

# FURUNO

# OPERATOR'S MANUAL

AUTOPILOT

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MODEL FAP-330

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**FURUNO ELECTRIC CO., LTD.**  
NISHINOMIYA, JAPAN

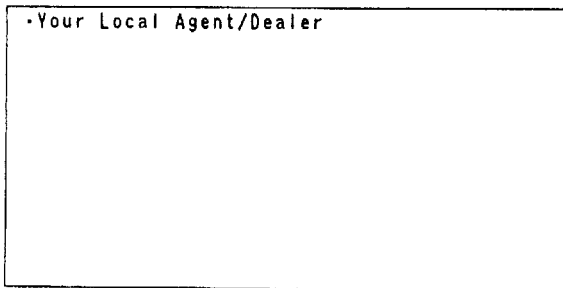
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-Your Local Agent/Dealer



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FAP-330





# SAFETY INSTRUCTIONS

"DANGER", "WARNING" and "CAUTION" notices appear throughout this manual. It is the responsibility of the operator and the installer of the equipment to read, understand and follow these notices. If you have any questions regarding these safety instructions, please contact a FURUNO agent or dealer.



**DANGER**

This notice indicates a potentially hazardous situation which, if not avoided, will result in death or serious injury.



**WARNING**

This notice indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



**CAUTION**

This notice indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury, or property damage.

# Safety Instructions for the Operator

## **WARNING**

**Do not disassemble or modify the equipment.**

Fire, electrical shock or serious injury can result.

**Turn off the power immediately if water leaks into the equipment or the equipment is emitting smoke or fire.**

Continued use of the equipment can cause fire or electrical shock.

**Do not operate the equipment with wet hands.**

Electrical shock can result.

**Keep heater away from equipment.**

Heat can alter equipment shape and melt the power cord, which can cause fire or electrical shock.

**Do not set the course changing speed too high.**

The boat will be turned too sharply at the course change, which could create a very dangerous situation.

## **WARNING**

**Do not use the autopilot at the following times:**

- Harbor entrance or narrow channel
- Where vessels change course often, such as a cape or small island

**Observe the following cautions when using the autopilot:**

- Maintain a vigilant watch
- Watch for drifting of vessel

**In an emergency situation manually steer the vessel.**

The autopilot cannot dodge vessels, etc. automatically.

## **CAUTION**

**In case of power failure turn off the autopilot or manually steer the vessel.**

Leaving the equipment in the AUTO or NAV mode in this situation will cause wear on the rudder mechanism.

**Use the proper fuse.**

Use of a wrong fuse can result in fire or permanent equipment damage.

**Only qualified personnel should work inside the equipment.**

# Safety Instructions for the Installer



## **WARNING**



Turn off the power at the mains switchboard before beginning the installation. Post a sign near the switch to indicate it should not be turned on while the equipment is being installed.

Fire, electrical shock or serious injury can result if the power is left on or is applied while the equipment is being installed.



## **CAUTION**



Ground the equipment to prevent electrical shock and mutual interference.

**Confirm that the power supply voltage is compatible with the voltage rating of the equipment.**

Connection to the wrong power supply can cause fire or equipment damage. The voltage rating appears on the label at the rear of the display unit.

**Use the correct fuse.**

Use of a wrong fuse can cause fire or equipment damage.

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# 1. PRINCIPLE OF OPERATION

An autopilot is a system connected to the ship's steering gear to automatically control rudder movement in order to steer the ship on a set course. Anyone can appreciate the advantages of being free to carry out navigational checks, trim adjustments, or simply to relax and enjoy himself.

To better understand how the autopilot system works, a brief knowledge of the history of the autopilot is necessary.

The first generation autopilot was developed in the 1930's. Off-course error was detected by a contact wire. The contact is made when the boat moves to one side of the desired course, the contact is broken when the boat moves to the other side. This causes the boat to continually "hunt" back and forth across the correct heading. Hence, the name hunting autopilot.

Although the components in this type of autopilot are relatively simple, the constant zig-zagging across the correct heading decreases fuel economy and increases wear and tear on the autopilot and the steering system.

The second type of autopilot, which was developed in the late 1940's, utilizes two contacts, one for port off-course, and one for starboard off-course. If the boat is on course neither contact is made, resulting in a small arc, or deadband. When a heading error greater than the deadband is detected, the helm is moved in the appropriate direction in an amount proportional to the heading error. As long as the boat remains on a course within this deadband, the helm is at rest.

One of the advantages of this type of autopilot is that it eliminates the constant zig-zagging across the heading. However the boat still may wander within the deadband, thus the course is usually not as tight as desirable.

The latest generation of autopilots, the FAP-330 included, utilizes a proportional rate system to steer the boat. The proportional rate system is similar to the highly accurate and reliable system used on aircraft, missiles, and space vehicles. The proportional rate autopilot provides the necessary course correction to the helm proportional to the speed and the amount the boat moved off-course.

With the removal of the deadband (NAV Mode), the autopilot no longer wanders within a deadband but now steers a prescribed course, taking action within the presence of even a minute course error. The amount of action depends on the course error detected; i.e., when the course error rate is small a very low helm correction rate is applied.

Because the wandering is eliminated, the proportional rate autopilot has the advantages of low power consumption and low wear and tear on the autopilot and the steering system. Off-course correction is smooth, not jerking back and forth at full speed.

The force necessary to steer the boat back onto the set course is provided by a power or drive unit.

Now lets see how an off-course error is detected and how the boat is steered back onto the set course. Figure A on the next page shows a simplified block diagram of the autopilot.

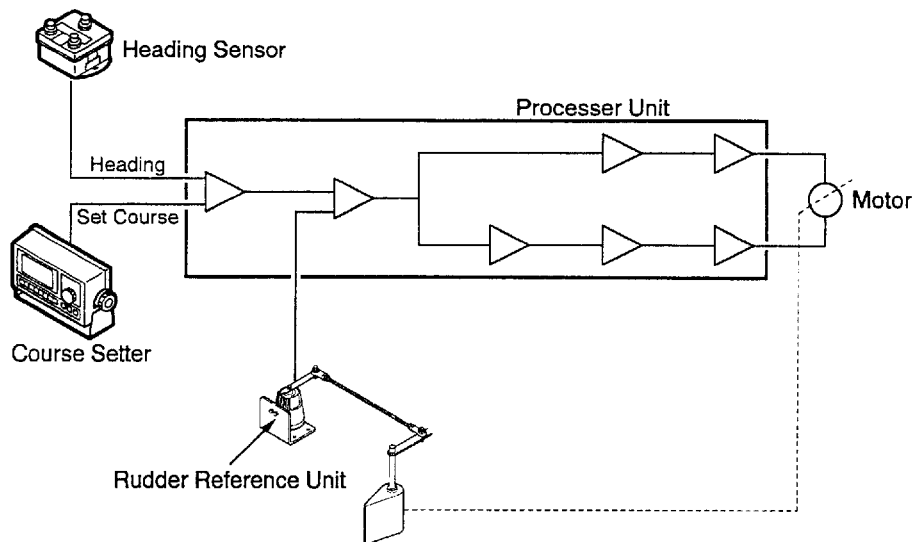


Fig. 1-1 Simplified Block Diagram of the Autopilot

In the AUTO mode, the primary heading information from the (fluxgate sensor) is continuously compared with the set course. With the boat on course, the two signals are equal.

Once the boat goes off course, the difference between the primary heading and the set course will change proportionally and there will be an imbalance at the comparator, whose output will move up or down depending on whether the course error is to the left or right of the set heading.

The rudder continues to move until a balanced condition is obtained at the comparator, at which point the drive switches off.

To set the rudder when the boat is off-course, the rudder angle is generated at the rudder reference unit, then fed back to the processor unit.

**Although the autopilot is capable of steering a steady course for the helmsman, it cannot think for him. Always post a lookout while under way and never use the autopilot in congested harbors or areas of heavy traffic.**

**As a final note of caution, it must be remembered that no machine can perform to the utmost of its ability unless it is installed and maintained properly. The reliability and performance of your autopilot is directly related to the quality of the installation. The installation is one of the most complicated of all marine electronics equipment and is best left to a qualified technician. Happy sailing.**

# 2. SYSTEM CONFIGURATIONS

## 1. Hydraulic steering boat with engine pump

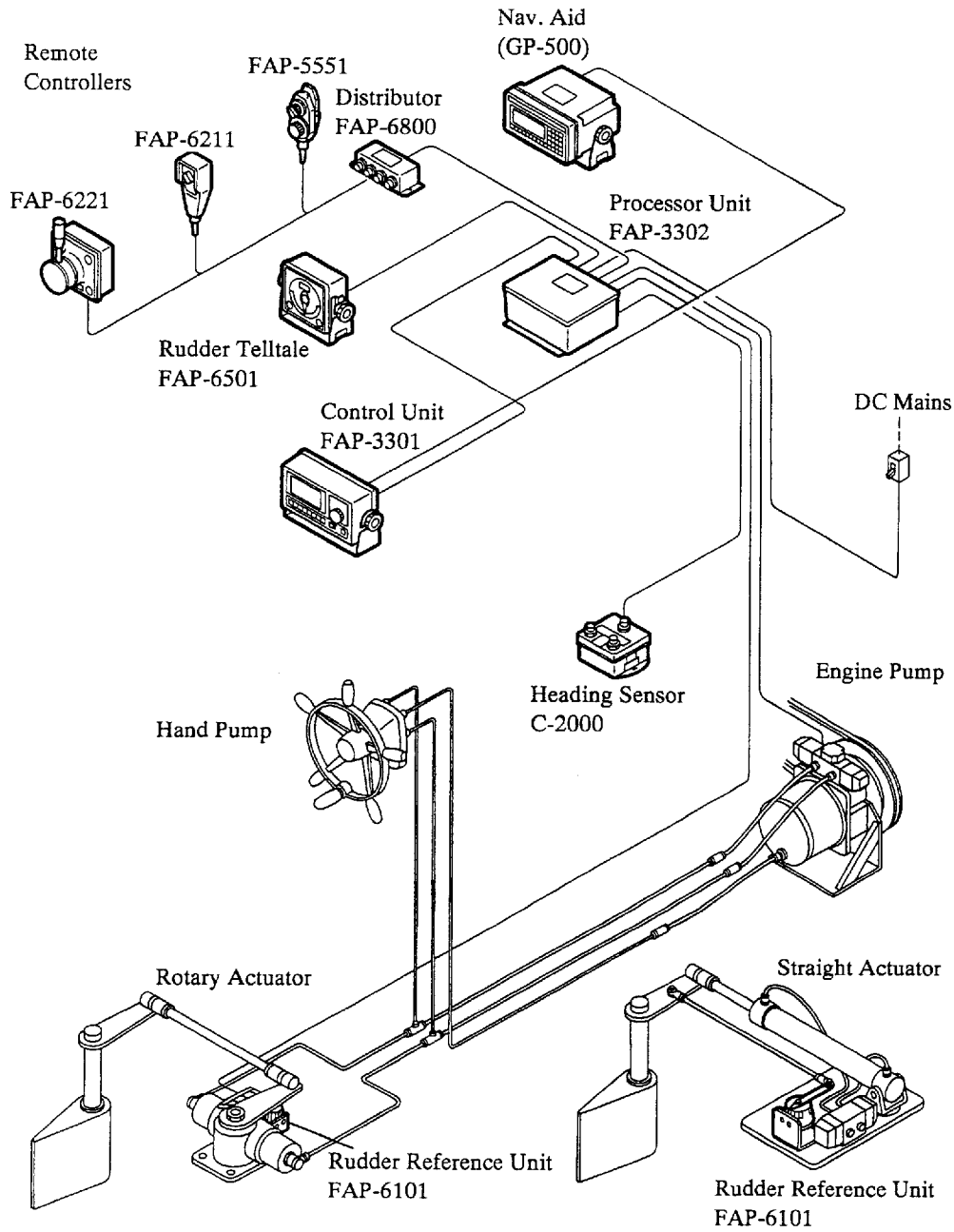


Fig. 2-1 Hydraulic steering boat with engine pump

## 2. Hydraulic steering boat with engine pump and valve unit

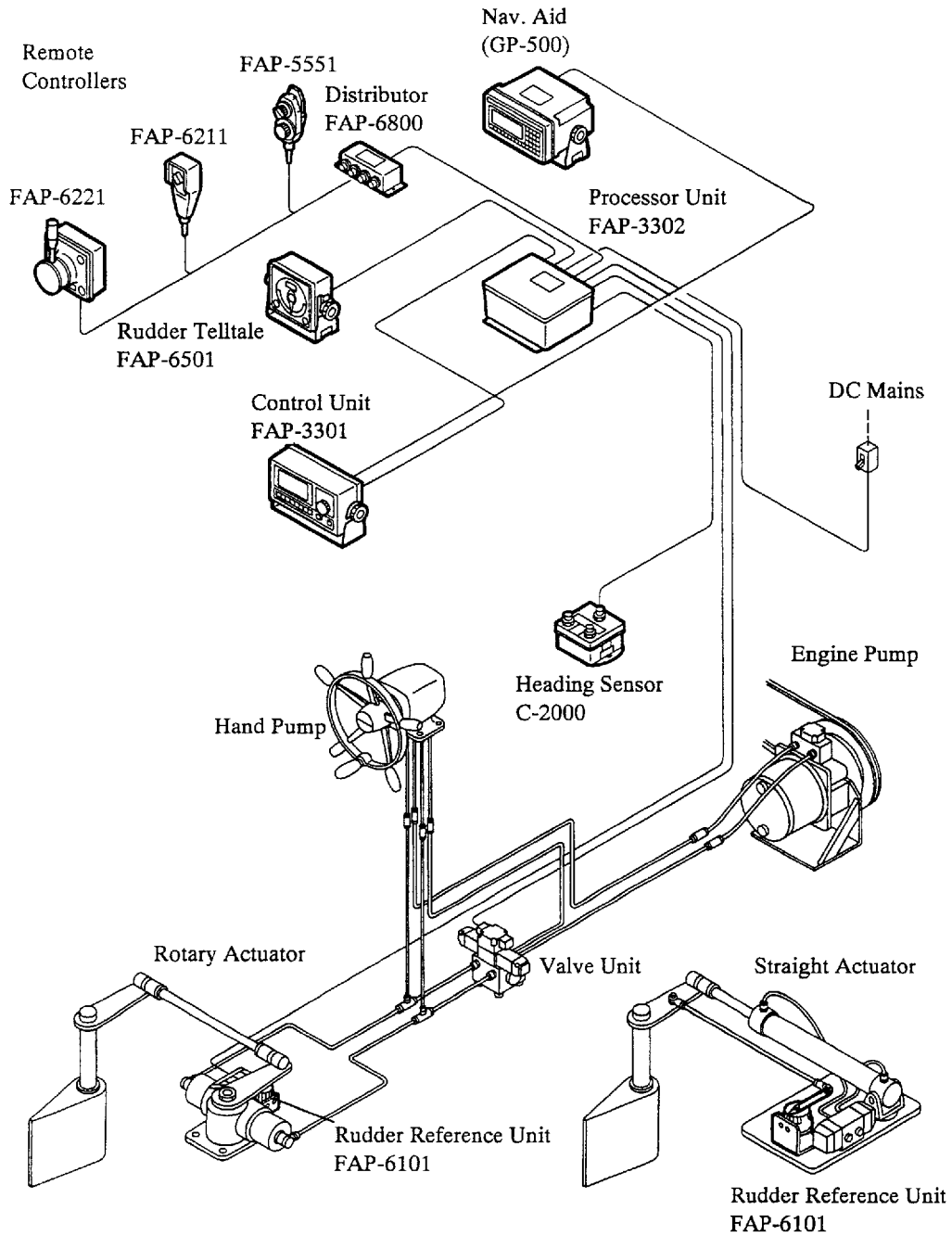


Fig. 1-1 Hydraulic steering boat with engine pump and valve unit

### 3. Hydraulic steering boat with motor pump

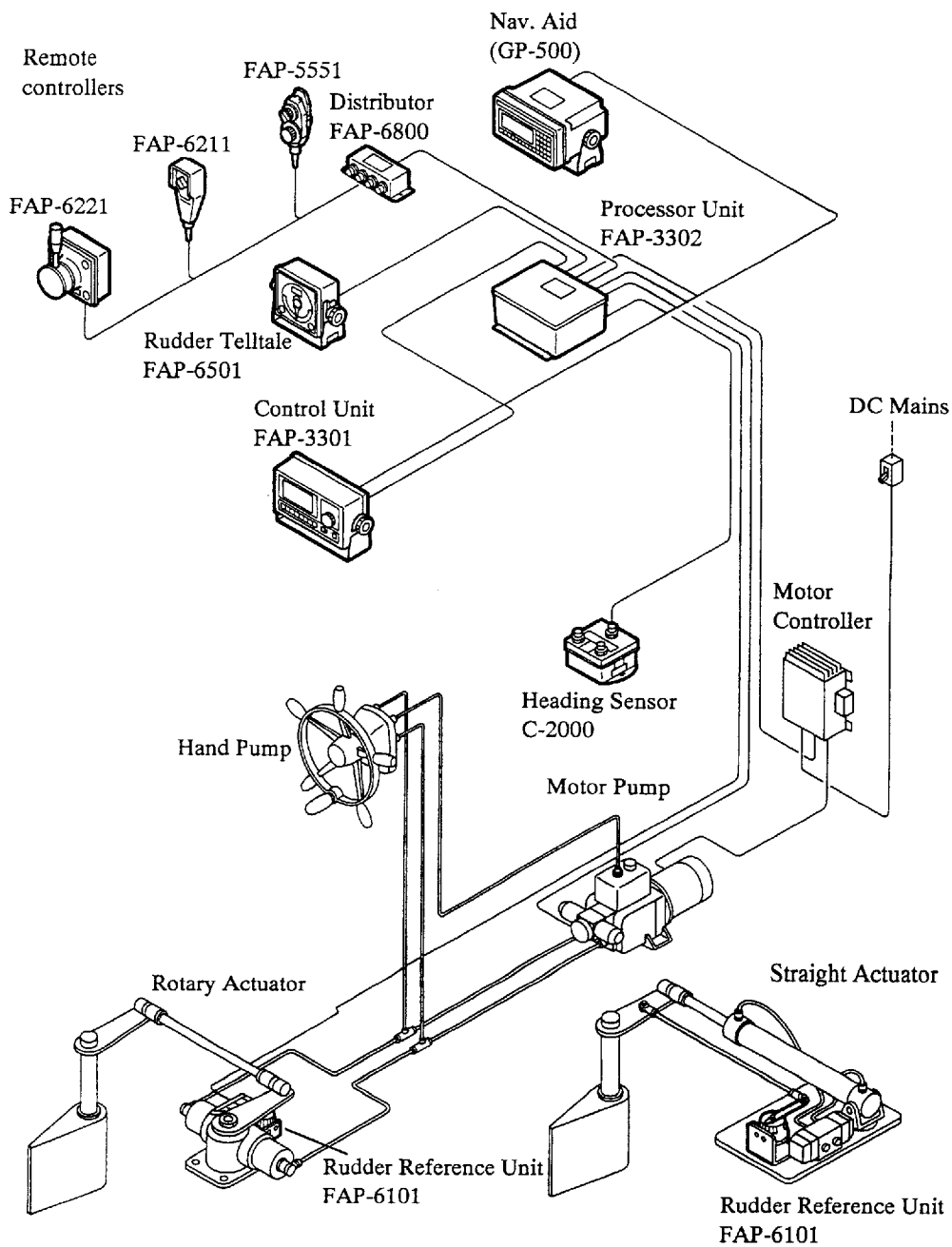


Fig. 1-1 Hydraulic steering boat with motor pump



# 3. CONTROL PANEL LAYOUT

Operation of the FAP-330 may be done from the control unit or the remote controller.

## 1. Control Unit (FAP-3301)

### 1) LCD display

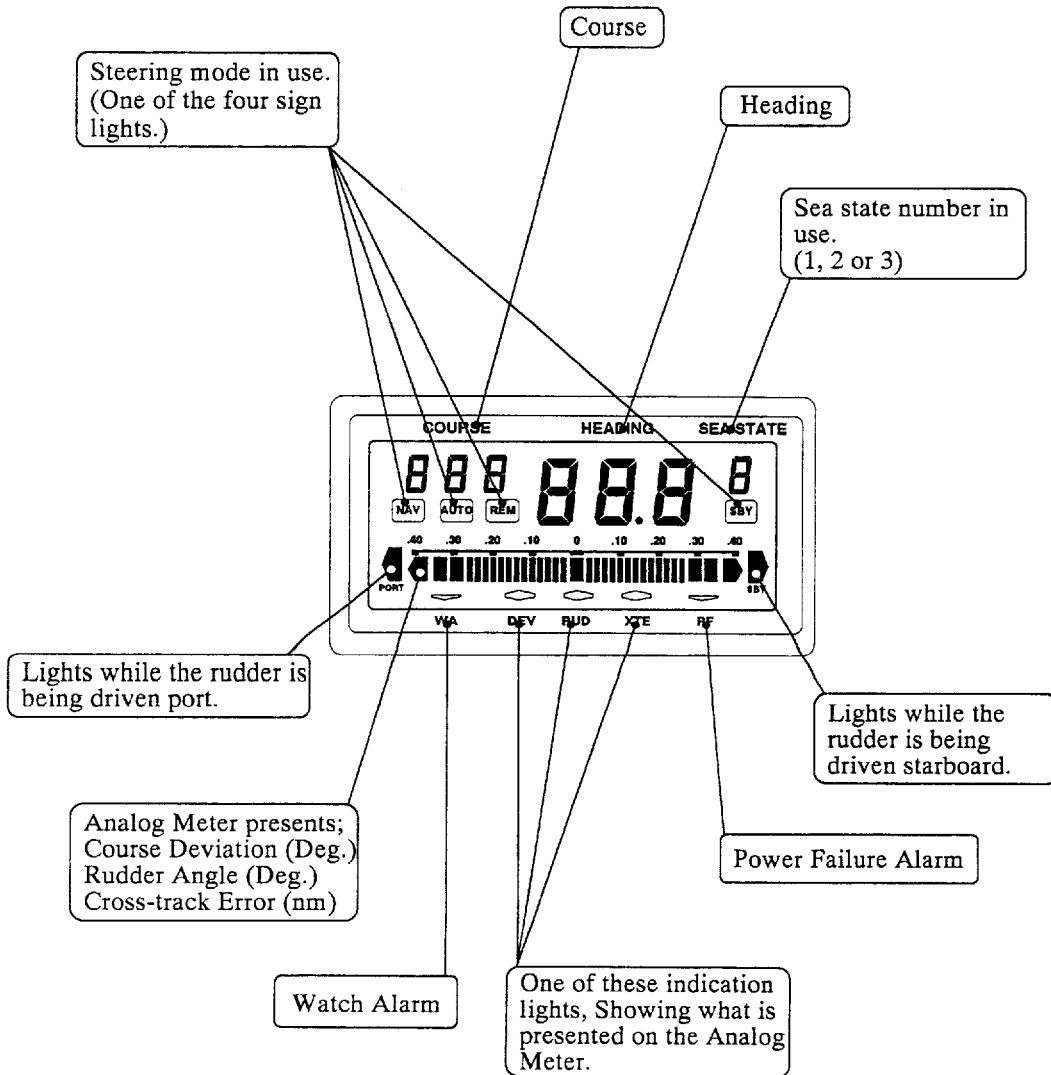


Fig. 3-1 LCD display



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## 2) Key pad

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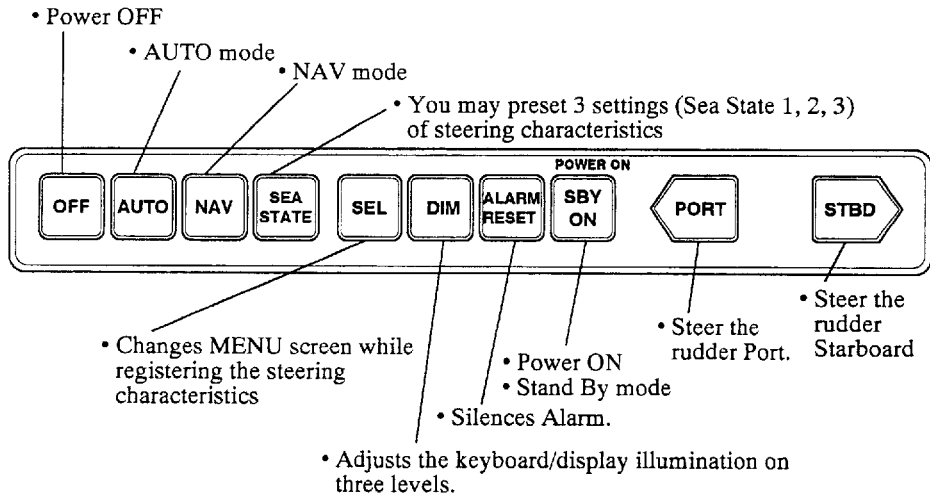


Fig. 3-2 Showing functions of the key

### **Key-pressing Acknowledgment Beep**

A press of any key is acknowledged by a short beep. When an illegal key stroke is detected, two short beeps will be generated. In this case press the desired key(s) again.

---

## 3) Course control

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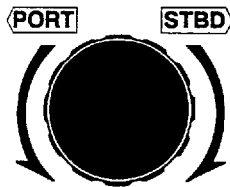


Fig. 3-3 Course control

Turn the dial to change the course at AUTO mode. The course may be set in 1 degree steps.

## 2. Rudder Telltale (FAP-6501)

(Optional supply)

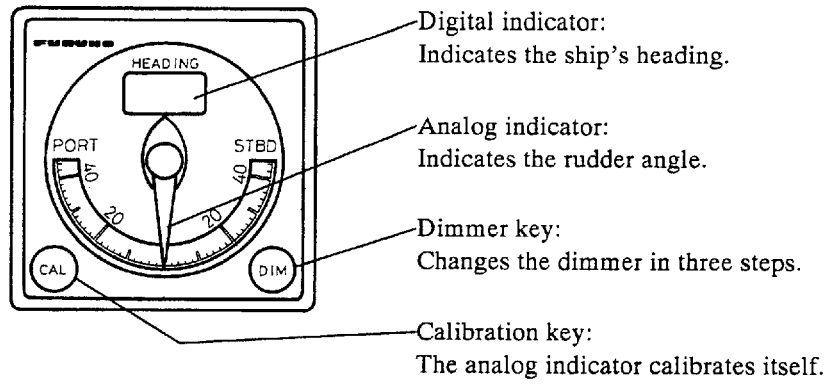


Fig. 3-4 FAP-6501



# 4. OPERATING PROCEDURE


## 1. From departure to arrival (How to use the AUTO mode)

---

### 1) Turning on the FAP-330

---

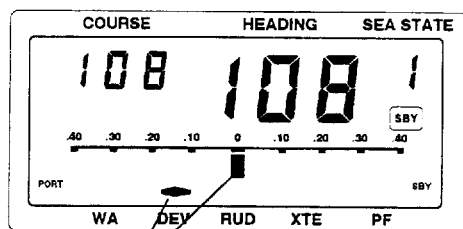
#### Procedure

Press  key to turn on the FAP-330.

The FAP-330 is turned on and a long beep is generated.

The selftest procedure is conducted for 5 seconds.

The FAP-330 goes into the SBY node;  
(The boat's wheel may be turned manually when in SBY mode. )



Rudder angle is read out.

Fig. 4-1 STB mode indication

---

#### **NOTE :**

A "PF" sign presentation at power on does not indicate power failure.  
At this time please ignore it.


---


---

## 2) Selecting a SEA STATE setting

---

As detailed in chapter 5, you may preset three sets of autopilot steering characteristics. Select one of the characteristic sets (1, 2 or 3) in accordance with the present sea and vessel loading conditions.

Press .

Select a set number by pressing .

The selected SEA STATE number is presented.

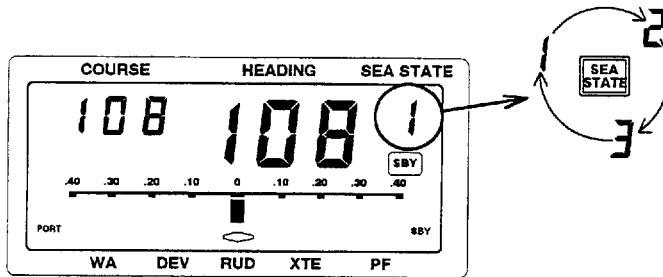


Fig. 4-2 Sea state number selection

---

### 3) Manually steer the vessel

---

Sail out of the harbor and steer the vessel manually. Do not use the AUTO or NAV mode (mentioned later on) in a congested area.

When the vessel enters the open sea, head the vessel to the desired destination.

