

Instruction Book

Z-g DIAGRAPH

Type ZDU

BN 35610/50 BN 35610/60 BN 35610/75

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

R 12162

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(131.)

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1. Specifications

1.1 Use as Impedance-Admittance Meter and Reflectometer

Frequency range 30 to 420 MHz

Characteristic impedance Z_0

(source impedance of Type ZDU)

model BN 35610/50 50 Ω

model BN 35610/60 60 Ω

model BN 35610/75 75 Ω

Indication direct visual indication by light spot;
optional on
a) Smith chart (resistive and reactive component)
b) Carter chart (magnitude and phase)
c) reflection-coefficient chart (magnitude and phase)

Measurement range for resistance and reactances $Z_0/50$ to $Z_0/50 \times Z_0$

Radius q of error circle after amplitude and phase adjustment at the measurement frequency

normal $\frac{q}{\text{mm}} = 100 (0.01 + 0.015 r)$

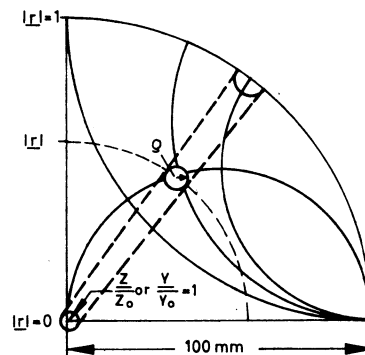
spread $\frac{q}{\text{mm}} = 300 (0.01 + 0.015 r)$

Near the matched condition ($Z \approx Z_0$)

the impedance error is $\frac{\Delta Z}{Z_0} \cong 3\%$

the admittance error is $\frac{\Delta Y}{Y_0} \cong 3\%$

the reflection-coefficient error $\Delta r \cong 1.0\%$

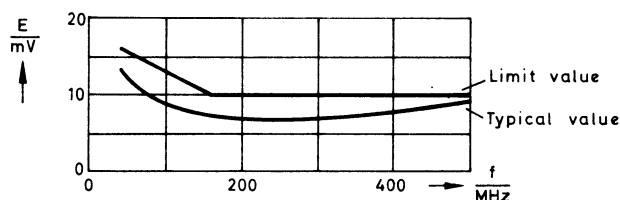


(Section of diagram of Fig. 24)

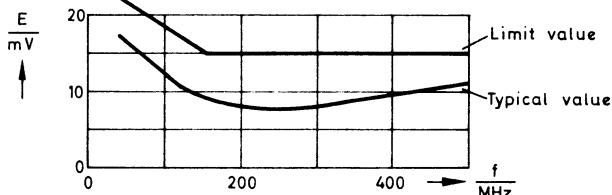
Voltage across test item under matched conditions

model BN 35610/50

model BN 35610/60



model BN 35610/75



Required generator voltage < 2 V

Connector for test item and generator

R&S connector Dezifix B, suitable for adaptation to other plug or socket systems, see section 3.9

1.2 Use as Test Set for the Determination of the Transmission Characteristics of 4- and Multi-terminal Networks

Frequency range 30 to 420 MHz

Indication direct visual indication by light spot on a polar diagram (transfer constant with respect to magnitude and phase in dB and °)

Measurement range

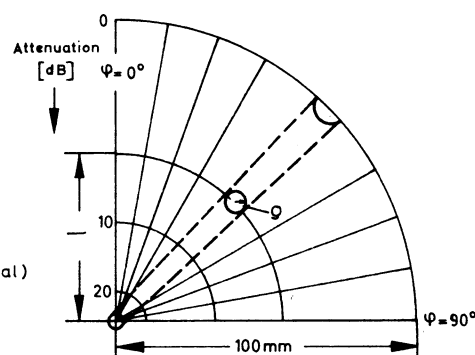
attenuation 0 to 30 dB

phase 0 to 360°

Radius q of error circle after amplitude and phase adjustment at the measurement frequency

$$\begin{aligned} \text{normal} \quad & \frac{q}{\text{mm}} = 1.0 + 0.015 \times \frac{1}{\text{mm}_1} \\ \text{spread} \quad & \frac{q}{\text{mm}} = 3 (1.0 + 0.015 \times \frac{1}{\text{mm}_1}) \end{aligned}$$

e. g. at an attenuation of 10 dB
max. attenuation error ± 0.6 dB
max. phase error $\pm 3.5^\circ$



(Section of diagram of Fig. 30
(l = amplitude of the transmitted signal))

Connection between network and test set	two cables of equal electrical length with connectors mating with those of test set *), a T-section and two 20-dB attenuator pads. Under certain conditions a 4-terminal feed unit is used instead of the T-section and the attenuator pads.
Source impedance of attenuator pads or 4-terminal feed unit . .	$Z_0 \pm 5\%$
Load impedance of the network (without cable)	$Z_0 \pm 6\%$
Voltage across input of passive networks under matched conditions	$< 20 \text{ mV}$ (see frequency response curves, section 1.1)
Voltage across input of active networks under matched conditions	$< \frac{20 \text{ mV}}{\text{transmission gain}}$ (see frequency response curves, section 1.1)
Connectors	as in section 1.1

1.3 Use as Test Set for the Determination of the Phase Angle between two Voltages of Identical Frequencies

Frequency range	30 to 420 MHz
Measurement range	0 to $\pm 180^\circ$
Error limits	$\pm 1.5^\circ$
Indication	direct visual indication by light spot on a polar diagram
Minimum voltage requirement for phase measurement	approx. 2 mV
Maximum permissible voltage .	approx. 15 mV

*) Cable pairs adjusted for equal electrical length may be ordered from ROHDE & SCHWARZ; see section 3.2.

Input impedance of coaxial test
line and coaxial reference line

model BN 35610/50	50 Ω $\pm 1\%$
model BN 35610/60	60 Ω $\pm 1\%$
model BN 35610/75	75 Ω $\pm 1\%$
Connectors	as in section 1.1

1.4 Use as a Tuned Linear Test Receiver

Frequency range	30 to 420 MHz
Input requirement for full-scale deflection on reference meter. .	approx. 20 mV
Threshold sensitivity	approx. 0.5 mV
Bandwidth	approx. 70 kHz increases to approx. 500 kHz by automatic tuning
Input impedance and connector .	see section 1.1

1.5 Other Data

Power supply	115/125/220/235 V $\pm 10\%$ 47 to 63 Hz and 400 Hz
Power consumption	approx. 180 VA
Valves, etc.	2 valves EA 50 1 valve EC 81 14 valves EF 80 2 valves EF 800 1 valve EL 84 2 valves EZ 80 2 valves PL 81 1 reference tube 85 A 2 2 crystal diodes R&S Stock No. GK 1011 C 1 crystal diode R&S Stock No. GK 1111 7 crystal diodes R&S Stock No. GK/OA95

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1 incandescent lamp
 R&S Stock No. RL 93015
 1 projector lamp
 R&S Stock No. RL 301
 1 miniature glow lamp
 R&S Stock No. RL 210
 2 scale lamps
 R&S Stock No. RL 165 S
 1 1.6-A fuse
 1,6 D DIN 41571 (for 220/235 V)
 1 0.25-A fuse
 0,25 C DIN 41571

Dimensions 560 x 340 x 480 mm
 Weight approx. 55 kg

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S U P P L E M E N T

to the instruction book Z-g Diagraph Type ZDU BN 35610/...

Valid for instruments with FNr. F1870/1...50

The following amendments to the instruction book are due to a number of technical improvements which were made to the Z-g Diagraph Type ZDU. We regret that it was too late for these to be incorporated in the instruction book, which had already gone to press.

1. Text

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Section 1.5

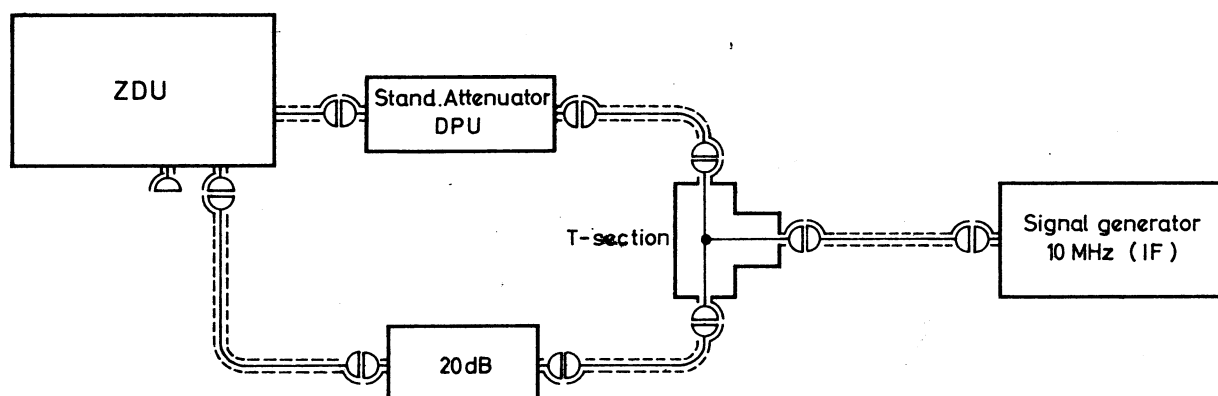
Under the heading "Valves, etc." delete "2 valves EA 50". Add the following: "1 crystal diode R&S Stock No. GK/BA 111" and "1 crystal diode R&S Stock No. GK/Z 12". The letter "M" should be placed before the Stock Numbers of the fuses.

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Insert under the main section "8. Periodical Checking of the Set" the following sub-section:

Checking the Reference-meter and the Phase Indication as a Function of Reflection Coefficient and Return Loss

A voltage of equal frequency to that of the intermediate frequency of Type ZDU (10 to 11 MHz) is fed from a signal generator via a T-section into the coaxial test line 9 (Fig. 23) and the coaxial reference line 11. Between the T-section and Type ZDU an attenuator box (e.g. Type DPU) is connected to the coaxial test line and a 20 dB attenuator to the coaxial reference line (see section 3.3.2.2). The attenuator box should be connected directly to the coaxial test line, without intervening cable, as shown in the diagram below, and it should be set for a basic attenuation of 20 dB. The input 14 of Type ZDU remains open.

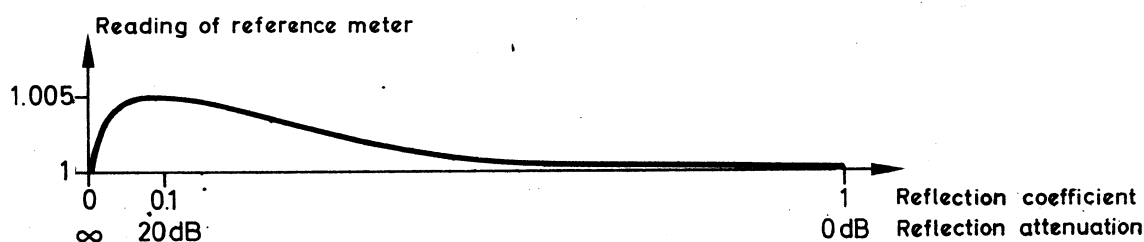


Now adjust the frequency of the signal generator so that the pointer of the discriminator instrument (4) is at the middle mark of the red field. Do not press button (3). After inserting a chart with angular division (reflection chart Fig. 28 or transfer constant chart Fig. 30), proceed with

(a) Checking the Amplitude

Adjust the voltage of the signal generator so that the cross-wires of the light spot come to rest on the largest circle of the chart ($r = 1$ or 0 dB). Set knob (5) for a reference meter deflection to division 99.

Now switch in the full attenuation of the attenuator box, whereby the light spot moves to the middle of the chart (reflection coefficient $r = 0$ or attenuation $= \infty$). The pointer of the reference meter must still stay at division 99. Any deviation can be corrected by carefully turning the trimmer C10 (Fig. 32). Next, reduce the attenuation of the attenuator box by steps of 5 dB while observing the reference meter. The maximum error should not exceed 0.5%. It occurs in the vicinity of $r = 0.1$ on the reflection coefficient chart or of 20 dB on the transfer constant chart, as can be seen from the diagram below.



The amplitude check is followed by

(b) Checking the Phase

With the same voltage and the same setup as for the amplitude check, switch the attenuator box to the value of 35 dB and adjust the phase in the usual way with the PHASE ADJ. knob (13), after depressing knob (3). The deviation from 0° which then occurs is due to the difference in electrical length of the attenuator in the reference line branch and the attenuator box in the test line branch. Using PHASE COR. knob (7), the phase can be shifted so that the light spot coincides exactly with one of the radial lines (10° , 15° , etc.). This facilitates the spotting of any error which may later occur.

Now select an attenuation of 20 dB on the attenuation box, whereby the light spot moves outwards ($r = 1$ or attenuation = 0 dB). After repeating the phase adjustment with knob (13), the error should not be greater than 1%. A larger error can be corrected by means of R168, the position of which is shown on the attached Fig. 32a. This drawing replaces Fig. 32 in the instruction book. After compensation with R168, the maximum indication may have to be improved, as set forth in section 9.11.

With an attenuation up to 25 dB (45 dB in the attenuation box taking the basic 20 dB into account), the permissible error after compensation with R168 is 1° . If the attenuation is greater than 25 dB, the maximum permissible error is 10° .

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Section 8.6 now reads as follows:

The electrical zero is correctly adjusted if upon switching from NORMAL to SPREAD the zero deflection of the light spot remains unchanged or does not shift more than 1 mm to the left. This small shift is caused by noise.

During this investigation the signal generator must be disconnected. If the light-spot shifts by more than 1 mm, attempt a correction by means of resistor R207 (Fig. 34). If no correction can be effected with R207, then valve Rø12 must be replaced.

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Paragraph Rø12 now reads as follows:

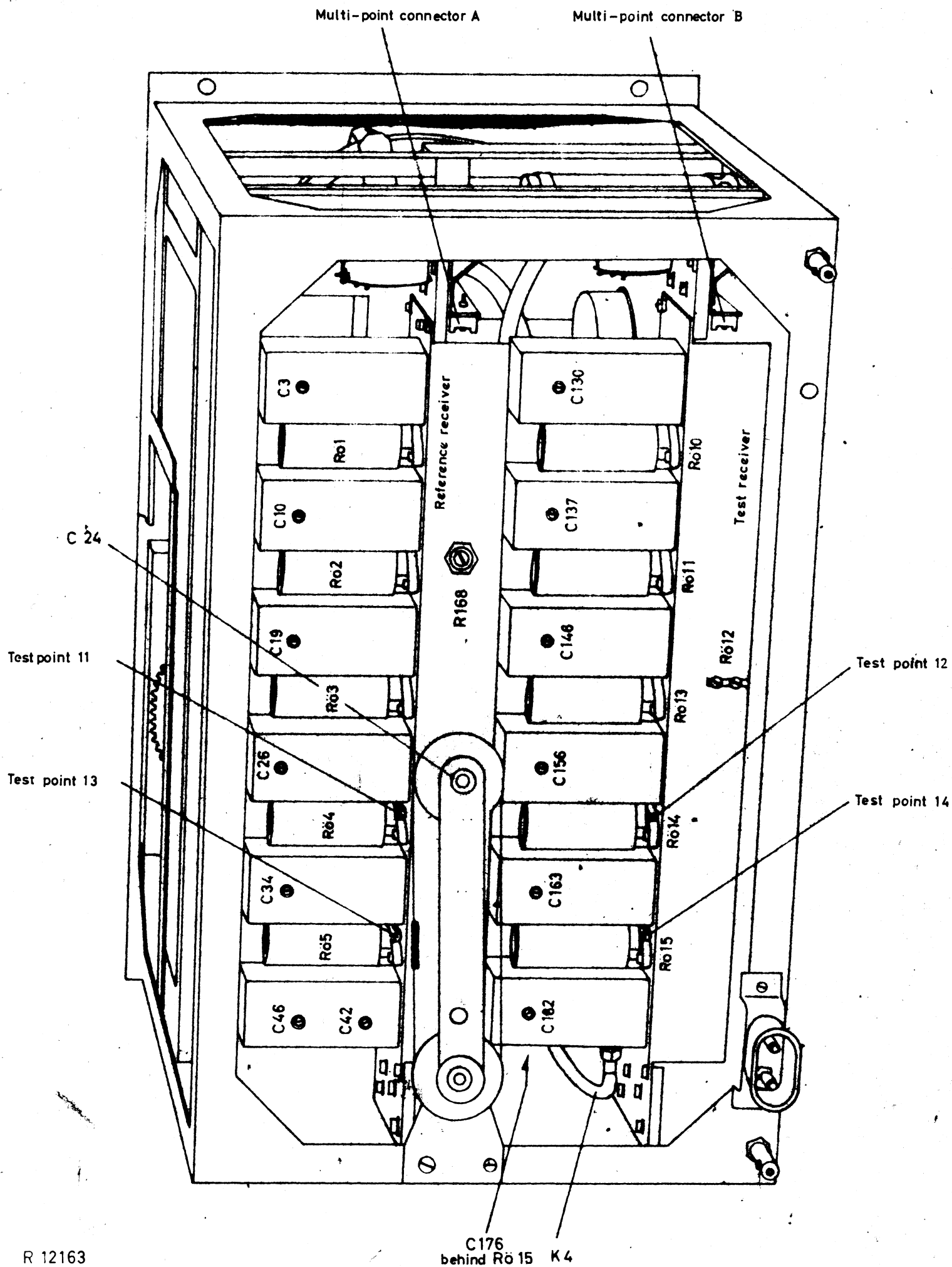
Open the cover on the underside of the lower IF amplifier and loosen the two cheese head screws on the rear panel (Fig. 32). The socket of the valve Rø12 (E 91 AA) can then be drawn out downwards and the valve replaced. Replace the socket with the new valve and the cover of the IF amplifier. The set can now be switched on. Allow a few minutes for warming up, and adjust the electrical zero of the galvanometer using resistor R207 (Fig. 34). See also section 8.6.

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Paragraph Rø19 is deleted

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Fig. 32 in the instruction book is replaced by Fig. 32a in this supplement.



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Fig.32 a Rear view

2. Accessories Supplied

- | | | |
|----|--|-----------------------------|
| 1 | Connecting cable, 2 m, with female connector and earthing-contact type plug for connection of Type ZDU to the power supply | R&S Stock No. LK 333 |
| 2 | R&S short-circuit connectors
Dezifix | R&S Stock No. FZ 434 |
| 20 | Transmission-line charts impedance-admittance chart for resistive and reactive components | BN 35611/1709 (Fig. 24, p. |
| 20 | Transmission-line charts impedance-admittance chart for resistive and reactive components, three times enlarged | BN 35611/2692 (Fig. 25, p. |
| 20 | Transmission-line charts impedance-admittance chart for magnitude and phase | BN 35611/1659 (Fig. 26, p. |
| 20 | Transmission-line charts impedance-admittance chart for magnitude and phase, three times enlarged | BN 35611/1895 (Fig. 27, p. |
| 20 | Transmission-line charts reflection-coefficient chart | BN 35611/1657 (Fig. 28, p. |
| 20 | Transmission-line charts reflection-coefficient chart, three times enlarged | BN 35611/12394 (Fig. 29, p. |
| 20 | Transmission-line charts transfer-constant chart | BN 35611/1658 (Fig. 30, p. |
| 1 | Chart case, for storage of the charts | BN 3561 - 46 |

3. Recommended Accessories for Extending the Scope of Measurements (to be ordered separately)

3.1 Feed Cable

1 m long, with Dezifix B connectors at both ends for connecting Type ZDU to the signal generator BN 9111105/100

3.2 Pair of 2-terminal Measuring Cables

For Type ZDU	Connector	Length	Order Number
BN 35610/50	Dezifix B	1 m	BN 35613/50/1
		2 m	BN 35613/50/2
		5 m	BN 35613/50/5
	Series N UG-21 D/U	1 m	BN 35613/11/1
		2 m	BN 35613/11/2
		5 m	BN 35613/11/5
BN 35610/60	Dezifix B	1 m	BN 35612/1
		2 m	BN 35612/2
		5 m	BN 35612/5
BN 35610/75	Dezifix B	1 m	BN 35613/80/1
		2 m	BN 35613/80/2
		5 m	BN 35613/80/5

The two cables of a pair are of equal electrical length; they are used in measuring test items which cannot be directly connected to the Type ZDU. Moreover, they are used for 4-terminal network measurements.

