FURUNO

SERVICE MANUAL

SSB RADIOTELEPHONE

MODEL **FS-8000**

(ROM Version No.11)

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·Your Local Agent/Dealer

FIRST EDITION : JAN 1993

PUB. No. SME-55210-A
(TOSA) FS-8000

FURUNO
Information

NO. : FQ5-93-001
Date : 1993 - 02
Issued by : FURUNO ELECTRIC CO., LTD.
TECHNICAL DOCUMENTATION SECTION

Addenda No. 24 to Service Manual of FS-5000 SM-E5519
Addenda No. 1 to
Service Manual of
FS-8000 SM-E5521

FS-5000/8000
ROM PROGRAM CHANGE

The program of the ROMs (three) in the Control Unit, Transceiver Unit and Antenna Coupler has been changed as follows from the production of February 1993.

Unit	Control	Transceiver	Antenna Coupler
ROM Version No.	1.12 (CPU board)	Same as left.	1.02 (COUPLER board)
Program No.	05-501-31-112		05-501-54-102
Code No.	005-927-440-00		005-860-330-00

Modification

ROMs for Control and Transceiver Units (Ver. 1.12)

(1) When the circuit of the EXC board (05P0349) was changed to "suffix-33" in January 1992 to reduce transmission noise on duplex communication (refer to Furuno Information FQ5-92-009 issued in April 1992), tuning power of the FS-8000 was reduced, which caused tuning error. To resolve this problem, the tuning power of the FS-8000 has been increased.

(2) A terminal board on the INTERFACE board (05P0354) was newly added for detection of the AC mains failure in December 1992. For the sets produced in December 1992 and after (incl. RC-5000/8000 series):

1. The software bug, that the output power is not always reduced automatically when AC mains cuts off, has been removed. (RC-5000/8000 series only)

2. Automatic power reduction data (power data) when AC mains fails can be adjusted as shown below.

   - [STO] → [LOW] → press and hold [LOW] or [FULL] → [ENT]

(For previous ROM, the above data was determined by maximum power data setting.)

(3) The minimum output power, when system setting 9928 ([STO] 9928) is set to "1" (60W or higher), is increased to get 60W power securely.

When you select system setting 9928 to "1", the minimum power data is automatically set as below, and the maximum power data is preset to the default setting ("255").

Model	Minimum Power Data
FS-5000	MF: 115, HF: 110
FS-8000	MF: 90, HF: 85

(4) For system setting 9980, when "31" (Netherlands) is entered, system setting 9901 is automatically set to "3" (Marine free).

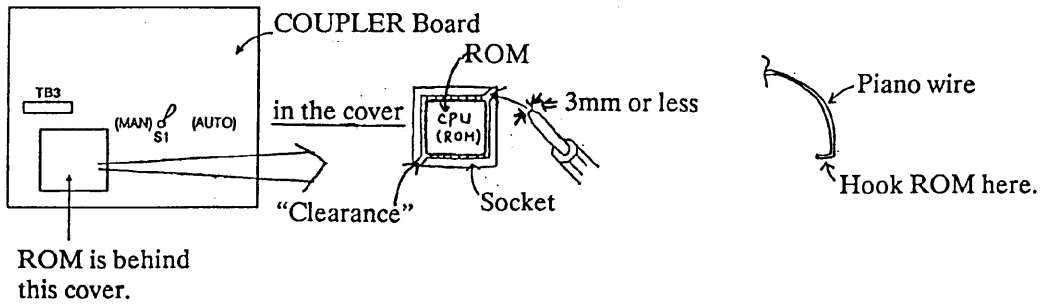
ROM for Antenna Coupler (Ver. 1.02)

(1) The software bug described below has been removed.

The "Tuning error" occurs on the frequency higher than 3.36 MHz. This is because the pi-network tuning sequence is skipped (software bug) if the gamma-network cannot be tuned.

How to remove ROM on the COUPLER board

Using a slotted-head screwdriver (blade width 3mm or less), remove ROM by inserting it into "clearance" between ROM and socket as shown below. (Piano wire may be used instead of a screwdriver.)



Relationship between Model & ROM to be replaced

Model	ROM to be replaced
RC-5000/8000 series	All ROMs (Three ROMs)
FS-8000 in which tuning error occurs.	
FS-5000 in which tuning error occurs.	ROM in the antenna coupler only.

FURUNO
Information

NO. : FQ5-93-012
Date : 1993 - 04
Issued by : FURUNO ELECTRIC CO., LTD.
TECHNICAL DOCUMENTATION SECTION

Addenda No. 25 to Service Manual of FS-5000 SM-E5519

Addenda No.2 to
Service Manual of
FS-8000 SM-E5521

FS-5000/8000

1. Protection of PA Transistors
2. Installation of ANTENNA EARTH RELAY Board (for Grounding TX Antenna)

1. Protection of PA Transistors (Overcurrent protection: max. 21A)

Excessive current may flow into the PA transistors momentarily when the matching status between an antenna and a coupler changes, damaging the transistors. To solve this problem, the PA CHECK board has been changed from 12/92. (The new PA CHECK board (05P0367-22) detects current flowing into the PA transistors and delivers its output to the ALC circuit of the EXC board.)

The next page shows how to mount and adjust the new PA CHECK board locally. This modification can be done for the sets having suffix number shown below. (Production in 11/92 and earlier)

INTERFACE board: 05P0354-11
INTERFACE board: 05P0362-11 (FS-8000)
PA CHECK board: 05P0367-11

2. Installation of ANTENNA EARTH RELAY Board

To connect a transmission antenna to ground automatically while the unit is not transmitting, install the ANTENNA EARTH RELAY board in the antenna coupler. This protects the transmission circuit against lightning when the 50 ohm BK relay in the TX FIL board is turned on, that is, the transmission circuit is connected to the antenna. The procedure for installation is on page 6/8.

Applicable equipment: Units using new antenna coupler
(Serial No. 1001 and after)

Modification for protection of PA transistors (For FS-5000)

		Qty
Necessary Parts:	1. New PA CHECK Board	1
	2. PH Connector Assy. (2P-10P)	1
	3. Carbon Resistor (680, 1/6W)	1

Procedure

Before replacing the PA CHECK board, measure the Ic current, using the existing PA CHECK board.

Conditions

Frequency	: 4MHz (SSB)
Output Power	: LOW1
Tone	: Single tone **[STO] [9926] [ENT] [0] [ENT]**
Ic Indication	: ON **[STO] [9910] [ENT] [1] [ENT]**

1. Turn off the power and replace the PA CHECK board with new one.

2. Turn on the power and measure the Ic current using the same conditions mentioned above.

3. Compare both values of Ic. If they are not the same, adjust R4 on the new PA CHECK board for coincidence.

4. Turn off the power and connect a PH connector assembly between J4 on the PA CHECK board and J9 (ALC terminal) on the INTERFACE board.

5. Change resistance value of R146 on the EXC board from 3.3k ohms to 560 ohms by inserting a 680 ohm resistor in parallel with R146. (Short L9 on the INTERFACE board.)

6. Turn on the power, set the output power to FULL and transmit by single tone (SSB) on all bands.

7. Confirm that Ic indication does not exeeds 21A on all bands. If it exceeds 21A, adjust R35 (clockwise) on the PA CHECK board.

8. Restore "Tone" and "Ic Indication" system settings to previous settings.

Modification for protection of PA transistors (For FS-8000)

Necessary Parts:

	Qty
1. New PA CHECK Board	2
2. PH Connector Assy. (2P-10P)	2
3. PH Connector Assy. (10P-)	2
4. Carbon Resistor (680, 1/6W)	1
5. ROM (Ver. 1.11 or 1.12)	2

Procedure

1. Replace ROMs on the CPU board in the control unit and transceiver unit with new ones. (Ver 1.11 or 1.12)

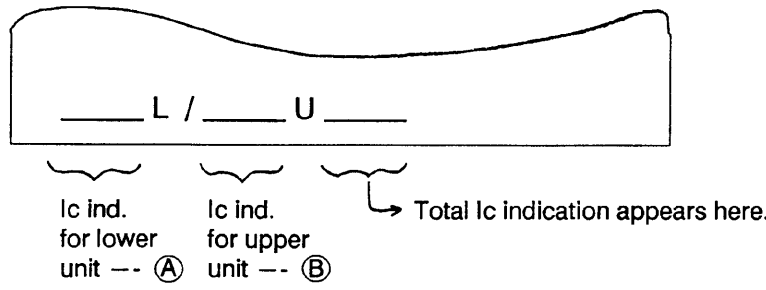
2. Turn on the power and change the system setting **9964** as shown below, to display respective Ic indication of the upper and lower units.

   [STO] [9964] [ENT] [1] [ENT]

3. Before replacing the two PA CHECK boards, measure Ic current of both the upper and lower units using the existing PA CHECK board.

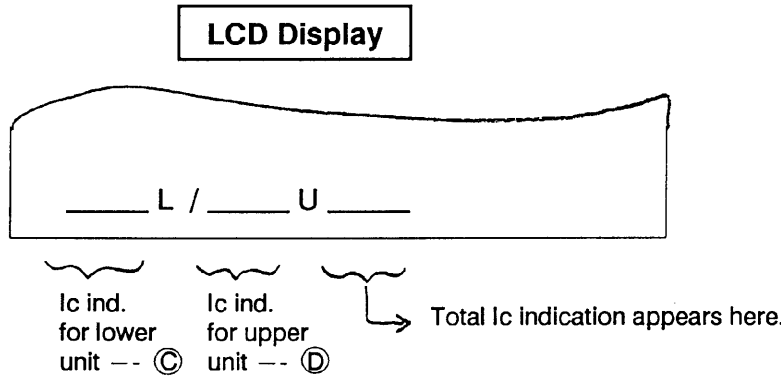
   Conditions
   Frequency :4MHz (SSB)
   Output Power :LOW 1
   Tone : Single tone
   [STO] [9926] [ENT] [0] [ENT]
   Ic Indication : ON
   [STO] [9910] [ENT] [1] [ENT]

LCD Display



4. Turn off the power and replace the PA CHECK boards with new ones.

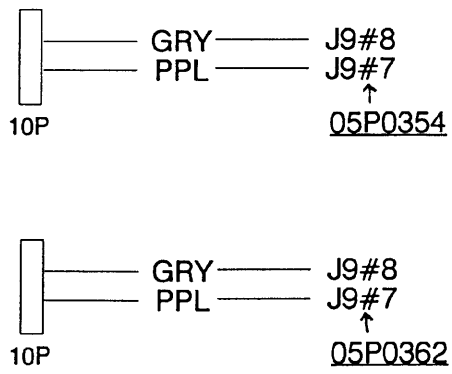
5. Turn on the power and measure the Ic current of both the upper and lower units using the same conditions mentioned earlier.

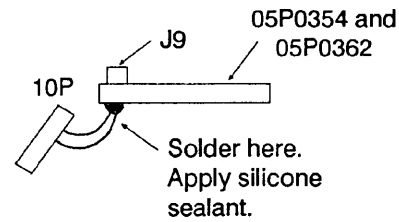


6. Compare values of Ⓐ and Ⓒ. If they are not the same, adjust R4 on the new PA CHECK board in the lower unit.

7. Adjust R4 on the new PA CHECK board in the upper unit if the values of Ⓑ and Ⓓ are not the same.

8. Turn off the power and solder two flying wires from a PH connector assembly (10P-) to J9 on the INTERFACE boards (05P0354 and 05P0362) as shown below.





9. Connect a PH Connector assembly (2P-10P) between J4 on the PA CHECK board and 10P connector from the INTERFACE board (05P0354) in the lower unit, and between J4 on the PA CHECK board and 10P connector from the INTERFACE board (05P0362) in the upper unit.

10. Change resistance value of R146 on the EXC board from 3.3k ohms to 560 ohms by inserting a 680 ohm resistor in parallel with R146. (Short L9 on INT board(05P0354).)

11. Turn on the power, set the output power to FULL and transmit by single tone (SSB) on all bands.

12. Confirm that Ic indication does not exceed 21A on all bands (for both lower and upper units). If it exceeds 21A, adjust R35 (clockwise) on the PA CHECK board.

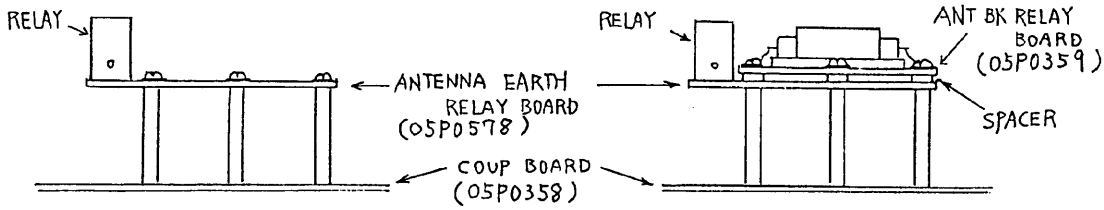
13. Restore the system settings to the previous settings.

Mounting ANTENNA EARTH RELAY PCB on Antenna Coupler (New Coupler)

		Q'ty
Necessary Parts:	① ANTENNA EARTH RELAY PCB (05P0578, with cables)	1
	② Spacer for mounting ANT BK RELAY PCB	5
	③ CK clamp (CK-05H)	1
	④ Panhead screw B (M3 × 10)	5

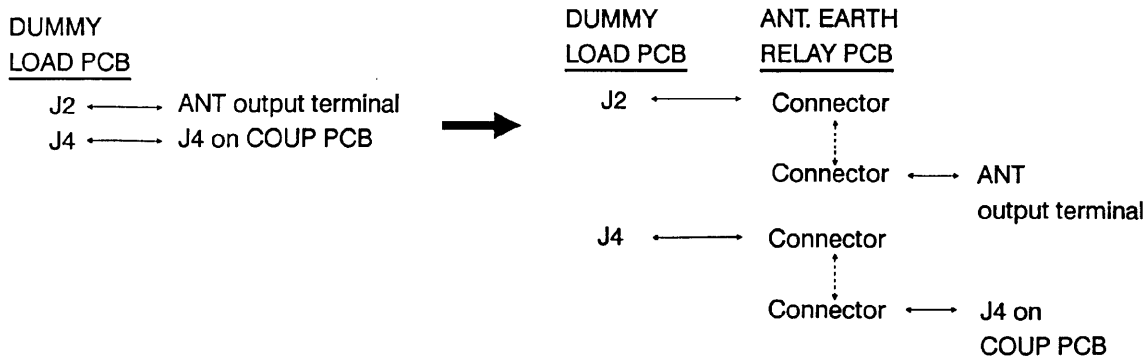
Procedure

1. Mount the board on the COUPLER board by using screws and spacers (if necessary).



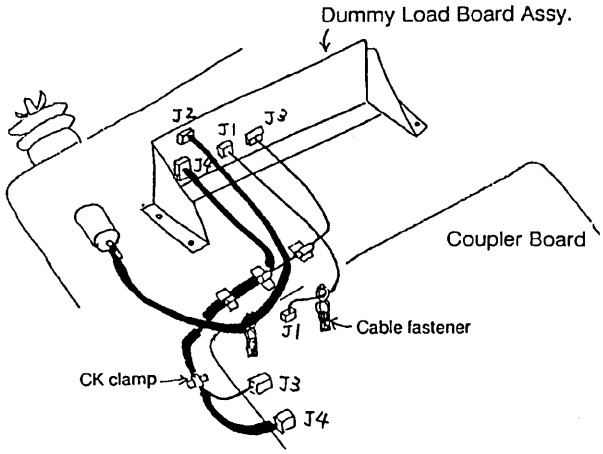
Without ANT BK RELAY PCB　　With ANT BK RELAY PCB

2. Change wire connections as shown below.

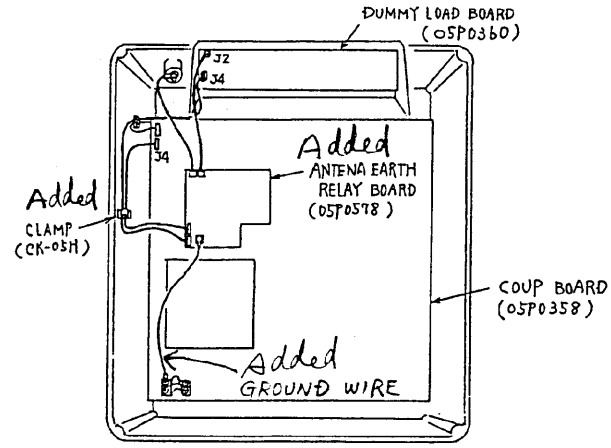


(*) Connect ground wire as shown on the next page.

Previous　　**New**



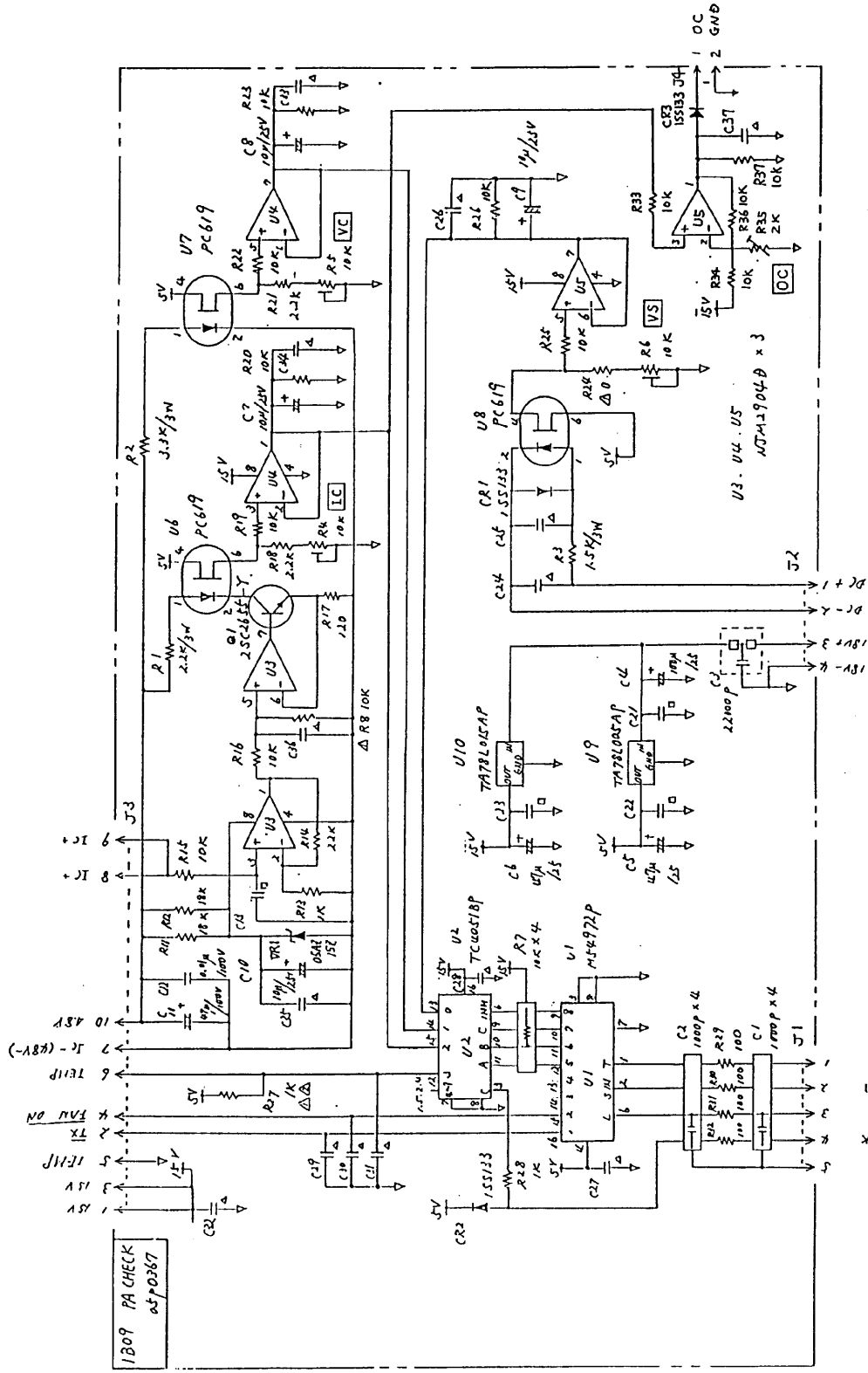
Previous



New

Operation: When the DUMMY key is on or the power is turned off, a transmission antenna is automatically connected to ground to protect the transmission circuit in the transceiver unit against lightning.

PA CHECK BOARD



NOTE (1) Resistors are in Ω(0.1W). Capacitors are in F.
Inductors are in H, unless otherwise noted.
(2) Marks ○ are 1000pF/50WV capacitors.
△ are 0.01μF/50WV capacitors and
□ are 0.1μF/25WV capacitors.

主任	FS-1600	コード						SHEET NO.	1/1
係	FS-2500	型名							
課長	FS-5000	検図	設計	製図	TITLE	1809 PA CHECK (TRANSCEIVER UNIT)			
					DWG. NO.	C5519-K07-D			

古野電気株式会社

FURUNO

Information

No. : FQ5-93-016

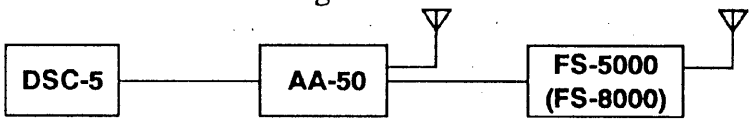
Date : 1993 - 05

Issued by: FURUNO ELECTRIC CO., LTD.
TECHNICAL DOCUMENTATION SECTION

Addenda No.26 to FS-5000 SM-E5519.
Addenda No.3 to FS-8000 SM-E5521.
Addenda No.2 to DSC-5 SM-E5522.

FS-5000/8000 series, DSC-5 Remedy for Key Lock up

The keyboard of the FS-5000/8000 and/or the SCAN key of the DSC-5 may lock when equipment is connected as shown in the figure below.



Symptom

The keyboard of the FS-5000/8000 and/or the SCAN key of the DSC-5 may lock when the AA-50 detects a dot pattern while the FS-5000/8000 scans the DSC frequency through the DSC-5 (preselector: ON).
(To restart operation, turn the power switch or the breaker off and turn it on again.)

Cause

Software bug.

Local Remedy

Replace three ROMs.

Name	Type	Code no.	Qty
FS-5000	05501-31-113 (Ver. 13)	005-927-440-02	2
DSC-5	05501-39-115 (Ver. 15)	005-996-140-02	1

Contents of ROM Change

Refer to the following Furuno Information.
•FS-5000/8000 ROM Program Change
•DSC-5 ROM Program Change

Urgency

Immediately replace ROMs when returning to port.

Factory Modification

From the production in May 1993.

ROM Replacement

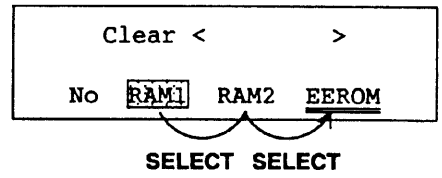
FS-5000/8000

1. Replace the ROMs on the CPU board in the Control and the Transceiver Units with new ones.

DSC-5

(Clearing EEPROM is required.)

1. Replace the ROM on the Control board.
2. Turn the power on. The following screen appears.



3. Press **SELECT** twice to advance the cursor to "EEPROM."
4. To print out the contents of the EEPROM, press **0**. The ship's ID number, "COMM" setting, etc. will be printed.
5. Press **ENT** to clear the contents of the EEPROM.
6. Restore the system settings as they were before.

FURUNO

Information

No. : FQ5-93-015
Date : 1993 - 05
Issued by: FURUNO ELECTRIC CO., LTD.
TECHNICAL DOCUMENTATION SECTION

Addenda No. 27 to FS-5000 SM-E5519
Addenda No. 4 to FS-8000 SM-E5521

FS-5000/8000 ROM PROGRAM CHANGE (Ver. 13)

Contents of ROM Change

(1) In the series connections of the DSC-5/AA-50/FS-5000 (8000), the keyboard of the FS-5000 may lock when the FS-5000 scans the DSC frequency through the DSC-5 with the PRESELECTOR key turned on. This software bug has been removed.

(2) System setting 9952 is added.

[STO]→ [9952]→ Tx antenna status at reception
(0: OFF (No change)→Default
1: ON (Connected to GND)・・(*1))

(*1) This function is available only when the Rx antenna is installed and dummy load board with antenna earth relay is mounted in the coupler.
If you want to connect the Tx antenna to ground manually (irrespective of 9952 setting), press the [DUMMY] key. (For HF band of the FS-8000, this function is operative only when the output power is selected for "Low2" or less.)

(3) Tuning is automatically done when pressing the PTT switch after turning on or off the [DUMMY] key.

(4) If sensitivity setting is less than "7", the AGC and sensitivity settings are automatically changed to "ON" and "maximum", respectively when the [2182] or [2187.5] key is pressed or the "DR" command from other equipment is received.

(5) System setting 9951 is amended as below.

Incorrect		Correct
[0: YES, 1: NO]	⟶	[0: NO, 1: YES]

Shading shows default setting.

Factory Modification From the production in May 1993.

Urgency Replace ROM immediately in case of item (1).

Program Number 05501-31-113

Code Number 005-927-440-02

Remarks For the RC-5000/8000 radio console sets having ROM version number 11 or earlier, adjust automatic power reduction data (minimum power data) after replacing ROM, referring to Furuno Information FQ5-93-001 issued in March 1993.

Applicable Operator's Manual for Version No. 13:
OM-E5519-0K (FS-5000)
OM-E5521-0F (FS-8000)

FURUNO

Information

No. : FQ5-93-017
Date : 1993 - 06
Issued by: FURUNO ELECTRIC CO., LTD.
TECHNICAL DOCUMENTATION SECTION

Addenda No. 28 to Service Manual FS-5000 SM-E5519
Addenda No. 5 to Service Manual FS-8000 SM-E5521

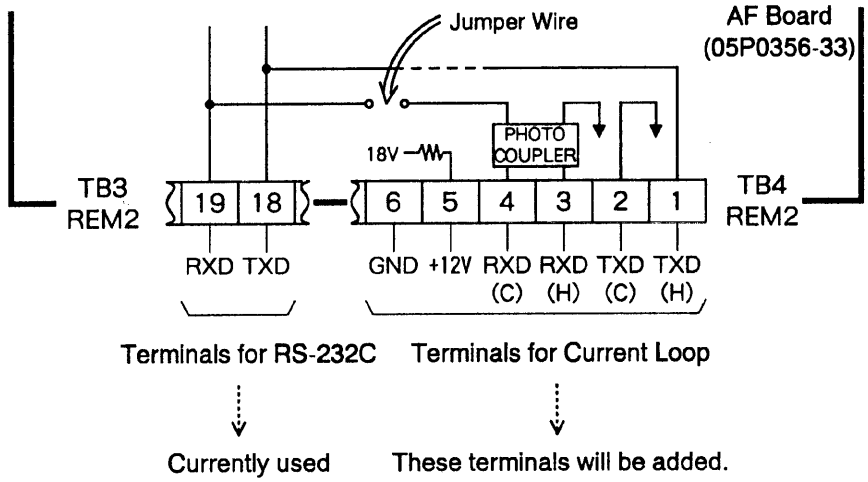
FS-5000/8000 SSB RADIOTELEPHONE
New Version AF Board (-33)

The FS-5000/8000 will have a new version AF Board from the production in August 1993. The new version no. is 05P0356-33. This technical information describes the changes made to this board.

Changes

Connection of Remote Station RB-500

1) The new version AF Board has terminals for **current loop**. They are on the REM2 terminal and are connected as follows.

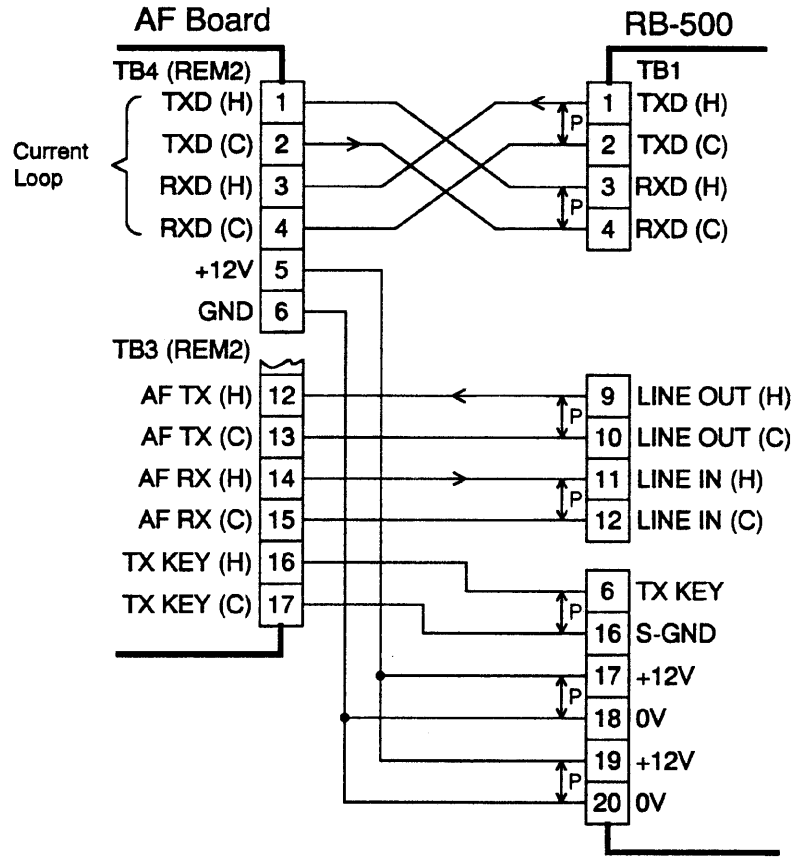


The new version AF Board has the terminals for current loop (TB4 #1–#4). Because of the addition of those terminals, the terminals for connection of CIF/NMEA will be changed from TB4 #1–#4 to #7–#10.
You set the data format of equipment connected to the REM2 by jumper wire, as shown in the table below.

Jumper Wire (see drawing on page 4/6)	Format
Short	Current Loop
Open (factory setting)	RS-232C

2) As shown in the illustration on the previous page, + 12 V power for the RB-500 is taken from the #5 terminal of TB4. (Currently + 18 V is taken from the #9 terminal of TB1 and a resistor is inserted on the RB-500 to lower voltage to + 12 V.)

   As the result the new version AF Board is connected to the RB-500 as follows.



3) Squelch function will be available at the RB-500. (Currently the AF signal comes to the line output (AF RX) terminal on the FS-5000 without passing through the squelch circuit. In the new version AF board it passes through the squelch circuit.)

Intercom function available with RB-500 connection

The intercom function was added to the FS-5000 in November 1992, by ROM version 1.11. No hardware was available at that time; however, the new version AF Board has an intercom circuit. You can enable the intercom function by pressing the following keys

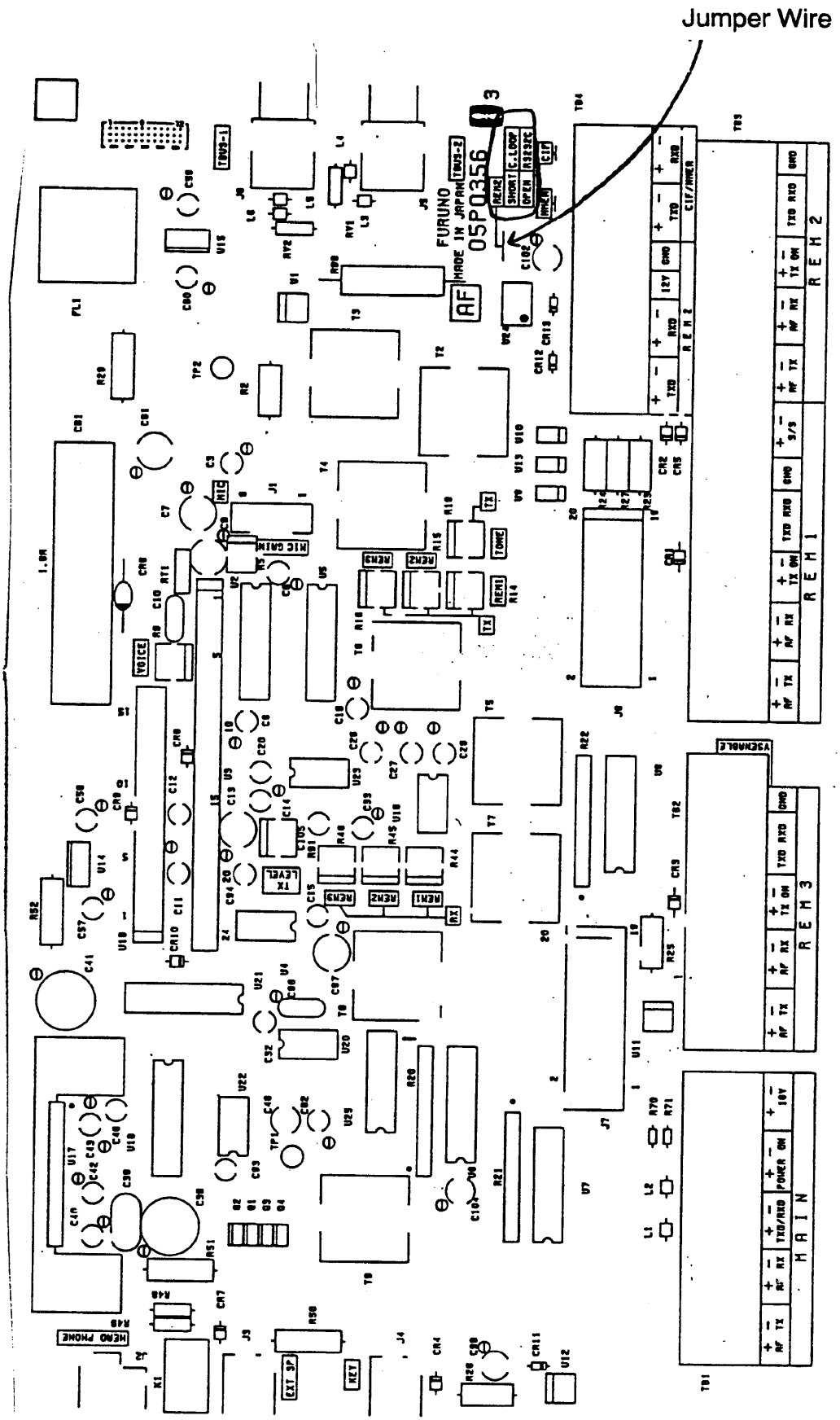
[STO] [9916] [ENT] [2] [ENT]

You operate the intercom function on the front panel by using [*], [ENT], [CLEAR] keys.

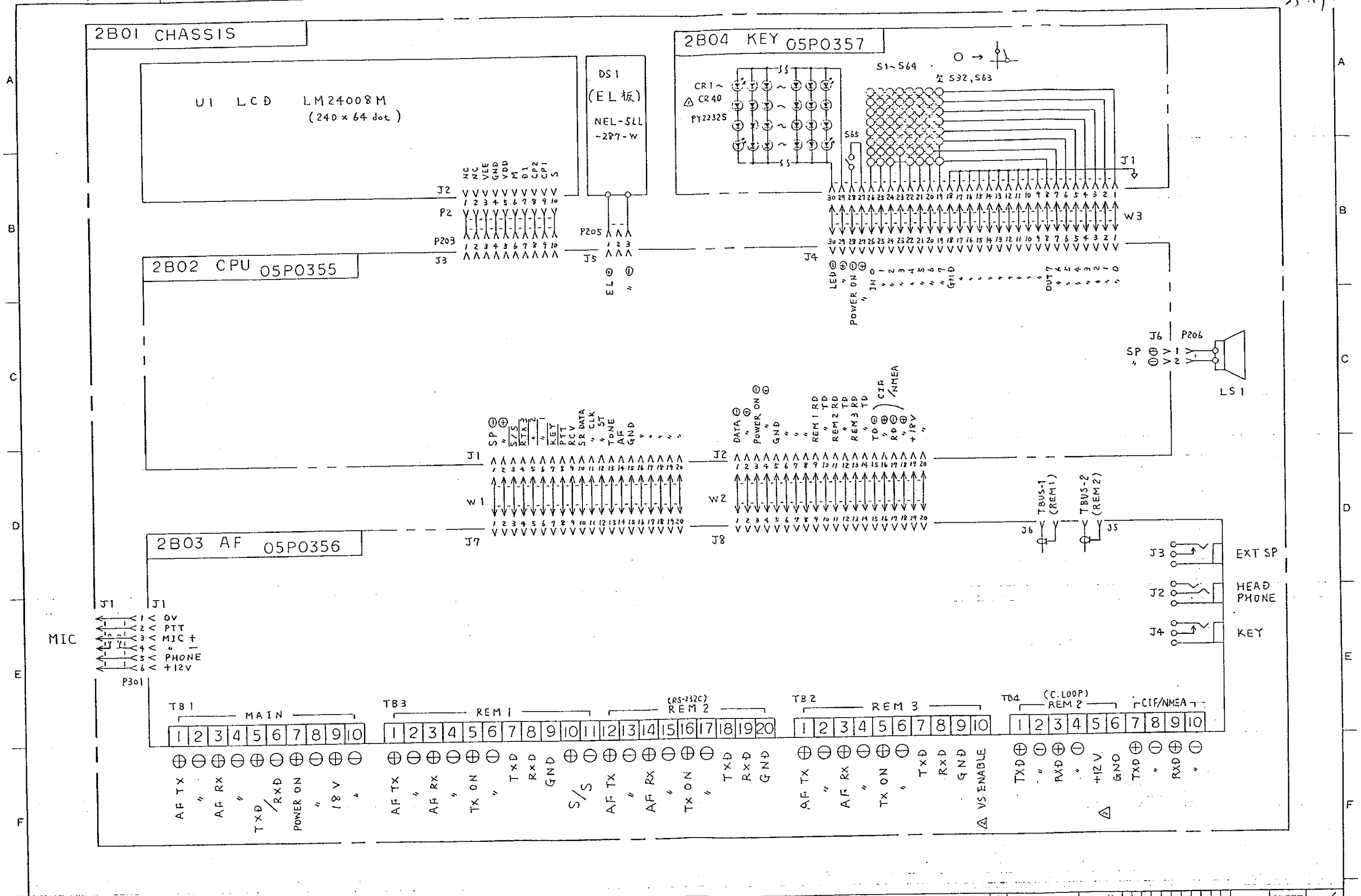
- Calling: [*], (terminal no.), [ENT], then communicate
- Ending communications: [CLEAR]
- Answering: [ENT], then communicate

Potentiometer for adjustment of MIC gain

A potentiometer for adjustment of MIC gain (R5: MIC GAIN) is added. Adjust it when MIC gain is too high.



AF Board (05P0356-33)

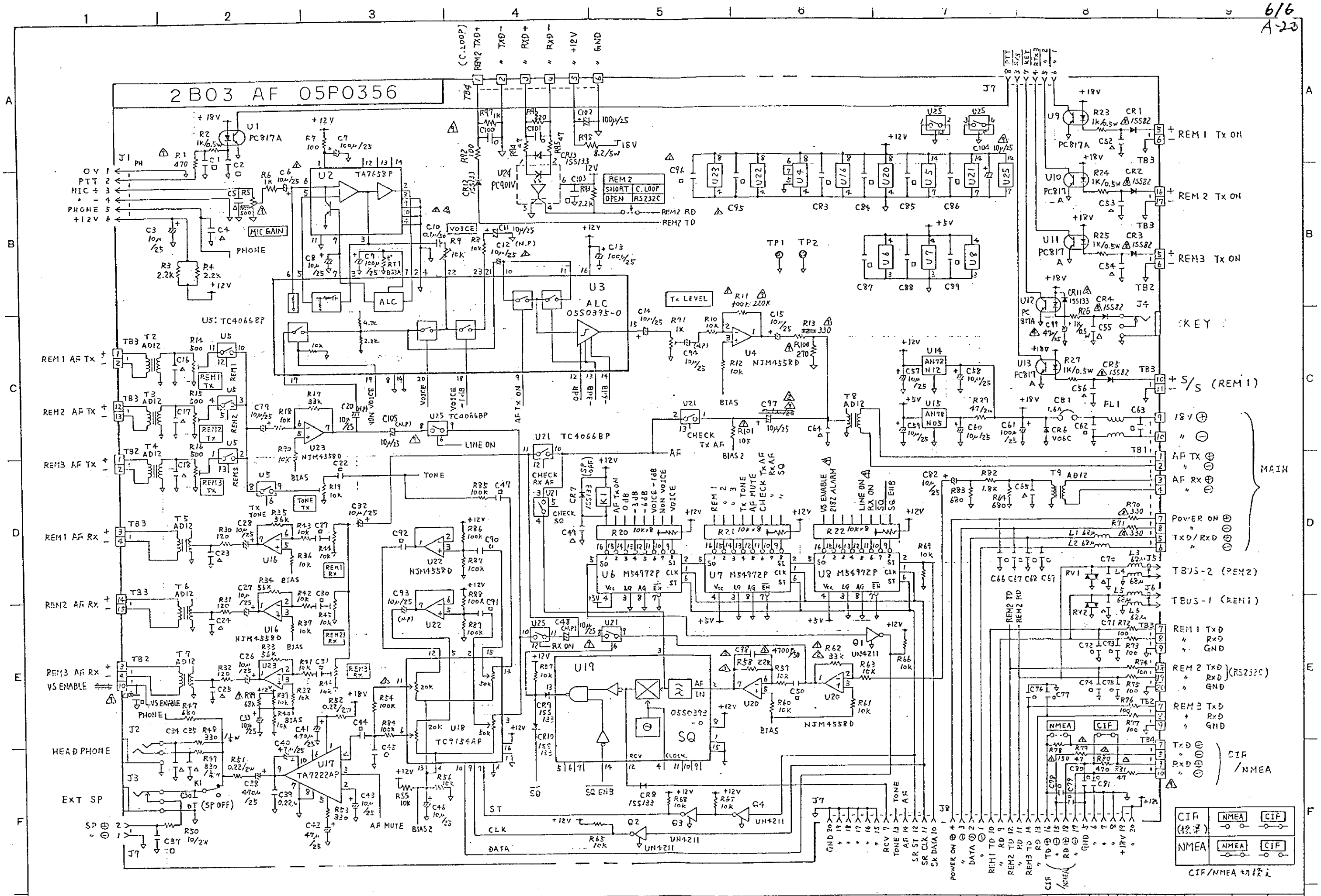


05E3-1899	△2	2.10.30	リモートハンドセット対応 F6組立	追田
05E3-1601	△1	2.5.10	LED 28個→40個	山本
変更通知書番号	符号	訂正年月日	訂正記事	担当

A-19

主機種	FS-5000 / FS-2500 / FS-1500
コード	
型名	
課長 / 検図 / 設計 / 製図	89.10.11 追田 / 89.10.3 山本 / 89.10.3 家城
名称	2B01 CHASSIS (CONTROLLER UNIT)
図番	05-001-3331-2
SHEET NO.	1/1

古野電気株式会社



A-20

変更通知書番号	符号	訂正年月日	訂正記事	担当
05E3-1741	△5 ×1	3.9.26	フォトカプラ 追加と保護	迫田
05E3-1646	△4 ×1	2.10.18	4チャンネル防止 (C96)	山本
05E3-1585	△3	2.3.8	Tx 手動改善, スケルチ...	宮城
05E3-1566	△2	2.1.12		宮城
05E3-1559	△1	1.11.6	誤記訂正, CIF/NMEA...	宮城

05E3-1899	△ ×15	4.10.30		迫田
05E3-1782	△ ×7	4.1.10		迫田
05E3-1752	△ ×1	3.10.21	PTT回り込み保護	山本
05E3-1743	△ ×1	3.10.2	スケルチ...	迫田

NOTE (1) Resistors are in Ω(0.1W). Capacitors are in F, Inductors are in H, unless otherwise noted.
(2) Marks ○ are 1000pF/50WV capacitors.
△ are 0.01uF/50WV capacitors and
□ are 0.1uF/25WV capacitors.

主機種: FS-5000
名称: 2B03 AF (CONTROLLER UNIT)
図番: 05-001-3333-9
SHEET NO. 1/1

古野電気株式会社

FURUNO

Information

No. : FQ5-93-023 .

Date : 1993 - 06

Issued by: FURUNO ELECTRIC CO., LTD.
TECHNICAL DOCUMENTATION SECTION

Addenda No. 29 to
FS-5000 SM-E5519
Addenda No. 6 to
FS-8000 SM-E5521

FS-5000/8000
Remedy for Garbled Audio

Symptom

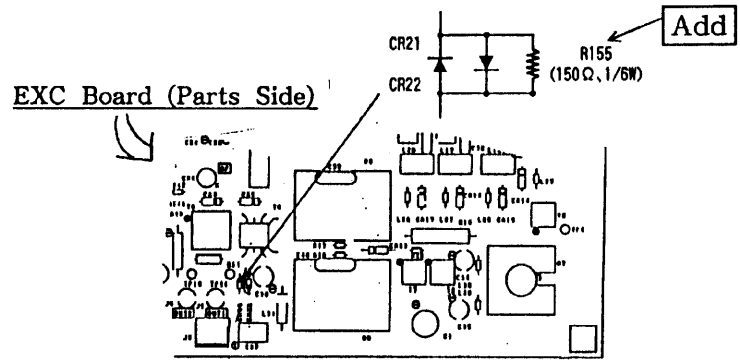
Your partner cannot hear your voice clearly.

Cause

Low level audio is cut off by CR21 and CR22 on the EXC board (05P0349-33), which were added for noise reduction (reduction of interference from own transmitter to receiver) on duplex communication, in January 1992.

Field remedy

(1) Note white noise level by pressing PTT switch on duplex mode; (2) **Add a resistor** (R155: 150 ohms, 1/6W, 000-329-017) in parallel with CR21 and CR22 on the EXC board, and (3) Compare the level of white noise with that of before modification.
White noise should increase slightly. If necessary, adjust resistance of R155; the higher the resistance (max. 220 ohms), the lower the level of the white noise on the duplex mode but the worse the clarification.



Urgency

Tick	Action
	Immediately (ask ship's captain to remedy if the ship is out)
	As soon as the ship returns to port
	When it is convenient
✓	When symptom occurs

Factory modification

From the production in July 1993.

Remarks

If the duplex mode is not used, short CR21 and CR22 to clarify voice.

FURUNO

Information

No. : FQ5-93-028

Date : 1993 - 08

Issued by: FURUNO ELECTRIC CO., LTD.
TECHNICAL DOCUMENTATION SECTION

Addenda No. 30 to
FS-5000 SM-E5519
Addenda No. 7 to
FS-8000 SM-E5521

FS-5000 Series
ROM Program Changes (Ver. 15)

Changes made to ROM program

- The following problems were eliminated.
  1. Frequency cannot be set 30 seconds to one minute after turning on the power and the error message "Tx frequency unlock" appears.
  2. Telex communication errors; NBDP terminal DP-5 cannot receive message completely, or connection is broken.

- The factory settings of the system channels were changed as follows.

System CH	Function	Factory Setting
9947	Squelch in telex mode	1 (OFF)
9948	Noise blanker in telex mode	1 (OFF)
9949	AGC in telex mode	1 (FAST)
9965	Scan response time	1 (FAST)

Program number

PROM0550131115

Note for replacement of ROM in the field

After replacing the ROM, display the system channels and set them as shown in above table.
setting procedure (key operation)

[STO] [9] [9] [ ] [ ] [ENT] [ ] [ENT]

system channel　　setting

Factory modification

From the production in July 1993.

Remarks

The ROM program version number of the DP-5 is now 2.00. (It eliminates Telex Communication problems.)
We recommend that the DP-5 having new ROM (ver. 2.00) be used with FS-5000 series.

FURUNO

Information

No. : FQ5-94-002

Date : 1994 - 02

Issued by: FURUNO ELECTRIC CO., LTD.
TECHNICAL DOCUMENTATION SECTION

Addenda No. 31 to FS-5000
Service Manual SM-E5519

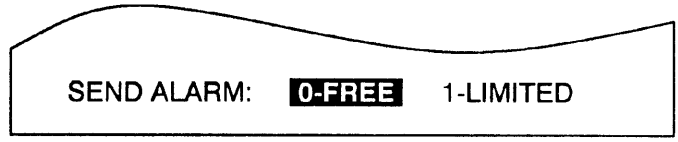
Addenda No. 8 to FS-8000
Service Manual SM-E5521

FS-5000/8000
ROM Program Changes (Ver. 17)

Changes made to ROM program

System setting 9966 is added so as to determine whether the transmission of two-tone alarm is restricted or not.

Procedure: **[STO]** → **9966** → **[ENT]**



In accordance with both the above setting and system setting 9953 (Operation on AM mode), the transmission of two-tone alarm on AM mode is as follows:

System setting 9966 Setting No.	System setting 9953 Setting No.	TX of two-tone alarm on AM mode
0 (FREE) (Factory setting)	0 (TX/RX)	Possible on all frequencies.
	1 (RX only)	
	2 (No)	Disabled
	3 (2182)	Possible on all frequencies.
1 (LIMITED)	0 (TX/RX)	Possible on all frequencies.
	1 (RX only)	Disabled
	2 (No)	
	3 (2182)	Possible on 2182 kHz only.

⑤

Program number	PROM 0550131117
Code number	005-927-440
Factory modification	From the production in Feb. 1994
Remarks	The version no. of the ROM on the COUPLER board in the antenna coupler will be changed from 03 to 05 in April 1994 (Minor change). However, ROM version no. 3 remains compatible with the transceiver unit having ROM version no. 17.

FURUNO

Information

No. : FQ5-2000-013
Date: 2000-06

Issued by: FURUNO ELECTRIC CO., LTD
SERVICE MANAGEMENT & COMMANDING DEPARTMENT

APPROVED BY
WRITTEN BY

Addenda No.32 to FS-5000 Service Manual SM-E5519
Addenda No.9 to FS-8000 Service Manual SM-E5521

FS-5000/8000
New Software (V. 21)

The Convention and the International Regulations were changed and H3E 2182 kHz watch receiver need not be fitted on board a ship after full implementation of GMDSS. Now 2182 kHz is transmitted only on J3E.

According to this change, the software for the FS-5000 was changed as follows.

New software: 05-501-31-121

Factory-modified sets
FS-5000 (Control Unit): 2508-1979 and after
FS-5000T: 3423 and after
FS-8000: From the next production

Changes to be made

1) System channel 9904 (Emission mode on 2182 kHz): "2:J3E FIX" is added.
2) System channel 9923 (Dummy): Default is changed to 1: Prohibited.
3) System channel 9953 (AM operation): Default is changed to 0: TX/RX for Japan and 1: RX for other countries.
4) System channel 9966 (Two-tone alarm TX): "2: TX prohibited" is added. Default is 0: Free for all countries. If "2: TX prohibited" is selected, regardless of 9953 setting, two-tone alarm is not emitted.
5) Two-tone alarm test with dummy load functions as follows.
   With system channel 9911 set to 1: TX, emission mode depends on the setting on 9904, and output power is Full on H3E and Low-1 on J3E.
6) GGA (NMEA sentence) is receivable.
7) With 9937 to 9939 (emission mode of TX for REMOTE) set to other than 0: No change, every time after transmission on an ITU channel by the TX KEY, tuning is made. This problem is solved.
8) With 9937 to 9939 (emission mode of TX for REMOTE) set to 1: AM, TX cannot be stopped by setting TX KEY to OFF if 9953 is set to other than 1. This problem is solved.
9) RX self-test (9914) sometimes ends with NG if AGC is set to SLOW in CW and AM modes. This problem is solved.
10) With system channel 9949 set to 1: FAST, AGC remains FAST when the mode is changed from TELEX to SSB. This problem is solved.
11) Default of MF power data (FS-2500) is changed to 200 and its upper limit to 255.

⑤
SSB

CONTENTS

Page

SPECIFICATIONS OF FS-8000 SSB RADIOTELEPHONE

GENERAL

1) Communication System	Full duplex, semi-duplex or simplex (duplex operation requires receiving antenna)
2) Class of Emission	J3E, (USB, LSB), H3E, R3E, A1A, F1B (J2B), J3C
3) Frequency Range	1.6 MHz to 30 MHz
4) Number of Channels	Preset (User): 400 TX/RX pairs All ITU channels incorporated (Incl. DSC channels)
5) Frequency Accuracy	± 10Hz (-20°C to +50°C)
6) Ambient Temperature Range	-20°C to 55°C
7) Power Supply	24/32 VDC +30%, -10% Consumption at 24 VDC Receive ---------- 3A Transmit (SSB) ---- Peak 120A 100/110/120/200/220/240 VAC, 1ø, 50/60 Hz, 4.8 kVA (by two Rectifier Units PR-850, optional supply)
8) Coating Color	Control Unit front panel: Munsell N-3.0 Transceiver Unit: 2.5GY5/1.5 Antenna Coupler: White

TRANSMITTER

1) Frequency Range

1.6065 MHz to 29.9999 MHz
(100 Hz steps)

2) RF Output Power

800 W pep +0/-1.4 dB (1.6 - 25.5 MHz)
at 50 ohm load (400 W pep --- below 4 MHz)
(@ 24 VDC, IEC rec.)

3) Modulation AF Response

350 Hz to 2700 Hz

4) Keying Speed

CW: 25 bauds TELEX: 100 bauds

5) AF Input

-46 dBm/600 ohms

6) Tone Frequency

1500 Hz

7) Accessories

Two-tone alarm generator

RECEIVER

1) Receiving System

Double conversion superheterodyne
IF: 45455 kHz and 455 kHz

2) Frequency Range

10 kHz to 29.9999 MHz
(10 Hz steps)

3) Sensitivity

Input level at 50 ohms to produce
SINAD 20 dB

Frequency Range	SSB	AM
100 kHz to 300 kHz	25 dBμV	39 dBμV
300 kHz to 1.6 MHz	15 dBμV	29 dBμV
1.6 MHz to 30 MHz	3 dBμV	17 dBμV

4) Intermodulation

90 dBμV (CEPT method test)

5) Cross Modulation

94 dBμV (CEPT method test)

6) Selectivity

J3E/R3E: 350 to 2700 Hz
H3E: ±3 kHz
A1A/F1B: ±150 Hz

7) AF Output Power

Internal speaker: 2 W/8 ohms
External speaker: 4 W/4 ohms
Handset: 10 mW/200 ohms

8) Standard Features

Scan, Sweep, Noise Blanker, Voice-activated Squelch, Preselector (for MF)

ANTENNA COUPLER

1) Tuning System	CPU controlled manual tuning possible for 2182 kHz
2) Frequency Range	1.6 MHz to 30 MHz
3) Input Impedance	50 ohms
4) Required Antenna	7 to 18 meter wire and/or whip
5) Tuning Power	10 W
6) VSWR	1.5 max.
7) Tuning Speed	0.2 to 2 sec. typical. 15 sec. max.
8) SOLAS Dummy Load	Internal (10 ohms +250 pF, 200W average), optional supply
9) Antenna BK Relay	Internal, optional supply
10) Ambient Temperature Range	-30°C to +70°C
11) Relative Humidity	95% @ 35°C

MISCELLANEOUS FUNCTIONS

1) Ship's L/L Position display (inputs for CIF/NMEA format sentences)
2) Timer
3) Digital Selective Calling (DSC) & Narrow Band Direct Printing (NBDP) possible
4) Intership FAX connection possible
5) Remote station (RB-500) connection possible

COMPASS SAFE DISTANCE

Unit	Standard Compass	Steering Compass
Control Unit	0.9	0.7
Transceiver Unit	2.3	1.8
Antenna Coupler	1.0	0.7
Rectifier Unit	1.5	1.2

(dimensions in meters)

CHAPTER 1 BLOCK DESCRIPTION

1. GENERAL

As shown in the block diagram on the next page, the FS-8000 consists mainly of a Control Unit, a Transceiver Unit and an Antenna Coupler, and operates from 24/32VDC mains. For AC mains, two rectifier units (PR-850) are required.

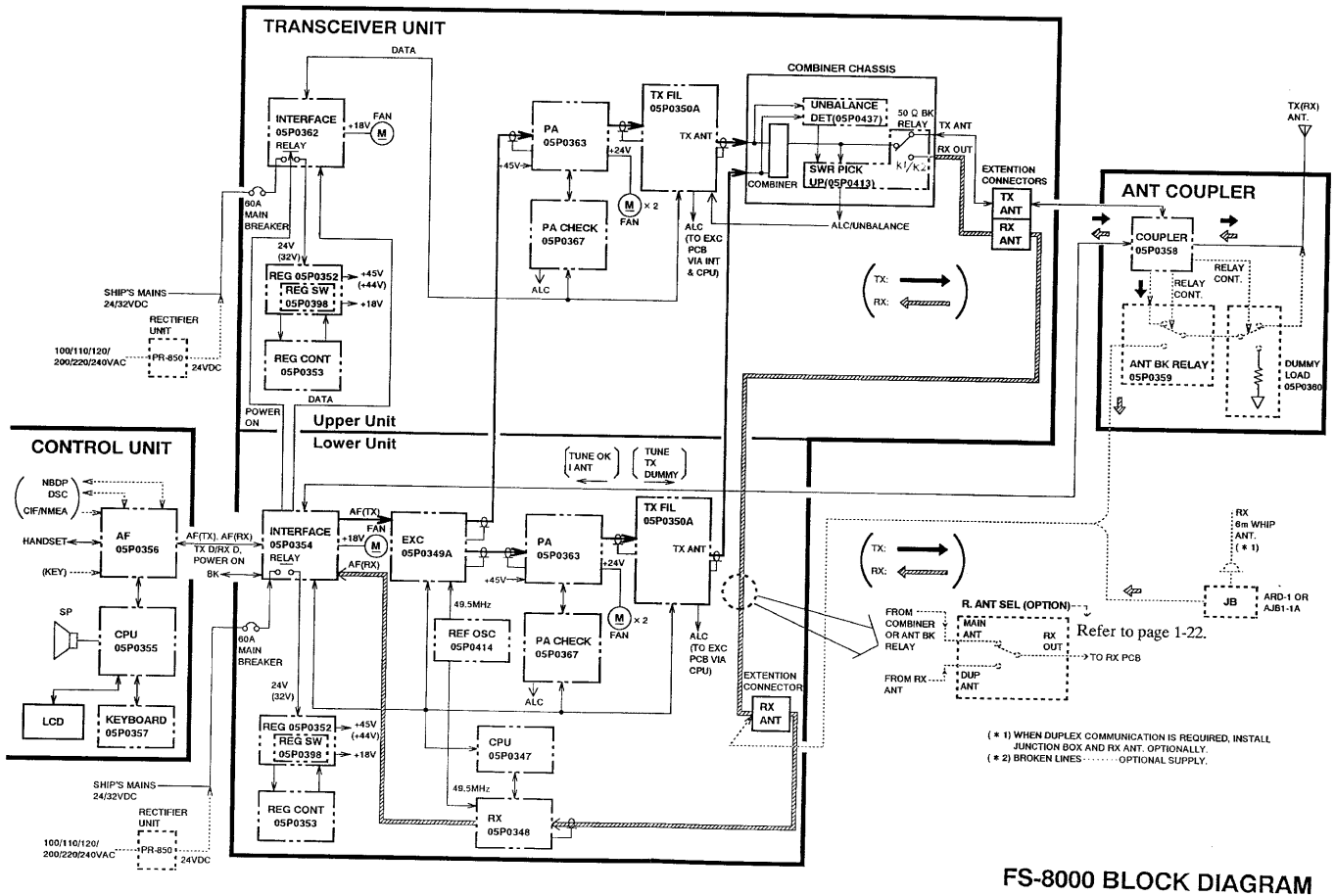
The transceiver unit consists of the lower and upper units. The function of the lower unit is basically the same as the transceiver unit of the FS-5000. The upper unit is composed of the power supply block, power amplifier and power combiner where 400Wpep power produced in the lower unit and 400Wpep power produced in the power amplifier in the upper unit are added.

MIC signal amplified thru the AF board is converted to SSB signal in the EXC board in the lower unit. SSB signal is fed to two PA boards to be amplified up to 400Wpep each. 800Wpep output power from the combiner chassis is then fed to the COUPLER board in the antenna coupler, to make impedance matching (automatic tuning) between the transceiver unit and antenna.

RF signal received by the antenna passes through the COUPLER board (tuned for TX frequency) and 50 ohm BK relays in the combiner chassis, and then is fed to the RX board in the lower unit which converts it to AF signal. The AF signal is amplified in the AF board up to the level high enough to drive the speaker. If the ANT BK RELAY board (optional) is mounted in the antenna coupler or a speciality receiving antenna is installed, the RF signal is directly applied to the RX board. (Signal does not pass thru the COUPLER board.) If the R. ANT SEL board is optionally installed in the lower unit, the duplex antenna can be used only when duplex function is on. That means the main antenna (normal antenna) is used for both transmission and reception if communication mode other than duplex is selected. For further details, refer to page 1-22.

Data communication between the CPU boards in the control and transceiver units is executed thru the AF board and INTERFACE board in the lower unit. And data communication between the CPU board in the transceiver unit and the CPU in the COUPLER board is done thru the INTERFACE board in the lower unit.

Two ship's mains of 24VDC (or 32VDC) are applied to two REG boards in the transceiver unit (lower and upper units) via the INTERFACE boards to produce +18V and +45V (or +44V) for the PA boards.



FS-8000 BLOCK DIAGRAM

2. FUNCTION OF EACH BOARD

Unit	Board Name	Major Function
Control Unit	AF (05P0356)	• Amplification of AF and MIC signals (– 46dBm → 0dBm). • Squelch control • Interface with combined equipment (REM 1 to 3). • Driving loudspeaker.
	CPU (05P0355)	• Data communications with keyboard and Transceiver Unit. • Control of wake-up timer, LCD contrast and keyboard dimmer. • Storing power data & user channel data in E^2PROM.
Transceiver Unit	EXC (05P0349A)	• Power control (by ALC voltage & power data). • Conversion of TX signal from AF to RF. • Control of synthesizer circuit (PLL).
	PA (05P0363, 2pcs.)	• Power Amplification (30dB approx.). • Detection of high temp. (≥ 90°C) & excessive collector current (≥24.5A), for power reduction.
	PA CHECK (05P0367, 2pcs.)	• Indication of Ic, Vc and Vs (ship's mains). • Overcurrent protection (Max.21A)
	TX FIL (2pcs.) (05P0350A)	• SWR detection for power reduction. • Detection of ALC peak voltage.
	RX (05P0348)	• RF amplification. • AGC & NB controls. • Conversion of RX signal from RF to AF. • Control of synthesizer circuit (PLL).
	REF OSC (05P0414)	• Reference oscillation of 49.5MHz for EXC/RX boards.
	CPU (05P0347)	• Data communications with Control Unit and Antenna Coupler. • Read-in check signals (check meter data & self check data) from each board.
	INTERFACE (05P0354)	• Starter of power supply for both lower/upper units. • Interface among control, antenna, lower and upper units.
	REG/REG SW/ REG CONT (2pcs. each)	• Producing +18V and +45V (or +44V).
	INTERFACE (05P0362)	• Interface between lower and upper units.
	COMBINER CHASSIS	• Detection of unbalanced power & SWR. • Power combination (800Wpep in total)
Antenna Coupler	COUPLER (05P0358)	• Automatic tuning (by detecting SWR, antenna current and phase of antenna).

3. TX SIGNAL

Refer to the block diagram on the next page.

MIC signal of – 46dBm/600 ohms is amplified up to 0dBm by U2 to U4 on the AF board, and sent to the EXC board to produce SSB signal. If the input signal level at TP1 on the EXC board exceeds a threshold level, CR1 (AF) lights. The AF signal is mixed with the 1st local oscillation frequency at U15 and passes through filter FL1 (SSB) or FL2 (telex). R13/R14/R15 function to adjust the carrier injection level for A1A/H3E/R3E, respectively.

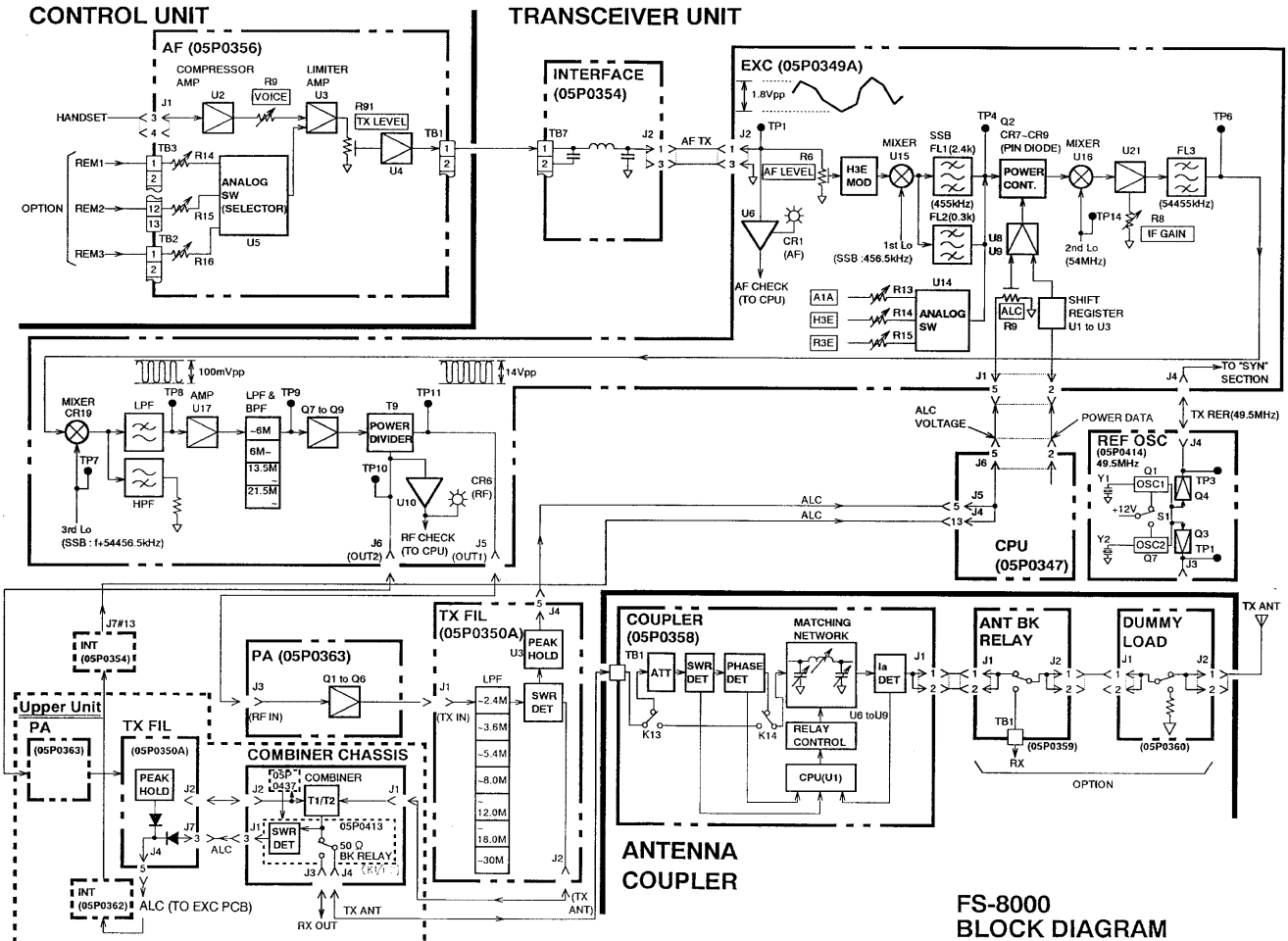
The power control circuit composed of PIN diodes (CR7 to CR9) is on the EXC board. Both the ALC (Automatic Level Control) voltage picked up by the TX FIL boards (both lower and upper units) and the power data read out from the CPU board control the output power of the transceiver unit by changing the resistance of PIN diodes according to the voltage at U9 output. ALC pot (R9) is adjusted so that the output power of the transceiver unit is limited to 800Wpep.

After the signal is mixed with the 3rd local oscillation frequency at CR19, it passes through a diplexer made up of a LPF and a HPF to reduce harmonic frequencies with minimum power loss. The amplified signal thru Q7 to Q9 is divided into two lines ("out 1" & "out 2" terminals). The "out 1" terminal is connected to the PA board in the lower unit and the "out2" terminal is for the upper unit. 14Vpp approx. is obtained at TP11.

The PA boards (both lower and upper units) amplify the signal by 30dB approx. each. The signals from the PA boards are fed to the TX FIL boards, composed of filters, and are sent to the combiner chassis in the upper unit to produce 800Wpep output power at the transceiver unit. When the output power exceeds 800Wpep, the ALC circuit in the combiner chassis is on, causing the output power to be kept constant thru the power control circuit on the EXC board. If the transmission line of either the lower unit or upper unit is defective, the unbalance detection circuit in the combiner chassis turns on, resulting in the output power of 0W. It protects the parts on the combiner chassis from being damaged.

The COUPLER board has a CPU which keeps a close watch on SWR, antenna current (Ia) and antenna phase. The CPU drives the relays which select optimum L-C combination so that SWR gets below 2.0 and Ia is maximum. If the best tuning point is not detected, "Tuning error" indication appears and the RF output signal bypasses the matching network.(All coils: short, capacitors: off)

For the sets produced in Dec. 1992 and after, overcurrent protection circuit is added to the PA CHECK board. It protects collector current (Ic) of the power amplifiers from exceeding 21A through the ALC circuit on the EXC board.


