Radio Communications

RECEIVER SYSTEM
CR 300

ITT

Standard Radio & Telefon AB

RECEIVER SYSTEM CR 300

SHORT DESCRIPTION

This description deals mainly with receivers CR 301 and CR 305, which are two of the receiver versions of Receiver Systems CR 300.

CONTENTS:

(The information given in this description is subject to change without notice)

700120 FN/id
(Rev. 700820)

DESCRIPTION CR 301

General

CR 300 is a summary designation for a receiver system the basic design of which allows for a large number of special requirements to meet by means of a number of additional plug-in subunits.

The control system of the receiver has been designed so as to allow for use in very modern communication systems as for instance radio exchange systems and automatic channel scanning, etc. All subunits can be exchanged without the need of alignment, which makes maintenance simpler and cheeper.The frequency processing plan with a high (139.3 MHz) fixed first intermediate frequency makes it possible to exchange the RF-stages of the receiver to a parametric up-converter with crystal filter for the first intermediate frequency should this technique in the future prove advantages technically and economically. The receiver described below, CR 301, can be completed for reception of I.S.B. by adding two subunits. Only about 15 minutes will be needed for this operation.

The local oscillator outlets from the synthesizer are doubled and can together with the control signals of the receiver, be made available on the rear panel of the receiver. In this way two receivers, one without a synthesizer, can be operated in diversity.

1. Front Panel

The front panel is to be regarded as a plug-in-unit as it can be remo ed by loosening four screws and a multipole connector. The front panel has no mechanical coupling to the receiver. On the front panel are the following controls:

a) Six decade switches for frequency setting, indication by means of nixie valves.

b) Clarifier for tuning between 100 Hz-steps.

c) Press button for switching on and off the clarifier.

d) Emission type switch

e) Press button for power on.

f) Press button for loudspeaker.

g) Press button for AGC. Three different AGC-time constants or AGC + MGC.

h) Press button for - 20 dB antenna attenuator.

i) Earphone jack.

j) RF-gain control.

k) Line level adjustment (screwdriver)

l) RF- gain (MGC)

m) Instrument switch.

n) Control instrument.

o) BFO frequency tuning.

2. Control Logic

The controls on the front panel are not direct coupled to the subunits of the receiver. Instead they give information about frequency, emission type AGC etc. in a binary form using BCD-code and logic levels compatible with integrated circuits of TTL-type. The BCD-coded information is then decoded in the control logic, which takes care of the switchings, which are to take place in the receiver unit and the synthesizer. This makes it possible to remote control CR 301 over short distances (approx. 50 m). This is made by removing the frontpanel and providing it with an extension cable. The binary control of the receiver gives its biggest advantages when the receiver is remote controlled. Then the output of the remote control receiver can be connected directly to the control logic and the remote control is performed without using any moving mechanical parts. Remote control equipment type RC 1000 is used for full remote control.

3. The Receiver Part

The following short description of the units refers to block diagram B01002 0002 3.

a) The Protection Unit

The protection unit contains in order: One protection circuit which protects the receiver input from high voltages on the aerial, a low-pass filter 30 MHz and an antenna attenuator - 20 dB, which can be switched in and out by means of a relay.

b) The Input Filters

The input filters consist of 10 filters, which are switched in by means of reed relays controlled from the control logic.

The filters are three-pole band-pass filters of Chebyshev-type. The filters divide the frequency range of the receiver into the following bands:

1. 0 - 1.6 MHz (lowpass filter)
2. 1.6 - 2.2 MHz
3. 2.2 - 3.0 MHz
4. 3.0 - 4.0 MHz
5. 4.0 - 5.6 MHz
6. 5.6 - 8.0 MHz
7. 8.0 - 11.0 MHz
8. 11.0 - 15.0 MHz
9. 15.0 - 21.0 MHz
10. 21.0 - 30.0 MHz

The number of filters and the bandwidths have been chosen to obtain the best possible data at the following difficult cases of operation:

i. A strong interferring signal on a subharmonic to the tuned frequency.

ii. Two strong signals placed anywhere in the frequency range but with the mutual frequency difference being the same as the frequency tuned.

iii. A very strong (blocking signal far from the frequency tuned.

c) RF-Unit

The RF-unit contains a wide-band amplifier covering 10 kHz to 30 MHz. It is built up with field effect transistors giving approximately 6 dB gain before the mixer.

The input of the amplifier is connected in parallel with a photo-resistor combined with a lamp, which is energized from the AGC-amplifier. This method gives an RF-AGC, which does not cause distortion at large signals.

The mixer is built up with hot-carrier diods. In the RF-unit there is also an amplifier for the oscillator signal 109.3 MHz to 139.3 MHz.

d) 1st IF-Units

The 1st IF-unit works on 139.3 MHz and thus have a band-pass filter for this frequency. The filter contains an amplifier with a field effect transistor.

e) 2nd IF-Unit

The 2nd IF-unit contains the 10.7 MHz mixer which is built up with hot-carrier-diodes. Thereafter follows the 10.7 MHz-filter and an amplifier for the 150 MHz local oscillator, the matching components for the crystal-filters, a pre-amplifier for 10.7 MHz, a diode-mixer for 200 kHz, and two buffer amplifiers to feed the IF-filters.

f) Filter-Unit

The filter-unit consists of a printed circuit board with mechanical filters for 200 kHz IF and reed-relays to switch in the required filter. The reed-relays are operated from the control logic.

CR 301 includes filters for upper and lower sidebands and two filters for A1 alternatively F1. For A2 and A3 a low-pass-filter is used. The required selection for these emission types is obtained in the 10.7 MHz-crystal filter.

g) 3rd IF-Unit

Up to the mechanical filters the receiver gain is practically zero. This is necessary to keep a good linearity and good large signal performance. In the 3rd IF-unit on the other hand the gain is very high. The 3rd IF-amplifier consists of a multistage resistance coupled amplifier. This unit also contains the detector. It is of diode-type and can be switched from product- to envelop-detecting. The switching takes place electronically and is controlled from the control logic.

h) The AGC-Unit

The AGC-unit contains the AGC-detector, which has three different decay times, controlled from the control logic, and amplifiers to drive the AGC diodes in the 3rd IF-amplifier and the AGC-lamp in the RF-unit.

i) The BFO-Unit

In the BFO-unit there is a common output amplifier to which can be switched the following four signals:

i. fixed 200 kHz for SSB.

ii. tunable oscillator frequency 200 ± 2 kHz for A1 local.

iii. fixed crystal oscillator 200.8 kHz for A1.Remote. (not used in version CR 301.)

iiii. fixed crystal oscillator 202.55 kHz for F1.

The BFO-unit comprises the output amplifier, the three oscillators and components for electric selection of the oscillator. The switching is controlled from the control logic.

k) AF-Unit Channel A

The AF-unit for channel A contains a line amplifier and a loudspeaker amplifier with transformer output. The output level of the line amplifier can be monitored on the test instrument on the frontpanel. The level can be adjusted by means of a screwdriver from the front panel. The earphone jack is connected to the output of the loudspeaker amplifier. The AF-level in the earphone jacket is thus controlled by the AF-gain control. The loudspeaker can be switched off by means of a pressbutton on the frontpanel.

4. The Synthesizer

The synthesizer supplies the required local oscillator signals for the receiver as follows:

109.3 - 139.3 MHz in 100 Hz-steps, 150 MHz, 10.5 MHz and 200 kHz.

The frequencies are generated in two phase locked loops. The main loop, which in the block diagram B 01002 0002 3 comprises VC 01, phase discriminator and Divider 1, generates 10 MHz, 1 MHz and the 100 Hz-steps while the 10 kHz steps, 1 kHz and the 100 Hz-steps are generated in the secondary loop, which comprises VC 02 and Divider 2.

a) 5 MHz MXO

The CR 301 is equipped with a RACAL TYPE 840 oscillator, which allows a frequency error less than 10^{-7} after a 10 minutes heating period. If required MXO with higher stability can be provided.

b) The Fixed Divider

The fixed divider contains a frequency divider built up with TTL-circuits and also buffer stages to increase the isolation between the outputs delivering 5 MHz, 200 kHz, 100 kHz and 1 kHz.

c) VCO 2 and Divider 2

These units form the secondary, loop for generating the 10 kHz, 1 kHz and 100 kHz-steps. VCO 2 contains a VCO which is phase-locked in 1 kHZ-steps from 11.000 to 11.999 MHz. Thereafter the VCO frequency is divided by 10, which gives the range 1.1000 to 1.1999 MHz in 100 Hz-steps. This methode gives a much better short term stability (less phase gitter) and a shorter tuning time at frequency changing compared with locking a 1.1000 to 1.1999 MHz oscillator direct to 100 100 Hz comparing frequency. The tuning time at frequency changes for the CR 300-receivers is less than 100 milliseconds, which is necessary to make it possible to use the receivers for automatic channel scanning. Divider 2 is a frequency divider with adjustable dividing ratio. The dividing ratio is decided by logic levels on four wires for each decade (BCD-code). VCO 2 contains in addition to the VCO also buffer amplifiers, 10-divider with lowpass filter and the phase detector, which is of the type "sample-and-hold".

d) Mixer Unit No 1.

