

-BFO-**Technical description**

The principal function of this circuit is to mix the receiver IF into the AF range. For this purpose the beat frequency oscillator (BFO) is used as a variable mixing oscillator.

The heart of the circuit is the phase-locked loop (PLL), consisting of a voltage-controlled oscillator (VCO), a frequency divider (prescaler), a programmable frequency divider, a phase comparator and a loop filter. The VCO centre frequency is 49.985 MHz and is divided by divider IC - A down to a frequency which can be handled by the PLL-IC. Both this input signal and the reference frequency of 100 kHz are divided down by IC A and compared with each other. The reference frequency in this case is 100 Hz and this is therefore the step spacing of the VCO. The VCO output signal is fed to a 1:5 frequency divider which can be switched in and out of circuit and a fixed 1:2 frequency divider. The signal is amplified by a driver with adjustable output level and then passed through a low-pass filter. The software sets the address and data lines to high in modes in which the BFO is not required. Because all these lines are AND-connected by IC-K, the BFO is switched off by IC -C. The precise reference frequency required by the PLL is derived from a 10 MHz temperature-compensated crystal oscillator (TCXO) or an external 1 MHz frequency standard. The TCXO signal is designed to be blocked as soon as an external reference standard is present at the necessary level (IC D, E).

The two signal paths are connected together by an EXOR-circuit (IC E), the TCXO signal is divided by a factor of 10 and the external reference signal is used directly. The 100 kHz reference is obtained by dividing the 1 MHz signal by 10 (IC F). Further dividers then produce the reference frequencies of 10 kHz for VCO A (1:10 divider, IC H) and 25 kHz for VCO B (1:4 divider, IC H).

The BITE facility allows all important circuit components to be tested. It checks that the PLL is locked and that the reference frequencies for VCOs A and B are present. If these items are correct, an LED illuminates on the rear of the cassette and a signal is also given to the HELP-OUT line. If the BFO is malfunctioning, the HELP-OUT line is pulled to ground (St 4/1).

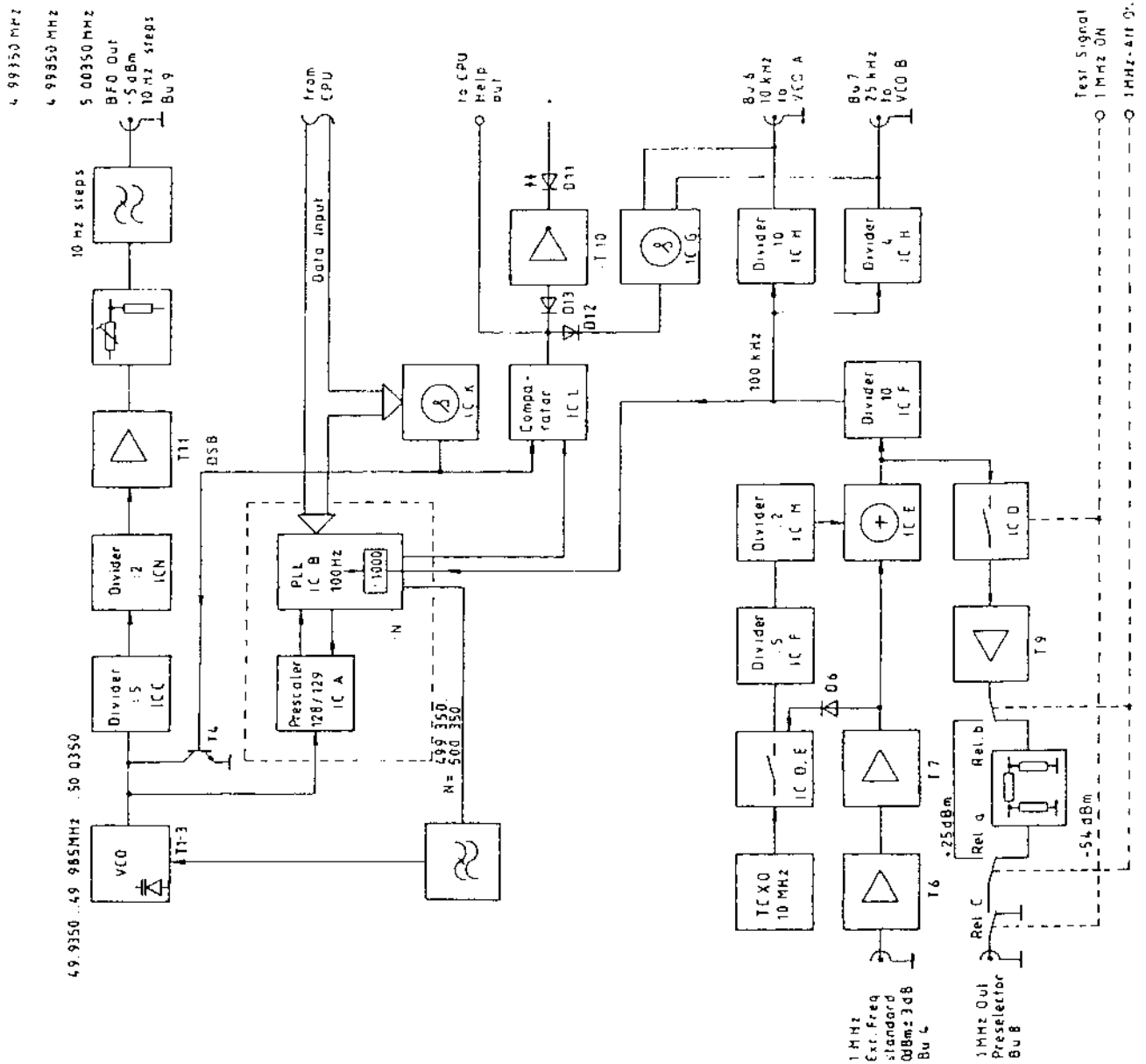
-BFO-

- Monitoring of reference frequencies for VCO A and B:
The two signals are rectified and combined by an AND gate. If one of the two signals is absent, the gate output switches to LOW and pulls the HELP- OUT line to earth via D 12.
- Monitoring of locked condition of the VCO:
IC TBB 146 (IC B) has a lock detector output (pin 13) whereby the locked condition can be recognized. In the out-of lock state, pulses appear at this output and are narrower the closer the output frequency matches the ref frequency or the closer the divided-down VCO frequency approaches the reference frequency (100 Hz). The mark/space ratio becomes larger and larger until eventually the voltage of the lock detector output goes completely to "high" in the locked condition. This signal is integrated for further evaluation - i. e., a DC voltage proportional to the mark/space ratio is obtained from the sampled signal. This is compared in the comparator (IC L) with an internal reference voltage and signalled via the HELP line and displayed visually by the LED (D11) on the rear of the cassette.