CONTROL UNIT
TRANSCEIVER UNIT
AF (05P0356)
COMPRESSOR AMP
LIMITER AMP
VOICE
TX LEVEL
HANDSET
OPTION
REM1
REM2
REM3
ANALOG SW (SELECTOR)
INTERFACE (05P0354)
EXC (05P0349A)
1.8Vpp
AF TX
AF LEVEL
H3E MOD
MIXER U15
SSB FL1(2.4k)
(455kHz)
FL2(0.3k)
1st Lo (SSB :456.5kHz)
POWER CONT.
Q2 CR7~CR9 (PIN DIODE)
MIXER U16
2nd Lo (54MHz)
U21
FL3
(54455kHz)
IF GAIN
AF CHECK (TO CPU)
CR1 (AF)
A1A
H3E
R3E
ANALOG SW
SHIFT REGISTER U1 to U3
TO "SYN" SECTION
100mVpp
14Vpp
MIXER CR19
LPF
HPF
AMP U17
LPF & BPF
-6M
6M-
13.5M
21.5M
Q7 to Q9
POWER DIVIDER
3rd Lo (SSB : f+54456.5kHz)
RF CHECK (TO CPU)
CR6 (RF)
(OUT2)
(OUT1)
ALC VOLTAGE
POWER DATA
TX RER(49.5MHz)
REF OSC (05P0414) 49.5MHz
CPU (05P0347)
ALC
TX FIL (05P0350A)
PEAK HOLD
SWR DET
PA (05P0363)
Q1 to Q6
(RF IN)
(TX IN)
Upper Unit
COMBINER CHASSIS
COMBINER
T1/T2
50 Ω BK RELAY
INT (05P0354)
INT (05P0362)
ALC (TO EXC PCB)
RX OUT
TX ANT
COUPLER (05P0358)
MATCHING NETWORK
ATT
SWR DET
PHASE DET
Ia DET
RELAY CONTROL
CPU(U1)
ANT BK RELAY
(05P0359)
DUMMY LOAD
(05P0360)
RX
OPTION
ANTENNA COUPLER
FS-8000
BLOCK DIAGRAM
OF TRANSMITTER

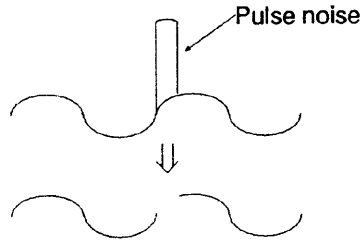
4. RX SIGNAL

Refer to the block diagram on page 1-8. Unless a speciality receiving antenna or ANT BK RELAY board is connected, the RF signal passes through the matching network of the COUPLER board which is tuned to the TX frequency (if the difference between TX freq. and RX freq. is large, some of the received signal may be lost in the matching network), and is applied to the RX board through 50 ohm BK relays in the combiner chassis. If the ANT BK RELAY board or the receiving antenna is installed, the RF signal is directly applied to the RX board via 50 ohm BK relays (in this case, signal is not attenuated by the matching network).

Relay K13 turns on if the [ON] key is pressed when the frequency is below 4.5MHz. When K13 turns on, the coils which form a preselector circuit are relay-controlled to tune the receiver to the antenna (for cancellation of capacitance components of antenna).

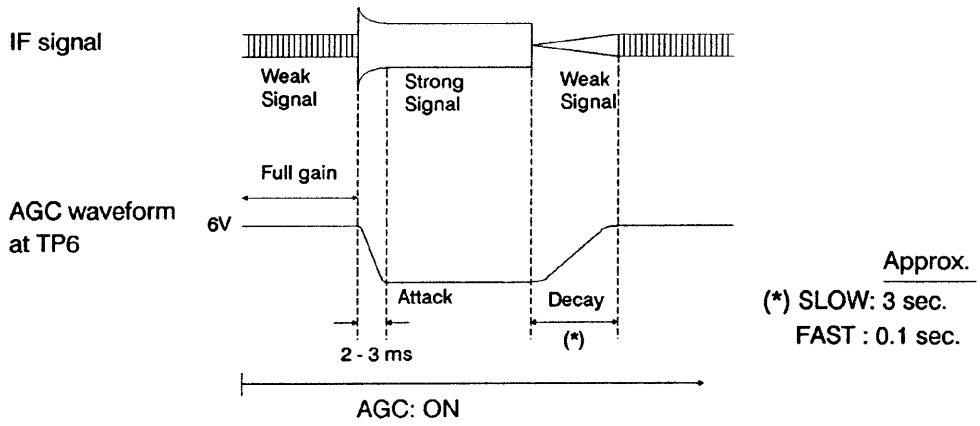
When the preselector is off, the RF signal passes through the 30MHz low-pass filter, and is applied to the band-pass filter or duplex filter (for duplex operation) depending on the key command selected.

The second IF signal is fed to the noise blanker (NB) circuit. When the [NB] key is pressed, the NB detector (U3) becomes conductive and detects pulse noise, whose threshold level is controlled by R76. Since the NB gate consisting of CR31 and CR32 turns off during "pulse noise " period, the noise can not pass thru the gate.



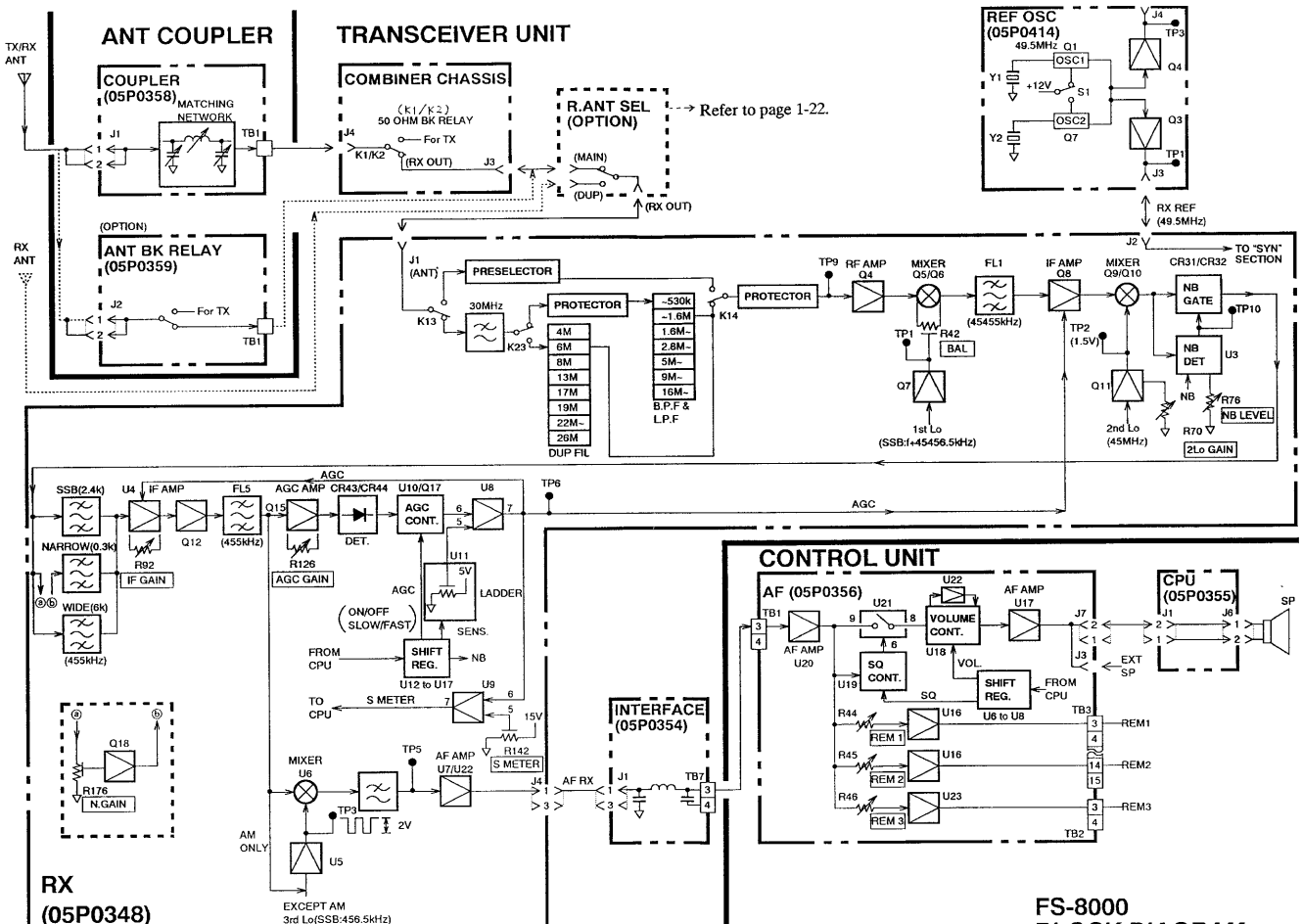
The 455kHz IF signal is amplified by U4 and divided into two lines; one is for the AGC circuit (composed of Q15, CR43/CR44, Q17, U8 to U10), the other for audio output. The IF signal amplified by Q15 is detected by CR43/CR44. When AGC is turned off through the keyboard, the IF signal does not pass through the AGC circuit, causing the voltage at TP6 (output of differential amplifier U8) to vary depending on the sensitivity setting (pin #5 of U8), selected through the keyboard (2V to 6V approx.). When AGC is on, the voltage at TP6 changes according to the IF signal level as well as the sensitivity setting. The output of U8 is applied to IF amplifiers Q8/U4 and differential amplifier U9 for the S meter indication. The voltage at pin #5 of U9 is adjusted for 6V approx. by R142 (S METER) at the factory.

The R. ANT SEL board is optionally supplied to avoid to attenuate the receiving signal on modes other than duplex. Refer to page 1-22 for further details.



The IF signal is mixed with the 3rd local oscillator frequency to convert it to the AF signal. The AF signal from the transceiver unit is amplified by U20 on the AF board and applied to the SQ (squelch) circuit composed of U19/U21. When the SQ circuit is turned on through the keyboard, U19 functions so that voice signal, of which the frequency is lower than 1kHz (60ms or more consecutively), passes thru U21 and noise consisting of frequency higher than 1kHz (1.3 sec or more consecutively) does not pass.

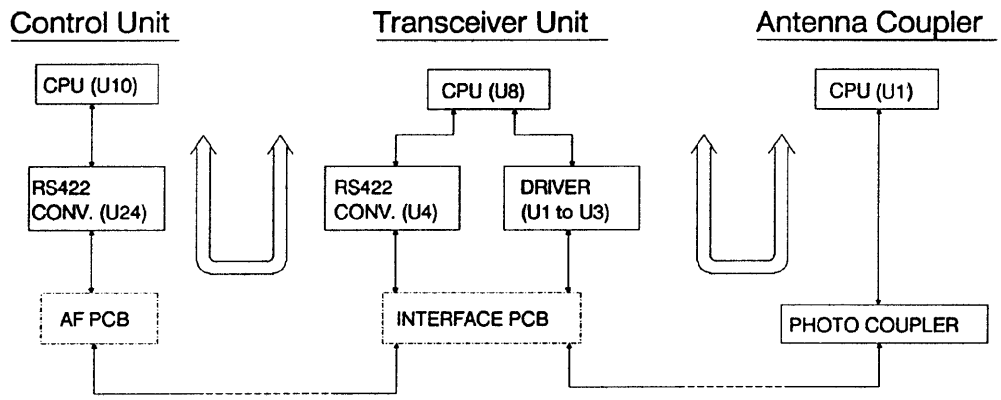
R44 thru R46 serve to adjust the line out level for peripheral equipment such as NBDP, DSC terminal, selcall, etc.


ANT COUPLER
TRANSCEIVER UNIT
TX/RX ANT
COUPLER (05P0358)
MATCHING NETWORK
COMBINER CHASSIS
(K1/K2) 50 OHM BK RELAY
For TX
(RX OUT)
R.ANT SEL (OPTION)
(MAIN)
(DUP)
(RX OUT)
→ Refer to page 1-22.
REF OSC (05P0414)
49.5MHz
OSC1
OSC2
+12V
RX REF (49.5MHz)
TO "SYN" SECTION
RX ANT
(OPTION)
ANT BK RELAY (05P0359)
PRESELECTOR
PROTECTOR
30MHz
4M
6M
8M
13M
17M
19M
22M~
26M
DUP FIL
~530k
~1.6M
1.6M~
2.8M~
5M~
9M~
16M~
B.P.F & L.P.F
RF AMP Q4
MIXER Q5/Q6
FL1
(45455kHz)
IF AMP Q8
MIXER Q9/Q10
CR31/CR32
NB GATE
NB DET
NB LEVEL
BAL
1st Lo (SSB:f+45456.5kHz)
2nd Lo (45MHz)
2Lo GAIN
AGC
SSB(2.4k)
NARROW(0.3k)
WIDE(6k)
IF AMP
FL5
(455kHz)
AGC AMP
CR43/CR44
DET.
U10/Q17
AGC CONT.
IF GAIN
AGC GAIN
LADDER
SENS.
ON/OFF SLOW/FAST
SHIFT REG.
U12 to U17
FROM CPU
TO CPU
S METER
NB
R142
N.GAIN
MIXER U6
AF AMP U7/U22
AM ONLY
EXCEPT AM 3rd Lo(SSB:456.5kHz)
INTERFACE (05P0354)
AF RX
RX (05P0348)
CONTROL UNIT
AF (05P0356)
AF AMP U20
AF AMP U17
VOLUME CONT.
SQ CONT.
SHIFT REG.
U6 to U8
REM1
REM2
REM3
CPU (05P0355)
SP
EXT SP
FS-8000
BLOCK DIAGRAM
OF RECEIVER

5. SYSTEM CONTROL

5.1 CPU's Data Communications

The figure below and the block diagram on page 1-11 show CPU's data communications among three units.



5.2 CPU Board in the Control Unit

The CPU (U10) in the Control Unit controls the following:

1 Command from/to keyboard

2 IRQ (Interrupt Request) command (U16)

3 LCD driver (U14)

4 LCD contrast & keyboard dimmer

5 Input of CIF/NMEA data & Input/output of REM1 to REM3 data

E^2PROM U1 memorizes the power data and user channel data entered through the keyboard. ROM U9 memorizes all the ITU/DSC frequency data.

When the present time agrees with the wake-up time set by operator, the $\overline{\text{ALARM}}$ signal is produced in the RTC (Real Time Control, U11) to activate U20, causing the power supply circuit in the transceiver unit (lower unit) to turn on.

The CPU (U10) transfers the frequency, class of emission and bandwidth data to the CPU of the transceiver unit and receives the check data, such as data for check meter and results of self-check. CR1 blinks when the CPU is operating properly.

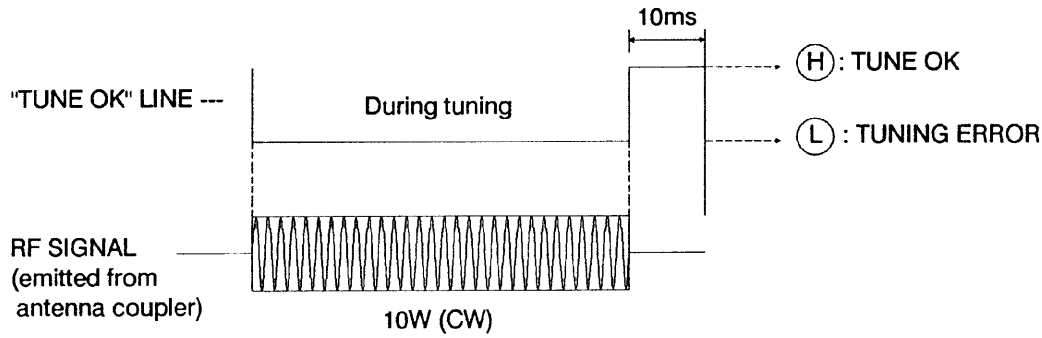
5.3 CPU Board in the Transceiver Unit

Data transfer and reception in the CPU (U8) in the Transceiver Unit are executed via drivers U1 to U3 and AD converter U5, respectively. The serial data produced by the CPU is converted into parallel data by the shift registers on each board in the Transceiver Unit.

The CPU sends the "TUNE", "TX" and "DUMMY" commands to the antenna coupler and receives "TUNE OK" command and antenna current data from the coupler.

5.4 COUPLER Board in the Antenna Coupler

When the CPU (U1) in the COUPLER board acknowledges the "TUNE" command from the transceiver unit, it begins driving the relays whose function is to select the components of the matching network for best tuning by checking the SWR and antenna current. For instance, the relays are activated so that the SWR value becomes the lowest (< 2.0) and antenna current becomes maximum. If the best tuning point is detected, the "TUNE OK" command is outputted from the CPU to the transceiver unit, since "TUNE OK" line level goes high 10ms after tuning is completed. If it is not detected, the "TUNING ERROR" command is outputted because "TUNE OK" line level goes low. The TX signal is divided by counter U4 and fed to RAM in the CPU as a address data for automatic tuning. The relay status data for the best tuning is stored in EE-PROM U2. For details of the automatic tuning circuit, refer to page 1-12.



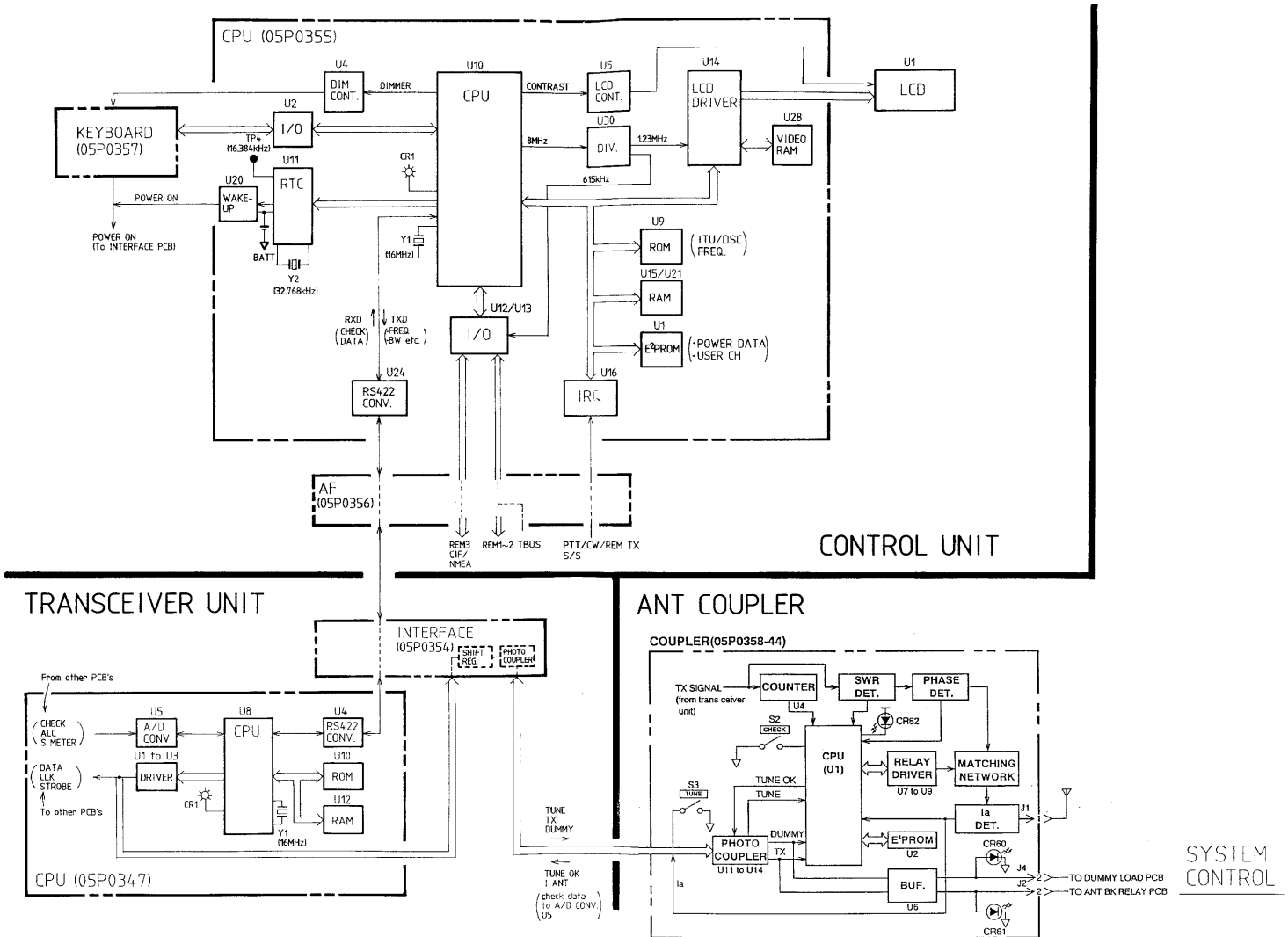
For automatic tuning without keyboard operation press the [TUNE] button (S3) on the COUPLER board.

To check the Antenna Coupler for proper operation, press the [CHECK] button (S2) on the COUPLER board. The relays start chattering and LEDs CR1 to CR24 blink one by one in ascending order. If device failure is found, an appropriate LED lights to indicate the offending device:

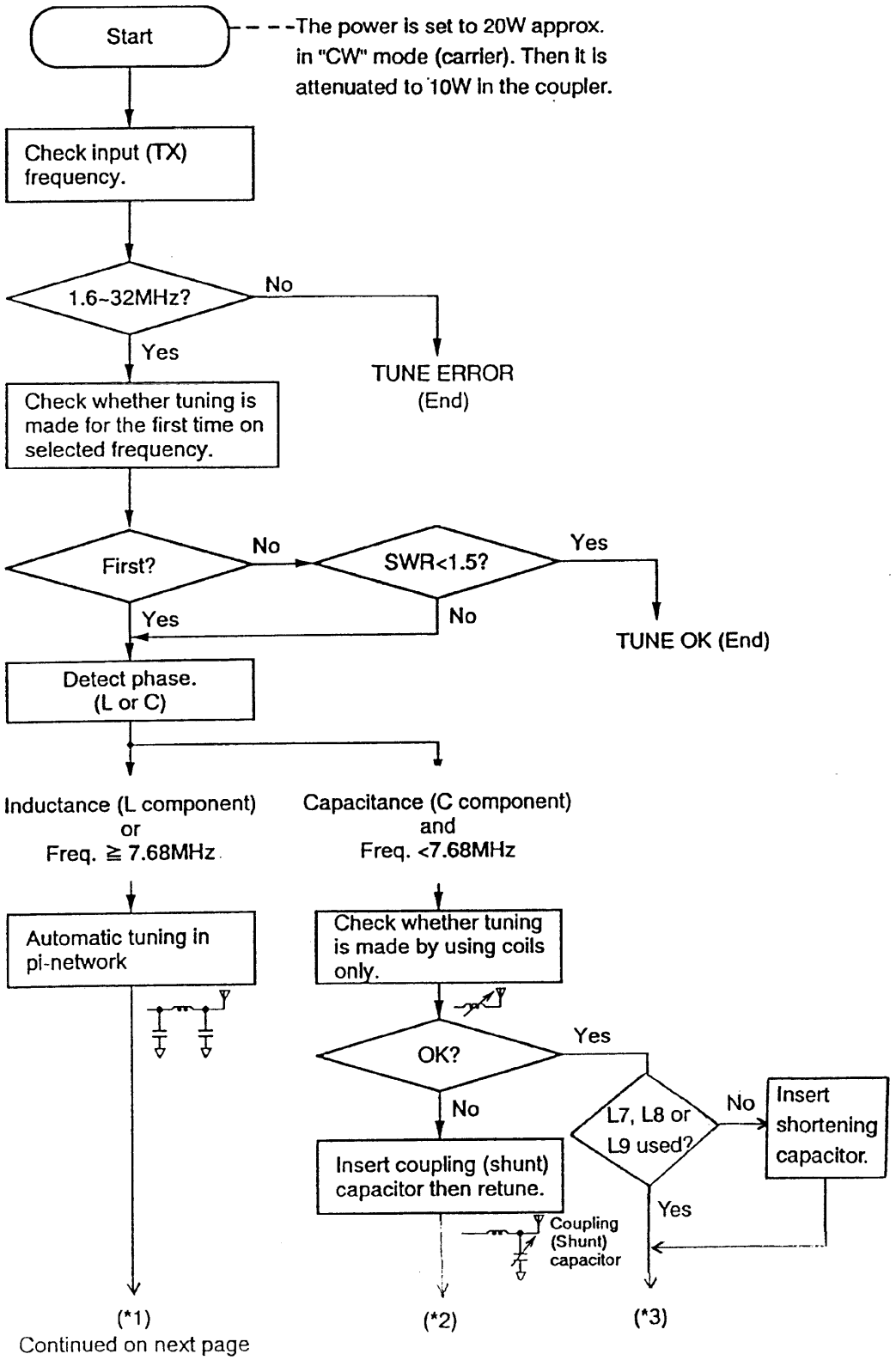
Device	LED
ROM	CR1
RAM	CR2
A/D Converter or SWR Detector	CR3

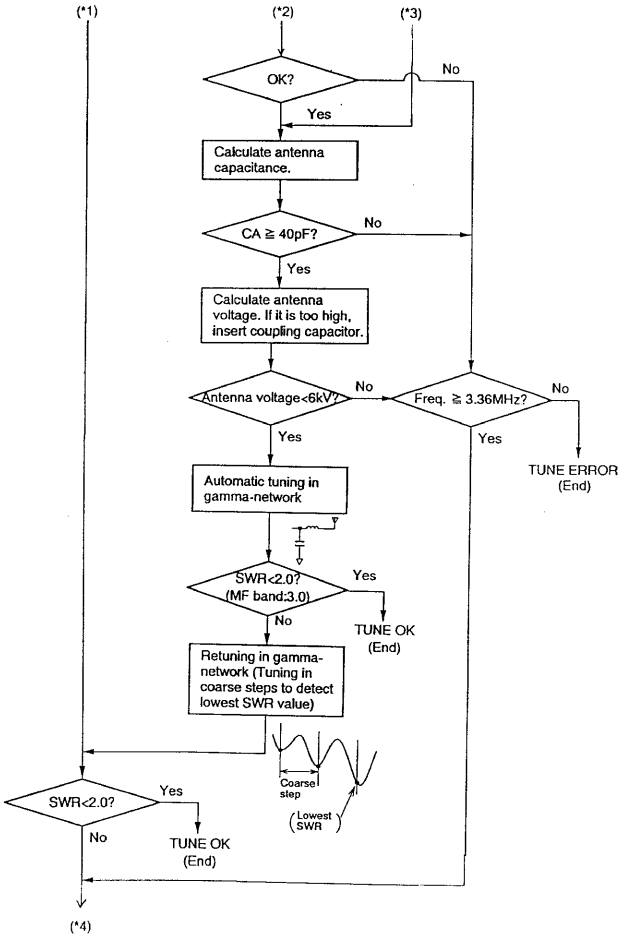
Note 1. ROM/RAM/A/D converter are incorporated in the CPU.

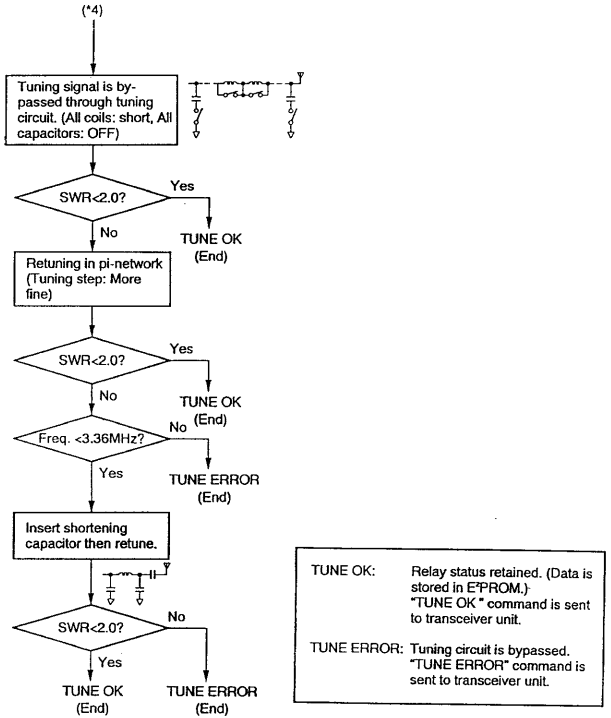
Note2. After completion of the test, tuning circuit (matching network) is bypassed. (All coils: short, capacitors: off)


CPU (05P0355)
U4
DIM CONT.
DIMMER
U10
CPU
CONTRAST
U5
LCD CONT.
U14
LCD DRIVER
U1
LCD
KEYBOARD (05P0357)
U2
I/O
TP4 (16.384kHz)
U30
DIV.
8MHz
12.3MHz
U28
VIDEO RAM
CR1
615kHz
U11
RTC
U20
WAKE-UP
POWER ON
POWER ON (To INTERFACE PCB)
BATT
Y2 (32.768kHz)
Y1 (16MHz)
U9
ROM
(ITU/DSC FREQ.
U15/U21
RAM
U12/U13
I/O
U1
E²PROM
(-POWER DATA
-USER CH
RXD (CHECK) (DATA)
TXD (FREQ +BW etc.)
U24
RS422 CONV.
U16
IRC
AF (05P0356)
REM3 CIF/ NMEA
REM1~2 TBUS
PTT/CW/REM TX S/S
CONTROL UNIT
TRANSCEIVER UNIT
INTERFACE (05P0354)
SHIFT REG.
PHOTO COUPLER
From other PCB's
(CHECK ALC S METER)
(DATA CLK STROBE)
To other PCB's
U5
A/D CONV.
U1 to U3
DRIVER
U8
CPU
U4
RS422 CONV.
U10
ROM
U12
RAM
CR1
Y1 (16MHz)
CPU (05P0347)
TUNE TX DUMMY
TUNE OK I ANT
(check data to A/D CONV. U5)
ANT COUPLER
COUPLER(05P0358-44)
TX SIGNAL (from trans ceiver unit)
COUNTER
U4
SWR DET.
PHASE DET.
S2
CHECK
CR62
CPU (U1)
RELAY DRIVER
U7 to U9
MATCHING NETWORK
S3
TUNE
TUNE OK
TUNE
Ia DET.
J1
DUMMY
TX
PHOTO COUPLER
U11 to U14
E²PROM
U2
CR60
J4
J3
TO DUMMY LOAD PCB
TO ANT BK RELAY PCB
Ia
BUF.
U6
CR61
SYSTEM CONTROL

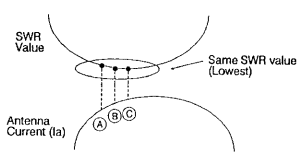
6. AUTOMATIC TUNING CIRCUIT







- The best tuning point is searched for observing SWR value; that is, best tuning point is where the SWR is the lowest. If three SWR values are the same (see below), the tuning data at the point Ⓒ, where Ia value is the largest among them, is used.



7. AUTOMATIC POWER REDUCTION

Power is automatically reduced in the following instances:

1. Excessive collector current (≥ 24.5A)
2. High temperature at power amplifiers (≥90 °C)
3. High SWR value

The following shows the operation of the power reduction circuit in the lower unit.

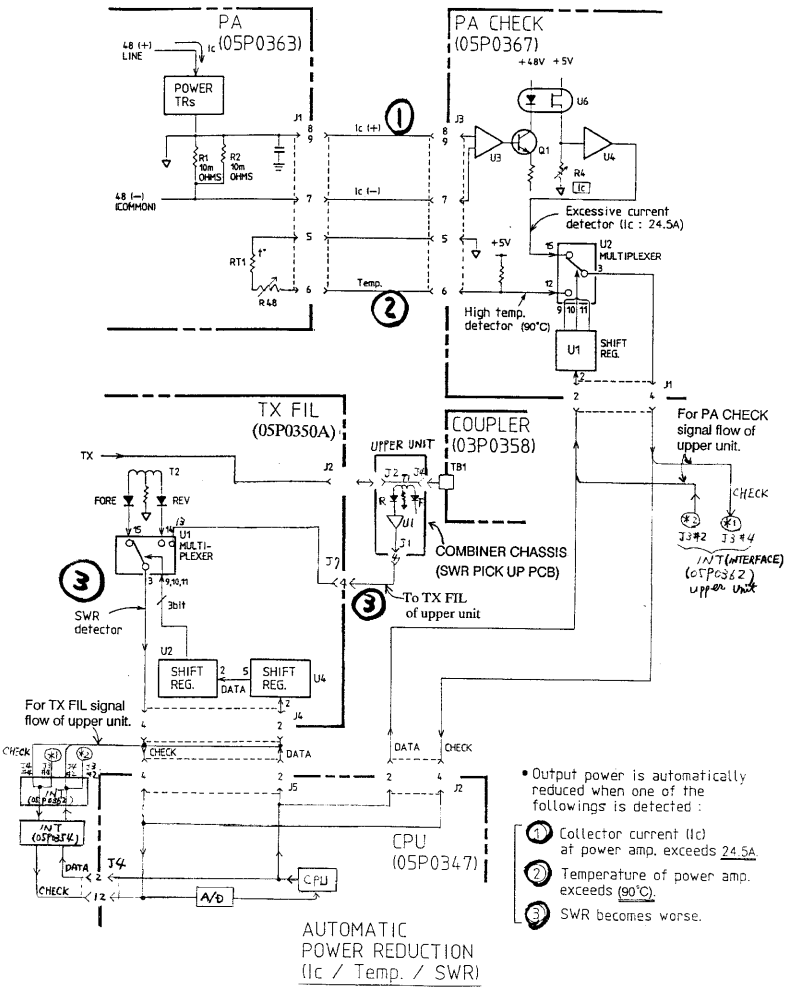
1. The collector current (Ic) detected by R1/R2 on the PA board is amplified in U3 on the PA CHECK board and passed through the multiplexer (U2), then fed to the CPU board for AD conversion. If Ic exceeds 24.5A (adjusted by R4 on the PA CHECK board at the factory), the CPU reduces the value of the "power data" for the exciter power control circuit.

2. Posistor RT1 on the PA board detects the temperature of the power amplifiers. When the temperature exceeds 90°C, the CPU reduces the value of the "power data". R48 on the PA board is adjusted at the factory so that the temperature indication on the LCD is the same value as the temperature of the power amplifiers (heat sink).

3. The forward and reverse current are picked up by T2 on the TX FIL board and fed to the CPU board via the multiplexer (U1) to calculate the SWR value. If the CPU acknowledges the SWR value as too high, the "power data" is reduced.

Note 1: The operation of the power reduction circuit in the upper unit is basically the same as that in the lower unit except that the check data from the PA CHECK & TX FIL boards are fed to the CPU board via two INTERFACE boards as shown in the right.

Note 2: The TX FIL board in the upper unit receives the reverse current data (SWR data) picked up by T1 on the SWR PICK UP board in the combiner chassis. Then, the SWR data is sent to the CPU board thru two INTERFACE boards.



8. SYNTHESIZER CIRCUIT

This equipment incorporates two synthesizer circuits: one is a TX synthesizer on the EXC board and the other a RX synthesizer on the RX board.

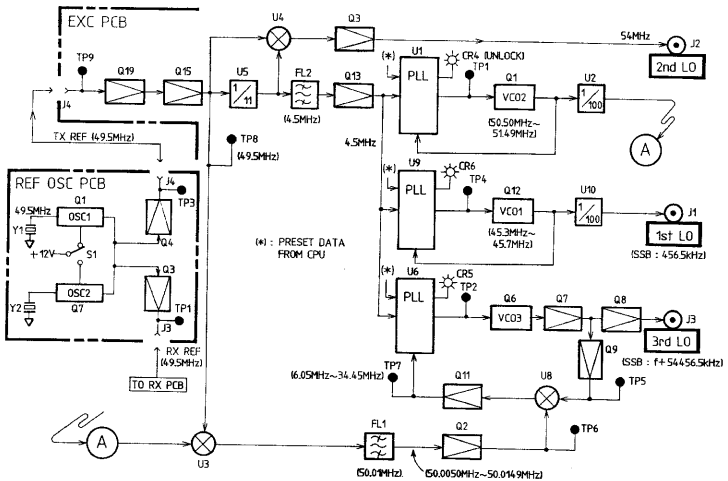
8.1 TX Synthesizer (EXC board)

Either of two crystals Y1 and Y2 which oscillate on 49.5MHz on the REF OSC board are selected with slide switch S1. The 49.5MHz amplified thru Q3 on the REF OSC board is fed to J3 to be used as a reference signal of the RX synthesizer on the RX board.

Three PLL circuits are employed. The reference frequency for the PLL circuits is 4.5MHz which is obtained by dividing the 49.5MHz signal. The PLL circuit (VC02) composed of U1 and Q1 controls the lower two digits of the transmission frequency (that means the output frequency of VC02 is changed depending on the value of the lower two digits of the transmission frequency), and then mixed with the other PLL circuit (VC03) composed of U6 and Q6 which controls the upper four digits, resulting in the generation of the 3rd local oscillation frequency.

The table below shows the output frequencies of each local oscillation.

	Output Frequency (kHz)					Test Point	LED (lit in unlock)	Remarks
	USB H3E	LSB	F1B	A1A	FAX			
1st Lo	456.5	453.5	456.7	455	456.9	J1	CR6	VCO1
2nd Lo	54MHz					J2		
3rd Lo	Ft + 54456.5	Ft + 54453.5	Ft + 54456.7	Ft + 54455	Ft + 54456.9	J3	CR5	VC03



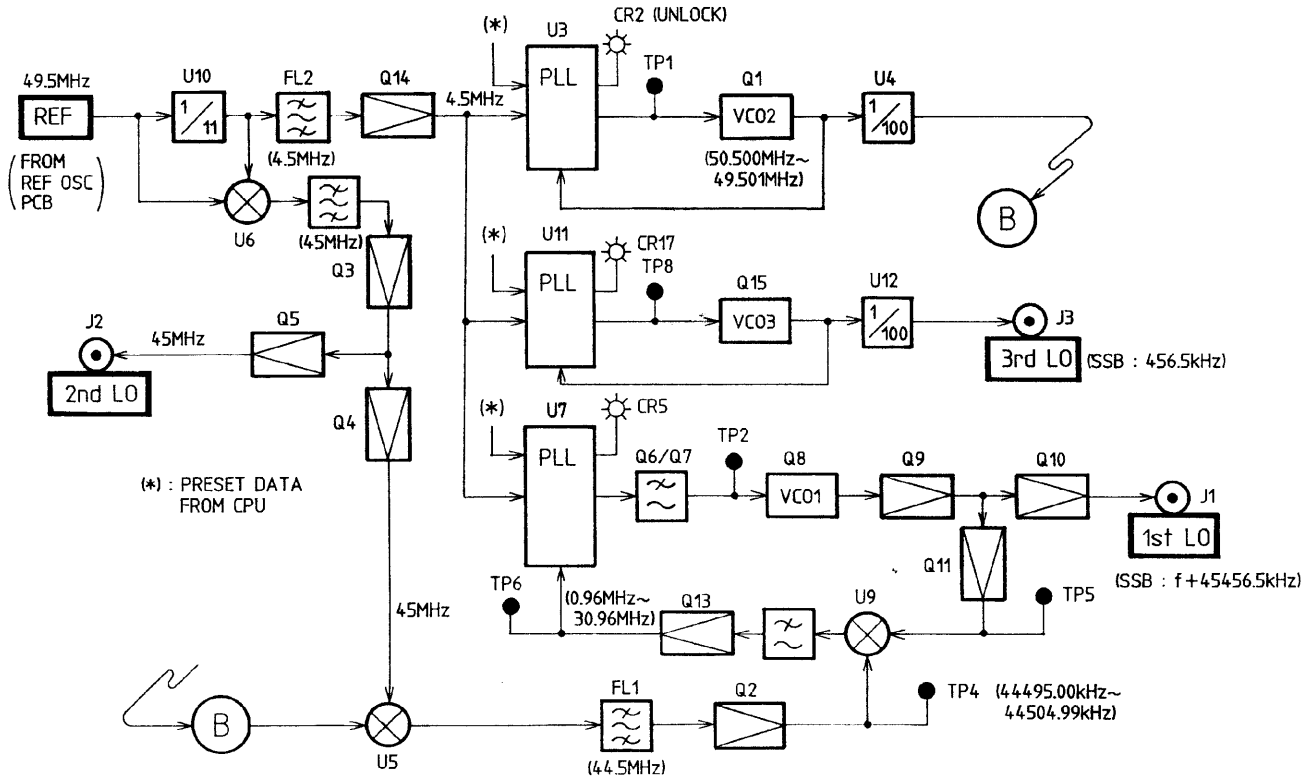
TX SYNTHESIZER (EXC & REF OSC PCBs)

8.2 RX Synthesizer (RX board)

This synthesizer functions almost the same as the TX synthesizer. The RX synthesizer circuit starts operating by the reference signal (49.5MHz) derived from the REF OSC board.

The table below shows the output frequencies of each local oscillation frequency.

	Output Frequency (kHz)						Test Point	LED (lit in unlock)	Remarks
	USB	LSB	H3E	F1B	A1A	FAX			
1st Lo	Fr + 45456.5	Fr + 45453.5	Fr + 45455				J1	CR5	VCO1
2nd Lo	45MHz						J2		
3rd Lo	456.5	453.5	OFF	456.7	455.8	456.9	J3	CR17	VCO3
				Changeable by BFO frequency.					



RX SYNTHESIZER (RX PCB)

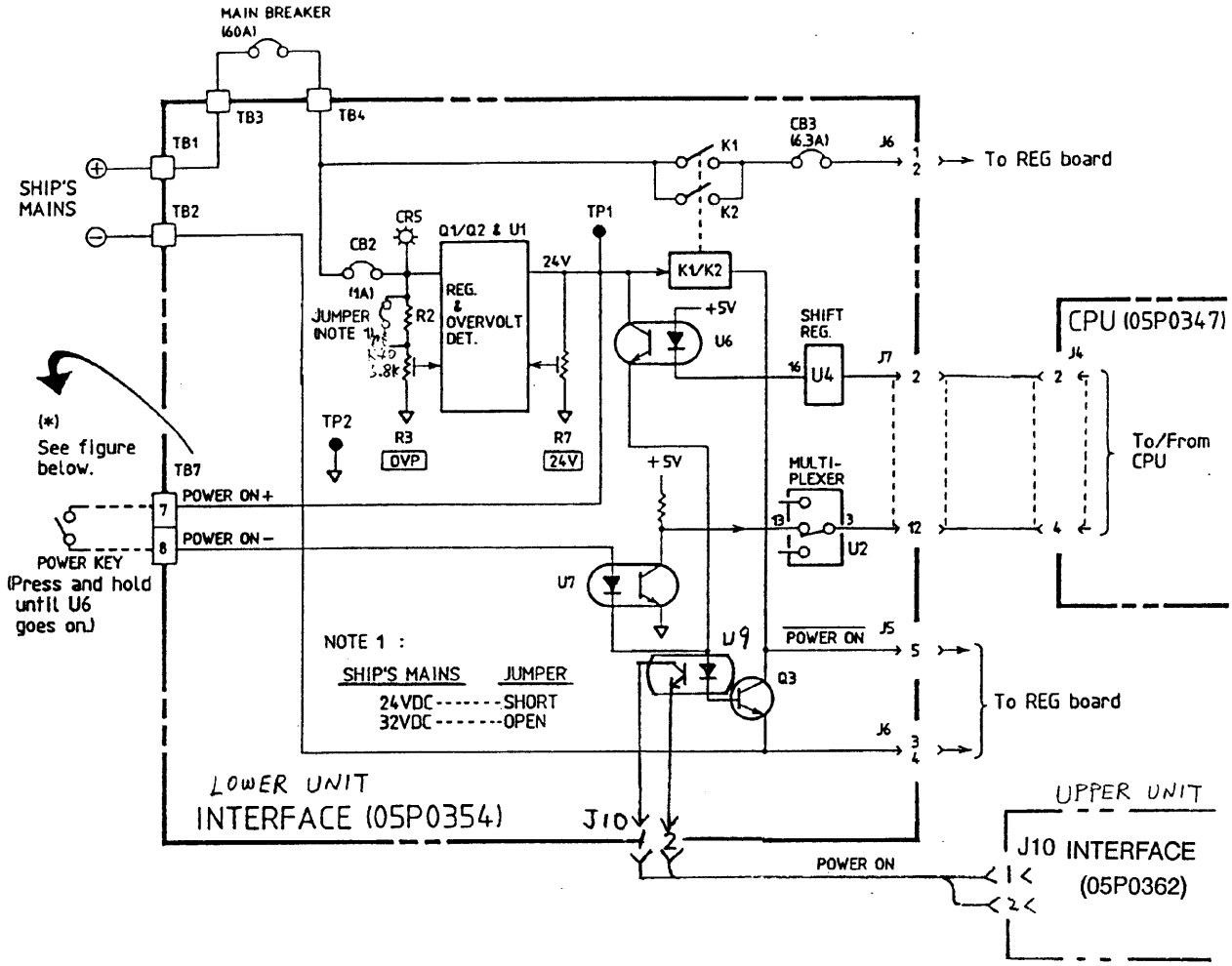
9. POWER SUPPLY

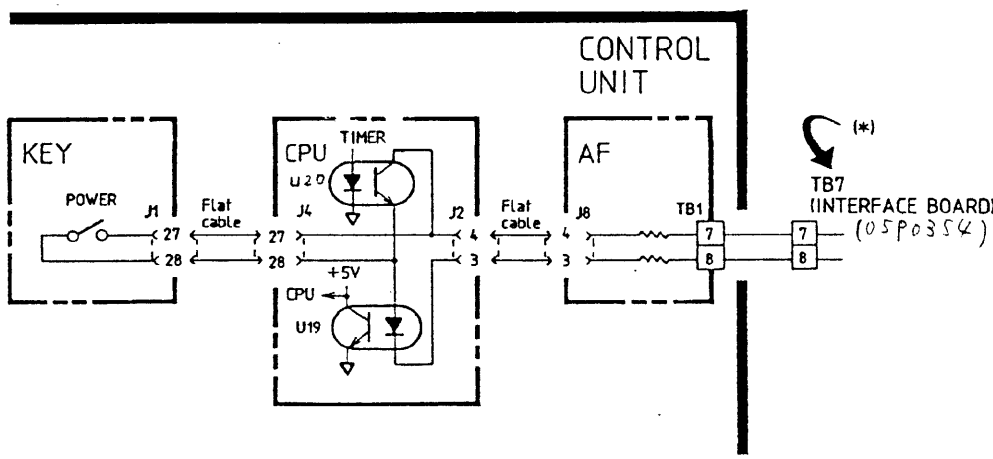
9.1 Starter Circuit

The starter circuit is on the INTERFACE board (05P0354) in the lower unit. Refer to the next page. When the [POWER] key is pressed, photo coupler U7 goes on, causing Q3 to go on. Then the CPU receives the command ("L" status) derived from U7 via multiplexer U2 and sends the command ("L" status) to photo coupler U6 via shift register U4. Consequently U6 is kept on, causing Q3 and U9 to be kept on even if the [POWER] key is released. It takes 1 second approx. to make U6 conductive when the [POWER] key has been pressed. When Q3 goes on, relays K1 and K2 turn on and the ship's mains is supplied to the REG board. And, when U9 goes on, relays K1 and K2 on the INTERFACE board (05P0362) in the upper unit turn on.

Q1/Q2 and U1 function to produce regulated +24V for the relays. CR5 lights when the ship's mains is correctly supplied to the INTERFACE board (05P0354) in the lower unit. R3 and R7 are for adjustment of overvoltage protection and 24V output, respectively. The INTERFACE board (05P0362) in the upper unit operates in the same manner as the INTERFACE board (05P0354) in the lower unit.

When the present time coincides with the wake-up time set by operator, the timer on the CPU board turns on, and the relays (K1/K2) turn on in the same manner as mentioned above.





POWER SUPPLY CIRCUIT (1)
(STARTER)

9.2 Power Supply (for both lower and upper units)

Refer to the block diagram on the next page.

The ship's mains supply is applied to the following circuits thru the INTERFACE and REG boards.

① Input voltage indication ("VS")

② + 18V switching regulator (+ 18V output)

③ Starter circuit for two switching regulators

④ + 21V (or + 12V) switching regulator (+ 45V or + 44V output)

① : Ship's mains is directly sent to the PA CHECK board to display the input voltage by bar graph and/or numeral. R6 adjusts the value of "VS" indication.

② : When relays K1 and K2 are activated, ship's mains supply is fed to the + 18V switching regulator thru the + 16V regulator composed of Q9 to Q12 on the REG CONT board. + 18V is obtained at TP1 on the REG board.

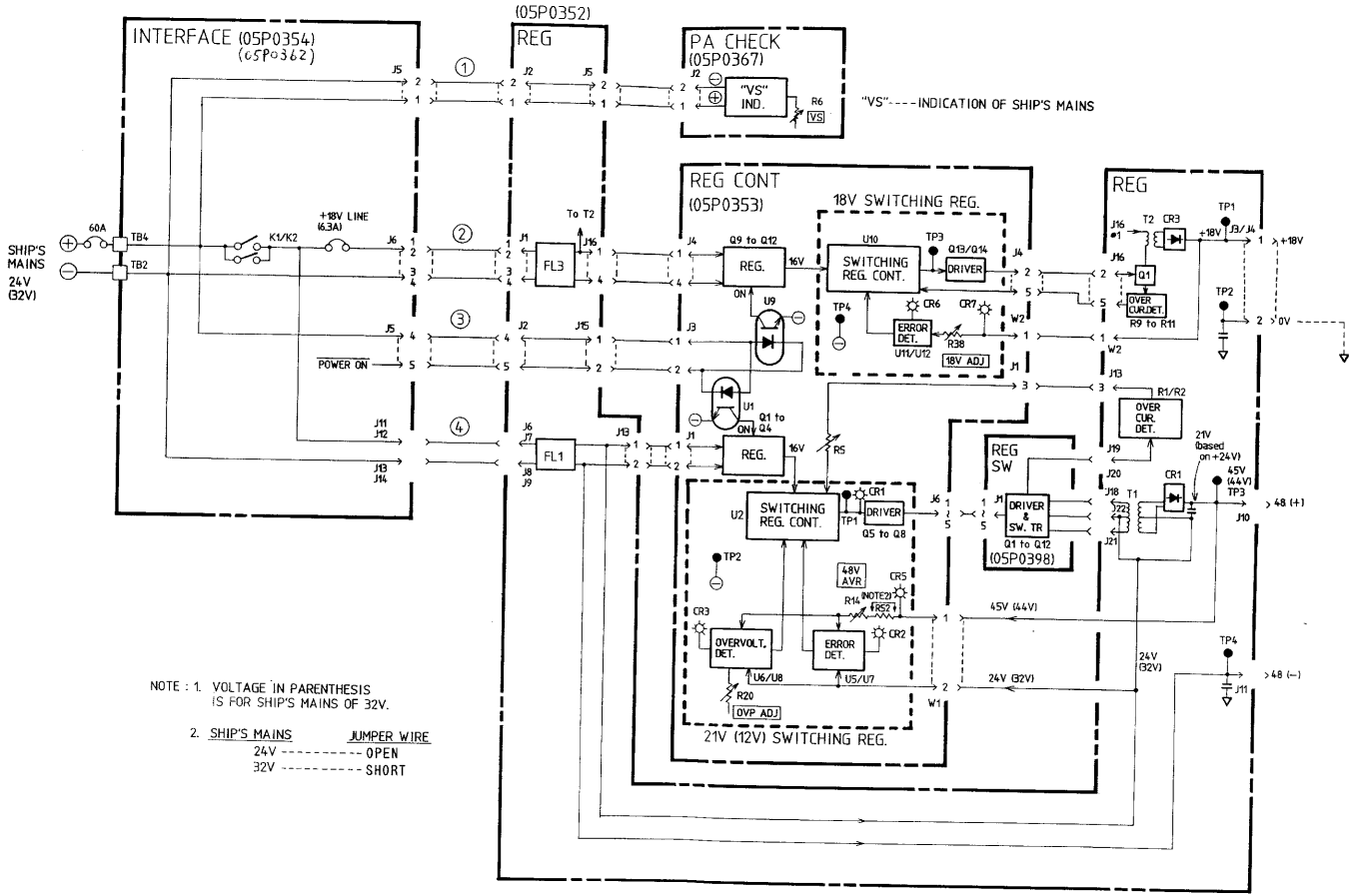
R38 is for adjustment of + 18V. CR7 lights when + 18V is correctly produced.

③ : After the power supply starter circuit (see page 1-16) becomes active, $\overline{\text{POWER ON}}$ signal ("L" status) on the INTERFACE is fed to photo couplers U9 and U1 on the REG CONT board, causing two + 16V regulators to go on.

④ : The + 21V switching regulator produces " + 45V" for the PA board. The output from the REG SW board is rectified by CR1 on the REG board, producing + 21V on the basis of the hot line (+ 24V) of ship's mains, for instance, + 45V (+ 24V plus + 21V) is obtained at TP3. (+ 45V for 24VDC set, + 44V for 32VDC set)

R14 and R20 are for adjustment of + 45V and overvoltage protection, respectively. R5 adjusted for overcurrent protection (24Aapprox.). CR5 lights when + 45V is correctly supplied. CR3 lights at the moment the overvoltage protector trips.

As for alteration of ship's mains, refer to Appendix 1.



NOTE : 1. VOLTAGE IN PARENTHESIS IS FOR SHIP'S MAINS OF 32V.

2. SHIP'S MAINS — JUMPER WIRE
24V ---------- OPEN
32V ---------- SHORT

POWER SUPPLY CIRCUIT (2) (For both lower and upper units)

10. SELF TEST

10.1 TX Check

Refer to the block diagram on the next page.

The "TONE" signal (1.5kHz) is derived from the CPU (U10) of the control unit at the moment the TX circuit test is started. It is fed to the AF board and divided into two lines: one is fed back to the CPU thru the analog switch (U21) to check the transmission line of the AF board, the other sent to the EXC board to check the TX circuit of the next stage.

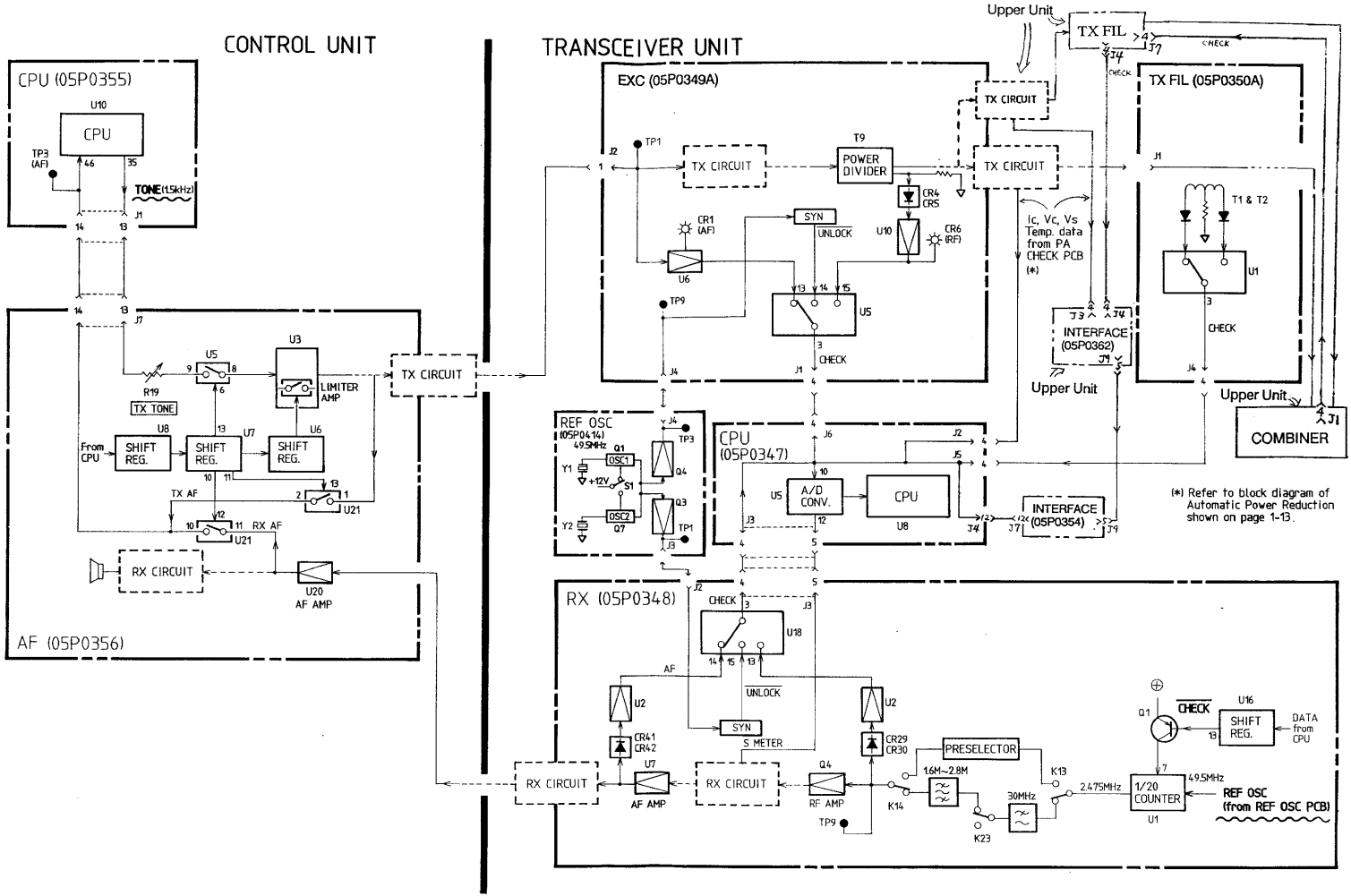
If the test signal level at the input of U6 on the EXC board is more than -36dBm, CR1 lights (MIC input test) and the signal is fed to the multiplexer (U5) which selects each test signal of MIC input/output and local oscillator. If the output signal of T9 is sufficient in level, CR6 lights (MIC output test).

The test signal from the EXC board passes through the PA board to check collector voltage (Vc) and current (Ic) and is then sent to the TX FIL board to check the SWR detection circuit and LPF. Then, it is fed to the combiner to check the combiner circuit and connection to the antenna coupler.

10.2 RX Check

When the unit is in the RX test sequence, the CPU (U8) of the transceiver unit sends the "CHECK" signal to the shift register (U16) on the RX board, causing counter U1 to start operating. U1 divides 49.5MHz from the REF OSC board by 20, resulting that the 2.475MHz test signal is produced. It passes through the preselector and filters composed of 30 MHz (LPF) and 1.6MHz to 2.8MHz (BPF). It is then detected by CR29/30 and fed to the multiplexer (U18) which selects each test signal. The output signal of AF amp. U7 is divided into two lines: one is fed to U18 to check the RX board, the other to the AF board.

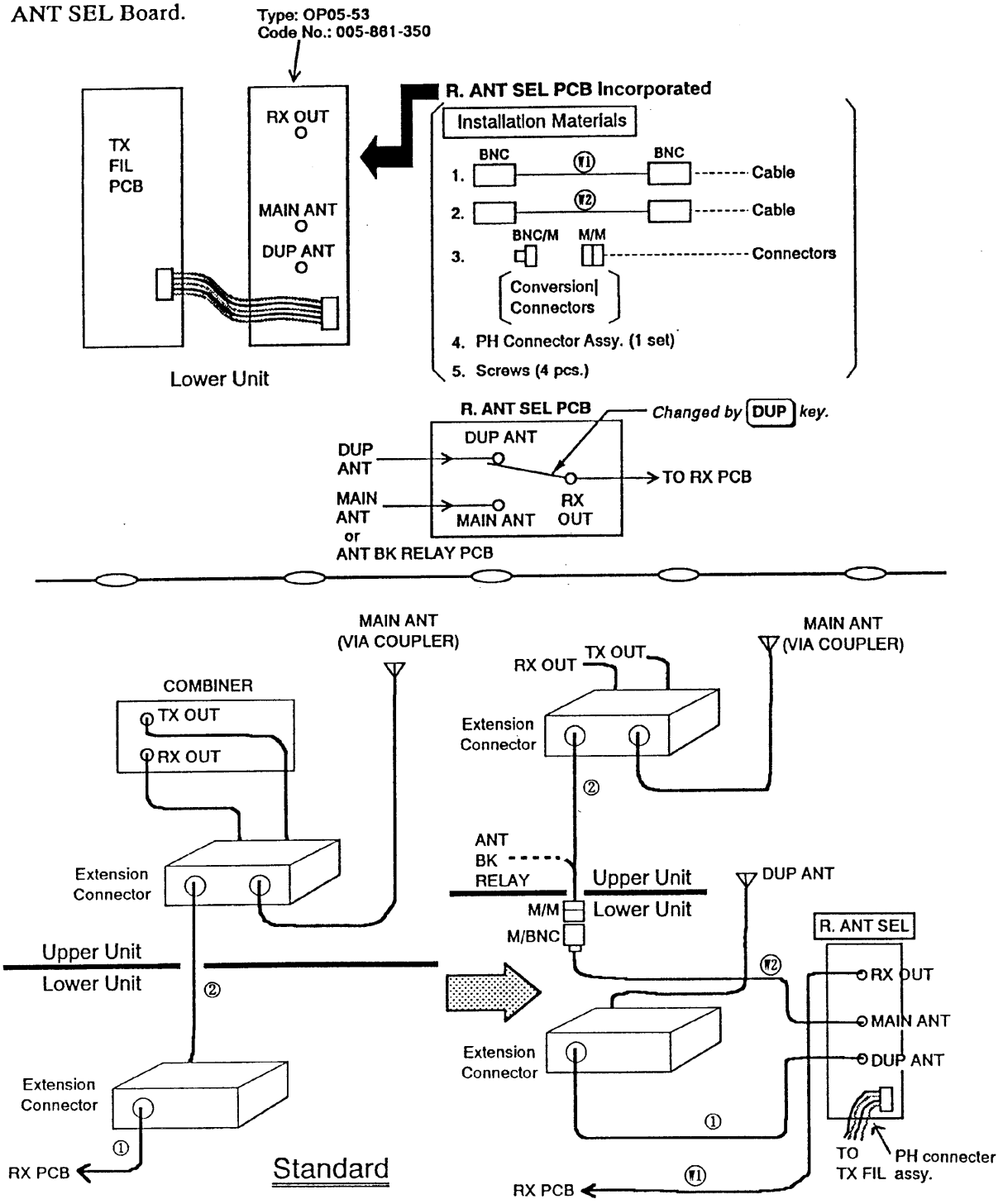
The test signal from the RX board is amplified by U20 on the AF board and fed to the CPU (U10) on the CPU board in the control unit via the analog switch (U21), to check the receiver circuit of the AF board.



SELF CHECK SIGNAL FLOW

INSTALLATION OF R. ANT SEL BOARD

The R. ANT SEL Board(option) helps prevent signal attenuation on communication modes other than duplex. That is, the duplex antenna is used only when duplex function is on. ("DUP" appears on screen.) If duplex antenna is installed far from transceiver unit, the receiving signal on communication modes other than duplex will be attenuated. To solve this problem use the R. ANT SEL Board.



CHAPTER 2 ADJUSTMENT

1. NECESSARY MEASURING INSTRUMENTS

No.	Measuring Instrument	Specifications / Remarks
1	Standard Signal Gen. (SSG)	0.1 to 40 MHz, –10 to +30dBμV, 50ohms
2	AF Signal Gen.(AF SG)	1 to 3kHz, –60 to +10dBm, 600ohms (2 sets required for two-tone test)
3	Electronic Voltmeter (VTVM)	0.1 to 10kHz, –20 to +20dBm, with RF probe
4	Oscilloscope	DC to 100MHz
5	Frequency Counter	DC to 100MHz
6	Digital Multimeter	10mV to 50V
7	Variable DC power supply	50V(max), 3A (only for overvoltage protector)
8	Ampere Meter	2A, 20A
9	Power Meter	50ohms, 1kW, terminated type or thru-line type and 50ohm dummy
10	Dummy Load	For 1.6 to 4MHz, 10ohms + 250pF, with 10A RF ammeter

All adjustment should be done at the factory. Only when adjusment is required in the field, execute it by using the "Adjustment Table" shown on the next page.

2. ADJUSTING POINTS & RATINGS

Item		Ratings	Adjuster	Check Point	PCB's / Remarks
CONTROL UNIT					
Frequency of RTC		16.384 to 16.3841kHz	C3	TP4(+)–TP1(–)	CPU PCB (Page 2 - 8)
AF Gain	①	0dBm ±0.5dBm	R91	TB 1 #1(+)–#2(–) Dummy: 600 ohms	AF PCB (Adjustment ① and ② should be done in this order) (Page 2-8)
		Conditions R14:Turned fully clockwise(max) REM 1 AF TX: 1500Hz, –15dBm(TB3 #1/#2) REM 1 "TX ON" line: "L" level			
	②	0dBm ±0.5dBm	R9		
		Conditions MIC Input: 1500Hz, PTT: ON –35dBm(J1 #3/#4)			
REM 1 Line-in		0dBm ±0.5dBm Conditions	R14	TB1 #1(+)–#2(–) Dummy: 600 ohms	AF PCB (Do this adjustment after completion of MIC gain adjustment.) (Page 2-9)
REM 2 Line-in		REM[ ] line-in level: 1500Hz, 0dBm REM TX ON	R15		
REM 3 Line-in			R16		
TX Tone Level		0dBm ±0.5dBm (TONE: ON PTT: ON)	R19	TB1 #1(+)–#2(–) Dummy: 600 ohms	AF PCB (Page 2-9)
REM1 Line-out		0dBm ±0.5dBm Conditions	R44	TB3 #3(+)–#4(–) Dummy: 600 ohms	AF PCB (Page 2-9)
REM 2 Line-out		AF input:1500Hz, 5dBm(TB1#3/#4)	R45	TB3 #14(+)–#15(–) Dummy: 600 ohms	
REM 3 Line-out			R46	TB2 #3(+)–#4(–) Dummy: 600 ohms	
TRANSCEIVER UNIT					
RX 2nd Lo level		1.5±0.1Vpp	R70	TP2(+)–TP7(–)	RX PCB
RX 1st Lo level		3.0Vpp or more	Confirmation	TP1(+)–TP7(–)	(See next page.)