This unit contains a 150 MHz crystal oscillator, which gives the local oscillator signal for the second mixer. In the mixer unit the 1.1 to 1.2 MHz-signal from the secondary loop is mixed with 5 MHz from the fixed divider and the result - 6.1 to 6.2 MHz - is filtered by means of a band-pass filter. This frequency is then mixed with the 150 MHz and used to analyse the main oscillator frequency. Thereby the frequency error of the 150 MHz oscillator will be eliminated.

e) VCO 1

The VCO 1 contains a VCO which can be pretuned in discrete steps by means of binary switched capacitors. A varicap controls the frequency continuously between the steps.

The capacitor switches are connected to an automatic pretuning device in the Phase Discriminator and the varicap to the phase detector. In this way the tuning range of the varicap can be kept small in spite of the large (30 MHz) tuning range of the VCO, and a high purity of the output signal can thus be obtained. This is essential in order to meet the required figure for two-signal-selectivity: 80 dB at 10 kHz separation. The VCO 1 also contains the buffer amplifier for the receiver´s first mixer, buffer amplifier, mixer and wide-band amplifier for the main loop 1F 4,6 - 34,6 MHz.

f) Divider 1

Divider 1 is a tunable frequency divider, the dividing ratio of which can be chosen from 46 to 345 by means of logical levels on 10 wires, four for the 100 kHz-decade, four for the 1 MHz-decade, and two for the 10 MHz-decade. The output frequency from the divider, which is 100 kHz when the main loop is in syncronism, is switched to the phase discriminator.

g) The Phase Discriminator

The phase discriminator contains a phase detector of the diode type, the loop filter, and an automatic pretuning device for the VCO 1. The automatic pretuning device operates in such a way that a special circuit decides if the frequencies at the phase detector are equal. If the frequencies are not equal, the circuit gives an output in the form of pulses which are fed into a binary counter. The flip-flops in the counter are connected to the capacitor switches in the VCO 1. Thus the VCO 1 is tuned in steps until the frequency error at the phase detector is small enough for the loop to lock. When synchronism is obtained, the pulses to the binary counter disappears and the state of the counter remains and corresponds to the desired pre-tuning of the VCO. The whole procedure takes place in a few milliseconds. This method increases the reliability due to the fact that the loop will be independent of frequency drift of the VCO due to temperature, ageing etc.

h) The 10.5 MHz-Oscillator

This oscillator gives the local oscillator signal to the third mixer. The frequency from a 10.5 MHz crystal oscillator is divided by 21 in a divider and compared with 500 kHz from the reference divider in phase detector. The error signal is connected to a varicap in the oscillator circuit. The 10.5 MHz oscillator thus comprises a phase locked loop.

When the clarifier is switched in, the locked loop is opened, and the varicap is instead fed with a voltage, which can be varied by means of a potentiometer on the front panel.

5. The Power Supply Unit

The power supply unit delivers the following voltages: -12 V, +5 V, +15 V, and approximately +170 V to operate the nixievalves on the front panel.

SPECIFICATION CR 301

1. Power Supply

1.1 Built-in power supply for 105, 115, 127, 220, 230, and 240 V ± 10 % 45 - 400 Hz.

1.2 24 V DC, separated from earth. Optional, separate unit.

2. Environmental Conditions

2.1 Temperature limits at operation -30° to +55°C, humidity 80% or less.

2.3 The performance of CR 301 will not be affected by vibration frequencies of 50 Hz or less at an amplitude of 0.25 mm. The vibration type test is made in two main directions and for at least 30 minutes in each direction.

2.4 Bump type test: 500 bumps of 40 g in main direction.

2.5 A humidity type test is made during at least 24 hours at a relative humidity of 95 % and the temperature +55°C.

3. Electrical Data

3.1 Frequency Ranges:

10 kHz to 30 MHz.

3.2 Modes of Emission:

A1, A2, A2H, A3, A3A, A3H, A3J, F1. (Version CR 302 also A3B).

The CR 301 may easily be completed to version CR 302 for reception also of emission type A3B.

3.3 Sensitivity:

Noise factor better than 10 dB. Sensitivity slightly reduced below 50 kHz.

3.4 Selectivity:

CR 301 is provided with the following IF-filters:

Filter:	3 dB-band width:	60 dB-band width:
a) AM-filter	± 3.75 kHz	± 8.7 kHz
b) SSB-filter	3.1 kHz	5.2 kHz (USB)
SSB-filter	3.1 kHz	5.2 kHz (LSB)
c) A1-filter	± 0.75 kHz	± 1.25 kHz
d) A1-filter	± 0.15 kHz	± 0.6 kHz

3.5 Ripple:

The ripple in the pass band is less than ± 2 dB.

3.6 IF- Attenuation:

Better than 100 dB (referred to 12 dB SINAD)

3.7 Image Rejection:

Better than 100 dB (referred to 12 dB SINAD)

3.8 Attenuation of External Spurious:

Better than 80 dB (referred to 12 dB SINAD)

3.9 Internally Generated Spurious Signals:

Not exceeding 0.2 uV emf equivalent antenna input signal.

3.10 Intermodulation Distortion in AF-Channel at A3J:

The 2nd and the 3rd order intermodulation products are attenuated more than 50 dB.

3.11 Harmonic Distortion:

Better than - 40 dB.

3.12 Blocking:

Better than 100 dB.

3.13 Two-Signal Selectivity:

Better than 80 dB.

3.14 Three-Signal Selectivity:

a) The receiver is set for reception of A3J with the wanted signal adjusted to give 12 dB SINAD. One interferring signal is set ± 10 kHz off the wanted signal and the 2nd interferring signal is set ± 20 kHz off the wanted signal. The levels of the two interferring signals are simultaneously increased until the SINAD ratio of the wanted signal is reduced by 6 dB.

The levels of the two interferring signals are allowed to be 75 dB above the levels of the wanted signal.

b) The measurement is carried out as above with the exception that a 2nd interferring signal is set to the double frequency of the wanted signal ± 10 kHz.

The three-signal selectivity is then better than 80 dB.

3.15 Gain Control:

Manual and automatic. At the AGC the output level does not vary more than 4 dB if the input level is varied between 2 uV emf and 200 mV emf.
Separate manual 20 dB antenna attenuator.

3.16 AGC Time Constant

The following time constants are available:

	Rise Time	Decay Time
a)	2 ms	100 ms
b)	2 ms	1 s
c)	2 ms	5 s

The AGC-detector is made in such way that the decay time for short interferring pulses is of the same order as the rise time. This gives the advantage that the CR 300 in spite of this short rise time is not blocked by interference of impulse type.

3.17 Channel Separation:

100 Hz, with clarifier for continuous tuning between the 100 Hz-steps.

3.18 Frequency Stability:

Better than 5×10^{-7} per 24 hours after a 3 minutes warming up period.

3.19 BFO:

The beat frequency can be varied ± 2 kHz.
Fixed XO (center frequency 2550 Hz) for F1.

3.20 Oscillator Radiation:

Less than 10 uV when the antenna input is terminated with 50 ohms measured up for 1000 MHz.

3.21 Attenuation of RF-Signals on the Power Supply Inlet:

Better than 80 dB.

3.22 Antenna Input Protection:

50 V emf at 50 ohms is allowed on the antenna input during up to 15 minutes.

3.23 Test Meter:

CR 300 is provided with an instrument with switch, which operates as a level meter and also as a test instrument for fault tracing.

