Document Revisions

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Guideline on the Application of AIS on Buoys

# Introduction

This document considers the application of employing AIS on buoys and is designed to offer guidance regarding specification, installation and maintenance. This document should be considered as complimentary to higher level documents such as IALA Recommendation A-126

# Selection of the AIS unit

AIS has the capability of transmitting various messages. The comprehensive list of messages available is in the IALA Recommendation A-126 Edition 1.5. The main messages that are of interest to the AIS as an AtoN provider are as follows;

## Messages

In addition to Aids to Navigation Report, Message 21, an AIS AtoN may also transmit Messages 6, 7, 8, 12, 13, 14, and 25. Note that Type 1 and Type 2 AIS AtoN stations, not having full AIS receiver capability, cannot send Messages 7 or 13.

1. Summary of optional AIS AtoN Station messages

|  |  |  |  |
| --- | --- | --- | --- |
| **Msg ID** | **Message Name** | **Message Description** | **Application examples** |
| 6 | Binary Addressed Message | Binary data for addressed Communication | Monitoring of AtoN lantern,  power supply, etc. |
| 7 | Binary acknowledge message | Acknowledge of addressed binary message |  |
| 8 | Binary Broadcast Message | Binary data for broadcast communication | Meteorological and hydrological data |
| 12 | Addressed Safety Related Message | Safety related data for addressed communication | Warn AtoN malfunctioning |
| 13 | Safety related acknowledge message | Acknowledge of addressed safety related message |  |
| 14 | Broadcast Safety Related Message | Safety related data for broadcast communication | Warn AtoN malfunctioning |
| 21 | AIS AtoN message |  |  |
| 25 | Single slot binary message | Binary data for addressed or broadcast communication | Status report |

### Message 6

Message 6, Addressed Binary Message, can be employed by an AIS AtoN for sending AtoN status reports to the competent authority responsible for the AtoN. Useful data includes those for battery, lantern status, and solar power system charging current. The benefits for the competent authority include knowledge of equipment status, opportunity for preventative maintenance, early notification of faults, and ultimately increased availability. Such performance information can be fed back into the design process for AtoN systems.

### Message 8

Message 8 is a binary broadcast message. IMO has published a limited list of Message 8, Application Specific Messages, for international use (SN.1/Circ.289). Competent authorities may use other Message 8 formats on a regional basis.

As an example, among the list of IMO Application Specific Messages is a message for meteorological and hydrological data. Sensors on the AtoN provide this data to the AIS AtoN Station, which in turn broadcasts this Message 8.

### Message 21

Defines the “Aids to Navigation Report”. AIS AtoN service enables AtoN providers to broadcast information on the following :

* Type of AtoN;
* Name of AtoN;
* Position of AtoN;
* Position accuracy indicator;
* Type of position fixing device;
* On/Off position status;
* Real and Virtual AtoN identification;
* Dimension of the AtoN and reference positions;
* Status of the AtoN systems.

### Message 25

Message 25 is a single slot binary message that can for example be used to send encrypted configuration data. See IEC 62320-2 for further details.

### Message 26

Message 26 may also be received, processed, and transmitted by an AIS AtoN station. Note that this message is not included in IEC62320-2.

### Messages 12, 14 , 25 and 26

There are two types of protocols for sending AtoN AIS messages. They are Fixed Access Time Division Multiple Access (FATDMA) and Random Access Time Division Multiple Access (RATDMA). These two protocols are set to ensure that messages from nearby AIS stations do not conflict.

## AIS AtoN type

### Type 1

This AIS AtoN Station is a transmit-only station, operating in FATDMA mode. Hence the slots used by the Type 1 AIS AtoN Station need to be reserved by a competent authority, using Message 20, transmitted from an AIS station in the coverage area. The Type 1 unit must be configured to use the slots reserved for it before being placed into service.

This is the simplest type of AIS AtoN station, likely to have low cost and low power consumption.

### Type 2

This AIS AtoN Station is similar to a Type 1, but has, in addition, an AIS receiver of limited capability which allows the Type 2 Station to be remotely configured via the AIS VDL. This receiver operates on a single AIS channel.

### Type 3

This AIS AtoN Station is more complex than the Type 1 and Type 2, and contains two AIS receiving processes that allow it to participate fully on the AIS VDL. This means that in addition to FATDMA, the Type 3 station can function in RATDMA mode.

The Type 3 station is therefore capable of:

* Autonomous operation, not requiring slot reservations (RATDMA);
* Autonomous operation using slots reserved by a competent authority, using message 20, transmitted from another AIS Station in the coverage area (FATDMA);
* Receiving and relaying AIS messages, including control and configuration messages for itself or for other AIS AtoN stations in a chain. See IEC 62320-2 for more details of chaining;
* Repeating AIS messages;
* Indirect synchronisation, using its receiving processes.

# Primary considerations

## Power consumption.

The power consumption needs to be balanced to the generation facility as well as the power consumption other AtoN such as lights etc. to deliver the required autonomy. The power consumption at the agreed configuration is recommended to be measured, rather than rely on the manufacturer’s generic data. The power consumption will vary depending on the transmit frequency and the sleep interval. See point 5 Commissioning & Testing for further details. Refer to IALA guidance note 1039 on Designing Solar Power Systems for AtoN

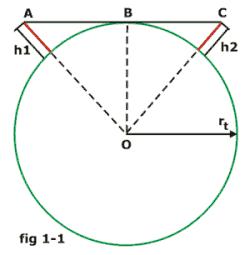
## Transmission range.

A typical transmission range is between 5 to 20 miles though this will increase with a higher aerial on the buoy and a high receiving station. In areas of very heavy traffic, the volume of AIS transmissions may overload the base station which will reduce the range at which the base station will be able to cover. With Type 1 AIS (FATDMA) in an area of heavy traffic, there may not be enough available slots to be allocated to enable transmission from the AIS station.

