Repairing Siemens E311b

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Sommario

Introduction

Content

I am repairing an E311b1b and specifically the Raster module Rel 455 N 300a. In this document you can find the history of this repair and all the related translation in English of the parts of the manuals that were useful for me.


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The swan's song

The E 311 is the last Siemens professional receiver using tubes. It was the second designed after after the E 309, depicted in the previous pages. It E-311 appeared in early 1960's in parallel to the E-310 (called "rainbow" for the coloured frequency indicator) and was advertised as an alternative to communications receivers from Collins or Rhode & Schwarz.

With triple conversion and capable to receive SSB, it was rather power-hungry, with 16-tubes requiring more than 70W and 30 more for the crystal heater.

Interesting the tuning system: according to the setting of the band switch, the segment of the frequency is visible in the main dial, with the coarse 100 kHz marks. A lamp lights when on exact 100-kHz multiple is selected. A second display, odometer-type, shows the frequency with a mark every 100 Hz. With the "coarse" tuning knob at the left hand, the kHz tens are selected and with the right knob, the 10 kHz and 1 kHz digits of the desired frequency.

In short: an absolutely awesome receiver, the swan song of the tube technology, now destined to succumb to the arrival of semiconductor devices.

1961

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German equipment

Great thanks to Francesco Sartorello, owner of this perfect specimen of E 311.

The Siemens E311 in the Surplus Photo Parade booklet (you can download it for free from http://www.k100.biz/parade.htm)

The problems

The problems, that triggered my work and whose solution I describe here, were:

- *the locked ("gerästet") tuning mode was not working. The tuning light was always on;*
- *the interpolation oscillator was not working below 30 kHz.*

What this is not

This document does not pretend to be a manual or an alternate source of information, respect to the original manuals. It is just the history of my repair work on the E311 but also contains the English translation of the part of the manual that I needed to study and understand for this purpose. There are a lot of parts not covered here.

Source of information

The source of information was the original Siemens manuals:

- *May 1964, related to receiver Rel 445E 311a & b (thanks to Francesco Sartorello);*
- *November 1968, related to receiver Rel 445E 311e.*

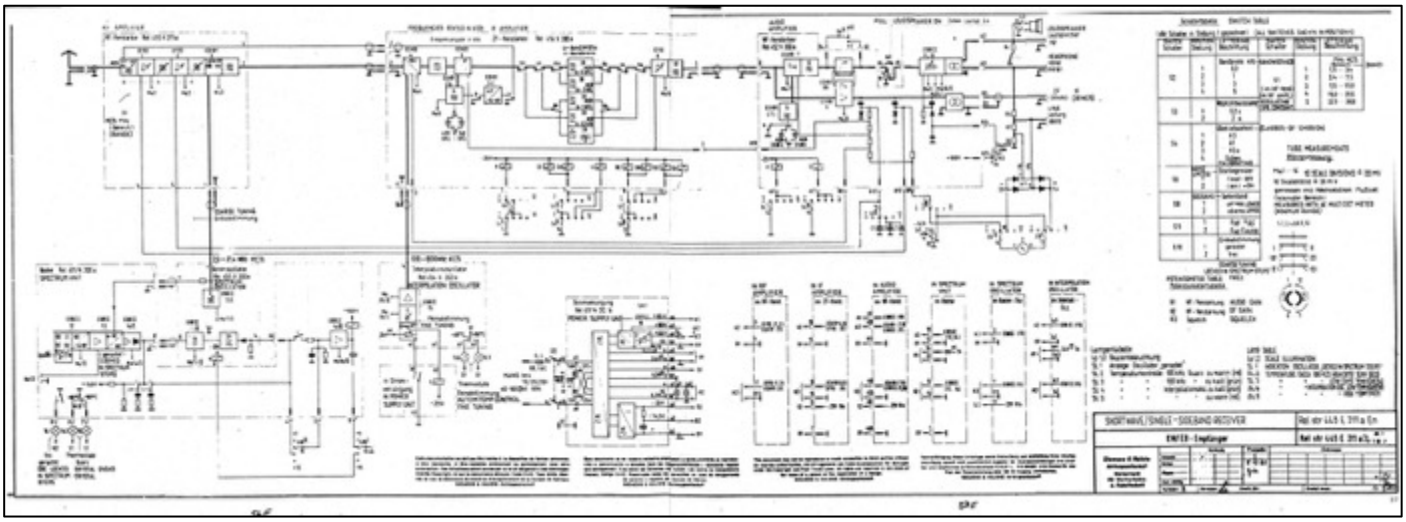
These manuals are available for free online, even if some sly guy is trying to sell them or to catch your credit card number for them.

I worked a little on these documents:

- *I made them searchable, using an OCR tool;*

- *for the a & b versions, I recomposed the diagrams that were made by pieces, to make them more readable;*
- *I made them downloadable from my web page (http://www.k100.biz/parade.htm), where this document as well can be downloaded.*

The text printed with Italic font is by me, so you can distinguish, in this document, the parts got from the original Siemens manuals.



Sample of a recomposed schematic diagram.

German chaos

The circuit is complex and its operating logic not very clear. Furthermore, despite of their name, German guys are, as usual, rather imprecise, and chaotic, and this makes things not easier, not only for their language.

Let's start with relays. This module has two relays: K and J.

- *K relay is used only for the temperature control of the crystal; in my unit its power supply is just a rectifier bridge. In subsequent versions there is a transistorized control;*
- *J relay is the one that is interesting for us, but… in Rel 455 N 300a schematic, its contacts are wrongly marked as "i". In Rel 455 N 300c1, some of them are corrected to "j" but not all.*

RELAY TABLE
Relaistabelle

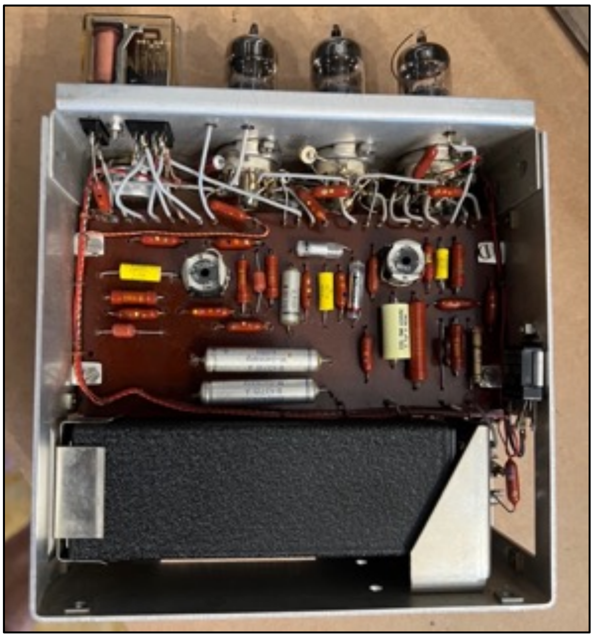
RELAY Relais	CONTACTS Kontakte II	I	CIRCUIT Schaltung	COMP SPEC Bv
K	2 – 10, 9, 8		1 – 4	TBv 65422/93c
J	2 – 16, 15, 14; 1 – 10, 9, 8	13, 12, 11, 7, 6, 5	1 – 4	TBv 65403/134e

"I" and "II" are instead the identifier of the section and not the reference to a specific component. But relays have subsection (see the table on side), so they added a letter, and the notation $i^{I1,7}$ so means relay "i", contacts series 1, pin 7. Note that I corrected in this document the wrong "i" to "j". lost a lot of time understanding all that.

Furthermore, they don't write the tube pin numbers or the component values on the schematic diagram. I annotated them manually on the schematics I worked on.

To increase the confusion, they have not unique reference designators. So, you can find, for example, more R1, even in the same module. They have an R1 on the PCB and another R1 for the components not mounted on the PCB, so you must be very careful. But to better understand this point it's better if you read next paragraph.

Documentation organization

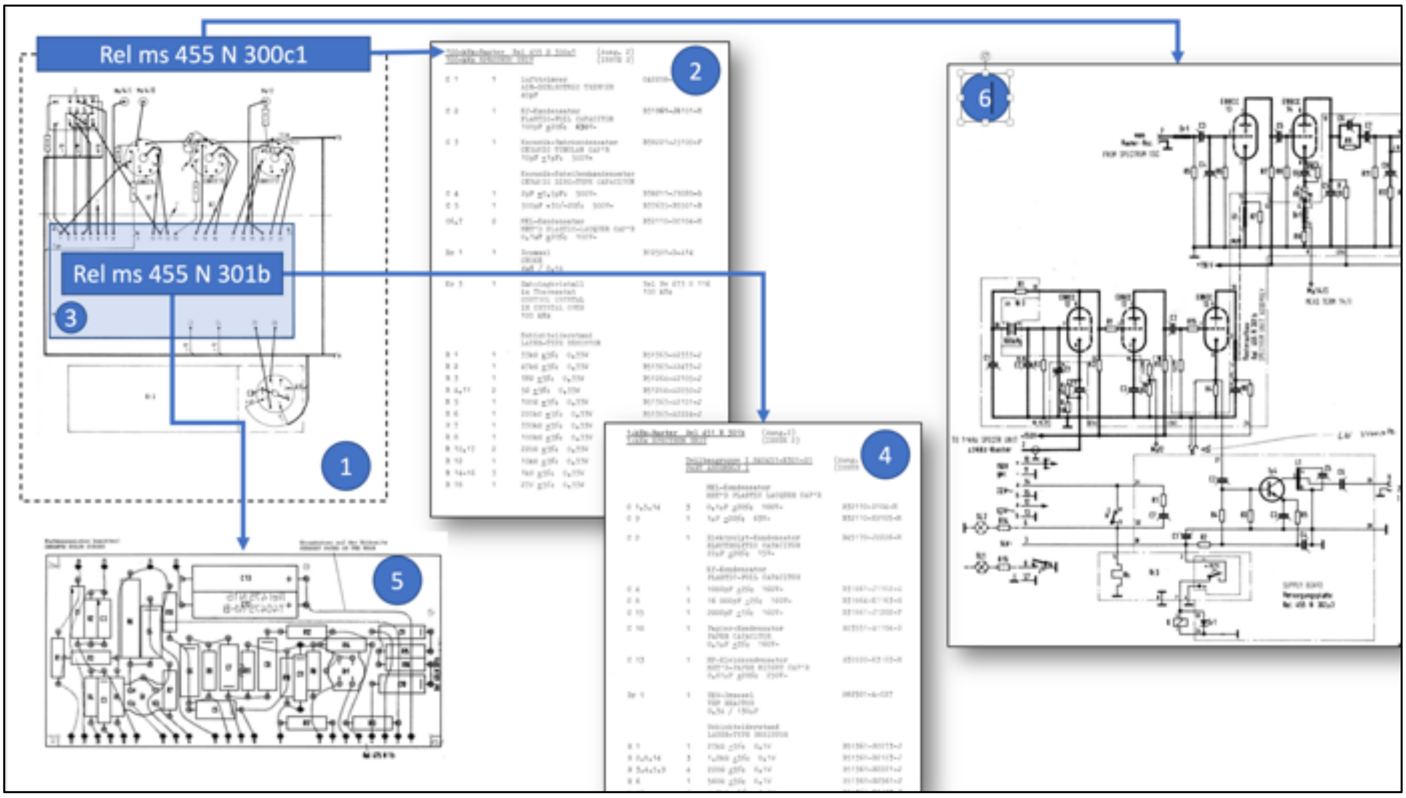


The raster module taken as an example below in the text

The E311 receiver is composed by well identified modules. Most of them have a connector and are very easy to remove. Others require some extra work but are however removable.

*Each module is identified by a code, like e.g.**, Rel ms 455 N 300c1**, where "Rel ms 455" is the same for all, "N 300" is the module identifier and "c1" is the revision index.*

With reference to the following picture:



- *Rel ms 455 N 300c1 is the module identifier (in this case the Raster module);*
- *the wiring schematic (1) is related to the entire module; its part list is contained in document (2) and its overall electric schematic diagram is document (6);*
- *the schematic (1) contains the sub-assembly (3), i.e., the PCB. It has a separate part list in document (4);*

- *the topographic drawing for the PCB is in document (5).*

This explains why you have two R1 (and so on) in the same module: the first is from part list (2) and the other from part list (4). For this reason, the electrical schematic could be rather tricky: remember that the parts mounted on the PCB are identified by an area, delimited by a dotted line.

Like in their language, Germans have often rules for everything but they are not always so easy to figure out…

Table of content

I don't know why, but the table of content at the beginning of the manual does not include the following important sections:

- *Section 4 – Troubleshooting*
- *Section 5 – Trouble fixing (it includes the instructions for physical disassembly)*

Paragraph numbering

I did not add paragraph numbers, I let the originals references of the manual where possible.

Theory of operation

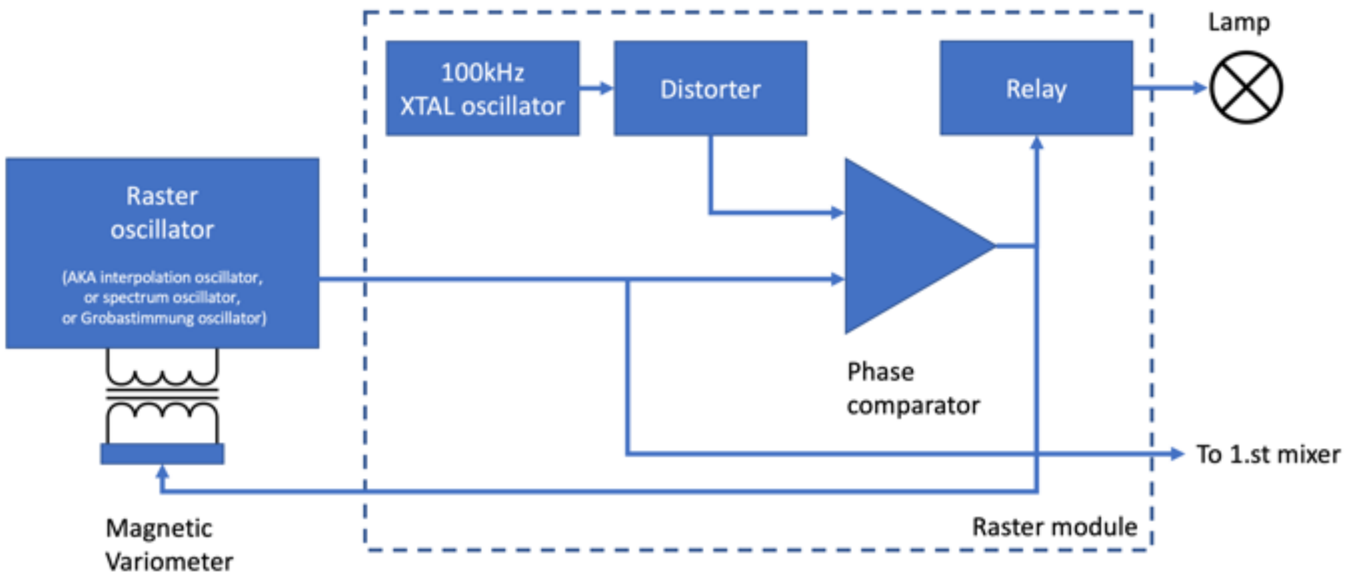
Short explanation

I add this short text to the official description, because to understand these few things was the most difficult part of my work and perhaps the most important.

The E311 tuning system is one of the most interesting circuits I have ever seen. Let's start distinguishing the two tuning modes available via the ***Grobabstimmung gerästet/frei*** *knob:*

- ***frei*** *(free) In this mode the tuning system is very conventional. If you set the interpolation oscillator ("Feinabstimmung knob) to zero, you can use the Grobabstimmung knob exactly like your old family receiver. The Feinabstimmung knob can be used to fine-tune a station, adding kHz's to the Grobabstimmung value shown on the scale display;*
- ***gerästet*** *(locked) This is the novelty: in this mode, the Grobabstimmung knob does not anymore change continuously the received frequency, but moves for "quantum", like a switch, in 100kHz increments. You tune the knob in proximity of a 100kHz-mark and the received frequency "locks" to it. The lock is signaled by the sync lamp steady on. In this way, you can use the Feinabstimmung to explore the 100kHz-segment above the lock, with a marvelous 100Hz resolution.*

How is this little miracle done? In a way that is furthermore reasonably simple. Before we can understand the circuit, we must introduce a component, that was to me absolutely new: the Magnetic Variometer. It is a four-pin component, similar to a transformer. A variable AC current on the primary, changes the inductance value of the secondary. This allows to create the E311 Phase Locked Oscillator, i.e., the circuit that make possible the locked tuning mode, replacing today's VCOs (Voltage Controlled Oscillator).