Continued

Item	Ratings	Adjuster	Check Point	PCB's / Remarks
RF Gain	−10dBm±1dBm	R92	J4 #1(+)–#3(−) Dummy: 600 ohms	RX PCB (Mode: SSB, BW: 3kHz, SENS: Max, NB: OFF, PRESELECTOR: OFF, RX freq: 4200kHz, SSG: 4201kHz) (Page 2-10)
	Conditions RF input(J1):-5dBμV,AGC:OFF			
Mixer Balance	Minimum noise level	R42	With SSG output set to OFF, adjust R42 for minimum noise level.	
	Conditions RF input(J1); OFF, AGC: OFF, RX freq: 100kHz			
AGCVoltage	5.8±0.1V	R126	TP6 (Page 2-11)	
	Conditions RF input(J1): 5dBμV AGC: FAST			
S Meter Level	0.51 to 0.55V	R142	J3 #5(+)–#6(−) (Page 2-11)	
	Conditions RF input(J1): OFF AGC: FAST			
NB(Noise Blanker)	Center position	R76 (RX board)	Turn R76 counterclockwise to increase effectiveness of NB. (Page 2-10)	
REF OSC Frequency	49.5MHz ±20Hz	C1: For OSC1 C31: For OSC2	TX: TP3(+)-chassis RX: TP1(+)-chassis	REF OSC PCB Select s1 (osc1 or osc2) (page 2-11)
REF OSC Level	1.5Vpp or more (Dummy: at J3 or J4 50 ohms)	Confirmation		
TX AF level	250±10mVpp (PTT: ON)	R6	TP3(+)–TP5(−)	EXC PCB Mode: SSB, TX freq: 4MHz AF input: 1500Hz 0dBm(J2#1) (page 2-12)
Tx IF Gain	14±0.5Vpp (PTT: ON)	R8	TP11(+)–TP5(−) Dummy: 50 ohms 2W	
Carrier Injection level (Coarse)	12±0.5Vpp	R13(A1A)	TP11(+)–TP5(−) Dummy: 50 ohms 2W	EXC PCB TX freq: 4MHz, AF input: OFF(J2#1) (page 2-12)
	7.0±0.5Vpp	R14(H3E)		
	1.4±0.1Vpp	R15(R3E)		
Line Voltage (with load)	18±0.1V	R38 (REG CONT)	TP1(+)–TP2(−) (REG PCB)	(Page 2-13) This should be done for both lower and upper units.
	21±0.1V(for 24V) 12±0.1V(for 32V)	R14 (REG CONT)	Across C10 (REG PCB)	
Overvoltage Protector of Switching Reg.	See page 2-13	R20 (REG CONT)	TP3(+)–TP4(−) (REG PCB)	

Continued

Item	Ratings	Adjuster	Check Point	PCB's / Remarks
Relay Drive Voltage	24±0.5V (For 27V input voltage or more)	R7	TP1(+)–TP2(–)	INTERFACE PCB (Page 2- 13) This should be done for both lower and upper units.
Overvoltage Protector of Ship's Mains	15V±1V Conditions Input voltage: 34V for 24V set 44V for 32V set	R3		
ALC (Automatic Level Control)	800Wpep Conditions TX freq: 4100kHz, SSB Two tone signals, PTT: ON (Power data: 255)	R9	Power meter connected to Transceiver Unit	EXC PCB (Page 2-14)
MIC Gain See page 2-14.	Find the frequency (1.6 to 25MHz) which the output power of the transceiver unit is the lowest, when the MIC input level is -53dBm of single tone. Then adjust R8 on the EXC board for the output power of 100W for FS-5000, 200W (100W on MF band) for FS-8000.			
The following should be first adjusted in the lower unit with the upper unit inactive. For instance, turn breaker of upper unit off, disconnect J9 of INTERFACE PCB in lower unit, connect a dummy to TX FIL output in lower unit and change system setting to "FS-5000." After that, adjust the upper unit in the same manner as the lower unit. (Restore system setting to "FS-8000.")				
"VS" Indication	LCD indication is the same value as input voltage	R6 (PA CHECK)	TB1(+)–TB2(–) (INTERFACE)	(Page 2-15) LCD indication = (Values obtained by both lower and upper units) ÷2
"VC" Indication	LCD indication is the same value as collector voltage	R5 (PA CHECK)	J4(+)–J5(–) (PA PCB)	
"IC" Indication (with fan motors inoperative)	Total current flowing into PA PCB (at "LOW1") minus 2A	R4 (PA CHECK)	Ampere meter connecting to PA PCB (Refer to page 2-15.)	LCD indication = (Values obtained by both lower and upper unit) - 4A
"TEMP" indication (Page 2-15)	LCD indication is the same value as the thermometer indication on the heat sink.	R48 (PA PCB)	Thermometer placed on the heat sink	Fan motors: OFF, at more than 30°C LCD indication = (Values obtained by both lower and upper units) ÷2
IDLING CURRENT(collector current) on PA PCB(When replacing transistors)				
For Power Transistors (Q3 to Q6)	1.5A ± 10mA	R47	See Fig. 2-1	PA PCB No RF Input (SSB, AF: OFF, PTT: ON, Fan motors: OFF) (Page 2-5)
For Driver Transistors (Q1/Q2)	150±10mA	R41	See Fig. 2-2	

Idling Current (PA PCB)

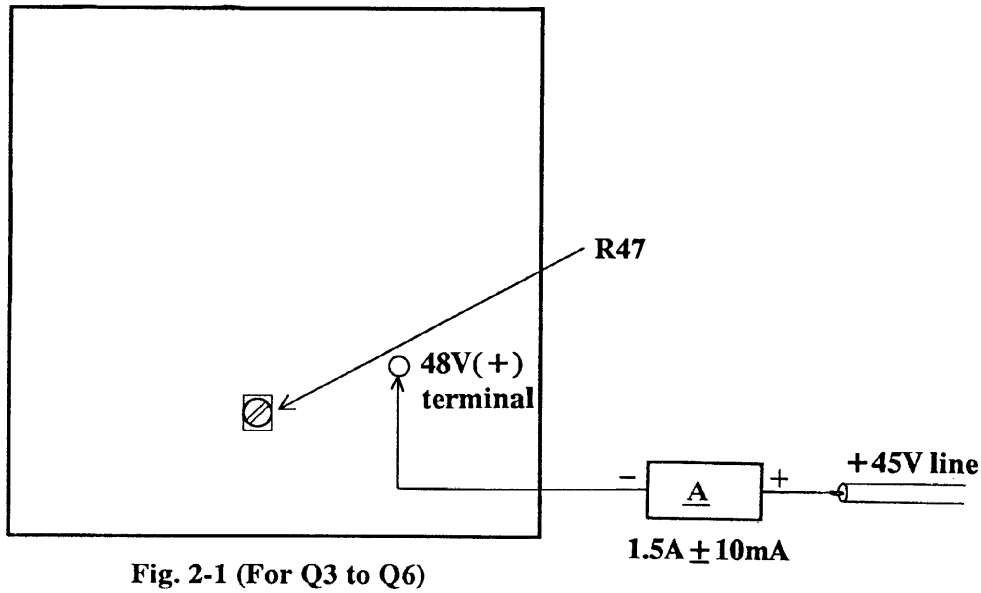


Fig. 2-1 (For Q3 to Q6)

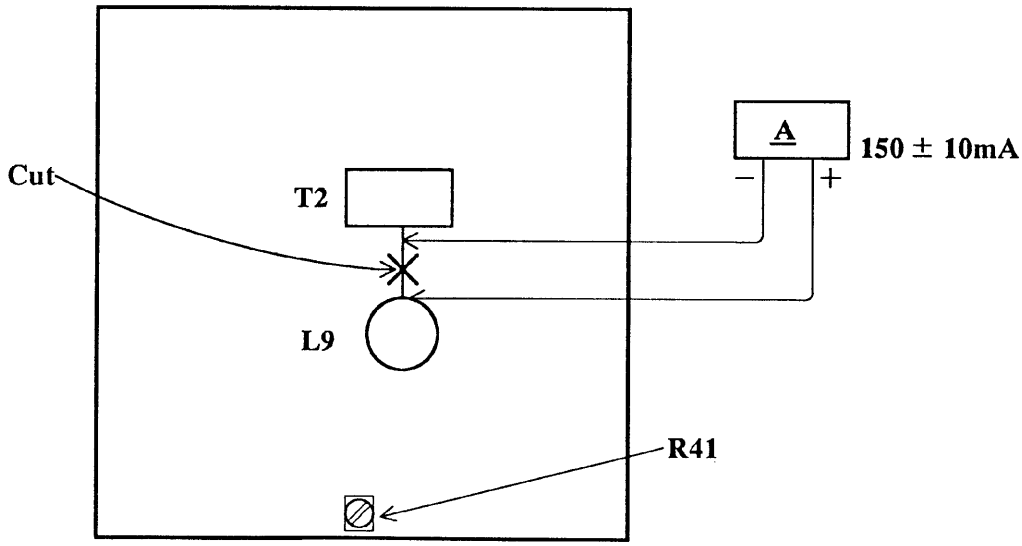


Fig. 2-2 (For Q1/Q2)

Note: After completing this adjustment, solder coil (wire L9) securely.

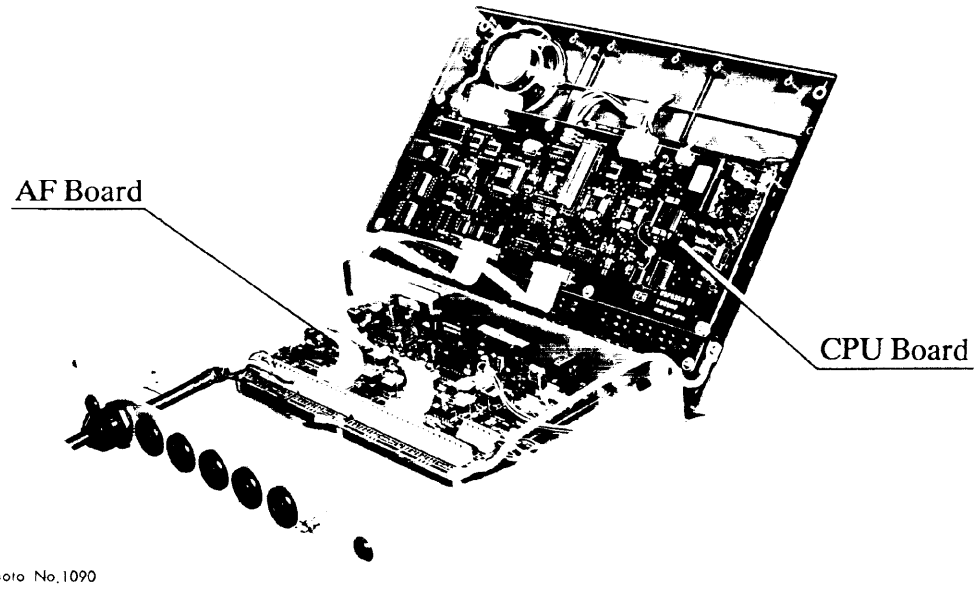


Fig. 2-3 Control Unit

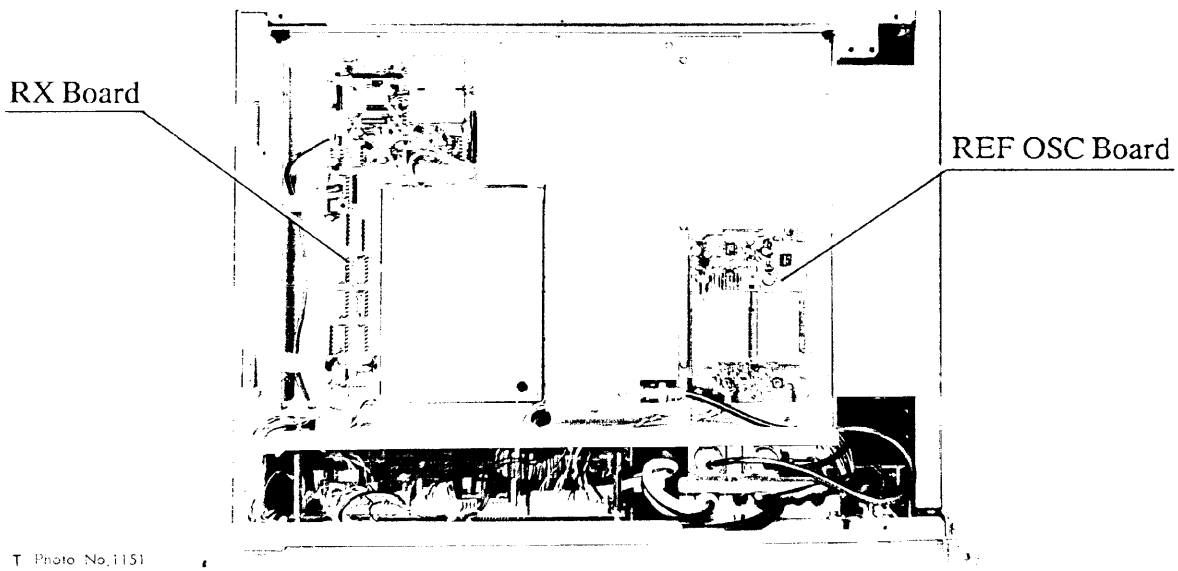


Fig. 2-4 Transceiver Unit with front cover removed
(Lower Unit)

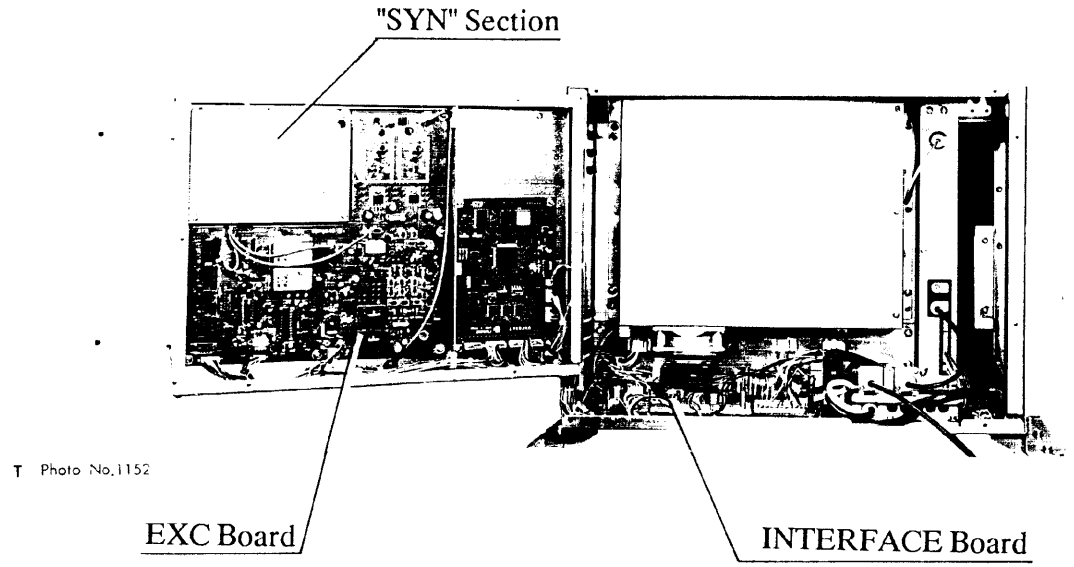


Fig. 2-5 Transceiver Unit with front door opened
(Lower Unit)

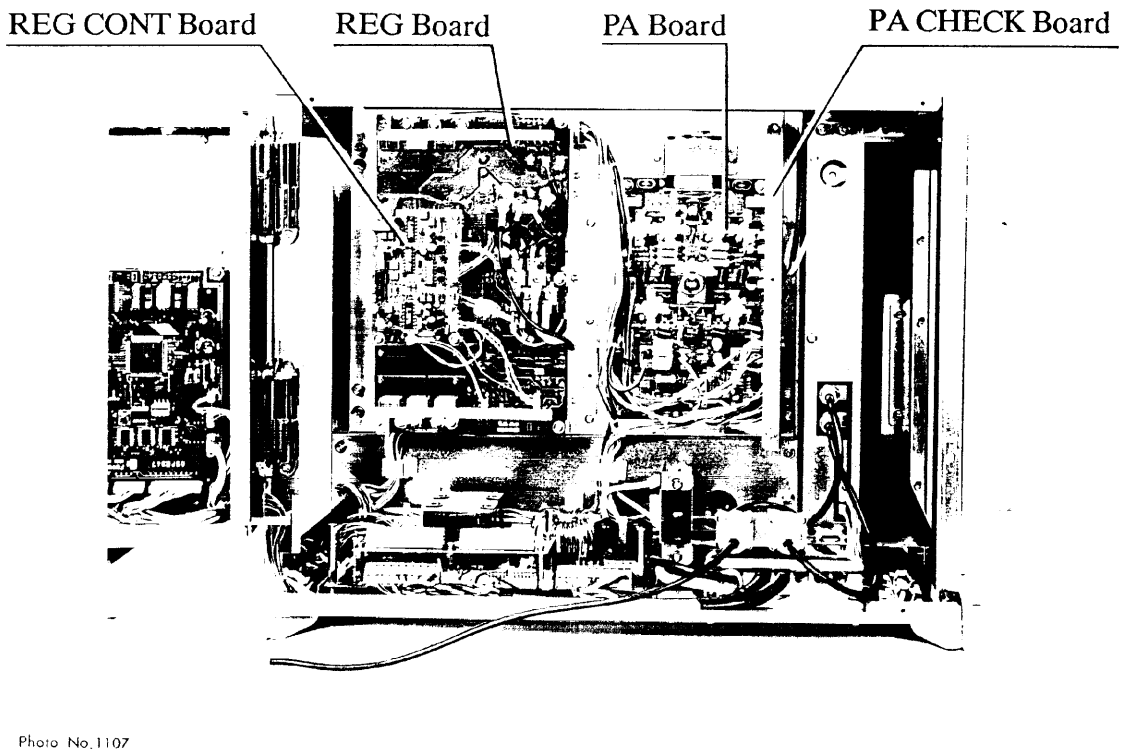
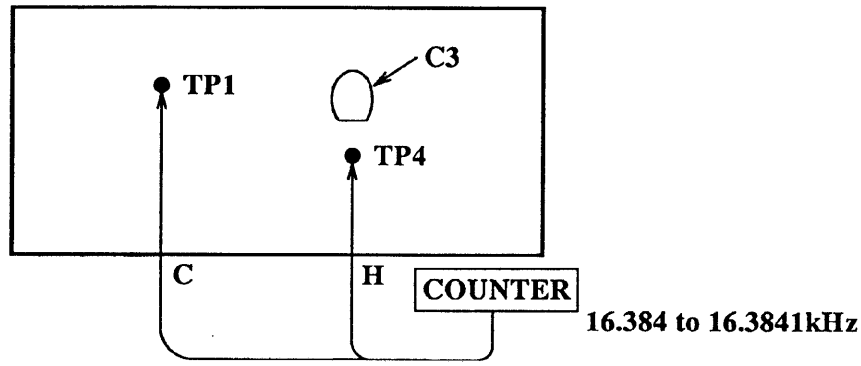


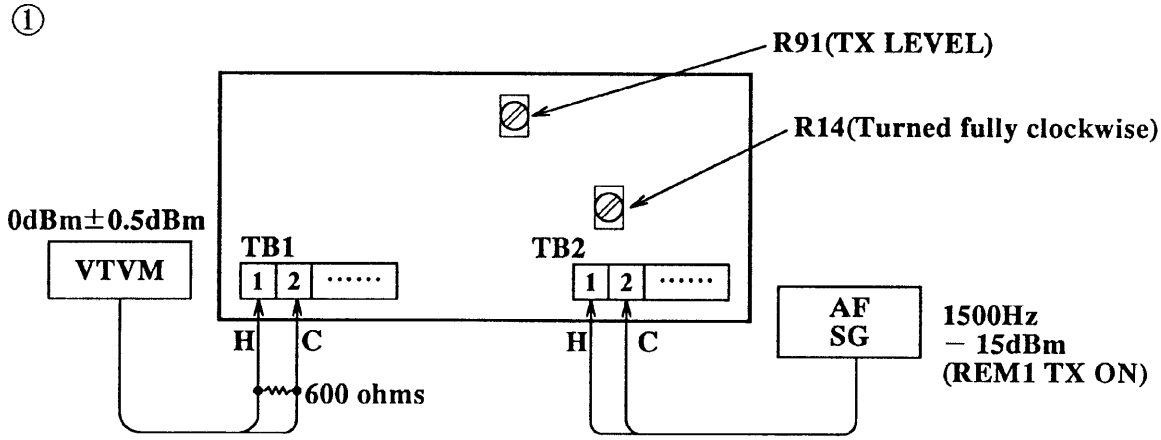
Fig. 2-6 Transceiver Unit with inner cover removed
(Lower Unit)

Frequency of RTC (CPU PCB)

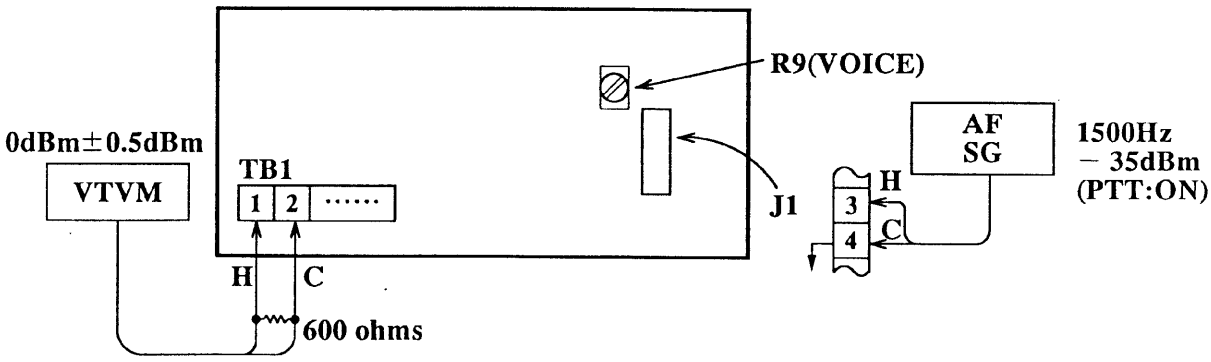


AF Gain (AF PCB)

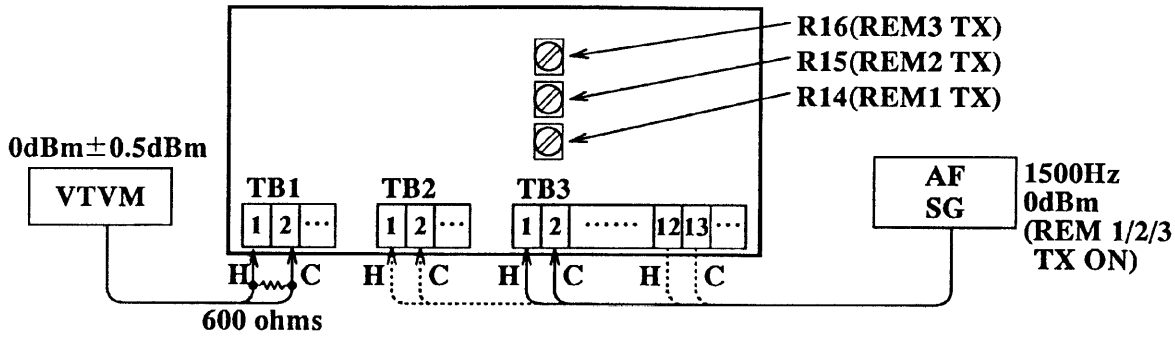
①



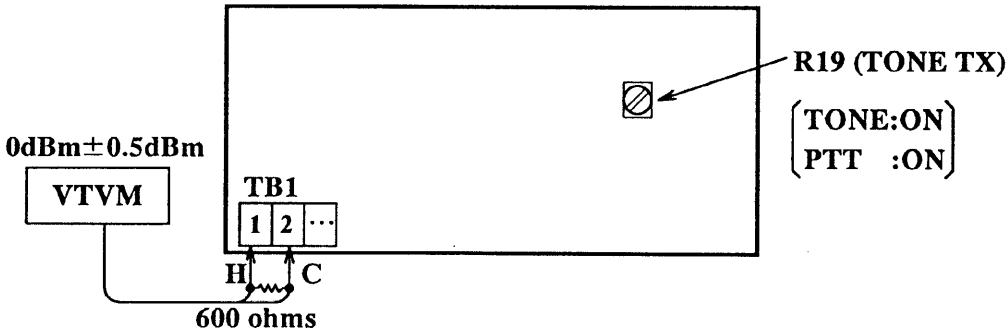
②



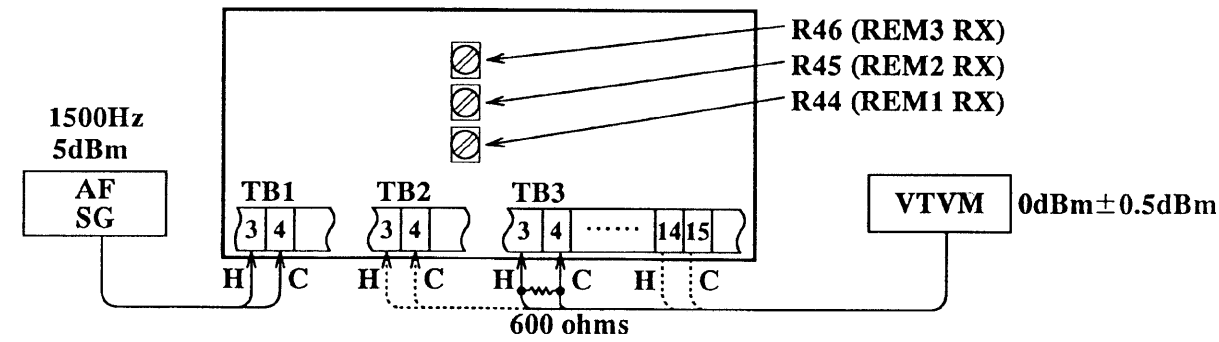
REM1 to REM3 Line-in (AF PCB)



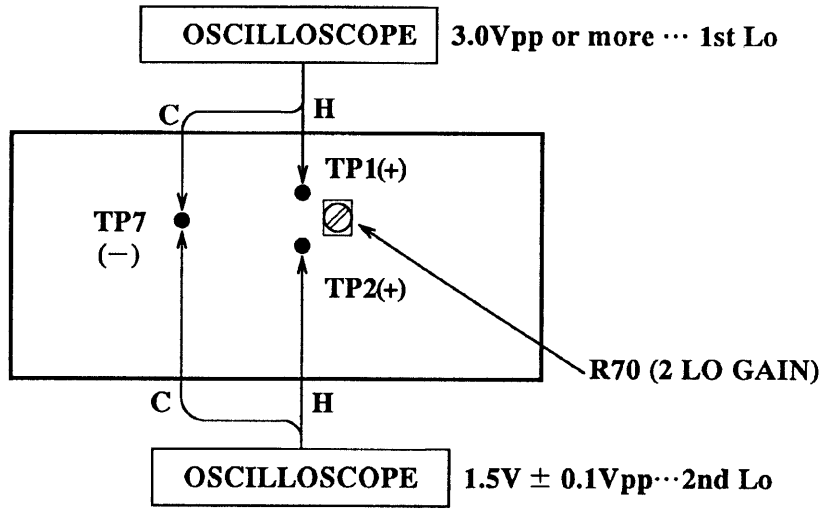
TX Tone Level (AF PCB)



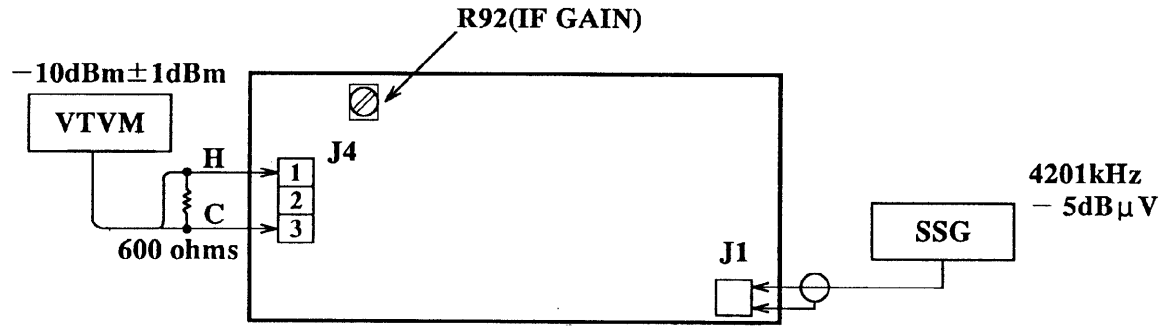
REM1 to REM3 Line-out (AF PCB)



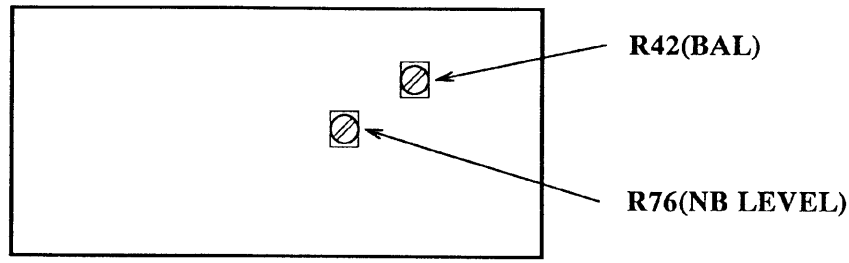
RX 2nd Lo/1st Lo Level (RX PCB)



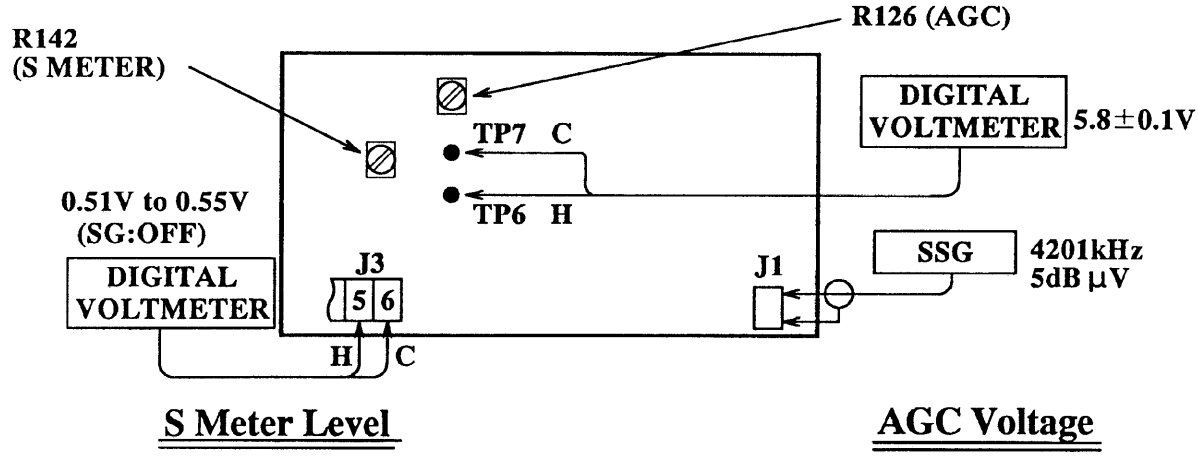
RF Gain (RX PCB)



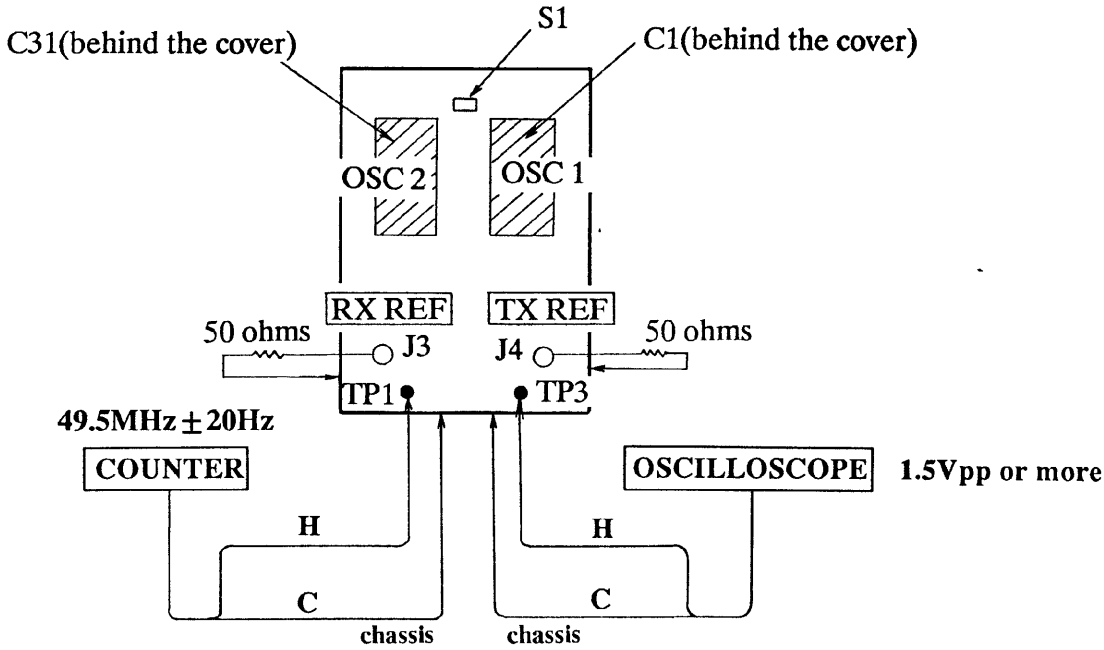
Mixer Balance & NB Level (RX PCB)



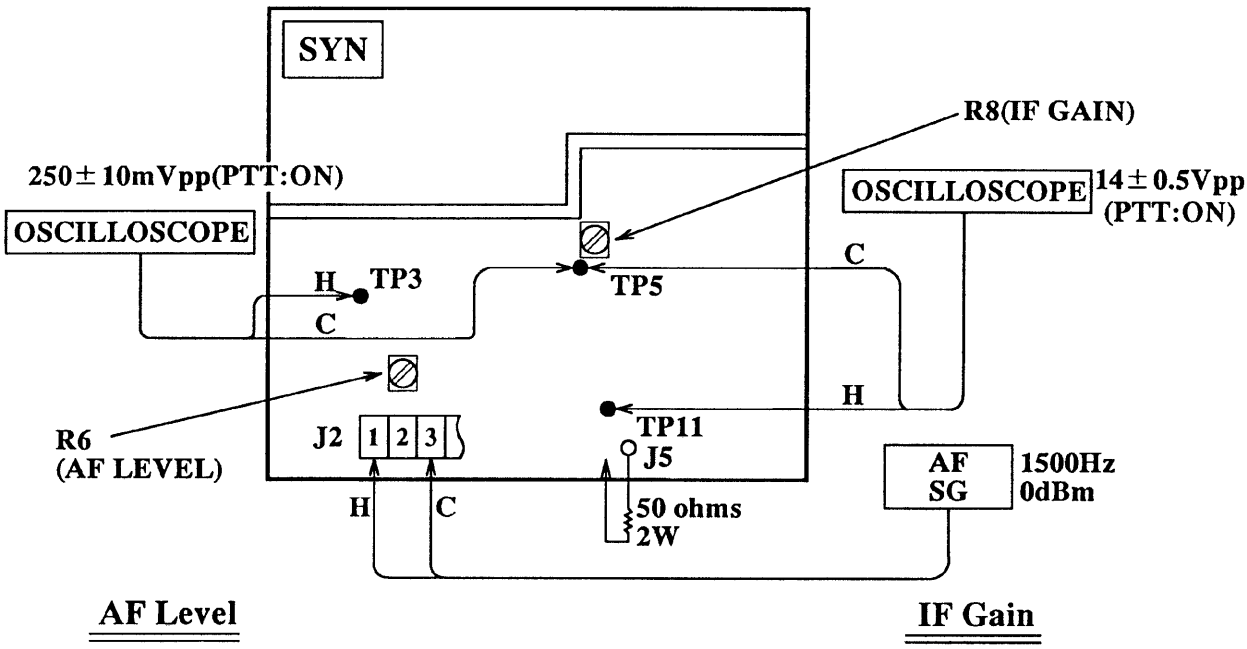
AGC Voltage & S Meter Level (RX PCB)



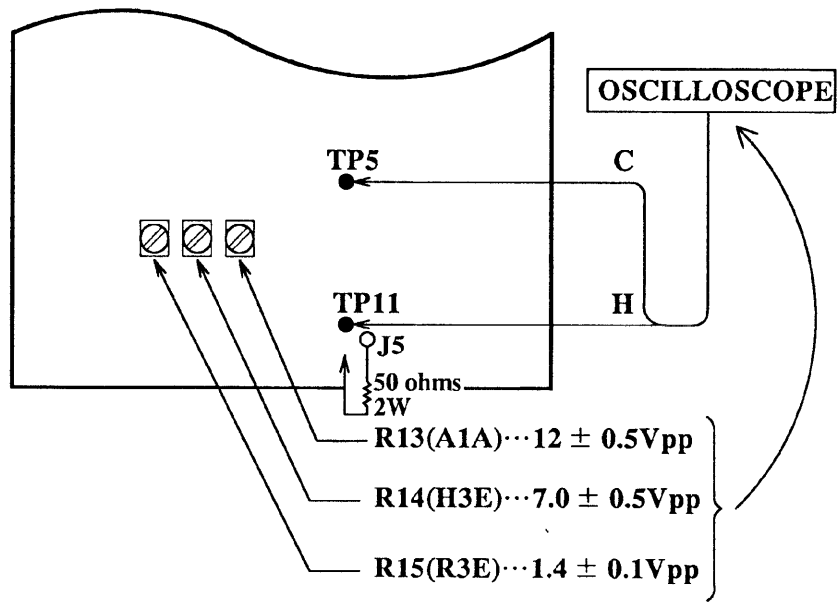
REF OSC Frequency & Level (REF OSC PCB)



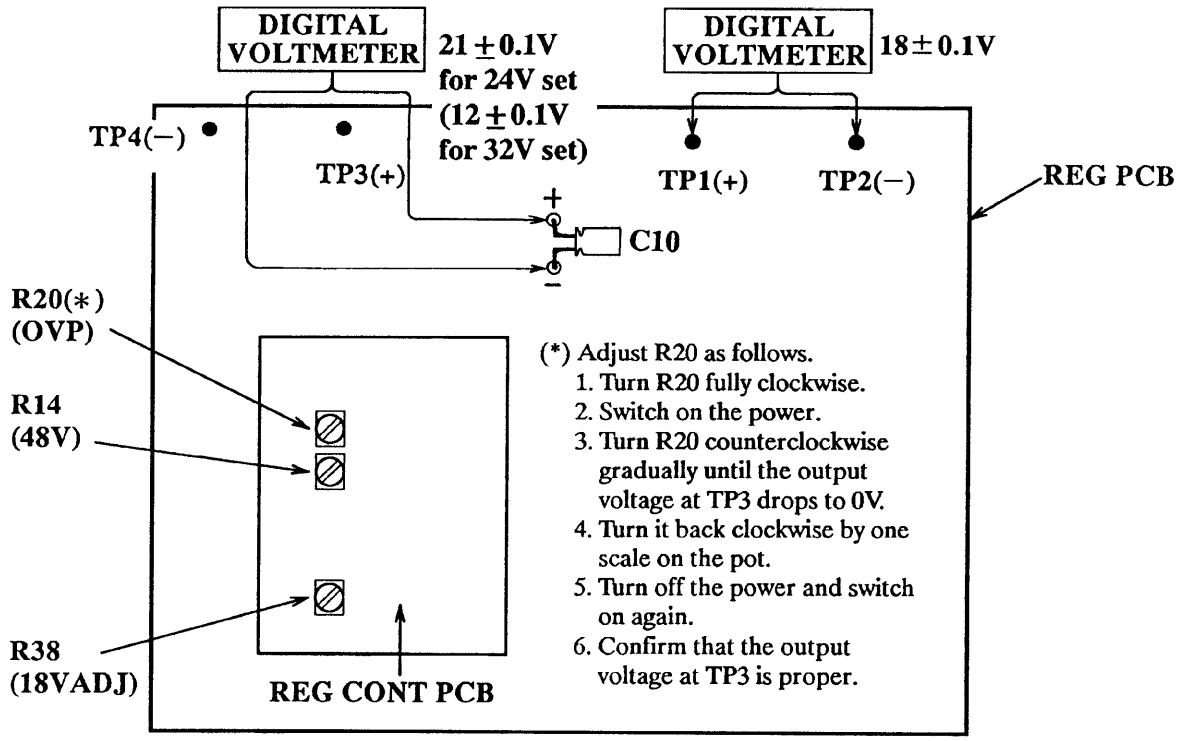
TX AF Level & RX IF Gain (EXC PCB)



Carrier Injection Level (EXC PCB)

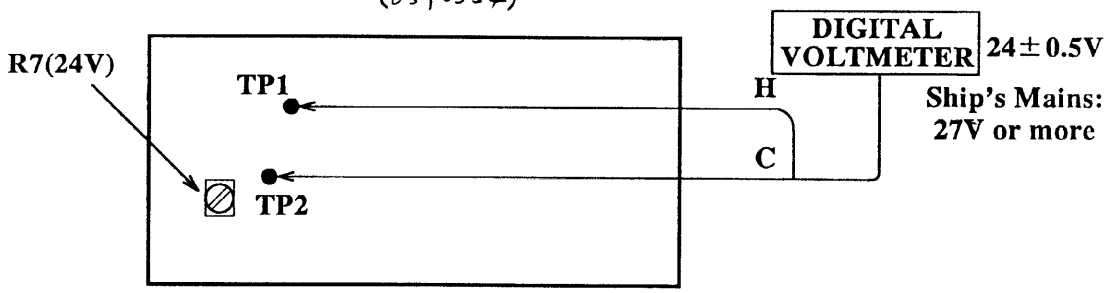


Line Voltage (REG & REG CONT PCBs)···with load



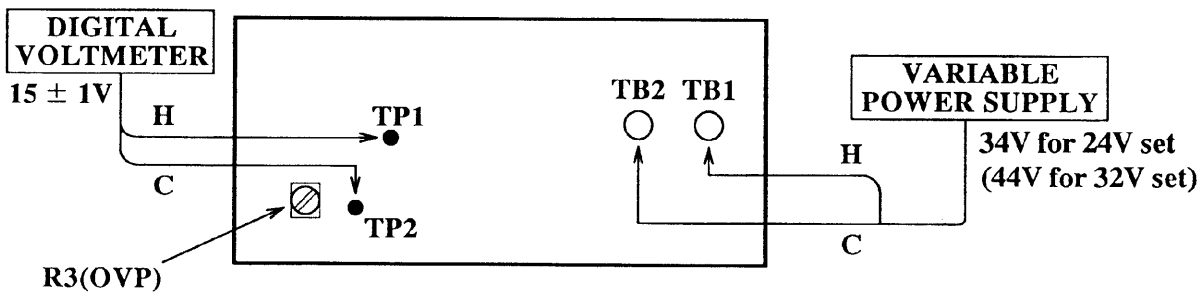
Relay Drive Voltage (INTERFACE PCB)

(05P0354)

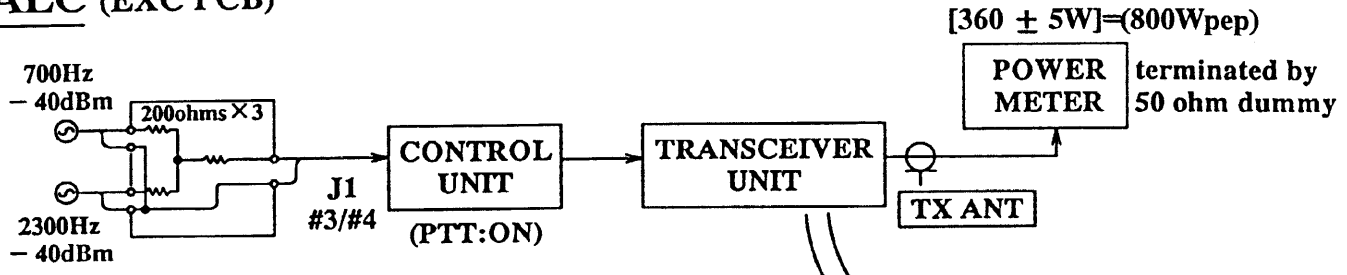


Overvoltage Protector of Ship's Mains (INTERFACE PCB)

(05P0354)

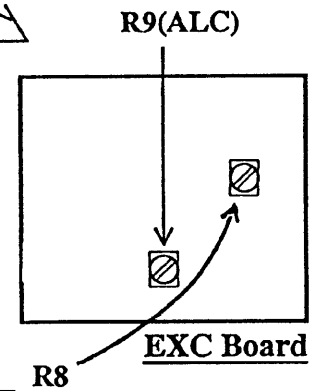


ALC (EXC PCB)

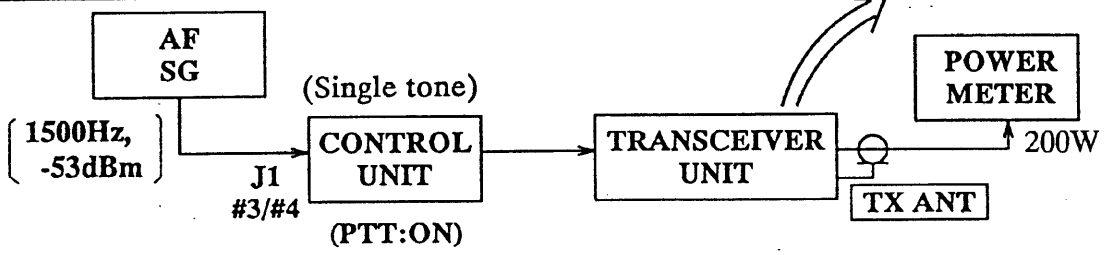


Procedure

1. Turn R9 fully counterclockwise, then transmit by pressing the PTT switch.
2. Turn R9 clockwise gradually until the power meter indicates 370W.
3. Adjust it for meter indication of 360W.



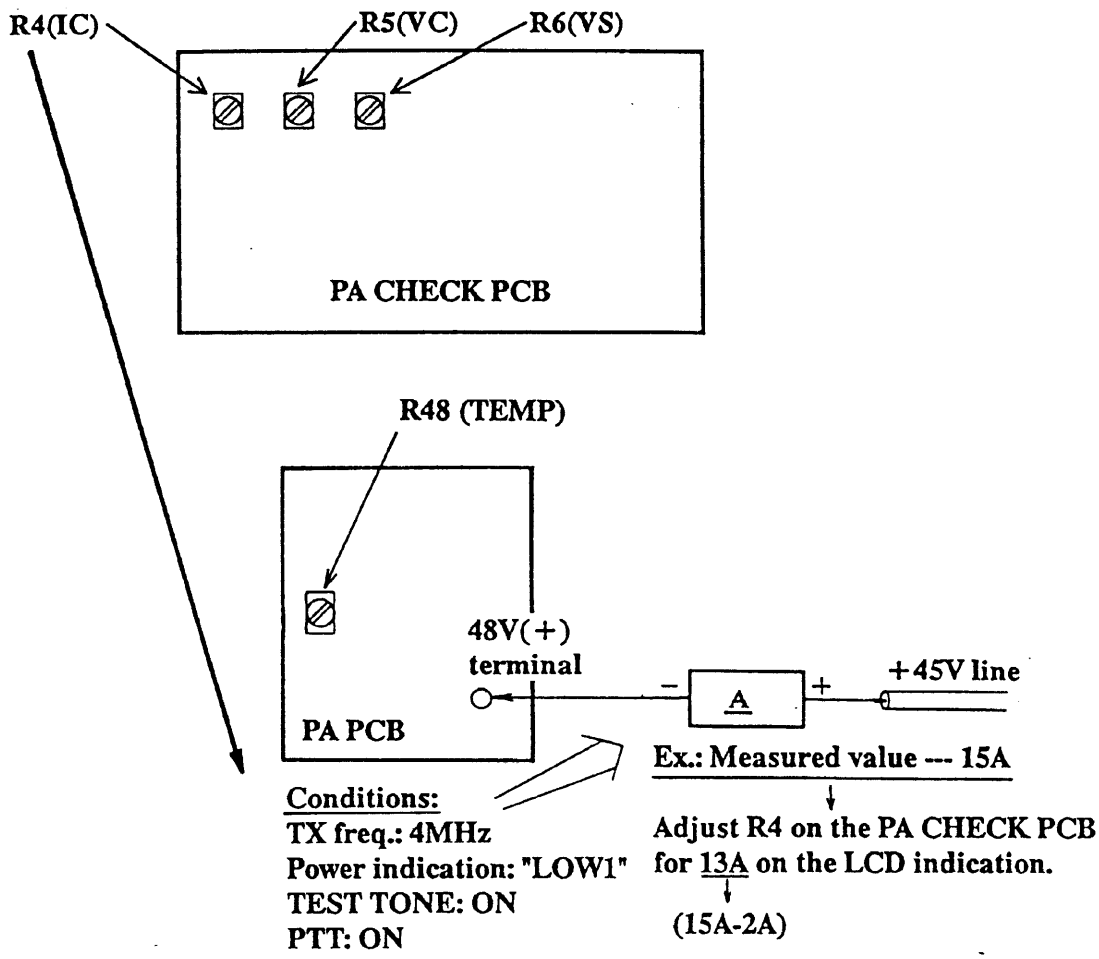
MIC Gain (EXC PCB)



POWER DATA:

FS-8000 -- 255(HF)
--180(MF)

"VS", "VC", "IC" & "TEMP" Indications



These adjustments should be done for the lower unit with the upper unit inactive. After that, adjust the upper unit in the same manner as the lower unit.

(Restore system setting to "FS-8000.")

CHAPTER 3
LED CHECK & SWITCH SETTING

1. LED CHECK

Several boards have LEDs which indicate unit status. The location, status and function of these LEDs are tabulated below and on the next page.

NOTE: The LEDs status is shown in tables as follows:

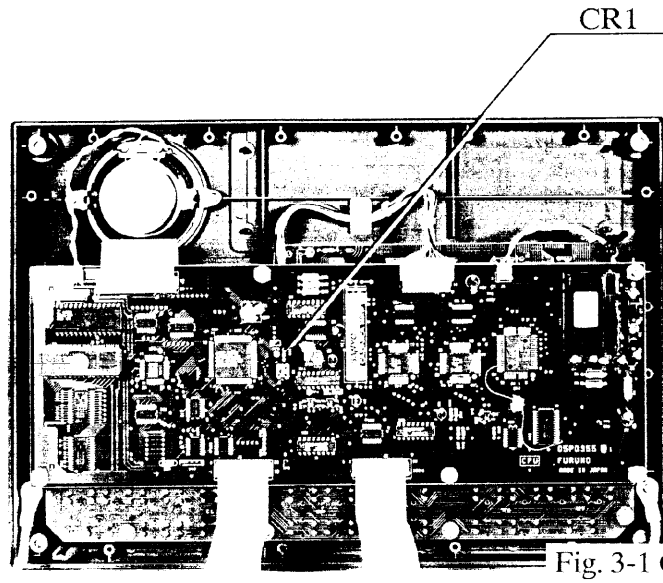
○ : lit ◑ :blinking ● : not lit (OFF)

PCB Name	LED No.	Status	Remarks
Control Unit			
CPU (05P0355)	CR1	◑	Blinks when the CPU is operating normally.
Transceiver Unit			
CPU (05P0347)	CR1	◑	Blinks when the CPU is operating normally.
INTERFACE (05P0354/05P0362)	CR5 (DC IN)	○	Lights when turning on the main breaker.
REG CONT (05P0353)	CR1 (OSC)	○	Lights when the +21V switching regulator control (U2) is operating normally.
	CR2 (48V AVR)	○	Lights dimly when +45V feedback circuit operates normally.
	CR3 (OVP)	●	Lights at the moment overvoltage is detected on +45V line.
	CR5 (48V)	○	Lights when +45V output is correctly produced.
	CR6 (18V AVR)	○	Lights dimly when +18V feed back circuit is operating normally.
	CR7 (18V)	○	Lights when +18V output is correctly produced.

For both lower & upper units

continued

PCB Name	LED No.	Status	Remarks
EXC "SYN" (05P349A)	CR4 (UNLOCK 2)	●	Lights when PLL circuit of VCO2 is unlocked.
	CR5 (UNLOCK 3)	●	Lights when PLL circuit of VCO3 is unlocked.
	CR6 (UNLOCK 1)	●	Lights when PLL circuit of VCO1 is unlocked.
EXC (05P349A)	CR1 (AF)	●	Lights when sufficient input signal is applied to the board.
	CR6 (RF)	●	Lights when signal is correctly outputted in level.
RX "SYN" (05P0348)	CR2 (VCO2 UNLOCK)	●	Lights when PLL circuit of VCO2 is unlocked.
	CR5 (VCO1 UNLOCK)	●	Lights when PLL circuit of VCO1 is unlocked.
	CR17 (VCO3 UNLOCK)	●	Lights when PLL circuit of VCO3 is unlocked.
Antenna Coupler			
COUPLER (05P0358)	CR59 (For old type) CR61 (For new type)	●	Lights when the PTT switch is pressed.
	CR65 (For old type) CR60 (For new type)	●	Lights when the [DUMMY] key is pressed.
	CR62 (only for new type)	◑	Blinks when the CPU is operating normally.



T Photo No.1091

Fig. 3-1 CPU Board (Control Unit)

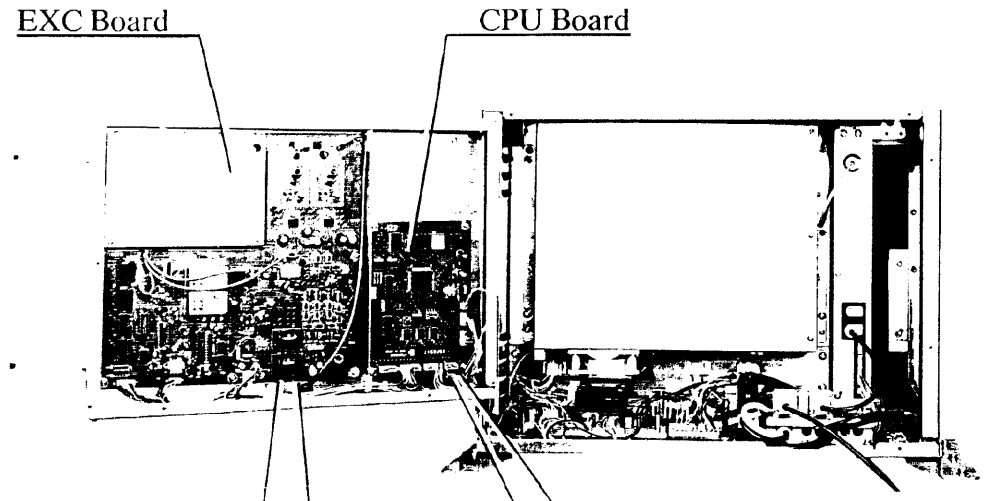
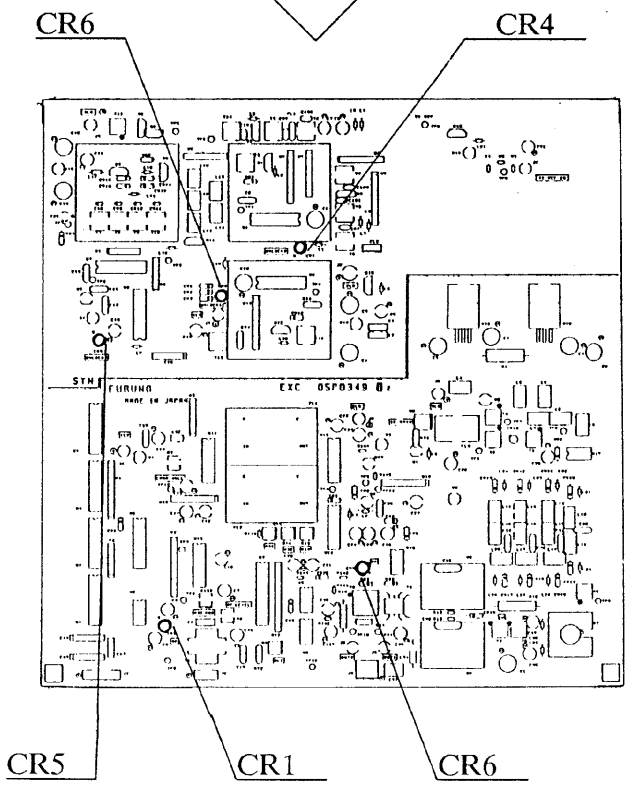
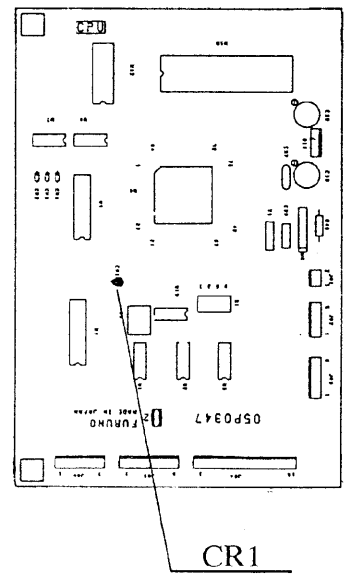


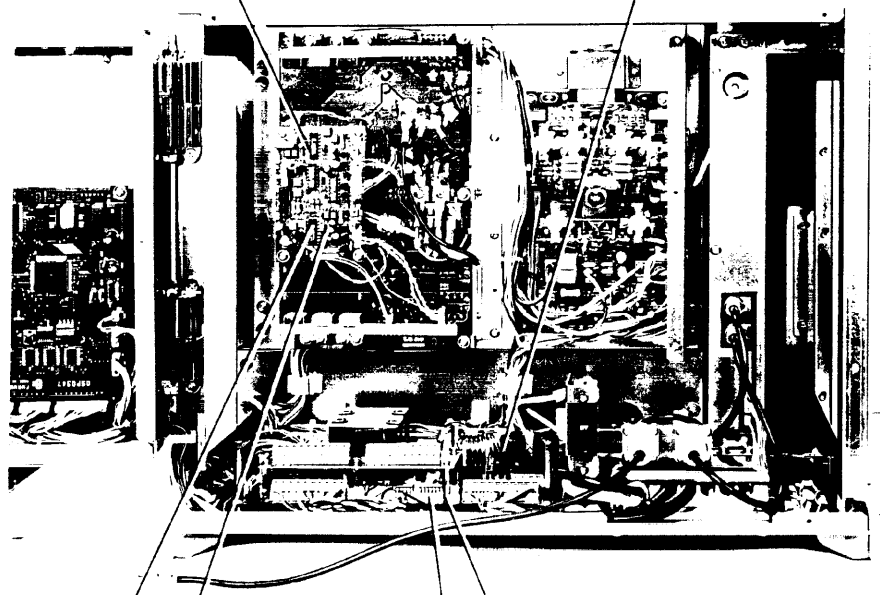
Fig. 3-2 Transceiver Unit (Lower Unit) with front door opened



EXC Board

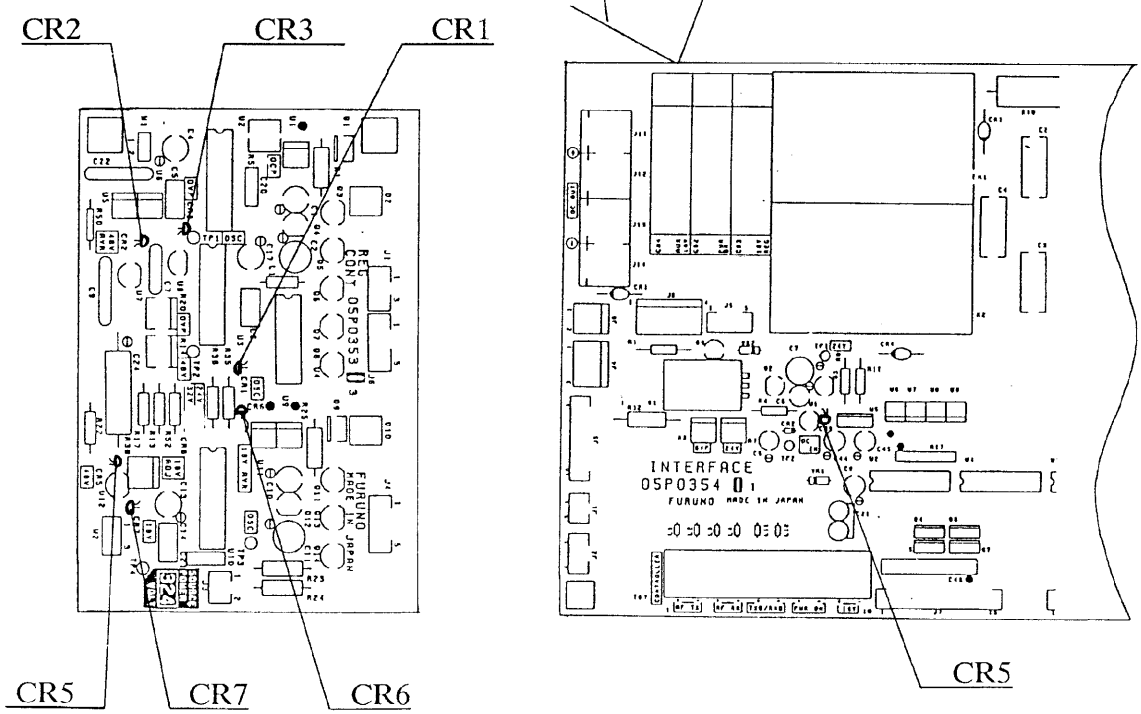


CPU Board



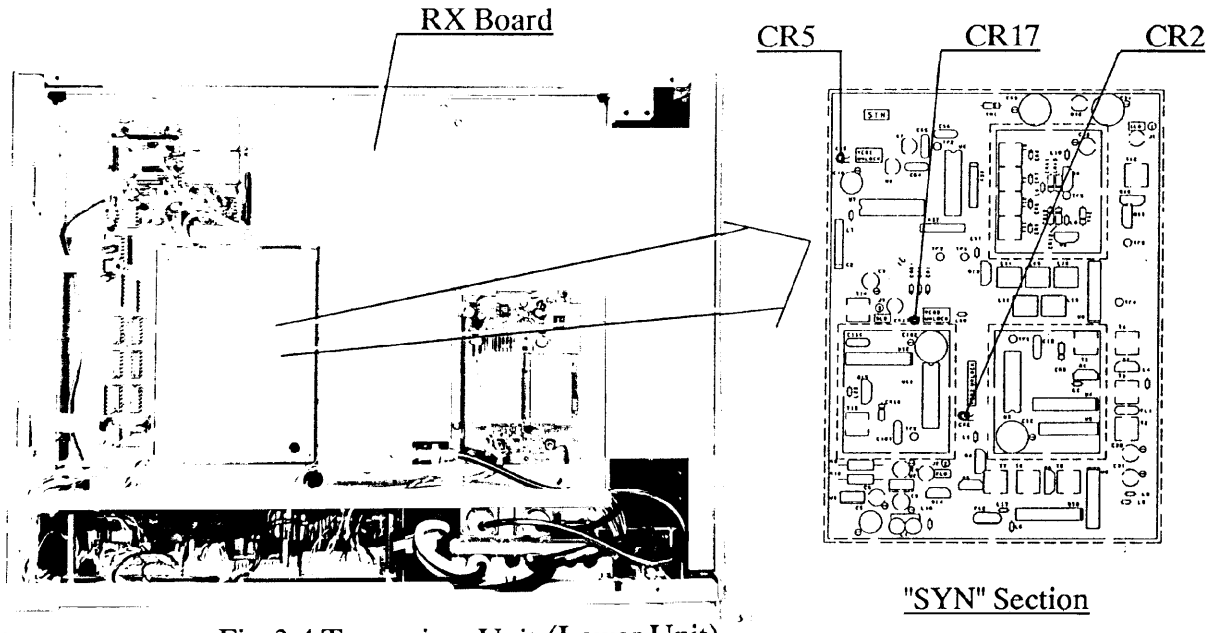
T Photo No.1107

Fig. 3-3 Transceiver Unit (Lower Unit) with inner cover removed



REG CONT Board

INTERFACE Board



T Photo No.1151 Fig. 3-4 Transceiver Unit (Lower Unit) with front cover removed

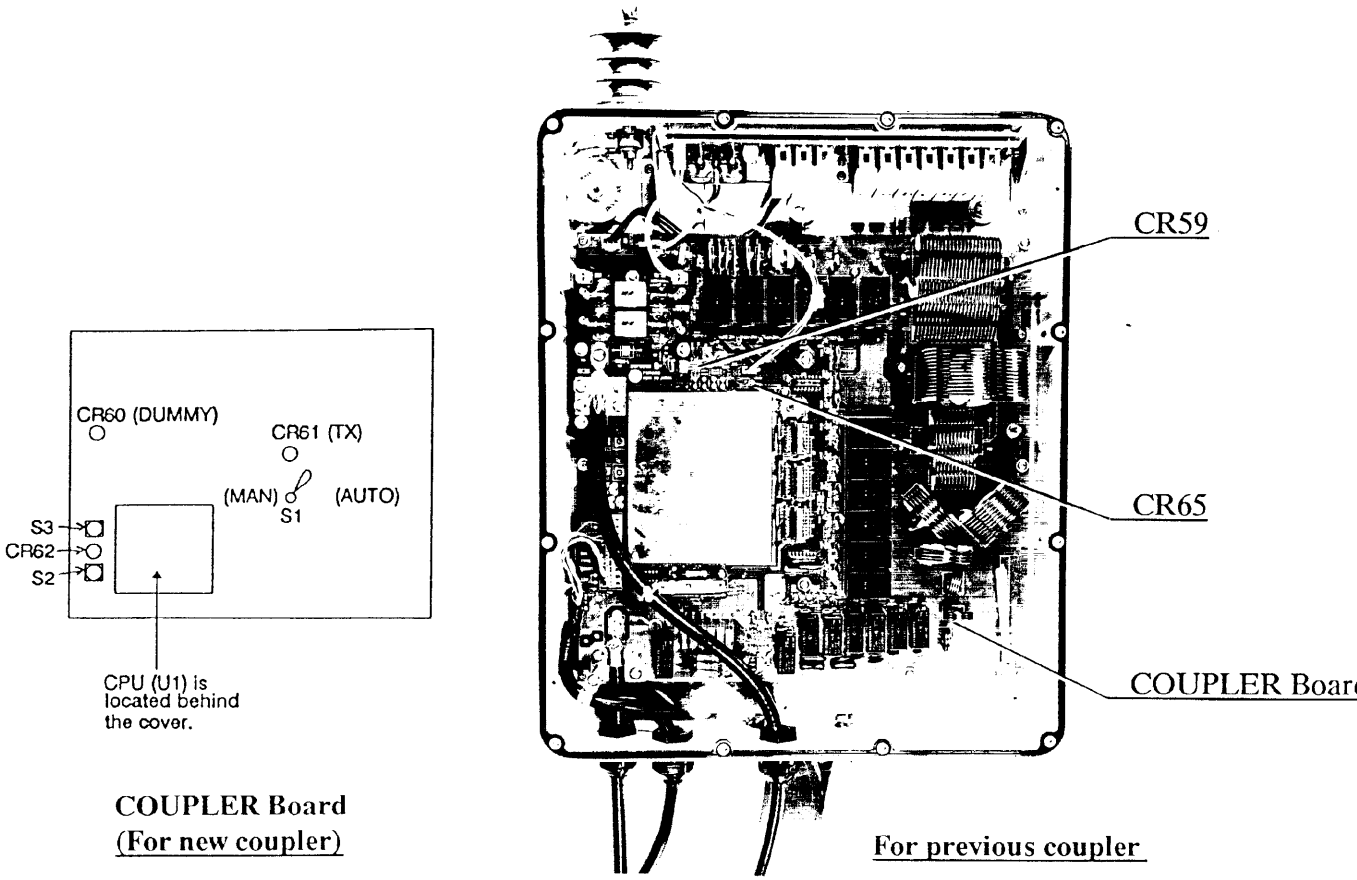
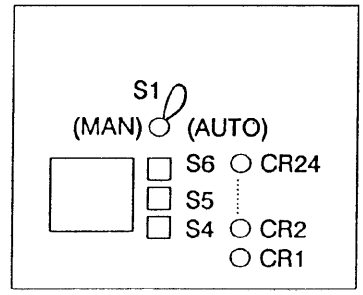


Fig. 3-5 Antenna Coupler

2. SWITCH SETTING

Antenna Coupler

DIP Switch S1 permits manual transmission of 2182kHz in the event the automatic tuning circuit fails.



COUPLER Board
(05P0358-44)

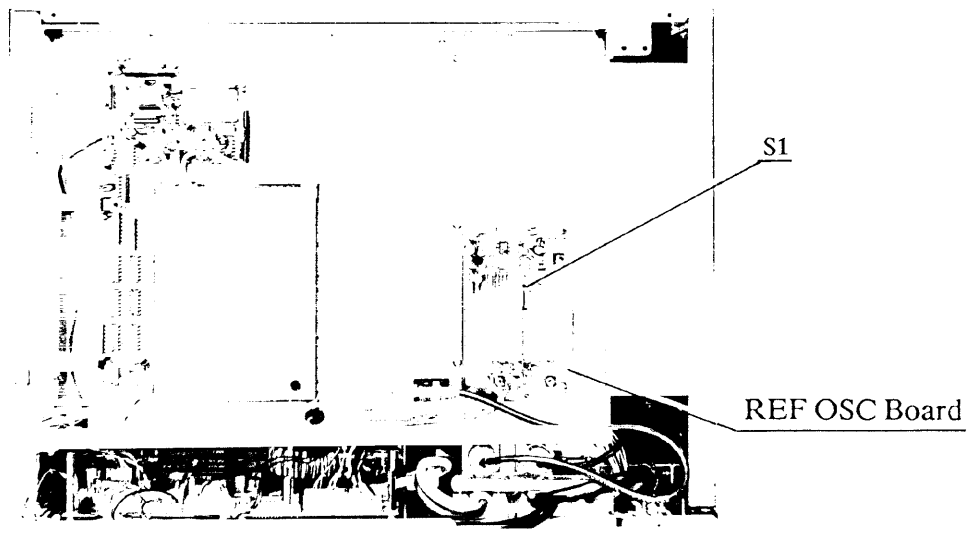
Note that frequencies other than 2182kHz can also be transmitted manually by changing the settings of DIP Switches S4 thru S6. Record the status of LEDs CR1 to CR23 during automatic tuning of an often-used frequency and set DIP switches S4 thru S6 according to LED status with S1 turned to "MAN".

DIP Switch		LED
S4	#8	CR1
	7	CR2
	6	CR3
	5	CR4
	4	CR5
	3	CR6
	2	CR7
	1	CR8
S5	#8	CR9
	7	CR10
	6	CR11
	5	CR12
	4	CR13
	3	CR14
	2	CR15
	1	CR16
S6	#8	CR17
	7	CR18
	6	CR19
	5	CR20
	4	CR21
	3	CR22
	2	CR23

Be sure that S6 #1 is set to "OFF" any time.

REF OSC Board

Slide Switch S1 provides for selection of local oscillator, OSC1 or OSC2. (Same ones) When one is malfunctioning, select the other.



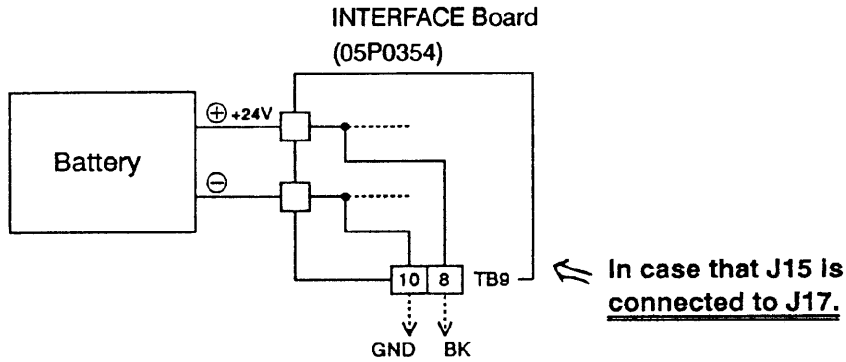
T Photo No.1151

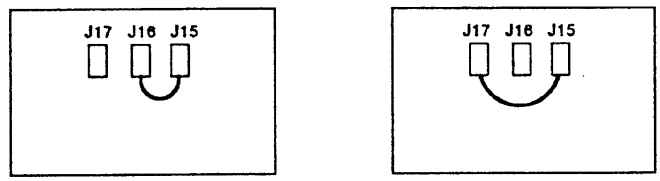
Transceiver Unit (Lower Unit)

3. JUMPER BLOCK SETTING

For the sets produced in Dec. 1992 and after, a jumper block is added to the INTERFACE board (05P0354) in the transceiver unit (lower unit) to enable the BK power for the other radio to be selected.

