

**Technical Manual**

**Radiotelephone  
DEBEG 3120**



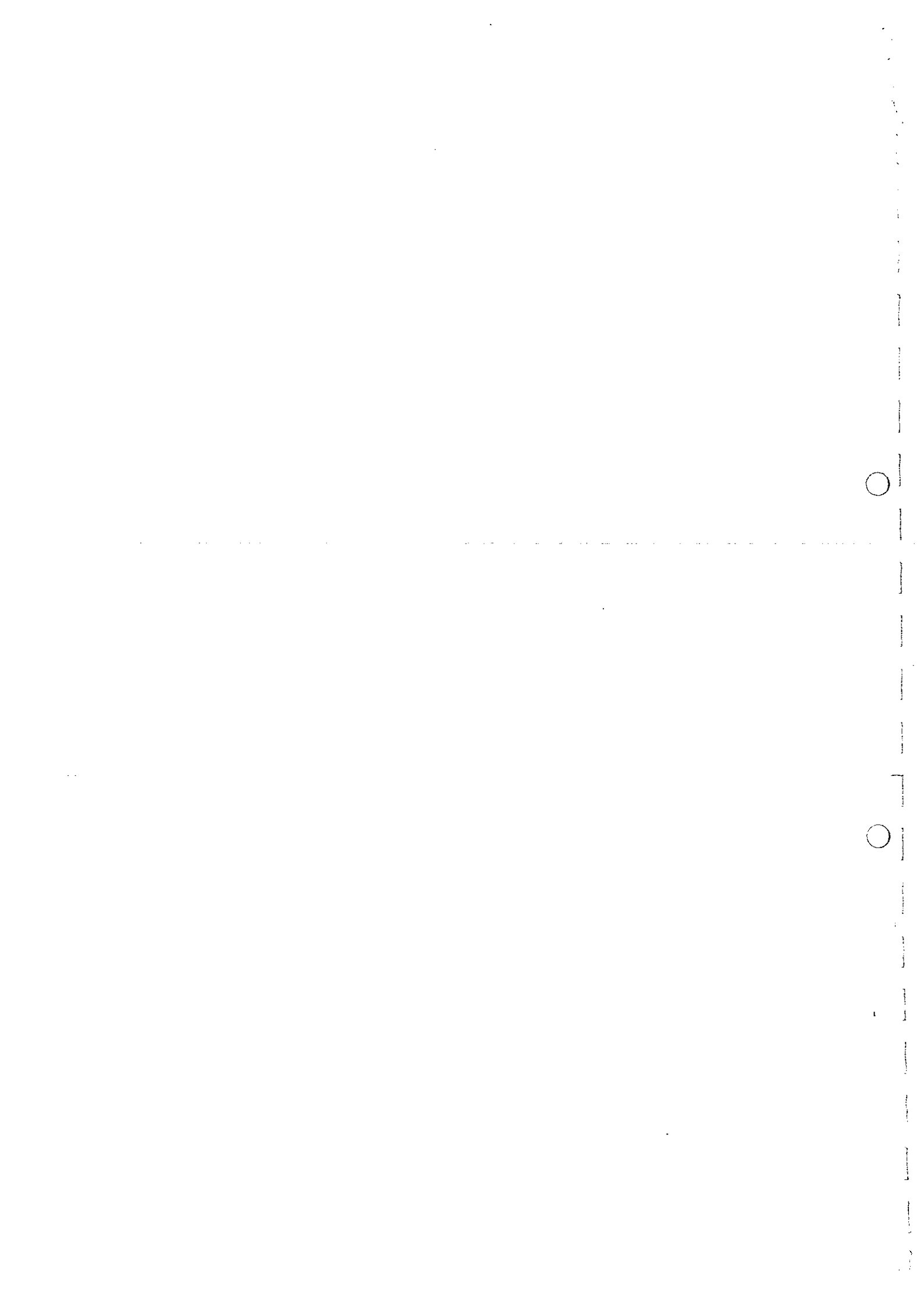
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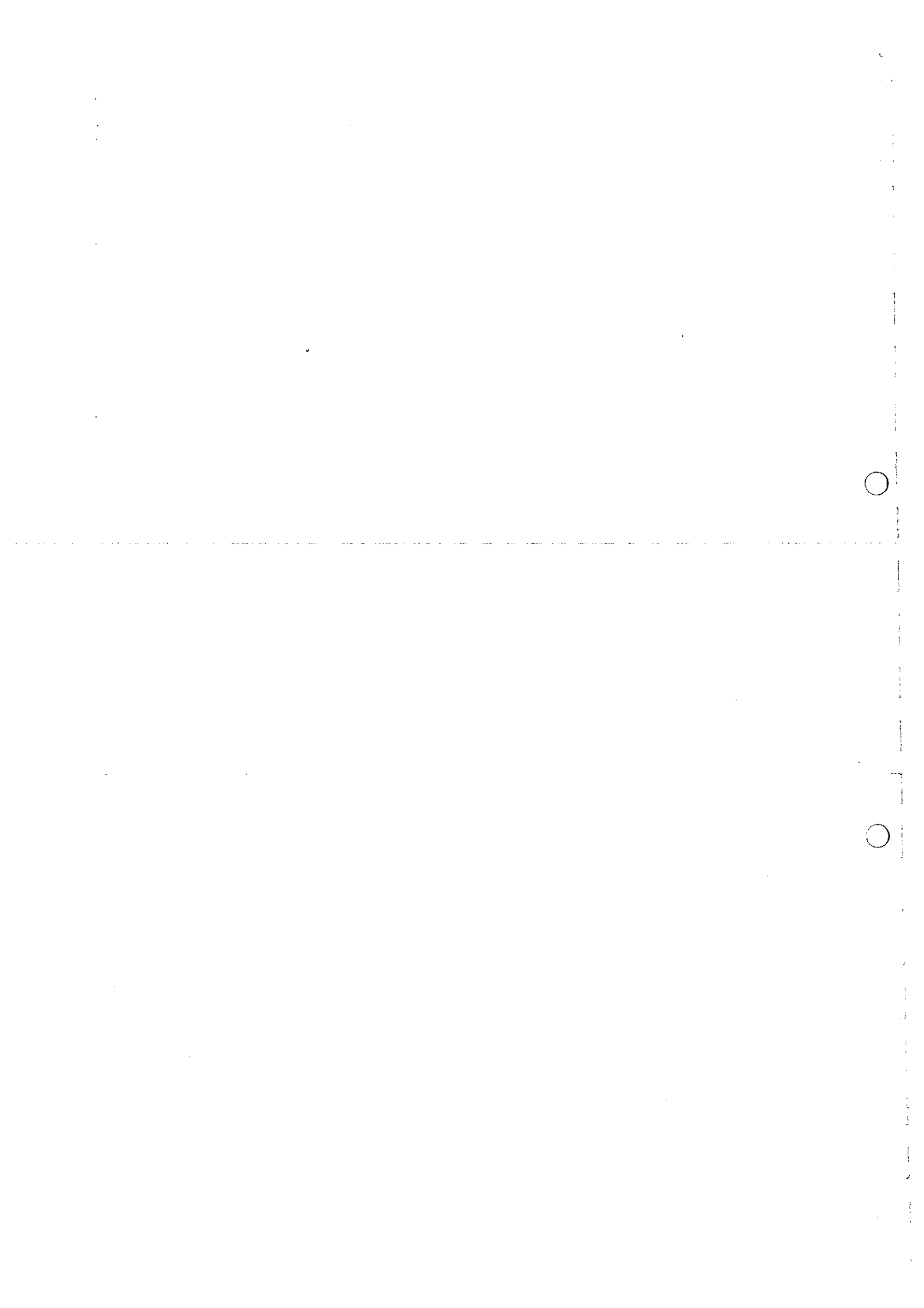
Technical Manual

Radiotelephone  
DEBEG 3120

07/91







Technical Manual  
Radiotelephone DEBEG 3120

- Part 1 Description
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**Part 1**

**DESCRIPTION**



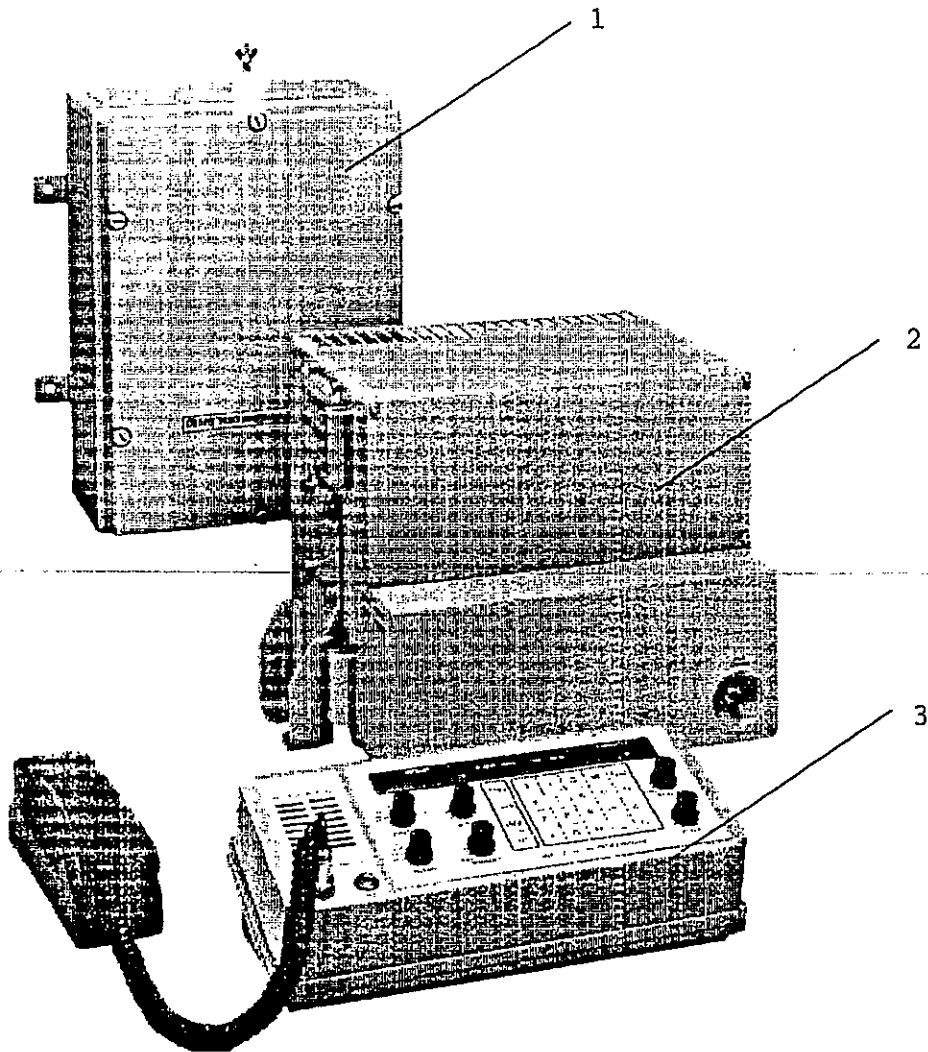


Figure 1-1 General View

- 1 Antenna Tuning Unit
- 2 Transceiver Unit
- 3 Control Unit





## 1.1 General Description

The radiotelephone DEBEG 3120 is designed for marine as well as for point-to-point applications and meets the technical requirements of CEPT, ECC, FTZ, MPT and PTT NL.

The standard version offers simplex/semiduplex communication in the frequency range 1.6 to 28 MHz in the classes of emission H3E, J3E (USB and LSB) and J2B.

Optional facilities as preselector, radio telex, and Morse telegraphy permit an adjustment to various needs.

The easy to operate radiotelephone consists of two units:  
- the transceiver with receiver, exciter, transmitter and power supply, the remote control unit and  
- the automatic antenna tuning unit.

The control unit contains all receiver and transmitter operating controls. Separate LED-displays indicate the RX and TX frequencies, which are selected separately with the exception of simplex channels. A bargraph display shows alternatively the receiver signal strength or the antenna current, controlled by the push-to-talk button.

Frequency and channel selection are done by the membrane keyboard which facilitates the entering at darkness by back illumination.

Up to 50 frequency pairs are user programmable or can be factory-programmed.

The marine version additionally offers 176 ITU duplex and 68 ITU simplex maritime mobile voice channels being selected by entering a 3 or 4 digit number (in case of optional J2B this is valid for 338 ITU telex channels, too) and a direct access key to the distress frequency 2182 kHz with automatic selection of H3E (optionally J3E/USB) as well as a built-in two-tone alarm signal generator.

The receiver can be tuned in selectable steps of 10 Hz to 5 kHz at the choice of the operator.

The RF output power of the solid state radiotelephone is 200 W PEP into the antenna and can be reduced in two steps (-4 dB and -12 dB).

The fast tuning, microprocessor controlled automatic antenna tuning unit is used to match all antennas between 12 m and 18 m including 3 m feeder line.

The equipment DEBEG 3120 can be supplied directly from 12 V or 24V DC and with an additional rectifier unit from 110/220V AC mains.

## 1.2 Technical Data

### General:

Frequency Generation: Synthesizer

Frequency Selection: via keyboard, direct access key  
2182 kHz incl. H3E (J3E  
optionally). 50 user programm-  
able frequency pairs.  
176 ITU duplex and 68 ITU  
simplex voice channels, 338 ITU  
telex channels

Frequency indication: separate LED-displays for trans-  
mit and receive frequencies

Frequency stability: +/-20 Hz, typical +/-10 Hz

Classes of emission: A3E (RX only), H3E (2182 kHz)  
J3E (USB/LSB), J2B  
A1A (option)

Environmental condition:  
Temperature range: 0 C to 40 C, performance  
specification met  
-15 C to +55 C, operational

Humidity: 95% rel. at 40 C

Power supply: 12 V or 24V DC (-10%, +30%)

Power consumption:  
Transmitt mode: H3E: 24V DC 15 A  
12V DC 35 A  
J3E: 24V DC 12 A  
12V DC 28 A  
A1A: 24V DC 25 A  
12V DC 55 A

TX off, RX only: 1.1 A

Dimensions:  
Transceiver Unit: H 300, W 350, D 300  
Antenna Tuning Unit: H 400, W 300, D 185

Transmitter:  
Frequency range: 1.6 to 28 MHz, selectable  
in 100 Hz steps

RF output power: 250 W PEP -1.4dB

Power reduction: in two steps (-4dB, -12dB)  
Medium: 80 W PEP approx.  
Low: 13 W PEP approx.

## 1.2 Technical Data (Cont.)

**Receiver:**  
Frequency range: 0.1 to 30 MHz, tunable  
in selectable steps of  
10 Hz to 5 kHz

IF-Rejection: > 80 dB, 90 dB typical

Image rejection: > 70 dB, 80 dB typical

Intermodulation: > 80 dB

Crossmodulation: > 90 dB

Blocking: > 90 dB, 100 dB typical

Input sensitivity: EMF at 20 dB SINAD  
A3E, H3E < 15 uV  
J3E, J2B < 2 uV

Bandwidth: -6 dB -60 dB  
A3E, H3E: +/-2.7 kHz +/-10 kHz  
J3E (USB): +350 Hz -500 Hz  
+2700 Hz +3800 Hz  
J3E (LSB): -350 Hz +500 Hz  
-2700 Hz -3800 Hz  
J2B, A1A: +/-250 Hz +/-1300 Hz  
(up to S.No. 9000 0390)

J2B, A1A: +/-170 Hz +/-500 Hz  
(from S.No. 9000 0391)

Input protection: 30 V EMF up to 15 min

AF output power: > 3 W into 8 Ohms

**Antenna-Tuning Unit:**  
Frequency range: 1.6 to 28 MHz

Antenna tuning: fully automatic. manual  
setting possible

Matching range: all antennas (wire or whip)  
from 12 to 18 m incl. feeder  
line

Input impedance  
after tuning: 50 Ohms, SWR < 1.5 typical

**Options:**  
- Preselector  
- External loudspeaker  
- Morse telegraphy  
- Reference frequency oscillator of 0.5 ppm stability  
- J3E (USB) for direct access key 2182 kHz

### 1.3 Control Unit

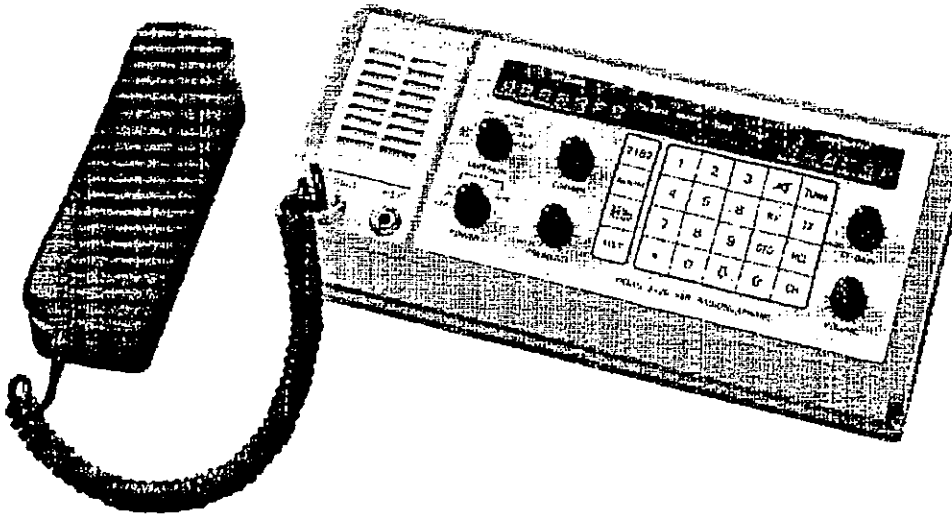


Figure 1-2 Control Unit

This unit includes keyboard, control section (5P01765A), AF section (5P01545B) and the display card (5P01544A). The unit controls the whole transceiver by the signals coming from the keyboard and the function selectors. The control unit is generally used as a remote control unit with addition of the junction board (5P01555B).