BITE test signal

This part of the circuit generates the 1 MHz test signal for the receiver. It consists of a switching transistor (T 9) and an attenuator which can be switched into circuit. The various functions are controlled via two lines: 1 MHz ON and 1 MHz ATT. ON. The signal is switched ON or OFF via the 1 MHz ON line (IC D, relay C) and the attenuator is connected or by passed by the 1 MHz ATT. ON line (relays A and B).

-BFO-



-BFO-

Test and alignment instructions (BFO - VCO)

Required: circuit diagram BFO - HAGENUK Drawing No.
97 Sa B 2.155.50
frequency counter, spectrum analyser, power supply

Test configuration: The BFO module is removed, the cassette is opened and the BFO - VCO is removed from the BFO board.

Testing the BFO-VCO

Connect the BFO-VCO board plug ST 5 pin 2 to earth
ST 5 pin 6 to +12 V
ST 5 pin 1 to frequency
counter/spectrum analyser

Measuring the current consumption

Test values: specified < 50 mA

Tuning range of VCO

Connect a voltage of +2.5 V to plug ST 5 pin 11.

Test values:

The VCO frequency should be 50 MHz \pm 10 kHz (it can be trimmed with C 3). Vary the voltage on plug St 5 pin 11 from +1 V to +4 V.

Test values:

The frequency change of the VCO should be > 100 Hz and the output level should be > 4 dBm.

-BFO-

Test and alignment instructions

Required: Circuit diagram BFO - HAGENUK Drawing No.
97 Sa B 2.155.50
spectrum analyser, frequency counter

Test configuration: The BFO module is removed and cassette cover is taken off. The module is reconnected to the receiver by means of the service adapter.

Test the TCXO

Connect the frequency counter to MP 15.

Test values:

The output frequency should be $10 \text{ MHz} \pm 3 \text{ Hz}$ (the frequency can be trimmed by internal trimmer or external potentiometer if fitted).

Test values:

Frequency at MP 9 should be 2 MHz
MP 10 should be 1 MHz
MP 11 should be 100 kHz

Disconnect plug ST 4 pins 2 and 3. Connect the spectrum analyser to socket Bu 8, 1 MHz OUT. Connect plug ST 4 pin 3 to HIGH level (1MHz ON).

Connect plug ST 4 pin 2 to HIGH (1 MHz ATT. ON)

Test values:

Output level on socket Bu 8 should be $-54 \text{ dBm} \pm 1 \text{ dB}$
connect plug ST 4 pin 2 to LOW level (1 MHz ATT.OFF)

Test values:

Output level on socket Bu 8 should be $+25 \text{ dBm} \pm 1 \text{ dB}$
Connect plug ST 4 pin 3 to LOW level.

Test values:

Functional test: no 1 MHz signal on socket Bu 8.

Testing the BFO frequency

Select module A1A on receiver; BFO offset 0.00 kHz.

Measure output signal on socket Bu 9 (50 Ohm termination).

Test values:

Specified: $f_{\text{out}} 4.9985 \text{ MHz}$, $P_{\text{out}} -5 \text{ dBm} \pm 1 \text{ dB}$.

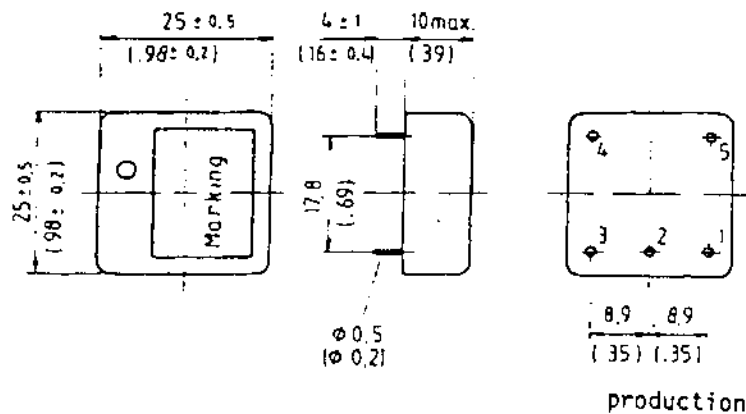
Vary frequency offset from -5.00 kHz to $+5.00 \text{ kHz}$ on BFO knob.

Test values:

Functional test: the output frequency must track the frequency offset.

