

Sailor

Sailor

INSTRUKTIONSBOG FOR
SAILOR R2122

INSTRUCTION BOOK FOR
SAILOR R2122

INSTRUKTIONSBUCH FÜR
SAILOR R2122

INSTRUCTIONS POUR
SAILOR R2122

INSTRUCCIONES PARA
SAILOR R2122



A/S S. P. RADIO · AALBORG · DENMARK

1.2. TECHNICAL DATA

(complies with SOLAS, ITU, CEPT, MPT, DOC, FTZ, KSR, FCC)

<u>Frequency Range:</u>	100 kHz to 30 MHz
<u>Frequency Stability:</u>	Better than 1.3 ppm
<u>Audio Power:</u>	5 Watt, 8 ohm, supply voltage 24V 10 Watt, 4 ohm, supply voltage 24V
<u>Supply Voltage:</u>	10V to 32V DC
<u>Current Drain:</u>	0.7A
<u>Operating Temperature Range:</u>	-15° C to + 55° C
<u>Scanning Facilities:</u>	10 scanning programmes, each able to contain 128 channels.
<u>Channel Capacity:</u>	100 user defined quick-select channels and ITU defined telephony channels in the maritime bands.
<u>Selectivity:</u>	SSB 350 Hz to 2700 Hz at -6dB AM ±3300 Hz at -6dB
<u>Sensitivity:</u>	SSB < 0dB/uV for 10 dB SINAD AM <14 dB/uV for 10 dB SINAD
<u>Spurious and IF Rejection:</u>	Better than -70 dB
<u>Cross Modulation:</u>	Better than 90 dB/uV
<u>Desensitization:</u>	Better than 100 dB/uV
<u>AGC:</u>	Less than 2 dB audio level change from 10dB/uV to 80 dB/uV. Fast attack, slow release time.
<u>Intermodulation:</u>	Better than 90dB/uV.
<u>Spurious Emission:</u>	Better than 1 nW into dummy aerial.
<u>Clarifier:</u>	±150 Hz in steps of 10 Hz.
<u>Squelch:</u>	Voice activated, opens for SINAD >6dB.

1.3. CONTROLS



Volume control and on/off switch for the mains.



Manual RF gain control.



Tunes the receive frequency down.



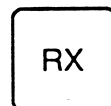
Tunes the receive frequency up.



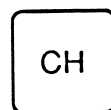
Tunes the receive frequency down in 10 Hz steps.



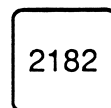
Tunes the receive frequency up in 10 Hz steps.



Selects receive functions or converts a channel number to the corresponding frequency.



Selects channel functions.



Selects the distress frequency 2182 kHz.



Reduces/increases the display light or switches on/off the display and keyboard panel.

1.3. CONTROLS cont.:

SQ

Switches the squelch function on/off.

MODE

Selects modulation type J3E, R3E, H3E and J3E lower side band.

SC

Selects the scan programmes.

SC

ADD

Adds a new channel to the scanning table.

SC

DEL

Deletes a channel from the scanning table.

CH

(Digits 0-99)

ADD

Adds the RX/TX frequency to the channel number.

CH

(Digits 0-99)

DEL

Deletes the RX/TX frequency from the channel.

7

Digits from 1 to 0.

ENT

Terminates the keying-in sequence, stops the alarm signal, stops the scanning.

.

Sets the decimal point for the frequency in kHz.

1.4. PRINCIPLE OF OPERATION

SAILOR Compact HF SSB R2122 is the general receiver in the SAILOR Compact HF SSB Programme 2000. It contains following circuits.

PROCESSOR UNIT

This unit controls all modules and operate as interface between the user and the radio (keyboard, display). Nearly all communication from the microprocessor to the modules is done on an internal serial bus (SPI).

The unit holds all user defined memory is in an EEPROM, so even when supply voltage is removed, the contents of the memory is preserved. If the supply voltage to the RE2100 gets too low, the display will show error 00, and the performance of the RE2100 will be reduced.

There is also an external serial bus (SP-Bus). This bus is used to communicate with remote terminals, primarily for test.

DISPLAY UNIT

This unit contains the display and the field strength meter.

SYNTHESIZER UNIT

This unit contains all frequency generating parts.

There is only one reference oscillator which is a temperature compensated crystal oscillator (TCXO) with a frequency of 10.73 MHz.

Both receiver and exciter are using two LO-signals. These signals are generated in two separate PLL's, one having output frequencies from 70 MHz to 100 MHz and the other having output frequencies of 59.27 MHz and 80.73 MHz. The synthesizer which covers from 70 to 100 MHz is a fractional synthesizer with a resolution of 10 Hz.

The other synthesizer is a conventional synthesizer. It has two output frequencies, one for lower sideband 80.73 MHz and another for upper sideband 59.27 MHz.

RECEIVER FRONT END

This unit contains input protection circuit, input filters, mixer and 70 MHz IF.

The input filter is a mixture of lowpass, highpass and bandpass filter to obtain max. performance in the entire band from 100 kHz to 30 MHz.

The mixer is a FET mixer with a high level LO-injection to give the mixer good high signal quality. The mixer is followed by a 70 MHz bilitic quartz filter with a bandwidth of 15 kHz.

RECEIVER UNIT

This unit contains all necessary circuits to convert a 70 MHz IF signal to an audio signal.

1.4. PRINCIPLE OF OPERATION cont.:

It starts with the second mixer which is a FET mixer. From the mixer the signal is fed to a high order monolithic quartz filter, one for AM and one for SSB. The type of filter is selected from the microprocessor.

From the filter the signal is fed to the 10.73 MHz IF amplifier. The gain of this amplifier is regulated from the AGC amplifier. The regulated IF amplifier is followed by a ceramic filter to reduce the wideband noise. The signal is from here fed to the demodulator, which can operate as an SSB detector or an AM detector controlled from the microprocessor. The detector is followed by a filter circuit. In AM mode the filter width is from 70 Hz to 3000 Hz, and in SSB mode the filter is from 300 Hz to 3000 Hz. From here the AF signal passes some switches and then it is amplified in three AF amplifiers, one for the microtelephone earpiece, one for the 0 dBm output, and an amplifier with volume control for the AF signal to the AF power amplifier in T2130.

The signal from the AF filters is also fed to the voice controlled squelch. This contains a limiting amplifier, a frequency to voltage converter, and a threshold amplifier. On/off switching of the squelch is controlled by the microprocessor.

In scan mode the squelch is used to detect if there is signal on the channel in question.

POWER SUPPLY MODULE

This module contains a switch mode power supply, which converts the battery voltage to all necessary voltages for the other modules in the R2122.

AF AMPLIFIER MODULE

This module contains the audio power amplifier.

CONTENTS

- 1. INTRODUCTION
 - 1.1. GENERAL DESCRIPTION
 - 1.2. TECHNICAL DATA
 - 1.3. CONTROLS
 - 1.4. PRINCIPLE OF OPERATION AND BLOCK DIAGRAM
- 2. INSTALLATION
 - 2.1. MOUNTING POSSIBILITIES
 - 2.2. DIMENSIONS AND DRILLING PLAN
 - 2.3. ELECTRICAL CONNECTION AND ASSEMBLING
- 3. SERVICE
 - 3.1. MAINTENANCE
 - 3.2. ALIGNMENT INSTRUCTIONS
 - 3.3. PROPOSAL FOR NECESSARY TEST EQUIPMENT
 - 3.4. TROUBLE SHOOTING
 - 3.5. PERFORMANCE CHECK
 - 3.5.1. PERFORMANCE CHECK OF DISPLAY AND KEYBOARD
 - 3.5.2. PERFORMANCE CHECK OF RECEIVER
 - 3.6. MODULE PERFORMANCE CHECK
 - 3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT
 - 3.6.2. MODULE PERFORMANCE CHECK OF FRONT END UNIT
 - 3.6.3. MODULE PERFORMANCE CHECK OF SYNTHESIZER UNIT
 - 3.6.5. MODULE PERFORMANCE CHECK OF PROCESSOR UNIT
 - 3.6.8. MODULE PERFORMANCE CHECK OF POWER SUPPLY MODULE
 - 3.6.10. MODULE PERFORMANCE CHECK OF AF AMPLIFIER MODULE
 - 3.7. ADJUSTMENT PROCEDURE
 - 3.7.1. ADJUSTMENT PROCEDURE FOR FRONT END AND RECEIVER UNIT
 - 3.7.2. ADJUSTMENT PROCEDURE FOR SYNTHESIZER UNIT

- 3.8. NECESSARY ADJUSTMENT AND CHECK AFTER REPAIR
- 3.9. FUNCTION CHECK
- 3.10. SELECTION AND DESCRIPTION OF THE SERVICE PROGRAMMES

- 4. MECHANICAL DESCRIPTION
 - 4.1. MECHANICAL DISASSEMBLING AND MODULE LOCATION

- 5. CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAMS
 - 5.1. RECEIVER UNIT (MODULE 1)
 - 5.2. RECEIVER FRONT END (MODULE 2)
 - 5.3. SYNTHESIZER UNIT (MODULE 3)
 - 5.5. PROCESSOR UNIT (MODULE 5)
 - 5.6. KEYBOARD UNIT (MODULE 6)
 - 5.7. DISPLAY UNIT (MODULE 7)
 - 5.8. POWER SUPPLY UNIT (MODULE 8)
 - 5.9. INTERCONNECTION CABLE DIAGRAM
 - 5.10. AF AMPLIFIER MODULE (MODULE 10)

- 7. PARTS LIST

CONTENTS

- 1. INTRODUCTION
- 1.1. GENERAL DESCRIPTION
- 1.2. TECHNICAL DATA
- 1.3. CONTROLS
- 1.4. PRINCIPLE OF OPERATION AND BLOCK DIAGRAM

1. INTRODUCTION

SAILOR Compact HF SSB R2122 is the general purpose receiver in SAILOR Compact HF SSB Programme 2000.

SAILOR Compact HF SSB Programme 2000 is a powerful, advanced, high technology short wave communication system which is extremely easy to operate.

It has been developed on the basis of S. P. Radio's many years of experience with short wave communication equipment.

It has the same high reliability as all SAILOR equipment is known for.

It has been constructed so that it fits in with the other units in the SAILOR Compact Programme 2000.

1.1. GENERAL DESCRIPTION

- SAILOR HF SSB R2122 is an all solid state constructed microcomputer controlled SSB short wave telephony receiver.
- SAILOR HF SSB R2122 covers the frequency range from 100 kHz to 30 MHz in receive mode.
- SAILOR HF SSB R2122 includes all ITU channels from 4 MHz to 22 MHz.
- SAILOR HF SSB R2122 includes channel scanning facilities.
- SAILOR HF SSB R2122 includes 100 quick select frequencies.
- SAILOR HF SSB R2122 has continuous tuning in receive mode.
- SAILOR HF SSB R2122 has clarifier function ± 150 Hz in 10 Hz steps.
- SAILOR HF SSB R2122 is fully synthesized and has a high stability reference oscillator (TCXO).
- SAILOR HF SSB R2122 has an easy to read display with red light figures.
- SAILOR HF SSB R2122 has a push-button keyboard offering an attractive tactile feeling and a safe finger-guide in the metal front. The keyboard is fitted with night-time illumination of the lettering.
- SAILOR HF SSB R2122 has one key operation of the distress frequency 2182 kHz.
- SAILOR HF SSB R2122 has a special serial input (SP-BUS) enabling R2122 to communicate with other units.

CONTENTS

- 2. INSTALLATION
- 2.1. MOUNTING POSSIBILITIES
- 2.2. DIMENSIONS AND DRILLING PLAN
- 2.3. ELECTRICAL CONNECTION AND ASSEMBLING

CONTENTS

- 3. SERVICE
- 3.1. MAINTENANCE
- 3.2. ALIGNMENT INSTRUCTIONS
- 3.3. PROPOSAL FOR NECESSARY TEST EQUIPMENT
- 3.4. TROUBLE SHOOTING
- 3.5. PERFORMANCE CHECK
 - 3.5.1. PERFORMANCE CHECK OF DISPLAY AND KEYBOARD
 - 3.5.2. PERFORMANCE CHECK OF RECEIVER
- 3.6. MODULE PERFORMANCE CHECK
 - 3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT
 - 3.6.2. MODULE PERFORMANCE CHECK OF FRONT END UNIT
 - 3.6.3. MODULE PERFORMANCE CHECK OF SYNTHESIZER UNIT
 - 3.6.5. MODULE PERFORMANCE CHECK OF PROCESSOR UNIT
 - 3.6.8. MODULE PERFORMANCE CHECK OF POWER SUPPLY MODULE
 - 3.6.10. MODULE PERFORMANCE CHECK OF AF AMPLIFIER MODULE
- 3.7. ADJUSTMENT PROCEDURE
 - 3.7.1. ADJUSTMENT PROCEDURE FOR FRONT END AND RECEIVER UNIT
 - 3.7.2. ADJUSTMENT PROCEDURE FOR SYNTHESIZER UNIT
- 3.8. NECESSARY ADJUSTMENT AND CHECK AFTER REPAIR
- 3.9. FUNCTION CHECK
- 3.10. SELECTION AND DESCRIPTION OF THE SERVICE PROGRAMMES

3. SERVICE

3.1. MAINTENANCE

PREVENTIVE MAINTENANCE

If the HF SSB R2122 has been installed in a proper way the maintenance can, dependent on the environments and working hours, be reduced to a performance check at the service workshop at intervals, not exceeding 12 months. A complete performance check list is enclosed in this manual, chapter 3.5 PERFORMANCE CHECK.

Inspection of the antenna, cables, and plugs for mechanical defects, salt deposits, corrosion, and any foreign bodies shall be done at regular intervals not exceeding 12 months.

Along with each R2122 a test sheet is delivered in which all the measurements, made in the test department of the factory, are listed. If the control measurings made in the service workshop should not show the same values as those listed in the test sheet, the set must be adjusted as specified in chapter 3.7. ADJUSTMENT PROCEDURE.

3.2. ALIGNMENT INSTRUCTIONS

INTRODUCTION

The measuring values indicated in chapter 5. CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAMS are typical values and as indicated it will be necessary to use instruments in absolute conformity with the below list:

3.3. PROPOSAL FOR NECESSARY TEST EQUIPMENT

OSCILLOSCOPE:

Bandwidth	DC-35 MHz
Sensitivity	2mV/div
Output Impedance	1 Mohm//20 pF
E.g. Philips type	PM3050

PASSIVE PROBE:

Attenuator	20 dB
Input Impedance	10 Mohm//15 pF
Compensation Range	10-30 pF
E.g. Philips type	PM8936/091

MULTIMETER:

Sensitivity DC (f.s.d.)	100 mV
Input Impedance	10 Mohm
Accuracy DC (f.s.d.)	1.5%
E.g. Philips type	PM2505

FREQUENCY COUNTER:

Frequency Range	100 Hz - 120 MHz
Resolution	1 Hz at $f = 100$ MHz
Accuracy	$1 \cdot 10^{-7}$
Sensitivity	100 mV RMS
Input Impedance	1 Mohm//30 pF
E.g. Philips type	PM6669/031

HF SIGNAL GENERATOR:

Frequency Range	100 kHz - 100 MHz
Output Voltage:	0dB/uV - 120 dB/uV
Output Impedance	50 ohm
Type of Modulation	AM
Modulation Frequency	External
E.g. Marconi type	2019

LF SIGNAL GENERATOR:

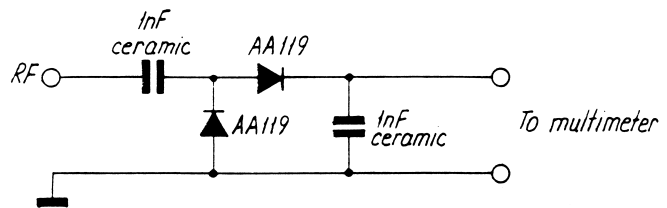
Frequency Range	10 Hz - 10 kHz
Output Voltage	20 mVRMS - 1VRMS
Output Impedance	600 ohm
Output Waveform	sine wave
E.g. Philips type	PM5110

LF DISTORTION METER:

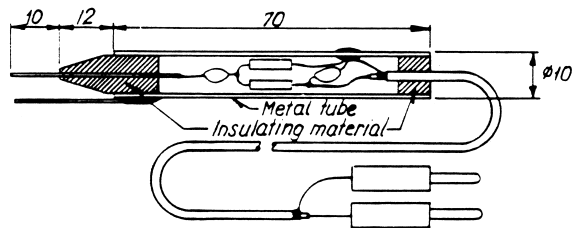
Frequency Range	$f = 1000$ Hz
Distortion Range (f.s.d.)	1-10%
Input Impedance	1 Mohm
Accuracy (f.s.d.)	3%
E.g. Philips type	PM6309

3.3. PROPOSAL FOR NECESSARY TEST EQUIPMENT cont.:

DIODE PROBE



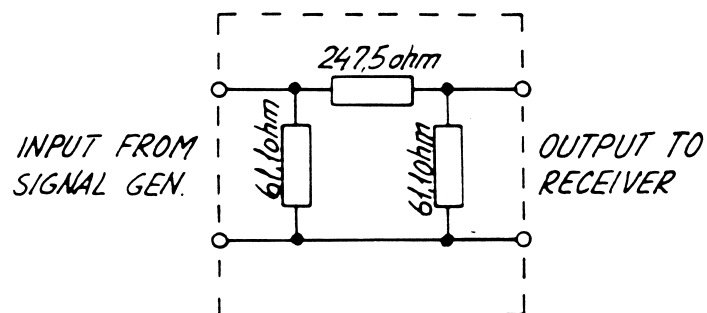
LAYOUT OF THE PROBE



50 OHM DUMMY LOAD

EMF-loss 20 dB

50 ohm -> 50 ohm:



3.3. PROPOSAL FOR NECESSARY TEST EQUIPMENT cont.:

POWER SUPPLY:

Vout1	18V DC
Vout2	18V DC
Iout1	2 Amp DC
Iout2	0.5 Amp DC
E.g. 2 pcs. ELCANIC type	3010

3.4. TROUBLE SHOOTING

Trouble shooting should only be performed by persons with sufficient technical knowledge, who have the necessary measuring instruments at their disposal, and who have carefully studied the operation principles and structure of the SAILOR Compact HF SSB System.

SAILOR HF SSB R2122 has a number of trimming cores and trimmers, which must not be touched, unless adjustments as specified in chapter 3.7. ADJUSTMENT PROCEDURE, can be made.

When measuring the units, short-circuits must be avoided as the transistors would then be spoiled.

LOCATING THE FAULTY CIRCUIT

When the faulty module has been found, it can be difficult to find the faulty circuit or component.

One way is to change the module. If this is not possible, the faulty component or circuit can be found in a more systematic way by using the chapter 3.6. MODULE PERFORMANCE CHECK.

Chapter 3.6. MODULE PERFORMANCE CHECK is divided into sections with a headline indicating a possibility of checking some main parameters, and this may be a great help.

3.5. PERFORMANCE CHECK

GENERAL

A performance check is intended to be used as a check after repair and before reinstallation of the equipment.

A performance check can be used to check the equipment after a certain time to make sure that the equipment is according to the required technical specifications.

The performance check is divided into three sections, and it is possible to perform one of the sections or all of them.

This chapter includes a number of measurements where a signal generator is needed. The output level of the generator is, in this manual, expressed in terms of the Electromotive Force (EMF), and it is measured in terms of the unit: $\text{dB/uV} = 20 \log(\text{EMF}/1\mu\text{V})$, (dB above one microvolt).

The output level from signal generators in general is sometimes expressed in terms of the available power P_a , which is measured in terms of the unit: $\text{dBm} = 10 \log(P_a/1\text{mW})$, (dB above one milliwatt). For this reason the conversion formulas between EMF and available power and vice versa are given here:

$$\begin{aligned} P_a (\text{dBm}) &= \text{EMF} (\text{dB/uV}) - 113 \text{ dB} \\ \text{EMF} (\text{dB/uV}) &= P_a (\text{dBm}) + 113 \text{ dB} \end{aligned}$$

where P_a is the available power and EMF is the Electromotive Force of the generator.

3.5.1. PERFORMANCE CHECK OF DISPLAY AND KEYBOARD

Connect the R2122 to a 24V/3A power supply and a loudspeaker.

The necessary test equipment to carry out a performance check is described in this manual chapter 3.3. PROPOSAL FOR NECESSARY TEST EQUIPMENT.

3.5.1.1. Performance Check of Display

1. Select test programme SP-00-2.
2. Control that the display is switched between all possible combinations of lighted bars.
3. Control that the mode indicating bars are toggled.
4. Control that the power reduction bars are alight.
5. Press the keyboard ENT key.
6. Press the keyboard RX button.
7. Turn the RF GAIN button fully counter clockwise.
8. Control that the bars in the signal meter are all alight.
9. Turn the RF gain fully clockwise.

3.5.1.2. Performance Check of Keyboard

1. Turn the VOL-OFF button fully counter clockwise and then fully clockwise.
2. Control that it is possible to switch the R2122 on and off by the VOL-OFF button.
3. Press the keyboard buttons to key-in the receiver frequency 12345.6 kHz.
4. Press the keyboard button ENT.
5. Control that noise is heard from the loudspeaker.
6. Press the keyboard button CH.
7. The display will now show 'CH-----'.
8. Press the keyboard button SC.
9. The display will now show 'SC X'.
10. Press the keyboard button RX.

3.5.1. PERFORMANCE CHECK OF DISPLAY AND KEYBOARD cont.:

11. The display will now show '12345.6 kHz'
12. Control that the emission mode can be toggled by pressing the keyboard button MODE.
13. Control that the display light can be dimmed by pressing the keyboard button DIM.
14. Control that the led marked AGC can be toggled by pressing the keyboard button AGC.
15. Control that the led marked SQ can be toggled by pressing the keyboard button SQ.
16. Press the keyboard CLARIF Δ or ∇ buttons to toggle the 10 Hz decimal up and down.
17. Press the keyboard FREQ Δ or ∇ buttons to toggle the 100 Hz or 1000 Hz decimal (dependent on emission mode) up and down.
18. Press the keyboard 2182 button.
19. Control that the display shows '2182.0 kHz'

3.5.2. PERFORMANCE CHECK OF RECEIVER

Connect the R2122 to a 24V/3A power supply and a loudspeaker to the proper inputs on the R2122.

The necessary test equipment to carry out a performance check is described in this manual, chapter 3.3. PROPOSAL FOR NECESSARY TEST EQUIPMENT.

This chapter contains the following sections:

- 3.5.2.1. Performance Check of Receiver Sensitivity
- 3.5.2.2. Performance Check of Receiver Distortion
- 3.5.2.3. Performance Check of Receiver Audio Passband
- 3.5.2.4. Performance Check of Receiver Clarifier and Frequency
- 3.5.2.5. Performance Check of Receiver AGC
- 3.5.2.6. Performance Check of Receiver Squelch
- 3.5.2.7. Performance Check of Receiver External Connections

3.5.2.1. Performance Check of Receiver Sensitivity

1. Connect the signal generator to the aerial socket through the 50 ohm dummy load described in this manual, chapter 3.3.
2. Connect a voltmeter or a distortion meter to the 0 dBm output.
3. Choose receiver frequency f_{RX} , generator frequency f_G , and generator output level V_G according to table in point 5.
4. Measure the signal to noise ratio SND/N with the distortion meter or the voltmeter as described in point 6. The measured signal to noise ratio shall be better than 20 dB.

3.5.2. PERFORMANCE CHECK OF RECEIVER cont.:

5.

Signal Generator			R2122		
f_g (MHz)	V_g (EMF)	MODE	f_{RX} (MHz)	MODE	
0.100	30 dB/uV	AM	0.100	H3E	
0.384		30% with 1 kHz	0.384		
0.385			0.385		
1.599			1.599		
1.601	11 dB/uV	CW	1.600	J3E	
2.101			2.100		
2.182	25 dB/uV	AM 30% with 1 kHz	2.182	H3E	FIXED
4.500	11 dB/uV	CW	4.499	J3E	
4.501			4.500		
9.000			8.999		
9.001			9.000		
13.251			13.250		
18.000			17.999		
18.101			18.100		
25.001			25.000		
25.998	11 dB/uV	CW	29.999	J3E/LSB	

6. Measurement of the signal to noise SND/N.
With the specified test signal applied to the receiver, the measurement of SND/N is performed as described below.

SSB MODE

- Turn the RF-GAIN control fully clockwise and make sure that the AGC is operative.
- Notice the output LF level by means of a voltmeter.
- Turn the AGC OFF and adjust the RF-GAIN control to achieve the output level found in point 6.b.
- Change the signal generator frequency f_g to $f_{RX} + 30$ kHz and notice the reduction of the LF output level, which expresses the signal to noise ratio.

3.5.2. PERFORMANCE CHECK OF RECEIVER cont.:

AM MODE

- e. Turn the RF-GAIN fully clockwise and make sure that the AGC is operative.
- f. Notice the output level by means of a voltmeter.
- g. Remove modulation from the generator signal and notice the reduction of the output, which expresses the signal to noise ratio.

3.5.2.2. Performance Check of Receiver Distortion

To carry out the check as described below, it is necessary to have a distortion meter at your disposal. If this is not possible, the check can be done by an oscilloscope, but please note that it should not be possible to see a distortion of 10% or less on the oscilloscope.

1. Connect a distortion meter to the 0 dBm output.
2. Connect a signal generator to the aerial socket through a 50 ohm dummy load.
3. Choose receiver frequency f_{RX} generator frequency f_G and generator output level V_G according to point 5.
4. Measure the signal distortion SND/ND with the distortion meter. The measured distortion SND/ND shall be better than the figures given in the table in point 5.
- 5.

Signal Generator			R2122		
f_G (kHz)	V_G (EMF)	MODE	f_{RX} (kHz)	MODE	Distortion SND/ND
2182	83 dB/uV	AM 30% with 1 kHz	2182	H3E	2.0%
2183	83 dB/uV	CW	2182	J3E	1.5%

3.5.2.3. Performance Check of Receiver Audio Passband

1. Connect the signal generator to the aerial socket through a 50 ohm dummy load.
2. Connect a voltmeter to the 0 dBm output.
3. Choose receiver frequency f_{RX} , generator frequency f_G , generator output level V_G according to point 7.

3.5.2. PERFORMANCE CHECK OF RECEIVER cont.:

4. USB-SSB MODE

- a. Set the f_{RX} , f_G and V_G according to point 1 in the table in point 7.
- b. Turn the RF-GAIN control fully clockwise and make sure that the AGC is operative.
- c. Notice the AF output level by means of the voltmeter.
- d. Turn the AGC off and adjust the RF-GAIN control to achieve the output level found in point 4.c.
- e. Change the signal generator frequency f_G , and the generator output level V_G according to point 2 in table 7, and control the voltage on 0 dBm output to be above the value found in point 4.c.
- f. Change f_G according to point 3 in table 7 and control the voltage on 0 dBm output to be below the value found in point 4.c.

5. LSB-SSB MODE

Carry out point 4. USB-SSB MODE, but use the figures mentioned in point 7, under "lower sideband audio passband".

6. AM MODE

- a. Set f_{RX} , f_G and V_G according to point 4 in table 7.
- b. Notice the AF output level by means of the voltmeter.
- c. Change the modulation frequency according to the figures in point 5 in table 7, and control that the voltage on 0 dBm output has not dropped 6 dB below the value found in point 6.b.
- d. Change the modulation frequency according to the figures in point 6 in table 7, and control that the voltage on 0 dBm output has dropped more than 20 dB below the value found in point 6.b.

3.5.2. PERFORMANCE CHECK OF RECEIVER cont.:

7.

Signal Generator			R2122		
f_g (kHz)	V_g (EMF)	MODE	f_{rx} (kHz)	MODE	Point
Upper sideband audio passband					
4126	53 dB/uV	CW	4125	J3E	1
4125.35	59 dB/uV				2
4127.7					3
4128.1					73 dB/uV
Lower sideband audio passband					
4124	53 dB/uV	CW	4125	LSB/J3E	1
4124.65	59 dB/uV				2
4122.3					3
4121.9					73 dB/uV
Audio passband by amplitude modulation					
4125	63 dB/uV	AM 30% with 1 kHz	4125	H3E	4
		AM 30% with 100 Hz			5
		AM 30% with 3000 Hz			
		AM 30% with 6000 Hz			

R2122

3.5.2.4. Performance Check of Receiver Clarifier and Frequency

1. Connect the signal generator to the aerial socket through a 50 ohm dummy load.
2. Choose receiver frequency f_{RX} , signal generator frequency f_g , and the generator output level V_g according to point 6.
3. Connect a frequency counter to the 0 dBm output.
4. Activate the frequency tune and let the frequency f_{RX} change in 100 Hz steps and control with the counter that this happens.
5. Activate the clarifier tune and let the frequency f_{RX} change in 10 Hz steps and control with the counter that this happens.

