Automatic Identification Systems (AIS)
Automatic Identification Systems

- AIS Fundamentals
- Equipment Installation
- Configuration Requirements
What is an AIS?

An automated shipboard system operating on marine VHF channels for the purpose of transmitting and receiving vessel position, speed, heading and other vessel specific information.
• Purpose: Increase Vessel Safety
  - Automatic Exchange of Navigation Information
  - Reduction of VHF Navigational Traffic

• Available to
  - All AIS-Equipped Vessel Operators
  - Shore-Based Traffic Control Operations
33 CFR 164.46

• Vessels on International Voyages
  - Tankers
  - Passenger Vessels > 150 Gross Tons
  - Any Other Vessel > 300 Gross Tons

• Vessels Transiting VTS Areas
  - Self-propelled, > 65 Feet (Other Than Fishing or Small Passenger Vessels)
  - Towing Vessels > 26 Feet and > 600 Horsepower
  - Passenger Vessels > 150 Gross Tons
• IMO – International Maritime Organization (UN)

MSC (Marine Safety Committee)
  • COMSAR Subcommittee
  • Safety Nav Subcommittee
  • Plus 7 others related to training, design, pollution, …
• ITU – International Telecommunication Union (UN) - Spectrum
• IEC – International Electrotechnical Commission - Standards
• ISO – International Standards Organization - Standards
• IHO – International Hydrographic Organization - Charts
• IALA – International Association of Marine Aids to Navigation and Lighthouse Authorities
  - Aids to Navigation Standards
• RTCM – Radio Technical Committee for Maritime Services - Standards
• NMEA – National Marine Electronics Association - Standards
AIS Operation

60 Seconds
2,250 Slots

AIS-1
A B C A C ... 

AIS-2
B C A ... 

26.67 ms
1 Slot = 256 Bits

- Identity
- Position
- Speed over Ground
- Course over Ground
- Heading
- Rate of Turn
- Navigation Status
- Time Stamp
<table>
<thead>
<tr>
<th>Shipboard AIS Comparison</th>
<th>Class A (SOLAS compliant)</th>
<th>Class B/CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmit Power</td>
<td>12.5w (nominal) / 2w (low-power)</td>
<td>2w</td>
</tr>
<tr>
<td>Unique Communication Access Scheme</td>
<td>SO-TDMA Self-organizing amongst Class A's</td>
<td>CS-TDMA Carrier-Sense(s) polite to Class A's</td>
</tr>
<tr>
<td>Frequency Range &amp; Bandwidth</td>
<td>156.025 - 162.025 MHz @ 12/25 kHz DSC (156.525 MHz) required</td>
<td>161.500 - 162.025 MHz @ 25 kHz DSC (156.525 MHz) &amp; 12.5 kHz optional</td>
</tr>
<tr>
<td>Position Source &amp; External Inputs</td>
<td>External GPS, heading, rate of turn indicator required &amp; AIS Internal GPS</td>
<td>AIS Internal GPS Heading optional</td>
</tr>
<tr>
<td>Display &amp; Digital Interfaces</td>
<td>Minimum keyboard display (MKD) Multiple input-output ports &amp; single-outputs</td>
<td>All optional</td>
</tr>
<tr>
<td>Position &amp; Static Messages (msg) &amp; Reporting Rates (s = seconds)</td>
<td>Position data via either AIS msg 1, 2 or 3 &gt; 0kts @ 10/3.3s* &gt; 14kts @ 6/2s* &gt; 23kts @ 2s * if also changing course ± 5°, moored @ 180s Static &amp; voyage data via AIS Msg5 @ 360s</td>
<td>Position data via AIS msg18 &lt; 2kts @ 180s &gt; 2kts @ 30s Static data via AIS Msg24 @ 360s No rate of turn, navigation status, static draft, destination, ETA, or IMO# required/provided</td>
</tr>
<tr>
<td>Safety Text Messaging</td>
<td>Receive &amp; transmit</td>
<td>Transmit optional &amp; only pre-configured</td>
</tr>
<tr>
<td># of USCG Type-Approval Models</td>
<td>22 models - 16 manufacturers</td>
<td>8 models - 8 manufacturers</td>
</tr>
<tr>
<td>Approximate Cost</td>
<td>$2,800 - 4,000</td>
<td>$700 - 1,500</td>
</tr>
</tbody>
</table>
Class A AIS Schematic

Schematic Diagram of Class “A” Ship-borne AIS Station

*1) The external keyboard/display may be e.g. radar, ECDIS or dedicated devices.
*2) The internal keyboard/display may optionally be remote.
Class A broadcasts the following information every 2 - 10 seconds while underway and every 3 minutes while at anchor.