---

### 4) Heading to the destination in the AUTO mode

---

— **NOTE :** —

*When the AUTO mode is selected with a FAP-5551 (remote controller) turned on, a beep is generated and the "REM" indication blinks. In this case, turn the remote controller off.*

---

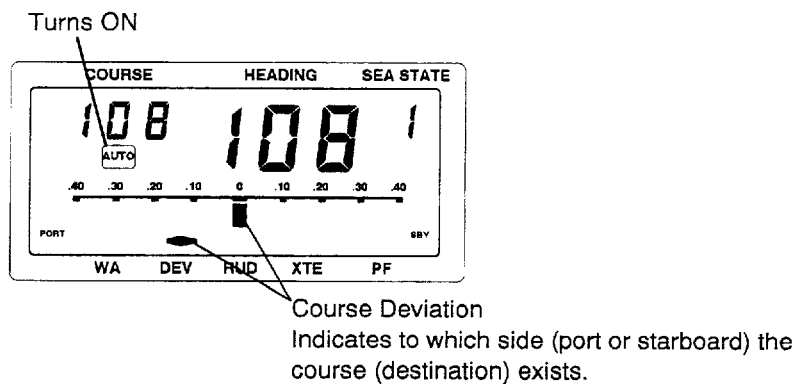


Fig. 4-3 AUTO mode indication

Adjust the desired course reading by turning the course control left or right.

When ever the heading deviates from the set course, the FAP-330 automatically adjusts the rudder to return the vessel to the set course. To change or readjust the course setting in the AUTO mode, simply turn the course control.

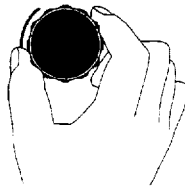




Fig. 4-4 Setting the course

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## 5) Dodging other boats or objects in the course

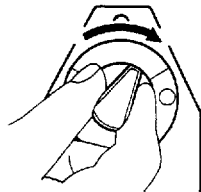
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### 1) By turning the wheel manually (SBY mode)

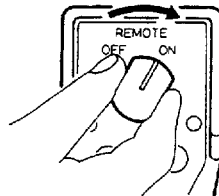
1. Press .
2. Dodge other boat or object, then direct the vessels heading to the destination by turning the wheel manually.
3. Recall the AUTO mode by pressing , and adjust the course control for the correct course reading on the digital display.

### 2) When using the remote controller (REM mode)

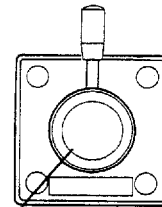
1. Turn on the remote controller switch.  
The FAP-330 goes into the REM mode which is similar to the SBY mode.



FAP-5551



FAP-6211



FAP-6221

Pull

Fig. 4-5 Turning ON the remote controller

2. Dodge other boat or object, then direct the heading to the destination. Turn the steering dial (FAP-5551) or press the button (FAP-6211) or switch the lever (FAP-6221).

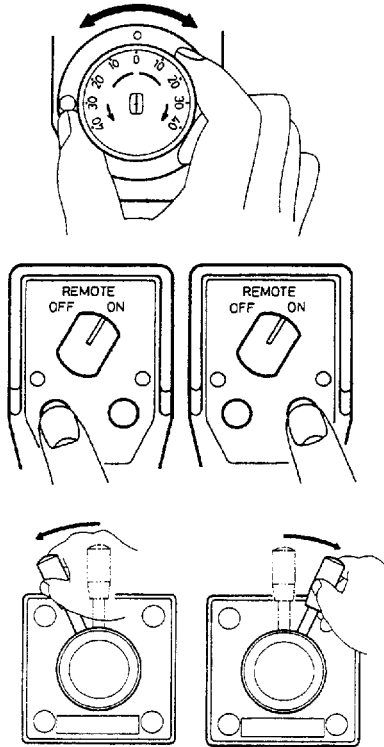


Fig. 4-6 Dodging with the remote controller

3. Turn off the remote controller, and the previously used mode (AUTO) is recalled. Adjust the course control for the desired course reading on the digital display.

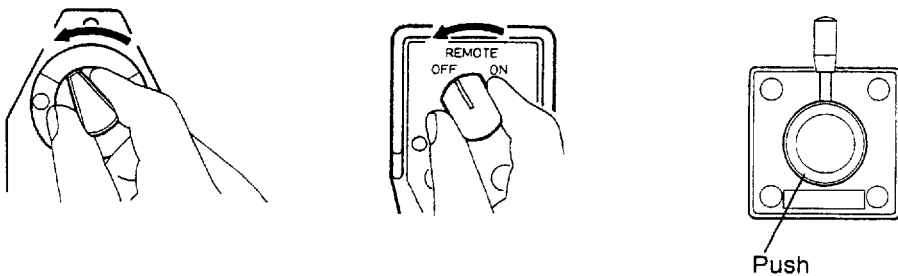




Fig. 4-7 Turning OFF the remote controller

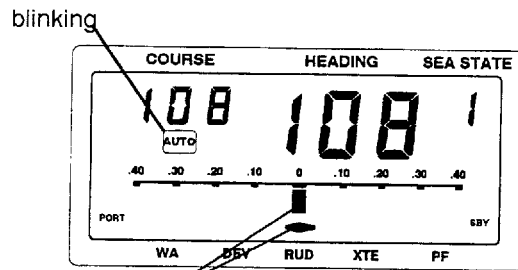
The heading after using the remote controller can be one of the followings:

- a) The heading before using the remote controller
  - b) The heading at the moment the remote controller is turned off.
- Refer to page 5-15 for detail.



### 3) By using dodge keys (DODGE mode)

1. Dodge other boat or object by steering the rudder with  or .  
Hold down both keys to lock in the course.
2. The rudder angle is presented on bar indicator.



Rudder angle is read out.


Fig. 4-8 Indication while dodging

3. Release the keys.  
The FAP-330 returns to the previously used mode (AUTO).

---

### 6) Arrival by manually steering the vessel


---

When approaching the destination, press  and steer the vessel manually.

---

### 7) Turning off the FAP-330

---

Press  to turn off the FAP-330.

The FAP-330 is turned off.

Manual steering is available.

---

#### ***A NOTE WHEN THE BOAT IS NOT RUNNING.***

---

*While the mode is AUTO or NAV, the rudder is continually driven even the boat is not running. In order to save the battery power and prevent the rudder driving mechanism wear, it is recommendable to place the FAP-330 in the SBY mode or turn off the input power.*

---

## 2. From departure to arrival (How to use the NAV mode)

### NOTE:

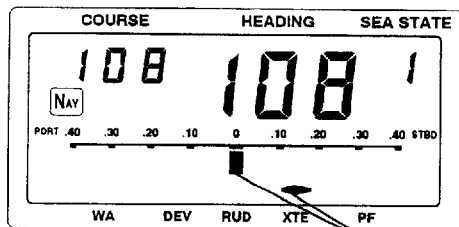
1. For the NAV mode operation, an external navaid must be connected to FAP-330. Turn it on and select a TO WAYPOINT before hand.

The navaid knows the present position and the TO WAYPOINT location. The FAP-330, while receiving this information, adjusts the course direction automatically and guides the boat to the TO WAYPOINT. The operating procedure from the departure to arrival is basically same as 1) thru 7) described at section 1 of this Chapter, but conduct the following operation in the place of “4) Heading for the destination by AUTO mode” and “5) Dodging other boat/object in the course.”  
The following paragraph will describe.

### 1) Heading for the destination by the NAV mode

After directing the boat’s heading to the destination, press **NAV**.  
The FAP-330 goes into the NAV mode.

The Course is set automatically so that the boat sails on the intended trackline. When **NAV** is pressed, the heading at that moment becomes the course, and thereafter the course changes automatically in order to follow the intended track line.  
The course reading on the FAP-330 is not always equal to the waypoint direction which is presented on the navaid.



Cross-track error (NM)  
Indicates to which side (port or starboard) of the intended track line your boat is thrown off.

Fig. 4-9 NAV mode indication

### NOTE:


1. If navigational information is not received properly, a long beep is generated, the “NAV” indication blinks, then the previously used mode is recalled automatically.
2. If the boat's position is far away from the intended track line, CROSS-TRACK ERROR WARNING will be activated. See next page.

The FAP-330 automatically adjusts the rudder so that the boat follows the intended track line connecting the FROM and TO WAYPOINTS.

---

— **About CROSS TRACK ERROR WARNING** —

---

When the cross-track error exceeds 0.4 nm, the XTE indication blinks, and a beep is generated repeatedly. Press  to silence the beep.

---

---

## 2) Dodging other boats or objects in the course


---

— **NOTE :** —

---

*The dodging operation may be conducted in the same manner as the AUTO mode. When the REM or DODGE mode is selected, "NAV" will blink to indicate that the NAV mode will be recalled when the REM or DODGE mode is terminated.*

---

When an arrival alarm information is transferred from the navaid, the course reading blinks and beep is generated. Press  to silence the beep.

# 5. MODIFYING STEERING CHARACTERISTICS

When using the FAP-330 during an actual voyage, it may be necessary to modify the steering characteristics. This chapter shows the operating procedures and guidance in adjusting the characteristic values. Default setting "Type 1" and "Type 2" may be switched with the DIP switch in the processor unit. The default setting is "Type 2".

## 1. List of Adjustments

— *Sea State 1, 2, 3:* —

As you see in the table below, three settings (①, ② and ③) of WEATHER, RUDDER RATIO and COUNTER RUDDER may be preset. In a voyage, you may use one of the three settings in accordance with sea conditions.

Item	Adjustment	Default					
		Type 1			Type 2		
		①	②	③	①	②	③
Weather	To prevent frequent steering in bad weather.	3	5	7	2	3	4
Rudder Ratio	To adjust the amount of rudder reaction versus course deviation.	4	5	6	3	4	5
Counter Rudder	To prevent excessive turning by inertia in course changing.	0	0	0	0	1	2
Trim	To offset the influence of current and wind.	0			0		
Automatic Trim Sensitivity	To adjust the sensitivity in monitoring the boat's trim.	5			7		
Rudder Angle Limitation (AUTO, NAV)	To limit the maximum rudder angle for safety in AUTO and NAV mode.	5			5		
Rudder Angle Limitation (REM, DODGE)	To limit the maximum rudder angle for safety in REM and DODGE mode.	8			6		
Rudder Dead Band	To prevent the rudder from hunting.	A (Automatic)			A (Automatic)		
Course Changing Speed	To adjust the course changing speed by the FAP-330.	3			5		

Item	Adjustment	Default	
		Type 1	Type 2
Remote Controller Number 1	To select the course after using the number 1 remote controller.	H	H
Remote Controller Number 2	To select the course after using the number 2 remote controller.	H	H
Plotter Connection	For future use.	0	0

## ***2. Record of steering characteristics***

Item	Default						Settings
	Type 1			Type 2			
	①	②	③	①	②	③	
Weather	3	5	7	2	3	4	
Rudder Ratio	4	5	6	3	4	5	
Counter Rudder	0	0	0	0	1	2	
Trim	0			0			
Automatic Trim Sensitivity	5			7			
Rudder Limit Angle (AUTO, Nav)	5			5			
Rudder Limit Angle (REM, DODGE)	8			6			
Rudder Dead Band	A (Automatic)			A (Automatic)			
Course Changing Speed	3			5			
Remote Controller Number 1	H			H			
Remote Controller Number 2	H			H			
Plotter Connection	0			0			

### 3. Before the modification

The FAP-330 employs two adjusting modes. One is “TECHNICIAN MODE” and the other is “USER MODE”. The factory setting is “USER MODE”. The technician mode allows 12 items of adjustment. The user mode allows 5 items. They are as follows:

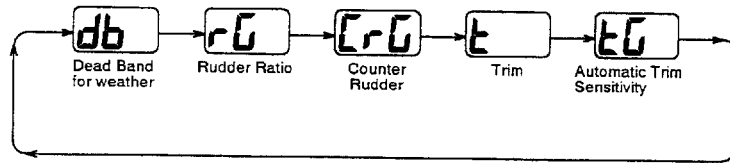


Fig. 5-1 Five adjusting items for USER mode

To change to “TECHNICIAN MODE”, turn ON the equipment while holding down **SEL**.

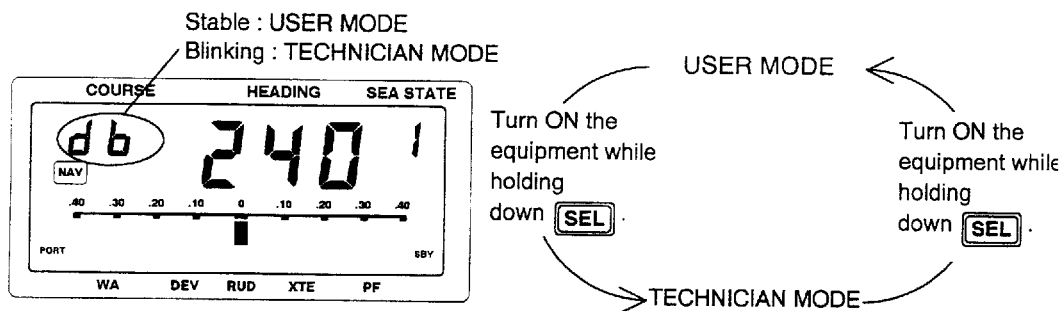


Fig. 5-2 Mode identification

After the modification, turn ON the equipment while holding down **SEL** to set the adjusting mode to “USER MODE”. The mode after turning on is the previous mode.

It is recommended to operate the FAP-330 at “USER MODE” while running the boat. Only the five items are needed to adjust for best performance. Not all the items of “TECHNICIAN MODE” is needed.

## 4. Adjustment

Press **SEL** to go into the Adjustment mode

The adjusting item is presented on COURSE presentation. Confirm this is blinking. Blinking shows "TECHNICIAN MODE" and stable shows "USER MODE".

If the presentation is not blinking, perform the sequence again to change the mode.

Every pressing of **SEL** changes the "Course" presentation as follows.

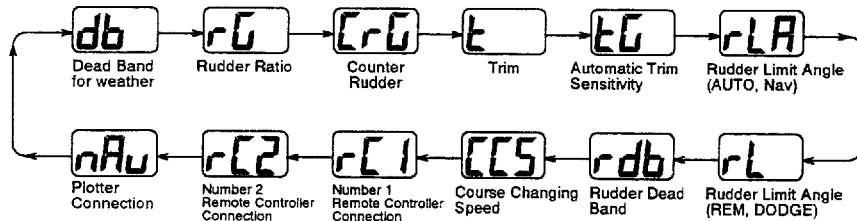


Fig. 5-3 Twelve adjusting items for technician mode

**Weather**  
**Rudder ratio**

*(Prevents frequent steering in bad weather.)*

*(Adjusts the amount of rudder reaction versus course deviation.)*

**Counter rudder**

*(Prevents excessive turning by inertia in course changing.)*

Three sets, of above-mentioned characteristics may be registered.

Press **SEL**.

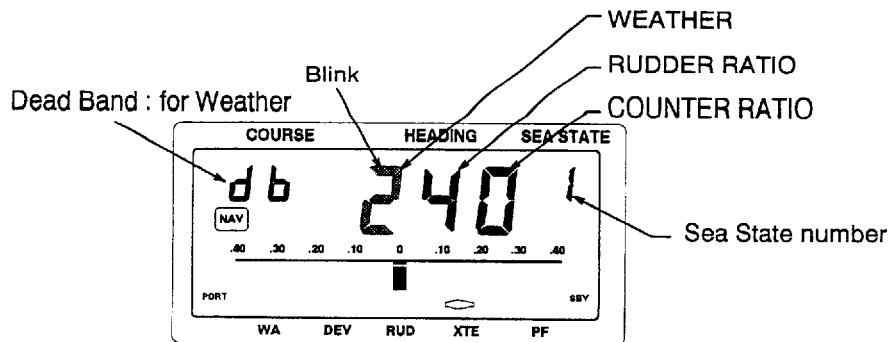


Fig. 5-4 Adjusting weather

The WEATHER value becomes adjustable, and its value blinks.

Press **SEA STATE** to change the sea state number.

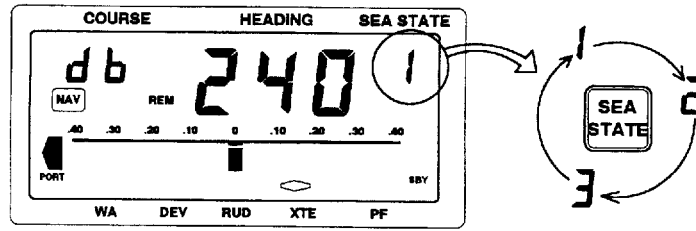


Fig. 5-5 Change sea state number

The Sea state number may be changed any time during “Weather” “Rudder Ratio” “Counter Rudder” adjustment.

Change the value with control dial.



One notch for each increment.

Fig. 5-6 Changing the value

#### About WEATHER.

When the sea is rough, the boat’s heading wanders between port and starboard. If the rudder is driven very often to maintain the set course, the helm mechanism may wear. In order to prevent this, the WEATHER adjustment makes the FAP-330 insensitive to a minute course deviations.

You may choose a deadband among the following nine. Until the course deviation exceeds the selected deadband, steering to correct the heading will not be initiated.

Value	1	2	3	4	5	6	7	8	9
Dead Band	0	± 0.5°	± 1.0°	± 1.5°	± 2.0°	± 2.5°	± 3.0°	± 4.0°	± 5.0°

The following illustrations show boat’s track lines with weather settings 3 and 7. When 7 is set, the rudder is not driven until the course deviation exceeds 7 degrees. Increasing the setting reduces chattering of the rudder, however the boat tends to zigzag.



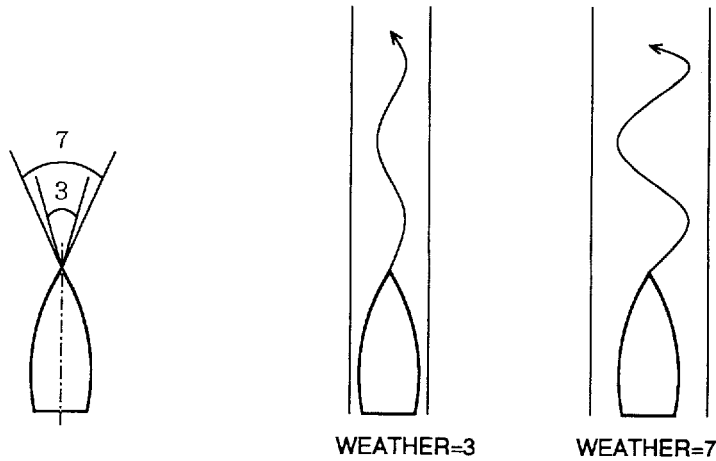


Fig. 5-7 Track line versus value

When favorable sea conditions exist, a setting of “1” or “2” will be appropriate. For rough seas, a higher setting is required.

Press **SEL** to proceed to the next step.

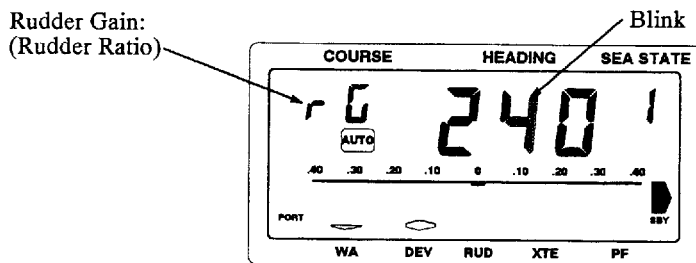


Fig. 5-8 Adjusting rudder ratio

The RUDDER RATIO value becomes adjustable, and its value blinks.

Change the value with the control dial.

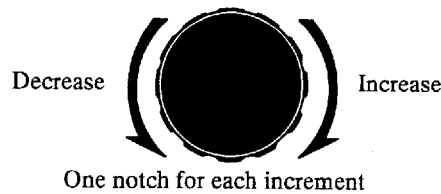


Fig. 5-9 Changing the value

When the boat’s heading deviates from the set course, the FAP-330 adjusts the rudder to correct it. The rudder angle (number of degrees) which is steered against every degree of course deviation is known as the rudder ratio. Nine rudder ratio settings are available as tabulated below.

Setting	1	2	3	4	5	6	7	8	9
Rudder Ratio	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.2	1.5

The following illustrations show how many degrees the FAP-330 adjusts the rudder in order to nullify 10 degrees of course deviation with various settings of the rudder ratio :

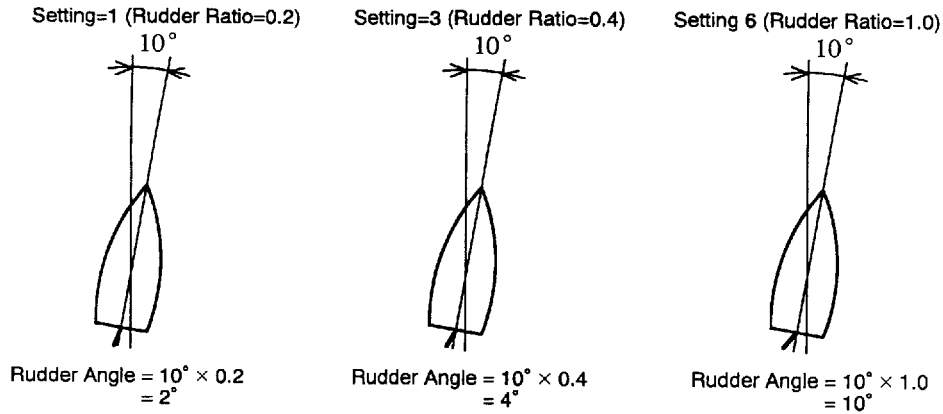
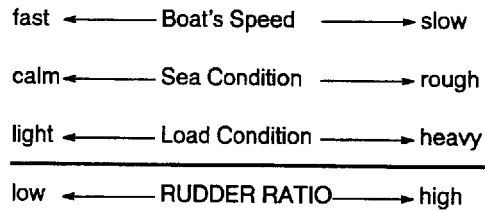


Fig. 5-9 Rudder angle versus value

Increase the setting until over-steering occurs, then reduce it by one. Rudder ratio should be adjusted considering the following factors. (Setting of "4" is commonly used.)



Press **SEL** to proceed to the next step.

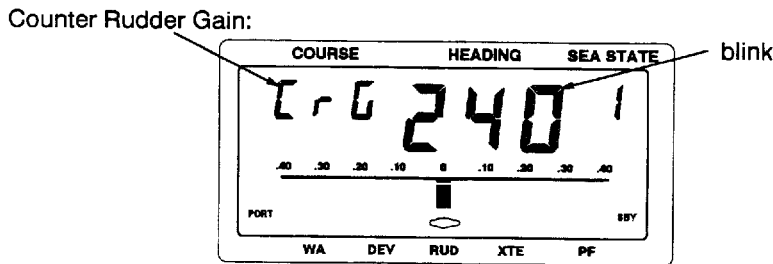
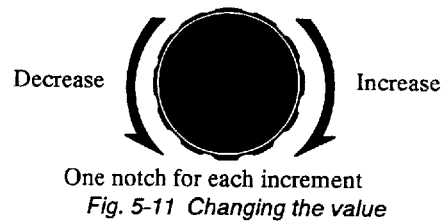


Fig. 5-10 Adjusting counter rudder gain

The COUNTER RUDDER value becomes adjustable, and its value blinks. Change the value with the control dial



If the boat is heavily loaded, the heading will turn excessively by inertia, passing the new course. Then, the FAP-330 will steer the rudder to the opposite side, the heading will turn in that direction excessively again..... In an extreme case the heading oscillates several times until it finally settles in the new course. An adjustment known as COUNTER RUDDER is used to prevent this kind of oscillation.

You may set the value of counter rudder from “0” to “9”; the higher the setting, the more counter rudder is steered by the FAP-330. (“0” = No Counter Rudder)

Setting	0	1	2	3	4	5	6	7	8	9
Counter Rudder	None	0.2	0.3	0.4	0.6	0.8	1.2	1.6	2.4	3.2

Counter rudder is usually not required for small boats. When your boat zigzags a lot before settling in the new course, increase the setting.

Press **SEL** to proceed to the next step.

To escape from adjusting mode, press **ALARM RESET**.

---

## Trim (How to offset the influence of current and wind.)

---

When sea current or wind is very strong, or the vessel's loading condition is unbalanced, the vessel may deviate from the set course.

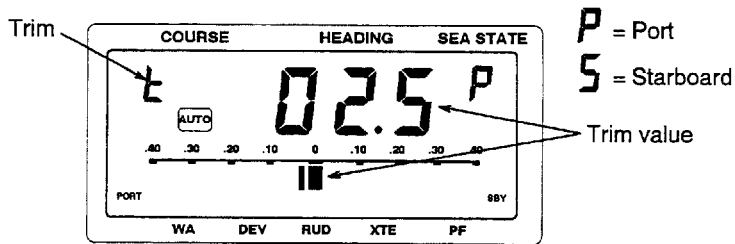


Fig. 5-12 Adjusting trim

Change the value with the control dial

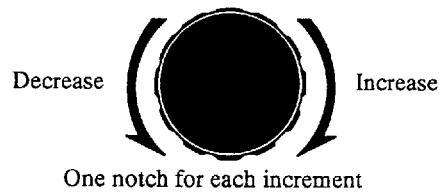


Fig. 5-13 Changing the value

Adjust the trim compensation value by the control dial so that the vessel stays on course.

Press **SEL** to proceed to the next step.  
To escape from adjusting mode, press **ALARM RESET**.

---

## Auto trim sensitivity *(To adjust the sensitivity in monitoring the boat's trim.)*

---

The FAP-330 continually monitors the boat's trim in order to keep the compensation value optimum. You may enter a number from "1" to "9"; A lower setting is common because boat's trim usually does not change quickly. A large number updates the trim compensation value more frequently. A too high setting may result excessive yawing

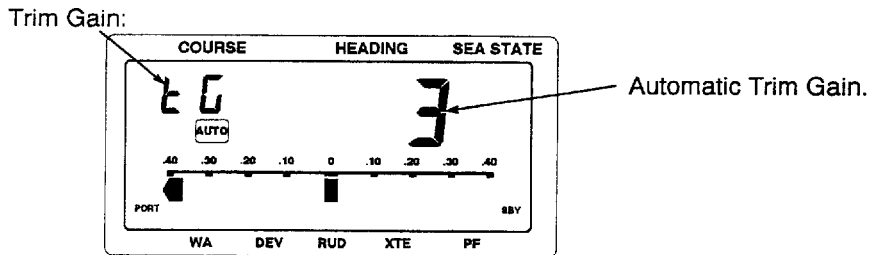


Fig. 5-14 Adjusting trim gain

Change the value with the control dial



Fig. 5-15 Changing the value

Press **SEL** to proceed to the next step.  
To escape from adjusting mode, press **ALARM RESET**.

## Rudder angle limitation (for the AUTO/NAV modes)

In the AUTO or NAV mode the FAP-330 drives the rudder for course keeping only where a wide rudder angle is usually not required. It is recommended to limit the rudder angle so that violent course changes are not possible, and to protect the rudder from damage.

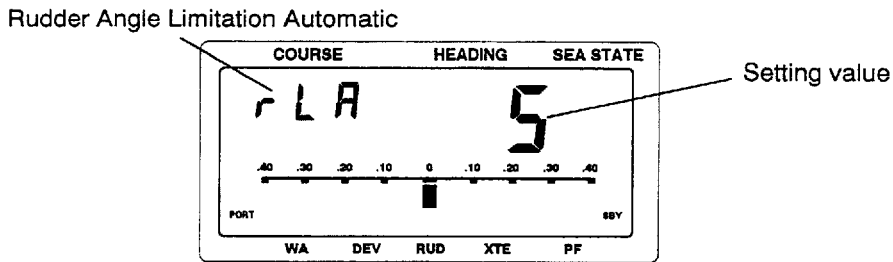


Fig. 5-16 Adjusting rudder angle limitation for auto and nav mode

Change the value with the control dial



Fig. 5-17 Changing the value

You may enter a number from “2” to “9”, and the actual rudder angle limitation (degree) is obtained by multiplying the number by five;

Setting	2	3	4	5	6	7	8	9
Rudder Angle Limitation	$\pm 10^\circ$	$\pm 15^\circ$	$\pm 20^\circ$	$\pm 25^\circ$	$\pm 30^\circ$	$\pm 35^\circ$	$\pm 40^\circ$	$\pm 45^\circ$

### NOTE:

The boat which has the following characteristics often zigzags seriously in following sea.

- Its heading is easily changed when the stern is hit by a wave or when the rudder is steered.
- Its rudder can not move quickly, i. e., hardover to hardover requires a long time, say 10 seconds or more. This causes a lag in recovering to the set course.
- Adjustment of WEATHER, RUDDER RATIO or COUNTER RUDDER can not remedy this type of problem. Narrow the RUDDER ANGLE LIMITATION,  $\pm 20$  degrees for example, and considerable improvement will be observed.

Press **SEL** to proceed to the next step.  
To escape from adjusting mode, press **ALARM RESET**.

## Rudder angle limitation (for the REM/DODGE modes)

In the REM or DODGING mode steering, we usually use a wide range of rudder angle, and therefore a larger number should be entered. However, it must not exceed the rudder limit angle which is inherent for your boat.