3.5.2. PERFORMANCE CHECK OF RECEIVER cont.:

6.

Signal Generator			R2122	
f_g (kHz)	V_g (EMF)	MODE	f_{RX} (kHz)	MODE
25001.0	73 dB/uV	CW	25000.1	J3E

7. With the frequency and clarifier tune, set the frequency f_{RX} to 25000.07 kHz.

8. Control with the counter the output frequency to be 930 Hz ± 10 Hz.

NOTE! The frequency tolerance of the signal generator shall be better than ± 2.5 Hz 0.1 ppm. If not and if the counter has a frequency tolerance of 0.1 ppm, you are unable to do this test!

3.5.2.5. Performance Check of Receiver AGC

1. Connect the signal generator to the aerial socket through a 50 ohm dummy load.
2. Connect a voltmeter to the 0 dBm output.
3. Choose receiver frequency f_{RX} , generator frequency f_g , and generator output level V_g according to the table in point 4.

4.

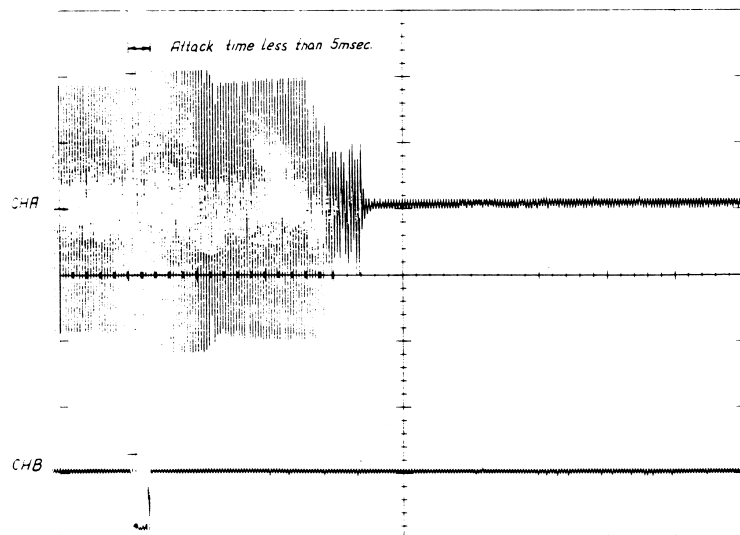
Signal Generator			R2122	
f_g (kHz)	V_g (EMF)	MODE	f_{RX} (kHz)	MODE
1991	8 dB/uV	CW	1990	J3E

5. Turn the RF-GAIN control fully clockwise, and make sure that the AGC is operative.
6. Notice the AF output level by means of the voltmeter at the 0 dBm output.
7. Increase the output level of the signal generator to 28 dB/uV.
8. The increase in AF output level measured with the voltmeter shall be less than 3 dB.
9. Notice the AF output level by means of the voltmeter at the 0 dBm

3.5.2. PERFORMANCE CHECK OF RECEIVER cont.:

10. Turn the AGC OFF and adjust the RF-GAIN control to achieve the output level found in point 9.
11. Disconnect the signal generator from the aerial socket and notice the reduction of the AF output level, which shall be at least 35 dB.
12. Reconnect the signal generator to the aerial socket.
13. Turn the RF-GAIN control fully clockwise and make sure that the AGC is operative.
14. Notice the AF output level by means of the voltmeter at the 0 dBm output.
15. Increase the output level of the signal generator to 78 dB/uV.
16. The increase in AF output level measured with the voltmeter shall be less than 2 dB.
17. Connect the 0 dBm output to channel A on the oscilloscope.
18. Connect the SP-BUS output socket on R2122 to channel B on the oscilloscope.
19. Select test programme SP-04-6.
20. Set the timebase on the oscilloscope to 20 msec/div.
21. Set the oscilloscope to trig on channel B.
22. Control that the oscilloscope displays the response shown in figure SSB attack.

SSB ATTACK

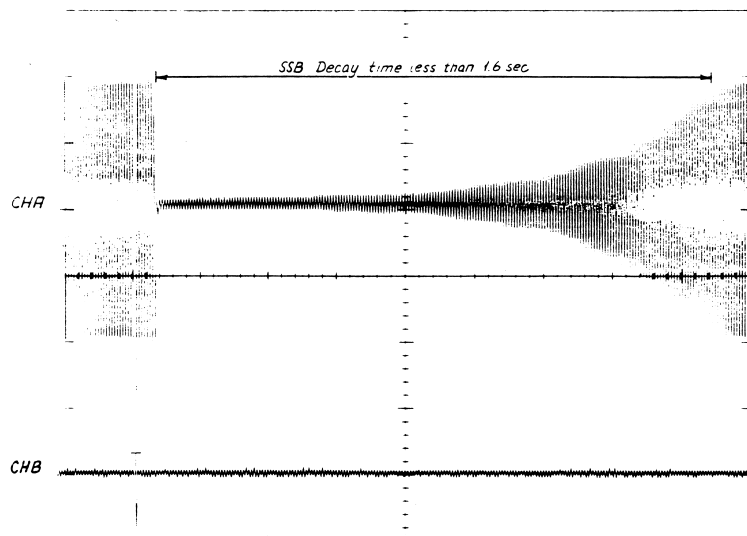


A = 0.5V/div 20 msec/div
B = 5V /div.

23. Set the timebase on the oscilloscope to 200 msec/div.
24. Control that the oscilloscope displays the response shown in figure SSB decay.

3.5.2. PERFORMANCE CHECK OF RECEIVER cont.:

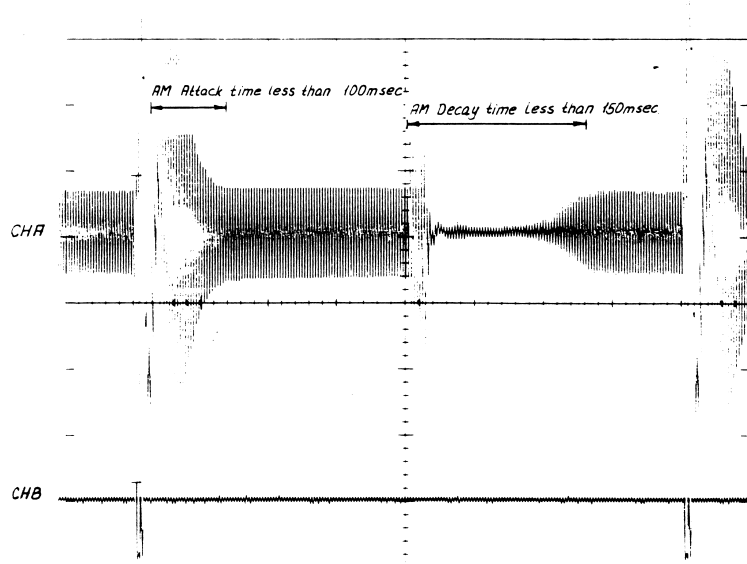
SSB DECAY



A = 0.5V/div. 200 msec/div.
B = 5V /div.

25. Select test programme SP-04-7.
26. Set the timebase on the oscilloscope to 50 msec/div.
27. Set the signal generator in amplitude modulation mode, modulating LF signal 1.0 kHz and modulating index $M = 0.3$.
28. Control that the oscilloscope displays the response shown in figure AM attack and decay.

AM ATTACK AND DECAY



A = 1.0V/div. 50 msec/div.
B = 5.0V/div.

3.5.2. PERFORMANCE CHECK OF RECEIVER cont.:

3.5.2.6. Performance Check of Receiver Squelch

1. Connect a signal generator to the aerial socket through a 50 ohm dummy load.
2. Choose the receiver frequency f_{RX} , signal generator frequency f_G , and the generator output level V_G according to table in point 8.
3. Make sure that the AGC and SQUELCH are active and adjust the AF volumen until a tone is heard in the loudspeaker.
4. Disconnect the signal generator from the aerial socket on the R2122. You will now hear the receiver noise from the loudspeaker.
5. Control that the AF output is muted after about 10 secs.
6. Connect the signal generator to the aerial socket again.
7. Control that the squelch opens instantly and that you now hear a 1 kHz tone from the loudspeaker.
8. Control that the squelch closes after about 10 secs.
- 9.

Signal Generator			R2122	
f_G (kHz)	V_G (EMF)	MODE	f_{RX} (kHz)	MODE
1991	13 dB/uV	CW	1990	J3E

3.5.2.7. Performance Check of Receiver External Connections

1. Connect a signal generator to the aerial socket through a 50 ohm dummy load.
2. Choose receiver frequency f_{RX} , signal generator frequency f_G and the generator output V_G according to table in point 3.
- 3.

Signal Generator			R2122	
f_G (kHz)	V_G (EMF)	MODE	f_{RX} (kHz)	MODE
2183	50 dB/uV	CW	2182	J3E

3.5.2. PERFORMANCE CHECK OF RECEIVER cont.:

4. A 1 kHz tone shall be heard from the loudspeaker and approx. seven bars in the signal strength meter are alight.
5. Activate the RX mute in the 25 pin connector at the rear of R2122.
6. No tone or noise shall now be heard from the loudspeaker and approx. 2 bars in the signal strength meter are alight.
7. Release the RX mute.

3.6. MODULE PERFORMANCE CHECK

GENERAL

A module performance check is intended to be used as an integral part of the trouble-shooting, because it gives the technician a chance to control the individual modules and parts of the circuit on each module.

The module performance check is divided into subsections, which correspond to the individual modules, and each of these subsections contains a number of check procedures.

The module performance check is carried out with all modules mounted in the HF SSB R2122, and with R2122 connected to a 24V/3A power supply and a loudspeaker.

This chapter includes a number of measurements where a signal generator is needed. The output level of the generator is, in this manual, expressed in terms of the Electromotive Force (EMF), and it is measured in terms of the unit: dB/uV = 20 log(EMF/1uV), (dB above one microvolt).

The output level from signal generators in general is sometimes expressed in terms of the available power P_a , which is measured in terms of the unit: dBm = 10 log(P_a /1mW), (dB above one milliwatt). For this reason the conversion formulas between EMF and available power and vice versa are given here:

$$\begin{aligned} P_a \text{ (dBm)} &= \text{EMF (dB/uV)} - 113 \text{ dB} \\ \text{EMF (dB/uV)} &= P_a \text{ (dBm)} + 113 \text{ dB} \end{aligned}$$

where P_a is the available power and EMF is the Electromotive Force of the generator.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT

This chapter contains the following sections:

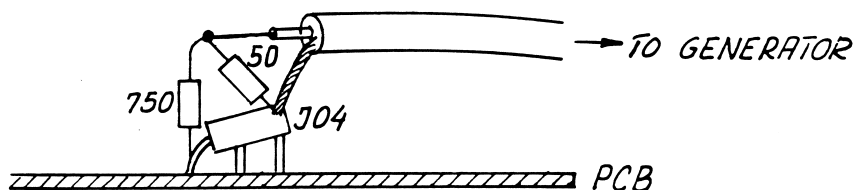
- 3.6.1.1. Check of Sensitivity (RX-Module)
- 3.6.1.2. Check of LO2 and Reinjection Signals
- 3.6.1.3. Check of Crystal Filters (2nd IF)
- 3.6.1.4. Check of 2nd IF Amplifier
- 3.6.1.5. Check of AGC Circuit
- 3.6.1.6. Check of Detector
- 3.6.1.7. Check of AF Filters
- 3.6.1.8. Check of Earpiece Amplifier
- 3.6.1.9. Check of Squelch Circuit

3.6.1.1. Check of Sensitivity (RX Module)

The sensitivity of the receiver unit is mainly determined by the Second Mixer because of its relatively large power gain of about 8 dB. It is therefore most likely that a degradation of the sensitivity is caused by the mixer; but be aware that this is not the only possible failure.

A degradation of the sensitivity could also be caused by a failure in the IF-amplifier, detector, audio frequency circuit, or simply by a missing local oscillator signal (LO2 or carrier reinjection).

To obtain a correct measurement of sensitivity, it is necessary to feed the generator signal through an impedance matching network as shown below.



Impedance matching between generator and receiver module.

1. Connect the generator to receiver module through the impedance matching network shown above.
2. Connect the voltmeter to earpiece output at testpoint TR2-1 for measuring the AC-voltage.
3. Turn the R2122 on.
4. Choose generator frequency f_g and generator output level V_g as specified in point 6. Select the wanted Receiver Module (SSB/AM).
5. Measure the signal to noise ratio SND/N at the earpiece output and check that it is above 20 dB. (see section 3.5.2.1., point 6 for instructions about how to measure SND/N).

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

6.

Signal Generator			R2122	
f_g	V_g (EMF)	MODE	f_{RX}	MODE
69.999.640 Hz	20 dB/uV	CW	no specification	J3E (SSB)
70.000.640 Hz	35 dB/uV	AM mod. 30% with 1 kHz	no specification	H3E (AM)

3.6.1.2. Check of L02 and Reinjection Signals

The L02 signal is used in the mixing process from the 1st IF at 70.00064 MHz to the 2nd IF at 10.73152 MHz. The frequency of the L02 signal is 59.26912 MHz when receiving a H3E signal or J3E-USB signal. In J3E-LSB mode the frequency of the L02 signal is 80.73216 MHz.

The carrier reinjection signal is used in the detection of signals with a reduced carrier or signals without any carrier. The frequency of the carrier reinjection signal is 10.73152 MHz and is given by the TCX0.

1. Turn the R2122 on and select J3E-USB mode.
2. To check the L02 signal, connect the diode probe across the resistor R188-1, which is located at the output of the L0 buffer at the Receiver Unit (module 1).
3. Check the measured DC voltage to be $3.3V \pm 0.5V$.
4. To check the reinjection signal connect a DC voltmeter through the diode probe to pin 8 at the detector IC (LM3189).
5. Check the measured DC voltage to be $300\text{ mV} \pm 50\text{ mV}$.

3.6.1.3. Check of Crystal Filters (2nd IF)

The selectivity of the second intermediate frequency is given by the crystal filters (SSB or AM filter), which form an important part of the overall receiver selectivity.

If the 2nd IF selectivity cannot fulfil the specified requirements, it is probably caused by a mistuning of the two crystal filters or by a mistuning of the 1st IF filter at 70 MHz.

The crystal filters are tuned by the trimming capacitor C18-1, which is located at the receiver unit. The adjustment procedure for this capacitor is described in section 3.7.1.3.

The 1st IF filter is tuned by three trimming coils and two transformers. The adjustment procedure for these components is described in section 3.7.1.1.

In this test of selectivity, the 6 dB bandwidth and the stop band attenuation is controlled. The test is performed by using variations in the level detector output voltage, which can be measured at testpoint TP1-1 in the AGC circuit. The voltage can be measured by using an analog multimeter, but it is easier to use a digital multimeter, because the variations in the level detector output voltage are relatively small (about 200 mV).

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

SSB MODE

1. Connect the generator to the aerial socket at the front end unit (module 2).
2. Connect the voltmeter to testpoint TP1-1 for measuring the DC voltage at the level detector output.
3. Connect the counter to earpiece output at testpoint TP2-1.
4. Turn the RE2100 on.
5. Turn the RF gain control fully clockwise and make sure that the AGC is operative.
6. Choose generator frequency f_G , generator output level V_G and receiver frequency f_{RX} according to the table in point 20.
7. Make sure that J3E mode (SSB) is selected and that the AF signal frequency is approx. 1 kHz.
8. Wait 15 min. before proceeding, to temperature stabilize the receiver.
9. Turn off the AGC and adjust the manual RF GAIN Control to achieve a voltage of about 5 volt at testpoint TP1-1.
10. Finetune the receiver frequency by means of the arrow keys until maximum meter deflection, when measuring at testpoint TP1-1.
11. Readjust the manual RF GAIN to achieve a voltage of 5 volt at testpoint TP1-1.
12. To measure the 6 dB bandwidth, increase V_G by 6 dB and notice that the measured voltage will increase to about 14 Volt.
13. Increase the receiver by means of the upward arrow key until the voltage at testpoint TP1-1 is just about 5V.
14. Activate the clarifier function by pressing the <CLARIF> key and finetune the receiver frequency with the arrow keys until the voltage measured at testpoint TP1-1 is just above 5 volt. Now notice the receiver frequency in the display.
15. Deactivate the clarifier function by pressing the <CLARIF> key and decrease the receiver frequency by means of the downward arrow key until the measured voltage is just about 5 volt.
16. Key-in point 14.
17. Calculate the difference between the two frequencies found in points 14 and 16. This difference is equal to the 6 dB bandwidth, which must be above 2550 Hz.
18. To check the stopband attenuation, increase generator output level V_G by 20 dB relative to V_G in point 20.
19. Key-in the frequencies 1987.7 kHz and 1991.2 kHz and remember to turn off the AGC in each case. Control in both cases the DC voltage at testpoint TP1-1 to be below 5 volt.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

20.

Signal Generator			R2122	
f_G	V_G (EMF)	MODE	f_{RX}	MODE
1991 kHz	50 dB/uV	CW	1990 kHz	J3E (SSB)*
990 kHz	50 dB/uV	CW	990 kHz	H3E (AM)

AM MODE

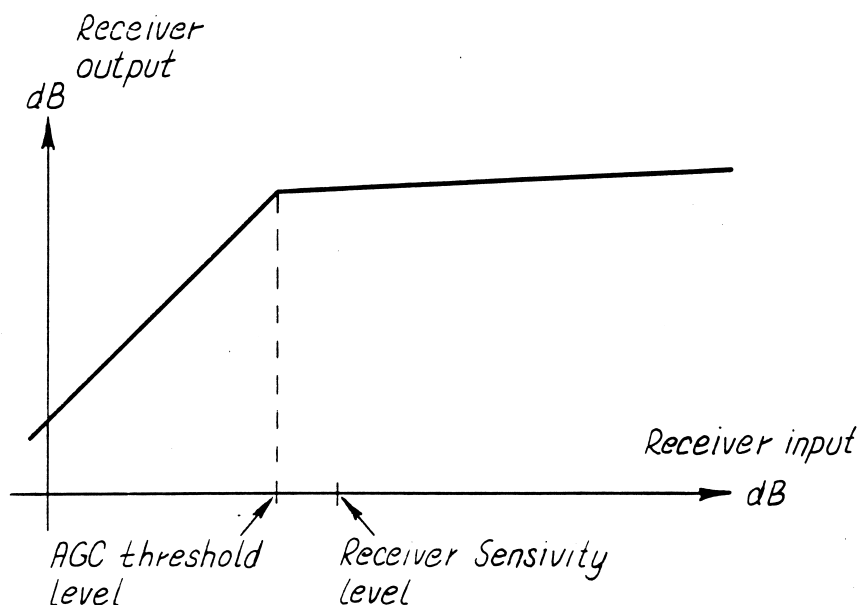
21. Repeat points 1, 2 and 4-6.
22. Make sure that H3E mode (AM) is selected.
23. Repeat point 8-11.
24. Increase generator output level V_G by 6 dB.
25. To check the 6 dB bandwidth, key-in the frequencies 986,7 kHz and 993.3 kHz, and control in each case the voltage at testpoint TP1-1 to be above 5 volt. Remember in each case to turn off the AGC.
26. Increase generator output level V_G by 36 dB relative to V_G in point 20.
27. To check the stopband attenuation, key-in the frequencies 982,9 kHz and 997,1 kHz, and control in each case the voltage at testpoint TP1-1 to be below 5 volt. Remember in each case to turn off the AGC.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

3.6.1.4. Check of 2nd IF Amplifier

In this test the gain of the 2nd IF amplifier is controlled by checking the threshold level of the Automatic Gain Control.

This threshold level is defined in the figure below, where the AGC-characteristic is sketched.



AGC-characteristic used to define the sensitivity or threshold level of the AGC.

Below the threshold level the input signal is too weak to be detected by the AGC circuit. The gain of the 2nd IF amplifier is then unregulated and the receiver output level will increase as 1:1 with increasing input level.

Above the threshold level the input signal is large enough to be detected by the AGC. The gain of the 2nd IF amplifier will then be regulated and the output from the receiver will idealistically be kept at a constant level. However, in practice the receiver output level will increase slightly with increasing input level, because a constant output level would require an infinite gain of the 2nd IF amplifier.

The performance of the AGC above the threshold level is checked by measuring the "flatness" of the AGC characteristic. This measurement is also included in the check procedure given below, because it is measured in the same manner as the threshold level.

The threshold level must, as indicated in the AGC characteristic, be less than the sensitivity level of the receiver to ensure correct function of the AGC. The threshold level is determined by the level detector and the open loop gain from the aerial input to the level detector input. To study this in more details, the simplified block diagram is used in the following description.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

9.

Signal Generator			R2122	
f_G	V_G (EMF)	MODE	f_{RX}	MODE
1991 kHz	7 dB/uV	CW	1990 kHz	J3E (SSB)

3.6.1.5. Check of AGC Circuit

In this test the attack and decay time of the automatic gain control is controlled by measuring the step response of the AGC circuit.

In J3E mode (SSB) the attack time is determined by the resistors R89-1, R91-1 and capacitor C72-1, while the decay time is determined by R63-1 and C69-1.

In H3E mode (AM) the attack time and decay time are determined by R89-1, R91-1 and C71-1.

The measurement of step response is performed by a sudden increment or decrement of the RF input level. This step in input level is obtained by toggling the RX mute relay, which is located at the front end unit. The relay is controlled by two different service programmes.

The step response will be displayed on an oscilloscope, which with advantage may be a storagescope.

1. Connect the generator to aerial socket at the front end unit (module 2).
2. Connect the oscilloscope to testpoint TP3-1 for measuring the AGC voltage and select AC coupling.
3. Connect a probe from testpoint TP4-2 (collector of transistor Q01-2, located at front end unit) to the external trigger input on the oscilloscope.
4. Select external trig source, DC trig mode, and positive slope trig.
5. Turn the R2122 on and turn the RF gain control fully clockwise.
6. Choose generator frequency and generator output level V_G as specified in point 12.
7. In points 8-10 the AGC responses are measured with the oscilloscope and they must be similar to the responses shown below.
NOTE! It may be necessary to adjust trig level to obtain an image on the oscilloscope.
8. To measure the attack time in J3E mode, select service programme SP-04-6.
9. To measure the decay time in J3E mode, select service programme SP-04-6 and change the setting of the oscilloscope.
NOTE! To change service programme press <STOP>.
10. To measure the attack and decay time in H3E mode, select service programme SP-04-7 and change the setting of the oscilloscope. Select positive slope trig.

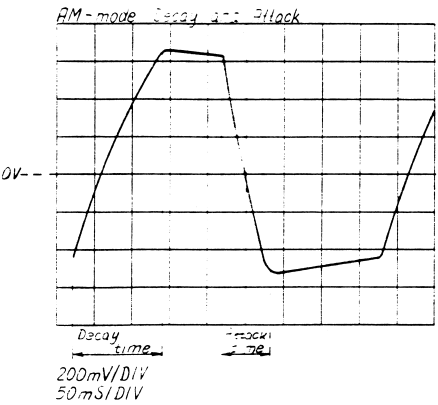
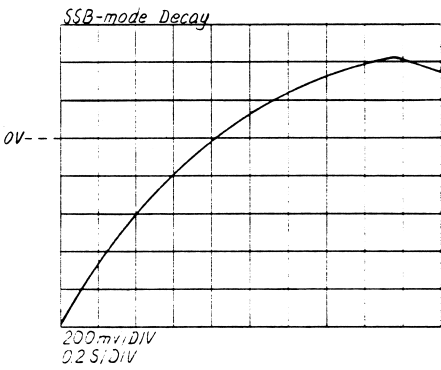
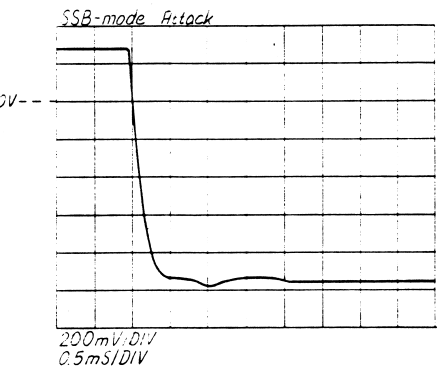
3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

11. Press <TUNE> to leave service programme mode.

12.

Signal Generator			R2122	
f_G	V_G (EMF)	MODE	f_{RX}	MODE
1991 kHz	70 dB/uV	CW	1990 kHz	J3E (SSB)
1991 kHz	70 dB/uV	AM mod. 30% with 1 kHz	1991 kHz	H3E (AM)

The R2122 is automatically set by the service programmes.



AGC Step Responses.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

3.6.1.6. Check of Detector

In this section the audio frequency output level and distortion from the detector are controlled.

The output level from the detector is determined by the input level to the detector and by the detector itself.

The input level to the detector is given by the base-to-emitter voltage of transistor Q14-1 divided by the voltage gain of the AGC amplifier, which is built-up around transistor Q16-1.

1. Connect the generator to the aerial socket at the front end unit (module 2).
2. Connect the voltmeter and a distortion meter to detector output at U06, pin 6.
3. Turn the R2122 on, and turn the RF gain control fully clockwise.
4. Choose generator frequency f_g , generator output level V_g , and receiver frequency f_{RX} according to point 6.
5. Measure the AF output level and distortion at detector output and control the result by comparing it to the values given in point 6.
- 6.

Signal Generator			R2122		Detector Output	
f_g	V_g (EMF)	MODE	f_{RX}	MODE	Level	Distortion
1991 kHz	70 dB/uV	CW	1990 kHz	J3E(SSB)	600 mV _{RMS} -800 mV _{RMS}	1.5%
1991 kHz	70 dB/uV	AM-mod. 30% with 1 kHz	1991 kHz	H3E(AM)	75 mV _{RMS} -95 mV _{RMS}	2%

3.6.1.7. Check of AF Filters

The audio frequency selectivity is controlled by measuring the overall selectivity of the receiver.

If the measured data cannot fulfil the specified requirements, it is necessary to control the 2nd IF selectivity before any conclusion can be made.

SSB MODE

1. Connect the generator to the aerial socket at the front end unit (module 2).
2. Connect the voltmeter and the counter to testpoint TP2-1 (earpiece output).
3. Turn the R2122 on and turn the RF gain control fully clockwise.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

4. Choose generator frequency f_g , generator output level V_g , and receiver frequency f_{RX} according to point 11.
5. Make sure that J3E mode (SSB) is selected, that AGC is on, and that the AF signal frequency is approx. 1 kHz.
6. Finetune the receiver frequency by means of the arrow keys until maximum meter deflection when measuring at testpoint TP2-1.
7. Notice the AC voltage at testpoint TP2-1.
8. Turn the AGC off and adjust the RF gain control to achieve the output level found in point 7.
9. To check the 6 dB bandwidth, choose the generator frequencies 1990.35 kHz and 1992,70 kHz and control in each case the AC voltage at testpoint TP2-1 not to decrease more than 6 dB relative to the value measured in point 7.
10. To check the stopband attenuation, choose the generator frequency 1993,1 kHz and control the AC voltage at testpoint TP2-1 to decrease more than 20 dB relative to the value measured in point 7.
- 11.

Signal Generator			R2122	
f_g	V_g (EMF)	MODE	f_{RX}	MODE
1991 kHz	70 dB/uV	CW	1990 kHz	J3E (SSB)
1991 kHz	70 dB/uV	AM mod. 30% with 1 kHz	1991 kHz	H3E (AM)

AM MODE

12. Repeat point 1-4.
13. Make sure that H3E mode (AM) is selected, that AGC is on, and that the AF signal frequency is approx. 1 kHz.
14. Finetune the receiver frequency by means of the arrow keys until maximum meter deflection at testpoint TP2-1.
15. Notice the AC voltage at testpoint TP2-1.
16. To check the 6 dB bandwidth, change the modulation frequency of the generator to 100 Hz and 3000 Hz, and control in each case the AC voltage at testpoint TP2-1 not to decrease more than 6 dB relative to the value measured in point 15.
17. To check the stopband attenuation, change the modulation frequency of the generator to 6 kHz and control the AC voltage at testpoint TP2-1

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

3.6.1.8. Check of Earpiece Amplifier

The purpose of this test is to control the earpiece amplifier, which is built-up around the integrated circuit U07. If the earpiece output level is outside the specified range, it is necessary to re-adjust the trimming resistor R52-1, which is located at the receiver unit. If it is not possible to adjust the output level to be within the specified range, it is necessary to control the detector output level before any conclusion can be made.