The following measurements can be carried out by means of the instrument switch:

1. The relative level of the RF-signal.

2. The audio frequency level on the line output for channel A with 0 dBm calibrated.

3. The level of the audio frequency signal on the line output for channel B with 0 dBm calibrated. (For version CR 301 channel B is not included).

4-10. 7 positions to check the function and localize faults down to subunit.

11. In this position the instrument is switched to a test probe, which is included in the CR 300. This probe can be connected to a number of test points in the receiver.

3.24 Antenna Input:

50 ohms unbalanced, SWR less than 1:3.

3.25 Audio Frequency Output:

a) Line output 600 ohms symmetric and unearthed. Adjustable up to +10 dBm.

b) Earphone outlet, adjustable.

c) 15 ohms loudspeaker outlet symmetric and unearthed. Output power 1 W at max 5 % distortion. Adjustable.

d) Built-in monitoring loudspeaker, which can be switched in and out by means of a press button. Adjustable.

SPECIFICATION CR 305

1. Power Supply

1.1 Built-in power supply for 105, 115, 127, 220, 230, and 240 V ±10 % 45-400 Hz.

2. Environmental Conditions

2.1 Temperature limits at operation -30° to +55°C, humidity 80% or less.

2.2 Storing temperature -40° to +70°C, humidity 65 % or less.

2.3 The performance of CR 305 will not be affected by vibration frequencies of 50 Hz or less at an amplitude of 0.25 mm. The vibration type test is made in two main directions and for at least 30 minutes in each direction.

2.4 Bump type test: 500 bumps of 40 g in main direction.

2.5 A humidity type test is made during at least 24 hours at a relative humidity of 95 % and the temperature +55°C.

3. Electrical Data

3.1 Frequency Ranges:

10 kHz to 30 MHz.

3.2 Modes of Emission:

A1, A2, A2H, A3, A3A, A3H, A3J.

3.3 Sensitivitv:

duced

3.4 Selectivity:

andwidth:

CR 305 is provided with the following IF-filters:

z

~~+3800~~ Hz

Filter:	3 dB bandwidth:	60 dB bandwidth
a) AM-filter	± 3.75 kHz	± 8.7 kHz
b) SSB-filter (USB)	+350 to +2700 Hz	-500 to +3800 Hz
c) A1-filter	± 200 Hz at 6 dB	± 2 kHz
d) A2/A1-filter	± 1 kHz at 3 dB	± 3.3 kHz

Better than 100 dB (referred to 12 dB SINAD).

3.8 Attenuation of External Spurious:

Better than 60 dB (referred to 12 dB SINAD).

3.9 Internally Generated Spurious Signals:

Not exceeding 0.2 µV emf equivalent antenna input signal.

3.10 Intermodulation Distortion in AF-Channel at A3J:

The 2nd order intermodulation products are attenuated more than 50 dB and the 3rd more than 50 dB.

3.11 Harmonic Distortion:

Better than -40 dB.

3.12 Blocking:

Better than 100 dB.

3.13 Two-Signal Selectivity:

Better than 80 dB.

3.14 Three-Signal Selectivity:

a) The receiver is set for reception of A3J with the wanted signal adjusted to give 12 dB SINAD. One interfering signal is set ± 10 kHz off the wanted signal and the 2nd interfering signal is set ± 20 kHz off the wanted signal. The levels of the two interfering signals are simultaneously increased until the SINAD ratio of the wanted signal is reduced by 6 dB.

   The levels of the two interfering signals are allowed to be 75 dB above the levels of the wanted signal.

b) The measurement is carried out as above with the exception that a 2nd interfering signal is set to the double frequency of the wanted signal ± 10 kHz.

   The three-signal selectivity is then better than 75 dB.

3.15 Gain Control:

Manual and automatic. At the AGC the output level does not vary more than 4 dB if the input level is varied between 2 µV emf and 200 mV emf.
Separate manual 20 dB antenna attenuator.

3.16 AGC Time Constant

The following time constants are available:

	Rise Time	Decay Time
a)	2 ms	100 ms
b)	2 ms	1 s
c)	2 ms	5 s

The AGC-detector is made in such way that the decay time for short interferring pulses is of the same order as the rise time. This gives the advantage that the CR 305 in spite of this short rise time is not blocked by interference of impulse type.

3.17 Channel Separation:

100 Hz, with clarifier for continuous tuning between the 100 Hz-steps.

3.18 Frequency Stability:

Better than 10^{-6} per 24 hours after a 3 minutes warming up period.

3.19 BFO:

The beat frequency can be varied ± 2 kHz.

3.20 Oscillator Radiation:

Less than 10 µV when the antenna input is terminated with 50 ohms. Measured up to 1000 MHz.

3.21 Attenuation of RF-Signals on the Power Supply Inlet:

Better than 80 dB.

3.22 Antenna Input Protection:

50 V emf is allowed on the antenna input during up to 15 minutes.

3.23 Test Meter:

CR 305 is provided with an instrument with switch, which operates as a level meter and also as a test instrument for fault tracing.

The following measurements can be carried out by means of the instrument switch:

1. The relative level of the RF-signal.
2. The audio frequency level on the line output with 0 dBm calibrated.

3. The level of the audio frequency signal on the line output for channel B with 0 dBm calibrated. (For version CR 305 channel B is not included).

4-10. 7 positions to check the function and localize faults down to subunit.

11. In this position the instrument is switched to a test probe, which is included in the CR 305. This probe can be connected to a number of test points in the receiver.

3.24 Antenna Input:

50 ohms unbalanced, SWR less than 1:3.

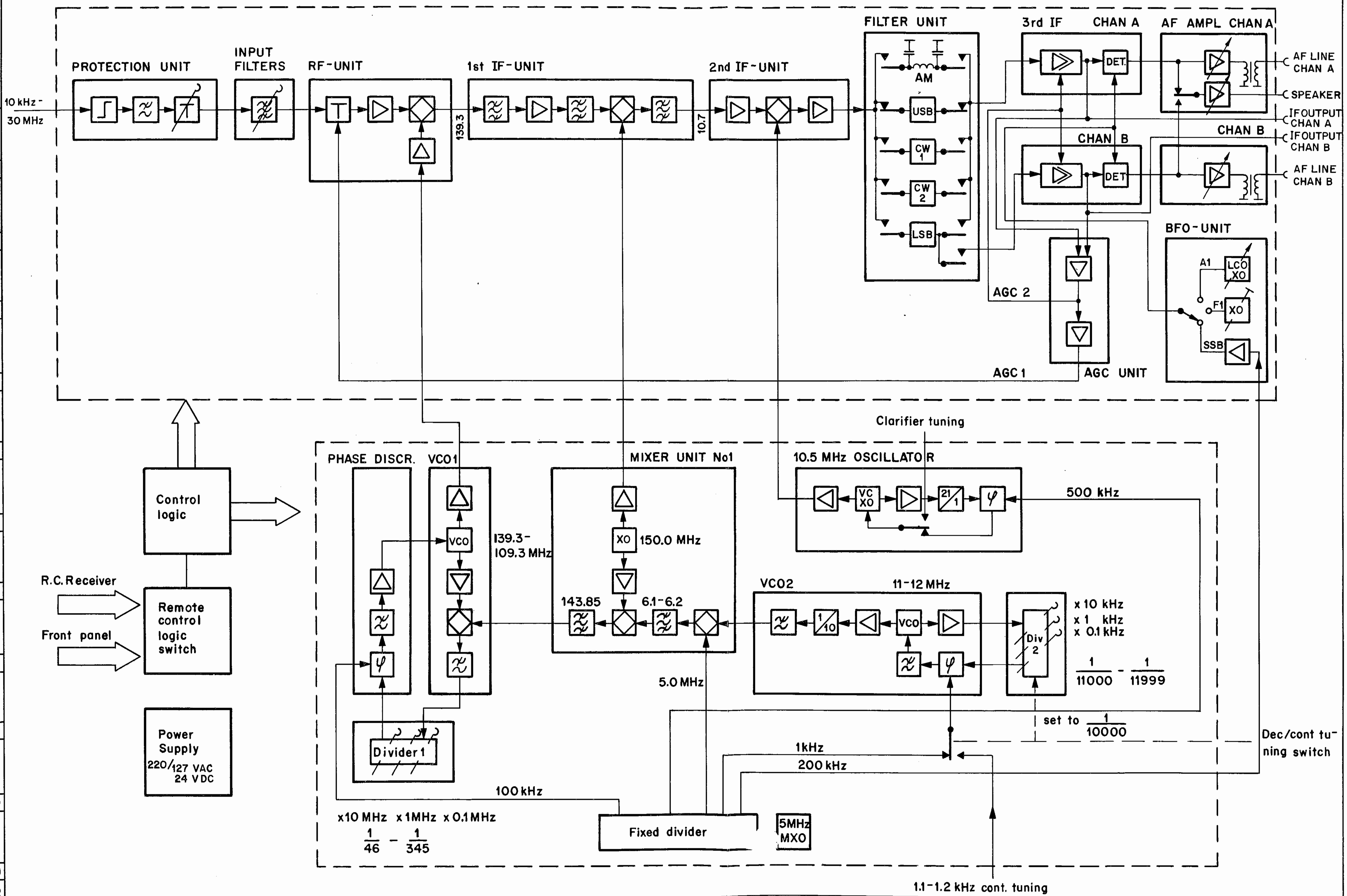
3.25 Audio Frequency Output:

a) Line output 600 ohms symmetric and unearthed. Adjustable up to +10 dBm.

