MANUAL 2275

AP 2000 MOBILE

2M 25W

Intermitt. use

Simplex S.C.

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Technical Data AP 2000 Series 2 m.

General:

The equipment is homologated in several countries where the technical requirements are based on the CEPT Recommendation T/R 17.

Frequency range:	146 - 174 MHZ
Principle:	Digital frequency synthesizer
Number of channels:	Max. 80
Channel spacing:	25 kHz or 20 kHz
RF-bandwidth:	typ. 2 MHz at 1 dB reduction
Mode of operation:	Simplex, semi-duplex and duplex
Supply voltage:	12 V DC chassis negative - nom. 13,2V. DC-DC converter available for 6V, 24V and 12V chassis positive operation. A 220V AC supply is available too.
Supply voltage variations:	10,8V to 15,6V
Operation Temperature:	- 25°C to + 60°C
Frequency stability:	typ. ± 10 ppm for the above specified temperature and supply voltage variations
Loudspeaker:	External 4Ω
Microphone:	1 kΩ condenser microphone or 200Ω dynamic close talk microphone with push-button
Antenna impedance:	50Ω
Power consumption:	At 13,2 V reception approx. 0,25 A transmission {25W approx. 5,5A { 6W " 2,0A

Receiver:

Sensitivity:	typ. 0,4µV (½ E.M.F.) for 20 dB SINAD.
Adjacent channel sensitivity:	typ. 75 dB (CEPT Method)
Spurious and image rejection:	typ. 80 dB (CEPT Method)
Intermodulation attenuation:	typ. 71 dB (CEPT Method)
Undesired conducted power:	typ. 0,5 nW
Deemphasis:	Following 6dB per octave curve from 0,3 to 3 KHz within +1-3dB relative level at 1000 Hz

Audio output power:	3 Watts into 4 Ω at 10 per cent distortion, 13,2V supply voltage
Output for microtelephone:	1mW in 300Ω
Hum and noise:	Typ. 50 dB (CEPT Method)
Function of limiter:	Less than 1dB variation in output voltage for RF-input levels between 1µV and 100 mV EMF
Transmitter:	
Power output:	without external PA: 6W± 0,5 dB from ϑ 25°C to + 60°C and supply voltages between 10,8V and 15,6V
	with external PA: 25W + 0dB ϑ 2dB from ϑ 25°C to + 60°C and supply voltages between 10,8V and 15,6V
Spurious outputs and harmonics:	typ. each less than 2µW into 50Ω
Adjacent channel power:	typ. 85dB below the output power
Frequency deviation:	max. ± 5 kHz
Preemphasis:	Following 6dB per octave curve from 0,3 to 3 kHz within +1-3dB relative level at 1000 Hz
Harmonic distortion:	typ. 1 per cent at ± 3kHz deviation and 1000 Hz modulation frequency
Hum and noise:	typ. 50 dB relative ± 3kHz deviation and 1000 Hz modulation frequency (CEPT Method)

Technical description for AP 2ooo

RECEIVER (Fig. 1)

Aerial switch (75011-4E2)

The aerial switch is made by a relay, while C1, TR1 and D1 makes a forward power sensing circuit for the transmitter. (In a duplex set, the relay is not mounted).

RF-amplifier and 1st mixer (75o15-4E2)

The RF amplifier consists of a Dual-gate Mos-transistor with several tuned circuits to give the necessary selectivity. The first mixer converts the RF-signal 147 - 174 Mc to 21,4 Mc with an oscillator injection of 168,4 - 195,4 Mc on gate 2. Matching of the mixer output impedance to the crystal filter is made by the turned circuit L 6.

21,4 Mc and 455 kc IF (75o76-3E2)

The 21,4 Mc crystal filter is followed by a dual-gate Mos-amplifier which gives approximately 2o dB gain. This stage is followed by the second mixer which converts 21,4 Mc to the low IF 455 kc. The second mixer consists of an integrated doublebalanced transistor mixer, in which one section is used as the crystal oscillator. An emitter follower with some RC low-pass sections feeds the signal to IC 2, which is an integrated high gain amplifier/limiter and quadrature detector. The coil L 4 is the detector phase shift network. AF output is supplied by the emitter follower Q 3.

AF-amplifier, squelch and key circuit (75o17-3E2)

The AF-signal goes through an amplifier stage Q 6 to the volume control circuit. Here, the diodes D 1, D 2 and D 3 act as an

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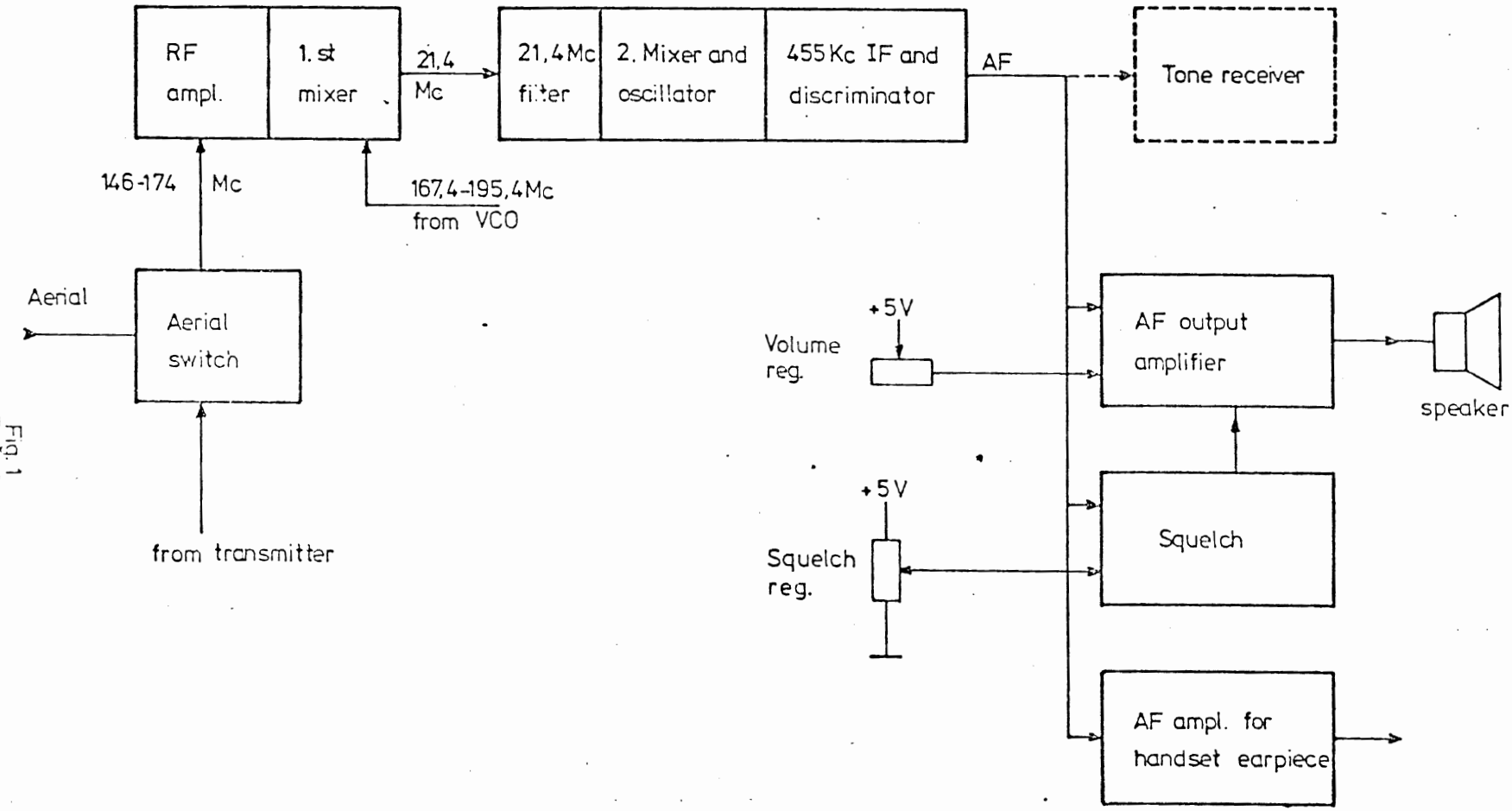

Fig. 1

electronic attenuator regulated by the diode current. This circuit is also used for external AF-blocking and squelch. An integrated AF output amplifier is used for the 3 W loud-speaker output and here the feedback-capacitors C 6 and C 7 produce the deemphasis.

For the handset earpiece Q 4 and Q 5 makes an amplifier while D 15 is for blocking . The squelch circuit consists of an 8 kc tuned amplifier Q 3 followed by a detector D 11 and D 12. With increasing noise level on the AF-input the voltage on the negative side on C 19 will decrease from + 5 V. Getting lower than the squelch reg. voltage on point 7, the amplifier IC 2 switches over to an output voltage of + 5 V and thus blocking the AF-output through the volume control circuit.

In the key control circuit Q 1 and Q 2 goes ON when the button in the handset connects point 11 to chassis, thus producing + 12 V on point 14. A positive voltage applied on point 10 will inhibit this function.

TRANSMITTER (Fig. 2)

Transmitter mixer and amplifier (75014-4E2)

Because the VCO has a frequency 21,4 Mc higher than the operating RX-frequency this signal is fed to the transmitter mixer and converted to the desired transmitting frequency. For simplex operation the necessary 21,4 Mc signal comes from a combined crystal oscillator/doubler. Thus the crystal will be 10,7 Mc. For good suppression of VCO - and 21,4 Mc injection the TX-mixer is a balanced diode type. The three amplifier stages Q 1, Q 2 and Q 3 give further suppression of unwanted sidebands and the necessary amplification to reach an output of approx. 150 mW.

25W PA-stage 76307-4E2

The output from the 25 W PA-stage consisting of Q1, Q2 and Q3 goes through a forward powersensing circuit to the aerial switch. (75011-4E2)

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AP-RADIOTELEFON A/S

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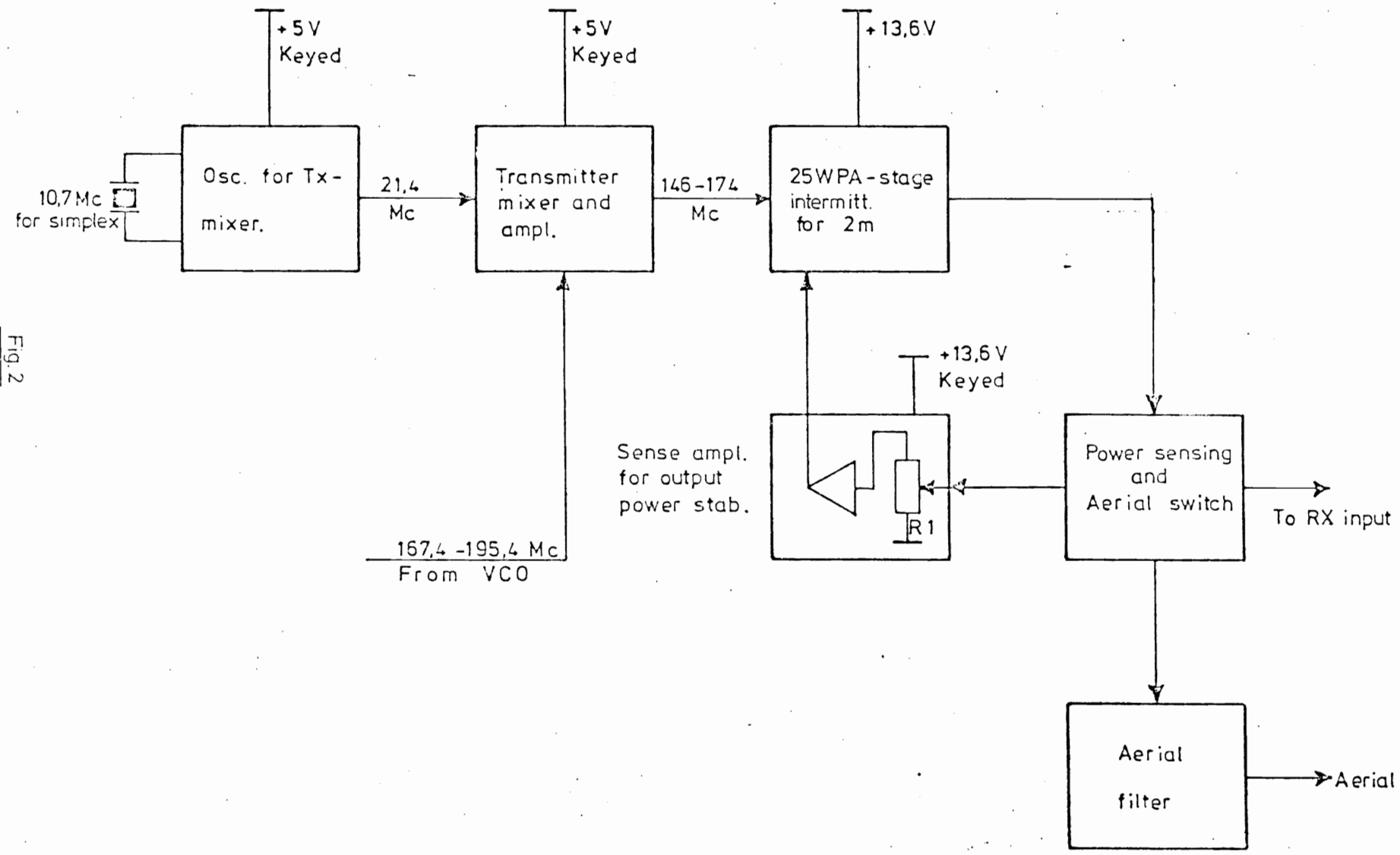


Fig. 2

Output power stabilizing 75622-4E2

From the power-sensing circuit a DC voltage proportional to the forward power is led to an amplifier. Here it is compared to a zener-voltage, and if it is greater than this threshold level, the amplifier IC 1 will give less base-current for Q 1, and thus reduce the voltage for driver transistor Q 1.
This will act in the following manner:
For low supply voltages (~ 11 V) the output power will increase with increasing supply voltage, and when the output reaches 25 W it will be constant for further increase in supply voltage. The output level for supply voltage greater than approx. 13 V is adjustable with R 1. Note that the oscillator for TX-mixer, the transmitter mixer and amplifier, and sense amplifier have keyed supply lines, while the last 2 transistors in the 25 W stage are supplied independent of the key.

Aerial filter (75o16-4E2)

The aerial filter is a low-pass filter for suppression of the harmonics from the transmitter.

Modulation amplifier (75o18-3E2)

The modulation amplifier has a preamplifier Q 1 for the most sensitive input (input 1). Using the less sensitive input 2, the Mic. switch terminal shall have + 5 V so that Q 1 will be blocked via D 3 and D 4 will be conducting for the input signal to IC 1. For selective tone transmission the tone TX input is used while Q 1 is blocked via D 2. D 5 is used for blocking of the modulation amplifier while receiving in simplex mode. IC 1 and the first part of IC 2 work as a compressor/amplifier to limit the maximum output AF-voltage. When using a variable gain type amplifier as IC 1 it is possible to avoid the distortion for high AF-levels, which occurs in a conventional clipper-circuit. The other amplifier in IC 2 is used as a 3 kc active low-pass filter. A tuning diode in the VCO is used for modulation.

FREQUENCY SYNTHESIZER CIRCUIT 2M

Basic phase lock loop operation

A simple phase locked loop consists of 3 elements, a phase comparator, a filter and the VCO (Fig. 1).

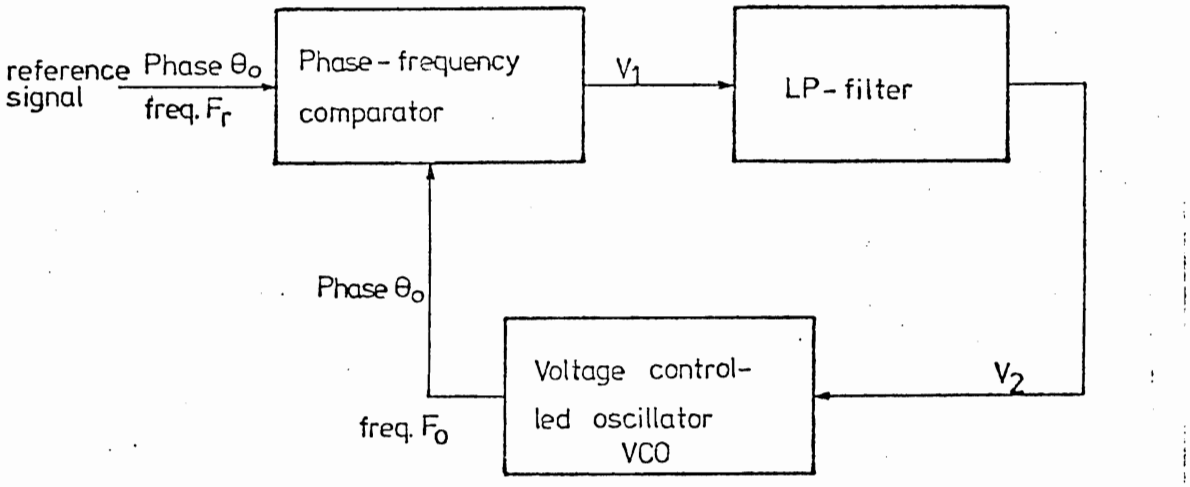


Fig. 1 Basic phase locked loop.

