 6-4*** with corresponding parameter and unit.

Property	Parameter	Unit
Heading Output	Heading	Deg. M
	StDev Heading	Deg. M
External Heading Output	External Heading	Deg. M
Pitch and Roll Output	Pitch	Deg
	Roll	Deg
	StDev Pitch	Deg
	StDev Roll	Deg
System Parameters Output	Input Voltage	V
	Input Current	mA
	Memory Used	Bytes

Table 6-4: Output Properties and corresponding Parameters

Name with unit	Type	Explanation
Heading[Deg.M]	Float	Averaged heading from one interval, one heading measurement per ping, vector averaged.
Std Dev Heading[Deg.M]	Float	Standard deviation calculation on all heading values from one interval. Indicates how much the sensor rotates around the vertical axis during a measurement interval.
External Heading[Deg.M]	Float	Averaged heading from one interval based on input from external compass.
Pitch[Deg]	Float	Pitch angle, average from one interval, one tilt measurement per ping. Pitch is the rotation angle around the x-axis of the sensor (same axis as Transducer 1 and 3)
Roll[Deg]	Float	Roll angle, average from one interval, one tilt measurement per ping. Roll is the rotation angle around the y-axis of the sensor (same axis as transducer 4 and 2)
Std Dev Pitch[Deg]	Float	Standard deviation Pitch from all values of the pitch in the interval. Indicates if the sensor is moving around with variable tilt during the measurement interval.
Std Dev Roll[Deg]	Float	Standard deviation Roll from all values of the roll in the interval. Indicates if the sensor is moving around with variable tilt during the measurement interval.
Input Voltage[V]	Float	The minimum input voltage measured while charging the capacitor bank. It should normally be >6.0V
Input Current[mA]	Float	The current measured when not charging while awake, averaged.
Memory Used[Bytes]	Integer	Used heap memory.

Table 6-5: Sensor parameter details and explanation

6.9 Help command output

Commands:

Do_SUBCMD<CRLF>	= Execute SUBCMD
Get_PROPERTY<CRLF>	= Output PROPERTY value.
Get_All<CRLF>	= Output all property values.
Get_All Parameters<CRLF>	= Output all parameter values.
Set_PROPERTY(V,..V)<CRLF>	= Set PROPERTY to V,..V.
Set_Passkey(V)<CRLF>	= Set Passkey.
Save<CRLF>	= Store current settings.
Load<CRLF>	= Load stored settings.
Reset<CRLF>	= Reset node.
Stop<CRLF>	= Stop measurement
Start<CRLF>	= Start measurement
Help<CRLF>	= Print help information.

Sub commands:

Sample
Output
Set Clock
Get Clock

Argument list for enumerated properties:

Wave Height Unit:	Metric [m], Imperial [Feet]
Interface:	RS232
Baudrate:	4800,9600,57600,115200
Flow Control:	None,Xon/Xoff
Comm Timeout:	Always On,10 s,20 s,30 s,1 min,2 min,5 min,10 min
Compass Type:	HSC100 NMEA,Generic NMEA
Compass Sample Average Number:	4,8,16,32,64,128
Processing Time Output:	Off,Output
FE State Parameters Output:	Off,Output
HW State Parameter Output:	Off,Output
Mode:	AiCaP,Smart Sensor Terminal,AADI Real-Time,AIS Output
Wave Integration Time:	5 min,10 min,15 min,20 min,25 min,30 min,35 min,40 min,45 min,50 min,55 min,1 hour
Time Series Record Length:	5 min,10 min,15 min,20 min,25 min,30 min,35 min,40 min,45 min,50 min,55 min,1 hour
Mean Spreading Angle Output:	Off,Output
First Order Spread Output:	Off,Output
Long Crestedness Output:	Off,Output
Energy Spectrum Output:	Off,Output
Directional Spectrum Output:	Off,Output
Principal Dir Spectrum Output:	Off,Output
Orbital Ratio Spectrum Output:	Off,Output
Fourier Coeff Spectrum Output:	Off,Output
Wave Peak Dir Wind Output:	Off,Output
Wave Peak Dir Swell Output:	Off,Output
Wave Mean Dir Output:	Off,Output
Wave Height Wind Hm0 Output:	Off,Output
Wave Height Swell Hm0 Output:	Off,Output
Wave Height Hmax Output:	Off,Output
Wave Height Max Trough Output:	Off,Output
Wave Height Max Crest Output:	Off,Output

Wave Period Tmax Output:	Off,Output
Wave Mean Period Tz Output:	Off,Output
Wave Height H1/3 Output:	Off,Output
Wave Height H1/10 Output:	Off,Output
Wave Height H1/1 Output:	Off,Output
Wave Mean Period T1/3 Output:	Off,Output
Wave Mean Period T1/10 Output:	Off,Output
Heave Vert. Time Series Output:	Off,Output
Heave Hor. Time Series Output:	Off,Output
Wave Mean Period Tm02 Output:	Off,Output
Wave Peak Period Wind Output:	Off,Output
Wave Peak Period Swell Output:	Off,Output
Heading Output:	Off,Output
External Heading Output:	Off,Output
Pitch and Roll Output:	Off,Output
System Parameters Output:	Off,Output
Interval:	10 sec,20 sec,30 sec,1 min,2 min,3 min,5 min,6 min,10 min,15 min,20 min,30 min,1 hour,2 hour,3 hour

6.10 Example 4: Even more compact output, text off and decimal format

//Press Enter to start communicating with the sensor.
↵ //press Enter
Stop ↵// Stop current measurement. Wait for ack #. Repeat if necessary.
Set Passkey(1) ↵//wait for ack #
Set Enable Text(No) ↵//wait for ack #
Set Enable Decimalformat(Yes) ↵//wait for ack #
Save ↵// wait for ack #
Reset ↵// the sensor will restart with new settings

When you turn off text you also turn off the ***StartupInfo*** so this example gives an output without start up message and the parameter names also disappears; refer ***Figure 6-8***. The orders of parameters will be the same as in Example 1 before we turned of thr text,

```
File   Edit   Setup   Control   Window   Help
reset
#
%5729  50  0.00  0.00    0.00   0.00  0.00  0.00   11.74  -0.59  0.93  10.67  0.30  16.71
5729   50  0.06  91.05   28.44  0.01  0.06  31.00  11.62  -0.61  0.85  7.56   0.00  11.86
5729   50  0.04  351.15  28.44  0.01  0.04  31.00  11.50  -0.63  0.76  0.18   0.00  0.52
```

Figure 6-6: Example 2 showing output message with text off and decimal format

CHAPTER 7 Use of External Compass

7.1 General information

An important input parameter for calculation of wave parameters is the heading information. If the magnetic distortion at the location where the sensor is to be installed is too large the heading should be provided by an external compass placed at an undistorted location, for instance in the mast.

In a system with SmartGuard logger the external compass can be connected directly to the logger or directly to the wave sensor:

- External compass connected directly to sensor:
  - The wave sensor has a separate connector for connection of external compass. When properly configured the sensor will power up the external compass and receive heading information at preset intervals. Refer to chapter 3.10.5 when controlled via logger or chapter 4.8.5, when used as stand-alone sensor, for detailed information on how to configure the sensor for connection of external compass.
  - A special configuration option is provided for the HSC100 compass from Digital Yacht. By using this option no setup of the compass itself will be required.
  - When an external compass is connected directly to the sensor and the wave sensor is connected to SmartGuard via AiCaP bus the external compass heading information can be distributed to other AiCaP sensors in the system.

