Document Revisions

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**On**

**Guideline on the Application of AIS on Buoys**

**Edition 1**

**[Date issued]**

Revisions to the IALA Document are to be noted in the table prior to the issue of a revised document.

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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. This document should be considered as complimentary to higher level documents such as IALA Recommendation A-126 Edition 1.4.

# 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 1.4. The main messages that are of interest to the AIS as an AtoN provider are as follows;

## Message 21

This is the prime Aids to Navigation message detailing the AtoN position and light status.

## Message 8

This is for the provision of Application Specific Messages such as Meteorological data.

## Message 6

This is for monitoring the status of selected parameter on the buoy such as battery voltage.

## 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.

## Type 1 - FATDMA

This needs to be within transmission range of an AIS base station for slot reservation purposes. The benefits of this type of device are lower power consumption and reduced capital outlay.

## Type 3 - RATDMA

This can be located anywhere and will be received by a receiving station when within range. It will draw more power than the Type 1and will cost more but it is more versatile in its location as it does not require any slot reservation by a base station.

## Type 2

The Type 2 device will accept incoming information regarding slot reservation and messaging and will re transmit this from remote stations onto a base station. This enables the range of the AIS units to be extended to form a chain.

# Primary considerations

## Navigational Requirements

## 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.

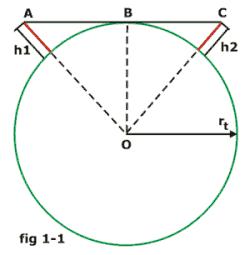
## Transmission range.

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. Satellite monitoring of AIS may be available in the future. In areas of very heavy traffic, the volume of AIS transmissions may overload the bases 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 their reach.

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 beacon

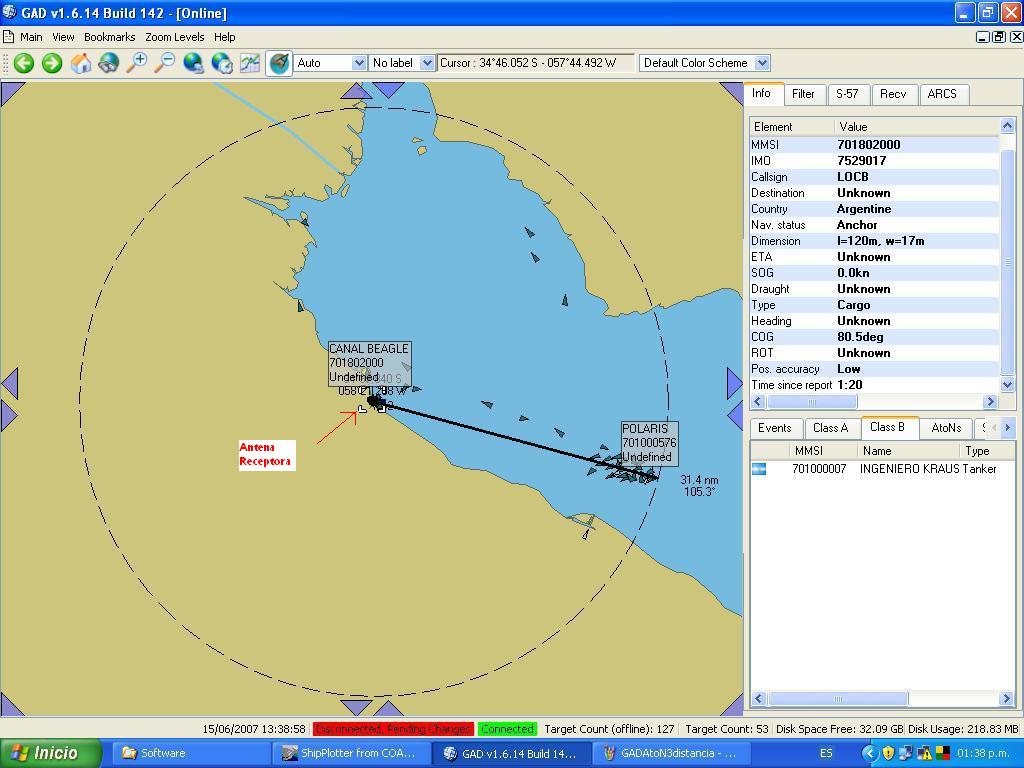
Sample formula to estimate coverage reached by different types of floating beacons.