The control section consists of the back illuminated keyboard, the 8 bit microprocessor to control the switch positions and the data communication between the transceiver unit and the display circuit to drive all indicators except the LED bargraph for receiver signal strength and TX output power (ant. current for 2182 kHz).

The AF section consists of the ALC circuit, the speaker amplifier circuit, the bar LED driver, the dimmer control circuit and the alarm signal generator.

## 1.4 Transceiver Unit

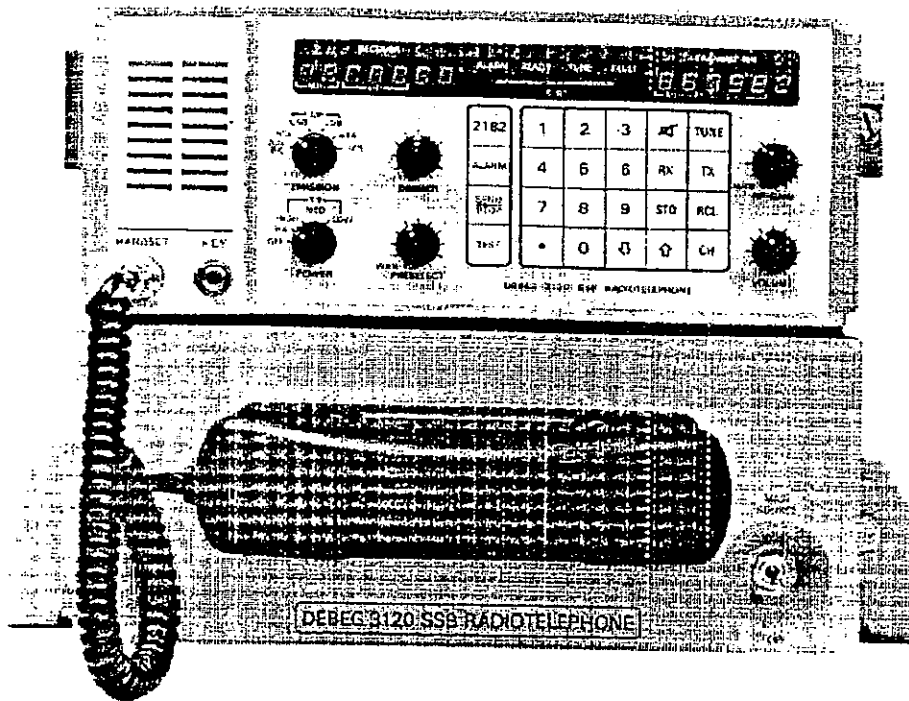


Figure 1-3 Transceiver Unit

The transceiver unit consists of RX/Exciter, frequency pll synthesizer, T/R control, preselector, RF power amplifier, low pass filter, power supply unit and junction board. The transceiver unit is controlled by signals of the control unit.

### 1.4.1 T/R Control Section

This section consists mainly of an 8 bit MPU which controls the circuits of the transceiver unit and ATU according to the data signals of the control unit.

### 1.4.2 RX/Exciter Section

This board consists of the receiver and the exciter. They are switched over by the transistor switch and the diode switch, which are controlled by the signal of the PTT key. In the receiver, the RF signals are converted to AF signals. In the exciter the AF signals are reversely converted to RF signals. This frequency conversion is made by two passive DBM (double balanced mixer) and one active DBM.

#### 1.4.3 Frequency Synthesizer Section (PLL)

The frequency synthesizer consists mainly of 6 PLL circuits as Hybrid IC's. These circuits generate all RF signals needed for transmission and reception. The signals are sent to the RX/Exciter which produces the RF signals of 455 kHz (for modulation/demodulation), 70 MHz (2nd local) and 70.555 MHz - 100.455 MHz (3rd. local) for selection of transmitting/receiving frequency) based on 10 MHz of the standard oscillator.

#### 1.4.4 RF (Power Amplifier) Section

This section consists of the RF amplifier, the bias circuit and the self diagnosis circuit. The specified performance of the RF amplifier is as follows:

Frequency range: 1.6 to 28MHz  
Impedance (output and input): 50 Ohms  
Power gain: 44 dB (approximately)  
Output power: 250W  
Heat dissipation: Heat sink cooling

#### 1.4.5 L.P.F. (Low Pass Filter) Section

The filter circuit is designed to eliminate the high order harmonics included in the RF signal output to power amplifier.

#### 1.4.6 Power Supply Section

This unit converts input voltage 12/24V DC (-10%, +30%) by the DC-DC converter to voltages 48V DC, 24V DC, 19V DC and 6V DC needed in various sections.

#### 1.4.7 Preselector Section (Option)

This section consists of the RF tuners provided at input stage of the receiver. The receiving frequency range of 100 kHz to 29999.99 kHz is divided into 7 bands by PB3 to PB5 and further divided in smaller bands by PB1 and PB2. These bands are switched over according to the control signals to T/R Control (5P01738A).

#### 1.4.8 Junction Board

The junction board is provided for connection between the transceiver unit, control unit and ATU. Connection is made by means of the terminal board and plug-in connectors.

## 1.5 Antenna Tuning Unit

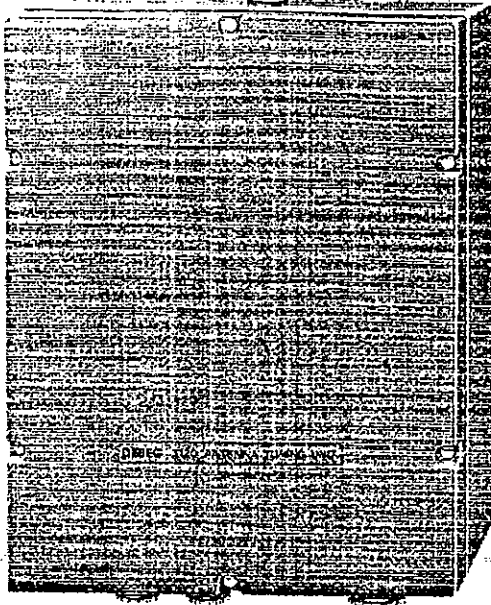


Figure 1-4 Antenna Tuning Unit

The ATU (Antenna Tuning Unit) is composed of LC network and the shielded ATU control circuit. The transceiver unit and the ATU are connected by the 12-wires system cable, the transmitting coaxial cable and the receiving coaxial cable. Antenna matching is automatically performed with the TUNE signal of the transceiver unit.





Part 2

OPERATION



## 2.1 DISTRESS OPERATION ON 2182 kHz

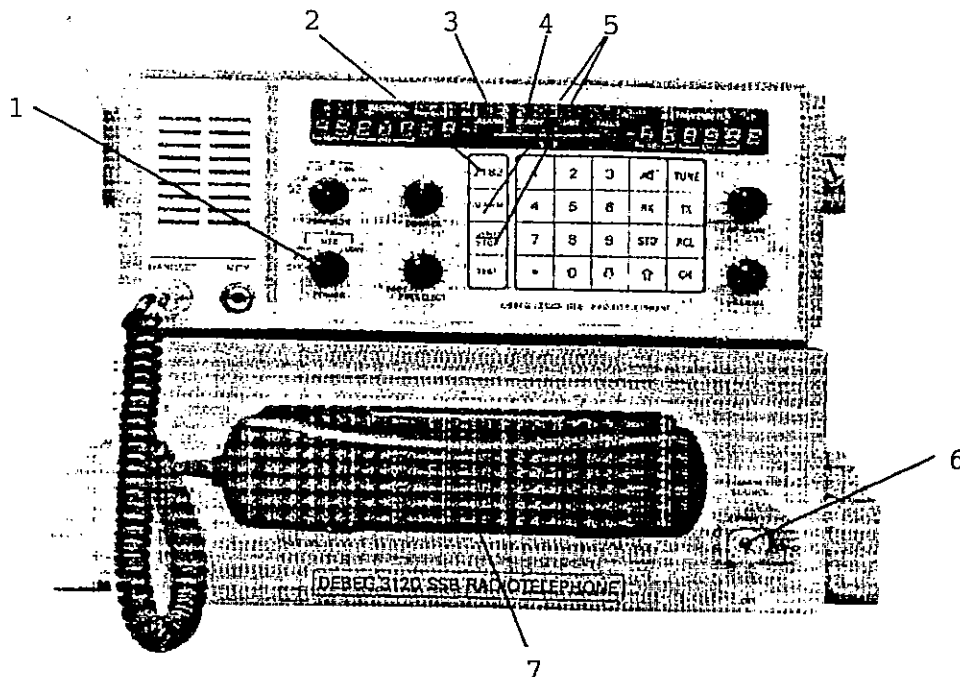


Figure 2-1 Controls for Distress Operation

### TRANSMISSION OF TWO-TONE ALARM SIGNAL

1. Switch MAIN SOURCE (6) switch to ON Position
2. Switch POWER switch (1) to TX HIGH Position
3. Press 2182 push button (2) at keyboard
4. Press ALARM and SEND/STOP push button (5) simultaneously

Transmission starts immediately after the automatically initiated tuning sequence and the two-tone alarm signal is now transmitted for 45 seconds. The antenna current is displayed at the bargraph (4), the ALARM LED (3) blinks, and the alarm tone is audible in the built-in loudspeaker.

To repeat the alarm signal transmission, just press ALARM and SEND/STOP (5) again simultaneously.

The alarm signal transmission may be interrupted any time by pressing SEND/STOP.

### TRANSMISSION OF DISTRESS MESSAGE

When the alarm signal ceases, press PTT (7) at handset and transmit the distress message by speaking into the handset microphone with a clear and calm voice.

Release PTT key and wait for reply.

Repeat the distress message at intervals until a reply is received.

## 2.2 Information Before Operation

Connect each section and assure that plugs and connectors are inserted before operation. Usually connectors of the transceiver unit have been connected. Mainly check before external connection.

### Before Operation

Check the following switch positions before connection of each section.

The mains switch (at lower right in front of unit) shall be switched off.

The power switch (rotary switch at control panel) shall be switched off.

TX (transmitting) control cord shall not be connected to the telegraph key connector.

### Connection of each Section

Connect coaxial cable to the TX-OUT connector at the rear side of the main unit and to TX connector (J1) of ATU.

Connect coaxial cable to the RX connector at the rear side of main unit and to RX connector (J2) of ATU.

Fix the ground wiring to the earth terminal at the rear side of the main unit. (Use copper band only).

Use multi-core screened cable to connect TB3 terminal of the junction board inside the main unit to terminal TB2 of the ATU.

Connect the ground wiring from the ATU earth terminal strip.

Connect antenna (feeder) to the ATU output terminal (TB1). Upon completion of above checks, connect the power supply.

Connect 12V DC or 24V DC power supply to + (plus) and - (minus) terminals at the rear side of the unit. At this time pay attention to connect plus (+) and minus (-) correctly. In addition the remote control and external speakers may be connected to TB1 and TB2 on the junction board of the main unit.

2.3 Operation of the Unit  
Refer figure 2-3 at page 2-19.

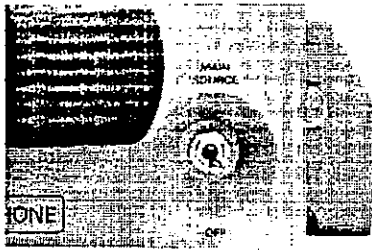


Figure 2-2 Main Source Switch

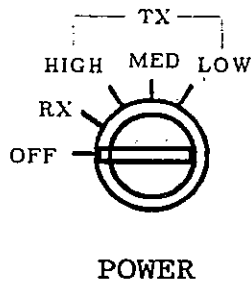
Switch MAIN SOURCE to ON

When Main Source Switch is switched to ON, the relay power control is activated and the power switch at control panel is enabled.

2.3.1 Operation at Control Panel

All switches except for the Main Source Switch are positioned at the control panel.

Turn POWER on



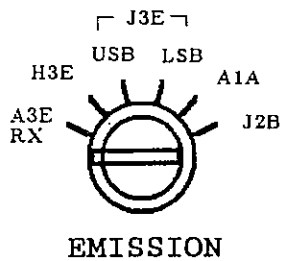
Set the power switch from OFF position to receiving position (for transmission, set it to TX one of HIGH, MED and LOW).

Selfcheck function operates and RX/TX display flashes. Upon completion of selfcheck, error codes are indicated in RX display and then the last frequency used previously is displayed. The unit is now ready for reception.

Set RX/TX Frequency by the keyboard.  
(Keyboard selection is described later)

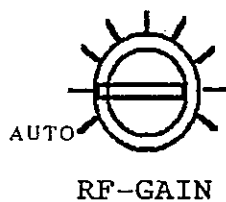
RX/TX frequency is displayed on the RX/TX display.

### 2.3.1 Operation at Control Panel (Cont.)

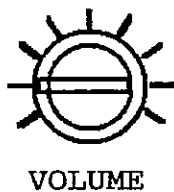


The standard version of DEBEG 3120 offers four different classes of emission: A3E, H3E and J3E (USB/LSB). A3E is used for broadcast reception-only. ITU channels are selected with previous setting of corresponding class of emission, J3E (USB) for voice communication and J2B for telex. If a private channel has been selected and is indicated on the RX/TX frequency display, the previously stored class of emission has to be switched to enable the transmission.

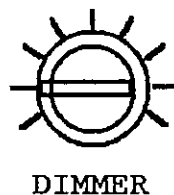
The setting to other types of emission will disable the transmission. If a frequency is displayed only on the RX display, the transmission is disabled at all classes of emission, at all. A1A is an optional function and thus may not be operated usually.



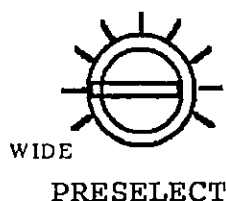
Control for the receiver RF amplifier gain. At "AUTO" position, the inside circuit adjusts the RF gain automatically. Except at "AUTO" position, the gain can be changed continuously from minimum to maximum.



Control for the AF level during reception. Set it to appropriate position for listening.



Control for brightness of all LED's (excluding FAULT LED) of control panel.



Switching ON and tuning the preselector of the receiver.  
WIDE position: Preselector OFF

### 2.3.1 Operation at Control Panel (Cont.)

TUNE

Pressing this key will start the automatic tuning process in the ATU and the TUNE LED lights up. Tuning is performed after extinction of TUNE LED and illumination of the green READY LED. The unit is now ready for transmission. If tuning cannot be made, "TUNE" extinguishes and FAULT LED lights up. (Handset PTT button may be substituted for TUNE switch.)

2182

When operating this switch, RX/TX frequency is set automatically to 2182 kHz and the type of emission is set to H3E. When 2182 is displayed on the RX/TX display, the unit enters automatically into the tuning state.

TEST

When TEST is pressed alone, a selftest of the RX circuitry is started. Nothing will be indicated on the RX frequency display during test procedure.

TX

TEST

When TX and TEST are pressed simultaneously the transceiver is set for a self test. The self test includes all transmitter, receiver and power sections of the unit. After completion of the test, either the previous selected RX frequency appears, or an error message consisting an "E" and a two digit number, if a failure occurs.

