





To AIS Presented by Digital Yacht 1st April 2020



- AIS (Automatic Identification System) is the latest and most significant advance in marine navigation aids since RADAR
- AIS uses GPS, VHF radio and DSP to automatically communicate between vessels
- Vessels can Transmit and Receive (Transponder) or just Receive (Receiver)
- An AIS transponder is mandatory fit on all vessels greater than 300 tons or that carry 12 or more fare paying passengers



What is AIS ?



Class A Transponder



Class B or B+ Transponder



AIS Receiver



Types of AIS



- AIS was first conceived in the early 1990s, but the first working systems called UAIS at the time were not seen until 2000
- When first released there were no "Classes" of AIS, just transponders for SOLAS ships (later referred to as Class A)
- The success of AIS has resulted in the different classes, types and uses of AIS that we now see

A hist	ory of AIS de	velopment	t										
	🔾 The be	ginnings o	f AIS		G	CLASS	B IEC sta	andards	0	Nationa	I mandate	es	
			MO m	andate				Aids to	Navigatior	n IEC star	ndard		
				Class B	AIS deve	loped			First spa	ace based	I AIS sate	llite	
						0	Class B	products	begin to a	appear			
							0) EU inla	nd waterw	ay standa	ard		
									•	Search	and Resc	ue Transp	oonder
1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012

History of AIS



- AIS uses a technique called TDMA* that allows multiple transmitters to grab available time slots during which they can transmit their information
- There are 4500 time slots every minute and if overloaded, Class A systems can share time slots and only vessels further away will be subject to drop-out
- Class A systems use "Self Organised" SOTDMA which gives them priority and effectively guarantees a time slot



- Class B Systems use "Carrier Sense" CSTDMA where they sense if a time slot is empty and quickly grab it, collisions can occur and Class B transmissions are not guaranteed
- The new Class B+ Systems uses the same "Self Organised" SOTDMA protocol that Class A Systems use, but transmits at a lower power and less often.

* Time Division Multiple Access – same technique as used In GSM mobile phone networks

How AIS Works



- AIS uses two VHF frequencies;
 - 161.975 MHz
 - 162.025 MHz
- AIS is subject to the same constraints as VHF radio i.e. line of sight range
- AIS data can be transmitted in NMEA 2000 or in the older NMEA 0183 serial protocol but at a higher 38,400 baud rate (normal = 4800 baud)
- There are a new set of NMEA 2000 PGNs reserved for AIS, while for NMEA 0183 just two sentences wwere reserved for AIS;
 - !AIVDM (other vessels)
 - !AIVDO (own vessel)
- A transponder must have a GPS position, whilst a receiver does not have to have one as it does not transmit its position

AIS - The Technical Stuff



- AIS uses VHF radio frequencies and is subject to the same range issues
- Higher the antenna and higher the transmit power, the longer the range
 - Class A Transponders transmit at 12.5W
 - Class B+ Transponders transmit at 5W
 - Class B Transponders transmit at 2W
 - AIS MOB/SARTs transmit at 1W

expect 20-25 Nm expect 10-12 Nm expect 7-8 Nm expect 3-4 Nm

AIS Range



There are three types of AIS data automatically and continuously transmitted and received by each unit on the two VHF channels dedicated to AIS

- Dynamic Data: such as position and speed automatically calculated by the transponder using its internal GPS or external sensors
- Static Data: programmed into unit at time of purchase: MMSI, Vessel name, size, contact info
- Voyage Data: programmed into Class A units before and/or during each voyage: Destination, ETA, Draught, Number on Board, Nav Status





AIS Data Types



- The table below shows the frequency of transmission for different classes of AIS
- The Speed Over Ground (SOG) from the transponders GPS decides the update rate and on a Class A transponder, the Rate of Turn from the Gyro/Compass decides if it is changing course

Ship's Dynamic Conditions	Class A	Class B+	Class B
Ship at Anchor or Moored	3 mins	3 mins	3 mins
SOG 0-2 knots	10 secs	3 mins	3 mins
SOG 2-14 knots	10 secs	30 secs	30 secs
SOG 2-14 knots and changing course	3.3 secs	30 secs	30 secs
SOG 14-23 knots	6 secs	15 secs	30 secs
SOG 14-23 knots and changing course	2 secs	15 secs	30 secs
SOG > 23 knots	2 secs	5 secs	30 secs
Ship Static Information	6 mins	6 mins	6 mins

Frequency of AIS Transmissions



- The table shows what information is communicated by different classes of AIS
- In terms of data transmitted Class B and Class B+ are the same

Data Transmitted	Class A	Class B and 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	YES	NO

What data is communicated ?



