ISA200, ISA500 & ISA500 11K

Underwater Altimeter & Echosounder

Installation & Operation Manual

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1.0 Introduction

The ISA200, ISA500 & ISA500 11K provide exceptionally accurate and long-range underwater distance measurement capability. Each can also optionally provide Heading, Pitch & Roll readings.

Designed to measure distance to the seabed (as an underwater Altimeter) the ISA200, ISA500 & ISA500 11K can also be used in a number of underwater applications where a distance requires to be measured or monitored.

Optionally each sensor can be provided with ECHOGRAM capability. ECHOGRAM enables sonar backscatter data for each ping to be shown. This is ideal for hydrographic survey operations.

Utilising a broadband composite transducer and advanced digital signal processing techniques enables the ISA500 & ISA500 11K to achieve long range capability with a high degree of accuracy and stability. Ranges in excess of 120 meters are achievable as are 1mm accuracy range measurements. The ISA200 utilises a monolithic transducer with a range in excess of 250 meters.

The availability of heading, pitch and roll provides the capability to clearly understand the orientation of the sensor at all times. This can also be used to automatically correct slant range readings; providing a true altitude measurement in all dynamic conditions. Alternatively, these sensor readings can be used for navigation purposes of a ROV, AUV or other underwater items.

Enclosed in compact titanium or lightweight acetal housings, the ISA200 & ISA500 are offered in both forward looking and right angle configurations, ensuring they are not only at the forefront of sensor technology, but are available in a configuration that suit any underwater distance measurement application. The ISA500 11K, available exclusively in titanium and forward looking configuration, is an ideal and robust option for use at full ocean depths (to 11,000 meters).

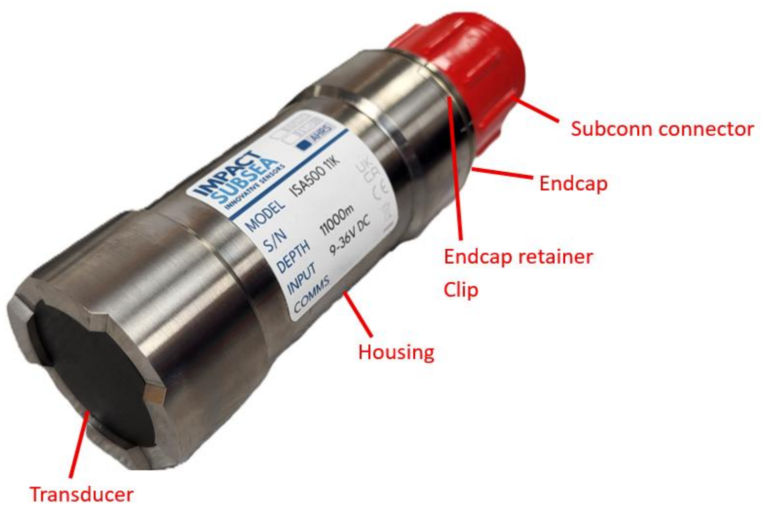
ISA200/ISA500 (Forward Looking, Titanium), ISA500 11K (Forward Looking, Titanium), ISA200/ISA500 (Right Angle, Acetal)

2.0 Specification

2.1 Overview

ISA200/ISA500 Forward Looking, Titanium Housing

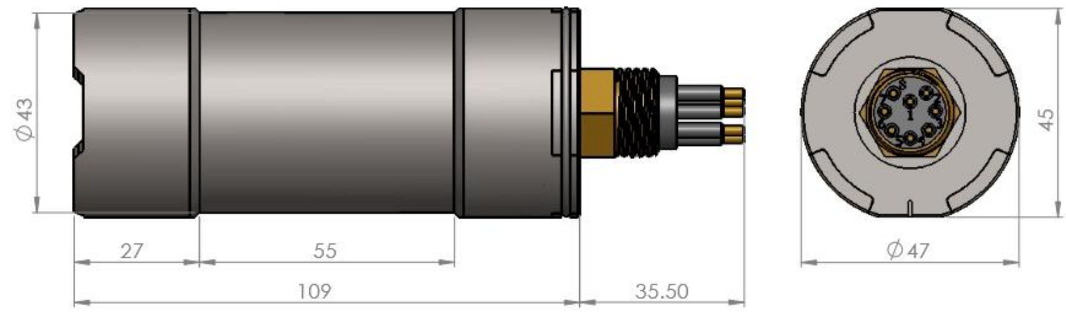
ISA200/ISA500 Right Angle, Acetal Housing



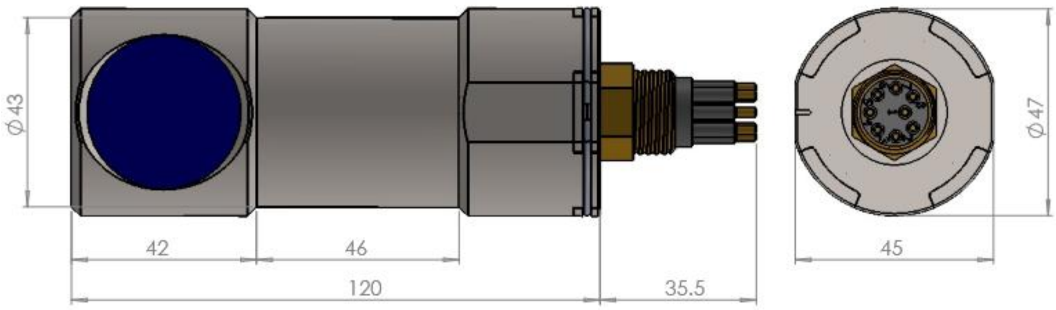
ISA500 11K, Forward Looking, Titanium Housing

2.2 Dimensions

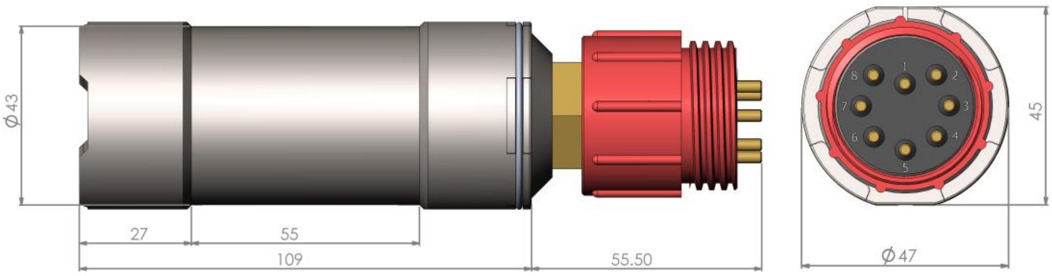
2.2.1 ISA200/ISA500 Forward Looking Housing



2.2.2 ISA200/ISA500 Right Angle Housing



2.2.3 ISA500 11K Forward Looking Housing



All dimensions given in mm.

2.3 Acoustic

Acoustic – ISA500 & ISA500 11K	
Frequency	500kHz Standard *(400 to 600kHz Definable)*
Range	0.1 to 120m+ (Maximum range dependant on seabed type: Ranges in excess of 175 meters are achievable with a strong acoustic reflector)
Accuracy & Resolution	1mm
Beam Angle	6° conical at 500kHz
Signalling	Monotonic
Pulse Length	User Defined

Acoustic – ISA200	
Frequency	200kHz
Range	0.2 to 250m+ (Maximum range dependant on seabed type: Ranges in excess of 250 meters are achievable with a strong acoustic reflector)
Accuracy & Resolution	1mm
Beam Angle	15.2° conical at 200kHz
Signalling	Monotonic
Pulse Length	User Defined

2.4 Heading, Attitude & Temperature

Heading	
Accuracy	± 1° of local magnetic north
Resolution	0.1°
Attitude	
Pitch Range	± 90°
Roll Range	± 180°
Accuracy	0.2°
Resolution	0.1°

2.5 Communications & Power

Communications & Power	
Digital	RS232 & RS485
Protocol	4800 to 115200 baud
Analogue	0 to 5 V DC or 0 to 10V DC or 4-20mA*
Data	Continuous or on demand
Data/Ping Rate	Up to 100Hz
Input Voltage	9 to 36V DC
Power (No Altitude)	26mA @ 24V DC
Power (With Altitude)	52mA @ 24V DC **
*** Not available in all ISA500 Altimeters – check at time of ordering** **** 100% Tx power, 10Hz update rate**	

2.6 Physical

		ISA200		**ISA500**		**ISA500 11K**
Housing material		**Titanium**	**Acetal**	**Titanium**	**Acetal**	**Titanium**
Weight (Air/Water)	F/L:	0.525/0.37kg	0.3/0.1kg	0.5/0.325kg	0.3/0.11kg	0.62/0.41kg
	R/A:	0.545/0.37kg	0.3/0.125kg	0.52/0.35kg	0.325/0.125kg	N/A
Depth rating		6,000 meters	1,000 meters	6,000 meters	1,000 meters	11,000 meters
Temperature rating	Operating:	-10 to 40°C				
	Storage:	-20 to 60°C				
Connector		Subconn MCBH8M-SS fitted as standard		Subconn MCBH8M-SS fitted as standard		Subconn BH8M-SS fitted as standard

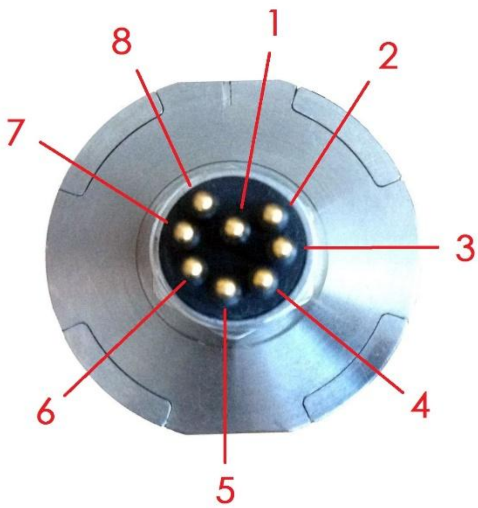
3.0 Installation

3.1 Electrical Installation

The ISA200 & ISA500 are fitted with a SubConn MCBH8M-SS connector as standard. This will mate to a SubConn MCIL8F connector/cable assembly. The ISA500 11K is fitted with a Subconn BH8M-SS connector as standard. This will mate to a Subconn IL8F connector/cable assembly. Other connector options for all are available upon request.

