1. OPERATION

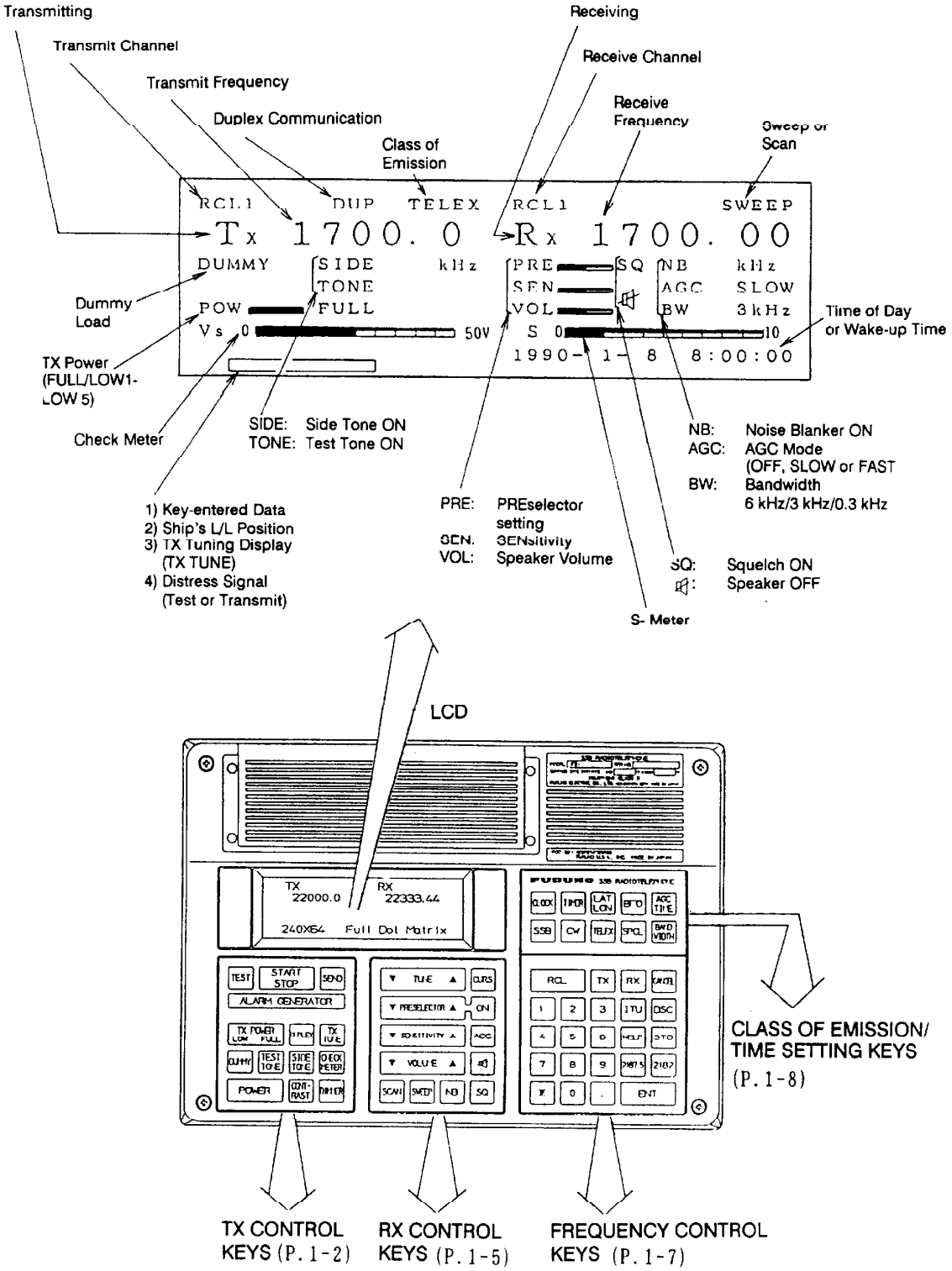


Fig. 1-1 Front Panel Controls & Indications

* * * * OPERATOR'S GUIDE * * * *

SSB RADIOTELEPHONE MODEL FS-5000/8000

USER (PRESET) CHANNEL			
Storing frequency		(Call up ITU or DSC CH.) [STO] (CH No.) [ENT] [ENT] 1 to 8999CH (Storage capacity: 400CH)	Class of emission & bandwidth are also stored.
Recalling freq.	TX/RX	[RCL] (CH No.) [ENT]	To see stored USER CH, press [RCL] [9] [9] [9] [8] [ENT] in that order.
	TX	[RCL] [TX] (CH No.) [ENT]	
	RX	[RCL] [RX] (CH No.) [ENT]	
Changing CH No. quickly		Move the cursor to "CH No.indication" by using the [CURS] key. Then, press [▼ TUNE ▲] key. (This operation is available for ITU/DSC CH as well.)	
Watching TX freq. on two-frequency communication	Watch	[RX] [ENT]	
	Cancel	[CANCEL]	
ITU/DSC CHANNEL			
Recalling (Select class of emission prior to recalling.)	TX/RX	{[ITU] [DSC]} (CH No.) [ENT]	**CH No.** DSC: 1 to 79CH ITU: (EX) Recalling of 401 CH 41, 401 or 4001
	RX	{[ITU] [DSC]} [RX] (CH No.) [ENT]	
RX FREQ SETTING FROM KEYBOARD			
		[RX] (Freq. in kHz) [ENT]	
REMARKS ON RX			
Tuning(Preselector)		[ON] [▼PRESELECTOR▲]	Effective for freq. less than 4.5MHz.
When changing RX freq. band		[TX TUNE] (Change TX freq. band to agree with RX freq. band, then press this key.)	Only when ANT BK RELAY board is not provided in the ANT COUPLER.
Normal Setting		AGC---SLOW NB----- ON	

FREQUENCY SCANNING (AGC: ON)

Starting	(Call up ITU, DSC or USER CH) SCAN	CH / Scan range • DSC/ USER: All CH • ITU: Within band selected. (EX) ① Standard---→"3" ② 5 sec.-------→"5"
Stopping	SCAN	
Changing the settings	STO SCAN ① (Set stop signal level) ENT ② (Set stop time) ENT	

FREQUENCY SWEEPING (AGC: ON)

Starting	(Set RX freq.) SWEEP	
Stopping	SWEEP	
Changing the settings	STO SWEEP ① (Set sweep width freq.) ENT ② (Set step freq.) ENT ③ (Set stop signal level) ENT ④ (Set stop time) ENT	(EX) ① 10MHz---→"10000" ② 100kHz---→"100" ③ Standard--→"3" ④ 5 sec.------→"5"

TIMER

Time setting	STO CLOCK (Y.M.D.H.M) ENT (EX) 1990-4-8 7H5M 9 0 . 4 . 8 . 7 . 5
Timer	STO TIMER (D.H.M) ENT - - - -> Switch off after timer function is turned on ("Wake up" is displayed). (EX 1) 8H5M (daily) 8 . 5 (EX 2) 9th (day), 7H3M 9 . 7 . 3

CHAPTER 1 BLOCK DESCRIPTION

1. GENERAL

As shown in the block diagram on the next page, the FS-5000 consists mainly of a Control Unit, a Transceiver Unit and an Antenna Coupler, and operates from 24/32VDC mains. For AC mains, a rectifier unit (PR-850) is required.

MIC signal amplified thru the AF board is converted to SSB signal in the EXC board. SSB signal is amplified in the PA board to produce 400Wpep output power at the transceiver unit. The signal is then fed to the COUPLER board in the antenna coupler via a 50 ohm BK relay in the TX FIL board, 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 the TX FIL board, and is fed to the RX board 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.)

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

The ship's mains of 24VDC (or 32VDC) is applied to the REG board in the transceiver unit via the INTERFACE board to produce +18V and +45V (or +44V) for the PA board.

FURUNO

CONTROL UNIT

NBDP
DSC
CIF/NMEA
HANDSET
(KEY)
AF 05P0356
SP
CPU 05P0355
LCD
KEYBOARD 05P0357

TRANSCEIVER UNIT

AF (TX), AF (RX)
TX D/RX D, POWER ON
BK
INTERFACE 05P0354
RELAY
AF (TX)
+18V
FAN
AF (RX)
60A MAIN BREAKER
24V (32V)
REG 05P0352
+45V (+44V)
REG SW 05P0398
+18V
REG CONT 05P0353
EXC 05P0349
49.5MHz
REF OSC 05P0414
+45V
PA 05P0363
+24V
PA CHECK 05P0367
M ×2
FAN
TX FIL 05P0350
TX ANT
50Ω BK RELAY
RX OUT
CPU 05P0347
49.5MHz
RX 05P0348
TUNE OK
I ANT
TUNE
TX
DUMMY

ANT COUPLER

TX/(RX) ANT.
COUPLER 05P0358
RELAY CONT.
RELAY CONT.
DUMMY LOAD 05P0360
EXTENTION CONNECTORS
TX ANT
RX ANT
ANT BK RELAY 05P0359
TX IN
ANT
RX ANT
RX 6m WHIP ANT. (*1)
JB
ARD-1 OR AJB1-1A

SHIP'S MAINS 24/32VDC
RECTIFIER UNIT
100/110/120/ 200/220/240VAC
PR-850
24VDC

(*1) WHEN DUPLEX COMMUNICATION IS REQUIRED, INSTALL JUNCTION BOX AND RX ANT. OPTIONALLY.

(*2) BROKEN LINES------OPTIONAL SUPPLY.

TX
RX

承認 APPROVED	JUN.20.'90 T.NAKANO	名称 TITLE	FS-5000 BLOCK DIAGRAM
検図 CHECKED	June 20.'90 M.IKEDA		
製図 DRAWN	JUNE 20.'90 T.SAITO	図番 DWG.NO.	E5519-B04-B

FURUNO ELECTRIC CO., LTD.

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 key-board dimmer. • Storing power data & user channel data in E^2PROM.
Transceiver Unit	EXC (05P0349)	• Power control (by ALC voltage & power data). • Conversion of TX signal from AF to RF. • Control of synthesizer circuit (PLL).
	PA (05P0363)	• Power Amplification (31dB approx.). • Detection of high temp. (≥ 80°C) & excessive col-lector current (≥24.5A), for power reduction.
	PA CHECK (05P0367)	• Indication of Ic, Vc and Vs (ship's mains).
	TX FIL (05P0350)	• 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 An-tenna Coupler. • Read-in check signals (check meter data & self check data) from each board.
	INTERFACE (05P0354)	• Starter of power supply. • Interface among three units.
	REG/REG SW/ REG CONT	• Producing +18V and +45V (or +44V).
Antenna Coupler	COUPLER (05P0358)	• Automatic tuning (by detecting SWR and antenna current).

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 and U3 on the AF board, and sent to the EXC board to produce SSB signal. If the input signal level at TP1 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 is on the EXC board. Both the ALC (Automatic Level Control) voltage picked up by the TX FIL board 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 is limited to 400Wpep.

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 used in the FS-5000 and both the "out 1" & "out 2" terminals are for the FS-8000 (800W). 14Vpp approx. is obtained at TP11.

The PA board amplifies the signal by 31dB approx. The signal from the PA board is fed to the TX FIL board, composed of filters, and is sent to the COUPLER board.

The COUPLER board has a CPU which keeps a close watch on SWR and antenna current (Ia). 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, the RF output signal bypasses the matching network.

