

INSTRUCTION BOOK

VHF MONITORING RECEIVER 30/180

for AM and FM

Type ESM 180

BN 15073/2

Note: Always quote the Type and Order Number (BN) in addition to the Serial Number (FNr.) of the set when asking for technical information and, in particular, when ordering replacements.

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1. Specifications

Frequency range	30 to 180 MHz
in 5 sub-ranges	30 to 42.5/61/87.5/126/180 MHz
Scale calibration	approx. linear
in the 1st range	approx. 70 kHz per 1 mm of scale length
in the 5th range	approx. 150 kHz per 1 mm of scale length
Self-checking	in all ranges by harmonics of the crystal-controlled standardizing oscillator (21.4 MHz \pm 0.01%)
Antenna socket	unbalanced, R&S connector Dezifix B
Input impedance	approx. 60 Ω
Modes of operation	FM less de-emphasis (FM LESS DE) FM with de-emphasis (FM WITH DE) AM WITH AVC AM LESS AVC

Sensitivity

The following input voltages are required for a signal-to-noise ratio of 10 dB between the modulated and the unmodulated carrier:

AM narrow-band operation (modulation 30%, IF bandwidth 40 kHz)

Ranges 1 to 4 less than 2.5 μ V

Range 5 less than 5 μ V

FM less DE, narrow-band operation (frequency deviation 10 kHz, IF bandwidth 40 kHz)

Ranges 1 to 4 less than 2 μ V

Range 5 less than 3 μ V

FM with DE, wide-band operation (frequency deviation 40 kHz, IF bandwidth 200 kHz)

Ranges 1 to 4 less than 2 μ V

Range 5 less than 4 μ V

Image frequency rejection

Ranges 1 to 4 better than 80 dB

Range 5 better than 60 dB

IF rejection better than 100 dB

Intermediate frequency

Narrow-band operation 21.4 and 3.4 MHz

Wide-band operation 21.4 MHz

IF bandwidth

Narrow-band operation 40 kHz

Wide-band operation 200 kHz

AF bandwidth

Narrow-band operation 0.3 to 3 kHz

Wide-band operation 0.03 to 15 kHz

IF output I	13-mm socket, 21.4 MHz or 3.4 MHz, depending upon IF bandwidth, approx. 100 mV into 60 Ω										
IF output II	13-mm socket, 21.4 MHz or 3.4 MHz, depending upon IF bandwidth, approx. 100 mV into 60 Ω , overdriving capacity better than that of IF output I										
AF outputs											
Output for oscilloscope	13-mm socket; upper frequency limit 100 kHz										
Headphone output	50 mW into 2000 Ω										
Power output	80 V/2 W										
Built-in loudspeaker	0.5 W; can be switched off										
Input voltage indication	by meter										
With AVC	logarithmic scale (for absolute measurements the calibration must be made with a separate standardizing oscillator)										
Less AVC	linear scale with relative values										
Tuning indication	by meter										
2nd local oscillator											
Used as frequency standardizing oscillator	21.4 MHz \pm 0.01%, crystal-controlled										
Used as oscillator for A1 operation	21.4 MHz (wide-band operation) 3.4 MHz (narrow-band operation)										
Power supply	115/125/220/235 V \pm 10% 47 to 63 Hz (110 VA)										
Valves, etc.	<table border="0" style="display: inline-table; vertical-align: top;"> <tr> <td style="padding-right: 10px;">1 valve EC 80</td> <td style="border-left: 1px solid black; padding-left: 10px;">1 valve EL 41</td> </tr> <tr> <td>1 valve EC 81</td> <td style="border-left: 1px solid black; padding-left: 10px;">2 valves EZ 80</td> </tr> <tr> <td>1 valve ECC 81</td> <td style="border-left: 1px solid black; padding-left: 10px;">1 valve PCF 80</td> </tr> <tr> <td>1 valve EF 40</td> <td style="border-left: 1px solid black; padding-left: 10px;">2 valves PL 81</td> </tr> <tr> <td>8 valves EF 42</td> <td style="border-left: 1px solid black;"></td> </tr> </table> 1 reference tube 85 A 2 1 festoon lamp 6.3 V/0.3 A 2 fuses 1 A; M 1 C DIN 41571 (for 220 and 235 V) 1 fuse 0.16 A; M 0.16 C DIN 41571	1 valve EC 80	1 valve EL 41	1 valve EC 81	2 valves EZ 80	1 valve ECC 81	1 valve PCF 80	1 valve EF 40	2 valves PL 81	8 valves EF 42	
1 valve EC 80	1 valve EL 41										
1 valve EC 81	2 valves EZ 80										
1 valve ECC 81	1 valve PCF 80										
1 valve EF 40	2 valves PL 81										
8 valves EF 42											
Dimensions	540 x 233 x 378 mm (R&S Standard Cabinet 56)										
Weight	28 kg										
Accessories supplied	1 patch cord LK 333										

2. Uses

The Type ESM 180 is a versatile superheterodyne receiver for the frequency range 30 to 180 MHz and is preferably suited for radio monitoring and radio interference control. It enables the following signals to be received:

- (a) **Keyed continuous waves (CW).** The keyed carrier is made audible by switching on the built-in auxiliary oscillator and by tuning the RF section for the desired pitch.
- (b) **Keyed modulated waves (MCW) or AM sound-modulated waves.** Here it is possible to select either an IF bandwidth of 40 kHz with an AF band of 0.3 to 3 kHz or an IF bandwidth of 200 kHz with an AF bandwidth of 0.03 to 15 kHz.
- (c) **FM sound-modulated waves.** IF bandwidth and AF band can be selected as in AM reception. At an IF bandwidth of 40 kHz, the ratio detector can handle a frequency deviation of about 18 kHz and at an IF bandwidth of 200 kHz a frequency deviation of 75 kHz.
- (d) **Pulse-modulated waves or interfering frequencies.** From the frequency spectrum of an interfering pulse, the receiver cuts out a portion corresponding to the IF bandwidth and, for evaluation, applies the pulses resulting after demodulation to an oscilloscope. IF output I, which after the 4th IF stage supplies approx. 100 mV into 60 Ω via a built-in cathode follower, permits, for example, an oscilloscope to be connected. IF output II derives its voltage from the cathode resistor of the 3rd IF stage; it supplies a voltage of approx. 10 mV into 60 Ω but makes increased overdriving possible and is specially suited for connection of a Radio Interference Indicator Type EZS.

With this receiver it is also possible to carry out direct, relatively accurate frequency measurements, since the individual frequency scales can be checked and corrected on all multiples of 21.4 MHz with an accuracy of $\pm 0.01\%$ using the built-in crystal oscillator. For considerably more accurate remote frequency measurements this sensitive receiver can be used as an auxiliary unit. In this case, the incoming frequency and the output of a frequency synthesizer are heterodyned within the receiver. This receiver can advantageously be used for voltage indication when it is intended to measure a small voltage from a VHF signal generator by comparison with an accurately-known VHF voltage. A relatively accurate comparison voltage can be obtained, for example, from the following combination of instruments: Power Signal

Generator Type SMLM, BN 4105, 30 to 300 MHz, up to 3 V across 60 Ω ; UHF Voltmeter Type URU, BN 1980, with Insertion Unit BN 10804/60, 0.1 to 30 V, accuracy better than 3% up to 300 MHz; VHF Standard Attenuator Type DPR, BN 18042/60, 0 to 300 MHz, 0 to 100 dB, accuracy better than ± 0.2 dB. With this VHF reference voltage source and a suitable antenna, this receiver can also be used for measuring field intensity.

3. Preparation for Use

3.1 Adapting to the Local AC Supply, Voltage

The receiver leaves the factory adjusted for operation from 220 V AC. To adapt it to 115 V, 125 V or 235 V, first loosen the screws at the left and right edges of the front panel and remove the chassis from its cabinet. Next, put the little brass rod into the proper pair of contact clips on the tapping panel. At 115 V or 125 V, the 1-A fuses (M1 C DIN 41571) accessible from the front panel must be replaced by 2-A fuses (M2 D DIN 41571).

3.2 Setting the Mechanical Zero on the Meters

With the receiver switched off, the pointers of the meters should be at their mechanical zero. On the meter beside the frequency scale, this is the zero mark of the two scales; the mechanical zero of the other meter is at mid-scale. Zeroing is possible by means of the slotted screws recessed in the cases of the meters.

3.3 Switching on

Switch the receiver on by turning the selector switch from OFF to one of its four positions FM LESS DE, FM WITH DE, etc. The lamp illuminating the frequency scale is also the AC supply voltage indicator.

The set is ready for operation about one minute after switching on. To retain the accuracy of the calibration, it is, however, advisable to allow a warm-up period of about half an hour. The final temperature is reached after about three hours.

3.4 Connections

AC Supply: For connection to the AC supply a power cord with appliance plug and earthing-contact type plug (R&S Stock No. LK 333) is supplied with the set. The connector is provided at the lower right-hand corner of the front panel.

Antenna: Connect the antenna to the upper left-hand corner of the front panel, using a coaxial 60- Ω cable with an R&S connector Dezifix B.

Headset or Loudspeaker: One or two headsets with an impedance of 2000 Ω or higher can be connected to the sockets marked PHONES. The associated sockets are arranged one above the other. In each case, the two upper sockets are floating and carry no direct current whereas the lower ones connect to the cabinet. This holds also for the three sockets "80 V/2 W" provided for connection of an external loudspeaker with an impedance of 3500 Ω or higher.



Front View of the VHF Monitoring Receiver Type ESM 180 *)

Earthing: Where the set is not earthed via the power cord this can be done by connecting a separate line to the knurled terminal in the lower left-hand corner.

