ROHDE & SCHWARZ

BESCHREIBUNG

Instruction Book

RC - OSCILLATOR

Type SRB BN 40851

R 8366
363
Bl. 1
(40 Bl.)

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 repair parts.

Edition R 8366/363
(Translation of the German edition R 7938/163)

Table of Contents

Page

1. Specifications

Frequency range	10 cps to 1 Mc
divided into 5 sub-ranges	10 to 100/1000 cps/10/100 kc/1 Mc
Frequency accuracy	±2% at 10 to 100 cps ±1% at 100 cps to 1 Mc
Scale discrimination	1.0 to 1.7 mm/%
Frequency shift caused by AC supply voltage fluctuations of ±10%	less than ±2 parts in 10^4 up to 200 kc less than ±5 parts in 10^4 up to 1 Mc
Frequency drift within 10 minutes after 1 hour of operation	less than ±3 parts in 10^4
Temperature coefficient of frequency	approx. +3 parts in 10^4 per °C
Output	unbalanced; adaptable RF socket 4/13 DIN 47284
Source impedance	50/60/75/150/600 Ω ±1%, switch-selected; shunt capacitance approx. 40 pf
Maximum output power	1.5 w
Output voltage (free from DC)	adjustable in steps and continuously in between
direct (Z = 20 to 50 Ω)	0 to 30 v, continuously adjustable
via voltage divider	
with Z = 50, 60, 75 Ω	1/3/10/30/100/300 mv/1/3 v
with Z = 150 Ω	3/10/30/100/300 mv/1/3/10 v
with Z = 600 Ω	10/30/100/300 mv/1/3/10/30 v
Voltage-divider accuracy	better than ±0.2 db
Frequency response of output voltage between 15 cps and 1 Mc	flat within 0.3 db referred to 10 kc, for all voltage-divider steps
Voltage indication	calibrated in v and db
Accuracy of indication	±1.5% of f.s.d.
Frequency response of indication	flat within 0.1 db
Temperature coefficient of indication	+5 parts in 10^4 per °C

Distortion factor

direct output 0 to 30 v with Z_1 greater than 1200 Ω and low voltage-divider positions (see also typical distortion-factor curve Fig. 1)

10 cps to 100 cps	approx. 1%
100 cps to 100 kc	less than 0.1%
100 kc to 1 Mc	approx. 1%

max. output, 30 v into 600 Ω, and voltage divider set for max. EMF

10 cps to 100 cps	approx. 1%
100 cps to 100 kc	less than 0.3%
100 kc to 1 Mc	less than 3%

Valves, etc.	2 valves ECC 81 1 valve E 88 CC 2 valves EL 86 1 0.5-amp fuse 0,5 C DIN 41571
Power supply	115/125/220/235 v, 40 to 60 cps
Dimensions	286 x 227 x 226 mm (R&S standard cabinet 35)
Weight	13.5 kg

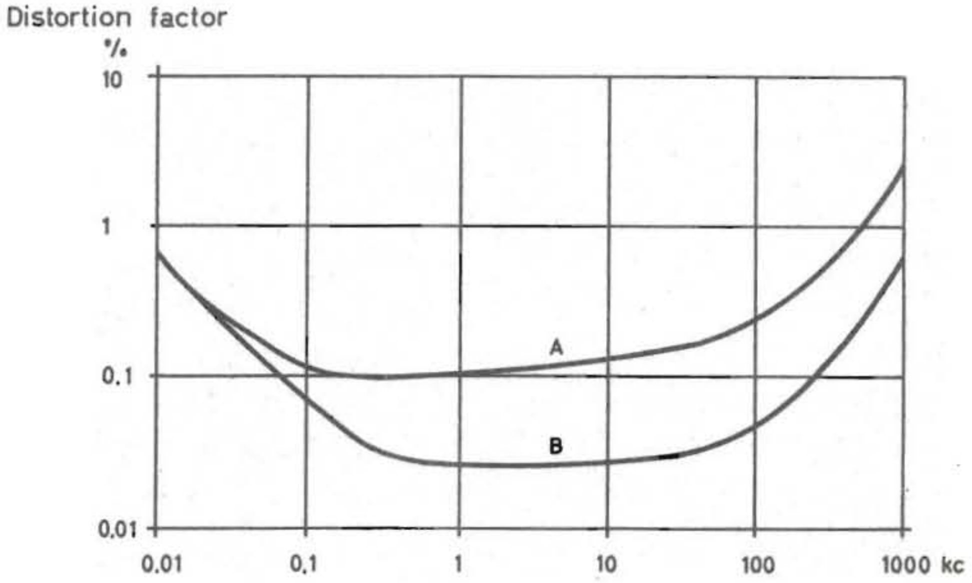


Fig. 1. Typical distortion factor

Curve A: Most unfavourable operating conditions: maximum power and voltage divider set for maximum EMF

Curve B: For all voltage-divider positions at any Z_1 and Z_s

2. Uses

The wide frequency range of the RC Oscillator Type SRB is of great value in AF engineering in the development and installation of transmission systems and in CF engineering for fault location and level adjustments. The output voltage, adjustable in steps and continuously in between within a wide range, is indicated very accurately and the distortion factor is very low. High frequency stability even at the lowest audio frequencies is a distinctive feature of the RC Oscillator Type SRB. This is of special importance when the frequency of the Type SRB is used as a reference frequency for oscilloscopic frequency comparisons. Due to the low distortion of the output voltage the instrument is suitable, for example, as a modulation voltage source for transmitters or for feeding AF and RF bridges.

The flat frequency response of the output voltage makes it possible to carry out series of measurements at different frequencies without readjusting the output voltage after a frequency change. Separate standard 1/3-octave scales are marked on the dial, facilitating the execution of series of measurements. The frequency scale is almost logarithmic and common to the 5 sub-ranges. Thus the percentage reading accuracy is the same at all points and the specified accuracy can be fully used.

3. Preparation for Use

3.1 Adjusting to the Available AC Supply Voltage

The instrument leaves the factory adjusted for operation from 220 v AC supply. To adapt it to 115 v, 125 v or 235 v insert a suitable fuse into the pair of clips marked with the available AC supply voltage on the tapping panel. The tapping panel is mounted on the power transformer and accessible after removal of the four screws in the corners of the front panel and withdrawal of the chassis from the cabinet. The 500-ma fuse used for 220 v is also suitable for 235 v. Use a 1-amp fuse (1 C DIN 41571) for 115 v or 125 v.

3.2 Adjusting the Mechanical Zero of the Meter

When the instrument is switched off the pointer of the meter should be at zero. The screwdriver adjustment recessed in the meter case serves for correction.

3.3 Connection to the AC Supply

The power cable comes out at the front panel. The toggle switch ⑤ +) is the on/off switch. The glow lamp ④ above this switch lights when the instrument is switched on.

The AC supply voltage is allowed to deviate ±10% from the nominal value without impairing the performance of the instrument apart from the slight frequency variation specified in section "1. Specifications". Long periods of under- or overvoltage should be avoided to save the valves. If the AC supply exhibits regular under- or overvoltage, a regulating transformer or stabilizer should be connected in series.

4. Operating Instructions

4.1 Frequency Setting

Select the frequency range with the frequency range switch ⑩ on the front panel. Each of the five sub-ranges covers a decade between 10 cps and 1 Mc. Use knob ⑨ for fine setting, referring to the outer scale marked 1 to 10 of the dial ① . The pointer is provided with a hairline at its front and rear sides. Correct setting and reading are ensured if the two hairlines and the scale division marking the desired frequency coincide. With this setting the maximum possible frequency error is ±2% between 10 cps and 100 cps and ±1% between 100 cps and 1 Mc. The frequency shift caused by AC supply voltage fluctuations is very small. With the AC supply voltage varying ±10% the frequency changes by 0.05% at the most.

4.2 Connecting the Load

No DC or AC voltage exceeding 3 v must enter into the Type SRB from the load. The resistors of the voltage divider or of the switch selecting the source impedance might be damaged by higher voltages.

+) All encircled figures refer to the front view shown in Fig. 12.

If a DC voltage is present across the input of the load a suitable coupling capacitor should be interconnected. Its capacitance must suit the lowest frequency to be transmitted and the input impedance of the load. The additional voltage division caused by the coupling capacitor is negligible if the resulting limit frequency of coupling capacitor, input impedance of the load and source impedance of the oscillator is at least 10 times lower than the lowest operating frequency (error less than 0.5%). The limit frequency is best determined from the well-known reactance chart, which shows the relationship between reactance and limit frequency.

In the 50-Ω, 60-Ω, 75-Ω and 150-Ω positions, use a coaxial cable as patch cord between the Type SRB and the load. If the characteristic impedance of the cable equals the output impedance selected on the Type SRB the voltage at the cable end is determined by the EMF set on the Type SRB according to the formula given in section 4.5, even for fairly great cable lengths and higher frequencies. Only if at the same time the cable is very long, the frequency very high and the Type SRB operated with the highest EMF setting (3 v), the EMF indication may, without readjustment, vary with frequency by a greater amount than would correspond to the frequency response if the terminating impedance of the cable differs considerably from its characteristic impedance. If, however, the terminating impedance of the cable equals its characteristic impedance the source impedance selected on the Type SRB is of no importance for the frequency response. The cable attenuation must be taken into account if the cable is very long. It remains below 0.1 db at frequencies below 1 Mc for conventional cables up to 10 m in length with diameters of the inner conductor of 0.6 mm or more.

In the 600-Ω position of the source impedance switch the limit frequency is reached at 1 Mc with a load capacitance of 260 pf, as can be seen from the reactance chart, and only 70% of the voltage that would be present without the capacitive load is applied to the load. When high frequencies are used and the source impedance switch is in the 600-Ω position, the input circuit of the load should therefore present low capacitance, especially under open-circuit conditions, i.e. with a load of very high impedance. In this case single-wire patch cords without closely adjacent metal bodies are preferably used. A single-wire cable of 1 m length has a capacitance of about 10 pf, in contrast with 100 pf for 50-Ω cables, 84 pf for 60-Ω cables and 68 pf for 75-Ω cables (with solid insulation, $\varepsilon = 2.3$).

The output socket ⑦ is suitable for coaxial plugs of the R&S Stock No. FS 413/11 or FS 413/12. For the connection of other types of plugs see section 6.4.

4.3 Setting the Output Voltage

The voltage available at the output socket ⑦ can be varied with two knobs. The step switch ⑥ covers the range of from 1 mv to 3 v in eight 10-db steps and has a ninth step for 30 v. The OUTPUT VOLTAGE knob ⑧ fills in between the steps.

4.3.1 Voltage-divider Position 30 V

In this position the output socket presents an impedance of 20 to 50 Ω. Both the voltage divider and the source-impedance switch ② are ineffective. Depending on the position of the control ⑧ a voltage up to 30 v is available. The built-in voltmeter directly indicates the voltage present at the output. Take the reading at the scale calibrated 0 to 3 v. Multiply the scale readings by the factor 10.

4.3.2 Voltage-divider Positions +10 DB/3 V to -60 DB/1 MV

The voltage-divider provided in the output permits the setting of small output voltages such as required for measurements on amplifiers. The output voltage is adjustable in eight 10-db steps from +10 db to -60 db with 6 Knob ⑧ serves again for the continuous adjustment. The voltages indicated at the voltage divider hold for the 50-Ω, 60-Ω and 75-Ω positions of the source impedance switch. In the 150-Ω position the output voltage is +10 db higher, in the 600-Ω position +20 db higher. (See also section 4.4).

4.3.3 Output Voltages below 100 µv

R 8366
363
Bl. 9

The lower limit of output voltage that can readily be set on the Type SRB is about 100 µv. If still smaller output voltages are required the use of a standard attenuator is recommended. Attenuation of 0 to 100 or 130 db is possible, depending on the type used. Suitable standard attenuators made by Rohde & Schwarz are listed below. Connect the standard attenuator between the oscillator and the load. All models except BN 18014 are provided with Dezifix B connectors; if standard attenuators are to be used frequently it is advisable to adapt the output socket of the oscillator, which is an RF socket 4/13 DIN 47284, to the Dezifix B system (see section 6.4 "Adaptation to Other Connector Systems").