Difference in electrical length between the two cables of a pair, on delivery	$\cong 0.002 \times l + 2 \text{ mm}$
Tolerance of mechanical length of a pair of cables	-60 to +90 mm
Permissible strain	
Bending radius	$\cong 30 \text{ cm}$
Tensile strength	$< 2 \text{ kgf}$
Weight	1 to 4 kg depending on BN
VSWR	see Fig. 1

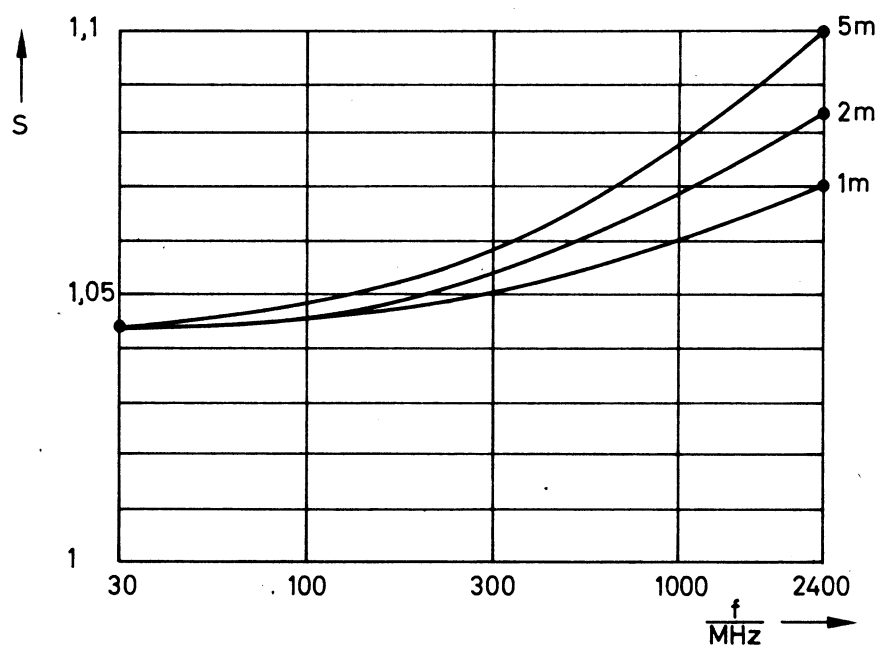


Fig. 1 VSWR of a single cable 1 m, 2 m and 5 m in length

Instructions on how to maintain the high electrical quality of the cables are given in the "Technical Information R 7352".

3.3 Accessories for Measuring Transmission Characteristics

3.3.1 4-terminal Feed Unit for Nearly Matched Networks

For Type ZDU BN 35610/50	BN 35615/2/550
For Type ZDU BN 35610/60	BN 35614/2/660
For Type ZDU BN 35610/75	BN 35615/2/880

Generator impedance	1.5 k Ω
Reflection within the coaxial line section	< 5%
Insertion loss from generator end to output end	approx. 30 dB

The 4-terminal feed unit is fitted with Dezifix connectors which can be adapted to suit other connector systems.

3.3.2 T-section and UHF Attenuators for Feeding Networks of any Input Impedances

For measurements on networks of any input impedances, a T-section as specified in section 3.3.2.1 and two UHF Attenuators as specified in section 3.3.2.2 are required for feeding in.

3.3.2.1 T-section

T-sections are supplied in three models with the following Order Nos. :

Characteristic impedance $Z = 50 \Omega$	FS 532/50
$Z = 60 \Omega$	FS 532
$Z = 75 \Omega$	FS 532/75

The T-sections are fitted with precision Dezifix B connectors which can be adapted to suit other connector systems.

3.3.2.2 UHF Attenuators Type DPF

Model	Z _O	Attenuation	Frequency range	Power-handling capacity
BN 18060/50	50 Ω	5 dB	0 to 4000 MHz	0.5 W
BN 18060/60	60 Ω			
BN 18061/50	50 Ω	10 dB		
BN 18061/60	60 Ω			
BN 18062/50	50 Ω	20 dB		
BN 18062/60	60 Ω			

These attenuators have adaptable R&S Dezifix B connectors with a power handling capacity of 0.5 W.

3.4 Matching Pads Type DAF

Model	Impedance transformation	Attenuation	Frequency
BN 18083	60 Ω to 75 Ω	4 dB	0 to 1000 MHz
	75 Ω to 60 Ω	6 dB	
BN 18084	50 Ω to 75 Ω	4.2 dB	
	75 Ω to 50 Ω	7.8 dB	
BN 18085	50 Ω to 60 Ω	4.2 dB	
	60 Ω to 50 Ω	5.8 dB	

These matching pads are fitted with adaptable R&S connectors Dezifix B. They are an excellent and mostly indispensable accessory if two instruments or cables with varying impedance characteristics must be matched. They

are also usable as attenuators. If, for example, two pads BN 18083 are connected by their 75- Ω ends, they form an attenuator with $Z = 60 \Omega$ and an attenuation of $4 + 6 = 10$ dB. If the 60- Ω ends are connected together, $Z = 75 \Omega$ and again $4 + 6 = 10$ dB attenuation are obtained. The power handling capacity is 0.5 W.

3.5 Calibrated Adjustable Shorts . BN 39591/50, BN 39592/50, $Z_0 = 50 \Omega$
 BN 39591/60, BN 39592/60, $Z_0 = 60 \Omega$
 BN 39591/75, BN 39592/75, $Z_0 = 75 \Omega$

Generally speaking, adjustable shorts serve to obtain accurately-known reactances. Because of their perfect homogeneity and close tolerances they can be regarded as reactance standards. The Adjustable Short BN 39591 has a maximum usable length of 130 mm; the setting accuracy is ± 0.05 mm with vernier and ± 0.005 mm with the accompanying gauge blocks 2, 5, 10, 20, 30 and 40 mm. Adjustable Short BN 39592 has a maximum usable length of 500 mm and the same setting accuracy as mentioned above. In conjunction with Type ZDU, the adjustable short can be used for compensation, for example, when a test item must be connected via a short length of cable or air line and the result must be referred to the test item at the end of the cable or air line. Of course, the electrical length of the cable or line must not exceed the maximum electrical length (maximum usable length) of the adjustable short.

3.6 Transistor Adapter BN 35616/50, $Z_0 = 50 \Omega$
 BN 35616/60, $Z_0 = 60 \Omega$
 with accessories for DC supply

Transistors cannot simply be connected to the Type ZDU because of their small dimensions. Thus a transistor adapter is required. The transistor adapter prolongs two coaxial lines, maintaining their characteristic impedance while changing the dimensions. Thus the input impedance or admittance of transistors with three or more electrodes can be measured along with their transmission characteristics in both directions, the terminating loads being selectable. For details see the relevant instruction book.

3.7 Impedance Transformer Type BSI

The different models of the Impedance Transformer Type BSI serve to match measuring instruments of 50, 60 or 75 Ω unbalanced input to balanced test items of 200, 240 or 300 Ω . The following models are used in conjunction with Type ZDU:

Model	Characteristic impedance unbal. / bal.	Frequency range
BN 90634/200	50 Ω : 200 Ω	10 to 100 MHz
BN 90635/200		100 to 420 MHz
BN 90634/240	60 Ω : 240 Ω	10 to 100 MHz
BN 90635/240		100 to 420 MHz
BN 90634/300	75 Ω : 300 Ω	10 to 100 MHz
BN 90635/300		100 to 420 MHz

These impedance transformers have an adjustable Dezifix B connector on the unbalanced side and two sockets for 1.3 mm plug pins 12.6 mm apart on the balanced side. Thus a two-pin plug, BN E 454/4 - 30, is required for connecting a balanced twin lead, together with an adaptor, BN E 454/4 - 28, for a two-pin plug with 3 mm pins 12 mm apart. All these impedance transformers have a transformation ratio of 1:4, and by their use Type ZDU is made available for measuring balanced test objects. Moreover, high-valued impedances can be measured more accurately, since the impedance value indicated by Type ZDU is four times smaller. Care must be taken that the unbalanced characteristic impedance value of the Impedance Transformer Type BSI used corresponds with that of Type ZDU. Thus with a Type ZDU of which $Z_0 = 60 \Omega$, an Impedance Transformer Type BSI for 60/240 Ω must always be used, even if it is desired to measure an impedance of, say, 300 Ω .

3.8 Broadband Baluns Type BSU

The Broadband Baluns Type BSU provide a low-reflection transition between a balanced and an unbalanced coaxial line of identical characteristic impedance. In conjunction with Type ZDU, the test input of which is unbalanced, they enable measurements of balanced test items, such as the input impedance of a balanced antenna to be made, without any transformation of the impedance taking place. The following table shows the characteristic impedances and frequency ranges of the different BSU models.

Model	unbalanced/balanced	Frequency range
BN 90610/50	50 Ω : 50 Ω	10 to 90 MHz
BN 90611/50		30 to 180 MHz
BN 90612/50		85 to 300 MHz
BN 90610/60	60 Ω : 60 Ω	10 to 90 MHz
BN 90611/60		30 to 180 MHz
BN 90612/60		85 to 300 MHz
BN 90610/D		10 to 90 MHz
BN 90611/D		30 to 180 MHz
BN 90612/D		85 to 300 MHz

All models possess an adaptable Dezifix B connector on the unbalanced side. On the balanced side, the models BN 90610/D, BN 90611/D and BN 90612/D have a shielded twin-pole socket for connection. All other models have two knurled terminals.

3.9 Screw-in Assemblies

The screw-in assemblies listed in the following table are available to adapt the Dezifix connectors of Type ZDU to other connector systems. A screw-in assembly consists of an outer and an inner conductor. The connector systems for which screw-in assemblies are available are listed in the left column and the corresponding order numbers in the two other columns.

Desired type of connector			Order Number of Screw-in Assemblies	
			for ZDU input	for coaxial test line and coaxial reference line
UHF socket	(Small Single) (MIL)	50 Ω	FHD 10910/50	FHD 10900/50
UHF plug	(Small Single) (MIL)	50 Ω	FHS 10910/50	FHS 10900/50
N socket	(MIL)	50 Ω	FHD 20910/50	FHD 20900/50
N plug	(MIL)	50 Ω	FHS 20910/50	FHS 20900/50
N socket	(MIL)	75 Ω	—	FHD 20900/75
N plug	(MIL)	75 Ω	—	FHS 20900/75
C socket	(MIL)	50 Ω	FHD 30910/50	FHD 30900/50
C plug	(MIL)	50 Ω	FHS 30910/50	FHS 30900/50
BNC socket	(MIL)	50 Ω	FHD 40910/50	FHD 40900/50
BNC plug	(MIL)	50 Ω	FHS 40910/50	FHS 40900/50
RF socket	4.1/9.5	50 Ω	FID 20910/50	FID 20900/50
RF plug	4.1/9.5	50 Ω	FIS 20910/50	FIS 20900/50
RF socket	7/16	50 Ω	FID 40910/50	FID 40900/50
RF plug	7/16	50 Ω	FIS 40910/50	FIS 40900/50
RF socket	3.5/9.5 DIN 47281	60 Ω	FID 20910/60	FID 20900/60
RF plug	3.5/9.5 DIN 47281	60 Ω	FIS 20910/60	FIS 20900/60
RF socket	6/16 DIN 47282	60 Ω	FID 40910/60	FID 40900/60
RF plug	6/16 DIN 47282	60 Ω	FIS 40910/60	FIS 40900/60
General Radio connector 874		50 Ω	FLA 20910/50	FLA 20900/50
Marconi connector H 4		50 Ω	FLB 20910/50	FLB 20900/50

The screw-in assemblies are easily attached: unscrew the outer conductor of the Dezifix connector with the special wrench FZM 10900 and the inner conductor with a (4 mm) screwdriver. The inner and outer conductors of the desired screw-in assembly can then be screwed in. Dezifix connectors and screw-in assemblies should be treated with care and stored in a safe place, since their electrical properties can be adversely affected by even slight mechanical damage.

4. Uses

As far as the measuring of complex impedances and transmission parameters is concerned, the frequency range of the Z-g Diagraph Type ZDU represents a boundary region distinguished by the use of test methods employing distributed constants instead of lumped constants. Nevertheless, a uniform procedure of great and consistent accuracy is also possible for this frequency range.

Z-g Diagraph Type ZDU employs the principle of the coaxial directional coupler. This principle is used especially for decimetre and centimetre waves but is equally suitable for the short-wave and ultra-short-wave ranges. By means of two built-in coaxial directional couplers the Z-g Diagraph measures the complex reflection coefficient originated by a test item connected to the coaxial test line. Although it is basically a reflection-coefficient meter, the Z-g Diagraph is not confined to measuring reflection coefficients, since impedance and admittance as well as a number of other quantities - which are dealt with further on - can be determined from a reflection-coefficient measurement. Thus the field of application is extremely varied, all the more since other quantities of interest can be derived from impedance or admittance. For example, the investigation of cables for their characteristic impedance and homogeneity, and the determination of material characteristics are based on impedance measurements. The measurement of negative resistance is also an impedance measurement.

Sometimes it is necessary to measure the impedance of an item of difficult access, which cannot be connected directly to the Z-g Diagraph. An example is a high antenna. In these cases it is always found to be annoying that the impedance measured at the input of a connecting cable must first be changed by the phase angle of this cable to determine the true antenna input impedance, and that this phase shift varies with frequency. Thanks to the special design of the Z-g Diagraph Type ZDD, it is possible to indicate the true impedance of the test item on the screen by connecting a second cable, having the same electrical length as the test cable, to a test output provided on the set for this purpose. The phase shift thus being eliminated, there is no need for any conversion or graphic evaluation, provided the characteristic impedance of the cable employed is sufficiently uniform; errors with respect to Z will fully enter into the test result.

The measuring method employed permits the transmission parameters of 4- and multi-terminal networks to be measured in addition to the reflection coefficient, impedance and admittance. The effective transmission factor for the condition $Z_S = Z_1 = Z_0$ can be measured with the help of two RF cables of equal electrical length and characteristic impedance Z_0 . If Z_S and Z_1 are not equal to Z_0 , measurements are possible in conjunction with suitable matching elements, e. g. the Matching Pads Type DAF.

The 4-terminal parameters of transistors can be determined by means of impedance or admittance measurements or from transmission parameters. However, on account of the small dimensions of transistors, the transistor adapter mentioned in section 3.6 is required for this purpose.

Within the frequency range 30 to 420 MHz the phase angle between two voltages of equal frequency can be directly read between $+180^\circ$ and -180° from a polar-coordinate chart. In this case, the voltages to be compared need not be of the same value, the only condition being that they lie within the specified voltage range.

Between about 0.2 and 20 mV, the built-in superheterodyne receiver may also be used as a linear test receiver. This may be of interest in spite of the fact that the sensitivity is reduced by the directional couplers, since the input impedance of the receiver is Z_0 within 1% over the entire frequency range.

Depending on the measurement problem, the result can be read directly on a Smith chart or on a special polar-coordinate chart without any arithmetical or graphical evaluation. This is of particular importance in studying test items over a broad frequency band since these measurements are tedious when using standing wave detectors. The Z-g Diagraph permits broad-band impedance or admittance diagrams of any apparatus, such as antennas, transformers, absorbers, filters to be plotted within a few minutes. Exchangeable charts make the procedure particularly easy.

Finally attention is called to the fact that the coaxial test and reference lines and the directional couplers proper do not include moving parts. This is of particular importance for the reproducibility of the results and for the operating stability of the equipment.

5. Description

There is a directional coupler in a coaxial test line and another in a coaxial reference line. The one mounted in the coaxial test line furnishes a voltage proportional to the reflection coefficient p_x of the test item, while the one mounted in the coaxial reference line supplies a reference voltage proportional to unity reflection coefficient. The reflection coefficient is obtained from the comparison of the two voltages. The phase angle between these two voltages equals the phase angle of the reflection coefficient of the test item plus a constant angle which depends on the termination of the reference line.

The two quantities p_x and ϕ_x of the complex reflection coefficient p_x are represented linearly on the Smith chart (Fig. 24) used for direct visual indication. p_x is a vector whose length, for $Z/Z_0 = 1$, equals zero and, for any reactances, is equal to the radius of the diagram. ϕ_x is the angle of this vector in relation to the real axis between $R/Z_0 = 1$ and $R/Z_0 = \infty$ and, for $Z/Z_0 = 0$, reaches the value $\pm 180^\circ$. In order to determine this phase angle, the two directional-coupler voltages are first converted to a constant intermediate frequency and impressed on both ends of an artificial line after amplification and limitation. If the amplitudes of these two IF voltages are of equal level, distinct minima are created on this line, the distance of these minima from the ends of the line being a linear function of ϕ_x . In order to co-ordinate the linear characteristic of the phase angle on the chart and on the artificial line, the latter has been wound round the chart and the chart has been made rotatable about $Z/Z_0 = 1$ and mechanically coupled with the probe of the artificial line. For indication of the magnitude of the reflection coefficient p_x , use has been made of a sturdy mirror galvanometer which furnishes a light spot travelling along a constant base between $Z/Z_0 = 1$ and the reactance circle. After the probe minimum has been found, the position of this light spot immediately yields Z/Z_0 if the reference voltage is set to a red mark, i. e., its rated value.

A special automatic frequency control makes the local oscillator follow any variations of the signal-generator frequency so that errors due to this reason are largely eliminated.

In order to enable measurements to be made on radiating test items, the coaxial test and reference lines have been provided at the side of the cabinet so that shieldings that are possibly set up do not bother the operator when measuring.

6. Operating Instructions

Note:

Before moving the set, even if only from one place to another within the laboratory, the indication and power switch (18) (Fig. 23) should be turned to OFF in order to avoid any damage to the built-in galvanometer.

6.1 Adapting the Set to the Local AC Supply Voltage and Frequency

The Z-g Diagraph has been designed for operation from an AC power supply and factory-adjusted to 220 V and 47 to 63 Hz. For a voltage other than 220 V, the set must be adapted correspondingly. To this end, it is necessary to loosen the four cylinder-head bolts at the corners of the front panel; it is then possible to remove the set from its cabinet. With the power cut off, the fuse must be inserted in the clips in the power supply (Fig. 31), identified by the required voltage rating. The fuse provided for an AC supply voltage of 220 V or 235 V is rated for 1.6 A (1, 6 DIN 41571) and is to be replaced by a 2.5-A fuse (2, 5 DIN 41571) in the case of a 115-V or 125-V AC supply. The set is connected to the AC supply through the power cable supplied.

For an AC supply frequency of 400 Hz, the AC supply frequency selector (Fig. 31) located near the AC supply tapping panel must be adjusted correspondingly. For this purpose it is necessary to loosen the two screws, to change over the link, so that the connection between the two screws is interrupted, and then to tighten the screws again.

6.2 Preparation for Use

Place the set on a practically horizontal base. Take the long coaxial test line from the lid of the set, where it is kept for transport, and screw it clockwise as far as it will go into the hole in the right-hand wall of the cabinet.

Throw INDICATION switch (18) to NORMAL; the set is then switched on. After a short warm-up period, the pointer of the discriminator meter (4) moves to the right stop. This is a normal reaction which does not mean any danger for the instrument. The pointer remains at the stop until an input voltage is applied to the Z-g Diagraph and the Z-g Diagraph is tuned to the frequency of this voltage, i. e., until a signal reaches the discriminator.

The signal generator used for the measurement should be capable of delivering 2 V open circuit at a source impedance of 50 Ω , 60 Ω or 75 Ω , resp., so as to fully drive the Z-g Diagraph at every frequency. The maximum permissible RF input voltage is 5 V.

We recommend the use of the following Power Signal Generators included in our production programme: Type SMLM (30 to 300 MHz), Type SDR (300 to 1000 MHz), Type SLRD (275 to 2750 MHz), Type SLSV (25 to 470 MHz). Connect the signal generator to the INPUT socket (14). Allow a warm-up period of about 15 minutes before measuring.

6.3 Handling the Chart Holder

The following charts are used for indication of the measured values:

- (a) Impedance-admittance chart (for resistive and reactive components, Figs. 24 and 25);
- (b) impedance-admittance chart (for magnitude and phase, Figs. 26 and 27);
- (c) reflection-coefficient chart (for magnitude and phase, Figs. 28 and 29);
- (d) transfer-constant chart (attenuation constant and phase constant, Fig. 30).

For inserting the chart, remove the bezel (17) and put the chart, fitted with two guide holes, on the plexiglass screen. Replace the bezel, thus pressing the chart against the plexiglass screen. The impedance-admittance charts (Figs. 24 and 26) can be inserted in such a way that either 0 or ∞ (with the charts of Figs. 25 and 27 either 0.5 or 2, because of the extended scale) is above the black line of the plexiglass screen. In the first case, the results represented on the chart are impedances, in the second case, they are admittances. Insert the charts shown in Figs. 28 and 29 so that 180° is above the black line and that of Fig. 30 so that 0° is above the black line.

