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General

In the following pages it will be briefly explained how a PRESELECTOR in a receiver and an INTERSELECTOR in a transmitter can improve the performance of a receiver.

Historically, receivers have always contained selectivity. The tuned radio frequency receiver (TRF) was nothing but a preselector, followed by a demodulator and an amplifier. The superheterodyne type receivers have always had a tracking preselector in the front end. The introduction of the broadband 50-ohm input solid state front ends got away with expensive tracking tuning networks, but the broadband front ends inherited a decrease in receive performance in the presence of strong receiving signals. Especially in those critical applications, were receivers and transmitters together with their associated antennas are collocated (like on ships) the new receivers were at a disadvantage to the old type vacuum tube receivers.

Additionally the tube receivers were much more immune to overload phenomena and to destructive overload stress then the broadband front end receivers. Therefore, if the broadband front end type receivers are used in a collocated HF-system, external selectivity (preselection) is required.

The key to good receiver performance in a collocated situation is to reduce the level of interfering signals so that the distortion products generated in the front end of the receiver are held to an acceptable level relative to the desired signal strength. The easiest way to visualize the helpfull influence of the preselector is to think in terms of the signal level required at the receiver antenna terminals necessary to produce a reference interference level at the output. If the multitone interfering signal is, for example, 0.1 volt/per tone, the addition of a preselector, which demonstrates a 40-dB attenuation to the interfering signal, in series with the receiver antenna input will result in a receiver-preselector subsystem that now requires a 10 volt (40 dB higher) interfering signal to produce the same reference interference level at the receiver output. Thus, a receiver with a 3rd order intermodulation intercept of +30 dBm, with a preselector offering 50 dB of attenuation at the interfering frequencies, now has a 3rd order intermodulation intercept of +80 dBm.

A key point to keep in mind in applying a preselector at a receiver input is that the preselector will be of enormous benefit in attenuating transmitter products outside the desired receive passband, but will have absolutely no effect on transmitter products falling within the desired passband. When the transmitter products are coincident with the desired receiver frequency, they can be reduced only by adding selectivity to the transmitter in order to attenuate all but the desired transmit signal. Interselectors are useful when applied to the low-level transmitter stages like between exciters and power amplifiers.

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The following is a list of characteristics which will be improved by the use of a preselector.

a) Out-of-band intermodulation distortion
This distortion product is caused by mixing, due to front-end nonlinearities, of two undesired signals and their harmonics, all of which are outside the passband of the receiver. The mathematical relationship is such that the tuned frequency of the receiver is equal to the sum or difference of all integer multiples of the interfering signal harmonics. Second order and third order products are typically of most concern in system engineering, as they will have the highest levels. The intermodulation intercept performance of a given receiver will be improved dB for dB by the amount of attenuation given by the preselector at the frequency of the interfering tones. That is to say, the greater the spacing of the interfering signals from the desired signal, the greater they will be attenuated and hence the lower the level of interfering will occur.

b) Cross Modulation
Cross modulation is another third-order intermodulation phenomenon which, when the interfering signal is strong enough, has the effect of transferring the modulation envelope of the interfering signal to the weak desired signal. Again, a preselector will solve this problem by attenuating the interfering signal. Note that an HF preselector will also attenuate such chronic interference sources as AM broadcast stations which are significantly outside the HF passband.

c) Image rejection
In a superheterodyne receiver, the mixer circuits generate both the sum and difference of the desired and local oscillator frequencies. The desired mixing product will be termed the intermediate frequency, and the undesired mixing product is discarded. There exists a second frequency which, when mixed with the local oscillator, also yields a mixing product (sum or difference) equal to the intermediate frequency. This is defined as the image frequency. The image frequency will be twice the IF frequency in separation from the desired signal, and will be on the high side of the local oscillator if the desired signal is on the low side, and vice versa. A key receiver design criterion is to choose the frequency scheme so that the image frequency does not fall within the operating frequency range of the receiver, making it easy to attenuate the image frequency by bandpass filtering. A preselector improves the image rejection of a receiver by the amount of attenuation at the image frequency.

d) IF rejection
The IF rejection of a receiver is the measure of attenuation by the receiver to an input signal at an intermediate frequency of the receiver while the receiver is tuned to another frequency. For example, if the receiver's rated sensitivity is 1 µV for a 10 dB (S+N)N, the receiver will have 80 dB of IF rejection if a 1 mV signal at the 455 kHz IF frequency produces a 10 dB (S+N)/N when it is applied to the antenna input. A preselector further improves IF rejection by attenuating out-of-channel signals, including the IF frequency (s).

e) Noise modulation and desensitization
Noise modulation (also called "reciprocal mixing") occurs in a superheterodyne receiver due to the mixing action of a strong interfering signal with the phase noise of the local oscillator. In effect, this noise of the local oscillator signal is transferred to the interfering signal, and hence that portion of the noise within the receive passband will degrade the sensitivity of the receiver. This effect is called desensitization, and decreases sensitivity in two ways: by reducing (S+N)/N by increasing N (noise power in the passband), and also by causing the AGC to reduce the receiver gain if the noise is sufficient in level. Again the key is the reduction on the interfering signal, since the resulting noise level in the receiver passband will be proportional to the level of interfering signal at the receiver input. The desensitization performance will be improved by the amount of additional selectivity applied by the preselector at the interfering signal frequency.

f) High voltage protection

The attenuation characteristics of a preselector can reduce out-of-channel signals to nondamaging levels at the receiver input. Damaging signal levels in-channel as well as out-of-channel are prevented from reaching the receiver input by a preselector overload protection circuit. Units such as the Hagenuk preselector will give protection up to 100 V_{rms} input voltage.

The following is a list of characteristics which will be improved by the use of an interselector in a transmitter path.

a) Broadband noise
The noise shelf associated with the output spectrum of an interfering transmitter will result in noise power falling within the receiver passband. This noise will effectively degrade the noise figure and sensitivity of the receiver. Historically, the majority of this broadband noise comes from the local oscillator injections in the low level stages of the transmitter. Very little noise contribution is generally caused by the high power amplifier stages.

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Thus, the interselector is a natural solution on the broadband noise problem because, when applied in series with low-level transmitter stages, e. g. between the output at the Hagenuk exciter EX 1010 and a power amplifier like the PA 500, PA 1510 the out-of-passband noise level is reduced by the amount of attenuation exhibited by the interselector at the desired out-of-channel frequency.

b) Spurious outputs
Nonharmonically related products present in the transmitter output spectrum are generally caused by synthesizer spurious responses at the low level stages. The interselector may be used to advantage in the low-level transmitter stages to reduce the out-of-passband spurious responses. Barring a parasitic oscillation, very little is generated in the way of spurious responses in the high power stages of a transmitter.

c) Harmonics
To the extent that harmonics are generated in the low-level stages of a transmitter, the interselector will attenuate them. However, most harmonics are generated in the high-power stages of a transmitter, and hence the interselector will offer only a limited improvement in performance. As it is obvious by now, there are certain characteristics that a preselector will not affect. Basically, any signal that falls within the desired passband of the receiver cannot be attenuated by a preselector at the receiver. Similarly, an interfering signal within the transmitter passband cannot be attenuated there by an interselector. The parameters which will not be improved by a selector include receive and transmit in-band-intermodulation distortion, in-band broadband noise, and in-band spurious harmonics, that is, where a spurious or harmonic discrete signal falls directly within the receiver passband. The key to this criterion is whether or not the receiver is able to (frequency) discriminate between an undesired and a desired signal.

The special characteristics described by the above parameters are summarized in the following figures. These figures show a typical HF receiver spectrum that would cause interference, and the effects of adding a preselector and an interselector to the system.

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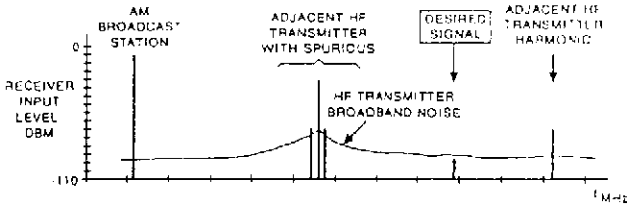
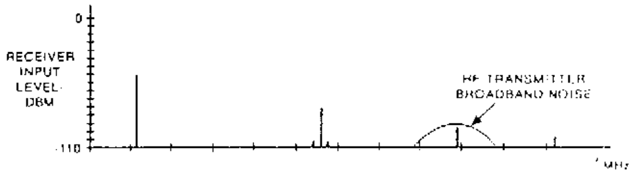
Typical preselector and interselector characteristics

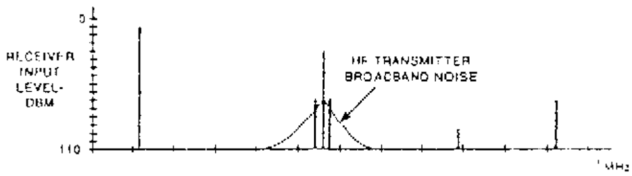


RX input spectrum with no preselection



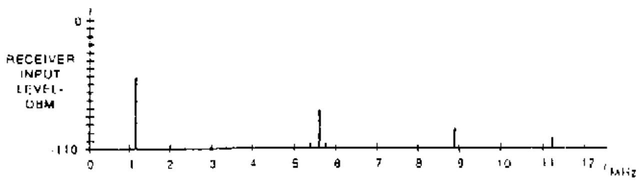
RX input spectrum with preselection

Receive preselector effects:
AM-broadcast level reduced
Adjacent HF-transmitter spectrum reduced.
In-band adjacent HF-noise still burries desired signal although out of band level is reduced.



RX input spectrum with no preselection and interselection of interfering transmitter

Transmit interselector effects:
Broadband noise significantly reduced
Main signal, harmonics and AM-broadcast level unchanged



RX input spectrum with preselection and interselection of interfering transmitter

Combined preselector and interselector effects:
Broadband noise no longer noticable.
AM-broadcast level reduced
Adjacent HF-transmitter spectrum reduced

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Technical description
If the receiver is fitted with a PRESELECTOR, the PROTECTOR cassette is no longer required, since the preselector also fulfils this function. Preselection makes possible the use of receivers and transmitters at collocated sites. Even where the antenna distances are not favourable, concurrent transmission and reception is made possible with a frequency interval > 10 %. For frequencies under 1.6 MHz, the automatically tuning preselector contains a low pass filter, for the frequency range 1.6... 30 MHz, four three circuit band filters are present. Since tuning of a three circuit filter is only possible in a frequency ratio of about 2:1, the pre-selector has four ranges: 1.6 ... 4; 4 ... 8; 8 ...17; 17 ... 30 MHz. Filter attenuation (10 % offset from the pass frequency) related to the pass band attenuation is at least 40 dB. The preselection tuning is inductive, the tuning cores move within fixed coils. The position of the tuning core in the filter coils is specified by an analogue voltage U REF from 5 ... 10 V to the motor control circuit of the preselector which comes from the D/A converter on the Buffer D/A converter board. Data for the D/A converter are stored in an EPROM on the audio board. The tuning position is therefore stored in an EPROM. A 30 MHz low pass filter is also permanently switched on at the output of the filter trains. The 1 MHz signal from the BFO is fed in for the self-test. Apart from adjustment motor and servo-potentiometer, all electrical components are located on replaceable boards.
These are:

a) LP protector board
b) 1.6 - 4 MHZ/8 - 17 MHz filter
c) 4 - 8 MHz/17 - 30 MHz filter
d) Relay board
e) Motor control board

a) The LP protector board contains the connector for the ribbon cable to the control unit of the receiver. Relay board and motor control are attached to the LP protector board via connectors.

Four protective circuits are installed to prevent overload of the preselector or receiver:

1) 20 dBm Level Sensor
The level sensor protects the receiver input from voltages that are too high. As soon as the input signal at the output of the preselector reaches more than 20 dBm or 6 V_{pp}, the level sensor switches the 20 dB attenuation unit (20 dB $\overline{ATT}$) on.
The LEVEL SENSOR with the transistors T1 to T4 consists of two branches with different gain. The amplification of the stages T1/T3 is lower than that of the stages T1/T2/T4. At the output of T3 and T4 is connected a rectifier (D1/D8 or D7/D6 respectively) which are linked to the comparator IC A via the NC contact or the NO contact of Rel A. If the rectified voltage exceeds the reference voltage specified with resistors R22/R23, the relay switches on the 20 dB attenuation unit.

Since the level measured at the output of the 30 MHz low pass filter is now less, the level sensor would no longer recognise an "overload status", the relay F would therefore release and thus a too high voltage would be recognised again. The relay would energize again etc.. In order to prevent the "oscillation" of the relay F, the amplification of the stages T1/T2/T4 was selected so high that when Rel F has been energized and Rel A has switched over to the more sensitive branch, an overload is still recognised at the output of the 30 MHz low pass filter, oscillation of Rel F is thus prevented.

2) Filter protector
The first resonance circuit of each band filter is connected via a coupling capacitor (C314, 315, 330, 340) with the FILTER PROTECTOR circuit. The input of the 1.6 MHz low pass filter is also connected with the protector circuit via C75. These capacitors form a capacitive voltage divider with C204. The high frequency is rectified by means of D202 and D203 and fed to the IC A, connected as a comparator, via the normally closed contact of relay A. If the rectified voltage is greater than the reference voltage formed by R22/R23, Rel A and F respond, the 20 dB is switched on. This prevents the coils of the band filters and the 1.6 MHz low pass being damaged by overheating. Because the NC contact of the relay A disconnects the error signal from the comparator when the 20 dB attenuator is active, the attenuator switches on and off rapidly if the filter input voltages are too high.

If triggered by the filter protector circuit, the circuit will hold for about 250 ms and then switches back to normal and then switches back in about 10 - 50 ms time if the high voltages still persist. At high voltages near the trigger level the 'ON'delay time will be 50 ms. At high voltages far above the trigger level the 'ON'delay time will be about 10 ms. At high voltages across the first filter coil just above trigger level, with the filter protection circuit in action, the 20 dB switch will be activated for about 250 ms and deactivated for about 50 ms.

The circuit operation described above can just be seen by the flickering 20 dB attenuator LED (constantly on for 250 ms and off for 50 ms) When the first filter coil voltage increases, the OFF time of the LED cannot be recognized, although the oscillation of the 20 dB attenuator switch can be heard in the preselector unit.

3) Overload switch
The overload switch protects the preselector in case either the input voltage exceeds 100 V or the input current exceeds 2 A. Protection against excess current is necessary, since the filters can have a very low impedance outside their pass range and current above 2 A would destroy the coils. For this reason the overload switch separates the antenna input from the filters by means of the relay G. If the overload switch is activated, the receiver is at the same time disabled and the LED RX MUTE lights up on the front panel.

4) In addition to the overload switch, the input is protected from static discharge and voltages > 100 Veff from the antenna by a surge arrester and a 1 M Ohm resistance.
In addition to the addressed protection circuits the low pass and protector board contains the following function groups:
- 30 MHz low pass filter
- 1.6 MHz low pass filter

1.6 MHz low pass filter (Cauer low pass)
With a pass range from 0.01 ... 1.6 MHz and a pass attenuation less than 3 dB and attenuation of more than 40 dB above 1.76 MHz.
Low pass filter 30 MHz (chebyshev low pass)
With the pass range 0.01... 30 MHz and a pass attenuation less than 3 dB. If the pre-selector is turned off, the two bypass relays B and C bridge the tuned filter or the 1.6 MHz low pass.

Inputs and Outputs to the Preselector
In addition to the bypass control and the 20 dB attenuator which can be switched on/off by the receive front panel, the microprocessor must also select the various filter ranges. The interface to the processor thus goes via the buffer D/A converter board. The filter ranges are connected via the output memory and driver ICs.
Tuning of the filters (position of the adjustment cores in the filter coil) is specified via an analogue voltage U_{REF} from 5 ... 10 V to the motor control circuit of the preselector which comes from the D/A converter on the buffer D/A converter board. The data for the D/A converter are stored in an EPROM on the audio board.

b) 1.6 - 4 MHz and 8 - 17 MHz Filter
This module contains two three circuit matched band filters. Each band filter is constructed on its own board. Two of the boards are compiled to a filter module.

c) 4 - 8 MHz and 17 - 30 MHz Filter
This filter module is constructed in a similar way to the filter described above, only the values of the capacitors and the coils are different.

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d) Relay board
The relays are used for switching on the relevant three circuit filter; the boards also contain the rectifier and filtering of the circuit for filter protection.

e) Motor Control Board
The matching of the band filter takes place by means of a direct current motor which is controlled by the motor control board. With the servo-potentiometer R12, a statement is obtained on the position of the coil cores in the band filter coils. Tuning cores, servo-potentiometer and motor are linked via a mechanical gear. The matching voltage U_{REF} is stored digitally in an EPROM and is converted into an analogue voltage in the D/A converter on the buffer D/A converter board. This voltage is the nominal value of the preselector. The actual position of the preselector is picked up from the servo-potentiometer. A comparator on the motor control board compares the two voltages and controls the motor in the right direction until the two voltages are matched.
The switch-on delay keeps the motor still after the mains has been switched on until all data have been delivered from microprocessor to the DA converter.