R&S Standard Attenuators

Type	Char. impedance	Frequency range	Attenuation	Order Number
DPR	60 Ω	0 - 30 Mc	0 - 130 db	BN 18014/60
DPR	75 Ω	0 - 30 Mc	0 - 130 db	BN 18014/75
DPR	50 Ω	0 - 300 Mc	0 - 100 db	BN 18042/50
DPR	60 Ω	0 - 300 Mc	0 - 100 db	BN 18042/60
DPR	75 Ω	0 - 300 Mc	0 - 100 db	BN 18042/75
DPU	50 Ω	0 - 1500 Mc	0 - 110 db	BN 18043/50
DPU	60 Ω	0 - 1500 Mc	0 - 110 db	BN 18043/60
DPU	75 Ω	0 - 1500 Mc	0 - 110 db	BN 18043/75
DPU	50 Ω	0 - 3000 Mc	0 - 109 db	BN 18044/50
DPU	60 Ω	0 - 3000 Mc	0 - 109 db	BN 18044/60

4.3.4 Obtaining Extremely Low Voltages

The problem of obtaining an extremely small defined voltage at the load regards not only the attenuation in the signal generator or attenuator but also the connection of signal generator and load (receiver). Unsuitable patch cords between signal generator and load or inappropriate earthing of the instruments may cause a spurious voltage at the input of the load, which may under certain circumstances be much greater than the signal voltage. Broadband loads are particularly susceptible to disturbance if, for example, they amplify a hum voltage originating from the AC supply in the same way as a signal voltage of higher frequency.

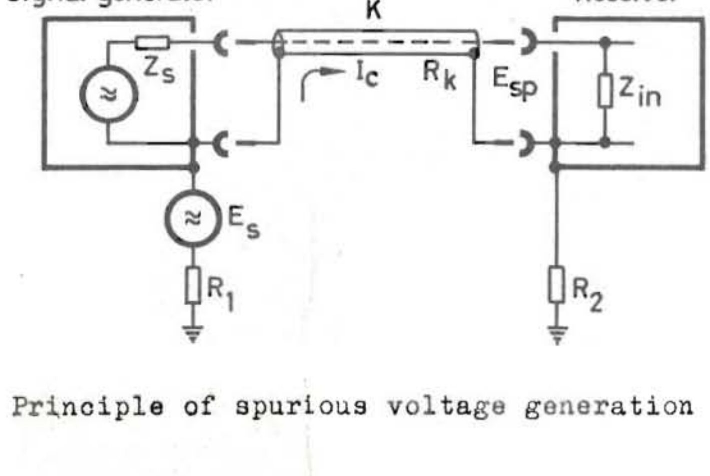


Fig. 2. Principle of spurious voltage generation

The generation of a spurious voltage is shown in Fig. 2. A spurious voltage may become effective at the receiver input when a spurious current I_k flows through the outer conductor of the coaxial cable K causing a voltage drop $E_{sp} = I_k R_k$ across the resistance R_k of this outer conductor. The source E_s of this current may be in either of the lines by which the instruments are taken to earth. Thus a circuit is formed via R_1, R_k and R_2. The spurious voltage resulting at the receiver input

$$E_{sp} = I_k R_k = E_s \frac{R_k}{R_1 + R_2 + R_k}$$

will be the smaller, the lower the cable resistance and the greater the resistances of the two earth conductors. The input impedance of the receiver is here assumed to be great as compared to the source impedance of the signal generator. If the impedances are equal, the spurious voltage reduces to half this value. The resistances of the earth conductors cannot, of course, be made arbitrarily high to reduce the spurious current if these earth conductors are to fulfil their purpose. On the other hand, the resistance of the cable outer conductor can be made as low as possible. It consists of the contact resistances of the two connections and the resistance of the cable sheathing. At low frequencies the resistance R_k equals the DC resistance of the three partial resistances connector-sheathing-connector, whereas at high frequencies the skin effect and other effects have an appreciable influence as a result of which the resistance R_k may be considerably higher than the resistance measured at DC. (Cables with connectors presenting a very low resistance R_k are available from Rohde & Schwarz.)

In the load itself a leakage resistance may be present and cause a spurious voltage at the grid of the first amplifier. The leakage resistance is the smaller the lower the inductance of the connection between the outer conductor of the coaxial input socket and the chassis point of the input valve. The spurious voltage is a minimum if the sheathing of the coaxial input socket is connected directly, without an intermediate line section, to a chassis that encloses the complete input stage or the complete receiver (shielding).

An annoying source of spurious voltage often encountered at low frequencies is the voltage drop between the earth wires of the two power cords, as shown in Fig. 3. This voltage drop may be particularly high if one of the two supply phases serves at the same time as earth wire and a line of some length is between the two wall sockets with earthing contacts. The voltage drop E_s between the two connecting points A and B of the earth wires may be caused in this case not only by the power consumption of the generator but also by other loads connected to the same line after the generator. If the earth wire were disconnected the circuit $R_1 - R_k - R_2 - B - A$ would be interrupted and consequently no voltage drop would exist across the outer conductor of the cable K. This, however, is not advisable for reasons of safety, since in the case of a short-circuit between the power cord and chassis the full AC supply voltage would exist between chassis and earth and constitute a danger for the operator. Moreover, this method cannot sufficiently reduce the spurious voltage, since usually a capacitance exists in the receiver between the power cord and chassis, replacing, at least partially, the resistance R_2 of the earth wire.

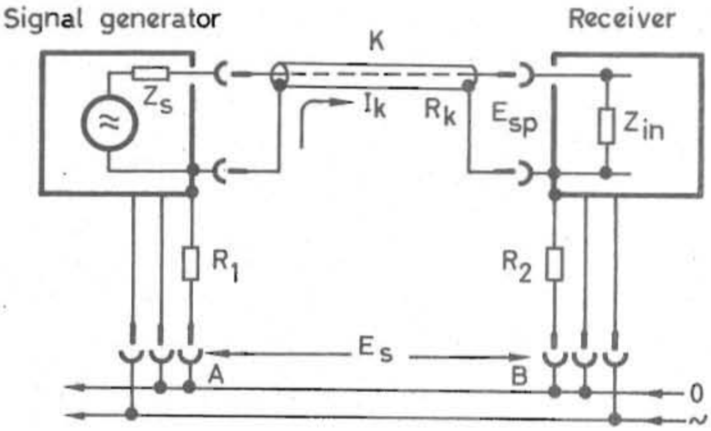


Fig. 3. Generation of a spurious voltage when a voltage drop exists between the connecting points A and B of the earth wires.

The best way of suppressing the spurious voltage resulting from the AC supply is to put the power plugs of the generator and of the receiver into a double wall socket, as shown in Fig. 4. When no power line is present between the two plugs the source of spurious voltages disappears.

R 8366
363
Bl. 12

The electromagnetic field of a nearby power transformer, inducing a voltage in one or the other cable, may have the same effect as the spurious voltage source E_{sp} shown in Fig. 2.

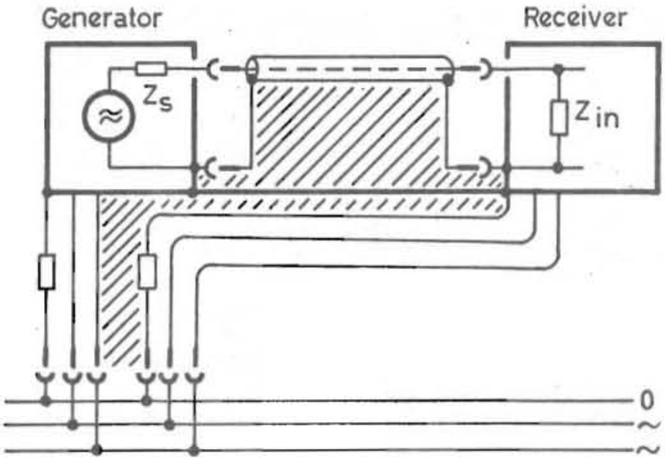


Fig. 4. Reducing the spurious voltage by suitable running of the lines.

This influence can be reduced by leading a low-impedance connection together with the patch cord between the chassis of the receiver and the case of the generator, as shown in Fig. 4. Moreover, the power cords of the generator and of the receiver can be located in such a way that the hatched area of Fig. 4 is as small as possible. Thus not only AF but also RF spurious voltages can be compensated for.

4.3.5 Generation of Balanced Output Voltages

For generating balanced or floating voltages the Type SRB must be followed by a transformer suitable for the frequency range. The frequency range of a transformer is limited toward both the low and the high frequencies. If a transformer is used for measurements near the limit frequencies the voltage drop should be taken into account in these regions. The frequency response of the R&S Balanced General-Purpose Transformer Type TAN BN 96900 in the arrangement of Fig. 5 is shown in Fig. 6. The arrangement has been established experimentally, the aim being a low distortion factor and a frequency curve avoiding transformer self-resonance at high frequencies. The additional iron distortion is kept low by the use of the 50-Ω output of the Type SRB; the 1.25-kΩ resistor R_1 damps the natural resonance of the Transformer Type TAN at high frequencies. The output of the transformer is designed for a 600-Ω load. With the transformation ratio of 1 : 1 the open-circuit output of the transformer equals the voltage setting of the Type SRB minus the voltage drop at the source impedance of the Type SRB and the transformer of 0.7 db (0.92 times the open-circuit output of the Type SRB). Half of this voltage exists from one connection point to chassis. Take care to use the correct terminals (4, 6, 8) of the Type TAN (see Fig. 5).

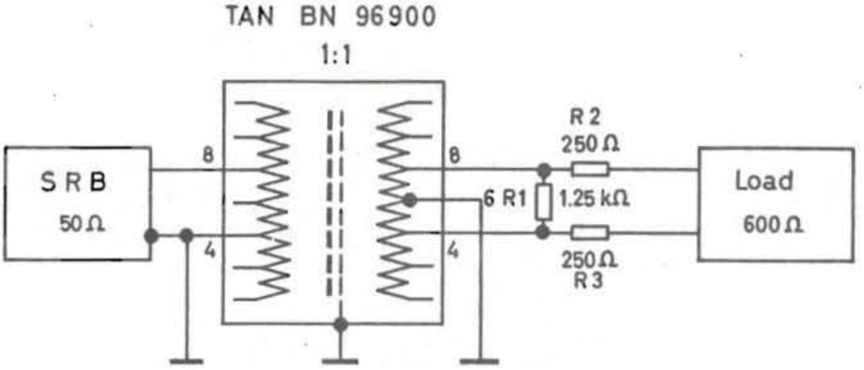


Fig. 5. Generation of a balanced output voltage using the Balanced General-Purpose Transformer Type TAN

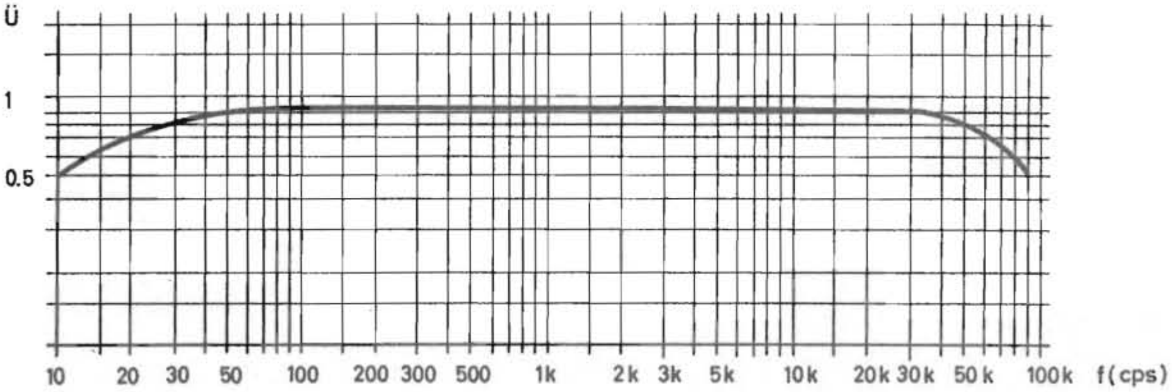


Fig. 6. Frequency response of the open-circuit output voltage (Z_s = 600 Ω) for the arrangement of Fig. 5

4.4 Switching the Source Impedance

The switch ② permits a source impedance of 50 Ω, 60 Ω, 75 Ω, 150 Ω or 600 Ω to be selected. The source impedance is independent of the selected voltage-divider step, apart from the 30-v range, where the source-impedance switch is ineffective (see section 4.3.1). The accuracy of the source-impedance steps is ±1%; the capacitance is constant and amounts to about 40 pf. Note that in the 150-Ω and 600-Ω positions the output voltage is increased respectively by +10 db and +20 db (see section 4.6 "Reading").