In a VHF bandwidth operation system, Transmission (Tx) and Reception (Rx) reach is understood to be tightly linked to the height of the antenna. Therefore, location is of key importance, ensuring the highest position in the AtoN for safe installation and maintenance.

Considering Earth’s curvature, the straight distance between two points can be calculated by contemplating a supposedly smooth surface, that is, devoid of any flaws. Nonetheless, the heights to be considered are those upon real surfaces plus the height of these above sea levels, in the exact same place.

Figure 1 shows a cross-section of the geoids by tracing a line tangent to the circumference, passing through the upper border of the point under consideration (i.e. the antenna) forming a right-angled triangle as in OAB, where:



1. Cross-section of the geoids

OA = rt + h1.

Where:

rt : Earth’s radius

h1: Height of antenna 1 plus height of position against sea level.

h2: Height of Antenna 2 plus height of position against sea level.

AB: Distance between point and horizon of this point

In this way, there can be calculated data-reception coverage of an AIS installed on a ship as compared to transmission coverage of an AIS installed on a floating beacon. Knowing the height of the ship’s antenna in question, coverage can be estimated by adding the later to the height of the beacon’s antenna, as shown in the formula below in nautical miles:

formula alcance

In conclusion, the higher the Tx/Rx antenna are placed, the greater the range.

A1: Height above sea level of antenna installed on the AIS on ship ≈ 25 m.

A2: Height above sea level of antenna of the AIS installed on the buoy

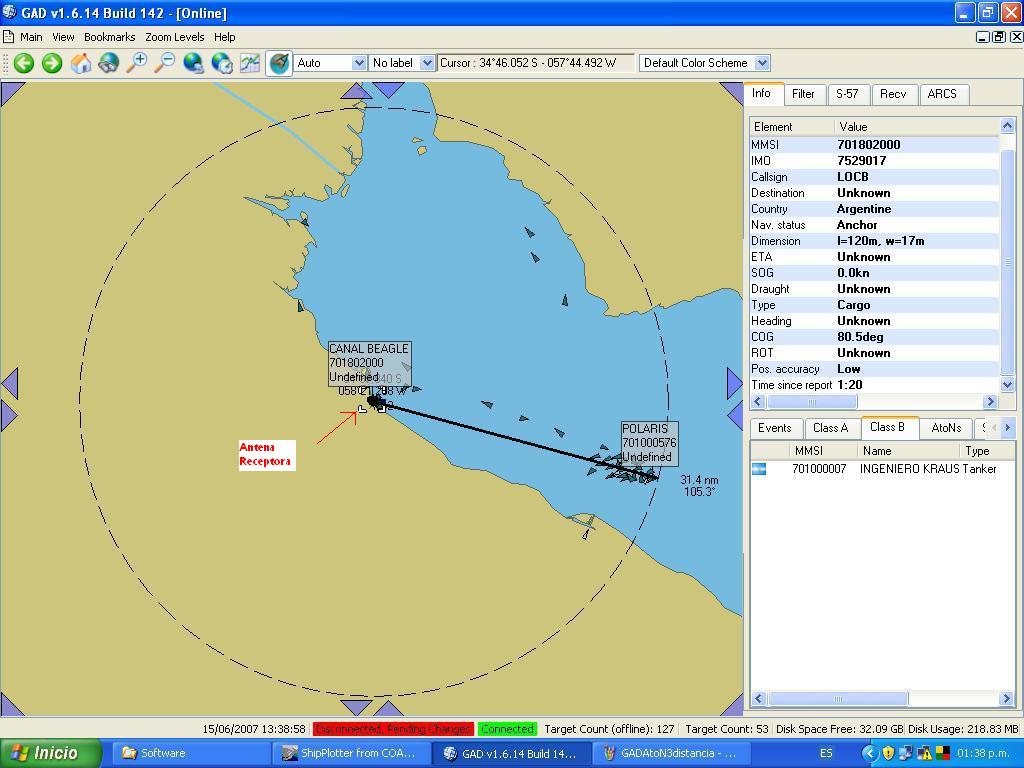
Sample formula to estimate coverage reached by different types of floating beacons.

* Spar Buoy– Height of AIS-Aton - A2=10m Range= 41.2 Km
* Maritime Buoy-type floating signal – Height of AIS-Aton - A2=4m Range= 35.3 Km

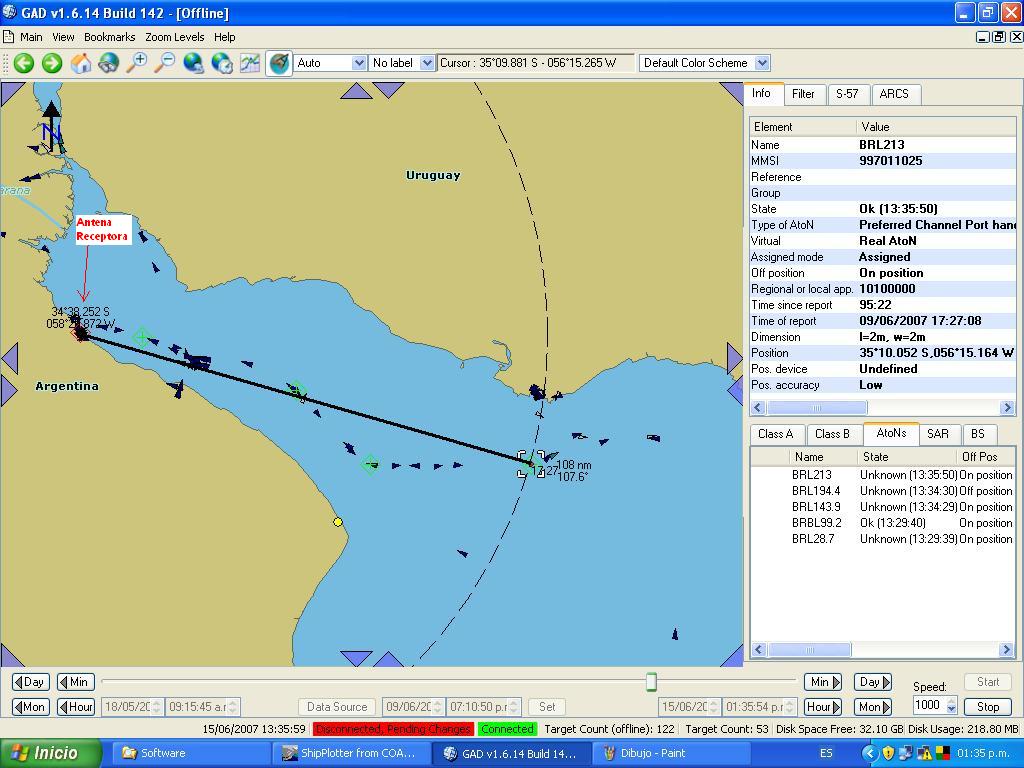
### Extraordinary coverage – Ducts or Tropospheric Refraction