6.4 Adjustments

6.4.1 Zero Setting of the Light-spot Galvanometer

With zero voltage applied to the light-spot galvanometer (reduce amplitude of the signal generator to 0 or disconnect the patch cord from the signal generator or switch to another range), set the crosslines of the light spot

of the galvanometer precisely to the centre of the chart (mechanical zero) using a screwdriver. In the impedance-admittance chart the centre of the chart is the point $Z/Z_0 = 1$. The two slotted screws (15) and (16) serve for the VERTICAL and HORIZONTAL adjustments (Fig. 23).

6.4.2 Amplitude and Phase Adjustment for 2-terminal Network Measurement

Before starting the measurement, adjust the instrument with respect to amplitude and phase. If impedances, admittances or reflection coefficients are to be measured, short the coaxial reference line and the coaxial test line using short-circuit Dezifix connectors FZ 434. If, however, the effective transmission factor of a 4-terminal network is to be measured, proceed as described in section 7.6.2 or 7.6.3.

Make the amplitude and phase adjustment each time the frequency range is changed to maintain the accuracy specified under 1.1. For a long series of measurements check the two adjustments several times, especially during the first hour after the set has been switched on. When making the adjustment, use the measuring frequency which will be employed afterwards for carrying out the measurements, or a frequency in the middle of the range in which it lies.

6.4.2.1 Amplitude Adjustment

After tuning the Z-g Diagram to the signal-generator frequency, adjust the amplitude of the signal-generator frequency until the centre of the cross-
1. lines of the light spot comes to a standstill at the outermost circle of the chart. When this output of the signal generator is reached, the reference meter (6) should deflect to 100 (red line). If this is not the case, adjust
2. the knob marked REFERENCE VOLTAGE COR. (5) for a deflection to this value. If the signal generator has changed its frequency while the amplitude was adjusted, retune the signal generator.

6.4.2.2 Phase Adjustment

Small phase variations caused by minor differences in the reactances of the two mixers or by aging and the slight temperature response of the IF amplifiers result in an error of the phase angle of the reflection coefficient. These variations can be compensated for with the knob PHASE COR. (7).

For this purpose, insert a chart, preferably the one used later on for the measurement. With the aid of the PHASE ADJ. knob (13), turn the chart until the crosslines of the light spot, which after amplitude adjustment is on the greatest chart circle, appear at $Z_0 = 0$ (impedance measurement) or ∞ (admittance measurement), depending on the chart used. The chart holder should be in such a position that the black line of the plexiglass screen is at that side to which the light spot deflects. After having pressed the button *) (3) below the small meter, turn the PHASE COR. knob (7) so that the meter (4) shows maximum deflection. To check this adjustment, find the maximum once again by rotating the chart. The Z-g Diagram is ready for measuring if, at maximum deflection of the meter, the crosslines appear at the same place as before.

*) If this button is pressed, it remains down until it is released by being pressed anew.

7. Measuring

7.1 Frequency Adjustment

After the desired measuring frequency has been adjusted on the signal generator, throw the FREQUENCY RANGE switch (12) (Fig. 23) to the corresponding range. Now tune the built-in oscillator by means of the coarse-fine drive marked FREQUENCY (10). Do not press the button (3). During tuning, the pointer of the discriminator meter (4) moves from the right to the left stop and then back again. The tuning is completed when the pointer, coming from the right stop, is at the red mark. Unambiguous tuning is ensured since the incorporated automatic frequency control will always shift the oscillator away from the resonance point if the adjustment is made to the image frequency.

To find the correct adjustment easily, turn the tuning knob counterclockwise; the first large pointer deflection of the discriminator meter is the correct one. When turning the tuning knob, further deflections of the pointer will occur, due to mixing of signal-generator harmonics with harmonics of the oscillator of the Type ZDU. However, on account of their much smaller amplitude, these deflections are easily distinguished from the deflection caused by mixing with the fundamental.

The fine adjustment of the frequency is made using the larger one of the two knobs mounted on the same shaft (10).

7.2 Impedance Measurement

Insert the chart shown in Fig. 24 or Fig. 26 as an impedance chart, i. e., $Z/Z_0 = 0$ should be above the black line of the plexiglass screen. The chart is chosen according to whether the result is to be represented by its resistive and reactive components or by magnitude and phase. Connect the test item to the coaxial test line (9) while the coaxial reference line (11)

remains short-circuited. After adjustment for the desired measuring frequency, increase the input voltage until the pointer of the reference meter (6) deflects to 100 (red line). Once again check on the discriminator meter (4) that its pointer is still in the red range; if this is no longer the case retune the signal generator to the proper frequency. Press the button (3) and turn the PHASE ADJ. knob (13) until the pointer of the meter (4) is at maximum. Read the result on the chart or mark the point of intersection of the crosslines in pencil.

If, in the entire frequency range of interest, the crosslines of the light spot do not leave a circle around the centre with the values $\underline{Z}/Z_0 = 0.5$ or $\underline{Z}/Z_0 = 2$, insert a spread chart (Fig. 25 or 27) and switch (18) to INDICATION SPREAD. This means x3 magnification of the chart. The reference meter should be at full deflection, 100, (red mark) also for measurements in the spread range.

7.3 Admittance Measurement

Admittances are measured in the same way as impedances. The charts of Figs. 24 and 26, however, are inserted as admittance charts, i. e., so that $\underline{Z}/Z_0 = \infty$ is above the black line.

When using the spread range and the associated chart according to Fig. 25 or 27, insert this chart so that $\underline{Z}/Z_0 = 2$ is above the black line.

7.4 Investigating the Impedance or Admittance of Hard-to-get-at Items

Connect the test item to the coaxial test line (9) using a 50- Ω or 60- Ω or 75- Ω cable, respectively. Replace the short-circuit connector by a second cable of equal Z_0 and identical electrical length connected to the coaxial reference line (11). Insert the short-circuit Dezifix into the free end of this cable. Fig. 2 shows an example of such a test assembly. To check whether

the electrical lengths of the two cables are actually equal, short-circuit also the coaxial test line at its end, select the input voltage so high that the pointer of the reference meter deflects up to the red mark, press the button (3) and turn the chart until the meter (4) shows maximum deflection. The crosslines of the light spot should then again by on $Z/Z_0 = 0$ or $Z/Z_0 = \infty$, depending upon whether the chart has been inserted for impedance or admittance measurement. If the phase adjustment was carried out before this measurement, it immediately shows the difference in the electrical lengths of the cables.

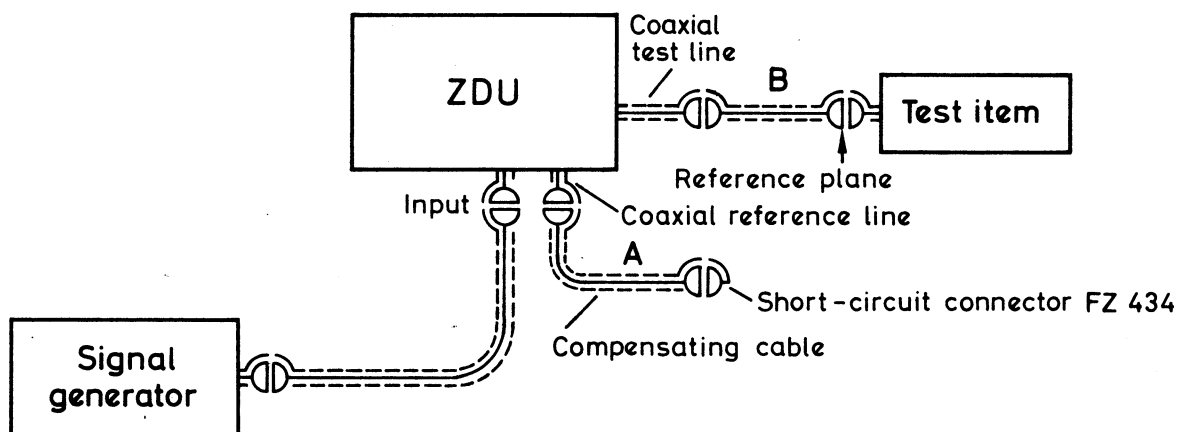


Fig. 2 Setup for impedance measurement on an item which is accessible only by means of a cable (A and B are a pair of 2-terminal measuring cables)

After the check has been completed, remove the short-circuit Dezifix connector from the measuring cable and connect the test item. Make the measurement as set forth under 7.2 or 7.3. The measured values read from the chart do not refer to the junction plane of the Dezifix connector at the Z-g Diagram, but to the junction plane of the Dezifix connector at the end of the cable connected to the test item.

As mentioned before, it is important for the accuracy of the measurement that the electrical lengths of the cables are equal and that their characteristic impedances are equal to that of the Z-g Diagram. Suitable cables,

i. e. pairs of 2-terminal measuring cables (see section 3.2), may be ordered from ROHDE & SCHWARZ.

Measurements with cables, of which the electrical lengths are not exactly equal, can be made if the phase shift is eliminated by adjusting the PHASE COR. knob (7). This adjustment must be made after each change of frequency.

7.5 Determination of the Complex Reflection Coefficient

Measure the complex reflection coefficient p_x , defined by the equation

$$p_x = \frac{\underline{Z} - Z_0}{\underline{Z} + Z_0}$$

with the coaxial test line terminated by a test item of the input impedance \underline{Z}_x , and proceed as in the impedance or admittance measurement set forth under 7.2 or 7.3. However, instead of the impedance chart, insert a chart bearing the inscription "Complex Reflection Coefficient Chart" (Fig. 28) in such a way that the angle of 180° is over the black line of the plexiglass screen.

If the reflection coefficient is not greater than 0.33 within the frequency range being investigated, the enlarged chart (Fig. 29) can be used. The measuring procedure remains the same. Switch (18) must be set to SPREAD.

7.6 Measurement of Transmission Characteristics of 4-terminal Networks

7.6.1 Definition of the Effective Transmission Factor

The effective transmission factor is the complex quantity

$$g_B = \log_e \frac{E_0}{2E_2} = a_B + jb_B,$$

the real component a_B [Np] being the effective attenuation and the imaginary

component b_B [radian] being the effective phase angle (cf R. Feldtkeller: Einführung in die Vierpoltheorie der elektrischen Nachrichtentechnik). The quantities E_0 and E_2 are defined according to Fig. 3.

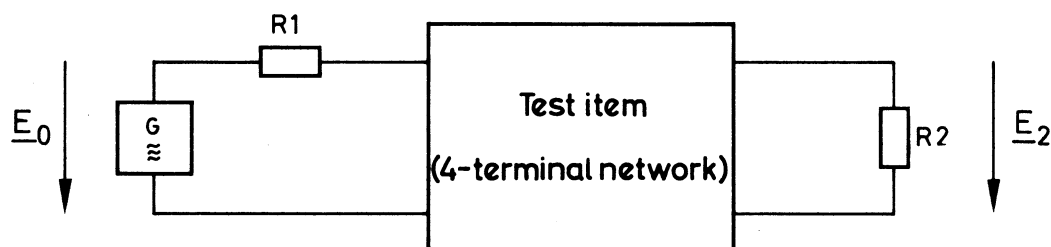


Fig. 3 Simplified diagram for the definition of the effective transmission factor

In the general case all the quantities, including $R1$ and $R2$, may be complex. The following instructions, however, are restricted to the case that $R1 = R2 = Z_0$, i. e. equal to the characteristic impedance of the Z-g Diagram and of the coaxial lines used in the test setup, since only under this condition can accurate results be obtained. Matching Pads Type DAF (section 3.4) can be used for measuring the effective transmission factor in test assemblies that contain source and load resistances differing from the characteristic impedance of the Z-g Diagram.

The transfer-constant chart (Fig. 30) is best used for measuring the effective transmission factor g_B or the effective attenuation a_B .

7.6.2 Measurement of Effective Attenuation Using the 4-terminal Feed Unit

Whereas the measurement of the effective transmission factor according to section 7.6.3 necessitates a T-section and two attenuator pads for feeding in the signal, the 4-terminal feed unit (section 3.3.1), which is less expensive, is sufficient when only the real component, i. e. the effective attenuation a_B is to be measured. Fig. 4 is the modified diagram of Fig. 3 depicting the measurement of effective attenuation with the help of the 4-terminal feed unit and Fig. 5 schematically shows the test setup.

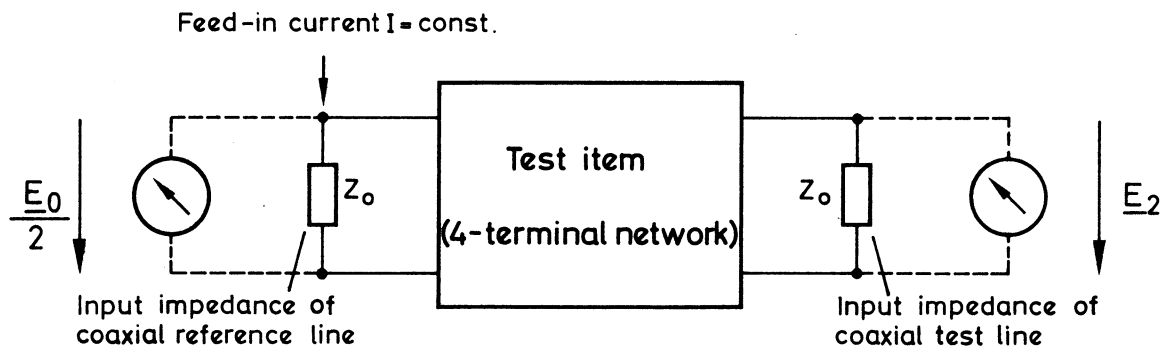


Fig. 4 Modified diagram of Fig. 3 depicting the measurement of effective attenuation with the help of the 4-terminal feed unit (section 3.3.1)

If the measurement is made according to Figs. 4 and 5, the source of the impedance Z_0 is represented by an impressed current in the input impedance of the coaxial reference line, which is transformed, without being changed, to the branching point via a matched cable.

Set up the test assembly according to Fig. 5 but without the 4-terminal network, i. e. connect the test cable B directly to the coaxial test line (9) (Fig. 23). Leave the input (14) of the Z-g Diagram open. Adjust the signal generator to the desired frequency and tune the Z-g Diagram. Then adjust the signal-generator voltage so that the light spot of the Z-g Diagram goes to the outer circle of the chart (0 dB). If the 4-terminal network is

now inserted in the test assembly the effective attenuation can be read directly on the transfer-constant chart (Fig. 30). The correct result is obtained only if the signal-generator voltage is not readjusted after insertion of the 4-terminal network when the indication of the reference meter has changed. Since the input impedance of the 4-terminal network may differ from Z_0 the voltage conditions at the branching point may be changed.

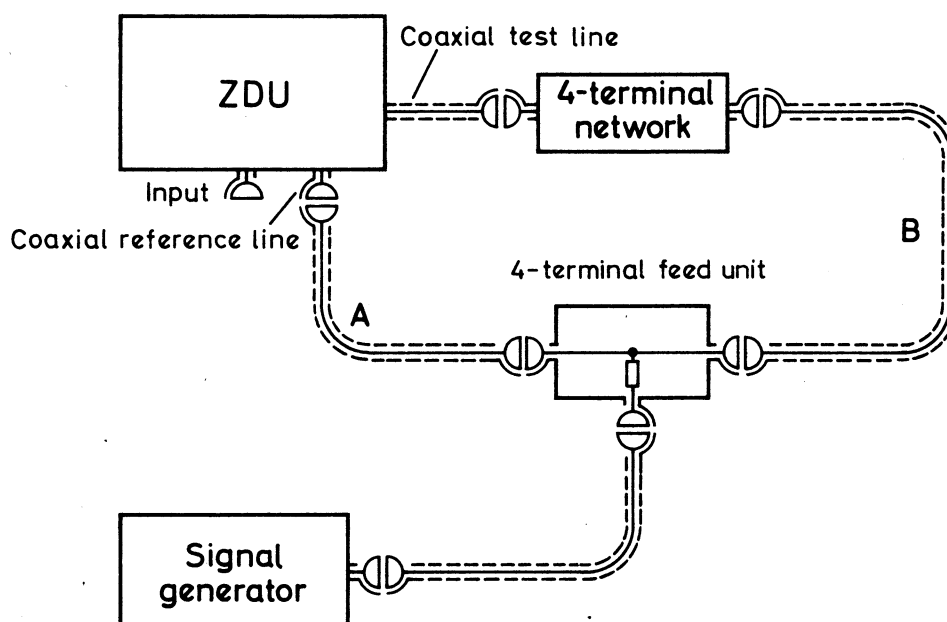


Fig. 5 Setup for the measurement of the effective attenuation a_B with the help of the 4-terminal feed unit (section 3.3.1) according to the simplified diagram of Fig. 4 (A and B are a pair of 2-terminal measuring cables according to section 3.2).

7.6.3 Measurement of Effective Transmission Factor Using Two Attenuator Pads and a T-section

Only if the input impedance of the 4-terminal network is not very different from Z_0 can the 4-terminal feed unit (section 3.3.1) be used for measuring the effective phase angle. Otherwise an error will occur which increases roughly linearly with the reflection of the 4-terminal network. If the input of the 4-terminal network presents a VSWR of, say, 1.4 the maximum error is 10° .

The setup shown in Fig. 6, which is a modification of Fig. 3, permits the exact measurement of effective attenuation and effective phase angle regardless of the input reflection of the 4-terminal network being measured. E_0 and E_2 can be read simultaneously on the Z-g Diagram.

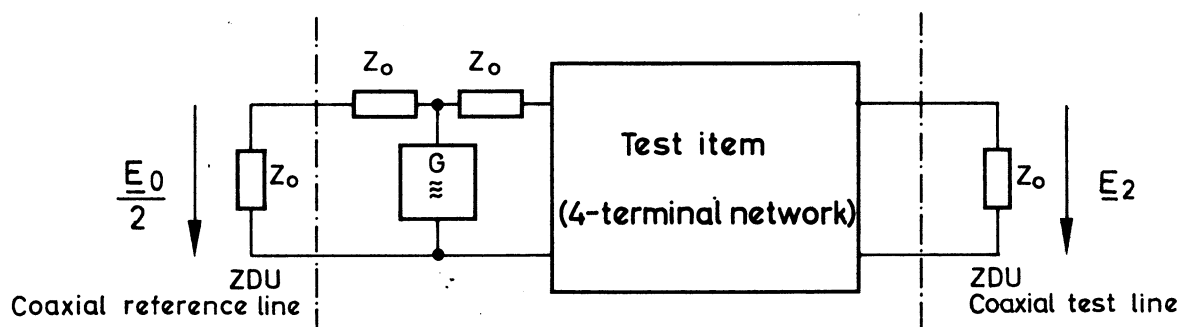


Fig. 6 Modified diagram of Fig. 3 depicting the measurement of the effective transmission factor with the help of two separate circuits

In the test setup of Fig. 7, the generator of Fig. 6, with the internal impedance $R_i = 0$ and the source impedance Z_0 connected ahead, is replaced by a generator of arbitrary internal impedance (preferably $R_i = Z_0$) and two equal attenuator pads of ≈ 20 dB (section 3.3.2.2).

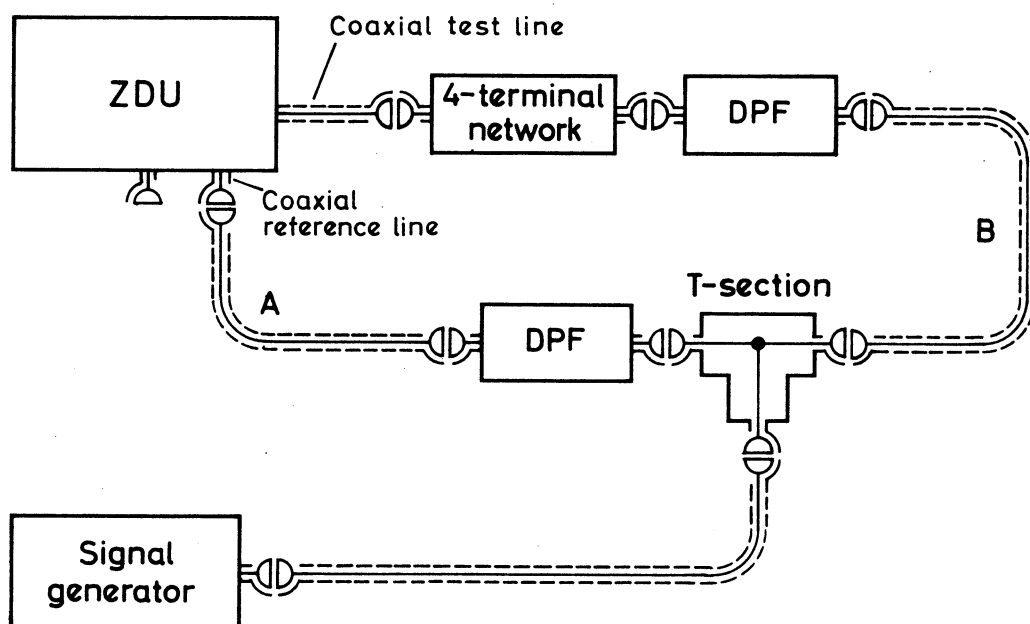


Fig. 7 Setup for the measurement of the effective transmission factor g_B with the help of a T-section and two 20-dB attenuator pads according to Fig. 6 (A and B are a pair of 2-terminal measuring cables according to section 3.2)

It is obvious that now the waves coming towards the inputs of the Z-g Diagram are equal in amplitude and phase. Also the condition that the source impedance must equal Z_0 is fulfilled with sufficient accuracy through the use of attenuator pads of ≈ 20 dB; even a short circuit at the generator would result in a source-impedance error of less than 2%.