4.5 Open-circuit Output - Load Impedance

The meter ③ indicates the open-circuit output voltage. With a finite load impedance Z_l the voltage division caused by Z_s and Z_l should be taken into account. The voltage across the load is

$$E_2 = E_1 \frac{Z_l}{Z_l + Z_s}$$

(E_1 = open-circuit voltage, E_2 = voltage at Z_l) and, for a desired voltage E_2, the open-circuit voltage is

$$E_1 = E_2 \frac{Z_s + Z_l}{Z_s}$$

Often it is advantageous to terminate the signal generator with its source impedance. The voltage at the load is then half the voltage setting or, in other words, 6 db smaller than the setting.

4.6 Reading

Read on the scale divided 0 to 10 in the voltage-divider steps 1 mv/-60 db, 10 mv/-40 db, 0.1 v/-20 db and 1 v/0 db and on the scale divided 0 to 3 in the voltage-divider steps 3 mv/-50 db, 30 mv/-30 db, 0.3 v/-10 db and 3 v/+10 db. To determine the output level take the reading on the scale calibrated -20 to +2 db. The open-circuit output level is the sum of switch position and scale reading, for example:

+10 db and -1 db = +9 db
0 db and 0 db = 0 db = 0.775 v
-20 db and +2 db = -18 db
-60 db and -10 db = -70 db.

This holds only for the positions of 50 Ω, 60 Ω and 75 Ω source impedance. In the positions 150 Ω and 600 Ω of the switch ② the output voltage ranges change because of a different output circuit. In the 150-Ω position +10 db and in the 600-Ω position +20 db must be added to the above open-circuit level.

4.7 Calculating the Power Consumption of the Load in dbm

Since slight mismatch of the load with respect to the voltage source has only a very slight influence on the power consumption, as is shown by the curve of Fig. 7, it is often advantageous to indicate the output in dbm (reference level 1 mw consumption of the load). The power drop between the commonly used systems of 50 Ω, 60 Ω and 75 Ω is in most cases negligible. If the power consumption of the load is to be determined in dbm, set the source impedance of the Type SRB to the value of the load impedance and read the output voltage in db. The power consumption of the load is then

Load	dbm reading (incl. setting of Z_s switch)	dbm reading (without setting of Z_s switch)
50 Ω	+4.7 dbm	+4.7 dbm
60 Ω	+4 dbm	+4 dbm
75 Ω	+3 dbm	+3 dbm
150 Ω	+0 dbm	+10 dbm
600 Ω	-6 dbm	+14 dbm

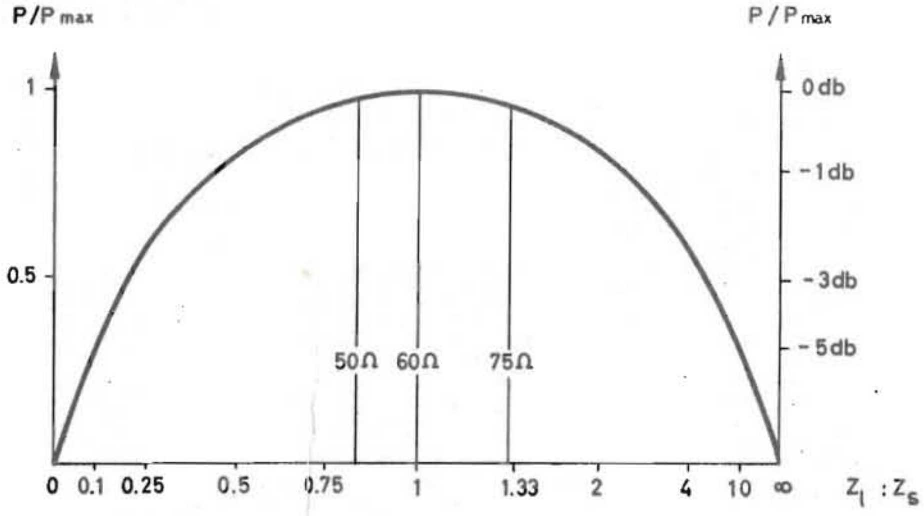


Fig. 7. Active power under mismatch condition

4.8 Conversion to Other db Voltage Levels

Apart from the voltage level $db_{(0.775\ v)}$ the levels db_v and $db_{\mu v}$ are used. The open-circuit voltage reading on the Type SRB can readily be converted to these levels by referring to the following table:

Value in	= Value in		
	$db_{\mu v}$	$db_{(0.775\ v)}$	db_v
$db_{\mu v}$		+117.8	+120
$db_{(0.775\ v)}$	-117.8		+2.2
db_v	-120	-2.2	

4.9 Obtaining Extremely Low Output Distortion

Although the distortion factor of the Type SRB is relatively low in all uses its effective magnitude depends on the type of operation. When trying to obtain the lowest possible distortion, you should bear in mind that with a smaller output amplitude and a higher load impedance of the output stage the distortion factor of the instrument can be brought down to the distortion factor of the oscillator. In this case it is advantageous to take either or both of the following measures:

1. Do not fully advance the continuous voltage control ⑧ ; for example, to obtain 10 mv open circuit set the voltage divider switch ⑥ to 30 mv instead of 10 mv and back off the continuous control ⑧ correspondingly.
2. To reduce the loading of the output stage do not use the 3-v position of switch ⑥ . When the 30-v position is used the load impedance should not be less than 1200 Ω.

This does not involve any restriction to the voltage range. If, for example, an open-circuit output of 3 v is required, the 1-v position and $Z_s = 150\ \Omega$ can be selected instead of the 3-v position together with $Z_s = 50\ \Omega$.

As long as the 3-v position is avoided and a load exceeding 1200 Ω is used, the small distortion factors specified in section 1. are maintained.

4.10 Using the Type SRB as a Bridge Generator

When non-linear circuit elements are measured with a bridge, errors may occur, even if selective indicating amplifiers are used, whenever the signal generator used presents too great a distortion factor. Since overdriving of the Type SRB, resulting in excessive distortion, is possible only in the 30-v position and with output loads of less than 600 Ω, high open-circuit outputs up to 30 v, if permissible at all for the bridge measurement, should be obtained in the 3-v position and with Z_s = 600 Ω. In this and all lower EMF positions loading up to short-circuit is possible without overdriving the output stage.

4.11 The Standard Frequencies of the 1st 1/3-octave Scale and 2nd 1/3-octave Scale

The dial ① is provided with an inner circle marked 1st 1/3-octave scale and 2nd 1/3-octave scale. Since this is a novel feature its application shall be explained in some detail.

Measurements in the fields of acoustics and electroacoustics are more readily comparable if frequency-dependent magnitudes are always measured at the same frequencies. This has not been done up to now although no physical reason objects to it.

In measurements of spectra often logarithmic frequency scales or geometrical frequency ratios are used, as for example in 1/3-octave filters, the centre frequency of which is spaced 1/6 octave from the cutoff frequency. Since three 1/3-octaves make an octave it is possible to cover all cutoff and centre frequencies of 1/3-octave and octave filters with the frequencies listed in the table of Fig. 8. Since often two sets of filters differing by half a 1/3-octave or octave are used to permit the transition region to be measured, one set of filters will replace the cutoff frequencies by the centre frequencies and vice versa. Thus all centre and cutoff frequencies of 1/3-octave and octave filters are values of the above-mentioned table. The same series of figures may be retained through several decades with an error of less than 0.8%. Since 1000 cps is the usual centre

R 8366
363
Bl. 18

1st 1/3-oct. scale	31.5		40		50		63		80		100		125		160		200		250	
2nd 1/3-oct. scale		35.5		45		56		71		90		112		140		180		224		280
1st octave scale	31.5						63						125						250	
2nd octave scale				45						90						180				
1st 1/3-oct. scale	315		400		500		630		800		1000		1250		1600		2000		2500	
2nd 1/3-oct. scale		355		450		560		710		900		1120		1400		1800		2240		2800
1st octave scale					500						1000						2000			
2nd octave scale		355						710						1400						2800
1st 1/3-oct. scale	3150		4000		5000		6300		8000		10000		12500		16000					
2nd 1/3-oct. scale		3550		4500		5600		7100		9000		11200		14000						
1st octave scale			4000						8000						16000					
2nd octave scale						5600						11200								

Fig. 8. Frequencies of the 1/3-octave and octave scales

frequency, the series is based on this value. The series of figures used corresponds to the German standard DIN 323. This series includes departures up to 1.22% from the accurate values but avoids a great number of irrational figures.

The inscriptions of the 1/3-octave scale give the value "log f" instead of the frequency to transform the logarithmic relationship of the standard frequency series into a linear numerical relationship and to facilitate the series of measurements. The ranges of the frequency switch ⑩ are marked additionally log f 1 to 5 and the 1/3-octave scale is provided with the inscriptions 0 to 1.0. The following table gives the relationship. The log f setting is the sum of the log f of the range and the log f of the 1/3-octave scale.

<u>Example</u>

Required log f = 2.4
Range switch at log f   2. (100-1000 cps)
1/3-octave scale at   .4
log f = 2.4 = 250 cps

Relationship between f and log f

1st 1/3-octave scale				2nd 1/3-octave scale			
log f	cps	log f	cps	log f	cps	log f	cps
1.0	10	3.6	4,000	1.05	11.2	3.55	3,550
1.1	12.5	3.7	5,000	1.15	14	3.65	4,500
1.2	16	3.8	6,300	1.25	18	3.75	5,600
1.3	20	3.9	8,000	1.35	22.4	3.85	7,100
1.4	25	4.0	10,000	1.45	28	3.95	9,000
1.5	31.5	4.1	12,500	1.55	35.5	4.05	11,200
1.6	40	4.2	16,000	1.65	45	4.15	14,000
1.7	50	4.3	20,000	1.75	56	4.25	18,000
1.8	63	4.4	25,000	1.85	71	4.35	22,400
1.9	80	4.5	31,500	1.95	90	4.45	28,000
2.0	100	4.6	40,000	2.05	112	4.55	35,500
2.1	125	4.7	50,000	2.15	140	4.65	45,000
2.2	160	4.8	63,000	2.25	180	4.75	56,000
2.3	200	4.9	80,000	2.35	224	4.85	71,000
2.4	250	5.0	100,000	2.45	280	4.95	90,000
2.5	315	5.1	125,000	2.55	355	5.05	112,000
2.6	400	5.2	160,000	2.65	450	5.15	140,000
2.7	500	5.3	200,000	2.75	560	5.25	180,000
2.8	630	5.4	250,000	2.85	710	5.35	224,000
2.9	800	5.5	315,000	2.95	900	5.45	280,000
3.0	1,000	5.6	400,000	3.05	1,120	5.55	355,000
3.1	1,250	5.7	500,000	3.15	1,400	5.65	450,000
3.2	1,600	5.8	630,000	3.25	1,800	5.75	560,000
3.3	2,000	5.9	800,000	3.35	2,240	5.85	710,000
3.4	2,500	6.0	1,000,000	3.45	2.800	5.95	900,000
3.5	3,150						

1st octave scale				2nd octave scale			
log f	cps	log f	cps	log f	cps	log f	cps
1.2	16	3.9	8,000	1.05	11.2	3.75	5,600
1.5	31.5	4.2	16,000	1.35	22.4	4.05	11,200
1.8	63	4.5	31,500	1.65	45	4.35	22,400
2.1	125	4.8	63,000	1.95	90	4.65	45,000
2.4	250	5.1	125,000	2.25	180	4.95	90,000
2.7	500	5.4	250,000	2.55	355	5.25	180,000
3.0	1,000	5.7	500,000	2.85	710	5.55	355,000
3.3	2,000	6.0	1,000,000	3.15	1,400	5.85	710,000
3.6	4,000			3.45	2,800		

R 8366
363
Bl. 20

Up to now it was necessary to establish a table of the frequencies at which measurements had to be made if an unskilled worker was to carry out a series of measurements. By referring to the 1/3-octave scales it is now possible to have measured, e.g., the complete 1st series of 1/3 octaves from log f 1.3 to log f 4.2. In our example, this would cover the frequencies from 20 cps to 16 kc in 1/3 octaves. Or, e.g., every third 1/3 octave from log f 1.2 to log f 4.2 would cover the frequencies from 16 cps to 16 kc in octaves. In all cases the reference frequency of 1000 cps (log f 3.0) is included.