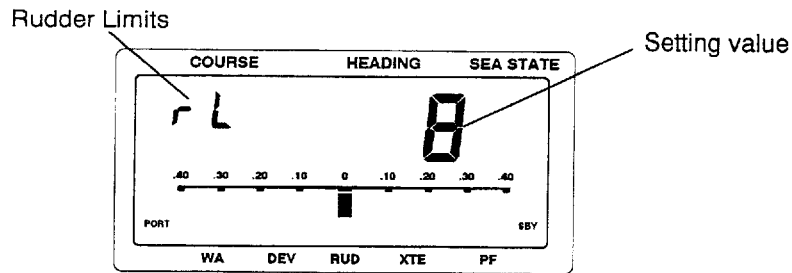


Fig. 5-18 Adjusting the rudder angle limitation for rem and dodge mode

Change the value with the control dial



Fig. 5-19 Changing the value

A number from “2” to “9” may be entered, and the actual rudder angle limitation in degrees is obtained by multiplying the number by five;

Setting	2	3	4	5	6	7	8	9
Rudder Limits	$\pm 10^\circ$	$\pm 15^\circ$	$\pm 20^\circ$	$\pm 25^\circ$	$\pm 30^\circ$	$\pm 35^\circ$	$\pm 40^\circ$	$\pm 45^\circ$

Press **SEL** to proceed to the the step.  
To escape from adjusting mode, press **ALARM RESET**.

---

## Rudder dead band *(Prevents the rudder from hunting.)*

---

Leave the setting in “Automatic.” Change the value manually only at the following cases.

- 1) While investigating other items for the best setting.  
Set to “0”.
- 2) When the rudder speed of the boat is extremely fast.  
This result in hunting.
- 3) The malfunction of a hydraulic system. The automatic control will be impossible.

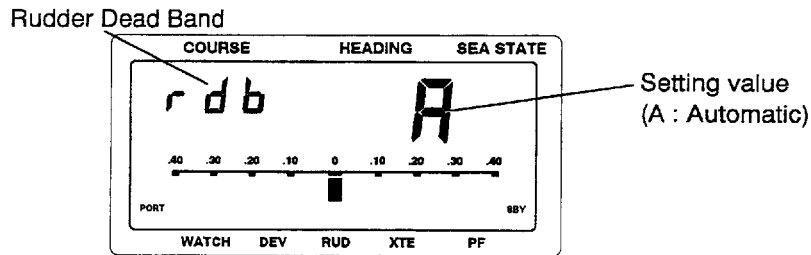


Fig. 5-20 Adjusting rudder dead band

Change the value with the control dial

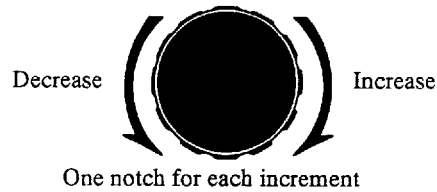


Fig. 5-21 Changing the value

A higher values increase the dead band. Too high a value may increase deviation.

Press **SEL** to proceed to the next step.  
To escape from adjusting mode, press **ALARM RESET**.



## Course changing speed *(Adjust the course changing speed by the FAP-330 autopilot.)*

When the mode is changed or when the NAV mode is used, the course is controlled by the FAP-330. It may be dangerous to change course too quickly, but changing course too slowly may also be dangerous, and a waste of time.

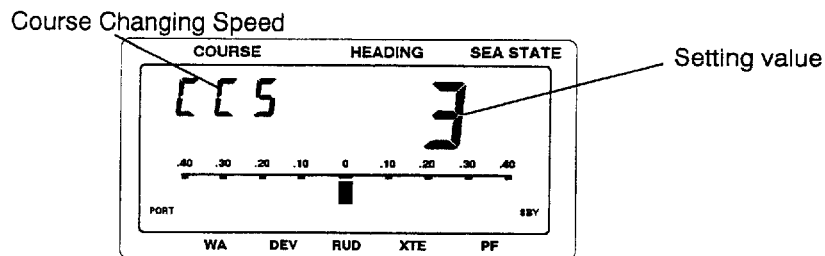


Fig. 5-22 Adjusting course changing speed

Change the value with the control dial

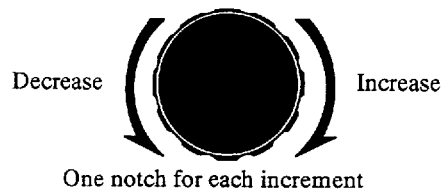


Fig. 5-23 Changing the value

You may enter a number from “1” to “9”, which corresponds to the course changing speed of 1 degree/sec to 9 degrees/sec, respectively.

Setting	1	2	3	4	5	6	7	8	9
Course Changing Speed (Degree/second)	1	2	3	4	5	6	7	8	9

**⚠ WARNING**

**Too high a setting will turn the boat sharply at a course change.**

A setting of “5” or so is commonly used for a 10 to 15-knot cruising speed.

When you feel the course changing speed is too fast, decrease the setting.

Press **SEL** to proceed to the next step.  
To escape from adjusting mode, press **ALARM RESET**.

## Remote controller number 1

*(Select the course after using the number 1 remote controller.)*

## Remote controller number 2

*(Select the course after using the number 2 remote controller.)*

When the remote controller is turned off, the heading can be one of the following:

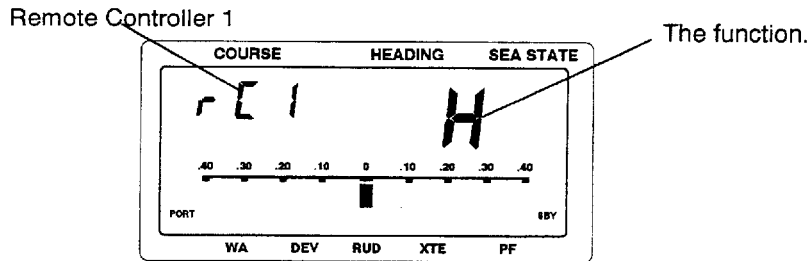


Fig. 5-24 Selecting the function of remote controller

Change the function with the control dial

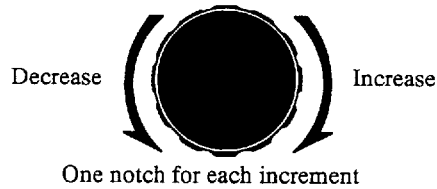


Fig. 5-25 Changing the value

Refer to the figure below for the function "H" and "C".

Setting	H	C
Function	The heading at the moment the remote controller is turned off.	The previous course before using the remote controller.

### Setting : H (Default)

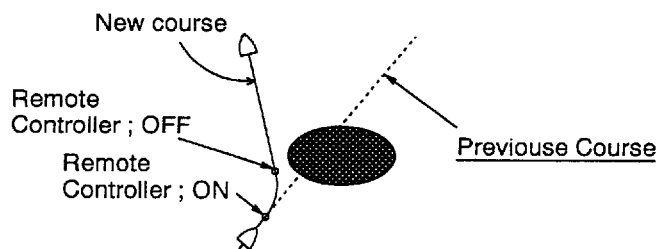


Fig. 5-26 The new course for setting H

## Setting : C

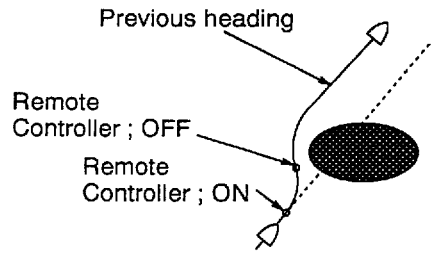


Fig. 5-27 The new course for setting C

Press **SEL** to proceed to the next step.  
To escape from adjusting mode, press **ALARM RESET**.

---

## **Plotter connection (For future use)**

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This menu has been prepared for future use.

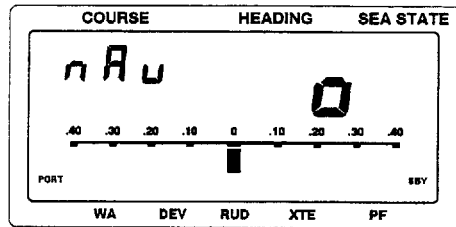


Fig. 5-28 The screen prepared for future use

Press **SEL** to go back to the first item (WEATHER).  
To escape from adjusting mode, press **ALARM RESET**.

# 6. ALARM AND WARNINGS

## 1. Watch alarm

If the watch alarm function is enabled, it will periodically warn the helmsman to check the autopilot navigation.

The watch alarm function can be turned on or off at the segment number 5 of the DIP switch in the processor unit.

Turn ON the DIP switch to turn ON the function.

Press **NAV** or **AUTO** to activate watch alarm function.

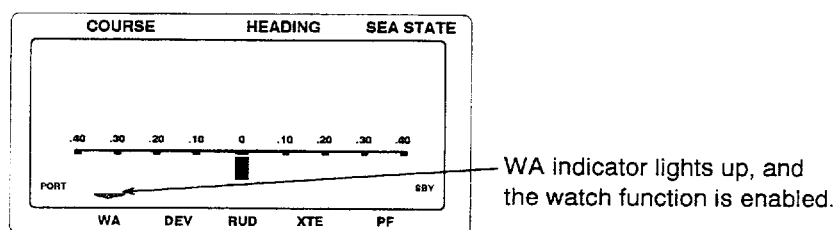


Fig. 6-1 Watch alarm indication

a) “WA” lights up, and the watch function is enabled.

(If any key is not pressed for 4 minutes.)

b) Preliminary warning sounds “Pip Pip Pip Pip....”.

(If any key is not pressed for another 1 minute.)

c) Watch alarm sounds continually “Peep Peep Peep....”.

### NOTE :



*When any key is pressed, the FAP-330 recognizes that a helmsman is attending, and as a result it turns to start point in the above sequence. When you are operating the FAP-330 by pressing keys one after another, for example, the alarm does not sound because the FAP-330 returns to the starting point at every key depression.*

Press of **ALARM RESET** silence the beep, but it does not disable the watch alarm function.

Turn OFF the DIP switch to turn OFF the function.

## 2. Warnings

---

While pressing , an error code is presented on the course reading. When more than one abnormality are detected, error codes are presented one by one. Every pressing of  presents an error code.

---

### Error Code 1

---

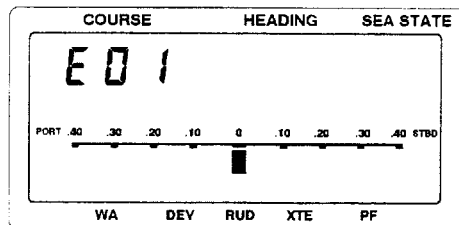


Fig. 6-2 Indication for error code E01

A communication between the control unit and the processor unit has been interrupted for more than 2 seconds.

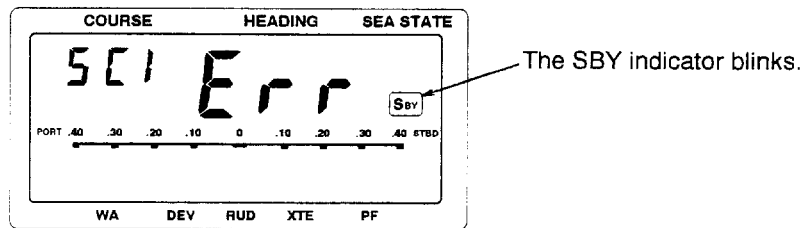


Fig. 6-3 Blinking SBY indication

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## Error Code 2

---

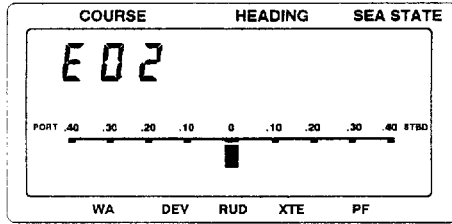


Fig. 6-4 Indication for error code E02

Power supply was interrupted for more than 2 seconds.

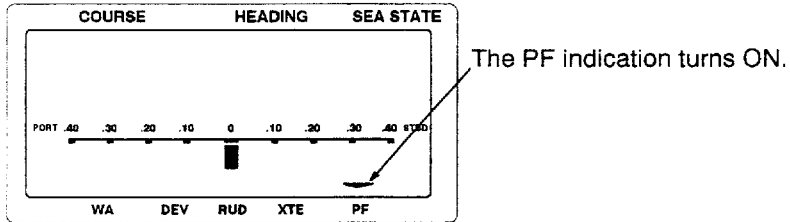


Fig. 6-5 The power failure indication turns ON

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## Error Code 4

---

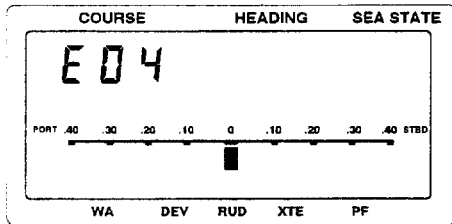


Fig. 6-6 Indication for error code E

All contents of the EEROM have been destroyed. All the data have been cleared and reset to default settings.

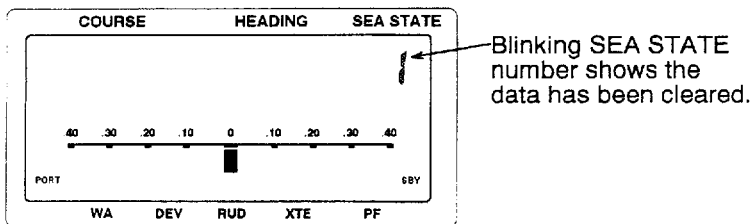


Fig. 6-7 Blinking sea state indicator

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## Error Code 11

---

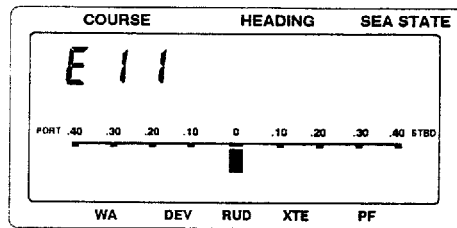


Fig. 6-8 Indication for error code E11

The rudder angle sent from the rudder reference unit exceeded 55 degrees.

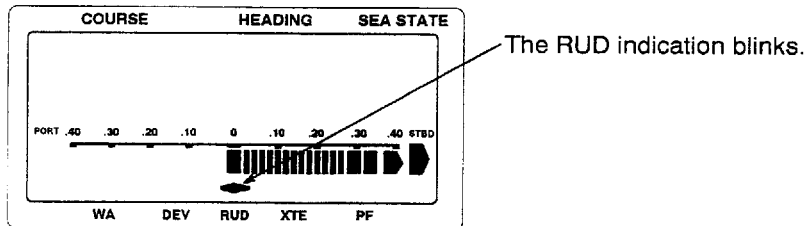


Fig. 6-9 Abnormal rudder angle sent from the RRU

---

## Error Code 12

---

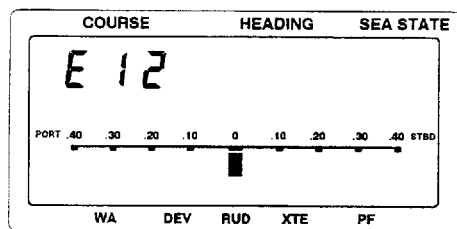


Fig. 6-10 Indication for error code E12

The rudder did not move more than 0.5 degrees within 6 seconds after the CPU's order

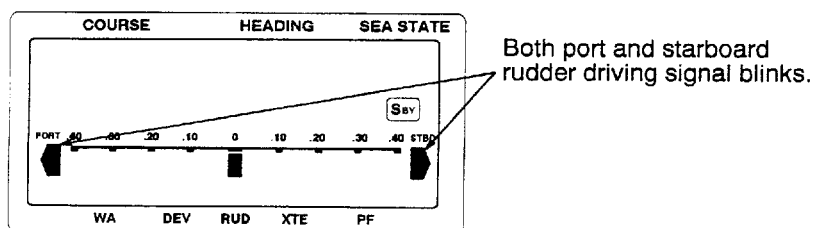


Fig. 6-11 Blinking of both rudder driving signal

---

## Error Code 21

---

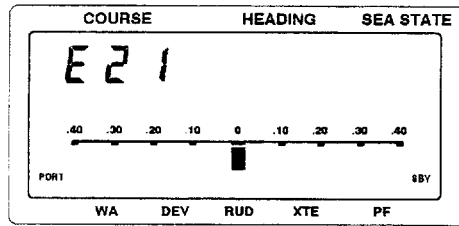


Fig. 6-12 Indication for error code E21

The heading data from heading sensor is missing.

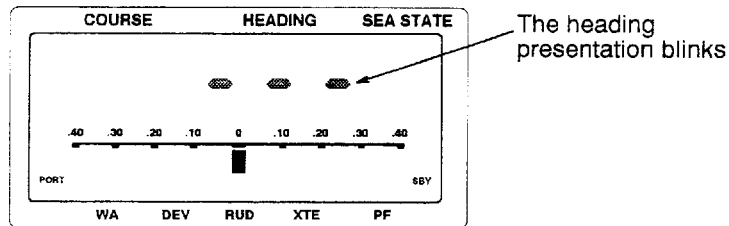


Fig. 6-13 Blinking heading indicator

---

## Error code 22

---

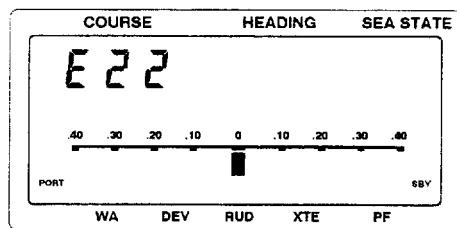


Fig. 6-14 Indication for error code E22

The heading data from heading sensor is not in the range from 0 degree to 359 degrees.

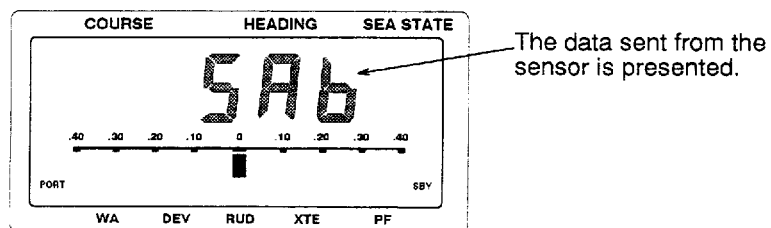


Fig. 6-15 Abnormal heading indicator



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## Error code 23

---

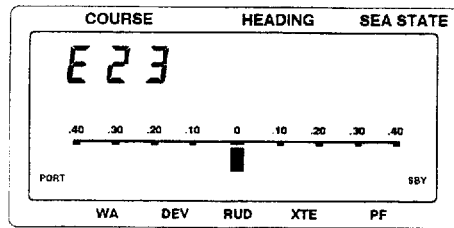


Fig. 6-16 Indication for error code E23

The data from the heading sensor abruptly changed more than 15 degrees.

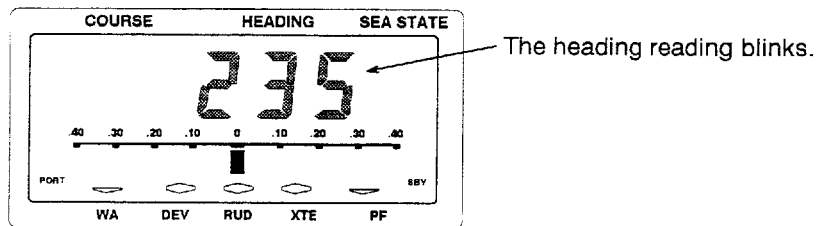


Fig. 6-17 Blinking heading data

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## Error Code 24

---

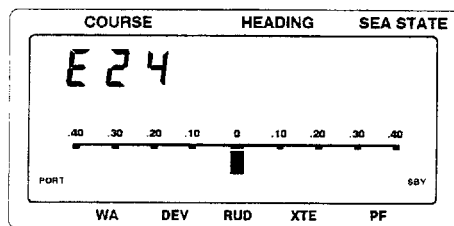


Fig. 6-18 Indication for error code E24

The heading or course has been deviated more than 30 degrees.

---

## Error Code 31

---

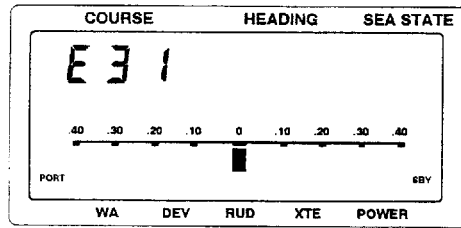


Fig. 6-19 Indication for error code E31

The remote controller FAP-5551 is turned ON. The mode can not be changed into the AUTO mode. Turn OFF the remote controller to go into the AUTO mode.

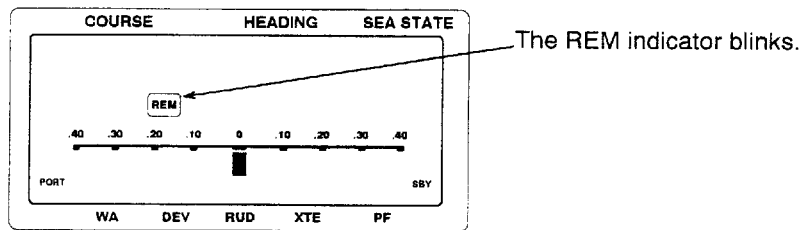


Fig. 6-20 Blinking REM indicator

---

## Error Code 32

---

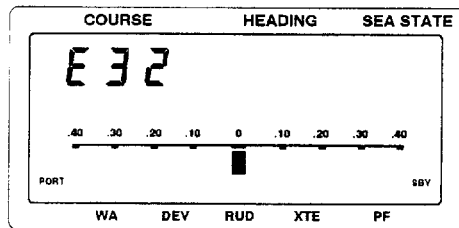


Fig. 6-21 Indication for error code E32

The remote controller FAP-5551 is defective.

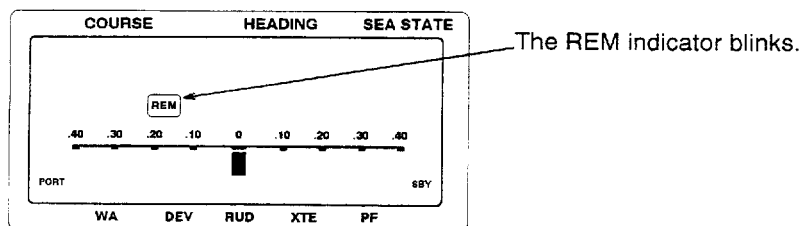


Fig. 6-22 Blinking REM indicator

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## Error Code 51

---

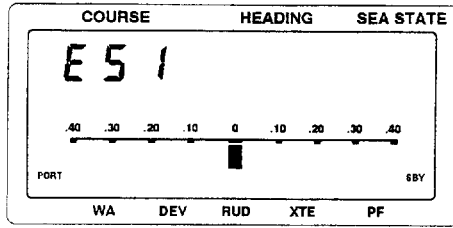


Fig. 6-23 Indication for error code E51

The navigational data used for the NAV mode has been interrupted for more than 15 seconds.

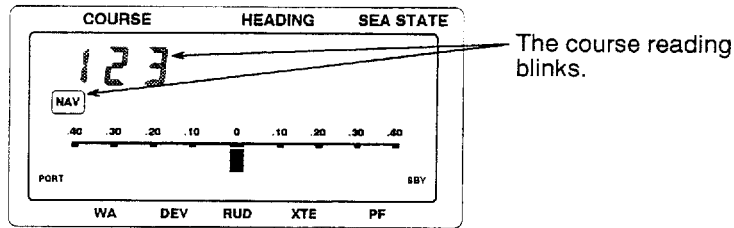


Fig. 6-24 Blinking course and nav indicator

---

## Error Code 52

---

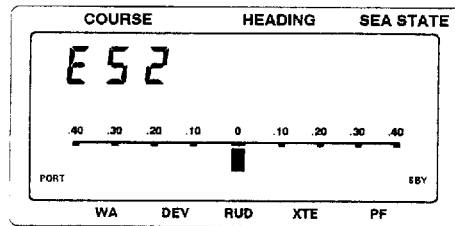


Fig. 6-25 Indication for error code E52

The navigational data used for NAV mode can not be recognized as a data.

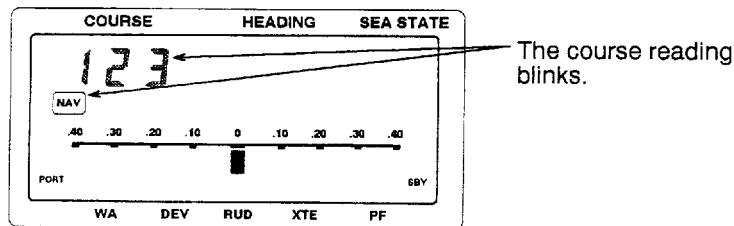


Fig. 6-26 Blinking course and nav indicator

---

## Error Code 53

---

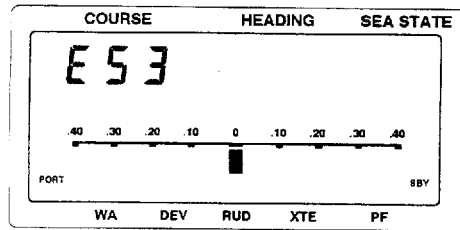


Fig. 6-27 Indication for error code E53

The navigational data used for NAV mode includes an error flag.

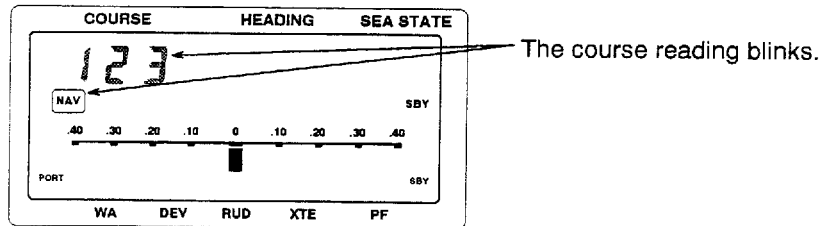


Fig. 6-28 Blinking course and nav indicator

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## Error Code 54

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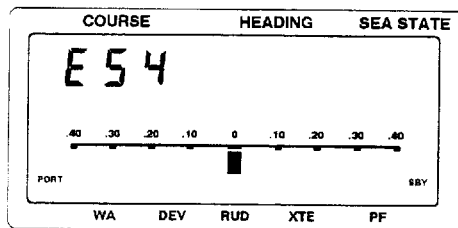


Fig. 6-29 Indication for error code E54

The course error has exceeded 60 degrees.

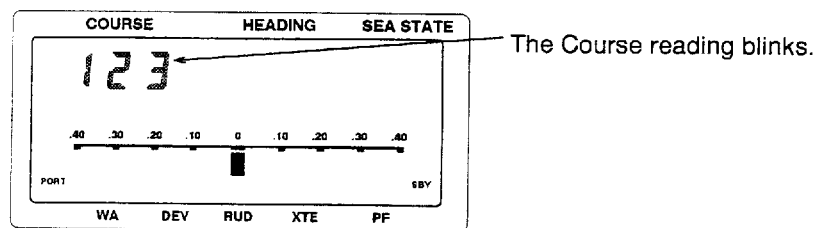


Fig. 6-30 Blinking course indicator

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## Error Code 55

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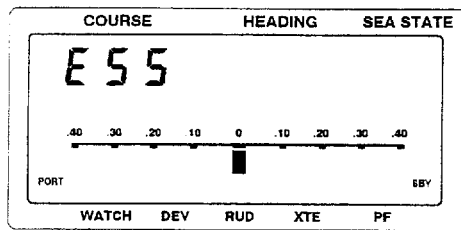


Fig. 6-31 Indication for error code E55

The waypoint number included in the navigational data used for NAV mode has changed.

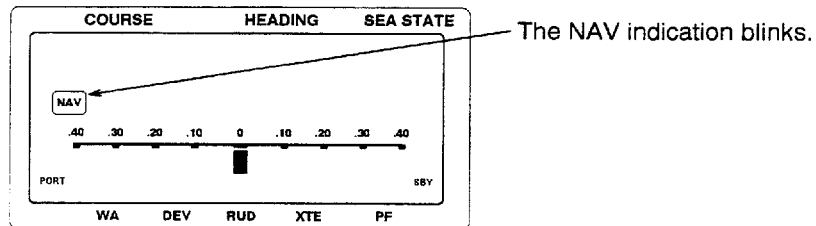


Fig. 6-32 Blinking nav indicator

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## Error Code 56

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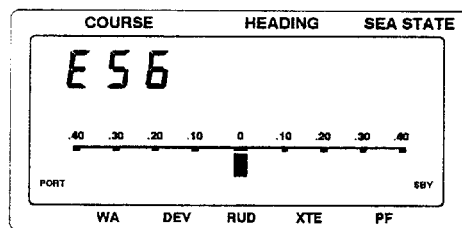


Fig. 6-33 Indication for error code E56

The boat has arrived at the waypoint.

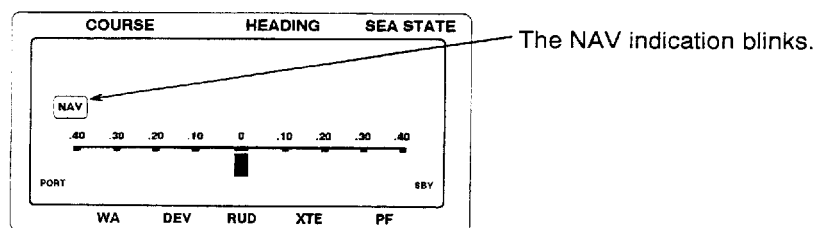


Fig. 6-34 Blinking nav indicator

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## Error Code 57

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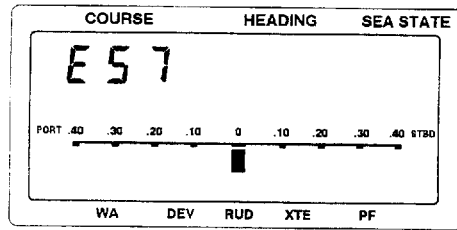


Fig. 6-35 Indication for error code E57

The cross-track error exceeded 0.4NM.

