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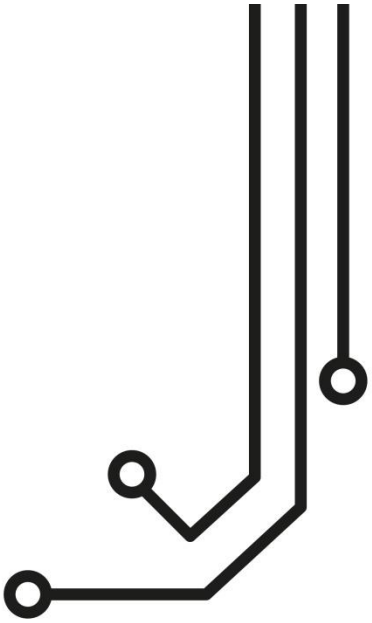

Introduction to AIS White Paper

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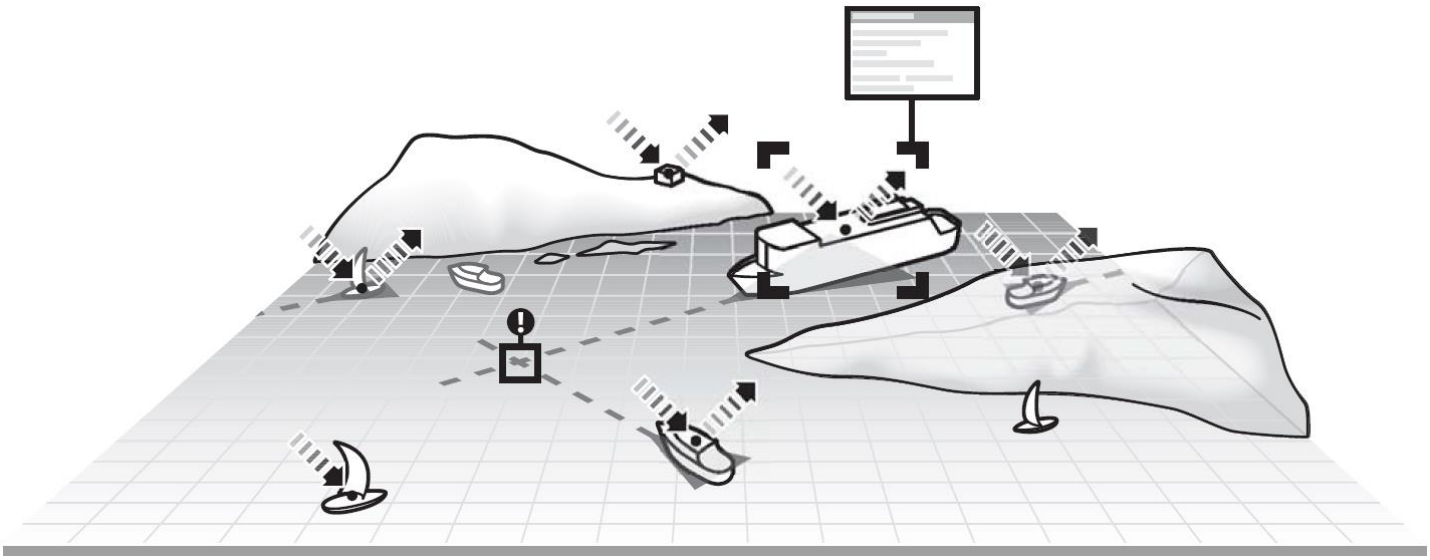
1. Background

AIS (Automatic Identification System) is the mariner's most significant development in navigation safety since the introduction of radar. The system was originally developed as a collision avoidance tool to enable commercial vessels to 'see' each other more clearly in all conditions and improve the helmsman's information about his surrounding environment.



AIS does this by continuously transmitting a vessels identity, position, speed and course along with other relevant information to all other AIS equipped vessels within range. Combined with a shore station, this system also offers port authorities and maritime safety bodies the ability to manage maritime traffic and reduce the hazards of marine navigation.

