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Introduction to the Research and Application of single-slot AIS AtoN

# Summary

This proposal introduces the research and testing on single-slot AIS AtoN by China MSA.

## Purpose of the document

This document aims to provide reference on the application of single-slot AIS for AtoN authorities.

## Related documents

G1082 AN OVERVIEW OF AIS.

G1062 ESTABLISHMENT OF AIS AS AN AID TO NAVIGATION.

# Background

2.1 The broadcasting mechanism of AIS AtoN

AIS AtoN is an important part of navigation aid facilities and plays an important role in the water transportation. It provides navigation, positioning, avoidance or other navigational aid information for vessels, and is of great significance for ships to grasp surrounding information.

AIS employs Time Division Multiple Access (TDMA), communication protocol to divide a time period into a fixed number of time slots. Each time slot has a fixed number of data packets, and appropriate time segmentation is the key to the success of each launch. AIS has two assigned frequencies of 161.975MHz and 162.025MHz, with a total of 4500 time slots.

The existing AIS AtoN sends information through the Message (hereinafter referred to as MSG) 21 statement, and dynamic and static information is integrated in a single statement, which leads to a long single statement, so it adopts the 2-slot mode to send. The number of time slots in a launch cycle is 2250, which needs to cover the launch of all AIS devices in the range. If the number of AIS targets in the area reaches the limit, time slot conflicts will inevitably occur. AIS AtoN occupying two time slots are more prone to time slot conflicts, resulting in information transmission failure and affecting the communication of AIS ship stations and other equipment.

2.2 The broadcasting mechanism of single-slot AIS AtoN

The Chairman's report adopted on the ITU-R Working Party 5B in 2023 describes the single-slot AIS AtoN as follows: The single-slot AIS AtoN device is an AIS beacon that emits single-slot messages and can be used alternately or as an alternative to the 2-slot MSG21. This is one of the solutions that the experts around the world have come up with as the radio environment becomes increasingly crowded.

AIS AtoN can send dynamic information of AtoN in the form of sending MSG28, static information is sent through MSG24. Static information is sent at a frequency of 6 minutes, while dynamic information is sent at a frequency of 3 minutes, which reduces the transmission frequency of static information. And the two messages are sent using a single time slot, which can improve the success rate of sending.

# Discussion

## Principle of single-slot AIS AtoN

Single-slot ATON sends AIS MSG 28, which occupies only one slot, to the vessel as the reporting of position information. MSG 24A reports the name information of the AtoN, and MSG 6 reports the current and voltage of the AtoN to the AIS base station. The AtoN authorities can obtain the dynamic and static information of all the single time-slot AtoN through the base station. (Figure 1)

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Figure 1

## Design parameters of single-slot AIS AtoN

2-slot AIS navigation AtoN has been widely used. In order to adapt to the currently used environment as much as possible and reduce costs, a widely used AIS AtoN device is adopted for transformation. The main design parameters are as table 1:

|  |  |
| --- | --- |
| Transmitting frequency： | AIS 1（161.975MHz），AIS 2（162.025MHz） |
| Communication mode： | FATDMA |
| Message type： | MSG 6、MSG 21、MSG28（selectable） |
| Launch interval： | 3～60 minutes（Can set） |
| Transmitting power： | 2-5W (tunable) |
| Current consumption： | ≤40mA（12V） |
| port： | RS232，NMEA 0183 |
| Operating temperature | -15~+55℃ |
| Supply voltage： | DC 12V（Range：DC 12V~18V） |
| Class of protection： | IP68 |

Table 1: Design parameter

## Development of single-slot AIS AtoN model machine

The single-slot AIS AtoN device performs the logical control of device transceiver through the micro-MCU, accesses the corresponding AIS transmitting module and the GPS Beidou dual-mode positioning unit module, and then connects with the auxiliary communication link, independently designs the power module of the device, and finally sends and receives data through the RF antenna. The size of the motherboard of the entire equipment is only about 3cm\*10cm, and the key RF part is shielded to ensure the anti-interference of the equipment.（Figure 2）



Figure 2

## Single slot AIS AtoN test situation

**3.4.1 Laboratory test**

After the key indicators of the motherboard are tested, the simulation test is carried out to determine the success rate. After AIS comprehensive tester test, spectrometer test and signal emission index test, launch pull distance test and aging emission test are carried out to ensure that the equipment can meet the design requirements.

**3.4.2** **Marine application test**

Two single-slot AIS AtoNs were deployed at Mawei Port in the East China Sea. Through a total of more than 800 hours of continuous testing from October 23, 2023 to November 28, 2023, all AIS data, including surrounding ship data, were obtained. According to the analysis results of the day's data selected every ten days, the difference between the success rate of receiving four times and the success rate of transmitting 2-slot messages for the ATON 28 TEST003 is 4.972%, 4.327%, 5.229% and 3.424%, respectively. The average is 4.488%. For the ATON 28 TEST001, the difference between the success rate of receiving four times and the success rate of transmitting 2-slot messages is 7.271%, 5.535%, 7.292% and 5.319%, respectively. The average is 6.35425%. The detail is shown in table 2-5.

