

INSTRUCTION MANUAL
OF
AUTOMATIC DIGITAL DIRECTION FINDER

T D - L 1 6 3 0

- OPERATION, INSTALLATION and MAINTENANCE-

TAIYO MUSEN CO., LTD.









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SAFETY PRECAUTIONS

DESCRIPTION OF SYMBOLS

 DANGER	This symbol indicates topics that could lead to death or serious injury if ignored or handled improperly.
 WARNING	This symbol indicates topics that may cause death or serious injury if ignored or handled improperly.
 CAUTION	This symbol indicates topics that may cause injury or damage on property if ignored or handled improperly.
	This symbol indicates topics that may cause electric shock if ignored or handled improperly.
	This symbol indicates to request connection of GND terminal to earth.
	This symbol indicates topics that may cause injury like electric shock if opened.
	This symbol indicates topics that may cause outbreak of fire or smoke if ignored or handled improperly.
	This symbol indicates topics that may cause injury by poisonous materials to the human body included.

SAFETY INSTRUCTION

CAUTION

-  • The product should be operated with the specified voltage.
The operation with incorrect voltage may cause electric shock, or outbreak of fire or smoke.
-  • Do not put any liquid including water in the product that may cause electric shock.
- Do not put any item including metal in the product that may cause outbreak of fire by its short circuit.

CAUTION FOR INSTALLATION

For the selection of location to install the product, please take the followings into your consideration.


CAUTION

- Do not install the main unit of the product at the location where it receives rainfall, water splash, humidity in order to avoid possible machine trouble caused by them.
- Do not install the main unit of the product at the location where lots of direct sunshine or dust, vibration, shock that may cause possible machine trouble.
- If the compass safety distance is specified, install the product at the place apart from the compass by more than the specified distance.
If the compass safety distance is not specified, install the product at the place apart from the compass not to affect more than 0.5 degree of its readout.

CAUTION FOR HANDLING

For the handling of the product, please take the followings into your consideration.

WARNING

- Please be careful not to give any mechanical shock to LCD display.
-  • Handle it carefully not to break its glass. When the glass is broken, do not touch the liquid in it. Particularly keep it away from mouth or eye. When you touch the liquid, wash it out with running water. If you put it into your mouth or eye, rinse it away, then visit a doctor.
- Take care not to drop the antenna.
Please paint oily paint once a year to prevent the joint part of the Adcock antenna and a stanchion being corroded. Note that the antenna might fall due to corrosion of antenna base and stanchion when leaving without painting there for a long time.

CAUTION

- Do not use organic solvent.
Do not use organic solvent like thinner or alcohol when wipe the product.
Please wipe the product with soft cloth (use neuter cleanser, and squeeze the cloth well) when it soiled.

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Chapter 1 GENERAL DESCRIPTION

1.1 INTRODUCTION

VHF Automatic Digital Direction Finder (VHF ADDF) TD-L1630 is the succeeding model of TD-L1620A adding the following functions with suitable structure for flush mount.

- User friendly operation panel - Single purpose switches are applied for function keys.
- One-touch reception of 121.5 MHz and CH16 by individual push button.
- Data output port (NMEA 0183, bearing data) is provided.

1.2 FEATURES

- A) A wide frequency range from 110 MHz to 169.995 MHz.
- B) computer-controlled synthesizer with a triple super-heterodyne circuit provides high sensitivity, accuracy and stability. Thus, the unit is very suitable for stand-by reception.
- C) A new tracking technique is adopted to give a high stability even receiving a weak signal with low S/N ratio.
- D) Holding function is provided to maintain the last bearing data while receiving no signal. Bearing data is updated when receiving new signal regardless the holding function is on or off.
- E) 4 modes in selecting the frequency are available as follows.
 1. MANU mode : Manual frequency setting in 5 kHz step.
 2. SPOT mode : Quick reception by channel selection. Max. 30 frequencies can be stored in the memory.
 3. SRCH mode : Search reception covers a frequency range, $F_c \pm 500$ kHz, in 5 kHz step. (Fc : center frequency)
 4. SCAN mode : Automatic scanning reception of SPOT frequencies in group. Max. 10 channels with the same group number can be scanned. Scan stops and display bearing when a signal is received.
- F) New electrical modulation system provides clear sound of a received signal even while direction finding.
- G) Two bearing indicators (36 pcs. of ring LEDs in 10° step, and digital LCD in 1° step) provides easy and accurate homing.

1.3 COMPONENTS

A standard complete set is composed of the following items.

Item	Quantity	Remark
TD-L1630 main unit	1	11 ~ 35V DC
H type Adcock antenna	1	Model EA-351A
Accessories	1 set	Power cable with a 3P plug (3 m), Speaker with cable and plug (4Ω), Instruction Manual
Spare parts	1	Fuse (3A)
Installation materials	1 set	Antenna cable (Twin coaxial, standard: RG-58A/U 16 m), cable clammer, earth wire (3 m), Tapping screws, FB tape

1.4 NOTES ON USE

- (1) Please read through this manual, and operate the TD-L1630 properly.
Mis-handling would cause deterioration of the performance and mis-erase of memory contents.
- (2) The input voltage for the TD-L1630 is 11~ 35V DC.
When AC power supply is required, please use TG-1637CS or equivalent rectifier.
Please note that the sound clearness might decrease when the power supply with a large ripple is used.
- (3) The frequencies memorized in the memory are maintained with the built-in Nickel Cadmium (Ni-Cd) backup battery.
The Ni-Cd battery is automatically re-charged while the power of the main unit is ON.
When the equipment is operated for the first time, not operated over one month or replaced the Ni-Cd battery with the new one, keep the power "ON" for more than 15 hours to charge the backup battery.
Data in memory would fade away when the Ni-Cd battery is completely discharged. In that case, enter the data again after re-charge or replace the battery. It is recommended to note down the memory data.
- (4) Circuit boards in the equipment are firmly adjusted at our factory. Do not re-adjust Trimmer Potentiometers on the circuit boards. Otherwise, adjustment might be improperly shifted and the equipment would not work properly.
- (5) Keep away the equipment from heat, humidity or strong shock. Otherwise, performance might be deteriorated.
- (6) Set the GAIN knob to maximum when measuring the direction of a received signal.
- (7) The SW1 on PCA BM is used for special case such as installing on a aircraft. Normally it must be set to "NOR" position.

1.5 SPECIFICATIONS

- Antenna (EA-351A)

Type	: H type Adcock antenna
Antenna cable	: Twin coaxial cable with armor
16 m or shorter	: RG-58A/U
17 ~ 29 m	: 5D-2V (option)
30 m or longer	: 8D-2V (option)

- Receiving System

Receiving circuit	: Synthesized triple super-heterodyne
Mode of reception	: Manual, spot, search and scan
	SPOT : Max. 30 channels in the memory
	SRCH : Fc (center frequency) \pm 500 kHz, in 5 kHz step
	SCAN : Max. 10 SPOT channels in a group x 3 groups
One-touch reception	: 121.5 International distress frequency
	CH16 International VHF channel number 16
Frequency range	: 110 ~ 169.995 MHz, in 5 kHz step
Mode of modulation	: AM or FM (waveform : A3E or F3E)
Frequency resolution	: 5kHz
Image rejection ratio	: 60dB or more
Frequency stability	: $\pm 10 \times 10^{-6}$
Sensitivity	: For DF mode, minimum field strength 0.5 μ V/m or less
	For RCV mode, 2 μ V or less at 20 dB QS input
Selectivity	: ± 6 kHz at -6 dB or wider
	± 12 kHz at -60 dB or narrower

- Output

Displays	: Digital bearing display with LCD in 1° step
	Direct bearing display with 36 pcs. of ring LED in 10° step
Audio output	: 1W (impedance 4 Ω)
Data output	: NMEA 0183 (RS-422)

- Power Supply : 11 ~ 35V DC, 0.6 ~ 1.5A

AC Power Supply (TG-1637CS) is available on option (100/110/115/200/220/230V AC)

- Backup Battery : Built-in, Ni-Cd battery, rechargeable 3HB70-MX

- Size and Weight

Main unit	: 332(W) x 165(H) x 327(D) mm, 8.2 kg
Adcock antenna	: 410(W) x 930(H) x 410(D) mm, 3.4 kg

Chapter 2 OPERATION

2.1 KEYS AND CONTROLS

2.1.1 Front Panel

Fig.1 shows layout of keys and display devices on the front panel of TD-L1630.