In certain zones, under specific environmental conditions, the troposphere may experience a meteorological phenomenon that creates ducts and channels enabling VHF frequencies to extend across greater distances.

This phenomenon takes place during certain weather conditions during which there are different refractive indices which force electromagnetic waves to bounce back to the surface, thus broadly enhancing VHF coverage. This phenomenon should not be relied on to provide enhanced coverage.



1. Normal situation – Reception coverage ≈ 35 km



1. Situation with ducts – Reception coverage ≈ 200 km

### Selection of VHF antenna

The measurements and graphs shown above were obtained by means of an antenna analyzer AEA make, model Analyzer 140-525, which features an embedded frequency generator and a power meter to measure the Standing Wave Ratio (SWR).

The SWR is the ratio between maximum and minimum voltage of the standing wave. It may also be related to reflected and incident power, as shown below:

SWR= D+R / D-R

Where D is the number of divisions indicated by the instrument in a direct position, and R is the number of divisions indicated in a reverse position.

In case of perfect adaptation, SWR is 1 and all the power delivered by the system is radiated by the antenna, requiring that all installations endeavour to obtain the lowest possible SWR within the bandwidth or the frequency range in which the antenna operates.

VHF antenna to be installed for AIS applications is required to be marine VHF-type. Generally they have a central frequency is 156-157 MHz, and a bandwidth of between 6 and 7 MHz, ensuring good performance between 152 and 160MHz, and optimum work (SWR=1) in their central frequency.

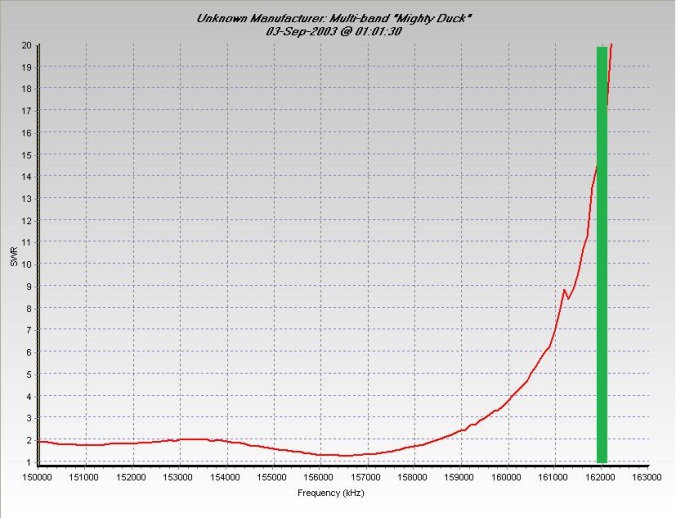
Given that the frequency channels used by AIS are 161,975 MHz and 162,025 MHz, it is critical to use an antenna with a broader bandwidth or tuned to a frequency closer to that defined for the work of AIS.

### Comparison of different marine antenna

The installation of AIS equipment must be designed around the performance of the antenna, since marine antenna is exposed to metal, dielectric and human influences.

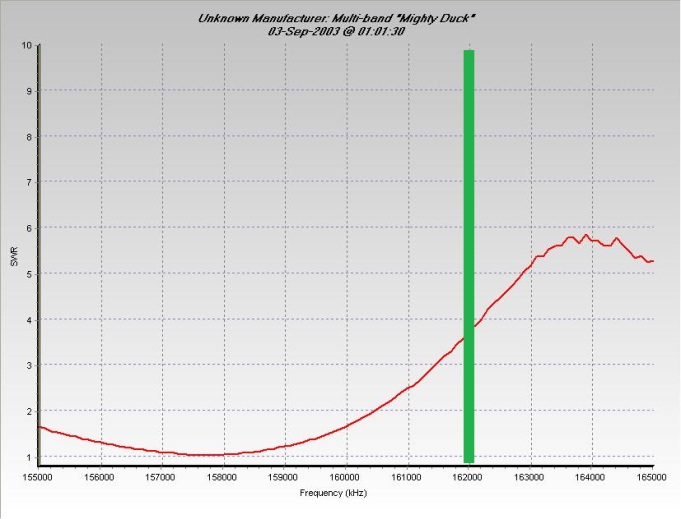
In order to make best choice of antenna to ensure a higher AIS efficiency and hence a greater coverage, there have been proposed three trials/measurements of different marine antenna associated to AISs installed on operational floating beacons.

As shown in graph Measurement 1, the measured antenna has a very low SWR (SWR around 1 is only achieved between 156 MHz and 157 MHz), though it lacks good response within the AIS frequency of 161,975 MHz and 162,025 MHz where that the SWR exceeds 10.