-BFO-

- | | | | | | | | | | |
|--|---|-----------|-----------|-------------|--------|--------------|---------|------------|--------|
| 1. Output frequency | $f_0 = 10.000 \text{ MHz}$ | | | | | | | | |
| 2. Frequency stability vs temperature 0°C to $+70^\circ\text{C}$ | $\Delta f/f \leq \pm 0,5 \times 10^{-6}$ | | | | | | | | |
| 3. Frequency stability vs temperature -15°C to $+75^\circ\text{C}$ | $\Delta f/f \leq \pm 1 \times 10^{-6}$ | | | | | | | | |
| 4. Frequency stability vs aging | $\Delta f/f \leq \pm 1 \times 10^{-6}/\text{year}$ | | | | | | | | |
| 4.2 Frequency stability vs supply voltage | $\Delta f/f \leq \pm 0,3 \text{ ppm}/\pm 5\%$ | | | | | | | | |
| 5. Supply voltage | $U_B = 18 \text{ V} \pm 5\%$ | | | | | | | | |
| 6. Dissipation current | $I_B \leq 10 \text{ mA}$ | | | | | | | | |
| 7. Output voltage | $U_{\text{out}} \approx \text{TTL Low Power}$ | | | | | | | | |
| 8. Open collector: Load | $R_L = 470 \Omega$ to $+5\text{V}$, parallel | | | | | | | | |
| 9. Frequency adjustment with internal trimmer
Or less: In case it is possible over a period of ten years to compensate the frequency drift because of aging and external, potentiometer $2,2 \text{ k}\Omega$ | $\Delta f/f \geq \pm 3 \times 10^{-6}$ ^{24 LS 08} | | | | | | | | |
| 10. Suppression of spurious frequencies (except harmonics) | $< 80 \text{ dB}$ | | | | | | | | |
| 11. Vibration | <table border="0"> <tr> <td>Frequency</td> <td>Amplitude</td> </tr> <tr> <td>0...12.5 Hz</td> <td>3.2 mm</td> </tr> <tr> <td>12.5...25 Hz</td> <td>0,76 mm</td> </tr> <tr> <td>25...50 Hz</td> <td>0,2 mm</td> </tr> </table> | Frequency | Amplitude | 0...12.5 Hz | 3.2 mm | 12.5...25 Hz | 0,76 mm | 25...50 Hz | 0,2 mm |
| Frequency | Amplitude | | | | | | | | |
| 0...12.5 Hz | 3.2 mm | | | | | | | | |
| 12.5...25 Hz | 0,76 mm | | | | | | | | |
| 25...50 Hz | 0,2 mm | | | | | | | | |
| 12. Shock | 800 g, 1 ms. 1/2sinus, all directions | | | | | | | | |
| 13. Storage temperature | $-40 \dots + 85^\circ\text{C}$ | | | | | | | | |
| 14. Humidity | 75% for 60 days | | | | | | | | |
| 15. Dimension and pin connections | <p>Pin connection</p> <p>1-2-5 freq adj
3 +V
4 output
5 GND to case</p> <p>external potentiometer
2.2k
or
fixed resistors
1k 1k</p> | | | | | | | | |

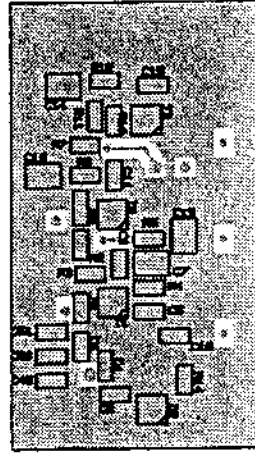
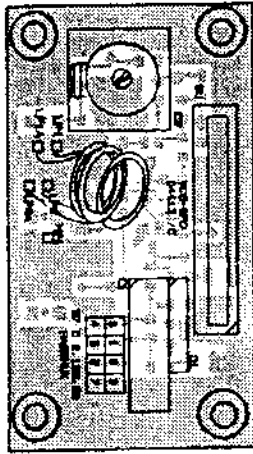