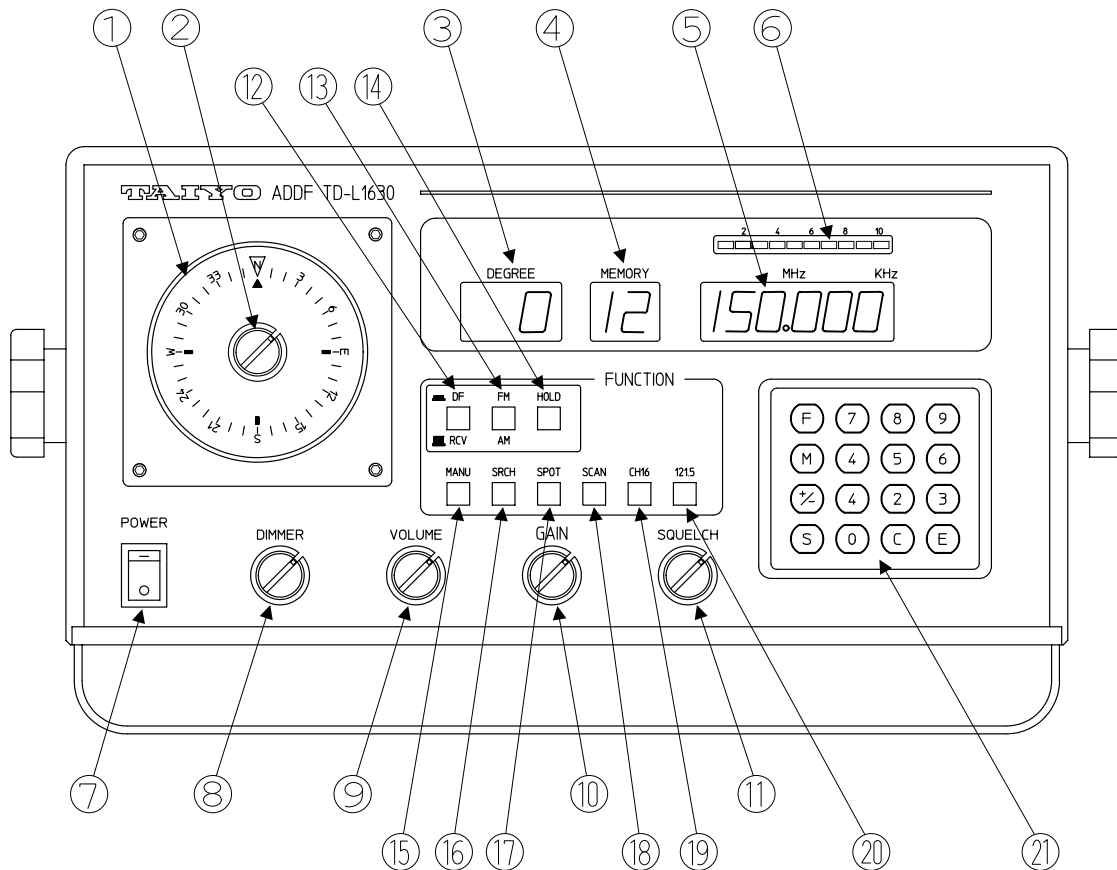


Fig.1 Layout of keys and display devices on front panel

No.	Name	Functions														
①	Ring display	Relative bearing of a received signal is displayed in 10° step with 36 pcs. of LEDs arranged in the circle.														
②	Azimuth card	True bearing can be read by rotating the azimuth card.														
③	DEGREE display	Relative bearing is displayed by numerals in 1° step. It also shows entry condition with keyboard.														
④	MEMORY display	The channel number of the memorized frequency is displayed.														
⑤	Frequency display	A selected frequency is displayed in 5 kHz step.														
⑥	Level indicator	The signal strength is indicated with 10 LEDs. Stronger electric field strength lights a lot of LEDs.														
⑦	POWER switch	Turn to “-” position to power ON, and turn to “o” to power OFF.														
⑧	DIMMER knob	Rotate the knob clockwise to increase the brightness of LEDs and LCDs. Also, pull the knob to illuminate a lamp on azimuth card.														
⑨	VOLUME knob	Rotate the knob clockwise to increase volume.														
⑩	GAIN knob	Rotate the knob clockwise to increase gain. Please set gain maximum when measuring direction. In SCAN or SRCH mode, it would be possible to receive only the strong signal (a signal from short distance) by decreasing the gain.														
⑪	SQUELCH knob	Rotate clockwise to suppress noise when no-signal in AM and FM reception. Note: Too much suppression may hinder reception of weak signal.														
⑫	DF/RCV switch	Press the button for DF mode, release it for RCV mode. High sensitivity reception is possible at RCV mode, and direction finding is not possible at RCV mode. In the RCV mode, nothing is indicated on Ring display and DEGREE display.														
⑬	FM/AM switch	Press the button for FM reception, release it for AM reception.														
⑭	HOLD button	While it is ON, a bearing data is held until next signal comes.														
⑮	MANU button	Manual reception or, enter/renew a data by keyboard.														
⑯	SRCH button	Search over a frequency range, Fc (center frequency) ± 500 kHz in 5 kHz step.														
⑰	SPOT button	Call up a frequency with its channel number.														
⑱	SCAN button	Scan a group of frequencies (max. 10 frequencies in a group x 3 groups). Scan stops when a signal is received. When the HOLD button is ON, bearing is maintained until next signal reception.														
⑲	CH16 button	Press to receive international VHF channel number 16.														
⑳	121.5 button	Press to receive international distress signal 121.5 MHz.														
㉑	Keyboard	<table border="0"> <tr> <td style="border: 1px solid black; padding: 2px;">F</td> <td>Frequency key. Enter a frequency. (MANU or SRCH mode)</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">M</td> <td>Memory key. Enter data in a memory. (SPOT, SRCH or SCAN mode)</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">+/-</td> <td>Up-down key. Alter the number of frequency ascending or descending. (MANU or SRCH mode) Change the 2nd digit of channel number when Memory key is ON.</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">S</td> <td>Start key. Use with a function key as follows. Restart SRCH or SCAN. (SRCH or SCAN mode) Change the frequency by 5 kHz step. (MANU mode) Change the channel number by 1. (SPOT mode)</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">C</td> <td>Clear key to erase an erroneous input.</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">E</td> <td>Enter key to execute input command.</td> </tr> <tr> <td style="border: 1px solid black; padding: 2px;">0 ~ 9</td> <td>Numeric keys to enter number.</td> </tr> </table>	F	Frequency key. Enter a frequency. (MANU or SRCH mode)	M	Memory key. Enter data in a memory. (SPOT, SRCH or SCAN mode)	+/-	Up-down key. Alter the number of frequency ascending or descending. (MANU or SRCH mode) Change the 2 nd digit of channel number when Memory key is ON.	S	Start key. Use with a function key as follows. Restart SRCH or SCAN. (SRCH or SCAN mode) Change the frequency by 5 kHz step. (MANU mode) Change the channel number by 1. (SPOT mode)	C	Clear key to erase an erroneous input.	E	Enter key to execute input command.	0 ~ 9	Numeric keys to enter number.
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C	Clear key to erase an erroneous input.															
E	Enter key to execute input command.															
0 ~ 9	Numeric keys to enter number.															

2.1.2 Rear Panel

Fig.2 shows layout of terminals on the rear panel of TD-L1630.

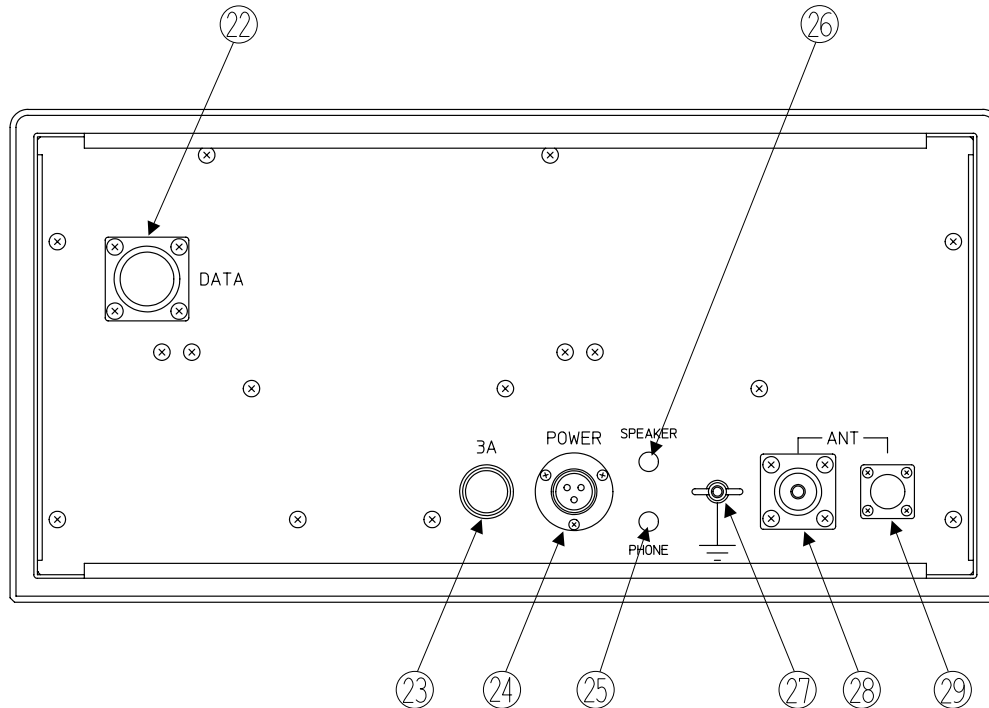


Fig.2 Layout of terminals on rear panel

No.	Name	Functions
②②	DATA	Data output terminal. See article 2.4 for the details of output data.
②③	Fuse 3A	Fuse holder contains a fuse MF60NR 250V 3A.
②④	POWER	Power connector for power cable.
②⑤	SPEAKER	Mini-jack to connect with a speaker (4Ω).
②⑥	PHONE	Mini-jack to connect with a earphone or headphone.
②⑦	GND	Ground terminal to connect to the ship's ground terminal.
②⑧	ANT left	Antenna cable connector for M type connector.
②⑨	ANT right	Antenna cable connector for BNC connector.

2.2 PREPARATION

2.2.1 Power

- (1) Confirm that a DC power 11V ~ 35V is supplied from a DC source.
If AC power source is supplied, use optional AC power supply unit TG-1637CS.
- (2) Turn power switch on. All settings and adjustments at the last power off are restored.
For example, the unit starts and continues signal reception after power on with the same condition as the unit was receiving before the last power off.
- (3) Turn power switch off to terminate operation.

2.2.2 Frequency Memory

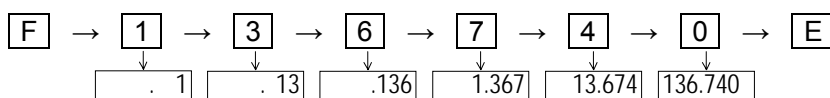
- (1) Basic procedure to set a frequency (MANU mode)

A) Confirm that the MANU button is ON. If not, press MANU button.

B) Enter frequency, press **[F]** → **[Frequency, 6 digits]** → **[E]**

Note: Bearing display (DEGREE) blinks until **[E]** is pressed.

Example : Enter 136.740 MHz



Note: In case of mis entry, press **[C]** to clear, then enter the correct number.

Input frequency should be between 110.000 MHz and 169.995 MHz, 5 kHz step.

Erroneous input is not accepted.

Above procedures are rewritten as : **[MANU]** → **[F]** → **[Frequency, 6 digits]** → **[E]**

The unit starts reception when a frequency is set.

To set a frequency in step of 5 kHz when the unit is receiving a frequency in MANU mode.

Press **[S]** as many times as wanted. The frequency increases or decreases in step of 5 kHz.

(ascending or descending is selectable by pressing **[+/-]** key.)

- (2) Enter the frequency in a memory

After setting a frequency by procedure (1), press **[M]** and set a channel number in the order of a group number and a last digit, and finally, press **[E]** to enter the frequency in the memory channel.

The basic procedures to enter a frequency in a memory channel is rewritten as:

[MANU] → **[F]** → **[Frequency]** → **[E]** → **[M]** → **[+/-]** → **[Last digit]** → **[E]**.

Note: There are 3 groups, with group numbers, 0, 1 and 2.

A channel number consists of a group number and a last digit.

For example, a channel number "26" has a group number "2" and a last digit "6".

(3) Memory of a frequency in SRCH mode

When an interesting frequency is found in SRCH reception, hold that frequency by pressing **HOLD** and enter it into the memory with a channel number by following procedures.

HOLD → **M** → **+/-** → **Last digit** → **E**.

(4) Enter a new SPOT frequency in an existing memory channel

Set a new frequency and enter the frequency to the memory channel. The old data is canceled by overwriting.

(5) To erase all SPOT frequencies in the memory

- A) Turn power switch off once.
- B) Turn power switch on while pressing **M**, all frequencies in the memory are erased.

2.2.3 Mode Selection

(1) Select a mode of reception and a mode of modulation

- A) Select the mode at first, MANU, SPOT, SRCH or SCAN, and press the key.
- B) Check the mode of modulation, FM or AM. Press or release the FM/AM key when necessary.