- **Longitude** - to 1/1000 minute
- **Latitude** – to 1/1000 minute
- **Course over Ground** – relative to true north 1/10\(^{\text{th}}\) degree
- **True Heading** – 0-359 degrees derived from gyro input
- **Time Stamp** – the universal time to the nearest second the information was generated
• **MMSI Number** – unique identification
• **Navigation Status** – as defined by the COLREGS
• **Rate of Turn** – right or left 0-720 degree/min
• **Speed over Ground** – 1/10 knot resolution from 0–102 knots
• **Position Accuracy** – differential GPS or other indication if RAIM (Receiver Autonomous Integrity Monitoring) processing is being used
Class A broadcasts the following information every 6 minutes

- **MMSI** - same unique id number
- **IMO Number** - unique id
- **Radio Call Sign** - international call sign assigned to ship
- **Name** - name of ship up to 20 characters are available
- **Type of Ship/ Cargo** - there is a table of possibilities
- **Dimensions of Ship** - to the nearest meter
• **Location of Reference Point** - where reference point for position reports are located

• **Type of Position Fixing Device** – various options from differential GPS to undefined

• **Draught of Ship** – 1/10 -25.5 meter (note “air draught is not provided)

• **Destination** - 20 characters are available

• **Estimated Time of Arrival at Destination** - month, day, hour, minute in UTC
Class B broadcasts the following information every 30 seconds if traveling in excess of 2 knots and every 3 minutes slower than 2 knots:

- **Longitude** - to 1/10000 minute
- **Latitude** - to 1/10000 minute
- **True Heading** - 0-359 degrees derived from gyro input (if available)
- **Time Stamp** - the universal time to the nearest second the information was generated
- **DSC Receiver Installed** - Y/N
• **MMSI Number** – unique identification
• **Speed over Ground** – 1/10th resolution from 0 to 102 knots
• **Position Accuracy** – differential GPS or other indication if RAIM (Receiver Autonomous Integrity Monitoring) processing is being used
• **Course of Ground** – relative to true north 1/10th degree
Class B broadcasts the following information every 6 minutes

- **MMSI** - same unique id number, links the data to the vessel
- **Radio Call Sign** - international call sign assigned to ship
- **Name** - name of ship, 20 characters are available
- **Vendor ID number**
- **Type of Ship/ Cargo** - there is a table of possibilities
- **Dimensions of Ship** - to the nearest meter
- **Location of Reference Point** - where reference point for position reports are located
SN Circular 227 - AIS Installations

- Drawings
- VHF Antenna Placement
- Cable Types
- GNSS Antenna Placement
- Power Sources
- Pilot Plug
- Interfacing
- Programming
There should be the following documentation for a new AIS installation:

1 - Antenna layout showing the placement of the AIS related antennas with respect to the others.

2 - AIS arrangement in the Pilothouse showing component locations

3 - A one line Block diagram showing the AIS, its power supply(s), pilot plug, antennas. Cable types and circuit breaker locations are suggested.
An AIS is fundamentally a VHF-FM transceiver with a companion GPS antenna input

• **A very important difference** on the VHF side is:

  The normal transmit frequencies are on the high end of the VHF-FM band (@ 162 mhz).