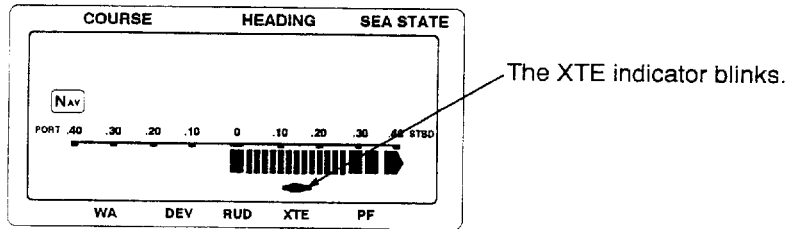


Fig. 6-36 Blinking XTE Indicator

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## Error Code 91

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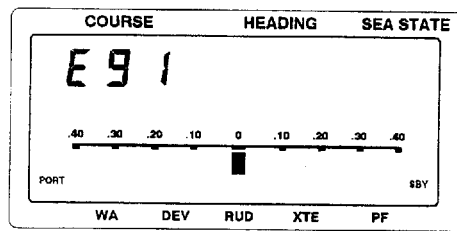


Fig. 6-37 Indication for error code E91

The input power source has fluctuated beyond tolerance.

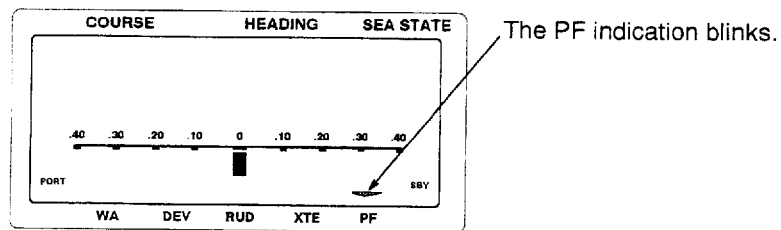


Fig. 6-38 Blinking power failure indicator

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## Error Code 92

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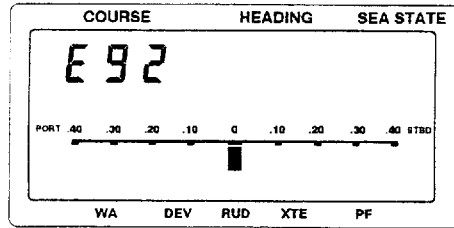


Fig. 6-39 Indication for error code E92

No key was pressed for 4 minutes while the watch alarm function is turned ON.

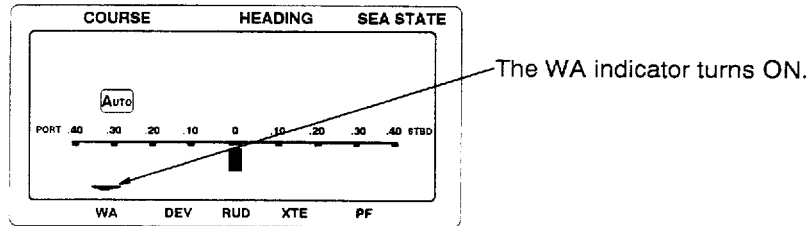


Fig. 6-40 Indication for error code E

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## Error Code 93

---

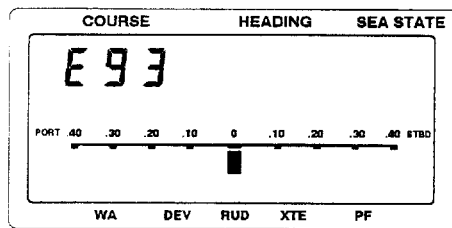


Fig. 6-41 Indication for error code E93

No key was pressed for another 1 minute after first watch alarm (E92).

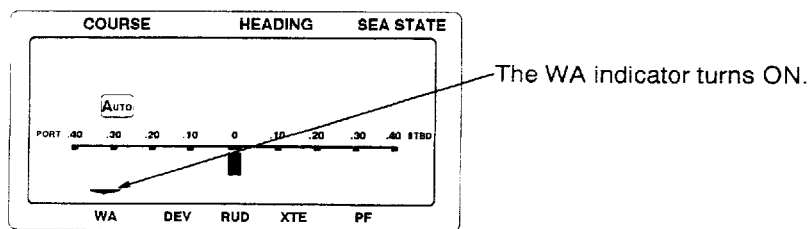






Fig. 6-40 Indication for error code E

# 1. CHECK BEFORE LEAVING PORT

When the FAP-330 has not been used for an extended period of time, or before you go on a long voyage, it is recommended that you conduct the following function test with the vessel safe in a harbor.


 <b>WARNING</b>
<b>Make sure that there is no person nor any obstruction in the area near the rudder.</b>

 <b>CAUTION</b>
<b>If the rudder is driven continually, immediately shut down the input power or press [SBY] key. The FAP-330 may be faulty or not installed properly.</b>
<b>The FUNCTION TEST must be conducted by a person who has through knowledge of the autopilot's operation.</b>


- (1) With the FAP-330 turned off, steer the wheel from hard over to hard over, then return it to neutral. ----> The rudder should move smoothly without undue stiffness.
- (2) Turn on the FAP-330 by pressing  ----> The SBY mode indicator should appear. The rudder angle indication should be zero. (If not, conduct [Rudder Angle Null Adjustment].)
- (3) Steer the wheel from hard over to presentation should then return it to neutral. ----> The rudder angle hard over, change reasonably.
- (4) Compare the heading presentation (digital) with the compass reading. ----> The heading presentation should be reasonable.
- (5) Press  . ----> The AUTO mode presentation should appear.
- (6) By adjusting the course control, change the course by 10 degrees in starboard direction, i. e., increase the course reading by 10 degrees. ----> The analog meter should indicate a 10 degree course change to starboard.
- (7) Press  . ----> The analog meter should indicate



reasonable rudder angle in starboard direction. See NOTE on the next page.

(8) Press .

(9) By adjusting the course degrees' change the control, course by 10 degrees in port direction, i. e., decrease the course reading by 10 degrees. ---> The analog meter should indicate 10 course deviation to port.

(10) Press . ---> The analog meter should indicate reasonable rudder angle in port direction. See NOTE on the next page.

(11) Press .


(12) Turn on the remote controller. ---> The REM mode presentation should appear.

(13) Slowly turn the steeringdial on the remote controller from hard over to hard over. ---> The rudder angle (analog) presentation should change accordingly. The rudder driving signal should be lit while the rudder is driven in that direction.

(14) Turn off the remote controller. ---> The AUTO mode should be recalled.

(15) If a navaid is connected to the FAP-330;

Place the navaid in the fully operating condition, and select a TO WAYPOINT. (Assign the present position to FROM WAYPOINT.)

Press . ---> The NAV mode presentation should appear. (The "NAV" sign should not blink.)

The course reading on the FAP-330 should be the same as the one presented on the navaid.

(16) By pressing OFF, turn off the FAP-330.

---

**NOTE:**

*An indicated rudder angle against 10 degrees' course change is given by the following formula;*

$$(Rudder\ Angle) = (10\ degrees) \times (Rudder\ Ratio) - (Deadband)$$

*Normally the indicated rudder angle should be equal to the calculated one.*

---

In addition to the above-mentioned Function Test, it is always a good idea to proceed out of the harbor and check FAP-330's performance in every mode.

---

***IMPORTANT***

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*The trial must be conducted in the open sea where other boat traffic, and obstruction will not interfere.*

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## 2. POWER-ON SELFTEST

When the FAP-330 is turned on, the following sequence is initiated automatically:

The memories (ROM/RAM) are checked for proper operation. If any abnormality is detected, the faulty memory (or memories) is (are) identified with a numeric code and the FAP-330 is made inoperative.

If normal, FAP-330 becomes operational.

Abnormality detected

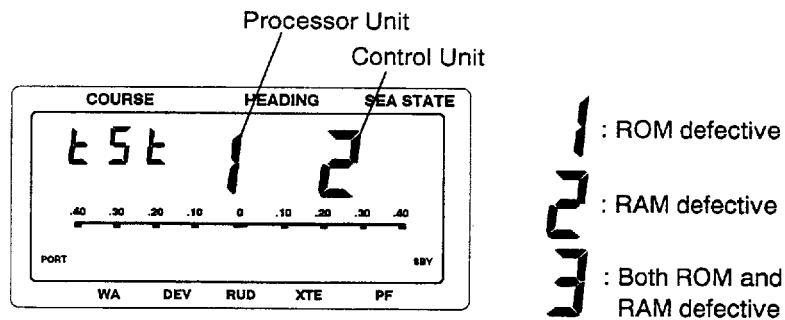




Fig. M-1 A result of memory test

### 3. SELFTEST PROGRAM

Turn on the power while holding down  key.

The course segment presents what test is available. Each pressing of  changes the test item as follows.

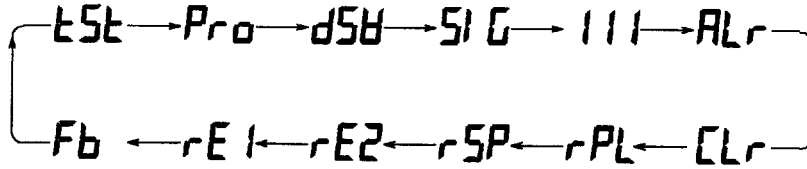


Fig. M-2 The sequence of selftest

<b>tSt</b>	ROM and RAM test	<b>Fb</b>	Rudder reference feedback signal test
<b>Pro</b>	Program version number presentaion	<b>rE1</b>	Remote controller number 1 function test
<b>dSw</b>	DIP switch setting presentation	<b>rE2</b>	Remote controller number 2 function test
<b>SIG</b>	Navigational signal test	<b>rSP</b>	Rudder speed test
<b>III</b>	LCD segment test	<b>rPL</b>	Rudder play test
<b>ALr</b>	External buzzer test	<b>CLr</b>	Memory all clear

# 1. ROM and RAM test

Number 1 controller presents the result of number 1 remote controller and processor unit test. Number 2 controller presents the result of number 2 remote controller and processor unit test.

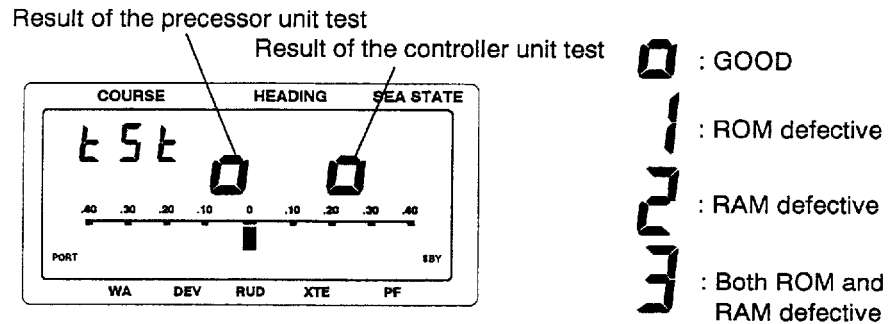


Fig. M-3 A result of memory test

Press **SEL** for next test.

To escape from selftest mode, Press **ALARM RESET**.

## 2. Program version number presentation

Number 1 controller presents the version number of number 1 remote controller and processor unit. Number 2 controller presents the version number of number 2 remote controller and processor unit.

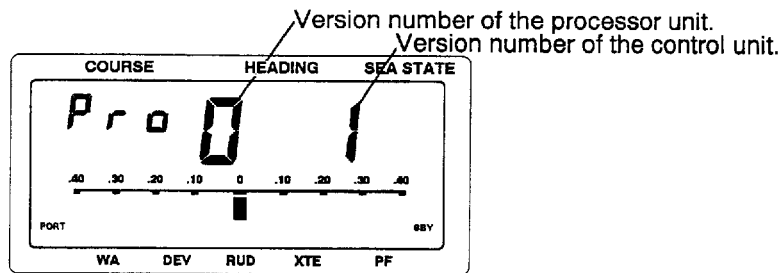


Fig. M-4 A presentation of a program version number

Press **SEL** for next test.

To escape from selftest mode, Press **ALARM RESET**.

### 3. DIP switch setting presentation

Number 1 controller presents the DIP switch setting of number 1 remote controller and processor unit. Number 2 controller presents the DIP switch setting of number 2 remote controller and processor unit.

The results are shown in hexadecimal notation. "OFF" is "0" and "ON" is "1".

#### Example

Segment 5, 6, 7, 8 had status OFF, OFF, ON, ON.  
This is 1, 1, 0, 0 so the presentation will be "C".

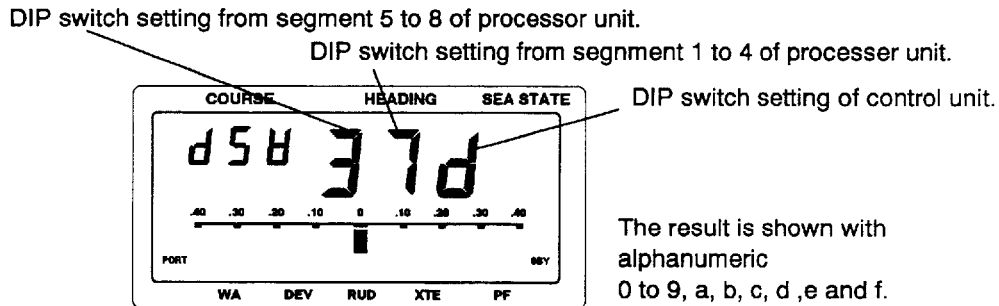


Fig. M-5 A DIP switch setting for each unit

Press **SEL** for next test.

To escape from selftest mode, Press **ALARM RESET**.

## 4. Navigation signal test

Navigation signals such as waypoint data, cross-track error data, speed data and arrival data are required to control the FAP-330.

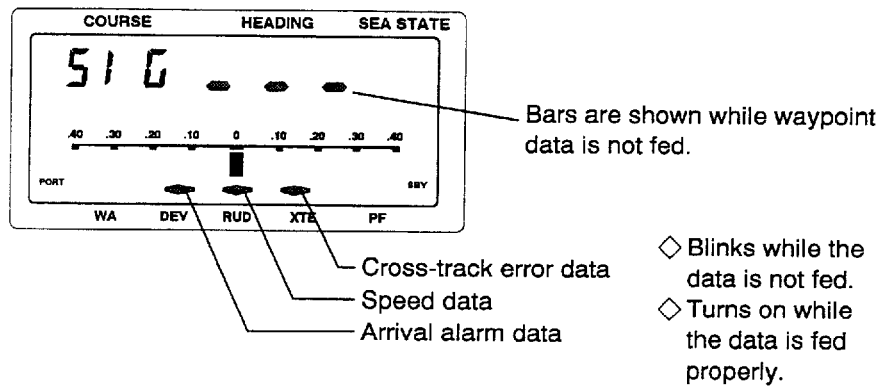


Fig. M-6 An indication when no data is fed

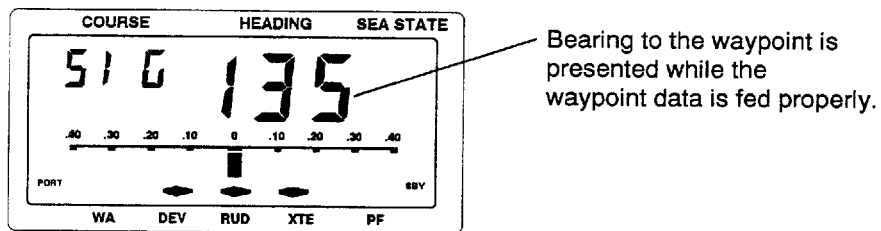


Fig. M-7 An indication when all data is fed

Press **SEL** for next test.

To escape from selftest mode, Press **ALARM RESET**.



## 5. LCD segment test

Press **DIM** to start the test. The LCD segments turns on one by one as follows:

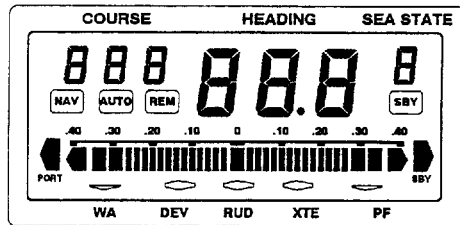


Fig. M-8 LCD test (step 1)

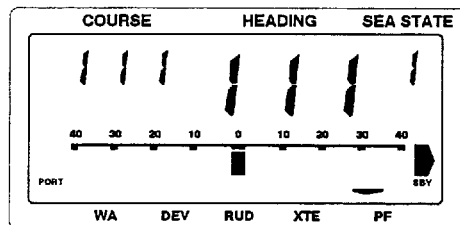


Fig. M-9 LCD test (step 2)

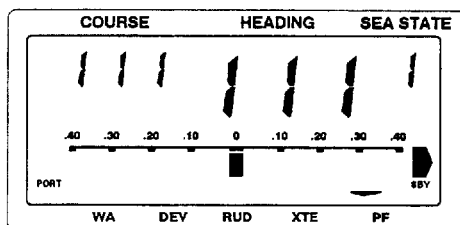


Fig. M-10 LCD test (step 3)

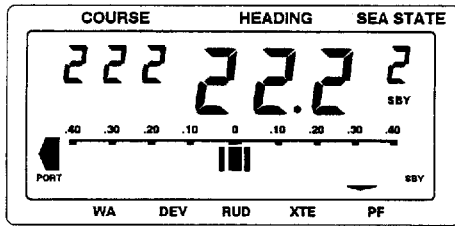


Fig. M-11 LCD test (step 4)

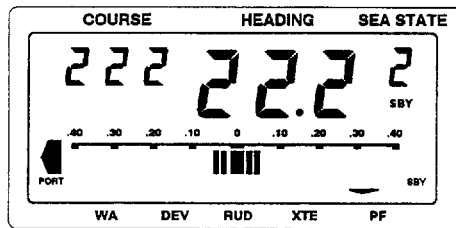


Fig. M-12 LCD test (step 5)

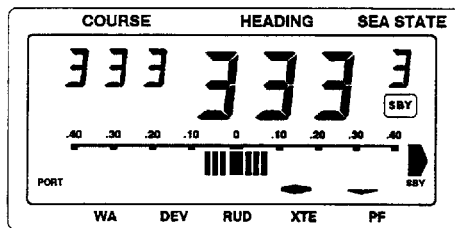


Fig. M-13 LCD test (step 6)

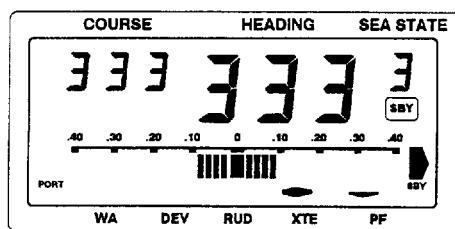


Fig. M-14 LCD test (step 7)

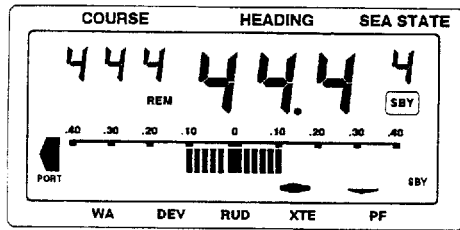


Fig. M-15 LCD test (step 8)

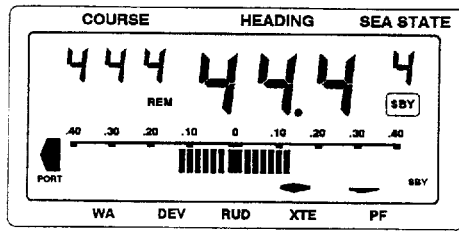


Fig. M-16 LCD test (step 9)

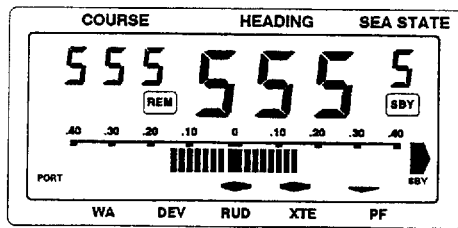


Fig. M-17 LCD test (step 10)

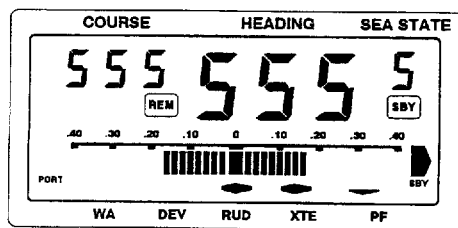


Fig. M-18 LCD test (step 11)

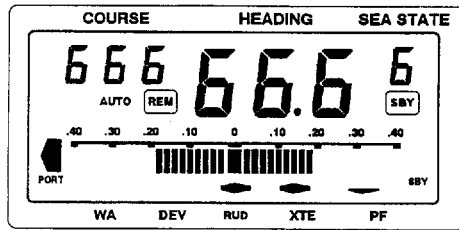


Fig. M-19 LCD test (step 12)

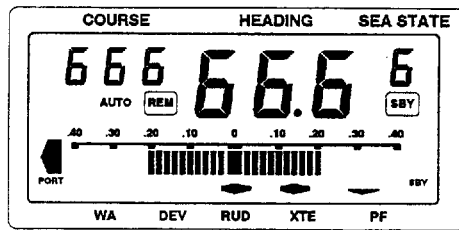


Fig. M-20 LCD test (step 13)

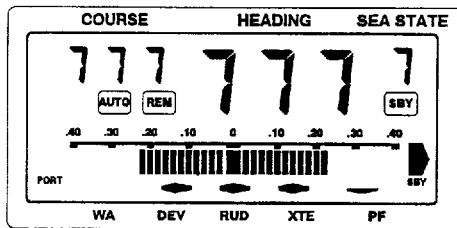


Fig. M-21 LCD test (step 14)

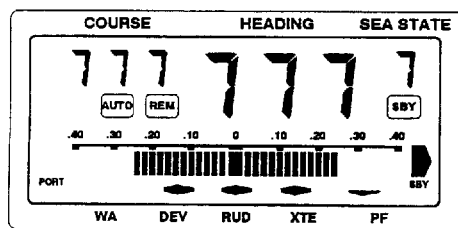


Fig. M-22 LCD test (step 15)

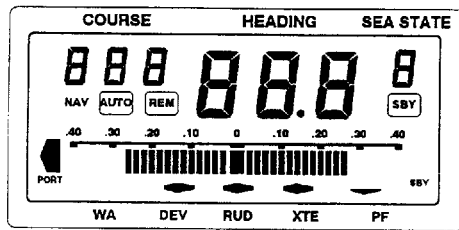


Fig. M-23 LCD test (step 16)

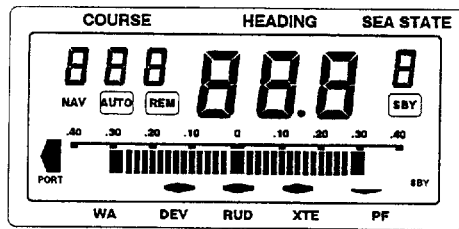


Fig. M-24 LCD test (step 17)

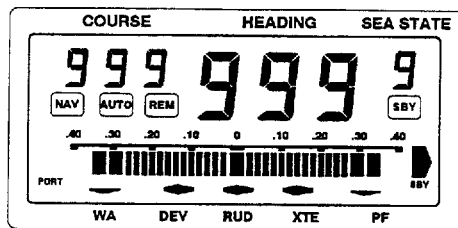


Fig. M-25 LCD test (step 18)

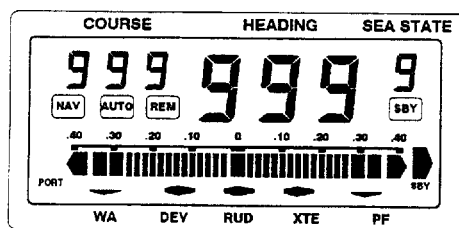


Fig. M-26 LCD test (step 19)

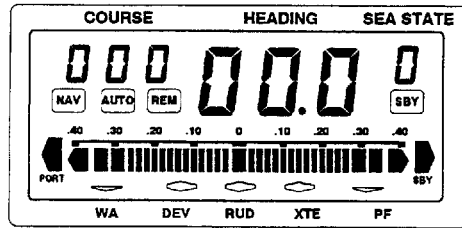


Fig. M-27 LCD test (step 20)

Press  for next test.

To escape from selftest mode, Press .

## 6. External buzzer test

Press **DIM** to activate the external buzzer.

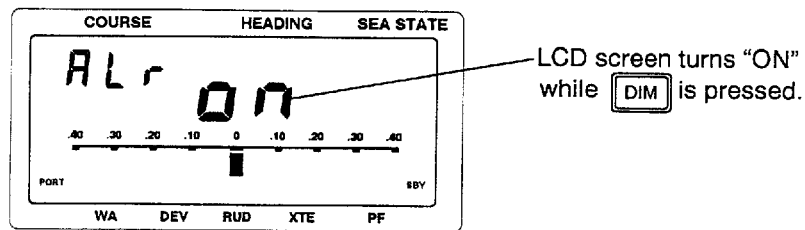


Fig. M-28 An indication while the external buzzer is sounding

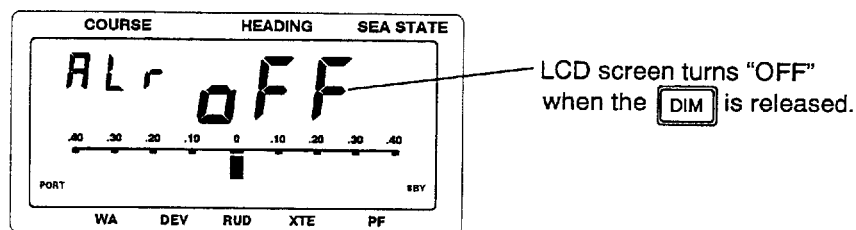


Fig. M-29 An indication while the external buzzer is silence

Press **SEL** for next test.

To escape from selftest mode, Press **ALARM RESET**.

## 7. Rudder reference unit feedback signal test

The data sent from rudder reference unit is presented on the screen.

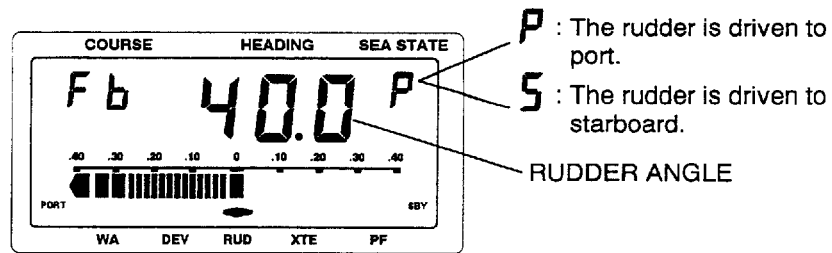


Fig. M-30 An indication of RRU signal

Press **SEL** for next test.

To escape from selftest mode, Press **ALARM RESET**.



## 8. Remote controller number 1 function test

The LCD screen presents the data sent from the remote controller connected to “REM 1” connector.

With the FU remote controller (FAP-5551), the presentation is as follows:

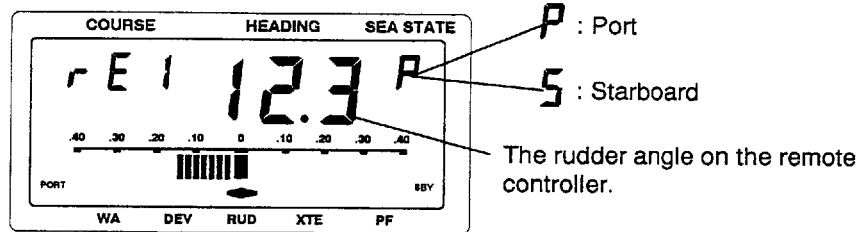


Fig. M-31 An indication for FU remote controller

With the NFU remote controller (FAP-6211 or 6221), the presentation is as follows:

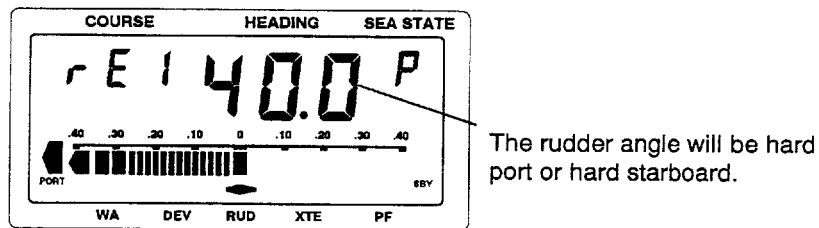


Fig. M-32 An indication for NFU remote controller

While the remote controller is turned off, the LCD presentation is as follows:

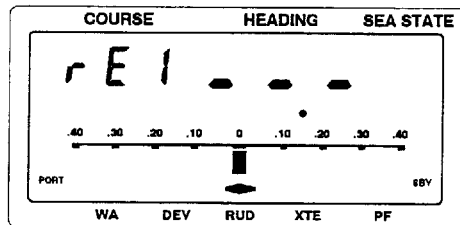


Fig. M-33 An indication while the remote controller is turned off

Press **SEL** for next test.


To escape from selftest mode, Press **ALARM RESET**.


## ***9. Remote controller number 2 function test***

---

The LCD screen presents the data sent from the remote controller connected to “REM 2” connector.

Refer to “8. Remote Controller Number 1 Function Test” for the presentation.