Due to the great safety benefits offered by AIS, the fitting of a Class A transponder was made compulsory throughout the world in 2002 for all vessels over 300 gross tonnes or that carried more than 12 passengers. For smaller vessels that fell outside of the mandate, a new Class B transponder was defined which allowed fishing and leisure vessels to fit a lower power/cost transponder that worked on the same AIS network and could receive and transmit signals to the Class A transponders fitted to commercial vessels.

AIS transponders are now commonly seen on many leisure vessels, particularly blue water or racing yachts where many organisers are insisting that all competitors must fit a Class B transponder. Some National Maritime administrations have included AIS in their local carriage requirements, two examples in Europe are that all fishing vessels must fit Class A transponders now and all commercial craft on the European waterways must fit an Inland AIS transponder or a Class A transponder.

Recently personal AIS SARTs have been approved for use as Man Overboard systems and with Search and Rescue vessels/helicopters now fitting SAR transponders, AIS is becoming an important part of the Global Maritime Distress and Safety System (GMDSS).

Other new AIS applications include vessel tracking, with websites like Marine Traffic and AISLive that collect and display thousands of AIS targets from their shore based AIS reception networks or global satellite reception via companies such as Orbcomm, exactEarth and Spacequest.

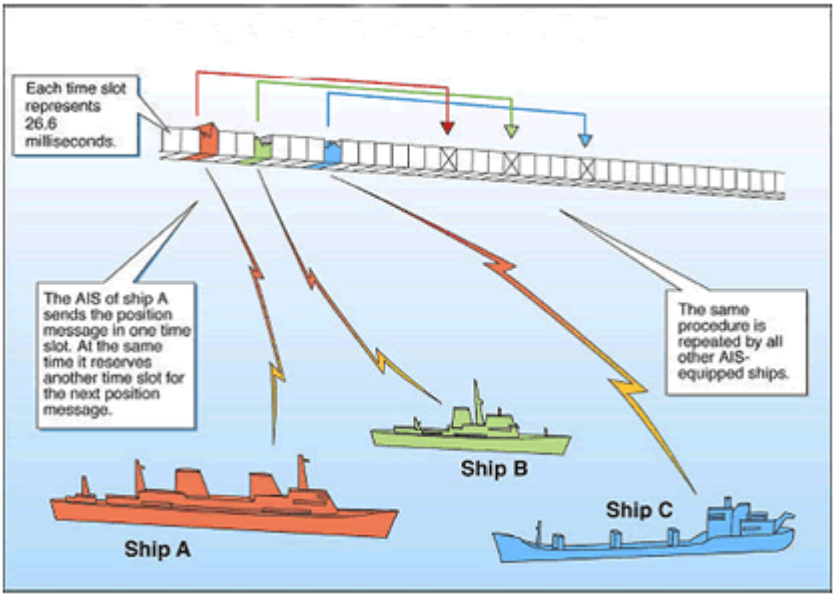
Many national marine authorities are installing special Aids to Navigation (AtoN) transponders that can replace traditional Buoys and Beacons and transmit local weather/tidal information to passing vessels, while some large and busy harbours or shipping areas use AIS as part of their Vessel Traffic Services (VTS) to manage and control shipping movements.

2. How AIS Works

An AIS transponder consists of a GPS receiver and a VHF “Data” Radio. The transponder takes its GPS position and transmits this in Digital Form on two VHF channels dedicated to AIS (161.975MHz and 162.025MHz).

In order that multiple AIS transponders can “play nicely together” and avoid all of the devices transmitting at the same time, causing interference and loss of data, AIS transponders use a system called Time Division Multiple Access (TDMA). This is a similar system to that used in mobile phones, where each AIS transponder claims a very short 26.6 millisecond “time slot” where it transmits its information. The claiming of Class A time slots uses “Self Organised” TDMA where multiple transponders know how to claim and reserve time slots and what to do if there is a dispute with another transponder trying to claim the same time slot.

The system works well and allows up to 4500 ships to work within close proximity of one another, automatically giving priority based on distance apart, i.e. as the number of vessels increases, the ones furthest away do not get a time slot.