3.1.1 Connector Pin Out

The standard connector pin out is provided below and applies to both SubConn MCBH8M-SS and Subconn BH8M-SS connectors:



Male Connector on ISA200 & ISA500 Sensor

Male connector on ISA500 11K sensor

Pin	Function	Mating Wire Colour
1	0VDC	Black
2	9-36VDC	White
3	Analogue Out	Red
4	0V Analogue	Green
5	0V Digital	Orange
6	Trigger	Blue
7	RS232 TX & RS485 A+	White/Black
8	RS232 RX & RS485 B-	Red/Black

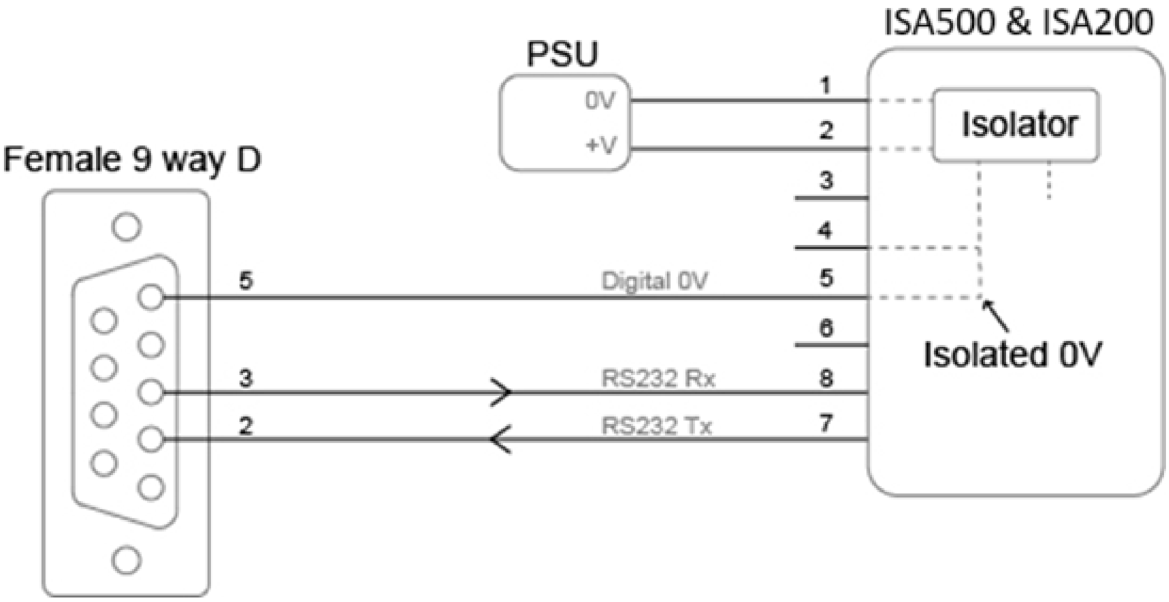
3.1.2 Power

The ISA200, ISA500 & ISA500 11K are polarity protected and fused with a 400mA resettable poly fuse. Internal circuitry isolates the supply from the outside environment requiring the serial interface, TTL trigger and analogue output to use the digital and analogue 0V reference pin.

3.1.3 Serial Interface

The RS232 and RS485 interfaces are isolated from the supply and has in-line fused protection on the serial lines. A prolonged transient voltage on these lines will blow the surface mount fuses which will require replacement by Impact Subsea or an approved distributor.

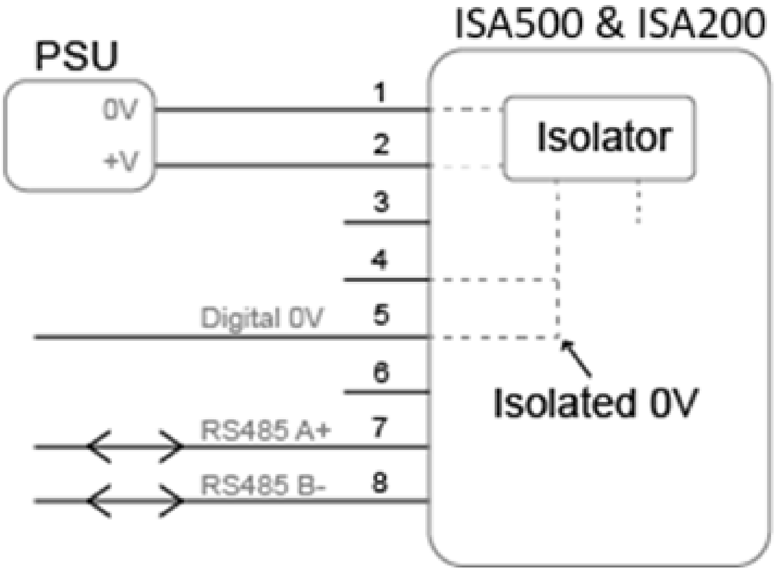
3.1.4 RS232 Wiring



Note: RS232 will not function if the digital 0V pin is not used as the RS232 ground.

3.1.5 RS485 Wiring

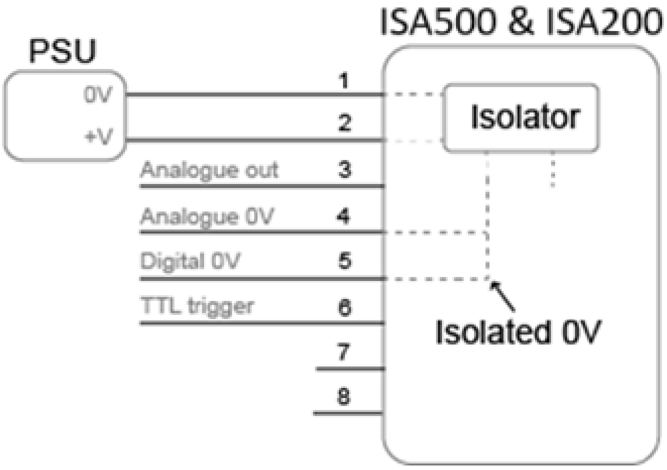
The RS485 termination resistor is software selectable.



Note: The digital 0V must be connected on an RS485 interfaces, otherwise the voltage potential between one of the A+ or B- lines to ground could reach a damaging level

3.1.6 *Analogue Out and TTL Trigger*

The Analogue interface can be configured to output voltage or current (current option is not available on all ISA500 & ISA500 11K sensors). It is isolated from the supply and has in-line fused protection. A prolonged transient voltage on this line will blow the surface mount fuses which will require replacement by Impact Subsea or an approved distributor.



The TTL input can be used to trigger a ping, update the analogue output and transmit the user selected serial string. These events can happen when the trigger is connected to digital 0V or disconnected, the software allows the user to choose.

The trigger input has been designed to work with volt free contact relays, buttons and also a switching voltage from 0V to at least 3.3V or to a maximum of 10V (to support legacy TTL 0V-5V).

Internally the trigger input is pulled up to 3.3V with reference to pin 5 (digital 0V) and just requires grounding to pin 5 to trigger.

Note pin 5 (digital 0V) is isolated from pin 1 (0V power).

If the driving electronics shares the same pin 5 ground, then it can be driven with an open collector / open drain or push pull output as the input is tolerant to 10V.

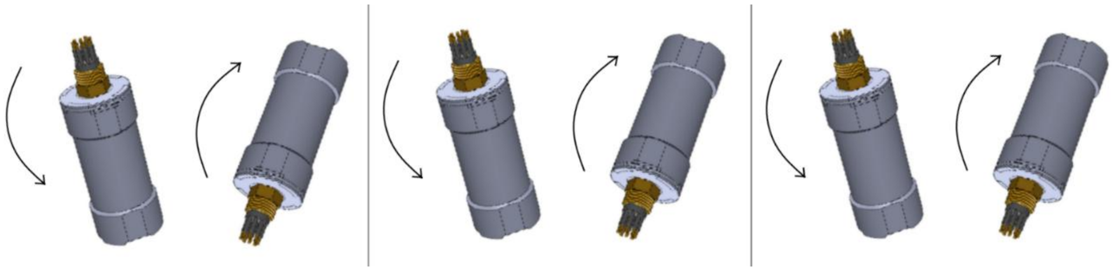
If using a relay, switch or open collector / open drain to connect the tigger input to pin 5 then it must be able to sink 350µA, which should pose no problem at all.

If using a push pull output then it must be able to sink 350µA and source 2mA @ 5V or 8mA @ 10V.

From seaView you can select the setting so that it pings on connection (falling edge) or disconnection (rising edge) to pin 5.

3.1.7 Establishing Communications

If the ISA500, ISA500 11K or ISA200 is tilted from vertical to upside down 3 times within the first 10 seconds of applying power then it will **temporarily** configure the serial interface to (**RS232, 9600, N81**) and output an ASCII message displaying the settings.



Note: When the device is power cycled the serial interface setting will revert back to the last saved configuration.

All ISA200 sensors and ISA500 & ISA500 11K sensors which have firmware V3 and above can also be configured to **RS485, 9600, N81**. This is done by inverting the sensor 6 times, starting within the first 10 seconds of applying power.

3.1.8 Connector Mating

When mating the cable to the SubConn connector, to maximise the life of the connector, it is important to observe the following:

- Always apply grease before mating. Molykote 44 Medium grease must be used.
- Disconnect by pulling straight, not at an angle.
- Do not pull on the cable and avoid sharp bends at cable entry.
- Do not over-tighten the bulkhead nut.

Do not expose the connector to extended periods of heat or direct sunlight. If a connector becomes very dry, it should be soaked in fresh water before use

3.1.9 Connector Cleaning

General cleaning and removal of any accumulated sand or mud on a connector should be performed using spray based cleaner (for example Isopropyl Alcohol).

New grease **must be applied** again prior to mating.

3.2 Location

When evaluating the installation location of the ISA200, ISA500 or ISA500 11K, there are several factors to consider to achieve optimum operation:

–	**Acoustics**	(Altitude/Distance Measurement)
–	**Magnetic Disturbers**	(Heading)
–	**Alignment with Vehicle**	(Pitch/Roll)
–	**Heat Sources**	(Temperature Measurement)

3.2.1 Acoustics (Altitude Measurement Performance)

The transducer must have a clear view of the seabed or target to measure distance to. Any items which obstruct this view may result in erroneous Altitude/distance measurements. If entirely obstructed, no Altitude/distance readings will be possible. The ISA500 & ISA500 11K has a 6° conical beam, any item within this beam will be detected and measured to. The ISA200 has a 15.2° conical beam, any item within this beam will be detected and measured to.

Ideally the ISA200/ISA500/ISA500 11K should not be operated in close proximity to other acoustic equipment with the same operational frequency (500kHz for the ISA500 & ISA500 11K or 200kHz for the ISA200). Other acoustic equipment may cause the ISA200/ISA500 to produce erratic Altitude readings.

If the ISA500 or ISA200 is found to be causing interference with other acoustic systems, the operational frequency can be adjusted to move it out of band with the other equipment – see the seaView application demonstration on our website for details or click into the ISA200/ISA500/ISA500 11K settings in seaView to see the various settings which can be adjusted. The ISA500 can be adjusted from 400 to 600kHz. The ISA200 has a more limited bandwidth and can be adjusted from 195kHz to 205kHz.

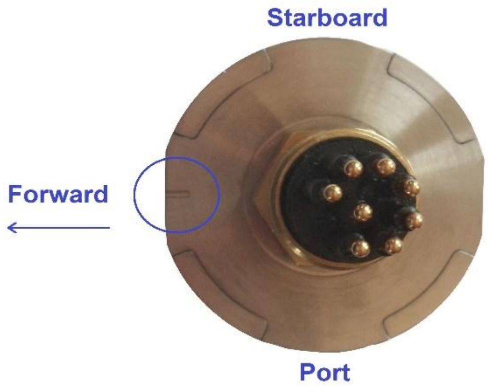
3.2.2 Magnetic Disturbers (Heading Performance)

Where the heading output is to be used, the ISA200/ISA500/ISA500 11K should be mounted as far as possible from sources of magnetic interference.

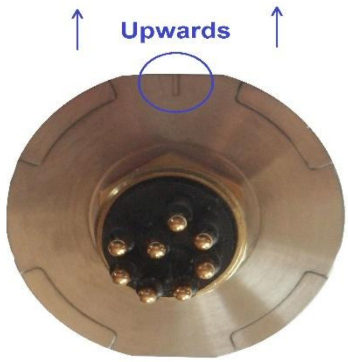
Electrical items which can cause magnetic interference include motors, transformers and valve packs. Ferrous metals, or any other magnetically active materials will also have influence on the heading reading. Thus, where possible, the unit should be installed as far as possible from magnetically active materials.