ALARM

SEND  
STOP

SEND  
STOP

When pressing ALARM and SEND/STOP simultaneously, the two tone alarm signal is transmitted for about 45 seconds. The alarm signal will be transmitted after completion of tuning procedure. While the alarm tone sounds, keys except SEND/STOP shall not be used. To stop transmission press SEND/STOP.

ALARM

TEST

SEND  
STOP

When pressing ALARM and TEST simultaneously, the two tone alarm signal is sent to the built-in speaker, handset and external speaker line regardless of the selected frequency. The test time is about 45 seconds. To stop the alarm signal test press SEND/STOP.

### 2.3.1 Operation at Control Panel (Cont.)



This control switches the built-in speaker ON and OFF.



These switches are used for counting up/down the channel number and RX frequency changes in defined steps.



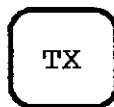
To store RX/TX frequency into the memory.



To recall RX/TX frequency from memory.



To enter RX frequency.



To enter TX frequency.



To enter a channel number.



### 2.3.2 Keyboard Entry

Frequency setting, changing and channel calling are described in the table below.

1. Selection of receiving frequency  
(regardless of channel)
2. Up/Down of receiving frequency
3. Up/Down of receiving frequency  
in specified step
4. Selection of channel
5. Selection of another channel
6. Up/Down of channels
7. Fine adjustment of receiving frequency  
ALA - BFO
8. Emergency 2182 kHz and alarm test
9. Private channel to be entered  
Example No. 1
10. Private channel to be entered  
Example No. 2
11. Selection of private channels
12. Change of transmit frequency

## 2.3.2 Keyboard Entry (Cont.)

### 1. Selection of Receiving Frequency (regardless of channel)

Example: to receive 14225.32 MHz

Step	Function Key	RX Display	TX Display	Remarks
1	1	1		The last receiving frequency remains  The position of dot "." on the display represents kHz. The newly entered frequency is ready for receiving. The emission mode switch should be positioned at the desired mode.
2	4	14		
3	2	142		
4	2	1422		
5	5	14222		
6	.	14225.00		
7	3	14225.30		
8	2	14225.32		
9	RX	14225.32		

### 2. UP/DOWN of Receiving Frequency

Step	Function Key	RX Display	TX Display	Remarks
1	⬆	14225.32 14225.33		Single push (0.5s max.) increases 50 Hz. Press down continuously to increase to 100 Hz in 10 steps/s. Single push (0.5s max.) decreases 10 Hz. Hold down continuously to decrease to 100Hz in 10 steps/s. (New frequency is received all the time the indication has changed.)
2	⬆	14225.43		
3	⬇	14225.42		
4	⬇	14225.32		

2.3.2 Keyboard entry (Cont.)

3. Up/Down of receiving frequency in specified step

Step	Function Key	RX Display	TX Display	Remarks
1	1	14225.32 1		Single push (0.5s max.) increases 1.5 kHz.
2	.	1.00		
3	5	1.50		
4	⬆	14226.82		Press down cont. to increase to 10 steps/s. Single push (0.5s max.) decreases 1.5 kHz. Hold down cont. to decrease to 10 steps/s. (Step can be set within 10 Hz to 5 kHz,
5	⬆	14241.82		
6	⬇	14240.32		
7	⬇	14225.32		

4. Selection of Channel ex Ch 2201

Step	Function Key	RX Display	TX Display	Remarks
1	CH	14225.32 C		No channel number is displayed if the channel is not specified prev. TX frequency is displ. only when TX power supply is switched on.
2	2	C 2		
3	2	G 22		
4	0	C 220		
5	1	C2201		
6	RCL	22596.00	22000.0	
7	TUNE or MIC PRESS	22596.00	22000.00	New freq. is ready for receiving. If the setting of the emission switch at the panel does not meet the required Class of Emission, the TX display blinks. When TUNE or MIC PRESS is pressed, ATU operates and READY lamp lights up to indicate the unit is ready for transmission.

### 2.3.2 Keyboard entry (Cont.)

#### 5. Selection of another channel

Example: CH 2201 - CH 1201

Step	Function Key	RX Display	TX Display	Remarks
1	CH	22596.00 C2201	22000.0	The last channel is displayed. Ready for receiving CH 1201.
2	1	C 1		
3	2	C 12		
4	0	C 120		
5	1	C 1201		
6	RCL	13100.80	12330.0	

#### 6. Up/Down of channels

Step	Function Key	RX Display	TX Display	Remarks
1	CH	13100.80 C1201	12330.0	Single push (0.5s max.) increases 1 CH.
2	⬆	C1202		
3	⬆	C 810		Press down continuesly to increase to 10 ch/s (in the circle order of 12MHz band to 16MHz band to 22 MHz band to private channel band to 4MHz band to 6MHz band to 8MHz band) Single push (0.5s max.) decrease 1 CH. Press down continuesly to decrease at 10 ch/s (in the reverse order of UP operation).
4	⬆	C 809		
5	⬆	C2201		
6	RCL	22596.00		

2.3.2 Keyboard entry (Cont.)

7. Fine adjustment of receiving frequency  
ALA - BFO

Step	Function Key	RX Display	TX Display	Remarks
1	⊕	22596.00 22596.01	22000.0 22000.0	RX/TX freq. of CH 2201. single push (0.5 s max) increases 10 Hz. Press down continuously to increase to 50 Hz at 5 steps/s up to +500 Hz. Single push (0.5 s max.) decreases 10 Hz. Hold down continuously to decrease to 50 Hz at 5 steps/s down to -500Hz.  Step width can be speci- fied (see para. 3). However the maximum up/ down is +500 Hz.
2	⊕	22596.50	22000.0	
3	⊖	22596.49	22000.0	
4	⊖	22595.50	22000.0	

8. Emergency 2182 kHz and alarm test

Step	Function Key	RX Display	TX Display	Remarks
1	2182	22595.50 2182.0	22000.0 2182.0	Automatic selection of emission mode H3E. Ready for transm/reception. Automatic transmission of the 2-tone alarm sign. for about 45 seconds. "ALARM" LED lights up. Automatic transmission stops. Automatic transmission stops.  2-tone alarm signal is transmitted by phone channel set previously. Alarm sound is heard of speakers, however, no transmission made. The alarm sound goes off.
2	ALARM SEND STOP	2182.00	2182.0	
3	SEND STOP			
4	ALARM TEST	FREE	FREE	
5	SEND STOP	FREE	FREE	

2.3.2 Keyboard entry (Cont.)

9. Private channel to be entered  
Example No. 1

Step	Function Key	RX Display	TX Display	Remarks
				Storage of RX 6124.3 kHz, TX 6012.1 kHz. and emis. mode J3E(USB) into channel 07 is shown.
1	J3E(USB)			Set emission mode select. at J3E(USB).
2	6	6		Entry of RX frequency.
3	1	61		(6124.3 kHz)
4	2	612		
5	4	6124		
6	.	6124.00		
7	3	6124.30		Completion of entry (RX frequency)
8	RX			
9	6	6		Entry of TX frequency.
10	0	60		(6012.1 kHz)
11	1	601		
12	2	6012		
13	.	6012.00		
14	1	6012.10		Completion of entry (TX frequency).
15	TX	6124.30	6012.1	
16	CH	C		Entry of channel number 07
17	0	C 0		
18	7	C 07		
19	STO	C 07		Completion of storage to chan. 07. After chan. No. is displayed for one second, frequencies are displayed and memorized with class of emission J3E(USB)
20		6124.30	6012.1	

2.3.2 Keyboard entry (Cont.)

10. Private channel to be entered  
Example No. 2

Step	Function Key	RX Display	TX Display	Remarks
1	J3E(LSB)			Storage of RX/TX 8452.4kHz and emission mode J3E(LSB) into channel 36 is shown.
2	8	8		Set emission mode selector at J3B (LSB). Entry of RX/TX frequency. (8452.4 kHz)
3	4	84		
4	5	845		
5	2	8452		
6	.	8452.00		
7	4	8452.40		
8	RX	8452.40		
9	TX	8452.40	18452.4	Completion of entry (TX frequency).
10	CH	C		Entry of channel No. 36
11	3	C 3		
12	6	C 36		
13	STO	C 36		Completion of storage to channel 36
14		8452.40	18452.4	After channel No. is displayed for one to two seconds. frequencies are displayed and memorized with class of emission J3E (LSB)

### 2.3.2 Keyboard entry (Cont.)

#### 11. Selection of private channels

Step	Function Key	RX Display	TX Display	Remarks
1	CH	8452.40 CH 36	8452.4	The last channel is displayed.
2	0	C 0		
3	7	C 07		
4	RCL	6124.30	6012.1	

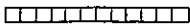
#### 12. Change of transmit frequency

Step	Function Key	RX Display	TX Display	Remarks
		8452.40	8452.4	Previous selected TX/RX frequencies
1	1	1	8452.4	TX frequency to be changed to 16615.0 kHz class of emission: J2E LSB) unchanged Entry of new TX freq.
2	6	16	8452.4	
3	6	166	8452.4	
4	1	1661	8452.4	
5	5	16615	8452.4	
6	.	16615.	8452.4	
7	0	16615.0	8452.4	
8	TX	8452.4	16615.0	Completion of TX freq. entry

Note: In case of DEBEG 3120 version with free frequency selection, TX and RX frequencies as well as classes of emission can be changed according to the customer's requirements.



### 2.3.3 Panel Display Function (LED Display)

  
S/R F

Electric field strength indicator

Indicates relative electric field strength at receiving input in RX mode and transmitter feeder current in TX mode.  
In case 2182kHz is selected, SRF indicates antenna current (When ATU of DEBEG 3120 is used).

RECEIVER  
  
MHz kHz

Receiver display has 7 digits to indicate RX frequency and channel.

TRANSMITTER  
  
MHz--kHz

Transmitter display has 6 digits to indicate TX frequency.

ALARM LED

This LED illuminates during transmission of 2-tone alarm.

READY LED

This LED illuminates upon completion of ATU automatic adjustment.

TUNE LED

This LED illuminates while ATU is tuning. TUNE LED lights up, when SWR becomes worse.

FAULT LED

This LED illuminates in case ATU tuning fails and transmission is impossible.

#### 2.3.4 ATU Operation

All control switches and indicators for this unit are incorporated internally.

**POWER switch:**

Power switch for power supplied from the transceiver unit to the unit. Normally this switch is kept on.

**AUTO-MAN switch:**

Normally, this switch is set to AUTO.  
At MANUAL position, ATU can be manually operated by MANUAL SET SWITCHES.

**TUNE switch:**

When this switch is pressed TUNE function operates.

**MANUAL SET switch:**

Switch corresponding to LC network control relay.  
Used when setting 2182 kHz manually.

**ANTENNA CURRENT and PF-PR switch:**

At ANTENNA CURRENT (about 4A max.) position,  
Bar LED indicates antenna current.  
At Pf-Pr position, Bar LED indicates the forward  
or reflected wave of ATU input.

**PF-PR switch:**

"ANT POWER LED" selector switch.  
Indicates forward wave power when set to "Pf"  
and indicates reflected wave power when set to "Pr".

**BAR LED:**

Indicates forward and reflected wave power  
detected by ANT output circuit during transmission.

**OVERLOAD LED:**

Illuminates when power supply output is overloaded.  
OVERLOAD LED lights up until it is reset by TUNE.  
During this position, the communication is impossible.

**SET LED:**

Indicates when the LC network control relay operates.

2.3.5 Presetting for Manual Tuning to 2182 kHz during Installation

Adjustment of ATU at 2182kHz:

At control unit: Type 2182 kHz via keyboard

Press TX

Press TUNE

ATU tunes to 2182 kHz

Open the cabinet of ATU.

Set dip-switches S5 - S8 in accordance with the LED's D18 - D36.

LED lights: DIP-switch ON

Close the cabinet of ATU.

Manual Antenna Tuning to 2182 kHz in case of an inoperable antenna tuning unit:

Remove the cover of ATU.

Set switch AUTO/MAN to MAN-position.

The tuning has been carried out when all LED'S are lighting in correspondence with the pre-setted DIP-switches.

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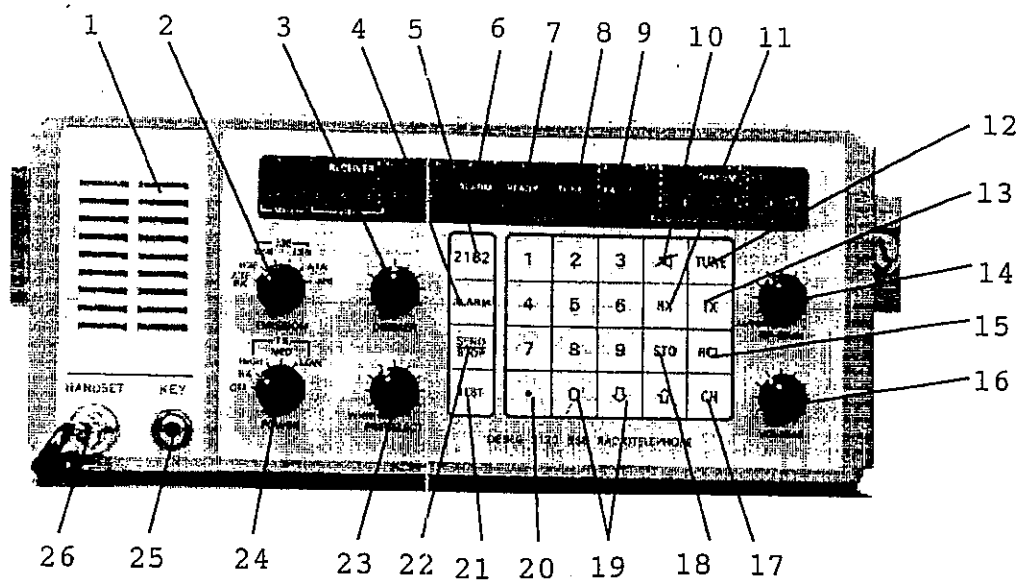
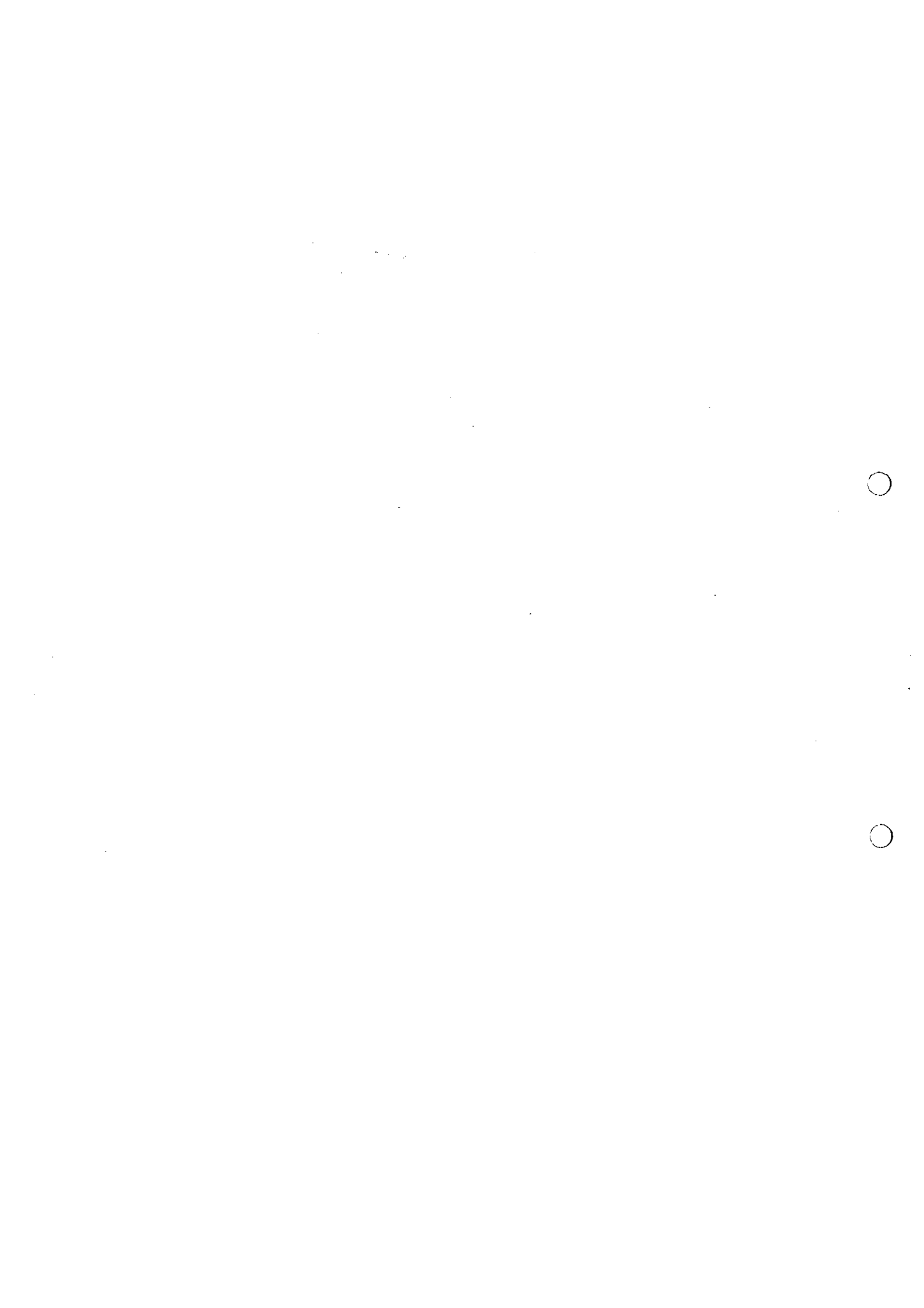


Figure 2-3 Control Panel

- 1 Speaker
- 2 Emission
- 3 Dimmer
- 4 Alarm
- 5 2182
- 6 LED Alarm
- 7 LED Ready
- 8 LED Tune
- 9 LED Fault
- 10 Speaker On/Off
- 11 RX
- 12 Tune
- 13 TX
- 14 RF Gain
- 15 Recall
- 16 Volume
- 17 Channel
- 18 Store
- 19 Frequency Up/Down
- 20 Keyboard
- 21 Two Tone Alarm Test
- 22 Two Tone Alarm Send/Stop
- 23 Preselect
- 24 Power Mode
- 25 Key
- 26 Handset



**Part 3**

**MAINTENANCE AND REPAIR**





### 3.1 Technical Description

#### 3.1.1 Fuses

The fuses of the equipment are fitted inside transceiver unit.

