JRC

Green Book
2015

Marine Products Maintenance Handbook

JRC Japan Radio Co., Ltd.
Marine Service Department

Foreword

Since the first edition was published in 1981, we had many persons love to read, but was not able to revise it for long time of 6 years. We caused all of you inconvenience very much, but it is as far as we are happy, that we are going to be able to reprint the 100th anniversary year unexpectedly.
This handbook covers the latest equipment, the latest rule and the basic technology document as the performance and the function of our equipment in which safe navigation of the ship is aided will be maintained also it's some help of the service engineer trusted by the users.
We hope to be using this handbook all the time by all of you engaged in marine relations of the whole world.

March, 2015

Marine Service Department
General Manager
Hajime Hirota

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A. General Information

(Before you begin)

1. Cautions for high voltage

High voltages from hundreds volts to tens of thousands volts are to be applied to the electronic equipment such radio and radar devices. You do not face any danger during normal operation, but sufficient cares are required for maintenance, inspection and adjustment of their internal components. (Maintenance, check-up and adjustment of the inside of the equipment are prohibited except by maintenance specialists.)

High voltages of tens of thousands volts are so dangerous as to bring an instantaneous death from electric shock, but even voltages of hundred volts may sometimes lead to a death from electric shock. When you touch any parts inside these devices, before doing so, you should make it a rule to turn off the power switch to prevent such an accident caused by electric shock, and discharge capacitors with a wire surely earthed on an end and make sure that internal parts are no longer charged. Furthermore, when doing so, wearing dry cotton gloves protect you from such danger. It is also necessary to put one of your hands in the pocket and not to use both your hands at the same time.

It is also important to select a stable foothold always to prevent secondary accidents once you were electrically shocked. If you are injured from electric shock, you disinfect the burn sufficiently and give medical treatment to it promptly.

2. What to do for Electric Shock

When finding a victim of electric shock, you should call a person(s) near there, and turn off the power source and earth the circuit immediately. If it is impossible for you to turn off the circuit immediately, you should move the victim away promptly using insulators such as dry wood plate and cloth without touching the victim directly.

In case of electric shock, breathing may stop suddenly if current flows to the respiration center in the brain. If the shock is not so strong, artificial respiration may recover breathing. When shocked by electricity, the victim will come to look very bad with weak pulse or without beating, resulting in unconsciousness and rigidity.

First-aid treatments

As far as the victim of electric shock is not in dangerous condition, you should not move the victim and practice artificial respiration on the victim immediately. Once respiration is started, it should be continued rhythmically.

(1) Tell the accident to persons near there loudly and ask them to gather

(2) Do not touch the victim confusedly as result of the accident, or rescuer may also get an electric shock.

(3) Turn off the power source calmly and move the victim away quietly from the electric line. (make sure whether places near there is safe.)

(4) Try to contact persons or offices concerted (Clinic, hospital, doctor, emergency call, etc.)

(5) Lay the victim on his back and loosen his necktie, clothes, belt, etc.

(6) - a Feel the victim's pulse.
- b Fell the victim's heartbeat bringing your ear close to his heart.
- c Examine his breathing bringing the back of your hand or your face close to his face.
- d Check the size of the pupils of his eyes.

(7) Open the victim's mouth and take out artificial teeth, cigarette or chewing gum if any. Keep his mouth open, stretch his tongue and insert a towel or the like in his mouth to prevent the tongue from suffocating. (If it is hard to open his mouth due to set teeth, open it with a screwdriver and insert a towel in this mouth.)

(8) Then, clean the victim's mouth so that foaming mucus does not accumulate inside the mouth.

3. When pulse is beating but breathing has stopped Give a (Mouth-to-mouth respiration) Fig. 1

(1) Tilt the victim's head back as far as this face looks back. (A pillow may be inserted his neck.)

(2) Push the victim's jaw upward to open his throat wide (to spread his airway).

(3) Pinch the victim's nostrils and take a deep breath, cover the victim's mouth completely with yours and blow into the victim's mouth strongly. Take a deep breath again and blow into the victim's mouth. Continue this 10 to 15 times a minute (blocking his nostrils).

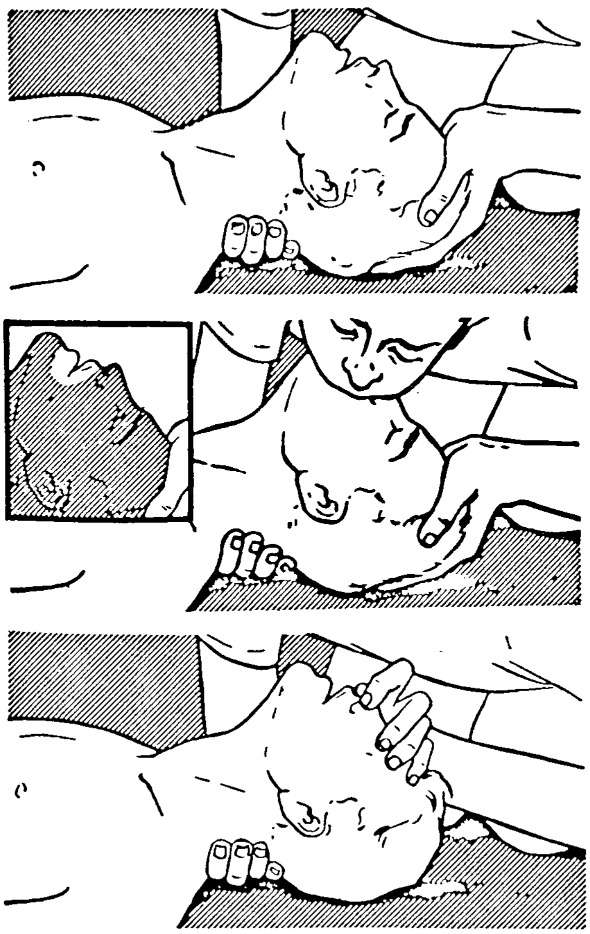
(4) Practicing artificial respiration, carefully watch whether the victim has recovered his natural breathing, soon after the victim recovered, stop respiration.

(5) If it is difficult to open the victim's mouth, insert a rubber or vinyl tube into one of the victim's nostrils and take a deep breath and blow into it, blocking the victim's other nostril and mouth completely.

(6) When the victim recovers consciousness, the victim may try to stand up suddenly, but let the victim lie calmly and serve the victim with a cup of hot coffee or tea and keep the victim warm and quiet. (Never give him alcoholic drinks.)

Method of mouth-to-mouth respiration by raising head

①
②
③



(1) Raise the victim's head. Support his forehead with one of your hand and his neck with the other hand. → ①
When you tilt his head backward, the victim, in most cases, opens his mouth to the air. This makes mouth-to-mouth respiration easy.

(2) Cover his mouth as widely as possible with yours and press your cheek against his nose → ②
Or, pinch his nostrils with your fingers to prevent air from leaking. → ③

(3) Blow into lung.
Blowing into mouth until his breast swells. Blow into his mouth as quickly as possible 10 times at first.

Fig. 1 Mouth-to-mouth respiration

4. When both pulse and breathing have stopped Give a (Cardiac massage). Fig. 2

When pulse has come not to be felt, his pupils are open and no heartbeat is heard, cardiac arrest is supposed to have occurred and artificial respiration must be performed.

(1) Place your both hands, one hand on the other, on the lower one third area of his breastbone and compress his breast with your elbows applying your weight on his breast so that it is dented about 2 cm (Repeat compressing his beast 50 times / minute or so). (Cardiac massage)

(2) In case of one rescuer,
Repeat cardiac massages about 15 times and blow into his mouth 2 times quickly, and repeat his combination.

(3) In case of two rescuers,
One person repeats cardiac massages 15 times while the other person blow into his mouth once, and they shall repeat this combination. (Perform the cardiac massage and mouth-to-mouth respiration)

(4) Examine his pupils and his pulse sometimes. When the both have returned to normal, stop he artificial respiration, serve him with a cup of hot coffee or tea and keep him warm and calm while watching him carefully. (Never give him alcoholic drinks.)

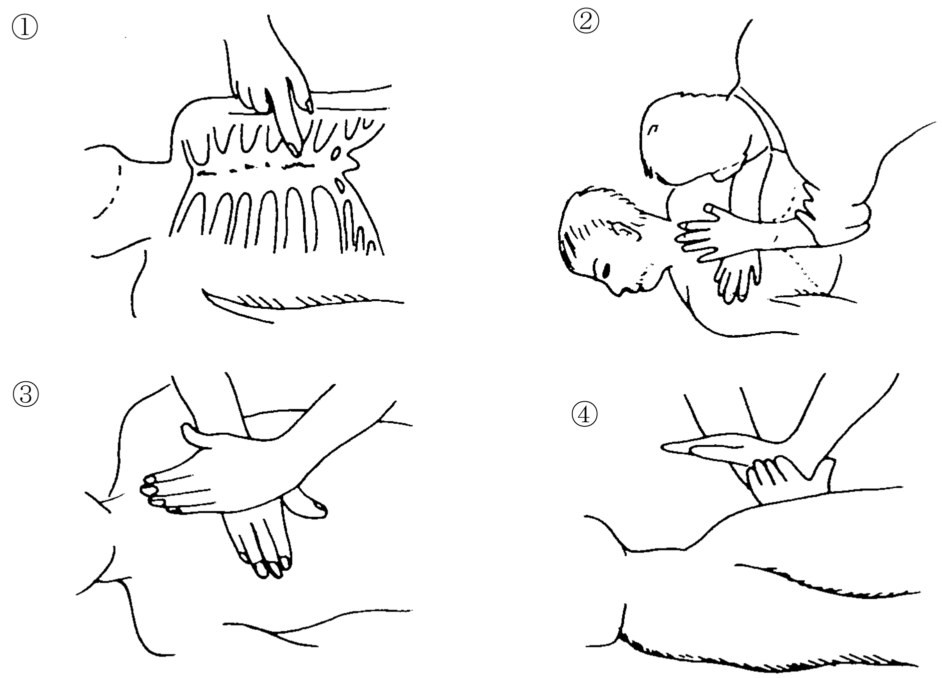


Fig. 2 Cardiac massage

5. Procedure for cardiopulmonary resuscitation using the AED (flow chart)

A person is collapsing.
-Secure the safety of the surrounding area.
-Prevent secondary disasters.

↓

Check for response.
-Call while tapping the shoulder.

→ Responding → Listen to appeal of the injured or ill person and give the necessary first-aid treatment

↓ Not responding

Ask for help.
-Make an 119 emergency call.
-Ask to bring an AED

↓

Open the airway.
-Check for breathing.

→ Breathing → Recovery position.
-Lay the injured or ill person on his-her side and wait for the arrival of the emergency service.

↓

Give 2 rescue breaths;omittable.Note(1)

↓

Give CPR
-30 Chest compressions.
-Give 2 rescue breaths; omittable.

↓

Arrival of an AED.
-Turn on the power.
-Use the AED by following its voice pompts. Fitting of the electrode pads,etc.

↓

Automatic electrocardiogram analysis.
-Do not touch the injured or ill person.

→ Electric shock is not needed → Resume CRP

↓ Electric shock is needed

Delivery of electric shock.

↓

Resume CRP from chest compressions by following the voice prompts of the AED.

→ When to stop CRP. → When the injured or ill person has been handed over to the emergency services or has started moaning or breathing normally,lay him/her side in a recovery position and wait for the arrival of emergency services.

→ The AED automatically analyzes the heart rhythm every 2 minutes. → Automatic electrocardiogram analysis.

Note(1)
Omission of rescue breathing:if there is a fear of infection because the injured or ill person has an intraoral imjury,you are hesitant about giving mouth-to-mouth resuscitation,or preparing the mothpiece for rescue breathing takes too long,omit rescue breathing and proceed to next step.

6. Procedure for cardiopulmonary resuscitation (CPR) using the AED (Automated External Defibrillator)

1. Check the scene for safety to prevent secondary disasters

a) Do not touch the injured or ill person in panic when an accident has occurred. (Doing so may cause electric shock to the first-aiders.)

b) Do not panic and be sure to turn off the power. Then, gently move the injured or ill person to a safe place away from the electrical circuit.

2. Check for responsiveness

a) Tap the shoulder of the injured or ill and shout in the ear saying, "Are you OK?"

b) It the person opens his/her eyes or there is some response or gesture, determine it as "responding." But, if there is no response or gesture, determine it as "not responding."

3. If responding

a) Give first-aid treatment.

4. If not responding

a) Ask for help loudly. Ask somebody to make an emergency 119 call and bring an AED.
   1) Somebody has collapsed. Please help.
   2) Please call 119.
   3) Please bring an AED.
   4) If there is nobody to help, call 119 yourself.

5. Open the airway

a) Touch the forehead with one hand. Lift the chin with the two fingers of the middle finger and forefinger of the other hand and push down on the forehead as you lift the jaw to bring the chin forward to open the airway. If neck injury is suspected, open the airway by lifting the lower jaw.

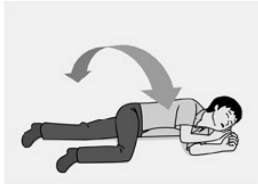
6. Check for breathing

a) After opening the airway, check quickly for breathing for no more than 10 seconds. Put your cheek down by the mouth and nose area of the injured or ill person, look at his/her chest and abdomen, and check the following three points.

1) Look to see if the chest and abdomen are rising and falling.
2) Listen for breathing.
3) Feel for breath against your cheek.

b) If the injured or ill person is breathing, place him/her in the recovery position and wait for the arrival of the emergency services.

1) Position the injured or ill person on his/her side, maintain a clear and open airway by pushing the head backward while positioning their mouth downward. To maintain proper blood circulation, roll him/her gently to position them in the recovery position in the opposite direction every 30 minutes.



Roll gently in the oppsite direction every 30 minutes.

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7. Give 2 rescue breaths (omittable)

a) If opening the airway does not cause the injured or ill person to begin to breathe normally, give rescue breaths.

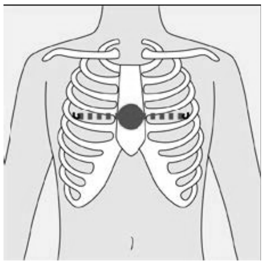
b) If there is a fear of infection because the injured or ill person has an intraoral injury, you are hesitant about giving mouth-to-mouth resuscitation, or getting and preparing the mouthpiece for rescue breathing takes too long, omit rescue breathing and perform chest compressions.

c) When performing rescue breathing, it is recommended to use a mouthpiece for rescue breathing and other protective devices to prevent infections.

d) While maintaining an open airway, pinch the person's nose shut with your thumb and forefinger of the hand used to push down the forehead.

e) Open your mouth widely to completely cover the mouth of the injured or ill person so that no air will escape. Give rescue breathing twice in about 1 second and check if the chest rises.

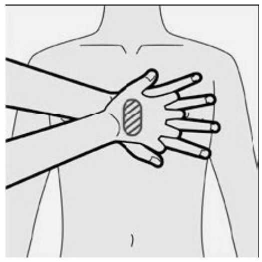
8. Cardiopulmonary resuscitation (CPR) (combination of chest compressions and rescue breaths)



a) Chest compressions

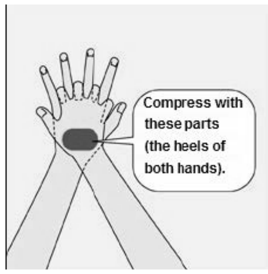
1) Position of chest compressions

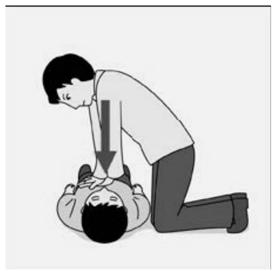
- Position the heel of one hand in the center of the chest, approximately between the nipples, and place your other hand on top of the one that is in position.



2) Perform chest compressions

- Perform uninterrupted chest compressions of 30 at the rate of about 100 times per minute. While locking your elbows positioning yourself vertically above your hands.
- With each compression, depress the chest wall to a depth of approximately 4 to 5 cm.



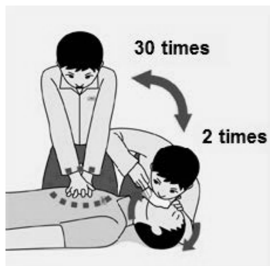


b) Combination of 30 chest compressions and 2 rescue breaths

1) After performing 30 chest compressions, give 2 rescue breaths. If rescue breathing is omitted, perform only chest compressions.

2) Continuously perform the combination of 30 chest compressions and 2 rescue breaths without interruption.

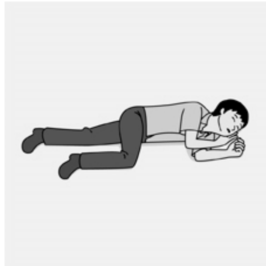
3) If there are two or more first-aiders, alternate with each other approximately every two minutes (five cycles of compressions and ventilations at a ratio of 30:2) without interruption.



9. When to stop cardiopulmonary resuscitation (CPR)

a) When the injured or ill person has been handed over to the emergency services

b) When the injured or ill person has started moaning or breathing normally, lay him/her on his/her side in a recovery position and wait for the arrival of emergency services.

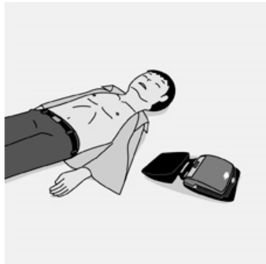


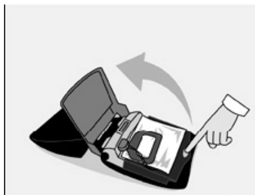
10. Arrival and preparation of an AED

a) Place the AED at an easy-to-use position. If there are multiple first-aiders, continue CPR until the AED becomes ready.

b) Turn on the power to the AED unit. Depending on the model of the AED, you may have to push the power on button, or the AED automatically turns on when you open the cover.

c) Follow the voice prompts of the AED.





Turn on the power.

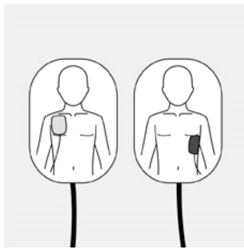
11. Attach the electrode pads to the injured or ill person's bare chest

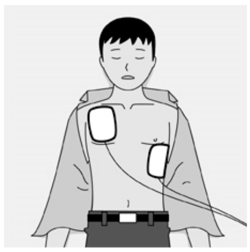
a) Remove all clothing from the chest, abdomen, and arms (male or emale).

b) Open the package of electrode pads, peel the pads off and securely place them on the chest of the injured or ill person, with the adhesive side facing the chest. If the pads are not securely attached to the chest, the AED may not function. Paste the pads exactly at the positions indicated on the pads, if the chest is wet with water, wipe dry with a dry towel and the like, and then paste the pads. If there is a pacemaker or implantable cardioverter defibrillator (ICD), paste the pads at least 3cm away from them. If a medical patch or plaster is present, peel it off and then paste the pads. If the injured or ill person's chest hair is thick, paste the pads on the chest hair once, peel them off to remove the chest hair, and then paste new pads.

c) Some AED models require to connect a connector by following voice prompts.

d) The electrode pads for small children should not be used for children over the age of 8 and for adults.





A

12. Electrocardiogram analysis

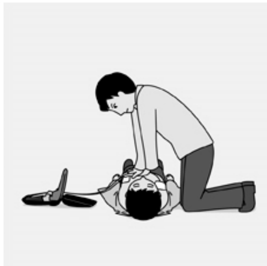
a) The AED automatically analyzes electrocardiograms. Follow the voice prompts of the AED and ensure that nobody is touching the injured or ill person while you are operating the AED.
b) On some AED models, you may need to push a button to analyze the heart rhythm.

13. Electric shock (defibrillation)

Press the shock button.

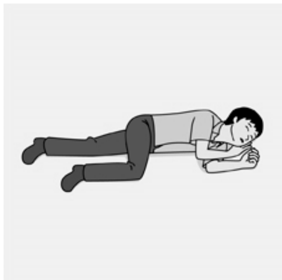
a) If the AED determines that electric shock is needed, the voice prompt saying, "Shock is needed" is issued and charging starts automatically.
b) When charging is completed, the voice prompt saying, "Push the shock button" is issued and the shock button flashes.
c) The first-aider must get away from the injured or ill person, make sure that no one is touching him/her, and then press the shock button.
d) When electric shock is delivered, the body of the injured or ill person may jerk.

14. Resume cardiopulmonary resuscitation (CPR).



Resume CPR consisting of 30 chest compressions and 2 rescue breaths by following the voice
Prompts of the AED.

15. Automatic electrocardiogram analysis



a) When 2 minutes have elapsed since you resumed cardiopulmonary resuscitation (CPR), the AED automatically analyzes the electrocardiogram.
b) If you suspended CPR by following voice prompts and AED voice prompt informs you that shock is needed, give electric shock again by following the voice prompts. If AED voice prompt informs you that no shock is needed, immediately resume CPR.

16. When to stop CPR (Keep the electrode pads on.)

a) When the injured or ill person has been handed over to the emergency services
b) When the injured or ill person has started moaning or breathing normally, lay him/her on his/her side in a recovery position and wait for the arrival of emergency services.

7. Observance of Safety Routine Rules at Work

1	Working clothes	Wear long sleeve jacket and button the wristbands, regardless of heat and cold, and not be untidily dressed.
		Wear safety hat/helmet, safety belt, gaiters and a hard hat, a security zone, a gaiter, safety shoes at the shipyard in particular
2	Protective goods	Make sure of safety before use of protective goods.
	Safety belt	Use a safety belt above the height of 2 m
		Put a sling hook of safety belt on place 2 m higher than waist
	Safety hat or helmet	At work at higher places or in shipyards, wear safety hat or helmet and tighten a chin belt.
		Gap between inner clothes of helmet and helmet is at least 25 mm.
	Protective glasses and earplug	Put on dust-proof glasses against dust while grinding or chipping and put on earplug at noisy places.
3	Check / maintenance of appliance / tools	Check your own tools by yourself before use of it and make sure whether it is safe.
		Use proper tools and do not use temporary tools.
4	Clear and put up in order	Always clear up things around you and set up it in order and clear up after work is finished.
5	Passage	Do not pass through under Cargo handling places and container yards and Crane etc.
		Walk along the proper passage in shipyards or customer's yards etc.
6	Work at high places	Use a safety belt surely.
		Be careful enough not to drop your tools below.
7	Transportation	Do not lift heavy equipment etc. over 30 kg alone.
		While transporting by crane onboard ships, on windy days, obey orders of site supervisors.
		While climbing up or down ladders, with tools etc. in knapsack, use both hands.
8	Work onboard ships carrying dangerous cargos(Tanker etc.)	Do not transmit radio waves during cargo handling.
		Do not put on hobnailed shoes.
		Do not smoke at nonsmoking areas.
9	Work at ship's bottom	Notify to vessel, open the hatch of manhole for ventilation more than 24hours ago of start work.
		Make sure whether gaser are not exist by using gas (oxygen etc) measuring devices.
		Don't use the fire. As a poisonous gas may be generated.
		At least two persons work together for emergency case.
		Use worklights with metal-protective gaurd and bring flashlight(s).
10	Work in shipyards	Take safety lectures of each shipyard and work in accordance with shipyard safety rules.
11	Group work	Before starting work, decide a leader of work and obey his orders.
		Work together in harmony communicating with each other if dangerous situation may exist.

12	Use of mobile phone	If use of mobile phone onboard ships carrying dangerous cargo etc. is restricted, obey rules of the ship.
		Do not use mobile phone during driving. If telephoning is needed, use hands-free phone not to disturb driving.
		If a mobile phone is used at high place, fall-preventing mechanism is applied to it.
13	Driving a car	Check a car before driving brake, lights, remaining amount of gasoline.
		Observance of traffic rules Use sheet belts and keep regulation speed.
		Drive into company's facilities or factory Indicate Driving-Permission-in-yard and keep the company's traffic rules.
14	Use of data terminal equipment	Use a camera after obtaining permission. (In particular onboard ships carrying dangerous cargos, use flash after obtaining permission.)
		While downloading data from VDR etc. and updating software of AIS, ECDIS and others, be careful of management of PC and media and data in PC etc are possibly minimized not to lose data brought in.
		Data PC is always check and scan for protect from PC virus.
15	Smoking	Do not smoke in smoking-restricted areas, and neither smoking while walking nor working with a cigarette in your mouth is never permitted.
		Be fully careful of the fire after smoking.

8. Things taken into account at work

There are many things to know at work at radio stations. The followings below are especially important.

8-1 Observance of Radio regulations and rules concerned

You should not only observe the regulations and rules above, but you should also observe rules of each port or each ship. Especially onboard ships which carry dangerous cargos, when fire work is carried out and radio waves are transmitted or work is done on open deck such as compass deck, permission should be obtained before work is started.

8-2 No permission to transmit radio waves by unqualified persons

When transmissions of radio waves are needed during repairing or maintenance, work should be carried out under observation of ship's qualified persons.

8-3 Dummy antenna may be used during adjustment of transmitters if possible.

8-4 Whatever equipment may be operated, distress signals should not be transmitted even through dummy antenna. (Note 1)

If distress signals were transmitted by accident, nearby Competent Authority's Radio station or Coast Radio Stations should be immediately informed of what happed.

Contents to be informed

1) Ship's name
2) Call sign
3) the time of transmission and the time of ceasing transmitting
4) the reason why erroneously transmitted

Note1 : When maintenance or test of EPIRBs is carried out onboard ships, and radio wave shielded confined room such as engine control room etc. should be used not to transmit radio wave outside the ship (If an antenna is there, it should be removed temporally.) and stop transmission soon after test is over.

MEMO

A

B. GMDSS

About GMDSS rule－

The content described in this chapter is based on Japanese rule. There are many rules in common, but for your sake,it is best to contact with a Competent Authority or a classification authority, since some points do differ depending on the country and / orclassification authority. Please refer the document issued by IMO and SOLAS.

1. Entery into Force

The Conference of Contracting Government to SOLAS for amendment to the 1974 SOLAS Convention (for introduction of GMDSS) and the 1978 Protocol was held in the headquarters of IMO in London, from 31 October to 11 November, in 1988, and the draft amendment was adopted. This Convention entered into force on 1 February, 1992.

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2. Background of GMDSS Introduction

Background of introduction of GMDSS is as follows. In the 25th MSC (Maritime Safety Committee) held in 1972, MSC determined to consider the developments of maritime distress and safe system, and discussion of developmets of it was started at the 19th Sub-Committee on Radio Communication (COM) in 1978. Study on it and discussion were continued for the long term of about 10 years until the 34th COM held in January, 1988. Finally, in the 55th MSC held in April, 1988, the agreement of the requirements to a vessel, such as performance standards and requirements for operation and installation of GMDSS equipment, was reached on the whole as the amendments to the SOLAS Convention.

The present distress and safe system sends alerts (signals) for mainly asking other vessels navigating near the own ship for rescue, and is a rescue system between vessels chiefly. The radio voice telecommunication by 2182kHz and 156.8MHz for all ships not less than 300 GT, or Morse telegraphic communication by 500kHz for all ships not less than 1600 GT, was required to be fitted with according to the 1974 SOLAS Convention.
However, the following restriction or limitationhas been found.

(a) Since there were some kinds of restrictions or limitations, such as a short range communication of 100-150 nautical miles, transmission by hand, hearing by ears,etc. it was difficult to keep communicating rapidly and without fails.
(b) As different systems are required on the basis of ship’s type or size, communication between ships was sometimes not possible.

Therefore, the necessity for modernization of these systems came out.
Moreover, In order to secure victims in the sea quickly and effectively, the international Convention (International Convention on Maritime Search and Rescue, 1979:SAR Convention), aiming at establishing cooperation between neighboring states for carrying out search and rescue, was adopted.

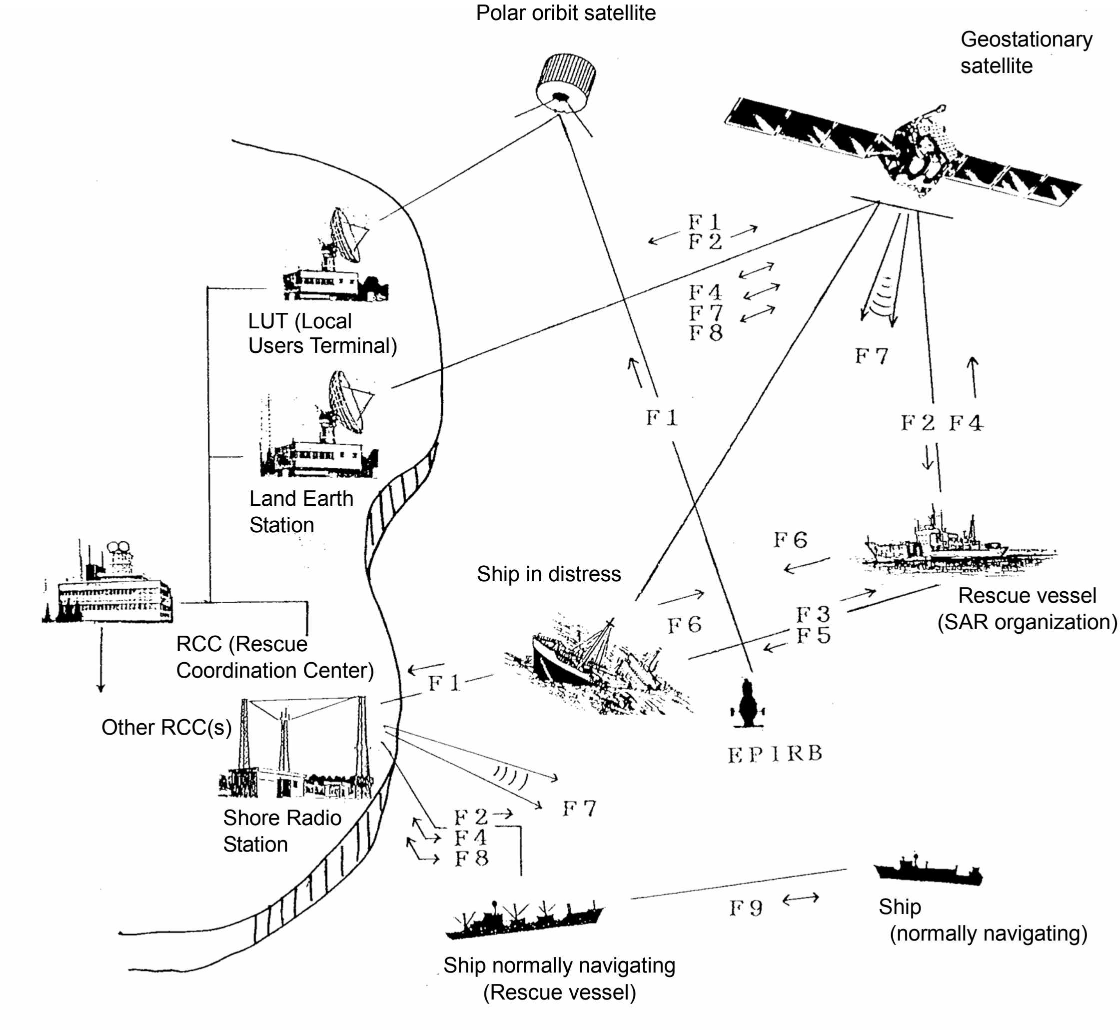
In order to employ effectively the search and rescue schemes specified in the SAR Convention, the necessity of supportive and effective communication for distress and safety navigation has been recognized, and development and introduction of GMDSS were surely made. And IMO has tried to introduce a new comprehensive system, considering the coming future, for developing a global maritime distress alert system by introducing the latest techniques in Radio communication which has been rapidly progressing.

3. Outline of GMDSS Introduction

As mentioned above, GMDSS equipment of which operation mainly used to depend on manual operation has changed to automatically-operated equipment and it has been operated through land and the seas, and then, even if ships come across the distress in any sea, distress alert signals transmitted from them can be received by not only ships navigating nearby but also by land search and rescue stations without fails. Accordingly, a communication link will be established as a link on line through ship and Rescue Coordination Center on land. Consequently, more effective communication and search and rescue operation in distress has been possible.

For that purpose, it is necessary to install equipment which enables equipment to be much more easily operated and exchange various information quickly. That is, the ships for 1974 SOLAS Convention are equipped with commonly required minimum equipment, and also in accordance with the sea areas (divided into 4 sea areas) in which each ship navigate, by using INMARSAT Ship Earth Station, Satellite communication equipment of EPIRB,etc. using INMARSAT Geostationary Satellite system, radio system using automation technology by the new radio telecommunication technology using digital selective calling (DSC) and narrow band direct printer telegraphy (NBDP) and using digital technologies, and land-based communication system using HF Radio Telephone (RT) ,etc. , even if ships are navigating in any sea area, they can transmit and receive distress and safety signals to and from ships navigating nearby and land search and rescue stations Therefore, also in the International Telecommunication Union (ITU), amendments to Radio Regulation (R. R.), about the frequency used for this system and the management procedure of the system, was adopted in World Administrative Radio Conference for the Mobile Services (Geneva, 1987) held in Geneva in September, 1987 and resolution and guideliene,etc. were also adopted.

4. Image of GMDSS operation



Communication patterns in GMDSS operation

F1: alert from ship to land (INMARSAT, DSC, and EPIRB)
F2: alert from land to ship (INMARSAT, DSC and EPIRB)
F3: alert from ship to ship (DSC)
F4: communication for cordination (NBDP, R/T)
F5: on-site communication (R/T)
F6: locating (radar transponder, radar)
F7: alert for navigation (INMARSAT, NBDP and R/T)
F8: general communication (INMARSAT, NBDP and R/T)
F9: Bridge-to-Bridge Communication (R/T)

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5. Function and Advantage of GMDSS

Communication Type	Communication area	Communication methods	Advantage
Distress report	Wrecked ship ↔ ships ↳ Land Stations	VHF (Ch 70) & MF (2182kHz), DSC VHF/MF/HF DSC, NBDP, and Radiotelephony INMARSAT TLX Satellite EPIRB	- Not only ships navigating nearby but land stations can be notified without fail. - Stations can be linked automatically and rapidly without fail
Search & Rescue Communication	Rescue headquarters ↕ Rescue boat ↕ Ships navigating nearby	VHF/MF/HF DSC, NBDP, and Radiotelephony INMARSAT TLX	- Since the minimum communicable range is 100-150 nautical miles, Ships and land stations may be unable to be notified other than ships navigating nearby and close near land station.
On-site Communication	Wrecked ship ↕ Rescue boat ↕ Ships navigating nearby		
Communication in general	ships ↔ ships ↳ Land Stations		- Communications can be established between ships in any seas in the world and/or land stations anytime.
Homing signal	Wrecked ship ↕ Rescue boat ↕ Ships navigating nearby	Satellite EPIRB Radar Transponder	- Since the position of a wrecked ship is known correctly, prompt Search & Rescue activities can be performed.
Bridge to Bridge communication	Ships ↔ Ships	mainly VHF Radiotelephony	---
Marine safety Information broadcast	Land Station → Ships	NAVTEX EGC MSI	- Information about safety navigation, such as weather information, is obtained.

6. Terms on GMDSS

6-1 Bridge-to-bridge communications

Safety communications between ships from the position from which the ships are normally navigated.

6-2 General radiocommunications

Operational and public correspondence traffic, other than distress, urgency and safety messages, conducted by radio.

6-3 DSC (Digital selective calling)

A technique using digital codes which enables a radio station to establish contact with, and transfer information to, another station or group of stations. VHF, MF and MF/HF bands are used.

6-4 INMARSAT Ship Earth Station

The radio station installed in a ship in order to perform direct highly qualified communication between a ship and a ship or between land (telephone and telex subscribers) and a ship through the INMARSAT geostationary satellite.
There is standard C type (only telex communication and e-mail communication) using an omnidirectional antenna, besides the standard B type (telex, telephone communication and facsimile/data communication by telephone communication line(9600bps)) using a directinal antenna. C type has been further developed aiming at the miniaturization in INMARSAT Ship Earth Station of which the duty of installation is imposed by GMDSS.

6-5 NBDP (Narrow Band Direct Printing telegraphy)

It performes automatical telefax communication with shore radio stations and with other ships, connecting MF/HF radio equipmet

6-6 NAVTEX receiver

NAVTEX system is one of functions in WWNWS (World-Wide Navigational Warning Service) which was established by IMO and IHO (International Hydrographic Organization).
NAVTEX receiver receives automatically and print the information, relating to navigation, weather and Search/Rescue, broadcasted on the globally coordinated frequency (English: 518 kHz, Native language: 490 kHz) from shore station to the ships navigating within the sea areas 400NM away from shores.
It receives the information broadcasted from the International NAVTEX service.
According to the revised performance standards for NAVTEX, NAVTEX installed on or after 1 July 2005 is permitted to receive two NAVTEX signals (518KHz+490KHz or 518KHz+4209.5KHz) simultaneously and its output data can be displayed on a screen.

6-7 MSI (Maritime Safety Information) receiver

Navigational and meteorological warnings, meteorological forecasts and other urgent safety related messages broadcasted to ships. As MSI receivers, there are NAVTEX reviver, INMARSAT EGC receiver and MF band MHI receiver.

6-8 EGC (Enhanced Group Call)

Highly qualified INMARSAT group receiver (EGC:Enhanced Group Call)
It can recive automatically the information transferred through INMARSAT by adding the receiver of exclusive use to INMARSAT Ship Earth Station.

6-9 Locating

Finding of ships, aircraft, units or persons in distress.

6-10 HF band MSI receiver

It receives information of MSI broadcasted on HF band, using NBDP. In GMDSS, it can use depending on conditions.

6-11 Polar orbiting satellite service

A service is based on polar orbiting satellites which receive and relay distress alerts from satellite EPIRBs and which provides their position.

6-12 Satellite EPIRB: Emergency Position Indicating Radio Beacon using satellite

When a ship sinks, Radio Beacon is automatically released and floats on the sea-surface free (or in the lifeboat) and is automatically activated, and transmit a distress alert to land statins through the polar orbiting satellite service. There is an L band EPIRB which used the COSPAS/SARSAT satellite in this satellite EPIRB.

6-13 Radar Transponder for Search and Rescue

When a ship is wrecked or sinks, Radar Transponder is automatically released and floats on the sea-surface free (or in the lifeboat) and is automatically activated or is carrried by one person in any survival claft and transmits automatically homing signals. In addition, it receives radar signals (9GHz band) radiated from ships and reflects the responding signals, and then when any ship receive the reflected signal from the transponder, its radar display indicates the wrecked ship position on its radar display.

6-14 AIS (Automatic Identification System)

AIS identifies ships automatically using VHF radio device.
AIS broadcasts navigational information of own ship's position, course, speed etc. and ship's name or cargo etc. by TDMA method periodically with VHF band. In addition, AIS receives always such information broadcasted from other ships and display those data. Two frequencies for the high seas are used (AIS1 161.975MHz, AIS2 162.025MHz).

6-15 SSAS (Ship Security Alert System)

In the case that harmful attacks such as terrorism etc. are given to a ship, a SSAS installed the ship transmits a security alert to the shore to indicate to a competent authority that the security of a ship is under threat or has been compromised. It is expected that the Maritime security will be much more developed by introducing this system.

6-16 VDR (Voyage Data Recorder)

VDR records information concerning ship's position, course, speed, physical status, conversarion in the bridge etc. to identify the cause(s) of an incident. VDR is for new constructed ships, and S-VDR (Simplified-Voyage Data Recorder) is isntalled on board exsisting cargo ships. The performance standards of S-VDR is relaxed in comparison with VDR and it is positioned as a simplified VDR as the name shows.

6-17 LRIT (Long Range Identification and Tracking of ships)

LRIT transmits automatically the ship's identity, position etc. to the data center on the land.
As a result, it is expected to be possible to grasp the status of ships all over the world.
Amendments to SOLAS chapter V was adopted by IMO MSC. 81 held in May 2006 and ships noted below are required to be fitted with LRIT according to the amendments. The amendments has already entered into force on 1 Jan 2008. The LRIT Carriage requirements applies to Mandatory ships on or after 31 December 2008.
Note: passenger ships (including high-speed passenger craft), cargo ships (including high-speed craft) of 300 gross tonnage and upwards, mobile offshore drilling units.

6-18 Two-Way Radio (Two- Way VHF Radiotelephone)

In the case of a distress, the Two-Way VHF Radiotelephone is used for the communication between the life boat each other, and is used for the local communication between the life boat and the rescue boat.
There are conformity requirements, such as the use frequency has two or more including ch16; it is possessed battery capacity to operate in the ratio of "transmission 1: reception 9" more than eight hours; it is possessing watertightness to be worthy of depth of the water 1m for five minutes.

7. Range of the application of SOLAS (Safety of Life at Sea) treaty

7-1 Application

Unless expressly provided otherwise, the present regulations apply only to ships engaged on international voyages.

Exceptions:

1. Ships of war and troopships.
2. Cargo ships of less than 500 gross tonnage.
3. Ships not propelled by mechanical means.
4. Wooden ships of primitive build.
5. Pleasure yachts not engaged in trade.
6. Fishing vessels.

＊ The details refer to a Regulation 1 Application Regulation 3

7-2 Requirements for ships and life-saving appliances

All passenger ships and all cargo ships of 300 gross tonnage and upwards.
life-saving appliances: Two-way VHF radiotelephone apparatus and Radar transponders

＊ The details refer to a CHAPTER Ⅲ Requirements for ships and life-saving appliances Regulation 6 Communications

7-3 Radiocommunications

Unless expressly provided other wise, this chapter applies to all ships to which the present regulations apply and to cargo ships of 300 gross tonnage and upwards.

＊ The details refer to a CHAPTER IV Radiocommunications Regulation 1 Application

7-4 Terms and definitions

1. **Sea area A1** means an area within the radiotelephone coverage of at least one VHF coast station in which continuous DSC alerting is available, as may be defined by a Contracting Government.＊＊＊
2. **Sea area A2** means an area, excluding sea area Al, within the radiotelephone coverage of at least one MF coast station in which continuous DSC alerting is available, as may be defined by a Contracting Government. ＊＊＊
3. **Sea area A3** means an area, excluding sea areas Al and A2, within the coverage of an INMARSAT geostationary satellite in which continuous alerting is available.
4. **Sea area A4** means an area outside sea areas Al, A2 and A3.

＊ The details refer to a CHAPTER IV Radiocommunications Regulation 2

7-5 Safety of navigation

1. Unless expressly provided otherwise, this chapter shall apply to all ships on all voyages, except:
   1) warships, naval auxiliaries and other ships ････････････
   2) ships solely navigating the Great Lakes of North America and ･･･････････････････
2. The Administration shall determine to what extent the provisions of regulations 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27 and 28 do not apply to the following categories of Ships:
   1) ships below 150 grosstonnage engaged on any voyage;
   2) ships below 500 grosstonnage not engaged on international voyages; and
   3) fishing vessels.

＊ The details refer to a CHAPTER V Safety of navigation Regulation 1 Application

7-6 Reference

Carriage requirements for shipborne navigational systems and equipment

1. All ships of 300 gross tonnage and upwards and passenger ships irrespective of size shall, ･････････････
   Echo sounder / Radar (9GHz) / ATA / Speed log / THD (300-500 gross tonnage)
2. All ships of 300 gross tonnage and upwards engaged on international voyages and cargo ships of 500 gross tonnage and upwards not engaged on international voyages and passenger ships irrespective of size shall be fitted with an automatic identification system （AIS）, as follows：
3. All ships of **3000 gross tonnage and upwards** ･････････････
   3GHz Radar 1 set + 9GHz Radar 1 set, ATA 2 sets
4. All ships of **10,000 gross tonnage and upwards** ････････････
   ARPA 1 set
5. All ships of **50,000 gross tonnage and upwards** ･･･････････
   a speed and distance measuring device, or other means, to indicate speed and distance over the ground in the forward and athwartships direction.

＊ The details refer to a CHAPTER V Safety of navigation Regulation 19

Voyage data recorders (VDR)

1.To assist in casualty investigations, ships, when engaged on international voyages, sbject to the provisions of regulation 1.4, Shall be fitted with a voyage data recorder（VDR）as follows：
   1) passenger ships constructed on or after 1 July 2002；
   2) ro – ro passenger ships constructed before 1 July 2002 not later than the first survey on or after 1 July 2002；
   3) passenger ships other than ro – ro passenger Ships constructed before 1 July 2002 not later than 1 January 2004；and
   4) ships, other than passenger ships, of 3,000 gross tonnage and upwards constructed on or after 1 July 2002.

2.To assist in casualty investigations, Cargo ships, when engaged on international voyages, shall be fitted with a VDR which may be a simplified voyage data recorder（S－VDR） as follows：
   1) in the case of cargo ships of 20,000 gross tonnage and upwards constructed before 1 July 2002, at the first scheduled dry – docking after 1 July 2006 but not later than 1 July 2009；
   2) in the case of cargo ships of 3,000 gross tonnage and upwards but less than 20,000 gross tonnage constructed before 1 July 2002, at the first scheduled dry - docking after 1 July 2007 but not later than 1 July 2010；and
   3) Administrations may exempt cargo ships from the application of the requirements of subparagraphs .1 and .2 when such ships will be taken permanently out of service within two years after the implementation date specified in subparagraphs .1 and .2 above.

3.Administrations may exempt ships, other than ro – ro passenger ships, constructed before
   1) July 2002 from being fitted with a VDR where it can be demonstrated that interfacing a VDR with the existing equipment on the ship is unreasonable and impracticable.

＊ The details refer to a CHAPTER V Safety of navigation Regulation 20

Bridge Navigatinal Watch Alarm System (BNWAS)

1. a bridge navigational watch alarm system (BNWAS), as follows:
   1) cargo ships of 150 gross tonnage and upwards and passenger ships irrespective of size constructed on or after 1 July 2011;
   2) passenger ships irrespective of size constructed before l July 2011, not later than the first surveyafter 1 July 2012;
   3) cargo ships of 3,000 gross tonnage and upwards constructed before 1 July 2011, not later than the first survey after 1 July 2012;'
   4) cargo ships of 500 gross tonnage and upwards but less than3,000 gross tonnage constructed before 1 July 2011, not later than the first survey after 1 July 2013;and

5) cargo ships of 150 gross tonnage and upwards but less than 500 gross tonnage
Before 1 July 2011, not later than the first survey* after 1 July 2014.

The bridge navigational watch alarm system shall be in operation whenever the ship is underway at sea ;

2. a bridge navigational watch alarm system (BNWAS) installed prior to 1 July 2011 Subsequently be exempted from full compliance with the standards adopted by the Organization at the discretion of the Administration.

∗ The details refer to a CHAPTER V Safety of navigation Regulation 19

Long-Range Identification and Tracking of ships (LRIT)

1. Nothing in this regulation or the provisions of performance standards and functional requirements* adopted by the Organization in relation to the long-range identification tracking of ships shall prejudice the rights, jurisdiction or obligations of State under international law, in particular, the legal regimes of the high seas, the exclusive economic zone, the contiguous zone, the territorial seas or the straits used for international navigation and archipelagic sea lanes.

2.1 Subject to the provisions of paragraphs 4.1 and 4.2, this regulation shall apply to the following types of ships engaged on international voyages:

1. passenger ships, including high-Seed passenger craft ;
2. cargo ships, including high-Speed craft, of 300 gross tonnage** and upwards; and
3. mobile offshore drilling units.

2.2 The term “ship”, when used in paragraphs 3 to 11.2, includes the passenger and cargo ships, the high-speed craft and the mobile offshore drilling units which are subject to the provision of this regulation.

3. This regulation establishes provisions to enable Contracting Governments to undertake the long-range identification and tracking of ships.

4.1 Ships shall be fitted with a system to automatically transmit the information specified in paragraph 5 as follows:
1. ships constructed on or after 31 December 2008;
2. ships constructed before 31 December 2008 and certified for operations;
1 in sea areas A1 and A2, as defined in regulations IV/2.1.12 and IV/2.1.13; or
2 in sea areas Al,A2 and A3, as defined in regulations IV/2.1.12, IV/2.1.13 and IV/2.1.14;
not later than the first survey of the radio installation after 31 December 2008 ;
3 ships constructed before 31December 2008 and certified for operations in sea areas Al,A2,A3 andA4, as defined in regulations IV/2.1.12,IV2.1.13 and IV/2.1.14 and IV/2.1.15, not later than the first survey of the radio installation after 1 July 2009, However, these ships shall comply with the provisions of subparagraph 2) above whilst they operate within sea areas A1,A2 and A3.

4.2 Ships, irrespective of the date of construction, fitted with an automatic identification system (AIS) as defined in regulation19.2.4, and operated exclusively within sea area A1, as defined in regulation IV/2.1.12, Shall not be required to comply with the provisions of this regulation.

5. Subject to the provisions of paragraph 4.1, ships shall automatically transmit the following range identification and tracking information:
1. the identity of the ship;
2. the position of the ship(latitude and longitude); and
3. the date and time of the position provided.

6. Systems and equipment used to meet the requirements of this regulation shall conform to Performance standards and functional requirements*** not inferior to those adopted by the Organization. Any shipboard equipment shall be of a type approved by the Administration.

7. Systems and equipment used to meet the requirements of this regulation shall be capable of being switched off on board or be capable of ceasing the distribution of long-range identification and tracking information:

1.where international agreements, rules or standards provide for the protection of navigational information;or

2. in exceptional circumstance and for the shortest duration possible where the operation is considered by the master to compromise the safety or security of the ship. In such a case, master shall inform the Administration without undue delay and make an entry in the record navigational activities and incidents maintained in accordance with regulation 28 setting out the reasons for the decision and indicating the period during which the system or equipment was switched off.

*Refer to the Performance standards and functional requirements for the long-range identification and tracking of ships, adopted by the Maritime Safety Committee of the Organization by resolution MSC.210(81).

**The gross tonnage to be used for determining whether a cargo ship or high-Speed craft is required to comply with the provisions of this regulation shall be that determined under the provisions of the International Convention on Tonnage Measurement of Ships, 1969 irrespective of the date on which the ship or high-speed craft has been or is being constructed.

***Refer to the Performance standards and functional requirements for the long-range identification and tracking of ships, adopted by the Maritime Safety Committee of the Organization by resolution MSC.210(81).

∗ The details refer to a CHAPTER V Safety of navigation Regulation 19-1
Regulation 19-1 Long-range identification and tracking of ships

——— MEMO ———

8. Carriage Requirements for Ship Station of SOLAS Ship

8-1 Radio equipment to be fitted on board

SOLAS ship: engaged on International voyage + (Passenger ships, Cargo ships of 300 GT or upwards) etc.

No.	Equipment	Navigation Area	Ship Type	Number of sets	Gross tonnage (GT)										Auxiliary system	Remarks 1	Remarks 2
						20	100	150	300	500	1,000	3,000	10,000	50,000			
1	VHF (incl. DSC) + VHF DSC listening watch receiver	A1 A2 A3 A4	Passenger ship	1set											1set		Maintenance requirements 1. A1,A2: one among auxiliary system, land maintenance and onboard maintenance is selected. 2. A3,A4: two among auxiliary system, land maintenance and onboard maintenance are selected 3. Auxiliary system 1) VHF(incl. DSC) , unnecessary DSC listening watch receiver. 2) MF/HF Radio equipment (incl. DSC+NBDP) + MF/HF DSC listening watch receiver or INMARSAT(INM-B or INM-C).
			Cargo ship														
2	MF Radio equipment (incl. DSC) + MF DSC listening watch receiver	A1 A4		1set											1set	①: only when Inmarsat ship station is selected in A3 sea area	
		A2 A3①	Passenger ship														
			Cargo ship														
3	MF/HF Radio equipment (incl. DSC+NBDP) + MF/HF DSC Listening watch receiver	A1 A2		1set											1set	- Alternative apparatus: not necessary when Inmarsat ship station (B,C type)+ MF Radio apparatus are equipped on board a ship navigating in A3 sea area	
		A3 A4	Passenger ship														
			Cargo ship														
4	Inmarsat Ship Earth staton	A1 A2 A4		1set											1set	- if equipped as an alternative to existing MF/HF Radio apparatus, MF Radio apparatus is necessary. - if equipped as an Auxiliary apparatus, it is an auxiliary apparatus of MF/HF.	
		A3	Passenger ship														
			Cargo ship														
5	NAVTEX Receiver	A1 A2 A3 A4	Passenger ship	1set												Other than 518kHz, 490kHz、4209.5kHz were added	Entered into force on 1 July 2005
			Cargo ship														
6	EGC	A1 A2 A3 A4	Passenger ship	1set												EGC is not necessary when naviagtng only in a NAVTEX reception area.	
			Cargo ship														
7	Sattelite EPIRB	A1 A2 A3 A4	Passenger ship	1set												*COSPAS/SARSAT system is equipped. *Inmarsat system is not accepted for use in A4 area.	
			Cargo ship														
8	VHF EPIRB	A1		1set												It can be equipped instead of satellite EPIRB.	
9	Radar Transponder (Search and rescue locating devices)	A1 A2 A3 A4	Passenger ship	2set②												②: more than 1/4 sets to the number of life boats are to be added.	
			Cargo ship	1-2 set					1set	2set	→	→	→	→			
10	Two-way Radiotelephone apparatus	A1 A2 A3 A4	Passenger ship	3 set ③												③: For two-way radiocommunications between ship and airplane, a radiotelephony set is to be added.	For a high-speed rescue boats fitted with mandatory system, a hands-free two-way radiotelephony is required.
			Cargo ship	2-3 sets					2set	3set	→	→	→	→			
11	AIS (Automatic Identification System)	A1 A2 A3 A4	Passenger ship	1set												* A radiotelephony set is to be added for two-way radiocommunications between ship and airplane.	
			Cargo ship														
12	LRIT (Long-range identification and tracking of ships)	A1 A2 A3 A4	Passenger ship	1set													not later than the first survey of the radio installation after 31 December 2008
			Cargo ship														
13	GPS (Global Positioning System)	A1 A2 A3 A4	Passenger ship	1set												GPS fitted before 1 July 2007 is accepted.	
			Cargo ship														

No.	Equipment	Navigation Area	Ship Type	Number of sets	Gross tonnage (GT)	20	100	150	300	500	1,000	3,000	10,000	50,000	Auxiliary system	Remarks 1	Remarks 2
14	Radiocommunication apparatus between ship and land)	A1 A2 A3 A4		1set												It can be used in common with other mandatory ships.	
15	Distress alert operation panel		Passenger ship	1set												Distress alert receiving funciton is fitted together.	
16	RADAR + EPA ATA ARPA		Passenger ship	1-2set	EPA	→	→	→	→	ATA	→	→	ARPA	→		-2 radars (for a ship of 3,000 GT or upwards) (2nd set is of S band type. Where the Administration considers appropriate, a second 9 GHz radar is accepted. - One set is accepted as ATA. (for a ship of 10,000 GT or upwards)	New IMO rule was applied on or after 1 July 2008.
			Cargo ship						EPA	ATA	→	→	ARPA	→			
	Minimum operational display area diameter (mm)								180mm	250mm	→	→	320mm	→			
17	Speed and distance measuring device (LOG)		Passenger ship	1set												for a ship of 50,000 GT or upwards, both SDME for over the ground and through the water are required.	
			Cargo ship														
18	Echo-sounding device (E/S)		Passenger ship	1set													
			Cargo ship														
19	VDR (Voyage data recorder)		Passenger ship	1set												-Ships constructed after 1 Jan.2015 Added float-free capsule for 48 hours recording. Long time recording media for 720 hours	
			Cargo ship														
20	THD (Transmiting Heading Device)		Passenger ship	1set													
			Cargo ship														
21	ECDIS (Electronic Chart Display and information system)		Passenger ship	1set												- Passenger ships: over 500 GT, Tankers: over 3,000 GT, other Cargo ships: over 10,000 GT	Planned as follows. Passenger ships: 1 July 2012 Tankers: 1 July 2013 Other Cargo ships: 1 July 2014 Existing ships: 2014/7/1 to be phased subject to ship type.
			Cargo ship														
	Backup ECDIS			1set					Apply to all the ships fitted with ECDIS							It is required if paper charts are not carried on board.	
22	BNWAS Bridge Navigational Watch Alarm System		Passenger ship	1set												-All Passenger ships and over 150 GT Cargo ships. applies to after 1 July 2011.	MSC.282(86) Carriage Requirements. MSC.128(75) / IEC 62616
			Cargo ship														

* Cargo ship: ships other than passenger ships

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8-2 SOLAS Chapter Ⅴ Carriage Requirements Rerulation 19 and 20 (JRC Products)

Nov. 2014

No	Equipment	The requirements for loading			Ship gross tonnage (GT) 20 / 150 / 300 / 500 / 1,000 / 3,000 / 10,000 / 50,000	as at November 2014 JRC Produts examples	Remarks
1	1st RADAR (X-Band) Desplay effectivediamatar MSC192(79) 150-499 GT: 180mm 500-9,999 GT: 250mm ≧10,000 GT: 320mm (effective after 1 July 2008)	International Convention for SOLAS	Passenger ship	All the ships	Passenger ships	①JMR-7200 series (25cm) ②JMR-9200 series (32cm) ③JMA-5200 MKII series(18cm) ④JMA-5300 MKII series(25cm) ⑤JMA-7100 series(25cm) ⑥JMA-9100 series(32cm) ⑦JMA-900B series(32cm)	MSC.192(79)/IEC 62388 MSC.191(79)/IEC 62288 applies to after 1 July 2007
			Except a passenger ship	≧300GT	Ohter than passenger ships		
2	Electronic Plotting Aids (EPA) MSC.192(79)	International Convention for SOLAS	Passenger ship	＜500GT	Passenger ships	RADAR with ATA superior to EPA can be installed. ①JMR-7200 series (25cm) ②JMR-9200 series (32cm) ③JMA-5200 MKII series(18cm) ④JMA-5300 MKII series(25cm) ⑤JMA-7100 series(25cm) ⑥JMA-9100 series(32cm) ⑦JMA-900B series(32cm)	MSC.192(79)/IEC 62388 MSC.191(79)/IEC 62288 applies to after 1 July 2007
			Except a passenger ship	300GT≦Δ＜500GT	Ohter than passenger ships		
3	Automatic Tracking Aids (ATA) MSC.192(79)	International Convention for SOLAS	Passenger ship Except a passenger ship	≧500GT	Ships	①JMR-7200 series (25cm) ②JMR-9200 series (32cm) ④JMA-5300 MKII series(25cm) ⑤JMA-7100 series(25cm) ⑥JMA-9100 series(32cm) ⑦JMA-900B series(32cm)	MSC.192(79)/IEC 62388 MSC.191(79)/IEC 62288 applies to after 1 July 2007
4	2nd RADAR (S-Band*) MSC.192(79) * X-Band is acceptable if the Administration permits.	International Convention for SOLAS	Passenger ship Except a passenger ship	≧3,000GT	Ships	①JMR-7200 series (25cm) ②JMR-9200 series (32cm) ④JMA-5300 MKII series(25cm) ⑤JMA-7100 series(25cm) ⑥JMA-9100 series(32cm) ⑦JMA-900B series(32cm)	MSC.192(79)/IEC 62388 MSC.191(79)/IEC 62288 applies to after 1 July 2007
5	2nd Automatic Tracking Aids (2nd ATA) MSC.192(79)	International Convention for SOLAS	Passenger ship Except a passenger ship	3,000GT≦Δ＜10,000GT	Ships	①JMR-7200 series (25cm) ②JMR-9200 series (32cm) ④JMA-5300 MKII series(25cm) ⑤JMA-7100 series(25cm) ⑥JMA-9100 series(32cm) ⑦JMA-900B series(32cm)	MSC.192(79)/IEC 62388 MSC.191(79)/IEC 62288 applies to after 1 July 2007
6	Automatic Radar Plotting Aids (ARPA) MSC.192(79)	International Convention for SOLAS	Passenger ship Except a passenger ship	≧10,000GT	Ships	② JMR-9200 series (32cm) ④JMA-9100 series(32cm ARPA) ⑤JMA-900B series(32cm ARPA)	MSC.192(79)/IEC 62388 MSC.191(79)/IEC 62288 applies to after 1 July 2007
	Carriage requirements for Radar (on or after 1 July 2008)	300GT X Babd 180 mm	500GT X Band 250 mm	3,000GT X, S Band 250 mm 10,000GT X, S Band 320 mm			
7	Chart etc (ECDIS)	International Convention for SOLAS		Carriage requirements is to beadopteby MSC86(May 2009) Passenger ship: ＞500GT,Tanker＞3000GT, Cargo ship＞10,000GT 2012/7/1- 2013/7/1- 2014/7/1- Existing ships: to be phased after 1 July 2014 subject to	Ships Passenger ship＞500GT, Tanker＞3000GT, Cargo ship＞10,000GT	JAN-9201 JAN-7201 JAN-901B, JAN-701B, JAN-2000	MSC.232(82) IEC 61174 applies to after 1 Jan. 2009 MSC.191(79)/IEC 62288 applies to after 1 July 2008 Exemption of paper charts is subject to the Administration.
8	Backup ECDIS (required if electronic charts are carried insteaed of paper charts etc.)	International Convention for SOLAS		All the ships already fitted with ECDIS	Ships	JAN-9201 JAN-7201 JAN-901B, JAN-701B, JAN-2000	
9	Satellte navigation equipment(GPS/DGPS)	International Convention for SOLAS	Passenger ship	All the ships	International passenger ships	JLR-7900, JLR-7600 JLR-7800, JLR-7500 JLRL-21/ JLR-31	MSC.114(73)/IEC 61108-1
			Except a passenger ship		Other than international passenger ships		

8-2 SOLAS Chapter Ⅴ Carriage Requirements Rerulation 19 and 20 (JRC Products)

Nov. 2014

No	Equipment	The requirements for loading					Ship gross tonnage (GT) 20 / 150 / 300 / 500 / 1,000 / 3,000 / 10,000 / 50,000	as at November 2014 JRC Produts examples	Remarks
10	Echo Sounder	International Convention for SOLAS	Passenger ship	All the ships			International passenger ships	JFE-380 (LCD Type None Printer) JFE-680 (LCD Type With Printer)	MSC.74(69) Anx.4/ISO 9875
			Except a passenger ship	≧300GT		equivalent to equiment required for ship <300GT	Other than international passenger ships		
11	Speed and Ditance Measuring Equipment(Through the water) (DSME)	International Convention for SOLAS	Passenger ship	All the ships			International passenger ships	JLN-205	MSC.96(72)/IEC 61023
			Except a passenger ship	≧300GT			Other than internation passenger ships		
	Speed and Ditance Measuring Equipment(Over the water) (DSME)	International Convention for SOLAS	≧50,000GT				Ship	JLN-550 Water Track(Through the water) DSME and Bottom Track(Over the water)DSME must be equipped individually.	MSC.96(72)/IEC 61023 MSC 334(90)
12	Transmitting Heading Device (THD)	International Convention for SOLAS	Passenger ship	<500GT			International passenger ships	JLR-21/JLR-31	MSC.116(73)/ISO 22090-3
			Except a passenger ship	300GT≦Δ<500GT					
13	Automatic Identification System (AIS)	International Convention for SOLAS	Passenger ship	All the ships			International passenger ships	JHS-183 JHS-182	MSC.74(69) Anx.3/IEC 61993-2
			Except a passenger ship	An owner international	≧300GT		Non-international passenger ships		
				A non-international	≧500GT		Other than international passenger ships		
14	Voyage Data Recoder (VDR)	International Convention for SOLAS	Passenger ship	An owner international	All the ships		International passenger ships	JCY-1900	MSC.333(90)/ IEC 61996-1 Ed2 applies toVDR installation after 1 July 2014.
			Except a passenger ship	An owner international	≧3,000GT		Other than international	(JCY-1800)	IMO A.861(20)/IEC 61996-1Ed.1 SN.Circ.246 applies to after 1 Jun 2008
15	Simpllfind-Voyage Data Recoder (S-VDR)	International Convention for SOLAS	Except a passenger ship	An owner international	≧3,000GT		Other than international	JCY-1950	MSC.163(78)/IEC 61996-2 SN.Circ.246 MSC.214(81) applies to after 1 Jun 2008.
16	Long-Range Identification and Tracking of Ships (LRIT) to be fitted with it after 31 Dec. 2008 (subject to navigating sea area)	International Convention for SOLAS	Passenger ship	All the ships			Other than international passenger ships	JUE-87 JUE-85 JUE-95LT	MSC.202(81) Carriage Requirements. Applied depending on sea area after 31 Dec. 2008. MSC.263(84) Paformance Staderds
			Except a passenger ship	An owner international	≧300GT		Other than international passenger ships		
17	Bridge Navigational Watch Alarm System(BNWAS) to be fitted with it after 1 July 2011	International Convention for SOLAS MSC.282(86)	Passenger ship	All the ships			Other than international passenger ships	JCX-161	MSC.282(86) Carriage Requirements. applies to after 1 July 2011. MSC.128(75) / IEC 62616
			Except a passenger ship	An owner international	≧150GT		Other than international passenger ships		
18	Heading Control system (HCS or Track Control System(TCS))	International Convention for SOLAS	Passenger ship / Except a passenger ship	≧10,000GT			Ships	JAN-9201 JAN-7201 JAN-901B, JAN-701B	IMO MSC 74(69) Annex.2/IEC62065

9. Maintenance etc. of Radio Equipment

1. On passenger ships and cargo ships of 300 GT and upwards, which are engaged on international voyages and navigate in sea area A3 and A4, the availability of radio equipment shall be ensured by using a combination of at least two methods shown below such as duplication of equipment, shore-based maintenance or at-sea electronic maintenance capability, as may be approved by the Administration. To ascertain what items are selected, a document which describes it is to be prepared and carried on board.
   (According to SOLAS, it is to be described in Safey Radio Certificate.)

(1) Duplication of equipment	It means that an auxiliary radio equipment is fitted. * Refer to the next page.
(2) Shore-based maintenance	It means that, in order to ensure the availability of radio equipment, a qualified engineer (except crew) checks and repairs the said equipment periodically.
(3) Onboard maintenance	It means that, in order to ensure the availability of radio equipment, qualified crew check and repair the said equipment.

2. On ships (other than passenger ships), which are not engaged on international voyages and navigate in sea area A1 and A2, and on ships other than passenger ships engaged on international voyages, which navigate in sea area A3 and A4, any one method among three methods (1), (2), (3) shown above is used.

3. Satellite EPIRB
   1) Annually tested for all aspects of operational efficiency.
   2) The test maybe conducted onboard the ship or at an approved testing station.
   3) Subject to maintenance at intervals not exceeding five years, to be performed at an approved shore – based maintenance facility.

∗ The details refer to a SOLAS CHAPTER IV Radiocommunications **Regulation 15** Maintenance requirements

10. Duplication of Equipment

Sea area	Voyage type	Auxiliary Radio Equipment
A4	Passenger ships etc. engaged on International voyage	(a) NBDP, R/T, DSC, DSC W/R by HF and MF (b) R/T and DSC by VHF, (referred to as VHF Radio Equipment below) Note In the case of the vessel which cruises only single time, when it replaces with (b) and a government office accepts, it can restrict, and it can be replaced with INMARSAT DP.
	Ships other than Passenger ships etc. engaged on International voyage	(a) Either the following (1) or (2) Radio Equipment (1) NBDP, DSC, DSC W/R by HF (2) R/T, DSC, DSC W/R by HF (b) VHF Radio Equipment (however, unnecessary for ships of less than 100 GT) Note: In the case of ships which navigate only for a short time, if the Administration permits, it can be replaced with INMARSAT R/T or INMARSAT DP.
A3	Passenger ships etc. engaged on International voyage	(a) Either the following (1) or (2) Radio Equipment (1) NBDP, R/T, DSC, DSC W/R by HF and MF (2) INMARSAT DP (b) VHF Radio Equipment
	Ships other than Passenger ships etc. engaged on International voyage	(a) Any one among the following (1) to (4) Radio Equipment (1) NBDP, DSC, DSC W/R by HF (2) R/T, DSC, DSC W/R by HF (3) INMARSAT DP (4) INMARSAT R/T (b) VHF Radio Equipment (however, ships of less than 100 GT, and ships navigating 2-hour limited coastal area (3 of Article 2 of Ship Equipment Regulation), etc. are unnecessary)
A2	All the ships	(a) Any one among the following (1) to (5) Radio Equipment (1) NBDP, DSC, DSC W/R by HF (2) R/T, DSC, DSC W/R by HF (3) INMARSAT DP (4) INMARSAT R/T (5) MF R/T and MF DSC (b) VHF Radio Equipment (however, unnecessary for ships of less than 100 GT) Note: Ships as shown below other than passenger ship etc engaged on international voyage. can be fitted with a general radio communication equipment etc. (except Inmarsat R/T or Inmarsat DP) or MF Radiotelephone equipment (limited to equipment which can exert radiocommunication on ship's navigation between ship and shore continuously) (1) Ships of less than look GT (2) Ships other than passenger ships navigating in a greater coasting area, as the Administration permits.
A1	All the ships	VHF Radio Equipment "Ships of less than 100GT other than passenger ship etc engaged on international voyage. can be fitted with a general radio communication equipment etc. or MF Radiotelephone Equipment (limited to equipment which can exert radiocommunication on ship's navigation between ship and shore continuously)."

* Passenger ships etc, engaged on international voyage means:

Passenger ships engaged on international voyage [except ships of less than 300 G/T and other than passenger ships, and fishing vessels of 300 GT and upward (engaged exclusively in fishing)]

11. Emergency Source of Electrical Power and Reserve Power

Reference

- SOLAS CHAPTER Ⅱ-1 Part D Electrical INSTALLATIONS **Regulation 42, 43**
- SOLAS CHAPTER Ⅳ Radiocommunications **Regulation 13** Sources of energy

11-1 Electric Power Supply (Regarding fishing ship, Japanese rules are introduced below as well)

<table>
<tr><td rowspan="3"></td><td colspan="6">Application</td></tr>
<tr><td rowspan="2">Ship type</td><td rowspan="2">International voyage</td><td rowspan="2">Navigation area (Japan)</td><td colspan="3">Gross tonnage</td></tr>
<tr><td></td><td>300</td><td>500</td></tr>
<tr><td rowspan="5">Emergency source of electrical power (ES) applies to ships constructed on and after February 1, 1995.</td><td rowspan="2">Passenger ship</td><td>Yes</td><td></td><td colspan="3">36H</td></tr>
<tr><td>No</td><td>Ocean/ near seas</td><td colspan="3">18H</td></tr>
<tr><td rowspan="2">Cargo ship.
Fishing ship (includes product ship, mother ship, and government's own ship)</td><td>Yes</td><td></td><td colspan="2">Not apply</td><td>18H</td></tr>
<tr><td>No</td><td>Ocean/ near seas</td><td colspan="2">Not apply</td><td>18H</td></tr>
<tr><td>Fishing ship</td><td>Yes</td><td></td><td colspan="2">Not apply</td><td>0H</td></tr>
<tr><td rowspan="5">Reserve power (RS) (battery) applies to ships constructed on and after February 1, 1995. Moreover, applies from the time of GMDSS shift about ships constructed on and after January 31, 1995 and</td><td rowspan="2">Passenger ship</td><td>Yes</td><td></td><td colspan="3">ES: mandatory ship 1H</td></tr>
<tr><td>No</td><td>Ocean/ near seas</td><td colspan="3">ES: Not mandatory ship
When electric power is supplied from ES 1H
When electric power is not supplied from ES 6H</td></tr>
<tr><td rowspan="2">Cargo ship
Fishing ship (includes product ship, mother ship, and government's own ship)</td><td></td><td></td><td rowspan="2">Not apply</td><td rowspan="3" colspan="2">ES mandatory ship 1H
ES: not mandatory ship
When electric power is supplied from ES 1H
When electric power is not supplied from ES 6H</td></tr>
<tr><td>No</td><td>Ocean/ near seas</td></tr>
<tr><td>Fishing ship</td><td></td><td></td><td>Not apply</td></tr>
<tr><td colspan="7">Note: Maritime Competent Authority considers voyage feature of a ship concerned and admits it, required time can be based on the time directed by the Authority. (Japan)</td></tr>
</table>

11-2 Power Supply system

		INMARSAT		MF/HF				MF				VHF			GPS
		RT	DP	RT	NBDP	DSC	DSC WR	RT	NBDP	DSC	DSC WR	RT	DSC	DSC WR	
Emergency electric power	Main system	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
	Doubled Emergency system	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**		
Auxiliary power	Main system	**Y**	**Y**	**Y**	**Y**	**Y**		**Y**	**Y**	**Y**		**Y**	**Y**		**Y**
	Doubled Emergency system	**Y**	**Y**	**Y**	**Y**	**Y**		**Y**	**Y**	**Y**		**Y**	**Y**		

Note:
* Sufficient capacity is required to operate simultaneously equipment or system specified by Maritime Competent Authority
* Auxiliary power is always supplied to VHF. Moreover, power can be switched to MF, or MF/MHF, or INMARSAT, and the biggest power consumption in equipment is selected for requirement in this case.
* In equipment which the maritime competent Authority admits, there is a gyrocompass in Inmarsat of the main system.

The electric supply time to this is separately directed by Maritime Competent Authority.

12. Assignment of Mariners for Radio Part on board

GMDSS ship

Voyage	Ship Type	Sea Area	Tonnage	Qualification required for maintenance: Onboard maintenance	Qualification required for maintenance: Not onboard maintenance	Remarks
International voyage	Passenger Ship	A1, A2	-	2 nd Class Mariner	3 rd Class Mariner	
		A3, A4	-	1 st Class Mariner	3 rd Class Mariner	
	Cargo Ship	A1, A2	less than 300GT	-	-	
			not less than 300GT	2 nd Class Mariner	3 rd Class Mariner	
		A3, A4	less than 300GT	2 nd Class Mariner	3 rd Class Mariner	
			not less than 300GT	2 nd Class Mariner	3 rd Class Mariner	
	Fishing Ship	A1, A2	-	-	-	
		A3	-	2 nd Class Mariner	* 4 th Class Mariner	Main equipment: INMARSAT on board
			-	2 nd Class Mariner	3 rd Class Mariner	Main equipment: MF/HF on board.
		A4	-	2 nd Class Mariner	3 rd Class Mariner	
Non-International voyage	Passenger Ship	A1, A2	-	-	-	
		A3, A4	-	2 nd Class Mariner	3 rd Class Mariner	
	Cargo Ship	A1, A2, A3, A4	-	-	-	
	Fishing Ship	A1, A2	-	-	-	
		A3	-	2 nd Class Mariner	* 4 th Class Mariner	Main equipment: INMARSAT on board
			-	2 nd Class Mariner	3 rd Class Mariner	Main equipment: MF/HF on board
		A4	-	2 nd Class Mariner	3 rd Class Mariner	

- A mariner of each class in the list above is referred to as a mariner (electronic radiocommunications).
- The above-mentioned table does not apply, when applying old Ship Safety Law.
  Example: Equivalent Fishing ships (Ships, to which the old law applies, is permitted to radiocommunicate with Morse equipment etc.)

*: In the case of ships which are equipped with INMARSAT, if system is doubled with HF, the Third Class Mariner (electronic communications) is required.

[Relations between Radio Operator's Radio Electronic Certificate of R. R. and Radio law]

the Ministry of Land, Infrastructure and Transport (Marine Personnel Low)	the Ministry of Internal Affairs and Communications (Radio Law)	International Convention (RR: Radio Regulation).
First-class mariner (Radiocommunications)	First-class General Radio operator	First-class Radio Electronic Certificate (1st REC)
First-class mariner (Electronic Radiocommunications)	First-class Marine Radio operator	First-class Radio Electronic Certificate (1st REC)
Second class mariner (Electronic Radiocommunications)	Second class Marine Radio operator	Second class Radio Electronic Certificate (2nd REC)
Third class mariner (Electronic Radiocommunications)	Third class Marine Radio operator	General Operator's Certificate (GOC)
Fourth class mariner (Electronic Radiocommunications)	First-class Marine Special Radio operator	Restricted Operator's Certificate (ROC)

1st REC: First Class Radio Electronic Certificate
2nd REC: Second Class Radio Electronic Certificate
GOC: General Operator's Certificate
ROC: Restricted Operator' Certificate

13. Frequency used in GMDSS

Frequency band	Digital Selectiive Call (DSC)	Direct Printer Telegraphy (NBDP:Narrow band Direct Print)	Radio Telephone (R/T)
VHF	156.525 MHz (ch70)		156.800 MHz (ch16) 156.650 MHz (ch13) 156.300 MHz (ch6)
MF		490 kHz 518 kHz (for NAVTEX)	
	2177.0 kHz 2187.5 kHz	2174.5 kHz	2182.0 kHz
HF	4207.5 kHz	4177.5 kHz 4209.5 kHz * 4210.0 kHz **	4125.0 kHz
	6312.0 kHz	6268.0 kHz 6314.0 kHz **	6215.0 kHz
	8414.5 kHz	8376.5 kHz 8416.5 kHz **	8291.0 kHz
	12577.0 kHz	12520.0 kHz 12579.0 kHz **	12290.0 kHz
	16804.5 kHz	16695.0 kHz 16806.5 kHz ** 19680.5 kHz ** 22376.0 kHz ** 26100.5 kHz **	16420.0 kHz
Satellite	INMARSAT (standard C)	1530.0 to 1545.0 MHz 1626.5 to 1646.5 MHz	(reception) EGC (transmission)
	Satellite EPIRB	406.0-406.1 MHz 406.0-406.1 MHz 406.0-406.1 MHz 406.0-406.1 MHz	(406.025 MHz) (406.028 MHz) (406.037 MHz) (406.07MHz)
X band	Radar transponder	9200.0 to 9500.0 MHz	

* : for broadcast of NAVTEX form
** : for broadcast of marine safety information by MSI

B

14. Radio communication-related Qualification Certificate of Liberia and Panama Flag.

14-1 Liberia Flag

In GMDSS, regarding the Radio Communication-related qualification for the Liberia flag ships, the followings are required by Liberia Government.

1. Crew of the Liberia Flag Ships are required to have the Qualification Certificate (GOC or REC) issued by the Liberia Government.

2. Radio-Communications Staff's Qualification and Number which are required of GMDSS Ships.

   2-1. In the case that GMDSS equipment's maintenance in workshop for GMDSS Ships, navigating across A1 sea area, is selected.

   Two navigation officers who possess GOC, or

   One full-time radio operator who posses 1st Class REC, or 2nd Class REC.

   * The qualification certificate shall be that the Liberia government issues.

   2-2. In the case that onboard maintenance of GMDSS equipment for GMDSS Ships, navigating across A1 sea area, is selected.

   An inquiry is required for Nippon Kaiji Kyokai.

GOC: It is "General Operator's Certificate" of Rule C, Chapter III A, Article 55th of ITU R Radio Communication Regulation.

REC: It is "1st class or 2nd class Radio Electronic Certificate" of Rule C, Chapter III A, Article 55th of ITU R Radio Communication Regulation.

14-2 Panama Flag

In GMDSS, regarding the Radio Communication-related qualification for the Panama flag ships, the followings are required by Panama Government.

1. Crew of the Panama Flag Ships are required to have the Qualification Certificate (GOC or REC) issued by the Panama Government.

2. Radio-Communications Staff's Qualification and Number which are required of GMDSS Ships

   2-1. In the case that GMDSS equipment's maintenance in workshop for GMDSS Ships, navigating across A1 sea area, is selected.

   Two on-duty navigation officers (Captain and one navigation officer, or two navigation officer) who possess GOC, or

   One full-time radio operator who posses GOC.

   * The qualification certificate shall be a certificate that the Panama government issues.

   2-2. In the case that onboard maintenance of GMDSS equipment for GMDSS Ships, navigating across A1 sea area, is selected.

   One full-time radio operator who possesses GMDSS Radio Electronic-First or second class Qualification Certificate issued by the Panama government, and

   One navigation officer who possesses GMDSS Radio Operator-Restricted, or General Qualification Certificate issued by the Panama government

   * A qualification certificate shall be that the Panama government issues.

GOC: It is "General Operator's Certificate" of Rule C, Chapter III A, Article 55th of ITU R Radio Communication Regulation.

REC: It is "1st class or 2nd class Radio Electronic Certificate" of Rule C, Chapter III A, Article 55th of ITU R Radio Communication Regulation.

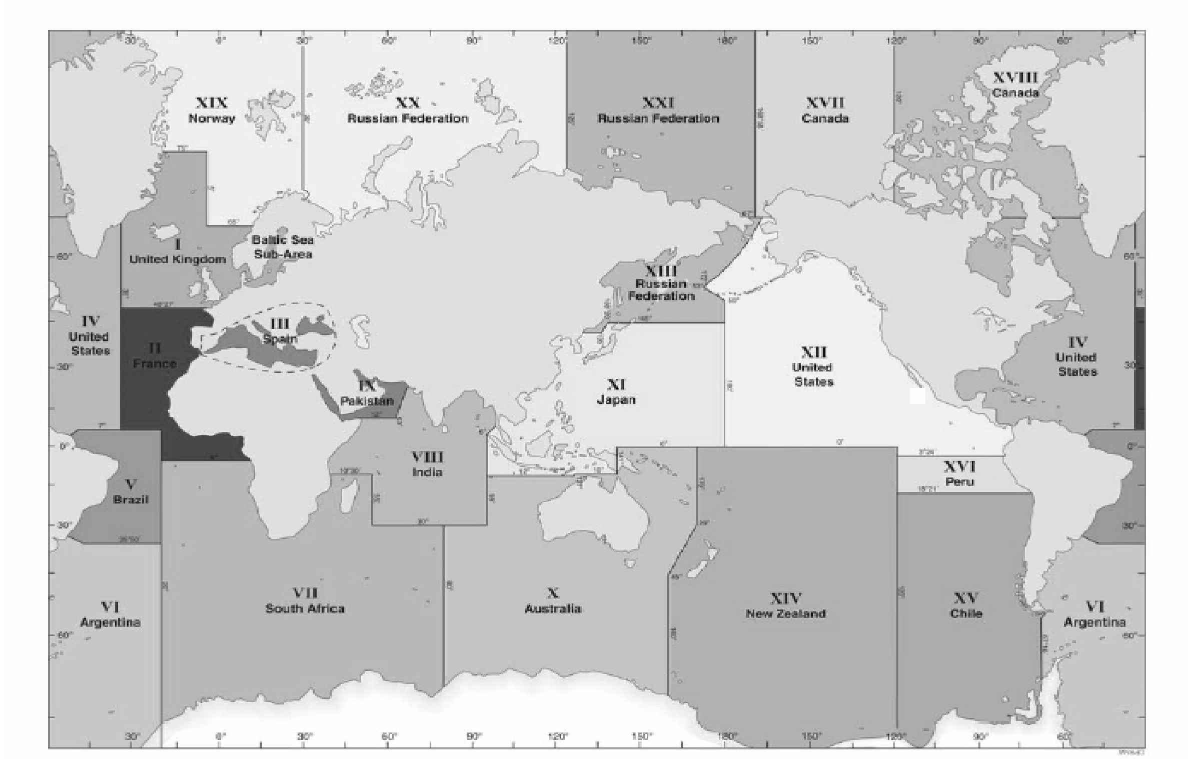
15. MSI (Maritime Safety Information Service)

15-1 WWNWS (World Wide Navigational Warning Service)

WWNWS, which was established by WMO (World Meteorological Organization) and IHO (International Hydrographic Organization), broadcasts weather information and navigation alarms for ships navigating. For every sea area called NAVAREA divided into 21 in sea area, broadcasting is carried out on CW and TELEX periodically.
Services are roughly following two types.

(1) NAVAREA SERVICE.... Service for navigation in Oceans
NAVAREA SERVICE broadcasts obstructions to navigation for ships (engaged on the international voyage) navigating at a long distance from shores. Broadcast coverage areas are the NAVAREA area and the neighboring areas 700 miles outside it. Broadcast is performed in English, and in addition to A1A mode, FEC (FOWARD ERROR CORRECTION) mode is used if required.

In GMDSS, eight waves of 4210.0, 6314.0, 8416.5, 12579.0, 16806.5, 19680.5, 22376.0 and 26100.5 kHz are used by NBDP for broadcast of MSI.



(2) NAVTEX SERVICE.... Service for coastal sea area
Refer to item C-13 of this handbook.

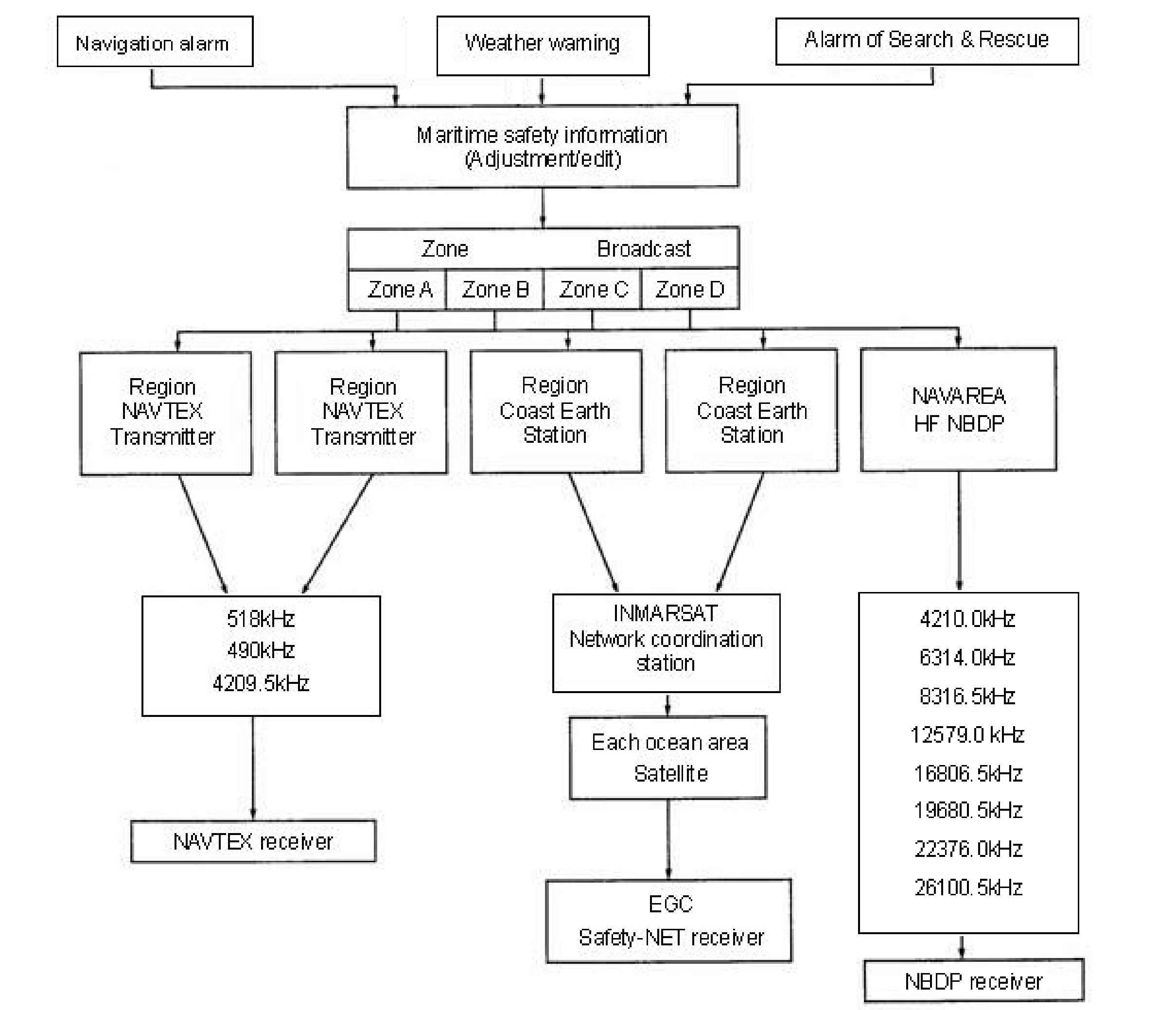
15-2 EGC (Enhanced Group Call)

Broadcast by SAFETY-NET of INMARSAT C.
Refer to item C-10 of this handbook.

> COFFEE BREAK
>
> U.T.C.(Universal Time Coordinated)
> It is a universally coordinated artificial time, which is always adjusted within error of 0.9 or less seconds compared with universal time (U.T.), while the atomic time is ticking away the time.

15-3 NAVAREA SERVICE

	NAVAREA Coordinator	Weather Information		NAVAREA Coordinator	Weather Information
I (1)	Britain	Britain	XII (12)	USA (west coast)	USA
II (2)	France	France	XIII (13)	Russia	Russia
III (3)	Spain	---	XIV (14)	New Zealand	New Zealand
IV (4)	USA (east coast)	USA	XV (15)	Chile	Chile
V (5)	Brazil	Brazil	XVI (16)	Peru	USA
VI (6)	Argentina	Argentina	XVII (17)	Canada	Canada
VII (7)	South Africa	South Africa	XVIII (18)	Canada	Canada
VIII (8)	India	India	XIX (19)	Norway	Norway
IX (9)	Pakistan	Saudi Arabia	XX (20)	Russia	Russia
X (10)	Australia	Australia	XXI(21)	Russia	Russia
XI (11)	Japan	Japan			



Note: HF NBDP system can be used in order to provide the auxiliary equivalent service to EGC Safety-NET.

(International Maritime Safety Information Work)

16. JRC Products for Type Approval by Countries, Classification Societies and Others

March 2015

Country /Classification Society / and Others — Equipment name (JRC model)		Country								Classification Society									INM
		Japan (Ministry of Internal Affairs and Communications)	Japan (Ministry of Land, Infrastructure and Transport)	MED	South Korea	Russia	U.S (FCC・USCG)	China (CMIIT)	Singapore (MPA)	NK (Japan)	LR (U.K)	ABS (U.S.A)	DNV・GL (Norway)	BV (France)	RINA (Italy)	CCS (China)	KR (South Korea)	RMRS (Russia)	INMARRSAT
MF/HF	JSB-196					Y												Y	
	JSS-296	Y	Y	Y	Y				Y							Y			
	JSS-596	Y	Y	Y	Y											Y			
	JSS-896	Y	Y	Y															
	JSS-2150	Y	Y	Y	Y	Y			Y									Y	
	JSS-2150N			Y					Y										
	JSS-2250			Y	Y				Y										
	JSS-2250N			Y	Y				Y										
	JSS-2250R			Y															
	JSS-2250NR			Y															
	JSS-2500			Y	Y				Y										
	JSS-2500N			Y	Y				Y										
	JSB-196GM	Y	Y	Y			Y									Y			
VHF	JHS-32B	Y	Y				Y												
	JHS-770S	Y	Y	Y				Y	Y							Y			
	JHS-780D	Y	Y	Y				Y	Y							Y			
Two-Way	JHS-7	Y	Y	Y			Y		Y							Y			
	JHS-430																		
	JHS-413											Y							
EPIRB	JQE-103	Y	Y	Y	Y	Y			Y							Y		Y	
SART	JQX-30A	Y	Y	Y					Y										
	Tron SART20	Y	Y	Y					Y										
NAVTEX	NCR-733		Y																
	NCR-333	Y	Y	Y	Y	Y	Y		Y									Y	
INM-C	JUE-85	Y	Y	Y					Y						Y	Y			Y
	JUE-87		Y	Y	Y		Y		Y								Y		Y
INM Mini-C	JUE-95																		
	JUE-95VM					Y												Y	Y
	JUE-95SA			Y		Y									Y			Y	Y
	JUE-95LT						Y												Y
INM –F77	JUE-410F																		Y
INM –F33	JUE-33					Y												Y	Y
INM -FBB	JUE-250															Y			Y
	JUE-251																		Y
	JUE-500																		Y
	JUE-501																		Y

B

Equipment name	(JRC model)	Japan (Ministry of Internal Affairs and Communications)	Japan (Ministry of Land, Infrastructure and Transport)	MED	South Korea	Russia	U.S (FCC・USCG)	China (CMIIT)	Singapore (MPA)	NK (Japan)	LR (U.K)	ABS(U.S.A)	DNV・GL (Norway)	BV (France)	RINA (Italy)	CCS (China)	KR (South Korea)	RMRS (Russia)	INMARRSAT
Country /Classification Society / and Others		Country								Classification Society									INM
RADAR /ARPA	JMA-9912-10DA	Y																	
	JMA-9922-6/9XA	Y	Y				Y												
	JMA-9923-7/9XA	Y	Y				Y												
	JMA-9932-SA	Y	Y				Y												
	JMA-9933-SA	Y	Y				Y	Y											
ARPA/ATA	JAS-9800		Y																
RADAR	JMA-5310-6	Y	Y				Y												
	JMA-5320-7/9	Y	Y				Y												
	JMA-5330-12	Y	Y				Y												
	JMA-5300 SERIES															Y			
ARPA/ATA	JAS-5300W		Y																
RADAR /ARPA	JMA-5312-4/6	Y	Y				Y	Y											
	JMA-5312-6		Y																
	JMA-5322-7	Y			Y														
	JMA-5322-7/9	Y	Y				Y	Y											
	JMA-5332-12	Y	Y		Y		Y	Y											
	JMA-5300MK2 SERIES			Y					Y										
ARPA/ATA	JAS-5302W		Y																
RADAR	JMA-5972-SA			Y															
	JMA-5372-SA			Y															
	JMA-5900 SERIES			Y															
RADAR /ARPA	JMA-9122-6XA				Y														
	JMA-9122-9XA				Y														
	JMA-9122-6/9XA	Y	Y				Y	Y											
	JMA-9123-7XA	Y	Y		Y			Y											
	JMA-9123-9XA	Y	Y																
	JMA-9123-7/9XA						Y												
	JMA-9132-SA	Y	Y		Y		Y	Y											
	JMA-9133-SA	Y	Y		Y		Y												
	JMA-9100 SERIES	Y		Y					Y				Y			Y			
ARPA/ATA	JAS-9100		Y																
SOLID STATE RADAR	JMA-9172-SA			Y		Y		Y								Y		Y	

Country /Classification Society / and Others — Equipment name (JRC model)		Country								Classification Society									INM
		Japan (Ministry of Internal Affairs and Communications)	Japan (Ministry of Land, Infrastructure and Transport)	MED	South Korea	Russia	U.S (FCC・USCG)	China (CMIIT)	Singapore (MPA)	NK (Japan)	LR (U.K)	ABS (U.S.A)	DNV・GL (Norway)	BV (France)	RINA (Italy)	CCS (China)	KR (South Korea)	RMRS (Russia)	INMARRSAT
RADAR /ARPA	JMA-7110-6XA						Y												
	JMA-7122-6XA	Y			Y														
	JMA-7122-9XA				Y														
	JMA-7122-6/9XA	Y	Y				Y	Y											
	JMA-7123-7/9XA						Y	Y											
	JMA-7132-SA	Y	Y		Y		Y	Y											
	JMA-7133-SA						Y	Y											
	JMA-7100 SERIES			Y					Y							Y			
ARPA/ATA	JAS-7100		Y																
RADAR /ARPA	JMA-922B-6/9X A		Y				Y												
	JMA-923B-7/9X A	Y	Y				Y												
	JMA-932B-SA	Y	Y				Y												
	JMA-933B-SA	Y	Y				Y												
	JMA-900B SERIES			Y									Y						
ARPA/ATA	JAS-900B		Y																
CHART RADAR	JMA-922M6/9XA	Y	Y				Y												
	JMA-923M7/9XA	Y	Y				Y												
	JMA-932MSA	Y	Y				Y												
	JMA-933MSA	Y	Y				Y												
RADAR SYSTEM	JMR-7200 SERIES	Y	Y	Y					Y										
	JMR-7200 SERIES	Y	Y	Y					Y										
ARPA/ATA	JAS-7200/9200		Y																
ECDIS	JAN-901M												Y						
	JAN-701												Y						
	JAN-901B		Y	Y	Y								Y			Y			
	JAN-701B		Y	Y	Y								Y			Y			
	JAN-701B/901B			Y									Y						
	JAN-2000		Y	Y		Y							Y					Y	
ECDIS BAM	JAN-9201		Y	Y			Y		Y				Y						
	JAN-7201		Y	Y			Y		Y				Y						
RPS/NWS	NDC-1186 SERIES												Y						
CONNING DISPLAY	JAN-701B/ 901B-CON												Y						
	JCY-1800		Y	Y	Y	Y			Y									Y	
	JCY-1900		Y	Y					Y										
	JCY-1850		Y	Y	Y	Y									Y			Y	
	JCY-1950			Y															

B

Country /Classification Society / and Others — Equipment name (JRC model		Country								Classification Society									INM
		Japan (Ministry of Internal Affairs and Communications)	Japan (Ministry of Land, Infrastructure and Transport)	MED	South Korea	Russia	U.S (FCC・USCG)	China (CMIIT)	Singapore (MPA)	NK (Japan)	LR (U.K)	ABS(U.S.A)	DNV・GL (Norway)	BV (France)	RINA (Italy)	CCS (China)	KR (South Korea)	RMRS (Russia)	INMARRSAT
GPS	JLR-7700MK2												Y						
	JLR-7500		Y	Y		Y			Y									Y	
	JLR-7800		Y	Y	Y	Y							Y					Y	
	JLR-7900			Y															
	JLR-7600			Y															
	JLR-4331					Y												Y	
	NWZ-4551					Y												Y	
	JLR-4331-NV		Y																
GPS COMPASS	JLR-20/30		Y																
	JLR-21/31		Y	Y		Y												Y	
ECHO SOUNDER	JFE-582		Y																
	JFE-585																		
	JFE-680		Y		Y											Y			
	JFE-380		Y													Y			
DOPPLER LOG	JLN-205		Y			Y												Y	
	JLN-205MK2																		
DOPPLER SONAR	JLN-550		Y	Y		Y							Y			Y		Y	
AIS	JHS-182	Y	Y	Y					Y							Y			
	JHS-183			Y	Y				Y										
BNWAS	JCX-151/152			Y			Y		Y							Y			
	JCX-161			Y			Y		Y										
WX FAX	JAX-9B															Y			
	JAX-91															Y			

Y : Type Approoved

Please ask persopns in charge of bisiness section conerned about detailes and equipment not listed here.

16-2 Main Classification table

Name of Classification	Country
ABS (American Bureau of Shipping)	USA
BV (Bureau Veritas)	FRANCE
CCS (China Classification Society)	CHINA
DNV･GL (DNV GL AS)	NORWAY
KR (Korean Register of Shipping)	KOREA
LR (Lloyd's Register)	UK
NK (Nippon Kaiji Kyokai)	JAPAN
RINA (Registro Italiano Navale)	ITALY
RMRS (Russian Maritime Register of Shipping)	RUSSIA

C. Radio Communication

1. Abbreviation for International Telex Communication

Abbreviation	Meanings
ABS	Absent subscriber, office closed.
ADV	Advise
ACK	Acknowledge
AGN	Again
BI	Good bye
BK	I cut off
CFM	Confirm
COL	Collation
CRV	How do you receive ?
CER	Out of order.
DF	You are in communication with the called subscriber.
DWN	Down
EEE	Error
FM	From
GA	Go ahead
MNS	Minutes
MOM	Wait (Waiting)
MUTI	Mutilated
NA	Correspondence to this subscriber is not admitted.
NC	No circuits
NCH	Subscriber's number has been changed.
NR	Indicate your call number. (My call number is -- --)
NP	No Party
OCC	Subscriber is engaged.
OK	Agreed
P	Stop your transmission.
PLS (PSE)	Please
PPR	Paper
RCV (D)	Received
RAP	I will call you again.
RD	Read
RE	Referring to
RPT	Repeat
SRY	Sorry
SVP	Please
TAX	What is the charge ?
TEST MSG	Please send a test message.
THRU	You are in communication with a telex position.
TKS	Thanks
TLX	Telex
TPR	Teleprinter
W	Words
WRU	Who is this?
+?	Over

2. Phonetic alphabets list

Character	Identifier Word	Pronunciation (based on the Latin alphabet)	Character	Identifier Word	Pronunciation (based on the Latin alphabet)
A	Alfa	AL FAH	N	November	NO VEM BER
B	Bravo	BRAH VOH	O	Oscar	OSS CAH
C	Charlie	CHAR LEE	P	Papa	PAH PAH
D	Delta	DELL TAH	Q	Quebec	KEH BECK
E	Echo	ECK OH	R	Romeo	ROW ME OH
F	Foxtrot	FOKS TROT	S	Sierra	SEE AIR RAH
G	Golf	GOLF	T	Tango	TANG GO
H	Hotel	HO TELL	U	Uniform	YOU NEE FORM
I	India	IN DEEAH	V	Victor	VIK TAH
J	Juliet	JEW LEE ETT	W	Whiskey	WISS KEY
K	Kilo	KEY LOH	X	X-ray	ECKS RAY
L	Lima	LEE MAH	Y	Yankee	YANG KEY
M	Mike	MIKE	Z	Zulu	ZOO LOO

Note: An underlined syllable is pronounced strongly.