(2) Select DF/RCV (this selection may be changed while in operation)

Reception only (RCV mode) is selected when release the DF/RCV key. DF mode is selected when it is pressed, and both reception and bearing measurement are available. RCV mode is usually selected when the level of signal is too weak to measure the bearing or wish to hear the voice sound much clearly.

(3) Select HOLD (this selection may be changed while in operation)

There are two functions for hold, one is to keep the bearing data while there is no signal in MANU or SPOT mode, and the other one is to lock the frequency in SRCH or SCAN mode.

- A) Bearing data in MANU or SPOT mode (the frequency does not change)
 - When there is no signal, the bearing output fluctuates. When a signal is received, instantaneous bearing data is displayed (data is continuously updated).
 - When the signal stops and HOLD is off, the bearing output fluctuates widely.
 - When the signal stops and HOLD is on, the bearing output keeps the last received data until another signal comes.
- B) Bearing data and frequency in SRCH or SCAN mode
 - When there is no signal, the bearing output fluctuates and frequency is automatically swept.
 - When a signal is received, frequency change stops and instantaneous bearing data is updated every second.
 - When HOLD is off and the signal stops, the unit automatically restarts SRCH or SCAN sweep and bearing output fluctuates.
 - When HOLD is on and the signal stops, the bearing output keeps the last data until another signal comes and the frequency is locked. When another signal comes at that frequency, the bearing data is updated. To restart SRCH or SCAN, press **S**.

2.2.4 Adjustment

(1) DIMMER

When the DIMMER knob is pulled, the azimuth card is illuminated. Rotate the knob clockwise to raise brightness of LEDs and LCD.

(2) VOLUME

Rotate the volume clockwise to increase the loudness of the speaker.

(3) GAIN

Rotate the GAIN knob to elevate RF sensitivity.

(4) SQUELCH

Rotate the SQUELCH knob clockwise to suppress the audio noise when there is no signal.

(5) AZIMUTH (should be adjusted for true bearing measurement)

Rotate the AZIMUTH card according to the reading of the compass on board. The reading of LED to the AZIMUTH card gives the true bearing of the radio signal. Since azimuth setting is manual, AZIMUTH card should be rotated according to the compass reading when true bearing is required.

2.3 RECEPTION AND BEARING MEASUREMENT

2.3.1 Operation – MANU

(1) Basic procedure for manual reception

Confirm that MANU is ON. If not, press MANU key. Set a frequency and receive.

[F] → **[Frequency, 6 digits]** → **[E]**.

Note: a) When **[F]** is pressed, **[000]** blinks in DF mode at the bearing display (DEGREE).

b) The first digit should be 1, the second should be 1,2,3,4,5 or 6, and the last one should be 0 or 5.

c) When an incorrect number is entered, press **[C]** and enter correct number.

d) The relative bearing is displayed in DF mode when a signal is received.

e) When there is no signal and HOLD is OFF, bearing data fluctuates.

f) When there is no signal and HOLD is ON, last bearing data remains.

(2) Change to another frequency in 5 kHz step while receiving in MANU mode.

[S] or **[+/-]** → **[S]**

Note: Press **[S]** as many times as necessary.

A press of **[+/-]** ascends/descends the frequency.

2.3.2 Operation – SPOT

(1) Basic procedure for spot reception

Confirm that SPOT is ON. If not, press SPOT key. Call up a channel and receive.

M → **+/-** → **Last digit** → **E**

- Note:
- When **M** is pressed, **000** blinks in DF mode at the bearing display (DEGREE).
 - The relative bearing is displayed in DF mode when a signal is received.
 - When there is no signal and HOLD is OFF, bearing data fluctuates.
 - When there is no signal and HOLD is ON, last bearing data remains.

(2) Change to another channel in the same group while receiving in SPOT mode.

Press **S** as many times as necessary.

2.3.3 Operation – SRCH

(1) Basic procedure for search reception

Confirm that SRCH is ON. If not, press SRCH key. Set a center frequency, Fc.

When **E** is pressed, searching starts in step of 5 kHz in the range of $F_c \pm 500$ kHz.

F → **Center frequency, 6 digits** → **E**

(2) Reverse the frequency sweep, press **+/-**.

(3) When a signal is received and frequency search stops, press **S** several times to find a frequency at which the level indicator shows maximum.

(4) When an interesting frequency is found in SRCH reception, store it in a memory channel by following procedure. **HOLD** → **M** → **+/-** → **Last digit** → **E**

(5) When HOLD is on, incoming signal locks frequency search. To restart search, press **S**.

2.3.4 Operation – SCAN

(1) Set SCAN mode

Confirm that SCAN is ON. If not, press SCAN key.

When SCAN mode was selected at the last power off, SCAN restarts when the power is turned on.

(2) Check the group number. To change the group number, operate key as following.

Press **+/-** a few times: **M** → **+/-** → **E**

(3) When HOLD is on, incoming signal locks frequency scan. To restart scan, press **S**.

(4) SCAN pass

When a frequency is not necessary to be scanned while it is being received, following procedure restarts scanning and that frequency is skipped from the next scan: **M** → **E** → **S**

(5) A frequency returns to be scanned again from being scan-passed, enter the last digit of its channel number by following procedure. **M** → **Last digit** → **E**

2.3.5 One-touch reception

There are two one-touch reception buttons.

- (1) Press **121.5** (red button) to receive international distress signal 121.5 MHz.
FM mode is automatically selected regardless of the condition of the FM/AM switch.
- (2) Press **CH16** (blue button) to receive international VHF channel 16.
AM mode is automatically selected regardless of the condition of the FM/AM switch.

This one-touch reception is effective at any time after power switch ON.

2.3.6 Bearing Measurement

- (1) Bearing data relative to the bow direction is displayed while a signal is being received both on the digital display in 1° step and on the ring display in 10° step.
- (2) The relative bearing is updated every second, and a displayed value is an averaged one over a second.
- (3) When the true bearing (relative to the North direction) is necessary, read the bow direction on the compass and rotate the azimuth card. Then the true direction is shown on the azimuth card. Digital true bearing is calculated as the sum of the bow direction and the relative bearing.

2.4 DATA OUTPUT

There is a data output terminal on the rear panel to output frequency and bearing of received signal.

Pin assignment of data output terminal (connector: PRC04-21A16-14M)

Pin number	Name of signal	Signal contents	Data format	Interface
A	OUT 1	+ output	NMEA0183	RS-422
B	OUT 2	- output	NMEA0183	RS-422
C ~ N	Not used	-	-	-

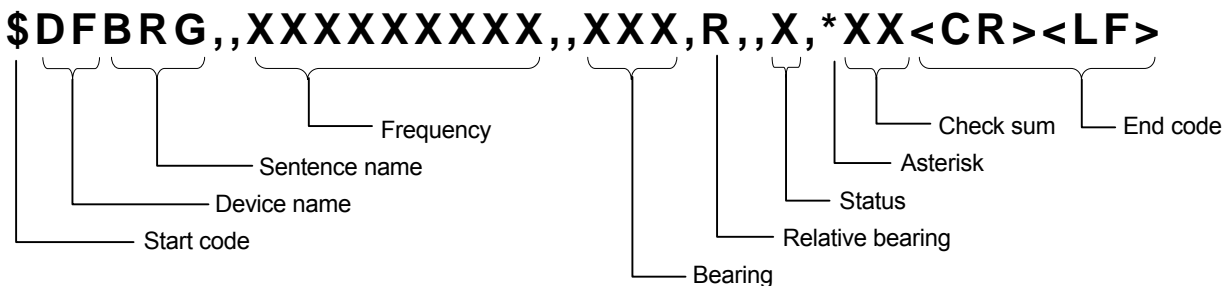
Specification of interface

Baud rate	4800 bps
Data bit	8 bit
Parity	Non
Start bit	1 bit
Stop bit	1 bit
Forwarding data	ASCII

Data format

Number	Name of data	Description	Bite
1	Start code	{ \$ }	1
2	Device name	{ DF }	2
3	Sentence name	{ BRG }	3
4	Comma	{ , : HEX code 2C }	1
5	Comma	{ , : HEX code 2C }	1
6	Frequency	110,000,000 ~ 170,000,000 Hz	9
7	Comma	{ , : HEX code 2C }	1
8	Comma	{ , : HEX code 2C }	1
9	Bearing	000 ~ 359 deg	3
10	Comma	{ , : HEX code 2C }	1
11	Relative bearing	{ R }	1
12	Comma	{ , : HEX code 2C }	1
13	Comma	{ , : HEX code 2C }	1
14	Status	{ A : Valid, V : Invalid }	1
15	Comma	{ , : HEX code 2C }	1
16	Asterisk	{ * : HEX code 2A }	1
17	Check sum	00 ~ FF	2
18	End code	{ CR : HEX code 0D }	1
19	End code	{ LF : HEX code 0A }	1

Note: Check sum field is XOR of all 8 bit characters, and include { } between { \$ } and { * } ({ \$ } and { * } are excluded).
The value of the hexadecimal notation in four high rank bits and four subordinate position bits of the result is converted into two ASCII characters (0-9,A-F) and transmitted.



Chapter 3 INSTALLATION

3.1 ANTENNA

3.1.1 Antenna Site

Following instructions shall be noted for antenna installation to minimize disturbance on direction measurement, since the performance of a short wave direction finder is vulnerable to the influence of conductive bodies nearby. (e.g., upper structure, stay cables, derricks and other antennas.)