For error recognition, a comparison is carried out between the reference voltage U_{REF} of the D/A converter and the servo-potentiometer voltage. When the two voltages deviate, an error is notified. The P output then goes to LOW. When the preselector is switched off, the motor moves to the middle position, the potentiometer voltage is then
5 V + 2.5 V = 7.5 V. This value is also monitored in the voltage comparator and when it deviates it is notified as a fault.

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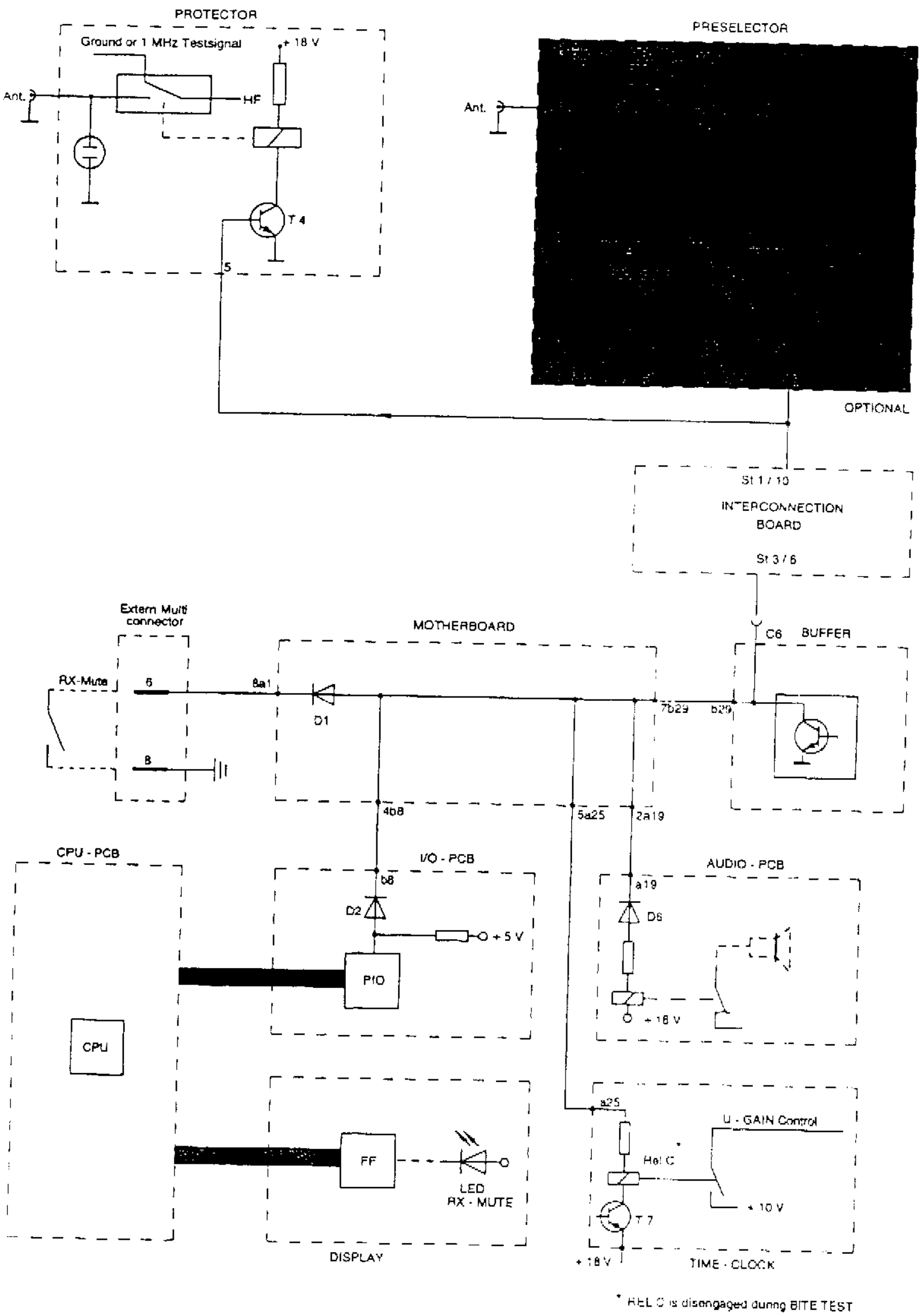

Mute Interconnection

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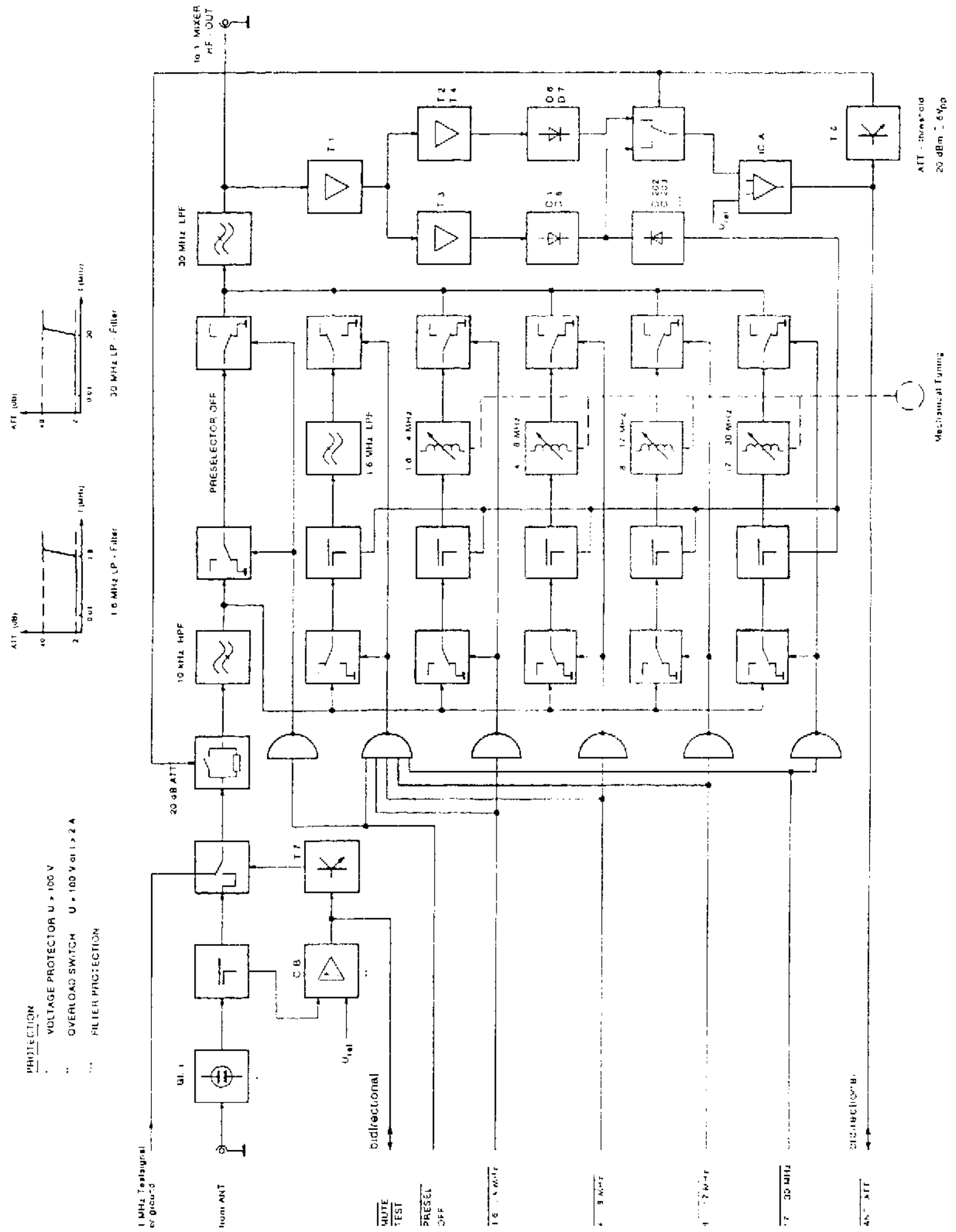

Blockdiagram Preselector

Test and alignment instructions

Required:	Circuit diagram PRESELECTOR automatic/manual Drawing No. 97 Sa B 2.140.150 B tracking generator, spectrum analyser, digital voltmeter
Test configuration and instruments:	The PRESELECTOR module remains installed. The plugs/sockets on the connections Bu 14 (IN 1 MHz TEST), Bu 12 (ANT.INPUT) and RF OUT are disconnected. Spectrum analyser: to socket RF OUT Tracking generator: to socket Bu 12 (ANT.INPUT)

Checking operation of the band-pass filters
Switch on receiver and switch on preselector; the LEDs ANT.ATT. 20 dB and RX MUTE must be off.

Spectrum analyser settings:			
	Centre frequency	20	MHz
	Span	40	MHz
	Reference level	0	dBm
	Tracking generator-level	0	dBm

Select the following frequencies on the receiver in succession:
01.000.00 MHz, 01.600.00 MHz, 04.000.00 MHz, 08.000.00 MHz, 17.000.00 MHz and 29.999.99 MHz.
Check operation of filters.

Activate RX MUTE, then select all frequencies as in item 1.
Test values:
The attenuation should increase by min. 35 dB for each filter activated.
Cancel RX MUTE, and then activate ANT.ATT. 20 dB. Switch all frequencies as in item 1.

Test values:
The attenuation should be 20 dB (tolerance +3 dB -2 dB) for each filter activated.

Cancel ANT.ATT. 20 dB and set the receiver to a frequency of 01 599.99 MHz.

Spectrum analyser settings:			
	Centre frequency	1.6	MHz
	Span	1	MHz
	Reference level	0	dBm
	Tracking generator-level	0	dBm

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Test values:
Passband attenuation < 3 dB at 1.6 MHz
Stopband attenuation > 40 dB at 1.76 MHz
Set the receiver to 1.601 MHz

Spectrum analyser settings:		
Centre frequency	50	MHz
Span	100	MHz
Reference level	0	dBm
Tracking generator-level	0	dBm

Test values:
Passband attenuation < 2 dB in the frequency rage 0 - 30 MHz
Offband attenuation > 60 dB at frequencies above 50 MHz

Alignment of the 1.6-4 MHz band-pass filter cassette
Set the receiver to a frequency of 02 700.00 MHz and check the reference voltage U_{REF}= 2.444 V (measuring on the outer pins of the servopotentiometer). If necessary, readjust the center frequency of the passband bandfilter to this frequency.
Test values:
Check reference voltage and passband characteristic of the filter, when the receiver is set to the following operating frequencies.

f(MHz)	U_{Ref}(V)
01 600.00	0.106
02 000.00	1.340
02 500.00	2.182
02 700.00	2.444
03 000.00	2.807
03 500.00	3.393
03 990.00	4.961

Spectrum analyser settings:		
Centre frequency	3	MHz
Span	6	MHz
Reference level	0	dBm
Tracking generator-level	0	dBm

Set the receiver to a frequency of 1.600.00 MHz

Spectrum analyser settings:		
Centre frequency	1.6	MHz
Span	0.5	MHz
Reference level	0	MHz
Tracking generator-level	0	dBm

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Test values:
Passband attenuation should be < 10 dB.
Adjust the reference level of the spectrum analyser in a manner that the passband of the filter touches the 0 dB reference line.
Measure the attenuation at f = 1.44 MHz and f = 1.76 MHz.
Stopband attenuation should be > 40 dB.

Set the receiver to 2.700.00 MHz.

Spectrum analyser settings:	Centre frequency	2.7 MHz
	Span	0.5 MHz
	Reference level	0 dBm
	Tracking generator-level	0 dBm

Test values:
Passband attenuation should be < 10 dB.
Adjust the filter pass curve on to the reference line on the spectrum analyser and measure the stopband attenuation at f = 2.43 MHz and f = 2.97 MHz.
Stopband attenuation should be > 40 dB.

Alignment of the 4-8 MHz band-pass filter cassette
Tune the receiver to 06.000.00 MHz and check the reference voltage U_{REF}= 3.090 V. If necessary, adjust the center frequency of band filter to this frequency.

Test values:
Check the reference voltage and passband characteristics, set the receiver to the following operating frequencies.

f(MHz)	U_{REF}(V)
04.000.00	1.650
04.500.00	2.254
05.000.00	2.596
05.500.00	2.858
06.000.00	3.090
06.500.00	3.309
07.000.00	3.541
07.500.00	3.841
07.980.00	5.041

Spectrum analyser settings:	Centre frequency	6 MHz
	Span	6 MHz
	Reference level	0 dBm
	Tracking generator-level	0 dBm

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Tune receiver to 04.000.00 MHz.

Spectrum analyser settings:

Centre frequency	4	MHz
Span	2	MHz
Reference level	0	dBm
Tracking generator-level	0	dBm

Test values:
Passband attenuation should be < 10 dB.
Adjust the filter pass curve on to the reference line on the spectrum analyser and measure the stopband attenuation at f = 3.6 MHz and f = 4.4 MHz.
Stopband attenuation should be > 40 dB.

Tune receiver to 06.000.00 MHz.

Spectrum analyser settings:

Centre frequency	6	MHz
Span	2	MHz
Reference level	0	dBm
Tracking generator-level	0	dBm

Passband attenuation should be < 10 dB.
Adjust the filter pass curve on to the reference line on the spectrum analyser and measure the stopband attenuation at f = 5.4 MHz and f = 6.6 MHz.
Stopband attenuation should be > 40 dB.

Alignment of the 8-17 MHz band-pass filter cassette
Set the receiver to 12.500.00 MHz and check the reference voltage U_{REF} = 2.613 V. If necessary, adjust the center frequency of band filter to this frequency.
Test values:
Check reference voltage and passband characteristics, set the receiver to the following operating frequencies.

f(MHz)	U_{REF}(V)
8.0	0.495
9.0	1.548
10.0	1.978
11.0	2.269
12.5	2.613
14.0	2.929
15.0	3.153
16.0	3.452
16.95	4.704

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Spectrum analyser settings:

Centre frequency	13.5	MHz
Span	20	MHz
Reference level	0	dBm
Tracking generator level	0	dBm

Tune the receiver to 08.000.00 MHz (U_{REF} = 0.495 V)

Spectrum analyser settings:

Centre frequency	8	MHz
Span	2	MHz
Reference level	0	dBm
Tracking generator-level	0	dBm

Test values:
Passband attenuation should be < 10 dB.
Adjust the filter pass curve on to the reference line on the spectrum analyser and measure the stopband attenuation at f = 7.2 MHz and f = 8.8 MHz.
Stopband attenuation should be > 40 dB.

Alignment of the 17-30 MHz band-pass filter cassettes
Tune the receiver to 23.500.00 MHz and check reference voltage U_{REF} = 2.193 V. If necessary, adjust the band filter to this frequency.
Test values:
Check reference voltage and passband characteristics, set the receiver to the following operating frequencies.

f(MHz)	U_{REF}(V)
17.000.00	0.103
19.000.00	0.889
21.000.00	1.513
23.500.00	1.193
25.000.00	2.573
27.000.00	3.103
29.000.00	3.813
29.900.00	4.900

Spectrum analyser settings:

Centre frequency	23.5	MHz
Span	20	MHz
Reference level	0	dBm
Tracking generator-level	0	dBm

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Tune receiver to 17.000.00 MHz.

Spectrum analyser settings:

Centre frequency	17.0	MHz
Span	5	MHz
Reference level	0	dBm
Tracking generator-level	0	dBm

Test values:
Passband attenuation should be < 10 dB.
Adjust the filter pass curve on to the reference line on the spectrum analyser and measure the stopband attenuation at f = 15.30 MHz and f = 18.70 MHz.

Tune receiver to 23.500.00 MHz.

Spectrum analyser settings:

Centre frequency	23.50	MHz
Span	10	MHz
Reference level	0	dBm
Trecking generator-level	0	dBm

Test values:
Passband attenuation should be < 10 dB.
Adjust the filter pass curve on to the reference line on the spectrum analyser and measure the stopband attenuation at f = 21.25 MHz and f = 25.85 MHz.
Stopband attenuation should be > 40 dB.

NOTE
All tuning slugs in the band filters are secured with paint.
After adjusting apply paint again.

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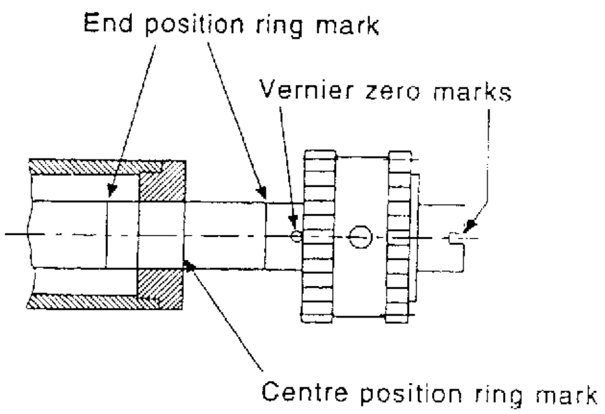
Mechanical centering of preselector
If due to a faulty D/A converter or a faulty motor control PCB the moving plate runs to a dead stop, the friction clutch on the potentiometer shaft may have slipped. The preselector ends up in a latched condition and can only be reset by mechanically moving the moving plate towards center position.