The +18V or +24V can be supplied by changing the plug connection (J15/J16/J17) on the INTERFACE board as shown below. Be sure that the +24V can not be used when the ground line (signal ground) of the other radio is connected to the chassis, since the ground line of TB9 #10 on the INTERFACE board is directly connected to the battery.





+18 V output
(Factory setting)

+24 V output

INTERFACE Board
(05P0354)

CHAPTER 4 PARTS LOCATION

1. CONTROL UNIT

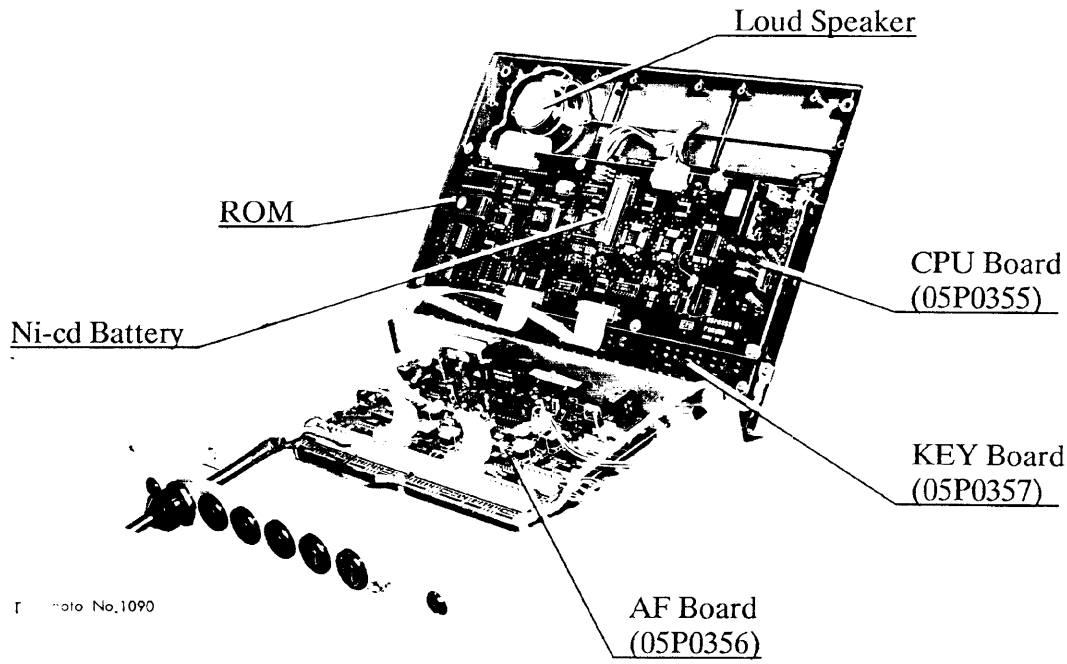


Fig. 4-1

2. TRANSCEIVER UNIT

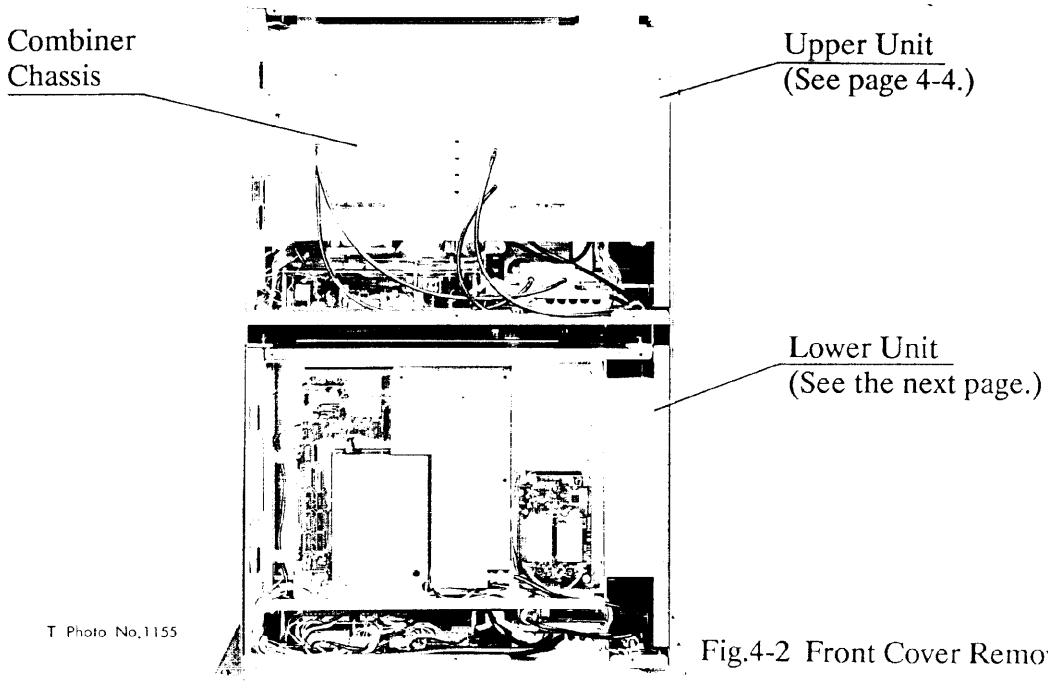


Fig.4-2 Front Cover Removed

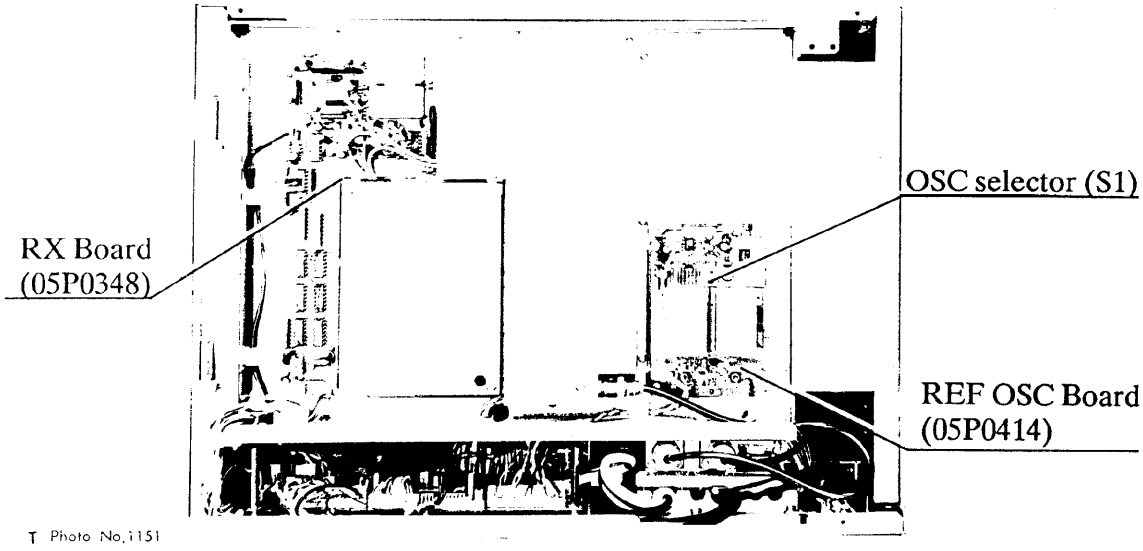


Fig.4-3 Lower Unit

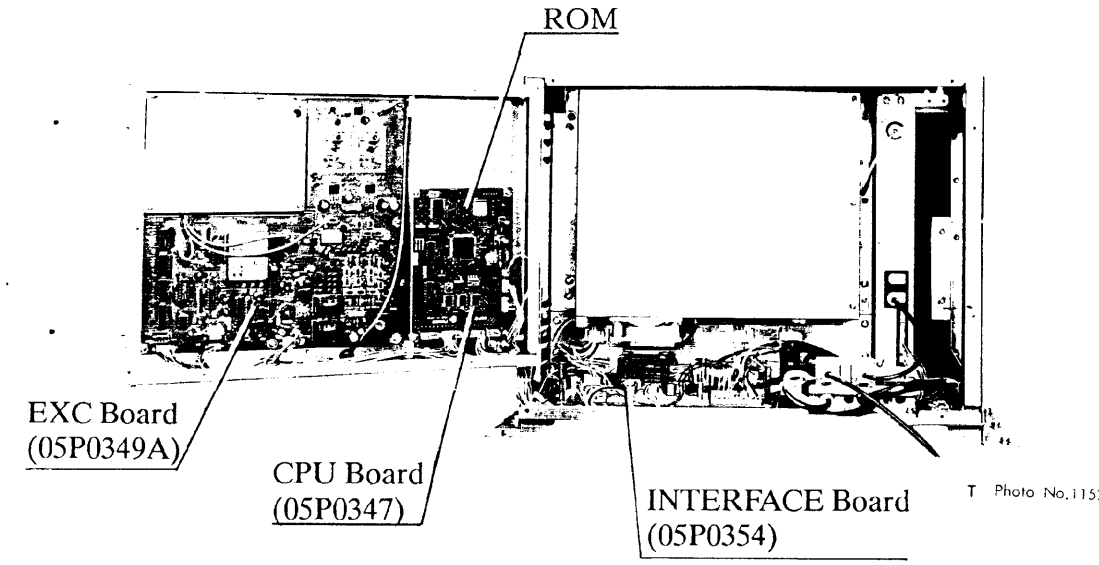


Fig.4-4 Lower Unit (Front Door Opened)

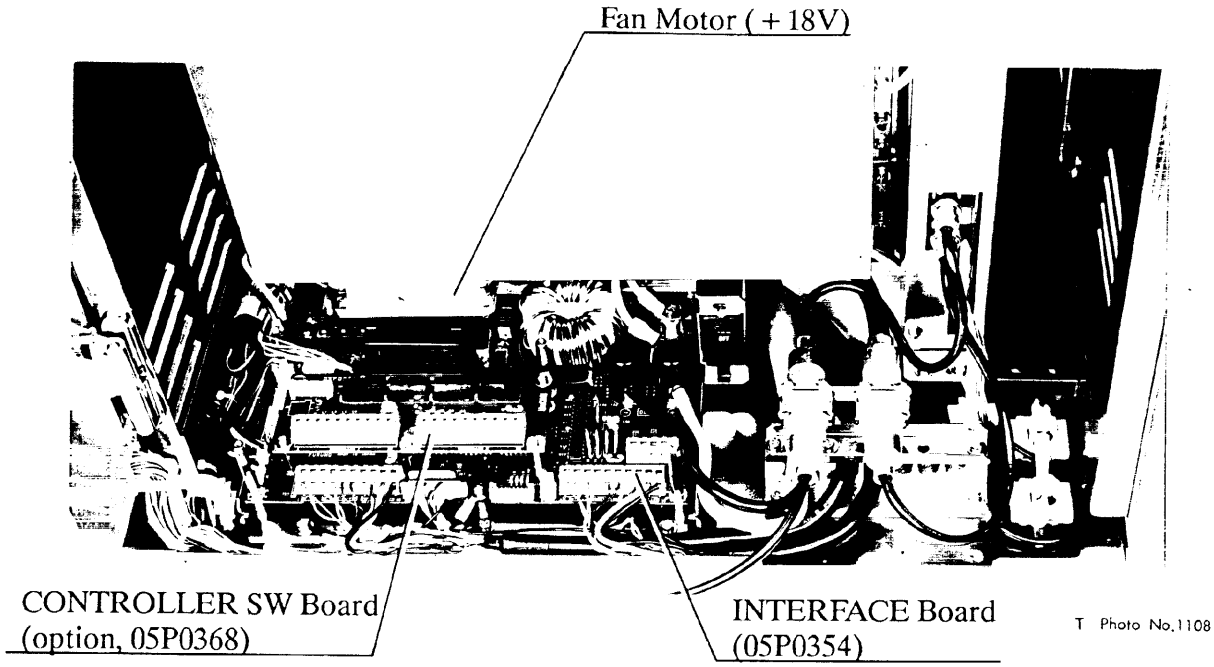


Fig.4-5 Lower Unit (Front Door Opened)

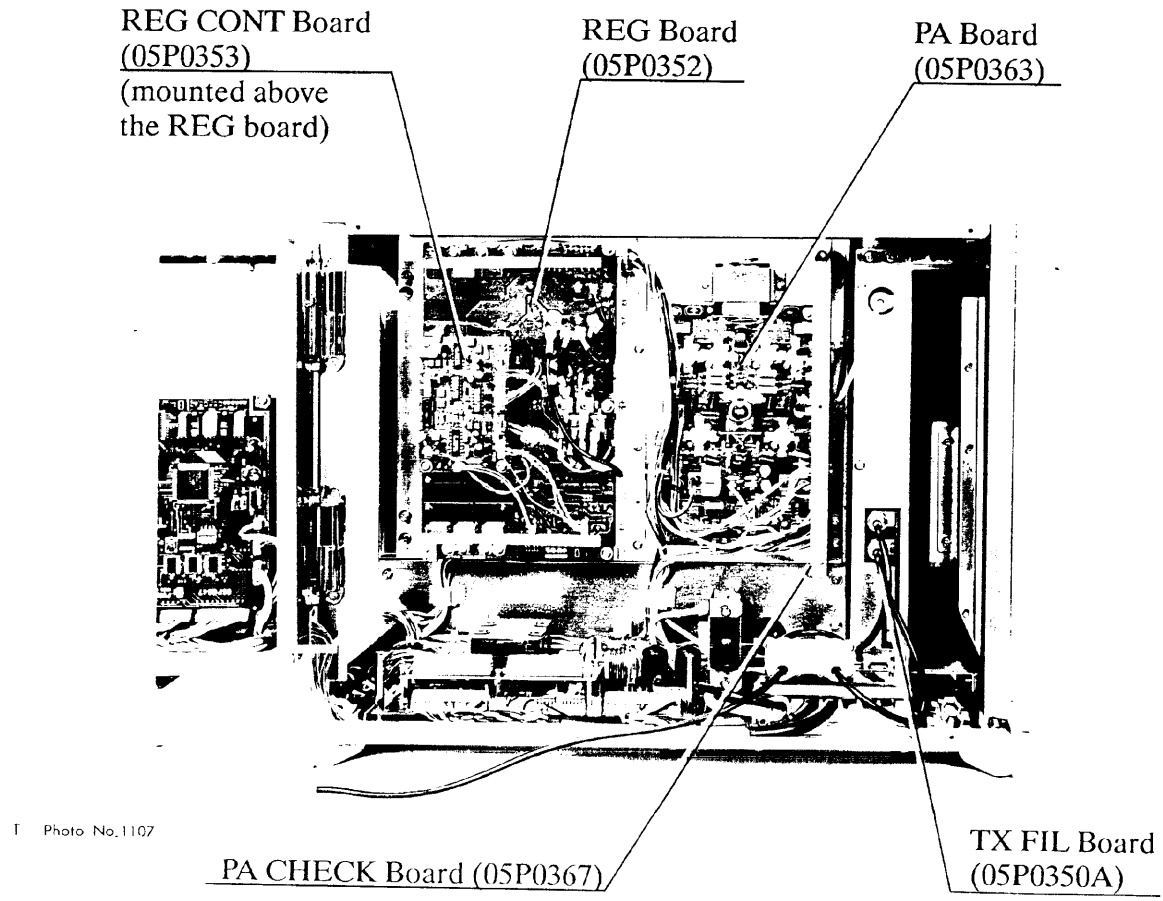


Fig.4-6 Lower Unit

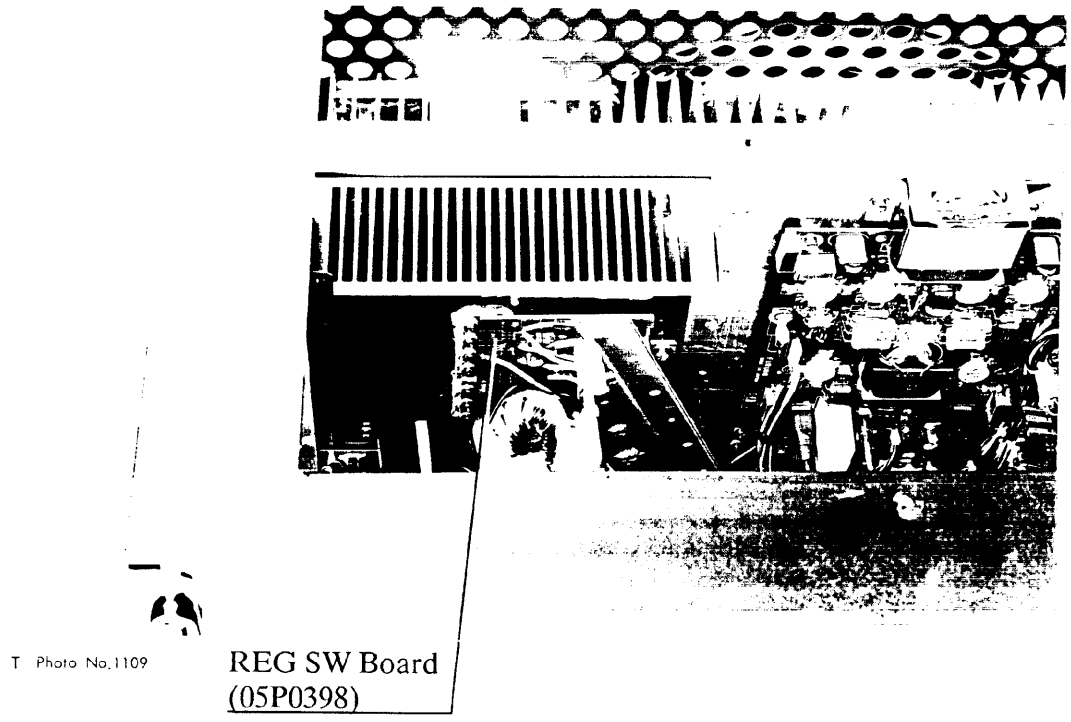

T Photo No.1109
REG SW Board
(05P0398)

Fig.4-7

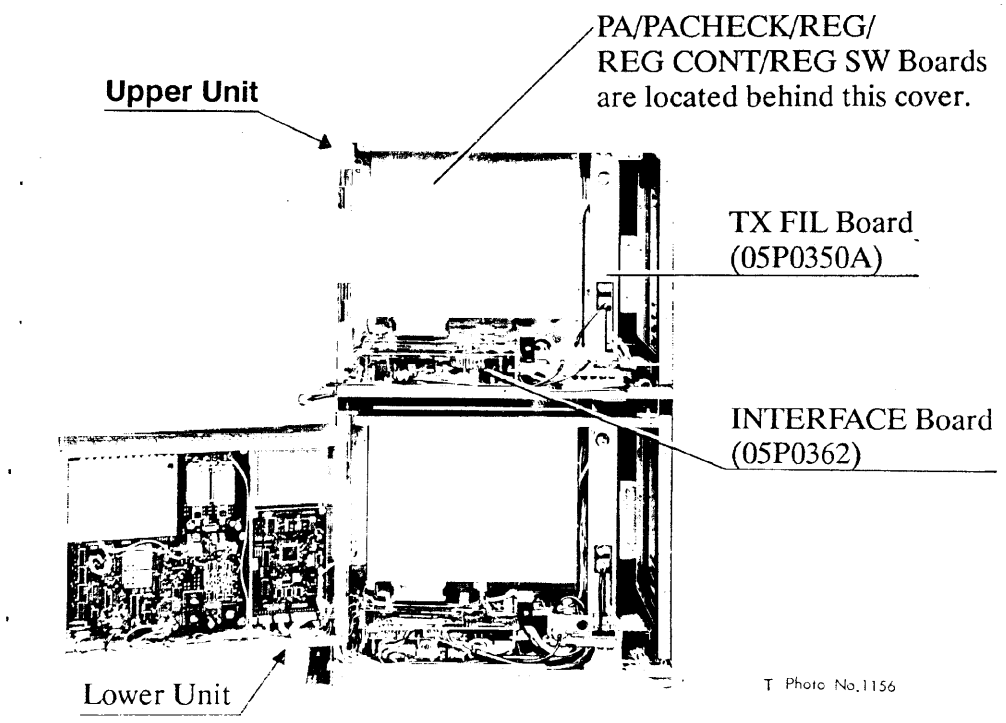
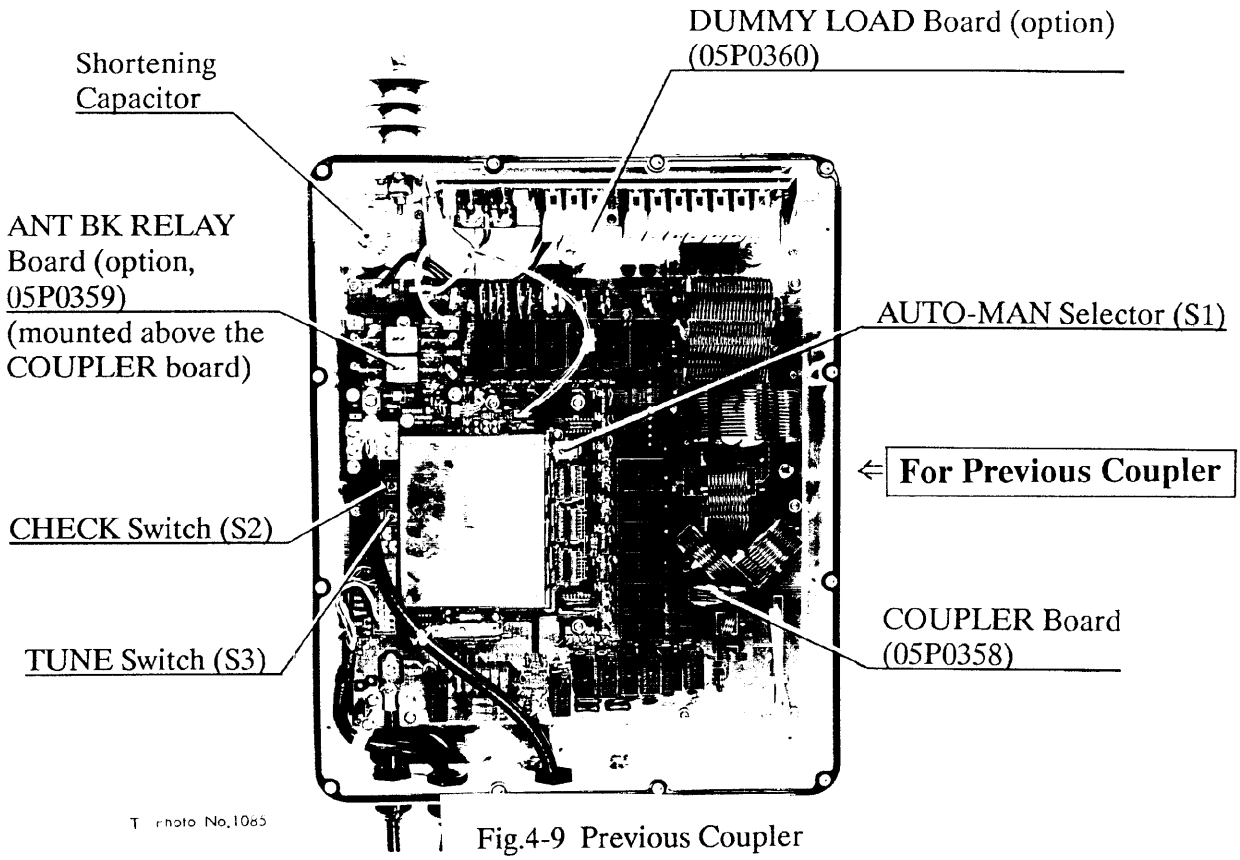

PA/PACHECK/REG/
REG CONT/REG SW Boards
are located behind this cover.
Upper Unit
TX FIL Board
(05P0350A)
INTERFACE Board
(05P0362)
Lower Unit
T Photo No.1156

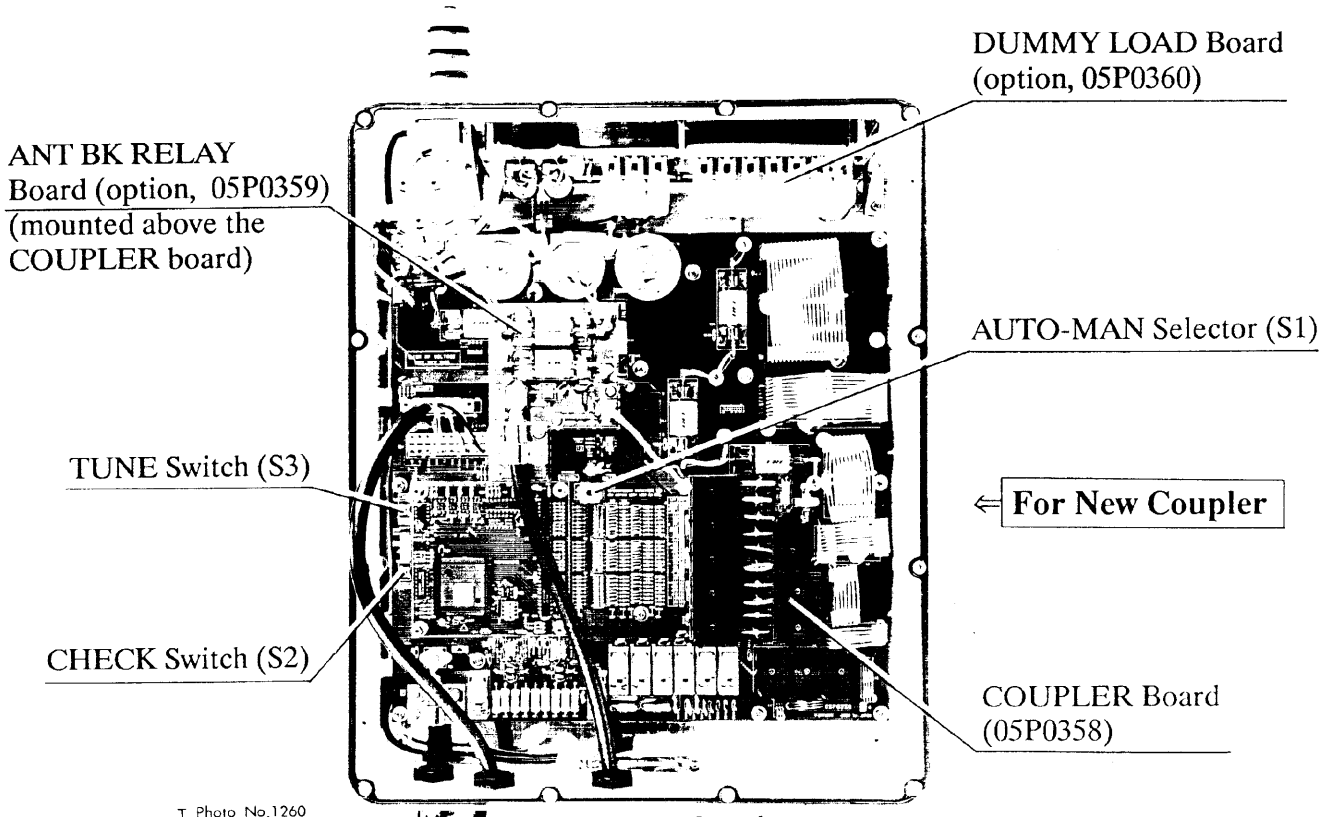
Fig.4-8

3. ANTENNA COUPLER



T Photo No.1065

Fig.4-9 Previous Coupler



T Photo No.1260

Fig.4-10 New Coupler

4. RECTIFIER UNIT (OPTION)

Photo No.1094

Fig.4-11 Cover Removed

CHAPTER 5 TROUBLESHOOTING

1. SELF-DIAGNOSIS TEST

1.1 Control Unit & Transceiver Unit

To execute a self test, press the **RCL** key, enter a test number and hit the **ENT** key. The LCD displays an appropriate indication during testing, and, after completion of the test, the results, either OK or an error message. For error messages, see Appendix 4. To escape from a self test at any time, press any key after the test is completed.

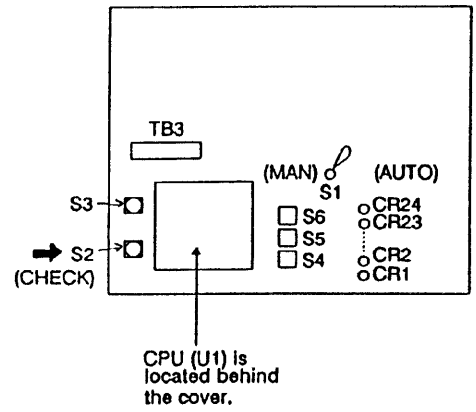
Test No.	Test	Indication During Testing
9900	All self tests except the key/LCD test	
TRANSCEIVER UNIT		
9910	Consecutive execution of tests 9911 to 9916	
9911	TX synthesizer on the EXC Board (PLL)	Checking Tx Local OSC
9912	MIC Input/Output on EXC Board Vc/Ic on PA Boards SWR detection on TX FIL Boards SWR detection on COMBINER Board	Checking Tx board (*)
9913	RX synthesizer on RX Board (PLL)	Checking Rx Local OSC
9914	RX Board	Checking Rx board
9915	ROM (U10) on CPU Board	Checking TRx ROM
9916	RAM (U12) on CPU Board	Checking TRx RAM
CONTROL UNIT		
9920	Consecutive execution of tests 9921-9925	
9921	Key Check The name of each key appears on the LCD. Press each key one by one, and its corresponding indication will be highlighted if the key is functioning properly.	
9922	LCD Check Properly functioning LCD segments appear in highlight.	
9923	AF Board	Checking AF board
9924	ROM (U9) on the CPU Board	Checking Control ROM
9925	RAM (U15/U21) on the CPU Board	Checking Control RAM
Connection between Transceiver Unit and Antenna Coupler		
9930	Connection between Transceiver Unit and Antenna Coupler	Checking ATU (*)

(*) If some board is faulty, an error message appears. The message with "800 W unit" means the boards in the upper unit.
ex "No TX signal on TX FIL PCB" ---------- in lower unit
"No TX signal on TX FIL PCB (800 W unit)" --- in upper unit

1.2 Antenna Coupler

To check the Antenna Coupler for proper operation, press the **CHECK** button (S2) on the Coupler Board. The relays start chattering and LEDs CR1 to CR24 blink one by one in ascending order. If device failure is found, an appropriate LED lights to indicate the offending device:

Device	LED
ROM	CR1
RAM	CR2
A/D converter or SWR detector	CR3



CHECK Button on the Coupler Board

NOTE: ROM/RAM/A/D converter are incorporated in the CPU.

2. TROUBLESHOOTING MATRIX TABLE

This section provides a troubleshooting matrix table which helps the service technician to quickly identify defective pcb's or blocks. To use the table, locate the symptom in one of the three columns of the table. Possibly defective circuits and their likelihood of defectiveness, indicated by a circle, star or triangle, corresponding to 70 - 80%, approximately 20% and a few percent respectively, are listed in each column. Numeral inside circle shows degrees of possibility; the smaller the number, the higher the possibility.

NOTE: 1. Check the ship's mains (input supply voltage: 24 or 32VDC) for proper voltage before using the matrix table.

2. If more extensive troubleshooting is required, refer to the troubleshooting flow chart number given below the symptom number.

Symptom / Flow Chart No. / Ref. Page / Check Points		① Power can not be supplied. ② Power is supplied but nothing appears on the LCD. ③ Keyboard locks.			④ CIF/NMEA data is not input. ⑤ Cannot hear receiving signal. ⑥ No automatic tuning.			⑦ Output power is insufficient.		
		1	2	3	4	5	6	7		9
		1 (5-5)	2 (5-7)	3 (5-8)	4 (5-8)	5 (5-9)	6 (5-11)	7 (5-12)		
CONTROL UNIT	AF PCB (05P0356)				△	②		③		
	CPU PCB (05P0355)		①	①	①					
	KEYBOARD (05P0357)	△		②						
	LCD ASSY		②							
	SPEAKER					☆				
TRANSCEIVER UNIT	INTERFACE PCB (05P0354)	①					②			
	EXC PCB (05P0349)							②		
	PA PCB (05P0363)							①		
	TX FIL PCB (05P0350)							△		
	COMBINER CHASSIS					△		☆		
	RX PCB (05P0348)					①				
	REF OSC PCB (05P0414)					☆				
	CPU PCB (05P0347)	☆					☆			
	REG PCB (05P0352) (*1)	△								
	REG CONT PCB (05P0353) (*1)	③								
	REG SW PCB (05P0398) (*1)	②								
ANTENNA COUPLER	COUPLER PCB (05P0358)						①			
	ANT BK RELAY PCB (05P0359, option)									
	DUMMY LOAD PCB (05P0360, option)									
	RECTIFIER UNIT (PR-850, option)	△								

(*1): These are supplied as a REG UNIT.

Two REG UNITs and two PA/PA CHECK/TX FIL PCBs are incorporated in the transceiver unit.

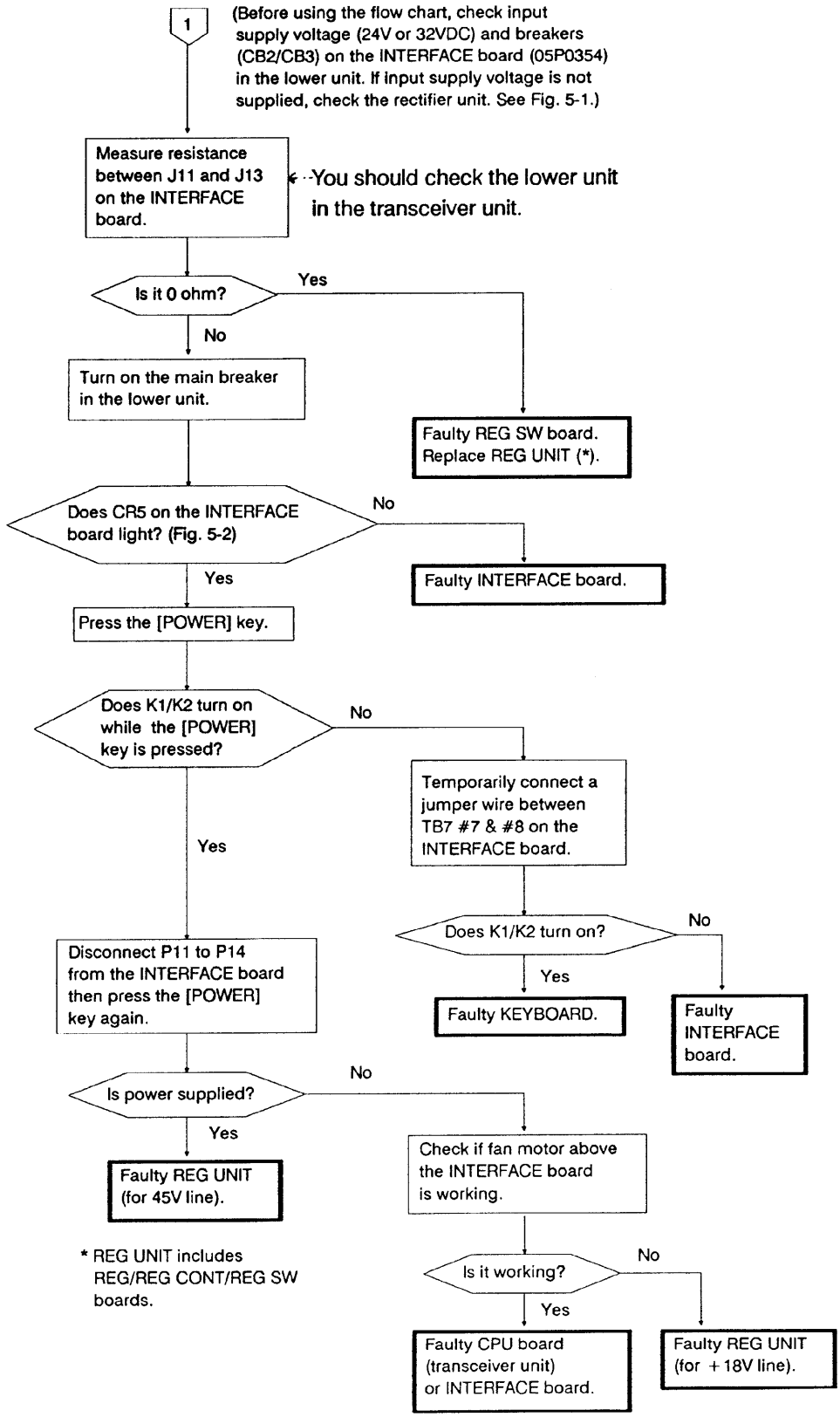
Likelihood of defectiveness

○-------70 to 80%

☆-------20% approx.

△-------a few percent

Symptom 1 Power can not be supplied.



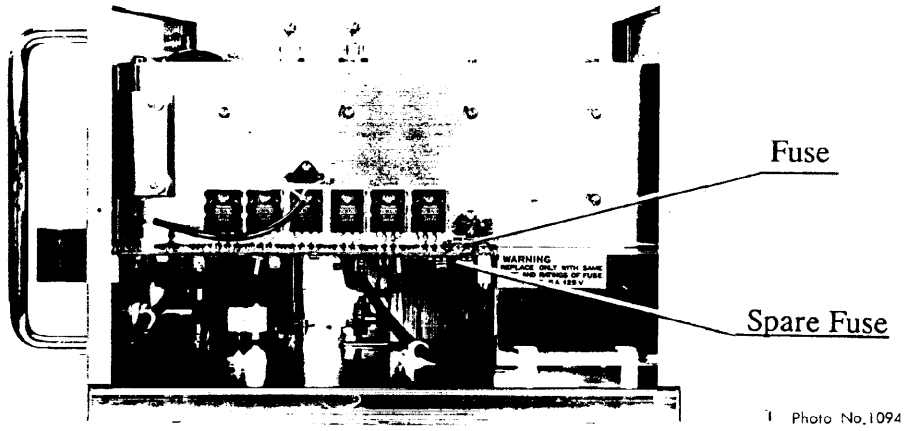


Fig. 5-1 Rectifier Unit

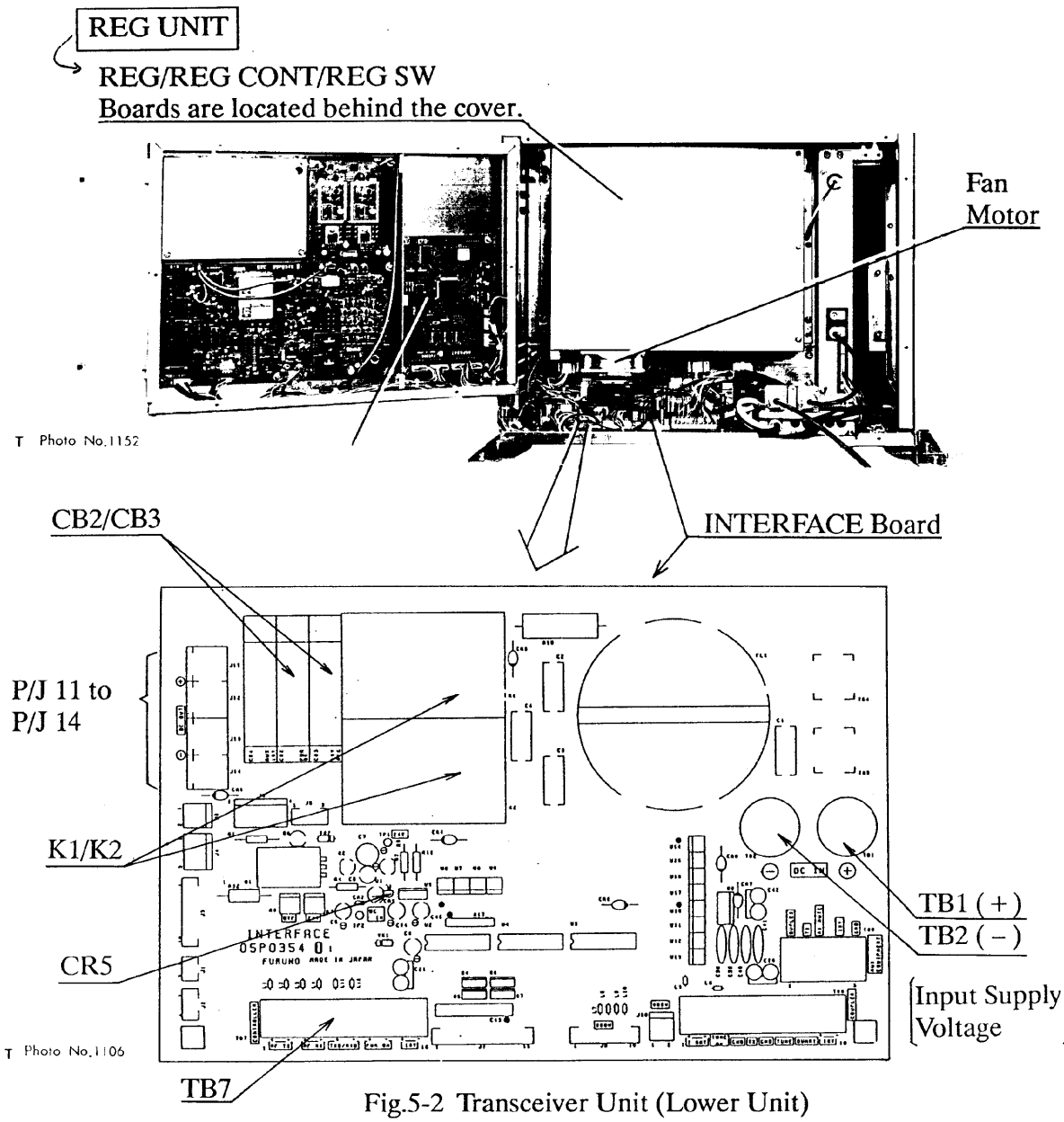
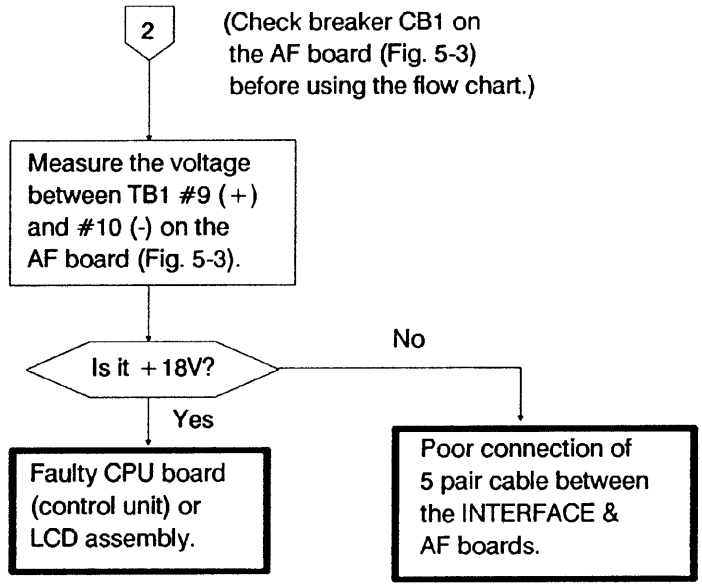


Fig.5-2 Transceiver Unit (Lower Unit)

Symptom 2 Nothing appears on the LCD.



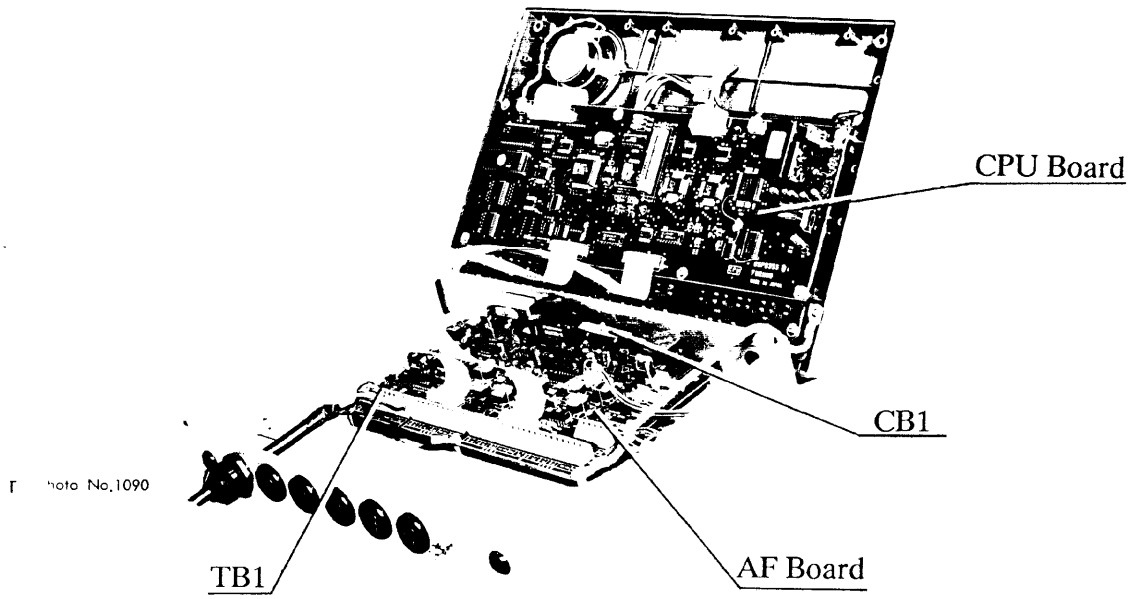
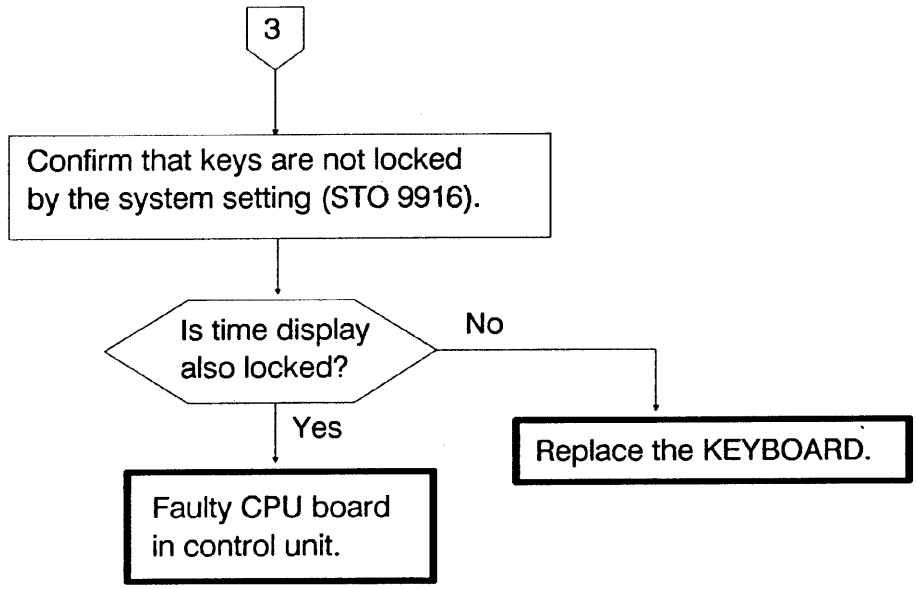
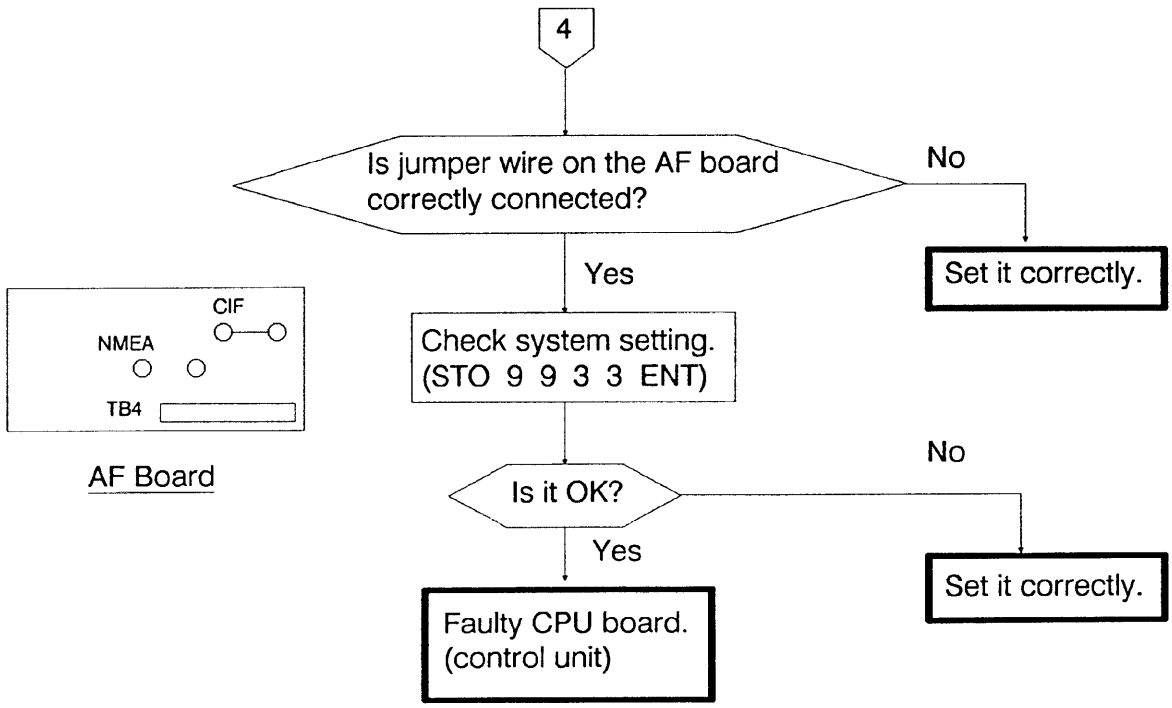


Fig. 5-3 Control Unit

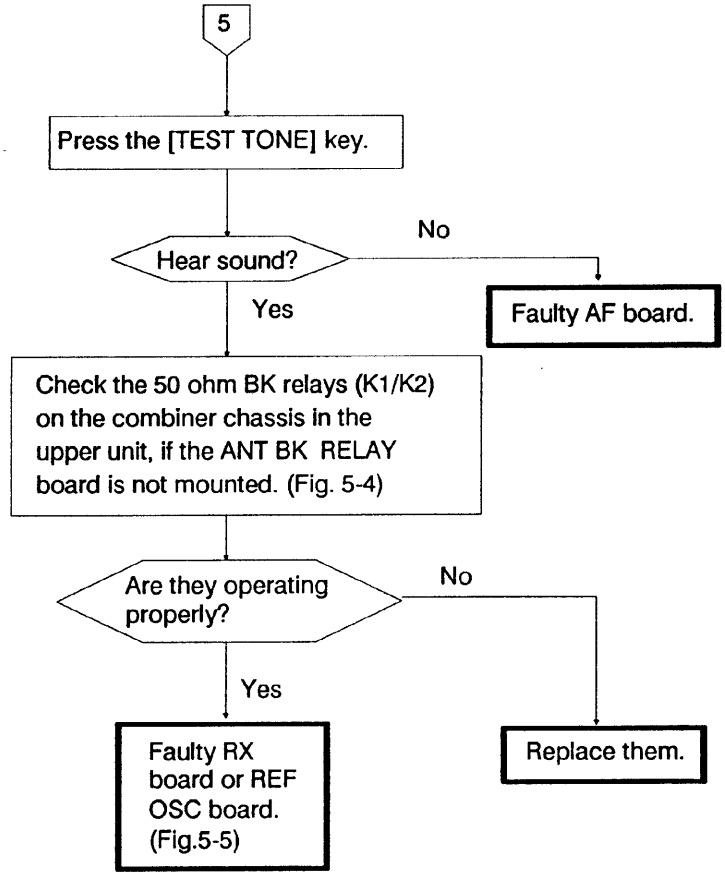
Symptom 3 Keyboard locks.



Symptom 4 CIF/NMEA data is not input.



Symptom 5 Cannot hear receiving signal.



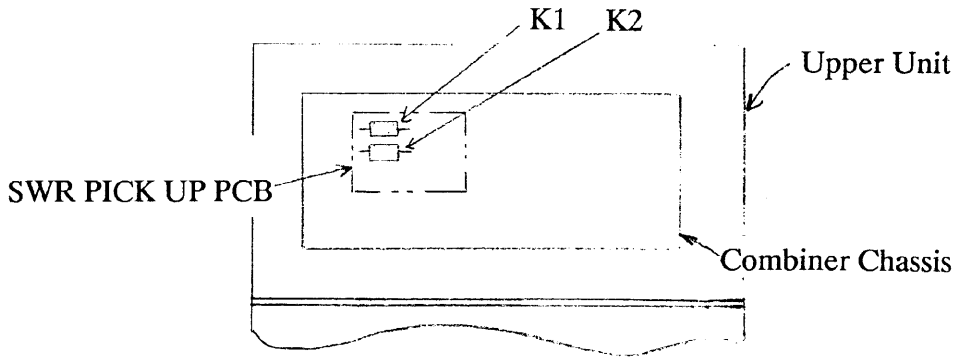


Fig.5-4

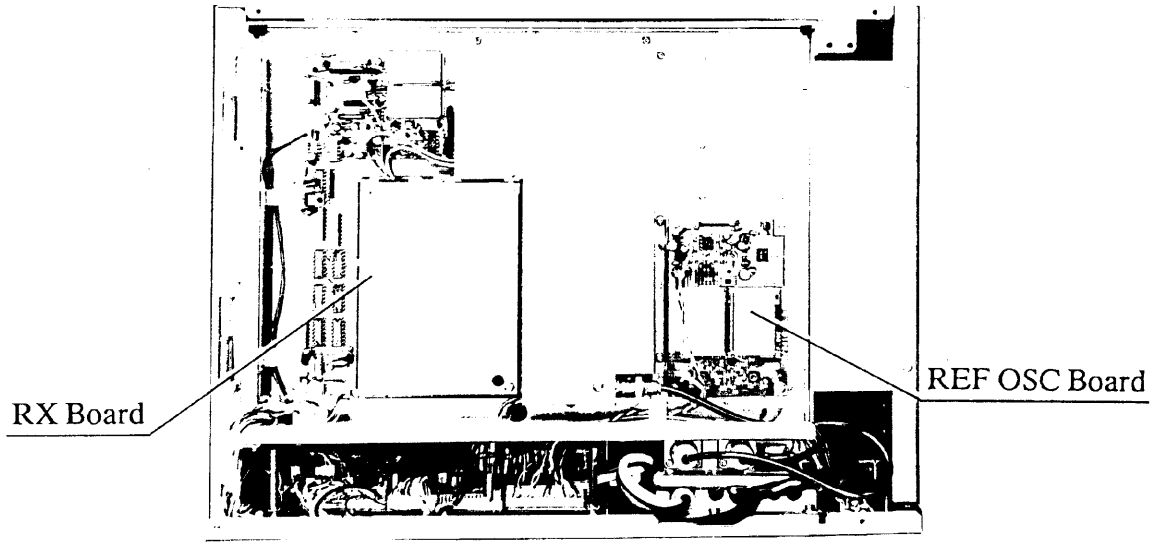
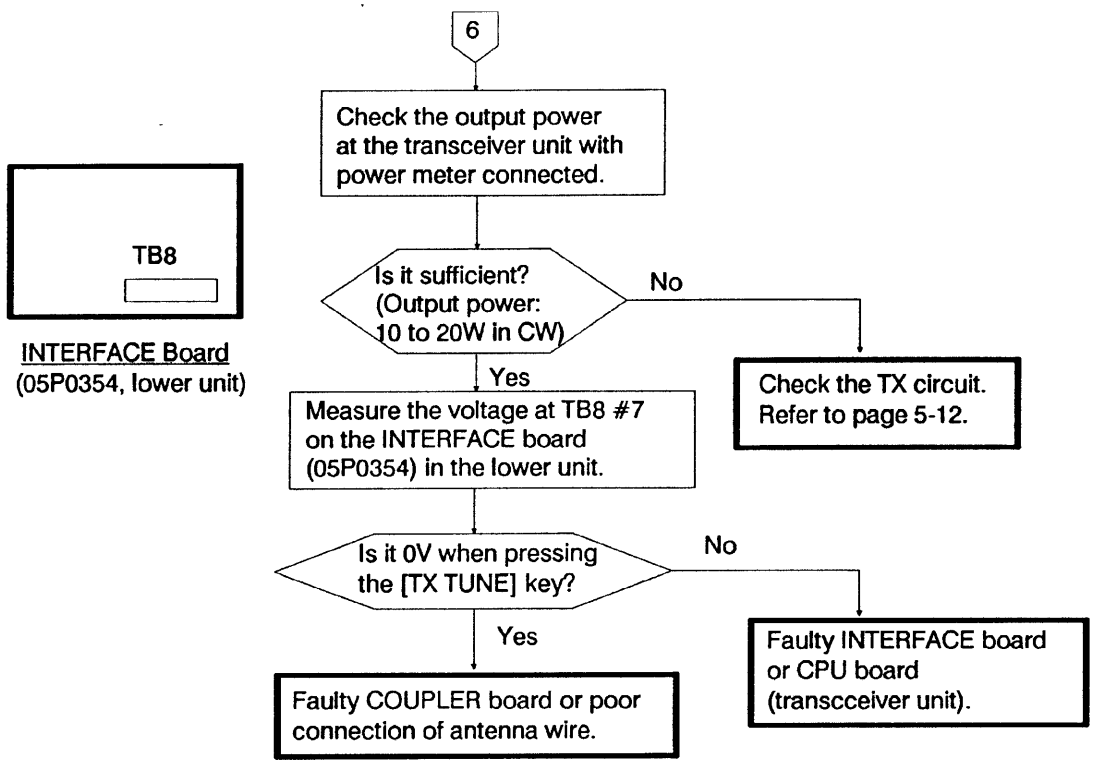
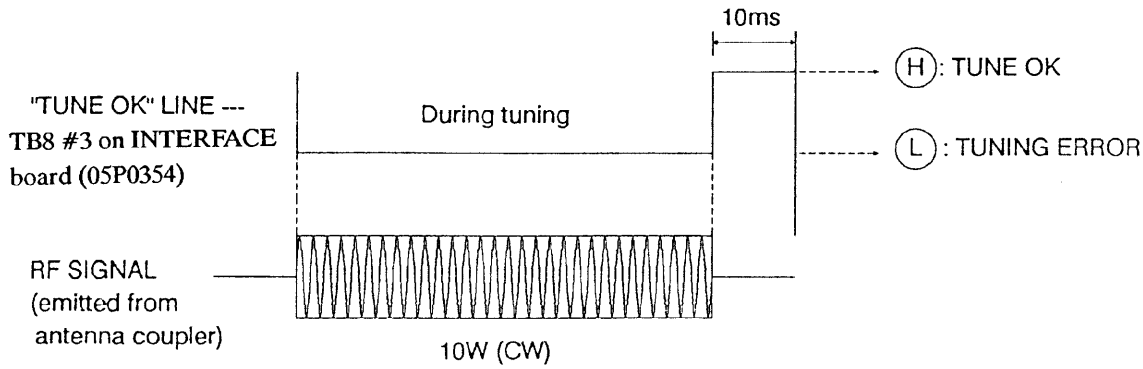


Fig.5-5 Transceiver Unit (Lower Unit)

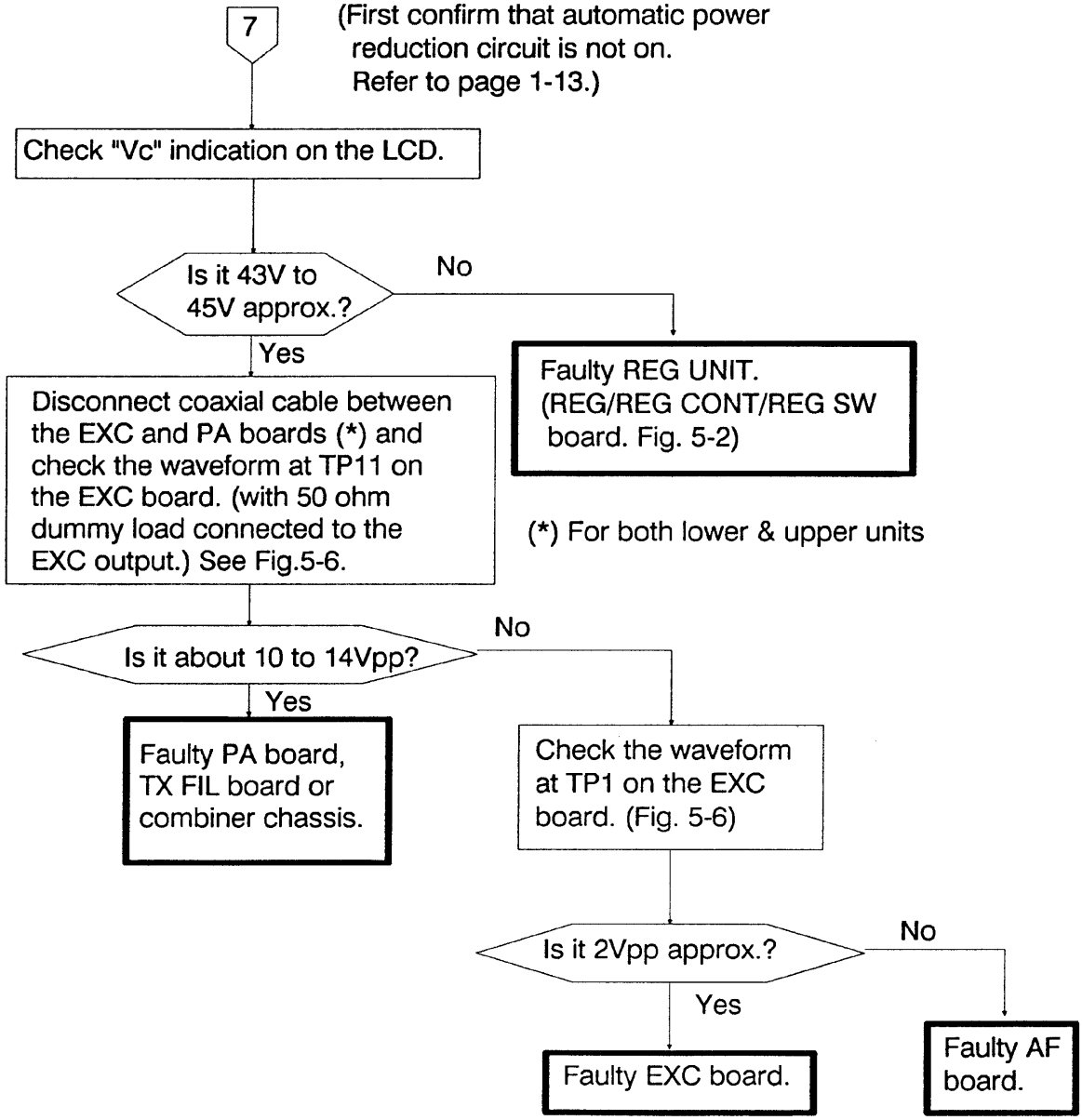
Symptom 6 No automatic tuning.



Note: After tuning is completed, TUNE OK line level at TB8 #3 on the INTERFACE board (05P0354) goes low when best tuning point could not be found. ("TUNING ERROR" is displayed.)



Symptom 7 Output power is insufficient.