Number Character	Identifier word	Pronunciation
0	Nadazero	NAH – DAH – ZAY - ROH
1	Unaone	OO – NAH - WUN
2	Bissotwo	BEES – SOH - TOO
3	Terrathree	TAY - RAH - TREE
4	Kartefour	KAR – TAY - FOWER
5	Pantafive	PAN – TAY - FIVE
6	Soxisis	SOK – SEE - SIX
7	Sstteseven	SAY – TAY - SEVEN
8	Oktoeeight	OK – TOH - AIT
9	Novenine	NO – VAY - NINER
Decimal point	Decimal	DAY – SEE - MAL
Full stop	Stop	

3. MF/HF Radio Equipment

3-1 Outline

MF/HF radio equipment is a radio equipment which conforms to the requirements for Global Maritime Distress and Safety System (GMDSS), and is suitable for middle distance and long distance communication.
Main communication functions are the Radiotelephone by a handset and Morse communication by a key. In addition, the communication line connection by Digital Selective Calling (DSC) for the general communication and distress communication is possible, and the reception of the distress communications by DSC receiver is possible. Further, telex communication such as ARQ or FEC by Narrow Band Direct Print (NBDP) is possible by connecting data terminal.

3-2 Guidance of Operation

Please understand the following matters, when you use MF/HF radio equipment.

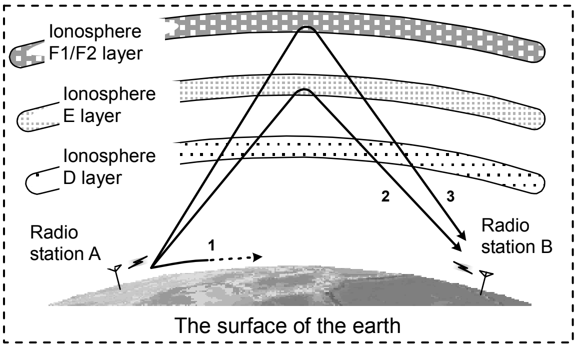
- The frequency which can be communicated always changes.
- You may not always be able to communicate in all frequency bands.
- There may not be a reply on the DSC test for a coast station by all means.

(1) MF/HF radio equipment

Marine MF/HF radio equipment can generally use the frequency of 1.6 MHz - 27.5 MHz. However, when actually communicating, frequency suitable for communication is selected from the frequency permitted to the ship. Since frequency suitable for this communication is dependent on the radio propagation characteristic of the ionosphere like the after-mentioned, even if equipment is normal, you may not always be able to communicate in all frequencies.

(2) Characteristic of MF/HF radio communications line

The electric wave of a MF/HF belt is spread by the surface wave (course 1) as mainly shown in the right figure, or the reflected wave (courses 2 and 3) of the ionosphere. As the surface wave makes limitation an effective communication distance, the communication is really carried out using the reflection of the ionosphere and the earth surface.[1] Since it depends on the radio propagation characteristics of the ionosphere, the frequency range which can communicate greatly changes by the distance or location between the radio station, a season, the time, the sun sunspot number (about 0-250) changing in 11 year cycle etc.[2]



(3) How to select communication frequency

The communication frequency of MF/HF band is not decided uniquely. Please select the frequency in reference to the past communication history, and the frequency transition table and the radio propagation image of "How to select communication frequencies in the MF/HF band (reference)" of mention on the following page.

(4) DSC test

The operations / instruction of DSC is prescribed in an international standard of International Telecommunications Union (ITU)[3] and the coast station which received DSC test signal is to reply after operating the series.
On this occasion, not automatic reply, but a manual reply is sometimes performed depending on the facilities of the coast station. Therefore it sometimes takes time before the reply is received **even if equipment is normal and the selected frequency is appropriate.**

[1] Near the reaching limit distance of a surface wave, the blind zone from which a surface wave or ionospheric reflection wave is not obtained, either may arise.
[2] Radio propagation may be affected by influence by various phasing, a Dellinger phenomenon, a magnetic storm, atmospheric interference, etc. Moreover, since a distant electric wave arrives easily at night, it is in the tendency for interference to increase.
[3] ITU-R Rec. M.541

C

How to select communication frequencies in the MF/HF band (reference)

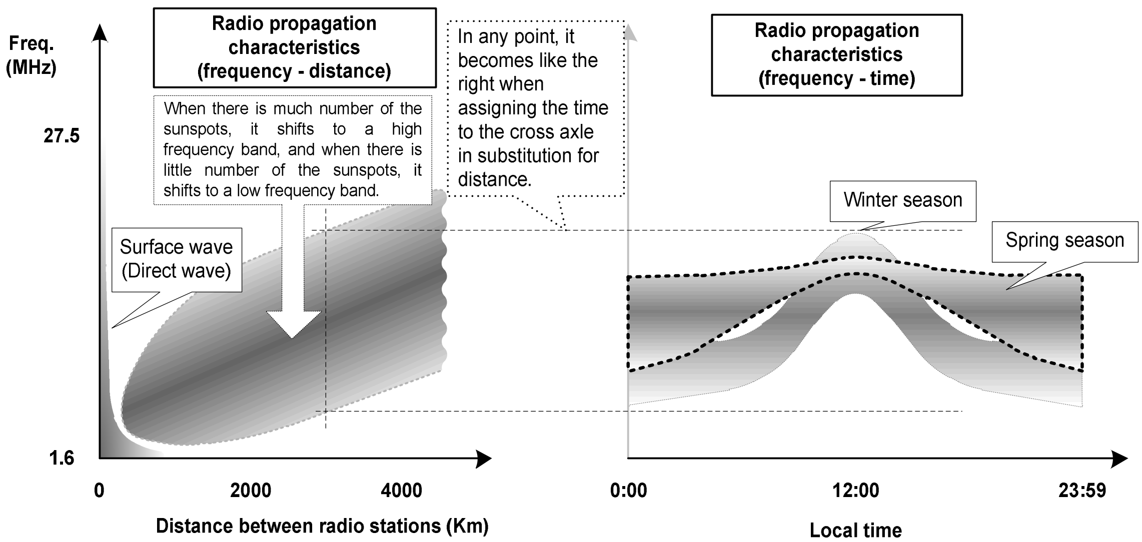
When you communicate with MF/HF radio equipment, please refer to the following frequency transition tables and radio propagation images (A pole latitude area is excluded.), and select frequency.[4]

Example: When communicating with the radio station which is in the distance of approx. 5000 km in the daytime around 12:00 of winter, if the number of sunspots in the sun is 100, it will be thought that frequency selection of either 18/22/25 MHz bands is appropriate.

➢ Frequency transition table

Communication condition			Aim of frequency selection (Number of sunspots = 100)								
Distance	Season / time		2M	4M	6M	8M	12M	16M	18M	22M	25M
Long distance (e.g.:5000km)	Winter	Day time									
		Night									
	Summer	Day time									
		Night									
Short distance (e.g.:1000km)	Winter	Day time									
		Night									
	Summer	Day time									
		Night									

➢ Electric wave propagation image



4 These are based on radio propagation prediction, and communication is not guaranteed.

3-3 Specification / Performance

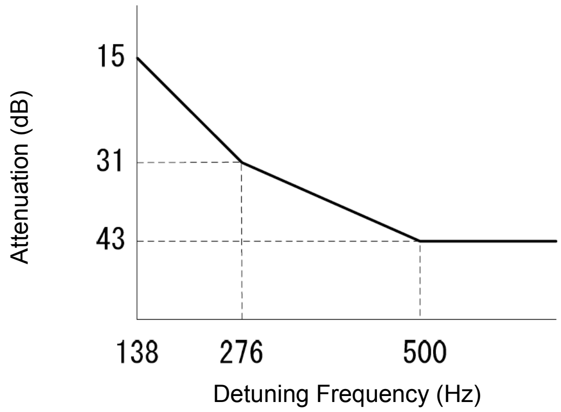
(1) General

a. Transmit frequency: 1605.0 to 27500.0 kHz
b. Receive frequency: 90.0 to 29999.9 kHz
c. Frequency deviation: Less than ±10 Hz
d. Radio Wave Type: J3E, F1B (J2B)
e. Antenna impedance: 50 ohms Unbalance
f. Frequency shift time: Less than 15 seconds
g. Main power supply: AC100/220V±10%
h. Auxiliary power: DC24V+30%/-10%

(2) Transmitter

a. Output power: HF band: 150W, 250W or 500W, (depending on each model, main power supply in use)
b. Occupied Bandwidth: J3E: within 3 kHz, F1B: within 0.5 kHz
c. Carrier power: J3E: not lees than damping ratio 40 dB
d. Intensity of spurious emission:
43 dB lower than fundamental frequency, and 50 mW or less
e. Attenuation for every frequency of unnecessary emission
J3E: 1.5 - 4.5kHz: not less than 31 dB,
4.5 - 7.5 kHz: not less than 38 dB,
above 7.5kHz: not less than 43 dB
(However, Peak power of unnecessary emission: 50 mW or less)

F1B (J2B):



f. Total distortion and noise: -20 dB or less
g. AF frequency response: deviation: within 6 dB between 350Hz and 2700Hz

(3) Receiver

a. Frequency stability: within ±10 Hz
b. Sensitivity (SINAD 20dB)
J3E: 6.3 μ V or less (1605.0 to 4000.0 kHz), 3.5 μ V or less (4000.0 to 27500.0 kHz)
F1B: 1.8 μ V or less (1605.0 to 4000.0 kHz), 1.0 μ V or less (4000.0 to 27500.0 kHz)
c. Selectivity
J3E: 2.4 to 3.0 kHz (6dB bandwidth), within ±2.1kHz (66dB bandwidth)
F1B: 270 to 300 Hz (6dB bandwidth), within ±550Hz (60dB bandwidth)
d. Spurious response
J3E: Not less than 60 dB
F1B: Character error rate: 1% or less (when interfered by an interfering wave which is 31.6 mV and is 750 Hz off a desired wave with 10 μ V)
e. Sensitivity suppression effect

C

J3E: Interfering wave input voltage: not less than 10mV
An interfering wave causes 3dB suppression of a desired wave output with10μV and is 3 kHz off a desired wave.

F1B: Character error rate: 1% or less (when interfered by an interfering wave which is 1 mV and is 500 Hz off a desired wave with 10μV)

f. Total distortion and noise: ratio of low frequency 1000Hz to unnecessary component included in it: not less than 30 dB (when an input signal with 30μV is added.)

g. Electric waves etc. which are emitted secondarily:
power emitted from an antenna terminal: 4nW or less

(4) DSC Watchkeeping Receiver

a. Frequency: 2187.5 kHz/ 8414.5 kHz / 4207.5 kHz/ 6312.0 kHz/12577 kHz/ 16804.5 kHz

b. Frequency Stability: Less than ±10 Hz

c. Sensitivity: Character error rate: 1% or less, at 1μV of reception input voltage

d. Bandwidth: width 6 dB: 270 to 300 Hz, width 30dB: within ±380Hz,
width 60dB: within ±550Hz

e. Spurious response: Character error rate: 1% or less (when interfered by an interfering wave which is 31.6 mV and is 750 Hz off a desired wave with10μV)

f. Sensitivity suppression effect
Character error rate: 1% or less (when interfered by an interfering wave which is 1 mV and is 500 Hz off a desired wave with 10μV)

g. Electric waves etc. are secondarily emitted:
power emitted from an antenna terminal: 4nW or less

(5) DSC modem

a. Modulation rate:	within 100 baud ± 30 ppm
b. Modulation:	FSK (subcarrier: 1700 Hz)
c. Y signal frequency:	within 1615Hz±0.5Hz
d. B signal frequency:	within 1785Hz±0.5Hz
e. Protocol:	ITU-R recommendation M.493
f. Operational Procedure:	ITU-R recommendation, M.541, M.821
g. Code in use:	Ten-bit error-detecting code

(6) NBDP modem

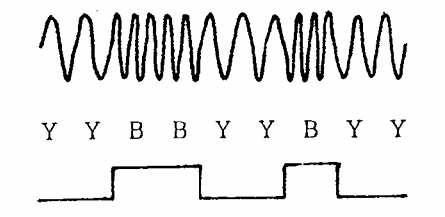
a. Modulation rate:	within 100 baud ± 30 ppm
b. Modulation:	FSK (subcarrier: 1700 Hz)
c. Y signal frequency:within	1615 Hz ± 0.5 Hz
d. B signal frequency:	within 1785 Hz ± 0.5Hz
e. Protocol:	ITU-R recommendation M.476, M.491, M.625
f. Operational Procedure:	ITU-R recommendation, M.492
g. Code in use:	Seven -bit code 4B / 3Y

(7) Antenna tuner

a. Frequency range:	1605.0 to 27500.0 kHz
b. Maximum input power:	based on each model.
c. VSWR after tuned:	2:1 or less
d. Tuning:	Preset or automatic tuning.

4. DSC (Digital Selective Calling)

- DSC is the name of Communication Technology with which radio stations set up communication links with other stations or groups and can transmit information using a digital coded signals.
  Generally, the word “DSC” is referred to as for calling the modulator and demodulator which adopted DSC technology.
- The technical requirements of DSC is prescribed in “CCIR Recommendation 493-13 and 541-9.

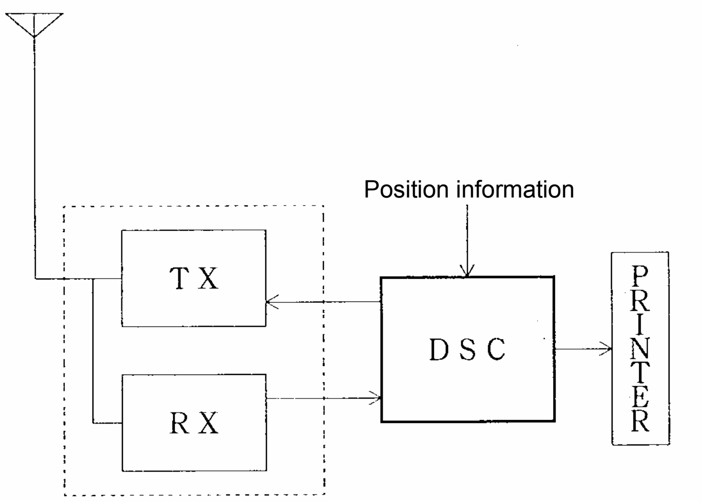


f deflection = less than ±10 Hz

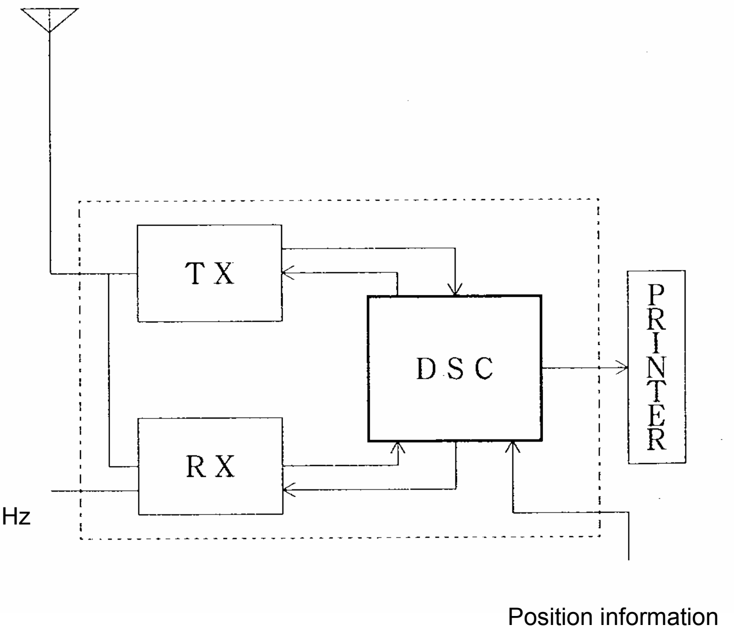
Frequency for DSC Calling
2187.5 kHz
4207.5 kHz 6312.0 kHz 8414.5 kHz 12577.0 kHz 16804.5 kHz
156.525MHz (CH70)

(Assigned frequency)

Band width = less than 300 Hz



in the case that a DSC device is externally interfaced.



Example(JSS-710): DSC is built in a console.

(DSC General Scheme)

	Frequency	Calling person	Calling method	Identification	Device	Acknowledge establishment
Previous	500 kHz 2182 kHz	Only Radio operator	Morse etc. by Manual/ Automatically	Radio operator identifies call sign by hearing..	Auto keyer/ Auto alarm	unstable and low.
DSC	2187.5 kHz HF VHF	Anyone (Special-skills is not needed)	Digital code (9 bits) Automatic	DSC identifies automatically digital code called	Watching DSC Call	MF/HF: less than 3min, VHF: immediately not less than 95% within 300 miles.

(Comparison between previous and preset distress calling)

- In DSC operation, while many stations use it together at the same time with same frequency, a specific station or groups can be designated or call sign can be broadcasted to all ships around. Outline fo DSC communications is as follows.
  1. Individual call , Group call or Call in whole from ship(s) and Coast Station(s)
  2. Distress Call from ship(s)
  3. Send the acknowledgement of Distress Call from Coast Station
  4. Call for Relaying Distress Call
- In DSC operation, the text sentence such as telex and NBDP, which is used in INMARSAT, is not used. The Information which is to be sent is chosen with the symbol number coded beforehand, and is transmitted in pre-determined order.

  Example: in the case of sending distress information in categories, the symbol number "112." Is send.
- There are 128 sysmbols. For sending symbol, at first, erroneous characters is detected by 10-bit BY code, and then, in order to further minimize the miswritten characters, all symbols are sent twice every time with the symbols grouped into a group with 4 characters.

  (It is called “time diversity”.)

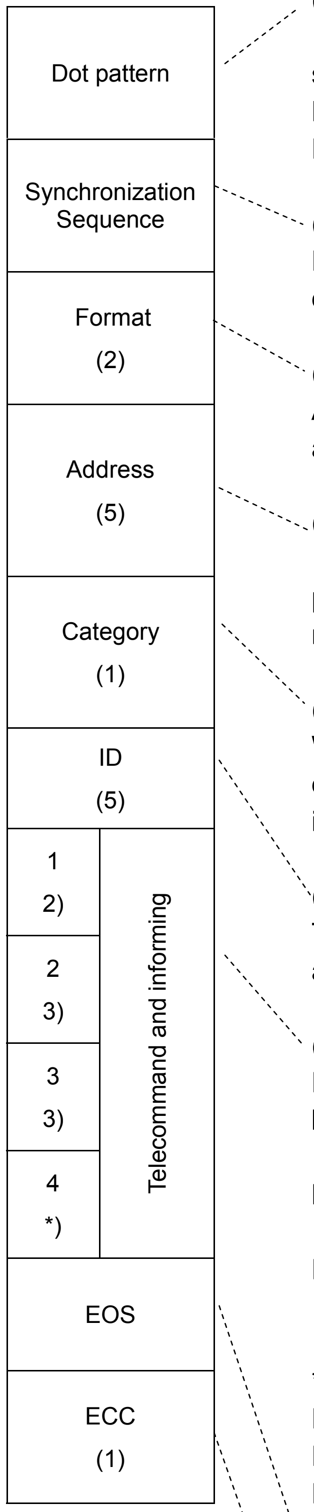
  Example: Symbol number 112 - $\underbrace{\text{B B B B Y Y Y}}_{\text{Information bit}}$ $\underbrace{\text{Y B B}}$ The number of B in an information bits (binary)

  $\begin{cases} B=0 \\ Y=1 \end{cases}$

DSC	Wave type	Modulation frequency	Baud rate	Specification	Remarks
For MF/HF	F1B	1700±85 Hz	100 bauds	CLASS A CCIR full specifications	compatible with IMO requirements.
	J2B	1700±85 Hz			
For VHF	F2B G2B	1700±400 Hz	1200 bauds	CLASS B with no group call	A1, for the small ships of A2 ocean space
VHF For transceivers	F2B G2B	1700±400 Hz	1200 bauds	CLASS C	fixed distress alert (easy add-on type)

(Comparison of DSC)

Composition of DSC signals.   In the case of distress call



(1) Dot pattern
In order to ensure synchronization certainly and fast, a B signal and a Y signal are sent out by turns.
MF/HF distress sequence: 200 bits
Except for the above, and VHF: 20 bits

(2) Synchronizing sequence
Receiver synchronizes correctly and the position of information sent is decided correctly.

(3) Call type (format)
Assignment of Distress, all ships, individual, sea area, fleet call, or VHF automatic service

(4) Identification of the someone who is called (address)
In other than distress and all ship calls, it is applicable, and when pinpointing the area on geography and calling, the rectangle on a mercato figure can be selected.

(5) Priority of a call (category)
When a call other than distress call is selected in (3), the priority, of distress, emergency, safety, the priority decision of ships, or normal call, is selected.

(6) Identification of own station
The nine-digit number which the Competent Authority of the Flag State assigns to the ships to which are entitled to fly its flag.

(7) In * distress call, it consists of the following four reports.
Report 1: Kind of distress
Report 2: Position of the ship in distress (number 9 is used when no position information is input)
Report 3: UTC in Distress (number 8 is used when no time information is input)
Report 4: Communication type after successful call (telecommand 1)

* In the case of other than distress call
Report 1: Telecommand information 1
Report 2: Channel number for communicating, or frequency
Report 3: Report 4: not used

(8) EOS: END OF SEQUENCE
Designate whether acknowledge may be required or not.

(9) Error check character
The errors, which were not able to be corrected by a ten-unit error detection code and time diversity, are detected, and, in the case of miswritten characters, acknowledgement is not sent.

5. NBDP (Shortwave Narrow-band Direct Printing System)

5-1 Outline

It is the NBDP system, that it has the function of correcting erroneous characters using shortwave bands, direct communication between offices and ships is possible through International Telex line as well, automatic receiving is possible and the speed (maximum about 400 characters per minute by International method) of it is 3 to 4 times than the speed of Morse communication, etc. Automation of communication and avoiding workloads are possible.

5-2 Flow of Information

At a transmitter side, the wordings of a telegram are input into I/O device (DTE: Data Terminal Equipment), and are coded and FS modulated in a terminal device and finally are changed to 100 bauds for radio communication. Processed wordings are transmitted as F1B radio wave from the transmitter. At a receiver side, FS modulated telegrams are received, decoded, printed and indicated at an information I/O device.

5-3 Communicate Mode

(1) ARQ (Automatic ReQuest for repetition) mode: Using automatic-request for retransmission method with return line for responding to, only one-to-one communication can be carried out. A Selective Calling Number of 5 digits (for Ship) or 4 digits (for Shore station) is assigned to Each satiation, and in the future 9 digits are to be used for these function. At a transmitting side, a Selective Calling Number for destination is selected and transmitted. Aftr a line is established between stations, telegram is sent to.

(2) FEC (Forward Error Correction) mode : This is the mode which transmits the same characters twice at an interval, and check, and corrects erroneous characters at receiving side. In this mode, there two methods such as simultaneous-transmission to multiple receiving sites (CFEC: Collective FEC= all call) and transmission to a certain specific receiving site (SFEC: Selective FEC= selection broadcast). In CFEC, since synchronizing signals are not transmitted first but wordings of a telegram are sent out succeeding, all receiving stations can receive the telegram. On the hand, regarding in SFEC mode, as Selective Calling Number is sent out following the synchronizing signal, only the station which is selected can receive it. And the other stations return to receiving state (STD BY).

5-4 Connection Transceiver Machine

Connectable transmitter is SSB transmitter and the followings are required.

(1) High voltage of transmitter is controllable externally.
(2) Frequency deviation is below 40 Hz and stability is high.
(3) Rise up time of a relay of Key line should be 10 or less ms.
Synthesizer system is desirable as receiver from a viewpoint of frequency deviation and stability.

6. DSC / NBDP Station Frequency List

6-1 DSC Station List

Station	Frequency (kHz) and Operating time (UTC)					
SHANGHAI RADIO (XSG) MMSI:004122100	4207.5 [H24]	6312 [H24]	8414.5 [H24]	I2577 [H24]	16804.5 [H24]	
GUANGZHOU RADIO (XSQ) MMSI:004123100	—	—	—	—	—	
VLADIVOSTOK RADIO (UFL) MMSI:00273714	4207.5	6312	8414.5	I2577	16804.5	
SEOUL RADIO (HLS) MMSI:004400002	4207.5 [H24]	6312 [H24]	8414.5 [H24]	I2577 [H24]	16804.5 [H24]	
KEELUNG RADIO (XSX) MMSI:004162019	4207.5 [H24]	6312 [H24]	8414.5 [H24]	I2577 [H24]	16804.5 [H24]	
	KEELUNG RADIO: In 2014, HF DSC is stopping for facilities repair. Re-operation plan is in 2015.					

6-2 NBDP Station List

Station	Frequency (kHz) and Operating time (UTC)					
SHANGHAI RADIO (XSG) SELLCALL No. 2010	4215 (4177) [1000-2200]	6326 (6275) [2200-1000]	8425.5 (8385.5) [H24]	I2637.5 (12535.5) [H24]	16892 (16774) [2200-1600]	
Coast station TELEX No. (85)337305			8430 (8390) [2200-1600]	12649.5 (12547.5) [H24]	16898.5 (16780.5) [H24]	
(SMTNC CN)			8436 (8396) [2200-1000]			
GUANGZHOU RADIO (XSQ) SELLCALL No. 2017	4212 (4174) [1200-0000]	6316 (6264.5) [0000-1200]	8422.5 (8382.5) [HX]	12584.5 (12482) [HX]	16812 (16688.5) [HX]	22381.5 (22289.5) [HX]
Coast station TELEX No.(85)440212 (GUMAT CN)	4219 (4181.5) [HX]	6329 (6283) [HX]	8429 (8389) [HX]	12613 (12510.5) [H24]	16823.5 (16700.5) [HX]	22420 (22328) [HX]
(85)441200 (GZRDO CN)			8431 (8391) [HX]	12600.5 (12498) [HX]	16854 (16731) [HX]	22435 (22343) [HX]
			8435 (8395) [H24]	12662.5 (12520.5) [HX]	16880 (16762) [2200～1600]	
				12648.5 (12546.5) [2300-1200]		
VLADIVOSTOK RADIO (UFL) SELLCALL No. 4620 Coast station TELEX No.(64)213115 (MRF RU)	4210.5 (4172.5) [H24]		8423 (8383) [H24]	12591.5 (12489) [2000-1300]	(16836) 16713 [2000-1000]	

Note: 1. [HX]: irregular operation
2. ( ) Receiving Frequency for Ship's Station

Commands used are as follows.

BRK+=	cancellation of connection of radio communications.
CEMAILnn+=	transmissions of E-mail reporting by Kanji(Japanese latter).
CFAXxy+=	transmissions of FAX reporting by Kanji(Japanese latter).
CHISREP=	transmissions of Chinese Ship Report (in accordance with Laws of China Authority).
CMUFAXxy,xy…+=	transmissions of FAX reporting by Kanji (to multiple members).
DIRTLXxy+=	direct connection to telex members, x means a country number which starts from 0, y means a member's number.
EMAILnn+=	transmission of an E-mail report in a Western language to Internet/E-mail.
FAXxy+=	transmission of a report in a Western language to a facsimile member, x means a country number which starts from 00 or area code which starts from 0, y means a facsimile member's number.
FREQ+=	reporting of hearing information (frequency) by a ship station.
HELP+(HLP+)=	available Commands list.
INF+=	request of information list which system can provide.
KKKK=	finish of connection to land channel.
MED+=	connection to medical channel.
MSG+=	request of communication.
MULFAXxy,xy…+=	transmission of a report in Western language to multiple facsimile members, x means a country number which starts from 00 or area code which starts from 0, y means a facsimile member's number.
MULTLXxy,xy…+=	transmission of store and forward report to multiple telex members, x means a country number which starts from 0, y means a telex member's number.
NAV+=	request of retransmission of the latest navigation alarm number (in English) and its list number.
NAW+=	request of retransmission of the latest navigation alarm number (in Chinese) and its list number.
OBS+=	transmission of ship weather information.
OPR+=	operator's operation (OCC means a operator is in communication).
QRC+=	means ship AAIC information.
RPT+=	request of retransmission list of navigation alarm etc.
STA+=	request of distribution information of report available within 24 hours.
STS+=	transmission of information between ships.
SVC+=	transmission of business report.
TEST+(TST+)=	request of QBF message(test message).
TGM+=	transmission of radiotelegram message.
TLXxy+=	transmission of store and forward report to telex members, x means a country number which starts from 0, y means a telex member's number.
URG+=	request the connection with the operator. this command is used only in an EMERGENCY.
WX+=	request to receive a weather report immediately.

7. International VHF
(for Maritime Mobile Communication)

7-1 Characteristics

(1) Main performance of transmitter

a. Output power: 25W

b. Frequency stability: less than (±)10x10^{-6}

c. The maximum frequency distortion: less than 5 kHz

d. Occupancy frequency band width: 16 kHz or less

e. Modulation frequency characteristics: based on 1 kHz.

0.3 kHz : -10.5±2 dB

2 kHz : + 4±2 dB

3 kHz : + 6±2 dB

f. Signal to noise ratio: not less than 40 dB

g. Spurious emission:

compared with a fundamental wave output

strength tolerance	between 142-162 MHz
within the band	Value of 80 dB lower than
outside the band	Value of 60 dB lower than

h. Antenna impedance: 50 Ω (previous model: 75Ω)

i. Voice modulation input impedance: 40Ω

(2) Main performance of receiver

a. Receiving sensitivity:
receiver input voltage required to obtain 20-dB noise suppression: less than 2 μV

b. Squelch sensitivity 0.5μV

c. Signal to noise ratio not less than 40 dB

d. Receiving bandwidth and Selectivity

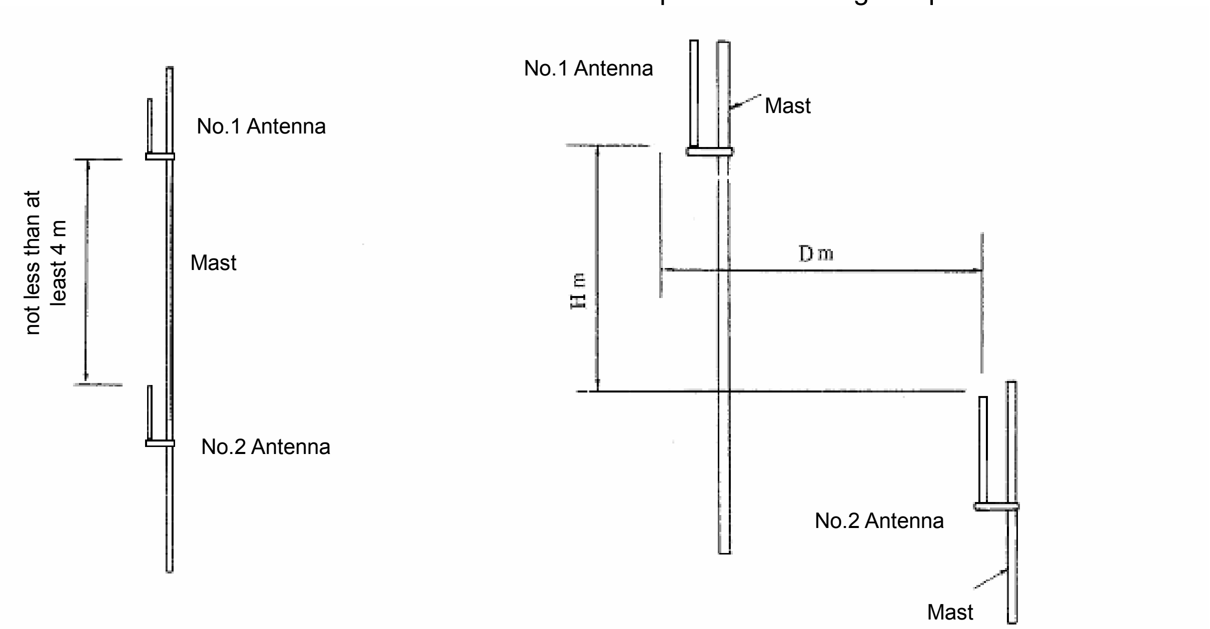
Pass band of a received signal:

at a point of 6 dB below: not less than 12 kHz

bandwidth at a point of 70 dB below:
less than 2.5 kHz.

7-2 Antenna position in the case of installation of more than 2 antennas

(1) No.1 antenna position is generally higher than No.2 antenna position. And, No.1 antenna is installed onboard as high as possible. For example, it is desirable that its height should be almost the same as a radar scanner, and should be away from transmission antennas for Medium wave and for Short wave as much as possible in a large ship.

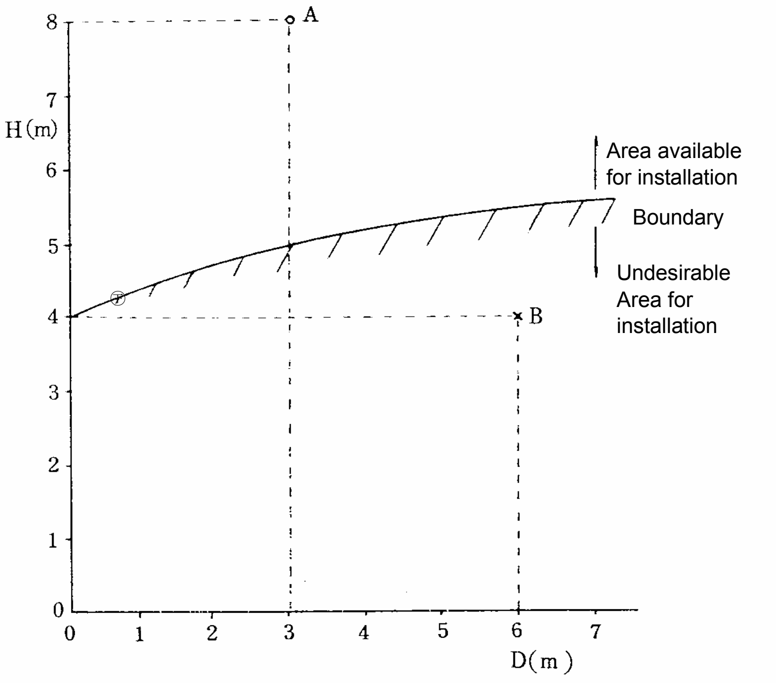


Arranged on the same vertical line. Not arranged on the same vertical line or obliquely

Fig. 7-1 Arrangement of antenna

(2) Two or more antennas are normally arranged on the same vertical line. The distance between antennas is at least 4 m as a minimum, and the desirable distance between antennas is bigger than 4 m, as much as possible.

(3) When two or more antennas are not arranged on the same vertical line, a minimum distance is found as shown in the following figure, an actual distance should be bigger than a minimum distance (4m). Influences given to receiving by transmissions should be fully investigated and then antenna installation is designed and carried out.



Example of a minimum distance at which a transmitter does not interfere a receiver.

- when H is 8 m and D is 3 m, these distances are usable . (A point).
- If H is set to 4 m and D is set to 6 m, while transmitting, a trouble that noise of a receiver increases , etc. are caused. (B point).

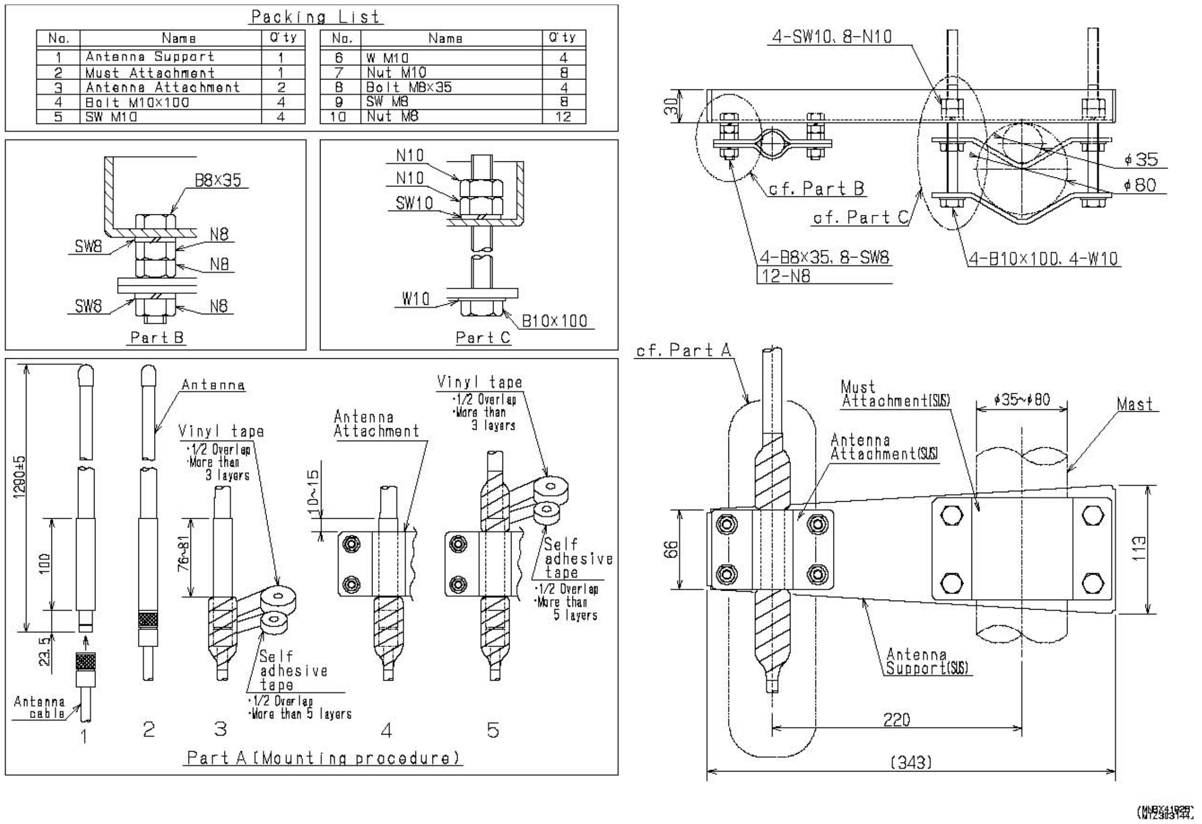
Fig. 7-2 Distance between antennas

(4) The diameter of a mast for antenna installation, and the distance between an antenna and a mast:
The electric field intensity pattern of an antenna changes according to the diameter of a mast and the distance between antennas.

(5) Installation position for antennas: It is desirably far apart from a funnel, a radar mast and other structures, which may have a shielding effect, as much as possible (because such structures affect the field intensity pattern.).

(6) Installation of two VHF antennas: It is desirable that antennas should be vertically installed as much as possible. In this case, the distance between antennas is not less than 4 m. If antennas are horizontally arranged unavoidably, the distance between antennas should be not less than 17 m. Even in such an arrangement of antennas, when one VHF transmits, the other receiving VHF is interfered by the transmitting VHF during receiving. For reference, the following is introduced, in order to eliminate interference completely, in the case of the vertical installation of VHF antennas, at least a separation of 50 m is required, and in the case of horizontal installation of VHF antennas, antennas are at least 80 m away from another one.

7-3 Antenna Installation and Waterproofing



No.	Name	Q'ty	No.	Name	Q'ty
1	Antenna Support	1	6	W M10	4
2	Must Attachment	1	7	Nut M10	8
3	Antenna Attachment	2	8	Bolt M8×35	4
4	Bolt M10×100	4	9	SW M8	8
5	SW M10	4	10	Nut M8	12

Fig. 7-3 Antenna Installation

According to the following procedure, antenna is installed.

(1) Insert a coaxial connector into an antenna connector straight.
(2) Screw a coaxial connector up to the end.
(3) Waterproof a coaxial cable up to an antenna metal base (up to the position of 76-81 mm from a top end of the metal base). A self-adhesive tape is bound 5 times with the tape half-overlapped. A vinyl tape is bound three times over the self-adhesive tape bound with the tape half-overlapped as shown in Figure 6-3.
(4) Fix the antenna base with the antenna attachment. A metal base top end should juts 10-15 mm out of the antenna attachment.
(5) Waterproof the metal base above the antenna attachment up to an antenna element. A self-adhesive tape is bound 5 times with the tape half-overlapped. A vinyl tape is bound three times over the self-adhesive tape bound as shown in Figure 6-3.
(6) The antenna attachment is fitted to the mast (suitable diameter: Φ 35-80mm).

C

7-4 International Maritime Mobile Communication VHF Channel List

7-4-1 ITU Channel（ITU-RR Appendix18）

CH	TX (MHz)	RX (MHz)	Simplex	Semi-Duplex/ Duplex	Remarks
01	156.050	160.650		●	
02	156.100	160.700		●	
03	156.150	160.750		●	
04	156.200	160.800		●	
05	156.250	160.850		●	
06	156.300	156.300	●		Ship to Ship Communication
07	156.350	160.950		●	
08	156.400	156.400	●		Ship to Ship Communication
09	156.450	156.450	●		
10	156.500	156.500	●		
11	156.550	156.550	●		
12	156.600	156.600	●		
13	156.650	156.650	●		
14	156.700	156.700	●		
15	156.750	156.750	●		
16	156.800	156.800	●		
17	156.850	156.850	●		
18	156.900	161.500		●	
19	156.950	161.550		●	
1019	**156.950**	**156.950**	●		**Add :New Simplex（2013/1）**
2019	**161.550**	**161.550**	●		**Add :New Simplex（2013/1）**
20	157.000	161.600		●	
1020	**157.000**	**157.000**	●		**Add :New Simplex（2013/1）**
2020	**161.600**	**161.600**	●		**Add :New Simplex（2013/1）**
21	157.050	161.650		●	
22	157.100	161.700		●	
23	157.150	161.750		●	
24	157.200	161.800		●	
25	157.250	161.850		●	
26	157.300	161.900		●	
27	157.350	161.950		●	
28	157.400	162.000		●	
60	156.025	160.625		●	
61	156.075	160.675		●	
62	156.125	160.725		●	

63	156.175	160.775		●	
64	156.225	160.825		●	
65	156.275	160.875		●	
66	156.325	160.925		●	
67	156.375	156.375	●		
68	156.425	156.425	●		
69	156.475	156.475	●		
70	156.525	156.525	●		Exclusively used for DSC
71	156.575	156.575	●		
72	156.625	156.625	●		Ship to Ship Communication
73	156.675	156.675	●		
74	156.725	156.725	●		
75	156.775	156.775	●		Fixed at 1W
76	156.825	156.825	●		Fixed at 1W
77	156.875	156.875	●		Ship to Ship Communication
78	156.925	161.525		●	
1078	**156.925**	**156.925**	●		**Add :New Simplex（2013/1）**
2078	**161.525**	**161.525**	●		**Add :New Simplex（2013/1）**
79	156.975	161.575		●	
1079	**156.975**	**156.975**	●		**Add :New Simlex（2013/1）**
2079	**161.575**	**161.575**	●		**Add :New Simlex（2013/1）**
80	157.025	161.625		●	
81	157.075	161.675		●	
82	157.125	161.725		●	
83	157.175	161.775		●	
84	157.225	161.825		●	
85	157.275	161.875		●	
86	157.325	161.925		●	
87	157.375	157.375	●		
88	157.425	157.425	●		

Note:　CH87and CH88 receiving frequency used for the previous purpose (161.975Mhz and 162.025MHz）were assigned for the exclusive use in AIS.

C

7-4-2 USA Channel（FCC Rule 47 CER80.371(c) and 80.373(f)）

CH	TX (MHz)	RX (MHz)	Simplex	Semi-Duplex/ Duplex	Remarks
01	156.050	156.050	●		
02					Not used
03					Not used
04					Not used
05	156.250	156.250	●		
06	156.300	156.300	●		Ship to Ship Communication
07	156.350	156.350	●		
08	156.400	156.400	●		Ship to Ship Communication
09	156.450	156.450	●		
10	156.500	156.500	●		
11	156.550	156.550	●		
12	156.600	156.600	●		
13	156.650	156.650	●		during an initial stage, 1W
14	156.700	156.700	●		
15		156.750			Transmission is prohibited
16	156.800	156.800	●		
17	156.850	156.850	●		
18	156.900	156.900	●		
19	156.950	156.950	●		
20	157.000	157.000	●		Ship to Ship Communication
21	157.050	157.050	●		for USCG (General use is prohibited.)
22	157.100	157.100	●		
23	157.150	157.150	●		for USCG (General use is prohibited.)
24	157.200	161.800		●	
25	157.250	161.850		●	
26	157.300	161.900		●	
27	157.350	161.950		●	
28	157.400	162.000		●	
60					Not used
61					Not used
62					Not used
63	156.175	156.175	●		
64					Not used
65	156.275	156.275	●		
66	156.325	156.325	●		
67	156.375	156.375	●		during an initial stage, 1W

68	156.425	156.425	●		
69	156.475	156.475	●		
70	156.525	156.525	●		Exclusively used for DSC
71	156.575	156.575	●		
72	156.625	156.625	●		Ship to Ship Communication
73	156.675	156.675	●		
74	156.725	156.725	●		
75	156.775	156.775	●		Fixed at 1W
76	156.825	156.825	●		Fixed at 1W
77	156.875	156.875	●		Ship to Ship Communication & Fixed at 1W
78	156.925	156.925	●		
79	156.975	156.975	●		
80	157.025	157.025	●		
81	157.075	157.075	●		(General use is prohibited.)
82	157.125	157.125	●		(General use is prohibited.)
83	157.175	157.175	●		for USCG (General use is prohibited.)
84	157.225	161.825		●	
85	157.275	161.875		●	
86	157.325	161.925		●	
87	157.375	161.975		●	
88	157.425		●		Ship to Ship Communication

Note: In the above listed channels, “Not used” are not able to be set in USA channel mode.

7-4-3 Canada Channel (INDUSTRY CANADA RIC-13)

CH	TX (MHz)	RX (MHz)	Simplex	Semi-Duplex/ Duplex	Remarks
01	156.050	160.650		●	
02	156.100	160.700		●	
03	156.150	160.750		●	
04	156.200	156.200	●		for CCG (General use is prohibited.)
05	156.250	156.250	●		
06	156.300	156.300	●		(General use is prohibited.)
07	156.350	156.350	●		
08	156.400	156.400	●		(General use is prohibited.)
09	156.450	156.450	●		
10	156.500	156.500	●		
11	156.550	156.550	●		
12	156.600	156.600	●		
13	156.650	156.650	●		
14	156.700	156.700	●		
15	156.750	156.750	●		Fixed at 1W
16	156.800	156.800	●		
17	156.850	156.850	●		Fixed at 1W
18	156.900	156.900	●		
19	156.950	156.950	●		for CCG (General use is prohibited.)
20	157.000	161.600		●	Fixed at 1W
21		161.650			Transmission is prohibited. (Weather cannnel)
22	157.100	157.100	●		(General use is prohibited.)
23	157.150	161.750		●	
24	157.200	161.800		●	
25	157.250	161.850		●	
26	157.300	161.900		●	
27	157.350	161.950		●	
28	157.400	162.000		●	
60	156.025	160.625		●	
61	156.075	156.075	●		for CCG (General use is prohibited.)
62	156.125	156.125	●		for CCG (General use is prohibited.)
63					Not used
64	156.225	160.825		●	
65	156.275	156.275	●		Fixed at 1W
66	156.325	156.325	●		Fixed at 1W

67	156.375	156.375	●		(General use is prohibited.)
68	156.425	156.425	●		
69	156.475	156.475	●		
70	156.525	156.525	●		Exclusively used for DSC
71	156.575	156.575	●		
72	156.625	156.625	●		
73	156.675	156.675	●		
74	156.725	156.725	●		
75					Not used
76					Not used
77	156.875	156.875	●		Fixed at 1W
78	156.925	156.925	●		
79	156.975	156.975	●		
80	157.025	157.025	●		
81	157.075	157.075	●		for CCG (General use is prohibited.)
82	157.125	157.125	●		for CCG (General use is prohibited.)
83		161.775			Transmission is prohibited. (Weather cannnel)
84	157.225	161.825		●	
85	157.275	161.875		●	
86	157.325	161.925		●	
87	157.375	161.975		●	
88	157.425	162.025		●	

Note: In the above listed channels, "Not used" are not able to be set in CANADA channel mode.

C

7-4-4 IWW channel（ETSI EN 300 698-1 V1.3.1）

CH	TX (MHz)	RX (MHz)	Simplex	Semi-Duplex/ Duplex	Remarks
01	156.050	160.650		●	
02	156.100	160.700		●	
03	156.150	160.750		●	
04	156.200	160.800		●	
05	156.250	160.850		●	
06	156.300	156.300	●		Fixed at 1W Ship to Ship Communication
07	156.350	160.950		●	
08	156.400	156.400	●		Fixed at 1W Ship to Ship Communication
09	156.450	156.450	●		
10	156.500	156.500	●		Fixed at 1W
11	156.550	156.550	●		Fixed at 1W
12	156.600	156.600	●		Fixed at 1W
13	156.650	156.650	●		Fixed at 1W
14	156.700	156.700	●		Fixed at 1W
15	156.750	156.750	●		Fixed at 1W
16	156.800	156.800	●		
17	156.850	156.850	●		Fixed at 1W
18	156.900	161.500		●	
19	156.950	161.550		●	
20	157.000	161.600		●	
21	157.050	161.650		●	
22	157.100	161.700		●	
23	157.150	161.750		●	
24	157.200	161.800		●	
25	157.250	161.850		●	
26	157.300	161.900		●	
27	157.350	161.950		●	
28	157.400	162.000		●	
60	156.025	160.625		●	
61	156.075	160.675		●	
62	156.125	160.725		●	
63	156.175	160.775		●	
64	156.225	160.825		●	
65	156.275	160.875		●	
66	156.325	160.925		●	
67	156.375	156.375	●		

68	156.425	156.425	●		
69	156.475	156.475	●		
70	156.525	156.525	●		Exclusively used for DSC
71	156.575	156.575	●		Fixed at 1W
72	156.625	156.625	●		Fixed at 1W Ship to Ship Communication
73	156.675	156.675	●		
74	156.725	156.725	●		Fixed at 1W
75	156.775	156.775	●		Fixed at 1W
76	156.825	156.825	●		Fixed at 1W
77	156.875	156.875	●		Fixed at 1W Ship to Ship Communication
78	156.925	161.525		●	
79	156.975	161.575		●	
80	157.025	161.625		●	
81	157.075	161.675		●	
82	157.125	161.725		●	
83	157.175	161.775		●	
84	157.225	161.825		●	
85	157.275	161.875		●	
86	157.325	161.925		●	
87	157.375	157.375	●		
88	157.425	157.425	●		

Note:　CH87and CH88 receiving frequency used for the previous purpose (161.975Mhz and 162.025MHz）were assigned for the exclusive use in AIS.

7-4-5 Weather Channel (FCC Rule 47CER80.371(c) and 80.373(f))

CH	RX (MHz)	Remarks
WX1	162.550	NOAA Weather Channel
WX2	162.400	NOAA Weather Channel
WX3	162.475	NOAA Weather Channel
WX4	162.425	NOAA Weather Channel
WX5	162.450	NOAA Weather Channel
WX6	162.500	NOAA Weather Channel
WX7	162.525	NOAA Weather Channel
WX8	161.650	CANADA CMB Service
WX9	161.775	CANADA CMB Service
WX0	163.275	NOAA Weather Channel(only assignment)

8. INMARSAT System

8-1 Background of INMARSAT

INMARSAT was first established as the International Maritime Satellite Organization. The process was began with the study of introduction of satellite communication technology by IMO (International Maritime Organization) as substitution of the maritime telecommunication which was mainly dependent on short-wave radio communication so that it may aim at development of the means of communication for maritime and quality of maritime telecommunication. As a result of the study by IMO, the intergovernmental meeting was held in 1971 in response to the guideline "it is appropriate that every country in the world uses a single maritime satellite system together", and the "Treaty on INMARSAT" and the "INMARSAT Operation Agreement" were adopted in 1976. The INMARSAT headquarters was founded in British London and the full-scale maritime satellite communication service has started since 1982.

After that, INMARSAT revised the treaty, in order to open a Space portion subsequently to a Land Mobile Communication, Aviation and, and it changed the name into the IIMSO (International Mobile Satellite Organization.

Along with the trend of privatization of the communication in each country in the latter part of 1990's, a study on privatization was made aiming at efficient management of INMARSAT and at raising funds for next-generation satellite system etc. As a result of the study made for several years, an agreement was made as follows. (1) Operating department is separated from INMARSAT and only a supervisor function (Plenary meeting, secretariat) as an International mobile satellite Organization is left. (2) The operation department is placed under control of a commercial company which is newly established. After revising the treaty, Inmarsat was formally shifted to the private management company from the international organization in April, 1999.

Privatized INMARSAT, in order to realize flexible financing, was aimed at IPO (Initial Public Offering) within two years after privatization, but IPO continued to be unrealizable because the satellite company which was planning new entry into iridium, etc. failed in administrating and because stock quotations hovered around in those days. Under such a situation, Apax and Permira, which were Europe leading private equity fund companies, purchased the INMARSAT's stocks in December, 2003 and got a majority of stocks of he holding company group (four companies, such as Inmarsat Group Holding Ltd) newly established and became the largest stockholders.

8-2 INMARSAT System

INMARSAT offers the communication service between land and mobile earth stations using the geostationary satellite on the equator. At first, although its service was given with the analog system called INMARSAT A, the various digital systems have been introduced accordingly to date. Regarding targets of mobile earth stations, the offer range have been expanded not only to ships, but to an airplanes, land mobile stations , in addition to these, and portable type system which people can carry about. In respect of service, data communication has been introduced in addition to telephone and FAX, and data transfer speed was developed to 64kbps/ 128kbps from 9.6kbps and Internet access system as always-on connection of the packet mode service which uses IP communication as the base has been also newly introduced .

The general idea of the INMARSAT network is shown in Fig. 1. A telecommunication link is set up between a mobile earth station and a land earth station through satellites. A land earth station transmits and receives signals of telephone, FAX and data, etc. through land telecommunication system. C band frequency range (uplink 6GHz/downlink 4GHz) is used for feedering (link between land earth station and satellites) like other satellite systems, and for the service link (link between satellite and mobile earth stations), L band (uplink 1.6GHz /downlink 1.5GHz), which is suitable for mobile communication because of not being much affected by rain, is used. Moreover, for telecommunication of division methods, signals for telephone are multiplexed using FDM/FDMA (Frequency Division Multiplexing/Frequency Division Multiple Access) method and signals for data are multiplexed using TDM/TDMA (Time Division Multiplexing/Time Division Multiple Access) method. And, by introduction of spot beam system*, while realization of high-density of electric power transmitted from satellites was realized (miniaturization of mobile station terminal) and frequency between spot beams is reused (increase in the number of usable links).

* A beam of satellite, which covers the earth surface of which holizontal line can be seen from a satellite, is called a global beam. On the other hand, a narrow beam, which irradiates a part of earths, is called a spot beam and therefore, high powerful irradiation is realized compared with a global beam.

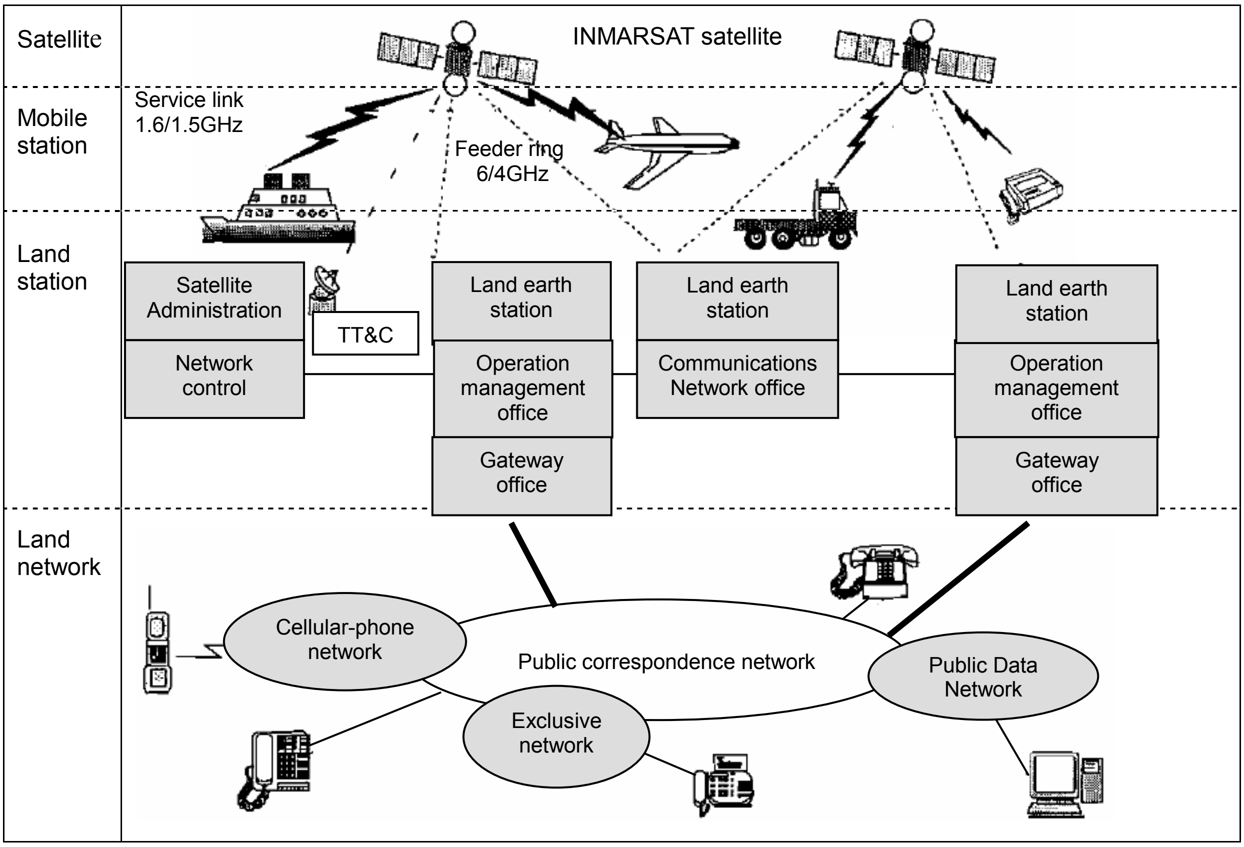


Fig. 1　INMARSAT Network

8-3　INMARSAT Satellite

As a satellite which INMARSAT uses, at first, ARISAT satellite was used, and then MARIX satellites were launched in 1981, and the 2nd generation satellite for the own use of INMARSAT was arranged over the Indian Ocean in 1990, and the INMARSAT telecommunication got into stride.

The characteristics etc. relating to the several types of INMARSAT satellites were compared in table 1.2. Although satellites up to the 2nd generation satellite (I-2) had only a global beam, in the 3rd generation satellite (I-3) launched one by one from 1996, seven spot beams were installed and it contributed to miniaturization of terminals and development of communicative advanced features. Moreover, the 4th generation satellite (I-4) launched in 2005 has the function which can generate the various beams of a maximum of 256 in the service link. That is, it has three kinds of irradiation beams of one global beam, 19 wide spot beams and 200 or more narrow spot beams other than the beam for control of a satellite as a beam for users. A global beam and wide spot beams are used for the existing service except INMARSAT A, and the BGAN (Broadband Global Area Network) service, in which the packet communication of a maximum of 492 kbps is possible, is offered using narrow spot beams. Furthermore, in the 4th generation satellite, since reuse of the service link frequency band (L band) by a narrow spot beam is performed, compared with the feedering frequency bandwidth (C band) of the 3rd generation satellite, and since a bandwidth (30MHz -150MHz) is equivalently about 5 times width of C band, the capability of a satellite system is markedly upgraded.　As both the clockwise rotation round polarization　and reverse polarization are utilized, it has the no less than 300MHz band width in total.

At the time of launching of the 4th generation satellite, it weighs about 6 ton. Its length including solar battery panel is no less than 48m and it is the largest class satellite in the world.
Secondly, deployment of the INMARSAT satellites is described. INMARSAT satellite

telecommunication system is a communication system using the geostationary satellites on the geostationary orbit in the equatorial space of 36000 km high above sea level. Since the whole earth was mostly covered by arranging three satellites at equal intervals on an orbit theoretically, INMARSAT was also the system which used three satellites at the beginning. However, since three satellite's position was not equally spaced in the space because of the positions of Land Earth Stations of each country, dead spaces of telecommunication existed in a portion of Pacific Ocean and in a portion of Atlantic Ocean. Then, for effective use of the reserve satellites launched on the orbit in the time of the 2nd generation satellite, and for dispersion of communication channels, the Atlantic Ocean Western Region Satellite was launched in order to complement the communication dead spaces as mentioned above. Finally, the 4 Ocean Space Satellite System was established.

Furthermore, the old system was developed to the today's high reliability system deploying the reserve satellites which stay in the vicinity of each main operative satellite individually.
hen, from the position of effective use of the administrative resources needed by privatization, the reserve satellite were moved to the position (about 40-degree interval between two satellites) at which enables reuse of frequency between the present satellite in operation and reserve satellites and reserve satellites are utilized for link lease service. Now 11 satellites are always in operation in the sum total of the main satellites and the reserve satellites including two sets of I-4 satellite. Moreover, the contingency plan (for emergency operation) was prepared in operation of the satellite telecommunication system and it is applied in each case of satellite failure.

Table 1 Comparison of Satellite

	INMARSAT the 2nd Generation Satellite	INMARSAT the 3rd Generation Satellite	INMARSAT the 4th Generation Satellite
The number of satellites	4	4+1 Reserve	3
The number of beams	Global beam	Wide spot beam + global beam	200 narrow spot + 19 wide spot + Global beam
Maximum EIRP	39dBW	49dBW	67dBW
Frequency band (Service link) (Feeder link)	 1530.0-1548.0/1626.5-1649.5 3600.0-3623.0/6425.0-6443.0	 1530.0-1559.0/626.5-1649.5 3600.0-3629.0/6425.0-6454.0	 1530.0-1559.0/1626.5-1660.5 3600.0-3700.0/6425.0-6575.0
Overall length	14.5m	20.7m	45.0m
Weight (dry mass)	700kg	1000kg	3000kg
Weights at Launching	1500kg	2050kg	6000kg
Life time Designed	10 years	13 years	10 years

8-4 Terminal of INMARSAT System

The system took over from MARISAT was called INMARSAT A, and then INMARSAT B, C and D in alphabetic order was named every time system was developed. The system has been developed from Analog to Digital, and it is now following the way of miniaturization and improvement in the speed. The outline of INMARSAT systems is described below.

(1) INMARSAT A system

"INMARSAT A " system was operated in supplying maritime telecommunication service for a long life of 20 years since the system service was started in 1982. It can supply FAX and data communication besides telephone and telex. The modulation method used in space uses the narrow band FM analog modulation for telephone link. "INMARSAT A " service was brought to an end on and after December 31, 2007, from a viewpoint of effective use of frequencies for satellite system and repair part supply.

(2) INMARSAT B system

"INMARSAT B" system was introduced as a succeeding system of "INMARSAT A " in order to resolve the problem of increase in Maritime satellite telecommunication traffic. Voice signal and the whole communication channels were digitized and band became the narrower than "INMARSAT A". In "INMARSAT B" system, various services of telephone, telex, FAX of 9.6kbps, data and the high-speed data of 64kbps can be used.
INMARSAT B system was expected to end service on December 31, 2014, but it was extended for 2 years until December 31, 2016.

(3) INMARSAT M system

Digital technology was applied to it as well as "INMARSAT B" system, and the merit obtained by digitization was applied to miniaturization of a mobile earth station terminal unit. In INMARSAT M system, services of telephone, FAX of 2.4kbps and data can be used.
The INMARSAT M system has ended service on December 31, 2014.

(4) INMARSAT C system

"INMARSAT C" system was developed so that it may be installed to small vessels or long-distance transport tracks, and message communication and data communication by the so-called accumulation transfer (Store and Transfer) system are possible for it. In "INMARSAT C" system, communication between mobile terminals and telex terminals/ data terminals is possible, in addition, messages from mobile terminal can be output to a FAX terminal, and messages can be transferred to mobile terminals from land earth station simultaneously.

(5) INMARSAT mini M system

Digital technology was applied to "INMARSAT mini M" as well as "INMARSAT M/B" system, in addition to it, it was further miniaturized more than M system by using the spot beam which was utilized on and after the 3rd generation satellite of INMARSAT. By use of spot beams, It was possible to attain further reduction in antenna gain and transmission power, and the merit of using spot beams has been applied to miniaturization and lightweight of a mobile earth terminal unit. It can offer services of telephone, FAX and data transfer as well as M system, and its service is applied to IC card telephone service called credit card communication or SIM (Subscriber Identity Module).

(6) INMARSAT D+ system

This system is the smallest in the INMARSAT system and has a data terminal with a directional and hemispherical antenna. It was born as a satellite pager and can transmit the response massage to the polling signal from land. In Japan, it has been used as SSAS (Ship Security Alert System) from 2004. INMARSAT D+ system has ended service on December 31, 2014.

(7) INMARSAT F system

This system was introduced as a successor to INMARSAT A service which ended in December, 2007, and three kinds of systems, F77, F55, and F33, are working. In order of the antenna caliber, F77's is the largest, F55's is second and F33 is the smallest. .
F77 and F55 system have function of line switching type data-communications (ISDN) of 64kbps and a packet-switching type data-communications (MPDS : Mobile Packet Data Service), and have the function which was adapted for the Internet communications, such as always-connection. On the other hand, F33 has functions of line switching type data-communications of 9.6kbps.and the above-mentioned MPDS function. With the ISDN function of 128kbps added, F77 is also equipped with the functions of distress alert communication and emergency communication in

C

navigation of vessels, and has the function that , in distress or emergency, cutting communication of low priority, F77 transmits distress signals and emergency signals and surely receives distress signals and emergency signals from land.

(8) INMARSAT BGAN/Fleet Broadband system

In INMARSAT, INMARSAT BGAN service offered by the 4th generation satellite is regarded as the satellite version of the third generation mobile phone (3GUMTS:3 rd Generation Universal Mobile Telecommunications System). For interfacing in wireless communication area, the TDM/TDMA system of INMARSAT original specification, which is different form W-CDMA (Wideband-Code Division Multiple Access), is utilized. And for interfacing with land station, called core network (CN), .the system of the same specification as 3G UMITS is used.
This system was introduced as a land mobile communication system in the ends of the year of 2005, and Fleet Broadband (FB) was introduced as a marine mobile communication in November, 2008.
FB system is classified into FB500 (class 8), FB250 (class 9), and FB150 (class 14) of three types (class) according to the kind of communications service. Moreover, when using FB system, it is a different point from other INMARSAT system that a SIM card is indispensable. The available service by FB system are the telephone (4kHz AMBE+), Fax (3.1kHz Audio), UDI/RDI (ISDN 64/56kbps data) communication, Standard IP (packet communication of amount of data accounting of best effort), Streaming IP communication (packet communication of time accounting of the band guarantee type) and SMS (Short Message Service).

8-5 SSAS (Ship Security Alert System)

It aims at notifying of the Competent Authorities of SOLAS Convention Contracting Governments and management companies, without being noticed by anyone, when a vessel is attacked by armed groups, such as terrorists and pirates, or when danger is drawing near.
SSAS is required by SOLAS chapter XI-1/XI-2 and International Code for the Security of Ships and of Port Facilities (ISPS code).

(1) Ships to be installed with equipment as scheduled below

Object vessel			At the time of Construction	Until first radio inspection on and after July 1, 2004	Until first radio inspection on and after July 1, 2006
Voyage	New Construction or Existing Ship	Ship type			
International voyage	Construction on and after July 1, 2004	1. passenger ships(including high-speed passenger craft) .2 cargo ships, (including high-speed craft) of 500 G/T and upwards .3 Mobile offshore drilling units; and .4 Port facilities serving such ships engaged on international voyages.		•	
	Construction before July 1, 2004	passenger ships(including high-speed passenger craft)			
		The following cargo boat of 500 G/T and upwards Oil/chemical tanker Gas/bulk carrier High-speed cargo Ship			
		The following cargo boat of 500 GT and upwards Mobile offshore drilling units Port facilities serving such ships engaged on international voyages.	•		
Non-international voyage	Constructed on and after July 1, 2004		Installation: not required		
	Constructed before July 1, 2004		Installation: not required		

(2) Requirements for equipment

- Power supply
  Supplied by main power supply inboard and also inboard alternative power supply.
- Alerting place
  There need to be at least two alert places. One should be on Bridge.
- Operation
  Adjustments for Alert equipment (tuning, change in the mode, etc.) is not needed.
  Any inboard alarms should not happen.
- Transmitting system
  Vessel identification ID and ship's position are included in signal transmitted.
  It is transmitted to shore stations.

(3) Installation guidance (MSC/Circ.1072)

MSC/Circ.1072 (Guidance on Provision of Ship Security Alert System) was adopted by IMO (International Maritime Organization in May, 2003 as follows.

- Alert is able to be transmitted from ship, without being noticed by anyone onboard.
- Transmission method is possible to choose freely.
- The means and equipment, which sends alerts, should be based on the following method.
  .1 Method of using tracking system provided by existing Vessel Surveillance system by Satellite Communications.
  .2 Method of using GMDSS equipment etc. (by equipment newly being installed or by modification of existing equipment).
  .3 Method of exchanging messages including "Keyword" between the vessel and the company side by using satellite communication services.

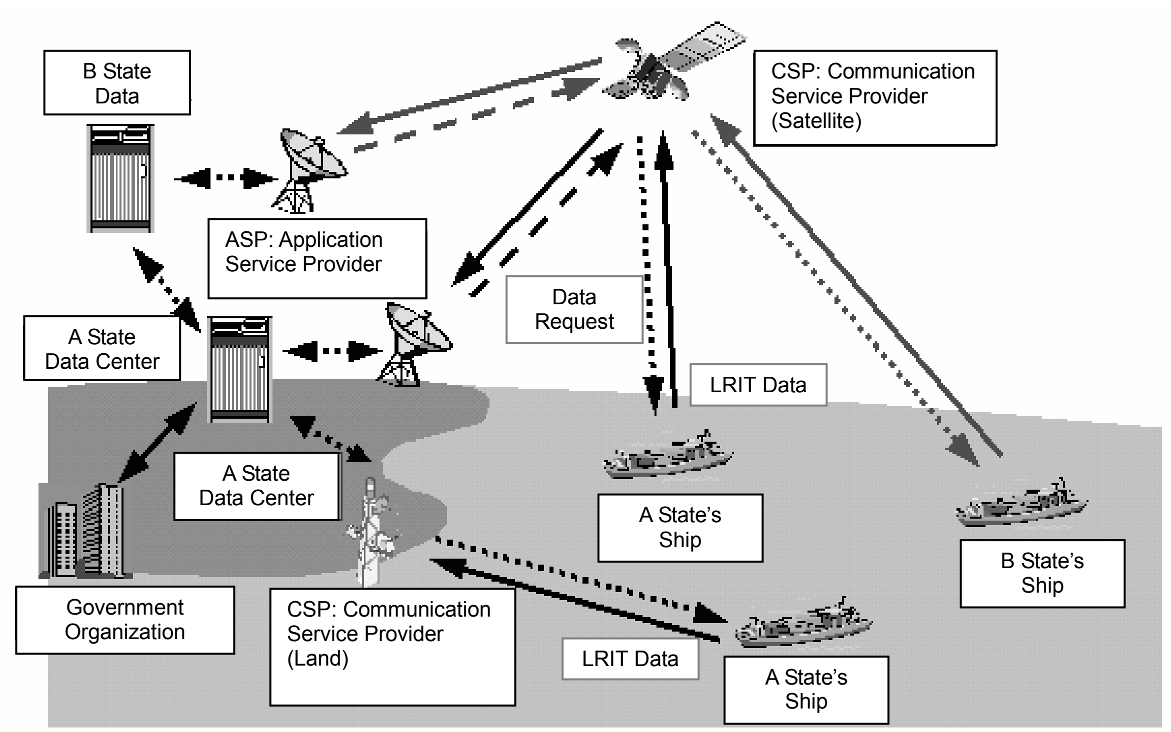
8-6 LRIT (Long Range Identification and Tracking)

Long-Range Identification and Tracking (LRIT) system provides for the global identification and tracking of ships.

- LRIT system is mandatory required by IMO.
- The system transmits the individual information belonging to each vessel (Ship's Communication ID, Ship's position) periodically from Inmarsat-C equipment or other communication equipment onboard a vessel. Transmission interval can be changed by a remote control signal from a Land station.
- installation is required on the following ships
  - .1 passenger ships, including high-speed passenger craft;
  - .2 cargo ships, including high-speed craft, of 300 GT and upwards; and
  - .3 mobile offshore drilling units.
- **to be installed until the first radio survey on and after December 31, 2008.**

(1) LRIT system

LRIT system is an architecture as shown in the figure below. LRIT information on each ship to fly the flag of each Contracting State is managed by the Data Center of each Contracting State. The LRIT information on each ship to fly the flag of another Contracting State is obtained by requesting the Data Center of another Contracting State to send it .



(2) Installation requirements for LRIT

Requirement was added to SOLAS V by MSC.202(81).

(3) This regulation shall apply to the following types of ships engaged on international voyages.

.1 passenger ships, including high-speed passenger craft;

.2 cargo ships, including high-speed craft, of 300 gross tonnage3 and upwards; and

.3 mobile offshore drilling units

(4) Requirement SOLAS V 19-1 regulation

Ships shall be fitted with a system to automatically transmit the information specified in SOLAS as follows:

.1 ships constructed on or after 31 December 2008;

.2 ships constructed before 31 December 2008 and certified for operations:

- in sea areas A1 and A2
- in sea areas Al, A2 and A3,

not later than the first survey of the radio installation after 31 December 2008;

.3 ships constructed before 31 December 2008 and certified for operations in sea areas Al, A2, A3 and A4, not later than the first survey of the radio installation after 1 July 2009. However, these ships shall comply with the provisions of subparagraph .2 above whilst they operate within sea areas A1, A2 and A3.

.4 Ships, irrespective of the date of construction, fitted with AIS unit , and operated exclusively within sea area A1, shall not be required to comply with the provisions of this regulation

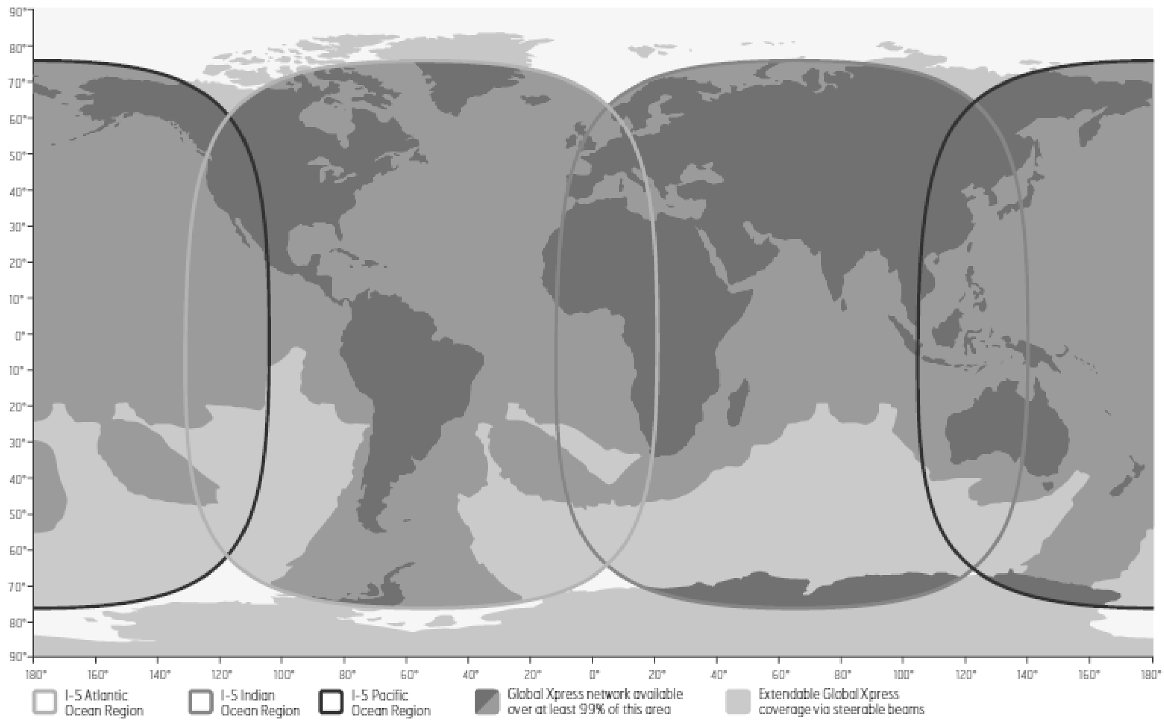
(5) Requirements for LRIT terminal

Required by MSC.210(81), MSC.254(83) and MSC.242(83)
- Transmit LRIT information automatically every 6 hours.
- transmitting interval (from 15 minutes to 6 hours) is possible to change by remote control from land.
- Transmit LRIT information by polling.

8-7 INMARSAT GX (Inmarsat Global Xpress)

INMARSAT is planning to provide the service using Ka band (up-link 30GHz band / down-link 20GHz band) in the first half of 2015 in order to respond to the demand for marine high speed communication.
- Whole-world service except Polar Regions by three sets of 5th generation of INMARSAT satellites.
- The use in Ka band where a broadband frequency is available to cope with high speed communication.
- The use of INMARSAT Fleet Broadband which is using as backup L band which is not affected by the influence of rain because Ka band has large rain attenuation.

The coverage planned at present is shown below.



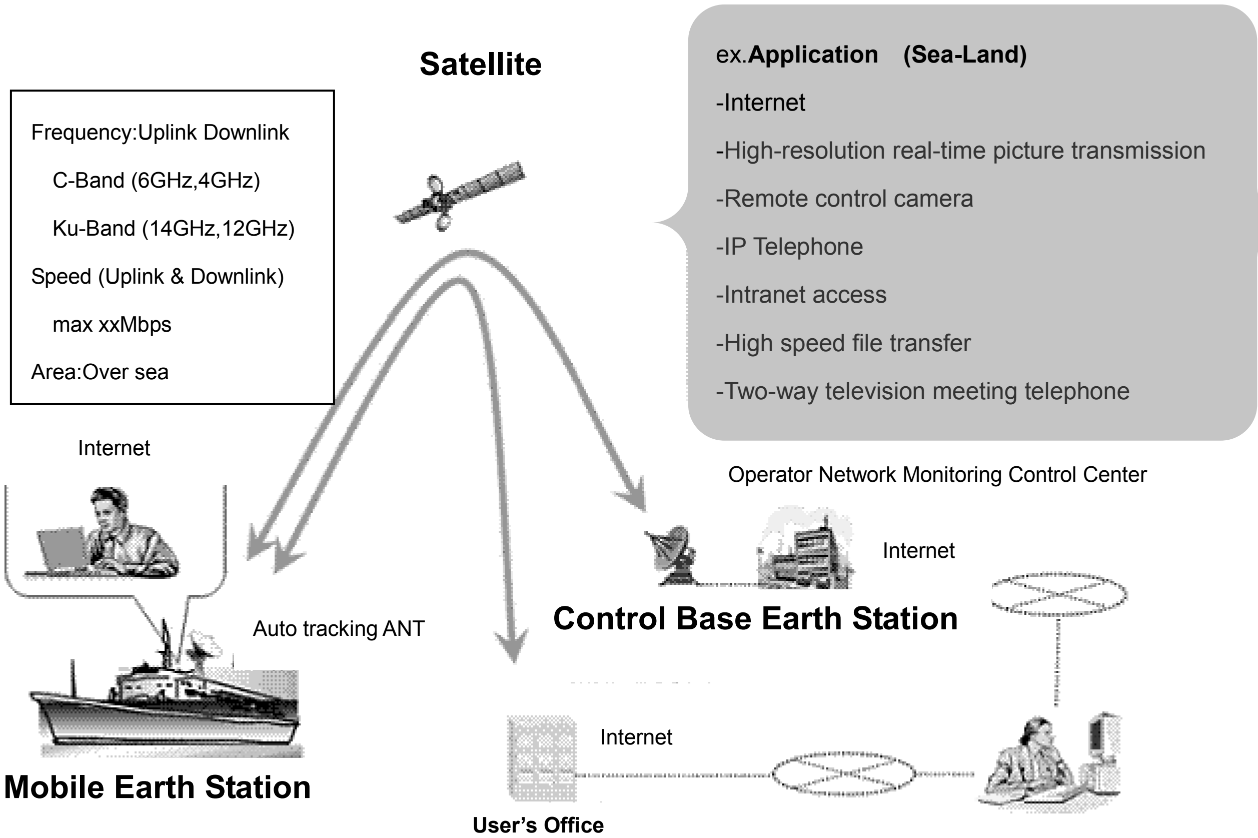
Source of reference:
http://www.inmarsat.com/wp-content/uploads/2014/06/Global-Xpress-introduction-June-2014.pdf

9. ESV (Earth Station on Board Vessel)

9-1. Outline

In World Radiocommunication Conference (WRC-03) held in June, 2003 based on rise of worldwide demand for the high speed data communication and large volume communication in the marine field , it was deliberated about the Ship Earth Station (ESV: Earth Stations on board Vessels) by which the high speed communication and large volume communication are possible at the sea. And the ESV system which used the space station of the fixed satellite services of C band or Ku band (artificial satellite) was introduced.
(C band: up-link 6GHz band / down-link 4GHz band, Ku band: up-link 14GHz band / down-link 12GHz band)

9-2. System Configuration

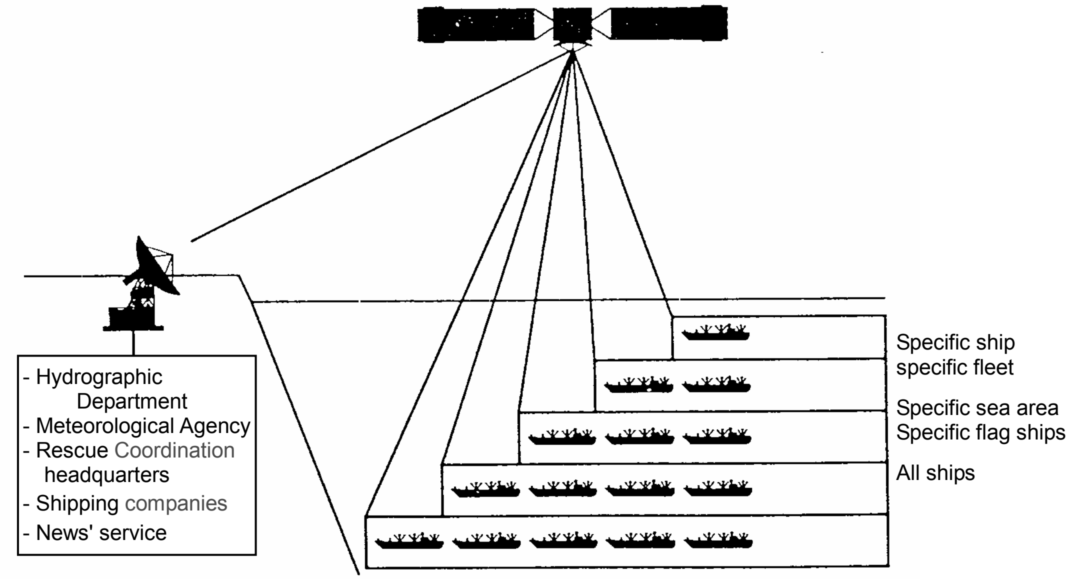


http://www.tele.soumu.go.jp/j/adm/system/satellit/move/index.htm#4000384

10. EGC (Enhanced Group Call)

10-1 Outline

- EGC is the one-way broadcasting function to send messages to the ships of the specific group from land using the INMARSAT C communications system.



- In EGC, when its function is synchronizing with COMMON CHANNEL of NCS (NETWORK COODINATING STATION) of INMARSAT in the sea area around there, in the condition of being ready for receiving, the following two services are applicable.

10-2 Safety-NET Service

This service is offered free of charge by broadcasting from the information supply organizations such as the Maritime Safety Department and the Meteorological Agency approved by IMO as shown below.

A: Cruise alarm (Hydrographic Organization)
B: A weather warning, a forecast (Meteorological organization)
C: Distress information for Land -> Ships, other emergency information (RCC)
D: Rebroadcast of NAVTEX
E: Drifting ice alarm (ICE PATROL)

10-3 Fleet-NET Service

This is a commercial broadcasting service for members. Shipping companies and data providers permitted by the government, contract with CES and they broadcast to SES of the specific groups. It is expected that service will be expanded by companies other than CIGNATRY of INMARSAT from now on.
In the most case, members are charged. The contents is as follows.

A: Simultaneous broadcasting to all shipping companies B: News, amusement broadcast C: correction information on electronic chart, weather information D: Commodity market E: Simultaneous broadcast to all the flag ships

In the case of broadcasting with charge, each ship shall make a contract with information provider and pay registration fee to the provider.

- Registration and cancellation of GROUP ID
  Data provider write the Group ID in the EGC receiving devices in ships via CES using the peculiar identification number (UNIQUE ID, FORWARD ID.) assigned to EGC or INMARSAT C.
  Once the Group ID is set into the EGC receiving device, it is reserved in the EGC receiving device until it is overwritten by next input and is canceled again or it is re-set up.
  Each ship can be registered to two or more information providers.

- In order to receive the broadcast for each sea area correctly, it is desirable to interface the device with any of proper navigational equipment, and to update own ship's position automatically with the data obtained from the navigational equipment.

10-4 Fleet-NET Service: Revised Performance Standards for EGC Equipment (July 1, 2012)

The revised performance standards to be replaced with the present performance standards (A. 664 (16)) of Enhanced Group Calling (EGC) in IMO Maritime Safety Committee having been held in May, 2010 (MSC.87) is adopted, and it is applied from July 1, 2012. (Resolution MSC.306 (87)).

The added requirements for performance

1) The equipment should provide a visual indication that the ship's position has not been updated during the last 12 h.
2) A local audible alarm should be sounded to give advanced warning of the printing device "paper low" condition.
3) It should not be possible to confuse the sound of the "paper low" alarm with that of the distress or urgency alarm caused by the reception of a distress or urgency priority message.
4) Means should be provided to enter the NAVAREA/METAREA code.

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11. Satellite EPIRB

(Emergency Position Indicating Radio Beacon)

11-1 Comparison with Conventional Distress transmitting Equipment

- The portable radio apparatus (for lifeboat) which transmits 500 kHz, 8364 kHz, or 2182 kHz and VHF EPIRB of 121.5MHz, and 243MHz are used to be used as a means of communication at the time of distress. However, since there were such faults that mastery is needed in operation and the range is short, the still more reliable distress alert transmitting and receiving system was required.

	Frequency	Receiving station	Position check	Power supply	Operation
Life boat Radio	500,2182 8364kHz	Land station Ship station	Low accuracy Low probability	generator operated by hand	Skill required (Antenna)
EPIRB	406.025 406.028 406.037 121.5MHz	COSPAS/ SARSAT satellite	About 5km 98% of probability	Lithium battery Valid life: five years	Operated Automatically / by manual Easily

Comparison of distress alert transmitting device

11-2 Outline of System

- It is required to be installed on ships over 300 GT engaged on all international voyages on and after August 1, 1993.
- It accesses polar orbiting satellites (COSPAS/SARSAT) in 406.025 MHz, 406.028MHz, and 406.037MHz, and by using distress transmitting device, country code, ID, type of beacon and its position of a wrecked ship, are transmitted to shore stations. At the shore station, the information can be confirmed.
- There are two types, one is a floating type which is automatically released before reaching a depth of 4 m at sea from float-free mounting, and the other has not automatically-release mechanism. EPIRB itself is floatable.
- For homing the wrecked ship, 121.5 kHz can be initiated simultaneously.
  Processing of the 121.5MHz homing signal by a satellite is stopped on and after February 1, 2009.
- Tow types, such as 406MHz EPIRB and 1.5GHz L band EPIRB using satellites, have been used, but 1.5GHz L band EPIRB operation was terminated on and after December 1, 2006.
  406MHz EPIRB is still in accordance with requirements of GMDSS and 1.5GHz L band EPIRB was also in accordance with requirements of GMDSS.

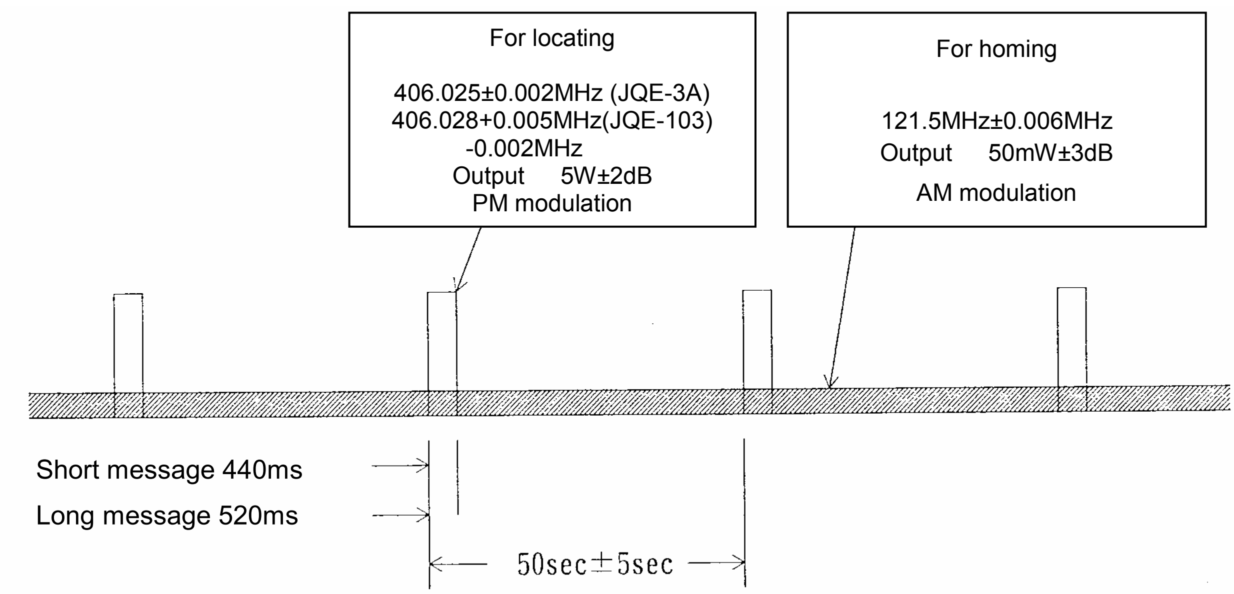
	Coverage	Satellite	Access	Frequency	Position information
406 MHz band	All over the world	COSPAS/SARSAT Polar orbiting	Only visible range maximum waiting time : 110 minutes	406.025MHz 406.028MHz 406.037MHz (high stability needed)	Calculated at shore station etc.
L band	Except two poles	Geostationary INMARSAT	Immediately	1.6GHz	Transmitted from a ship.

Comparison between 406M EPIRB and L band EPIRB

11-3 System (COSPAS/SARSAT Satellites) on Land and in Space

- The SARSAT system by US, Canada and French and the COSPAS system of Russia started to operate together as the global system for the position finding of a plane in the accident at the time of the airplane accident in 1982. Then IMO accepted the usability of it and put it into operation from July, 1998
- At the first stage, The Cospas-Sarsat Low-altitude Earth Orbit System for Search and Rescue (LEOSAR) orbiting at the height of 1,000km above the ground were used.
  From 1996, the Geostationary Orbit Satellite Search and Rescue system (GEOSAR) of which satellites stay on the equator about 36,000km above ground was also established.
  In 2005, Medium-Altitude Earth Orbit Navigation Satellite Systems (MEOSAR) which goes around the earth about 20,000km above the ground started to be developed.
  AS of July, 2006, seven(7) LEOSAR(s) (Low-Altitude Earth-Orbit Satellite: SARSAT satellite : five satellites , COSPAS satellite : 2 satellites), and five(5) GEOSAR(s) (Geostationary Orbit Satellite) are in operation for COSPAS/SARSAT service. 75 satellites of MEOSAR were to be launched in due order from 2005, but MEOSAR system is still under test.
- LUT (Local User Terminal) : receive the electric wave from satellites.
  The data relayed from a satellite is received at LUT, the position of a wrecked ship is calculated based on the orbital data of the satellite from MCC, and it is sent to MCC.
  The following LUT exists for each Satellite System used.
  LEOLUT (for Low-Altitude Earth-Orbit Satellite System)
  GEOLUT (for Geostationary Orbit Satellite System)
  MEOLUT (for Medium-Altitude Earth Orbit Navigation Satellite System)
- MCC (Mission Control Center) : distribute data.
  One LUT of the area or a country deals with the function of MCC, and controls distress alerts and orbital demand data to all the LUT(s). It requests Rescue activities of RCC.
- RCC (Rescue Coordination Center) : coordinate rescue activities.

11-4 Composition of Transmission Signal (Refer to ITU-R Rec.M.633 for further details)

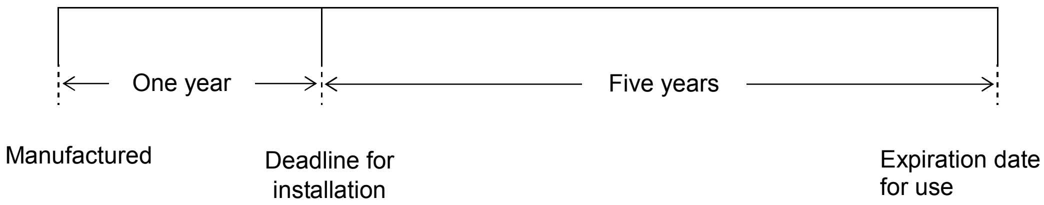


- From equipment onboard ships, transmit the identification signal (there are three kinds) of the vessel which is digitally coded in the form of a burst as mentioned above. In the LEOSAR satellite, in order to calculate a position from which was initiated by measuring the doppler shifts of a signal, very high short-term frequency stability is needed.

- The following information is inputted into the 406MHz beacon.
  (1) MMSI : It consists of nine-digit number, and the first 3 digit numbers means the ships name, the 6 remaining digit numbers means ship's identification number (0-9) which the Competent Authority of the flag state designate. (refer to APPENDIX 43 of R.R. for further details)
  (2) RADIO CALL SIGN : Call sign assigned to the vessel
  (3) SERIALIZED ID : So to speak, it is the serial number of EPIRB, and when EPIRB is installed in a vessel, it is registered with the database of MCC.

11-5 Maintenance

- When the nationality of a ship is changed, it is necessary to rewrite the identification number currently written in ROM in EPIRB. Proper device is needed for wrting. (Refer to B-44 pages)
- lithium battery JQE-3A is 11.2VDC. Installation deadline and expiration date for use is as follows below.
- lithium battery JQE103 is 8.4VDC. Installation deadline and expiration date for use is as follows below.

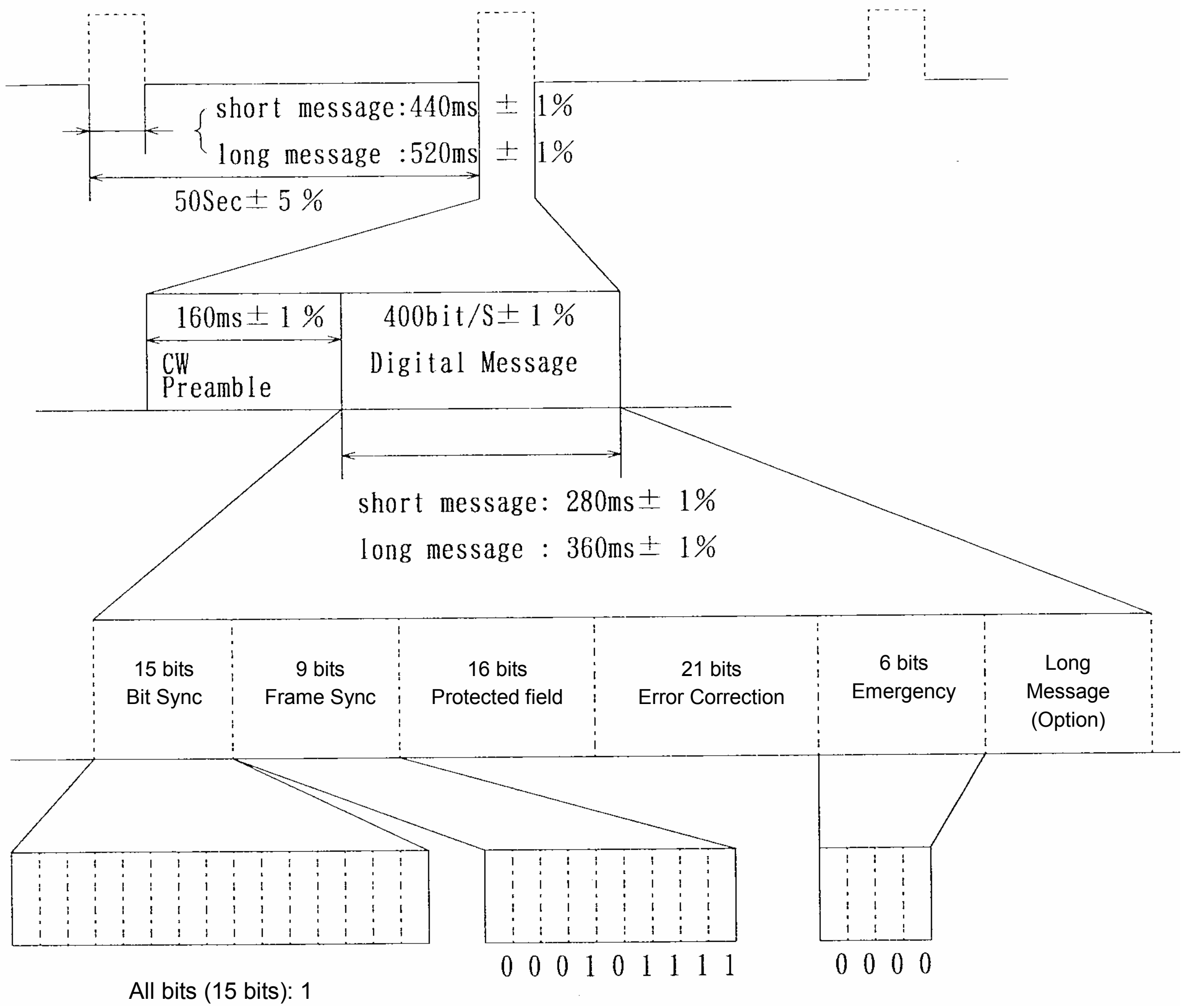


11-6 Installation place

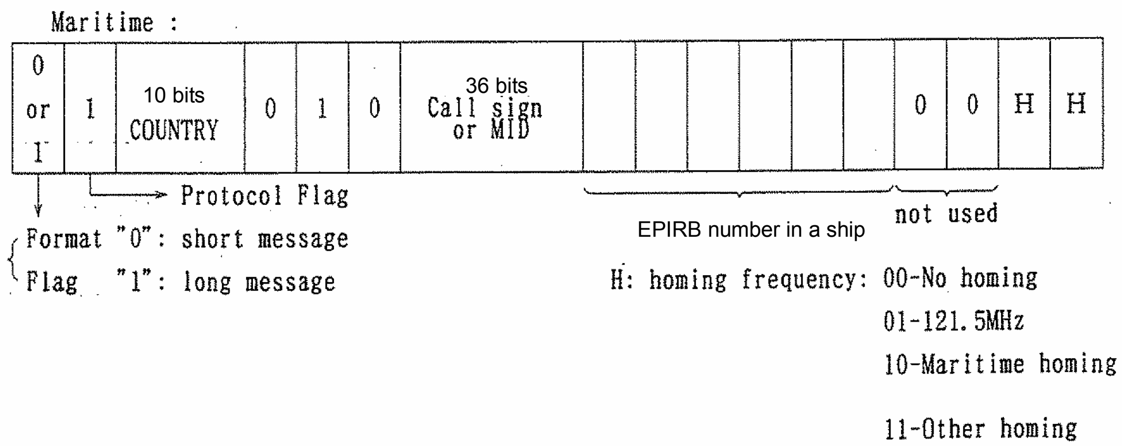
A search and rescue locating device shall be stowed in such protected and easily accessible location that they can be rapidly carried by one person into a survival craft In case of emergency. (83 SOLAS III Regulation 6)
It shall be usually stowed in one of two wings which is as open around there as possible, or on compass deck which is as open around there as possible. But such a place is located only near a staircase in order to easily carry the locating device into a survival craft.

