Research and Proposal on One Mile SART

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Abstract

As a point that should be improved further in present SART, the size, the number, and the economy were enumerated. Some SART developed to solve them in Japan were introduced in this paper. That is automatically operating SART, circular polarization SART and so on. In addition, One Mile SART was mentioned. It is SART miniaturized instead of limiting the function, because all crews and passengers can always carry the small and light SART. The parts were made for trial purposes and the performance was confirmed.

Keyword : SART, personal equipment, marine distress

1. Introduction

After it is completely equipped with GMDSS (Global Maritime Distress and Safety System) by the SOLAS (the Safety of Life at Sea) agreement by IMO (International Maritime Organization), the accident ship came to be rescued effectively. At the same time, however, some problems and points that should be improved are understood. In this paper, SART (Search and Rescue Radar Transponder) of GMDSS was examined.

The main problems in use are thought the size and the number of installations. To solve them, a necessary performance requirement was limited and the miniaturization was tried.

2. Present SART

2.1 Externals specification and cost

SART was developed to detect and to do homing for the lifeboat with the radar of the search ship. It is provided to one of GMDSS as an equipment goods of the ship and the lifeboat. Though the height of the main body is about 30- 40cm, when using it, it installs in the ceiling of the lifeboat or in the stick of the attachment, and 1m or more in height of the surface of the sea is secured. Weight is about 1- 4 kg. A price on the market is about 900US$, and it costs 500US$ the battery kit that should be exchange every 3- 4 years.

2.2 Performance requirement

The main of the performance requirements provided by the SOLAS agreement is listed in Table 1.

Table 1 The main performance requirement for SART

Temperature range	-20 - +55 ℃
Operation time	After stand-by 96 hours, continuous response for 8 hours
Height of antenna surface of the sea	1m or more
Reception sensitivity	below -50 dBm
Radiation electric power	400mW (+26dBm) or more
frequency	9200-9500 MHz
polarization	horizontal

2.3 Problems and improvement point until present

At first of the SOLAS agreement enforcement concerning GMDSS, SART was one (Passenger boat etc. are 2) in each ship. It is fewer than the number of crew and passenger or the number of lifeboats. This is thought to be a result of considering an economic side very much. When actually leaving from the mother ship, it is necessary to carry SART. It is, however, not easy to go to installation place and board the lifeboat by carrying it in the dark night or at rough sea. There is a possibility of dropping it to the sea, too. In Japan, the development and study are done to solve these problems. Three kinds of SART, that is, life raft installation type, dropping type, life jacket installation type are developed and the result is achieved[1),2)].

(1) Life raft equipment type SART

It is a type to install SART in the ceiling part of an automatic restoration life raft beforehand. It is not an obstacle even if the life raft is usually folded and put it in the container. When the container is dropped to the sea and the life raft expands, the switch of SART is automatically pulled out and operation begins. Figure 1 and 2 show the photograph of the life raft.

Fig.1 Life raft equipped SART

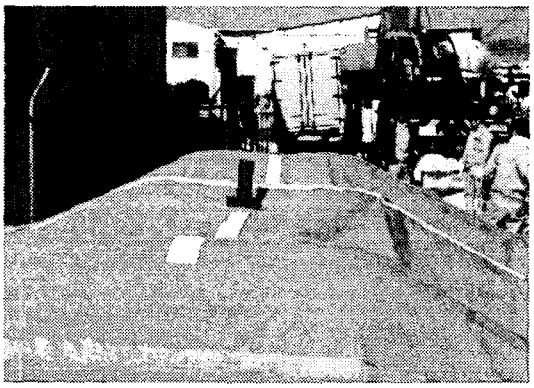


Fig.2 Ceiling of the life raft with SART

(2) Dropping type SART

It is SART of the type in which the fold stick of about 2m in total length previously installed only the antenna. It is folded compactly, and the stick expands automatically when drop it, the floating body expands, and SART also begins operating. The main body of SART and battery are installed from the center of the stick a little below with the floating body. The weight is attached on the opposite side of the stick, and the height of about 1.5m is maintained on the surface of the sea. The photograph is shown in Figure 3. This is installed to the buoy for the examination.