16. Label: 10 MHz, 97 E 2.155.52-3, 742 - week

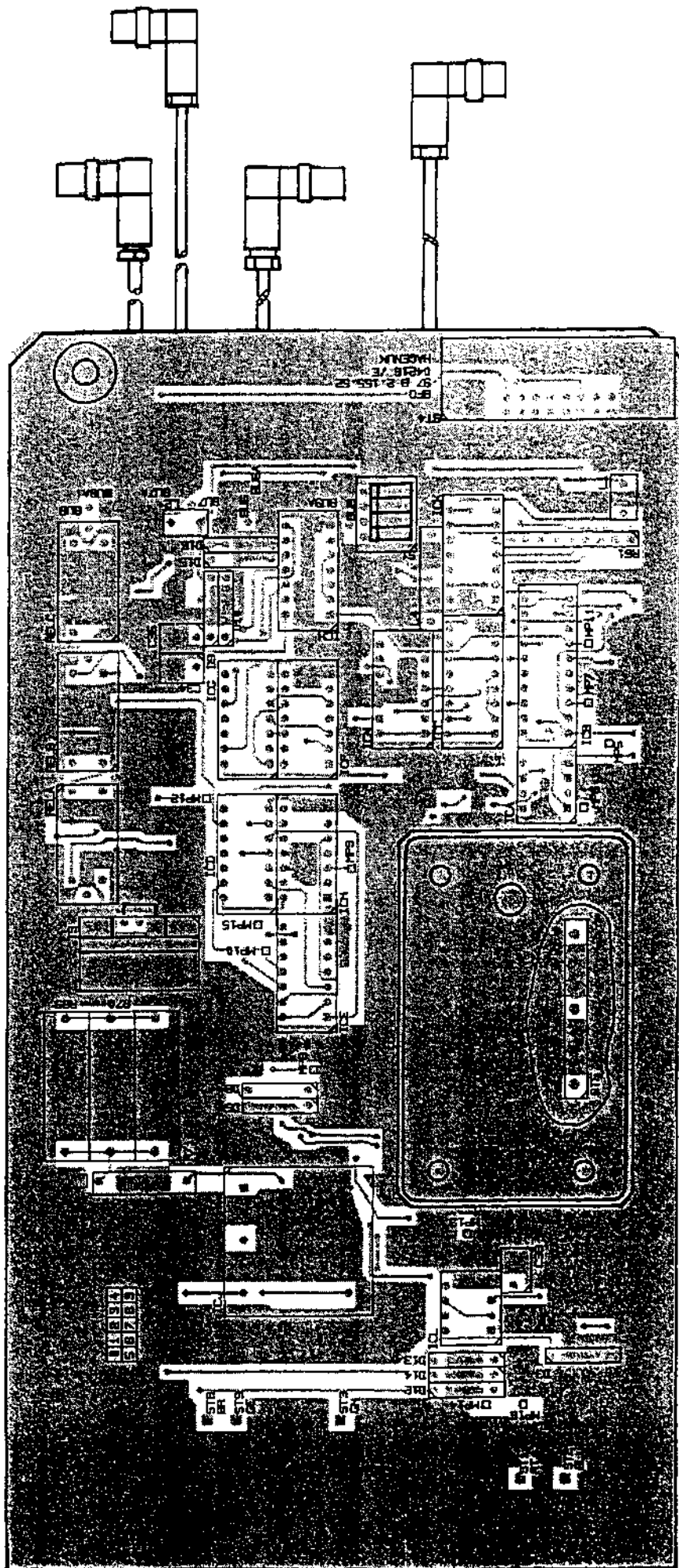
10 MHz TCXO drawing No. 97 E 2.155.52-3

-BFO-

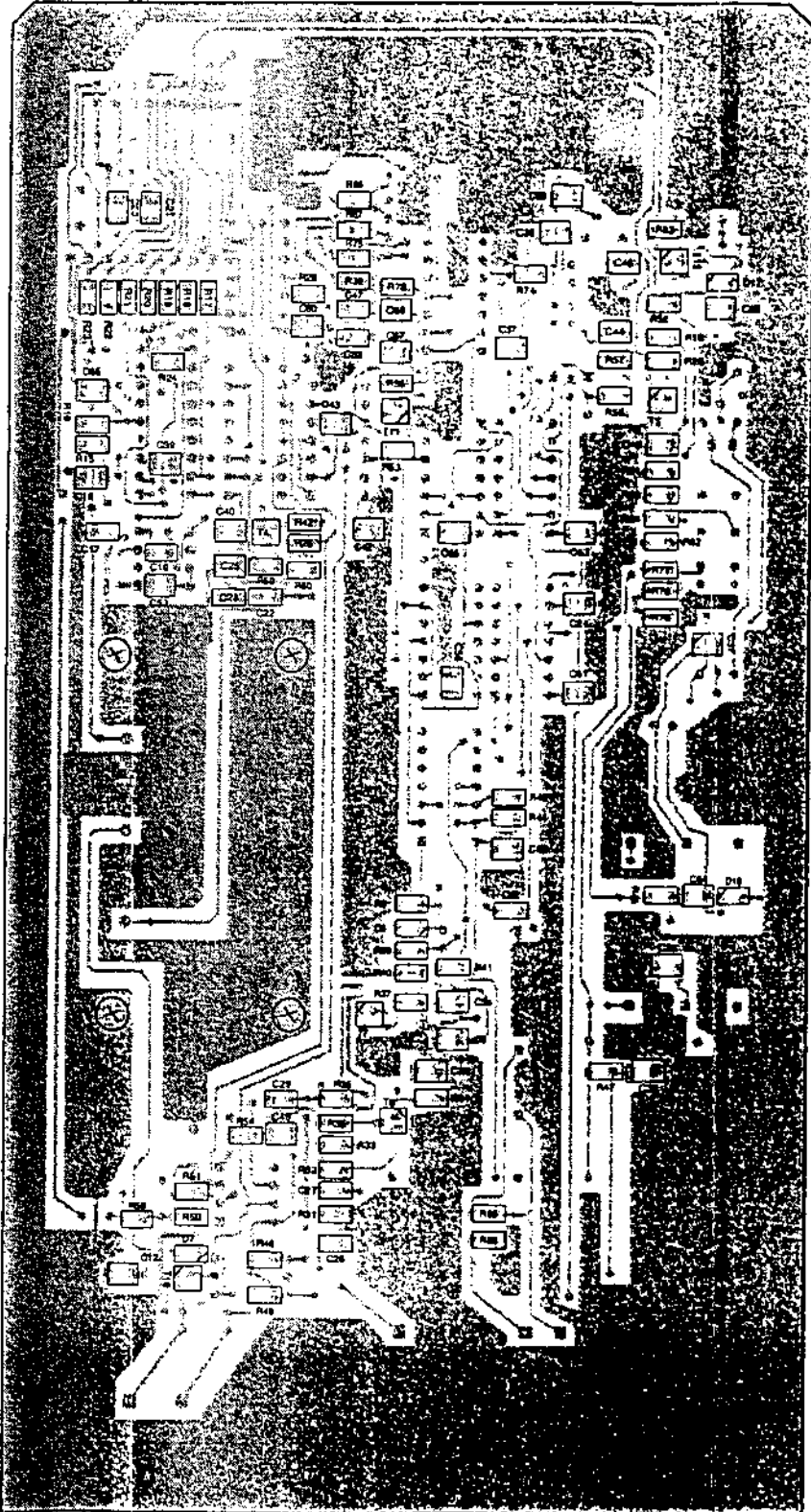
see circuit diagram - BFO 97 Sa C.2155.50/50 B