Misalignment between filter and potentiometer will be recognized when all filters are detuned to one direction of the center frequency. Tuning can be accomplished by fixing the potentiometer shaft with a 14 mm open end spanner and tuning the filter to the proper center frequency again. Before the preselector is tuned in the factory it will be electromechanically centered, i. e. at a ref voltage of 2.56 V the preselector has to move to the mechanical center position. This circumstance can help to retune a preselector.

The receiver generates exactly 2.56 V when the preselector is switched off from the frontpanel. The mechanical center position can be recognized, if the nut connected to the moving plate just covers the center ring on the shaft, and the vernier mark is positioned on top.



Moving plate at centre position

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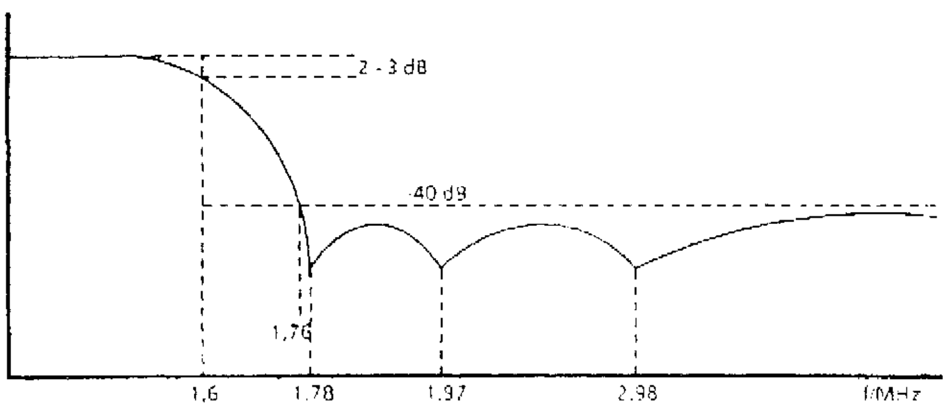
Test and alignment instructions (LP Protector)

Required:	Circuit diagram PRESELECTOR automatic/manual - drawing No. 97 Sa B.140.150 B spectrum analyser, tracking generator
Test configuration	Remove PRESELECTOR module and reconnect flat cable to receiver. Connect socket Bu 12 ANT.INPUT to trecking generator. (Test configuration No. 1) Switch on preselector (PRESL. ON 21), tune the receiver to f < 01.600.00 MHz; e.g. 01.000.00 MHz.

Tracking generator settings:	Output level	0	dBm
	Centre frequency	3	MHz
	Span	6	MHz

Connect spectrum analyser to socket CA 1 RF OUT.

Testing the 1.6 MHz low-pass filter
Test values:
Adjust the passband of the low-pass filter to the reference line of the spectrum analyser. Three discontinuities will be observed in the stopband of the low-pass filter; these must be aligned with the tuning slugs of coils L 12, 13 and 14, the overall frequency response conforming to the following curve:



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Testing the 30 MHz low-pass filter

Set the test equipment to PRESEL.OFF. Connect the equipment "Impedancer" as shown in test configuration No. 2, but without link C.

Spectrum analyser settings:	Centre frequency	20	MHz
	Span	40	MHz
	Tracking generator-level	0	dBm

The spectrum analyser display shows a line, adjust it on to the 0 dBm reference line. Insert link C, the reflection loss is displayed.
Test values: In the frequency range up to 30 MHz the reflection loss should be > 15 dB. Reaching this reflection loss is obtained by squeezing the two outer coils and lengthening the pitch of the turns of the three inner coils. Compare the spectrum analyser's display after each new alignment with the stored display of the alignment action before.

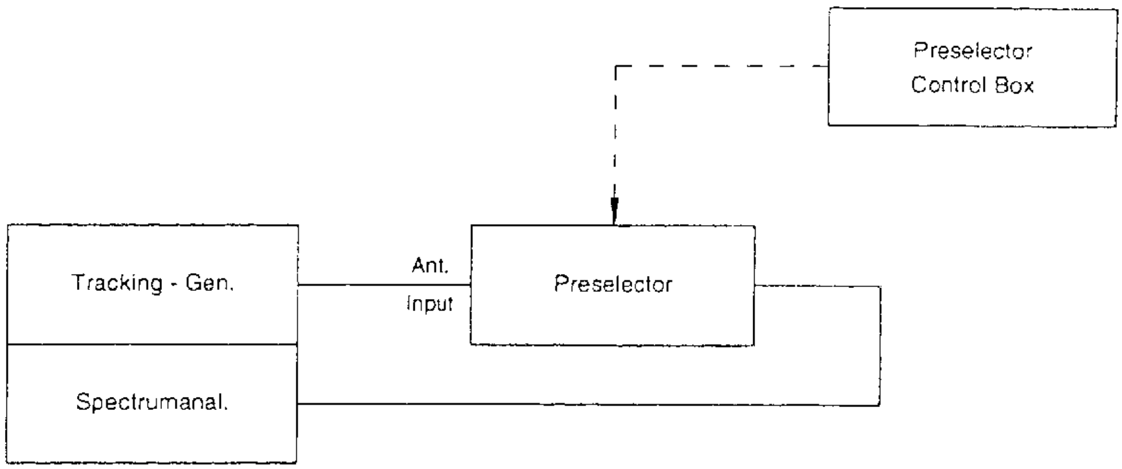
Check the MUTE-function. Activate MUTE, connect pin 6 with pin 8 of the EXTERNAL connector. Connect the spectrum analyser's input to CA 1 and the tracking generator to the antenna input connector.
Test value: Attenuation should be > 35 dB.

Check the connection between BU 14 and CA 1, if the MUTE selector of the test equipment is switched to position ON. (BU 13 pin 5 is now +18 V DC)
Connect a high power Rf-signal generator and an oscilloscope to the antenna input connector. Set the Rf-signal generator to f = 4.2 MHz and connect a terminal resistor of 50 ohms to CA 1.
Set the test equipment selector to position "PRES. OFF"
Increase the input level until the 20 dB attenuator is switched on at a level of 125 ... 135 $dB\mu V_{EMK}$, resp. 2.5 ... 7.95 V_{pp}.

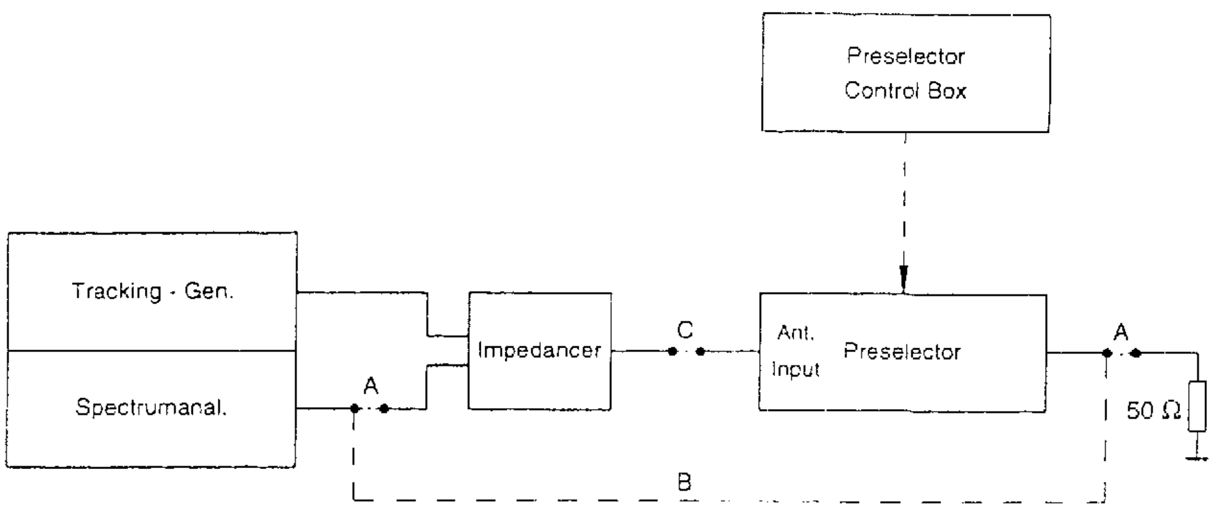
-Preselector-

Test configuration

Test configuration No. 1

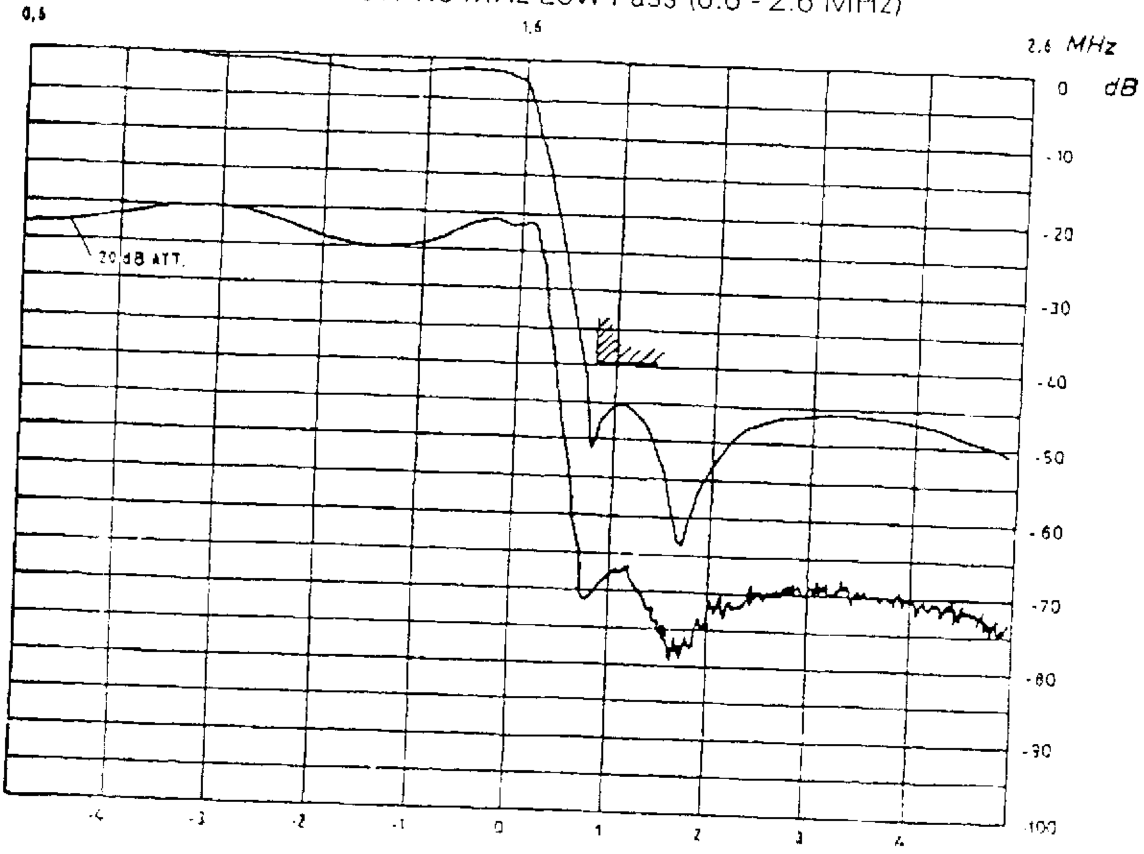


Test configuration No. 2

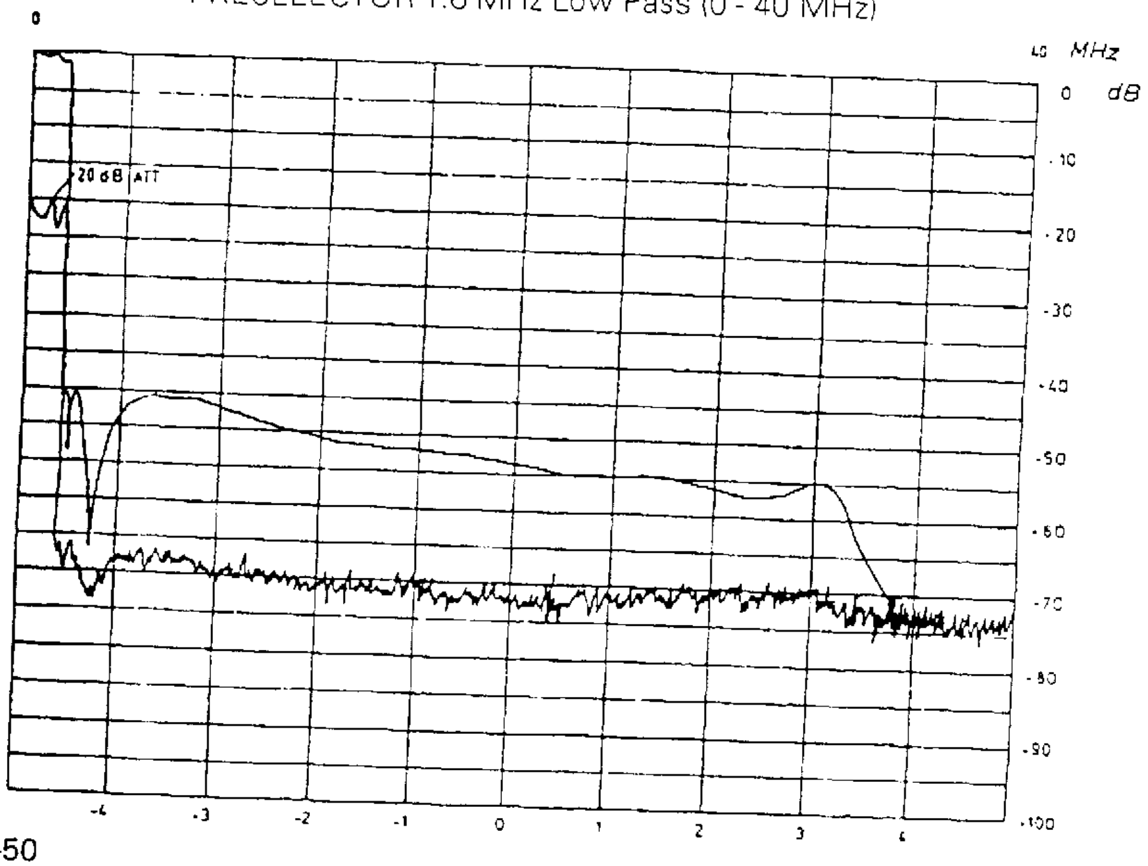


-Preselector-

PRESELECTOR 1.6 MHz Low Pass (0.6 - 2.6 MHz)



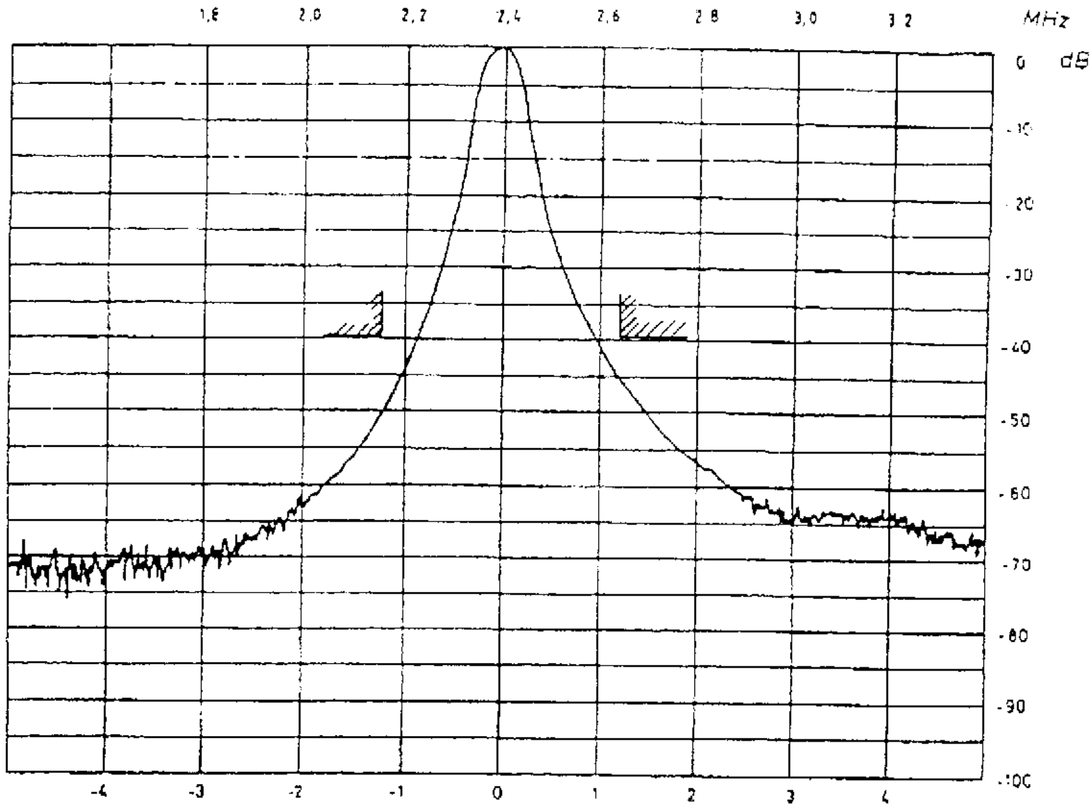
PRESELECTOR 1.6 MHz Low Pass (0 - 40 MHz)