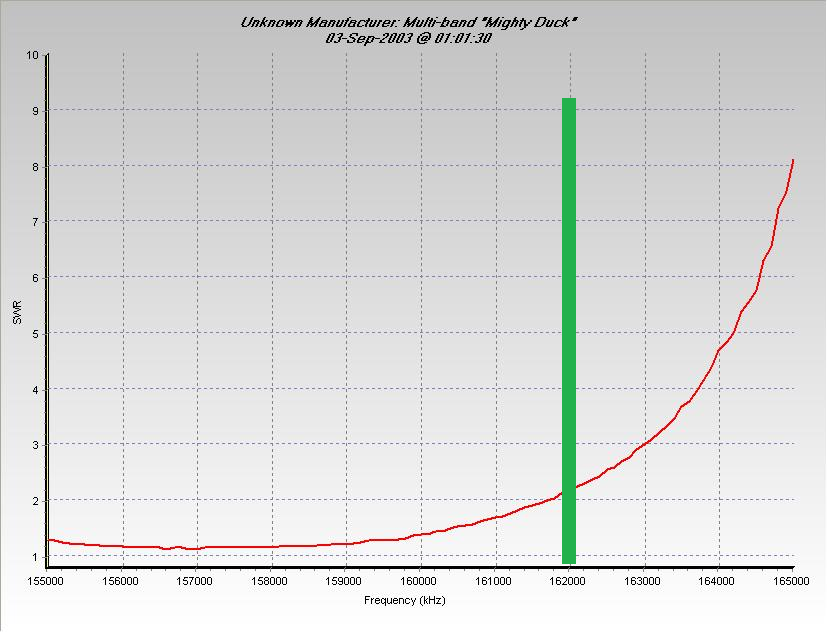
1. Measurement 1

In graph Measurement 2, this antenna has obtained better SWR figures for the AIS frequency with an SWR of 4.



1. Measurement 2

In graph Measurement 3, it is seen that this antenna is specially designed for AIS with a broader bandwidth than conventional marine antenna. This allows for a SWR of 2 within the working frequency of AIS, a highly acceptable ratio in terms of installations. Moreover, SWR remains close to 1 between 155 MHz and 159 MHz and gives a much flatter response than the previous ones, showing the high quality of the antenna.



1. Measurement 3

## Additional services.

### Message 8

AIS can be used to deliver additional services such as meteorological data and wave data. These can be incorporated into the e-Navigation services infrastructure. Accurate meteorological equipment can be very expensive and will require an analysis of the benefits over the cost of installation. Therefore, it may be a consideration to install the AIS on a Meteorological buoy rather than the other way round. Meteorological data can be difficult to verify and confirmation of the accuracy of this service needs to be assessed with any consequent liability. An assessment of the number of users who are able to receive and display message 8 with Meteorological data needs to considered otherwise this service will be of little value.

One problem with this AIS capability is that AIS units do not always interface easily with meteorological transducers.

Different suppliers present alternatives to capture the meteorological information.

* The AIS AtoN may receive signals only from sensors supplied by the firm. This is very inconvenient for already installed networks due to the difficulty of changing sensors
* The AIS AtoN may require additional software.
* The AIS unit may require an interface to be designed and built by the user.

This means that in all cases an important development of software and in some cases hardware has to be carried out in-house.

As a general conclusion it can be said that it is not straightforward to transmit message 8 and that it should not be taken for granted that this will always be possible.

### Message 21 Regional bits - Monitoring capability (battery voltage, light status etc).

Message 21 can also be used to measure the energy source, photovoltaic level and the light system. This turns an AIS-AtoN into a highly efficient management tool when it comes to understanding the performance of the equipment, and in this way, the system itself.

The setting standards are detailed in Recommendation A-126 Edition 1.5 Item 4.8.4, and are to be established in the management software/AIS display.

In order to display the values being monitored by the AIS system (eg Battery voltage, Light on/off, Racon on/off) suitable software is required. This software may be offered by either the AIS manufacturer or as a standard AIS tracking package via the internet or bespoke software from a third party.

### Satellite monitoring of AIS

May be available in the future.

## Integrated AIS Units.

### Integrated unit with 3rd party equipment

AIS can be supplied as an integrated unit with 3rd party equipment such as lanterns, metrological or hydrological sensors. Monitoring data can include solar voltage, battery voltage, status of operating lamp or flasher, number of available lamps remaining (lamp changer), sun switch status, flash code.

### Integrated with Lantern and power system

AIS AtoN can be supplied complete with an integrated lantern, solar PV power supply with battery storage and all required controls and monitoring facilities.

## Licensing by local licensing authority

When an AtoN has an associated AIS, it becomes part of a dynamic network of information which is run by the users according to their own requirements.

The AIS may be Real, Synthetic or Virtual (Recommendation A-126 Edition 1.5 item 4.2), but in every case they must be properly registered with their Maritime Mobile Service Identity (MMSI) accordingly (Recommendation A-126 Edition 1.5, Item 4.3), which must be applied for with the National Telecommunications Authority.

Usually the organization with responsibility at national level gives a preliminary authorization, which after time becomes definitive.

To obtain the MMSI for the first time in their country an interaction with the corresponding agency to define them is usually required. Each country will have their own licensing authority with particular fees and renewal arrangements that need to be followed.

# Physical Application

## IP rating

Electronic equipment installed on a Navigation Buoy will subject it to severe environmental exposure.

In order to safeguard the integrity of the equipment, increase its lifespan and ensure its reliability, the installation must prevent the condensation cycle from starting. In order to achieve this, an IP(Ingress Protection) level of no less than IP66 should be specified

### Issues

AIS-AtoN equipment installation is exposed to sudden changes in temperature during the night, which allows water vapour present within the enclosure to condense and produce water drops which rapidly inhibit the protection conferred by the desiccating agent installed.

As the air gets cooler and releases water drops, the volume of air is reduced giving way to a vacuum inside the enclosure. If the air tightness of the enclosure does not keep humid air from seeping in, the day-night temperature oscillation creates a constant condensation of the water vapour that gets drawn in during the night by the vacuum effect inside the container.