* Speque-type floating beacon – 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

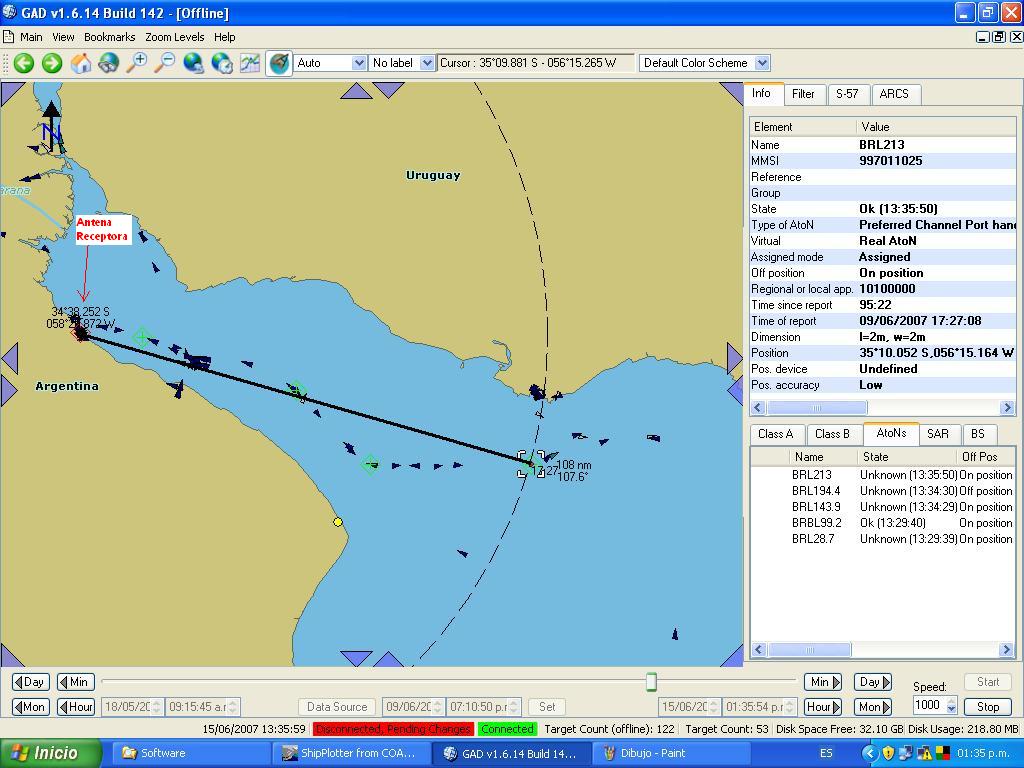
### Extraordinary coverage – Ducts or Tropospheric Refraction

In certain zones, under specific environmental conditions, the troposphere may experience a meteorological phenomenon which 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 indexes which force electromagnetic waves to bounce back to the surface, thus broadly enhancing VHF coverage.



1. Normal situation – Reception coverage ≈ 35 km



1. Situation with ducts – Reception coverage ≈ 200 km

### Selection of VHF antenna

The measurements and graphs hereby presented 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 (henceforth “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 pursue to obtain the lowest possible SWR within the bandwidth or the frequency range in which the antenna operates.

VHF antenna viable to be installed associated to AIS 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.