IF Output I: Either plug FMS 90100 is suitable for this socket at the left-hand side of the front panel. This output supplies a voltage of about 100 mV into 60 Ω . The frequency depends upon the selected IF bandwidth and is 21.4 MHz at an IF bandwidth of 200 kHz or 3.4 MHz at an IF bandwidth of 40 kHz.

IF Output II: Concerning location, suitable plug and frequency, the details given for IF output I hold also for this output. It supplies only 10 mV into 60 Ω but makes increased overdriving possible (approx. 40 dB). Therefore, this output is specially suited for connection of a Radio Interference Indicator Type EZS.

*) The above photograph does not fully correspond with the set described here. The latter is additionally equipped with IF output II located below IF output I which is shown above and is at the left-hand side of the front panel.

Oscilloscope Output: This output (at the lower right-hand side of the front panel) provides the demodulated IF with frequencies of about 30 Hz to about 100 kHz at a selected IF bandwidth of 200 kHz. The input impedance is approx. 200 Ω in series with 4 μ F. With regard to the lower limit frequency (30 Hz) the input impedance of the oscilloscope should be at least 1.5 k Ω . Adjust the voltage at this output with the control "VHF" since here the control "IF" would be ineffective. Select the mode of operation AM LESS AVC.

4. Operation

4.1 Tuning

First select the frequency band by means of the wing knob below the frequency dial and then adjust for the desired receiving frequency, using the crank type knob TUNING. The mask, which rotates with the frequency-band switch and bears the inscription of the lower and upper frequency limit of each band, brings into view only the scale of the band adjusted for. The procedure for correcting the calibration of the scale is set forth under 5.6.

The right-hand meter is used for accurate tuning in FM reception, whereas the left-hand meter is used for tuning in AM reception. In FM operation the receiver is in tune when the pointer deflects to the left or right of its mid-position when the tuning adjustment is slightly varied. Tune for maximum deflection when receiving amplitude-modulated waves.

4.2 Selecting the Mode of Operation

The adjustment of the bar type knobs for the 2ND OSCILLATOR, for the modes of operation FM LESS DE, FM WITH DE, AM WITH AVC or AM LESS AVC and for the IF bandwidth 40 kHz or 200 kHz depends on the type of modulation of the transmitter to be received and on the IF bandwidth which the receiver should have in this case.

4.2.1 Operation FM LESS DE

This type of operation is selected for the reception of frequency-modulated transmissions. Here the receiver does not eliminate the pre-emphasis of a transmitter. The 2ND OSCILLATOR knob should be in the OFF position.

IF bandwidth. Select an IF bandwidth of **40 kHz** when receiving an FM signal with a peak deviation of up to 15 kHz if a narrow AF bandwidth of "0.3 to 3 kHz" is desired. However, select the IF bandwidth of **200 kHz** if the receiver is to handle a peak deviation of up to 75 kHz and the need is for an AF bandwidth of "0.03 to 15 kHz".

Gain control. In this mode of operation, the input valve of the RF section and two valves of the IF section operate with automatic gain control. The gain control marked "VHF" is then inoperative.

Voltage indication. The voltage appearing at the antenna input is indicated by the left-hand meter. Refer to the scale graduated from 0 to $10^5 \mu\text{V}$. The reading depends on the somewhat frequency-sensitive amplification of the RF section and also slightly on the AC supply voltage. To measure the voltage accurately, compare it with a precisely known reference voltage.

AF control. The desired output voltage, i.e. the volume, is obtained by turning the knob marked **AF**. The built-in loudspeaker is switched on when this knob is pulled out.

4.2.2 Operation FM WITH DE

This mode of operation is selected for reception of frequency-modulated transmissions with the standard pre-emphasis of $50 \mu\text{sec}$. The receiver then operates with a corresponding de-emphasis. In all other respects refer to section 4.2.1.

4.2.3 Operation AM WITH AVC

This operation serves to receive MCW or sound-modulated waves. For IF and AF bandwidths, gain control, voltage indication and AF control refer to section 4.2.1.

4.2.4 Operation AM LESS AVC

This mode of operation is likewise intended for the reception of MCW or sound-modulated waves, however, it is especially suited to receive keyed continuous waves or interfering frequencies that are to be studied on an oscilloscope. For the reception of keyed continuous waves turn the 2ND OSCILLATOR knob to ON. The control marked **VHF** permits the gain to be varied. The gain should be so adjusted that the pointer of the left-hand meter does not go off-scale. A further increase of the gain would lead to overdriving. In this mode of operation, the linear meter scale, without voltage calibration, serves to indicate the voltage.

When monitoring the signals with the built-in loudspeaker, advance the AF control only to the point where there is no acoustic feedback.

5. Description (see block diagram and circuit diagram)

5.1 Radio-frequency Section

Essentially, the RF section comprises an input band-pass filter; a balanced four-gang capacitor; four coil turrets arranged one after the other on one shaft and containing five range coils each; a low-noise input valve, R_{ö1}, an earthed-grid connection; an amplifier valve, R_{ö2}; a mixer valve, R_{ö3}; an oscillator valve, R_{ö4}; and the primary circuit of the first IF band-pass filter.

The input band-pass filter suppresses all frequencies below and above the receiving range and hence prevents ambiguities. The signal passes from this filter via a coupling coil to the first resonant circuit and from there via another coupling coil to the cathode of valve R_{ö1}. For radio frequencies, the grid of this valve is taken to earth through two low-inductance capacitors; thus it is possible to include this valve in the automatic volume control circuit. The delayed automatic volume control, which is operative in the modes of operation FM LESS DE, FM WITH DE and AM WITH AVC, prevents overdriving of the subsequent stages with high input voltages while optimum sensitivity is achieved with low input voltages.

The second tuned circuit is arranged symmetrically between R_{ö1} and R_{ö2} via capacitances. The same holds for the third tuned circuit between R_{ö2} and the mixer R_{ö3}. Tracking at three frequencies exists between the oscillator tank circuit, whose frequency is higher by the intermediate frequency (21.4 MHz) than the receiving frequency, and the other tuned circuits of the radio-frequency section. Each of the 4 x 5 tuned-circuit coils is provided with a trimmer for capacitance adjustment. The trimmers are located in the coil turrets under the associated inductor. The scale of the four-gang capacitor is calibrated in receiving frequencies. A mask coupled to the shaft of the coil turret ensures that only the scale of the receiving range adjusted for is visible.

The crystal-controlled standardizing oscillator R_{ö11} oscillates at a fundamental frequency of 21.4 MHz $\pm 0.01\%$ and produces so many harmonics of sufficient amplitude that the calibration of the frequency scale, which is subdivided into 5 separate ranges, can be checked in steps of 21.4 MHz and, if necessary, corrected by means of the trimmer C56 – controlled by a knob at the right of the frequency scale – of the oscillator R_{ö4}. The standardizing oscillator is put into operation by applying its anode voltage with the aid of switch S7, which is marked 2ND OSCILLATOR on the front panel. The bandwidth selector should be at 200 kHz as it is only

in this position that the 2nd oscillator will deliver the frequency of 21.4 MHz. If button S2, located to the left of the frequency dial, is now depressed, the frequency spectrum passes via cable K5 and the small capacitance C23 – C22 to the second tuned circuit of the RF section. At the same time, the output voltage of the standardizing oscillator is applied to the grid of the IF valve R08 through cable K4 and thus mixed with the intermediate frequency of 21.4 MHz. Frequency calibration is achieved by adjusting the trimmer C56 for zero beat.

5.2 Intermediate-frequency Section

The input of the IF section consists of four filter circuits, the first of which is included in the RF section. The connection is made through cable K3. Valves R05, R06, R07 and R08 are IF amplifiers. After the first IF valve, R05, it is possible to select a bandwidth of 200 kHz or 40 kHz. At a bandwidth of 200 kHz, the intermediate frequency is 21.4 MHz, while at a bandwidth of 40 kHz it is 3.4 MHz. A separate set of IF circuits is provided for each of the intermediate frequencies. The upper IF circuits shown in the circuit diagram are associated with the intermediate frequency of 21.4 MHz, whereas the lower ones are associated with the intermediate frequency of 3.4 MHz. In order to produce the intermediate frequency of 3.4 MHz, the first IF valve, R05, with the crystal Q1 functions as a self-oscillating mixer. The crystal oscillates at $18 \text{ MHz} \pm 0.01\%$, an intermediate frequency of $21.4 - 18 = 3.4 \text{ MHz}$ thus being obtained.

To produce the negative voltage for the automatic volume control, the IF output of R08 is rectified by the crystal diode G12. The IF valves R06 and R07 as well as the first radio-frequency valve R01 are included in the AVC circuit. However, this is true only for the three modes of operation FM LESS DE, FM WITH DE and AM WITH AVC. In the fourth operation, AM LESS AVC, the control loop is taken to chassis via switch S51R. On the other hand, it is here possible to adjust the RF and IF amplification by means of the control R70 permitting the cathode voltage of R02 and R06 to be varied.

The AVC voltage produced by the crystal diode G12 is also used to indicate the voltage at the receiver input, on the moving-coil meter J1. This holds for the modes of operation FM LESS DE, FM WITH DE and AM WITH AVC. Here the meter covers a range of indication from 5 to 100,000 μV . A position bias fed into the crystal-diode circuit through R118 ensures that a control voltage and reading are obtained only when the voltage at the receiver input exceeds about 3 μV . With lower voltages the receiver operates at its maximum sensitivity. In operating AM LESS AVC, the meter

covers a range of indication of about 1 : 10. The reading has then no direct relation to the input voltage and serves principally for comparison measurements.