- (1) The separation between the Adcock antenna and the keel line shall be minimized.
- (2) The top of the fore mast, radar mast or the highest possible position is recommended to install the Adcock antenna.
- (3) The Adcock antenna shall be situated 2m or higher from the TX/RX main antenna. Make the horizontal separation larger than 2m from the main antenna by inserting insulators. The separation of Adcock antenna and the navigation lamp shall be larger than 1m. (Refer to Fig. 3 - A)
- (4) The Adcock antenna shall be 1m or higher than radar antenna and the horizontal separation from a tip of radar antenna shall be 0.8m or more. (Refer to Fig. 3 - B)
- (5) Keep a horizontal separation of 2m or more and vertical separation of 1m or more from a perpendicular metallic object (metallic mast, pole, etc.). If there is a metallic object higher than the Adcock antenna, keep a horizontal separation of 5m or more. (Refer to Fig. 3 - C)
- (6) When wire stays are used for the stanchion, insert insulators 1m from the stanchion. (Refer to Fig. 3 - D)
- (7) When whip antenna or like is close to the Adcock antenna, keep a vertical separation of 1m and a horizontal separation of 4m. When such separation is impossible, tilt the whip antenna. (Refer to Fig. 3 - E)

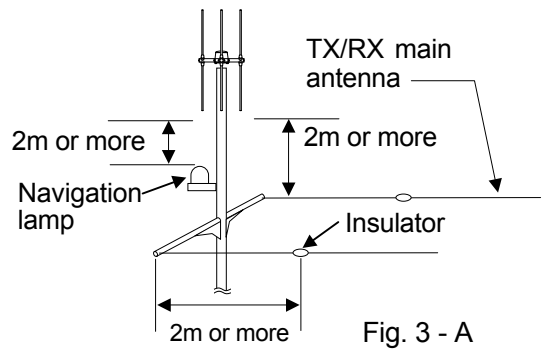


Fig. 3 - A

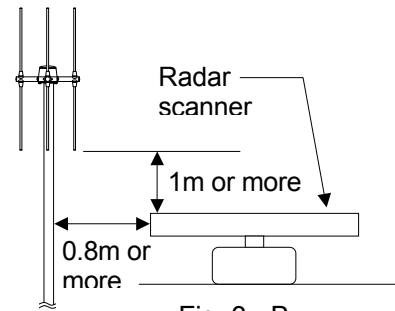


Fig. 3 - B

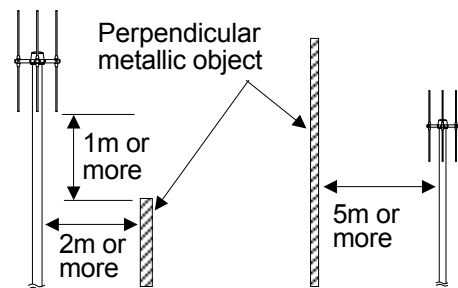


Fig. 3 - C

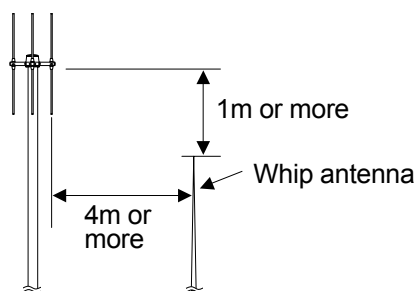


Fig. 3 - E

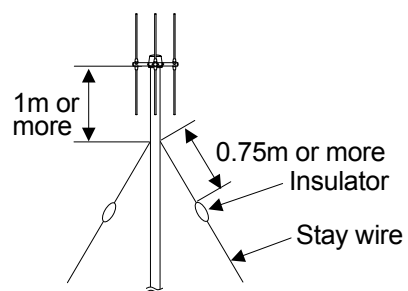
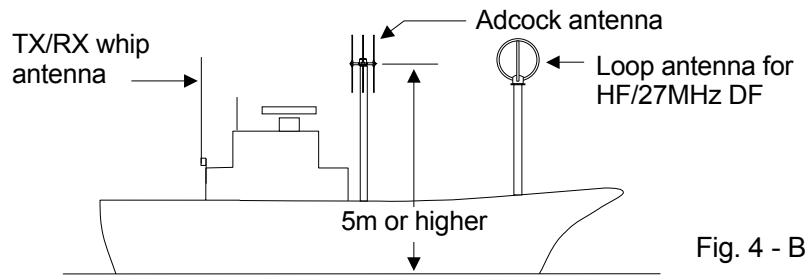
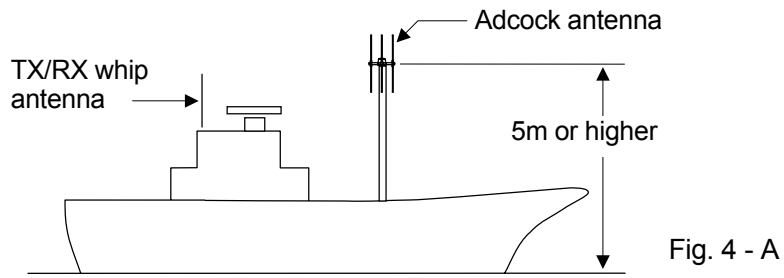
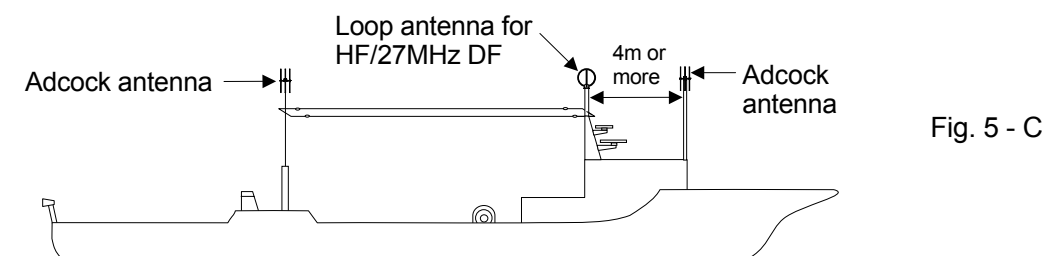
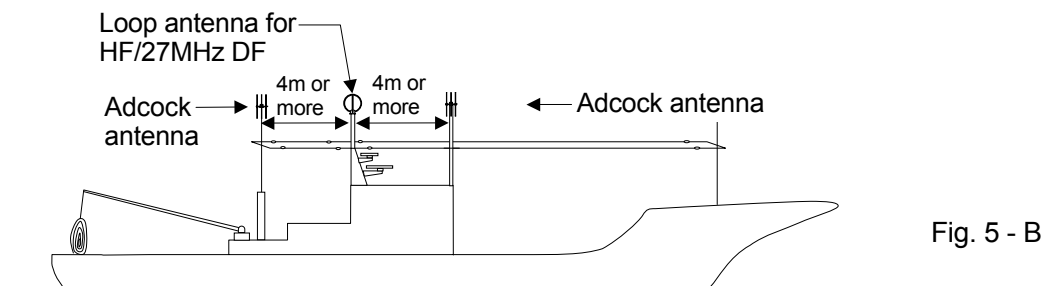
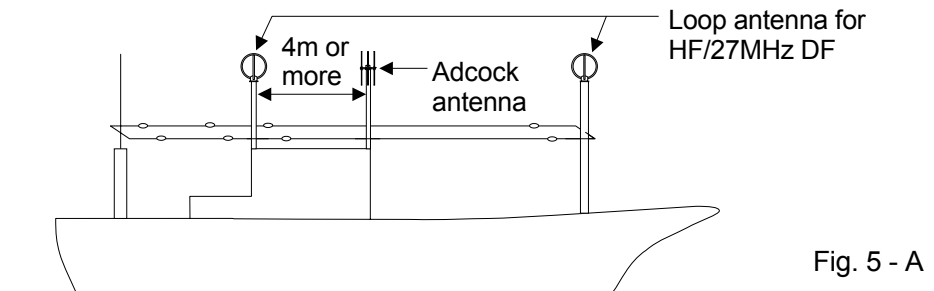


Fig. 3 - D

When an H type Adcock antenna is installed on board a small fishing boat 15m or smaller, please refer to the following figure.



When a H type Adcock antenna is installed on board a fishing boat 20 ~ 30 m long or more, please refer to the following figure.



3.1.2 Flange

Weld a flange to a mast or a stanchion by paying attention to its direction.

Work with care while welding, since the antenna cable is not heat resistive.

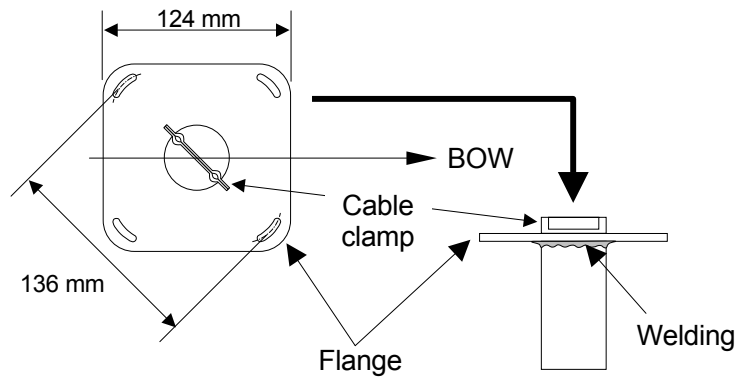


Fig. 6

3.1.3 Antenna Cable

- (1) Keep separation from heat sources as the cables are not heat resistive.
- (2) Protect the cables from mechanical damage. When inevitable, protect cable in steel or plastic pipe.
- (3) Pay strict attention to welding after the cable has been laid.
- (4) Avoid electromagnetic interference by keeping distance from power cables of other equipments.
- (5) Never lay the cable along stays or other wires which may cause large error in bearing measurement.
- (6) Fix the cable length before shipment. Avoid to cut or elongate the cable because re-adjustment of the main unit is required to change the cable length.

Note: Two RF coaxial cables (RG-58A/U) are required. One for balanced modulator output signal and the other for sense signal. The sense signal cable is connected with BNC and M type plug. The balanced modulator cable is connected with both BNC plugs. BNC plug with M type plug is painted with red. Any cable length is allowed, but its sensitivity is affected by its length. The cable length is recommended as short as possible. The difference in the length of the coaxial cables must be within ± 2 cm.

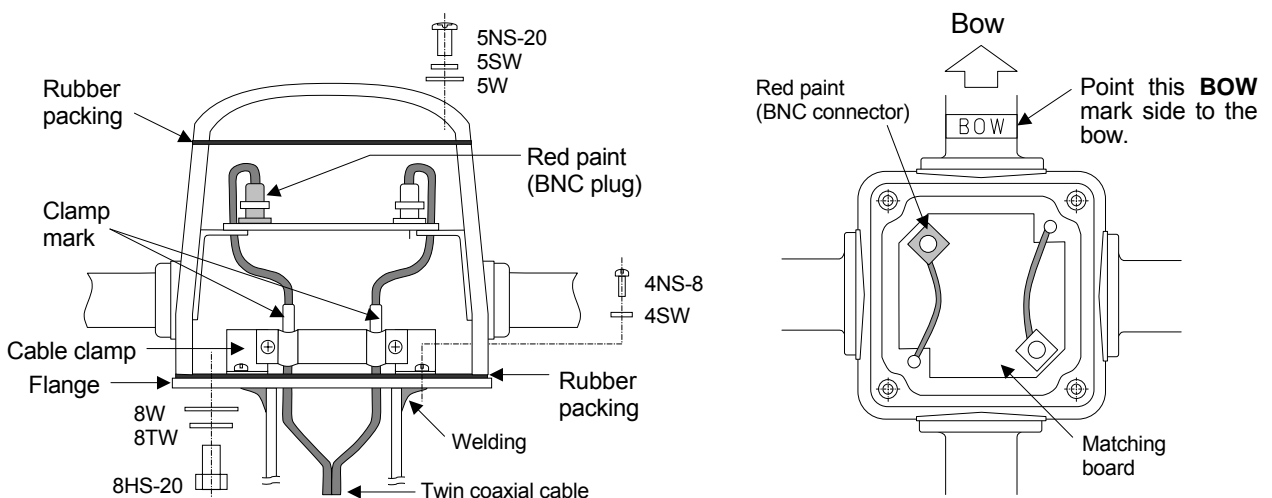
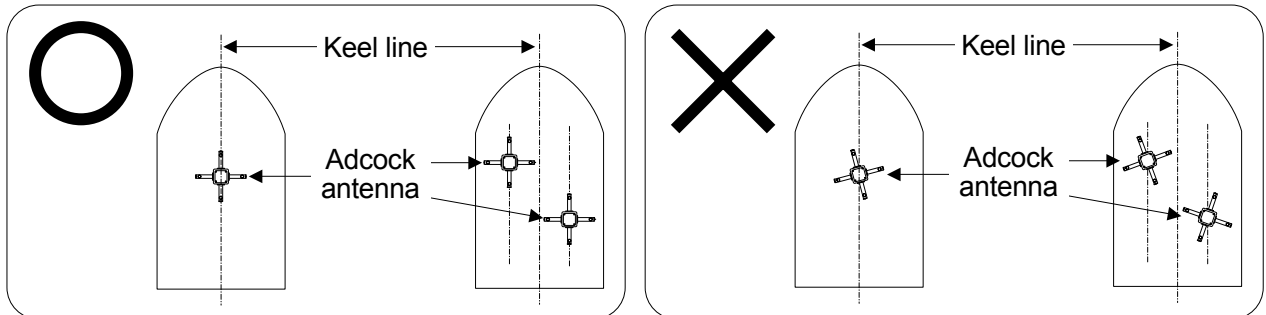


Fig. 7 Antenna Cable Connection

3.1.4 Installation of Antenna

Set the antenna on the flange welded at the selected position. Adjust its direction so that the connection between N and S element is set in parallel to the keel line. Confirm that **BOW** mark is on the bow direction. Pay attention to sea water or rain so that printed boards, connectors and so on in the antenna are not wet or contaminated during the work.