When Class B transponders were introduced, they used a slightly different technology called “Carrier Sense” TDMA where the Class B transponder listens to the Class A transponders and as soon as it detects an empty time slot, grabs it and makes its transmission. Occasionally a Class A transponder will “steal” a time slot from a Class B transponder and the system is designed that Class A transponders always take priority over Class B, so the Class B transponder will have to delay its transmission and start listening again for another empty slot.

The number of transmissions that a transponder makes and the type of data it sends varies based on its Class (A or B), its speed, whether it is manoeuvring and its navigation status. A fast moving ferry may output its position every couple of seconds while a yacht at anchor will only transmit every 3 minutes.

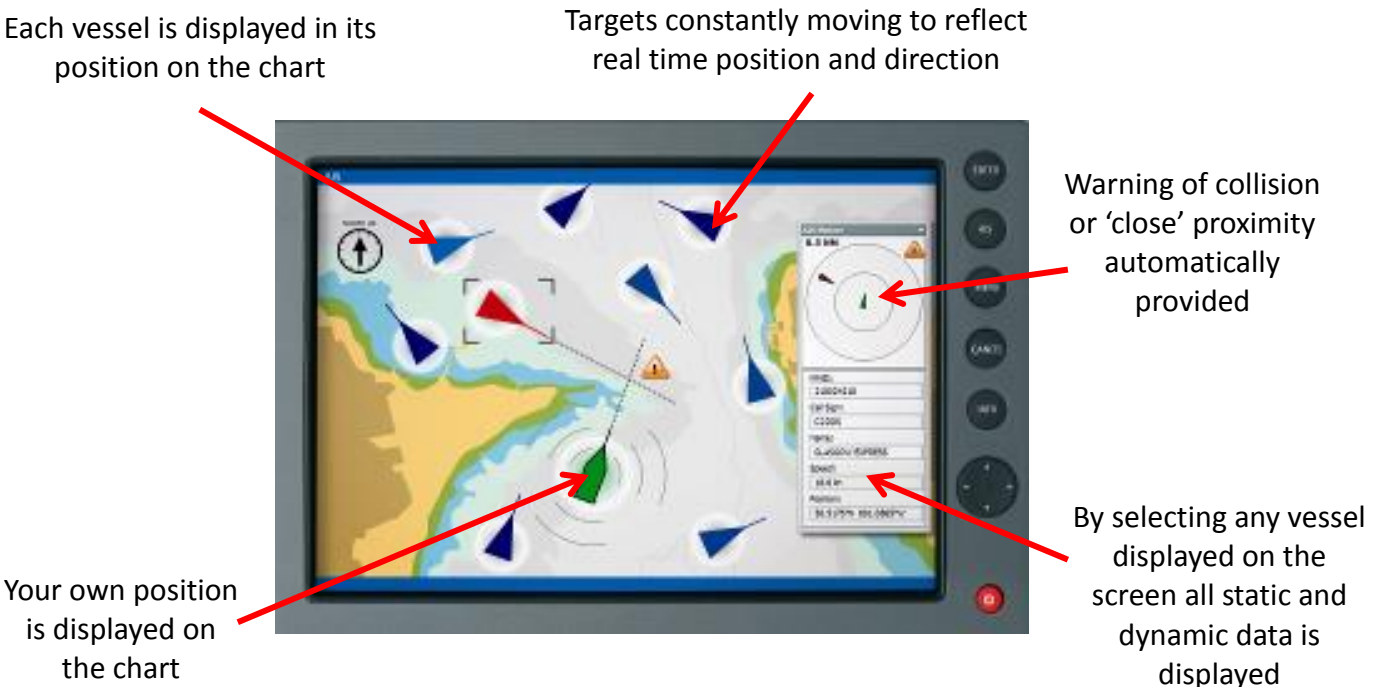
To avoid too much data being transmitted, only the “Dynamic Data”; Position, Speed, Course and Heading are transmitted at regular intervals, while the “Static Data”; Vessel Name, Call Sign, Dimensions, Vessel Type, etc. is transmitted every 6 minutes. The two sets of data are linked by the vessels MMSI number and this is why you will see AIS targets with no boat name (only their MMSI) for a few minutes when you first turn on an AIS display system.