The demodulation of amplitude-modulated signals for sound and MCW transmissions is achieved by the crystal diode G110 located in the anode circuit of valve R68. The AF signal leaves the IF section via a choke and passes through K7 – S51F to the volume control R75 and from there via C158 to the input of the AF amplifier R614 – R615.

When receiving the signals of a transmitter operating on keyed continuous waves it is advisable to use an IF bandwidth of 40 kHz, that is to say, an intermediate frequency of 3.4 MHz. To make the signals audible, the right-hand triode section of valve R611 operates as a Hartley oscillator at a frequency of 3.4 MHz. Through cable K4, this frequency is applied to the grid of the IF valve R68 and the difference frequency, or beat note, thus resulting is passed on to the AF amplifier for monitoring, just as in AM reception. The desired beat note can be obtained by slightly varying the RF tuning adjustment on the scale of C10.

The crystal diode G110 used for demodulation also serves to rectify interference voltages that are to be studied on an oscilloscope. To this end, the IF amplifier is operated at a bandwidth of 200 kHz. To obtain a wide frequency spectrum, the AF signal supplied to the output OSCILLOSCOPE is not passed through the AF amplifier but through the cathode follower R610 specially provided for this purpose. The capacitor C157 isolates the output from direct current. The output impedance is approximately 200 Ω , the upper frequency limit lies in the vicinity of 100 kHz. Since for many measurements it is necessary to evaluate the IF voltage, two IF outputs are provided: For IF output I the voltage is supplied after the 4th IF stage R68 via C113 to the triode system of R69 where it is amplified and decoupled via C150 – K24. This output delivers approx. 100 mV into 60 Ω , but its overdriving capacity is insufficient for special measurements. For this reason, IF output II has been provided. The voltage for this output is derived from the cathode resistor R40 of the 3rd IF valve R67 and decoupled via the attenuator R124 – R125. Approx. 10 mV into 60 Ω is available which is sufficient for the Radio Interference Indicator Type EZS.

In FM reception the pentode section of valve R69 operates as an amplitude limiter. Two separate ratio detectors have been provided for the two IF bandwidths. The ratio detector with the crystal diodes G14 – G15 is operative at a bandwidth of 200 kHz, while the one using G16 – G17 is operative at a bandwidth of 40 kHz. The AF signal is applied to the bandwidth selector S31R through cable K21 + K8 or K21 + K9, passes

subsequently to the volume control R75 through K10 – S5IF and from there to the AF amplifier. The AF lines K21+K8 and K21+K9 also carry the rectified current which causes the moving-coil meter J2 to indicate the off-tune condition. The meter covers a range of ± 100 kHz at a bandwidth of 200 kHz and a range of ± 20 kHz at a bandwidth of 40 kHz. Correct tuning to the centre frequency of the carrier is indicated by a pointer deflection to the left or right of its mid-position if the tuning control is slightly varied.

5.3 Audio-frequency Section

The audio-frequency section comprises the pre-amplifier Rø14 and the power amplifier Rø15 which has an output of 2 W. The volume control R75 with a subsequent RC network R77 – C159 used to eliminate the transmitter pre-emphasis (50 μ sec) in FM reception has been inserted at the input of the AF section. This de-emphasis network is operative only in FM WITH DE.

When the IF bandwidth is switched from 200 kHz to 40 kHz the AF bandwidth is narrowed down in the AF section by the insertion of additional frequency-sensitive degenerative elements. With an IF bandwidth of 200 kHz, the AF bandwidth is 0.03 to 15 kHz, and with an IF bandwidth of 40 kHz, the AF bandwidth is 0.3 to 3 kHz.

The output transformer Tr1 has three electrically isolated secondary windings: one for an external loudspeaker having an impedance of about 3.5 k Ω (sockets marked "80 V/2 W"); one for two headphones having an impedance of about 4 k Ω (sockets marked PHONES); another for the built-in 0.5-W loudspeaker Lt1 which can be turned on by the panel switch S4. S4 is combined with the volume control R75. The loudspeaker Lt1 can be switched into circuit by pulling out the control knob of R75.

5.4 Power Supply

The primary circuit of the power supply is designed for operation from an AC supply voltage of 115 V, 125 V, 220 V or 235 V and protected by the two fuses Si1 and Si2. The on-off switch S6 is mechanically coupled to S5 which selects the type of operation. In the OFF position of the switch S5, S6 is open. Filtering prevents RF interference from entering the power leads.

The secondary circuit of the power supply incorporates the two rectifier valves Rø16 and Rø17 placed in parallel to produce the anode voltage, and the valves Rø18, Rø19, Rø20 and Rø21 used for stabilization. This voltage regulator circuit, which keeps the anode voltage constant regardless of AC supply fluctuations and changes

in the anode current, operates as follows: the regulator valves R_{ö18} and R_{ö19}, power pentodes of low anode resistance, are in series with the load and thus pass the total anode current.

With the AC supply voltage rising, the screen-grid voltage of the regulator control amplifier valve R_{ö20} becomes more positive, its anode current and the voltage drop across the anode resistor R₉₂ increase, the grid voltage of the series regulator valves R_{ö18}–R_{ö19} becomes more negative and their anode resistance increase to the extent that the voltage across the load drops to the original value. The reference tube R_{ö21} serves to maintain a certain reference voltage at the grid of control valve R_{ö20}. The anode voltage of the receiver changes by less than 1% with AC supply fluctuations between 200 V and 240 V.

For example, if the voltage across the load drops due to a higher current through the load, then the voltage tapped at the voltage divider resistor R₉₆ likewise drops, the grid bias of R_{ö20} thus becomes more negative, the voltage drop across the anode load resistor R₉₂ decreases, the grid bias of the series regulator valves R_{ö18}–R_{ö19} becomes less negative and hence their anode resistances decrease to the extent that the voltage across the load increases to the original value. The potentiometer R₉₆ serves to adjust the anode voltage to 220 V.

The 160-mA fine-wire fuse Si3 is inserted in the anode lead to protect the power supply. A particular advantage of this kind of voltage-regulator circuit is a noteworthy decrease in the AC hum. The hum present at the load end passes through the RC network R₉₅–R₉₆–C₂₀₄ to the grid of valve R_{ö20} where it is amplified, shifted in phase by 180° and applied to the grid of the series regulator valves R_{ö18}–R_{ö19}.

5.5 Interior and Exterior Construction

The RF section, the standardizing oscillator with R_{ö11}, the IF section, the AF section and the power supply are self-contained assemblies mounted in such a manner as to be readily replaceable after a few screws have been loosened and a few connections interrupted.

All the controls and switches of the receiver as well as the terminals for the antenna, headphones, loudspeaker and power cord are on the front panel. From the upper left-hand corner to the right there are R&S connector for the antenna load-in (60 Ω), the button S₂ (CALIBRATION), the five-section frequency dial, the trimmer C₅₆ (CALIBRATION) of the oscillator R_{ö4}, the meter J₁ for direct reading of the input voltage, the discriminator meter J₂ for tuning indication in FM reception, and the

0.5 W loudspeaker Lt1 which is behind the perforated section of the front panel. The wing knob of the frequency-band switch is below the frequency scale, the gain control R70 is below J1, and the volume control R75 combined with S4 for switching the built-in loudspeaker Lt1 on and off is below J2. The coaxial 13-mm sockets for the two IF outputs are on the left-hand side of the front panel, near the centre.

From the lower left-hand corner to the right, there are the knurled terminal for connection of the earth wire, the switch S7 of the 2ND OSCILLATOR with the positions OFF and ON (CALIBRATION), the crank-type knob TUNING of the frequency dial, the power and selector switch S5 with the positions OFF, FM LESS DE, FM WITH DE, AM WITH AVC and AM LESS AVC, the terminal panel with nine jacks for two headphones and one loudspeaker (80 V/2 W), the coaxial 13-mm socket for connection of an oscilloscope and the bandwidth selector S3 which is above the OSCILLOSCOPE socket and has the positions 40 kHz and 200 kHz. Located on the right-hand side of the front panel are the connector for the AC supply lead and the two AC supply fuses Si1 and Si2.

5.6 Frequency Calibration, Replacement of Valves and Scale Lamp

The spectrum of harmonics – multiples of $21.4 \text{ MHz} \pm 0.01\%$ – of the standardizing oscillator permits the frequency scale to be checked at the red calibration marks. To this end, set 2ND OSCILLATOR to ON (CALIBRATION), IF bandwidth selector to 200 kHz, selector switch to AM WITH AVC, turn on the loudspeaker by pulling out the knob AF, advance the AF control and press the knob CALIBRATION to the left of the frequency dial. If the calibration is correct a beat note will be heard in the vicinity of each calibration mark, while zero beat will be obtained exactly at each calibration mark. The calibration can be corrected using the knob CALIBRATION to the right of the frequency dial.

All the valves are readily replaceable after removal of the set from its cabinet. However, it is advisable to check and, if necessary, to correct the scale calibration after replacement of the oscillator valve RÖ4 (EC81). A small sheet-metal case is held by a spring behind the plexiglass dial, between the RF-section and the mounting panel parallel to the front panel. Turn this spring. The case with its handle can now be swung out and removed by pulling upward. The scale lamp (festoon lamp R&S Stock No. RL 163 S) is then readily accessible.