b) Earphone outlet, adjustable.

c) 15 ohms loudspeaker outlet symmetric and unearthed. Output power 1 W at max. 5% distortion. Adjustable.

d) Built-in monitoring loudspeaker, which can be switched in and out by means of a press button. Adjustable.



RECEIVER CR 300
BLOCK DIAGRAM

Standard Radio & Telefon AB
SWEDEN

B01002 0002 3

MF
R.J. 691027

Rev I 691029 OMRIT.

CR 300 MECHANICAL DESIGN

The dimensions of the receiver are given in drawing B01002 0003 4.

The receiver is built-up of subunits, which are plug-in printed boards or screened units. The screened units are combined to two big plug-in units. One is the receiver unit, which consists of 7 screened subunits and comprises the receiver from the aerial up to and including the last AF amplifier (200 kHz) and the other big unit comprises the synthesizer, which consists of 8 screened subunits.

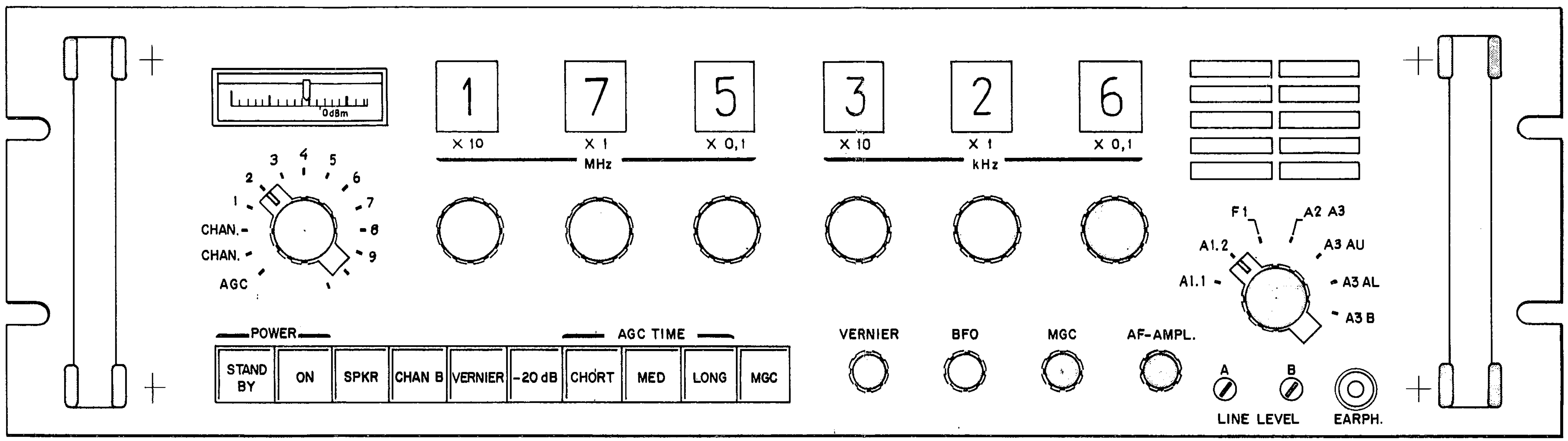
The AF-amplifiers, AGC-unit, BFO and the control logic are built on 5 plug-in boards.

On the rear of the receiver are mounted metal shoes to prevent the connectors from being damaged if the receiver is put with the rear-side downwards. The frontpanel has no mechanical coupling to the receiver. The panel is electrically connected to the receiver by means of a mulitpole connector. The frontpanel is to be regarded as a plug-in-unit, it can be removed by loosening four screws and the multipole connector.

The measures of the chassis allow the receiver to be mounted in a cabinet either using rolling slides or simple tracks.

The different controls and indicators available on the frontpanel are shown on drawing EA 30154 8.

The weight of CR 302 (the ISB-version) is 17 kgs.



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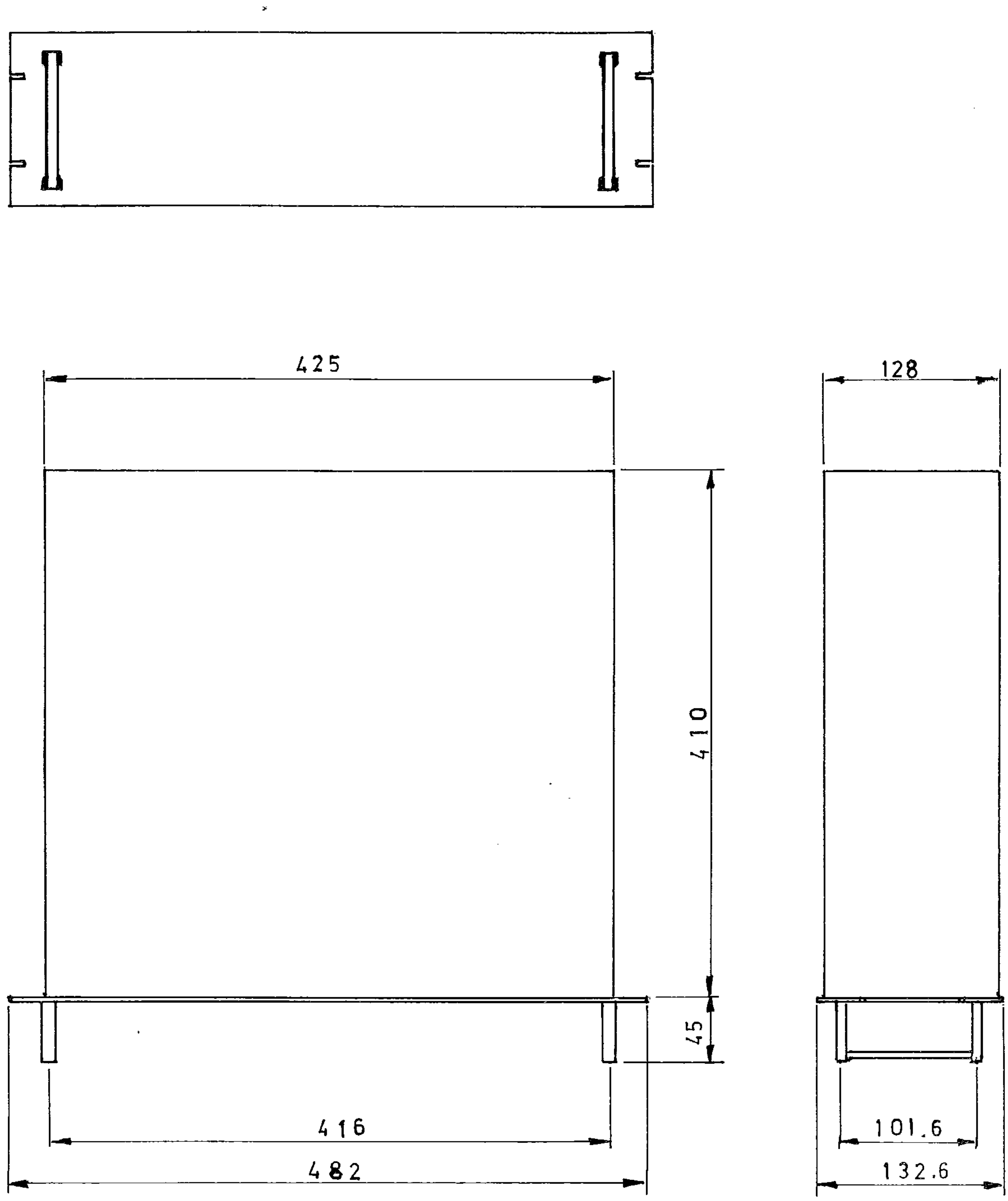
REV.1



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REV.1

SRT 301:43

CR 301 RELIABILITY PREDICTION

1. General

The reliability characteristics of most electronic components under normal operating conditions are generally determined by the sudden failures. Generally, these can be considered as random failures. The main part of CR 300 is built up by such components and the reliability can therefore be predicted by conventional methods.