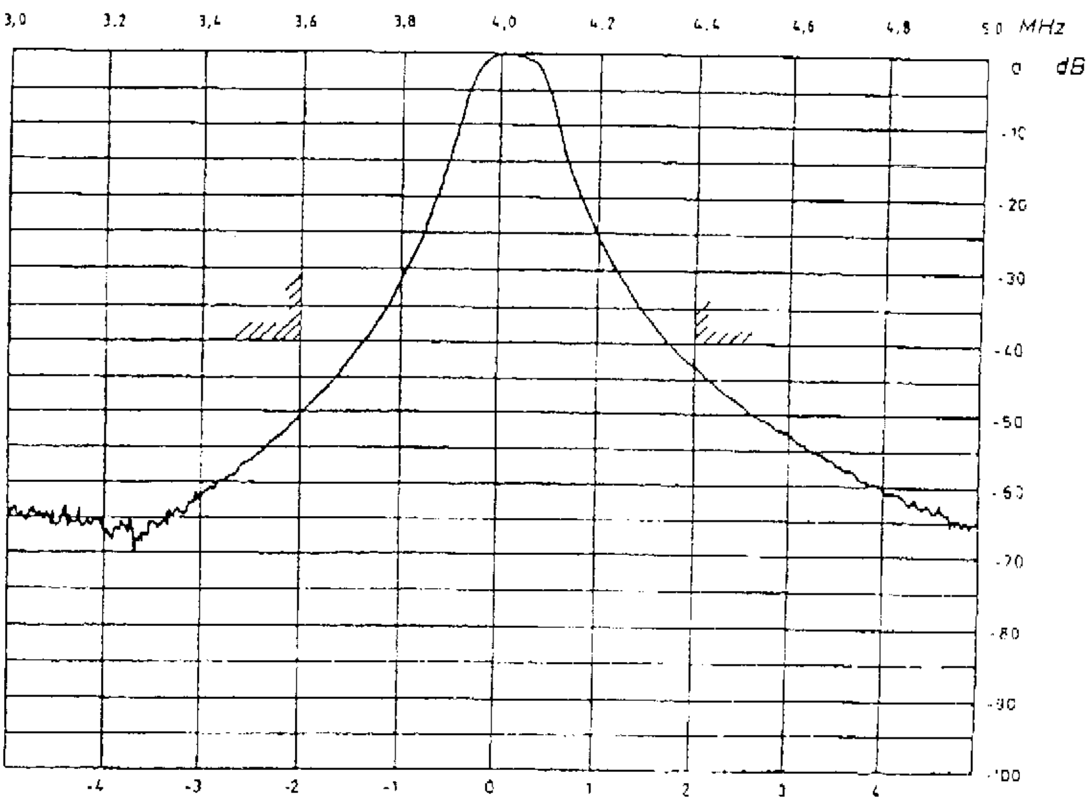
HAG/ROD 016-09.92

-Preselector-

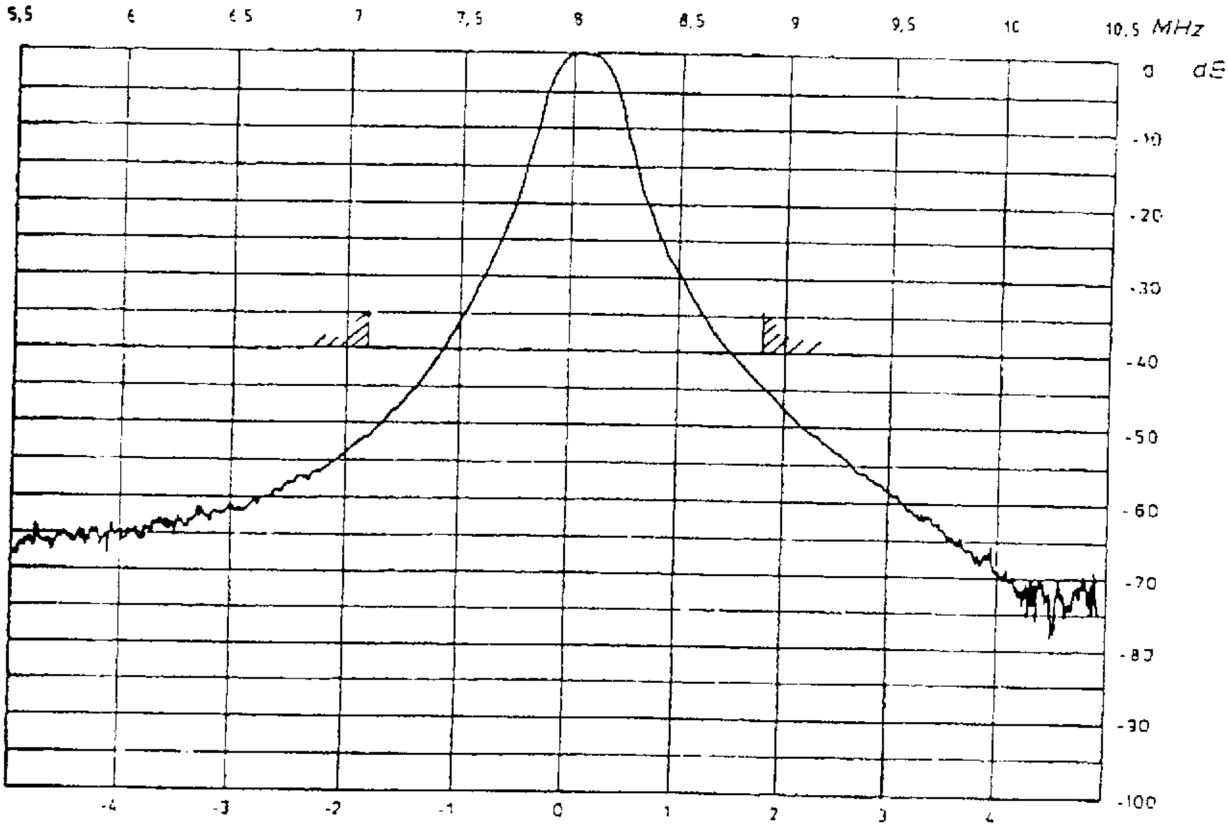
PRESELECTOR 2.4 MHz Insertion Loss 5.5 dB



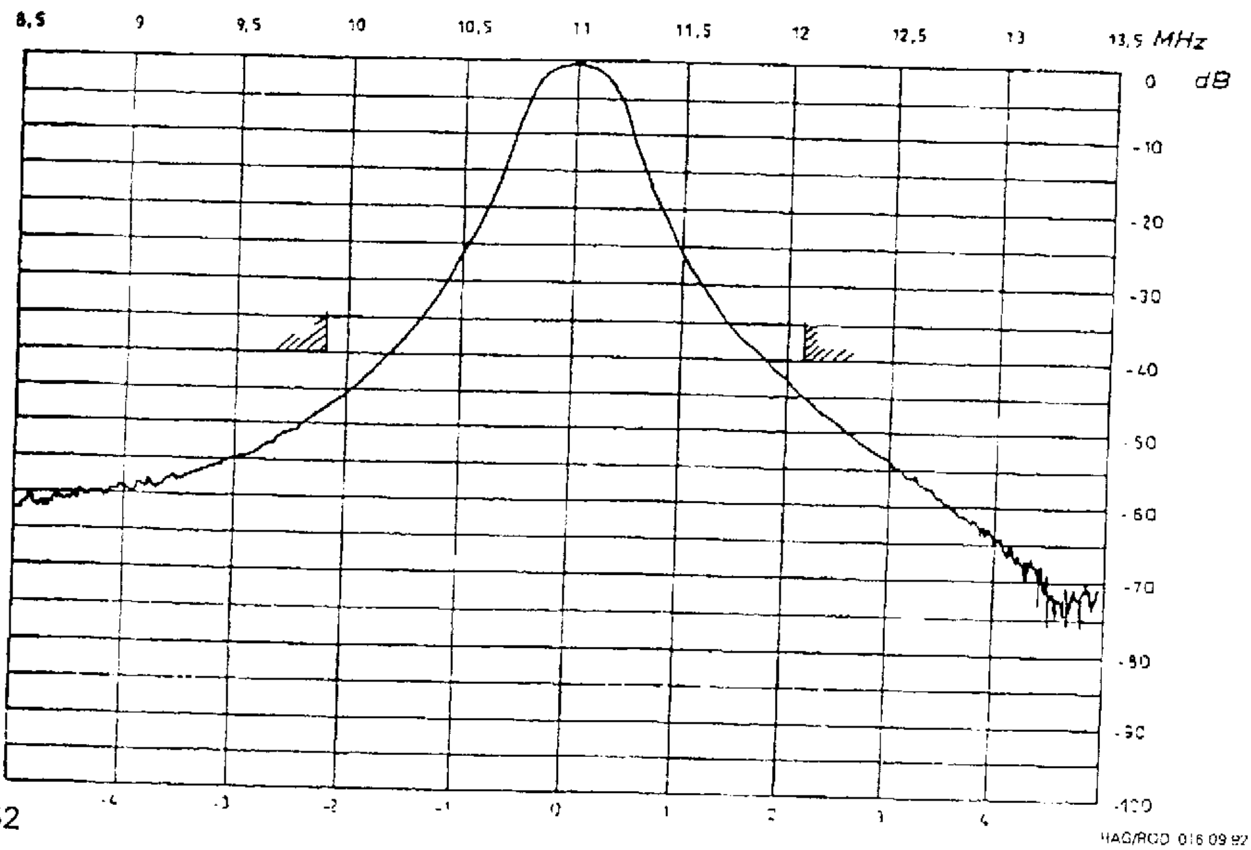
PRESELECTOR 4.0 MHz Insertion Loss 4.7 dB



PRESELECTOR 8 MHz Insertion Loss 6 dB

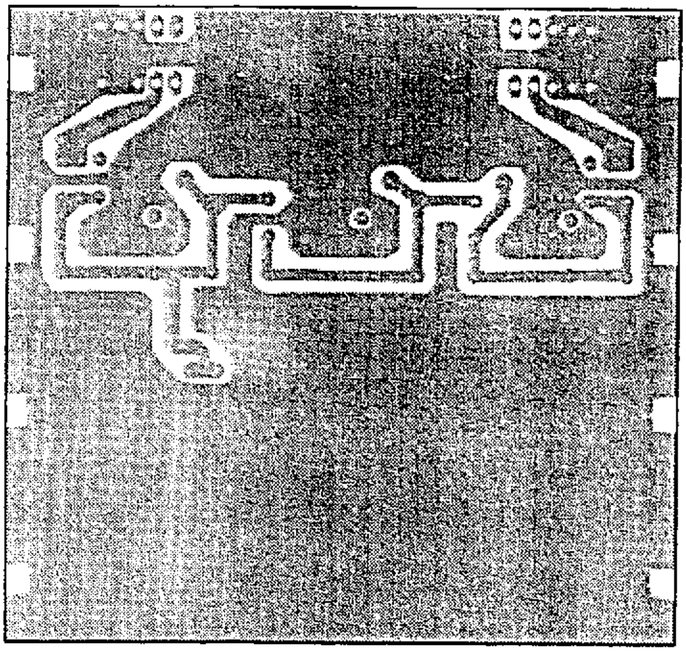


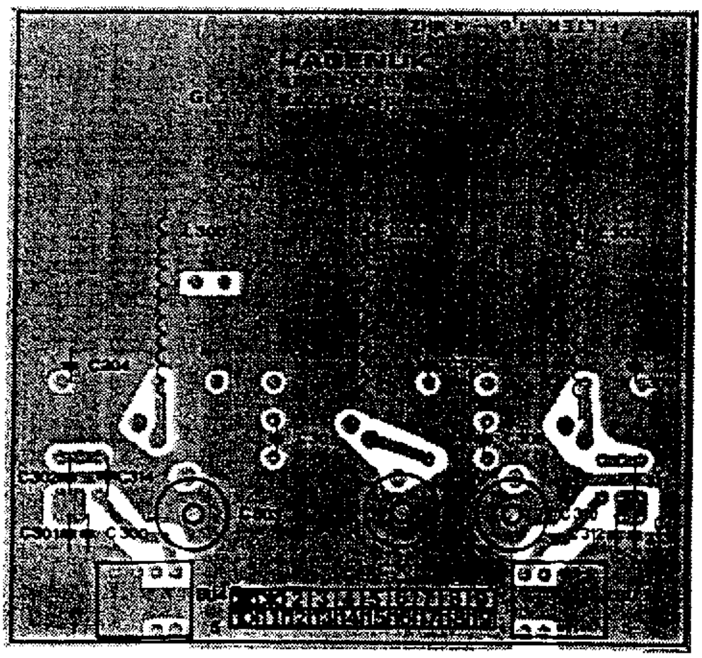
PRESELECTOR 11 MHz Insertion Loss 6.3 dB