3.2.3 Alignment with Vehicle (Pitch/Roll Accuracy)

When mounting **vertically**, the ISA200/ISA500/ISA500 11K should be mounted with the transducer facing downwards (to the seabed) and the indentation in the connector end cap pointing forwards, in the direction of forward vehicle travel:



When mounting **horizontally** (for horizontal range measurements) the ISA200/ISA500/ISA500 11K should be mounted with the transducer facing in the direction of measurement to be made, with the indentation in the connector end cap pointing upwards:



3.2.4 Heat Sources (Temperature Accuracy)

In order for the ISA200/ISA500/ISA500 11K to read the ambient temperature of the water, it should not be installed in close proximity of any heat sources (such as Hydraulic Power Packs).

Of note, the ISA200/ISA500/ISA500 11K temperature sensor is embedded in the connector endcap. For this reason, it is usual for the sensor to experience some latency when moving to a new temperature of water. Self-heating of the sensors will also influence this reading, meaning the provided reading is higher than the actual water temperature.

3.3 Mounting

The ISA200/ISA500/ISA500 11K should be mounted using clamps around the mid-section of the body. The forward looking unit has a 55mm recess in the main body to enable a clamp to be tightened securely around the unit. The right angled unit has a 46mm recess.

Ideally a non-metallic clamp should be used, however in the event that this is not possible, effort should be made to electrically isolate the clamp from the housing. This can be achieved by using rubber or plastic strips around the body of the ISA200/ISA500/ISA500 11K.

The ISA200/ISA500/ISA500 11K has two flats, on either side of the body – these are to enable the unit to sit tightly against another flat surface if available. These flats also help prevent the unit moving when on the workbench for testing.

4.0 Operation

4.1 ISA200/ISA500/ISA500 11K Configuration & Use with seaView software

The ISA200/ISA500/ISA500 11K supplied with the highly intuitive Impact Subsea seaView software on USB. The latest version of seaView can also be downloaded from www.impactsubsea.com.

seaView is designed to operate any Impact Subsea sensor. Single sensors can be operated, or multiple sensors together.

The software is designed for use with a PC running the Windows 10 or 11 operating system.

seaView uses an advance framed binary protocol to communicate to the sensor and can do so over RS232 or RS485 at any standard baud rates above 4800. The parity must be none, stop bits 1 and data bits 8. If the sensor's communication settings differ from this then perform the communications reset as described in the establishing communications section of this manual.

All ISA200/ISA500/ISA500 11K settings (min/max ranges, operational frequency, output rate, output string etc) can be configured using the seaView software. Once configured, these settings are saved to the ISA200/ISA500/ISA500 11K firmware and will remain until next changed.

For all settings, hints and tips are provided on hover over to aid finding the correct setting for the required application. It is also advisable to view the ISA200/ISA500/ISA500 11K application demo video provided on the USB drive, or available on the Altimeter page of the Impact Subsea website prior to adjusting any settings.

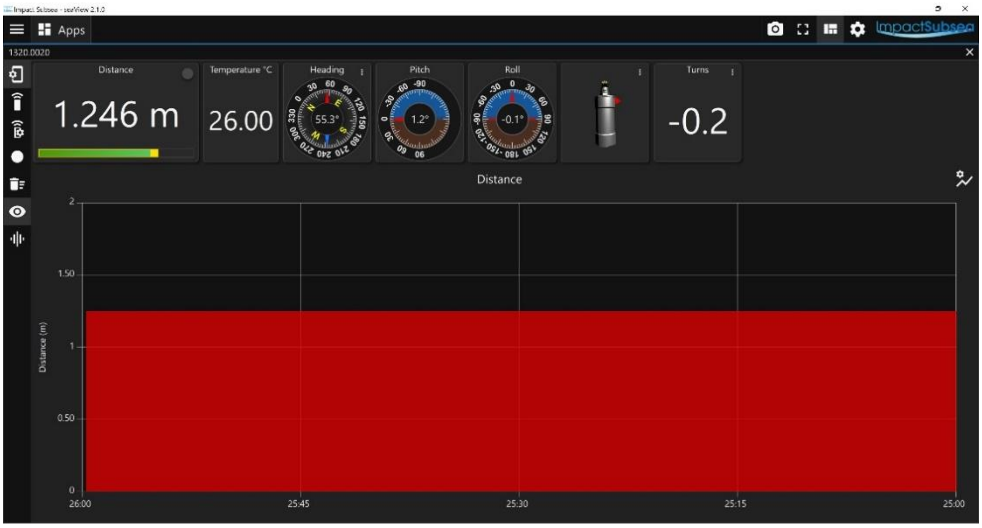
Note:

Firmware: If your ISA500/ISA500 11K has firmware version 3.0 or above, it will **only** operate with seaView V3.0 and above.

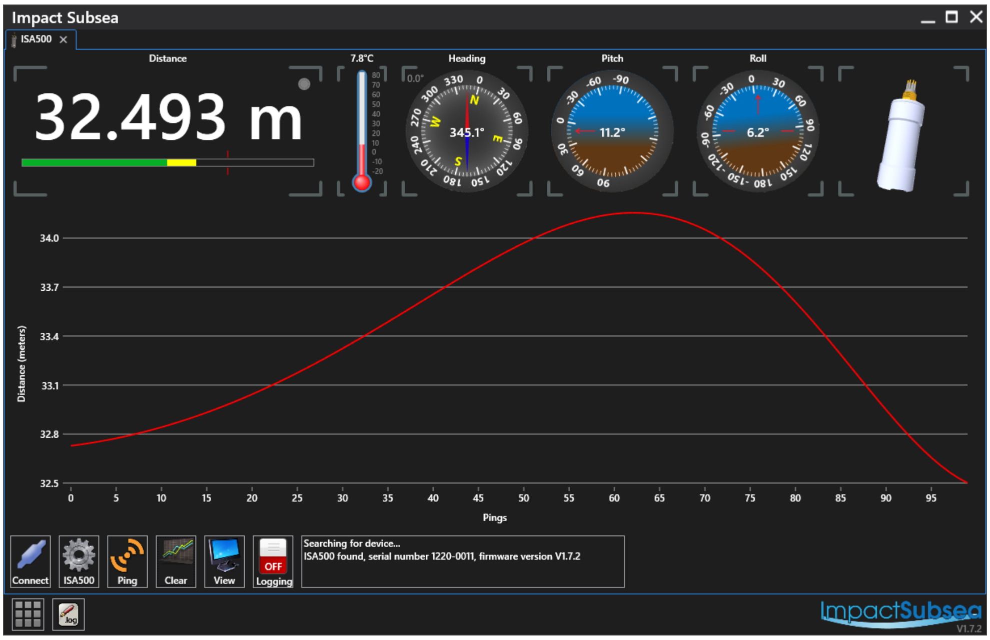
If your ISA500/ISA500 11K has an earlier version of firmware it will **only** operate with seaView 1.9.2 or earlier.

If you would like to upgrade the firmware of your ISA500/ISA500 11K to version 3.0 or newer, please contact Impact Subsea support. Please note that if upgrading to firmware V3.0 or newer, the firmware cannot be downgraded again.

All ISA200 sensors operate firmware version 3.0 and above and will operate with seaView V3.1.7 and above.



seaView V3.0 ISA200/ISA500 Application



seaView V1.9.0 ISA500 Application

4.2 Integration with Systems

Conceptually there are two modes of operation, Interrogation and Autonomous.

Integration mode requires a user to request the ISA200/ISA500/ISA500 11K to make a measurement and report this back.

The ISA200/ISA500/ISA500 11K can be interrogated by a user defined interrogation string (set using seaView software), or by the TTL trigger input. Upon interrogation the ISA200/ISA500/ISA500 11K will make a measurement and report back the result over the configured output, whether this be a serial string or analogue voltage / current loop output.

Autonomous mode will make a measurement and output the result over serial or analogue at a specified time interval.

The ISA200/ISA500/ISA500 11K can be configured to operate in one or both of these modes at the same time.

Altimeters with the AHRS option make use of the same interrogated and autonomous mechanises to output heading pitch and roll data over the serial interface.

4.3 Understanding advanced features

Some serial output strings for altitude measurement report back the energy level of the echo and also a correlation factor.

The energy level ranges from 0 to 1 where 1 represents full saturation of the ISA200/ISA500/ISA500 11K receiver. An energy level of 0.707 (square root of 2) is the theoretical perfect level as it represents the energy of a pure sine wave with an amplitude utilising the maximum dynamic range of the ISA200/ISA500/ISA500 11K.

The correlation factor ranges from 0 to 1 which represents a quality factor of the returned echo. A value of 1 would represent a return echo of perfection with negligible noise and distortion.

The correlation value can be used alone as a trust factor where low values such as 0.3 mean there a good possibility it's a false reading. A more detailed picture can be built by combining this information with the energy level as shown in the table:

	Low energy levels	**High energy levels**
Low correlation	Weak signal probably false reading	High noise level most likely a false reading
High correlation	Weak signal but likely a good reading	Ideal conditions very trust worthy readings

These values can also give some insight for adjusting the transmit power. If the energy level is low then consider increasing the amplitude and length of the transmit pulse.

The ISA200/ISA500/ISA500 11K does not average or filter readings in any way. This provides zero lag making it ideal for control systems.

A simple reliable target tracking algorithm can be created by applying the last known altitude reading to analyse the multi echo outputs. Using the correlation and energy values will further improve the reliability.

4.4 Magnetic Calibration

Following final physical installation on the vehicle (or other structure) it is critical that a magnetic calibration is conducted.

The magnetic calibration takes into account all local hard and soft iron artefacts of the vehicle (or other structure the ISA200/ISA500/ISA500 11K is mounted to). This enables the correction of any heading offsets that permanent magnetic interferers may cause.

If the magnetic calibration is not conducted, the heading will not be correct and will suffer from non-linear movement when rotated. For example a 90° physical rotation may only be recognised as a 80° rotation.

To conduct a good magnetic calibration, please complete the following procedure. There is also a video demonstration of this procedure available on the Altimeter product page of the Impact Subsea website.

For ISA200/ISA500/ISA500 11K sensors with V3 firmware and seaView version 3.1.6 onwards a 2D calibration is also available. This is useful for WROVs or other large subsea equipment which the ISA200/ISA500/ISA500 11K has been mounted on. It allows a magnetic calibration to be performed by purely rotating the vehicle 360° in open water away from magnetic interferers.

For current versions of seaView inertial mode is not available for ISA200/ISA500/ISA500 11K units.

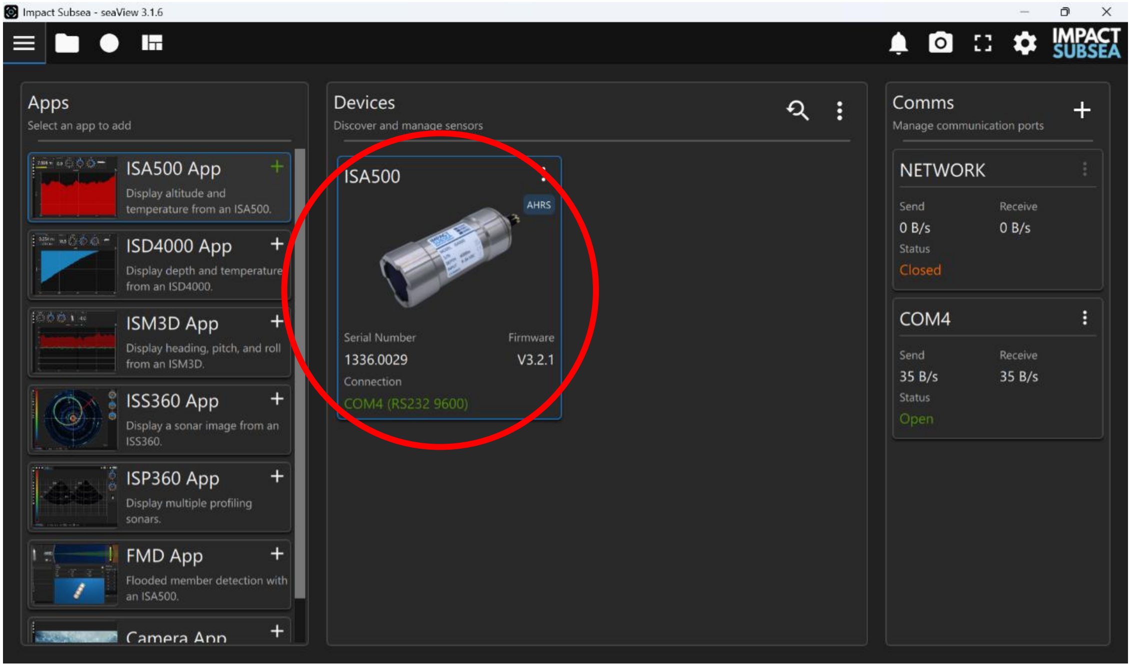
4.4.1 3D Magnetic Calibration Procedure

Step 1: Ensure that the ISA200/ISA500/ISA500 11K has been physically installed in a location as free from magnetic interference as possible (away from valve packs, thrusters etc).