However, the protection unit contains one long life lamp. The model with random failures must be applied with caution. Instead it is important that information about wear-out life is given.

2. Reliability Model

In the predicitons it is assumed that every component is required for successful operation of the units and the component life distributions are exponential. The failure rate of the units are in this case the sum of the component failure rates. The serial model is also used in the reliability prediction of CR 300 with the units as elements.

3. Reliability Parameters

For each subunit the failure rate is predicted. For CR 300 $m = \frac{1}{z}$ is then calculated. The parameters are predicted for normal operating conditions, stand by and storage.

4. Environment

The prediction refers to ground equipment at an ambient temperature of 25^{o} C and a relative humidity - 80 %. The internal heating of the equipment is estimated to be 5^{o}C.

5. Component Failure Rates

The component failure rates are generally in accordance with MIL-HDBK 217 A.

Other Sources

Reliability in Large Electronic Data Processing System by P.Cox and K.F. Ranking (ATE Journal, Vol.21, No 4. p.162.)

SAAB-report ZG-Tkm-5R 229

Field experience at SRT, F00-6910
A factor = 0,1 has been applied for storage.

6. Proposal of Maintenance Model

We propose that the maintenance is performed at the following levels:

A-Level (at the Equipment)

Necessary maintenance is performed at the equipment and includes:

Failure localization on subunit level and replacement of faulty subunits.

Performance check after the replace of subunits.

B-Level (Regional Workshop)

Necessary maintenance is performed on replaced subunit and includes:

Trouble-shooting at component level and replacement of faulty components.

Parameter check after the replacement of faulty components.

The spare part store is located at B-level.

C-Level (Central Workshop)

The C-level need only be used in exeptional cases.

7. Mean Time to Repair

When calculating the MTTR it has been assumed that a faulty subunit is localized and replaced.

MTTR of the CR 301 is the weighted MTTR of the subunits with the failure rate of the corresponding subunits as the weight factors.

$$MTTR = \frac{MTTR_i \cdot z_i}{z_i}$$

90 % of all failures can be localized to a subunit using the built-in test instrument.(Maintenance on A-level according to clause 6.)

For the remaining failures a more complete measuring equipment is required. (Maintenance on B-level according to clause 6.)

No alignment is required after the replacement of a subunit.

8. Maintenance Personnel

90 % of the failures can be repaired by operating personnel with comparatively low technical education. This personnel should, however, be trained in trouble-shooting and repair on CR 301.

Remaining failures have to be repaired by engineers, who have been trained on CR 301.

9. Result

Predicted Reliability CR 301

Normal operating conditions:	$z_{tot} = 0{,}21\ kh^{-1}$	MTBF = 4800 h
Stand by:	$z_{tot} = 0{,}09\ kh^{-1}$	MTBF = 11000 h
Storage:	$z_{tot} = 0{,}015\ kh^{-1}$	MTBF = 67000 h

Subunit failure rate is given in table 1.

MTTR

$$MTTR_{CR300} = 1\ h$$

Mean time to localize a fault when maintenance is performed at the A-level = 0,3 h.

Mean time to replace a faulty subunit when maintenance is performed at A-level = 0,6 h.

Mean time to repair when maintenance is performed at B-level = 2 h.

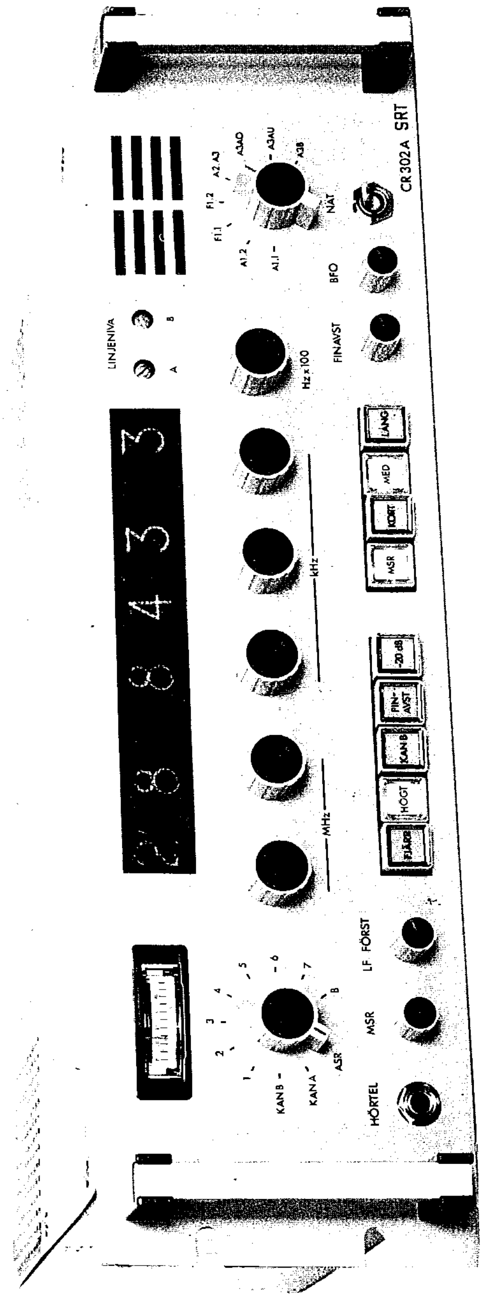
Mean time to localize resp. replace a faulty subunit when maintenance is performed at A-level is given in table 1.

10. Comments

Since only about every tenth failure needs a more complete measuring equipment to be repaired, an individual receiver has to be sent to the central workshop only one or a few times during a calculated useful life of 10 years.