Junction Board: F1 (2A semi delayed, DC for ATU).

Power Supply: F1 (100A semi delayed, DC power supply)

Power Supply A1: F1 (15A semi delayed)

F2 (0.5A semi delayed)

#### Procedure:

Disconnect the DC power supply.

Open the housing of transceiver unit.

Remove power supply unit (1):

Unscrew 4 screws (2) at heat sink

Disconnect plugs P3, P4 and P5 at Junction Board.

Remove power supply unit carefully, pay attention to connection cables.

Remove AF-unit (left side) if necessary.

Remove Junction Board, pay attention to connection cables.

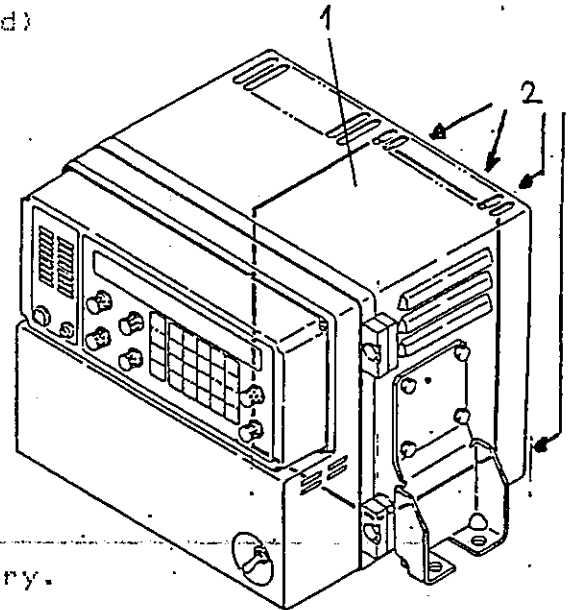


Figure 3-1 Transceiver Unit

Check fuses F1 and F2 of Power Supply A1:  
Unscrew side cover

Check fuse F1 of Power Supply:  
unscrew bottom cover

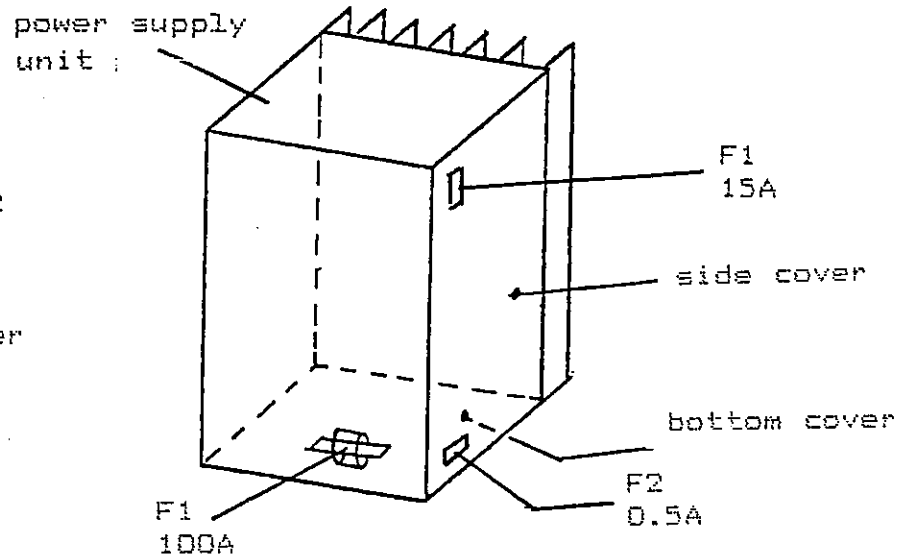


Figure 3-2 Location of Fuses

#### Reassembly:

Mount AF-unit if necessary.

Move power supply unit into housing, pay attention to connection cables.

Connect plugs P3, P4 and P5 at Junction Board.

Slide Junction Board into guide, pay attention to connection cables.

Fitt power supply.

connect the DC power supply.

### 3.2 Control Unit

The control unit includes the control section (5P01765A), AF section (5P01545B), Display card (5P01544A), Hand-set Filter (5P02038) and Key board.

The control unit is removable from the cabinet case and can be used as the remote control unit with addition of the Junction Board (5P01555B).

#### 3.2.1 Control Section 5P01765A

The control section is composed of the 8-bit HPU (IC-5), the program ROM (IC-7), the ITU telephone channel ROM (IC-8), ITU J2B channel ROM (IC-9), the RAM (IC-10) with back-up battery, and the scan decoder/driver circuit (IC11 to IC-15).

The display of transmitting frequency, receiving frequency and 4 lamp LEDs is selected by IC-11 and IC -12.

The scanning of the key board matrix and the 7 segment LEDs of the Display card are made by IC-13 to IC-15.

Lighting of these 7 segment LEDs and of the 4 lamp LEDs located above the Bar LED are made by IC-16 and IC-17.

Scanning Data (by IC-13 to IC -15) of the key board, the control switches of the control panel and the Link A to Link D are applied to PA and PC ports of HPU ( IC-5).

The control signal of AF section (5P0545B) is applied from the HPU PC port through the driver IC-1.

Data communication between Control unit and Main unit is made on serial signals through the circuits of HPU PC port (PC 0 Output, PC 1 Input ) and Line receiver driver (IC-2).

#### 3.2.2 AF Section 5P01545B

AF section is composed of the audio signal transmitting circuit, the interface for the transmitting signal from RTTY, the circuit which transmits the audio signal of the receiver to the loud speaker, Hand-set receiver, and RTTY, the 2-tone alarm signal generator, the control logic circuit, the Bar LED driver and the dimmer circuit.

### Transmitting of Audio Signals

Audio frequency signals from the microphone are applied to IC-4 through the hand-set filter (5P02038) eliminating radio frequency signals and T-1.

IC-4 having function of ALC ( automatic level control ) regulates the output level within the specified allowance.

The output of IC-4 is applied to IC-5 2/2 for amplification through the analogue switch IC-9 that is "on" in transmission of audio signals on emission mode K3E and J3E.

After amplification, the output is mixed with other transmitting signals at IC-5 1/2 to make the transmitting audio signals which are transmitted to the main unit.

Transmitting signals from RTTY are applied to the limiter circuit consisting of D-13 and D-15 through the filter consisting of L-4 and L-5 which eliminates radio frequencies.

The output is applied to the mixing amplifier IC-5 1/2 through the analogue switch IC-9 (different with the above IC-9) that is "on" in transmission of RTTY signals ( tone) on emission mode J2B.

The amplified output is applied to the the main unit.

### Receiving of Audio Signals

Audio signals from the receiver (main unit ) is applied to IC-6 1/2 for amplification through the analogue switch IC-9 (different with the above IC-9s) that is "on" only when receiving.

The amplified output is divided and applied to (1) the terminal of RTTY (2) the volume control of the front panel and (3) hand-set receiver.

Audio frequency output of the volume control is applied through IC-7 amplifier to both of the internal speaker and the external speaker (terminal).

The relay K-1 is provided between the internal speaker and IC-7 in order to "off " the internal speaker when to be disconnected.

The audio frequency output to the hand-set receiver is applied through IC-6 1/2 to IC -6 2/2 for amplification.

Phone RV-9 of the IC-6 2/2 circuit is provided for adjustment of the hand-set receiver output level.

### 2-Tone Alarm Signal Generator

The tone signals of 1300 Hz and 2200 Hz are generated by the 180° phase shift oscillator consisting of TR-2 and TR-3.

1300 Hz and 2200 Hz are switched by the control signal from the control section. The two tone signals are applied to the excitor ( main unit ) through IC-5 1/2 and to the hand-set receiver , the internal speaker, and the external loud speaker through IC -6 1/2 and IC-7.

### Control Logic Circuit

The logic circuit is composed of IC-11 and IC-12. The circuit is designed to select according to the control signals from the control section, the transmitting audio signals, the receiving audio signals, the handset keying signals and the RTTY keying signals.

Voice signals of emission mode J3E and H3E are transmitted and received by the microphone, receiver and the press switch of the hand set.

Press signals & tone signals are transmitted and received by RTTY on emission mode of J2B .

### Bar LED Driver

The lighting of Bar LED of Display card (5P01544A) is controlled by IC-1 according to the strength of receiving signals and the transmitting signals of the main unit. DC voltages of these inputs are A/D converted by IC-1 to light up LED bars. The number of bars to be lighted is proportional to the strength of the signals.

### Dimmer Circuit

The dimmer volume consists of two control sections. One section controls the brightness of thirteen 7-segment LEDs used for transmitting frequency display and for receiving frequency display as well as three lamp LEDs (READY, TUNE and ALARM). These controls are performed by changing the base voltage of TR-1 in the control section (5P01765A).

The other section controls the brightness of Bar LEDs and back-light LEDs for the key board.

Their controls are performed as follows.

The control section supplies the control voltage to the comparator (IC-2) at which the control voltage is compared with the output of the triangle wave form oscillator (IC-3) to produce pulse signals whose duty rate is changed according to the control voltage.

The pulse signals of changeable duty rate control the output current of IC-1 and then the power supply voltage of bar LEDs by controlling the base voltage of TR-1 in AF section (5P01545B).

### Others

TR-7 in AF section is the power supply to give +5 V DC to the control section (5P01765A).

### 3.2.3 Display Card 5P01544A

The card consists of five groups of LEDs as mentioned below.

- (1) Lamp LEDs      ALARM, TUNE, READY, FAULT ..... D- 1 to D- 4
- (2) Receiving frequency Display (7 digits, 7 segment ) ..... D- 5 to D-11
- (3) Transmitting frequency display (6 digits, 7 segment ) ..... D-12 to D-17
- (4) Key Board back lighting ..... D-19 to D-43
- (5) Bar LED ..... D-18

#### 3.2.4 Handset Filter 5P02038

The filter is provided to eliminate radio frequency signals induced in transmission in the hand-set and the curl cord.

The filter circuit is composed of three filters (coils L1 to L3 and condensers C1 to C6) and connected to the Hand-set connector J-6 directly.

They are inserted in the microphone Line , the receiver Line and the presstalk Line respectively.

#### 3.2.5 Keyboard

The key board circuit is made up of  $4 \times 8$  matrix. which is directly connected through connectors to Control Section (5P01765).

#### 3.2.6 Junction Board 5P01555B (Option)

For remote control operation , the control unit is removed from the main cabinet.

Junction Board is used for connection between the removed control unit and the main unit of the main cabinet.

J1 is the connector to the control unit and TB-1 is the connector to Junction Board ( not same) installed in the main unit. TB-2 is the terminal for connection with RTTY and the external loud speaker.

### 3.3 Transceiver Unit (Main Unit)

The main unit consists of RX/ Exciter (5P02077), Frequency Synthesizer (5P02078), T/R Control (5P01738A), Pre-Selector (5P02039), RF Power Amplifier (5P02033), Low Pass Filter (5P02034), Power Supply unit (NJD-1966B) and Junction Board(5P01764A).

The former four components are installed in the front portion of the cabinet case and the latter four components are installed in the rear portion of the cabinet.

The main unit is controlled by the signals from the control unit:

The control signals from the control unit are applied by the flatcable in the compact type system and by the system cable in the remote control type system.

The control signals are applied to T/R control via Junction Board and to each component. +8 V DC, +19V DC and +24V DC produced at P.S Unit (NJD - 1966B) are applied to each component with exception of RF Power Amplifier.

+19V DC and +48V DC are directly applied to RF Power Amplifier from P.S. unit.

### 3.3.1 T/R Control 5P01738A

The board consisting mainly of a 8 bits MPU controls the circuits of the main unit and ATU according to the data signals from the control unit.

#### Entry of Data into the 6 PLLs of the Frequency Synthesizer Board

According to the data of transmitting and receiving frequencies from the control unit, MPU IC-16 transmits the data from PB port to the frequency synthesizer board through the latch circuit (IC-2) that is controlled by PC-4 port signal.

Frequency data (from J4 - 38 ) and Clock data (from J4 - 37 ) are applied to each of 6 PLLs.

But entry of frequency data to them is controlled by Latch signal LAT - 1 to LAT - 6.

#### Switching of Emission Mode

The output data from the MPU (IC-16) PB port is passed to the Latch circuit (IC- 5) which is controlled by the signal from the PC-5 port .

The data of emission mode is applied to the frequency synthesizer board, the key timing circuit and RX/Exciter board through one of the drivers (IC-3 and IC-9 open collectors).

Crystals are switched over by the data to Frequency Synthesizer board.

Different key signals are generated by the key timing circuit according to the emission mode selected.

The receiver filters and AGC circuit are switched over by the data to RX/Exciter.



### Key Timing Circuit

KEY signal from P1-26 is passed to the line receiver (IC21-2), added by the signal from PC-1 port (IC19-38), level inverted by TR-10 and applied through the key timing circuit to the RX/Exciter, ATU and PLL etc with appropriate timing delay according to the emission mode selected.

The delay is varied by the delay circuit and signals on some mode not needing delay are by passed the delay circuit.

The switch IC-30 is provided to select these signals needing the time delay and other signals not needing time delay.

Those signals applied to Frequency Synthesizer are

- (1) T (J4-23) to switch the transmitting frequency PLL (2 ea.)
- (2) R (J4-24) to switch the receiving frequency PLL (2 ea.)
- (3) A1R (J4-25) to actuate BFO when receiving A1A signals
- (4) ST (J4-26) to actuate 455 KHZ Local signal

Different key signals are applied

- (1) KEY (P2-30) to RX/Exciter
- (2) PK (P1-54) to RF Power Amplifier
- (3) ATU KEY (P1-32) to ATU

Besides the above signals, two AF CUT signals are generated .

The one is generated in the key timing circuit in order to eliminate the spike noises which are produced in the receiver on the instant of conversion from transmitting to receiving.

The other one is generated in Frequency Synthesizer circuit in order to eliminate unwanted signals which are produced on lock-out of PLL.

These AF CUT signals are superposed and transmitted to P4-10 and then to RX/Exciter.

### Data Output Circuit

The receiving bands switching signal (RXB-1 to RXB-6) of HPU (IC-16) PB port is applied to RX/Exciter board through IC-3 which is latched by the signal from the PC-port and through the buffer amplifiers IC-14 and IC-15 (open collector).

Transmitting Low Pass Filters switching signal (TB-1 to TB -8) of IC-19 PB port is applied to the Low Pass Filter through the buffer amplifiers IC-22 and IC-27 (open collectors) and through the junction board via P1 connector.