Press  for next test.

To escape from selftest mode, Press .

## 10. Rudder speed test

### WARNING

While running the boat, omit this test by pressing **SEL** key. This test drives the rudder from hard port to hard starboard to calculate actual rudder speed.

Press **DIM** to start the test.

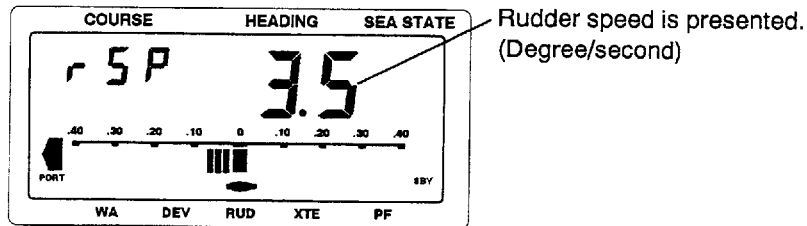


Fig. M-34 An indication of rudder speed

While calculating, the presentation is as follows:

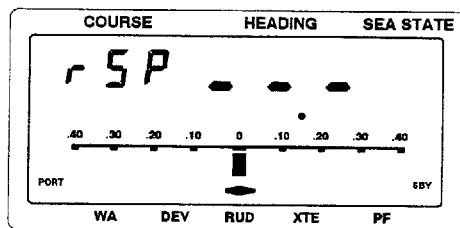


Fig. M-35 An indication while calculating rudder speed

Press **SEL** for next test.

To escape from selftest mode, Press **ALARM RESET**.

## 11. Rudder play test

The CPU calculates the rudder play while testing the rudder speed. Without conducting "Rudder Speed Test", the calculation can not be done.

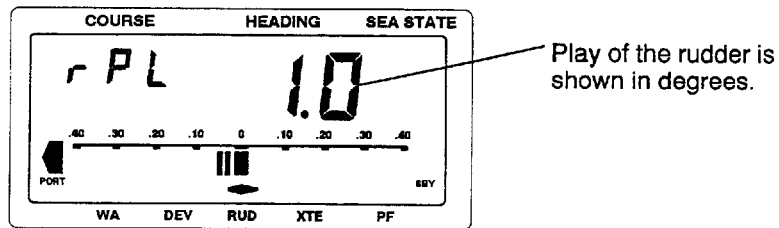


Fig. M-36 An indication of rudder play

While calculating, the presentation is as follows:

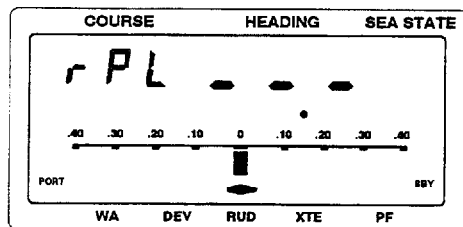


Fig. M-37 An indication while calculating rudder play

Press **SEL** for next test.

To escape from selftest mode, Press **ALARM RESET**.

## 12. Memory all clear

You can clear all the internal settings memorized in the EEROM  
Press **DIM** to clear the memory.

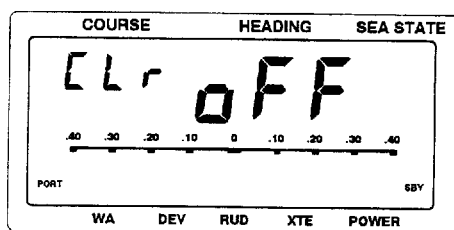


Fig. M-38 An indication before clearing the memory

The presentation is as follows while clearing the memory:

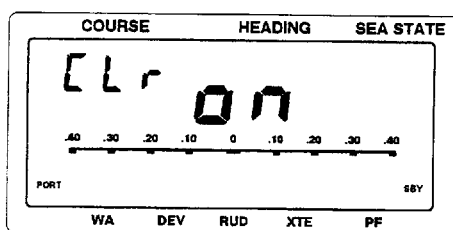


Fig. M-39 An indication while clearing the memory

The presentation is as follows while the memory is cleared:

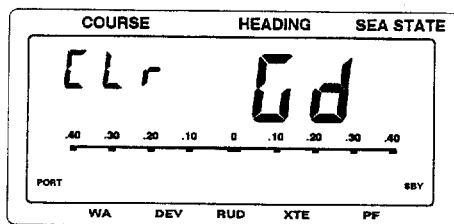


Fig. M-40 An indication after clearing the memory

The presentation is as follows if clearing the memory has failed. The EEROM may be defective.

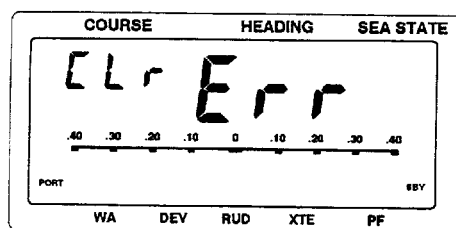


Fig. M-41 An indication when clearing the memory has failed

Press **SEL** for first test (ROM and RAM test).  
To escape from selftest mode, Press **ALARM  
RESET** .

# 1. SPECIFICATIONS

1. Operating Mode
  - Manual (SBY)    • Automatic (AUTO) • Navigational (NAV)
  - Remote (REM)   • Dodge (DODGE)
2. Controls
  - Course setting . . . . . by knob (1° step)
  - others   . . . . . by touchpad key
3. Setting of Steering Characteristics
  - Trim . . . from - 30° to +30° (1° step)
  - Weather (Deadband of Course Deviation) . . .from ±1° to ±10°  
(9 steps)
  - Rudder Ratio . . . from 0.2 to 1.9 (9 steps)
  - Counter Rudder . . . 9 steps + OFF
  - Auto Trim Sensitivity . . . (9 steps)
  - Course Changing Speed . . . from 1°/sec to 9°/sec (9 steps)
  - Rudder Limit Angle . . . from 10° to 45° (9 steps)  
(2 angles may be registered for AUTO/NAV and REM/DODGE, respectively.)
  - Rudder Deadband . . . 9 steps

*NOTE: 3 sets of the characteristic values may be memorized, and one characteristic set may be used in accordance with weather condition, etc.*
4. LCD Display
  - with backlight dimmer  
(common to keyboard dimmer)
5. Presentations
  - 7 segment Digital . . . Heading, Course and Sea state
  - Bar . . . Rudder Angle, Course Deviation or Cross-track Error
  - Warnings . . . Watch Alarm, Power Failure, Inter-unit Signal Failure, etc.
6. Heading Sensor
  - Fluxgate Heading Sensor (C-2000)
  - Gyro Compass (Gyro Converter AD-100 required)
7. Steering Unit
  - Hydraulic or mechanical steering system
8. Navaid
  - NMEA 0183 (GP-70, LC-88, LC-90, LC-90M2, LP-1000, GD-180/185/1000) connectable
9. Power Supply
  - Control+Processor Units --- 10 to 30 Vdc, 20W
  - Valve Unit (optional) --- 12/24/32 Vdc, 24W

## 10. Standard Supply

- Control Unit FAP-3301E × 1
- Processor Unit FAP-3302E × 1
- Rudder Reference Unit FAP-610 × 1
- Accessories × 1 set
- Spare Parts × 1 set
- Installation Material × 1 set

## Optional Supply

- Number 2 Control Unit FAP-3301E
- FU Remote Controller FAP-5551E (Dial type)
- NFU Remote Controller FAP-6211E (Button type)
- NFU Remote Controller FAP-6221E (Lever type)
- Distributor FAP-6800  
(Up to three NFU remote controllers may be connected)
- Rudder Telltale FAP-6501E
- Valve Unit (with 8m cable and crimp-on lugs)  
SPF-1SVF-12/E (12Vdc) [000-090-130] or  
SPF-1SVF-24/E (24Vdc) [000-090-131] or  
SPF-1SVF-32/E (32Vdc) [000-090-132]
- Flush Mounting Materials for FAP-3301 (Control Unit)  
OP64-1 [009-004-020]
- Hanger for FAP-5551 (Dial type remote controller)  
OP64-2 [009-004-030]
- Flush Mounting Materials for FAP-6221(Lever type remote controller)  
OP64-4 (F type) [009-005-790]
- Flush Mounting Materials for FAP-6501 (Rudder telltale)  
OP64-4 (F type) [009-005-790]  
OP64-5 (S type) [009-005-800]



## 2. INSTALLATION

### 1. *Control unit (FAP-3301)*

---

#### 1) Mounting considerations

---

Avoid the following places:

- A place exposed to direct sunlight,
- A place exposed to direct water splash or rain,
- A place exposed to direct air from an air-conditioner,
- High-temperature, poorly ventilated environment.

When deciding a mounting place, take the viewing angle into account.

Tabletop, bulkhead and overhead mountings are available by using the hanger bracket supplied. The flushmount kit is optionally available.



## **CAUTION**

**Do not work inside the equipment unless totally familiar with electrical circuits.**

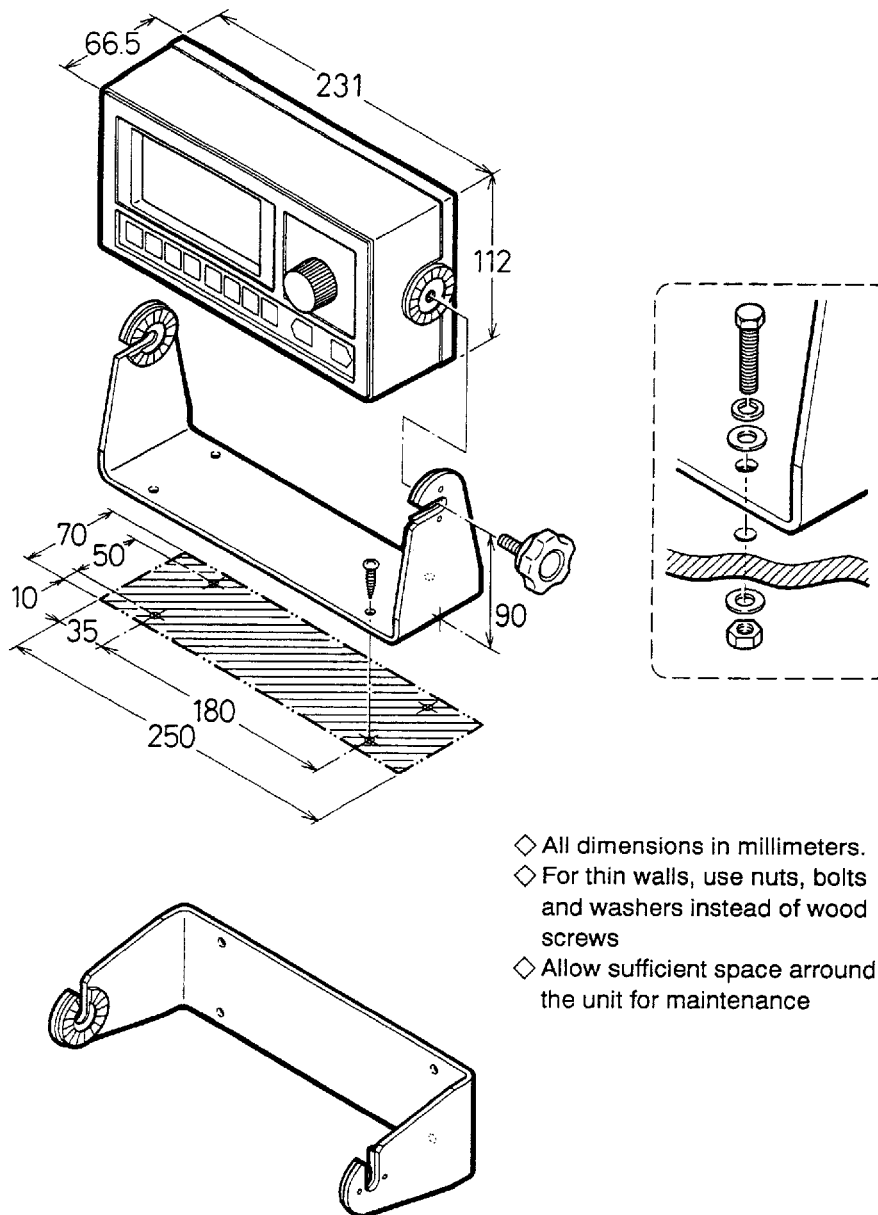
Only qualified personnel should work in the unit.

---

## 2) Mounting dimensions

---

### 1) Tabletop/Bulkhead



Face the slot in the bracket upward for bulkhead mounting.

*Fig. AP2-1 Table top and bulkhead mounting*

## 2) Flushmount

The optional flushmount kit OP64-1 (Code number 009-004-020) required.

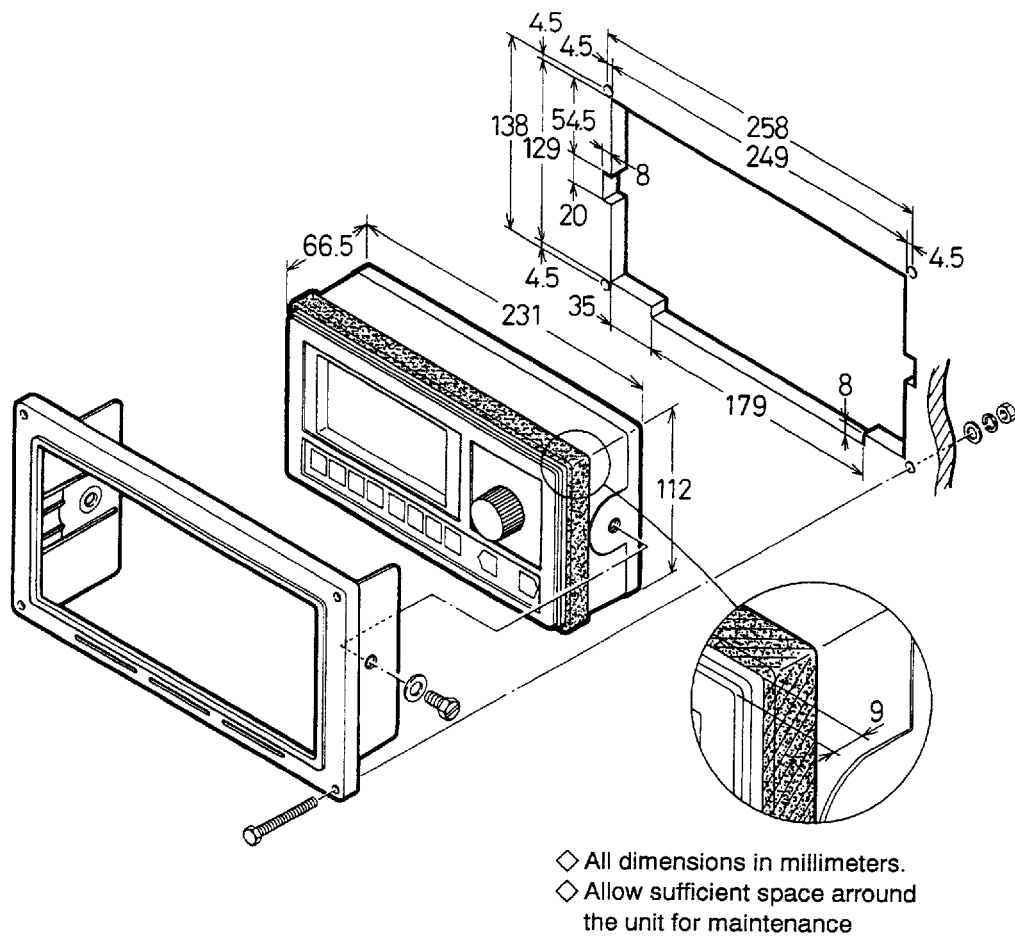


Fig. AP2-3 Flushmounting

## 2. Processor unit (FAP-3302)

### 1) Mounting considerations

Avoid the following places:

- A place exposed to direct sunlight,
- A place exposed to direct water splash or rain,
- A place exposed to direct air from an air-conditioner,
- High-temperature, poorly ventilated environment.

### 2) Mounting dimensions

#### 1) Tabletop/Bulkhead

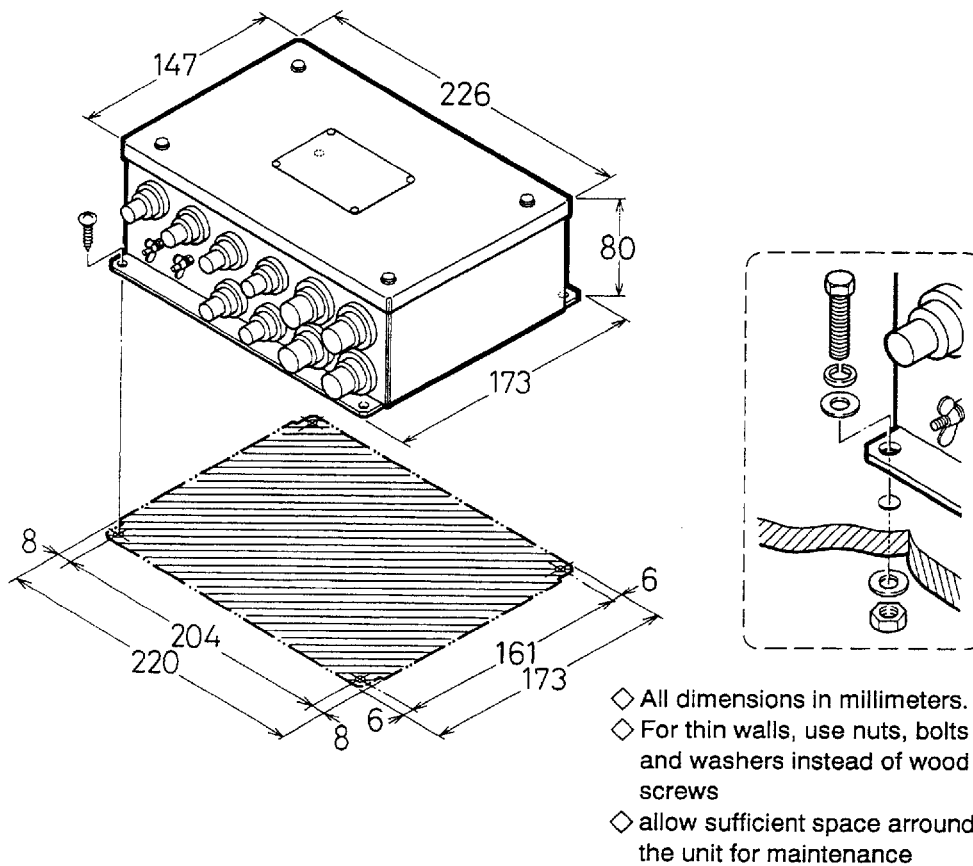


Fig. AP2-3 Tabletop mounting

### 3. Rudder reference unit (FAP-6101)

#### 1) Mounting considerations

Give sufficient clearance around all moving parts.

The unit must be coupled to the rudder as shown on page D-11, where the following conditions must be satisfied:

$$Y2 < 600 \text{ mm}$$

$$X1 = X2$$

$$Y1 = Y2$$

When the rudder is in neutral position:

The rudder reference unit should be also neutral (centered).

The arm of rudder reference unit should be 90 degrees with the tie rod. Also the rudder stock should be at 90 degrees with the tie rod.

After the installation, apply grease at both ends of the rod.

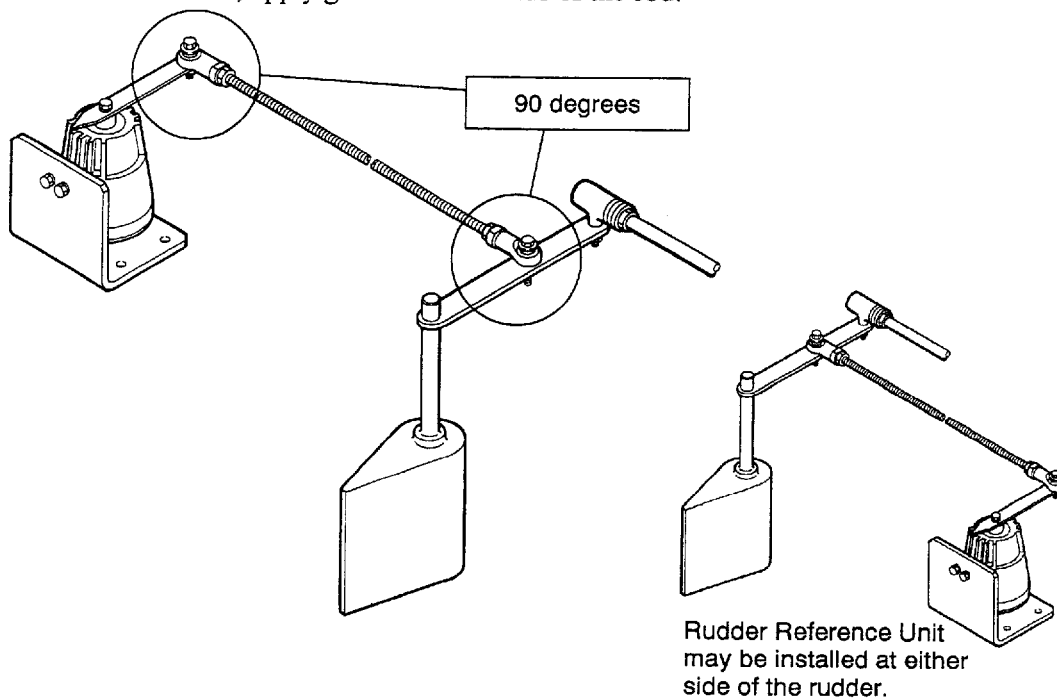


Fig. AP2-4 Mounting the RRU at the same side of the tie rod

---

## 2) Mounting dimensions

---

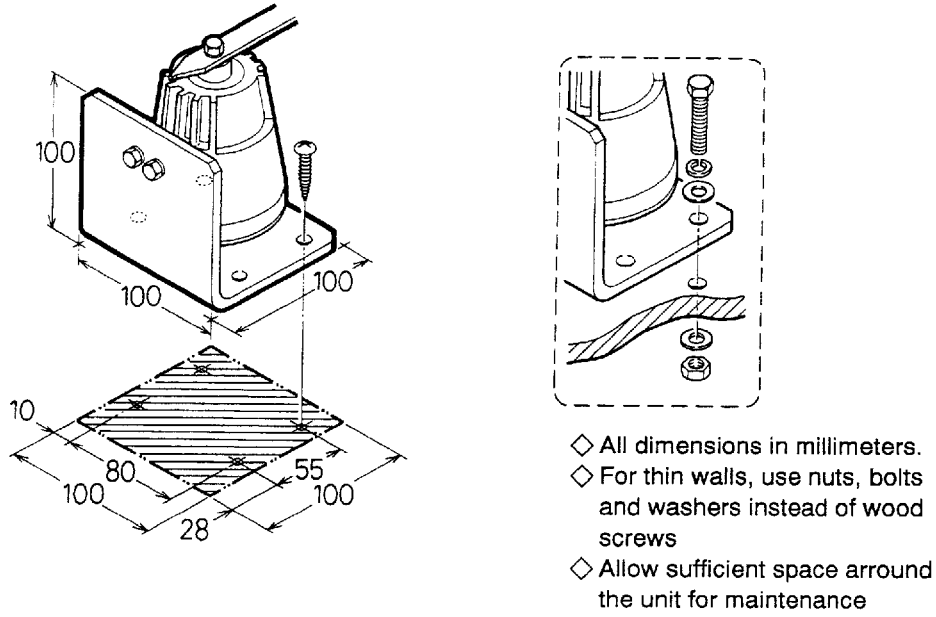


Fig. AP2-5 Mounting the RRU

---

## 3) Mounting at the opposite side of the tie rod

---

When installing the rudder reference unit at the opposite side of the tie rod as shown below, change the wire connection.

Open the bottom plate of the rudder reference unit then exchange white and green wire. Refer to the figure below.

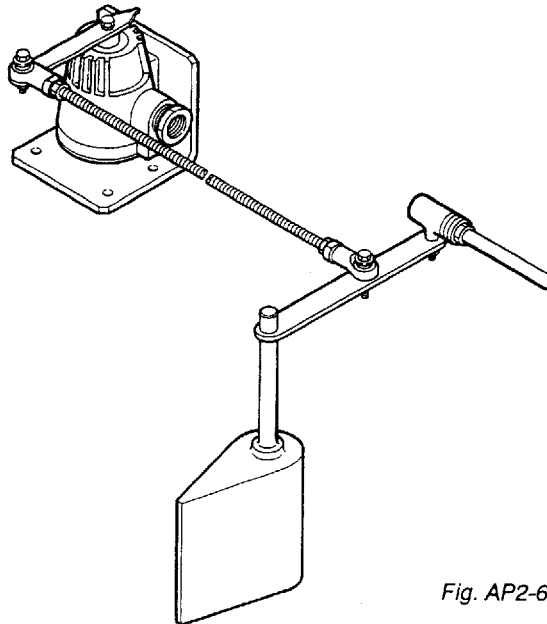


Fig. AP2-6 Mounting the RRU at the opposite side of the tie rod

# CAUTION

Install the rudder reference unit at the same side of the tie rod when the rudder angle limitation inherent in boat's structure is more than 45 degrees.

Steering the rudder more than 45 degrees with the unit installed opposite side of the tie rod may turn the arm of the unit more than the unit's limit. The unit may be damaged.

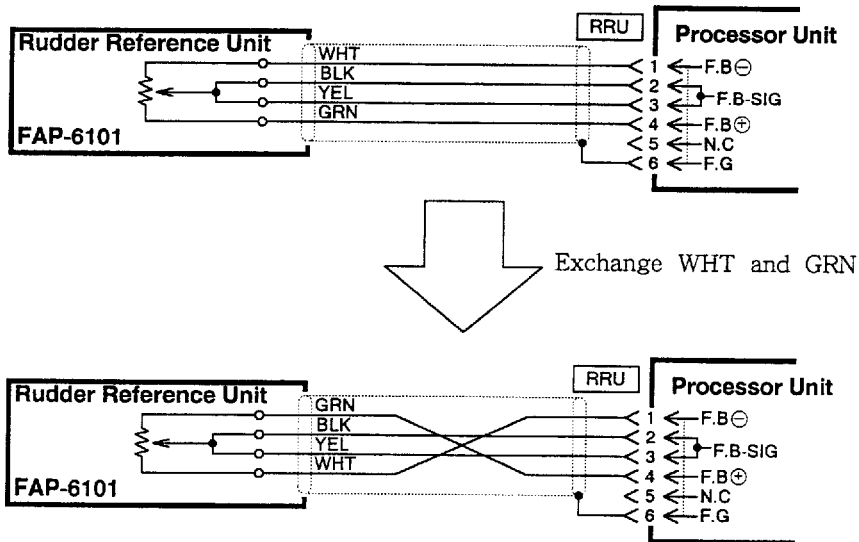


Fig. AP2-7 After exchanging the cables

## 4. Heading sensor (C-2000)

---

### 1) Precaution

---

The heading data is magnetic. While operating FAP-330 in "NAV" mode, the bearing data of the navigational equipment should be magnetic.

Compensate the C-2000 before operating FAP-330. Without compensation, the FAP-330 can not control the vessel properly.

Select small damping value. Large damping causes the vessel (especially small boats) to meander after a turn. The default setting is "1".

### 2) Mounting considerations

---

The C-2000 is designed for tabletop mountings. When selecting a mounting location keep the following points in mind.

Align the unit parallel to with the keel line.

Align the C-2000 so the arrow mark on the top side of the sensor points forward.

Face the keyboard side upward.

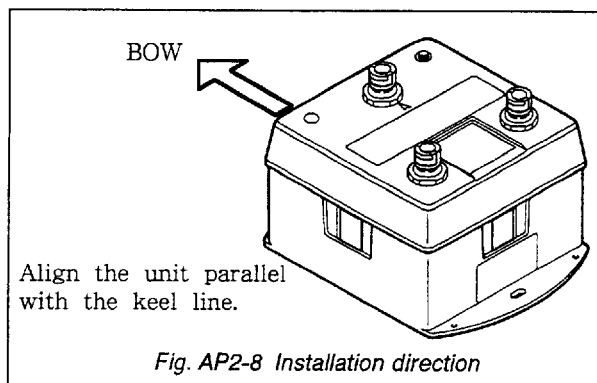
Install the sensor close to the boat's center of the gravity.

Install the sensor as far as possible from:

- Engine,
- Steel fuel tank,
- Steel water tank,
- Bilge pump,
- Anchor and anchor chain,
- Antenna cable for radio equipment,
- Power cable,
- Steel mast,
- Steel mast support,
- Steel keel,

Use the supplied power cable.

Cover unused data output connector with cap (supplied).