-Preselector-

see circuit diagram - PRESELECTOR 97 Sa B 2.140.150 B

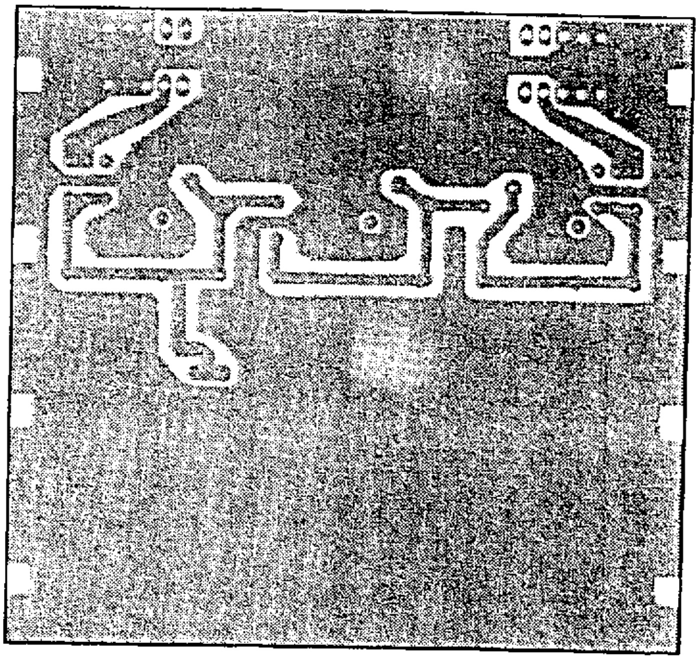


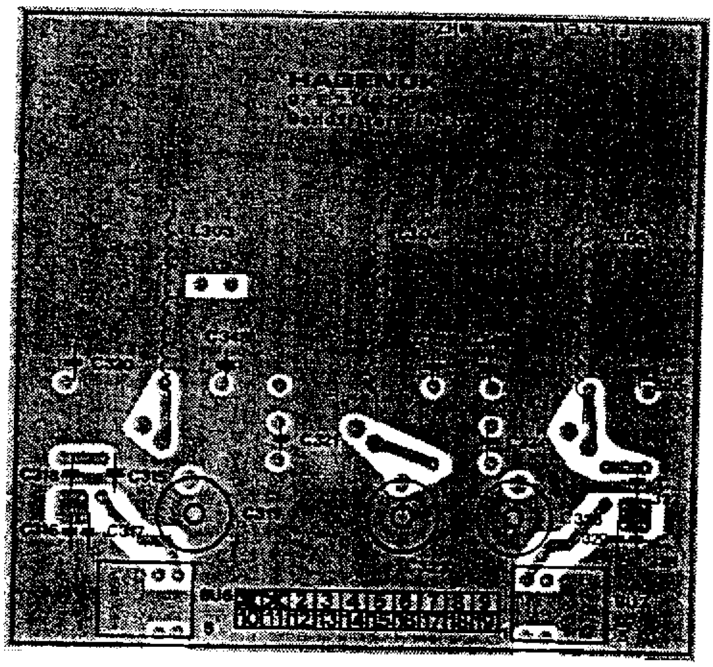


1.6-4 MHz Filter - 97 E 2.145.60-1

-Preselector-

see circuit diagram - PRESELECTOR 97 Sa B 2.140.150 B

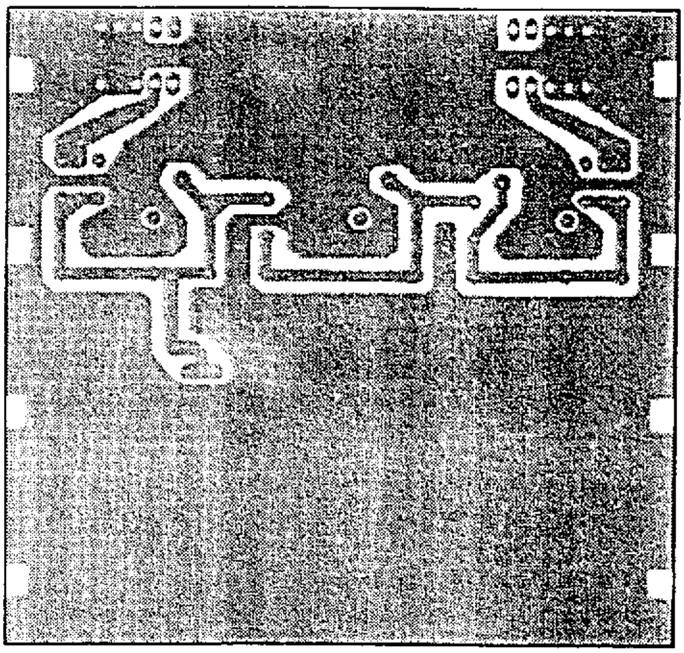


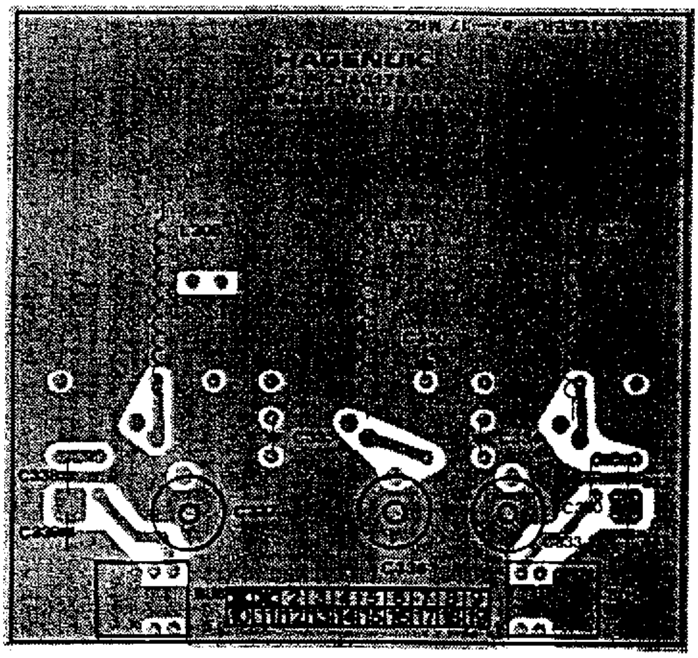


4-8 MHz Filter - 97 E 2.140.170

-Preselector-

see circuit diagram - PRESELECTOR 97 Sa B 2.140.150 B

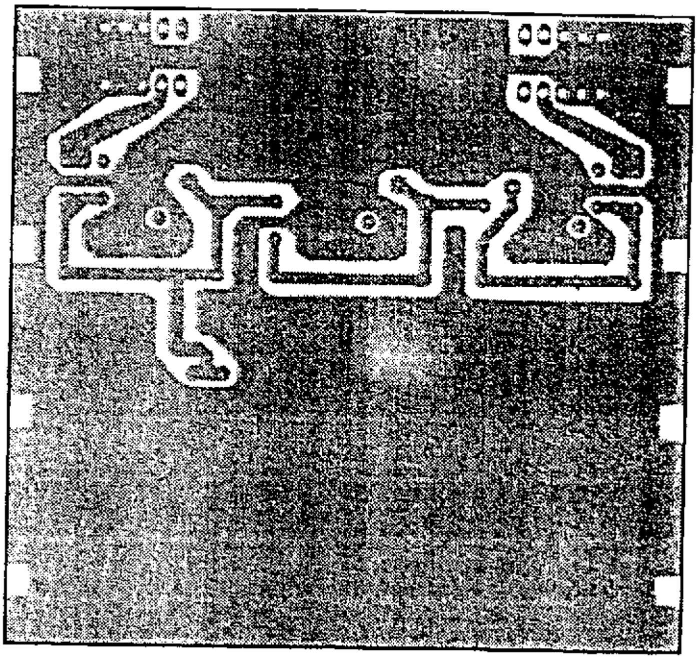


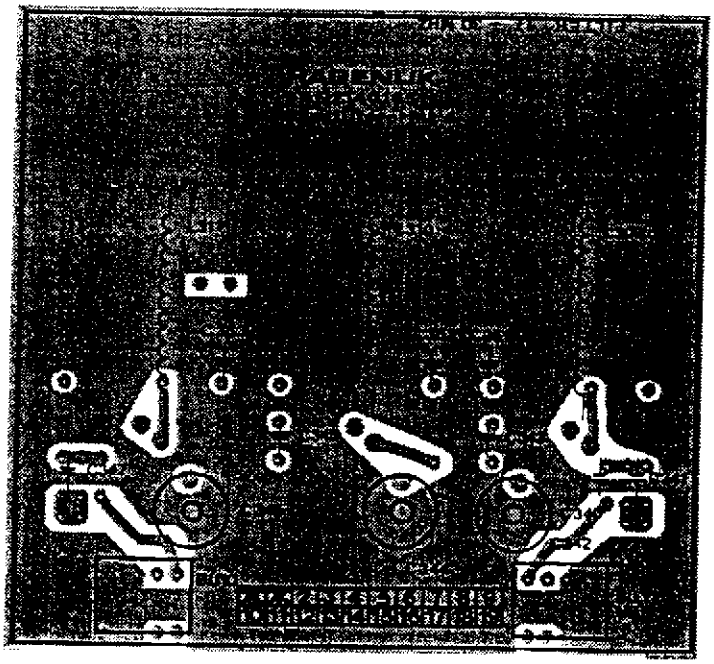


8-17 MHz Filter - 97 E 2.140.178

-Preselector-

see circuit diagram - PRESELECTOR 97 Sa B 2.140.150 B

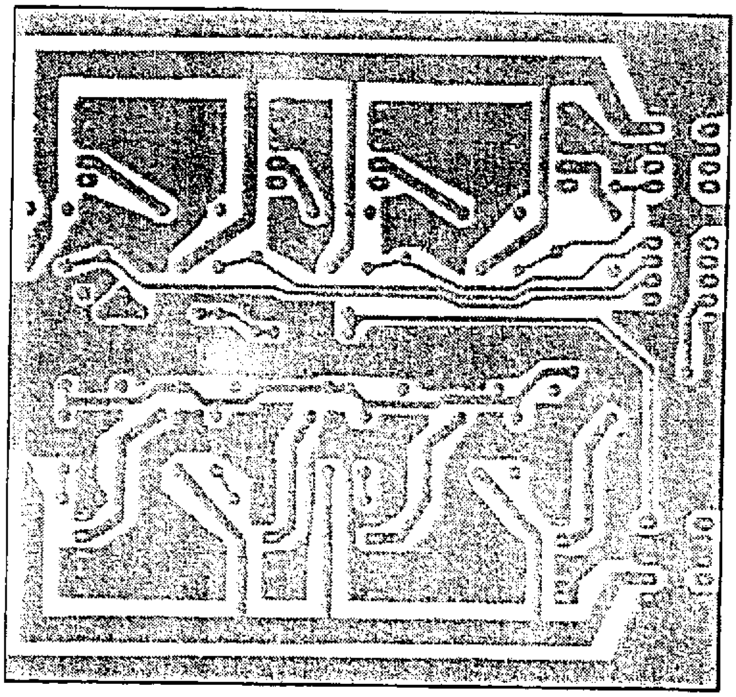


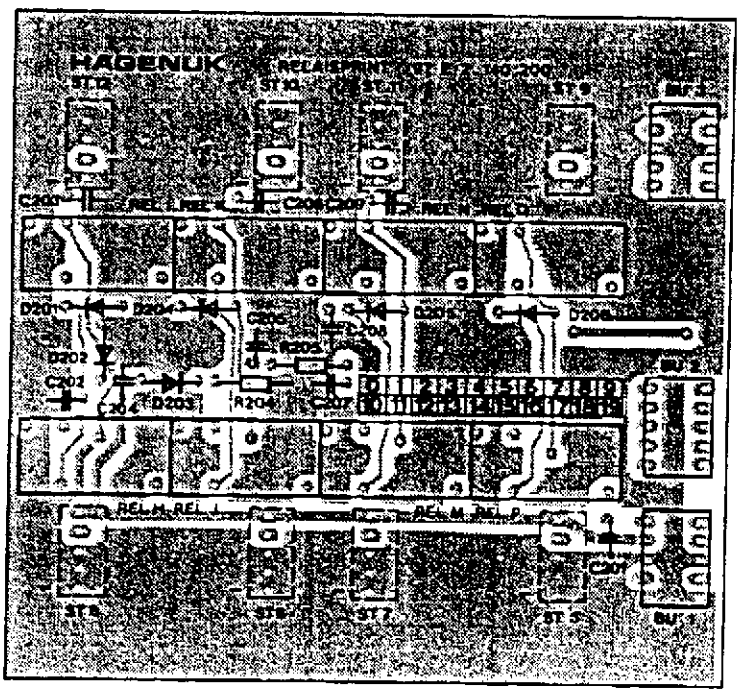


17-30 MHz Filter - 97 E 2.140.185

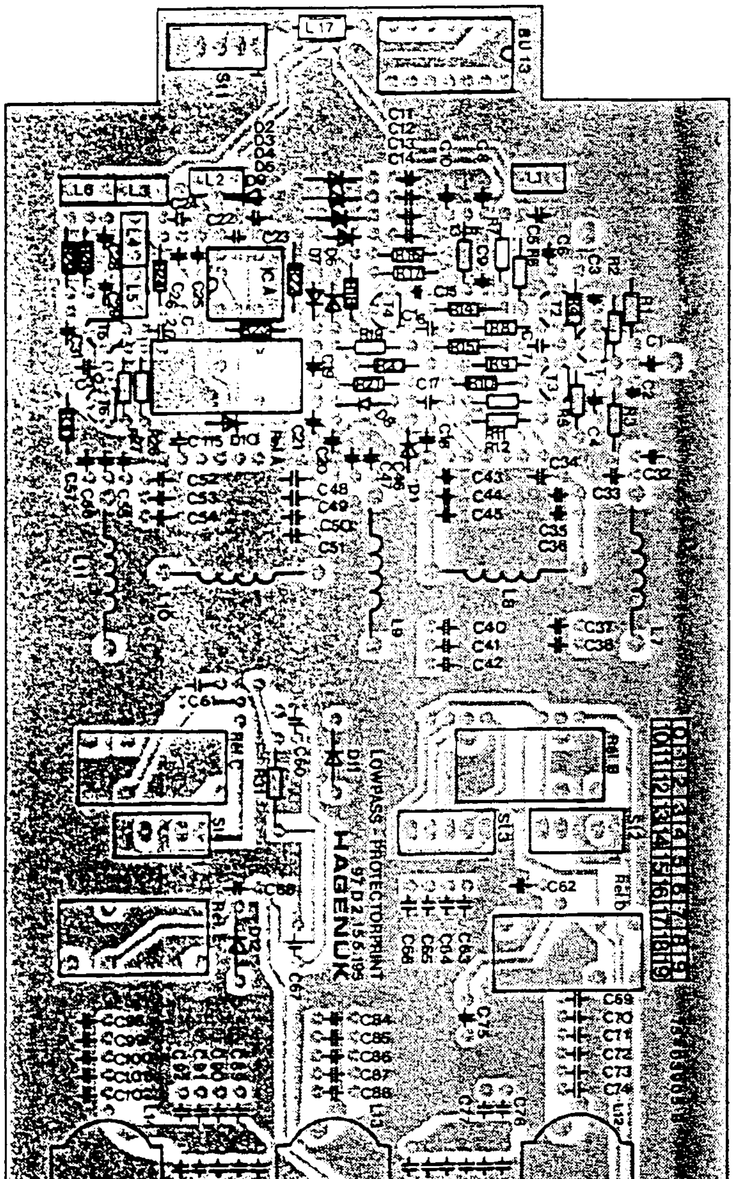
-Preselector-

see circuit diagram - PRESELECTOR 97 Sa B 2.140.150 B

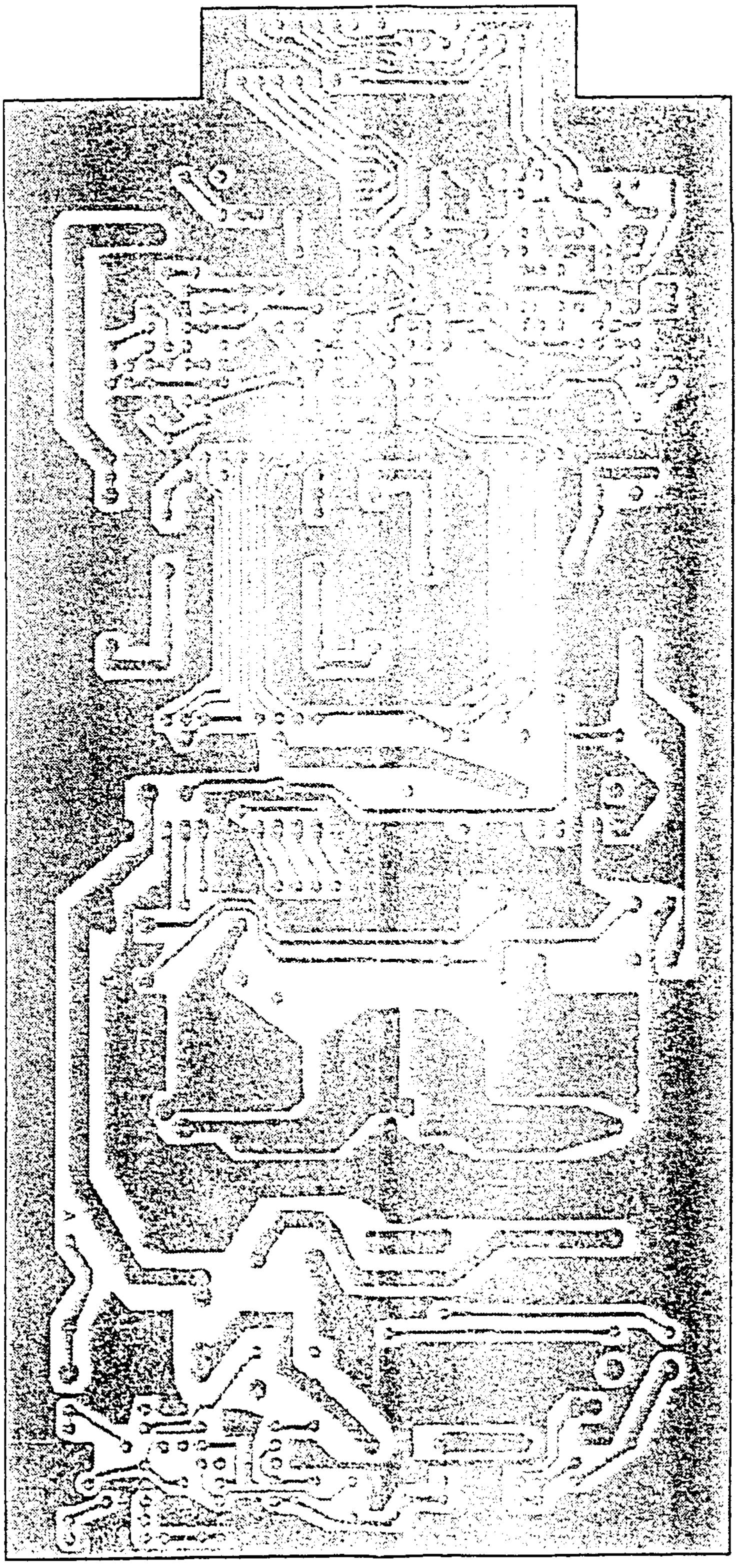




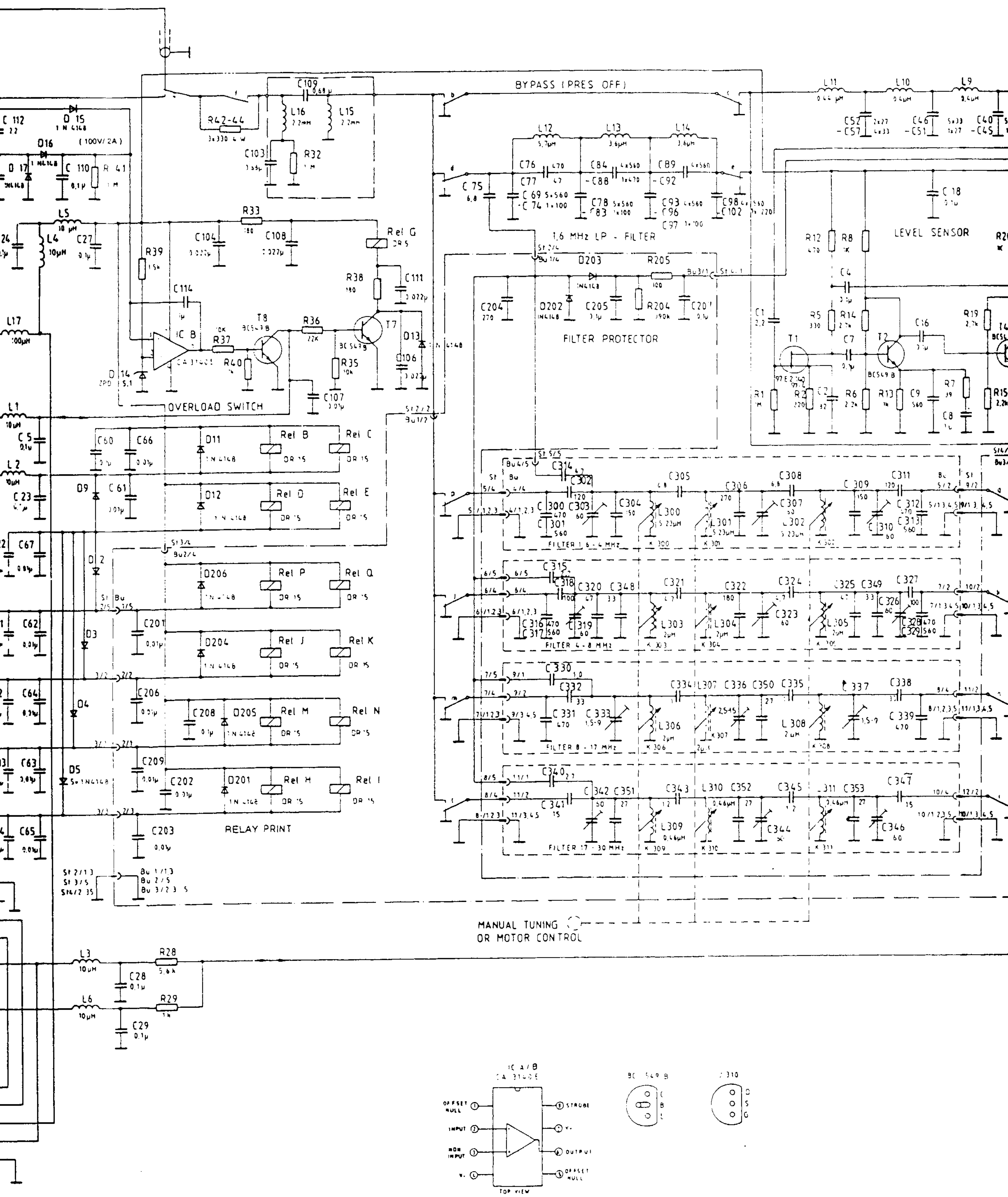
Relay Board - 97 E 2.140.200


LOWPASS - PROTECTORPRINT
97.D2.156.195
HAGENUK

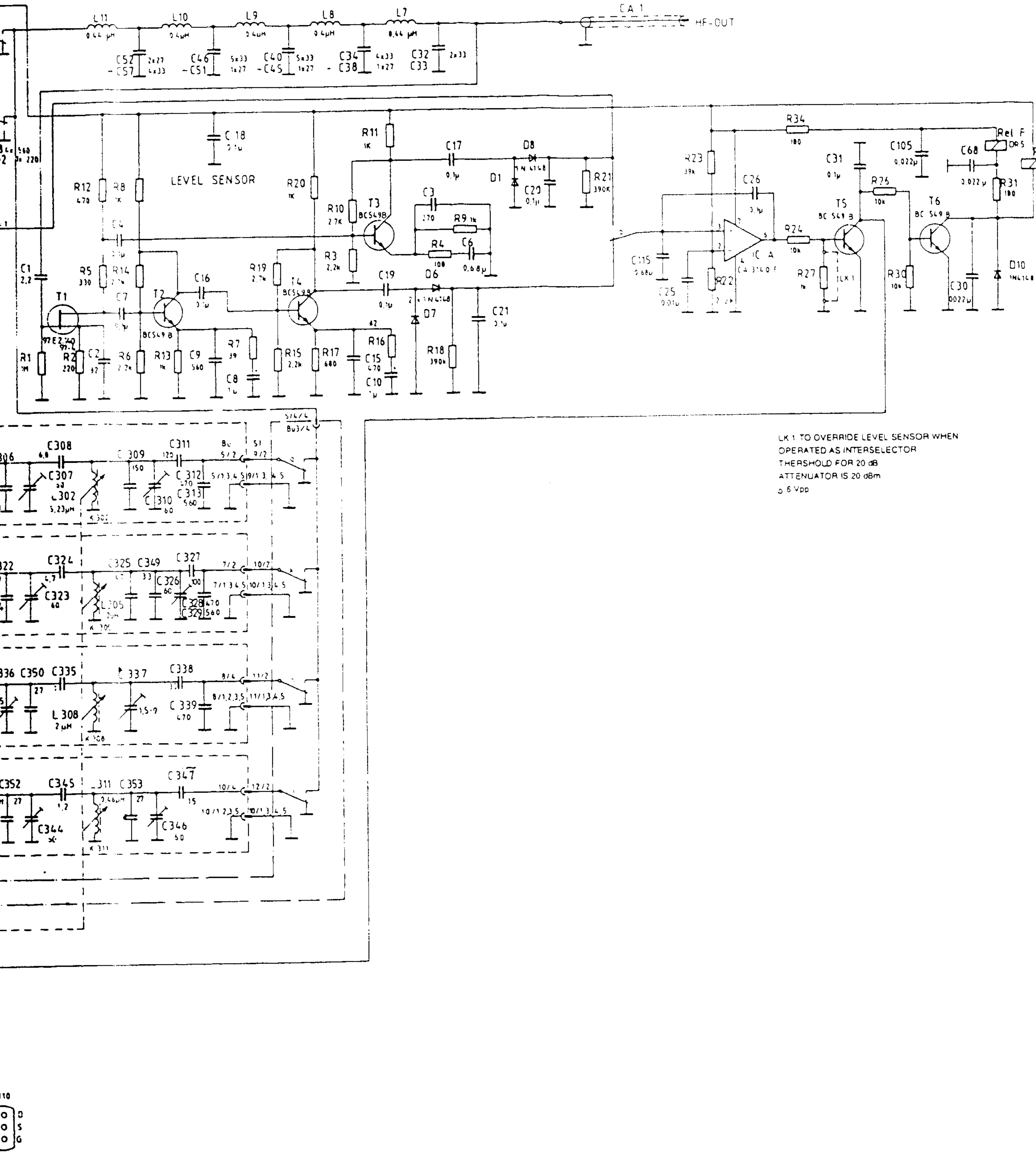
see circuit diagram - PRESELECTOR 97 Sa B 2.140.150



Printed Circuit Board
LP-Protector
97 C 2.155.195



BYPASS (PRES OFF)
1,6 MHz LP - FILTER
FILTER PROTECTOR
OVERLOAD SWITCH
LEVEL SENSOR
RELAY PRINT
FILTER 1,6 - 4 MHz
FILTER 4 - 8 MHz
FILTER 8 - 17 MHz
FILTER 17 - 30 MHz
MANUAL TUNING
OR MOTOR CONTROL
IC A/B
CA 3140E
OFFSET NULL
INPUT
NON INPUT
STROBE
OUTPUT
TOP VIEW



PRESELECTOR
Circuit Diagram
97 Sa B 2.140.150 B

Ident-No.	Mark	Electr. value	Identity	Manufacturer

Capacitors

1521.691	C1	2,2 pF/2 %/500 V	EDPU 222265010228	VALVO
1116.231	C2	82 pF/2 %/63 V	EDPU DIN 41923	VALVO
1157.108	C3	270 pF/2 %/63 V	EDPU N 750-IB	VALVO
1423.037	C4	0,1 µ1/20 %/63 V	MKS 2	WIMA
1505.629	C6	0,68 µ/10 %/50 V	MKS 2	WIMA
1423.037	C7	0,1 µ/20 %/63 V	MKS 2	WIMA
1453.173	C8	1 µ/20 %/25 V	SAL 122	VALVO
1115.804	C9	560 pF/2 %/63 V	EDPU N 1500	VALVO
1453.173	C10	1 µF/20 %/25 V	SAL 122	VALVO
	C11	0,1 µ/50 V	CK 05 BX 104 K	
	C12	0,1 µ/50 V	CK 05 BX 104 K	
	C13	0,1 µ/50 V	CK 05 BX 104 K	
	C14	0,1 µ/50 V	CK 05 BX 104 K	
0945.757	C15	470 pF/10 %/63 V	EDPU 0,6 N 1500	VALVO
1423.037	C16	0,1 µ/20 %/63 V	MKS 2	WIMA
1423.037	C17	0,1 µ/20 %/63 V	MKS 2	WIMA
1423.037	C18	0,1 µ/20 %/63 V	MKS 2	WIMA
1423.037	C19	0,1 µ/20 %/63 V	MKS 2	WIMA
1423.037	C20	0,1 µ/20 %/63 V	MKS 2	WIMA
1423.037	C21	0,1 µ/20 %/63 V	MKS 2	WIMA
1078.615	C22	0,1 µ/50 V	CK 05 BX 104 K	
1078.615	C23	0,1 µ/50 V	CK 05 BX 104 K	
1078.615	C24	0,1 µ/50 V	CK 05 BX 104 K	
1425.196	C25	0,01 µ/20 %/63 V	MKS 2 RM 5	WIMA
1423.037	C26	0,1 µ/20 %/63 V	MKS 2	WIMA
1078.615	C27	0,1 µ/50 V	CK 05 BX 104 K	
1078.615	C28	0,1 µ/50 V	CK 05 BX 104 K	
1078.615	C29	0,1 µ/50 V	CK 05 BX 104 K	
	C30	0,022 µ/20 %/63 V	MKS 2	WIMA
1423.037	C31	0,1 µ/20 %/63 V	MKS 2	WIMA
1425.145	C32	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C33	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C34	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C35	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C36	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C 37	33 pF/2 %/500 V	EDPU 222265010339	VALVO
	C38	27 pF/2 %/500 V	EDPU 222265010279	VALVO
1425.145	C40	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C41	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C42	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C43	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C44	33 pF/2 %/500 V	EDPU 222265010339	VALVO
	C45	27 pF/2 %/500 V	EDPU 222265010279	VALVO

-Preselector- Automatic/Manual

Parts lists No.
97 Sa 2.140.150 B

Ident-No.	Mark	Electr. value	Identity	Manufacturer
1425.145	C46	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C47	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C48	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C49	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C50	33 pF/2 %/500 V	EDPU 222265010339	VALVO
	C51	27 pF/2 %/500 V	EDPU 222265010279	VALVO
	C52	27 pF/2 %/500 V	EDPU 222265010279	VALVO
	C53	27 pF/2 %/500 V	EDPU 222265010279	VALVO
1425.145	C54	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C55	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C56	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C57	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1423.037	C60	0,1 µ/20 %/63 V	MKS 2	WIMA
1425.196	C61	0,01 µ/20 %/63 V	MKS 2	WIMA
1425,196	C62	0,01 µ/20 %/63 V	MKS 2	WIMA
1425.196	C63	0,01 µ/20 %/63 V	MKS 2	WIMA
1425.196	C64	0,01 µ/20 %/63 V	MKS 2	WIMA
1425.196	C65	0,01 µ/20 %/63 V	MKS 2	WIMA
1425.196	C66	0,01 µ/20 %/63 V	MKS 2	WIMA
1425.196	C67	0,01 µ/20 %/63 V	MKS 2	WIMA
	C68	0,022 µ/20 %/63 V	MKS 2	WIMA
	C69	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C70	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C71	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C72	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C73	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C74	100 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C75	6,8 pF/2 %/500 V	EDPU 222265010688	VALVO
	C76	470 pF/2 %/200 V	COG 8131A-200/001-COG-471 G	ERIE
	C77	47 pF/2 %/500 V	EDPU 222265010479	VALVO
	C78	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C79	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C80	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C81	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE

Parts lists No.