1. Connect the generator to the aerial socket at the front end unit (module 2).
2. Connect the voltmeter and the distortion meter to earpiece output at testpoint TP2-1.
3. Turn the R2122 on and turn the RF gain control fully clockwise.
4. Choose generator frequency f_g , generator output level V_g , and receiver frequency f_{RX} according to point 7.
5. Measure the earpiece output level at testpoint TP2-1 and control the result to be within the range $0.7V_{RMS} - 0.9V_{RMS}$.
6. Measure the earpiece output distortion at testpoint TP2-1 and control the result to be less than 1.5%.
- 7.

Signal Generator			R2122	
f_g	V_g (EMF)	MODE	f_{RX}	MODE
1991 kHz	70 dB/uV	CW	1990 kHz	J3E (SSB)

3.6.1.9. Check of Squelch Circuit

The squelch circuit in the R2122 is voice activated and it works in principle by detecting deviations in the frequency of the received signal. This relative complex squelch function is implemented by means of four separate blocks, which are:

1. Limiting amplifier
2. Frequency to Voltage Converter
3. Voltage Change Detector
4. Hold Circuit

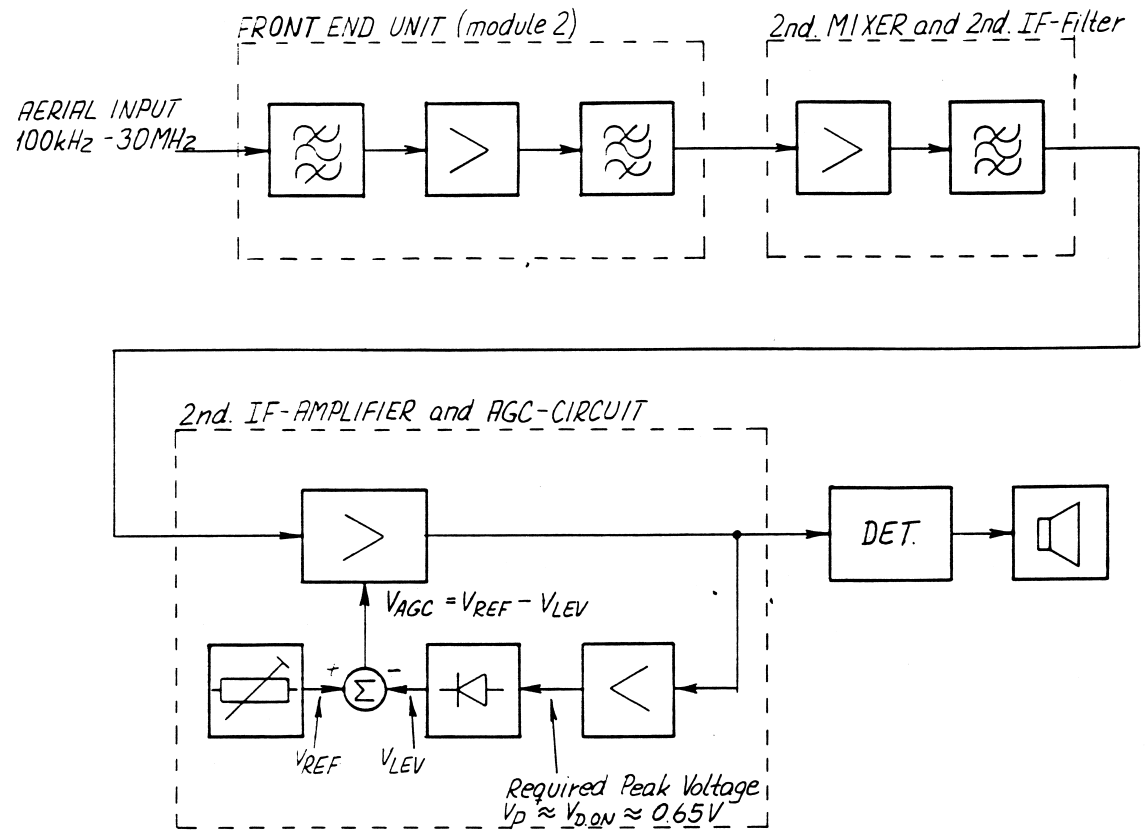
The output voltage from the Hold Circuit is sensed by the microprocessor and this unit is then controlling the analog switch, which is used to mute the audio frequency output.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

In the check procedure given below only the analog part of the squelch is controlled and if this is performing as expected, a failure may be caused by the microprocessor or the connection cabling.

1. Connect the generator to the aerial socket at the front end unit.
2. Connect a loudspeaker to the R2122.
3. Turn the R2122 on and turn the RF gain control fully clockwise.
4. Choose generator frequency f_g , generator output level V_g , and receiver frequency f_{rx} as specified in point 15.
5. Switch off the squelch and make sure that you now hear a 1600 Hz tone.
6. To control the limiting amplifier connect the oscilloscope to the output of the operational amplifier U02/1, pin 1. Control the measured signal to be squarewave with a frequency of 1600 Hz and an amplitude of about 13Vpp.
7. To control the frequency to voltage converter, connect the voltmeter to the output of the operational amplifier U02/4, pin 14 and control the DC voltage to be about 7V.
8. Increase the generator frequency with 1 kHz and control the DC voltage at U02/4, pin 14, to increase to about 11V. Decrease the generator frequency with 2 kHz ($f_g = 1990.6$ kHz) and control the DC voltage to decrease to about 4V.
9. To control the voltage change detector, connect the oscilloscope to the output of the operational amplifier U01/4, pin 14. Select DC trig mode and positive slope trig.
10. Change the generator frequency with ± 1 kHz relative to the frequency specified in point 15 and control in each case the voltage change detector to generate an impulse with a magnitude of about 13V and a duration of about 350 msec.
11. To control the Hold Circuit, choose the generator frequency specified in point 15, and switch on the squelch.
12. Connect the voltmeter to the output of the operational amplifier U01/1, pin 1.
13. Decrease the generator frequency with 1 kHz and control the DC voltage at U01/1, pin 1 to be about 13V. You will now hear a 600 Hz tone in your handset or loudspeaker.
14. Control the DC voltage at U01/1, pin 1 to fall to 0V after a time period of about 10 secs and control that the audio frequency output is muted.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:



Simplified block diagram for the entire receiver.

In the level detector, which is built-up around the transistor Q14-1, the base-emitter diode is used to convert the received AC signal to a DC signal. Thus the input voltage to the level detector is almost a constant and is equal to the diode cut-in voltage. The open loop gain from the aerial input to the level detector input must then be sufficiently high to produce the required peak voltage of about 0.65V with an input signal at the receiver sensitivity level.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

In the simplified block diagram, the amplification from the aerial input to the level detector input is divided into four blocks, which are:

1. Front End Unit
2. 2nd Mixer plus 2nd IF Filter
3. 2nd IF Amplifier
4. AGC Amplifier.

If the receiver does not pass the test of the threshold level given below, it is probably caused by a loss of gain in one of the four blocks.

The gain of the Front End Unit can be controlled directly by the test procedure given in the section 3.6.2.5., while the gain of the 2nd mixer and the 2nd IF filter can only be controlled indirectly by the sensitivity test of the RX module given in section 3.6.1.1.

The gain of the AGC amplifier can be controlled by measuring the detector output level, which must be almost constant from one module to another, because of the rectifying diode in the level detector. To control the detector output level, use the check procedure given in section 3.6.1.6.

If the Front End Unit, the 2nd mixer and 2nd IF filter, and the AGC amplifier all perform as expected, the 2nd IF amplifier must finally be examined. The problem may be solved by adjusting the reference voltage V_{REF} in the AGC circuit. The adjustment is performed by the trimming resistor R203-1 and is described in section 3.7.1.4.

1. Connect the generator to the aerial socket at the front end unit (module 2).
2. Connect the voltmeter to testpoint TP2-1 for measuring the AC voltage at the earpiece output.
3. Turn the R2122 on and turn the RF gain control fully clockwise.
4. Choose generator frequency f_g , generator output level V_g , and receiver frequency f_{RX} according to point 9.
5. Measure the signal to noise ratio SND/N at the earpiece output (see section 3.5.2.1., point 6 for instructions about how to measure SND/N). If the signal to noise ratio SND/N is different from 20 dB, the generator output level must be adjusted until this value is obtained.
6. Notice the earpiece output at testpoint TP2-1.
7. To control the threshold level of the AGC, increase the generator output level V_g by 20 dB and control that the earpiece output level does not increase by more than 2 dB relative to the level measured in point 6.
8. To control the flatness of the AGC, increase the generator output level V_g by 50 dB so the total increase is 70 dB. Control that the earpiece output level does not increase by more than 3 dB relative to the level measured in point 6.

3.6.1. MODULE PERFORMANCE CHECK OF RECEIVER UNIT cont.:

15.

Signal Generator			R2122	
f_g	V_g (EMF)	MODE	f_{RX}	MODE
1991.6 kHz	70 dB/uV	CW	1990 kHz	J3E (SSB)

3.6.2. MODULE PERFORMANCE CHECK OF FRONT END UNIT

This chapter contains the following sections:

- 3.6.2.1. Check of Sensitivity
- 3.6.2.2. Check of Front End Gain
- 3.6.2.3. Check of Mute and RX/TX Switch
- 3.6.2.4. Check of Selection Circuit for Pre-Filters
- 3.6.2.5. Check of LO1 Signal and Buffer

3.6.2.1. Check of Sensitivity

The sensitivity of the entire receiver can in J3E mode be calculated from the following equation:

$$\text{SENS} \approx 10 \log \left(F_{\text{front}} + \frac{F_{\text{RX}} - 1}{G_{\text{front}}} \right) - 7 \text{ dB} \quad (\text{dB}/\mu\text{V})$$

where the following figures shall be taken as typical values:

$$\begin{aligned} F_{\text{front}} &= 5.2 \approx 7.2 \text{ dB} : \text{Noise factor and figure for Front End} \\ F_{\text{RX}} &= 6.3 \approx 8.0 \text{ dB} : \text{Noise factor and figure for Receiver} \\ G_{\text{front}} &= 0.5 \approx -3.0 \text{ dB} : \text{Available power gain for Front End} \end{aligned}$$

The equation is only valid when using a single tone SSB test signal, which produces a signal to noise ratio of 20 dB at the receiver output, and when using a signal generator with an impedance of 50 ohm.

From the figures it can be seen that both the Front End Unit and the Receiver Unit are determining the sensitivity level.

To exclude the receiver unit, it is necessary to check the sensitivity level of this unit separately, which can be done by means of the check procedure described in section 3.6.1.1.

The available power gain, G_{front} , of the Front End Unit can be controlled by the check procedure given in the next section (3.6.2.2.).

The check procedure in this section is especially useful to control the insertion loss of the six parallel coupled bandpass filters, which are used as pre-filters in the Front End Unit. If the sensitivity is poor in only one band, it is very likely that the corresponding filter or the filter selection circuit has a failure.

The filter selection circuit can be checked by means of the check procedure given in section 3.6.2.3.

1. Connect the generator to the aerial socket through the 50 ohm impedance matching network shown in chapter 3.3. PROPOSAL FOR NECESSARY TEST EQUIPMENT.
2. Connect the voltmeter to the earpiece output at testpoint TP2-1 for measuring the AC voltage.

3.6.2. MODULE PERFORMANCE CHECK OF FRONT END UNIT cont.:

3. Turn the R2122 on.
4. Choose generator frequency f_g , generator output level V_g , and Receiver frequency f_{RX} as specified in point 6.
5. Measure the signal to noise ratio SND/N at the earpiece output and check that it is above 20 dB. (See section 3.5.2.1., point 6 for instructions about how to measure SND/N).
- 6.

Pre-filter number	Signal Generator		R2122		
	f_g (kHz)	V_g (EMF)	MODE	f_{RX}	MODE
1	101	18 dB/uV	CW	100	J3E USB
	385	10 dB/uV		384	
2	386	10 dB/uV		385	
	1600	8 dB/uV		1599	
	995	23 dB/uV	AM 30% with 1 kHz	995	H3E
3	1601	8 dB/uV	CW	1600	J3E USB
	4500	8 dB/uV		4499	
	2182	23 dB/uV	AM 30% with 1 kHz	2182	H3E
4	4501	8 dB/uV	CW	4500	J3E USB
	9000	8 dB/uV		8999	
5	9001	8 dB/uV		9000	
	18000	9 dB/uV		17999	
	12352	8 dB/uV		12353	J3E LSB
6	18001	9 dB/uV		18000	J3E USB
	29981	9 dB/uV		29980	H3E
	18373	23 dB/uV	AM 30% with 1 kHz	18373	

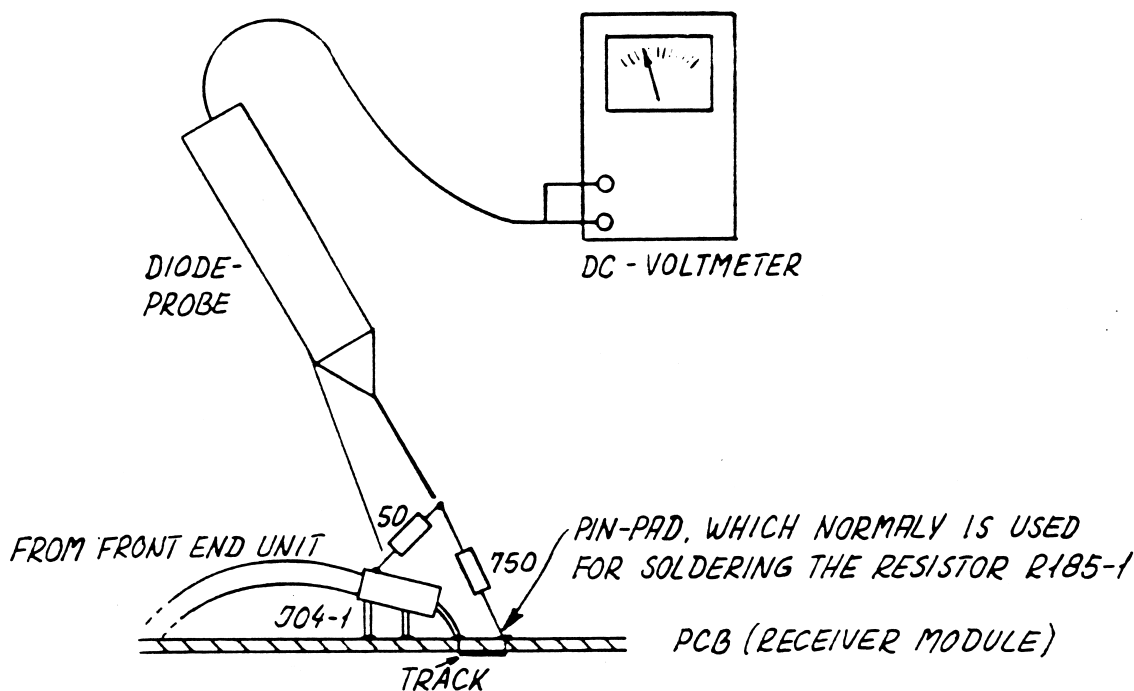
NOTE! The signal levels given in point 6 are referring to the output of the 50 ohm impedance matching network, which has an EMF insertion loss of 20 dB. To obtain the setting of the signal generator, the insertion loss of 20 dB must be added to the levels given in point 6.

3.6.2. MODULE PERFORMANCE CHECK OF FRONT END UNIT cont.:

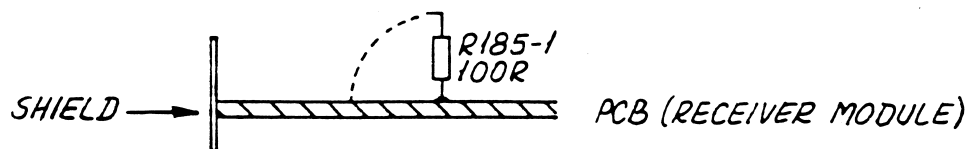
3.6.2.2. Check of Front End Gain

In this test the available power gain of the Front End Unit is controlled. The gain is determined by an indirect measurement and it is therefore necessary to correct the measured data afterwards.

In the test procedure given below, the input and output levels of the Front End Unit are measured by means of the diode probe. To avoid mistuning of the 70 MHz output filter, because of the capacitive loading introduced by the diode probe, it is necessary to measure the output level through a voltage divider. The Front End Unit must then be terminated as shown in the figures below, where the wanted loading impedance of 800 ohm is realized with a voltage divider consisting of a resistor of 750 ohm in series connection with a resistor of 50 ohm.



Termination of the Front End Unit for measurement of the available power gain. The termination is realized at the Receiver Unit (module 1).



The resistor R185-1 must be disconnected as shown above, before the termination of the Front End Unit can be implemented.

1. Terminate the Front End Unit as shown in the figures above.
2. Turn the R2122 on.
3. Choose generator frequency f_g , generator output level V_g , and receiver frequency f_{rx} as specified in point 10.

3.6.2. MODULE PERFORMANCE CHECK OF FRONT END UNIT cont.:

4. Connect the diode probe across the 50 ohm resistor in the Front End terminating network (see figure above).
5. Notice the diode probe voltage.
6. Connect the diode probe across the neon lamp at the input of the front end unit.
7. Adjust the signal generator level V_G until the diode probe voltage is equal to the value measured in point 5.
8. Calculate the difference between the signal generator level used in point 3 and the level found in point 7.
9. The available power gain of the front end unit can now be calculated by means of the equation

$$G_{\text{front}} = 12 \text{ dB} - \Delta V_G$$

where ΔV_G is the difference in generator level found in point 8. The gain should be $-2 \text{ dB} \pm 2 \text{ dB}$.

10.

Signal Generator			R2122	
f_G	V_G (EMF)	MODE	f_{RX}	MODE
1991 kHz	120 dB/uV	CW	1990 kHz	J3E (SSB)

3.6.2.3. Check of Mute and RX/TX Switch

The mute relay RE01-2 is used for external mute functions and for protection of the Front End Unit, when the R2122 is switched off. The mute function is checked by toggling the relay RE01, which is done by means of the service programme SP-04-6.

The RX/TX relay RE02-2 is used for switching between receiver and transmitter mode. The RX/TX relay is normally in the non-activated state, which corresponds to RX-mode. To obtain the TX-mode, the relay must be activated.

1. To check the mute relay, connect the signal generator to the aerial socket at the Front End Unit.
2. Choose the generator frequency $f_G = 1991 \text{ kHz}$ and the generator level, $V_G = 70 \text{ dB/uV}$.
3. Select the service programme SP-04-6 and control the number of lighted LED's in the signal strength meter to change between about five and eight with a time interval of about 2 secs.
NOTE! Make sure that the signal strength meter is correctly adjusted.
4. To leave service programme mode press <RX>.

3.6.2. MODULE PERFORMANCE CHECK OF FRONT END UNIT cont.:

3.6.2.4. Check of Selection Circuit for Pre-Filters

The switching between the pre-filters is controlled from the microprocessor through the shift register J01-2 and six operational amplifiers which are included in the two IC's U02-2 and U03-2.

1. Key-in the receiver frequencies and control the DC-voltage at the output of U02-2 and U03-2 to be in accordance with the table in point 2.
- 2.

Receiver Freq. (kHz)	U02				U03	
	pin 1	pin 7	pin 8	pin 14	pin 1	pin 7
196	0V	0V	0V	0V	0V	13V
785	0V	0V	0V	0V	13V	0V
2683	0V	0V	0V	13V	0V	0V
6364	0V	0V	13V	0V	0V	0V
12728	0V	13V	0V	0V	0V	0V
23238	13V	0V	0V	0V	0V	0V

3.6.2.5. Check of L01 Signal and Buffer

In this test the level of the L01 signal at the output of the buffer is controlled.

The L01 signal is used in the mixing process from the receiver frequency f_{RX} to the 1st IF at 70,000,640 MHz.

The frequency of the L01 signal can be varied from 70 MHz to 100 MHz and is determined by the equation:

$$f_{LO1} = f_{RX} + f_{IF1} = f_{RX} + 70,000,640 \text{ MHz}$$

where f_{RX} is the receiver frequency.

1. Connect the voltmeter through the diode probe across the coil L41-2.
2. Turn the R2122 on.
3. Key-in the receiver frequency 2182 kHz.
4. Control the measured DC voltage to be 7.5V ±1V

3.6.3. MODULE PERFORMANCE CHECK OF SYNTHESIZER UNIT

This chapter contains the following sections:

- 3.6.3.1. Check of TCXO
- 3.6.3.2. Check of PLL1
- 3.6.3.3. Check of PLL2

3.6.3.1. Check of TCXO

The TCXO signal is used as reference frequency in both PLL1 and PLL2, and it is also used as carrier injection signal for both transmitter and receiver.

1. Turn the R2122 on.
NOTE! The R2122 must be on for at least 15 minutes before the check is carried out.
2. Connect the counter to TP4-3 through passive probe.
3. Check the frequency on TP4-3 to be 10.731520 MHz \pm 1 Hz.

3.6.3.2. Check of PLL1

The PLL1 consists of four independent VCO's, which together cover the whole frequency band from 70 MHz to 100 MHz.

1. Turn the R2122 on.
2. Connect the voltmeter to TP1-3.
3. Connect the counter to TP3-3.
4. Key-in the RX frequency and check the DC-voltage on TP1-3 and the frequency on TP3-3 to be in accordance with table in point 5.
- 5.

RX frequency	Frequency on TP3-3	Voltage on TP1-3
7499.0	77.49964 MHz \pm 10 Hz	-11.0V \pm 1V
14999.0	84.99964 MHz \pm 10 Hz	-11.0V \pm 1V
22499.0	92.49964 MHz \pm 10 Hz	-11.0V \pm 1V
29999.0	99.99964 MHz \pm 10 Hz	-11.0V \pm 1V

6. Key in the RX-frequency and check the DC-voltage on TP1-3 and the frequency on TP3-3 to be in accordance with point 7.

3.6.3. MODULE PERFORMANCE CHECK OF SYNTHESIZER UNIT cont.:

7.

RX frequency	Frequency on TP3-3	Voltage on TP1-3
100.0	70.10064 MHz ± 10 Hz	-3.0V ± 1 V
7500.0	77.50064 MHz ± 10 Hz	-3.0V ± 1 V
15000.0	85.00064 MHz ± 10 Hz	-3.0V ± 1 V
22500.0	92.50064 MHz ± 10 Hz	-3.0V ± 1 V

8. Select RX-frequency 2225.4 kHz and measure the frequency on TP3-3.
9. Select RX-frequency 2075.3 kHz and measure the frequency on TP3-3, then subtract it from the frequency measured in check point 8. The result must be 150.100 kHz ± 2 Hz.
10. Connect the voltmeter to TP3-3 through diode probe.
11. Select RX-frequency and check the voltage on TP3-3 to be in accordance with point 12.

12.

RX Frequency	Voltage on TP3-3
3750.0	>0.8 Volt
11250.0	>0.8 Volt
18750.0	>0.8 Volt
26250.0	>0.8 Volt

13. Connect the voltmeter to TP2-3 through diode probe.
14. Select service programme SP-04-5 as described in this manual, section 3.10.1. and check the voltage on TP2-3 to be above 0.8 Volt.

3.6.3.3. Check of PLL2

The PLL2 consists of two independent VCO's and is capable of delivering two different signals with the frequencies 59.26912 MHz and 80.73216 MHz.

1. Turn the R2122 on.
2. Connect the voltmeter to TP5-3.
3. Connect the counter to TP7-3.
4. Select receiver mode and check the DC-voltage on TP5-3 and the frequency on TP7-3 to be in accordance with point 5.

3.6.3. MODULE PERFORMANCE CHECK OF SYNTHESIZER UNIT cont.:

5.

MODE	Frequency on TP7-3	Voltage on TP5-3
J3E	59.26912 MHz ± 10 Hz	-6.5V ± 0.5 V
LSB	80.73216 MHz ± 10 Hz	-6.5V ± 0.5 V

6. Connect the voltmeter to TP7-3 through diode probe.

7. Check the voltage on TP7-3 to be in accordance with table 8.

8.

MODE	Voltage on TP7-3
J3E	>0.8 Volt
LSB	>0.8 Volt

9. Connect the voltmeter to TP6-3 through diode probe.

10. Select service programme SP-04-5 as described in this manual, section 3.10.1., and check the voltage on TP6-3 to be above 0.8 Volt.

3.6.5 PERFORMANCE CHECK OF MICROPROCESSOR MODULE 5.

GENERAL

To execute a performance check of a microprocessor unit, keyboard unit and display unit (module 5, 6 and 7) it is necessary to dismantle the cover and remove the 2 PCB covers on module 5. Disconnect the BNC and 25 poles D-connector to T2130. Connect an external +18V power supply at J03 pin 12 or pin 24, an external -18V power supply at J03 pin 10 and an adjustable +9V power supply at J03 pin 11 or pin 23.

CHECK OF ON BOARD POWER SUPPLY

Connect a voltmeter between ground and anode of D02.

Control the voltage to: $> 7.0V$. Normally $9.0V$.

Connect a voltmeter between ground and U15 pin 2.

Control the voltage: $4.75V < +5VA < 5.25V$.

Connect a voltmeter between ground and U17 pin 3.

Control the voltage: $4.50V < +5VB < 5.50V$.

Connect a voltmeter between ground and U18 pin 3.

Control the voltage: $-4.50V > -5VB > -5.50V$.

CHECK OF MICROPROCESSOR

Control of Strap in P02.

If the strap is connected between pin 1 and pin 2, the microprocessor will read the programme from internal ROM. This is only used if the microprocessor U07 is mask programmed. In that case the ROM U06 will not be mounted. If the strap is connected between pin 2 and pin 3, the microprocessor will read the programme from U06.

Control of Strap in P03.

If the strap is connected between pin 1 and pin 2, the microprocessor will run in service programme mode. The display will read out "SP- ". Look up the description of Service Programmes in chapter 3.10. If the strap is connected between pin 2 and pin 3, the microprocessor will run the normal programme.

Control of the Internal Clock Frequency.

Connect a frequency counter to U07 pin 64. The frequency must be $2000 \text{ kHz} \pm 16.0 \text{ kHz}$ ($X-tal/4$).

CHECK OF EXTERNAL ROM

If the microprocessor is strapped to external ROM, control the strap in P01. If the strap is connected between pin 1 and pin 2, the device (ROM) in socket U06 must be a 256 Kbyte type (e.g. 27C256). If the strap is connected between pin 2 and pin 3, the device (ROM) in socket U06 must be a 128 Kbyte type (e.g. 27C128).

3.6.5. PERFORMANCE CHECK OF MICROPROCESSOR MODULE 5 cont.:

CHECK OF WATCH DOG AND POWER LOW CIRCUIT

Control of Power Low circuit

After the power is switched on, connect a voltmeter to U15 pin 4 (Power Low In) and control the voltage to $> 1.25V$. If the voltage goes below $1.25V$, the display will read out "Error 00" for Power Low Fail. Connect a test wire between ground and U15 pin 4 and look for Power Low Fail in the display. Disconnect the test wire.

Control of Watch Dog Circuit

Connect an oscilloscope to U15 pin 6 and control that the square wave seen has a $5.0V \pm 0.5V$ amplitude, that the duty cycle is 50%, and that the frequency is one of 3 possible:

1. 15 Hz. Standard after power is switch on
2. 20 Hz. Standard for Test Alarm mode
3. 50 Hz. Standard for Scan Run mode

Connect a test wire between ground and U15 pin 6. Control that the microprocessor will start a reset cycle after every 1.6 s. (the display will flash). Disconnect the test wire again and control that the microprocessor will stop the reset cycle.

CHECK OF BAUD RATE GENERATOR

Connect a frequency counter to U02 pin 9. The frequency will be a 26th part of the internal clock frequency (normally $76.923 \text{ kHz} \pm 600 \text{ Hz}$), and the duty cycle is 50%.

CHECK OF METER AMPLIFIER

Connect a test wire between ground and J03 pin 15. Connect a voltmeter between ground and U12 pin 7. Control the voltage to $600 \text{ mV} \pm 50\text{mV}$. Connect the test wire between J03 pin 15 and U17 pin 3. Control the voltage on U12 pin 7 to $3.6V \pm 250\text{mV}$.