11-7 EPIRB ITU-R Coding

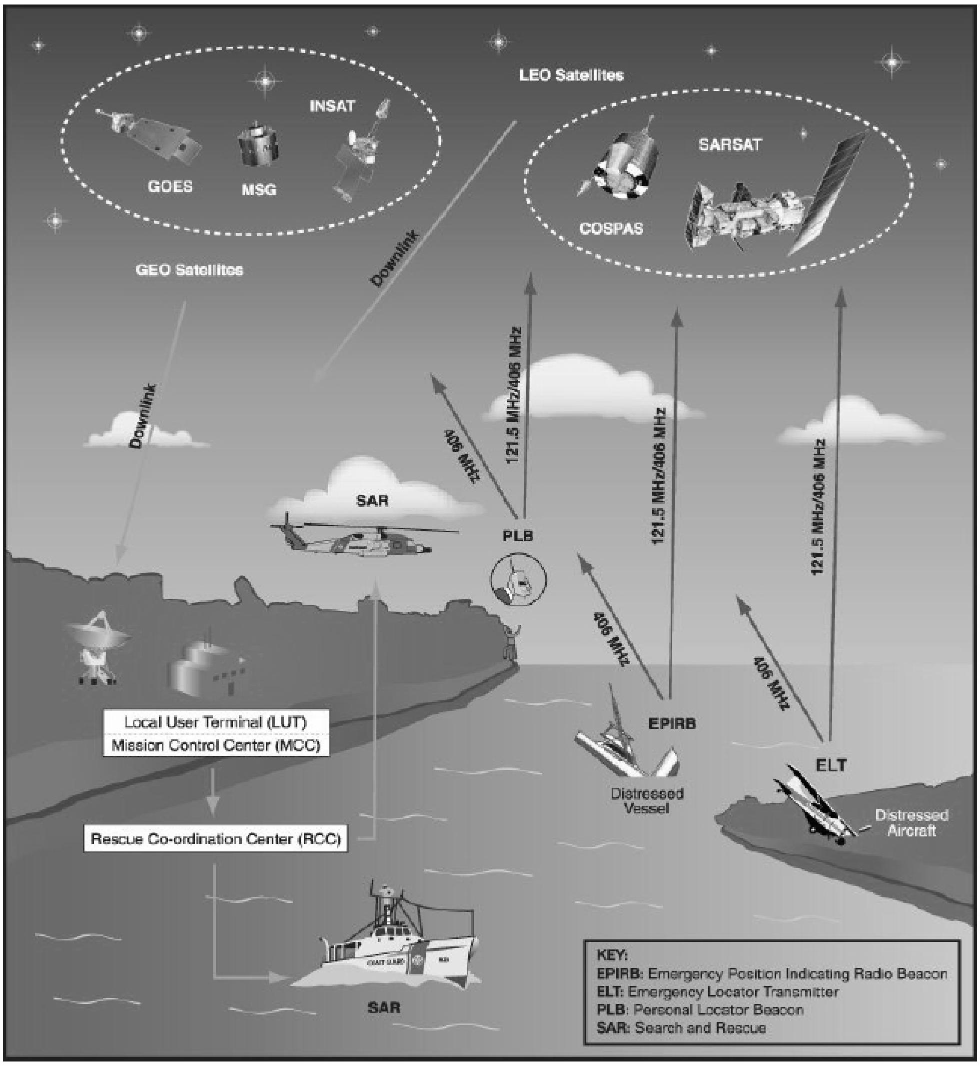
(1) Outline of transmission signal structure



(2) Protection field



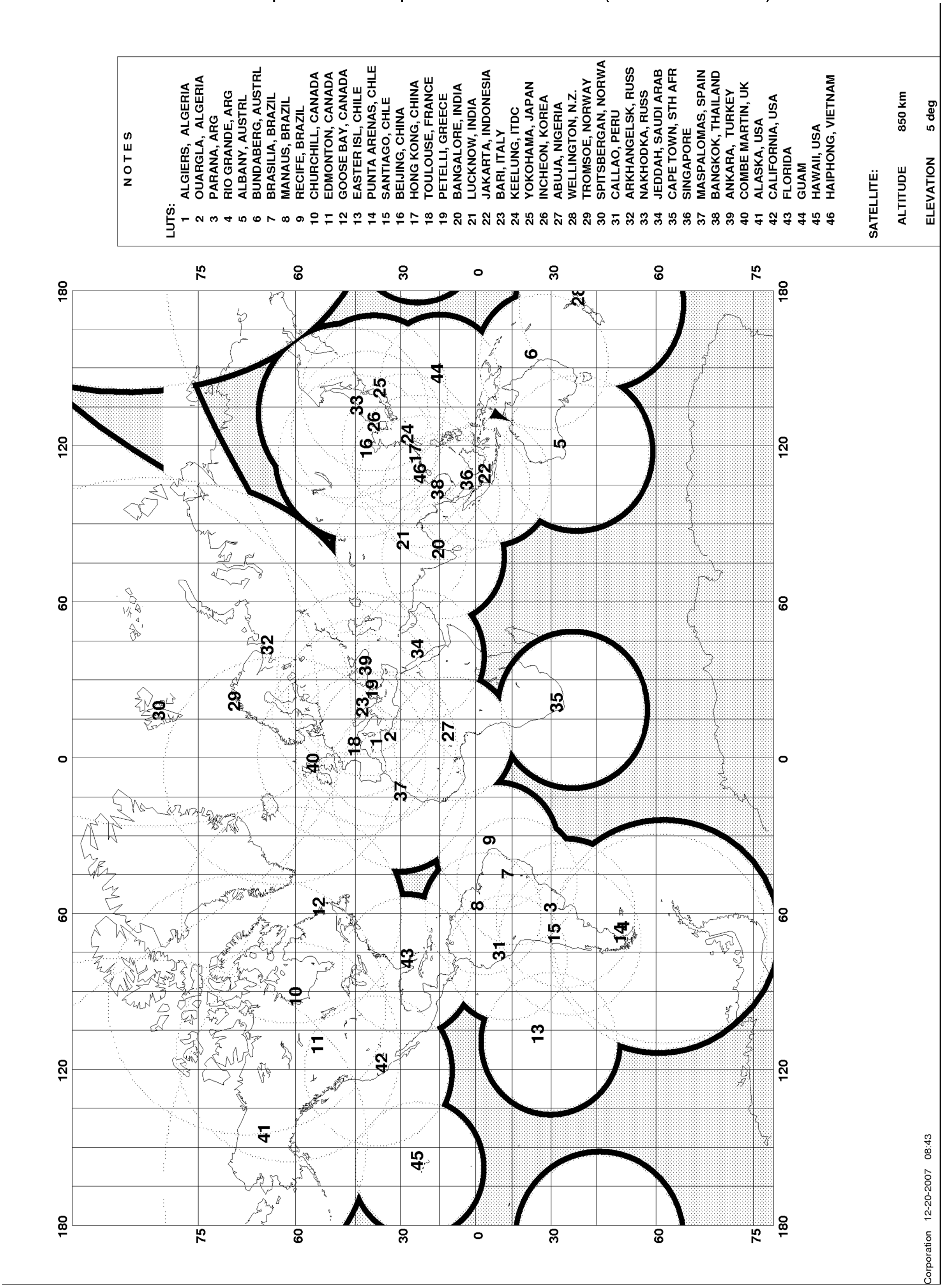
C



Notes:

COSPAS	Space system for the search of vessels in distress (Russia)	MSG	Meteosat second generation satellite (EUMETSAT)
GOES	Geostationary operational environmental satellite (USA)	SARSAT	Search and rescue satellite-aided tracking system
INSAT	Indian geostationary satellite		
GEOLUT	Local user terminal in a GEOSAR system	GEOSAR	Geostationary satellite system for SAR
LEOLUT	Local user terminal in a LEOSAR system	LEOSAR	Low Earth Orbit satellite system for SAR

Satellite-Visible Area of Cospas-Sarsat Operational LEOLUTs (December 2007)



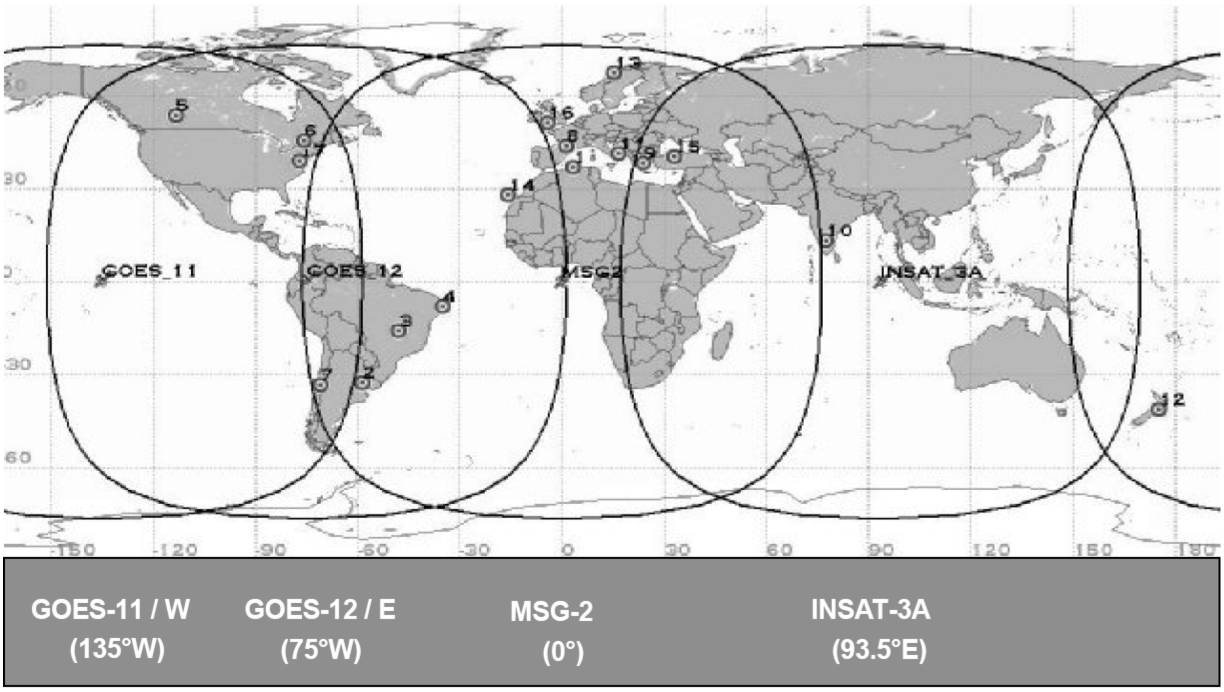
C

GEOSAR Ground Segment Status (December 2007)

Country	GEOLUT Name	Number on Map (Figure 5)	Geostationary Satellite	GEOLUT Status
Algeria	Algiers	1	MSG-2	In operation, commissioned
Argentina	Ezeiza	2	GOES-East	In operation, commissioned
Brazil	Brasilia	3	GOES-East	In operation, commissioned
	Recife	4	GOES-East	In operation, commissioned
Canada	Edmonton	5	GOES-West	In operation, commissioned
	Ottawa	6	GOES-East	In operation, commissioned
Chile	Santiago	7	GOES-East	In operation, commissioned
France	Toulouse	8	MSG-2	In operation, commissioned
Greece	Pentelli	9	MSG-2	In operation, commissioned
India	Bangalore	10	INSAT-3A	In operation (see Note below)
Italy	Bari	11	MSG-2	In operation, commissioned
New Zealand	Wellington (1)	12	GOES-West	In operation, commissioned
	Wellington (2)		GOES-West	In operation, commissioned
Norway	Fauske	13	MSG-2	In operation, commissioned
Spain	Maspalomas (1)	14	GOES-East	In operation, commissioned
	Maspalomas (2)		MSG-2	In operation, commissioned
Turkey	Ankara	15	MSG-2	In operation, commissioned
UK	Combe Martin	16	MSG-2 GOES-East	In operation, commissioned; Used as standby satellite when needed
USA	Maryland (1)	17	GOES-East	In operation, commissioned
	Maryland (2)		GOES-West	In operation, commissioned

Note: GEOLUT has not been commissioned, however, alert data is used operationally.

406 MHz GEOSAR Satellite Coverage and GEOLUTs(December 2007)



406 MHz GEOSAR Satellite Coverage and GEOLUTs (December 2007)

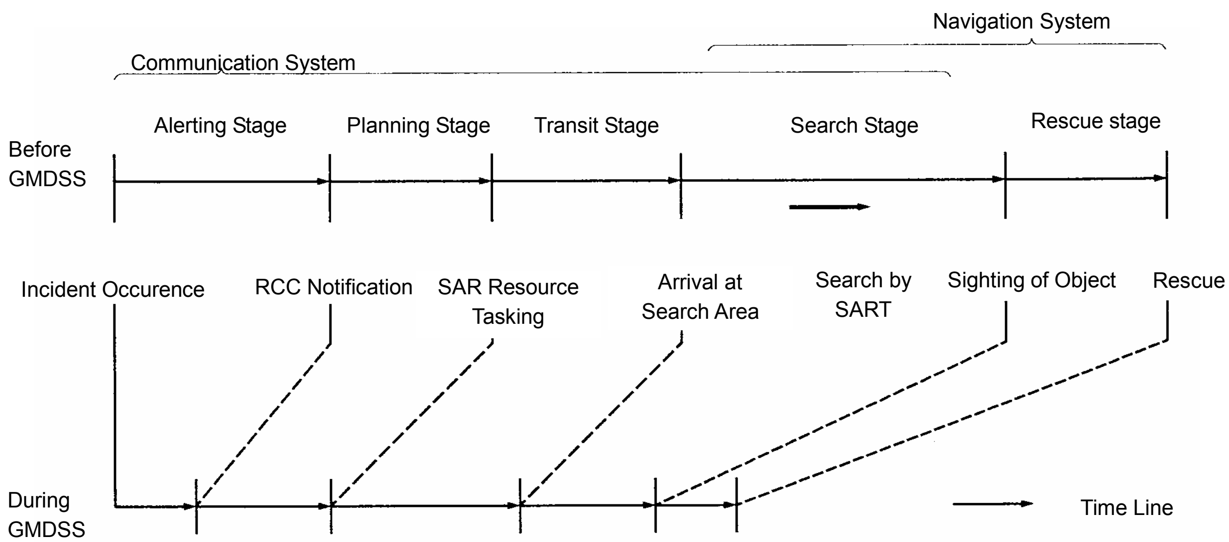
12. SART (Search & Rescue Radar Transponder)

As for maritime distress, although the various kinds of methods, such as SOS alerting by radiotelegraphy, radiophone, the emergency radio equipment, or EPIRB, etc. has been applied to distress informing, any of methods above cannot become ideal ones.

The reason is that, firstly even if distress alert is transmitted but the information about it is not processed fully. Secondly, a position at which a distress occurs cannot be identified rather correctly. Due to those reasons, Search and rescue operation may be carried out in the rather wide sea area and then it takes time. Thirdly, with the time elapsing after an occurrence of distress, liferafts are drifted by current, wind, etc. and then the position of it also changes. Moreover, regarding direction finding equipment searching HF and V/UHF band, there is a fault that, as accuracy measured is not enough to search, search and rescue sea area will become wide.

Radar Transponder system was designed for developing more effective search and rescue operation, in the case ships or airplanes may be in distress in the sea or in the similar cases. In any case above, it is for 9 GHz band radar (marine radars for ships, radars for search and rescue airplanes, etc.), several dots behind every radar target detected are indicated on a radar display, and information of direction and range about target and such peculiar dotted symbols can inform the distress.

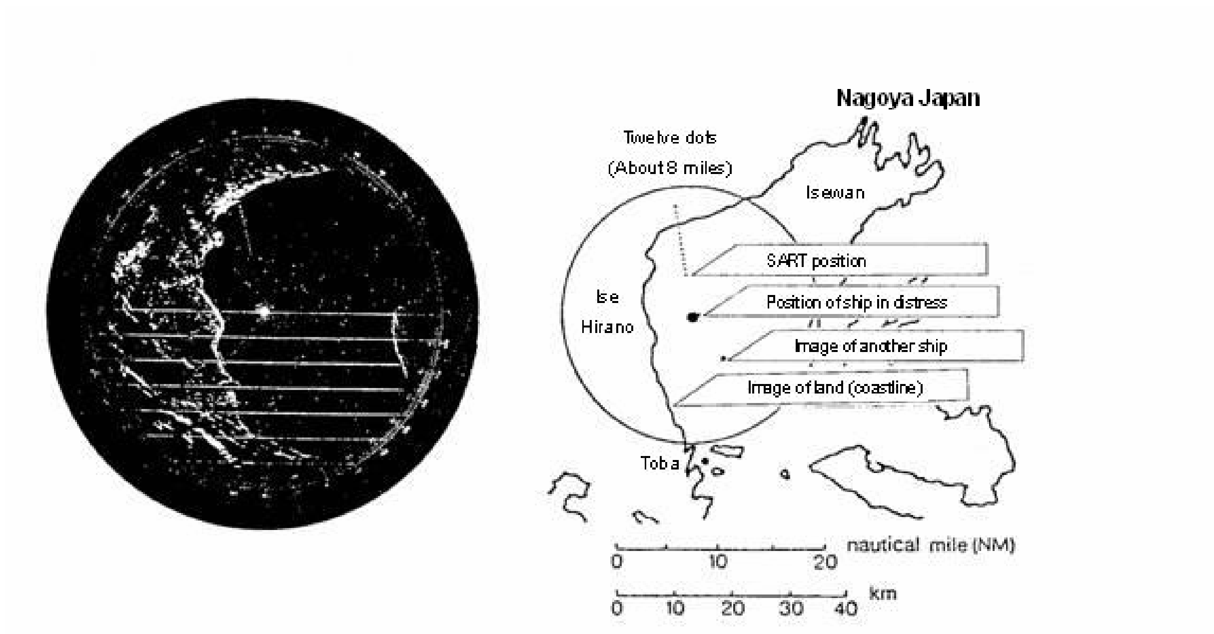
Generally, in the case of radars for ships, the average effective range of SART is about 10 nautical miles, and in the case of radars for search and rescue airplanes, it is about 30 nautical miles (According to data in some states, it is 50-60 nautical miles). There is a report that, in any case, after initial detection of targets, the positions of the targets can be pinpointed.



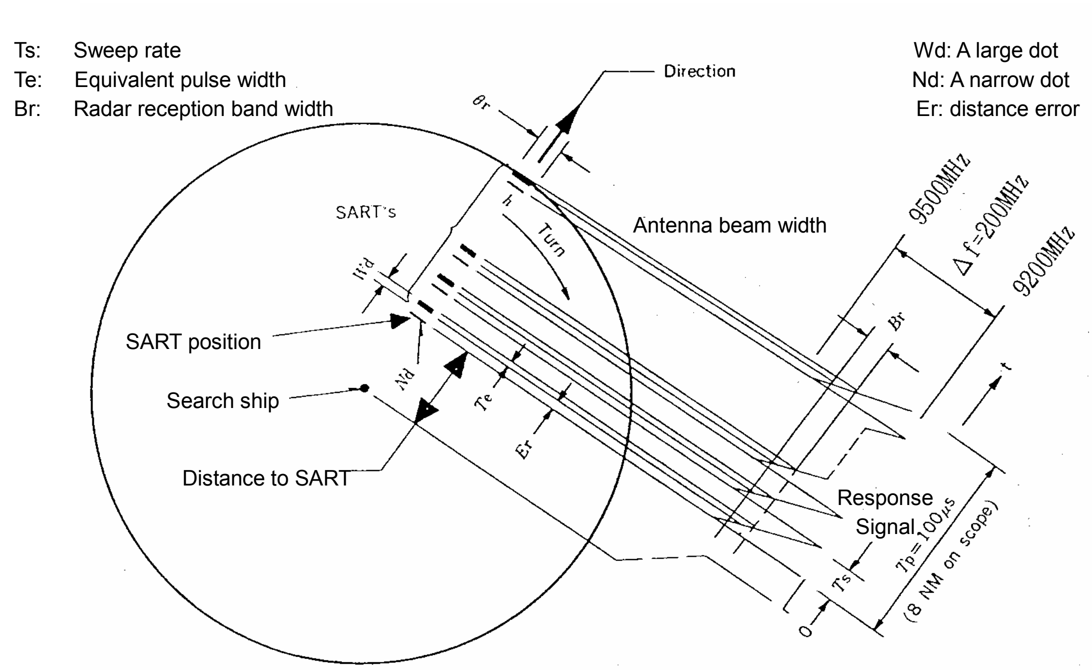
(1) Distress Alerting
(2) Identifying Ship's name
(3) Positioning Altitude / longitude detection
(4) SAR coordinating communications
(5) On-scene communications
(6) Locating Victim
(7) Rescue operations (unit in distress or survivors)
(8) Preventive actions (safety information and ship’s position)

Concept of Global Maritime Distress Safety System

C



(Example: SART code on a radar indicator for ships)



(SART responding signal and SART code)

* For details, it is prescribed by REC628 of R. R. 832A and CCIR.

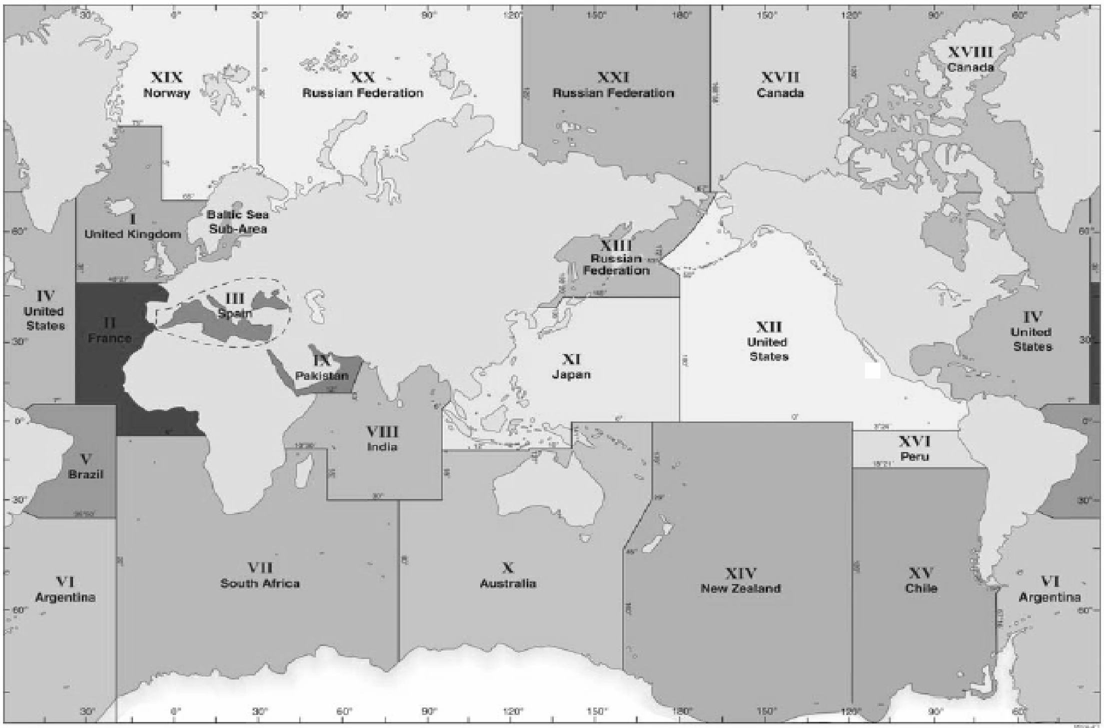
Installation place of SART: in the vicinity of entrances for passage to wings in Bridge

Victims can know by lamp and alarm if radar waves of SART search ship are detected.

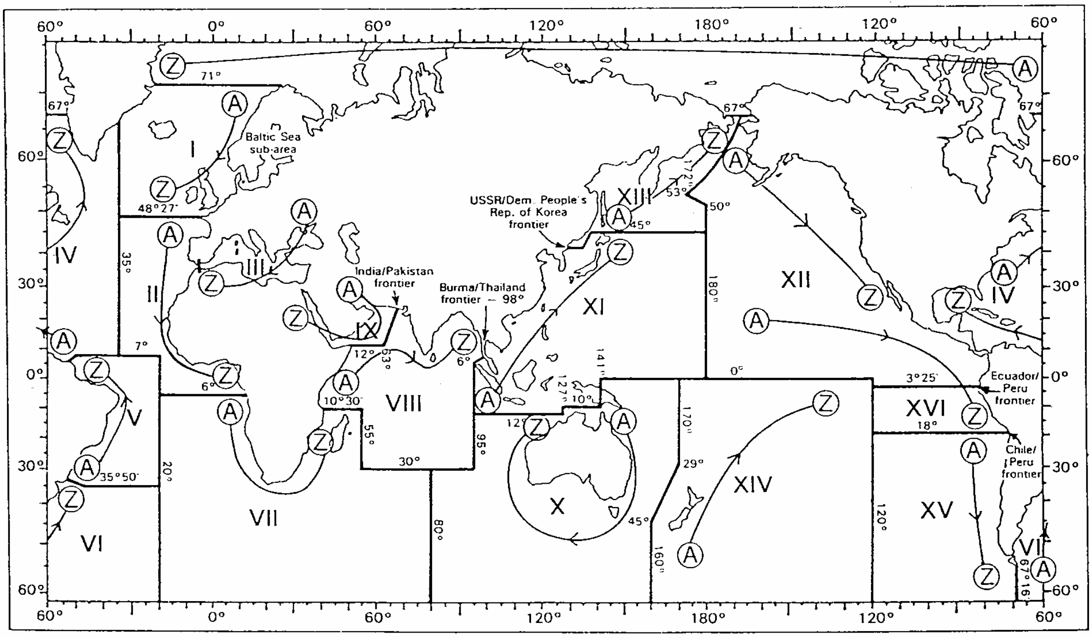
13. NAVTEX

13-1 Outline

* Free telex service from the Land station to ships within the area of about 400 miles away from the seashore.
* Broadcast repeatedly safety and alarm information of navigation and weather by in the common and global frequency “518kHz F1B mode” (CFEC mode).
* Shore stations are divided into each group of NAVAREA, and they sure located every about 400 miles along the main coastline.
* In Japan, five stations such as Otaru, Kushiro, Yokohama, Moji and Naha, have started their services by February, 1992, and are operated by Japan Coast Guard.
* The NAVTEX receiver in a ship navigating near any coast station receives and prints a message automatically.
* From August 1, 1993, mandatory ships of 300 GT and upwards are required to be equipped with NAVTEX.
* Regarding installation, any special procedure is unnecessary, but, equipment type-aprroved by the Competent Authority of the ship, shall be installed.
* In order to prevent interference by the single frequency in the same sea area, it is broadcasted periodically, and transmitted electric power is limited.
* Within NAVAREA each station broadcasts once in 4 hours for 10 minutes. But distress alert or important alarms are broadcasted at any time.
* Although messages are repeatedly broadcasted for improvement of reception probability, since the same message is not printed even if it is received, there is no waste of a recording paper.



NAVAREA OF WORLD



Allocation scheme of coverage of broadcasters (B_1)

13-2 Concept of NAVTEX System

Coastguard
Voyage Authority
Electronic navaids
Offshore Operator
Govt. Departments
Reports from ships

NAVAREA coordination
Organization

↓

Navigation Alarm
Coordination Organization

The first
distress

Message

↓

Search and Rescue
Coordination
Organization

Surveillance of
Ice

Report of the
weather

↓

Weather warning
Coordination
Organization

↓

NAVTEX
Coordination
Organization

Selection by operator	518-kHz receiver	Automatic processing capability
Geographical selection of area	Microprocessor - Decoder	Judgment of signal quality
Deletion of unnecessary and optional messages		Comparison with the contents in the memory
	Printer	Throw-away of insufficient/ unnecessary messages

Time Schedule (UTC)		Broadcaster Identification Character (B1)																							
		Group 1						Group 2						Group 3						Group 4					
Hour	Minute	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
00	00	■																							
	10		■																						
	20			■																					
	30				■																				
	40					■																			
	50						■																		
01	00							■																	
	10								■																
	20									■															
	30										■														
	40											■													
	50												■												
02	00													■											
	10														■										
	20															■									
	30																■								
	40																	■							
	50																		■						
03	00																			■					
	10																				■				
	20																					■			
	30																						■		
	40																							■	
	50																								■

■ : transmitted at intervals of 10 minutes. After 04:00 to 24:00 , broadcast is again repeated from A station to X station.

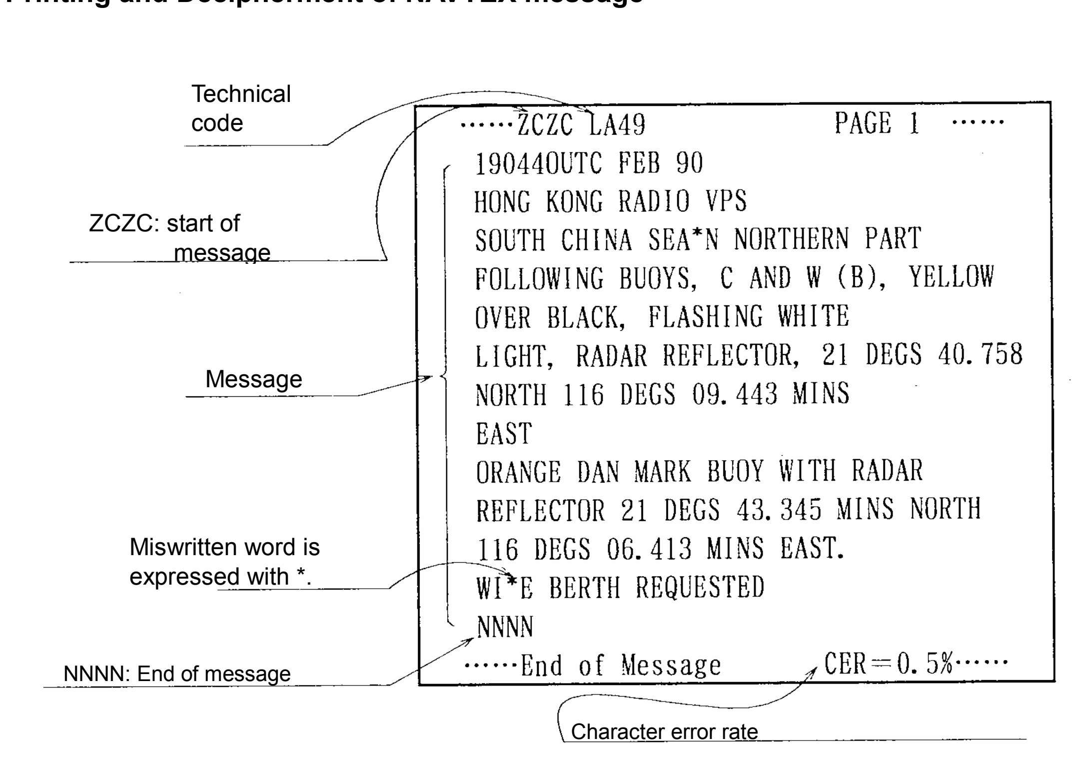
Distribution table of a transmitting schedule

(As of 2014) Extract

NAVAREA XI			air time (UTC)					
C	SINGAPORE	SINGAPORE	0020	0420	0820	1220	1420	2020
E	INDONESIA	JAKARTA	0040	0440	0840	1240	1640	2040
G		NAHA	0100	0500	0900	1300	1700	2100
H		MOJI	0110	0510	0910	1310	1710	2110
I	JAPAN	YOKOHAMA	0120	0520	0920	1320	1720	2120
J		OTARU	0130	0530	0930	1330	1730	2130
K		KUSHIRO	0140	0540	0940	1340	1740	2140
L		HONG KONG	0150	0550	0950	1350	1750	2150
M		SANYA	0200	0600	1000	1400	1800	2200
N	CHINA	GUANGZHOU	0210	0610	1010	1410	1810	2210
O		FUZHOU	0220	0620	1020	1420	1820	2220
Q		SHANGHAI	0240	0640	1040	1440	1840	2240
R		DALIAN	0250	0650	1050	1450	1850	2250
P	TAIWAN	CHI-LUNG	0630	1430	2230			
V	USA	GUAM	0100	0500	0900	1300	1700	2100
W	KOREA	PYONSAN	0340	0740	1140	1540	1940	2340
X	VIETNAM	HO CHI MING	0350	0750	1150	1550	1950	2350

Notes: For further details, refer to the latest documents

Printing and Decipherment of NAVTEX message




```
······ZCZC LA49              PAGE 1  ······
 190440UTC FEB 90
 HONG KONG RADIO VPS
 SOUTH CHINA SEA*N NORTHERN PART
 FOLLOWING BUOYS, C AND W (B), YELLOW
 OVER BLACK, FLASHING WHITE
 LIGHT, RADAR REFLECTOR, 21 DEGS 40.758
 NORTH 116 DEGS 09.443 MINS
 EAST
 ORANGE DAN MARK BUOY WITH RADAR
 REFLECTOR 21 DEGS 43.345 MINS NORTH
 116 DEGS 06.413 MINS EAST.
 WI*E BERTH REQUESTED
 NNNN
······End of Message        CER=0.5%······
```

The meanigs of technical code by four characters

Technical code

L A 49

(A-Z)
Identification Code of transmitting station

Serial number of message
(01-99)
(00 is printed in all the ships within the coverage)

Message type

* : the message which cannot be rejected by ship side

A:	NAVIGATIONAL WARNINGS	(Navigation alarm) *
B:	METEOROLOGICAL WARNINGS	(Weather warning) *
C:	ICE REPORTS	(ice-covered water information)
D:	SEARCH AND RESCUE INFORMATON	(Search & Rescue information) *
E:	METEOROLOGICAL FORECASTS	(Weather forecast)
F:	PILOT SERVICE MESSAGES	(Pilot communication)
G:	AIS MESSAGES	(AIS information)
H:	LORAN MESSAGES	(Loran information)
I:		
J:	SATNAV MESSAGES	(Navigation satellite information)
K:	OTHER ELECTRONIC NAVAID MESSAGES	(Other electronic navigation information)
L:	NAVIGATIONAL WARNINGS-ADDITIONAL TO LETTER A	(Navigation alarm added to A) *
V:	SPECIAL SERVICES-TRIAL ALLOCATION BY NAVTEX PANEL	
W:	SPECIAL SERVICES-TRIAL ALLOCATION BY NAVTEX PANEL	
X:	SPECIAL SERVICES-TRIAL ALLOCATION BY NAVTEX PANEL	
Y:	SPECIAL SERVICES-TRIAL ALLOCATION BY NAVTEX PANEL (Special work -Trial assignment by NAVTEX working group)	
Z:	NO MESSAGE ON HAND	(no message)

14. AIS (Automatic Identification System)

14-1 Outline

Universal shipborne AIS has been developed newly, in order to ensure the safety of navigation of ships more and it was introduced into ships as a mandatory equipment as of 1 July, 2007. AIS transmits ship's name, position, course, speed, etc. to the coast stations using VHF band frequency with TDMA method and displays information transmitted from other ships. If AIS is interfaced with Radar or ECDIS and if AIS information are superimposed, other ships' status can be confirmed visibly. Consequently, safety of navigation of ships is able to be improved further.

14-2 Basic Specification

The basic specification of the main rule "Recommendation ITU-R M.1371-1 and IEC61993-2 for Class A Ship mobile equipment, which is required to be installed on ships of SOLAS Convention, is as follows.

(1) International channel: CH87B (161.975 MHz), CH88B (162.025 MHz)

(2) Modulation: GMSK

(3) Bit rate: 9600 bps

(4) Communication method: SOTDMA, 2250 slot/min/CH
SOTDMA:Self-Organized Time Division Multiple Access,

(5) Identification: MMSI is added to all the transmitting information.

(6) Static data: IMO number, ship's name, call sign, type of ship, dimension of ship

(7) Dynamic data: time (UTC), latitude, longitude, COG, SOG, Heading, Rate of turn

(8) Voyage related data: Draft, Hazardous cargo type, Destination and ETA

(9) Reporting Rate of Static Information:
Every 6 min or, when data has been amended, on request.

(10) Reporting Rate of Static Information:
Dependent on speed and course

Ship's dynamic conditions	Nominal reporting interval
Ship at anchor or moored and not moving faster than 3 knots	3 min(1)
Ship at anchor or moored and moving faster than 3 knots	10 s (1)
Ship 0-14 knots	10 s(1)
Ship 0-14 knots and changing course	3 1/3 s(1)
Ship 14-23 knots	6 s(1)
Ship 14-23 knots and changing course	2 s
Ship > 23 knots	2 s
Ship > 23 knots and changing course	2 s

(11) Reporting Rate of Voyage related information:
Every 6 min or, when data has been amended, on request.

14-3 SOTDMA Communication Protocol

A SOTDMA (Self-Organized Time Division Multiple Access) protocol is used for Class A AIS communication. This is characterized by transmitting AIS information including reservation information of time slot information for the next transmission. The conceptual figure for time slots in use is shown in Fig. 1.

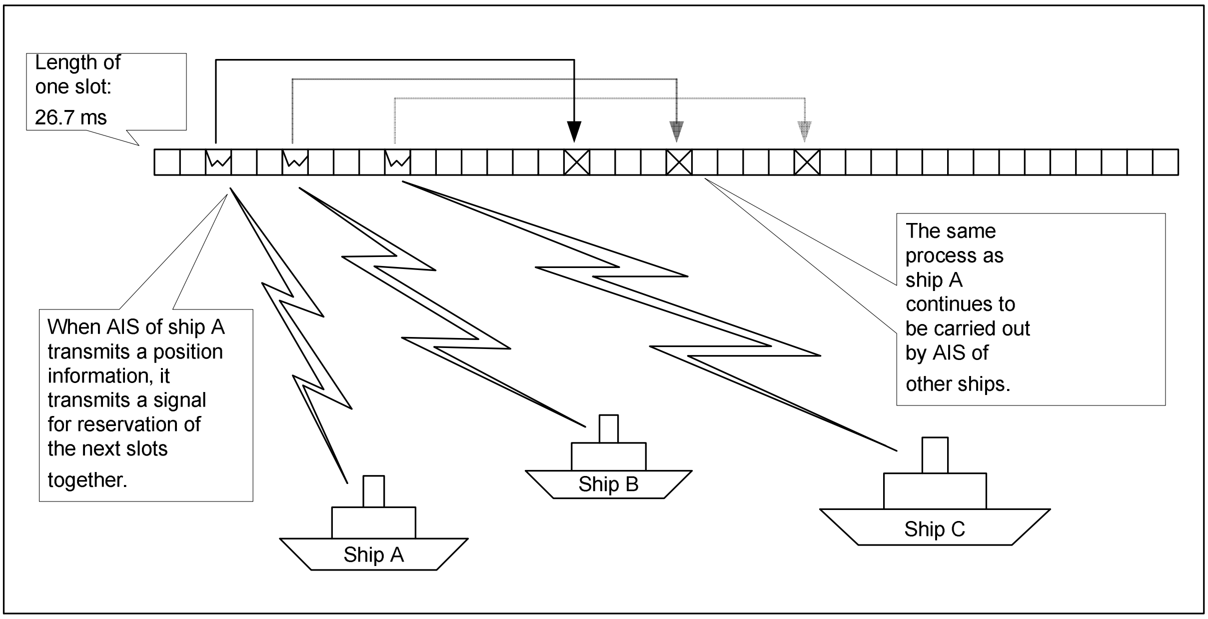


Fig.1 Conceptual Figure of Time Slots in use (for one channel)

AIS communication is carried out as shown in Fig.1. AIS of ship A transmits own ship's information and reservation information for the next own slots as a one packet, and AIS of ship B transmits own ship's information and reservation information for the next own slots, avoiding the slots reserved by ship A. AIS of ship C transmits own ship's information and reservation information for the next own slots, avoiding the slots reserved by ship A and B. SOTDMA is a communication protocol that such processes is repeated by each AIS and each AIS avoids collisions between transmissions. Two channels are used for AIS. Therefore, a conceptual image of slot allocation is that the above slot is doubled actually

14-4 General System Configuration of shipborne AIS

A Class A AIS consists of the following functional blocks, as generally shown in Fig. 2.

(1) VHF antenna
(2) An antenna change / distribution part
(3) TDMA/DSC transmit part
(4) TDMA receive part (two units)
(5) DSC receive part
(6) GPS antenna
(7) GPS receive part (PPS;Pulse Per Second reception)
(8) Control part
(9) Display (keyboard included)

Moreover, the following inputs (10) (11) are required as main navigation equipment data from external equipment.

(10) GPS receiving signal
(position information, course over the ground, speed over the ground)
(11) Gyrocompass signal (Heading, Rate of turn)

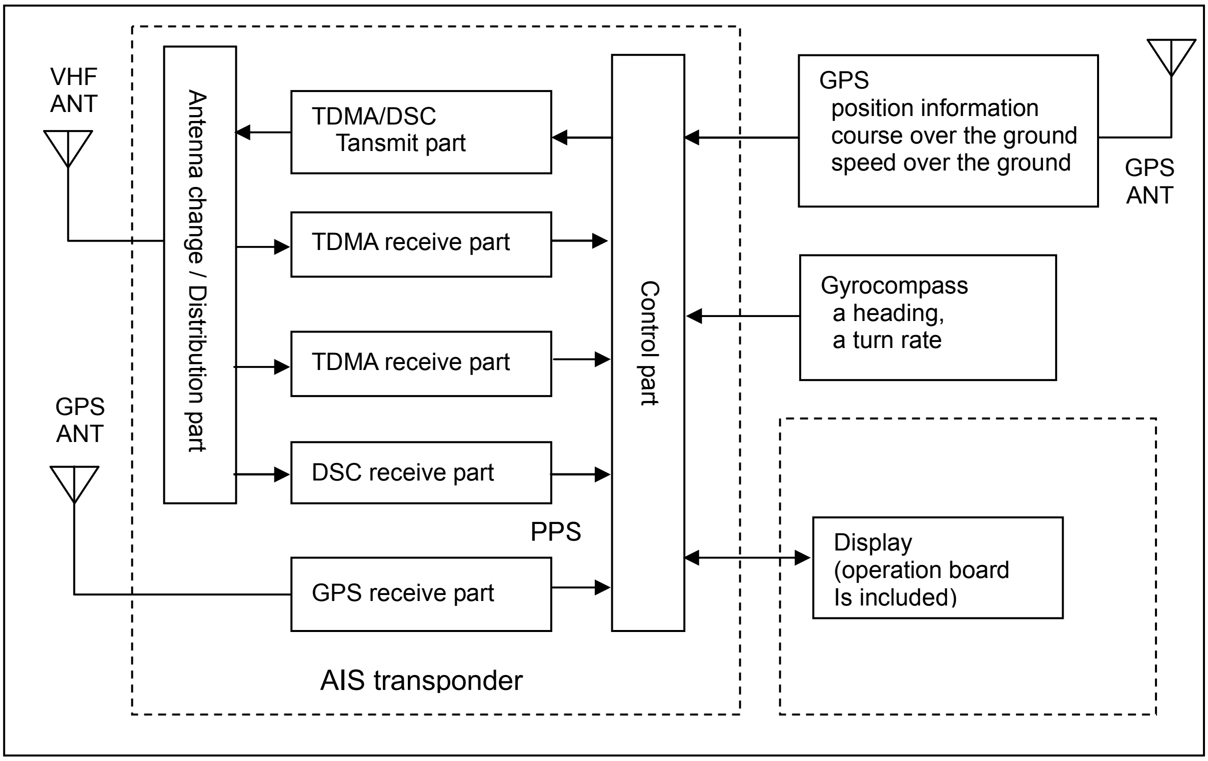


Fig. 2 General System Configuration of shipborne AIS

14-5 AIS Display

AIS Display and Keyboard which has the minimum functions is defined as a MKD (Minimum Display and Keyboard) by the International Standards. The Standards requires that at least 3 other ships or more can be displayed on it. The basic screen of AIS display is the displaying of a list of other ships (Fig.3), and AIS display is capable of indicating bearings, ranges, ship's names of other ships as a list and is capable of indicating own ship's latitude, longitude, SOG, COG in the lower part of the screen of the display. If one of the ships displayed in the list is selected, the information about it is displayed in detail.

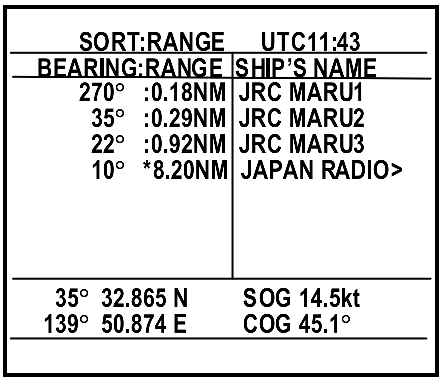


Fig. 3 Displaying of other ships as a list

15. Two Way VHF Radio Equipment

Specification and Performance

(1) General

a. Channel already installed:

CH6 (156.300 MHz)

*Ships flying the Japanese flag are not fitted with this channel.

CH13 (156.650 MHz)

*Ships flying the Japanese flag are not fitted with this channel.

CH15 (156.750MHz)

CH16 (156.800MHz)

CH17 (156.850MHz)

CH67 (156.375 MHz)

*Ships flying the Japanese flag are not fitted with this channel.

b. Optional channel: 7 waves (156.300-156.875 MHz)

* Ships flying the Japanese flag cannot be fitted with these channels.

c. Communication type:	Simplex
d. Radio Wave Type:	F3E (G3E)
e. Antenna:	Vertical, Omnidirectional type
f. Continuous operation time:	not less than 8 hour
	(Transmit, Receive, Waiting: 6 sec, 6 sec, 48 sec)
g. Supply voltage:	between 7.2VDC and 9.0VDC ±10%
h. Environmental condition:	High temperature
	Low temperature
	Watertight

(2) Transmit section

a. Antenna power:	0.8W+50%, -20%
b. Effective radiation power:	not less than 0.25W
c. Frequency deviation:	within 10×10^{-6}
d. Preemphasis characteristics:	6 dB / Oct
e. Occupied bandwidth:	16 kHz or less
f. Maximum frequency deviation:	±2.5 kHz - ±5 kHz of
g. Total distortion and noise:	not less than 20 dB

(3) Receive section

a. Sensitivity:	2 μV (6dBμ) or less
b. Selectivity:	6 dB bandwidth : not less than 12 kHz
	70 dB attenuation: within 25 kHz
c. Spurious response:	not less than 70dB
d. Frequency fluctuation of local oscillator:	0.001% or less
e. Sensitivity suppression effect:	not less than 10 mV (80dBμ)
f. Intermodulation characteristics:	not less than 1.78 mV (65dBμ)
g. Deemphasis characteristics:	-6 dB/Oct
h. Total distortion and noise:	not less than 20 dB

C

16. Shipborne 400 MHz Communication Equipment

UHF Transceiver

16-1 Outline

This equipment is used for communication at sea, during cargo handling, bringing a ship alongside the pier, mooring, etc. and for communication between ships, between a ship and the bridge, between a ship and a pier. There are two types such as explosion-proof type and non-explosion proof type. Fixing type (for base station) is non-explosion type.

A explosion-proof type radio equipment is compatible with the standards related to intrinsically safety proof and can be used on tankers such as LPG(Liquefied Petroleum Gas) tanker, on LNG (Liquefied Natural Gas) tanker and Heavy Oil Tanker or in the Type 1 Dangerous Place.

Moreover, by IMO Resolution MSC.338 (91), a minimum of two two-way portable radiotelephone equipment for each fire party for fire-fighter's communication shall be carried on board.

16-2 Operating Frequency

<table>
<tr><th rowspan="2"></th><th rowspan="2">ch</th><th colspan="2">Portable type</th><th rowspan="2">ch</th><th colspan="2">Fix type</th></tr>
<tr><th>Transmit</th><th>Receive</th><th>Transmit</th><th>Receive</th></tr>
<tr><td rowspan="3">S</td><td>1</td><td colspan="2">457.525MHz</td><td>1</td><td colspan="2">457.525MHz</td></tr>
<tr><td>2</td><td colspan="2">457.550MHz</td><td>2</td><td colspan="2">457.550MHz</td></tr>
<tr><td>3</td><td colspan="2">457.575MHz</td><td>3</td><td colspan="2">457.575MHz</td></tr>
<tr><td rowspan="7">S D</td><td rowspan="2">1</td><td rowspan="2">467.525MHz</td><td rowspan="2">457.525MHz</td><td>1</td><td>457.525MHz</td><td>467.525MHz</td></tr>
<tr><td>2</td><td>457.550MHz</td><td>467.550MHz</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">467.550MHz</td><td rowspan="2">457.550MHz</td><td>3</td><td>457.575MHz</td><td>467.575MHz</td></tr>
<tr><td>4</td><td>457.525MHz</td><td>467.750MHz</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">467.575MHz</td><td rowspan="3">457.575MHz</td><td>5</td><td>457.550MHz</td><td>467.775MHz</td></tr>
<tr><td>6</td><td>457.575MHz</td><td>467.800MHz</td></tr>
<tr><td>7</td><td>457.600MHz</td><td>467.825MHz</td></tr>
</table>

S: Simplex (press talk) channel
SD: Semi-duplex (press talk) channel
It is used through a relay station.

16-3 Tone squelch

By using a tone squelch circuit, the unnecessary contents of communication caused by using the same frequency in common, can be avoided.

16-4 Tone Signal Frequency

Identification	Licensee group	Tone signal frequency (Hz)
A	The 1st group - the 3rd group	107.2 114.8 123.0 131.8
B	The 4th group - the 6th group	141.3 151.4 162.2 173.8
C	The 7th group - the 9th group	186.2 203.5 218.8 233.6
D	The 10th group - the 12th group	103.5 110.9 118.8 127.3
E	The 13th group - the 15th group	136.5 146.2 156.7 167.9
F	The 16th group - the 18th group	179.9 192.8 210.7 225.7
Used for pilotage, towing work or bringing a ship to pier, mooring		67 77 88.5 (One wave which is designated for every unit area)

17. Weather Facsimile

17-1 WMO (World Meteorological Organization) Broadcasting Station and Frequency

Feb.2012

Country	Station	Call sign	Frequency(kHz)
JAPAN	Tokyo	JMH	3622.5、7795.0、13988.5
CHINA	Beijing	3SD	8461.9、12831.9、16903.9
		BAF	5526.9、8121.9、10116.9、14366.9、16025.9、18236.9
REPUBLIC OF CHINA	Taipei	BMF	4616.0、8140.0、13900.0、18560.0
REPUBLIC OF KOREA	Seoul	HLL2	3585.0、5857.5、7433.5、9165.0、13570.0
THAILAND	Bangkok	HSW64	7395.0
AUSTRALIA	Charleville Wiluna	VMC VMW	2628.0、5100.0、11030.0、13920.0、20469.0 5755.0、7535.0、10555.0、15615.0、18060.0
NEW ZEALAND	Wellington	ZKLF	3247.4、5807.0、9459.0、13550.5、16340.1
HAWAII(U.S.A)	Honolulu	KVM70	9982.5、11090.0、16135.0
CANADA	Halifax Iqaluit／Resolute Sydney Inuvik	CFH VFF/VFR VCO VFA	122.5、4271.0、6496.4、10536.0、13510.0 3253.0、7710.0 4416.0、6915.1 8457.8
U.S.A	Kodiak AL PT. Reyes CA New Orleans AL Boston MA	NOJ NMC NMG NMF	2054.0、4298.0、8459.0、12412.5 4346.0、8682.0、12786.0、17151.2、22527.0 4317.9、8503.9、12789.9、17146.4 4235.0、6340.5、9110.0、12750.0
BRAZIL	Rio De Janeiro	PWZ33	12665.0、16978.0
CHILE	Valparaiso Punta Arenas.	CBV	4228.0、8677.0、17146.5
	Malparaiso	CBM	4322.0、8696.0
SOUTH AFRICA	Cape Naval	ZSJ	4014.0、7508.0、13538.0、18238.0
GREECE	Athens	SVJ4	4481.0、8105.0
GERMANY	Hamburg	DDH3 DDK3 DDK6	3855.0 7880.0 13882.5
RUSSIA	Murmansk	RBW41	5336.0、6445.5、7908.8
		RBW48	10130.0
U.K	Northwood	GYA	2618.5、4610.0、8040.0、11086.5
	Persian Gulf	GYA	6834.0、12390.0、18261.0

http://www.nws.noaa.gov/om/marine/rfax.pdf

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17-2 Meteorological Agency (JMH)

Broadcast schedule and Frequency

"The following schedule table is issued by JMH."
Japan Meteorological Agency homepage: Weather Radio Facsimile (JMH)

J M H BROADCAST SCHEDULE

JAPAN METEOROLOGICAL AGENCY-TOKYO EFFECTIVE:22nd Jan.2014

3622.5, 7795, 13988.5 (kHz) F3C WHITE:+400 BLACK:-400 5kW

TOT	(*)	HEADING	OBS	CONTENT OF CHART
0000		FSAS04	12	RETRANSMISSION OF 2200
		FSAS07	12	RETRANSMISSION OF 2200
0020		FSAS09	12	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (96HOUR)
0040		FSAS12	12	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (120HOUR)
0103				TEST CHART
0110			00	METEOROLOGICAL SATELLITE PICTURE (MTSAT)
0130		STPN		RETRANSMISSION OF 1019
		FIOH04/16	00	RETRANSMISSION OF 1019
0150	1)	WTAS07	00	TROPICAL CYCLONE FORECAST
0210	2)	SOPQ		SEA SURFACE CURRENT, WATER TEMPERATURE AT 100M DEPTH
0229	3)			RADIO PREDICTION
0240		ASAS	00	SURFACE ANALYSIS
0300	2)	COPQ1		SEA SURFACE WATER TEMPERATURE
0320		ASAS	00	THE FIRST RETRANSMISSION OF 0240
0340		MANAM		JMH BROADCAST SCHEDULE AND MANUAL AMENDMENTS
0400	6)	WTAS12	00	TROPICAL CYCLONE FORECAST
0421		AWPN	00	OCEAN WAVE ANALYSIS
0440		AWJP	00	COASTAL WAVE ANALYSIS
0459		AUAS50	00	500HPA HEIGHT, TEMPERATURE
0518		AUAS85	00	850HPA HEIGHT, TEMPERATURE, DEW POINT DEPRESSION
0537		FUFE502	00	500HPA HEIGHT, VORTICITY PROGNOSIS (24HOUR)
		FSFE02	00	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (24HOUR)
0548		FSAS24	00	SURFACE PRESSURE, WIND, FOG, ICING, SEA ICE PROGNOSIS (24HOUR)
0610	1)	WTAS07	00	RETRANSMISSION OF 0150
0630		FSAS04	00	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (48HOUR)
		FSAS07	00	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (72HOUR)
0651		FWPN	00	OCEAN WAVE PROGNOSIS (24HOUR)
0710			06	METEOROLOGICAL SATELLITE PICTURE (MTSAT)
0730		FWJP	00	COASTAL WAVE PROGNOSIS (24HOUR)
0750	1)	WTAS07	06	TROPICAL CYCLONE FORECAST
0809		FUFE503	00	500HPA HEIGHT, VORTICITY PROGNOSIS (36HOUR)
		FSFE03	00	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (36HOUR)
0820		FSAS48	00	SURFACE PRESSURE, WIND, ICING, SEA ICE PROGNOSIS (48HOUR)
0840		ASAS	06	SURFACE ANALYSIS
0900	6)	WTAS12	06	TROPICAL CYCLONE FORECAST
0920		ASAS	06	THE FIRST RETRANSMISSION OF 0840
0940		FSAS04	00	RETRANSMISSION OF 0630
		FSAS07	00	RETRANSMISSION OF 0630
1000		FSAS48	00	RETRANSMISSION OF 0820
1019	4)	STPN		SEA ICE CONDITION (SEASONAL)
	5)	FIOH04/16	00	SEA ICE CONDITION PROGNOSIS (48 AND 168HOUR, SEASONAL)
1040		FSAS24	00	RETRANSMISSION OF 0548
1100		AWPN	00	RETRANSMISSION OF 0421
1119		AWJP	00	RETRANSMISSION OF 0440
1140		FWPN	00	RETRANSMISSION OF 0651
1200	1)	WTAS07	06	RETRANSMISSION OF 0750
1220		FWPN07	00	OCEAN WAVE PROGNOSIS (12,24,48,72HOUR)
1240		FXFE572	00	500HPA TEMPERATURE, AND 700HPA DEW POINT DEPRESSION PROGNOSIS (24HOUR)
		FXFE782	00	850HPA TEMPERATURE, WIND AND 700HPA VERTICAL P-VELOCITY PROGNOSIS (24HOUR)

TOT	(*)	HEADING	OBS	CONTENT OF CHART
1251		FXFE573	00	500HPA TEMPERATURE, AND 700HPA DEW POINT DEPRESSION PROGNOSIS (36HOUR)
		FXFE783	00	850HPA TEMPERATURE, WIND AND 700HPA VERTICAL P-VELOCITY PROGNOSIS (36HOUR)
1303				TEST CHART
1310			12	METEOROLOGICAL SATELLITE PICTURE (MTSAT)
1330		FWJP	00	RETRANSMISSION OF 0730
1350	1)	WTAS07	12	TROPICAL CYCLONE FORECAST
1420	2)	SOPQ		RETRANSMISSION OF 0210
1440		ASAS	12	SURFACE ANALYSIS
1520		ASAS	12	THE FIRST RETRANSMISSION OF 1440
1540	6)	WTAS12	12	TROPICAL CYCLONE FORECAST
1600	2)	COPQ1		SEA SURFACE WATER TEMPERATURE
1620		AWPN	12	OCEAN WAVE ANALYSIS
1640		AUAS50	12	500HPA HEIGHT, TEMPERATURE
1700		AUAS85	12	850HPA HEIGHT, TEMPERATURE, DEW POINT DEPRESSION
1719		AWJP	12	COASTAL WAVE ANALYSIS
1739		FUFE502	12	500HPA HEIGHT, VORTICITY PROGNOSIS (24HOUR)
		FSFE02	12	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (24HOUR)
1750	1)	WTAS07	12	RETRANSMISSION OF 1350
1810		FUFE503	12	500HPA HEIGHT, VORTICITY PROGNOSIS (36HOUR)
		FSFE03	12	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (36HOUR)
1821		FXFE572	12	500HPA TEMPERATURE, AND 700HPA DEW POINT DEPRESSION PROGNOSIS (24HOUR)
		FXFE782	12	850HPA TEMPERATURE, WIND AND 700HPA VERTICAL P-VELOCITY PROGNOSIS (24HOUR)
1832		FXFE573	12	500HPA TEMPERATURE, AND 700HPA DEW POINT DEPRESSION PROGNOSIS (36HOUR)
		FXFE783	12	850HPA TEMPERATURE, WIND AND 700HPA VERTICAL P-VELOCITY PROGNOSIS (36HOUR)
1850		FWPN07	12	OCEAN WAVE PROGNOSIS (12,24,48,72HOUR)
1910			18	METEOROLOGICAL SATELLITE PICTURE (MTSAT)
1930		FSAS24	12	SURFACE PRESSURE, WIND, FOG, ICING, SEA ICE PROGNOSIS (24HOUR)
1950	1)	WTAS07	18	TROPICAL CYCLONE FORECAST
2010		FWJP	12	COASTAL WAVE PROGNOSIS (24HOUR)
2040		ASAS	18	SURFACE ANALYSIS
2100		FSAS48	12	SURFACE PRESSURE, WIND, ICING, SEA ICE PROGNOSIS (48HOUR)
2120		ASAS	18	THE FIRST RETRANSMISSION OF 2040
2140	6)	WTAS12	18	TROPICAL CYCLONE FORECAST
2200		FSAS04	12	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (48HOUR)
		FSAS07	12	SURFACE PRESSURE, PRECIPITATION PROGNOSIS (72HOUR)
2220		FWPN	12	OCEAN WAVE PROGNOSIS (24HOUR)
2240	1)	WTAS07	18	RETRANSMISSION OF 1950
2300		FSAS24	12	RETRANSMISSION OF 1930
2320		AWJP	12	RETRANSMISSION OF 1719
2340		FSAS48	12	RETRANSMISSION OF 2100

(*)
1) IN CASE OF TROPICAL CYCLONE.
2) EVERY TUESDAY AND FRIDAY.
3) ON THE 20TH AND 21ST.
4) EVERY TUESDAY AND FRIDAY (SEASONAL).
RETRANSMISSION:AT 0130 ON THE NEXT DAY.
5) EVERY WEDNESDAY AND SATURDAY (SEASONAL).
RETRANSMISSION:AT 0130 ON THE NEXT DAY.
6) IF A TROPICAL CYCLONE IS EXPECTED TO EXIST IN 4 DAYS.

http://www.jma-net.go.jp/common/177jmh/JMH-ENG.pdf

17-3 Weather Facsimile Specification & Term

17-3-1 Facsimile

(1) Recording system

There are some methods such as electric-discharge-recording method using needles for recording, thermal-recording method using a thermal head, etc. in storage devices.

- Recording-needle method:
  supply voltage to recording paper (1 needle-method, 3 needle-method)
- Thermal head Method:
  supply heat to recording paper (solid method, sliding method)

(2) Recording paper

There are two kinds of recording paper such as electric-discharge-recording paper and thermal-recording paper, depending on recording methods.

- Electric-discharge-recording paper:

  AC high-voltage destruction method (smells)
  DC low-voltage destruction method (aluminum-vapor-deposition paper etc.)

- Thermal-recording paper:
  reacts to heat and then colors. Its storage is taken into account.

(3) Effective recording width:

The width with which information are drawn actually is called “Effective width”. This is the basis of the calculation of the density of scanning lines (below paragraph 4), using a Index of cooperation.

(4) Index of cooperation (IOC):

(a) When the paper size for transmission device is different from the paper size for recording device, “index of cooperation” 288 and 576 are defined as similar figures, but in most cases, transmission is made by using 576.

(b) The relation between recording paper width and line density is as follows.

Recording paper size	10-inch recording paper		12-inch recording paper		14-inch recording paper		15-inch recording paper	
Index of Cooperation	288	576	288	576	288	576	288	576
Line density	3.5l /mm	7l /mm	3l /mm	6l /mm	2.5l /mm	5l /mm	2.4l /mm	4.7l /mm

(5) Scan speed

(a) Scan speed means a speed which scans one line. According to WMO specification, there are basically 3 speeds such as 60, 90, and 120 SPM (SCAN / MIN.).

(b) When using any speed other than the above-mentioned speed, multiples of 60 are used. (For example, 180, 240 SPM)

(c) In most cases, transmission is carried out actually by 120SPM. Transmission by 60SPM or 90SPM is rare. (Note: Kyodo News: combined use of 60/120SPM)

(6) Independent synchronization

A transmitting side transmits at highly accurate fixed speed, without restrictions imposed by a receiving side.

The receiving side receives at the same speed in accordance with the accuracy of the transmitting side. While each sends and receives independently, the synchronization of receiving side is called independent synchronization.

(7) Automatic control signal

This is a control signal for starting or stopping Fax automatically and remotely. A START signal which specifies a cooperation coefficient, and a Phase Control signal which specifies SCAN SPEED, are transmitted. STOP signal is transmitted at the end of broadcast. These remote signals are used for FAX, and FAX is automatically controlled by such signals.

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(1) START signal		(2) STOP signal	(3) Phase signal
675Hz	Select Index of cooperation : No.288	450 Hz (Common)	At each scanning speed, black is 95% and white is 5%.
300Hz	Select Index of cooperation : No.576		

17-3-2 Receiver

(1) Mode of emission: F3C

Although there is a subcarrier method by direct FS and SSB, the same wave type is used. Moreover, a photograph broadcast is performed by FM method and the same wave type is used.

(2) Frequency range

The FAX broadcast is carried out using shortwave and long wave.
Frequency range

SW (Short wave): 2 MHz - 25 MHz

LW (Long wave): 80 kHz - 160 kHz

The frequencies used for broadcasting stations all over the world are changed frequently. Since reception is impossible, with old frequency set up, the service call of “reception default” may be made. Therefore, frequency changes should be taken into account.

(3) FAX signal

The FAX signal is 1900Hz±400Hz FS signal, and 2300Hz is assigned to a white signal, and 1500 Hz is assigned to a black signal.
In the case of using external receivers, setup is carried out so that this signal may be acquired.

18. Interface Standards

In this chapter, the standards related to interface (standard of physical specifications of hardware, data format and connectors and cables) needed in data communications, such as electronic navigation equipment, navigation apparatus, radio communication and personal computer, are introduced.

18-1 Global Standard

Regarding the requirements related to the interfacing between electronic devices, IEC (International Electrotechnical Commission) issues global standards, which are applied to the communication between maritime electronic navigation equipment and computers, etc. as well.

IEC develops global standards and publishes these standards for the Electric/Electronic Industry and users of standard. All of the industrialized countries are contained in members to IEC. Standards developed by IEC are used by more than 100 countries. Standards, Guidelines and Technical Reports issued by IEC are all numbered, since the year 1997, the number of 60000 to 79999 has been used by IEC. The IEC/ISO international standard numbering system was unified by the IEC/ISO (International Organization for standardization) Joint Expert Advisory Council. Numbers are shared by IEC and ISO, and ISO uses any number of 1-59999, and IEC uses any number of 60000 to 79999 according to the unified numbering. The publications issued before 1997 by IEC is also unified into a new numbering system adding the number of 60000 to the previous numbering (for example, IEC 950 is set to IEC 60950).

In this chapter, especially Standard IEC 61162: [Maritime navigation and radiocommunication equipment and systems – Digital interfaces, Single talker and multiple listeners] is chosen from among IEC standards, and the global standards of hardware and data formats relating to the interfaces and communications between electronic navigation equipment or between Electronic navigation equipment and personnel computers is described. IEC 61162 part 1 regulates the frequency of sentence transmission of about once per second. In addition, IEC 61162 part 2 defines a high-speed transmission of around once per 20 ms. This chapter focuses on the standard in high-speed communication.

In IEC 61162, it is noted that circuits used in electronic equipment meet the requirements of ITU. ITU (International Telecommunication Union) consists of ITU-T (International Telecommunication Union *Telecommunication Standardization Sector* of ITU) and ITU-R (International Telecommunication Union Radiocommunications Sector of ITU) and each sector issues recommendations as an International Standards as required. This chapter relates to ITU-T Recommendations V. defining modem etc.

The portion relating to the data format in IEC standards is strictly in cooperation with NMEA 0183 version 2.30, and both coincide on the contents. NMEA is an acronym for "The National Marine Electronics Association", and aims at contributing to the spread and the development of the Maritime Electronic Equipment Industry and the Market, and defines the interfaces between navigation equipment, the communication protocol, etc. Regarding the data formatter of IEC standard, only some examples are shown in IEC standard. Therefore, for details, it is necessary to refer to manufacturer's instructions or publications of NMEA. IEC recommends manufacturers to describe necessary information about communication on equipment instruction books or publications for exclusive use.

However, regarding connector, the standard IEC 61162 introduces *"No standard connector is specified. Wherever possible readily available commercial connectors shall be used. Manufacturers shall provide means for user identification of the connections used."* In the latter half of this chapter, the international standards on connectors widely used for the connection between electronic equipment, is described. Although it has been released as "standard which Electronic Industries Association (EIA) recommends", many electronic devices including personal computers support this standard, and it serves as the global standard substantially.

Moreover, IEC 60945 standard and IEC 61162 series standard are outlined in this chapter.
The Guidelines and the homepage address of publishers related to this chapter are introduced below.

IEC 60945 Ed.4.0:2002

Fourth edition 2002-08, IEC 60945: Maritime navigation and radiocommunication equipment

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and systems – General requirements – Methods of testing and required test results
IEC 61162-1 Ed.4.0:2010
2002, Maritime navigation and radiocommunication equipment and systems –Digital interfaces – Part 1: Single talker and multiple listeners
IEC 61162-2 Ed.1:1998
1998, Maritime navigation and radiocommunication equipment and systems –Digital interfaces – Part 2: Single talker and multiple listeners, high-speed transmission
IEC 61162-3 Ed.1.2:2014
2014, Maritime navigation and radiocommunication equipment and systems –Digital interfaces – Part 3: Serial data installment network
IEC 61162-450 Ed.1:2011
2011, Maritime navigation and radiocommunication equipment and systems –Digital interfaces – Part 450: Multiple talkers and multiple listeners - Ethernet interconnection

The abovementioned standards are related to IEC, http://www.iec.ch (English)

ITU-T X.27/V.11: (for low speed)
1996, Electrical characteristics for balanced double-current interchange circuits operating at data signalling rates up to 10 Mbit/s
ITU-T V.11: (for high speed)
1996, Electrical characteristics for balanced double-current interchange circuits operating at data signalling rates up to 10 Mbit/s, http://www.itu.int/ITU-T/(English)
NMEA 0183 Version 4.10:2008
2008, National Marine Electronics Association (USA) – Standard For Interfacing Marine electronic devices, version 4.10, http://www.nmea.org (English)
EIA 485:
1991, Standard for electrical characteristics of generators and receivers for use in balanced digital multipoint systems, http://www.eia.org（English）

18-2 Hardware specification / Data format (IEC 61162 standard)

IEC 61162 standard is outlined below. The underlied portions relate only to a high-speed transmission and does not describe a standard-speed transmission.

In this chapter, the connection between one talker (data transmitting side) and two or more listeners (data reception side) is assumed. For example, a combination of a GPS receiver (talker), a personal computer, or a chart plotter (listener) is treated here in detail.
Most of description on standards of IEC61162 below is cited from IEC61162-1/-2.

18-2-1 Hardware specification

One talker and multiple listeners may be connected in parallel through interconnecting wires. Shielded cables are recommended in order to meet EMC requirements. The number of listeners depends on the output capability of a talker and is subject to the use of termination resistors.

(1) Interconnecting wires

A cables interconnecting a talker and a listener consists of a shielded twisted-pair wire (two-conductor: A, B) and a ground wire (C) for a talker an a listener.
Regarding a ground wire, there are two cases as follows.
- another third wire additional to the twisted pair wire, or
- double-shielded wire (an inner shield and an outer shiled are insulated.)

(2) Conductor definitions

The conductors are the signal lines A, B and shield (signal lines A, B, C and shield).

(3) Requirements for Electrical connection/shield

Single-Shielded cable

A talker's signal line A is connected in parallel with A terminals of all devices and A talker's signal line B is connected in parallel with B terminals of all devices and A talker's common shield line C is connected in parallel with C terminals of all devices. If a cable has an independent shield line (C) and a single outer layer shield, the outer layer shield should be connected to the chassis of the talker, and should not be connected at each listener. However, a inner common shield terminal of the talker is interconnected to an inner common shield terminal of every listener. (Refer to Figure 9.2-1 and Figure 9.2-2 (a))

Double-Shielded cable

With double-shielded cables and the inner shield used as common line C (signal ground), the outer shield shall be connected to the chassis of the talker and shall not be connected to any listener. However, the outer shield shall be continuous (unbroken) between all listeners (Refer to Figure 9.2-1 and Figure 9.2-2 (b)).

With double-shielded cables and a separate wire as common line C (signal ground), the inner shield shall be connected to the chassis of the talker and shall not be connected to any listener. However, the inner shield shall be continuous (unbroken) between all listeners. The outer shield may be connected to the chassis on either side if required (Refer to Figure 9.2-1 and Figure 9.2-2 (c)).

In cabling, the end of a cable should not left open cables are as short as possible. If a long cable is required, the end of the cable should be terminated in accordance with ITU-T V.11.

(Note: In the case of standard transmission speed, all listeners' shield wires should be connected only to the chassis of the talker but not to the chassis of the listeners.(Refer to Figure 9.2-3)

C

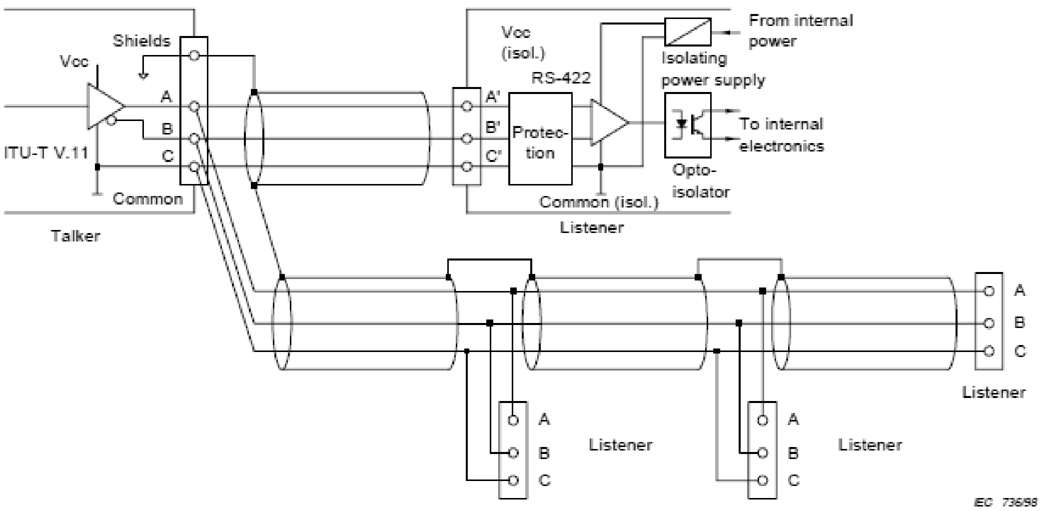


Fig. 18.2-1 Talker/listener connection

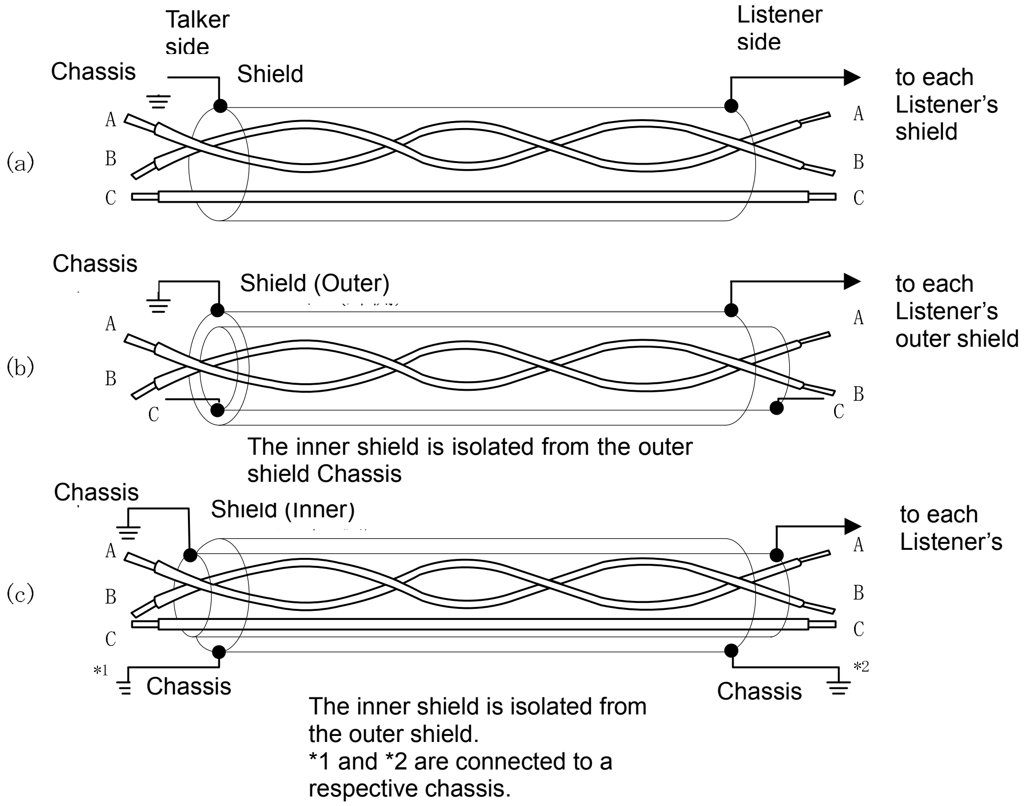


Fig. 18.2-2 Cables – Electrical shield requirements

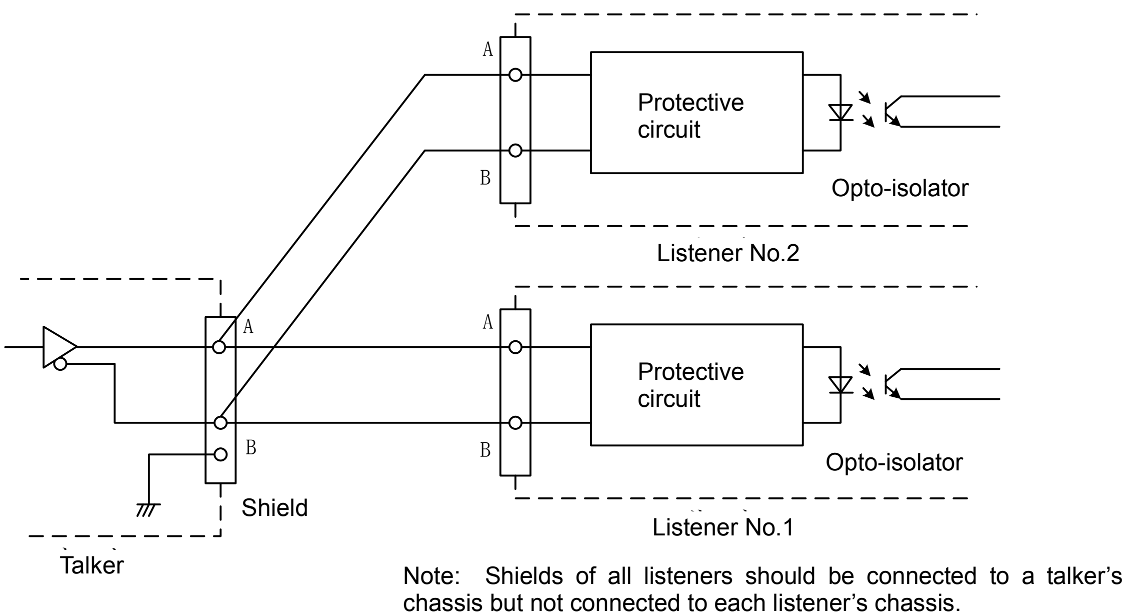


Fig. 18.2-3 Listener receive circuit

(4) Connector

No standards of connector is specified by IEC61162. Wherever possible, readily available commercial connectors shall be used. Manufacturers shall provide means for user identification of the connections used.
(Note: The International Standards of connector is introduced in paragraph 3.)

(5) Electrical signal characteristics

This subclause describes the electrical characteristics of transmitters and receivers.

(A) Signal state definitions

The idle, marking, logical 1, OFF or stop bit state is defined by a negative voltage on line A with respect to line B.

The active, spacing, logical 0, ON or start bit state is defined by a positive voltage on line A with respect to line B.

It should be noted that the above A with respect to B levels are inverted from the voltage input/output requirements of standard UARTs* and that many line drivers and receivers provide a logic inversion.

*：UART（Universal Asynchronous Receiver/Transmitter）

(B) Talker drive circuits

No provision is made for more than a single talker to be connected to the bus. The drive circuit used to provide the signal A and the return B shall meet, as a minimum, the requirements of ITU-T X.27/V.11.

Improved and compatible driver circuits (e.g. EIA-485) used in a compliant way are allowed.

(C) Listener receive circuits

Multiple listeners may be connected to a single talker. The listener's receive circuit shall comply with ITU-T V.11. Optional termination resistors for the line shall be provided as shown in Figure 1 and 3. The input terminals A, B and C shall be electrically isolated from the remaining electronics of the listening device. Reference is made to (D).　A termination resistor is used as required.

The receive circuit shall be designed for operation with a minimum differential input voltage of 2,0 V 1 and shall not take more than 2,0 mA from the line at that voltage.

(D) Electrical isolation

Within a listener there shall be no direct electrical connection between the signal lines A and signal return lines B, or the shield to ship's mains ground or power line. Isolation from ships' ground is required.

In the case of high speed, Within a listener there shall be no direct electrical connection between the signal lines A and B, the signal ground C or the shield to ship's mains ground or power line. This isolation shall be in accordance with IEC 60945.

(E) Maximum voltage on the bus

The maximum applied voltage between signal lines A and B and between either line and ground shall be in accordance with ITU-T X.27/V.11.

For protection against miswiring and for unintended connection to earlier TALKER designs, all receive circuit devices shall be capable of withstanding 15 V between either lines and signal ground (between A and B, between A and C and between B and C) for an indefinite period.

18-2-2 Data transmission

Data is transmitted in serial asynchronous form according to the standards. The first bit is a start bit and is followed by data bits, least-significant-bit first, as illustrated by Figure 9.2-4. The logical level is high during no data sent, and 1 bit of the logic value 0 is sent as a start signal which means the commencement of data transmission. This is called a start bit. Listeners begin reception once Logical level becomes Logical 0.

The first bit is a start bit and is followed by 8 data bits. A transmission starts with a least-significant-bit. Only 7 bits are required for the transmission of Alphabet characters. Therefore, 7 bits mode may be supported. (In Japan, 8 bits are used.)
Stop bit is the logical 1 and the end signal of a transmission of one byte.

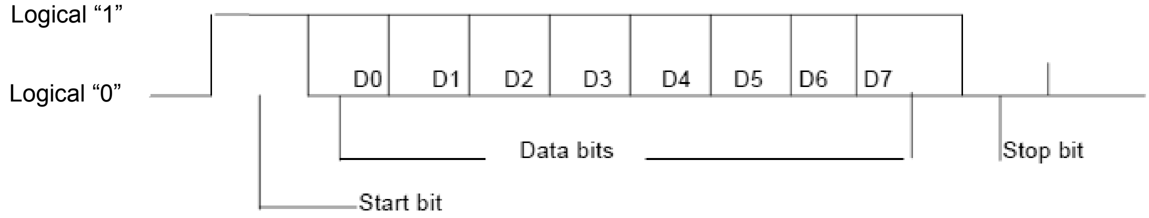


Fig. 18.2-4 Data transmission format

The relation between voltage and logic value is described below. For reasons of compatibility with equipment designed to comply with earlier versions of NMEA 0183, it is noted that the idle, marking, logical "1", OFF or stop bit state had previously been defined to be in the range –15,0 V to +0,5 V. The active, spacing, logical "0", ON or start bit state was defined to be in the range +4,0 V to +15,0 V while sourcing was not less than 15 mA.

The following parameters are used:

- baud rate 38,400 bps (in the standard case: 4,800 bps);
- data bits 8 (D7 = 0),
- parity none;
- stop bits 1.

A unit of bps (bits per second) shows how many bits are sent per second. In Japan, 8 bits of data, a start bit and a stop bit forms one block such as 1 byte and then 10 bits will be sent as 1 byte. Therefore, the number of bytes sent per second is one third of the number indicated by the unit of bps. In the case of 4800bps, about 480 characters per second can be sent.

18-2-3 Data format protocol

The type of data transmitted from a talker is ASCII and are printable. For example, data contain a position, satellite information, etc.

A typical message consists of 11 to 79 of maximum characters in length, it can be sent generally not more frequently than once per 20 ms. (In the case of the standard transmission, 20 to 79 characters are sent normally once per second.)

(1) Characters

All transmitted data shall be interpreted as ASCII characters. The most significant bit of the eight-bit character shall always be transmitted as zero (D7 = 0).

(A) Reserved characters

The reserved character set consists of those characters shown in Table 9.2-1. Except a character “^” HEX 5E, shall not be used in data fields.

Table 18.2-1 Reserved characters

ASCII	HEX	DEC	Description
<CR>	0D	13	Carriage return
<LF>	0A	10	Line feed – End of sentence delimiter
$	24	36	Start of sentence delimiter
*	2A	42	Checksum field delimiter
,	2C	44	Field delimiter
!	21	33	Start of encapsulation sentence delimiter
/	5C	92	Comment block delimiter
^	5E	94	Code delimiter for HEX representation of ISO 8859-1 (ASCII) characters
~	7E	126	Reserved for future use
<del>	7F	127	Reserved for future use

(B) Valid characters

The valid character set consists of all printable ASCII characters (HEX 20 to HEX 7E) except those defined as reserved characters. The list of the valid character set is given in Table 18.2-2.

Table 18.2-2 Valid Characters

ASCII	HEX	DEC	ASCII	HEX	DEC	ASCII	HEX	DEC
Space	20	32	@	40	64	`	60	96
Reserved	21	33	A	41	65	a	61	97
""	22	34	B	42	66	b	62	98
#	23	35	C	43	67	c	63	99
Reserved	24	36	D	44	68	d	64	100
%	25	37	E	45	69	e	65	101
&	26	38	F	46	70	f	66	102
'	27	39	G	47	71	g	67	103
(	28	40	H	48	72	h	68	104
)	29	41	I	49	73	i	69	105
Reserved	2A	42	J	4A	74	j	6A	106
+	2B	43	K	4B	75	k	6B	107
Reserved	2C	44	L	4C	76	l	6C	108
-	2D	45	M	4D	77	m	6D	109
.	2E	46	N	4E	78	n	6E	110
/	2F	47	O	4F	79	o	6F	111
0	30	48	P	50	80	p	70	112
1	31	49	Q	51	81	q	71	113
2	32	50	R	52	82	r	72	114
3	33	51	S	53	83	s	73	115
4	34	52	T	54	84	t	74	116
5	35	53	U	55	85	u	75	117
6	36	54	V	56	86	v	76	118
7	37	55	W	57	87	w	77	119
8	38	56	X	58	88	x	78	120
9	39	57	Y	59	89	y	79	121
:	3A	58	Z	5A	90	z	7A	122
;	3B	59	[	5B	91	{	7B	123
<	3C	60	Reserved	5C	92	|	7C	124
=	3D	61	]	5D	93	}	7D	125
>	3E	62	Reserved	5E	94	Reserved	7E	126
?	3F	63	_	5F	95	Reserved	7F	127

(C) Undefined characters

ASCII values not specified as either “reserved characters” or “valid characters” are excluded and shall not be transmitted at any time. When it is necessary to transmit an 8-bit character defined by IEC 68859-1, three characters should be transmitted with the reserved character “^“ (HEX 5E) followed by two ASCII characters.

For example, when "127.5°" is transmitted, as “°”(HEX F8)is not valid character, “127.5 ^F8” is transmitted. To send the reserved characters <CR><LF>, ^0D^0A” is transmitted. And to send the reserved character "^", “^5E” is transmitted.

(D) Character symbols

When individual characters are used in this standard to define units of measurement, to indicate the type of data field, type of sentence, etc., they shall be interpreted according to the character symbol in Table 9.2-3.

Table 18.2-3 Character symbols, Characters used as symbols and the meaning

Character	Meanings
A	Status symbol; Yes; Data valid; Warning flag clear; Auto; Ampere, ASCII
a	Alphabet character variable A through Z or a through z
B	Bar (pressure, 1 000 mb = 100 kPa(Pascal(Pa))),Bottom
C	Celsius (Degrees); Course-up
c	Valid character; Calculating
D	Degrees (of arc)
E	Error; East; Engine
F	Fathoms (1 fathom equals 1,828 766 m)
f	Feet (1 foot equals 0,304 79 m)
G	Great circle; Green
g	good
H	Compass heading; Head-up; Hertz; Humidity
h	Hours; HEX number
I	Inches (1 inch equals 0,0254 m)
J	Input operation completed
K	Kilometres; km/h; kg/m3
k	Kilograms（kg）
L	Left; Local; Lost target
l	Latitude; Litres; l/s
M	Metres; m/s; Magnetic; Manual; Cubic metres
m	Minutes; message
N	Nautical miles; Knots; North; North-up; Newtons
n	Numeral; address
P	Purple; Proprietary (only when following "$" or "!"); Position sensor; Per cent; Pascal (pressure)
Q	Query; Target-being-acquired
R	Right; Rhumb line; Red; Relative; Reference; Radar tracking; revolutions/min (RPM)
S	South; Statute miles (1 609,31 m); Statute miles/h; Shaft Salinity parts/thousand; Simulator mode
s	Seconds; Six-bit number
T	Time difference; True; Track; Tracked target
t	Test
U	Dead reckoning estimate
u	Sign, if minus "-" (HEX 2D)
V	Data invalid; No; Warning flag set; Manual; Volt
W	West; Water; Wheelover
x	Numeric character variable
y	Longitude
Z	Time

(2) Fields

A field consists of a string of valid characters, or no characters (null field), located between two appropriate delimiter characters.

(A) Address field

An address field is the first field in a sentence and follows the "$" or “!” delimiter; it serves to define the sentence. Characters within the address field are limited to digits and upper case letters. The address field shall not be a null field. Only sentences with the following three types of address fields shall be transmitted.

(a-1) Approved address field

Approved address fields consist of five digits. The first two characters are for identifying a talker, and the type of data is identified by these two characters. The next three characters define the form and format of data. These are shown in table 4, 5 respectively.

Regarding the first two characters, equipment, which can transmit data from multiple sources, shall transmit the appropriate talker identifier. For example a device, which is equipped with both a GPS receiver and a LORAN-C receiver, transmit GP when data is transmitted by GPS, and transmits LC when data is transmitted by LORAN-C. If a ship’ s position is determined by combining both data of GPS and LORAN-C, IN is transmitted as an integrated navigation.

(a-2) Query address field

The query address field consists of five characters and is used for the purpose of requesting the transmission of a specific sentence on a separate bus from an identified talker.

The first two characters indicates the talker identifier of a device requesting data, and the next two characters indicates the talker identifier of a device being requested. The query character “Q” is used for the last one character.

(a-3) Proprietary address field

The proprietary address field consists of the proprietary character “P” and manufacturer's mnemonic code (three characters), and it is used to identify a talker issuing a proprietary sentence. Any additional character may be required, if necessary.

Valid manufacturer's codes can be obtained from NMEA (See (C) in paragraph (3) sentence).

C

Table 18.2-4 Talker Identifiers

Talker device		Identifier
Heading/track controller (autopilot)	general	*AG
Heading/track controller (autopilot)	magnetic	AP
Automatic identification system （AIS）		AI
Bridge Navigational Watch Alarm System (BNWAS)		BI
Bilge System		BN
Communications: digital selective calling (DSC)		*CD
	data receiver CR	CR
	satellite	*CS
	radio-telephone (MF/HF)	*CT
	radio-telephone (VHF)	*CV
	scanning receiver	*CX
Direction finder (DF)		*DF
Duplex Repeater Station		DU
Electronic chart system (ECS)		EC
Electronic chart display and information system (ECDIS)		EI
Emergency position indicating radio beacon (EPIRB)		*EP
Engine room monitoring system ER		ER
Fire prevention door control system		FD
Fire extinguishing system		FE

Talker device	Identifier
Fire detection system	FR
Fire sprinkler system	FS
Galileo satellite navigation system	GA
Global positioning system (GPS)	GP
GLONASS positioning system	GL
Global navigation satellite system (GNSS) GN	GN
Heading sensors: compass, magnetic	*HC
gyro, north seeking	*HE
gyro, non-north seeking	HN
Hull door control system	HD
Hull stress monitoring	HS
Integrated instrumentation	II
Integrated navigation	IN
LORAN: LORAN-C	LC
Navigation light control system	NL
Proprietary code	P
Radar and/or radar plotting	*RA
Propeller mechanism	RC
Sounder, depth	*SD
Electronic positioning system, other/general	SN
Sounder, scanning	SS
Turn rate indicator TI	*TI
Micro processor control	UP
User setting talker 0<=#<=9	U#
Velocity sensors: Doppler, other/general	*VD
speed log, water, magnetic	VM
speed log, water, mechanical	VW
Voyage data recorder VR	VR
Water proof door control system	WD
Water level detection	WL
Transducer	YX
Timekeeper, time/date: atomic clock	ZA
chronometer	ZC
quartz	ZQ
radio update	ZV
Weather instrument	WI

*: Identifiers in this standard are used for electronic navigation equipment required by IMO.

Table 18.2-5 Approved sentence formatters

Formatter	Meaning
AAM	Waypoint arrival alarm
ABK	UAIS Addressed and binary broadcast acknowledgement
ABM	UAIS Addressed and binary broadcast acknowledgement
ACA	UAIS Regional Channel Assignment Message
ACK	Acknowledge alarm

Formatter	Meaning
ACS	UAIS Channel management information Source
AIR	UAIS Interrogation Request
AKD	Acknowledge detail alarm condition
ALA	Set detail alarm condition
ALM	GPS almanac data
ALR	Set alarm state
APB	Heading/track controller (autopilot) sentence BB
BBM	AIS broadcast binary message
BEC	Bearing and distance to waypoint – dead reckoning
BOD	Bearing origin to destination
BWC	Bearing and distance to waypoint – great circle
BWR	Bearing and distance to waypoint – rhumb line
BWW	Bearing waypoint to waypoint
CBR	Configure broadcast rates for ais aton station massage command
CUR	Water Current Layer
DBT	Depth below transducer
DDC	Display dimming control
DDR	Door detection
DPT	Depth
DSC	Digital selective calling information
DSE	Expanded digital selective calling
DTM	Datum reference
ETL	Engine telegraph operation status
EVE	General Event message
FIR	Fire detection
FSI	Frequency set information
GBS	GNSS satellite fault detection
GEN	Generic binary information
GFA	GNSS pointing precision
GGA	Global positioning system (GPS) fix data
GLL	Geographic position – latitude/longitude
GNS	GNSS fix data
GRS	GNSS range residuals
GSA	GNSS DOP and active satellites
GST	GNSS pseudorange noise statistics
GSV	GNSS satellites in view
HBT	Heart beat monitoring sentence
HDG	Heading, deviation and variation
HDT	Heading true
HMR	Heading monitor receive
HMS	Heading monitor set
HSC	Heading steering command
HSS	Hull stress surveillance system
HTC	Heading/track control command
HTD	Heading/Track Control Data
LR1	UAIS Long-range Reply Sentence 1
LR2	UAIS Long-range Reply Sentence 2
LR3	UAIS Long-range Reply Sentence 3
LRF	UAIS Long-Range Function

C

Formatter	Meaning
LRI	Heading /track control data
LCD	LORAN-C signal data
MEB	Message input for broadcast, command
MLA	GLONASS almanac data
MSK	MSK receiver interface
MSS	MSK receiver signal status
MTW	Water temperature
MWD	Wind direction and speed
MWV	Wind speed and angle
NAK	Negative acknowledgement
NRM	NAVTEX receiver mask command
NRX	NAVTEX received massage
OSD	Own ship data
POS	Device position and ship dimensions report or configuration command
PRC	Propulsion remote control status
RMA	Recommended minimum specific LORAN-C data
RMB	Recommended minimum navigation information
RMC	Recommended minimum specific GNSS data
ROR	Rudder order status
ROT	Rate of turn
RPM	Revolutions
RSA	Rudder sensor angle
RSD	Radar system data
RTE	Routes
SFI	Scanning frequency information
SSD	UAIS Ship Static Data
STN	Multiple data ID
TLB	Target label
THS	True heading and status
TLL	Target latitude and longitude
TRC	Thruster control data
TRD	Thruster response data
TTD	Tracked target data
TTM	Tracked target message
TUT	Transmission of Multi-language Text
TXT	Text transmission
UID	User identification code transmission
VBW	Dual ground/water speed
VDM	AIS VHF data-link massage
VDO	AIS VHF data-link own-vessel report
VDR	Set and drift
VHW	Water speed and heading
VLW	Dual ground/water distance
VPW	Speed measured parallel to wind
VSD	UAIS Voyage Static Data
VTG	Course over ground and ground speed
WCV	Waypoint closure velocity
WAT	Water level detection
WNC	Distance waypoint to waypoint

Formatter	Meaning
WPL	Waypoint location
XDR	Transducer measurements
XTE	Cross-track error, measured
XTR	Cross-track error, dead reckoning
ZDA	Time and date
ZDL	Time and distance to variable point
ZFO	UTC and time from origin waypoint
ZTG	UTC and time to destination waypoint

(B) Data fields

Data fields in approved sentences follow a "," delimiter and contain valid characters (and code delimiters "^"). Peculiar Data fields in other sentences except approved sentences contain only valid characters and the delimiter characters "," and "^", but are not defined by IEC 61162.

Because of the presence of variable data fields and null fields, specific data fields shall only be located within a sentence by observing the field delimiters ",". Therefore, it is essential for the listener to locate fields by counting delimiters rather than counting the total number of characters received from the start of the sentence.

(b-1) Variable length fields
Although some data fields are defined to have fixed length, many are of variable length in order to allow devices to convey information and to provide data with more or less precision, according to the capability or requirements of a particular device.

Variable length fields may be alphanumeric or numeric fields. Variable numeric fields may contain a decimal point and may contain leading or trailing zeros.

(b-2) Data field types
Data fields may be alpha, numeric, alphanumeric, variable length, fixed length or fixed/ variable (with a portion fixed in length while the remainder varies). Some fields are constant, with their value dictated by a specific sentence definition. The allowable field types are summarized in Table 6.

(b-3) Null fields
A null field is a field of length zero, i.e. no characters are transmitted in the field. Null fields shall be used when the value is unreliable or not available.

For example, if heading information were not available, sending data of "000" is misleading because a user cannot distinguish between "000" meaning no data and a legitimate heading of "000". However, a null field, with no characters at all, clearly indicates that no data is being transmitted.

Null fields with their delimiters can have the following appearance depending on where they are located in the sentence: ",," ",*"
The ASCII NULL character (HEX 00) shall not be used as the null field.