When these had been designed, in the process of examining the miniaturization of the antenna and the connection of the main body of SART and the antenna about the simplification, it has been understood that the

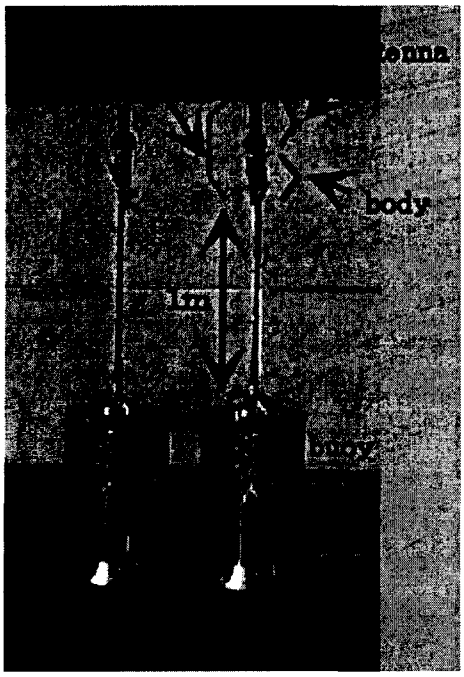
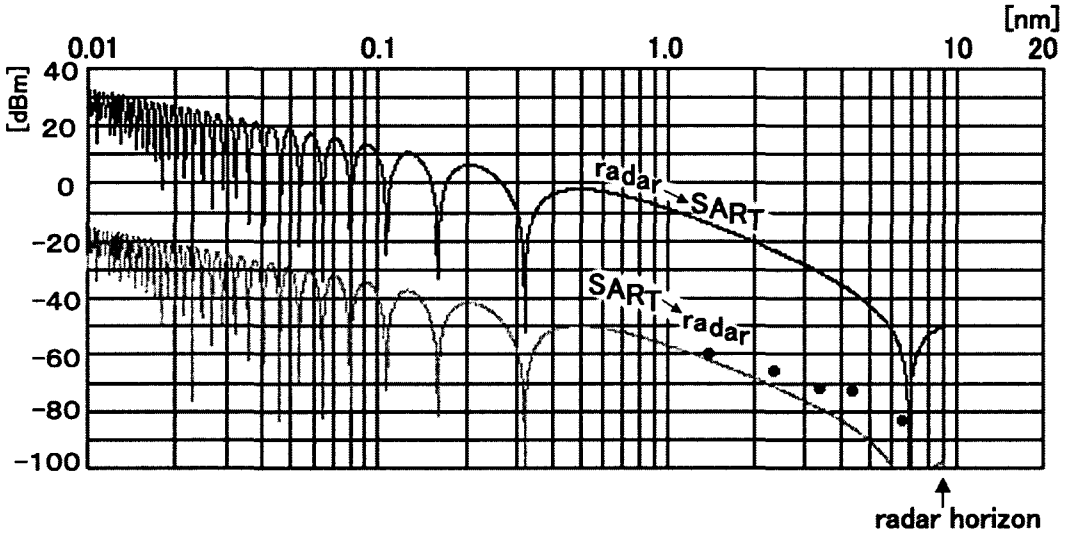


Fig.3 Dropping type SART

use of circular polarization has advantage. The antenna of SART is provided the horizontal polarization according to ship's radar. SART, however, doesn't necessarily keep the polarization, because big wave motion is generated at sea. It is thought that it is a cause the decrease in the detection distance and the detection probability. In the examination in the water tank and the sea, circular polarization often gave strong receiving signal for the horizontal polarization. Figure 4 shows the one example. Green line in the graph is theoretical value of horizontal polarization and the red dots are received signal from circular polarization SART. The value that is stronger than the theoretical value of horizontal polarization is indicated, and it is also understood that detection distance has expanded as a result. In the use of circular polarization, the antenna can be miniaturized. Furthermore, there is an advantage with an easy separation of the distance of the main body and the antenna because of connect possible by the semi-rigid cable. It means the antenna can be miniaturized and the design has flexibility.