- External compass reading input from SmartGuard.
  - In cases where the buoy is equipped with sensors giving heading information directly to the logger the heading information can be distributed by the logger to other sensors connected to the AiCaP bus. This feature enables the wave sensor to receive heading information from other connected sensor in the system via SmartGuard or SeaGuardII.

When using an external compass the orientation angle between the wave sensor and the compass must be taken into account. This angle must be set in the ***Ext Compass Alignment Offset (Deg.M)*** - property in the sensor configuration. By default this is set to zero which means that if the external compass can be aligned to the orientation arrow of the wave sensor the direction will be correct. A self-leveling crossline laser might be a god tool for aligning the two sensors. If the installation does not allow for alignment, the angle between the sensors should be measured and the ***External Compass Offset*** updated accordingly.

For cable assembly refer to chapter 10.2 in this document.

7.2 External compass types

7.2.1 HSC 100-NMEA

- Digital Yacht HSC100 Compass sensor

Figure 7-1: Digital Yacht HSC100

- Mounting Bracket:
  - Included in delivery of compass sensor.

- Connecting cable:
  - Supplied with a 15-meter cable.
  - Link cable between SmartGuard serial port and sensor cable.

- Data output (RS-232):
  - NMEA0183 sentence 'HDG' (Magnetic Heading).
  - Baud rate: 4800 , 8N1

7.2.2 Airmar H2183

- Airmar H2183 Heading sensor

Figure 7-2: Airmar H2183

- Mounting Bracket:
  - Included in delivery of compass sensor.

- Connecting cable:
  - Cable between Sensor and SmartGuard included
  - 5855 Cable from Motus with free-end to be used with included sensor cable
  - 5868 cable between sensor and Motus

- Data output (RS-232):
  - NMEA HDG
  - Baud rate: 4800 , 8N1

7.3 Input format for external compass

$HC**HDG**

Summary
NMEA 0183 standard Heading, Deviation and Variation.
Syntax
$HCHDG,<1>,<2>,<3>,<4>,<5>*hh<CR><LF>
Fields
<1> Magnetic sensor heading, degrees, to the nearest 0.1 degree.
<2> Magnetic deviation, degrees east or west, to the nearest 0.1 degree.
<3> E if field <2> is degrees East
W if field <2> is degrees West
<4> Magnetic variation, degrees east or west, to the nearest 0.1 degree.
<5> E if field <4> is degrees East
W if field <4> is degrees West

$HC**HDT**

Summary
NMEA 0183 standard Heading relative to True North
Syntax
$HCHDT,<1>,<2>*hh<CR><LF>
Fields
<1> Heading relative to True North
<2> T = True

$HC**HDM**

Summary
NMEA 0183 standard Heading in degrees Magnetic derived from the true heading calculated
$HCHDM,<1>,<2>*hh<CR><LF>
Fields
<1> Current Heading in degrees
<2> M = Magnetic heading

$HC**HCC**

Summary
NMEA 0183 standard Compass Heading , which differs from magnetic heading by the amount of uncorrected magnetic deviation.
$HCHCC,<1>*hh<CR><LF>
Fields
<1> Compass Heading in degrees

$GP**HDT**

Summary
NMEA 0183 standard Heading relative to True North
Syntax
$HCHDT,<1>,<2>*hh<CR><LF>
Fields
<1> Heading relative to True North
<2> T = True

$GP**HDM**

Summary
NMEA 0183 standard Heading in degrees Magnetic derived from the true heading calculated
$HCHDM,<1>,<2>*hh<CR><LF>
Fields
<1> Current Heading in degrees
<2> M = Magnetic heading

CHAPTER 8 Electro Magnetic Compatibility and Cables

In order for a manufacturer to legally produce and sell a product, it has to apply for CE marking. This means that the commercialized product is conform to the CE applicable standards and can freely circulate within the EFTA (European Free Trade Association) & European Union countries. The applicable directive for the Motus wave sensor is the EU EMC 89/336/EMC (all electrical and electronic appliances) which mainly focus on the electromagnetic disturbances the sensor can generate, which should not exceed a level allowing radio and telecommunication equipment to operate as intended, and that the sensor has an adequate level of intrinsic immunity to electromagnetic disturbance to be able to operate as intended.

This chapter describes the requirements for the Electromagnetic Compatibility (EMC) of the sensor. . And also addresses the different cables available for use with the sensor.

8.1 EMC Testing

The Motus wave sensor has been tested at an accredited test laboratory to verify that the sensor fulfils the requirements in the EU EMC directive (89/336/EMC).

Applied standards

- EN 55011 (2009)+A1
- EN 61326-1 (2013)

Applied tests

- Conducted Emissions
- Electrostatic Discharge Immunity
- Surge Immunity
- Conducted RF Disturbance Immunity

8.2 Cables

Different cables are available for stand-alone use with free end and connectors. The cables have both power and signal lines RS-232. See chapter 10.2 for more information on cables that is best suited for use in the actual application. When delivered, system drawings/cable drawings give details on parts connection and installation overview with best EMC performance (best noise and surge immunity).

8.3 Power – Voltage range

The input voltage range is from 6 to 30Vdc. When using long cables the voltage should be as close to 30V as possible. The peak current while the sensor is measuring (after power on) is normally well below, but it varies dependent on how high the input voltage is and how large the voltage drop is in the cable (lower voltage on the sensor gives higher peak current).

CHAPTER 9 Maintenance

With 50 years of instruments design and production for the scientific community, in use around the world, you can count on our reputation for designing the most reliable products available.

We are guided by three underlying principles: quality, service, and commitment. We take these principles seriously, as they form the foundation upon which we provide lasting value to our customers. Our unmatched quality is based on a relentless program of continuous monitoring to maintain the highest standards of reliability.

9.1 General

In order to assure the quality of this sensor, critical properties are tested during production. A special form, named 'Test and Specification Sheet' (delivered with the sensor) lists the tests and their results and checkpoints.

As this sensor is normally installed above water and inside cabinets it requires very little maintenance. Only cleaning and check of mounting brackets connectors and cables should be necessary.

9.2 Retrieval of the sensor

Clean the Sensor after each deployment if necessary.

The sensor housing will tolerate most cleaning agents. Often 30% Hydrochloric acid (HCL) (Muriatic acid) or acetic acid will be useful for removing barnacles and similar fouling.

Be sure to follow the safety precaution for such acids.

When removing or disconnecting the sensor from attached cables always protect connectors on sensor and cables with appropriate dummy plugs. Always apply grease on connectors and sealing plugs if earlier applied grease is dried out.

Figure 9-1: Grease for Subconn plug

9.3 Factory service

Factory service is offered for maintenance, repair or calibration.

Before returning the sensors to factory please contact Aanderaa.support@xyleminc.com for a RMA number and needed paper.

When returning Motus Wave Sensor, always include the Instrument Service Order, Form No. 135 following the RMA request or see our web pages under ‘Support and Training’.

Normal servicing time is four to six weeks, but in special cases the service time can be reduced.