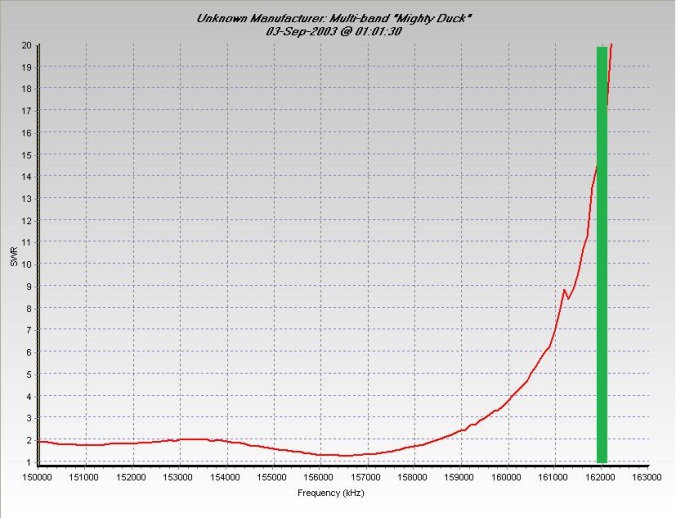
Given that the frequency channels used by AIS are 161,975 MHz and 162,025 MHz, it is critical to use an antenna with a broader bandwidth or tuned to a frequency closer to that defined for the work of AIS.

### Comparison of different marine antenna

The installation of AIS equipment must be designed upon the functioning hypothesis of its associated antenna, since marine antenna is exposed to metal, dielectric and human presence.

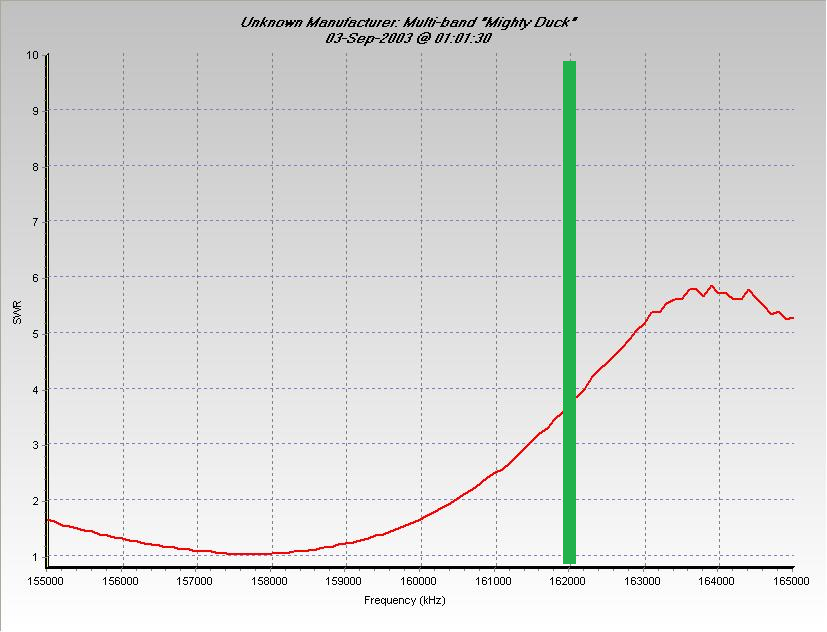
In order to make best choice of antenna to ensure a higher AIS efficiency and hence a greater coverage, there have been proposed three trials/measurements of different marine antenna associated to AISs installed on operational floating beacons.

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 frequency in question, considering that the SWR exceeds 10.