6. Parts List

Ref. No.	Designation	Ratings	R&S Stock No.
C 1	Capacitor, ceramic	102 pF	CCH 68/102
C 2	Capacitor, ceramic	152 pF	CCH 68/152
C 3	Capacitor, ceramic	51 pF	CCH 68/51
C 4	Capacitor, ceramic	152 pF	CCH 68/152
C 5	Trimmer, disc	2 to 10 pF	CV 914
C 6	Trimmer, disc	2 to 10 pF	CV 914
C 7	Trimmer, disc	2 to 10 pF	CV 914
C 8	Trimmer, disc	2 to 10 pF	CV 914
C 9	Trimmer, disc	2 to 10 pF	CV 914
C 10	Capacitor, variable		15072 - 1.2
C 11	Capacitor, ceramic	1000 pF	CCG 94/1000
C 12	Capacitor, ceramic	220 pF	CCG 91/220
C 13	Capacitor, ceramic	220 pF	CCG 91/220
C 14	Trimmer, disc	2 to 10 pF	CV 914
C 15	Trimmer, disc	2 to 10 pF	CV 914
C 16	Trimmer, disc	2 to 10 pF	CV 914
C 17	Trimmer, disc	2 to 10 pF	CV 914
C 18	Trimmer, disc	2 to 10 pF	CV 914
C 19	Capacitor, ceramic	102 pF	CCH 68/102
C 20	Capacitor, ceramic	82 pF	CCH 68/82
C 21	Capacitor, ceramic	82 pF	CCH 68/82
C 22	Capacitor, ceramic	0.5 pF	CCG 11/0,5
C 23	Capacitor, ceramic	2 pF	CCG 41/2
C 24	Capacitor, ceramic	1000 pF	CCG 94/1000
C 25	Capacitor, ceramic	1000 pF	CCG 94/1000
C 26	Capacitor, ceramic	82 pF	CCH 68/82
C 27	Trimmer, disc	2 to 10 pF	CV 914
C 28	Trimmer, disc	2 to 10 pF	CV 914
C 29	Trimmer, disc	2 to 10 pF	CV 914
C 30	Trimmer, disc	2 to 10 pF	CV 914
C 31	Trimmer, disc	2 to 10 pF	CV 914
C 32	Capacitor, paper	100,000 pF/250 V	CPK 58004 n 100
C 33	Capacitor, ceramic	82 pF	CCH 68/82
C 34	Trimmer, disc Capacitor, ceramic	4 to 20 pF 12 pF	CV 924 CCH 31/12 parallel
C 35	Capacitor, ceramic	1000 pF	CCG 94/1000
C 36	Capacitor, ceramic	1000 pF	CCG 94/1000
C 37	Capacitor, ceramic	2 pF	CCG 41/2
C 38	Trimmer, disc	2 to 10 pF	CV 914
C 39	Trimmer, disc	2 to 10 pF	CV 914
C 40	Trimmer, disc	2 to 10 pF	CV 914
C 41	Trimmer, disc	2 to 10 pF	CV 914
C 42	Trimmer, disc	2 to 10 pF	CV 914

Ref. No.	Designation	Ratings	R & S Stock No.
C 43	Capacitor, ceramic	100 pF	CCH 68/100
C 44	Capacitor, ceramic	137 pF	CCH 68/137
C 45	Capacitor, ceramic	180 pF	CCH 68/180
C 46	Capacitor, ceramic	270 pF	CCH 68/270
C 47	Capacitor, ceramic	200 pF	CCH 68/200
C 48	Capacitor, ceramic	100 pF	CCH 68/100
C 49	Capacitor, ceramic	137 pF	CCH 68/137
C 50	Capacitor, ceramic	180 pF	CCH 68/180
C 51	Capacitor, ceramic	270 pF	CCH 68/270
C 52	Capacitor, ceramic	200 pF	CCH 68/200
C 54	Capacitor, ceramic	27 pF	CCH 31/27
C 55	Capacitor, ceramic	18 pF	CCH 11/18
C 56	Trimmer		1507 - 1.24.8
C 57	Capacitor, feed-through	125 pF	CFG 125/5
C 58	Capacitor, feed-through	125 pF	CFG 125
C 59	Capacitor, feed-through, ceramic	500 pF	CFS 500
C 60	Capacitor, feed-through	125 pF	CFG 125
C 61	Capacitor, feed-through	125 pF	CFG 125/5
C 62	Capacitor, feed-through, ceramic	125 pF	CFS 500
C 63	Capacitor, feed-through, ceramic	500 pF	CFS 500
C 64	Capacitor, feed-through	125 pF	CFG 125/5
C 65	Capacitor, feed-through	125 pF	CFG 125
C 66	Capacitor, feed-through	125 pF	CFG 125/5
C 67	Capacitor, feed-through	125 pF	CFG 125
C 70	Capacitor, ceramic	47 pF	CCH 31/47
C 71	Capacitor, ceramic	56 pF	CCH 31/56
C 73	Capacitor, ceramic	1000 pF	CCG 94/1000
C 74	Trimmer, tubular, ceramic Capacitor, ceramic	1 to 11 pF 33 pF	CV 72692 p 12 CCH 31/33 parallel
C 75	Capacitor, ceramic	6 pF	CCG 41/6
C 76	Trimmer, air Capacitor, ceramic	4 to 29 pF 8 pF	CV 8125 CCG 41/8 parallel
C 77	Trimmer, air Capacitor, ceramic	4 to 29 pF 8 pF	CV 8125 CCG 41/8 parallel
C 78	Capacitor, ceramic	15 pF	CCH 31/15
C 79	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 80	Capacitor, ceramic	27 pF	CCH 31/27
C 81	Trimmer, air Capacitor, ceramic	4 to 29 pF 8 pF	CV 8125 CCG 41/8 parallel
C 82	Trimmer, air Capacitor, ceramic	4 to 29 pF 39 pF	CV 8125 CCH 31/39 parallel
C 83	Capacitor, paper	10,000 pF/250 V	CPK 10 000/250
C 84	Trimmer, air Capacitor, ceramic	4 to 29 pF 6 pF	CV 8125 CCG 41/6 parallel
C 85	Trimmer, air Capacitor, ceramic	4 to 29 pF 33 pF	CV 8125 CCH 31/33 parallel

Ref. No.	Designation	Ratings	R&S Stock No.
C 86	Capacitor, ceramic	2 pF	CCG 41/2
C 87	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 88	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 89	Trimmer, air Capacitor, ceramic	4 to 29 pF 8 pF	CV 8125 CCG 41/8 parallel
C 90	Trimmer, air Capacitor, ceramic	4 to 29 pF 39 pF	CV 8125 CCH 31/39 parallel
C 91	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 92	Trimmer, air Capacitor, ceramic	4 to 29 pF 6 pF	CV 8125 CCG 41/6 parallel
C 93	Trimmer, air Capacitor, ceramic	4 to 29 pF 39 pF	CV 8125 CCH 31/39 parallel
C 94	Capacitor, ceramic	18 pF	CCH 31/18
C 95	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 96	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 97	Trimmer, air Capacitor, ceramic	4 to 29 pF 8 pF	CV 8125 CCG 41/8 parallel
C 98	Trimmer, air Capacitor, ceramic	4 to 29 pF 39 pF	CV 8125 CCH 31/39 parallel
C 99	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 100	Trimmer, air Capacitor, ceramic	4 to 29 pF 6 pF	CV 8125 CCG 41/6 parallel
C 101	Trimmer, air Capacitor, ceramic	4 to 29 pF 39 pF	CV 8125 CCH 31/39 parallel
C 102	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 103	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 104	Trimmer, air	4 to 29 pF	CV 8125
C 105	Trimmer, air Capacitor, ceramic	4 to 29 pF 27 pF	CV 8125 CCH 31/27 parallel
C 106	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 107	Capacitor, ceramic	6 pF	CCG 41/6
C 108	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 109	Capacitor, ceramic	470 pF	CCG 94/470
C 110	Capacitor, ceramic	0.5 pF	CCG 11/0,5
C 111	Capacitor, ceramic	27 pF	CCH 31/27
C 112	Capacitor, ceramic	6 pF	CCG 41/6
C 113	Capacitor, ceramic	2 pF	CCG 41/2
C 114	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 115	Capacitor, MP	0.25 μ F/500 V	CMR 0,25/500
C 116	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 117	Trimmer, air Capacitor, ceramic	4 to 29 pF 15 pF	CV 8125 CCH 31/15 parallel
C 118	Trimmer, air Capacitor, ceramic	4 to 29 pF 18 pF	CV 8125 CCH 31/18 parallel
C 119	Capacitor, ceramic	220 pF	CCG 91/220
C 120	Capacitor, ceramic	220 pF	CCG 91/220
C 121	Capacitor, electrolytic	10 μ F/70 V	CED 3/10/70
C 122	Trimmer, air Capacitor, ceramic	4 to 29 pF 39 pF	CV 8125 CCH 31/39 parallel

Ref. No.	Designation	Ratings	R&S Stock No.
C 123	Trimmer, air Capacitor, ceramic	4 to 29 pF 3 x 56 pF + 18 pF	CV 8125 3 x CCH 31/56 + 1 x CCH 31/18 parallel
C 124	Capacitor, ceramic	220 pF	CCG 91/220
C 125	Capacitor, ceramic	220 pF	CCG 91/220
C 126	Capacitor, electrolytic	10 μ F/70 V	CED 3/10/70
C 127	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 128	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 129	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 130	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 131	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 132	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 133	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 134	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 135	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 136	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 137	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 138	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 139	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 140	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 141	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 142	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 143	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 144	Capacitor, feed-through, ceramic	100 pF	CFR 2/100
C 145	Capacitor, feed-through, ceramic	100 pF	CFR 2/100
C 146	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 147	Capacitor, feed-through, ceramic	100 pF	CFR 2/100
C 148	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 149	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 150	Capacitor, ceramic	2200 pF	CCG 94/2200