FURUNO

1-5

CONTROL UNIT

AF (05P0356)

HANDSET — J1 (3, 4) — COMPRESSOR AMP U2 — R9 VOICE — LIMITER AMP U3 — R91 TX LEVEL — TB1 (1, 2)

OPTION: REM1 — TB3 (1, 2) — R14; REM2 — TB3 (12, 13) — R15; REM3 — TB2 (1, 2) — R16

R14, R15, R16 → ANALOG SW (SELECTOR) U5

TRANSCEIVER UNIT

INTERFACE (05P0354)

TB7 (1, 2) — J2 (1, 3) — AF TX

EXC (05P0349)

J2 (1, 3) — AF TX

2Vpp — TP1 — R6 AF LEVEL — CR1 (AF) — AF CHECK (TO CPU)

MIXER U15 — 1st Lo (SSB : 456.5kHz)

FL1 (2.4k) (455kHz) — FL2 (0.3k) — TP4

Q2 CR7~CR9 (PIN DIODE) POWER CONT. — U8 U9

MIXER U16 — 2nd Lo (54MHz) — TP14

Q4 — R8 IF GAIN

FL3 (54455kHz) — TP6

A1A, H3E, R3E — R13, R14, R15 — U14 ANALOG SW

SHIFT REGISTER U1 to U3

MIXER CR19 — TP7 — 3rd Lo (SSB : f+54456.5kHz)

100mVpp — LPF — TP8 — HPF

LPF & BPF — ~6M, 6M~, 13.5M~, 21.5M~ — TP9

Q7 to Q9

T9 POWER DIVIDER — (OUT2) — RF CHECK (TO CPU) — CR6 (RF)

TP11 — 14Vpp — J5 (OUT1)

TO "SYN" SECTION — J4 — TX REF (49.5MHz)

REF OSC (05P0414) — 49.5MHz — Q1 OSC1 — Y1 — +12V — S1 — Y2 — OSC2 Q7 — Q4 — Q3 — TP3 — TP1 — J3

J1 (5, 2) — ALC VOLTAGE — POWER DATA

J6 (5, 2) — J5 (5) — CPU (05P0347)

ALC

TX FIL (05P0350) — J4 (5) — U3 PEAK HOLD — SWR DET — J2 (TX ANT)

J1 (TX IN) — LPF ~2.4M, ~3.6M, ~5.4M, ~8.0M, ~12.0M, ~18.0M, ~30M

PA (05P0363) — J3 (RF IN) — Q1 to Q6

COUPLER (05P0358) — TB1 — SWR DET — MATCHING NETWORK — Ia DET — J1 (1, 2)

U9 to U11 — RELAY CONTROL

U2 to U4 — CONTROLLER (CPU/ROM/RAM)

DUMMY LOAD (05P0360) — J1 (1, 2)

ANT BK RELAY (05P0359) — J1 (1, 2) — TB1 — RX

TX ANT

OPTION

ANTENNA COUPLER

FS-5000

承認 APPROVED	JUN·20·'90 T.NAKANO	名称 TITLE	BLOCK DIAGRAM OF TRANSMITTER
検図 CHECKED	June·20·'90 M.IKEDA		
製図 DRAWN	JUNE·20·'90 T.SAITO	図番 DWG.NO.	E5519-B05-B

FURUNO ELECTRIC CO., LTD.

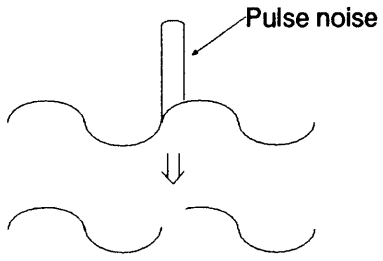
4. RX SIGNAL

Refer to the block diagram on page 1-8. Unless a speciality receiving antenna or "Antenna BK Relay" 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. If the ANT BK RELAY board or the receiving antenna is installed, the RF signal is directly applied to the RX board (in this case, signal is not attenuated by the matching network).

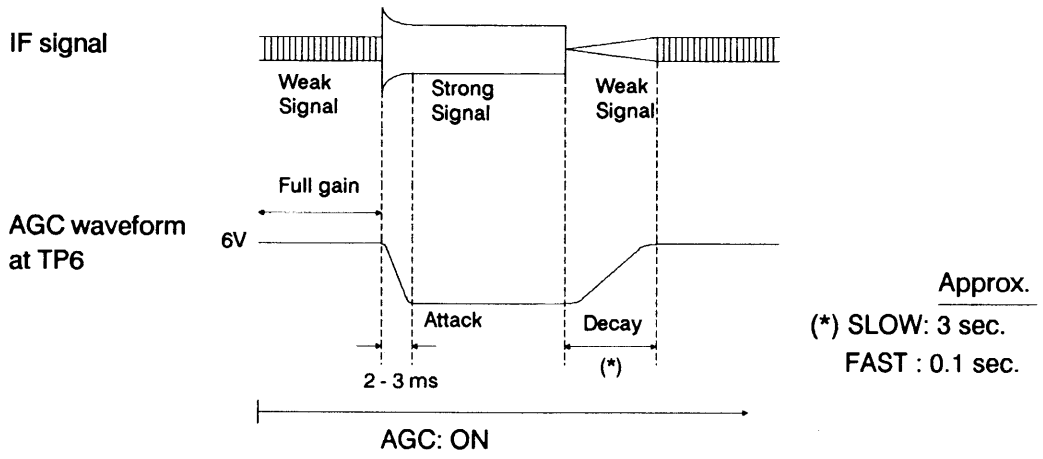
Relay K13 turns on if the [ON] key is pressed when the frequency is below 4.5MHz. When K13 turns on, the coils which form a preselector circuit are relay-controlled to tune the receiver to the antenna (for cancellation of capacitance components of antenna).

When the receiving frequency is higher than 4.5MHz, the RF signal passes through the protector (limiter) to cut off the signal more than 14Vpp, 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/CR32 turns off during "pulse" 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). 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 which detects signal strength for the S meter. The voltage at pin #5 of U9 is adjusted for 6V approx. by R142 (S METER) at the factory.



The IF signal is mixed with the 3rd local oscillator frequency to convert it to the AF signal. The AF signal 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.

TX/RX ANT

RX ANT

ANT COUPLER

COUPLER

MATCHING NETWORK

J1 1 2 TB1

(05P0358)

(OPTION)

ANT BK RELAY (05P0359)

J2 For Tx 1 2 TB1

TRANSCEIVER UNIT

TX FIL (05P0350)

K15 (50 OHM BK)

J2 For Tx

(RX OUT) J3

REF OSC (05P0414)

49.5MHz Q1 OSC1 Y1 +12V S1 OSC2 Q7 Y2

Q4 Q3 TP3 TP1 J4 J3

RX REF (49.5MHz)

J2 TO "SYN" SECTION

J1 (ANT)

PRESELECTOR PROTECTOR

K13 PROTECTOR 30MHz K23

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

K14 TP9 RF AMP Q4 MIXER Q5/Q6 TP1 R42 BAL Q7 1st Lo (SSB : f+45456.5kHz)

FL1 (45455kHz) IF AMP Q8 TP2 (1.5V) MIXER Q9/Q10 Q11 R70 NB 2Lo GAIN 2nd Lo (45MHz)

CR31/CR32 NB GATE U3 NB DET TP10 R76 NB LEVEL

RX (05P0348)

AGC

SSB (2.4k) NARROW (0.3k) WIDE (6k) (455kHz)

U4 IF AMP R92 IF GAIN FL5 (455kHz) Q15 AGC AMP R126 AGC GAIN CR43/CR44 DET. U10/Q17 AGC CONT. U8 TP6 AGC

U11 5V LADDER AGC (ON/OFF SLOW/FAST) SENS. FROM CPU SHIFT REG. NB U12 to U7

U9 TO CPU S METER 15V R142 S METER

MIXER U6 TP5 AF AMP U7/U22 J4 AF RX

AM ONLY U5 TP3 2V EXCEPT AM 3rd Lo (SSB : 456.5kHz)

INTERFACE (05P0354) J1 TB7

CONTROL UNIT

AF (05P0356) TB1 AF AMP U20 U21 SQ CONT. U19 SQ U22 VOLUME CONT. U18 VOL. AF AMP U17 SHIFT REG. U6 to U8 FROM CPU J7 J3 EXT SP

CPU (05P0355) J1 J6 SP

TB3 R44 U16 REM1 R45 U16 REM2 R46 U23 REM3 TB2

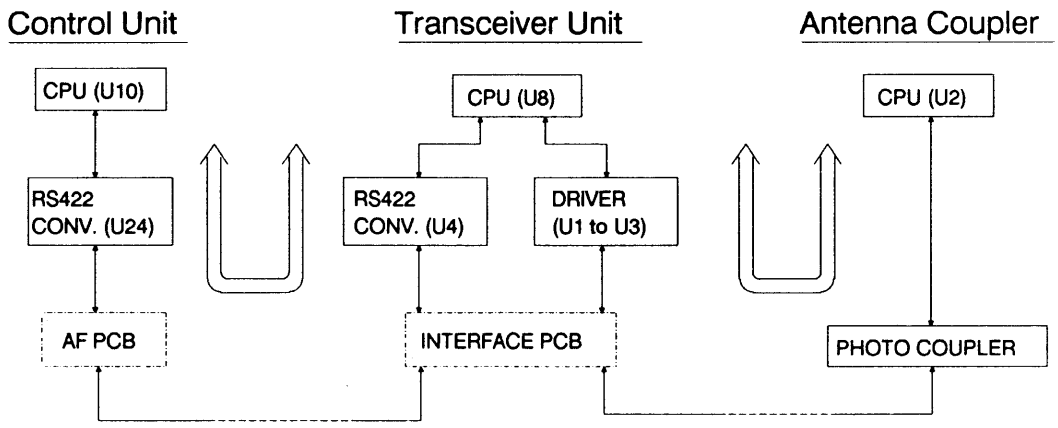
FS-5000

承認 APPROVED	JUN. 20. '90 T.NAKAUC	名称 TITLE	BLOCK DIAGRAM OF RECEIVER
検図 CHECKED	June 20 '90 M. IKEDA		
製図 DRAWN	JUNE. 20. '90 T. SAITO	図番 DWG. NO.	E5519-B06-B

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/Output of CIF/NMEA data & 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 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.

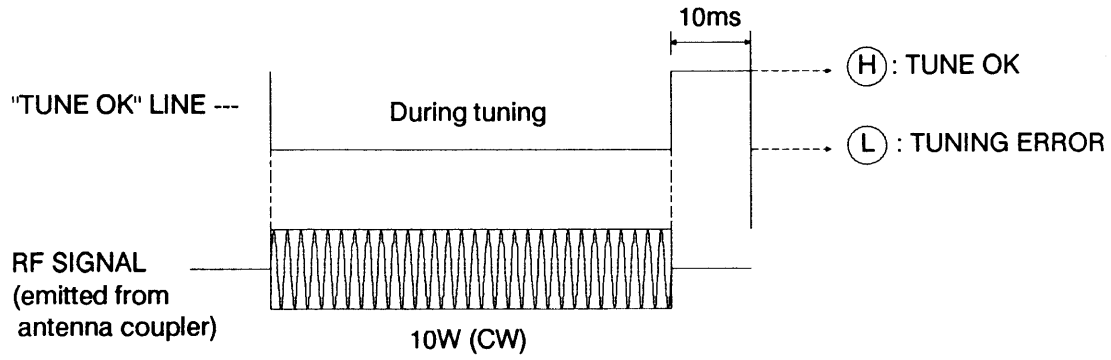
5.3 CPU Board in the Transceiver Unit

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

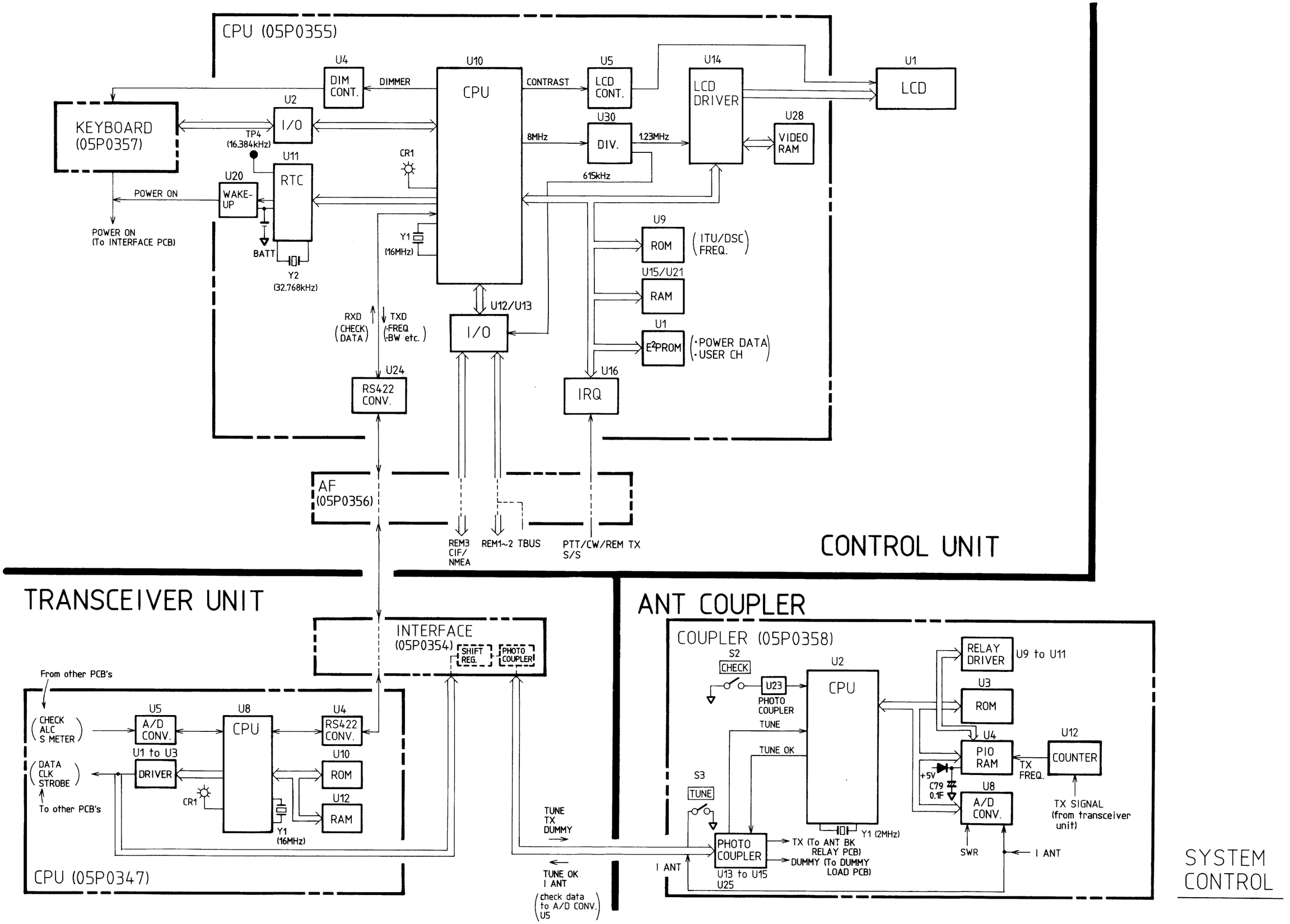
When the CPU (U2) in the Antenna Coupler acknowledges the "TUNE" command from the transceiver unit, it begins driving the relays whose function is to select the components of the matching network for best tuning by checking the SWR and antenna current. For instance, the relays are activated so that the 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 U12 and fed to RAM U4 as a address data for automatic tuning. For details of the automatic tuning circuit, refer to page 1-12. The contents of the RAM are preserved for approximately one week by the charge in C79 (0.1F).