97 Sa 2.140.150 B

-Preselector- Automatic/Manual

dent-No.	Mark	Electr. value	Identity	Manufacturer
	C82	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C83	100 pF/2 %I200 V	COG 8131A-200/001-COG-101 G	ERIE
	C84	560 pF/2 %/200 V	COG 8131A-200/001-COG-561	ERIE
	C85	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C86	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C87	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C88	470pF/2%/200 V	COG 8131A-200/001-COG-471 G	ERIE
	C89	560pF/2%/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C90	560pF/2%/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C91	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C92	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C93	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C 94	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C95	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C96	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C97	100 pF/2%/200 V	COG 8131A-200/001-COG-101 G	ERIE
	C98	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C99	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C100	560pF/2%/200 V	COG 8131A-200/001-COG-561 G	ERIE
1521.586	C101	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
1521.683	C102	220 pF/2 %/200 V	COG 8131A-200/001-COG-221 G	ERIE
1179.225	C103	0,68 µF/5 %/100 V	B 32540-A1684 J	SIEMENS
1445.596	C104	0,022 µ/20 %/63 V	MKS 2	WIMA
1445.596	C105	0,022 µ/20 %/63 V	MKS 2	WIMA

-Preselector- Automatic/Manual

Parts lists No.
97 Sa 2.140.150 B

Ident-No.	Mark	Electr. value	Identity	Manufacturer
1445.596	C106	0,022 µ/20 %/63 V	MKS 2	WIMA
1425.196	C107	0,01 µ/20 %/63 V	MKS 2	WIMA
1445.596	C108	0,022 µ/20 %/63 V	MKS 2	WIMA
1179.225	C109	0,68 µF/5 %/100 V	B 32540-A1684 J	SIEMENS
1423.037	C110	0,1 µ/20 %/63 V	MKS 2	WIMA
1445.596	C111	0,022 µ/20 %/63 V	MKS 2	WIMA
1521.691	C112	2,2 pF/2 %/500 V	EDPU 222265010228	VALVO
1521.705	C113	100 pF/2 %/100 V	EDPU RM 5 2222638-10101	VALVO
1479.644	C114	1 µF/10 %/50 V	MKS 2	WIMA
1505.629	C115	0,68 µ/10 %/50 V	MKS 2	WIMA
1425.196	C201	0,01 µ/20 %/63 V	MKS 2	WIMA
1425.196	C202	0,01 µ/20 %/63 V	MKS 2	WIMA
1425.196	C203	0,01 µ/20 %/63 V	MKS 2	WIMA
	C204	270 pF/2 %/200 V	COG 8131A-200/001-COG-271 G	ERIE
1423.037	C205	0,1 µ/20 %/63 V	MKS 2	WIMA
1425.196	C206	0,01 µ/20 %/63 V	MKS 2	WIMA
1423.037	C207	0,1 µ/20 %/63 V	MKS 2	WIMA
1423.037	C208	0,1 µ /20 %/63 V	MKS 2	WIMA
	C209	0,01 µ/20 %/63 V	MKS 2	WIMA
	C300	470 pF/2 %/200 V	COG 8131A-200/001-COG-471 G	ERIE
	C301	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
	C302	120 pF/2 %/500 V	4815F/120/2/500	JAHRE
	C303	4,5-60 pF/200 V	119.4901.060	DAU
	C304	150 pF/2 %/500 V	4815/F150/2/500	JAHRE
	C305	6,8 pF/2 %/500 V	EDPU 222265010688	VALVO
	C306	270 pF/2 %/500 V	4815F/270/2/500	JAHRE
	C307	4,5-60 pF/200 V	119.4901.060	DAU
	C308	6,8 pF/2 %/500 V	EDPU 222265010688	VALVO
	C309	150 pF/2 %/500 V	4815/F/150/2/500	JAHRE
	C310	4,5-60 pF/200 V	119.4901.060	DAU
	C311	120 pF/2 %/500 V	4815/F/120/2/500	JAHRE
	C312	470 pF/2 %/200 V	COG 8131A-200/001-COG-471 C	ERIE
	C313	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 C	ERIE
	C314	4,7 pF/2 %/500 V	EDPU 222265010478	VALVO
	C315	2,7 pF/2 %/500 V	EDPU 222265010278	VALVO
1521.578	C316	470 pF/2 %/200 V	COG 8131A-200/001-COG-471 G	ERIE

-Preselector- Automatic/Manual

Parts lists No.
97 Sa 2.140.150 B

Ident-No.	Mark	Electr. value	Identity	Manufacturer
1521.586	C317	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
1521.594	C318	100 pF/2 %/500 V	4815/F/100/2/500	JAHRE
1521.543	C319	4,5-60 pF/200 V	119.4901.060	DAU
1521.527	C320	47 pF/2 %/500 V	EDPU 222265010479	VALVO
1425.188	C321	4,7 pF/2 %/500 V	EDPU 222265010478	VALVO
1521.616	C322	180 pF/2 %/500 V	4815/F/180/2/500	JAHRE
1521.543	C323	4,5-60 pF/200 V	119.4901.060	DAU
1521.188	C324	4,7 pF/2 %/500 V	EDPU 222265010478	VALVO
1521.527	C325	47 pF/2 %/500 V	EDPU 222265010479	VALVO
1521.543	C326	4,5-60 pF/200 V	119.4901.060	DAU
1521.594	C327	100 pF/2 %/500 V	4815/F/100/2/500	JAHRE
1521.578	C328	470 pF/2 %/200 V	COG 8131A-200/001-COG-471 G	ERIE
1521.586	C329	560 pF/2 %/200 V	COG 8131A-200/001-COG-561 G	ERIE
1521.519	C330	1,0 pF/2 %/500 V	EDPU 222265010108	VALVO
1521.578	C331	470 pF/2 %/200 V	COG 8131A-200/001-COG-471 G	ERIE
1425.145	C332	33 pF/2 %/500 V	EDPU 222265010339	VALVO
	C333	1,5 - 9 pF	Type 119.1901.009	DAU
1960.083	C334	1,8 pF/2 %/500 V	EDPU 222265009188	VALVO
1960.083	C335	1,8 pF/2 %/500 V	EDPU 222265009188	VALVO
	C336	2,5 - 15 pF	Type 119.1901.015	DAU
	C337	1,5 - 9 pF	Type 119.1901.009	DAU
1425.145	C338	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1521.578	C339	470 pF/2 %/200 V	COG 8131A-200/001-COG-471 G	ERIE
1521.500	C340	2,7 pF/2 %/500 V	EDPU 222265010278	VALVO
	C341	15 pF/2 %/500 V	EDPU 222265010159	VALVO
	C342	4,5-60 pF/200 V	119.4901.060	DAU
	C343	1,2 pF/2 %/500 V	EDPU 222265010128	VALVO
	C344	4,5-60 pF/200 V	119.4901.060	DAU
	C345	1,2 pF/2 %/500 V	EDPU 222265010128	VALVO
	C346	4,5-60 pF/200 V	119.4901.060	DAU
	C347	15 pF/2 %/500 V	EDPU 222265010159	VALVO
1425.145	C348	33 pF/2 %/500 V	EDPU 222265010339	VALVO
1425.145	C349	33 pF/2 %/500 V	EDPU 222265010339	VALVO
	C350	27 pF/2 %/500 V	EDPU 222265010279	VALVO
	C351	27 pF/2 %/500 V	EDPU 222265010279	VALVO
	C352	27 pF/2 %/500 V	EDPU 222265010279	VALVO
	C353	27 pF/2 %/500 V	EDPU 222265010279	VALVO
1960.083	C356	1,8 pF/2 %/500 V	222265009188	VALVO
1960.083	C357	1,8 pF/2 %/500 V	222265009188	VALVO