Table 18.2-6 Field type summary

Special format fields

Field type	Symbol	Description
Status	A	Single character field: A = Yes, data valid, warning flag clear V = No, data invalid, warning flag set
Latitude	llll.ll	Fixed/variable length field: degrees/minutes and decimal – two fixed digits of degrees, two fixed digits of minutes and a variable number of digits for a decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal fraction are optional if full resolution is not required.
Longitude	yyyyy.yy	Fixed/variable length field: degrees/minutes and decimal – three fixed digits of degrees, two fixed digits of minutes and a variable number of digits for a decimal fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal fraction are optional if full resolution is not required.
Time	hhmmss.ss	Fixed/variable length field: hours/minutes/seconds and decimal – two fixed digits of hours, two fixed digits of minutes, two fixed digits of seconds and a variable number of digits for decimal fraction of seconds. Leading zeros always included for hours, minutes and seconds to maintain fixed length. The decimal point and associated decimal fraction are optional if full resolution is not required.
Defined field		Some fields are specified to contain pre-defined constants, most often alpha characters. Such a field is indicated in this standard by the presence of one or more valid characters. Excluded from the list of allowable characters are the following which are used to indicate field types within this standard: "A", "a", "c", "hh", "hhmmss.ss", "llll.ll", "x", "yyyyy.yy".

Numeric value fields

Field type	Symbol	Definition
Variable numbers	x.x	Variable length integer or floating numeric field. Optional leading and trailing zeros. The decimal point and associated decimal fraction are optional if full resolution is not required (example: 73.10 = 73.1 = 073.1 = 73). The specific use of this formatter and restrictions (for example integer, range) is defined in the sentence definition.
Fixed HEX field	hh-	Fixed length HEX numbers only, MSB on the left.
Variable HEX field	h--h	Variable length HEX numbers only, MSB on the left.
Fixed six-bit field	ss___	Fixed length six-bit coded characters only. See Annex C for field conversions.
Variable six-bit field	s--s	Variable length six-bit coded characters only. See Annex C for field conversions.

Information fields

Field type	Symbol	Definition
Variable text	c--c	Variable length valid character field.
Fixed alpha field	aa-	Fixed length field of upper-case or lower-case alpha characters.
Fixed number field	xx-	Fixed length field of numeric characters.
Fixed text field	cc-	Fixed length field of valid characters.

NOTE 1: Spaces should only be used in variable text fields.

NOTE 2: A negative sign "–" (HEX 2D) is the first character in a field if the value is negative. When used, this increases the specified size of fixed length fields by one. The sign is omitted if the value is positive.

NOTE 3: Units of measure fields are appropriate characters from the symbol table (Table 3) unless a specific unit of measure is indicated.

(C) Checksum field

A checksum field shall be transmitted in all sentences. The checksum field is the last field in a sentence and follows the checksum delimiter character "*". The checksum is the eight-bit exclusive OR (no start or stop bits) of all characters in the sentence, including "," and "^" delimiters, between but not including the "$" or "!" and the "*" delimiters.

(For reference: EX-OR is an abbreviation of Exclusive OR. In the case that an input signal A and an input signal B are used, only when A is 1 or B is 1 (A=1 or B=1), the output is "1". Otherwise, when both A and B are "1" etc, the output is "0".)

The hexadecimal value of the most significant and least significant four bits of the result is converted to two ASCII characters (0-9, A-F) for transmission. The most significant character is transmitted first.

Examples of the checksum field are:

$GPGLL,5057.970,N,00146.110,E,142451,A*27 and
$GPVTG,089.0,T,,,15.2,N,,,*7F.

(3) Sentences

The maximum number of characters in a sentence shall be 82, consisting of a maximum of 79 characters between the starting delimiter "$" or "!" and the terminating delimiter <CR><LF>. The minimum number of fields in a sentence is one (1).

The first field shall be an address field containing the identity of the talker and the sentence formatter which specifies the number of data fields in the sentence, the type of data they contain and the order in which the data fields are transmitted.

The remaining portion of the sentence may contain zero or multiple data fields. The maximum number of fields allowed in a single sentence is limited only by the maximum sentence length of 82 characters. Null fields may be present in the sentence and shall always be used if data for that field is unavailable.

All sentences begin with the sentence-starting delimiter character "$" or "!" and end with the sentence-terminating delimiter <CR><LF>.

(A) Description of approved sentences

Approved sentences are those designed for general use and detailed in IEC 61162 (as shown below). (in this guideline, it is not described.)
Other sentences, not recommended for new designs, may be found in practice.
Such sentences are listed in NMEA 0183. Information on such sentences may be obtained from the National Marine Electronics Association (NMEA).

An approved sentence contains, in the order shown, the following elements:

ASCII	HEX	Description
“ $ ”	24	start of sentence, starting delimiter.
<address field>		talker identifier and sentence formatter
"," <data field>		zero or more data fields
"," <data field>		
"*" <checksum field>		checksum field
<CR><LF>	0D0A	end of sentence, sentence terminating delimiter.

(a-1) Approved parametric sentence structure

The following provides a summary explanation of the approved parametric sentence structure:

ASCII	HEX	Description
“ $ ”	24	Start of sentence: starting delimiter.
aaccc		Address field: alphanumeric characters identifying type of talker, and sentence formatter. The first two characters identify the talker. The last three are the sentence formatter mnemonic code identifying the data type and the string format of the successive fields. Mnemonics will be used as far as possible to facilitate read-outs by users.
“,”	2C	Field delimiter: starts each field except address and checksum fields. If it is followed by a null field, it is all that remains to indicate no data in a field.
c----c		Data sentence block: follows address field and is a series of data fields containing all of the data to be transmitted. Data field sequence is fixed and identified by the third and subsequent characters of the address field (the sentence formatter). Data fields may be of variable length and are preceded by delimiters ",".
“*”	2A	checksum delimiter: follows last data field of the sentence. It indicates that the following two alpha-numeric characters show the HEX value of the checksum.
hh		Checksum field: the absolute value calculated by exclusive- OR'ing the eight data bits (no start bits or stop bits) of each character in the sentence between, but excluding, "$" and "*". The hexadecimal value of the most significant and least significant four bits of the result are converted to two ASCII characters (0-9, A-F) for transmission. The most significant character is transmitted first. The checksum field is required in all cases.
<CR><LF>	0D0A	End of sentence: sentence terminating delimiter.

(B) Query sentences

Query sentences are intended to request approved sentences to be transmitted in a form of two-way communication. The use of query sentences implies that the listener shall have the capability of being a talker with its own bus. Query sentences shall always be constructed with the "$" – start of sentence delimiter.

The approved query sentence contains, in the order shown, the following elements:

ASCII	HEX	description
" $ "	24	start of sentence
<aa>		talker identifier of requester
<aa>		talker identifier for device from which data is being requested
"Q"		query character, identifies query address
","		data field delimiter
<ccc>		approved sentence formatter of data being requested
"*" <checksum field>		checksum field
<CR><LF>	0D0A	end of sentence

(b-1) Reply to query sentence

The reply to a query sentence is the approved sentence that was requested. The use of query sentences requires cooperation between the devices that are interconnected. A reply to a query sentence is not mandatory and there is no specified time delay between the receipt of a query and the reply.

(C) Proprietary sentences

These are sentences not included within this standard; these provide a means for manufacturers to use the sentence structure definitions of this standard to transfer data which does not fall within the scope of approved sentences.

This will generally be for one of the following reasons:

(c-1) data is intended for another device from the same manufacturer, is device specific, and not in a form or of a type of interest to the general user;

(c-2) data is being used for test purposes prior to the adoption of approved sentences;

(c-3) data is not of a type and general usefulness which merits the creation of an approved sentence.

The manufacturer's reference list of mnemonic codes is a component of the equivalent specification NMEA 0183.*

A proprietary sentence contains, in the order shown, the following elements:

ASCII	HEX	description
" $ "	24	start of sentence
"P"	50	proprietary sentence ID
<aaa>		manufacturer's mnemonic code (The NMEA secretariat maintains the master reference list which comprises codes registered and formally adopted by
<valid characters,"^" and "," >		manufacturer's data
"*"<checksum field>		checksum field
<CR><LF>	0D0A	end of sentence

Proprietary sentences shall include checksums and conform to requirements limiting overall sentence length. Manufacturer's data fields shall contain only valid characters but may include "^" and "," for delimiting or as manufacturer's data. Details of proprietary data fields are not included in this standard and need not be submitted for approval. However, it is required that such sentences be published in the manufacturer's manuals for reference.

(D) Valid sentences

Approved sentences, query sentences and proprietary sentences are the only valid sentences. Sentences of any other form are non-valid and shall not be transmitted on the bus.

(E) Sentence transmission timing

Frequency of sentence transmission shall be consistent with the basic measurement or calculation cycle but generally not more frequently than once per 20 ms (in the case of low speed, not more frequently than once per 1second). It is desirable that sentences be transmitted with a minimum inter-character spacing, preferable as near continuous burst, but under no circumstances shall the time to complete the transmission of a sentence be greater than 100 ms (in the case of low speed, under no circumstances shall the time to complete the transmission of a sentence be greater than 1 s) .

(F) Additions to approved sentences

In order to allow for improvements or additions, future revisions of this standard may modify existing sentences by adding new data fields after the last data field but before the checksum delimiter character "*" and checksum field. Listeners shall determine the end of the sentence by recognition of "<CR><LF>" and "*" rather than by counting field delimiters. The checksum value shall be computed on all received characters between, but not including, "$" or "!" and "*" whether or not the listener recognizes all fields.

(4) Error detection and handling

Listening devices shall detect errors in data transmission including:

– checksum error;
– invalid characters;
– incorrect length of talker identifier and/or formatter;
– time out.

Listening devices shall use only correct sentences. Checksum error

(5) Example of sentence

(A) In the case of the latitude and longitude of Loran C

$LCGLL, 4728.31, N, 12254.25, W091342 and A, and A*4C<CR> <LF>
In the case that the latitude and longitude of the present location is determined by Loran C.

$:	Start of sentence
LC:	Result of positioning by Loran C
GLL:	The latitude and the longitude of the present location, 4728.3,1N: Latitude 47degrees 28, 31minutes north 12254.25, W: Longitude 122 degrees 54, 25minutes west
091342:	Positioning time, 9:13 a.m. 42-second (UTC)
A:	Receiver state: not in warning state
A:	Display mode: Independent mode
*4C:	Checksum hexadecimal number: 4C
<CR><LF>:	End of sentence

(B) Example of Query sentence

Query

$GPCRQ, MSK*2E<CR><LF>

GP:	GPS Talker Identifier of Requester (Talker)
CR:	GPS Talker Identifier for device from which data is being requested (Listener)
Q:	Query character, Identifies Query address
MSK:	MSK receiver （Beacon receiver） interface
*2E:	Checksum hexadecimal number: 2E

Reply

$CRMSK,293.0,M,100,A,10,1*6F<CR><LF>

CR:	Data receiver
MSK:	MSK receiver interface (Beacon receiver)
293.0:	Beacon frequency (kHz)
M:	Beacon frequency automatic/manual (manual)
100:	Bit rate of beacon, 100bits/second
A:	Bit rate of beacon automatic/manual (automatic)
10:	Communication interval
1:	Channel number
*6F :	Checksum hexadecimal number: 6

(6) Others

Operator manuals or other appropriate literature provided for equipment that is intended to meet the requirements of this standard shall contain as a minimum the following information:

a) identification of the A, B and common (C) signal lines;

b) the output drive capability as a talker;

c) a list of approved sentences, noting unused fields, proprietary sentences transmitted as a talker, data latency and transmission interval for each sentence;

d) the load requirements as a listener;

e) a list of sentences and associated data fields that are required by, or are acceptable to, a listener;

f) the current software and hardware revision if this is relevant to the interface;

g) an electrical description or schematic of the listener/talker input/output circuits citing actual components and devices used, including connector type and part number;

h) the version number and date of update of the standard for which compliance is sought.

As latency, filtering, error handling and data transmission interval can have a serious influence on the performance of a system, the manufacturer shall give careful consideration to these aspects. Documentation should include such data where applicable.

Therefore, information required for communication is acquired from documents attached to equipment.
Regarding details of the standard which is a basis, it is good to refer to the homepage etc. in cluase1.

C

18-3 Internatio
Cables and Connectors

Standard cables used for the connection between listeners and a talker are the same as serial interface cables used for connecting peripheral equipment with personal computers. And three kinds of standard cables meeting the standard for RS-232C, RS-422 and RS-485 are mainly used. Such standards define the allocation of the signal line of the port (at terminal) of equipment and are not the standard for connectors.

Although various types of connectors are adopted for every talker or listener, some typical types are shown below.

18-3-1 RS-232C

This is one of EIA (Electronic Industries Association) standards and the oldest one in three standards. Although the official name of this standard came to TIA/EIA-232-E in 1994, a name called RS-232C usually used till then is still used in many cases.

The feature is shown in Table 7. Since a signal is an unbalanced type a logical value of which always determined in comparison with 0V, the minimum sensitivity to an input level is high. Therefore, since it takes time for a status to change from a logical level 0 to 1, it is not suitable for a high-speed communication in comparison with RS-422 etc. shown blew.

D-sub 25-pin connector is used widely. The arrangement of pins and the shape of a connector are shown in Figure 9.3-1 and the assignment of typical signals is shown in Table 9.3-2. However, as a certain connector may have a peculiar assignment, making reference to each manual is actually needed when used.

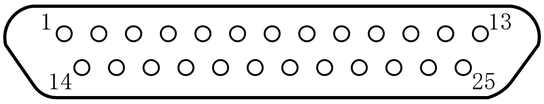


Figure18.3-1 D-sub25 connector (male) Pin arrangement

Table 18.3-1 Feature of RS-232C

Connectable Number	Talker 1 Listener 1
Maximum cable length	15 m: at 19.2k bps
Maximum data rate	19.2k bps: at 15 m
Signal	Unbalanced
Logical level 1	-5V Minimum -15V Maximum
Logical level 0	5V Minimum 15V Maximum
Minimum input level sensitivity	±3V
Output current	500mA

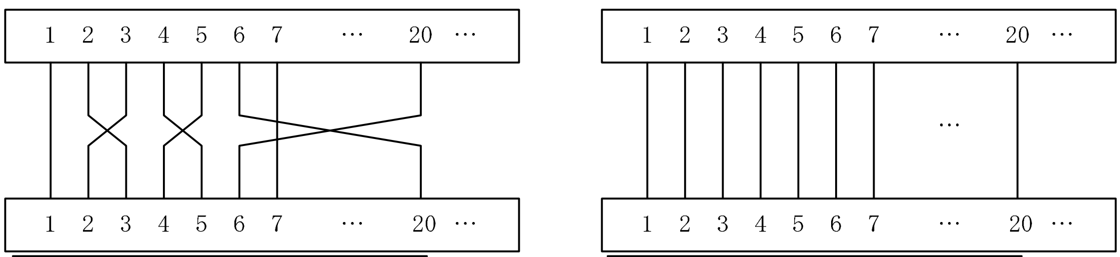
Table 18.3-2 Assignment of pins for RS-232C (EIA-232)

Pin number	Abbreviation for Signal Name	Direction	Signal Name and Description*
1	PG	G	Protective Ground
2	TxD	O	Transmitted data
3	RxD	I	Received data
4	RTS	O	Request To Send
5	CTS	I	Clear To Send
6	DSR	I	Data Set Ready
7	GND	G	Common Ground
8	DCD	I	Carrier Detect
15	STCE	I	Sending Timing of DCE*
17	SCR	I	Receive Timing of DCE*
20	DTR	O	Data Terminal Ready
22	RI	I	Ring Indicator
24	DCTE	O	Transmitting Timing of DTE*

Pins seldom used are not described in this document.
“Symbol”: Each abbreviation in the "symbol" column is used as a common name.
"Direction": an input I is “I”, and output is “0”, looking toward a talker from a listener and G means ground.

A listener is called DTE (Data Terminal Equipment). On the other hand, the other side equipment is called DCE (Data Communications Equipment). As for the pin arrangement of DCE, in arrangement of pins in Table 9.3-2, pins change as pin 2 to pin 3, pin 4 to pin 5, and pin 6 to pin 20 respectively. That is, an output "Transmitted data" of No. 2 pin of DTE corresponds to an input "Received data" of No. 2 pin of DCE. Therefore, what is necessary is just to use the cable (called “straight cable”) which connects between the same pin numbers, when connecting DTE and DCE. These are shown in Figure 9.3-2.

However, DCE type is not always used for all the talkers and DTE type may be used instead of DCE. In that case, a cable, both wire ends of which are crossed as No. 2 cable to No. 3, No. 4 to No. 5, and No. 6 to No. 20, is used. A cable of this type is called “cross cable or reverse cable”. Even if RS-232C standard is applied, as about nine pins are usually sufficient for simple communication of signals, except for in the complicated signal control. Therefore, a connector of nine pins is defined as EIA-574 standard or D-Sub9 pin. It may be called RS-232C of nine pins. It is equipped in DOS/V computers in many cases. The connector shape of nine pins is shown in Figure 9.3-3 and assignment of pins is shown in Table 9.3-3.



Cross cable for DTE-DTE connection

Straight cable for DTE-DCE connection

Figure 18.3-2 Cross cable and straight cable

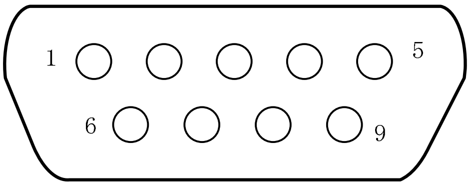


Figure 18.3-3 Pin arrangement D-sub9 pin (male)

Table 18.3-3 Pin assignment of EIA-574

Pin number	Abbreviation for Signal Name	Direction	Signal Name and Description*
1	DCD	I	Carrier Detect
2	RxD	I	Received data
3	TxD	O	Transmitted data
4	DTR	-	Data Terminal Ready
5	GND	G	Common Ground
6	DSR	I	Data Set Ready
7	RTS	O	Request To Send
8	CTS	I	Clear to Send
9	RI	-	Ring Indicator

18-3-2 RS-422

In comparison with RS-232C, a high speed and a further-distance data communication is possible. Main features are shown in Table 9.3-4.

Table 18.3-4 Feature of RS-422

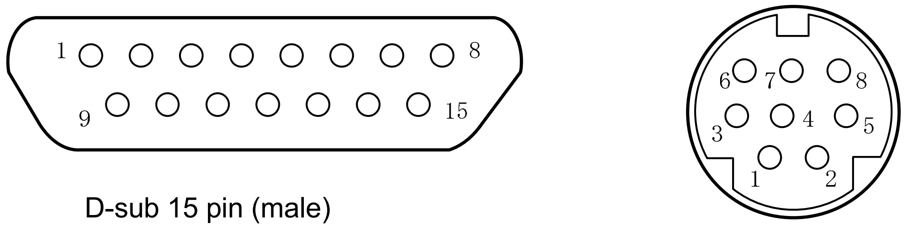
Connectable number	Talker 1, Listener 10
Maximum cable length	1200 m: at 100K bps
Maximum data rate	10Mbps: at 15 m
Signal	Balanced
Logical level 1	-0.3 V minimum, -6V maximum
Logical level 0	0.3 V minimum, 6V maximum
Minimum Input level sensitivity	0.2V difference
Output current	150mA

In this standard, two signal lines are separated from ground, and when one side voltage is high, the other side voltage is to be low. At receiving sides, as two voltages are compared and then it is confirmed whether the result is “0” or “1”, even if a voltage difference decreases due to voltage drop etc., errors seldom happen.

In order to avoid the distortion and the attenuation of a signal of high frequency, it is necessary to set a terminator between two input terminals of a listener which is most distant from a talker. In order to stabilize the output levels of Pins not used in talker side, input terminal (TLL input side)shall be connected to GND or to Vcc. And pins not used in listener sides shall be left open, if a fail-safe circuit is internally fitted. If a fail-safe circuit is not internally fitted, in order to stabilize an output level, input A shall be connected to Vcc, and input B shall be connected to GND.

Regarding RS-422, a connector of 15 pins in accordance with ITU-T V.10 or X.26 or Mini-DIN-8 pin is used in many cases. Mini-DIN-8 pin used in personal computers of Macintosh is called a modem port.

The shapes of connectors are shown in Figure 9.3-4 and the assignment of pins is shown in Table 9.3-5.



D-sub 15 pin (male)

Mini-DIN-8

Figure 18.3-4 Pin arrangement of D-sub 15 pin (male) and Mini-DIN-8

Table 18.3-5 Pin allocation of RS-422

Pin number	Symbol	Direction	Meaning
2	T	O	Transmitted data
4	R	I	Received data
8	G	-	Signal ground or common return
9	Ga	O	DTE common return
11	Gb	I	DCE common return

18-3-3 RS-485

RS-485 is basically the same as RS-422. Main features are shown in Table 18.3-6.

Table 18.3-6 Feature of RS-485

Connectable number	Talker 32, Listener 32
Maximum cable length	1200 m: at 100K bps
Maximum data rate	15 m: at 10Mbps
Signals	Balanced
Logical level 1	-1.5V minimum, -5V maximum
Logical level 0	1.5V minimum, 5V maximum
Minimum Input level sensitivity	0.2V difference
Output current	250mA

Although the type of a signal cable and a connector of RS-422 are also compatible with the specification of RS-485, since a data collision protection circuit is not fitted in talker of RS-422, RS-422 cannot be used within a system using RS-485 standard.

D. Navigation and Fishing System

D

1. Positioning System Used Now

The table of systems using satellites is shown below.

Table 1 Global Positioning System

Satellite	GPS	GLONASS	Galileo	BeiDou	IRNSS
Management entity	United States Department of Defense	Russian Federal Space Agency	European Union (EU)	China National Space Administration	Indian Space Research Organization
Service area	Global	Global	Global	Global (At present Particular area)	At present Particular area
Orbit	Altitude approx. 20,000 km, circular orbit, orbit inclination 56 °	Altitude approx. 19,100 km, circular orbit, orbit inclination 64.8 °	Altitude approx. 23,222 km, circular orbit, orbit inclination 56 °	MEO: Altitude approx. 21,500 km, circular orbit, orbit inclination 55 ° IGSO: Altitude 36,000 km, circular orbit, orbit inclination 55 ° GSO: East longitude 60 ° , 84 ° , 110.5 ° , 144.5 ° , 160 °	IGSO: Altitude approx. 36,000 km, circular orbit, orbit inclination 29 ° GSO: East longitude 32.5 ° , 83 ° , 131.5 °
Constellation	24 satellites of 6 orbit planes x 4 satellites + spare satellite on orbit 27 satellite system was shifted after June, 2011.	24 satellites of 3 orbit planes x 8 satellites + spare satellite on orbit	27 satellites of 3 orbit planes x 9 satellites + 3 spare satellites on orbit Total 30 satellites	MEO: 27 satellites of 3 orbit planes x 9 satellites GEO: 5 satellites IGSO: 3 satellites Total 35 satellites	GEO: 3 satellites IGSO: 4 satellites of ground track 2 x 2 satellite Total 7 satellites
Service purpose (Target positioning accuracy)	For military use For consumer use (accuracy 10 m or less)	For military use For consumer use (present conditions, accuracy 5-7m. Aiming at the accuracy improvement by satellite renewal)	For consumer use (accuracy 4 m or less) (traffic navigation, the police and fire fighting, refuge rescue, etc. are especially borne in mind)	For military use For consumer use (Accuracy 10m or less. Aiming for accuracy 1m by the combination with the wide area reinforcement service)	(Aiming for accuracy 20 m or less)
Positioning signal	For consumer use: L1 C/A, L2C, L5, L1C (Block III-) For military use: L1P, L2P, L1-M, L2-M	For consumer use: L10F, L20F, L30C (GLONASS-K-) For military use: L1SF, L2SF	For consumer use: OS:E1, E5a, E5b CS:E1,E5a/b, E6 For public use : PRS, E1, E6	For consumer use: B1-C, B-2a, B-2b For military use: B1, B3, -A	For consumer / public use: L5 S band
Operational situation	31 satellites are operating at the present in April, 2013.	29 satellites are operating a test at the present in April, 2013 (the satellite which can be used in it is 23 satellites).	4 satellites are operating a test at the present in April, 2013.	16 satellites are operating at the present in November, 2012.	As of April, 2013, there is no announce of a first number satellite launch.

As a reinforcement system of GPS, there are QZSS (Japan), EGNOS (EU), WAAS (U.S.), and MSAS (Japan).

There is LORAN C of a ground system as systems other than a satellite. LORAN C: LOng RAnge Navigation C

Frequency: 100 kHz, main station, and slave station:2-4, a types of radio wave: pulse,
Effective range: 1,000NM from a main station, and less than accuracy:100m (inside of an effective range)

(by Japan Coast Guard: LORAN C)

* In Japan, it was abolished all with GMT0:00 on February 1, 2015.

D

2. GPS (Global Positioning System)

2-1 Outline

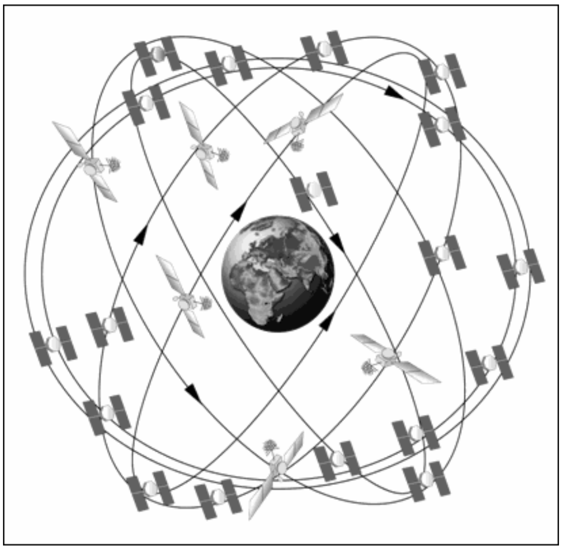
The first satellite of GPS system was launched in 1978 and 24 satellites which were originally planned were completed in 1994.

(The system is under operation using 31 satellites, as of October, 2008.)

The whole system consists of control portion, space portion and user portion. The control portion consists of the Monitor Station (MS) which measures the orbits of the satellites, etc., main control station (MCS: Master Control Station) which controls Monitor Stations and calculates orbital values, and Transmitting Station (US: Up-Station) which transmits orbital information etc. to satellites. Transmitting station transmits orbital information, clock drift and data of propagation delay to each satellite once a day. Old data are replaced with such data and modulated as navigation signals.

24 satellites go around on nearly round elliptical orbit of orbit inclination (angle to the equator) of 55 degrees and altitude of 20,183 km, and cycle of each satellite is 12 hours (accurately 11-hour and 58-minute 02. 02-second: 0.5 sidereal day). Four artificial satellites are arranged on each of six orbital planes. In this case, at least four satellites can be observed at an elevation angle of five degrees or more and five satellites can always be observed on the horizon.

Accuracy obtained by using L band (1575.42 MHz) is about 10m(2drms) since SA was ceased in May ,2000.



Orbital plane 1: No. 7, 24, 30, 31

Orbital plane 2: No. 3, 12, 16, 25, 28

Orbital plane 3: No. 17, 19, 27, 29

Orbital plane 4: No. 1, 2, 4, 6, 11, 21

Orbital plane 5: No. 5, 10, 18, 20, 22, 32

Orbital plane 6: No. 9, 13, 14, 15, 23

Data from Japan Coast Guard. Jan.29 2015

Fig. 1. GPS Satellites and their Orbits

2-2 Technique of position determination

Four satellites are usually required, and using the orbital data transmitted from satellites, a receiver chooses four satellites automatically so that the best positioning may be obtained. Distances to four satellites can be found from propagation time and the velocity of light. Since information of 6 orbital elements are transmitted, a receiver calculates a position of each satellite based on the information at the time of signal transmission. It is necessary to synchronize time of a satellite with time of GPS first. GPS time can be obtained using atomic Frequency Standard of a satellite and clock compensation value transmitted from Control Segment of the satellite. If the receiver synchronizes with GPS time correctly, three satellites are enough for calculation, and position can be calculated based on an intersection of three spheres centering on the respective satellite. The 4th satellite is used for error presumption of the clock of the receiver. In this case, four unknown factors are included in the equation of position determination. That is, it is a three-dimensional position (latitude, longitude and altitude) and the clock of the user receiver.

Since the clock which is not so accurate is used in the receiver, the measurement distance is called false distance (Pseudo-Range) and the fixed bias based on a clock error is included in it. And a definition is given as follows (refer to Fig. 2).

$\overline{R_i}=R_i+C\,(t_{Ai}+C\,(t_u-(t_{Si})))$

Here

$\overline{R_i}$: False distance to a satellite

R_i: True distance

C: Velocity of light

(Δts_i: Offset of i position satellite time from GPS time)

(Δt_u: Offset of clock of a receiver from GPS time)

(Δt_{Ai}: Propagation delay time and other errors)

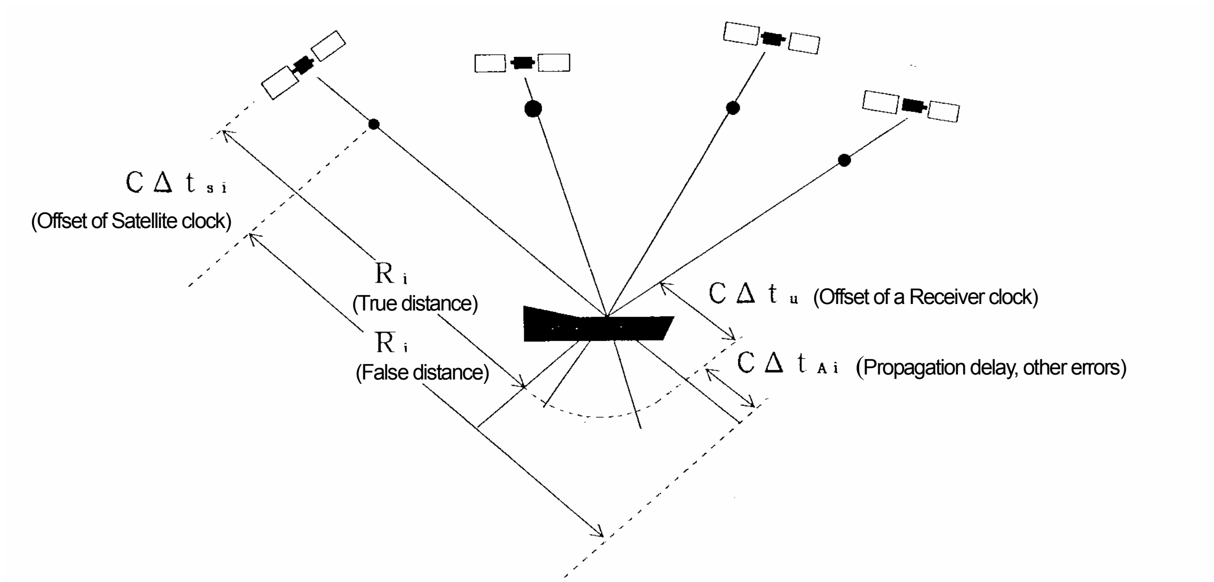


Fig. 2 True distance and false distance

Phase shift of PN code (false noise) generated in the GPS receiver which coincides with satellite phase is measured, and false distance propagation time is measured. The PN code of the receiver is shifted until correlation with the received PN code reaches the maximum. The shift time is the measured value of false distance propagation time.

Determination of user position is obtained subtracting fixed distance bias from each presumed distance (measured false distance). Although circles centering respective satellites are drawn at the respective radius of the false distances, the circles do not intersect at a point. Circles with the respective radius obtained by subtracting (or adding) C·Δtu from (to) false distances intersect at a point and it is user's position.

3. GPS Compass

3-1 Outline

Although gyrocompasses and magnetic compasses are generally installed in a ship and heading is obtained using these compasses, attention is drawn to GPS compass which replaces these traditional compasses and is cheap and accuracy of which is equivalent to or more accurate than gyrocompasses. According to the carriage requirement of new SOLAS-V as of July, 2002, all passenger ships and all ships of 300 to 500 GT engaged on International voyage were required to be fitted with THD (Transmitting Heading Device). Furthermore, ISO standard ISO 22090-3 of THD was enacted, and GPS compass was also able to be used as THD using GNSS Principle. In revision of the MED list expected in the near future, GPS compass is expected to be MED equipment and it is considered that use of GPS compass will be expanded further from now on.

3-2 Difference between GPS compass and GPS

Difference between a direction measured by using GPS compass and a direction measured by using general GPS navigation equipment is explained. Each content of measurement is as follows.

- GPS compass: Heading
- GPS navigation equipment:: progressing direction

As shown in Fig. 1, heading and progressing direction do not coincide with each other due to influence of tide or wind, and it may completely be reverse depending on the case.

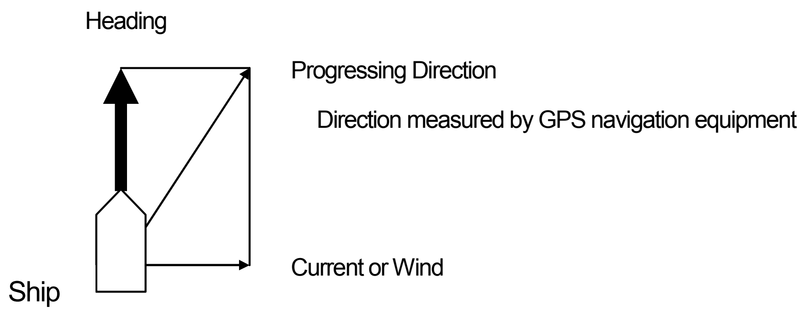


Fig. 1 Heading and progressing direction

Although heading is obtained traditionally by using direction sensor such as gyrocompass or magnetic compass, there are an advantage and a fault respectively. Gyrocompass has sufficient accuracy, but it is expensive and it takes time to settle. Moreover, Gyrocompass has a problem such as inaccuracy in high latitude areas.

Magnetic compass is cheap and is easy to use, but it has a fault of instability. GPS compass can resolve such faults and it can be said that it is a next-generation direction sensor.

Comparison of sensors aforementioned is shown in Table 1.

Table 1　Comparison of sensors

	GPS compass JLR-21/31	Gyrocompass	Magnetic compass
Maintenance	not required	Required	Required　(Correction of deviation and deflection)
Settling time	Less than 2 minutes (About 30 seconds)	About 2 to 3 hours	not required
Follow-up	Quick.	Middle rank	Late.
Accuracy	Good.	Good.	Bad. (unstable,　being easily influenced by circumference environment)
Compensation	not required	Latitude compensation	Deflection compensation

D

4. ECDIS and INS

4-1 Outline

ECDIS (Electronic Chart Display System) can display information such as own ship position, course, speed ,etc. required for safe navigation other than Electronic Navigational Chart (ENC) which has been published under Each Government Organization such as the Hydrographic Department.

ECDIS consists of a display part, a control part, and a processing part, and in the processing part, hydrographic information displaying, input signal processing and realtime route monitoring are carried out. The conceptual scheme of ECDIS display are shown in Fig.1 respectively.

ECDIS is described in the Performance Standards for ECDIS adopted by IMO (International Maritime Organization) as follows.
"ECDIS means a navigation information system, which, with adequate back-up arrangements, can be accepted as complying with the up-to-date chart required by regulation V/20 of the 1974 SOLAS Convention, by displaying selected information from a system electronic navigational chart (SENC) with positional information from navigation sensors to assist the mariner in route planning and route monitoring, and by displaying additional navigation-related information if required."

ENC is a vector method type of Hydrographic Chart which is compatible with IHO Transfer Standard for Digital Hydrographic Data "S-57" about hydrographic information specified by International Hydrographic Organization, but since it is not suitable for being displayed as a hydrographic chart due to its data structure, it is transformed into SENC (System ENC) for use. The hydrographic chart is updated by taking the latest information periodically published about ENC into SENC. SENC is displayed as a hydrographic chart which is processed according to Standard S-52 Appendix 2 "Color and Symbol Specifications for ECDIS" published by IHO.

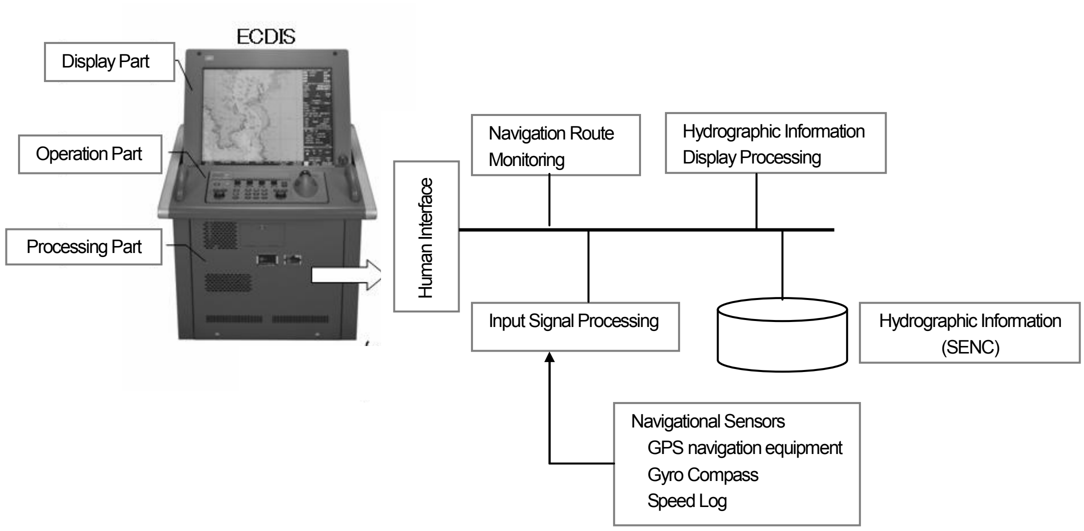


Fig. 1 Conceptual Scheme

The main functions of ECDIS are shown below.

- All the information in SENC can be displayed.

- There are two steps such as the first step of "cautions" by indication and the second step of the "alarm" by a visible alarm and an audible alarm. An alarm is be provided when own ship is going to cross the safety depth contour or reaches a dangerous area closely.
- An alarm should be provided when the actual position of own ship deviates from the planned track beyond a preset cross track limit, or when own ship is reaching the next waypoint.
- A caution indication should be provided when the planned route crosses a safety contour line or a dangerous area.
- can preserve the record of the previous 12 hours and of the voyage track to reconstruct the Navigation.
- may display radar image information and other ships' information of a radar and an AIS (Automatic Identification System)

Integration of systems like Integrated Navigation System (INS), which is a combination of systems, such as a Conning Display, which indicates various navigation information, Radars, an Autopilot and ECDISs, which are interconnected between or to, aiming at safe and efficient navigation, and the other integration of systems like IBS (Integrated Bridge System), which is a combination of INS, Machinery systems and Cargo systems, etc., have progressed. And ECDIS serves as a core of such systems.

As future trends, expansion of ships which is fitted with ECDIS, and development of S-100 that a data structure type and time-varying information like a current is added to S-57 has been also considered.

D

4-2 ECDIS

4-2-1 ENC and its Updating

Since ENC is not suitable for being displayed as a hydrographic chart due to its data structure, it is transformed into system ENC (SENC) for use. The hydrographic chart is kept latest by taking the up-to-date information periodically published about ENC into SENC. SENC is displayed as a hydrographic chart which is processed according to Standard S-52 Appendix 2 "Color and Symbol Specifications for ECDIS" published by IHO. This structure is shown below.

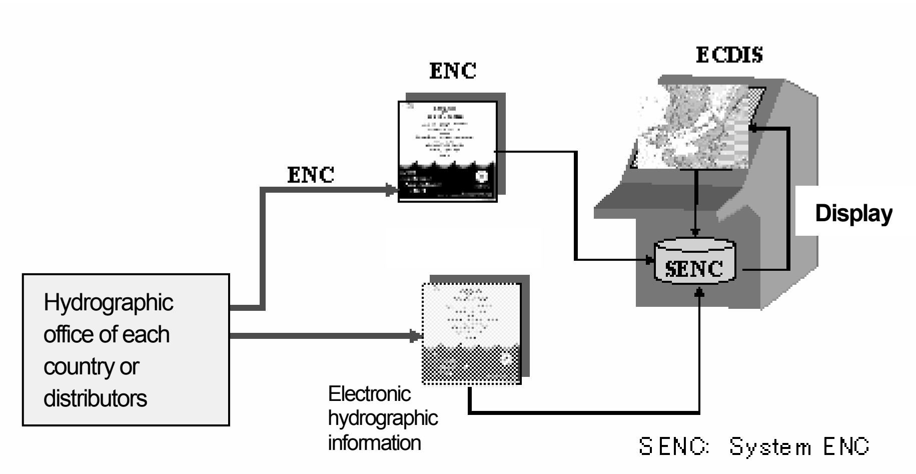


Fig. 2 Chart Updating Flow

4-2-2 Electronic hydrographic charts applicable to JRC ECDIS

Since ENCs published by the Hydrographic Office of each country have not covered the whole world yet, other types of charts overing the area uncovered by ENC are used as well. Types of Electronic hydrographic charts which are applicable for JRC ECDIS are shown below.

Table 1

	ENC	AVCS	C-MAP	ARCS
Publisher	Hydrographic Office of each country	UK Hydrographic Office	Jeppesen	UK Hydrographic Office
Data format	Vector data	Vector data	Vector data	Raster data
Cover area	This does not cover all charts in the whole world.	This covers charts in the whole world.	This covers charts in the whole world.	This covers charts in the whole world.
Feature	The electronic hydrographic chart officially accepted by IMO. It can be used instead of a paper chart.	I addition to official ENC published in each country,Official ENC is covered in vector chart that UKHO developed an area of non-publication priginally.	The original vector chart by the private company. This covers charts for the whole world and it is known all over the world. Other than formal ENC, there is C-MAP ENC which C-MAP company developed originally	This covers charts for the whole world and it is known all over the world In the area that ENC chart can use, you must give priority to ENC chart.

According to the Performance Standards for ECDIS adopted by IMO, it is defined that, when ENCs are not produced or not published, RNCs can be used in ECDIS instead to satisfy the carriage requirements of charts on board a ship. However, when using RNCs in ECDIS, an appropriate portfolio of up-to-date paper Charts are carried onboard a ship and are used together with RNCs.

RNC: Raster Navigational Chart
a facsimile of a paper chart originated by, or distributed on the authority of, a government-authorized hydrographic office. RNC is used in these standards to mean either a single chart or a collection of charts

4-2-3 Vector data and Raster data

(1) Vector data

Vector data consists of attributes and coordinate values.

The following data are taken for instance.

Table 2

No.	Attribute 1	Attribute 2	Coordinate value
P0	Black	Solid line	(x0,y0)
P1	Black	Solid line	(x1,y1)
P2	Black	Solid line	(x2,y2)
P3	Red	Solid line	(x3,y3)
P4	Red	Dotted line	(x4,y4)
P5	Red	Dotted line	(x5,y5)

If a computer reads these data and displays such data, it is shown in the following figure. Moreover, for an attribute, it is possible to define data such as the coastline and depth contour other than color and the types of lines freely.

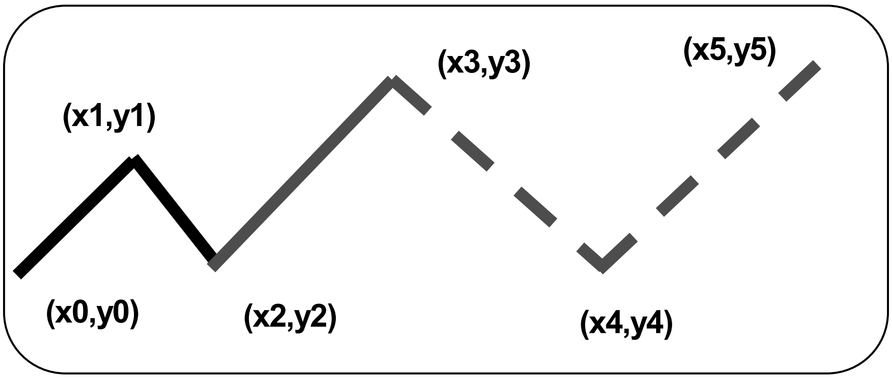


Fig.3 Vector data

(2) Raster data

Raster data consists of a collection of pixels (points). A pixel is the minimum component of display. This data only has the information of color as an attribute. When people watch what is displayed on a screen, people can recognize what it is. But a computer cannot recognize.

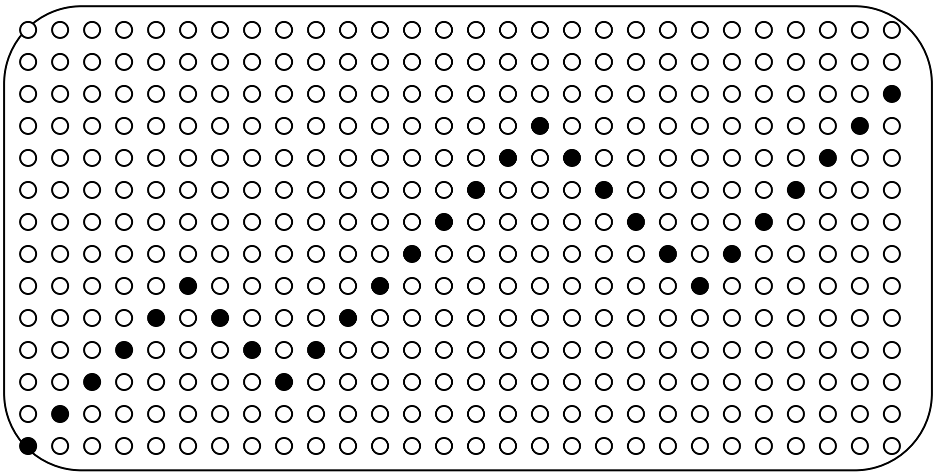


Fig.4 Raster

4-3 Performance requirements

The performance requirements of ECDIS are shown below.

(1) All the SENC information can be displayed.

(2) A safety contour and a safety depth can be chosen, emphasized and displayed.

(3) ENCs can be updated and a means for ensuring of loading it into SENC should be provided.

(4) The same Geodetic System should be used for all navigation information inputted to ECDIS. (WGS-84).

(5) A means of setting waypoints is provided in route planning, and addition, cancellation, revision ,etc. can be carried out.

D

(6) Route monitoring, during which the waters included in ENC can be drawn out arbitrarily, can be performed, and when the own ship's planned routes are included in a screen being displayed, the own ship's position can be always displayed on the screen.

(7) The recorded last 12 hours' voyages can be played back.

(8) Have the following alarm function.

- when planned routes cross safety contours.
- when own ship's position deviates from the planned track beyond a preset cross track limit.
- when approaching a waypoint.
- when interfaced equipment is abnormal.

(9) The display size for route monitoring should be not less than 270x270 mm.

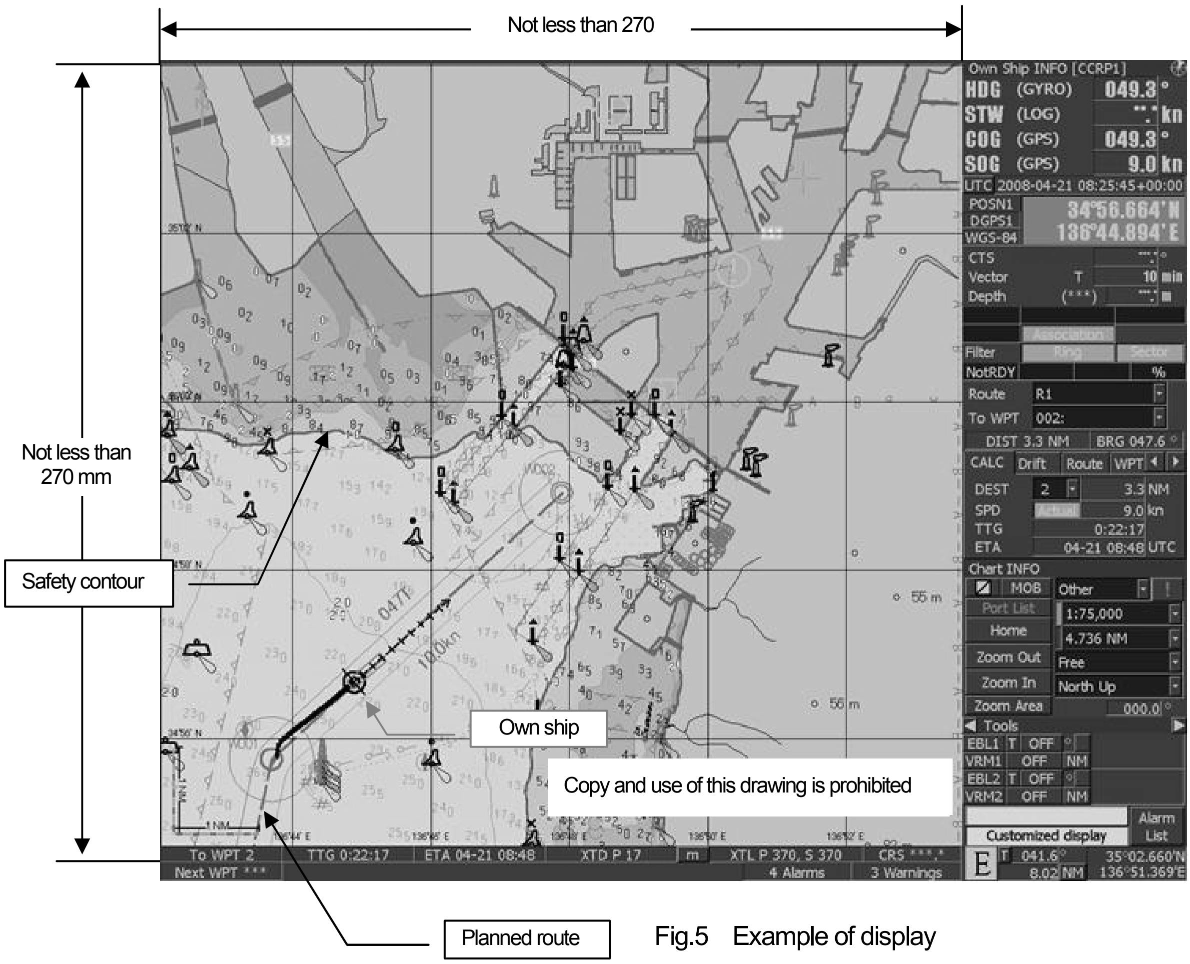


Fig.5 Example of display

4-4. Being made mandatory for the carriage of ECDIS

SOLAS Chapter V Regulation 19 Paragraph 2.1.4 was revised in the 86th Maritime Safety Committee held in June, 2009 (MSC86), and the mandatory for the carriage of ECDIS was decided. According to the following schedules, ECDIS is gradually introduced to a new building ship and the existing ship.

Table 1: The schedule for being made mandatory of the carriage for new ship

	Passenger ship 500 GT and upward	Tanker 3000 GT and upward	Cargo ship except tanker 10000 GT and upward	Cargo ship except tanker 3000 GT and upward
Applied object	Ship which starts to construct after July 1, 2012	Ship which starts to construct after July 1, 2012	Ship which starts to construct after July 1, 2013	Ship which starts to construct after July 1, 2014
Application time	At the time of completion	At the time of completion	At the time of completion	At the time of completion

Table 2: The schedule for being made mandatory of the carriage for existing ship

	Passenger ship 500 GT and upward	Tanker 3000 GT and upward	Cargo ship except tanker 50000 GT and upward	Cargo ship except tanker 20000 GT and upward	Cargo ship except tanker 10000 GT and upward
Applied object	Ship which starts to construct before July 1, 2012	Ship which starts to construct before July 1, 2012	Ship which starts to construct before July 1, 2013	Ship which starts to construct before July 1, 2013	Ship which starts to construct before July 1, 2013
Application time	The first ship survey* after July 1, 2014	The first ship survey* after July 1, 2015	The first ship survey* after July 1, 2016	The first ship survey* after July 1, 2017	The first ship survey* after July 1, 2018

* The first ship survey: the first periodic survey after a designated date (MSC.1/Circ.1290)

D

4-5 Acquisition of ENC

4-5-1 Encryption of ENC and Acquisition of the license for decryption

Most of ENCs are encrypted in accordance with S-63 (IHO Special Publication No.63) defined by IHO and provided to users.

Users can use ENC by acquiring a license according to the following flow. "key (Cell Permit)" shown in the following figure corresponds to a license. In addition, five sets of ECDIS can be used with one license per ship.

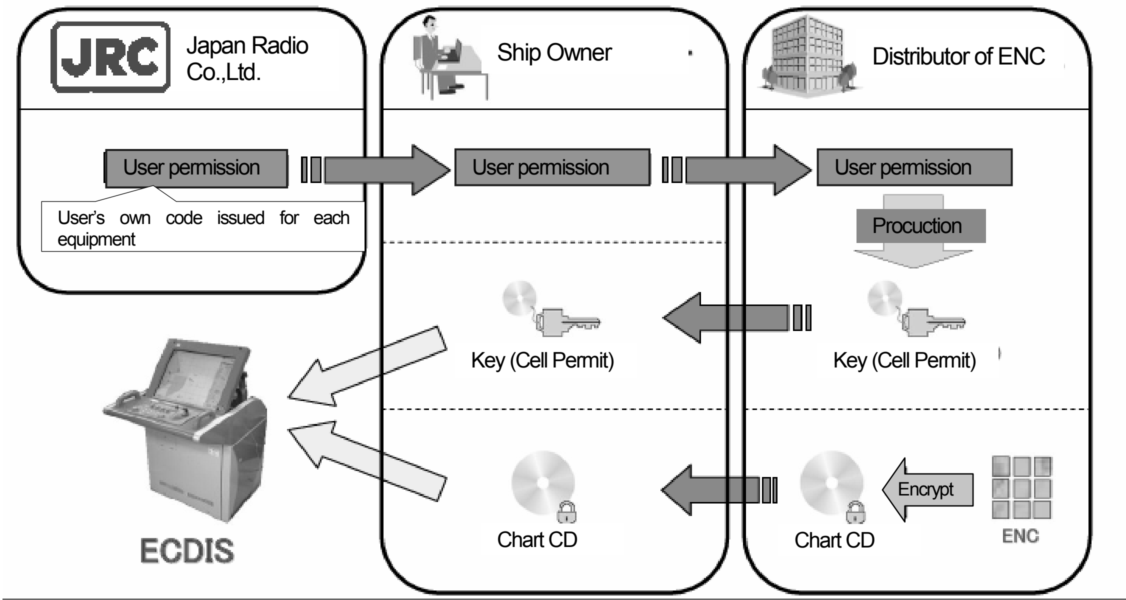


Fig.6 Acquisition of license

4-5-2 Introduction of C-MAP

C-MAP CM93/3 of Jeppesen Marine are introduced in the following procedures.

- inform C-MAP of eToken* number.
- one set of CD-ROMs which covers the whole world is sent from C-MAP.
- load the CD-ROM sent from C-MAP in ECDIS.
- select an area which will be used in ECDIS
- file for order is created and it is sent to C-MAP.
- licensed file is sent from C-MAP.
- licensed file is loaded in ECDIS and then the ordered area of C-MAP chart can be displayed.

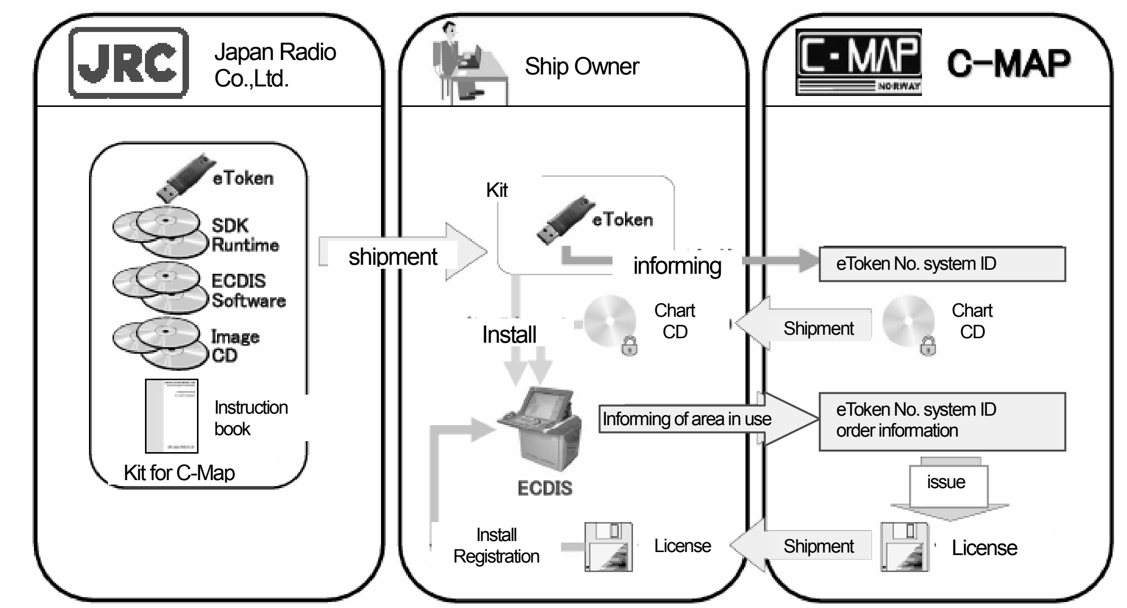
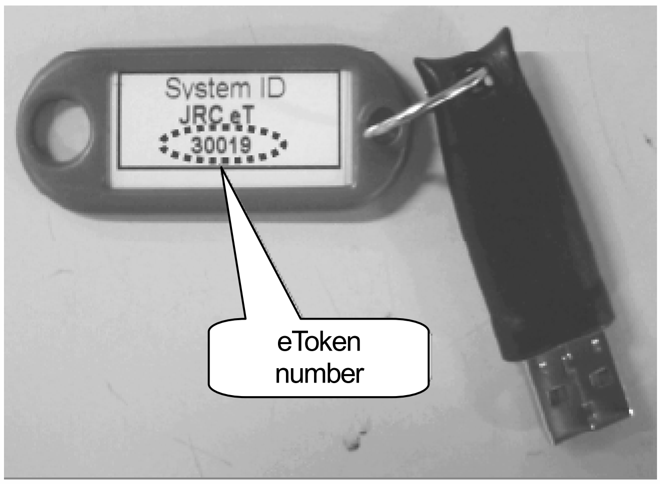


Fig.7 Introduction of C-MAP

*** eToken and its number**

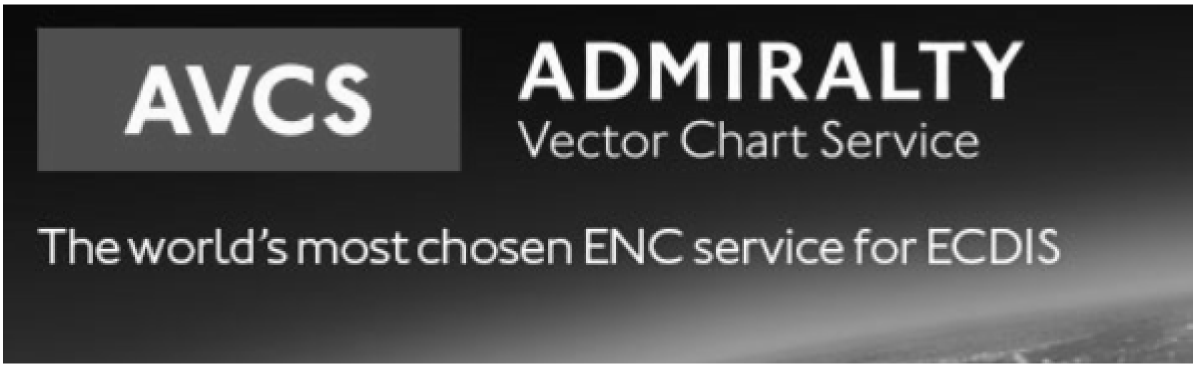
eToken is an option item and the device shown below is inserted in USB memory jack of ECDIS.



eToken

4-5-3 AVCS(Admiralty Vector Chart Service)

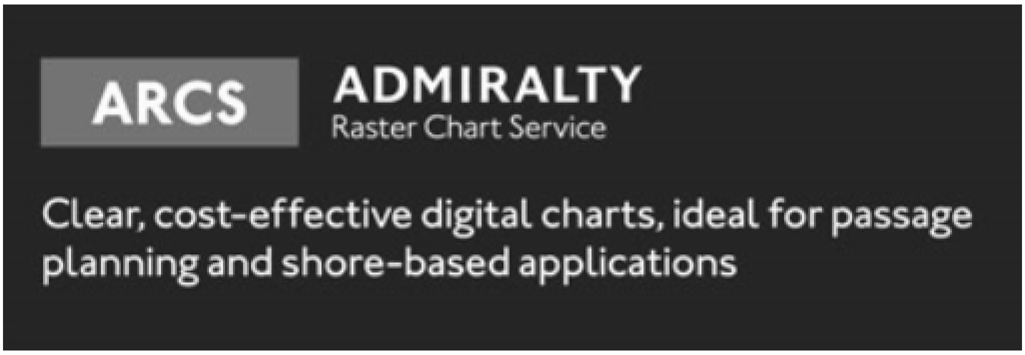
AVCS is the service which covered the whole world mostly by Vector chart which UKHO developed uniquely in addition to Official ENC. Since a contract of a license form can be made in 3, 6, 9, and 12 months, it can hold down the license cost of an electronic chart. The package purchase the object for a general voyage, the object for coasting, for port approach, etc. is possible.



Picture quotation: https://www.ukho.gov.uk/ProductsandServices/ElectronicCharts/Pages/AVCS.aspx

4-5-4 ARCS(Admiralty Raster Chart Service)

It is what carried out the digital copy of the British style version paper chart which UK Hydrographic Office (UKHO) created, and the same thing as a paper chart is displayed on a screen. Although the whole world is covered, in the place which can use ENC for a complement use until ENC is maintained must give priority to ENC.



Picture quotation :https://www.ukho.gov.uk/ProductsandServices/ElectronicCharts/Pages/ARCS.aspx

4-5-5 Jeppesen Chart (Old C-MAP Chart)

This chart is digital chart data (Vector chart) made from Jeppesen Norway (old C-MAP Norway).

There are the following three kinds as vector chart products.

- Jeppesen PRIMAR ECDIS Service
- Jeppesen ENC Service
- Jeppesen Professional+

JEPPESEN
A BOEING COMPANY

However, since Jeppesen Professional+ is not ENC, it does not conform to the requirements for the carriage of a chart.

Moreover, Jeppesen PRIMAR ECDIS Service is a product in which ENC and Jeppesen Professional+

were composed, and does not conform to the requirements for the carriage of a chart in the ocean area which has not purchased the license of ENC.

Picture quotation: http://ww1.jeppesen.com/index.jsp

4-5-6 AIO(Admiralty Information Overlay)

AIO (Admiralty Information Overlay) is additional information service original with UKHO (British Hydrographic Department), and can display supplementary information, such as T&P Notice to Mariner (momentary relation report) on ENC. It enables this to acquire information required for a voyage efficiently.

Fig.8 The display example of AIO information (enclosure portion of a red dashed line)

D

4-6 Track Control System (TCS)

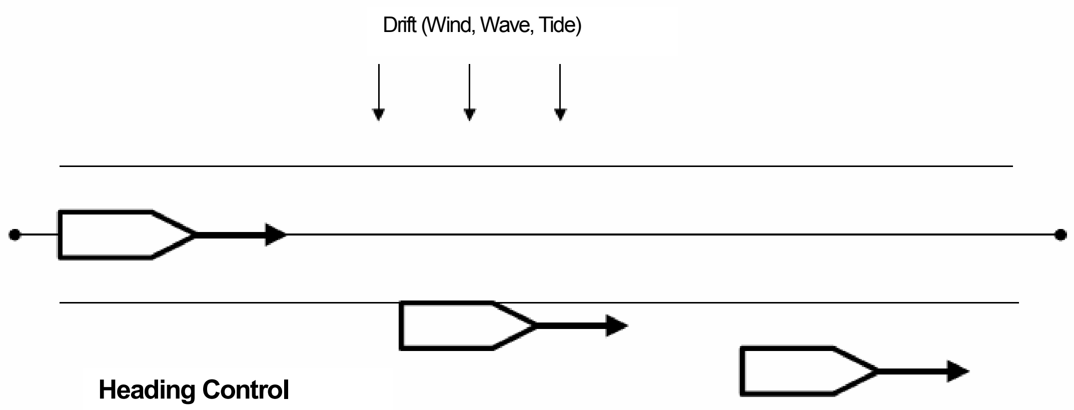
According to the revised SOLAS chapter V Regulation 19 "Carriage requirements for shipborne navigational systems and equipment", all ships of 10,000 gross tonnage and upwards are required to have a heading control system (HCS) or track control system (TCS), or other means, to automatically control and keep to a heading and/or straight track. An autopilot is normally installed on board a ship and it is fitted with Heading Control function. In JRC ECDIS, TCS which is fitted with in ECDIS is interfaced with an Autopilot to meet the SOLAS requirement.

In addition, TCS provided by JRC is established by interfacing it with only autopilots of YOKOGAWA Denshikiki Co., Ltd. And TOKIMEC, Inc..

4-6-1 Characteristics of Heading Control System /Track Control System

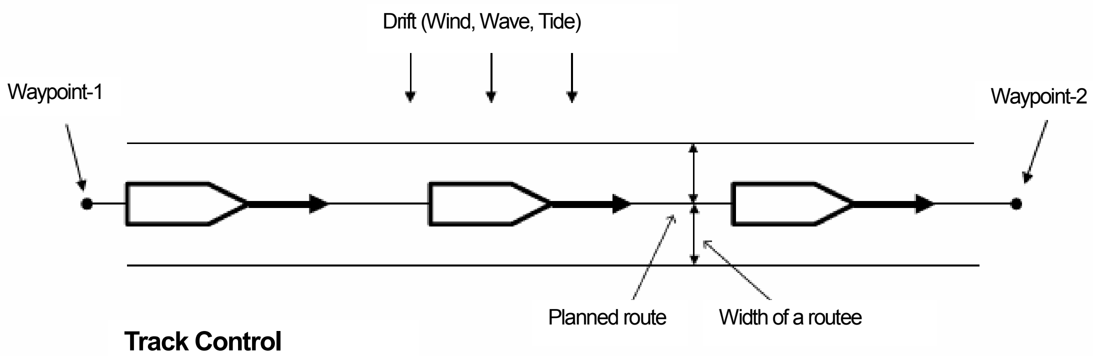
(1) Characteristics of Heading Control System

Although a Heading Control System (HCS) keeps a ship's heading in a preset direction automatically, the ship is drifted by the wind, the wave or the tide and the ship's course may deviates from the course of the preset direction.



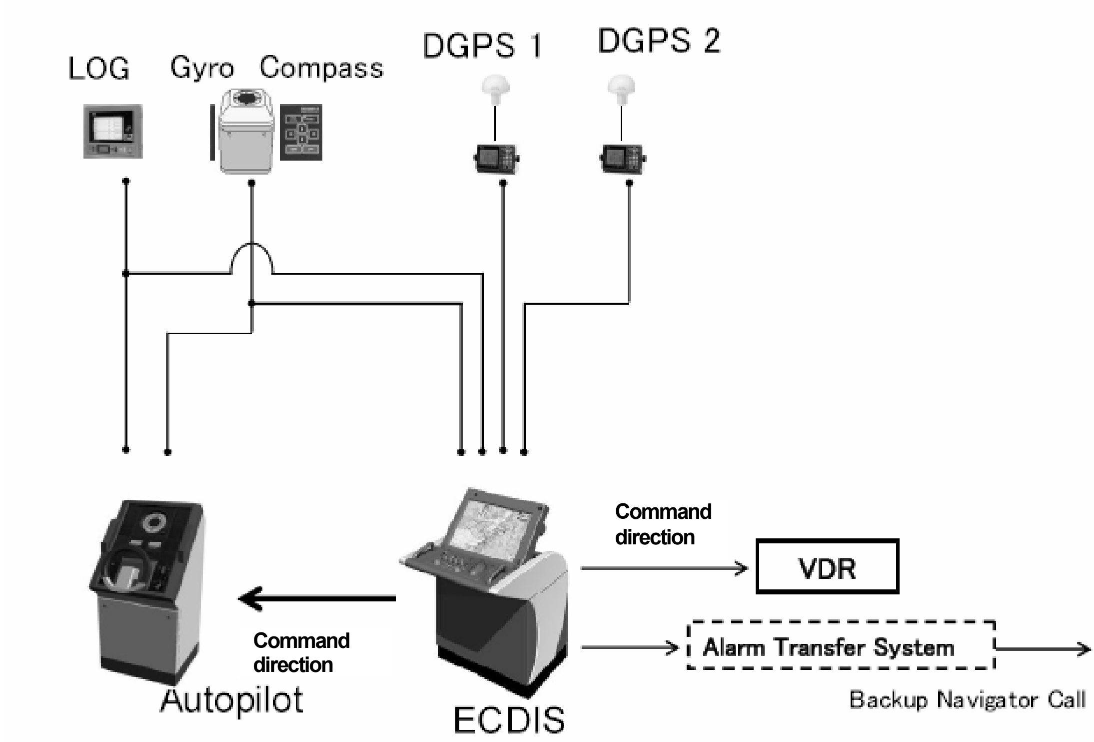
(2) Characteristics of Track Control System

Track Control System (TCS) keeps a ship's position on a preset route automatically, by computing a new direction with a planned route and a present position and sending the new direction to a autopilot. A ship is drifted by the wind, the wave or the tide and then ship's course may deviate from the preset route. Compensation signals for such deviations are sent to a steering system for keeping a ship's route.



4-6-2 Configuration of TCS

A TCS function is established as shown in the following figure.



4-6-3 Category for TCS

There are following three categories in TCS and JRC supports the categories B and C of these.

Category A: Single straight leg track control or multiple straight leg track control without assisted turns between legs;

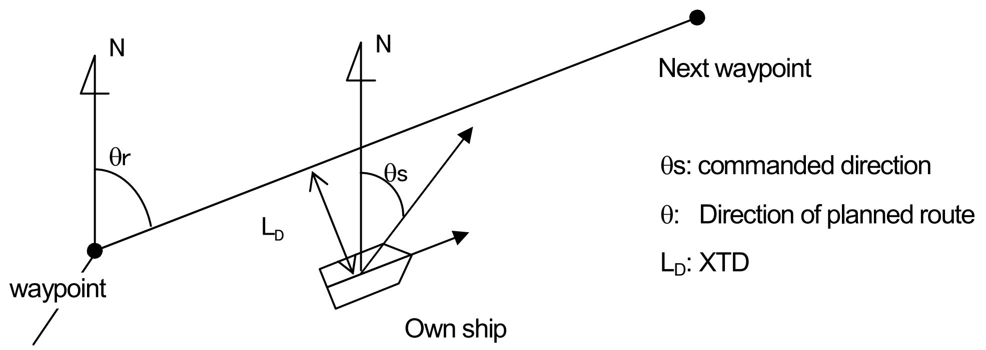
Category B: Multiple straight leg track control with assisted turns between legs (Assist Turn);

Category C: Full track control on straight legs and turns (Full Automatic).

4-6-4 Route Keeping and Turn performance

(1) A brief outline of route keeping in a straight line route

Command directions are calculated for Category-B and C practically according to the following formula in TCS of JRC to keep planned routes.



$$\theta s = \theta r - (a_1 L_D + a_2 \frac{dL_D}{dt})$$ (in the case that own ship is at the right side of a route.)

$$\theta s = \theta r + (a_1 L_D + a_2 \frac{dL_D}{dt})$$ (in the case that own ship is at the left side of a route.)

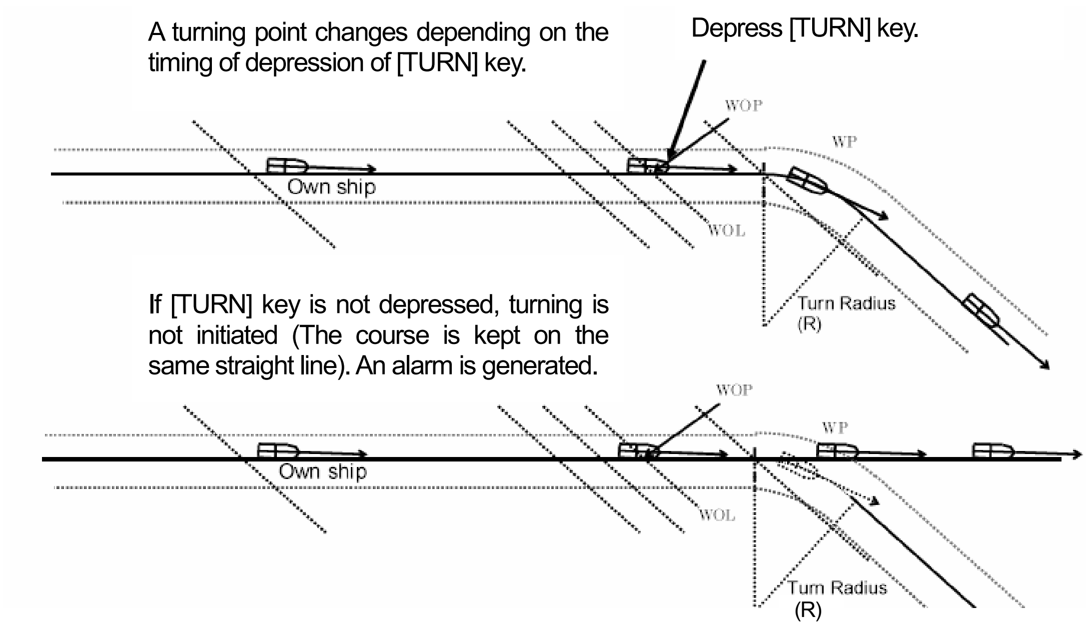
Note: "a_1" is called "tracking Gain", it is set by an operator.

"a_2" is called "difference parameter",

(2) Turn Performance

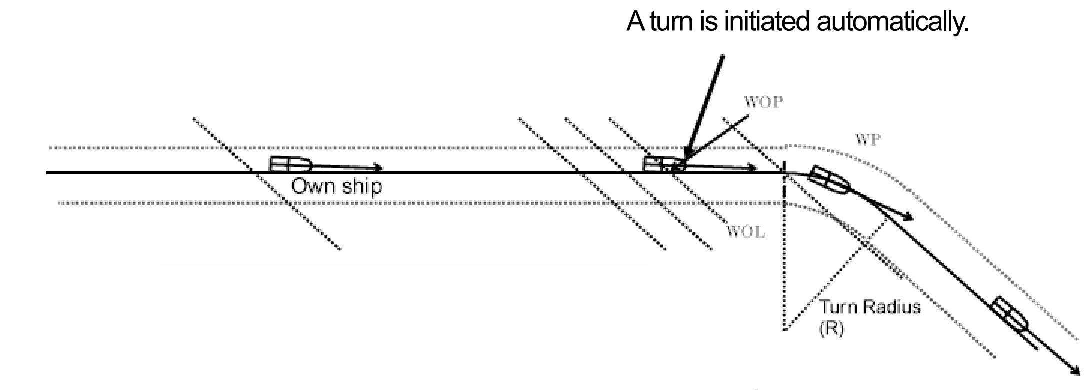
a) Category-B

An alarm is generated before own ship reaches a WOL (Wheel over line), at this time, if an operator depresses a key [TURN], a turn is initiated. If the key [TURN] is not depressed, own ship is kept on the straight line.



b) Category-C

An alarm is generated before own ship reaches a WOL, and a turn is initiated automatically.



4-6-5 Monitoring of alarms required for TCS

Monitoring of the following alarms is required for TCS according to the Performance Standards.

- power supply abnormal
- monitoring of position information
  (monitoring of a position difference of two positioning equipment)
- monitoring of the actual heading
- positioning sensor abnormal ***1**
- monitoring of a position deviation
- monitoring of a course difference
- monitoring of a low ship speed
- monitoring of a End of track ***1**
- monitoring of TCS abnormal ***1**
- monitoring of reaching Wheel Over Line (WOL)

*** 1**: If an officer in charge does not acknowledge the alarm, a back-up navigator call is generated and is sent to captain room etc..

D

5. Marine Radar

5-1 System and Circuit of Marine Radar

There are generally two types of Marine Radars. One consists of 3 units such as an antenna unit, a transmitter/receiver unit and a display unit, and the other consists of 2 units, such as an antenna unit fitted with transmitter/receiver unit in it and a Display unit, for simplification.

Moreover, Marine Radar is divided into 5 Units based on its functions systematically, as shown in the following figure,

(1) Antenna Unit (2) Transmitter/receiver Unit (3) Display processing Unit

(4) Display Unit (5) Control unit

The operation outline of each unit is described below.

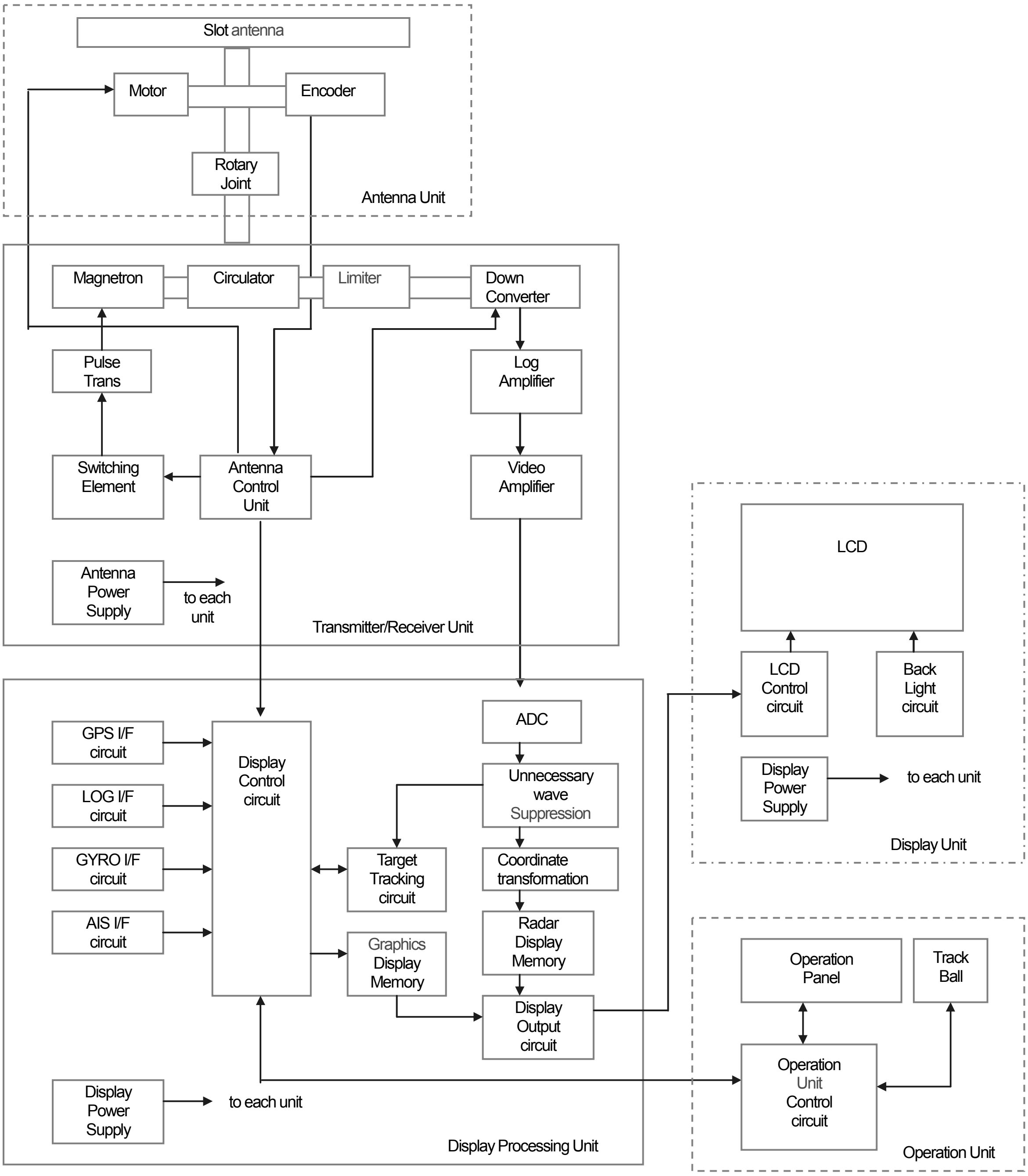


Fig.1 Schematic Diagram of Marine Radar

5-1-1 Antenna Unit

Antenna Unit radiates radar transmission pulse to space and receives the radar pulse reflected from targets.
Simple and lightweight slotted waveguide antenna is usually used as an antenna.
An antenna is rotated by a motor and can emit a radar wave over all the directions by operation of rotary joint. The radiation direction of a radar wave is detected by the encoder.

5-1-2 Transmitter/Receiver Unit

A Transmitter/Receiver Unit generates the radar wave, radiates it and amplifies received radar signals reflected and then generates radar video signals.
Antenna control circuit drives a switching element periodically to generate a high power pulse signal. After carrying out impedance conversion of this pulse signal with pulse transformer, it is inputted to a magnetron, and a pulse modulated microwave of high power is generated, and is supplied to the Antenna Unit through a circulator.
The received radar wave is led to a receiving circuit through a circulator, and after it passes the limiter for high power protection, it is changed into IF signal by a down converter. Then, it is amplified and detected by a LOG amplifier circuit to generate a radar video signal.

5-1-3 Display Processing Unit

The Display Processing Unit processes radar video signals and draws radar echos. Moreover, the Display Processing Unit exchanges information with control circuit of each Unit and controls the whole system.
After the radar video signals outputted from the transmitter/receiver are changed into digital data in ADC and unnecessary waves, such as sea clatter, rain/ snow clutter and waves interfered by the other radars, are removed from these signals. And then these signals are processed with polar coordinate to rectangular coordinates conversion and the processed signals are drawn as radar echos into a radar display memory. At the same time, the radar echo trails of moving paths of targets are drawn as well.
A target tracking circuit follows targets automatically using the radar data obtained after unnecessary waves are removed, and computes the existence position, course and speed.
The display control circuit receives the information on navigation systems, such as GPS, LOG, GYRO, AIS, etc. connected with it, and uses these signals for control of radar. Moreover, it draws various information, such as navigational tolls and symbols for target tracking into a graphics display memory as graphic information
The contents of the radar display memory and the graphics display memory are read by a display output circuit, and are outputted to the display Unit.

5-1-4 Display Unit

A Display portion displays display signals sent from the Display Processing Unit on a LCD panel.
A back light circuit controls the luminescent brightness of the LCD panel according to surrounding illuminance.

5-1-5 Control Unit

A control unit sends information, which are generated by operator's operation on a navigation panel, or operation of a track ball, to the Display Processing Unit.

5-2 Example of Radar Display

5-2-1 Display of radar echoes

Marine Radars used at present display radar echoes on a plane centering on own ship. (PPI display)
The following are examples of displaying radar echoes, and unnecessary waves, such as sea clutters, are removed, and fixed targets of fishing gears and moving targets of other ships are displayed clearly. Echo trails of moving targets are displayed, and states of the moving targets can be grasped easily.

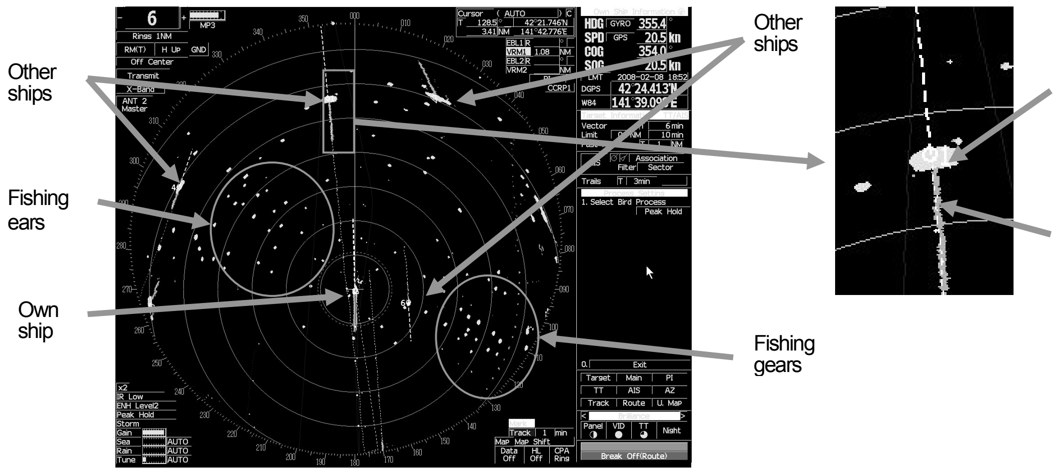


Fig.2 Display of radar echos

5-2-2 Display of symbols for target tracking

The position information of targets computed by using target tracking function are displayed as target tracking symbols.
A course speed of a target is displayed as a vector and this vector expresses advancing direction of the target and a future position where the target reaches after an appointed time.
Moreover, information of other ships sent from AIS (Automatic Identification System) can be displayed by the symbol and a vector.

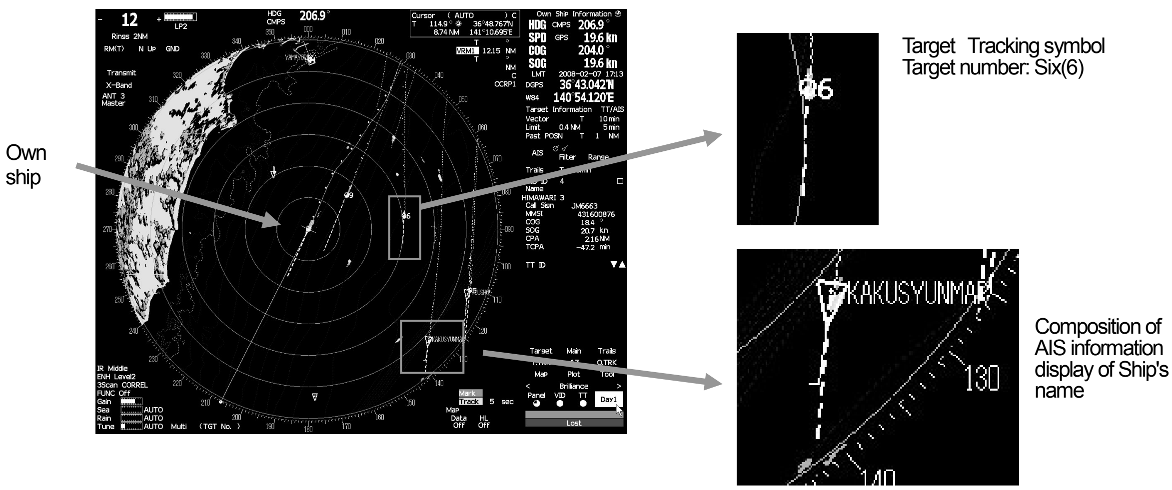


Fig.3 Display of symbols for target tracking

5-3 Measurement of Target

5-3-1 Measurement of Direction

When measuring a direction of small target such as a buoy, a cursor mark or EBL (electronic cursor) is positioned on the center of an echo and the direction is measured.

Since it may be impossible to measure an exact direction due to direction expansion effect when measuring directions of the end of a target, such as a quay, attention must be paid.

5-3-2 Bearing expansion effect

When a beam width of a radar pulse is A in the right figure, at a position of a line C or D, radiated radar beam will hit a target, this echo will be displayed while a line moves from C to D on a scope, and then a width "E" of the target will be displayed instead of a width "B" of the target. (X end and Y end is expanded with 1/2 of Beam width A)

5-3-3 Measurement of Distance

A distance is measured by positioning a cursor mark or VRM (Variable Range Marker) on an inner side of the echo (the center side of a screen).

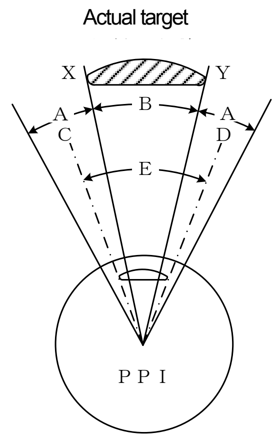


Fig.4 Measurement of Target

5-4 Minimum Detectable Range

Minimum Detectable Range is a minimum distance at which the approaching target can be displayed on a screen. A distance ΔR (m) depends on a pulse width $\tau(\mu s)$, and it is calculated by the following formula.

$R=150\cdot\tau(m)$ Formula 1

But actually, since a dead angle exists due to an antenna height and a vertical beam width as shown in a figure below, it is impossible to detect short-range targets in fact.

Although the target A within a vertical beam width can reflects radiation waves well, since the radiated wave cannot hit the target B in a dead angle and there are also few reflected waves, it is hard to detect such targets. Then if antenna is located at a lower position to shorten a minimum detectable range, a maximum detectable range will also become short conversely.

In order to satisfy these situations to some extent, the wide vertical beam width is designed to be wide angles of 20 to 30 degrees.

Moreover, this is effective also to lessen influence of rolling and pitching.

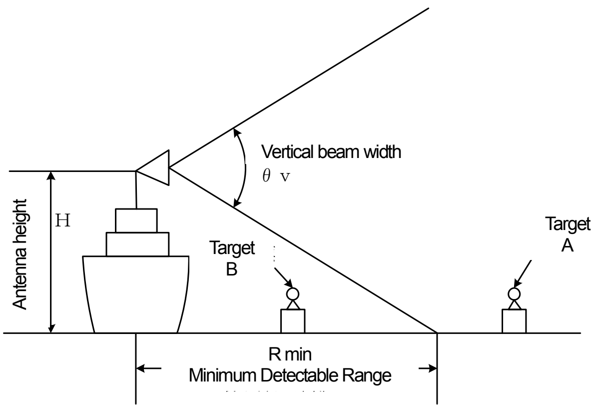


Fig.5 Minimum Detectable Range

A minimum detectable range will be calculated from the following formula.

Antenna height: H (m),

Vertical beam width: θv (degree)

$$R_{min} = \frac{H}{\tan\frac{\theta v}{2}} \quad (m)$$

Formula 2

5-5 Resolution

When detecting targets, in order to display targets as separate targets respectively, range resolution and bearing resolution are required

5-5-1 Range Resolution

Range resolution depends on transmission pulse width τ and a size of dot on a screen.

The electric wave goes and returns 150 (m) per 1(μs).

In a condition that two targets exist 150(m) away from each other on a electric wave propagation line, when an electric wave of pulse width of τ (1μs) is radiated, soon after a wave reflected from target 1 returns, a wave reflected from target 2 returns, and then two reflected waves overlap, therefore, these two waves cannot be identified.

If distance (R) is more than 150(m), targets are able to be identified. Therefore, if pulse width is τ (μs), resolution R is obtained from the following formula.

R=150x τ (m) Formula 3

The narrower the pulse width is, the better the range resolution is. Conversely, the wider the pulse width is, the worse the range resolution is.

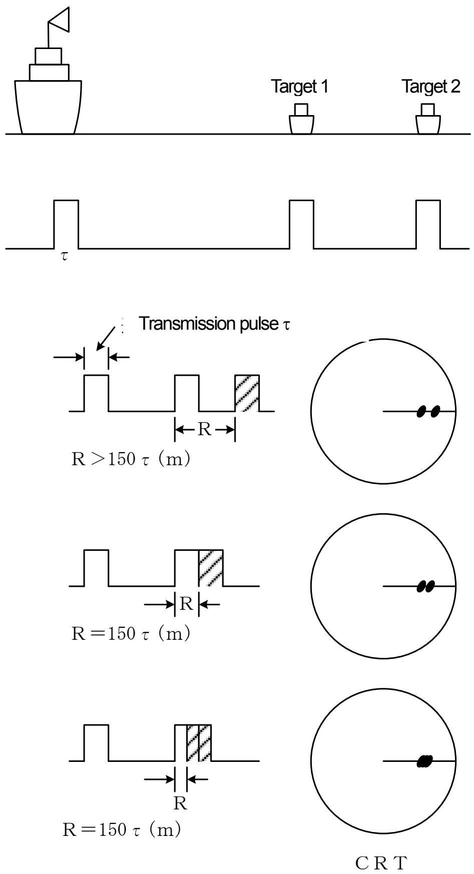


Fig.6 Range Resolution

5-5-2 Bearing Resolution

Bearing Resolution is a limit of width of transmission pulse which can discriminate two or more targets which exist at the same distance from a radar antenna.

Bearing resolution depends mainly on antenna directionality.

The directionality of an antenna depends on a beam widthθ (at a half point (-3 dB) of electric power), it is mostly expressed with the following formula.

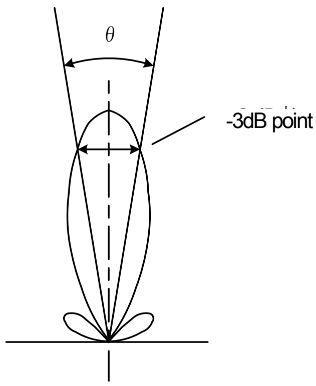


Fig.7 Antenna Directionality

Antenna beam width is proportional to wavelength in use and inversely proportional to antenna effective length

$$\theta = \frac{70 \cdot \lambda}{D} \quad \text{(degree)}$$

θ : Antenna beam width (degree)
λ: wavelength in use (m)
D: antenna effective length (m)

Formula 4

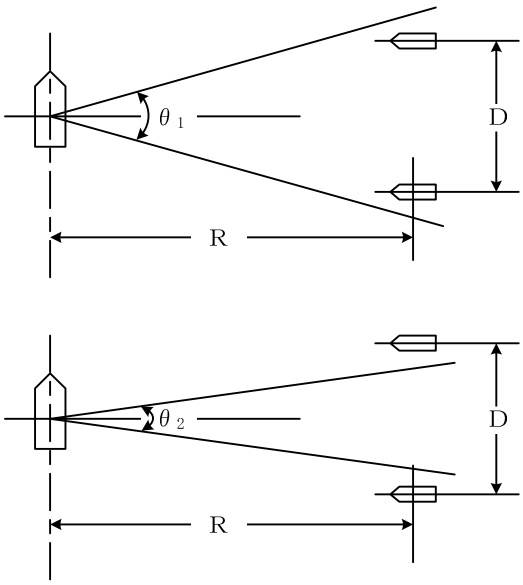


Fig.8　Bearing Measurement

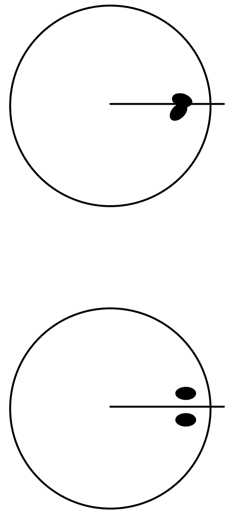


Fig.9　Bearing Resolution

5-5-3 Wavelength type and Feature

Band	Wavelength (cm)	Detectable Distance	Bearing / Range Resolution	Attenuation due to Rain dB/km		
				16mm/h	4mm/h	1mm/h
S	**10**	**Long distance**	**Low.**	0.122	0.017	0.0024
C	5	Middle of S and X	Middle of S and X	0.145	0.021	0.0032
X	**3**	**Middle Distance**	**High.**	0.373	0.064	0.011
Q	0.9	Short Distance	very High.	3.37	0.286	0.042

Table 1

Reference: The name of S･C･X used in radar frequency band was used as a code during World War II, and there is no meaning in particular.

[Circularly-polarized wave antenna]

If a circularly-polarized wave antenna is used, it will be hard to be affected by the influence of rain, snow and fog, however if the size of antenna is the same, sensitivity will fall a little.

5-6 Difference in Radar Wave Propagation of S Band and X Band

Although a long-distance mountain etc. can be seen clearly by S band radar compared with X-band radar, it may be said that small ships or coastlines nearly 10-20-nm are not clearly caught by S band radar.

Although S band is advantageous to high targets, and X band is advantageous to low targets which, (however, X band is apt to be affected by the influence of the weather). It is based on the following reasons.

The figure on the right side shows propagation of radar waves.　Assuming that point A is a radar antenna and point B is a target, a combined wave of a direct wave

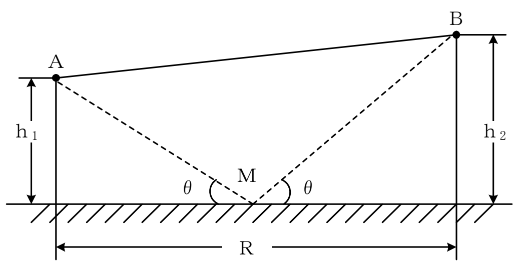


Fig.10　Propagation on reflective object

from a radar antenna and a wave reflected by the sea surface reaches the target of point B. If the combined wave is strong, the radar echoes are easy to display clearly.
Then, considering the ratio “F” of the direct wave and the combined wave, in the case of the distance difference between AB and AMB and that θ is small, the following equation is obtained,

$$AMB - AB = \frac{2h_1h_2}{R} \qquad \text{Formula 5}$$

And this formula is changed to the phase difference of the direct wave and the reflected wave, and then the following formula is obtained,

$$\phi = \varphi + \frac{4h_1h_2}{R\lambda} \qquad \text{Formula 6}$$

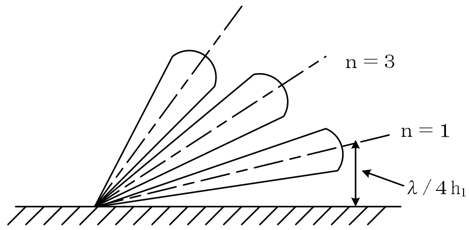


Fig.11 Vertical pattern

θ is a phase change at point M, and in the actually usual case that θ is less than 2° (degrees), even in the case of X band or S band, even in the case of a horizontally polarized wave or a vertically polarized wave, $\theta \approx \pi$, and reflection coefficient θ at the point M is equal to “0” as well.
Therefore, setting the following formulas,

$$F^2 = 4\sin^2\left(\frac{\pi}{R} \times \frac{4h_1h_2}{R\lambda}\right) \qquad \frac{4h_1h_2}{R\lambda} = n \qquad \text{Formula 7}$$

In the case that n is odd, F=2 of the maximum is shown. In the case that n is even, a result of F=0 is shown.
A height at the position of maximum width of the lowest robe which is important for radar, is as follows.
If n=1, h_2 is as follows.

$$h_2 = \frac{R\lambda}{4h_1} \qquad \text{Formula 8}$$

Unit of R is (m). 1 (NM) = 1852 (m)

If this is applied to actual numerical values, figure below is obtained, and therefore, it turns out that small ships, small targets, etc. are hard for a wave of S band to reflect. For example, height required in order to be vividly reflected in the case of a radar antenna height of 20 m and a distance to target of 10 nm, is 23.1 m in S band and is 6.9 m in X band.