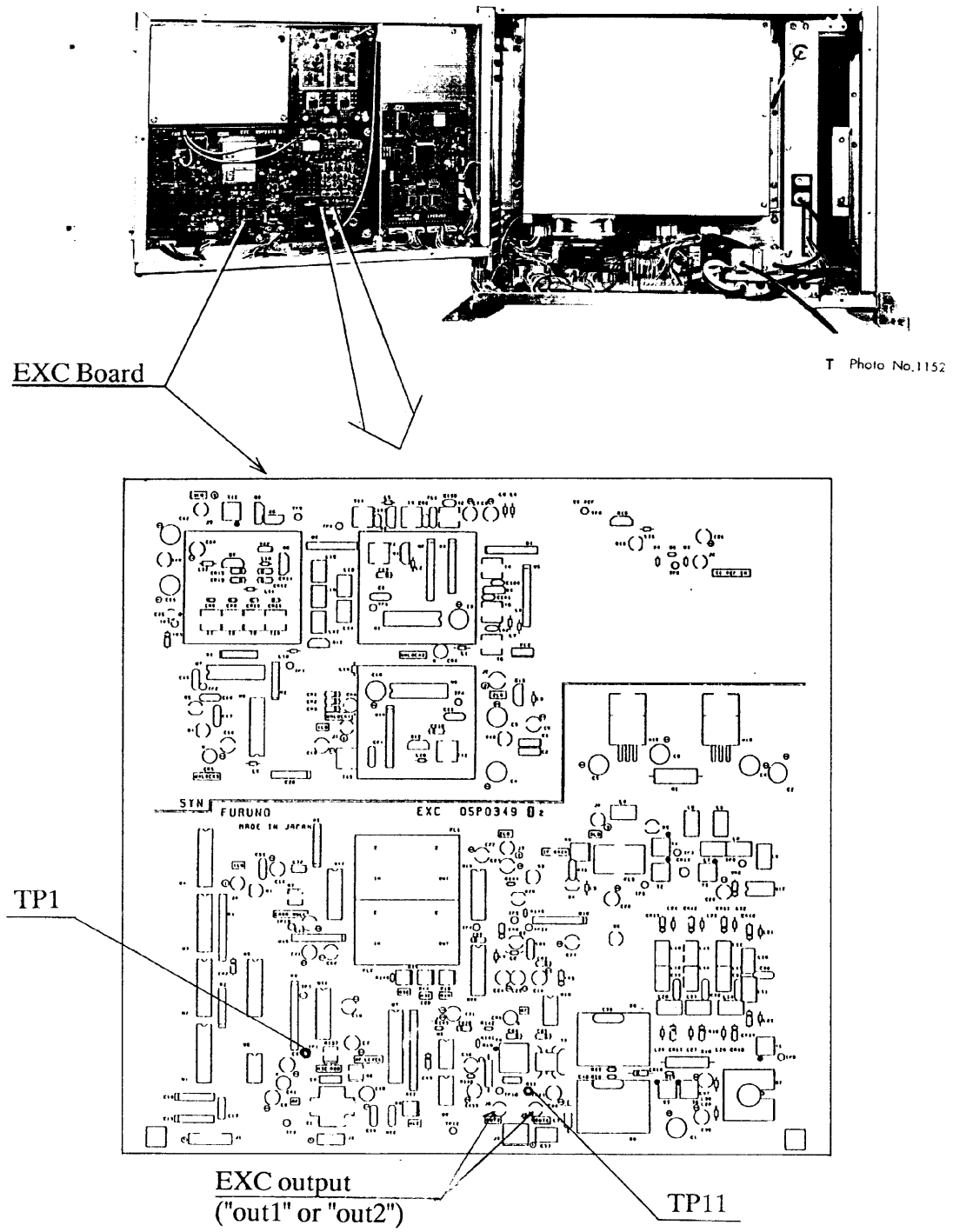


Fig.5-6 Transceiver Unit (Lower Unit)

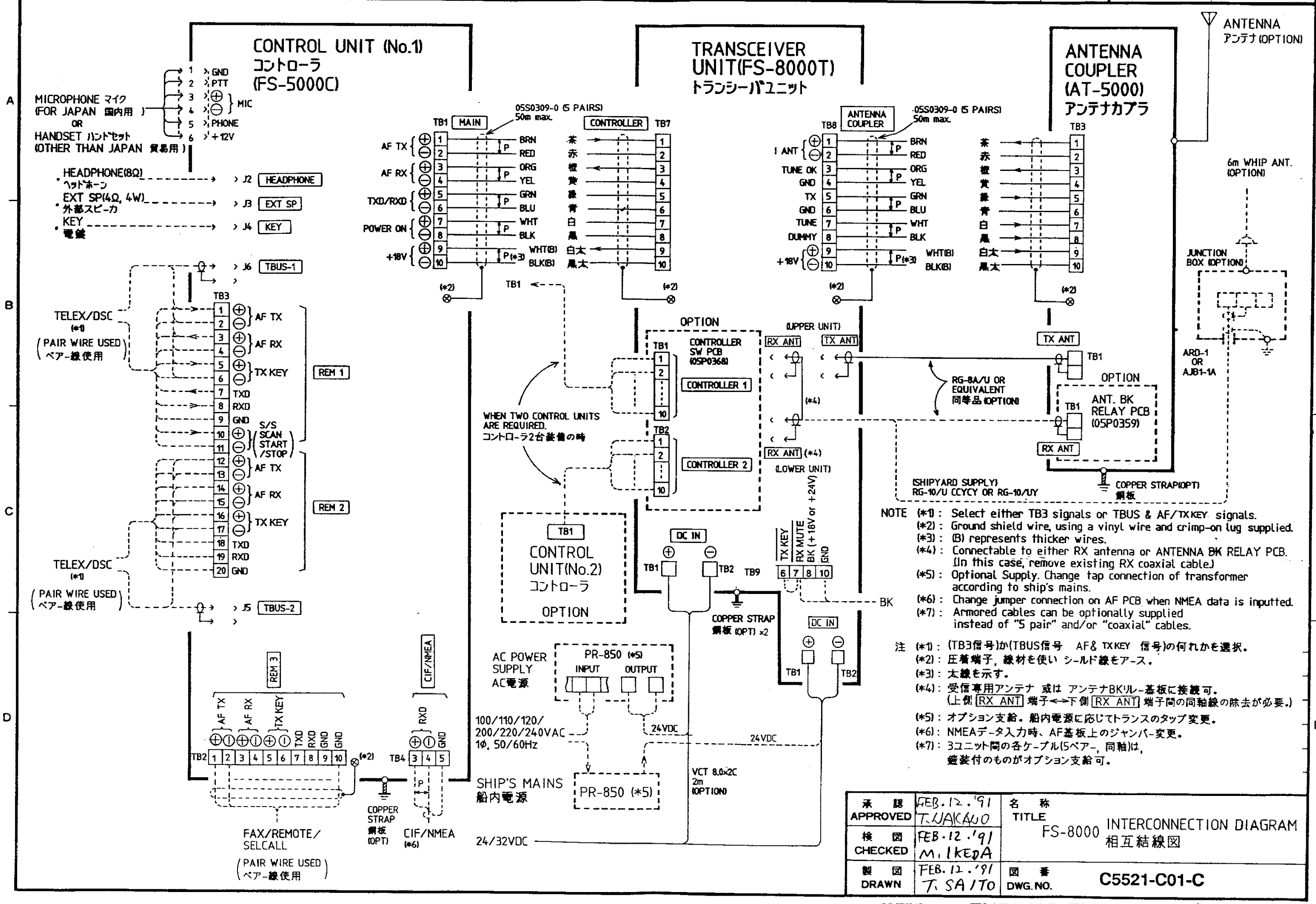
MAINTENANCE PARTS LIST NO.M61900
FOR FS-5000/8000

*1:DEPOT MAINTENANCE PARTS FOR 10 SETS IN 2 YEARS
*2:SHIPBORNE RUNNING PARTS FOR 1 SET IN 2 YEARS

CODE NO.	NAME OF PARTS	TYPE	SPECIFICATIONS	QUANTITY *1	QUANTITY *2	REMARKS
000-119-440	TRANSISTOR	MRF-448MP	05S0546-1	6	2	PA PCB (2 PAIRS)
000-121-823	MOS FET	IRFP150		6	2	REG SW PCB
000-104-429	DIODE	05AZ18Z	ZENER	6	2	REG SW PCB
000-106-066	RELAY	JR1-DC12V	AJR3221	1	1	TX FIL PCB (50 OHMS BK)
000-106-068	RELAY	JC1AF-DC12V	AR321173	3	1	COUP PCB
000-106-069	RELAY	FRD-12023		3	1	COUP PCB
000-106-216	RELAY	JC2AF-DC12V	AR322173	3	1	COUP PCB
000-116-371	RELAY	HD1-M-DC12V	AG4013	1	1	RX PCB
000-119-485	RELAY	JR1A-DC12V	AJR3211	3	1	COUP PCB
000-445-356	RELAY	JH2A-DC24V AR5222		1	1	INTERFACE PCB
000-113-376	CRYSTAL	05S0402-0 49.5MHZ	05S0402-0	1	1	EXC PCB
000-119-322	FAN MOTOR	MD1225A-24		1		FOR PA COOLING
000-121-337	MOTOR	109E0824H402		1		
000-580-091	LOUDSPEAKER	EAS-65P16S	8, 2W	1		
000-112-623	HANDSET WITH CURL CORD	HS6000FZ5		1	1	
000-835-126	NI-CD BATTERY	N-50SB3		2		
005-594-140	PRINTED CIRCUIT BOARD	05P0367 PA CHECK	FS-5000T/8000T	3	1	
005-594-200	PRINTED CIRCUIT BOARD	05P0347 CPU	FS-5000T/8000T	3	1	TRANSCEIVER UNIT
005-594-220	PRINTED CIRCUIT BOARD	05P0348 RX	FS-5000T/8000T	3	1	
005-594-240	PRINTED CIRCUIT BOARD	05P0349 EXC	FS-5000T	3	1	OLD ONE. ONLY FOR FS-5000
005-594-290	PRINTED CIRCUIT BOARD	05P0358 COUPLER	AT-5000	3	1	
005-594-520	PRINTED CIRCUIT BOARD	05P0357 KEY	FS-5000C	3	1	
005-594-540	PRINTED CIRCUIT BOARD	05P0355 CPU	FS-5000C	3	1	CONTROL UNIT
005-594-560	PRINTED CIRCUIT BOARD	05P0356 AF	FS-5000C	3	1	
005-594-710	PRINTED CIRCUIT BOARD	05P0359	ANT BK RELAY	1		OPTION
005-594-730	PRINTED CIRCUIT BOARD	05P0368	CONTROLLER SW	1		OPTION
005-594-990	PRINTED CIRCUIT BOARD	05P0362 I/F 24V	FS-8000T	3	1	ONLY FOR FS-8000/24VDC
005-595-010	PRINTED CIRCUIT BOARD	05P0413 SWR PICKUP	FS-8000T	3	1	ONLY FOR FS-8000
005-927-240	PRINTED CIRCUIT BOARD	05P0350 TX FIL	FS-5000T	3	1	ONLY FOR FS-5000
005-927-250	PRINTED CIRCUIT BOARD	05P0354 I/F 24V	FS-5000T/8000T	3	1	FOR 24VDC SET
005-927-460	PRINTED CIRCUIT BOARD	LM24008M LCD	FS-5000C	3	1	
005-927-610	DUMMY LOAD PCB ASSEMBLY	05P0360	FS5000/8000	1		OPTION. W/MOUNTING PLATE
005-931-830	REG ASSEMBLY (32V)	FS-5000/8000T	REG/R CONT.P.	3	1	OLD ONE. FOR 32VDC SET
005-931-840	PRINTED CIRCUIT BOARD	05P0349A EXC	FS-8000T	3	1	OLD ONE. ONLY FOR FS-8000
005-941-810	PA PCB ASSEMBLY	05P0363 W/HEAT SINK	FS-5000T/8000T	3	1	OLD ONE
005-942-450	REG ASSEMBLY (24V)	FS-5000/8000T	REG/R CONT.P.	3	1	OLD ONE. FOR 24VDC SET
005-943-020	PA/REG ASSEMBLY (24V)	05P0363 W/REG.SHIELD	FS-5000T/8000T	1		FOR 24VDC SET
005-943-030	PA/REG ASSEMBLY (32V)	05P0363A W/REG COVER	FS-5000T/8000T	1		FOR 32VDC SET
005-943-040	REG ASSEMBLY (24V)-Z	05P0352Z/353Z/398Z	FS-5000T/8000T	3	1	NEW ONE. FOR 24VDC SET

CODE NO.	NAME OF PARTS	TYPE	SPECIFICATIONS	QUANTITY *1	QUANTITY *2	REMARKS
005-943-050	REG ASSEMBLY (32V)-Z	05P0352Z/353AZ/398Z	FS-5000T/8000T	3	1	NEW ONE. FOR 32VDC SET
005-943-060	PA PCB ASSEMBLY-Z	05P0363 W/HEAT SINK	FS-5000T/8000T	3	1	NEW ONE
005-943-070	PRINTED CIRCUIT BOARD	05P0349-Z EXC	FS-5000T	3	1	NEW ONE. ONLY FOR FS-5000
005-943-080	PRINTED CIRCUIT BOARD	05P0414 REF OSC	FS-5000T/8000T	3	1	
005-943-090	PRINTED CIRCUIT BOARD	05P0354A I/F	FS-5000T/8000T	3	1	FOR 32VDC SET
005-943-100	PRINTED CIRCUIT BOARD	05P0349A-Z EXC	FS-8000T	3	1	NEW ONE. ONLY FOR FS-8000
005-943-110	PRINTED CIRCUIT BOARD	05P0350A TX FIL	FS-8000T	3	1	ONLY FOR FS-8000
005-943-120	PRINTED CIRCUIT BOARD	05P0362A I/F 32V	FS-8000T	3	1	ONLY FOR FS-8000/32VDC
005-943-130	PRINTED CIRCUIT BOARD	05P0437 UNBAL DET	FS-8000T	3	1	ONLY FOR FS-8000
000-119-467	FLEXIBLE CABLE	SMCD-1.25-20-400-NBD		1	1	CONTROL UNIT

LIST OF SCHEMATIC DIAGRAMS



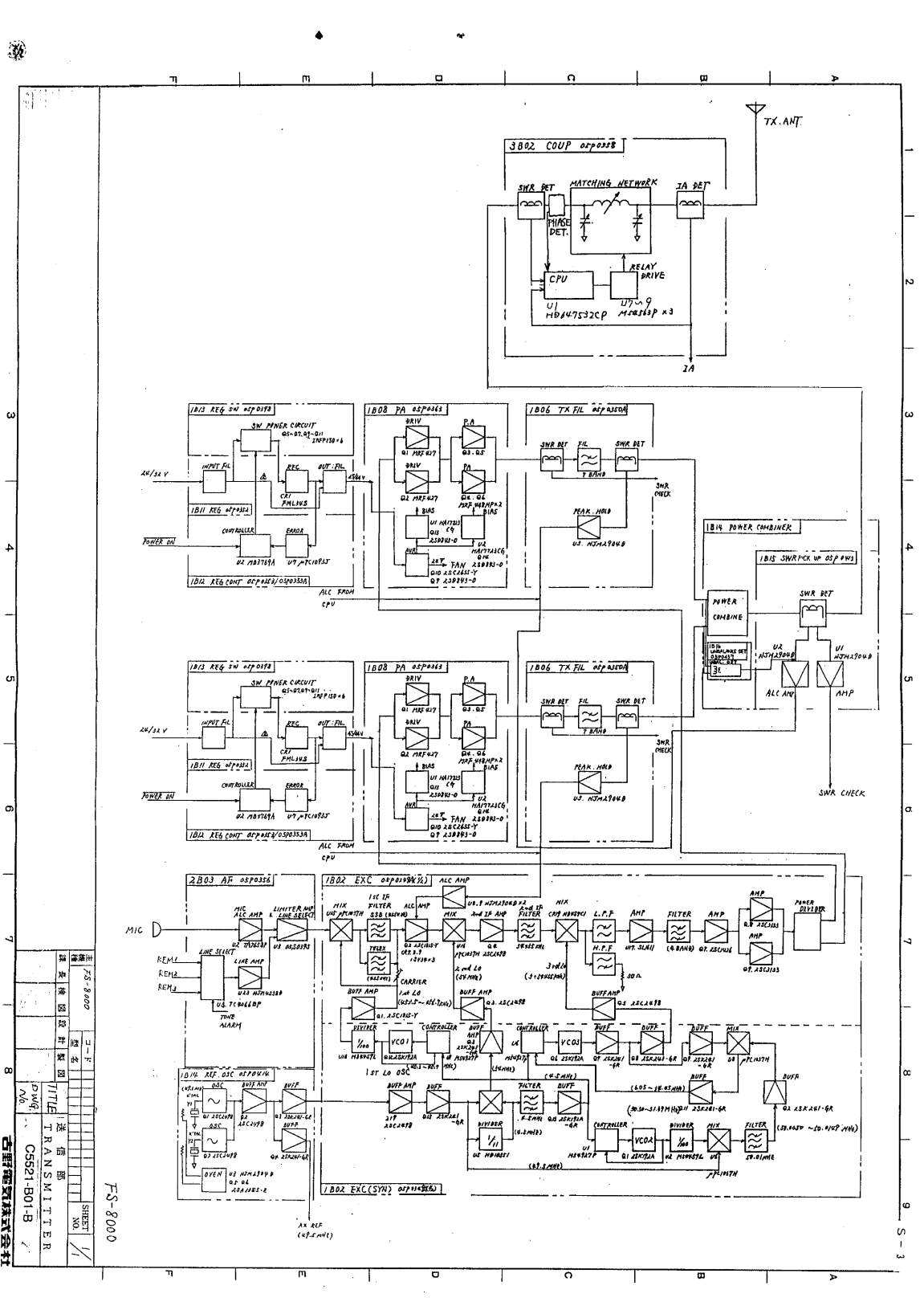
NOTE
(*1): Select either TB3 signals or TBUS & AF/TXKEY signals.
(*2): Ground shield wire, using a vinyl wire and crimp-on lug supplied.
(*3): (B) represents thicker wires.
(*4): Connectable to either RX antenna or ANTENNA BK RELAY PCB. (In this case, remove existing RX coaxial cable.)
(*5): Optional Supply. Change tap connection of transformer according to ship's mains.
(*6): Change jumper connection on AF PCB when NMEA data is inputted.
(*7): Armored cables can be optionally supplied instead of "5 pair" and/or "coaxial" cables.

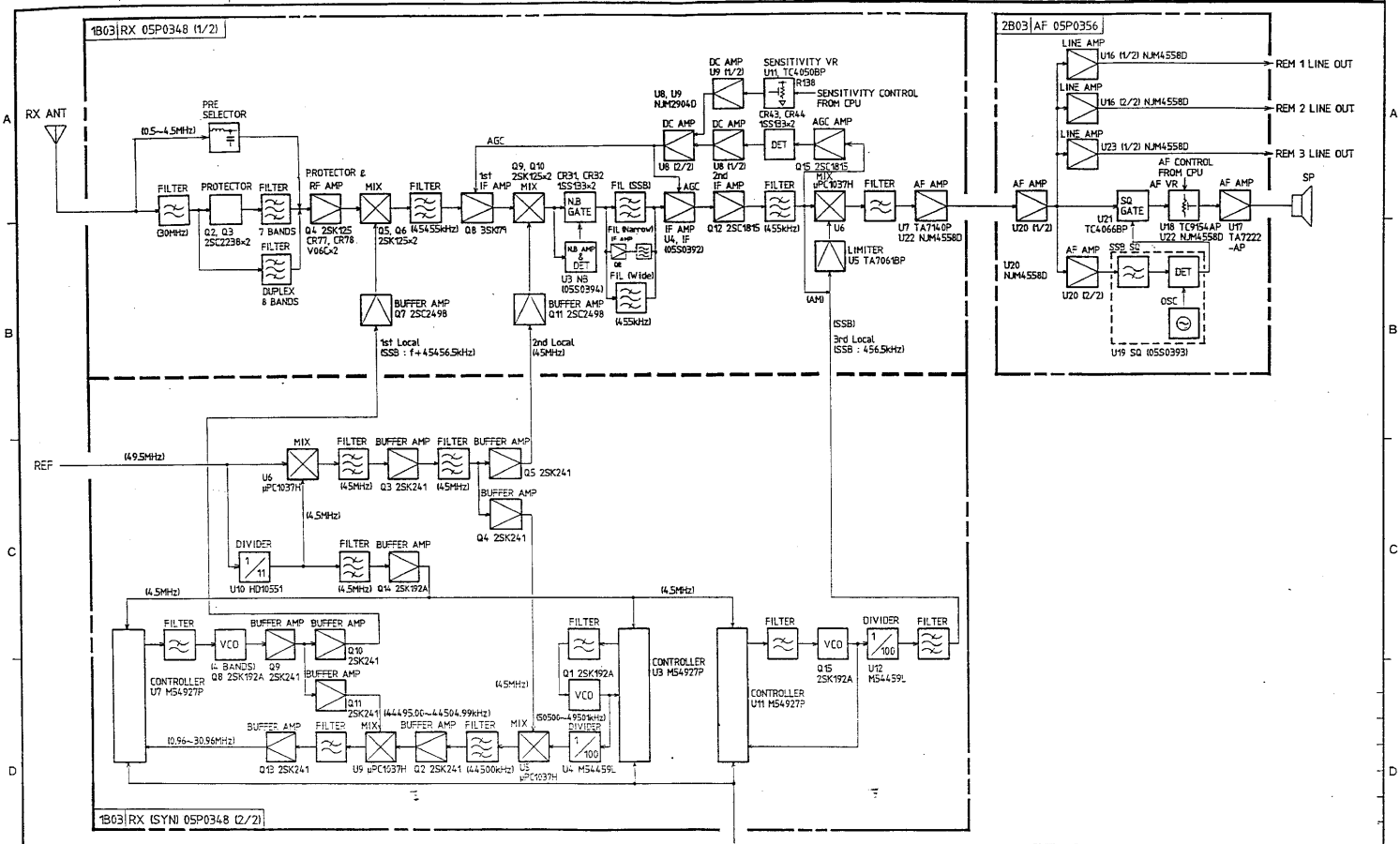
注
(*1): (TB3信号)か(TBUS信号 AF& TXKEY 信号)の何れかを選択。
(*2): 圧着端子，線材を使い シールド線をアース。
(*3): 太線を示す。
(*4): 受信専用アンテナ 或は アンテナBKリレー基板に接続可。(上側 RX ANT 端子←→下側 RX ANT 端子間の同軸線の除去が必要。)
(*5): オプション支給。船内電源に応じてトランスのタップ変更。
(*6): NMEAデータ入力時、AF基板上のジャンパー変更。
(*7): 3ユニット間の各ケーブル(5ペアー、同軸)は，鎧装付のものがオプション支給可。

承認 APPROVED	FEB. 12. '91 T. NAKANO	名称 TITLE	FS-8000 INTERCONNECTION DIAGRAM 相互結線図
検図 CHECKED	FEB. 12. '91 M. IKEDA		
製図 DRAWN	FEB. 12. '91 T. SAITO	図番 DWG. NO.	C5521-C01-C

REV : AUG '91 NOV.'92

FURUNO ELECTRIC CO., LTD.


TX. ANT.
3B02 COUP
SWR DET
MATCHING NETWORK
IA DET
PHASE DET.
RELAY DRIVE
CPU
IA
1B13 REG SW
1B08 PA
1B06 TX FIL
1B14 POWER COMBINER
1B15 SWR PCB
1B11 REG CONT
POWER ON
ALC FROM CPU
SWR CHECK
2B03 AF
1B02 EXC
MIC
REM1
REM2
REM3
1B12 REF. OSC
1B02 EXC(SYN)
FS-8000
TRANSMITTER
C5521-B01-B
SHEET NO. 1/1
S-3



承認 APPROVED	FEB·28·'90 T.NAKANO	名称 TITLE	受信部 RECEIVER
検図 CHECKED	FEB·28·'90 M.IKEDA		
製図 DRAWN	FEB·28·'90 T.SAITO	図番 DWG.NO.	C5519-B01-C

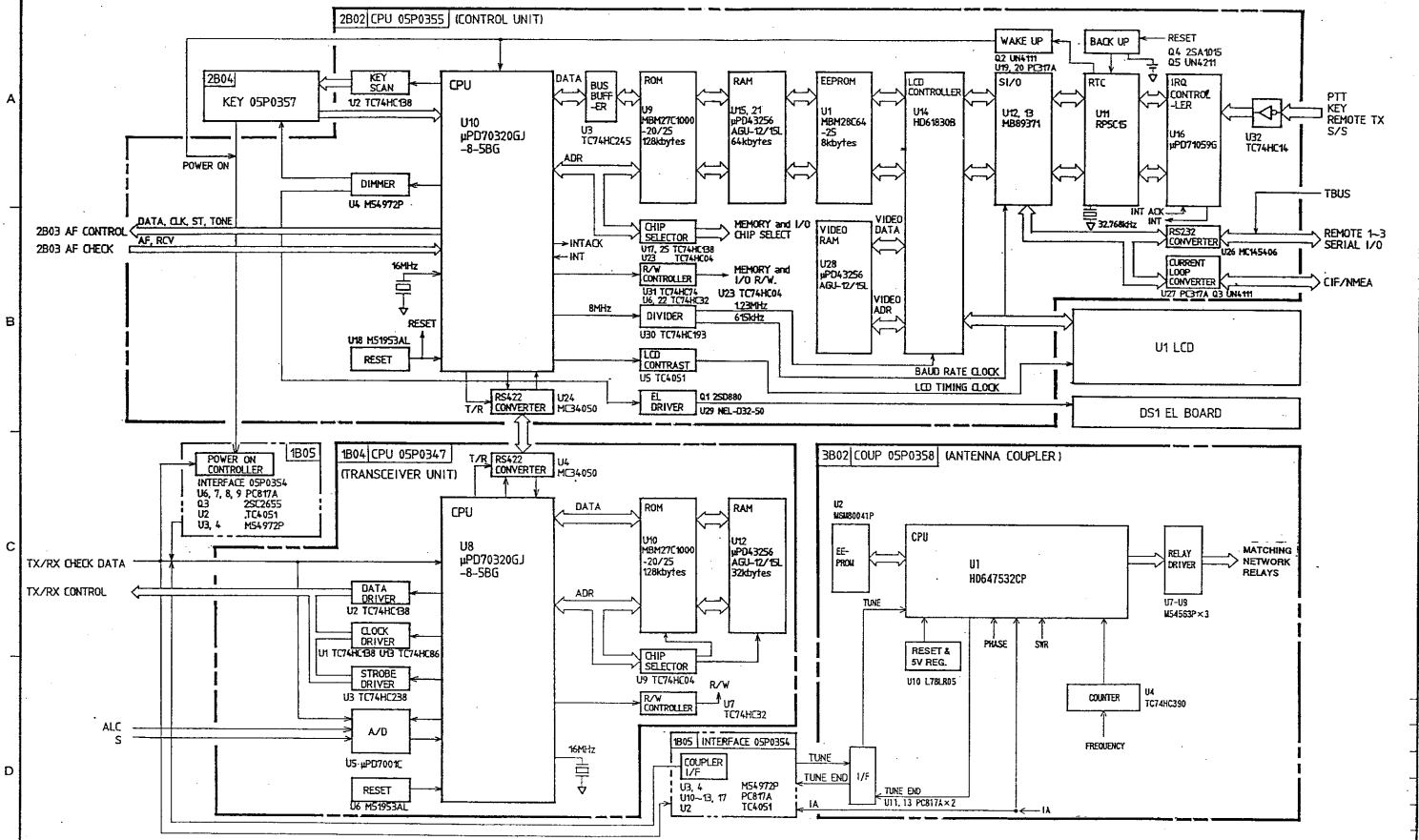
FS-1600
FS-2500
FS-5000

REV : JAN. '91
APRIL '92

FURUNO ELECTRIC CO., LTD.

FURUNO

S – 5

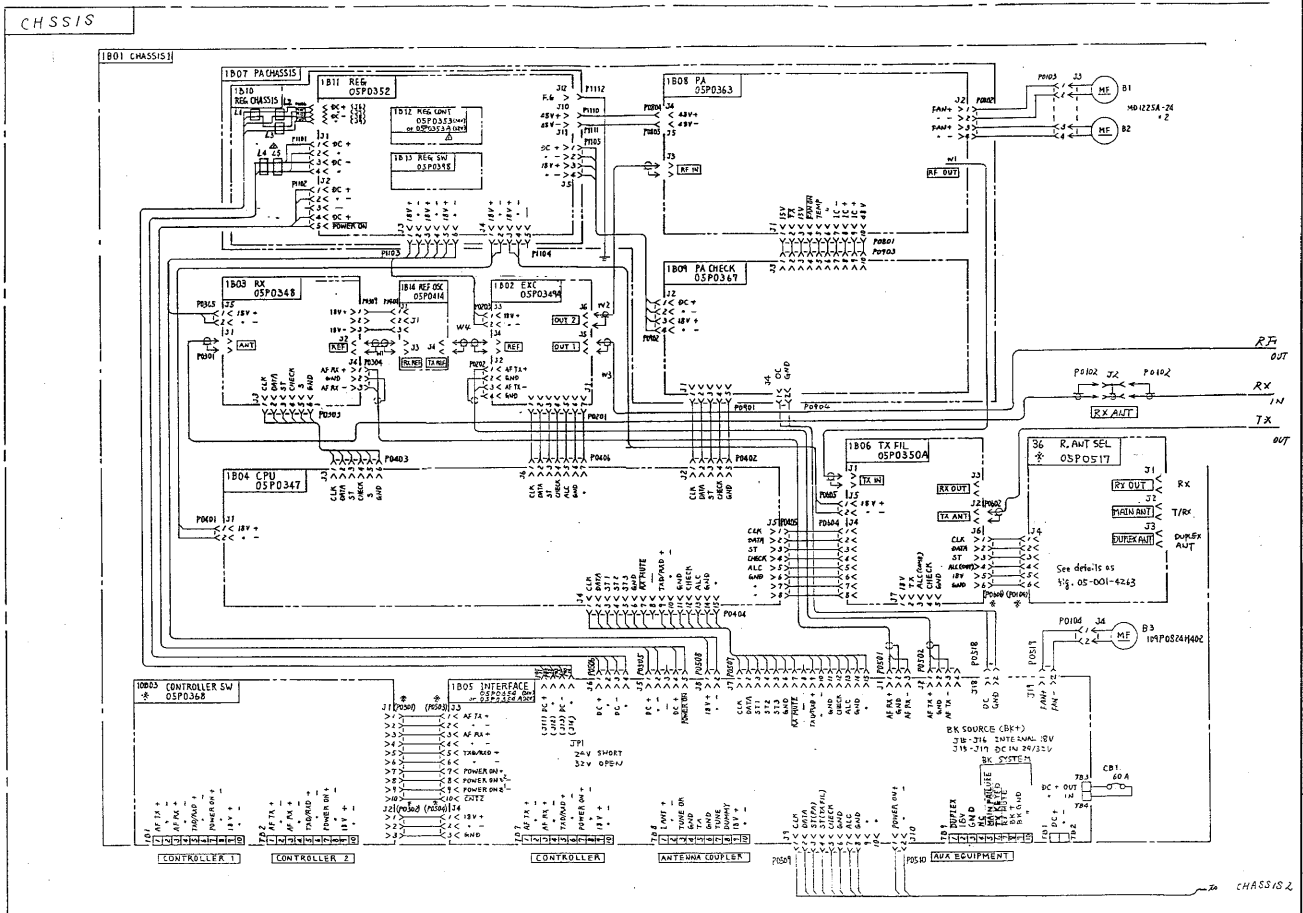


承認 APPROVED	FEB·28·'90 T.WAKANO	名称 TITLE	制御部 SYSTEM CONTROL
検図 CHECKED	FEB·28·'90 M.IKEDA		
製図 DRAWN	FEB·28·'90 T.SAITO	図番 DWG.NO.	C5519-B03-B

FS-1600
FS-2500
FS-5000

REV.: Aug '92

FURUNO ELECTRIC CO., LTD.

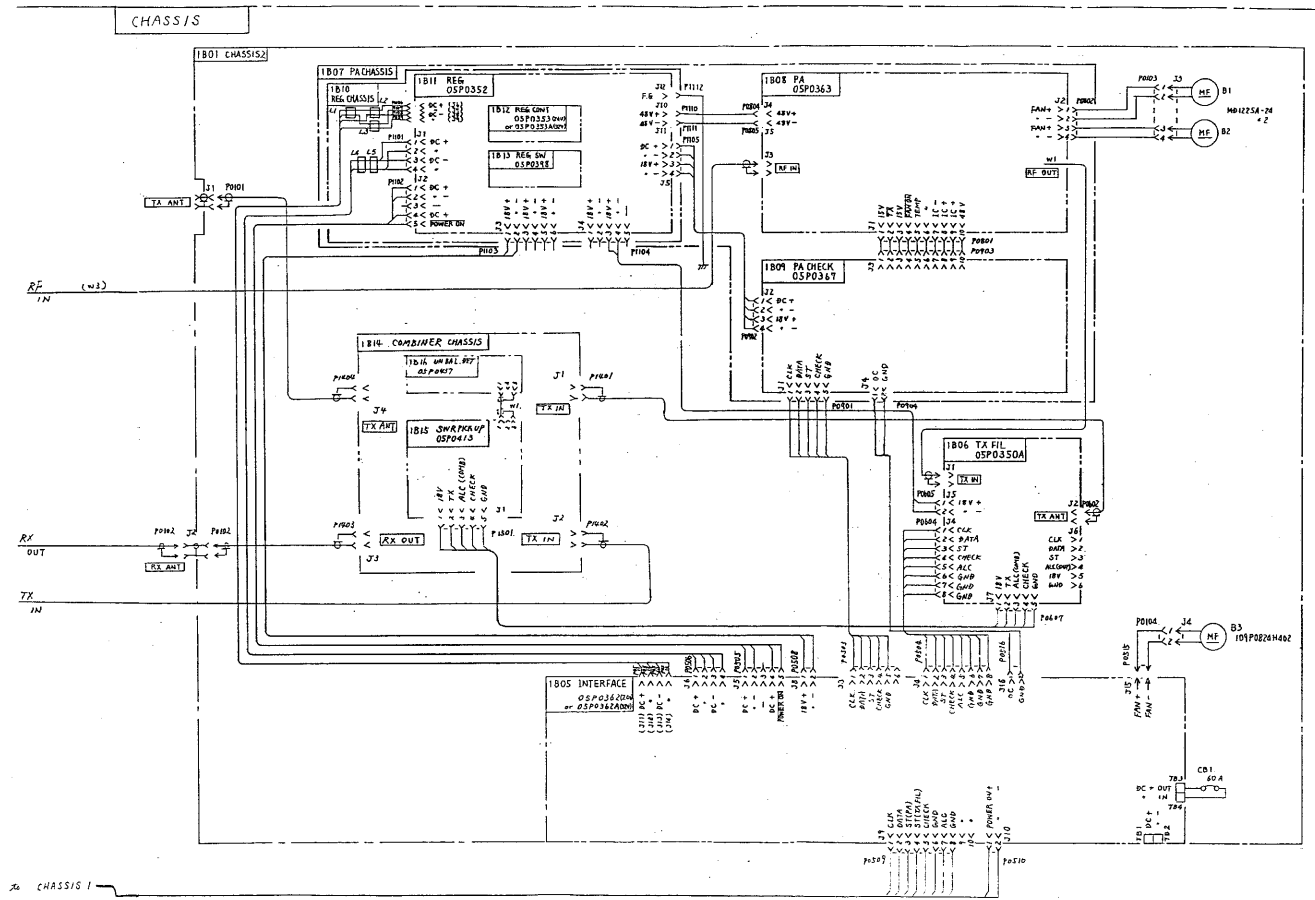


※ : OPTION

(LOWER UNIT) FS-8000

主機種	FS-8000	コード				SHEET NO.	1/2
課長	検図	設計	製図	型名		TITLE	1B01 (TRANSCEIVER UNIT) CHASSIS (CHASSIS-1) (1/2)
						DWG. NO.	C5521-K03-B

古野電気株式会社



(UPPER UNIT) FS-8000

承認	検図	設計	製図	FS-8000	コード			SHEET NO.	2/2
課長					型名				
				TITLE	1B01 (TRANSCEIVER UNIT) CHASSIS (CHASSIS-2)				
				DWG NO	C5521-K02-B				

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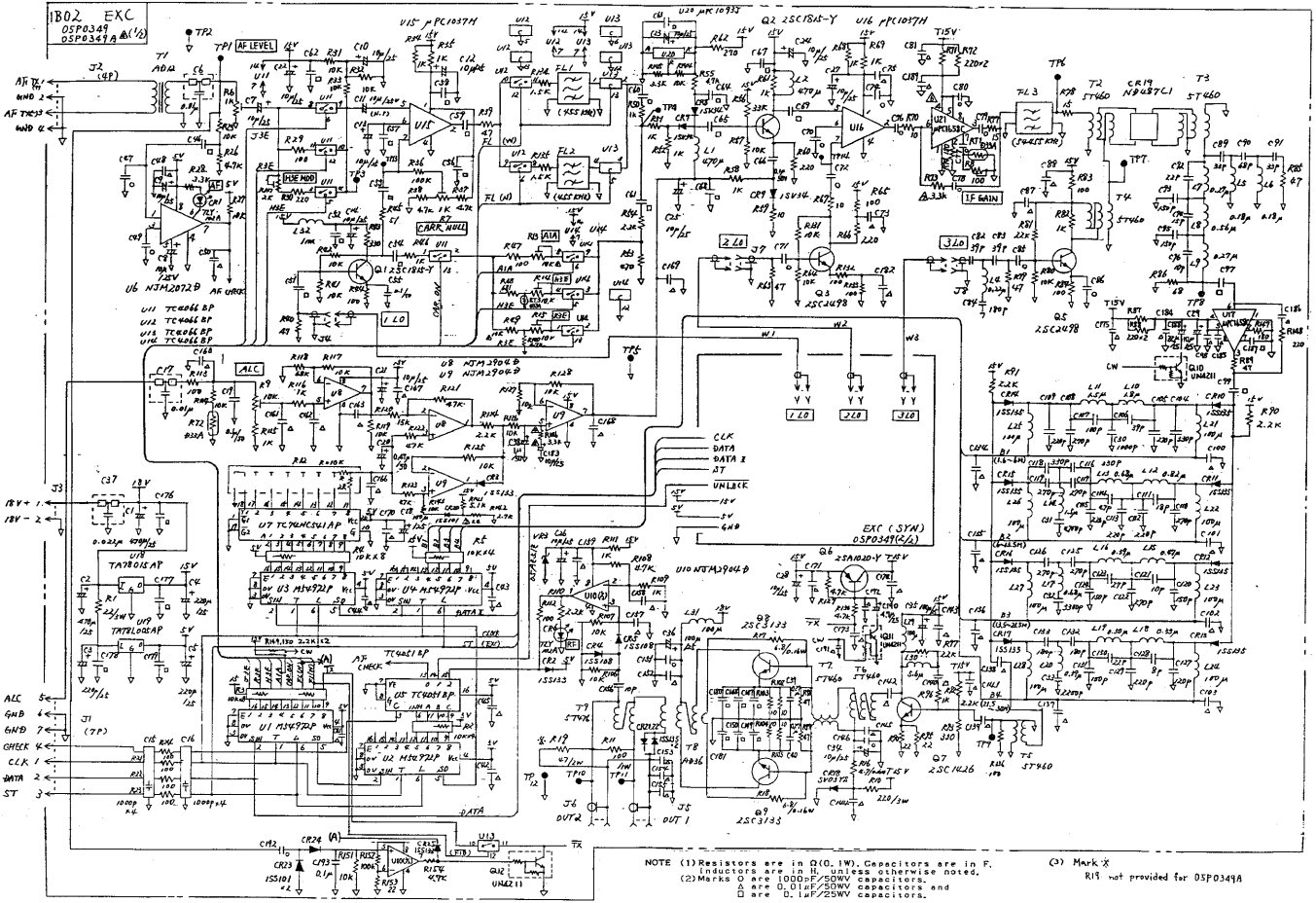

NOTE (1) Resistors are in Ω(0.1W), Capacitors are in F, Inductors are in H, unless otherwise noted.
(2) Marks ○ are 1000pF/50WV capacitors.
△ are 0.01μF/50WV capacitors, and
□ are 0.1μF/25WV capacitors.

(3) Mark ※
R19 not provided for 05P0349A

主機種	FS-5000	コード番号				SHEET NO.	1/2
課長	係長	検図	設計	製図		TITLE	1B02 (1/2) EXC (TRANSCEIVER UNIT)
						DWG. NO.	C5519-K09-E

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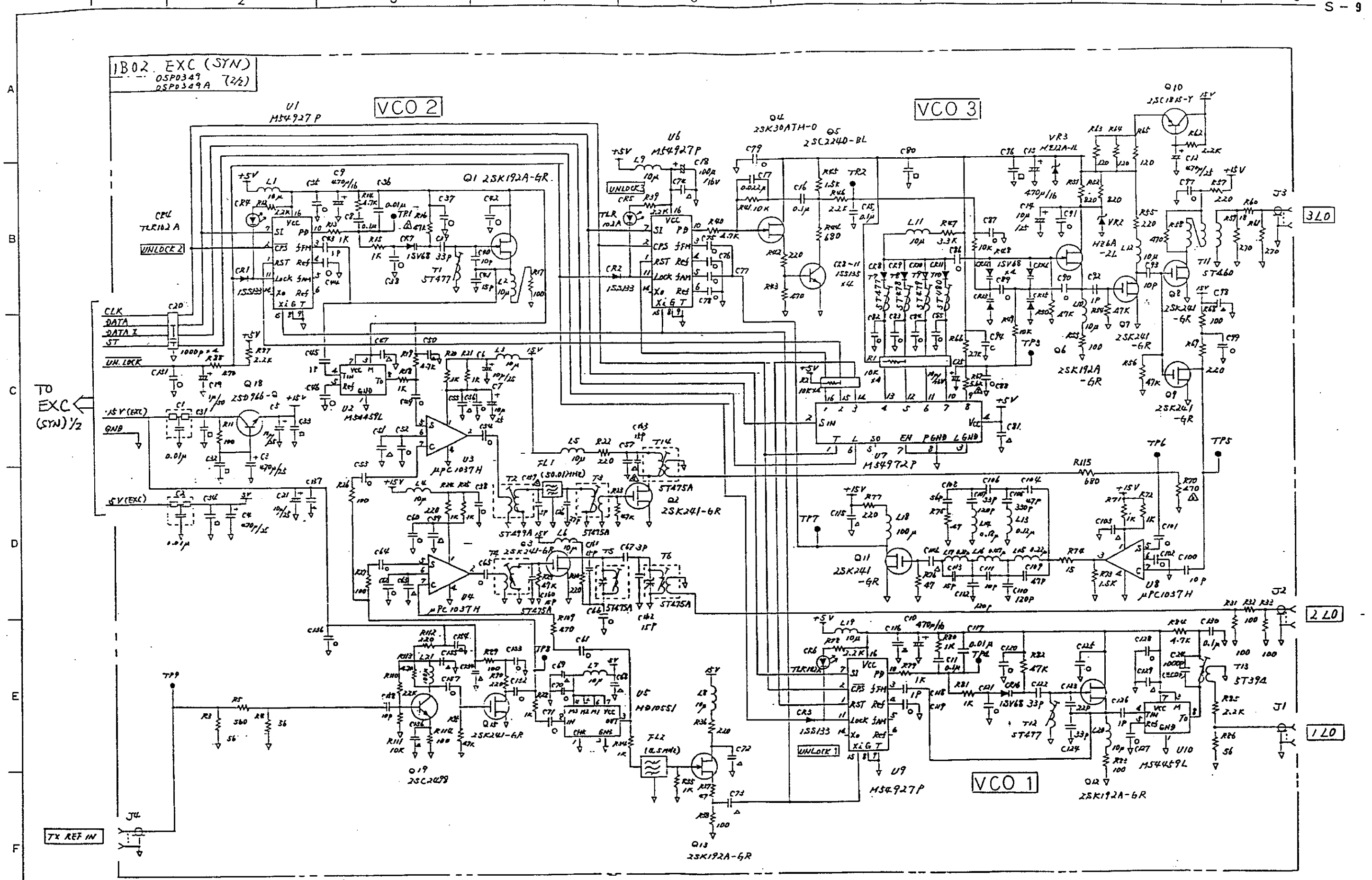

NOTE (1) Resistors are in Ω(0.1W). Capacitors are in F.
Inductors are in H. unless otherwise noted.
(2) Marks O are 1000pF/50WV capacitors.
Δ are 0.01μF/50WV capacitors and
□ are 0.1μF/25WV capacitors.

主機種	FS-5000	コード		SHEET NO.	2/2
		型名			
課長 検図 設計 製図		TITLE	1B02 (2/2) EXC (SYN) (TRANSCEIVER UNIT)		
		DWG No.	C5519-K10-D		

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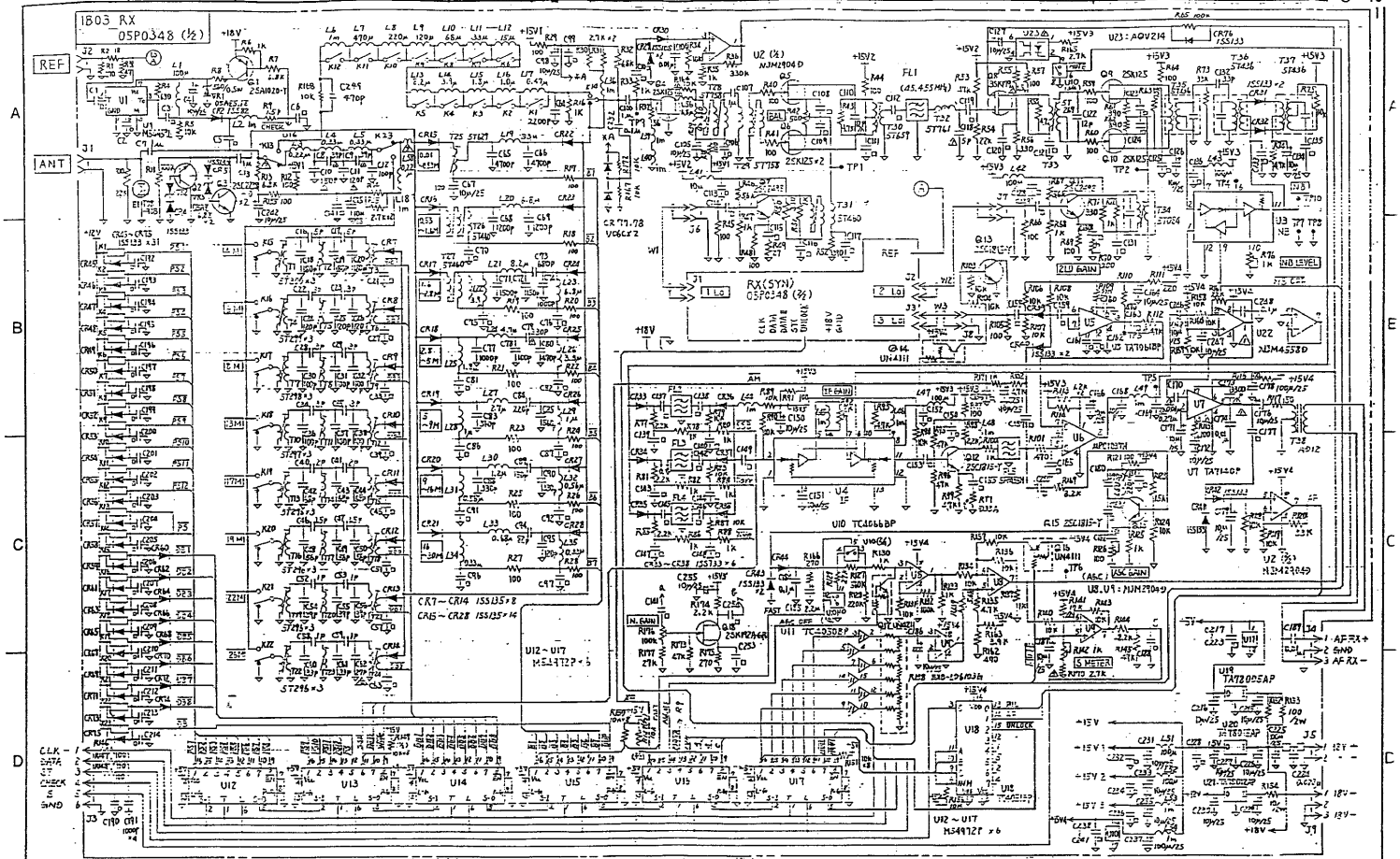

Note. 1) Marks ○ are 1000pF 50WV Capacitors.
2) Marks △ are 0.01μF 50WV Capacitors.
3) Marks ◎ are 0.1μF 25WV Capacitors.
4) Resistors are in Ω (0.1W). Capacitors are in F. Inductors are in H, unless otherwise noted.

主機種	FS-5000	コード				SHEET NO.	1/2
		型名					
課長	検図	設計	製図	TITLE	1B03 (½) RX (TRANSCEIVER UNIT)		
				DWG. No.	C5519-K02-D		

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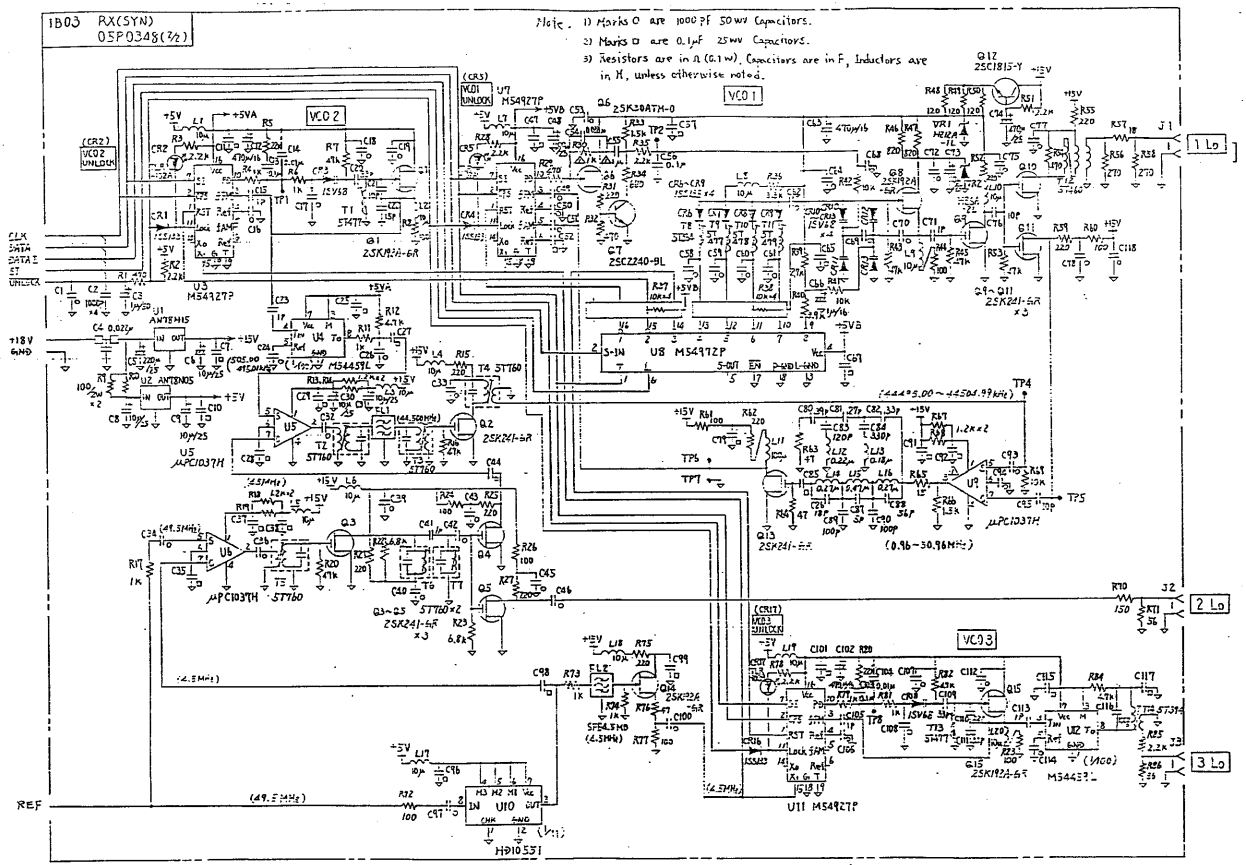
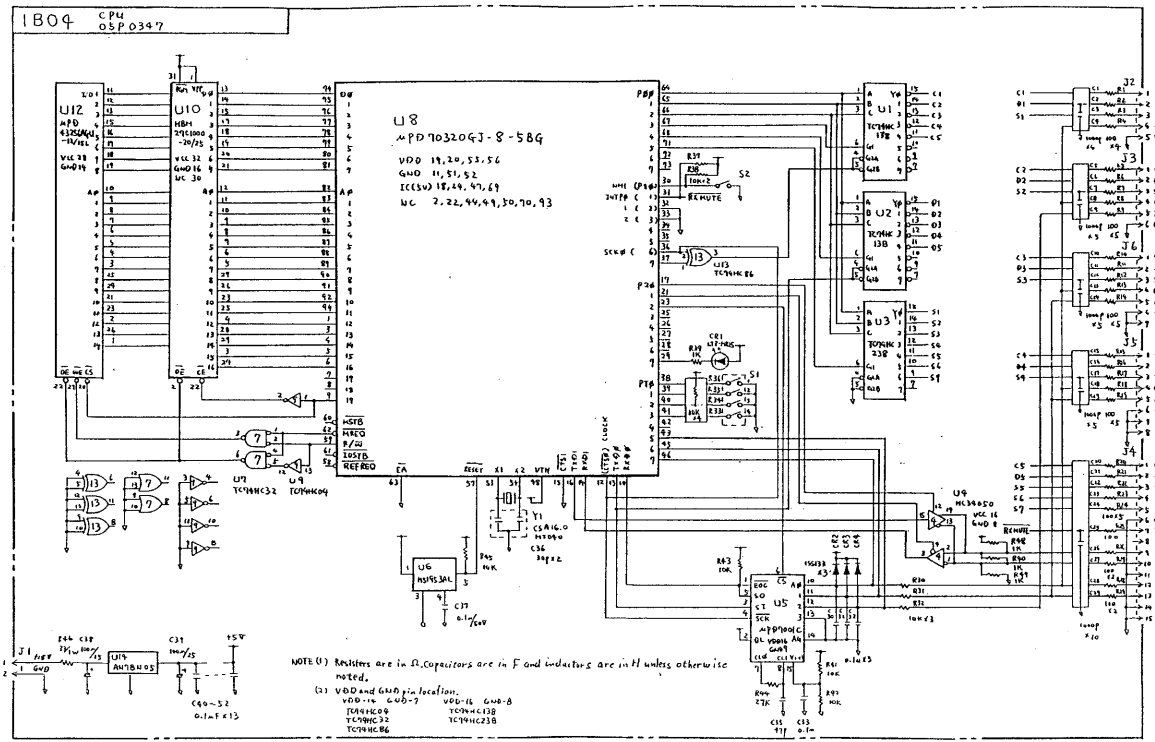
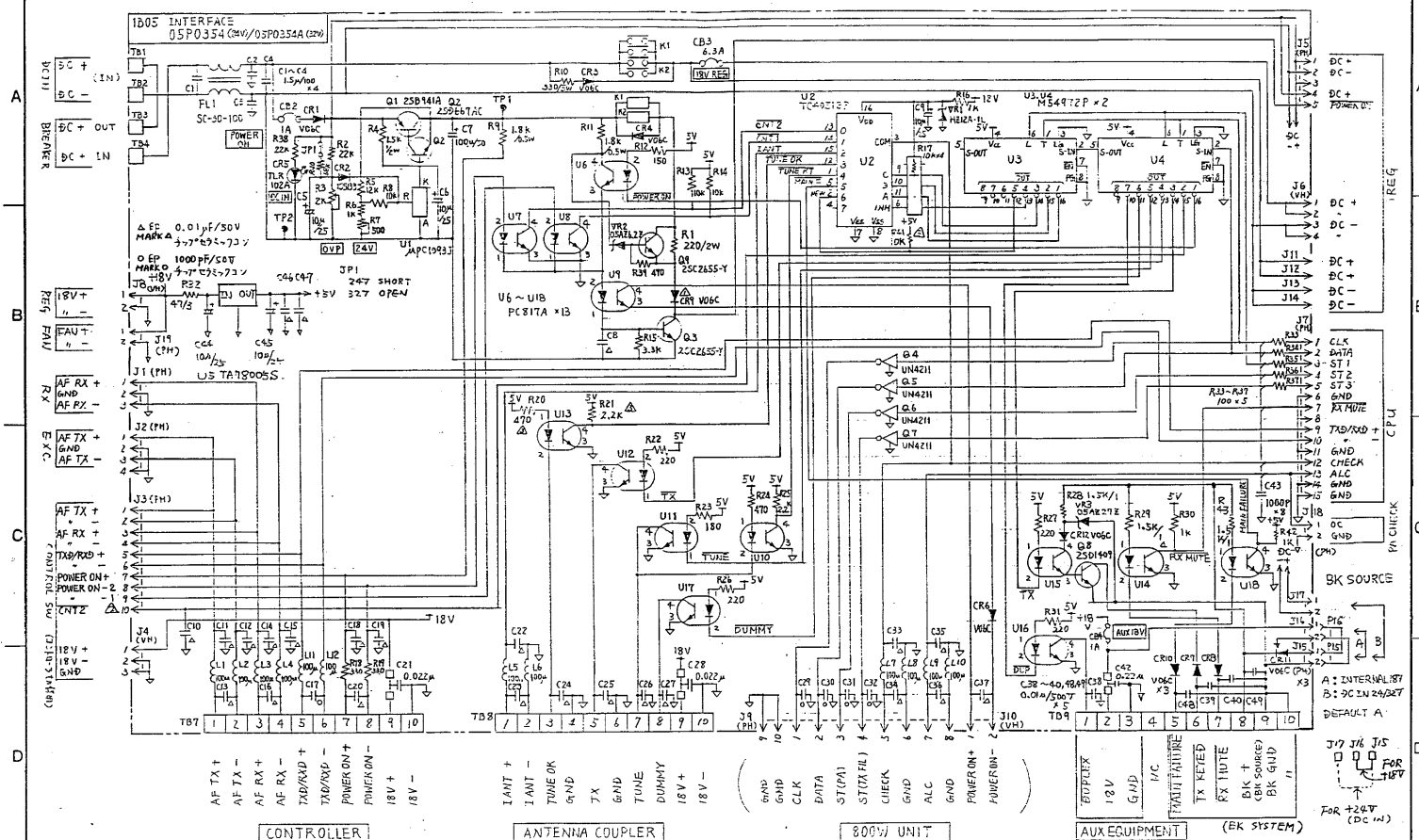


主機種	FS-500D	コード						SHEET NO.	2/2
		型名							
課長	検図	設計	製図	TITLE	1B03 (2/2) RX (SYN) (TRANSCEIVER UNIT)				
				DWG. No.	C5519-K03-D				

古野電気株式会社



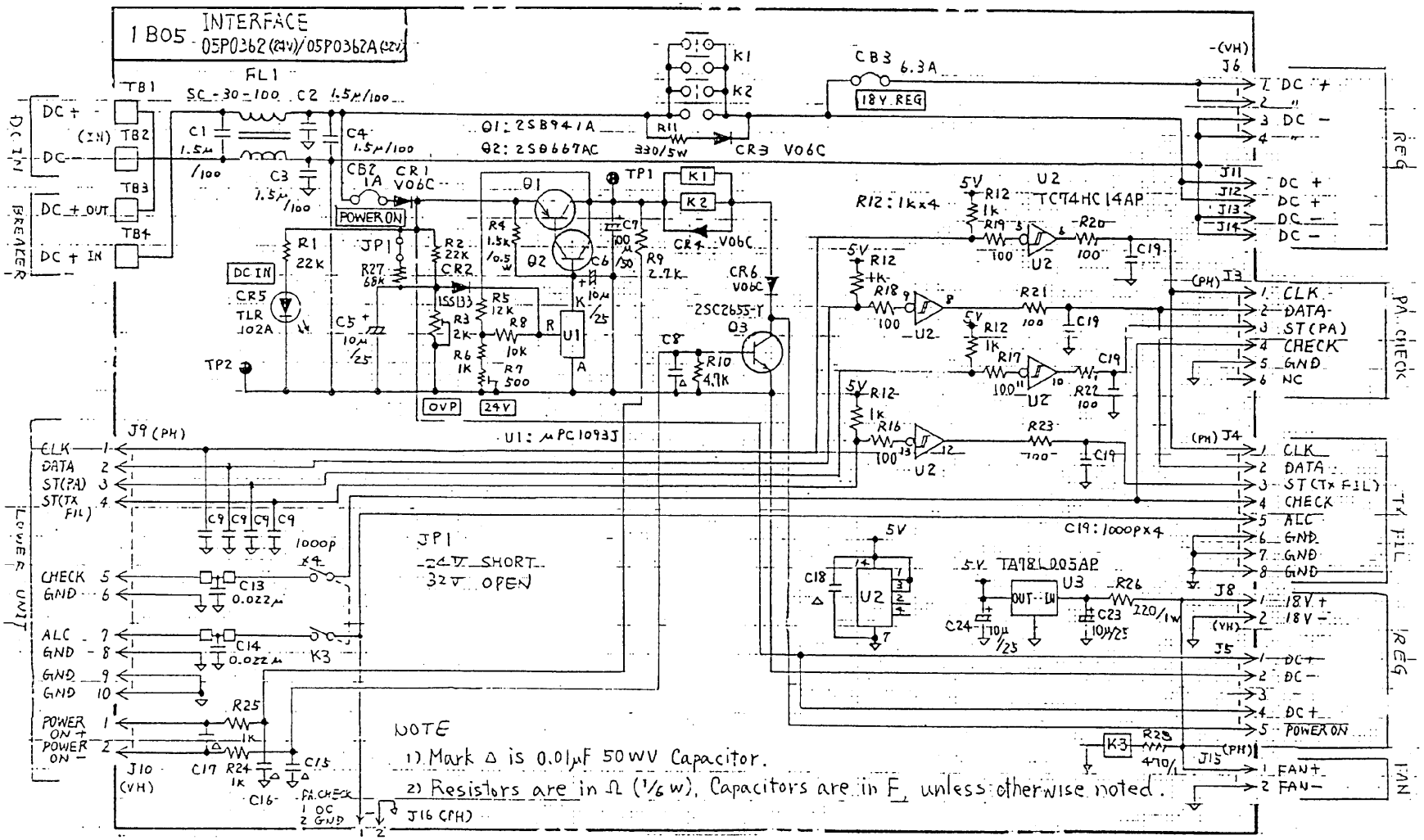
主機種	FS-1650 FS-3500 FS-5000	コード						SHEET NO.	1/1
設計	作成	検図	設計	製図					
								TITLE	1804 CPU (TRANSCEIVER UNIT)
									C5519-K08-B



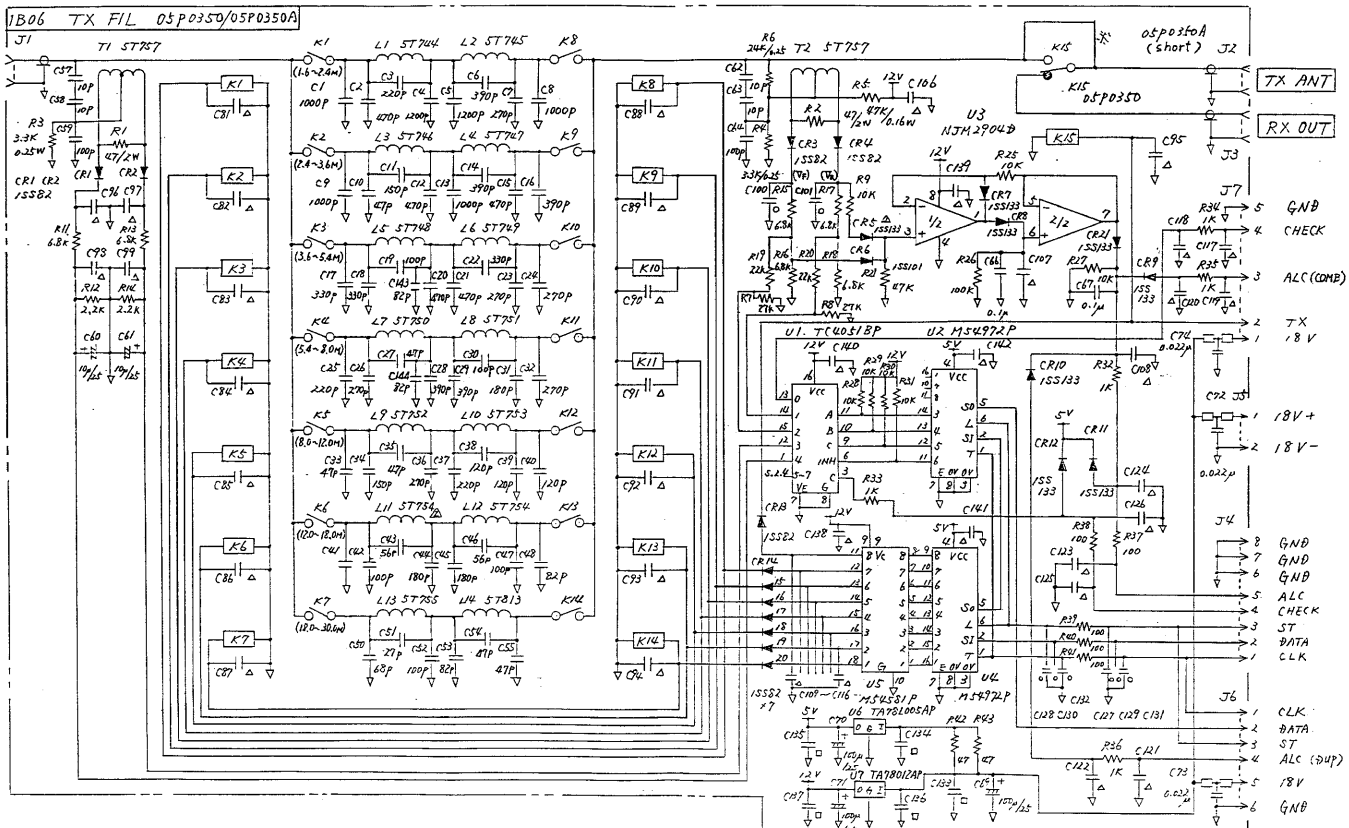
Note. 1) Marks ○ are 1000 pF 50WV Capacitors.
2) Marks △ are 0.01μF 50WV Capacitors.
3) Resistors are in Ω (0.1W), Capacitors are in F, Inductors are in H, unless otherwise noted.

主機種	FS-5000	コード		SHEET NO.	1/1
		型名			
課長	検図	設計	製図	TITLE	1B05 CHASSIS-1 INTERFACE (TRANSCEIVER UNIT)
				DWG. No.	C5519-K04-E

古野電気株式会社



主機種	FS-8000	コード			SHEET NO.	1	1
		型名					
課長	検図	設計	製図	TITLE	1B05 FS-8000 (CHASSIS-2) INTERFACE (TRANSCEIVER UNIT)		
				DWG No.	C5521-K01-B		



NOTE (1) Resistors are in Ω(0.1W). Capacitors are in F. Inductors are in H, unless otherwise noted.
(2) Marks ○ are 1000pF/50WV capacitors.
△ are 0.01μF/50WV capacitors and
□ are 0.1μF/25WV capacitors.

主機種	FS-5000	コード		SHEET NO.	1/1
		型名			

課長	検図	設計	製図

TITLE: 1B06 TX FIL (TRANSCEIVER UNIT)

DWG No. C5519-K05-E

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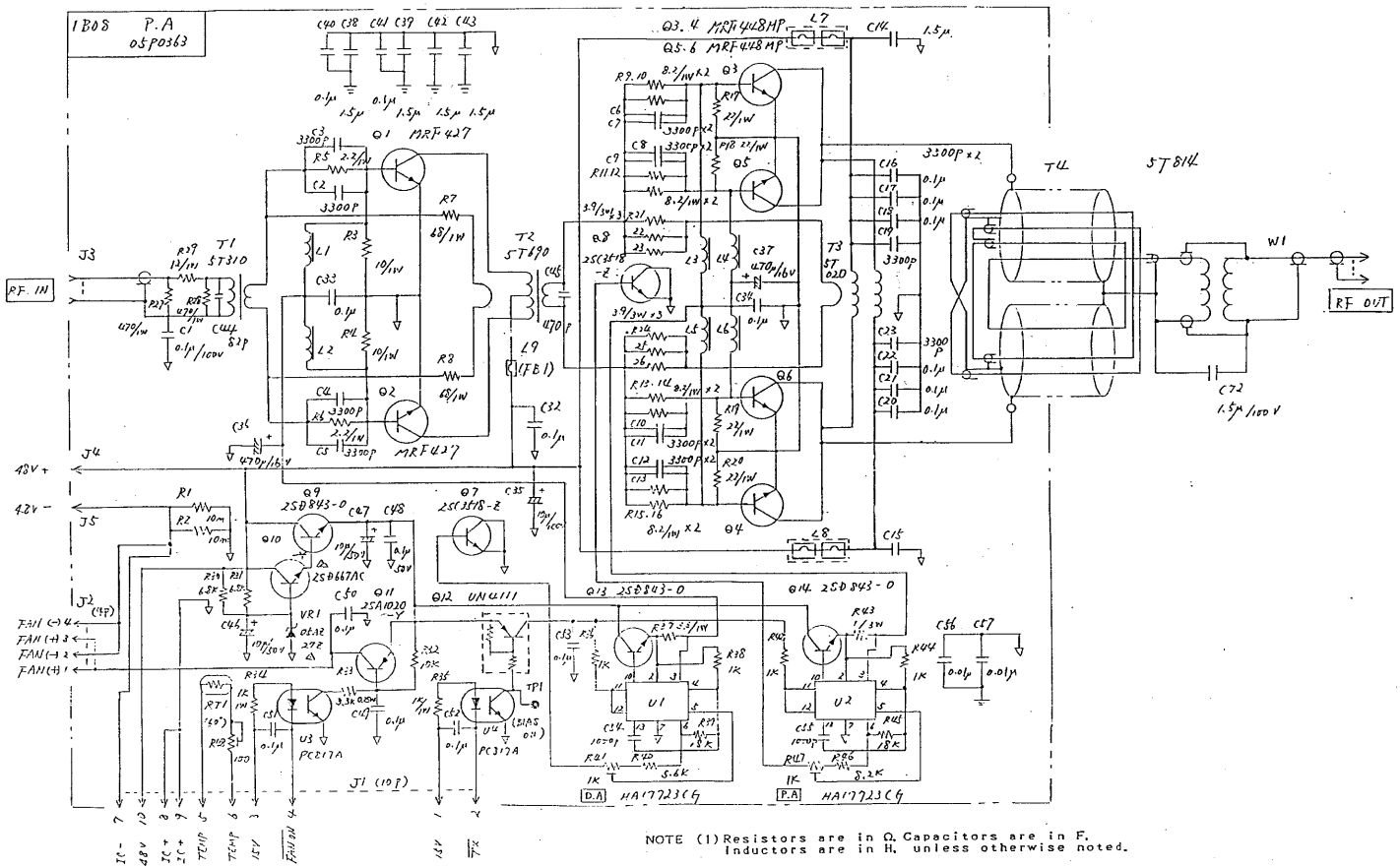

NOTE (1) Resistors are in Ω, Capacitors are in F.
Inductors are in H, unless otherwise noted.

主機種	FS-1600 / FS-2500 / FS-5000	コード		SHEET NO.	1/1	
課長	検図	設計	製図	TITLE	1B08 P.A (TRANSCEIVER UNIT)	
				DWG. No.	C5519-K06-C	

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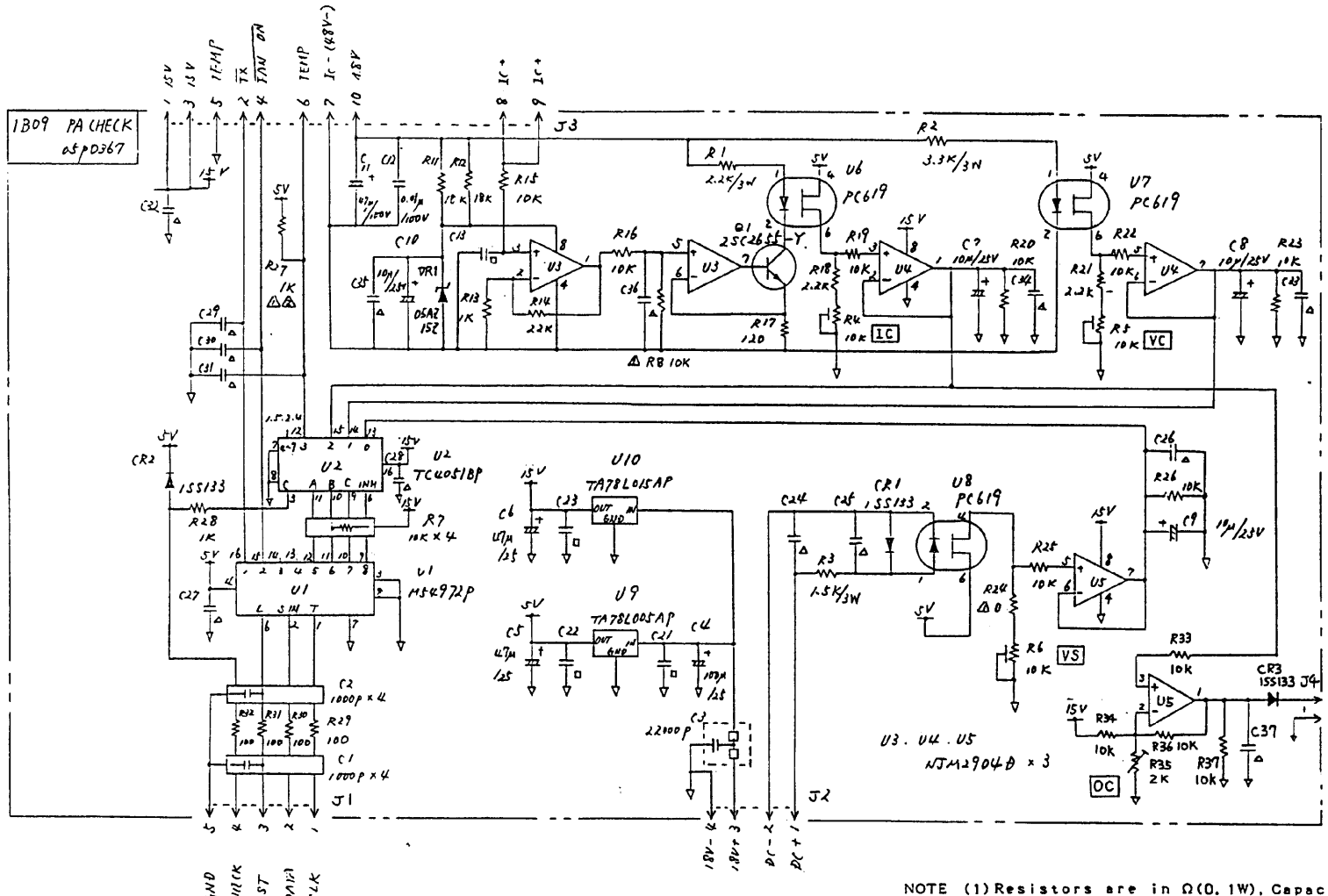

NOTE (1) Resistors are in Ω(0.1W). Capacitors are in F. Inductors are in H. unless otherwise noted.
(2) Marks ○ are 1000pF/50WV capacitors.
△ are 0.01μF/50WV capacitors and
□ are 0.1μF/25WV capacitors.