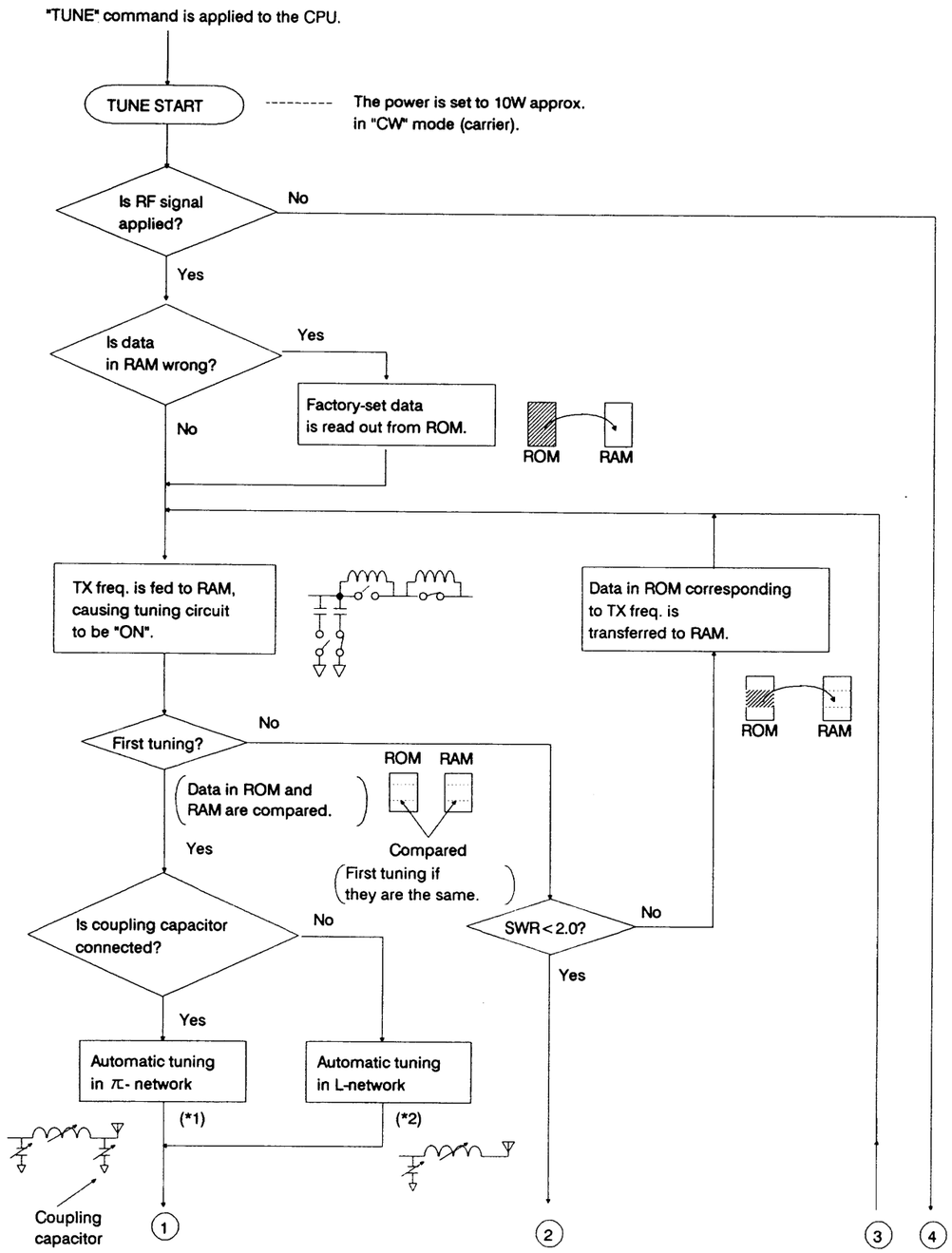
For automatic tuning without keyboard operation press the [TUNE] button (S3) on the COUPLER board.

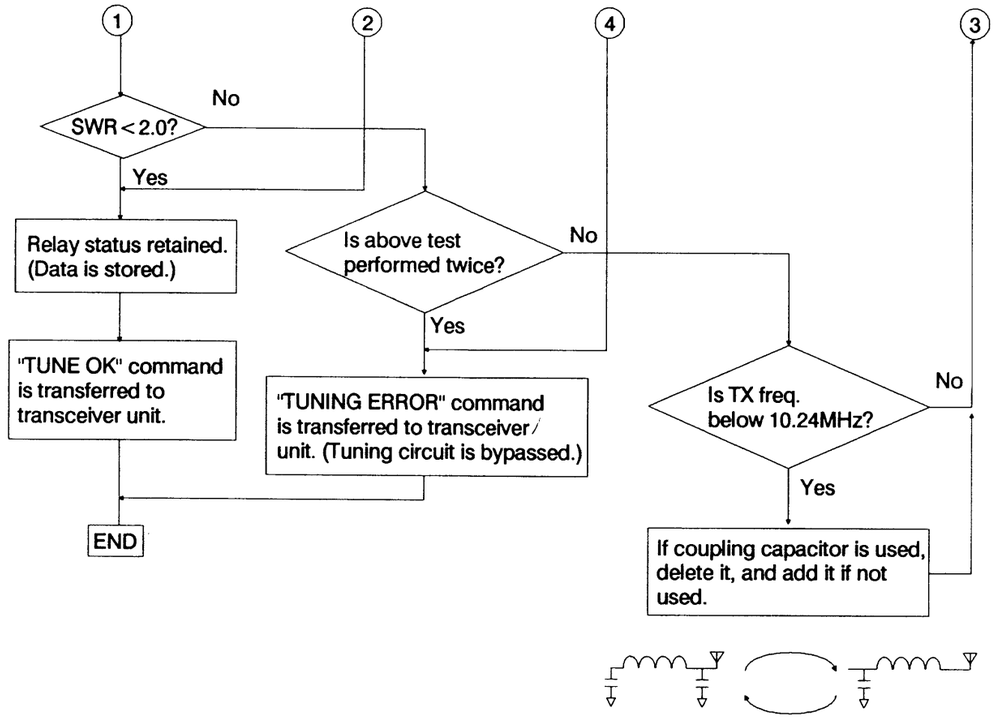
To check the Antenna Coupler for proper operation, press the [CHECK] button (S2) on the COUPLER board. The relays start chattering and LEDs CR37 to CR57 blink one by one in ascending order. If device failure is found, an appropriate LED lights to indicate the offending device:

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

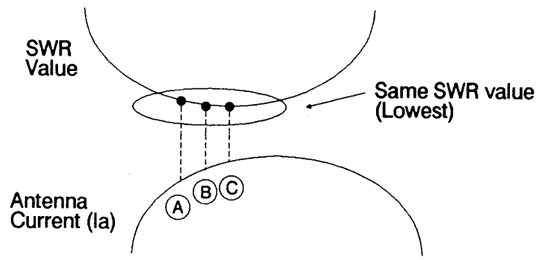

CPU (05P0355)
U4
DIM CONT.
DIMMER
U10
CPU
CONTRAST
U5
LCD CONT.
U14
LCD DRIVER
U1
LCD
KEYBOARD (05P0357)
U2
I/O
TP4 (16.384kHz)
U30
DIV.
8MHz
1.23MHz
U28
VIDEO RAM
CR1
615kHz
U11
RTC
U20
WAKE-UP
POWER ON
POWER ON (To INTERFACE PCB)
BATT
Y2 (32.768kHz)
Y1 (16MHz)
U9
ROM
ITU/DSC FREQ.
U15/U21
RAM
U12/U13
I/O
U1
E²PROM
·POWER DATA
·USER CH
RXD (CHECK DATA)
TXD (·FREQ ·BW etc.)
U24
RS422 CONV.
U16
IRQ
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
U5
A/D CONV.
U8
CPU
U4
RS422 CONV.
DATA CLK STROBE
To other PCB's
U1 to U3
DRIVER
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)
S2
CHECK
U23
PHOTO COUPLER
U2
CPU
TUNE
TUNE OK
RELAY DRIVER
U9 to U11
U3
ROM
U4
PIO RAM
U12
COUNTER
TX FREQ.
+5V
C79 0.1F
U8
A/D CONV.
TX SIGNAL (from transceiver unit)
S3
TUNE
PHOTO COUPLER
U13 to U15
U25
Y1 (2MHz)
TX (To ANT BK RELAY PCB)
DUMMY (To DUMMY LOAD PCB)
I ANT
SWR
I ANT
SYSTEM CONTROL

6. AUTOMATIC TUNING CIRCUIT





(*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.

7. AUTOMATIC POWER REDUCTION

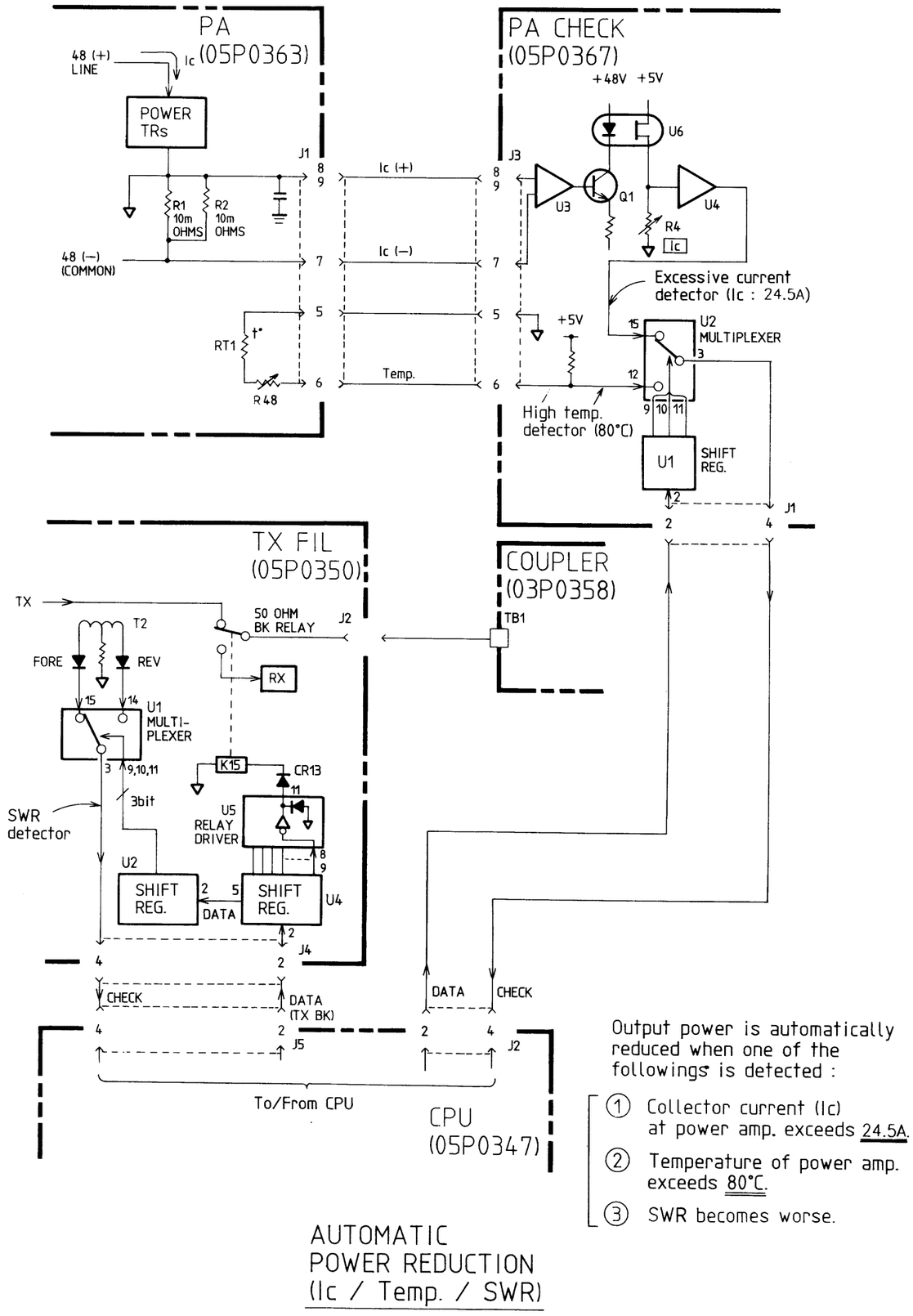
Power is automatically reduced in the following instances:

1. Excessive collector current (≥ 24.5A)
2. High temperature at power amplifiers (≥ 80 °C)
3. High SWR value

1. The collector current (Ic) detected by R1/R2 on the PA board is amplified in U3 and passed through the multiplexer (U2) on the PA CHECK board, 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 detects the temperature of the power amplifiers. When the temperature exceeds 80°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 p 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.