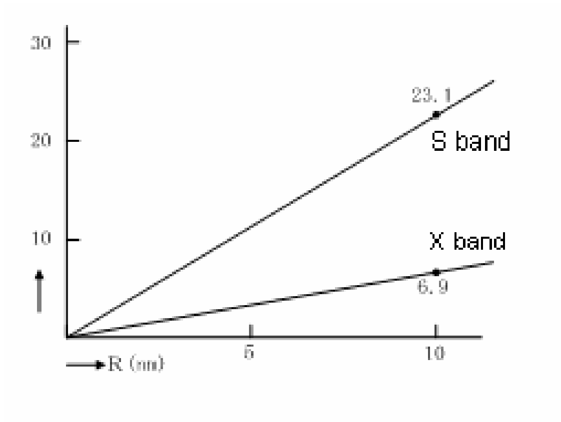


Fig.12 Maximum point of the lowest robe

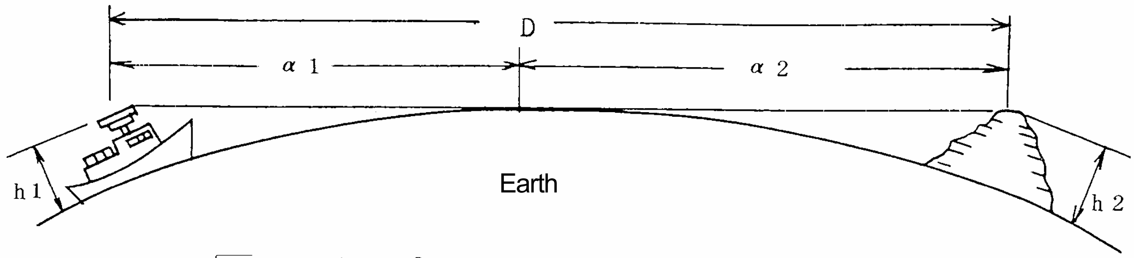
5-7 Propagation and Maximum Detectable Range of Radar Wave

5-7-1 Propagation

The radar wave has the characteristics that a very small amount of radar waves propagate along the curved surface of the earth. Although this characteristics changes according to differences of density of atmospheric layer which an electric wave spreads, a distance D (NM) of a radar wave to the horizon is 10% longer than a distance (D) to the optical horizon, and is shown by the following formula.

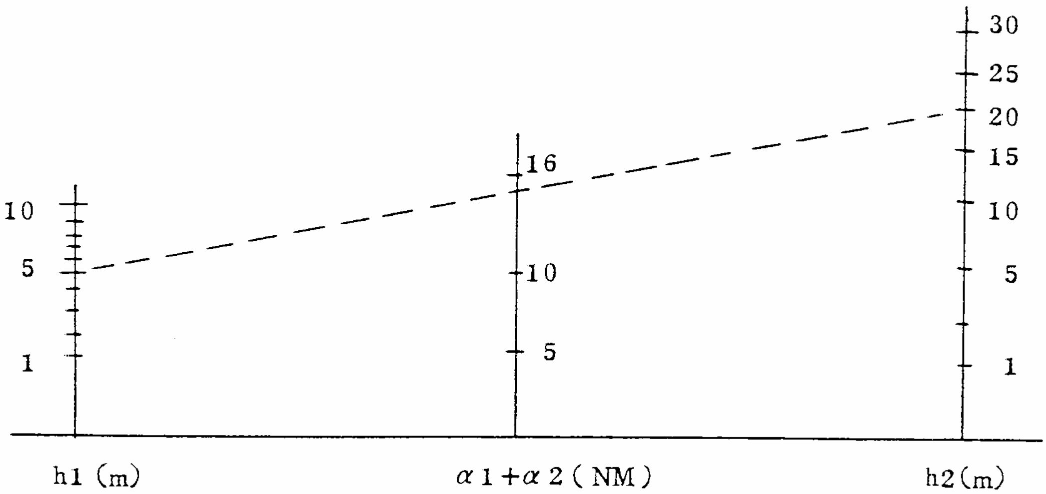
$$D=2.23\sqrt{h} \quad \text{(NM)} \qquad \text{Formula 8}$$

h shows the height (m) of a radar antenna and the height of a target from sea level.



$$\begin{cases} \alpha 1 = 2.23\sqrt{h_1} & \alpha 1 \cdot \alpha 2 : \text{Unit NM.} \\ \alpha 2 = 2.23\sqrt{h_2} & h_1 \cdot h_2 : \text{Unit meter.} \end{cases}$$

$$D = \alpha 1 + \alpha 2 = 2.23\,(\sqrt{h_1} + \sqrt{h_2})$$



Radar horizon

Fig.13 Propagation of Radar Wave

For example, in the figure above, and if the height of an antenna is 5 m, the echo of a cliff of 20 m in height (NM) will appear at D≈15.

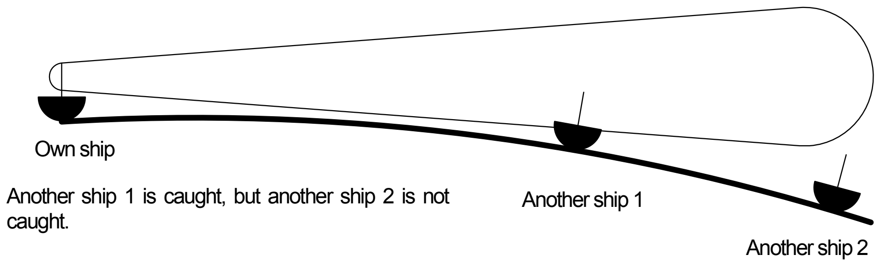
However, it may also be that D is short or is long if a climate condition is unusual.

*** Long-Range effect**

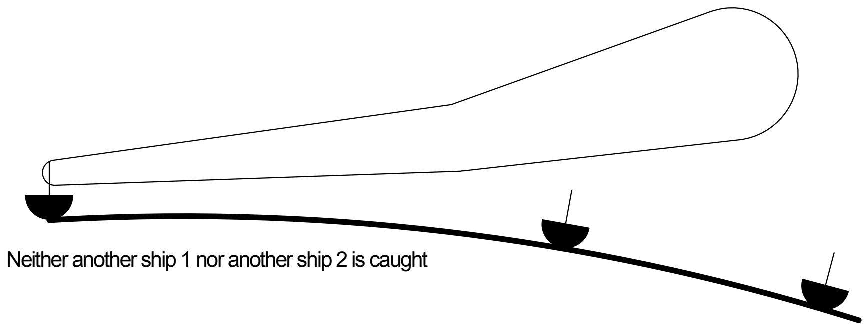
In the case of the extraordinary propagation due to high mountains in the distance and duct, even if targets, etc. below the horizon are beyond a radar range, it may appear as an echo.

For example

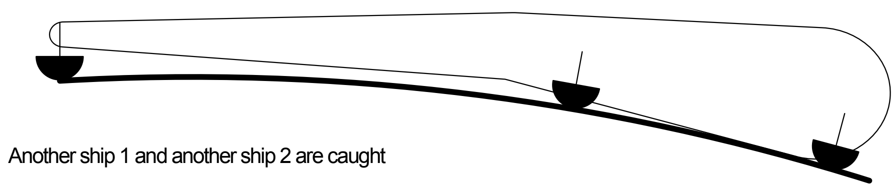
Case 1: In the case of usual



Case 2: In the case that the atmosphere is cold and seawater is warm



Case 3: In the case that the atmosphere is warm and seawater is cold



Case 4: In the case that the atmosphere is warm in a low layer and it is cold in a high layer and sea water is cold.

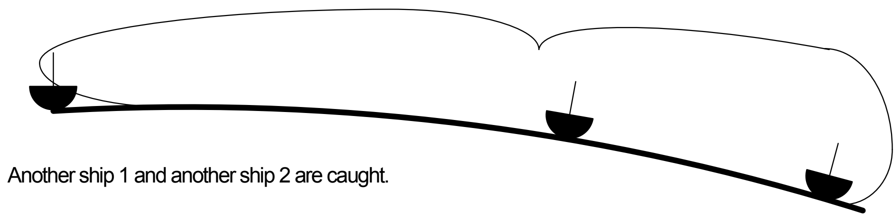


Fig.14 Long-Range Effects

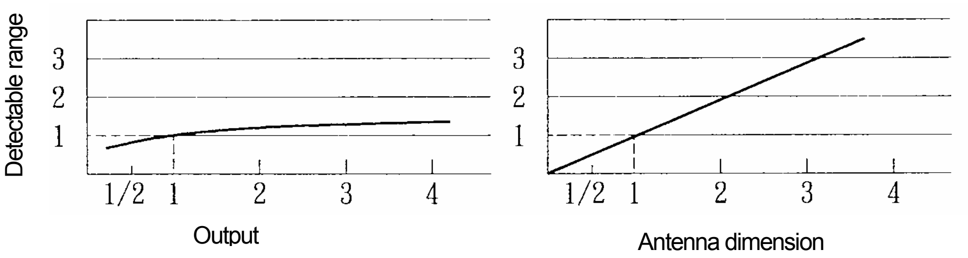
5-7-2 Detectable range

Detectable range is determined by an output and antenna dimension, and if an output and antenna dimension are changed, the result is like the following table below.

Table 2

magnification		I/5	1/4	I/3	1/2	1	2	3	4	5
If an output is one of numbers in the column above,	Detectable range	0.67	0.71	0.76	0.84	1	1.19	1.32	1.41	1.5 times
If antenna dimension is one of numbers in the column above,		I/5	1/4	I/3	1/2	1	2	3	4	5 times

Example: Detectable range will be 1.19 times if an output is doubled.

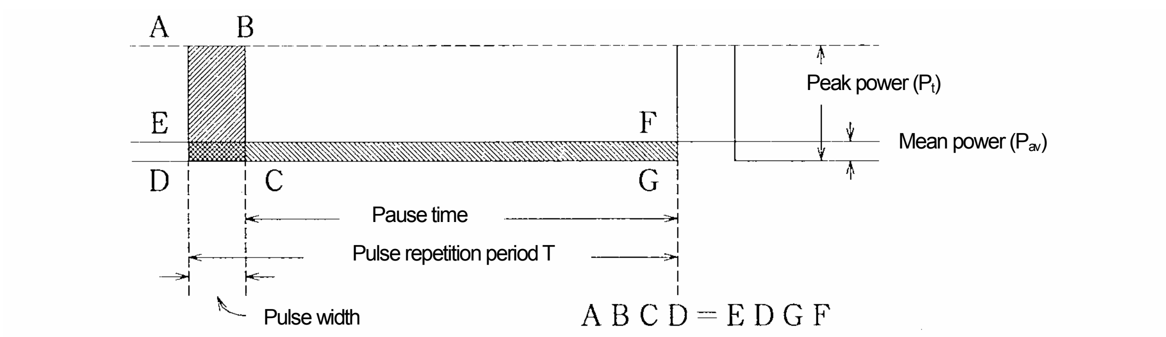


In order to improve detection performance, making an antenna dimension biger is efficient in comparison with increasing output.

5-8 Output Power of Radar

A magnetron generally used as a transmitter tube for pulse radars radiates several thousand times as high peak power as mean power for a extremely short time (pulse width τ) at a transmission time.

The ratio of a pulse repetition period and pulse width is called “Duty Ratio”, and although there is a limitation depending on a magnetron, a sufficient peak power can be outputted within the limitation.



Rectangular pulse

Fig.15 Pulse Transmission Timing

In the above figure, in the case that a transmission pulse width is τ (sec), a pulse repetition period is T (sec) and a repetition frequency is f (Hz), Duty Ratio (Du) is shown by the following formula.

$$D_U = \frac{\tau}{T} = \tau \cdot f$$ Formula 9

However, since a perfect square wave shown in the above figure, is not obtained actually, a pulse width is usually shown as a width which is measured at a point of -3 dB from peak power observing a detection output of the transmitted wave.

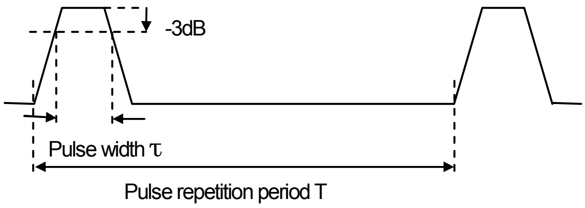


Fig.16　Actual Pulse Width

A mean power is obtained using peak power and Duty Ratio. Since any energy is not generated between pulses (transmission pause period), all the energies contained in Pulse repetition period T are equal to the product of a peak power P_t and a transmission pulse width τ. Therefore, a mean power P_{av} is obtained by dividing all the energies by Pulse repetition period T.

$$Pav = \frac{Pt \times \tau}{T} = Pt \times Du \quad \text{(W)} \qquad \text{Formula 10}$$

Usually, Duty Ratio of a marine radar is as small as one over thousands, for example, in the case of a pulse width of 1 μs (microsecond) and a repetition frequency of 500 Hz (a repetition period of 2000 μs), even though a peak power amounts to an output of 25 kW, a mean power remains an output of about 12.5W.
In recent years, the solid-state transmitter using semiconductors, such as FET, as a radiating system which replaces a magnetron is now being developed with the progress of device technology.　Although the conventional system using a magnetron can make efficient and high output, there is demerit of periodical exchange of a magnetron or need of a high voltage circuit of kV as well.
In a solid-state system, a peak power is reduced within the tolerance of a semiconductor device used for an output stage and a detectable range performance equivalent to a magnetron system is accomplished by enlarging a pulse width to attain the same mean power. However, for reservation of a range resolution, frequency modulation is applied to the radiated wave within a pulse and a received signal is processed by performing signal processing, such as pulse compression.

5-9 Antenna Installation

5-9-1 Height and Position for antenna installation

(A) Regarding marine radar, there is installation height of a radar antenna as an element which affects detectable range in addition to each performance. Antenna installation height is measured from the draft line of a ship, and the higher antenna position can attain the more distant target detection.　However, if it is installed much higher, energies of radar wave may decline remarkably in a short distance which is not covered by an antenna vertical beam width (at a point which is -3 dB lower than a peak power of a major lobe), and then it turns out that detection of small targets is difficult and sea clutters in the distance also increases more.　Regarding a 3 unit type radar, if its antenna is installed higher, length of waveguide may become long and transmission loss of an radar wave may increase (the loss of waveguide is affected twice, because the radar wave goes and returns through the waveguide.) and received signal strength may fall. Consequently, it leads to declination of long distance sensitivity. Especially waveguide transmission loss is remarkably great in X-band radar. As mentioned above, as for the waveguide length in the case of equipping 3 unit type radar, the waveguide length is generally at least 15-30m.

In the content of the ease of equipment installation, 2 unit-type radar which does not need any waveguide is equipped in many cases in recent years with the improvement in reliability of equipment. For radars for large ships, cables are generally installed without using junction box for amplifying a signal on the way if those cables are 65 m or less in full length, depending on characteristics of cables (especially transmission of video signals).Therefore, regarding the installation height of an antenna, 2 unit-type radar is more advantageous than 3 unit-type radar because that a performance decline due to transmission loss of a waveguide is decreased.

On the other hand, when the installation height of an antenna is low, it is hard to detect long-distance targets, and a mast, derricks, a chimney, etc. of a ship serve as an obstacle, and the dead angles, which cannot be seen by a radar, increase. In this case, it is desirable to install an antenna at a height so that an angle (θ), which looks down on the peak of an obstacle (a dashed line AB in the following figure), may be more than l/2 of an antenna vertical beam width (generally 10-12.5 degrees) from an antenna.

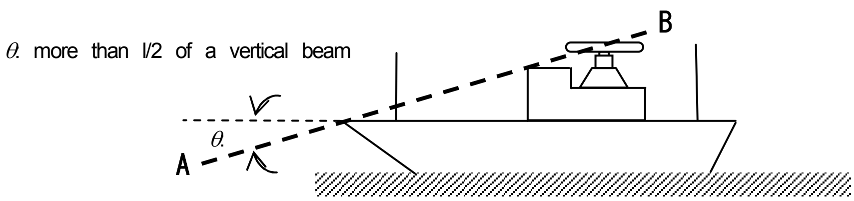


Fig.17 A minimum installation height of an antenna

Further, regarding usual radars, depending on installation heights of an antenna, electric wave phases of a radar wave interfere due to the direct wave and the reflected wave from the surface of the sea, and then an electric wave cannot reach around the surface of the sea over about 20 miles away from a radar, consequently, since a power reflected from a target may be extremely weak, it is considered to be usual except for unusual electric wave propagation that a maximum detectable range is limited and it is the smaller than a theoretical value.

(B) As for a platform of a mast, at which a radar antenna is installed, it is desirable that it is on a keel line and there are no obstacles interrupting the sight around it over 360 degrees. If there is a mast etc. which interrupts a field of view, since its angle (α in the following figure) is a shade and shadowed (grade is such that sensitivity will fall if it is 1-2 degrees) on a radar display, it is serious when there is an obstacle of a mast or are other obstacles in the direction of a bow.

In order to clear obstacles, when raising antenna installation height in the case of a 3 unit type, since a length of waveguide becomes longer, consideration should be paid to a performance decrement.

D

There are various obstacles which interrupt a visual field of radar installed in a ship. For example, derrick posts, a chimney, a radar mast for a sub-radar, etc. may be shades or obstacles casing a false echo on a radar display, these conditions may be cleared during designing stages or in some cause, false echoes may be found for the first time after used for voyages for a long time.

When a structure is within a vertical beam width and a false echo is suspected, effective way is such that wave absorbers (As there are two types of absorbers, such as a wide band type which do not have the specific resonant frequencies or a narrow band type which absorbs only the specific frequencies, these are used depending on purposes in use.) may be installed on the structure or a reflecting metal plate may be installed between a structure and a antenna for a wave not to hit a structure.

It is effective to install the metal passive reflectors reflected upwards between an antenna and a structure.

In all cases, navigating officers and those who navigate a ship should know a possibility of generation of false echos. It is also required to discuss such items with shipyards and designers in charge enough.

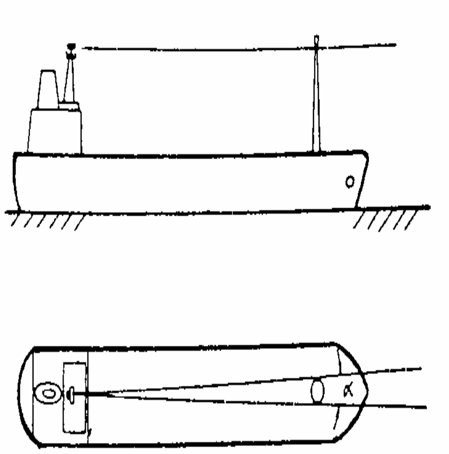


Fig.18 An angle of a shade of an obstacle

(C) Safety conditions for Structure of mast, Platform for maintenance and Handrails

(C-1) Radar mast should be such the structure that should not sway simply or it does not incline, due to starting of rotation of an antenna, vibration of hull, shocks, etc. Depending on a size and structure of an antenna, it is required not to cause resonance of a mast and to make resonance frequency high using reinforcement etc. if needed.

(C-2) An antenna platform should be large because it is a place for check and maintenance of an antenna as much as possible, and it should be taken into account that workers can work safely there. There is a entrance to the platform, and a ladder is located for climbing up to the entrance, and a lid should be attached to this entrance.

A steel plate patterned with non-slip should be used as a platform, suitable steel plates should be fitted along the edge of the platform so that a tool etc. may not fall during maintenance and check.

Moreover, it is desirable to design a platform, taking into account structures around the platform, in order to carry out easily the maintenance to the tip of an antenna radiation part if possible. Moreover, it is necessary to take into account the design that rotation may not be barred with a rope, a signal flag, etc.,twining round a reflector.

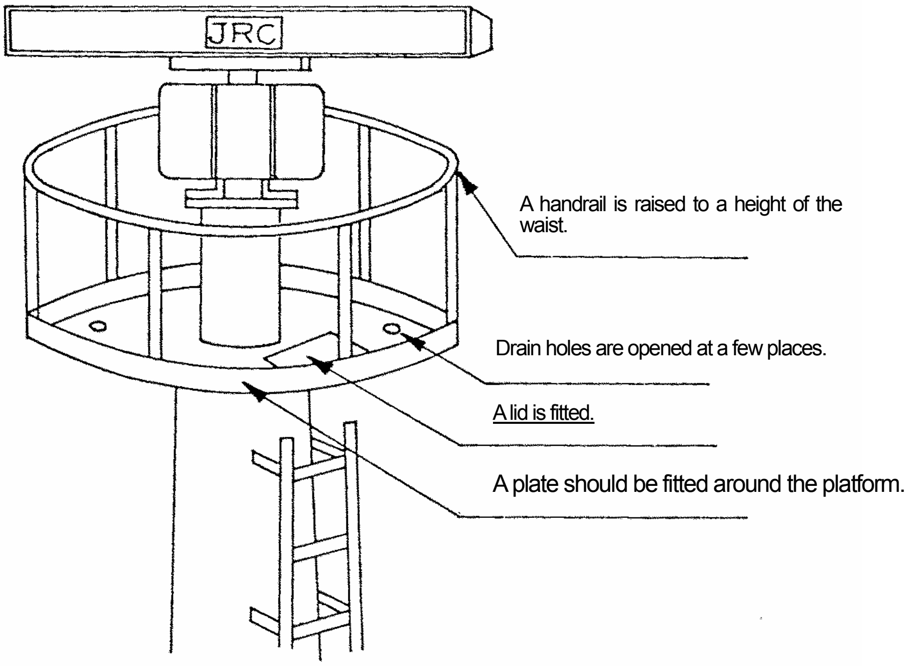


Fig.19 An example of a platform for a radar antenna

5-9-2 Fixing of an antenna

A steel plate, which is thick enough to fix an antenna, and enhancement steel are used as a plate (mount base) for fixing an antenna, it is necessary that its surface should be flat (smooth) to reduce vibrations and impacts on an antenna etc.

When a gap exists partly between the mount base and an antenna pedestal, it is necessary to smooth the mount base, or to adjust the gap inserting metal shims. If an antenna is tightened hard and fixed in the state that there is a gap, an antenna case may be distorted and the case itself may be damaged by vibration.

In addition, since the amplitude of vibration may be large and may lead to breakage of an antenna if elastic materials such as rubber and resin are inserted into the gap between the mount base and the antenna pedestal for vibration proof, such method is not be adopted.

Stainless bolts should be generally used for fixing of an antenna, and all nuts are doubled for slack prevention and all bolts should be equally tightened. And in order to prevent corrosion, the head of bolts and all nuts are shielded applying sealant etc.

Moreover, the antenna case and the mount base are grounded with an earth wire, and sealant etc. is applied to connections an earth wire for the prevention from damage by vibration and corrosion.

D

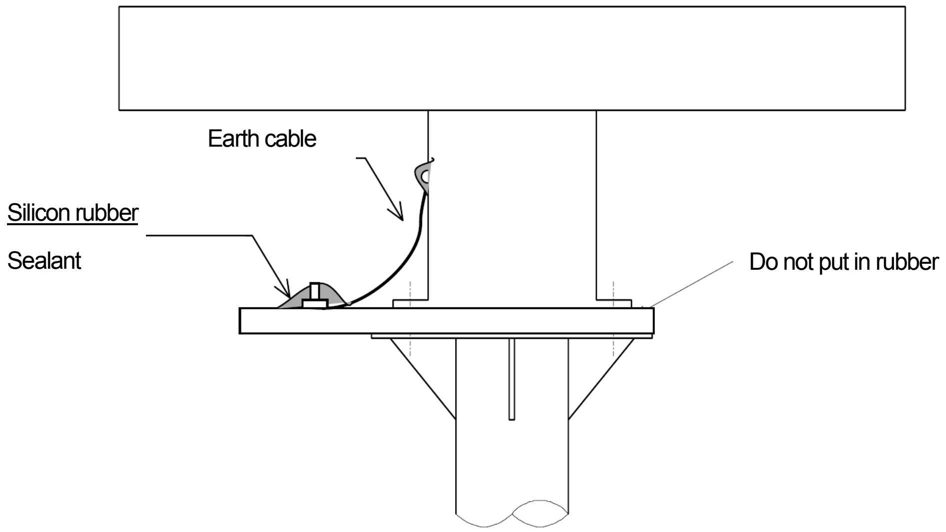
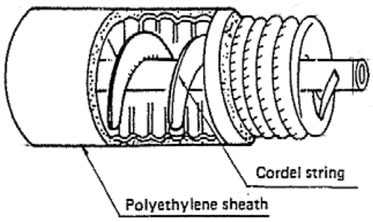


Fig.20 Grounding and corrosion prevention

5-10 Example of Waveguide Installation and Name of each part

Coaxial cable (S band) and flexible waveguide (X band) are generally used for installation of 3 unit type radar. Since the inside of Coaxial cable and flexible waveguide is hollow, it is necessary not to fasten too much while fastening by using cable fastening band. If fastened too much, there is a possibility of receiving sensitivity fall or transmitter/receiver damage caused by the dent inside Coaxial cable and flexible waveguide or blockade.



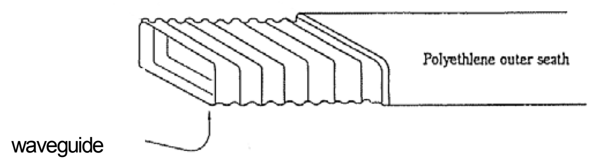
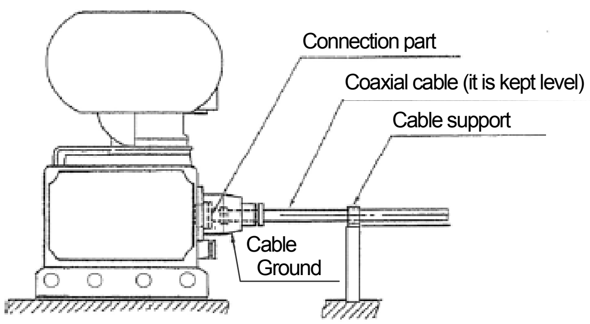


Fig.21 Coaxial cable Flexible waveguide

In connecting a coaxial cable or a flexible waveguide with an antenna case, a connection part is kept level, and for prevention of fall by vibration, as shown in the following figure, cable supports are fitted.
In addition, a distance between a connection part and a nearest support and a distance between support is suitable to reduce the metal fatigue by vibration.



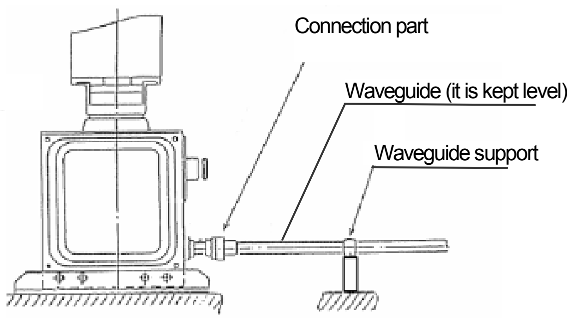


Fig.22 Support position for S band Support position for X band

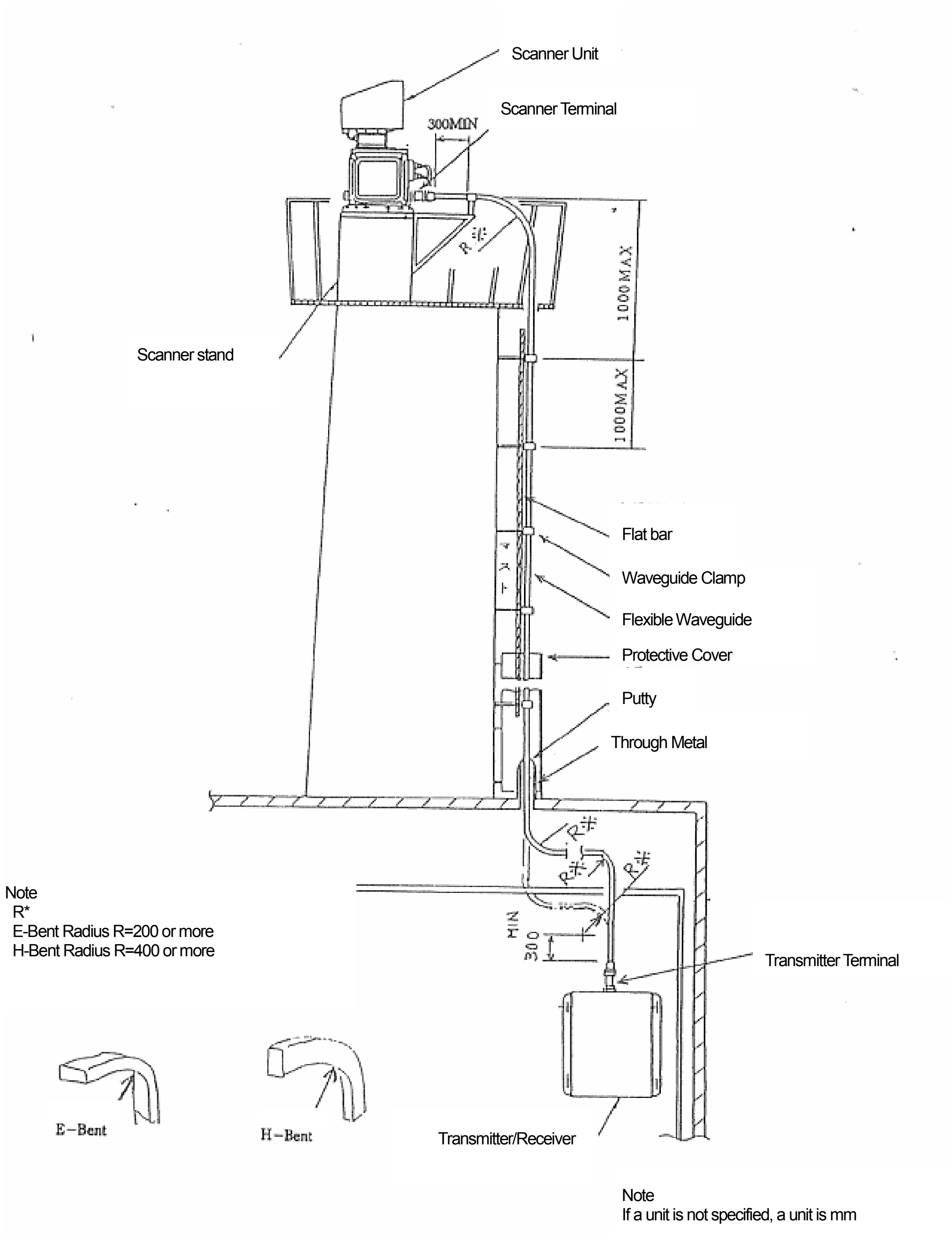


Fig.23 Example of Flexible waveguide Installation

5-11 False Echo

Even though the actual target does not exist, its echo, which appears on the screen of a radar as if it existed really, is called a false echo. The following cases can be considered as a cause of a false echo.

5-11-1 Secondary reflected echo

Echoes other than actual echo reflecting from a target when a radar antenna target, reflecting from a mast or a funnel when a radar antenna is in the direction of the target, is called "Secondary reflected echo" (Secondary reflected echoes appear in the direction of a mast or a funnel.)

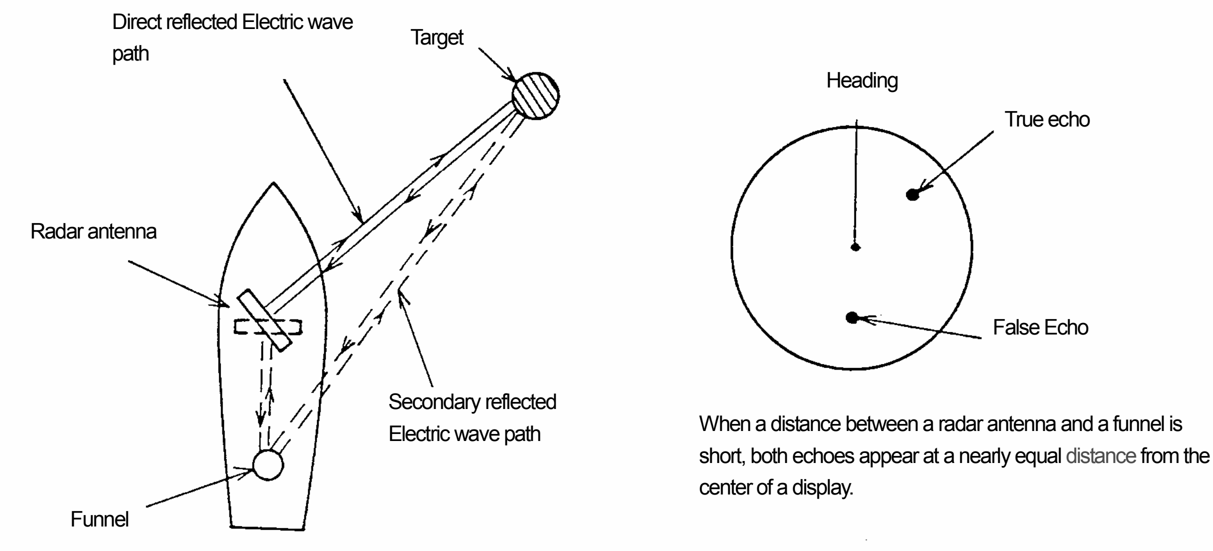


Fig.24 Secondary reflected echo

As shown in the above figure, when an obstacle onboard is a cause, a false echo and a true echo appear in an equal distance from an own ship.
Since these echoes are displayed at an equal distance, generations of false echoes are found by setting VRM on the false echo or the true echo. Under such circumstances, false echoes present generally an unnatural motion in many cases.

5-11-2 Multiple reflection echoes

If buildings or large-size of ships, which have big vertical plane, exist or stay at a short distance from an own ship, multiple echoes appear. (Although these echoes appear at equal intervals, the nearest echo is an echo of a true target.)

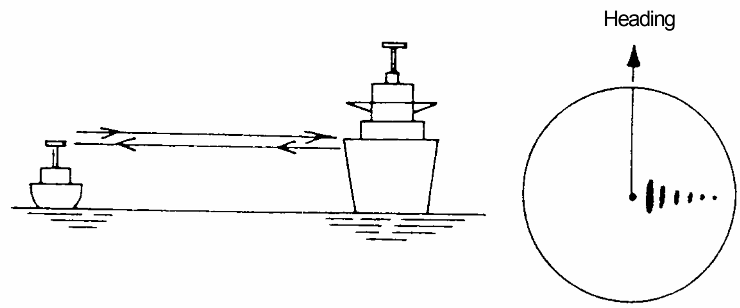


Fig.25 Multiple reflection echo

5-11-3 Side lobe

A beam radiated from a radar antenna always generates some side lobes.
Depending on circumferential conditions or gain adjustment of a radar, a circular arc of false echoes appear at a distance equal to a distance of a true echo as shown in the right figure.
Especially during voyages, it can be seen as an actual phenomenon, during an observation of a large target approaching near etc. Moreover, when an obstacle exists near an antenna, since side lobes increases due to diffraction, in a direction that a influence of the obstacle exists, side lobes appear remarkably.
Side lobes are reduced a little by adjusting Gain and STC.

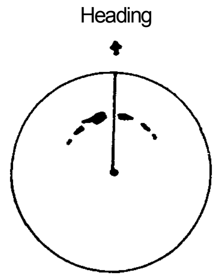


Fig.26 Side lobe

5-11-4 Radar interference

Radar interference is that, if other radars using the same frequency band are close, many spots appear on a radar display due to the interference.
Since spots appear in various aspects and do not always appear at the same positions, it can be distinguished from an echo of a true target in many cases.

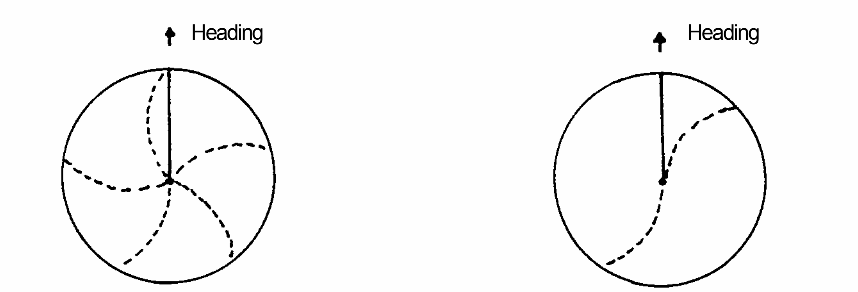


Fig.27 Circular spots on a display

However, when radar with a frequency of a near repetition period is close, interference appears circularly on a display. It may not be removed by interference elimination processing.

5-11-5 Shadow

A shadow differs from a false echo, and consideration should be given to shadows for antenna installation.
That is that, a radar wave is interrupted by a mast and a funnel near a radar antenna,
an echo of a target which exists in the direction of a mast and a funnel is hard to appear on a display.
In order to investigate whether there are shadows, at the sight of sea clutters on a display, confirmation is carried out that the echoes of sea clutters are thin or that there is a zone at which no echo can be seen.
Such shadows always exist in the same direction as ever.
Moreover, as described in the paragraph (3) side lobe, false echoes are apt to appear in the inside of such zones,
Since the signal strength reflected from targets also declines, echoes of targets may be removed by signal processing etc.

5-11-6 Secondary echo

As shown in the following figure, target echoes from distant places are not displayed within the transmission repetition period, but during the next transmission repetition period, such echoes are displayed at a nearer position than the true position. These echoes are called a secondary echo.
The thing of the phenomenon displayed is said.

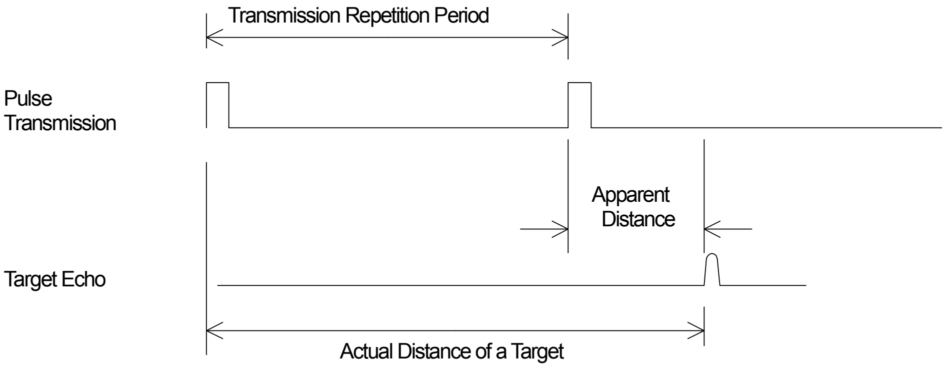


Fig.28 Secondary Echo

Secondary echoes are reduced by changing a transmission repetition period at each transmission and by carrying out reduction of interference together.

MEMO

5-12 Magnetron Table

Typical models of Magnetron manufacturers are shown in the following table.

A type which aims at extension of life-span and spurious reduction is developed in recent years.

*Advanced Spectrum Magnetrons

Output	X band			S band
	9375MHz	9410MHz	9445MHz	3050MHz
1.5kW			M1516 RMC-1	
2kW		MAF1560N *MAF1610B	M1568 RMC-2	
4kW		MSF1421B MG4004 E3571 MG5248 MAF1561N MSF1611B *MAF1611B	M599A JP9-25D JP9-25F MSF1421C MRF1421C	
5kW		9M80 M5115		
6kW		MSF1422B MAF1422B MG4006 MAF1562N MSF1562B MAF1562B *MAF1562R		
10kW	2J42 M1347 JP9-7	9M61 M5108 MSF1425B MAF1425B MSF1565N *MAF1565N		
12kW		MSF1615N *MAF1565N		
20kW	9M40 2J42A 6027	9M90		
22kW	M1304 M513B YJ1110	M1312 M598B JP9-18		
25kW	M1311 M5039 E3509L QKH1535 M1475A	9M72 9M72A E3509 M1437(A) M1458A M1568B(J) *M1568BS M1569		2J70A
30kW				M1302 *M1555
50kW	2J55 M1348	9M31	2J55H	
60kW				2J70B M5063 M1461

Life of Magnetron
Even when a radar is used in a standby condition for a long time, a life of a magnetron becomes short by consumption of a cathode electrode etc.

D

Magnetron type for JRC RADAR Typical Model

RADAR Model	Magnetron	Output	RADAR Model	Magnetron	Output
JMA-9252/9253 (X-BAND)	M1437(A)	25KW	JMA-5350 (X-BAND)	2J55	50KW
JMA-9303 (S-BAND)	M1302	30KW	JMA-5360 (S-BAND)	M1461	60KW
JMA-7252/7253 (X-BAND)	M1437(A)	25KW	JMA-5352 (X-BAND)	2J55	50KW
JMA-7303 (S-BAND)	M1302	30KW	JMA-5362 (S-BAND)	M1461	60KW
JMA-9822/9823 (X-BAND)	M1437(A)	25KW	JMA-7710 (X-BAND)	MSF1425B	10KW
JMA-9832/9833 (S-BAND)	M1302	30KW	JMA-7725 (X-BAND)	M1437(A)	25KW
JMA-9922/9923 (X-BAND)	M1568B(J)	25KW	JMA-7750 (X-BAND)	2J55	50KW
JMA-9932/9933 (S-BAND)	M1302	30KW	JMA-7776 (S-BAND)	M1461	60KW
JMA-9953 (X-BAND)	2J55	50KW	JMA-3910 (X-BAND)	MSF1425B	10KW
JMA-9963 (S-BAND)	2J70B	60KW	JMA-3925 (X-BAND)	M1437(A)	25KW
JMA-9110 (X-BAND)	MAF1565N	10KW	JMA-3810 (X-BAND)	MSF1425B	10KW
JMA-9122/9123 (X-BAND)	M1568BS	25KW	JMA-3811 (X-BAND)	MSF1425B	10KW
JMA-9132/9133 (S-BAND)	M1555	30KW	JMA-3806 (X-BAND)	MSF1422B	6KW
JMA-7110 (X-BAND)	MAF1565N	10KW	JMA-3807 (X-BAND)	MSF1422B	6KW
JMA-7122/7123 (X-BAND)	M1568BS	25KW	JMA-3204 (X-BAND)	MSF1421B	4KW
JMA-7132/7133 (S-BAND)	M1555	30KW	JMA-3210 (X-BAND)	MSF1425B	10KW
JMA-922B/923B (X-BAND)	M1568BS	25KW	JMA-3211 (X-BAND)	9M61	10KW
JMA-932B/933B (S-BAND)	M1555	30KW	JMA-2343 (X-BAND)	MSF1421B	4KW
JMA-5104 (X-BAND)	MSF1421B	4KW	JMA-2344 (X-BAND)	MSF1422B	6KW
JMA-5106 (X-BAND)	MSF1422B	6KW	JMA-608 (X-BAND)	MSF1422B	6KW
JMA-5110 (X-BAND)	MSF1425B	10KW	JMA-609 (X-BAND)	MSF1422B	6KW
JMA-5206 (X-BAND)	MSF1422B	6KW	JMA-610 (X-BAND)	MAF1562R	25KW
JMA-5210 (X-BAND)	MSF1425B	10KW	JMA-3314/3334 (X-BAND)	MSF1421B	4KW
JMA-5220 (X-BAND)	M1568B(J)	25KW	JMA-3316/3336 (X-BAND)	MSF1422B	6KW
JMA-5212 (X-BAND)	MAF1565N	10KW	JMA-3340 (X-BAND)	MAF1565N	10KW
JMA-5222 (X-BAND)	M1568BS	25KW	JMA-2253 (X-BAND)	MSF1421B	4KW
JMA-5310 (X-BAND)	MSF1425B	10KW	JMA-2254 (X-BAND)	MSF1422B	6KW
JMA-5320 (X-BAND)	M1568B(J)	25KW			
JMA-5330 (S-BAND)	M1302	30KW			
JMA-5312 (X-BAND)	MAF1565N	10KW			
JMA-5322 (X-BAND)	M1568BS	25KW			
JMA-5332 (S-BAND)	M1555	30KW			

5-13 Waveguide Loss (X-BAND)

Waveguide type	Loss [dB/m]	Remarks
Straight waveguide	about 0.1	X band
E, H Bent	about 0.04	Loss is smaller in using each one of E,H Bent in comparison with in using twisted waveguide.
Twisted waveguide	about 0.3	
Flexible waveguide	about 0.1	Flexible waveguide: FR-9
Coaxial cable	about 0.08	For S band (HF-20D)

5-14 Slot Antenna Beam Width Standard

X band		S band	
Radiation part Length [ft]	Beam width θ [°]	Radiation part Length [ft]	Beam width θ [°]
3	3	10	2.3
4	2	12	1.9
5	1.5		
6	1.2		
7	1.0		
8	0.9		
9	0.8		

$\theta = 2.3 \times \lambda / D$

θ: Beam width [°]

D: Antenna aperture length [f t]

λ: wavelength [cm]

D

6. Radar Indicator

6-1 Radar Indicator

6-1-1 Outline

The Type of Display used for marine radars has changed from a display fitted with Analog type PPI monitor, then a display fitted with Cathode-Ray Tube CRT monitor, to LCD monitor fitted with LCD panel.

The problem of a analog type of display fitted with PPI monitor (Analog display type) is that, CRT brightness is related to a sweep time of a trace, since CRT brightness dose not reach the maximum brightness in the case of selection of a short range, it is sometimes difficult to use the display in a bright place without a shade hood.

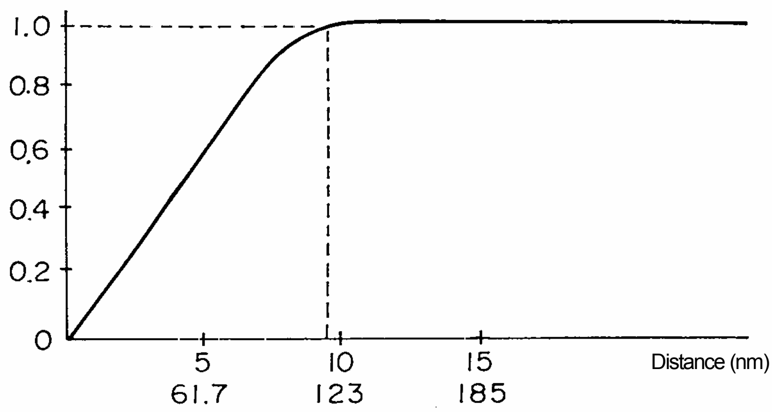


Fig.1 Brightness Characteristics of CRT

To resolve this problem, In some case, received radar echo signals are once written in a memory (Video Memory) in real time, next, while reading out and displaying, read-out time is expanded more than 80 μs, a trace may be synchronized with this time-extended radar echo signals, and a trace time is expanded and then the maximum brightness is able to be accomplished in any range scale.

A raster scan type of display exists in display types of CRT monitor fitted with Cathode Ray Tube (digital display type), and information for PPI scan is transformed for Television scan (Raster Scan) and is displayed in high brightness.

Regarding a LCD monitor type of display fitted with LCD panel, information for PPI scan is also transformed for Television scan (Raster Scan) and is displayed in high brightness. For example, JMA-9100 series, JMA-900M series, and JMA-900B series, JMR-7200/9200 series are this system.

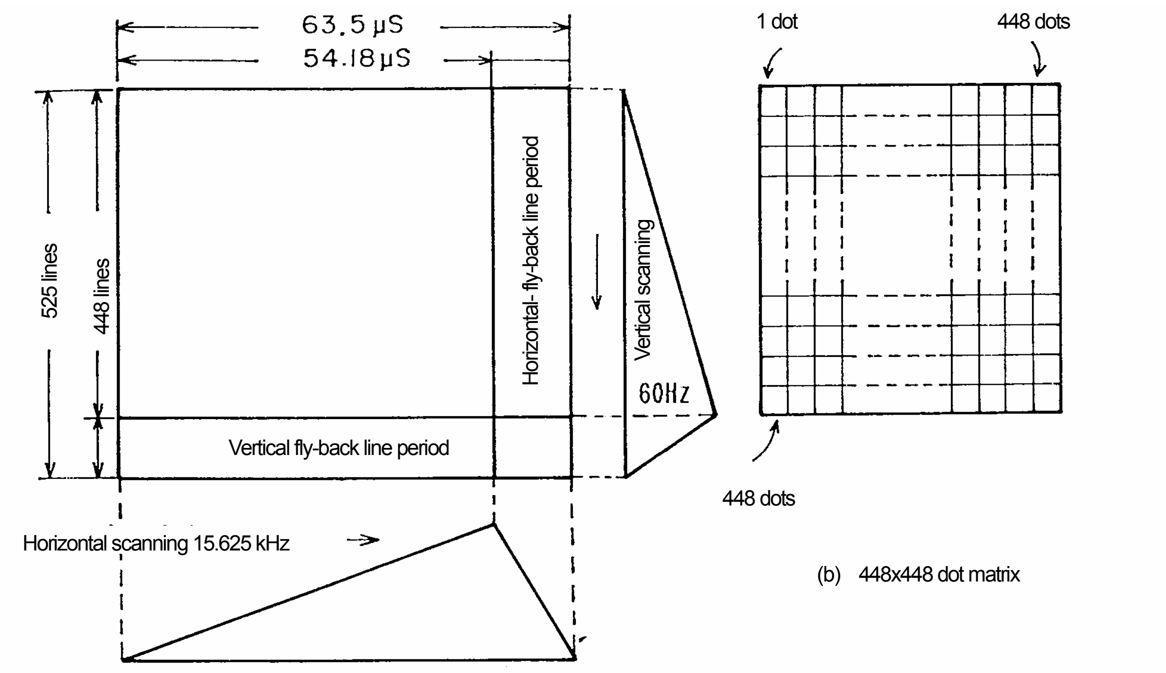
A LCD monitor type of display fitted with LCD panel is not only a high brightness display for displaying radar videos, but to memorize radar information, the following functions are able to be added easily and distortion of a picture etc. is able to be improved.

- as for a common PPI display, the brightness of radar video decays with the progress of time, but it can keep the brightness constant until the next video is updated.
- trail of moving target can be displayed.

- radar data from two or more sensors can be displayed synthetically, For example, spectral indication of target symbols, speed, course and routes, etc. are possible to superimpose on a display like an ARPA display.
- distortion of a picture by earth magnetism, a color gap, etc. such problems are pointed out on PPI monitor/ CRT monitor, it is hard to receive such problems.
  Now, a display of LCD monitor type (Raster scan display) fitted with LCD panel is in use.

6-1-2 Principle of Raster Scan Display

In order to understand a raster scan display, it is necessary to understand a TV picture display method. TV picture is shown in Fig.5-1. Generally, a TV picture consists of 525 scanning lines, and the number of the effective scanning lines except a fly-back line period is 448. 224 scanning lines are scanned at a rate of 60 scans per second totally by Interlace Scanning. One display consists of 448 dots vertically and horizontally...

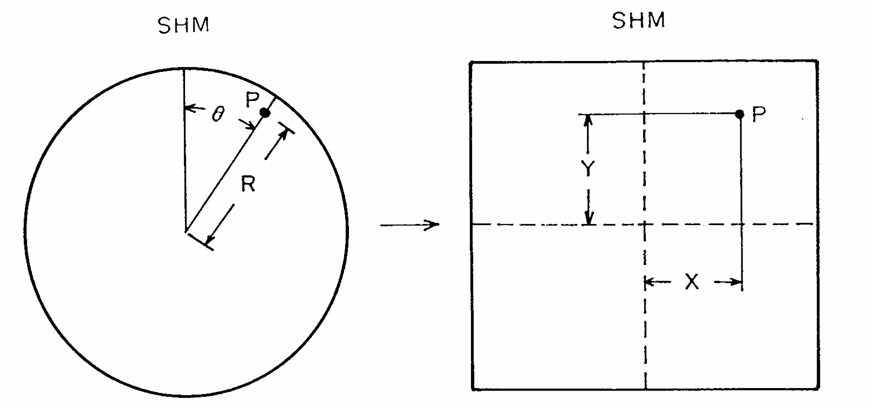


(a) TV picture

Fig. 2 TV picture and dot matrix

That is, the display which consists of 448x448 dot matrix is refreshed 30 times per second. Although a raster scan radar displays the PPI scan radar data on this TV picture, a polar coordinate is used for a PPI display which uses a distance "R" from own ship and bearing "θ" from heading to display a target. Rectangular coordinate is used for TV a picture which displays targets by X and Y component of rectangular coordinates. In order to display Radar data received by the PPI scan, the data needs to be converted to TV scan. A device which performs this conversion is called Scan converter.
For this scan converter,

D



PPI display TV picture

Fig.3 PPI display and TV picture

there are two types of converts such as an analog type and a digital type. An analog type converter uses a Storage Tube, and digital type converter uses IC memory (radar data written into the memory by PPI scan is read out in the form of TV scan). Now, since the digital scanning method is used in many cases as for the raster scan radar, in this book, a digital scan converter is to be described.

6-1-3 Principle of Scan Converter

If as for the position P on a PPI display, its coordinates is converted to the rectangular coordinates, the position can be shown by the following formula.

$$X = R \cdot \sin\theta \qquad \text{Formula 1}$$
$$Y = R \cdot \cos\theta$$

The principle of this scan converter is shown in Fig. 5. A distance R is acquired by counting with Range Clock. Moreover, a direction "θ" is convertible to Sin θ and Cos θ using a signal characterizer. The formula (1) is realized by multiplication of these signals,

A minimum unit value of a distance which a range clock counter is set to Δr, and Δx and Δy of a respective change component in X axis and Y axis to Δr is shown as Fig. 6.

In Fig. 6, the rectangular-coordinates component (xn, yn) of a quantization point Tn can be expressed with the following formula.

$$xn = n \cdot \Delta x = xn\text{-}1 + \Delta x \qquad \text{Formula 2}$$
$$yn = n\text{-}\Delta y = yn\text{-}1 + \Delta y$$

The rectangular-coordinates component (xn, yn) of the quantization point Tn can be obtained by adding the change component of X axis and of Y axis. A block diagram of a scan converter is shown in Fig. 7. Signals from an antenna are converted into digital signals with a Sin/Cos function generator (ROM), and the converted signals become Rate input signals to B.R.M. (Binary Rate Multiplier) and the signals are multiplied by Range signals in B.R.M. and then the processed signals are outputted from B.R.M.. These outputted signals are counted by a address counter and become address data of the rectangular coordinates (xn, yn) of TV display.

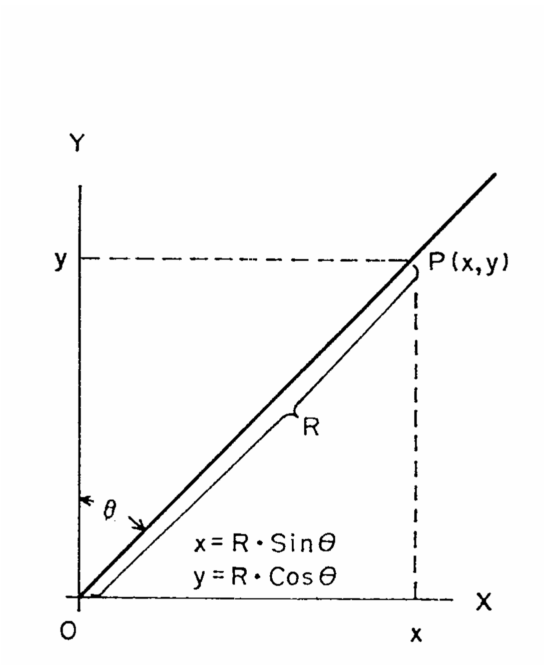


Fig. 4 Polar coordinate - Rectangular coordinates

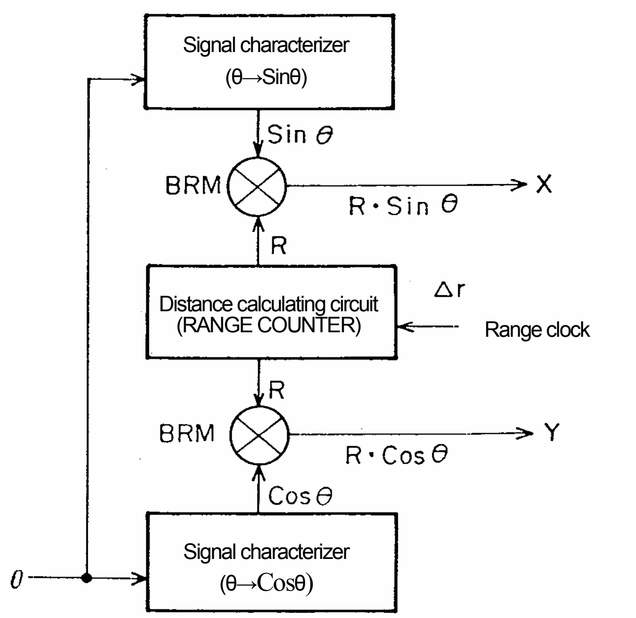


Fig. 5 Polar coordinate - Rectangular-coordinates conversion Principle figure

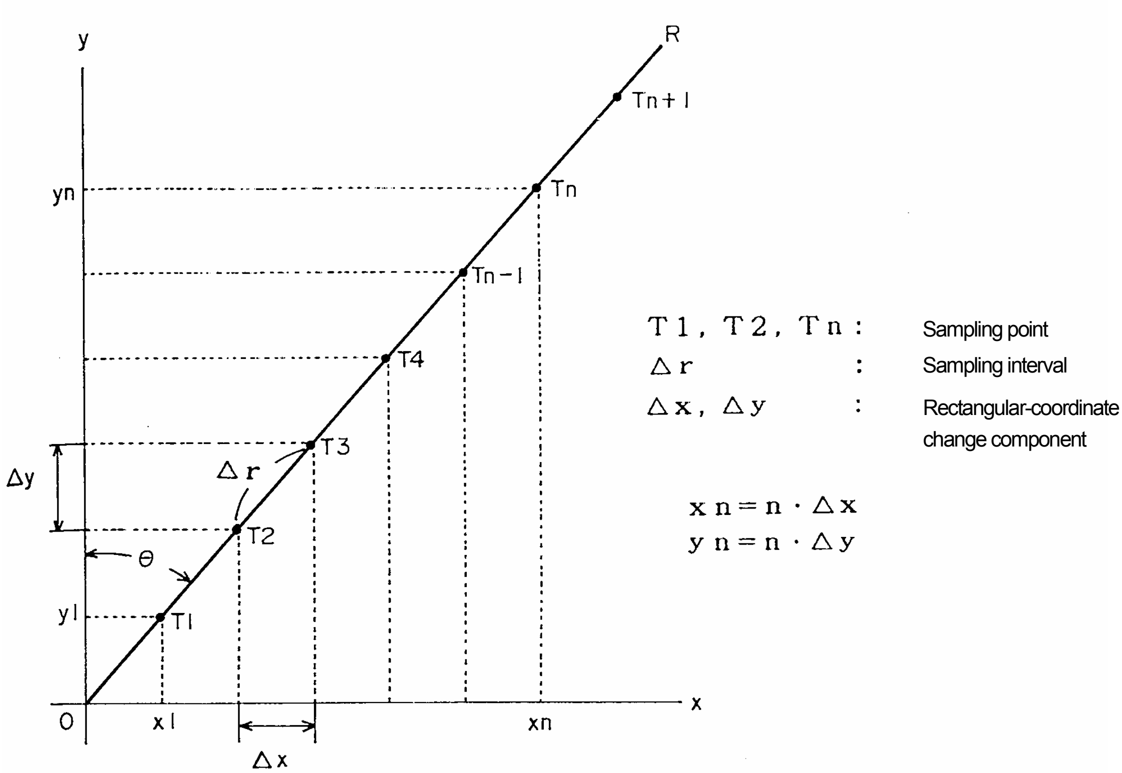


Fig. 6 Polar Coordinate – Rectangular Coordinates Conversion Diagram

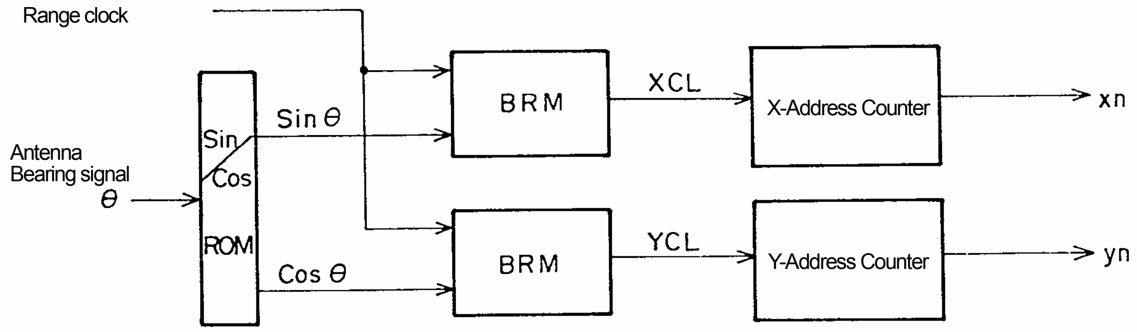


Fig. 7 Block Diagram of Coordinates Exchanger

7. Target Tracking System

7-1 Basic Concept of Collision Prevention

The following two items, such as prediction and avoidance of collisions, should be considered for prevention of collisions.

In an extreme case, regarding prediction of a collision, prediction of the case that two or more vessels may occupy the same point at one and the same time is carried out, and avoidance is that navigation of each ship is carried out so that each ship may not occupy the same point at one and the same time.

It is necessary to consider one blockade area in actual navigation, and this can be caught by the concept of CPA (Closest Point of Approach). Moreover, regarding prediction, time taken to reach CPA about prediction must be taken into account, and danger of collision is judged by using TCPA (Time to CPA)

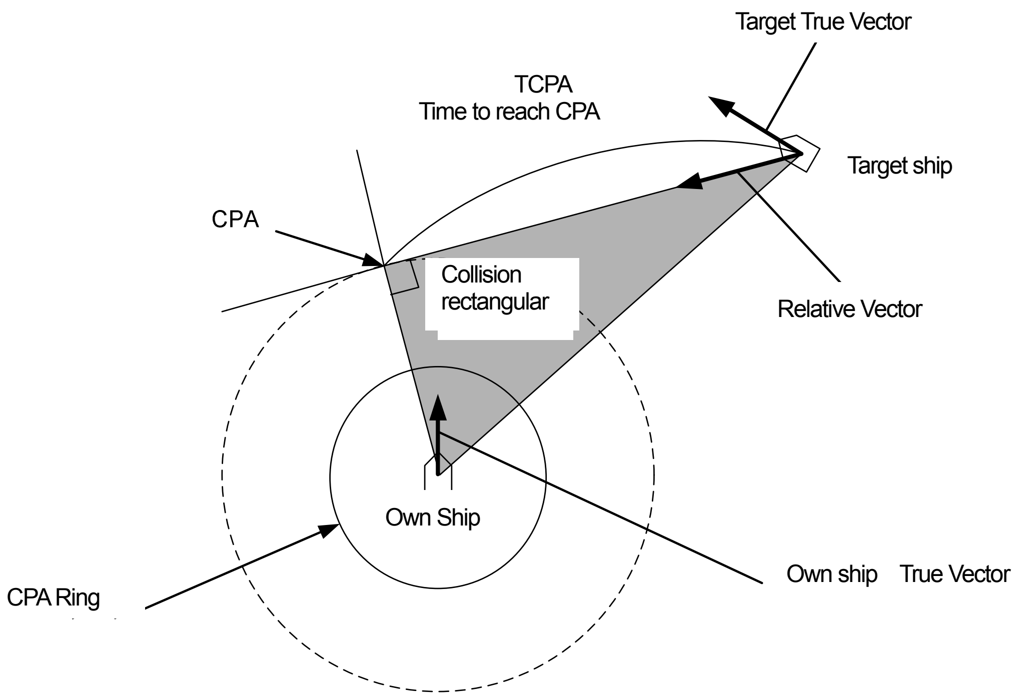


Fig.1 Concept of CPA and TCPA

[Explanation of a collision triangle]

By a relative speed vector, CPA and TCPA can be known easily. There is an advantage that danger of collision can be grasped at a glance by such concept. By a true speed vector, speeds and courses of other ships can be grasped easily and a relative attitude of each ship (crossing, overtaking, head-on, alongside, etc.) can be grasped as well.

In the above figure, when a relative vector is in the direction of a CPA ring, (that is, when a CPA is within a CPA ring), a danger of collision may occurs.

In addition, according to a situation, each ship operator sets up a CPA ring.

7-2 Rule

According to the new IMO radar performance standards in effect on July 1, 2008, the rule relating to target tracking function is as follows.

	IMO Performance Standard	IEC Standard
Previous standard	A.823(19),	IEC-60872-1/2/3
New standard	MSC.192(79)	IEC-62388

Therefore, a target tracking function called ARPA/ATA/EPA is now called TT (Target Tracking). With the revision of the standard, in the following description, a target tracking function is described as TT function, and a tracked target is described as TT target.

7-3 Basic Concept of System

7-3-1 The 1st step: detection and acquisition of targets from radar video signals

That is, ship navigators plot targets using trackball etc. After radar signals are processed with elimination of interference and sea clutters and such processed radar signals are sent as sweep data to a target tracking processing circuit. A target tracking processing circuit contains functions such as quantization of video signals, detection of targets in positions picked up (for use in manual acquisition), detection of targets in a sector (for use in automatic acquisition) and prediction of movement of moving targets, and a function of target tracking processing circuit is that position data of target required are sent to a main CPU.

7-3-2 The 2nd step: Tracking of targets

Prediction of a position to which a target may move from a position of a previously detected target, is carried out, for every antenna rotation. A target which is considered to be most suitable is detected from previously predicted video signals around a predicted position, and finally detected target position is set as the latest target position. Target tracking function is performed repeatedly by predicting and detecting targets.

7-3-3 The 3rd step : Judgment of ship in danger of collision

Based on the position information of the targets described in the above previous steps, target vectors (speed, course) are computed, and then a judgment of whether any danger of collision exists is made. Once targets' vectors are found, the closest point (CPA: Closest Point of Approach）approaching own ship and a time taken (TCPA: Time to CPA) for the target to approach that point from the target position can be computed. Such computed CPA and TCPA are compared with a limit of CPA and a limit of TCPA which have been beforehand set up according to situations surrounding own ship and a judgment of danger of collision is made. At this time, a function which simulates how a target vector changes by simulating a speed and a course of an own ship is called “Trial Manoeuvre”.

7-3-4 The 4th step: Display

The changing situations of the targets processed in the above steps, are displayed on a display and ship navigators are notified of these information.

Displaying is performed with symbols or numerical values and a course and a speed and a status of each target can be judged by the forms and the colors of symbols. Moreover, it is possible that audible alarms and alarm indications draw notice of ship navigators.

7-4 Description of Term of Operation

Alarm	Alarm display	
	CPA/TCPA	Alarm for target in danger of collision
	New Target	Alarm for targets entering a automatic acquisition area
	Lost	Alarm for Lost Target
Target Data	Numerical data display for target tracking	
	BRG (Bearing)	Bearing of Target
	Range	Range of Target
	Course	Direction in which a target is moving
	Speed	Speed of Target in direction of target's moving
	CPA	Closest Point of Approach
	TCPA	Time to Closest Point of Approach
	BCR (Bow Crossing Range)	Range to a collision point for bow to cross
	BCT (Bow Crossing Time)	Time taken for bow to cross a collision point
Trial Maneuver	Trial Maneuver	Manual simulation, Course,/Speed, and setting of dynamic characteristics
Target Vector	Target vector	Displaying Information of Course and Speed of acquired target as vectors on a target echo.
	True/REL	True vector / Relative vector indication
	Length	Selection of Vector Length (1 to 60 minutes, unit: 1 minute)
Limit	Safe full limits	
	CPA limit	Setting of Safety limit of Closest Point of approach
	TCPA limit	Setting of Safety limit of Time to Closest Point of approach
Own Speed	Speed of Own ship MAN/LOG/2AXW/2AXG/ GPS	Change and Manual setting of speed of own ship
Azimuth Mode	Display mode	
	RM	Relative motion
	TM	True motion
CNCL TT (CaNCeL Target Tracking)		Cancellation of a tracked target
All Cancel TT		Cancellation of all tracked targets
ALARM ACK (Alarm ACKnowledge)	Acknowledge Alarm	Cancellation of audible alarm
ACQ (ACQuisition)	Acquisition	Starting of selection and tracking of targets required to track.
		Acquisition of a target by manual using cursor
		Automatic acquisition of target within a automatic acquisition zone

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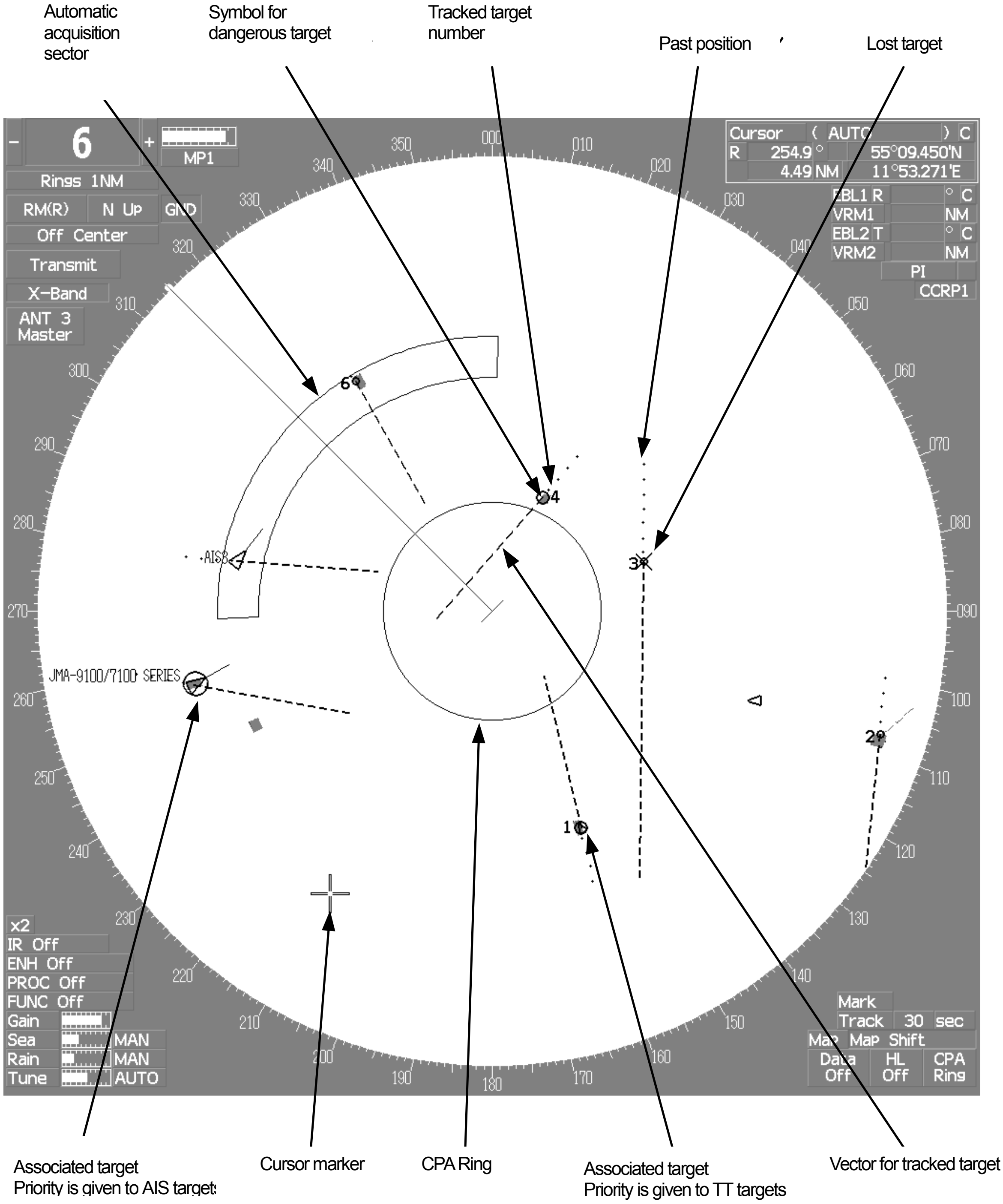
AZ (Acquisition Zone)	Automatic acquisition zone	Setting of zone with EBL/VRM/Cursor
		Automatic acquisition of target entering automatic acquisition zone
		Generation of New Target alarm
		The same as for the automatic activation zone for AIS
Past POSN (Past POSitioN)	Past position	Display of the maximum of ten(10) past positions at convenient intervals.
TT Test Menu		Functional Check of system
Association		Identification of Tracked Target and AIS Target as the same target.
Reference Target		Finding and displaying of own ship speed by tracking target fixed on the ground.

7-5 Example of Display

(NORTH UP, Relative vector mode)



Fixed Range Marker (Range Ring) / Variable Range Marker (VRM) / Electronic Cursor other than the above (EBL) displayed symbols etc. are displayed.
In the relative vector mode, CPA Ring is indicated as a solid line.

D

8. AIS Superimposition Display

8-1 Basic Concept of System

8-1-1 The 1st step : reception/decoding of AIS target information

Data of an AIS target (VDM sentence) are transmitted as compressed data. These data are received and decoded, and dynamic data, such as latitude/longitude, COG, SOG, and navigation status, and static data, such as ship's name, call sign, destination, etc. of an AIS target are acquired.

8-1-2 The 2nd step: Complement of target position

AIS target data are transmitted at intervals of 2 seconds to 3 minutes, depending on target speed, turning round, etc. When an interval between neighboring transmissions is long, the present target position is predicted and displayed using COG/SOG received last time.

8-1-3 The 3rd step: Judgment of ship in danger of collision

This step judges whether ships are in danger of collision. Once speed and course of target are found, it is easy to calculate CPA (Closest Point of Approach) and TCPA (Time to CPA). Such calculated CPA and TCPA are compared with a limit of CPA and a limit of TCPA which have been beforehand set according to situations surrounding own ship and danger of collision is judged. At this time, a function, which simulates how a target vector changes by simulating speeds and courses of own ship, is called “Trial Maneuver”.

8-1-4 The 4th step: Filtering

If AIS filter is set, AIS targets in such area can be displayed preferentially, or only AIS targets in the area can be displayed. The form of filter can be chosen from the three following types.

- a circle centering on own ship
- a shape of a fan enclosed by two bearings positioned on either side from right ahead
- a zone enclosed by two bearings positioned on either side from right ahead and by two lines based on own ship

8-1-5 The 5th step: Judging of being the same target

Complicatedness of a radar display can be reduced by displaying one association symbol instead of displaying two symbols such as AIS symbol and TT symbol, when AIS target and TT target can be judged as the same target. Judgment of being the same target is carried out by a difference in course/speed of each target, and bearing /distance from own ship.

8-1-6 The 6th step: Display

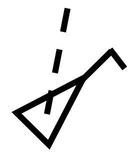
The changing situations of the targets processed in the above steps, are displayed on a display and ship navigators are notified of these information. Usually, AIS target is displayed as a symbol of sleeping target shown in the right figure.

Sleeping target

Direction of vertex of a triangle shows a heading or a course of a target.

activated

AIS targets entering an automatic activation zone are activated automatically or activated by manual, such activated AIS targets are displayed as a symbol as shown in the right figure. A heading is displayed as a solid line and a course vector is displayed as a dotted line. A line perpendicular to a heading line shows a direction of turning.



Activated target

Moreover, ship navigators' attention is called by audible alarm or alarm indication other than symbol indication.

8-2 Description of Term for Operation

Alarm	Display of Alarm	
	CPA/TCPA	Alarm for dangerous target
	New Target	Alarm for target entering an automatic activation area
	Lost	Alarm for Lost target
Target Data	Numeric data display of AIS target	
	Name	Ship's name
	Call Sign	Call sign
	MMSI	Maritime Mobile Service Identity
	COG or CTW	Course Over the Ground (Course relative to the ground) or Course Through the Water(Course relative to the water)
	SOG or STW	Speed Over the Ground (Speed relative to the ground) or Speed Through the Water (Speed relative to the water)
	CPA	Closest Point of Approach (The closest point of approach from own ship)
	TCPA	Time to Closest Point of Approach (Time to approach the closest point from own ship)
	BRG	Target Bearing
	Range	Range to Target
	HDG	Target Heading
	ROT	Rate of turn (turning speed)
	POSN	Latitude/Longitude
	Destination	Destination
	NAV Status	Navigational status data
Trial Maneuver	Setting of Trial Maneuver	Setting of Manual Simulation, Course/Speed and Dynamic Characteristics
Vector	Target vector	Information of a course and a speed of an AIS target are displayed as a vector on a target echo.
	True/REL	True vector, Relative vector
	Length	Selection of Length of a vector (1 to 60 minutes, per 1-minute)
Limit	Safety limit values	
	CPA limit	Setup of the safety limit of Closest Point of Approach
	TCPA limit	Setup of the safety limit of Time to Closest Point of Approach
ACT AIS		ACTivate AIS target Activation of AIS targets
DEACT AIS		DEACTivate AIS target Deactivated AIS targets
ALARM ACK		ALARM ACKnowledgef Cancellation of Audible alarms

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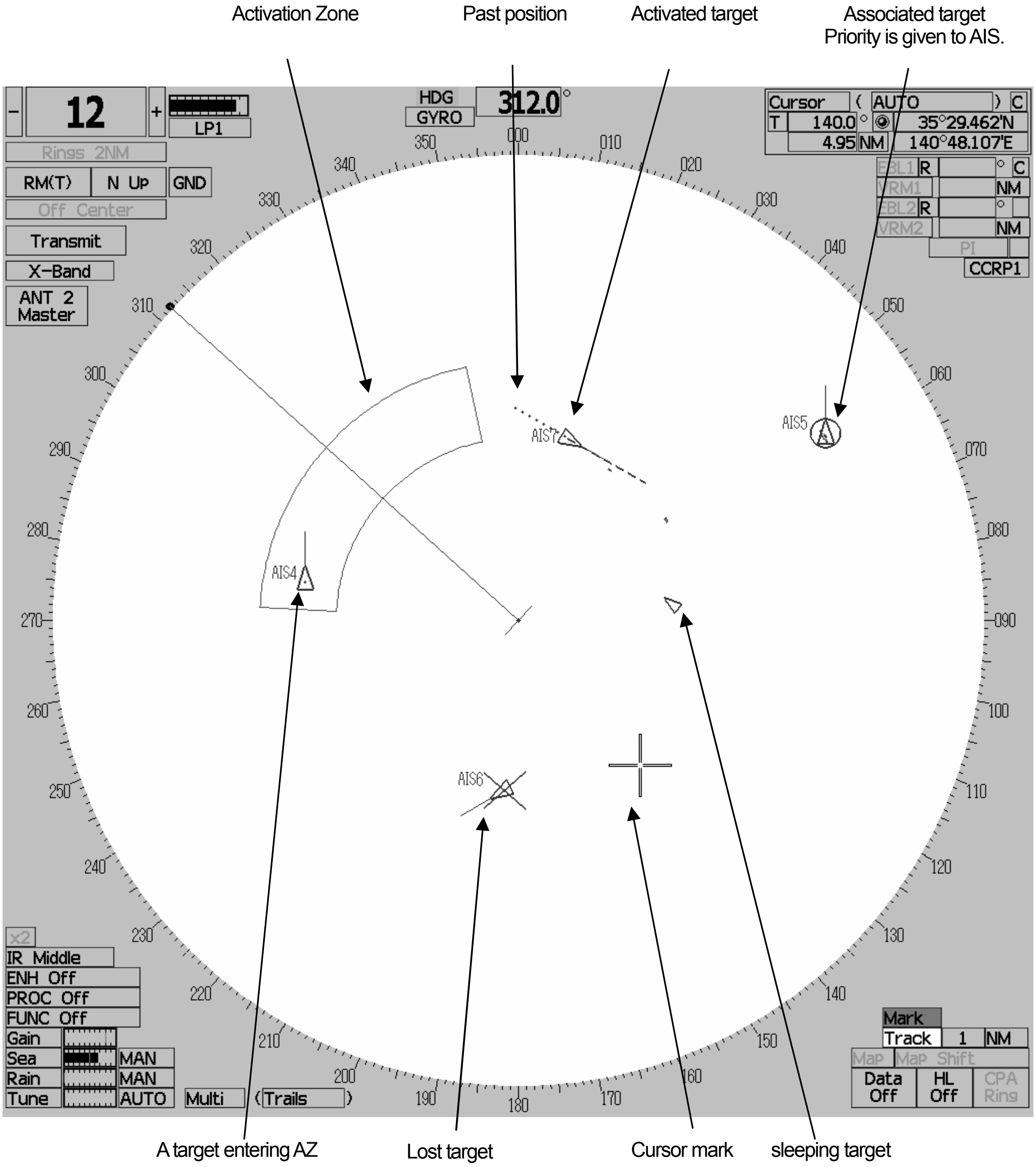
Activation Zone	Automatic activation region	Sector setup using EBL/VRM/cursor Sleeping AIS target in the zone is activated automatically. Generation of alarm for New Target The same as for the automatic acquisition zone for target tracking function
Past POSN		Past POSitioN A maximum of ten Past positions are displayed at convenient intervals.
Association		Identification of Tracked Target and AIS Target as the same target.

8-3 Example of Display

(NORTH UP, TRUE vector mode)



In addition to the above markers, Fixed (Fix) / Variable (VRM) Range Marker, Electronic cursor, etc. are displayed.
In the relative speed vector mode, a CPA ring is displayed as a solid line.

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9. Chart Radar

9-1 Outline of Chart Radar

The request of the safe and efficient voyage is strong with modernization of a vessel. To this request, the technical solution to Integrated Bridge System (IBS) is proposed, and the shipping classification society defines the requirements for IBS. Among these, since the Norway classification society (DNV) made mandatory for the carriage of the chart radar as configuration equipment of Integrated Navigation System (INS) which is a subsystem of IBS, The chart radar came to be required from the market as radar which bears a safer voyage.

9-2 System of Chart Radar

The chart radar is a radar equipment which displays the electronic charts, such as Electronic Navigational Chart (ENC), by superposition on a radar screen. In addition, there is Electronic Chart Display and Information System (ECDIS) as equipment which can display an electronic chart on a screen, By receiving the slave picture signal from a radar, a superposition display of a radar image is possible on the chart of an ECDIS screen. However, since the ECDIS itself does not have a radar function (it does not have a sensor which transmits and receives an electric wave), a chart radar differs in the category of equipment.
The chart radar can perform simultaneously a target tailing function, stranding prevention besides the collision prevention by AIS, and route surveillance. The composition of equipment is the same as that of common radar equipment fundamentally, and there are a 3 unit type which consists of an antenna, a transmitter-receiver, and a display unit, and a 2 unit type which contained the transmitter-receiver in the antenna.
There is a standalone type of display unit which installation can be constructed easily. In addition, there is the desk-top type suitable for the implantation to the console which a display unit, a processor unit, a operation unit were separated.

About an antenna and a transmitter-receiver, since it is the same as that of common radar, the display unit which exhibits the function as chart radar here is explained.

An example (Fig.1) of the system block figure of a display unit is used for below, and the feature is described about each unit of a display, a processor unit, and operation unit which constitutes a display unit.

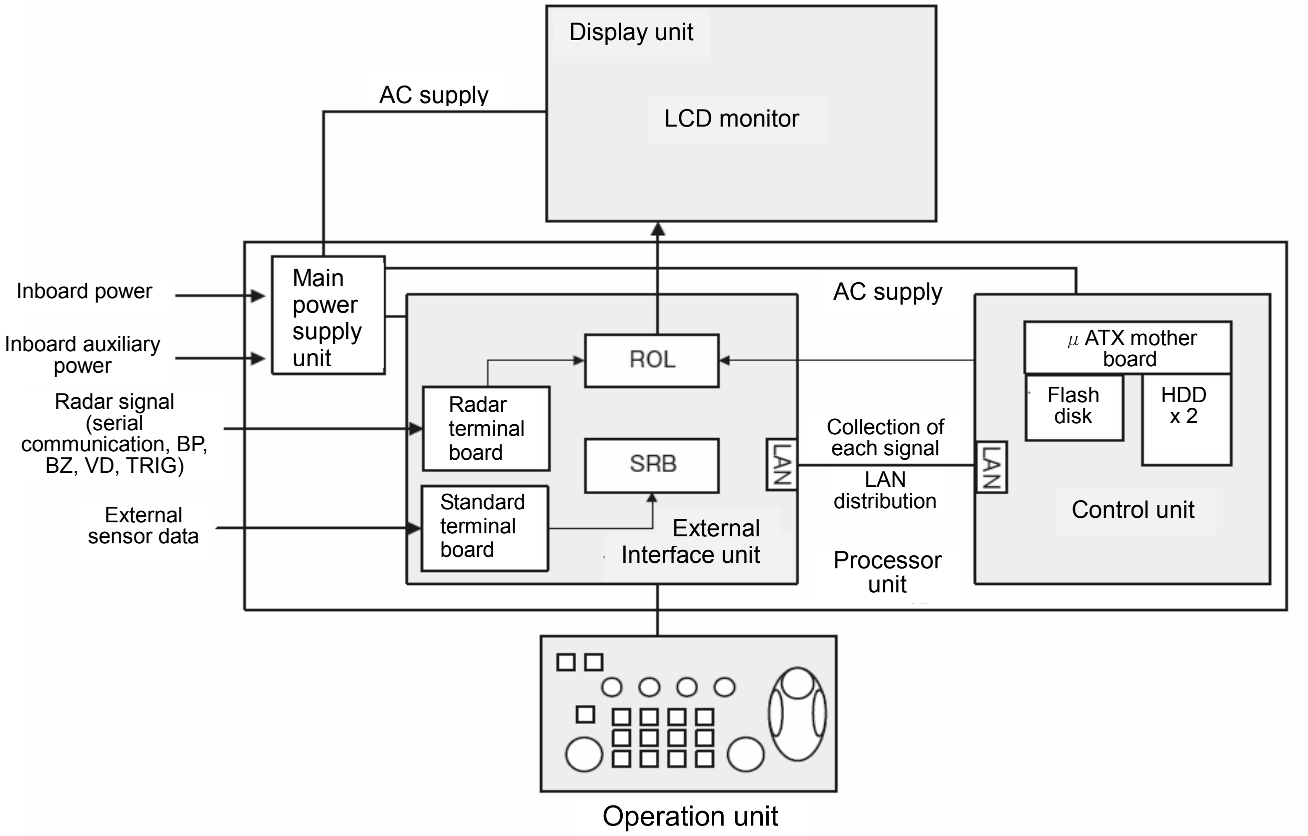


Fig.1 Composition of a chart radar display unit

9-2-1 Display unit

A display adopts the light-weight, long life, large size (23.1 inches and 26 inches), and high-intensity color LCD.
A radar screen is displayed in high-resolution UXGA (1600 x 1200 dot), and the good resolution performance and visibility are achieved.

9-2-2 Processor Unit

Processor unit consists of a control unit, an external interface unit, and a main power supply unit, and they are designed so that it may be based on international standard IEC60945 Ed.4.0 which is the requirements for environmental-resistant performance.

(a) Control unit

The mother board for industry excellent in the environmental-resistant performance is adopted as μ ATX mother board currently used by the control unit, it is low power consumption and high-speed operation is realized. The flash disk is adopted as the system drive which is OS storing media. The flash disk is excellent in environmental performance / durability, and realizes stabilization of operation.
Moreover, aside from the flash disk, as data storing media, such as a chart database and track data, two or more hard disks for record are installed, and improvement in reliability is aimed at by backupping mutually.

(b) External interface unit

The external interface unit is installed with a standard terminal board, a radar terminal board, serial signal (IEC61162-1/2), the input-output interface unit (Serial Relay Interface Board: It is called

SRB hereafter.) of the contact signal and a radar signal processor unit (Radar Overlay unit: It is called ROL hereafter) as standard.
A batch distribution is delivered to control unit via LAN after collection in SRB, and it's possible to display the external sensor data from a standard terminal board as own ship data. Moreover, sensor data sharing with each equipment is possible by connecting LAN of SRB to the network of an external equipment.
SRB adopts a TAG-VLAN system and network doubleness is attained by preparing the output for subnetworks of a standby system other than the output for main networks of the existing system. When a main network is cut under a certain influence, the reliability of the system in a large scale system is improving by using a subnetwork automatically.
On the other hand, a signal processing is performed by ROL and the radar signal from a radar terminal board generates a radar echo. The generated radar echo is composed with the chart which a control unit draws, and is outputted to the display.

(c) Main power supply unit
The main power supply unit consists of a filter circuit, an overvoltage protection circuit, and a control circuit, and supplies the power supply (+12V, +5V) to the inside of the display unit. Moreover, inboard auxiliary power (+24V) is inputted and it is used as an object for AC input interception detection.

9-2-3 Operation unit
The operation unit is commonized in radar and ECDIS, and unification of the operability is achieved by making the allocating place of a key same about common function with a radar and ECDIS.
Moreover, key arrangement is designed so that a key required of radar mode and a key required of ECDIS mode can use it by one operation unit.

9-3 Function of Chart Radar
This equipment conforms to the radar performance and the function which are demanded by MSC.192 (79), and has a still more original display function. The main functions are shown in below.

9-3-1 Transparent display of chart data
When the radar echo was displayed by superposition on a chart, it made it possible to indicate the chart symbol by transparency which hides and is not visible to a radar echo. A chart symbol can be confirmed by this even when the sea clutter and rain and snow clutter of a weak level remain.

9-3-2 Superior operability
The human machine interface established from the conventional model was evolved further, and equipment adopted the "Automatic Mode" which judges the operation mode automatically at the time of the cursor operation in a radar screen. Thereby, the target capture, AIS target activation, and numeric display of target became able to operate by one action altogether, and user's operation was simplified largely.

9-3-3 Possibility as Backup ECDIS
It is also possible to use screen mode for ECDIS mode, changing it from radar mode, and MED certification has been acquired as backup of the ECDIS equipment of our company.
However, the confirmation to the administration of each country and a classification is required for the possibility of the paper chart exemption in the case of using this equipment as Backup ECDIS.

Below, the example of a radar mode screen of a chart radar and the example of an ECDIS mode screen are shown.

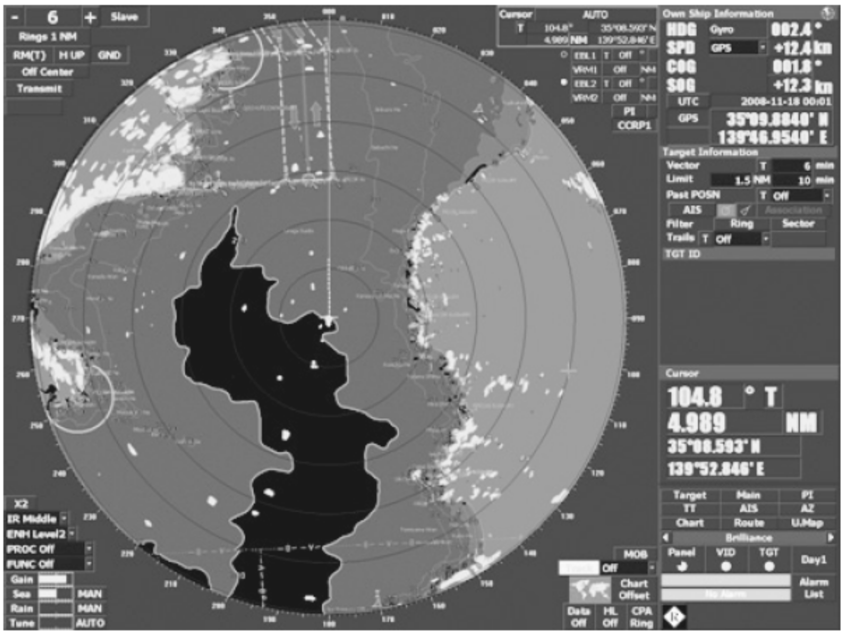


Fig.2 The example of a radar mode display screen

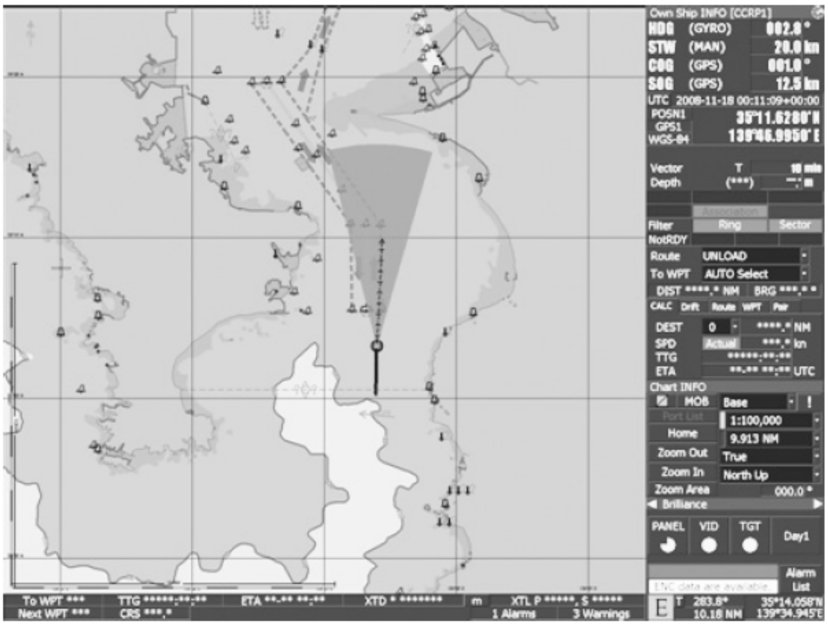


Fig.3 The example of an ECDIS mode display screen

9-4 Network connection to ECDIS and Conning display

By carrying out network connection to equipment, such as ECDIS and a conning display, since data sharing and linkage are attained, it is possible to improve the function.

9-4-1 Sharing of navigation data

For example, the navigation data of the Gyro and GPS, etc. collected by ECDIS can be used via LAN by two or more chart radars.

9-4-2 Sharing of route data and user map data

The route data and user map data created by ECDIS can be used sharing them between ECDIS and a chart radar.

9-4-3 Interlocking in screen color mode

When screen color mode (daytime / night mode) is changed by a chart radar, the screen color mode of other ECDIS(s) and the conning display which are connected to LAN, and also are changed with interlocking.

As mentioned above, it is required as configuration equipment which conforms to the requirements for DNV, becoming a core as a task station which composes INS is expected in future, and the chart radar is equipment which contributes to a safer and efficient voyage.

10. Solid State Radar

10-1 Outline of Solidification Radar

In the marine radar, in order to transmit the microwave by which pulse modulation was carried out, the magnetron (self oscillation tube) which can be composed comparatively inexpensively is widely used in the efficient transmitter from the former.
Development of the Solid State Radar which used the semiconductor device instead of the magnetron which was being conventionally used for the transmitting unit is furthered with progress in a semiconductor device in recent years. As the background, reduction of the maintenance cost is enabled by not adopting magnetron needing periodical exchange. And it is mentioned that it is required to conform to tighten up legal restrictions of making narrow band of the occupancy frequency aiming at electric wave effective use etc.

A Solid State system has many merits, such as maintenance free, reduction of unwanted radiation, and improvement in detection performance, and conversion to a Solid State system will be promoted increasingly in future.

10-1-1 Key feature of Solid State Radar

a) Improvement in target detection performance

The Solid State Radar is to generate a phase controlled transmission wave in a digital circuit, and to build a coherent system becomes possible. As the frequency information is available in addition to the system which depended only on the amplitude information like conventional magnetron radar, the realization of the function that is effective for target detection such as the Doppler processing is possible.

b) Improvement in reliability

As for the system which uses a magnetron, a high-voltage circuit is required for a modulation unit, therefore, electric parts also require the kind of the high resisting voltage characteristic. However, the circuit construction by the low voltage is possible since the voltage used by a Solid State Radar is usually less than 50 V (power supply of the semiconductor device for the power amplifiers). Therefore, since the risk of the failure accident resulting from part resisting voltage is also reduced, the high reliability can be achieved.

c) Downsizing and lightening of equipment

Since large-sized parts, such as a magnetron and a wave guide tube, can be deleted, reduction of circuit structure is possible. The small weight saving of the whole equipment is realizable as a result. Since this reduces the material resources to be used, also in the field for environment, it leads to effective use of resources.

d) Reduction of power consumption

Since the transmitting power is suppressed low compared with magnetron method, the electric power saving of equipment can be achieved. For example, the transmitting power consumption of the conventional 30 kW of S band magnetron radar is able to save the power to a half grade by Solid State Radar to one hundred and several tens of W. A Solid State Radar can be called to be the system which can contribute in respect of the performance for environment also from this point.

10-2 Base System of Solid State Radar

As for the typical method of a Solid State Radar, pulse compression method and a FM-CW (Frequency Modulated Continuous Wave) method are held. Here, about the pulse compression method used as the present main method, the base system is explained below.

Outline of pulse compression method

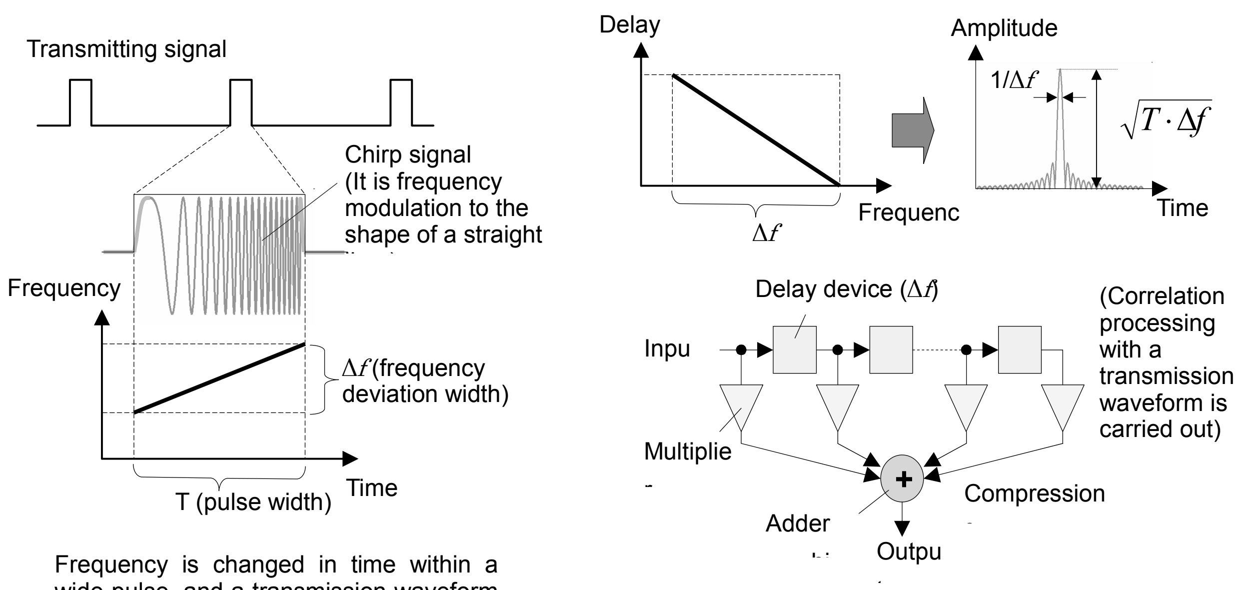
In order to secure long distance sensitivity and high resolution (distance resolution), it is necessary to transmit a pulse with narrow width with high transmitting peak power. Of course even a Solid State Radar can transmit the peak power of the magnetron equivalency, but is not realistic since the cost of the power amplifier (PA) unit becomes large, and the equipment becomes big.

Therefore when even if the transmission peak power is low, it transmits the wide pulse within a pulse with the frequency modulation, and when receiving the reflected wave from a target, it is possible to get the same effect as the case when a narrow pulse was transmitted with the high transmission peak power by doing signal processing as pulse compression processing. The outline of pulse compression method is shown in the following figure.

Usually, in order to raise the process gain by pulse compression, a chirp waveform with a sharp autocorrelation function, a phase modulation wave form with a pseudorandom numbers code, etc. are used for a transmitted waveform.

The generation of an extension pulse and pulse compression are available for realization by adopting a SAW device (Surface Acoustic Wave device). However, implementation by digital processing is common with speedup and large scale of LSI of DDS (Direct Digital Synthesizer) and FPGA (Field Programmable Gate Array), etc. in recent years.