antenna height	9.5[m]
target height	1.0[m]
radar horizon	9.0[nm]
radar transmission power	25[kW]
SART output	26[dBm]=400[mW]
SART minimum sensitivity	-60[dBm]

Fig.4 Theoretical value of horizontal polarization and observed value of circular polarization

(3) Life jacket installation type SART

Life jacket installation type SART (called life jacket SART in this paper) was developed using circular polarization antenna based on the obtained result by above mentioned (1) and (2). One example of images is

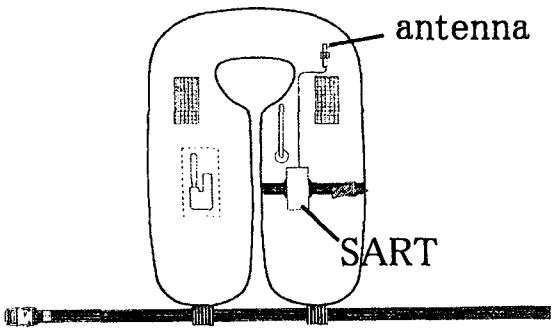


Fig. 5 Life jacket SART

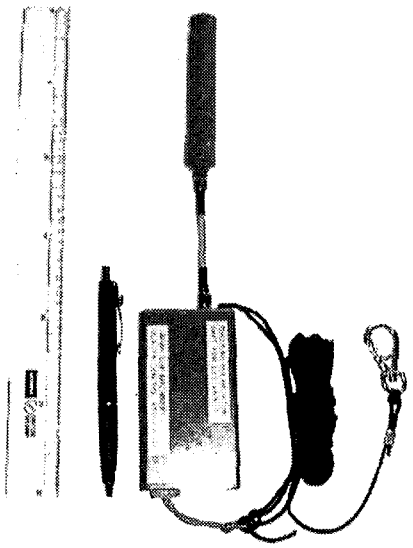


Fig.6 Picture of life jacket SART

shown in Figure 5.

In this type, the case where person falls in water is assumed. Therefore, some of the specification in Table 1 are severer than a suitable performance for the life jacket installation. The suitable specification is shown in Table 2.

Table 2 The Specification of the life jacket SART

Temperature range	-1 - +55 ℃
Operation time	After stand-by 24 hours, continuous response for 4 hours
Height of antenna surface of the sea	20cm or more
Reception sensitivity	below -50 dBm
Radiation electric power	400mW (+26dBm) or more
frequency	9200-9500 MHz
polarization	circular
weight	180g

When these are decided, the situation of the occurrences of the shipwreck in the near shore waters and the accident of falling in the sea are researched, furthermore, the relation between temperature of sea water and time that person who fall in the sea can live, was considered. The main change point is a use temperature and continuous operation time. Though the height of the antenna is not especially decided, the shoulder or the top of head of man who floats on the sea wearing the life jacket are assumed.

As the result, the use of a small general-purpose battery became possible, and the main body became the size of 8mm videocassette tape. The prototype is shown in Figure 6.

3. One mile SART

The authors aimed at the development of less expensive and smaller SART based on these results. To reduce the size to always carry it, and to reduce the cost for all crews and passengers it is our purpose.

SART consists an antenna, a battery, an oscillation module, a control module and the case. It made the limitation of the effective range to about one mile to reduce the battery so that the battery might occupy most of weight. One mile is about 1/10 compared with SOLAS agreement SART. It is, however, difficult to find person who floats on the surface of the sea even by the distance of only hundreds of meters with the unassisted eye. It is thought that the effect of reflecting in radar is large even if the distance is only as much as one mile. This SART is called One Mile SART in this paper.

3.1 Specification

The specification at which One Mile SART aims shows in Table 3.