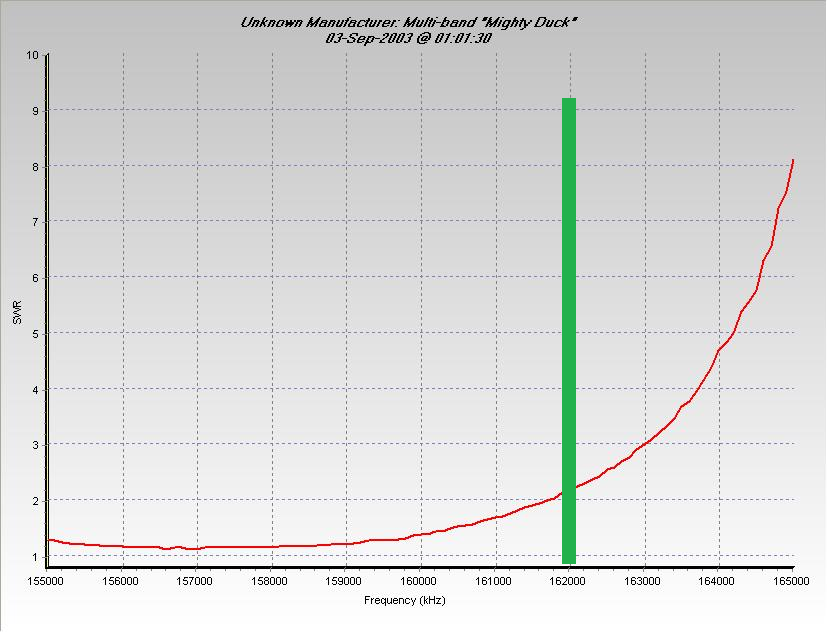
1. Measurement 1

In graph Measurement 2, this antenna has obtained better SWR figures for the frequency of work of the AIS, reducing SWR to 4.



1. Measurement 2

In graph Measurement 3, it may be observed that this antenna model specially designed for AIS features a broader bandwidth than conventional marine antenna. This allows for a SWR of 2 within 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.

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 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. Most standard navigation buoys are not wave following types and therefore wave data will need to be analysed. A n 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.

## Integrated unit with lantern.

## Monitoring capability (of battery voltage, light status etc).

The use of regional bit from message 21 to take a census of the energetic/photovoltaic and light system of the signal, turns AIS-AtoN into a highly efficient management tool when it comes to learning the real functioning and performance of the equipment, and in this way, that of the system itself.

The setting standards are detailed in Recommendation A-126 Edition 1.4, Item 4.8.4, and are to be established in the management software/AIS display. This information may be viewed by environment – (to be completed).

When AIS-AtoN are either presented like in point 3.5 (Integrated unit with lantern) or linked to the synchronizing cable of the lantern, producing synergy / functionality boost of the system.

## Certification compliance

## 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 1.4, item 4.2), but in every case they must be properly registered with their Maritime Mobile Service Identification (MMSI) accordingly (Recommendation A-126 Edition 1.4, Item 4.3), which must be applied for before the National Telecommunications Authority.

Usually the Organization with responsibility at National level gives a preliminary authorization which after time becomes definitive.

When the Service have to obtain the MMSI for the first time in their country an interaction with the corresponding agency to define them is usually required.

It is of utmost importance that this information be given official status / navigation safety - (to be completed).

# Physical Application

## IP rating

The installation of electronic equipment in an AtoN implies exposure to main environmental conditions amidst signal operation.

In favour of safeguarding the integrity of the equipment, increase its lifespan and ensure its reliability, the installation must, on the whole, prevent the condensation cycle from starting.

### Issues

AIS-AtoN equipment installation is exposed to sudden changes in temperature during the night, which allows water vapour present within the IP box 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 IP box. If the air tightness of the box 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 annulment of one of these three factors stops continuous condensation.

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

## Lightning protection.

## Location of antennas and receivers.

### On floating Aids to navigation

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 of the signal, since this section undergoes the greater oscillation during the synchronic pendular movement displayed by the signal when operating.

This section is the one that strikes the upperworks of a vessel that gets engaged.



1. Title required

### On fixed Aids to navigation

For this type of signals, the greater the coverage of the signals, the higher the VHF antenna may be installed, and the better physical protection it may be conferred.

Likewise, fixed signals such as beacons and lighthouses are rarely placed close to navigation channels, avoiding in this way, being engaged by vessels.

Nonetheless, when close to the shore, there is a chance of exposure to other physical hazards such as vandalism, for which no protection can be applied without interfering with the normal performance of the antenna.

It is of key importance that the horizon be clear and without shadows to enable the broadest range of VHF propagation in accordance with the power of the equipment.

As regards installations placed in port areas, there may not exist a straight line of sight toward the monitoring station, in which case it may be necessary to install a repeating system to triangulate the information to the station of reception.

### GPS Antenna

When planning the installation of a GPS antenna on an AtoN, it is priority that it be fully absent of any vertical obstruction at all times, considering as well, the visual angles of vertical divergence.

It is important to study thoroughly the position of satellites as per geographic location. This information is critical to locate the minimum number of satellites in the shortest time possible, to ensure effective synchronization.