CHECK OF SPI DATA BUS

Press "2182" (Distress), the display will show "2182.0". Then press CH-1-ADD and 2-ADD, the distress frequency is now programmed into channel 1 and 2. Then press SC-8-ENT. If the scanning is started, then press STOP and delete the channels for scan programme no. 8, until the display shows "CH- no". Press 1-ADD-2-ADD-ENT, channel 1 and channel 2 are now programmed in scan programme 8, and the receiver will now scan channel 1 and channel 2 with the same frequency. If the scanner stops at the channel, then disconnect the antenna plug.

Check of SPI Data

Connect an oscilloscope channel A to U10 pin 4 and channel B to U10 pin 10. Set TB=50 μs . Control that the two wave forms are the same. The voltage is $5V_{pp} \pm 0.5V$.

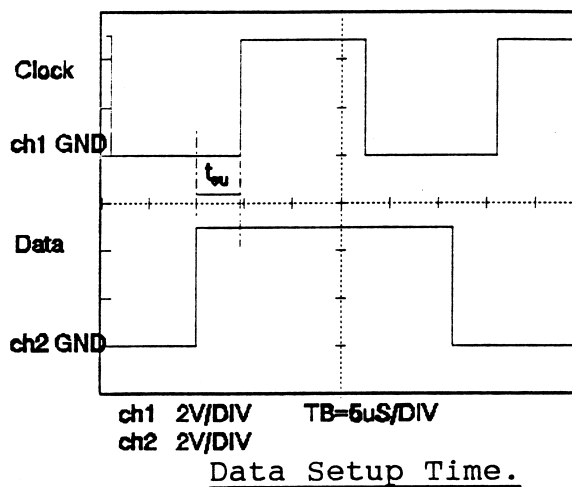
3.6.5. PERFORMANCE CHECK OF MICROPROCESSOR MODULE 5 cont.:

Check of SPI Clock

Connect an oscilloscope channel A to U10 pin 2 and channel B to U10 pin 12. Set TB=50 μ S. Control that the two wave forms are the same. The voltage is 5Vpp \pm 0.5V. The clock period is 26 μ S.

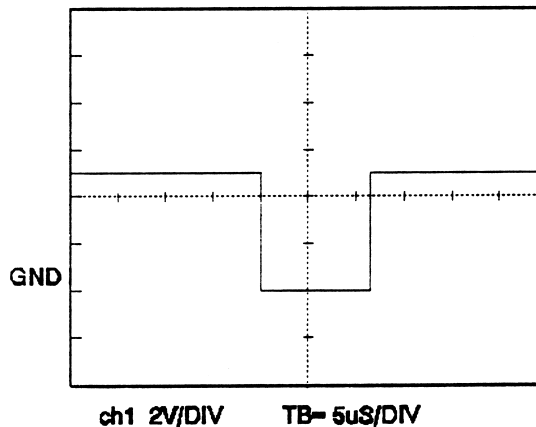
Check of Timing between SPI Data and Clock

Connect an oscilloscope channel A to U10 pin 2 and channel B to U10 pin 4. Set TB=5 μ S and control the data set-up time as shown below.



Check SPI Address Select

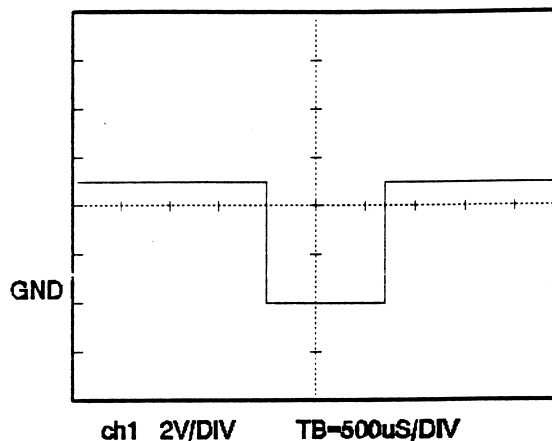
Connect an oscilloscope channel A to U09 pin 2. Set TB=5 μ S and control the wave form as shown below. Control the same wave form on U09 pin 3,4,5,6,7,8 and 16.



Address Select U09 Pin2,3,4,5,-
6,7,8 and pin16.

3.6.5. PERFORMANCE CHECK OF MICROPROCESSOR MODULE 5 cont.:

Connect an oscilloscope channel A to U09 pin 13. Set TB=500uS and control the wave form as shown below. Control the same wave form on U09 pin 14 and 15.

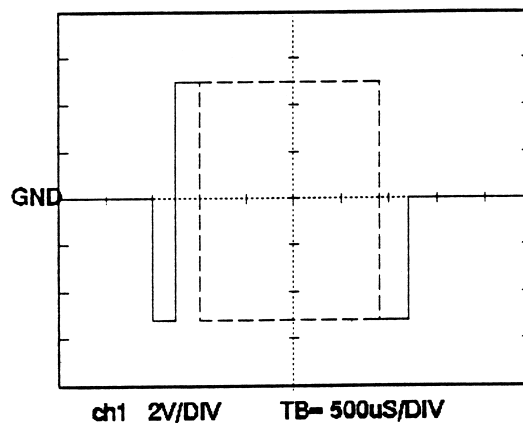


Address Select U09 Pin13, 14 and Pin15

CHECK OF SP-BUS TRANSMITTER/RECEIVER.

Press the digits 0 and 1 at the same time. The equipment will now be in Quick Service mode and the display will show "SP- ".

Select the service programme SP-00-3 (ref. to chapter 3.10). If the SP-BUS does not work satisfactorily, an "E" will be displayed in Tx-display. Connect an oscilloscope to BNC connector J04 (SP-BUS output). Control that the wave form seen is approx. equal to the one shown below. The 8 data bit and parities bit will change every time the SP-BUS transmitter sends a new byte. Transmit speed is 4800 baud and time between two bytes is approx. 14 mS.



Tx signal on SP-BUS.

CHECK OF EEPROM U05.

To test the Electrical Erasable PROM, the service programme SP-10-0 has to be run. Press the digits 1 and 0 at same time, the equipment will now be in Quick Service mode and the display will show "SP- ". Then press the digits 1-0-0 and finish with ENT. The Rx-display will read out "SP-10-0 and the Tx-display will start to count from 0 to 512. If the counting stops with 512 and an "A" is shown, the EEPROM is ok. But if the counting is stopped between 0 and 512 and an "E" is shown, there has to be a programming error.

3.6.8. MODULE PERFORMANCE CHECK OF POWER UNIT

3.6.8.1. Check of Output Voltages

1. Connect a power supply 11V/3A to the R2122 and check with a voltmeter the following voltage:

+ 5V at P2 pin 5	+9V at P1 pin 5
+15V at P2 pin 7	
+18V at P2 pin 8	
-18V at P2 pin 9	

2. Connect a power supply 32V/3A to the R2122 and check with a voltmeter the following voltages:

+ 5V at P2 pin 5	+9V at P1 pin5
+15V at P2 pin 7	
+18V at P2 pin 8	
-18V at P2 pin 9	

3.6.10. MODULE PERFORMANCE CHECK OF AF AMPLIFIER

3.6.10.1. Check of Distortion and Output Power

1. Connect the generator to the aerial socket at the front end unit (module 2).
2. Connect the voltmeter and distortion meter to the loudspeaker output.
3. Turn on the R2122 and turn the RF gain control fully clockwise.
4. Choose operator frequency f_g , generator output level V_g , and receiver frequency f_{RX} , according the point 7.
5. Adjust the input supply voltage to 24V. Adjust the audio output level to 6V by means of the vol. control.
6. Measure the output distortion and control that the distortion is less than 5%.
- 7.

Signal Generator			R2122	
f_g	V_g (EMF)	MODE	f_{RX}	MODE
1991 kHz	70 dB/uV	CW	1990 kHz	J3E (SSB)

3.7. ADJUSTMENT PROCEDURE

This chapter contains the adjustment procedure for all adjustable components in the R2122.

3.7.1. ADJUSTMENT PROCEDURE FOR FRONT END AND RECEIVER UNIT

This chapter contains the following sections:

- 3.7.1.1. Adjustment of 70 MHz IF-Filter (Front End and Receiver)
- 3.7.1.2. Adjustment of 70 MHz Transformer (Receiver)
- 3.7.1.3. Adjustment of SSB/AM Filter (Receiver)
- 3.7.1.4. Adjustment of 2nd IF-Gain (Receiver)
- 3.7.1.5. Adjustment of Signal Meter (Receiver)
- 3.7.1.6. Adjustment of Earpiece Level (Receiver)

3.7.1.1. Adjustment of 70 MHz IF-Filter (Front End and Receiver)

The 70 MHz IF-filter is adjusted by tuning the three trimming coils L35-2, L36-2, L37-2, and the two transformers TR04-2, TR01-1.

The components L35-2, L36-2, L37-2 and TR04-2 are all located at the front end unit (module 2), while TR01-1 is located at the receiver unit (module 1).

The adjustment is performed by using the two service programmes SP-04-0 and SP-04-1. These programmes set-up the first local oscillator (LO1) as a test signal and therefore no external signal generator is necessary.

1. Disconnect any input to the aerial socket.
2. Connect a voltmeter to test point TP1-1 for measuring the DC-output voltage from the AGC level detector.
3. Turn the R2122 on.
4. Select service programme SP-04-0 as described in section 3.10.1. of this manual.
5. Tune the transformer TR01-1 (Receiver Module) and the trimming coil L37-2 (Front End Module) to maximum meter deflection.
6. Select service programme SP-04-1 (press <STOP> to terminate the first service programme).
7. Tune the transformer TR04-2 and the trimming coils L35-2 and L36-2 to maximum meter deflection.
8. Select service programme SP-04-0.
9. Turn off the AGC and adjust the manual RF GAIN until the DC-output voltage from the AGC level detector is about 5 volt.

3.7.1. ADJUSTMENT PROCEDURE FOR FRONT END AND RECEIVER UNIT cont.:

10. Finetune all five components by repeating point 5-7. Remember to turn off the AGC in point 6 after selecting the service programme SP-04-1.
NOTE! If the DC-output voltage from the AGC level detector is increased to a level above 9 Volt, it is necessary to readjust the manual RF-gain until the voltage level is about 5 Volt.
11. Press <TUNE> to leave the service programme mode.

3.7.1.2. Adjustment of 70 MHz Transformer (Receiver)

The position number of the 70 MHz transformer is TR01-1 and it is located at the receiver unit (module 1). The adjustment is performed by tuning TR01-1 until the DC-output voltage from the AGC level detector is maximum. The tuning is performed by using the service programme SP-04-0. This programme sets-up the first local oscillator (LO1) as a test signal and therefore no external signal generator is necessary.

1. Execute points 1-4 in section 3.7.1.1.
2. Tune the 70 MHz transformer TR01-1 to maximum meter deflection.
3. Turn off the AGC and adjust the manual RF GAIN until the DC-output voltage from the AGC level detector is about 5 Volt.
4. Finetune TR01-2.
5. Press <TUNE> to leave the service programme mode.

3.7.1.3. Adjustment of SSB/AM-Filter (Receiver)

The SSB/AM-filter is adjusted by tuning the trimming capacitor C18-1 until the DC-output voltage from the AGC level detector is maximum. The trimming capacitor C18-1 is located at the receiver unit (module 1). The adjustment is performed by using the service programme SP-04-2. This programme sets-up the first local oscillator (LO1) as a test signal and therefore no external signal generator is necessary.

1. Execute points 1-3 in section 3.7.1.1.
2. Select service programme SP-04-2.
3. Adjust the manual RF-gain until the DC-output voltage from the AGC level detector is about 5V.
4. Tune the trimming capacitor C18-1 to maximum meter deflection.
5. Press <TUNE> to leave the service programme mode.

3.7.1.4. Adjustment of 2nd IF-Gain (Receiver)

To meet the gain variations from one transistor to another, the 2nd IF-amplifier has been constructed with a reserve of power gain. This implies that the 2nd IF-gain may be very large, which may cause unstable conditions because of unwanted feedback.

3.7.1. ADJUSTMENT PROCEDURE FOR FRONT END AND RECEIVER UNIT cont.:

It is therefore necessary to adjust the unregulated gain of the 2nd IF-amplifier, which must be done in accordance with the procedure given below.

The 2nd IF-gain is adjusted by trimming the resistor R203-1, which is located at the receiver unit (module 1).

The adjustment is performed by using a signal generator and an AC voltmeter.

1. Connect the signal generator to the aerial socket at the front end unit.
2. Connect the AC voltmeter to earpiece output at testpoint TP2-1.
3. Turn the R2122 on.
NOTE! The R2122 must be on for at least five minutes before proceeding.
4. Select the setting of the signal generator and the R2122 according to point 5.
- 5.

Signal Generator			R2122	
Frequency	Level	MODE	Frequency	MODE
1991 kHz	33 dB/uV	CW	1990 kHz	J3E (SSB)

6. Measure the AC voltage at the earpiece output.
7. Change the generator output level to 0dB/uV.
8. Adjust the resistor R203-1 until the AC voltage at earpiece output is decreased by 4 dB relative to the level measured in point 6.

3.7.1.5. Adjustment of Signal Meter (Receiver)

The signal meter is adjusted by trimming the resistor R76-1, which is located at the receiver unit (module 1).

1. Disconnect any input to the aerial socket.
2. Turn the R2122 on and make sure that J3E-mode (SSB) is selected and that the AGC is operative.
3. Adjust R76-1 until the first LED-bar in the display is just about to light.

3.7.1.6. Adjustment of Earpiece Level (Receiver)

The earpiece level is adjusted by trimming the resistor R52-1, which is located at the receiver unit (module 1).

The adjustment is performed by using the service programme SP-04-3. This programme sets-up the first local oscillator (LO1) as a test signal and therefore no external signal generator is necessary.

3.7.1. ADJUSTMENT PROCEDURE FOR FRONT END AND RECEIVER UNIT cont.:

1. Disconnect any input to the aerial socket.
2. Connect a voltmeter to earpiece output at testpoint TP2-1 for measuring the AC-voltage.
3. Turn the R2122 on.
4. Select service programme SP-04-3.
5. Adjust R52-1 until the earpiece level is $0.8 V_{RMS} + x_{0.1} V_{RMS}$.
6. Press <TUNE> to leave the service programme mode.

3.7.2. ADJUSTMENT PROCEDURE FOR SYNTHESIZER UNIT

This chapter contains the following sections:

- 3.7.2.1. Adjustment of TCXO
- 3.7.2.2. Adjustment of API Voltage in PLL1
- 3.7.2.3. Adjustment of the VCO Circuits in PLL1
- 3.7.2.4. Adjustment of the VCO Circuits in PLL2

3.7.2.1. Adjustment of TCXO

The Temperature Compensated X-tal Oscillator (TCXO) delivers the reference frequency, which is common for both PLL1 and PLL2.

The adjustment is performed by measuring the TCXO frequency at the output of the TCXO buffer at testpoint TP4-3 (collector of transistor Q26-3).

1. Turn the R2122 on.
NOTE! The R2122 must be on for at least 15 minutes before the adjustment is carried out.
2. Connect the counter to TP4-3 through passive probe.
3. Adjust the TCXO, until the frequency at TP4-3 is 10.731520 MHz \pm 1 Hz.

3.7.2.2. Adjustment of API Voltage in PLL1

The API voltage is adjusted by trimming the resistor R88-3, which is located at the Synthesizer Unit (module 3).

The adjustment is performed by using the service programme SP-04-4. This programme sets up a special receiver mode, where the API sideband from the L01 is passed through the SSB crystal filter and the 2nd IF-amplifier. The level of the API sideband can then be measured as a DC voltage at the level detector output at testpoint TP1-1.

1. Turn the R2122 on.
2. Connect the DC voltmeter to TP1-1 located on the Receiver Unit (module 1).
3. Select service programme SP-04-4 as described in this manual, section 3.10.1.
4. Adjust potentiometer R88-3 for minimum meter deflection.

3.7.2.3. Adjustment of the VCO Circuits in PLL1

The PLL1 consists of four independent Voltage Controlled Oscillators, which each covers about a quarter of the whole frequency band of 30 MHz.

The VCO circuits are adjusted by four individual coils. The adjustment is performed at the upper frequency in each of the four VCO bands and the coils are adjusted until the output voltage from the active loop filter is -11.0 Volt.

3.7.2. ADJUSTMENT PROCEDURE FOR SYNTHESIZER UNIT cont.:

1. Turn the R2122 on.
2. Connect the voltmeter to TP1-3.
3. Key-in the RX-frequencies and adjust VCO coils according to table 4 until voltage on TP1-3 is -11.0 Volt.
- 4.

RX frequency	Adjustment of
7499.0	TR03
14999.0	TR04
22499.0	TR05
29999.0	TR06

5. Key-in the RX-frequencies according to table 6 and check the voltage on TP1-3 to be -3 Volt ± 1.0 Volt.
NOTE! No adjustments of VCO coils shall be made.

6.

RX-frequency:

100.0
7500.0
15000.0
22500.0

3.7.2.4. Adjustment of the VCO Circuits in PLL2

The PLL2 consists of two independent Voltage Controlled Oscillators, which are used in USB and LSB mode respectively.

The VCO circuits are adjusted by two individual coils, which are adjusted until the output voltage from the active loop filter is -6.5 Volt.

1. Turn the R2122 on.
2. Connect the voltmeter to TP5-3.
3. Select J3E mode and adjust TR08 until the voltage on TP5-3 is -6.5 Volt.
4. Select LSB mode and adjust TR07 until the voltage on TP5-3 is -6.5 Volt.

3.8. NECESSARY ADJUSTMENT AND CHECK AFTER REPAIR

GENERAL

After repair of the R2122 it may be necessary to do some adjustments and checks.

The extent of these adjustments and checks can only be decided by the person, who has done the repair, and this manual section must only be looked upon as a guide.

Any repair must, as mentioned previously, be followed by a function check after reinstallation of the R2122.

RECEIVER UNIT (MODULE 1)

After a Change of the Module

Execute 3.7.1.5. Adjustment of Signal Meter, and 3.5.2. Performance Check of Receiver.

Repair in 2nd Mixer and the Corresponding Input Matching Circuit

Execute 3.7.1.2. Adjustment of 70 MHz Transformer, and 3.5.2.1. Performance Check of Receiver Sensitivity.

Repair in L02 Buffer

Execute 3.6.1.2. Check of L02 and Reinjection Signals, and 3.5.2.1. Performance Check of Receiver Sensitivity.

Repair in SSB/AM Crystal Filters and the Corresponding Input/Output Matching Network

Execute 3.7.1.3. Adjustment of SSB/AM Filter.

Execute 3.6.1.3. Check of Crystal Filters, and 3.5.2.1. Performance Check of Receiver Sensitivity.

Repair in 2nd IF Amplifier and AGC Circuit

Execute 3.7.1.4. Adjustment of 2nd IF Gain, and 3.7.1.5. Adjustment of Signal Meter.

Execute 3.5.2.5. Performance Check of Receiver AGC, and 3.5.2.1. Performance Check of Receiver Sensitivity.

Repair in Detector

Execute 3.5.2.1. Performance Check of Receiver Sensitivity, and 3.5.2.2. Performance Check of Receiver Distortion.

Repair in Audio Frequency Filter

Execute 3.5.2.3. Performance Check of Receiver Audio Passband, and 3.5.2.1. Performance Check of Receiver Distortion.

Repair in Earpiece Amplifier

Execute 3.7.1.6. Performance Check of Earpiece Level, and 3.5.2.2. Performance Check of Receiver Distortion.

Repair in Squelch Circuit

Execute 3.5.2.6. Performance Check of Receiver Squelch.

3.8. NECESSARY ADJUSTMENT AND CHECK AFTER REPAIR cont.:

FRONT END UNIT (MODULE 2)

After a Change of the Module

Execute 3.5.2.1. Performance Check of Receiver Sensitivity, and 3.5.2.3. Performance Check of Receiver Audio Passband.

Repair in Input Protection Circuit and Pre-Filters

Execute 3.5.2.1. Performance Check of Receiver Sensitivity, and 3.5.2.2. Performance Check of Receiver Distortion.

Repair in 1st Mixer and 70 MHz IF Filter

Execute 3.7.1.1. Adjustment of 70 MHz IF Filter.

Execute 3.5.2.1. Performance Check of Receiver Sensitivity, and 3.5.2.3. Performance Check of Receiver Audio Passband.

Repair in L01 Buffer

Execute 3.5.2.1. Performance Check of Receiver Sensitivity.

SYNTHESIZER UNIT (MODULE 3)

After a Change of the Module

Execute 3.5.2.1. Performance Check of Receiver Sensitivity, and 3.5.2.4. Performance Check of Receiver Clarifier and Frequency.

Execute 3.5.3.2. Performance Check of Exciter Frequencies and Classes of Emission.

Repair in the TCXO and Buffer

Execute 3.7.2.1. Adjustment of TCXO.

Repair in Phase Detector, Current Mirror and API Circuit (PLL1)

Execute 3.7.2.2. Adjustment of API Voltage in PLL1, and 3.7.2.3. Adjustment of the VCO Circuits in PLL1.

Execute 3.5.2.1. Performance Check of Receiver Sensitivity, and 3.5.2.4. Performance Check of Receiver Clarifier and Frequency.

Repair in the PLL1

Execute 3.7.2.3. Adjustment of the VCO Circuit in PLL1.

Execute 3.5.2.1. Performance Check of Receiver Sensitivity, 3.5.2.4. Performance Check of Receiver Clarifier and Frequency, and 3.5.3.2. Performance Check of Exciter Frequencies and Classes of Emission.

Repair in the PLL2

Execute 3.7.2.4. Adjustment of the VCO Circuits in PLL2.

Execute 3.5.2.1. Performance Check of Receiver Sensitivity, 3.5.2.4. Performance Check of Receiver Clarifier and Frequency, and 3.5.3.2. Performance Check of Exciter Frequencies and Classes of Emission.

PROCESSOR UNIT (MODULE 5)

After a Change or Repair of the Module

Execute 3.5.1.1. and 3.5.1.2. Performance Check of Display and Keyboard.

Execute 3.5.2.4. Performance Check of Receiver Clarifier and Frequency, and 3.5.3.2. Performance Check of Exciter Frequencies and Classes of Emission.

3.8. NECESSARY ADJUSTMENT AND CHECK AFTER REPAIR cont.:

KEYBOARD UNIT (MODULE 6)

After a Change or Repair of the Module

Execute 3.5.1.2. Performance Check of Keyboard.

DISPLAY UNIT (MODULE 7)

After a Change or Repair of the Module

Execute 3.5.1.1. Performance Check of Display.

3.9. FUNCTION CHECK

The function check is a simple test to ensure that the R2122 is working properly after installation.

The function check must always be carried out after a repair of the R2122. Any repair of the R2122 must be followed by a performance check, and after reinstallation a function check must be carried out in order to make sure that the fault has been repaired and that the RE2100 is working correctly.

1. Turn on the VOL-OFF switch and control that noise is heard in the loudspeaker and the display is alight.
2. Press the keyboard buttons 0 and 1 simultaneously.
3. Select the test programme SP-00-2.
4. Control that all the leds in the display are activated, the mode indicating light emitting diodes are toggled, and the three light emitting diodes, indicating the power level, are alight.
5. Press the RF-GAIN control fully counter clockwise and control that all the light emitting diodes in the signal meter are alight.
7. Key-in a known broadcast station in the frequency range 100 - 384 kHz.
8. Notice that the detected AF signal is heard from the loudspeaker and from the handset earpiece without distortion.
9. Toggle the keyboard button MODE, until J3E mode is chosen.
10. Notice that no beat note is heard in the loudspeaker.
11. Press the keyboard FREQ arrow buttons to toggle the 100 Hz decimal up and down.
12. Control that the beat note heard in the loudspeaker changes with the 100 Hz steps.
13. Key-in a known broadcast station in the frequency range 385 - 1600 kHz.
14. Notice that the detected AF signal is heard from the loudspeaker without distortion.
15. Key-in a known coastal station frequency in the frequency range 1600 - 3990 kHz.
16. When listening to the coastal station, activate the clarifier and control that it is working properly.
17. Key-in one ITU channel in each of the maritime bands from 4.0 - 25.0 MHz and control that the receiver is working properly.

3.9. FUNCTION CHECK cont.:

18. Activate a scan programme or key-in a scan programme, and control that the scan function is working correctly.
19. Active the keyboard AGC and SQ button and control that the leds marked AGC and SQ can be toggled.
20. When activating the SQ function, control that the noise from the loudspeaker disappears.

3.10. SELECTION AND DESCRIPTION OF THE SERVICE PROGRAMMES

3.10.1. How to Select a Service Programme

In order to help the operator, and the service engineer during installation or repair, the R2122 has some built-in service programmes.

The R2122 has a service mode, which is activated by pressing the keyboard buttons 1 and 0 simultaneously. The display of the R2122 will now show 'SP-'.

The various service programmes can now be selected by keying-in a three digit number. The display of the R2122 will then show 'SP-XX-X'.

A new service programme may be chosen after the keyboard button ENT has been pressed once. The display shows 'SP-' again, and a new three digit number can be keyed-in.

In order to return to normal operation mode, press the keyboard button <RX>.

3.10.2. Description of Service Programmes

SP-00-X TEST OF PROCESSOR, KEYBOARD AND DISPLAY MODULE

When 00 has been keyed-in, the RX display shows 'SP-00-', and the programmes 0 to 3 and 8 may be selected.

SP-00-0 READ OUT OF SOFTWARE VERSION NUMBER

In the TX display a 4 digit number will be read out, possibly followed by a letter. The number indicates S. P. Radio's internal software number and the letter indicates the software release.

Ex. 1085E => C-number C1085 and rel. E.

SP-00-1 READS OUT WHICH ITU FREQUENCY TABLE IS USED

When P-91 is read out, an earlier ITU table is used. When A-91 is read out, the ITU table in force from 1st June 1991 is used.

When keying-in the digit 0 or 1, the read out will be changed from A-91 to P-91 or P-91 to A-91 respectively.

SP-00-2 STARTS TEST OF THE DISPLAY

This test programme is used in the performance check, section 3.5.1.1.

When pressing <ENT> during the test, the test procedure stops. When pressing <ENT> again, the programme steps forward. When pressing <0>, the programme continues again automatically.

SP-00-3 TEST OF SP-BUS

This test programme is used in the performance check, section 3.5.1.1.

The processor sends a byte to itself via the serial SCI communication port. Each time an error is received, the display reads-out an 'E'. If there is no error, a bar '-' runs through the TX display.

3.10. SELECTION AND DESCRIPTION OF THE SERVICE PROGRAMMES cont.:

SP-00-8 TEST OF KEYBOARD

This test programme is used to test all the keyboard buttons. When the programme is selected, press the keyboard from the top of the right corner down to the left corner. E.g. 1,2,3,4,5,6,-FREQ DOWN,.....0,.,ENT. When the buttons are pressed, the display reads-out the number of the button (ref. chapter 5.6. KEYBOARD UNIT). If the button does not work, the display reads-out the number of the button with a letter "E", when the next button is pressed.

SP-04-X TEST OF FRONTEND, RECEIVER AND SYNTHESIZER MODULE

When 04 has been keyed in, the RX display shows 'SP-04-', and the programmes 0 to 7 may be selected.

SP-04-0 ADJUSTMENT OF 70 MHz RECEIVER FILTER

This test programme is used in the adjustment procedure, sections 3.7.1.1. and 3.7.1.2, where it sets up the synthesizer, frontend, and receiver module for adjustment of the 70 MHz intermediate filter.

SP-04-1 ADJUSTMENT OF 70 MHz RECEIVER FILTER

This test programme is used in the adjustment procedure, section 3.7.1.1., where it sets up the synthesizer, frontend, and receiver module for adjustment of the 70 MHz intermediate filter.

SP-04-2 ADJUSTMENT OF SSB/AM RECEIVER FILTER

This test programme is used in the adjustment procedure, section 3.7.1.3., where it sets up the synthesizer, frontend, and receiver module for adjustment of the 10.7 MHz SSB/AM intermediate filter.

SP-04-3 ADJUSTMENT OF EARPIECE LEVEL

This test programme is used in the adjustment procedure, section 3.7.1.6., where it sets up the synthesizer, frontend, and receiver module for adjustment of the earpiece level.

SP-04-4 ADJUSTMENT OF API VOLTAGE

This test programme is used in the adjustment procedure, section 3.7.2.2., where it sets up the synthesizer, frontend, and receiver module for adjustment of the API sideband level.