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### 3) Mounting dimensions

---

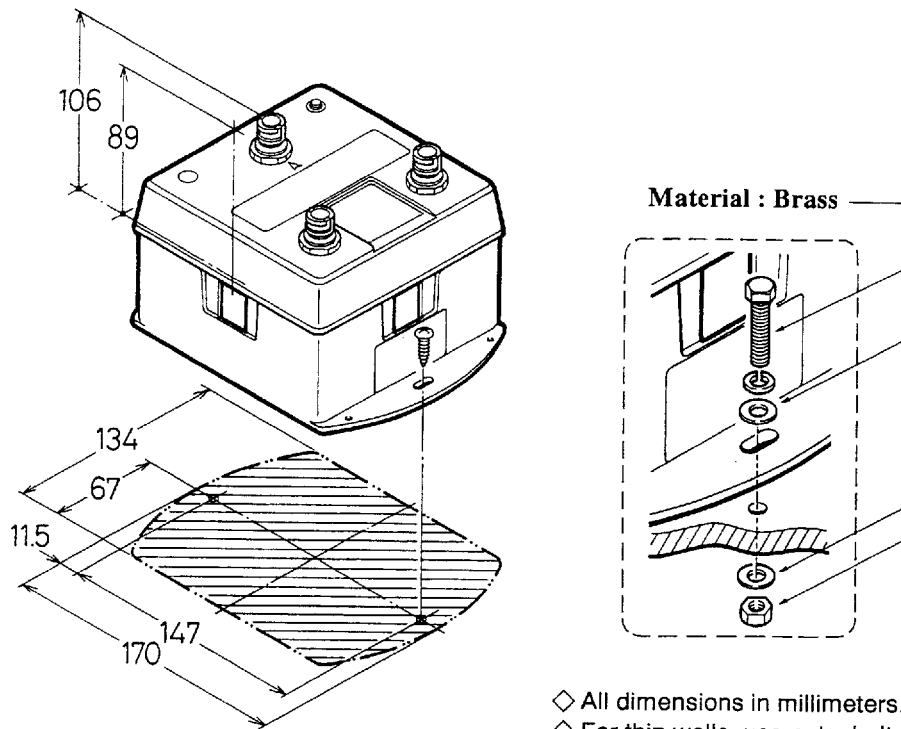


Fig. AP2-9 Tabletop mounting

- ◇ All dimensions in millimeters.
- ◇ For thin walls, use nuts, bolts and washers instead of wood screws
- ◇ Allow sufficient space around the unit for maintenance

---

### 4) Grounding

---

Ground the C-2000 only if it interferes with other equipment, such as a radiotelephone or a video sounder with increased noise.

For grounding, use a cable about 1.25 sqmm that does not contain steel. A cable larger than 1.25 sqmm causes heading error.

If the C-2000 causes interference to a magnetic compass, change the location.

## 5. Remote controller (FAP-5551/6211/6221)

---

### 1) Mounting considerations

---

Avoid the following places:

- A place exposed to direct sunlight,
- A place exposed to direct water splash or rain,
- A place exposed to direct air from an air-conditioner,
- A high-temperature, poorly ventilated environment.

The flushmount kit is optionally available for FAP-6221.

---

### 2) Mounting dimensions

---

#### 1) FAP-5551

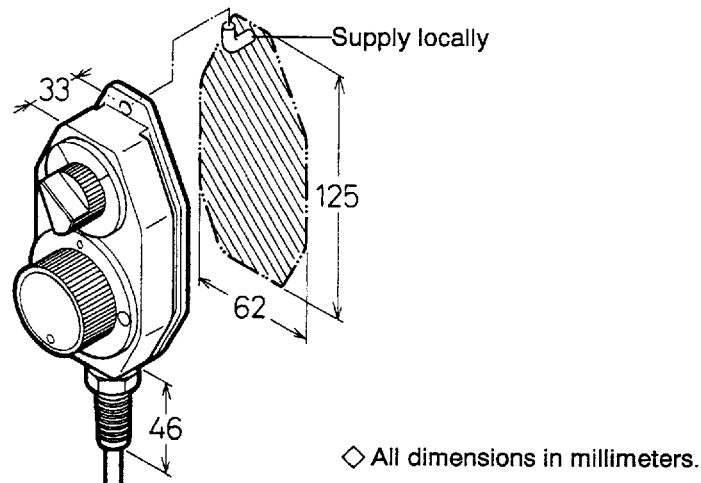
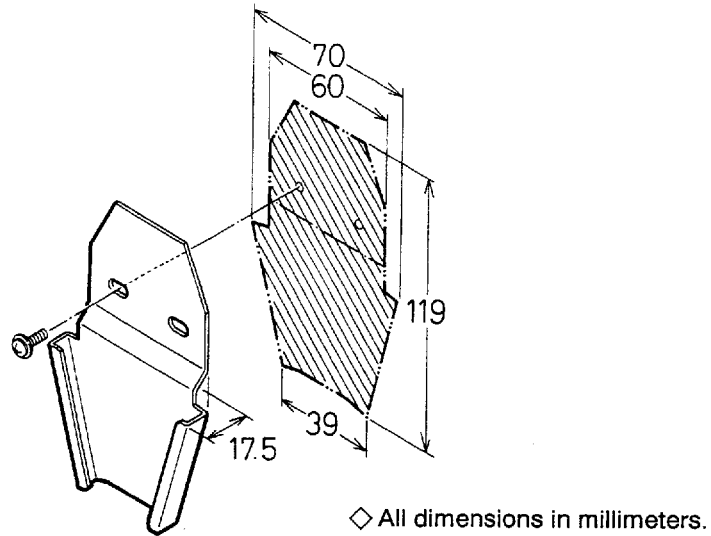


Fig. AP2-10 Bulkhead mounting

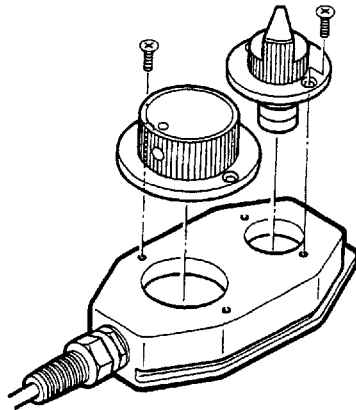
## 2) Bulkhead Mount

An optional hanger OP64-2 (Code number 009-004-030) is required.



*Fig. AP2-11 Mounting the hanger*

The remote controller is usually fixed to a bulkhead. If you want to hand-hold it, you may reverse the switch and dial blocks so that the dial would be readable. To accomplish this, loosen the four screws shown below. Note that the switch and dial blocks are inserted into the controller body with O-rings. Be careful not to damage them.



*Fig. AP2-12 Reversing the switch and dial blocks*

### 3) FAP-6211

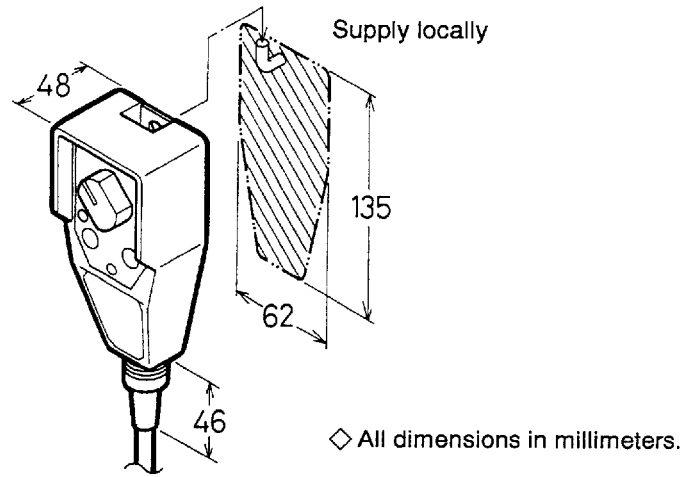


Fig. AP2-13 Bulkhead mounting

### 4) FAP-6221

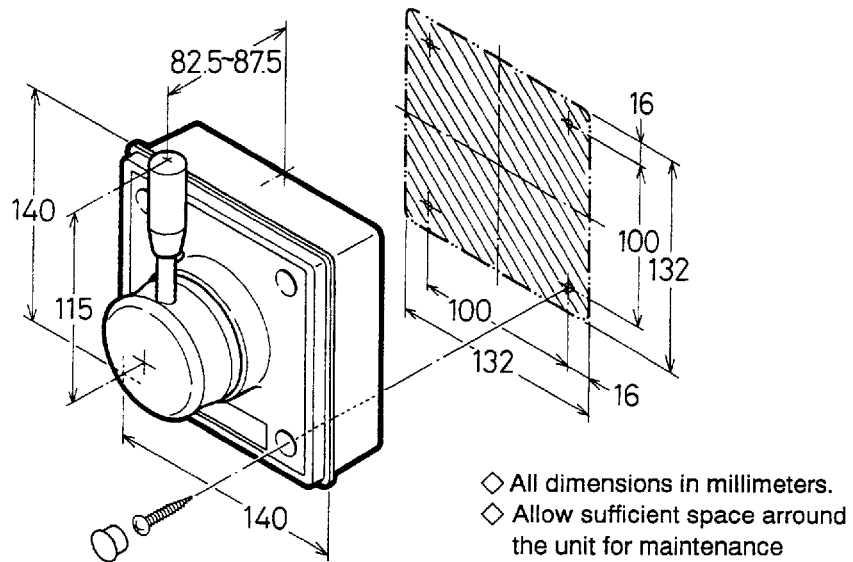


Fig. AP2-14 Bulkhead mounting

## 5) FAP-6221 Flushmount

An optional flushmount kit OP64-4 (Code number 009-005-790) is required.

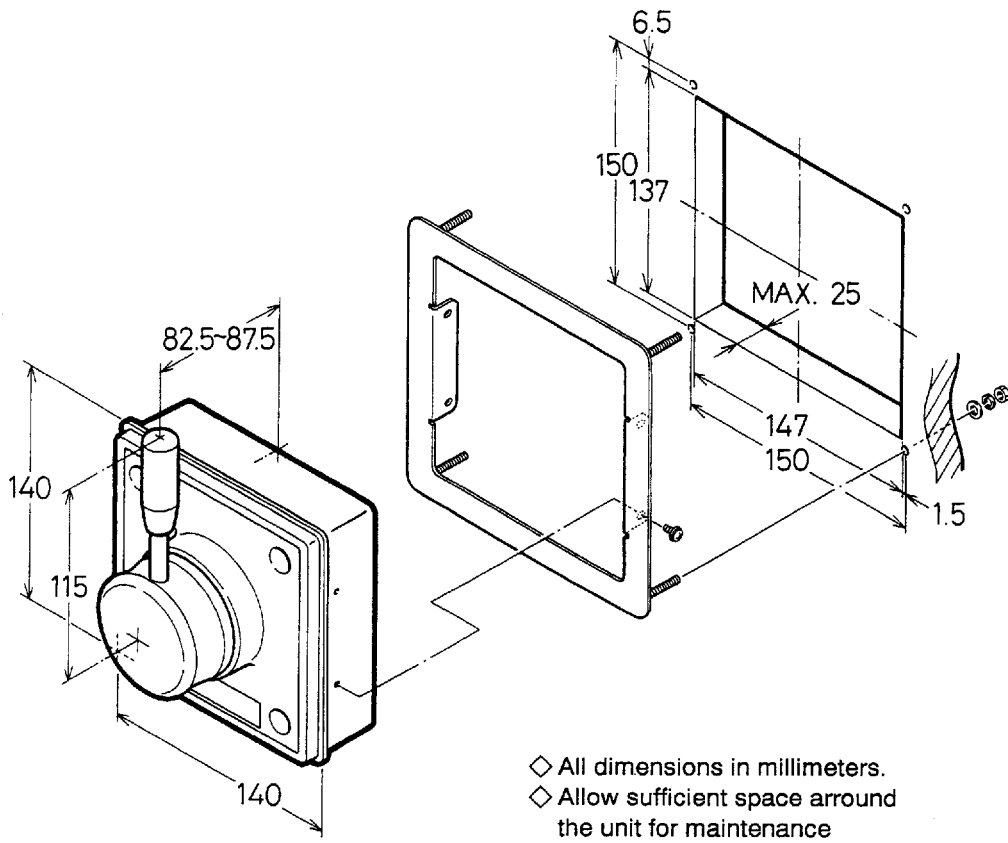


Fig. AP2-15 Flushmounting (F-type)

## 6. Rudder telltale (FAP-6501)

### 1) Mounting considerations

Avoid the following places:

- A place exposed to direct sunlight,
- A place exposed to direct water splash or rain,
- A place exposed to direct air from an air-condition,
- A high-temperature, poorly ventilated environment,

Tabletop, bulkhead and overhead mountings are available by using the hanger bracket supplied. The flushmount kit is optionally available.

An external power supply is required for each unit.

### 2) Mounting dimensions

#### 1) Tabletop/Bulkhead

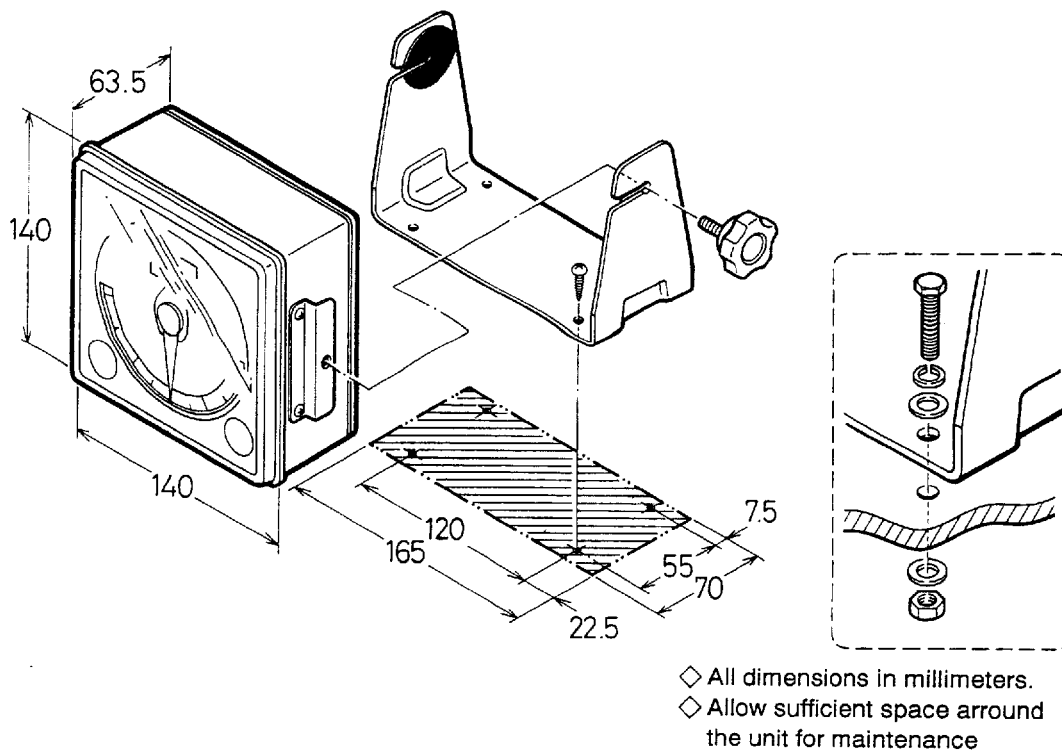


Fig. AP2-16 Tabletop mounting

## 2) Flushmount (F-type)

An optional flushmount kit OP64-4 (Code number 009-005-790) is required.

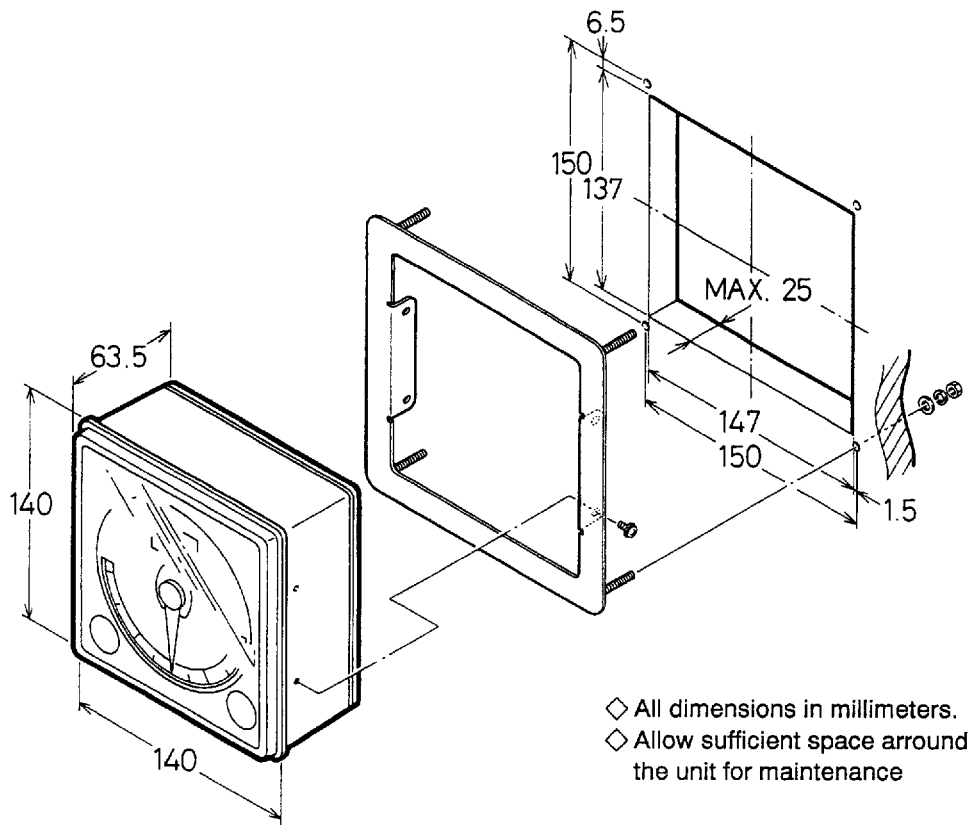
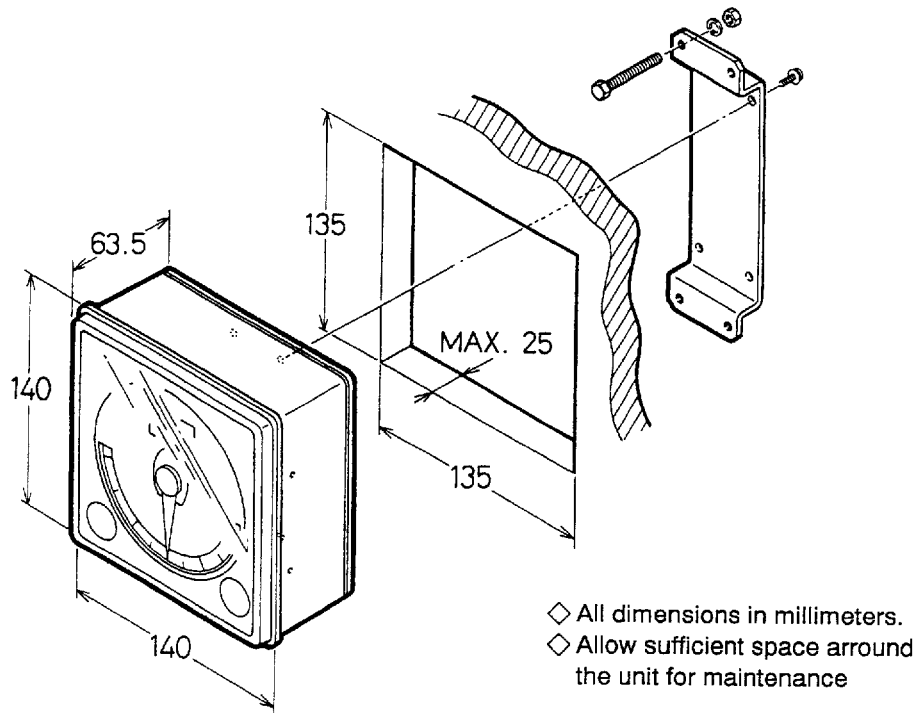


Fig. AP2-17 Flushmounting (F-type)

### 3) Flushmount (S-type)

An optional flushmount kit OP64-5 (Code number 009-005-800) is required.



*Fig. AP2-18 Flushmounting (S-type)*



### 3) Multiple unit installation

#### 1) Connection

A maximum of three units may be connected in series. Refer to the figure below.

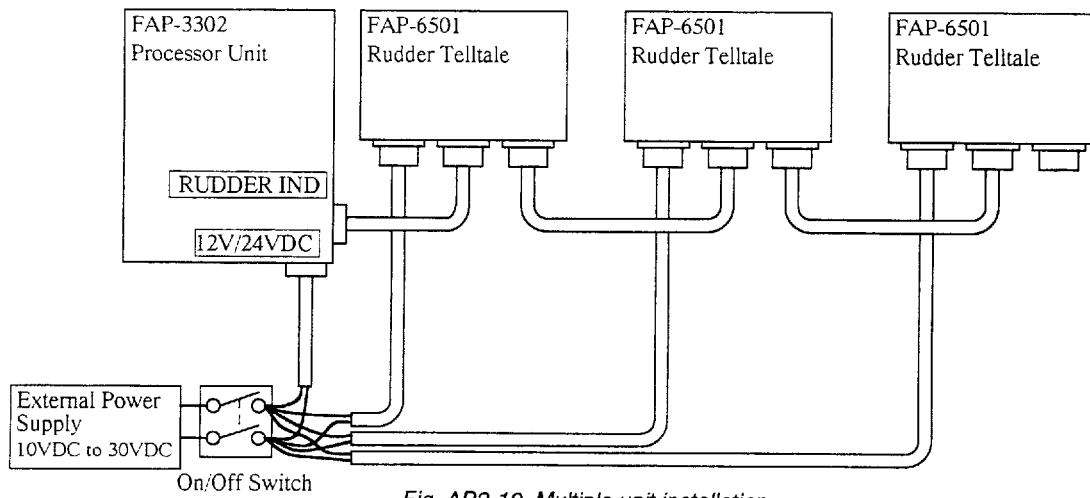


Fig. AP2-19 Multiple unit installation

#### 2) Power Supply

Supply the voltage between 10VDC and 30VDC.

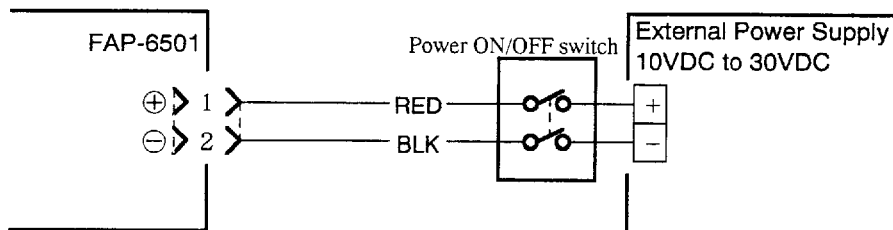


Fig. AP2-20 Connection of a power supply

## 7. Distributor (FAP-6800)

The distributor FAP-6800 enables connection of 3 NFU remote controllers to a single connector of the processor unit. By using two distributors, a maximum of 6 NFU remote controllers may be connected to the processor unit. Only a single FU remote controller is available per distributor.

### 1) Example of connection

#### 2 remote controllers

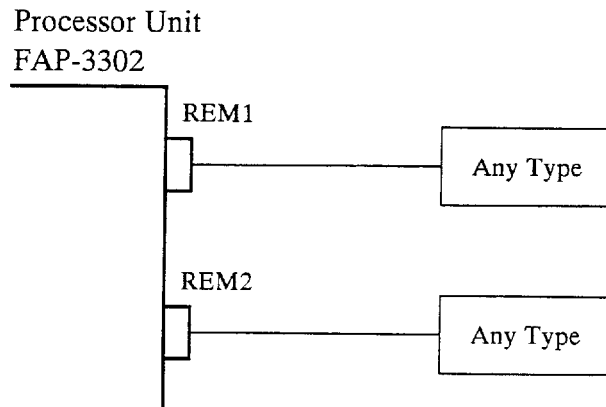


Fig. AP2-21 Two remote controllers

#### 4 remote controllers

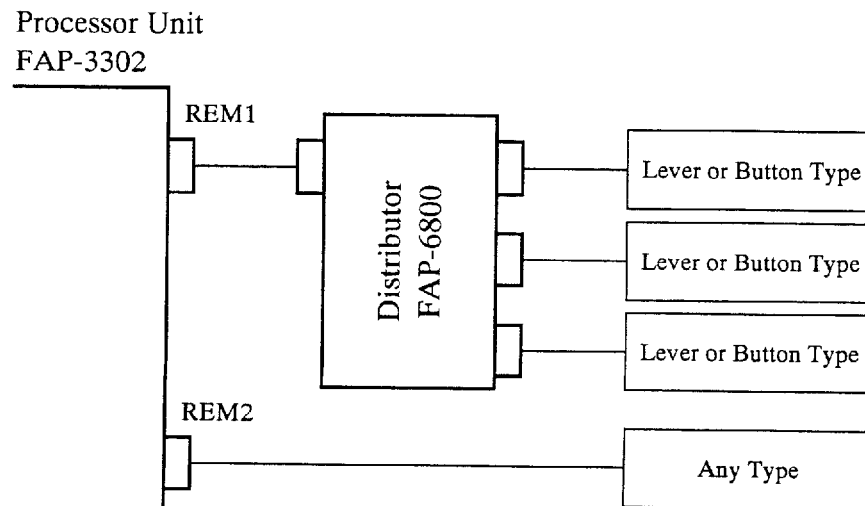


Fig. AP2-22 Four remote controllers

## 6 remote controllers

Processor Unit  
FAP-3302

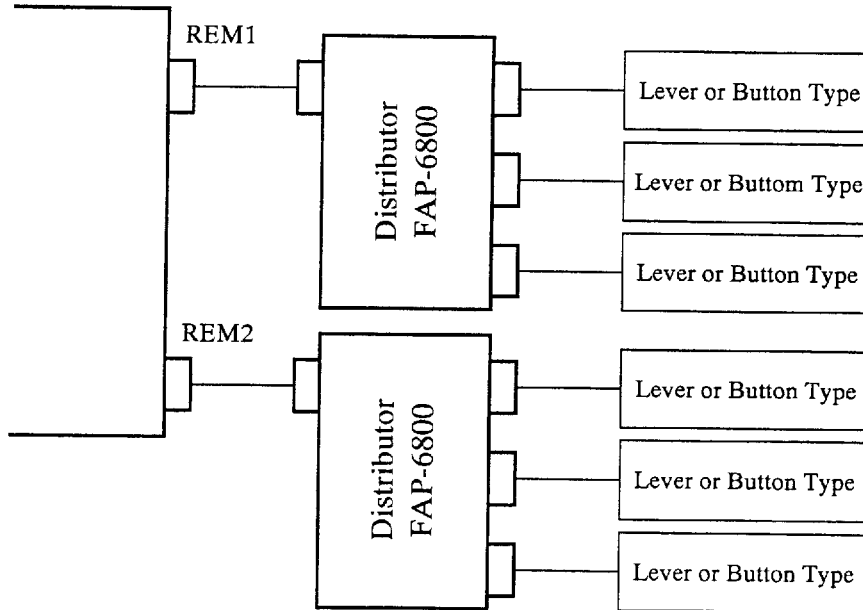


Fig. AP2-23 Six remote controllers

The following installation is not available.

Processor Unit  
FAP-3302

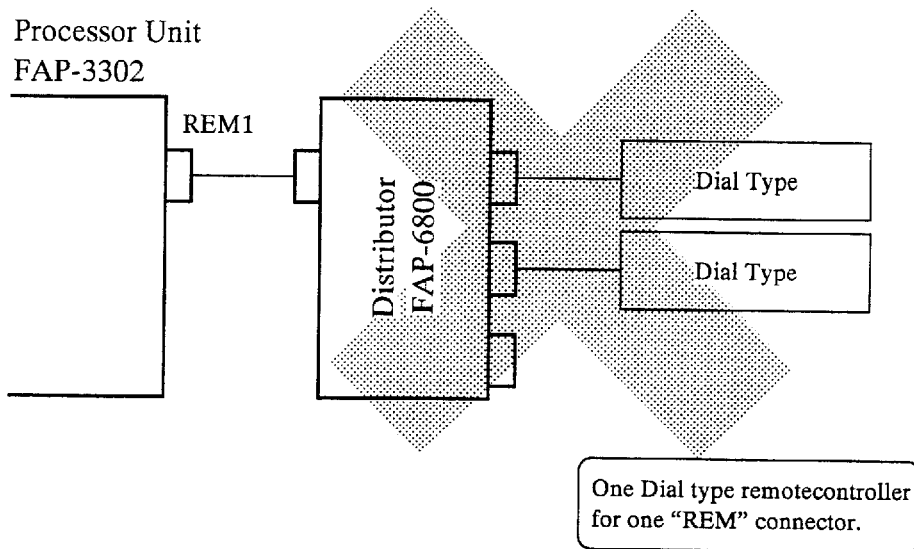


Fig. AP2-24 One dial type remote controller is available

## 2) Mounting dimensions

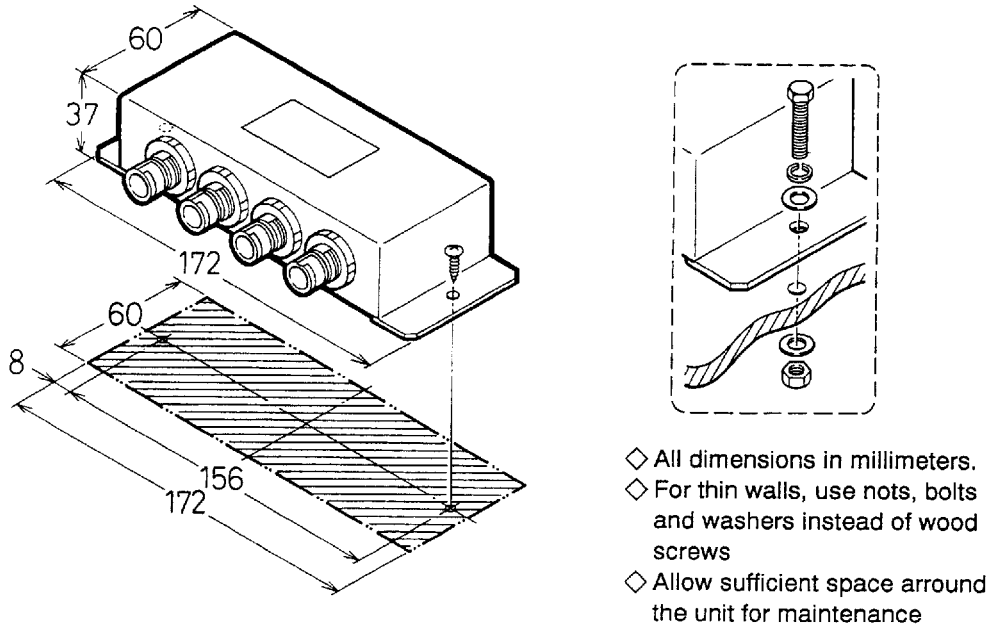


Fig. AP2-25 Tabletop mounting

## **8. Cabling**

---

Cabling should be carried out as shown in the interconnection diagram.