- Inside the Binary Encapsulation will be one of the 26 AIS Message types
- Some of the messages are specific to a Class A or Class B transponder
- Other messages are specific to particular types of AIS targets;
 - Aids to Navigation (AtoN)
 - AIS SART
 - Search and Rescue
- Not all AIS units or Chart Plotters can read all message types
- This can lead to some products not displaying all AIS targets

Message ID	Name	Description			
1	Position report	Scheduled position report; (Class A shipborne mobile equipment)			
2	Position report	Assigned scheduled position report; (Class A shipborne mobile equipment)			
3	Position report	Special position report, response to interrogation; (Class A shipborne mobile equipment)			
4	Base station report	Position, UTC, date and current slot number of base station			
5	Static and voyage related data	Scheduled static and voyage related vessel data report; (Class A shipborne mobile equipment)			
6	Binary addressed message	Binary data for addressed communication			
7	Binary acknowledgement	Acknowledgement of received addressed binary data			
8	Binary broadcast message	Binary data for broadcast communication			
9	Standard SAR aircraft position report	Position report for airborne stations involved in SAR operations, only			
10	UTC/date inquiry	Request UTC and date			
11	UTC/date response	Current UTC and date if available			
12	Addressed safety related message	Safety related data for addressed communication			
13	Safety related acknowledgement	Acknowledgement of received addressed safety related message			
14	Safety related broadcast message	Safety related data for broadcast communication			
15	Interrogation	Request for a specific message type (can result in multiple responses from one or several stations)(4)			
16	Assignment mode command	Assignment of a specific report behaviour by competent authority using a Base station			
17	DGNSS broadcast binary message	DGNSS corrections provided by a base station			
18	Standard Class B equipment position report	Standard position report for Class B shipborne mobile equipment to be used instead of Messages 1, 2, $3(8)$			
19	Extended Class B equipment position report	Extended position report for class B shipborne mobile equipment; contains additional static information(8)			
20	Data link management message	Reserve slots for Base station(s)			
21	Aids-tonavigation report	Position and status report for aids-to-navigation			
22	Channel manage- ment(6)	Management of channels and transceiver modes by a Base station			
23	Group assignment command	Assignment of a specific report behaviour by competent authority using a Base station to a specific group of mobiles			
24	Static data report	Additional data assigned to an MMSI Part A: Name Part B: Static Data			
25	Single slot binary message	Short unscheduled binary data transmission (Broadcast or addressed)			
26	Multiple slot binary message with	Scheduled binary data transmission (Broadcast or addressed)			

AIS Message Types



There are two NMEA0183 sentences reserved for AIS;

- !AIVDM (other vessels)
- IAIVDO (own vessel)

The VDO message was intended to provide own ship data to a listening ECS or ECDIS but in reality very few systems read and use this message

The VDM sentence is transmitted each time an AIS message is received

!AIVDM,1,1,,A,177I?m9000`:Pk`<i`kh0ISd00R;,0*30 !AIVDO,1,1,,,B>eq`d@3wk?8mP=18D3Q3wv5sP06,0*6C

Unlike normal NMEA 0183 sentences that use human readable ASCII characters, the two AIS sentences use 6 bit binary encoding for the bulk of the sentence to reduce the amount of data

AIS NMEA 0183 Data



The first section of the VDM sentence is ASCII;

!AIVDM,1,1,,A,177I?m9000`:Pk`<i`kh0ISd00R;,0*30

So using the key below we can tell that the VDM sentence above is message 1 of 1 and it was received on AIS channel A

!--VDM,x,x,x,a,s—s,x*hh<CR><LF>



To understand more we have to decode the binary encapsulated message !

Breaking Down the VDM sentence



As very few people can read 6 bit encoded Binary, Digital Yacht have created a simple, free NMEA Display program that does this for you....

WWW NMEA Data Display Program								
Setup Log View Help								
Parse Result 5								
!AIVDM_MSG1		Name	Type	Value		A		
\$GPRMC	1	Id		1		=		
AIVDM_MSG18	-			-				
!AIVDM_MSG4	2	Repeated		0				
IAIVDM_MSG5	3	UserID		235002514				
AIVDIM_INSG24	4	Naxigational St		0				
	5	Rate of Tum		-128				
	6	Speed Over Gro		0		+		
	10	VIZOLATAJPUDI				₽×		
!AIVDM,1,1,,B,13P9<@P01Bwr	eE(0M2lM9k`4P089t	t,0*79			^		
!AIVDO,1,1,,,3>pf8WQP?w <tsf< td=""><td>014</td><td>Q@>4?wv0rHP,</td><td>0*12</td><td></td><td></td><td></td></tsf<>	014	Q@>4?wv0rHP,	0*12					
!AIVDM,1,1,,B,13P;1MOP00OrwStM4cHd3?vR0<0t,0*14								
SGPRMC, VN*53								
AIVDO,I,I,,3>pt8WQP?w <tsf0l4q@>4?wv0rHP;0*12</tsf0l4q@>								
SGPRMC, V								
!AIVDM,1,1,,B,13P;Qe@03rwrl2:M2okiqAJT0<1C,0*6A								
!AIVDM,1,1,,B,13P7JTPP00OrL`@M1uH18gvR0D1R,0*13								
Listening Port COM44 Developed by Digital Yacht								