Ref. No.	Designation	Ratings	R&S Stock No.
C 151	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 152	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 153	Capacitor, feed-through, ceramic	5000 pF/500 V	CFR 1/5000/500
C 154	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 155	Capacitor, paper	100,000 pF/250 V	CPK 58004 n 100
C 156	Capacitor, feed-through, ceramic	100 pF	CFR 2/100
C 157	Capacitor, MP	4 μ F/160 V	CMR 4/160/2 D
C 158	Capacitor, paper	10,000 pF/250 V	CPK 58003 n 10
C 159	Capacitor, ceramic	12 pF	CCH 31/12
C 160	Capacitor, MP	0.5 μ F/500 V	CMR 0,5/500
C 161	Capacitor, paper	22,000 pF/250 V	CPK 58003 n 22
C 162	Capacitor, MP	1 μ F/250 V	CMR 1/250
C 163	Capacitor, paper	47,000 pF/250 V	CPK 58003 n 47
C 164	Capacitor, paper	2 x 2200 pF/1000 V in series	2 x CPK 70003 n 2,2 in series
C 165	Capacitor, ceramic	82 pF	CCH 31/82
C 166	Capacitor, MP	0.25 μ F/500 V	CMR 0,25/500
C 167	Capacitor, ceramic	10 pF	CCH 31/10
C 168	Capacitor, synth. foil	500 pF/500 V	CKS 500/500
C 179	Capacitor, MP	1 μ F/250 V	CMR 1/250
C 180	Capacitor, synth. foil	1000 pF/500 V	CKS 1000/500
C 181	Capacitor, ceramic	3 pF	CCG 11/3
C 182	Capacitor, ceramic	8 pF	CCG 41/8
C 183	Capacitor, ceramic	6 pF	CCG 41/6
C 184	Capacitor, ceramic	22 pF	CCH 31/22
C 185	Trimmer, air	4 to 29 pF	CV 8125
C 186	Capacitor, ceramic	100 pF	CCH 31/100
C 187	Capacitor, feed-through, ceramic	2000 pF	CFS 2000
C 188	Capacitor, feed-through, ceramic	2000 pF	CFS 2000
C 189	Capacitor, feed-through, ceramic	2000 pF	CFS 2000
C 190	Capacitor, feed-through, ceramic	2000 pF	CFS 2000
C 191	Capacitor, feed-through, ceramic	2000 pF	CFS 2000
C 192	Capacitor, feed-through, ceramic	2000 pF	CFS 2000
C 193	Capacitor, feed-through, ceramic	2000 pF	CFS 2000
C 194	Capacitor, feed-through, ceramic	2000 pF	CFS 2000
C 195	Capacitor, feed-through, ceramic	2000 pF	CFS 2000
C 196	Capacitor, ceramic	33 pF	CCH 31/33
C 197	Capacitor, ceramic	33 pF	CCH 31/33

Ref. No.	Designation	Ratings	R&S Stock No.
C 198	Capacitor, paper	100,000 pF/250 V	CPK 58004 n 100
C 199	Capacitor, ceramic	47 pF	CCH 31/47
C 200	Capacitor, MP	8 μ F/350 V	CMR 8 + 8/350
C 201		8 μ F/350 V	
C 202	Capacitor, MP	1 μ F/500 V	CMR 1/500
C 203	Capacitor, paper	100,000 pF/250 V	CPK 58004 n 100
C 204	Capacitor, paper	100,000 pF/250 V	CPK 58004 n 100
C 205	Capacitor, paper	1000 pF/1000 V	CPK 70003 n 1
D 1	Filter, feed-through		DPF 14502
D 2	Filter, feed-through		DPF 14502
GI 1	Diode, crystal		GK/S 33
GI 2	Diode, germanium		GK/OA 95
GI 4	Diode, germanium		} GK/2 x AA 118
GI 5	Diode, germanium		
GI 6	Diode, germanium		} GK/2 x AA 118
GI 7	Diode, germanium		
GI 8	Diode, germanium		GK/OA 95
GI 10	Diode, germanium		GK/OA 95
J 1	Meter, moving-coil	20 μ A	IS 021/20 μ A
J 2	Meter, moving-coil	2 x 10 μ A	IP 004/2 x 10 μ A
K 1	Cable, RF		LKK 61900
K 3	Cable, RF		LKK 61900
K 4	Cable, RF		LK 126/6
K 5	Cable, RF		LK 126/6
K 6	Litz wire, shielded		LKK 91600
K 7	Jumper, wire, shielded		LKK 92220
K 8	Jumper, wire, shielded		LKK 92220
K 9	Jumper, wire, shielded		LKK 92220
K 10	Jumper, wire, shielded		LKK 92220
K 12	Jumper, wire, shielded		LKK 92220
K 14	Jumper, wire, shielded		LKK 92220
K 16	Twin wire, shielded		LFA 03022
K 17	Twin wire, shielded		LFA 03022
K 18	Twin wire, shielded		LFA 03022
K 19	Cable, RF		LKK 61900
K 20	Jumper wire, shielded		LKK 92220
K 21	Twin wire, shielded		LFA 03022
K 23	Jumper wire, shielded		LKK 92220
K 24	Cable, RF		LK 126/6

Ref. No.	Designation	Ratings	R&S Stock No.
L 1	Coil, filter		15071 - 6.1
L 2	Coil, filter		15071 - 6.1
L 5	Coil, oscillator		15071 - 1.3.1
L 6	Coil, oscillator		15071 - 1.3.2
L 7	Coil, oscillator		15071 - 1.3.3
L 8	Coil, oscillator		15071 - 1.3.4
L 9	Coil, oscillator		15071 - 1.3.5
L 10	Coil, oscillator		15071 - 1.4.1
L 11	Coil, oscillator		15071 - 1.4.2
L 12	Coil, oscillator		15071 - 1.4.3
L 13	Coil, oscillator		15071 - 1.4.4
L 14	Coil, oscillator		15071 - 1.4.5
L 15	Coil, oscillator		15071 - 1.4.1
L 16	Coil, oscillator		15071 - 1.4.2
L 17	Coil, oscillator		15071 - 1.4.3
L 18	Coil, oscillator		15071 - 1.4.4
L 19	Coil, oscillator		15071 - 1.4.5
L 20	Coil, oscillator		15071 - 1.5.1
L 21	Coil, oscillator		15071 - 1.5.2
L 22	Coil, oscillator		15071 - 1.5.3
L 23	Coil, oscillator		15071 - 1.5.4
L 24	Coil, oscillator		15071 - 1.5.5
L 27	Transformer, IF		15071 - 1.13
L 29	Choke		1507 - 1.24.17
L 30	Choke		1507 - 1.24.18
L 31	Choke		1507 - 1.24.17
L 32	Choke		1507 - 1.24.18
L 34	Coil, coupling		1507 - 2.34.2
L 35	Coil, filter		1507 - 2.34.1
L 36	Coil, filter		1507 - 2.33.2
L 37	Coil, filter		15071 - 2.31.1
L 38	Coil, filter		15071 - 2.30.1
L 39	Coil, filter		15071 - 2.31.1
L 40	Coil, filter		15071 - 2.32.2
L 41	Coil, filter		15071 - 2.32.1
L 42	Coil, filter		15071 - 2.30.1
L 43	Coil, filter		15071 - 2.31.1
L 44	Coil, filter		15071 - 2.32.2
L 45	Coil, filter		15071 - 2.32.1
L 46	Coil, filter		15071 - 2.30.1
L 47	Coil, filter		15071 - 2.31.1
L 48	Coil, filter		15071 - 2.32.2
L 49	Coil, filter		15071 - 2.32.1
L 50	Coil, filter		15071 - 2.30.1
L 51	Coil, filter		15071 - 2.32.1

Ref. No.	Designation	Ratings	R&S Stock No.
L 52	Coil		15071 - 2.28.3
L 54	Coil, discriminator		15071 - 2.28.4
L 55	Coil		15071 - 2.29.1
L 57	Coil, discriminator		15071 - 2.29.2
L 58	Choke		DUF 311/20
L 59	Choke		DUF 311/20
L 60	Choke		DUF 311/20
L 61	Choke		DUF 311/20
L 62	Choke		DUF 311/20
L 63	Choke		DUF 311/20
L 64	Choke		DUF 311/20
L 65	Choke		DUF 311/20
L 66	Choke		DUF 311/20
L 67	Choke		DUF 311/20
L 68	Choke		DUF 311/20
L 69	Choke		DUF 311/20
L 70	Choke		DUF 311/20
L 71	Choke		DUF 311/20
L 72	Choke		DUF 311/20
L 73	Choke		DUF 311/20
L 74	Choke		DUF 311/20
L 75	Choke		DUF 311/20
L 76	Choke		DUF 311/20
L 77	Coil, oscillator		15071 - 4.12
L 78	Choke		DUF 311/20
L 79	Choke		DUF 311/20
L 80	Choke		15071 - 4.13
L 81	Choke		DUF 311/20
L 82	Choke		DUF 311/20
L 83	Choke		15071 - 4.13
L 84	Choke		DUF 311/20
L 85	Choke		DUF 311/20
L 86	Choke		15071 - 4.14
L 87	Choke		15071 - 43
L 88	Choke		DB 125/2
L 91	Choke		15071 - 30
Lt 1	Loudspeaker		PM 95/16 BR trop
Q 1	Crystal, oscillator	18.00 MHz \pm 0.01%	QS 1/1
Q 2	Crystal, oscillator	21.40 MHz \pm 0.01%	QS 2/1
R 1	Resistor, depos. carbon	100 Ω \pm 1%/0.5 W	WFE 341 E 100
R 2	Resistor, depos. carbon	200 k Ω /0.5 W	WFE 321 k 200
R 3	Resistor, depos. carbon	5 k Ω /1 W	WFE 521 k 5