A main overhaul and service is recommended at the factory every three years

9.4 Status Codes

The sensor produces some status codes if there are some errors with the sensor or with the quality of collected data. These status codes are either shown in the data string or when using post-processing software. Each status code has both a hexadecimal value and a decimal value shown in table below. The status codes are separated in three groups. ***Ok*** is when everything is normal and this status code will not be visible. An ***Error*** status code is critical state and requires normally a service and repair on the sensor. ***Warnings*** are more temporary errors that may reduce the data quality for a shorter period and normally don’t need a factory service but it still important to investigate and remove the cause.

OK

Parameter	***Hex value***	***Status Code***	***Description***
Ok	0	0	Ok

Errors

Parameter	***Hex value***	***Status Code***	***Description***
InvalidVectorError	41	65	Internal use only
AccessError	42	66	Access error
RequestTimeError	43	67	Input time is shorter than the processing time
NotValidError	44	68	Some internal fails
CopyDataError	45	69	Recorder error

Warnings

Parameter	***Hex value***	***Status Code***	***Description***
OutOfMeasureRange	51	81	Data outside range. The data is not reliable
OutOfCalibRange	52	82	Data Outside Calibration range. The data can be reliable, but out of calibration range
ReducedQuality	53	83	e.g. supply voltage to low
NotReady	54	84	e.g., timeseries is not finish to the first recording
NotImplemented	55	85	Not a valid parameter
StoredDataWarning	56	86	e.g. Storing data that reduce precision
LowQuality	57	87	Indicates lower quality than reduced quality
DiscardData	58	88	Data useless, can be discarded

9.5 Example of Test & Specifications sheet and Certificates

AANDERAA a xylem brand

TEST & SPECIFICATIONS

Form No. 858, February 2017

Program Version: 5.0.1

Product: 5729
Serial No: 2

Visual and Mechanical Checks:

1.1	Soldering quality	☒
1.2	Visual surface	☒
1.3	Galvanic isolation between housing and electronics	☒

Current Drain and Voltages:

2.1	Average Current Drain @ RS232, 2 minute output interval,12V (Max.: 110 mA)	100.0	mA
2.2	Average Current Drain @ AiCaP, 2 minute output interval,12V (Max.: 110 mA)	100.0	mA
2.3	Quiescent Current Drain @ RS232, 12V (Max.: 8000 µA)	6000	µA
2.4	Quiescent Current Drain @ AiCaP, 12V (Max.: 8000 µA)	6000	µA
2.5	DSP IO Voltage, Jx.x. (3.3 ±0.15V)	3.28	V
2.6	DSP Core Voltage, Jx.x(1.8 ±0.05 V)	1.82	V

Performance test:

3.1	Check external compass input function	☒	
3.2	Hm0 @ 1 sec. in final test jig (2.83±0.01m)	2.830	m
3.3	Hm0 @ 5 sec. in final test jig (2.83±0.01m)	2.830	m
3.4	Hm0 @ 30 sec. in final test jig (2.83±0.01m)	2.830	m
3.5	Wave Peek Direction @ 1 sec. in final test jig (yyy°±1°)	180.00	m
3.6	Wave Peek Direction @ 5 sec. in final test jig (yyy°±1°)	180.00	m
3.7	Wave Peek Direction @ 30 sec. in final test jig (yyy°±1°)	180.00	m

Date: 27 Feb 2017 Sign:

Jostein Hovdenes, Product Manager, Sensors

Figure 9-2: Example of Test & Spec. sheet

AANDERAA a xylem brand

CALIBRATION CERTIFICATE

Form No 856, Feb 10th 2020

Certificate no: 5729_114_00172170

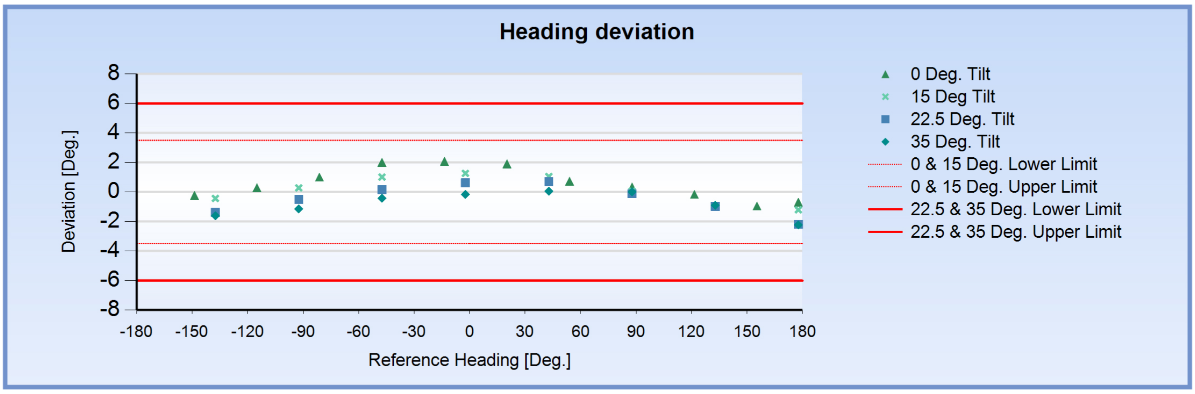
Product: 5729
Calibration date: 25.06.2020

Serial no: Demo
Page 1 of 1

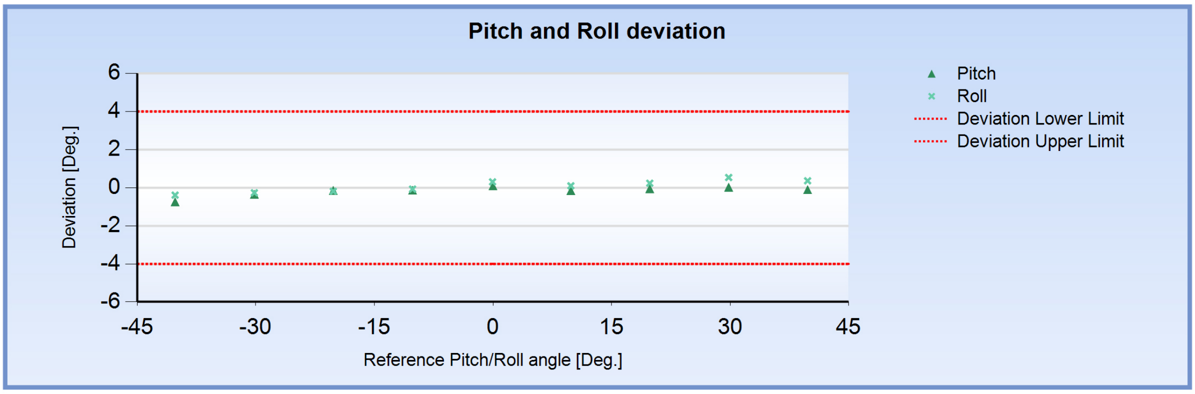
This is to certify that this product has been calibrated and verified using the following reference equipment:

Reference Equipment Description	Serial
HMR3500	13987
Sendix F3653	1412501654
Sendix F3653	1412501655
Sendix F3653	1412501653

Obtained Heading deviation for this product:



Obtained Pitch and Roll deviation for this product:



Date:25.06.2020

Halvard Skurve

Halvard Skurve, Production Engineer

Page 1

Figure 9-3: Example of calibration certificate

CHAPTER 10 Installation

10.1 Mounting Brackets

- Horizontal "Mounting plate" Aanderaa part no: 0975853 included with sensor

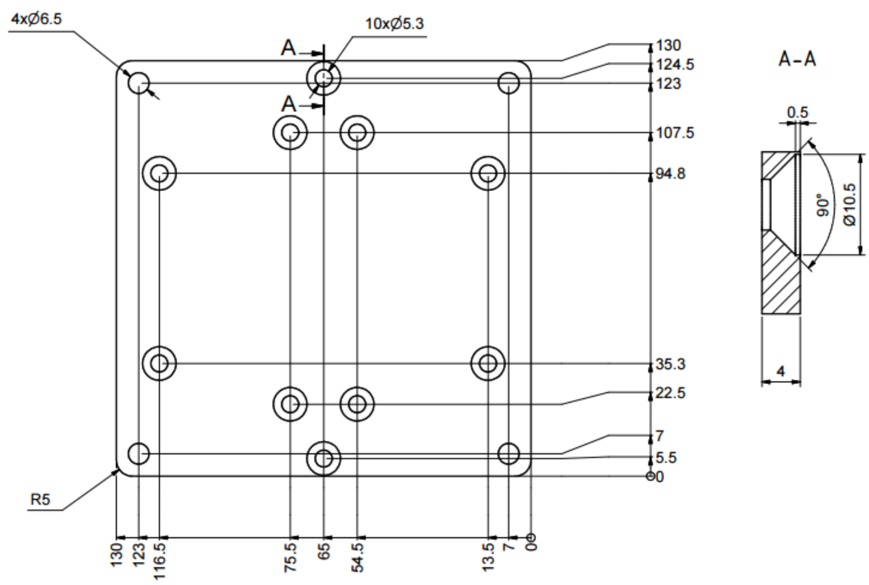


Figure 10-1: Horizontal mounting plate

- Vertical "Wall mount bracket" Aanderaa part no: 0975854, not included

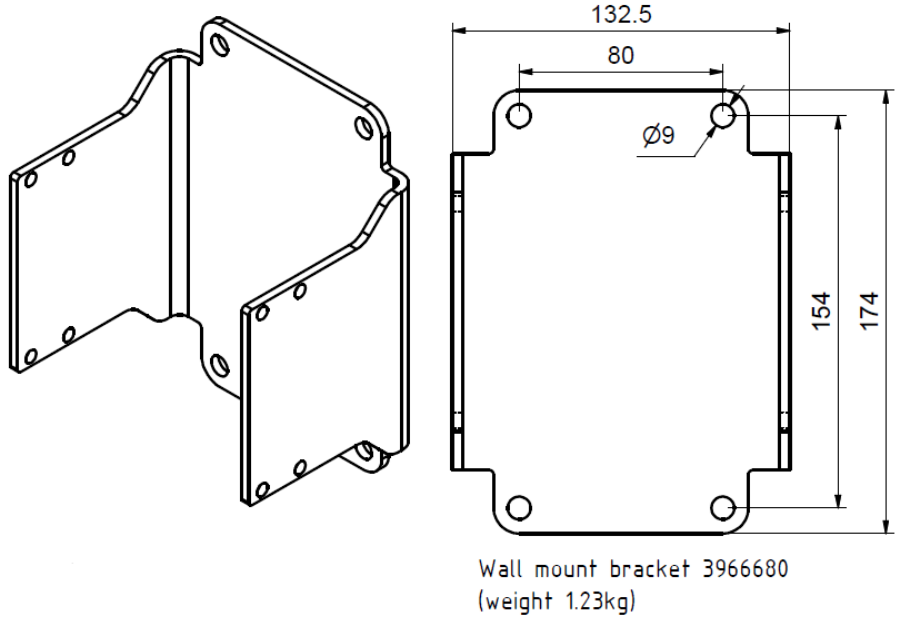


Figure 10-2: Vertical mounting plate

10.2 AADI Real-Time Collector connection with Windows 10

Windows 10 USB to SeaGuard / SmartGuard fixes

Download Windows mobile device center (WMDC) 32 or 64 bit version:

https://support.microsoft.com/en-us/help/931937/description-of-windows-mobile-device-center

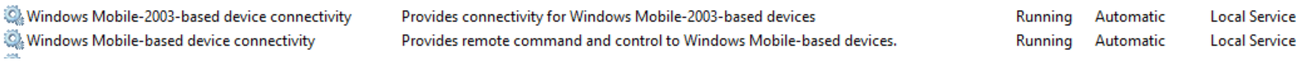
Windows 10 ver. 1703 / 1709

Problem: WMDC (Windows mobile device center) hangs at splash screen

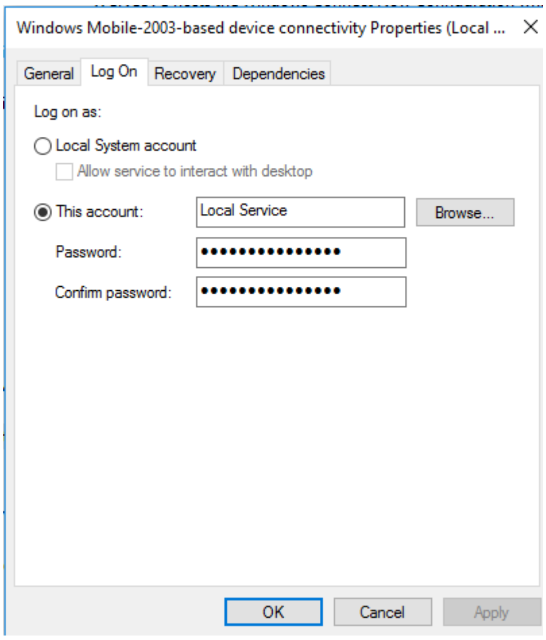
Log on with local administrator privileges

In the search field enter: services

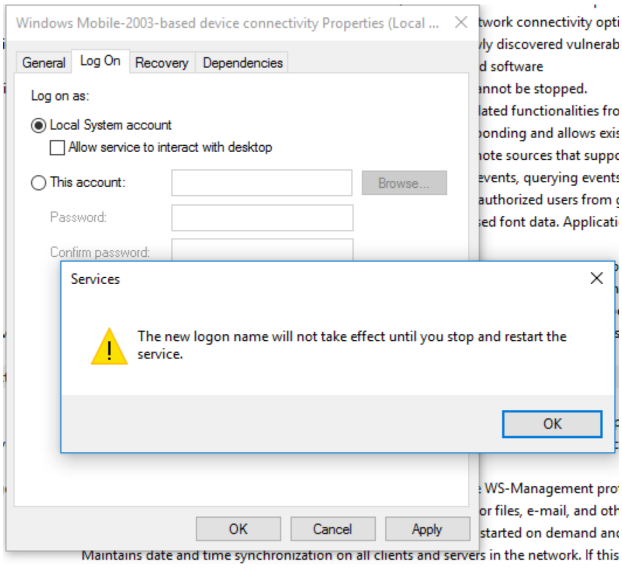
Scroll down to “Windows Mobile-2003-based device connectivity”



Right click and click on properties on the Windows Mobile-2003-based device connectivity



Click on Local System account.



Click ok and ok.

Do the same with Windows Mobile-based device connectivity.

Restart pc and plug in the USB cable from SmartGuard / SeaGuard.

10.3 Connecting Cables

Aanderaa offers a wide range of standard cables; see Table 10-1 for more details.