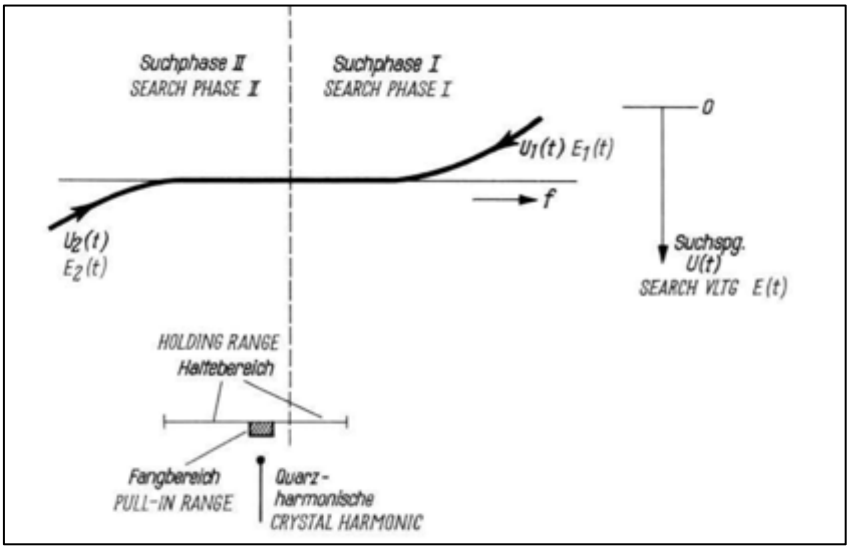


In few words:

- *a very stable, crystal controlled, 100kHz-oscillator is connected to a distorter, which produces harmonics up to 30MHz and above;*
- *this signal ("A") is mixed with the Raster (Grobabstimmung) oscillator ("B").*
- *In the mixing, we have the 100kHz A-signal and the x MHz B signal. When B is near to a 100kHz, a phase-difference C signal is generated. This C signal is used to control the B frequency by mean of the Magnetic Variometer, locking thus it to the phase of the 100kHz signal.*

An old PLL without digital electronics. But it is not finished: there is also the "search" circuit to be described. Its purpose is to make easier the use of this wonderful receiver.

The Magnetic Variometer has a limited variation range and thus the "capture range" of the PLL is limited to few kHz. You should then be very careful with the knob movement to catch the right point where the lock happens. If something drifts, or when you switch off and, on the receiver, you should again fine tune the Grobabstimmung knob to get the receiver again locked. So, the genial Siemens designers invented a simple but effective circuit that can "explore" the neighbors of the oscillator frequency to try to catch again the lock. This search circuit use just one relay and with some tricks produces a voltage, from negative to positive, that explore few kHz near the base frequency. If we are near to the locking frequency, we lock to it (see the picture below). Genial, very simple and… and it works perfectly!



A note: trimmer R9 allows to make more precise or more ample the range in which the lock is done.

I reveal you the killer: in my case, it was the C3 capacitor which lost its value and that was blocking the normal operation of the Raster logic, but I will talk about corrections later.

B. Tunable oscillators

The auxiliary oscillation for the first conversion is provided by the first oscillator.

It consists of the raster oscillator (Rö11), which can be tuned between 2.9 and 31.4 MHz and can be synchronized with the help of a magnetic variometer, and the raster assembly Rö12 to Rö14, which generates a 100 kHz spectrum. The raster oscillator can be freely tuned (for quickly searching through a larger frequency range) or can be tuned in frequency steps of 100 kHz (exploitation of the extraordinarily high accuracy of the receiver). In the second case, it is synchronized with the 100 kHz quartz Raster (Rö12).

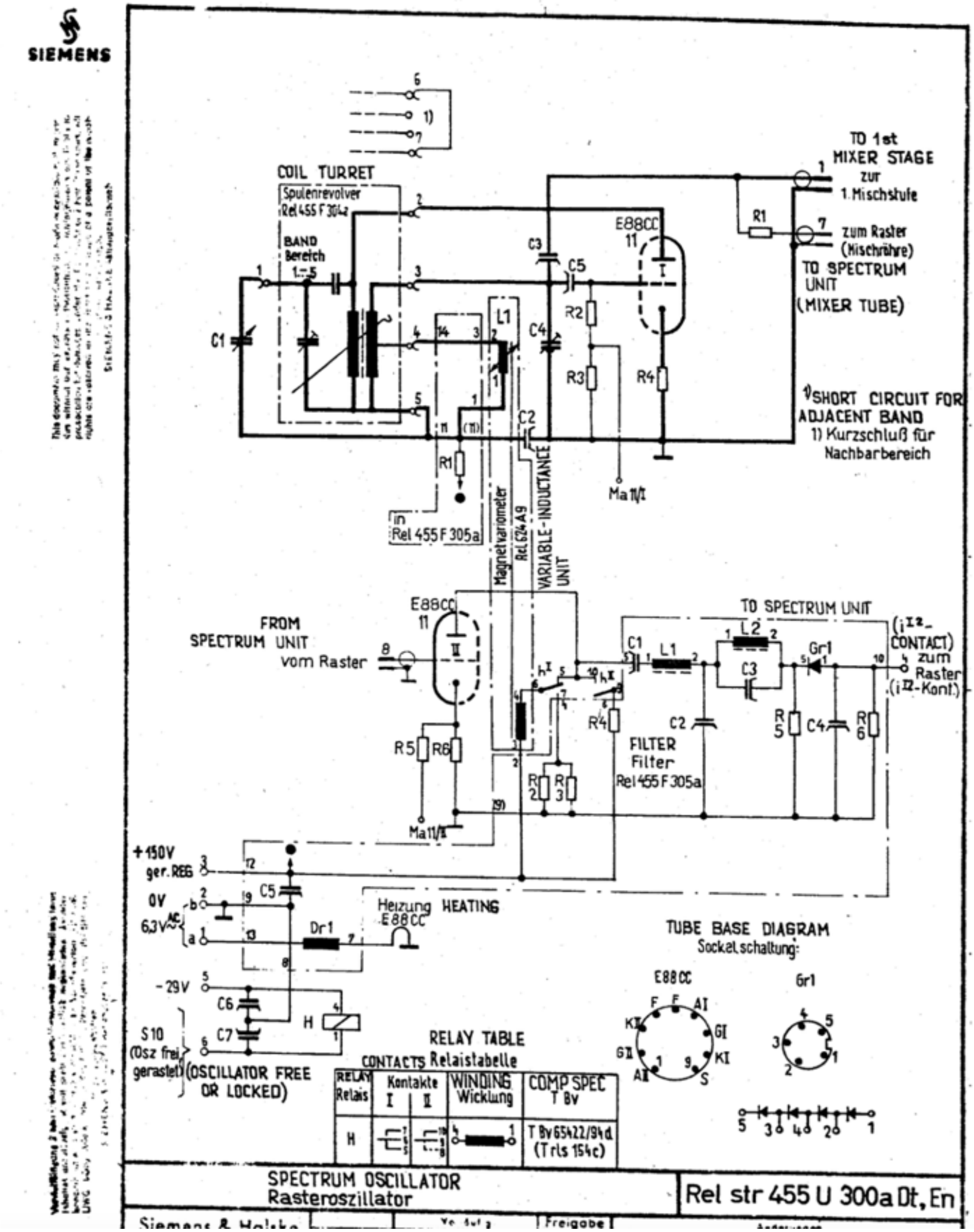
Within the holding ranges, the retuning voltage for the magnetic variometer is created in the pulse mixer (Rö13) by comparing the phase position of the 100 kHz vector resulting from the individual quartz harmonics with the phase position of the vector that is formed from the oscillator frequency and the neighboring quartz harmonics.

A wobble circuit (Rö14) is used to catch larger frequency deviations or after the mains has been switched off.

The raster oscillator is tuned in synchronism with the four HF circuits with variable capacitor and range switch for coil switching.

The second oscillator (interpolation oscillator Rö15) is used for fine-tuning to frequencies between two locking stages, the frequency of which can be adjusted from 1030 to 930 kHz and can be read off a counter. To correct the synchronism, the pre-circuit retuning can be adjusted accordingly by hand. If the 1 kHz grid is used, the second oscillator can be synchronized at every full 1 kHz fourth.

The Raster Oscillator module



Some notes

The Raster oscillator (called Spectrum in English) generates the base frequency for the reception. It has a main output to the 1.st Mixer stage (connector 1) and an output and an input toward the Raster module:

- *the output informs the Raster module about the current frequency value (connector 7);*
- *the input allows the Raster module to slightly change the oscillation frequency to lock it to 100kHz-multiples (connector 8).*

The input from Raster module has the form of an ac voltage, which is applied to Rö11, which drives the magnetic variometer, which in turn adjust the frequency value ("This tube works in Audion circuit; their anode direct current is therefore dependent on the amplitude of their AC grid voltage, which is emitted by the Raster module").

D. Raster oscillator (circuit Rel str 455 U 300b in the circuit diagrams section)

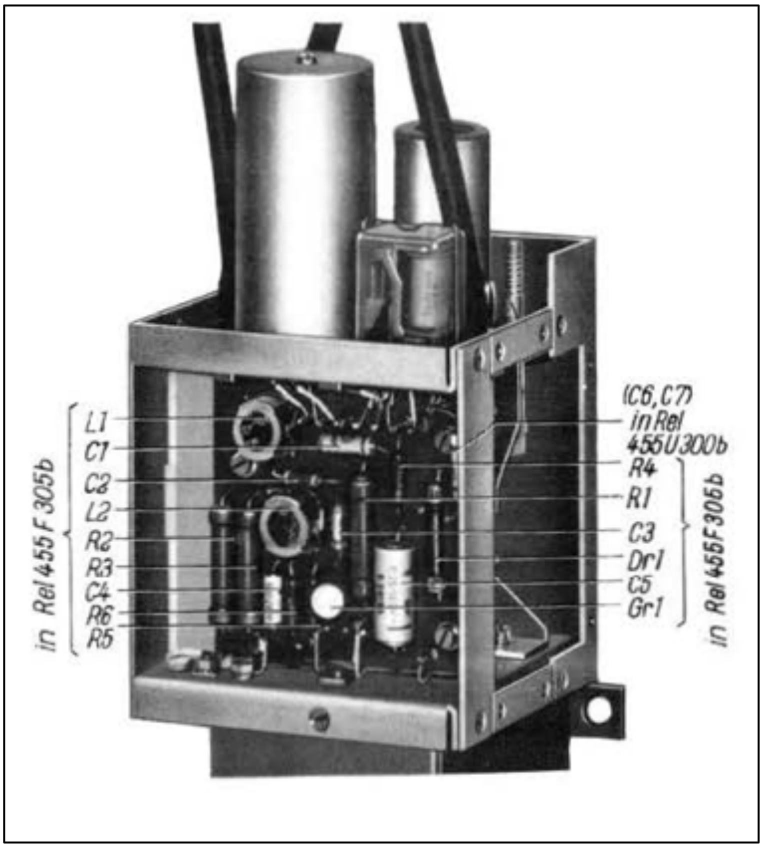
The oscillation required for the first conversion is generated in the tube system Rö11 II with one of five selectable LC oscillating circuits in a Meissner circuit.

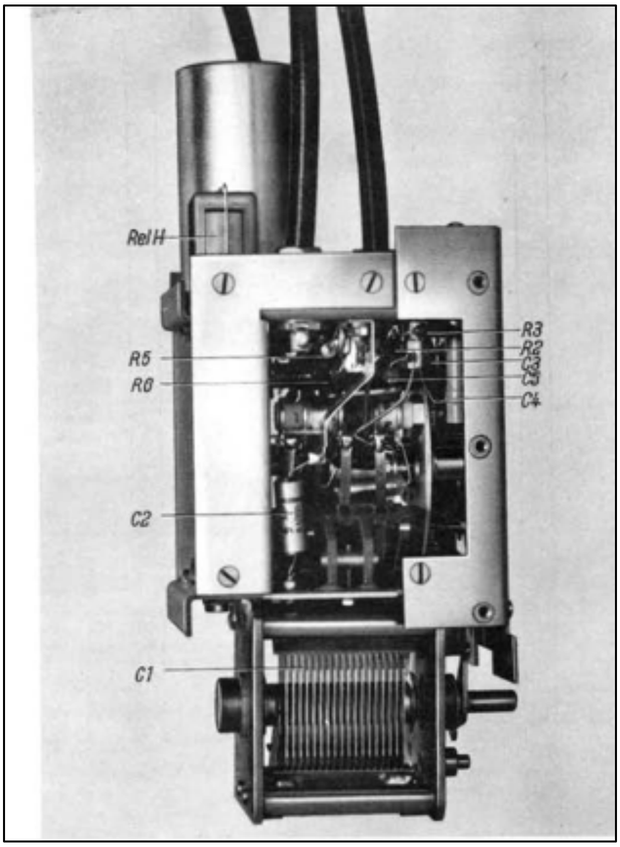
The inductors and trimmer capacitors for the five areas are housed in a coil turret. With the variable capacitor C1, each oscillating circuit can be continuously tuned. C1 is mechanically linked with the quadruple variable capacitor of the RF amplifier; the relative position of the two variable capacitors can be changed slightly by adjusting a sliding wedge (see troubleshooting, Fig. 2).

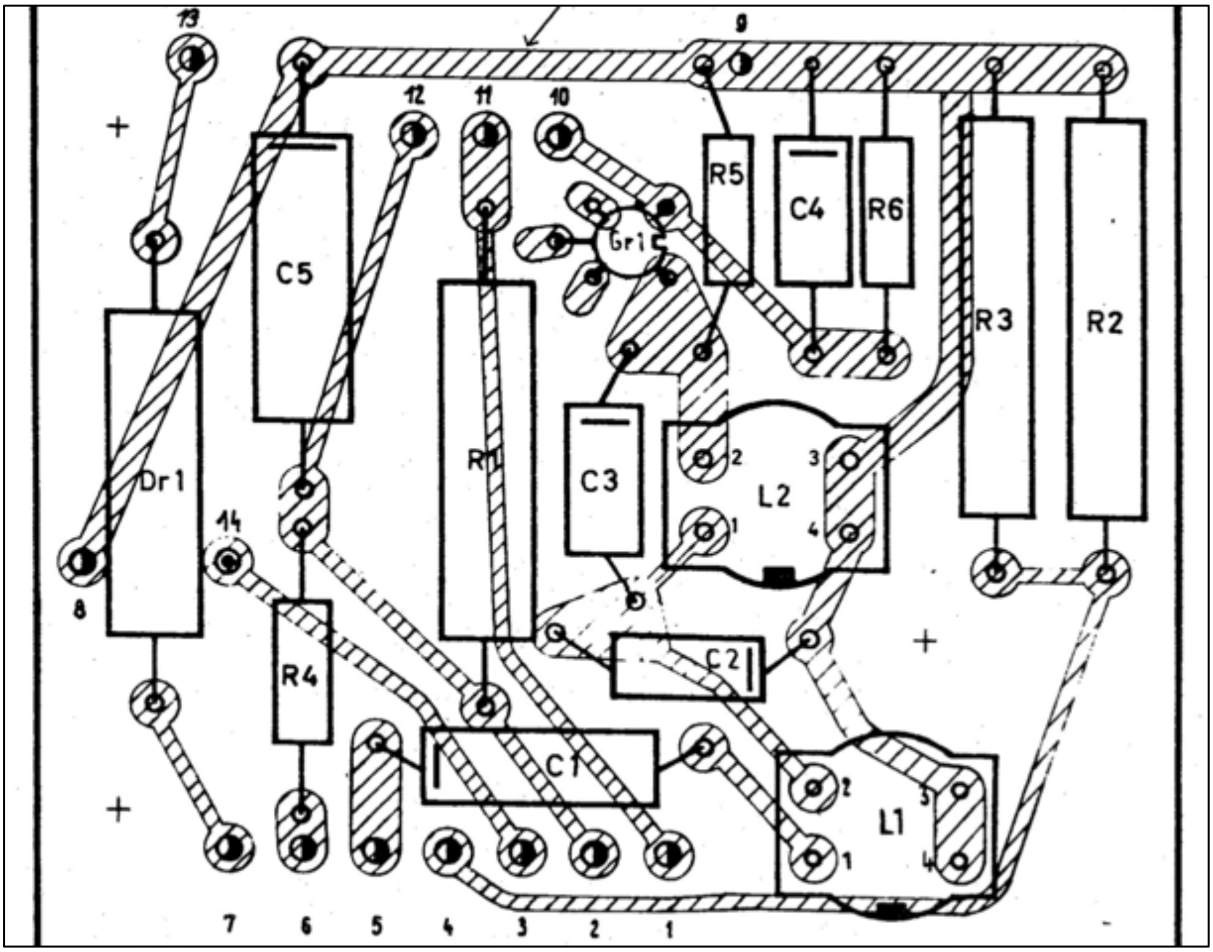
(Pre-loop re-tuning with a counter position deviating from 0 kHz, and to maintain synchronization between the pre-loops and the 1st oscillator with a changed IF1; the first IF filter does not need to be re-tuned, as its bandwidth is sufficient big.)