The voltage E_0 present at the branching point of the T-section is measured in the coaxial reference line via a 20-dB attenuator pad and a cable of correct characteristic impedance and defined length. To compensate for the phase rotation caused by the cable and the attenuator pad and to make $R_i = Z_0$, a cable of equal electrical length and a similar attenuator pad must be connected into the test branch. The attenuator pad is best connected directly ahead of the 4-terminal network to reduce any residual cable errors. Since the inputs of the coaxial lines of the Z-g Diagram

present very accurate impedances, E_0/E_2 is measured at the coaxial reference line and E_2 at the coaxial test line. The quantities E_0 and E_2 are defined in Fig. 6.

The signal-generator voltage must be adjusted before the measurement. A correction of magnitude and phase on the Z-g Diagram may also be necessary. It is therefore best to set up the test assembly of Fig. 7 without inserting the test item, i. e. to connect the attenuator pad directly to the coaxial test line. Then insert the transfer constant chart and adjust the signal-generator voltage so that the light spot is on the 0-dB circle. Correct for magnitude and phase as described in sections 6.4.2.1 and 6.4.2.2. Insert the 4-terminal network into the test branch, adjust the phase of the Z-g Diagram and read the result in dB and degrees of angle on the chart. If the zero adjustment of the Z-g Diagram is valid over a whole frequency range the 4-terminal network need not be removed for calibration after every frequency change. It is in this case sufficient to adjust the signal-generator voltage so as to obtain the reading of 100 on the reference meter and to make the phase adjustment. The result can then be directly read on the chart.

7.6.4 Measurement of Effective Transmission Factor on Amplifying Test Items

The foregoing sections deal with the measurement on passive 4-terminal networks such as filters, attenuators, etc. Often the effective transmission factor of amplifying, i. e. active 4-terminal networks such as tunnel-diode amplifiers and travelling-wave tubes is also interesting. If an amplifying network is connected into the test assembly according to section 7.6.2 or 7.6.3 after the Z-g Diagram has been adjusted to 0° and 0 dB the light spot goes beyond the boundary of the chart. The test setup must therefore be modified according to section 7.6.4.1 or 7.6.4.2.

7.6.4.1 Measurement Using Attenuator Pad and Compensating Line

An attenuator pad which has an attenuation greater than the gain of the 4-terminal network being tested is to be connected in series. The attenuation and phase rotation of the attenuator pad can be determined by a separate measurement and entered into the final result by calculation.

If the electrical length of the attenuator pad is known a compensating line of correct characteristic impedance and equal electrical length can be connected ahead of the coaxial reference line. In this case only the attenuation but not the phase rotation of the attenuator pad enters into the result.

Compensating lines of 10 cm and 20 cm electrical length are available from R&S. An electrical length of 30 cm is obtained by series connection. Compensating lines of other length can be made according to the sets of drawings (LNB 023/L/50, LNB 023/L/60 and LNB 023/L/75) attached to this instruction book. R&S supply the necessary tubular line and the corresponding inner conductor in 50-cm sections for the characteristic impedances of 50, 60 and 75 Ω under the order designations LNB 05/50, LNB 050/60 and LNB 05/75, respectively. The designation LNB 05/75, for example, refers to a 75- Ω line (outer conductor 21 mm dia.) of 50 cm length, R&S also supply the necessary Dezifix elements; the corresponding R&S stock numbers can be found in the relevant parts lists.

Instead of the mentioned attenuator pad the Standard Attenuator Type DPU BN 18043 can be used for measuring amplifying items. Its electrical length is approximately 48 cm, largely independent of the attenuation setting. If a standard attenuator is provided in both the test branch and the reference branch it is possible to measure high positive or negative values of effective attenuation.

7.6.4.2 Measurement by Interchanging the Connections to the Coaxial Test Line and Coaxial Reference Line

Apart from the method described in section 7.6.4.1, a negative effective attenuation, i.e. gain, can be measured according to section 7.6.3 if, after adjustment of the Z-g Diagram to 0° and 0 dB and insertion of the 4-terminal network into the test branch, the connections to the coaxial test line and to the coaxial reference line are interchanged and the signal-generator voltage is so far reduced that the reading of the reference meter is again 100.

The measured quantity is then

$$\frac{2\underline{E}_2}{\underline{E}_0} = \frac{1}{r} e^{-j\varphi}$$

instead of

$$\frac{\underline{E}_0}{2\underline{E}_2} = r e^{j\varphi}$$

This method is described in more detail in section 7.11. Although this section deals with the measurement of negative impedance and admittance it also applies to the measurement of active 4-terminal networks.

7.6.5 Scattering Matrix

The scattering matrix is now frequently used above all in American literature for describing n-port networks (2n-terminal networks) such as directional couplers, filters, magic T's, etc.

The scattering matrix serves to calculate the waves reflected and transmitted by n-port networks as functions of the terminating loads and of the incident waves of the individual ports. A port corresponds to a reference plane for the measurement. One wave enters and one wave leaves every

port. The ratio of the two waves is determined by the connected 2-terminal networks.

In linear arrangements a linear relation exists between the incident waves

$$a_1 \dots a_n$$

and the reflected waves

$$b_1 \dots b_n;$$

for a 3-port, for example:

$$b_1 = S_{11} a_1 + S_{12} a_2 + S_{13} a_3$$

$$b_2 = S_{21} a_1 + S_{22} a_2 + S_{23} a_3$$

$$b_3 = S_{31} a_1 + S_{32} a_2 + S_{33} a_3$$

or as a matrix

$$\begin{pmatrix} b_1 \\ b_2 \\ b_3 \end{pmatrix} = \begin{pmatrix} S_{11} & S_{12} & S_{13} \\ S_{21} & S_{22} & S_{23} \\ S_{31} & S_{32} & S_{33} \end{pmatrix} \begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix}$$

$$(b) = (S) \times (a)$$

It is found by comparison that S_{11} , S_{22} , S_{33} are complex reflection coefficients referred to the chosen reference planes, say the connection planes of a directional coupler, and that S_{12} , S_{21} , S_{13} , S_{31} , S_{23} , S_{32} are the complex effective transmission factors between the individual ports of the n-port if all other ports not involved in the measurement are terminated with zero reflection coefficient, i. e.

$$b_i/a_i = 0.$$

The scattering matrix is suitable to describe passive, reciprocal and non-reciprocal, as well as active elements (gyrators, amplifiers).

The Z-g Diagram is very useful for determining the elements of the scattering matrix since it indicates them directly on suitable charts.

7.7 Measuring the Phase Angle of Two Voltages of Identical Frequencies

When making investigations on directional antennas (straight groups, circular groups, etc.) and compensators, it is often necessary to determine the phase angle between two voltages of identical frequencies. After the amplitude and phase have been adjusted, apply one of the two voltages to be compared to (9) (Fig. 23), and the other to (11) (input impedance Z_0). Press the button (3) and, by turning the PHASE ADJ. knob (13), bring the pointer of the meter (4) to a maximum deflection. The result is then shown on the transfer constant chart (Fig. 30). In the case of an angle between 0 and 180° , the voltage applied to the coaxial test line is retarded by the measured angle in relation to the voltage present at the coaxial reference line. With angles between 180° and 360° , the conditions are reversed. The specified measurement accuracy holds under the assumption that the voltages applied deflect the spot galvanometer and the reference meter by at least 50%. If the voltages are too high, insert attenuator pads in both leads. The input 14 at the front panel remains open.

7.8 Using the Spot Galvanometer Section as a Linear Test Receiver

The input requirement of the coaxial test line is about 20 mV for full-scale deflection. The indication can be made either on a linear scale (reflection coefficient chart) or on a logarithmic scale (transfer constant chart), depending upon which of the two charts is used.

7.9 Measurements on Transistors

Similarly to the electron valve, a transistor can be treated as a 4-terminal network. For this reason it can be tested with the Z-g Diagraph like a 4-terminal network, i. e., the input and output impedances or admittances and the transmission characteristics can be measured as in any 4-terminal

network, thus permitting the determination of the 4-terminal network parameters in the high frequency range in question.

Due to the small size of the transistors, their connection to the Z-g Diagram causes some difficulties, since the section of line between the coaxial test line and the transistor connection should have a characteristic impedance of Z_0 , if possible, up to the pin. To this end, an adapter has been developed which meets these requirements and which, moreover, finds many other applications. This adapter serves for measuring the input impedances or admittances of transistors with three or more electrodes as set forth in sections 7.2 and 7.3 or their 4-terminal network transmission characteristics as outlined in section 7.6. The often necessary impedance and admittance measurements, during which the output electrodes of the 4-terminal network are short-circuited or open for RF signals, can be made in a simple manner. Finally, this adapter also permits testing of diodes, chokes, resistors and other small circuit elements.

The Coaxial DC Feed Section with Capacitive DC Separation (BN 35616-2), which is supplied as an accessory unit to the Transistor Adapter (BN 35616) and is necessary for the measurement on transistors, can also be used without the adapter, if the test items must be fed with direct current. The electrical length of the Coaxial DC Feed Section is eliminated by a special compensating line.

7.10 Measurement with Reduced Voltage

If too high an AC voltage is applied, say, for measuring the input impedance of a receiver, the measurement result will be incorrect due to overdriving. In the same manner, erroneous results may occur if the transistor is driven into the saturation region.

To avoid this error, reduce the voltage applied to the unknown to one third. Proceed as follows: short the coaxial test line and the coaxial reference

line, reduce the generator voltage and insert a "normal" impedance-admittance chart (Fig. 24) into the chart holder. Switch to INDICATION SPREAD. This makes the galvanometer three times as sensitive as before. Adjust the generator voltage so that the crosslines of the light spot are on the outermost chart circle. Due to the higher galvanometer sensitivity, this is the case with one third of the generator voltage required for INDICATION NORMAL. The reference meter, therefore, gives one third of its full-scale deflection. Take this voltage as reference in the following measurements. To facilitate the adjustment and to increase the accuracy, adjust for an even value on the reference meter, using the REFERENCE VOLTAGE COR. knob.

7.11 Measurement of Negative Impedance and Admittance

Negative impedances occur in elements whose current-voltage characteristic is partly falling. Fig. 8 shows the characteristics of the two possible types of negative impedance, namely the electric arc and the element group, for example the tunnel diode.

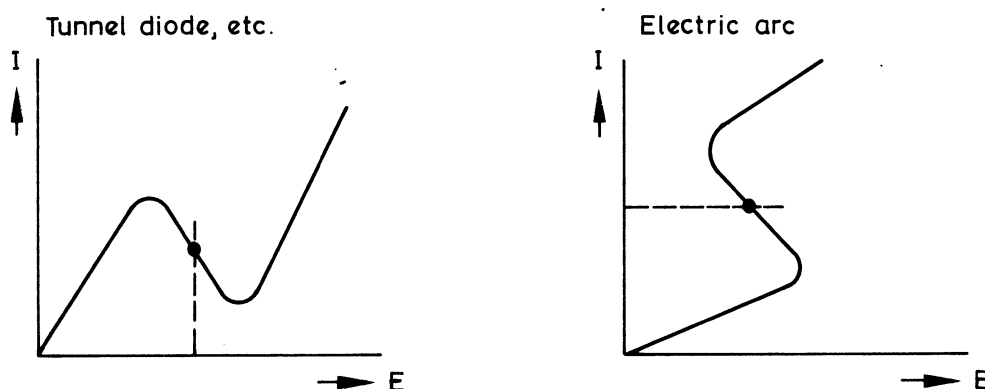


Fig. 8 Characteristics of the two possible types of negative impedance

Tunnel diodes have gained great importance at very high frequencies. A reliable and quick measuring method is therefore of great value. The measurement is best based on the directional-coupler principle since it is the only way to find, in addition to the magnitude of the impedance or

admittance, whether its real component is positive or negative. Since the Z-g Diagraph uses coaxial directional couplers it is suitable for measuring impedances and admittances having a negative real component. A directional coupler is the only means of determining whether the amplitude of the incident or the reflected wave is greater, whereas a slotted line always shows a standing wave irrespective of whether the real component of the terminating admittance is positive or negative. Thus it is impossible to determine whether the amplitude of the incident or reflected wave is greater, and consequently whether a positive or negative real component is concerned.

An impedance of the tunnel-diode type, presenting a falling voltage-current characteristic, requires a suitable parallel admittance for stable operation. This admittance is represented by attenuator pads in both the coaxial test line and the coaxial reference line. The Z-g Diagraph thus permits the direct measurement of such test items up to the reciprocal of its characteristic impedance (50Ω , 60Ω , 75Ω). Higher negative admittances can be measured by connecting a suitable positive admittance in parallel to the test item and eliminating it from the measured result by calculation. The additional positive admittance must be so proportioned that together with that of the coaxial test line or the coaxial reference line it is equal to or greater than the negative admittance of the test item.

If an admittance with a negative real component is connected to the Z-g Diagraph in the normal way, the light spot goes beyond the outer circle of the chart. The measurement is nevertheless possible if the connections are changed, i. e. the test item is connected to the coaxial reference line and the coaxial test line is shorted. The reference meter gives a reading > 100 which is to be adjusted to 100 by reducing the signal-generator voltage. After the ordinary phase adjustment the negative impedance or admittance can be read on the chart. The impedance or admittance is referred to the negative impedance Z_0 (50Ω , 60Ω or 75Ω) or to the negative admittance Y_0 .

The connection of a tunnel diode to the Z-g Diagram via a DC feed section is shown in Fig. 9. The compensating line inserted between the coaxial test line and the short-circuit compensates for the electrical length of the DC feed section. If the test item is connected directly to the coaxial reference line without a DC feed section the short-circuit is also to be connected directly to the coaxial test line.

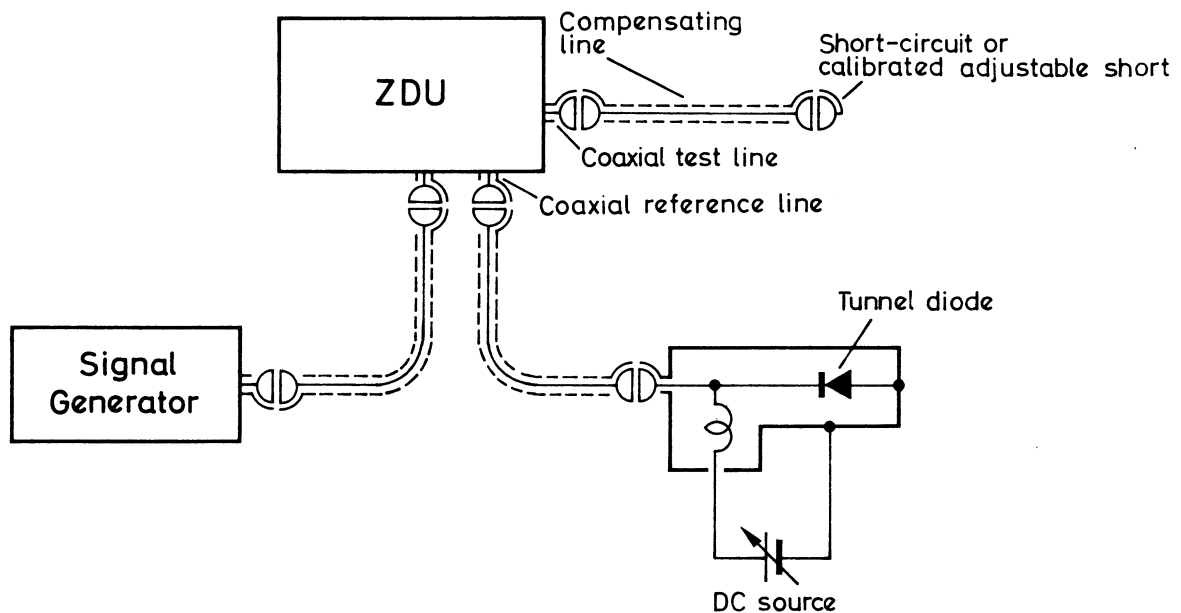


Fig. 9 Connection of a tunnel diode to the Z-g Diagram via a DC feed section for impedance and admittance measurement

The described method for measuring impedances or admittances with negative real components is based on the following fact:

normally the Z-g Diagram measures the complex reflection coefficient

$$r e^{j\phi} = \frac{1 - \left(\frac{R}{Z_0} + j \frac{X}{Z_0} \right)}{1 + \left(\frac{R}{Z_0} + j \frac{X}{Z_0} \right)}$$

This expression is greater than unity if $\frac{R}{Z}$ is negative. A reflection coefficient > 1 cannot be measured with the Z-g Diagram since the light spot goes

beyond the outmost circle of the chart. The reciprocal is therefore measured by interchanging the connections:

$$\frac{1}{r} e^{-j\phi} = \frac{1 + \left(\frac{R}{Z_0} + j \frac{X}{Z_0} \right)}{1 - \left(\frac{R}{Z_0} + j \frac{X}{Z_0} \right)}$$

This value is less than unity for negative R values and can therefore be measured. The method is equivalent to the introduction of a negative reference impedance $-Z_0$.

The introduction of a negative reference impedance has the following effects in the representation of the result in impedance-admittance charts:

- (a) The chart is oriented counterclockwise. This means that the curve representing the impedance of a line section as a function of frequency runs counterclockwise with increasing frequency.
- (b) The imaginary component changes its polarity because of the negative reference impedance. A point on the outer circle of the chart lying in the region of positive imaginary components for a positive reference impedance (Fig. 10 a) appears in the region of negative imaginary components with a negative reference impedance (Fig. 10 b).

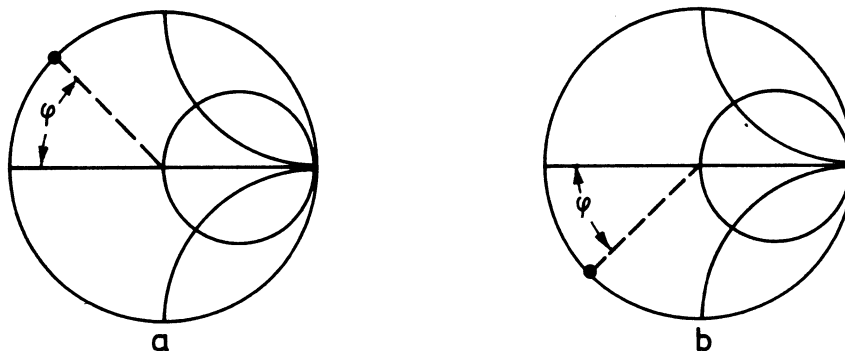


Fig. 10 Effect of the negative reference impedance on the imaginary component of an impedance or admittance

- (c) As mentioned above, the negative reference impedance is obtained by interchanging the coaxial test line and the coaxial reference line. The chart remains in its normal position in the chart holder. If the reading obtained on the chart is, say,

$$\frac{R + jX}{(-Z)} = 0.3 + j0.7$$

the true impedance is

$$R + jX = 0.3Z - j0.7Z$$

where $Z > 0$.

- (d) When the impedance curve of a tunnel diode is plotted as a function of the DC bias at a fixed frequency, some parts of the curve will lie in the positive and others in the negative impedance region. A typical curve is shown in Fig. 11.

The positive and negative real components can be shown immediately adjacent to each other if the chart is turned over on its axis while making the $\frac{1}{r}$ measurement with interchanged coaxials, so that the matte side comes against the plexiglass screen. The curves can then be traced with a grease pencil or something similar.