Reading the Binary Data



- When designing the NMEA 2000 PGNs for AIS, the NMEA created a PGN for each AIS message
- Some PGNs cover more than one AIS message type
- Not all NMEA2000 Chart Plotters accept all of the AIS PGNs
- There is no VDO type PGN, but applicable PGNs have a field that indicates "Own Data"

Message	Name	Description	PGN
1	Position report	Scheduled position report; (Class A shipborne mobile equipment)	129038
2	Position report	Assigned scheduled position report; (Class A shipborne mobile equipment)	129038
3	Position report	Special position report, response to interrogation; (Class A shipborne mobile equipment)	129038
4	Base station report	Position, UTC, date and current slot number of base station	129793
5	Static and voyage related data	Scheduled static and voyage related vessel data report; (Class A shipborne mobile equipment)	129794
6	Binary addressed Message	Binary data for addressed communication	129795
7	Binary acknowledgement	Acknowledgement of received addressed binary data	129796
8	Binary broadcast message	Binary data for broadcast communication	129797
9	Standard SAR aircraft position report	Position report for airborne stations involved in SAR operations only	129798
10	UTC/date inquiry	Request UTC and date	129800
11	UTC/date response	Current UTC and date if available	129793
12	Addressed safety related message	Safety related data for addressed communication	129801
13	Safety related acknowledgement	Acknowledgement of received addressed safety related message	129796
14	Safety related broadcast message	Safety related data for broadcast communication	129802
15	Interrogation	Request for a specific message type (can result in multiple responses from one or several stations)	129803
16	Assignment mode command	Assignment of a specific report behaviour by competent authority using a Base station	129804
17	DGNSS broadcast binary message	DGNSS corrections provided by a base station	129792
18	Standard Class B equipment position report	Standard position report for Class B shipborne mobile equipment to be used instead of Messages 1, 2, 3	129039
19	Extended Class B equipment position report	Extended position report for class B shipborne mobile equipment; contains additional static information	129040
20	Data link management message	Reserve slots for Base station(s)	129805
21	Aids-tonavigation report	Position and status report for aids-to-navigation	129041
22	Channel management	Management of channels and transceiver modes by a Base station	N/A
23	Group assignment command	Assignment of a specific report behaviour by competent authority using a Base station to a specific group of mobiles	N/A
24	Static data report	Additional data assigned to an MMSI Part A; Name Part B; Static Data	129809 + 129810
25	Single slot binary message	Short unscheduled binary data transmission (Broadcast or addressed)	N/A
26	Multiple slot binary message	Scheduled binary data transmission (Broadcast or addressed)	N/A

AIS and NMEA 2000



• Although AIS data is always the same, it can be displayed in a variety of ways



AIS Displays

 By far the most informative and easy to use AIS display is when the data is overlaid on an Electronic Charting System (Dedicated or PC)

IGITA



AIS and Electronic Charts



 Warnings of potential collisions based on course and speed can be automatically generated to warn mariners of the hazard



Benefits of AIS – Collision Avoidance



 Most but not all Chart Plotters and PC Navigation software that is AIS compatible have some form of CPA and TCPA alarm



Benefits of AIS – CPA and TCPA



 Vessel to vessel identification has a range of applications including navigational safety, "buddy tracking", Yacht racing and vessel to vessel communications



Benefits of AIS – Identification



• Emergency services can use AIS to co-ordinate search and rescue operations, whilst shore stations can receive vessel details automatically and provide maritime services



Benefits of AIS – Safety + Security



 AIS can 'see round corners' and beyond the RADAR line of sight. The combination of AIS + RADAR gives the 'best possible picture' of the navigation environment



Benefits of AIS – "See Round Corners"



- With only a £300 price difference between a Receiver and a Class B Transponder, many people will buy a transponder rather than a receiver
- Theoretically, if every small craft fitted a Class B Transponder tomorrow, we could see a reduction in the update frequency and range of Class B targets
- In reality, such a situation would require thousands of Class B Transponders in a very small area and such gatherings of small craft generally only occur in good conditions
- Diligent use of the "Silence Button" on Class B transponders, only transmitting in poor visibility or when crossing shipping lanes should be considered good practice



To Transmit or not to Transmit....that is the question !