Each grid coil has a tap on which the secondary winding of the magneto variometer L1 is connected. The primary winding of this variometer is driven by the anode current of the tube system 11 /II flows through. This tube works in Audion circuit; their anode direct current is therefore dependent on the amplitude of their AC grid voltage, which is emitted by the raster assembly.

The contacts h^{I} and h^{II} and the filter Rel 455 F 305e are required within the sweep circuit; their function will be discussed together with the Raster assembly (see IV.E).







The filter

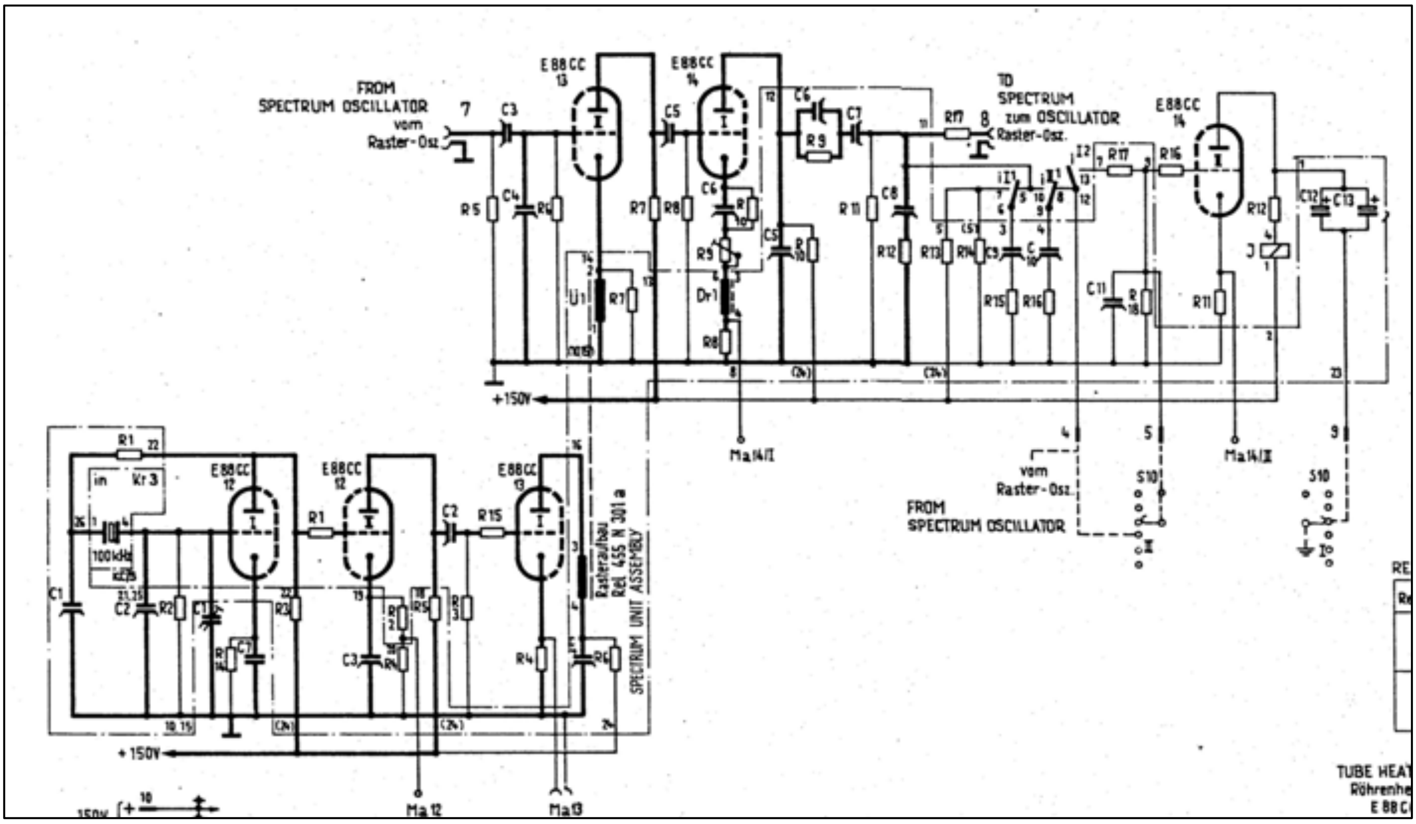
Raster-Oszillator Rel 455 U 300b (Ausg. 6)
SPECTRUM OSCILLATOR (ISSUE 6)

C 1	1	Regelkondensator REGULATING CAPACITOR 250pF	C42208-Z9-C361
C 2	1	HP-Kondensator MET'D-PAPER CAP'R 0,025µF ±20%; 250V-	B23510-J2253-M
C 3	1	Keramik-Scheibenkondensator CERAMIC DISC-TYPE CAPACITOR 4700pF +30/-20%; 500V-	B37632-B5472-R001
C 4	1	Keramik-Schraubtrimmer CERAMIC SCREW TRIMMER 7pF 500V-	7/500 B 3902
C 5	1	Kf-Kondensator PLASTIC-FOIL CAPACITOR 200pF ±20%; 500V-	B31141-J5201-M
C 6,7	2	MKL-Kondensator MET'D PLASTIC-LACQUER CAP'R 0,1µF ±20%; 100V-	B32110-D0104-M
L 1	1	Magnetvariometer VARIABLE-INDUCTANCE UNIT	Rel 624 A 9
		Schichtwiderstand LAYER-TYPE RESISTOR	
R 1	1	1kΩ ±5%; 0,33W	B51363-A2102-J
R 2	1	6,8kΩ ±5%; 0,33W	B51363-A2682-J
R 3,4	2	100Ω ±5%; 0,33W	B51363-A2101-J
R 5	1	150Ω ±2%; 0,33W	B51264-A2151-G
R 6	1	5Ω ±2%; 0,33W	B51264-A2050-G
H	1	Kammrelais, steckbar CRADLE RELAY, PLUG-IN TYPE 7700 Wdg 1250Ω	T rls 154c T Bv 65422/94d V23154-C0422-B204

Raster-Oszillator Rel 455 U 300b (Ausg. 6)
SPECTRUM OSCILLATOR (ISSUE 6)

C 1	1	Regelkondensator REGULATING CAPACITOR 250pF	C42208-Z9-C361
C 2	1	HP-Kondensator MET'D-PAPER CAP'R 0,025µF ±20%; 250V-	B23510-J2253-M
C 3	1	Keramik-Scheibenkondensator CERAMIC DISC-TYPE CAPACITOR 4700pF +30/-20%; 500V-	B37632-B5472-R001
C 4	1	Keramik-Schraubtrimmer CERAMIC SCREW TRIMMER 7pF 500V-	7/500 B 3902
C 5	1	Kf-Kondensator PLASTIC-FOIL CAPACITOR 200pF ±20%; 500V-	B31141-J5201-M
C 6,7	2	MKL-Kondensator MET'D PLASTIC-LACQUER CAP'R 0,1µF ±20%; 100V-	B32110-D0104-M
L 1	1	Magnetvariometer VARIABLE-INDUCTANCE UNIT	Rel 624 A 9
		Schichtwiderstand LAYER-TYPE RESISTOR	
R 1	1	1kΩ ±5%; 0,33W	B51363-A2102-J
R 2	1	6,8kΩ ±5%; 0,33W	B51363-A2682-J
R 3,4	2	100Ω ±5%; 0,33W	B51363-A2101-J
R 5	1	150Ω ±2%; 0,33W	B51264-A2151-G
R 6	1	5Ω ±2%; 0,33W	B51264-A2050-G
H	1	Kammrelais, steckbar CRADLE RELAY, PLUG-IN TYPE 7700 Wdg 1250Ω	T rls 154c T Bv 65422/94d V23154-C0422-B204

The Raster module



Schematic Rel 455 N 300a (mine)

1. 100-kHz, Oscillator, distorter, mixer

The tube system 12/I together with the quartz Kr3 forms a very stable oscillator. The 100 kHz oscillation generated here is severely distorted in tubes 12/II and 13/I, resulting in a 100 kHz spectrum containing harmonics up to over 30 MHz. For this purpose, the first distortion stage works in the lower curve and the second distortion stage in the curve at the top.

A transformer Ü1 couples the spectrum in the form of needle pulses into the cathode line of the mixing tube 13/II, while the oscillation of the raster oscillator is on the grid of this tube (from connector 7). At the anode of the mixing tube, a 100 kHz oscillation is created from two 100 kHz vectors. One vector is formed from the individual quartz harmonics, the other from the oscillator oscillation and the adjacent kHz oscillation is harmonically dependent on the phase difference of the detuning of the tuning oscillator. The 100 kHz oscillation can therefore provide a retuning criterion. For this purpose, it is amplified in tube 14/I and rectified in tube 11/II. The anode current of Rö11/II controls the magnetic variometer.

The mixing stage 13/II therefore works as a phase discriminator without a defined zero point. It is replaced by an average value of the 100 kHz voltage, which inevitably determines the operating point of the variometer.

The magnitude of this basic voltage, which occurs in the locked state, depends on the crystal, distortion, mixer, and amplifier stage.

The operating points of these stages must therefore be kept very constant.

Due to the low cut-off frequency of the mixer stage and the amplifier stage, the high frequency components of the spectrum as well as the oscillator oscillation itself are strongly damped. An approximately sinusoidal 100 kHz voltage is therefore present as the control voltage on the grid of the variometer tube 11/11.

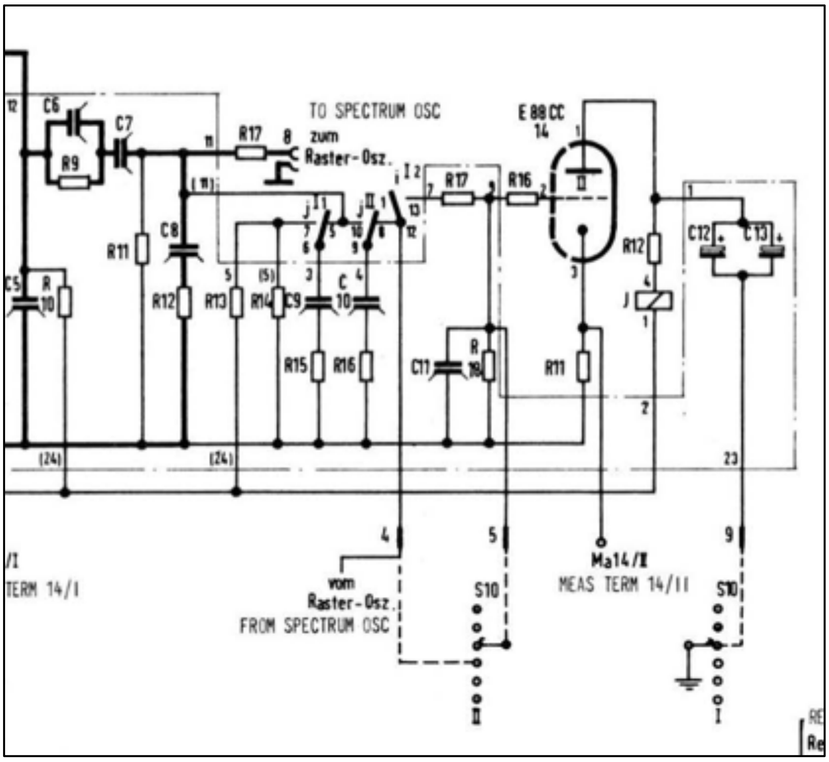
If a long-wave equipment is to be connected, the 100 kHz spectrum from tube 13 1 is routed via connection 10 to a socket on the front panel to synchronize it.

The search circuit

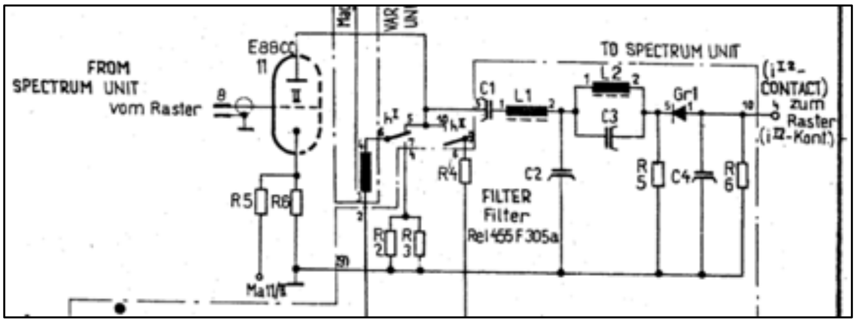
Without special measures, the oscillator will only be attracted to the quartz harmonic if the deviation is not greater than about +/-3 kHz.

As a result of a change in temperature or turning the tuning knob, it can happen that the oscillator frequency is no longer within the capture range. Even after the mains was switched off for a short time, the oscillator would no longer lock in and would have to be synchronized again by hand. For this reason, a search circuit is provided which sweeps through the oscillator frequency.

For this purpose, a periodic search voltage is also applied to the grid of the variometer tube, which is generated in the following way:



Schematic Rel 455 N 300c1. See some of the "i" corrected to "j" on relay contacts.



When the receiver is turned on, Rö14/II is open [*i.e., conducting*] and relay J is energized.

When the relay J is energized:

- the capacitor C9 is charged positively via contact $\mathbf{j}^{I1,7}$;
- the capacitor C11 is connected to the filter output of the raster oscillator via contact $\mathbf{j}^{I2,13}$ and terminal 4. There is a negative voltage there, which is created by rectifying the 100 kHz signal. The blocking circuit

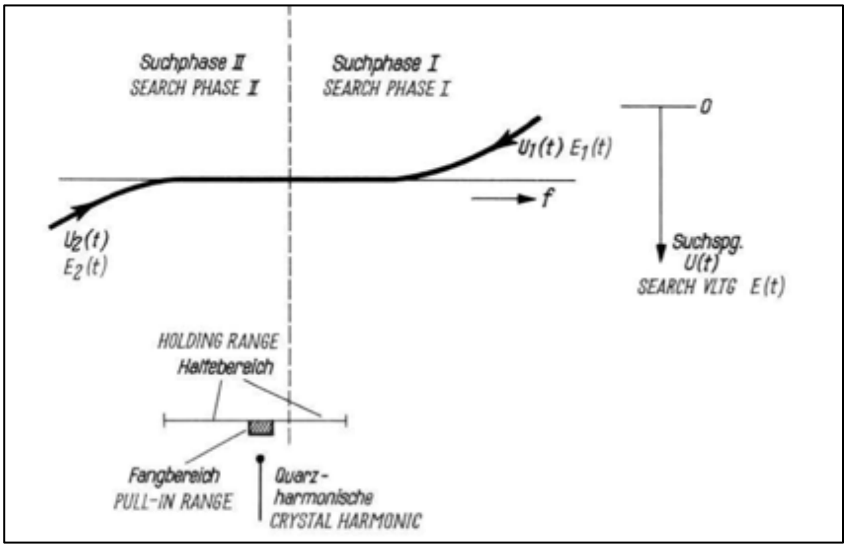
L2/C3 (cf. Rel str 455 U 300b) retains the 100 kHz component. *Thus,* capacitor C11 charges negatively, blocking tube 14/II *[and deactivating the J relay]*.