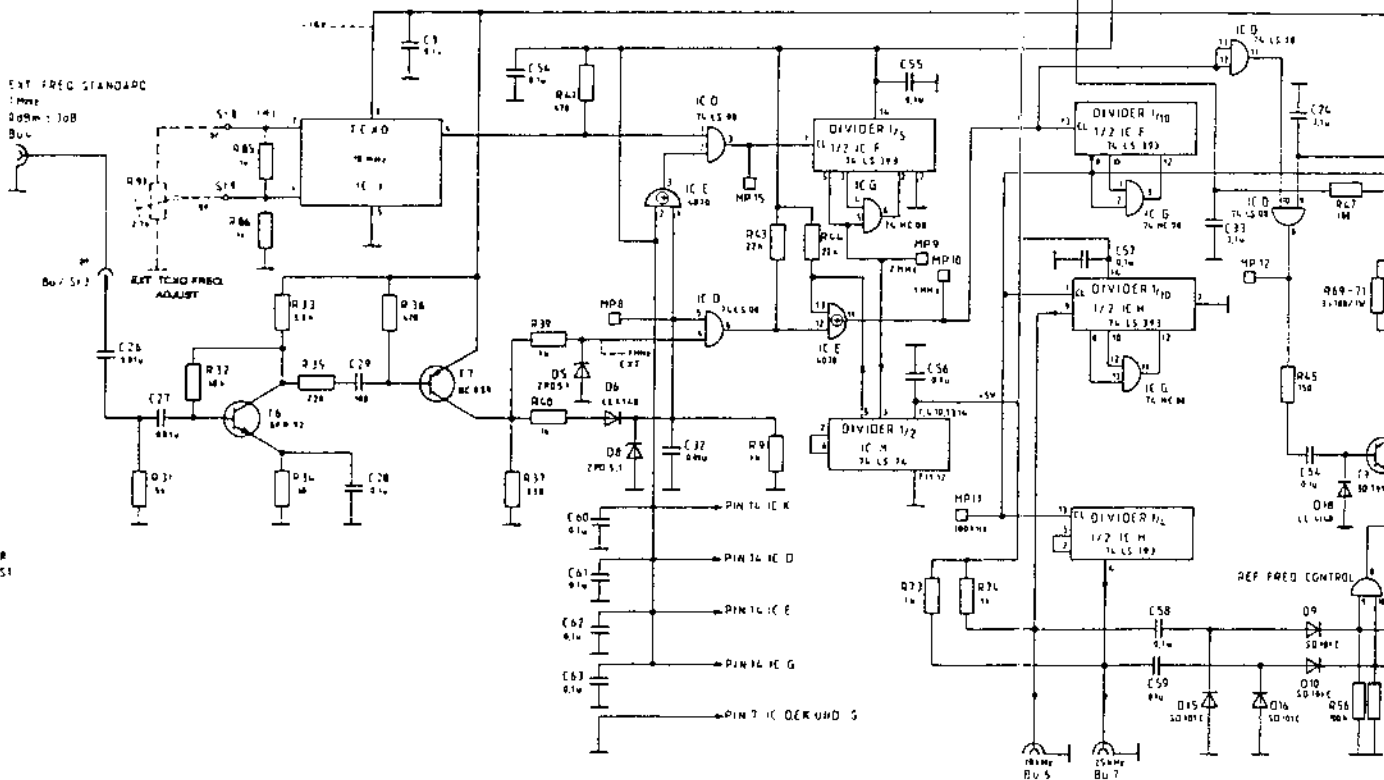
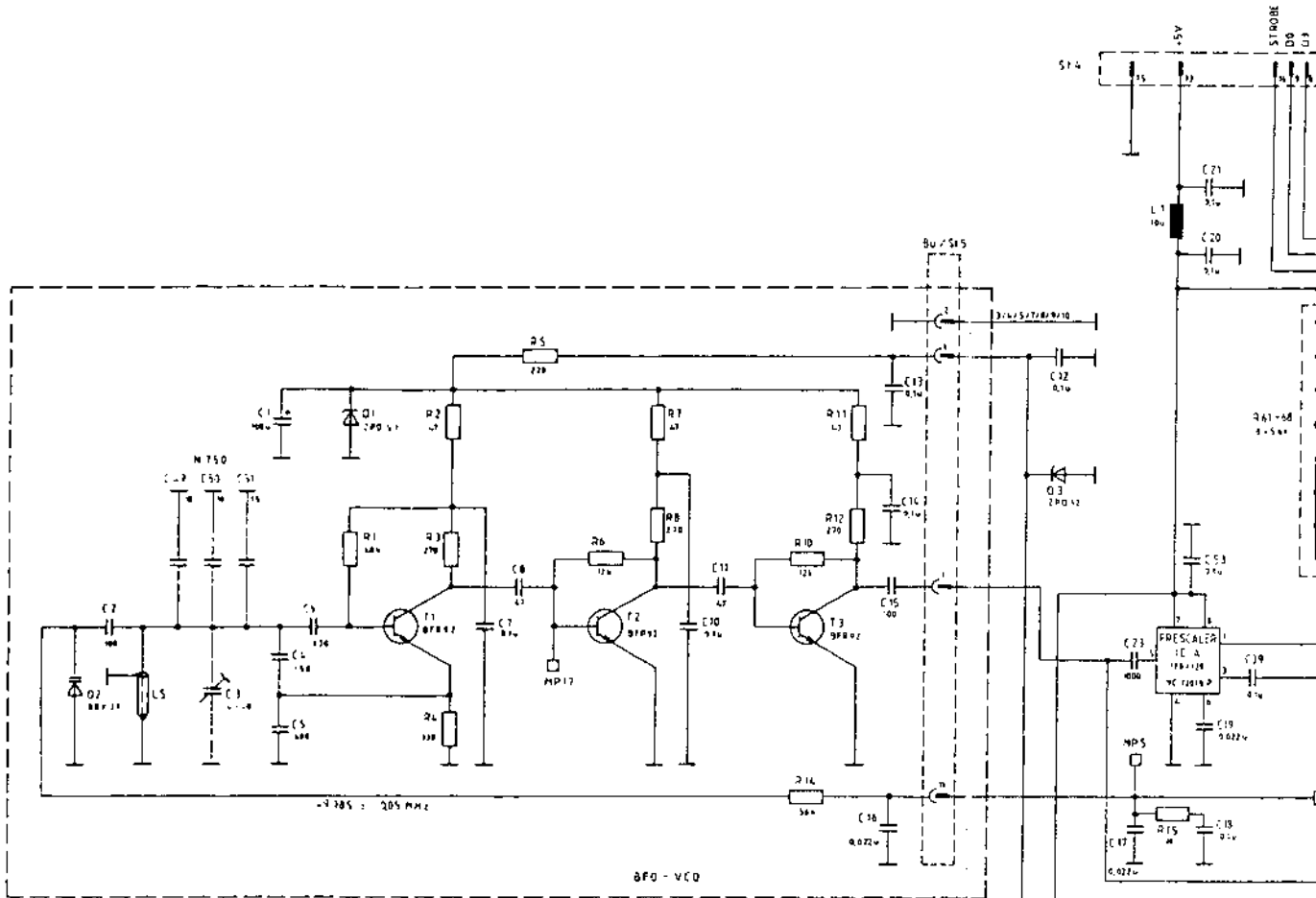
BFO-VCO - 97 E 2.155.53