Since the log f is the linear expression of a logarithmic series, graph paper with millimetre squares can be used for the representation of a series of measurements. If the db calibration of the voltmeter is used for the voltage levels, one obtains the same representation as with exponential graph paper, which has the drawback of having a non-linear division making the recording more difficult especially if the measurement steps follow a geometrical series.

5. Description

5.1 General

The RC Oscillator Type SRB consists of the following electrical groups:

RC oscillator section
Amplifier
Voltmeter
Output voltage divider
Power section

5.2 RC Oscillator Section

The simplified diagram of the RC oscillator section, covering the frequency range of 10 cps to 1 Mc in 5 bands, is shown in Fig. 9. The reference numbers of the circuit components are identical with those indicated in the circuit diagram.

The RC oscillator section consists of the two-stage amplifier Rö1-Rö2, an auxiliary transistor T1 and the tunable section comprising the resistors R1 to R6, R7 to R12, the ganged capacitor C1I-C1II and the capacitors C2 to C9 (see circuit diagram). This section constitutes a frequency-dependent phase-shifting voltage divider determining the frequency that is excited with the aid of the amplifier. Always that frequency is excited at which

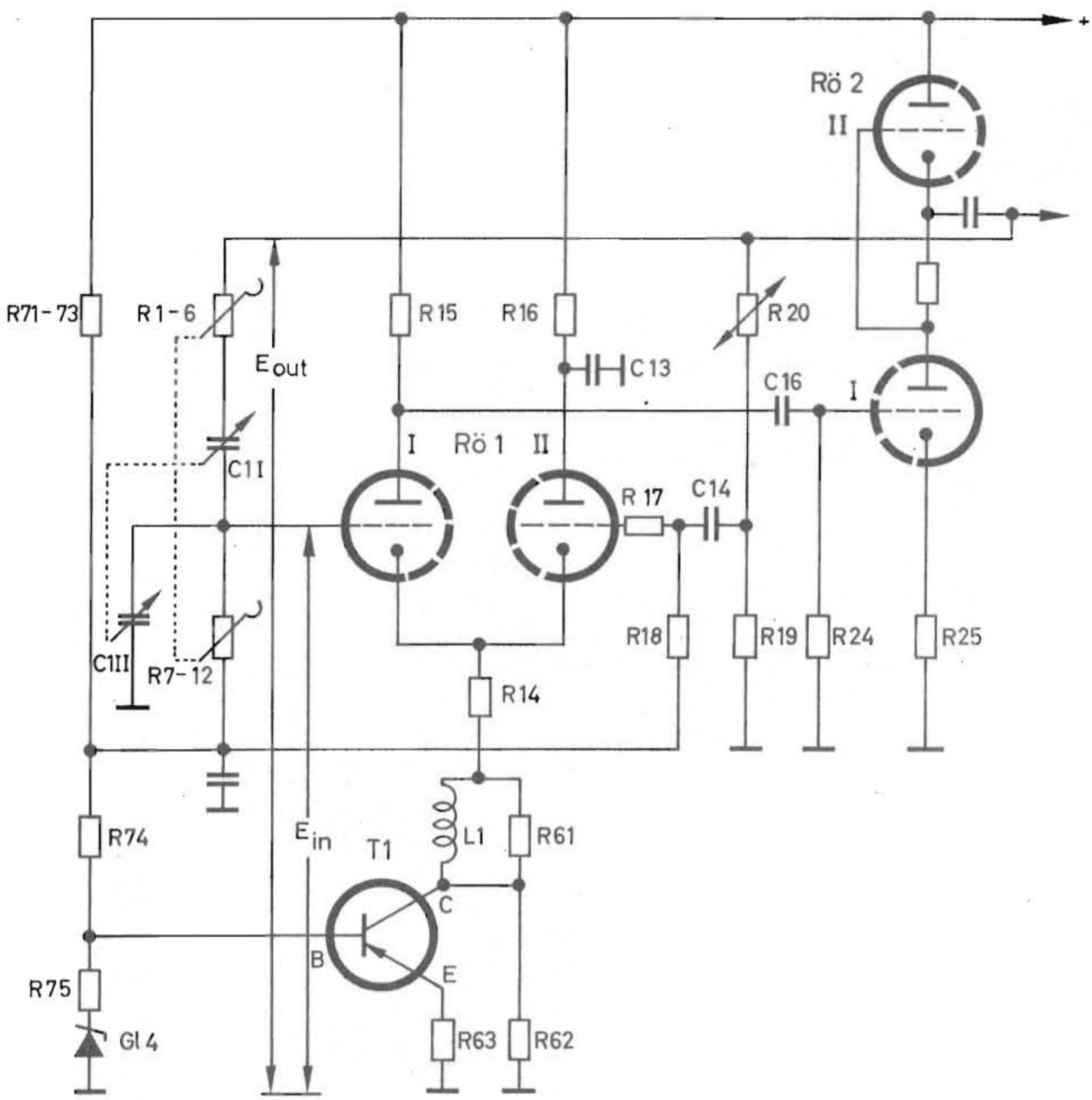


Fig. 9. Simplified diagram of the RC oscillator section

the input voltage E_{in} and the output voltage E_{out} of the amplifier have the same phase. The two halves of the double triode Rö1 (ECC 81) together form the first stage of the two-stage RC oscillator section. The tunable section drives the grid of Rö1I and is fed from the second stage, Rö2 (E 88 CC). The two resistors R19-R20, the latter being a thermistor, provide for heavy negative feedback, which is dependent on the amplitude and limits and stabilizes the amplitude of the excited oscillation.

R 8366
363
Bl. 22

The thermistor R20 in the feedback path keeps the amplitude at a constant value by automatic variation of the feedback factor, i.e. the voltage divider ratio R19/R20. The voltage divider ratio is such that the two valves

Rö1 and Rö2 under the normal feedback condition accomplish just as much gain as is necessary to maintain the oscillations.

If for any reason the voltage E_{out} increases, the current through R19-R20 increases and the resistance of the thermistor decreases because of the development of additional heat. As a result, the gain decreases, because of the increased feedback factor, so much that the amplitude of oscillation returns to its normal value.

To obtain the lowest possible distortion factor it is advisable to make the negative feedback as heavy as possible. The degree of feedback has, however, its natural limitations. Applying the feedback to the cathode, as is customary, not only reduces the external gain due to the intended feedback but also the internal gain due to unwanted cathode feedback. Even with valves of maximum transconductance there are limits to the negative feedback and consequently to the reduction of distortion due to a reduced internal gain.

The circuit developed for the Type SRB is free from this drawback. It is thus possible to obtain a very low distortion factor, high stability, flat frequency response and low source impedance by means of heavy negative feedback as a result of high internal gain. The feedback is effective via C14 and R17 at the grid of the valve section Rö1II and not at the cathode of the oscillator valve, as usual. The cathodes of Rö1I and Rö1II are connected with each other and are taken to zero potential via the collector-emitter path of transistor T1. The base of the transistor is connected to a DC voltage partially stabilized by Gl4 for stabilization of the operating point of Rö1.

R 8366
363
Bl. 23

The higher internal gain of the input stage of the oscillator is based on the fact that in the cathode circuit of the input valve Rö1I only the cathode input impedance of the feedback valve Rö1II is substantially effective. With the valve sections Rö1I and Rö1II identical and adjusted for the same operating point, the gain of Rö1I is reduced to only half the ordinary value by internal negative feedback. Since the cathodes are connected Rö1I and Rö1II are in series for AC and the feedback applied to Rö1II has the same effect as though it were applied to the input valve Rö1I. Experience and calculation show that this design requires a very high-valued cathode resistor in order to reduce the distortion factor most effectively. An ohmic resistor of high value is not suitable since it would require extremely high operating voltages. For this reason use is made of the transistor T1, whose collector-emitter path functions as cathode resistor of high differential value. Resistor R14 in the emitter circuit provides for a stable and sufficient grid swing. The choke L1 increases the effective cathode resistance of Rö1 at high frequencies, where the transistor output impedance decreases. The resistors R61 and R62 damp the series resonance between the inductance of L1 and the collector output capacitance of T1. This prevents a deterioration of the amplifier performance in the range of the resonant frequency. Transistor T1 is operated in a grounded-base circuit to obtain a high collector output impedance. A partially stabilized voltage is impressed via low resistance to the base of the transistor by means of the Zener diode Gl4 and a constant current is impressed on the emitter via resistor R63. The sum of the currents of Rö1I and Rö1II is thus kept constant; fluctuations of operating voltage and aging remain without influence. Moreover, the gain and negative feedback of Rö1 are stabilized thereby. Thus the amplifier arrangement used here gives better performance with an unstabilized feed voltage taken from the AC supply than is obtained with conventional heater and anode-supply stabilized amplifiers, since the influences of valve aging are also eliminated. The partial stabilization of the transistor base, achieved by connecting the Zener diode, instead of directly, via the resistor R75 to the base of transistor T1, has been chosen for a special reason. If the anode supply voltage fluctuates, and even if the heater voltage fluctuates at the same time, the sum current of Rö1I and Rö1II is regulated just so much that the variation of the gain of these valves including the variation of direct capacitance caused by the voltage fluctuation compensates for the variation in gain of the subsequent stage Rö2. In this way very high frequency stability is ensured.

In the circuit arrangement shown in Fig. 9, the Zener diode is fed via the resistors R71 to R74 and R75, at which the grid bias for Rö1I and Rö1II is tapped. These valves should have, as far as possible, equal control characteristics. For this reason Rö1II, which is not used for driving the following stages, is provided with an anode load resistor R16 equal to that of Rö1I (R15). Rö1II is also provided with a capacitor, C13, which is, however, greater than C16 at the anode of Rö1I, to obtain smaller distortion factors and frequency responses at high frequencies than would be possible with full symmetry of the anode circuits.