主機種	FS-1600 FS-2500 FS-5000	コード			SHEET NO.	1/1
		型名				
課長	検図	設計	製図	TITLE	1B09 PA CHECK (TRANSCEIVER UNIT)	
				DWG. No.	C5519-K07-D	

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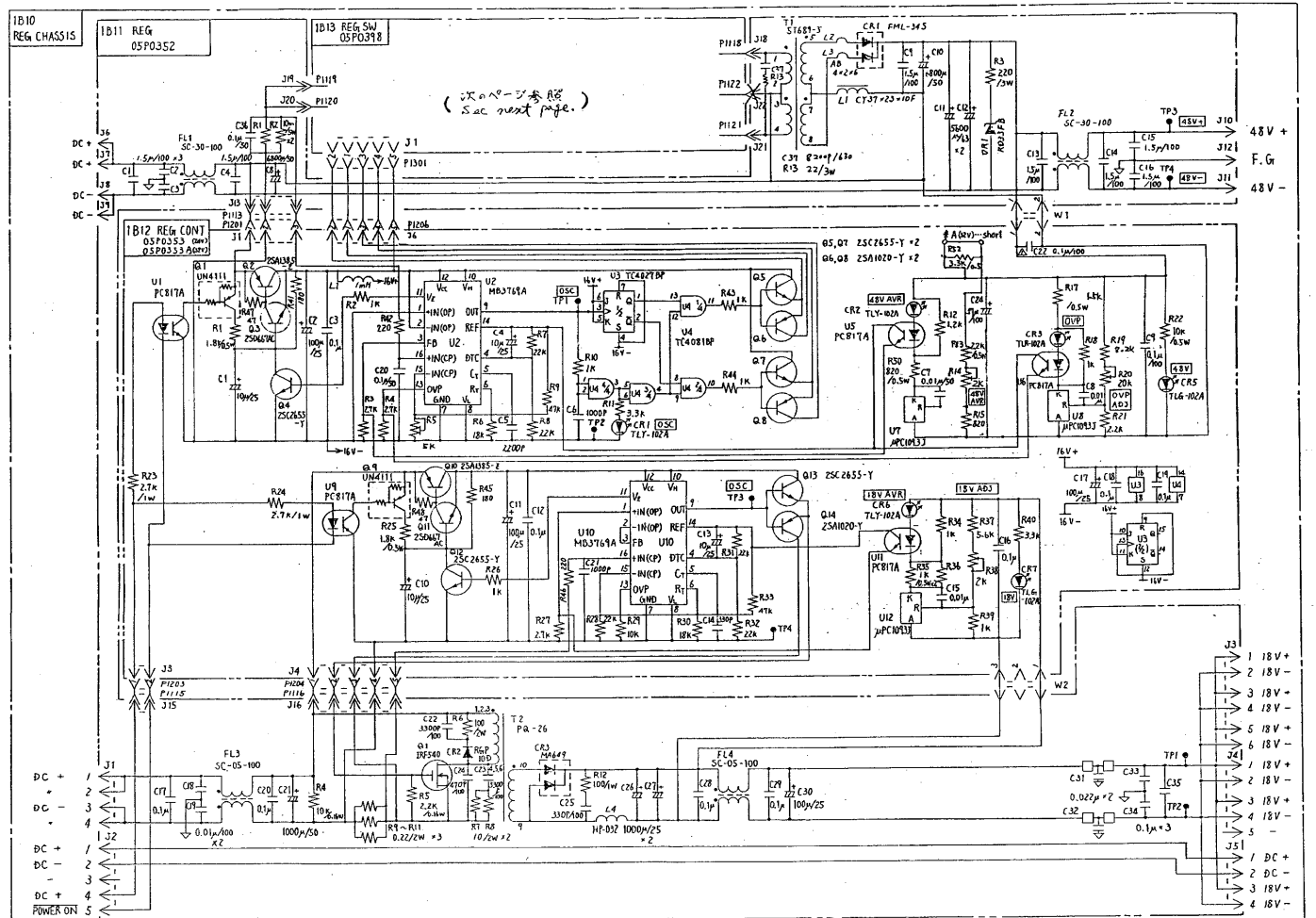
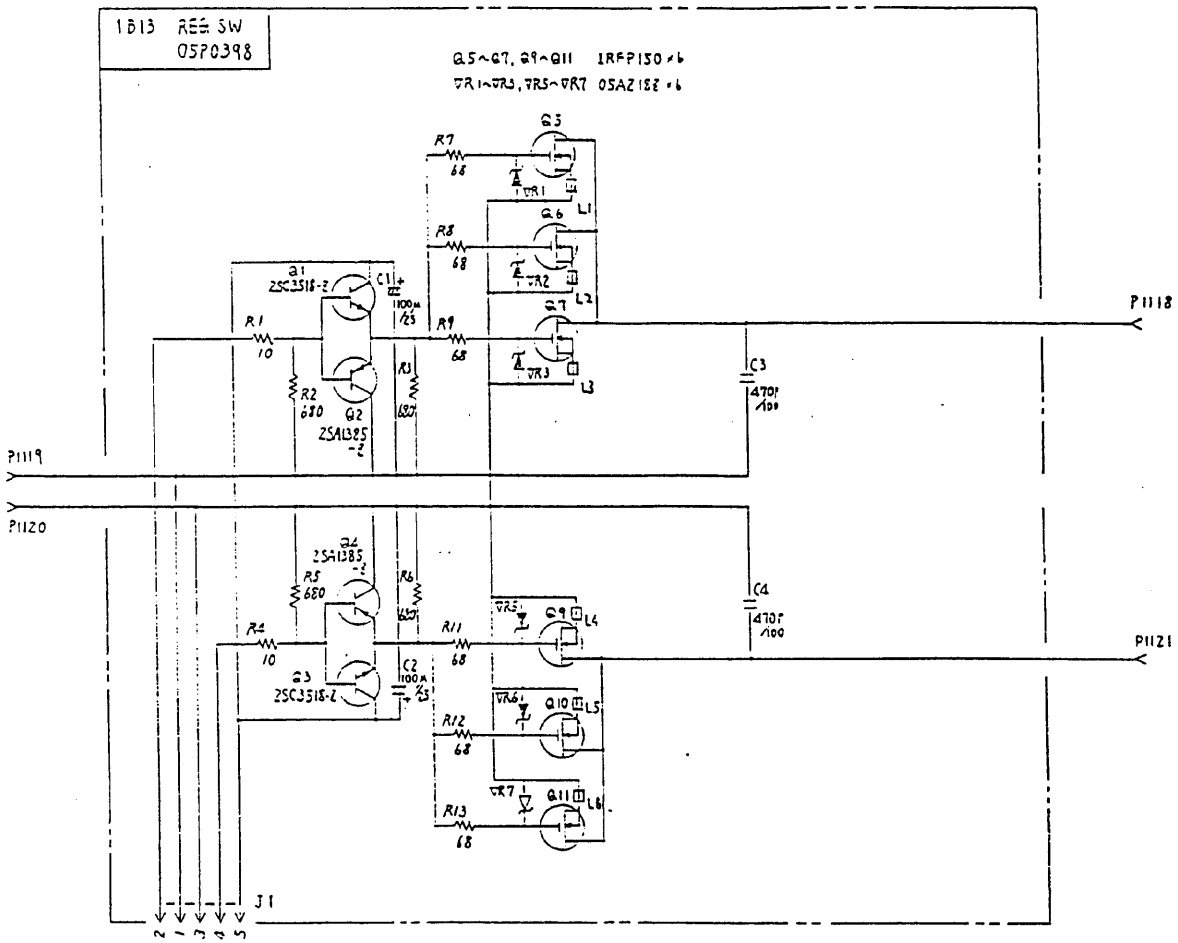


Note. Resistors are in Ω (0.1W), Capacitors are in F, Inductors are in H, unless otherwise noted.

主機	FS-7600	コード				SHEET NO.	1/1
副機	FS-2600 FS-5000	型名					
課長	検図	設計	製図			TITLE	1B10 REG CHASSIS (TRANSCEIVER UNIT) (1B11 REG, 1B12 REG CONT, 1B13 REG SW)
						DWG.No.	C5519-K11-D

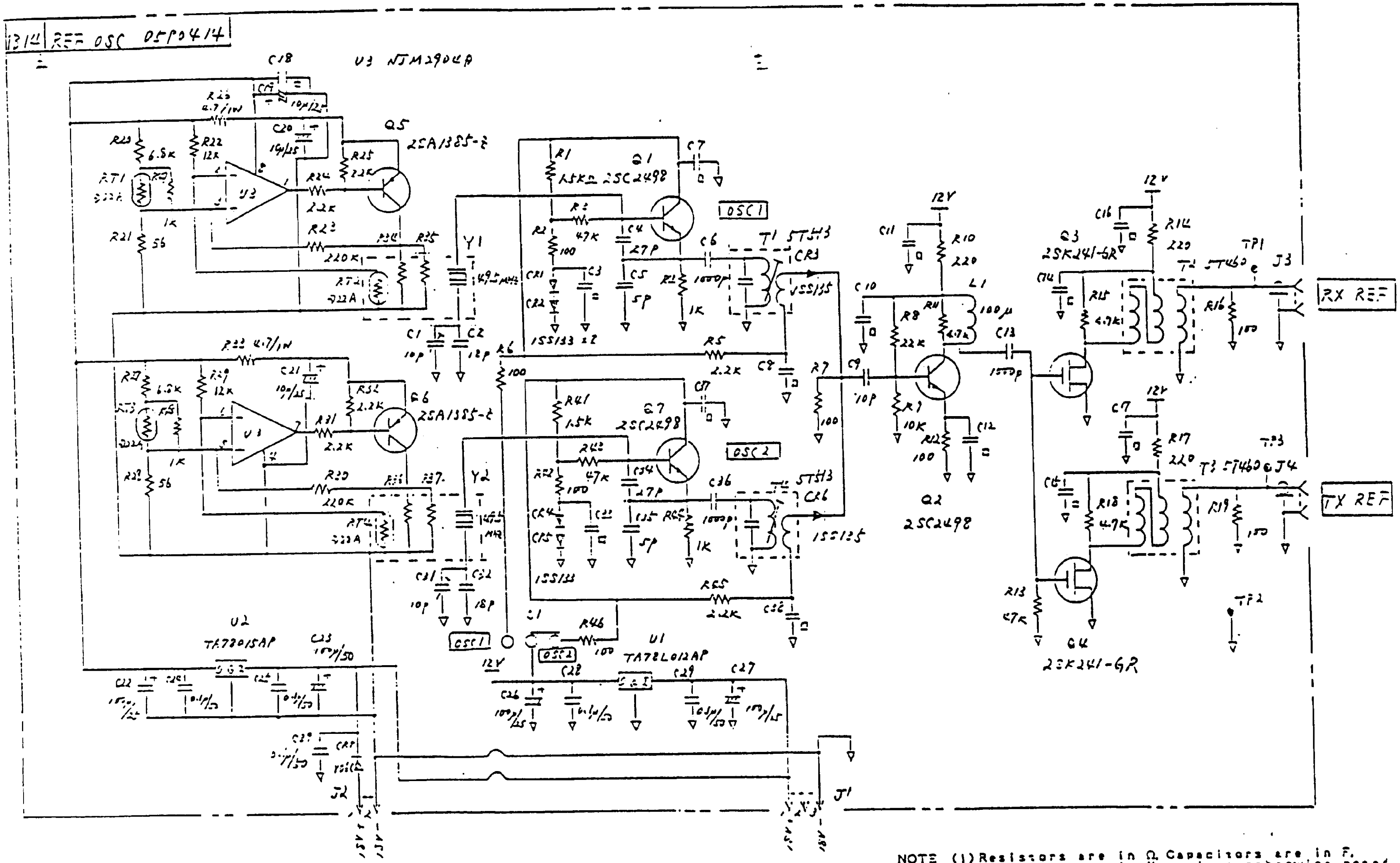


Note. Resistors are in Ω (0.25W), Capacitors are in F. unless otherwise noted.

X28

三機種	FS-5000	コード / 型名	SHEET NO. 2/2
課長	検図	設計	製図
TITLE	1B10 REG CHASSIS (TRANSCEIVER UNIT) (1B13. REG SW)		
DWG. No.	C5519-K21-B		

古野電気株式会社



NOTE (1) Resistors are in Ω, Capacitors are in F, Inductors are in H, unless otherwise noted.
(2) Marks ○ are 1000pF/50WV capacitors.
△ are 0.01μF/50WV capacitors and
□ are 0.1μF/25WV capacitors.

課長	検図	設計	製図	TITLE	1814 REF OSC	(CHASSIS-1) (TRANSCEIVER UNIT)
				DWG No.	C5519-K22-B	SHEET NO. 1/1

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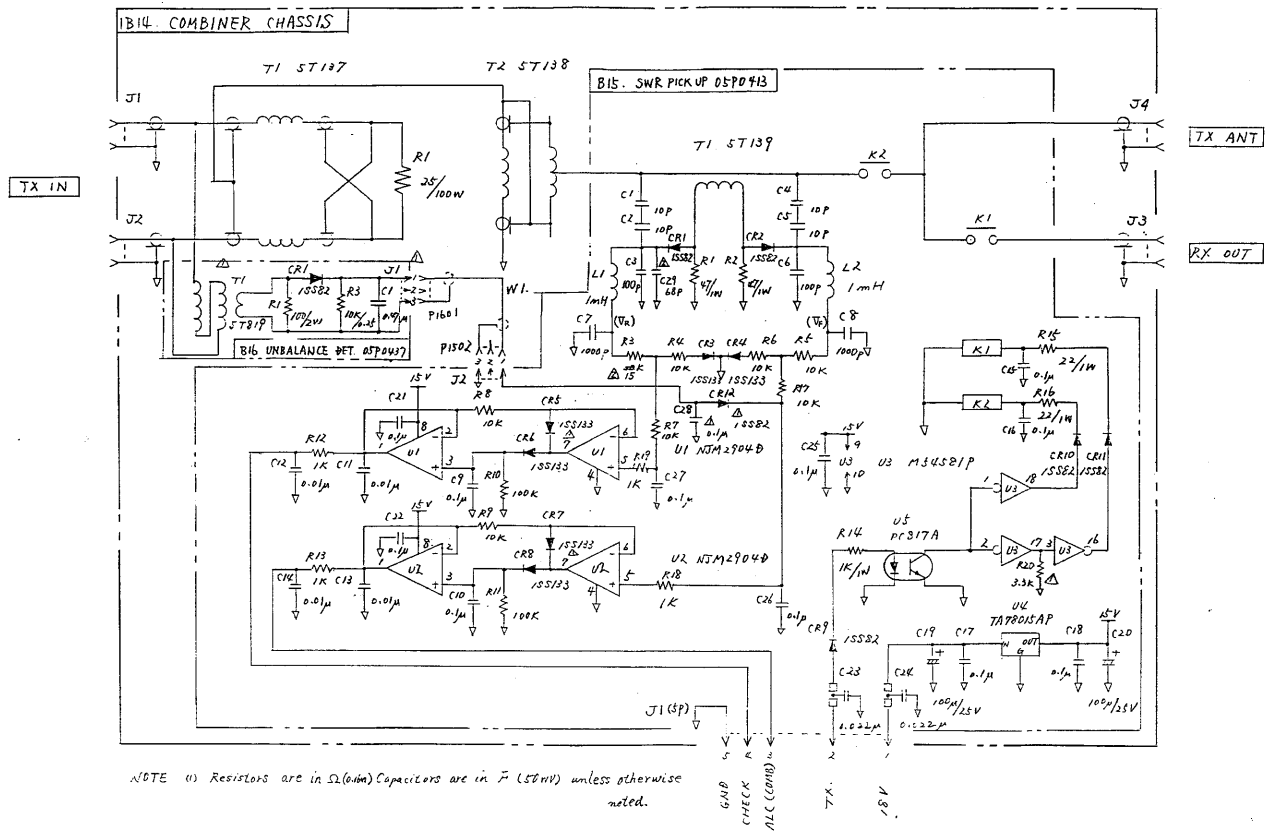

NOTE (1) Resistors are in Ω(0.6W) Capacitors are in F (50WV) unless otherwise noted.

FS-8000

主機種	FS-8000	コード		SHEET NO.	1/1
		型名			

課長	検図	設計	製図	TITLE	1B14. (TRANSCEIVER UNIT) COMBINER CHASSIS
				DWG. No.	C5521-K04-C

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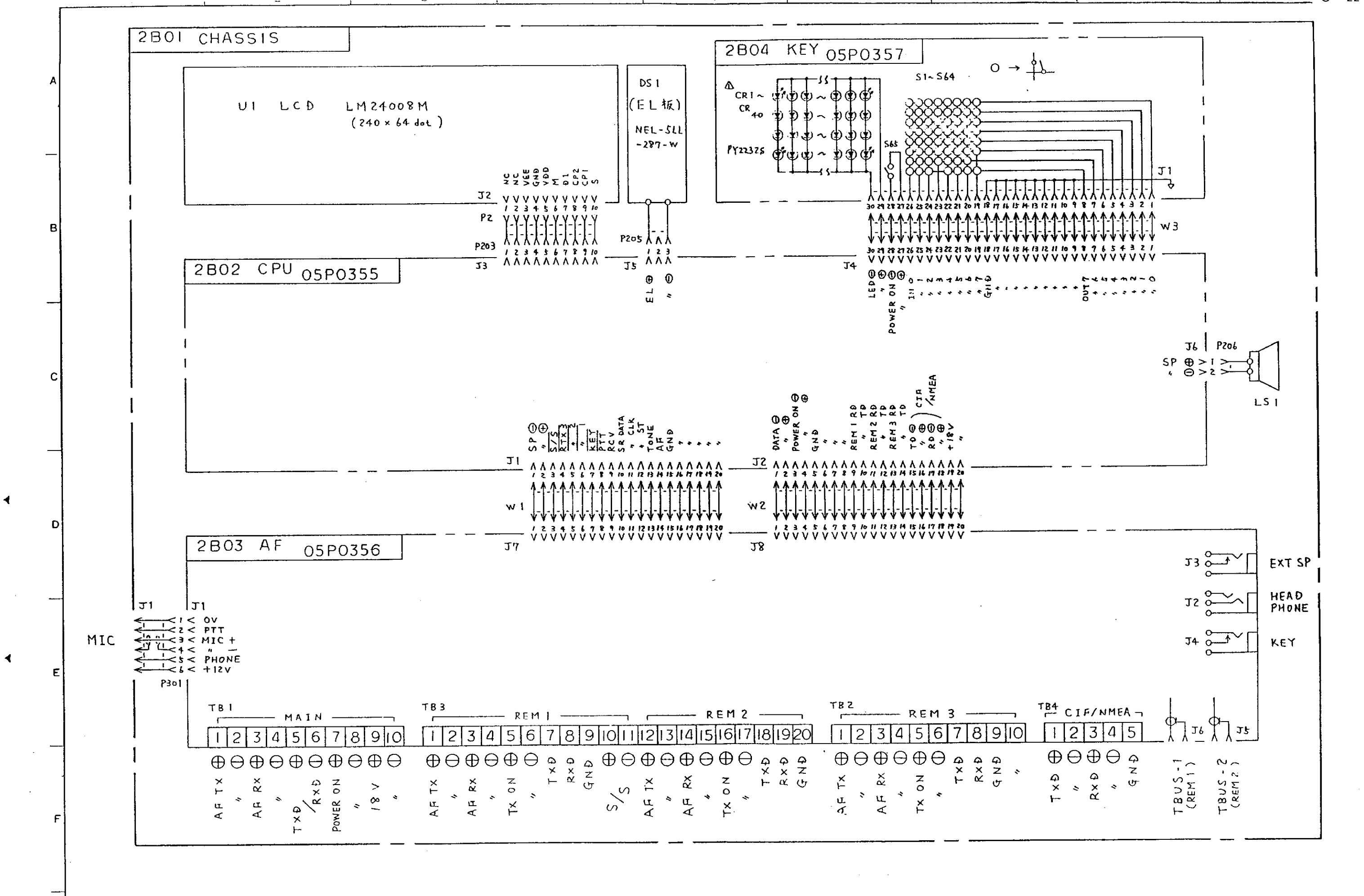

主機種	FS-1600 / FS-2500 / FS-5000	コード	
		型名	
課長	検図	設計	製図
TITLE	2B01 CHASSIS (CONTROLLER UNIT)		
図番	C5519-K13-B		
SHEET NO.	1/1		

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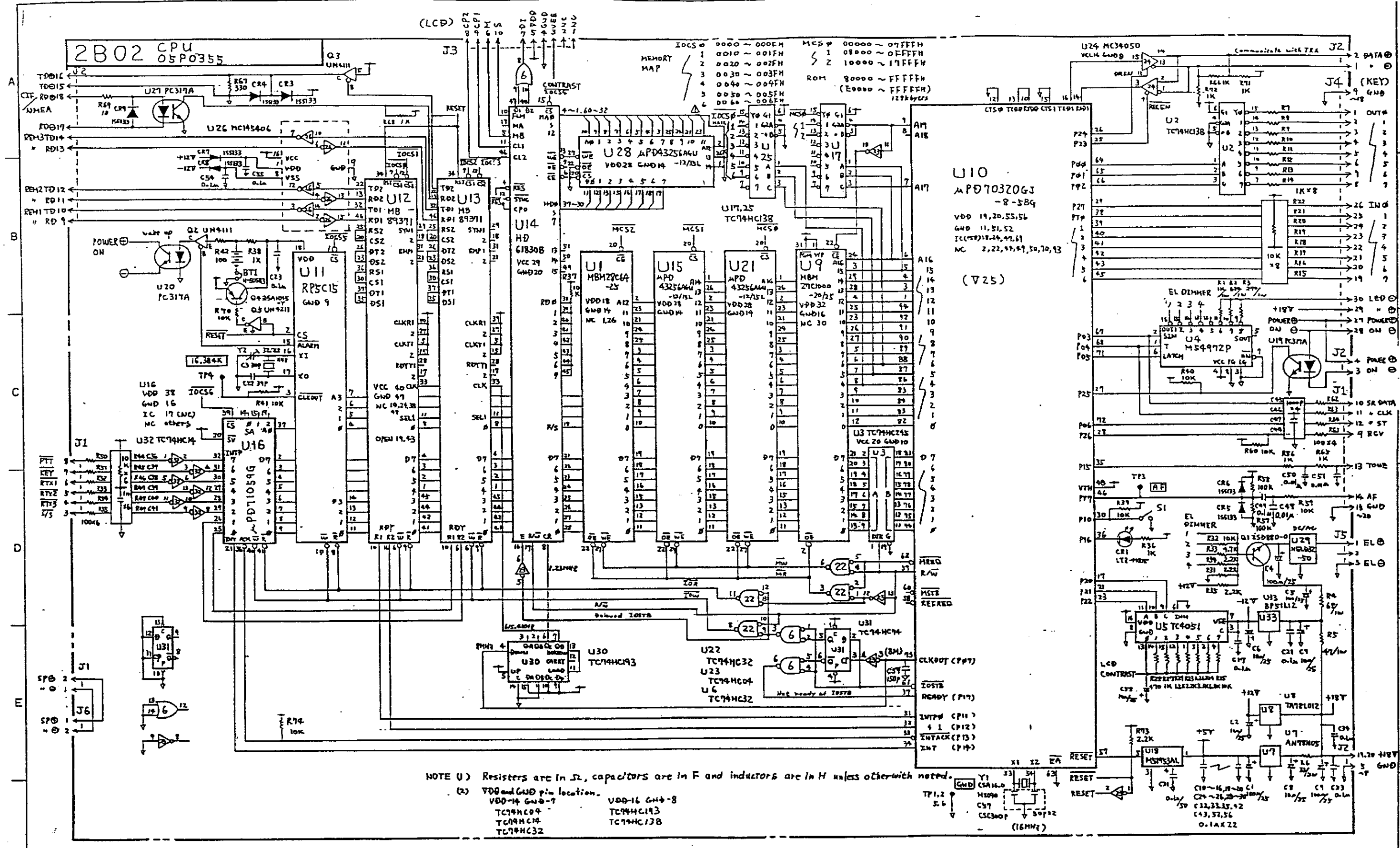

三技種 FS-5000	コード	SHEET NO. 1/1
	型名	
課長 検図 設計 製図	TITLE	2B02 CPU (CONTROLLER UNIT)
	No.	C5519-K15-D

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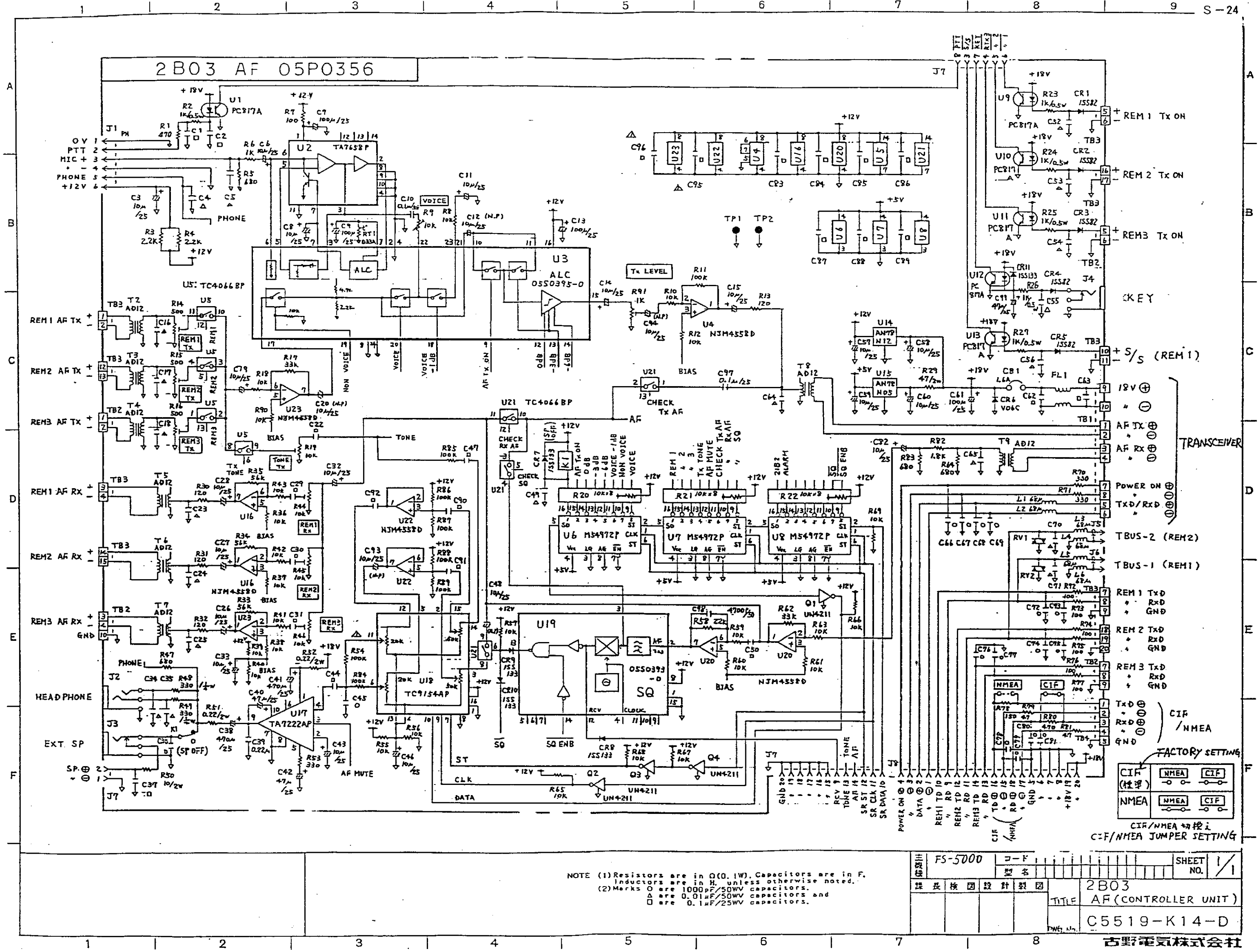
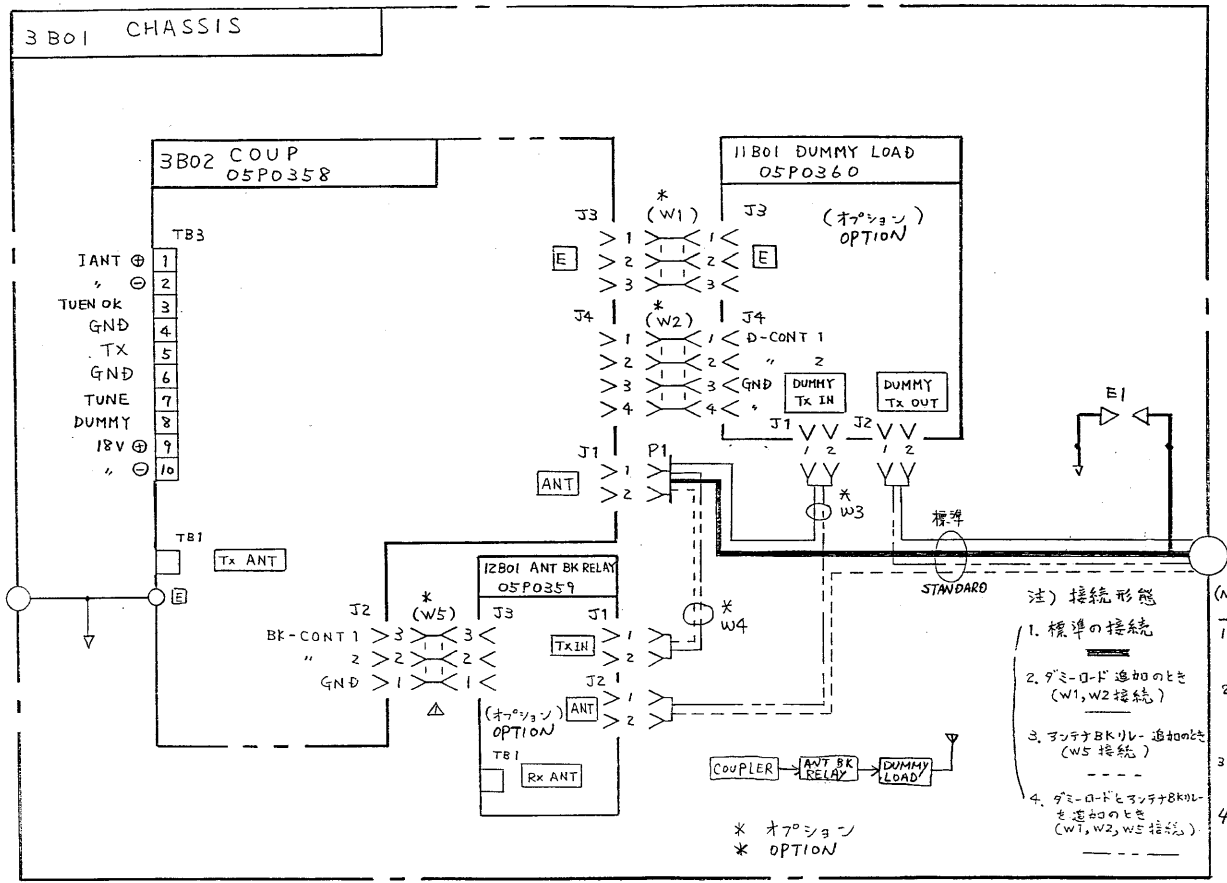
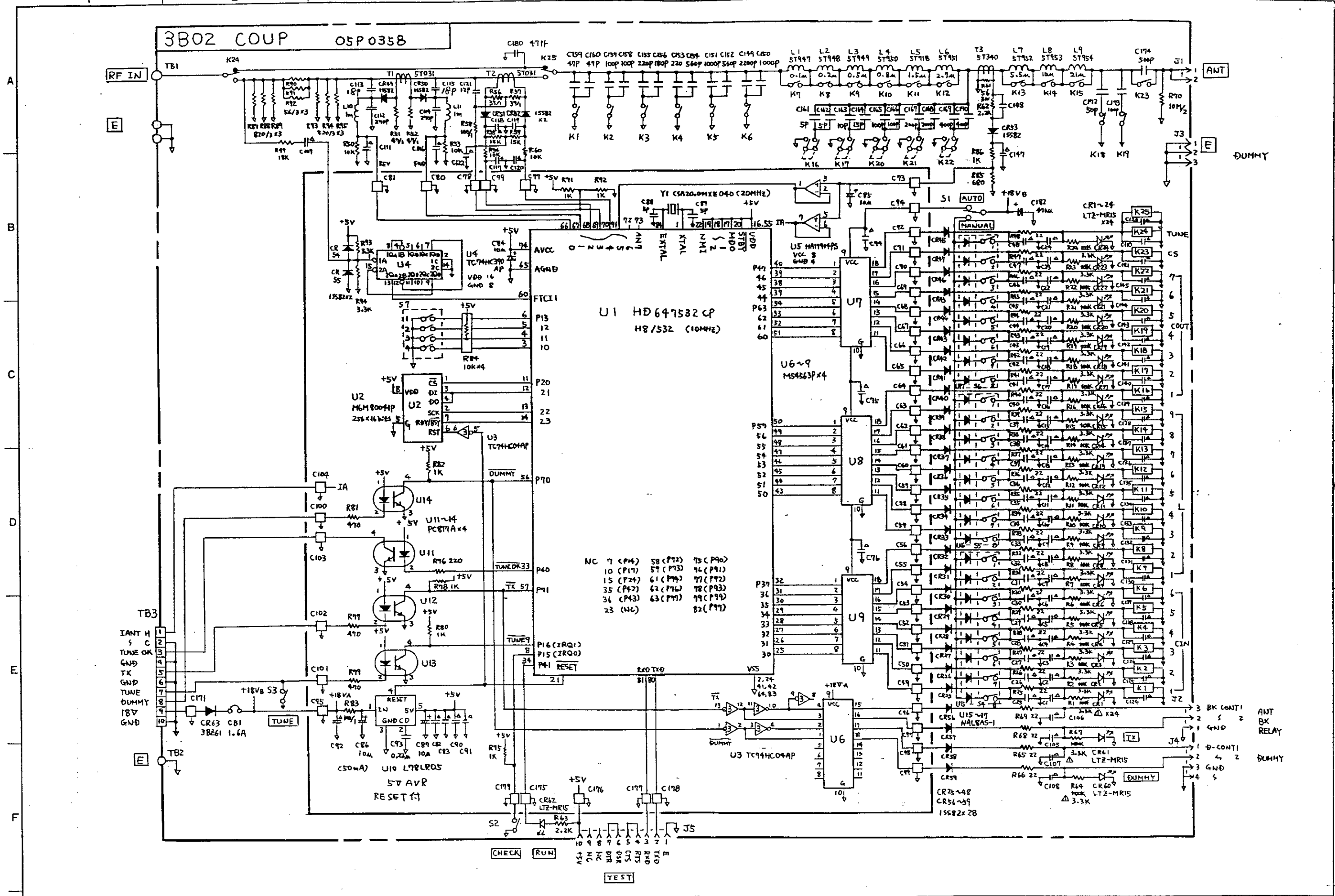

2B03 AF 05P0356
J1
0V 1
PTT 2
MIC + 3
- 4
PHONE 5
+12V 6
PHONE
U1 PC817A
U2 TA7658P
U3 ALC 0550395-0
VOICE
Tx LEVEL
U4 NJM4558D
BIAS
U5: TC4066BP
REM1 AF Tx
REM2 AF Tx
REM3 AF Tx
REM1 AF Rx
REM2 AF Rx
REM3 AF Rx
GND
U21 TC4066BP
CHECK Tx AF
CHECK Rx AF
CHECK SQ
TONE
AF
U23 NJM4558D
U16
U22 NJM4558D
U6 M54972P
U7 M54972P
U8 M54972P
U18 TC9154AP
U19
0550393
SQ
SQ ENB
U17 TA7222AP
HEADPHONE
EXT. SP
AF MUTE
ST
CLK
DATA
Q1 UN4211
Q2 UN4211
Q3
Q4 UN4211
NJM4558D
J7
PTT
S/S
KEY
RxS
REM1 Tx ON
REM2 Tx ON
REM3 Tx ON
KEY
S/S (REM1)
18V ⊕
" ⊖
AF TX ⊕
AF RX ⊕
TRANSCEIVER
POWER ON ⊕
TxD/RxD
TBUS-2 (REM2)
TBUS-1 (REM1)
REM1 TxD
RxD
GND
REM2 TxD
REM3 TxD
TxD ⊕
RxD ⊕
GND
CIF /NMEA
FACTORY SETTING
CIF (標準)
NMEA
CIF/NMEA 切換え
CIF/NMEA JUMPER SETTING
TP1
TP2
U14 AN78N12
U15 AN78N05
FL1
NOTE (1) Resistors are in Ω(0.1W). Capacitors are in F. Inductors are in H. unless otherwise noted.
(2) Marks ○ are 1000pF/50WV capacitors.
△ are 0.01μF/50WV capacitors and
□ are 0.1μF/25WV capacitors.
FS-5000
コード
型名
SHEET NO. 1/1
課長 検図 設計 製図
TITLE 2B03 AF (CONTROLLER UNIT)
DWG. No. C5519-K14-D
古野電気株式会社



主機種	FS-1600 FS-2500 FS-5000/9000	コード	SHEET NO. 1/1
		型名	
課長	検図	設計	製図
TITLE	3B01 CHASSIS (COUPLER UNIT)		
DWG. No.	C5519-K18-C		

古野電気株式会社



NOTE (1) Resistors are in Ω(0.1W), Capacitors are in F, Inductors are in H, unless otherwise noted.
(2) Marks ○ are 1000pF/50WV capacitors,
△ are 0.01μF/50WV capacitors and
□ are 0.1μF/25WV capacitors.

主搭載機種	FS-1600 FS-2500 FS-5000/8000	コード	SHEET NO. 1/1
		型名	
課長 検図 設計 製図		TITLE	3B02 COUPLER PCB (COUPLER UNIT)
		DWG.No.	C5519-K19-D

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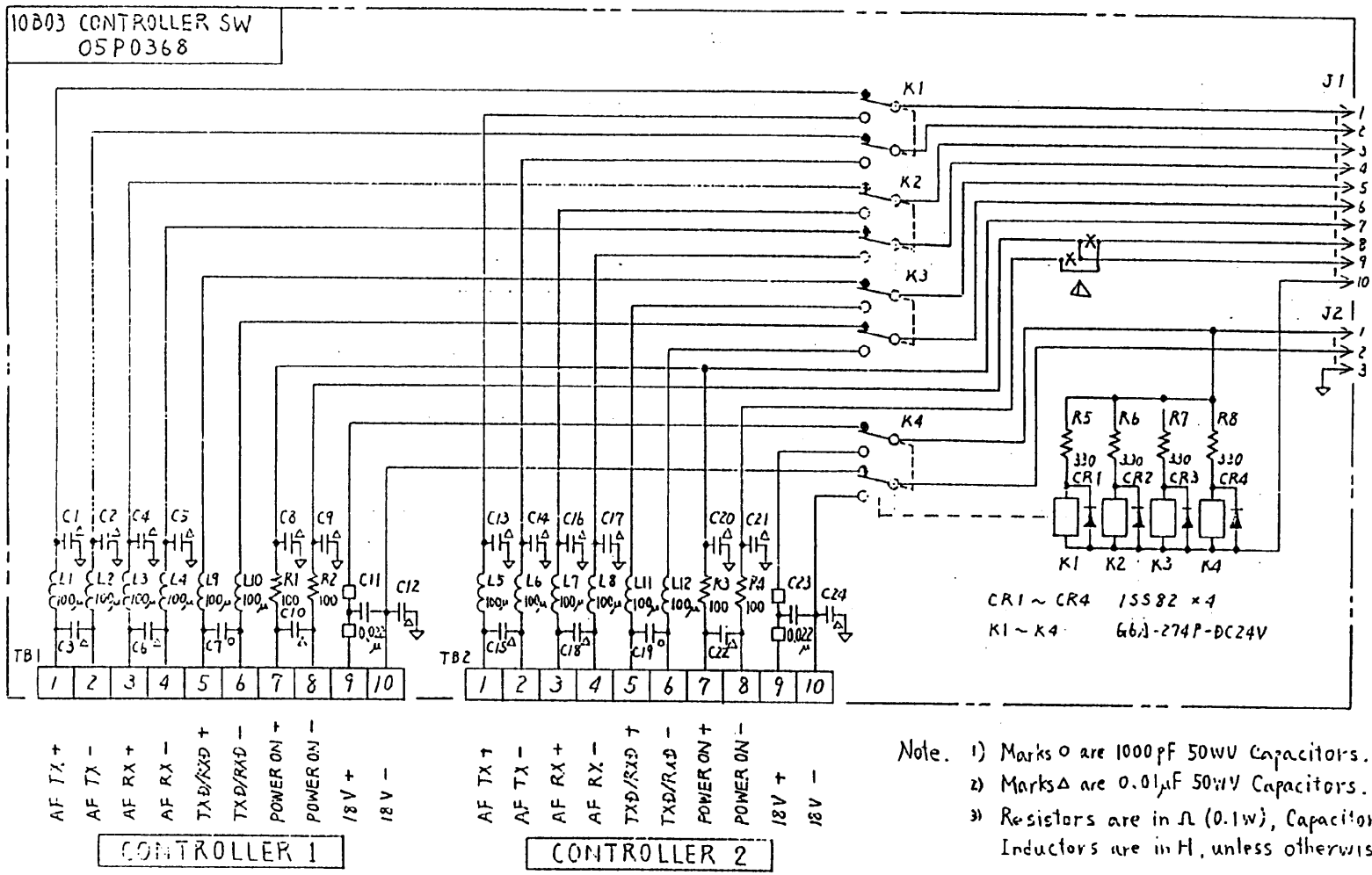
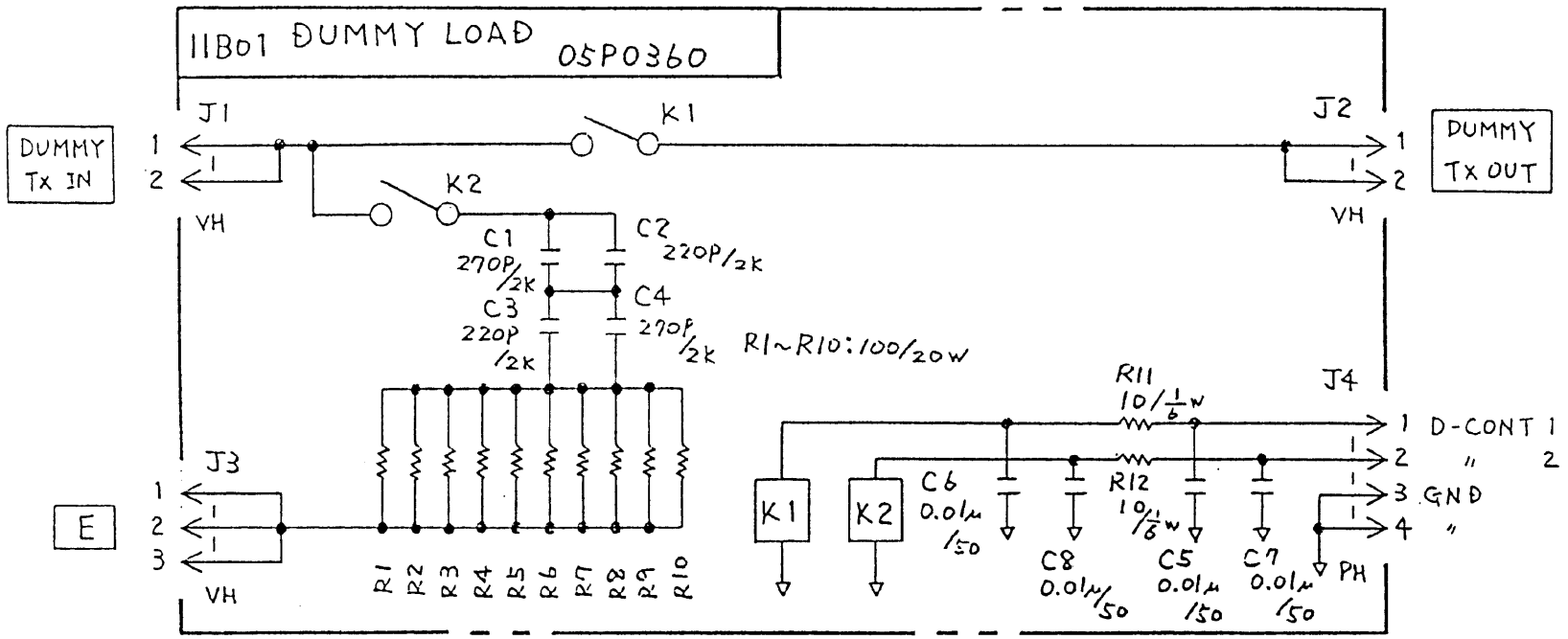


Note. 1) Marks ○ are 1000pF 50WV Capacitors.
2) Marks △ are 0.01μF 50WV Capacitors.
3) Resistors are in Ω (0.1W), Capacitors are in F, Inductors are in H, unless otherwise noted.

主機種	FS-1600 FS-2500 FS-5000	コード			SHEET NO.	1/1
		型名				
課長	検図	設計	製図	TITLE	10B03 CONTROLLER SW (OPTION) (TRANSCEIVER UNIT)	
				DWG.No.	C5519-K01-B	



NOTE) Resistors are in Ω, Capacitors are in F.

主機種	FS-1600 FS-2500 FS-5000	コード			SHEET NO.	1/1
		型名				
課長	検図	設計	製図	TITLE	11B01 DUMMY LOAD (OPTION) (COUPLER UNIT)	
				DWG. No.	C5519-K16-B	

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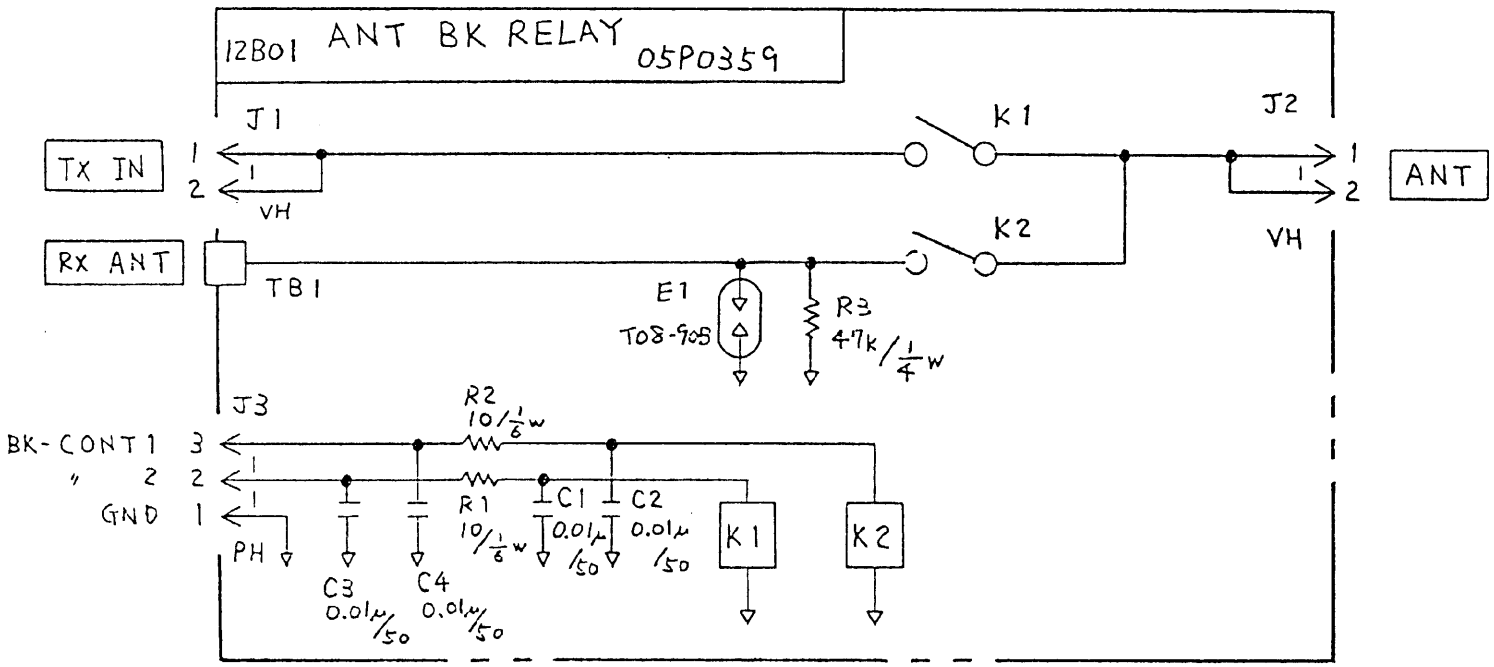
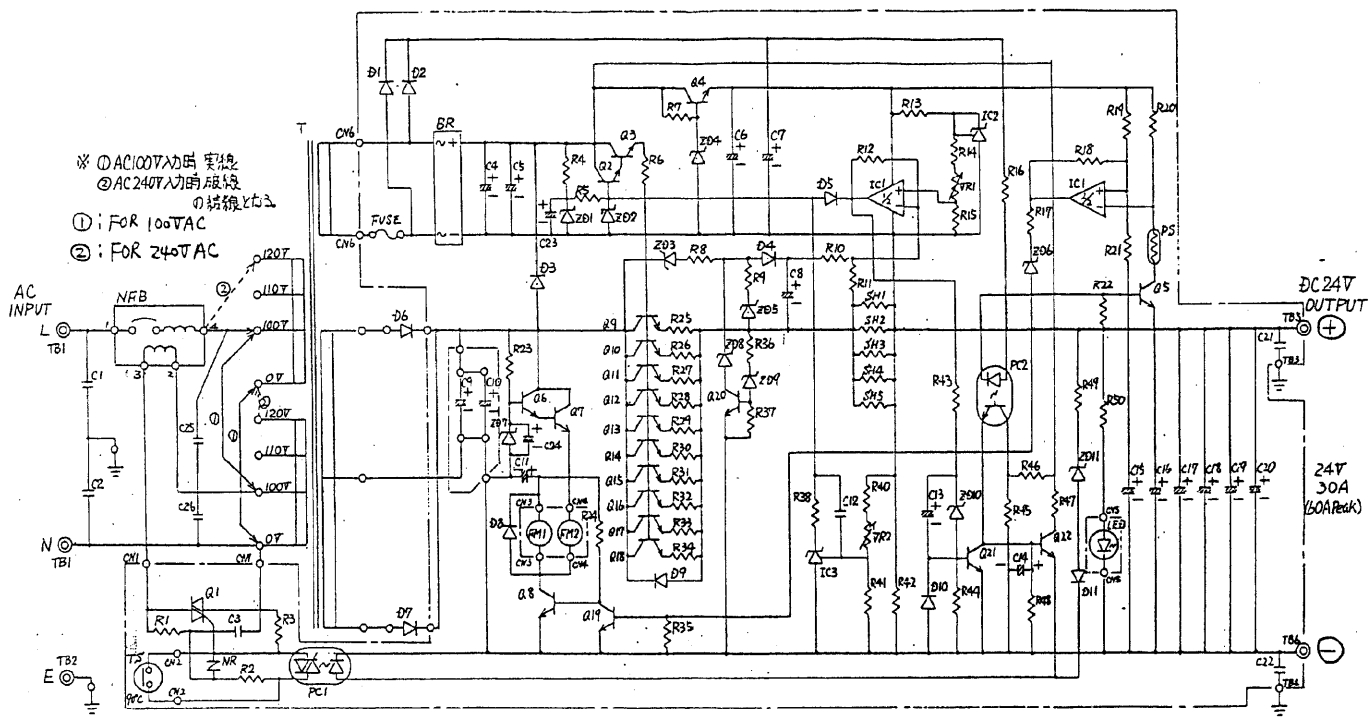


NOTE) Resistors are in Ω, Capacitors are in Fi.

主機種	FS-1600 FS-2500 FS-5000	コード 型名	SHEET NO. 1/1
課長	検図	設計	製図
			TITLE: 12B01 ANT BK RELAY (OPTION) (COUPLER UNIT)
			DWG. No.: C5519-K17-B

古野電気株式会社

FURUNO



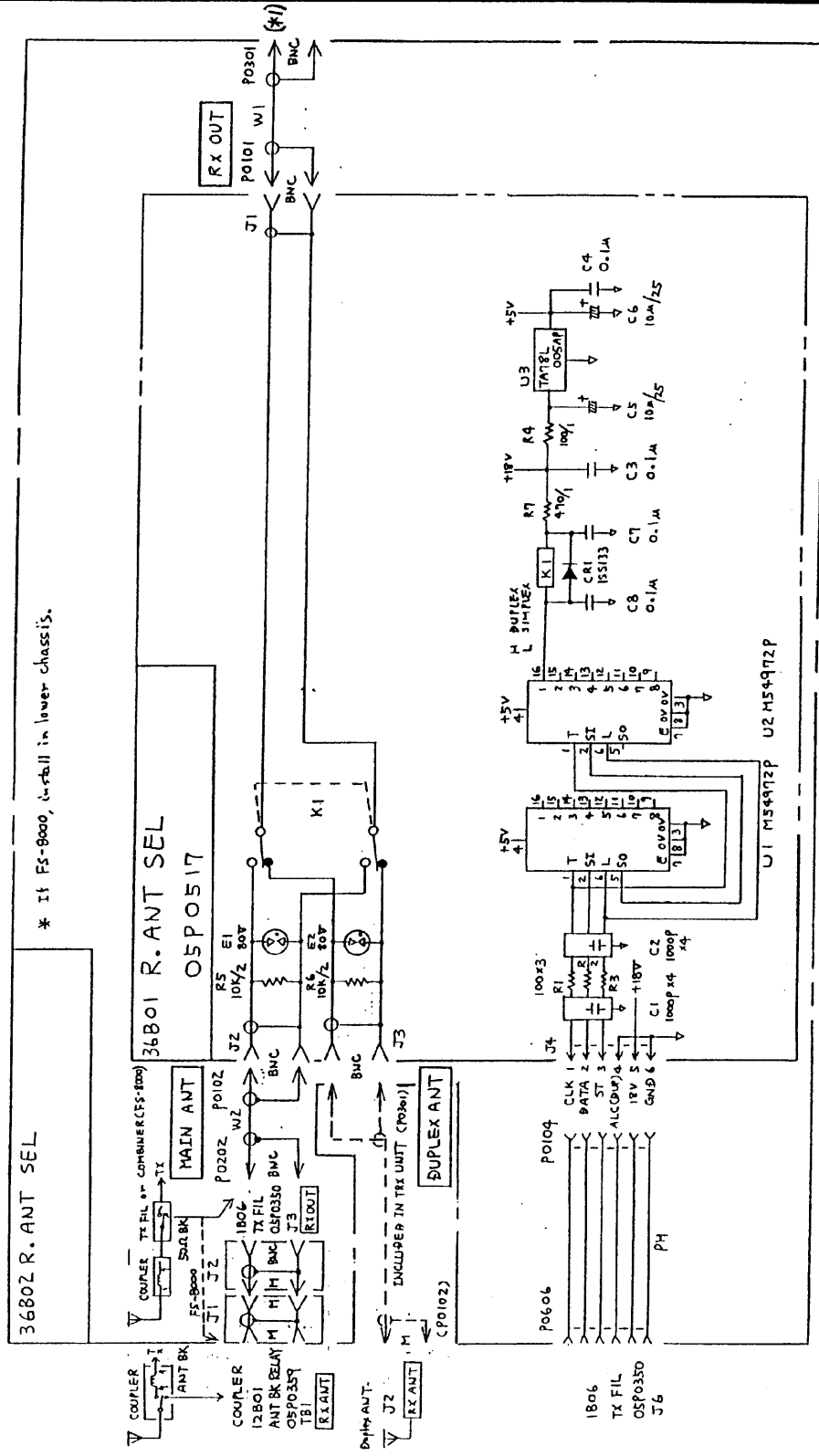
品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS

承認 APPROVED		三角法 THIRD ANGLE PROJECTION	名称 TITLE: PR-850 AC電源ユニット AC POWER UNIT
検図 CHECKED		尺度 SCALE	
製図 DRAWN		重量 WEIGHT kg	図番 DWG.NO. C5519-K20-B

FS-1600
2500
5000
8000

FURUNO ELECTRIC CO., LTD.

FURUNO



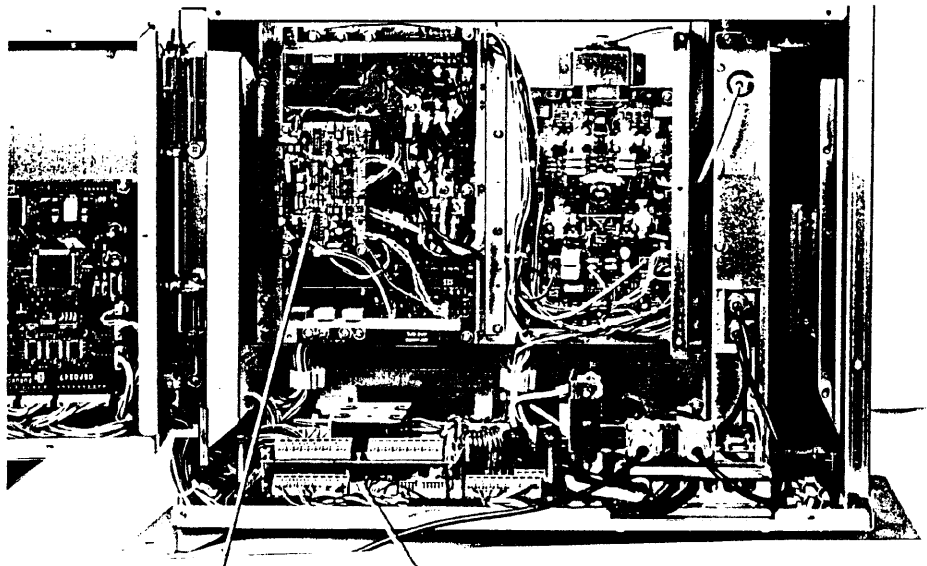
FS-5000 SERIES	品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
承認 APPROVED	AUG. 25. 92 T. NAKANO	三角法 THIRD ANGLE PROJECTION	名称 TITLE	36B01/02 05P0517 R. ANT SEL Board		
検図 CHECKED	25. AUG. '92 K. GOTO	尺度 SCALE				
製図 DRAWN	25. AUG '92 T. SAITO	重量 WEIGHT kg	図番 DWG. NO.	C5519-K23-A		

APPENDIX 1
ALTERATION OF SHIP'S MAINS

Change the jumper wire on the two REG CONT Boards and two INTERFACE Boards according to ship's mains (24 or 32 VDC).

① Modification of REG CONT Board ----- For both lower & upper units.

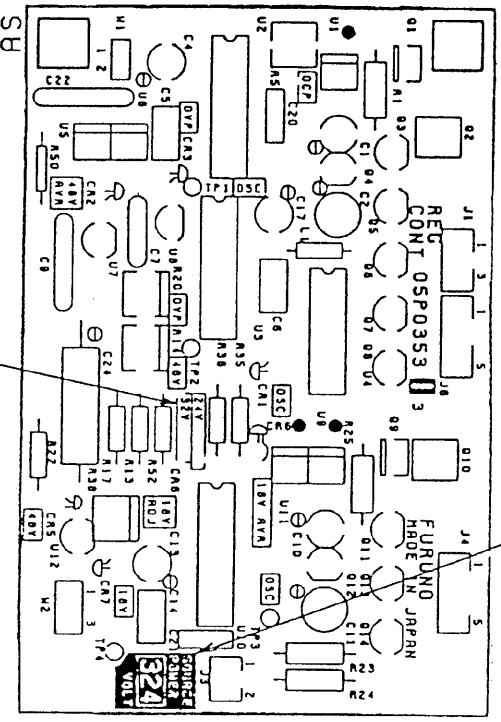
Example for Lower Unit



T Photo No.1107

INTERFACE Board

REG CONT Board



Jumper Wire
[24 VDC: open
[32 VDC: short

Input power displayed here.

24 VDC: 3 2 4
32 VDC: 3 2 4

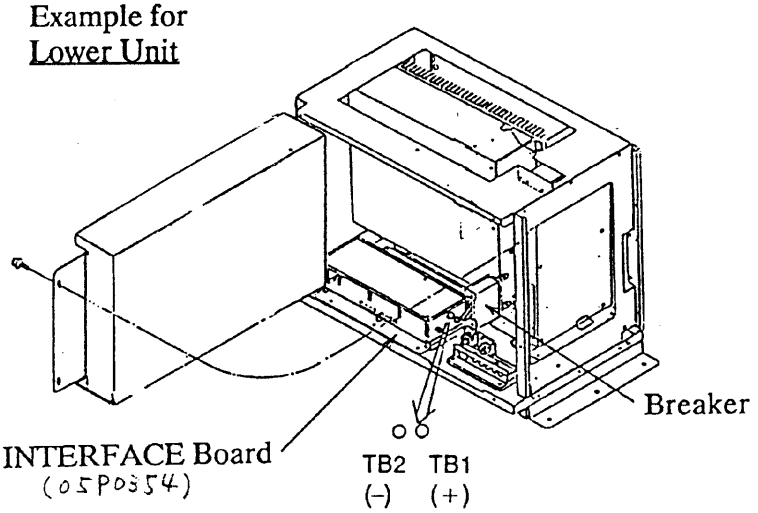
Black out a digit to show voltage.

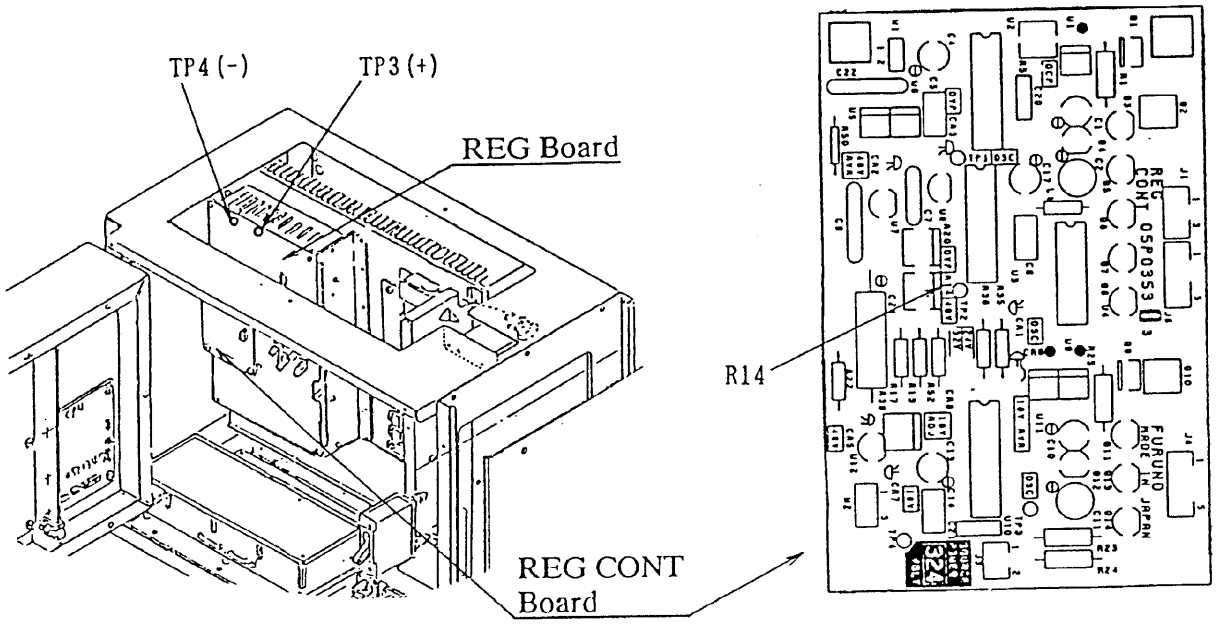
Checking Voltage (for both lower & upper units)

Measure input voltage and the 48 V line under receiving condition. If the voltage of 48 V line is not within the rating shown in the table below, adjust it with R14 on the REG CONT Board.

Ship's Mains	Input Voltage		48 V Line Voltage		
	Measuring Point	Rating	Measuring Point	Rating	Adjuster
24VDC	INTERFACE Board	21.6 – 31.2 V	REG Board	45 V (± 0.1 V) (at 24V supply)	REG CONT Board
32VDC	TB1 (+) TB2 (–)	28.8 – 41.6 V	TP3 (+) TP4 (–)	44 V (± 0.1 V) (at 32V supply)	R14

Example for
Lower Unit

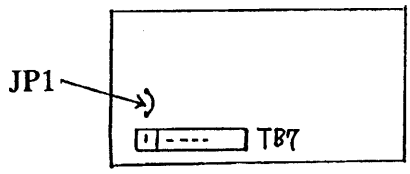




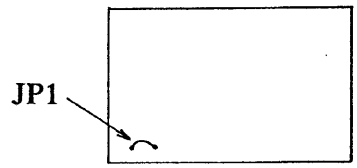
② Modification of INTERFACE Board ----- For both lower & upper units.

(Overvoltage Setting)

Ship's Mains	Jumper Setting (JP1)
24 VDC	Short
32 VDC	Open



05P0354
(Lower Unit)



05P0362
(Upper Unit)

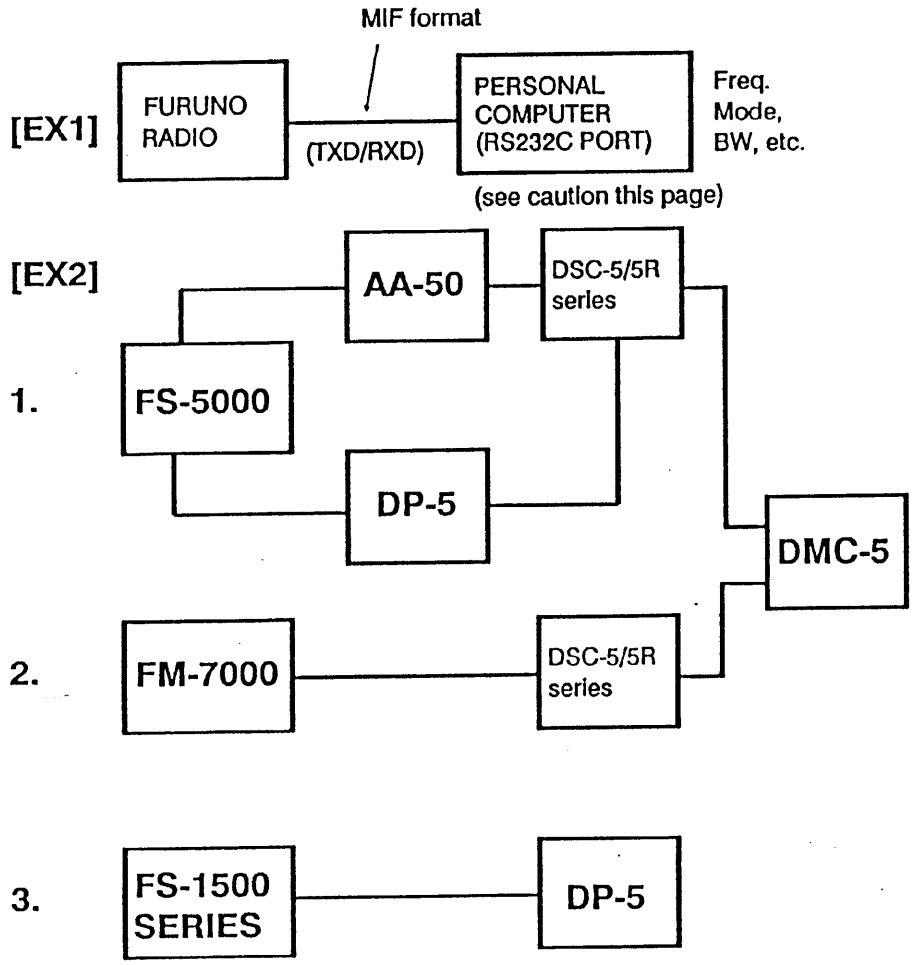
After modification, overvoltage value is automatically set as follows.

Ship's Mains	Overvoltage value
24 VDC	34 VDC
32 VDC	44 VDC

APPENDIX 2 MIF FORMAT

MIF is a handshaking type signal exchange system developed by FURUNO for remote control of newly developed FURUNO radio equipment; for example, DP-5, FS-5000, FS-8000, DSC-5 and others.

Example for interconnection



* All data are communicated in MIF format.