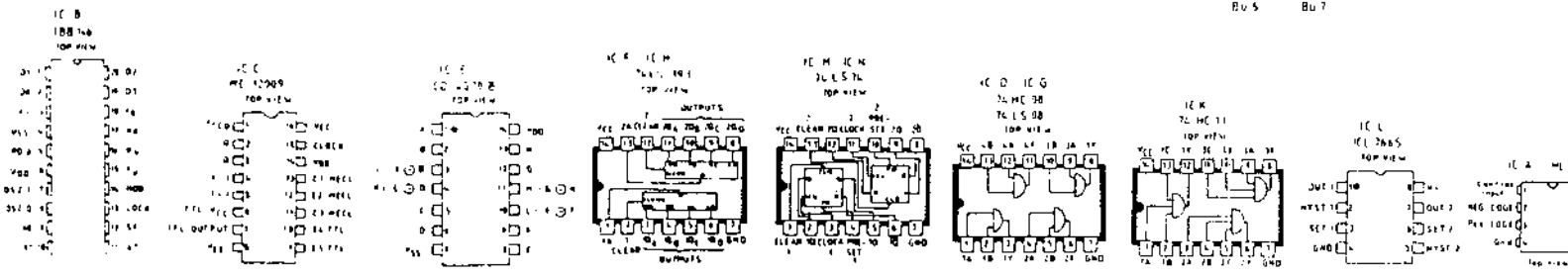
see circuit diagram - BFO 97 Sa B 2.155.50