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.

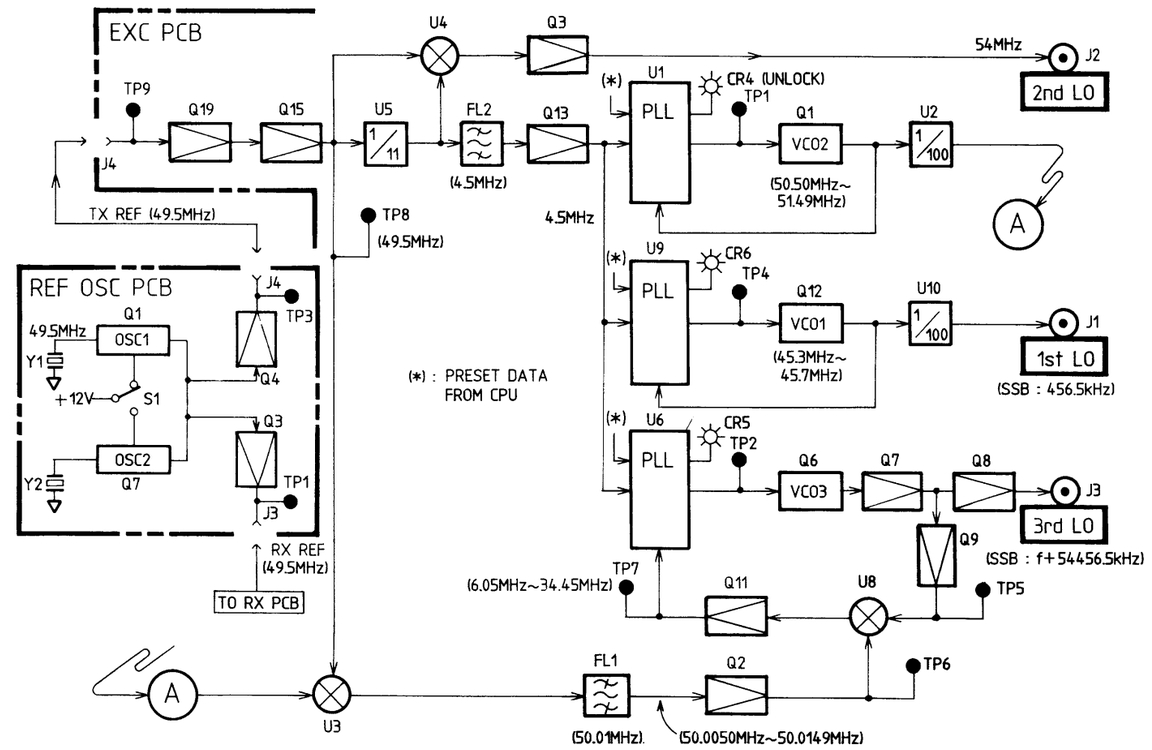
8.1 TX Synthesizer (EXC board)

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



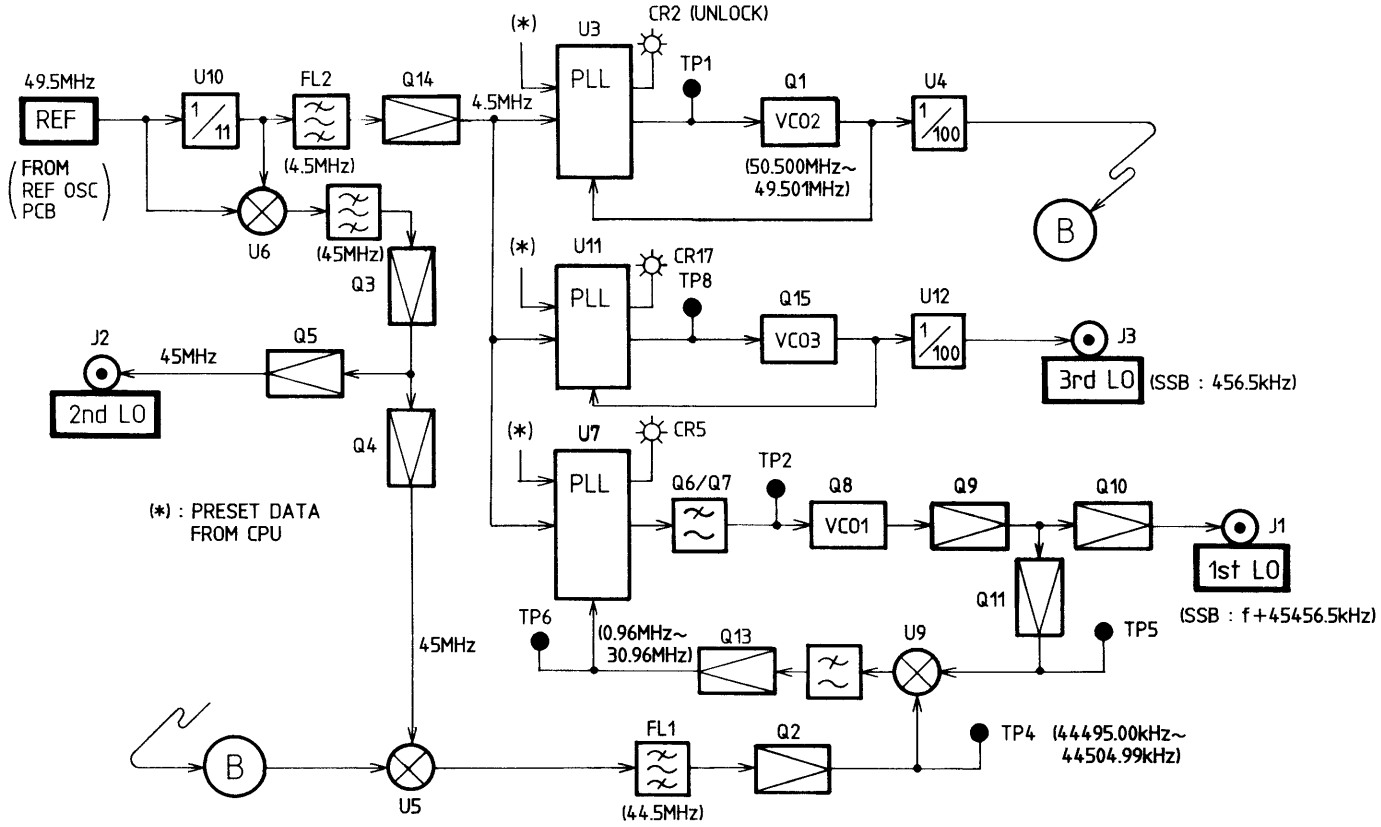
TX SYNTHESIZER (EXC & REF OSC PCBs)

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)

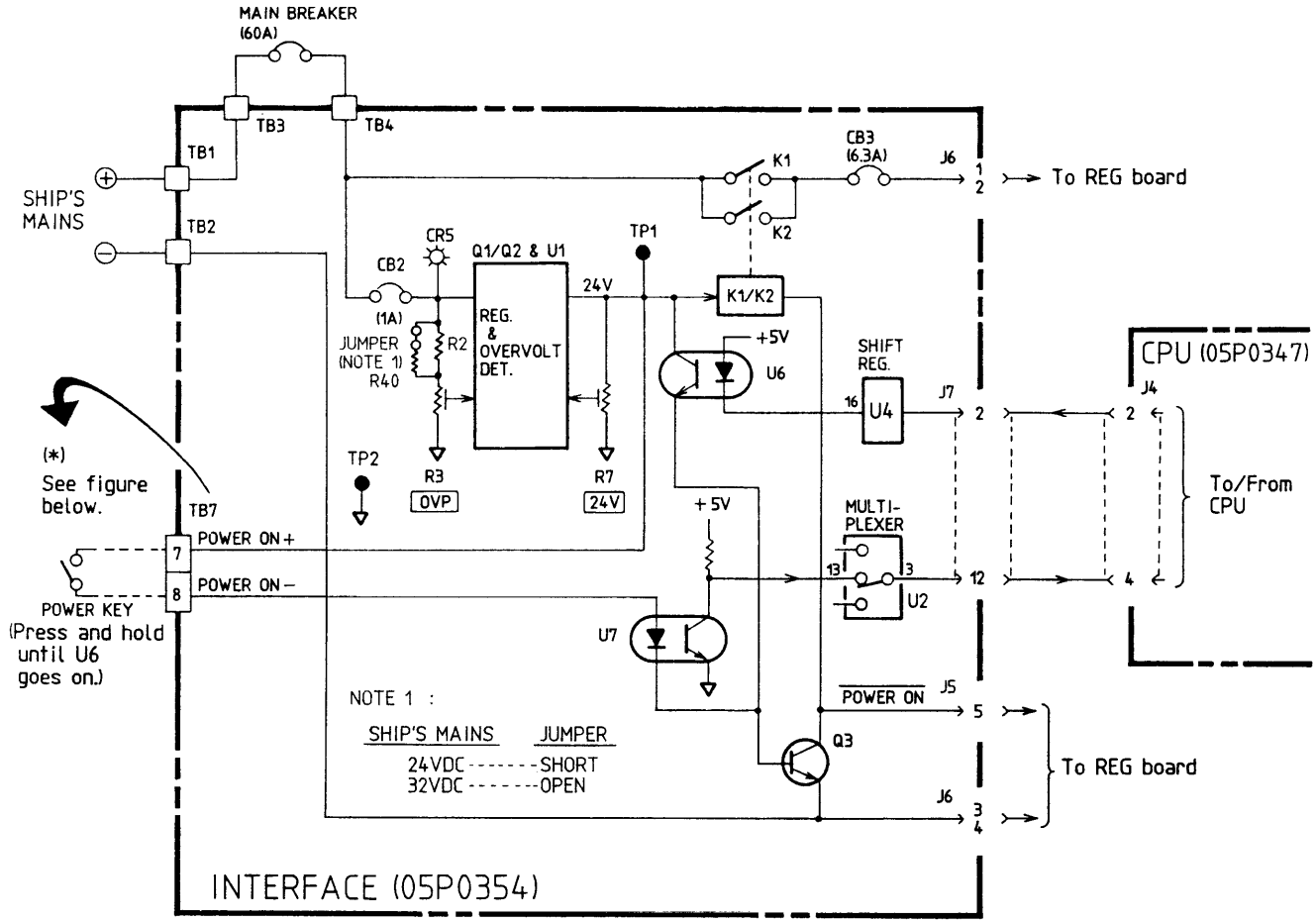
9. POWER SUPPLY

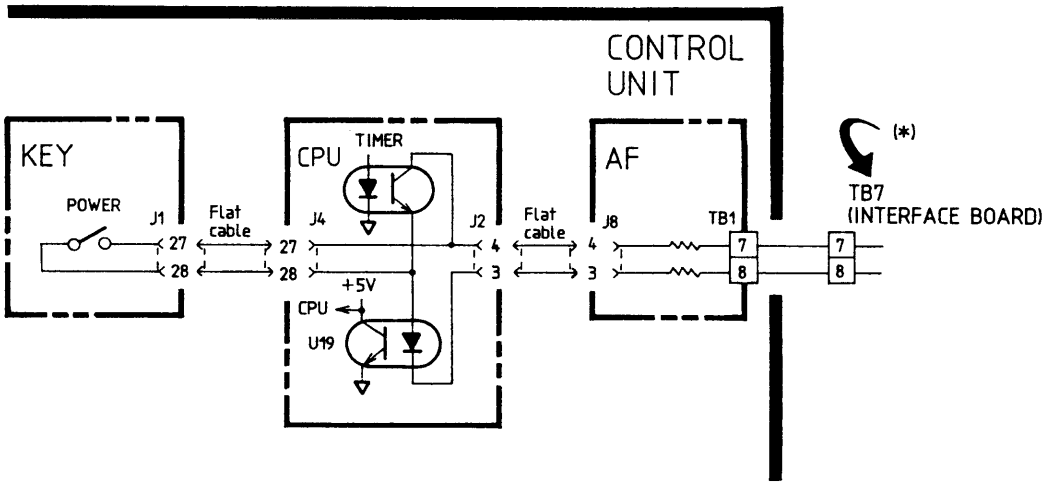
9.1 Starter Circuit

The starter circuit is on the INTERFACE board. 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 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.