3.2 MAIN UNIT

- (1) Select a position (table, rack, etc.) for the main unit satisfying following conditions:
 - A) Convenient for operation, easy to maintain and with a good view of the display.
 - B) Avoid direct sunshine, water splash, high temperature and strong vibration.
 - C) Give a separation of 150 mm or more for both sides and back of the main unit.

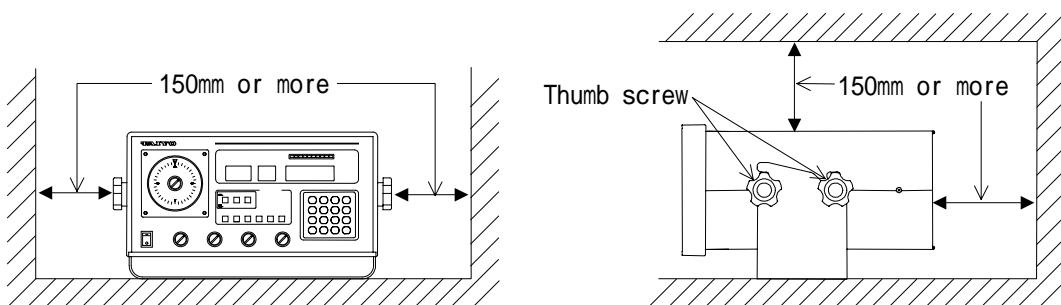
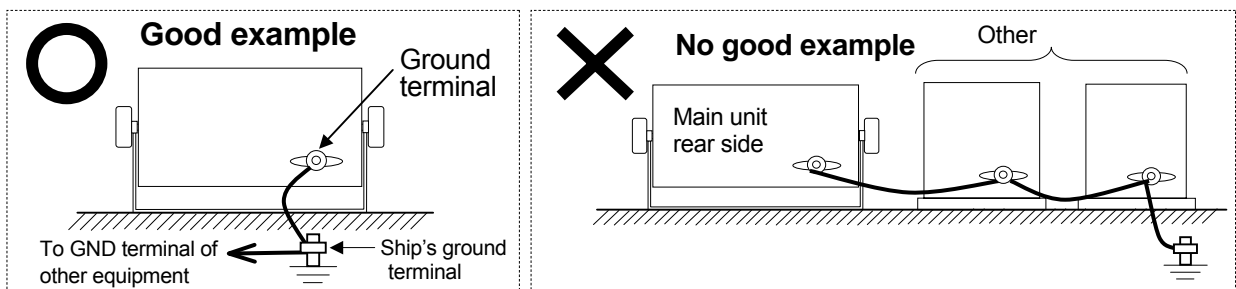


Fig. 8

- (2) Grounding of the main unit shall be made with a low impedance cable, as short as possible, to a grounding point of the vessel.



- (3) Follow the procedures shown below to install the main unit.
 - A) Loosen two knobs combining the unit and its support and separate them.
 - B) Fix the support to a table, rack or like, with 6 screws (attached).
 - C) Fasten the main unit to the support with four Thumb screws.

3.3 DESCRIPTION OF CIRCUIT

3.3.1 Antenna Circuit

The antenna is a H type Adcock antenna, and a sense signal is synthesized with signals from NS and EW elements by special matching circuit. NS and EW signal are modulated by 135.6 Hz and the output signal is fed to the main unit through coaxial cable A. The 135.6 Hz is supplied from PCA CPU (appendix 7) through coaxial cable A and B. The sense signal is applied through coaxial cable B.

3.3.2 Printed Circuit Assemblies

(1) PCA HF

PCA HF involves super heterodyne circuits which are shown as following:

A) VHF Amp.

The antenna output are amplified by Q1 and Q2 and its both output are applied to Q3. Q1 ~ Q6 and Q11 ~ Q12 are VHF amplifiers and the gain is controlled automatically. The capacitor diodes in the tuning circuit are variable.

B) 1st Mixer

The 1st mixer, U1, generates a 1st IF in 30 ~ 30.995 MHz which is supplied from PCA VCO-1 (appendix 8).

C) 1st IF

The 1st IF 30 ~ 30.995 MHz is amplified by Q7, Q8 and Q9.

D) 2nd Mixer

U2 is the 2nd mixer which generates a 2nd IF of 21.4 MHz which is supplied from PCA VCO-2 (appendix 9).

(2) PCA IF/AF

PCA IF/AF is in charge of IF and AF circuits which are explained as following:

A) 2nd IF Amplifier

The 2nd IF, 21.4 MHz, is amplified by Q1 and Q2, and FL1 is a crystal filter of 21.4 MHz.

B) 3rd Local Oscillator

Q4 is the 3rd local oscillator and generates 20.945 MHz.

C) 3rd Mixer

Q3 is the 3rd mixer for 21.4 MHz and 20.945 MHz, the difference, 455 kHz.

D) 3rd IF Amplifier

The 3rd IF, 455 kHz, is amplified by Q5 ~ Q10, and the signal is detected by CR8, and applied to ADDF amplifier circuit.

E) AGC, SQUELCH, AF, Amplifier

Q11 and Q12 are AGC amplifiers, which supply the AGC voltages to Q4, Q6 and Q9 of PCA HF and Q2, Q7 and Q9 of PCA IF/AF. Q14, Q15 and Q16 are the other 455 kHz amplifier and the amplified signal is detected by diodes CR9 and CR10 to detect FM signal. Q20 and Q21 are squelch control, and Q22, Q23, Q24 and Q25 are audio amplifiers. Noise is amplified by U1, Q26 and Q27. Its output voltage is applied to stop the scanning and to control a squelch. Q17, Q18, Q19, Q30 and Q31 amplify the signal of 135.6 Hz ADDF. L2 and C79 make band pass filter for 135.6 Hz. Q13 is a level indicator amplifier and its gain is adjusted by RV1 and RV2. Q28 and Q29 control a voltage for dimmer.

- (3) PCA VCO-1
It has the 1st local oscillator with frequency synthesizer circuit, which generates 80 ~ 139 MHz. U3, U4 and U5 are the programmable counter for MHz setting. U2 is a phase detector and Q1, Q2 and Q3 are low pass filter circuits. Q4, CR1 ~ CR4 and T1 consists of a VCO circuit. The circuit generates frequency and it is amplified by Q5, Q6 and Q7. Then it is applied to the 1st mixer of PCA HF. U11 and U7 are frequency divider for the programmable counter. Q8 is a buffer amplifier for the variable capacitor diode of PCA HF.
- (4) PCA VCO-2
It has the 2nd local oscillator with frequency synthesizer and generates 8.6 ~ 9.595 MHz. U3, U4 and U5 are the programmable counter for kHz setting. U10 is the phase detector and Q1, Q2 and Q3 are low pass filter circuits. Q4, CR1 ~ CR4 and T1 consists of a VCO circuit and the circuit generates frequency and it is amplified by Q5, Q6 and Q7. Then it is applied to the 2nd mixer of PCA HF.
- (5) PCA CPU
The ADDF signal is applied from PCA IF/AF and the outputs are transferred to PCA DISPLAY and LED to display bearing information, and all process is controlled by the CPU. The PCA includes a master counter for bearing display, a basic frequency generator of 5 MHz, and encoder by key board switch, a scanning control, a back up circuit for memory, a balanced modulator signal generator, and the latch for the display. U12, U13, U14, U8, U17, U18 and U15 are CPU circuits. U20 is the master counter, and 135 Hz, 270 Hz and 540 Hz are generated from the master counter and are applied to PCA BM. Q1, Q2 and Q3 are the back-up battery over circuit.
- (6) PCA NMEA
This PCA composes the RS-422 interface, and is used for the data output.
- (7) PCA Display
The PCA consists of the key board switch, and LCD display circuits.
- (8) PCA LED
The PCA consists of the bearing indicator with 10° step on the LED display.
- (9) PCA Chopper
The PCA is a voltage regulator.
Input voltage allows from 11V to 35V and output voltage is regulated to 9V by chopper control circuit.
- (10) PCA AVR (appendix 11)
This PCA is on the rear side of chassis, and it consists of 3 voltage regulators, 5V, 5V and 30V for computers.
- (11) PCA BM
The PCA supplies 4 phase balanced modulator signal.
- (12) PCA Noise Limiter
The PCA consists of a noise limiter circuit and Q1 is an audio amplifier.
- (13) PCA Switch 1
This PCA is composed of the switch that switches the function.
- (14) PCA Switch 2
This PCA is composed of the switch and the relay that switches the function.

3.4 PERFORMANCE CHECK AND REPLACEMENT

3.4.1 Test Equipment

Performance check of the direction finder requires following test equipment.

- (1) Antenna Simulator
- (2) Signal Generators
It shall cover 400 kHz to 200 MHz with variable output up to 1V, and within output impedance of 50Ω.
- (3) Others
 - (a) HF voltmeter
A voltmeter with high input impedance for 150 MHz and to have 10mV ~ 3V range.
 - (b) Frequency counter
 - (c) AC voltmeter
 - (d) Oscilloscope
 - (e) Multimeter (DC 20 kΩ/V)
 - (f) DC power supply 24V DC, 2A

3.4.2 Test Arrangements

(1) VHF Check

The overall test shall be carried out on VHF by the arrangements as shown in Fig. 9 and the following test procedures.