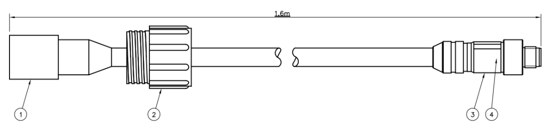
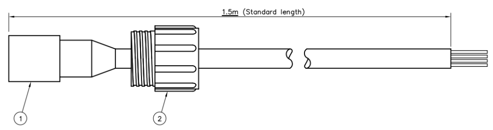
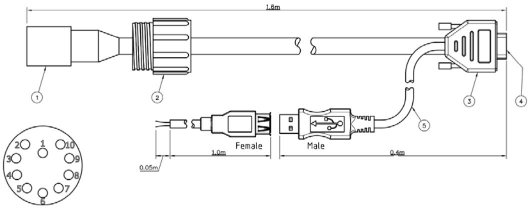
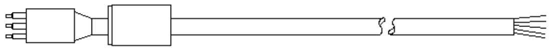
	a) Cable 5835 with connectors • MCIL10F to SmartGuard AiCaP connector (M12) • Length; 5835L=1.5m, 5835F=3m
	b) Cable 5834 with free end • MCIL10F to pre-crimped single wires • Length: 1.5m • Used together with cable glands • Connects to SmartGuard Link cable, AiCaP
	c) Configuration Cable 5789 • MCIL10F to 9pin D-sub female & USB. • Length: 1.6m
	d) Compass cable 5855 with free end • Used together with external "general type compass" • MCIL6M to free end • Length: 0.6m

Table 10-1: Cables

10.4 Mounting considerations EMM 2.0

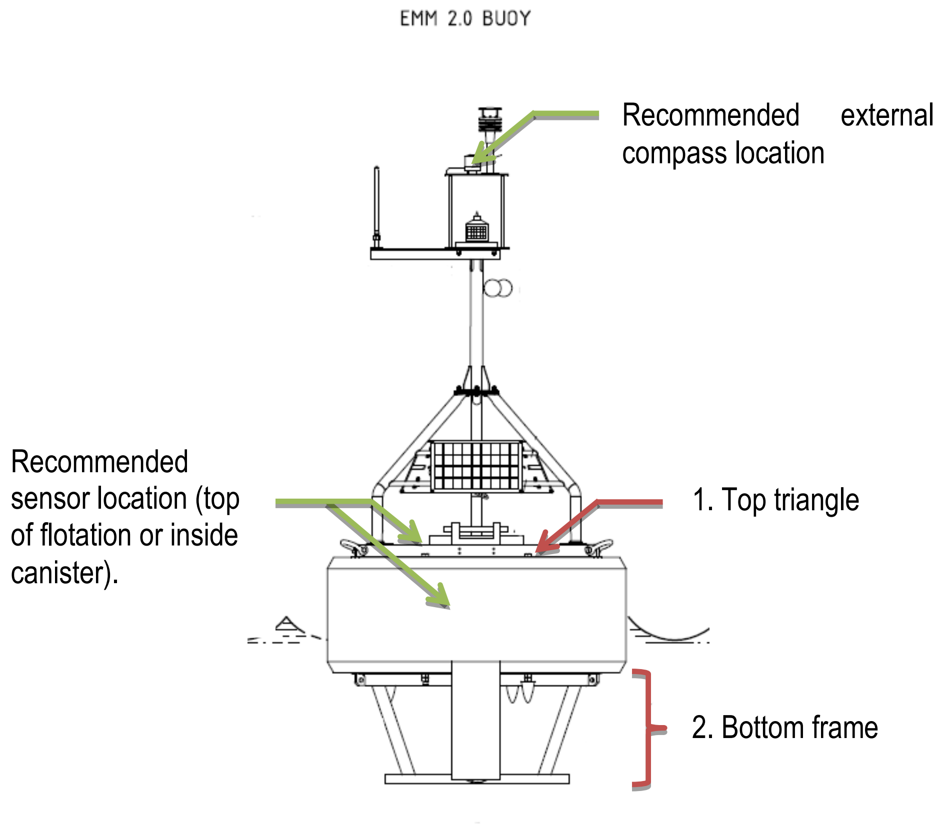


Figure 10-3: Mounting considerations EMM 2.0

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10.4.1 Magnetic distortion areas on EMM 2.0

- Areas around parts made of steel. See figure 5.
    1. Top triangle (hot dip galvanized steel).
    2. Bottom frame (hot dip galvanized steel).
- Due to the magnetic influence from metal parts on a standard EMM 2.0 it is recommended to add an external compass to the sensor or to the system.

- NOTE! After external compass has been mounted avoid mounting magnetic objects in the vicinity of the compass.

10.4.2 Recommended sensor location

- It is difficult to avoid magnetic distortion areas on the lower parts of an EMM 2.0. It is therefore recommended to add an external compass to the system.
- The best location for mounting the sensor is:
    1. As close to the center of the buoy as possible.
    2. As close to the waterline as possible.
        - For buoys with central canister it is recommended to mount the sensor inside the canister.
        - For buoys without central canister the sensor can be fixed to the surface of the buoy flotation.

10.4.3 Connecting cables

- Refer to chapter 10.2 in this document.

10.4.4 Sensor mounting arrangement

- Sensor can be fixed to the surface of the flotation by using the horizontal "Mounting plate" Aanderaa part no: 5853. Drawing DID-51257.

Figure 10-4: Sensor mounted with horizontal mounting plate

10.5 Mounting considerations Motus DB 1750

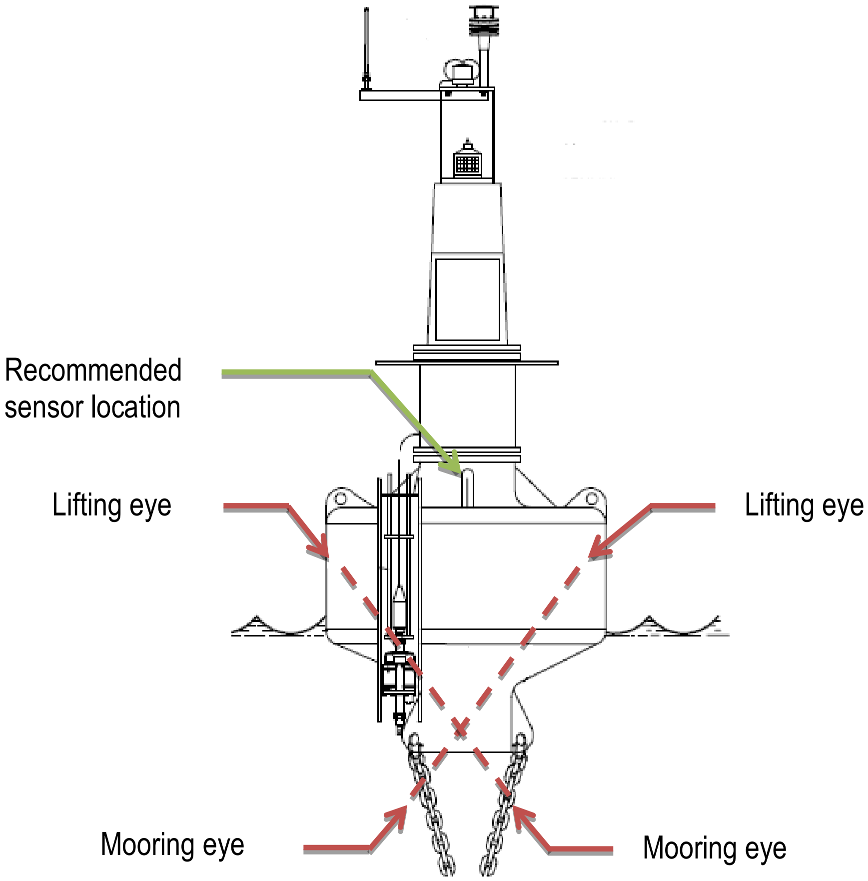

Figure 10-5: Mounting considerations Motus DB1750

10.5.1 Magnetic distortion areas on Motus DB1750

- Areas around parts made of steel. See figure 6. The DB1750 has a float section with internally cross brazed stainless steel rods that are connected to stainless steel bushings in mooring and lifting eyes. The magnetic influence from these parts is very low and will not alone affect the sensors internal compass readings.
- Due to the low magnetic influence from materials in the buoy itself it is normally not necessary to add an external compass to a Motus DB1750 buoy.