|  |  |  |  |
| --- | --- | --- | --- |
| MMSI of tested AtoN | 999992402 | Name of tested AtoN | ATON 28 TEST003 |
| Testing period | 2023.10.26 all day | Testing place | Fuzhou |
| Reception conditon of MSG21 | Receive 10782 pieces ，Success rate of reception:74.875% | | |
| Reception conditon of MSG28 | Receive 11498 pieces，Success rate of reception:79.847% | | |
| Note | Difference value: 4.972% | | |
| Test recorder | Zhang Cheng | Recording time | 2023.10.27 |
| MMSI of tested AtoN | 999990828 | Name of tested AtoN | ATON 28 TEST001 |
| Testing period | 2023.10.26 all day | Testing place | Fuzhou |
| Reception conditon of MSG21 | Receive 10923 pieces，Success rate of reception:75.854% | | |
| Reception conditon of MSG28 | Receive 11970 pieces，Success rate of reception:83.125% | | |
| Note | Difference value: 7.271% | | |
| Test recorder | Zhang Cheng | Recording time | 2023.10.27 |

**Table 2: Testing result on 2023.10.26**

|  |  |  |  |
| --- | --- | --- | --- |
| MMSI of tested AtoN | 999992402 | Name of tested AtoN | ATON 28 TEST003 |
| Testing period | 2023.11.6 all day | Testing place | Fuzhou |
| Reception conditon of MSG21 | Receive 5197 pieces，Success rate of reception:36.09% | | |
| Reception conditon of MSG28 | Receive 5820 pieces，Success rate of reception:40.417% | | |
| Note | Difference value:4.327% | | |
| Test recorder | Zhang Cheng | Recording time | 2023.11.7 |
| MMSI of tested AtoN | 999990828 | Name of tested AtoN | ATON 28 TEST001 |
| Testing period | 2023.11.6 all day | Testing place | Fuzhou |
| Reception conditon of MSG21 | Receive 12612 pieces，Success rate of reception:87.583% | | |
| Reception conditon of MSG28 | Receive13409 pieces，Success rate of reception:93.118% | | |
| Note | Difference value: 5.535% | | |
| Test recorder | Zhang Cheng | Recording time | 2023.11.7 |

**Table 3: Testing result on 2023.11.6**

|  |  |  |  |
| --- | --- | --- | --- |
| MMSI of tested AtoN | 999992402 | Name of tested AtoN | ATON 28 TEST003 |
| Testing period | 2023.11.16 all day | Testing place | Fuzhou |
| Reception conditon of MSG21 | Receive 11483 pieces，Success rate of reception:79.743% | | |
| Reception conditon of MSG28 | Receive 12236 pieces，Success rate of reception:84.972% | | |
| Note | Difference value: 5.229% | | |
| Test recorder | Zhang Cheng | Recording time | 2023.11.17 |

|  |  |  |  |
| --- | --- | --- | --- |
| MMSI of tested AtoN | 999990828 | Name of tested AtoN | ATON 28 TEST001 |
| Testing period | 2023.11.16 all day | Testing place | Fuzhou |
| Reception conditon of MSG21 | Receive 11162 pieces，Success rate of reception:77.514% | | |
| Reception conditon of MSG28 | Receive 12212 pieces，Success rate of reception:84.806% | | |
| Note | Difference value: 7.292% | | |
| Test recorder | Zhang Cheng | Recording time | 2023.11.17 |

**Table 4: Testing result on 2023.11.16**

|  |  |  |  |
| --- | --- | --- | --- |
| MMSI of tested AtoN | 999992402 | Name of tested AtoN | ATON 28 TEST003 |
| Testing period | 2023.11.26 all day | Testing place | Fuzhou |
| Reception conditon of MSG21 | Receive 13549 pieces，Success rate of reception:94.09% | | |
| Reception conditon of MSG28 | Receive 14042 pieces，Success rate of reception:97.514% | | |
| Note | Difference value: 3.424% | | |
| Test recorder | Zhang Cheng | Recording time | 2023.11.27 |

|  |  |  |  |
| --- | --- | --- | --- |
| MMSI of tested AtoN | 999990828 | Name of tested AtoN | ATON 28 TEST001 |
| Testing period | 2023.11.26 all day | Testing place | Fuzhou |
| Reception conditon of MSG21 | Receive 11528 pieces，Success rate of reception:80.056% | | |
| Reception conditon of MSG28 | Receive 12294 pieces，Success rate of reception:85.375% | | |
| Note | Difference value: 5.319% | | |
| Test recorder | Zhang Cheng | Recording time | 2023.11.27 |

**Table 5: Testing result on 2023.11.26**

## Conclusion

According to the practical application test, the single-slot AIS AtoN device can broadcast AIS message information completely and normally. Compared with 2-slot AIS AtoN, the success rate of single-slot device is higher, but the difference is not obvious. After analyzing the reasons, it’s considered that single-slot AIS AtoN can improve the success rate of sending, and the more crowded the communication environment, the greater the advantage.

# Next step

FATDMA mode was used to design the single-slot AIS AtoN in this test, and RATDMA mode was used for research and development and testing in the following attempts to observe the effect of slot conflict control. The various forms of application testing will be carried out and the data will be fully collected further to verify the advantages and reliability of single-slot AIS AtoN.

To ensure that the single-slot AIS AtoN can be recognized by the current AIS ship station and AIS shore-based station, it is necessary to synchronize the upgrading of various AIS equipments.

# References

G1082 AN OVERVIEW OF AIS.

G1062 ESTABLISHMENT OF AIS AS AN AID TO NAVIGATION.

# Action requested of the Committee

The Committee is requested to note the infomation in this document.

1. Leave open if uncertain [↑](#footnote-ref-1)