SP-04-5 TEST OF LO1 AND LO2 SIGNALS TO EXCITER

This test programme is used in the module performance check, section 3.6.1.5., where it sets up the synthesizer, exciter, and frontend module, in order to control that the local oscillator signals are present at the exciter module.

SP-04-6 TEST OF ATTACK AND DECAY TIME FOR AGC IN SSB MODE

This test programme is used in the module performance check, section 3.6.1.5., and performance check, section 3.5.2.5., where it sets up the synthesizer, frontend, and receiver module, in order to control that the SSB AGC attack and decay times are inside the limits.

3.10. SELECTION AND DESCRIPTION OF THE SERVICE PROGRAMMES cont.:

SP-04-7 TEST OF ATTACK AND DECAY TIME FOR AGC IN AM MODE

This test programme is used in the module performance check, section 3.6.1.5., and performance check, section 3.5.2.5., where it sets up the synthesizer, frontend, and receiver module, in order to control that the AM AGC attack and decay time are inside the limits.

SP-09-X SQUELCH ON OR OFF AS DEFAULT

When 09 has been keyed, the RX display shows 'SP-09-X', with X indicating the present switch. Now 0 or 1 may be keyed followed by <ENT>. In the TX display an 'A' or 'E' appears, indicating accept or error, respectively.

Selection of:

SP-09-0 => squelch off as default

SP-09-1 => squelch on as default

SP-10-X TEST OR PROGRAMMING OF EEPROM

When 10 has been keyed, the RX display shows 'SP-10-'. Now 1 or 0 may be keyed followed by <ENT>. In the TX display a counting will begin, starting from 0 to 512. The counting ends up with 'A 512' or 'E' followed by a number between 0 and 512.

If it ends up with 'A 512' it means that the test or programming has been completed and accepted. If it ends up with 'E' it indicates that there has been an error in the test or programming and the following number is the decimal value of the 16 byte page in which the error has occurred.

CAUTION! The programming will clear all the channels, frequencies and scan programmes in R2122.

SP-10-0 => Tests all bits in EEPROM by turning them twice so that the contents will only be changed if there is an error in the EEPROM.

SP-10-1 => Clears EEPROM.

NOTE! Before running service programme SP-10-1, you have to turn the radio off, move the jumper P03 on Processor module from normal operation to service mode (ref. diagram in chapter 5.5.)

Turn the radio on again, and the display will show "SP- ".

Then select service programme SP-10-1.

CONTENTS

- 4. MECHANICAL DESCRIPTION
- 4.1. MECHANICAL DISASSEMBLING AND MODULE LOCATION

CONTENTS

- 5. CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAMS
 - 5.1. RECEIVER UNIT (MODULE 1)
 - 5.2. RECEIVER FRONT END (MODULE 2)
 - 5.3. SYNTHESIZER UNIT (MODULE 3)
 - 5.5. PROCESSOR UNIT (MODULE 5)
 - 5.6. KEYBOARD UNIT (MODULE 6)
 - 5.7. DISPLAY UNIT (MODULE 7)
 - 5.8. POWER SUPPLY UNIT (MODULE 8)
 - 5.9. INTERCONNECTION CABLE DIAGRAM
 - 5.10. AF AMPLIFIER MODULE (MODULE 10)

5. CIRCUIT DESCRIPTION AND SCHEMATIC DIAGRAMS

5.1. RECEIVER UNIT (MODULE 1)

The receiver unit consists of a 70.0 MHz to 10.7 MHz mixer followed by an SSB/AM filter and a gain regulated IF amplifier. From the amplifier the signal is fed to the detector and low frequency filter unit. The receiver unit contains low frequency derived squelchs which can be set to control the low frequency output.

SECOND MIXER AND CRYSTAL FILTERS

The signal from the 70 MHz selectivity (module 2) is led through the balanced transformer TR01 to the gates of the J-FET's Q01 and Q02.

The second LO signal from the frequency synthesizer (module 3) is led through the LO-buffer Q03 and BPF (L01, L03, L04, and C04, C05, C11) in order to give about +17 dBm signal to the sources of the FET's. The mixed signals are fed through the balanced transformer TR02 and the impedance matching network (C17-C19 and R10) to one of the two high order monolithic crystal filters FL01 or FL02. The filter selection is controlled by the microprocessor through the shift register U10, pin 2.

IF AMPLIFIER

The signal from the crystal filters is fed through the diode D07 or D08 to the IF amplifier.

The IF amplifier consists of transistors Q07-Q11 and filter FL03 in cascade.

The gain in Q07, Q08, and Q09, which are dual gate Mos-FET's, is controlled by the AGC voltage applied to gate 2 of the FET's. This is done to keep the input level to the detector at the same level, independent of the input level to the receiver. From Q09 the signal is led to an amplifier built-up around Q10 and further to the ceramic filter FL03, which reduces the noise bandwidth to about 300 kHz. From the ceramic filter, the signal is fed through the emitter follower Q11 to the detector.

AGC GENERATOR

From the amplifier Q11 the signal is fed to the common emitter amplifier Q16. The voltage gain in this amplifier determines through the AGC system the magnitude of the output from the IF amplifier.

From the amplifier Q16 the signal is fed to transistor Q14, which together with R89, R91, C72, and C71 forms a magnitude detector.

SSB Mode

In SSB mode the signal from the magnitude detector ensures fast control of the gain in the IF amplifier. A slow control of the gain in the IF amplifier is activated by feeding the detector output voltage to the amplifier U03/2. U03/2 buffers the charging of C69 through D11 and R69 and the charging is removed from C69 through R63.

5.1. RECEIVER UNIT (MODULE 1) cont.:

The voltage on C69 is fed through the unity gain buffer U03/1 and D10 to the cathode of D14, where it is added to the actual voltage level from the detector. The added voltage is then subtracted from a reference voltage in U03/3 to make the AGC voltage, which is fed through an LP filter to the gates of Q07, Q08, and Q09.

The fast AGC system ensures noise immunity and the slow AGC system will decrease distortion caused by the AGC on an SSB signal.

AM Mode

In AM mode C71 is connected parallel to C72 through Q15. This increases both rise and fall time for the (fast) AGC system, so that modulation compression does not occur. The slow SSB-AGC is disabled by shunting C69 through Q04.

The manual IF gain voltage is added to the AGC system through D13. In scan mode the IF gain is set to max., independent of the position of the IF gain potentiometer (on module 7), by short-circuiting the potentiometer with Q12. To switch the AGC system off, C71 (and C72 in AM mode) is short-circuited with Q13.

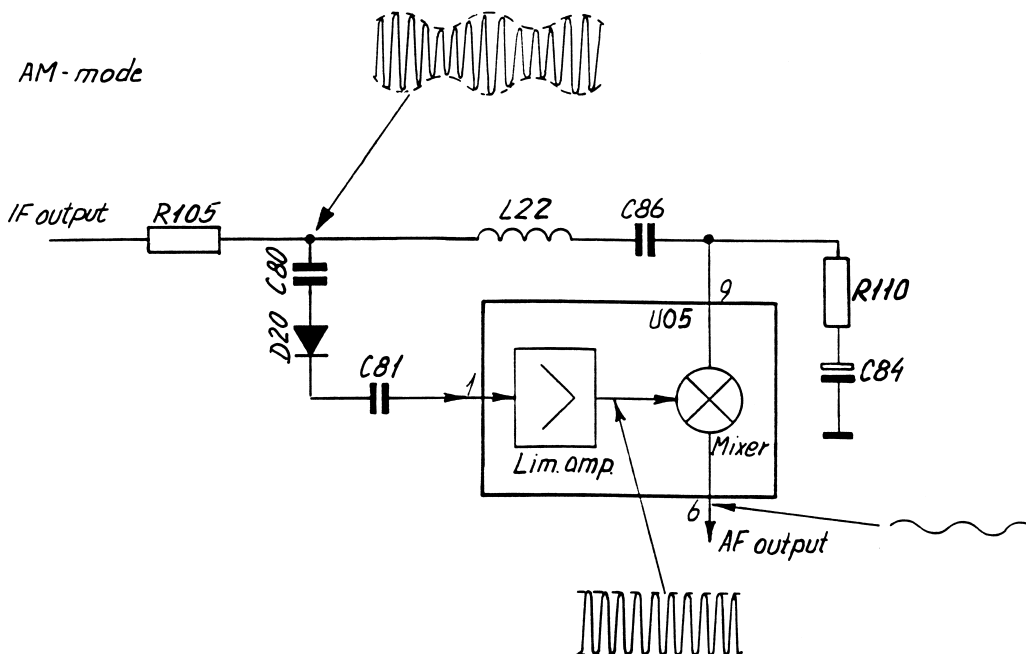
All mode shifts in the AGC system are controlled by the microprocessor through the shift register U10.

DETECTOR

The detector circuit, which can demodulate A3E, H3E, R3E, and J3E is built-up around U05. Switching between the two different detector modes, AM and SSB mode is controlled by the microprocessor through U10, Q17 and the diode switching circuit built-up around D17-D20. AM: D18 and D20 ON, SSB: D17 and D19 ON.

AM Mode

In AM mode the principle is to remove the modulation from the IF signal through the limiting amplifier (pin 1) and leave just the carrier signal. This signal is then mixed with the original IF signal (pin 9) to create the wanted AF signal (pin 6).

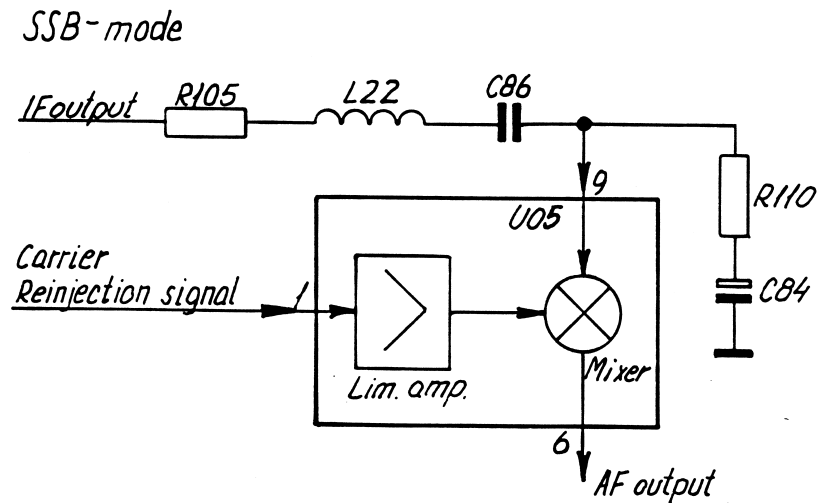


5.1. RECEIVER UNIT (MODULE 1) cont.:

SSB Mode

In SSB mode the carrier reinjection signal (pin 1) is simply mixed with the IF signal (pin 9) and the AF signal is then created.

U05 features a muting facility controlled by the microprocessor by applying voltage to pin 5.



AF FILTERS

To reduce white noise from the non-tuned IF amplifier, the AF signal from the detector is led through three active filters in cascade.

A 5th order, 3 kHz lowpass filter is built-up around U04/3 and U04/4. A 3rd order, 70 Hz highpass filter is built-up around U04/1, and a 3rd order, 350 Hz highpass filter is built-up around U02/2.

AM Mode

In AM mode only the LP filter and the 70 Hz HP filter is used. This is done by applying a logic high voltage to the analog switch U07, pin 9.

SSB Mode

In SSB mode all filters are used by applying a logic low voltage to the analog switch U07, pin 9.

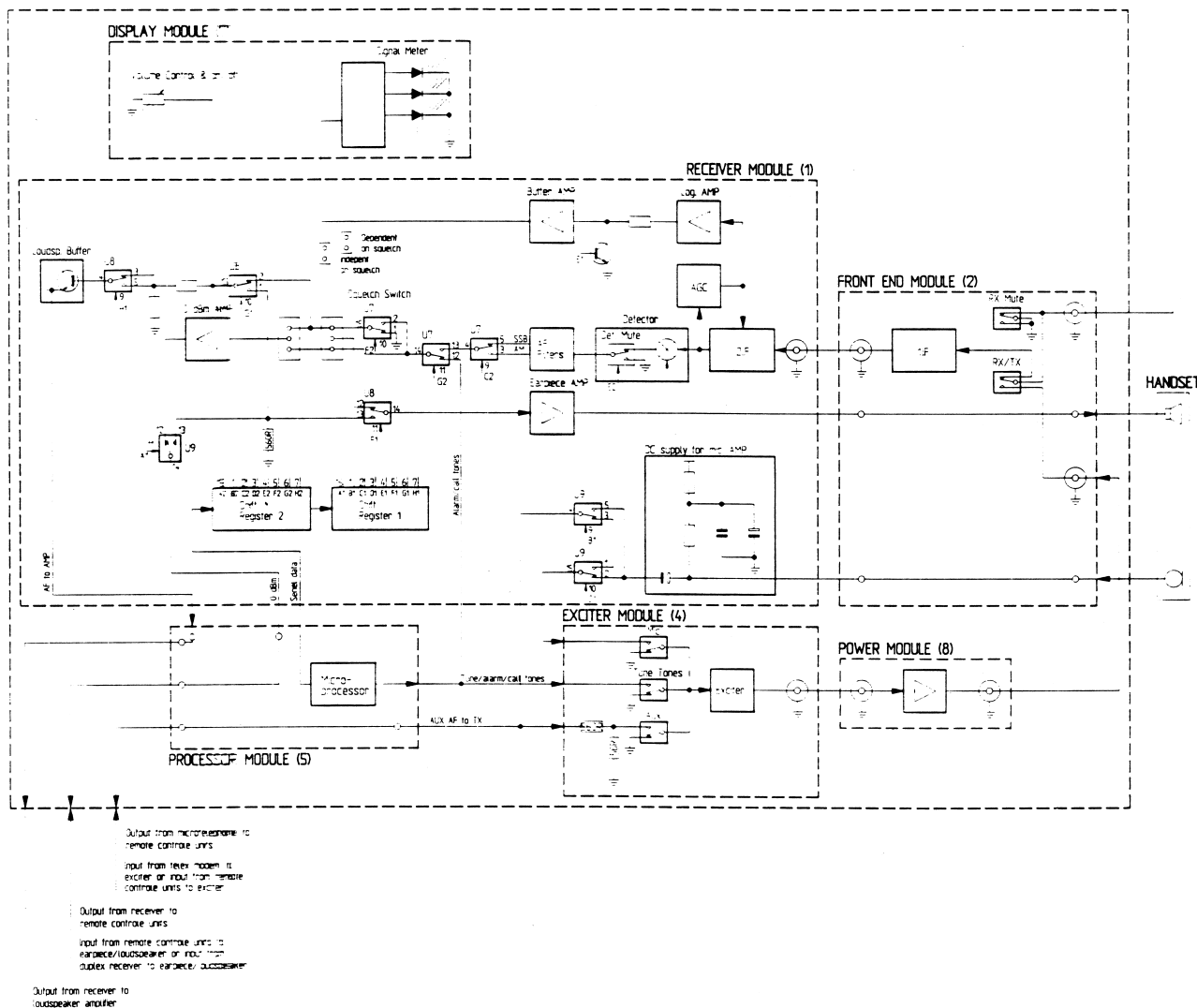
Filter selection is controlled by the microprocessor through the shift register U10, pin 2.

5.1. RECEIVER UNIT (MODULE 1) cont.:

AF SWITCHES

From the output of the AF filter, the signal is fed through a number of analog switches, which are all included in the three IC's U7, U8, and U9. These switches are used to control the transfer of AF signals between the RE2100 and the peripheral equipment, which as an example could be a telex modem, a duplex receiver, and one or more remote control units. The interconnection between the individual switches is shown in the block diagram below.

Block Diagram AF Switches



AF OUTPUT AMPLIFIERS

From the AF switches, the signals are led to three different output amplifiers, which are described below.

AF Pre. Amplifier (Loudspeaker Output)

The purpose of the Pre. Amplifier is to buffer the AF signal before it is led to the power amplifier placed on module 4 in T2130. The output level can either be controlled by the volume potentiometer or by a constant voltage divider. The constant voltage divider is used in the situation where an intercom call to the RE2100 is detected. This situation is indicated by a ringing tone in the loudspeaker and to avoid this tone from vanishing it must necessarily be kept independent of the volume potentiometer.

5.1. RECEIVER UNIT (MODULE 1) cont.:

Earpiece Amplifier

The input signal to the earpiece amplifier is fed through the adjustable resistor R52, where the output level can be selected. The earpiece output can be means of P1 be selected to follow the squelch or not.

0 dBm Amplifier

In this amplifier the AF signal is amplified in order to give a 0 dBm output (in 600 ohm). The 0 dBm signal is led to the remote control units and it can by means of P4 be selected to follow the squelch or not.

SQUELCH

The squelch is voice activated, which is realized by detecting whether there is a change in the mean frequency at the AF-filter output. The squelch circuit, which contains limiting amplifier, frequency to voltage converter, voltage change detector, and hold circuit, generates a signal by which the microprocessor controls the squelch switch U07 at the receiver output.

Limiting Amplifier

U02/2 and U02/1 are connected as amplifier with about 100 dB voltage gain so that the output from U02/1 will be square wave with the same frequency as the input signal from the AF filter.

Frequency to Voltage Converter

The signal from the limiting amplifier is fed to the frequency to voltage converter, built-up around C99-C100, D26-D27, R142, and U02/4. The output from the converter is a voltage with an amplitude depending on the input frequency.

Voltage Change Detector

The voltage from the frequency to voltage converter is fed to capacitor C98 which only will pass a variation in the DC voltage. The resulting signal is amplified and filtered in the circuit built around U02/3. The inverter U01/3 and D22-D23 provide both positive and negative changes in the voltage to be converted to a positive change before the signal reaches the hold circuit.

Hold Circuit

The hold circuit has two functions. Fast opening for the AF signal when a conversation begins and keeping it open for a period after the conversation stops, e.g. during a short interruption of the conversation.

The signal from the voltage change detector is fed to comparator U01/4, which goes high and buffers the charging of C95 through D21 and R120 when the input signal is higher than the reference voltage (determined by R127-R128). The charging is removed from C95 through R119. As long as the voltage on C95 is higher than the reference voltage determined by R117-R118 the output from the comparator U01/1 will be high.

5.1. RECEIVER UNIT (MODULE 1) cont.:

Microprocessor Controlling

The output from the comparator U01/1 is led to the microprocessor. If the microprocessor detects a high voltage, it will turn the squelch switch ON and the AF-signal will then reach the loudspeaker, the earpiece and the 0 dBm amplifier.

When a conversation stops, C95 will slowly be discharged through R119. After about seven seconds the voltage across C95 will fall below the reference voltage and the output of comparator U01/1 will go low. This will be detected by the microprocessor, which will turn the squelch OFF.

In scan mode the squelch circuit is used to control scanning by detecting whether the receiver is scanning a channel with voice activity.

If the microprocessor detects a high voltage at the output of the comparator U01/1, it will immediately reset it by discharging C95 through Q20.

If the receiver actually receives a voice signal it will quickly build-up a new voltage across C95 and the output of the comparator will go high again. This cycle of measuring the comparator voltage and resetting it will be repeated six times to prevent noise spikes from stopping the scanning.

If the microprocessor after these six dischargings still detects a high voltage, it will stop the scanning for a period of about 3 secs. In this period the squelch switch will be turned ON and the AF signal will then reach the loudspeaker.

SIGNAL STRENGTH DETECTOR

The signal strength detector generates a DC voltage to light the LED bar at the display unit (module 7). The circuit consists of a logarithmic amplifier and a buffer amplifier.

Logarithmic Amplifier

The AGC voltage is fed to the input of the operational amplifier U03/4. With the potentiometer R76 the output voltage is adjusted so that the first LED in the bar is just about to light with no antenna connected to the receiver. Because of R69, R72, and D12 the amplifier has an approximately logarithmic characteristic, which means that the RF signal level must be much higher to light the last LED's than to light the first LED's.

Buffer Amplifier

The output from the logarithmic amplifier is fed to a voltage divider, which consists of the resistor R213 and the transistor Q18. With this voltage divider it is possible to ground the signal strength voltage and thereby turn off the light in the LED bar. From the voltage divider, the signal is fed to the unity gain buffer U01/2. This buffer is included to avoid the loading by the resistor R213, which is necessary for the wanted function of the voltage divider.

5.2. RECEIVER FRONT END (MODULE 2)

This module consists of a transmit/receive relay and the receiver front end. The front end consists of a receiver input protection circuit, a radio frequency filter unit, a radio frequency to first intermediate frequency (70 MHz) mixer, and a first IF (70 MHz) filter unit.

AERIAL/EXCITER SWITCH

The aerial signal enters the receiver through the aerial/exciter socket J01, when relay RE02 is in RX position. The exciter signal from the power module (8) is connected to relay RE02 through the EX socket J04. When relay RE02 is in TX position the exciter signal will pass through the aerial/exciter socket J01 and a coax cable to the HF power amplifier in T2130. Switching between RX and TX with RE02 is controlled from the microprocessor through register U01 and Q02.

INPUT PROTECTION

Protection of the pre-filters and the first mixer is done with R02, R03, TR01 and the circuit around D05, and it guaranties that the voltages to the pre-filters cannot be higher than about 4.5V. In addition the RX input is grounded with relay RE01 when the transceiver is switched off.

PRE-FILTERS

The pre-filters consists of the following units:

- | | | | |
|---|-------------------|---------|--|
| - | 100 kHz | HPF | consisting of L01-L02 and C08 |
| - | 385 kHz | LPF (1) | consisting of L29, C49-C50 and D16-D17 |
| - | 385 kHz - 1.6 MHz | BPF (2) | consisting of L24-L26, C42-C44 and D14-D15 |
| - | 1.6 MHz - 4.5 MHz | BPF (3) | consisting of L20-L22, C36-C38 and D12-D13 |
| - | 4.5 MHz - 9 MHz | BPF (4) | consisting of L16-L18, C30-C32 and D10-D11 |
| - | 9 MHz - 18 MHz | BPF (5) | consisting of L12-L14, C24-C26 and D08-D09 |
| - | 18 MHz - 30 MHz | BPF (6) | consisting of L09-L11, C18-C20 and D06-D07 |
| - | 30 MHz | LPF | consisting of L31-L33, and C54-C56 |

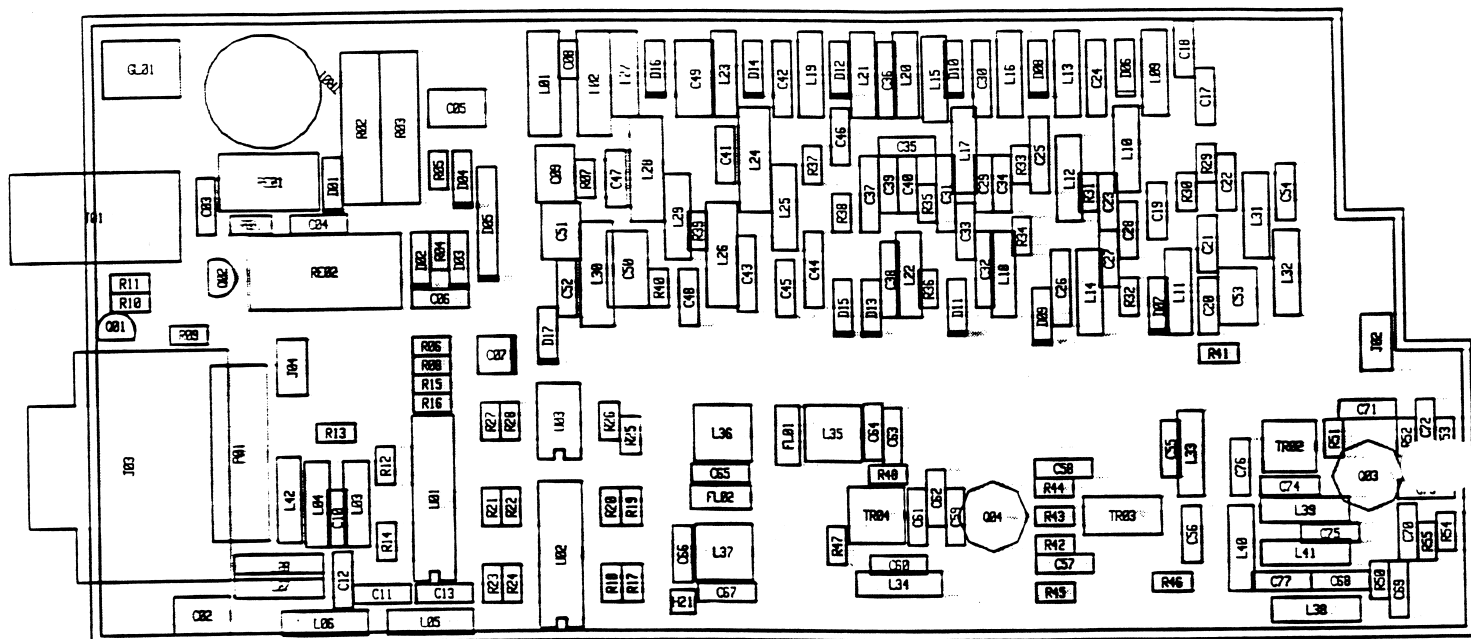
The switching between the filters is controlled from the microprocessor through U01, U02 and U03.

FIRST MIXER AND IF-FILTER

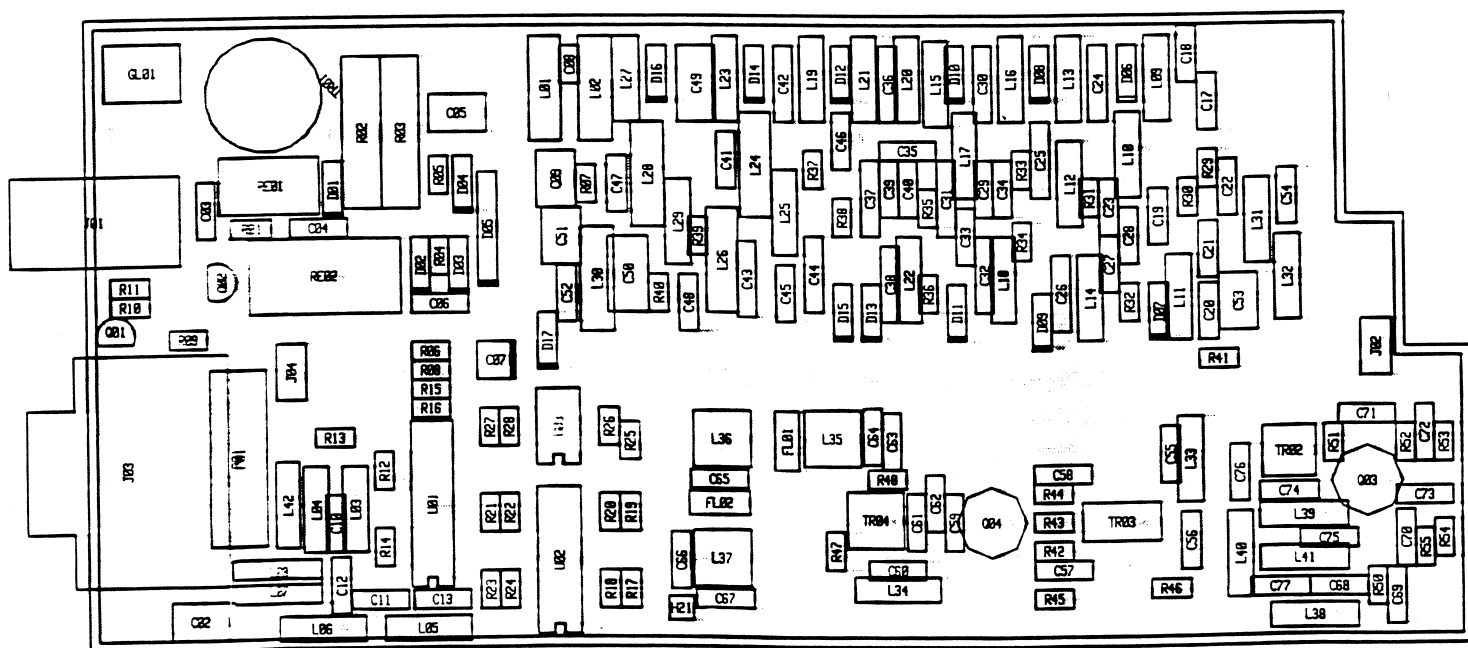
The first mixer is an active J-FET mixer with good, large signal properties and low noise factor.