When the relay J is de-energized:

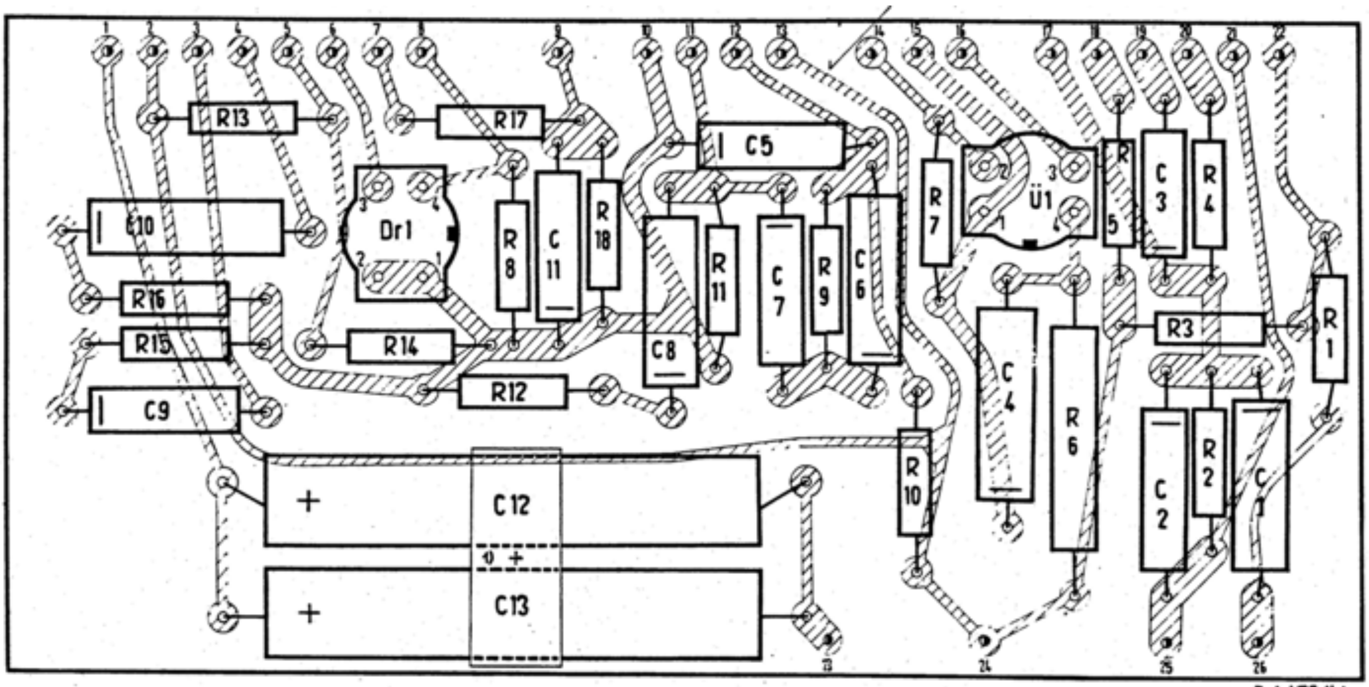
- contact $j^{II1,8}$ connects capacitor C10 to the raster oscillator filter output; so C10 gets also negatively charged.
- Meanwhile, the positively charged capacitor C9 is connected via **$j^{I1,5}$** and connection 8 to the grid of the variometer tube 11/II; it gradually discharges again, so that the grid voltage of the variometer tube drops.

Then, the oscillator frequency runs from higher to lower values.

Meanwhile, C11 discharges through R18; as a result, tube 14/II opens again. Relay J is energized, thereby connecting the negatively charged capacitor C10 to the grid of the variometer tube via i(II1,10) and pin 8.



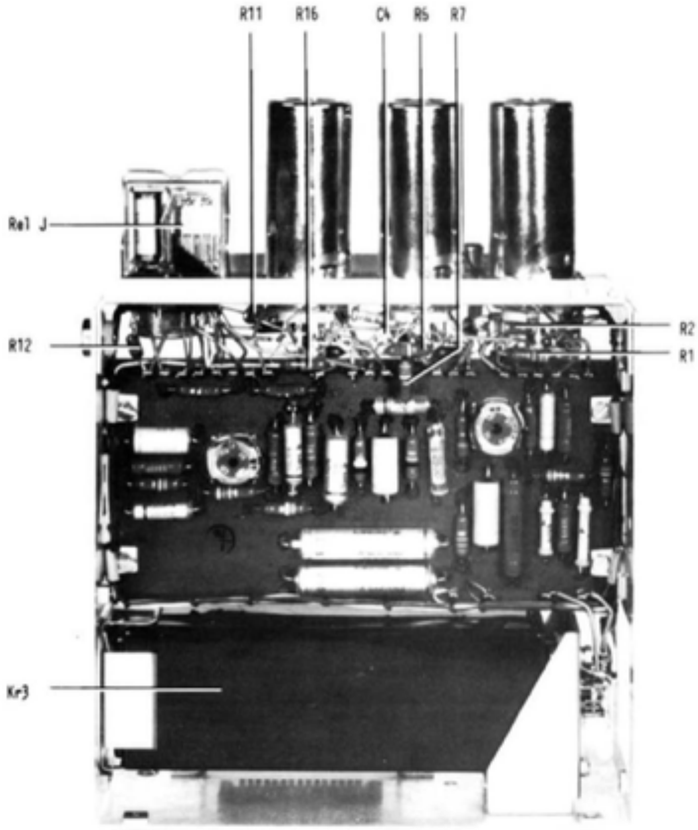
As a result of the gradual discharge of C10, the negative grid voltage decreases as the oscillator frequency sweeps from lower to higher values. In the example (Figure 5), the corresponding quartz harmonic is passed, the oscillator locks in, the negative DC voltage at the filter output of the raster oscillator disappears and the search process is terminated. Via the contact i(II2,16), the signal lamp SL1 is always live when the tube 14/II is live. The lamp therefore lights up periodically during the search process; the resting state is indicated by a continuous illumination.



With the regulator R9 in the cathode line of tube 14/I, the amplification of this stage and ultimately the operating point of the variometer tube can be set. The RC arrangement behind tube 14/I serves to balance the search areas.

The raster oscillator can also be operated freely, if e.g. a larger frequency range can be searched quickly. For this purpose, the relay H (cf. Rel str 455 U 300b) is excited via switch S10. The relay contact h(I) separates the primary winding of the magneto variometer from the variometer tube.

The magnetic variometer is now excited via R2/R3 with a current that corresponds to the middle operating point. The tube is connected to the regulated operating voltage +150 V via h(II) and R4.

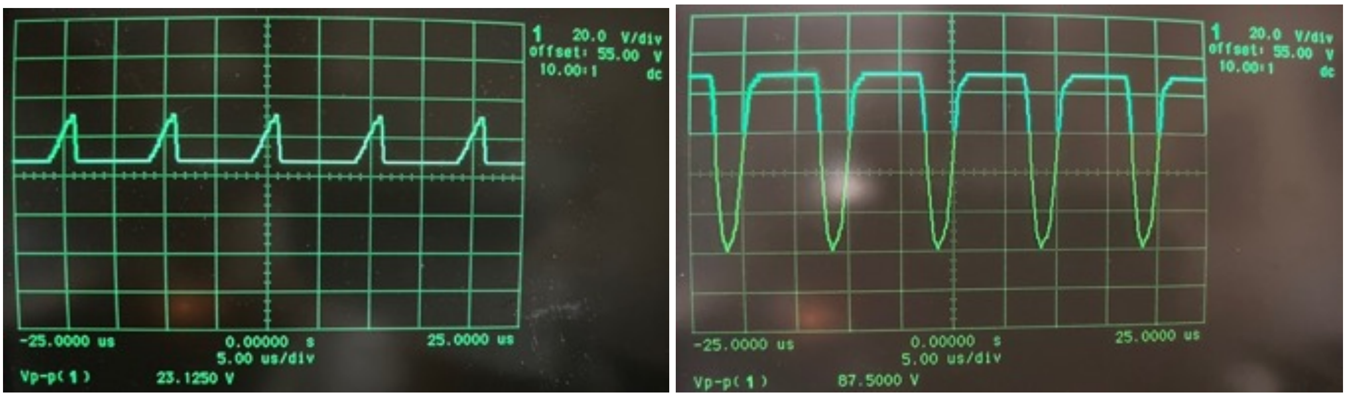


Rasteraufbau Rel 455 N 301b (Ausg. 4)
SPECTRUM UNIT ASSEMBLY (ISSUE 4)

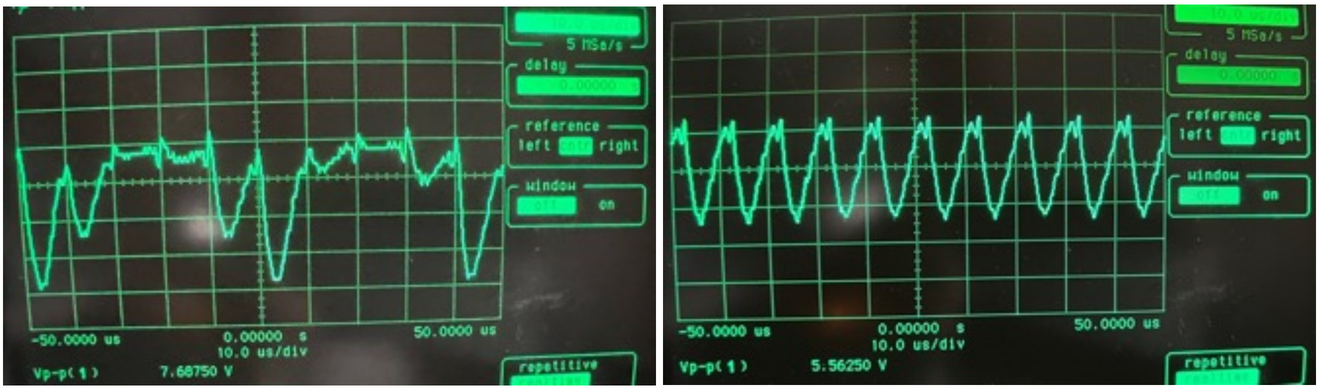
		Keramik-Rohrkondensator CERAMIC TUBULAR CAPACITOR	
C 1	1	91pF ±1%; 500V-	B38221-J5910-F
C 2	1	68pF ±5%; 500V-	B38221-J5680-J
		MKH-Kondensator MKH CAPACITOR	
C 3	1	0,01µF ±20%; 250V-	B32220-K3103-M
C 4	1	0,1µF ±20%; 250V-	B32220-K3104-M
C 7,10	2	0,047µF ±20%; 250V-	B32220-K3473-M
		Kf-Kondensator PLASTIC-FOIL CAPACITOR	
C 5	1	160pF ±20%; 630V-	B31861-J6161-M
C 6	1	2500pF ±20%; 160V-	B31861-J1252-M
		MKL-Kondensator MET'D PLASTIC-LACQUER CAP'R	
C 8	1	0,47µF ±20%; 100V-	B32110-D0474-M
C 9,11	2	0,1µF ±20%; 100V-	B32110-C0104-M
C 12,13	2	Elektrolyt-Kondensator ELECTROLYTIC CAPACITOR 4µF +50/-10%; 250V-	B43711-A2405-T
Dr 1	1	Drossel CHOKE 70 Wdg 0,10 CuL; 4Ω 280µH; ±5%	Rel Bv 622 W 296
R 1,12,15	3	Schichtwiderstand LAYER-TYPE RESISTOR 150kΩ ±5%; 0,33W	B51363-A2154-J

		Schichtwiderstand LAYER-TYPE RESISTOR	
R 2	1	560kΩ ±5%; 0,33W	B51264-A2564-J
R 3	1	33kΩ ±5%; 0,33W	B51363-A2333-J
R 4	1	18Ω ±5%; 0,33W	B51264-A2180-J
R 5,13	2	220kΩ ±5%; 0,33W	B513[illegible]-A22[illegible]-J
R 6	1	20kΩ ±5%; 1W	B51266-A5203-J
R 7	1	150Ω ±5%; 0,33W	B51363-A2151-J
R 8	1	10Ω ±5%; 0,33W	B51264-A2100-J
R 9,17	2	10kΩ ±5%; 0,33W	B51363-A2103-J
R 10	1	27kΩ ±5%; 0,33W	B51363-A2273-J
R 11	1	100kΩ ±5%; 0,33W	B51363-A2104-J
R 14	1	47kΩ ±5%; 0,33W	B51363-A2473-J
R 16	1	680kΩ ±5%; 0,33W	B51264-A2684-J
R 18	1	1MΩ ±5%; 0,33W	B51264-A2105-J
U 1	1	Pulsübertrager PULSE TRANSFORMER Wicklg.I (3,4) 7 Wdg 0,40 CuL Wicklg.II (1,2) 7 Wdg 0,40 CuL I+II = 5,8µH ±6%	Rel Bv 622 W 297

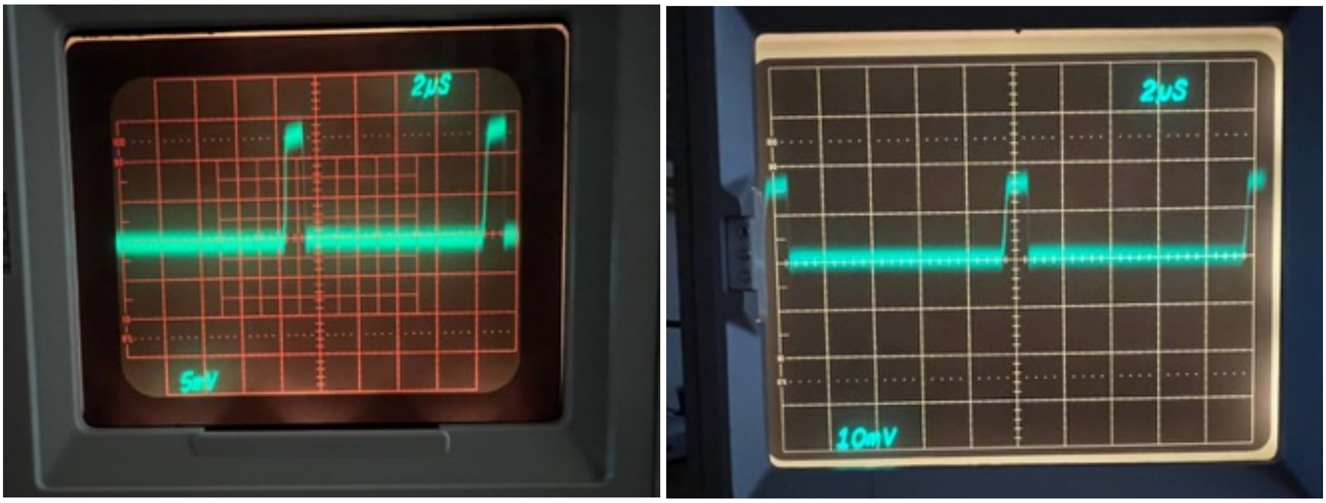
Raster module oscillograms



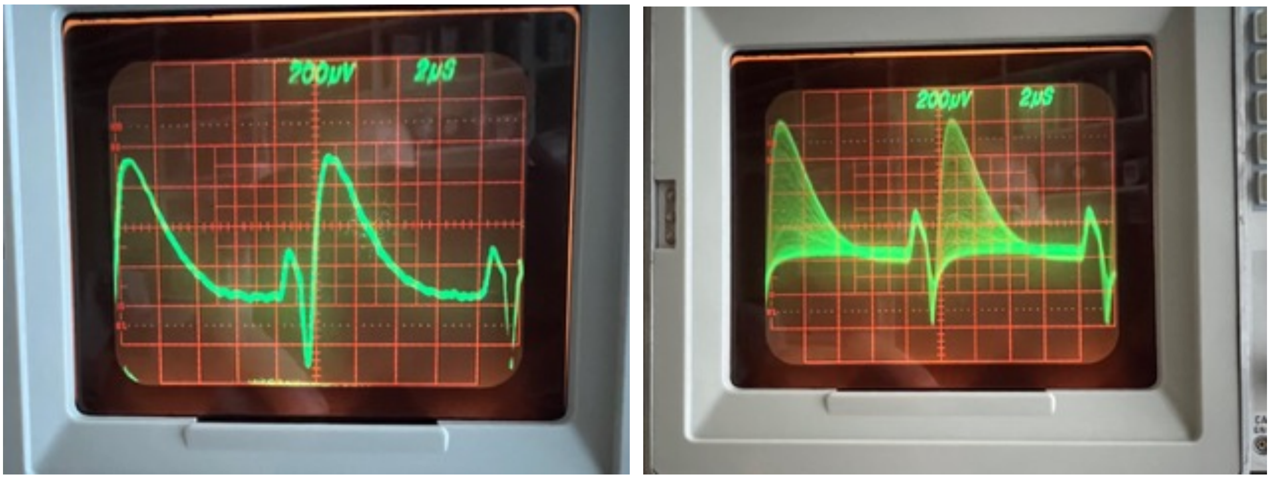
The 100kHz oscillator signal on the plate of Rö12-I (left) and Rö12-II (right)