Phase-frequency comparator

If the VCO-frequency $F_o = F_r$, the comparator gives out a DC-level proportional to the phase difference between F_o and F_r (Fig. 2). We have $V_1 = K_1 \times (\theta_r - \theta_o)$ where K_1 is a constant. When there is a frequency difference between F_o and F_r, V_1 will be low for F_o greater than F_r and high for F_o less than F_r.

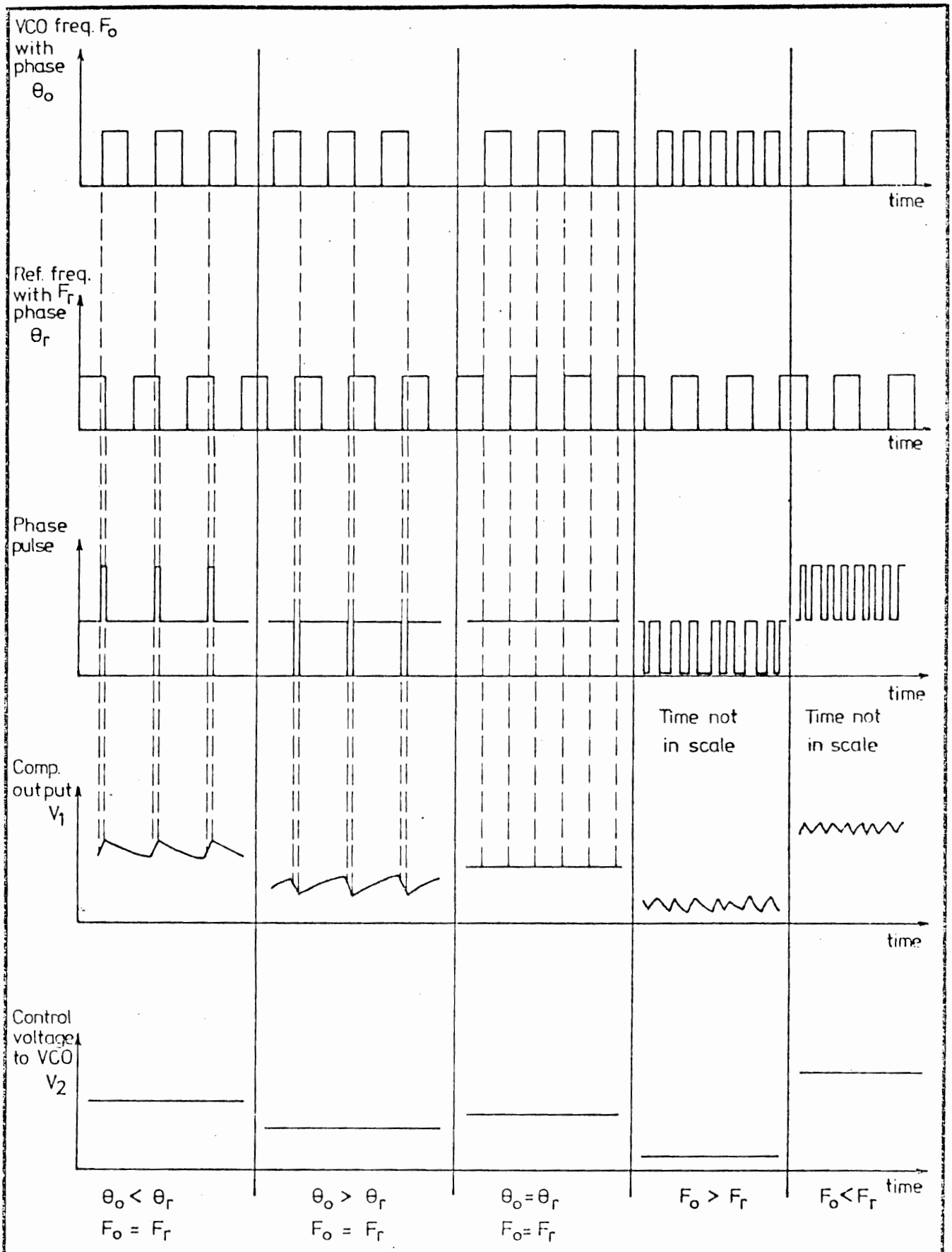
Voltage controlled oscillator

This can be a LC-oscillator whose frequency is controlled with a varicap. $F_o = K_2 \times V_1$ where K_2 is a constant.

LP-filter

This filter removes the ripple on V_1 (Fig. 2) and determines the dynamic behaviour (stability, step response) of the loop.

Let us consider a situation where the loop is out of lock and



SIMPLIFIED OPERATION of frequency and phase comparator.

Fig. 2

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F_o is greater than F_r. The comparator output voltage V_1 will contain the normal ripple with frequency F_r and a beat note, but the mean DC level (= V_2 after the filter) will be low (Fig. 4). Thus the VCO frequency will decrease and at the time F_o reaches F_r the loop will go in lock. Now $F_o = F_r$ and the phase difference will assume a level for V_2 sufficient to hold the VCO frequency in lock with F_r. If the tuning of the VCO is changed (such as by varying the value of the tuning capacitor) the frequency F_o from the VCO will attempt to change. This will result in a change in phase angle between F_o and F_r, resulting in a change in DC-level of V_1 which will act to maintain frequency lock. In this way tuning of the VCO will change the ripple and the DC-level on V_1 but as long as lock is maintained F_o will be equal F_r.

A multichannel synthesizer (Fig. 3)

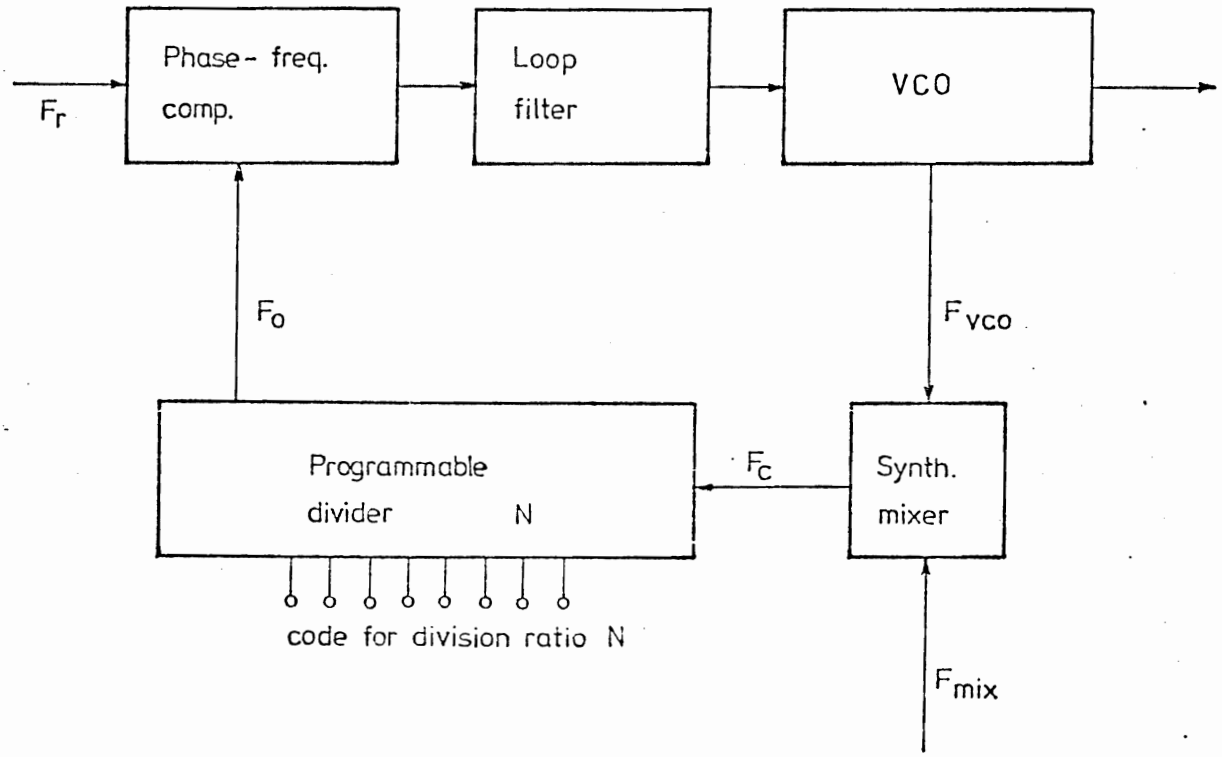

Fig. 3 Synthesizer loop

To build a multichannel synthesizer we have to add some more components (Fig. 3) but the basic function is the same. Here the VCO frequency is converted to a lower frequency F_c suitable

for the digital divider. $F_c = F_{vco} - F_{mix}$ (1). When the loop is in lock the incoming frequencies F_r and F_o are equal, but they can have a phase difference. $F_o = F_r$ (2). The programmable divider divides frequency F_c with a number N, which can be selected by a binary code. $F_c = N \times F_o$ (3).

Combining equations (1), (2) and (3) give

$$F_{vco} = F_{mix} + N \times F_r \quad (4).$$

By changing the division ratio N we can get a lot of VCO-frequencies with the spacing F_r, and the stability depends only on F_{mix} and F_r which can be crystal oscillators.

The synthesizer circuit in AP 2000 (Fig. 4)

Synthesizer logic (75o62-3E2)

The 25 kc reference frequency is produced by dividing a 400 kc crystal oscillator (X 1 and Q 4) by 16 in the counter IC 6.

The input signal to the programmable divider is amplified in Q 1 and Q 2, while the two gates from IC 1 shape the waveform to narrow pulses. IC 2 and IC 3 form the programmable divider, where the division ratio N is the Binary number on the eight channel code lines. The numbers on the code lines correspond to the binary value of each line. In this way a division ratio N = 168 will have a channel code:

Number on code line	128	64	32	16	8	4	2	1
Binary value	128	64	32	16	8	4	2	1
Code for N = 168	1	0	1	0	1	0	0	0

where 0 means 0V and 1 means + 5 V.

The two cascaded counters IC 2 and IC 3 count down from 168. When the counters reach zero a borrow pulse is generated and used to preset the number 168, thus starting a new count cycle. The very narrow borrow pulses with a repetition rate of 25 kc are used as input to the frequency-phase comparator IC 4. The comparator output voltage V_1 can be seen on a test point TP 1. To suppress the 25 kc ripple on the comparator output voltage Q 3 is connected as an active lowpass filter. IC 5 is for DC-amplification.

Fig. 4

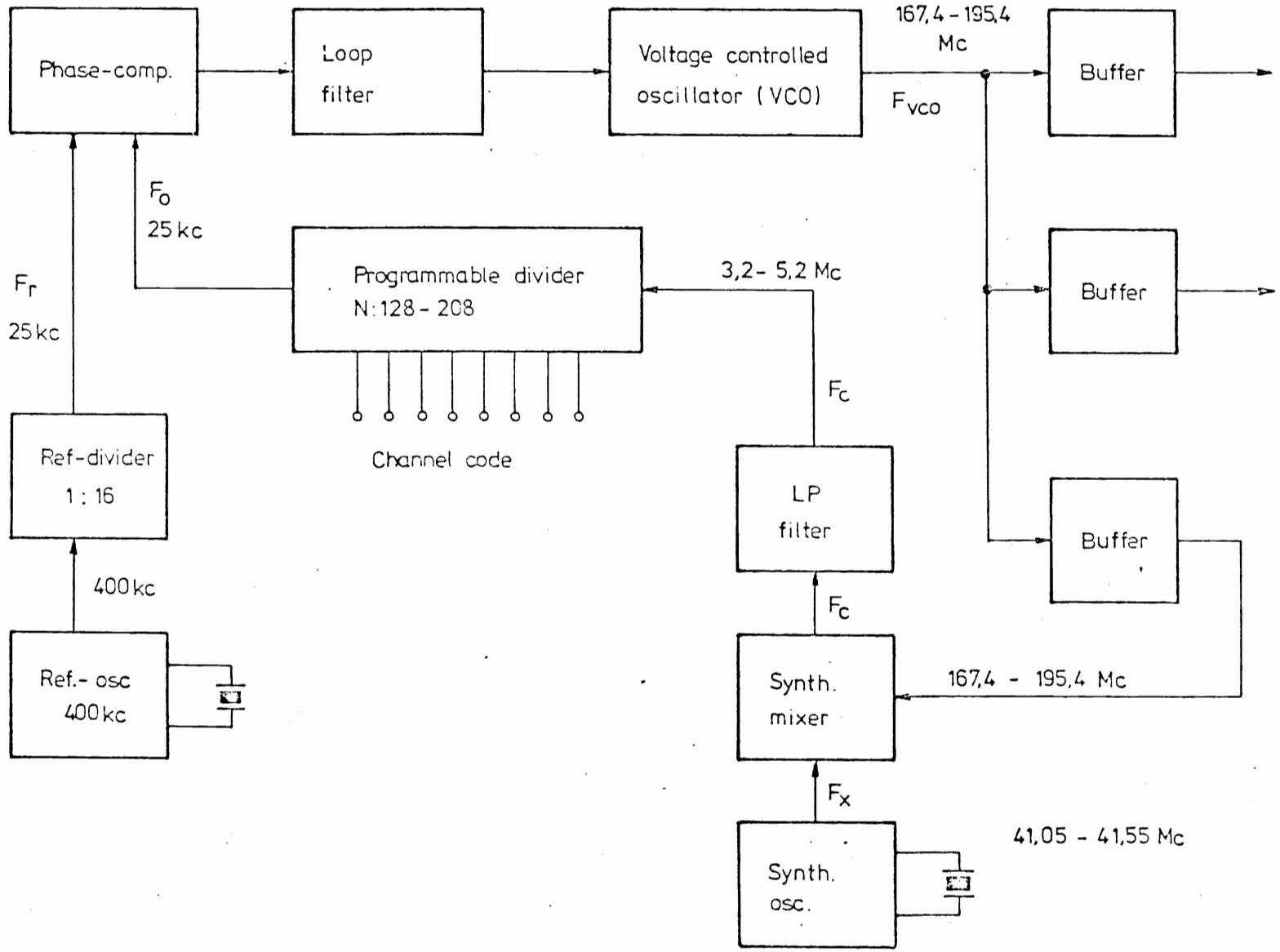

Figure for synthesizer description

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Voltage controlled oscillator (75o82-3E2)

The transistor Q 1 is used to switch between two loop filters. When Q 1 is 'ON' the slow filter R 1, R 3 and C 2 are in function while R 1, R 2 and C 1 give the loop a fast step response for Q 1 'OFF'. The fast loop filter is only used in connection with automatic channel scanning. Diode D 1 is used to clamp the control voltage thus preventing too great VCO frequency excursions when the loop is out of lock. The frequency of oscillator Q 2 is controlled by tuning diode D 2 while diode D 3 is for modulation. Transistors Q 3 to Q 7 make the three output buffers with ferrite core transformers L 3 to L 5.

Synthesizer mixer (75o19-3E2)

In the synthesizer mixer Q 1 is a 4o Mc oscillator with third overtone crystal X 1. This frequency is fed via L 1 to the mixer transistor Q 2. The VCO-signal goes through the dual gate Mos-transistor buffer Q 4 which gives high backward isolation but no amplification. Reaching the base of Q 2 the VCO-signal is mixed with the fourth harmonic of the 40 Mc to give an output signal of 3,2 - 5,2 Mc. DR 1 and DR 2 are part of a 10 Mc low-pass filter connected to the amplifier stage Q 3.

Channel coue

From the blockschematic of the Synthesizer circuit (Fig. 4) we have:

$$F_{vco} = 4\ F_x + N \times 0{,}025\ \text{Mc} \quad \text{where } 128 < N < 208.$$

The VCO frequency lies 21,4 Mc above the receiver frequency leading to:

$$\text{Receiver frequency } F_{Rx} = 4\ F_x + N \times 0{,}025 - 21{,}4\ \text{Mc} \quad (5).$$

Here N is the division ratio and F_x is the synthesizer mixer crystal.

1. Computation of the receiver frequency:

Known is: Crystal frequency F_x and channel code.

Example: F_x = 42,05 Mc

Code: 1 0 0 1 0 0 1 1

Division ratio N = 128 + 16 + 2 + 1 = 147

Using equation (5):

F_{Rx} = 4 x 42,05 +(147 x 0,025)- 21,4 = 150,475 Mc.

2. Computation of the channel code:

Known is: Crystal frequency F_x and desired receiver frequency F_m.

Rearranging equation (5) gives

$$N = \frac{F_{Rx} - 4\,F_x + 21{,}4}{0{,}025}$$

Example: F_x = 42,05 Mc, F_{Rx}= 151,625 Mc.

N = (151,625 - 4 x 42,05 + 21,4)/0,025 = 193

N = 128 + 64 + 0 + 0 + 0 + 0 + 0 + 1

Channel code 1 1 0 0 0 0 0 1

DIVISION RATIO AND CHANNELCODE

The division ratio N corresponds to the 8 - bit channel code in this way.