The signal is led through the balanced transformer TR03 to the sources of the dual J-FET Q04. The first LO signal from the frequency synthesizer (module 3) is led through the LO buffer (Q03) to give about +17 dBm signal to the gates of the two J-FET transistors. The mixed signals are fed through the balanced output transformer TR04 to the two high order bilitic crystal filters FL01 and FL02 where the wanted 70 MHz signal is selected. The selected signal is then fed on to the receiver PCB (module 1).

5.2. COMPONENT LOCATION RECEIVER FRONT END (MODULE 2).



View from component side with upper side tracks.



View from component side with lower side tracks.

5.7. DISPLAY UNIT (MODULE 7)

The display module uses 13 pcs. 7 segments (U08-U20), 12 pcs. LED (D03 -D14) and 1 pc. LED-bar (U01) for reading-out information to the operator.

DISPLAY DRIVER

The display driver U03-U05 is a serial read-in driver, which is able to drive 34 segments. U03, U04, and U05 in combination drive the RX and TX display and the individual LEDs, except from D06 and D07 (indication of Dummy Load and Tune).

The 34 bit data for each display driver is read-in serially by means of the internal SPI-Bus. The power in the individual segments is determined by the power in Brightness input, pin 19. The Brightness control circuit consists of Q03, Q04, Q05, and U07. The adjustment takes place in 4 steps:

- | | | |
|----|--------|--|
| 1) | OFF | All segments are off. U06, pin 15, 1 and 2 are high, |
| 2) | Min. | The power in the segments is approx. 0.5 mA. U06, pin 15 goes low. |
| 3) | Normal | The power in the segments is approx. 1.0 mA. U06, pin 2 goes low. |
| 4) | Max. | The power in the segments is approx. 3.5 mA. U06, pin 15 goes low. |

DUMMY LOAD AND TUNE LED

For read-out of the dummy load and tune functions, 2 separate LED's are used. These LEDs cannot be reduced or switched off after the functions have been selected. The two LEDs are controlled by U06 (74HC595) an 8 bit serial register, which is also supplied by the internal serial SPI-Bus.

KEYBOARD LIGHT DRIVER

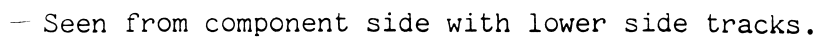
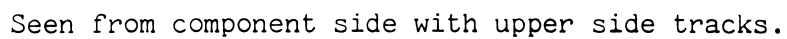
When the light in the keyboard is turned on, U06, pin 3 goes low, after which Q02 is turned on and supplies the 13 pcs. LEDs on the keyboard with 8V. The zener diode D15 (5V1) prevents Q02 from turning on when U06, pin 3 is high.

LED-BAR AND LED-BAR DRIVER

For visual read-out of aerial power and RF-gain, a 10 segment LED bar with driver, i.e. U01 and U02, is used. The two signals are added in D01 and D02, and through the filter R01, R02 and C02 passed on to U02, pin 5. +5V on U02, pin 6 is reference for the signal. The individual segments in the LED bar are turned on by a rise in the signal of 500 mV.

The brightness of the LED bar is controlled by bits 4 and 5 in the 8 bit serial register U06. The adjustment follows the 4 steps, which also apply to brightness in the display. In order to be able to switch off the LED bar completely, Q01 is set off when U06, bits 4 and 5 are high.

RE2100 / R2122
4-6-25637D



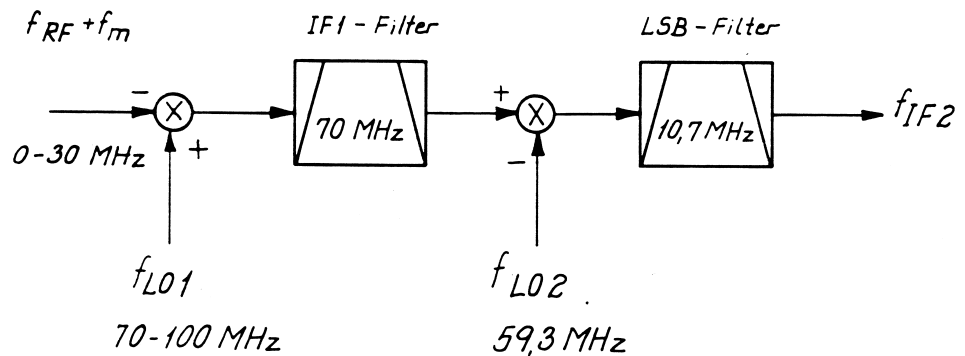
5.3. SYNTHESIZER UNIT (MODULE 3) cont.:

The control of RE01 is carried out by serial to parallel register. The prescaler buffer consists of Q18 and Q21 and the major task of the circuit is to prevent spurious signals created in the prescaler from being added to the VCO signal and through that imply spectral impurity of the LO1 signal. The TCXO signal is led to the TCXO buffer, which consists of Q27 and Q26. The buffer delivers signal for the reference divider and carrier reinjection signal for both receiver and exciter modules.

PHASE LOCKED LOOP 2

The change between transmitted and received upper and lower sideband is generated by a frequency change in PLL2 as illustrated below.

USB Receiver

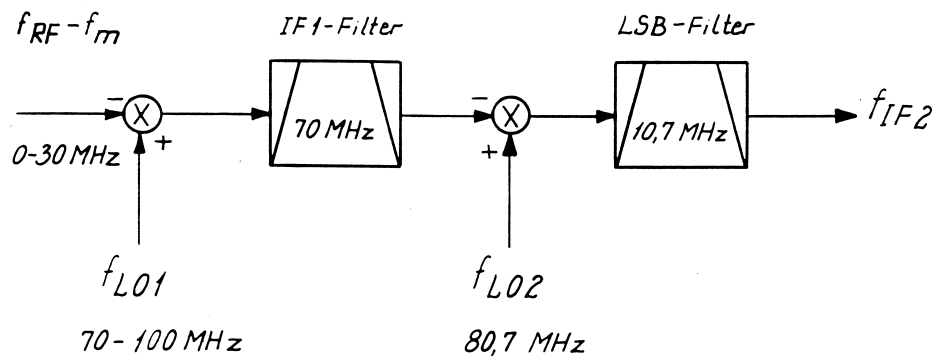


f_m = Modulation frequency

$$f_{IF2} = f_{LO1} - f_{LO2} - f_{RF} - f_m.$$

The modulation frequency f_m changes sign meaning that a received upper sideband signal will pass through the 10.7 MHz lower sideband IF-filter.

LSB Receiver



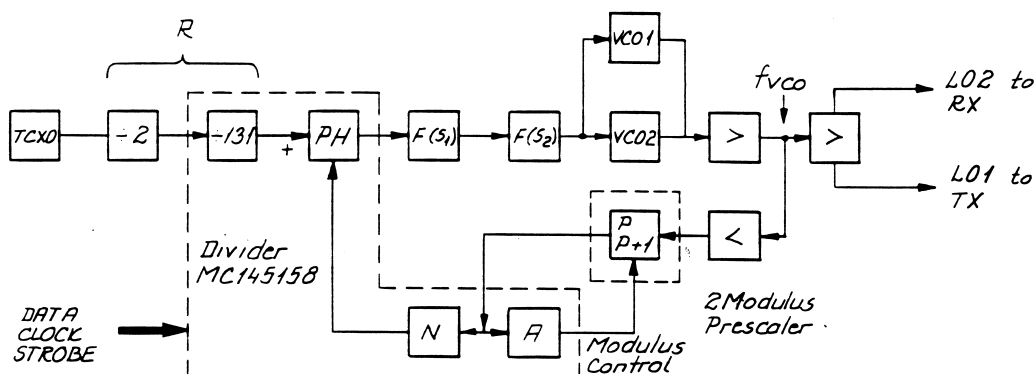
f_m = Modulation frequency

$$f_{IF2} = f_{LO2} - f_{LO1} + (f_{RF} - f_m)$$

The modulation frequency f_m does not change sign meaning that a received lower sideband signal will pass through the 10.7 MHz lower sideband IF filter.

5.3. SYNTHESIZER UNIT (MODULE 3) cont.:

Block Diagram of USB/LSB Synthesizer



From the block diagram it can be shown that the output frequency f_{vco} has the following function of f_{TCXO} :

$$f_{vco} = f_{TCXO} \cdot \frac{1}{R} (N \cdot P + A) \quad P \text{ chosen to } 32.$$

$$f_{TCXO} = 10.73152 \text{ MHz}$$

When upper sideband is chosen the following counts are read into the divider U35. $R = 2 \times 131$, $N = 45$, $A = 7$, this gives $N \cdot P + A = 1447$ and the lock frequency is $f_{vco} = 59,269.120 \text{ MHz}$.

When lower sideband is chosen the following counts are read into the divider U35. $R = 2 \times 131$, $N = 61$, $A = 19$, this gives $N \cdot P + A = 1971$ and the lock frequency is $f_{vco} = 80,732.160 \text{ MHz}$.

VOLTAGE CONTROLLED OSCILLATOR

The circuit contains two similar VCO's. One is active in LSB mode and the other is active in USB mode.

The oscillator which is active in the LSB mode is built around the transistor Q30. Coil L31, paralleled with C130 and C129 in combination with the variable capacitor D19 form the main part of the frequency determining elements. D20 and R120 which are connected to the gate of the oscillator transistor prevent the gate source voltage from becoming positive which will cause the oscillator noise to increase.

To activate the oscillator U01 - pin Qg is "LOW" which means that transistor Q28 is off and the transistors Q29, Q31 are on supplying the oscillator transistor with DC voltage.

The oscillator which is active in the USB mode is built around the transistor Q33. Coil L37 parallel with C150 and C149 in combination with the variable capacitor D22 form the main part of the frequency determining elements.

5.5. PROCESSOR UNIT (MODULE 5)

The processor module has been built up around a microprocessor of the type HD63B03VP with belonging 8.005 MHz crystal. The purpose of the microprocessor is to control the other modules in the R2122 by means of a Serial Peripheral Interface Bus (SPI), and to scan the keyboard. Furthermore the processor must also control the Serial Communication Interface Bus (SCI), also called the SP-BUS. The same processor module is also used in SAILOR RE2100.

MICROPROCESSOR

The microprocessor module is normally equipped with a ROM less processor, type HD63B03VP, however mass produced types may also occur. The placing of a strap in P02 informs the processor from where to read the programme. If the strap is placed between pin 1 and pin 2, the programme is read from the internal ROM store. If the strap is placed between pin 2 and pin 3, the programme is read from the external store (27C128/27C256). The internal clock frequency of the processor is 2 MHz.

WATCH DOG

The microprocessor supervising circuit U15 works as watch dog and power sense. In U15, pin 6 (watch dog input) the level must change at least once every 1.6 sec. If not, the U15 generates a reset pulse to the microprocessor.

Power fail input U15, pin 4 detects when the 9V supply falls below 7.0V. In this case, the microprocessor receives an interruption via power fail output U15, pin 5. The programme starts storing data in the EEPROM. This function is used when the receiver is switched off (see the paragraph below: ON BOARD POWER SUPPLY).

When VCC to U15 is below 4.65V the reset output U15, pin 7 goes low, and the U15 does not generate a reset to the microprocessor until the VCC is above 4.75V again.

MEMORY

The microprocessor has two memory circuits. One for programmes and one for data.

The programme memory U06 is a 16 or 32 kbyte PROM, e.g. the type 27C128/27C256 with a max. access time of 250 nS. If 16 kbyte is used, the strap in P01 is mounted between pin 2 and pin 3. When 32 kbyte is used, the strap is mounted between pin 1 and pin 2.

The data memory U05 is an 8 kbyte EEPROM, e.g. the type 28C64 with max. access time of 250 nS. Furthermore it must contain page mode programming of min. 16 kbyte. U15 contains data, such as frequency tables, country versions, scanning tables, and latest set-up after the receiver has been switched off.

KEYBOARD

The keyboard module 6 has been built-up as a 4x8 matrix of which 26 keys are used. The keyboard is scanned by means of 4 ports from the microprocessor and the data bus. When the processor reads from the keyboard, access is made to the bus driver U04.

5.5. PROCESSOR UNIT (MODULE 5) cont.:

EXT. PORT

The Bus Driver U19 acts as an 8-bit input port, which is connected to the internal Data Bus.

ON BOARD POWER SUPPLY

On this PCB, 3 power supplies are found, i.e. 5VA, 5VB and -5VB.

5VA (U16) supplies the microprocessor, memory, watch dog, baud rate generator, and address select.

5VB (U17) supplies the remaining circuits, using +5V.

-5VB (U18) supplies half of the SP-Bus transmitter.

Power supply 5VA is a low drop 5V regulator. The power supply also works as a power back-up, when the 9V supply disappears. C11 is able to keep the supply for the microprocessor for approx. 50 mS after the 9V supply has disappeared.

The microprocessor spends approx. 20 mS for storing the data in U05. A parallel connection of C14 and C45 has been carried out in order to keep the serial resistance below 1 ohm at low temperatures.

Power supply 5VB is a standard 5V regulator (LM340T5).

TUNE/ALARM TONE GENERATOR

Tune and alarm tones are generated in the microprocessor and sent out in P26.

Tune tones consist of two simultaneous frequencies of 1000 Hz and 2000 Hz. The microprocessor generates a signal of 2000 Hz. A divider (1/2 U02), enabled by P54, divides the signal to 1000 Hz, and the transistor Q01 adds the two signals before they are passed on to the exciter unit (module 4).

The alarm tones consist of two changing frequencies of 1300 Hz and 2200 Hz. Both tones are generated in the microprocessor. The divider (1/2 U02) will be disabled.

The Tune/alarm tone generator is only used when the PCB is installed in SAILOR RE2100.

MUTE LOUDSPEAKER

When the loudspeaker has to be mute, the microprocessor port P20 goes high and Q03 will be able to source RE1 on AF amplifier PCB.

SERIAL PERIPHERAL INTERFACE BUS (SPI)

The SPI-Bus is a synchronous serial bus supplying the other units with data. The clock speed is 38.5 kHz. Through 4 drivers in U10, the clock and data are passed on to the modules which are connected to the SPI-bus. The strobes for the various modules are generated in SPI address select U09. Through the 4 ports of the microprocessor, P60 - P63, an address is set up, which is suitable for the module which is going to receive the serial data.

BAUD RATE GENERATOR

The baud rate generator U01 and 1/2 U02 divide the internal clock frequency of 2 MHz by 26 by means of a duty cycle of 50 per cent. The divided frequency is equal to the frequency which must be added to the internal serial communication interface (SCI) of the microprocessor, so that the baud rate of the SP-Bus will be 4800 baud.

5.5. PROCESSOR UNIT (MODULE 5) cont.:

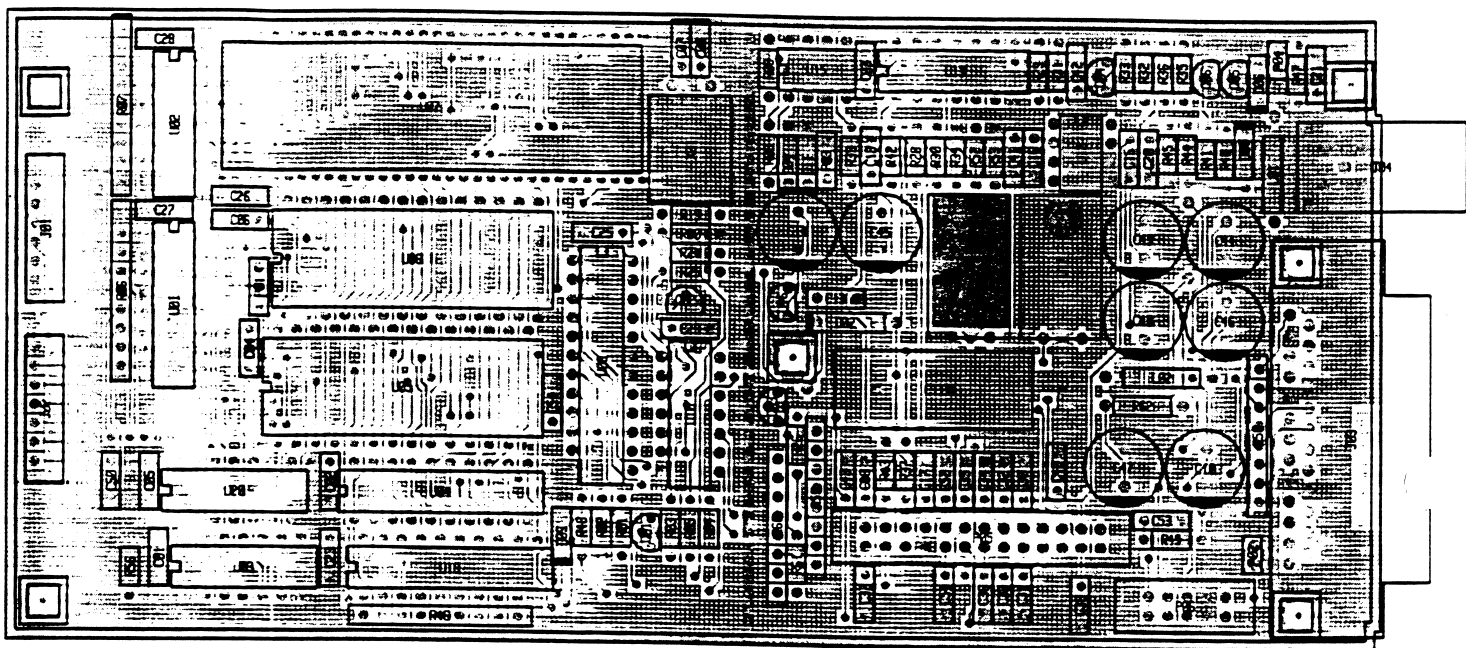
SP-BUS TRANSMITTER AND RECEIVER

The communication from and to the R2122 is time multiplexed data bus. It is implemented with a 50 ohm coaxial cable, terminated in both ends, and a transmitter and a receiver in each connected unit.

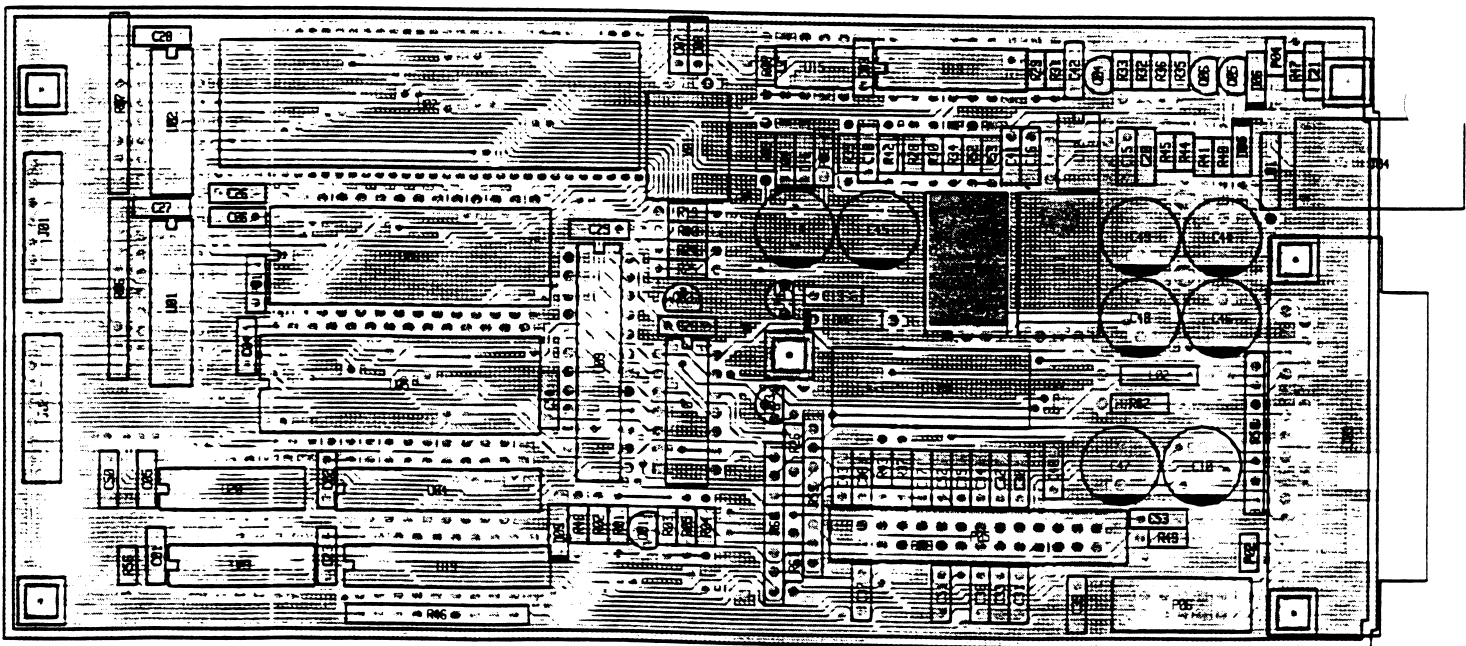
The R2122 is the master and a number of slaves may be connected to the SP-Bus. When a slave wants to be called, the slave sends an interrupt to R2122 on the SP-Bus INTERRUPT. The transmitter and the receiver are identical in each unit connected to the SP-Bus. The transmitter output is normally in high impedance state except when transmitting on the SP-Bus. The transmitter consists of two gates, U13/1 and U13/2 (74HC00), a transistor Q04 (BC558) for level shifting, and two complementary output transistors Q05 (BC640) and Q06 (BC639). The transmitter is connected to the microprocessor P24 (Transmit Data), and P55 (Transmitter Enable).

The receiver consists of an op-amp, (U12/1, MC1458) which is configured as a Schmitt Trigger and two diodes D04 and D11 for level conditioning. The receiver is connected to the microprocessor P23 (Receive Data). As the levels on the SP-Bus approximately match the RS232C standard, it is possible to connect an RS232C to the SP-Bus. The cable terminations (jumper P04) must be removed when the external RS232C is to transmit on the bus.

5.5. COMPONENT LOCATION PROCESSOR UNIT (MODULE 5)



View from component side with upper side tracks.



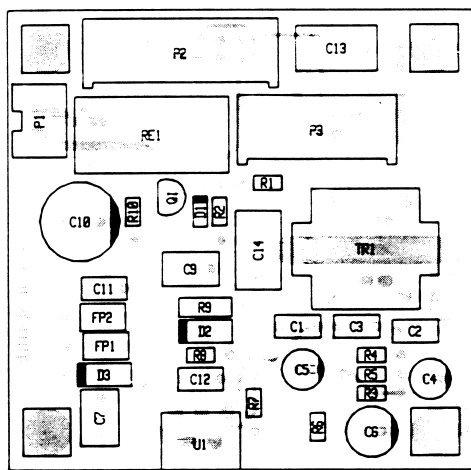
View from component side with lower side tracks.

5.10. AF AMPLIFIER (MODULE 10) SP NO. 626410

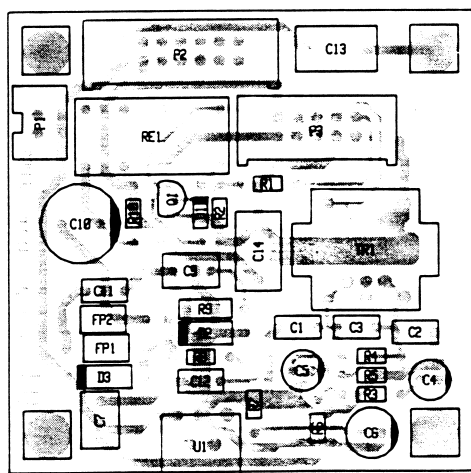
The audio amplifier is an integrated circuit TDA2030 U1, and it is supplied from the 28 Volt supply for the PA module. To insulate the battery from ground, there is a transformer TR1 at the input of the amplifier. RE1 and Q1 form a muting circuit for the loudspeaker. This circuit is controlled from the processor.

5.10. AF AMPLIFIER (MODULE 10) cont.:

COMPONENT LOCATION AMPLIFIER MODULE 10.



View from component side with upper side tracks.



View from component side with lower side tracks.

5.8. POWER SUPPLY (MODULE 8)

This module contains the power supply for the entire radio.

The ON/OFF relay RE1 is located at the input of the power supply. This relay switches the battery supply completely off.

The power supply circuit can be divided into two separate circuits, a step-up converter and a 100 % push-pull converter. The step-up converter converts the input supply voltage to a fixed level of approx. 36V DC. This voltage is then transformed to the 5 different output voltages by the push-pull converter.

STEP-UP CONVERTER

The input current runs through the input filter C4, L1, C5, and C6 to a step-up converter.

Inside the integrated circuit U1, an oscillator, a reference voltage, a voltage error amplifier, and an output transistor with a current sense resistor in the emitter are situated.

The purpose of the cascade coupling, formed by Q2 and the output transistor in U1, is only to increase the sustaining voltage of the output transistor. In the following description it is named the output transistor.

R4 prevents high frequency oscillations during turn ON and OFF of Q2.

At the start of each clock period, the output transistor is turned ON, the current rises in L2, and D7 stops conducting. When the current reaches a fixed value, the transistor is turned OFF. The inductor tries to continue the current, forces D7 to conduct and charges C9, C10 and C11. Control of the approx. 36V voltage on C9, C10 and C11 is obtained by using the fixed current trip level. This gives a pulse width modulation.

The voltage error amplifier senses the voltage via R5 and R6. The RC-combination C8 and R3 is a frequency compensation of the error amplifier.

The supply voltage to U1 is supplied by Q1, R1 and D2.

UNDERVOLTAGE LOCK-OUT

If the input voltage is less than 9.2V, the low voltage at pin 1 of U1 inhibits U1. When the voltage rises, D3 starts conducting and U1 starts functioning. When working, the output voltage on C9, C10 and C11 is approx. 36V, even though the input voltage is 10.2V. The circuit continues to supply the output voltage until the internal current limiter in U1 starts. D6 charges C9, C10 and C11 to the input voltage to avoid saturation during start-up.

PUSH-PULL CONVERTER

The clock signal of the step-up converter is sensed by Q3 and fed to U2.1 by R8. This D-flip/flop is connected as a Schmitt-trigger by R7, R8 and R9. The hysteresis is approx. 1.2V in order to avoid noise sensitivity. The output from U2.1 is fed to U2.2. This D-flip/flop makes two signals with an exact 50% duty cycle and with a 180 degrees phase displacement. The frequency is half of the clock frequency of the step-up converter.

5.8. POWER SUPPLY (MODULE 8) cont.:

These two signals are used to drive the push-pull transistors Q5 and Q6. The diode resistor combination R12, D10 and R13, D11 gives a slow turn ON and a fast turn OFF to avoid an overlap in conduction. D15 and D16 protect the sensitive gates against spikes.

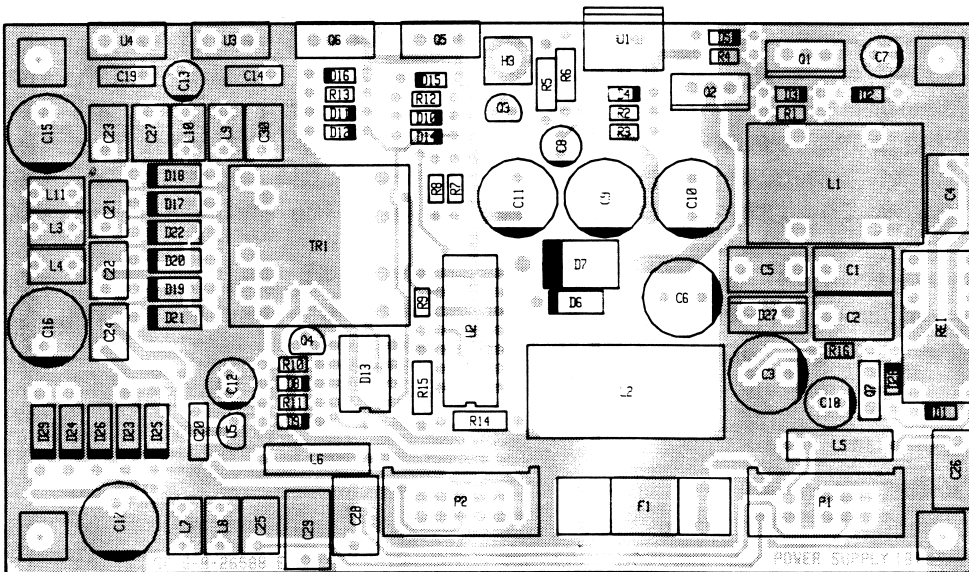
D13 senses the input voltage through R14 and R15. If the voltage is higher than approx. 36V, D15 starts conducting and shunts the drive signals to the push-pull converter, eliminating the input voltage to get to the outputs.