- NOTE! After external compass has been mounted avoid mounting magnetic objects in the vicinity of the compass.

10.5.2 Recommended sensor location

- In general the best sensor location is as close as possible to the center of the buoy and as near as possible to the waterline.

- Battery weight and location is important as it will affect the buoy's point of gravity.
  - For new buoys preferred location of batteries is the lower battery tray. Preferred sensor location is just above the batteries (see figure 10).
  - For existing buoys where the battery tray is positioned higher it is recommended to use only one lead acid battery. As an option two "light weight" lithium–ion batteries can be used. Preferred sensor location is in the center just below the battery tray (see figure 11).

10.5.3 Connecting cables

- Refer to chapter 10.2 in this document.

10.6 Sensor mounting arrangement

- Using the horizontal "Mounting plate" Aanderaa part no: 5853. Drawing DID-51257 the sensor can be mounted in the center of the buoy.

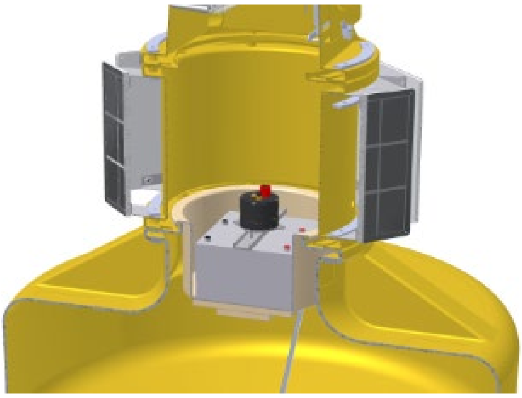

Figure 10-6: Battery and sensor location on new buoys

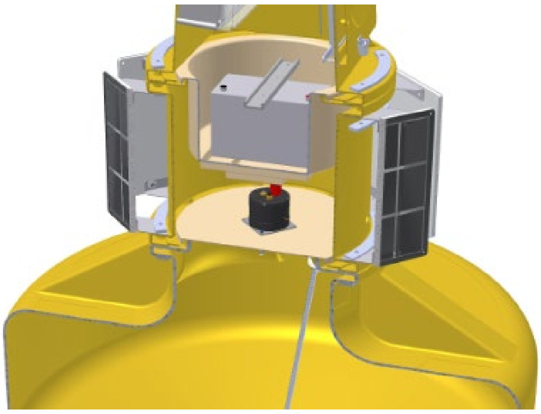

Figure 10-7: Battery and sensor on retrofit buoy

10.7 Mooring

10.7.1 General mooring information

Traditionally navigation buoys and data buoys not equipped with wave sensors have been moored with chains or a combination of chains and ropes. These traditional moorings are initially designed to stabilize and limit the buoy motion in waves. When installing a wave sensor on a data buoy, it is important that the mooring does not limit the motion we want to capture. A more flexible mooring is required so that the wave sensor captures the required movements of the buoy fully. To obtain the required flexibility one section of the mooring should consist of a rubber cord.

A typical flexible mooring normally includes these sections:

Section 1:

- Ballast and bridle chain.
- Purpose:
  - Stabilize the buoy vertically.

Section 2:

- Swivel.
- Purpose:
  - Avoid twisting of mooring due to buoy rotation.

Section 3:

- Rubber cord with safety line and short chain.
- Purpose:
  - Enables buoy to follow wave motions.
  - Chain is used to stabilize rubber cord.

Section 4:

- Rope with subsurface flotation and light chain.
- Purpose:
  - Enables slack in the upper part of the mooring enabling the buoy to capture wave motions more accurately.
  - This section is used to adjust the total mooring length.
  - To eliminate tear and wear caused by mooring rubbing against seabed the attached buoyancy lifts the rope and light chain above seabed.

Section 5:

- Sinker and ground chain
- Purpose:
  - Make a robust connection between the mooring and the bottom weight.
  - Keep the buoy positioned in its originally deployed location.