Step	Procedure	Normal condition
1.	Connect equipments as shown in Fig.9. Apply 24V DC to the equipment.	9.2V DC is applied to the amplifier circuit of PCA IF/AF.
2.	2-1 Switch ON NS of TM-643. Signal generator to 145.5 MHz, 1000Hz, 3.5 kHz DEV.	LCD display is lit. Noise tone is heard from the speaker. The bearing shall be $0^\circ \pm 3^\circ$.
2-2	TD-L1630, Turn power switch ON. Select DF mode.	
2-3	SQUELCH to counterclockwise to the end.	
2-4	Rotate GAIN and VOLUME clockwise to the end.	
2-5	Set the signal generator output 60 dB (1mV).	
2-6	Set frequency to 145.5 MHz and switch ON NS and V of TM-643.	

2-7	Switch ON EW of the TM-643.	The bearing shall be $45^\circ \pm 3^\circ$.
2-8	Switch OFF NS of the TM-643.	The bearing shall be $90^\circ \pm 3^\circ$.
2-9	Set the signal generator output 36dB.	The bearing shall be 90° on $1\mu\text{V/m}$.
3.	<p>3-1 Connect the signal generator output to M type connector of ANT directly, and set the mode switch RCV.</p> <p>3-2 Set the signal generator to 145.5 MHz, CW.</p> <p>3-3 Same as 2-3.</p> <p>3-4 Same as 2-4.</p> <p>3-5 Adjust the VOLUME so that the speaker output become 1.0V when no output from signal generator.</p> <p>3-6 Set the signal generator output to 6 dB, and confirm that the speaker output is less than 0.1V.</p>	

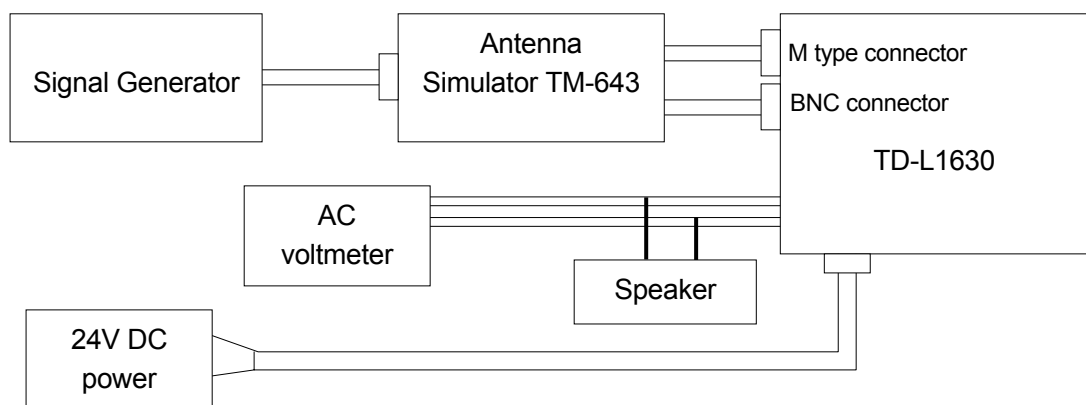


Fig. 9 Test Arrangement

(2) Test of frequency synthesizer as the 1st local oscillator (PCA VCO-1)

(a) Test Procedure

When a trouble is in the frequency synthesizer, check as follows:
Set the receiving frequency to 110 MHz.

- (i) To measure the standard frequency 25 kHz, connect a frequency counter to 1 pin of U2 MC4044 and ground.
- (ii) Connect a multimeter to TP3 (collector of Q2) and the ground. Measured voltage is about 2.5V DC. The voltage is adjusted with the dust core of T1.
- (iii) Connect a HF voltmeter to TP2 (secondary of T2) and the ground. It is normal when 0.16V r.m.s. is measured.
- (iv) Connect the multimeter to TP1 (source of Q8) and the ground. Normal value is about 4.1V.
- (v) Connect the frequency counter to TP2 (secondary of T2). The frequency is 80 MHz. When the frequency is deviated, adjust it by CV1 on **PCA CPU**.

(b) Set the receiving frequency to 169 MHz, and measure following points

	TP1	TP2	TP3
Voltage	15.1V DC	0.05V r.m.s.	15.5V DC
Frequency		139 MHz	

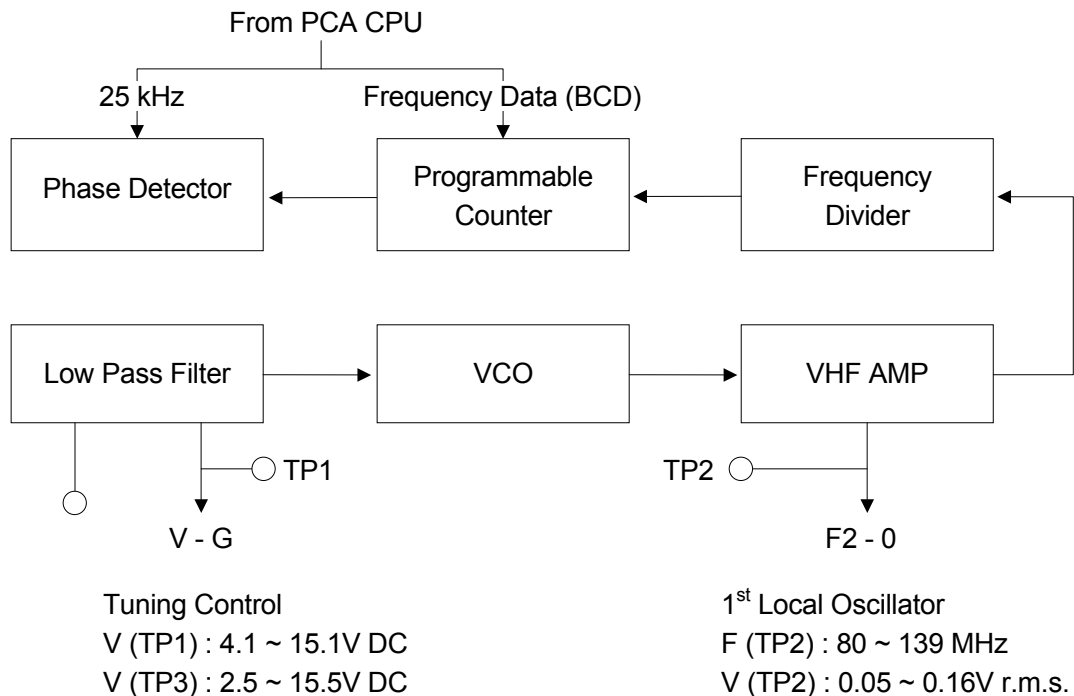


Fig. 10 Schematic diagram of PCA VCO-1

(3) Test of frequency synthesizer as the 2nd local oscillator (PCA VCO-2)

When a trouble is in the frequency synthesizer, check as follows:

- (a) Set the receiving frequency to 110 MHz.
 - (i) Connect the frequency counter to 1 pin of U10, MC4044, and measure the standard frequency 5 kHz.
 - (ii) Connect the multimeter to TP2 (collector of Q2) and the ground, and the measured voltage is about 2.6V DC, which is normal.
The voltage is adjusted with the dust core of T1.
 - (iii) Connect a AC voltmeter to TP1 (secondary of T2) and the ground.
OK when the voltage is circ. 0.2V r.m.s.
 - (iv) Connect a frequency counter to TP1 (secondary of T2) and the ground.
OK when the measured frequency is 8.6 MHz.

- (b) Set the receiving frequency to 110.995 MHz.
Measure voltage on TP1 or TP2 and frequency at TP1.
The values are as follows:

	TP1	TP2
Voltage	Circ. 0.2V r.m.s.	Circ. 3.9V DC
Frequency	9.595 MHz	

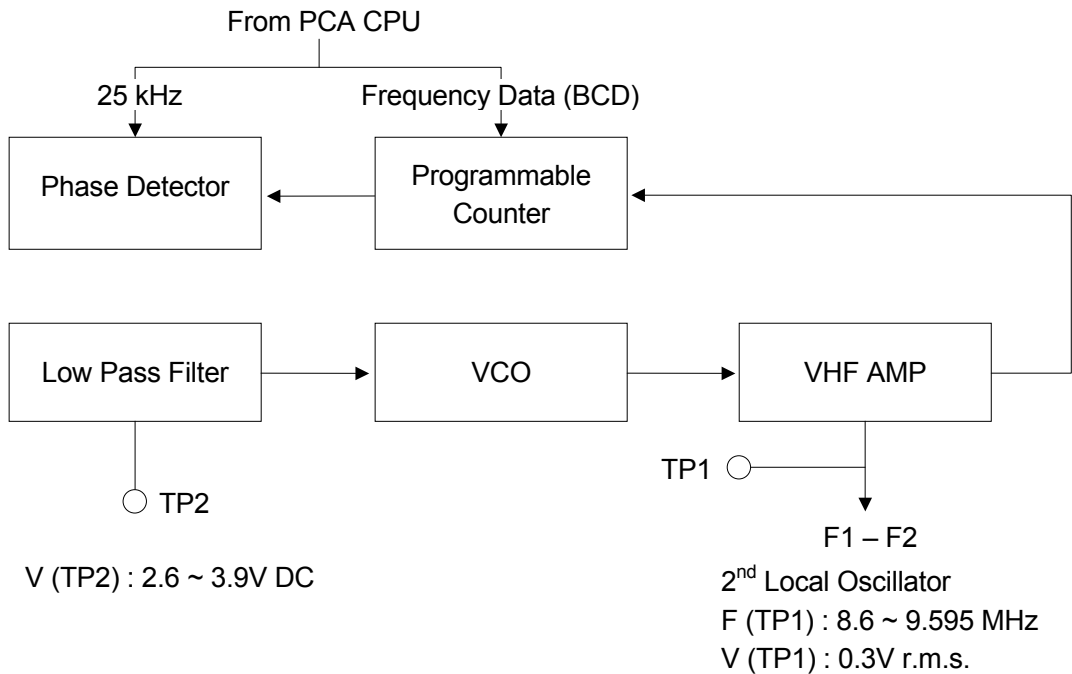


Fig. 11 Schematic diagram of PCA VCO-2

3.4.3 Replacement and Re-adjustment

(1) Re-adjustment of PCA IF/AF

All IF amplifier circuits are tuned at their center frequencies to get the maximum gain. Therefore, shunt resistors for many coils shall not be changed. The following table gives standard level of the IF circuit.

Transistor	Input (dB mV)	Frequency
Q1	25	21.4 MHz
Q3	45	455 kHz
Q5	62	455 kHz
Q6	38	455 kHz
Q8	63	455 kHz
Q10	78	455 kHz

* The output voltage 0.2V r.m.s. on secondary of T9 and **GAIN** is set to the minimum position.

(2) Re-adjustment of PCA HF

- (a) T2, T3, T4 and T5 are tuned at 115 MHz and RV2/RV3 are adjusted at 165 MHz to get the maximum gain, connecting the signal generator directly to J2 (BNC), and 50Ω (47Ω) resistor to the J1 (M type).