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

## Protection from physical damage.

## 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.

## 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 later must be designed in such a way that the required power is delivered in every phase, and any energy imbalance is avoided should greater intensity be needed during the more demanding phases of the equipment’s operation.

## Selection of equipment.

### Advantages

* Favourable cost-benefit ratio;
* Small size suitable for installation;
* Setting-friendly, Soft enjoyable and intuitive configuration;
* Upgrade easy to perform;
* After-sales service;
* Capacity expansion at the hardware and software;
* Different hardware solutions adaptable to the equipment base;
* External LED status indicators;
* Integrated device, easy to install;
* External connection, (Example: military-style).

### Issues to consider

* Not have incorporated protections against atmospheric discharges;
* Not work properly with any GPS antenna, it only works with some antennas 3.2V;
* Complicated repair / maintenance on site.

## Security of mounting against shock loading & vibration

# Commissioning & Testing

*Note – Check GLA commissioning sheets & data*

## 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.

### Description of equipment used

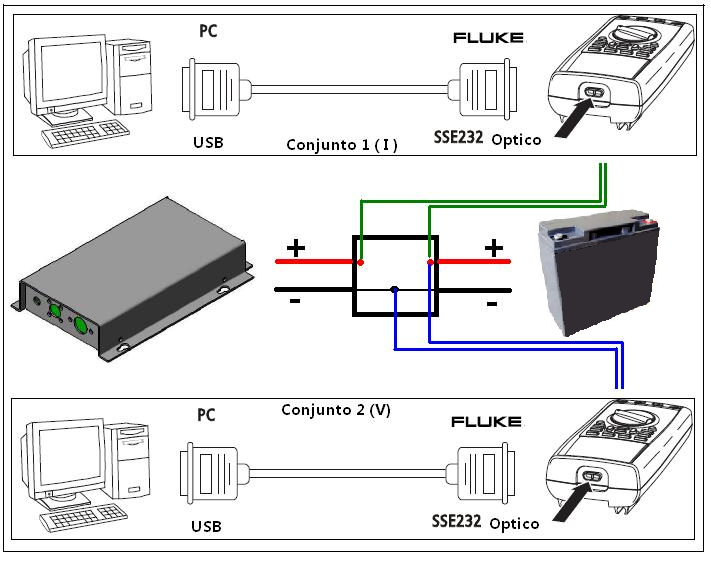
The test consists of measuring the consumption of the equipment at the time and then analyze whether the transmission power and frequency comply with pre-configured on the AIS-AtoN.

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

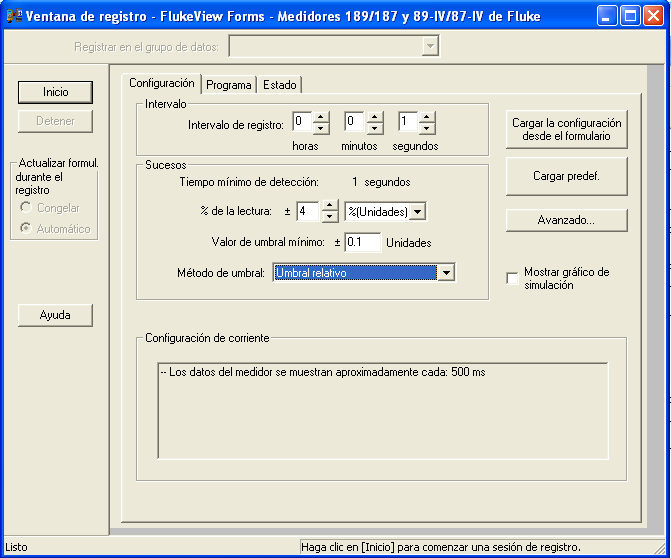
The measuring system 1 measures current measured while 2 voltages.Leer fonéticamente