Step 2: Check that the ISA200/ISA500/ISA500 11K is mounted securely to the structure ensuring the unit is not able to move independently from the structure.

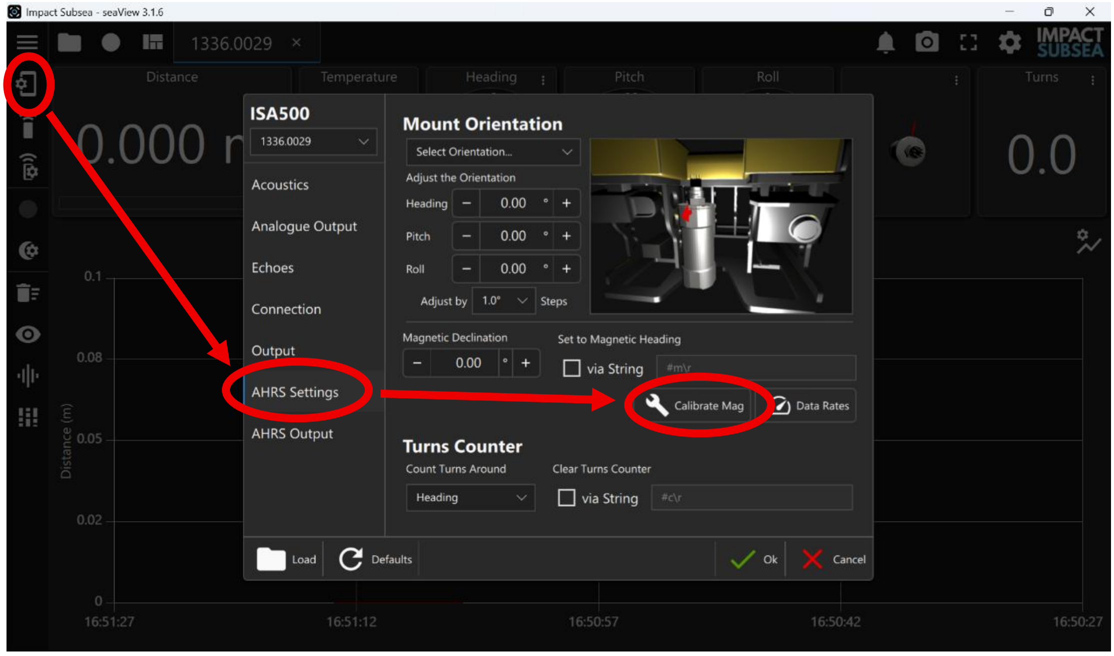
Step 3: If conducting the magnetic calibration in a workshop, ideally hang the ROV from a crane away from magnetic sources. If conducting the calibration at sea, deploy the ROV and move into open water, away from any structures with a magnetic property (vessel, pipeline etc). **Do not conduct the calibration with the ROV on the vessel.**

Step 4: Run the seaView software, select the ISA200/ISA500 application and connect to the ISA200/ISA500/ISA500 11K unit:

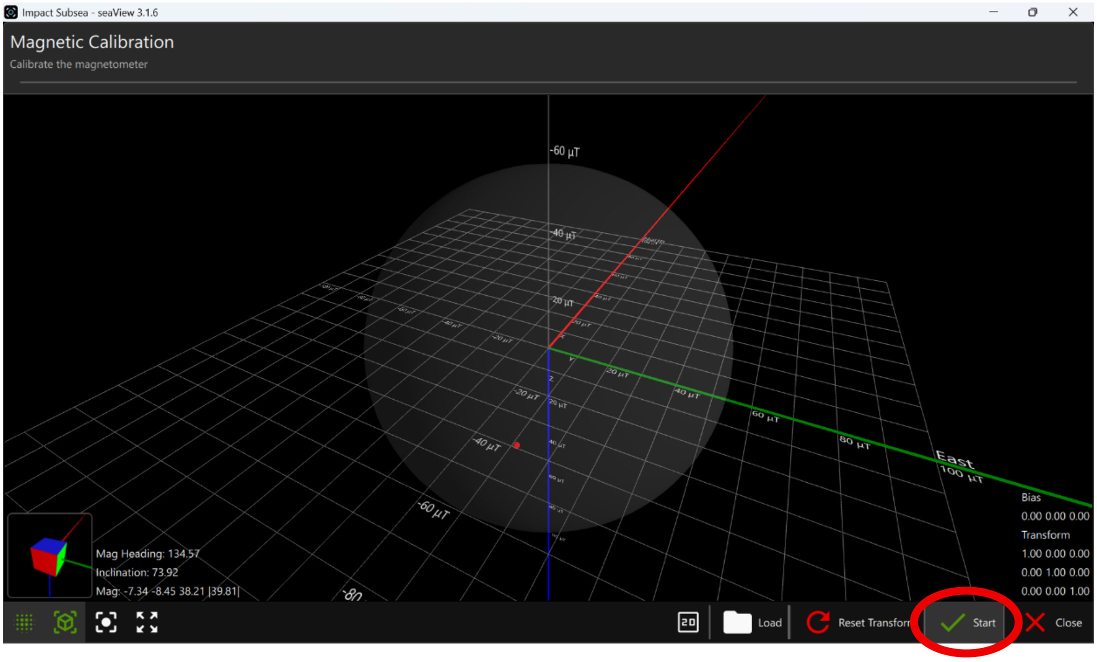


Step 5: Once connected to the ISA200/ISA500/ISA500 11K, go into settings:

Step 6: Select AHRS Settings then click on 'Calibrate Mag'.

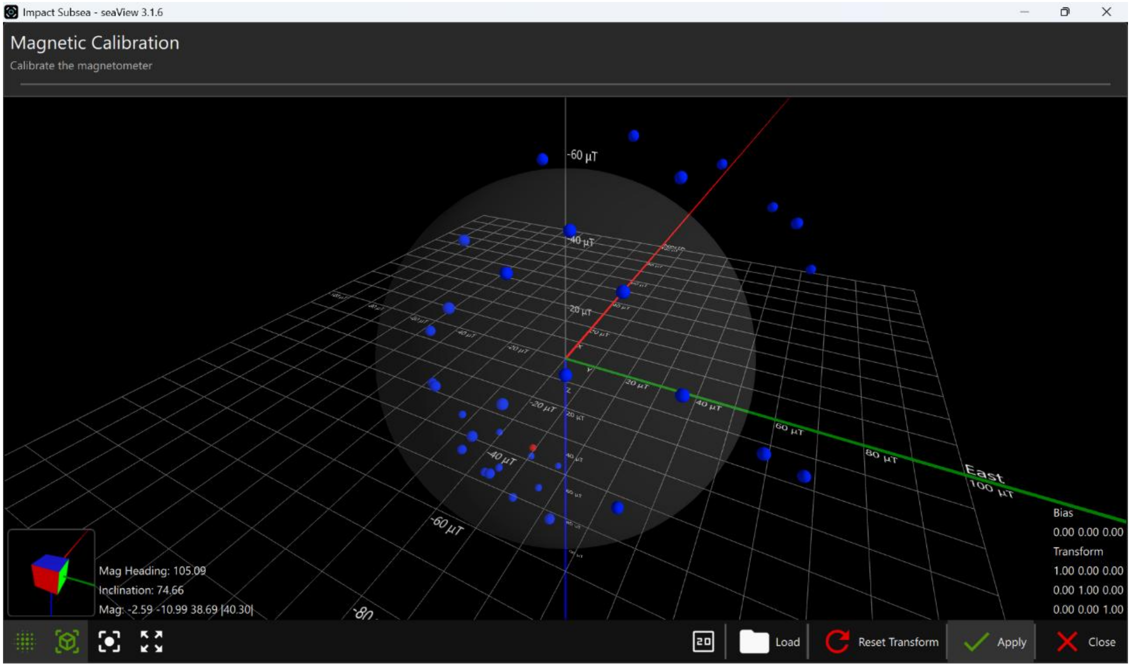


Step 9: Press Start and rotate the ROV through 360 degrees.

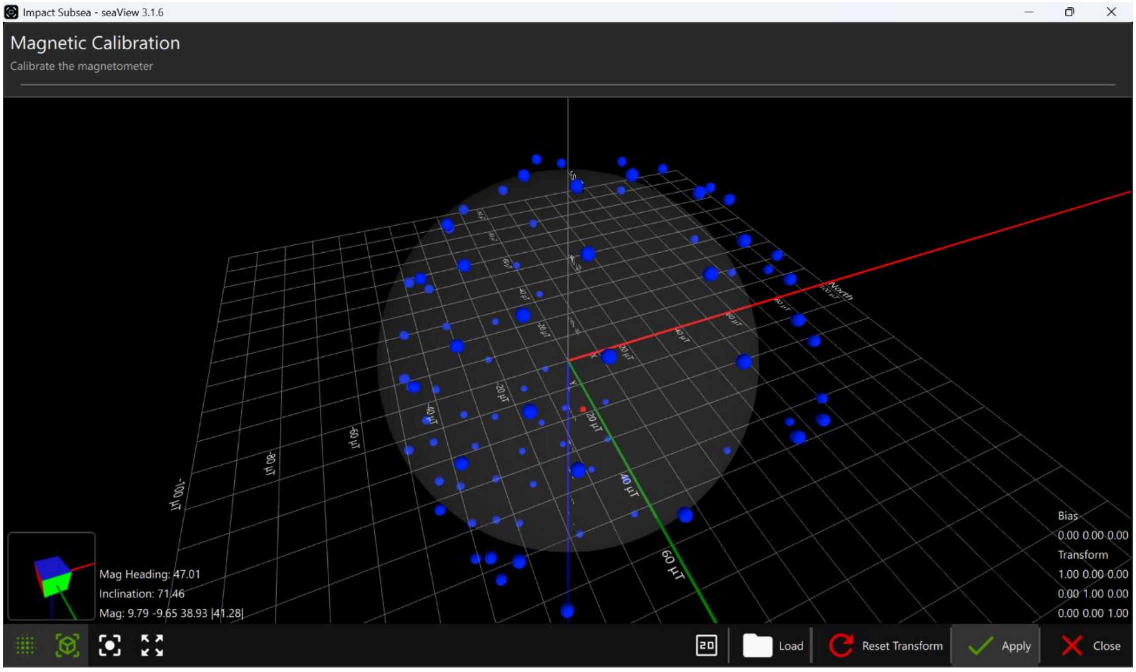


Step 10: Keep rotating the ROV through 360 degrees and pitch/roll the ROV as much as possible.