-**Preselector**- Automatic/Manual

Parts lists No.
97 Sa 2.140.150 B

Ident-No.	Mark	Electr. value	Identity	Manufacturer
Diodes:				
0745.677	D1		1 N 4148	ITT
0745.677	D2		1 N 4148	ITT
0745.677	D3		1 N 4148	ITT
0745.677	D4		1 N 4148	ITT
0745.677	D5		1 N 4148	ITT
0745.677	D6		1 N 4148	ITT
0745.677	D7		1 N 4148	ITT
0745.677	D8		1 N 4148	ITT
0745.677	D9		1 N 4148	ITT
0745.677	D10		1 N 4148	ITT
0745.677	D11		1 N 4148	ITT
0745.677	D12		1 N 4148	ITT
0745.677	D13		1 N 4148	ITT
0758.353	D14		ZPD 5,1	ITT
0745.677	D15		1 N 4148	ITT
0745.677	D16		1 N 4148	ITT
0745.677	D17		1 N 4148	ITT
0745.677	D201		1 N 4148	ITT
0745.677	D202		1 N 4148	ITT
0745.677	D203		1 N 4148	ITT
0745.677	D204		1 N 4148	ITT
0745.677	D205		1 N 4148	ITT
0745.677	D206		1 N 4148	ITT
Resistors:				
0542.946	R1	1 M/5 %/0207	DIN 44052	
0542.938	R2	220/5 %/0207	DIN 44052	
0744.808	R3	2,2 K/5 %/0207	DIN 44052	
0179.639	R4	100/5 %/0207	DIN 44052	
0744.859	R5	330/5 %/0207	DIN 44052	
0744.808	R6	2,2 K/5 %/0207	DIN 44052	
0744.824	R7	39/5 %/0207	DIN 44052	
0179.698	R8	1 K/5 %/0207	DIN 44052	
0179.698	R9	1 K/5 %/0207	DIN 44052	
0745.820	R10	2,7 K/5 %/0207	DIN 44052	
0179.698	R11	1 K/5 %/0207	DIN 44052	
0554.898	R12	470/5 %/0207	DIN 44052	
0179.698	R13	1 K/5 %/0207	DIN 44052	
0745.820	R14	2,7 K/5 %/0207	DIN 44052	
0744.808	R15	2,2 K/5 %/0207	DIN 44052	

-Preselector- Automatic/Manual

Parts Lists No.
97 Sa 2.140.150 B

Ident-No.	Mark	Electr. value	Identity	Manufacturer
0744.913	R16	82/5 %/0207	DIN 44052	
0698.172	R17	680/5 %/0207	DIN 44052	
0542.806	R18	390 K/5 %/0207	DIN 44052	
0745.820	R19	2,7 K/5 %/0207	DIN 44052	
0179.698	R20	1 K/5 %/0207	DIN 44052	
0542.806	R21	390 K/5 %/0207	DIN 44052	
0744.808	R22	2,2 K/5 %/0207	DIN 44052	
0799.300	R23	39 K/5 %/0207	DIN 44052	
0179.701	R24	10 K/5 %/0207	DIN 44052	
0179.701	R26	10 K/5 %/0207	DIN 44052	
0179.698	R27	1 K/5 %/0207	DIN 44052	
0744.840	R28	5,6 K/5 %/0207	DIN 44052	
0179.698	R29	1 K/5 %/0207	DIN 44052	
0179.701	R30	10 K/5 %/0207	DIN 44052	
0744.883	R31	180/5 %/0207	DIN 44052	
0542.946	R32	1 M/5 %/0207	DIN 44052	
0744.883	R33	180/5 %/0207	DIN 44052	
0744.883	R34	180/5 %/0207	DIN 44052	
0179.701	R35	10 K/5 %/0207	DIN 44052	
0767.204	R36	22 K/5 %/0207	DIN 44052	
0179.701	R37	10 K/5 %/0207	DIN 44052	
0744.883	R38	180/5 %/0207	DIN 44052	
0480.444	R39	1,5 K/5 %/0207	DIN 44052	
0179.698	R40	1 K/5 %/0207	DIN 44052	
0542.946	R41	1 M/5 %/0207	DIN 44052	
1084.461	R42	330 Ohm/5 %/4 W	SXA-0922	DRALORIC
1084.461	R43	330 Ohm/5 %/4 W	SXA-0922	DRALORIC
1084.461	R44	330 Ohm/5 %/4 W	SXA-0922	DRALORIC
0799.408	R45	47 Ohm/5 %/0414	DIN 44052	
0542.806	R204	390 K/5 %/0207	DIN 44052	
0179.639	R205	100 Ohm/5 %/0207	DIN 44052	

Coils:

1500.678	L1	10 µH ± 5 %	Best.-Nr. Sd7500612200	NEOSID
1500.678	L2	10 µH ± 5 %	Best.-Nr. Sd7500612200	NEOSID
1500.678	L3	10 µH ± 5 %	Best.-Nr. Sd7500612200	NEOSID
1500.678	L4	10 µH ± 5 %	Best.-Nr. Sd7500612200	NEOSID
1500.678	L5	10 µH ± 5 %	Best.-Nr. Sd7500612200	NEOSID
1500.678	L6	10 µH ± 5 %	Best.-Nr. Sd7500612200	NEOSID
1526.065	L7	0,44 µH	97 E 2.140.195-8	HAGENUK
1425.129	L8	0,4 µH	97 E 2.140.97-3	HAGENUK
1425.129	L9	0,4 µH	97 E 2.140.97-3	HAGENUK

Parts lists No.
97 Sa 2.140.150 B

-Preselector- Automatic/Manual

Ident-No	Mark	Electr. value	Identity	Manufacturer
1425.129	L10	0,4 µH	97 E 2.140.97-3	HAGENUK
1526.065	L11	0,44 µH	97 E 2.140.195-8	HAGENUK
1521.160	L12	5,7 µH	97 E 2.140.197	HAGENUK
1521.179	L13	3,6 µH	97 E 2.140.198	HAGENUK
1521.187	L14	3,6 µH	97 E 2.140.199	HAGENUK
1116.312	L15	2,2 mH	Nr. 2500-44	AMPHENOL
1116.312	L16	2,2 mH	Nr. 2500-44	AMPHENOL
1929.879	L17	100 µH 5 %	Best.-Nr. 78108-S1104-J	SIEMENS
1521.012	L 300	1,6-4 MHz 5,23 µH	97 E 2.140.168	HAGENUK
1521.012	L 301	1,6-4 MHz 5,23 µH	97 E 2.140.168	HAGENUK
1521.012	L302	1,6-4 MHz 5,23 µH	97 E 2.140.168	HAGENUK
1521.063	L303	4-8 MHz, 8-17 MHz 2 µH	97 E 2.140.172	HAGENUK
1521.063	L304	4-8 MHz, 8-17 MHz 2 µH	97 E 2.140.172	HAGENUK
1521.063	L305	4-8 MHz, 8-17 MHz 2 µH	97 E 2.140.172	HAGENUK
1521.063	L306	4-8 MHz, 8-17 MHz 2 µH	97 E 2.140.172	HAGENUK
1521.063	L307	4-8 MHz, 8-17 MHz 2 µH	97 E 2.140.172	HAGENUK
	L308	4-8 MHz, 8-17 MHz 2 µH	97 E 2.140.172	HAGENUK
	L309	17-30 MHz 0,46 µH	97 E 2.140.187	HAGENUK
	L310	17-30 MHz 0,46 µH	97 E 2.140.187	HAGENUK
	L311	17-30 MHz 0,46 µH	97 E 2.140.187	HAGENUK

Integrated circuits:

1300.326	IC A	CA 3140 E	RCA
	IC B	CA 3140 E	RCA

Transistors:

1425.137	T1	J 310	SILICONIX
1291.033	T2	BC 549 B	THOMSEN
1291.033	T3	BC 549 B	THOMSEN
1291.033	T4	BC 549 B	THOMSEN
1291.033	T5	BC 549 B	THOMSEN
1291.033	T6	BC 549 B	THOMSEN
1291.033	T7	BC 549 B	THOMSEN
1291.033	T8	BC 549 B	THOMSEN

-Preselector- Automatic/Manual

Parts lists No.
97 Sa 2.140.150 B

Ident-No.	Mark	Electr. value	Identity	Manufacturer
Connectors:				
	Bu1	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu2	5-pins	Best.-Nr. 316-80105	ODU KON
	Bu3	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu4	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu5	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu6	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu7	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu8	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu9	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu10	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu11	5-pins	Best.-Nr. 316-80105	ODU KON.
	Bu12		UG 58 A/U R 161404	RADIALL
1189.735	Bu13		DIL B 14-P 108	BURNDY
	St1	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St2	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St3	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St4	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St5	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St6	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St7	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St8	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St9	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St10	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St11	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St12	5-pins	Best.-Nr. 310-70105	ODU-Kontakt
	St13		R 114563	RADIALL
Supplement:				
	GL1	S 1-A 230	Best.Nr.069-X801	SIEMENS
	CA1		97 E 2.140.202	HAGENUK
	K300	1,6-4 MHz, 4-8 MHz and 8-17 MHz range	97 E 2.140.153 B	HAGENUK
	K301	1,6-4 MHz, 4-8 MHz and 8-17 MHz range	97 E 2.140.153 B	HAGENUK
	K302	1,6-4 MHz, 4-8 MHz and 8-17 MHz range	97 E 2.140.153 B	HAGENUK

Parts lists No.
97 Sa 2.140.150 B

-**Presel**ector- Automatic/Manual

Ident-No.	Mark	Electr. value	Identity	Manufacturer
	K303	1,6-4 MHz, 4-8 MHz and 8-17 MHz range	97 E 2.140.153 B	HAGENUK
	K304	1,6-4 MHz, 4-8 MHz and 8-17 MHz range	97 E 2.140.153 B	HAGENUK
	K305	1,6-4 MHz, 4-8 MHz and 8-17 MHz range	97 E 2.140.153 B	HAGENUK
	K306	1,6-4 MHz, 4-8 MHz and 8-17 MHz range	97 E 2.140.153 B	HAGENUK
	K307	1,6-4 MHz, 4-8 MHz and 8-17 MHz range	97 E 2.140.153 B	HAGENUK
	K308	1,6-4 MHz, 4-8 MHz and 8-17 MHz range	97 E 2.140.153 B	HAGENUK
	K309	17-30 MHz range	97 E 2.140.152	HAGENUK
	K310	17-30 MHz range	97 E 2.140.152	HAGENUK
	K311	17-30 MHz range	97 E 2.140.152	HAGENUK

Relays:

	Rel A	DR-15 V		SDS-ELEKTRO
	Rel B	DR-15 V		SDS-ELEKTRO
	Rel C	DR-15 V		SDS-ELEKTRO
	Rel D	DR-15 V		SDS-ELEKTRO
	Rel E	DR-15 V		SDS-ELEKTRO
	Rel F	DR-5 V		SDS-ELEKTRO
	Rel G	DR-5 V		SDS-ELEKTRO
	Rel H	DR-15 V		SDS-ELEKTRO
	Rel I	DR-15 V		SDS-ELEKTRO
	Rel J	DR-15 V		SDS-ELEKTRO
	Rel K	DR-15 V		SDS-ELEKTRO
	Rel L	DR- 15 V		SDS-ELEKTRO
	Rel M	DR-15 V		SDS-ELEKTRO
	Rel N	DR-15 V		SDS-ELEKTRO
	Rel O	DR-15 V		SDS-ELEKTRO
	Rel P	DR-15 V		SDS-ELEKTRO
	Rel Q	DR-15 V		SDS-ELEKTRO

Transformers:

	Tr1		97 E 2.140.196	HAGENUK

-Preselector- Automatic/Manual

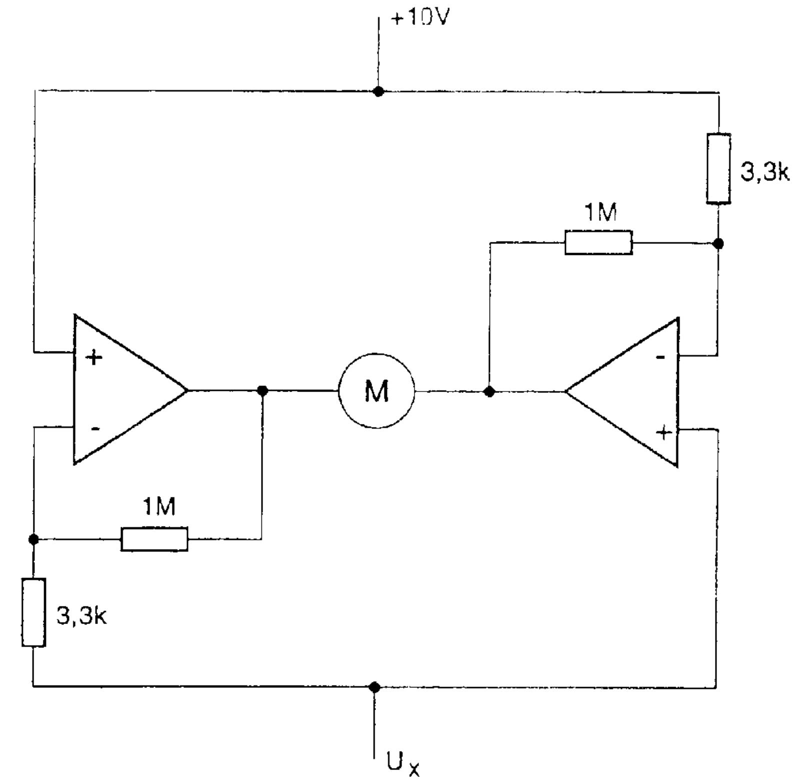
Parts lists No.
97 Sa E 2.155.205

Ident-No.	Mark	Electr. value	Identity	Manufacturer
Capacitors:				
1423.304	C1	10 µF/25 V	222 122 90006	VALVO
1404.822	C2	0,1 µF/10 %/63 V	MKS 2	WIMA
1423.304	C3	10 µF/25 V	222 122 90006	VALVO
1078.585	C4	0,022 µF/40V	0,022/2/40 EDPU	VALVO
1400.568	C5	0,22 µF/63 V	MKS 2	WIMA
1423.304	C6	10 µF/25 V	2222 122 90006	VALVO
1404.822	C7	0,1 µF/10 %/63 V	MKS 2	WIMA
1078.585	C8	0,022 µF/40V	0,022/2/40 EDPU	VALVO
1479.644	C9	1 µF/50 V	MKS 2	WIMA
Diodes:				
0745.677	D1		1 N 4148	
0745.677	D2		1 N 4148	
0745.677	D3		1 N 4148	
Resistor:				
1521.241	R1	180K 0,1 % 1/8 W	DIN 44061	
1047.345	R2	3,3K 1 % 1/8 W	DIN 44061	
1047.345	R3	3,3K 1 % 1/8 W	DIN 44061	
1521.241	R4	180K 0,1 % 1/8 W	DIN 44061	
1047.345	R5	3,3K 1 % 1/8 W	DIN 44061	
1047.345	R6	3,3K 1 % 1/8 W	DIN 44061	
0542.946	R8	IM 5 % 1/8 W	DIN 44052	
	R9	5,6 25°C/25 %	Best-Nr. 2322662	VALVO
0626.708	R10	10 5 % 1/8 W	DIN 44052	
0542.946	R11	IM 5 % 1/8 W	DIN 44052	
	R12	5K/5 %/±0,25 %L	AL2410	MEGATRON
0179.701	R13	10K 5 % 1/8 W	DIN 44052	
0766.190	R14	100K/5 % 1/8 W	DIN 44052	
0767.190	R15	100K/5 %/0207	DINM 44052	
0179.701	R16	10K/5 %/0207	DIN 44052	
0542.946	R18	IM 5 % 1/8W	DIN 44052	
1521.241	R19	180K 0,1 % 1/8 W	DIN 44061	
0767.190	R20	100K/5 %/0207	DIN 44052	
0767.190	R21	100K/5 %/0207	DIN 44052	
0767.190	R22	100K/5 %/0207	DIN 44052	
0179.701	R23	10K/5 %/0207	DIN 44052	
0542.806	R24	390K/5 %/0207	DIN 44052	