Repeat above procedures 3 ~ 4 times.

Finally, rotate the adjuster of T2 for one revolution clockwise.

- (b) VHF amplifier circuit T1 is tuned at 115 MHz, and RV1 is adjusted at 165 MHz to get maximum gain, connecting the signal generator directly to J1 (M type connector) and 50Ω (or 47Ω) resistor to the J2 (BNC connector).

Repeat above procedures 3 ~ 4 times.

The following table gives standard level of the PCA HF.

Transistor	Input (dB mV)	Frequency
Q1	3	14.5 MHz
Q2	5	14.5 MHz
Q3	11	14.5 MHz
Q5	21	14.5 MHz
Q7	6	30.5 MHz
Q8	20	30.5 MHz
Q10	21	21.4 MHz

* The output voltage 0.2V on secondary of T9 on PCA IF/AF, and **GAIN** is set to the minimum position.

(3) Re-adjustment of voltage regulator

The output voltage of voltage regulator shall be adjusted to 9.2V with a variable resistor RV1 on the PCA Chopper.

(4) Phase adjustment

Connect the antenna simulator as shown in Fig. 9.

Set the frequency and apply 145.5 MHz 65 dB from the signal generator. Switch NS and V to ON the antenna simulator to get indicate 0° of digital display adjusting RV3 on the PCA IF/AF. Check 45° and 90° switching NS and EW to ON and NS to OFF, EW to ON.

3.5 PROCEDURE OF PHASE ADJUSTMENT

When the TD-L1630 is installed under improper environmental conditions at shore station or land station, the disturbance and/or some other harmful phenomenon may happen. Depends on the scale of disturbance, phase adjustment is required, otherwise low receiving sensitivity and/or malfunction of direction indication may be caused in TD-L1630. To avoid this situation, make some 10 cm length of extension cables with connectors beforehand, and make an adjustment with following procedure to a good phase status by adding the extension cable for either vertical cable or loop cable.

- (1) Prepare some 10 cm length of extension coaxial cables (e.g. 10 cm, 20 cm, 30 cm, 40 cm. . . . Since wave length of 150MHz is 2 m, it is better to prepare 10 kinds of extension cable from 10 cm to 100 cm at 10 cm steps.) with M type connectors. (Refer to Fig. 12)

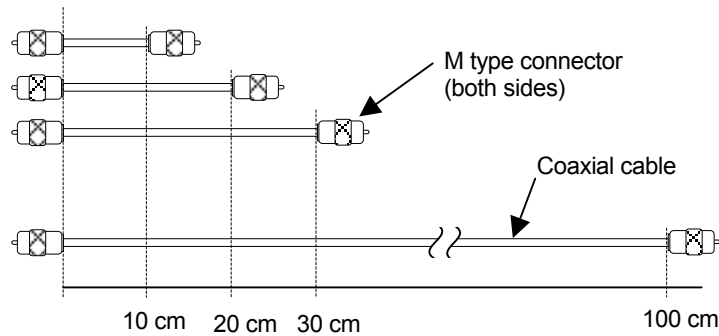


Fig. 12

- (2) Connect an extension cable in between **V** cable (vertical cable) of antenna cable first. Use M-A-JJ connectors. Refer to Fig. 13-A and 13-B

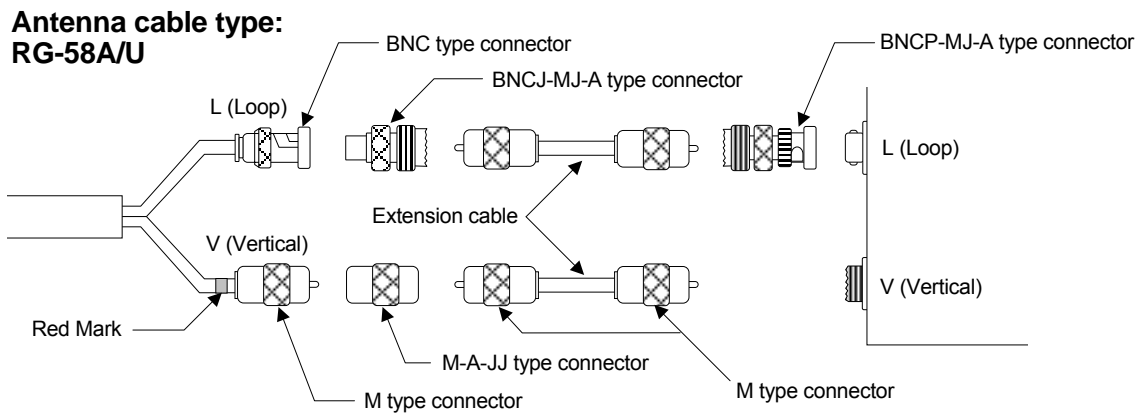


Fig. 13 - A

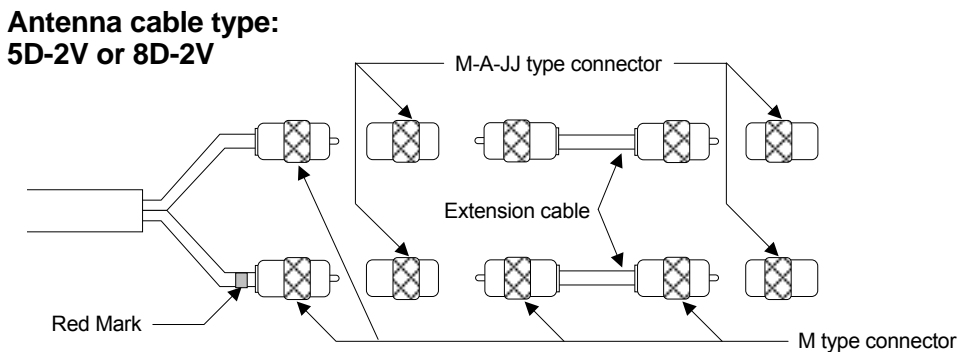


Fig. 13 - B

- (3) Put a probe of oscilloscope on TP terminal of PCA IF/AF to check if the modulation wave is good. PCA IF is installed on the tail side of PCA CPU in the main unit. (Refer to Fig.15)
- (4) Arrange a boat equipped with a VHF transmitter at 45 degrees against bow of the ship which installed the TD-L1630, and transmit VHF signal. (Refer to Fig.14)
At that time, both ships shall cast an anchor to do not move.

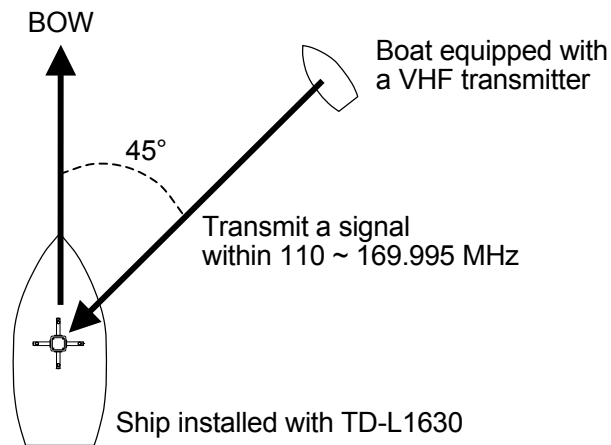


Fig. 14

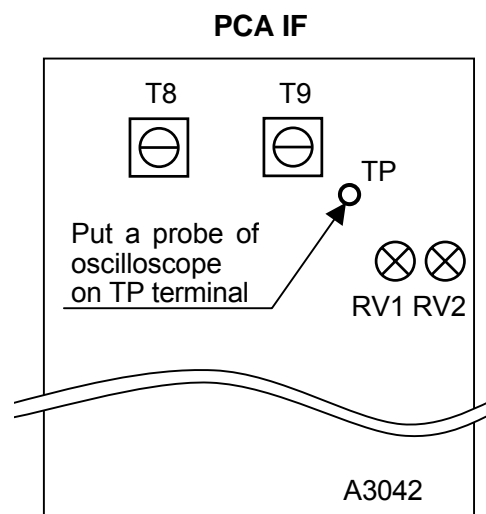


Fig. 15

- (5) Change the length of extension cable so that the ratio of BM wave form between vertical and loop shall be in the ratio ranging between 1 (V) : 1 (L) and 3 (V) : 1 (L), when TD-L1630 receives transmitting radio wave from 45 degrees of heading. (Refer to Fig.16)

Caution: If radio emission source is not 45 degrees from the heading of mother ship, shape of Balanced Modulation Wave (Fig.16) is displayed on the oscilloscope improperly. Be sure to set the radio emission source at 45 degrees from the heading of mother ship.

- (6) If the phase status is not good even adjusted by extension cable, pull out every extension cable(s) from **V** cable and connect it in between **L** cable (Loop cable; Refer to Fig.13-A, 13-B) instead. Then, make an adjustment so that the ratio of BM wave form between vertical and loop shall be in the ratio ranging between 1 (V) : 1(L) and 3 (V) : 1 (L), when TD-L1630 receives transmitting radio wave from 45 degrees of heading.

- (7) Make sure that DF measurement can be done with good accuracy of direction angle.