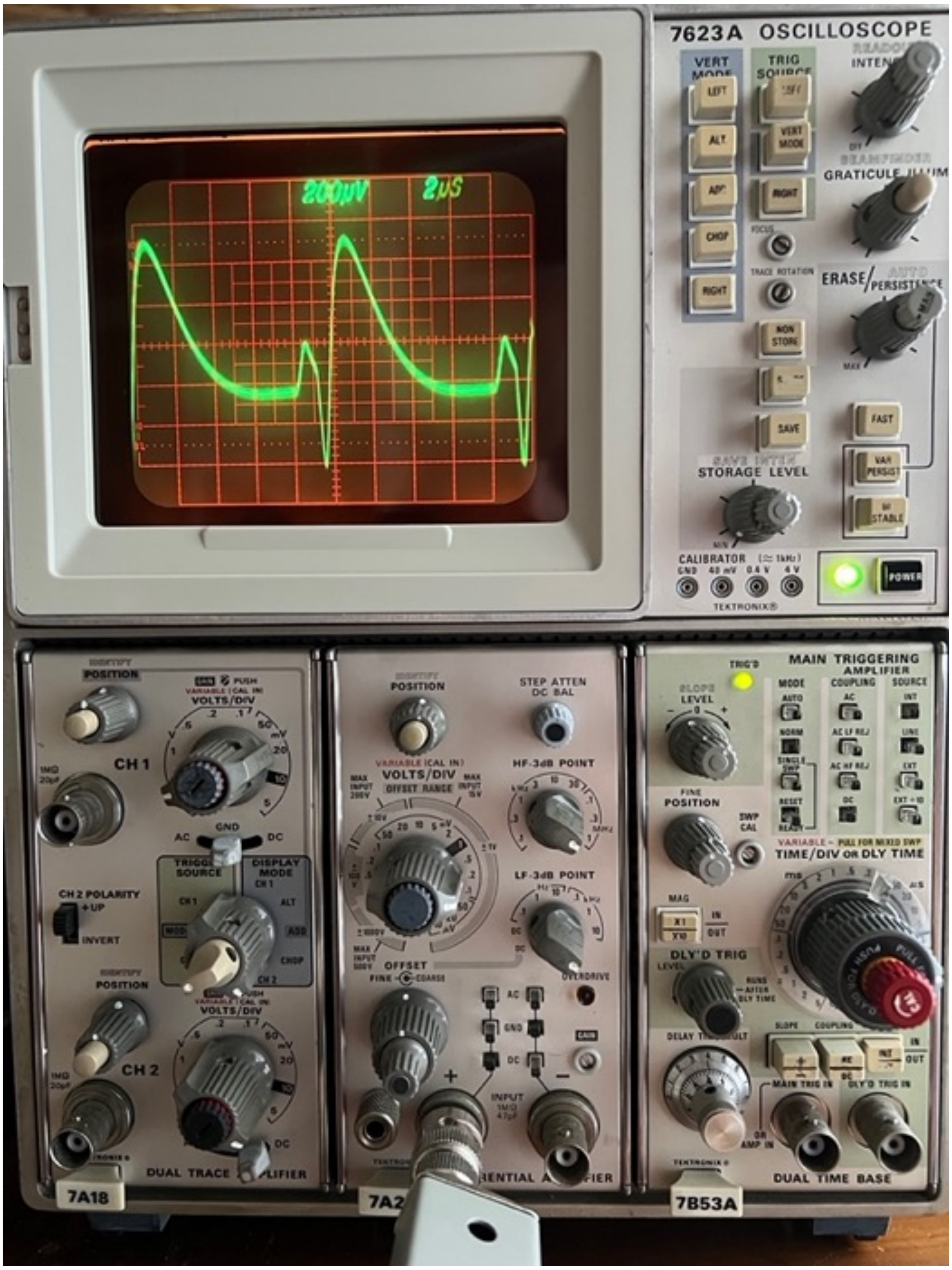
On the left, the plate of Rö14-I when searching the lock (lamp blinks) or when locked (right)



Ma3 connector (Tektronix 7623A and 7603 scopes)



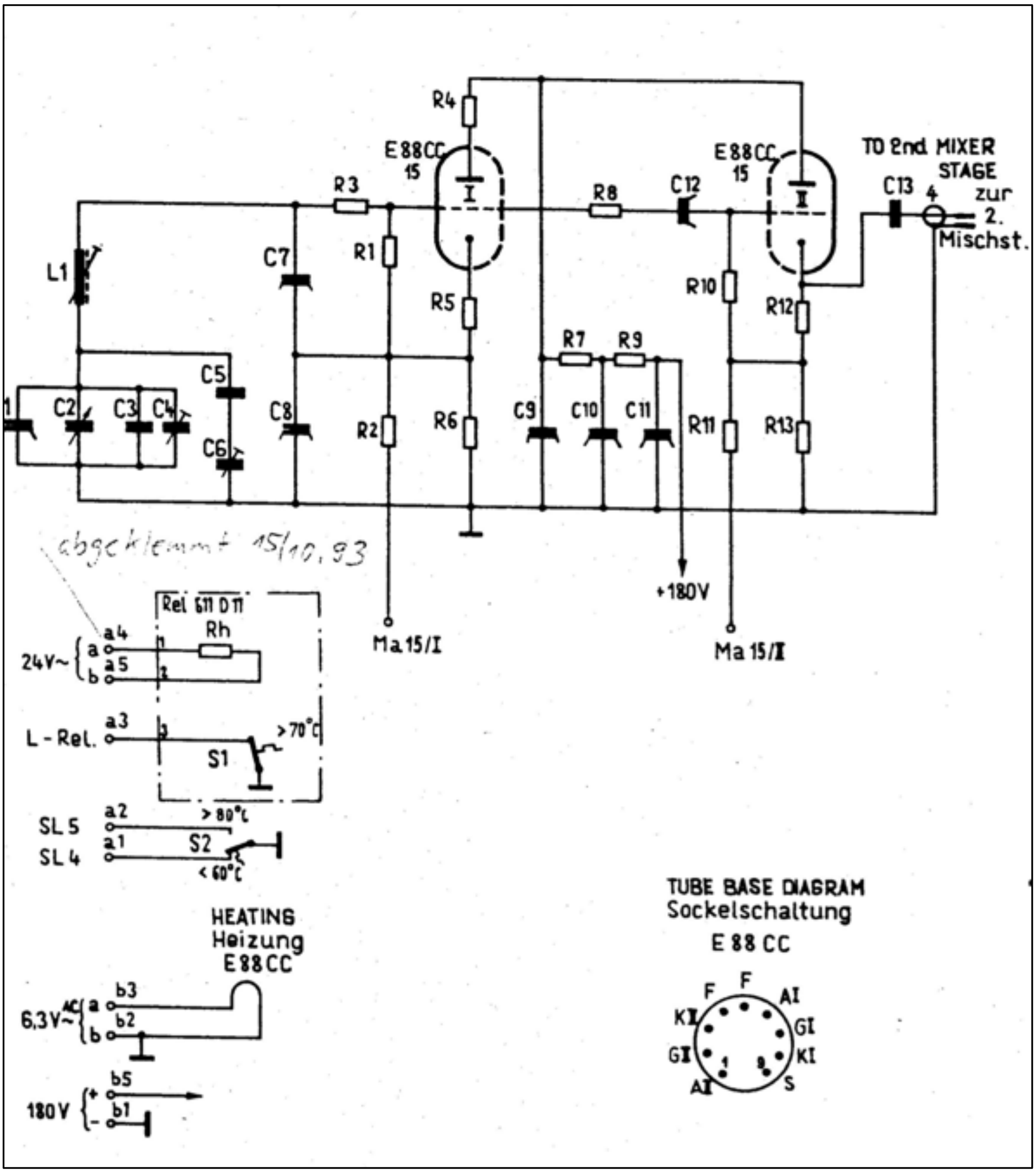
Ma14, left in locked state, right lamp flashing (7623A scope)



I could not see this signal with the 7A18 or 7A26 plug-in, because the signal is too low. The sensitivity here is 200uV (probe 10:1, so real 2000uV/div = 2mV/div). I add this photo to remember the scope set-up.

F. Interpolation oscillator (circuit diagram Rel str 454 U 302c1)

Theory of operation



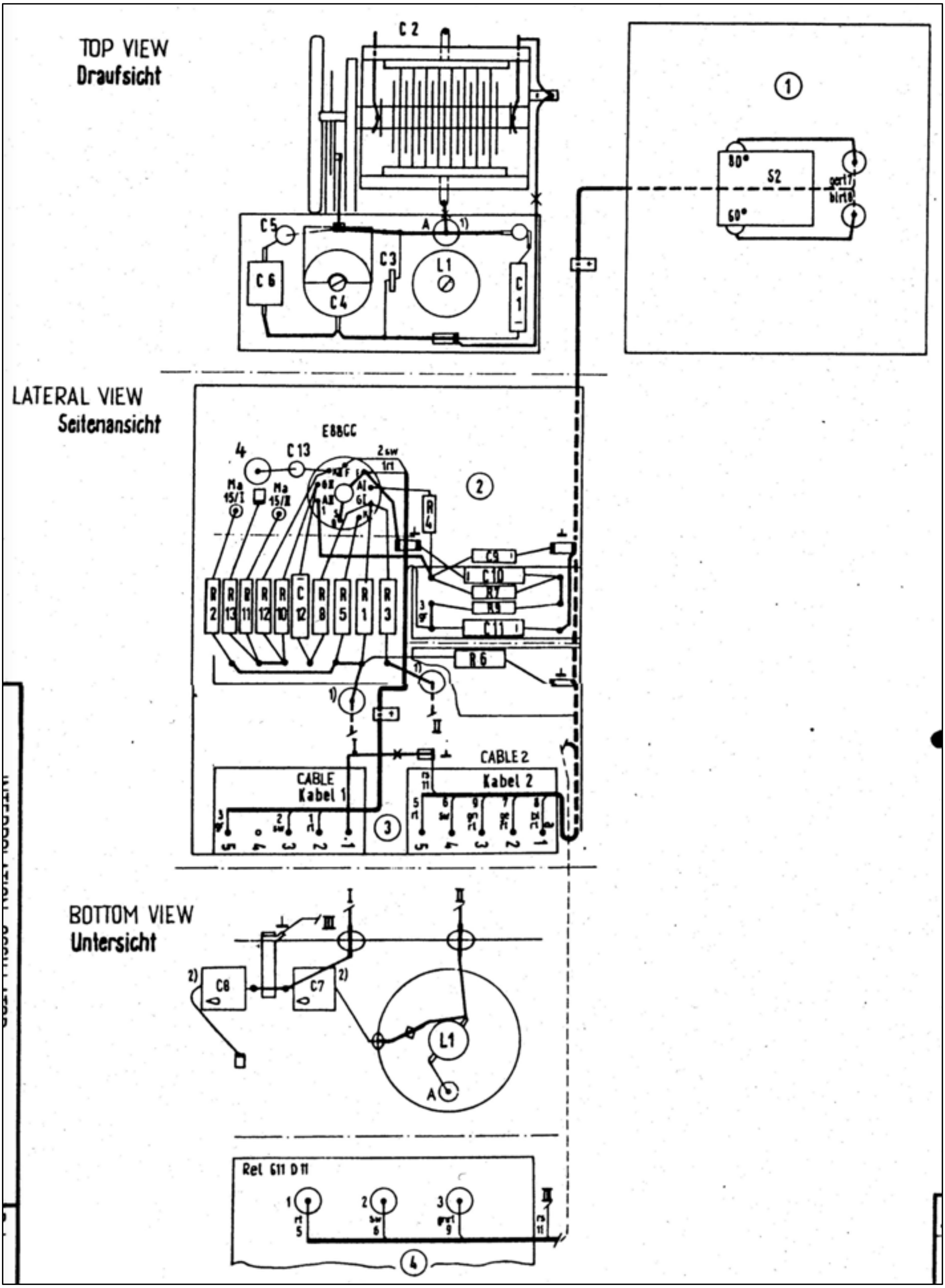
The interpolation oscillator, which is used to detect the areas between the 100 kHz marks, has a significant influence on the setting accuracy and frequency stability of the receiver. Apart from the tube 15 it is therefore housed in a thermostat as well as the 100 kHz crystal.

The oscillating tube 15/1 works with a large parallel capacitance to the grid-cathode path, which largely eliminates the influence of the grid-cathode capacitance (Clapp oscillator).

The oscillator oscillation (930 to 1030 kHz) reaches the intermediate stage in the IF module via the isolating stage 15/II, which is switched as a cathode amplifier.

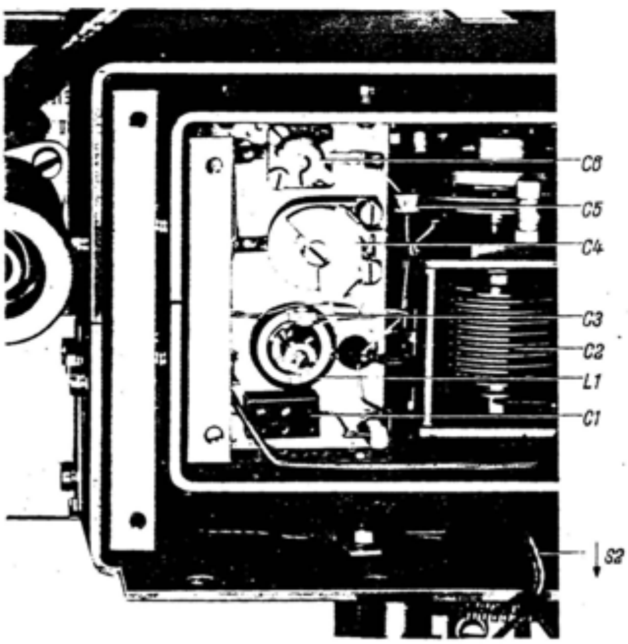
The heating coil Rh of the thermostat is connected to contact I(I) of the L relay (in Rel str 451 N 300f), which is switched on above 70° C by an electronic thermometer. The heating process is then interrupted and the green signal lamp SL3 for the thermostat heating goes out.

The electronic thermometer works in the same way as that used in the 100 kHz grid.