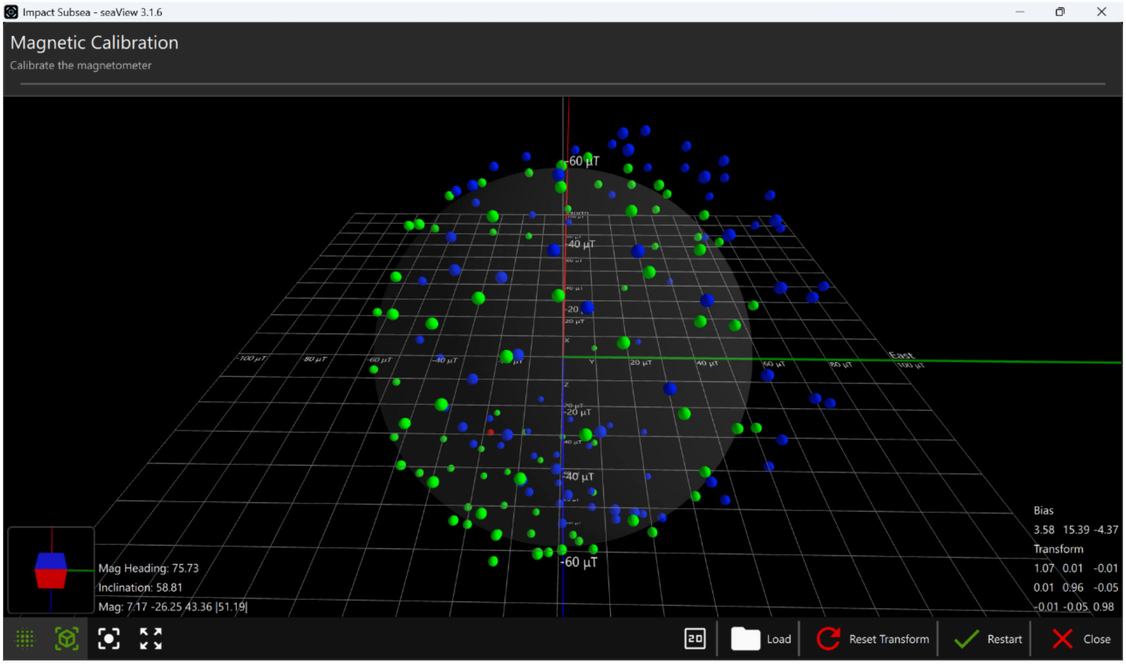
On screen you will see the sides of a ball forming from a number of dots.



Click on the ball to rotate and see if there are any gaps in data. Physically move the ROV to fill this data. Continue this process, until a good amount of data points are visible on screen. The ideal calibration will result in a complete 3D ball on screen – this may not be achievable with large ROVs, but effort should be made to get as close to this as possible:



Step 11: Once you have completed the calibration click 'Apply' to save the calibration to the ISA200/ISA500/ISA500 11K unit.



Step 12: Power Cycle the ISA200/ISA500/ISA500 11K unit.

The ISA200/ISA500/ISA500 11K will now point to magnetic north and provide good operation. If this is not the case, the magnetic calibration has not been completed to a sufficiently high standard and will require to be conducted again.

If a good calibration cannot be performed, due to lack of movement or excessive magnetic interference Power the unit and allow ten seconds for the heading to stabilise.

Once the heading has stabilised, a Heading Offset can be applied. This can be used to correct the heading of the unit to a known true value.

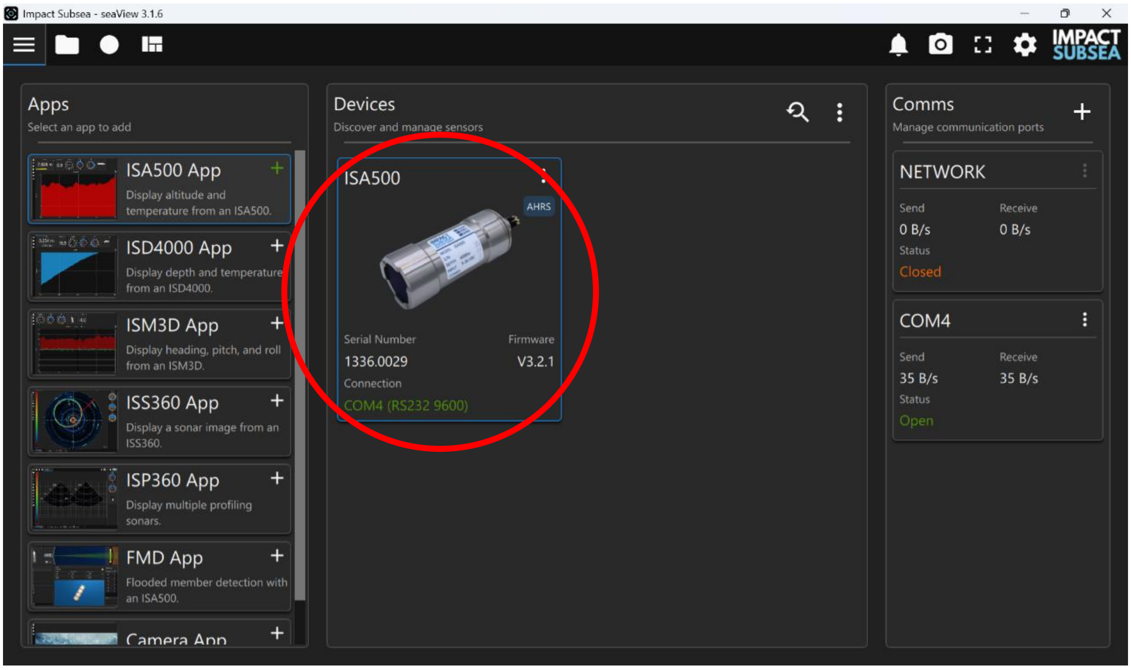
5.4.2 2D Magnetic Calibration Procedure

Step 1: Ensure that the ISA200/ISA500/ISA500 11K has been physically installed in a location as free from magnetic interference as possible (away from valve packs, thrusters etc).

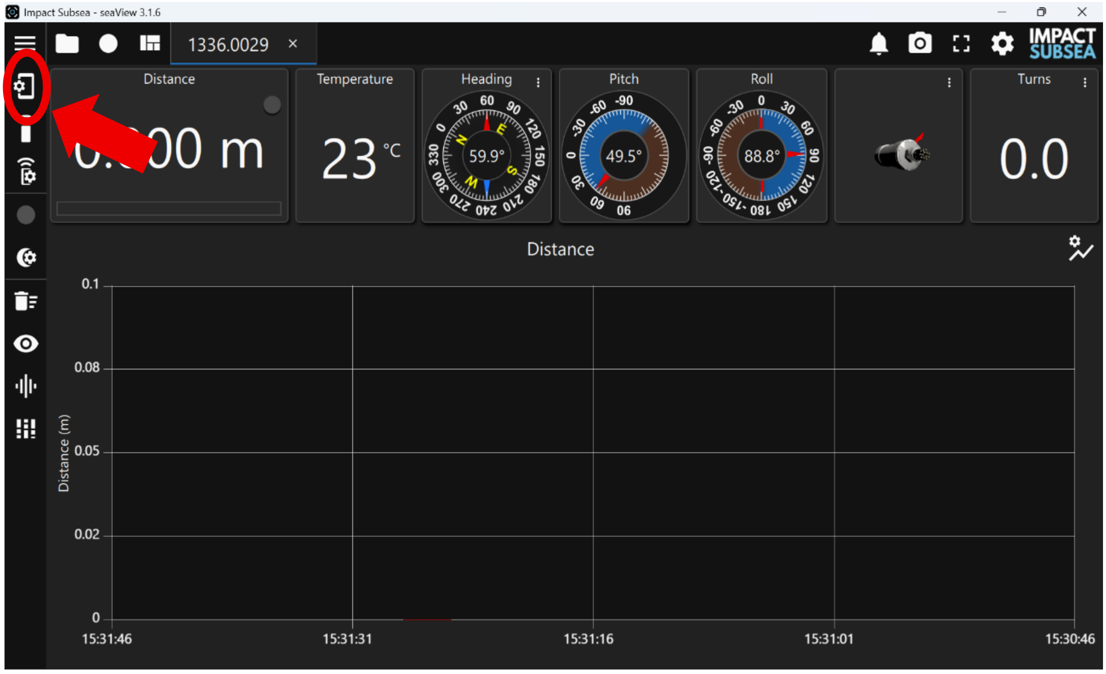
Step 2: Check that the ISA200/ISA500/ISA500 11K is mounted securely to the structure ensuring the unit is not able to move independently from the structure.

Step 3: If conducting the magnetic calibration in a workshop, ideally hang the ROV from a crane away from magnetic sources. If conducting the calibration at sea, deploy the ROV and move into open water, away from any structures with a magnetic property (vessel, pipeline etc). **Do not conduct the calibration with the ROV on the vessel.**

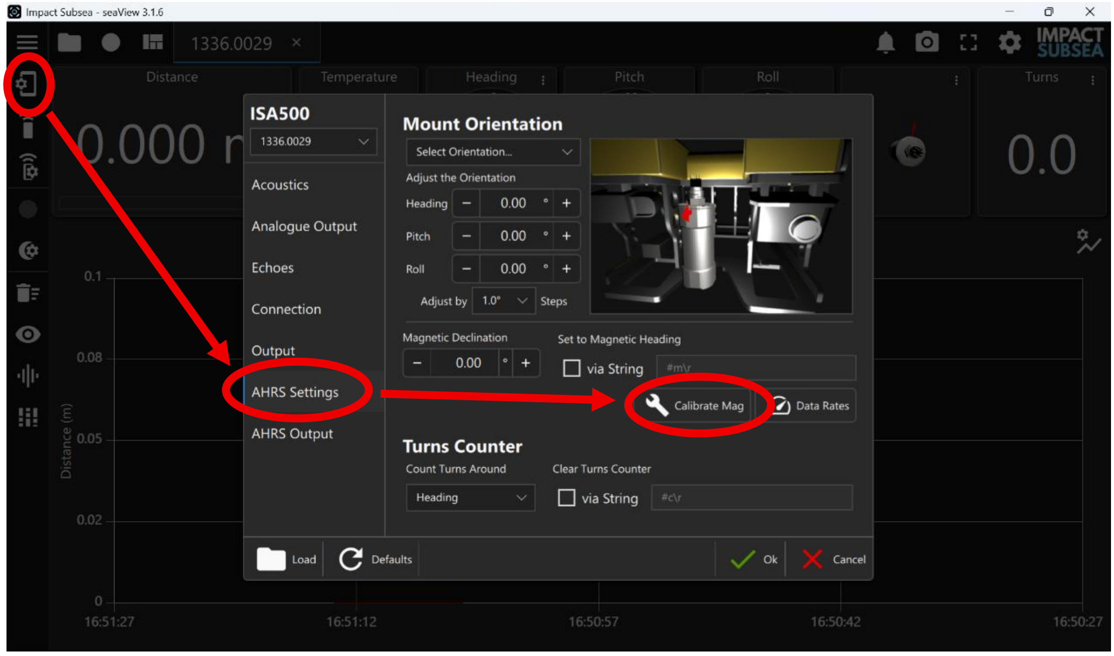
Step 4: Run the seaView software, select the ISA200/ISA500/ISA500 11K application and connect to the ISA200/ISA500/ISA500 11K unit:



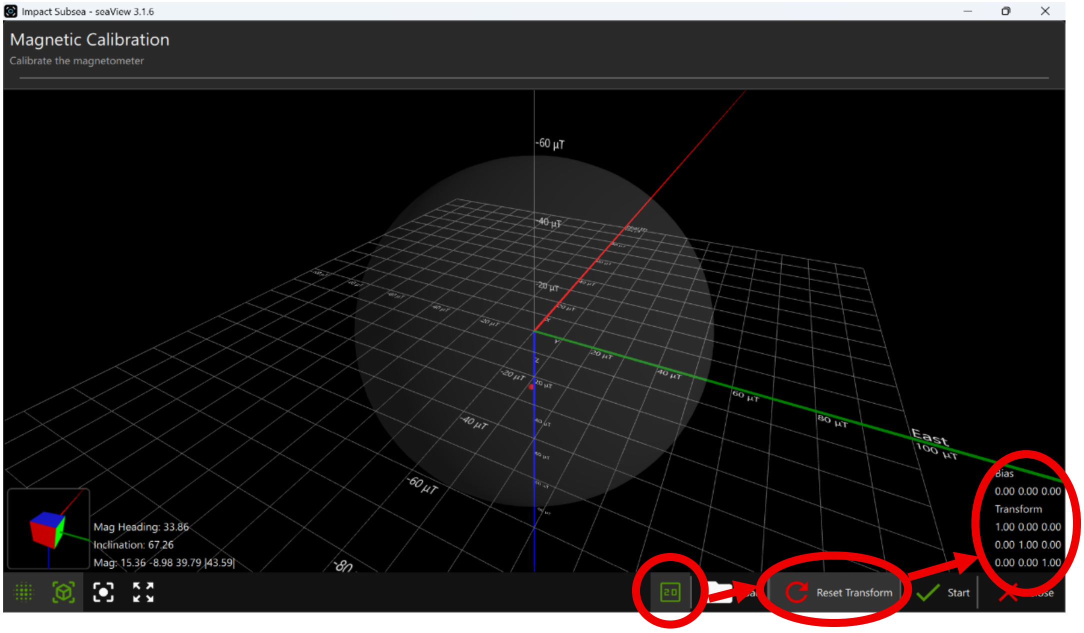
Step 5: Double click on the ISA200/ISA500/ISA500 11K icon to launch the ISA200/ISA500 application, then click on the settings button:



Step 6: Navigate to AHRS Settings and then click on ‘Calibrate Mag’.

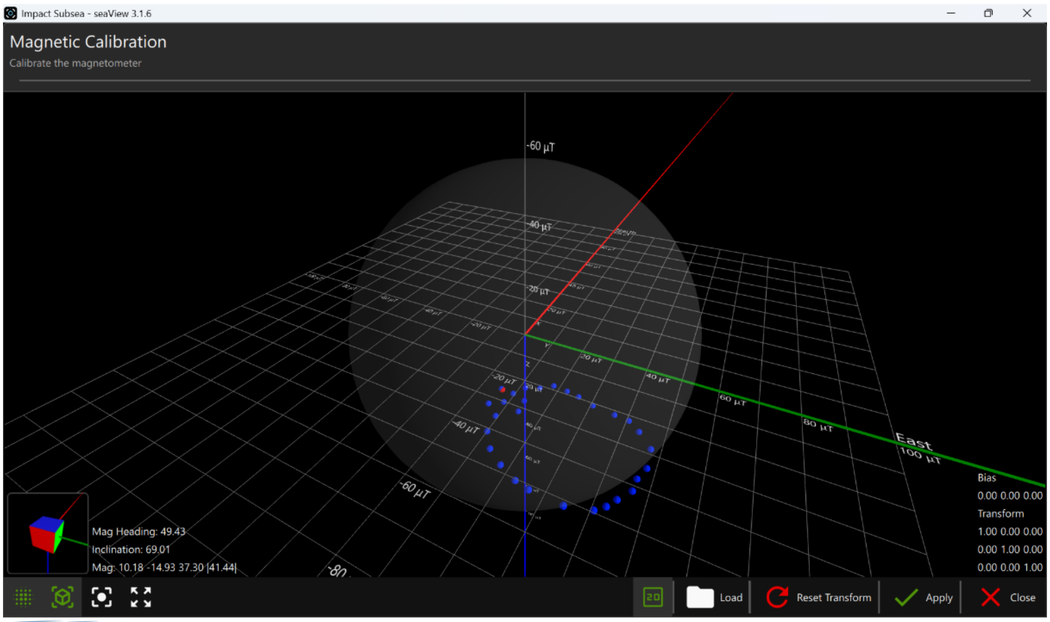


Step 7: Click the 2D calibration button, followed by the 'Reset Transform' button. This will enable the 2D calibration mode and remove any prior calibration data from the ISA200/ISA500/ISA500 11K, enabling a completely new calibration to be performed. The transform numbers will be reset to those shown below:

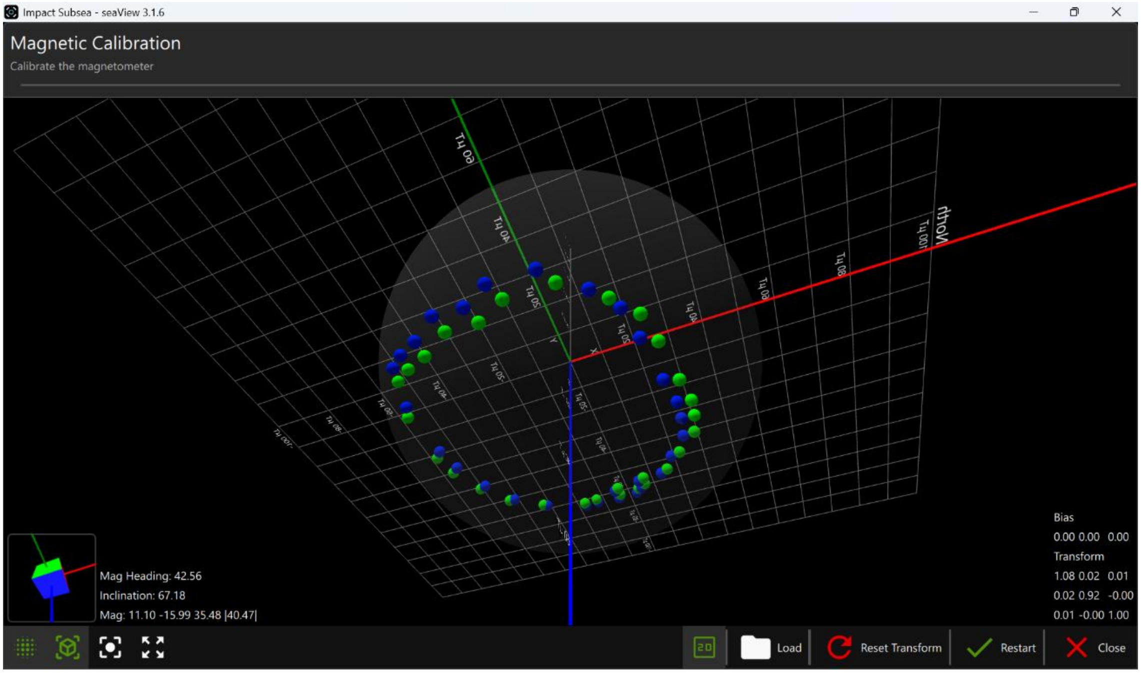


Step 8: Click 'Start' and move the ROV/underwater item which the ISA200/ISA500/ISA500 11K is attached to, rotate 360° until a complete set of largely flat points is achieved on screen.

The 3D image can be clicked and dragged to view the data from other perspectives. Scrolling on the mouse wheel will allow the screen to be zoomed in or out of. Depending on the strength of the magnetic field from the ROV, zooming out may be required to see the data points:



Step 9: Once sufficient data points have been gathered (ROV fully rotated), click the 'Apply' button. If the calibration has a sufficient number of points to be useful, it will be applied and a new set of bright green points will be displayed:



You can now close the calibration window and close the settings window. The calibration has been applied and saved to the ISA200/ISA500/ISA500 11K firmware.

If the heading has not been improved, please repeat the calibration procedure and gather a greater number of points.

5.0 Servicing

The ISA200/ISA500/ISA500 11K is a highly robust Altitude and Attitude measurement device. The unit has been designed to require minimal maintenance and as such there are no user serviceable components within the unit.

The unit should be rinsed in fresh water to remove growth and salt deposits. If required a light detergent (such as that used to clean household dishes) can be used.

DO NOT USE SOLVENTS TO CLEAN THE UNIT

Following rinsing the unit should be dried with a cloth.

The connector should be cleaned, and a light coating of Molykote 44 Medium grease should be applied.

The unit should be stored in its original case, in a cool, dry place.

It is recommended that the unit be returned to Impact Subsea Ltd, on an annual basis to have a health check and service conducted.

6.0 Output Strings

The string IDs below are for ISA200/ISA500/ISA500 11K with firmware version 3.0 and above.

The **number shown in brackets** after the **IDXXX** (**X**) is the ID of the string in firmware earlier than version 3.0. If there is no number in brackets, the string is only available from firmware version 3.0 onwards.

6.1 Altitude

ID101 (1): Impact Subsea altitude and temperature

$ISADS,*ddd.ddd*,M,*tt.t,*C**xx*<CR><LF>

ddd.ddd	Distance in meters from the transducer face to the target
tt.t	Temperature in degrees Celsius
xx	NMEA standard checksum

ID102 (2): Impact Subsea altitude, signal level, correlation and temperature

$ISADI,*ddd.ddd*,M,*e.eeee,c.cccc,tt.t,*C**xx*<CR><LF>

ddd.ddd	Distance in meters from the transducer face to the target
e.eeee	Energy level (0 to 1)
c.cccc	Correlation factor (0 to 1)
tt.t	Temperature in Celsius
xx	NMEA standard checksum

ID103 (3): Impact Subsea multi echo output

$ISAMD,*tt.t*,C,*ddd.ddd*,...**xx*<CR><LF>

tt.t	Temperature in Celsius
ddd.ddd	Distance in meters from the transducer face to the target
…	Another *ddd.ddd* reading
xx	NMEA standard checksum

Example string format for 3 echoes (*Note: 10 echoes maximum number of multi-echoes output via ASCII string*):

$ISAMD,*tt.t*,C,*ddd.ddd,ddd.ddd,ddd.ddd***xx*<CR><LF>

ID104 (4): Impact Subsea multi echo output with signal level, correlation and temperature

$ISAMI,*tt.t*,C,*ddd.ddd,e.eeee,c.cccc*,...,...,...**xx*<CR><LF>

tt.t	Temperature in Celsius
ddd.ddd	Distance in meters from the transducer face to the target
e.eeee	Energy level (0 to 1)
c.cccc	Correlation factor (0 to 1)
,...,...,...	Another *ddd.ddd,e.eeee,c.cccc* reading
xx	NMEA standard checksum

Example string format for 2 echoes:

$ISAMD,*tt.t*,C,*ddd.ddd,e.eeee,c.cccc,ddd.ddd,e.eeee,c.cccc**xx*<CR><LF>

ID105 (5): Tritech 3P3

*ddd.ddd*m<CR><LF>

ddd.ddd	Distance in meters from the transducer face to the target

ID106 (6): Tritech 2P3

*dd.ddd*m<CR><LF>

dd.ddd	Distance in meters from the transducer face to the target

ID107 (7): Tritech 3P2

*ddd.dd*m<CR><LF>

ddd.dd	Distance in meters from the transducer face to the target

ID108 (8): Tritech multidrop

*xddd.ddd*m<CR><LF>

x	Node address. This is the first character of the interrogation string
ddd.ddd	Distance in meters from the transducer face to the target

ID109 (9): Benthos

R*dd.dd*<CR><LF> or when there's no echo return R*dd.dd*E<CR><LF>

dd.dd	Distance in meters from the transducer face to the target

ID110 (10): Valeport

$PRVAT,*dd.ddd,*M,0000.000dBar**xx*<CR><LF>

dd.ddd	Distance in meters from the transducer face to the target
xx	NMEA standard checksum