The supply voltage to U2 is generated by Q4. Q4 starts to conduct when the collector voltage is higher than approx. 30V. This is done to delay the start of the push-pull transistors, until the clock oscillator is stabilized.

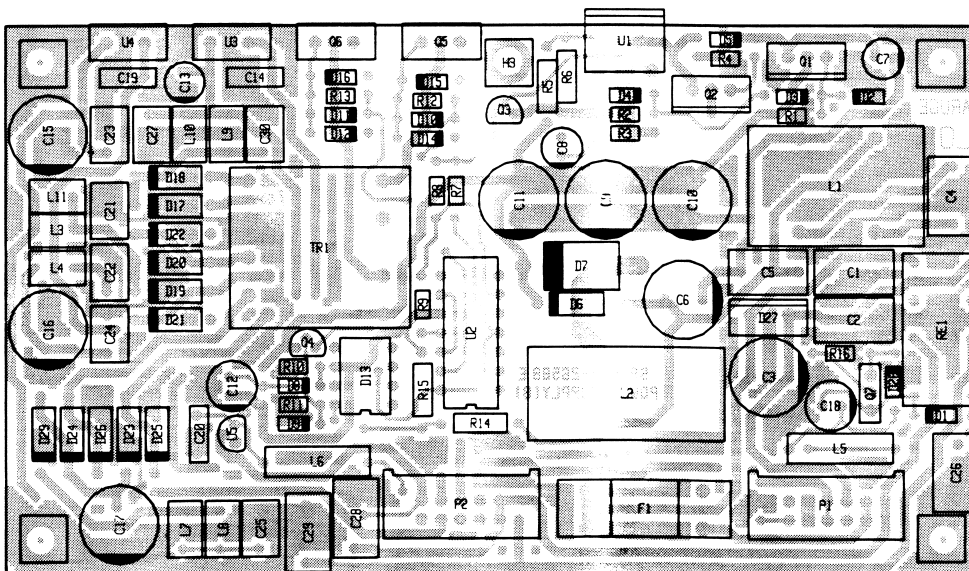
OUTPUT CIRCUIT

The secondary windings of the switch transformer TR1 are connected to a filter unit, capacitor and coil, through the rectifier diodes. The resulting DC voltages are fed to the output plugs or to a fixed voltage regulator.

5.8. COMPONENT LOCATION POWER SUPPLY (MODULE 8)



View from component side with upper side tracks.



View from component side with lower side tracks.

AF-amplifier (10)

TO LOUDSPEAKER

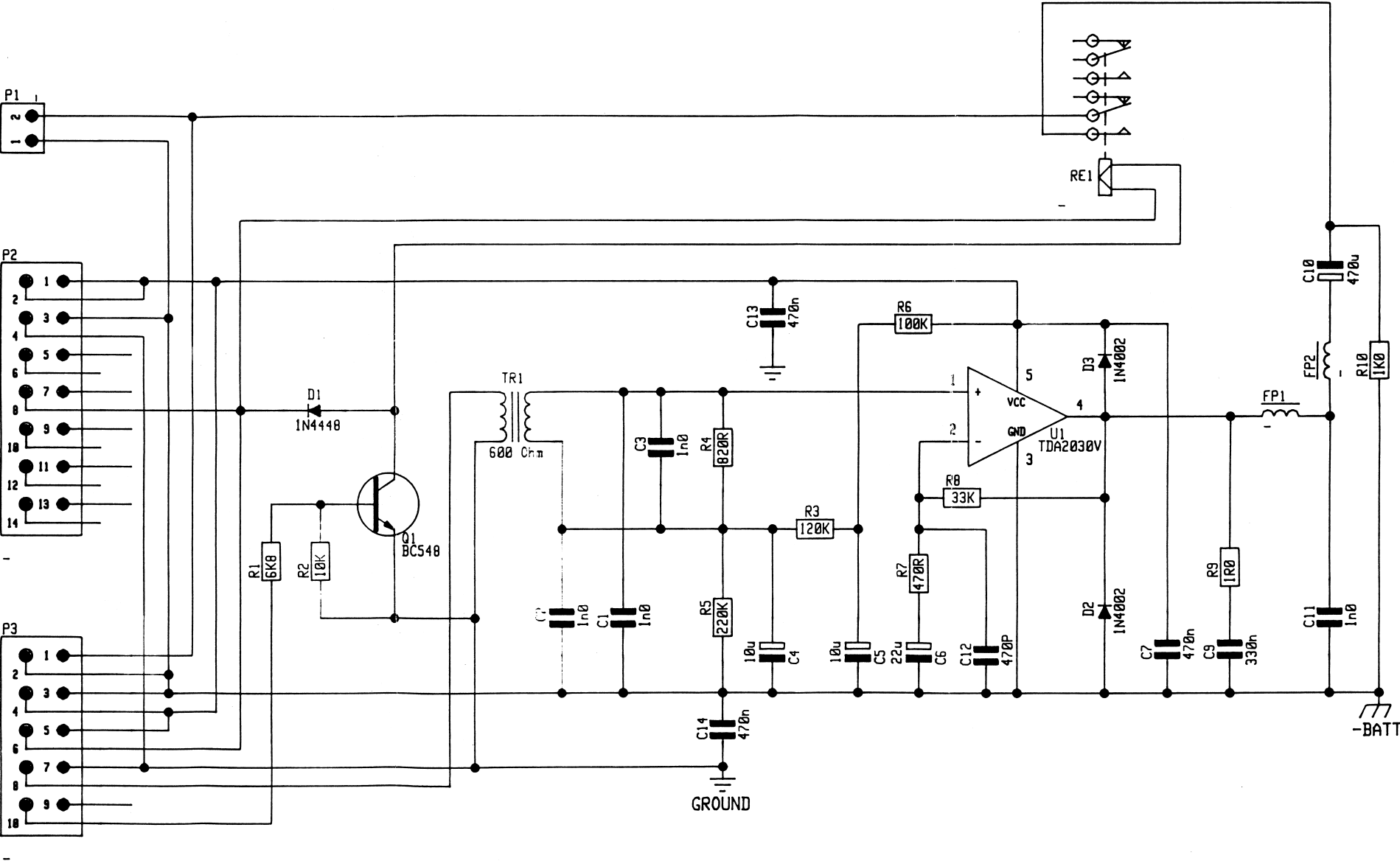
- PIN 1 AF-OUT
- PIN 2 -BATT.

TO SYNTHESIZER RE2100

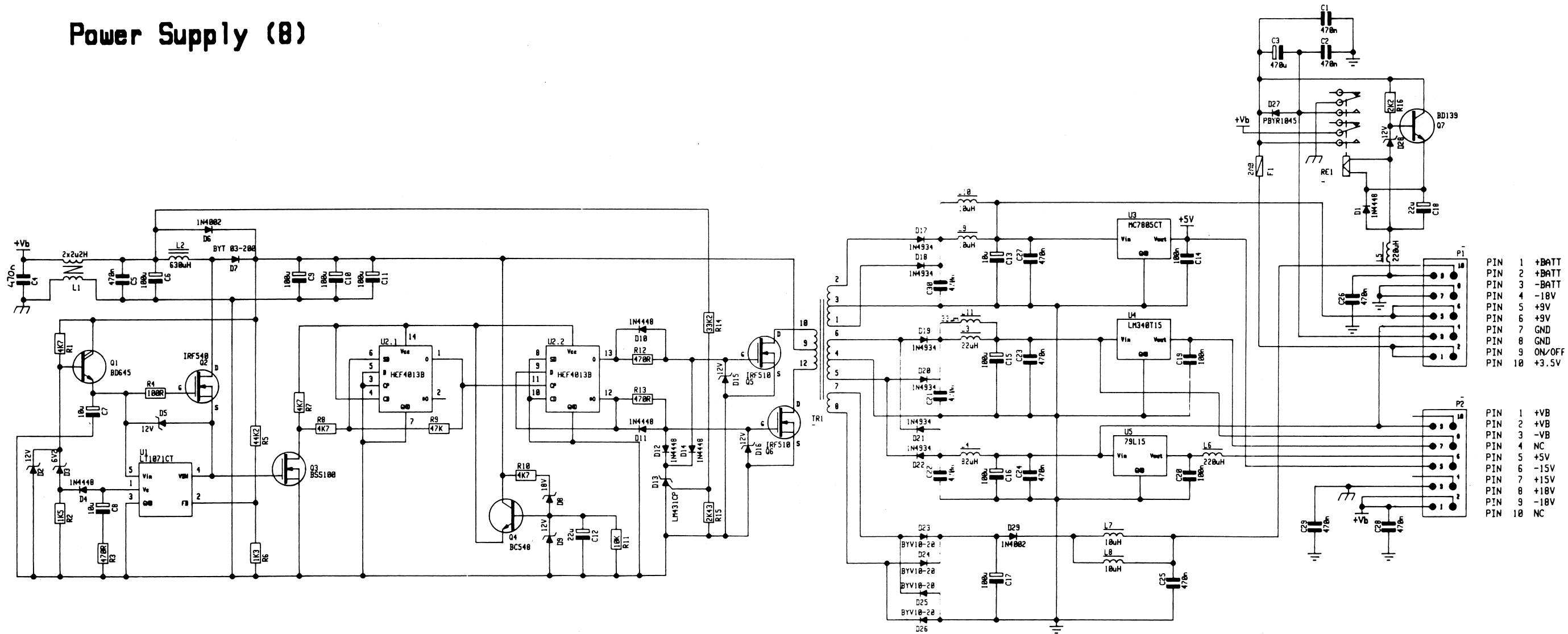
- PIN 1 +28V
- PIN 2 +28V
- PIN 3 -BATT.
- PIN 4 NC
- PIN 5
- PIN 6
- PIN 7
- PIN 8 +18V
- PIN 9
- PIN 10
- PIN 11
- PIN 12
- PIN 13
- PIN 14

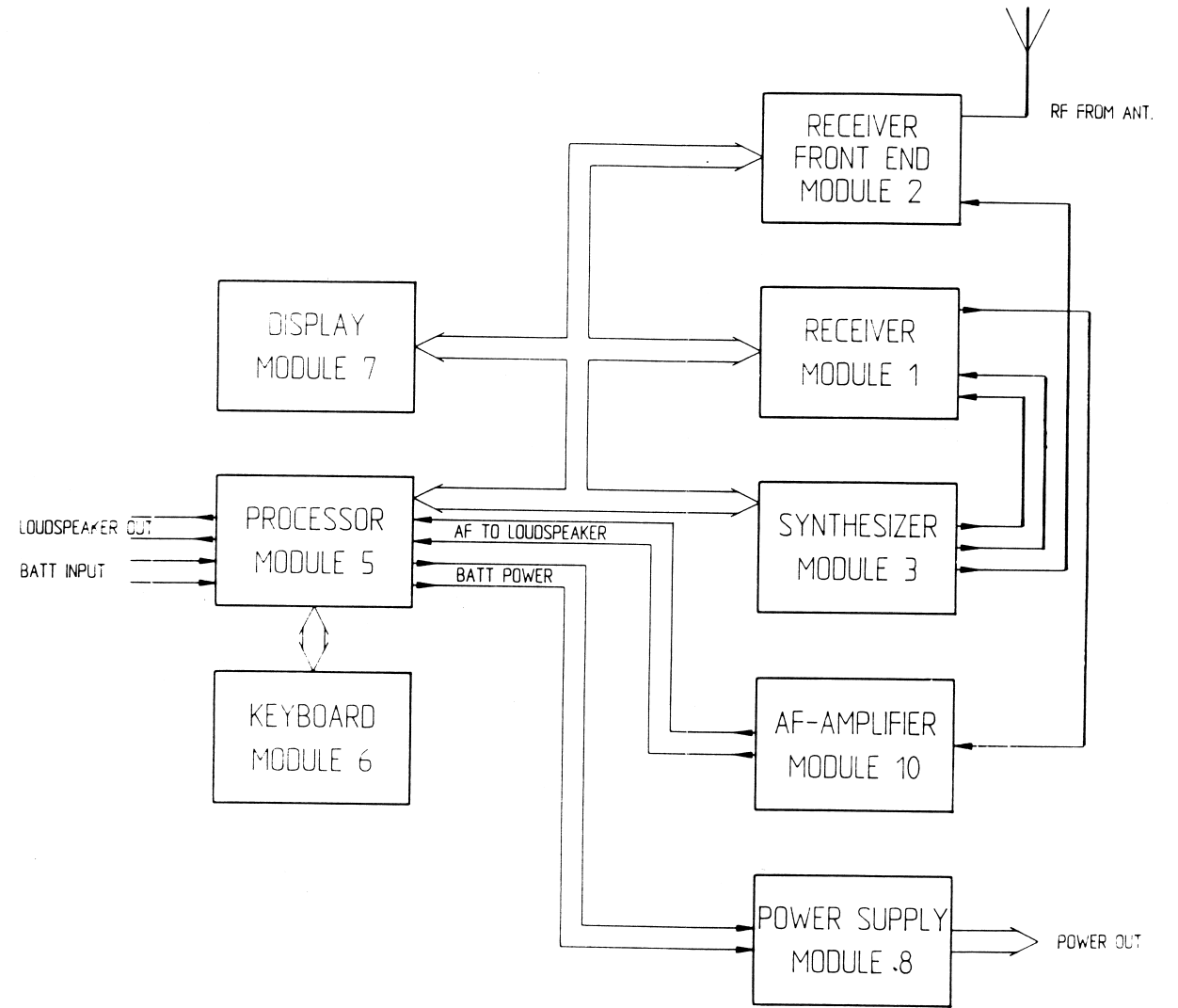
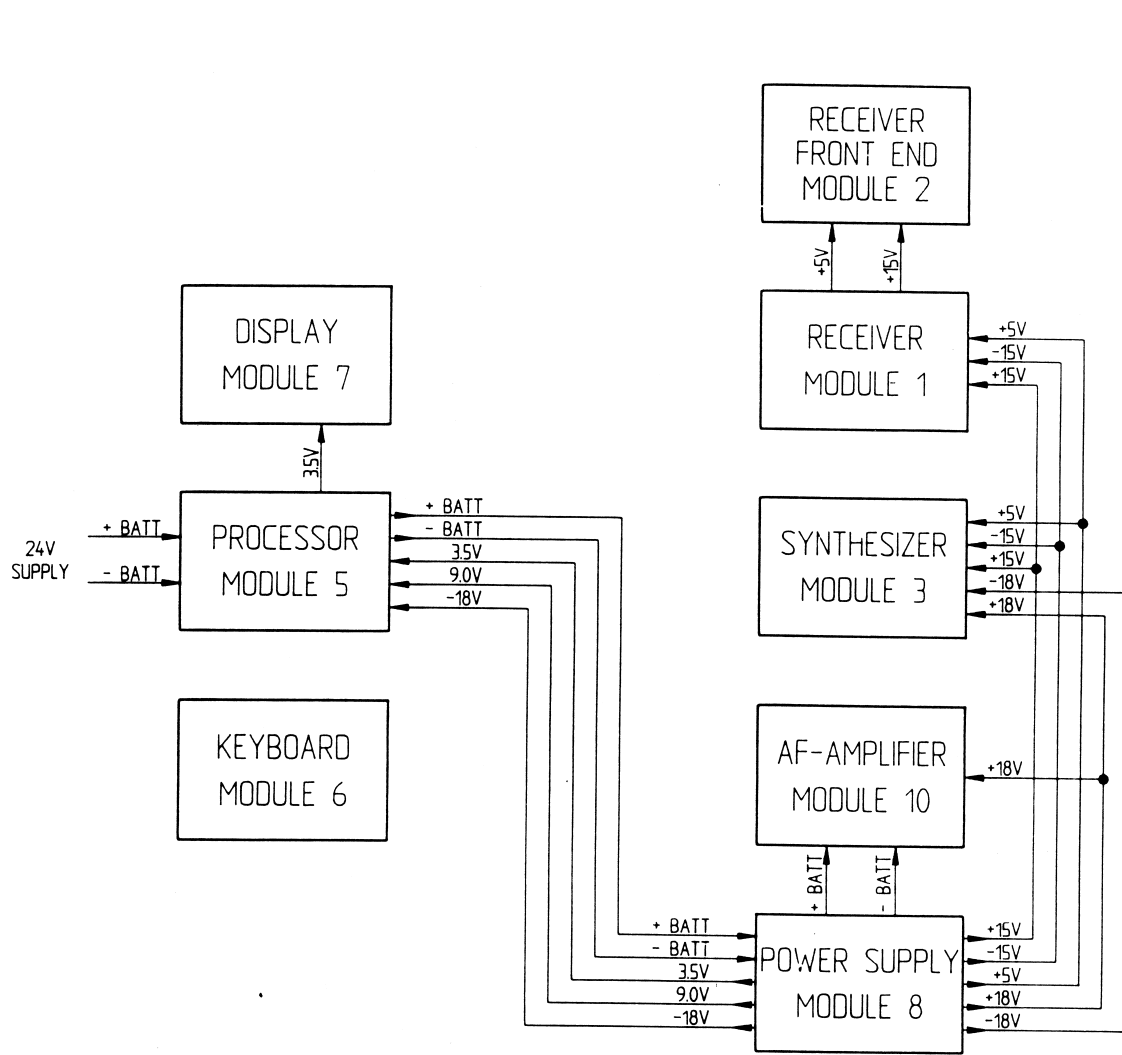
TO RECEIVER RE2100
TO CONNECTION BOARD

- PIN 1 AF-OUT
- PIN 2 -BATT.
- PIN 3 -BATT.
- PIN 4 +28V
- PIN 5 +28V
- PIN 6 +18V
- PIN 7 GND
- PIN 8 AF-IN
- PIN 9
- PIN 10 MUTE LOUDSPEAKER

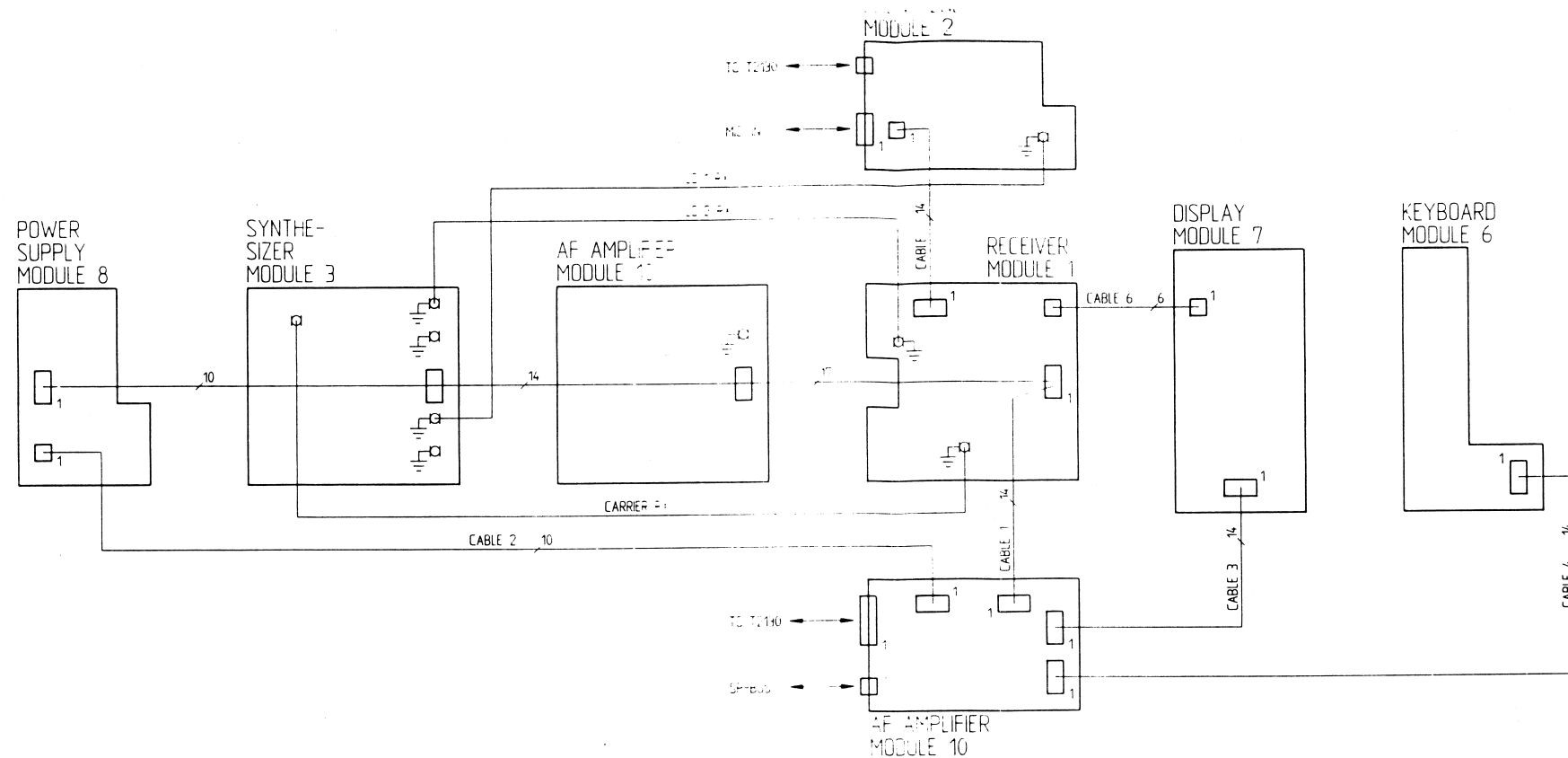


Power Supply (8)





INTERCONNECTION CABLE PLAN



CABLE 1: MAIN CABLE - RE2100

SYNTHESIZER UNIT (3) AF-AMPLIFIER (10) POWER SUPPLY (8)

PROCESSOR UNIT (5) RECEIVER UNIT (1)

1 HOOK SWITCH 1

2 +5V 2

3 -15V 3

4 +15V 4

5 +18V 5

6 -18V 6

7 SYNTHESE 1 A/N 7

8 SYNTHESE REG 8

9 SYNTHESE 2 A/N 9

10 CLOCK 10

11 DATA 11

12

13

14

15

16

17

18 EXT RF-CONTROL 18

19 0 dBm OUT 19

20 GND 20

21 AF TO AMP 21

22

23 MUTE LOUDSPEAKER 23

24 SQUELS SENSE 24

25 FRONT END 25

26 MODE RX 26

1 +VB 1

2 +VB 2

3 -VB 3

4

5

6

7

8

9

10

11

12

13

14

P01-3 P02-10

AF-AMPLIFIER (10)

1

2

3

4

5

6

7

8

9

10

P03-10

AF AMPLIFIER (10) PROCESSOR UNIT (5)

- BATT 1 LOUDSPEAKER 3 + BATT

2 LOUDSPEAKER 2

P01-10 P03-5

CABLE 2: PROCESSOR TO POWER SUPPLY

Diagram of the power supply connector for the processor unit. The connector has 10 pins, labeled 1 through 10. The labels for each pin are:

- Pin 1: +BATT
- Pin 2: +BATT
- Pin 3: -BATT
- Pin 4: +18V
- Pin 5: +9V
- Pin 6: +9V
- Pin 7: GND
- Pin 8: GND
- Pin 9: ON/OFF
- Pin 10: +3.3V

The connector is labeled "PROCESSOR UNIT (8)" and "POWER SUPPLY (8)".

CABLE 4: PROCESSOR TO KEYBOARD

Diagram of the J01-5 processor unit showing 14 pins and their functions:

- 1: GND
- 2: KEYBOARD LIGHT
- 3: X5
- 4: X6
- 5: X4
- 6: X7
- 7: X8
- 8: X2
- 9: X3
- 10: Y8
- 11: Y4
- 12: Y2
- 13: Y1
- 14: X1

Labels at the bottom: J01-5 (left) and J01-6 (right).

CABLE 5: RECEIVER TO FRONT END

RECEIVER UNIT (2)

1 ——— +5V ——— 1

2 ——— +15V ——— 2

3 ——— +15V ——— 3

4 ——— +18V ——— 4

5 ——— FRONT END ——— 5

6 ——— HOOK SWITCH ——— 6

7 ——— CLOCK ——— 7

8 ——— DATA ——— 8

9 ——— MIC ——— 9

10 ——— MIC KEY ——— 10

11 ——— SIGNAL GND ——— 11

12 ——— DISTRESS ——— 12

13 ——— EXT TELEPHONE ——— 13

14 ——— HOOK SWITCH ——— 14

P02-1 P01-2

CABLE 3: PROCESSOR TO DISPLAY

Diagram of the 12-pin connector for the Processor Unit (7). The pins are labeled as follows:

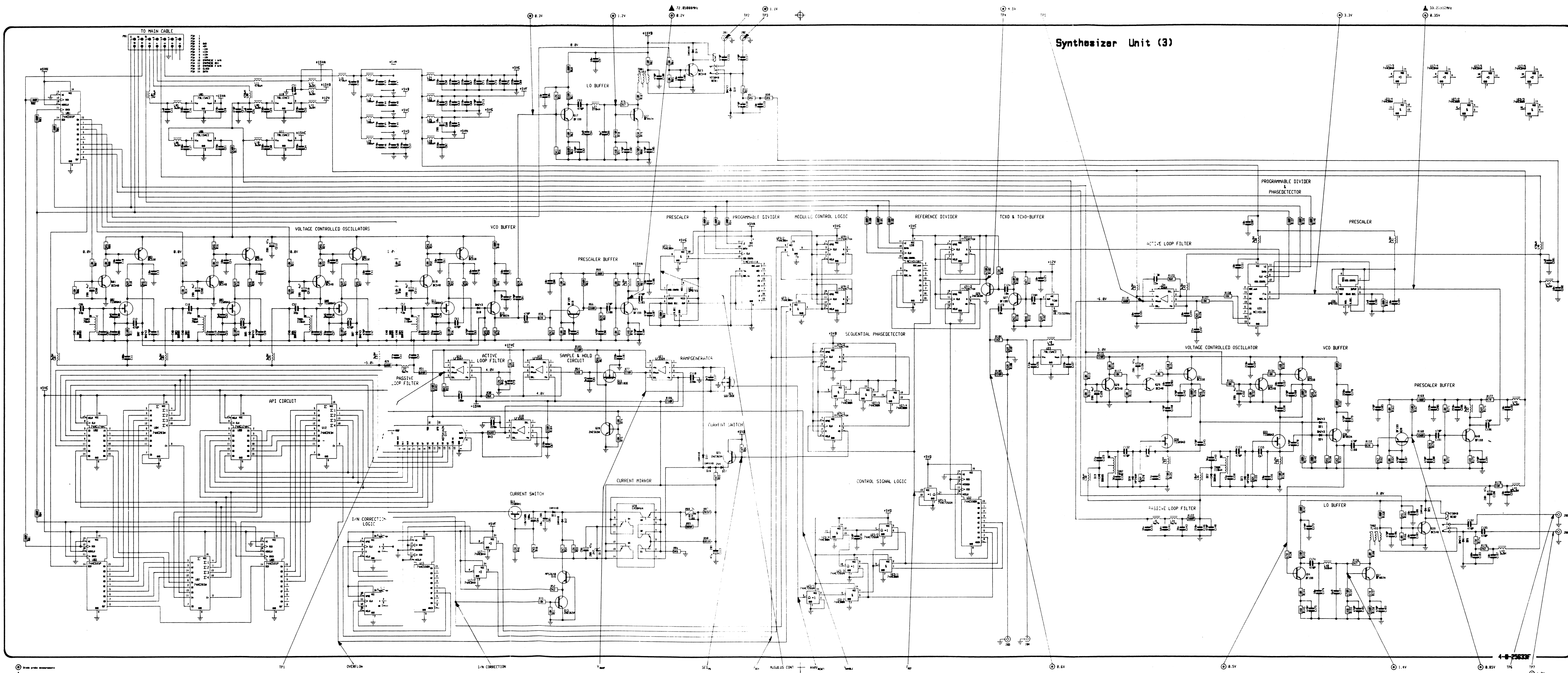
Pin Number	Label
1	GND
2	+35V
3	-5V
4	+9V
5	KEYBOARD LIGHT
6	DIS. 1
7	DIS. 2
8	DIS. 3
9	DIS. 4
10	CLOCK
11	DATA
12	AERIAL CURRENT

CABLE 6: RECEIVER TO DISPLAY

Diagram illustrating the connection between the Receiver Unit (1) and the Display Unit (7):