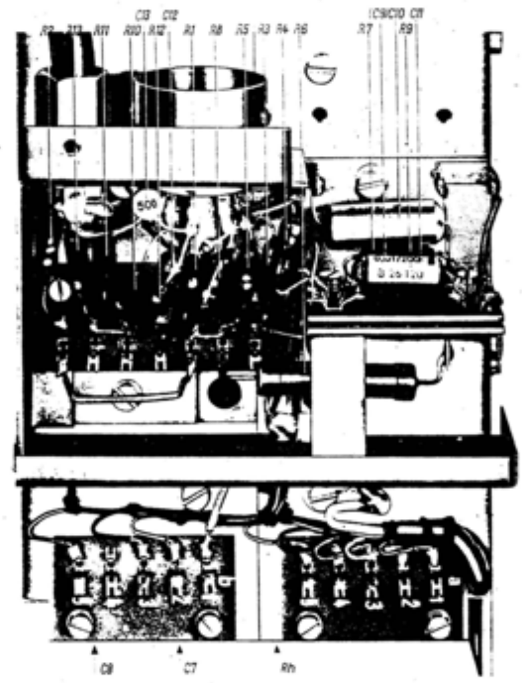

TOP VIEW
Draufsicht
LATERAL VIEW
Seitenansicht
BOTTOM VIEW
Untersicht
C 2
C5
C 6
C4
C3
L1
C 1
A
S2
80°
60°
E88CC
C 13
Ma 15/I
Ma 15/II
R 4
C9
C10
R7
R9
C11
R6
CABLE 2
CABLE
Kabel 1
Kabel 2
C8
C7
Rel 611 D11

Symbol SYMBOL	Stk QTY	Gegenstand DESCRIPTION	Bestellangabe ORDERING DATA
Interpolations-Oszillator Rel 454 U 302a **INTERPOLATION OSCILLATOR**		Ausgabe I ISSUE 1	
C 1	1	Glimmer-Kondensator MICA CAPACITOR 150 pF ±2 % 300 V	B 34211 A 150 G 300 sprungfest
C 2	1	Regelkondensator REGULATING CAPACITOR 64 pF	Rel Ko 138a
C 3	1	Keramik-Scheibenkondensator CERAMIC DISC-TYPE CAPACITOR 8 pF ±1 pF 500 V	B 38215 N 750 A 8 F
C 4	1	Lufttrimmer AIR-DIELECTRIC TRIMMER 19 pF	Rel Ko 130a
C 5	1	Keramik-Scheibenkondensator CERAMIC DISC-TYPE CAPACITOR 2 pF ±0,5 pF 500 V	B 38215 N 075 A 2 D
C 6	1	Lufttrimmer AIR-DIELECTRIC TRIMMER 5 pF	Rel Ko 131c
C 7, 8	2	Glimmer-Kondensator MICA CAPACITOR 2000 pF ±2 % 500 V	B 34214 A 2000 G 500 sprungfest
		MP-Kleinkondensator MET'D-PAPER MIDGET CAP'R	
C 9 11	2	0,01 µF ±20 % 200 V	B 26120 A 0,01 M 200 K
C 10	1	0,1 µF ±20 % 200 V	B 26120 A 0,1 M 200 I
C 12	1	Kf-Kondensator PLASTIC-FOIL CAPACITOR 200 pF ±20 % 500 V	EN 200/20/500 B 3101
C 13	1	Keramik-Scheibenkondensator CERAMIC DISC-TYPE CAPACITOR 500 pF +30/-20 % 500 V	B 37635 L 500 R

Symbol SYMBOL	Stk QTY	Gegenstand DESCRIPTION	Bestellangabe ORDERING DATA
L 1	1	Schwingkreisspule TUNING COIL Wicklg. I (7a, 1b) 154 Wdg 0,12 CuL 11 Ω; 140 µH enthält/CONTAINING Abgleichkolben/ALIGNING SCREW 9 Rel sp 8 Tz 1 Massekern/POWDERED IRON CORE 9 Rel sp 8 Tz 13	Rel Bv 623 A 1107
Rh	1	Heizkörper HEATER 24 V 10 W	Rel Bv 611 D 11
		Schichtwiderstand LAYER-TYPE RESISTOR	
R 1	1	220 kΩ ±5% 0,33 W	B 51363 A 220 k 5/2
R 2	1	390 kΩ ±5% 0,33 W	B 51363 A 390 k 5/2
R 3	1	100 Ω ±5% 0,33 W	B 51363 A 100 Ω 5/2
R 4	1	47 Ω ±5% 0,33 W	B 51363 A 47 Ω 5/2
R 5	1	150 Ω ±5% 0,33 W	B 51363 A 150 Ω 5/2
R 6	1	10 kΩ ±5% 1 W	B 51266 A 10 k 5/5
R 7	1	1,5 kΩ ±5% 0,33 W	B 51363 A 1,5 k 5/2
R 8	1	18 kΩ ±5% 0,33 W	B 51363 A 18 k 5/2
R 9	1	1,2 kΩ ±5% 0,33 W	B 51363 A 1,2 k 5/2
R 10	1	470 kΩ ±5% 0,33 W	B 51363 A 470 k 5/2
R 11	1	82 kΩ ±5% 0,33 W	B 51363 A 82 k 5/2
R 12	1	680 Ω ±5% 0,33 W	B 51363 A 680 Ω 5/2
R 13	1	3,3 kΩ ±5% 0,33 W	B 51363 A 3,3 k 5/2
S 2	1	Bimetall-Thermoschalter BIMETAL THERMOSTAT RELAY 60/80°	Rel Bv 678 S 60/80



Interpolations-Oszillator Rel 454 U 302a (von oben gesehen)
Interpolation oscillator Type Rel 454 U 302a (viewed from above)



Interpolations-Oszillator Rel 454 U 302a (von links gesehen)
Interpolation oscillator Type Rel 454 U 302a (viewed from the left)

F. Removing the Interpolation Oscillator

The entire assembly only needs to be removed in rare cases, e.g., for work on the gearbox. Most repairs can be performed by removing the top or bottom cover without removing the assembly.

That's simply not true. Or you remove the whole group, or you have no access to the passive components that require substitution. The group removal is not too difficult, apart from the need of de-soldering the wire connections. Just follow the instruction.

1. Remove the lower top panel

The lower double cover plate has to be removed in order to remove the Interpolation Oscillator.

To be able to remove the oscillator as a whole, but also if the subassembly - without removal - has to be opened at the bottom (e.g. to replace the heating coil of the thermostat or the electronic thermometer).

(a) If necessary, after removing the 1 kHz grid, unscrew the socket strip for this assembly.

(b) Remove the double cover plate after loosening the four captive screws at the corners (see figure 1b).

(c) Unsolder the four wires coming from the outside (red, black, red/green, red/yellow) at the ceramic bushings.

(d) Loosen the two retaining screws for the two clamping bolts on the underside of the interpolation oscillator, push out the bolts on one side, then pull out at an angle.

(e) Using flat-nosed pliers, carefully pull the short leg of the base plate, which has the heating coil on the outside and the electronic thermometer on the inside, away from the assembly.

Danger! Do not interfere with the frequency-determining parts of the interpolation oscillator.

(f) When reassembling, do not overtighten the tension bolt retaining screws, but secure with paint.2.

Remove the entire interpolator assembly

First as under F.1. (a) to (c) as described. Then the following measures are required:

(a) Determine and note the counter position at the left and right stops (*suggestion: take a photo).*

(b) Remove the appropriate RF connection cables; remove the Raster assembly and the AF amplifier.

(c) Unsolder the wiring harness on the interpolation oscillator.

(d) Loosen the four screws on the bellow joint (Figure 7) (two from the top of the receiver, two from the bottom with a long, narrow screwdriver) and move the coupling in the direction away from the interpolation oscillator. *The joint is similar in concept to those in R390 receivers.*

(e) Loosen the four fixing screws on the mounting plate (picture 3) from behind, two screws on top, two on the bottom (in picture 1b behind the double cover plate).

(f) Pull out the interpolation oscillator backwards.

(g) Proceed in reverse order when reassembling.

Check that stops are effective again at approximately the same counter positions as before (approximately 99.4 and 103.3). Otherwise loosen the multi-plate clutch again and correct the position.

Adjusting the interpolation oscillator if necessary. along with the 1 kHz grid is shown in the MAINTENANCE INSTRUCTIONS section.

The assignment between variable capacitor and counter position is fixed and is not affected by the expansion of the interpolation oscillator.

Danger! However, the assignment would be disturbed by removing and reinstalling gear parts (e.g. the worm) between the variable capacitor and the counter. In this case, a new individual calibration of the variable capacitor together with the counter would be necessary, which can only be carried out in the factory!

E. 1 kHz Raster

It is only for the "e" version and is an option. I haven't it. Just to satisfy my curiosity.

This (retrofittable) module is used if the 2nd oscillator (interpolator) is to enable crystal-precise operation at all full 1 kHz values.

The quartz-stabilized oscillation of the 100 kHz grid reaches a frequency divider consisting of two blocking oscillators for 10 kHz and 1 kHz connected in series via an isolating stage. The subsequent monostable multivibrator converts the 1 kHz oscillation into steep pulses. These pulses and the oscillation of the interpolator to be synchronized are fed to a mixing stage, where a mixing product is formed whose amplitude depends on the phase difference between the pulses and the oscillator oscillation.

This mixed product is amplified, rectified, and fed via a low-pass filter with a limit frequency of 600 Hz to two varactor diodes, which retune the interpolator's oscillating circuit.

In the locked state, the lowest frequency occurring before the low-pass filter is 1 kHz. The output of the low-pass filter is therefore AC-free. If, on the other hand, the interpolator is not locked (frequency between two spectral lines of the 1 kHz grid), the lowest frequency is below 500 Hz. After rectification, this AC voltage sets a search circuit in operation, which periodically changes the interpolator frequency with the help of a sweep voltage. The search process is indicated by the rhythmic lighting up of a lamp. If the oscillator locks when passing through a spectral line, the AC voltage at the output of the low-pass filter disappears immediately, the search circuit switches off and the lock indicator lamp lights up continuously.

Checks suggested by the manual

E. Prüfen und Abgleichen des Raster-Oszillators (Rel str 455 U 300b)

Measuring devices

- A-V-Q Multizet
- µA multimeter
- HF multimeter or HF millivoltmeter; Measuring range 1 V
- Frequency meter 2.85 to 31.55 MHz or test receiver, setting error ~ ±1 kHz (e.g. a second E 311 receiver if adjustment is not necessary in range 5 above, or R & S, type WEN).
- Adapter A1: measuring adapter V42250-F2-V1 (picture 12),
- Adapter A2: adapter plug C40145-A4138-B193 (image 12).
- Adjustment Screwdriver B63399-A2
- Adjustment key radio rec. 138 Tz 48.

1. Operating voltages

In general, measurements at test connections 11/I and 11/II are sufficient when installed.

An A-V-Q multimeter should show in the measuring range 60 mV at Ma11/I 11 to 17 Skt (plus terminal to ground).

With the H relay dropped and cable 8 (gII) short-circuited, a value of 19.0 to 22.5 Skt should be measured at Ma11/II (negative terminal to ground).

Note: Skt = scale units, marks

2. Oscillator voltage

(a) Connect adapter A1 to cable 7, adapter A2 to cable 1 as termination.

(b) Connect an HF multimeter (measuring range 1 V) or HF millivoltmeter to the output of adapter A1 and measure voltages in all five frequency ranges; the values should be between about 0.48 and 0.68 V at the beginning and end of ranges 1 and 2 and between about 0.48 and 1.05 V at the beginning and end of ranges 3, 4, 5.

3. Fine adjustment of the raster oscillator.

<u>Small non-uniform deviations</u> between the 400 kHz calibration marks and the whistle points during calibration can, for example, occur over longer periods of time due to aging. A compensation with the scale correction screw is then not possible; Rather, it is necessary to readjust the coils and trimmers in the affected oscillating circuits of the raster oscillator to the 400 kHz mark on the scale, and that in installed condition.

Small non-uniform deviations between the 400 kHz calibration marks and the whistle points during calibration can, for example, occur over longer periods of time due to aging. A compensation with the scale correction screw is then not possible; Rather, it is necessary to readjust the coils and trimmers in the affected circuits of the raster oscillator to the 400 kHz mark on the scale, and that in installed condition.

The coil and trimmer of the switched-on oscillator circuit are accessible through cut-outs in the front panel and behind them through corresponding openings in the gear wheel attached to the raster oscillator (Figure 2).

(a) Set the operating mode switch to 11F.ichen 11.

(b) Use the associated special wrench for the adjustment (trimmers are connected to the anode voltage, : risk of contact!). Adjust with L at the lowest calibration mark of the respective frequency range and with C at the top.

(c) Repeat these operations several times until there is no significant change.

(d) Then examine the location of several intervening 400 kHz marks.

4. Pre-match the raster oscillator

(a) Proceed as follows only in the case of larger detuning of the oscillator circuits:

Connect adapter A1 to cable 7, adapter A2 to cable 1 as termination.

(b) Connect a frequency meter or measuring receiver to the output of adapter A1 which covers the frequency range from 2.85 to 31.55 MHz with an accuracy of ±1 kHz.

(c) Set coarse tuning to 11free 11 (relay H energized).

(d) Use the associated special key for the adjustment (danger of contact!).

In each range first the lower adjustment frequency (see following table) on the frequency meter and adjust the coil; then carry out the C adjustment at the upper adjustment frequency. Repeat operations several times until tuning frequencies are achieved with an accuracy of about ±1 kHz.

Frequenz-bereich	Abgleich-punkt	untere Abgleich-frequenz in MHz	Abgleich-punkt	obere Abgleich-frequenz in MHz
1	L1	2,85	C1	4,85
2	L2	4,75	C5	8,95
3	L3	8,85	C9	16,45
4	L4	16,35	C13	23,95
5	L5	23,85	C17	31,45

(e) Finally carry out fine adjustment as shown under E3.

F. Checking and adjusting the 100 kHz Raster module (Rel str 455 N 300c1)

Measuring devices:

- A-V-0 multimeter
- µA multimeter
- HF multimeter or HF tube voltmeter; Measuring range 1 V.

1. Operating voltages

To measure the electrode voltages according to Table TROUBLESHOOTING II.C. after removing the HF cable and loosening the five fastening screws (see Figure 1b), pull out the module, open it and connect it to the associated multipoint connector in the slot using the adapter cable. In many cases, however, the tube test at the test points is sufficient.

3. Detent areas and detent indicator

The rest areas should be approximately symmetrical to the respective 100 kHz mark in all frequency ranges. (In the upper frequency ranges, the detent ranges may overlap.)

The symmetry is influenced by the position of the potentiometer R9 in the grid.

R9 should generally be set in such a way that the detent areas at about 23 MHz {frequency range 5) are symmetrical. An adjustment of this potentiometer can be necessary especially after changing the tube 13, possibly also when changing the tubes 11, 12 and 14.

During the search process, the rest indicator lamp should flicker at a rhythm of about 0.5 to 2 seconds.

4. Balance coil L2

The coil L2 in the 100 kHz blocking circuit (Rel 455 F 305b) is only accessible after removing the cover cap, i.e. after removing the raster oscillator.

It must be balanced in such a way that the HF voltage across resistor R5 is a minimum (< 0.25 V with HF Multizet, range 1 V, frequency range 4).

The rest indicator lamp must be on. During this measurement, the coil turret in the raster oscillator must be between two detent positions so that the oscillator does not oscillate.

5. Checking and adjusting the 100 kHz crystal (after heating up)

The measures required for this are shown under MAINTENANCE INSTRUCTIONS.

6. Adjust coil L1 on the supply board

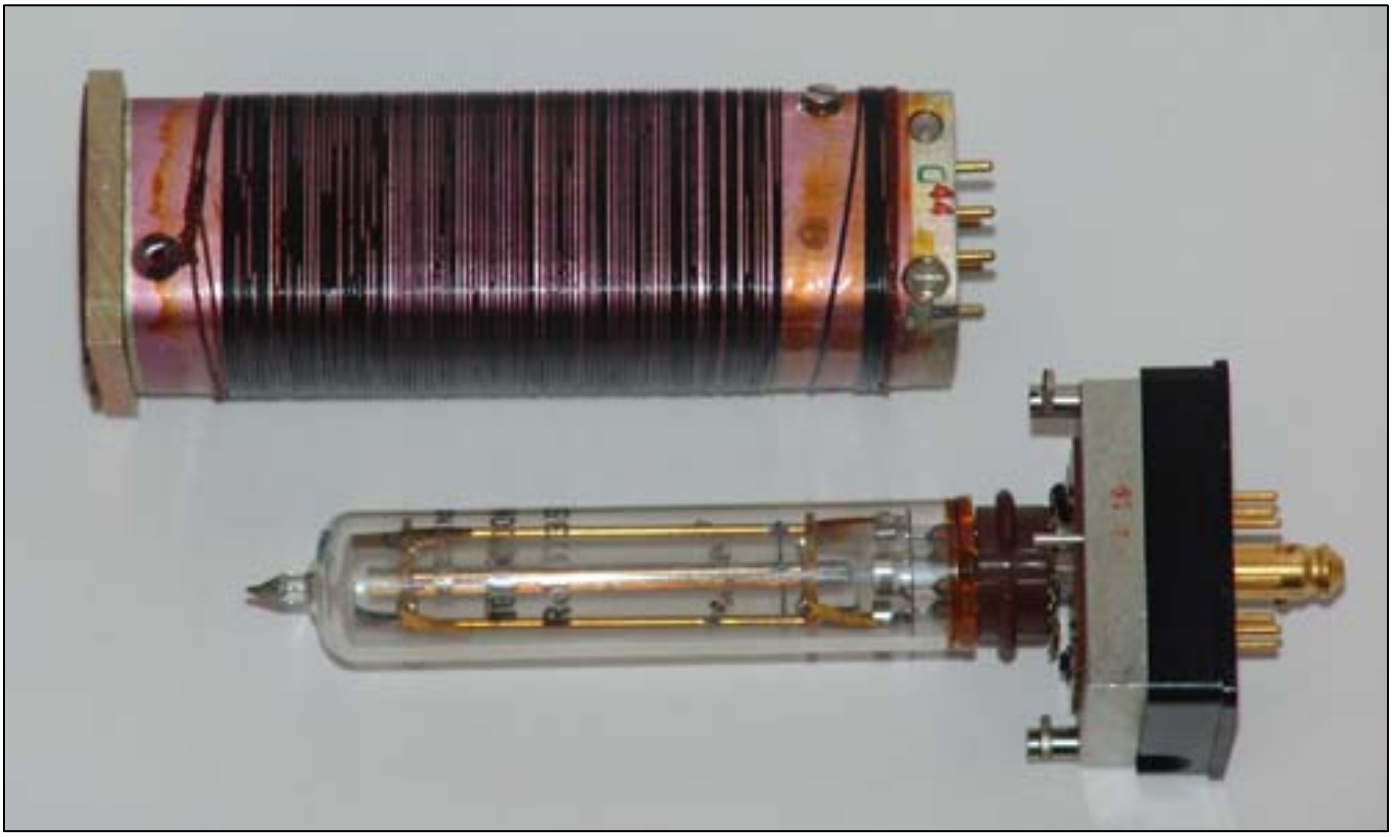
A voltage of 80 mV t10% (measuring range 0.2 or 0.25 V) is to be measured at socket 10 of the grid assembly. Then connect HF Multizet to socket 9 (measuring range 5 V), adjust coil L1 to maximum output voltage (approx. 3 V at 400 kHz).