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. R3 and R7 are for adjustment of overvoltage protection and 24V output, respectively.

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

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 check circuit ("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. + 18V is obtained at TP1 on the REG board.

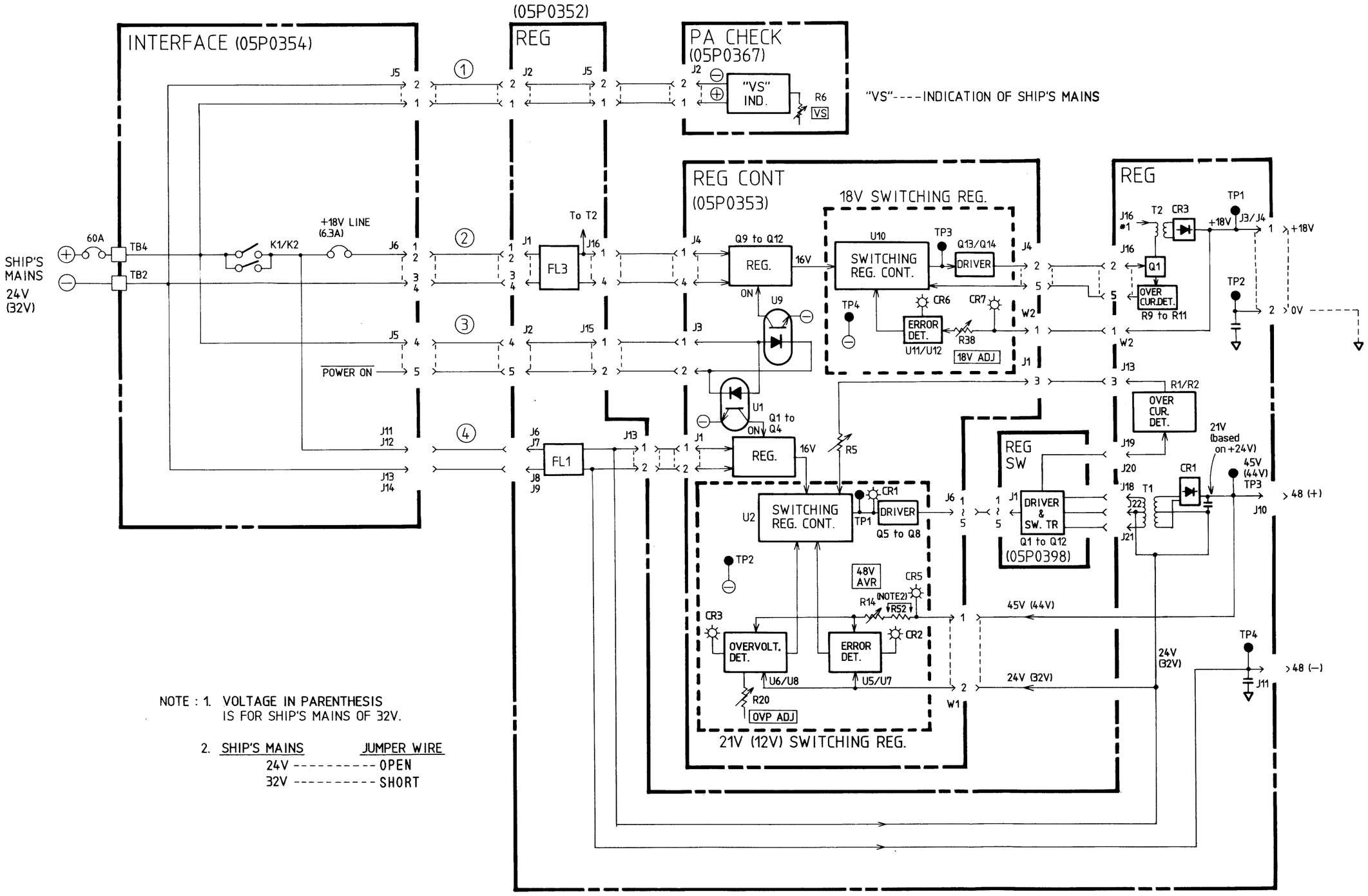
R38 is for adjustment of + 18V. CR7 lights when + 18V is correctly produced.

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.

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 pages AP1-1 to AP1-3.



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)

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 AF board, the other sent to the EXC board.

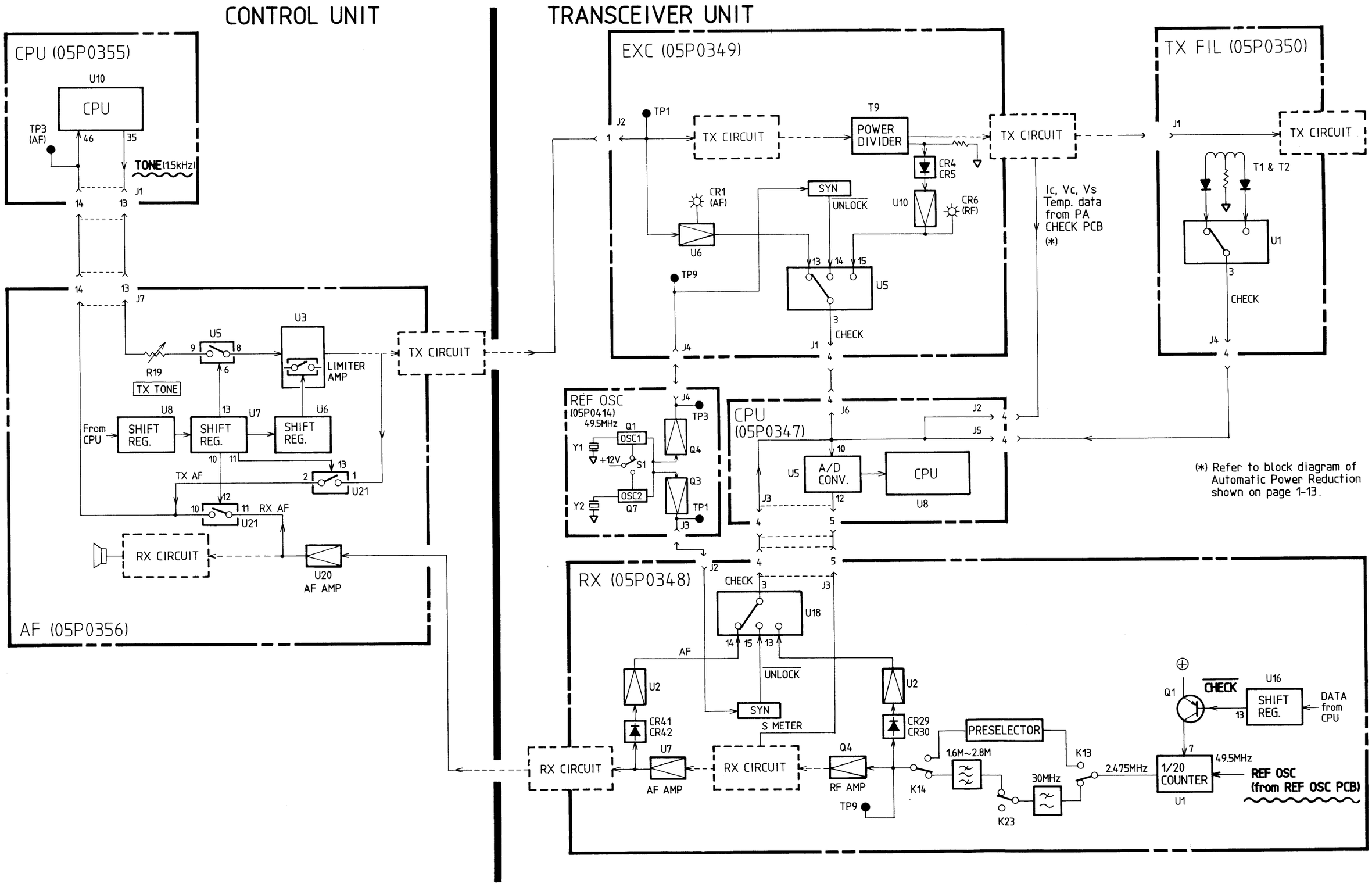
If the test signal level at the input of U6 on the EXC board is more than -36dBm, CR1 lights (MIC input test) and the signal is fed to the multiplexer (U5) which selects each test signal of MIC input/output and local oscillator. If the output signal of T9 is sufficient in level, CR6 lights (MIC output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