Ref. No.	Designation	Ratings	R&S Stock No.
R 4	Resistor, depos. carbon	20 k Ω /0.3 W	WFE 221 k 20
R 5	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 6	Resistor, depos. carbon	160 Ω \pm 1%/0.5 W	WFE 341 E 160
R 7	Resistor, depos. carbon	160 k Ω /0.5 W	WFE 321 k 160
R 8	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 9	Resistor, depos. carbon	5 k Ω /1 W	WFE 521 k 1
R 10	Resistor, depos. carbon	100 k Ω /0.3 W	WFE 221 k 100
R 11	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 12	Resistor, depos. carbon	2 k Ω /1 W	WFE 521 k 2
R 13	Resistor, depos. carbon	30 k Ω /1 W	WFE 521 k 30
R 14	Resistor, depos. carbon	30 k Ω /0.3 W	WFE 221 k 30
R 15	Resistor, depos. carbon	5 Ω /0.3 W	WFE 221 E 5
R 16	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 17	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 18	Resistor, depos. carbon	10 k Ω /1 W	WFE 521 k 10
R 19	Resistor, depos. carbon	50 k Ω /0.3 W	WFE 221 k 50
R 20	Resistor, depos. carbon	40 k Ω /0.3 W	WFE 221 k 40
R 21	Resistor, depos. carbon	40 k Ω /0.3 W	WFE 221 k 40
R 22	Resistor, depos. carbon	500 k Ω /0.5 W	WFE 321 k 500
R 23	Resistor, depos. carbon	10 k Ω /0.5 W	WFE 321 k 10
R 24	Resistor, depos. carbon	40 k Ω /0.3 W	WFE 221 k 40
R 25	Resistor, depos. carbon	60 k Ω /0.3 W	WFE 221 k 60
R 26	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 27	Resistor, depos. carbon	40 k Ω /0.3 W	WFE 221 k 40
R 28	Resistor, depos. carbon	60 k Ω /0.3 W	WFE 221 k 60
R 29	Resistor, depos. carbon	200 k Ω /0.5 W	WFE 321 k 200
R 30	Resistor, depos. carbon	50 Ω /0.3 W	WFE 221 E 50
R 31	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 32	Resistor, depos. carbon	50 k Ω /1 W	WFE 521 k 50
R 33	Resistor, depos. carbon	160 Ω /0.5 W	WFE 321 E 160
R 34	Resistor, depos. carbon	40 k Ω /0.3 W	WFE 221 k 40
R 35	Resistor, depos. carbon	60 k Ω /0.3 W	WFE 221 k 60
R 36	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 37	Resistor, depos. carbon	40 k Ω /0.3 W	WFE 221 k 40
R 38	Resistor, depos. carbon	60 k Ω /0.3 W	WFE 221 k 60
R 39	Resistor, depos. carbon	200 k Ω /0.5 W	WFE 321 k 200
R 40	Resistor, depos. carbon	50 Ω /0.3 W	WFE 221 E 50
R 41	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 42	Resistor, depos. carbon	12.5 k Ω /0.3 W	WFE 221 k 12,5
R 43	Resistor, depos. carbon	160 Ω /0.5 W	WFE 321 E 160
R 44	Resistor, depos. carbon	40 k Ω /0.3 W	WFE 221 k 40
R 45	Resistor, depos. carbon	60 k Ω /0.3 W	WFE 221 k 60
R 46	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 47	Resistor, depos. carbon	40 k Ω /0.3 W	WFE 221 k 40
R 48	Resistor, depos. carbon	60 k Ω /0.3 W	WFE 221 k 60

Ref. No.	Designation	Ratings	R & S Stock No.
R 50	Resistor, depos. carbon,	1 k Ω /0.5 W	WFE 321 k 1
R 51	Resistor, depos. carbon,	160 k Ω /0.5 W	WFE 321 k 160
R 52	Resistor, depos. carbon,	160 Ω /0.5 W	WFE 321 E 160
R 53	Resistor, depos. carbon,	30 Ω /0.5 W	WFE 321 E 30
R 54	Resistor, depos. carbon,	12.5 k Ω /0.5 W	WFE 221 k 12,5
R 55	Resistor, depos. carbon,	1 k Ω /0.5 W	WFE 321 k 1
R 56	Resistor, depos. carbon,	30 k Ω /0.5 W	WFE 321 k 30
R 57	Resistor, depos. carbon,	40 k Ω /0.5 W	WFE 321 k 40
R 58	Resistor, depos. carbon,	2 x 10 k Ω /0.5 W	2 x WFO 10 k/0,5 parallel
R 59	Resistor, depos. carbon,	100 k Ω /0.5 W	WFE 321 k 100
R 60	Resistor, depos. carbon,	200 k Ω /0.5 W	WFE 321 k 200
R 61	Resistor, depos. carbon,	100 k Ω /0.3 W	WFE 221 k 100
R 62	Resistor, depos. carbon,	100 k Ω /0.3 W	WFE 221 k 100
R 63	Resistor, depos. carbon,	50 k Ω /0.5 W	WFE 321 k 50
R 64	Resistor, depos. carbon,	160 Ω /0.5 W	WFE 321 E 160
R 65	Resistor, depos. carbon,	100 k Ω /0.5 W	WFE 321 k 100
R 66	Resistor, depos. carbon,	200 k Ω /0.5 W	WFE 321 k 200
R 67	Resistor, depos. carbon,	1 k Ω /0.5 W	WFE 321 k 1
R 68	Resistor, depos. carbon,	20 k Ω /0.5 W	WFE 321 k 20
R 69	Resistor, depos. carbon,	100 k Ω /0.3 W	WFE 221 k 100
R 70	Resistor, depos. carbon, variable	1 k Ω lin.	WS 7126/1 k
R 71	Resistor, depos. carbon	200 k Ω /0.5 W	WFE 321 k 200
R 72	Resistor, depos. carbon	100 Ω /0.5 W	WFE 321 E 100
R 73	Resistor, depos. carbon	400 k Ω /0.5 W	WFE 321 k 400
R 74	Resistor, depos. carbon	100 k Ω /0.5 W	WFE 321 k 100
R 75	Resistor, depos. carbon, variable	1 M Ω log.	WS/SS 5226/1 M
R 76	Resistor, depos. carbon	3 M Ω /0.5 W	WFE 321 M 3
R 77	Resistor, depos. carbon	1.6 M Ω /0.5 W	WFE 321 M 1,6
R 78	Resistor, depos. carbon	1.6 k Ω /0.5 W	WFE 321 k 1,6
R 79	Resistor, depos. carbon	600 k Ω /0.5 W	WFE 321 k 600
R 80	Resistor, depos. carbon	200 k Ω /0.5 W	WFE 321 k 200
R 81	Resistor, depos. carbon	50 k Ω /0.5 W	WFE 321 k 50
R 82	Resistor, depos. carbon	600 k Ω /0.5 W	WFE 321 k 600
R 83	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 84	Resistor, depos. carbon	1 M Ω /0.5 W	WFE 321 M 1
R 85	Resistor, depos. carbon	160 Ω \pm 1%/0.5 W	WFE 341 E 160
R 86	Resistor, depos. carbon	50 k Ω /0.5 W	WFE 321 k 50
R 87	Resistor, depos. carbon	10 k Ω /0.5 W	WFE 321 k 10
R 88	Resistor, depos. carbon	100 k Ω /0.5 W	WFE 321 k 100
R 89	Resistor, depos. carbon	80 k Ω /0.5 W	WFE 321 k 80
R 90	Resistor, depos. carbon	20 k Ω /0.5 W	WFE 321 k 20
R 91	Resistor, depos. carbon	80 k Ω /0.5 W	WFE 321 k 80
R 92	Resistor, depos. carbon	500 k Ω /0.5 W	WFE 321 k 500
R 93	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1

Ref. No.	Designation	Ratings	R & S Stock No.
R 94	Resistor, depos. carbon	1 k Ω /0.5 W	WFE 321 k 1
R 95	Resistor, depos. carbon	125 k Ω /0.5 W	WFE 321 k 125
R 96	Resistor, depos. carbon, variable	10 k Ω lin.	WS 9122 F/10 k
R 97	Resistor, depos. carbon	80 k Ω /0.5 W	WFE 321 k 80
R 98	Resistor, depos. carbon	30 Ω /0.5 W	WFE 321 E 30
R 99	Resistor, depos. carbon	30 Ω /0.5 W	WFE 321 E 30
R 100	Resistor, depos. carbon	125 k Ω /0.5 W	WFE 321 k 125
R 101	Resistor, depos. carbon	200 Ω /0.5 W	WFE 321 E 200
R 102	Resistor, depos. carbon, variable	1 k Ω lin.	WS 9122 F/1 k
R 103	Resistor, depos. carbon, variable	1 k Ω lin.	WS 9122 F/1 k
R 104	Resistor, depos. carbon	2 k Ω /0.5 W	WFE 321 k 2
R 105	Resistor, depos. carbon	10 k Ω /0.5 W	WFE 321 k 10
R 106	Resistor, depos. carbon	2 x 20 Ω /1 W	2 x WFE 521 E 20 parallel
R 107	Resistor, depos. carbon	5 k Ω /0.5 W	WFE 321 k 5
R 108	Resistor, depos. carbon	factory-adjusted	WFE 221 . . .
R 109	Resistor, depos. carbon	50 k Ω /0.3 W	WFE 221 k 50
R 110	Resistor, depos. carbon	50 Ω /0.3 W	WFE 221 E 50
R 111	Resistor, depos. carbon	1 M Ω /0.3 W	WFE 221 M 1
R 112	Resistor, depos. carbon	10 k Ω /0.3 W	WFE 221 k 10
R 113	Resistor, depos. carbon	10 k Ω /0.3 W	WFE 221 k 10
R 114	Resistor, depos. carbon	50 Ω /0.3 W	WFE 221 E 50
R 115	Resistor, depos. carbon	1 M Ω /0.3 W	WFE 221 M 1
R 116	Resistor, depos. carbon	10 k Ω /0.3 W	WFE 221 k 10
R 117	Resistor, depos. carbon	10 k Ω /0.3 W	WFE 221 k 10
R 118	Resistor, depos. carbon, variable	500 k Ω lin.	WS 9122 F/500 k
R 119	Resistor, depos. carbon	500 k Ω /0.5 W	WFE 321 k 500 in series
R 120	Resistor, depos. carbon	60 Ω /0.5 W	WFE 321 E 60
R 121	Resistor, depos. carbon	100 k Ω /0.5 W	WFE 321 k 100
R 122	Resistor, depos. carbon	100 k Ω /0.5 W	WFE 321 k 100
R 122	Resistor, depos. carbon	10 k Ω /1 W	WFO 10 k/1
R 123	Resistor, depos. carbon	10 k Ω /1 W	WFO 10 k/1
R 124	Resistor, depos. carbon	125 Ω /0.3 W	WFE 321 E 125
R 125	Resistor, depos. carbon	80 Ω /0.3 W	WFE 221 E 80
R 130	Resistor, depos. carbon	20 k Ω /0.3 W	WFE 221 k 20 parallel L 15
R 131	Resistor, depos. carbon	16 k Ω /0.3 W	WFE 221 k 16 parallel L 16
R 132	Resistor, depos. carbon	20 k Ω /0.3 W	WFE 221 k 20 parallel L 17
R 133	Resistor, depos. carbon	25 k Ω /0.3 W	WFE 221 k 25 parallel L 18
RI 2	Festoon lamp	6.3 V/0.3 A	RL 163 S