1. Title required

### Acquisition and data processing

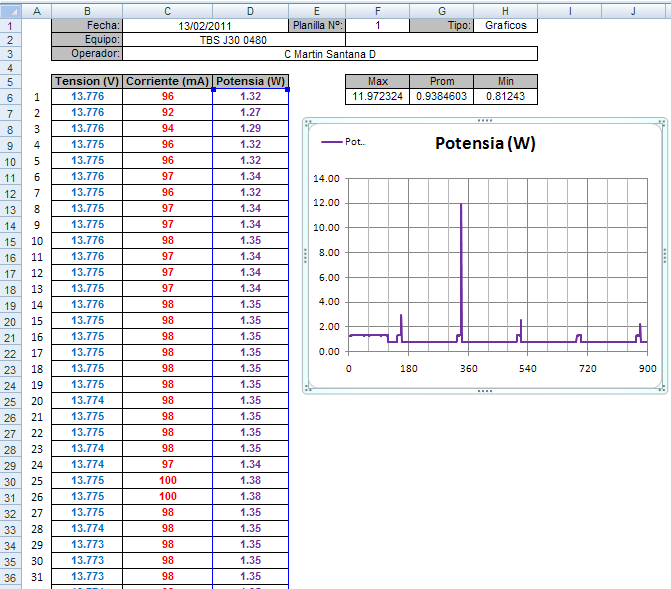
With the AIS-AtoN connected to the measuring instruments must be configured data acquisition scheme of the Fluke multimeter to store the data every 1 second and when the measure gained generates a jump of 4%.



1. Title required

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.



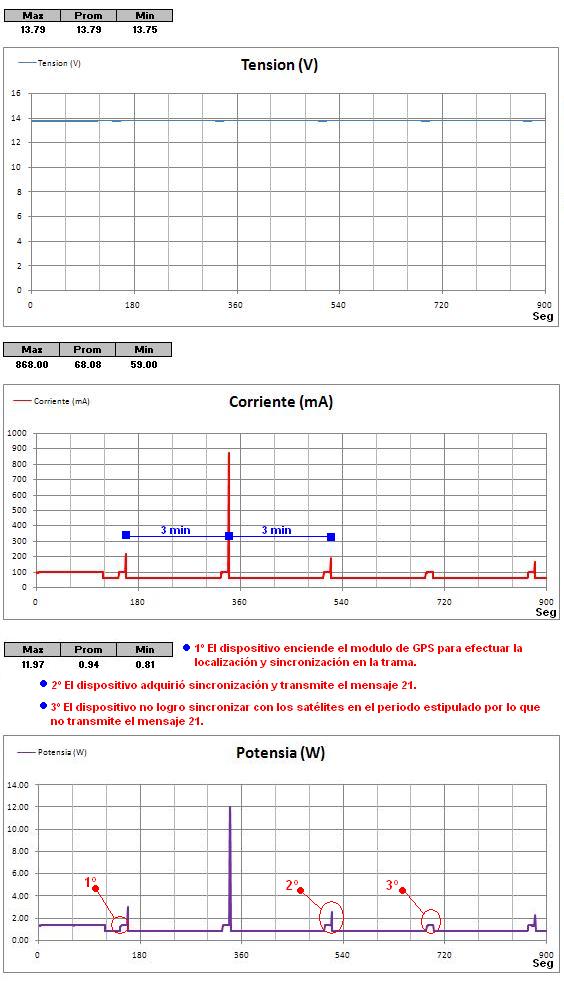
Power (w)

1. Title required



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

Leer fonéticamente



Voltage (V)

Power (w)

Current (mA)

1. Title required

## Range testing

## Frequency verification

# MaintenANCE & oPERATION

## 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 transponder 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

1. Title required

|  |  |
| --- | --- |
| 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 % |

## 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. These people are not the usual lanternist.

# rEFERENCES

1. aaaaa
2. bbbbb
3. Annex Title

Guidelines should have Annexes. Appendices are attached to Annexes.

1. ANNEX HEAD1

Body Text

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* Office 2003, go to Format / Bullets and Numbering / Restart numbering (lower left in the box)
* Office 2007, go to down arrow next to Numbering icon and select Set Numbering Value
  1. Annex Heading 2

Body text

* + 1. Annex Heading 3

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* + - 1. Annex Heading 4

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1. APPENDIX TITLE
2. APPENDIX Heading 1

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* 1. Appendix Heading 2

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