This condensation takes place when the temperature gradient cools a mass of air up to the saturation point, which means that at this temperature a mass of air cannot hold water molecules in gaseous state, therefore releasing them as water drops.

Saturation can only happen given the following three factors:

* Temperature gradient (Temperature difference between the air inside and outside the IP box);
* Water vapour (The higher the temperature of the air mass, the more water vapour it will carry);
* Air flow.

The removal of one of these three factors stops continuous condensation.

To this effect, it is fundamental that water-tightness be preserved, but above all, there should exist a state of balance between exterior and interior pressures eliminating air flow and breaking the cycle that generates condensation.

### IP enclosure rating

The enclosures and their connections should be rated to minimum IP66 and be protected from direct water spray. For more details see section 8.1.1

### Pressure balance

The pressure in the enclosure needs to be balanced with the outside in order to eliminate air flow between and thus eliminate condensation. This can be achieved with a propriety vapour barrier to the appropriate IP rating. For more details see section 8.1.2

## Lightning protection.

In areas where Lightning strikes are considered to be a specific hazard, consideration should be given to protecting the AIS unit from this by installing Surge Protection.

The implementation of a surge protection to ensure the equipment against an atmospheric discharge is essential in any installation of electronic equipment afloat.  
These atmospheric discharges affects stability of the equipment for the operation in the GPS signal acquisition and transmission.

The implementation of secure lightning protection requires good grounding to the water.

Block diagram of surge protection device

### Grounding

Block diagram of grounding device

## Location of VHF antenna and GPS antenna receivers.

### VHF antenna

In the case of floating signals, installing VHF and GPS antenna at the uppermost section of a superstructure is a disadvantage from the structural point of view as it is vulnerable to damage if the buoy is struck by a passing ship or when the buoy is being recovered for maintenance.



1. Collision effect

### GPS Antenna Receiver

When planning the installation of a GPS antenna on a buoy, it is priority that it be clear of any vertical obstruction at all times, considering also the angles of vertical divergence.

It is important to assess the position of satellites for the geographic location. This information is critical to locate the minimum number of satellites in the shortest time possible to assure effective transmission in slot allocation.

As long as the search sequence and reception of GPS signals is optimized for transmission, the timeframe of the equipment’s synchronization phase may be narrowed, with reduced energy use.

## Protection from physical damage.

### Security of mounting against shock loading & vibration

Consideration needs to be given to ensure that the AIS unit is mounted such that it is free from vibration. A buoy can produce vibration in the upper superstructure from the motion of the waves. In order to alleviate this, the unit can be mounted lower down in a stronger area of the superstructure or mounted with anti vibration pads.

## Hard wired or plug connections.

The weather conditions which AIS AtoN have to endure, may affect normal functioning thus shortening their lifespan.

It is of utmost importance that VHF and GPS wiring be well protected. In the case of GPS antenna, when they are not integrated in non-integrated equipment.

Deterioration and loss of flexibility and malleability of cables due to climate, UV rays and temperature gradient, plus mesh oxidation, lead to reduction or even loss of conductivity and increase of impedance.

# Commissioning & Testing – To review at EEP19 October 2012

## Power supply adequate for current spikes.

In terms of electrical energy used by equipment in standby mode, synchronization and transmission are generally fed by a photovoltaic generator.

The energy demand of an AIS system will vary during the various modes of operation and the power supply and cables must be designed to support the most onerous power consumption conditions

## Message testing

### Laboratory tests

It is important to set the measurement protocol in the tests that are performed on new equipment to be incorporated into stock and to those devices returning from the buoy station after a replacement for preventive maintenance. These measurements include operating current and voltage and stability to acquire GPS signals and subsequent transmission. The following describes a method of testing an AIS unit to assure that it is fit for purpose.

### Description of suitable equipment

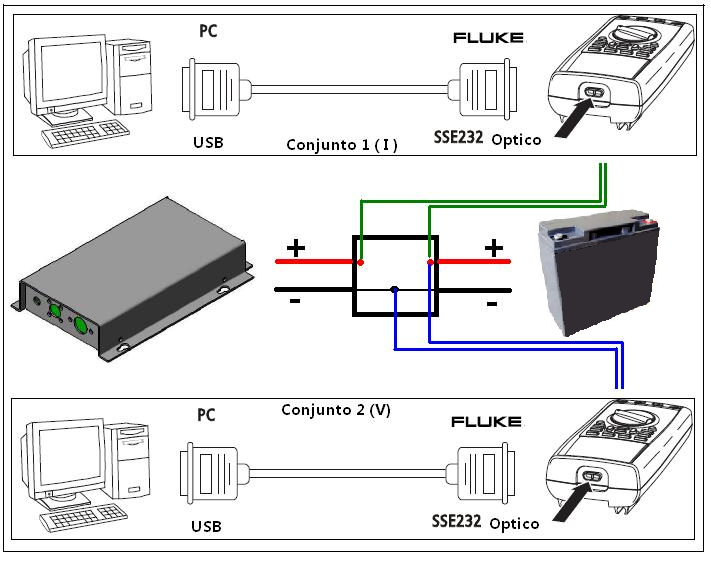
The test consists of measuring the power consumption of the equipment at the time and then analyze whether the transmission power and frequency comply with pre-configured on the AIS-AtoN.

The devices used are:

* Two multimeters Fluke 289 (Multimeter with PC data link);
* Two Notebooks with Fluke View Forms program installed;
* Configuration cable modified to facilitate the measurements;
* Equipment or AIS test AtoN;
* Power supply.