CAUTION

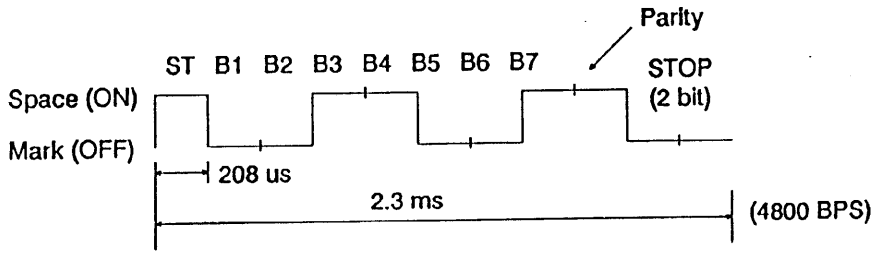
Furuno will assume no responsibility for the inconvenience/disturbance to communications or unlawful emission due to inadequate command from personal computer.

SPECIFICATION OF MIF

1. Communication System: Serial asynchronous (half-duplex)

2. Baud Rate: 4800 BPS standard
(1200/2400/9600 BPS selectable)

3. Character Format



Start	:	1 bit
Data (B1 to B7)	:	7 bit
Parity	:	1 bit (Even)
Stop	:	2 bit

------> 11 bit

4. Signal Level (RS-232C compatible, except FM-7000)

Name	Space	Mark
Logic	0 (ON)	1 (OFF)
Output	+ 5 to + 15 V	– 15 to – 5 V
Input	≥ 3 V	≤ – 3 V

* FM-7000 ----- Current Loop (±20 mA)

5. Pin Arrangement (except FM-7000)
(DTE: Data Terminal Equipment)

	Pin No.	Name	Function	Signal Logic	
				Positive Voltage	Negative Voltage
	1	FG	Frame Ground	—	—
	2	TXD	Transmission Data	Space (0)	Mark (1)
	3	RXD	Reception Data	Space (0)	Mark (1)
Jumper wire required	4	RTS (Not used)	Request to Send	Valid	Invalid
	5	CTS (Not used)	Clear to Send	—	—
	6	DSR (Not used)	Data Set Ready	Valid	Invalid
Jumper wire required	7	SG	Signal Ground	—	—
	20	DTR (Not used)	Data Transmit Ready	Valid	Invalid

* FM-7000	Pin No.	Name
	1	TXD (H)
	2	TXD (C)
	3	RXD (H)
	4	RXD (C)
	5	FG
	9	SG

6. Command Input: ASCII code,
Alphanumerals
(Alphabet: 2 digits, numeral: more than 1 digit)
End of Data ----- CR, LF or CR

Example

F R 1 2 3 4 5 6 7 CR (,LF)

↑ ↑

Command ID Data (Parameter)

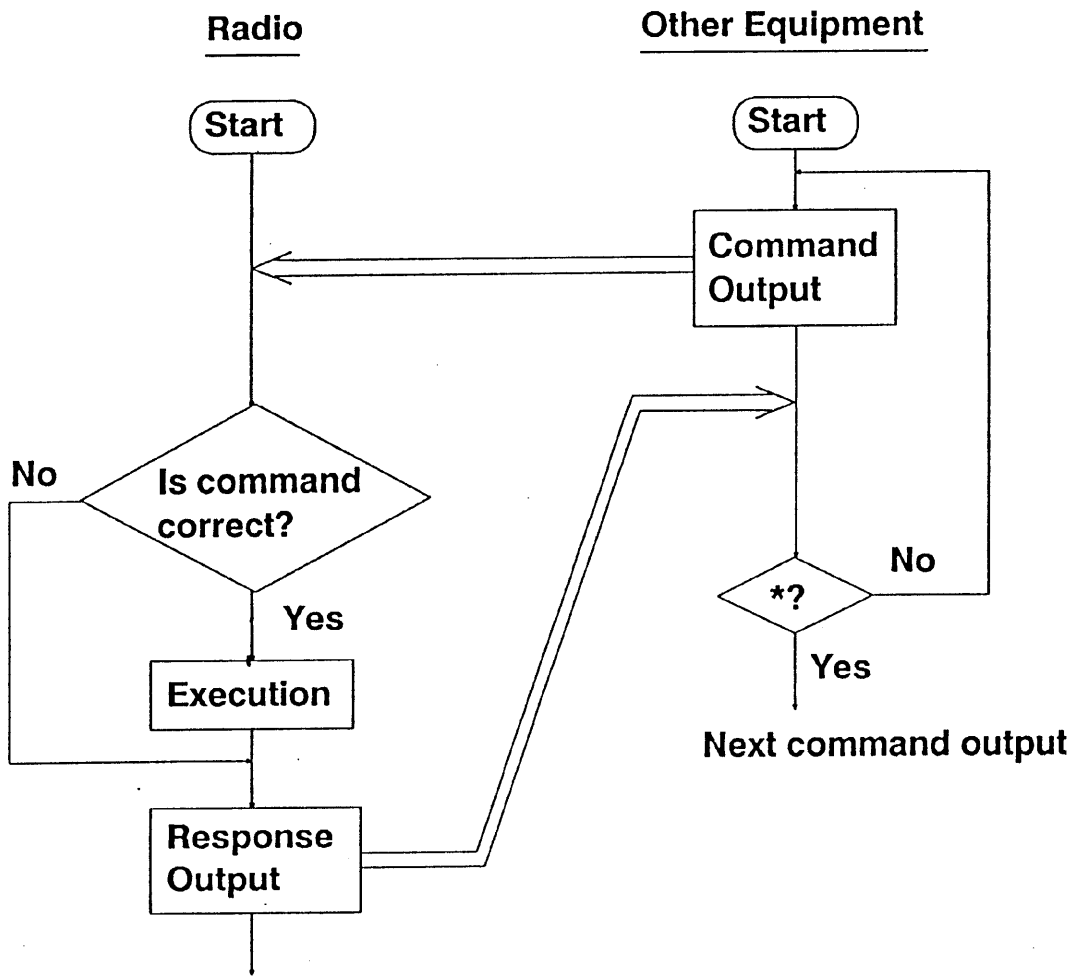
7. Response Output

1 * CR (LF) ------ When the command is correctly executed.

2 ? CR (LF) ------ When incorrect command is input,
or error takes place during execution
of the command.

Time out: 1 sec.

Retry: 3 times (60 sec only for tune command ("TU"))



8. Command Tables

The command tables show the function and valid parameter for each command. Note that some commands may not be valid **depending on transceiver/transmitter/receiver connected.**

Control	Command	Parameter
TRANSMISSION FREQUENCY	FT	6 digits/7 digits (last unit must be 10 Hz place) 1 2 3 4 5 6 7 10 MHz 1 MHz 1 kHz 10 Hz
RECEPTION FREQUENCY	FR	same as above
CLASS OF EMISSION	EM	0 to 6 : 1 digit 0: LSB 4: CW 1: USB 5: FSK (TELEX) 2: AM 6: FAX 3: R3E A1A : 3 digits For USB, enter "J3E".
BANDWIDTH	BW	0 to 7 : 1 digit 0: W-FM (25 kHz) 4: FSK (1kHz) 1: FM (16 kHz) 5: N-CW (0.5 kHz) 2: AM (6 kHz) 6: N-CW (0.3 kHz) 3: SSB (3 kHz) 7: VERY-N (0.2 kHz) 030 : 3 digits (10 kHz, 1 kHz, 100 Hz places)
AGC	AG	S : 1 digit 0: AGC OFF S: AGC ON 1: AGC ON (SLOW) R: AGC OFF 2: AGC ON (FAST) 3: AGC ON (MID)
BFO	BF	+ 0 8 0 0 : 5 digits (+/-, 1kHz, 100 Hz, 10 Hz, 1 Hz) S : 1 digit S: BFO ON U: BFO UP R: BFO OFF D: BFO DOWN
CLARIFIER	CL	+ 0 1 0 0 : 5 digits (+/-, 1kHz, 100 Hz, 10 Hz, 1 Hz) S : 1 digit S: Clarifier ON U: Clarifier UP R: Clarifier OFF D: Clarifier DOWN

continued

Control	Command	Parameter
SQUELCH	SQ	10 : 2 digits To adjust squelch threshold, enter hexadecimal code; FF provides tightest squelch. S : 1 digit S: Squelch ON R: Squelch OFF
NOISE BLANKER	NB	S : 1 digit S: Noise Blanker ON R: Noise Blanker OFF 1 0 : 2 digits To adjust sensitivity of noise blanker, enter hexadecimal code (00-FF); FF is highest threshold.
SPEAKER CONTROL	SP	S : 1 digit S: Speaker ON R: Speaker OFF
MUTE	MU	S : 1 digit S: Mute ON R: Mute OFF
BK	BK	S : 1 digit S: BK ON R: BK OFF
TX	TX	S : 1 digit S: TX ON R: TX OFF
EXCITER	EX	S : 1 digit S: Exciter ON R: Exciter OFF
TUNING	TU	No fixed parameter (Time out: 15 sec)
SPEAKER VOLUME	AF	U : 1 digit U: Increase Volume D: Decrease Volume 1 0 : 2 digits Enter hexadecimal code (00-FF); FF for maximum volume
SENSITIVITY	RF	U : 1 digit, same as "speaker volume" 1 0 : 2 digits, same as speaker volume.

continued

Control	Command	Parameter
DIMMER	DI	S : 1 digit S: Dimmer ON U: Brighten R: Dimmer OFF D: Dim 0 F : 2 digits Enter hexadecimal code (00-FF); FF for maximum brightness.
RF POWER	PO	0 to 3 : 1 digit 3: Full Power 1: Low Power 2: Mid Power 0: Zero Power 1 0 : 2 digits Enter hexadecimal code (00-FF); FF for maximum RF power.
RAISE FREQUENCY, CHANNEL	UP	0 to 7 : 1 digit 0: Raise Channel by one 4: Raise Freq. by 10 kHz 1: Raise Freq. by 10 Hz 5: Raise Freq. by 100 kHz 2: Raise Freq. by 100 Hz 6: Raise Freq. by 1 MHz 3: Raise Freq. by 1 kHz 7: Raise Freq. by 10 MHz
LOWER FREQUENCY, CHANNEL	DN	1 : 1 digit Same as above
CHANNEL NUMBER	CH	0001 : 4 digits --- retain current channel number. U001 : 4 digits --- U (W, N or P) + 3 digit ch. No. [U: USA, W: Weather, N: International, P: Private] PF01 : 4 digits --- PX + 2 digit ch. No. [X: F, P, L or M] G0101 : 5 digits --- G + 2 digit group No. + 2 digit ch. No. (for group ch.) I01001 : 6 digits --- I + 2 digit band No. + 3 digit ch. No. (for ITU ch.)
WRITE TO MEMORY	ST	Same as for channel number
RECALL FROM MEMORY	RC	Same as for channel number
FSK SHIFT WIDTH	FS	0 to 2 : 1 digit 0: 850 Hz 1: 425 Hz 2: 170 Hz 850 : 3 digits (desired width in Hz)
DUPLEX, SIMPLEX	DU	S : 1 digit S: Duplex ON 0: Full Duplex R: Duplex OFF 1: Semi Duplex 2: Simplex
FREQUENCY SCANNING	SC	S : 1 digit S: Start R: Stop

continued

Control	Command	Parameter
SCAN MODE	SM	1 to 4 : 1 digit 1: Scan Channel 2: Group Scan 3: Frequency Scan 4: Sweep
DATE	DT	10 digits: Example: March 20, 1991 1 9 9 1 / 0 3 / 2 0 Year Month Day
TIME OF DAY	TI	8 digits: Example: 13:25:30 1 3 / 2 5 / 3 0 Hour Minute Second
TIMER START & STOP	TS	S: :1 digit S: Start R: Stop
WAKE-UP TIMER	TM	1 to 4 : 1 digit 1: Timer 1 2: Timer 2 3: Timer 3 4: Timer 4
TIMER ON & OFF SETTING	TP	as desired
ATTENUATION ON & OFF	AT	S: :1 digit S: Receiver front end attenuator ON R: Receiver front end attenuator OFF
BAND	BA	1 : 1 digit 0: BAND 0 〉 F: BAND 15
FILTER SETTING	FL	1 : 1 digit 0: FILTER 0 〉 F: FILTER 15
SWITCH SETTING	SW	1 S : 2 digits 0S: SW 0 ON 0R: SW 0 OFF 〉 FS: SW 15 ON FR: SW 15 OFF

continued

Control	Command	Parameter
TRANSCEIVER CONDITION	CA	FT : 2 digits Type CA followed by desired command. Example: To show current receive frequency, enter CAFR.
TRANSCEIVER MODEL NAME	CA	ID : 2 digits Example # ID FS5000
S-METER LEVEL	CA	SL : 2 digits Example # SL0F (0F = hexadecimal)
OPERATION LOCK	FZ	S : 1 digit S: Prevents operation of the transceiver. R: Releases the transceiver.
DISTRESS TRANSMISSION	DR	S : Start distress R : Stop distress
SELCALL TRANSMISSION	SE	S (ID CODE): S: Own Station ID setting G: Group ID setting C: Selcall Transmission
AUTOMATIC PUBLIC TELEPHONE DIALING	TL	Telephone Number Example: TL 0798 65 2111 Command Parameter
INTERCOM	IC	1 digit Intercom Number, or S or R: If calling from a controller, command and parameter are transmitted. I C 3 S Command S: Intercom ON R: Intercom OFF
RESET	RE	No parameters required. SSB generates "RE" command when it turns on, to try to receive again the command sent previously.
OPTION	OP	Unique command for an equipment . ex: OP FR xxxxxxxxxx 10 digits

Note: For FS-5000 (8000) and FM-7000 radiotelephones, the following commands are available.

FS-5000(8000)

FT/FR/EM (0 to 6)/BW/AG/BF/SQ/NB/ SP/TX/TU/AF/RF/DI/PO/UP/DN/CH/ ST/RC/DU/SC/SM/DT/TI/FZ/DR/RE/ CAFT/CAFR/CAID/CAEM/CASL/ CASQ/CABF, etc.

FM-7000

SQ/SP/MU/TX/PO/UP/DN/CH/ DU/SC/SE/TL/DW (Dual watch)/ IC/FZ/DR/RE/CACH/CAID/ CADU, etc.

APPENDIX 3 PREVIOUS ANTENNA COUPLER

The numbering of the new antenna coupler begins from 1001. (The previous coupler has serial number of 999 and earlier.) The following shows characteristics of the new coupler.

1. In the tuning circuit, voltage tolerance and capacitance of each element are remarkably increased. The COUPLER board is completely changed. Note that a new COUPLER board (05P0358-44) is interchangeable with a previous one (05P0358-33).

2. Antenna tuning sequence is changed.

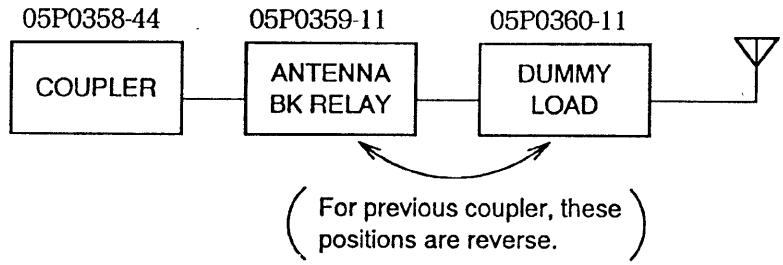
3. A shortening capacitor and coupling capacitor (shunt capacitor) are automatically connected according to antenna length.

4. Memory device to store tuning data is changed from a RAM to a E^2PROM, to store the data permanently.

5. CPU is changed. (ROM/RAM/AD converter incorporated)

6. DUMMY LOAD and ANT BK RELAY boards are modified to withstand a higher voltage. (Both boards can be used in a previous version antenna coupler; but both previous boards can not be used in a new coupler.)

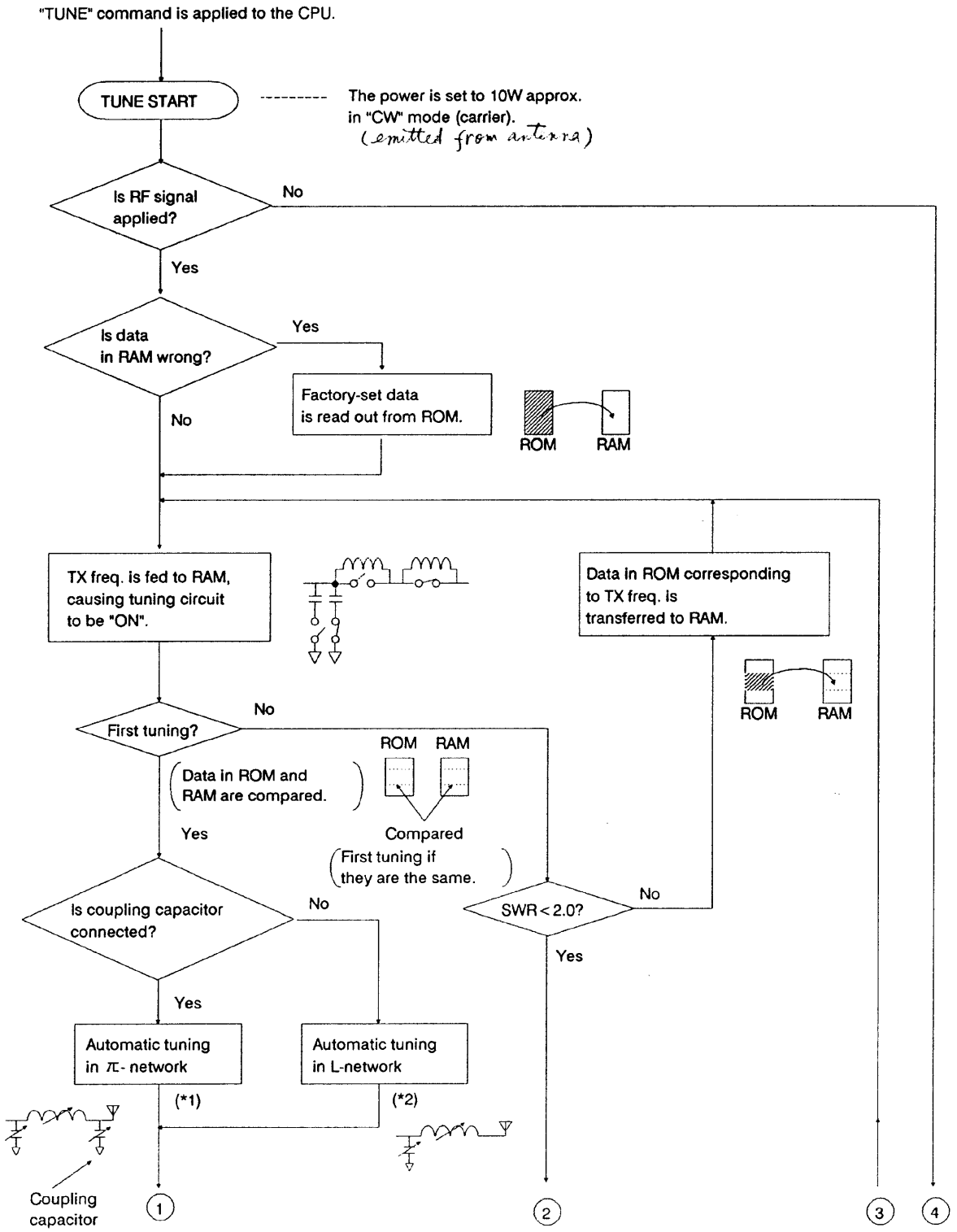
7. Interconnection of COUPLER, DUMMY LOAD and ANT BK RELAY boards is changed.

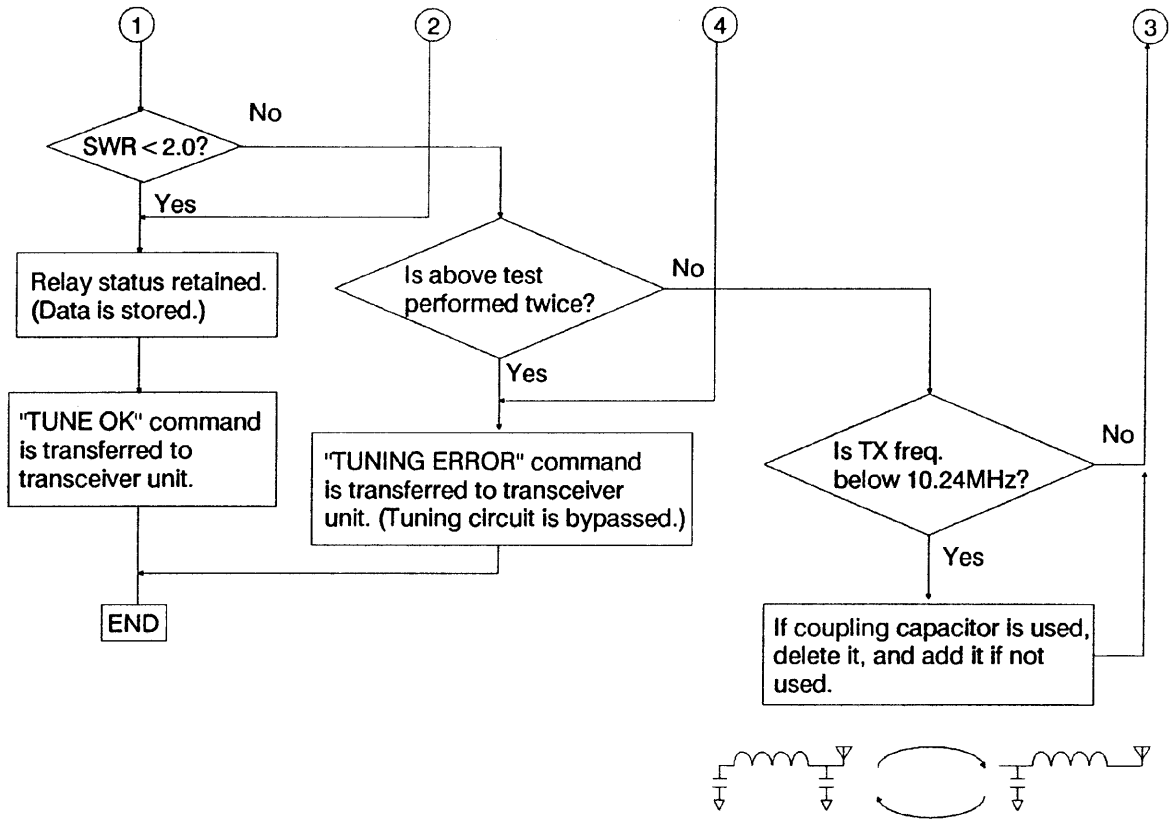


8. Arrester gap is changed to 3mm.

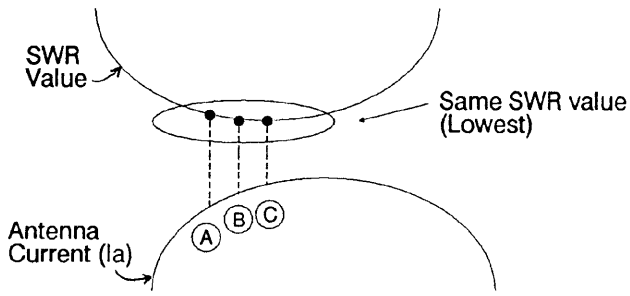
9. Fixing method of coaxial cable is changed. (Two cable clamps are supplied.)

Automatic Tuning for Previous Coupler





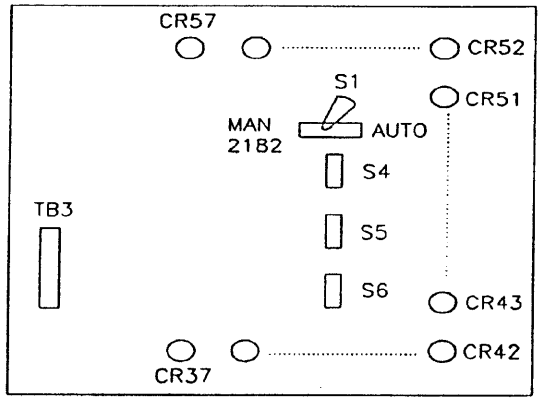
(*1)/(*2): The best tuning point is searched for observing SWR value; that is, best tuning point is where the SWR is the lowest. If three SWR values are the same (see below), the tuning data at the point Ⓒ, where Ia value is the largest among them, is used.



(*2): If the tuning point is not found on 2.56MHz or less, a shunt capacitor is inserted and tuning is restarted.

Manual 2182kHz Tuning Preset

For parts location of the previous coupler, refer to page 4-5.



COUPLER Board

DIP Switch S1 permits manual transmission of 2182kHz in the event the automatic tuning circuit fails.

Note that frequencies other than 2182kHz can also be transmitted manually by changing the settings of DIP Switches S4 thru S6. Record the status of LEDs CR37 to CR57 during automatic tuning of an often-used frequency and set DIP switches S4 thru S6 according to LED status with S1 turned to "MAN".

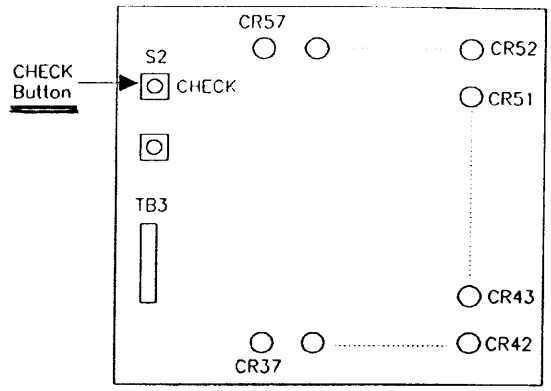
DIP Switch		LED
S4	4	CR57
	5	CR56
	⋮	⋮
	8	CR53
S5	1	CR52
	2	CR51
	⋮	⋮
	8	CR45
S6	1	CR44
	2	CR43
	⋮	⋮
	8	CR37

Relationship between DIP switches and LEDs

Self-test

To check the Antenna Coupler for proper operation, press the **CHECK** button (S2) on the Coupler Board. The relays start chattering and LEDs CR37 to CR57 blink one by one in ascending order. If device failure is found, an appropriate LED lights to indicate the offending device:

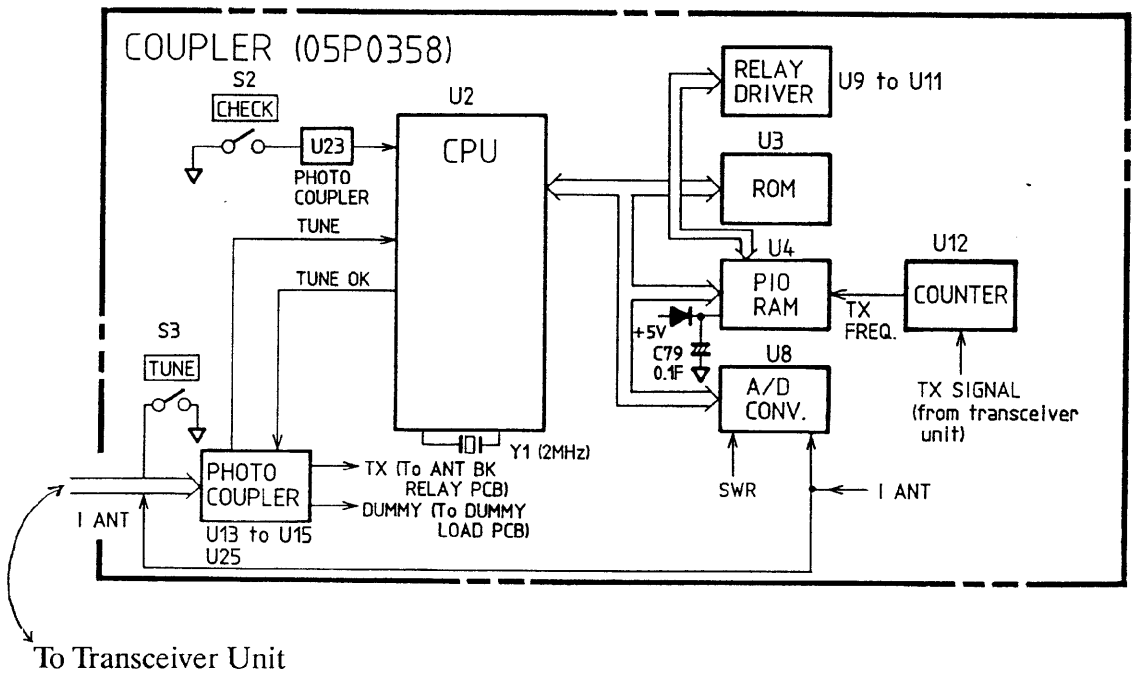
Device	LED
ROM (U3)	CR37
RAM (U4)	CR38
A/D Converter IC (U8)	CR39



CHECK Button on the Coupler Board

NOTE: The Antenna Coupler cannot be checked for proper operation when the CPU or associated circuit is malfunctioning.

Block Diagram



Installation of Shorting Capacitor

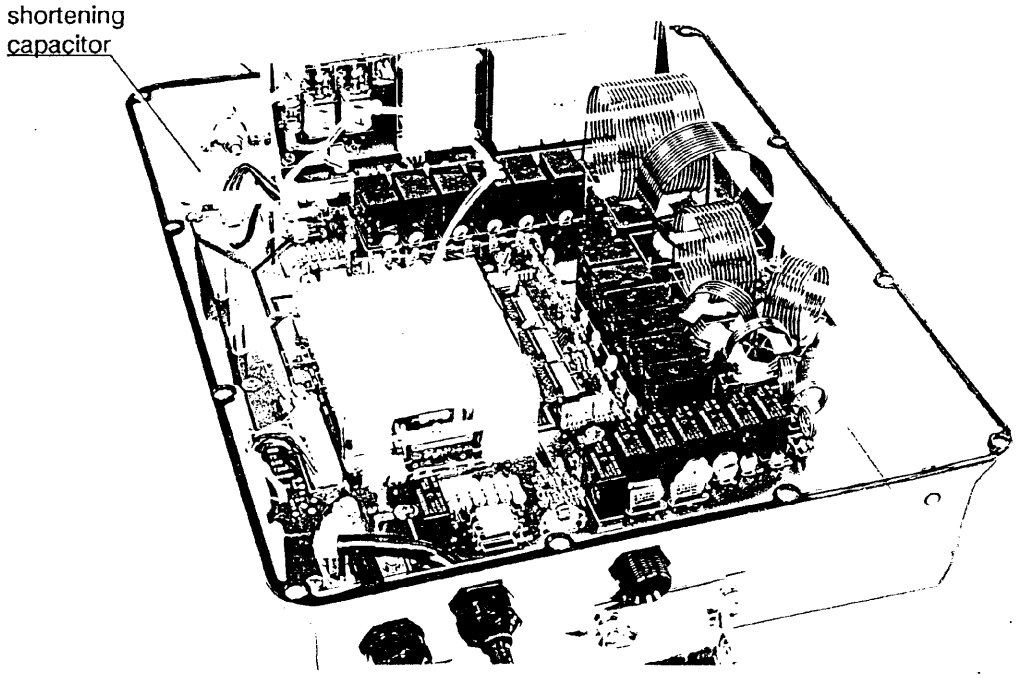
If not all frequencies are tuned automatically (because the antenna is too long), connect a shortening capacitor (500pF capacitor is provided in coupler but not connected). To insert a shortening capacitor only for a specific range, modify the DUMMY LOAD Board as shown on the next page.

Parts

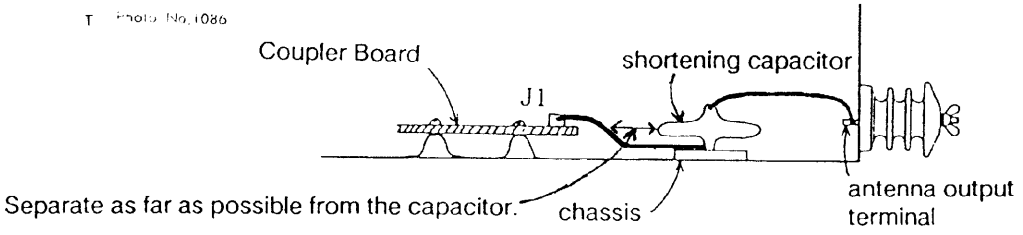
Capacitance	Type	Code No.
500 pF	DC-40 500P	000-258-703
400 pF	DC-40 400P	000-258-702
300 pF	DC-40 300P	000-258-701

} Use a 300 pF capacitor or more.

NOTE: In most cases a 500 pF capacitor is sufficient. To determine which capacitance to use, temporarily connect the coupler to the antenna with a 500 pF capacitor and confirm that all frequencies are tuned automatically. If some frequencies cannot be tuned, try a 300 pF capacitor.



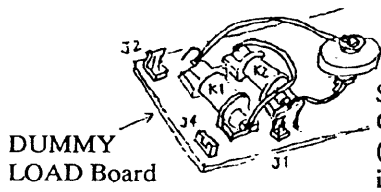
T Photo No. 1086



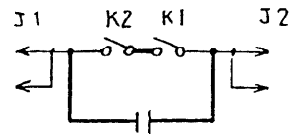
Modification of Dummy Load Board (installation of shortening capacitor to DUMMY LOAD PCB)

When a certain MF frequency cannot be tuned, due to improper length of antenna, a shortening capacitor can be inserted only to tune that frequency. Control of the shortening capacitor is assigned to system settings 9923 – 9925. *This modification requires the optional DUMMY LOAD Board, (type: OP05-34, code no.: 005-925-830) and nullifies the dummy load function. If the dummy load is required, install an external dummy load.*

DUMMY LOAD Board with shortening capacitor



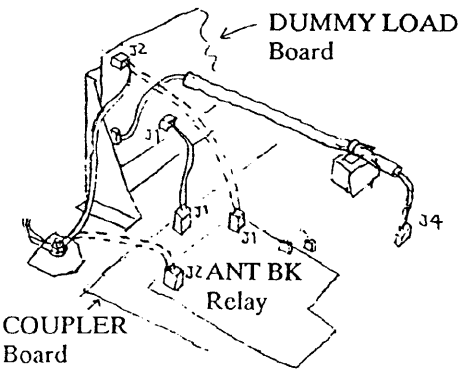
Signal flow with addition of shortening capacitor



Bold line shows modification

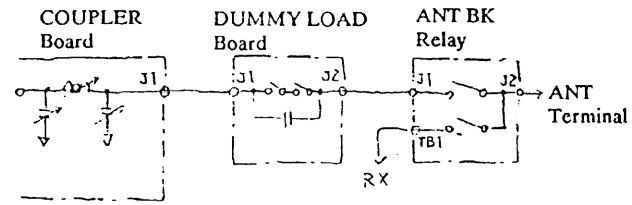
shortening capacitor (300 pF or higher)

DUMMY LOAD Board with ANT BK relay



Dotted lines show wiring for ANT BK relay.

Signal flow with addition of ANT BK relay



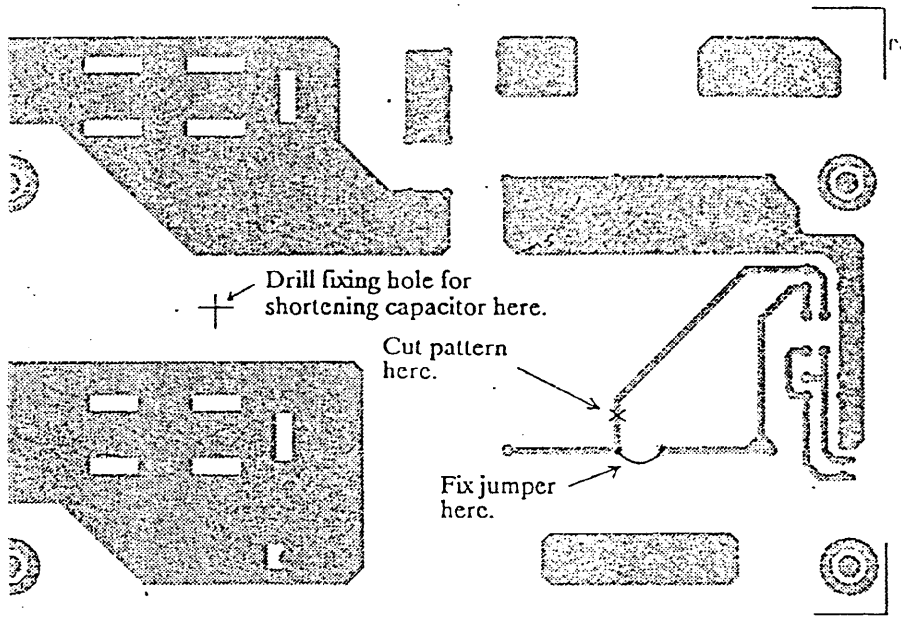
NOTE: Be sure wiring does not touch other wiring.

Procedure

1. Prepare optional DUMMY LOAD board (OP05-34, code no. 005-925-830).

2. Remove C1 – C4 and R1 – R3.

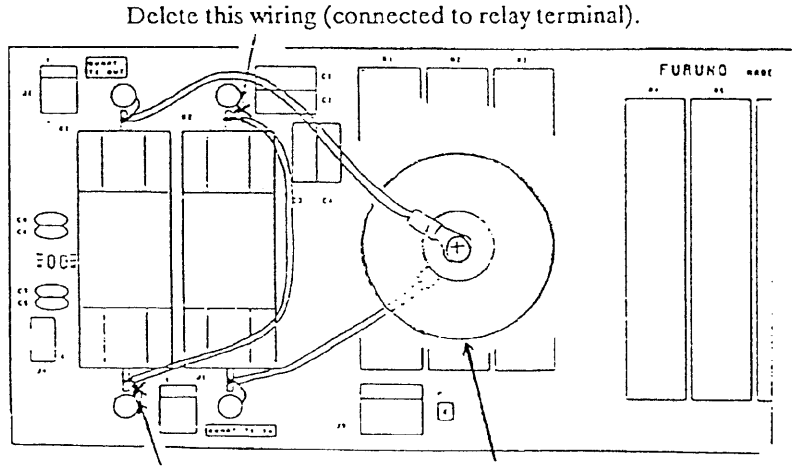
(SOLDER SIDE OF DUMMY LOAD BOARD)

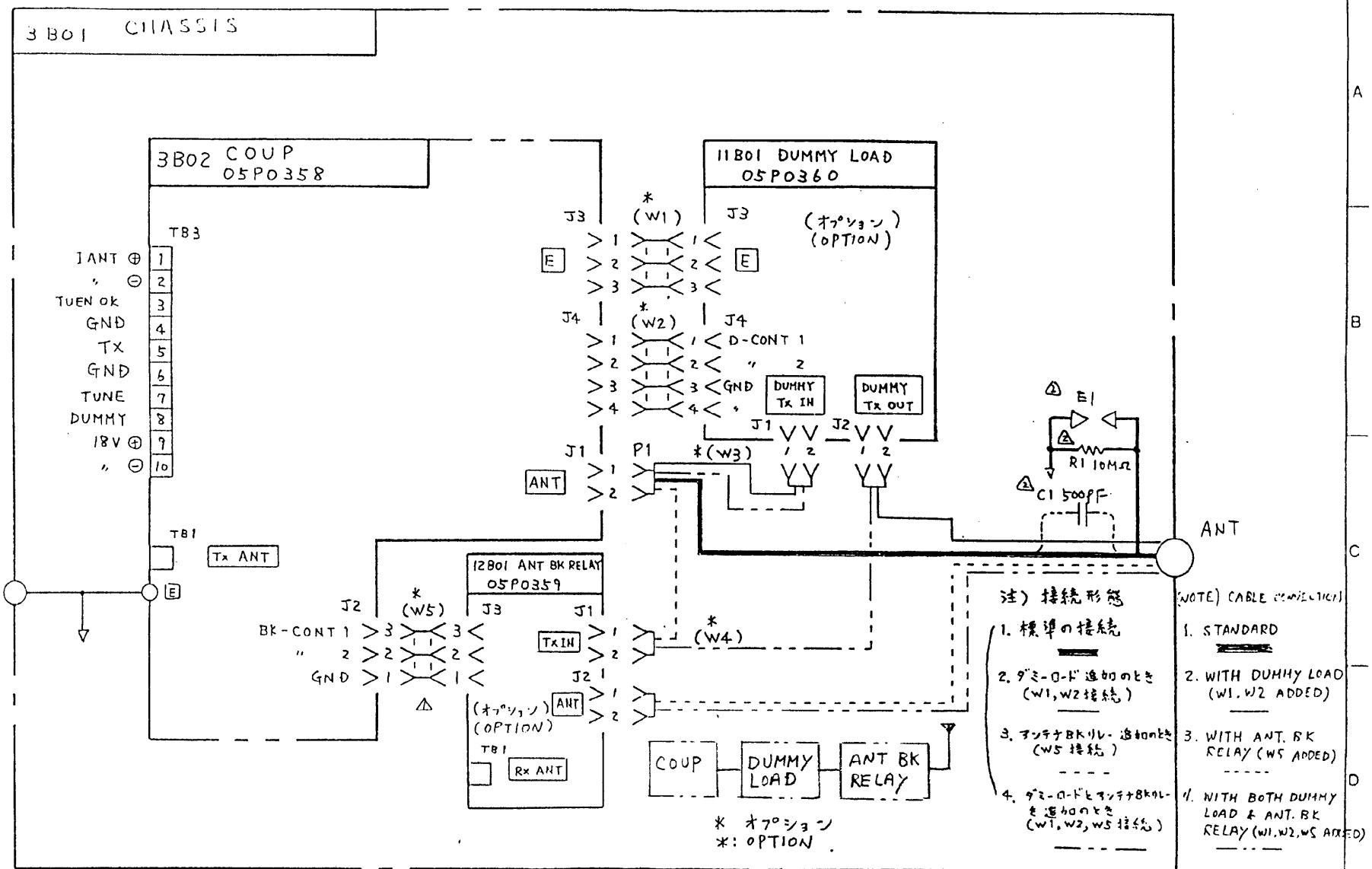


3. To install the shortening capacitor, drill fixing hole under R2 in the center of where there is no pattern.

4. Cut pattern and fit a jumper wire as shown in the figure below.

5. Install and wire the shortening capacitor. Be sure wiring does not contact other wiring and parts.

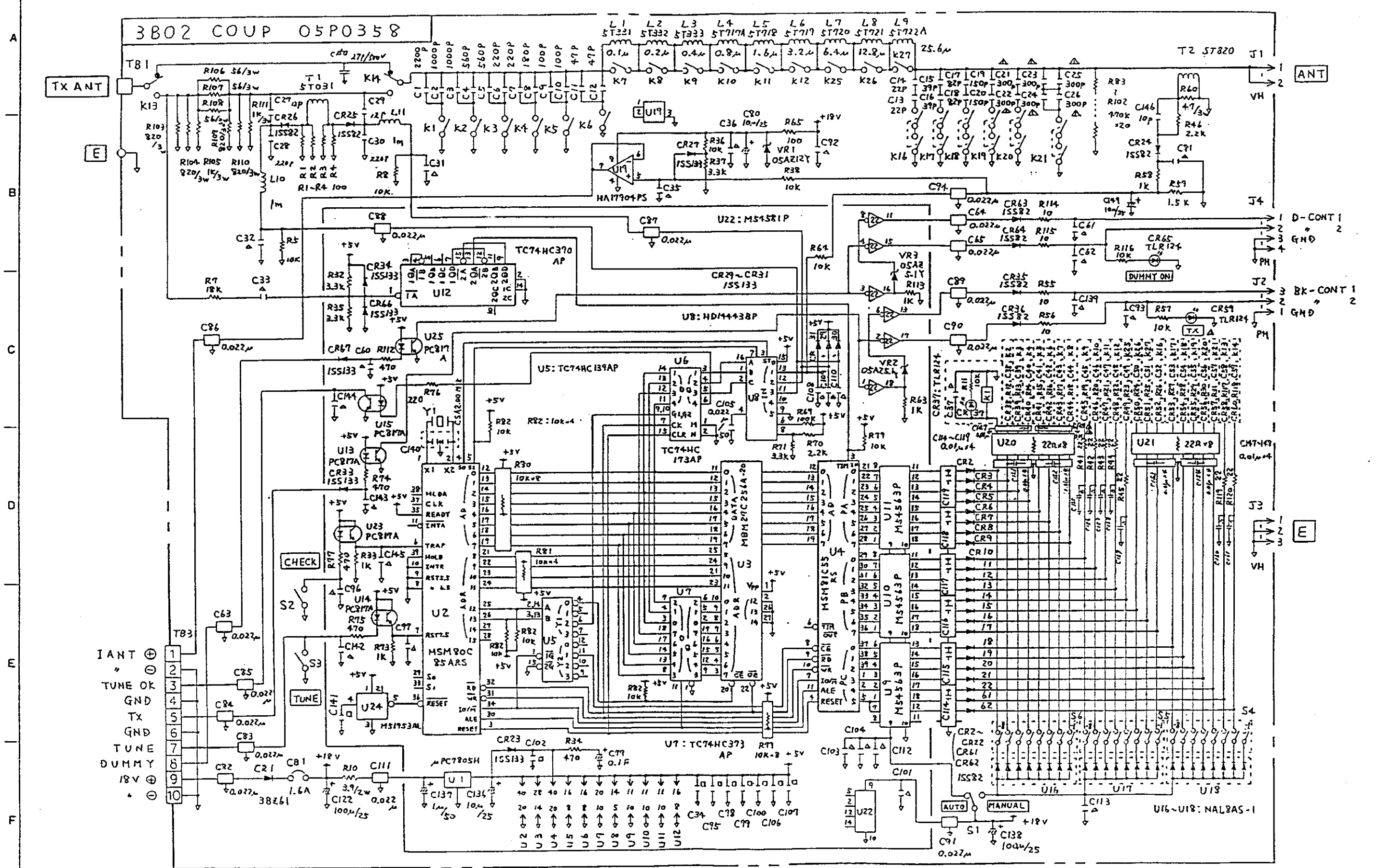




Previous Coupler

主機種	FS-1600 FS-2500 FS-5000	コード		SHEET NO.	1/1
		型名			
課長	検図	設計	製図	TITLE	3B01 CHASSIS (COUPLER UNIT)
				DWG.No.	C5519-K18-B

西野無線株式会社



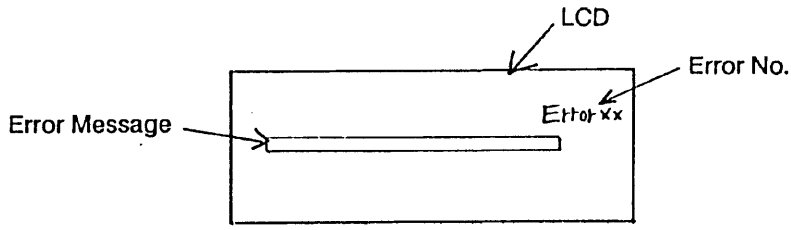
Previous Coupler

NOTE (1) Resistors are in Ω(0.1W). Capacitors are in F. Inductors are in H. unless otherwise noted.
(2) Marks ○ are 1000pF/50WV capacitors.
Δ are 0.01µF/50WV capacitors and
◻ are 0.1µF/25WV capacitors.

FS-1600 FS-2500 FS-5000	SHEET NO. 1/1
TITLE	3802 COUPLER PCB (COUPLER UNIT)
	C5519-K19-C

APPENDIX 4 ERROR MESSAGES OF SELF-TESTS

If one of the error messages shown below appears at self tests, check the corresponding boards.



Test No.	Error No.	Error Message	Check Point
9915/9916	1	CPU/Communication error	CPU board (in the transceiver unit) or Interconnection cable
9924/9925	1	CPU/Communication error	CPU board (in the control unit) or Inter-connection cable
9923	2	No Tx AF signal on AF PCB	AF board
	3	No Rx AF sig. on AF PCB or TRx unit	AF board or RX board
	4	No SQ AF signal on AF PCB	AF board
	5	SQ not open on AF PCB	
	6	SQ not closed on AF PCB	
9913	7	Unlock freq. xxxx.xx kHz on RX PCB	RX board
9911	8	Unlock freq. xxxx.xx kHz on EXC PCB	EXC board
9914	9	No Rx signal through BPF on RX PCB	RX board
	10	No Rx signal through Pre-sel on RX PCB	
	11	No Rx signal on RX PCB	
	12	No S signal on RX PCB	
	13	Unable to control sensitivity on RX	
	14	Unable to mute Rx on RX PCB	

Continued

Test No.	Error No.	Error Message	Check Point
9912	15	No Mic signal from Control Unit on EXC	AF board, EXC board or Intercomnection cable
	16	No Tx signal on EXC PCB	EXC board
	17	Unwanted Tx signal on EXC PCB	
	18	Insufficient source voltage	Low input voltage
	19	Insufficient PA Vc	REG Unit (+45V line voltage)
	20	Excessive PA idle current	PA board
	21	High temperature on PA	Temperature at PA board exceeds 90°C.
	22	Low source voltage (800W unit)	Low input voltage
	23	Low PA Vc (800W unit)	REG Unit (+45V line voltage)
	24	Excessive PA idle curr. (800W unit)	PA board
	25	High temperature on PA (800W unit)	Temperature at PA board exceeds 90°C.
	26	Unwanted Tx signal on PA or TX FIL PCB	PA board or TX FIL board
	27	Unwanted sig. on PA or TX FIL (800W)	
	28	Unwanted signal on Power Combiner	COMBINER board
	29	No Tx signal on PA or TX FIL PCB	PA board, TX FIL board or Interconnection cable
	30	No Tx sig. on PA or TX FIL (800W unit)	
	31	No Tx signal on Power Combiner	COMBINER board
	33	No Tx signal on PA	PA board
	34	No Tx signal on PA (800W unit)	
	35	No Tx signal on TX FIL PCB	TX FIL board
	36	No Tx signal on TX FIL PCB (800W unit)	
9930	32	No acknowledge signal from Coupler	COUP board

(Note) The error message with " 800W unit " means the board of the upper unit in the transceiver unit.

APPENDIX 5 SYSTEM SETTINGS & POWER ADJUSTMENT

(Incl. Preset Frequency List)

CAUTION:

These instructions are intended for use by authorized Furuno agents and dealers to comply said radiotelephone with local regulations and user requirements. Please carefully read and follow the instructions for system initialization and output power adjustment.

The presetting of this radiotelephone must be carried out by an authorized agent or dealer, not by the operator or owner of the equipment. Under no circumstances should these instructions be released to the operator or owner of the equipment.

Furuno will assume no responsibility for the inconvenience or disturbance to communications due to inadequate or unlawful presetting of the equipment.

CONTENTS

1. System Setting

Changeable specifications are shown in Table-1 and Table-2. If necessary, change the specifications with the following key sequence.

Item	Key Sequence
Calling up screen for specification change	STO (CH No.) ENT ↑ 9900 to 9999
Selecting setting No.	(setting No.) ENT ↑ 0 to 3

(EX) When only the frequencies stored in the user channel are authorized for transmitting.

STO 9 9 0 1 ENT 2 ENT

Table-1 Only Furuno Technician Changeable Specifications

Shading shows factory setting.

Channel No.	Function	Setting No.			
		0	1	2	3
9900	Model selection (*1)	FS-5000	FS-2500	FS-1600	FS-8000
9901	TX freq. selection (*2)	Free	Limited	ROM	Marine (Marine band)
9903	Output power of transceiver unit on MF band (adjustable)	400 (Other than USA)	150 (USA)	50	—
9904	Class of emission on 2182kHz (immediate selection)	AM	SSB (USA)	—	—
9905	TX TUNE (**TX TUNE** key)	Enable	Disable ("TX TUNE is off" appears when this key is pressed.)	Auto (Tuning is done when setting TX freq.)	—
9906	Scan of TX channel	Enable	Disable	—	—
9911	Test alarm	Disable	Enable(*3)	—	—
9912	Test alarm frequency	2191 kHz (Enter another freq. if 2191kHz is inadequate.)			

Channel No.	Function	Setting No.			
		0	1	2	3
9913	TX delay time	30 ms (Selectable: 5 to 99ms) FS-8000→10ms			
9914	Alarm sending time	45 sec. (1 to 9999 sec.)			
9917	50 ohm BK relay	ON/OFF	ON (Fixed) (*4)	–	–
9926	Test tone	Enable	Disable (Europe)	–	–
9927	Power reduction on 2182/2187.5 kHz	Enable	Disable	–	–
9928	Minimum output power (*5)	Less than 60W	60W or more	–	–
9930	Data to "REM1" terminal	MIF (*6)	TBUS (*7)	CIF	NMEA
9931	Data to "REM2" terminal	MIF	TBUS	CIF	NMEA
9932	Data to "REM3" terminal	MIF	TBUS	CIF	NMEA
9933	Data to "CIF/NMEA" terminal	MIF	TBUS	CIF	NMEA
9934	Class of emission of TX/RX, when unit connected to "REM1" is once keyed.	No change (*8)	SSB	AM	TLX
9935	Class of emission of TX/RX, when unit connected to "REM2" is once keyed.	No change	SSB	AM	TLX
9936	Class of emission of TX/RX, when unit connected to "REM3" is once keyed.	No change	SSB	AM	TLX
9937	Class of emission of TX only while unit connected to "REM1" is keyed.	No change	SSB	AM	TLX
9938	Class of emission of TX only while unit connected to "REM2" is keyed.	No change	SSB	AM	TLX
9939	Class of emission of TX only while unit connected to "REM3" is keyed.	No change	SSB	AM	TLX
9947	SQ on telex mode (If set to [1], SQ turns OFF when TELEX mode is selected.)	Def (Default) (No change)	OFF	–	–
9948	NB on telex mode	Def	OFF	–	–
9949	AGC on telex mode	Def	FAST	–	–
9950	Duplex on telex mode	Def	OFF	–	–
9953	Operation on AM mode	T/Rx	RX only	No	2182 (*9) (Europe)

9954	Operation on R3E mode	T/Rx (USA)	RX only (other than USA)	No	–
9955	Operation on weather FAX mode	T/Rx (USA)	RX only (other than USA)	No	–
9956	Operation on LSB mode	T/Rx (USA)	RX only (other than USA)	No	–
9957	Cypher communication (Cyper communication apparatus not developed)	Disable	Enable	–	–
9960	Recall of 27 MHz SSB/DSB frequencies (for Japanese vessels)	Disable	Enable	–	–
9961	ITU frequency table selection	INT (Other than USA)	USA	EU (ITU on MF)	–
9962	MF band transmission (405-526.5 kHz) (MF tuner AT-410 not developed)	Disable	Enable	–	–
9963	User channel programing	Enable	Disable	–	–
9964	Check meter indication for both upper & lower transceiver units. (FS-8000 only)	No	Yes	–	–
9980	Default setting depending on countries (*10)	Enter country code. See page 6. (AP5-8)			
9981	Dummy load installation (Both functions of 9911 and 9923 are determined.)	No	Yes	–	
9982	Ant. BK relay or Rx ant. installation (Both functions of 9913 and 9917 are determined.)	No	Yes	–	
9998	System lock (Important system settings are not changeable.)	[OFF/ON]: Enter "present time" to change setting. (*11)			
9999	System initialization (Default)	Disable	Enable	–	–

Setting No.	[0] (NO)	[1] (YES)
9911 Test alarm	Disable	Enable
9923 Dummy	Disable	Enable

Setting No.	[0] (NO)	[1] (YES)
9913 TX delay	30ms	10ms
9917 50 ohm BK relay	ON/OFF	ON (Fixed)

Table-2 User Changeable Specifications

Shading shows factory setting.

Channel No.	Function		Setting No.			
			0	1	2	3
9907	Time display format		JAPAN	USA	EUROPE	–
9908	Second unit display		ON	OFF	–	–
9909	Display of class of emission		NOR(SSB)	ITU(J3E)	–	–
9910	Numerical display of check meter data		OFF	ON	–	–
9915	Check meter items		FULL	SHORT (*12)	–	–
9916	Keyboard lock (controlled by [*] key)		OFF	ON (*13)	Intercom call [New AF band 05P0356-33 (not developed) required.]	–
9918	Time adj. (Clock)		Auto	Man	–	–
9919	Control unit priority (*14)		No	#1	#2	–
9920	Beep sound	ON/OFF	OFF	ON	–	–
9921		Level	6 (0 to 10)			
9922		Freq.	2000 Hz (100 to 3000 Hz)			
9923	Dummy (*15)		Enable	Disable	Not used	–
9940	Receiver bandwidth in kHz (Changeable thru keyboard)	SSB	6 k	3 k	0.3 k	–
9941		CW	6 k	3 k	0.3 k	–
9942		TELEX	6 k	3 k	0.3 k	–
9943		AM	6 k	3 k	0.3 k	–
9944		R3E	6 k	3 k	0.3 k	–
9945		FAX	6 k	3 k	0.3 k	–
9946		LSB	6 k	3 k	0.3 k	–
9951	Receiving antenna in telex mode (Only when optional R. ANT SEL board is installed.)		Used	Not used	–	–
9997	All user CH clear		–	ON	–	–

(*1): Output power of ITU/DSC channels and direct key-in frequencies are preset as shown below.

Table-3 Model vs Max. Output Power (*): for Japanese vessels only.

	FS-5000	FS-2500 (*)	FS-1600 (*)	FS-8000
Output Power	400W	250W	150W	800W

(*2): Free ------ Any frequencies (1.6065 to 29.9999 MHz) can be transmitted by direct key-in. (Function of "Limited" shown below is also included.)
Limited -- The frequencies in the ITU/DSC and user channels can be transmitted.
ROM --- Only the frequencies stored in the user channel can be transmitted.
Marine ---- Marine band frequencies shown below can be transmitted by direct key-in. (Function of "Limited" shown above is also included.)

1606.5 to 4438, 5680, 6200 to 6525, 8100 to 8815, 12230 to 13200,
16360 to 17410, 18780 to 18900, 19680 to 19800, 22000 to 22855,
25070 to 25210, 26100 to 26175 (unit: kHz)

(*3): To test the transmitter press **TEST** and **START** keys in this order. The dummy load (if equipped, set the channel No. 9923 to "0") is connected automatically and the test signal of 2191kHz, modulated by two-tone alarm, is sent to the dummy load.

(*4) Selective if installation contains a specialty receiving antenna or ANT BK RELAY board (in antenna coupler). For high speed switching between receiving and transmitting (for example, telex) set to "1." Then, TX delay time (system setting 9913) is set to "10ms." For FS-8000, it is not necessary to set "50 ohm BK relay (9917)" to "1" due to use of high speed switching relay.

(*5): For 1988 SOLAS Convention ships (GMDSS) set to "1." Then, minimum output power is automatically set more than 60W (power data: 115 on MF, 110 on HF for FS-5000), except for minimum power data already stored into user channel.

(*6): MIF ----- Furuno Multi Interface for Radio communication
Select MIF when DP-5 or DSC-5 (new Furuno products) is connected.

(*7): TBUS ----- For equipment made by "Thrane & Thrane A/S" of Denmark.
If TBUS data is used, it is not necessary to connect TXD/RXD lines.

(*8): Ex. ----- Selcall is connected to "REM1".
If you wish to change the class of emission only while the selcall is transmitted and to restore it automatically to previous status after transmission, set the channel Nos. 9934 and 9937 to "0" (No change) and "2" (AM), respectively.

(*9): Transmission ----- 2182 kHz, Reception ----- all frequencies

(*10): System Setting defaults for different countries (accessed via setting no. 9980)

			Country Code					
Setting Number	Function	Default 0	Japan 81	USA 1	Europe 44	Norway 47	Holland 31	Result of selection
9901	TX freq. selection	0				3		Marine
9903	TX o/p on MF band	0	2	1				50/150
9904	Class of emission on 2182 KHz	0		1				J3E
9907	Time display format	0		1	2	2	2	USA/EU
9910	Check meter numerics	0	1					
9913	System delay	30				10		
9917	50 ohm BK relay	0				1		on
9923	Dummy load	0	1	1	1	1	1	off
9926	Test tone	0		1	1	1	1	off
9927	Power reduction enable	0		1	1	1	1	2182
9928	Min o/p power	0		1	1	1	1	more than 60w
9947	SQ on TLX	0					1	off
9948	NB on TLX	0					1	off
9949	AGC FAST on TLX	0					1	FAST
9950	DUPLEX on TLX	0					1	Inhibit
9953	AM Operation	0		3	3	3	3	2182
9954	R3E Operation	0	1		1	1	1	RX
9955	FAX Operation	0	1		1	1	1	RX
9956	LSB Operation	0	1		1	1	1	RX
9961	ITU Freq. Table	0		1	2	2	2	USA/EU

Note: Where no data appears, default setting applies.

(*11): Ex. – – - Present time is 12 : 35.
Press **1 2 3 5 ENT** in this order to turn on or off the system lock function. The following system settings are not changeable when you turn on the system lock function.

- **STO FULL** (or **LOW**) – – - Power Adjustment
- **STO**
  - **9900** – – - Model
  - **9901** – – - Tx freq. selection
  - **9903** – – - Output power of SSB on MF band
  - **9914** – – - Alarm sending time
  - **9960** – – - Recall 27MHz freq.
  - **9999** – – - System initialization

(*12): If you select "1" (short), only check data for Ia, Vc, Ic and Pi are displayed repeatedly every pressing of the **CHECK METER** key.

(*13): To enable to lock the keys except for **SEND, START, 2182,** and **2187.5** keys, select "1" (ON). Then press the * key to turn on the key lock function. First press of the * key make the keys inactive. ("Keyboard Lock [ON]" will be displayed.)

(*14) For control unit priority, select the same setting numbers for both control units.

No. 1 Control Unit priority

Control Unit	Setting No.
No. 1	"1"
No. 2	"1"

No. 2 Control Unit priority

Control Unit	Setting No.
No. 1	"2"
No. 2	"2"

(*15)

Setting No.	Contents	LCD Indication	Remarks
"0" (Enable)	Dummy load can be switched by **DUMMY** key.	DUMMY	With DUMMY LOAD PCB.
"1" (Disable)	**DUMMY** key is not operative.	–	Without DUMMY LOAD PCB.

CONFIRMATION OF SETTING

To confirm settings, press **RCL, 9, 9, 9, 9** and **ENT** in this order. Then press **ENT** key successively.

2. How to Store Frequencies to the User (Preset) Channel

For USA Flag Vessels

The "TX freq. selection" (9901) for the sets distributed thru Furuno USA is factory-set to "0" (Free), so you may store frequencies by recalling the ITU/DSC channels or by keying in a frequency through the keyboard.

Select class of emission, bandwidth and frequency then press the following keys to store the frequencies (class of emission & BW as well) into the user channel.

STO (CH No.) ENT ENT

1 to 8999 CH (storage capacity: 400 CH)

Non-USA Flag Vessels

The "TX freq. selection" (9901) is factory-set to "1" (Limited), so only the frequencies in the ITU/DSC channels can be used.

Execute the following key sequence to store ITU/DSC frequencies (class of emission & BW as well) into the user channel.

{ITU / DSC} (CH No.) ENT STO (CH No.) ENT ENT

DSC: 1 to 79 CH
ITU:
(ex) Recalling of 401 CH
41, 401 or 4001

1 to 8999 CH
(Storage capacity: 400 CH)

Note: 1. To see stored user channels, press the following keys.

RCL 9 9 9 8 ENT

3. Power Adjustment

When precise power adjustment is required, adjust the "power data" referring to the procedure below.

Table-4 Channel & Resolution of Memory

Channel	Resolution of Memory
User channel	Each channel
Free direct key-in ITU Channel DSC Channel	MF --- 500 kHz steps (2.0-2.5MHz 2.5-3.0MHz ⋮) HF --- 1 MHz steps

Note 1. *If the "Model name setting (9900)" is correctly made, maximum power data will be "255" (MAX).*

2. *If the error message "Excessive Ic on PA." (when Ic exceeds 24.5A) appears during transmission, output power is reduced automatically from "FULL" to "LOW1" → "LOW2 ---." In this case, reduce the output power to prevent overcurrent from flowing into the power amp, by following the steps from 6 to 9 shown below.*

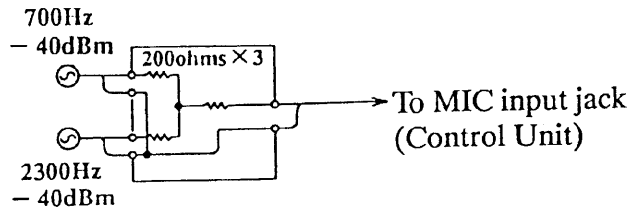
Procedure

1. Connect a power meter (input impedance 50 ohms, measurable range 500 W ave. for FS-5000, 800 W ave. for FS-8000.) to the TX ANT jack on the transceiver unit.

2. To display the numeral check meter data on the screen, press **STO 9 9 1 0 ENT 1 ENT** in this order.

3. Press the **CHECK METER** key successively until the "Collector Current (A)" can be monitored.

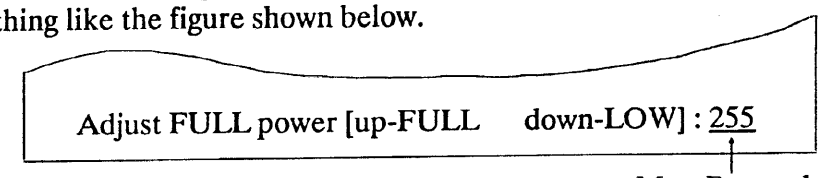
4. Connect two AF oscillators to the MIC input jack as below, and then press PTT switch.



5. Read the meter indication.

Model	Meter ind.	(Output power)
FS-5000	180 W	(400 W pep)
FS-8000	360 W	(800 W pep)

6. Stop transmission and press the **STO** key followed by the **FULL** key. The screen should look something like the figure shown below.



7. To decrease the output power, decrease the "power data" by pressing and holding the **LOW** key.

8. Transmit again and check that the output power is as desired and Ic on the LCD is lower than 24.5A (the indication "FULL" remains).

9. If the power is decreased excessively, increase the power by pressing and holding the **FULL** key.

10. Repeat steps 7 to 9 until desired power is obtained. Then press the ENT key to memorize the power data.

The relationship between power data and output power of the transceiver unit is as follows. Refer to pages 12 and 13.
(AP5-14 & AP5-15)

Table-5 Power Data & Output Power

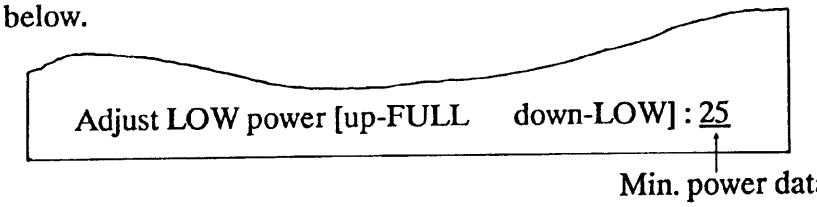
Power data	Output power (approx.)	
	FS-5000	FS-8000
255	400W	800W
200	250W	500W
175	200W	370W
150	150W	280W
80	50W	110W
25	10W	30W
0	5W	10W

MINIMUM POWER SET

If necessary, you may change the minimum output power.