All AIS transponders (types A and B) transmit and receive AIS data from every other type of AIS transponder including the latest AIS SARTs, AtoNs, Base Stations and Search and Rescue transponders. For smaller vessels wishing to save money or for applications that do not require AIS transmission, it is possible to use AIS Receivers that only receive AIS data and do not try and transmit their own position.

AIS Receivers were initially single channel devices that listened to one of the AIS channels for a period of time and then switched and listened to the other AIS channel. Whilst listening to one channel, any AIS transmissions occurring on the

other channel were missed and so single channel receivers are no longer recommended. If looking for an AIS receiver. make sure to check that it is a true “Dual Channel” receiver that is constantly monitoring both AIS channels.

Whether you install a receiver or a transponder, by connecting the AIS data to an AIS enabled Chart Plotter, navigation software on a PC/Mac or an App running on a smart phone or tablet, you will immediately see a live graphical display of AIS traffic in your area. Similar to a radar type display but with the benefit that the data is digital and tells you exactly what vessels are around you and what they are doing, rather than having to study and try to interpret the different “blobs” on a radar screen



The range or coverage of the system is similar to a VHF radios and in general for best reception/transmission range, the AIS/VHF antenna should be mounted as high as possible. AIS also has the advantage that VHF radio signals will travel around bends and over islands giving better coverage than RADAR or enhancing a RADAR picture when used together.

AIS data can be interfaced in a four different ways;

1. High Speed NMEA0183 wired connection at 38400 baud, two additional sentences were created for AIS; **VDO** (for own ship data) and **VDM** (for all other vessels data).
2. NMEA2000 wired connection, a series of new PGNs were introduced for AIS but due to delays in adding the Class B PGNs, some early NMEA2000 chart plotters did not show Class B Static data.
3. USB wired connection at 38400 baud, which is the same format as the High Speed NMEA0183 but a USB interface for connecting to PCs and Macs.
4. Wireless NMEA0183 connection using UDP or TCP network protocols, currently the only way to get live on-board AIS data in to a smart phone or tablet.

3. Benefits of AIS

Prior to AIS, radar and visual look-out were the only tools available to monitor other vessels and avoid collisions, now every commercial vessel and an increasing number of leisure vessels are transmitting clear and concise information of where they are and what they doing. Now you can immediately see all of the commercial vessels within VHF range of you, set alarms that will warn you if they are going to pass too close to you and take efficient and effective action to identify and contact them.

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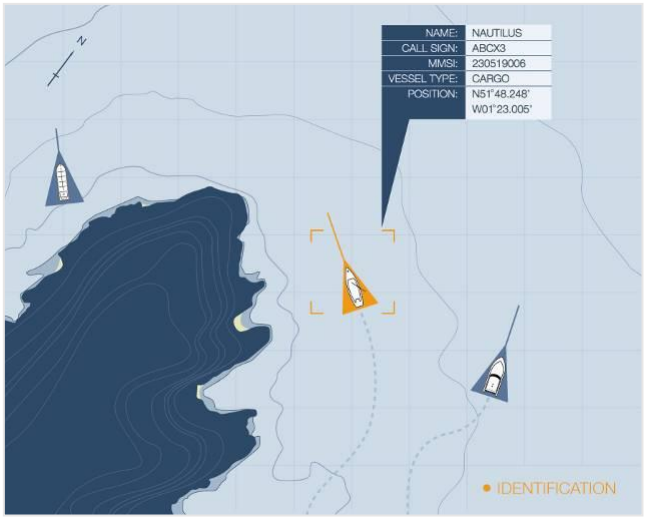
Below are some illustrations of the main benefits of AIS, but as more and more countries and maritime applications start to use AIS based products, the list of AIS benefits is sure to grow.