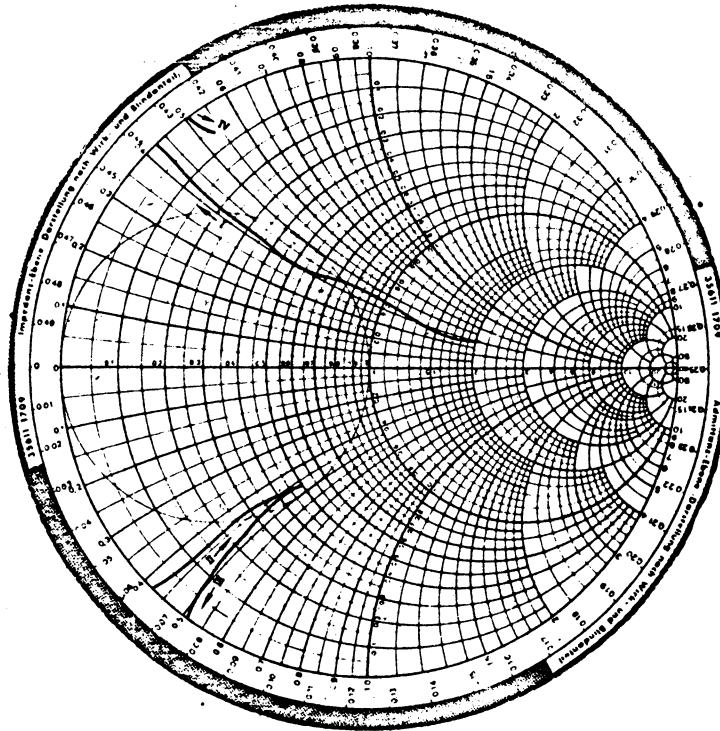


Fig. 11 Impedance curve of a tunnel diode as a function of DC bias. I and IV are portions with a positive real component (measured in the normal way), II and III are portions with a negative real component (measured with the coaxial test line and coaxial reference line interchanged).

7.12 Measurement with Higher or Variable Voltage Levels

The Z-g Diagram requires a fixed voltage for indication. It is so proportioned that the reference meter or the mirror galvanometer gives full deflection for a reflection coefficient $r = 1$. This voltage corresponds to a level at the test item of about 20 mV at normal indication and about 7 mV at spread indication. Certain measurements, however, require a higher voltage at the test item, for example:

- (a) Investigations on valves.

- (b) Investigations on power transistors used for large-signal operation. The test voltage level must in this case correspond to the levels encountered in large-signal operation. The results obtained with small-signal values are not valid for large-signal operation.
- (c) Measurements on items exposed to relatively high noise levels. If it is impossible to shield the test item the test voltage level must be so high that the noise level has no intolerable influence on the result. It is, of course, necessary that the test item withstands the test voltage level. An example is the measurement of input impedance or admittance of an antenna in a transmitter station where neighbouring transmitting antennas are operating.

Since it is impossible to increase the voltage level in the Z-g Diagram because of the required fixed voltage, two external directional couplers must be connected each via a standard attenuator to the coaxial test line and the coaxial reference line, respectively. Suitable directional couplers can be supplied by R&S; please enquire in the case of need. Fig. 12 shows a test assembly for any kind of test item, Fig. 13 for impedance measurement on transistors and Fig. 14 for the measurement of 4-terminal parameters of transistors.

If the signal generator supplies sufficient power and if the directional couplers present a suitable coupling attenuation this test setup permits measurements up to very high power. For example, the impedance of an antenna under the effect of hoarfrost, ice, etc. can be measured in CW operation if suitable check points for the connection of the directional couplers are available on the transmitter.

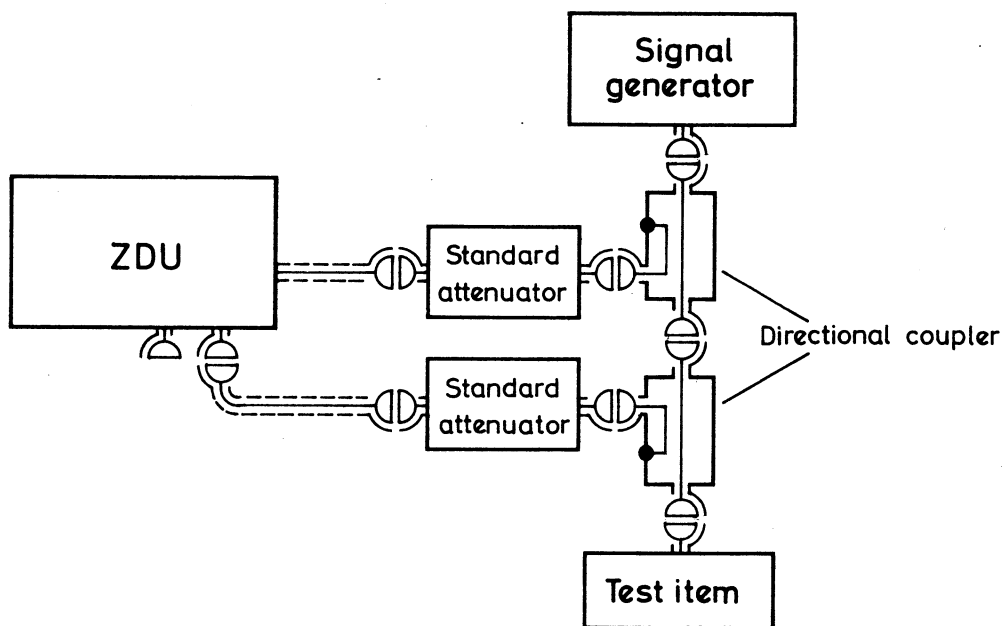


Fig. 12 Test setup for measurement with higher test voltage

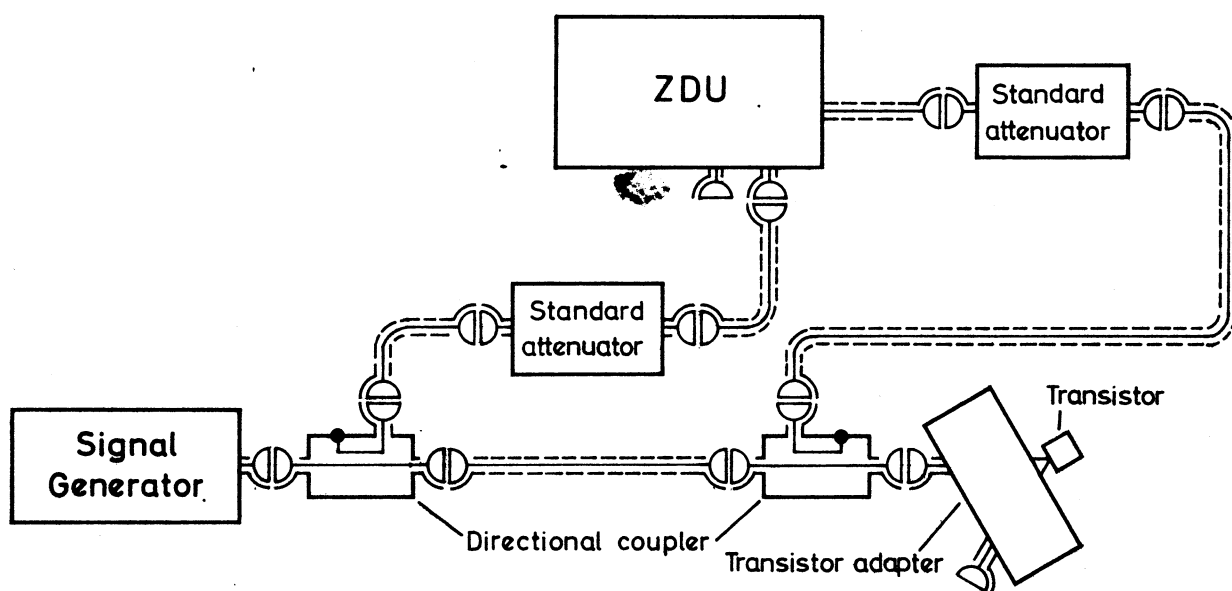


Fig. 13 Test setup for impedance measurement on transistors with higher test voltage

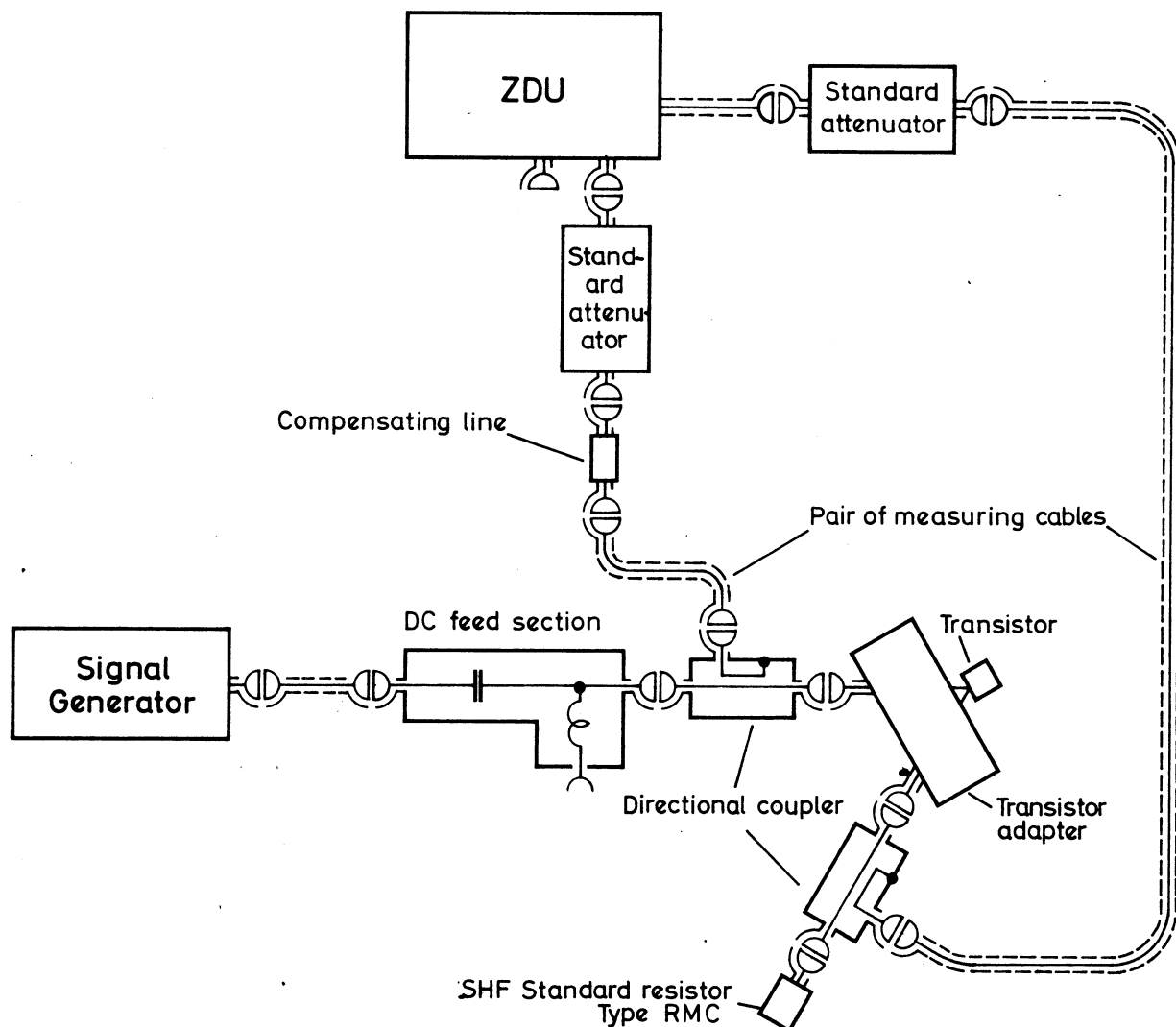


Fig. 14 Test setup for the measurement of transmission characteristics of transistors with higher test voltage

7.13 Measurement of Balanced Items

Since the coaxial test line of the Z-g Diagram is unbalanced, measurements of balanced test items can be made only when a balun is connected between the test item and the set. For test items with the same characteristic impedance as the Z-g Diagram in use ($50\ \Omega$, $60\ \Omega$ or $75\ \Omega$), the Broad-band Baluns Type BSU shown in Fig. 15 are very suitable. They are supplied in various models with different frequency ranges and with different

types of connection on the balanced side, as shown in the table in section 3.8.



Fig. 15 Broadband Baluns Type BSU

Balanced test objects frequently have high characteristic impedances ($200\ \Omega$, $240\ \Omega$ or $300\ \Omega$) corresponding to those of commercial strip transmission lines. In order to enable such items to be measured with the Z-g Diagram, a balanced Impedance Transformer Type BSI (Fig. 16) is connected between the set and the test item. This not only balances the coaxial test line but also transforms the characteristic impedance.



Fig. 16 Impedance Transformer Type BSI

Type BSI is available in nine models, differing in the characteristic impedance and frequency range. Six of them are listed in section 3.7, and these are suitable for use with Z-g Diagraph Type ZDU. The characteristic impedance of the unbalanced side of Type BSI must always be the same as that of the Z-g Diagraph employed. For instance, a Type BSI BN 90634/240 or BN 90635/240 with $60\ \Omega$ on the unbalanced side and $240\ \Omega$ on the balanced side matches a Z-g Diagraph Type ZDU having $Z = 60\ \Omega$.

7.14 Measurement of Material Characteristics

The measurement of the material characteristics ϵ_r , $\tan\delta_\epsilon$, μ and $\tan\delta_\mu$ is indispensable for the use of permeable and dielectric materials in RF engineering. Since these material characteristics are closely related to the molecular structure their behaviour depending on frequency and temperature permits conclusions to be drawn on mechanical and chemical properties. On the other hand, they help to find new methods of surveying and controlling chemical processes. The material characteristics measurements thus gain growing importance.

The four material characteristics are determined from impedance measurements and the specimen dimensions. The Z-g Diagraph Type ZDU is suitable as an impedance meter especially for measurements on materials with heavy attenuation, but not on very low-loss materials (small $\tan\delta_\epsilon$).

In addition to the Z-g Diagraph as impedance meter and a suitable signal generator, the material characteristics measurement requires a specimen container. Various models of specimen container are available. The description of the measurement and calculation of the material characteristics would go beyond the scope of this instruction book. The theory is treated in detail in the Kurzinformation 3-4/1962 and in the two papers by Dr. R. Eichacker:

- (a) A Material-Characteristics Test Assembly for Determining the Electromagnetic Material Constants of Solid and Liquid Media

at Frequencies between 30 and 7000 Mc and Temperatures between -60 and +240°C (R&S-Mitteilungen No. 11/December 1958)

- (b) Measurement of Material Characteristics Using Standing-Wave Detectors (R&S-Mitteilungen No. 15/April 1961)

Reprints of the two papers and No. 3-4/1962 of Kurzinformation can be obtained from R&S. It may also be interesting that ready-made programmes for IBM computers exist for the calculation of the material characteristics from the measured impedance values and the specimen dimensions.

7.15 Cable Measurement

7.15.1 Definition of the Quantities Characteristic Impedance, Attenuation, Propagation Velocity and Homogeneity

RF cables are designated by their characteristic impedance, attenuation and propagation velocity.

Also, to an increasing degree, the homogeneity plays a role as a measure of the constancy of these quantities and thus is a measure of the quality and usability of any given cable.

The homogeneity of a cable is determined by its structural and constructive make-up and is closely related to the wavelength at the operating frequency. Thus a coaxial cable with inner-conductor supports of Trolitul spaced periodically along its longitudinal axis is not homogeneous when the spacing is comparable with the operating wavelength; however, the line becomes quasi-homogeneous when the spacing is much smaller than the operating wavelength.

Almost all RF cables today are homogeneous with reference to their structure using materials such as Mipolan, Lupolen, polyethylene and Moltopren. The irregularities detectable on such cables are attributed to various

defects in manufacture, e. g., deviations in the outer diameter of the insulation, air bubbles and pockets, variations in winding pitch in the case of braided outer and stranded inner conductors of flexible cables. All of these defects are aggravated by continuous flexing movements. For this reason, appropriate acceptance tests must be made.

If the irregularities mentioned are periodic or statistically distributed along the cable, this causes variations in the three quantities characterizing the cable. Therefore, in addition to the general definition of the characteristic impedance,

$$Z \approx \sqrt{L'/C'} \quad (1)$$

it was decided (par. 2.8 of the IEC Recomm. 96-1, 1958) that an average characteristic impedance Z_m and an effective characteristic impedance \underline{Z}_e should be differentiated. The average characteristic impedance Z_m is defined as the arithmetical mean of the characteristic impedance for successive sections of cable.

The effective characteristic impedance \underline{Z}_e can be thought of as the input impedance of an infinitely long cable, this input impedance being caused by structural irregularities and measured at the operating frequency. For an infinitely long cable one could substitute a cable of such a length that its attenuation has a value of at least 20 dB.

This "effective characteristic impedance", i. e., the input impedance at any given test frequency, can under certain circumstances deviate substantially from the "average characteristic impedance", above all at frequencies whose wavelength along the cable is equal to twice the spacing of a periodic irregularity. Depending upon the regularity with which such an inhomogeneity is repeated, the peaks of the \underline{Z}_0 variations as a function of frequency have varying sharpness. Such peaks occurring in the frequency range of the intended energy transmission may render it impossible to use the cable.

In addition to determining the three basic constants Z_m , α and v , checks are now being made to determine the homogeneity using impedance measuring equipment or directional couplers. Since irregularities are especially noticeable in Z and α , it is sufficient to investigate only one of these two quantities. This is usually the characteristic impedance.

The attenuation of a cable is the logarithm of the ratio of the input power (P_1) to the output power (P_2) of a cable for a pure incident wave.

$$\alpha = \alpha_l = \frac{1}{2} \lg \frac{P_1}{P_2} = \left(\frac{R'}{2Z} + \frac{G'Z}{2} \right) l \quad (2)$$

where l is the physical length of the cable.

The cross-talk or coupling attenuation of a cable determines, referred to the primary power, the power induced by the cable being tested in another cable through direct or electromagnetic coupling.

The phase constant β , propagation velocity v and the electrical length l_e can all be determined from the relationship

$$v = \frac{1}{\sqrt{L'C'}} = \frac{\omega}{\beta} = c \frac{1}{l_e} = \frac{\lambda_k}{\lambda_o} \quad (3)$$

7.15.2 Determining the Characteristic Impedance

(see Mil C 17 B, 4.6.16 and IEC Publ. 96-1, 2.8 and 2.9)

7.15.2.1 Mean Characteristic Impedance Z_m

The usual method for determining Z_m from the distributed capacitance per unit length c' (measured at the low frequencies f_n) and the phase velocity v (measured at the operating frequency f) is only then reliable when the medium between the inner and outer conductor is exactly known and when the dielectric constant between f_n and f is practically independent of the fre-

quency. If this is true, in the most favourable case only one measurement is sufficient at the operating frequency to determine the mean characteristic impedance Z_m (section 7.15.2.1.1).

The method using the Calibrated Adjustable Short according to section 7.15.2.1.2 is somewhat more time consuming than the above method, but has the advantage that Z_m can be determined directly at the operating frequency without any limiting assumptions (dielectric constant does not change between f_n and f as described in section 7.15.2.1.1). A further advantage can be seen in the simultaneous determination of the cable attenuation (section 7.15.3).

Moreover, Z_m can be determined from the mean value of a large number of effective impedance values Z_e measured at frequencies at close intervals throughout the band of interest as long as this band is wide enough to provide an impedance curve with a sufficient number of deviations from its mean value.

7.15.2.1.1 Determining Z_m from the Phase Velocity v and the Capacitance C

Insertion of equation (3) and (1) gives

$$Z_m = \frac{1}{vC'} = \frac{1}{vC_{\text{total}}} \quad (4)$$

The capacitance $C_{\text{total}} = C' l$ of the cable is measured at a low frequency using a bridge of high accuracy; the phase velocity v is measured at the desired test frequency according to section 7.15.4.

Insertion of the relationship (16) found in section 7.15.4 in equation (4) gives

$$Z_m = \frac{1}{2\Delta f C_{\text{total}}} \quad (5)$$

This equation shows that Δf is constant with a given C_{total} and Z_k . The lowest frequency for a $\lambda_k/4$ resonance is $f_{\text{min}} = \frac{\Delta f}{2}$.

Equation (5) may therefore be written as follows:

$$Z = \frac{1}{4 f_{\text{min}} C_{\text{total}}} \quad (6)$$

Cables to be measured should not be more than 30 to 50 λ_k in length.

This is the most accurate method of determining the average characteristic impedance Z_m .

In addition to an error of 0.1 to 0.2% in the C_{total} , an error for v which is identical with the error of a frequency measurement must be considered. Accuracies of several tenths of a per cent may be obtained when using such equipment as the Frequency Synthesizer Type XUA, BN 444463 as a standard signal generator with high stability, or a frequency meter with an error less than 0.1%, e. g. Type WAL BN 4321/2.