The double triode Rö2 (E 88 CC) forms the second stage of the RC oscillator section. Because of the wide frequency range, 10 cps to 1 Mc, this stage must meet very stringent requirements. The use of a choke for coupling would be objectionable since it would result in an insufficient frequency response at the lowest and highest frequencies. Moreover, phase differences would restrict the desired heavy feedback. The circuit of Rö2 is therefore designed to form an ironless power stage permitting the transmission of a wider frequency band with flatter frequency response. The two valve sections Rö2I and Rö2II are in series for direct current. Each section draws about half of the total anode supply voltage. The AC voltage is applied to the control grid of Rö2I. The grid of Rö2II is controlled by the voltage drop of Rö2I. Since Rö2I effects a phase rotation by 180°, the power stages are driven in phase opposition without the additional use of a phase inverter. The valve has its own heater winding 9/10 at the power transformer Tr1 to avoid that the maximum permissible voltage filament/cathode of Rö2 is exceeded. The voltage divider R83-R84 in the anode supply voltage increases the potential of this heater winding to chassis by about 45 v. The AC output voltage of the second oscillator stage is applied to the output control R29, coupled via C18. The variable resistor R28 serves to adjust the maximum output voltage which can be obtained in the maximum position of R29.

5.3 Amplifier

The output voltage control R29 is followed by a two-stage amplifier using the valves Rö3, Rö4 and Rö5. The design of the amplifier is very similar to that of the two stages of the RC oscillator. The circuit diagram shows immediately that the basic circuits of Rö1 and Rö3 are of the same type. What has been said in section 5.2 for the functioning and required quality of Rö1 also holds to a great extent for Rö3. The differences are described in the following. The base of T2 is fully stabilized while the base of T1 is only partially stabilized by the series arrangement of G14 and R75. The negative feedback applied to the grid of a second valve section, Rö3I, comprises a normal resistor, R42, instead of a thermistor. The capacitor C26, in parallel with R42, is a trimmer, which permits the feedback to be corrected in the range of the maximum frequency of 1 Mc. In contrast with Rö1, only Rö3II is provided with a filter section R81-C45I for the anode supply voltage. This method provides for better decoupling than if the anode of Rö3I were also provided with an additional filter section. Ample dimensioning of C45I and C45II ensures good protection against short-term AC supply voltage fluctuations.

The power stage is formed by the valves Rö4 and Rö5. Like Rö2, it functions as a series arrangement for DC and as a push-pull parallel arrangement of two valves for AC, but uses two power pentodes EL 86. The functioning is the same as for Rö2. The decoupling of the cathode of Rö4 and of the screen grids of both valves is amply dimensioned.

5.4 Voltage Indication

The output voltage in the 30-v range or the open-circuit output voltage (input to the voltage divider) in the other ranges is measured with the moving-coil ammeter I1 together with the diode rectifier as voltage doubler. The simplified diagram of the indicator section is shown in Fig. 11.

This diode voltmeter measures the peak-to-peak voltage. Its scale is, however, calibrated in rms values. The time constant of the rectifier circuit is kept small to ensure quick response of the pointer of the meter. The error of indication resulting at low frequencies is compensated by a frequency-dependent division of the voltmeter input voltage by means of R53-R54-R55-C35. At higher frequencies the input impedance of the rectifier decreases because of the inherent capacitance so that the indication becomes too low. The section R53-C33-C34 compensates for this effect. The voltage indication is adjusted at three points. The variable resistor R57 is used to adjust for constant output voltage indication at 10 cps, R55 at 1 kc and C34 at 1 Mc. Thus very high accuracy of indication is ensured, the frequency response being flat within 0.1 db. The voltage doubler used is

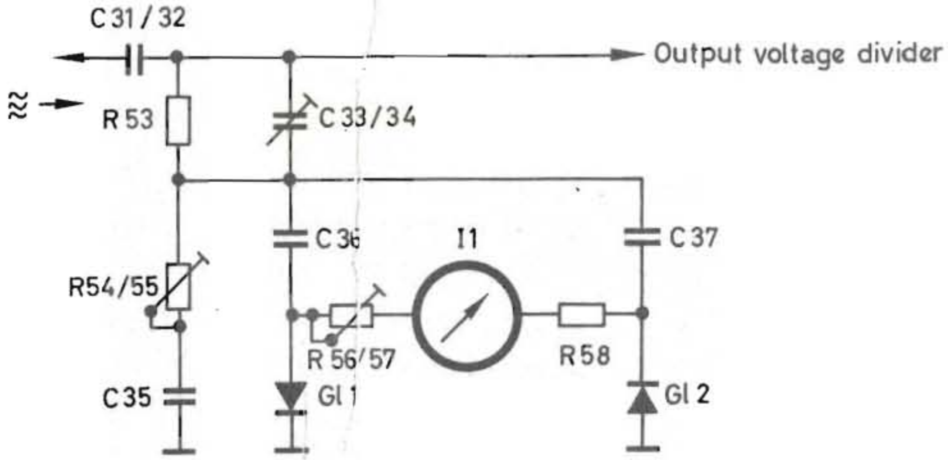


Fig. 10. Simplified diagram of the voltmeter

so designed that the even harmonics of the test frequency do not cause errors of indication with the rms calibration. Being a peak-responsive rectifier, the arrangement has the advantage over average-responsive rectifiers that the temperature coefficient remains negligible and that the pointer does not yet vibrate at 10 cps with the full-wave rectification used.

5.5 Output Voltage Divider

The potentiometer R29 at the input of the AF amplifier permits continuous control of the output voltage present across the output socket. The control effected at this point offers the advantage that with decreasing amplifier drive the distortion factor also decreases. In the 3-v range of switch S2 the resistor R97 is connected in series and in the 1-v and lower ranges the attenuator is in circuit. The self-regulating varistors R91 and R92 prevent damage to the meter rectifiers Gl1 and Gl2 by short voltage peaks resulting from switching over. Switch S3 permits selection of the source impedance of 50, 60, 75, 150 or 600 Ω. In the 30-v position of the range switch of the output voltage the voltage is directly applied to the output socket Bu1, avoiding the output attenuator. The source impedance in this position is between 20 and 50 Ω; both the output attenuator and the source impedance switch are ineffective. The voltage is directly adjustable between 0 and 30 v with R29. The maximum output power is 1.5 w; the output is free from DC voltage. The complete attenuator is shielded and divided into separated compartments. Stray voltages between the compartments are carefully avoided.

5.6 Power Section

The power section is of conventional design. Electronic regulation of the anode supply voltage is unnecessary because of the special circuit arrangement. The power transformer Tr1 is designed for 115, 125, 220 and 235 v. The fuse Si1 serves for the voltage selection. The glow lamp Rl1 lights when the set is switched on. Four silicon rectifiers Gl6 to Gl9 in a bridge circuit form the anode supply voltage rectifier, which is followed by the filter chain C46I-L4-C46II. Rö5 has its own heater winding 11/12. The valves Rö1, Rö3 and Rö4 are heated in common; R85 permits compensation for hum voltages, which would be disturbing mainly by beats resulting when the oscillator is tuned in the close vicinity of 50 cps. The heater winding 9/10 for Rö2 is brought by R83-R84 to a potential of about 45 v.

6. Valve Replacement, Reconditioning and Adaptation to Other Connector Systems

6.1 Valve Replacement

Any defective valve of the set can simply be replaced by the same type, no calibration being necessary, since the valves Rö1 and Rö3 are stabilized by the circuitry and the functions of Rö2, Rö4 and Rö5 are uncritical. Also the transistors can be replaced without impairing the performance of the set.

6.2 Output Voltage Divider

As indicated in section 4.2, the resistors of the output voltage divider may be damaged if a voltage exceeding 3 v is applied to the output from the load, especially in the 50-Ω position of the source impedance switch. Any defect of the output voltage divider can easily be located with a millivoltmeter. Use a test frequency of 1 dc and connect the millivoltmeter to the output. The input impedance of a millivoltmeter is very high compared with any source impedance of the RC oscillator. Thus it is practically the open-circuit output voltage of the oscillator that is measured and it is seen immediately whether the voltage equals the nominal value of the selected range. Select the different source impedance positions one after the other since their low-valued input resistors are particularly exposed to danger. Note that the voltage ranges are identical only for the impedances of 50, 60 and 75 Ω while they vary by a factor of $\sqrt{10}$ and 10, respectively, for 150 and 600 Ω. If any resistors are defective the measured voltages differ considerably from the nominal value. Should a repair be necessary, we recommend that the voltage divider be turned in to our factory. The repair may be carried out by the customer provided the necessary spare parts and measuring instruments are available. The voltage divider is a self-contained sub-assembly and can readily be removed.

6.3 Removing the Output Voltage Divider

(a) Disconnect the set from AC supply. Remove the four cylinder-head screws on the front panel and withdraw the chassis from the cabinet.

(b) Put the chassis upside down and unsolder the two wire connections leading to the solder lugs at the rear of the divider.

(c) Loosen the grub screw at the knob of the output voltage control and remove knob.

(d) Loosen the four countersunk screws fixing the voltage divider to the front panel and withdraw the voltage divider.

(e) After repair, reinsert the voltage divider proceeding in the reverse order.

6.4 Adaptation to Other Connector Systems

The output voltage socket can be adapted in a simple way to suit other connector systems should this be necessary for the use of the RC Oscillator Type SRB in a test assembly. It is only necessary to insert a suitable screw-in assembly into the thread of the output socket and to secure with the screws of the outer ring.

The connector systems for which screw-in assemblies are available from Rohde & Schwarz are listed in the following table. The R&S Stock-Nos. quoted serve as order numbers.

Desired connector system at the instrument	Order Number of the screw-in assembly
Dezifix B	FMU 10990
4/13 DIN 47283	FID 90990
UHF series	FHD 10990
N series	FHD 20990
C series	FHD 30990
BNC	FHD 40990
874 B	FLA 20990

7. Table of Replaceable Parts

Ref. No.	Designation	Ratings	R&S Stock No.
C1	Capacitor, variable	2xΔC = 518 pf ±13 pf	40851 - 3.1
C2	Trimmer, air	4 to 25 pf	CV 8025
C3	Capacitor, ceramic	18 pf	CCH 31/18
C4	Trimmer, air	4 to 25 pf	CV 8025
C5	Trimmer, air	4 to 25 pf	CV 8025
C6	Trimmer, air	4 to 25 pf	CV 8025
C7	Trimmer, air	4 to 25 pf	CV 8025
C8	Trimmer, air	4 to 25 pf	CV 8025
C9	Capacitor, paper	250,000 pf/250 v	CPK 250 000/250
C10	Capacitor, paper	10,000 pf/250 v	CPK 10 000/250
C13	Capacitor, ceramic	100 pf	CCG 91/100
C14	Capacitor, paper	250,000 pf/250 v	CPK 250 000/250
C15	Capacitor, ceramic	3 pf	CCG 41/3
C16	Capacitor, paper	25,000 pf/400 v	CPK 25 000/400
C17	Capacitor, paper	2500 pf/1000 v	CPK 2500/1000
C18	Capacitor, MP	8 µf/250 v	CMR 8/250
C19	Capacitor, ceramic	10 pf ±0.25 pf	CCH 31/10
C23	Capacitor, paper	250,000 pf/250 v	CPK 250 000/250
C24	Capacitor, ceramic	100 pf	CCG 91/100
C25	Capacitor, synth.foil	220,000 pf/160 v	CKG 54133/220
C26	Trimmer, tubular, ceramic	0.65 to 2.5 pf	CV 7202
C27	Capacitor, paper	250,000 pf/250 v	CPK 250 000/250
C28	Cap. electrolytic	100 µf/35 v	CED 21/100/35
C29	Cap. electrolytic	16 µf/350 v	CED 21/16/350
C30	Cap. electrolytic	16 µf/350 v	CED 21/16/350
C31	Capacitor, MP	32 µf/250 v	CMR 16+16/250 parallel