Class B for Small Craft



- Class A Transponders have been traditionally only found on commercial vessels that are mandated to have one
- This was mainly due to price (approx £4000) but recently prices have come down (approx £1750) and now some pleasure vessels are starting to look at Class A
- Class A does have some real advantages for certain pleasure vessels;
 - 12.5W Transmit Power
 - Fast Update Rate (2-3 sec)
 - ✓ Guaranteed Time Slot
 - Built-In display
- For large high speed power boats the 30sec update rate of Class B is too slow
- For Blue Water Sail Boats, the 2W transmit power of Class B does not give enough range

Class A for Small Craft





- If you cannot justify the cost or have room for a full Class A, Class B+ might be for you
- Utilising the same technology as Class A, but the black box design of Class B, Class B+ is the latest AIS class to be defined.
- Class B+ does have some real advantages for certain pleasure vessels;
 - ✓ 5W Transmit Power
 - Faster Update Rate for faster boats (5 sec)
 - Guaranteed Time Slot
- For high speed power boats the 30sec update rate of Class B is too slow
- For Blue Water Sail Boats, the 2W transmit power of Class B does not give enough range



Class B+ for Small Craft



 The table below gives a good overview of the differences between the three classes of AIS transponders

Function	Class A	Class B+	Class B	
Transmit Power	12.5W	5W	2W	
Transmit Rate	Up to every 2-3 secs	Up to every 5 secs	Every 30 secs	
Minimum Keyboard + Display (MKD)	YES NO		NO	
Technology	SOTDMA	SOTDMA	CSTDMA	
Guaranteed Time Slot Allocation	YES	YES	NO	
Voyage Data	YES	NO	NO	
External GPS Connection	YES	NO	NO	
Price (approx)	£2000	£650	£500	

Comparison of different AIS Classes



Single Channel

- Some old and current AIS receivers are one channel e.g. Nasa AIS, dAISy + Smart Radio SR161
- One RF receiver that is switched between the two AIS channels every 30 secs or more
- Targets received on single channel receivers can take twice as long to update

Dual Channel

- All Digital Yacht AIS units feature a high performance Dual Channel receiver
- Two RF receivers each one dedicated to the two AIS channels
- Maximum number of received targets with no update delays or missed targets



Single Channel vs Dual Channel

VS



Pros

- Single Antenna Solution
- Top of mast for Maximum Range
- Easy Installation no cables to run
- No loss of performance



Cons

- 4x the Cost of a Dedicated Antenna
- Misses Targets while VHF transmits

Pros

- Low Cost
- Backup Emergency Antenna for VHF
- Not affected by VHF voice activity



Cons

- Less Range at deck level (10-15NM)
- Installation can be time consuming/costly
- "Not Another Antenna !"

Splitter vs Dedicated Antenna

Splitter

- Single Antenna is shared by the AIS and VHF
- Two super fast, intelligent switches inside the splitter sense when AIS or VHF is transmitting
- A typical Class B AIS transmission only lasts 26mS
- VHF gets priority and whilst transmitting no AIS reception is possible
- When neither system is transmitting both systems are connected to the aerial
- Splitter Protects the VHF or AIS from receiving the full transmit power from the other device



Splitter – how it works







AIS Receiver with smart GPS driving NMEA 0183 Plotter and PC





AIS Transponder with splitter driving NMEA 2000 Plotter and NMEA 0183 VHF

AIS Transponder with internal splitter driving NMEA 0183, NMEA 2000, USB and Wi-Fi Devices

Connections



- AIS MOBs and SARTs have recently been approved for GMDSS use
- An AIS MOB/SART is basically a low power Class A transmitter (1W)
- Once activated, an AIS MOB/SART should start transmitting it's position within 1min and continue transmitting every minute until the battery is dead
- They also output a new Safety Related Message (SRM) every four minutes
- When held 1m above sea level the AIS SART should be received by all AIS units within 5NM radius





AIS MOBs and SARTs





• Websites like Marine Traffic are a great source of AIS information and maintain ship databases with photos, but beware holes in coverage and stations that are poor or off

AIS on the Internet





- "Realtime" AIS is now available on-line at a number of websites
- Beware of holes in coverage and delays in updating but they are improving

AIS on the Internet



- AIS is an invaluable navigational safety tool
 Demand for AIS on Small Craft is increasing
- AIS is a simple and automatic system where the clever stuff is mostly hidden from the user
- An understanding of the underlying technology is key for Dealers to sell the correct system and diagnose problems

THANK YOU FOR LISTENING

Any Questions ?