Bit number	8	7	6	5	4	3	2	1
Value of each bit	128	64	32	16	8	4	2	1
Example: channel code =	1	1	0	0	0	0	0	1
N = 193	= 128+	64	+ 0	+ 0+	0+	0+	0+	1

Logic 1 = +5 Volts. Logic 0 = 0 Volts

Div. ratio	Channel code							
N	128	64	32	16	8	4	2	1
128	1	0	0	0	0	0	0	0
129	1	0	0	0	0	0	0	1
130	1	0	0	0	0	0	1	0
131	1	0	0	0	0	0	1	1
132	1	0	0	0	0	1	0	0
133	1	0	0	0	0	1	0	1
134	1	0	0	0	0	1	1	0
135	1	0	0	0	0	1	1	1
136	1	0	0	0	1	0	0	0
137	1	0	0	0	1	0	0	1
138	1	0	0	0	1	0	1	0
139	1	0	0	0	1	0	1	1
140	1	0	0	0	1	1	0	0
141	1	0	0	0	1	1	0	1
142	1	0	0	0	1	1	1	0
143	1	0	0	0	1	1	1	1
144	1	0	0	1	0	0	0	0
145	1	0	0	1	0	0	0	1
146	1	0	0	1	0	0	1	0
147	1	0	0	1	0	0	1	1
148	1	0	0	1	0	1	0	0
149	1	0	0	1	0	1	0	1
150	1	0	0	1	0	1	1	0
151	1	0	0	1	0	1	1	1
152	1	0	0	1	1	0	0	0
153	1	0	0	1	1	0	0	1
154	1	0	0	1	1	0	1	0
155	1	0	0	1	1	0	1	1
156	1	0	0	1	1	1	0	0
157	1	0	0	1	1	1	0	1
158	1	0	0	1	1	1	1	0
159	1	0	0	1	1	1	1	1
160	1	0	1	0	0	0	0	0
161	1	0	1	0	0	0	0	1
162	1	0	1	0	0	0	1	0
163	1	0	1	0	0	0	1	1
164	1	0	1	0	0	1	0	0
165	1	0	1	0	0	1	0	1
166	1	0	1	0	0	1	1	0
167	1	0	1	0	0	1	1	1

Div. ratio	Channel code							
N	128	64	32	16	8	4	2	1
168	1	0	1	0	1	0	0	0
169	1	0	1	0	1	0	0	1
170	1	0	1	0	1	0	1	0
171	1	0	1	0	1	0	1	1
172	1	0	1	0	1	1	0	0
173	1	0	1	0	1	1	0	1
174	1	0	1	0	1	1	1	0
175	1	0	1	0	1	1	1	1
176	1	0	1	1	0	0	0	0
177	1	0	1	1	0	0	0	1
178	1	0	1	1	0	0	1	0
179	1	0	1	1	0	0	1	1
180	1	0	1	1	0	1	0	0
181	1	0	1	1	0	1	0	1
182	1	0	1	1	0	1	1	0
183	1	0	1	1	0	1	1	1
184	1	0	1	1	1	0	0	0
185	1	0	1	1	1	0	0	1
186	1	0	1	1	1	0	1	0
187	1	0	1	1	1	0	1	1
188	1	0	1	1	1	1	0	0
189	1	0	1	1	1	1	0	1
190	1	0	1	1	1	1	1	0
191	1	0	1	1	1	1	1	1
192	1	1	0	0	0	0	0	0
193	1	1	0	0	0	0	0	1
194	1	1	0	0	0	0	1	0
195	1	1	0	0	0	0	1	1
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202	1	1	0	0	1	0	1	0
203	1	1	0	0	1	0	1	1
204	1	1	0	0	1	1	0	0
205	1	1	0	0	1	1	0	1
206	1	1	0	0	1	1	1	0
207	1	1	0	0	1	1	1	1
208	1	1	0	1	0	0	0	0

Tuning instructions for AP 2000, 2 m

1. Tuning of the synthesizer circuit

A. Synthesizer oscillator

Connect a high input resistance DC-voltmeter to TP 1 on print board B 11. By tuning coil L 1 to max. a reading of approx. 3 V should be obtained. The coil L 2 is later used for frequency adjustment.

B. Phase locked loop

If the set contains more than one channel, turn the channel selector to a channel with frequency in the middle of the used band. Check the channel code with a voltmeter on points 1, 2 ..... 64, 128 on print board B 17. Computation of the channel code is contained in the technical description of the synthesizer circuit. Note that there are two types of VCO, one for the range 146-160 Mc and the other for RX-frequencies 160 - 174 Mc, and check that the right type is used for the desired frequency range. The marking is noted on the VCO-diagram. Connect the voltmeter to point 1 on the VCO print board and an oscilloscope (sensitivity 1 V/div.) to test point TP 1 on the logic print (print board B 17). Adjust the VCO trimmer until the loop goes in lock. The loop is in lock when a stable 25 kc ripple sawtooth is appearing on the scope, and the voltage on the voltmeter increases while turning the VCO trimmer clockwise. Adjust the VCO so that the loop voltage is 3 V. This loop voltage corresponds to min. 25 kc ripple on TP 1. For multi-channel sets, turn the channel selector to the lowest and highest frequency and check that the loop still goes in lock. Considering a set with the max. possible bandwidth 2 Mc, the loop voltage shall lie between 2 and 4 V going fro the lowest channel to the highest in such a manner that

increasing voltage corresponds to increasing frequency.

C. RX-frequency

Select the mid-frequency channel and connect a 200 Mc counter to the VCO-output point 5. The reading will be RX frequency + 21,4 Mc and for fine tuning of the RX-frequency, use coil L 2 on synthesizer mixer print board B 11.

2. Tuning of the receiver

A. 21,4 Mc and 455 kc IF (print board B 01)

Connect a 21,4 Mc sweep generator (a 10,7 Mc sweep generator normally contains sufficient second harmonics to be used on 21,4 Mc) to point TP 1 on the RF and mixer print board B 08 and the (DC) probe on point TP 1 on the IF print board B 01. Adjust L 6 (print B 08) and L 1 (print B 01) for minimum ripple. L 2 is tuned to max. amplitude while L 3 is tuned to best possible symmetry. Use the lowest possible input level to prevent limiting in the second mixer. Connect the probe to the AF output from the detector (a suitable point is pin 1 on the ampl. print B 09) and adjust L 4 in the IF to max. discriminator slope and the best linearity.

B. RF amplifier and mixer (print Board B 08)

With the voltmeter on TP 2 (print board B 08) C 17 and C 18 are adjusted to max. deflection (approx. 1 V DC). With the signal generator connected to the receiver input C 2, C 3, C 6, C 9 and C 10 are now tuned to give optimum sensitivity.

C. AF-amplifier, squelch and key circuit (print board B 09)

Adjust the output level for the handset earpiece to 60 mV with potmeter R 31. (3,5 kc dev., 1 kc modulation.)

Alternative method for tuning of Rx front IF without a sweep generator

Adjust C 17 and C 18 as desired under 'B'. Connect the RF-signal generator output to TP 1 in the RF-amplifier and use the horizontal deflection voltage from an oscilloscope for modulation (FM) of the generator. Now the IF can be tuned as previously described. By connecting the signal generator output to the aerial input, all the capacitors in the RF-amplifier and mixer can be tuned to max. deflection with the probe on TP 1 in the IF amplifier.

3. Tuning of the transmitter

A. Transmitter mixer and amplifier (print board B 07)

The transmitter shall be keyed. The oscillator injection to the transmitter mixer is tuned with L i (print B 07) to max. DC-voltage on TP 1. Turn the capacitors C 2, C 6, C 11, C 13 and C 18 to max. capacitance. Connect the voltmeter to the can of transistor Q 2 (can is connected to emitter) and tune C 2 and C 6 to max. reading. Remove the cable from the transmitter-amplifier output (pin 4) and replace it with a wattmeter (50 ohms, range 1 W). Now tune C 11, C 13 and C 18 and readjust C 2 and C 6 to get max. output power (approx. 150 mW). When X-tal = 10,7 MHz, C24 is removed. When X-tal > 10,7 MHz, C22 is removed. When X-tal < 10,7 MHz, both capacitor are used.

B. 25 W PA-stage (B 79)

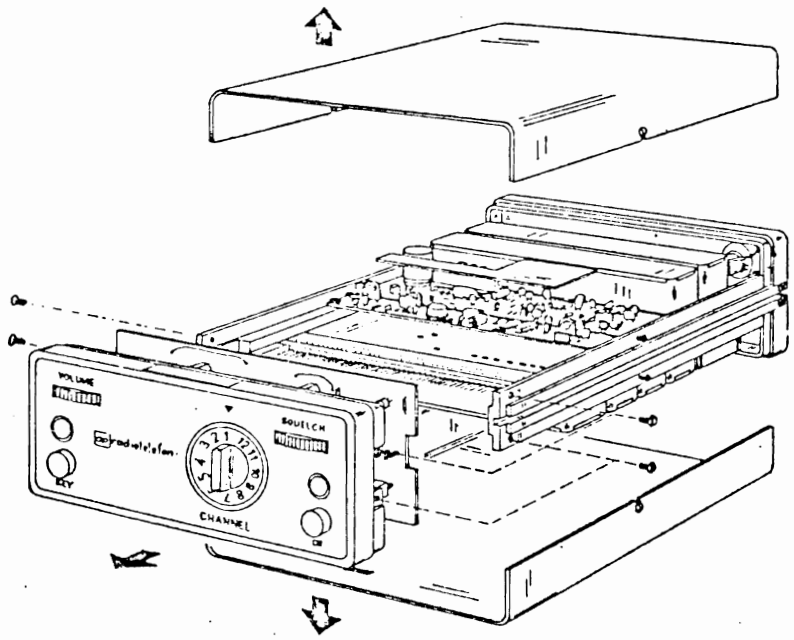
Turn the potmeter R 1 (print board B 57) counter-clockwise to get the output power stabilization out of function. Connect a wattmeter (50 Ω, 10 or 50 W) to the test installation output and set the supply voltage to 12,0 V. Now tune all the trimmers in the PA-stage to max. output power and finish with a fine adjustment of C 18 on the transmitter amplifier print B 07. Increase the supply voltage to 13,6V and turn the potmeter R 1 clockwise until the output power decreases to the desired value.

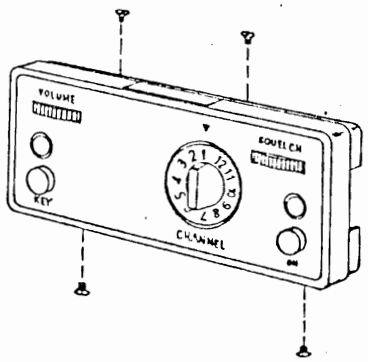
C. Transmitter frequency

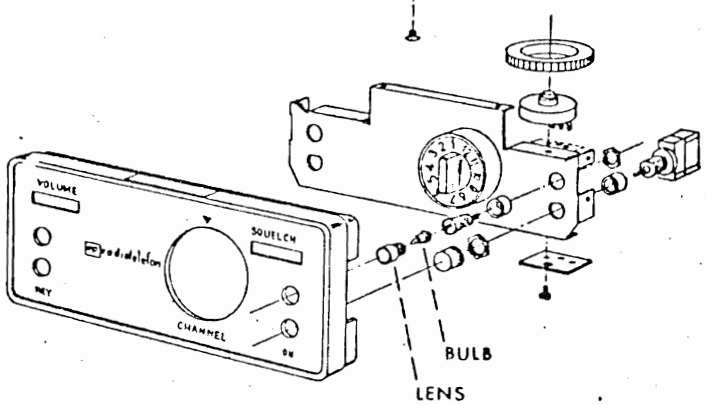
Connect a counter to the wattmeter and adjust the transmitter frequency with the capacitor C 29 in the Tx-oscillator print board B 11.

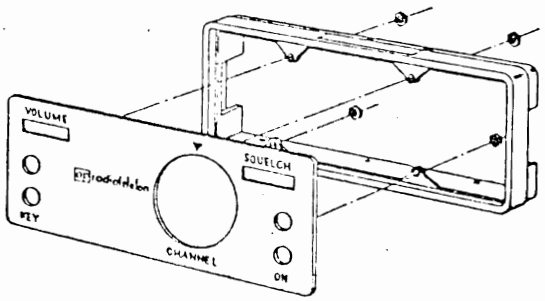
D. Modulation amplifier (print board B 10)

Connect a modulation meter to the transmitter and a tone generator to the microphone input 1. The generator must have a low output impedance. Turn the 3 potentiometers to centre position and set the generator to 1000 Hz. With an input level of 20 mV, potmeter R 27 is adjusted to give $\pm$ 5 kHz deviation on the modulation meter. Decrease the input level to 2mV and adjust potmeter R 3 to a deviation of $\pm$ 3 kHz. Repeat the procedure to check and fine adjust R 27 and R 3 if necessary. If the station is equipped with a handset, R 27 is adjusted to $\pm$ 5 kHz with an input level (1000 Hz) of 4 V. When the level is decreased to 400 mV R 28 is set to give a deviation of $\pm$ 3 kHz.

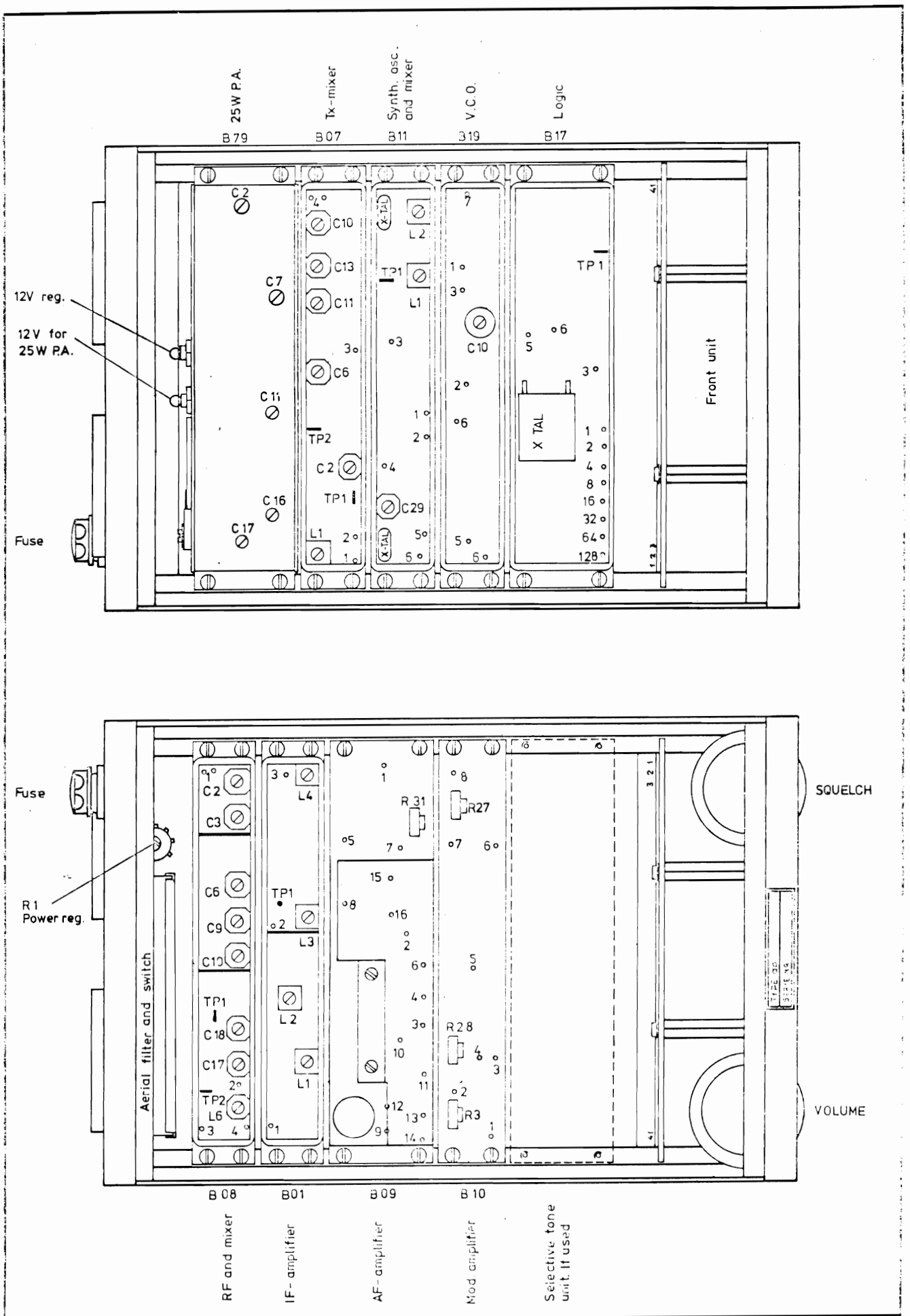








Rettet: 29-11-76 H.J.	Disassembling of AP 2000	Tegn.: 10-8-76 AC	Kontr.:
		Stykl. nr.:	
	AP-RADIOTELEFON A/S	Tegn. nr.: .76218 - 4M2	



Rettet:

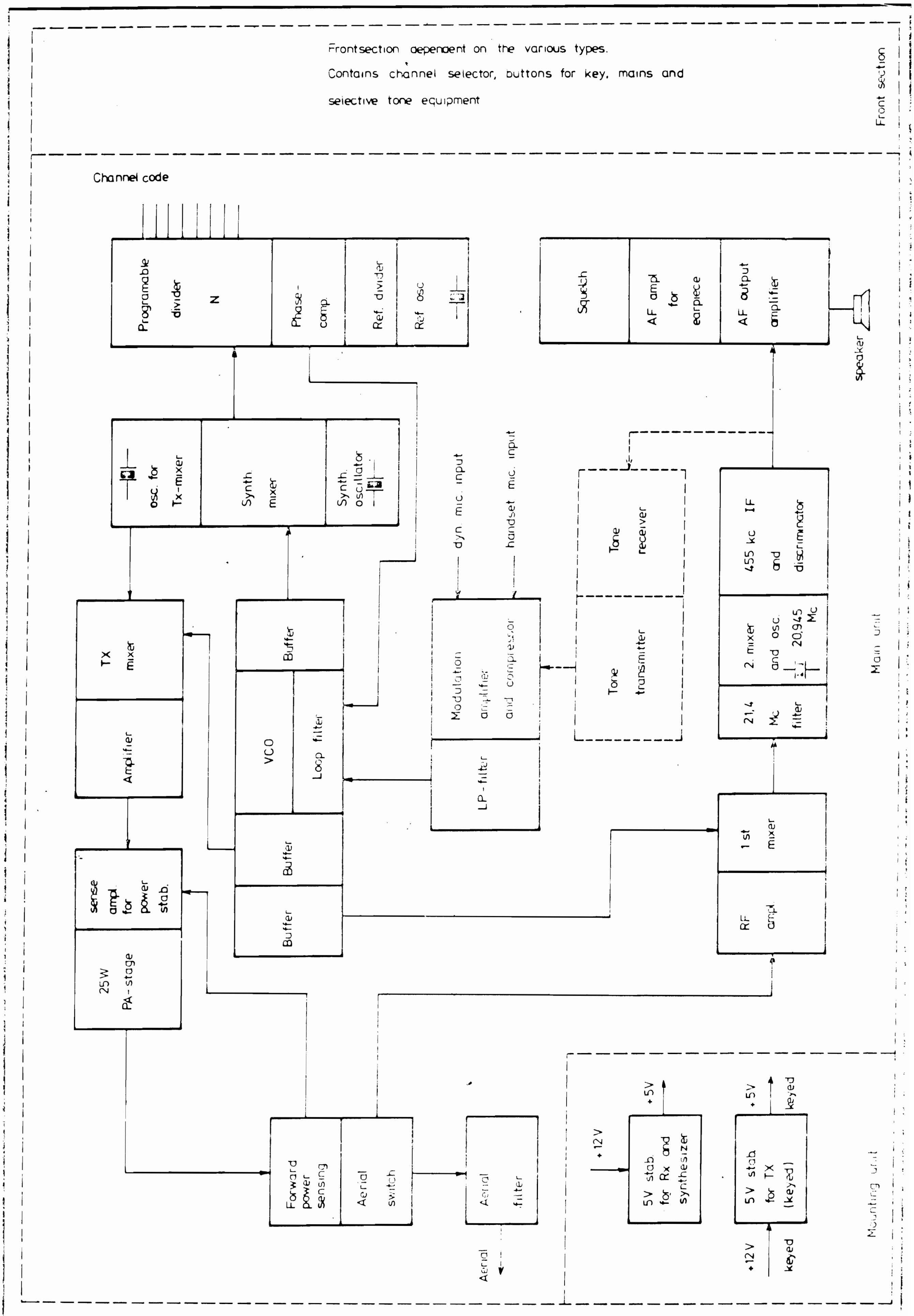
Interior view of AP2000, 25 W intermitt. 2m band Part no. 201-036

AP-RADIOTELEFON

Tegn. 19-11-76 Kontr.: NC LT

Stykl. nr.:

Tegn. nr.: 76358-3E2



Rettet:	Blockschematic for AP 2000 25 W intermitt. for 2 m	Tegn.: 15-5-75 AC	Kontr.:
		Stykl. nr.:	
		Tegn. nr.: 76361-3E2	

AP RADIOTELEFON

Rettet: 14-2-77 NC

AP-RADIOTELEFON A/S

Standard crystals for AP 2000 2m band
low range: 1, high: 2
For channel frequencies ending with
00, 25, 50, 75 ..... kHz

Tegn.: 16-5-75 AC

Stykl. nr.:

Kontr.:

Tegn. nr.: 75237-4E2

25 kHz Channel spacing

Synth. mixer x-tal F_x

SPECIFICATION
for Quartz Crystal Unit
AP 20

1.	Mode of operation	: 3rd overtone
2.	Holder	: HC-42/U
3.	Frequency range	: 40-48 MHz
4.	Adjustment tolerance	: ± 10 ppm at 25°C
5.	Temperature tolerance	: ± 10 ppm % 20°C to + 70°C
6.	Drive level	: 1 mW
7.	Load	: 0,5 µH
8.	Shunt capacitance (C_o)	: 5 pF max.
9.	Equivalent series resistance	: 40 Ω max.
10.	Marking	: AP 20 frequency in MHz

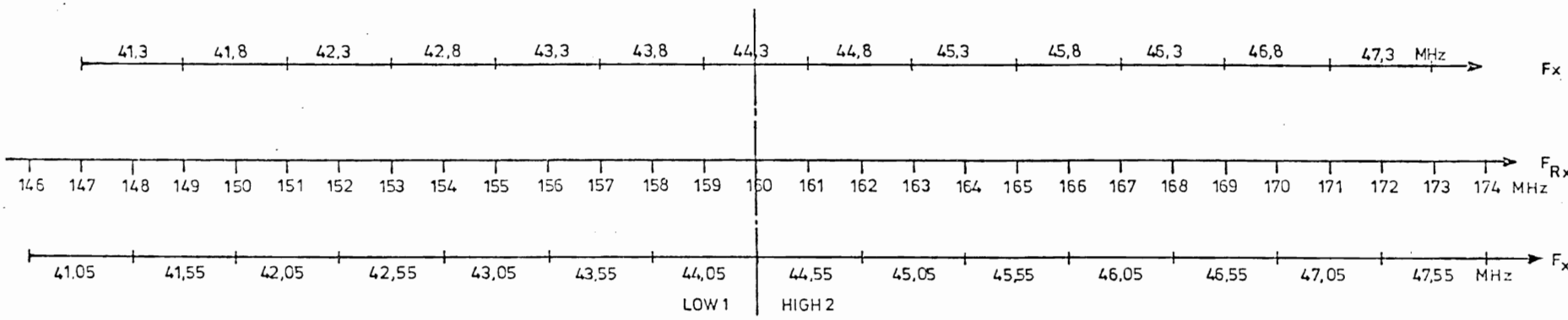
Calculation of the division ratio N

$$N = \frac{F_{Rx} - 4 F_x + 21,4}{0,025}$$

Example:

F_x = 42,05 MHz, F_{Rx} = 151,625 MHz

$$N = \frac{(151,625 - 4 \times 42,05 + 21,4)}{0,025} = 193$$



Transmitter mixer oscillator

SPECIFICATION
for Quartz Crystal Unit
AP 22

1.	Mode of operation	: AT-Fundamental
2.	Holder	: HC-42/U
3.	Frequency range	: 10-22 MHz
4.	Resonance	: Parallel (30 pF)
5.	Calibration tolerance	: ± 15 ppm at 25°C
6.	Temperature tolerance	: ± 10 ppm % 20°C to + 70°C
7.	Drive level	: 1 mW
8.	Equivalent serie resistance	: Max. 40 Ω
9.	Marking	: AP 22 frequency in MHz

Calculation of the crystal frequency for the transmitter mixer oscillator

$$F_{Tx\ mix} = 10,7 + \frac{F_{Rx} - F_{Tx}}{2}$$ Spec. AP 22

Normal mode of operation: F_{Rx} higher than or equal to F_{Tx}. However F_{Rx} can be lower than F_{Tx} if $F_{Tx} - F_{Rx}$ is less than 5 MHz.

Rettet: 14.-2-77 NC

AP-RADIOTELEFON A/S

Standard crystals for AP 2000 2m band
low range: 1, high: 2
For channel frequencies ending with
12,5, 37,5, 62,5, 87,5 ..... kHz

Tegn.: 31-1-77 AC

Stykl. nr.:

Kontr.:

Tegn. nr.: 77078-4E2

Synth. mixer x-tal F_x

SPECIFICATION
for Quartz Crystal Unit
AP 20

1.	Mode of operation	: 3rd overtone
2.	Holder	: HC-42/U
3.	Frequency range	: 40-48 MHz
4.	Adjustment tolerance	: ± 10 ppm at 25°C
5.	Temperature tolerance	: ± 10 ppm x 20°C to + 70°C
6.	Drive level	: 1 mW
7.	Load	: 0,5 µH
8.	Shunt capacitance (C_o)	: 5 pF max.
9.	Equivalent series resistance	: 40 Ω max.
10.	Marking	: AP 20 frequency in MHz

Calculation of the division ratio N

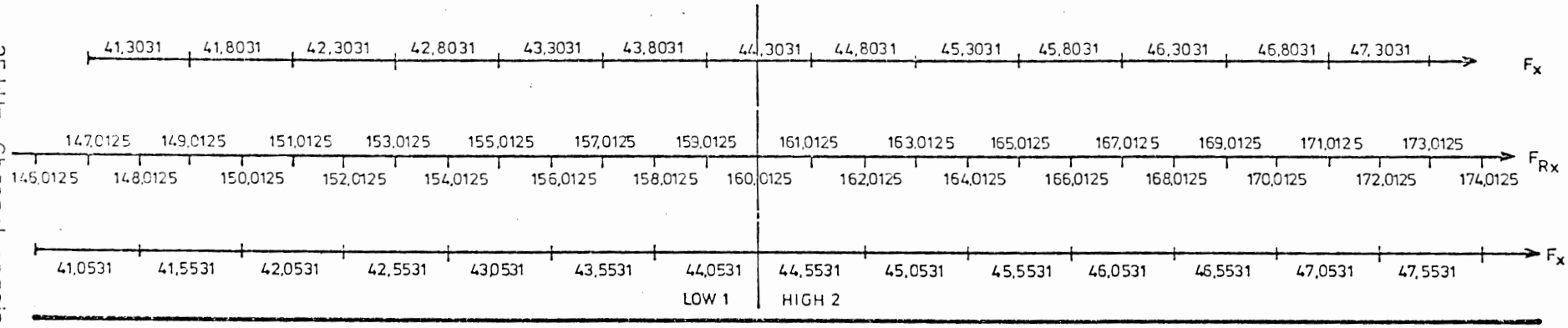
$$N = \frac{F_{Rx} - 4 F_x + 21,4}{0,025}$$

Example:

F_x = 42,0531 MHz, F_{Rx} = 151,6375

$$N = \frac{(151,6375 - 4 \times 42,0531 + 21,4)}{0,025} = 193,004$$

N = 193



Transmitter mixer osc.

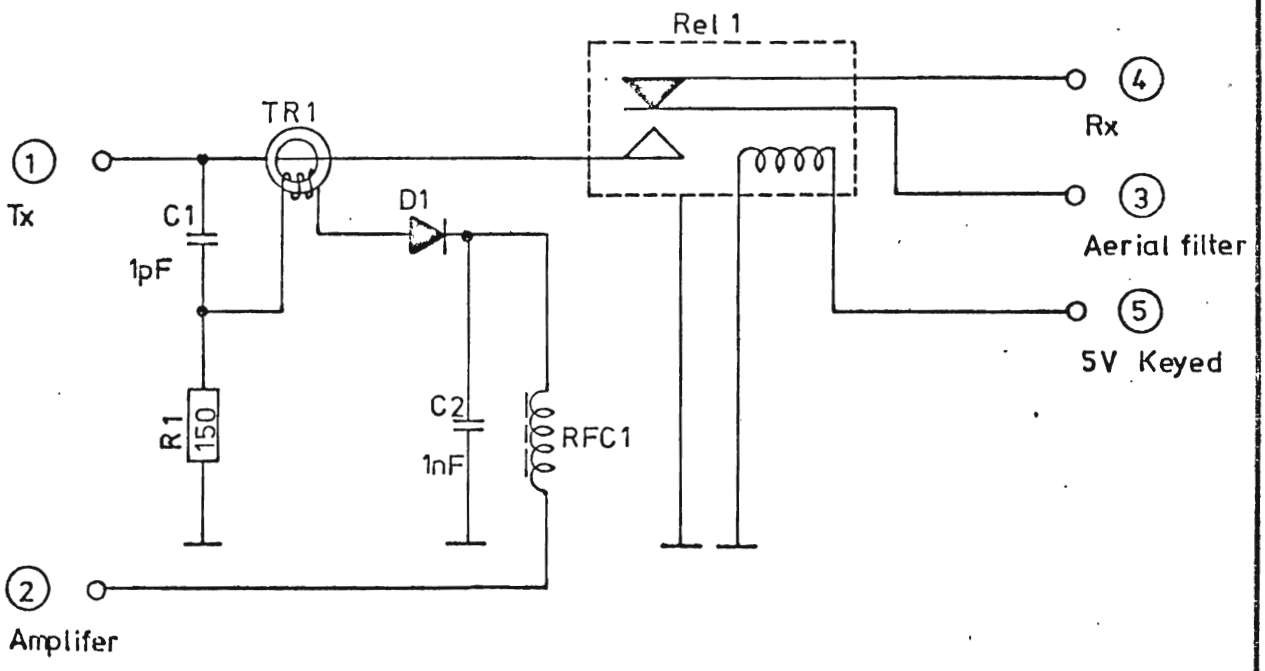
SPECIFICATION
for Quartz Crystal Unit
AP 22

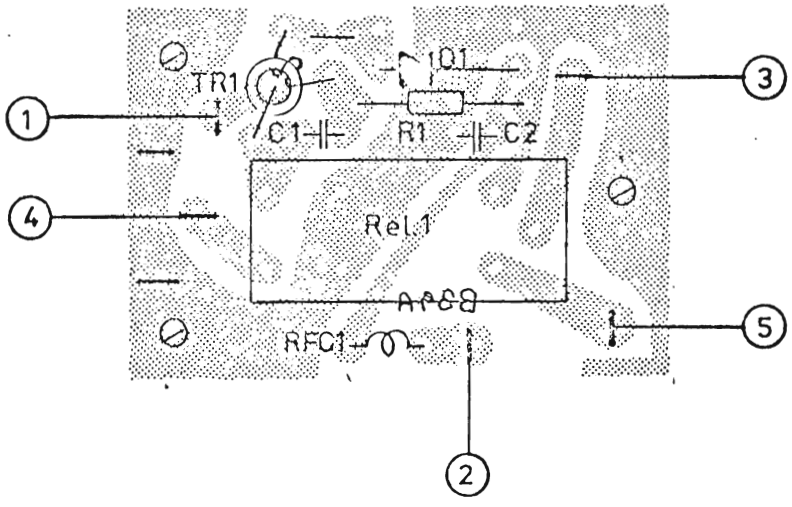
1.	Mode of operation	: AT-Fundamental
2.	Holder	: HC-42/U
3.	Frequency range	: 10-22 MHz
4.	Resonance	: Parallel (30 pF)
5.	Calibration tolerance	: ± 15 ppm at 25°C
6.	Temperature tolerance	: ± 10 ppm x 20°C to + 70°C
7.	Drive level	: 1 mW
8.	Equivalent serie resistance	: Max. 40 Ω
9.	Marking	: AP 22 frequency in MHz

Calculation of the crystal frequency for the transmitter mixer oscillator

$$F_{Tx\ mix} = 10,7 + \frac{F_{Rx} - F_{Tx}}{2}$$ Spec. AP 22

Normal mode of operation: F_{Rx} higher than or equal to F_{Tx} however F_{Rx} can be lower than F_{Tx} if $F_{Tx} - F_{Rx}$ is less than 5 MHz.