Ref. No.	Designation	Ratings	R&S Stock No.
C32	Capacitor, MP	32 µf/250 v	CMR 16+16/250 parallel
C33	Capacitor, ceramic	120 pf ±2 %	CCH 68/120
C34	Trimmer, disc	10 to 60 pf	CV 944
C35	Capacitor, MP	1 µf/160 v	CMR 1/160/2
C36	Capacitor, MP	1 µf/160 v	CMR 1/160/2
C37	Capacitor, MP	1 µf/160 v	CMR 1/160/2
C38	Capacitor, ceramic	100 pf	CCH 68/100
C41	Capacitor, paper	10,000 pf/250 v	CPK 10 000/250
C42	Capacitor, paper	50,000 pf/250 v	CPK 50 000/250
C43	Capacitor, paper	100,000 pf/250 v	CPK 100 000/250
C45	Cap., electrolytic	100+100 µf/350 v	CEG 21/100+100/350
C46	Cap., electrolytic	50+50 µf/500 v	CEG 21/50+50/500
G11	Diode, germanium		GK/OA 5
G12	Diode, germanium		GK/OA 5
G14	Diode, Zener		GK/Z 6
G16	Rectifier, silicon		GK/Si 01 M
G17	Rectifier, silicon		GK/Si 01 M
G18	Rectifier, silicon		GK/Si 01 M
G19	Rectifier, silicon		GK/Si 01 M
I1	Meter, moving-coil		INS 20202
K1	Cord, power		LKA 08031
K2	Sleeve, insulating, shielded		LJA 1,5 ge
K3	Sleeve, insulating, shielded		LJA 1,5 ge

Ref. No.	Designation	Ratings	R&S Stock No.
L1	Choke	160 mh ±10 %	40851 - 1.2.6
L2	Choke	160 mh ±10 %	40851 - 1.2.6
L4	Choke	16 h/75 ma	DB 75/2
R1	Resistor, depos.carb.	3 kΩ ±0.5 %/0.5 w	WF 3 k/0,5/0,5
R2	Resistor, depos.carb.	30 kΩ ±0.5 %/0.5 w	WF 30 k/0,5/0,5
R3	Resistor, depos.carb.	300 kΩ ±0.5 %/0.5 w	WF 300 k/0,5/0,5
R4	Resistor, depos.carb.	3 MΩ ±0.5 %/1 w	WFS 3/3 M/0,5/1
R5	Resistor, depos.carb.	15 MΩ ±1 %/1 w	WFS 3/15 M/1/1
R6	Resistor, depos.carb.	15 MΩ ±1 %/1 w	WFS 3/15 M/1/1
R7	Resistor, depos.carb.	3 kΩ ±0.5 %/0.5 w	WF 3 k/0,5/0,5
R8	Resistor, depos.carb.	30 kΩ ±0.5 %/0.5 w	WF 30 k/0,5/0,5
R9	Resistor, depos.carb.	300 kΩ ±0.5 %/0.5 w	WF 300 k/0,5/0,5
R10	Resistor, depos.carb.	3 MΩ ±0.5 %/1 w	WFS 3/3 M/0,5/1
R11	Resistor, depos.carb.	15 MΩ ±1 %/1 w	WFS 3/15 M/1/1
R12	Resistor, depos.carb.	15 MΩ ±1 %/1 w	WFS 3/15 M/1/1
R13	Resistor, depos.carb.	1 MΩ/0.25 w	WF 1 M/0,25
R14	Resistor, depos.carb.	1 kΩ/0.1 w	WF 1 k/0,1
R15	Resistor, depos.carb.	25 kΩ/0.25 w	WF 25 k/0,25
R16	Resistor, depos.carb.	25 kΩ/0.25 w	WF 25 k/0,25
R17	Resistor, depos.carb.	100 Ω/0.1 w	WF 100/0,1
R18	Resistor, depos.carb.	3 MΩ/0.1 w	WF 3 M/0,1
R19	Resistor, depos.carb.	1.25 kΩ/0.25 w	WF 1,25 k/0,25
R20	Thermistor		WHN 635/50 k
R23	Resistor, depos.carb.	100 Ω/0.1 w	WF 100/0,1
R24	Resistor, depos.carb.	1 MΩ/0.1 w	WF 1 M/0,1
R25	Resistor, depos.carb.	300 Ω/0.25 w	WF 300/0,25

R 8366
363
31. 32

Ref. No.	Designation	Ratings	R&S Stock No.
R26	Resistor, depos.carb.	100 Ω/0.1 w	WF 100/0,1
R27	Resistor, depos.carb.	200 Ω/0.1 w	WF 200/0,1
R28	Res., dep.carb., var.	10 kΩ lin.	WS 9122 F/10 k
R29	Res., dep.carb., var.	10 kΩ lin.	WS 7126/10 k
R32	Resistor, depos.carb.	10 kΩ/0.1 w	WF 10 k/0,1
R33	Resistor, depos.carb.	1 MΩ/0.1 w	WF 1 M/0,1
R34	Resistor, depos.carb.	1 kΩ/0.1 w	WF 1 k/0,1
R35	Resistor, depos.carb.	25 kΩ/1 w	WF 25 k/1
R36	Resistor, depos.carb.	25 kΩ/1 w	WF 25 k/1
R37	Resistor, depos.carb.	100 Ω/0.1 w	WF 100/0,1
R38	Resistor, depos.carb.	2 MΩ/0.1 w	WF 2 M/0,1
R41	Resistor, depos.carb.	5 kΩ/0.25 w	WF 5 k/0,25
R42	Resistor, depos.carb.	30 kΩ/1 w	WF 30 k/1
R43	Resistor, depos.carb.	3 MΩ/0.5 w	WF 3 M/0,5
R44	Resistor, depos.carb.	100 Ω/0.1 w	WF 100/0,1
R45	Resistor, depos.carb.	400 kΩ/0.1 w	WF 400 k/0,1
R46	Resistor, wire-wound	400 Ω/4 w	WD 400/4
R47	Resistor, depos.carb.	100 Ω/0.1 w	WF 100/0,1
R48	Resistor, depos.carb.	160 Ω/1 w	WF 160/1
R49	Resistor, depos.carb.	5 kΩ/0.5 w	WF 5 k/0,5
R50	Resistor, depos.carb.	5 kΩ/0.5 w	WF 5 k/0,5
R53	Resistor, depos.carb.	1.6 kΩ/0.1 w	WF 1,6 k/0,1
R54	Resistor, depos.carb.	16 kΩ/0.25 w	WF 16 k/0,25
R55	Res., dep.carb., var.	10 kΩ lin.	WS 9122 F/10 k
R56	Resistor, depos.carb.	800 kΩ/0.5 w	WF 800 k/0,5
R57	Res., dep.carb., var.	250 kΩ lin.	WS 9122 F/250 k
R58	Resistor, depos.carb.	1 MΩ/0.5 w	WF 1 M/0,5

R 8366
363
31. 33

Ref. No.	Designation	Ratings	R&S Stock No.
R61	Resistor, depos.carb.	100 kΩ/0.1 w	WF 100 k/0,1
R62	Resistor, depos.carb.	50 kΩ/0.1 w	WF 50 k/0,1
R63	Resistor, depos.carb.	2.5 kΩ/0.1 w	WF 2,5 k/0,1
R66	Resistor, depos.carb.	100 kΩ/0.1 w	WF 100 k/0,1
R67	Resistor, depos.carb.	100 kΩ/0.1 w	WF 100 k/0,1
R68	Resistor, depos.carb.	800 Ω/0.25 w	WF 800/0,25
R71	Resistor, depos.carb.	80 kΩ/1 w	WF 80 k/1
R72	Resistor, depos.carb.	8 kΩ/0.1 w	WF 8 k/0,1
R73	Resistor, depos.carb.	2 kΩ/0.1 w	WF 2 k/0,1
R74	Resistor, depos.carb.	5 kΩ/0.1 w	WF 5 k/0,1
R75	Resistor, depos.carb.	2 kΩ/0.1 w	WF 2 k/0,1
R81	Resistor, depos.carb.	3 kΩ/0.25 w	WF 3 k/0,25
R82	Resistor, wire-wound	6 kΩ/2 w	WDG 6 k/2
R83	Resistor, depos.carb.	125 kΩ/1 w	WF 125 k/1
R84	Resistor, depos.carb.	20 kΩ/0.25 w	WF 20 k/0,25
R85	Res., wire-wound,var.	1 kΩ/4 w lin.	WR 4 F/1 k
R91	VDR		WUC 31771
R92	VDR		WUC 31771
R93	Resistor, depos.carb.	3.2 kΩ/1 w	WF 3,2 k/1
R94	Resistor, depos.carb.	1.6 kΩ/2 w	WF 1,6 k/2
R95	Resistor, depos.carb.	1.25 kΩ/2 w	WF 1,25 k/2
R96	Resistor, depos.carb.	1.25 kΩ/2 w	WF 1,25 k/2
R97	Resistor, depos.carb.	475 Ω ±0.5 %/2 w	WF 475/0,5/2
R98	Resistor, depos.carb.	1.502 kΩ ±0.5 %/1 w	WF 1,502 k/0,5/1
R99	Resistor, depos.carb.	4.75 kΩ ±0.5 %/0.5 w	WF 4,75 k/0,5/0,5
R100	Resistor, depos.carb.	15.02 kΩ ±0.5 %/0.25 w	WF 15,02 k/0,5/0,25
R101	Resistor, depos.carb.	47.5 kΩ ±0.5 %/0.25 w	WF 47,5 k/0,5/0,25

Ref. No.	Designation	Ratings	R&S Stock No.
R103	Resistor, depos.carb.	694.5 Ω ±0.5 %/0.5 w	WF 694,5/0,5/0,5
R104	Resistor, depos.carb.	527.8 Ω ±0.5 %/0.25 w	WF 527,8/0,5/0,25
R105	Resistor, depos.carb.	490.9 Ω ±0.5 %/0.25 w	WF 490,9/0,5/0,25
R106	Resistor, depos.carb.	633.4 Ω ±0.5 %/0.25 w	WF 633,4/0,5/0,25
R107	Resistor, depos.carb.	1.3521 kΩ ±0.5 %/0.25 w	WF 1,3521 k/0,5/0,25
R108	Resistor, depos.carb.	915.1 Ω ±0.5 %/0.25 w	WF 915,1/0,5/0,25
R109	Resistor, depos.carb.	1.3521 kΩ ±0.5 %/0.25 w	WF 1,3521 k/0,5/0,25
R110	Resistor, depos.carb.	915.1 Ω ±0.5 %/0.25 w	WF 915,1/0,5/0,25
R111	Resistor, depos.carb.	1.3521 kΩ ±0.5 %/0.25 w	WF 1,3521 k/0,5/0,25
R112	Resistor, depos.carb.	625.4 Ω ±0.5 %/0.25 w	WF 625,4/0,5/0,25
R115	Resistor, depos.carb.	125 Ω ±0.5 %/0.5 w	WF 125/0,5/0,5
R117	Resistor, depos.carb.	220 Ω ±0.5 %/0.5 w	WF 220/0,5/0,5
R118	Resistor, depos.carb.	275 Ω ±0.5 %/0.5 w	WF 275/0,5/0,5
R119	Resistor, depos.carb.	83.3 Ω ±0.5 %/0.25 w	WF 83,3/0,5/0,25
R120	Resistor, depos.carb.	125 Ω ±0.5 %/0.25 w	WF 125/0,5/0,25
R121	Resistor, depos.carb.	66.7 Ω ±0.5 %/0.25 w	WF 66,7/0,5/0,25
R122	Resistor, depos.carb.	25 Ω ±0.5 %/0.25 w	WF 25/0,5/0,25
R123	Resistor, depos.carb.	55.6 Ω ±0.5 %/0.25 w	WF 55,6/0,5/0,25
Rl1	Lamp, glow, miniature		RL 210
Rö1	Triode, twin		ECC 81
Rö2	Triode, twin		E 88 CC
Rö3	Triode, twin		ECC 81
Rö4	Pentode, output		EL 86
Rö5	Pentode, output		EL 86