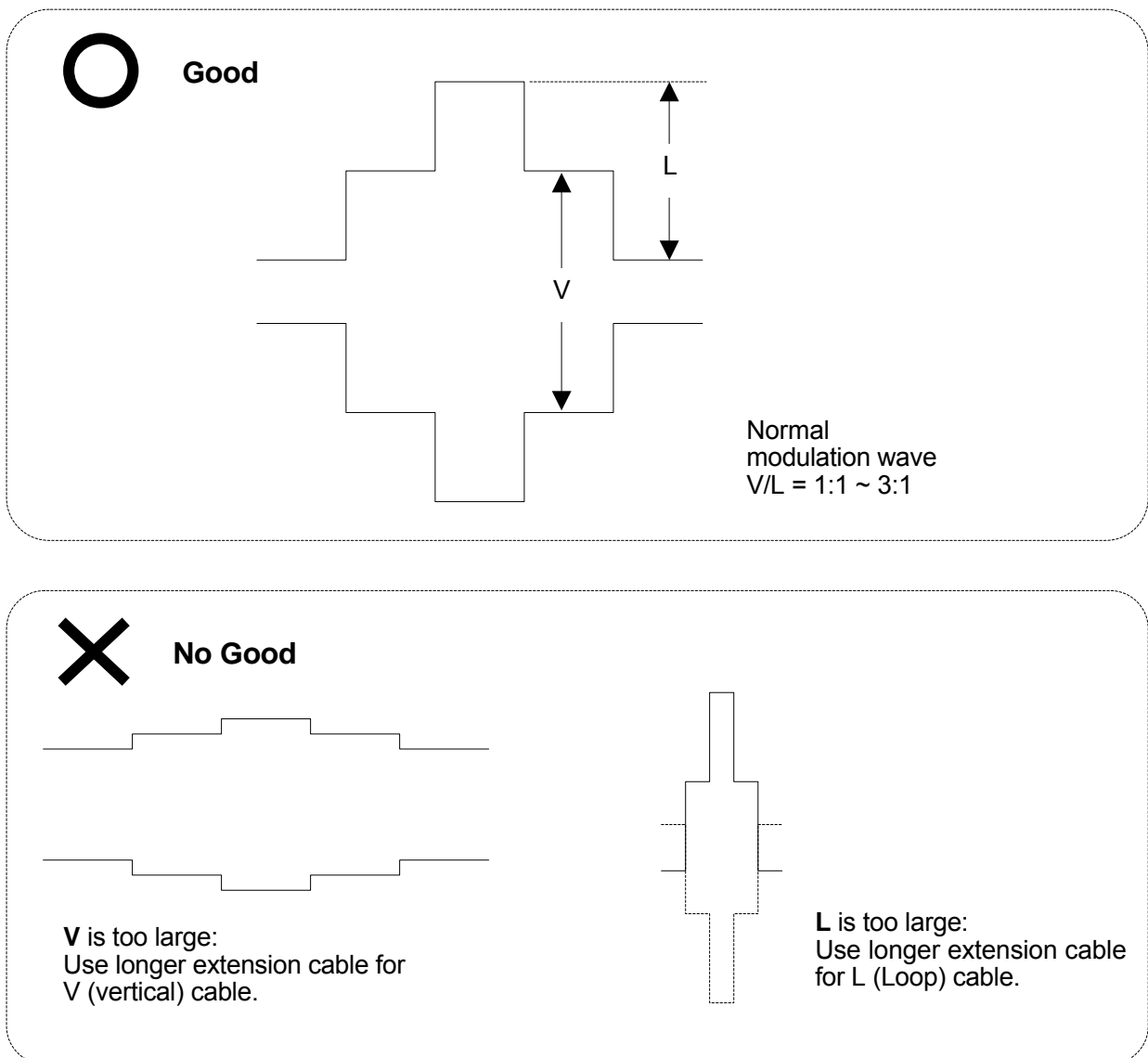


Fig. 16 Balanced modulation wave

Chapter 4 MAINTENANCE

The equipment is designed to have a high reliability and long life. However, both mechanical and short electrical check is recommended once a year to prevent troubles.

If the environmental condition is severe, such as high temperature/humidity, strong vibration, large variation in power supply and etc., shorten the period between checks in half or shorter.

In case it is inconvenient to check operations at its position, draw the main unit forward after loosening its knobs.

When a trouble occurs or a failure is found, try electrical check. Then follow the trouble-shooting procedures in this chapter. When the trouble can not be fixed, consult your agent or the manufacturer, Taiyo Musen Co., Ltd.



CAUTION

C-MOS ICs are used in the equipment and hence, transient phenomena accompanied with break in circuit may harm them. Therefore, cut off power supply and turn its power switch off while in mechanical check, before electrical check and while changing parts and PCAs.

4.1 MECHANICAL CHECK

4.1.1 Antenna

- (1) Check tilt, bend, damage or erosion of antenna elements, element holders and stanchion.
- (2) Check slackness, damage or breakage of cables and cable holders.

4.1.2 Main Unit

- (1) Check damage or breakage of main unit.
- (2) Check slackness, damage or breakage of cables and connectors

4.2 ELECTRICAL CHECK

4.2.1 Ni-Cd Battery for Backup Memory

The frequencies memorized in the memory are maintained by an electric power of the built-in Nickel Cadmium (Ni-Cd) backup battery.

The Ni-Cd battery is automatically re-charged while the power of the main unit is ON.

When the equipment is operated for the first time, or not operated over one month or replaced the Ni-Cd battery with the new one, keep the power "ON" for more than 15 hours to charge the back-up battery.

Data in memory would fade away when the Ni-Cd battery is completely discharged. In that case, enter the data again after re-charge or replace the battery.

4.2.2 Fuse

When the fuse blows while in operation, a trouble in circuit is suspicious. Check and shoot the cause. Afterwards, replace the fuse with a new MF60NR 250V 3A fuse.

4.3 TROUBLE SHOOTING

4.3.1 Troubles and Countermeasures

When a trouble has occurred, try to find the category of trouble shown in Table 3 and take a countermeasure to solve the trouble accordingly. When it is not successful by a countermeasure, ask the agent supplied the system or directly to Taiyo Musen Co., Ltd. with following information:

- A) Model name, i.e. TD-L1630
- B) Version number and check sum.
- C) Symptom

Table 3. Symptom of troubles, their causes and countermeasures

Symptom of troubles	Probable cause	Countermeasure
No power supply and hence, any operation is impossible	Trouble in power cable / connector	Ask replace or repair
	Failure of power switch	Ask for repair
	Fuse has blown away	Replace fuse with new one
Key or switch does not function	Bad contact of switch	Ask for repair
	Bad connection of internal connector(s)	Confirm connection
	Breaking of wire inside	Ask for repair
	Failure in PCA	Ask for replace or repair
	Bad contact at connection of PCA CPU and PCA Display	Separate them once and insert firmly
Complete silence on all frequency in all mode. Indicator does not work	DC power is not supplied to the receiver	Check fuse
	Defective power plug or interconnecting cord	Check conductance of power line
	Misconnection of polarity of the power line	Check the polarity
	Defective receiver	Remove receiver for test
No audio output	Defective audio volume control	Measure the resistance
	Defective audio circuit	Make voltage measurement of Q22 ~ Q25 on PCA IF/AF
	Defective speaker	Check conductance
	Defective squelch circuit	Make voltage measurement of Q20, Q21, Q26 & Q27 on PCA IF/AF
Noisy reception	Interference from outside source	Shut off engine and other electric equipments except TD-L1630
	Poor ground connections	Check a ground connection
	Defective antenna cable	Check conductance
Poor "RCV" and normal "DF"	Defective mode switch	Check conductance
	Defective audio circuit	Check audio circuit

Poor "DF" and normal "RCV" (continued)	Defective 135.6 Hz output circuit	Make voltage measurement J1 and J2
	Defective ADDF amplifier circuit	Make voltage measurement of Q17 ~ Q31 on PCA IF/AF
	Defective PCA CPU	Replace the PCA CPU
	Defective PCA DISPLAY	Replace the PCA DISPLAY
	Defective balanced modulator circuit in the Adcock antenna	Check diode and transformer
	Defective antenna cable	Check conductance
	Defective mode switch	Check conductance
Poor sensitivity in all mode and all frequency	Defective IF amplifier circuit	Measure gain value
Indicator shows always 0° or 90° (or those opposite angle)	Defective antenna cable	Check conductance
	Defective 135.6 Hz output circuit	Measure the voltage of J1 & J2
The bearing error occurs in a certain specific azimuth regardless of the frequency	Defective phase adjustment	Check RV3 on PCA IF/AF

Table 4. Voltage Measurement

PCA	Circuit No.	C (D) [volt]	B (G) [volt]	E (S) [volt]
PCA HF	Q1	3.9	0	0
	Q2	2.5	0	0
	Q3	4.1	0	0
	Q4	7.8	5.6	4.8
	Q5	4.2	1.3	0.5
	Q6	8.6	5.6	4.9
	Q7	8.2	1.5	0.8
	Q8	3.9	1.2	0.5
	Q9	7.6	5.6	4.5
	Q10	8.2	1.5	0.8
	Q11	6.2	4.6	3.9
	Q12	0	0.8	0
PCA IF/AF	Q1	3.9	1.4	0.7
	Q2	7.5	5.6	4.4
	Q3	8.3	1.5	0.9
	Q4	3.2	1.5	0.9
	Q5	7.2	2.1	1.4
	Q6	4.8	1.5	0.8
	Q7	7.5	5.6	5.0
	Q8	4.9	1.4	0.8
	Q9	8.3	5.6	5.0
	Q10	7.3	1.9	1.2
	Q11	6.6	0.8	0.2
	Q12	9.1	6.6	5.9
	Q13	0.8	5.7	6.3
	Q14	3.4	1.4	0.8
	Q15	6.4	3.5	4.5
	Q16	3.8	1.2	0.7
	Q17	7.5	1.3	0.6
Q18	7.4	1.4	0.8	
Q19	7.3	2.6	1.9	

PCA IF/AF (continued)	Q20	3.3	0.4	0
	Q21	6.6	3.3	2.7
	Q22	6.0	2.0	1.4
	Q23	4.8	1.4	0.8
	Q24	9.1	5.9	5.3
	Q25	0	4.8	5.3
	Q26	0	0.7	0
	Q27	2.4	0	0
	Q28	9.1	8.3	7.6
	Q29	9.0	7.6	7.0
	Q30	3.3	1.6	1.0
PCA VCO-1	Q31	3.3	1.7	1.0
	Q1	26.0	1.3	1.3
	Q2	10.3	1.3	0.7
	Q3	10.3	0.7	0
	Q4	5.8	0	0.5
	Q5	4.8	0	0.5
	Q6	4.8	0	0.5
	Q7	4.9	1.5	0.7
Q8	30.0	10.2	10.4	
PCA VCO-2	Q1	6.8	1.5	1.2
	Q2	3.3	1.2	0.7
	Q3	3.3	0.7	0
	Q4	6.8	0	1.9
	Q5	6.8	0	0.5
	Q6	6.8	3.4	3.8
	Q7	6.8	2.0	1.3
	Q8	1.6	0.8	0.3
PCA Noise Limiter	Q1	2.7	2.1	1.5
PCA BM	Q1	4.5	0.35	0
	Q2	4.5	0.35	0
	Q3	4.5	0.35	0
	Q4	4.5	0.35	0
	Q5	0	4.5	4.5
	Q6	9.1	4.5	4.5
	Q7	0	4.5	4.5
	Q8	9.1	4.5	4.5
	Q9	0	4.5	4.5
	Q10	9.1	4.5	4.5
	Q11	0	4.5	4.5
	Q12	9.1	4.5	4.5
PCA Chopper	Q1	23.8	9.7	9.3
	Q2	9.7	23.8	23.8
	Q3	0	9.3	9.3
PCA AVR	Q1	0	4.6	4.6
PCA CPU	Q1	5.0	4.3	5.1
	Q2	0	0.7	0
	Q3	5.0	0	0
	Q5	5.1	2.5	1.8
	Q6	5.1	2.5	1.8

Measurement condition : Use a Multimeter
 Frequency 145.5 MHz
 Power voltage 24V DC

Set the knob and switch position as follows:

GAIN : Maximum
 FM/AM : FM
 DF/RCV : DF

4.4 Remarks

The SW1 on PCA BM is used for special case such as installing on a aircraft. Normally it must be set to "NOR" position.

4.5 Disposal

Follow local regulations to dispose the equipment.

Recycling of Ni-Cd battery is advised. It is soldered on PCA CPU and easily removed by cutting its lead wire with a nipper. Apply insulation tape to its ends to prevent short circuit.