Collision Avoidance

- Receive clear and regular position reports of all AIS equipped vessels in your area
- Set CPA and TCPA alarms
- Identify and make a DSC radio call to a dangerous vessel using their MMSI number

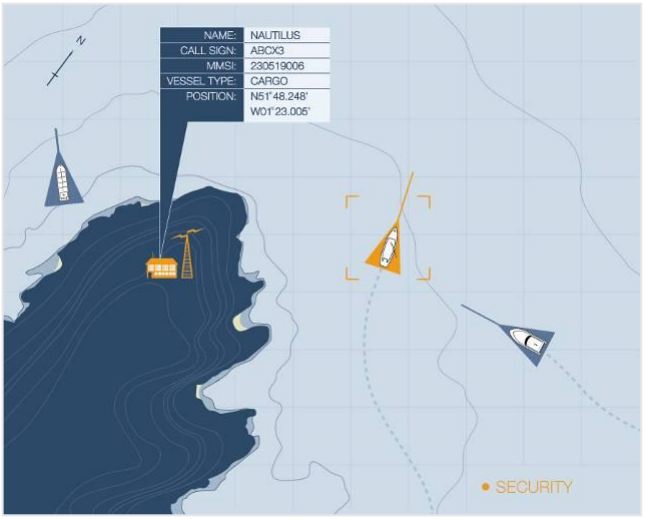
Identification and Tracking

- Receive MMSI number, vessel name and boat type of all AIS equipped vessels
- Find any of your friends' boats "Buddy Tracking"
- Friends and family can use online AIS services to track your trip/race from home



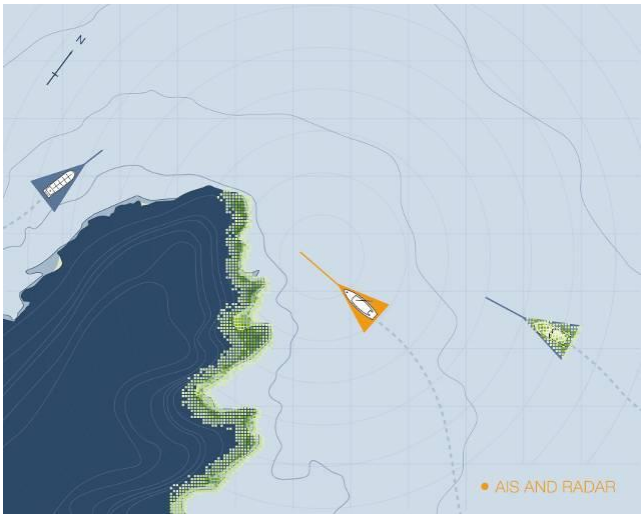
Safety and Security

- Emergency services now using AIS
- AIS SARTs are ideal for close proximity MOB rescue
- Quick and easy vessel identification for maritime services



Improving on Radar

- "See Around Corners"
- Vessels, AtoNs, Rescue Craft displayed as objects not "blobs"
- Low power and low cost alternative to radar for small boats



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4. AIS Alarms

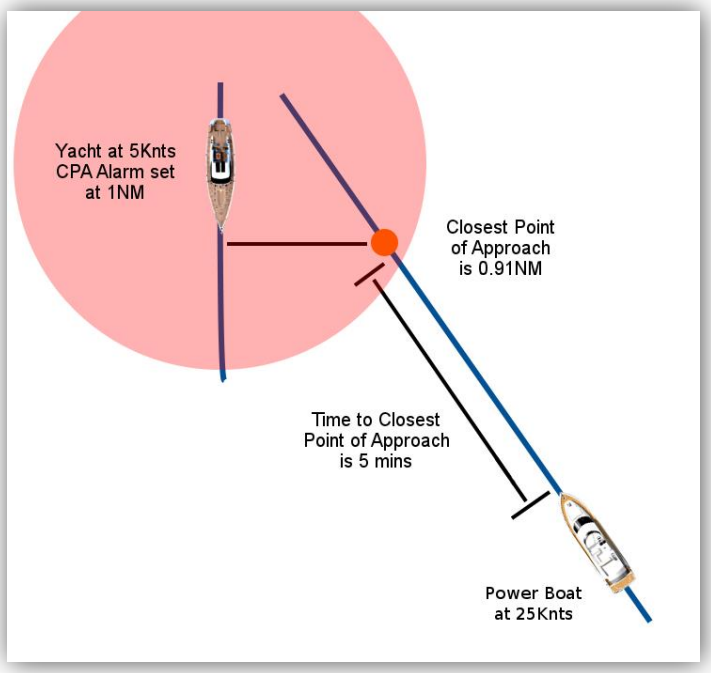
An AIS transponder or receiver, simply communicates the position, speed, course and boat details of the AIS targets around your boat, it is up to the equipment that displays the AIS data to work out range and bearings so that alarms can be generated for dangerous vessels that could potentially be on a collision course.