R 8366
363
Bl. 35

Ref. No.	Designation	Ratings	R&S Stock No.
S1	Switch, midget step		SRP 11120
S2	Switch, midget step		40851 - 2.3
S3	Switch, midget step		SRP 11120
S4	Panel, tapping		FD 60512
S5	Switch, power (combination)		SKK 120
Si1	Fuse	500 ma	0,5 C DIN 41571
T1	Transistor		GT/OC 141
T2	Transistor		GT/2 N 1304
Tr1	Transformer, power		40851 - 5

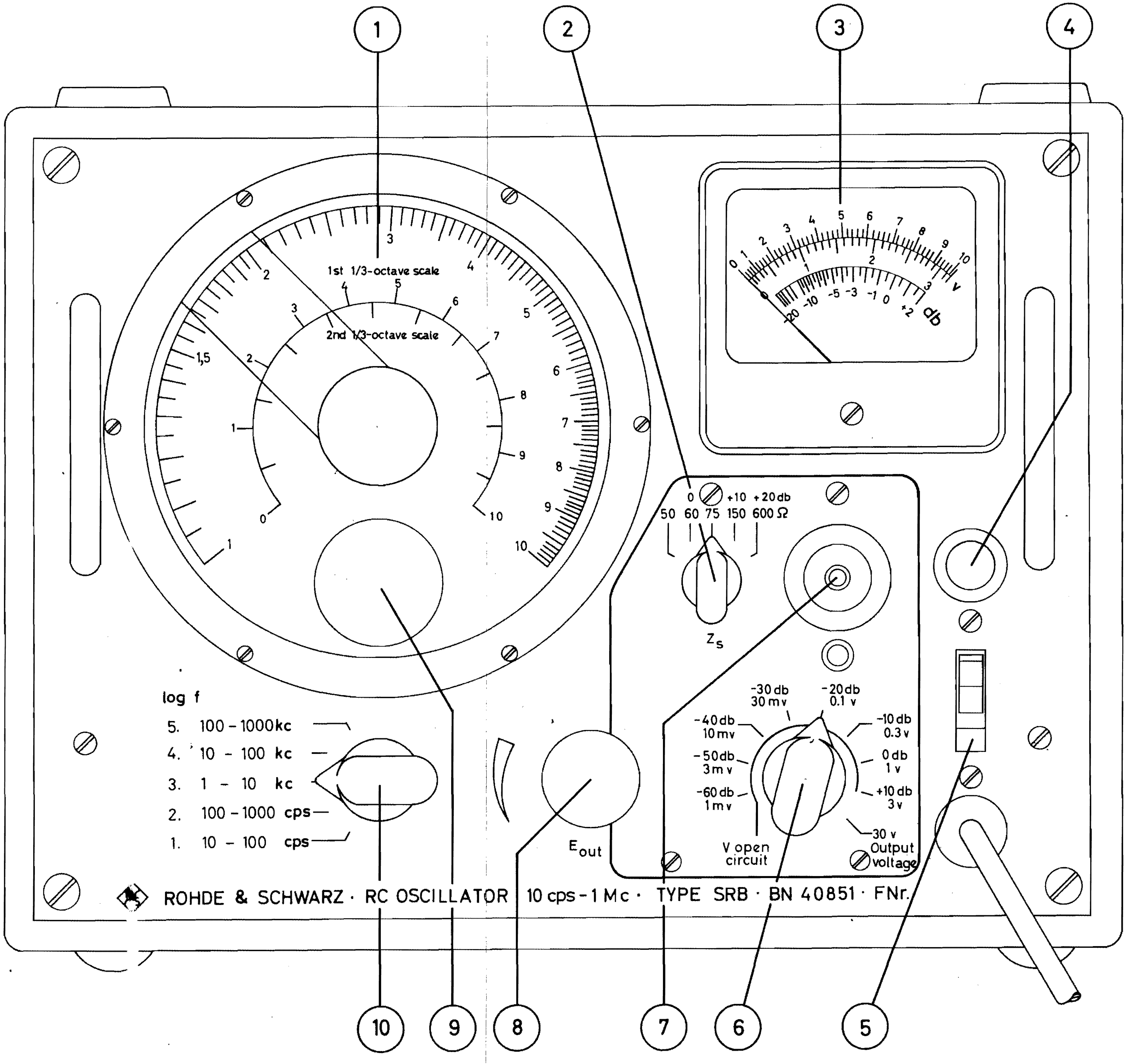
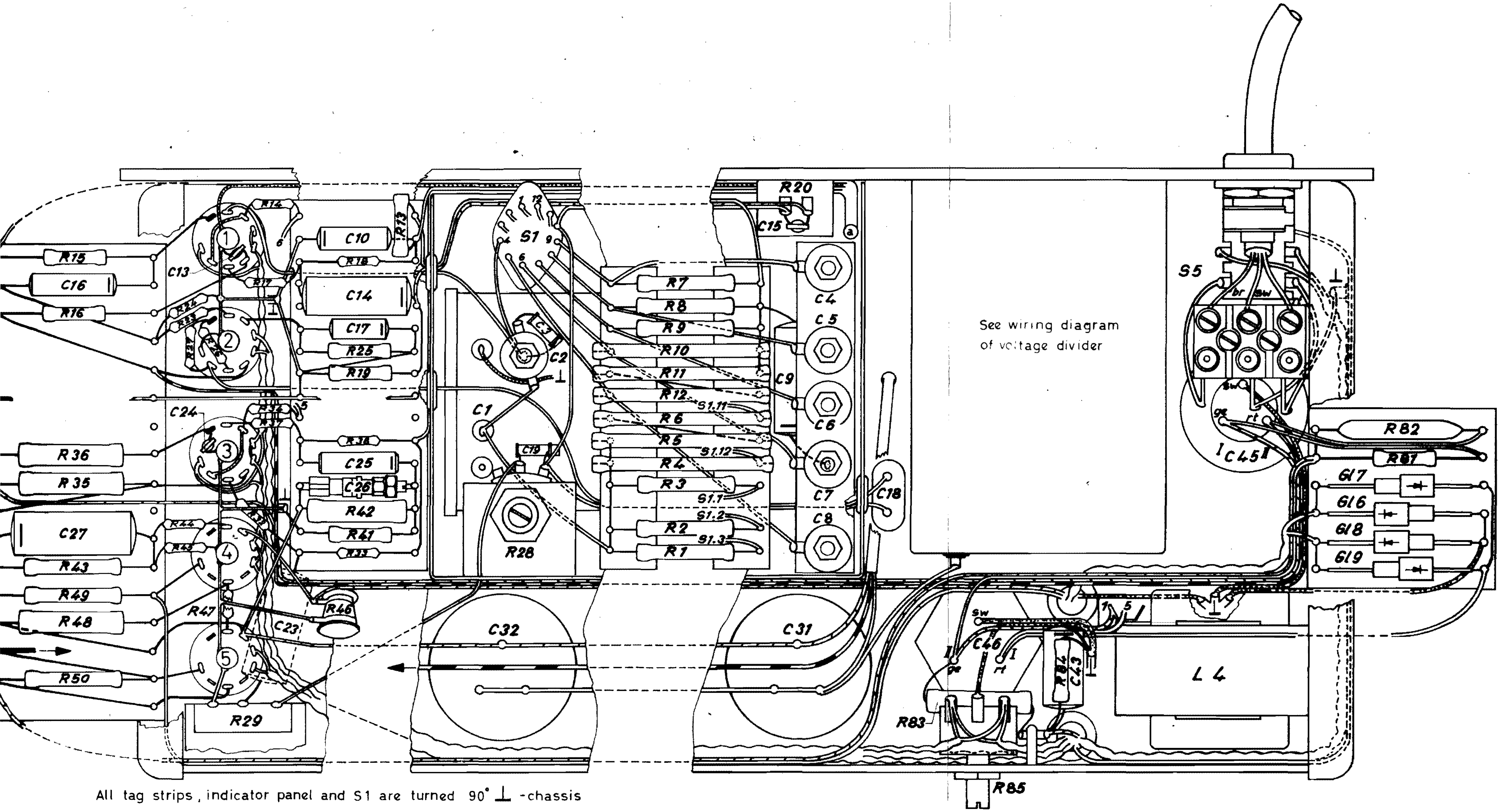