Pre-Selector receiving band switching signal (PB-1 to PB-5) of HPU (IC-16) is latched at IC-8 and applied to the Pre-Selector via P-3 connector through the buffer amplifier IC-7 (open collector).

Pre-Selector operation switching signal (to pass Pre-Selector tuning circuit or not ) is transmitted from HPU (IC-16) PF-7 port to Pre-Selector through IC-14.

IC-19 PC port output signals are

PC-0 : "TUNE" signal is applied to ATU via P1-36 through IC -22 and Buffer Amplifiers TR-8 and TR-9.

PC-1 : "KEY" signal is transmitted when ATU is in tuning operation and when the alarm signal is transmitted.

PC-2 : "RESET" signal (on overload) is applied to Power Supply unit from P1-7 (RST).

PC-3/PC-4 : "Power Reduction " signal is applied to RX/Exciter from P2-6 and P2-4.

PC-5 : "AGC manual operation signal" is applied to RX/Exciter from P4-5.

## Data Input

### Diagnosis Signal

The diagnosis signals are consist of digital signals and of analogue signals. Some of digital signals are through IC-1 and IC-4 applied to HPU (IC-16) PA port and others to the IC-19 (Input-Output port extension) PA port.

Digital Input signals are as follows.

- (1) Signals from the frequency synthesizer board
  - UNL 1 to 6 ..... indicate the PLL conditions
  - OSC 1 to 3 ..... indicate the Crystal Oscillator conditions
  
- (2) Signals from RX/Exciter board
  - 70 MC ..... indicate the 70 MHz local signal conditions
  - 455 C ..... indicate the 455 KHZ local signal conditions
  - CH C ..... indicate the channel signal conditions
  - EX OUT C ..... indicate the Exciter RF output conditions
  
- (3) Signals from P-1 connector
  - OL ..... indicate the P.S. (+48 V) current conditions
  - ATU FAULT ..... indicate ATU conditions
  - 100 °C ..... indicate the RF power amplifier temperature conditions
  - P48C ..... indicate the RF power amplifier power supply (+48 V) voltage conditions
  - OH ..... indicate the P.S. temperature conditions and the signal (generated by IC21-1 ) indicating the SWR conditions of transmitting output power

Analogue Input Signal are as follows.

- (1) Signals from Frequency Synthesizer board (J4)
  - PLL 5C ..... indicate the power supply (+5 V) voltage conditions
  - PLL 15C ..... indicate the power supply (+15 V) voltage conditions
  
- (2) Signals from RX/Exciter (P2)
  - RX/EX15C ..... indicate the power supply (+15V) voltage conditions

(3) Signals from Connector P 1

- A24C ..... indicate ATU power supply voltage conditions
- P19C ..... indicate RF Power Amplifier voltage conditions
- PA - PF ..... indicate RF Power Amplifier transmitting output power voltage conditions
- L - PR ..... indicate reflection power (Low Pass Filter output) voltage conditions
- L - PF ..... indicate the forward wave power (Low Pass Filter output) voltage conditions

Besides the above, the signals indicating the power supply (+24 V, +19 V and 5 V) voltage conditions.

These analogue signals are applied to MPU AN-port.

Other Input Data

- B-1 READY (P1-35) signal is applied from ATU to RX/Exciter (P2-24) through the line receiver IC21-4.  
The overall gain of the transmitter is automatically controlled by this signal for the specified transmitting power.  
Upon adjustment to the specified output power, READY (RST) signal is transmitted from P2-28 to IC-19 PA7 port.
- B-2 TX-TUNE (P1-33) signal is applied from ATU to IC-19 PA -4 port through IC21-3.  
Tuning operation of the main unit is remotely controlled by the signal from ATU.
- B-3 Emission mode switching (2182 KHZ) signal H3E mode is available by connecting JP-1 and JP-2 is common and J3E-USB by opening connection of JP-1 and JP-2.  
The switching signal is applied to MPU through IC-1.

### Bar LED Display Indicating RF signal strength

The Bar-LED Display is designed to indicate the strength of the receiving electric field and the transmitting output power. The selection between the receiving electric field strength and the transmitting output power is made by means of the analogue switch IC-26 that is controlled by the key signal from IC22-16.

The receiver AGC voltage is used for indication of the receiving electric field strength. The signal from P4-16 (AGC voltage) is converted in polarity by IC20-2 and adjusted by RV - 1 and RV-2 up to the appropriate level for LED display.

The forward wave voltage (L-PF) detected by the Low Pass Filter is used for indication of the transmitting power strength.

The signal is converted in polarity by IC20-1 and the signal wave is smoothed by D-22 and C-126 for LED display.

The signal then is through the buffer amplifier TR-3 to the control unit via P1-24.

### 3.3.2 Frequency Synthesizer 5PD2078

The board generates 455 KHz , 70 MHz and 70.555 MHz to 100.455 MHz local signals of RX/ Exciter from the 10 MHz (reference frequency ) oscillator.

The frequency synthesizer consists mainly of 6 PLLs which are Hybrid ICs.

#### 80MHz to 80.4MHz Synthesizer

IC-1 and IC-3 are Hybrid ICs (4155P00451) which are oscillated at 80 MHz to 80.4 MHz . IC-1 generates the last 2 digits of receiving channel frequency and IC-3 generates the last digit of transmitting channel frequency.

The Hybrid consists of prescaler, Up/Down counter, programmable divider, Reference divider, shift register, Phase comparator and Oscillator.

The data of dividing numbers of the programmable divider and the Reference divider, the frequency data of Up/Down counter (FDTA) which are applied from T/R Control Board are latched at the Hybrid IC in synchronization with clock (CLK).

Reference frequency of the Hybrid IC is 4 KHz and the dividing number of the programmable divider is 20000 to 20099.

The number is determined according to the oscillation frequency.

The output frequency of IC-1 is divided to 1/40 and then 1/10 by the fixed dividers IC-6 and IC-11 to make the square wave of 200 KHz to 201 KHz.

The output frequency of IC-3 is divided in the same way by IC-8 and IC-12 to make the same square wave.

The output of IC-11 (or IC-12 ) selected by R signal is converted to sine wave through the filters.

#### 91.16MHz Synthesizer (Option)

IC-5 is the Hybrid IC (4155P00453) that makes the RF local signal of 455.8 KHz for receiving A1A signals.

The Hybrid IC is oscillated at 90.86 MHz to 91.46 MHz.

The Hybrid is almost same to IC-2 and IC-4.

The reference frequency is 10 KHz and the dividing number of the programmable divider is 9086 to 9146.

The output of the Hybrid IC ( 90.86 MHz to 91.46 MHz) is divided to 1/20 then 1/10 by IC -10 and IC-13 to make the RF local signal (455.8 KHz ) which is variable  $\pm 1.5$  KHz by 50 Hz step.

The output of IC-13 is applied to TR-8 of 455 Local Amplifier consisting of TR-8 and TR-9.

### 98MHz to 108MHz Synthesizer

IC-2 and IC-4 are Hybrid ICs (4155P00452) for receiving channel RF signals and transmitting channel RF signals respectively.

They are oscillated at 98 MHz to 108 MHz and make the KHZ digits frequencies (1 KHZ, 10 KHZ and 100 KHZ) of receiving channels and transmitting channels.

IC-2 and IC-4 are almost same to IC-1 and IC-3.

The reference frequency of these Hybrid ICs is 10 KHZ.

The dividing number of the programmable divider is 9800 to 10800 and determined the oscillation frequency of the oscillator.

The output frequencies of IC-2 and IC-4 are divided to 1/10 by IC-7 and IC-9 to make the square waves of 9.8 MHz to 10.8 MHz.

The output of IC-7 (or IC-9) selected by R signal is converted to sine wave through the filters.

### 455MHz Local Amplifier

The amplifier consists of the mixer, 10.455 MHz oscillator, RF Amplifier and A1A transmitting Key Filter circuits.

RF signal from the 10.455 MHz oscillator and 10 MHz signal from the reference frequency oscillator are mixed at the mixer TR-6 to make 455 KHZ.

10.455 MHz oscillator consists of one of the crystals (X1 to X 4) and TR-10.

The selection of the crystal is made by the emission mode signal from T/R Control.

The RF signal of 10.455 MHz is applied to 455 KHZ Local Mixer and IC-16 to make 60.455 MHz. RF Amplifier consists of TR-8 and TR-9.

455 KHZ Local signal applied to TR-8 Buffer Amplifier is transmitted to TR-9 Buffer Amplifier through the filter of Impedance 600  $\Omega$  to eliminate high frequency elements of the signal. TR-9 is provided to reduce the output impedance of the signal.

The Key Filter circuit consists of IC-22 and TR-1 to TR-5.

ST signal of square wave is applied to IC-22 #5pin through TR-3 which is switched on and off to make the 15V DC - 0 V DC square signal.

The signal applied to IC-22 is passed to the two stages of operational amplifiers to eliminate high order harmonics modulation frequencies of Key signals from 455 KHZ Local Signal.

IC-22 is the circuit to smooth the 455 KHZ Local Signal wave form and TR-1 to TR-5 are provided to control 455 KHZ output level when transmitted A1A mode.

### Reference Frequency Oscillator and 70MHz Local Amplifier

The 10 MHz RF output of the reference frequency oscillator OSC-1 is amplified by TR-14 and applied through Buffer Amplifiers of TR-15 and TR-16 to 455 Local mixer , 70 MHz multiplier and 40 MHz multiplier.

The oscillated reference frequency output is multiplied by TR-18 and TR-19 to make 70 MHz local signal and then applied to RX/Exciter through TR-20 for Impedance conversion.

### 10MHz to 11MHz Amplifier

The Amplifier consists of the 16.7 MHz oscillator and three mixers.

The 16.7 MHz Oscillator consists of TR-21 and the crystal X-6.

The output of the oscillator is applied to the mixer of IC-18 and IC-20 through the Buffer Amplifier TR-22.

The 200 KHz frequency for (transmitting & receiving ) channel RF signal and the output of 16.7 MHz are mixed to make 16.9 MHz and 16.5 MHz.

The unwanted 16.5 MHz is eliminated at the filter FL-1.

The signal of 16.9 MHz is mixed at Mixer IC-19 with the 9.8 to 10.8 MHz for (transmitting & receiving ) channel RF signals to make RF signal of 26.7 MHz to 27.7 MHz.

The produced signal is again mixed with 16.7 MHz at IC-20 to make 10 MHz to 11 MHz RF signal that is applied to the 60.455 MHz circuit.

### 60.455MHz Amplifier

The reference frequency oscillator output of 10 MHz is multiplied at TR-18 to TR-20 to make 40 MHz which is mixed at IC -16 with 10.455 MHz to make 50.455 MHz RF signal.

The RF signal of 50.455 MHz is mixed with 10 to 11 MHz RF signal at IC-17 to make 60.455 to 61.455 MHz RF signal .

The RF signal of 60.455 to 61.455 MHz is tuned and amplified through T-16 to T-19 and TR -28 to be applied to the 70.455 to 100.455 MHz synthesizer.



### 70.455MHz to 100.455MHz Synthesizer

The synthesizer is the final stage PLL consisting of the mixer, the oscillator and Hybrid IC9 ( 4155P000454).

The RF signal from the 60.455 MHz amplifier, the channel RF signal from IC-15 and the RF signal of 70.455 MHz to 100.455 MHz are mixed at IC-14 to make 10 MHz to 40 MHz signals.

The reference frequency of 1 MHz is produced at IC-15 by dividing the reference oscillation frequency of 10 MHz to 1/10.

The RF signal of 10 MHz to 40 MHz also divided to 1/10 to 1/40 to make 1 MHz.

These two 1 MHz are compared to control the output frequencies of the oscillators in order to synthesize the channel RF signals.

There are provided three oscillators ( one inside of IC-15 and two outside of IC-15).

These three oscillators are switched by the control signal VB-1 to VB-3 from T/R control.

The synthesized RF signals are applied to RX/Exciter through RF amplifier, Buffer Amplifier of IC-15 for amplification and impedance conversion.

### Self-Diagnosis

The board has the circuit to monitor the following oscillations ..

- (1) 10.455 MHz oscillators 4 frequencies (very slightly different)
- (2) Reference Frequency Oscillator 10 MHz
- (3) 16.7 MHz oscillator

(1) The output is detected by D-8, amplified by TR-13 and applied to T/R control as the OSC 1C signal .

(2) The output is detected by D-9, amplified by TR-17 and applied to T/R control as the OSC 2C signal .

(1) The output is detected by D-10, amplified by TR-23 and applied to T/R control as the OSC 3C signal .

### 3.3.3 RX/Exciter 5P02077

The RX/Exciter board consists of the receiver and the exciter.

They are switched over by the transistor switch and the diode switch which are controlled by the key signals.

In the receiver, RF signals are converted to AF signals through the RF, 1st IF (70.455 MHz) the 2nd IF (455 KHz) and AF circuits.

In the Exciter, AF signals are reversely converted to RF signals.

Frequency conversion is made by the two passive DBM ( double ballanced mixer) and the one active DBM.

#### Receiver

RF signals received at the RX antenna are applied to RF stage.

The RF stage has the two protection circuits. One against the excessively large Input ( D- 17 to D-20 ) and the other against static electricity charged at the RX antenna. ( T -18)

There are provided the following six Band - Pass Filters which are switched over by diodes (D-21 to D-32 ) according to the RX-Band data signals and which are designed to eliminate inter-modulations and cross-modulations.

RXB1	.....	100 KHZ	to	405 KHZ	(except 405 KHZ)
RXB2	.....	405 KHZ	to	527 KHZ	(except 527 KHZ)
RXB3	.....	527 KHZ	to	1.6 MHZ	(except 1.6 MHZ)
RXB4	.....	1.6 MHZ	to	4.0 MHZ	(except 4.0 MHZ)
RXB5	.....	4.0 MHZ	to	1 4 MHZ	(except 1 4 MHZ)
RXB6	.....	1 4 MHZ	to	3 0 MHZ	

RXB1 to BXB4 have the impedance conversion circuits respectively which are designed for high capacitive impedance antenna.

Each impedance conversion circuit has three tap terminals, L, Center and H.

L and Center are connected for regular ( 50  $\Omega$  ) impedance and Center and H are connected for high impedance antenna. (TP-1 to TP-12 )

The output of BPF is applied to the attenuator circuit which is controlled by RF AGC signal.

The attenuator is composed of three pin diodes (D33 to D35 ) and its maximum attenuation is about 30 dB at its impedance ( input and output ) 50  $\Omega$ .

RF signal is amplified by the wide band RF Amplifier TR-13 and applied to the 1st mixer M 2 through the diplexer consisting of L and C elements.

The Mixer M2 is a DBM of impedance ( input and output ) 50 $\Omega$  and RF local signals of 70.555 MHz to 100.455 MHz are applied to the #8 pin of the mixer.

At the mixer, RF signals are converted to 70.455 MHz and amplified by the IF Amplifier consisting of two FETs, TR-14 and TR-15 (N-Channel Junction FET).

The amplified IF signal (70.455 MHz ) is applied to the crystal filter FL-1 through the attenuator of D33 to D35.

The performance characteristics of the crystal filter FL-1 is as follows .

the input & output impedance -----	50 $\Omega$
the Center Frequency -----	70.455 MHz
6 dB Band-width -----	15 KHz (approximately)

The crystal filter is provided to eliminate undesirable RF signals and to prevent inter-modulation and cross-modulation which are possibly produced at the subsequent IF stages.

The IF signal is amplified by TR-18 and TR-19 (FET) and applied to the 2nd mixer M1 which has the input & output impedance of 50 $\Omega$ .

The IF signal is mixed with 70 MHz RF local signal at the mixer M1 (DBM) (pin #8) to be converted to the 2nd IF signal of 455 KHz and to be applied to the next FET Amplifier of TR-20 and TR-21.

The input impedance 50 $\Omega$  of the FET Amplifier is converted to the output impedance 1.8 k  $\Omega$  through the output transformer T-9.

The 2nd IF signal is applied to the mechanical filter in order to eliminate unwanted signals. FL2, FL3 or FL4 of the mechanical filter is switched over according to the emission mode data.

The input and output impedance of the mechanical filter is 1.8 k $\Omega$  and the sharp attenuation characteristics is as follows .

FL 2 -----	2.4 KHz	for 6 dB attenuation band width
FL 3 -----	5.4 KHz	for 6 dB attenuation band width
FL 4 -----	0.5 KHz	for 6 dB attenuation band width

The IF stage consists of TR-22 to TR-24 and TR-28 ; two MOS FETs and two transistors. AGC voltage is applied to the gate 2 of the FETs in order to give the large dynamic range.