ID111 (11): SDDBT

$SDDBT,,f,*ddd.dddd,*M,,F**xx*<CR><LF>

ddd.dddd	Distance in meters from the transducer face to the target
xx	NMEA standard checksum

ID112 (12): Tritech bathy mode

ID113 (13): PSA900

T*tt.t* R*dd.dd*<CR><LF>

tt.t	Temperature in Celsius
dd.dd	Distance in meters from the transducer face to the target

ID114 (14): Ulvertech Bathy

00000,*dddd*<CR><LF>

dddd	Distance in centimetres from the transducer face to the target

ID115 (15): Impact Subsea time and temperature

$ISATS,*dddddd*,us,*tt.t*,C**xx*<CR><LF>

dddddd	Time in micro seconds to target
tt.t	Temperature in Celsius
xx	NMEA standard checksum

ID116 (16): Impact Subsea time, energy, correlation and temperature

$ISATI,*dddddd*,us,*e.eeee,c.cccc,tt.t,*C**xx*<CR><LF>

dddddd	Time in micro seconds to target
e.eeee	Energy level (0 to 1)
c.ccc	Correlation factor (0 to 1)
tt.t	Temperature in Celsius
xx	NMEA standard checksum

ID117 (17): Impact Subsea temperature and multi echo (time)

$ISAMT,*tt.t,*C,*dddddd,...**xx*<CR><LF>

tt.t	Temperature in Celsius
dddddd	Time in micro seconds to target
…	another *dddddd* reading
xx	NMEA standard checksum

Example string format for 3 echoes (*Note: 10 echoes maximum number of multi echoes output via ASCII string*):

$ISAMD,*tt.t*,C,*dddddd,dddddd,dddddd***xx*<CR><LF>

ID118 (18): Impact Subsea temperature and multi echo (time) with energy and correlation

$ISAMV,*tt.t*,C,*dddddd,e.eeee,c.cccc*,...,...,...**xx*<CR><LF>

tt.t	Temperature in Celsius
dddddd	Time in micro seconds to target.
e.eeee	Energy level (0 to 1)
c.cccc	Correlation factor (0 to 1)
,...,...,...	Another ddd.ddd,e.eeee,c.cccc reading
xx	NMEA standard checksum

Example string format for 2 echoes

$ISAMV,*tt.t*,C,*dddddd,e.eeee,c.cccc,dddddd,e.eeee,c.cccc***xx*<CR><LF>

ID119 (19): NMEA $SDDBT

$SDDBT,a.a,f,b.b,M,c.c,F*hh<CR><LF>

a.a	Distance in feet from the transducer face to the target
b.b	Distance in meters from the transducer face to the target
c.c	Distance in fathoms from the transducer face to the target
*	Checksum delimiter
hh	Checksum field
<CR><LF>	End of sentence carriage return and line feed characters

ID120 (20): NMEA $SDDPT

$SDDPT,x.x,x.x*hh

First x.x	Distance in meters from the transducer face to the target
Second x.x	Offset from transducer (positive means distance from transducer to water line, negative means distance from transducer to keel)
*hh	Checksum

ID121 (21): NMEA $GPSSS

$GPSSS,*ddd.dd*,*eeee*,*c.cc*,*t.t*,*m.m*,,*f<CR><LF>

ddd.dd	Distance in meters from the transducer face to the target
eeee	Sound velocity in meters per second
c.cc	Offset in meters
t.t	Pulse length (static 0.0)
m.m	Output rate (time in seconds between pings) (static 0.0)
**f*	Checksum
<CR><LF>	End of sentence carriage return and line feed characters

ID122: Tritech Micron

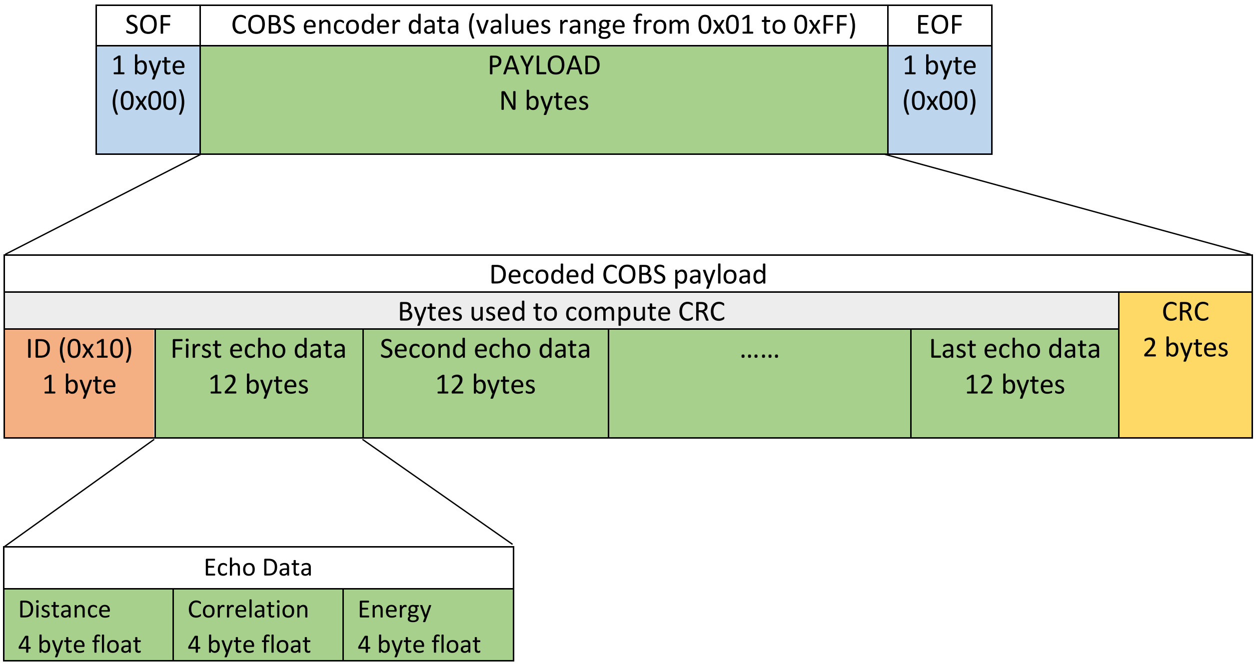
ddd.ddd<CR><LF>

ddd.ddd	distance in meters from the transducer face to the target.

Impact Subsea Binary multi echo data (ID22):

Binary data frame containing a list of up to 100 multi echo outputs.

The frame is COBS encoded, has a CRC16 checksum and uses 0x00 as a frame delimiter. The endianness is little endian. The binary frame format is as follows:



A frame can be buffered into an array by buffering all bytes between zeros. The COBS (Constant Overhead Byte Stuffing) algorithm removes all zeros from the data allowing for zero to be use for frame delimitation.

Search the internet or look at https://en.wikipedia.org/wiki/Consistent_Overhead_Byte_Stuffing for code examples and a description of the algorithm in order to decode the frame.

Once the frame is decoded the first byte should be 0x10. The last 2 bytes form the CRC 16 checksum and can optionally be used to check for data corruption. The CRC16 is a standard algorithm and uses the polynomial $x^{16} + x^{15} + x^2 + 1$. This is the one used for USB and is known as CRC-16-IBM.

The CRC algorithm is seeded with 0xFFFF and runs over all bytes in the decoded frame.

After the ID (0x10) is an array of 32 bit floats representing each echo's distance in meters to the target, normalised correlation factor (0.0 to 1.0) and normalised energy level (0.0 to 1.0).

6.2 AHRS

ID131 (1): Impact Subsea heading, pitch, roll

$ISHPR,*hhh.h,spp.p,srrr.r*xx*<CR><LF>

s	sign + or -
hhh.h	heading in degrees (0 to 359.9)
pp.p	pitch in degrees (90.0 to -90.0)
rrr.r	roll in degrees (180.0 to -180.0)
xx	NMEA standard checksum

ID132 (2): Impact Subsea quaternion

Quaternions represent the orientation of a 3D body in a 4 dimensional world. This avoids the associated gimbal lock / singular problems with conventional heading, pitch, roll.

$ISQUA,w,*x,y,z*xx*<CR><LF>

w	floating point number Q0
x	floating point number Q1
y	floating point number Q2
z	floating point number Q3
xx	NMEA standard checksum

ID133 (4): Impact Subsea Accelerometer, Gyro, Magnetometer

$ISAGM,*a.aaa,a.aaa,a.aaa,g.ggg,g.ggg,g.ggg,m.mmm,m.mmm,m.mmm***xx*<CR><LF>

a.aaa	Accelerometer reading: X then Y then Z
g.ggg	Gyroscope reading: X then Y then Z
m.mmm	magnetometer reading: X then Y then Z
xx	NMEA standard checksum

All values are floating point numbers. Sign only shown if negative

Accelerometer data is provided in G

Gyroscope data is provided in degrees per second

Magnetometer data is provided in micro Tesla

ID134: Impact Subsea heading, pitch, roll, accelerometer, gyro, magnetometer

$ISALL,*hhh.h,spp.p,srrr.r,a.aaa,a.aaa,a.aaa,g.ggg,g.ggg,g.ggg,m.mmm,m.mmm,m.mmm*xx*<CR><LF>

s	sign + or -
hhh.h	heading in degrees (0 to 359.9)
pp.p	pitch in degrees (90.0 to -90.0)
rrr.r	roll in degrees (180.0 to -180.0)
a.aaa	Accelerometer reading: X then Y then Z
g.ggg	Gyroscope reading: X then Y then Z
m.mmm	magnetometer reading: X then Y then Z
xx	NMEA standard checksum

ID135: Impact Subsea w,x,y,z,accelerometer, gyro, magnetometer

$ISQUR,*w,x,y,z,a.aaa,a.aaa,a.aaa,g.ggg,g.ggg,g.ggg,m.mmm,m.mmm,m.mmm**xx*<CR><LF>

w	floating point number Q0
x	floating point number Q1
y	floating point number Q2
z	floating point number Q3
a.aaa	Accelerometer reading: X then Y then Z
g.ggg	Gyroscope reading: X then Y then Z
m.mmm	magnetometer reading: X then Y then Z
xx	NMEA standard checksum

ID136 (3): TCM2 compass, pitch, roll

$C*hhh.h*,P*pp.p*,R*rr.r***xx*<CR><LF>

hhh.h	heading in degrees (0 to 359.9)
pp.p	pitch in degrees (90.0 to -90.0)
rr.r	roll in degrees (90.0 to -90.0)
xx	NMEA standard checksum

ID137: TOKIMEK2

$PTVF,*appp.pp*P,*brrr.rr*R,*hhh.h*T,*fgg.g*PR,*hii.i*RR,*jkk.k*AR,lmm.mN,yyyMD,zzzzAL*nn<CR><LF>

a	[-] stern down; [space] bow down
ppp.pp	pitch in degrees (90.00 to -90.00)
b	[-] starboard down; [space] port down
rrr.rr	roll in degrees (90.00 to -90.00)
hhh.h	heading in degrees (0 to 359.9)
f	[-] stern down; [space] bow down
gg.g	rate of pitch in degrees/second
h	[-] starboard down; [space] port down
ii.i	rate of roll in degrees/second
j	*[-] counter clock wise [space] clockwise*
kk.k	*rate of turn (degrees per second)*
lmm.m	not used
yyy	not used
zzzz	not used
nn	checksum of all in string between (but excluding) $ and *