Ref. No.	Designation	Ratings	R & S Stock No.
Rö 1	Triode		EC 80
Rö 2	Pentode		EF 42
Rö 3	Pentode		EF 42
Rö 4	Triode		EC 81
Rö 5	Pentode		EF 42
Rö 6	Pentode		EF 42
Rö 7	Pentode		EF 42
Rö 8	Pentode		EF 42
Rö 9	Pentode triode		PCF 80
Rö 10	Pentode		EF 42
Rö 11	Duotriode		ECC 81
Rö 14	Pentode		EF 42
Rö 15	Pentode, output		EL 41
Rö 16	Rectifier, full-wave		EZ 80
Rö 17	Rectifier, full-wave		EZ 80
Rö 18	Pentode, output		PL 81
Rö 19	Pentode, output		PL 81
Rö 20	Pentode		EF 40
Rö 21	Reference tube		85 A 2
S 1	Switch, turret		incl. in 15071 - 1
S 2	Contact arm		incl. in 15071 - 1.14
S 3 I	Contact arm		
S 3 II	Contact arm		
S 3 III	Contact arm		
S 3 IV	Contact arm		
S 3	Switch, wafer		15071 - 7.25
V-VIII			
S 3 IX	Spring contact assembly		SRF 3
S 4	Switch, slide		incl. in R 75
S 5	Switch, wafer		SRN 314/32
S 6	Switch, toggle		SR 132
S 7	Switch, rotary		SR 112/2/32
S 8	Tapping panel		FD 60500
Si 1	Fuse	1 A	M 1 C DIN 41571
Si 2	Fuse	1 A	M 1 C DIN 41571
Si 3	Fuse	160 mA	M 0,16 C DIN 41571
Tr 1	Transformer, output		1507 - 5.7
Tr 2	Transformer, power		15071 - 3.10/2

Table of Voltages & Levels

The following values hold for the input signal given, under No. 1, for operation AM LESS AVC, for the IF bandwidth of 40 kHz and full deflection of the meter J1. All voltages are measured against chassis.

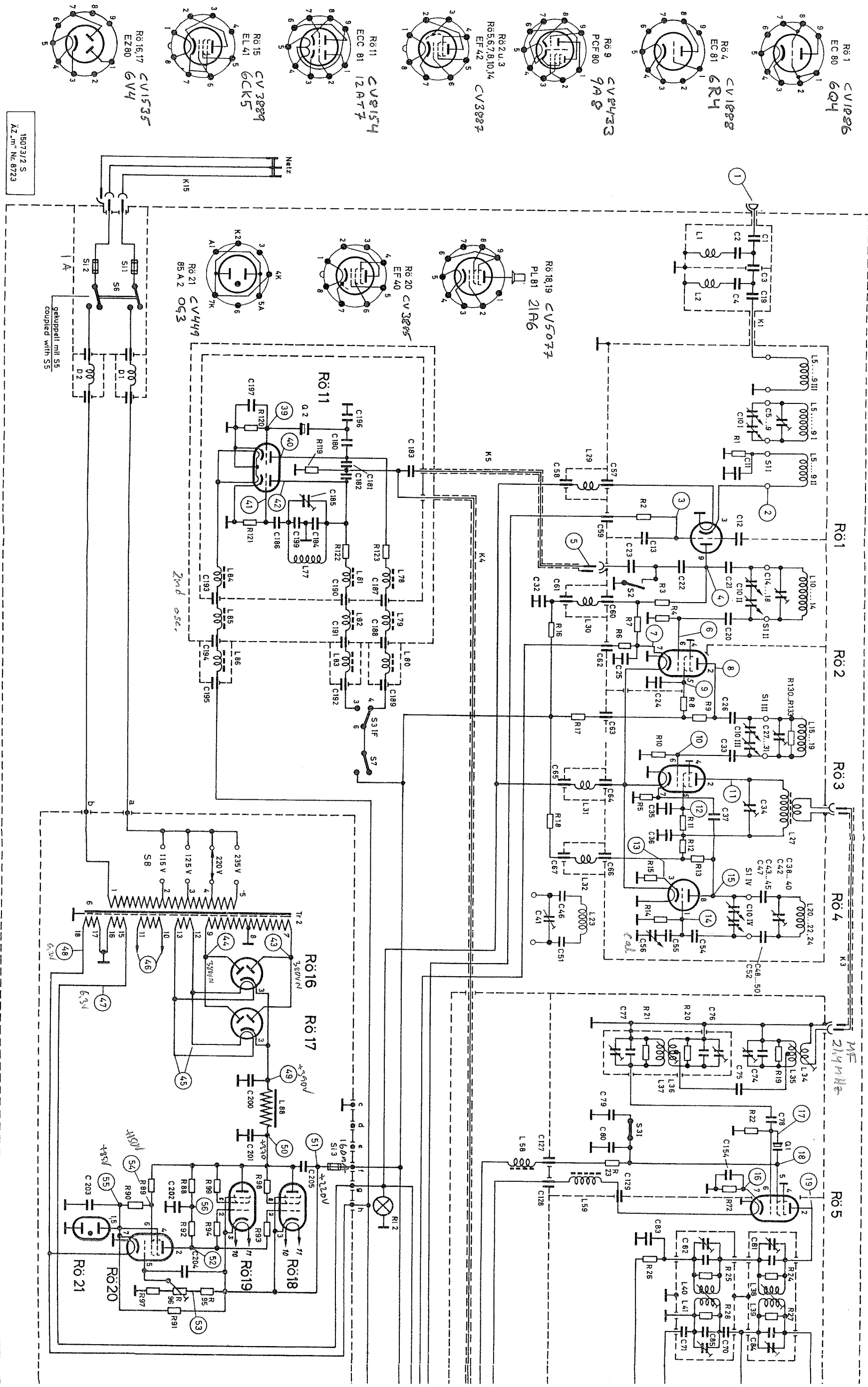
R & S measuring instruments: Type URV for RF voltages
 Type URI for DC voltages
 Type UVN for AF voltages

Numbers refer to circuit diagram

No.	Ratings	Remarks
1	100 MHz, 100 μ V AC, AM 30% 1000 Hz	input signal
2	+1 to +10 V DC, 1 to 10 mA DC	at R \ddot{o} 1
3	0 to -10 V DC, 4 μ V AC	at R \ddot{o} 1
4	+160 to +200 V DC, approx. 40 μ V AC	at R \ddot{o} 1
5	30 to 50 mV AC	at K 5
6	approx. 40 μ V AC	at R \ddot{o} 2
7	+1.2 to +10 V DC, 2 to 8 mA DC	at R \ddot{o} 2
8	+190 V DC, 400 μ V AC	at R \ddot{o} 2
9	+160 V DC	at R \ddot{o} 2
10	400 μ V AC	at R \ddot{o} 3
11	+180 V DC, approx. 2 mV AC	at R \ddot{o} 3
12	+150 V DC	at R \ddot{o} 3
13	approx. +15 mV DC, approx. 4 mA DC	at R \ddot{o} 4
14	approx. -5 V DC, approx. 3 V AC	at R \ddot{o} 4
15	approx. +160 V DC, approx. 8 V AC	at R \ddot{o} 4
16	+1.2 V DC, 10 mA DC	at R \ddot{o} 5
17	approx. 1.2 mV AC	at R \ddot{o} 5
18	approx. +180 V DC	at R \ddot{o} 5
19	+210 V DC, 14.4 mV AC	at R \ddot{o} 5
20	+1.2 to +10 V DC, approx. 10 mA	at R \ddot{o} 6
21	0 to -10 V DC, approx. 6 mV AC	at R \ddot{o} 6
22	+210 V DC	at R \ddot{o} 6
23	+210 V DC, approx. 72 mV AC	at R \ddot{o} 6
24	+2.1 V DC, 10 mA DC	at R \ddot{o} 7
25	0 to -10 V DC, approx. 60 mV AC	at R \ddot{o} 7
26	+210 V DC	at R \ddot{o} 7
27	+210 V DC, approx. 0.72 V AC	at R \ddot{o} 7
28	+1.8 V DC, 10 mA DC	at R \ddot{o} 8
29	approx. 0.6 V AC	at R \ddot{o} 8
30	+210 V DC	at R \ddot{o} 8
31	+210 V DC, approx. 12 V AC	at R \ddot{o} 8