- 1 (Receiver Unit) to 1 (Display Unit): AF TOP
- 2 (Receiver Unit) to 2 (Display Unit): AF CENTER
- 3 (Receiver Unit) to 3 (Display Unit): -15V
- 4 (Receiver Unit) to 4 (Display Unit): RF CENTER
- 5 (Receiver Unit) to 5 (Display Unit): GND
- 6 (Receiver Unit) to 6 (Display Unit): RX LEVEL "S"

4-0-25633F

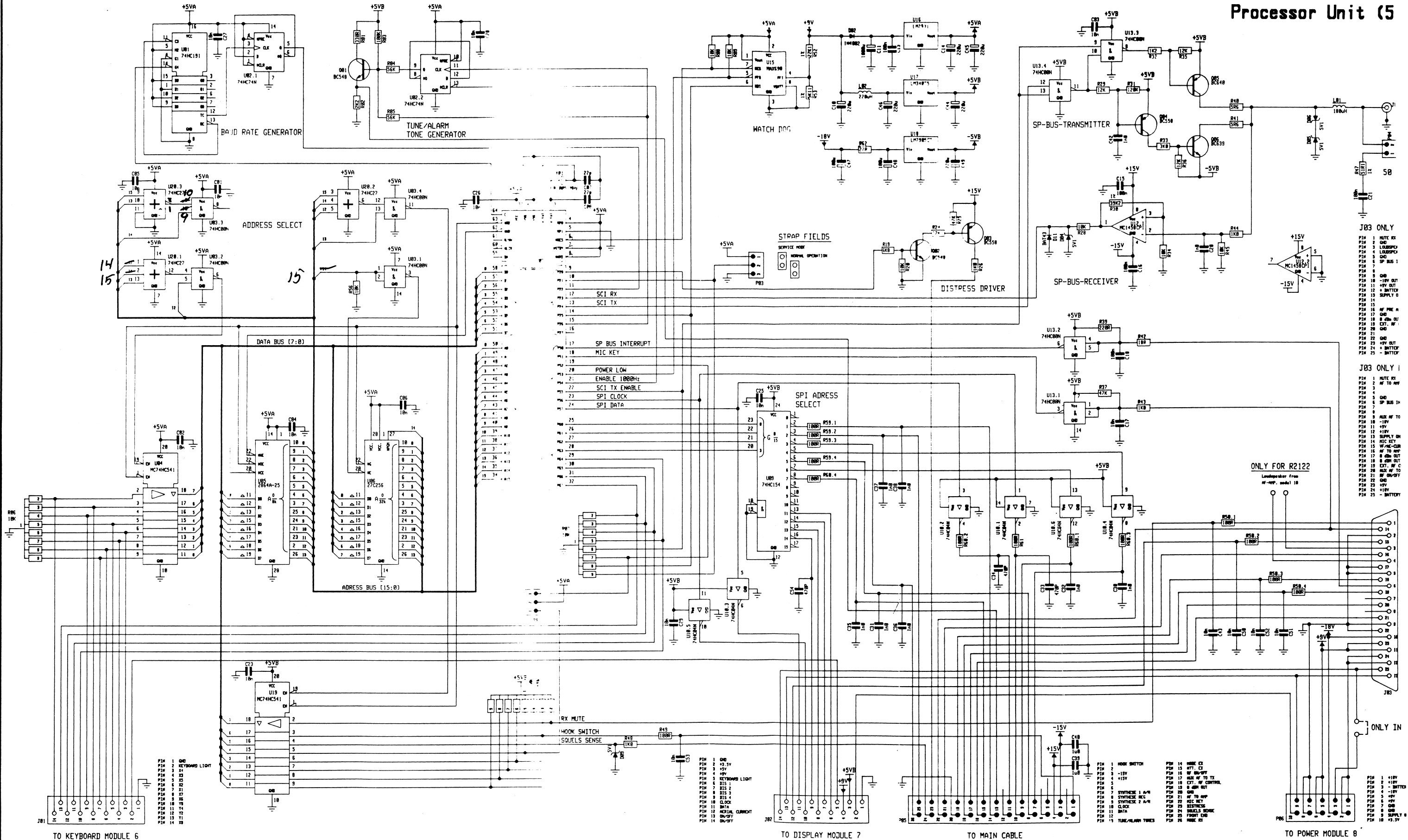


Synthesizer Unit (3)

Probe point measurement
Frequency meter measurement

4-0-25633F
TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP12 TP13 TP14 TP15 TP16 TP17

Processor Unit (5)



- J03 ONLY**
- PIN 1: MUTE KEY
 - PIN 2: MUTE KEY
 - PIN 3: MUTE KEY
 - PIN 4: MUTE KEY
 - PIN 5: MUTE KEY
 - PIN 6: MUTE KEY
 - PIN 7: MUTE KEY
 - PIN 8: MUTE KEY
 - PIN 9: MUTE KEY
 - PIN 10: MUTE KEY
 - PIN 11: MUTE KEY
 - PIN 12: MUTE KEY
 - PIN 13: MUTE KEY
 - PIN 14: MUTE KEY
 - PIN 15: MUTE KEY
 - PIN 16: MUTE KEY
 - PIN 17: MUTE KEY
 - PIN 18: MUTE KEY
 - PIN 19: MUTE KEY
 - PIN 20: MUTE KEY
 - PIN 21: MUTE KEY
 - PIN 22: MUTE KEY
 - PIN 23: MUTE KEY
 - PIN 24: MUTE KEY
 - PIN 25: MUTE KEY
- J03 ONLY 1**
- PIN 1: MUTE KEY
 - PIN 2: MUTE KEY
 - PIN 3: MUTE KEY
 - PIN 4: MUTE KEY
 - PIN 5: MUTE KEY
 - PIN 6: MUTE KEY
 - PIN 7: MUTE KEY
 - PIN 8: MUTE KEY
 - PIN 9: MUTE KEY
 - PIN 10: MUTE KEY
 - PIN 11: MUTE KEY
 - PIN 12: MUTE KEY
 - PIN 13: MUTE KEY
 - PIN 14: MUTE KEY
 - PIN 15: MUTE KEY
 - PIN 16: MUTE KEY
 - PIN 17: MUTE KEY
 - PIN 18: MUTE KEY
 - PIN 19: MUTE KEY
 - PIN 20: MUTE KEY
 - PIN 21: MUTE KEY
 - PIN 22: MUTE KEY
 - PIN 23: MUTE KEY
 - PIN 24: MUTE KEY
 - PIN 25: MUTE KEY

TO KEYBOARD MODULE 6

TO DISPLAY MODULE 7

TO MAIN CABLE

TO POWER MODULE 8

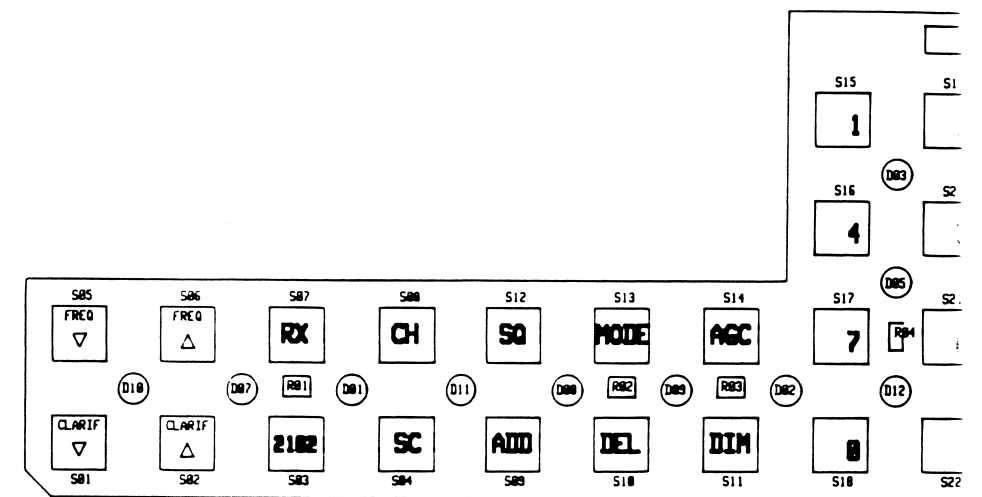
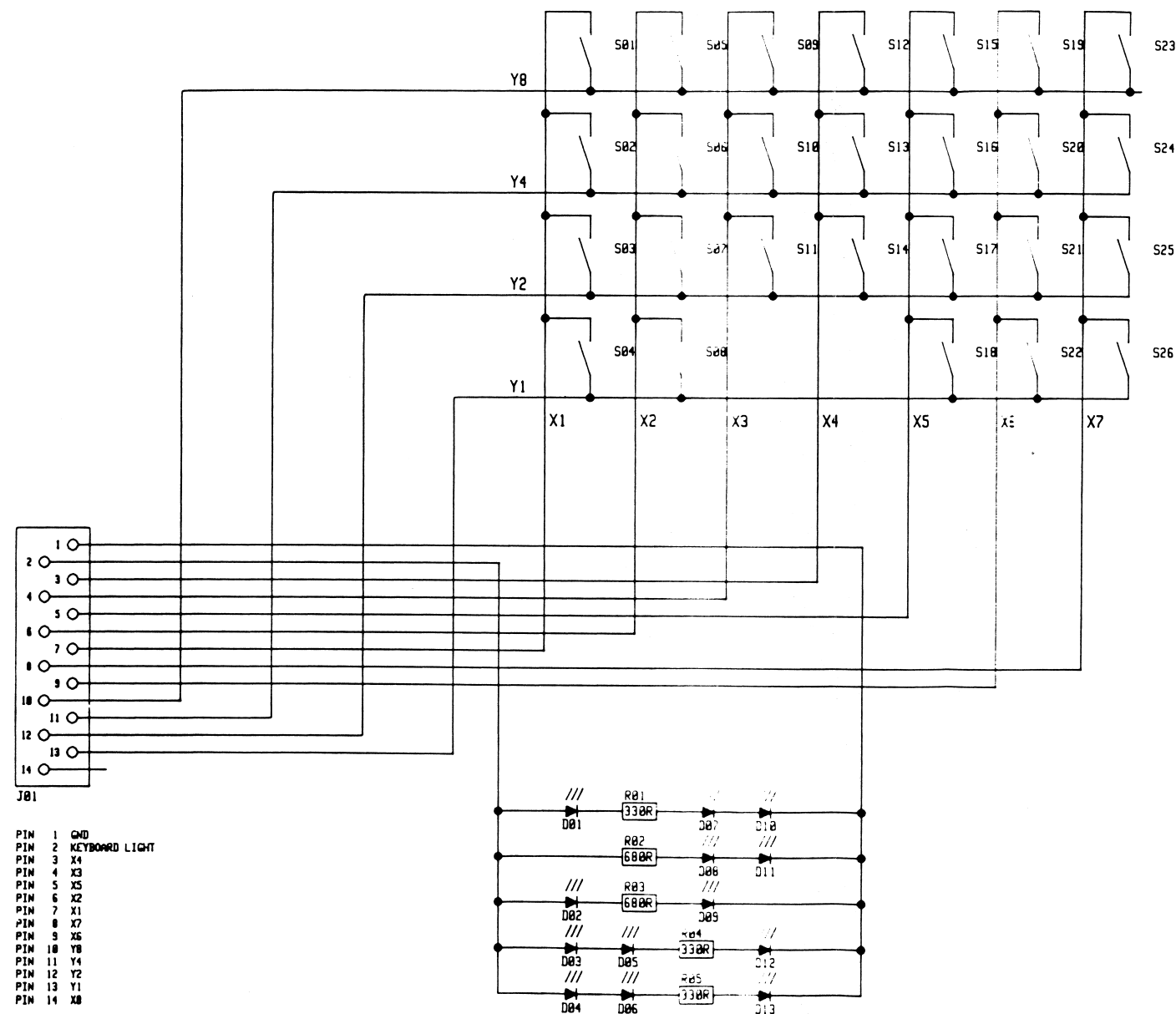
5.6. KEYBOARD UNIT (MODULE 6)

The keyboard consists of a 4x8 matrix of which 26 keys are used. One side is connected to the microprocessor data bus by an 8 bit driver. The other side is connected to 4 of the microprocessor ports.

By setting the 4 ports high and reading the data bus alternately it is possible to determine which key has been activated. In this way the keyboard is scanned 100 times per second.

The keyboard light, consisting of 13 LEDs divided in 5 columns, is controlled by an open collector (Q02) on the display print PCB, module 7. The power in each column is approx. 8.5 mA.

Keyboard Unit (6)



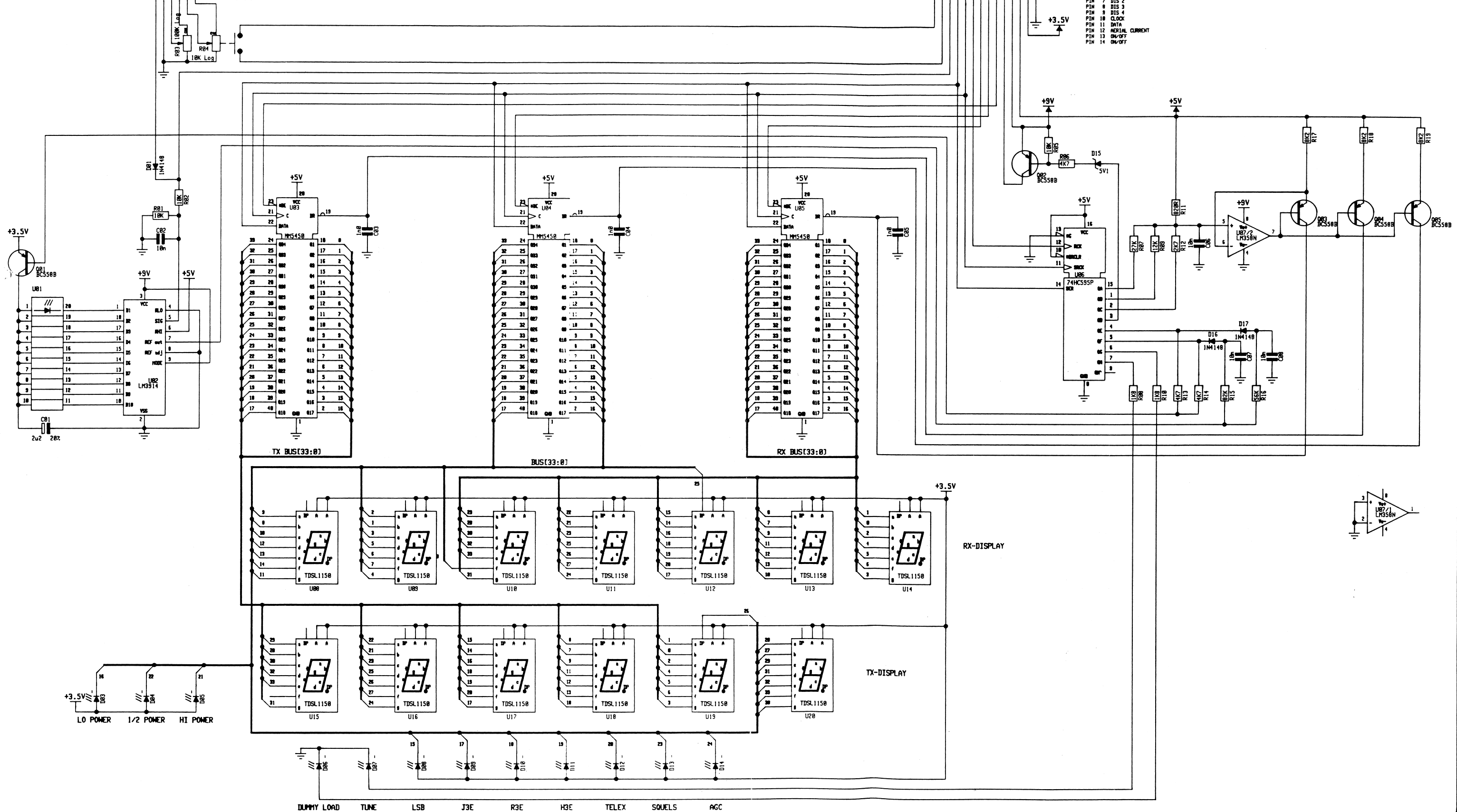
TO RECEIVER MODULE 1

J01
PIN 1 IN 10"
PIN 2 RF CENTER
PIN 3 RF TOP
PIN 4 RF CENTER
PIN 5 GND
PIN 6 RX LEVEL "5"

TO PROCESSOR MODULE 5

J02
PIN 1 GND
PIN 2 +3.5V
PIN 3 +5V
PIN 4 +9V
PIN 5 KEYBOARD LIGHT
PIN 6 DIS 1
PIN 7 DIS 2
PIN 8 DIS 3
PIN 9 DIS 4
PIN 10 CLOCK
PIN 11 DATA
PIN 12 SERIAL CURRENT
PIN 13 ON/OFF
PIN 14 ON/OFF

Display Unit (7)



D23 and R133 which are connected to the gate of the oscillator transistor prevent the gate source voltage from becoming positive which will cause the oscillator noise to increase. To activate the oscillator U01. Pin Qg is "high" which means that the transistors Q32 and Q35 are on supplying the oscillator transistor with DC voltage.

When one oscillator is supplied with DC voltage the other is off. The DC supply to the oscillator switches the diode D21 or D24 on and thereby supplies DC voltage to the oscillator buffer transistor Q36. From this transistor the local oscillator signal is fed to the prescaler buffer and to the output local oscillator buffer.

PRESALER BUFFER

From the oscillator buffer transistor Q36 the signal is fed through the network consisting of R159 and C180 to the grounded basis transistor Q38. The local oscillator signal is amplified here and fed through the attenuator R168/R170 and the amplifier transistor Q40. The result is an amplitude stabilized signal which is fed to the prescaler U36.

PRESALER AND DIVIDER

The programmable divider consists of a dual modulus divider U36, dividing by 32/33 and a programmable divider included in U35. The division ratio is determined by the number latched into U35 and together with U36 the divider works as a conventional dual modulus divider with the modulus control from U35 controlling the prescaler U36. The reference frequency divider is included in U35. The reference frequency input on pin 1 has the frequency 5,365.760 MHz and the reference division ratio R read into U35 is 131 leading to a reference frequency of 40.96 kHz which can be monitored on pin 13. This 40.96 kHz signal is used as the reference signal to the phase detector. The variable frequency to the phase detector is the VCO frequency divided with the read in "division ratio". This ratio is 1447 when USB mode is chosen, and by LSB mode 1971 leading to the two phase lock frequencies in USB of 59,269.120 MHz and in LSB mode 80,732.160 MHz.

PHASE DETECTOR AND LOOP FILTER

The phase detector is an integrated part of U35. The input reference frequency f_R is 40.96 kHz which can be monitored on pin 13 and the input variable frequency f_V can be monitored on pin-3. The three-state output of the phase detector produces a loop error signal which is used with the loop filter to control the VCO. The phase detector output is for frequency $f_V > f_R$ or f_V leading, negative pulses. For frequency $f_V < f_R$ or f_V lagging, positive pulses and for $f_V = f_R$ and phase coincidence, the output is in high impedance state. The loop filter consists of two parts. The first part of the loop filter built around the amplifier U34 and the R/C network R118 and C131 take care of the loop characteristic. The second part of the filter consisting of L34, L35 and C141/C143/C146 is a passive lowpass filter which removes the remaining part of the 40.96 kHz reference signal from the VCO control signal.

5.3. SYNTHESIZER UNIT (MODULE 3) cont.:

OUTPUT LOCAL OSCILLATOR BUFFER

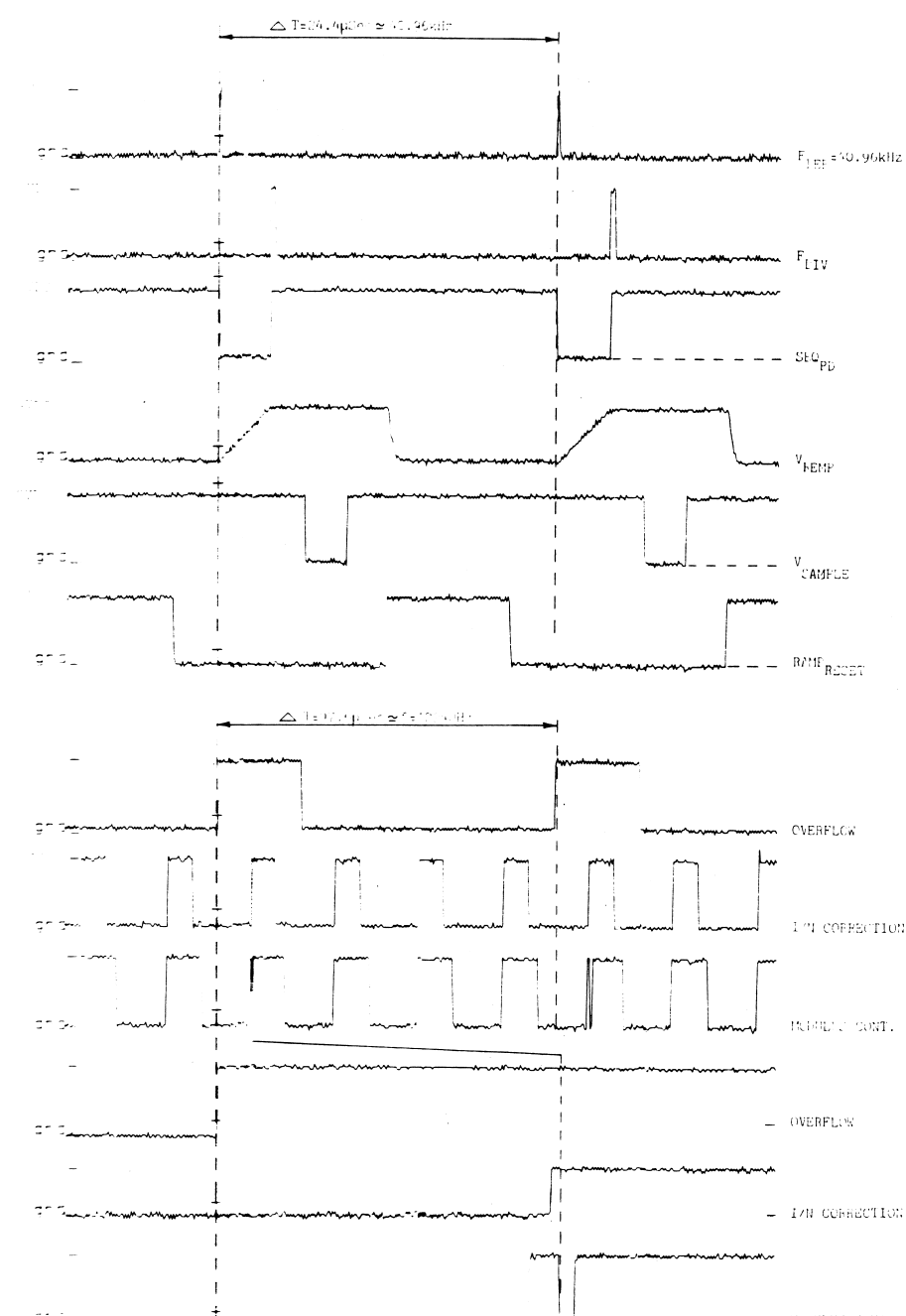
From the oscillator buffer transistor Q36 the VCO signal is amplified in transistor Q34 and filtered in the lowpass filter consisting of C176, L40, and C177. Before the signal is fed to the output terminal it is amplified in transistor Q37 and fed through the relay RE2. When the relay is activated the VCO signal is fed into the first mixer on the transmitter module. The diode D26 is conducting and thereby grounding the remaining part of the signal to the receiver module. When the relay RE2 is not activated the diode D26 is reversed and the VCO signal is fed to second mixer on the receiver module.

SYNTHESIZER WAVEFORMS

The below waveforms are identified with a signal name, which can be found in the diagram of the synthesizer module (3).

TEST CONDITIONS

Frequency setting $f_{RX} = 2058.24 \text{ kHz}$
Mode = J3E/USB



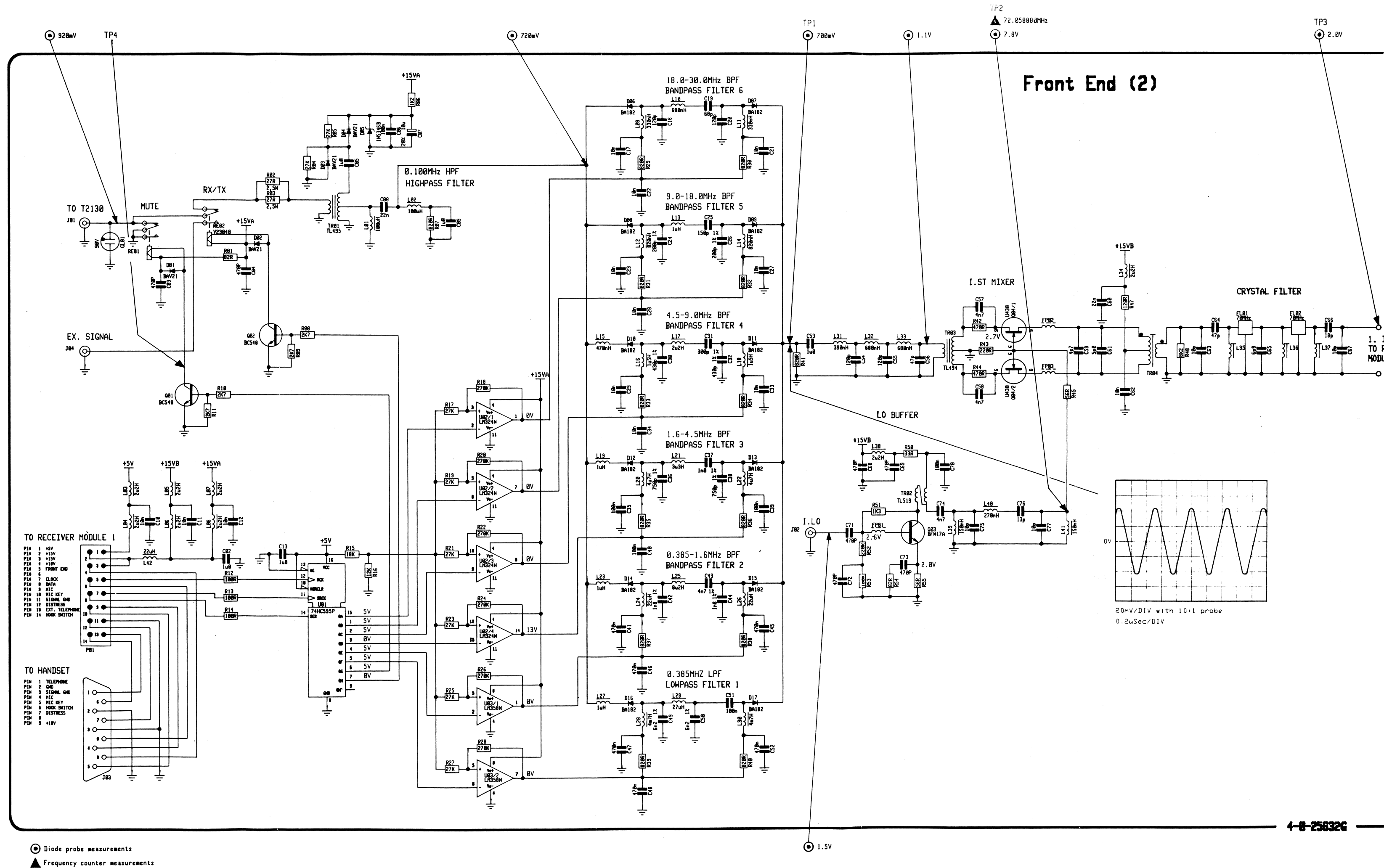
TEST CONDITIONSReceiver frequency : $f_{RX} = 2058.24\text{kHz}$

Receiver mode : J3E/USB

Generator frequency: $f_G = 2059.24\text{kHz}$ Generator level : $V_G = 117\text{dB}/\mu\text{V} \Rightarrow P_G = 4\text{dBm}$

Generator mode : CW

The generator signal must be feed to the aerial socket at the Front End Unit.



TEST CONDITIONS

Receiver frequency : $f_{RX} = 2058.24\text{kHz}$

Receiver mode : J3E/USB

Generator frequency: $f_G = 2059.24\text{kHz}$

Generator level : $V_G = 117\text{dB}/\mu\text{V} \Rightarrow P_G = 4\text{dBm}$

Generator mode : CW

The generator signal must be feed to the aerial socket at the Front End Unit.