10.7.2 Mooring example EMM 2.0

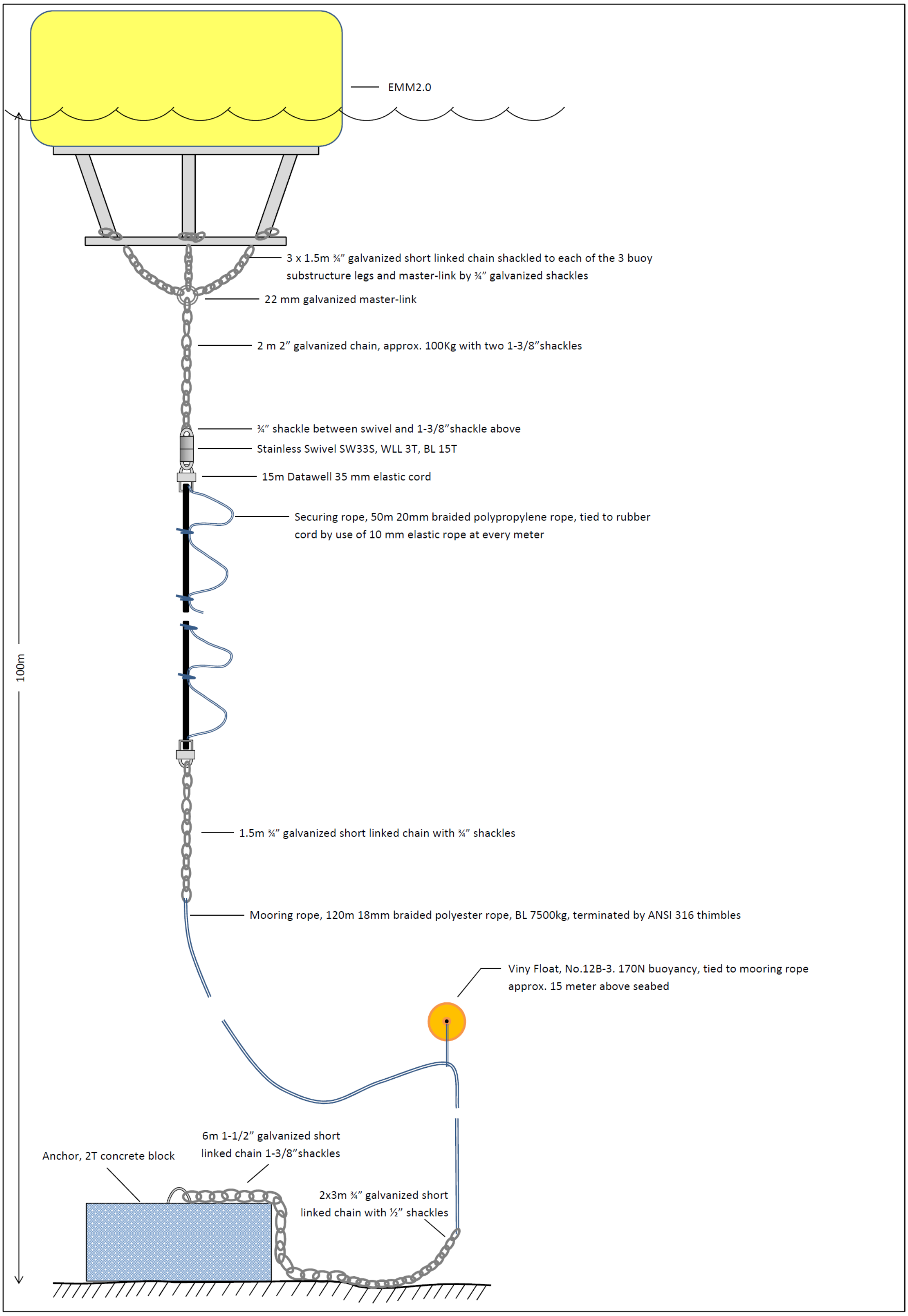

Figure 10-8: General mooring example with EMM 2.0 based on 100m water depth

10.8 Mooring Example Motus DB 1750

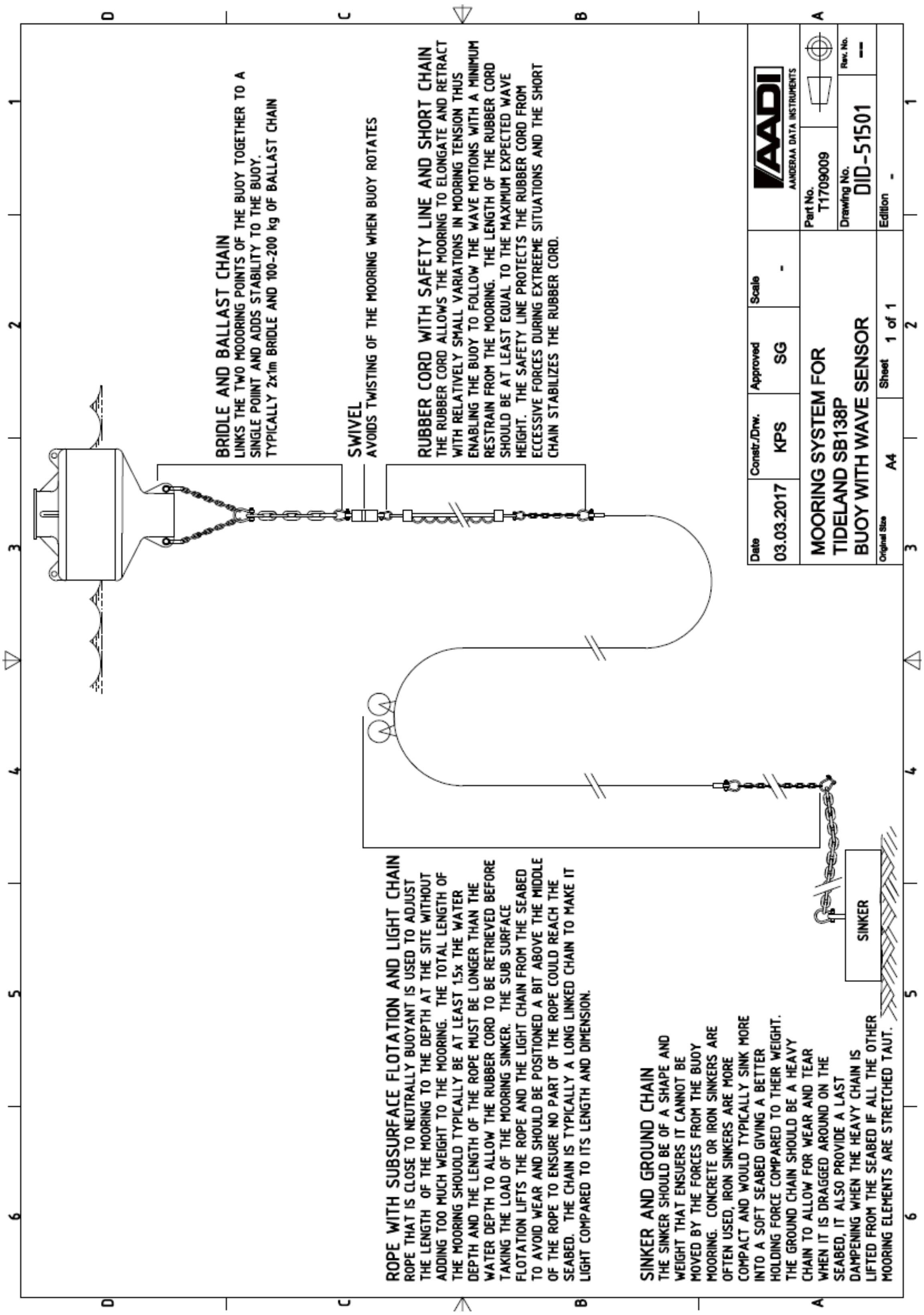

Figure 10-9: General mooring example with Motus DB 1750based on 100m water depth

10.8.1 Mooring component example for Motus DB 1750

Section	Description	QTY
1	Shackle AJ 852 MBL 90t w/NUT. 32-32-82mm	2
1	Chain LL GR80 16mm. Galvanized 4,3kg/m	2x2m
1	Shackle AJ 852 MBL 40t w/NUT. 22-25-52mm	1
1	Chain GR80 32mm. 23kg/m	4m
1	Shackle AJ 852 MBL 28t w/NUT, 19-22-44mm	1
2	Swivel	1
2	Shackle AJ 855 SWL 3.25t w/NUT. 16-19-27mm	2
3	Rubber cord ø35mm w/securing rope	20m
3	Shackle AJ 852 MBL 28t w/NUT, 19-22-44mm	1
3	Chain LL GR80 16mm. Galvanized 4,3kg/m	2m
3	Shackle AJ 852 MBL 28t w/NUT, 19-22-44mm	1
4	Tube Thimble G824K 316	2
4	Nylon rope 20mm BS8300	(m)
4	Float, Atlantic 280mm CH400	2
4	Chain LL GR80 16mm, galvanized 4.3kg/m	12m
4	Shackle AJ 852 MBL 28t w/NUT, 19-22-44mm	1
5	Chain GR80 32mm 23kg/m	6m
5	Shackle AJ 852 MBL 40t w/NUT. 22-25-52mm	1
5	3t sinker	1