Table 3 The Specification of One Mile SART

Temperature range	-1 - +30℃
Operation time	After stand-by 24 hours, continuous response for 4 hours
Height of antenna surface of the sea	20cm or more
Reception sensitivity	below -40 dBm
Radiation electric power	10mW (+10dBm) or more
frequency	9410MHz ±30MHz
polarization	Circular
weight	Less than 100g

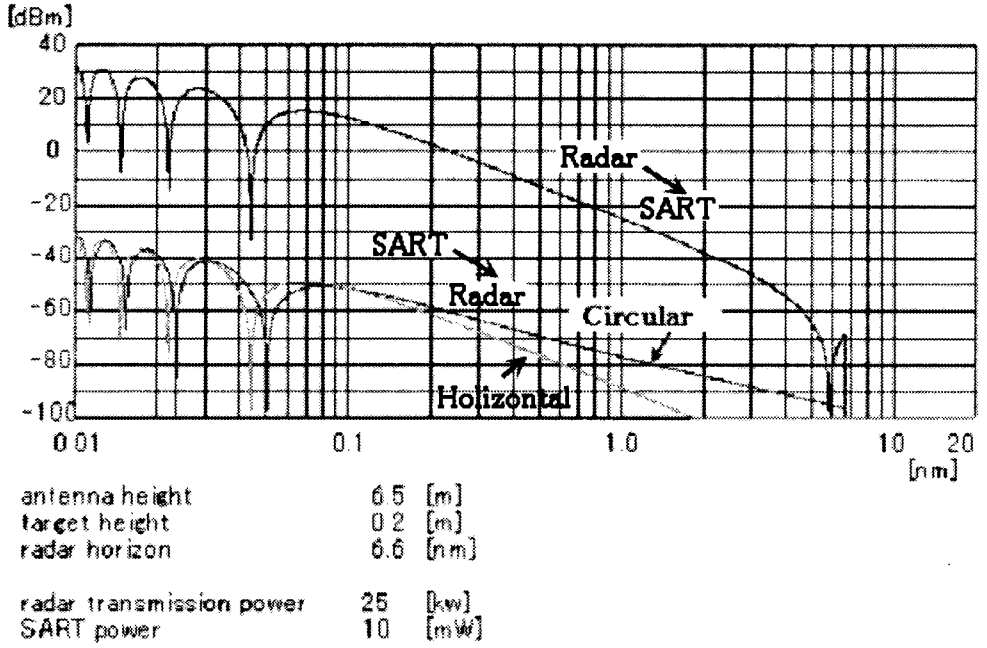


Fig. 7 The theoretical value of One Mile SART

Because it was assumption that the survivor in the sea was putting SART, the category temperature range was assumed to be almost -1 - +30℃ from the water temperature where person was able to live and the body temperature.

The effective receive sensitivity and the effect radiation electric power relates closely to the battery capacity and weight, and they should be made a minimum requirement. The theoretical value for effective

radiation electric power 10mW and the height of the antenna 20cm is shown in Figure 7 for the examination. The radar height is 6.5m as a small patrol vessel or fisher boat. When the minimum receive sensitivity of radar for the search is assumed to be -80dBm, it is understood to be able to secure the detection distance one mile. The effective receive sensitivity can be secured enough. It set it from this to 10mW.

The battery is consumed by the range of frequency and the circuit becomes complex, too. Because most of the radar actually used with the ship was a catalog value 9410MHz ±30MHz, the frequency limited to only having the minimum content of the range here.

About weight, it aimed at the level of the cellular phone or the penlight as extent that did not become obstructive even if it always carried, it aimed at 100g or less.

3.2 Examination of each component

SART consists of the antenna, the oscillation module, the control circuit, the battery and the case roughly separately, as mentioned. The result of review of each element to achieve the above-mentioned specification is described.

3,2,1 Antenna

The antenna for circular polarization includes a helical antenna used for life jacket SART. Weight is about 5g though it depends on the material of radome. The antenna for a dipole antenna, and the horizontal and vertical polarization combination antenna were made for trial purposes, and the performances were compared. Figure 8-9 shows the photograph of the prototype. The horizontal, vertical pattern of the antenna almost become omnidirectional except the dipole antenna, and weight become 1g or less for the dipole antenna, and 4g for other antenna. However, because the VSWR value is high, the antenna has understood there is a point that should be improved. The antenna will be selected considering the entire performance and weight.