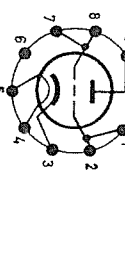
No.	Ratings	Remarks
32	approx. -3 V DC, approx. 3 V AC	at Rö 9
33	approx. +100 V DC	at Rö 9
34	+210 V DC, approx. 12 V AC	at Rö 9
35	+2.5 DC	at Rö 9
36	approx. 0.3 V AC	at Rö 9
37	+170 V DC	at Rö 9
38	approx. 300 mV AC	at K 4
39	approx. -3 V DC, approx. 2 V AC	at Rö 11
40	+180 V DC, approx. 10 V AC	at Rö 11
41	approx. -3 V DC, approx. 2 V AC	at Rö 11
42	± 180 V DC, approx. 10 V AC	at Rö 11
43	380 V AC	power transformer
44	380 V AC	power transformer
45	6.3 V AC	power transformer
46	21.5 V AC	power transformer
47	6.3 V AC	power transformer
48	6.3 V AC	power transformer
49	+390 V DC	at choke L 88
50	+370 V DC, 130 mA DC	at choke L 88
51	± 220 V DC, approx. 110 mA DC	at Rö 18 – Rö 19
52	approx. +216 V DC	at Rö 20
53	approx. +90 V DC	
54	approx. +150 V DC	at Rö 20
55	+85 V DC	at Rö 21
56	+330 V DC	
57	+16.5 V DC, 5 mA DC	at Rö 10
58	+15 V DC, approx. 0.3 V AC	at Rö 10
59	+220 V DC	at Rö 10
60	+8.8 V DC (+1.2 V with IF bandwidth = 200 kHz)	at Rö 14
61	0.1 V AC	at Rö 14
62	+85 V DC	at Rö 14
63	+60 V DC, 2 V AC	at Rö 14
64	+5 V DC, 42 mA DC	at Rö 15
65	2 V AC	at Rö 15
66	+220 V DC	at Rö 15
67	+220 V, 120 V AC	at Rö 15
68	approx 0.5 V AC when terminated with 1.5 kΩ	oscilloscope output

OSC.
51.44 - 20MHz M. 1.1

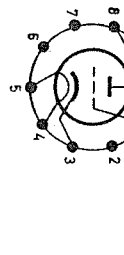


180731/2 S
AZ, m. Nr. 8723

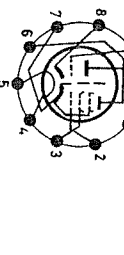
Rö 1 CV1826
EC 80 6Q4



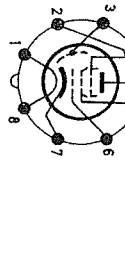
Rö 4 CV1826
EC 81 6R4



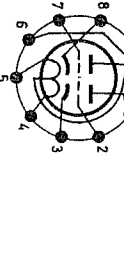
Rö 9 CV4433
PCF 80 9A8



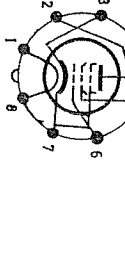
Rö 2 u. 3
Rö 5, 6, 7, 8, 10, 14
EF 42 CV3887



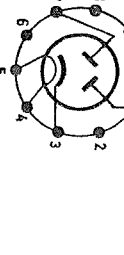
Rö 11 CV8154
ECC 81 12A77



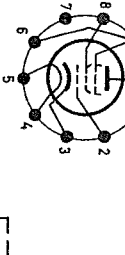
Rö 15 CV3829
EL 41 6CK5



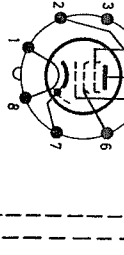
Rö 16, 17 CV1535
EZ 80 6V4



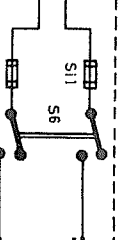
Rö 18, 19 CV5077
PL 81 21A6



Rö 20 CV3829
EF 40

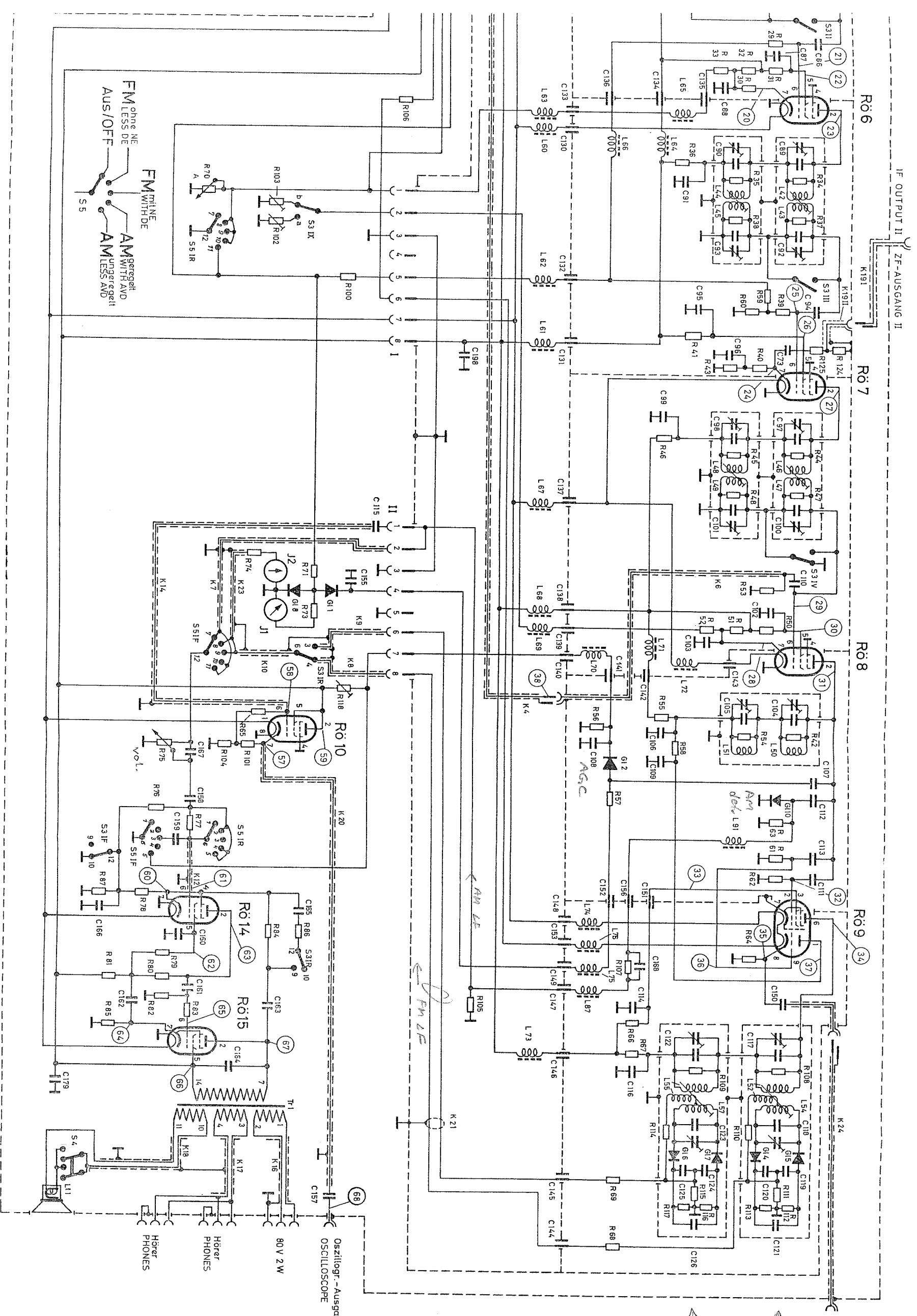


Rö 21 CV449
85A2 OQ3



Netz
K15

gekuppelt mit S5
coupled with S5



IF OUTPUT II ZF-AUSGANG II

Rö 6

Rö 7

Rö 8

Rö 9

Rö 10

Rö 14

Rö 15

ZF-Ausgang I
IF OUTPUT I

← best FM

← small FM

Schalterdiagramm von S3

ZF-Bandbreite	40 kHz	200 kHz
S3 I bei Rö 5		
S3 II bei Rö 6		
S3 III bei Rö 7		
S3 IV bei Rö 8	Gitter	Masse
S3 IF bei Rö 11	6-3	6-4
S3 IF bei Rö 14	12-9	12-10
S3 IR bei Rö 10	6-3	6-4
S3 IR bei Rö 14	12-9	12-10
S3 IX	a	b

• = Kontakt geschl.

Switch diagram of S3

IF Bandwidth	40 Kc	200 Kc
S3 I at Rö 5		
S3 II at Rö 6		
S3 III at Rö 7		
S3 IV at Rö 8	Gnd	Earth
S3 IF at Rö 11	6-3	6-4
S3 IF at Rö 14	12-9	12-10
S3 IR at Rö 10	6-3	6-4
S3 IR at Rö 14	12-9	12-10
S3 IX	a	b

• = Contact closed

Oszillogr.-Ausgang
OSCILLOSCOPE

AM-Signal

80V 2W

Hörer PHONES

Hörer PHONES

Hörer PHONES

Stromlauf

Circuit Diagram

Type ESM 180

Corrigendum:

Read "AVC" instead of "AVD" in the two AM positions of switch S5.