Thermostats

In general

A thermostat is positioned in the grid assembly. It contains the 100 kHz reference crystal. The second thermostat keeps the interpolator at a constant temperature. Depending on the version, the status of the temperature control is displayed on the front panel. In the versions with four lights, over- and under-temperature are signaled. All other versions with 2 or 3 lights show the status of the contact thermometer.

Depending on the device version, two differently working thermostats were installed in the grid assembly. In the early versions a to d there are thermostats with the designation Rel Bv 673 S 79. These work with Hg thermometers that switch a contact to ground. In the later versions from E, thermostats with the designation Rel Bv 673 S 116 were installed. These contain electronic thermometers that supply a voltage when the nominal temperature is reached. Due to this different way of working, they are not compatible. To avoid accidental damage, they also received a modified socket circuit.



The thermostat can be completely dismantled. After removing the two warranty seals and the countersunk screws underneath, the case cover can be removed (there is no longer a Siemens warranty).

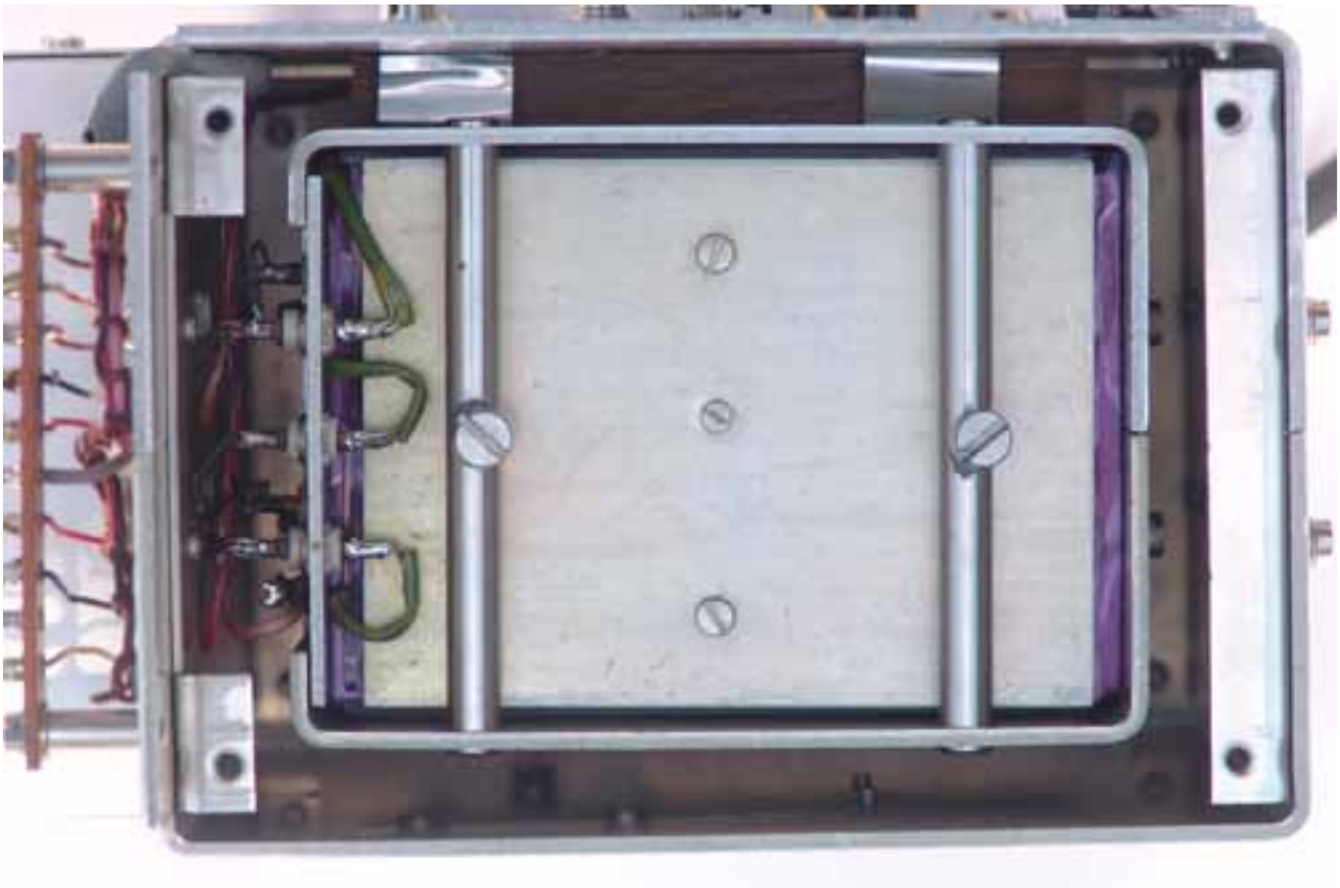
The heating coil is applied to the aluminum block, the thermal control elements are located inside. The form block is plugged into the base and can be separated after loosening the two tabs. Then you can see the 100 kHz quartz crystal. With both versions it would be possible to exchange the thermal control elements if you have one in reserve. I once saw a whole box of new contact thermometers at a flea market. Unfortunately, never an electronic thermometer.

In the interpolator of the receiver versions a to d, bimetallic elements are used for control, from version E also the more precisely working electronic thermometers. With regard to compatibility, the same applies as for the grid quartz thermostat. The heating element and encoder are located on the underside of the interpolator. After unscrewing the bottom cover, it could be taken out with the interpolator installed.

Interpolator heater repairs

(Notes taken from https://www.radiomuseum.org/forum/siemens_rel_445e311_wissenswertes_zum_e311.html)

The heating element consists of a U/L-shaped heat conducting sheet, the heating coil and the sensor elements on the other side. Only the bimetallic sensor for over- and under-temperature control is mounted on the top cover of the interpolator.



Interpolator view with unscrewed lower cover

The transmitter elements are not yet visible. However, the version can already be clearly identified. The heating element with electronic thermostat control has 4 insulated bushings, the bimetal-controlled one has 3 bushings.

After removing the two clamping bolts and unsoldering the external connections, the unit can be pulled out. It is not screwed to the housing but is only pressed on by the two clamping bolts. For the purpose of good heat conduction, however, it is fitted very tightly at the side, so that it has to be pulled out with "gentle painting". Just don't make the mistake of loosening the 3 or 2 screws visible in the middle. That doesn't help and only lets the nuts underneath fall into the slot. You can also remove the two upper covers and help out with "gentle force" from the other side. After that, the interpolator is transparent, and you are rewarded with a view of the linearization mechanics. The additional fixed tuning disc on the rotary capacitor and the slotted one with the eleven tuning segments are clearly visible. As a deterrent example, the large jump between two adjacent segments is clearly visible on the right. This results in a non-linearity in the counter display in the overlapping area (see later when adjusting).

CAUTION!!

HG thermometers and electronic thermometers are sensitive to excess temperature. Any error in the control circuit (e.g. broken wire, lack of control voltage, relay error) causes the thermostat heating to be switched on constantly. The result is an excessive rise in temperature, which in turn mechanically destroys the thermometer. Appropriate caution should be exercised in this respect during any repair or maintenance work. A defective thermometer is difficult to obtain.

At a room temperature of 20°, the following heating-up times can be expected:

- *9 minutes for the 100 kHz thermostat*
- *30 minutes for the interpolator*

After this running-in period, the 100 kHz quartz signal is sufficiently accurate. However, the interpolator needs about 1 hour until the output frequency is temperature-constant. During this time it changes by approx. 500 Hz.

For operation under changing climatic conditions or for months of continuous operation, this behavior makes sense and is not disruptive. However, it makes more sense to deactivate the temperature control of the interpolator for predominantly short-term operation and little different room temperatures. All you need to do is pull the control relay on the power pack and clamp it backwards under the retaining spring. The original condition can be easily restored at any time. The interpolator is already so well temperature-compensated that during a short break-in period only approx. 200 Hz frequency drift is passed through and then remains constant for a long time. See the forum post by Hans-Dieter Haase, who carried out the relevant measurements.

F. Testing and calibration of the interpolation oscillator without 1 kHz Raster

To be performed about every three months and after changing tube 15.

Place the range switch in an intermediate position between two detents so that the raster oscillator does not oscillate. Set operating mode A1 and bandwidth +/-0.15 kHz. Instead of an input signal, the quartz harmonics are effective at 1300 kHz or 1400 kHz. At "0 kHz" and "100 kHz" of the counter, a 1 kHz tone should be audible, which no longer changes its frequency when the sideband selector switch is actuated+. If this is not the case with these settings, the interpolation oscillator must be adjusted as follows:

(a) Set counter to 00 kHz.

(b) Change the L balance L1 (Figure 1) in the interpolation oscillator until the tone is the same when the sideband is switched.

(c) Set the counter at 100 kHz in such a way that the tones are identical when the sideband is switched.

(d) Read the counter, calculate the difference from 100 and multiply by 4. If the value read from the counter is greater than 100, add the quadrupled difference to 100; if the reading is less than 100, subtract the quadrupled difference from 100.

(e) Set the value thus obtained on the counter.

(f) Change C-adjustment C6 (Fig. 1) until the tonal balance occurs again when switching over to the sideband.

(g) Set the counter back to 00 kHz.

{h) as (b); If necessary, repeat operations several times until the error is sufficiently small. End adjustment with L correction at position 00 kHz.

(The factor 4 when calculating the difference is a value with which experience has shown that the target frequencies of 1030 kHz (counter 00) and 930 kHz (counter 100) are most quickly approached Carrying out the L adjustment at a higher level has proven to be expedient here.)

+ Some weaker whistles that can occur when cranking the fine tuning are irrelevant. They are so far from the whistles at 0 and 100 kHz that they cannot be confused with them as long as the interpolation oscillator has not been grossly detuned.

NOTE: this procedure is incredibly good, but my suggestion is to replace the uneasy and subjective method of flipping the sideband selector, applying instead a digital frequency meter to the output of the Interpolation Oscillator (after having detached it from the RF module). In this way you can read directly the two frequencies (930 and 1,030kHz).

F. 1. Supplement for checking and calibrating the interpolator

If errors > 50 Hz occur at the 10 kHz digits due to aging despite correct comparison with the counter positions 00 and 100, these errors can be corrected with the help of the segment screws accessible from the rear of the Interpolator.

(a) To do this, remove the grid assembly and reconnect it using the adapter.

(b) Remove the now accessible side cover of the interpolation oscillator. The segment screws are then accessible one after the other through a hole when turning the fine tuning.

(c) Feed in a 10 kHz spectrum (e.g. from a suitable counter) at the antenna input. Set coarse scale to 2 MHz in idle mode. Set transmission type A 1 and bandwidth ±.0.5 kHz.

(d) Since the counter settings are correct at 00 kHz based on the previous adjustment (Section F.), set the counter to 10 kHz and use the segment screw to adjust for tone equality when switching sideband. Repeat the calibration process with counter positions 20, 30 etc. up to 100.

Now check all 10 kHz digits from 00 to 100 and adjust if necessary.

(e) The comparison can also be carried out using a counter.

To do this, connect the output of the interpolator directly to the input of the counter and set the associated frequency from 0 to 100 every 10 kHz using the segment correction screws. In doing so, take into account the frequency detuning of the interpolator when the counter is loaded (observe the change in the beat pitch when the counter is connected).

F. 1. Ergäzung zur Prüfung und Eichung des Interpolator's

Sollten trotz richticen Abgleichs bei den Zählwerkstellungen 00 und 100 infolge Alterung Fehler > 50 Hz an den 10-kHz-Stellen auftreten, so können diese Fehler mit Hilfe der in Interpolator von hinten zugänglichen Segmentschrauben korrigiert werden.

(a) Dazu die Rasterbaugruppe ausbauen und über Adapter wieder anschließen.

(b) Die nun zugängliche seitliche Abdeckung des Interpolationsoszillators entfernen. Durch eine Bohrung sind dann die Segmentchrauben bein Durchdrehen der Feinabstinnung nacheinander zugänglich.

(c) Am Antenneneingang ein 10-kHz-Spektrum (z.B. aus geeignetem Counter) einspeisen. Grobskale auf 2 MHz im Rastbetrieb stellen. Sendeart A 1 und Bandbreite ±,0, 5 kHz einstellen.

(d) Da auf Grund des vorhergehenden Abgleichs (Abschnitt F.) die Zählwerkstellungen 00 kHz stimmt, Zählwerk auf 10 kHz stellen und mit der Segmentschraube auf Tongleichheit bei Seitenbandumschaltung abstimmen. Eichvorgang bei den Zählwerkstellungen 20, 30 usw. bis 100 wiederholen.

Nun alle 10-kHz-Stellen von 00 bis 100 kontrollieren und erforderlichenfalls nachsleichcn.

(e) Der Abgleich kann auch mit Hilfe eines Counters durchgeführt werden.

Hierfür den Ausgang des Interpolators direkt an den Eingang des Counters anschließen und von 0 bis 100 alle 10 kHz die zugehörige Frequenz mit Hilfe der Segment-Korrekturschrauben einstellen. Dabei die Frequenzverstimmung des Interpolators bei Belastung durch den Counter berücksichtigen (dazu die Änderung der Schwebungstonhöhe bei Anschluss des Counters beobachten).

Repair activity

25.6.2022 *Today I have:*

- *cleaned the J relay contacts;*
- *replaced some capacitors with new ones (C10, C7, C4, C2, C9, C11 and later C3)*
- *studied the manual and done lot of tests.*

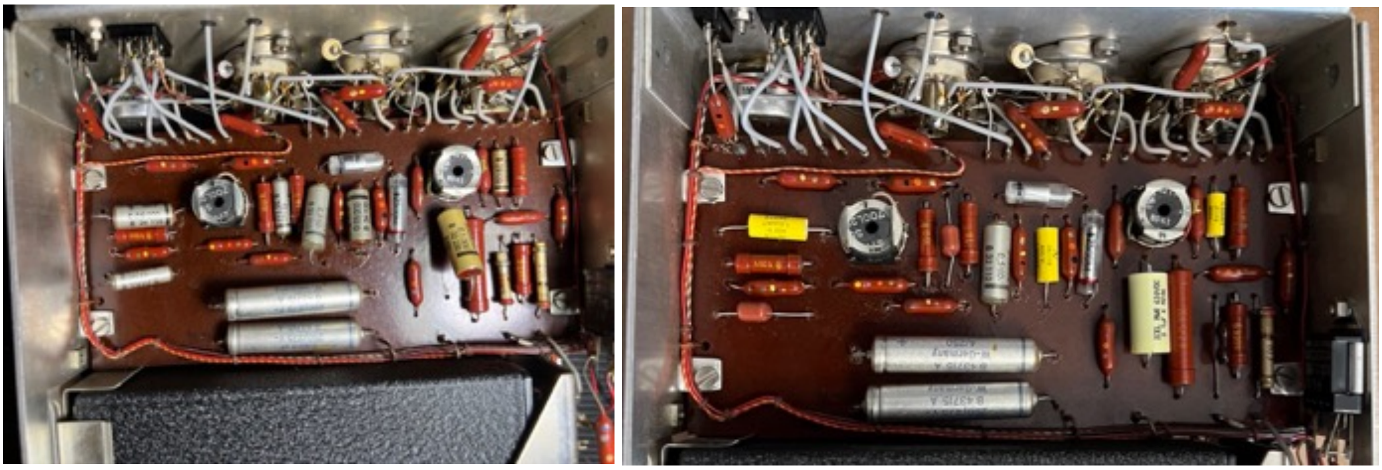
What I can now say is:

- *I start to have a better understanding of the theory of operation;*
- *Rö14 never goes into interdiction. It could be that its drive is not enough or that drive is enough, and it does not work properly;*
- *currently, the drive is a negative voltage of about 0.4V. With a -1.5V, Rö14 still does not interdict, with -9V it does.*
- *I believe that not a large voltage should be required, because at the end of the filter on the Raster Oscillator module, there is a 5ohm resistor toward ground.*

Tomorrow I will:

- *investigate the manual to see if some extra information is given in other sections;*
- *analyze the Rö14 circuit to understand which is the minimum drive to interdict;*
- *add to this document the schematic etc. for the Raster Oscillator.*

27.6.2022 *I won! I could find and fix the problem: C3 capacitor, 0.1uF (MKH type) on the cathode of Rö12-I was gone and was not any longer a capacitor. I replaced also other capacitors. It is rather easy and most of them are inexpensive. The electrolytics were good.*



The board at the beginning of recap (left) and after having been recapped.