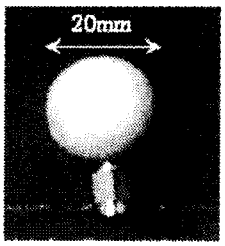


Fig. 8 Dipole antenna

Fig. 9 One of the prototype antenna

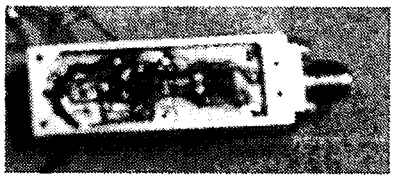


Fig.10 Oscillation module

3.2.2 Oscillation module

To fill the requirement in Table 3, the oscillation modules were designed, and made for the trial purposes. It shows in Figure 10. The wide is about 4cm. Figure 11-12 shows characteristics for two modules. The range of the frequency fills the requirement. The I / O characteristic has the response in -42dBm or more. Weight is about 15g including cables.

3.2.3 Control circuit

The circuit that controlled the transmission frequency and the transmission time was made by using general-purpose IC and electronic parts. IC of TTL was able to be composed of some pieces and the capacitor and resistance, etc. It is thought that it is easy to integrate. Though there are tens of grams because it used a universal basement in this prototype, if parts of the chip type used, about 15g can be achieved as well as the oscillation module.

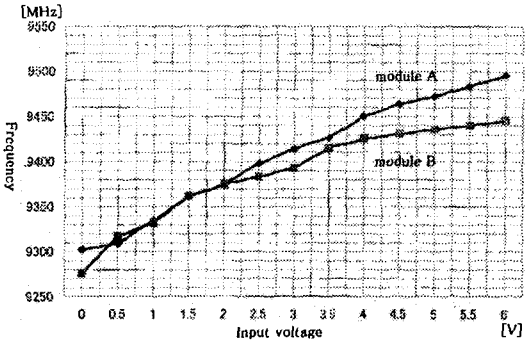


Fig.11 Frequency characteristic for input voltage

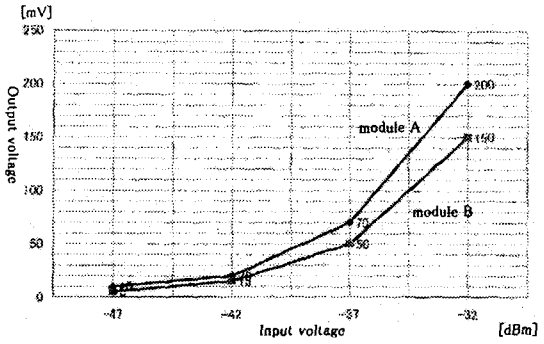


Fig.12 Voltage characteristic

3.2.4 Batteries

The kind never limited to the product of a specific maker only for SART is required about the battery. CR123A and 2CR5 were selected as general-purpose goods for the camera etc., and the performances were compared. A continuous standard current and maximum current were equal to both, but for the amount of the electric power that was able to be taken out at 0℃, 2CR5 was 5.8Wh against 5.2Wh CR123A (3V×2). Moreover, it was 6.6Wh and 7.2Wh at 20℃. After the integrated circuit is completed, details of a necessary electric power for the above-mentioned oscillation module and the control circuit will be measured. The life jacket SART previously developed was needed 2.2Wh in stand-by, 5.9Wh in transmitting, and 8.1Wh in total. Because 1.9Wh is, however, used to light LED, and the DC/DC converter for steady power-supply voltage efficiency is about 75%, it is thought that it can be assumed the amount of the electric power of about 6Wh by these improvements. Both of weight is about 35g, but 2CR5 of the price is 50% higher.

3.2.5 cases

Figure 13 shows the arrangement of the mock-up. The height is about 6cm. Batteries can be installed inside. The case only will be within the range of tens grams though actual weight changes by the material and watertight.

When the above-mentioned weight is brought together, it becomes about 100g.

Fig.13 Mock-up case

4. Summary

The size, the number, and the economy were enumerated as a problem of present SART. To solve them, SART developed in Japan was introduced. In addition, the examination that aimed at SART that each one was able to carry at any time was done, and the performance of the minimum requirement was maintained and miniaturized. Parts were made for trial purposed, the performance was confirmed and it was estimated that the weight became about 100g.

The authors will be going to put the improvement and integration to practical use achieving it in addition in the future, and to achieve a prompt salvage.

References

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