Table 1

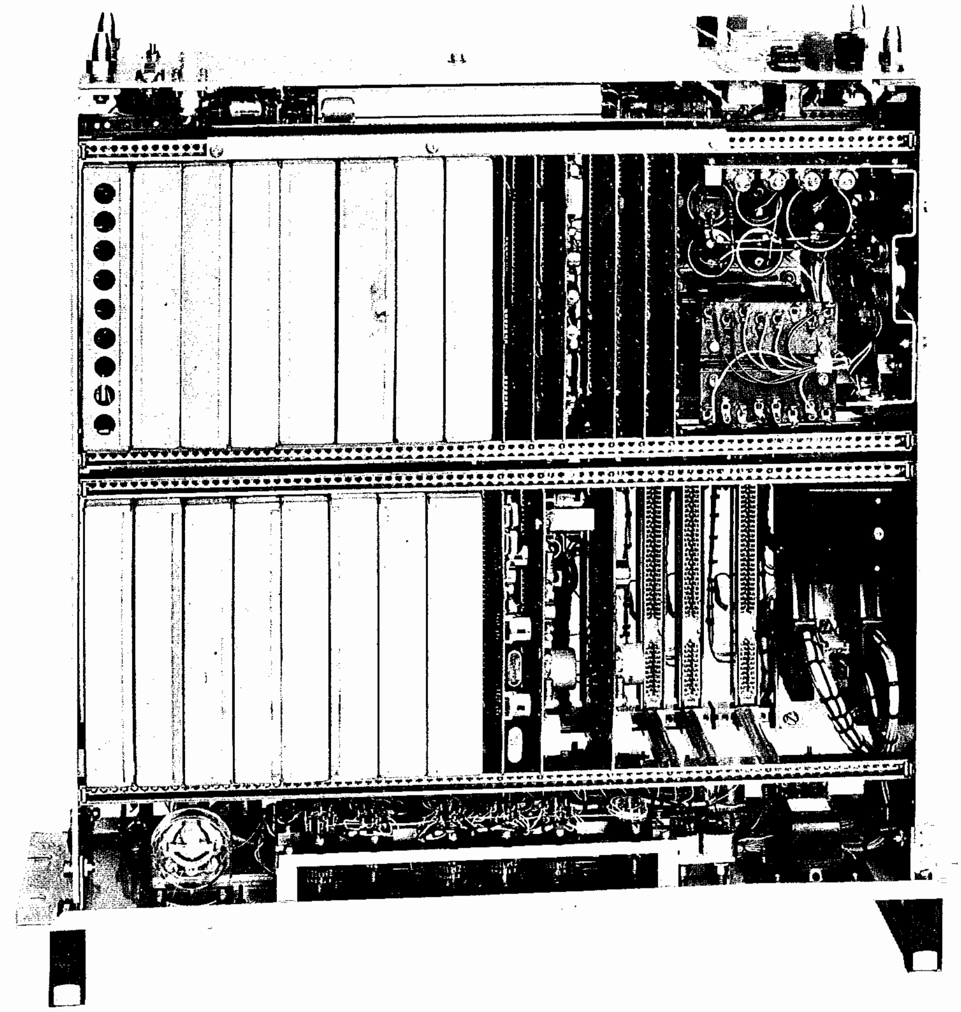
Subunit	Normal Operating Conditions $z_i(Mh^{-1})$	Stand by $z_i(Mh^{-1})$	Storage $z_i(Mh^{-1})$	Meantime to localize a fault h	Meantime to replace a faulty subunit h
Protection Unit	3.5	3.5	0.3	0.3	0.6
Input Filters	18	18	1.2	0.3	0.6
RF Unit	13	1.0	1.0	0.4	0.6
1st IF-Unit	6.0	0.5	0.5	0.5	0.6
2nd IF-Unit	3.4	0.3	0.3	0.6	0.6
3rd IF-Unit chan A.	16	0.9	0.9	0.6	0.6
Filter Unit	2.3	0.2	0.2	0.1	0.8
BFO Unit	11	0.5	0.5	0.1	0.1
AF Amplifier Unit	1.3	0.1	0.1	0.6	0.1
AGC-Unit	2.2	0.1	0.1	0.1	0.1
VCO 1	8	0.5	0.5	0.4	0.6
Divider 1	10	10	0.8	0.3	0.8
Mixer Unit No 1	14	1.0	1.0	0.5	0.6
Fixed Divider	12	12	1.0	0.4	0.7
5 MH$_3$ M x 0	14	14	0.8	0.1	0.7
VCO 2	13	0.8	0.8	0.1	0.6
10.5 MH$_3$ Oscillator	11	0.8	0.8	0.1	0.6
Divider 2	12	12	1.1	0.3	0.8
Control Logic	9	9	0.9	0.4	0.1
Power Supply	12	4	0.7	0.1	0.6
Front Panel	18	1.3	1.3	0.3	0.6
Receiver Chassis	3.0	0.2	0.2	0.3	0.6