### Connection Diagram

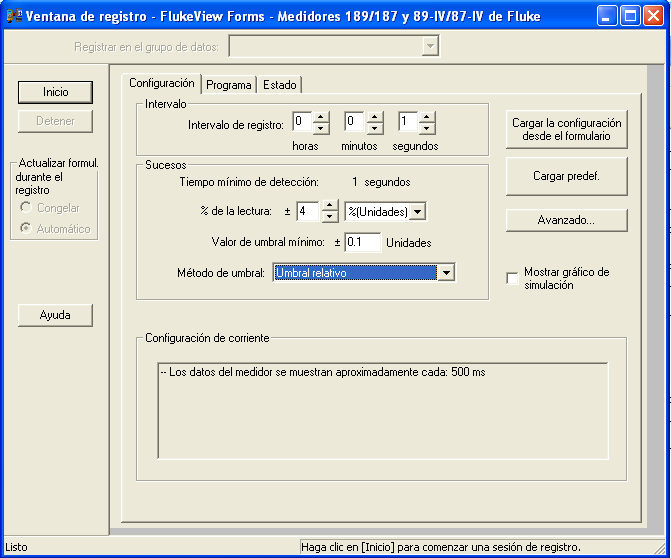
The measuring system 1 measures current measured while 2 voltages.



1. Power consumption measurement.

### Acquisition and data processing

With the AIS-AtoN connected to the measuring instruments it must be configured for the data acquisition scheme of the Fluke multimeter to store the data every 1 second and when the measure gained generates a jump of 4%.

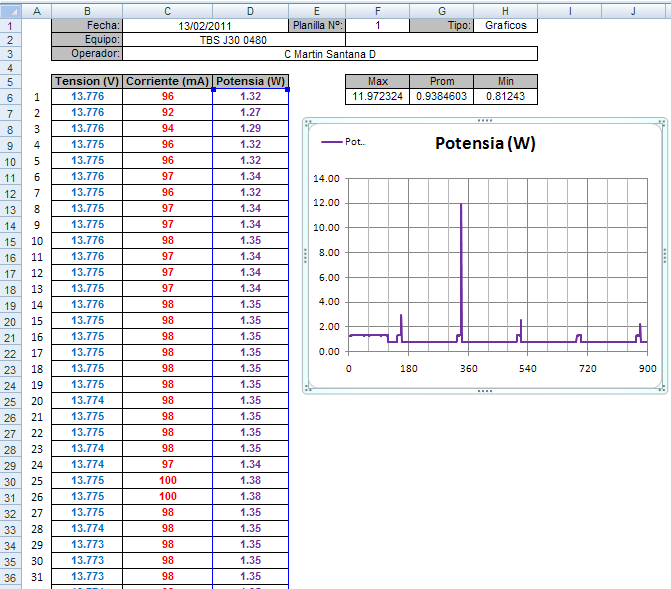


1. Fluke data acquisition screen

After configuring the data acquisition energize the equipment should be simultaneously initiate the data acquisition.

Completed the acquisition period predetermined in 15 minutes, dump the data from the two machines to a data sheet where data is extracted from voltage and current synchronized with the same time to produce the graphs of voltage / current and power.

Alternatively an oscilloscope can be used to monitor this power consumption

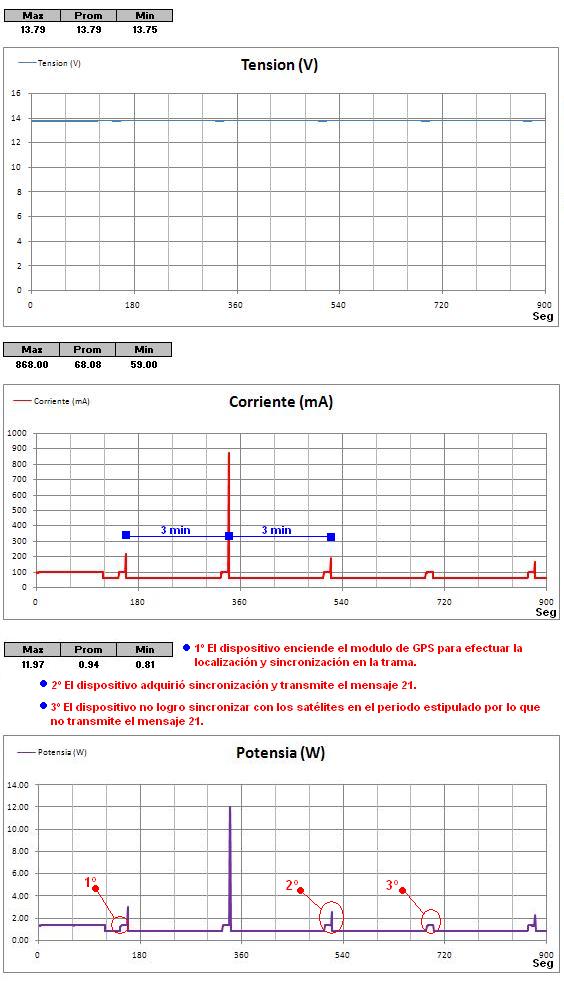


Power (w)

1. Results of power monitoring over a 15 minute period

Below is the graph of voltage, current and power and the observations are denoted.





Voltage (V)

Power (w)

Current (mA)

1. Title required

Explanation of the results.

1. In this example the AIS unit is operational over a 15 second period every 3 minutes (180 seconds)
2. In this example, the AIS unit remains in stand-by mode for 165 seconds drawing low power.
3. At 165 seconds after the last transmission, the unit wakes up and searches for its position by satellite location. This is the low part of the current spike.
4. When the AIS unit has identified its position, it synchronises and reserves or waits for a transmission slot, at 179 seconds it transmits its signal, this is the high value of the current reading.
5. The unit then returns to stand-by mode for the next 165 seconds.

The frequency of the sample period and the duration of the satellite sample can be adjusted by the user for specific locations & site conditions.