SELF CHECK SIGNAL FLOW

CHAPTER 4 PARTS LOCATION

1. CONTROL UNIT

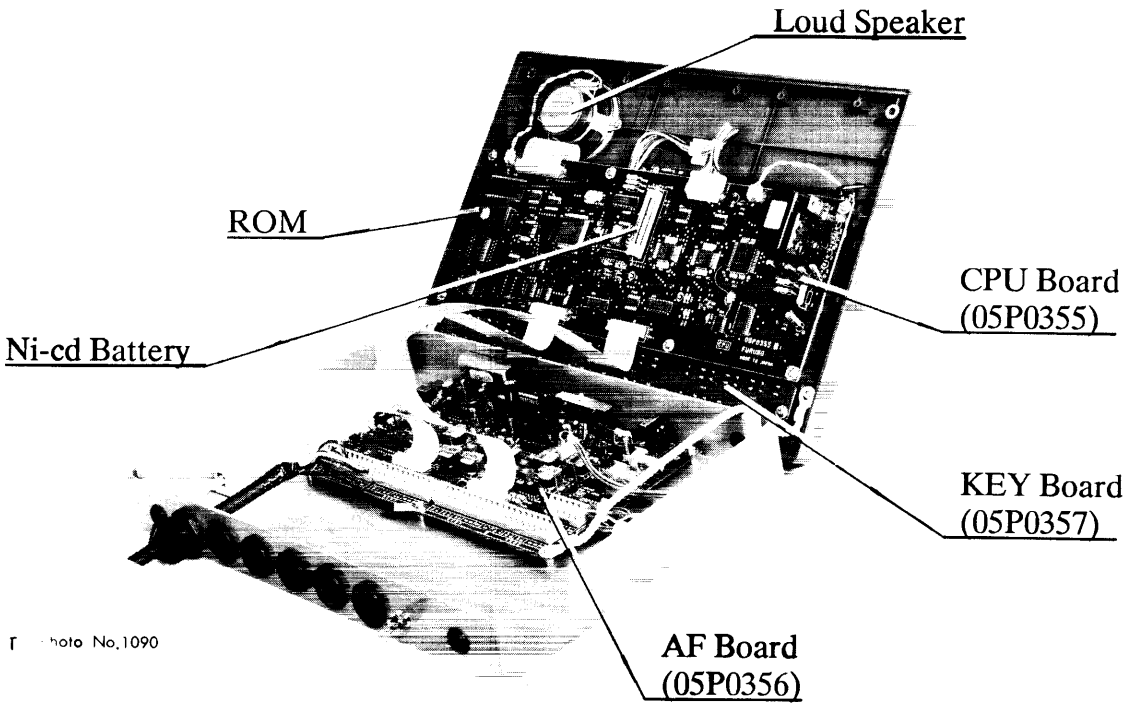


Fig. 4-1

2. TRANSCEIVER UNIT

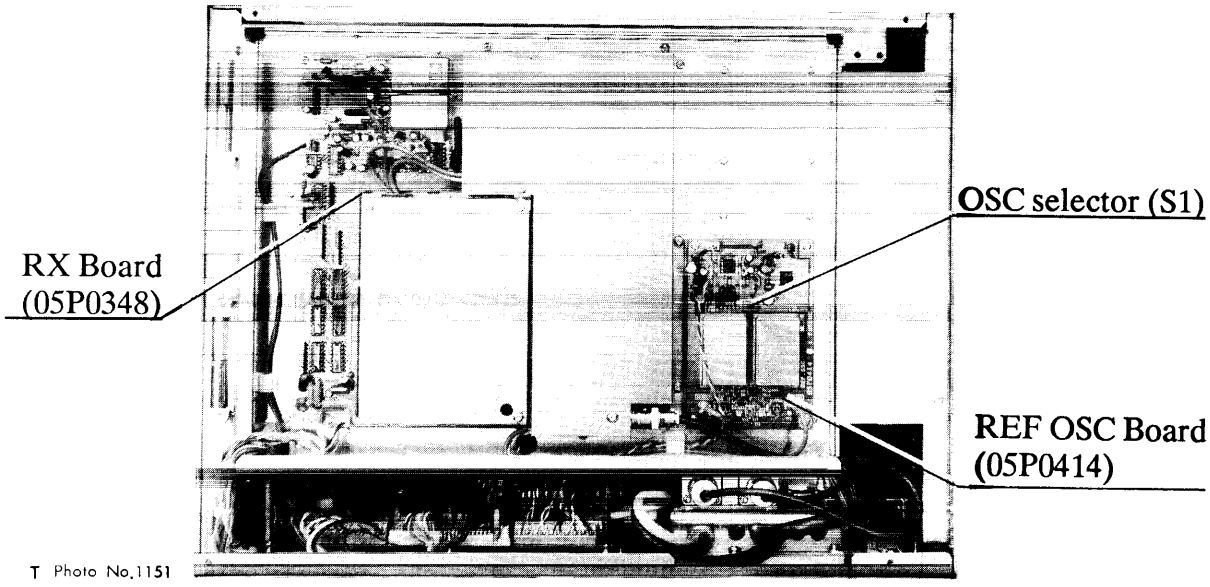
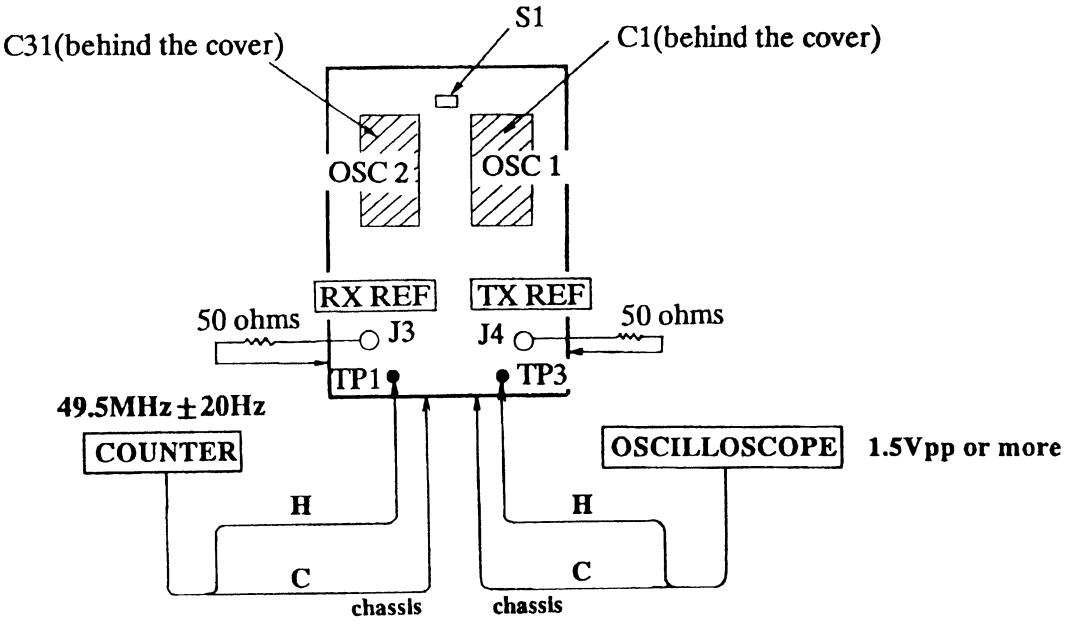


Fig. 4-2

REF OSC Frequency & Level (REF OSC PCB)



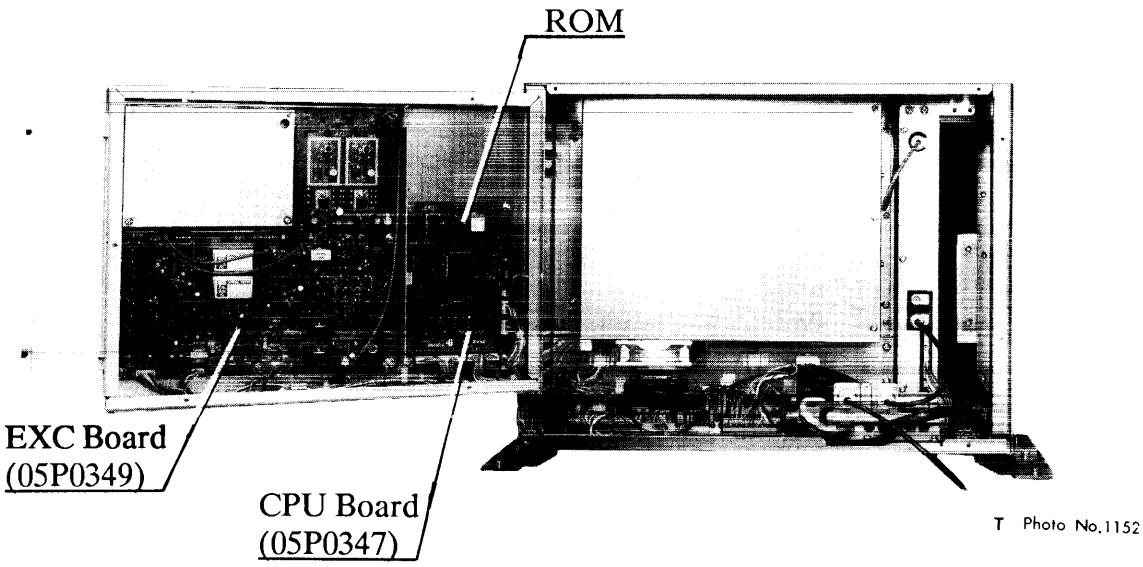

ROM
EXC Board
(05P0349)
CPU Board
(05P0347)
T Photo No.1152

Fig. 4-3

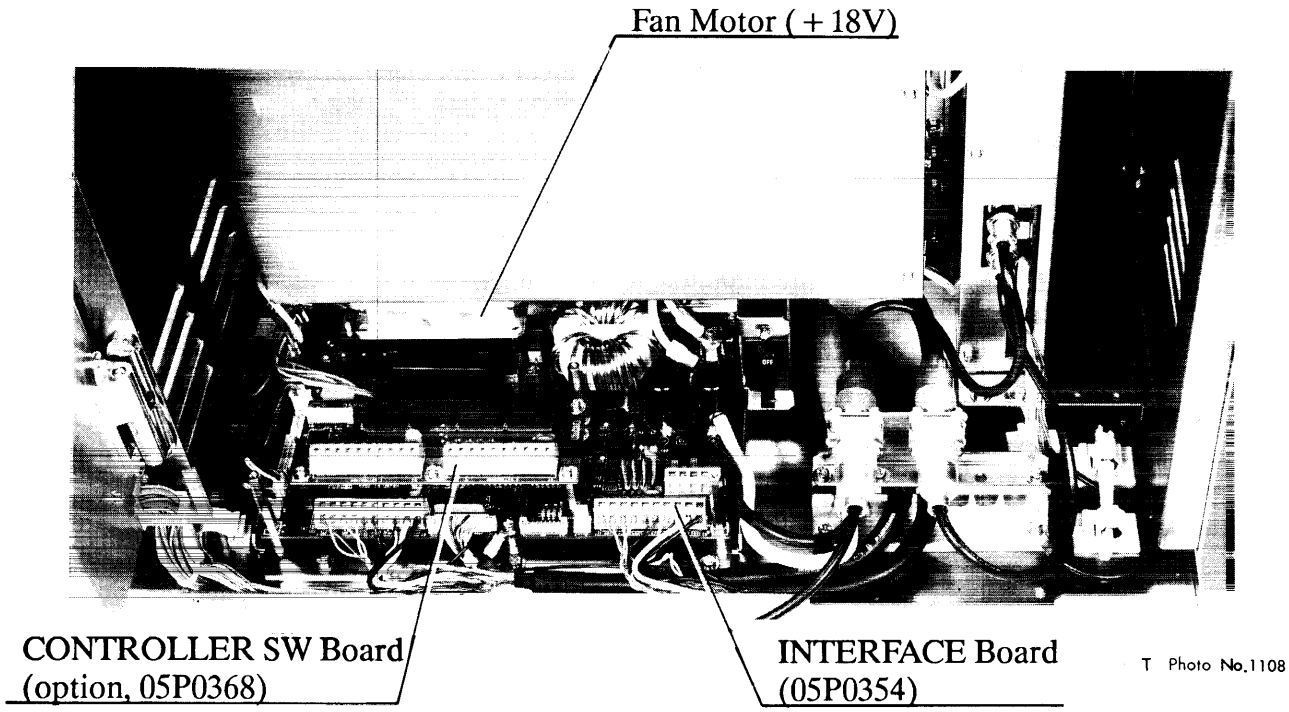

Fan Motor (+ 18V)
CONTROLLER SW Board
(option, 05P0368)
INTERFACE Board
(05P0354)
T Photo No.1108

Fig. 4-4

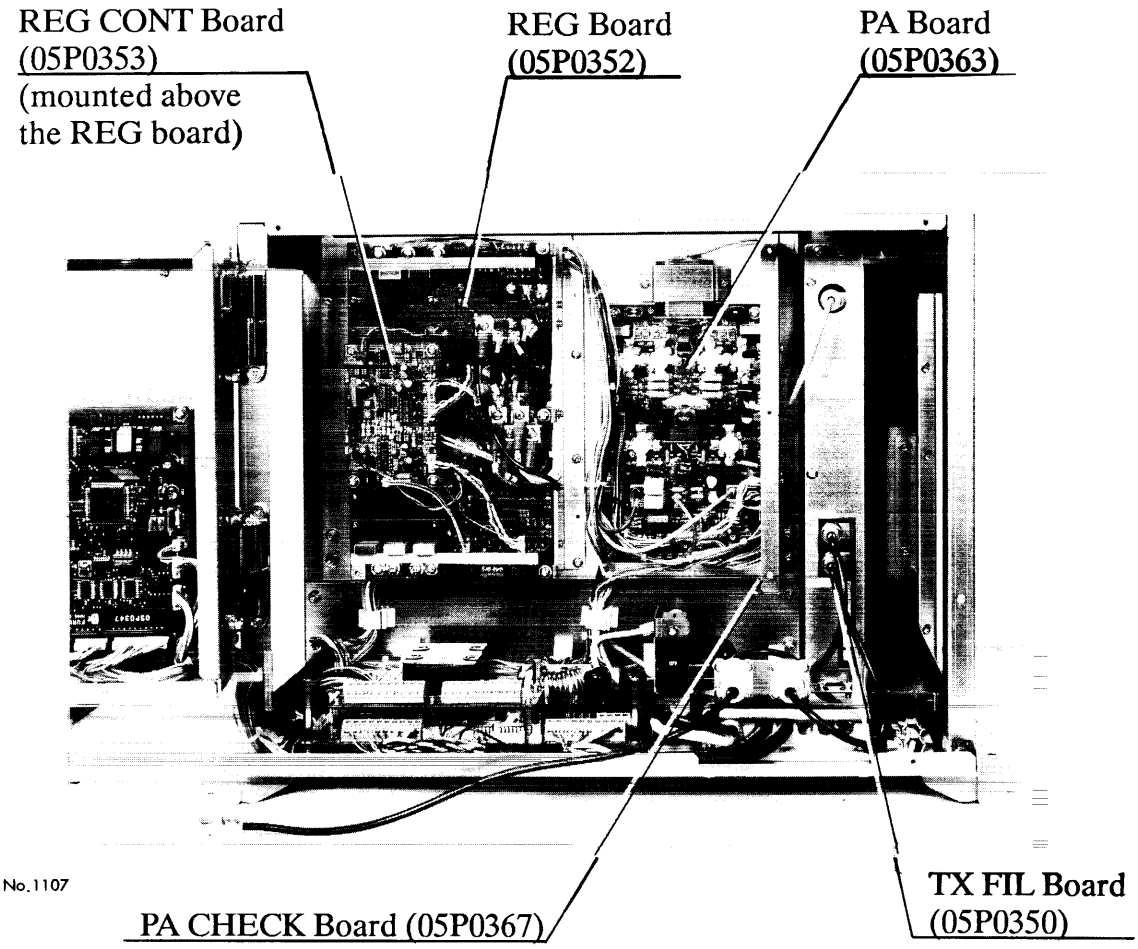

REG CONT Board
(05P0353)
(mounted above
the REG board)
REG Board
(05P0352)
PA Board
(05P0363)
T Photo No.1107
PA CHECK Board (05P0367)
TX FIL Board
(05P0350)