---

### **1) General notes on cabling**

---

1. The DC input power supply cable should be kept as short as possible, and must be taken directly from the battery for the processor unit via a circuit breaker (30A fuse incorporated) supplied locally. Longer cable runs require an even larger wire size to minimize voltage drop.

Under no circumstance should a cable be used to supply both the autopilot and other equipment; ship's power lines are notorious for being "dirty" electrically. The voltage can vary greatly as various heavy loads are placed on the line, and the power wiring is a prime source for interfering electrical signals (from such sources as alternators or generators, and other electronics equipment, like radars or echosounders).

2. All signal cables should be separated (not parallel) as far as possible from cables carrying RF or pulsed signals. At least 1m (3ft) separation is recommended.
3. The supplied cables should not be lengthened, otherwise the performance of the unit will be greatly reduced.
4. The 10 meter white cable supplied as installation material for FAP-3302 (processor unit) is for power supply and valve unit. Cut the cable considering a distance to the unit.

## 9. Tailoring DIP switches

---

By tailoring the DIP switches, you may preset the FAP-330 to your desired parameters.

### 1) Control unit

---


After loosening the four screws, open and remove the rear panel.

Segment	Setting	OFF	ON	Default
1	Connection of external alarm :	No	Yes	OFF
2	Language :	English	Japanese	ON
3	Analog (Bar) Indicator presents :	Rudder Angle, Course Deviation or Cross-track Error depending on the mode.	Rudder Angle only irrespective of operational mode.	OFF
4	Operating Mode :	Normal	Test (factory use)	OFF

## 2) Processor unit

Segment	Setting	OFF	ON	Default
1 (REM 1)	Type of remote controller number 1	FU Type	NFU Type	OFF
2 (REM 2)	Type of remote controller number 2	FU Type	NFU Type	OFF
3 (HEDG)	Output of Heading Sensor	Magnetic Bearing	True Bearing	OFF
4 (DHLT)	Default Setting	Type 2	Type 1	OFF
5 (WA)	Watch Alarm	Able	Disable	OFF
6 (XTE)	NAV mode control	Cross Track Error control	Course deviation control	OFF
7 (TEST)	Operating Mode	Normal	Test (factory use)	OFF
8 (TEST)	Operating Mode	Normal	Test (factory use)	OFF

## 10. Rudder angle null adjustment

Turn on the FAP-330 by pressing 

Set the rudder in its neutral position by steering the wheel manually. Visually inspect the rudder to confirm this. Do not rely on the rudder angle indication provided on the FAP-330 because it has not been adjusted yet.

Adjust R34 (ZERO ADJ) so that CR28 lights. (Temporary adjustment)

Sail out to the open sea.

Run the vessel straight.

Readjust the R34 so that CR28 lights. (Permanent adjustment)

## 11. Notes on the external buzzer

When the internal buzzer is not loud enough, you may install an external buzzer.

The buzzer driving signal may output a contact closure. The contact capacity is 3 amperes.

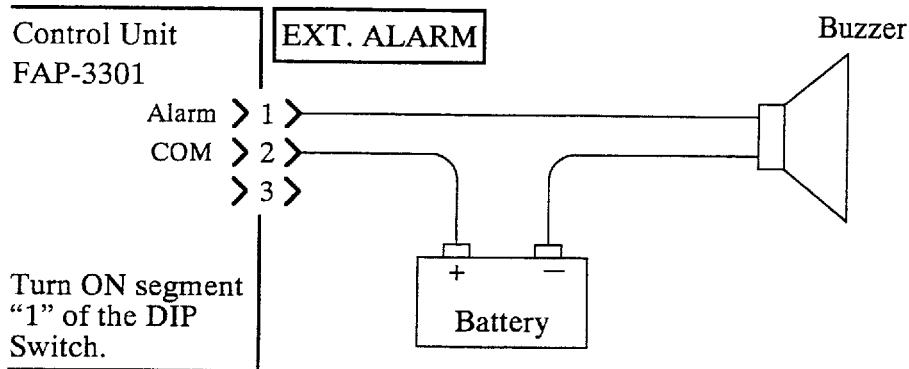


Fig. AP2-26 External buzzer connection

A horn for a car may be utilized as an external buzzer for FAP-330.

The external buzzer and the internal buzzer sound at the same time. If the power supply for the FAP-330 fails, only the external buzzer will sound continually.

The connection cable should be separated (not parallel) as far as possible from cables carrying RF signals or large power. Test the FAP-330 with a transmitter operated. Use a shielded cable if necessary.



## **12. After installation**

---

When the installation is completed, conduct the following:

- 1) CHECK BEFORE LEAVING PORT,
- 2) MODIFYING STEERING CHARACTERISTICS.

## **13. LED status**

---

<b>LED Number</b>	<b>Status</b>
CR2	Lights while driving a solenoid valve.
CR8	Lights while turning the rudder right.
CR9	Lights while turning the rudder left.
CR22	Flickers every 0.5 seconds.
CR28	Lights when the rudder angle is "0 degree".



# 3. NAVAID CONNECTION

## 1. *About NMEA0183 Sentences accepted by the FAP-330*

---

Immediately after power application, the FAP-330 conducts the following sequence:

- (1) Collects nav. data for a certain period,
- (2) Examines which of the following four are contained in the collected data;

1. (APB)\*, (VTG) and (AAM)

2. (APA)\*, (VTG) and (AAM)

\*composite sentence

3. (BOD), (XTE), (VTG) and (AAM)

4. (RMB), (VTG) and (AAM)

(3) "1." to "4." are priority numbers. (1 = top 4 = bottom)

The FAP-330 chooses format(s) with the highest priority.

The FAP-330 thereafter fetches the data selected in (3) only until it is turned off.

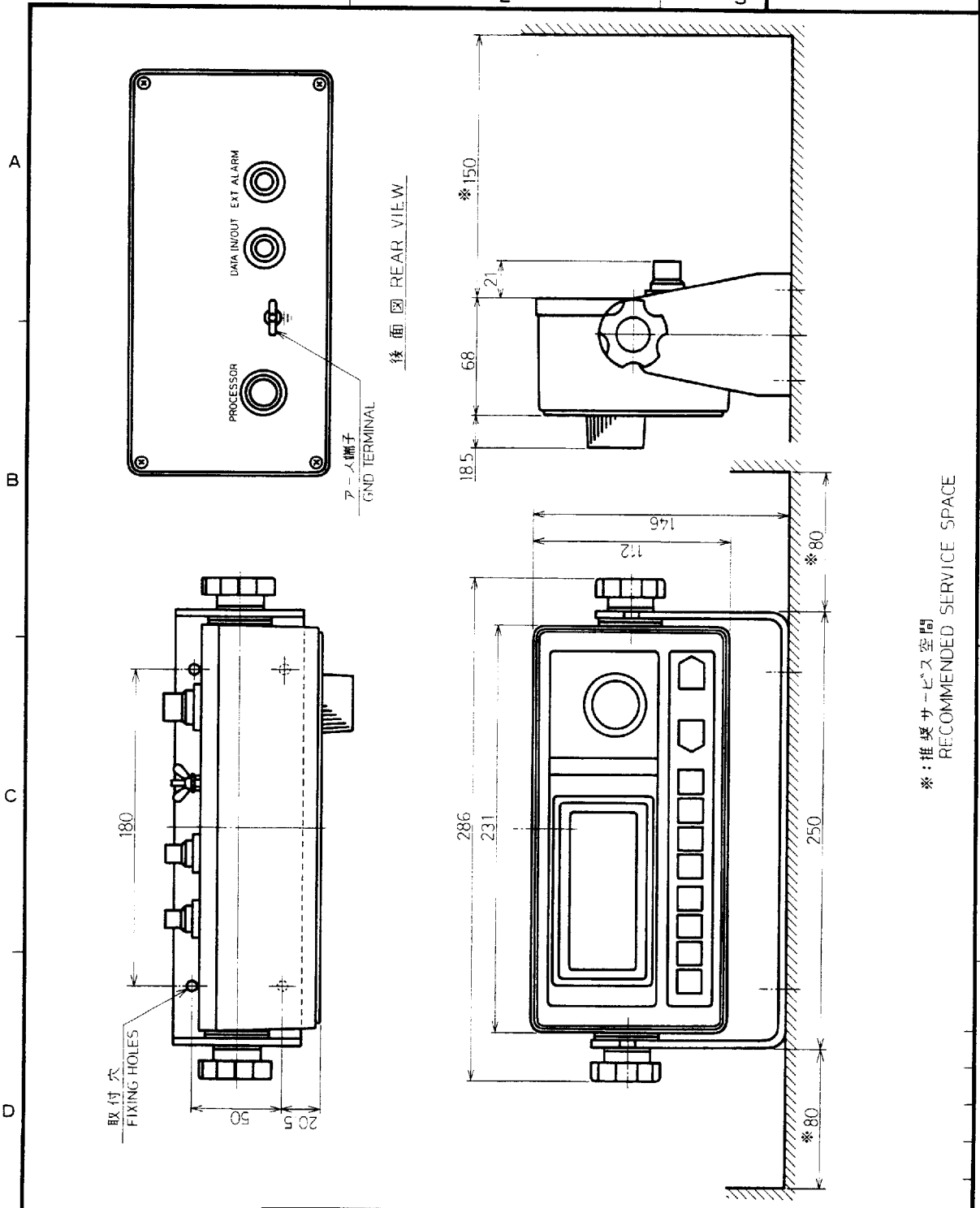
---

— **NOTE** (If data with various talker IDs are received.):

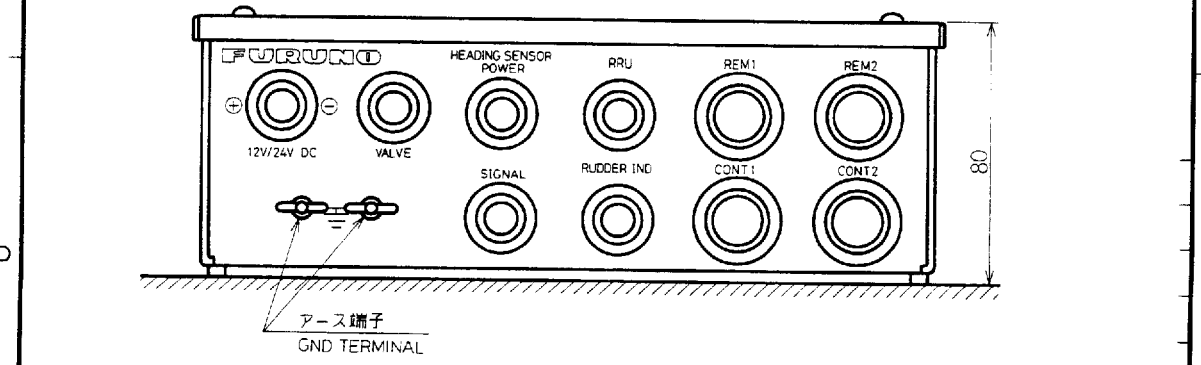
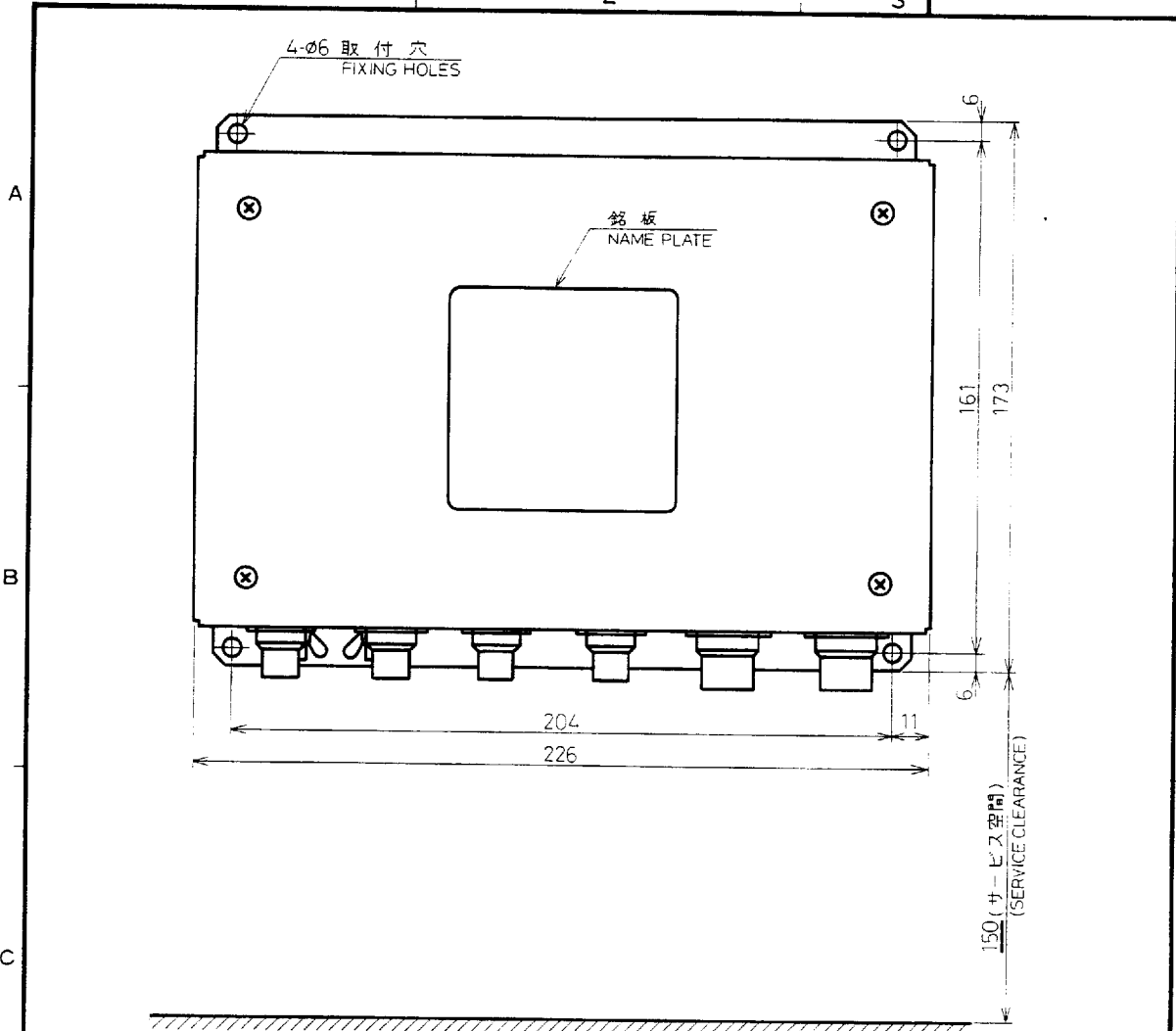
*Talkers are prioritized in the order of GP-LC-TR-DE-LA- II . The FAP-330 examines all the incoming data for a certain period after power-on, then judges which is the highest priority. The FAP-330 thereafter picks up only the data with that talker ID until power is turned off. Even if the data does not come for an extended period of time, the FAP-330 does not switch to a different talker ID because it is dangerous if data consistency is lost. Safety comes first!*

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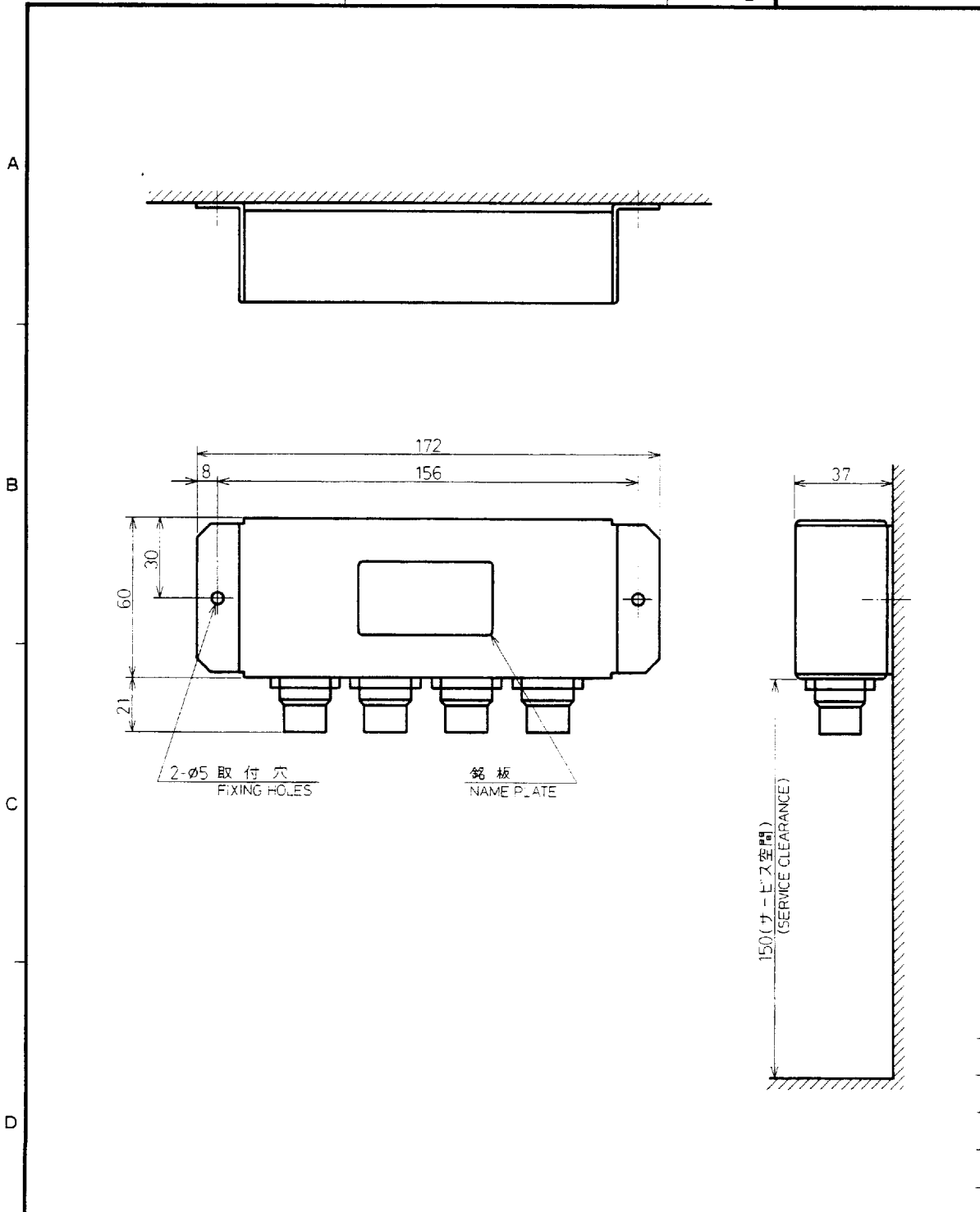




FAP-330		品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	摘要 REMARKS
承認 APPROVED	JUN. 3. '92 T. TAKANO	三角法 THIRD ANGLE PROJECTION		名称 TITLE	操作部		
検図 CHECKED	JUN. 2. '92 S. NISHI	尺度 SCALE	<i>N</i>	FAP-330	CONTROL UNIT		
製図 DRAWN	JUN. 2. '92 N. SAITO	重量 WEIGHT	1.6 kg	図番 DWG. NO.	C7235-G01-B		

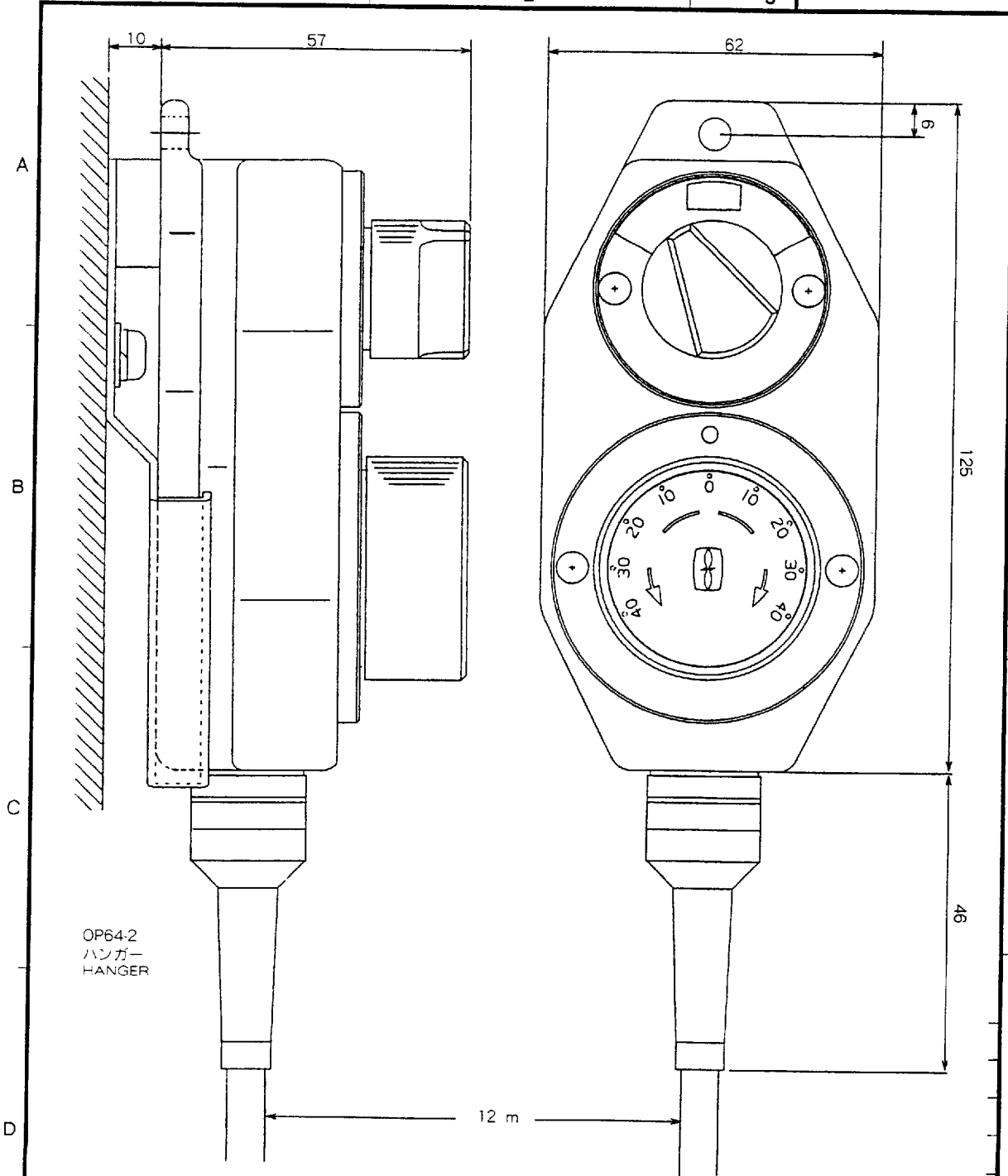


FAP-330		品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
承認 APPROVED	JUN. 3 '92 T. YAKAWO		三角法 THIRD ANGLE PROJECTION	名称 TITLE			制御部
検図 CHECKED	JUN. 2 '92 N. SAITO		尺度 SCALE	FAP-3302			PROCESSOR UNIT
製図 DRAWN	JUN. 2 '92 S. NISHI		重量 WEIGHT	0.8 kg		図番 DWG.NO.	C7235-G02-A



FAP-330

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
承認 APPROVED	JUN・3・'92 T. NAKANO	三角法 THIRD ANGLE PROJECTION	名称 TITLE	リモコン分配器 DISTRIBUTOR	
検図 CHECKED	JUN・2・'92 N. SAITO	尺度 SCALE	∞	FAP-6800	
製図 DRAWN	JUN・2・'92 S. NISHI	重量 WEIGHT	0.3 kg	図番 DWG.NO.	C7235-G03-A

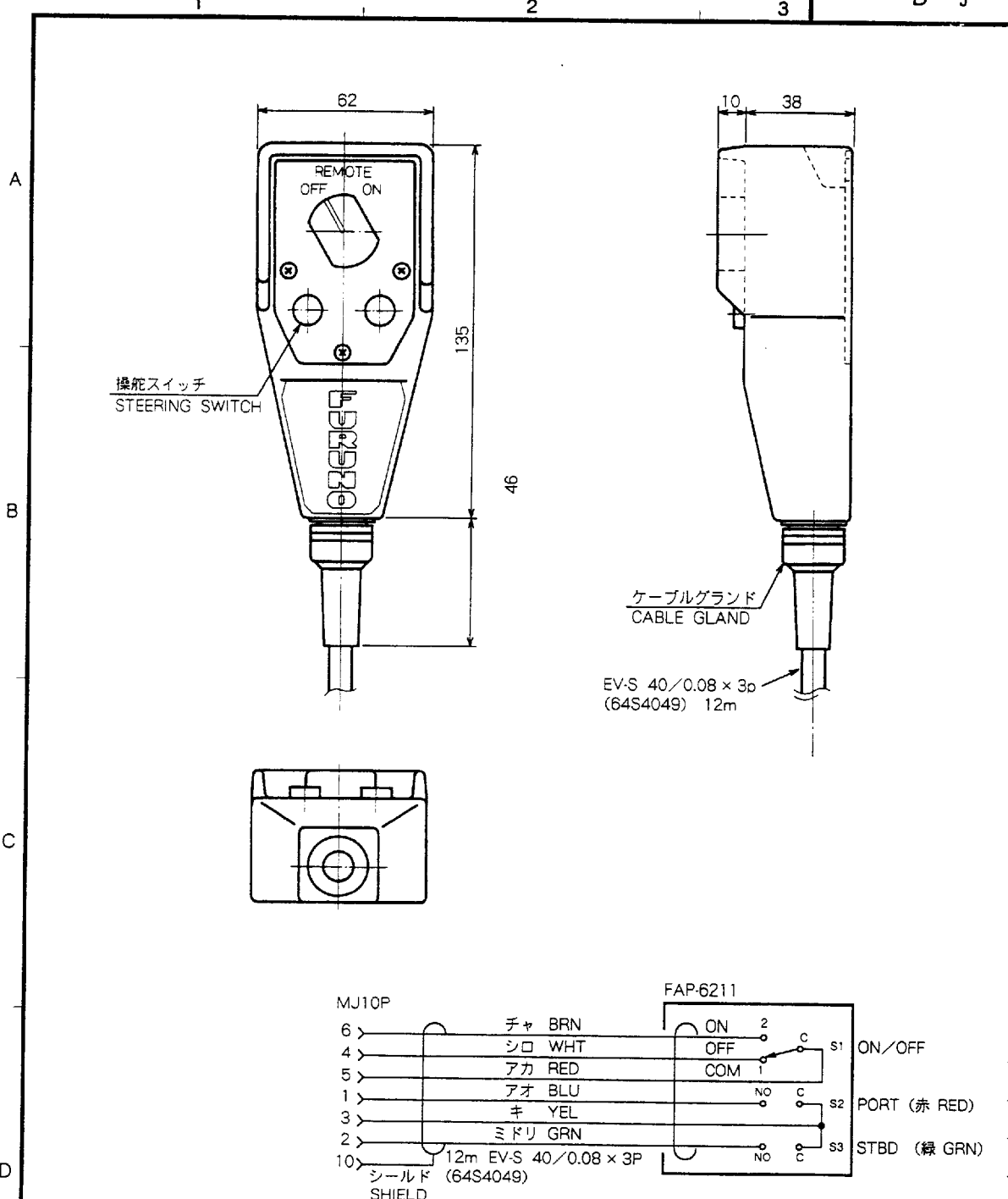


FAP-330

承認 APPROVED	品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	摘要 REMARKS
JUN・15・'92 T. NAKANO		三角法 THIRD ANGLE				名称 TITLE リモコン (遠隔制御器) REMOTE CONTROLLER
検図 CHECKED	JUN・15・'92 N. SAITO	尺度 SCALE				FAP-5551
製図 DRAWN	JUN・15・'92 S. NISHI	重量 WEIGHT	0.5 kg		図番 DWG.NO	C7235 - G04 - A

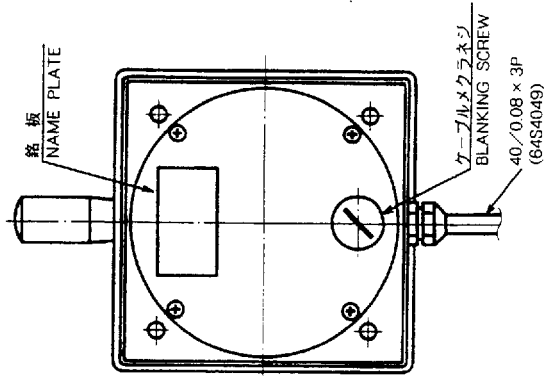
FURUNO ELECTRIC CO., LTD.