## Range testing

## Frequency verification

# MaintenANCE & oPERATION

## Programming

AIS AtoN units require programming for the following parameters

1. MMSI
2. Name of Navigation Aid
3. AIS type (Type1, 2 or 3)
4. Charted position
5. Guard zone (Fence)
6. Transmission interval
7. AIS type (Real, Virtual or Synthetic)
8. Slot allocation for type 1

This programming can be completed onshore or on station. The danger of programming ashore is that the buoy is not placed in the charted position and it will transmit an off station signal.

The issue with programming on station is the need to have programming equipment and trained staff on the ship to deliver this.

Confirmation of all on site programmed information needs to be recorded with the Competent Authority

## Spare transponders

It is necessary to have spare transponders to replace those that fail, are damaged by passing ships, vandalized or out of service for any other reason. The best way to maintain the service is to replace a malfunctioning transponder and to proceed to investigate the failure and eventually proceed to its reparation at the workshop

The spare number of transponders required depends on the installed number of them and an elevate compromised of level service. Assuming a high level of service the following list gives an indication

|  |  |
| --- | --- |
| Installed number of transponders | Recommended number of spare transponders |
| 1 | 1 |
| 2 to 3 | 1 |
| 4 to 6 | 2 |
| 7 to 10 | 3 |
| 11 to 16 | 4 |
| 17 to 50 | 25 % |

1. Spare transponders

## Maintenance requirements

## Training

### Capabilities required for lanternists. (Maintainers)

The technical staff associated with the maintenance and operation of AIS- Aton should have specific training that allows them to work independently in the resolution of faults that occur in AIS-AtoN. The skills required to maintain and programme AIS AtoN units at sea are at a higher level than that required to maintain a basic lighted buoy.

# Selection of equipment.

When selecting a suitable AIS AtoN system, the following points should be considered to ensure that the unit performs well in service;

* Favourable cost-benefit ratio;
* Size of unit compared to available space;
* Simple to configure and interrogate;
* Upgrade easy to perform;
* After-sales service;
* Hardware and software capacity expansion;
* Different hardware solutions adaptable to the equipment base;
* External LED status indicators;
* Integrated device, easy to install;
* External connection, (Example: military-style);
* Low power consumption.

### Issues to consider

* Protection against atmospheric discharge;
* Compatibility with GPS antenna. Complicated repair / maintenance on site.

# General Considerations for integrating an ais-AtoN System

The best method of work to achieve the flawless installation of an AIS-AtoN -whether integrated or not- is to ensure the highest quality of components, processes and people involved; moreover, to provide appropriate training for all the qualified personnel in charge at every stage of the deployment.

If the equipment is not fully integrated when delivered by the supplier, such service must be carried out by the installer, commonly making use of watertight enclosures which ensure the durability of the AIS equipment.

The purpose of this document is to offer guidelines for the perfect assembly of the watertight boxes mentioned above, and to establish sensible installation procedures, intended to ensure quality assembly and efficiency in the use of materials and resources, and in the avoidance of common errors.

## Impact on Buoy Performance

The installation of AIS on a small buoys of less than c. 2.5 m diameter may impair the buoyancy and stability characteristics. The overall mass and centre of gravity of any additional items needs to be considered at the design stage.

By definition, the AIS unit requires a GPS receiver and VHF antenna at high level, this will require cables to pass the light unit and may impair lantern performance. All cable routes need to be considered at the design stage to minimise this.

## General Assembly

Standardized assembly patterns ensure enclosure capable of withstanding challenging weather conditions, thereby preserving the equipment within.

In a harsh environment, consideration should be given to use 2 watertight boxes (> IP66) to provide double protection in case of flooding of the external box and condensation in the internal one.

This point stresses the necessary balance of pressure between both boxes to avoid condensation in the internal box, where the device is contained.

It is recommended that the VHF and GPS antennae be installed before the final stage of assembly of the external box onto the corresponding signal.

Consideration should be given to use of UV stabilized cables and protection to excessive UV rays and heat.



1. Fully assembled enclosure

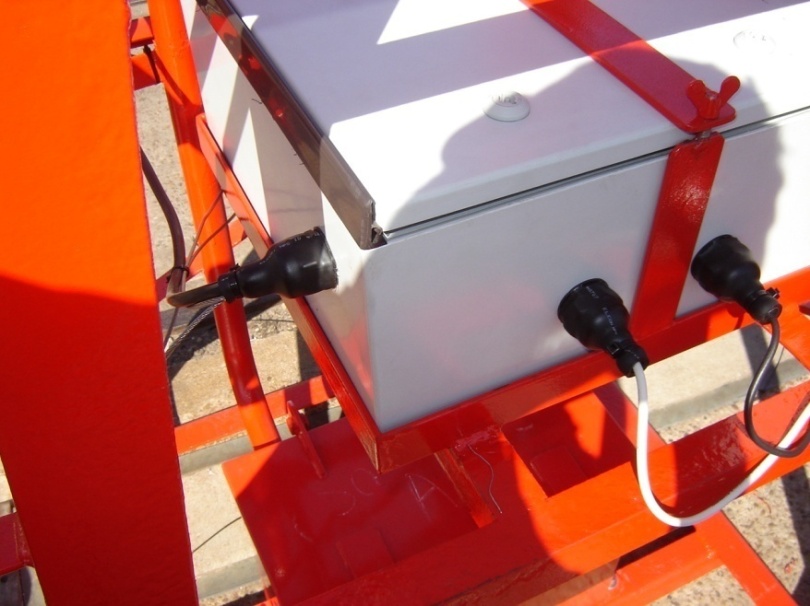
### Preparation of inlets in watertight enclosures

Ensuring a completely watertight enclosure is a challenging task given that the holes on the sides to let the cables in and to place cable glands or connectors are not original factory conditions.

Therefore, same calibre holes must be drilled into the front and/or sides of the boxes.

It is critical to seal all joints between the inlets and the corresponding cable glands and connectors using flexible glue so as to accompany the deformation derived from temperature oscillations.

In accordance with the installation guidelines, antennae must be plugged onto the same side in all boxes; likewise, power supply cables and earthing onto a different side.