■ Transmission ■ Reception



Frequency is changed in time within a wide pulse, and a transmission waveform is formed.

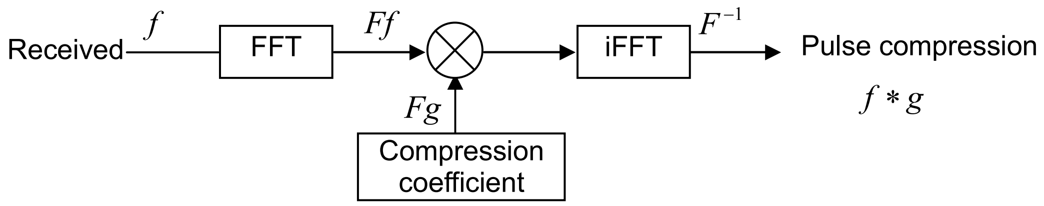
When putting a reception wave form through the frequency-delay time characteristic filter, the compression pulse of an amplitude $\sqrt{T \cdot \Delta f}$ and width $1/\Delta f$ is obtained.

Fig.1 The transmission and reception outline of pulse compression method

The pulse compression uses the wide pulse that gave special modulation (frequency sweep, code modulation, etc.) within a pulse as a transmission signal and it demodulates by processing after the reception and converts it into a narrow pulse signal. The pulse width of a received signal is reduced for a received signal by correlation processing with a transmitting signal in fact, and processing which multiplies an amplitude level is performed.

1) Use the transmitting signal of pulse width T and frequency deviation width Δf.
2) The signal reflected from the target is received in the same form as a transmitting signal by the delay and power (based on a radar equation) equivalent to distance. The amplitude of the received signal is made A here.
3) It processes a received signal with the filter which has the reverse delay characteristics of the frequency deviation in a transmitting signal pulse. This processing is pulse compression processing, and as a result, process so that signals may be collected to a certain time on a time axis.
4) The signal becomes the sinc function form after compression after the pulse compression processing, and the pulse width is reduced by 1/ Δf, and the amplitude is multiplied by $A\sqrt{T \cdot \Delta f}$.

When taking a large pulse compression ratio, since the composition of a transversal filter becomes large and realization becomes difficult in respect of circuit structure or processing time, as shown in the following figure, once it changes a received signal into a frequency domain by FFT etc., the technique of carrying out pulse compression processing is used well.



The basic composition of pulse compression method is shown in the following figure.
The basic composition of a magnetron method also illustrated for comparison.

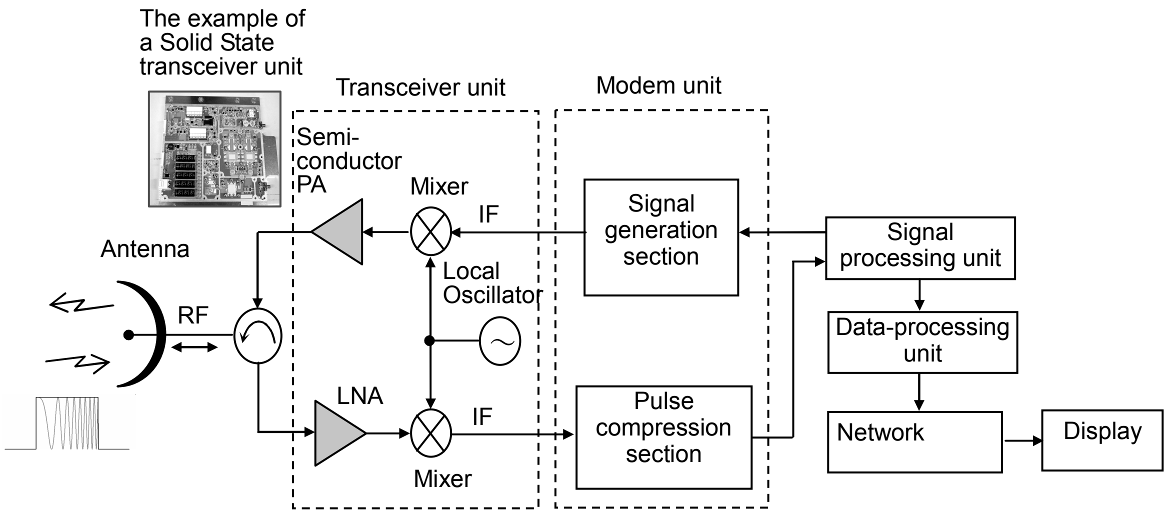


Fig.2 Basic composition of pulse compression method

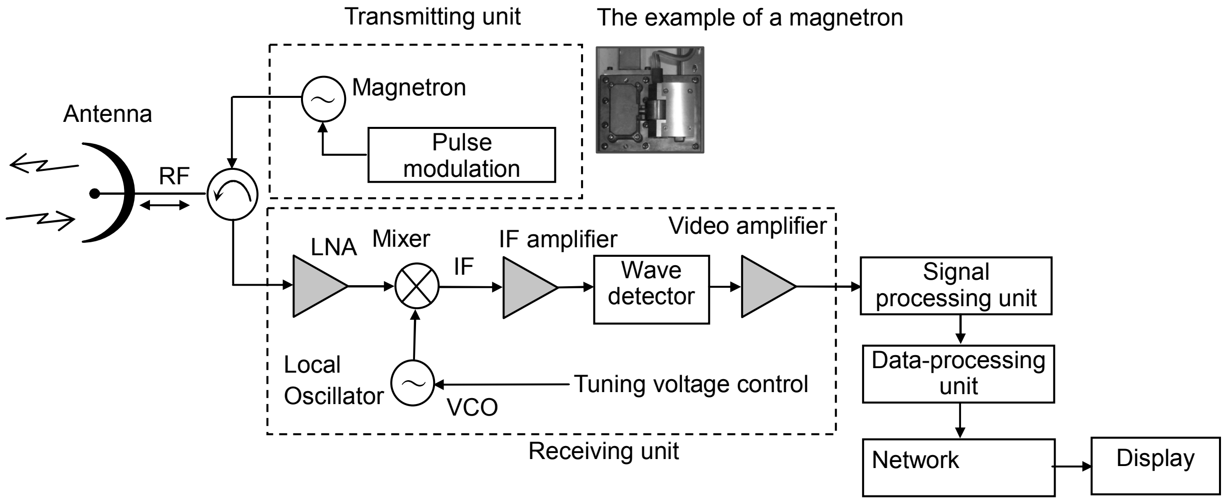


Fig.3 Basic composition of a magnetron method

In the basic composition of pulse compression method, the transmitted wave of the intermediate frequency (IF;Intermediate Frequency) generated in the signal generation section of the modulator/demodulator section, after up convert is carried out to microwave using a mixer and amplified by the predetermined output with the semiconductor PA (Power Amplifier), the power is supplied to the antenna through a circulator and it is radiated in space. After a received wave is amplified by LNA (Low Noise Amplifier), a down conversion is carried out by a mixer at IF of the same frequency band as a transmitted wave, compression processing is carried out in the pulse compression section of a modulator/demodulator section, and it is supplied to a signal processing unit as a video signal. Then, while being converted into a video signal with a display unit via a data processing unit, the data according to a use is distributed through a network. Since the signal of the stable frequency generated by digital control is used for a transmitting signal as one of the different points from a magnetron method, tuning control becomes unnecessary at the time of reception. Moreover, although the preheating time (about 3 minutes) to an oscillation is needed in the case of a magnetron method, it is unnecessary by a Solid State Radar, and transmission of it is immediately attained from powering on (the waiting time for tens of seconds is generated in the system startup etc. which include a display unit side in fact).

On the other hand, in the basic composition of magnetron method, transmitted wave of the magnetron oscillated by the predetermined pulse width by control in the pulse modulation section is supplied to the antenna through a circulator, and it's radiated in space. After a received wave is amplified by LNA (Low Noise Amplifier), a down conversion is carried out by a mixer at about 60MHz IF, and it is supplied to the signal processing unit through an IF amplifier (log amplifier), detection circuit, and video amplifier circuit.
Since frequency changes with temperature characteristics (about -0.2 MHz/(℃)), the oscillation of a magnetron adjusts the frequency of a local oscillator (tuning control), stabilizes IF signal and it is necessary to make sure that the optimal image sensitivity will be obtained. In addition, although a user can adjust tuning control manually from the operation unit, automatic processing is usually performed so that receiving sensitivity may become the maximum.

10-3 Challenge to Solid State Radar

10-3-1 Time side lobe

In pulse compression method, the unwanted signal of a time side lobe (it is also called a range side lobe) occurs as a result of the compression processing at the time of reception. The signal after the compression which performed pulse compression processing serves as sinc function form, and a time side lobe level becomes theoretically about 13.2 dB. It is because this serves as rectangle form to which the frequency characteristic of the after-compression signal was restricted in the band width of the transmitting signal and the time characteristic of the after-compression signal which is the inverse Fourier transform serves as sinc function form.

A time side lobe of 13.2 dB is not a generally permissible level on use of the radar. For example when considering use by the marine radar, the radar reflection cross-sectional area of a large ship of a tanker and a container ship is about $10^8 m^2$, and a reflective cross-sectional area of a small fishing boat is $10m^2$ at most, therefore the difference in the 70dB causes its reception power. Therefore, when a fishing boat is in the large vessel side, a small ship is buried in the time side lobe generated in pulse compression processing of the received signal of a large vessel, and discrimination becomes impossible.

Then, it is necessary to suppress a time side lobe level as much as possible, and there is the method of applying a window function as one of measures at the time of compression processing. This is the method of suppressing the time side lobe level of the time characteristic by weighting the frequency characteristic of an after-compression signal. It is effective to use the Blackman window function which can generally reduce a time side lobe level greatly. However, since the distance resolution deteriorates by applying a window function because the loss (degradation of S/N) of a signal arises or the pulse width after that compression spreads as shown in the following figure, the trade-off with such performances is required.

Application of window function

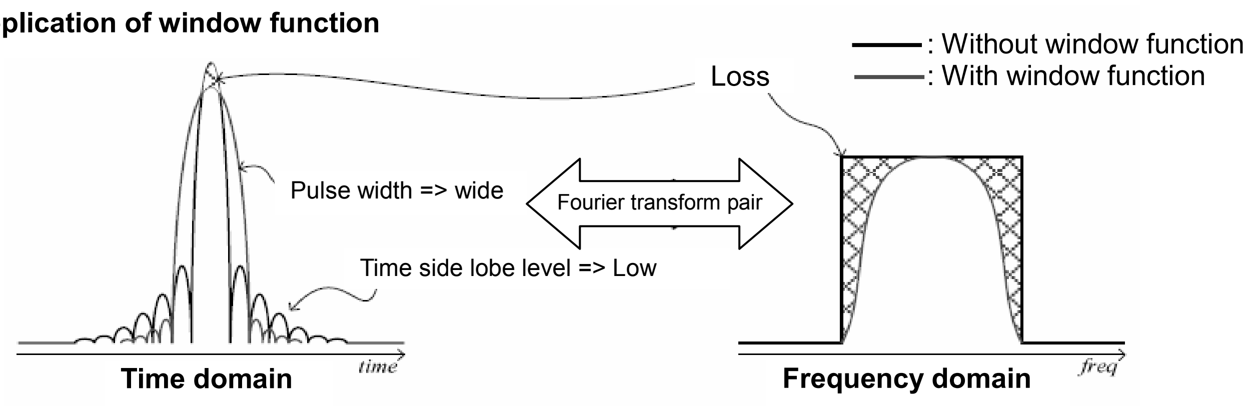


Fig.4 Pulse compression processing using a window function

10-3-2 Radar interference

Since the method adopted as Solid State Radars, such as pulse compression method and a FM-CW method, transmits a long pulse compared with the radar of a magnetron method, we are anxious about the interference between radars, especially interference given to the radar of the existing magnetron method.

The signal which is usually received as interference wave judges the sudden signal which has no continuity as interference signal, and is suppressed by correlation processing between the sweeps, however, the situation which cannot suppress it produces the long pulse signal to become strong in the correlation between the sweeps. The technique of heightening a suppressing effect by lowering the correlativity between the sweeps of an interference signal by the stagger function to fluctuate a transmitting repeating cycle is effective, however the range which fluctuates a transmitting repeating cycle has restriction from maintaining of the maximum detection range

scale.
The requirements to be installed with a function to reduce interference to give other radars on the Solid State Radar side, e.g., a function to change transmission frequency in itself are demanded.

10-4 Conclusion of Solid State Radar

It arranges about the concept of a magnetron method (pulse method) and pulse compression method below. A FM-CW method is also described as reference.
The following figure summarizes the change of state of 1 transmitting cycle (repeating cycle) about transmission power, transmission frequency, and a received signal.
In the pulse method using a magnetron, the pulse of narrow width is transmitted with high peak power. Moreover, the transmission frequency shows that it is constant during a period of the pulse width.
A transmitting signal returns as a received signal with the time delay according to the distance to a target, and level attenuation.

In pulse compression method, although peak transmission power falls about in 1/100 of a magnetron method, pulse width spreads in about 10 to 100 times. A transmission frequency in the period of a pulse width is changing linearly (FM pulse; this is also called chirp signal). This is control required in order to perform pulse compression processing, and serves as main parameters this frequency change ΔF decides a pulse compression ratio and the pulse width after compression.
In addition, explanation is omitted although there is also a code modulation method which performs a phase modulation discretely within a pulse according to the code sequence which takes a discrete value in pulse compression method.

In a FM-CW method, although peak transmission power falls about in 1/100 more from pulse compression method, a transmitted wave turns into a continious wave instead of a pulse. Transmit frequency changes linearly between repeating cycles. By a FM-CW method, the beat frequency (frequency difference of transmit signal and a received signal) of a transmit signal and a received signal is detected at the time of reception, and a target distance is found.

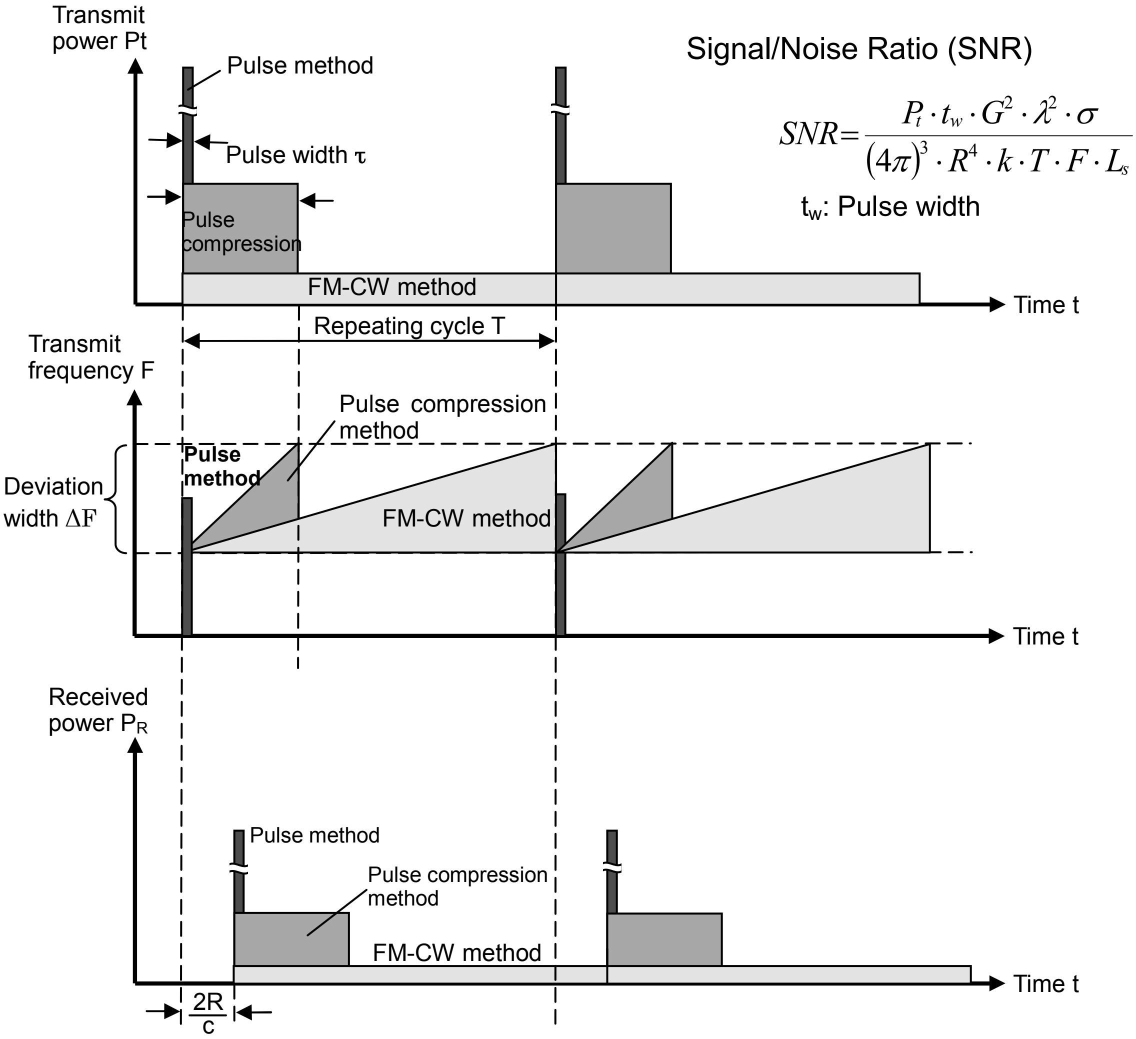


Fig.5 The concept of various radar Methods

Comparison of various radar methods is arranged at the following table.

	Magnetron radar (Pulse method)	Solid State Radar	
		FM pulse (pulse compression) method	FM-CW method
Transmission power	Several kW - tens of kW	Hundreds of W - several kW	Below tens of W
Pulse width	0.05-1.2 μsec	5-30 μsec	Up to 1msec
Modulation	Non FM	FM	FM
Merit	Low cost and high output power Easy signal processing	Improvement of long distance sensitivity is possible. Coherent processing is possible. Spurious suppression is easy.	RF circuit composition is simple and low cost. Coherent processing is possible. Spurious suppression is easy.
Demerit	Spurious suppression control is difficult. (High-output power waveform molding technique is required) Exchange of a magnetron is required.	The sensitivity of a blind area falls. (Short-distance target detection technology is required) Under the present circumstances, a device is expensive.	Long distance sensitivity is inferior. (The separation technology between transmission and reception is required) Radar interference technology is difficult.

11. VDR / S-VDR

VDR (Voyage Data Recorder) maintains continuously sequential records of preselected data items relating to the status and output of the ship’s equipment, and command and control of the ship, such as date and time, ship’s position, heading, speed, conversations in the Bridge, other ship status, etc. to investigate causes of an incident.

S-VDR (Simplified Voyage Data Recorder) is for existing cargo ships, and requirements for data recording and the capsule are relaxed.

11-1 Carriage requirements and Related ships

The carriage requirements for VDR/S-VDR is as follows. (SOLAS Chapter V Regulation 20)

Ship			Equipment	Terms of Installation
Ship engaged in International voyage	Passenger ships and RORO Passenger ships of 150 gross tonnage and upwards	Existing ships / Ships to be newly constructed	VDR	New standard (IEC61996-1 Ed2) applied from July 1, 2014 is demanding to record the specified data in a fixed capsule and the float-free type capsule for 48 hours as well as record in long record media for 720 hours.
	Cargo ships of 3,000 and upwards	Ships constructed after July 1, 2002	VDR	
		Ships constructed before July 1, 2002	VDR or S-VDR	20,000 GT and upwards July 1, 2006 to July 1 2009 3,000 - 20,000GT July 1, 2007 to July 1, 2010

Note: Definition of “Constructed”

.1 the keel is laid; or
.2 construction identifiable with a specific ship begins; or
.3 assembly of the ship has commenced comprising at least 50 tonnes or 1% of the estimated mass of all structural material, whichever is less.

11-2 Performance Requirements

The conventional standard (IEC61996-1 Ed1) is demanding to record the specified data to a fixed capsule for 12 hours. However, the new standard (IEC61996-1 Ed2) applied from July 1, 2014 is demanding to record the specified data in a fixed capsule and the float-free type capsule for 48 hours as well as record in long record media for 720 hours.

- Power supply : supplied from ship’s emergency source of electrical power supply
- Annual inspection is carried out by manufacturers approved by a Classification Society

- If the ship's emergency source of electrical power supply fails, VDR should continue to record Bridge audio from a dedicated reserve source of power (Battery) for a period of 2 h.
- Recording should not be terminated except for the following cases.
  - a) during essential maintenance purposes whilst the vessel is in port;
  - b) when the vessel is laid-up;
  - c) upon request by an investigation authority, for example after the vessel had been involved in a marine incident.

D

11-3 Data items to be recorded

11-3-1 Sensor data

Data		VDR		S-VDR
		IEC61996-1 Ed1	IEC61996-1 Ed2	
Date, Time	ZDA	Required	Required	Required
Ship's position	GNS (GGA), DTM	Required	Required	Required
Speed (through the water or over the ground)	VBW	Required	Required	Required
Heading (true value) (Magnetism)	THS, HDT HDG	Required	Required	Required
Depth of water	DPT	Required	Required	Required, when data in IEC61162 is outputted
The main alarm	ALR, ALA, FIR, WAT	Required	Required BAMS	
Rudder order and Response Rudder angle (Manual) (Automatic)	 RSA HTC, HTD	Required Automatic condition is required when autopilot is equipped.	Required Automatic condition is required when autopilot is equipped.	
Engine order and Response	ETL, PRC, TRC, TRD, RPM, XDR	Required	Required	
Watertight door, Fire door, Hull opening	DOR, GEN, XDR	Required Required in the case of Ro-Ro passenger ship	Required Required in the case of Ro-Ro passenger ship	
Acceleration and Hull stress	HSS, XDR, ALR	Required, when equipped	Required, when equipped	
Wind speed and Direction	MWV	Required, when equipped	Required, when equipped	
AIS	VDO,VDM,TXT, ALR	Optional	Required	Required, when radar data cannot be recorded.
Electronic Clinometer	HRM	Not demand to record.	Not demand to record.	Not demand to record.
Electronic Logbook	Undecided	Not demand to record.	Required, when equipped	Not demand to record.

11-3-2 Voice data

Data	VDR		S-VDR
	IEC61996-1 Ed1	IEC61996-1 Ed2	
VHF communications (transmitted and received conversations)	Required (Max 3 tracks mixing)	Required (Max 2 tracks mixing)	Required (Max 3 tracks mixing)
Bridge audio (Microphone)	Required (Max 3 tracks mixing)	Required (Max 2 tracks mixing)	Required (Max 3 tracks mixing)

11-3-3 Image data

Data	VDR		S-VDR
	IEC61996-1 Ed1	IEC61996-1 Ed2	
Radar data post-display selection (ever 15 second)	Either 1 image of X-BAND or S-BAND radar is required	2 images of X-BAND and S-BAND radar are required	When have I/F for connection.
ECDIS data post-display selection (ever 15 second)	Not demand to record.	Required (*Source of chart data and the version)	Not demand to record.

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11-4 Performance Requirements for Protective Capsule

11-4-1 Fixed Protective Capsule (FPC)

Item	Endurance Item	VDR		S-VDR
		IEC61996-1 Ed1	IEC61996-1 Ed2	
Record	Recoding time	12 hours	48 hours	12 hours
Environmental-proof performance There are not breakage of a memory media and a deficit of data under mentioned environment.	Shock	A half sine-wave pulse of 50 *g*, with a duration of 11 ms		
	Penetration	A mass of 250 kg with a pin of 100 mm diameter, dropped from a height of 3 m		not required
	Fire	A low temperature fire of 260 °C nominal for 10 h A high temperature fire of 1 100 °C nominal for 1 h		
	Deep-sea pressure	60Mpa (water pressure equivalent to a depth of 6000 m)		
Underwater Acoustic Beacon	Frequency	Center frequency: 37.5kHz±1kHz (25 to 50 kHz)		
	Operation time	30 days (min.) After submergence	90 days (min.) After submergence	30 days (min.) After submergence
	Distance range	1800m-3600m (subject to environments)		

11-4-2 Float –Free Capsule (FFC)

Item	Endurance Item	VDR		S-VDR
		IEC61996-1 Ed1	IEC61996-1 Ed2	
Record	Recoding time	12 hours	48 hours	12 hours
Transmitting	TX time	168 hours		
406MHz TX	Frequency	406.037MHz		
	TX Power	5W±2dB		
121.5MHz	Frequency	121.5MHz		
	TX Power	50mW±3dB		

11-4-3 International Media

Item	Endurance Item	VDR		S-VDR
		IEC61996-1 Ed1	IEC61996-1 Ed2	
Record	Recoding time	12 hours	720 hours	12 hours

11-5 Microphone Setting Position

Connection of a maximum of nine microphones is possible for VDR/S-VDR. However, voice data of three microphones are combined and recorded into CH1-3, CH4-6, and CH7-9 each. Microphones are so installed that each of 3 areas is covered by three microphones.

- Central Conning station, Wings, Main radar display, Chart table, Steering stand, Communication area

11-6 Sitting Position of Capsule

11-6-1 Fixed Protective Capsule (FPC)

A protective capsule shall be sited in the vicinity of the bridge on the external deck area of a ship so as to maximize the probability of its survival and recovery following an incident. The protective capsule shall be positioned clear of rigging and other potential obstructions and as near to a ship's centerline of the ship as practically possible.

(1) Separation from fuel or other potential fire sources.
(2) Separation from probable sources of mechanical damage.
(3) Operational environment for continued serviceability.
(4) Facilitation of underwater removal and retrieval by both divers and ROVs. There shall be a clear unobstructed space in the vicinity of the capsule to allow an ROV or diver to work.

11-6-2 Float –Free Capsule (FFC)

Float-free type capsule

The final recording medium is built in the float-free type capsule.

Install the float-free type capsule by the right method at a suitable place in order to make easy the stable normal operation, recovery, and maintenance work. Install and select the place according to the following conditions.

(1) The place which does not receive a wave directly
(2) The place which does not disturb the operation of automatic release
(3) The place which does not become the disturbance of work or passing
(4) The place which operation of a float-free type capsule is easy
(5) The place without a magnetic field (the magnet is built in automatic release device)
(6) The place with little vibration, such as a cabin wall
(7) The place which can secure 0.8 m of compass safe distance

11-7 Alarm of VDR/S-VDR

Since it is necessary to monitor the operating status of VDR/S-VDR in a Bridge, a monitor unit which generates an audible alarm and a visible alarm is installed in the Bridge. If Operation indication Unit is used, it is to be installed in the Bridge, and a main unit can be installed in a place other than the Bridge.

D

11-8 Reproduction Software for Investigation Authorities

According to the IMO Resolution (MSC.214 (81): amendments to A.861(20) and MSC.163(78)), the software for the investigators, which is compatible with the following requirements, is required to be provided together with VDR/S-VDR installed after 1 June, 2008. The software etc. for VDR/S-VDR provided by JRC is described below.

- Download of stored data
  It is possible to download the stored data from a sub-medium (CF-card etc.) in the Rerecord Control Unit using LAN. *1
- Data format conversion (additional function)
  It is possible to change the data stored in an original format into general-purpose formats.

Setting data:	Text file
IEC61162-1/-2 Sentence data:	Text file
Voice data:	WAV file
Radar image data:	PNG file (BMP, JPEG2000)

- Playback software
  Special purpose software for playing back the stored data downloaded

*1: According to the amendments to the original performance standards, a means was required to download the stored data to an external computer for Investigation authorities. Termination of the recoding should be executed upon request by an investigation authority.

Before amended, it was only possible to download the stored data from the protective capsule.

11-9 Annual Maintenance

An annual testing of VDR/S-VDR is required to be carried out in accordance with SOLAS Chapter V Regulation 18.8. Only the engineers qualified by a Classification Society, who have received trainings for the annual testing by a manufacturer, can carry out an annual testing. The annual testing items are briefly as follows.

(The followings are the annual survey contents introduced by IMO MSC.1/Circ.1222)

- the overall condition of the equipment is satisfactory (no alarms are present)
- external power removal test (Only voice in the bridge should be recorded for 12 hours.)
- the acoustic beacon for the capsule is functional and validity of its battery
- data have been recorded correctly for 12 hours
- validity of batteries reserved in a main unit
- alarm function (receiving error for input data)
- existence of software for investigation authorities

Issuance of test report

The manufacturer must complete a review, record any changes and issue the completed test report within 45 days.

The period of the annual testing is specified as follows.

- Passenger ships: Testing may be carried out up to 3 months before the due date
  (The maximum period between subsequent testing: 15 months)
- Cargo ships: Testing may be carried out up to 3 months before or after the due
- date for a cargo ship. (The maximum period between subsequent testing: 18 months)

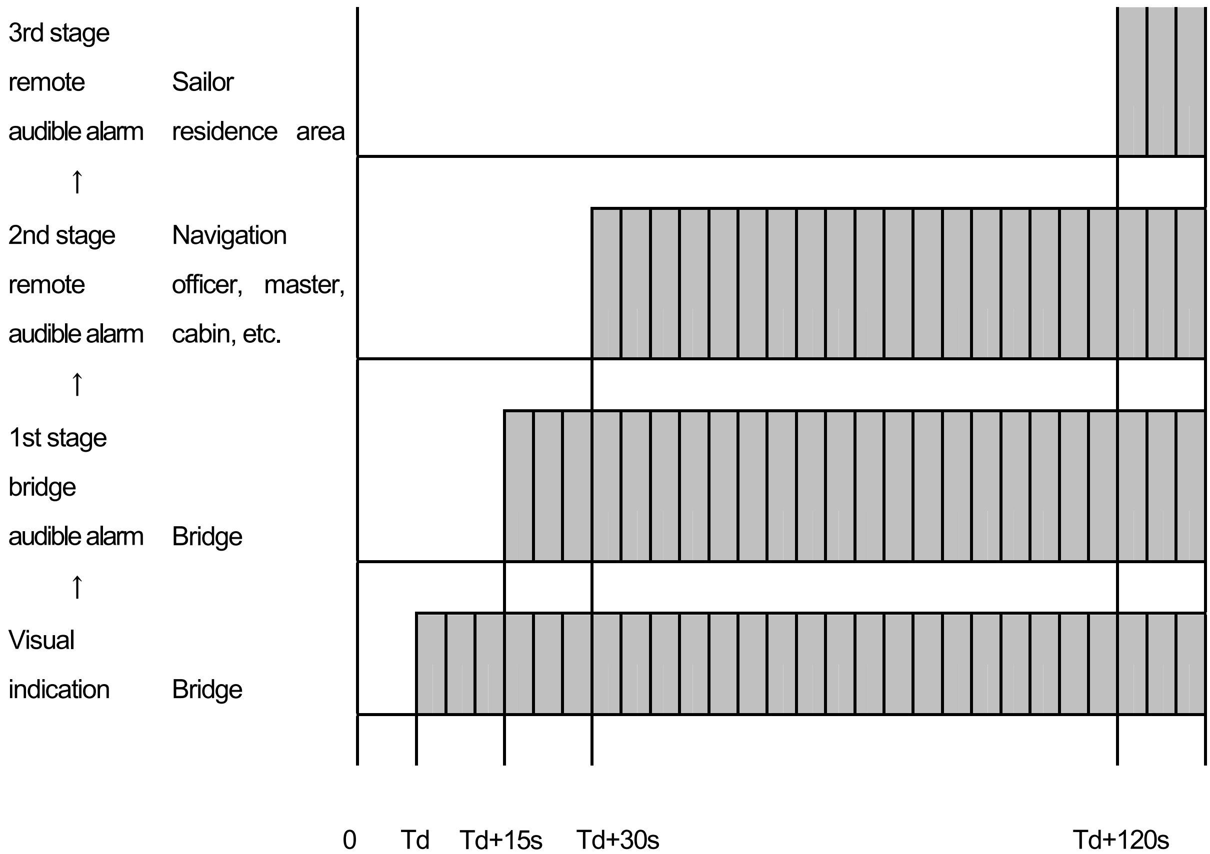
12. BNWAS (Bridge Navigational Watch Alarm System)

12-1 Outline of BNWAS

The Bridge Navigational Watch Alarm System (BNWAS) is a system preventing an accident to occur by absence, a doze and the sudden illness of the duty officer at the bridge.

If a warning timer is not reset by the duty officer, if a visible alarm (blinking of a LED lamp / LCD screen) and audible alarm (buzzer) are first emitted in a bridge and an alarm is not reset after that, it will pass through a ward room etc., and also an alarm is transferred to a sailor accommodation space and is informed.

If the alarm is not reset within the time which timer setting (possible to establish with one minute interval) was done beforehand between 3 minutes and 12 minutes, visual indication starts on the bridge. If not reset within 15 seconds since the visual indication is initiated, a 1st stage bridge audible alarm is started on the bridge. If not reset within 15 seconds since the 1st stage bridge audible alarm is initiated, a 2nd stage remote audible alarm is started in the navigation officer's and Master's cabin. Moreover, if not reset within 90 seconds since the 2nd stage remote audible alarm is initiated, a 3rd stage remote audible alarm is started at the locations of further crew members. Even during operation, the time from the 2nd stage remote audible alarm to the 3rd stage remote audible alarm can be changed by Captain or authority officers, 0s,or between 90 and 180s.



12-2 Carriage Requirements for BNWAS

Since the ship accident by the doze accounted for about 10 % of the whole accident, the SOLAS convention annex amendments to require to carry a BNWAS for the passenger ship and the ship of 150 gross tonnage and upwards was adopted in IMO in June, 2009 (MSC.282 (86)).

From these, as for the new building ship, the carriage to all passenger ship constructed after July, 2011 and the cargo ship of 150GT and upward was required. It is also going to be required by the following schedule about the existing ship.

- Passenger ship and the cargo ship of 3,000GT and upward -> Until the first survey after July 1, 2012
- Cargo ship of 500 GT and upward but less than 3,000 GT -> Until the first survey after July 1, 2013
- Cargo ship of 150 GT and upward but less than 500 GT -> Until the first survey after July 1, 2014

Moreover, the same requirements for carriage were made compulsory by the ministerial ordinance (May 31, 2011, Ministry of Land, Infrastructure, Transport and Tourism law No.45) which revises the parts of a ship equipment regulation etc. also in Japan.

Object vessel			Application day		
New building ship	construction after July 1, 2011	All the passenger ships	At the time of a completion		
		All the ships of 150 GT and upward	At the time of a completion		
Existing ship	construction after July 1, 2011	All the passenger ships	It carries by the first ship survey after July 1, 2012.		
		All the ships of 3000 GT and upward	It carries by the first ship survey after July 1, 2012.		
		All the ships of 500 GT and upward but less than 3,000 GT		It carries by the first ship survey after July 1, 2013.	
		All the ships of 150 GT and upward but less than 500 GT			It carries by the first ship survey after July 1, 2014.

12-3 Composition of Equipment and Function

12-3-1 Composition of Equipment

The composition of JCX-161

- Control unit (NCK-175)
- LCD display unit (NWZ-4650)
- Buzzer unit for audible alarm (NVS-785)
- Reset button unit (NCJ-895)
- Reset button unit (waterproof) (NCJ-896) (option), - Motion sensor (NYG-5) (option)
- LED visible warning lamp unit (NCD-2257) (option)

Table 1 The function and installation place of each equipment

		Function					Installation place	Remarks
		Timer Reset	Visible Display	1st stage Bridge Audible alarm	2nd stage Remote Audible alarm	3rd stage Remote Audible alarm		
Control unit	NCK-175	-	-	-	-	-		
Display	NWZ-4650	O	O	x	x	x	Bridge	There are no warning buzzers in the display.
The button for reset	NCJ-895	O	O	O	O	O	Bridge wing	With the buzzer for audible alarm
For waterproofing type reset Button	NCJ-896							
The buzzer for audible alarm (Bridge)	NVS-785	x	x	O	O	O	Bridge	
The buzzer for audible alarm (Backup Officer)	NVS-785	x	x	x	O *1	O	Backup officer room	Captain/Chief Off/ 2nd Off /3rd Off *1) At the time of selection
The buzzer for audible alarm (Except Backup Officer)	NVS-785	x	x	x	x	O	A dining-room, a salon, etc.	
Motion sensor	NYG-5	O	x	x	x	x	Bridge	
LED type visible alarm	NCD-2257	x	O	x	x	x	Bridge	

12-3-2 Requirement at the time of installation

The following is defined in IEC62616.Ed1.

- Connection with automatic steering equipment

  In order to perform operation interlocked with ON/OFF of automatic steering equipment at the time of automatic mode operation, connection with automatic steering equipment is indispensable.

- Connection with VDR

  The operation state of BNWAS is being output using a BNALR sentence, therefore a connection is needed to record that in VDR as navigation information.

- Connection of a reserve power supply (DC)

  In order to continue operation by a DC power supply at the time of AC power supply loss, it is required that a reserve power supply should have the capacity which the BNWAS can 6 hour or more operate.

- Buzzer volume

  The 1st stage bridge audible alarm should be not less than 75 dB and less than 85 dB in the distance of 1 m from a sound source. The 2nd and 3rd stage remote audible alarm should be not less than 75 dB and less than 120 dB.

13. Echo Sounder

13-1 Outline

An echo sounder transmits an ultrasonic wave into water like a fish finder and receives echoes reflected from the seabed and a shoal of fish and records those data, and measures the depth of water. Although a fish finder aims at various information in water such as a shoal of fish or the seabed, an aim of echo sounder is to search only the seabed and to measure the depth of water and to display it. An echo sounder is a mandatory equipment for large vessels and should meet IMO Resolution MSC.74 (69). Annex

The main specifications are as follows.

Refer to chapter 8. fish finder as to the basic explanation of an ultrasonic wave.

	Specification of Requirements	Remarks
Sounding Range	2m-200m	The previous standards requires up to 400m.
Main display	The displaying of 15 minutes of measured sounding records as a minimum.	
Data storage	Measured depth data should be recorded on a recording paper or displayed by other means for more than 12 hours.	The previous standards requires only recording on paper.
Accuracy	Based on a sound speed in water of 1,500 m/s, ± 0.5 m on the 20 m range scale, respectively ± 5 m on the 200 m range scale; or ± 2.5% of the indicated depth, Whichever is greater.	

[Frequency]

The typical frequency currently used for an echo sounder is 50 kHz and/or 200 kHz. The overwhelming majority of customers have chosen 200 kHz. Some customers who demand deep sounding exceeding a standard depth have chosen 50 kHz. As a general character, 200 kHz is short in wavelength and is resistant to air bubbles caused by the navigation of a ship. Although 50 kHz is long in wavelength and its sounding range is much longer, it is easily affected by the influence of air bubbles. Therefore, a mounting position should be selected carefully.

[Density of Reflective Substance and Reflection loss]

A sound wave is reflected from an object the density of which is different from the density of water. If the seabed is a rock, since the density difference between seawater and the rock is large, a sound wave reflects best. Conversely, in the case of a substance like mud, a density difference between mud and seawater is small and the reflection of a sound wave is weak.

13-2 Example of Echo Sounder Configuration

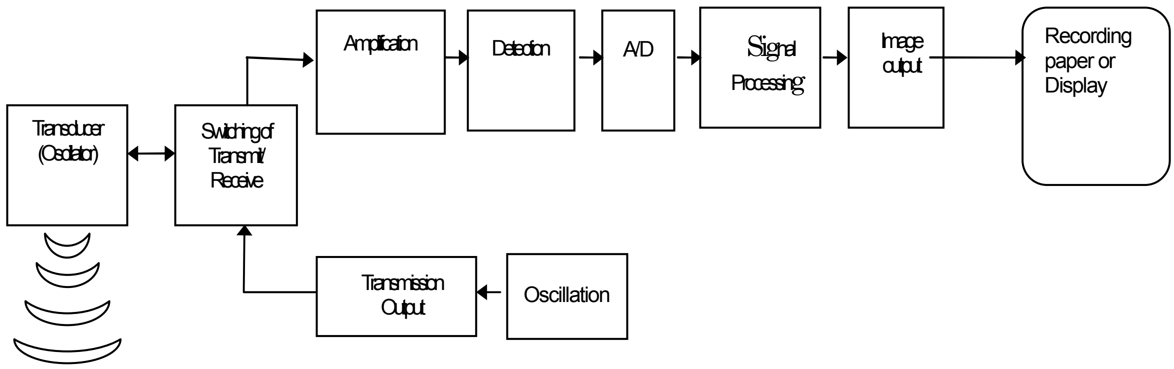


Fig.1 Echo Sounder Configuration

13-3 Operation of Eco Sounder

A recording method using discharge recording paper is used to be applied for previous echo sounders. For present models, a color LCD is used for displaying echoes, and sounding records of more than 12 hours are able to be displayed on a screen as well. In the case of a paper recording method, sounding data are drawn on a long continuous sheet of paper. Therefore, in order to confirm sounding data of 12 hours recorded, it is necessary to trace back the rolled recording paper unrolling it in order.

Features of a color LCD are summarized below in comparison with a recording paper method.

(1) Since there is no mechanical rotation part, the wear of parts does not occures. And, a mechanical malfunction rate is low.

(2) Since the strength of a signal was displayed with multiple colors (for example, eight colors, 16 colors) in proportion to the intensity of signals, it is easy to identify the seabed.

(3) Sounding records for the past 12 hours or the past 24 hours, such as the depth of water, time and position (only when a position data is inputted.), are stored in at regular intervals. These data are displayed as a form of a line graph and data are able to be displayed by placing a cursor on a line graph.

(4) Recording paper is not necessary for a color liquid crystal dysplay and the cost of running can be reduced.

13-4 Mounting Position of Transducer

When mounting a transducer of an echo sounder on the bottom of a ship, it is important to take into account not receiving the influence of air bubbles generated during navigation of a ship. If a position at a ship's bottom is not suitable, air bubbles coming in from the bow at the time of navigation will cover the surface of transducer oscillators and causes the generation of noises, the pausing of recording of images, etc. and then it turns out to be impossible to bring out the best performance.

Moreover, as the number of high speed ships increases, it has been difficult to determine a mounting position of a transducer. Therefore, a mounting position should be selected with care.

Regarding a mounting position of a transducer for commercial ships, a flat surface, which is as near to the bow as possible, is recommended. However, as the shape of a bow normally belongs under the know-how of each shipyard, it is difficult to predict the flow of air bubbles. It is effective to follow mounting positions of similar types of ships which are being constructed in series or in which similar or the same equipment were installed, etc. As the number of large ships increases, the case increases where a transducer is mounted at a bow and at a stern respectively. Mounting at a stern is still more difficult because a stern part is subject to the influence of air bubbles

Next, general recommendable positions are shown below.

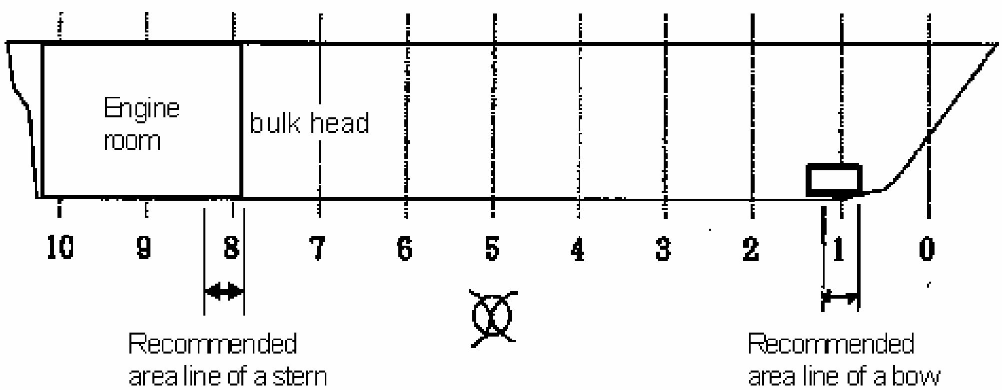
9-4-1 Installation of one position or two position:

(1) In case of one transducer position

Generally near front bulk head of engine room in the stern (not limited in the area of 8 /10 of over all teng of a ship from a front line.)

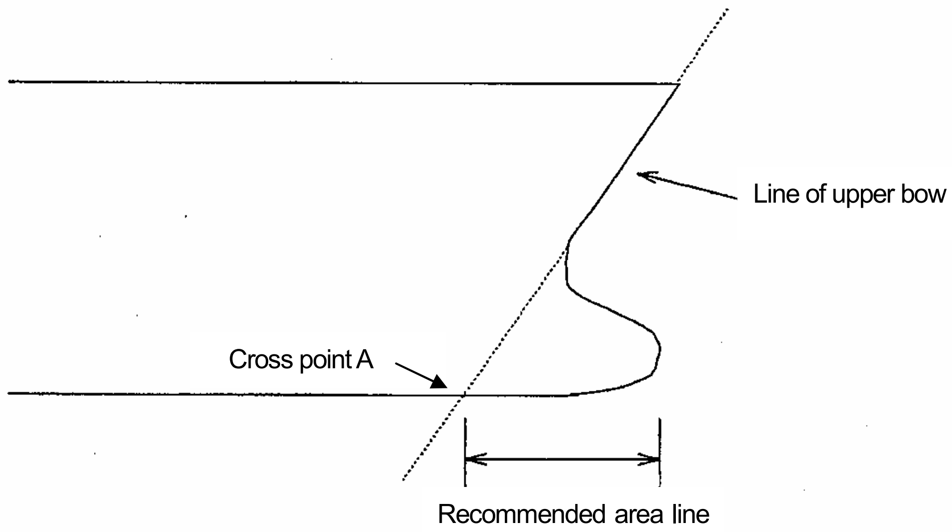
(2) In case of two transducer position (second transducer)

A general type of ships without a bulbous bow: near an area of 1 /10 of overall length of a ship from a front line.



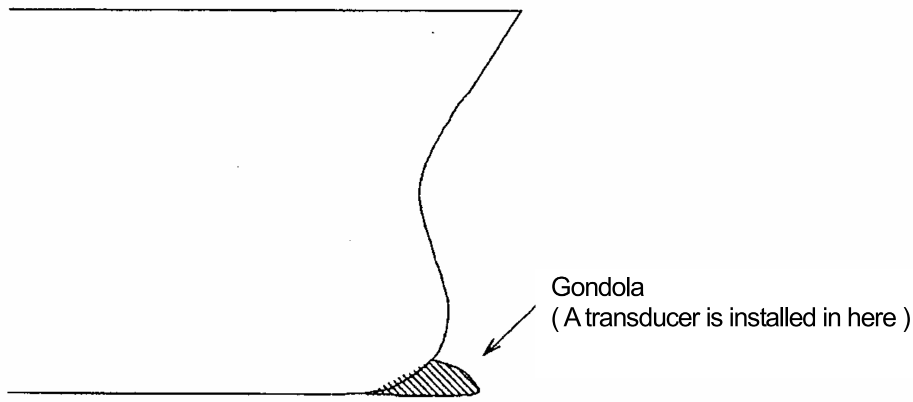
13-4-2 Ships with a bulbous bow:

Between the point at which crosses a line of upper bow and a bottom line and a bow.



9-4-3 Ships with a round bulbous bow or similar ones:

As the case of ship's bow line is dull, air bubbles do not go to the side of ship but go down to the bottom of a ship, a transducer may be mounted in an especially prepared gondola.



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13-5 Trial Running Test

At the time of finishing installing an Echo sounder, a trial running test is carried out and the performance of sounding and the influence of noises should be confirmed during the trial test. At a deepest point in an area where fishery is performed actually, at first, a trial running test is carried out at a speed of dead slow, and while a sensitivity knob is set at every point of 0 to 10, the performance of sounding is confirmed. Next, with a speed of a ship being increased gradually, the same test is carried out several times and ascertaining up to which speed (Revolution) sounding performance is available at the deepest range without the influence of noises is carried out.

Next, after an above mentioned test is over, at a sea area of depth of 20 to 30 m selected for a test, in ranges of dead slow to full speed, the same test as above is carried out again. (Appearance of air bubbles may be different under a shallow area and a deep area)

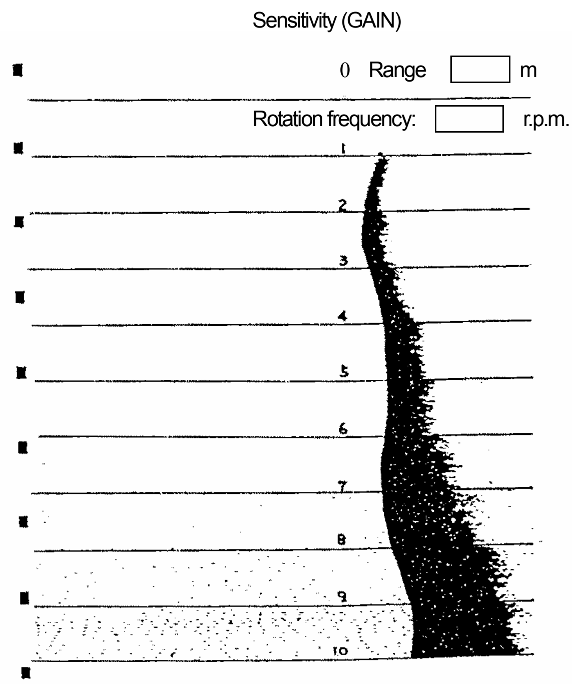


Fig.2 Example of the result of Trial test

If a mounting position of a transducer is not suitable, noises caused by the influence of air bubbles during a ship's running may occurs.

The recording of the generation of air bubbles is shown in a figure.

As shown in a picture on the right side, the seabed may not be identified due to the influence of air bubbles. In this case, since a mounting position of a transducer is not suitable, it is necessary to ascertain it.

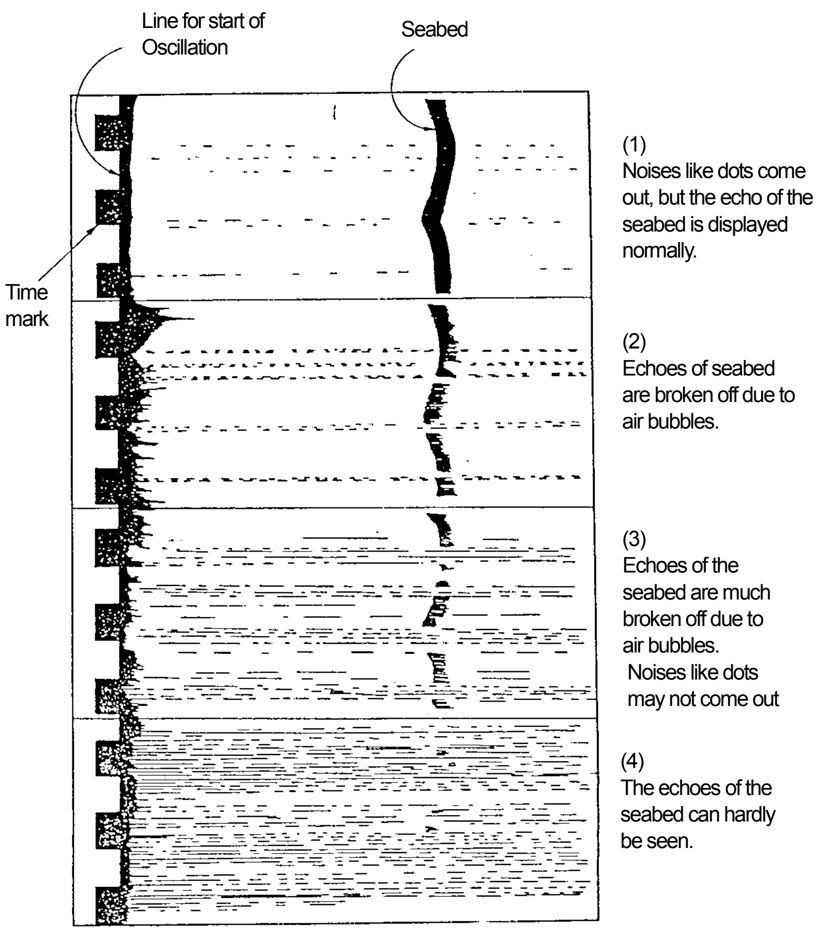
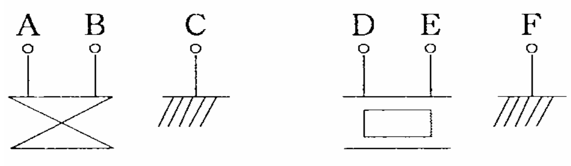


Fig.3 Example of recording of bubble generating

13-6 Judgment of Quality of Oscillator (500V Megger should be used.)

Magnetostriction Type	Electrostriction Type



A-B=0Ω	D-E= more than 2MΩ
B-C= more than 2MΩ	E-F= more than 2MΩ
A-C= more than 2MΩ	D-F= more than 2MΩ

13-7 Calculation of Transmitted Electric Power

a. $$P = \frac{E^2}{8R} \quad \text{(W)}$$

b. $$P = \frac{E^2}{2R} \quad \text{(W)}$$

E: Voltage p-p at secondary side output (oscilloscope used)

1. In the case of measuring at both terminals, formula a is applicable
2. In the case of measuring between one side and a ground, formula b is applicable.

R: Load impedance

Example: A voltage between one side and a ground is 500 VP-P, in the case of load 100Ω.

$$P = \frac{500^2}{2 \times 100} = 1250W^{P-P}$$

14. Doppler Log / Doppler Sonar

14-1 Outline

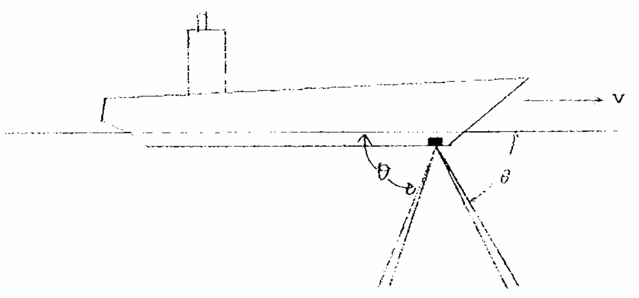
A Doppler Sonar and a Doppler log transmit an ultrasonic wave to the tilted forward direction in the water from a transducer fitted on the bottom of a ship, and receive waves reflected from the seabed or from the water and measure a ship speed.

The difference between Doppler Sonar and a Doppler Log cannot be defined clearly. Generally, a Doppler Log indicates only the forward and backward direction of a ship seed, and in addition, a Doppler Sonar indicates the right and left direction of a ship speed as well.

14-2 Principle (Doppler Effect)

When a sound wave or an electric wave transmitted from one object is reflected from the other objects, if the relative velocity between two objects exists, the difference between a transmitted frequency and a received frequency occurs. When an object is going out, the received frequency is lower than the transmitted frequency. When an object is coming toward the ship, an adverse phenomenon occurs. This phenomenon is called “Doppler effect”.

14-2-1 Doppler log



(1) An ultrasonic wave signal is transmitted at a tilted angle forward and backward from a transducer which is fitted onto a ship’s bottom.

(2) An ultrasonic wave transmitted is reflected diffusedly in the water, some signals to the transducer.

(3) At that time, supposing the ship is moving forward, a wave coming from an forward oblique angel is positively affected by the Doppler shift, and its frequency will be high, and conversely, a wave returning from a backward oblique angle is affected by the Doppler shift of minus, and it will become low.

(4) The amount of Doppler shifts is computed based on the following formula.

$$fd = \frac{2vf_0\cos\theta}{c}$$ (Doppler equation)

fd: Amount of Doppler shifts, v: Ship speed, θ: Transmission angle
c: Velocity of Supersonic wave (1500 m/s) in the sea water, f_0: Transmission frequency

(5) After this Doppler shifted signal is amplified, it is detected in a processor, and it is converted to a ship speed for indication of it.

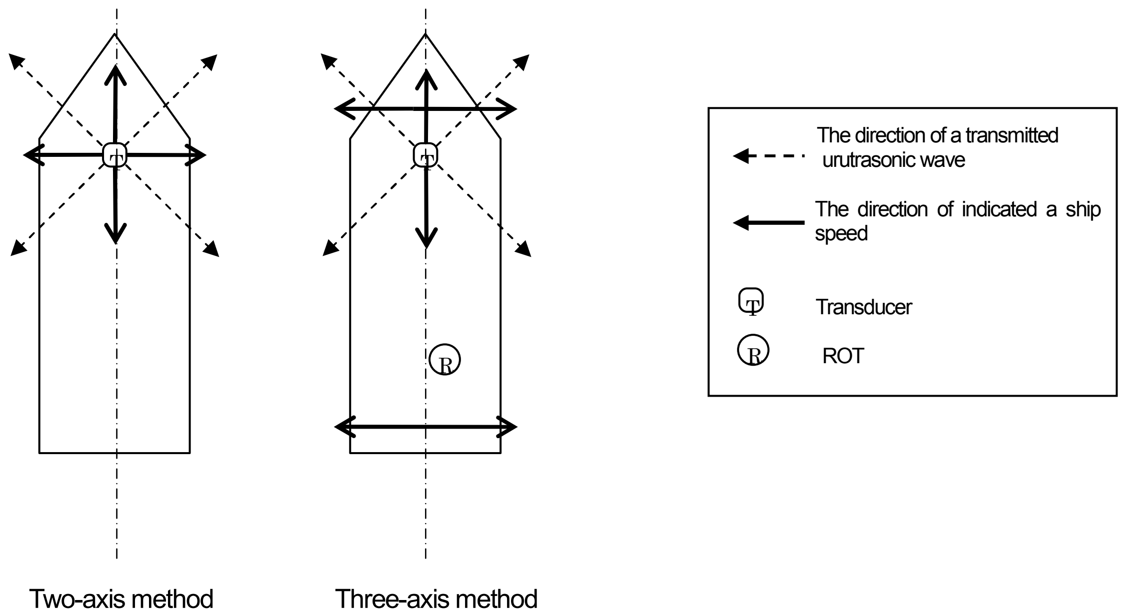
Theoretically, a ship speed can be calculated only by a signal of one way. However, according to the Doppler equation above, if a transmission angle changes, the amount of Doppler shifts will also change. As a result, it leads to a big error (A transmission angle changes according to a pitching of a ship).
Therefore, in order to compensate a pitching, a supersonic wave is transmitted to the other opposite direction as well, and this pitching error is compensated using a reflected signals from an opposite direction. This system is called a "dual beam" system.

14-2-2 Doppler SONAR

A Doppler SONAR is theoretically the same as a Doppler log. However, a Doppler log indicates only a ship speed, but a Doppler SONAR indicates a lateral ship speed and the depth of the sea as well. In order to reduce the influence of propeller noise, a transmission direction is rotated 45 degrees.
There are two types of Doppler SONARs. One is to calculate a longitudinal and lateral ship speed using a transducer fitted onto the ship's front bottom (Two-axis method), and the other is also to indicate a rear lateral ship speed by calculating a turning angle velocity signal from "ROT" (Three-axis method). A three-axis method is able to indicate a lateral ship speed of a front and a rear position required.

A Doppler SONAR has a function to track a ship speed over the ground up to hundreds m. And since an accurate motion of a ship is obtained by using this function, this type of Doppler SONAR can be used effectively during docking. Therefore, three-axis type of Doppler sonar may be called "Docking Sonar".

Moreover, since the information of this accurate ship's motion is also outputted to external equipment, ARPA and navigation systems function more effectively. (If it is used in ARPA, the motion of own ship can be more exact, and the motion of another ship can be obtained more correctly.)



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15. Doppler Log / Doppler Sonar Adjustment Procedure

15-1 Scope

A Doppler Log should be adjusted for the compensation of a mounting angle of a sensor. This adjustment procedure is applied to a work of obtaining data for the adjustment of a log.

15-2 Outline of Measurement

A correct ship speed is obtained by averaging two speeds by a round trip between two mileposts usually prepared ashore. Speeds measured at that time must be recorded accurately on a Log speed test recording sheet and kept. Such data will be useful for readjusting a system accurately at the time of the malfunction of a system.

15-3 Staff Assignment for Measurement

(1)	for confirmation of A point and B point in Fig.: (usually Dock master etc.)	1 person
(2)	for measurement of t_1 (usually dock staff in charge):	1 person
(3)	for calculation of speed (usually dock staff in charge):	1 perosn
(4)	for keeping a fixed course: (quarter master at under Dock master's command)	1 person
(5)	for keeping a propeller revolution (machinery persons):	some persons
(6)	for reset ting a Log distance meter for measuring t_2 staff (or two persons) for Log speed calculation	1 person (or 2 persons)

Note: 1. (1) - (5) usually dock persons concerned.

2. Refer to following page (5) and (6) for t_1 and t_2.

15-4 Measurement Apparatus

(1)	binocular for confirmation of A point and B point	1 piece
(2)	actual speed conversion table for a milepost (between point A and point B)	1 sheet
(3)	Stopwatch for measurement of t_1, and t_2	2 pieces
(4)	calculator for the calculation of log speed	1 piece
(5)	log speed test data sheet	3 pieces

Note: When a test is carried out while a ship is laid down in a dock, (1), (2) and one of two stopwatches may be prepared by a Dockyard.

15-5 Measurement Procedure

15-5-1 Speed test between mileposts

Several preliminary speed tests should be carried out sufficiently before actual speed tests are carried out, and it is necessary to pay an attention to decide the time when a speed is steady as much as possible, and it is important to run a ship correctly in a designated direction in a speed test area. If the influence of drift and wind is considered to be almost or completely steady during a speed test, one round - trip test would be enough. But, if such influence seems to be changing during a speed test, it is desirable that two round-trip tests should be carried out, but if the difference between speeds measured one way is over 0.5 knots, it is necessary to measure a speed repeatedly until the difference is within 0.5 knots.

(1) A round-trip speed test may be normally carried out at a revolution of 1/4, 2/4, 3/4 and 4/4 of a main engine rated revolution one time each and totally four times be carried out.

(2) A propeller revolution and a course should be kept steady at least one (1) mile before a ship enters a speed test line, and the test condition of the ship should not be changed until speed test measurement is over for each test.

(3) When the ship passes A point in Fig. l, stopwatch 1 and a distance meter are reset.

(4) Stopwatch 2 is depressed as a distance meter shows 0.01NM.

(5) When the ship passes B point in Fig. l, stopwatch 1 is depressed and the time required t_1 is confirmed. At this time, the reading of a distance meter is also confirmed.

(6) Stopwatch 2 is depressed as the ship passes as a distance meter shows 1.01NM. And the time t_2 required for the ship to run 1 NM measured by the Log is confirmed.

(7) Each speed is calculated according to the respective elapsed times.

Constant speed = $a \times \frac{3600}{t_1}$ (KT)   a: Distance between mileposts (NM)

Log speed = $1 \times \frac{3600}{t_2}$ (KT)   t: Time required (second)

(8) Furthermore, the ship runs the other test course off the outward course as shown Fig.1. When the ship enters a homeward course from an outward course, it should take a large roundabout route and a steady speed and a straight course are maintained between two mileposts and the same measurement as on an outward course is carried out on a homeward course.

(9) Measurement data are recorded as shown in table 1.

D

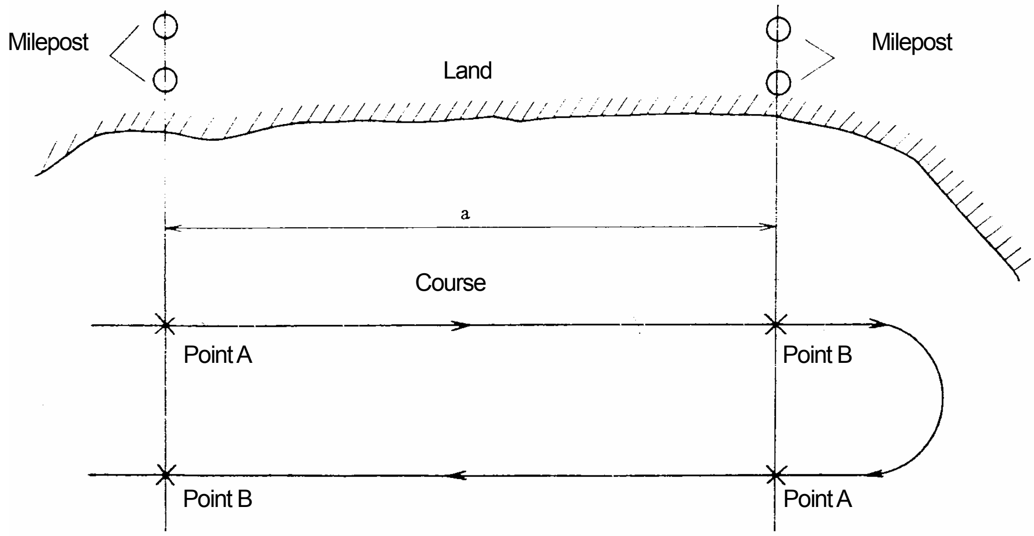


Fig. 1 Speed test between Mileposts

15-5-2 Simplified speed measuring method

(used when a speed test using a milepost cannot be carried out) (using radar)
This method is that, a ship runs a course of one mile on a straight line which aims at a target on the land and the measurement of speed is carried out at that time. Even in this case, preliminary speed tests should be carried out sufficiently before actual speed tests are carried out, and it is necessary to pay an attention to keep a test speed steady as much as possible and to run a ship correctly in a designated direction in a speed test area.
If the influence of drift and wind is steady with time during a speed test, one round - trip test would be enough. But, if such influence seems to be changing with time during a speed test, two-round-trip test is desirable.

(1) A round-trip speed test may be normally carried out at a revolution of 1/4, 2/4, 3/4 and 4/4 of a main engine rated revolution one time each and totally four times be carried out.

(2) A propeller revolution and a course should be kept steady until a ship runs completely one mile.

(3) When the ship passes C point (on a fixed marker) in Fig. 2, stopwatch 1 and a distance meter are reset.

(4) Stopwatch 2 is depressed as a distance meter shows 0.01NM.

(5) When the ship passes D point in Fig. 2(2) (D point is one (1) mile away from C point.), stopwatch 1 is depressed and the time t_1 required for the ship to run one (1) mile is confirmed. At this time, the reading of a distance meter is also confirmed.

(6) Stopwatch 2 is depressed as the ship passes as a distance meter shows 1.01NM. And the time t_2 required for the ship to run one (1) NM measured by the Log is confirmed.

(7) Each speed is calculated according to the respective the times required.

Constant speed = a x $\frac{3600}{t_1}$ (KT) a: Distance between point C and D (NM)

Log speed =1x $\frac{3600}{t_2}$ (KT) t: Time required (second)

(8) Furthermore, the ship turns 180 degrees after an outward course test is over and runs a homeward course and the same speed measurement is carried out.

(9) Enter measurement data in a predetermined data paper respectively.

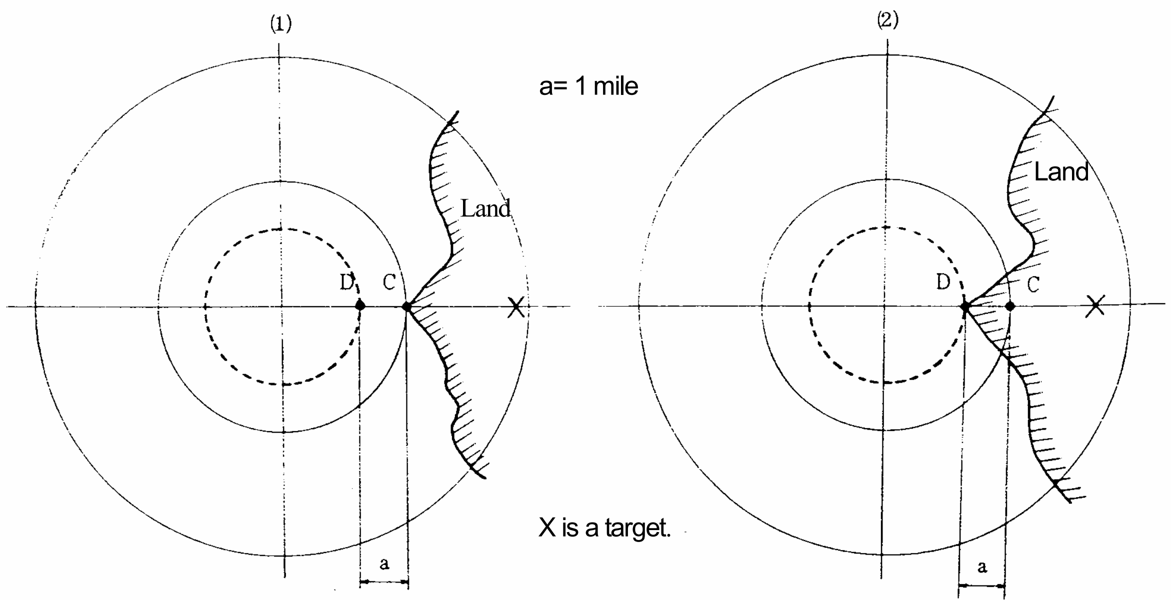


Fig. 2 Simplified speed measuring method by radar

Reference: A table on the next page is an example of data for Doppler Log measurement.

D

Table 1 Example data for Doppler Log measurement

MEASUREMENT DATA OF SPEED LOG

Ship's Name : JAG AABHA　　Date : 2008.10.21　　Ship's Officeer :

SPEED LOG MODEL : JLN-205　　Serial No :　　Engineer in Charge :

Speed Calibration Correction Value After Calibration : -6%						Location : N34.39.00 E129.07.00			Sea Condition : GOOD			Draft : 14.3M		
Run NO.	Load of Main Engine	Distance		Time		Speed		Average Speed		Error		Ship's Course	Wind	Remark
		TRUE	Log	TRUE	Log	TRUE	Log	TRUE	Log					
		nm	nm	sec	sec	kts	kts	kts	kts	kts	%			
1	50%				278	14.535	12.949					20		
2	50%				267	10.401	13.483	12.468	13.216	0.748	5.99936	200		Adj : -5%
3	75%				245	12.765	14.6939					200		
4	75%				252	15.897	14.2857	14.331	14.4898	0.1588	1.10806	20		Adj : -1%
5	85%				244	16.735	14.7541					20		
6	85%				236	13.413	15.2542	15.074	15.0042	-0.0698	-0.4633	200		
7	100%				228	14.254	15.7895					200		
8	100%				233	16.704	15.4506	15.479	15.6201	0.14106	0.91129	20		
9														
10														
11														
12														

16. Fish Finder

16-1 Introduction

A fish finder transmits a supersonic wave into the seawater and receives echoes reflected from the seabed and a shoal of fish and is one of fishing equipment aiming at development of a catch of fish. The reason why a supersonic is used for a fish finder is that other methods except for a supersonic wave are not used for the purpose of a fish finder. That is, a radio wave cannot propagate through the seawater, and light is able to be used only for measuring a closely near distance precisely and the maximum range is about 200 m due to the characteristics of excessive attenuation. Moreover, the wavelength of light is very short in comparison with the wavelength of a sound wave and light cannot be used for searching objects on the seabed (through the seawater) at all. Sound wave attenuation is much less than light attenuation in the sea and its propagation range is far longer. As a result, a sound wave is used for a fish finder.

16-2 Supersonic Wave and Audible Sound

A frequency of a supersonic wave is so high that people's ear does not hear it. As to an audible sound, it is possible for people's ear to hear it, as depends on an individual or age, and the range is usually about 20 Hz - 20 kHz. Therefore, a sound wave of more than 20 kHz is called a supersonic wave. In the case of a fish finder, a supersonic wave of 28 kHz to 200 kHz is used well. (However, fish finders of low frequency of 15 kHz also exist.)

16-3 Character of Underwater Supersonic waves

16-3-1 the speed of sound

in the sea:	1500 m/s	(20° Centigrade)
in fresh water:	1372 m/s	
in the air:	340 m/s	
through iron:	4663 m/s	

The speed of sound relates to the density of materials as described above, the higher the density is and the higher the temperature is, the faster the speed is. Therefore, although the speed of sound changes to a certain extent in the seawater, 1500 m/s is used for designing. The speed of sound changes depending on temperature, salt content and pressure of seawater, and since the amount of the change is about within ± 4% as a maximum, a supersonic wave functions well for a fish finder.

16-3-2 Sound wave propagation attenuation

[Frequency]

A frequency of 15 kHz to 460kHZ is permitted according to the Authority's rule and a frequency of 15 kHz to 200 kHz is used for fish finders on the market. A frequency of more than 100 kHz is called "High frequency" and a frequency of less than 100 kHz is called "Low frequency". The wavelength of Low frequency sound wave is long and low frequency propagates further, but identification of small objects is difficult. On the contrary, The wavelength of High frequency sound wave is short and high frequency cannot propagates further, but identification of small objects is possible.

[Diffusion loss]

A sound wave transmitted from a transducer spreads radiately. The face of a sound wave increases in proportion to the square of a distance, and as the strength of a sound wave is defined per unit area, the strength of a sound wave gets weak in inverse proportion to the square of a distance. This kind of attenuation is called “Diffusion Loss”.

This is expressed with a logarithmic function as follows.

$= 20\log (X/X_0)$ (dB)

X: Distance (m), X_0 : unit distance (1 m)

[Absorption loss]

A sound wave is affected by the influence of viscosity etc. during the propagation of it. A sound wave is absorbed at a regular rate in proportion to a propagation distance. This kind of attenuation is called “Absorption Loss”.

Absorption Loss is expressed as follows.

Absorption Loss = αX (dB)

α: Absorption index (dB/m)

note: α is usually a unit of “dB/km” for easy of understanding it.

A propagation loss is the sum of a diffusion loss and an absorption loss. In the case of a round - trip propagation, it is expressed as shown Fig.1. The following is obtained obviously from a figure below. The higher the frequency is, the bigger an absorption loss is. As a result, a propagation loss increases and a reaching range becomes short.

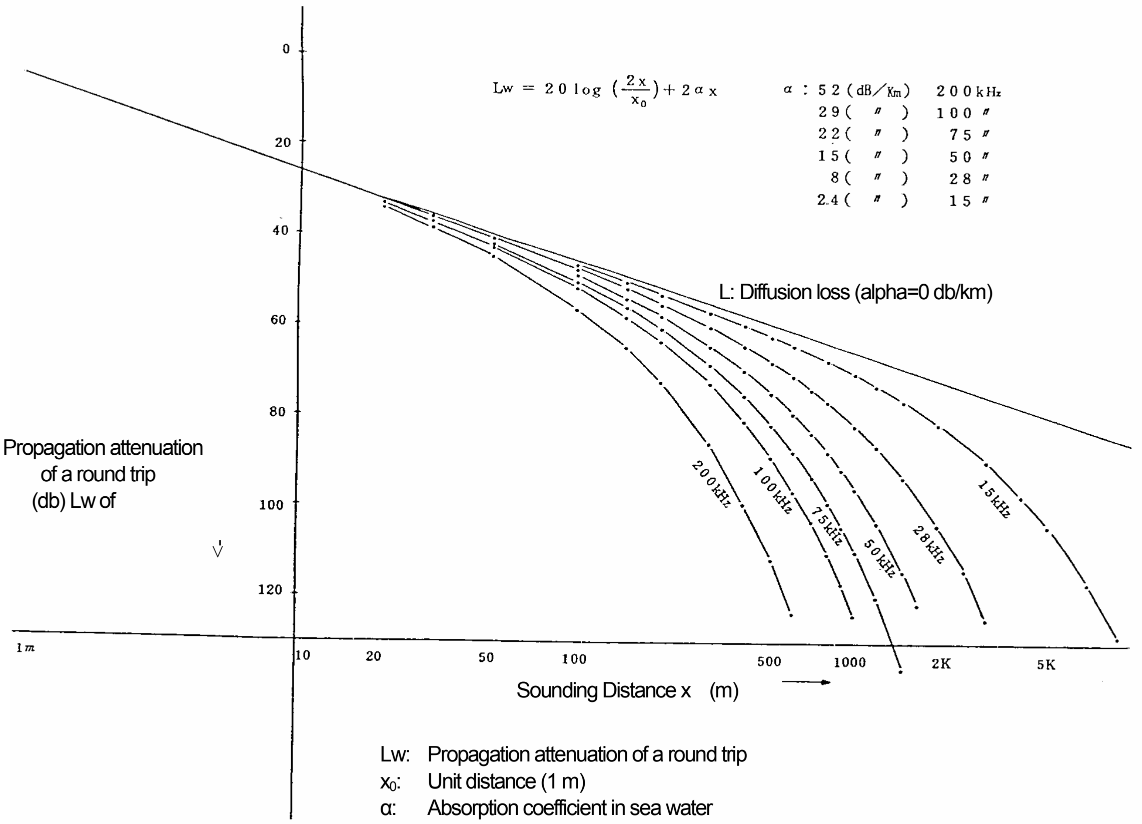


Fig. 1 Propagation loss curve of a sound wave underwater

[Relation between Wavelength and Reflection]

Generally, In the case that a wavelength is shorter than the size of a reflective object, the sound wave is reflected well. However, since attenuation is also large if a wavelength is short, a frequency in use is determined based on fish species and operating depth.

Frequency	underwater wavelength	Remarks
30 kHz	5cm	$wavelenght = \dfrac{velocity}{frequency}$
50 kHz	3cm	
200 kHz	0.75cm	

[Density of Reflective object and Reflection loss]

A sound wave is reflected well from the boundary between the two objects with a different density (a difference in sound wave speed)

Fishes are well caught by a fish finder, it is because, as a fish's air-filled swim bladder has a different density than seawater, a sound wave reflects at the boundary between a fish 's swim bladder and seawater. For fishes and cuttlefishes like a flat fish, as a sandfish without a swim bladder, a sound wave reflects from borne, skin and meat a little, such fishes are hard to catch by a fish finder. Likewise, if the seabed is like rock, a sound wave reflects well. On the contrary, if the seabed is like mud, a sousnd wave does not reflect well.

16-4 Basic Principle of Fish Finder

Regarding to the reflection of a sound wave, an "echo" in the air is known well. This is a phenomenon that voice is reflected back from mountains and valleys. In the sea, the same phenomenon occurs, and if a sound wave pulse is transmitted towards the seabed, it is reflected form the seabed. This principle makes sounding possible. If a shoal of fish exists, a sound wave is reflected from it and it is detected and the information of it can be obtained.

Assuming that the character of the sea is the same everywhere, basically, a fish finding is possible using the following characters of a sound wave in the sea.

(1) Reflectivity that reflection occurs well at the boundary between two different substances
(2) Straightness of propagation
(3) Uniform velocity

A sound wave pulse transmitted downwards from near the ship's bottom, hits a shoal of fish or the seabed, etc., and a part of a sound wave returns to the original direction of a transducer according to the principle of reflectivity (1). A receiver is fitted at a transmission side and the receiver receives returned signals and the received sound signals are converted to electric signals. The electric signals are displayed on a screen as a shoal of fish and the seabed.

Since a supersonic wave has the straightness of propagation (2), if the beam of a supersonic wave is narrowed, it is possible to determine the direction of a signal to be transmitted and to identify the direction of a returned signal (echoes).

D

Using the nature of uniform velocity makes distance measuring possible. The elapsed time between the time of transmission of a supersonic wave and the time of reception is measured and a round trip distance can be obtained by multiplying the elapsed time by the sound velocity. And then, a half of a round trip distance is a distance to a shoal of fish.

Take reflection from a depth of 1500 m for example, if a supersonic wave is transmitted from a transducer fitted onto a ship's bottom towards the seabed, since it propagates straight in seawater at a speed of 1500 m/s, it reaches the seabed one second after it is transmitted. A pulse reflected at the seabed returns to a transducer one second later. It takes two seconds for the pulse to go and return. That is, the relation between depth and the elapsed time is drawn as follows.

Depth: N (m)
Elapsed time: T (s) (time taken to go and return along a depth of N)

N (m) =(T/2 (s)) / 1500 (m/s) = Tx750

16-5 Example of Fish Finder Configuration

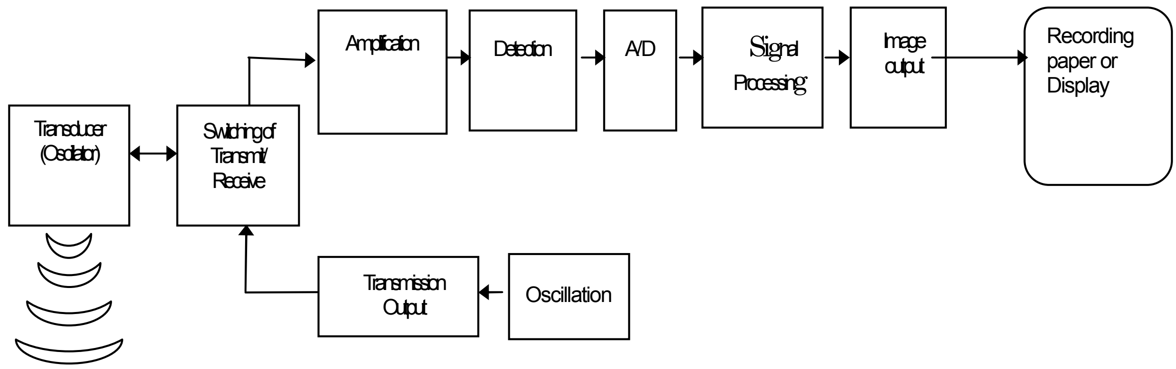


Fig.2 Fish Finder Configuration

16-6 Color Fish Finder

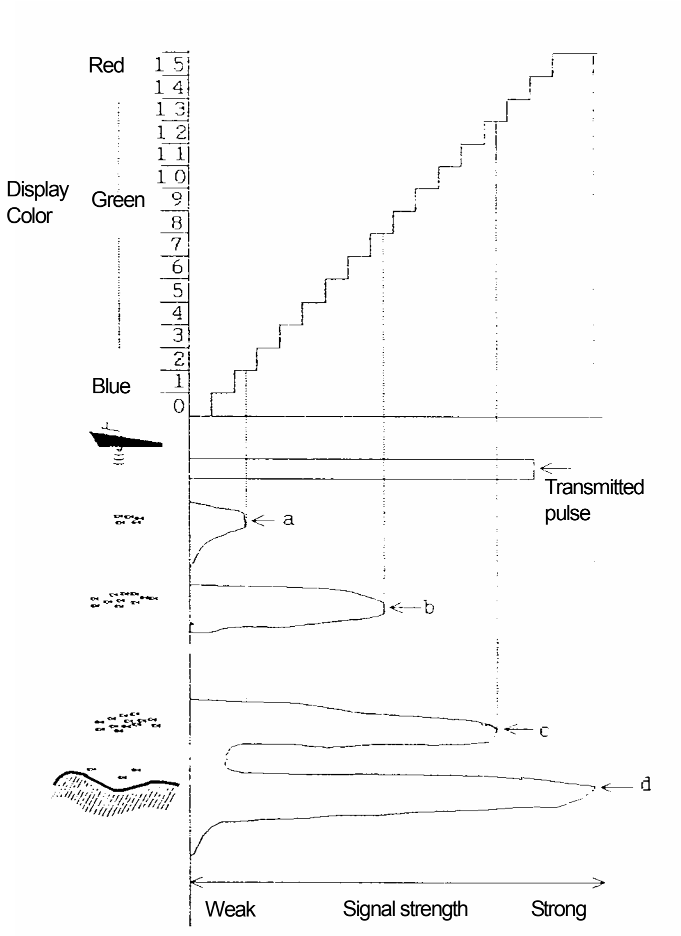
16-6-1 Basic principle

A cathode-ray tube for color televisions and a color liquid crystal display are used for a fish finder, and such a fish finder is called "a Color Fish Finder". A predecessor of a color fish finder used to record echoes shading in the strength of echoes on a piece of paper. A color fish finder indicates the strength of echoes in multicolor. A color cathode-ray tube used to be used as a color display until the beginning of the 2000s. And now, a color liquid crystal display is normally in use.

16-6-2 Feature

A Color Fish Finder is mostly characterized by being able to use a wide dynamic range (for example, 40 dB). Since a paper recording type of fish finder indicated only the strength of echoes, was expression of only a shade, its dynamic range was at most 20 dB. Moreover, for a color fish finder, a dynamic range can be set up freely.

The strength of signals returning from a shoal of fish and the seabed depends on reflective objects, and how to display such data is shown in the following figure.



A supersonic wave signal transmitted from a transducer is reflected from plankton in the sea, a shoal of fish, the seabed, etc., and returns to a transducer.
As the strength of reflected supersonic waves is shown in the left figure, the echoes of a shoal of a small fish is weak, in the case of a big shoal of fish and of high density, echoes are strong, and echoes from the seabed is reflected more strongly.

In the left figure, a strong response like d shows a strong electric signal level as well, and it is colored with "reddish brown". A big shoal of fish and of high density like c is colored with "orange", and a rather strong response like b is colored wit "green", and a small shoal of fish is colored with "blue".

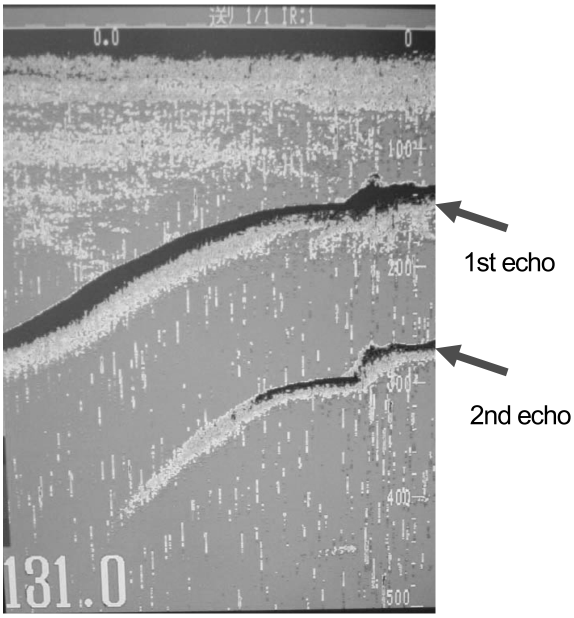
Fig.3 Signal strength

The followings are characterized below in comparison with an outdated recording paper method.

1. Since there is no mechanical rotation part, the wear of parts does not occures. And, a mechanical malfunction rate is low.
2. Since the strength of a signal was displayed with multiple colors (for example, eight colors, 16 colors) in proportion to the intensity of signals, it is easy to identify the seabed.
3. Since records cannot be reserved, if necessary, a hard copy unit is required outside.

Example of display

Multiple echoes



Like a picture on the left, two or more echoes other than an echo reflected from the seabed are observed sometimes. A supersonic pulse outputted from a transducer is reflected direct from the seabed, and the reflected echo is called "the First Echo". Furthermore, the first reflected echo is reflected from a ship's bottom (the sea surface) and it reaches the seabed and is reflected from the seabed again. Such an echo is called "the Second Echo" and it is displayed twice at a distance of the First Echo.
As mentioned above, after multiple round-trips of an original signal between the seabed and a ship's bottom, echoes are displayed at a constant interval. Such echoes are called "Multiple Echoes".

Interference

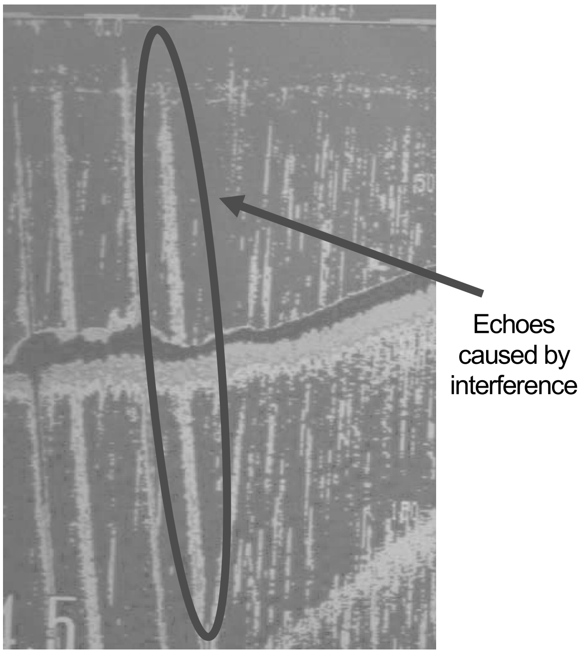


Fig.4 Multipule echoes and Interference

If other ship near own ship is using an ultrasonic equipment, a picture shown on the left side is displayed sometimes.
It is because that own ship and other ship use nearly equal frequency for Fish Finder and signals transmitted from other ship are displayed as echoes. This is called "interference by other ship". If the transmission cycle of a ship is different from that of other ship, interference echoes are displayed as a line of dots, and it is possible to remove such Interferences by applying an anti-interference effect.
In a picture shown on the left side, as each transmission cycle is nearly equal, interference echoes are displayed as a tilt line, and it is impossible to remove these kinds of interference echoes.
In order to remove such interference echoes, shifting a transmission cycle is effective. It is effective to shift a transmission cycle on a adjust menu and/or to change a range.

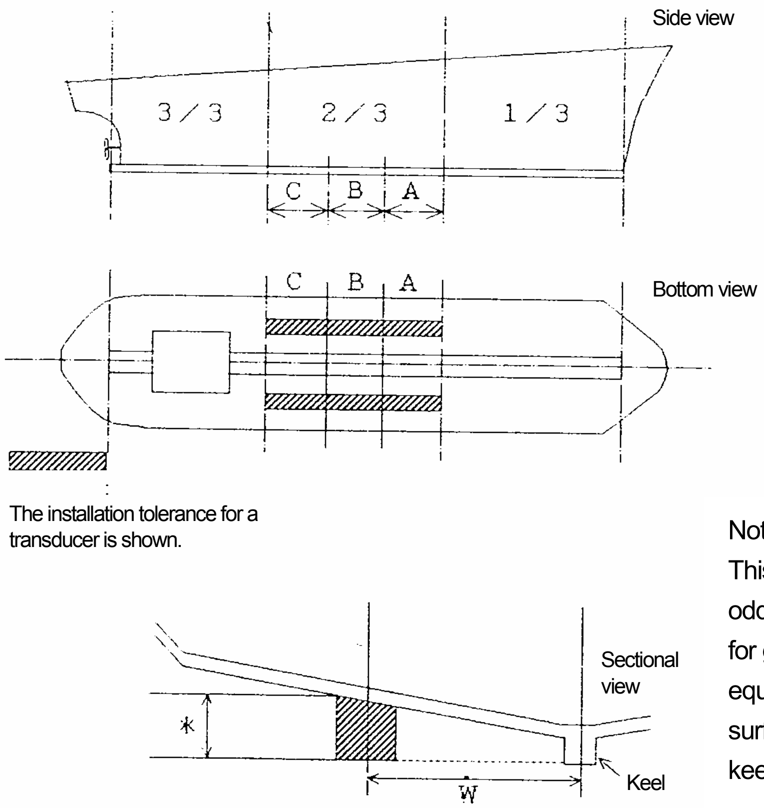
16-7 Installation Position of Transducer

For mounting a transducer of an echo sounder in the bottom of a ship, it is important to take into account not receiving the influence of air bubbles generated at sea. If a position on the bottom plate of a ship is not suitable for mounting, air bubbles coming in from the bow at sea may cover the surface of oscillators and causes the generation of noises, the pausing of recording of images, etc. and then it turns out to be impossible to bring out the best performance.

Moreover, as the number of high speed ships has increased, it has been difficult to determine a mounting position of a transducer. Therefore, a mounting position should be selected with care.

For an installation position for a fishing vessel, at first, the overall area between the keel head and a propeller is divided into three equal areas as shown in Fig.6, like a picture in the first raw, and a center area among those three areas is suggested for an installation position. Moreover, after the central area is divided into three equal areas again as shown in Fig.6, like a picture in the second raw, it is necessary to ascertain which area in such areas is suitable, taking into account the structure of a ship's hull.

Below, an installation position for a fusing vessel is shown under fish type and tonnage in paragraph 8. Since various shapes of hull exist and a certain shipyard may not issue such information, the determination of an installation position should be taken into account. If existing equipment is replaced with another one, the place at which equipment was removed is normally used again for reinstallation. Otherwise, reinstallation may costs much because of appurtenant works. Therefore, frequency, character, etc. of existing equipment, in use is checked in advance, and it should be ascertained whether the place is suitable for reinstallation. Normally, by confirming a good installation in the same model of ship and referring to it and determining a position, a good result can be obtained in many cases.



Notes * –
This gas is as large as possible in odder to avoid air bubbles. However, for grounding, this is normally almost equal to the depth up to the keel surface or a little shallower than the keel (one centimeter)

Fig.5 Installation position for a Transducer

D

16-8 Tolerance for Transducer Installation classified by Ship's Type

Various cases of installation positions are shown below.

A,B,C,W: Refer to Fig.6

16-8-1 **Tuna long-liner** (around 200-400 GT)

Tolerance: A-B-C
W : 1300-1700 mm

Since freezers, auxiliray machines and a propeller are close to a engine, a installation position of a transducer is apt to receive vibrations and noises. Such things should be taken into account.

16-8-2 **Bonito Pole and Line fishing vessel** (around 200-400 GT)

Tolerance: A-B-C
W : 1300-1700 mm

Since fishery warehouses are used for keeping sardines alive as a live bait in seawater as well, in order to circulate seawater, draft is enough deep to install a transducer.

16-8-3 Fishing vessels for such various fishes as bonito, tuna and cuttlefish fishing

(around 59-100 GT)

Tolerance: A-B-C
W : 800-1000 mm

Fishing vessels which belong to a small type to a medium type have been speeded up.
Therefore, shapes of such ships are showing a tendency to change. Smaller ships are taken into account.

16-8-4 Fishing vessels for one-hook fishing, cuttlefish fishing, and All round fishing boat

(around 10-20 tons)

Tolerance: B
W : 800-1000 mm

An area for mounting a transducer in especially high speed ships made from FRP is limited. Moreover, because fishery warehouses are close, mounting of a transducer near a engine room should be avoided.

＊ **Regarding**
Trial Running Test ,Judgment of Quality of Oscillator (500V Megger should be used.) and Calculation method of Transmitted Electric Power , refer to the same sections in the chapter 9 Echo Sounder

17. SONAR

17-1 Outline

SONAR is an acronym for **sound navigation and ranging** (combined with SO (SOund), N (Navigation), A (And), and R (Ranging).
It derives from the arms term of the U.S. navy.

17-2 Type of SONAR

17-2-1 Searchlight Sonar

A transducer of a fish detector is set horizontally, and the tilt angle and turning of the transducer is able to be controlled mechanically. Since it is still used for small ships these days since searchlight sonars are less expensive, but performance of a searchlight sonars is inferior to that of a scanning sonar. Therefore, scanning sonars are preferred to it for large ships.

Frequency in use: 60 kHz - 200 kHz

17-2-2 Omnidirectional Scanning Sonar

Many oscillators are fitted on to a transducer cylindrically and supersonic pulses are transmitted ominidirectionally from the transducer, and during a receiving interval, searching is carried out by scanning directional beams electronically at a high speed. It is a significant feature that all the directions can be searched by one transmission. However, since control of the tilt angle is performed by controlling the phase of a beam electronically and a variable range of the tilt angle is limited from 0 degree to 60 degrees, the direction right under a keel is impossible to search. Display method is a PPI display, and a relative position between own ship and a shoal of fish is easy to identify.

Frequency in use: 20 kHz - 100 kHz

17-2-3 Semicircular Scanning Sonar

A searching range covers 180 degrees. However, since the tilt angle is varied mechanically from 0 degree to 90 degrees and it is possible to set the tilt angle at any angle freely. Then, the direction right under a keel is searched unlike the Omnidirectional Scanning Sonar. Since a transducer is turned mechanically over 360 degrees, there is no area which is not able to be searched.
For the Semicircular Scanning Sonar, generally a high frequency is used, and it is suitable for the purpose of short distance searching with a high resolution. In the Omnidirectional Scanning Sonar and the Semicircular Scanning Sonar, there are individual features, and selection of either one depends on purposes.

Frequency in use: 75 kHz - 180 kHz

D

17-3 Scanning Sonar

17-3-1 Theory of operation

As for the searchlight sonar, a transducer is directed to a certain direction and a narrow beam of sound wave is transmitted from a transducer. A transmitted sound wave is reflected from a shoal of fish etc. and reflected sound waves are received. And then, the transducer head is changed to a different direction mechanically by using a transducer turning mechanics and a sound wave is again transmitted from the transducer and reflected signals are received. Such process for searching is repeated horizontally. However, the speed of sound wave propagating through the water is slow (1500 m/s), for example, in the case of searching at a depth of 0 to 750 m, if 10 degrees is selected as a width of sound wave (called beam width), it takes 18 seconds to search a width of 180 degrees by turning a oscillator. While an oscillator faces a certain direction, another direction is in a blind angle. Therefore, an omission in search occurs.

[(180degree/ (beam width)) x (a round-trip distance / sound speed)]
= (180 degrees/10 ") x (750x2/1500) = 18 seconds

A new type of scanning sonar has been developed to compensate for the fault of aforementioned searchlight sonar. For this type, a transducer to which many oscillators are fitted is used, and during a transmission interval, strong supersonic pulses are transmitted over all the directions simultaneously, and during a receiving interval, oscillators of the transducer are scanned electronically at a high speed. By repeating such operations, targets around a ship can be observed at a time.
As a basic structure, it consist of a display, a transducer which is fitted with oscillators, a circuit of transmitter/receiver unit which consist of a transmission circuit of high power output and a receiving circuit in which is fitted with a electronic circuit of a high speed electronic switching of beams, etc.. A block diagram of a scanning sonar is shown in Fig. 1.

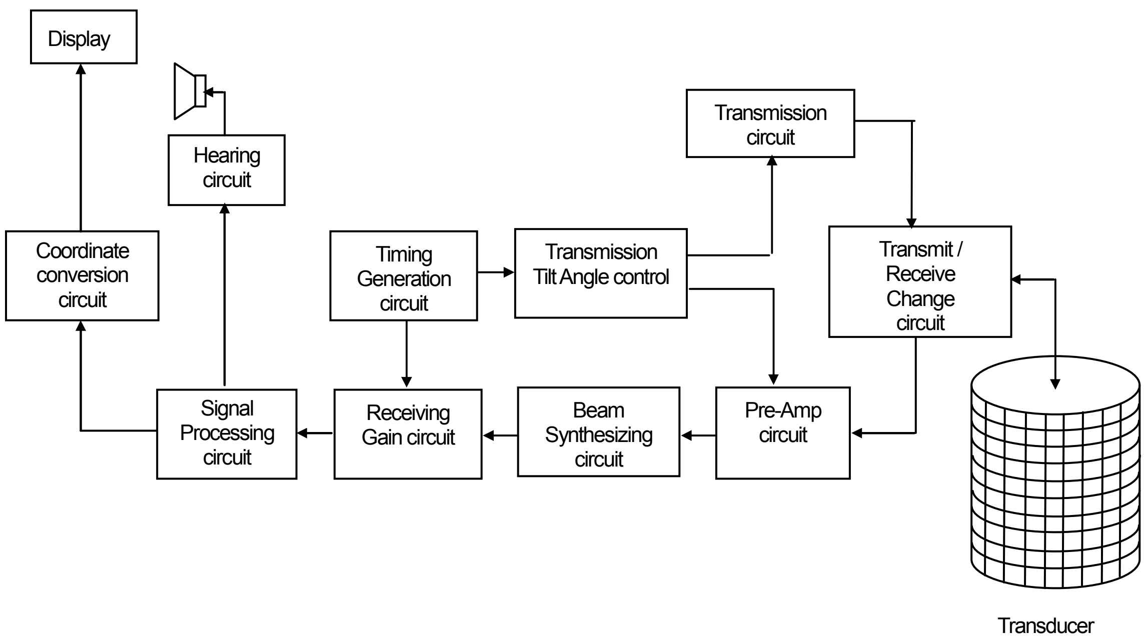


Fig.1 A block diagram of a scanning sonar

The whole system operating is controlled by a timing circuit, and this functions is basically similar to the function of searchlight sonar. During a transmission interval, supersonic sound waves are transmitted simultaneously in all directions from all the oscillators which are cylindrically arranged. When supersonic sound waves are transmitted at a tilt angle, an electric effect that a transmission frequency sent to each vertical layer of oscillators is phase-shifted is applied. During a receiving interval, target echoes in a designated direction are detected and identified, by switching receiving sharp beams electronically in turn at a high speed. Receiving sharp beams are made by combining some horizontal oscillators in a beam combining circuit. A certain tilt angle for receiving is made by adding a different phase of signal generated in a local oscillator to signals received. A distance and a direction of a received target echo are detected by switching beams electronically, and the coordinates of the distance and the direction of a target is transformed for display and is displayed. Based on this method, it takes only 1.3 seconds to search a range of 1000 m, and the omission of searching which occurs in the searchlight method does not occur in this method.