Figure 10-10: Partlist for Motus DB 1750 mooring example

10.9 Application examples

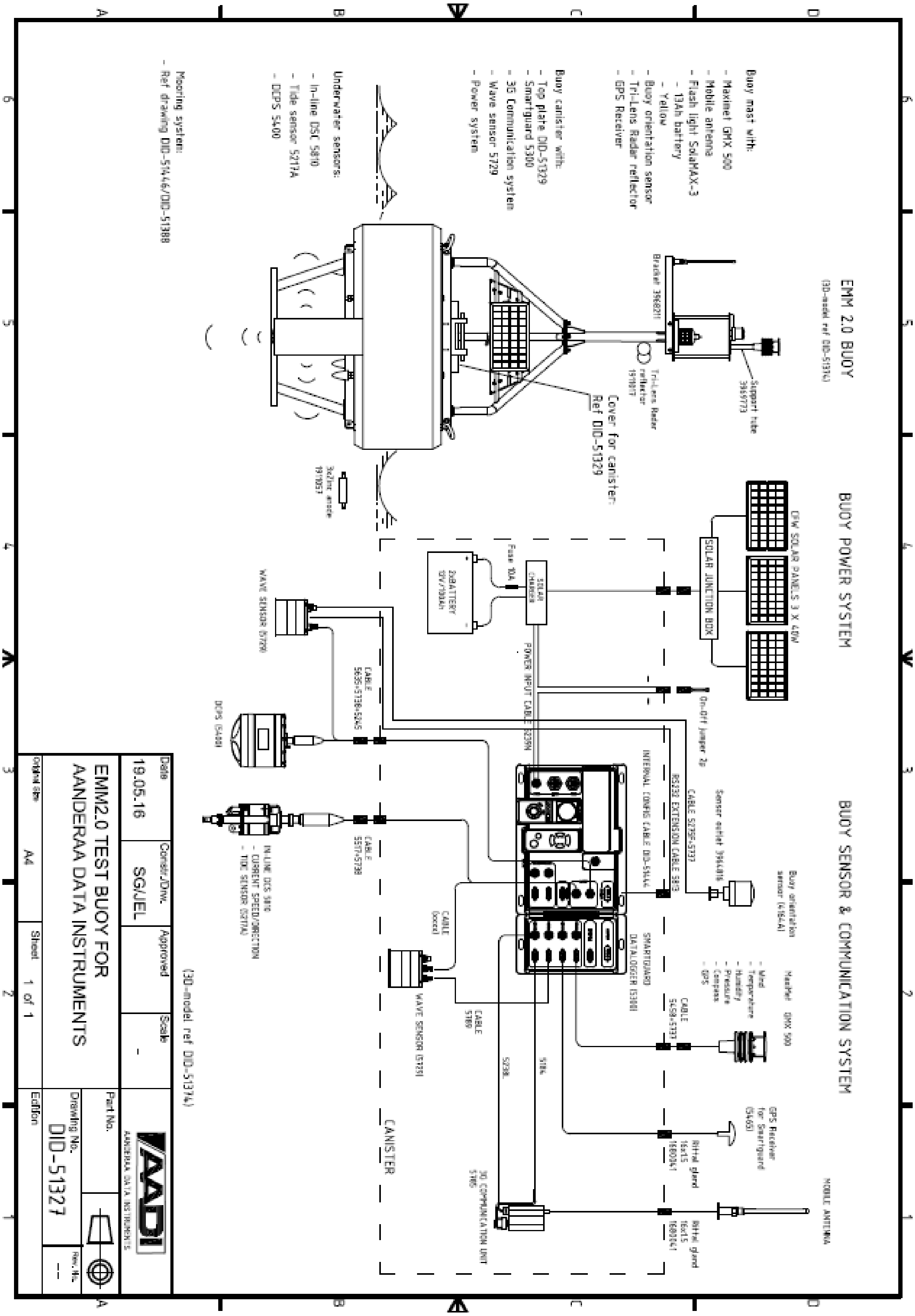

Figure 10-11: EMM 2.0 buoy with sensors and communication

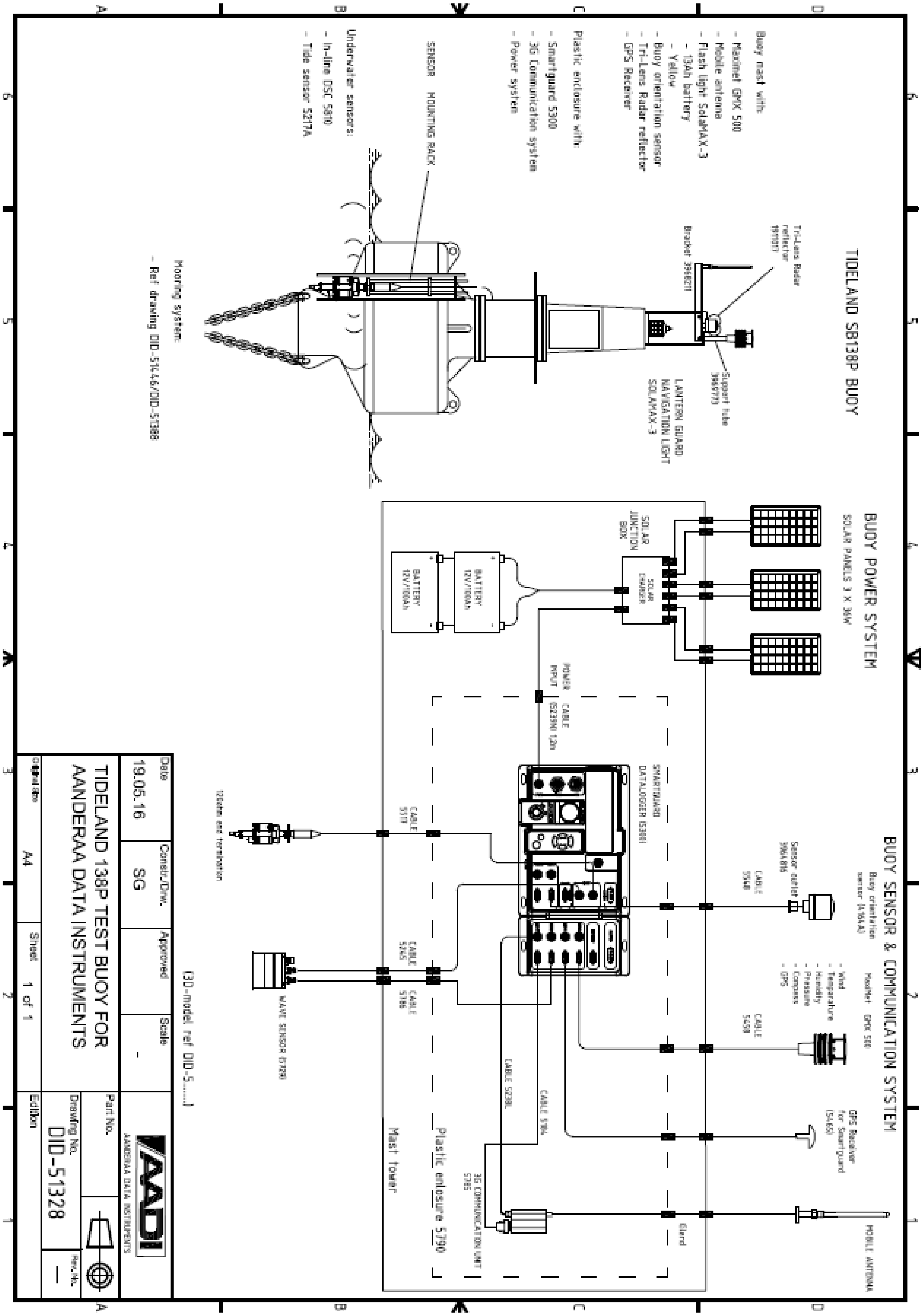

Figure 10-12: Motus DB 1750 buoy with sensors and communication

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