1. Different sides of the perforated box

### Assembly of cable glands

Cable glands and/or connectors must be fitted carefully so that both the inner and outer rubber washers of the box do not get blocked and deteriorated when screwing the inner nut, making sure in this way that the whole set is firmly attached to the sides.

The clearance between glands and cables must be as insignificant as possible to ensure the minimum filtering of moisture.

A selection of different consecutive diameters may be necessary since there is no heat shrink tubing that will simultaneously adjust both gland and coaxial cable.



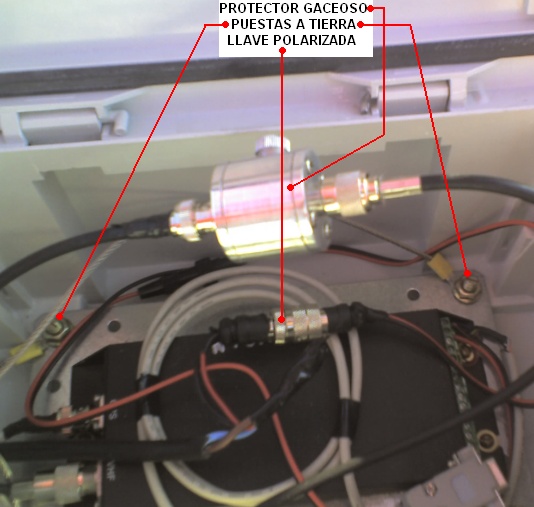
1. Different diameters of heat shrink tubes

### Preparation of the AIS System

Integrating different electronic devices requires that equipment and connections be firmly adjusted for the startup and fitting together of antennae and setup cables, thereby avoiding failure due to poor contact, loss of data and functional efficiency, and the possible ensuing breakdown of the equipment.

Inserting a rubber plate in the anchoring system of the AIS equipment has proven to be an effective way of softening vibration during the operation.

In some non-integrated installations it is recommended to fit a polarized key inserted between the power supply system and the input of the equipment. This key must remain inside the internal box.



1. Equipment with its protection



1. Complete Mixed IP Box

### Sealing of external connections

If the installation is performed using glands or connectors, moisture is liable to seep in, making necessary the use of heat shrink tubing. This component, which protects the cable connection of the external box, can be easily fitted; otherwise it can be stuffed with a paste that will seal the clearance between the heat shrink and the cable.

Once determined the stretch of heat shrink to be applied, the subsequent position of the cables must be calculated before the final adjustments are made.

When the heat shrinks have been properly fitted, the cables must protrude downwards -as shown on picture below- to enable smooth outpour of water.



1. Sealing of antenna and power supply inputs.



1. Sealed cable gland with heat shrink

### Connections and Completion

The gas shielding must be inserted in the input of the VHF antenna inside the internal watertight box keeping the connections isolated from any source of moisture.

Next, VHF and GPS antennae must be connected, verifying the SWR of the former, ensuring measurement around one (1) in line with point 3.2.3.

## General outlines for the assembly

1. Follow Installation Chart shown on Annex n°1.
2. The necessary components must be recorded on the chart.
3. The power supply system must always be inspected. Whether photovoltaic or not, redundancy must always be considered.
4. Boxes must be mechanized to enable the access of the power supply connections and the VHF/GPS antennae. It is important that this process be recorded in the Installation Chart so as to keep track of intermediate controls.
5. Once the external box has been anchored either to a superstructure, a floating AtoN or to its corresponding sledge -when it comes to fixed signals- the procedure must be recorded in the Installation Chart.
6. When antenna cables have been fitted, the SWR of the VHF antenna must be measured and the water tightness of the cable glands must be visually verified and recorded in the Installation Chart.
7. Having completed the installation and tested the system for at least one (1) week, the equipment will be ready to be installed.
8. List of necessary components for installations

|  |  |
| --- | --- |
| **Components** | **Non-Integrated Equipment** |
| Internal Box | Measurements |
| External Box | Measurements |
| Power Supply Cable | Cable prepared for open air exposure |
| Cable of VHF antennae | 50 ohms RG-58 coaxial cable prepared for open air installation |
| Ground cable | 5mm steel cable |
| GPS Antenna | Its voltage must be compatible with the output of the equipment |
| VHF Antenna | It must be set within frequency of channels 87 and 88 B |
| Protection against reverse polarity | Polarized key |
| Gas shielding | Gas shielding to be inserted in VHF antenna wiring |
| Connectors / Adapters | UHF / TNC / BNC |
| Sift-proof sealant | Flexible glue |
| Heat shrink tubes with watertight sealant | Consecutive stretches with different diameters |
| Cable glands / Connectors | Standalone |

# rEFERENCES

1. IALA Recommendation A-126 Edition 1.5
2. IEC 62320-2
3. IALA guidance note 1039 - Designing Solar Power Systems for AtoN
4. SAMPLE CHECKLIST
5. Sample checklist

|  |  |  |
| --- | --- | --- |
| **Checklist for the verification of AIS on AtoN installation** | | |
| **Signal** |  | |
| **Person at workshop** |  | |
| **Person on board** |  | |
| ***Item*** | ***Description*** | ***Agreement*** |
| **Signal type** |  |  |
| **AIS serial number** |  |  |
| **Internal & External Boxes** |  |  |
| **Internal & External Connectors** |  |  |
| **VHF Antenna** |  |  |
| **GPS Antenna** |  |  |
| **Gas shielding** |  |  |
| **Earthings** |  |  |
| **Heat shrink tubes** |  |  |
| **Insulation of cables and antennae** |  |  |
| **Attachment to structure** |  |  |
| **Equipment testing time** |  |  |
| **Regulator** |  |  |
| **Battery and solar panel** |  |  |
| **Antenna SWR** |  |  |
| **Photography** |  |  |
| **Start date/Finish date** |  |  |