The aforementioned describes an omnidirectional scanning sonar. A semicircular type (180 degrees) of scanning sonar is used widely as well.

A distance to a target displayed on a screen corresponds to a direct distance between a target and a transducer and it does not means a horizontal distance. If a tilt angle is big, it is taken into account that the difference between a direct distance and a horizontal distance becomes big as well. According to the relation between the direct distance, the horizontal distance and the tilt angle, the relation between a sound wave and an echo is shown in Fig.2 (Omnidirectional sonar: 360 degrees) and Fig.3 (Semicircular sonar: 180 degrees) in the case of an omnidirectional scanning sonar and a semicircular scanning sonar respectively.

D

17-3-2 Relation between sound wave and echo (Omnidirectional SONAR)

(1) Horizontal search (Surface and Medium layer)

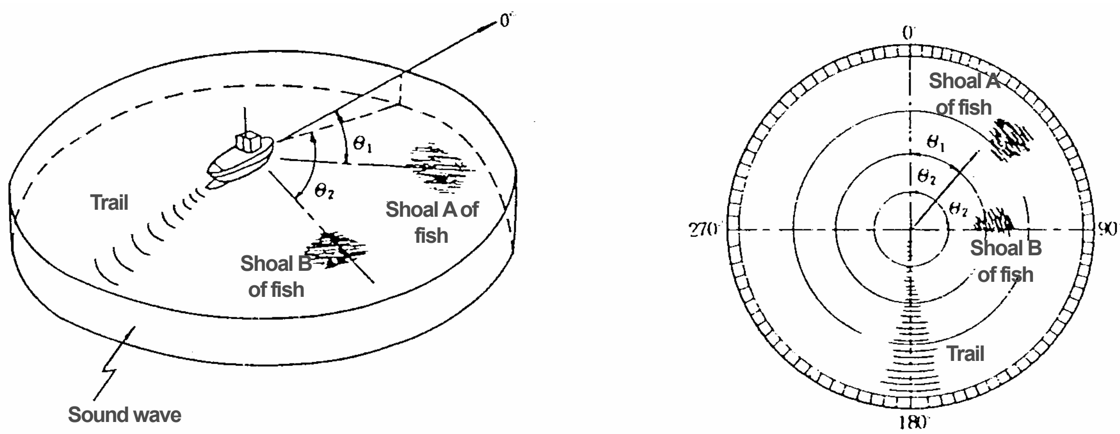
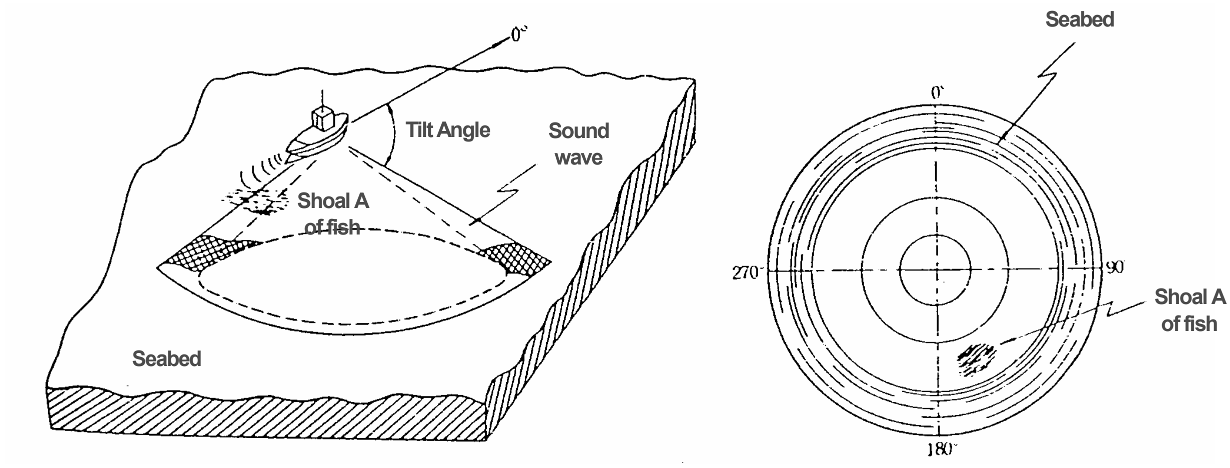


Fig.2

(2) Search of a shoal of fish living near the seabed



* If a tilt angle is applied, a sound wave becomes narrower circularly like a closing umbrella.

Fig.3

17-3-3 Relation between sound wave and Echo (Semicircular SONAR)

(1) Horizontal search (Surface / Medium layer)

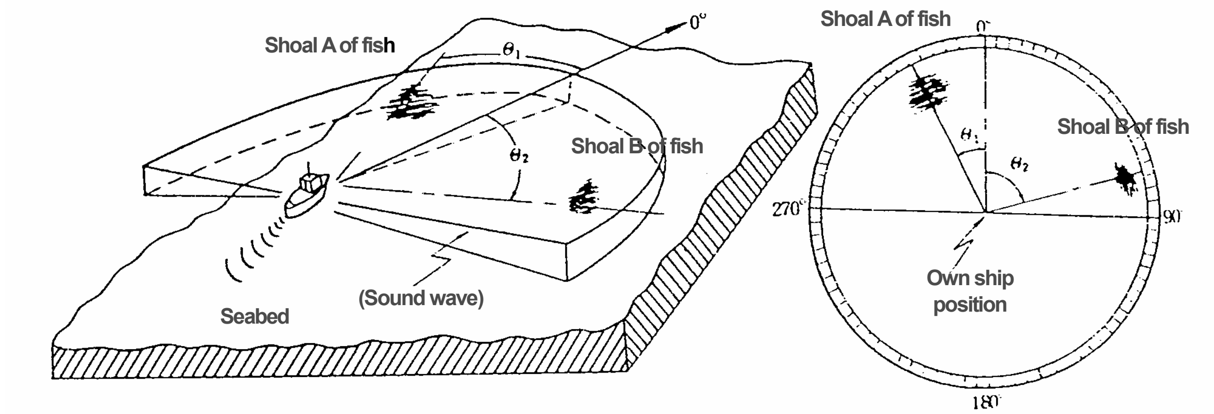


Fig.4

(2) Vertical plane search (Rapids, Fish living near the seabed)

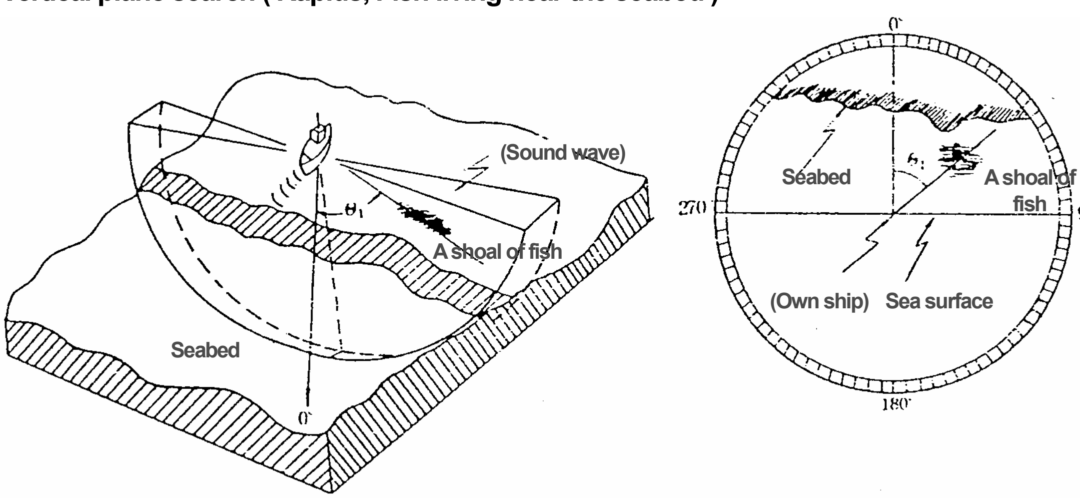


Fig.5

(3) A shoal of fish in a rope

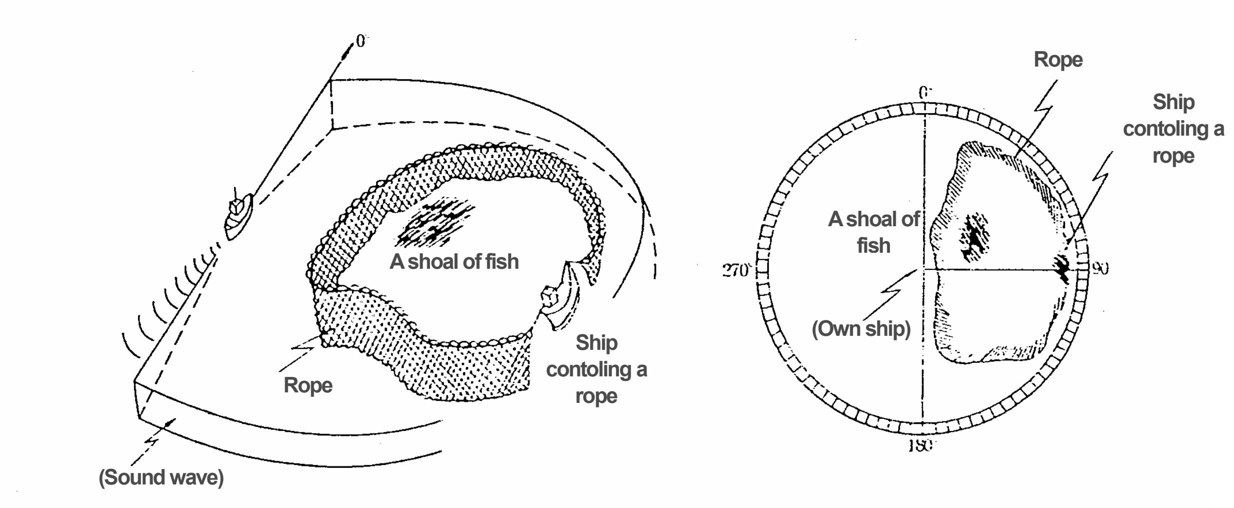


Fig.6

D

17-4 Installation position for each component and How to install

According to hull drawings, installation positions of equipment will be determined, and then cabling routes between equipment will be discussed. Generally, a display unit is installed in the bridge and transmitter/receiver units are installed in a sonar room. Avoiding installing equipment in places of high temperature and/or of high humidity and in places with excessive vibration, and is installed in places where equipment are maintained easily. Particularly, temperature and humidity in a sonar room should be taken into account, and ventilation fan, a fresh air inlet, etc. are fitted if necessary.

Regarding existing ships, since hull drawings may not match the present status of ships, the present status of each ship should be confirmed actually.

Especially an important matter for installation of a transducer is to select a place where influence of air bubbles is less.

The example of standard installation is shown in Fig.7

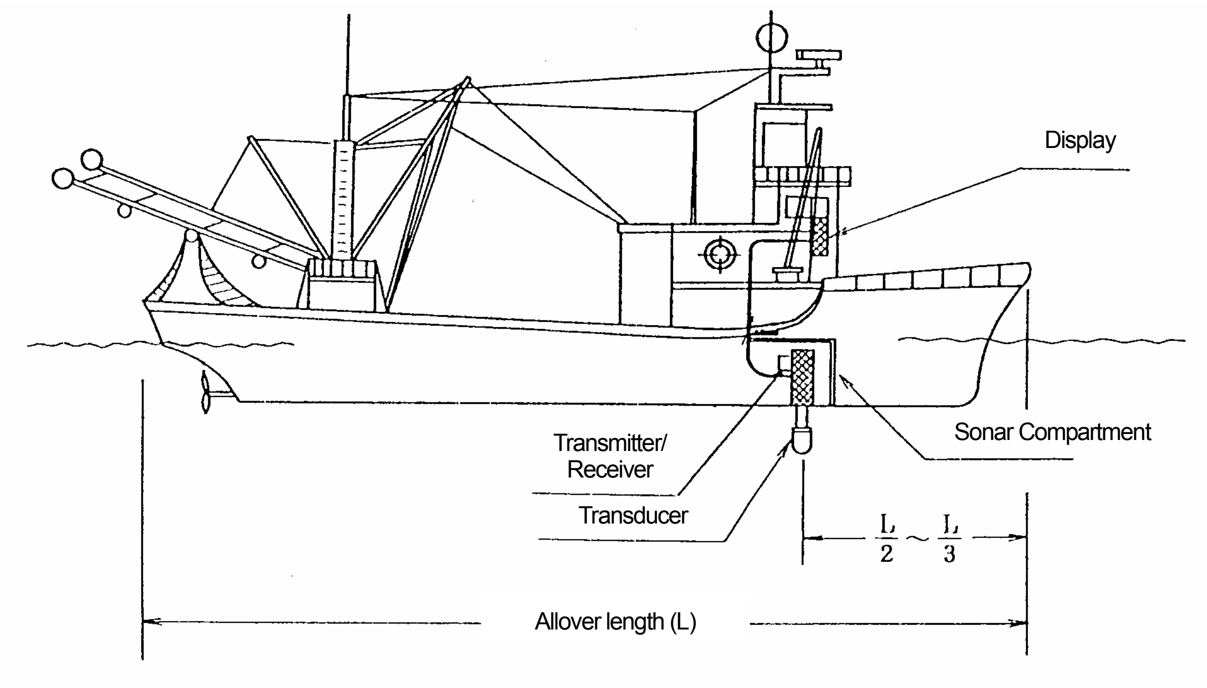


Fig. 7 Example of Standard Installation

17-5 Installation of Transmitter / Receiver

Taking the followings into account, installation positions should be determined.

(1) A position at which a transducer projects enough into the sea from a ship's bottom (keel).

(2) normally at a position of about 1/3 of the overall length of a ship from the bow of a ship. (Refer to Fig. 4)

(3) normally installed on a keel or within 800 mm from a keel (Refer to Fig. 5, 6) (However, in the case of installation on a keel, after confirming with a shipyard enough, the guarantee on strength of the keel should be obtained)

(4) a position at which air bubbles do not come or seldom come during running.

(5) a position out of which a transducer does not come in the air in a stormy weather.

(6) a position which does not receive noises from a propeller, Maine engine, generators, etc.

(7) a space enough for maintenance or test around transmitter and receiver is repair.

(8) compartment for transmitter and receiver is prepared and is waterproofed.

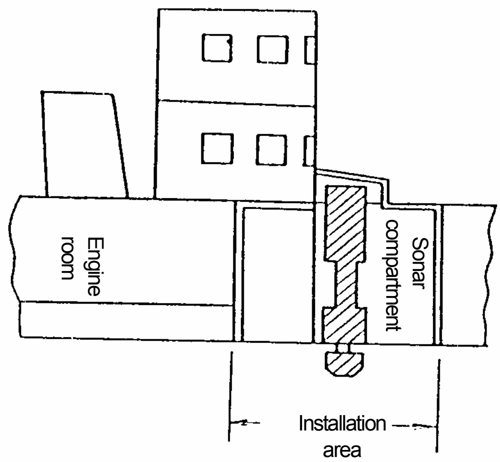
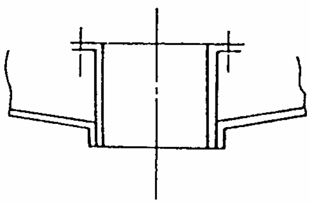
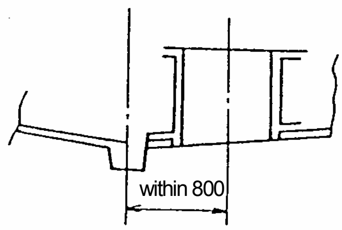


Fig.8



(1) Installation on a keel



(2) Installation off a keel

Fig.9

D

18. Doppler Finder (Current Meter)

18-1 Outline

The principle of this equipment is fundamentally the same as a Doppler sonar and a Doppler log, and directions of fishes etc. are searched at each depth three-dimensionally. Supersonic waves are transmitted from a transducer, which is fitted onto the bottom of a ship, at tilted angles of four directions such as forward and backward, to the right side and to the left side, and waves, which are reflected from the seabed and a shoal etc, such as moving objects in the selected layer of the water, are received and then actual speeds and directions of such shoals etc. as moving targets can be obtained free from any ship speed.
This device can measure tidal currents and directions in the surface layer of the sea and the deep-sea layer. However, since this is based on the Doppler-effect principle of detecting speeds of acoustically-reflective objects in the water, a measured speed is not actually a tidal current speed. On the other hand, acoustically-reflective objects moving in a tidal current are small organisms etc., which may have a certain relative speed to a tidal current, and when the relative speed is very small, indicted speed is considered to be almost the same as a tidal current. Therefore, this device is useful for predicting a tidal current speed and direction.

18-2 Features

(1) Speeds and directions of shoals etc. at three points in desired layers of the water can be measured simultaneously.
(2) It is possible to assume easily how much a fishnet spreads since a relative display on the basis of the speed of a desired depth can be made.
(3) A speed over the ground at a depth of up to 400 m, and a speed of a shoal etc. at a depth of up to100 m, is possible to detect stably.
(4) A measurement error caused by a ship movement has been reduced by using 4 direction beams.
(5) A source of failure can be easily discovered by a self-diagnostics.

18-3 Explanation of Principle for detecting speeds of moving objects in the water by the Doppler Effect

Generally, when sonic or electric waves transmitted from a certain objects return from other objects, if a relative speed between both objects exists, a frequency difference between a transmitted wave and a received wave is caused. While an object is moving out, a received frequency is lower than a transmitted frequency, and conversely, while an object is coming toward, an adverse effect is caused.

When a sound source moves at a speed of “v” in the same direction as a sound wave transmitted, the relation among the frequency “f_0 “a sound source, the velocity of the sound “C” and a wave length “λ” is given by a formula (2-1) as follows.

$$\lambda = \frac{C - v}{f_0} \qquad \text{.......................................}(2\text{-}1)$$

When this wave reflects from a fixed object and a receiver, which is moving at a speed of "V" in the direction of the sound source, receives the reflected wave, a frequency at this time is given by a formula (2-2).

$$f' = \frac{C+\upsilon}{\lambda} = \frac{C+\upsilon}{C-\upsilon} = f_o = (1 + \frac{2\upsilon}{C} + \frac{2\upsilon^2}{C^2} + \frac{2\upsilon^3}{C^3})\ f_o \quad \text{...............(2-2)}$$

When the frequency "f_0" of a supersonic wave transmitted at a tilted angle of "θ" in the water in a direction in which a ship is moving at a speed of "V_0", the frequency "f_1" of the supersonic wave in the water is given by a formula (2-3).

$$f_1 = \frac{C}{C - V_o \cos\theta} \cdot f_o \quad \text{.......... (2-3)}$$

When this wave reflects from the seabed and the ship moving at a speed of "V_0" receives the reflected wave, the frequency "f_B" of the received wave is given by a formula (2-4).

$$f_B = \frac{C + V_o \cos\theta}{C} \cdot f_1 \quad \text{.......... (2-4)}$$

$$= \frac{C + V_o \cos\theta}{C - V_o \cos\theta} \cdot f_o \quad \text{.......... (2-5)}$$

The next subject is to consider waves reflected from moving objects such as a shoal etc. in the water. When the wave with the frequency "f_1" reaches a object moving at a speed of "V_M" in the water in the same direction as a ship is moving, the frequency "f_2 " of the wave at the object is given by a formula (2-6).

$$f_2 = \frac{C - V_M \cos\theta}{C} \cdot f_1 \quad \text{.......... (2-6)}$$

The frequency "f_3 "of a wave reflected from this object moving toward a sound source is given by a formula (2-7).

$$f_3 = \frac{C}{C + V_M \cos\theta} \cdot f_2 \quad \text{.......... (2-7)}$$

$$= \frac{C}{C + V_M \cos\theta} \cdot \frac{C - V_M \cos\theta}{C} \cdot f_1 \quad \text{.......... (2-8)}$$

$$= \frac{C - V_M \cos\theta}{C + V_M \cos\theta} \cdot \frac{C}{C - V_M \cos\theta} \cdot f_o \quad \text{.......... (2-9)}$$

When this reflected wave is received at the ship, the frequency "f_M "of the received wave is given by a formula (2-10). This is a wave reflected from a moving object.

$$f_M = \frac{C + V_o \cos\theta}{C} \cdot f_3 \quad \text{.......... (2-10)}$$

$$= \frac{C - V_M \cos\theta}{C + V_M \cos\theta} \cdot \frac{C + V_M \cos\theta}{C - V_M \cos\theta} \cdot f_o \quad \text{.......... (2-11)}$$

$$= \frac{C - V_M \cos\theta}{C + V_M \cos\theta} \cdot f_B \quad \text{.......... (2-12)}$$

D

As a result, the following formula is obtained.

$$\frac{f_M}{f_B} = \frac{C - V_M\cos\theta}{C + V_M\cos\theta}$$
$$= 1 - 2\,\frac{V_M\cos\theta}{C} + 2\left(\frac{V_M\cos\theta}{C}\right)^2 - 2\left(\frac{V_M\cos\theta}{C}\right)^3 + \cdots\cdots, \quad \cdots\cdots\cdots\cdots (2-13)$$

Since V_M is the smaller than C ($V_M \ll C$) in a formula (2-13), members below the third member of a formula (2-13) can be omitted and it can be approximated by a formula (2-14).

$$\frac{f_M}{f_B} = 1 - \frac{2\,V_M\cos\theta}{C} \quad \cdots\cdots\cdots\cdots (2-14)$$

From a formula (2-14), the following formula is obtained.

$$V_M = \frac{C}{2\cos\theta}\left(1 - \frac{f_M}{f_B}\right)$$
$$= \frac{C}{2\cos\theta}\left(\frac{f_B - f_M}{f_B}\right) \quad \cdots\cdots\cdots\cdots (2-15)$$

According to the aforementioned, a speed of a moving object can be obtained on the basis of a wave reflected from the seabed and a wave reflected from a moving object.

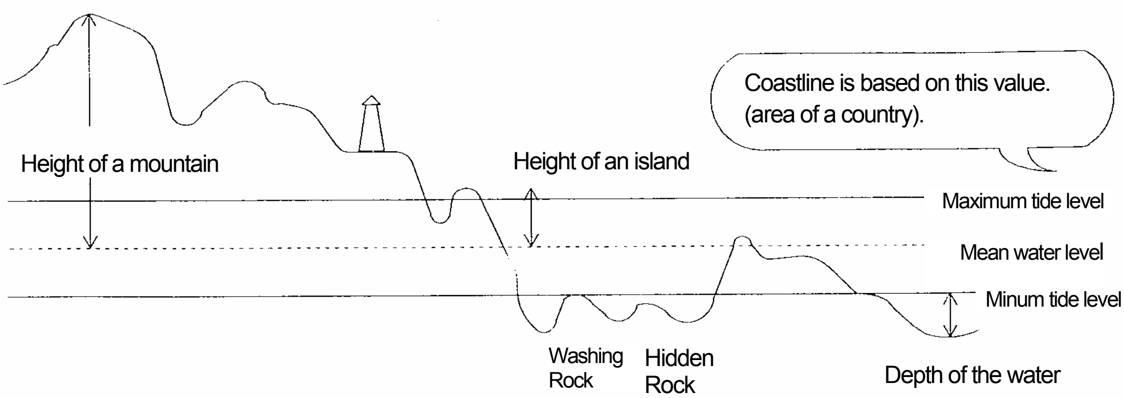
For Doppler Finders, in order to cancel changes of a reflection angle "θ" caused by the rolling and pitching motion of a ship, one beam each in a forward and a backward direction, and one beam each in each side direction, 4 beams of supersonic waves in all are actually used.

Moreover, Doppler finders (Current Meter) such as JLN -610/612/615/616/626/627/628 / 650 type are manufactured based on patent No. 805192.

COFFEE BREAK

The reference level for the depth of the water

* The height of object on land, it is measured from a mean water level.
  The depth of water is measured from a minimum tide level.



19. Color Plotter

19-1 Outline

A color plotter is connected with GPS navigation equipment etc. and draws wakes of own ship continuously on Mercator charts in color on a screen.

By using the function of indicating coastlines, it is easy to confirm an own ship position visually, and consequently, it contributes to safe navigation and increase in efficient fishery work.

In addition, as shown below in the paragraph “Specification”, there are many functions, and it is possible to indicate necessary data according to users’ demands.

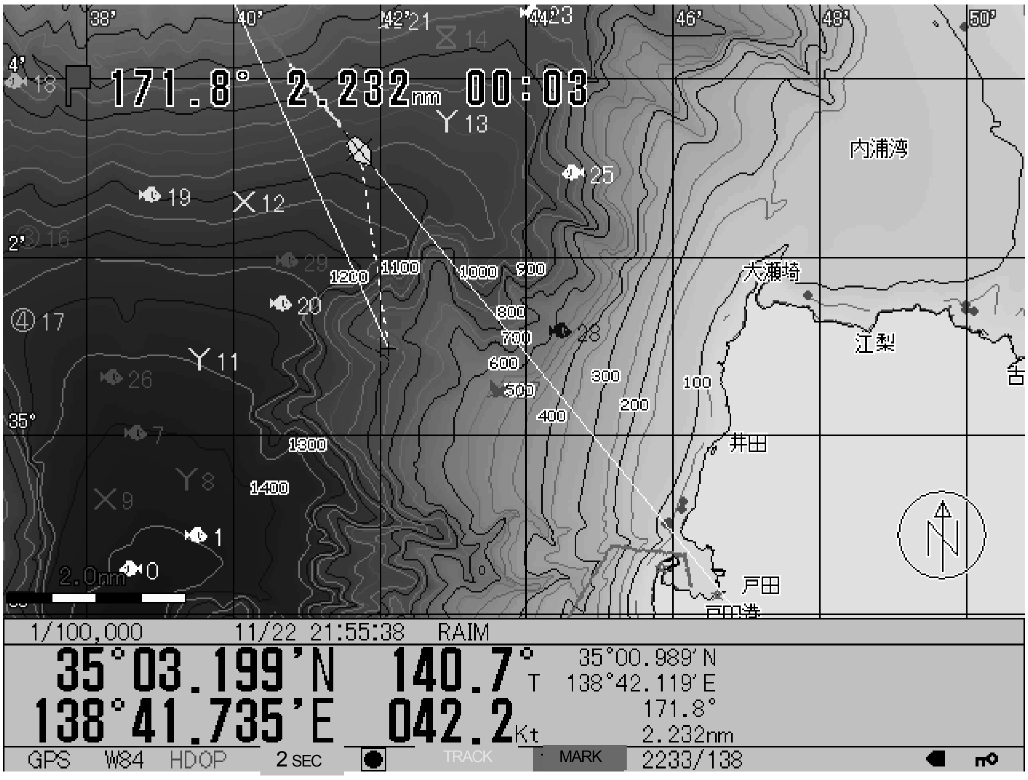
19-2 Specification (ex.JLZ-900)

Display			15-inch TFT liquid crystal display (Horizontal type of display)
Effective display range			Latitude 70 degrees or less
Chart data			ERC version Seashore data / Bathymetry data
Display scale			1 / 1,000 to 1/10,000,000, or 0.1 nm to 1000 nm
Display motion mode			North up, South up, East up, West up, Course up, Head up
Position information			Latitude longitude, loran C, the loran A, Decca
Main display screen			Two-dimensional screen, Three-dimensional screen, Three- and Two-dimensional screen together Sectional view and Two-dimensional screen together Sectional view and Three-dimensional screen together Numerical display screen, Tide forecast screen, Weather information screen
Wake	Memory interval		1, 2, 5, 10, 20, 30, 60, 120, 300, 600 seconds or 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10 nm
	Memory point		2000, 5000 points x 10 blocks
	Display color		Seven colors
	Another ships’ wakes		30 targets, 500 points each
Mark	Kind	Mark	28 types (including event marks)
		Line	3 types
	Memory point	Mark	15,000 points
		Line	1,000 points
	Display color		Seven colors
	Comment input		12 characters
Route	Memory point		49 routes (up to 50 waypoints per route)
	Comment input		12 characters
Drawing	Memory point		500 points x 7 blocks
	Display color		Seven colors

Others	External event input External buzzer output (log pulse) Tidal current data input GPS buoy data input direct connectable to DGPS212, GPS112 receiver

19-3 Screen Feature

Many data are sorted into several functions and arranged intelligibly.
By giving the gradation of the depth of the water which is based on not only coastline data, but isobath data and isobaths (depth contour lines), it is easy to confirm the ups and downs of the seabed visually.



E. General Materials

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1. Grouping of Radio Frequency by Frequency Band

Frequency band	Name (normally used)	
(9)～30 kHz	VLF（Very Low Frequency）	Extreme long wave
30～300 kHz	LF（Low Frequency）	Long wave
300～3,000 kHz	MF（Medium Frequency）	Medium wave
3～30 MHz	HF（High Frequency）	Short wave
30～300 MHz	VHF（Very High Frequency）	Very short wave
300～3,000 MHz	UHF（Ultra High Frequency）	Ultra short wave
3～30 GHz	SHF（Super High Frequency）	Micrometer wave
1～2 GHz		L band
2～4 GHz		S Band
4～8 GHz		C Band
8～12 GHz	Microwave band	X Band
12～18 GHz		Ku Band
18～26.5 GHz		KB and
26.5～40 GHz		Ka Band
30～300 GHz	EHF（Extremely high Frequency）	Millimeter wave
300～(400)GHz		Sub millimeter wave

Value in (   ) means upper limit or lower limit distributed in RR.

2. International Conventions related to Maritime Management

International Conventions	
SOLAS	International Convention for the Safety of Life at Sea, 1974
Load Lines	International Convention on Load Lines, 1966
COLREG	Convention on the International Regulations for the Preventing Collisions at Sea, 1972
STCW	International Convention on Standards of Training, Certification and Watchkeeping for the Seafares, 1978
SAR	International Convention on Maritime Search and Rescue, 1979
MARPOL 73/78	The International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978
TONNAGE	International Convention on Tonnage Measurement of Ships, 1969
SFV PROT	Cape Town Agreement of 2012 on the Implementation of the Provisions of the 1993 Protocol relating to the Torremolinos International Convention for the Safety of Fishing Vessels, 1977

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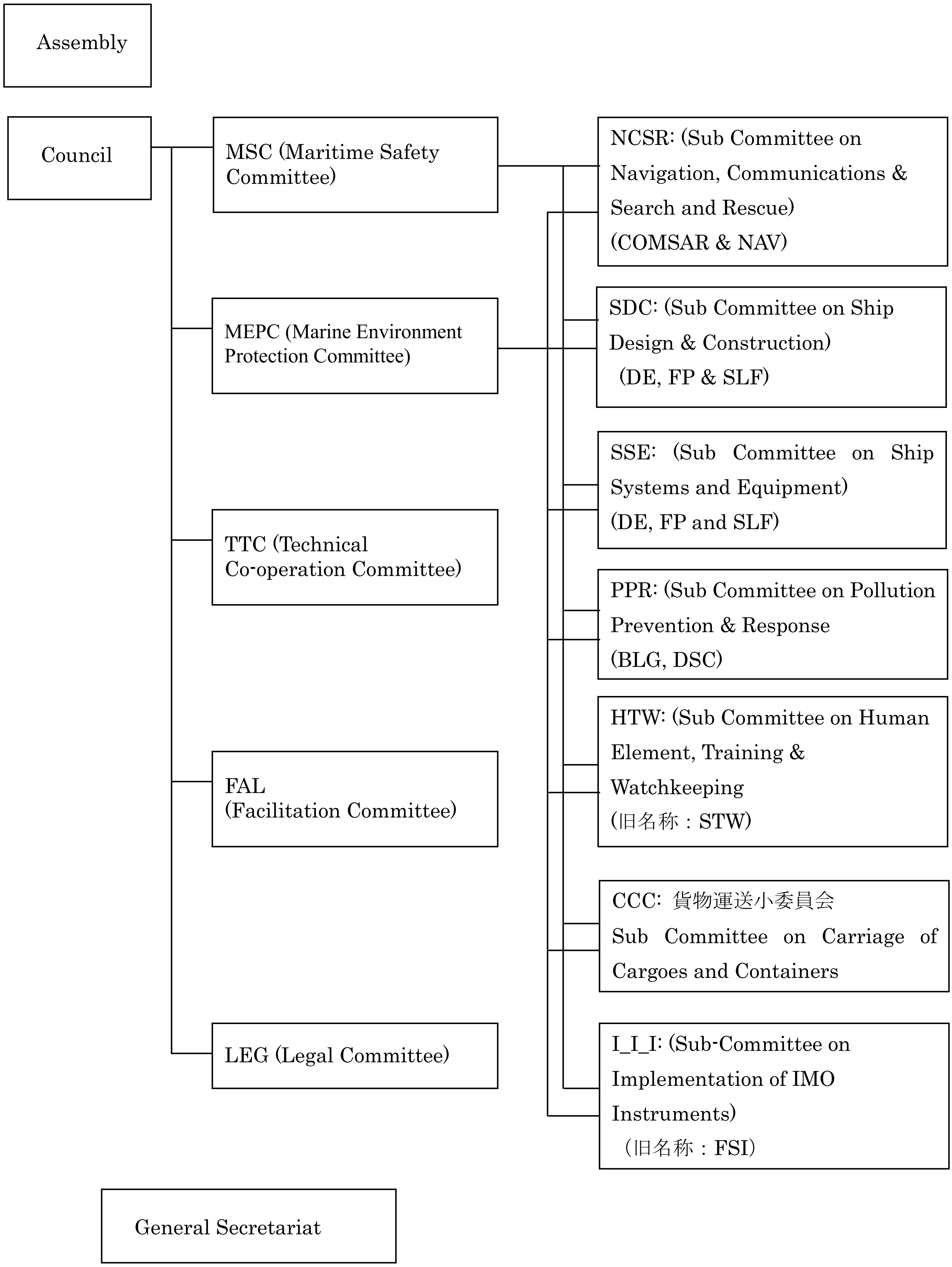
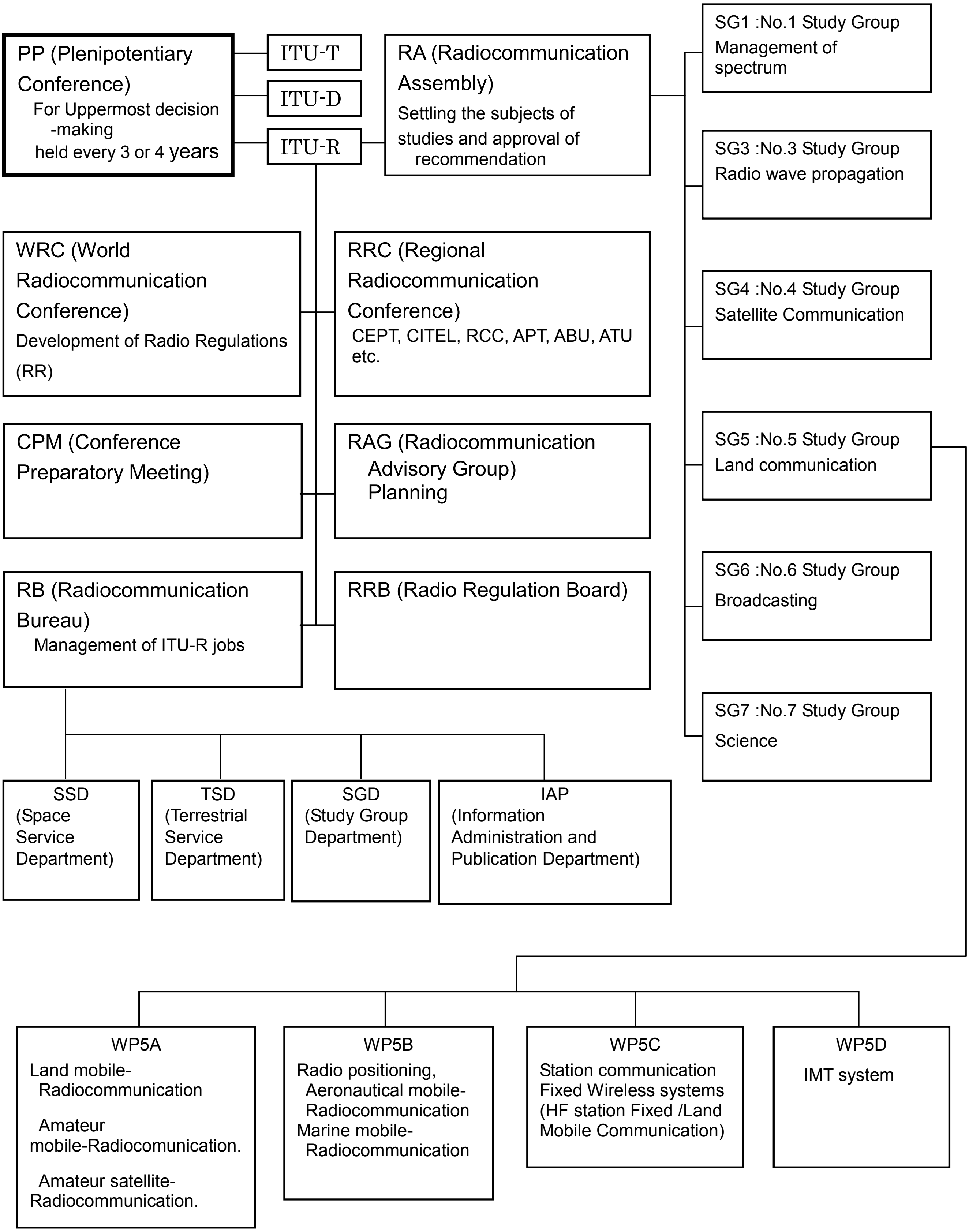
3. Organization of IMO



4. Organization of ITU-R



Note : SG: Study Group, WP: Working Party

5. Main Classification Table

	Name of Classification	Country	Since	Remarks
ABS	American Bureau of Shipping	USA	1862	
BKI	Biro Klasifikasi Indonesia	INDONESIA	1964	
BV	Bureau Veritas	FRANCE	1828	
CCS	China Classification Society	CHINA	1956	
CR	China Corporation Register of Shiping	TAIWAN	1951	
CRS	Croatian Register of Shipping	CROATIA	1949	
DNV GL	DNV GL AS	NORWAY	2013	
DNV	Det Norske Veritas	NORWAY	1864	DNV merged GL in September, 2013.
GL	Germanischer Lloyd	GERMANY	1867	
HR	Hellenic Register of Shipping	GREECE	1919	
ICS	Iranian Classification Society	IRAN	2007	
IRS	Indian Register of Shipping	INDIA	1975	
KR	Korean Register of Shipping	KOREA	1960	
LR	Lloyd's Register of Shipping	UK	1760	
NK	Nippon Kaiji Kyokai	JAPAN	1899	
PRS	Polish Register of Shipping	POLAND	1936	
RBNA	Brazilian Register of Shipping	BRAZIL	1982	
RINA	Registro Italiano Navale	ITALY	1861	
RS	Russian Maritime Register of Shipping	RUSSIA	1913	

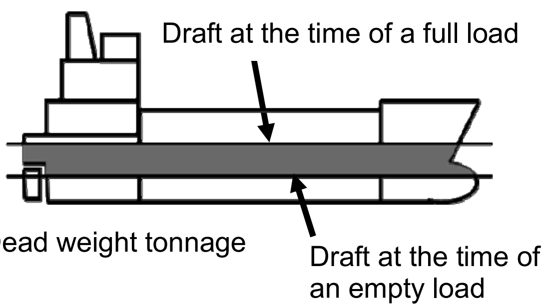
6. Tonnage of Ship

Gross tonnage added to the numerical value with the coefficient in the capacity calculated by measuring the size of the ship by the constant standard. This is merely name not the "tonnage" as the unit (weight).	
International gross tonnage	It is a numerical value showing the capacity of the ship calculated by the measurement method unified internationally. 1 ton = 100 cube feet 1 ton ≒2.83 cuby meter
Gross Tonnage Notation : G.T G/T GT	It is an index used since the size of the ship in Japan is expressed. The coefficient defined by “an international-gross-tonnage x tonnage” method (It becomes a value smaller than international gross tonnage)
Net Tonnage Notation : N.T N/T NT	It is the tonnage which subtracted the places (an engine room, a crew space, etc.) for accommodating cargo or a passenger. (Gross tonnage) - (an engine room, a crew space, etc.) = Capacity used only for cargo or a passenger

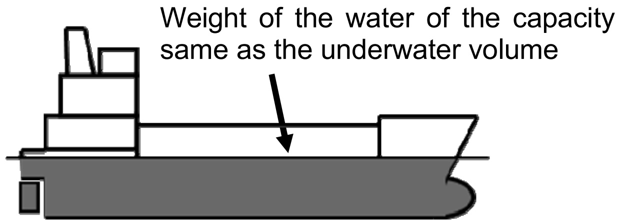
Gross tonnage

Net tonnage

Weight tonnage added the tonnage (1000kg) to the numerical value calculated by measuring the size of the ship by the constant standard.	
Dead Weight Tonnage Notation: D.W.T D/T DWT	Weight of the maximum loading of cargo Displacement tonnage when carried a full load of cargo by a design waterline - Displacement tonnage of light weight = At the time of a full load - Displacement tonnage at the time of an empty load
Displacement tonnage	Weight of the water of the capacity same as the underwater volume of the ship = Weight of the ship (Archimedes' principle) Fresh water: Sea water = 1 : 1.025 It is used for expressing the size of a warship etc. -> It is not necessary to take into consideration conversion of the gross weight by loading.



Dead weight tonnage

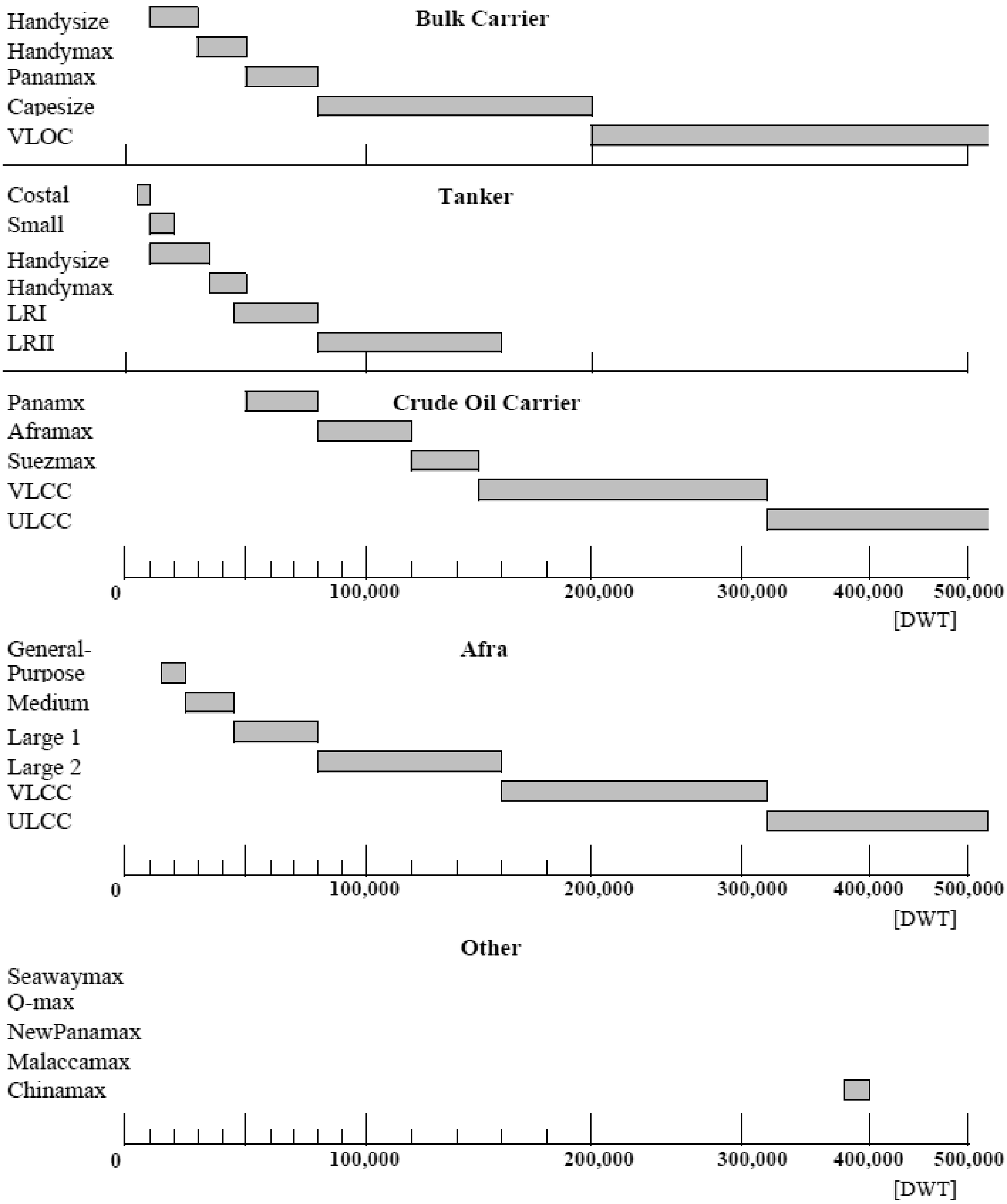


Displacement tonnage

7. Name of the Ship's Size

There are the names such as a bulk carrier, the tanker in the ship by size, and also division with the size may not be identical by the organization. However, the name shows the route in which an approximate size and cruise are possible. In the Panama Canal and the Suez Canal, since the maximum of hull length, width, and draft is decided, as for the vessel which passes through the bottom of a bridge, the height is also provided with restriction.

7-1 Ship's Size, and Name



7-2. Name and Size by Kind of Ship

7-2-1 Bulk carrier

Name	Dead Weight Tonnage [DWT]	Outline
Handysize	10000-30000	Small Bulk carrier which is short distance transportation mainly
Handymax	30001-50000	The ship by which Bulk and Tanker are the general size bigger than Handysaize
Panamax	50001-80000	The greatest ship that can pass the lock gate of the Panama Canal
Capesize	80001-199000	Since it cannot pass through the Panama Canal and the Suez Canal, it turns around Cape Horn in South America, and the Cape of Good Hope in South Africa. If the draft is not a port dug down deeply, she cannot arrive at a port and get to the shore.
VLOC	200000 +	(Very Large Ore Carriers) It is mainly an ore carrier.

7-2-2 Tanker

Costal	3001-10000	The tanker which carries the coast by tanker of the smallest size and carries petroleum products and chemicals in an adjacent-seas region
Small	10001-19000	A use is also almost the same by tanker of larger size than Coastal.
Handysize	10000-34999	The tanker of a general size
Handymax	35000-49999	The tanker of larger size
LR1	45000-79999	(Long Range 1) Long-distance size 1
LR2	80000-159999	(Long Range 2) Long-distance size 2

7-2-3 Crude Oil Tanker

Panamax	50001-80000	The tanker of the maximum size which can pass through the Panama Canal Full length 294.13m, Width 32.31m, Draft 12.04m and Draft high 57.91m
Aframax	80000-119000	AFRA is an abbreviation of Average Freight Rate Assessment. Tanker by the fare index London tanker broker is making from April, 1954
Suezmax	120000-150000	The tanker of the maximum size which can pass through the Suez Canal. Full length Undecided, Width 50.00m, Draft 20.10m, Draft high 68.00m
VLCC	150000-320000	The very large crude carrier used for crude-oil conveyance
ULCC	320000+	The ultra large crude carrier used for crude-oil conveyance of larger size than VLCC

7-2-4 Other names

Seawaymax	The ship which can cruise the St. Lawrence River to which the Great Lakes and the Atlantic Ocean of the North American Continent are connected. Full length 225.60m , Width 23.80m, Draft 7.92m, Draft high 35.50m
Q-max	(Qatar Max): LNG ship which can arrive at a shore at the LNG terminal of Middle East Qatar Full length 345.00m , Width 53.80m, Draft 12.00m, Draft high 34.70m
NewPanamax	Ship of the maximum size by the Panama Canal extension which can be passed. (That completion is scheduled for 2015) Full length 366.00m , Width 49.00m, Draft 15.20m, Draft high 57.91m (schedule)
Malaccamax	The ship of the maximum size which can pass the Strait of Malacca (strait where separates the Malay Peninsula and Indonesia Sumatra) Full length 400.00m , Width 59.00m, Draft 14.50m, Draft restrictions 25m
Chinamax	The large size Bulk carrier by which an iron ore is carried in China from Brazil mainly (It is not limited only to China now) Full length 360.00m , Width 65.00m, Draft 24.00m

8. Abbreviation Used in This Document

Abbreviation	Structure of Original Words
AIS	Automatic Identification System
	UAIS：Universal AIS
AMVER	Automated Mutual-assistance Vessel Rescue System
AtoN	Aids to Navigation
BNWAS	Bridge Navigational Watch Alarm System
CIRM	Committee International Radio Maritime
COMSAR	Communications and Search and Rescue
COSPAS	Cosmicheskaya Sistyema Poiska Avariynich Sudov (Space System for the Search of Vessels in Distress)
DSC	Digital Selective Calling
ECDIS	Electronic Chart Display
EGC	（Inmarsat） Enhanced Group Call
ELT	Emergency Location Transmitter
EMC	Electromagnetic Compatibility
EPIRB	（Satellite） Emergency Position Indicating Radio Beacons
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FCC	Federal Communication Commission
GLONASS	Global Navigation Satellite System
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
DGPS	Differential GPS
HCS	Heading Control Systems
HSC	High Speed Craft
IALA	International Association of Light-house Authorities
IBS	Integrated Bridge System
ICAO	International Civil Aviation Organization
IEC	International Electrotechnical Commission
IFRB	International Frequency Registration Board
IHO	International Hydrographic Organization
IMO	International Maritime Organization
INM	INMARSAT（International Maritime Satellite Organization）
INS	Integrated Navigational System
IRCS	Integrated Radiocommunication System
ISPS	International Ship and Port Facility Security Code
ITU	International Telecommunication Union
ITU-R	ITU Radiocommunication Sector
ITU-T	ITU Telecommunication Sector

LES	Land Earth Station
LRIT	Long Range Identification and Tracking of ships
LUT	Local User Terminal
MCC	Mission Control Center
MEPC	Marine Environment Protection Committee（of the Organization）
MES	Mobile Earth Station
MID	Maritime Identification Digit Code
MIL	Military Specifications and Standards
MKD	Minimum Keyboard Display
MMSI	Maritime Mobile Ship Identification
MSC	Maritime Safety Committee （of the Organization）
MSI	Maritime Safety Information
NAV	Safety of Navigation
NAVAREA	Navigational Area
NAVTEX	Navigation Telex
NBDP	Narrow Band Direct Print
NCS	Network Coordination Station
NCSR	Sub Committee on Navigation, Communications & Search and Rescue
NMEA	National Maritime Electronics Associations
PLB	Personal Locator Beacon
RADAR	Radio Detecting and Ranging
Radar SART	Radar Search and Rescue Transponders
AIS SART	AIS Search and Rescue Transmitters
RCC	Rescue Coordination Center
ROT	Rate-of-Turn indicators
RO-RO ship	Roll-on / roll-off ship
RR	Radio Regulations
SAR	Search and Rescue
SARSAT	Search and Rescue Satellite Aided Tracking
SDME	Speed and Distance Measuring Equipment
SES	Ship Earth Station
SOLAS	International Convention for the Safety of Life at Sea
SONAR	Sound Navigation and Ranging
SLF	Stability and Load Lines and Fishing Vessel Safety
SRR	Search and Rescue Region
SSAS	Ship Security Alert System
STCW	International Convention on Standards of Training Certification and Watchkeeping for Seafarers
TCS	Track Control System
TDMA	Time Division Multiple Access
THD	Transmitting Heading Device
TMHD	Transmitting Magnetic Heading Device
USCG	United States Coast Guard
UTC	Universal Time Coordinated

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VDR	Voyage Data Recorder
SVDR	SVDR：Simplified VDR
VCCI	Voluntary Control Council For Interference by Data Processing Equipment and Electronic Office Machine
VTS	Vessel Traffic Services
WMO	World Metrological Organization
WRC	World Radiocommunication Conference
WWNWS	World-Wide Navigational Warning System

9. Marine Storage Battery Etc.

9-1 Lead storage battery for Auxiliary Power

9-1-1 Principle

If lead peroxide (PbO_2) and lead (Pb) are immersed into dilute sulfuric acid, a voltage of about 2 v occurs between this PbO_2 and Pb, PbO_2 serves as an anode and Pb serves as cathode. The above-mentioned is the principle of lead storage battery, and anode, cathode and electrolytic solution (dilute sulfuric acid) change with charge and discharge as follows. However, all the active substances of two poles do not change to lead sulfate and all of the electrolytic solution do not change to water, respectively, with the progress of electric discharge.

Anode	Electrolytic solution	Cathode		Anode	Electrolytic solution	Cathode
PbO_2 +	$2H_2SO_4$ +	Pb	Electric discharge $\rightarrow$ $\leftarrow$ Charge	$PbSO_4$ +	$2H_2O$ +	PbSO
(Lead peroxide)	(sulfuric acid)	(Spongy pure lead)		(Lead sulfate)	(Water)	(Lead sulfate)

9-1-2 Change of electromotive force by specific gravity

The relation between specific gravity of electrolyte and electromotive force can be estimated by the following formula.

$Eo = S + 0.85 \sim 0.84$

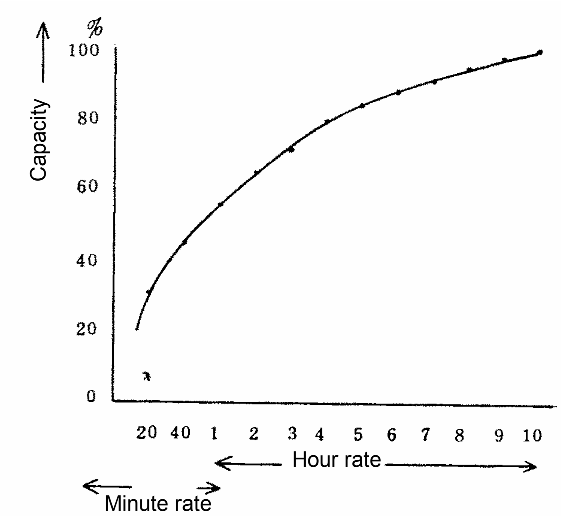
S: Specific gravity of electrolyte (20˚C)

9-1-3 Characteristic of Capacity to Discharge rate

There are types of 60, 84, 108, 200, 300, and 400AH, as capacity, and discharge and re-charge are repeated continuously in turn down to a discharge final voltage (1.8V) at a ten-hour rate, and it is assumed that the capacity bears this process 5 times and keep 95% of a capacity.

If a battery of 10-hour discharge rate “200AH” discharge at a current of 20A, it means that the battery can be used, maintaining a specified voltage for 10 hours.

Specific gravity is based on 1.24±0.01 in a state of complete charge.



The left chart indicates the Characteristics of Discharge to Capacity and is based on a battery with a capacity of 100% at a 10-hour discharge rate.

When a battery of 200AH discharges at a 7-hour rate (28.6A), the capacity of the battery is 91% (l82AH), and is able to bear a load for 6.4 hours.

Characteristic Chart of Electric discharge hour rate to Capacity

9-2 Alkaline Battery for Auxiliary Power

9-2-1 Alkaline battery

Generally an alkali storage battery is a nickel cadmium storage battery, and nickel oxide is used for an Anode and a cadmium compound is used for a Cathode and caustic potash is used for an electrolyte. During discharging, chemical reaction of nickel oxyhydroxide occurs at an Anode and chemical reaction between metal cadmium and cadmium hydroxide occurs at a Cathode, and the caustic potash of an electrolytic solution cannot participate in a reaction directly and concentration of an electrolytic solution can be disregarded mostly.

9-2-2 Charge and Discharge reaction formula

$$2\,NiOOH+Cd+2H_2O \underset{\text{Charge}}{\overset{\text{Electric discharge}}{\rightleftarrows}} 2nickel(OH)_2+Cd(OH)_2$$

9-2-3 Feature

(1) Charges and discharge of 500 times or more are possible. (JIS conditions)
(2) Internal resistance is very small and large current discharging is possible.
(3) Voltage variation under electric discharge is small.
(4) It is equal to overcharge and overdischarge and handling is easy.

9-2-4 Characteristic

(1) Charging characteristic

If charge is continued, charge voltage, inner gas pressure, and battery temperature change with the elapse of time. Such characteristic is affected by the influence of charging current, ambient temperature, etc.. From a final stage of charging to a stage of overcharging, oxygen gas is evolved from an anode plate and it is absorbed at a Cathode. If charging is continued without control by a current of more than an allowable current, the amount of evolved gas increases and inner gas cannot be absorbed adequately. Consequently, a pressure of the gas increases abnormally and then a safety valve activated to release the electrolyte. As a result, poor contracting may be caused due to the dirty of the overflowed electrolyte.

(2) Ambient temperature while charging

The charging characteristic of a battery varies with the change in ambient temperature, and if a charging temperature goes up, charging efficiency gets worse. For example, after a battery is charged at a temperature of 20˚C and then discharged, the charged battery can be used for 100 minutes. However, if a battery is charged at a temperature of 40 ˚C, it cannot be used only for 85 minutes (down to about 85%). Therefore, a temperature range of from 10˚C to 25˚C is extremely ideal for charging efficiently.

(3) Ambient temperature while discharging

A battery can be discharged at a temperature range of 20˚C to 60˚C, and discharging at high temperatures can be carried out like discharging at normal temperatures, but discharging performance deteriorates at low temperatures.

9-3 Battery currently used for Shipborne equipment

9-3-1 Nickel-metal hydride battery (Ni-MH battery)

(1) about Nickel-metal hydride battery

The Nickel-metal hydride battery (NiMH) uses a hydrogen-absorbing alloy for the negative electrode active material instead of cadmium (Cd) of a nickel-cadmium battery. Eelectromotive force of a Ni-MH battery is nearly the same voltage of 1.2 v as a nickel-cadmium battery.

(2) Charge-and-discharge reaction formula

$$NiOOH + MnO_2 + Zn + H_2O \quad \underset{\leftarrow \text{ Charge}}{\overset{\text{Electric discharge} \rightarrow}{\longleftrightarrow}} \quad Ni(OH)_2 + MnOOH + ZnO$$

(3) Feature

a. Charges and discharge of 500 times or more are possible.
b. In comparison with a nickel-cadmium battery, energy density is high and capacity is large.
c. Since the cadmium of a toxic substance is not used, an impact on environment is low.
d. There is memory effect (Ni-Cd battery gradually lose its maximum energy capacity, if it is repeatedly recharged after being only partially discharged.) like a nickel-cadmium battery.
e. in comparison with a nickel-cadmium battery, it is weak to overcharge.

9-3-2 Lithium battery

(1) about Lithium battery

The most common type of lithium cell is manganese dioxide lithium cell type in which metallic lithium as anode and manganese dioxide as cathode, and electrolytic solution in which a salt of lithium is dissolved in an organic solvent, are used respectively. It has a maximum ionization tendency among metals, and since it has very low potential, if this is used as anode, the high potential difference will be obtained, and as compared with a manganese cell, capacity is very large, and lithium has few voltage drops till the electric discharge last stage, and its self-discharge is small.

(2) Reaction formula

$$Mn(IV)O_2 + Li \quad \xrightarrow{\text{Electric discharge}} \quad Mn(III)O2\ (Li+)$$

(3) Feature

a. Electromotive force per cell is high, and one cell can be used for memory backup.
b. Since energy density is very high, it can be miniaturized.
c. Self-discharge is very low, and it has a life time of about five years.
d. Voltage drop is small till the last stage of electric discharge.
e. Its characteristic is not deteriorated even at lower temperatures and can be used even at lower temperatures,
f. Since energy density is high, it is necessary to pay attention very much to generation of heat in the case of a short circuit accident.

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9-3-3 Lithium ion battery

(1) about Lithium ion battery

In a typical Lithium ion battery, carbon as anode, lithium transition metal oxide as cathode, and organic solvent + lithium hexafluorophosphate(lithium salt), such as ethylene carbonate or diethyl carbonate, as electrolyte, are used respectively. Lithium ion in electrolyte acts as electrical conduction. There are two types of lithium ion batteries such as the primary battery which is not rechargeable, and the secondary battery which is rechargeable.

(2) Charge-and-discharge reaction formula

$$Li(1\longleftrightarrow X)\,CoO_2 + LixC \quad \underset{\leftarrow \text{ electric discharge}}{\overset{\text{Charge} \rightarrow}{\longleftrightarrow}} \quad LiCoO_2 + C$$

(3) Feature

a. Electromotive force per cell is high, and one cell can be used for memory backup.
b. Charges and discharge of 500 times or more are possible.
c. Energy density is very high, and it can be miniaturized.
d. Voltage drop does not occur due to memory effect which exists in nickel-cadmium battery.
e. Self-discharge characteristic is good.
f. Since the difference between a common use range and a safety use range is very small, a protection circuit is necessary to supervise charging and discharging for safety reservation.
g. Since electrolytic solution is an organic solvent, a fire may be caused by its volatilization.

10. Standing Wave and SWR

Standing Wave

Standing wave excitation is used for feeding high frequency currents to an antenna wire. If both ends of an antenna wire are electrically open, a state is presented that an infinite load is connected, and traveling waves are reflected completely at both end. That is that, regarding a standing wave excitation, traveling and reflected waves are fed to an antenna wire to radiate electric waves.

A traveling wave and a reflected wave are nothing more than electric energy currents substantially. However, only the difference between both waves is that directions of both waves are reverse to each other. As both waves are advancing, the phase of each wave is delayed. At points which are λ/4 odd times separate from a receiving terminal, a traveling wave and a reflected wave are in phase and emphasize each other. Conversely, at points which are λ/4 even times separate from a receiving terminal, two waves weaken each other. Such points always stay at the same points. Therefore, such waves are called “Standing Waves”.

Standing points stay on a feeding wire as well (If a load impedance is equal to the Characteristic Impedance of a feeder, a reflected wave does not exist.). SWR (standing wave ratio) is used to indicate the state of a standing wave.
When SWR is indicated by the ratio of the maximum voltage to the minimum voltage of a standing wave, VSWR is used especially as a unit of SWR.
SWR usually used is obtained from the following formula by measuring a traveling wave and a reflected wave with CM type power meter.

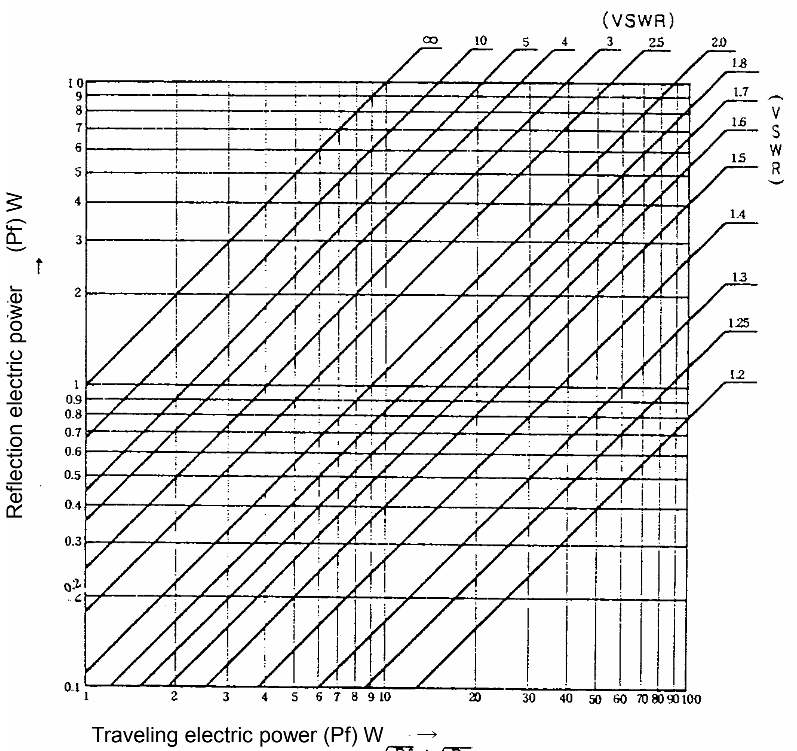
$$SWR = \frac{\sqrt{Pf} + \sqrt{Pr}}{\sqrt{Pf} - \sqrt{Pr}}$$

Pf: Traveling wave

Pr: Reflected wave

The case of SWR = 1 is referred to as being full matched. If there are some standing waves, the SWR is more than one (1). If the value of SWR is large, a feeder loss is large as well. Therefore, SWR should be as small as possible.

Traveling electric power – Reflected electric power - VSWR conversion diagram



$$VSWR = \frac{\sqrt{Pf} + \sqrt{Pr}}{\sqrt{Pf} - \sqrt{Pr}}$$

11. Marine Cables

Marine Cables for power and signal /communication used in Japan should comply with JIS C 3410 (2010). JIS C 3410 (2010) is compiled based on the following IEC standards relevant to marine cables. In 2004, JIS C 3410 was reviewed periodically, and the latest version of JIS C 3410 is 1999-revised one. For High frequency signal, cables compatible with US Military specification MIL-C-17 (or the Defense Ministry specification DSP C 3102 in Japan) ,such as RG(Radio Guide) cable, are normally used. Marine Cables for power and signal /communication (telephone) use is specified in Regulation 45 (Precautions against shock, fire and other hazards of electrical origin), 5.2 (SOLAS II-1, Part D, Electrical installations), Regulation 45 requires that all cables are flame retardant, and it is specified that installation of cables should be flame-retardant. However, the Administration permits that high frequency cables, such as RG cables, are installed onboard ships.

IEC 60092-351 : 2004	Electrical installations in ships-part 351:Insulating materials for shipboard and offshore units,power,control,instrumentation,telecommunication and data cables
IEC60092-353 : 1995	Electrical installations in ships-part 353:Single and multicore non-radial field power cables with extruded solid insulation for rated voltage 1kV and 3kV and Amendment 1:2001
IEC60092-354 : 2003	Iecctrical installations in ships-part 354:Single and three-core power cables with extruded solid insulation for rated voltage 6kV(*U*m=7.2kV) up to 30kV(*U*m=36kV)
IEC60092-359 : 1987	Electrical installations in ships-part 359:Sheathing materials for shipboard power and telecommunication cables,Amendment 1:1994 and Amendment 2:1999
IEC60092-376 : 2003	Electrical installations in ships-part 376:Cables for control and instrumentation circuits 150/250V (300V)

11-1 Cable Type and Use

11-1-1 Cable Type, Use and Flare retardant（Power, Signal, Flare retardant）

Regarding Cable type, there are two types, such as power and signal/ communication use, and 0.6/1.0kV EP (ethylene-propylene) rubber insulated, PVC(Polyvinyl Chloride)sheathed and steel wire braided cable is used for power use, and 250V EP (ethylene-propylene) rubber insulated, PVC(Polyvinyl Chloride)sheathed and steel wire braided cable is used for signal/ communication use. As aforementioned, all cables except for high frequency cables, shall be flame-resistant. In particular for flame retardant cables, symbol "FA" denoting flame retardant is added to the head of cable symbol (FA –DPYC -120) . (Refer to table 3)

Note : FA ： Initial letter "F" of Flame Retardant and, as Flame Retardant falls in IEC60332-3 Category "A", F and A is combined. Cable meeting IEC60332-1 is called "flame resistant" and any Symbol is not assigned.

11-1-2 Cables for signal/ communication (pair-twisted, multicore)

For signal not susceptible to interference (pilot lamp, alarm (contact signal etc.), multicore cable is used. For communication (telephone) and instrumentation/control (digital signal etc.) susceptible to interference, pair-twisted cable (i.e. TTYC) is used as it is noise-resistant. Furthermore, for signal highly susceptible to interference, shielded cable is used. There are two types of shielded cable, and the one is that whole conductors or pairs are common-shielded and the other one is that each conductor or each twisted pair is individually shielded. For the whole shield, the symbol "S" is added to the end of cable symbol (i.e. TTYCS), and for individual shield, the symbol "- S" is added to the end of cable symbol (i.e. TTYC-S). (Refer to table-2 symbol in column "Other").

11-1-3 High Frequency cables

This type of cables is used in particular for Radio communication signal transmission. It is called RG (Radio Guide) cable and specified by US Military Specification MIL-C-17(or The Defense Ministry specification DSP C 3102). In addition, there are other types of high frequency cables (i.e. 3C-2V etc.) which are specified by JIS C 3501. As to RG cable, RG-10 or RG-12 cables are often used.

11-1-4 Others

Nowadays, LAN cable is often used for intercommunication between systems onboard ships. Normally, for LAN cable onboard ships, steel-wire-braided armored LAN cable is used. Additionally, cable(s) prepared by a manufacturer for the specific purpose is used.

11-2 Cable symbol

Cable symbols and use for JIS C 3410 （2010 version） are shown below.

Table 1

Symbols for number of cores and use			
FA	Flame retardant	F	Four cores, Lighting and power
FR	Fire retardant	M	Multicore, control and signal
S	Single core, Lighting and power	TT	Telecommunication and instrumentation
D	Double cores, Lighting and power	P	Portable or flexible
T	Three cores, Lighting and power		

Note: Generally any cable except flame retardant type cable is flame resistant cable (except for flexible cables).

Table 2

Symbol for constituents									
insulation		Outer covering		Armoring*2		Protective covering *3		Others	
P	EP rubber	Y	PVC sheath	C	Steel wire braid	Y	PVC protective covering	-S	Each core or pair shield
SR	Silicone rubber	L	Lead sheath					SLA	Each core shield (Plastic tape with the aluminum foil)
Y	PVC	N	PCP sheath	CB	Copper alloy wire braid			-SLA	Each pair shield (Plastic tape with the aluminum foil)
C	Flame retardant XLPE							E	Earth wire

Legend 1: The nominal voltage 0.6/1kV of cable means the following:
Legend is the rated power-frequency voltage between conductor and earth or metallic screen, for which the cable is designed.
1 kV is the rated power- frequency voltage between conductors for which the cable is designed.

Legend 2: EP means ethylene-propylene.

Legend 3: PVC means Polyvinyl Chloride.

Note 1: 0.6/1.0 kV is assigned for lighting and power use. 250V is assigned for communication / instrumentation/ control use.

Note 2: As for material for wire braided arming, in the case of steel wire braided cable, symbol "C" is used, and in the case of copper alloyed wire braided cable, symbol "CB" is used.

Note 3: Insulation symbol for SPY (PVC insulated wires for controlling machines and apparatus) and for SCP (Flame retardant cross-linked poly ethylene (XLPE) insulated flexible switchboard wire) is not indicated on cable symbol.

Note 4: Asbestos insulated flexible switchboard wire is revoked and 0.6/1 kV SCP (Flame retardant cross-linked poly ethylene (XLPE) insulated flexible switchboard wire) is newly specified.

Note 5: For PVC protective covering cable, protective covering symbol(Y) is added to the end of cable symbol (MPYCY) (refer to table 3)

Note 6: Cable symbol for lighting and power is based on number of conductor and nominal sectional area of conductor. Cable symbol for multicore is based on number of conductors, and twisted -pair cable symbol is based on number of pairs.

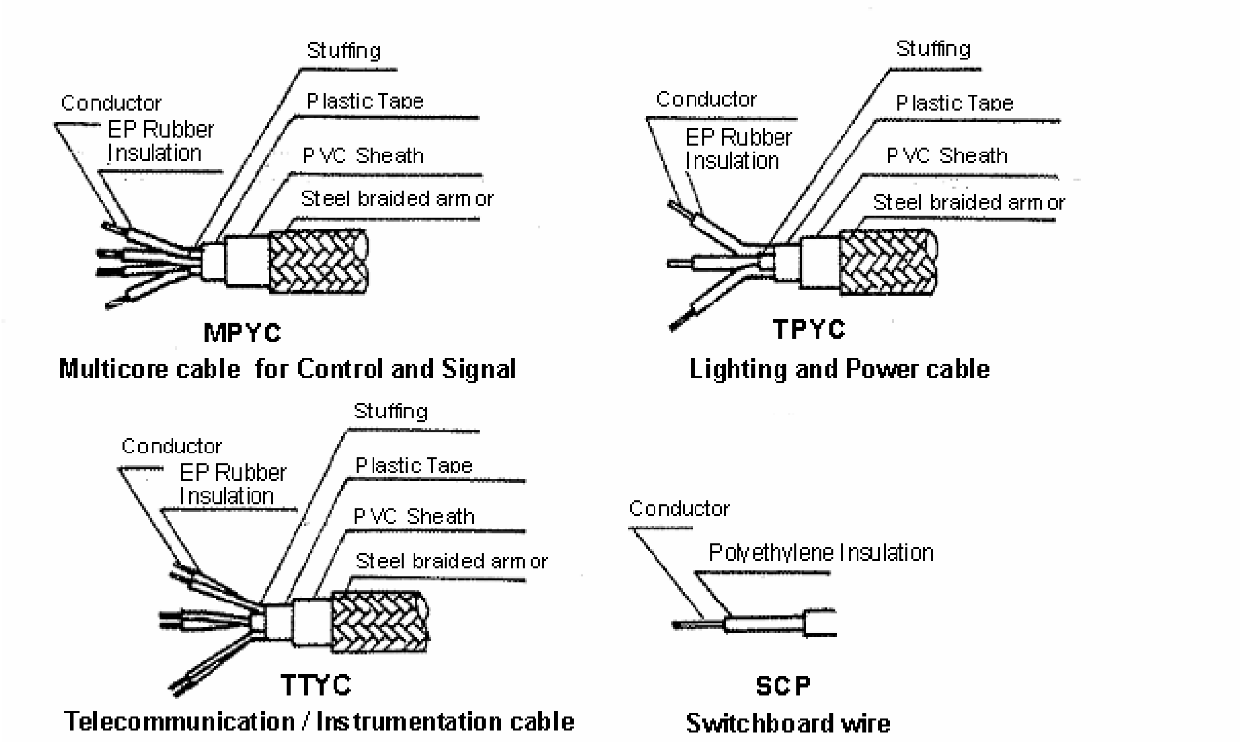
Cable symbol — Table 3

Voltage	Symbol for cable	Type of cable	Sectional area / Number of cores / Number of pairs
0.6/1 kV	DPY-120	Double core, EP rubber insulated and PVC sheathed cable	120 mm^2
	DPYC-120	Double core, EP rubber insulated, PVC sheathed and steel wire braided cable	
	DPYCY-120	Double core, EP rubber insulated, PVC sheathed and steel wire braided cable with PVC protective covering.	
	FA-DPY-120	Double core, EP rubber insulated and PVC sheathed flame retardant cable	
	FA-DPYC-120	Double core, EP rubber insulated, PVC sheathed and steel wire braided flame retardant cable	
	FA-DPYCY-120	Double core, EP rubber insulated, PVC sheathed and steel wire braided flame retardant cable with PVC protective covering.	
	"S" added to symbol means "with common shield".		
250V	MPY-12	Multicore, EP rubber insulated and PVC sheathed cable	12 cores
	MPYC-12	Multicore, EP rubber insulated, PVC sheathed and steel wire braided cable	
	MPYCY-12	Multicore, EP rubber insulated, PVC sheathed and steel wire braided cable with PVC protective covering.	
	FA-MPY-12	Multicore, EP rubber insulated and PVC sheathed flame retardant cable	
	FA-MPYC-12	Multicore, EP rubber insulated, PVC sheathed and steel wire braided flame retardant cable	
	FA- MPYCY-12	Multicore, EP rubber insulated, PVC sheathed and steel wire braided flame retardant cable with PVC protective covering.	
	"S" added to symbol means "with common shield". "-S" added to symbol means "with individual shield".		

250V	TTY-3	Twisted pair, PVC insulated and PVC sheathed telephone cable	3 pairs
	TTYC-3	Twisted pair, PVC insulated, PVC sheathed and steel wire braided telephone cable	
	TTYCY-3	Twisted pair, PVC insulated, PVC sheathed and steel wire braided telephone cable with PVC protective covering.	
	FA- TTY-3	Twisted pair, PVC insulated and PVC sheathed flame retardant telephone cable	
	FA- TTYC-3	Twisted pair, PVC insulated, PVC sheathed and steel wire braided flame retardant telephone cable	
	FA- TTYCY-3	Twisted pair, PVC insulated, PVC sheathed and steel wire braided flame retardant telephone cable with PVC protective covering.	
	"S" added to symbol means "with common shield". "-S" added to symbol means "with individual shield".		
0.6/1 kV	D(T,F)PNP	2(3,4) core, EP rubber insulated and polychloroprene (PCP) sheathed flexible cord	2(3,4) cores
	SCP	Single core, flame retardant cross-linked polyethylene (XLPE) insulated flexible switchboard wire	1core (1.5-95 mm^2)
	SYP	PVC insulated wires for controlling machines and apparatus	1core (0.75-16 mm^2)

11-3 Layer of cable

As marine cables may be mechanically damaged during cable installation or gas cutting/welding or welding, etc. steel or copper alloy wire braided armored cable are normally installed except flexible cord etc.). Cable layer of cables which are normally used are shown drawing 1 below.



Drawing 1 Cable layer

11-4 Characteristics of cables

Characteristics of cables which are normally installed are summarized below.

11-4-1 Lighting and power cable

cited from JJIS C 3410(1999) table 1,2,3 Table 4

0.6/1kV EP rubber insulated, PVC sheathed and steel wire braided cable
SPYC, DPYC, TPYC

0.6/1Kv EP rubber insulated, PVC sheathed and steel wire braided cable with PVC protective covering
SPYCY, DPYCY, TPYCY

No. of core	Conductor		Nominal overall diameter mm		Approximate weight Kg/10m	
	Nominal sectional area mm^2	No. of wire /Diameter	SPYC	SPYCY	SPYC	SPYCY
			DPYC	DPYCY	DPYC	DPYCY
			TPYC	TPYCY	TPYC	TPYCY
1	1.5	7/0.52	7.2	9.0	1	1.35
	2.5	7/0.67	7.6	9.4	1.2	1.5
	4	7/0.85	8.2	10.0	1.4	1.75
2	1.5	7/0.52	11.7	13.7	2.05	2.6
	2.5	7/0.67	12.8	14.8	2.5	3.1
	4	7/0.85	13.9	15.9	3.0	3.65
3	1.5	7/0.52	12.5	14.5	2.45	3.0
	2.5	7/0.67	13.5	15.5	2.95	3.55
	4	7/0.85	14.7	16.9	3.65	4.4

11-4-2 Multicore cable (for pilot lamp and alarm signal)

Table 5

250V EP rubber insulated, PVC sheathed and steel wire braided cable
MPYC

250V EP rubber insulated, PVC sheathed and steel wire braided cable with PVC protective covering
MPYCY

No. of core	Conductor		Nominal overall diameter mm		Approximate weight Kg/10m	
	Nominal sectional area mm^2	No. of wire /Diameter	MPYC	MPYCY	MPYC	MPYCY
2	1	7/0.43	10.0	12.0	1.55	2.05
4			11.2	13.2	2.05	2.6
7			13.2	15.2	2.90	3.5
12			16.8	19.0	4.45	5.3
19			19.6	22.0	6.15	7.2
27			23.4	26.0	8.40	9.8
37			26.1	28.9	10.7	12.4
44			29.3	32.1	12.9	14.7

cited from JIS C 3410(1999) table 8

11-4-3 Twisted pair cable (for communication, instrumentation and control)

Table 6

250V EP rubber insulated, PVC sheathed and steel wire braided cable
TTYC

250V EP rubber insulated, PVC sheathed and steel wire braided cable with PVC protective covering
TTYCY

No. of pair	No. of core	Conductor		Nominal overall diameter mm		Approximate weight Kg/10m	
		Nominal sectional area mm^2	No. of wire /Diameter	TTYC	TTYCY	TTYC	TTYCY
1	2	0.75	7/0.37	9.2	11.0	1.3	1.7
1T	3			9.9	11.7	1.55	2.05
1Q	4			10.6	12.6	1.8	2.3
4	8			15.5	17.7	3.2	4.0
7	14			18.2	20.6	4.4	5.45
10	20			23.0	25.6	6.4	7.75
14	24			24.8	27.4	7.7	9.2
19	38			27.7	30.5	9.65	11.4
24	48			33.7	36.7	13.8	16.1
30	60			35.8	39.2	15.9	18.6
37	74			38.7	42.3	18.6	21.7
48	96			44.6		23.8	27.6

cited from JIS C 3410(1999) table 11

11-5 Maximum rated conductor temperature

Table 7

Type of Insulation	EP rubber	Silicone rubber	PVC		Flame retardant XLPE
Maximum rated Conductor temperature ℃	85	95	60	75	85

E

11-6 Current rating of EP rubber insulated cable

First 10 items of Nominal Sectional area 1.5-300mm^2 are shown here. Current is shown at continuous rating.

Table 8

Nominal sectional area mm^2	Single core (d.c.)			Double core (a.c., d.c.)			Three core (a.c., d.c.)		
	Ambient temperature			Ambient temperature			Ambient temperature		
	40℃ A	45℃ A	50℃ A	40℃ A	45℃ A	50℃ A	40℃ A	45℃ A	50℃ A
1.5	21	20	19	18	17	16	15	14	13
2.5	30	28	26	25	24	23	21	20	19
4	42	38	36	34	32	31	28	27	26
6	51	48	45	43	41	39	36	34	32
10	71	67	63	60	57	55	50	47	45

Remarks 1. The values given above are for 6 cables or less bunched or laid together. When more than 6 cables are bunched or laid together, correction factor 0.85 should be applied to the values given above.

2. Frequency is 60Hz in the case of A.C.

cited from JIS C 3410(1999) informative reference table 1

11-7 Current rating of EP rubber insulated and PCP sheathed flexible cord

Table 9

Nominal sectional area mm^2	Double core			Three core			Four core		
	Ambient temperature			Ambient temperature			Ambient temperature		
	40℃ A	45℃ A	50℃ A	40℃ A	45℃ A	50℃ A	40℃ A	45℃ A	50℃ A
0.75	12	11	10	10	9	8	10	9	8
1	15	14	13	12	11	11	12	11	11
1.5	18	17	16	15	14	13	15	14	13
2.5	25	24	23	21	20	19	21	20	19
4	34	32	31	28	27	26	28	27	26
6	43	41	39	36	34	32	36	34	32

Remarks: Frequency is 60Hz in the case of A.C.

cited from JIS C 3410(1999) informative reference table 4

11-8 Maximum Length of cable

11-8-1 DC and 2 phase AC.

$$\text{Simplified formula} = \frac{1000 \times e \times A}{35.6 \times I} \quad \text{(m)}$$

e = Voltage drop 5% (V)

I = current (A)

A = conductor nominal sectional area (mm^2)

Example

Table 10

Cable→	1.25 mm^2		2.0 mm^2		3.5 mm^2		5.5 mm^2	
Voltage(V)→	24	100	24	100	24	100	24	100
Current(A)								
2	21	87	33	140	58	254	92	386
4	10	44	16	70	29	122	46	193
6	7	29	11	46	19	81	30	128
20			3.3	14	5.8	24	9.2	38
30					3.9	16	6.1	25

11-8-2 AC 3 phase / 3 cable method

Simplified formula $== \dfrac{1000 \times e \times A}{35.6 \times I}$ x $\dfrac{\sqrt{3}}{3}$ (m)

E

12. High Frequency Cable

12-1 RG Type High Frequency Coaxial cable

Symbol for cable	Cpacitance μμF/m	Characteristic impedance Z_0 Ω	Attenuation Rating dB/km			Wavelength compression rate %	Inner conductor m/m	Insulation material	Outer Braided screen	Protective covering	Outer cover	Outer diameter m/m	Remarks
			30 MHz	200 MHz	2,000 MHz								
RG-5/U	93	52.5	47	135	550	67	1.3	PE	CC	PVC		8.4	
RG-6/U	66	76	48	138	560	67	0.72CW	PE	SC	PVC		8.4	
RG-8/U	97	52	35	105	450	67	7/0.72	PE	C	PVC		10.3	
RG-8A/U	97	50	-	-	-	67	7/0.72	PE	C	PVC		10.3	General use
RG-9/U	98	51	35	102	440	67	7/0.72S	PE	SC	PVC		10.7	
RG-9A/U	98	51	40	111	510	67	7/0.72S	PE	SS	PVC		10.7	10,000MHz band use
RG-10/U	97	52	35	105	450	67	7/0.72	PE	C	PVC	yes	12.0	8/U with cover
RG-10A/U	97	50	-	-	-	67	7/0.72	PE	C	PVC	yes	12.0	8A/U with cover
RG-11/U	67	75	36	110	460	67	7/0.40T	PE	C	PVC		10.3	
RG-11A/U	67	75	-	-	-	67	7/0.42T	PE	C	PVC		10.3	for video transfer
RG-12/U	67	75	36	110	460	67	7/0.40T	PE	C	PVC	yes	12.0	11/U with cover
RG-12A/U	67	75	-	-	-	67	7/0.42T	PE	C	PVC	yes	12.0	11A/U with cover
RG-13/U	67	74	36	110	460	67	7/0.40T	PE	CC	PVC		10.7	
RG-13A/U	67	75	-	-	-	67	7/0.42T	PE	C	PVC		10.7	for video transfer
RG-14/U	97	52	25	75	340	67	2.6	PE	CC	PVC		13.8	
RG-14A/U	97	50	-	-	-	67	2.6	PE	C	PVC		13.8	Medium power
RG-17/U	97	52	15	48	250	67	4.8	PE	C	PVC		22.1	
RG-18/U	97	52	15	48	250	67	4.8	PE	C	PVC	yes	24.0	17/U with cover
RG-19/U	97	52	11	38	210	67	6.4	PE	C	PVC		28.5	
RG-20/U	97	52	11	38	210	67	6.4	PE	C	PVC	yes	30.3	19/U with cover
RG-21/U	95	53	250	660	2200	67	1.3N	PE	SS	PVC		8.4	for attenuation
RG-22/U	53	95	56	174	-	67	7/0.39x2wire	PE	T	PVC		10.3	symmetrical
RG-22A/U	53	95	56	174	-	67	7/0.39x2wire	PE	TT	PVC		10.7	symmetrical
RG-26A/U	164	48	11 at 1MHz			50	19/0.30T	Rub	T	Chloro	yes	12.8	for pulse
RG-27/U	164	48	6.5 at 1MHz				19/0.47T	Rub	T	PVC	yes	17.1	For pulse
RG-34/U	71	71	23	68	320	67	7/0.72	PE	C	PVC		15.9	
RG-35/U	71	71	15	48	250	67	2.9	PE	C	PVC	yes	23.8	
RG-55/U	94	53.5	72	195	750	67	0.81	PE	TT	PVC		5.2	
RG-57/U	56	95	50	160	-	67	7/0.72x2 wire	PE	T	PVC		15.8	symmetrical
RG-58/U	94	53.5	75	200	830	67	0.81	PE	T	PVC		5.0	
RG-58A/U	94	52	81	230	900	67	19/0.17T	PE	T	PVC		5.0	
RG-59/U	69	73	60	170	690	67	0.64CW	PE	C	PVC		6.2	
RG-62/U	44	93	45	125	440	84	0.64CW	PE	C	PVC		6.2	for small data
RG-63/U	33	125	31	88	330	84	0.64CW	PE	C	PVC		10.3	for small data
RG-65/U	144	950	500 at 5MHz			67	0.2F	PE	C	PVC		10.3	for delay
RG-74/U	97	52	25	75	340	67	2.6	PE	CC	PVC	yes	15.6	14/U with cover
RG-79/U	33	125	31	88	330	84	0.64CW	PE	C	PVC	yes	15.6	63/U with cover
RG-84/U	71	71	15	48	250	67	2.9	PE	C	PVC	yes	25.4	35/U with cover
RG-85/U	71	71	15	48	250	67	2.9	PE	C	PVC	yes	40	84/U with cover
RG-86/U	26	200	16	53	-	73	7/0.72 x2 wire	PE	-	-		16.5x7.2	symmetrical
RG-111/U	53	95	56	174	-	67	7/0.39x2 wire	PE	TT	PVC		42.5	22A/U with cover
RG-115/U	97	50	36	105	370	72	7/0.72 x2S	Tef	SS	F.G		9.4	for heat resistant

Symbols in table

PE : polyethylene, Rub : synthetic rubber, Tef : Teflon (polytetrafluorethylene), C :single annealed copper wire braided sheath with lead cover, CC : double annealed copper braided sheath, CL : single annealed copper braided sheath with lead cover, S : silver plated annealed copper wire, T : tinned annealed copper wire, CW : copper welded (or cladded) steel wire, N : Nichrome wire, PVC: Polyvinyl Chloride, Chloro : chloroprene (neoprene), F.G : fiber glass

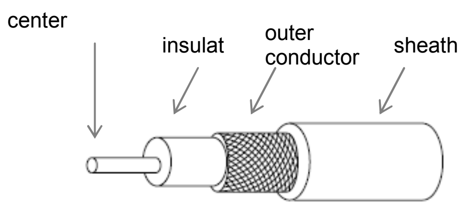
12-2 Symbol for RG cable

RG type high frequency coaxial cables are specified by US military specification “MIL-C-17 (or the Defense Ministry specification (DSP C 3102) in Japan).

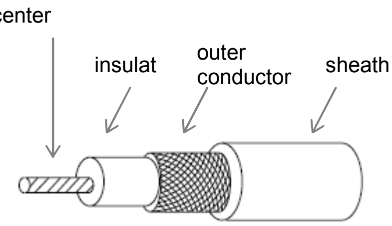
RG － □□□ □ ／ U

- U → Use (Universal)
- □ → Revision number（A, B, C …..）
- □□□ → Serial number
- RG → Category（Radio Guide）

General layer of RG Cable



Single solid center conductor



Twisted center conductor

12-3 Cables for High frequency use except RG Cable

Symbol for cable	Cpacitance μμF/m	Characteristic impedance Z_0 Ω	Attenuation Rating dB/km			Wavelength compression rate %	Inner conductor m/m	Insulation material	Outer Braided screen	Protective covering	Outer cover	Outer diameter m/m	Remarks
			30 MHz	200 MHz	2,000 MHz								
3C-2V	67	75		200		67	0.5T	PE	C	PVC		5.8	
3C-2Z	67	75		200		67	0.5T	PE	C			3.8	
5C-2L	67	75		135		67	0.8T	PE	CL	PVC		9.9	
5C-2W	67	75		135		67	0.8T	PE	CL	PVC		8.2	
5C-2V	67	75		135		67	0.8T	PE	C	PVC		7.5	
5C-2Z	67	75		135		67	0.8T	PE	C			5.5	
7C-2V	67	75		100		67	7/1.2T	PE	C	PVC		10.2	Similar to RG-12AU
10C-2V	67	75		85		67	7/1.5T	PE	C	PVC		13.4	
5D-2V	100	50		131		67	0.8T	PE	C	PVC		7.5	
8D-2V	100	50		95		67	7/2.4T	PE	C	PVC		11.5	

Cables for High frequency use except RG Cable specified by JIS C 3501 are shown.

Symbol for Cables for High frequency use except RG Cable

3 C 2 V

- First number : Inner diameter of outer conductor (mm)
- Second symbol : C : Z_0 = 75Ω, D : Z_0 = 50Ω,
- Third symbol : Insulation、 2: polyethylene filled
- Last symbol : V : single outer conductor + PVC covering
  L : single outer conductor + lead covering +PVC covering
  W: double outer conductor+ PVC covering
  Z : single outer conductor (without PVC covering)

PVC covering parallel feeder

Purpose	Conductor	Gap between conductors	Characteristics Impedance	Wavelength compress coefficient %
Feeder cable for TV	7 x 0.29 m/m	abt 9 m/m	300Ω ± 15	85
200Ω Feeder	7 x 0.70 m/m	abt 17 m/m	200Ω ± 10	75
150Ω Feeder		abt 6 m/m	140Ω ± 10	75

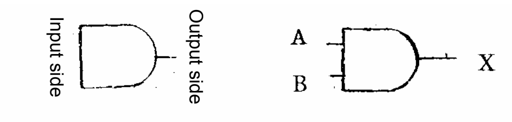
13. Logic Circuit IC

The basic element of logical circuits is as follows.

- Gate circuit (AND, NOT, OR, Exclusive OR)
- Memory circuit (Flip-Flop)

13-1 AND Circuit

The example of an AND sign and 2 input AND



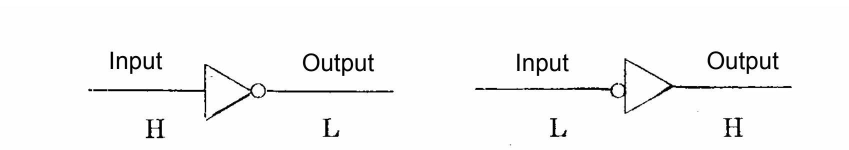
Only when all the inputs are H that an output is set to H.

Truth table of 2 input AND

Input		Output
A	B	X
L	L	L
L	H	L
H	L	L
H	H	H

13-2 NOT Circuit

Since the reversed state of an input is obtained through this circuit, it is also called “INVERTER”.



As shown in the figures above, a mark “O” means that a signal is reversed (NOT).

This mark “O” is not used independently of others but used together with logic input or output.

13-3 OR Circuit

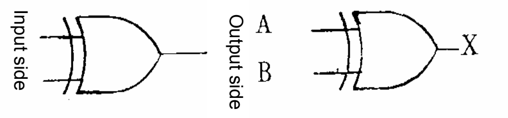
The example of OR sign and 2 input OR

Input		Output
A	B	X
L	L	L
L	H	H
H	L	H
H	H	H

Only when at least one of inputs is H, output is H.

13-4 EXCLUSIVE OR Circuit

Example of a symbol of an Exclusive OR and 2 input Exclusive OR



Truth Table

Input		Output
A	B	X
L	L	L
L	H	H
H	L	H
H	H	L

Only when all the inputs are L or H, output is L.

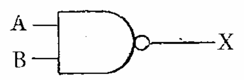
This point different from OR circuit.

13-5 NAND, NOR Circuit

NAND is combined together with AND and NOT.

NOR is combined together with NOT and OR.

NAND

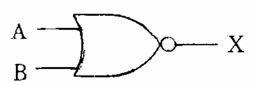


Truth Table

Input		Output
A	B	X
L	L	H
L	H	H
H	L	H
H	H	L

When all the inputs are H, an output is L.

NOR

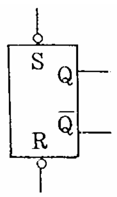


Input		Output
A	B	X
L	L	H
L	H	L
H	L	L
H	H	L

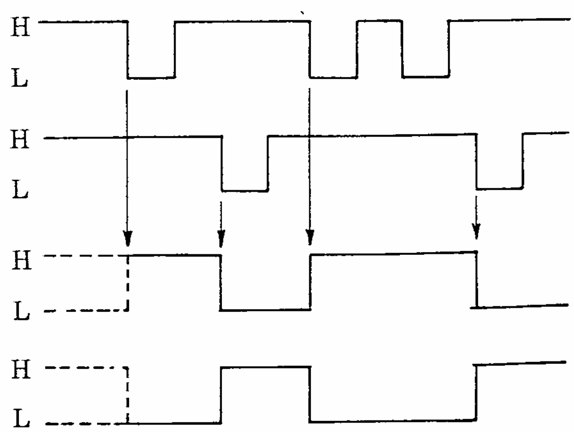
Only when at least one of inputs is H, an output is L .

13-6 Flip-flop Circuit

13-6-1 R-S Flip-Flop (R-S is the abbreviation for Reset-Set).

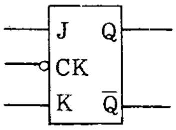


R	S	Q	$\overline{Q}$
L	L	*	*
L	H	L	H
H	L	H	L
H	H	Q_0	$\overline{Q_0}$



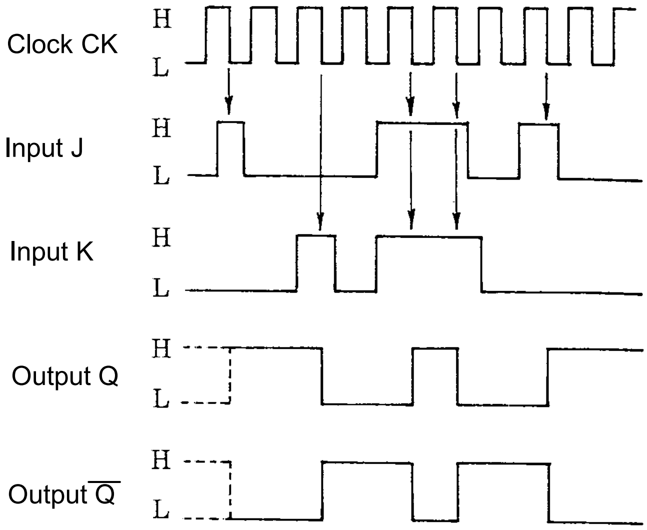
Q_0, $\overline{Q_0}$

13-6-2 J-K Flip-Flop

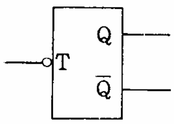


Input			Output	
CK	J	K	Q	$\overline{Q}$
↓	L	L	Q_0	$\overline{Q}_0$
↓	L	H	L	H
↓	H	L	H	L
↓	H	H	Q'_0	$\overline{Q}'_0$
H	*	*	Q_0	$\overline{Q}_0$

Q_0, $\overline{Q}_0$: The previous state is held.
Q'_0, $\overline{Q}_0$: The previous state is reversed.
* :H or L
↓ : Falling

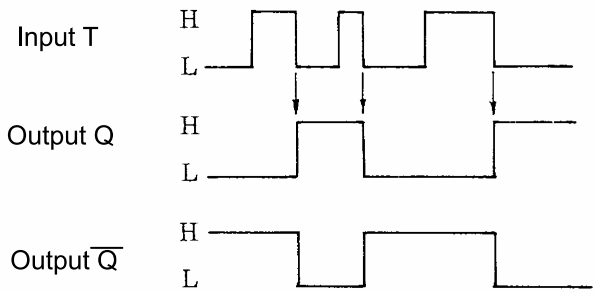


13-6-3 T type Flip-Flop (Trigger Flip-Flop)

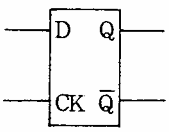


Input	Output	
T	Q	$\overline{Q}$
↓	Q'_0	$\overline{Q}'_0$
L	Q_0	$\overline{Q}_0$
H	Q_0	$\overline{Q}_0$

Q_0, $\overline{Q}_0$: The previous state is held.
Q'_0, $\overline{Q}_0$: The previous state is reversed.