In contrast to all other possible measuring techniques, the measuring accuracy is negligibly affected by irregularities. The reason for this is that periodic or statistically distributed irregularities in the cable cause variations in L' and C' which are opposite to one another. Thus the characteristic impedance is very highly affected while the phase velocity is practically the same. Even if an additional phase shift is produced by impedance transformation at the points where irregularities occur, this will be less than the impedance disturbance.

7.15.2.1.2 Cable Input Impedance when Terminated with an Adjustable Short

If, with a constant test frequency, the short-circuit piston of the adjustable short is moved through a half wavelength, the locus of all input impedances is obtained as a circle in a Smith chart. The centre point with its real component gives the mean characteristic impedance Z_m .

The most satisfactory length of cable is only a few metres for determining Z_m . The minimum attenuation of the cable should be approximately 1.5 dB. In no case should the entire attenuation of the cable be more than approximately 6 dB for impedance averaging by the node-shift method. In the case of cables which are too long, the effective characteristic impedance is measured instead of the average characteristic impedance.

7.15.2.2 Effective Characteristic Impedance Z_e

Measurements of Z_e and Z_m are justified in all those cases in which a doubt exists as to the frequency independence of the dielectric constant of an insulating material, or if a dispersion of the cable impedance appears possible because of the cable construction. In particular, such measurements will be useful if the actual input impedance of a long, terminated cable is to be determined.

The average characteristic impedance is obtained in the same manner using one of the three methods (7.15.2.2.1 - 3) by taking the average of a large number of individual measurements obtained at frequencies lying close to one another.

7.15.2.2.1 Short- and Open-Circuit Measurements

The input impedance \underline{Z}_K of a short-circuited section of cable with a characteristic impedance Z is

$$\underline{Z}_K = Z \tanh \gamma l \quad (7)$$

For an open-circuited cable, the following equation is valid

$$\underline{Z}_L = Z \coth \gamma l \quad (8)$$

Taking into account that the characteristic impedance is always practically inhomogeneous, the effective characteristic impedance is obtained from the measured open and short-circuit impedances.

$$\underline{Z}_e = \sqrt{\underline{Z}_K \underline{Z}_L} \quad (9)$$

The lengths of cable used for the measurement should be $(2k - 1) \lambda_K / 8$; ($k = 1, 2, 3, \dots$), i. e., in the most favourable range for measuring the reactance (small influence due to errors in length).

7.15.2.2.2 Input Impedance of Very Long Cables

In the case of long cables with an attenuation over 20 dB, the short-circuit and open-circuit input impedances become practically the same so that it is only necessary to make one measurement with any type of termination. The effective characteristic impedance \underline{Z}_e is then

$$\underline{Z}_e = \underline{Z}_K = \underline{Z}_L \quad (10)$$

7.15.2.2.3 Cables of Medium Length, Match-terminated

In the case of cables of medium length, it is possible to get by with only one measurement of the input impedance if provision is made for the attenuation of the reflected wave by proper termination. The cumulative effects of periodic irregularities, which cause a deviation of Z_e from Z_m , can only be sufficiently detected when the attenuation of the cable section is at least 20 dB.

7.15.2.3 The Influence of the Connector on the Z Measurement

In the four measurement possibilities described above, it was assumed that the connector used to terminate the cable has the same characteristic impedance as the cable under investigation. In practice, this is not always the case. The connector can - although it is itself homogeneous - have another absolute value of characteristic impedance. It can also be badly mounted and thus cause a series inductive or a parallel capacitive component between the cable and connector. If the connector is itself inhomogeneous (e. g., poorly compensated supports), and in addition is badly mounted, the evaluation of the above measurements can be substantially more difficult. If a result which is difficult to ascertain lies in the VHF-UHF range, it is best to lower the test frequency so far that the entire disturbance is much less than λ in order to obtain an average evaluation.

In the following paragraphs, typical examples are given for the determination of the effective characteristic impedance and the evaluation of the respective impedance charts.

7.15.2.3.1 Homogeneous Cable with a Reactive Discontinuity only at the Input, Discontinuity much less than λ

Z errors of the connector, defective mounting or equalization of the supports manifest themselves as concentrated series inductances or parallel capacitances under the assumption that the discontinuity is much smaller than the wavelength. Since the cable is assumed to be homogeneous, the mean characteristic impedance and the effective characteristic impedance are the same.

In the case of measurements according to 7.15.2.2.1 - 3, the input impedance of the cable in the Smith chart, as shown in Fig. 17a, is depicted as a point whose real component is the cable Z_0 and whose reactive component is the inductive discontinuity of the connector. In case b (capacitive discontinuity caused by connector), the characteristic impedance Z_m is designated by the intersection with the real axis of a circle which passes through $Z = 0$ and the measured value b since this involves a shunt quantity.

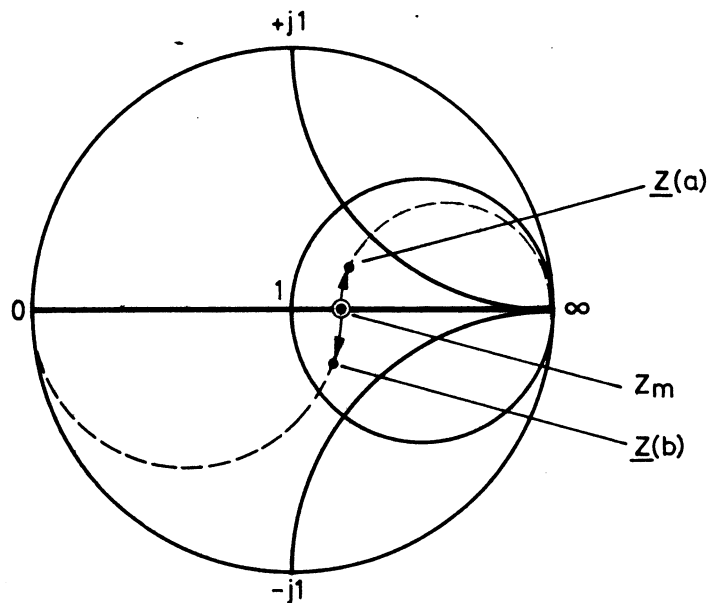


Fig. 17 Cable input impedance \underline{Z} with discontinuity at one end
(a) Inductive discontinuity,
(b) Capacitive discontinuity

7.15.2.3.2 Homogeneous Cable with a Reactive Discontinuity at the Input and at the Output, Discontinuity much less than λ

In contrast to section 7.15.2.3.1, in this case both ends of the cable have discontinuities. A single measurement according to one of the methods 7.15.2.2.1 - 3 is not sufficient to evaluate the result. Measurements made at close frequency intervals (e. g. f_1 to f_6) result in a circle around $Z(a)$ or $Z(b)$ whose diameter depends upon the amount of reflection from the end of the cable. In the case of long-length cables, the reflected wave is attenuated so that the points $Z(a)$ or $Z(b)$ are again obtained. Evaluation of $Z(a)$ and $Z(b)$ is made according to section 7.15.2.3.1.

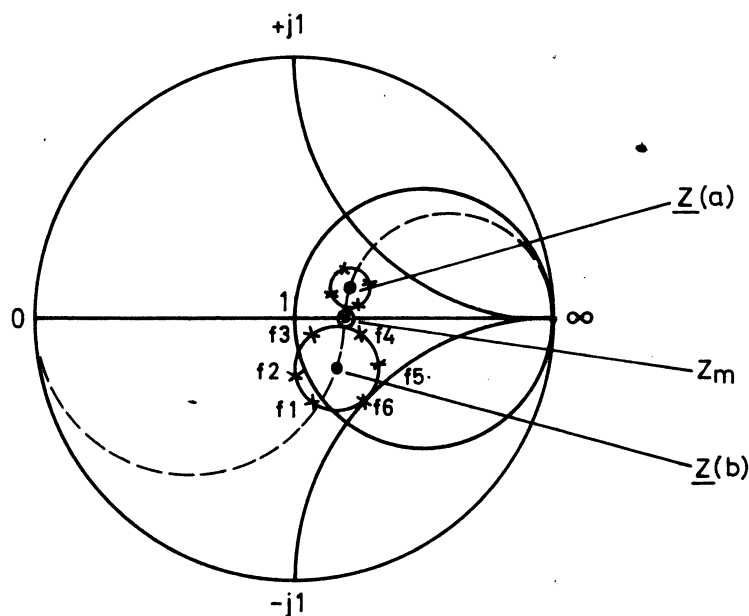


Fig. 18 Cable input impedance Z with discontinuities at both ends (frequency as parameter) for
 (a) Inductive discontinuity at input,
 (b) Capacitive discontinuity at input of cable with a characteristic impedance Z_m .

The reflection from the output discontinuity is in the case of (b) much greater than in the case of (a).

In order to obtain a circle, five or six points should be measured, the frequency interval being estimated very simply from the electrical length of

the cable and the operating wavelength. A circle may be obtained from a total frequency variation of

$$\frac{\Delta f}{f} \approx \frac{\lambda K}{2l} \quad (11)$$

This frequency interval is then divided into approximately five or six equal periods. In order to check the homogeneity of a cable, several circles should be obtained, all circles being the same in the case of a perfectly homogeneous cable.

If the total frequency interval is too large in comparison with the starting frequency, the circle will become a spiral (because of the change in reflection with frequency at the end of the cable), whose centre point wanders along the dashed semi-circle because of the frequency-dependent input reflection. Fig. 19 results from the assumption of two discontinuities, a capacitive one at the cable input and one of either kind at the cable end, which are equal in amplitude.

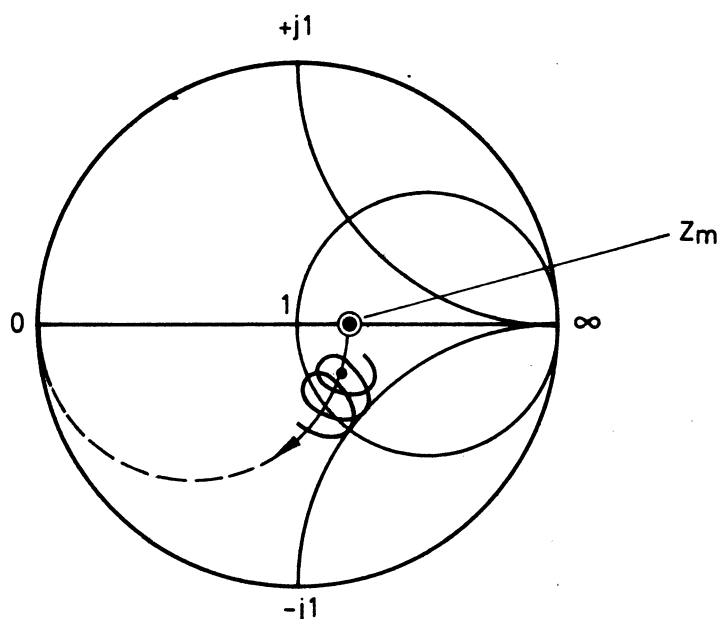


Fig. 19 Cable input impedance with a capacitive discontinuity at the input and either kind of discontinuity at the output (frequency as parameter), when Δf is not small compared with the test frequency.

In practice, the cables are always more or less inhomogeneous (see 7.15.2.3.5 and 7.15.2.3.6). It is therefore recommended that such spiral forms be avoided by sufficiently small frequency variations in order to avoid unnecessary complication of the evaluations.

7.15.2.3.3 Inhomogeneous Cable with a Reactive Discontinuity only at the Input, Discontinuity much less than λ

With reference to section 7.15.2.3.1, the impedance characteristic as shown in Fig. 20 is obtained in the case of inhomogeneous cables.

The input impedance curls in relatively small loops about a mean impedance value whose real component gives the mean absolute characteristic impedance. If this group of impedance loops is transposed through the distance of the discontinuity to the axis of reals, this transposed curve is identical with the effective characteristic impedance according to 7.15.2.2.

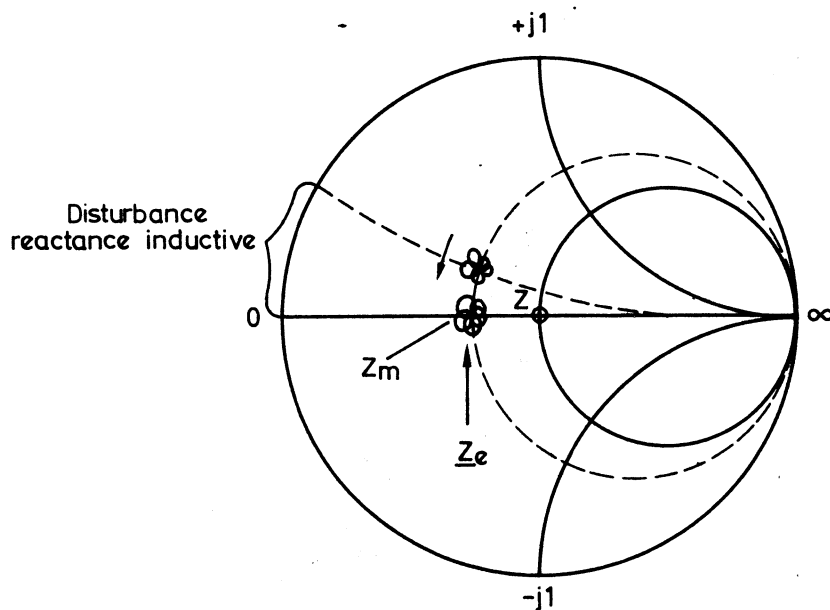


Fig. 20 Determining the effective characteristic impedance \underline{Z}_e and the mean characteristic impedance Z_m from the input impedance of a long cable.

If the loop family lies in the capacitive section of the Smith chart, it is best to use an admittance chart, the resistive component then being the centre point of the admittance which equals the characteristic impedance $Y_0 = \frac{1}{Z_0}$.

A cable with an input impedance corresponding to that shown in Fig. 23 can be designated as satisfactory to good depending upon the diameter of the loop family. The discontinuities of the characteristic impedance are mostly of statistical nature or residual reflections of the cable connector. The centre point of the loop family transposed to the horizontal axis is equal to the mean characteristic impedance Z_m to within a good approximation.

7.15.2.3.4 Inhomogeneous Cable with Periodic, Statistical and Input-connector Discontinuities in a Smith chart and in a Reflection-coefficient Chart. Analysis

The diagrams below are the two most commonly used representations of the cable impedance or reflection.

The more general display is naturally in the complex plane since, with the exception of the attenuation, all important cable characteristics are represented: the mean characteristic impedance, the effective characteristic impedance, and thus the homogeneity (see Fig. 21).

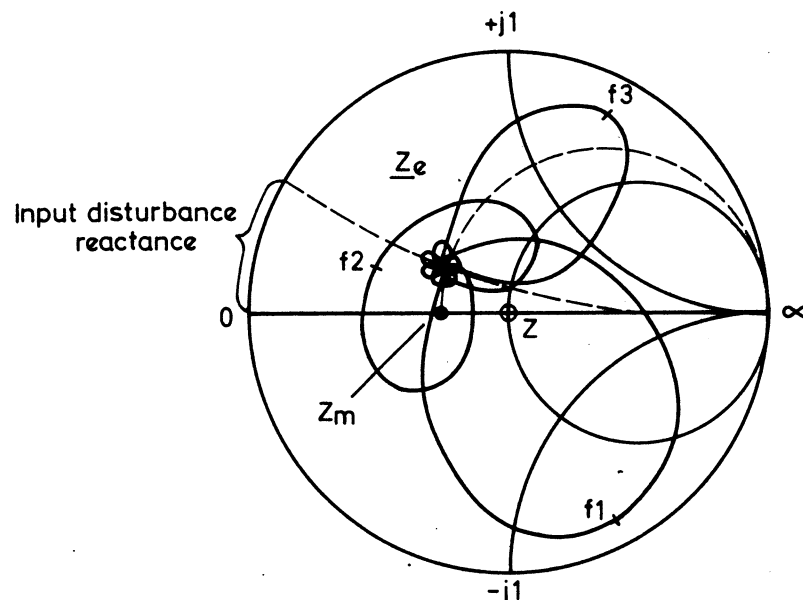


Fig. 21 The input impedance of an inhomogeneous cable with periodical, statistical and input-connector discontinuities

In addition to the loop family, whose details are no longer recognizable for long cables, large loops appear with the centre frequencies f_1 , f_2 and f_3 which are caused by large periodic discontinuities in the cable. The reactive component of the centre impedance of the loop family can be attributed to a connector discontinuity at the cable input while the resistive component again gives the mean characteristic impedance. The effective characteristic impedance can be read in magnitude and phase for each frequency when the entire loop family with its centre impedance is transposed to the horizontal axis. This effective characteristic impedance is an excellent measure of the cable homogeneity.

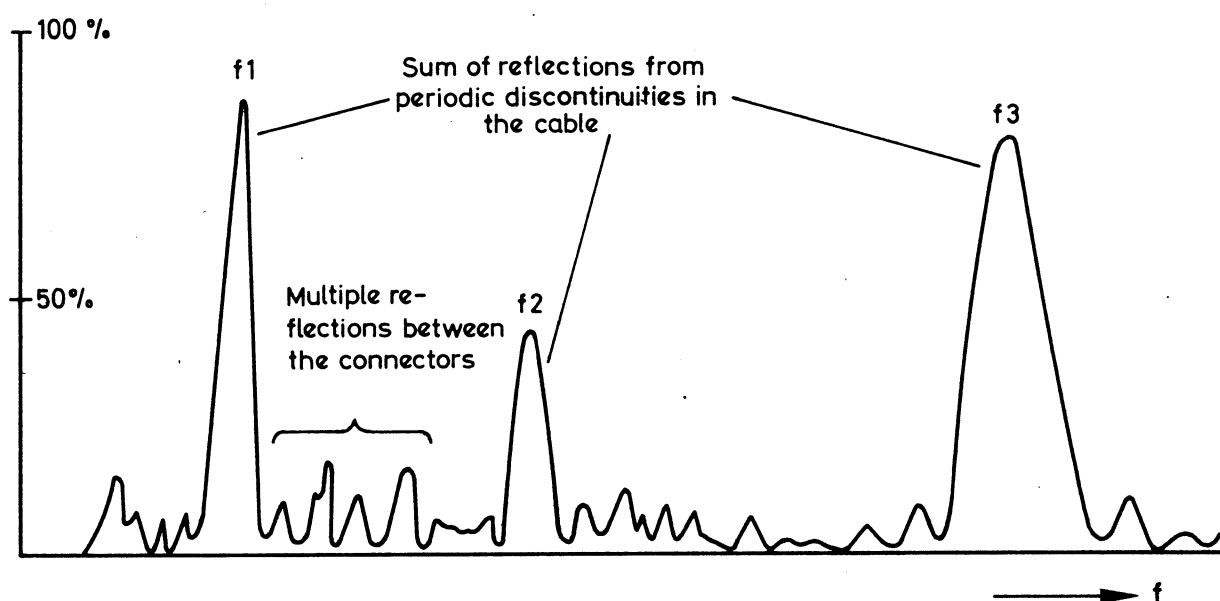


Fig. 22 Reflection coefficient of the non-transposed input impedance of the cable whose values are shown in complex representation in Fig. 21

For the same cable, Fig. 22 plotted against frequency gives a clearer picture, although only part of the information shown in Fig. 21 is obtainable, i. e., the reflection coefficient of the non-transposed input impedance. The mean characteristic impedance and the effective characteristic impedance are not shown.

The advantage of this representation lies in the easy interpretation of the loop family which now shows clear periodicity. In view of the small frequency intervals, the maxima are definitely to be traced back to the cable connector or the in-between multiple reflections. Maxima of the reflections are observed at the cable input when at least two reflections of the same type, i. e. equal-phase reflections are spaced from one another by $n\lambda_K/2$. A simple check is made by measuring the frequency difference Δf between two maxima, thus giving $n = \frac{f}{\Delta f}$ and thus the length of the cable when the cable wavelength $\lambda_K \frac{\lambda_0}{\sqrt{\epsilon}}$ is known.

The sharp peak at f_1 can with great probability be traced back to a periodic discontinuity within the cable caused, for example, by periodic crimps in the outer conductor or in the outer diameter of the dielectric. The distance "a" between maxima may easily be calculated from the correlation to the corresponding cable length λ_K .

Although each of the crimps may only cause a disturbance of a few parts in 1000, substantial input reflections result from the summation of hundreds of individual irregularities in long lengths of cable. Periodical discontinuities of this type naturally manifest themselves at $a = \lambda_K$ and $a = 3/2\lambda_K$ as higher peaks and are thus easy to recognize.