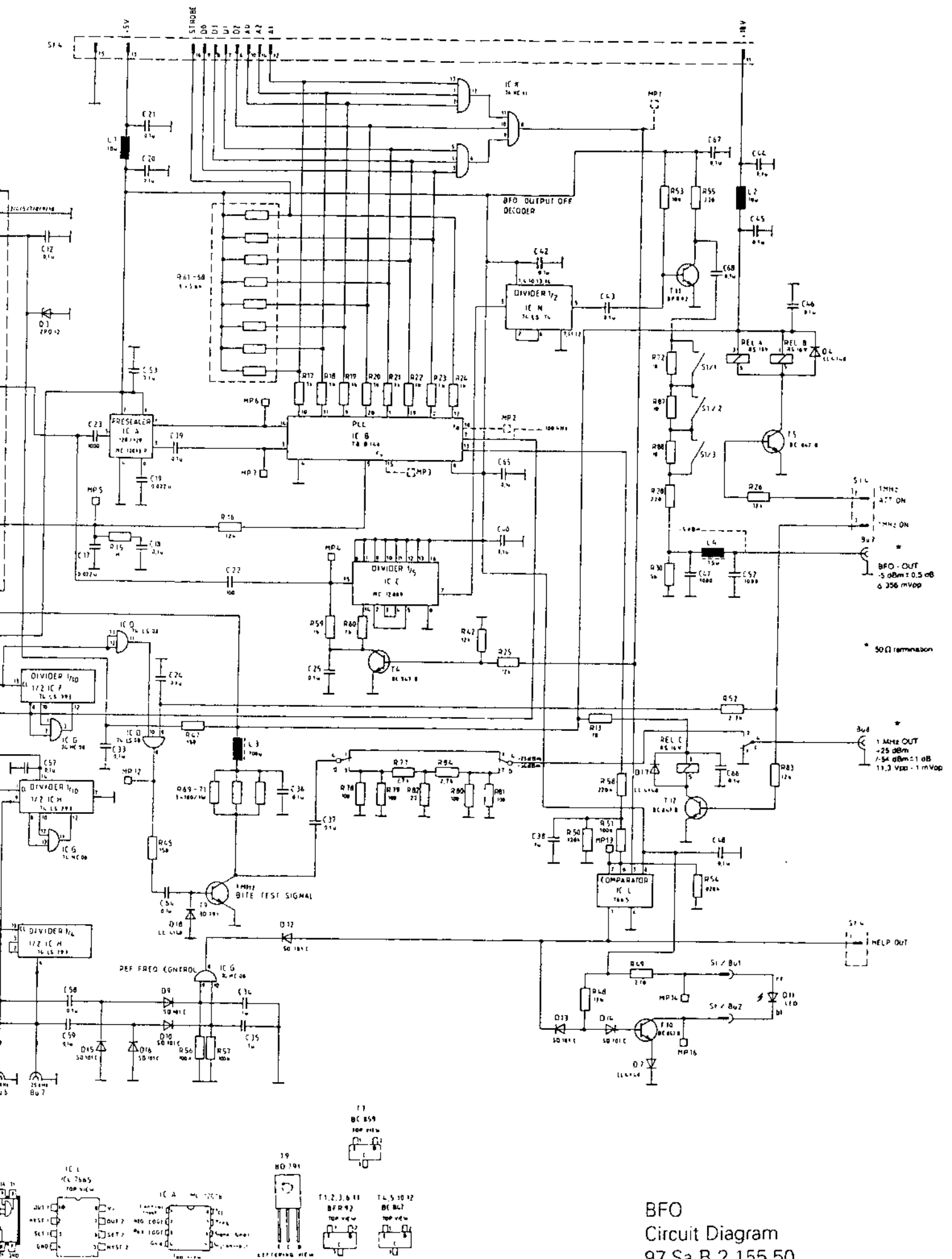


Printed Circuit Board
BFO
97 E 2.155.52



1. REMOVE R85 AND R86 FOR EXTERNAL FREQUENCY ADJUST WITH R91





BFO
Circuit Diagram
97 Sa B 2.155.50

-BFO-PCB-

Ident-No.	Mark	Electr. value	Identity	Manufacturer
Capacitors:				
1692.070	C1	100 μ /20/10 V		ELKO
1646.958	C2	100/5/63 V	0805	VALVO
1826.530	C3	4-40	Bestnr. 119390104	DAU
1646.842	C4	150/5/63 V	0805	VALVO
1643.991	C5	680/5/63 V	2x1, 25x1, 27	VALVO
1647.784	C6	330/5/63 V	0805	VALVO
1646.990	C7	0,1 μ /10/63 V	1210	VALVO
1643.932	C8	47/5/63 V	2x1, 25x0,5/0,7	VALVO
1646.990	C9	0,1 μ /10/63 V	1210	VALVO
1646.990	C10	0,1 μ /10/63 V	1210	VALVO
1643.932	C11	47/5/63 V	2x1, 25x0,5/0,7	VALVO
1646.990	C12	0,1 μ /10/63 V	1210	VALVO
1646.990	C13	0,1 μ /10/63 V	1210	VALVO
1646.990	C14	0,1 μ /10/63 V	1210	VALVO
1646.958	C15	100/5/63 V	0805	VALVO
1646.931	C16	0,022 μ /10/63 V	0805	VALVO
1646.931	C17	0,022 μ /10/63 V	0805	VALVO
1646.990	C18	0,1 μ /10/63 V	1210	VALVO
1646.931	C19	0,022 μ /10/63 V	0805	VALVO
1646.990	C20	0,1 μ /10/63 V	1210	VALVO
1646.990	C21	0,1 μ /10/63 V	1210	VALVO
1646.958	C22	100/5/63 V	0805	VALVO
1646.885	C23	1000/5/63 V	0805	VALVO
1646.990	C24	0,1 μ /10/63 V	1210	VALVO
1546.990	C25	0,1 μ /10/63 V	1210	VALVO
1556.029	C26	0,01 μ /10/63 V	1206	VALVO
1556.029	C27	0,01 μ /10/63 V	1206	VALVO
1646.990	C28	0,1 μ /10/63 V	1210	VALVO
1646.958	C29	100/5/63 V	0805	VALVO
1556.029	C32	0,01 μ /10/63 V	1206	VALVO
1646.990	C33	0,1 μ /10/63 V	1210	VALVO
1469.053	C34	1 μ MKS	R 5	WIMA
1469.053	C35	1 μ MKS	R 5	WIMA
1646.990	C36	0,1 μ /10/63 V	1210	VALVO
1646.990	C37	0,1 μ /10/63 V	1210	VALVO
1469.053	C38	1 μ MKS	R 5	WIMA
1646.990	C39	0,1/10/63 V	1210	VALVO
1646.990	C40	0,1/10/63 V	1210	VALVO
1646.990	C42	0,1/10/63 V	1210	VALVO
1646.990	C43	0,1/10/63 V	1210	VALVO
1646.990	C44	0,1/10/63 V	1210	VALVO
1646.990	C45	0,1/10/63 V	1210	VALVO

-BFO-PCB-

Parts lists No.
97 Sa 2.155.50

Ident-No.	Mark	Electr. value	Identity	Manufacturer
1646.990	C46	0,1/10/63 V	1210	VALVO
1646.885	C47	1000/5/63 V	0805	VALVO
1646.990	C48	0,1/10/63 V	1210	VALVO
	C49	10/5/63 V N750	0805	VALVO
	C50	10/5/63 V N750	0805	VALVO
	C51	15/5/63 V N750	0805	VALVO
1646.885	C52	1000/5/63 V	0805	VALVO
1646.990	C53	0,1/10/63 V	1210	VALVO
1646.990	C54	0,1/10/63 V	1210	VALVO
1646.990	C55	0,1/10/63 V	1210	VALVO
1646.990	C56	0,1/10/63 V	1210	VALVO
1646.990	C57	0,1/10/63 V	1210	VALVO
1646.990	C58	0,1/10/63 V	1210	VALVO
1646.990	C59	0,1/10/63 V	1210	VALVO
1646.990	C60	0,1/10/63 V	1210	VALVO
1646.990	C61	0,1/10/63 V	1210	VALVO
1646.990	C62	0,1/10/63 V	1210	VALVO
1646.990	C63	0,1/10/63 V	1210	VALVO
1646.990	C64	0,1/10/63 V	1210	VALVO
1646.990	C65	0,1/10/63 V	1210	VALVO
1646.990	C66	0,1/10/63 V	1210	VALVO
1646.990	C67	0,1/10/63 V	1210	VALVO
1646.990	C68	0,1/10/63 V	1210	VALVO

Integrated circuits:

1710.605	IC A		MC 120 18 P	MOTOROLA
1826.425	IC B		TB B 146	SIEMENS
1865.323	IC C		MC 120 09	MOTOROLA
1398.393	IC D		74 LS 08 N	
1336.193	IC E	4070 BF		
1570.676	IC F	74 LS 393 P		
1665.030	IC G	74 NC 08		
1570.676	IC H	74 LS 393 P		
1847.740	IC J	TCXO 10 MHz	97 E 2.155.52-3	
1878.069	IC K	74 HC 11		TEXAS
1630.180	IC L	L 7665 PA		
1653.172	IC M	74 LS 74		
1653.172	IC N	74 LS 74		

-BFO-PCB-

Ident-No.	Mark	Electr. value	Identity	Manufacturer
Diodes:				
0758.353	D1		ZPD 5,1	
1652.478	D2		BBY 31	
0922.684	D3		ZPD 12	
1613.162	D4		LL 4148	
0758.353	D5		ZPD 5,1	
1613.162	D6		LL 4148	
1613.162	D7		LL 4148	
0758.353	D8		ZPD 5,1	
1465.740	D9		SD 101	
1465.740	D10		SD 101	
1465.121	D11		LED TLUR 5400	
1465.740	D12		SD 101	
1465.740	D13		SD 101	
1465.740	D14		SD 101	
1465.740	D15		SD 101	
1465.740	D16		SK 101	
1613.162	D17		LL 4148	
1613.162	D18		LL 4148	

Coils:

1500.678	L1	10 μ H		NEOSID
1500.678	L2	10 μ H		NEOSID
0747.572	L3	100 μ H		JAHRE
1068.164	L4	1,5 μ H		JAHRE
1824.341	L5			97 E 2.155.53-3

Relays:

1249.053	Rel A		RS 16 V	SDS
1249.053	Rel B		RS 16 V	SDS
1249.053	Rel C		RS 16 V	SDS

Resistors:

1612.964	R1	68 K-5-0,125 W	3,2 x 1,6 x 0,58
1647.180	R2	47 K-5-0,125 W	3,2 x 1,6 x 0,58
1612.875	R3	270 K-5-0,125 W	3,2 x 1,6 x 0,58
1643.363	R4	330-5-0,125 W	3,2 x 1,6 x 0,58

-BFO-PCB-

Parts lists No.
97 Sa 2.155.50

Ident-No.	Mark	Electr. value	Identity	Manufacturer
1612.859	R5	100-5-0,125 W	3,2 x 1,6 x 0,58	
1647.202	R6	12 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.180	R7	47 K-5-0,125 W	3,2 x 1,6 x 0,58	
1612.875	R8	270 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R9	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.202	R10	12 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.180	R11	47 K-5-0,125 W	3,2 x 1,6 x 0,58	
1612.875	R12	270 K-5-0,125 W	3,2 x 1,6 x 0,58	
1672.738	R13	10 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.156	R14	56 K-5-0,125 W	3,2 x 1,6 x 0,58	
1555.987	R15	1 M-5-0,125 W	3,2 x 1,6 x 0,58	
1647.202	R16	12 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R17	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R18	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R19	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R20	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R21	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R22	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R23	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R24	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.202	R25	12 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.202	R26	12 K-5-0,125 W	3,2 x 1,6 x 0,58	
1612.875	R28	270-5-0,125 W	3,2 x 1,6 x 0,58	
1878.050	R30	56-5-0,125 W	3,2 x 1,6 x 0,58	
1878.050	R31	56-5-0,125 W	3,2 x 1,6 x 0,58	
1612.964	R32	68 K-5-0,125 W	3,2 x 1,6 x 0,58	
1649.094	R33	3,3 K-5-0,125 W	3,2 x 1,6 x 0,58	
1650.238	R34	68-5-0,125 W	3,2 x 1,6 x 0,58	
1612.859	R35	220-5-0,125 W	1,5 x 3,5	
1704.621	R36	470-5-0,125 W	3,2 x 1,6 x 0,58	
1643.398	R37	330-5-0,125 W	1,5 x 3,5	
1643.460	R39	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R40	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1704.621	R41	470 Ohm-5-0,125 W	3,2 x 1,6 x 0,58	
1647.202	R42	12 K-5-0,125 W	3,2 x 1,6 x 0,58	
1650.130	R43	22 K-5-0,125 W	3,2 x 1,6 x 0,58	
1650.130	R44	22 K-5-0,125 W	3,2 x 1,6 x 0,58	
1760.017	R45	150 K-5-0,125 W	3,2 x 1,6 x 0,58	
1866.540	R47	180 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.202	R48	12 K-5-0,125 W	3,2 x 1,6 x 0,58	
1612.875	R49	270 K-5-0,125 W	3,2 x 1,6 x 0,58	
1709.127	R50	120 K-5-0,125 W	3,2 x 1,6 x 0,58	
1612.980	R51	100 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.525	R52	2,2 K-5-0,125 W	3,2 x 1,6 x 0,58	

-BFO-PCB-

Ident-No.	Mark	Electr. value	Identity	Manufacturer
1612.948	R53	10 K-5-0,125 W	3,2 x 1,6 x 0,58	
1785.346	R54	820 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.363	R55	330 K-5-0,125 W	3,2 x 1,6 x 0,58	
1612.980	R56	100 K-5-0,125 W	3,2 x 1,6 x 0,58	
1612.980	R57	100 K-5-0,125 W	3,2 x 1,6 x 0,58	
1613.006	R58	220 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R59	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R60	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1595.695	R61			
1595.695	R62			
1595.695	R63			
1555.695	R64		network 5,6 K	
1595.695	R65			
1595.695	R66			
1595.695	R67			
1595.695	R68			
0793.507	R69	180-5-0,8-0719	DIN 44052-6	
0793.507	R70	180-5-0,8-0719	DIN 44052-6	
0793.507	R71	180-5-0,8-0719	DIN 44052-6	
1672.738	R72	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R73	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R74	1 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.431	R77	2,7 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.105	R78	100 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.105	R79	100-5-0,125 W	3,2 x 1,6 x 0,58	
1647.105	R80	100-5-0,125 W	3,2 x 1,6 x 0,58	
1647.105	R81	100-5-0,125 W	3,2 x 1,6 x 0,58	
1709.054	R82	27-5-0,125 W	3,2 x 1,6 x 0,58	
1647.202	R83	12 K-5-0,125 W	3,2 x 1,6 x 0,58	
1647.431	R84	2,7 K-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R85	1 k-5-0,125 W	3,2 x 1,6 x 0,58	
1643.460	R86	1 k-5-0,125 W	3,2 x 1,6 x 0,58	
1672.738	R87	10-5-0,125 W	3,2 x 1,6 x 0,58	
1672.738	R88	10-5-0,125 W	3,2 x 1,6 x 0,58	
	R91	2,7 k/20	Lin D 13 C 61 CK/P 9	DRA
Switches:				
	S1/1			
1315.293	S1/2		Nr.435166-2	AMP
	S1/3			

-BFO-PCB-

Parts lists No.

97 Sa 2.155.50

Ident-No.	Mark	Electr. value	Identity	Manufacturer
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Transistors:

1647.385	T1		BFR 92	MOTOROLA
1647.385	T2		BFR 92	MOTOROLA
1647.385	T3		BFR 92	MOTOROLA
1647.393	T4		BC 847 B	VALVO
1647.393	T5		BC 847 B	VALVO
1647.385	T6		BFR 92	MOTOROLA
1740.520	T7		BC 859 B	VALVO
1826.522	T9		BD 971	MOTOROLA
1647.393	T10		BC 847 B	VALVO
1647.385	T11		BFR 92	MOTOROLA
1647.393	T12		BC 847 B	VALVO