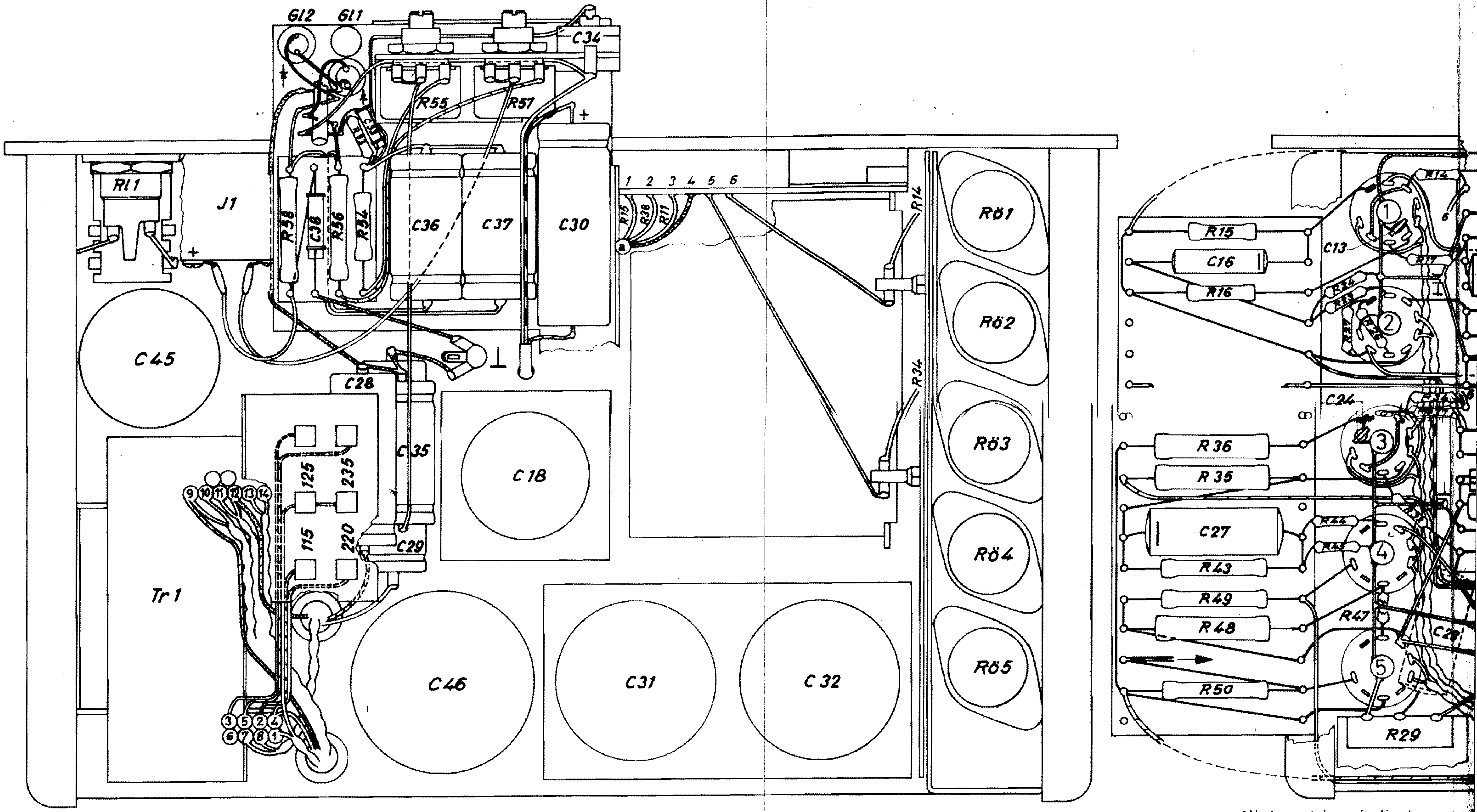
Fig. 11 Front panel



See wiring diagram of voltage divider

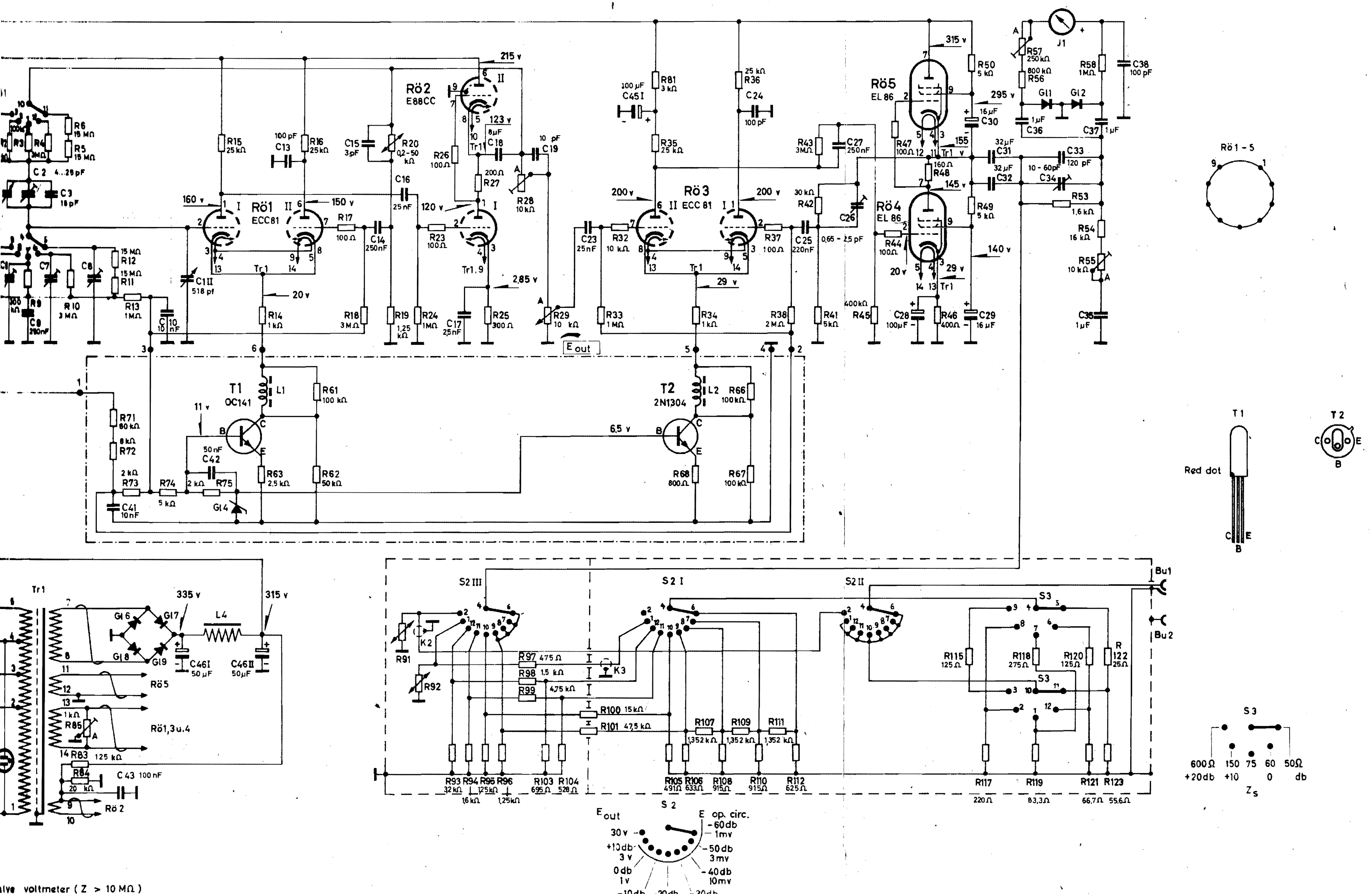
All tag strips, indicator panel and S1 are turned 90° ⊥ -chassis

Wiring diagram

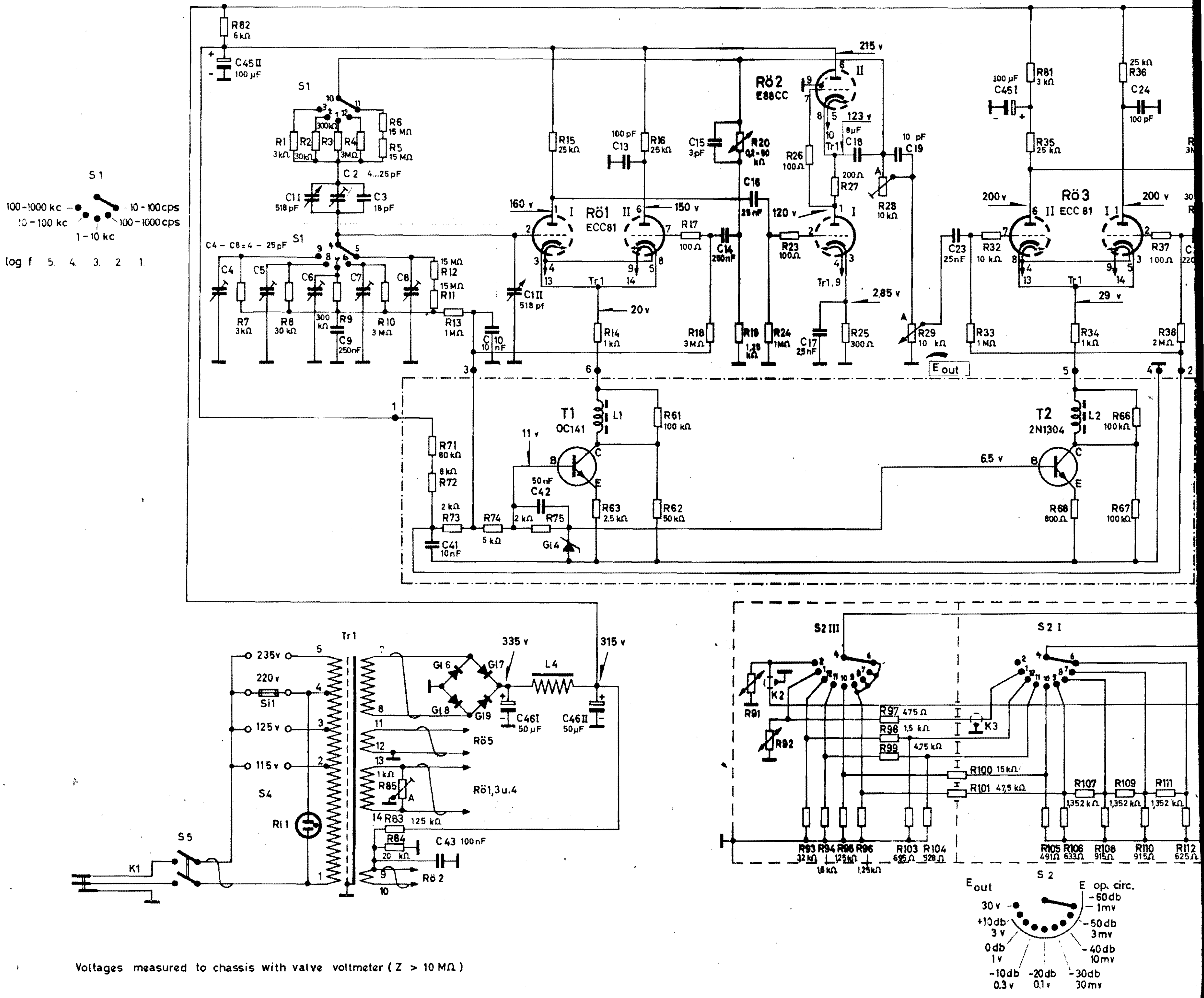


All tag strips , indicator pane

R 8366
363
Bl. 38

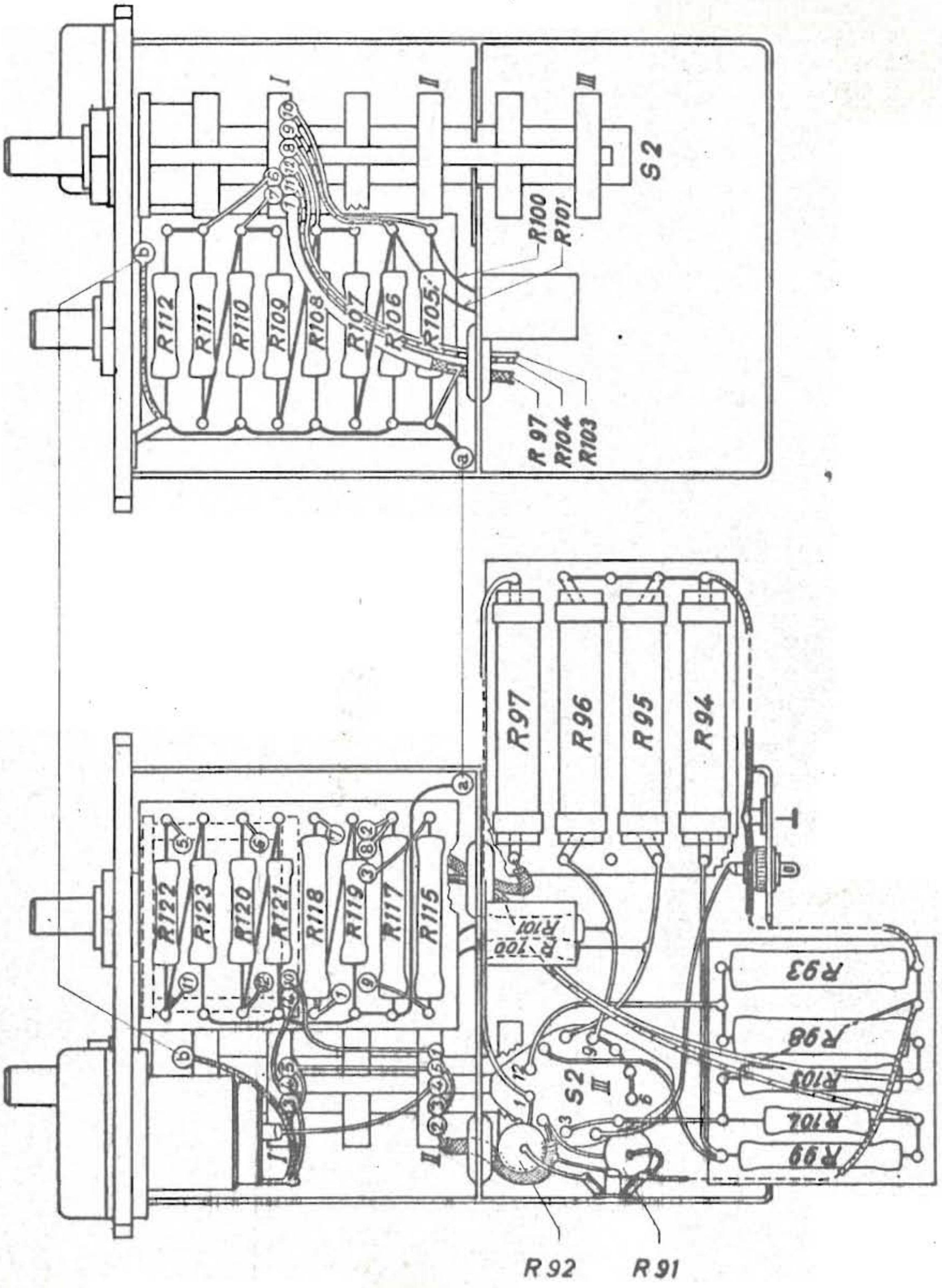


Circuit diagram



Voltages measured to chassis with valve voltmeter (Z > 10 MΩ)

R 8366
363
Bl. 40



Wiring diagram
(Voltage divider)