The width of a peak or reflection maximum is a measure of the periodicity of the distance between the discontinuities. The more perfect the periodicity of "a", the narrower the reflection maximum; the greater the deviation Δa from a mean value "a", the flatter the reflection maximum. In general, the reflection maxima occurring at harmonics of f_1 become flatter since the deviation Δa becomes more significant.

Additional reflection maxima can arise from periodicities occurring in the manufacture or also from multiple reflections between individual discontinuities within the cable and connectors.

The regularity of the high-frequency connector periodicity as seen in the graph permits the amount of statistical Z variations to be estimated as compared to the reflections caused by the connector. These statistical irregularities manifest themselves in the fine structure of the connector irregularities depending upon whether their amplitude changes are gradual or sudden.

Thus both methods of display, the complex and the amplitude method, are justified. In checking finished cables, the latter of the two displays is gaining increasing use, above all, in conjunction with a sweep frequency measurement in the operating frequency range using directional couplers which eliminate laborious transformation of measured values of the VSWR into reflection values as well as the time-consuming series of measurements by means of slotted lines.

However, for the determination of the mean and the effective characteristic impedance, the Non-slotted Line or semi-automatic impedance measuring sets (e.g. the Z-g Diagrams Type ZDU and ZDD) will still be desirable.

7.15.3 Measuring the Attenuation

Cable attenuations can be measured with Type ZDU according to the procedure described in section 7.6.3. The cable specimens should be of such a length that their attenuation is between 5 dB and 20 dB. If the cable tested is too short and thus its attenuation too low, the inherent error of the Z-g Diagram indicated in section 1.2 will be too large in comparison to the quantity to be measured. If, on the other hand, the tested cable is too long and thus its attenuation greater than 20 dB, a sufficiently accurate reading of the measured value cannot be obtained. With all measurements dependent on frequency, the zero adjustment must be made after each change of frequency.

The measurement of short lengths of cable is best made with standing-wave detectors, while for larger lengths the signal generator and measuring receiver is recommended.

7.15.4 Determining the Phase Velocity v and the Electrical Length l_e

The relationship between the two quantities is given by

$$\frac{v}{c} = \frac{\lambda_K}{\lambda_0} = \frac{1}{l_e} = \frac{1}{\sqrt{\epsilon}} \quad (12)$$

These quantities can be measured via the cable wavelength λ_K . To determine λ_K , the section of cable to be investigated, not too long in length, is operated with its output short-circuited or open-circuited. By choosing a suitable test frequency, an impedance minimum or maximum is adjusted. Depending upon the type of termination (short circuit or open circuit), multiples of $\lambda/4$ or $\lambda/2$ exist on the entire cable length.

The following example is given:

A short-circuit is at the cable output; an impedance maximum is adjusted.

The first resonance frequency used is f_1 and the associated wavelength along the cable is λ_{K1} . By raising the frequency, the next impedance maximum is adjusted, this being the frequency f_2 and the cable wavelength λ_{K2} .

The following is valid:

$$(2k - 1) \lambda_{K1}/4 = 1 = (2k - 1) + 2 \lambda_{K2}/4 \quad (13)$$

$$(k = 1, 2, 3, \dots)$$

$$(2k - 1) = 2 \frac{f_1}{f_2 - f_1} = 2 \frac{f_1}{\Delta f} \quad (14)$$

thus

$$\lambda_{K1} = 2 \frac{1}{f_1} \Delta f \quad (15)$$

and

$$v = c \frac{\lambda_{K1}}{\lambda_1} = f_1 \lambda_{K1} = 2 \frac{1}{\Delta f} \Delta f \quad (16)$$

is a general expression for a cable of any length and any excitation $(2k - 1)\lambda/4$ or $k\lambda/2$.

Also, with $f_{res_{min}}$ being the resonant frequency of a cable section excited in $\lambda/4$,

$$v = 4 f_{res_{min}} l \quad (17)$$

8. Periodical Checking of the Set

Should be carried out every 500 operating hours.

8.1 Checking the Anode and Filament Voltages (see circuit diagram)

- (a) The anode-supply voltage across contact 9 of the multi-point connector C (Fig. 31) should be 220 V $\pm 5\%$ to chassis. Deviations from this value can be compensated for by resistor R172. For AC supply fluctuations of $\pm 12\%$ referred to rating, the anode-supply voltage fluctuation ΔE should be less than ± 1 V. See also section 9.4.
- (b) The filament voltage is preferably measured across contact 3 of the multi-point connector C (Fig. 31). It should be 6.5 V $\pm 3\%$ to chassis. Deviations can be compensated for by resistor R156. For AC supply fluctuations of $\pm 12\%$ referred to rating, the filament-voltage fluctuation ΔE should be less than +30 mV. If the specified values are not obtainable, refer to section 9.5.

8.2 Relative Frequency Response of the Test Receiver versus Reference Receiver

Adjust amplitude and phase at any frequency whatsoever, according to section 6.4.2. Both the coaxial test line and the coaxial reference line remain shorted. Measure the voltage in each frequency range at several frequencies. Adjust the generator voltage each time so that the pointer of the reference meter points at the red mark (full deflection). The deviations of phase and amplitude, which are observed by means of the crosslines of the light spot, should not exceed 3° and 0.5 dB.

8.3 Checking the Quiescent DC Anode Current of Rø6

If valve Rø5 (Fig. 32) is removed from its socket, the pointer of the discriminator meter should exactly point to the centre of the red section. Correct for deviations using the variable resistor R37 (Fig. 31). If the adjustment range of R37 is not sufficient, replace valve Rø6 (Fig. 33).

8.4 Sensitivity of the Phase Indication with Respect to Frequency Adjustment within the Red Section RESONANCE

Tune the Z-g Diagram to the generator frequency, change this frequency so that the pointer of the discriminator meter (4) (Fig. 23) deflects to the left end of the red mark. Adjust the phase with the coaxial test line and the coaxial reference line short-circuited. Adjust the generator frequency so that the pointer of the discriminator meter points to the right end of the red mark and repeat the phase adjustment. The difference in the phase angle $\Delta\phi$ should be $\leq 1^{\circ}$; if this is not the case, realign the IF circuits (section 10.3).

8.5 Checking the Spread Chart Range

Insert the Smith chart (Fig. 24) as impedance chart into the chart holder. Short the coaxial test line and the coaxial reference line, adjust the generator for any desired frequency and tune the Z-g Diagram to this frequency. Adjust the generator voltage so that the crosslines of the light spot lie on the outermost chart circle. The INDICATION switch (18) (Fig. 23) is at SPREAD. If you then switch to NORMAL, the crosslines should indicate 0.5 on the real axis of the chart. If this is not the case, readjust the sensitivity of the galvanometer for both ranges, starting with the SPREAD range. With the coaxial test line and the coaxial reference line shorted, feed in a signal of any convenient frequency and tune the Z-g Diagram to this frequency. Adjust the voltage at the generator so that the reference meter points to 1/3 of full deflection (33.3 divisions). The crosslines of the light spot should then be on the outermost chart circle. If this is not the case, correct using the variable resistor R206 (Fig. 34). If you now switch to NORMAL, the crosslines should be at 0.5. If this value is not reached exactly, correct by means of resistor R204 (Fig. 34). Increase the voltage at the generator to give full scale deflection (100 scale divisions, red mark); the crosslines should again go to the outermost chart circle.

8.6 Checking the Zeroing of the Galvanometer

Valve R019 (Fig. 31) serves to compensate the initial-velocity current of the measuring diode R012 (Fig. 32) and to linearize its characteristic. The electrical zero is correct if, upon switching from NORMAL to SPREAD, the zero deflection of the light spot remains unchanged or shifts to the left by a maximum of 1 mm. This small shift is caused by noise. For this investigation, the signal generator should be cut off. If the shifting of the light spot upon switching is more than 1 mm, zero by using resistor R207

(Fig. 34). If no adjustment is possible with R207, it is a sign that the two valves R012 and R019 (EA 50) have aged at a different rate and must therefore be replaced (section 10.1).

9. Trouble Shooting

Below are a few hints to facilitate spotting any faults which may appear after a considerable period of operation. With their aid it should be possible to find and rectify the fault in the majority of cases.

9.1 Pilot Lamp Does not Light

- (a) Check AC supply voltage;
- (b) Check fuse Si1 in power section (Fig. 31);
- (c) Check pilot lamp R1 3;
- (d) Check power circuit in the set.

9.2 No Light Spot

- (a) Check that the set is in horizontal position;
- (b) Check mechanical zero, HORIZONTAL, VERTICAL;
- (c) Check projector lamp R1 2 (Fig. 34);
- (d) Check socket of projector lamp; after replacement obtain maximum brightness of light spot by turning and adjusting lamp vertically.
- (e) Falvanometer defective (Fig. 33);
- (f) Trouble in mirror case (Fig. 33).

9.3 No Pointer Deflection on Both Meters and on Galvanometer

- (a) Check AC supply voltage;
- (b) Check input voltage of signal generator (feeder);
- (c) Check anode voltage across contact No. 9 of multi-point connector C (Fig. 31); rating: 220 V $\pm 5\%$ (see also section 8.1 a).
- (d) Check filament voltage across contact No. 3 of multi-point connector C (Fig. 31); rating: 6.5 V $\pm 3\%$ (see also section 8.1 b).

9.4 Anode Supply Voltage Cannot be Adjusted to Rating, Stabilization Insufficient

Disconnect set from power supply. Check resistance to chassis at contact No. 9 of multi-point connector C (Figs. 31 and 33). Rating of resistance $R = 10 \text{ k}\Omega$. If $R > 10 \text{ k}\Omega$, check Rø21 to Rø25 in the power section and replace, if necessary. If $R < 10 \text{ k}\Omega$, check the capacitors in the anode leads.

9.5 Filament Voltage Cannot be Adjusted to Rated Value, Stabilization Insufficient

Check valves Rø17 and Rø18 in the power supply. Replace lamp R1 1 if these valves are satisfactory. If necessary, also check the capacitors and resistors which are in circuit with Rø17 and Rø18.

9.6 No Light Spot Deflection and, at the Same Time, Phase Maximum not Obtainable

Check valves Rø8 (Fig. 33), Rø9 (Fig. 35), Rø10, Rø11, Rø13 and Rø14 in the test receiver (Fig. 32), and valves Rø15 and Rø16 in the phase amplifier, to find out whether the operating voltages of these valves are present. The fault can also lie with the mixer diode G1 10. When replacing this crystal

diode refer to section 10.2, when replacing a valve refer to section 10.1. Be careful not to interchange the valves.

9.7 No Light Spot Deflection, Phase Maximum Well Obtainable

- (a) Check R012 (for replacing the valve see section 10.1).
- (b) Check galvanometer. Apply -10 V DC via 200 k Ω between chassis (+) and contact No. 6 of multi-point connector B (Fig. 32). This should give full deflection in the SPREAD range.

9.8 No Deflection on Reference Meter, no Phase Maximum Obtainable

Check valves R01, R02, R03 and R04 in the reference receiver (Fig. 32), valve R07 (Fig. 33), and the valves R015 and R016 (Fig. 32) in the phase amplifier. Also check that the operating voltages of these valves are present. Mixer diode G1 10 can also be faulty. When changing the crystal diode refer to section 10.2, when replacing a valve refer to section 10.1. Be careful not to interchange the valves.

9.9 No Deflection on Reference Meter, Phase Maximum Obtainable

Check reference meter. Apply 30 V DC through 300 k Ω between chassis and contact No. 6 of multi-point connector A (Fig. 32). This voltage should produce about full deflection. The deflection also depends on the adjustment of resistors R188 (Fig. 36) and R189 (REFERENCE VOLTAGE COR. on the front panel).

9.10 No Resonance Indication, Amplitude and Phase Indication Satisfactory

- (a) If the pointer always stays at mid-position, there may be a breakdown of valve R05 (Fig. 32) or of its operating voltage.

- (b) If the pointer is always at the left-hand stop, check valve R06 (Fig. 32) and replace if necessary. Also check push button (3) (Fig. 23) and incandescent lamp R1 1 for troublefree operation. The anode fuse Si2 (Fig. 31) can also be defective.
- (c) If the pointer is always at the right-hand stop, a short between the electrodes of valve R06 may be suspected. Check also the push-button switch (3) and incandescent lamp R1 1 for accidental contact to chassis.
- (d) If during tuning the pointer deflects only to the right or only to the left, the trouble is in the discriminator. Check crystal diodes G1 1 and G1 2, which are in the circuit of valve R06. For adjustment see instructions of section 10.3.2.

9.11 Phase Meter Shows Only Very Flat or no Maximum, Amplitude and Resonance Indication Satisfactory

- (a) The signal generator might be modulated or introduce considerable hum. If this is not the case,
- (b) try to improve maximum with R47 (Fig. 31). Short coaxial test line and coaxial reference line, adjust for phase maximum as well as possible and make the maximum as sharp as possible by means of R47. Readjust the maximum several times. Turn the chart by 360° and readjust to maximum. If this maximum is not sharp, adjust for the same and optimum sharpness of the two maxima. Sharpness of the maximum and amplitude of the deflection depend upon one another.

9.12 Phase Meter Shows Permanent Deflection

- (a) Check valves R015 and R016 and their operating voltages.
- (b) Check crystal diode G1 5, which lies in the anode circuit of valve R015.

- (c) If necessary, readjust the circuits of the amplifiers. Section 10.4 contains instructions for this readjustment and for checking the sensitivity.

9.13 During Amplitude Adjustment According to Section 6.4.2.1
Reference Meter Cannot be Set to 100%

First to readjust R188 (Fig. 36) so that 100% full deflection can be obtained with the REFERENCE VOLTAGE COR. knob. At the same time the voltage of the signal generator must be adjusted so that the light spot stays in the largest circle of the diagram.

If this is not possible because the reference voltage is always less than 100%, the trouble is in the reference receiver. If, however, the reference voltage is always greater than 100%, the trouble is in the test receiver. In both cases, check respectively valves R01, R02, R03, R04 and R07, or R08, R010, R011, R013 and R014. If a replacement of valves becomes necessary, observe section 10.1.

9.14 In Spite of Amplitude and Phase Adjustment at a Medium
Frequency (about 100 MHz), the Amplitude Error or Phase
Error Exceeds the Specified Tolerances at Other Frequencies

Check the mixer diodes G1 9 and G1 10 (mixer head). Both diodes should have equal input impedances and their characteristics should be approximately identical. The check on the characteristics is not particularly critical and can be made by a point-by-point method using DC. In the non-conductive region a current of $< 20 \mu\text{A}$ should flow with a voltage of 0.5 V; in the conductive region the current should be $> 0.5 \text{ mA}$ with $\pm 0.3 \text{ V}$. The forward current of the two diodes should be as equal as possible. The selection for equal input impedance is best made in the mixer head itself. One of the two diodes should be changed until a suitable pair has been found. Matched pairs of diodes may be ordered from ROHDE & SCHWARZ

by specifying the Serial Number (FNr.) of the set. However, a better frequency response will be obtained if the diodes are selected by inserting them in the mixer head as described above, since this will take care of any slight unbalance of the mixer head due to aging.

9.15 Amplitude Difference between Short-circuit and Open-circuit
Measurements Exceeds Tolerance

Check resistance of the matching elements. With the "input" open-circuited, $Z_0 \pm 1\%$ should be measured at the connectors of the coaxial reference line and coaxial test line. If the resistance differs from the Z_0 rating, replacement and elimination of the trouble can only be made at the factory. The amplitude difference can also be due to a fault in the coaxial directional coupler. In the case, too, the repair can only be carried out at the factory.

9.16 Light Spot Shows More than 1% Reflection with Exact Z_0
Termination of the Coaxial Test Line, e. g., with Precision
Termination Type RMC

- (a) Check mechanical zero with respect to VERTICAL and HORIZONTAL, with the signal generator disconnected from the input of the Type ZDU.
- (b) Check terminating resistor used. Repeat measurement using another terminating resistor.
- (c) Trouble in directional coupler. Replacement and readjustment only possible at our factory.

9.17 Phase Maximum Cannot be Adjusted to ZERO or 360° by
Making Use of the PHASE COR. Knob

- (a) Check the contact being made by the two short-circuit terminations FZ 434 with reference line and test line.

- (b) Check that mechanical drive for C24 (cord drive, Fig. 32) is in order.
- (c) Check that the test and reference lines are screwed in as far as they will go.
- (d) If necessary, readjust the reference and test receivers according to section 10.4.

9.18 Phase Maximum after Adjustment to 0° Does not Agree with Phase Maximum after 360° Rotation of Chart by Means of PHASE ADJ.

Zero frequency of discriminator is incorrect. Readjust discriminator and amplifier in accordance with section 10.3.

10. Maintenance and Replacement of Valves

The Z-g Diagraph Type ZDU does not require any routine servicing. Occasionally, it will be necessary to replace defective or extremely aged valves or crystal diodes. If the replacement of a valve or diode becomes necessary, please refer to section 10.1 or 10.2, respectively.

After a long time of operation, it may be possible that the brightness of the light spot of the galvanometer considerably decreases. This is due to dust covering the mirrors and the plexiglass screen. After removing the six screws, the plexiglass screen can be removed and easily be cleaned. To obtain access to the mirror case (Fig. 33), take the set out of its cabinet and remove the power supply. When taking off the lid, the mirrors and the window of the galvanometer can be cleaned from dust. It is, however, necessary to exercise great care. Do not exert pressure on the mirrors, so as not to change the path of the rays. Use only a very soft and clean piece

of leather for cleaning, since the surfaces of all mirrors contained in the mirror case are silver-plated and liable to be scratched.

10.1 Replacement of Valves

Rö1, Rö2, Rö3 and Rö4

Allow a warm-up period of one hour after insertion of the new valve; carefully adjust the IF circuits preceding and following the valve to obtain maximum amplitude. See also section 10.4.

Rö5

No adjustment necessary.

Rö6

After inserting the new valve, adjust the quiescent DC anode current in accordance with section 8.3.

Rö7, Rö8

No adjustment necessary.

Rö10, Rö11, Rö13 and Rö14

See Rö1, Rö2, Rö3, Rö4.

Rö15

Adjust C176, see section 10.4.3.

Rö16

Adjust C176 and C182, see section 10.4.3.

10357
5
L. 86

Rö21, Rö22, Rö23, Rö24 and Rö25

Adjust R172 (Fig. 31) so that the anode supply voltage E_a is 220 V. See also section 8.1 a.

Rö9

After inserting the valve (Fig. 35) allow the set to warm up. It is then advisable to make a few measurements in the frequency range 180 to 200 MHz, since with oscillator valves having UHF characteristics which depart considerably from average it is possible for dips or parasitic oscillations to occur.

Rö12

Open the cover on the underside of the lower IF amplifier and loosen the two cheese-head screws on the rear panel (Fig. 32). The socket of the valve Rö12 (EA 50) can then be drawn out downwards, so that after disconnecting the anode lead the valve can be replaced. Replace the socket with the new valve and the cover of the IF amplifier. The set can now be switched on. Allow a few minutes for warming up and adjust the electrical zero of the galvanometer using resistor R207 (Fig. 34) (see also section 8.6).

Rö17 and Rö18

After changing these valves, check the filament voltage according to section 8.1 b.

Rö19

After replacement, adjust the electrical zero of the galvanometer according to section 8.6.

10.2 Replacing the Diodes G1 9 and G1 10

These diodes are situated in the cans of the valves Rø7 and Rø8 (Fig. 33).

Note: Diodes should be protected from shock and static charge. See also section 9.14.

10.3 Aligning the IF Circuits

The rated intermediate frequency of the Z-g Diagram is the frequency for which the artificial line has a length of exactly π .

10.3.1 Finding the Rated IF

Allow a warm-up period of about one hour. Check the quiescent DC anode current according to section 8.3. Short both coaxial lines. Using a power signal generator of high frequency stability, apply a voltage to the input of the Z-g Diagram, the frequency of which is equal to the intermediate frequency of the Type ZDU, which is between 10 and 11 MHz. Adjust the frequency of the signal generator so that the pointer of the discriminator is exactly at the centre mark. Do not press the button (3) (Fig. 23). The position of the FREQUENCY knob, i. e., the oscillator tuning, is of no importance. Adjust the amplitude of the signal generator so that the reference meter shows approximately full deflection. Insert a chart which shows a division in degrees on its outermost circle (e. g., Fig. 28, 29 or 30). Press the button (3). Once pushed in, it will remain depressed. Adjust for maximum deflection on meter (4) using the PHASE ADJ. knob and find the phase angle on the chart. Next, turn the chart by 360° using the PHASE ADJ. knob and again adjust for maximum. The same phase angle as before will then be obtained if the IF is correct and the discriminator is tuned to this frequency. A phase angle deviation of $\pm 0.5^\circ$ is permissible. If the deviation is greater, repeat the above measurement with another frequency. Use a higher frequency if for finding the second phase maximum the chart

must be rotated more than 360° . Use a lower frequency if the angle of rotation was smaller than 360° . For every degree $\Delta\phi$, change the frequency by about 30 kHz.