Procedure

1. Press the **STO** key followed by the **LOW** key. The screen should look something like the figure shown below.



2. Press and hold the **FULL** or **LOW** key to increase or decrease power data, respectively.

3. To memorize power data, press the **ENT** key.

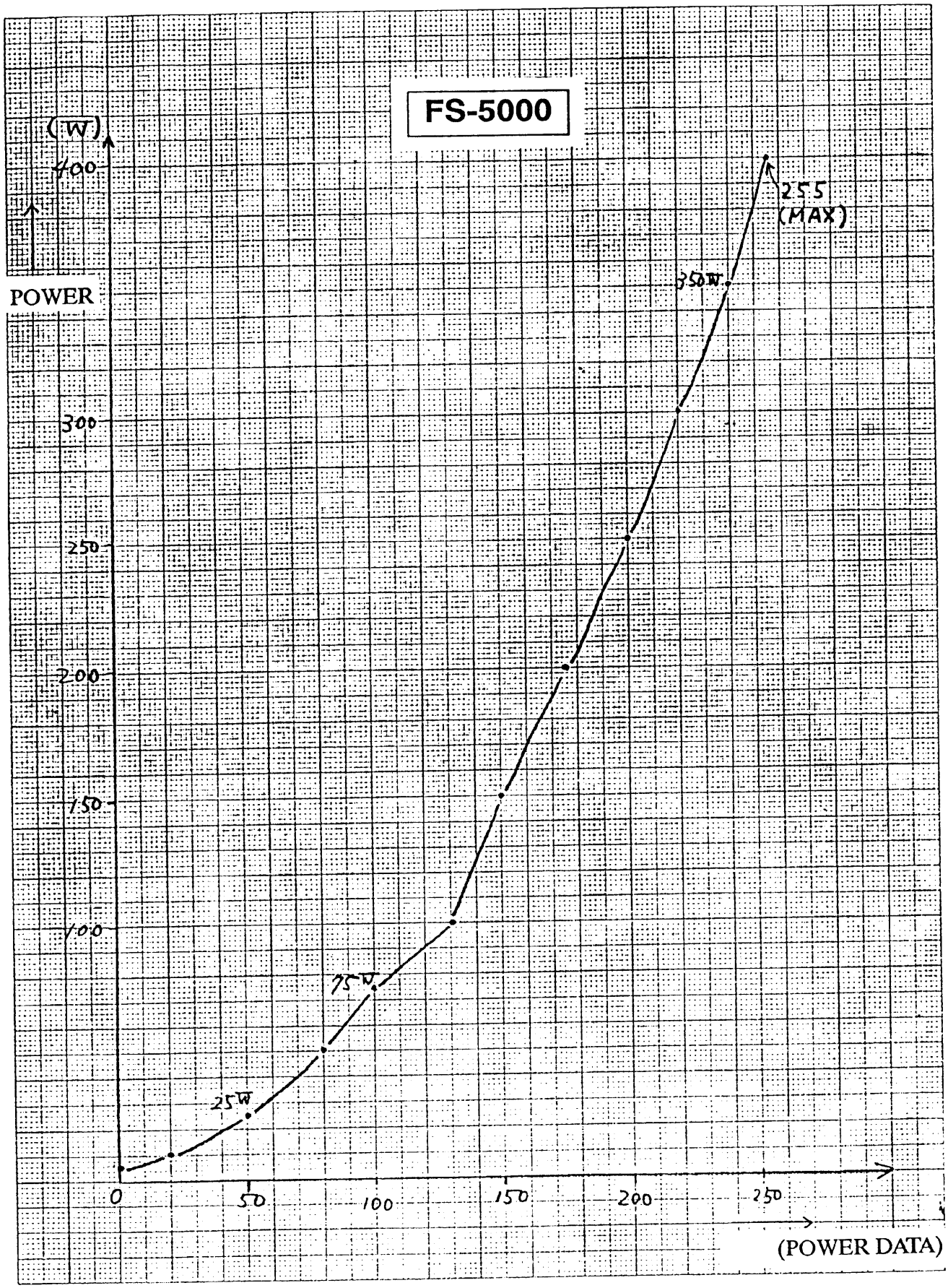
POWER DATA FOR POWER REDUCTION

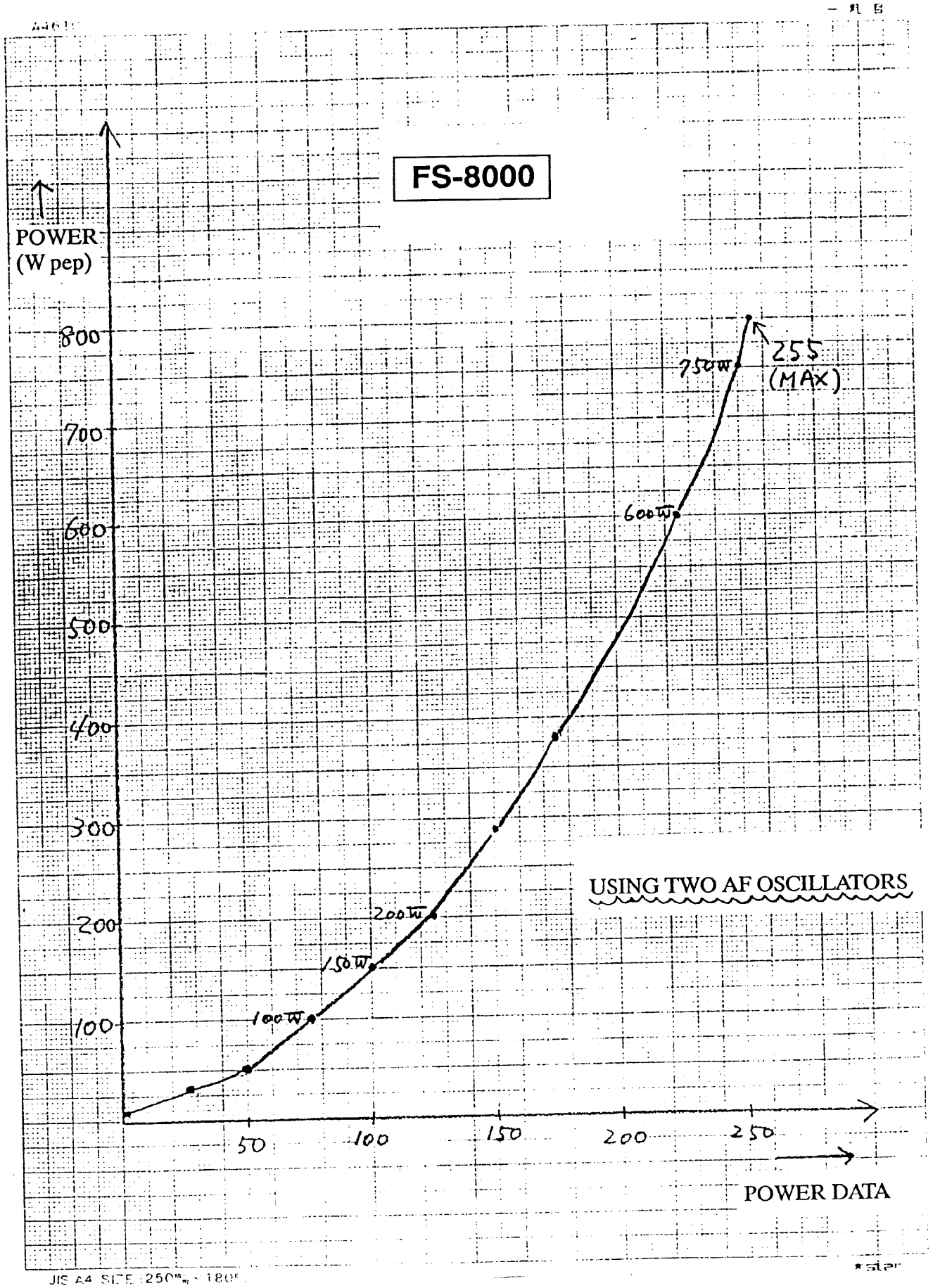
For every press of the **LOW** key in normal operation, the power indication on the screen changes from "FULL" to "LOW1" → "LOW2" --- "LOW5." The relationship between power indication and "power data" is as follows.

Table-6 Power Indication & Power Data

Power indication	Power data	Output power (approx.)	
		FS-5000	FS-8000
"FULL"	255	400W	800W (400W)
"LOW1"	200	250W	480W (200W)
"LOW2"	145	140W	280W (80W)
"LOW3"	90	60W	130W (25W)
"LOW4"	35	15W	30W
"LOW5"	Minimum power data		

Note: Number in parentheses is output power on frequencies below 4 MHz.


FS-5000
(W)
400
POWER
300
250
200
150
100
0
50
100
150
200
250
(POWER DATA)
25W
75W
350W
255
(MAX)


FS-8000
POWER
(W pep)
800
700
600
500
400
300
200
100
50
100
150
200
250
100W
150W
200W
600W
750W
255
(MAX)
USING TWO AF OSCILLATORS
POWER DATA

4. System Setting for Vessels of GMDSS Requirement

System Setting

1. Power reduction on both 2182 kHz and 2187.5 kHz is disable.

[STO] 9927 [ENT] 1 [ENT]

2. Minimum output power is 60W or more.

[STO] 9928 [ENT] 1 [ENT]

3. Setting for connection to NBDP

- FS-5000 (ANT BK RELAY PCB or Rx antenna required)
  [Tx delay time...10ms
  [50 ohm BK relay...ON (fixed)]

  ↓

  [STO] 9982 [ENT] 1 [ENT]

- FS-8000 (50 ohm BK relay can be used due to its high speed switching.)
  Tx delay time...10ms

  ↓

  [STO] 9913 [ENT] 10 [ENT]

5. Preset Frequency List

DSC & DISTRESS FREQUENCIES

CH. No.	TX	RX	Mode	ITU Ch. No.	Remarks
DSC 1	2182.0	2182.0	USB		DISTRESS
DSC 2	4125.0	4125.0	USB		DISTRESS
DSC 3	6215.0	6215.0	USB		DISTRESS
DSC 4	8291.0	8291.0	USB		DISTRESS
DSC 5	12290.0	12290.0	USB		DISTRESS
DSC 6	16420.0	16420.0	USB		DISTRESS
DSC 7		500.0	AM		DISTRESS
DSC 8	3023.0	3023.0	USB		DISTRESS
DSC 9	5680.0	5680.0	USB		DISTRESS
DSC 11	2187.5	2187.5	TLX		DSC
DSC 12	4207.5	4207.5	TLX	4030	DSC
DSC 13	6312.0	6312.0	TLX	6058	DSC
DSC 14	8414.5	8414.5	TLX	8077	DSC
DSC 15	12577.0	12577.0	TLX	12191	DSC
DSC 16	16804.5	16804.5	TLX	16233	DSC
DSC 21	2174.5	2174.5	TLX		
DSC 22	4177.5	4177.5	TLX	4011	
DSC 23	6268.0	6268.0	TLX	6011	
DSC 24	8376.5	8376.5	TLX	8001	
DSC 25	12520.0	12520.0	TLX	12087	
DSC 26	16695.0	16695.0	TLX	16024	
DSC 30	490.0	490.0	TLX		NAV.
DSC 31	518.0	518.0	TLX		NAV.
DSC 32	4209.5	4209.5	TLX		NAV.
DSC 42	4210.0	4210.0	TLX		MSI
DSC 43	6314.0	6314.0	TLX		MSI
DSC 44	8416.5	8416.5	TLX		MSI
DSC 45	12579.0	12579.0	TLX		MSI
DSC 46	16806.5	16806.5	TLX		MSI
DSC 47	19680.5	19680.5	TLX		MSI
DSC 48	22376.0	22376.0	TLX		MSI
DSC 49	26100.5	26100.5	TLX		MSI
DSC 50	458.5	455.5	TLX		DSC
DSC 51	2189.5	2177.0	TLX		DSC
DSC 52	4208.0	4219.5	TLX	4031	DSC
DSC 53	6312.5	6331.0	TLX	6059	DSC
DSC 54	8415.0	8436.5	TLX	8078	DSC
DSC 55	12577.5	12657.0	TLX	12192	DSC
DSC 56	16805.0	16903.0	TLX	16234	DSC
DSC 57	18898.5	19703.5	TLX	18057	DSC
DSC 58	22374.5	22444.0	TLX	22181	DSC
DSC 59	25208.5	26121.0	TLX	25072	DSC
DSC 61	2177.0	2177.0	TLX		Intership
DSC 62	4208.5	4220.0	TLX	4032	DSC
DSC 63	6313.0	6331.5	TLX	6060	DSC
DSC 64	8415.5	8437.0	TLX	8079	DSC
DSC 65	12578.0	12657.5	TLX	12193	DSC
DSC 66	16805.5	16903.5	TLX	16235	DSC
DSC 67	18899.0	19704.0	TLX	18058	DSC
DSC 68	22375.0	22444.5	TLX	22182	DSC
DSC 69	25209.0	26121.5	TLX	25073	DSC
DSC 72	4209.0	4220.5	TLX	4033	DSC
DSC 73	6313.5	6332.0	TLX	6061	DSC
DSC 74	8416.0	8437.5	TLX	8080	DSC
DSC 75	12578.5	12658.0	TLX	12194	DSC
DSC 76	16806.0	16904.0	TLX	16236	DSC
DSC 77	18899.5	19704.5	TLX	18059	DSC
DSC 78	22375.5	22445.0	TLX	22183	DSC
DSC 79	25209.5	26122.0	TLX	25074	DSC

FURUNO

ITU SSB FREQUENCY TABLE FOR FURUNO SSB RADIOTELEPHONES

1991/10 ITUSSB

4 MHz BAND			6 MHz BAND			8 MHz BAND			12 MHz BAND			16 MHz BAND			18/19 MHz BAND			22 MHz BAND			25/26 MHz BAND		
No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX
300	3023	3023	600	6215	6215	800	8291	8291	1200	12290	12290	1600	16420	16420									
400	4125	4125																					
500	5680	5680																					
401	4065	4357	601	6200	6501	801	8195	8719	1201	12230	13077	1601	16360	17242	1801	18780	19735	2201	22000	22698	2501	25070	26145
402	4068	4360	602	6203	6504	802	8198	8722	1202	12233	13080	1602	16363	17245	1802	18783	19758	2202	22003	22699	2502	25073	26148
403	4071	4363	603	6206	6507	803	8201	8725	1203	12236	13083	1603	16366	17248	1803	18786	19761	2203	22006	22702	2503	25076	26151
404	4074	4366	604	6209	6510	804	8204	8728	1204	12239	13086	1604	16369	17251	1804	18789	19764	2204	22009	22705	2504	25079	26154
405	4077	4369	605	6212	6513	805	8207	8731	1205	12242	13089	1605	16372	17254	1805	18792	19767	2205	22012	22708	2505	25082	26157
406	4080	4372	606	6215	6516	806	8210	8734	1206	12245	13092	1606	16375	17257	1806	18795	19770	2206	22015	22711	2506	25085	26160
407	4083	4375	607	6218	6519	807	8213	8737	1207	12248	13095	1607	16378	17260	1807	18798	19773	2207	22018	22714	2507	25088	26163
408	4086	4378	608	6221	6522	808	8216	8740	1208	12251	13098	1608	16381	17263	1808	18801	19776	2208	22021	22717	2508	25091	26166
409	4089	4381	609	6224	6224	809	8219	8743	1209	12254	13101	1609	16384	17266	1809	18804	19779	2209	22024	22720	2509	25094	26169
410	4092	4384	610	6227	6227	810	8222	8746	1210	12257	13104	1610	16387	17269	1810	18807	19782	2210	22027	22723	2510	25097	26172
411	4095	4387	611	6230	6230	811	8225	8749	1211	12260	13107	1611	16390	17272	1811	18810	19785	2211	22030	22726	2511	25100	25100
412	4098	4390				812	8228	8752	1212	12263	13110	1612	16393	17275	1812	18813	19788	2212	22033	22729	2512	25103	25103
413	4101	4393				813	8231	8755	1213	12266	13113	1613	16396	17278	1813	18816	19791	2213	22036	22732	2513	25106	25106
414	4104	4396				814	8234	8758	1214	12269	13116	1614	16399	17281	1814	18819	19794	2214	22039	22735	2514	25109	25109
415	4107	4399				815	8237	8761	1215	12272	13119	1615	16402	17284	1815	18822	19797	2215	22042	22738	2515	25112	25112
416	4110	4402				816	8240	8764	1216	12275	13122	1616	16405	17287	1816	18825	18825	2216	22045	22741	2516	25115	25115
417	4113	4405				817	8243	8767	1217	12278	13125	1617	16408	17290	1817	18828	18828	2217	22048	22744	2517	25118	25118
418	4116	4408				818	8246	8770	1218	12281	13128	1618	16411	17293	1818	18831	18831	2218	22051	22747			
419	4119	4411				819	8249	8773	1219	12284	13131	1619	16414	17296	1819	18834	18834	2219	22054	22750			
420	4122	4414				820	8252	8776	1220	12287	13134	1620	16417	17299	1820	18837	18837	2220	22057	22753			
421	4125	4417				821	8255	8779	1221	12290	13137	1621	16420	17302	1821	18840	18840	2221	22060	22756			
422	4128	4420				822	8258	8782	1222	12293	13140	1622	16423	17305	1822	18843	18843	2222	22063	22759			
423	4131	4423				823	8261	8785	1223	12296	13143	1623	16426	17308				2223	22066	22762			
424	4134	4426				824	8264	8788	1224	12299	13146	1624	16429	17311				2224	22069	22765			
425	4137	4429				825	8267	8791	1225	12302	13149	1625	16432	17314				2225	22072	22768			
426	4140	4432				826	8270	8794	1226	12305	13152	1626	16435	17317				2226	22075	22771			
427	4143	4435				827	8273	8797	1227	12308	13155	1627	16438	17320				2227	22078	22774			
428	4351	4351				828	8276	8800	1228	12311	13158	1628	16441	17323				2228	22081	22777			
429	4354	4354				829	8279	8803	1229	12314	13161	1629	16444	17326				2229	22084	22780			
430	4146	4146				830	8282	8806	1230	12317	13164	1630	16447	17329				2230	22087	22783			
431	4149	4149				831	8285	8809	1231	12320	13167	1631	16450	17332				2231	22090	22786			
432	4000	4000				832	8288	8812	1232	12323	13170	1632	16453	17335				2232	22093	22789			
433	4003	4003				833	8291	8291	1233	12326	13173	1633	16456	17338				2233	22096	22792			
434	4006	4006				834	8707	8707	1234	12329	13176	1634	16459	17341				2234	22099	22795			
435	4009	4009				835	8710	8710	1235	12332	13179	1635	16462	17344				2235	22102	22798			
436	4012	4012				836	8713	8713	1236	12335	13182	1636	16465	17347				2236	22105	22801			
437	4015	4015				837	8716	8716	1237	12338	13185	1637	16468	17350				2237	22108	22804			
438	4018	4018				838	8294	8294	1238	12341	13188	1638	16471	17353				2238	22111	22807			
439	4021	4021				839	8297	8297	1239	12344	13191	1639	16474	17356				2239	22114	22810			
440	4024	4024				840	8101	8101	1240	12347	13194	1640	16477	17359				2240	22117	22813			
441	4027	4027				841	8104	8104	1241	12350	13197	1641	16480	17362				2241	22120	22816			
442	4030	4030				842	8107	8107	1242	12353	12353	1642	16483	17365				2242	22123	22819			
443	4033	4033				843	8110	8110	1243	12356	12356	1643	16486	17368				2243	22126	22822			
444	4036	4036				844	8113	8113	1244	12359	12359	1644	16489	17371				2244	22129	22825			
445	4039	4039				845	8116	8116	1245	12362	12362	1645	16492	17374				2245	22132	22828			
446	4042	4042				846	8119	8119	1246	12365	12365	1646	16495	17377				2246	22135	22831			
447	4045	4045				847	8122	8122				1647	16498	17380				2247	22138	22834			
448	4048	4048				848	8125	8125				1648	16501	17383				2248	22141	22837			
449	4051	4051				849	8128	8128				1649	16504	17386				2249	22144	22840			
450	4054	4054				850	8131	8131				1650	16507	17389				2250	22147	22843			
451	4057	4057				851	8134	8134				1651	16510	17392				2251	22150	22846			
452	4060	4060				852	8137	8137				1652	16513	17395				2252	22153	22849			
						853	8140	8140				1653	16516	17398				2253	22156	22852			
						854	8143	8143				1654	16519	17401				2254	22159	22159			
						855	8146	8146				1655	16522	17404				2255	22162	22162			
						856	8149	8149				1656	16525	17407				2256	22165	22165			
						857	8152	8152				1657	16528	16528				2257	22168	22168			
						858	8155	8155				1658	16531	16531				2258	22171	22171			
						859	8158	8158				1659	16534	16534				2259	22174	22174			
						860	8161	8161				1660	16537	16537				2260	22177	22177			
						861	8164	8164				1661	16540	16540									
						862	8167	8167				1662	16543	16543									
						863	8170	8170				1663	16546	16546									
						864	8173	8173															
						865	8176	8176															
						866	8179	8179															
						867	8182	8182															
						868	8185	8185															
						869	8188	8188															
						870	8191	8191															

FURUNO ITU TELEX FREQUENCY TABLE (effective from July 1, 1991, 1991年7月1日より発効)

4 MHz BAND			6 MHz BAND			8 MHz BAND			12 MHz BAND			16 MHz BAND			18/19 MHz BAND			22 MHz BAND			25/26 MHz BAND		
No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX
4001	4172.5	4210.5	6001	6263.0	6314.5	8001	8376.5	8376.5	12001	12477.0	12579.5	16001	16683.5	16807.0	18001	18870.5	19681.0	22001	22284.5	22376.5	25001	25173.0	26101.0
4002	4173.0	4211.0	6002	6263.5	6315.0	8002	8377.0	8417.0	12002	12477.5	12580.0	16002	16684.0	16807.5	18002	18871.0	19681.5	22002	22285.0	22377.0	25002	25173.5	26101.5
4003	4173.5	4211.5	6003	6264.0	6315.5	8003	8377.5	8417.5	12003	12478.0	12580.5	16003	16684.5	16808.0	18003	18871.5	19682.0	22003	22285.5	22377.5	25003	25174.0	26102.0
4004	4174.0	4212.0	6004	6264.5	6316.0	8004	8378.0	8418.0	12004	12478.5	12581.0	16004	16685.0	16808.5	18004	18872.0	19682.5	22004	22286.0	22378.0	25004	25174.5	26102.5
4005	4174.5	4212.5	6005	6265.0	6316.5	8005	8378.5	8418.5	12005	12479.0	12581.5	16005	16685.5	16809.0	18005	18872.5	19683.0	22005	22286.5	22378.5	25005	25175.0	26103.0
4006	4175.0	4213.0	6006	6265.5	6317.0	8006	8379.0	8419.0	12006	12479.5	12582.0	16006	16686.0	16809.5	18006	18873.0	19683.5	22006	22287.0	22379.0	25006	25175.5	26103.5
4007	4175.5	4213.5	6007	6266.0	6317.5	8007	8379.5	8419.5	12007	12480.0	12582.5	16007	16686.5	16810.0	18007	18873.5	19684.0	22007	22287.5	22379.5	25007	25176.0	26104.0
4008	4176.0	4214.0	6008	6266.5	6318.0	8008	8380.0	8420.0	12008	12480.5	12583.0	16008	16687.0	16810.5	18008	18874.0	19684.5	22008	22288.0	22380.0	25008	25176.5	26104.5
4009	4176.5	4214.5	6009	6267.0	6318.5	8009	8380.5	8420.5	12009	12481.0	12583.5	16009	16687.5	16811.0	18009	18874.5	19685.0	22009	22288.5	22380.5	25009	25177.0	26105.0
4010	4177.0	4215.0	6010	6267.5	6319.0	8010	8381.0	8421.0	12010	12481.5	12584.0	16010	16688.0	16811.5	18010	18875.0	19685.5	22010	22289.0	22381.0	25010	25177.5	26105.5
4011	4177.5	4177.5	6011	6268.0	6268.0	8011	8381.5	8421.5	12011	12482.0	12584.5	16011	16688.5	16812.0	18011	18875.5	19686.0	22011	22289.5	22381.5	25011	25178.0	26106.0
4012	4178.0	4215.5	6012	6268.5	6319.5	8012	8382.0	8422.0	12012	12482.5	12585.0	16012	16689.0	16812.5	18012	18876.0	19686.5	22012	22290.0	22382.0	25012	25178.5	26106.5
4013	4178.5	4216.0	6013	6269.0	6320.0	8013	8382.5	8422.5	12013	12483.0	12585.5	16013	16689.5	16813.0	18013	18876.5	19687.0	22013	22290.5	22382.5	25013	25179.0	26107.0
4014	4179.0	4216.5	6014	6269.5	6320.5	8014	8383.0	8423.0	12014	12483.5	12586.0	16014	16690.0	16813.5	18014	18877.0	19687.5	22014	22291.0	22383.0	25014	25179.5	26107.5
4015	4179.5	4217.0	6015	6270.0	6321.0	8015	8383.5	8423.5	12015	12484.0	12586.5	16015	16690.5	16814.0	18015	18877.5	19688.0	22015	22291.5	22383.5	25015	25180.0	26108.0
4016	4180.0	4217.5	6016	6270.5	6321.5	8016	8384.0	8424.0	12016	12484.5	12587.0	16016	16691.0	16814.5	18016	18878.0	19688.5	22016	22292.0	22384.0	25016	25180.5	26108.5
4017	4180.5	4218.0	6017	6271.0	6322.0	8017	8384.5	8424.5	12017	12485.0	12587.5	16017	16691.5	16815.0	18017	18878.5	19689.0	22017	22292.5	22384.5	25017	25181.0	26109.0
4018	4181.0	4218.5	6018	6271.5	6322.5	8018	8385.0	8425.0	12018	12485.5	12588.0	16018	16692.0	16815.5	18018	18879.0	19689.5	22018	22293.0	22385.0	25018	25181.5	26109.5
4019	4181.5	4219.0	6019	6272.0	6323.0	8019	8385.5	8425.5	12019	12486.0	12588.5	16019	16692.5	16816.0	18019	18879.5	19690.0	22019	22293.5	22385.5	25019	25182.0	26110.0
4020	4202.5	4202.5	6020	6272.5	6323.5	8020	8386.0	8426.0	12020	12486.5	12589.0	16020	16693.0	16816.5	18020	18880.0	19690.5	22020	22294.0	22386.0	25020	25182.5	26110.5
4021	4203.0	4203.0	6021	6273.0	6324.0	8021	8386.5	8426.5	12021	12487.0	12589.5	16021	16693.5	16817.0	18021	18880.5	19691.0	22021	22294.5	22386.5	25021	25183.0	26111.0
4022	4203.5	4203.5	6022	6273.5	6324.5	8022	8387.0	8427.0	12022	12487.5	12590.0	16022	16694.0	16817.5	18022	18881.0	19691.5	22022	22295.0	22387.0	25022	25183.5	26111.5
4023	4204.0	4204.0	6023	6274.0	6325.0	8023	8387.5	8427.5	12023	12488.0	12590.5	16023	16694.5	16818.0	18023	18881.5	19692.0	22023	22295.5	22387.5	25023	25184.0	26112.0
4024	4204.5	4204.5	6024	6274.5	6325.5	8024	8388.0	8428.0	12024	12488.5	12591.0	16024	16695.0	16695.0	18024	18882.0	19692.5	22024	22296.0	22388.0	25024	25184.5	26112.5
4025	4205.0	4205.0	6025	6275.0	6326.0	8025	8388.5	8428.5	12025	12489.0	12591.5	16025	16695.5	16818.5	18025	18882.5	19693.0	22025	22296.5	22388.5	25025	25185.0	26113.0
4026	4205.5	4205.5	6026	6275.5	6326.5	8026	8389.0	8429.0	12026	12489.5	12592.0	16026	16696.0	16819.0	18026	18883.0	19693.5	22026	22297.0	22389.0	25026	25185.5	26113.5
4027	4206.0	4206.0	6027	6281.0	6327.0	8027	8389.5	8429.5	12027	12490.0	12592.5	16027	16696.5	16819.5	18027	18883.5	19694.0	22027	22297.5	22389.5	25027	25186.0	26114.0
4028	4206.5	4206.5	6028	6281.5	6327.5	8028	8390.0	8430.0	12028	12490.5	12593.0	16028	16697.0	16820.0	18028	18884.0	19694.5	22028	22298.0	22390.0	25028	25186.5	26114.5
4029	4207.0	4207.0	6029	6282.0	6328.0	8029	8390.5	8430.5	12029	12491.0	12593.5	16029	16697.5	16820.5	18029	18884.5	19695.0	22029	22298.5	22390.5	25029	25187.0	26115.0
4030	4207.5	4207.5	6030	6282.5	6328.5	8030	8391.0	8431.0	12030	12491.5	12594.0	16030	16698.0	16821.0	18030	18885.0	19695.5	22030	22299.0	22391.0	25030	25187.5	26115.5
4031	4208.0	4219.5	6031	6283.0	6329.0	8031	8391.5	8431.5	12031	12492.0	12594.5	16031	16698.5	16821.5	18031	18885.5	19696.0	22031	22299.5	22391.5	25031	25188.0	26116.0
4032	4208.5	4220.0	6032	6283.5	6329.5	8032	8392.0	8432.0	12032	12492.5	12595.0	16032	16699.0	16822.0	18032	18886.0	19696.5	22032	22300.0	22392.0	25032	25188.5	26116.5
4033	4209.0	4220.5	6033	6284.0	6330.0	8033	8392.5	8432.5	12033	12493.0	12595.5	16033	16699.5	16822.5	18033	18886.5	19697.0	22033	22300.5	22392.5	25033	25189.0	26117.0
			6034	6284.5	6330.5	8034	8393.0	8433.0	12034	12493.5	12596.0	16034	16700.0	16823.0	18034	18887.0	19697.5	22034	22301.0	22393.0	25034	25189.5	26117.5
			6035	6300.5	6300.5	8035	8393.5	8433.5	12035	12494.0	12596.5	16035	16700.5	16823.5	18035	18887.5	19698.0	22035	22301.5	22393.5	25035	25190.0	26118.0
			6036	6301.0	6301.0	8036	8394.0	8434.0	12036	12494.5	12597.0	16036	16701.0	16824.0	18036	18888.0	19698.5	22036	22302.0	22394.0	25036	25190.5	26118.5
			6037	6301.5	6301.5	8037	8394.5	8434.5	12037	12495.0	12597.5	16037	16701.5	16824.5	18037	18888.5	19699.0	22037	22302.5	22394.5	25037	25191.0	26119.0
			6038	6302.0	6302.0	8038	8395.0	8435.0	12038	12495.5	12598.0	16038	16702.0	16825.0	18038	18889.0	19699.5	22038	22303.0	22395.0	25038	25191.5	26119.5
			6039	6302.5	6302.5	8039	8395.5	8435.5	12039	12496.0	12598.5	16039	16702.5	16825.5	18039	18889.5	19700.0	22039	22303.5	22395.5	25039	25192.0	26120.0
			6040	6303.0	6303.0	8040	8396.0	8436.0	12040	12496.5	12599.0	16040	16703.0	16826.0	18040	18890.0	19700.5	22040	22304.0	22396.0	25040	25192.5	26120.5
			6041	6303.5	6303.5	8041	8396.5	8396.5	12041	12497.0	12599.5	16041	16703.5	16826.5	18041	18890.5	19701.0	22041	22304.5	22396.5	25041	25193.0	25193.0
			6042	6304.0	6304.0	8042	8397.0	8397.0	12042	12497.5	12600.0	16042	16704.0	16827.0	18042	18891.0	19701.5	22042	22305.0	22397.0	25042	25193.5	25193.5
			6043	6304.5	6304.5	8043	8397.5	8397.5	12043	12498.0	12600.5	16043	16704.5	16827.5	18043	18891.5	19702.0	22043	22305.5	22397.5	25043	25194.0	25194.0
			6044	6305.0	6305.0	8044	8398.0	8398.0	12044	12498.5	12601.0	16044	16705.0	16828.0	18044	18892.0	19702.5	22044	22306.0	22398.0	25044	25194.5	25194.5
			6045	6305.5	6305.5	8045	8398.5	8398.5	12045	12499.0	12601.5	16045	16705.5	16828.5	18045	18892.5	19703.0	22045	22306.5	22398.5	25045	25195.0	25195.0
			6046	6306.0	6306.0	8046	8399.0	8399.0	12046	12499.5	12602.0	16046	16706.0	16829.0	18046	18893.0	18893.0	22046	22307.0	22399.0	25046	25195.5	25195.5
			6047	6306.5	6306.5	8047	8399.5	8399.5	12047	12500.0	12602.5	16047	16706.5	16829.5	18047	18893.5	18893.5	22047	22307.5	22399.5	25047	25196.0	25196.0
			6048	6307.0	6307.0	8048	8400.0	8400.0	12048	12500.5	12603.0	16048	16707.0	16830.0	18048	18894.0	18894.0	22048	22308.0	22400.0	25048	25196.5	25196.5
			6049	6307.5	6307.5	8049	8400.5	8400.5	12049	12501.0	12603.5	16049	16707.5	16830.5	18049	18894.5	18894.5	22049	22308.5	22400.5	25049	25197.0	25197.0
			6050	6308.0	6308.0	8050	8401.0	8401.0	12050	12501.5	12604.0	16050	16708.0	16831.0	18050	18895.0	18895.0	22050	22309.0	22401.0	25050	25197.5	25197.5
			6051	6308.5	6308.5	8051	8401.5	8401.5	12051	12502.0	12604.5	16051	16708.5	16831.5	18051	18895.5	18895.5	22051	22309.5	22401.5	25051	25198.0	25198.0
			6052	6309.0	6309.0	8052	8402.0	8402.0	12052	12502.5	12605.0	16052	16709.0	16832.0	18052	18896.0	18896.0	22052	22310.0	22402.0	25052	25198.5	25198.5
			6053	6309.5	6309.5	8053	8402.5	8402.5	12053	12503.0	12605.5	16053	16709.5	16832.5	18053	18896.5	18896.5	22053	22310.5	22402.5	25053	25199.0	25199.0
			6054	6310.0	6310.0	8054	8403.0	8403.0	12054	12503.5	12606.0	16054	16710.0	16833.0	18054	18897.0	18897.0	22054	22311.0	22403.0	25054	25199.5	25199.5
			6055	6310.5	6310.5	8055	8403.5	8403.5	12055	12504.0	12606.5	16055	16710.5	16833.5	18055	18897.5	18897.5	22055	22311.5	22403.5	25055	25200.0	25200.0

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			6056	6311.0	6311.0	8056	8404.0	8404.0	12056	12504.5	12607.0	16056	16711.0	16834.0	18056	18898.0	18898.0	22056	22312.0	22404.0	25056	25200.5	25200.5
			6057	6311.5	6311.5	8057	8404.5	8404.5	12057	12505.0	12607.5	16057	16711.5	16834.5	18057	18898.5	19703.5	22057	22312.5	22404.5	25057	25201.0	25201.0
			6058	6312.0	6312.0	8058	8405.0	8405.0	12058	12505.5	12608.0	16058	16712.0	16835.0	18058	18899.0	19704.0	22058	22313.0	22405.0	25058	25201.5	25201.5
			6059	6312.5	6331.0	8059	8405.5	8405.5	12059	12506.0	12608.5	16059	16712.5	16835.5	18059	18899.5	19704.5	22059	22313.5	22405.5	25059	25202.0	25202.0
			6060	6313.0	6331.5	8060	8406.0	8406.0	12060	12506.5	12609.0	16060	16713.0	16836.0				22060	22314.0	22406.0	25060	25202.5	25202.5
			6061	6313.5	6332.0	8061	8405.5	8406.5	12061	12507.0	12609.5	16061	16713.5	16836.5				22061	22314.5	22406.5	25061	25203.0	25203.0
						8062	8407.0	8407.0	12062	12507.5	12610.0	16062	16714.0	16837.0				22062	22315.0	22407.0	25062	25203.5	25203.5
						8063	8407.5	8407.5	12063	12508.0	12610.5	16063	16714.5	16837.5				22063	22315.5	22407.5	25063	25204.0	25204.0
						8064	8408.0	8408.0	12064	12508.5	12611.0	16064	16715.0	16838.0				22064	22316.0	22408.0	25064	25204.5	25204.5
						8065	8408.5	8408.5	12065	12509.0	12611.5	16065	16715.5	16838.5				22065	22316.5	22408.5	25065	25205.0	25205.0
						8066	8409.0	8409.0	12066	12509.5	12612.0	16066	16716.0	16839.0				22066	22317.0	22409.0	25066	25205.5	25205.5
						8067	8409.5	8409.5	12067	12510.0	12612.5	16067	16716.5	16839.5				22067	22317.5	22409.5	25067	25206.0	25206.0
						8068	8410.0	8410.0	12068	12510.5	12613.0	16068	16717.0	16840.0				22068	22318.0	22410.0	25068	25206.5	25206.5
						8069	8410.5	8410.5	12069	12511.0	12613.5	16069	16717.5	16840.5				22069	22318.5	22410.5	25069	25207.0	25207.0
						8070	8411.0	8411.0	12070	12511.5	12614.0	16070	16718.0	16841.0				22070	22319.0	22411.0	25070	25207.5	25207.5
						8071	8411.5	8411.5	12071	12512.0	12614.5	16071	16718.5	16841.5				22071	22319.5	22411.5	25071	25208.0	25208.0
						8072	8412.0	8412.0	12072	12512.5	12615.0	16072	16719.0	16842.0				22072	22320.0	22412.0	25072	25208.5	26121.0
						8073	8412.5	8412.5	12073	12513.0	12615.5	16073	16719.5	16842.5				22073	22320.5	22412.5	25073	25209.0	26121.5
						8074	8413.0	8413.0	12074	12513.5	12616.0	16074	16720.0	16843.0				22074	22321.0	22413.0	25074	25209.5	26122.0
						8075	8413.5	8413.5	12075	12514.0	12616.5	16075	16720.5	16843.5				22075	22321.5	22413.5			
						8076	8414.0	8414.0	12076	12514.5	12617.0	16076	16721.0	16844.0				22076	22322.0	22414.0			
						8077	8414.5	8414.5	12077	12515.0	12617.5	16077	16721.5	16844.5				22077	22322.5	22414.5			
						8078	8415.0	8436.5	12078	12515.5	12618.0	16078	16722.0	16845.0				22078	22323.0	22415.0			
						8079	8415.5	8437.0	12079	12516.0	12618.5	16079	16722.5	16845.5				22079	22323.5	22415.5			
						8080	8416.0	8437.5	12080	12516.5	12619.0	16080	16723.0	16846.0				22080	22324.0	22416.0			
									12081	12517.0	12619.5	16081	16723.5	16846.5				22081	22324.5	22416.5			
									12082	12517.5	12620.0	16082	16724.0	16847.0				22082	22325.0	22417.0			
									12083	12518.0	12620.5	16083	16724.5	16847.5				22083	22325.5	22417.5			
									12084	12518.5	12621.0	16084	16725.0	16848.0				22084	22326.0	22418.0			
									12085	12519.0	12621.5	16085	16725.5	16848.5				22085	22326.5	22418.5			
									12086	12519.5	12622.0	16086	16726.0	16849.0				22086	22327.0	22419.0			
									12087	12520.0	12520.0	16087	16726.5	16849.5				22087	22327.5	22419.5			
									12088	12520.5	12622.5	16088	16727.0	16850.0				22088	22328.0	22420.0			
									12089	12521.0	12623.0	16089	16727.5	16850.5				22089	22328.5	22420.5			
									12090	12521.5	12623.5	16090	16728.0	16851.0				22090	22329.0	22421.0			
									12091	12522.0	12624.0	16091	16728.5	16851.5				22091	22329.5	22421.5			
									12092	12522.5	12624.5	16092	16729.0	16852.0				22092	22330.0	22422.0			
									12093	12523.0	12625.0	16093	16729.5	16852.5				22093	22330.5	22422.5			
									12094	12523.5	12625.5	16094	16730.0	16853.0				22094	22331.0	22423.0			
									12095	12524.0	12626.0	16095	16730.5	16853.5				22095	22331.5	22423.5			
									12096	12524.5	12626.5	16096	16731.0	16854.0				22096	22332.0	22424.0			
									12097	12525.0	12627.0	16097	16731.5	16854.5				22097	22332.5	22424.5			
									12098	12525.5	12627.5	16098	16732.0	16855.0				22098	22333.0	22425.0			
									12099	12526.0	12628.0	16099	16732.5	16855.5				22099	22333.5	22425.5			
									12100	12526.5	12628.5	16100	16733.0	16856.0				22100	22334.0	22426.0			
									12101	12527.0	12629.0	16101	16733.5	16856.5				22101	22334.5	22426.5			
									12102	12527.5	12629.5	16102	16739.0	16857.0				22102	22335.0	22427.0			
									12103	12528.0	12630.0	16103	16739.5	16857.5				22103	22335.5	22427.5			
									12104	12528.5	12630.5	16104	16740.0	16858.0				22104	22336.0	22428.0			
									12105	12529.0	12631.0	16105	16740.5	16858.5				22105	22336.5	22428.5			
									12106	12529.5	12631.5	16106	16741.0	16859.0				22106	22337.0	22429.0			
									12107	12530.0	12632.0	16107	16741.5	16859.5				22107	22337.5	22429.5			
									12108	12530.5	12632.5	16108	16742.0	16860.0				22108	22338.0	22430.0			
									12109	12531.0	12633.0	16109	16742.5	16860.5				22109	22338.5	22430.5			
									12110	12531.5	12633.5	16110	16743.0	16861.0				22110	22339.0	22431.0			
									12111	12532.0	12634.0	16111	16743.5	16861.5				22111	22339.5	22431.5			
									12112	12532.5	12634.5	16112	16744.0	16862.0				22112	22340.0	22432.0			
									12113	12533.0	12635.0	16113	16744.5	16862.5				22113	22340.5	22432.5			
									12114	12533.5	12635.5	16114	16745.0	16863.0				22114	22341.0	22433.0			
									12115	12534.0	12636.0	16115	16745.5	16863.5				22115	22341.5	22433.5			

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										12116	12534.5	12636.5	16116	16746.0	16864.0					22116	22342.0	22434.0							
										12117	12535.0	12637.0	16117	16746.5	16864.5					22117	22342.5	22434.5							
										12118	12535.5	12637.5	16118	16747.0	16865.0					22118	22343.0	22435.0							
										12119	12536.0	12638.0	16119	16747.5	16865.5					22119	22343.5	22435.5							
										12120	12536.5	12638.5	16120	16748.0	16866.0					22120	22344.0	22436.0							
										12121	12537.0	12639.0	16121	16748.5	16866.5					22121	22344.5	22436.5							
										12122	12537.5	12639.5	16122	16749.0	16867.0					22122	22345.0	22437.0							
										12123	12538.0	12640.0	16123	16749.5	16867.5					22123	22345.5	22437.5							
										12124	12538.5	12640.5	16124	16750.0	16868.0					22124	22346.0	22438.0							
										12125	12539.0	12641.0	16125	16750.5	16868.5					22125	22346.5	22438.5							
										12126	12539.5	12641.5	16126	16751.0	16869.0					22126	22347.0	22439.0							
										12127	12540.0	12642.0	16127	16751.5	16869.5					22127	22347.5	22439.5							
										12128	12540.5	12642.5	16128	16752.0	16870.0					22128	22348.0	22440.0							
										12129	12541.0	12643.0	16129	16752.5	16870.5					22129	22348.5	22440.5							
										12130	12541.5	12643.5	16130	16753.0	16871.0					22130	22349.0	22441.0							
										12131	12542.0	12644.0	16131	16753.5	16871.5					22131	22349.5	22441.5							
										12132	12542.5	12644.5	16132	16754.0	16872.0					22132	22350.0	22442.0							
										12133	12543.0	12645.0	16133	16754.5	16872.5					22133	22350.5	22442.5							
										12134	12543.5	12645.5	16134	16755.0	16873.0					22134	22351.0	22443.0							
										12135	12544.0	12646.0	16135	16755.5	16873.5					22135	22351.5	22443.5							
										12136	12544.5	12646.5	16136	16756.0	16874.0					22136	22352.0	22352.0							
										12137	12545.0	12647.0	16137	16756.5	16874.5					22137	22352.5	22352.5							
										12138	12545.5	12647.5	16138	16757.0	16875.0					22138	22353.0	22353.0							
										12139	12546.0	12648.0	16139	16757.5	16875.5					22139	22353.5	22353.5							
										12140	12546.5	12648.5	16140	16758.0	16876.0					22140	22354.0	22354.0							
										12141	12547.0	12649.0	16141	16758.5	16876.5					22141	22354.5	22354.5							
										12142	12547.5	12649.5	16142	16759.0	16877.0					22142	22355.0	22355.0							
										12143	12548.0	12650.0	16143	16759.5	16877.5					22143	22355.5	22355.5							
										12144	12548.5	12650.5	16144	16760.0	16878.0					22144	22356.0	22356.0							
										12145	12549.0	12651.0	16145	16760.5	16878.5					22145	22356.5	22356.5							
										12146	12549.5	12651.5	16146	16761.0	16879.0					22146	22357.0	22357.0							
										12147	12555.0	12652.0	16147	16761.5	16879.5					22147	22357.5	22357.5							
										12148	12555.5	12652.5	16148	16762.0	16880.0					22148	22358.0	22358.0							
										12149	12556.0	12653.0	16149	16762.5	16880.5					22149	22358.5	22358.5							
										12150	12556.5	12653.5	16150	16763.0	16881.0					22150	22359.0	22359.0							
										12151	12557.0	12654.0	16151	16763.5	16881.5					22151	22359.5	22359.5							
										12152	12557.5	12654.5	16152	16764.0	16882.0					22152	22360.0	22360.0							
										12153	12558.0	12655.0	16153	16764.5	16882.5					22153	22360.5	22360.5							
										12154	12558.5	12655.5	16154	16765.0	16883.0					22154	22361.0	22361.0							
										12155	12559.0	12656.0	16155	16765.5	16883.5					22155	22361.5	22361.5							
										12156	12559.5	12656.5	16156	16766.0	16884.0					22156	22362.0	22362.0							
										12157	12560.0	12560.0	16157	16766.5	16884.5					22157	22362.5	22362.5							
										12158	12560.5	12560.5	16158	16767.0	16885.0					22158	22363.0	22363.0							
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										12160	12561.5	12561.5	16160	16768.0	16886.0					22160	22364.0	22364.0							
										12161	12562.0	12562.0	16161	16768.5	16886.5					22161	22364.5	22364.5							
										12162	12562.5	12562.5	16162	16769.0	16887.0					22162	22365.0	22365.0							
										12163	12563.0	12563.0	16163	16769.5	16887.5					22163	22365.5	22365.5							
										12164	12563.5	12563.5	16164	16770.0	16888.0					22164	22366.0	22366.0							
										12165	12564.0	12564.0	16165	16770.5	16888.5					22165	22366.5	22366.5							
										12166	12564.5	12564.5	16166	16771.0	16889.0					22166	22367.0	22367.0							
										12167	12565.0	12565.0	16167	16771.5	16889.5					22167	22367.5	22367.5							
										12168	12565.5	12565.5	16168	16772.0	16890.0					22168	22368.0	22368.0							
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										12170	12566.5	12566.5	16170	16773.0	16891.0					22170	22369.0	22369.0							
										12171	12567.0	12567.0	16171	16773.5	16891.5					22171	22369.5	22369.5							
										12172	12567.5	12567.5	16172	16774.0	16892.0					22172	22370.0	22370.0							
										12173	12568.0	12568.0	16173	16774.5	16892.5					22173	22370.5	22370.5							
										12174	12568.5	12568.5	16174	16775.0	16893.0					22174	22371.0	22371.0							
										12175	12569.0	12569.0	16175	16775.5	16893.5					22175	22371.5	22371.5							

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12176	12569.5	12569.5
12177	12570.0	12570.0
12178	12570.5	12570.5
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12180	12571.5	12571.5
12181	12572.0	12572.0
12182	12572.5	12572.5
12183	12573.0	12573.0
12184	12573.5	12573.5
12185	12574.0	12574.0
12186	12574.5	12574.5
12187	12575.0	12575.0
12188	12575.5	12575.5
12189	12576.0	12576.0
12190	12576.5	12576.5
12191	12577.0	12577.0
12192	12577.5	12657.0
12193	12578.0	12657.5
12194	12578.5	12658.0

16176	16776.0	16894.0
16177	16776.5	16894.5
16178	16777.0	16895.0
16179	16777.5	16895.5
16180	16778.0	16896.0
16181	16778.5	16896.5
16182	16779.0	16897.0
16183	16779.5	16897.5
16184	16780.0	16898.0
16185	16780.5	16898.5
16186	16781.0	16899.0
16187	16781.5	16899.5
16188	16782.0	16900.0
16189	16782.5	16900.5
16190	16783.0	16901.0
16191	16783.5	16901.5
16192	16784.0	16902.0
16193	16784.5	16902.5
16194	16785.0	16785.0
16195	16785.5	16785.5
16196	16786.0	16786.0
16197	16786.5	16786.5
16198	16787.0	16787.0
16199	16787.5	16787.5
16200	16788.0	16788.0
16201	16788.5	16788.5
16202	16789.0	16789.0
16203	16789.5	16789.5
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16205	16790.5	16790.5
16206	16791.0	16791.0
16207	16791.5	16791.5
16208	16792.0	16792.0
16209	16792.5	16792.5
16210	16793.0	16793.0
16211	16793.5	16793.5
16212	16794.0	16794.0
16213	16794.5	16794.5
16214	16795.0	16795.0
16215	16795.5	16795.5
16216	16796.0	16796.0
16217	16796.5	16796.5
16218	16797.0	16797.0
16219	16797.5	16797.5
16220	16798.0	16798.0
16221	16798.5	16798.5
16222	16799.0	16799.0
16223	16799.5	16799.5
16224	16800.0	16800.0
16225	16800.5	16800.5
16226	16801.0	16801.0
16227	16801.5	16801.5
16228	16802.0	16802.0
16229	16802.5	16802.5
16230	16803.0	16803.0
16231	16803.5	16803.5
16232	16804.0	16804.0
16233	16804.5	16804.5
16234	16805.0	16903.0
16235	16805.5	16903.5
16236	16806.0	16904.0

22176	22372.0	22372.0
22177	22372.5	22372.5
22178	22373.0	22373.0
22179	22373.5	22373.5
22180	22374.0	22374.0
22181	22374.5	22444.0
22182	22375.0	22444.5
22183	22375.5	22445.0

FURUNO ITU CW FREQUENCY TABLE (effective from July 1, 1991, 1991年7月1日より発効)

No.	4 MHz	No.	6 MHz	No.	8 MHz	No.	12 MHz	No.	16 MHz	No.	22 MHz	No.	25/26 MHz
4001	4187.0	6001	6285.0	8001	8342.0	12001	12422.0	16001	16619.0	22001	22242.0	25001	25161.5
4002	4187.5	6002	6285.5	8002	8342.5	12002	12422.5	16002	16619.5	22002	22242.5	25002	25162.0
4003	4188.0	6003	6286.0	8003	8343.0	12003	12423.0	16003	16620.0	22003	22243.0	25003	25162.5
4004	4188.5	6004	6286.5	8004	8343.5	12004	12423.5	16004	16620.5	22004	22243.5	25004	25163.0
4005	4189.0	6005	6287.0	8005	8344.0	12005	12424.0	16005	16621.0	22005	22244.0	25005	25163.5
4006	4189.5	6006	6287.5	8006	8344.5	12006	12424.5	16006	16621.5	22006	22244.5	25006	25164.0
4007	4190.0	6007	6288.0	8007	8345.0	12007	12425.0	16007	16622.0	22007	22245.0	25007	25164.5
4008	4190.5	6008	6288.5	8008	8345.5	12008	12425.5	16008	16622.5	22008	22245.5	25008	25165.0
4009	4191.0	6009	6289.0	8009	8346.0	12009	12426.0	16009	16623.0	22009	22246.0	25009	25165.5
4010	4191.5	6010	6289.5	8010	8346.5	12010	12426.5	16010	16623.5	22010	22246.5	25010	25166.0
4011	4192.0	6011	6290.0	8011	8347.0	12011	12427.0	16011	16624.0	22011	22247.0	25011	25166.5
4012	4192.5	6012	6290.5	8012	8347.5	12012	12427.5	16012	16624.5	22012	22247.5	25012	25167.0
4013	4193.0	6013	6291.0	8013	8348.0	12013	12428.0	16013	16625.0	22013	22248.0	25013	25167.5
4014	4193.5	6014	6291.5	8014	8348.5	12014	12428.5	16014	16625.5	22014	22248.5	25014	25168.0
4015	4194.0	6015	6292.0	8015	8349.0	12015	12429.0	16015	16626.0	22015	22249.0	25015	25168.5
4016	4194.5	6016	6292.5	8016	8349.5	12016	12429.5	16016	16626.5	22016	22249.5	25016	25169.0
4017	4195.0	6017	6293.0	8017	8350.0	12017	12430.0	16017	16627.0	22017	22250.0	25017	25169.5
4018	4195.5	6018	6293.5	8018	8350.5	12018	12430.5	16018	16627.5	22018	22250.5	25018	25170.0
4019	4196.0	6019	6294.0	8019	8351.0	12019	12431.0	16019	16628.0	22019	22251.0	25019	25170.5
4020	4196.5	6020	6294.5	8020	8351.5	12020	12431.5	16020	16628.5	22020	22251.5	25020	25171.0
4021	4197.0	6021	6295.0	8021	8352.0	12021	12432.0	16021	16629.0	22021	22252.0	*25021	25171.5
4022	4197.5	6022	6295.5	8022	8352.5	12022	12432.5	16022	16629.5	22022	22252.5	*25022	25172.0
4023	4198.0	6023	6296.0	8023	8353.0	12023	12433.0	16023	16630.0	22023	22253.0	*25023	25172.5
4024	4198.5	6024	6296.5	8024	8353.5	12024	12433.5	16024	16630.5	22024	22253.5		
4025	4199.0	6025	6297.0	8025	8354.0	12025	12434.0	16025	16631.0	22025	22254.0		
4026	4199.5	6026	6297.5	8026	8354.5	12026	12434.5	16026	16631.5	22026	22254.5		
4027	4200.0	6027	6298.0	8027	8355.0	12027	12435.0	16027	16632.0	22027	22255.0		
4028	4200.5	6028	6298.5	8028	8355.5	12028	12435.5	16028	16632.5	22028	22255.5		
4029	4201.0	6029	6299.0	8029	8356.0	12029	12436.0	16029	16633.0	22029	22256.0		
4030	4201.5	6030	6299.5	8030	8356.5	12030	12436.5	16030	16633.5	22030	22256.5		
4031	4202.0	6031	6300.0	8031	8357.0	12031	12437.0	16031	16634.0	22031	22257.0		
*4032	4182.0	*6032	6276.0	8032	8357.5	12032	12437.5	16032	16634.5	22032	22257.5		
*4033	4182.5	*6033	6276.5	8033	8358.0	12033	12438.0	16033	16635.0	22033	22258.0		
*4034	4183.0	*6034	6277.0	8034	8358.5	12034	12438.5	16034	16635.5	22034	22258.5		
*4035	4183.5	*6035	6277.5	8035	8359.0	12035	12439.0	16035	16636.0	22035	22259.0		
*4036	4184.0	*6036	6278.0	8036	8359.5	12036	12439.5	16036	16636.5	22036	22259.5		
*4037	4184.5	*6037	6278.5	8037	8360.0	12037	12440.0	16037	16637.0	22037	22260.0		
*4038	4185.0	*6038	6279.0	8038	8360.5	12038	12440.5	16038	16637.5	22038	22260.5		
*4039	4185.5	*6039	6279.5	8039	8361.0	12039	12441.0	16039	16638.0	22039	22261.0		
*4040	4186.0	*6040	6280.0	8040	8361.5	12040	12441.5	16040	16638.5	22040	22261.5		
*4041	4186.5	*6041	6280.5	8041	8362.0	12041	12442.0	16041	16639.0	22041	22262.0		
				8042	8362.5	12042	12442.5	16042	16639.5	22042	22262.5		
				8043	8363.0	12043	12443.0	16043	16640.0	22043	22263.0		
				8044	8363.5	12044	12443.5	16044	16640.5	22044	22263.5		
				8045	8364.0	12045	12444.0	16045	16641.0	22045	22264.0		
				8046	8364.5	12046	12444.5	16046	16641.5	22046	22264.5		
				8047	8365.0	12047	12445.0	16047	16642.0	22047	22265.0		
				8048	8365.5	12048	12445.5	16048	16642.5	22048	22265.5		
				8049	8371.0	12049	12446.0	16049	16643.0	22049	22266.0		
				8050	8371.5	12050	12446.5	16050	16643.5	22050	22266.5		
				8051	8372.0	12051	12447.0	16051	16644.0	22051	22267.0		
				8052	8372.5	12052	12447.5	16052	16644.5	22052	22267.5		
				8053	8373.0	12053	12448.0	16053	16645.0	22053	22268.0		
				8054	8373.5	12054	12448.5	16054	16645.5	22054	22268.5		
				8055	8374.0	12055	12449.0	16055	16646.0	22055	22269.0		
				8056	8374.5	12056	12449.5	16056	16646.5	22056	22269.5		
				8057	8375.0	12057	12450.0	16057	16647.0	22057	22270.0		
				8058	8375.5	12058	12450.5	16058	16647.5	22058	22270.5		
				8059	8376.0	12059	12451.0	16059	16648.0	22059	22271.0		
				*8060	8366.0	12060	12451.5	16060	16648.5	22060	22271.5		

*: Calling Frequency

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				*8061	8366.5	12061	12452.0	16061	16649.0	22061	22272.0		
				*8062	8367.0	12062	12452.5	16062	16649.5	22062	22272.5		
				*8063	8367.5	12063	12453.0	16063	16650.0	22063	22273.0		
				*8064	8368.0	12064	12453.5	16064	16650.5	22064	22273.5		
				*8065	8368.5	12065	12454.0	16065	16651.0	22065	22274.0		
				*8066	8369.0	12066	12454.5	16066	16651.5	22066	22274.5		
				*8067	8369.5	12067	12455.0	16067	16652.0	22067	22275.0		
				*8068	8370.0	12068	12455.5	16068	16652.5	22068	22275.5		
				*8069	8370.5	12069	12456.0	16069	16653.0	22069	22276.0		
						12070	12456.5	16070	16653.5	22070	22276.5		
						12071	12457.0	16071	16654.0	22071	22277.0		
						12072	12457.5	16072	16654.5	22072	22277.5		
						12073	12458.0	16073	16655.0	22073	22278.0		
						12074	12458.5	16074	16655.5	22074	22278.5		
						12075	12459.0	16075	16656.0	22075	22279.0		
						12076	12459.5	16076	16656.5	*22076	22279.5		
						12077	12460.0	16077	16657.0	*22077	22280.0		
						12078	12460.5	16078	16657.5	*22078	22280.5		
						12079	12461.0	16079	16658.0	*22079	22281.0		
						12080	12461.5	16080	16658.5	*22080	22281.5		
						12081	12462.0	16081	16659.0	*22081	22282.0		
						12082	12462.5	16082	16659.5	*22082	22282.5		
						12083	12463.0	16083	16660.0	*22083	22283.0		
						12084	12463.5	16084	16660.5	*22084	22283.5		
						12085	12464.0	16085	16661.0	*22085	22284.0		
						12086	12464.5	16086	16661.5				
						12087	12465.0	16087	16662.0				
						12088	12465.5	16088	16662.5				
						12089	12466.0	16089	16663.0				
						12090	12466.5	16090	16663.5				
						12091	12467.0	16091	16664.0				
						12092	12467.5	16092	16664.5				
						12093	12468.0	16093	16665.0				
						12094	12468.5	16094	16665.5				
						12095	12469.0	16095	16666.0				
						12096	12469.5	16096	16666.5				
						12097	12470.0	16097	16667.0				
						12098	12470.5	16098	16667.5				
						12099	12471.0	16099	16668.0				
						12100	12471.5	16100	16668.5				
						12101	12472.0	16101	16669.0				
						12102	12472.5	16102	16669.5				
						12103	12473.0	16103	16670.0				
						12104	12473.5	16104	16670.5				
						12105	12474.0	16105	16671.0				
						12106	12474.5	16106	16671.5				
						12107	12475.0	16107	16672.0				
						12108	12475.5	16108	16672.5				
						12109	12476.0	16109	16673.0				
						12110	12476.5	16110	16673.5				
						*12111	12550.0	16111	16674.0				
						*12112	12550.5	16112	16674.5				
						*12113	12551.0	16113	16675.0				
						*12114	12551.5	16114	16675.5				
						*12115	12552.0	16115	16676.0				
						*12116	12552.5	16116	16676.5				
						*12117	12553.0	16117	16677.0				
						*12118	12553.5	16118	16677.5				
						*12119	12554.0	16119	16678.0				
						*12120	12554.5	16120	16678.5				

*: Calling Frequency

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								16121	16679.0
								16122	16679.5
								16123	16680.0
								16124	16680.5
								16125	16681.0
								16126	16681.5
								16127	16682.0
								16128	16682.5
								16129	16683.0
								*16130	16734.0
								*16131	16734.5
								*16132	16735.0
								*16133	16735.5
								*16134	16736.0
								*16135	16736.5
								*16136	16737.0
								*16137	16737.5
								*16138	16738.0
								*16139	16738.5

*: Calling Frequency

FURUNO

USA SSB FREQUENCY TABLE FOR FURUNO SSB RADIOTELEPHONES

SSBUSA

4 MHz BAND			6 MHz BAND			8 MHz BAND			12 MHz BAND			16 MHz BAND			18/19 MHz BAND			22 MHz BAND			25/26 MHz BAND			Remarks
No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	No.	TX	RX	
300	3023	3023	600	6215	6215	800	8291	8291	1200	12290	12290	1600	16420	16420										Distress Channels
400	4125	4125																						
500	5680	5680																						
401	4065	4357	601	6200	6501	801	8195	8719	1201	12230	13077	1601	16360	17242	1801	18780	19755	2201	22000	22696	2501	25070	26145	ITU SSB Duplex Channels
402	4068	4360	602	6203	6504	802	8198	8722	1202	12233	13080	1602	16363	17245	1802	18783	19758	2202	22003	22699	2502	25073	26148	
403	4071	4363	603	6206	6507	803	8201	8725	1203	12236	13083	1603	16366	17248	1803	18786	19761	2203	22006	22702	2503	25076	26151	
404	4074	4366	604	6209	6510	804	8204	8728	1204	12239	13086	1604	16369	17251	1804	18789	19764	2204	22009	22705	2504	25079	26154	
405	4077	4369	605	6212	6513	805	8207	8731	1205	12242	13089	1605	16372	17254	1805	18792	19767	2205	22012	22708	2505	25082	26157	
406	4080	4372	606	6215	6516	806	8210	8734	1206	12245	13092	1606	16375	17257	1806	18795	19770	2206	22015	22711	2506	25085	26160	
407	4083	4375	607	6218	6519	807	8213	8737	1207	12248	13095	1607	16378	17260	1807	18798	19773	2207	22018	22714	2507	25088	26163	
408	4086	4378	608	6221	6522	808	8216	8740	1208	12251	13098	1608	16381	17263	1808	18801	19776	2208	22021	22717	2508	25091	26166	
409	4089	4381				809	8219	8743	1209	12254	13101	1609	16384	17266	1809	18804	19779	2209	22024	22720	2509	25094	26169	
410	4092	4384				810	8222	8746	1210	12257	13104	1610	16387	17269	1810	18807	19782	2210	22027	22723	2510	25097	26172	
411	4095	4387				811	8225	8749	1211	12260	13107	1611	16390	17272	1811	18810	19785	2211	22030	22726				
412	4098	4390				812	8228	8752	1212	12263	13110	1612	16393	17275	1812	18813	19788	2212	22033	22729				
413	4101	4393				813	8231	8755	1213	12266	13113	1613	16396	17278	1813	18816	19791	2213	22036	22732				
414	4104	4396				814	8234	8758	1214	12269	13116	1614	16399	17281	1814	18819	19794	2214	22039	22735				
415	4107	4399				815	8237	8761	1215	12272	13119	1615	16402	17284	1815	18822	19797	2215	22042	22738				
416	4110	4402				816	8240	8764	1216	12275	13122	1616	16405	17287				2216	22045	22741				
417	4113	4405				817	8243	8767	1217	12278	13125	1617	16408	17290				2217	22048	22744				
418	4116	4408				818	8246	8770	1218	12281	13128	1618	16411	17293				2218	22051	22747				
419	4119	4411				819	8249	8773	1219	12284	13131	1619	16414	17296				2219	22054	22750				
420	4122	4414				820	8252	8776	1220	12287	13134	1620	16417	17299				2220	22057	22753				
421	4125	4417				821	8255	8779	1221	12290	13137	1621	16420	17302				2221	22060	22756				
422	4128	4420				822	8258	8782	1222	12293	13140	1622	16423	17305				2222	22063	22759				
423	4131	4423				823	8261	8785	1223	12296	13143	1623	16426	17308				2223	22066	22762				
424	4134	4426				824	8264	8788	1224	12299	13146	1624	16429	17311				2224	22069	22765				
425	4137	4429				825	8267	8791	1225	12302	13149	1625	16432	17314				2225	22072	22768				
426	4140	4432				826	8270	8794	1226	12305	13152	1626	16435	17317				2226	22075	22771				
427	4143	4435				827	8273	8797	1227	12308	13155	1627	16438	17320				2227	22078	22774				
428	4060	4351				828	8276	8800	1228	12311	13158	1628	16441	17323				2228	22081	22777				
						829	8279	8803	1229	12314	13161	1629	16444	17326				2229	22084	22780				
						830	8282	8806	1230	12317	13164	1630	16447	17329				2230	22087	22783				
						831	8285	8809	1231	12320	13167	1631	16450	17332				2231	22090	22786				
						832	8288	8812	1232	12323	13170	1632	16453	17335				2232	22093	22789				
									1233	12326	13173	1633	16456	17338				2233	22096	22792				
									1234	12329	13176	1634	16459	17341				2234	22099	22795				
									1235	12332	13179	1635	16462	17344				2235	22102	22798				
						836	8113	8713	1236	12335	13182	1636	16465	17347				2236	22105	22801				
						837	8128	8716	1237	12338	13185	1637	16468	17350				2237	22108	22804				
												1638	16471	17353				2238	22111	22807				
												1639	16474	17356				2239	22114	22810				
												1640	16477	17359				2240	22117	22813				
												1641	16480	17362				2241	22120	22816				
												1642	16483	17365				2242	22123	22819				
												1643	16486	17368				2243	22126	22822				
												1644	16489	17371				2244	22129	22825				
												1645	16492	17374				2245	22132	22828				
												1646	16495	17377				2246	22135	22831				
												1647	16498	17380				2247	22138	22834				
												1648	16501	17383										
												1649	16504	17386										
461	4146	4146	661	6224	6224	861	8294	8294	1261	12353	12353	1661	16528	16528	1861	18840	18840	2261	22159	22159	2561	25115	25115	Simplex Channels
462	4149	4149	662	6227	6227	862	8297	8297	1262	12356	12356	1662	16531	16531	1862	18843	18843	2262	22162	22162	2562	25118	25118	
463	4417	4417	663	6230	6230				1263	12359	12359	1663	16534	16534				2263	22165	22165				
			664	6516	6516													2264	22168	22168				
																		2265	22171	22171				
471	4065	4065	671	6209	6209	871	8201	8201	1271	12362	12362	1671	16543	16543										Mississippi River Channels
472	4089	4089	672	6212	6212	872	8213	8213	1272	12365	12365	1672	16546	16546										
473	4116	4116	673	6510	6510	873	8725	8725																
474	4408	4408	674	6513	6513	874	8737	8737																
481	4366	4366																						Alaska Radio Channels
482	4369	4369																						
483	4396	4396																						
484	4402	4402																						
485	4420	4420																						
486	4423	4423																						

MF BAND ITU TELEX FREQUENCY TABLE

Channel No.	Coast station (NBDP) (DSC) (kHz)	Ship station (NBDP) (DSC) (kHz)
201	1607	2142
202	1607.5	2142.5
203	1608	2143
204	1608.5	2143.5
205	1609	2144
206	1609.5	2144.5
207	1610	2145
208	1610.5	2145.5
209	1611	2146
210	1611.5	2146.5
211	1612	2147
212	1612.5	2147.5
213	1613	2148
214	1613.5	2148.5
215	1614	2149
:		
216	1614.5	2149.5
217	1615	2150
218	1615.5	2150.5
219	1616	2151
220	1616.5	2151.5
221	1617	2152
222	1617.5	2152.5
223	1618	2153
224	1618.5	2153.5
225	1619	2154
226	1619.5	2154.5
227	1620	2155
228	1620.5	2155.5
229	1621	2156
230	1621.5	2156.5
231	1622	2157
232	1622.5	2157.5
233	1623	2158
234	1623.5	2158.5
235	1624	2159
236	1624.5	2159.5

MF BAND ITU SSB FREQUENCY TABLE

Channel No.	Coast station assigned frequency (kHz)	Ship station assigned frequency (kHz)	Channel No.	Coast station assigned frequency (kHz)	Ship station assigned frequency (kHz)
241	1636.4 (1635)	2061.4 (2060)	271	1726.4 (1725)	2070.4 (2069)
242	1639.4 (1638)	2064.4 (2063)	272	1729.4 (1728)	2073.4 (2072)
243	1642.4 (1641)	2067.4 (2066)	273	1732.4 (1731)	2076.4 (2075)
244	1645.4 (1644)	2070.4 (2069)	274	1735.4 (1734)	2079.4 (2078)
245	1648.4 (1647)	2073.4 (2072)	275	1738.4 (1737)	2082.4 (2081)
246	1651.4 (1650)	2076.4 (2075)	276	1741.4 (1740)	2085.4 (2084)
247	1654.4 (1653)	2079.4 (2078)	277	1744.4 (1743)	2088.4 (2087)
248	1657.4 (1656)	2082.4 (2081)	278	1747.4 (1746)	2091.4 (2090)
249	1660.4 (1659)	2085.4 (2084)	279	1750.4 (1749)	2094.4 (2093)
250	1663.4 (1662)	2088.4 (2087)	280	1753.4 (1752)	2097.4 (2096)
251	1666.4 (1665)	2091.4 (2090)	281	1756.4 (1755)	2100.4 (2099)
252	1669.4 (1668)	2094.4 (2093)	282	1759.4 (1758)	2103.4 (2102)
253	1672.4 (1671)	2097.4 (2096)	283	1762.4 (1761)	2106.4 (2105)
254	1675.4 (1674)	2100.4 (2099)	284	1765.4 (1764)	2109.4 (2108)
255	1678.4 (1677)	2103.4 (2102)	285	1768.4 (1767)	2112.4 (2111)
256	1681.4 (1680)	2106.4 (2105)	286	1771.4 (1770)	2115.4 (2114)
257	1684.4 (1683)	2109.4 (2108)	287	1774.4 (1773)	2118.4 (2117)
258	1687.4 (1686)	2112.4 (2111)	288	1777.4 (1776)	2121.4 (2120)
259	1690.4 (1689)	2115.4 (2114)	289	1780.4 (1779)	2124.4 (2123)
260	1693.4 (1692)	2118.4 (2117)	290	1783.4 (1782)	2127.4 (2126)
261	1696.4 (1695)	2121.4 (2120)	291	1786.4 (1785)	2130.4 (2129)
262	1699.4 (1698)	2124.4 (2123)	292	1789.4 (1788)	2133.4 (2132)
263	1702.4 (1701)	2127.4 (2126)	293	1792.4 (1791)	2136.4 (2135)
264	1705.4 (1704)	2130.4 (2129)	294	1795.4 (1794)	2139.4 (2138)
265	1708.4 (1707)	2133.4 (2132)	295	1798.4 (1797)	2061.4 (2060)
266	1711.4 (1710)	2136.4 (2135)			
267	1714.4 (1713)	2139.4 (2138)			
268	1717.4 (1716)	2061.4 (2060)			
269	1720.4 (1719)	2064.4 (2063)			
270	1723.4 (1722)	2067.4 (2066)			

( ): CARRIER FREQUENCY