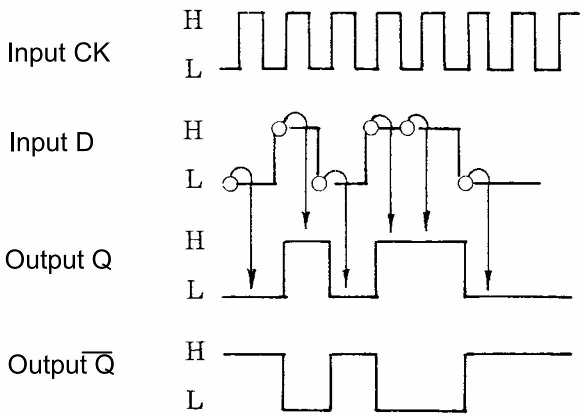


13-6-4 D type Flip-Flop (Delayed Flip-Flop)



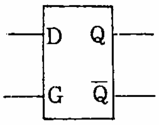
Input		Output	
CK	D	Q	$\overline{Q}$
↑	L	L	H
↑	H	H	L
L	*	Q_0	$\overline{Q}_0$

* :H or L
Q_0, $\overline{Q}_0$: The previous state is held.



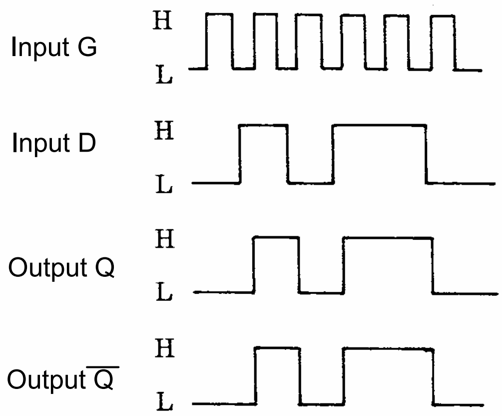
13-7 Latch Circuit

This logic circuit is requisite for microcomputers to store data for a certain period.



Input		Output	
G	D	Q	$\overline{Q}$
H	L	L	H
H	H	H	L
L	*	Q_0	$\overline{Q_0}$

Q_0, $\overline{Q_0}$: The previous state is held.
* :H or L



13-8 Decoder

Binary-coded information inputted into a decoder are decoded and its output are determined.
It is used well as a chip selector for selection of ROM and RAM,

13-9 Buffer

It does not reverse inputs unlike inverters.
Since only up to 10 gates cannot be connected to a terminal of In standard TTC-IC. Therefore, a buffer is used for connecting more than 10 gates.

13-10 Tristate Buffer

Tri means “3” in Latin and a tristate is a kind of buffer which has three states.
Three-state corresponds to H, L and High impedance.

13-11 Application of Flip-Flop Circuit

13-11-1 Counter

A counter counts the number of pulses coming in. Normally, a counter means an up-counter, but there is also an up-down counter which counts down from the number set to a certain number.

13-11-2 Ripple counter (asynchronous counter)

Composition is simple.
Time-delay occurs.

13-11-3 Synchronous counter

Since it operates simultaneously with clock input, time-delay does not occur.

13-11-4 Shift register

It is used for conversion between parallel data and serial data.
There are functions of storing data into a memory and time-delaying data otherwise.

14. Conversion Table for Various Units

1.Speed

	second[m/s]	hour[km/h]	knot [kn]	mile [mph]	foot [fps]
m/s	1	3.6	1.9438	2.2369	3.2808
km/s	0.27778	1	0.53996	0.62137	0.91134
kn	0.51444	1.852	1	1.1508	1.6878
mph	0.44704	1.609344	0.8689	1	1.4667
fps	0.3048	1.09728	0.59248	0.68181	1

2.Length

	尺 [syaku]	間 [ken]	meter [m]	inch [in]	foot [ft]	yard [yd]	n-mile[nm]
syaku	1	0.166667	0.30303	11.9303	0.994194	0.3314	0.000164
ken	6	1	1.81818	71.5819	5.96516	1.98839	0.000982
m	3.3	0.55	1	39.3701	3.28084	1.09361	0.00054
in	0.08382	0.01397	0.0254	1	0.08333	0.02778	0.000014
ft	1.00584	0.16764	0.3048	12	1	0.33333	0.000165
yd	3.01752	0.50292	0.9144	36	3	1	0.000494
nm	6112	1019	1852	7.29x10^4	6076	2025	1

3.Weigth

	貫 [kan]	斤 [kin]	gram [g]	UK ton [t]	USA ton [t]	ounce [oz]	pound [lb]
kan	1	6.25	3750	0.003691	0.004134	132.277	8.26733
kin	0.16	1	600	0.000591	0.000661	21.1644	1.32277
g	0.000267	0.001667	1	0.00000098	0.0000011	0.035274	0.0022046
Ukt	262.4543	1640.339	1016050	1	1.12	35840	2240
USAt	241.916	1511.975	907185	0.892857	1	32000	2000
oz	0.007569	0.047249	28.3495	0.000028	0.000031	1	0.0625
lb	0.120958	0.755987	453.5924	0.000446	0.0005	16	1

4.Area

	坪 [tsubo]	反 [tan]	町 [cyo]	meter [m^2]	are [a]	SQ mile	SQ acre
tsubo	1	0.003333	0.000333	3.305785	0.033058	0.000001	0.000817
tan	300	1	0.1	991.736	9.91736	0.000383	0.245063
cyo	3000	10	1	9917.36	99.1736	0.003828	2.450631
m^2	0.3025	0.001008	0.000101	1	0.01	0.0000004	0.000247
are	30.25	0.100833	0.010083	100	1	0.000039	0.02471
SQ mi	783471.4	2611.571	261.157	2589988	25899.88	1	640
SQ ac	1224.174	4.080578	0.408058	4046.855	40.46855	0.001562	1

5.Cubic Content

	合 [gou]	centi-m[cm^3]	litre [l]	UK gallon	USA gallon	inch[in3]	barrel
gou	1	180.39	0.18039	0.03968	0.04765	11.01	0.001135
cm3	0.00554	1	0.001	0.00022	0.00026	0.06102	0.000006
le	5.5435	1000	1	0.21997	0.26417	61.024	0.00629
UKgal	25.2	4546.09	4.54609	1	1.20095	277.42	0.028594
USAgal	20.98	3785.41	3.78541	0.833	1	231	0.02381
in3	0.0908	16.3871	0.01639	0.0036	0.0043	1	0.000103
Barr.	881.3482	158987	158.987	34.97225	41.99994	9701.961	1

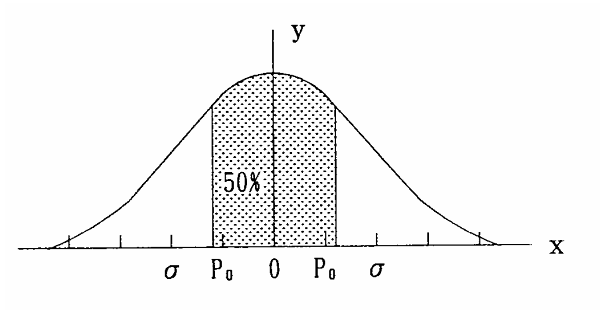
6.Temperature

F:Fahrenheit >> C:Centigrade ≒ (F° −30) * 1/2

C:Centigrade >> F:Fahrenheit ≒ 2C° + 30

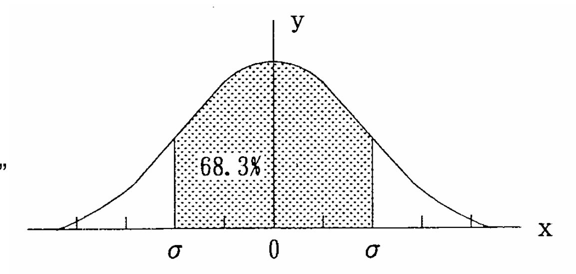
15. Method of Error Expression

15-1 Probable Error



When measured data have a normal distribution and a half of these data are distributed within a deviation from the mean of a normal distribution, the value of a deviation is called “probable error”. In the graph below, the value of “P_0” indicates “**Probable Error**”.

15-2 One Sigma Error



When measured data have a normal distribution and 68.3% of these data are distributed within a deviation from the mean of a normal distribution, the value of the deviation is called “**One Sigma Error**” In the graph below, the value of “σ ” indicates “**One Sigma Error**”.

15-3 Two Sigma Error

In the paragraph 5.2 above, when the value is 95.4% instead of 68.3%, the value of 2 σ is called “**Two Sigma Error**”.

15-4 RMS (Root Mean Square) Error

Each measured value (m_1, m_2, --m_n) and an average value (X_0) is compared, and a value obtained from a formula “$1/n \{(m_l - X_0)^2+(m_2 - X_0)^2+ .... + (m_n - X_0^2\}$ “(dispersion) is “Mean Square Error” and the square root of that value is RMS. When measred data have a normal distribution and the number of data is large, a mean value (X_0) is close to a true value “X”, and at this time, RMS is also close to “1 σ ”.

15-5 CEP (Circular Error Probable)

When a half of measured data are expected to be included within a circle of a radius centered about the mean, the value of this radious is called “CEP”.

15-6 SEP (Spherical Error Probable)

When a half of measured data are expected to be included within a sphere of a radius centered about the mean, the value of this radious is called “SEP”.

15-7 DRMS (Distance Root Mean Square)

When at least 68.3 % of position data measured at a point are expected to be included within a circle of a radius centered about the mean, the value of this radious is called “DRMS”. It is also called “rms (σ) radial error”. (63.2 to 68.3%). RMS of the distance from a true position to the measuring point can be calculated.

15-8 TDRMS (Two the distance root mean square)

In the paragraph 4-7 above, when the value is 95.4% instead of "63.8" , the value of this radious is called "TDRMS". The value is equal to twice DRMS and TDRMS is also called "2 σ radial error".

15-9 R_{95} (95% Error Probable)

When 95% of measured data are expected to be included within a circle of a radius centered about the mean, the value of this radious is called "R_{95}". It is considered to be the maximum error.

15-10 RSS (Root-Sum-Square)

When a system error is considered, RSS is used. On each different item such as δ_1, δ_2 .... δ_n, the square of each data is added and then the root of its sum is calculated. This value is "RSS".

$$RSS = \sqrt{\delta_1^2 + \delta_2^2 + \cdots\cdots + \delta_n^2}$$

15-11 GDOP(Geometric Dilution of Precision)

Geometric dilution of accuracy

$$GDOP = \sqrt{\sigma^2xx + \sigma^2yy + \sigma^2zz + c^2\sigma^2tt}/\sigma p$$

σxx = standard deviation of the direction of the east

σyy = standard deviation of the direction of the north

σzz = standard deviation of the direction of the zenith

σtt = standard deviation of time

σp = standard deviation of a false distance

PDOP (Position Dilution Of Precision)

$$= \sqrt{\sigma^2xx + \sigma^2yy + \sigma^2zz}/\sigma p$$

HDOP (Horizontal Dilution Of Precision)

$$= \sqrt{\sigma^2xx + \sigma^2yy}/\sigma p$$

VDOP (Vertical Dilution Of Precision)

$$= \sigma zz / \sigma p$$

TDOP (Time Dilution Of Precision)

$$= c\sigma tt / \sigma p$$

15-12 Predictable(Geodetic or Absolute)Accuracy

Accuracy of a position about the Earth Geodetic Coordinates

15-13 Repeatable Accuracy

Accuracy that a user can return to a position where the user was measured last time.

15-14 Relative Accuracy

Consistency of values which are simultaneously measured by using two or more receivers at the same place.

E

16. Configuration Factor of Antenna

Voltage and current: $dB = 20\log_{10}$ [Amplification ratio or Attenuation ratio]
Electric power: $dB = 10\log_{10}$ [Amplification ratio or Attenuation ratio]

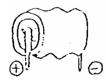
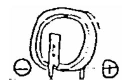
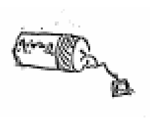
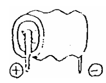
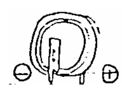
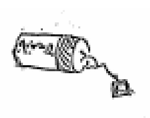
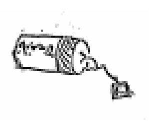
dB		Amplification ratio	Attenuation ratio	dB		Amplification ratio	Attenuation ratio
Voltage and current	Power			Voltage and current	Power		
1	0.5	1.122	0.891	51	25.5	355.	0.00282
2	1.0	1.259	0.794	52	26.0	399.	0.00251
3	1.5	1.413	0.708	53	26.5	447.	0.00224
4	2.0	1.585	0.631	54	27.0	501.	0.00200
5	2.5	1.778	0.562	55	27.5	562.	0.00178
6	3.0	1.995	0.501	56	28.0	631.	0.00158
7	3.5	2.24	0.447	57	28.5	708.	0.00141
8	4.0	2.51	0.398	58	29.0	794.	0.00126
9	4.5	2.82	0.355	59	29.5	891.	0.00112
10	5.0	3.16	0.316	60	30.0	1000.	0.00100
11	5.5	3.55	0.282	61	30.5	1120.	0.000891
12	6.0	3.98	0.251	62	31.0	1260.	0.000794
13	6.5	4.47	0.224	63	31.5	1410.	0.000708
14	7.0	5.01	0.200	64	32.0	1580.	0.000631
15	7.5	5.62	0.178	65	32.5	1780.	0.000562
16	8.0	6.31	0.158	66	33.0	2000.	0.000501
17	8.5	7.08	0.141	67	33.5	2240.	0.000447
18	9.0	7.94	0.126	68	34.0	2510.	0.000398
19	9.5	8.91	0.112	69	34.5	2820.	0.000355
20	10.0	10.0	0.100	70	35.0	3160.	0.000316
21	10.5	11.2	0.0891	71	35.5	3550.	0.000282
22	11.0	12.6	0.0794	72	36.0	3980.	0.000251
23	11.5	14.1	0.0708	73	36.5	4470.	0.000224
24	12.0	15.8	0.0631	74	37.0	5010.	0.000200
25	12.5	17.8	0.0562	75	37.5	5620.	0.000178
26	13.0	20.0	0.0501	76	38.0	6310.	0.000158
27	13.5	22.4	0.0447	77	38.5	7080.	0.000141
28	14.0	25.1	0.0398	78	39.0	7840.	0.000126
29	14.5	28.2	0.0355	79	39.5	8910.	0.000112
30	15.0	31.6	0.0316	80	40.0	10000.	0.000100
31	15.5	35.5	0.0282	81	40.5	11200.	0.0000891
32	16.0	39.8	0.0251	82	41.0	12600.	0.0000794
33	16.5	44.7	0.0224	83	41.5	14100.	0.0000708
34	17.0	50.1	0.0200	84	42.0	15800.	0.0000631
35	17.5	56.2	0.0178	85	42.5	17800.	0.0000562
36	18.0	63.1	0.0158	86	43.0	20000.	0.0000501
37	18.5	70.8	0.0141	87	43.5	22400.	0.0000447
38	19.0	79.4	0.0126	88	44.0	25100.	0.0000398
39	19.5	89.1	0.0112	89	44.5	28200.	0.0000355
40	20.0	100.0	0.0100	90	45.0	31600.	0.0000316
41	20.5	112.0	0.00891	91	45.5	35500.	0.0000282
42	21.0	126.0	0.00794	92	46.0	39800.	0.0000251
43	21.5	141.0	0.00708	93	46.5	44700.	0.0000224
44	22.0	158.0	0.00631	94	47.0	50100.	0.0000200
45	22.5	178.0	0.00562	95	47.5	56200.	0.0000178
46	23.0	200.0	0.00501	96	48.0	63100.	0.0000158
47	23.5	224.0	0.00447	97	48.5	70800.	0.0000141
48	24.0	251.0	0.00398	98	49.0	79400.	0.0000126
49	24.5	282.0	0.00355	99	49.5	89100.	0.0000112
50	25.0	316.0	0.00316	100	50.0	100000.	0.0000100

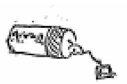
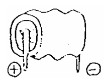
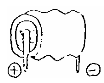
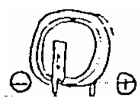
17. Decibel Conversion Table

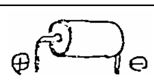
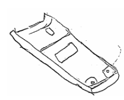
dB	mV／m	dB	mV／m	dB	mV／m
60.0	1.0	75.5	5.953	91.0	35.481
60.5	1.059	76.0	6.310	91.5	37.584
61.0	1.122	76.5	6.683	92.0	39.811
61.5	1.189	77.0	7.079	92.5	42.170
62.0	1.259	77.5	7.499	93.0	44.668
62.5	1.334	78.0	7.943	93.5	47.315
63.0	1.413	78.5	8.414	94.0	50.119
63.5	1.496	79.0	8.912	94.5	53.688
64.0	1.585	79.5	9.441	95.0	56.234
64.5	1.679	80.0	10.0	95.5	59.566
65.0	1.778	80.5	10.593	96.0	63.096
65.5	1.884	81.0	11.220	96.5	66.834
66.0	1.995	81.5	11.885	97.0	70.794
66.5	2.114	82.0	12.589	97.5	74.989
67.0	2.239	82.5	13.335	98.0	79.433
67.5	2.371	83.0	14.125	98.5	84.139
68.0	2.512	83.5	14.962	99.0	89.125
68.5	2.661	84.0	15.849	99.5	94.406
69.0	2.818	84.5	16.788	100.0	100.0
69.5	2.985	85.0	17.783		
70.0	3.162	85.5	18.836		
70.5	3.350	86.0	19.953		
71.0	3.548	86.5	21.135		
71.5	3.758	87.0	22.387		
72.0	3.981	87.5	23.714		
72.5	4.217	88.0	25.119		
73.0	4.467	88.5	26.607		
73.5	4.732	89.0	28.184		
74.0	5.012	89.5	29.854		
74.5	5.309	90.5	31.623		
75.0	5.623	90.5	33.497		

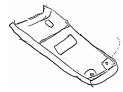
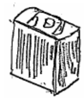
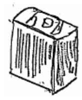
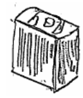
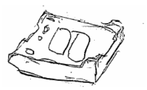
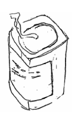
18. Battery List (exclusively used for each Product)

LIST OF JRC BACKUP BATTERY

TYPE	MODEL	MAKER	BATT. MODEL	JRC CODE	SHAPE	SIZE/VALIDITY	REMARKS
MF/HF	JSS-710 LOCAL CONT	Yuasa	3/V80H074763	5ZBRC00003		ϕ15.5×18.0mm	
	JSS-710/720 Rx-CPU 2SET	Panasonic	CR2032	5ZBCJ00012		ϕ20×3.2mm	New
	JSS-710/720 Rx-CPU 2SET	Toshiba	CR2032-THB	5ZBBJ00001 No stock		ϕ20×3..2mm	Old
	JSS-710/720 NDZ-800	Toshiba	17500V-C	5ZBBJ00009 No stock		ϕ17×50mm	
	JSS-800 LOCAL CONT	Yuasa	3/V80H074763	5ZBRC00003		ϕ15.5×18.0mm	
	JSS-800 NCH-801/2		VL2320/1HF	5ZBBD00006 No stock		ϕ23×2.0mm	Secondary
	JSS-800 Rx-CPU 2SET	Panasonic	CR2032	5ZBCJ00012		ϕ20×3.2mm	New
	JSS-800 Rx-CPU 2SET		CR2032-THB	5ZBBJ00001 No stock		ϕ20×3..2mm	Old
	JSS-825 CPU	Panasonic	CR2032	5ZBCJ00012		ϕ20×3.2mm	
	JSS-825 DTE		IVR-2025	5ZBBA00012 No stock		ϕ20×2.5mm	
	JSS-850 HOST/CONT	Toshiba	17500V-C	5ZBBJ00009 No stock		ϕ17×50mm	2 PCS
	JSS-850 DTE	Panasonic	CR2032	5ZBCJ00012		ϕ17×50mm	
	JSS-296 NDZ-127J	Toshiba	17500V-C	5ZBBJ00009 No stock		ϕ17×50mm	NDZ-127J1 type B Not used
	JSS-2150	Not used	EEPROM				
	JSS-2250	Not used	EEPROM				
	JSS-2500	Not used	EEPROM				

TYPE	MODEL	MAKER	BATT. MODEL	JRC CODE	SHAPE	SIZE/VALIDITY	REMARKS
SSB TEL	JSB-78 CPU/TUNE	Panasonic	CR2032-1HS	5ZBAB00047		ϕ20.0×3.2mm	2 PCS
	JSB-110						
	JSB-178						
	JSB-186						
	JSB-210	Panasonic	CR2032	5ZBCJ00012		ϕ20×3.2mm	2 PCS
	JSB-196	Not used					
VHF	JHS-31	Not used					
	JHS-32A/B						
	JHS-33						
	JHS-770/780						
NAVTEX	NCR-300	Not used					
	NCR-330						
	NCR-700						
	NCR-333						
INMRSAT	JUE-300B/345	Not used					
	JUE-310B						
	JUE-410F						
	JUE-33/250						
	JUE-75A/C						
	JUE-85						
	JUE-87						
	JUE-95						
	JUE-250/251	Not used					
	JUE-500/501						
	INM-C DTE	Toshiba	17500V-C	5ZBBJ00009 No stock		ϕ17×50mm	
	INM-B DTE						
INM FAX	JAX-830	Yuasa	3/V80H074763	5ZBRC00003		ϕ15.5×18.0mm	
	JAX-831 CKK-526	Yuasa	2/V80H07545	5ZBRC00002		ϕ15.0×14.0mm	
	JAX-831 CKK-526A/B	Toshiba	IVR2430THE	5ZBBJ00011 No stock		ϕ24.5×3.0mm	
	JAX-831 CKK-526C	Panasonic	VL2330/1HF	5ZBAB00067		ϕ23×30mm	

TYPE	MODEL	MAKER	BATT. MODEL	JRC CODE	SHAPE	SIZE/VALIDITY	REMARKS
AIS	JHS-180	Not used					
	JHS-182						
	JHS-183						
VDR/ SVDR	JCY-1000	JRC	DL9126 -48EPML	NBK129C		4 years after manufactured	
	JCY-1700/S	JRC	Periodical exchange parts	7ZXJD0094		4 years after manufactured	
	JCY-1800 /1850	JRC	Periodical exchange parts	7ZXJD0095		4 years after manufactured	
	JCY-1900 /1950	JRC	Periodical exchange parts	7ZZNA4134			RCU fan *2 Battery CBN80
BECON	NDH-288A/B		7ZZJD0056 or 7ZZNA4081+ 7ZZNA4108(ad apter)	7ZZJD0056 or 7ZZNA4081+ 7ZZNA4108 No stock		6 years after manufactured	DMK480 DMK502 DMK502+AD
	NDH-316/317		7ZZNA4081	7ZZNA4081		6 years after manufactured	DMK120 DMK502
	NDH-338		7ZZNA4138	7ZZNA4138		3 years after manufactured	
	NDH-339 (Float Free Capsule)	Battery				4^5years after installation	Exchange work needs training in JOTRON.
		HRU Release sensor				2 years after installation	
WX FAX	JAX-9/9A	Toshiba	ER3N4	5ZBBAU00023		ϕ14.5×29.5mm	
	JAX-9B	Panasonic	CR2032	5ZBCJ00012		ϕ20×3.2mm	
	JAX-39	Toshiba	ER3N4	5ZBBAU00023		ϕ14.5×29.5mm	
	JAX-79						
	JAX-90						
	JAX-91						
VHF TRANS CEIVER	JHV-621	JRC	NBB-102	NBB-102 No stock			

TYPE	MODEL	MAKER	BATT. MODEL	JRC CODE	SHAPE	SIZE/VALIDITY	REMARKS
UHF TRANS CEIVER	JHV-647T	JRC	NBB-116	NBB-116 No stock			Explosion proof
	JHP-44M01T	JRC	NBB-141	NBB-141		68W38D63H	Not Explosion proof
	JHP-44E01T	JRC	NBB-143	NBB-143		68W38D63H	Explosion proof
	JHS-410A/412P	JRC	NBB-248	NBB-248		62H40D58.5H	
	JHS-413	JRC	NBB-511	NBB-511 No stock		62H40D58.5H	
	JHS-430	JRC	BP227FM	7ZBJD0008			
TWO WAY VHF	JHS-7 Secondary battery	JRC	NBB-248	NBB-248		62W55D64.5H	
	JHS-7 Primary battery Invalid if label removed	JRC	NBB-389	NBB-389		62H40D58.5H	5 years after installation
SART	JQX-10A JQX-20A	JRC	6ZBKD00005	6ZBKD00005 (Battery kit)		ϕ35.0×190mm	
	JQX-30A	JRC	NBB-441	7ZBKD0002A (Battery kit)		ϕ34×120mm	
	Tron SART20	JOTRON/ JRC	82615	5ZBDG00001			5 years maintenance kit
EPIRB	JQE-2A	JRC	NBB-184A	6ZXSC75014 +6ZBSC00003 (Battery pack)		65W65D126H	3 years after installation
	Release sensor	JRC	Normal	7ZZSC0021			4 years after installation
			HK approved	7ZZSC0022			4 years after installation
	JQE-3A	JRC	NBB-303A	7ZZSC0036 (Battery kit)		70W34D123H	5 years after installation

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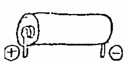
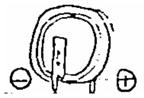
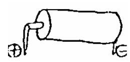
TYPE	MODEL	MAKER	BATT. MODEL	JRC CODE	SHAPE	SIZE/VALIDITY	REMARKS
EPIRB	Release sensor	JRC	Normal	7ZZSC0023			4 years after installation
			HK approved	7ZZSC0024			4 years after installation
	JQE-103A	JRC	P-35	7ZZSC0082 (Battery kit)			5 years after installation
	Release sensor	JRC	Normal	7ZZSC0080	H20-YSE/HAMMAR		2 years after installation
			HK approved	7ZZSC0081	H20-YSE/HAMMAR		2 years after installation
	Tron SART60S	JOTRON/ JRC	86225				
27MHz 1W DSB	JSD-27	Sanyo	CR2032-FT6-1	5ZBAD00096 No stock		ϕ21.0×3.2mm	
	JSD-280A	Not used					
	JSD-281		Ni-Ca Battery	ϕ21.0×3.2mm			Battery charge when equipment power on.
	JSD-282	Not used					
	JSD-283	Not used					
HF RADIO	JST-135	Sanyo	CR2032-FT6-1	5ZBAD00096		ϕ21.0×3.2mm	
	JST-145						
RADAR	JMA-2100 Series	Sanyo	CR2032-FT6-1	5ZBAD00096 No stock		ϕ21.0×3.2mm	
	JMA-2200 Series						
	JMA-2213						
	JMA-3253/4						
	JMA-3111	Maxell	ER3N4	5ZBAU00023		ϕ14.5×30.8mm	
	JMA-3200 Series						
	JMA-3500 Series						
	JMA-3600 Series						

TYPE	MODEL	MAKER	BATT. MODEL	JRC CODE	SHAPE	SIZE/VALIDITY	REMARKS
RADAR	JMA-3700 Series	Sanyo	CR12600SE-T1	5ZBAD00076 No stock		φ12.0×59.0mm	
	JMA-3900 Series	Maxell	ER3N4	5ZBAU00023		φ14.5×30.8mm	
	JMA-5100 Series	Sanyo	CR2477-1VC	5ZBCJ00009		φ24×7.7mm	
	JMA-5300 Series	Panasonic	CR2450	5ZBCJ00013 No stock		φ24×5.0mm	
	JMA-6000/8000 Series	Maxell	ER6	5ZBAU00025		φ14.5×54.3mm	
	JMA-7000/9000 Series	Sanyo	CR2032-FT6-1	5ZBAD00096 No stock		φ21.0×3.2mm	New IMO rule
	JMA-9100 Series	Panasonic	CR2032	5ZBCJ00012		φ20×3.2mm	
	JMA-9700 Series	Sanyo	CR2032-FT6-1	5ZBAD00096 No stock		φ21.0×3.2mm	
	JMA-9800M1 Series	Panasonic	CR2032	5ZBCJ00012		φ20×3.2mm	
	JMA-9800M2 Series	Panasonic	CR2477-1FT	5ZBBD00011		φ24×7.7mm	
	JMA-9800M3 Series	Panasonic	CR2032	5ZBCJ00012		φ20×3.2mm	
	JMA-9900 Series	Panasonic	CR2032	5ZBCJ00012		φ20×3.2mm	
	JMA-3810 JMA-3811	Panasonic	CR2032-T14-1	5ZBAD00089 No stock		φ20×3.2mm	
	JMA-3253/4	Sanyo	CR2032-FT6-1	5ZBAD00096 No stock		φ21.0×3.2mm	
	JMA-7736 Series	Maxell	ER3N4	5ZBAU00023		φ14.5×30.8mm	
	NCA-780/781	Maxell	ER6	5ZBAU00003		φ14.5×54.3mm	

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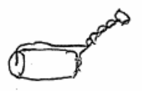
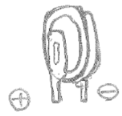
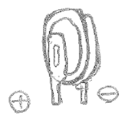
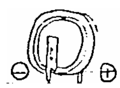
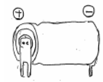
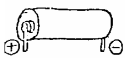
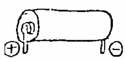
TYPE	MODEL	MAKER	BATT. MODEL	JRC CODE	SHAPE	SIZE/VALIDITY	REMARKS
RADAR	JMA-900Series	Panasonic	CR2032	5ZBCJ00012		φ20×3.2mm	
		JRC	CBD-1626	CBD-1626			UPS
ECDIS	JAN-1290	JRC	CBD-1446A	CBD-1446A			UPS
	JAN-1397/1497						
	JAN-3598						
	JAN-901/701 JAN-901B/701B		CBD-1626	CBD-1626			UPS
	JAN-901B/701B		CBD-1831	CBD-1831 No stock			UPS
	JAN-1290	Panasonic	CR14250-SE			φ14.5×50.0mm	Mather board
	JAN-1290	Panasonic	CR2032	5ZBCJ00012		φ20×3.2mm	Mather board
	JAN-1397/1497 JAN-3598	Panasonic	CR2032	5ZBCJ00012		φ20×3.2mm	Mather board
GPS	JLR-4110/M2	Panasonic	CR2032-1HS	5ZBAB00047 No stock		φ20.0×3.2mm	
	Same GPS core as above	Maxell	ER3N4	5ZBAU00023		φ14.5×30.8mm	
	JLR-6000M2	Maxell	CR2032-1HS	5ZBAB00047 No stock		φ20.0×3.2mm	Refer to JLR-4110/M2
	Same GPS core as above	Maxell	ER3N4	5ZBAU00023		φ14.5×30.8mm	Refer to same GPS core as above
	JLR-6800	Panasonic	CR2032-1HS	5ZBAB00047 No stock		φ20.0×3.2mm	Refer to JLR-4110/M2
	Same GPS core as above	Maxell	ER3N4	5ZBAU00023		φ14.5×30.8mm	Refer to same GPS core as above

TYPE	MODEL	MAKER	BATT. MODEL	JRC CODE	SHAPE	SIZE/VALIDITY	REMARKS
GPS	JLR-7700/M2	Hitachi Maxell	CR2032T16	5ZBAU00028		ϕ20.0×3.2mm	
	JLU-128	Maxell	ER3N4	5ZBAU00023		ϕ14.5×30.8mm	
	J-NAV500	Hitachi Maxell	CR2032T16	5ZBAU00028		ϕ20.0×3.2mm	
	JLR-7500/7800 NWZ-4740	Not used					
	JLR-4341 DGPS Receiver	Panasonic	CR2354-1VC	5ZBCJ00004		ϕ23.0×5.4mm	When removing a radome at the time of a battery exchange, change a radome newly.
			MPAE30534 Radome kit	MPAE30534			
GPS COMPAS	JLR-10	Hitachi Maxell	CR2032T16	5ZBAU00028		ϕ20.0×3.2mm	DISPLY
		Panasonic	CR2354-1VC	5ZBCJ00004		ϕ23.0×5.4mm	NNN-10
			CR2477-1VC	5ZBAB00012		ϕ24.5×7.8mm	NNN-10
	JLR-20/30 JLR-21/31 SENSOR	Panasonic	BR-2/3AGE2P	5ZBCJ00010		ϕ17×33.5mm	SENSOR
COLOR PLOTTER	NWU-51	Sanyo	CR12600SE-T1	5ZBAD00076		ϕ12×59mm	
	NWU-52	Sanyo	CR1/3N-FT1	5ZBAD00043 No stock		ϕ11.6×10.8mm	
	NWU-52A NWU-53 NWU-53A NWU-300	Sanyo	CR12600SE -FT3	5ZBAD00081 No stock		ϕ12×59mm	
	NWU-700 NWU-800 JLZ-700/900	Maxell	ER3N4	5ZBAU00023		ϕ14.5×30.8mm	

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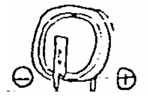
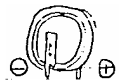
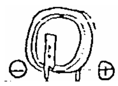
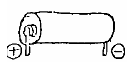
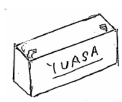
TYPE	MODEL	MAKER	BATT. MODEL	JRC CODE	SHAPE	SIZE/VALIDITY	REMARKS
FISH FINDER	JFV-60/61 JFV-82/86 JFV-90/91	Sanyo	CR2032-T9-2	5ZBAD00073		φ20.5×3.2mm	
	JFV-100/100M2	Sanyo	CR2430-FT	5ZBAD00038 No stock		φ25×3.0mm	
	JFV-120	Sanyo	CR2032-T9-2	5ZBAD00073 No stock		φ20.5×3.2mm	
	JFV-200	Seiko	S-22S12i10	5DEAK00016 No stock	NVRAM	98BSAL0001	Necessary modification
	JFV-216/230 /231	Sanyo	CR2430-FT	5ZBAD00038 No stock		φ25×3.0mm	
	JFV-250	Not used					
	JFV-850/8010	Sanyo	CR2032-1VC1	5ZBAB00059 No stock		φ20×3.2mm	
	JFV-130/HP	Not used					
	JFC-130/HP	Not used					
ECHO SOUNDER	JFE-570S/570SD	Not used					
	JFE-582	Not used					
	JFE-380/680	Sanyo	CR2032L/B	5ZBCJ00012		φ20×3.2mm	
DOPPLER LOG	JLN-201/202/203	Not used					
	JLN-205/205MK2	Not used					
DOPPLER SONAR	JLN-520/530	Sanyo	CR2032-P5-2	5ZBAD00077		φ20×3.2mm	
	JLN-550	Not used					
DUPPLER CURRENT METER	JLN-627/628 CKJ-111U/111UA	Sanyo	CR12600SE -FT3	5ZBAD00081 No stock		φ12×59mm	
	JLN-650/652	Not used					
OCEAN GRAPHIC	JCV-26	Hitachi/ Yuasa	HP3-6 NP3-6	5ZBBC00001 No stock 5ZBAE00080 No stock		135W35D57H	Lead shild
	JCV-36		PC BATT				

* The old model and a code of the battery which has no stock are also mentioned for reference.

19. Prevention Maintenance Table

19-1 Prevention Maintenance

By proposing exchange of applicable parts beforehand before the durable time progress which consumables and a parts supplier show, it tries to prevent generating of a failure or trouble.

* The number (1-10) of table upper right shows the number of years after installation and each mark shows the high order of a prevention maintenance effect. **O :1 ▲: 2 ■:3**

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
MF/HF	JSS-296	JSB-196GM	HANDSET	NQW-213							■					■
			COOLING FAN	7BZJD0001		1pc			O			O			O	
		NCT-196N	LCD	7WSJD0002A							O					O
		NAH-692	LCD(ROHS)	7WSJD0003A								■				
			POWER SUPPLY UNIT	CBG-2692-B							■					■
			PA_ UNIT	CAH-2692-A							▲					▲
			COOLING FAN FOR PA (B1/B2/B3)	5BFAH00055		need 3pcs			O			O			O	
			DC12V POWER SUPPLY	7EPJD0005		Outside maker					■					■
		NKG-800	PRINTER	NKG-800							■					■
			PRINTER HEAD	5ZYWZ00001							O					O
		NDZ-127J1B	DTE	NDZ-127J1B							■					■
			LCD BACK LIGHT	5WZBK00001					O			O			O	
		NAW-208S	ANT Wire 15m(TH-19/1.2)	2746111112					▲			▲			▲	
			ANT making materials (Feeder Kit)	6ZPKD00073		NAW-208S			▲			▲			▲	
MF/HF	JSS-596	JSB-196GM	HANDSET	NQW-213							■					■
			COOLING FAN	7BZJD0001		1pc			O			O			O	
		NCT-196N	LCD	7WSJD0002A							O					O
		NAH-695	LCD(ROHS conformity)	7WSJD0003A								■				

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TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
MF/HF	JSS-596	NAH-695	POWER SUPPLY UNIT	CBG-2692-B							■					■
			PA_ UNIT	CAH-2692A		2pc					▲					▲
			COOLING FAN FOR PA	5BFAH00055		need 3pcs			○			○			○	
			DC12V POWER SUPPLY	7EPJD0005		Outside maker					■					■
		NKG-800	PRINTER	NKG-800							■					■
			PRINTER HEAD	5ZYWZ00001							○					○
		NDZ-127J1B	DTE	NDZ-127J1B							■					■
			LCD BACK LIGHT	5WZBK00001					○			○			○	
		NAW-208S	ANT Wire 15m(TH-19/1.2)	2746111112					▲			▲			▲	
			ANT making materials (Feeder Kit)	6ZPKD00073		NAW-208S			▲			▲			▲	
MF/HF	JSS-2150	NTD-2150	TRANSCEIVER													
			COOLING FAN (2pcs)	5BFCM00011	50,000				○			○			○	
			PS UNIT	CBD-2415							▲					▲
		NCM-2150	CONTROLLER													
			HANDSET	NQW-261							■					■
			LCD UNIT	CDE-3770	20,000			○		○		○		○		○
		NDZ-227	DTE													
			LCD UNIT	CCN-3227-1	50,000						○					○
		NKG-800	PRINTER	NKG-800							■					■
			PRINTER HEAD	5ZYWZ00001							○					○
		AT100DS-H	ANT Wire 15m(TH-19/1.2)	2746111112					▲			▲			▲	
			ANT making materials (Feeder Kit)	6ZPKD00073		for NAW-208S			▲			▲			▲	

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
MF/HF	JSS-2250	NFC-2250	ANTENNA TUNER													
			COOLING FAN (1pcs)	7BZJD0008	50,000				○			○			○	
		NTD-2250	TRANSCEIVER													
			COOLING FAN (2pcs)	7BZJD0006	50,000				○			○			○	
		NCM-2150	CONTROLLER													
			HANDSET	NQW-261							■					■
			LCD UNIT	CDE-3770	20,000			○		○		○		○		○
		NDZ-227	DTE													
			LCD UNIT	CCN-3227-1	50,000						■					■
		NBD-2250	POWER SUPPLY													
			PA_PS UNIT	CBG-2416							■					■
			COOLING FAN (2pcs)	7BZJD0006	50,000				○			○			○	
		NKG-800	PRINTER	NKG-800							■					■
			PRINTER HEAD	5ZYWZ00001							■					■
		AT100DS-H	ANT Wire 15m(TH-19/1.2)	2746111112					▲			▲			▲	
			ANT making materials (Feeder Kit)	6ZPKD00073		for NAW-208			▲			▲			▲	
MF/HF	JSS-2500	NFC-2500	ANTENNA TUNER													
			COOLING FAN (1pcs)	7BZJD0008	50,000				○			○			○	
		NTD-2500	TRANSCEIVER													
			COOLING FAN (2pcs)	7BZJD0006	50,000				○			○			○	
		NCM-2150	CONTROLLER													
			HANDSET	NQW-261							■					■

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
MF/HF	JSS-2500	NCM-2150	LCD UNIT	CDE-3770	20,000			○		○		○		○		○
		NDZ-227	DTE													
			LCD UNIT	CCN-3227-1	50,000						○					○
		NBD-2500	POWER SUPPLY													
			PA_PS UNIT	CBG-2416							▲					▲
			COOLING FAN (2pcs)	7BZJD0006	50,000				○			○			○	
		NKG-800	PRINTER	NKG-800							■					■
			PRINTER HEAD	5ZYWZ00001							○					○
		NAW-208S	ANT Wire 15m(TH-19/1.2)	2746111112					▲			▲			▲	
			ANT making materials (Feeder Kit)	6ZPKD00073		for NAW-208S			▲			▲			▲	
NO.1 VHF	JHS-32B		DISPLAY UNIT	CDE-800							▲					▲
			HANDSET	5UMBL00003							▲					▲
			HANDSET CONNECTION BOX	NQE-846							■					■
			VHF TRX ANTENNA	7ABJD0004							▲					▲
			ANTENNA BRACKET	MPBX41928A							▲					▲
NO.2 VHF	JHS-32B		DISPLAY UNIT	CDE-800							▲					▲
			HANDSET	5UMBL00003							▲					▲
			HANDSET CONNECTION BOX	NQE-846							■					■
			VHF TRX ANTENNA	7ABJD0004							▲					▲
			ANTENNA BRACKET	MPBX41928A							▲					▲

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
NO.1 VHF	JHS-770S	NCM-1770	LCD UNIT	CDE-3770							▲					▲
			HANDSET	NQW-261							▲					▲
			HANDSET CONNECTION BOX	NQE-1846							■					■
			VHF TRX ANTENNA	7ABJD0004							▲					▲
			ANTENNA BRACKET	MPBX41928A							▲					▲
NO.2 VHF	JHS-770S	NCM-1770	LCD UNIT	CDE-3770							▲					▲
			HANDSET	NQW-261							▲					▲
			HANDSET CONNECTION BOX	NQE-1846							■					■
			VHF TRX ANTENNA	7ABJD0004							▲					▲
			ANTENNA BRACKET	MPBX41928A							▲					▲
INMAR-F	JUE-410F	NAF-214B-1	RFU	NAF-214B-1							■					■
		NBD-768A	PSU(ADE)	NBD-768A							■					■
		GSC-411A	EL,X AXIS Motor	MNEM30173		2pcs			○			○			○	
			AZ AXIS Motor	MNEM30174		1pc			○			○			○	
		CBD-1632A	PSU(BDE)	CBD-1632B							■					■
			BDE FAN	7BFSC0003B		2pcs Set		○		○		○		○		○
		TEL	NQW-132B			2pcs			○			○			○	
INMAR FBB	JUE-500	-	HANDSET	NQW-267							▲					▲
			Telephone	NQW-132B-2		1pc			○			○			○	
INMAR FBB	JUE-250		HANDSET	NQW-267							▲					▲
			Telephone	NQW-132B-2		1pc			○			○			○	
INMAR FAX	OKIOFFICE86		FAX-2820 (replacement)								■					■
INMAR FAX	FAX-2820		IMAGE DRUM UNIT UNIT	DR-2000							■					■

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
INMAR C	JUE-75C		EME	NAF-74B	N/A						▲					▲
			DTE	NDZ-127CC	N/A						■					■
		NTF-78A (IME)	POWER SUPPLY UNIT	CBD-1151B	N/A						■					■
		NKG-800	PRINTER								■					■
			PRINTER HEAD	5ZYWZ00001							○					○
SSAS		-	-	-												
INMAR C	JUE-85		EME	NAF-741GM							■					■
			DTE	NDZ-127C1C							■					■
		NKG-800	PRINTER								■					■
			PRINTER HEAD	5ZYWZ00001							○					○
SSAS		-	-	-												
INMAR C	JUE-87	NAF-253GM7	EME	NAF253GM7							■					■
		NDZ-227X	DTE													
			LCD for DTE	CCN-3227-1							○					○
		NKG-800	PRINTER								■					■
			PRINTER HEAD	5ZYWZ00001							○					○
SSAS		-	-	-												
AIS	JHS-182	CAV-2180	ANTENNA	CAV-2180							▲					▲
		NTE-182	TRANSPONDER	NTE-182-2							■					■
			LCD UNIT	CDE-1779							▲					▲

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
AIS	JHS-183	CAV-2180	ANTENNA	CAV-2180							▲					▲
		NTE-183	TRANSPONDER	NTE183-2							■					■
			LCD UNIT	CCN423							▲					▲
VDR	JCY-1700	NDH-288B	CAPSULE UNIT													
		DKM502	BEACON BATTERY	7ZZNA4081	3.5years	ex-DKM480			○			○			○	
			DKM502 adapter KIT	7ZZNA4108		ex-DKM480				○				○		
		CDJ-2142	CPU Battery (CR2032)	5ZBCJ00012							○					○
		NBL313A	UPS BATT(Z201) & FAN(2pcs)	7ZXJD0094	4years	regulation				○				○		
VDR	JCY-1800	NDH-316A	CAPSULE UNIT													
		DKM502	BEACON BATTERY	7ZZNA4081		3.5years			○			○			○	
		NQE-3163	CONNECTION BOX								■					■
		CDJ-2304	CPU Battery (CR2032)	5ZBCJ00012							○					○
		NBL-327	UPS & FAN(2pcs)	7ZXJD0095		regulation				○				○		
VDR	JCY-1850	NDH-317A	CAPSULE UNIT													
		DKM502	BEACON BATTERY	7ZZNA4081		3.5years			○			○			○	
		NQE-3163	CONNECTION BOX								■					■
		CDJ-2304	CPU Battery (CR2032)	5ZBCJ00012							○					○
		NBL-327	UPS & FAN(2pcs)	7ZXJD0095		regulation				○				○		
EPIRB	JQE-3A		BATTERY KIT	7ZZSC0036	5years	regulation					○					○
			RELEASE SENSOR(for HK)	7ZZSC0024	4years	regulation				○				○		
			RELEASE SENSOR	7ZZSC0023	4years	regulation										

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
EPIRB	JQE-103		BATTERY KIT	7ZZSC0082	5years	regulation					○					○
			RELEASE SENSOR(for HK)	7ZZSC0081	2years	regulation		○		○		○		○		○
			RELEASE SENSOR	7ZZSC0080	2years	regulation										
TWO-WAY	JHS-7		PRIMARY BATTERY	NBB-389-1							○					○
(3set)			Ni-Cd BATTERY	NBB-248-1							▲					▲
ONBORD	JHS-400A		HANDSET	5UMBL00003							■					■
COM	JHS-430		LI-ION BATTERY	7ZBJD0008							▲					▲
SART(2set)	JQX-30A	NBB-441	LITHIUM BATTERY	7ZBKD0002A					○			○			○	
SART(2set)	TRONSART 20		BATTERY KIT	7ZZJD0069	5years						○					○
NAVTEX	NCR-330	MTP401-40B-E	PRINTER UNIT	5HPCC00004							○					○
			MAIN SWITCH	7SZJD0002A							■					■
			STATE SWITCH	7SZJD0003A							■					■
NAVTEX	NCR-333		LCD UNIT	CCN-392							○					○
			PRINTER	DPU-414					▲			▲			▲	
PUBLICADD	NVA-1810MK2H2	-	-	-												
BNWAS	JCX-151		LED DISPLAY UNIT	NCD-2189							▲					▲
			RESET BUTTON UNIT	NCJ-879		WATERPROOF					■					■

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
RADAR(1)	JMA-9932-SA	NKE-1075	MOTOR WITH GEAR	MPEM30092B (AC110V)	10,000			○		○		○		○		○
			P/MONITOR	NJU63B1	5years						■					■
			ROTARY ENCODER + connector	CHT-71A	10,000			○		○		○		○		○
			FAN for REC	5BFAB00523	20,000	1pc			○			○			○	
			FAN for MOD	5BFAB00526	20,000	1pc			○			○			○	
			POWER SUPPLY	CBD-1682A	5years						▲					▲
			MAGNETRON	5VMAA00111	4,000		○	○	○	○	○	○	○	○	○	○
		NCD-4263	TRACK BALL	CCK-1013	3years				○			○			○	
			BACK-UP BATTERY	5ZBCJ00012	5years						○					○
			FAN FOR PROCESS UNIT	5BFAB00588	20,000				○			○			○	
			FAN FOR POWER SUPPLY UNIT	7BFRD0006	20,000				○			○			○	
			23 INCH LCD UNIT	CML799L	50,000						■					■
			OPERATION CIRCUIT-3	CCK-902A	5years						▲					▲
			POWER SUPPLY	CBD-1661A	5years						▲					▲
RADAR(2)	JMA-9922-6XA	NKE-1087-6	MOTOR WITH GEAR	MPEM30176	10,000			○		○		○		○		○
			P/MONITOR	NJU64B1	5years						■					■
			ROTARY ENCODER + connector	CHT-71A	10,000			○		○		○		○		○
			FAN (2pcs)	7BFRD0002	20,000				○			○			○	
			POWER SUPPLY	CBD-1682A	5years						▲					▲
			MAGNETRON	5VMAA00082	4,000		○	○	○	○	○	○	○	○	○	○
		NCD-4263	TRACK BALL	CCK-1013	3years				○			○			○	
			BACK-UP BATTERY	5ZBCJ00012	5years						○					○

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
	JMA-9922-6XA	NCD-4263	FAN FOR PROCESS UNIT	5BFAB00588	20,000				○			○			○	
			FAN FOR POWER SUPPLY UNIT	7BFRD0006	20,000				○			○			○	
			23 INCH LCD UNIT	CML799L	50,000						■					■
			OPERATION CIRCUIT-3	CCK-902A	5years						▲					▲
			POWER SUPPLY	CBD-1661A		109,000					▲					▲
		NKE-1079	MOTOR WITH GEAR	MPEM30092B (AC110V)	10,000			○		○		○		○		○
			P/MONITOR	NJU63B1	5years						●					●
			ROTARY ENCODER + connector	CHT-71A	10,000			○		○		○		○		○
		NTG-3037	FAN for REC	5BFAB00523	20,000	1pc			○			○			○	
			FAN for MOD	5BFAB00526	20,000	1pc			○			○			○	
			POWER SUPPLY	CBD-1682A	5years						▲					▲
			MAGNETRON	5VMAA00111	4,000		○	○	○	○	○	○	○	○	○	○
		NCD-4263	TRACK BALL	CCK-1013	3yaears				○			○			○	
			BACK-UP BATTERY	5ZBCJ00012	5years						○					○
			FAN FOR PROCESS UNIT	5BFAB00588	20,000				○			○			○	
			FAN FOR POWER SUPPLY UNIT	7BFRD0006	20,000				○			○			○	
			23 INCH LCD UNIT	CML799L	50,000						■					■
			OPERATION CIRCUIT-3	CCK-902A	5years						▲					▲
			POWER SUPPLY	CBD-1661A	5years						▲					▲
RADAR(2)	JMA-9923-9XA	NKE-1089-9	MOTOR WITH GEAR	MPEM30176	10,000	AC100V		○		○		○		○		○
			P/MONITOR	NJU64B1	5years						■					■
			ROTARY ENCODER + connector	CHT-71A	10,000			○		○		○		○		○

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
RADAR(2)	JMA-9923-9XA	NTG-3028	FAN not used													
			POWER SUPPLY	CBD-1682A	5years						■					■
			MAGNETRON	5VMAA00082	4,000		○	○	○	○	○	○	○	○	○	○
		NCD-4263	TRACK BALL	CCK-1013	3 年				○			○			○	
			BACK-UP BATTERY	5ZBCJ00012	5years						○					○
			FAN FOR PROCESS UNIT	5BFAB00588	20,000				○			○			○	
			FAN FOR POWER SUPPLY UNIT	7BFRD0006	20,000				○			○			○	
			23 INCH LCD UNIT	CML799L	50,000						■					■
			OPERATION CIRCUIT-3	CCK-902A	5years						▲					▲
			POWER SUPPLY	CBD-1661A	5years						▲					▲
RADAR(1)	JMA-9132-SA	NKE-1130	MOTOR WITH GEAR	MDBW10823	10,000	DC MOTOR		○		○		○		○		○
			P/MONITOR	NJU84-1	5years						■					■
			ROTARY ENCODER + connector	CHT-71A	10,000			○		○		○		○		○
			FAN (FAN1,FAN2)	7BFRD0002	20,000				○			○			○	
			POWER SUPPLY	CBD-1682A	5years						▲					▲
			MAGNETRON	5VMAA00104	4,000		○	○	○	○	○	○	○	○	○	○
		NCD-4990	TRACK BALL	CCK-1013	3 年				○			○			○	
			BACK-UP BATTERY	5ZBCJ00012	5years						○					○
			FAN FOR PROCESS UNIT	5BFAB00588	20,000				○			○			○	
			FAN FOR POWER SUPPLY UNIT	7BFRD0006	20,000				○			○			○	
			23 INCH LCD UNIT	CML799L	50,000						■					■
			OPERATION CIRCUIT A	CCK-973	5years						▲					▲
			POWER SUPPLY	CBD-1661A	5years						▲					▲

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
RADAR(2)	JMA-9122-9XA	NKE-1125-9	MOTOR WITH GEAR	MDBW10822	10,000	DC MOTOR		○		○		○		○		○
			P/MONITOR	NJU85-1	5years						■					■
			ROTARY ENCODER + connector	CHT-71A	10,000			○		○		○		○		○
			FAN (FAN1,FAN2)	7BFRD0002	20,000				○			○			○	
			POWER SUPPLY	CBD-1682A	5years						▲					▲
			MAGNETRON	5VMAA00106	4,000		○	○	○	○	○	○	○	○	○	○
		NCD-4990	TRACK BALL	CCK-1013	3years				○			○			○	
			BACK-UP BATTERY	5ZBCJ00012	5years						○					○
			FAN FOR PROCESS UNIT	5BFAB00588	20,000				○			○			○	
			FAN FOR POWER SUPPLY UNIT	7BFRD0006	20,000				○			○			○	
			23 INCH LCD UNIT	CML799L	50,000						■					■
			OPERATION CIRCUIT A	CCK-973	5years						▲					▲
			POWER SUPPLY	CBD-1661A	5years						▲					▲
RADAR(1)	JMA-9133-SA	NKE-1139	MOTOR WITH GEAR	MDBW10823	10,000	DC MOTOR		○		○		○		○		○
			P/MONITOR	NJU84-1	5years						■					■
			ROTARY ENCODER + connector	CHT-71A	10,000			○		○		○		○		○
			FAN Not used													
		NTG-3230	POWER SUPPLY	CBD-1682A	5years						▲					▲
			MAGNETRON	5VMAA00104	4,000		○	○	○	○	○	○	○	○	○	○
		NCD-4990	TRACK BALL	CCK-1013	3years				○			○			○	
			FAN FOR PROCESS UNIT	5BFAB00588	20,000				○			○			○	
			BACK-UP BATTERY	5ZBCJ00012	5years						○					○
			FAN FOR POWER SUPPLY UNIT	7BFRD0006	20,000				○			○			○	

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
	JMA-9133-SA	NCD-4990	23 INCH LCD UNIT	CML799L	50,000						■					■
			OPERATION CIRCUIT A	CCK-973	5years						▲					▲
			POWER SUPPLY	CBD-1661A	5years						▲					▲
RADAR(2)	JMA-9123-9XA	NKE-1129-9	MOTOR WITH GEAR	MDBW10822	10,000	DC MOTOR		○		○		○		○		○
			P/MONITOR	NJU85-1	5years						■					■
			ROTARY ENCODER + connector	CHT-71A	10,000			○		○		○		○		○
			FAN Not used													
		NTG-3225	POWER SUPPLY	CBD-1682A	5years						▲					▲
			MAGNETRON	5VMAA00106	4,000		○	○	○	○	○	○	○	○	○	○
		NCD-4990	TRACK BALL	CCK-1013	3yeard				○			○			○	
			BACK-UP BATTERY	5ZBCJ00012	5years						○					○
			FAN FOR PROCESS UNIT	5BFAB00588	20,000				○			○			○	
			FAN FOR POWER SUPPLY UNIT	7BFRD0006	20,000				○			○			○	
			23 INCH LCD UNIT	CML799L	50,000						■					■
			OPERATION CIRCUIT A	CCK-973	5years						▲					▲
			POWER SUPPLY	CBD-1661A	5years						▲					▲

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TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
ECDIS	JAN-701	NWZ-147-AC	18.1-INCH LCD MODULE	NWZ-147-AC	50,000						■					■
			BACKUP BATTERY CR-2032	5ZBCJ00012							○					○
			HDD UNIT 1	CDD-690A				○		○		○		○		○
			HDD UNIT 2	CDD-690A				○		○		○		○		○
			DVD-RAM DRIVE KIT	7ZZNA4118					▲			▲			▲	
			FD DRIVE UNIT	CDD-688							▲					▲
			FAN for CPU	7ZZNA4065		Mother Board			○			○			○	
			POWER SUPPLY	CBD-1625							▲					▲
			UPS BATTERY	CBD-1626						○				○		
			OPERATION CIRCUIT 3	CCK-902A	5years						■					■
			TRAK BALL	CCK-1013					○			○			○	
ECDIS	JAN-901M	NWZ-158-1	23.1-INCH LCD MODULE	NWZ-158-1	50,000						■					■
		NCM-758	BACKUP BATTERY CR-2032	5ZBCJ00012		Mother Board					○					○
			HDD UNIT 1	CDD-690A				○		○		○		○		○
			HDD UNIT 2	CDD-690A				○		○		○		○		○
			DVD-RAM DRIVE KIT	7ZZNA4118					▲			▲			▲	
			FD DRIVE UNIT	CDD-688							▲					▲
			FAN for CPU	7ZZNA4065		Mother Board			○			○			○	
			POWER SUPPLY	CBD-1625							▲					▲
			UPS BATTERY	CBD-1626						○				○		
			OPERATION CIRCUIT 3	CCK-902A	5years						■					■
			TRAK BALL	CCK-1013					○			○			○	

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
ECDIS	JAN-701B	NWZ-173-ET	19-INCH LCD MONITOR	NWZ-173-ET	50,000						■					■
	CONTROL	NCM-860	BACKUP BATTERY CR-2032	5ZBCJ00012		Mother Board					○					○
	UNIT		S-ATA1 HDD	CDD-717				○		○		○		○		○
			S-ATA2 HDD	CDD-717				○		○		○		○		○
			DVD-RAM DRIVE	CDD-719A					▲			▲			▲	
			FAN KIT FOR CPU	7ZZNA4065					○			○			○	
			ATX POWER SUPPLY	CBD-1625							▲					▲
	External I/F		UPS BATTERY	CBD-1626						○				○		
	PANEL		OPERATION CIRCUIT A	CCK-973	5years						■					■
			TRAK BALL	CCK-1013					○			○			○	
	NEW	NCM-860A	BACKUP BATTERY CR-2032	5ZBCJ00012		Mother Board					○					○
	CONTROL		S-ATA1 HDD	CDD749				○		○		○		○		○
	UNIT		S-ATA2 HDD	CDD749				○		○		○		○		○
			DVD-RAM DRIVE	CDD747					▲			▲			▲	
			FAN KIT FOR CPU	7EUNA4004					○			○			○	
			ATX POWER SUPPLY	CBD-1625							▲					▲
	External I/F	NCX-2111	UPS BATTERY	CBD-1626						○				○		
	PANEL	NCE-5163-E	OPERATION CIRCUIT A	CCK-973	5years						■					■
			TRAK BALL	CCK-1013	3years				○			○			○	

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TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
ECDIS	JAN-901B-SOR	NWZ-170-EL	23.1-INCH LCD MODULE	NWZ170-EL	50,000						■					■
	CONTROL	NCM-860	BACKUP BATTERY CR-2032	5ZBCJ00012		Mother Board					○					○
	UNIT		S-ATA1 HDD	CDD-717				○		○		○		○		○
			S-ATA2 HDD	CDD-717				○		○		○		○		○
			DVD-RAM DRIVE	CDD-719A					▲			▲			▲	
			FAN KIT FOR CPU	7ZZNA4065					○			○			○	
			ATX POWER SUPPLY	CBD-1625							▲					▲
	External I/F		UPS BATTERY	CBD-1626						○				○		
	PANEL		OPERATION CIRCUIT A	CCK-973	5years						■					■
			TRAK BALL	CCK-1013					○			○			○	
	NEW	NCM-860A	BACKUP BATTERY CR-2032	5ZBCJ00012		Mother Board					○					○
	CONTROL		S-ATA1 HDD	CDD749				○		○		○		○		○
	UNIT		S-ATA2 HDD	CDD749				○		○		○		○		○
			DVD-RAM DRIVE	CDD747					▲			▲			▲	
			FAN KIT FOR CPU	7EUNA4004					○			○			○	
			ATX POWER SUPPLY	CBD-1625							▲					▲
	External I/F	NCX-2111	UPS BATTERY	CBD-1626						○				○		
	PANEL	NCE-5163-E	OPERATION CIRCUIT A	CCK-973	5years						■					■
			TRAK BALL	CCK-1013	3years				○			○			○	

TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
DGPS(2set)	JLR-7700MKII	NWZ-4570B	LCD UNIT	CML-309A-1							▲					▲
DGPS(2set)	JLR-7800	NWZ-4740	LCD UNIT	CCN-392A							▲					▲
GPS COMPASS	JLR-21/31		LCD UNIT	CCN-392A							▲					▲
DPLR SONAR	JLN-550		240k TX UNIT	CMB-319							▲					▲
			240k RX UNIT	CMA-832							▲					▲
			2M TRX NIT	CMN-633C							▲					▲
			MONITOR UNIT	CDE-1011	5years						○					○
			POWER SUPPLY	CBD-1637							○					○
			TRANSDUCER (40m)	CFT-033-A	5years	In DOCK					▲					▲
DPLR LOG	JLN-205		TRANSDUCER (30m)	CFT022B-30	5years	In DOCK					▲					▲
		NWW-65A	EL PANEL of Display													
	JLN-205MK2	NWZ-4610	LCD UNIT	CCN423							▲					▲
ECHO SOUNDER	JFE-582/585		Recording Belt	MPGK01821							○					○
			Driving belt	MTV001990							○					○
			Recording Pen	MPXP00791A			○	○	○	○	○	○	○	○	○	○
			Peper feed Kit	CCB-539							▲					▲

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TYPE	MODEL	UNIT	NAME	CODE	LIFE(H)	REMARKS	1	2	3	4	5	6	7	8	9	10
ECHO SOUNDER	JFE-680		LCD UNIT	CCN415							▲					▲
			PRINTER UNIT	7HPJD0001							■					■
			BACKUP BATTERY	5ZBCJ00012							○					○
WX FAX	JAX-9A		GEAR ASSY	MPGK30093							■					■
			BACKUP BATTERY	5ZBCJ00012							○					○
	JAX-9B		GEAR ASSY	MPGK30093							■					■
			BACKUP BATTERY	5ZBCJ00012							○					○
	JAX-90		BACKUP BATTERY	5ZBAU00023							○					○
	JAX-91		BACKUP BATTERY	5ZBAU00023							○					○

20. Maintenance Guideline of Ship Electronic Device

Since the Japan Marine Equipment Association has published "Navigation Equipment and Radiocommunication Equipment Maintenance Guideline", for reference to maintainable period of products, it is introduced in this handbook together with JRC Product List.
(The permission for printing of this document was obtained from the Japan Marine Equipment Association.)

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1 July, 2008

Guidelines for Navigation and Radio Communication Equipment Maintenance

Japan Marine Equipment Association
Navigation Equipment Group

Unlike production of consumer equipment and automobiles, production of navigation and radio communication equipment used in the maritime industry could be described as "multi-product and low-volume". In addition, with the rapid innovation in technology taking place today, there have been dramatic changes in and obsolescence of the parts - especially electrical and electronic parts - which comprise such equipment and the period of availability relating to these key components from parts manufacturers has been declining every year.

Under these circumstances it has been a challenge for equipment manufacturers to secure parts necessary for repair work in carrying out product maintenance and there have been cases where the problem has hampered this task within relatively short timeframes after discontinuation of equipment production, greatly inconveniencing users in the process.

This policy, "Guidelines for Navigation and Radio Communication Equipment Maintenance" (see Note) and related arrangements and preparations have been developed and established by our Group in effort to minimize this problem and provide assurance to equipment users.

Note: This policy applies to the products for ocean-going and coastal vessels only and does not apply to the products for fishing and pleasure crafts.

Applicable Equipment
In principle, this policy includes all types of navigation and radio communication equipment for ocean-going and coastal vessels but excludes the following categories.

a. Equipment manufactured to special customer specifications.
b. Certain equipment such as satellite system-based emergency position indicating radio beacons (satellite EPIRB), etc., which has less than a 10-year service life.
c. Equipment which utilizes consumer products such as personal computers, etc.

Maintenance Support
Maintenance support should be assured on all equipment for a minimum period of ten years from the end of production. In addition, ongoing maintenance support should be provided beyond this period, depending on the availability of the parts necessary for equipment repair. In cases where such parts are no longer readily procurable and if requested by the user, the equipment manufacturer should consult with the user regarding relevant aspects such as delivery and pricing of the required parts in coping with this issue on an individual basis.

However there may be unavoidable circumstances where maintenance support on equipment cannot be provided because of the unavailability of the required parts or other factors.

Information Disclosure
Information pertaining to discontinuation of specific equipment and maintenance periods should be provided as appropriate on the equipment manufacturer's website, in instruction manuals, etc.

Prior information should be furnished in cases where the manufacturer may be unable to provide maintenance support on equipment because of the unavailability of the required parts or other factors.

Other

These Guidelines have been established in agreement with each member company and reflects the views of the Group. These Guidelines do not in any way compel individual companies to deal with individual cases, nor are they intended to bind the companies in any manner.

JRC Service parts supply status list for discontinued models

Sep.2014

Product name	Model	Discontinued Year	Service Parts supply status*	Replacement Model
MF/HF Radio Equipment	JSS-710	2002	N/A	JSS-2150/2250/2500
MF/HF Radio Equipment	JSS-720	2001	N/A	JSS-2150/2250/2500
MF/HF Radio Equipment	JSS-800	2003	N/A	JSS-2150/2250/2500
MF/HF Radio Equipment	JSS-850	2003	N/A	JSS-2150/2250/2500
MF/HF Radio Equipment	JSS-296	2014	X	JSS-2150/2250/2500
MF/HF Radio Equipment	JSS-596	2014	X	JSS-2150/2250/2500
MF/HF Radio Equipment	JSS-896	2014	X	JSS-2150/2250/2500
AIS	JHS-180	2006	N/A	JHS-182/183
NAVTEX	NCR-300A	2000	N/A	NCR-333
NAVTEX	NCR-330	2004	N/A	NCR-333
VHF Radio Telephone	JHS-31	1995	N/A	JHS-770S/780D
VHF Radio Telephone	JHS-32A	2003	N/A	JHS-770S/780D
VHF Radio Telephone	JHS-32B	2009	N/A	JHS-770S/780D
VHF Radio Telephone	JHS-33A	2003	N/A	JHS-770S/780D
UHF Transceiver (Base Station)	JHV-459T	1992	N/A	JHS-400A
UHF Transceiver	JHP-44E01T JHP-44M01T	2000	N/A	JHS-431
UHF Transceiver	JHS-410A	2001	N/A	JHS-431
Public Addressor	NVA-1700 Series	1991	N/A	NVA-1810MK2G/H
Public Addressor	NVA-1800 Series (Up to NVA-1810MK2F)	2003	N/A	NVA-1810MK2G/H
Multi Coupler	NAJ-1007	1995	N/A	NAJ-106
Marine Electronic Automatic Branch Exchange System	NCF-600/700/800/900 Series	2001	N/A	—
EPIRB	JQE-2A	1994	N/A	JQE-103
EPIRB	JQE-2A(HK)	1996	N/A	JQE-103
EPIRB	JQE-2A-E	1996	N/A	JQE-103

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Product name	Model	Discontinued Year	Service Parts supply status*	Replacement Model
EPIRB	JQE-3A	2007	○	JQE-103
SART	JQX-10A	1998	N/A	TRON SART20 (Jotron)
SART	JQX-20A	1999	X”	TRON SART20 (Jotron)
SART	JQX-30A	2007	X	TRON SART20 (Jotron)
INMARSAT-M	JUE-200M	1999	N/A	JUE-251(FB250) JUE-501(FB500)
INMARSAT-B	JUE-300B	1999	N/A	JUE-251(FB250) JUE-501(FB500)
INMARSAT-B	JUE-310B	2005	N/A	JUE-251(FB250) JUE-501(FB500)
INMARSAT-F	JUE-410F	2010	X	JUE-251(FB250) JUE-501(FB500)
INMARSAT FB250	JUE-250	2012	X	JUE-251(FB250) JUE-501(FB500)
INMARSAT FB500	JUE-500	2012	X	JUE-251(FB250) JUE-501(FB500)
INMARSAT-C	JUE-75A	1996	N/A	JUE-87
INMARSAT-C	JUE-75C	2007	X”	JUE-87
INMARSAT-C	JUE-85	2012	X	JUE-87
INMARSAT FAX	JAX-830	1993	N/A	FAX-2840 (Brother)
INMARSAT FAX	JAX-831	2005	N/A	FAX-2840 (Brother)
RADAR	JMA-6000 Series	1995	N/A	JMA-7100 Series
RADAR	JMA-8000 Series	1994	N/A	JMA-9100 Series
RADAR	JMA-8000MK2 Series	1996	N/A	JMA-9100 Series
RADAR	JMA-3728	1999	N/A	JMA-5300MK2
RADAR	JMA-7000 Series	2005	X”	JMA-7100 Series
RADAR	JMA-7700 Series	2004	N/A	JMA-5300MK2
RADAR	JMA-9000 Series	2002	N/A	JMA-9100 Series

Product name	Model	Discontinued Year	Service Parts supply status*	Replacement Model
RADAR	JMA-9700 Series	1999	N/A	JMA-9100 Series
RADAR	JMA-9800 Series	2004	N/A	JMA-9100 Series
RADAR	JMA-9900 Series	2008	X	JMA-9100 Series
ECDIS	JAN-1290	2002	N/A	JAN-701B
ECDIS	JAN-701	2007	N/A	JAN-701B
ECDIS	JAN-901/901M	2007	N/A	JAN-901B
ECDIS	JAN-1397	2000	N/A	JAN-901B
ECDIS	JAN-3598	2003	N/A	JAN-901B
WEATHER FAX	JAX-39	2001	N/A	JAX-9B
WEATHER FAX	JAX-78	1989	N/A	JAX-91
WEATHER FAX	JAX-79	1989	N/A	JAX-91
WEATHER FAX	JAX-90	2005	X”	JAX-91
WEATHER FAX	JAX-9	1993	N/A	JAX-9B
WEATHER FAX	JAX-9A	2008	X”	JAX-9B
GPS Navigator	JLR-4110	1994	N/A	JLR-7800/7500
GPS Navigator	JLR-4500 Series	1994	N/A	JLR-7800/7500
GPS Navigator	JLR-4110MK2	2002	N/A	JLR-7800/7500
GPS Navigator	JLR-6000	1993	N/A	JLR-7800/7500
GPS Navigator	JLR-6000MK2	1996	N/A	JLR-7800/7500
GPS Navigator	JLR-6800	1998	N/A	JLR-7800/7500
GPS Navigator	JLR-7700	2001	X”	JLR-7800/7500
Printer for GPS Navigator	NKG-22	2002	N/A	NKG-94
Printer for GPS Navigator	NKG-84	2010	N/A	NKG-94
GPS Data Buffer	NQA-602/602DC	2004	N/A	NQA-4251A
ECHO SOUNDER	JFE-570S	2001	N/A	JFE-380/680
ECHO SOUNDER	JFE-570SD	1999	N/A	JFE-380/680
ECHO SOUNDER	JFE-582	2007	N/A	JFE-380/680
ECHO SOUNDER	JFE-585	2007	N/A	JFE-380/680

Product name	Model	Discontinued Year	Service Parts supply status*	Replacement Model
DOPPLER SONAR	JLN-520	2002	×	JLN-550
DOPPLER SONAR	JLN-530	2002	×	JLN-550
SPEED LOG	JLN-201	1984	×	JLN-205MK2
SPEED LOG	JLN-202	2003	×	JLN-205MK2
SPEED LOG	JLN-203	2003	×	JLN-205MK2
VDR	JCY-1000	2004	×	JCY-1900
VDR	JCY-1700	2006	△	JCY-1900
VDR	JCY-1700S	2007	△	JCY-1950

*note: Service parts stock status code as follows.

X : Available all service parts.

X” : Available service parts except some limited parts.

N/A : Not Available.

21. Measures for Environment

Environmental pollution caused by Industrial activities broke out in the wide area. As a result, it expanded into the Global Environmental Problems. The International Chamber of Commerce announced “the International Charter of Sustainable Development” in 1996 to resolve the Global Environmental Problems. And then in 1996, "the Environmental Management System ISO 14001 standard 1st edition” was published through it etc.

"The Environmental Management System” was standardized as an Internationally Standard for Product Management system based on Environmental Program.

Japan Radio Co., Ltd. acquired a certification of ISO 14001 in 1998, and has been promoting reduction of loads to the environment together with company’s activities, aiming at a sustainable company.

Acquired a certification (February, 1998) of the environmental management system (ISO 14001), and Developing environmental activities.

1. Environmental Plan
2. Environmental Purpose and Target

Environmental Management System

Operation of Environmental Management System

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3. States of Environment-related Law and other State’s Directives for JRC to pay attention to.

21-1 Environmental Plan

[Basic Philosophy]

Japan Radio Co., Ltd. (hereafter referred to as "the Company") recognizes that preservation of “Earth Environment” is one of important tasks common to human beings and develops activities, taking into account Earth Environment at all stages of business.

[Basic Policy]

The Company fulfill its responsibility as a corporation for development of sustainable society by establishing the following environmental policies led by ISO14001 and conducting its business in accordance with them.

(1) In order to reduce the influence on the biodiversity accompanying active conduct of business, promote the many-sided maintenance activity based on a global viewpoint.

(2) To contribute by introducing environmentally conscious design products

In the field of wireless communications and data processing, the Company contributes to the public by introducing environmentally conscious design products less environmental impacts throughout its life cycle.

(3) To reduce environmental impacts in the business activity, products and services

1) To save energy

2) To promote 3R activities (reduce, reuse, recycle) to reduce discharge and wastes

3) To promote Green Procurement

(4) To comply with the laws and regulations related to the environment

The business activity, products and services of the Company shall comply with the laws and regulations related to the environment and other social requirements to which the Company subscribes.

(5) To make continuous improvement of environmental impacts and to prevent pollution

The Company makes effort to reduce environmental impacts of its business activity as well as products and services and prevents pollution by improving the environmental management system.

(6) To establish and do periodical review of the objectives and targets for environmental conservation

The Company establishes the objectives and targets of environmental conservation and reviews them periodically. The Company shall make maximum efforts to achieve such objectives and targets.

(7) To make announcement of the environmental policy to the public

The environmental policy, including the basic philosophy and basic policy, shall be made thoroughly known to all employees and all people working for the Company in order to obtain their full understanding and cooperation. In addition, this environmental policy shall be announced to outside the Company through the homepages on web site and other ways of announcement.

21-2 Environmental Objectives and Targets

(1) Expansion of Environmentally conscious products

- To raise the application rate of environmentally conscious products (products in compliance to the Type II-1101 environmental label) to more than 25% by 2014 in regard to such products newly and independently designed.
- To promote LCA.

(2) Promotion of measures against Global Warming

- To carry out energy management without exception (measure to the changes such as organizations with the business structure reform)

(3) Promote 3R.

- To raise the recycling rate more than 95% by 2014 including the country, foreign countries and a subsidiary company.

(4) Compliance to environmental laws and other social requirements

- To comply with standard value in laws and requirements of customers.

21-3 States of Environment-related Laws and Directives of Foreign Countries to be followed.

(1) Measures to realization of a low carbon society (Act on the Rational Use of Energy etc.)

Internationally, the first promise period (the 2008 to 2012 fiscal year) of the Kyoto Protocol expires, and about the framework of the greenhouse-gas-emission reduction in 2013 and afterwards, The future legal framework in which all the contracting States participate was adopted by 2015 regardless of the advanced nation and the developing country, and it has agreed on going into effect from 2020.

The energy management (the concept of time, such as a measure against a peak, was included) which a part of Law Concerning Rational Use of Energy was revised first, and was conscious of electric power demand-and-supply balance as a laws-and-regulations trend in addition to an improvement of energy efficiency or conventional energy saving called use reduction of a fossil fuel came to be called for.

A report of the change situation of 5 years was needed about the "demand for power leveling evaluation basic unit" which set the power purchase amount in "demand for power leveling time" as well as conventional "the daytime power purchase amount" and "the night power purchase amount" (8:00- 22:00 of July - September (summer) and December - March (winter): including the weekend and holiday) and power purchase amount in demand for power leveling time to 1.3 times concretely.

In addition, in Tokyo, the target which reduces a greenhouse gas 25 % in comparison with 2000 by 2020 and "greenhouse effect gas emission total volume reduction obligation and system of emission trading system" have been begun from April, 2010. Mitaka plant becomes the target business establishment, and the greenhouse gas reduction of "6%/year X 5 years" is assigned to us. When less than this, measures such as a purchase of the amount of emission and a company name official announcement are prepared.

Being conscious of the time zone which the amount of the energy used of a summer and winter increases especially, it continues and energy-saving activities are tackled positively.

(2) The law about processing of waste (Law Concerning Waste Disposal and Scavenging: Waste Disposal Law)

Processing of the waste (general waste from business activities and industrial waste) by which it is generated in connection with active conduct of business serves as a license system fundamentally, and it is necessary to entrust it to the contractor who obtained permission in advance.

Moreover, the kind of industrial waste entrusted when processing conveyance, disposal, etc., Quantity, form and a type of packing, the collection transport industry company name of after consignment, the disposal contractor name of after consignment, While creating "the control manifest for industrial waste (manifesto)" which indicated the schedule place of the final disposal, notes on handling, etc. and doing grasp and management of the flow of industrial

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waste oneself, it is obliged to check proper processing of waste.

Furthermore, "the control manifest for industrial waste (manifesto)" grantor draws up the report about a control documentation, and a duty of him is imposed so that this may be submitted to a prefectural governor or a government ordinance mayor.

To violation of the Waste Disposal Law penal regulations, such as imprisonment and a fine, may be imposed and the penal regulations are severe every year. Moreover a penalty to act on contravention, to a corporation as well as the actor person himself, like, the occasion to which inflicted penalty against employer and employee is applied is most. Therefore when wondering even a little, it's recommended as a professional section and polity to check the contents.

(3) RoHS Directive (RoHS2 : 2011/65-/EU)

With the present RoHS Directive, The European Parliament and council directive 2011 / 65 / EU (Directive on the Restriction of the use of certain Hazardous Substances in electrical equipment)as of June 8, 2011 about use restrictions of the specific harmful goods in electricity and an electronic device, and a light device also needs to be based on this. These directives revise the first directive (European Parliament and council directive 2002/95/EC) that went into effect in February, 2003. By revision directives, to the electricity and electronic item marketed by the EU market on and after July 1, 2006, which has forbidden using a lead, Mercury, cadmium, hexavalent chromium, polybrominated biphenyl (PBB), and six substances of polybrominated diphenyl ether (PBDE) in principle. [as for maximum allowable concentration, cadmium is 0.01wt% (percent by mass), and the five remaining substances are 0.1wt%].

The list of inapplicability uses was updated by May 5, 2014 by Annex III (Annex 3: all the categories of 1-11 is object) and Annex IV (Annex 4: the category 8, 9 exclusive use).

In addition, category 1-7, 10 are July 21, 2016 on expiration date of exemption, and category 8, 9 are seven years after the application starting date, and category 11 is five years after the application starting date.

Categories of electrical and electronic equipment covered by this Directive

1. Large household appliances.
2. Small household appliances.
3. IT and telecommunications equipment.
4. Consumer equipment.
5. Lighting equipment.
6. Electrical and electronic tools.
7. Toys, leisure and sports equipment.
8. Medical devices.
9. Monitoring and control instruments including industrial monitoring and control instruments.
10. Automatic dispensers.
11. Other electrical and electronic equipment not covered by any of the categories above.

(4) Chinese version RoHS

Other hazardous substances (to be clarified concretely later on) subject to Chinese version RoHS, in addition to RoHS 6 substances, are included in the substances which are restricted by the law of the Chinese version RoHS. The whole of electronic and electric equipment (However, refrigerator, washing machine and air-conditioner are excepted.) and packing materials used in distribution are included in products subject to Chinese version RoHS. After 1 March 2009, a label of the content subject to Chinese version RoHS, recyclable /non-recyclable, including a mark which specifies a period of safe use, shall be put on a product (if no space for a label on a product, it may be described in an instruction manual for the product.).

Although there is no inapplicability item, with the product registered into the important management list, it is due to set up.

First step: Indication of a poisonous and harmful substance (enforcement on March 3, 2007)

- The poisonous and harmful substance or the element in the article is marked and those names, the content and the product part in which that exists and the propriety of recycling, etc. are written clearly. (administrative measure 13 article).
- The environmental protection expiration date for use is marked. (administrative measure 11 article).
- The name of the wrapping material is marked on the wrapping material of the product. (administrative measure 14 article).

Second step: Compulsory certificate management (enforcement day undecided)

- Carry out management by the important management list of on the control of pollution caused by electronic information products, and carry out "compulsory product certificate" management to the listed product (administrative measure 18, 19 articles).

(5) REACH Directive

The European Parliament and of the council have adopted Directive (2006/121/EC) & Regulation (EC No 1907/2006) (the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH)) on 18 Dec 2006. The Regulation entered into force on 1 July 2007.

All chemicals of more than 1 ton per year manufactured in EU and imported to EU are required to be registered in three phases, on the basis of the treatment of these chemicals, by 2018. About 30 thousands of chemicals are assumed to be registered. A goal of REACH is to be able to trace the composition of chemicals, which are placed on the EU market, up to a substance level, and is to be able to identify the manufacturers of such substances (establishment of a big database).

The candidate substance for of the authorization in REACH regulation is called SVHC (substances of very high concern). New registration of the four substances was carried out on June 16, 2014 as the 11th addition SVHC, and SVHC became a total of 155 substances. Moreover, 10 substance of the 12th SVHC candidate were opened on September 1, 2014. The

4 substances of the phthalic acid expected by RoHS2 as addition substance are proposed to this.

(6) Korean version RoHS

The Korean version RoHS was formally enforced from 1 January 2008, as "Act for Resource Recycling of Electrical and Electronic Equipment and Vehicles”.

The content of the Law is ”Restriction on the use of hazardous substances in Electrical and Electronic Equipment and Vehicles”, and is “Establishment of Recycling System for Waste Electrical and Electronic Equipment and End-of-Life Vehicles”, and the hazardous material content and types of substances which are restricted are the same as EU RoHS.

Producers and importers should announce “the hazardous content level and the status of observance of a recycling rate, which is annually declared, to “Operation and Management Information system, which was established by the Ministry of the Environment, or broadcast it on their website and notify the President of Operation Management Organization of it.

(7) U.S. Environment-related Movement

In the stage where the federal government is holding a public hearing in the Standing Committee on Science and Technology of the House of Representatives, none of the environment-related directive by the federal government is settled yet.
However, since the law of restriction on chemical substances and waste of electrical and electronic equipment recycling, etc. was enacted in each state individually; the notification in accordance with each environment-related regulation in each state is required.

21-4 Engineer’s Attitude at shipyards etc.

Since the service section of US, including domestic and foreign service agencies, gets in contact with shipyards or ships directly, each person concerned has to recognize the influence caused by oneself to environment and observe the law and take actions.

In maintaining and/or repairing, packing materials remain as unnecessary materials after unpacking and the treatment of cable ends leaves residues, these residues, such as recyclable materials, flammable materials, nonflammable materials (including metal) and hazardous materials (buttery etc.), should be sorted and taken back to your office, and those should be sorted out and disposed of (including scrapping) in accordance with the company’s rules.

Various things, such as global warming, ozone layer depletion, forestdecline, desertification, marine pollution, etc. were caused, and environment is getting worse. In order not to leave over negative legacy to the future, many things such as saving electricity and water, waste sorting, etc. should be carried out nearby. Each person should consider environment and observe rules concerned and take care of the earth.

21-5 Restriction of certain Hazardous substances in Electronic Equipment in the world

Nowadays, restriction of the use of hazardous materials in electric and electronic equipment has become stricter in the world. European Directive RoHS (the restriction of the use of certain hazardous substances in electrical and electronic equipment) is well known in the world, restricting and prohibiting the use of hazardous materials (mercury, cadmium, lead, Chromium VI, PBB or PBDE). The similar regulation such as China RoHS is implemented in China. In Europe, Directive on waste electrical and electronic equipment (WEEE) is also implemented to reduce and recycle these wastes. REACH which restricts the chemicals in Europe entered into force on 1 June 2007, all of its Titles apply by on 1 June 2009. In accordance with the world's trend of restriction of hazardous materials, JRC has devoted itself to enhancing the Green Procurement to prohibit the use of hazardous materials to its products.

Secondly, regarding shipbreaking (The word "Ship Recycling" has recently been used instead of shipbreaking or ship scrapping because the efficiency of recycling of ship is so high compared with the efficiency relating to the recycling of cars etc.), in the 1980's, demolition of ships was active and Shipping Industry used to use the private form of contract for the sale of vessels. In 1987, BIMCO prepared "SALESCDRAP 87" as a form for sale of vessels for scrapping. After that, the issues of environment of ship scrapping yards and their worker's safety and health was often pointed out amongst countries, and then organizations related to Shipping Industry co-operated to develop the **"Industry Code of Practice on Ship Recycling"** (Hazardous materials are listed in it.) and accepted it in 2001. Accordingly, BIMCO reviewed "SALESCDRAP 87" and published it namely DemolishCOM in 2001. **Green Passport** is introduced in **"Industry Code of Practice on Ship Recycling"** for shipbuilders to use it for new ship building. However, such Code or form was not legally binding instrument. At the same time, from the point of view of inhibition of movement of hazardous materials to other countries through sale of ships, and from the point of view of sound environment, safety and health at ship scrapping yards, Parties to Basel Convention developed **"Technical Guidelines for the Environmentally Sound Management of the Full and Partial Dismantling of Ships"** (Hazardous materials are listed in it. It is referred to as "the Guidelines") and accepted it in 2002. This "the guidelines" is not mandatory as well, but Parties to the Basel Convention are encouraged to recommend it. IMO, in 1998, started to consider the issues related to environment, safety and health at ship scrapping yards on the basis of "the Industry Code" issued by the Shipping Industry and "the Guidelines" issued by the Parties to the Basel Convention, IMO prepared "IMO Guidelines on Ship Recycling" and accepted it (IMO resolution A.962(23)) in 2003. This includes the Hazardous Materials Lists annexed to aforementioned " the Industry Code" and "the Guidelines". Green passport is cited from the annex to "Industry Code" to this Guideline which recommends shipbuilders to minimize the hazardous materials at design stage and construction stage of new ship building. As for even the existing ships, shipowners are required to make every effort to minimize the hazardous materials and hazardous wastes aboard the exiting ships as well. For new ships, Green passport for individual ship should be prepared by shipbuilders and shipowners during shipbuilding, and for the existing ships, after commissioning, shipowners maintain it for the life of the ship, and when sold for recycling to recycling yard, it is to be handed over to recycling yard. Manufacturers may be required to co-operate with shipbuilders and/or shipowners and to submit the information of the hazardous materials in equipment to shipbuilders and/or shipowners if required.

Guideline etc. related to ship recycling, differ from RoHS etc. and is not to inhibit the hazardous materials, but it is intended to maintain the sound environment and workers' safety and health at recycling yards. IMO guideline shows the list of hazardous materials and their locations and amounts according to each item indicated in Green passport.

21-5-1 Green Passport

Green Passport is comprised of three parts such as Part 1, Part 2 and Part 3. (Detail is omitted)

(1) Part 1 (Potentially hazardous materials in the ship's structure and equipment)

- 1A. Asbestos
- 1B. Paint (on vessel's structure) - Additives
- 1C. Plastic Materials
- 1D. Materials containing PCBs, PCTs, PBBs at levels of 50mg/kg or more
- 1E. Gases sealed in ship's equipment or machinery
- 1F. Chemicals in ship's equipment or machinery
- 1G. Other Substances (e.g. Mercury, Radioactive materials etc.) inherent in ship's machinery, equipment or fittings

(2) Part 2 (Operationally generated wastes)

- 2A. Dry Tank Residues
- 2B. Bulk (non-oily) waste
- 2C. Oily Waste/Oily Residues

(3) PART 3 (Stores)

- 3A. Gases in store
- 3B. Chemicals in store
- 3C. Other Packaged items in store

Manufacturers of navigational equipment should take into account hazardous materials at design stage and/or production stage and at Green Procurement stage and pay attention particularly to handling of equipment in which hazardous materials are included. If the hazardous material is included, persons concerned should be informed of the way of handling of such equipment. Take radar wave oscillator for instance, as it corresponds to radioactive materials in 1G of Part 1, attention should be paid to handling it. After equipment or parts or component etc. including the hazardous materials, is replaced, removed one(s) should be managed according to the company's rule for the handling of hazardous materials.

21-5-2 Adoption of Ship Recycling Convention

The Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 was adopted on May 15, 2009 in Hong Kong.

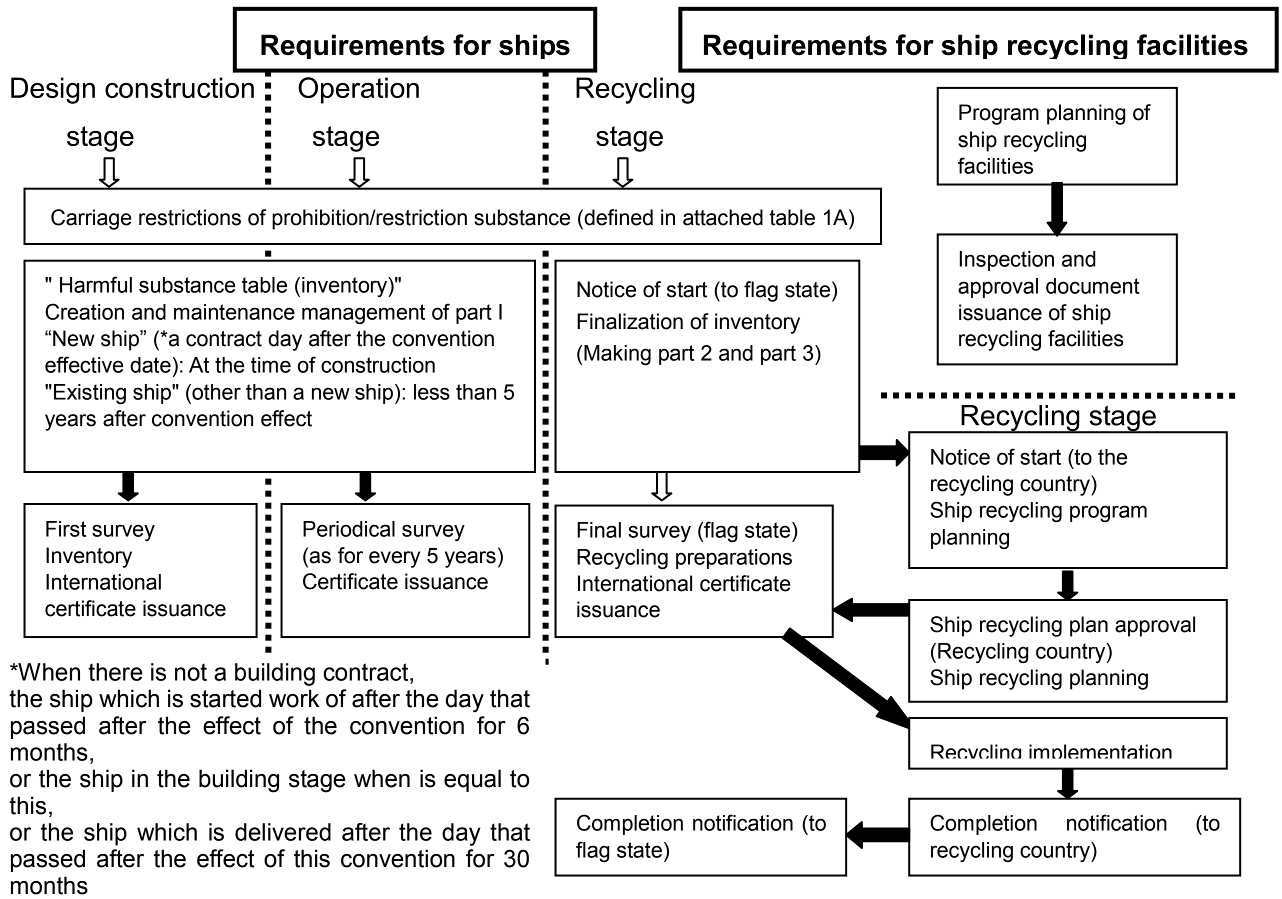
(1) Composition of convention

- Preface
- Article From article 1 to article 21
- Annex

  Chapter 1 - General Provisions, Chapter 2 - Requirements for Ships, Chapter 3 - Requirements for Ship Recycling Facilities, Chapter 4 - Reporting Requirements
- Appendix
- Guideline (Everything is already adopted until 2012.)

  Making of the harmful substance inventory, a ship recycling facility, a ship recycling program an approval of ship recycle facility, an inspection and certificate, PSC (Port State Control)

(2) The framework of the convention



Reference: Outline of ship recycling convention General foundation Nippon Kaiji Kyokai

(3) The effect requirements of the convention

It comes into effect 24 months later after achieving the following effect requirements.

The effect requirements	Possibility of coming into effect
1. More than 15 countries conclude.	Conclusion of EU accession country (28 nations, 20%)
2. Not less than 40% of merchant ship tonnage of conclusion Country (ship owner country provision)	It adds above and is conclusion of Panama (21%) and China (4%+7% of Hong Kong).
3. Sum total of the maximum annual demolition/removal ship tonnage in the latest ten years of conclusion country is not less than 3% of merchant ship tonnage of conclusion country. (demolition/removal country provision)	It adds above and is conclusion of India.

Ratification member nation: Norway (March 2013), Congo (May 2014), France (July 2014)

Signatory: France, Italy, Netherlands, St. Christopher and Nevis, Turkey

The country under work

Japan: The Ministry of Land, Infrastructure and Transport is adjusting with positive to early ratification, and relevant ministries and agencies.

European countries: The European Commission has declared the strategy of welcoming a ship recycling convention to ship recycling.

China: The recycling facility which suits a convention is improved and it is positive to ratification.

India: The government is planning to ratify although the opposition from a domestic recycling facility contractor is strong.

(4) Harmful substance inventory

- The definition of an inventory

A harmful substance table (an inventory, IHM) is the list which indicated "the quantity and the whereabouts of a harmful substance, waste, and stocks which exist onboard."

- The purpose of an inventory

The following effect is acquired by clarifying the information on the harmful substance which exists onboard.

- Reservation of workers' safety and hygiene in a recycling facility
- Prevention of environmental pollution
- Development of the substitute of a harmful substance, promotion of resource effective use

- Application ship

Merchant ships more than international gross ton 500GT

* Inapplicability " During life, the ship engaging only in a domestic voyage is excluded."

(5) Composition of an inventory

(6) Details of a substance indicated in Table A and Table B

(7) The items indicated in Table C and Table D

(8) Style of an inventory Part 1

(9) Style of an inventory Part 2, part 3

The (5) - (9) clause above-mentioned is omitted.

(10) Inventory creation of a new ship

- Create the inventory of a new ship in a shipyard.
  - Step1: Collection of harmful substance information

    As a general rule, the shipyard collects **Material Declaration (MD)** and **Supplier's Declaration of Conformity (SDoC)** from a supplier (maker, trading company, agency) about all procurement product.
  - Step2: Sorting of the information collected

    The product which contains a harmful substance about the collected Material Declaration exceeding a threshold value is sorted out.
  - Step3: Creation of inventory

    About the product sorted out, it arranges for every classification and the whereabouts (location) on the ship is indicated in the form of an inventory.

(11) Creation of an existing ship inventory

Omission

21-5-3 Relation between a green passport and a ship recycling convention

A green passport is created based on the guideline (IMO Resolution A962 (23)) of the unforce which IMO defined, and a specific creation procedure over an existing ship is not indicated.
An inventory is a compulsory thing demanded based on the convention after ship recycling convention effectuation. Even if it holds the green passport, the requirements based on a ship recycling convention are not eased.
Moreover, although there is mention of the harmful substance in the green passport which an existing ship has, in a ship recycling convention, the procedure of inventory creation is defined and an inventory must be created according to this procedure. Therefore, it cannot be considered that a green passport is an inventory of a ship recycling convention.
However, it seems that practical use is possible as reference at the time of a specialist creating an inventory since four substances which have been the inventory creation objects of the existing ship are the substances of a object of a green passport.

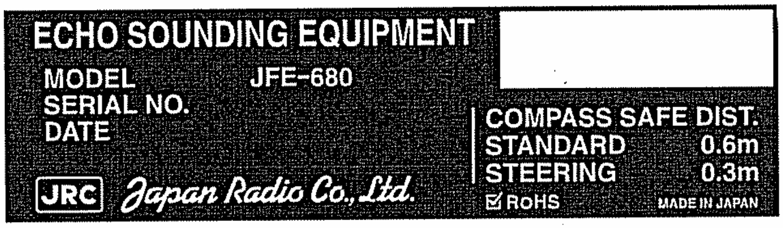
21-6 RoHS Marking and Affixing RoHS Marking on JRC Products

In order to recognize whether JRC products conform to the RoHS requirements, RoHS Marking is shown as a sample below.

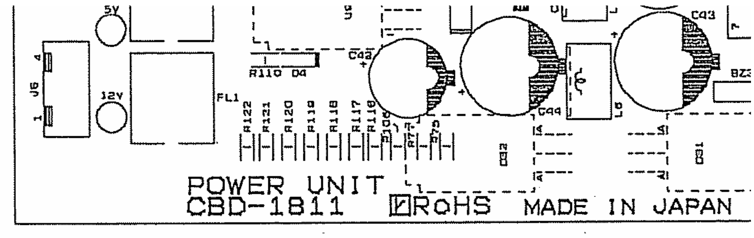
(1) RoHS marking

☑ RoHS

(2) Affixing RoHS marking on a product name plate



(3) Indication of RoHS marking on a UNIT



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World Marine Radio Communications Data / Japanese Marine Radio Station List 2014	Musen Tsuushin-sya
Ship Electricity Equipment Technical lecture (radar) Volume on AIS/VDR/GPS	Ship's Electric Installation Contractor's Association of Japan
Wide star area figure	NTT DoCoMo

Reference Homepage

Class NK Technical Information	Nippon Kaiji Kyokai
Radio Equipment Carried in a Small Ship (an example of the carriage requirements)	Japan Craft Inspection Organization
JMH (weather radio facsimile report) schedule	The Ministry of Land, Infrastructure and Transport Meteorological Agency homepage
Radio fax broadcast plan tables, such as fishery oceanic condition information	Japan Fisheries Information Service Center

* Additionally there is mention of the reference URL in the text.

Editor's postscript

6 years has passed since the 5th edition is issued in March, 2009 and we have obtained the opportunity to be able to issue the 6th edition this time. Meanwhile, it was necessary for decision of the reorganization of the publication items, a request and the editing of the manuscript to each department for about 1 year in considering it such as a technological change, the revision of the law and an environmental change to surround the field.
About the law in particular, we are referring to a radio law, a ship safety law and a related law and are reflected this. However, since the revision after the editing does not reflect it, please refer to the latest information by each person.

Since the skill of the engineer of the field leads to evaluation of equipment itself, and also evaluation of the company itself, the demand from a customer and expectation also become large. We are pleased, if this handbook becomes an aid of work in the field so that it may respond to them.

Please contact us the findings and the opinion on description content below.

March, 2015

Editor

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