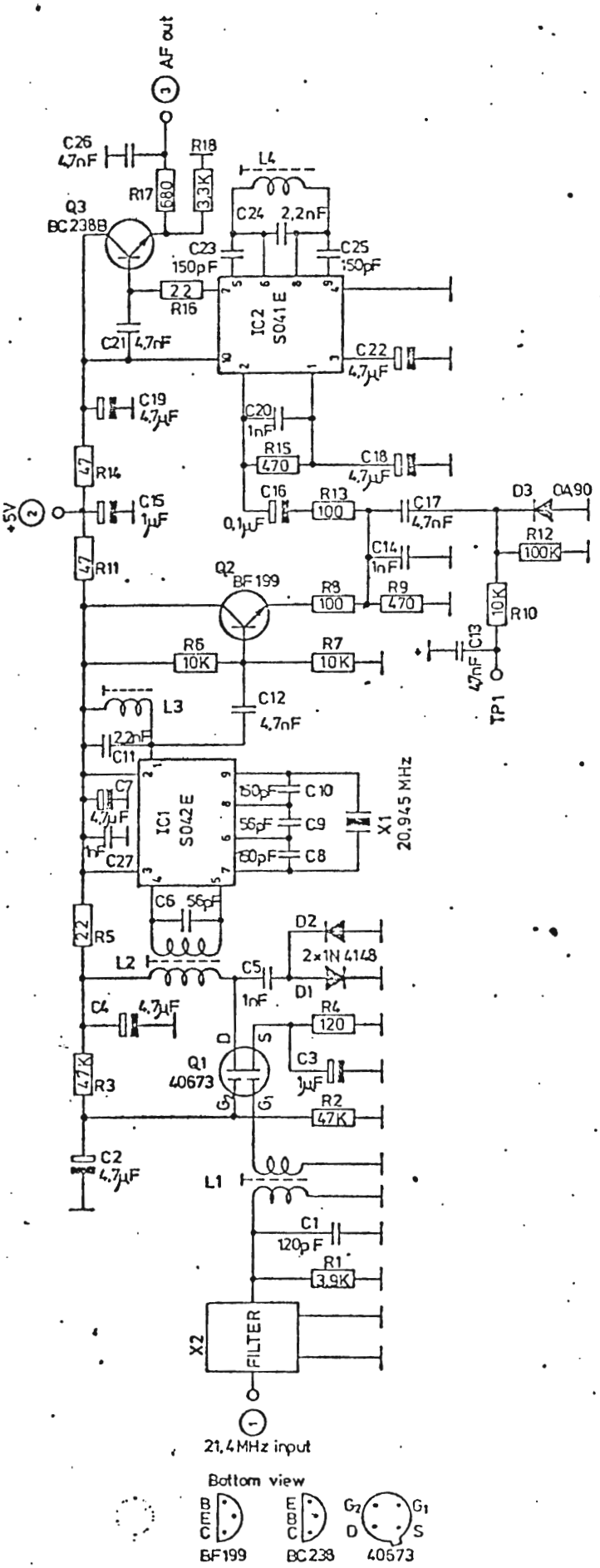


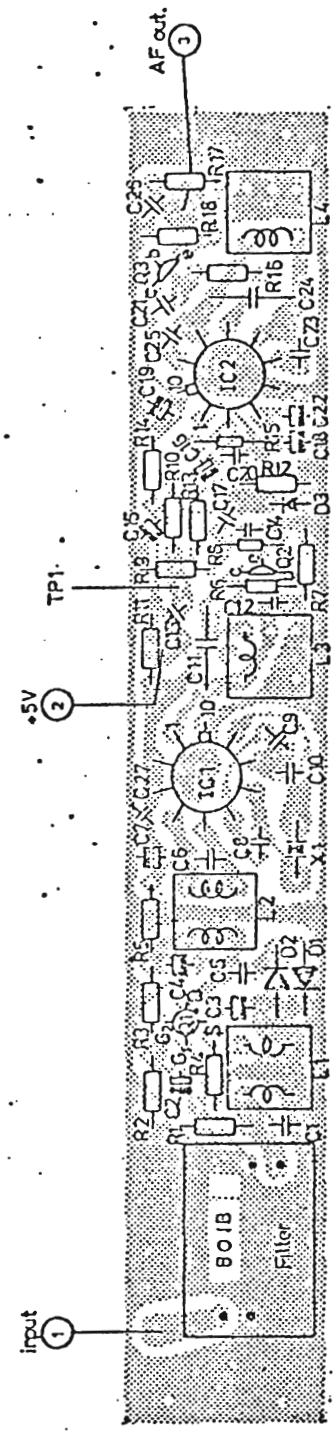
Rettet: 5-5-77 HJ.	Aerial switch for 2m internal PA Print board B 39A 1	Tegn.: 2-7-75 EH	Kontr.:
		Stykl. nr.:	
	AP-RADIOTELEFON A/S	Tegn. nr.: 75011 - 4E2	

AP-RADIOTELEFON

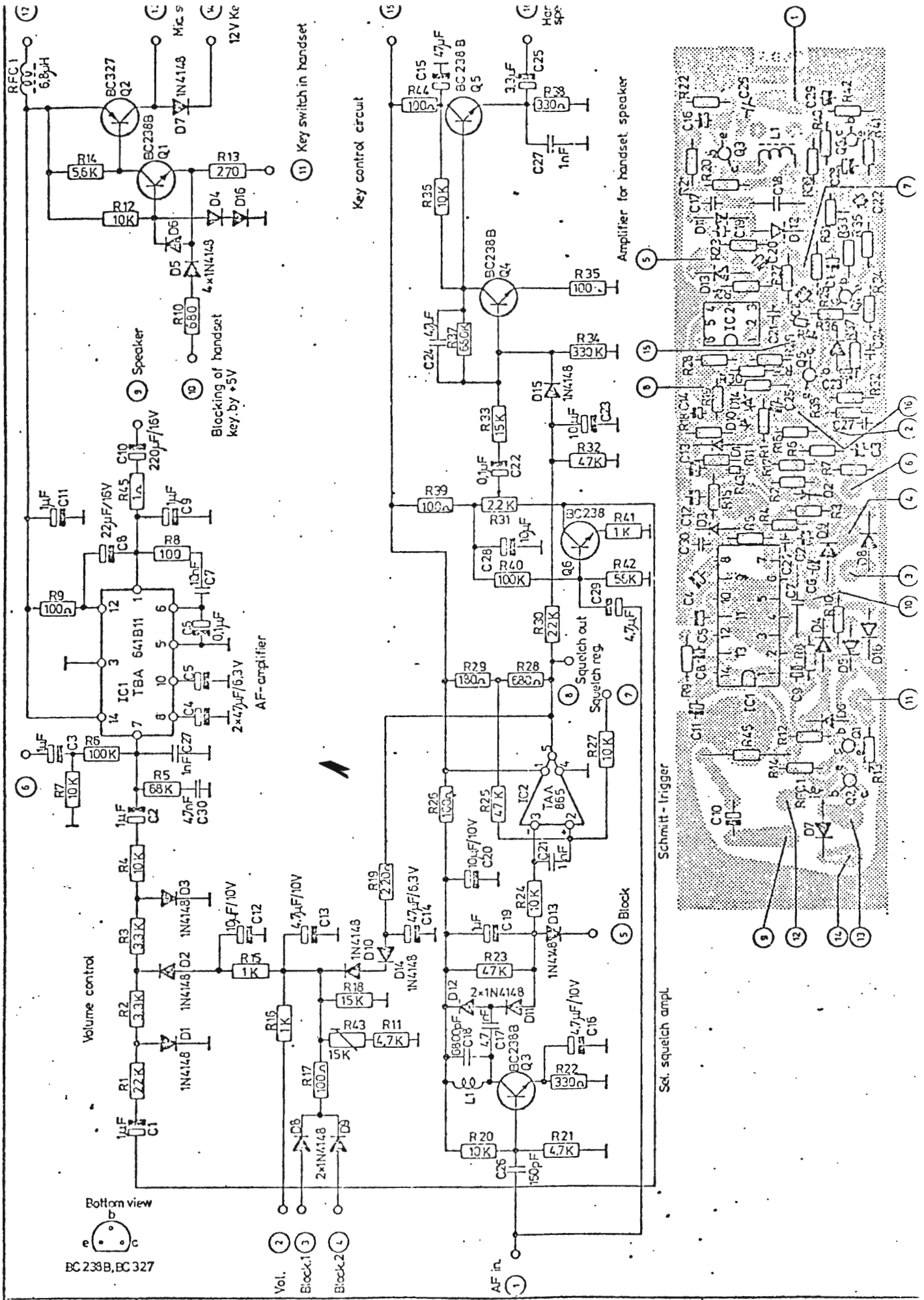
Nr.	Kode	Data	Nr.	Kode	Data
R1	13-402	150 Ω $\frac{1}{4}$ W CR 25			
C1	11-361	1 pF Ker.			
C2	11-409	1 nF "			
D1	04-062	1N4148			
TR1		75332-4E2			
RFC-1		75290-4E2			
RE 1	17-059	AE 5612-02, RS-6V National			

Aerial switch for 2 m internal PA Print board B 39A1 Tilhører tegn. nr.: 75011-4E2	Rettet:	Tegn.: Kontr.:	Stykl. nr.: 75011-4S2

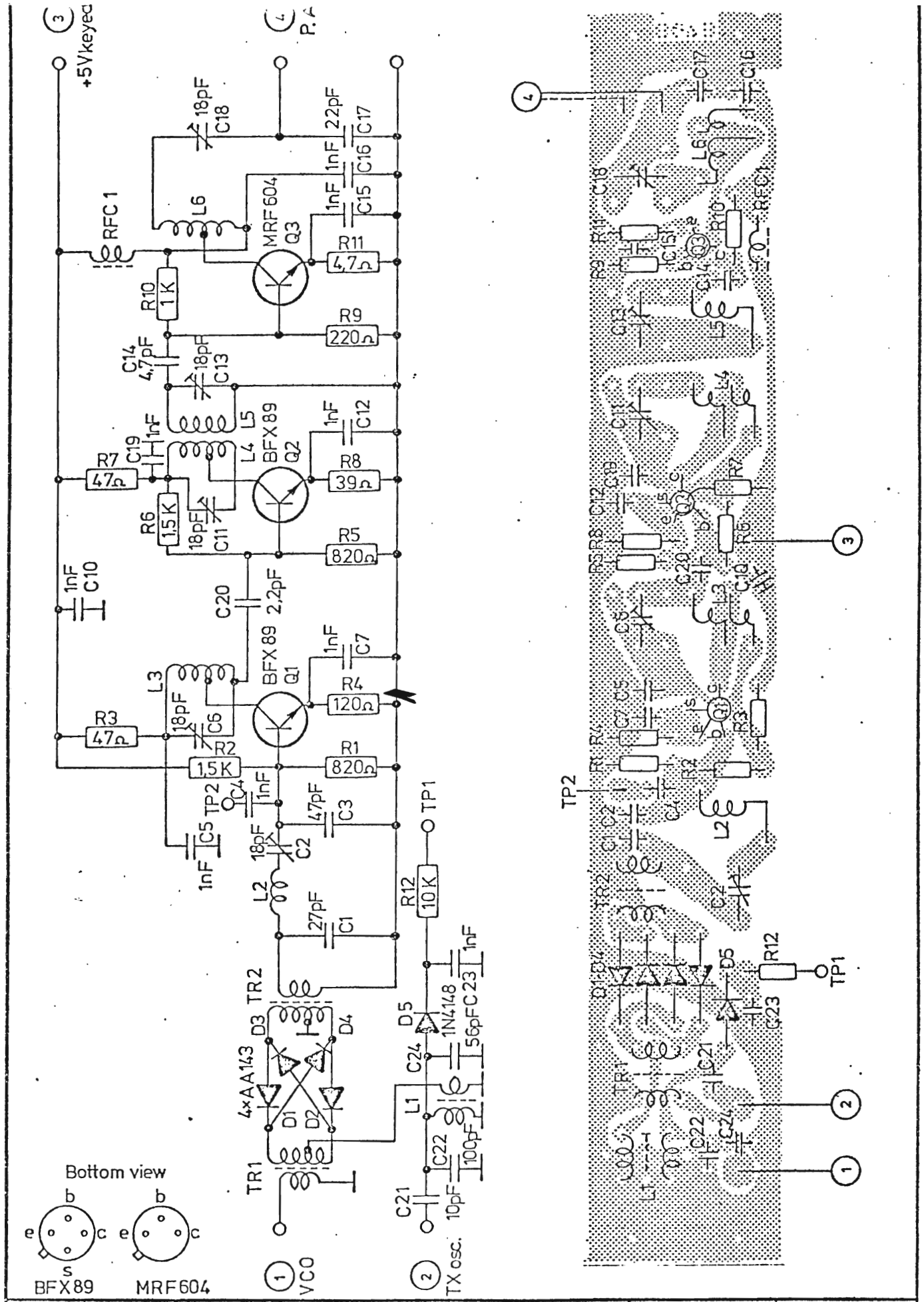




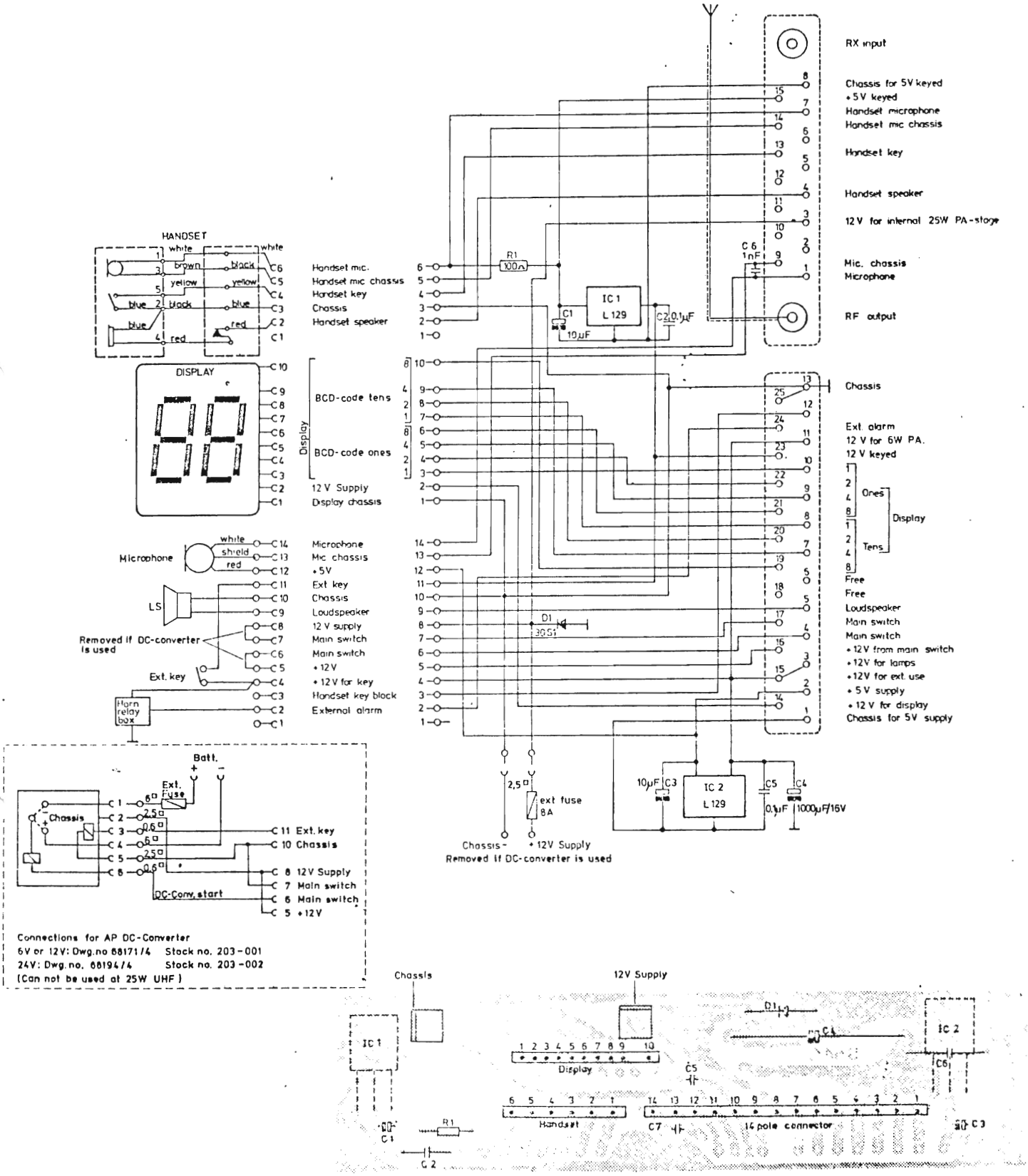
Rettet:	21,4 MHz IF Print B01B1	Tegn.: 28-2-75 AC | Kontr.: Stykl. nr.: Tegn. nr.: 75076-3E2
	AP-RADIOTELEFON	



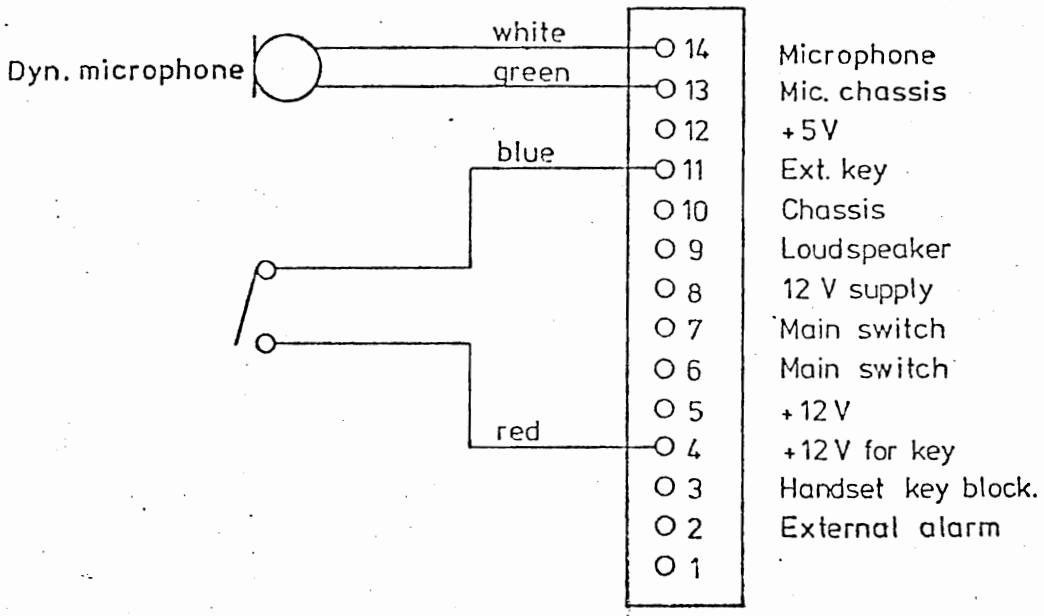
Rettet:	AF-amplifier, squelch and key circuit Print board B09 D 1	Tegn.: 15-1-75 AC | Kontr.: Stykl. nr.: Tegn. nr.: 75017-3E2
	AP-RADIOTELEFON	