ID138: Watson

I *hhh.hh arrr.r bppp.p cggg.g dkkk.k hiii.i* 0000.0 <CR><LF>

hhh.hh	heading in degrees (0 to 359.99)
a	[-] starboard down / [+] port down
rrr.r	Roll rate in degrees per second
b	[-] stern down / [+] bow down
ppp.p	Pitch rate in degrees
c	[-] heading increasing / [+] heading decreasing
ggg.g	heading rate in degrees
d	[-] port down / [+] starboard down
kkk.k	roll in degrees
h	[-] stern down / [+] bow down
iii.i	pitch in degrees

ID139: HEHDT Compass

$HEHDT,*hhh.h,*T**xx*<CR><LF>

hhh.h	heading in degrees (0 to 359.9)
xx	NMEA standard checksum (note: hex character are capital)

ID140: PRDID Pitch, Roll, Heading

$PRDID,*pp.p*,*rrr.r*,*hhh.h****xx*<CR><LF>

pp.p	Pitch in degrees (90.0 to -90.0)
rrr.r	Roll in degrees (180.0 to -180.0)
hhh.h	heading in degrees (0 to 359.9)
xx	NMEA standard checksum (note: hex character are capital)

ID141: TSS1

:*aaaabbbb* 0000U *rrrrr ppppp*<CR><LF>

aaaa	Horizontal acceleration
bbbb	Vertical acceleration
rrrrr	Roll in degrees * 100 (9000 to -9000)
ppppp	Pitch in degrees * 100 (9000 to -9000)

ID142: CDL TOGS

AH*hhh.hh* AP*bpp.pp* AR*drrr.rr* M*f* E*ggggggg* S*x* C*yyyy*<CR><LF>

hhh.hh	Heading in degrees
b	[-] bow down [+] stern down
pp.pp	Pitch in degrees
d	[-] port down [+] starboard down
rrr.rr	Roll in degrees
f	Mode flag
ggggggg	Cycle Counter
x	Fault field
yyyy	CRC value (hexadecimal)

ID143: Micro Tilt

P*app.pp*R*brr.rr*

a	+ or -
pp.pp	Pitch in degrees
b	+ or –
rr.rr	Roll in degrees

ID144: EM3000

Binary Output

ID145: Seapath

$PSXN,rrr.rr,pp.pp,hhh.hh, aa.aa*xx <CR><LF>

rrr.rr	roll in degrees (180.0 to -180.0)
pp.pp	pitch in degrees (90.0 to -90.0)
hhh.hh	heading in degrees (0 to 359.9)
aa.aa	vertical acceleration in m/s^2
xx	NMEA standard checksum

7.0 Theory of Operation

7.1 Altitude - Basic Principles

Throughout this section, Altitude is referred to – the ISA200/ISA500/ISA500 11K equally be used to measure ranges underwater (vertical and horizontal). For simplicity, only Altitude is referenced here, however the same principles apply to range measurements.

This section examines how Altitude measurement is achieved by the ISA200/ISA500/ISA500 11K.

For the purpose of measuring Altitude, the ISA200/ISA500/ISA500 11K is a hydro-acoustic device, which utilises sound pressure waves in order to determine Altitude.

Acoustics (also known as hydro-acoustics or sound pressure waves) are used by the ISA200/ISA500/ISA500 11K due to their high efficiency in travelling through water or liquid. Through water acoustics can travel far greater distances than signals in the light or radio frequency spectrum. Thus, are the ideal method to use for measuring distance underwater.

The ISA200/ISA500/ISA500 11K operates by emitting an acoustic pulse into the water. This pulse travels through the water until it comes into contact with the seabed. Upon contact with the seabed, part of the pulse is absorbed, and part is reflected back to the ISA200/ISA500/ISA500 11K.

This reflected portion is detected by the ISA200/ISA500/ISA500 11K and the time taken for this acoustic pulse to travel from the ISA200/ISA500/ISA500 11K, bounce off the seabed and return is recorded.

The distance the acoustic pulse has travelled can then be calculated by the simple equation:

Distance = Speed x Time

In water, the speed of sound is typically around 1,500 meters per second. This is influenced by various factors (temperature, salinity & pressure). However, for the purpose of this explanation, we will assume a speed of sound of 1,500m/s.

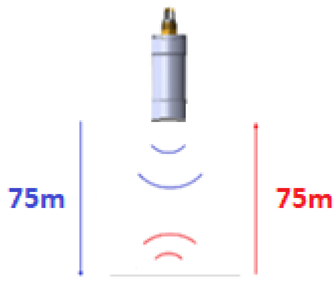
For example, if an acoustic pulse takes 0.1 seconds to return to the ISA200/ISA500/ISA500 11K after being sent, we can calculate its round-trip travel distance as:

Distance = Speed x Time

= 1,500 x 0.1

= 150m

Therefore, the total distance the sound has travelled is 150 meters (journey to the seabed + journey back from seabed).



To calculate the Altitude, we simply half this value.

i.e. the range to seabed from the ISA200/ISA500/ISA500 11K *Altimeter is 75 meters.*

7.2 The Sonar Equation

Any equipment which relies on acoustics underwater for ranging purposes, falls into the category of a Sonar, and hence the operation is governed by the 'Sonar Equation'.

A clear understanding of this equation is essential in the design of any acoustic equipment, and useful to have an understanding of for those wishing to utilise acoustic equipment to its full potential.

The Sonar equation is a fundamental equation, which is at the heart of all hydro-acoustic systems:

$$SL - TL - (NL - DI) > DT$$

SL = Source Level

TL = Transmission Loss

NL = Noise Level

DI = Directional Index

DT = Detection Threshold

7.2.1 Source Level (SL)

The Source level is the power at which the acoustic pulse is put into the water. A greater source level will increase the range capability; however, it will also increase the power consumption.

Therefore, a trade-off between power consumption of the device, and the range required must be achieved.

There is also a physical limit to the source level which can be achieved underwater, before cavitation occurs, and acoustic transmission breaks down.

7.2.2 Transmission Loss (TL)

As the acoustic pulse propagates through the water, it experiences spreading, which causes the energy of the signal to be dispersed over an ever-increasing area. This diminishes the energy at any specific point as distance increases.

The acoustic pulse will also experience absorption by the water. The rate at which the acoustic pulse is absorbed is directly related to the pulse frequency. The higher the frequency, the higher the absorption rate.

However, typically the higher the frequency, the higher the acoustic resolution can be achieved. Thus, another trade-off must be made to use the highest frequency possible, while achieving the desired range capability.

7.2.3 Noise Level (NL)

Noise level is environment specific, which can often be the reason for acoustic systems experiencing different levels of performance in different locations or even when operating at different times.

There are numerous sources which contribute to the background noise level underwater. All of which, make the detection of the return acoustic signal increasingly more difficult.

From an environmental perspective, marine life such as snapping shrimp can cause a reasonable level of noise. Also, wind and rain can be a factor if operating close to the water surface.

Man-made sources of noise include those from machinery – such as vessel noise (thrusters and props) and also noise from ROVs and AUVs.

Multipath effects can also add to the background noise. If operating acoustic equipment in an enclosed area/close to a structure, the acoustic signals tend to 'bounce around' which can cause sporadic operation of acoustic equipment.

7.2.4 Directional Index (DI)

The Directional Index gives a reduction in noise level, governed by the properties of the transmit/receive transducer.

An omni-directional transducer will theoretically pick-up noise from all directions. A directional transducer will hear noise from only one direction. Thus, a method of reducing the apparent background noise is to utilise a highly directional transducer.

The ISA500 & ISA500 11K utilise a 6° conical acoustic beam. Meaning that any potential interference effects which exist outside of this beam, will not have a negative impact on the operation of the unit.

The ISA200 uses a 15.2° conical acoustic beam. Meaning that any potential interference effects which exist outside of this beam, will not have a negative impact on the operation of the unit.

7.2.5 Detection Threshold (DT)

The Detection Threshold is a property of the acoustic system. It is defined as the minimal signal to noise ratio required in order to detect the acoustic signal.

The threshold can be lowered by minimising the device self-generated noise, utilising advanced acoustic signalling, and by having a highly capable matching filter, or a highly sensitive transducer on the receive side to detect the signal.

The ISA200/ISA500/ISA500 11K utilises a proprietary acoustic correlator to detect the returning acoustic signal, low noise digital electronics and a highly sensitive composite transducer to enable it to detect extremely small acoustic signals.

An appreciation of the Sonar equation will provide an understanding of the fundamental operation of the ISA200/ISA500/ISA500 11K. It may also help during installation and also when fault finding as it provides an indication as to influential factors.

7.3 Heading, Pitch & Roll

In addition to Altitude, ISA200/ISA500/ISA500 11K provides Heading, Pitch and Roll readings.

These readings are provided by a Micro-Electro-Mechanical System (MEMS) sensor within the unit.

Traditionally MEMS sensors were not particularly accurate, however they have significantly advanced in recent years. This advancement has made them ideal components to be implemented into various pieces of equipment (if you have a smart phone, the chances are that it has a built in MEMS sensor to provide you with a Compass (Heading) and spirit level (Pitch/Roll).

The ISA200/ISA500/ISA500 11K makes use of accelerometers, gyroscopes and magnetometer data fused in a digital algorithm to provide heading, pitch and roll to an accuracy level to suit basic ROV/AUV navigation.

7.4 Temperature

A final reading which the ISA200/ISA500/ISA500 11K provides, is Temperature. The ISA200/ISA500/ISA500 11K makes use of a temperature sensor, which sits against the ISA200/ISA500/ISA500 11K end cap (the end with the connector).

This reading can be used for reference, or to alter the speed of sound value used by the ISA200/ISA500/ISA500 11K. As the temperature of the water will influence the speed of sound, it is important to adjust for this to enable accuracy of measurements to be maintained.

Due to the location of the temperature sensor, self heating of the ISA200/ISA500/ISA500 11K sensor can cause the read temperature to be increased beyond the ambient water temperature.

8.0 Warranty

The ISA200/ISA500/ISA500 11K is supplied with a Limited Warranty. This warranty applies only to the ISA200/ISA500/ISA500 11K unit, and only if the ISA200/ISA500/ISA500 11K is purchased from Impact Subsea Ltd.

What does the limited warranty cover?

This Limited Warranty covers any defects in material or workmanship under normal use during the Warranty Period.

During the Warranty Period, Impact Subsea Ltd will repair or replace, at no charge, products or part of a product that prove defective because of improper material or workmanship under normal use and maintenance.

What will we do to correct the problems?

Impact Subsea Ltd will either replace or repair the Product at no charge, using new or refurbished replacement parts. Replacement or repair is at the discretion of Impact Subsea Ltd.

How long does the coverage last?

The Warranty Period for the ISA200/ISA500/ISA500 11K, purchased from Impact Subsea Ltd, is 1 year from the date of dispatch from Impact Subsea Ltd.

A replacement ISA200/ISA500/ISA500 11K, or part assumes the remaining warranty of the original ISA200/ISA500/ISA500 11K or 60 days from the replacement or repair, whichever is longer.

What does this limited warranty not cover?

This limited warranty does not cover any problem that is caused by conditions, malfunctions or damage not resulting from the defects in material or workmanship.

What do you have to do?

To obtain a warranty repair of your ISA200/ISA500/ISA500 11K unit, you must first contact Impact Subsea Support to determine the problem and the most appropriate solution for you.

9.0 Technical Support

Should you require technical support for your ISA200/ISA500/ISA500 11K unit, our Support team can be contacted as follows:

T. +44 (0) 1224 460 850

E. support@impactsubsea.co.uk

W. www.impactsubsea.com

An out of hours emergency number is available via the Impact Subsea website.

Utilising the above email address will ensure that a number of engineers are copied into your support request, and will ensure a prompt response.

When contacting our Support team, please provide the following details of the ISA200/ISA500/ISA500 11K:

- Serial Number
- Firmware version
- Software version (if applicable)
- Fault Description
- Remedial action undertaken thus far