Most modern chart plotters and PC/Mac navigation software packages support AIS Alarms and even some of the smart phone and tablet Apps now offer this functionality. There are generally two AIS Alarms;

1. Closest Point of Approach (CPA)
2. Time to Closest Point of Approach (TCPA)

Normally you would decide what the closest distance is that you would feel comfortable having a large commercial vessel pass you at, for example 0.5NM and also the time you need to take avoiding action for example 15 minutes. There are no “best settings” for CPA and TCPA and the settings you use will depend on the speed you are making, where you are sailing (confined river or open sea) and of course your experience and confidence level.

Once the CPA and TCPA alarm values are set and the AIS Alarm function is turned ON, the navigation system will start to monitor the AIS targets and work out a CPA and TCPA value for each target. Any target that becomes dangerous i.e. CPA or TCPA values are less than the alarm settings, will trigger a visual and/or audible alarm.



As well as alarming, some navigation systems will also display the actual location of the CPA and display the dangerous vessel in red, so that it is immediately obvious which vessel is causing the alarm. However, not all AIS implementations are the same and it is important to be aware of how AIS Alarms are displayed and handled on your navigation system.

5. More About AIS Classes

As has been explained, there are two distinct classes of AIS transponder; Class A the original transponder introduced for commercial vessels and Class B the transponder introduced in 2006 for non-SOLAS vessels including pleasure craft. On the following page is a table that shows the differences between the two AIS classes.

Class A and B Comparison of Functionality

Function	Class A	Class B
Transmit Power	12.5W	2W
Transmit Rate	Up to every 2-3secs	Every 30 secs
Minimum Keyboard + Display (MKD)	YES	NO
Technology	SOTDMA	CSTDMA
Guaranteed Time Slot Allocation	YES	NO
Voyage Data	YES	NO
External GPS Connection	YES	NO
Price (approx)	£2000	£500

As you can see from the table above, in normal operation a Class A transponder transmits at a much higher power than a Class B. In “real-life” terms a well installed Class B transponder should be able to transmit up to 7-8NMs whilst a Class A transponder maybe seen as far as 20-25NMs away.

In terms of the data that the two systems transmit, the table below shows the differences;

Class A and B Comparison of Data

Data Transmitted	Class A	Class B
MMSI + Vessel Name + Call Sign	YES	YES
Position + COG + SOG	YES	YES
True Heading	YES	YES
Rate Of Turn	YES	NO
Nav Status	YES	NO
IMO Number	YES	NO
Type of Vessel	YES	YES
Vessel Dimensions	YES	YES
ETA + Destination + Draught	NO	NO