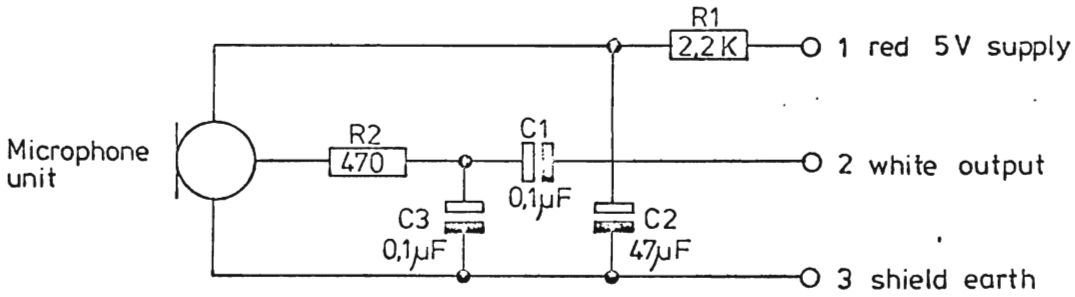
Rettet:	Transmitter mixer and amplifier 2 m Print board B07 B 1	Tegn.: 7-1- 75 AC	Kontr.:
		Stykl. nr.:	
	AP-RADIOTELEFON A/S	Tegn. nr.: 75014-4E2	

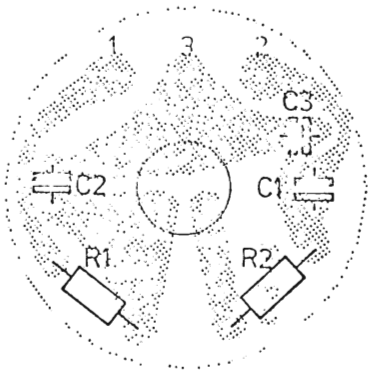


Kontrol 6.9.76 AC 6.3.77 AC	Installation for AP 2000 with internal PA-stage	Tegn.: 14-2-75 AC Skyld. nr.:

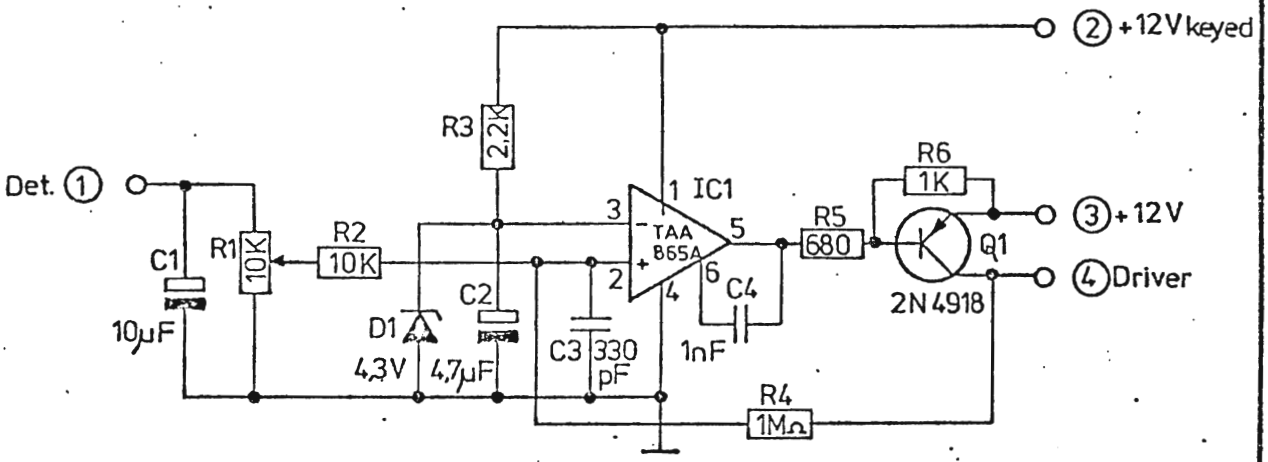


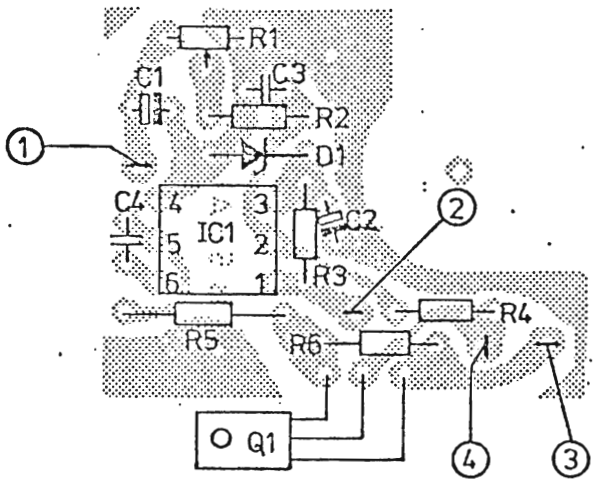
Rettet:	Installation for close talk microphone, AP 2000	Tegn.: 4-11-76 AC	Kontr.:
		Stykl. nr.:	
	AP-RADIOTELEFON A/S	Tegn. nr.: 76327-4E2	

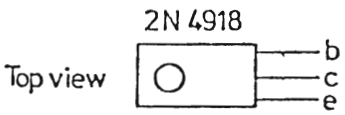




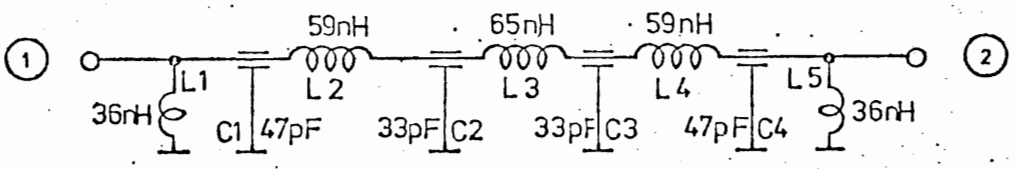
Rettet: 25-5-77 LT/AC	Microphone 213-020 Print board B 81 B1	Tegn.: 4-3-77 AC	Kontr.:
		Stykl. nr.:	
	AP-RADIOTELEFON A/S	Tegn. nr.: 77127-4E2	



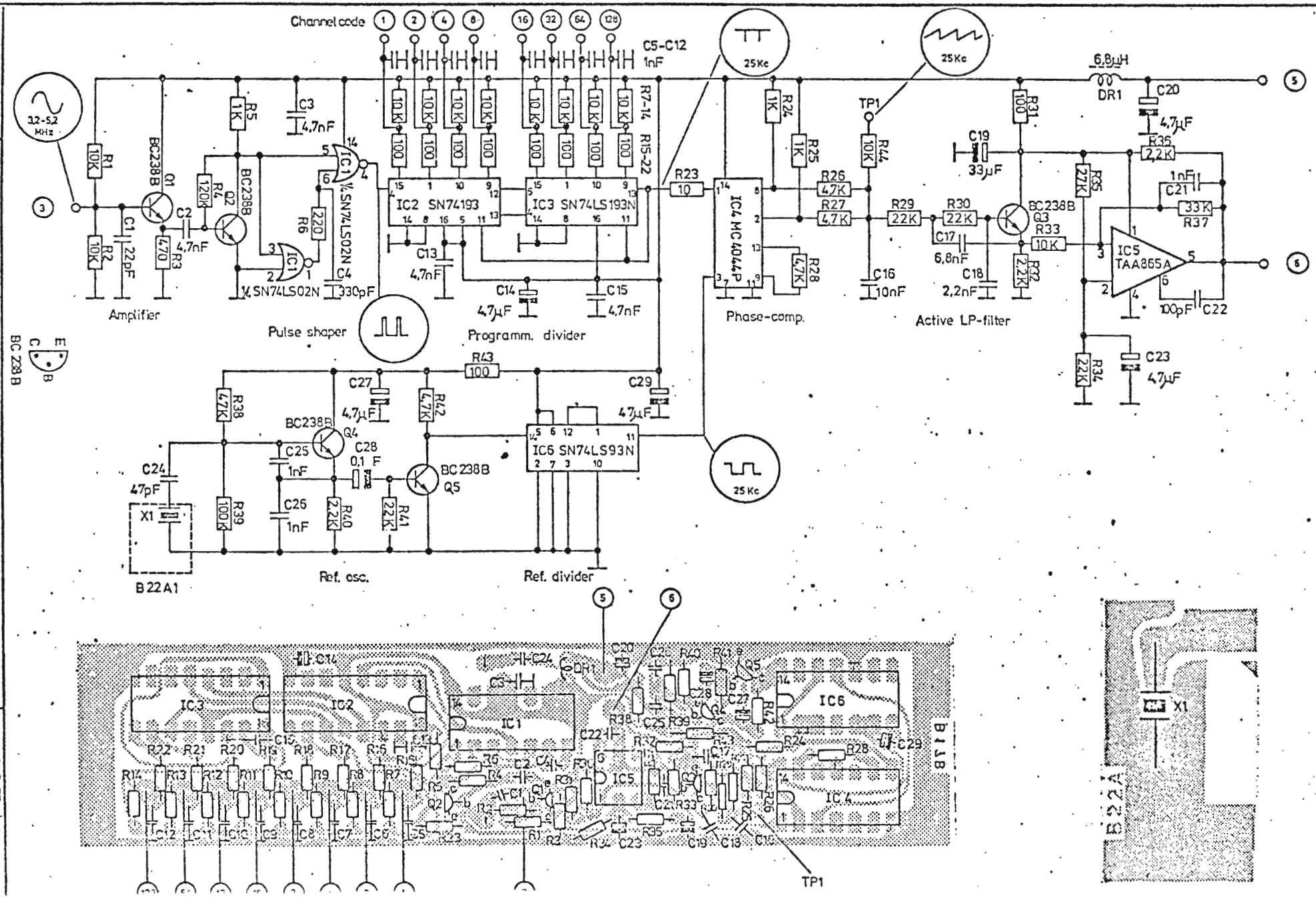




Rettet:	Sense amplifier for output power stabilizing of internal PA. Print board B 57 A 1	Tegn.: 29-12-75 AC	Kontr.:
		Stykl. nr.:	
	AP-RADIOTELEFON A/S	Tegn. nr.: 75622-4E2	



Rettet:	Aerial filter for 2 m	Tegn.: 9-1-75 AC	Kontr.:
		Stykl. nr.:	
		Tegn. nr.:	



Rettet:

Synthesizer logic

Print board B17B 1 + B 22 A 1

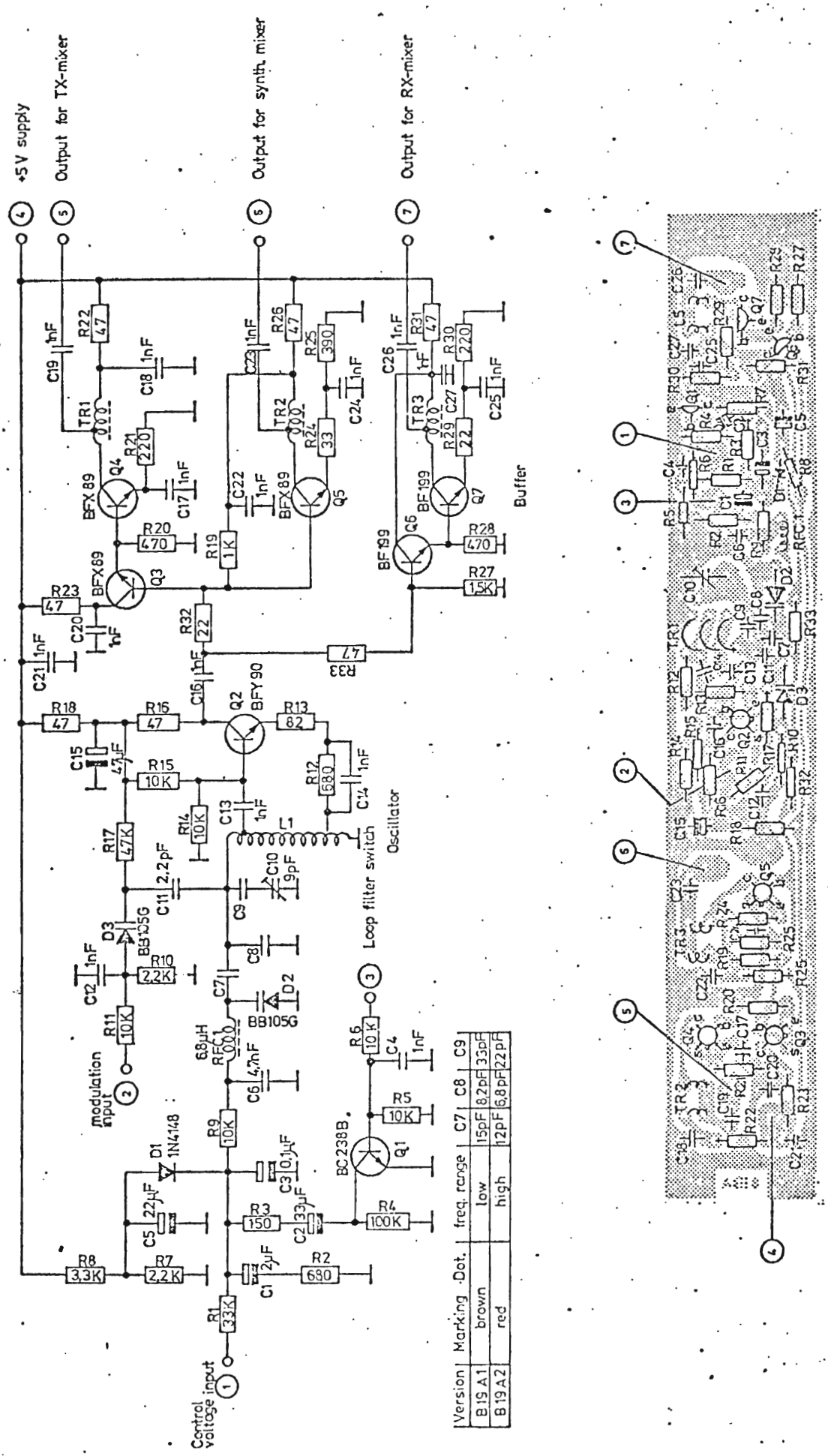
AP-RADIOTELEFON

Tegn.: 18-2-75 AC | Kontr.:

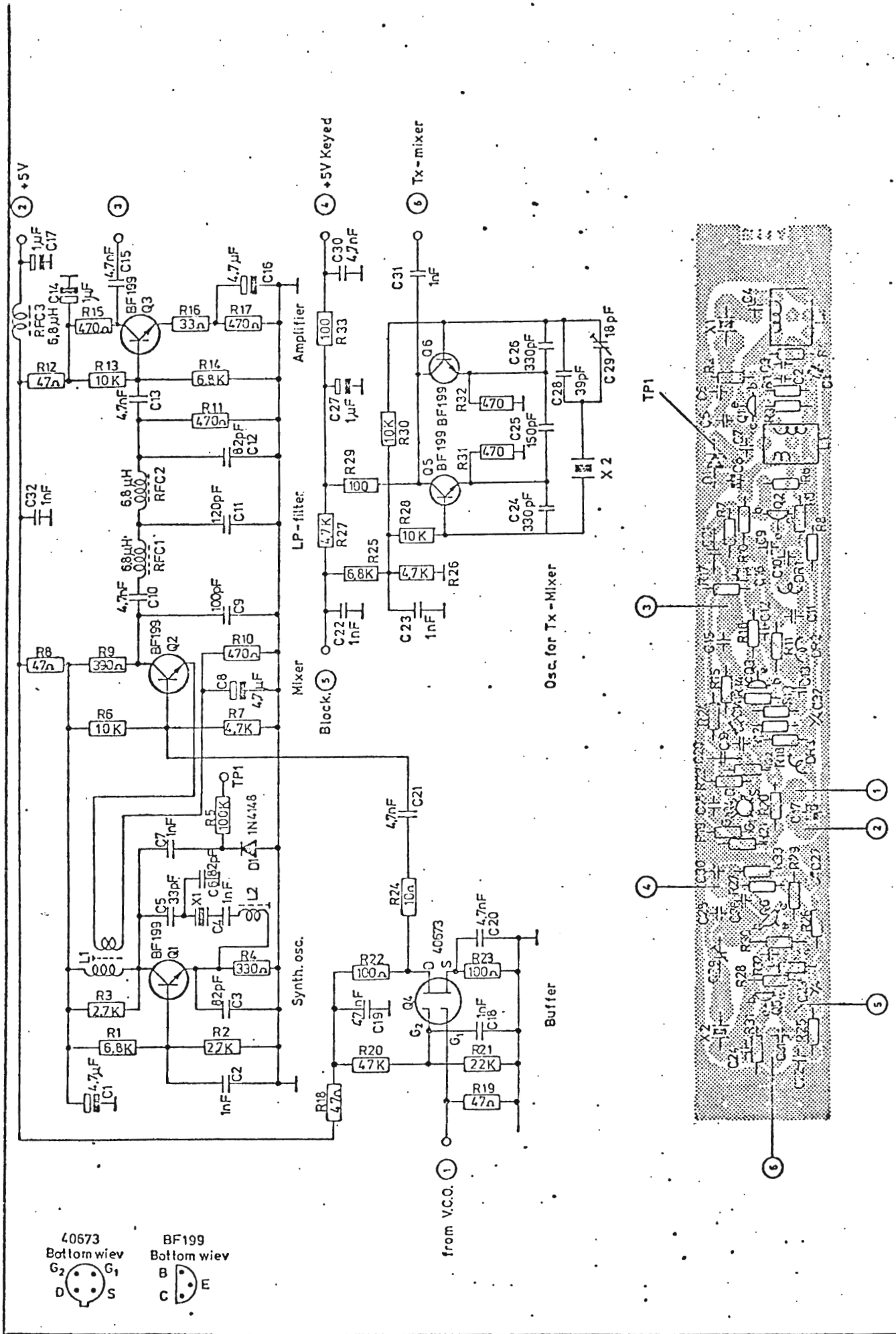
Stykl. nr.:

Tegn. nr.:

75062-3E2



Rettet: 26-6-75. EH	Voltage controlled oscillator for 2m. Print board B19 A 1,2	Tegn.: 7-3-75 AC | Konstr.:
		Stykl. nr.:
	AP-RADIOTELEFON	Tegn. nr.: 75082-3E2



Retet: 25-6-75 EH

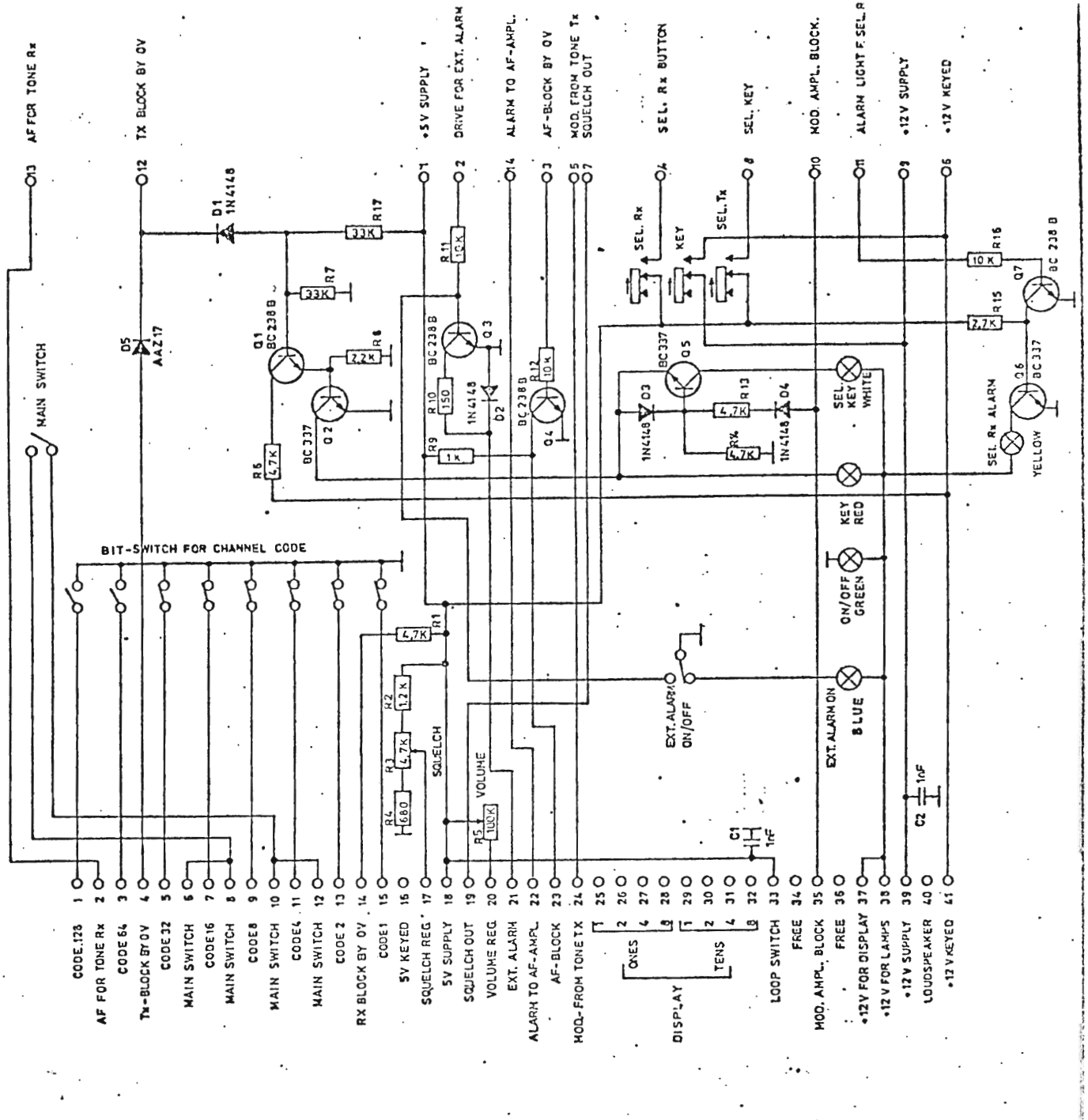
Synthesizer mixer and TX-oscillator for 2 m Print board B11A 1

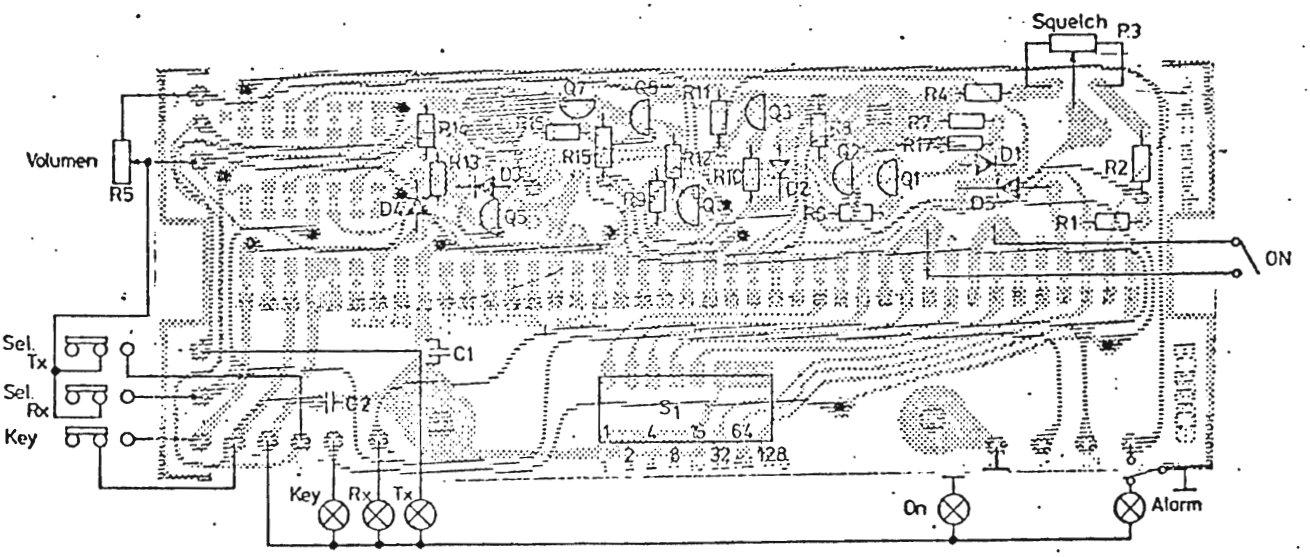
Tegn.: 13-1-75 AC | Kontr.:

Stykl. nr.:

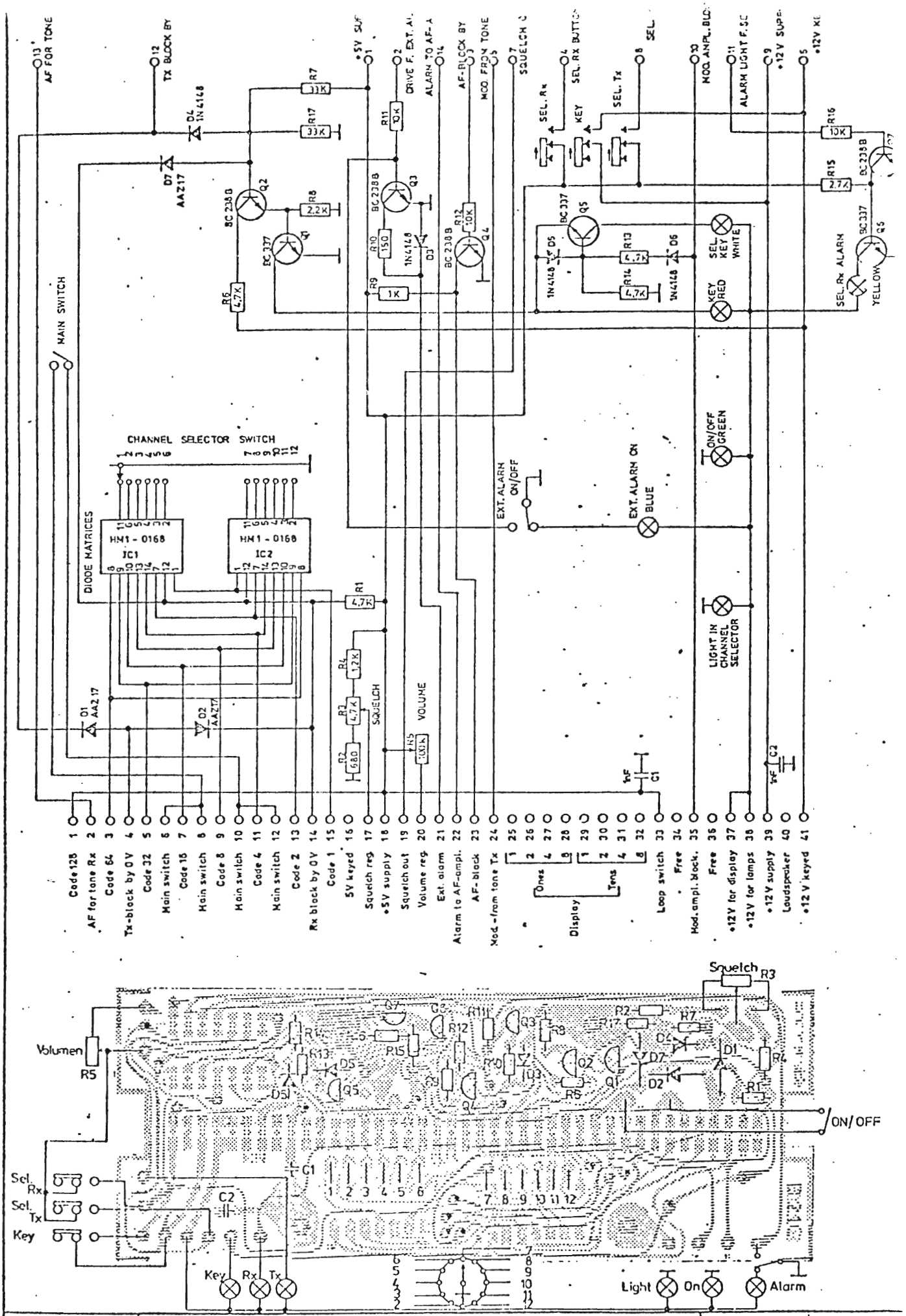
Tegn. nr.: 75019-3E2

AP-RADIOTELEFON

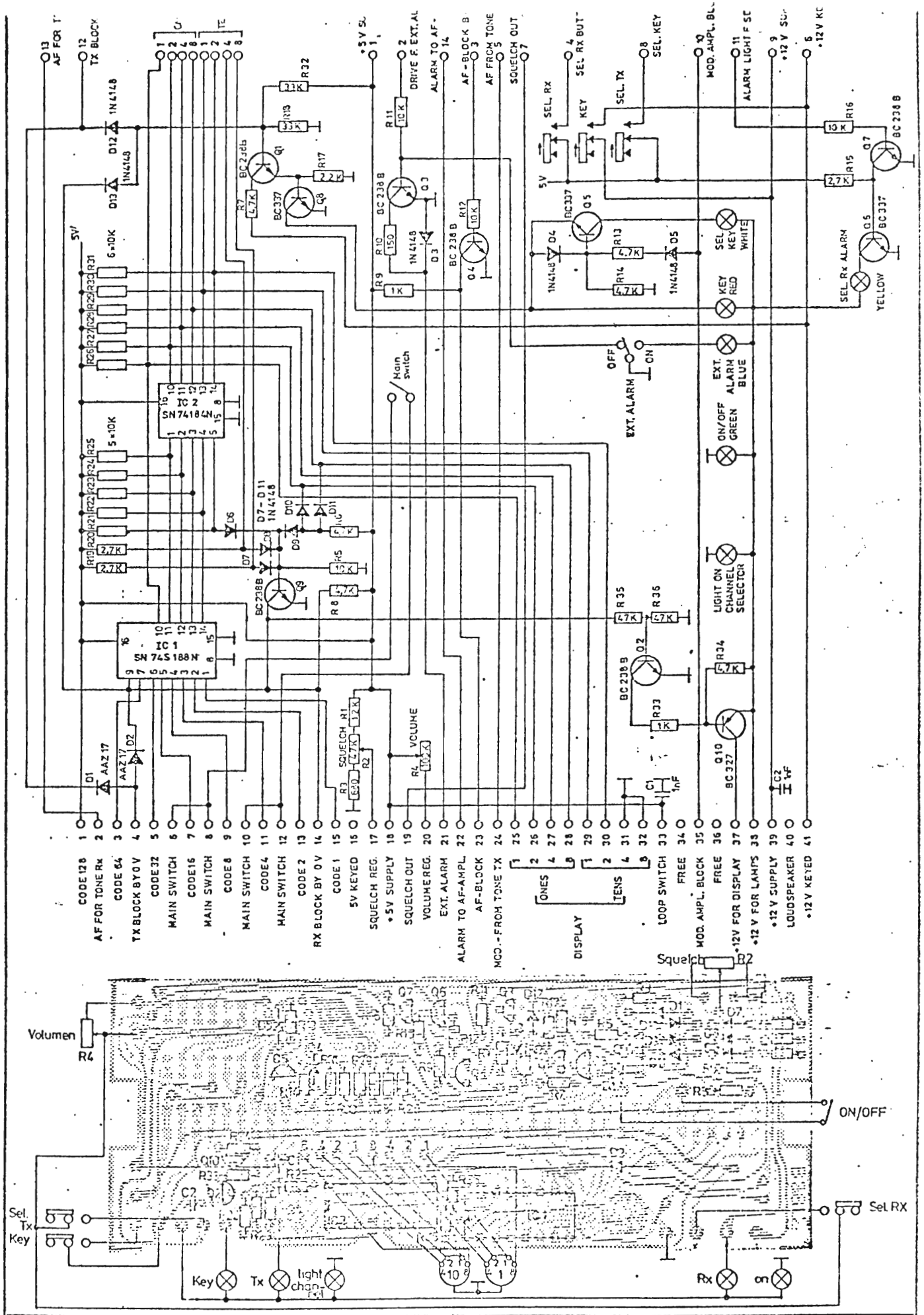




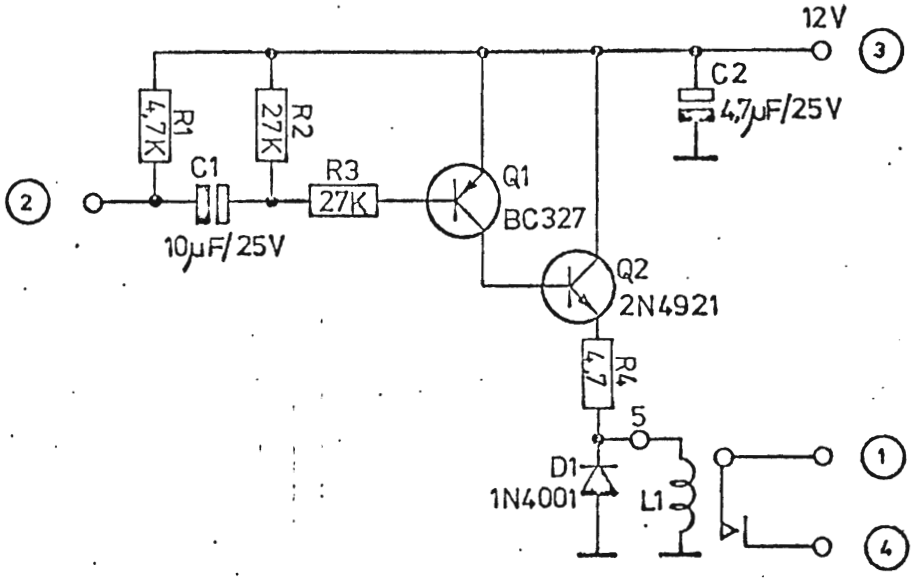
Rettet 30-9-75 LT/AC	CONTROL CIRCUIT FOR 1 CHANNEL, FRONTSECTION 04 PRINT B 20C1	Tegn.: 13.-2.-75 NC | Kontr.: 13.-2.-75 LT Stykl. nr.: Tegn. nr.: 75083-3E2
	AP-RADIOTELEFON	