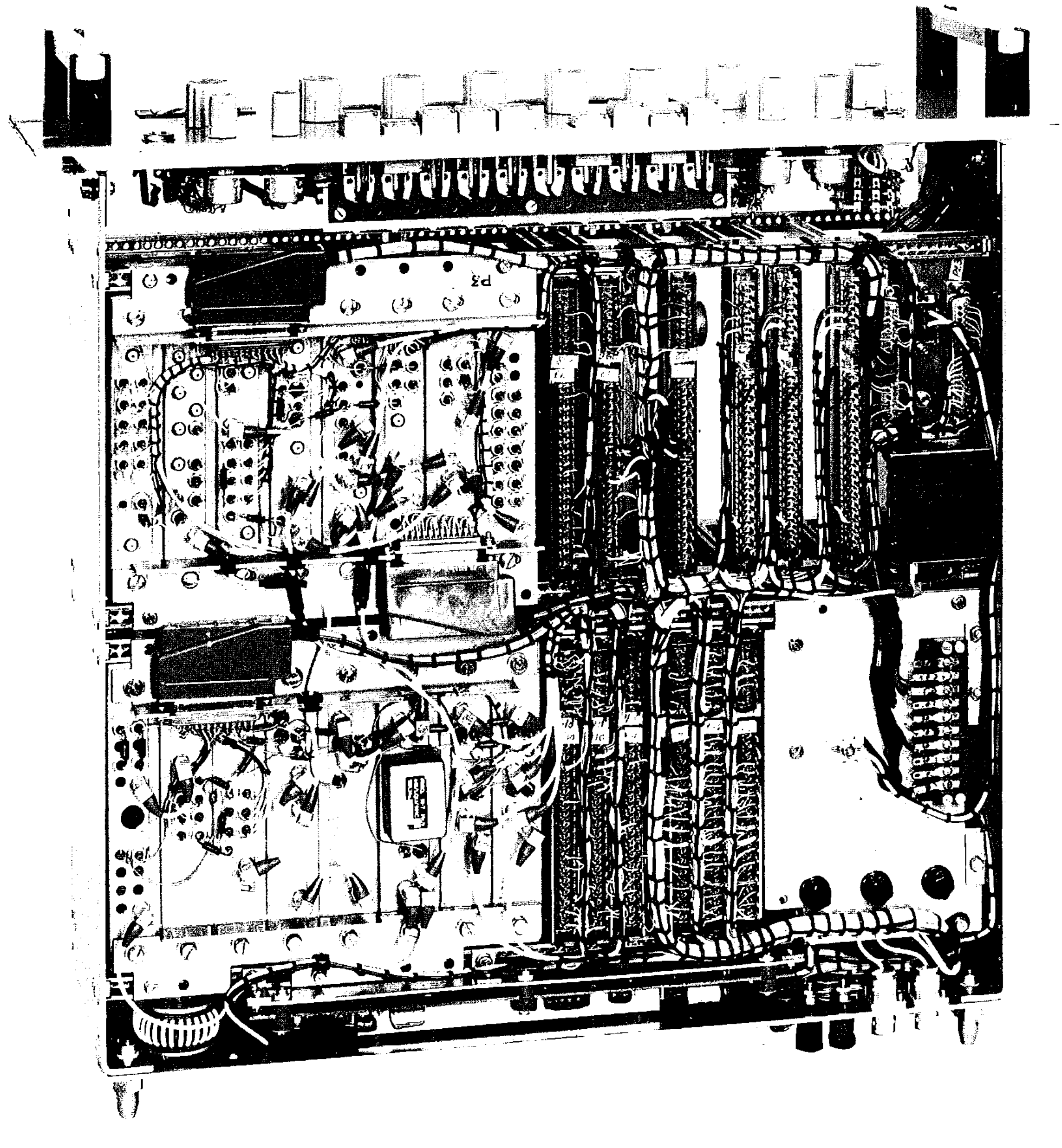
RECEIVER CR 302 A

Standard Radio & Telefon AB
BARKARBY SWEDEN

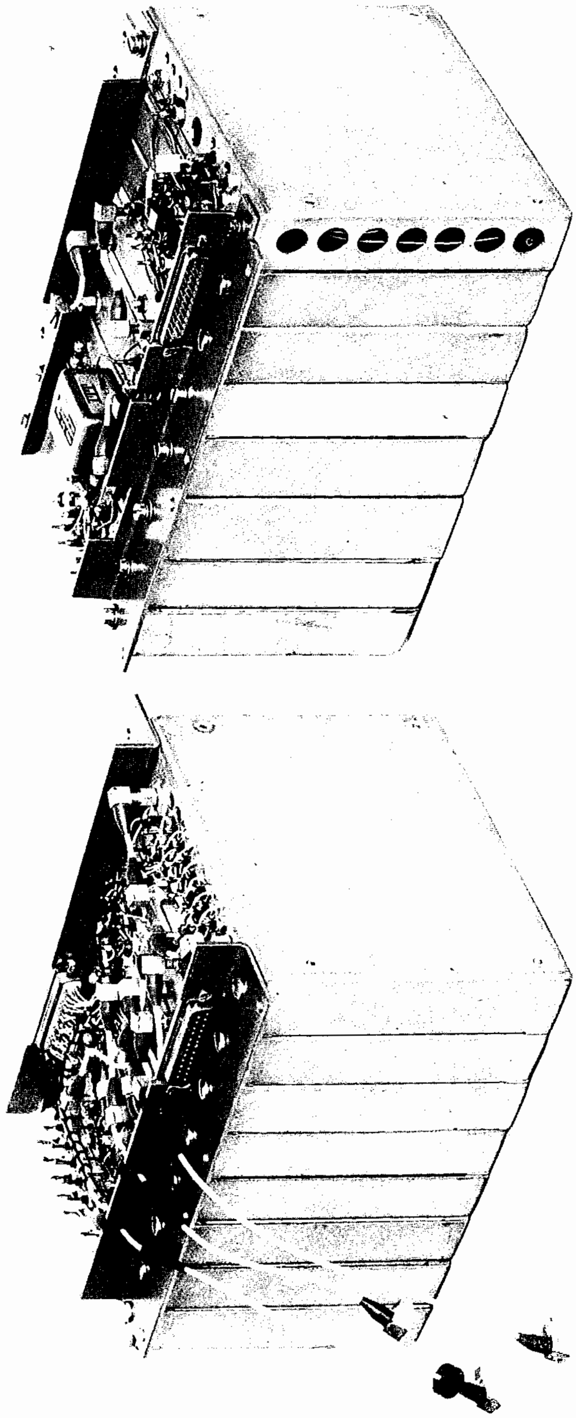
Photo 209



RECEIVER CR 302 A
Top view

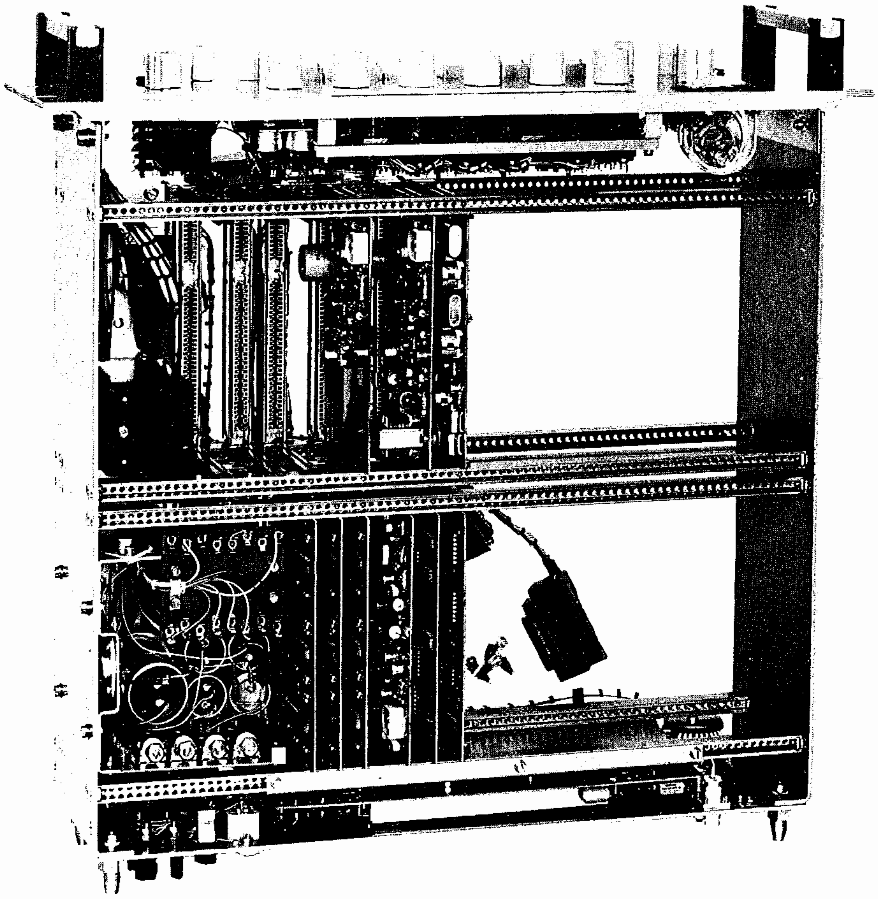


RECEIVER CR 302 A
Bottom view

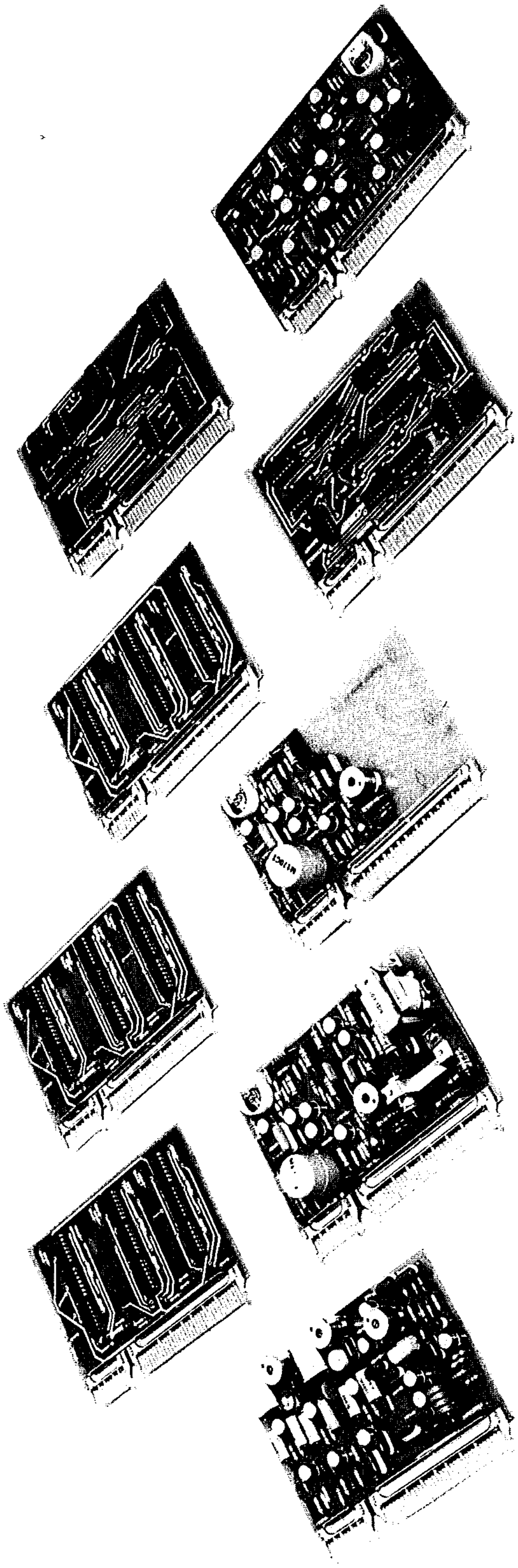


RECEIVER CR 302 A

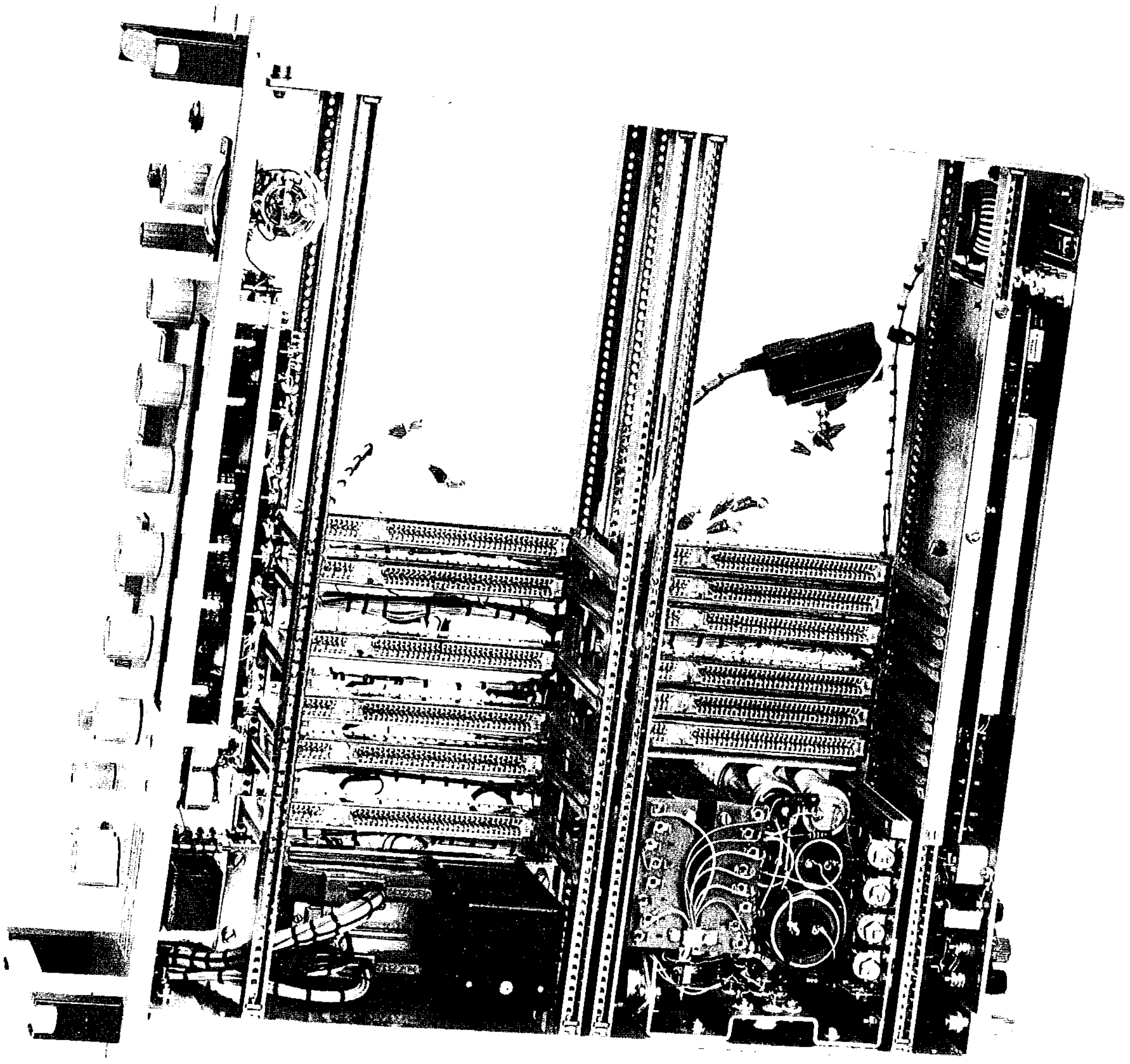
Synthesizer (left)
Receiver unit (right)



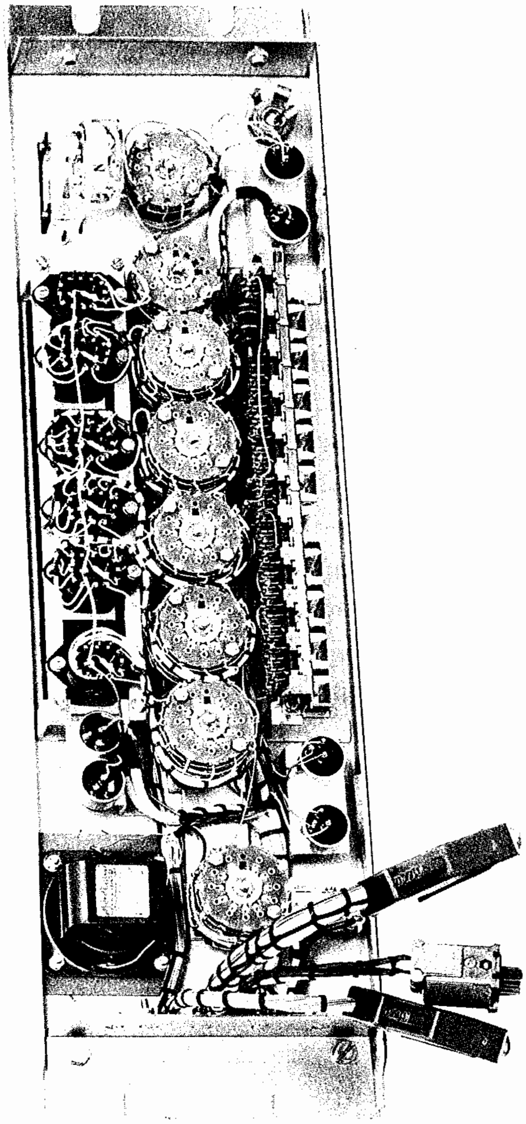