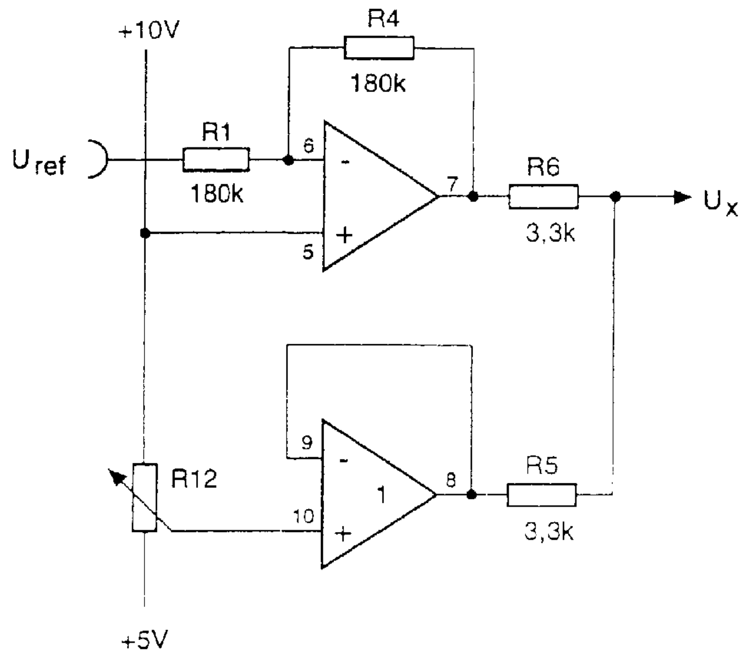
-**Preselector**- Automatic/Manual

Parts lists No.
97 Sa E 2.155.205

Ident-No.	Mark	Electr. value	Identity	Manufacturer
Integrated circuits:				
1427.172	IC A		LM 224	
1177.265	IC B		CA 741 CE	RCA
1630.180	IC C		ICL 7665 BCPA	INTERSIL
Transistors:				
1175.351	T1		BD 675	SIEMENS
1175.378	T2		BD 676	SIEMENS
1175.351	T3		BD 675	SIEMENS
1175.378	T4		BD 676	SIEMENS
1291.033	T5		BD 549 B	
Connectors:				
	Bu A	5-pins	Best-Nr. 316-80105	
1355.678	ST A	11-pins	2,5 MSF 11	LUMBERG
1295.667	ST B		RTM 12M630	BURKLIN
Supplements:				
1095.668	Rel.A	RG-16V		SDS
1186.574	Rel.B	RH-5V		NATIONAL
1118.226	GL 1	B80 C800		SES COSEM
	M	4.81	Best-Nr.2233R0126	FAULHABER



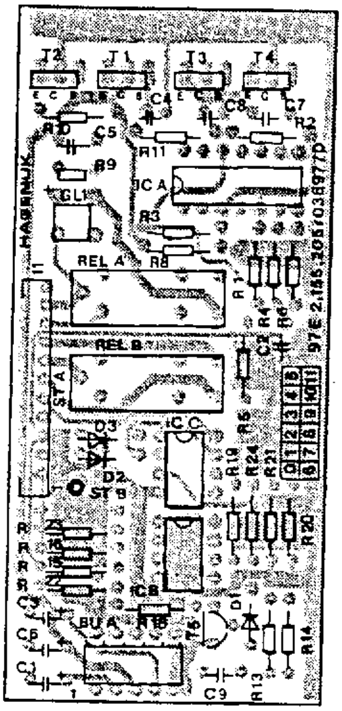
Motor control principle

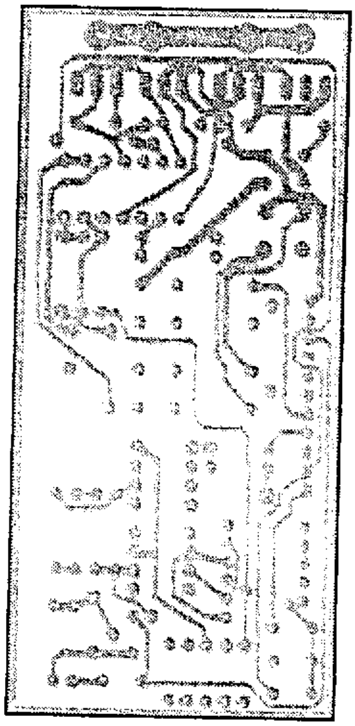


Voltage comparision principle

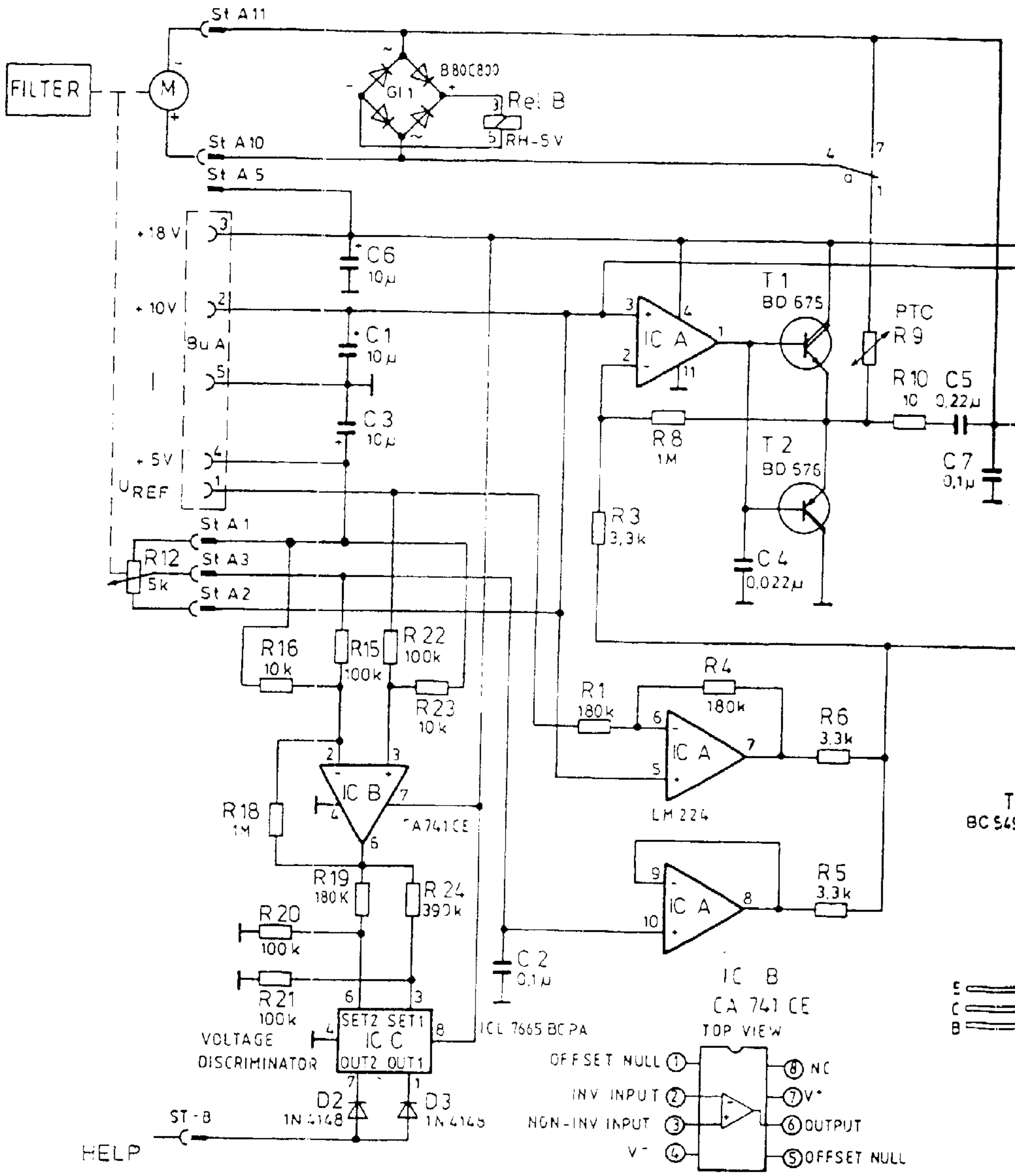
-Preselector-

see circuit diagram - MOTOR CONTROL 97 Sa E 2.155.205

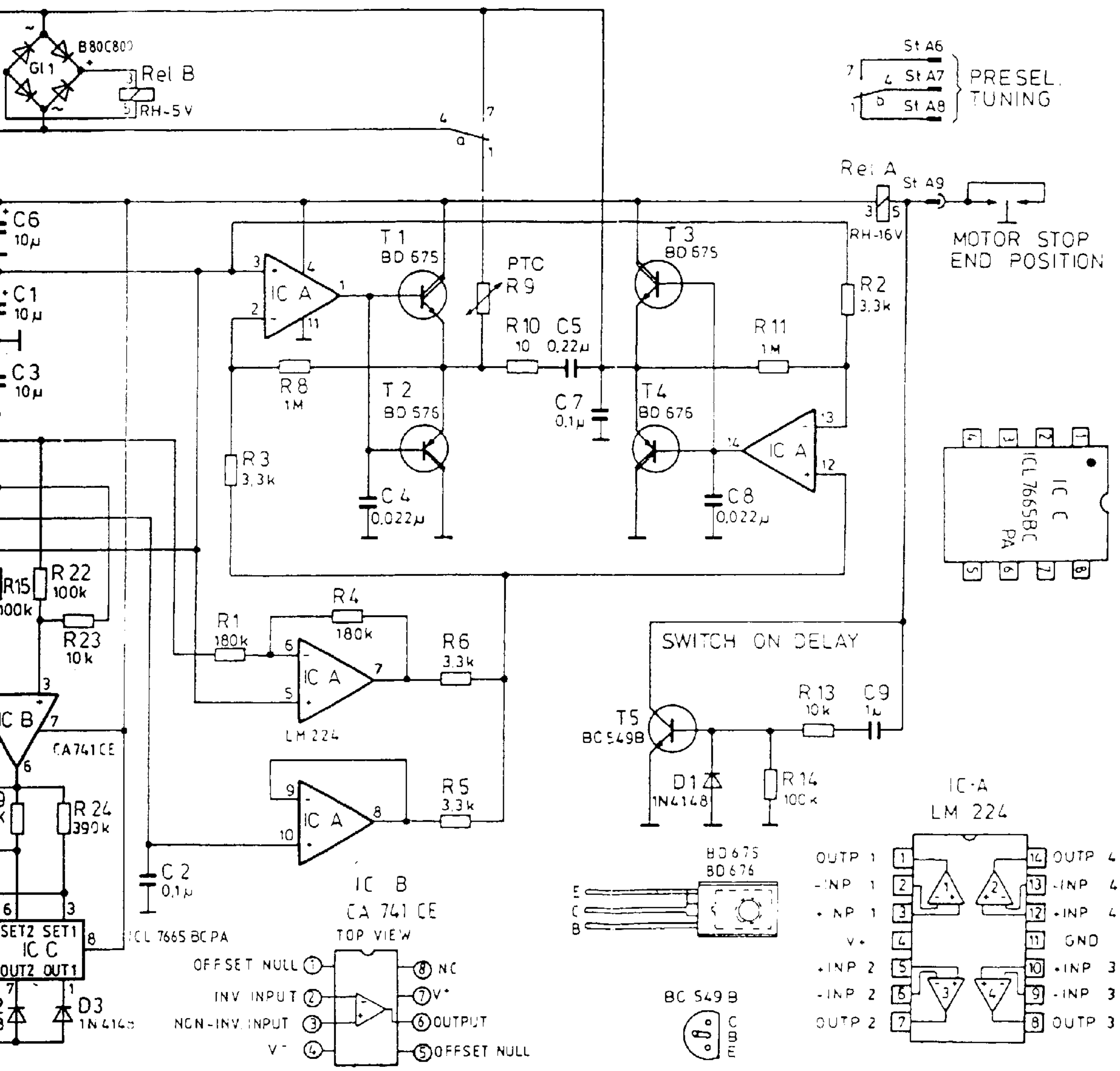




Motor Control PCB - 97 E 2.155.205



FILTER
M
St A11
St A10
St A5
B80C800
Gl 1
Rel B
RH-5V
+18 V
+10 V
+5 V
U REF
Bu A
C6 10μ
C1 10μ
C3 10μ
St A1
St A3
St A2
R12 5k
T1 BD 675
T2 BD 576
PTC R9
R10 10
C5 0,22μ
C7 0,1μ
IC A
R8 1M
R3 3,3k
C4 0,022μ
R16 10k
R15 100k
R22 100k
R23 10k
R1 180k
R4 180k
R6 3,3k
R5 3,3k
LM 224
IC B
CA741CE
R18 1M
R19 180K
R24 390k
R20 100k
R21 100k
C2 0,1μ
SET2 SET1
IC C
OUT2 OUT1
ICL 7665 BCPA
VOLTAGE DISCRIMINATOR
D2 1N4148
D3 1N4148
ST-B
HELP
IC B
CA 741 CE
TOP VIEW
OFFSET NULL
INV INPUT
NON-INV INPUT
V-
NC
V+
OUTPUT
OFFSET NULL



MOTOR CONTROL
PRESELECTOR
Circuit Diagram
97 Sa E 2.155.205

Parts lists No.
97 Sa 2.155.205

-Preselector- Motor Control

Ident-No.	Mark	Electr. value	Identity	Manufacturer
Capacitors:				
1423.304	C1	10 µF/25 V	222 122 90006	VALVO
1404.822	C2	0,1 µF/10 %/63 V	MKS 2	WIMA
1423.304	C3	10 µF/25 V	222 122 90006	VALVO
1078.585	C4	0,022 µF/40 V	0,022/2/40 EDPU	VALVO
1400.568	C5	0,22 µF/63 V	MKS 2	WIMA
1423.304	C6	10 µF/25 V	2222 122 90006	VALVO
1404.822	C7	0,1 µF/10 %/63 V	MKS 2	WIMA
1078.585	C8	0,022 µF/4O V	0,022/2/40 EDPU	VALVO
1479.644	C9	1 µF/50 V	MKS 2	WIMA
Diodes:				
0745.677	D1		1 N 4148	
0745.677	D2		1 N 4148	
0745.677	D3		1 N 4148	
Resistor:				
1521.241	R1	180 K 0,1 % 1/8 W	DIN 44061	
1047.345	R2	3,3 K 1 % 1/8 W	DIN 44061	
1047.345	R3	3,3 K 1 % 1/8 W	DIN 44061	
1521.241	R4	180 K 0,1 % 1/8 W	DIN 44061	
1047.345	R5	3,3 K 1 % 1/8 W	DIN 44061	
1047.345	R6	3,3 K 1 % 1/8 W	DIN 44061	
0542.946	R8	IM 5 % 1/8 W	DIN 44052	
	R9	5,6 25°C/25 %	Best-Nr. 2322662	VALVO
0626.708	R10	10 5 %/1/8 W	DIN 44052	
0542.946	R11	IM 5 %/ 1/8 W	DIN 44052	
	R12	5 K/5 %/± 0,25 %L	AL2410	MEGATRON
0179.701	R13	10 K/5 %/1/8 W	DIN 44052	
0766.190	R14	100 K/5 %/1/8 W	DIN 44052	
0767.190	R15	100 K/5 %/0207	DINM 44052	
0179.701	R16	10 K/5 %/0207	DIN 44052	
0542.946	R18	IM 5 %/1/8 W	DIN 44052	
1521.241	R19	180 K/0,1 %/1/8 W	DIN 44061	
0767.190	R20	100 K/5 %/0207	DIN 44052	
0767.190	R21	100 K/5 %/0207	DIN 44052	
0767.190	R22	100 K/5 %/0207	DIN 44052	
0179.701	R23	10 K/5 %/0207	DIN 44052	
0542.806	R24	390 K/5 %/02207	DIN 44052	

-Preselector- Motor Control

Parts lists No.
97 Sa 2.155.205

Ident-No.	Mark	Electr. value	Identity	Manufacturer
Integrated circuits:				
1427.172	IC A		LM 224	
1177.265	IC B		CA 741 CE	RCA
1630.180	IC C		ICL 7665 BCPA	INTERSIL
Transistors:				
1175.351	T1		BD 675	SIEMENS
1175.378	T2		BD 676	SIEMENS
1175.351	T3		BD 675	SIEMENS
1175.378	T4		BD 676	SIEMENS
1291.033	T5		BD 549 B	
Connectors:				
	Bu A	5-pins	Best-Nr. 316-80105	
1355.678	ST A	11-pins	2,5 MSF 11	LUMBERG
1295.667	ST B		RTM 12M630	BÜRKLIN
Supplements:				
1095.668	Rel.A		RG-16V	SDS
1186.574	Rel.B		RH-5V	NATIONAL
1118.226	GL1		B80 C800	SES COSEM
	M	4.81	Best-Nr.2233R0126	FAULHABER