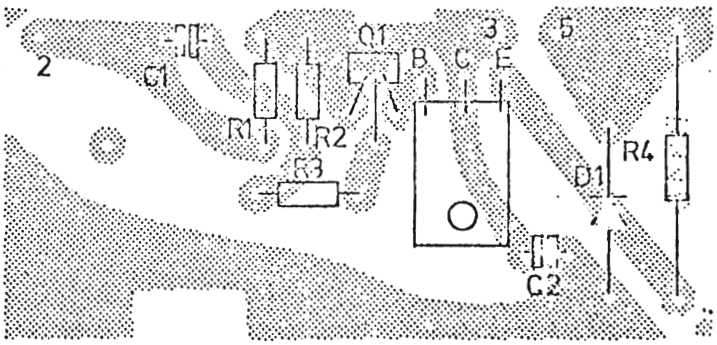


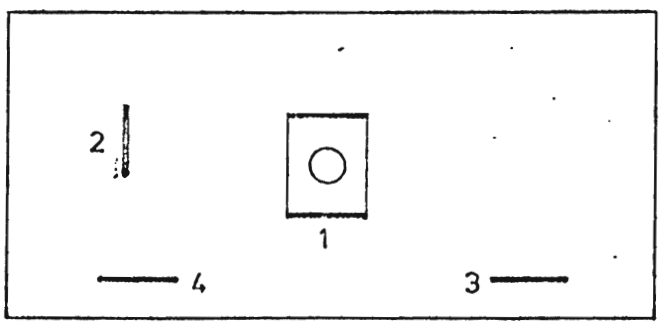
Rettet: 1-10-75 LT/AC	CONTROL CIRCUIT FOR 12 CHANNELS, FRONTSECTION 11	Tegn.: 15-6-75 AC / Kontr.:
	PRINT B 21C 1	Stykl. nr.:
	AR RADIOTELEFON	Tegn. nr.: 75084-3E2



Rettet: 30-9-75 LT/AC 16-6-76 NC/LT 21-2-77 AC/LT	CONTROL CIRCUIT FOR 32 CHANNELS, FRONTSECTION 12 PRINT B 38 C 1	Tegn.: 6-5-75 AC | Kontr.: 7-5-75 LT Stykl. nr.: Tegn. nr.: 75207-3 E 2
	AP-RADIOTELEFON	

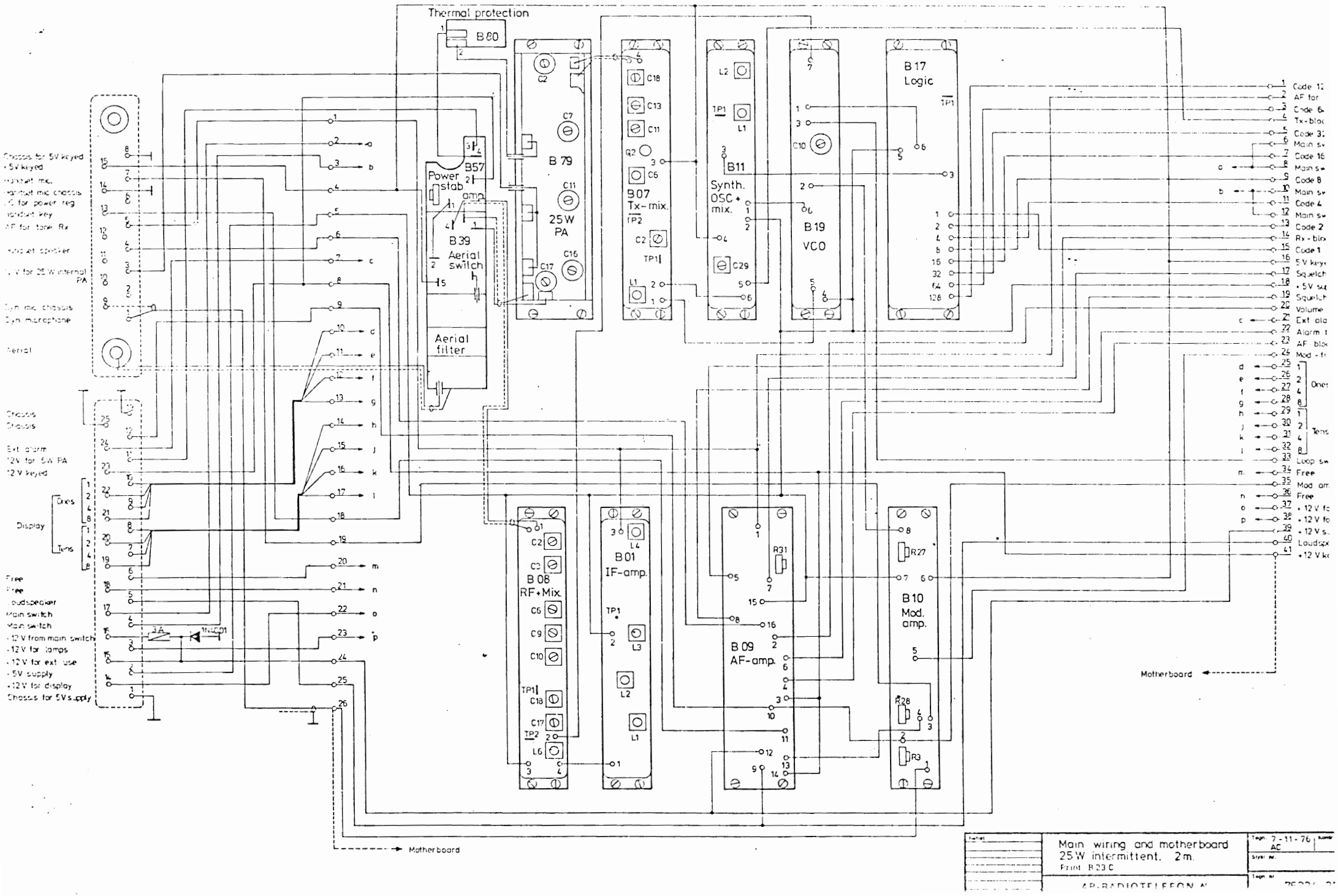






Relay box

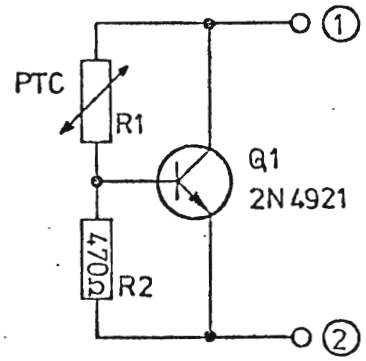
Rettet: 23-3-76 AC/LT	Extern timing for hornrelay Print board B 34 B 1	Tegn.: 21-4-75 AC	Kontr.: 21-4-75 TJ
		Stykl. nr.: 75169-4S2	
	AP-RADIOTELEFON A/	Tegn. nr.: 75169-4E2	

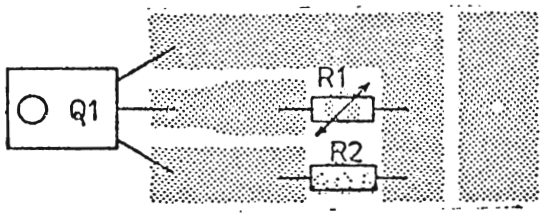


Main wiring and motherboard
25 W intermittent. 2 m.
Print B 23 C

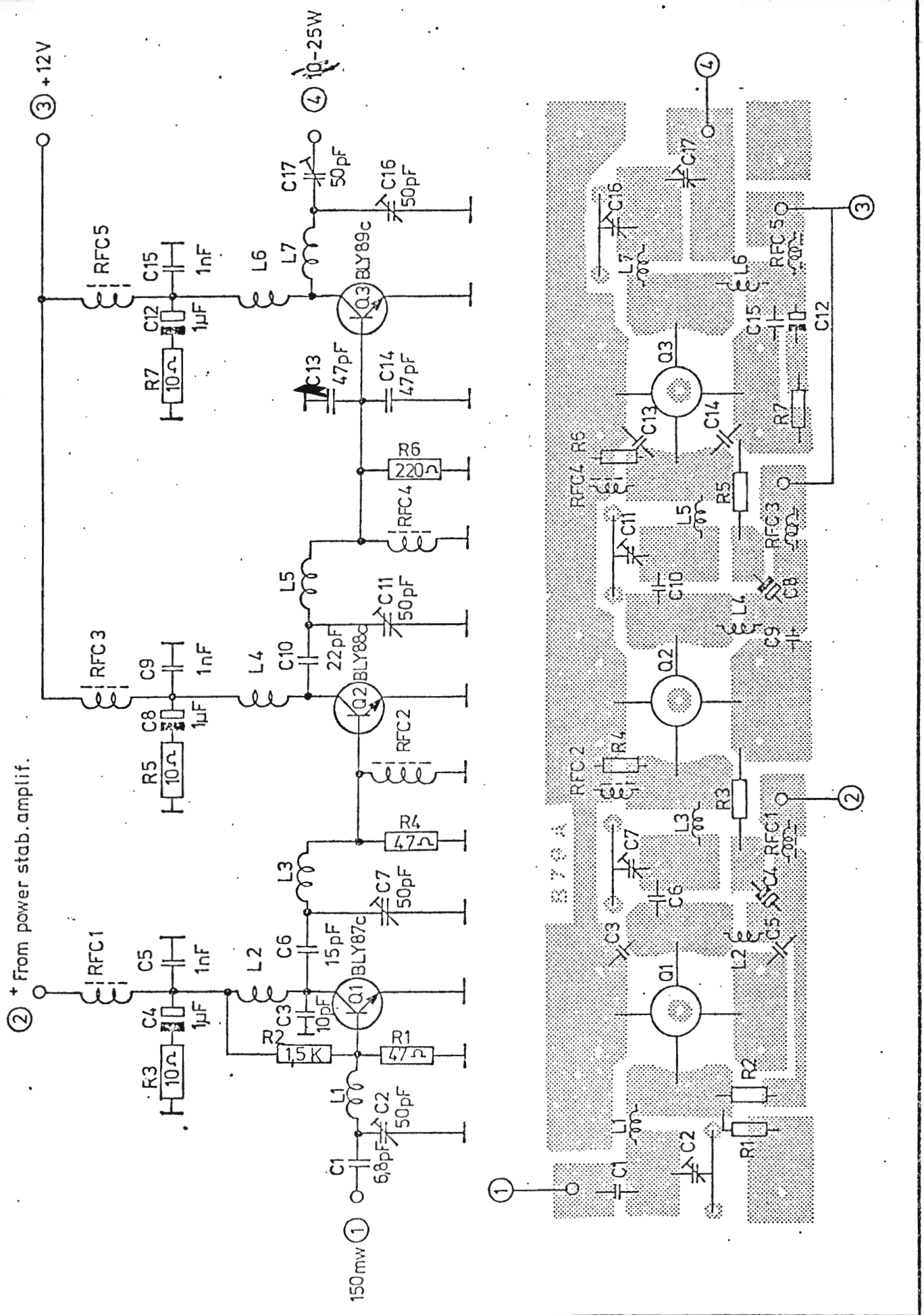
Tegn. 7-11-76 AC

AP-RADIOTELEFON A

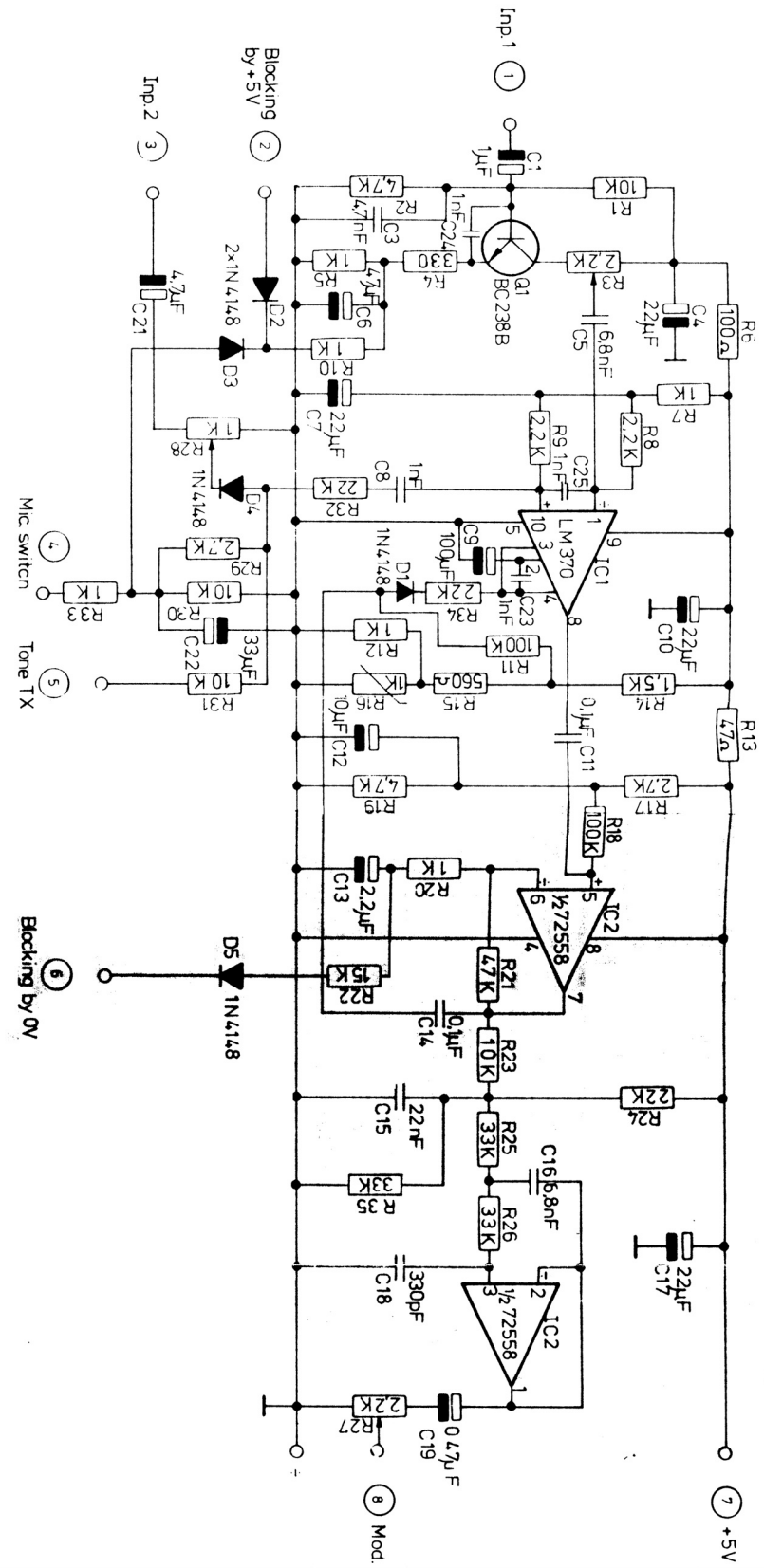


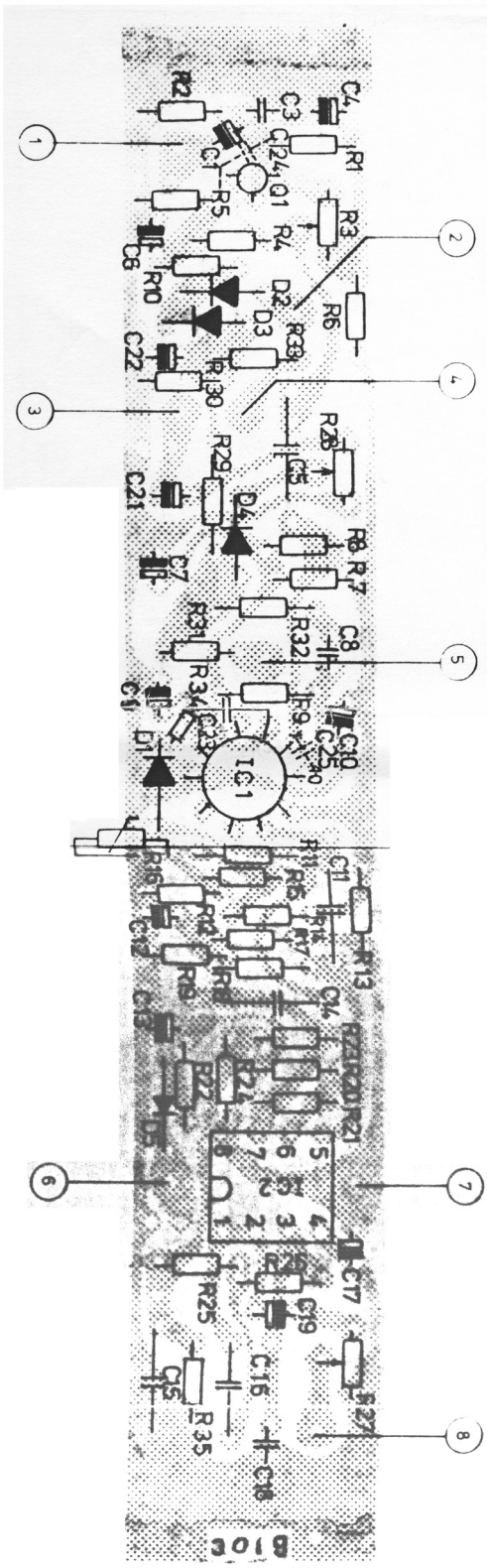


Rettet:	Thermal protection of 25W internal PA Print board B80A 1	Tegn.: 5-11-76 AC	Kontr.:
		Stykl. nr.:	
	AP-RADIOTELEFON A/S	Tegn. nr.: 76328-4E2	



Rettet:	25W internal P.A. 2m Print B 79A 1	Tegn.: 27-10-76 H.J.	Kontr.:
		Stykl. nr.:	
	AP-RADIOTELEFON A/S	Tegn. nr.: 76307- 4E2	





Rettet:	Modulation amplifier Print board B10D1	Tegn.: 8-1-75 AC	Kontr.:
7-9-76 JH/NC 1-2-77 HJ 27-5-77 LT/AC 9-6-77 LT/AC 22-6-77 JH/AC		Stykl. nr.:	
		Tegn. nr.:	75018-3E2
	AP-RADIOTELEFON		