Fig. 4-5

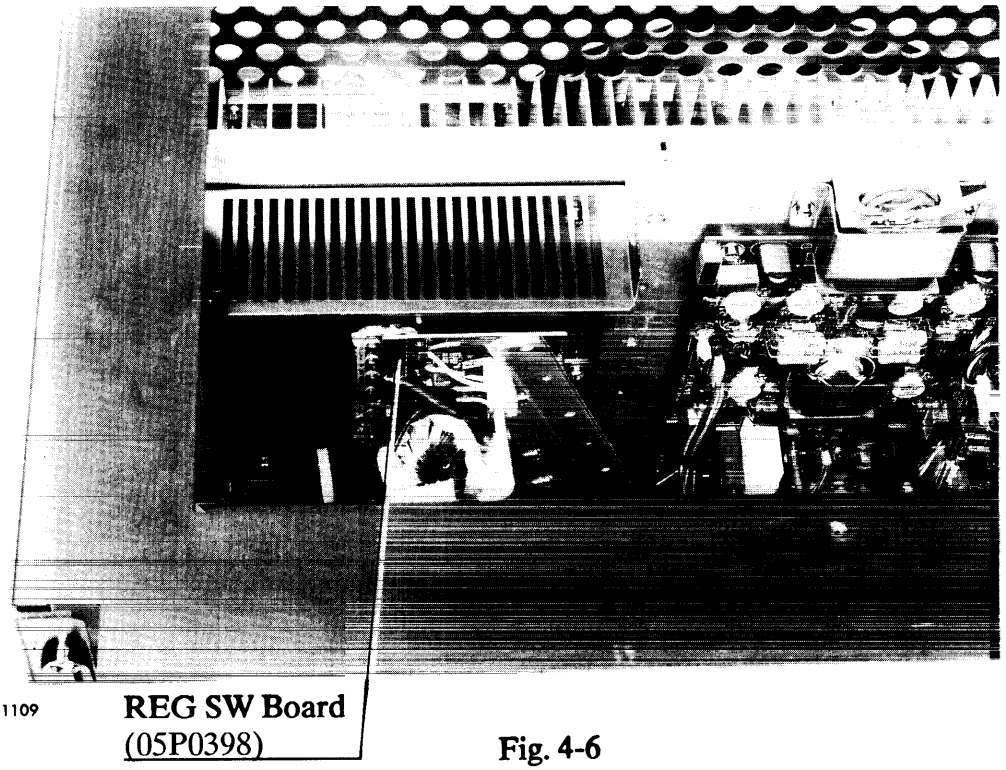

T Photo No.1109
REG SW Board
(05P0398)

Fig. 4-6

3. ANTENNA COUPLER

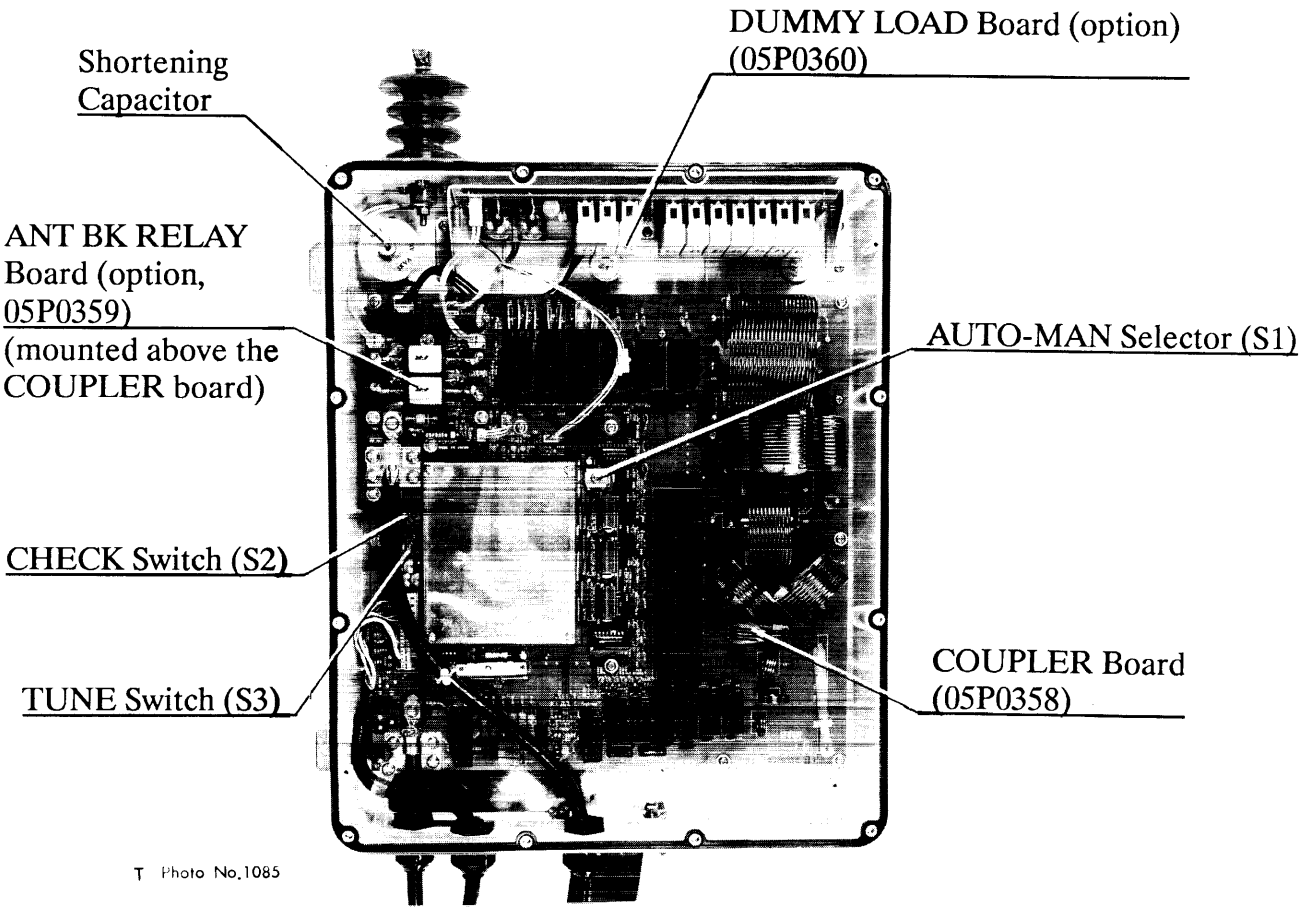


Fig. 4-7 Front cover removed

4. RECTIFIER UNIT (OPTION)

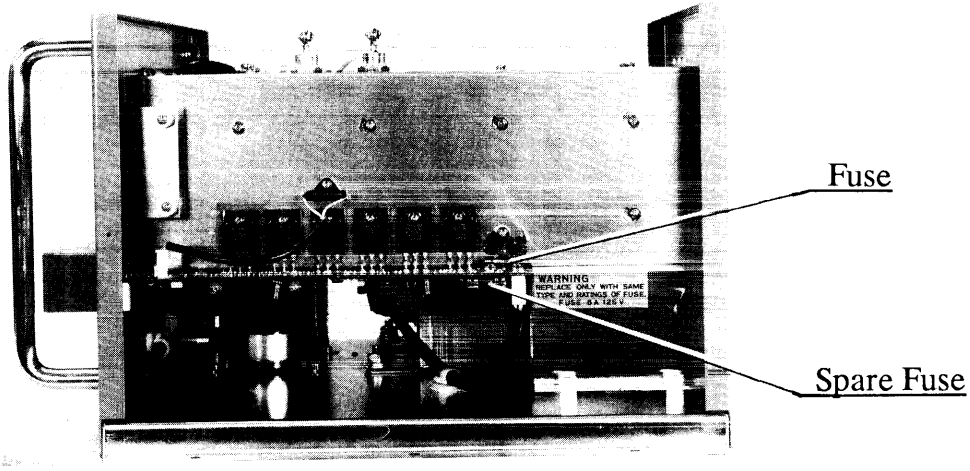


Fig. 4-8 Cover removed

DUMMY LOAD & ANTENNA BK RELAY

If the dummy load and antenna BK relay are to be installed together the wiring required is different than for separate installation.

Connect the Coupler Board, Antenna BK Relay Board and Dummy Load Board as shown in Fig. 4-5.

Parts

Name	Type	Code No.
Dummy Load	OP05-34-H	000-056-876
Antenna BK Relay	OP05-35-H	000-056-878
Coaxial Cable	RG-8A/U or equivalent (max. length 50 m)	

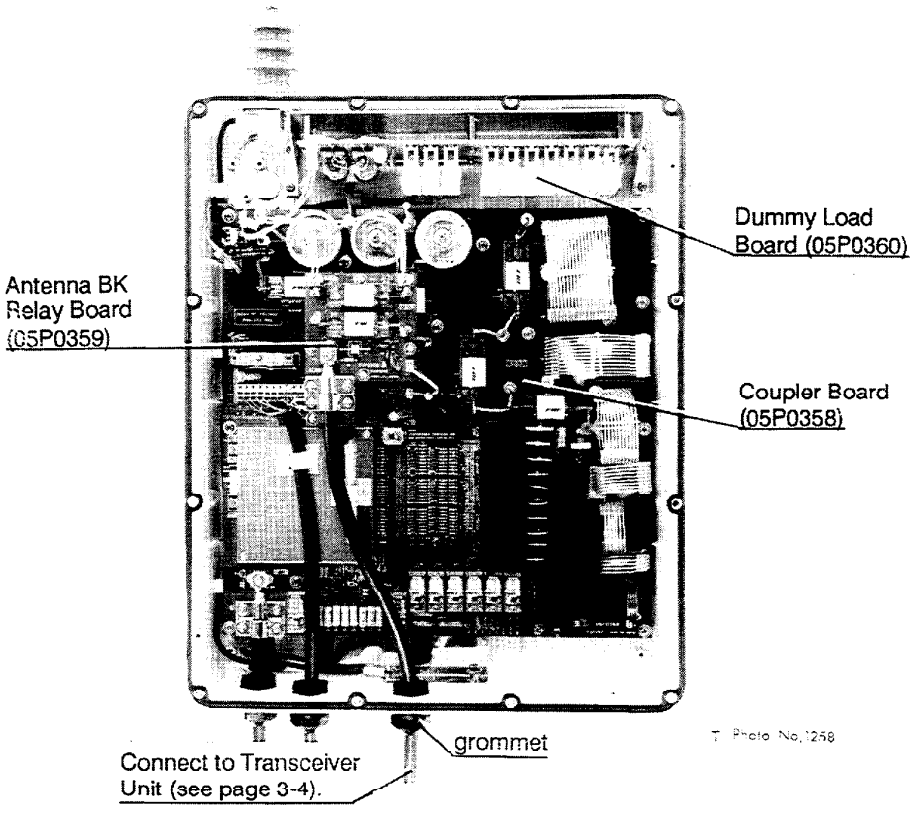


Fig. 4-5 Antenna Coupler, Inside View

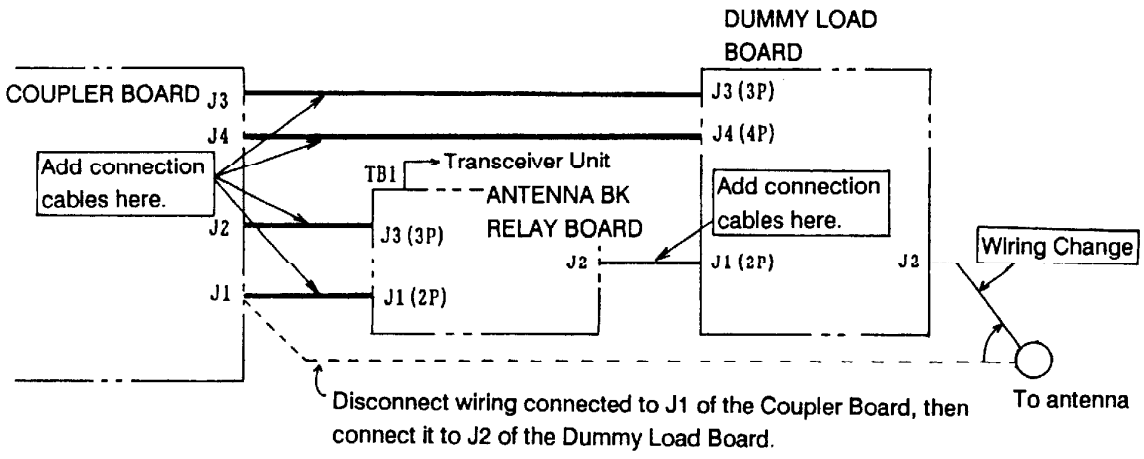
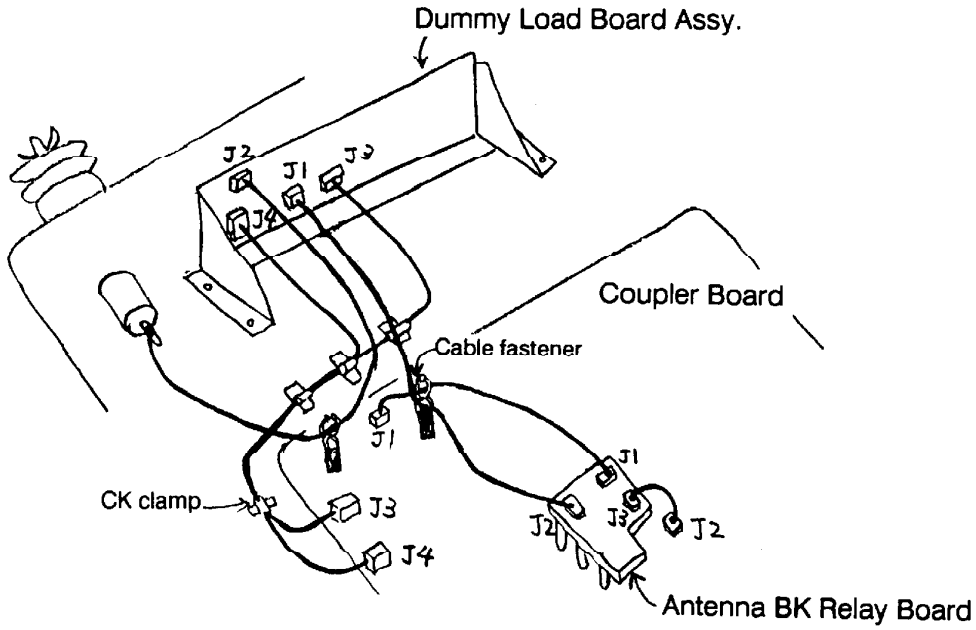


Fig. 4-6 Wiring for Installation of BK and Dummy Load

Note 1. To prevent leaks on the high voltage, separate each cable as far as possible by passing each through CK clamps and Cable fasteners as shown below.