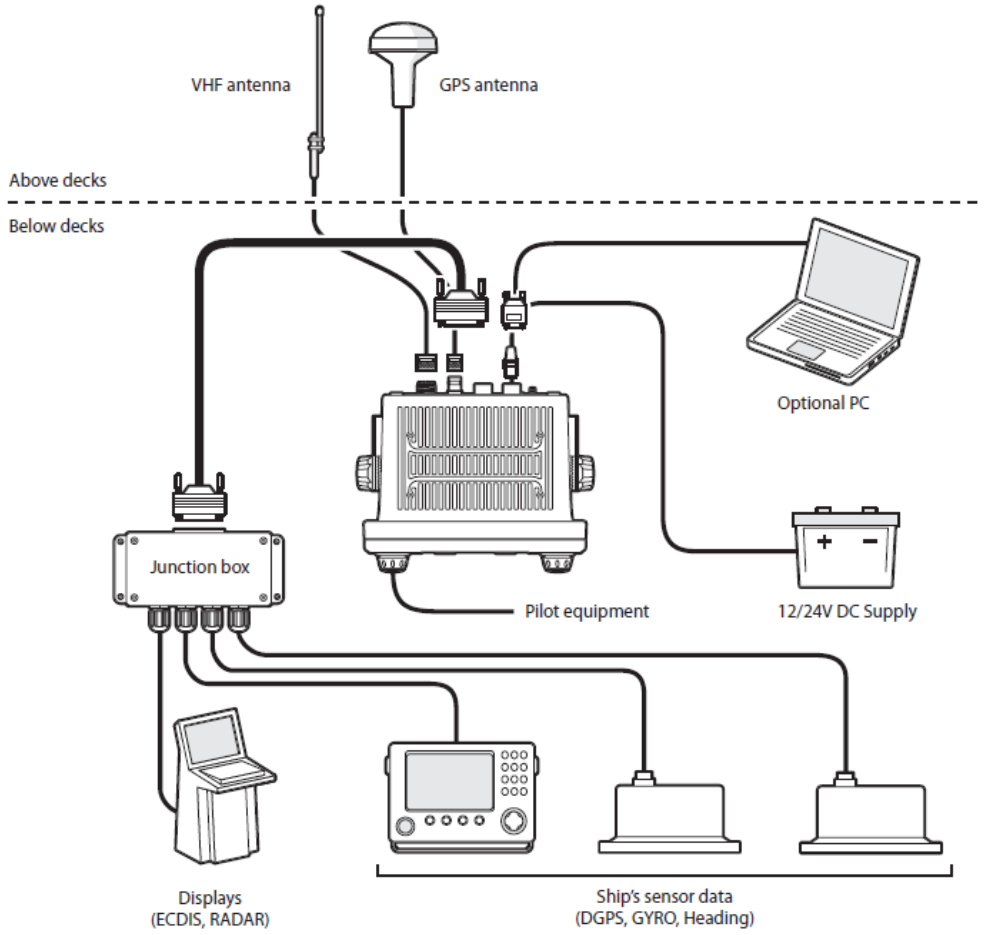
Finally the table on the next page shows the different data transmit rates of the two systems. As you can see the Class A transponder has a number of different transmit rates based on its speed, whether it is turning and also its Nav Status, whereas the Class B transponder simply outputs more often when it is doing more than 2 knots – a value that was chosen to allow for the typical inaccuracies of the GPS speed over the ground values in early GPS receivers.

Class A and B Transmit Rates

Ship's Dynamic Conditions	Class A	Class B
Ship at Anchor or Moored	3 Mins	3 Mins
SOG 0-2 knots	10 secs	3 mins
SOG 2-14 knots	10 secs	30 secs
SOG 2-14 knots and changing course	3.3 secs	30 secs
SOG 14-23 knots	6 secs	30 secs
SOG 14-23 knots and changing course	2 secs	30 secs
SOG > 23 knots	2 secs	30 secs
Ship Static Information	6 mins	6 mins