But the joy was short: after some minutes of operation, the problem arose again. Eventually, the problem was the heat. I disconnected the heater of the 100kHz-crystal and the Raster system is now OK. I am not feeling guilty for that, read what an expert says (for the Interpolator):

At a room temperature of 20°, the following heating-up times can be expected:

- 9 minutes for the 100 kHz thermostat
- 30 minutes for the interpolator

After this running-in period, the 100 kHz quartz signal is sufficiently accurate. However, the interpolator needs about 1 hour until the output frequency is temperature-constant. During this time it changes by approx. 500 Hz.

For operation under changing climatic conditions or for months of continuous operation, this behavior makes sense and is not disruptive. However, it makes more sense to deactivate the temperature control of the interpolator for predominantly short-term operation and little different room temperatures. All you need to do is pull the control relay on the power pack and clamp it backwards under the retaining spring. The original condition can be easily restored at any time.

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The interpolator is already so well temperature-compensated that during a short running-in period
only approx. 200 Hz frequency drift is passed through and then remains constant for a long time.
See the forum post by Hans-Dieter Haase, who carried out the relevant measurements.
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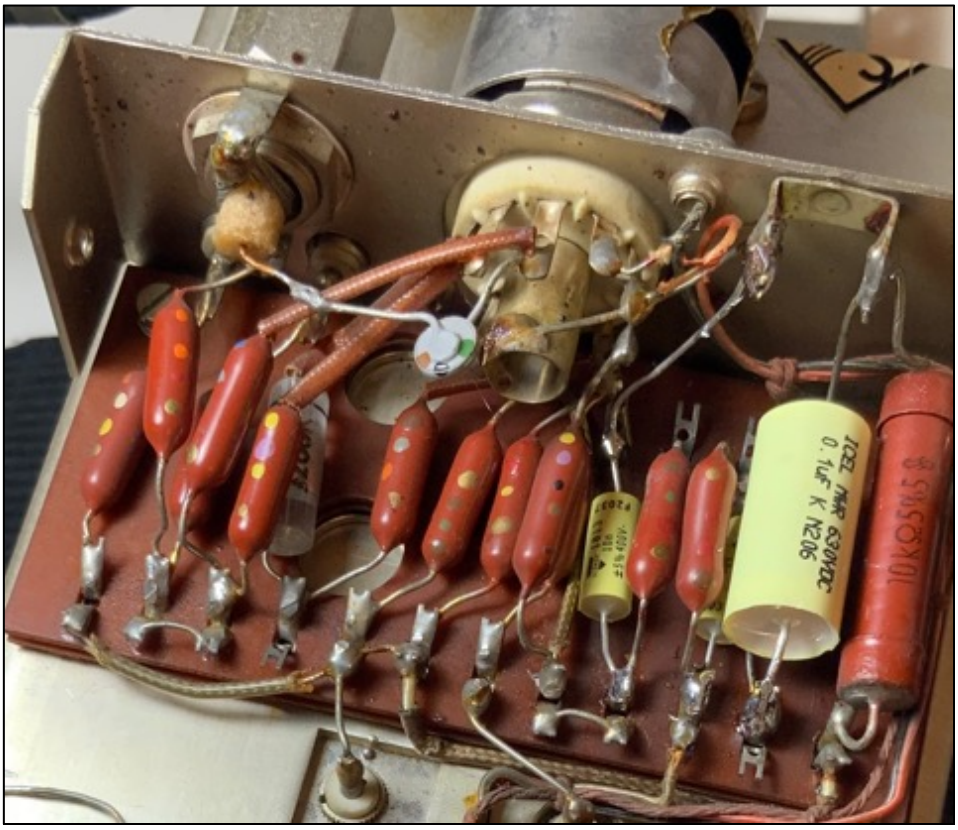
28.6.2022 *Today I decided to also fix the Interpolation Oscillator. I observed that:*

- *the frequency range goes from 930 to 1,030 kHz;*
- *the frequency is inversely proportional to the scale numbers, so going toward “00”, the frequency increases;*
- *the signal output fades going the “00” (1,030 kHz).*

After some checks, I decided to afford the removal of the Interpolation Oscillator. Not as bad as I feared. I found in it 3 paper capacitors (C9, C10, C11) which were not any longer a capacitor (not leaking but capacity almost zero). Tomorrow I will check if that is enough or if are there some others hidden bug.



The Interpolation Oscillator board, before (top) and after recapping (bottom)

To be appreciated the fact that the Interpolation Oscillator module carries on all the mechanical critical parts, so there are not problems to mechanically resync the things during reassembly. Obviously, you have not to disturb the gears in it.

I am asking myself if check the C7 and C8 mica capacitors. To do that I should cut/unsolder something and that could reduce the thermal stability of the produced frequency.

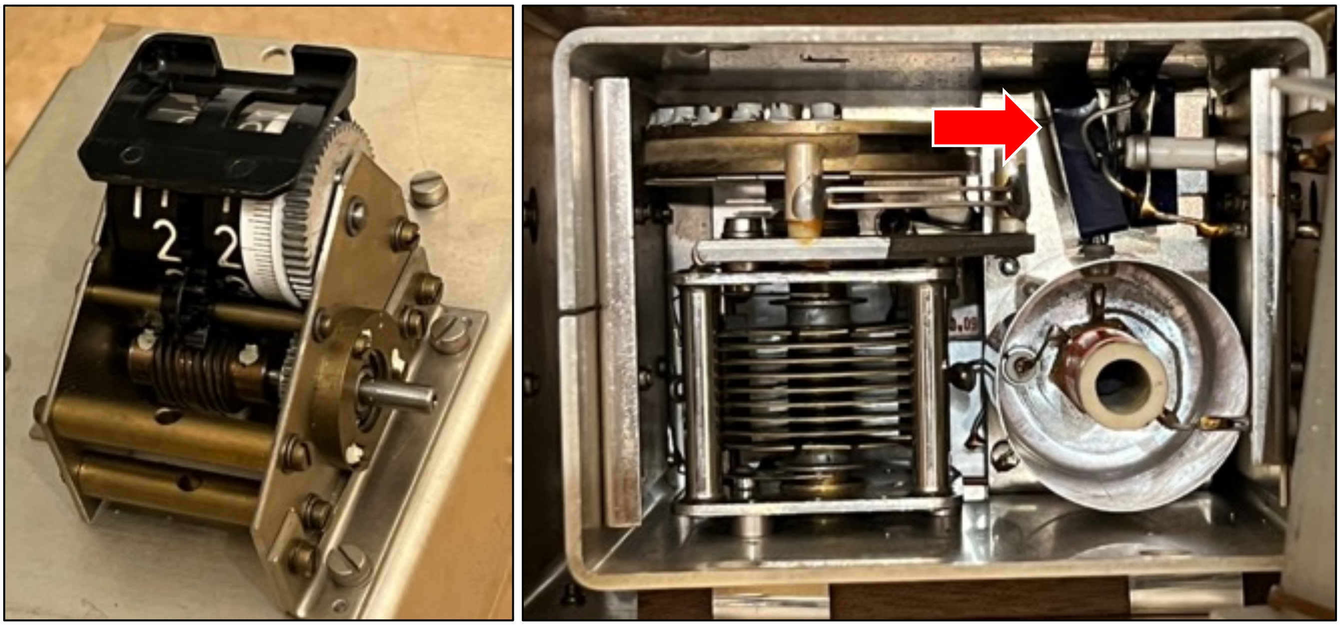
***29.6.2022** Today I checked C8 and found it good (ZM-11/B is really precious in this task!). So, I decided to reassembly everything and to check my work. Reassembly was not too difficult, only a little bit tedious. Power on and… OK, it works! The signal from the interpolation oscillator does not fade anymore. I tried to align it but with not too success… I must retry with more time, but it is only alignment, the circuit is now OK.*

I noted that:

- *in frei mode, the raster oscillator is not very stable;*
- *in gerästet mode, the raster oscillator is rock solid.*

Very, very satisfied!

Tomorrow I will explore the other modules to see if there is some capacitor that might be substituted.



The odometer type gear of the Interpolation Oscillator (left). The internal of the oscillator, the arrow indicates C8 (right).

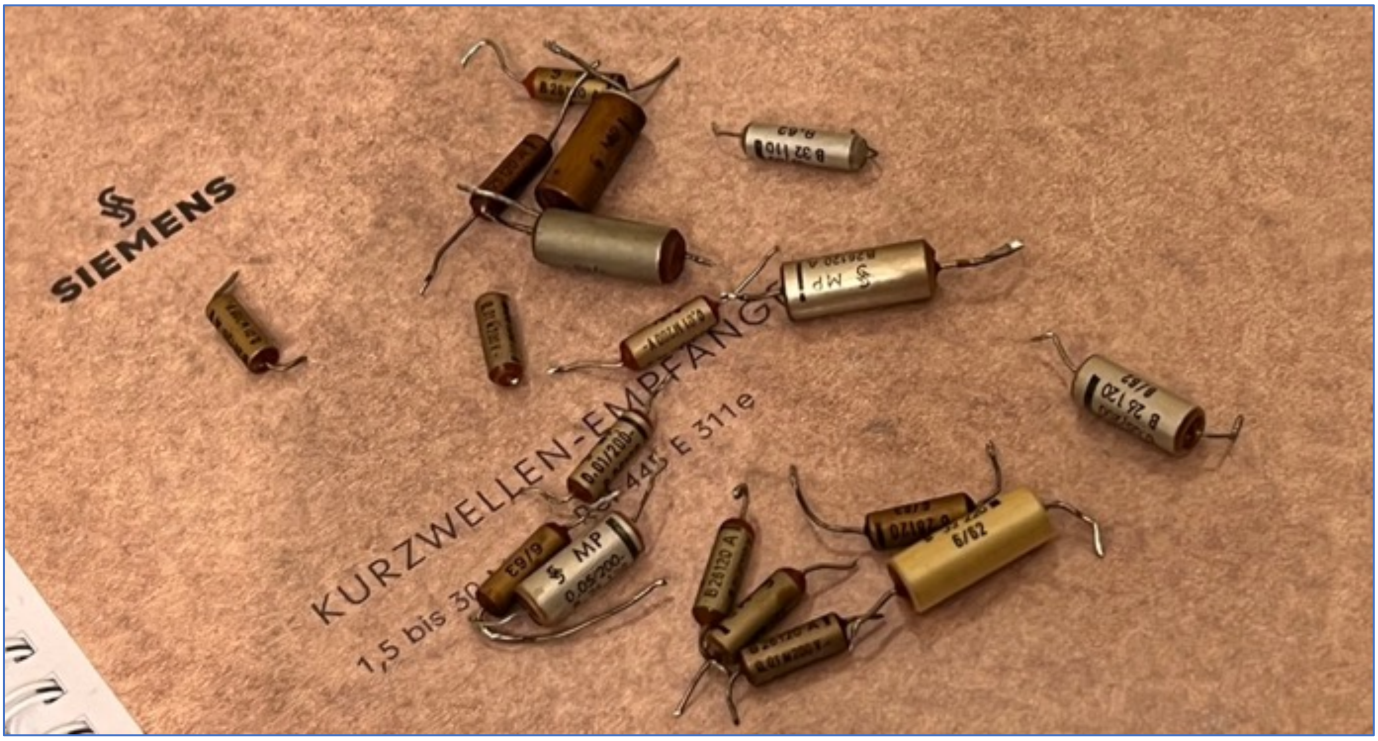
***30.6.2022** I completed my work replacing all the MP capacitor that I could. Many of them were faulty (capacity near to zero or in excessive value). All the other components that I checked were good.*

I suppose that, at this point, almost any E311 has the same problems as mine. They are just saying "automatic". If you have a receiver like, I strongly suggest replacing the MP capacitors.

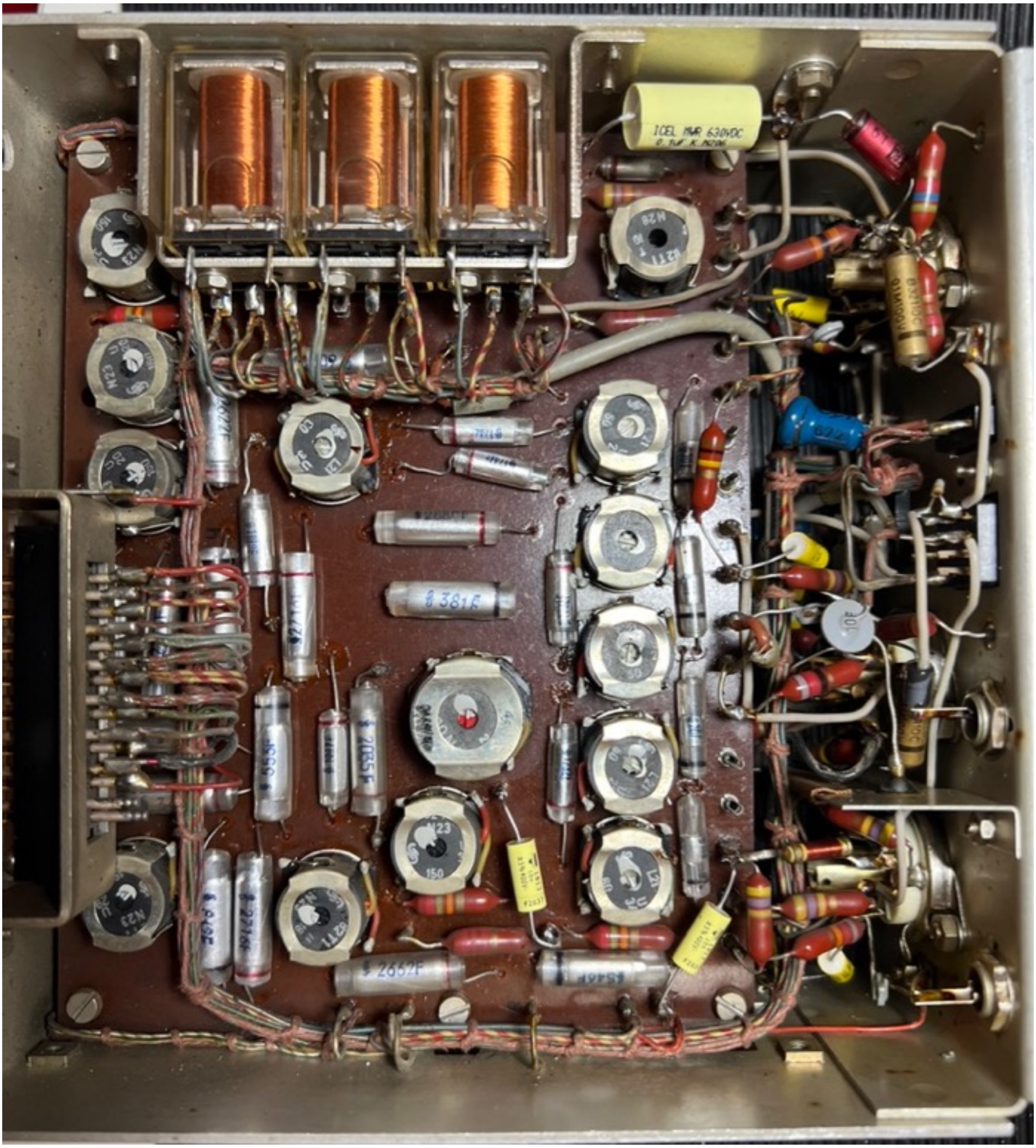
Then I checked all again and reassembled everything.

***1.7.2022** Reassembly completed. Some repaint work. Very satisfied. I note also that the receiver is very well shielded. Without an antenna it receives nothing.*

My E311 on the 1.st of July, 2022



Some of the replaced MP capacitors



Recapping: the yellow caps are the new one.