RECEIVER CR 302 A
Synthesizer and receiver unit removed



RECEIVER CR 302 A
Plug-in PC boards

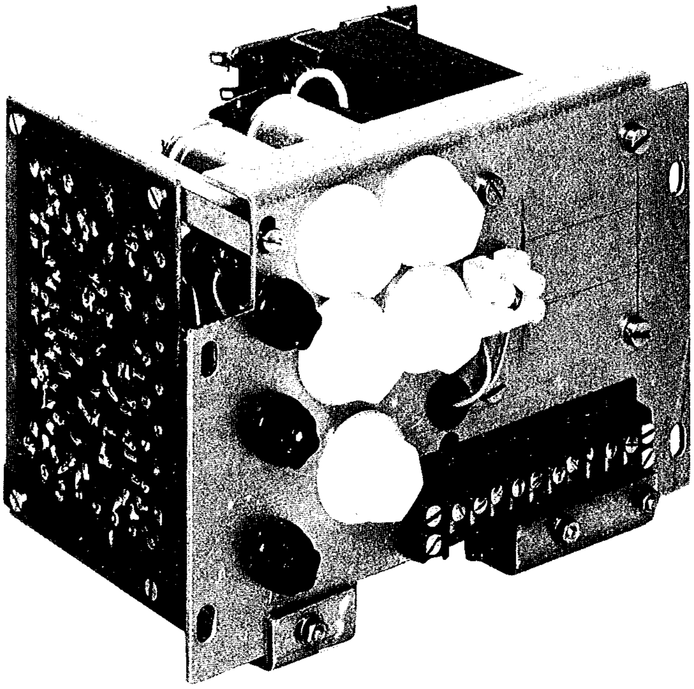


RECEIVER CR 302 A
Plug-in boards, synthesizer and receiver unit removed



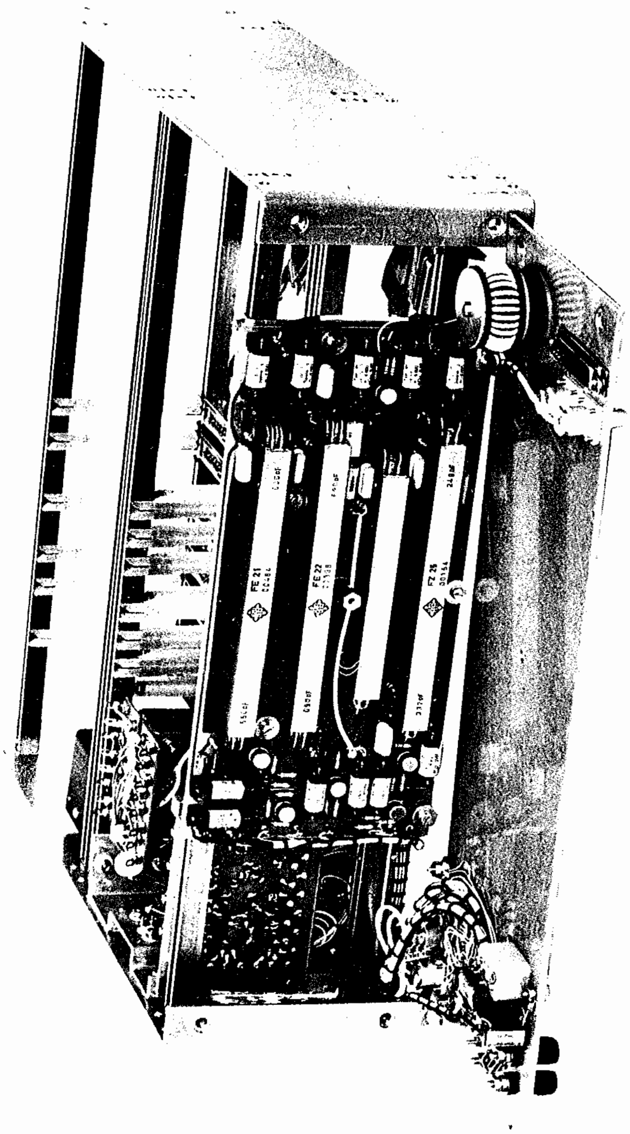
RECEIVER CR 302 A

Front Panel
Rear view



RECEIVER CR 302 A
Power Supply

Photo 208



RECEIVER CR 302 A

Back Panel tilted showing 3rd IF filter PC-board