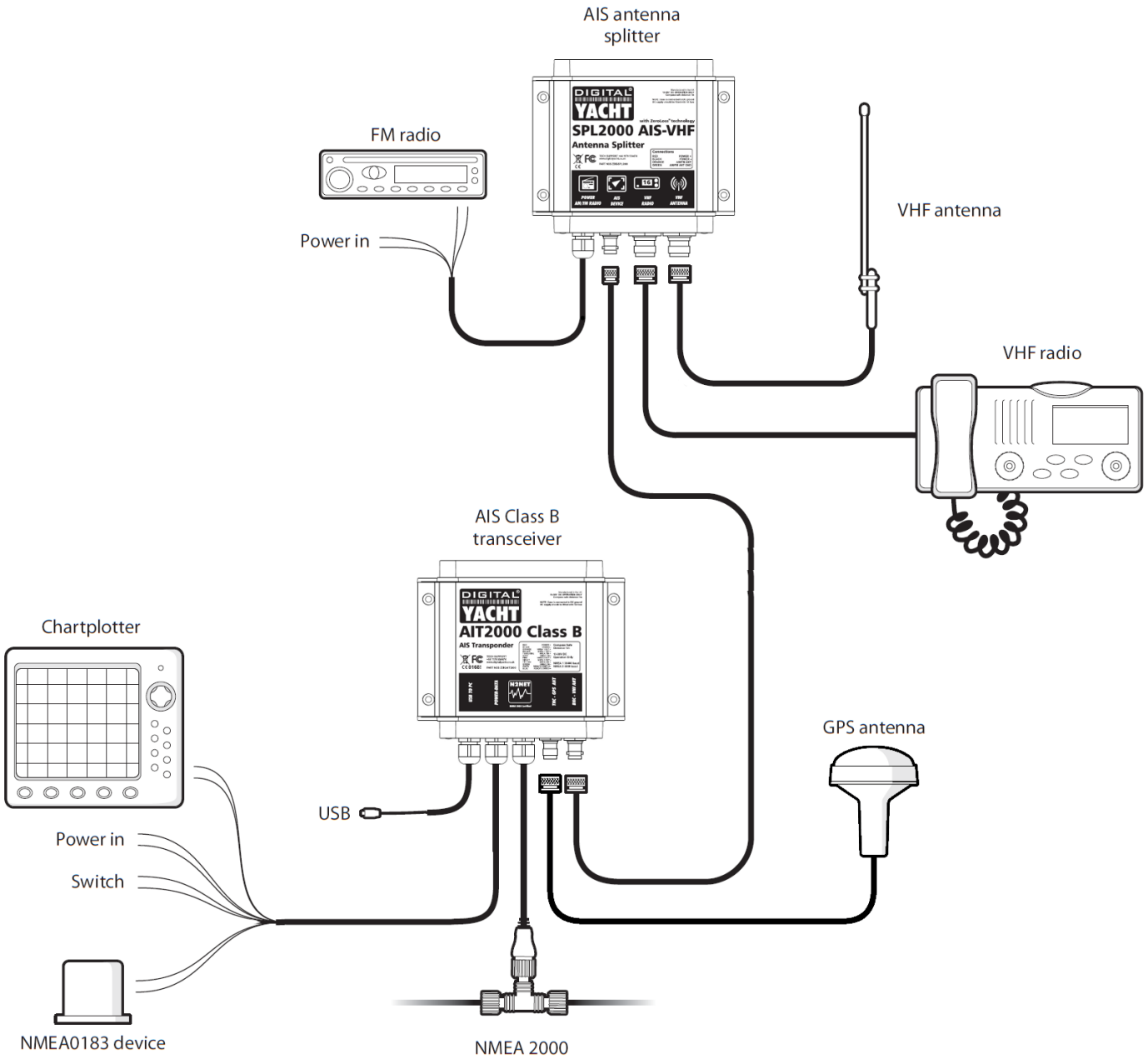
6. Typical AIS System Diagrams

The following diagram shows a typical Class A transponder system;



The following diagram shows a typical Class B transponder system with a VHF antenna splitter that allows the use of the same VHF antenna for both AIS and VHF operation. The latest generation of “Zero Loss” splitters now allow simple installation and no reduction in the range of VHF or AIS reception as has traditionally been the case with older splitters that introduced a -3dB loss.

Splitters are generally not recommended for use with Class A transponders as they affect the timing of the SOTDMA technology.



7. Useful Links

If this White Paper has encouraged you to learn more about AIS or even purchase an AIS system for your boat, then the links below should be of interest…

- Digital Yacht's Website where you can find the latest information on our AIS products.
- Digital Yacht's Blog for all of the latest news and articles on AIS
- All About AIS website for more information on AIS systems
- Wikipedia article on AIS
- IMO website that details the global carriage requirements of AIS
- US Coast Guards website on AIS
- Maritime VTS website that provides useful links to many online AIS websites