The 2nd IF signal is beat-detected by IC-2 on emission mode of J3E, A1A and J2B and envelope-detected by D-76 on emission mode of H3E and A3A to be converted to AF (Audio Frequency).

The detected output is applied to the AF Hybrid IC (IC-9) through the analogue switch IC -8 or TR-38.

Selection of the analogue switches is performed according to the emission mode selected. The AF Hybrid IC is an active low-pass filter of 4 order , and provided to eliminate unwanted high frequency elements from the detected output.

The performance characteristics of the active filter is as follows.

Input impedance	.....	10 K $\Omega$
Output impedance	.....	200 $\Omega$
Cut off frequency	.....	3 KHZ

AF signal, the output of the active filter is amplified by the operation amplifier to the specified level, balanced at the AF output transformer and applied to T/R Control Board (5P01738A).

TR-29 to TR-37 and IC-7 in the AGC circuit is provided to control the receiver gain.

## Exciter

In transmission, the AF signal is amplified by the AF Section board (5P01765A) to the specified level and applied to the modulator IC-2 through the analogue switch IC-1 to be converted to the transmitting 1st IF 455 KHz.

The transmitting 1st IF is applied to the filter FL-2 through RV-1 (or RV-2) and TR-1 for establishment of modulation level.

RV-1 is selected for emission mode of J3E and RV-2 for H3E.

The filter is provided to block the unwanted side band signals and carrier frequency, limiting the transmitting frequency bandwidth.

The 1st IF signal of the filter output is applied to the 2nd mixer of input impedance 50  $\Omega$  through the TR-2 Buffer Amplifier for impedance conversion.

On emission mode of A1A and H3E, the carrier frequency is applied through IC-4 to the base of TR-2.

The 2nd IF signal converted to 70.455 MHz at the mixer M1 is applied to the gate 1 of TR-3 through the filter FL-1 which is provided to increase the transmitting S/N.

The voltage of the gate 2 of TR-3 is controlled by IC-11.

Then the transmitting RF output of TR-3 is controlled (automatic power control) to prevent the overinput of Power Amplifier unit (5P02033).

TR-3 (FET) output is converted to RF signal through the 3rd mixer DBM M2.

RF amplifier consists of three transistors of TR-4 to TR-6 and there is provided between TR-4 and TR-5 the power reduction attenuation circuit of power medium and power low steps.

The RF signal is amplified to the specified level by TR-5 and TR-6 and applied to the Power Amplifier unit.

### 3.3.4 RF (Power Amplifier) 5PO2033

The unit consists of the RF Amplifier, the bias circuit and the self - diagnosis circuit. The specified performance of the RF Amplifier is as follows.

Frequency range .....	1.6 to 28 MHz
Impedance (output & input) .....	50 $\Omega$
Power gain .....	44 dB (approximately)
Output power .....	250 W
Heat dissipation .....	Heat - sink cooling

The RF signal from J-1 is amplified by TR-2 to the rated level . . .

TR-2 is a A-class single amplifier and its bias is supplied from TR-1 which is controlled by the key signal.

The amplified RF-signal is applied divided to the AB class push-pull amplifier of TR-3 and TR -4 through T-1 which converts impedance.

The bias of the push-pull amplifier is controlled by TR-7 to TR-10 which are controlled by the key signal.

TR-9 is the transistor for temperature compensation of the TR-3 and TR-4 bias circuit.

TR-5 and TR-6 compose the final stage of the push-pull AB class amplifier where the RF signal is amplified up to the specified output power.

The grounding of TR-5 and TR-6 is floating and insulated by T-4 and T-6.

The bias circuit of TR-5 and TR-6 is composed of TR-11 to TR-13 and IC-1 (key signal convertor ).

TR-12 is the transistor for temperature compensation of the bias circuit.

With the S-1 actuated, no key control signals are applied and no bias is applied to the final stage amplifier.

With S-2 actuated, T/R control reduces the output of RX/Exciter to "medium".

The diode D-1 detects only the forward wave of RF signal that is passed through T-7 and T -8. The detected forward wave is converted to DC (voltage ) of the specified level at the T/R control to be used as the DC signal which controls the RX/Exciter transmitting output power.

IC-3 is provided to monitor the power supply of 48 V for the final stage. If the 48 V is out of the voltage range allowed, IC-3 actuates TR-14 that applies the 48 V check signal to T/R control through IC-1.

IC-1 is the grounding isolation IC.

### 3.3.5 RF (Power Amplifier) 5PO3008

The unit consists of the RF Amplifier, the bias circuit and the self - diagnosis circuit. The specified performance of the RF Amplifier is as follows.

Frequency range .....	1.6 to 28 MHz
Impedance (output & input) .....	50 $\Omega$
Power gain .....	44 dB (approximately)
Output power .....	250 W
Heat dissipation .....	Heat - sink cooling

The RF signal from J-1 is amplified by TR-2 to the rated level .

TR-2 is a A-class single amplifier and its bias is supplied from TR-1 which is controlled by the key signal.

The amplified RF-signal is applied divided to the AB class push-pull amplifier of TR-3 and TR -4 through T-1 which converts impedance.

The bias of the push-pull amplifier is controlled by TR-7 to TR-10 which are controlled by the key signal.

TR-9 is the transistor for temperature compensation of the TR-3 and TR-4 bias circuit.

TR-5 and TR-6 compose the final stage of the push-pull AB class amplifier where the RF signal is amplified up to the specified output power.

The grounding of TR-5 and TR-6 is floating and insulated by T-4 and T-6.

The bias circuit of TR-5 and TR-6 is composed of TR-11 TR-12, and IC-1 (key signal convertor).

TR-12 is the transistor for temperature compensation of the bias circuit.

With the S-1 actuated, no key control signals are applied and no bias is applied to the final stage amplifier.

With S-2 actuated, T/R control reduces the output of RX/Exciter to "medium".

The diode D-1 detects only the forward wave of RF signal that is passed through T-7 and T -8. The detected forward wave is converted to DC (voltage ) of the specified level at the T/R control to be used as the DC signal which controls the RX/Exciter transmitting output power.

IC-3 is provided to monitor the power supply of 48 V for the final stage. If the 48 V is out of the voltage range allowed, IC-3 actuates TR-14 that applies the 48 V check signal to T/R control through IC-1.

IC-1 is the grounding isolation IC.

3.3.6 LPF (Low Pass Filter) 5PO2034

The filter circuit is designed to eliminate the high order harmonics included in the RF signal output of Power Amplifier.

The frequency range of 1.6 to 28 MHz is divided into 8 bands of TB -1 to TB-8 as described below.

These bands are switched according to the TB signals from the main unit.

TB-1	.....	1.6 MHz	to	2.3 MHz ( 2.3 MHz not included )
TB-2	.....	2.3 MHz	to	3.3 MHz ( 3.3 MHz not included )
TB-3	.....	3.3 MHz	to	4.7 MHz ( 4.7 MHz not included )
TB-4	.....	4.7 MHz	to	6.7 MHz ( 6.7 MHz not included )
TB-5	.....	6.7 MHz	to	9.7 MHz ( 9.7 MHz not included )
TB-6	.....	9.7 MHz	to	13.8 MHz (13.8 MHz not included )
TB-7	.....	13.8 MHz	to	19.7 MHz (19.7 MHz not included )
TB-8	.....	19.7 MHz	to	28 MHz

Each band is composed of the 7 order or 8 order type filter and its input and output impedance is 50  $\Omega$ .

T1 and T2 at the output of the Low Pass Filter are the directional couplers to detect the forward wave and the reflected wave of the RF signal.

The detected RF signal is rectified by D-9 and D-10 to be converted to the DC signal ( forward wave signal and reflected wave signal).

The DC signals are computer-processed by the T/R control PCB to be used for measurement of SWR and for self-diagnosis.



3.3.7 PS (Power Supply) NJD - 1966B

General

The power supply unit is designed to convert the input of 10.8 ~31.2V DC to the output of 48V, 24V, 19V and 6V.

Performance Specification

(1) Input voltage DC 12V/24 V (10.8 V ~31.2 V )

(2) Output voltage and output current

(a) 4.8 V  $\pm$  3 %      13 A ~ 0.1 A

(b) 24 V  $\pm$  10 %      1 A ~ 0.3 A

(c) 19 V  $\pm$  10 %      4 A ~ 1.6 A

(d) 8 V  $\pm$  2 V      1.2 A ~ 0.3 A

(3) Output ripple

(a) (b)      ..... 500 mV P-P

(c) (d)      ..... 300 mV P-P

(4) Overvoltage protection

The protection circuit works and the power supply unit does not operate when the 48 V output is increased more than up to 110 % .

(5) Overcurrent protection

The protection circuit works and the power supply unit does not operate when the current of 48 V output is increased more than up to 110 % (14.3 A).

(6) Operation temperature

- 20 °C ~ 60 °C

### Operation

- (a) Make sure that the input and the output connectors are secured in the right way.
- (b) Make sure that the switches "MSW", "RX" and "R/T" are put off.

Apply the DC power supply .

- (c) Apply the input and turn on "MSW".

The power unit works with "RX" or "T/R" switch turned on.

"MSW" switch ----- Main switch

"RX" switch ----- Switch for the outputs excepting 48 V

"R/T" switch ----- Switch for all outputs

During the warming-period of several seconds after turn on of "MSW", the power supply unit does not work. But this is not trouble.

The power supply unit operation is interrupted during the period when the power supply unit input voltage is instantaneous by dropped to below the specified minimum voltage.

### Theory

The Fig.-1 shows the Block Diagram of power supply unit which consists of the 48 V - chopper and the DC/DC converter to convert the 48 V to the other specified voltages.

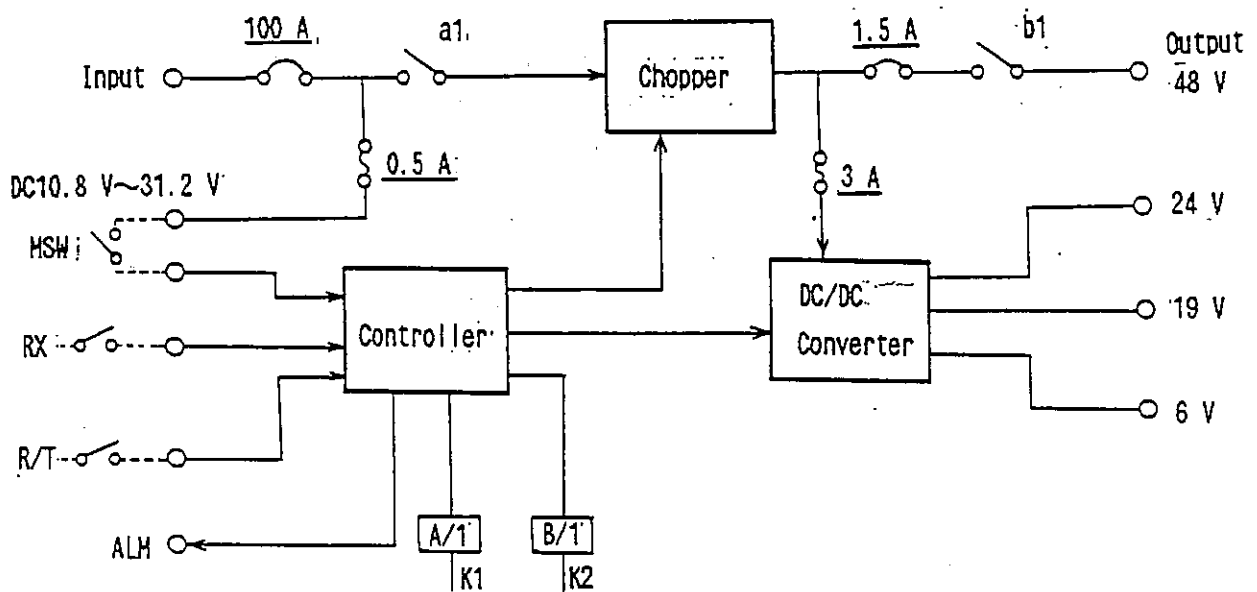


Fig. 1

With "MSW" turned on, the power supply unit is ready for operation.

With "RX" turned on, the chopper works and DC/DC converter works.

The DC/DC converter receives the 48 V output of the chopper and converts to the 24 V, 19 V and 6 V.

With "R/T" turned on, the output relay K2 works and the output current is applied to all the outputs of 48 V, 24 V, 19 V and 6 V.

## Chopper

The Fig.-2 shows the chopper circuit.

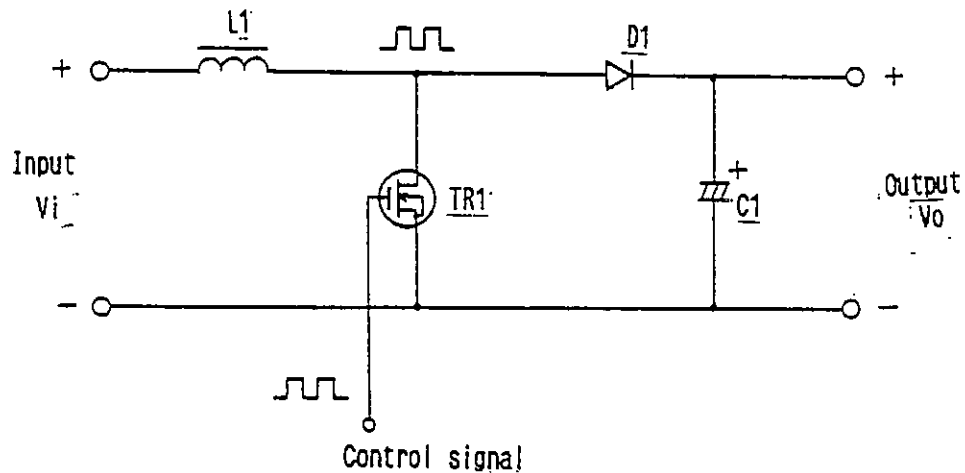


Fig.-2

The chopper circuit is a step-up type switching regulator to get the output voltage higher than the input voltage.

L1 and C1 are the reactor and the capacitor to store energy.

TR-1 is the switching transistor and D1 is the rectifier diode.

With the TR-1 switch on, the input voltage  $V_i$  is applied to the reactor L1 and energy is stored at L1.

With TR-1 switch off, energy stored at L1 is passed through D1 to the capacitor C1 keeping the output voltage  $V_o$  at constant.

$$V_o = V_i + V_i \frac{t_{\text{on}}}{t_{\text{off}}}$$

$t_{\text{on}}$  : TR-1 switch is on.

$t_{\text{off}}$  : TR-1 switch is off.

Therefore, the output voltage is kept at constant by controlling the time of "on" and time of "off". Time of "on" and time of "off" are the time ( period) while TR-1 switch is on and off.

The control signal of TR-1 is applied from the control IC ( MB3759).

The control IC has the oscillator, the high-gain amplifier and the reference voltage circuit and is able to supply the precise control .

DC/DC Converter

Fig-3 shows the converter circuit.

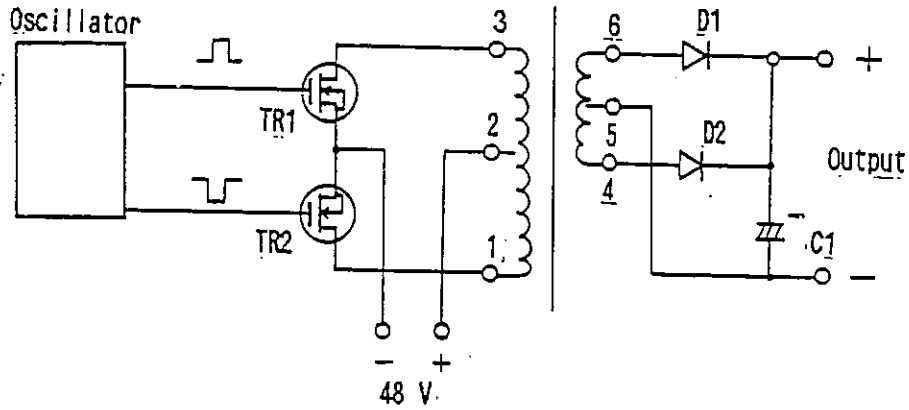


Fig.-3

The converter circuit is designed to convert the DC 48 V to 24 V, 19 V and 6 V.

The control IC ( $\mu$ PC1042C) is employed in the oscillator of the unit to generate the signal that is shifted  $180^\circ$  in phase alternately.(AC)

The signal is power-amplified to the specified level by the switching transistors TR-1 and TR-2.