Note 2. Change the specifications referring to page 1-17 (STO 9923).

SELF TESTS

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 pages 2-11 and 2-12.

To escape from a self test at any time, press any key after the test is completed.

Table 2-2 Self Tests

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 Board SWR detection on TX FIL 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

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

Note1: ROM/RAM/A/D converter are incorporated in the CPU.

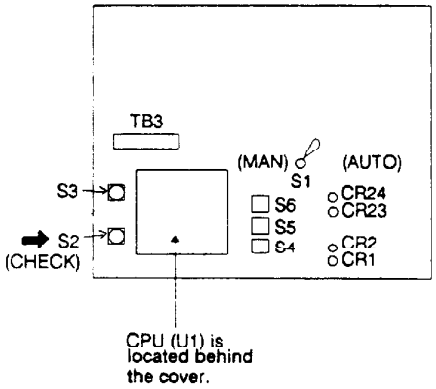


Fig. 2-2 CHECK Button on the Coupler Board

TROUBLESHOOTING

Table 2-3 Troubleshooting Guide

Symptom	Cause	Remedy
Cannot turn set on.	1. Breaker in Transceiver Unit has tripped (refer to Fig. 2-1). 2. Input voltage out of rating (24/32 VDC, +30%, -10%), or poor connection. 3. Forinstallations which use an AC Rectifier, confirm that the rectifier is on and there is no blown fuse (refer to Fig. 2-4). 4. The following breakers may have tripped: CB2 to CB4 on the Interface Board of the Transceiver Unit (refer to Fig. 2-3) CB1 on the AF Board of the Control Unit (refer to Fig. 2-5)	1. Turn the breaker on. 2. Measure input voltage at TB1 (+)/TB2 (-) on the Transceiver Unit. If low, check for discharged battery. 3. Reset breaker. Replace fuse. If the fuse blows after replacement, call for service. 4. Reset breakers. If they trip again, call for service.
Power is on but no noise from speaker.	1. Speaker is turned off. (🔇 appears when the speaker is off.) 2. Sensitivity is too low.	1. Press the 🔇 key to turn the speaker on. 2. Adjust sensitivity with the **SENSITIVITY** key.

Symptom	Cause	Remedy
Cannot receive SSB signal clearly.	1. Wrong class of emission 2. Frequency is off.	1. Select correct class of emission. 2. Tune with the **TUNE** key.
Cannot store user channel.	1. Memory is full (storage capacity: 1-8999, 100 channels max.).	
Time is wrong.	1. Backup battery on CPU Board (refer to Fig. 2-5) of the Control Unit has released its contents. (This occurs if the power is off for about one week.)	1. Reset the clock. (Press the **STO** and **CLOCK** keys to call up the time setting screen).
No scan receiving	1. Have not designated memory stored channels (ITU, DSC, or user) to be scanned.	1. Designate the channels to be scanned.
In scan receiving, cannot capture signal.	1. AGC is off. 2. Scan stop signal level setting is too high.	1. Turn AGC on. 2. Lower the setting. (Press the **STO** and **SCAN** keys to call up the scan parameter setting screen).
No sweep receiving, or cannot capture signal.	1. AGC is off. 2. Unsuitable sweep settings. Sweep width 100 = 100 kHz intervals Step 10 = 10 kHz intervals Stop signal level If too high cannot capture signal.	1. Turn the AGC circuit on. 2. Reenter settings. (Press **STO** and **SWEEP** keys to call up the sweep parameter setting screen).
No automatic antenna tuning.	1. Antenna is broken or damaged. 2. Bad connection between Antenna Coupler and Transceiver Unit. 3. AUTO/MAN 2182 switch (S1) inside the Antenna Coupler is set to MAN 2182 (refer to Fig. 2-6). 4. Breaker CB1 in the Antenna Coupler has tripped.	1. Check antenna connections and then check antenna itself. 2. Check connections. 3. Set to AUTO. 4. Reset breaker. If the breaker trips again, call for service.

Symptom	Cause	Remedy
L/L position does not appear when **LAT LON** key is pressed.	1. CIF/NMEA format data not input from external navigation device.	1. Check connection between navigation device and Control Unit. If normal, check navigation device for proper operation.
	2. Wrong setting of input data format.	2. Set correctly. (Refer to page 5-4.)

APPENDIX 2
SYSTEM SETTINGS & POWER ADJUSTMENT

(ROM Version No. 06)

(Including modification of DUMMY LOAD PCB for adding shortening capacitor)

IMPORTANT:

After installation, if necessary, change system settings and adjust output power.

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

Note: The setting in the tables 1 and 2 are applicable to the two ROMs having version No. 06.

Table-1 Changeable Specifications

Shading shows factory setting.

Channel No.	Function	Setting No.			
		0	1	2	3
9900	Model (*1)	FS-5000	FS-2500	FS-1600	FS-8000
9901	TX freq. selection (*2)	Free (USA)	Limited (Other than USA)	ROM	–
9903	Output power of transceiver unit on MF band (adjustable)	400 (Other than USA)	150 (USA)	50	–
9904	Class of emission on 2182kHz	AM	SSB (USA)	–	–
9905	TX TUNE (**TX TUNE** key)	Enable	Disable	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.)			

Continued

Channel No.	Function	Setting No.			
		0	1	2	3
9913	TX delay time	30 ms (Selectable: 10 to 99ms)			
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
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	–
9960	Recall of 27 MHz SSB/DSB frequencies (for Japanese vessels)	Disable	Enable	–	–
9998	System Lock (Important system settings are not changeable.)	[OFF /ON]: Enter "present time" to change setting. (*10)			
9999	System Initialization (Default)	Disable	Enable	–	–

Table-2 User Changeable Specifications

Shading shows factory setting.

Channel No.	Function		Setting No.			
			0	1	2	3
9902	ITU frequency		CURRENT	FUTURE	–	–
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 (*11)	–	–
9916	Keyboard lock (controlled by [*] key)		OFF	ON (*12)	–	–
9918	Time adj. (Clock)		Auto	Man	–	–
9919	Control unit priority (*13)		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 (*14)		Enable	Disable	Shorten-ing capacitor	—
9924	Freq. range in which shortening capacitor turns on. (9923 should be set at "2".)	Lower limit	2500.0 kHz			
9925		Upper limit	3999.9 kHz			
9940	Receiver bandwidth in kHz (Change-able 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	—
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.
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.

(*3): To test the transmitter press **TEST** and **START** keys in this order. The dummy load (if equipped) 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 shortened to "10ms." (In actual practice, data is transmitted with 14 ms delay.)

(*5): For 1988 SOLAS Convention ships (GMDSS) set to "1." Then, minimum output power is automatically set at 60W (power data: 100), except for minimum power data already stored into user channel.

(*6): MIF ----- Furuno Multi Interface for Radio communication
Select MIF when DP-5, DSC-5, selcall or intership FAX 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): Ex. ----- Preset 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

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

(*12): 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.)

(*13) 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"

(*14)

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.
"2" (Short Cap.)	Shortening capacitor automatically turns on in the range set by 9924/9925. Further, **DUMMY** key is allowed to turn on/off shortening capacitor.	S. CAP (Shortening Capacitor)	With modified DUMMY LOAD PCB. (Ref. to page AP2-12.)

CONFIRMATION OF SETTING

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

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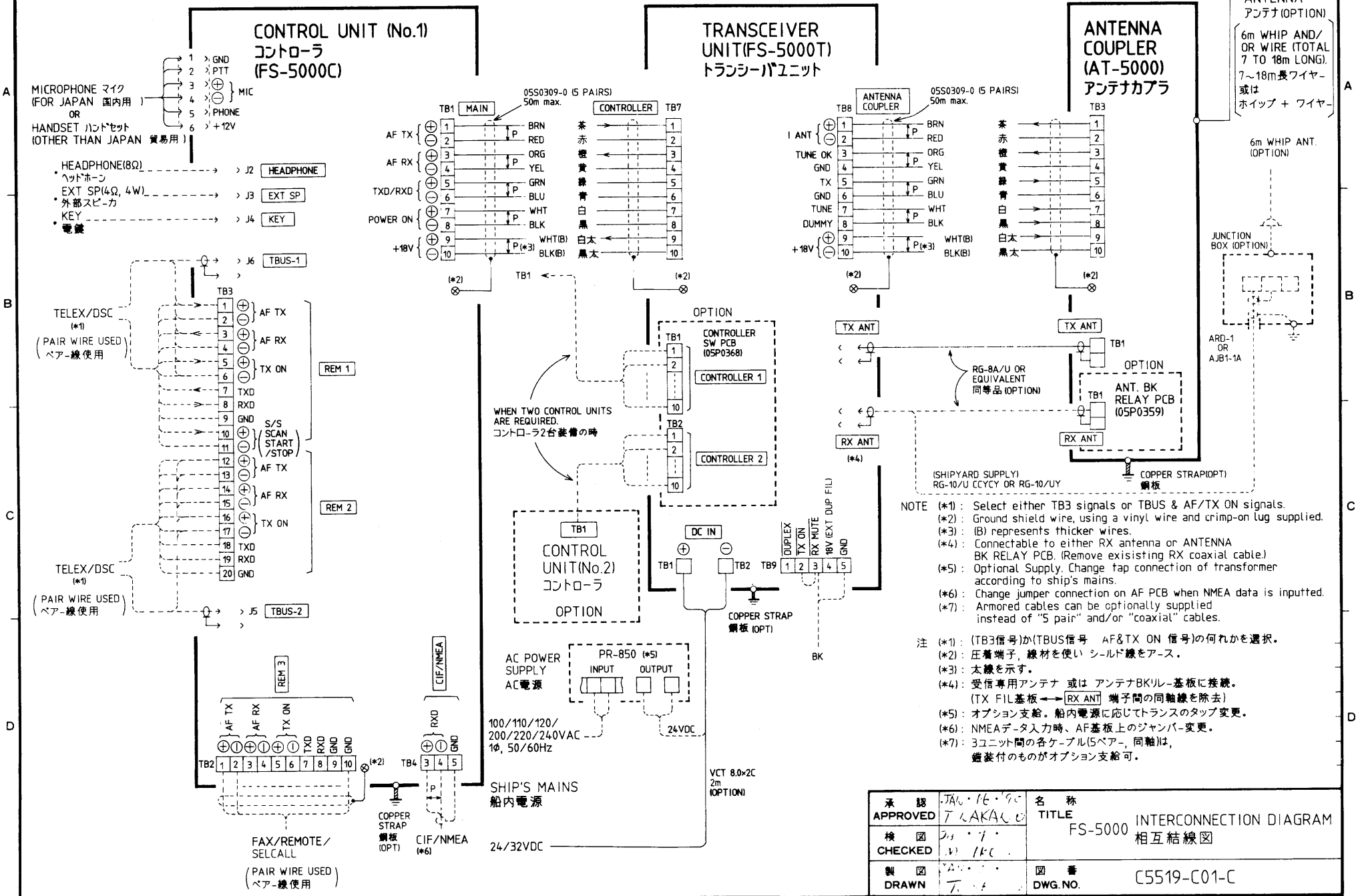

NOTE
(*1) : Select either TB3 signals or TBUS & AF/TX ON signals.
(*2) : Ground shield wire, using a vinyl wire and crimp-on lug supplied.
(*3) : (B) represents thicker wires.
(*4) : Connectable to either RX antenna or ANTENNA BK RELAY PCB. (Remove exisisting RX coaxial cable.)
(*5) : Optional Supply. 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&TX ON 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。
(TX FIL基板 ←→ RX ANT 端子間の同軸線を除去)
(*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	JAN.16.'91 T.AKAKU	名称 TITLE	FS-5000 INTERCONNECTION DIAGRAM 相互結線図
検図 CHECKED	JAN.17.'91 M.IKE		
製図 DRAWN	JAN.16.'91 T.F	図番 DWG.NO.	C5519-C01-C

REV : MAY '00, JAN '91

FURUNO ELECTRIC CO., LTD.