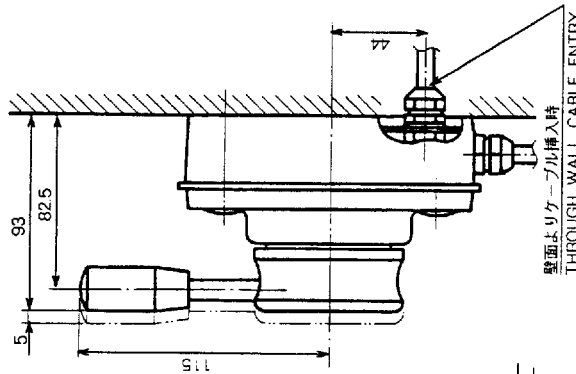


FAP-330		品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	摘要 REMARKS
承認 APPROVED	JUN・15・'92 T. NAKANO	三角法 THIRD ANGLE		名称 TITLE	遠隔操作器 (ボタン式) FAP-6211 REMOTE CONTROLLER (BUTTON SWITCH TYPE)		
検図 CHECKED	JUN・15・'92 N. SAITO	尺度 SCALE					
製図 DRAWN	JUN・15・'92 S. NISHI	重量 WEIGHT	0.5 kg	図番 DWG.NO	C7235 - G05 - A		

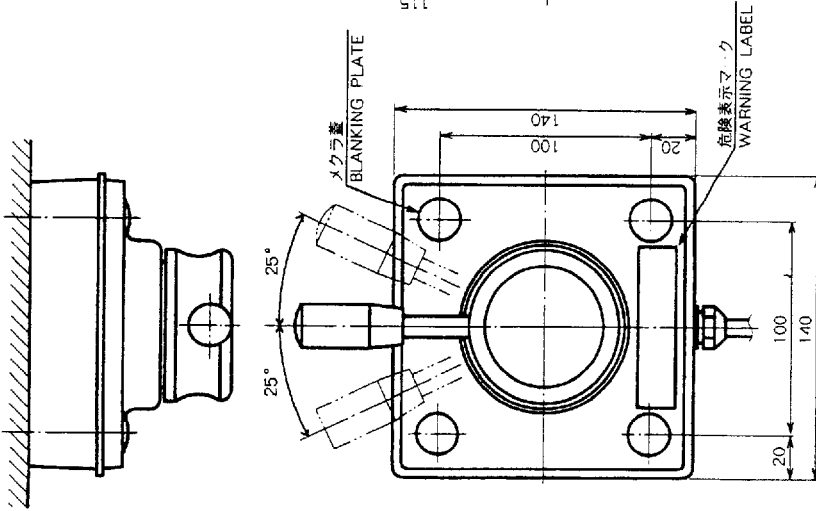
A



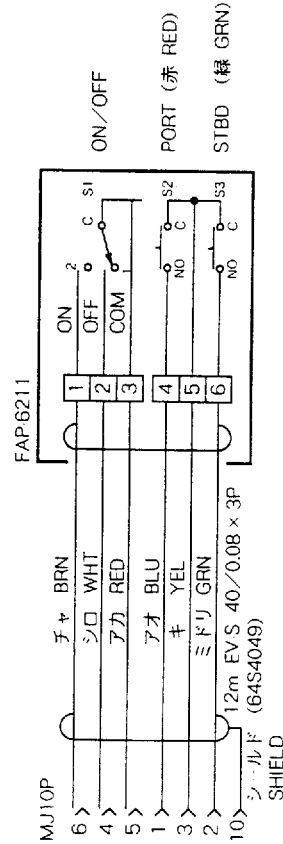
B



C



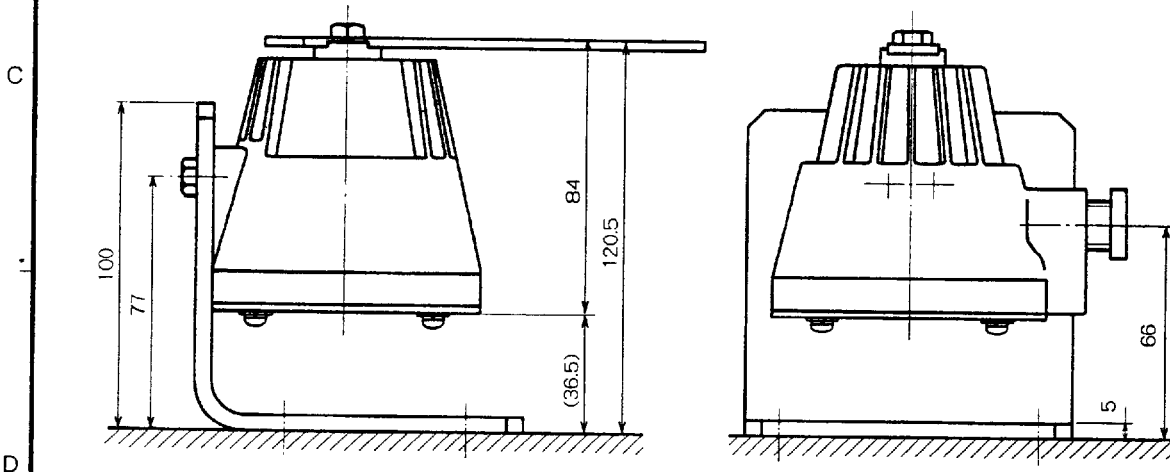
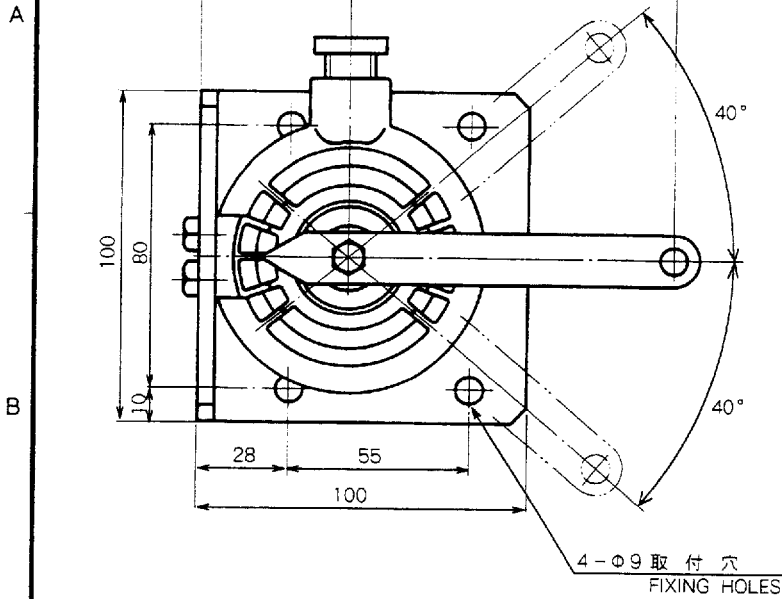
D



FAP-330

承認 APPROVED	検図 CHECKED	製図 DRAWN	品番 ITEM	品名 NAME	材質 MATERIAL	数量 QTY	図番 DWG. NO.	備考 REMARKS
JUN · 15 · '92 T. NAKANO	JUN · 15 · '92 N. SAITO	JUN · 15 · '92 S. NISHI		三角法 THIRD ANGLE				遠隔管制器 (レバー式) REMOTE CONTROLLER (LEVER TYPE)
				尺度 SCALE				
				重量 WEIGHT	1.8 kg		図番 DWG. NO.	C7235 - G06 - A

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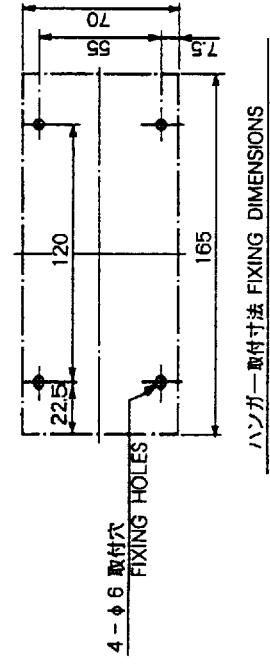
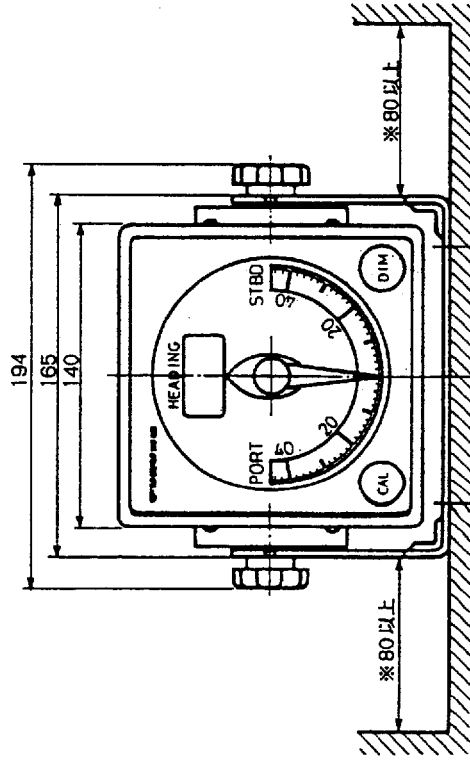
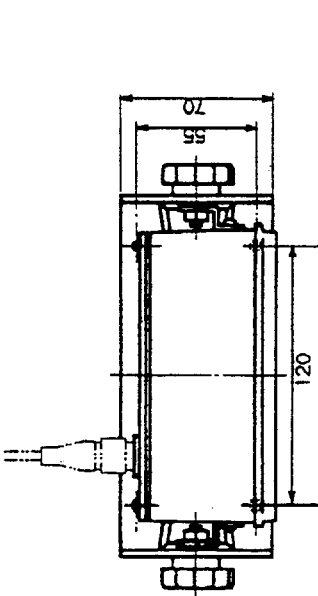
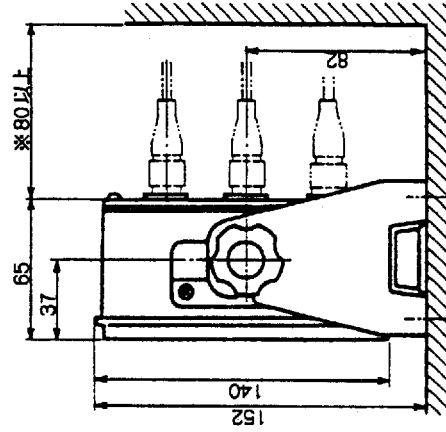
FAP-330

承認 APPROVED	品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	摘要 REMARKS
JUN · 15 · '92 T. NAKANO		三角法 THIRD ANGLE				名称 TITLE 追従発信器 FAP-6101 RUDDER REFERENCE UNIT
検図 CHECKED	JUN · 15 · '92 N. SAITO	尺度 SCALE	$\propto$			
製図 DRAWN	JUN · 15 · '92 S. NISHI	重量 WEIGHT	1.6 kg		図番 DWG.NO	C7235 - G07 - A

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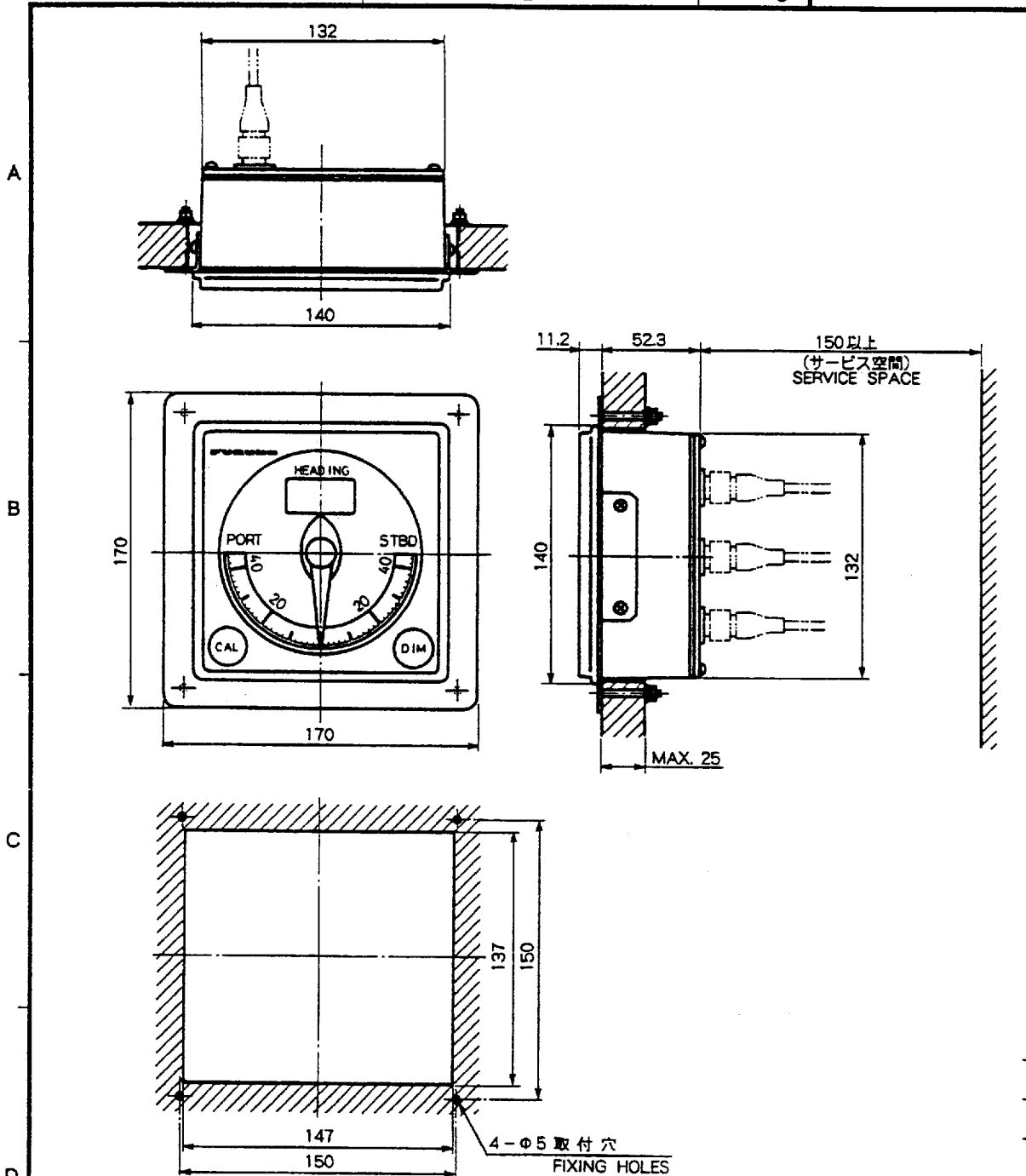
A  
B  
C  
D

※: 推奨サービス空間  
RECOMMENDED SERVICE SPACE



FAP-330  
FAP-300

品番 ITEM	品名 NAME	材質 MATERIAL	数量 QTY	図番 DWG. NO.	摘要 REMARKS
承認 APPROVED	JUN・15・'92 T. NAKANO	三角法 THIRD ANGLE	名称 TITLE	舵角表示器 (ハンガー装備) RUDDER TELLTALE (HANGER MOUNT)	
検図 CHECKED	JUN・15・'92 N. SAITO	尺度 SCALE	FAP-6501		
製図 DRAWN	JUN・15・'92 S. NISHI	重量 WEIGHT	1.3 kg	図番 DWG.NO	C7235-G08-D

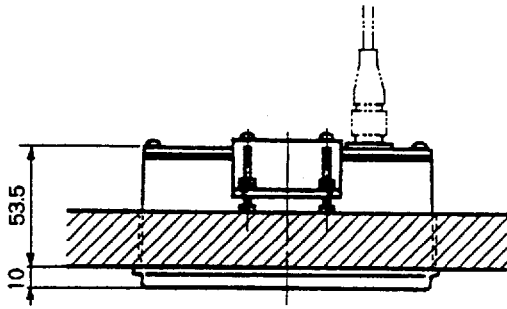


パネル取付穴寸法  
CUTTING DIMENSIONS

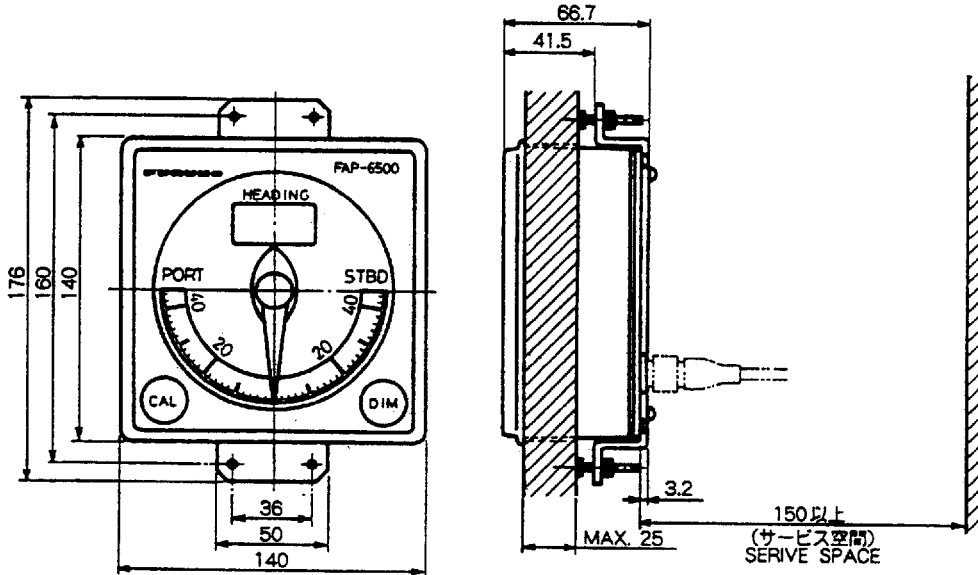
FAP-330  
FAP-300

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	備考 REMARKS
承認 APPROVED	JUN · 15 · '92 T. NAKANO	三角法 THIRD ANGLE	名称 TITLE	舵角表示器 (フラッシュマウント F) RUDDER TELLTALE (FLUSH MOUNT F)	
検図 CHECKED	JUN · 15 · '92 .N. SAITO	尺度 SCALE	FAP-6501		
製図 DRAWN	JUN · 15 · '92 S. NISHI	重量 WEIGHT	1.4 kg	図番 DWG. NO	C7235-G09-C

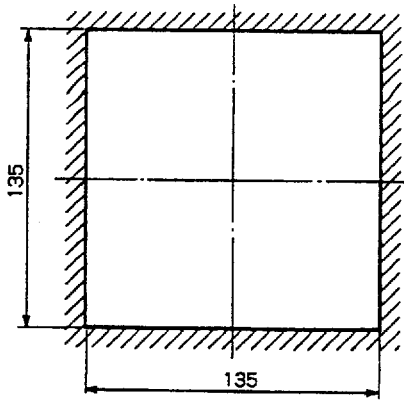
A



B



C



パネル取付け寸法  
CUTTING DIMENSIONS

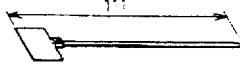
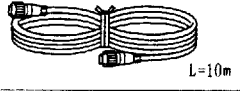
D

FAP-330  
FAP-300

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	摘要 REMARKS
承認 APPROVED	JUN・15・'92 T. NAKANO	三角法 THIRD ANGLE		名称 TITLE	舵角表示器 (フラッシュマウント) RUDDER TELLTALE (FLUSH MOUNT S)
検図 CHECKED	JUN・15・'92 N. SAITO	尺 SCALE		FAP-6501	
製図 DRAWN	JUN・15・'92 S. NISHI	重量 WEIGHT	1.3 kg	図番 DWG. NO	C7235-G10-C

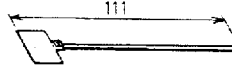
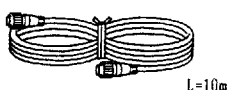
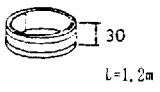
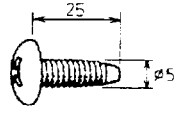
**FURUNO**

CODE NO.	000-090-225	64A0-X-9401
TYPE	CP64-01300	

工事材料表 INSTALLATION MATERIALS		FAP-3301	操作部 CONTROL UNIT		
番号 No.	名称 NAME	略図 OUTLINE	型名 / 規格 DESCRIPTIONS	数量 Q'TY	用途 / 備考 REMARKS
1	ケーブルハンコト CABLE CLAMP		PLF1M-M CODE NO. 000-116-921	2	
2	ケーブル組品 CABLE ASSY.		MJ-A10SPF0002-100 (7/0.18TAX4P+12/ 0.18X1P *10M*) CODE NO. 000-126-659	1	
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
					図番 (1/1) DWG. NO. C7235-M01-A

# FURUNO

CODE NO.	000-090-227	64A0-X-9402
TYPE	CP64-01310	

工事材料表 INSTALLATION MATERIALS		FAP-3302	制御部 PROCESSOR UNIT		
番号 No.	名称 NAME	略図 OUTLINE	型名 / 規格 DESCRIPTIONS	数量 Q'TY	用途 / 備考 REMARKS
1	ケーブルハント CABLE CLAMP		PLF1M-M CODE NO. 000-116-921	2	
2	ケーブル組品 CABLE ASSY.		MJ-A3SPF0002-100 (VV-30/0.18X3C *10M*) CODE NO. 000-126-672	1	*1 下記参照 SEE BELOW
3	アース銅板 COPPER STRAP		04S40801 (30X1200X0.3) CODE NO. 000-572-187	1	
4	+トラスタップソケット TAPPING SCREW		5X20 1種 SUS304 CODE NO. 000-802-081	4	
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		


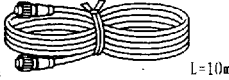
\*1 電源とソレノイドバルブに使用。  
USE FOR POWER SUPPLY AND VALVE UNIT.

図番 (1/1)  
DWG. NO. C7235-M02-B



# FURUNO

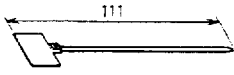
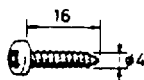

CODE NO.	000-090-230	64A0-X-9403
TYPE	CP64-01330	

工事材料表 INSTALLATION MATERIALS		FAP-6501	舵角表示器 RUDDER ANGLE INDICATOR		
番号 No.	名称 NAME	略図 OUTLINE	型名 / 規格 DESCRIPTIONS	数量 Q'TY	用途 / 備考 REMARKS
1	電源コード POWER CABLE	 L=3m	22S0019-2 CODE NO. 000-109-000	1	
2	ケーブル組品 CABLE ASSY.	 L=10m	MJ-A6SPF0007-100 (EV-S 7/0.16TAX2P *10M*) CODE NO. 000-125-237	1	
			CODE NO.		
			CODE NO.		
			CODE NO.		
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			CODE NO.		
			CODE NO.		
			CODE NO.		

図番 (1/1)  
DWG. NO. C7235-M03-A

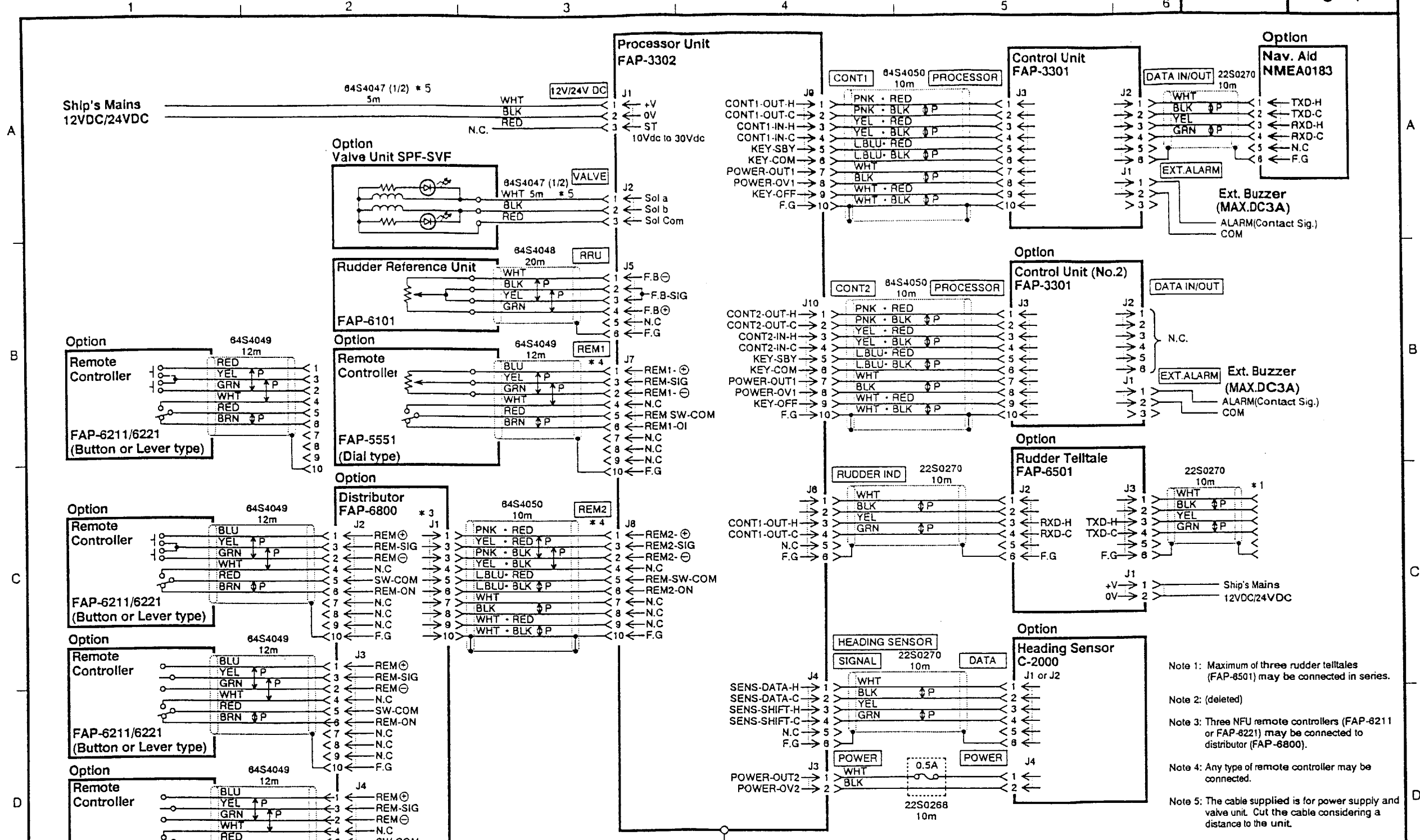
**FURUNO**

CODE NO.	000-090-237	64A0-X-9404-1
TYPE	CP64-01320	

工事材料表 INSTALLATION MATERIALS		リモコン分配器 REMOTE CONTROLLER DISTRIBUTOR			
番号 No.	名称 NAME	略図 OUTLINE	型名 / 規格 DESCRIPTIONS	数量 Q'TY	用途 / 備考 REMARKS
1	ケーブルハット CABLE CLAMP		PLF1M-M CODE NO. 000-116-921	2	
2	+トラスタッピングネジ +TAPPING SCREW		4X16 SUS304 1種 CODE NO. 000-802-080	2	
3	ケーブル組品 CABLE ASSY.		MJ-A10SPF0002-100 (7/0.18TAX4P+12/ 0.18X1P *10M*) CODE NO. 000-126-659	1	
			CODE NO.		
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			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		
			CODE NO.		

図番 (1/1)  
DWG. NO. C7235-M04-B





- Note 1: Maximum of three rudder telltales (FAP-6501) may be connected in series.
- Note 2: (deleted)
- Note 3: Three NFU remote controllers (FAP-6211 or FAP-6221) may be connected to distributor (FAP-6800).
- Note 4: Any type of remote controller may be connected.
- Note 5: The cable supplied is for power supply and valve unit. Cut the cable considering a distance to the unit.

品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	摘要 REMARKS
承認 APPROVED	JUL. 1. '92 T. WAKAJI	三角法 THIRD ANGLE			名称 TITLE FAP-330 Interconnection Diagram
検図 CHECKED	JUL. 1. '92 N. SAITO	R 度 SCALE			
製図 DRAWN	July. 1. '92 S. Nishi	重量 WEIGHT	kg	図番 DWG. NO.	E7235-C01-D

FURUNO ELECTRIC CO., LTD.