The voltage of power-amplified signal is transformed by the transformer T-1 and converted to-DC by D-1, D-2 and C-1 to produce the specified DC output voltages.

The Fig.-4 shows the driving signals of TR-1 and TR-2 and the wave-form applied on T-1. The driving signal TR-2 is delayed by (time)  $t_d$  from that of TR-1 to prevent Dead-Time zero (overcurrent) .

The output voltage are established by adjusting the time delay  $t_d$ .

The output voltages are not regulated and instable.

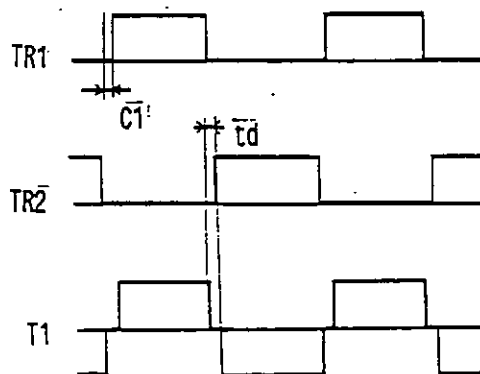


Fig. 4

## Control

The control circuit and its control signals are as follows.

- (a) MSW : to ON/OFF of power supply to the control circuit
- (b) RX : to drive the chopper circuit and actuate the DC/DC converter circuit
- (c) R/T : to actuate the output relay K-2 to supply all the outputs.
- (d) O.H : to cut-off the 48 V output on sensing over-heat of the power supply unit and to transmit the "L" level signal.  
(The power supply unit operates again when the temperature is decreased to the allowable level. )
- (e) O.C : to cut off the 48 V output on detection of the overload of the 48 V output circuit and transmit the "L" level signal.  
(Transmission is interrupted by the drop of 48 V output voltage.)  
For re-setting, "RST" shall be positioned to "L" level or "RX" and "R/T" signals shall be off.
- (f) RST : to re-set the power supply unit operation interruption due to the overcurrent (overload ) protection.
- (g) Sensing of the input voltage : The power supply unit is not operated when the input voltage is below the allowable level.

The timer is built in to delay operation of the power supply unit several seconds after the connection to the main power source and switch on of "MSW".

## Adjustment

Usually no adjustment is needed because the power supply unit is perfectly adjusted in factory before delivery.

But if necessary, the adjustment shall be made as follows.

### (a) 48 V output voltage adjustment

The output voltage shall be adjusted by VR-1(A-1 board) to the +48 V at the output connector terminal (P8).

### (b) 48 V output current adjustment

The output current shall be adjusted by VR-2 in the A-1 board.

The output current should be increased gradually (The load resistance is decreased.) up to about 14.3 A where the output voltage shall begin decreasing.

If the output voltage is excessively decreased down to below 45 V, no output is applied to the board and "O.C" (overcurrent ) signal is set to "L" level.

After restoration of load resistance to normal condition , the 48 V output is again applied with "KST" set to "L" level.

During the overcurrent adjustment, the 24 V, 19 V and 6 V outputs shall be the rated loads.

### (c) 24 V/ 19 V/ 6 V output voltage adjustment

The output voltages shall be adjusted by VR-1 in the A-2 board.

The 24 V output shall be adjusted at 24 V with the output load adjusted at about 70 % of the rating.

The 19 V output and the 6 V output shall be varied with the adjustment of the 24 V output. As it is impossible to adjust each of the outputs independently, their adjustments shall be achieved .

It should be noted that the output voltage is increased 10~ 15 % higher than the rating, if their output loads are none or very small. (less than 30 % of the rating voltage )

When adjusted , the adjusting volumes (VR-1 and VR-2) should be marked with white paint in order not to be tampered with.

It should be cautioned that the wrong adjustment of the output voltages and currents reduces performance and damages the power supply unit.

### 3.3.8 Junction Board PO1764A

Junction Board is provided for connection among the main unit, Control unit and ATU. Connection is made by means of the terminal boards and the plug-in connectors. The terminal boards are used for connection to the external units such as RTTY , external speaker, ATU and Remote Control unit while plug-in connectors are used for internal connections with for example power supply, T/R control, Power Amplifier etc. 2A fuse in the ATU +24 V DC line is provided for protection of ATU power supply and the main unit power supply. R1 and R2 in the +24 V DC line are provided to divide the line voltage to make A24C signal (low voltage) to monitor the line voltage. A24C signal (ATU +24 V DC check ) is applied to T/R control unit to be used for self-diagnosis test. The display card of the Control unit shows the error code (E-32) when the +24 V DC is out of the specified voltage range.

### 3.3.9 Preselector 5P02039 (Option)

The board consists of the RF tuners provided at the input stage of the receiver.

The receiving frequency range of 100 KHz to 29999.99 KHz is divided into 7 bands by PB-3 to PB-5 and further divided in smaller bands by PB-1 and PB-2.

These bands are switched over according to the control signals from T/R control (5P01738 A).

The division of frequency band by the control signal is shown on the next page.

The selection and switching to these bands are performed by the diode switches connected to the respective tuner circuits.

In case of "preselector wide (off)", the diode switch for "preselector wide" is selected and RF signal is directly applied to RX/Exciter.

Each multi-tuner circuit consists of transformers, varicap diodes, condensers and choke coils.

The varicap diodes are functioned as the tuning condensers and coupling condensers to the transformers.

The varicap diodes are controlled by the collector voltage of TR-1 that is controlled by the volume installed on the Control unit panel and connected to the PRSEL Input port.

The choke coils inserted in parallel in the multi-tuner circuit is provided to reduce inductance of the tuning transformers and these coils are selected depending upon the band frequency to be tuned.

In case of an antenna that is capacitive and high impedance (our design is based on  $10 \Omega + 250 \text{ PF}$  maximum), connection of jumping wires to the center and "H" position is recommended to apply RF signal to the tuning circuit.

Usually, the antenna impedance is  $50 \Omega$  at Factory adjustment for the connection of the "center" to "L" position.

The receiving frequency (band) signals from PB-1 to PB-5 are converted to the 11 bits signals by Decoder IC, (IC-1 and IC-2) and amplified by Driver IC (IC-3 and IC-4), selecting the diode switch and the receiving frequency band.



PRE - SELECTOR BAND CODE

<u>PRE - SELECTOR</u>	<u>P S E L</u>	<u>P 3 1</u>	<u>P 3 2</u>	<u>P 3 3</u>	<u>P 3 4</u>	<u>P 3 5</u>
W I D E	H	L	L	L	L	L
100.00 ~ 141.99 KHZ	L	L	L	H	H	L
142.00 ~ 199.99 KHZ	L	L	H	H	H	L
200.00 ~ 284.99 KHZ	L	H	L	H	H	L
285.00 ~ 404.99 KHZ	L	H	H	H	H	L
405.00 ~ 526.99 KHZ	L	L	L	H	L	H
527.00 ~ 933.99 KHZ	L	L	L	H	L	L
934.00 ~ 1599.99 KHZ	L	L	H	H	L	L
1600.00 ~ 2559.99 KHZ	L	L	L	L	H	H
2560.00 ~ 3999.99 KHZ	L	L	H	L	H	H
4000.00 ~ 5699.99 KHZ	L	L	L	L	H	L
5700.00 ~ 7999.99 KHZ	L	L	H	L	H	L
8000.00 ~ 11399.99 KHZ	L	L	L	L	L	H
11400.00 ~ 15999.99 KHZ	L	L	H	L	L	H
16000.00 ~ 21999.99 KHZ	L	L	L	L	L	L
22000.00 ~ 29999.99 KHZ	L	L	H	L	L	L

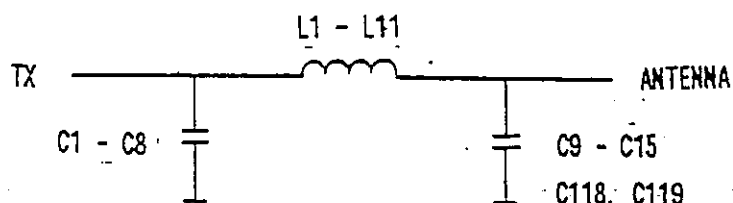
### 3.4 Antenna Tuning Unit

ATU (Antenna Tuning Unit) is composed of the LC Network (5P01553A) and the ATU Control (5P01749B) that is shielded.

The main Unit and ATU are connected by the 12-wires system cable, the transmitting coaxial cable and the receiving coaxial cable.

Antenna matching is automatically performed with the "tune" signal from the main Unit.

#### 3.4.1 LC-Network 5P01553A



LC Network is composed of (1) the attenuator that is inserted in tuning operation to the transmitting signal line (2) the directional coupler that measures the situation of antenna matching (3) the 90° phase-shift circuit (4) LC circuit as shown above and (5) the relay circuit switches the elements of the LC circuit.

The Attenuator (1) is designed to prevent the transmitter load impedance deviate largely from 50  $\Omega$

#### 3.4.2 ATU Control 5P01749B

ATU Control is composed of 8 bits MPU, the detector and the Bar LED Display.

The detector consists of the Double Balanced Mixers M1 and M2 and the Comparator IC-13.

The Bar LED Display indicates the strength of (1) the forward wave, (2) the reflected wave and (3) the antenna current.

### Theory of Tuning Operation

The forward wave voltages and the reflected wave voltages of the directional coupler are applied to DBM(M1) for product of these two voltages.

After elimination of the high frequency elements, the output is applied to the comparator IC-13 for estimation of the antenna Impedance absolute value.

$| Z_{ant} | > 50 \Omega$  if IC-13-1 output "H" (nearly + 5 V DC )  
 $| Z_{ant} | < 50 \Omega$  if IC-13-1 output "L" (nearly 0 V DC )

Also, the forward wave voltage of the directional coupler and the 90° phase shift circuit voltage are applied to DBM (M2) for product of these two voltages.

After elimination of the high frequency elements, the output is applied to the comparator IC-13 for estimation of the antenna Impedance Inductivity

$Z \dots\dots +J$  (Inductive) if IC-13-7 output "H" (nearly + 5 V DC )  
 $Z \dots\dots -J$  (Capacitive) if IC-13-7 output "L" (nearly 0 V DC )

The forward wave voltage and the reflected wave voltage are detected by D-8 and D-7 to be applied to the analogue input port of MPU (IC-1).

"Tuning" is performed by calculating the detected signal voltage in the MPU (IC-1).

When the reflected wave voltage is lower than the specified level, "Ready" signal is transmitted to indicate that tuning is completed.

Tuning is performed automatically with selection of the most appropriate combination of L and C elements of LC Network as described below.

Refer to the Figure of 3-1.

Here we call the group of C-1 to C-8 as CA (transmitter side capacitors), the group of C-9 to C-15, C-118 and C-119 as CB (Antenna side capacitors), the group of L1 to L11 as L. Their particular capacitance & inductance values are described in the table of 3-4.

If the antenna impedance is - J (capacitive), L should be increased from the smallest (L -1 ) value to an appropriate value ( signal L element or combination of some L elements ) where -J (capacitive ) is converted to +J (inductive).

The impedance absolute value Z shall be measured at this turning point.

If Z is lower than 50  $\Omega$ , tuning is performed by selecting appropriate combination of elements CA and L.

If Z is higher than 50  $\Omega$ , tuning is performed by selecting appropriate combination of elements CB and L.

If the antenna impedance is +J (inductive), capacitance should be increased from the smallest (C-9 + C-118) value to an appropriate value (signal C8 element or combination of some C8 elements) where +J is converted to -J.

The impedance absolute value Z shall be measured at this turning point.

If Z is higher than 50  $\Omega$ , tuning is performed by selecting appropriate combination of elements of C8 and L.

If Z is lower than 50  $\Omega$ , appropriate combination of CA elements (instead of C8 elements) and L elements shall be selected.

#### Bar LED Display

The display is provided to indicate the strength of the forward wave, the reflected wave and the antenna current.

The output DC voltage of the forward wave detected by D-8, the output DC voltage of the reflected wave detected by D-7 and the DC voltage proportional to the antenna current detected D-47 are applied to the Buffer Amplifier consisting IC-11 and IC-12.

These DC voltages are selected for Bar LED Display by means of S-4 and S-5 on the LC Network PCB.

The selected DC voltage is applied to IC-10 through the smoothing circuit consisting of IC-11 and D-16 which smoothes the instantaneously changing signal voltage for display purpose.

IC-10 is the Bar LED Driver having A/D convertor built in it.

The number of LED Bars which are lighted is varied depending upon the input voltage of IC - 10.

### 3.4.3 Input and Output Signals

<u>Input or Output Signals</u>	<u>Terminal</u>	<u>Level</u>
Power Supply +24 V DC	TB 2-2	
TUNE (Input)	TB 2-5	"L" 0 V to 6 V "H" 6 V to 12 V
KEY (Input)	TB 2-10	"L" 0 V to 6 V "H" 6 V to 12 V
OL (over load) (Input)	TB 2-7	"L" less than 10V "H" higher than 12 V or high impedance
READY (Output) ( tune completed)	TB 2-6	"L" 0 V "H" 12 V
FAULT (Output)	TB 2-3	"L" 0 V "H" high impedance
TX TUNE (Output)	TB 2-5	"L" 0 V "H" high impedance
MANUAL (Output)	TB 2-8	"L" 0 V "H" high impedance

#### Power Supply

+24 V DC is supplied from the main unit through the system cable.

The 24 V DC is directly supplied to the LC Network, Attenuator, and the antenna switch relay.

+12 V DC and +5 V DC are produced by IC-1 and IC-2 on the LC Network PCB.

+12 V DC is applied to the analogue circuit of the ATU control unit and +5 V DC is applied to the HPU and its associated circuits.

#### Tune and Key Signals to the ATU Control Unit

Through the line receiver IC-14, the tune signal is applied to MPU and the Key signal to the antenna switching relay driver circuit.

### Tune Completion Signal READY

Tune Signal is applied from the main unit. When tuning is completed, "READY" signal is transmitted from the MPU to the main unit through the line driver circuit consisting of TR-6 to TR-8.

### FAULT Signal

FAULT signal is transmitted to the main unit when (1) + 12 V DC power supply line and / or (2) + 5 V DC power supply line is not normal or (3) the power switch (S -1) on the LC Network PCB is not in "on" position.

### TX TUNE Signal

TX TUNE signal is transmitted through S-3 on the LC Network PCB (ATU) to the main unit in order to tune the exciter (main unit) at the transmitting frequency selected at the main unit side.

### MANUAL Signal

MANUAL signal is transmitted by setting S-2 (on the LC Network PCB) at "manual " position when LC elements of the LC Network should be manually selected.

### 3.4.4 Manual Selection of LC Elements of LC Network

The parts and switches

<u>Switch No.</u>	<u>Circuit Reference No.</u>	<u>Ratings</u>	<u>Responding LED</u>
S 6 - 1	C - 1	30 PF	D14 - 1
2	C - 2	60 PF	2
3	C - 3	120 PF	3
4	C - 4	240 PF	4
5	C - 5	480 PF	5
6	C - 6	960 PF	6
7	C - 7	1900 PF	7
8	C - 8	3800 PF	8
S 7 - 1	L - 1	60 nF	D15 - 1
2	L - 2	120 nF	2
3	L - 3	240 nF	3
4	L - 4	480 nF	4
5	L - 5	960 nF	5
6	L - 6	1.9 $\mu$ F	6
7	L - 7	3.8 $\mu$ F	7
8	L - 8	7.5 $\mu$ F	8
S 8 - 1	L - 9	15 $\mu$ F	D16 - 1
2	L - 10	30 $\mu$ F	2
3	L - 11	55 $\mu$ F	3
4	none	—	4
5	none	—	5
S 9 - 1	C 9 + C-118	15 PF	D17 - 1
2	C 10 + C-119	30 PF	2
3	C - 11	60 PF	3
4	C - 12	120 PF	4
5	C - 13	240 PF	5
6	C - 14	480 PF	6
7	C - 15	960 PF	7
8	none	—	8





**Part 4**

**TROUBLE SHOOTING CHECK LIST**



4. Trouble Shooting Check List

When a trouble occurs in DEBEG 3120 the cause of trouble is found by the check list which referring to the error message shown on RX DISPLAY.

Function of Self-Diagnosis

DEBEG 3120 has a function of Self - Diagnosis.

If there is some failure inside, the details are shown on RX DISPLAY.

There are 25 types of displaying the failure (Refer to table 2 ).

The error message is displayed when turn the power supply switch "ON", press the  button, and press the ,  button simultaneously.

The conditions of displaying the error messages are different in each case as follows.