Because of this, the standard marine VHF antennas are not manufactured for optimum performance at those transmitter frequencies.
Make sure that you supply an antenna whose bandwidth covers the AIS frequencies. You want to maximize your effective radiated power wherever you can and that starts with your antenna. *(A = 12.5 watts and B = 2 watts!)*
• VHF Antenna
  – Possibly Integrated GPS Antenna
• 6’ Feet from Conductive Objects
• Ideally 6’ Directly above or below VHF
• Otherwise 30’ Horizontal Separation
Antenna Location
Antenna Location
1 - The recommendation is to use RG214 coax which is the double silver shielded coax. In fact, the loss of this cable vs. RG213 is the same (2.3 db for 100 feet @ 150 mhz), however, the shielding of the 214 is about 2 points better (95% vs. 97%).

2 - The loss of RG-58 is 6 db per 100 feet and its shielding is 93%.

Point – go for the bigger cable whenever you can and if you suspect shielding issues, use a foil + shield cable.
Simply put, the GPS antenna needs to be installed at the highest point that you can. The recommendation is for a 360 degree view between the zenith and 5 degrees elevation. Lacking that availability, find the spot with the less likely opportunity for blockage. In cases where you have a combined VHF/GPS antenna, that could very well be a compromise of access and servicing vs sightlines.
When Reference Location Unavailable, Use: A = B = C = D = 0

When Reference Location Unavailable, Vessel Dimensions in B, D
A = C = 0, B ≠ 0, D ≠ 0
For Class A systems, the IMO recommendation SN Circ 227 is that the unit should be connected to an Emergency Source.

For IMO vessels built after 1986, this means the Emergency Generator to which all the Communication and Navigation equipment is to be connected to.

In addition, an Supplement to the Recommendation also requests that the AIS be connected to a UPS to ensure that the switchover from Main to Emergency does not shut down the AIS.
For Class B systems, there is no recommendation. However, I would suggest that the AIS be connected to the ‘last’ power source on the boat as should the VHF be as well.
Pilot Plugs

- Operation from Pilot’s Operating Position
- Pilot Plug
  - NMEA 0183-HS Interface
    aka IEC 61162-2 (38.4 kbps)
  Is specified to use a Amphenol 206486-1/2 type connector

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Transmit A</td>
</tr>
<tr>
<td>4</td>
<td>Transmit B</td>
</tr>
<tr>
<td>5</td>
<td>Receive A</td>
</tr>
<tr>
<td>6</td>
<td>Receive B</td>
</tr>
<tr>
<td>9</td>
<td>Shield</td>
</tr>
</tbody>
</table>
Interfacing

NMEA 2000®

Sensors and Displays

NMEA 0183 HS

Aux User / Pilot Interface

Single Wire

BIIT

AIS Transceiver

GPS Antenna

VHF Antenna

Other Equipment
## Connections

### Data NMEA 0183 Sentence Format

<table>
<thead>
<tr>
<th>Data</th>
<th>Reference Datum</th>
<th>NMEA 0183 Sentence Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Datum</td>
<td>DTM</td>
<td></td>
</tr>
<tr>
<td>Positioning System:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of Position, Latitude / Longitude, Position</td>
<td>GNS, GLL</td>
<td>GGA, RMC</td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed over Ground (SOG)</td>
<td>VBW</td>
<td>VTG, OSD, RMC</td>
</tr>
<tr>
<td>Course over Ground (COG)</td>
<td>RMC</td>
<td>VTG, OSD</td>
</tr>
<tr>
<td>Heading</td>
<td>HDT</td>
<td>OSD</td>
</tr>
<tr>
<td>RAIM Indicator</td>
<td>GBS</td>
<td></td>
</tr>
<tr>
<td>Rate of Turn (ROT)</td>
<td>ROT</td>
<td></td>
</tr>
</tbody>
</table>

**BIIT (Built-in Integrity Test) Is Connected to an Alarm Relay**
• **Vessel Data**
  - Maritime Mobile Service Identity (MMSI) Number *
  - IMO Vessel Number
  - Radio Call Sign *
  - Vessel Name *
  - Vessel Type *
  - GPS Antenna Location/Reference Position *
  - Type of Navigational Input (GPS, GLONASS, other)
  - ROT fitted (Y/N)
Web Resources

- http://www.imo.org
- http://www.vesseltracker.com/app
- http://www.navcen.uscg.gov