A. When turn the power supply switch "ON".

Function of Self - Diagnosis becomes operative with setting the TX and RX frequency to distress frequency 2182 KHZ (USB).

There are 21 types of error messages.

B. When press the  button.

Function of Self - Diagnosis becomes operative with TX and RX frequency on RX and TX DISPLAY. There are 21 types of error messages.

C. When press the  and  button simultaneously.

(Note ; Be sure to press the  button first.)

Function of Self - Diagnosis becomes operative with TX and RX frequency on RX DISPLAY.

There are 25 types of error messages (21 types in Item B plus 4 types as to transmission. )

List of Error Messages

<u>ERROR MESSAGE NO.</u>	<u>PRINTED CIRCUIT BOARD WITH SENSER</u>	<u>DETAILS OF FAILURE</u>
E01	Frequency Synthesizer UNL 6	IC15 RX/TX 1 MHz Step loop lock out
E02	Frequency Synthesizer UNL 2	IC 2 TX 100 Hz Step loop lock out
E03	Frequency Synthesizer UNL 4	IC 4 TX 1 KHz Step loop lock out
E04	Frequency Synthesizer UNL 3	IC 1 RX 10 Hz Step loop lock out
E05	Frequency Synthesizer UNL 5	IC 3 RX 1 KHz Step loop lock out
E06	Frequency Synthesizer UNL 1	IC 5 A1A BF0.50 Hz Step loop lock out
E13	Frequency Synthesizer OSC 3	16.7 MHz Crystal Oscillator (X 6) is inoperative.
E14	Frequency Synthesizer OSC 2	10 MHz Reference Oscillator (OSC 1) is inoperative.
E15	Frequency Synthesizer OSC 1	Crystal Oscillator (X1 - X4) is inoperative.
E17	RX / Exciter RX / EX 15C	Output of IC12 (+15 V DC, AVR) is not fed in RX / Exciter.
E18	T / R Control 19C	+19 V DC is not fed from P.S. unit or the actual current is quite different from +19 V DC.
E19	T / R Control 24C	+24 V DC is not fed from P.S. unit or the actual current is quite different from +24 V DC.

<u>ERROR MESSAGE NO.</u>	<u>PRINTED CIRCUIT BOARD WITH SENSER</u>	<u>DETAILS OF FAILURE</u>
E20	T / R Control 5 C	+ 5 V DC voltage from P.S. unit is different from the standard voltage + 5 V DC.
* E21	Low Pass Filter L - PFX	Transmitting signal is missing.
* E22	Low Pass Filter L - PR	Load of Low Pass Filter is quite different from 50Ω (Check the TX cable , ATU and Antenna. ).
E23	Frequency Synthesizer PLL 15C	Output of IC25 (+15 V DC, AVR) is not fed in Frequency Synthesizer.
E24	Frequency Synthesizer PLL 5C	Output of TR36 (+ 5 V DC ) is not fed in Frequency Synthesizer
E25	P.S. unit OH	Overheat in P.S. unit.
* E26	Power Amplifier P48C	+48 V DC is not fed from P.S. unit. (Check P3)
E27	Power Amplifier 100 °C	The temperature of Power Amplifier becomes more than 100 °C (S2).
E28	A T U ATU FAULT	Power switch is not tuned "on " or output of IC1 or IC2 (AVR) is not fed in ATU .
* E29	Power Amplifier P - PF	Transmitting signal is not fed to LPF unit from Power Amplifier.
E30	Power Amplifier P-19C	+19 V DC is not fed from P.S. unit. (Check P4).
E31	Power Amplifier 110 °C	The temperature of Power Amplifier becomes more than 110 °C (S1).
E32	Junction Card A24C	+24 V DC voltage is not fed to ATU. (Check F1)

\* TEST and TX only

### 4.3 Check List

#### 4.3.1 CPU

The following phenomenon occurs, when there is something wrong with CONTROL SECTION.

- (•The mark "8" is displayed on one segment of RX / TX DISPLAY and at the same time tones come out continuously.)

The following phenomenon occurs, when there is something wrong with T / R CONTROL.

- "CPU" is shown on Display several seconds after Main switch and RX switch are turned "on" .

The following phenomenon occurs, when there is something wrong with ATU CONTROL.

- "E28" is shown on RX Display when TEST or TUNE button is pressed.

#### 4.3.2 Frequency Synthesizer

Check items as to Power Supply

- E23; ① IC25 (+ 15 V, AVR )
  - ② Isn't there anything wrong with the load of + 15 V ?
  - ③ Is the voltage + 19 V fed to P1-49 and 50 ?
- E24; ① TR36 and D17 are bad.
  - ② The load of +5 V (IC1 - 13 ,23, 24 )
  - ③ Is approx. 6.5 V fed to P1-1 and 2 ?
  - ④ Is the voltage + 19 V fed to P1-49 and 50 ?

Check items as to Crystal Oscillator

- E13; ① X6
  - ② TR21 - 23
- E14; ① OSC1
  - ② IC21
  - ③ TR14,16,17
- E15; ① X1 - 4
  - ② TR10 - 13

Check items as to P.L.L

- E01; IC15,TR31,TR32 (RX / TX 1 MHz Loop)  
and IC6 - 14, 16 - 20 ,TR10 - 12, 14 - 16, 18 - 22, 24 - 30, 33 - 35
- E02; IC3(TX 100 Hz Loop) 80 - 80.4 MHz, IC 8 ; 1/40, IC12 ; 1/10
- E03; IC4(TX 1 KHz Loop) 98 -108 MHz, IC 9 ; 1/10
- E04; IC1(RX 10 Hz Loop) 80 - 80.4 MHz, IC 6 ; 1/40, IC11 ; 1/10
- E05; IC2(RX 1 KHz Loop) 98 -108 MHz, IC 7 ; 1/10
- E06; IC5(A1A BFO Loop) 91.16 MHz ; BFO center frequency
- IC1-6; Pin NO. 20 RF Output / Pin NO. 10 (IC1 - 5), NO. 9 (IC15)  
VCO control voltage ( +2 - +14V )

Check as to RF-Output

- P4 RF Output 70.455- 100.455 MHz
- P2 RF Output 455 KHz, TR1 - 9
- P3 RF Output 70 MHz, TR18 - 20



### 4.3.3 RX/Exciter

Check items as to Power Supply

- E17; ① IC12 (+ 15 V, AVR )
- ② Isn't the load of IC12 shorted out ?
- ③ Is the voltage +19V fed to J6-33 and 34 ?

Check items as to RX Power Supply

- TR49-51; Power Supply Switch of RX
- TR52-57; Power Supply Switch changing over at the each emission

Check items as to Power Supply of EXICITER

- TR46-48; Power Supply Switch of TX

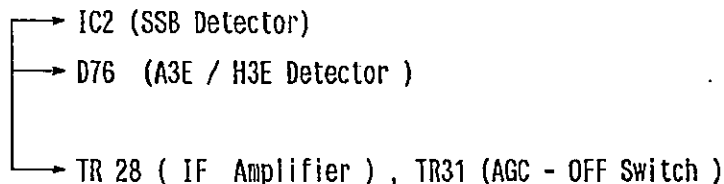
#### RX Section Main Circuit

Check items as to AF Amplifier of RX section

- SSB DETECTOR / MODULATOR IC2
- H3E / A3E DETECTOR D76
- AF Switches and Amplifier IC7, 8, TR38,39

Check Process when there is something wrong with the RF / IF Signal Line of RX SECTION

- J1 (RF input) → D17-20 (High voltage protector) → D21-32 (RX bands selector) → D33-35 (Voltage controlled attenuator) → TR13 (RF Amplifier) → D36 (T / R Switch) → M2 (Mixer) → D37 (T / R Switch) → TR 14, 15 (1st IF Amplifier 70.455 MHz) → D39-41 (Voltage controlled attenuator) → D38 (T / R Switch) → FL1 (70.455 MHz Crystal Filter) → D42 (T/R switch) → TR18, 19 (1st IF Amplifier) → D43 (T / R switch) → M1 (Mixer) → D44 (T / R switch) → TR 20, 21 (2nd IF Amplifier) → IC4, 6 (2nd IF Filters Selector) → FL2 (J3E) → FL3 (H3E / A3E), FL4 (J2B/A1A) → IC3, 5 (2nd IF Filters Selector) → TR 22-24 (2nd IF Amplifier 455 kHz) →



Check Process when there is something wrong with RF / IF AGC Line

- D45, 46 (AGC Detector) → TR29, 30, 32, 34, 35 (AGC Amplifier) → IC8 (AGC / HGC Switch) → IC7 (2/2) (DC Amplifier) → TR22, 23 (IF Amplifier) → TR36, 37 (AGC Amplifier) → TR12, 17 (Voltage controlled attenuator)

### Exciter Section

- Check Process when there is something wrong with SSB
- TX AF signal (J7-1, 2) → IC2 (Modulator) → D1, 2 (switches of level adjuster) → TR1 (DSB Amplifier) → IC3 (T / R Switch) → FL2 (SSB Filter 455 KHz) → IC4 (T/R switch) → TR2 (455 KHz Amplifier) → D3 (T/R Switch) → H1, D4, 5, FL1 (Mixer, T/R switch and 70.455 Crystal Filter) → D6 (T/R Switch) → TR3 (Gain controlled attenuator) → D7 (T/R Switch) → H2 (Mixer) → D8 (T/R switch) → TR4 (RF Amplifier) → D9-13 (Power reduction circuit) → TR5, 6 (RF Amplifier) → J5 (RF output)
- Check Process when there is something wrong with A1A
- J2 (455 KHz Local signal input) → D58-60 (A1A and H3E carrier level selector) → TR2 (455 KHz Amplifier) → After this same as the case of SSB

Check Process when there is something wrong with Local Signal Amplifier  
(70.455-100.455 MHz, 70 MHz)

- 70.455 - 100.455 MHz ; TR43, Frequency Synthesizer and J4
- 455 KHz ; Frequency Synthesizer and J2
- 70 MHz ; TR41, Frequency Synthesizer and J3

#### 4.3.4 RF Power Amplifier

Check items as to Power Supply

- When \*E26 and "FAULT" lamp light up except the over load and not in tuning, check P3, IC1-3, and TR14.
- E30; P4

Temperature

- E27; When the heat sink temperature rises up to 100 °C, even if Power Reduction Circuit is set to "H", it is made to set to "H".
- E31; When the heat sink temperature rises up to 110 °C, Key Circuit is to be "OFF" and RF output power is not fed.  
When the temperature falls down less than 110°C the situation becomes back automatically.

Check items as to Power Amplifier Circuit

- \*E29; ① Check T7, 8 and D1 .  
② Check TR1-6  
Check the bias circuit of TR3, 4 ---- TR7-9  
Check the bias circuit of TR5, 6 ---- IC1 (1/2), TR11-13

#### 4.3.5 Low Pass Filter

Check items as to Low Pass Filter

- E21; Transmitting signal is missing.

Check D9, 10, T1,2, J1, P1

- ① When the code of E29 comes out simultaneously with that of E21, Power Amplifier is bad.
- ② Check items when the code of E29 does not come out
  - Low Pass Filter elements
  - K1-16

- E22; Check J2, ATU and TX Cable

#### 4.3.6 P.S. Unit

Check items as to P.S. UNIT

- E18; The voltage +19 V is not within  $\pm 25\%$  limit.
- E19; The voltage +24 V is not within  $\pm 25\%$  limit.
- E20; The voltage + 5 V is not within  $\pm 10\%$  limit.
  - Fuse F1 (3A) in Card A2
  - DC-DC Converter transforming 48 V into 19 V, 24 V and +5 V
- E26; P8 (Connector), Fuse F1( 15A) in Card A2
- E30; P9 (Connector)

Check items when it is impossible to turn the Power Supply "ON"

- Fuse F1(100 A)
- F2 (0.5 A) in Card A1

#### 4.3.7 AF Card (in Control Unit)

Check items when the receiving tone is not fed to the loud speaker

- Check whether the error message of E01-06 is transmitted or not.
- IC6, 7, 9, K1, P3, P4

Check items when the receiving tone is not fed to the Handset.

- IC6, P3, Handset Filter, Connector of Handset

Check items when the receiving tone is not fed to the external terminal.

- T4

Check items when there is no modulation (USB / LSB / H3E )

- Handset Filter
- Connector of Handset
- IC4, 5, 9, T3

Check items when the output is not fed from 2-tone alarm signal generator.

- TR2, 3, IC5, 8, T3

Check items when the brightness of the bar LED does not change with the knob of DIMMER

Control or the bar LED dose not light up.

- IC1, 2, 3, 10

#### 4.3.8 ATU

- E32; +24 VDC fed to ATU is not within  $\pm 25\%$  limit.

Check F1 (2A) in JUNCTION BOARD.

- When it is impossible to tune.

① When there is something wrong with Antenna.

Impedance of Antenna is out of the standard.

( In this case, it is less than  $5\Omega + 180\text{PF}$  and the frequency is near the resonance point of  $\lambda/2$ .)

It is necessary to change the length of Antenna.

② Because of the capacitive load

Check K2-16, 18-20, 23-25, 33, 34, C1-8, L1-11

③ Because of the inductive load

Check K10, K26-34, C9-15, 118, 119

Appendix

Power Supply Trouble Shooting

Symptoms	Possible cases	Check points
No operation	<ul style="list-style-type: none"> <li>• The polarity of input (Voltage ) is not correct.</li> </ul>	<ul style="list-style-type: none"> <li>• the input polarity</li> </ul>
	<ul style="list-style-type: none"> <li>• The input voltage is not within the specified rating. ( more than 11 V necessary for starting operation)</li> </ul>	<ul style="list-style-type: none"> <li>• the input voltage</li> </ul>
	<ul style="list-style-type: none"> <li>• Fuse (F1) is broken.</li> <li>• Some transistors through TA1A to TA1T in the A1 board are broken.</li> </ul>	<ul style="list-style-type: none"> <li>• The transistors and the fuse (to be replaced if broken)</li> </ul>
	<ul style="list-style-type: none"> <li>• Fuse (F2) is broken.</li> <li>• The wirings of "MSW" switch circuit is open.</li> <li>• Defective parts in the A1 board.</li> </ul>	<ul style="list-style-type: none"> <li>• The wiring of "MSW" switch circuit</li> <li>• The fuse (F2) and the parts in the A1 board.</li> </ul>
	<ul style="list-style-type: none"> <li>• No operation some (less than 10) seconds after the tuning on of "MSW" switch or after the connection of the input</li> </ul>	<ul style="list-style-type: none"> <li>• No trouble</li> <li>• Operation begins after the warming period.</li> </ul>
	<ul style="list-style-type: none"> <li>• The over-voltage</li> <li>• Protection circuit of the 48V output is mal-functioned. (The output voltage is mis-adjusted.)</li> </ul>	<ul style="list-style-type: none"> <li>• The variable resistor(A1-board) for voltage adjustment (to be re-adjusted)</li> </ul>

Symptoms	Possible cases	Check points
No operation	<ul style="list-style-type: none"> <li>Defective parts of the control stage (A1 board)</li> </ul>	<ul style="list-style-type: none"> <li>The parts in the control stage (Probably IC-1 and its associated circuits to be replaced)</li> </ul>
No 48V-output	<ul style="list-style-type: none"> <li>"R/T" switch is not turned on.</li> </ul>	<ul style="list-style-type: none"> <li>The switch</li> </ul>
	<ul style="list-style-type: none"> <li>Mal-function of the over-heat protection circuit ("OH" signal is transmitted.)</li> </ul>	<ul style="list-style-type: none"> <li>If the temperature is higher than the specified degree, trace where the over-heating is caused.</li> <li>After repair, wait until cooled down.</li> </ul>
	<ul style="list-style-type: none"> <li>Mal-function of the over-current protection circuit ("OC" signal is transmitted.)</li> </ul>	<ul style="list-style-type: none"> <li>Trace where the over-current is caused.</li> <li>After repair, "RST" signal shall be set "L" level.</li> </ul>
	<ul style="list-style-type: none"> <li>Fuse (F1) is broken.</li> </ul>	<ul style="list-style-type: none"> <li>Trace where the over-current is caused. ( Fuse (F1) to be replaced)</li> </ul>
No 24V/19V/6V output	<ul style="list-style-type: none"> <li>Fuse (F2) in A2 board is broken.</li> <li>Transistor TR1 or TR2 is broken.</li> <li>The one of 24V/19V/or 6V circuit is overloaded or shorted.</li> </ul>	<ul style="list-style-type: none"> <li>Fuse(F1), transistors (to be replaced)</li> <li>Trace where the overload is caused.</li> </ul>