10.3.2 Adjusting the Discriminator

If you have thus obtained the rated IF, i. e., the one for which the artificial line has a length of π , press the button (3) (Fig. 23) below the discriminator meter. This button is thus released and switches the meter (4) over for tuning indication. It can now be seen that, due to the previous frequency detuning, the pointer of the meter is no longer on the centre mark. Adjust the discriminator to the new IF. To do this, slightly turn the trimmer C46 (Fig. 32) by only a few degrees of angle, until the pointer of the discriminator meter (4) again points to the centre mark. Do not change the frequency at the signal generator between the adjustment for the rated IF as per section 10.3.1 and retuning of the discriminator. For this reason, it is also imperative that the signal generator has a high frequency stability. Use a tuning wand of insulating material for retuning the discriminator.

10.4 Adjusting the Individual Circuits

10.4.1 Reference Receiver

Apply a signal as set forth in section 10.3.1. Short the coaxial test line and the coaxial reference line each with a FZ 434. For the duration of the tuning procedure described in the following, the signal-generator frequency should be kept constant. It is, therefore, advisable to check this frequency several times with the aid of the discriminator meter. The pointer of this meter should always exactly point to the centre line over the red mark. After a warm-up period of at least one hour, adjust successively:

- (a) C3, C10 and C19 (Fig. 32) for maximum amplitude at the reference meter. Adjust very carefully and repeat the procedure several times

- (b) C26 (Fig. 32) for amplitude maximum. As tuning indicator connect a 50- μ A moving-coil meter between test point 11 (Fig. 32) and chassis.
- (c) C34 for amplitude maximum. As tuning indicator connect a 50- μ A moving-coil meter between test point 13 (Fig. 32) and chassis.

C42 should be readjusted after a repair of the discriminator (amplitude maximum). As tuning indicator connect a 50- μ A moving-coil meter between test point 15 (Fig. 33) and chassis.

10.4.2 Test Receiver

The conditions under which the adjustment must be made are the same as for the adjustment of the reference receiver (section 10.4.1). On the test receiver, adjust successively:

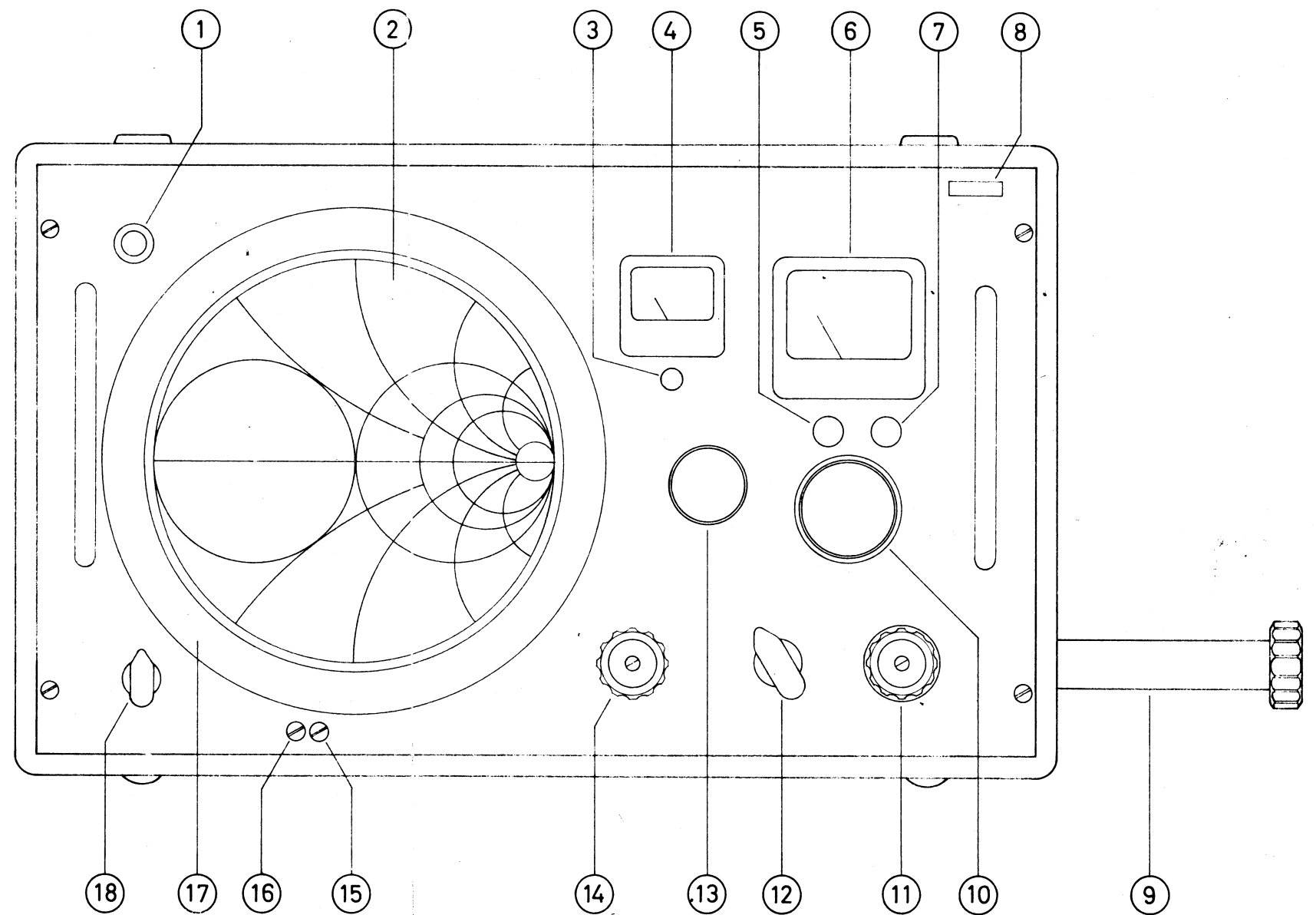
- (a) C130, C137 and C146 (Fig. 32) for amplitude maximum at the light spot galvanometer. Adjust carefully and repeat the procedure several times.
- (b) C156 for amplitude maximum. As tuning indicator connect a 50- μ A moving-coil meter between test point 12 (Fig. 32) and chassis.
- (c) C163 for amplitude maximum. As tuning indicator connect a 50- μ A moving-coil meter between test point 14 and chassis (Fig. 32).

10.4.3 Phase Meter Amplifier

The conditions for adjustment are the same as set forth in sections 10.4.1 and 10.4.2. Adjust C176 and C182. Depress button (3) (Fig. 23). Using the PHASE COR. KNOB, bring the phase close to the maximum (indication on discriminator meter) and, using C176 and C182 alternately, adjust for minimum pointer deflection. Bring the phase still closer to maximum and repeat the adjustment. The position of C182 is shown in Fig. 32. C176

cannot be seen; it is situated in the shielding can behind valve Rø15, and can be reached from above. But in order to get at it, the power pack must first be removed. The latter is contained in a separate frame which is inserted from above and can be lifted out after removing the five countersunk screws seen in Fig. 31. The set can still be kept in operation by connecting the multi-point connector of the power pack to the multi-point connector of the set by means of a suitable cable.

After the phase meter amplifier is adjusted, check its sensitivity. For this purpose, disconnect cable K4 (Fig. 32) from the test receiver and connect this amplifier to a standard signal generator, e. g. the R&S Type SMAF BN 41409, via a cable, which has a capacitance of 91 pF just as K4, and via 5 pF. Tune the standard signal generator to the IF of the Type ZDU. For tuning indicator, use the discriminator meter; press button (3) below it and tune for minimum deflection. This tuning should be made with a signal-generator output voltage of 2 mV. Decrease the signal-generator voltage to 0 by disconnecting the patch cord and check that the pointer deflection of the discriminator meter increases by at least 10% in the direction marked by the arrow. If the sensitivity is not sufficient, check valves Rø15 and Rø16. The crystal diode G1 5, too, may be cause of insufficient sensitivity. Check these circuit elements also if a minimum adjustment is impossible or if the sharpness of the minimum adjustment is insufficient.



- | | |
|---|---|
| 1) Pilot lamp | 9) Coaxial test line |
| 2) Chart | 10) Coarse and fine adjustment for oscillator tuning |
| 3) With button depressed discriminator meter (4) shows phase adjustment, with button not depressed, it shows oscillator tuning. Button remains down until it is released by being pressed anew. | 11) Coaxial reference line |
| 4) Discriminator meter for oscillator tuning and phase adjustment, when button (3) is depressed. | 12) FREQUENCY RANGE switch |
| 5) REFERENCE VOLTAGE COR. knob | 13) PHASE ADJ. knob |
| 6) Reference meter | 14) Test voltage input |
| 7) PHASE COR. knob | 15) VERT. } Slotted screws for zeroing the galvanometer |
| 8) Identification of characteristic impedance | 16) HORIZ. } |
| | 17) Bezel |
| | 18) POWER and NORMAL-SPREAD switch |

Fig. 23 Front view

R 10357
865
Bl. 114

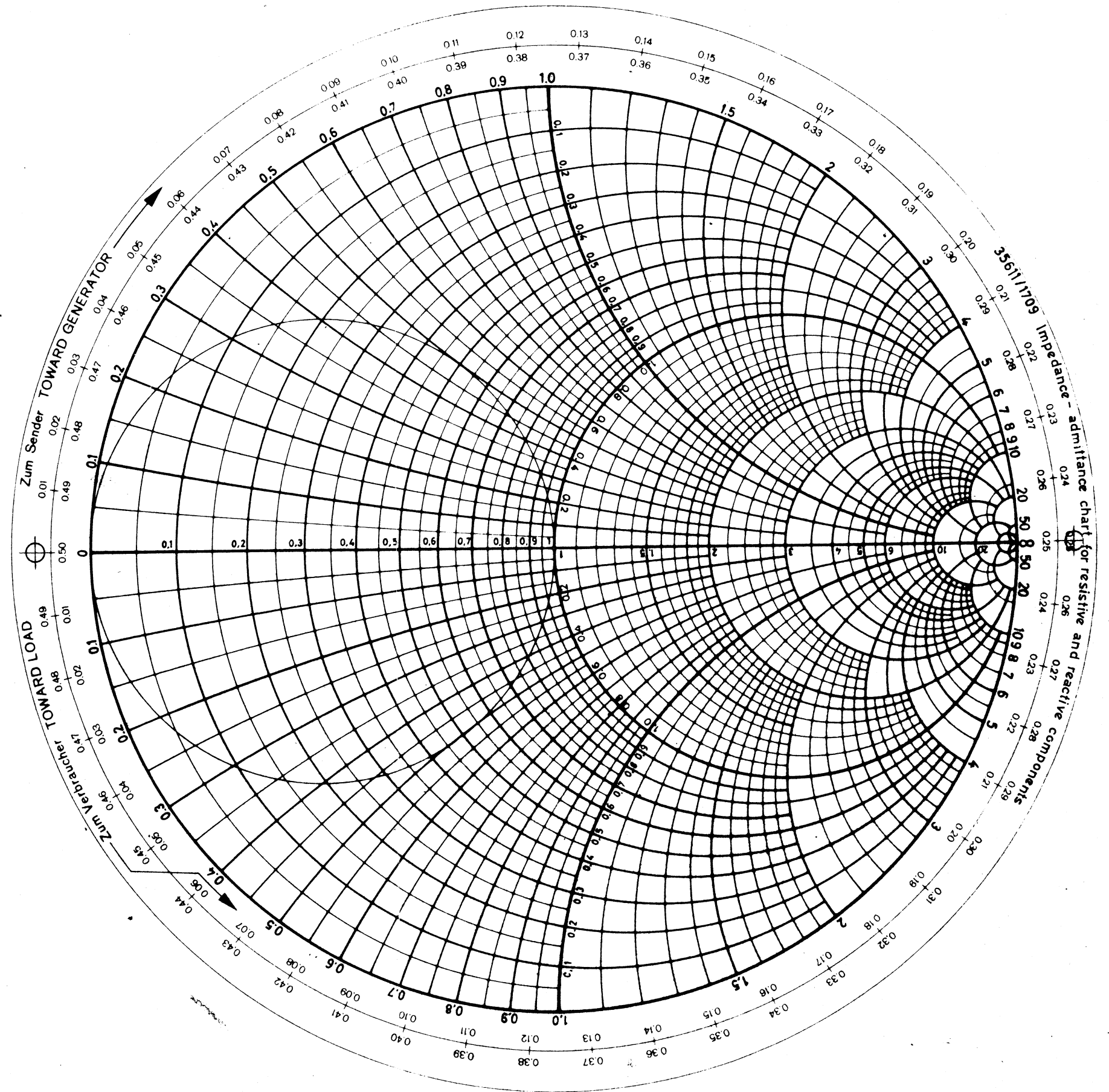


Fig. 24 Impedance - admittance chart
for resistive and reactive components

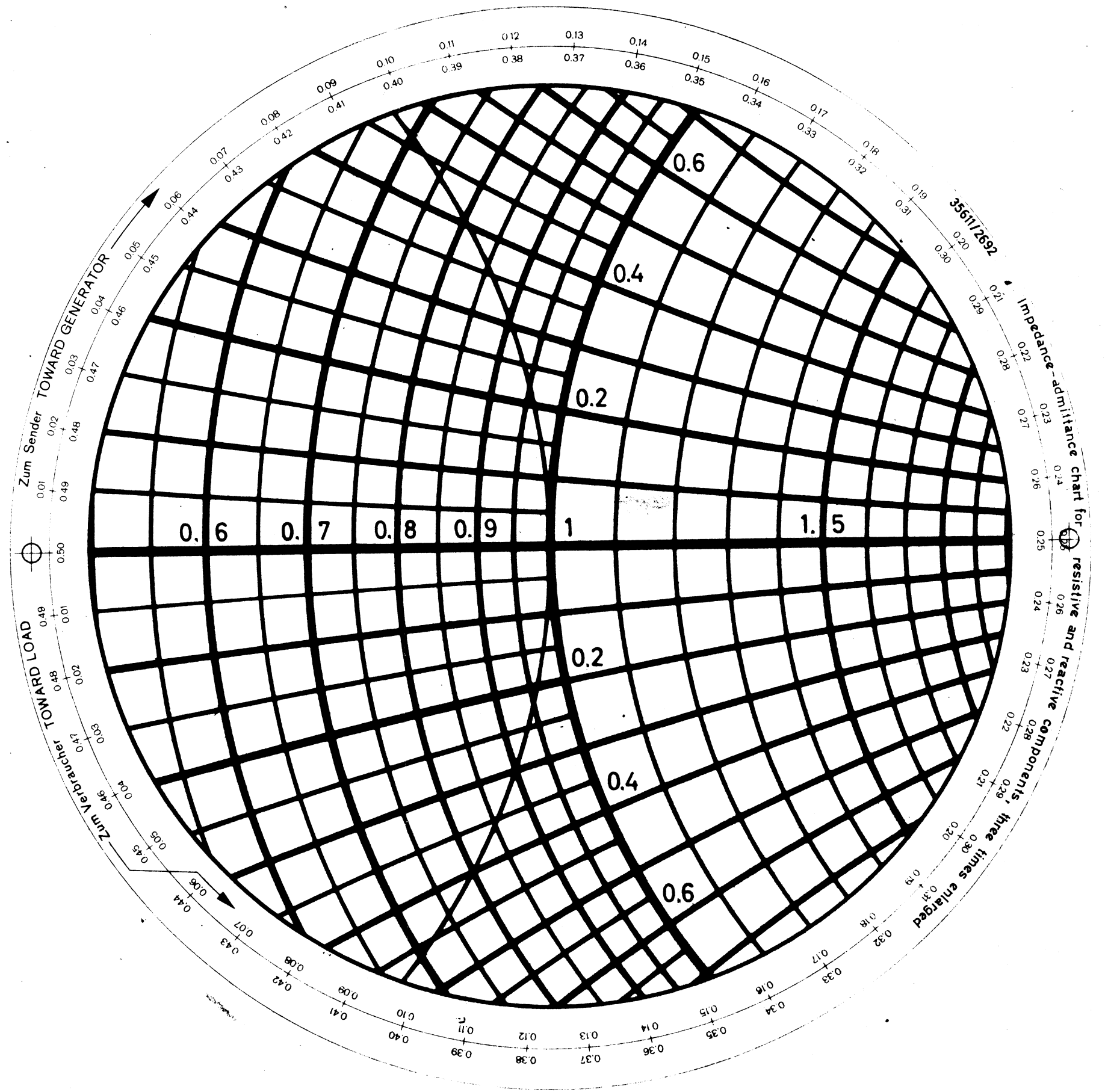


Fig. 25 Impedance-admittance chart
for resistive and reactive components,
three times enlarged

R 10357
865
Bl. 116

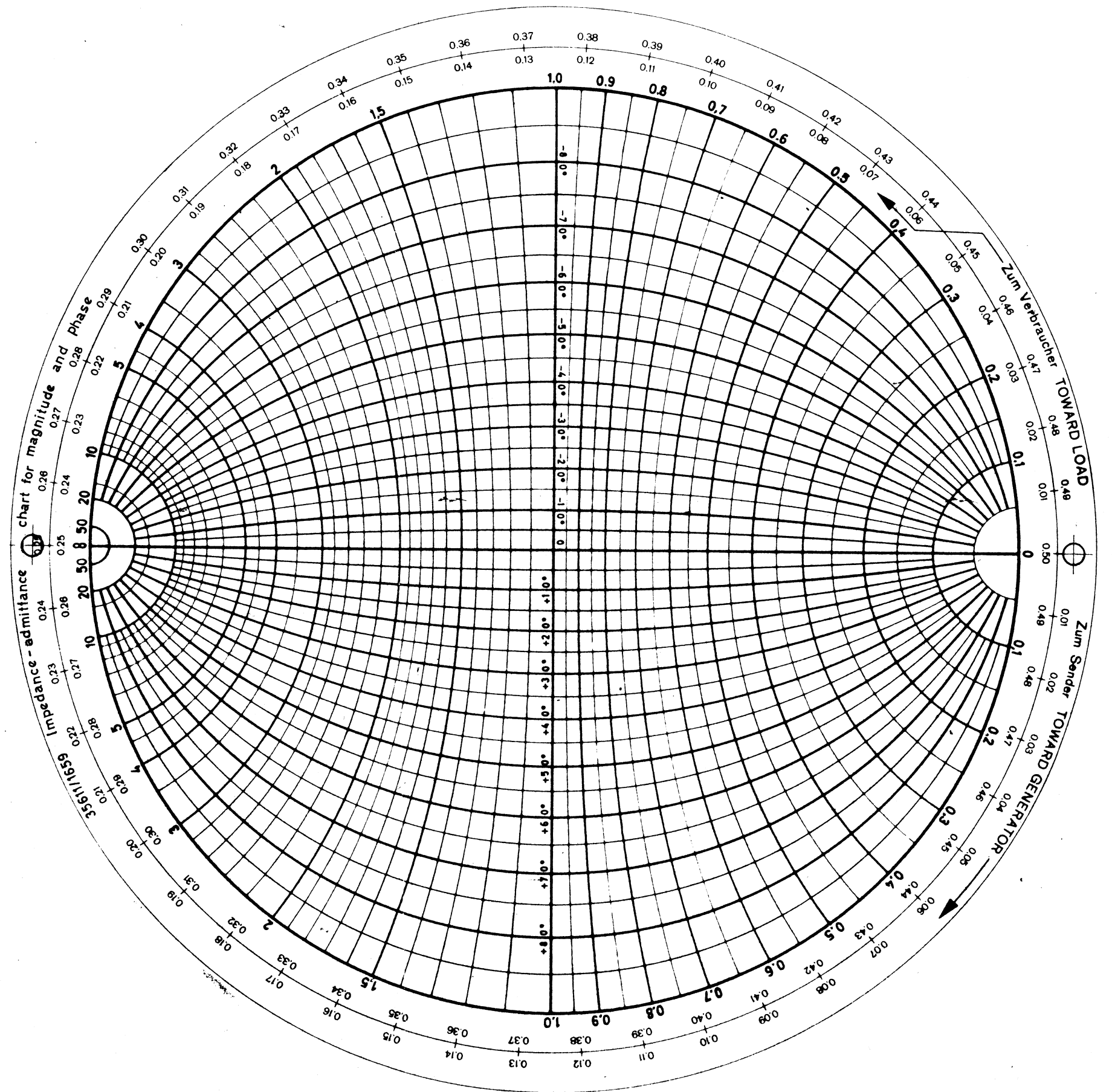
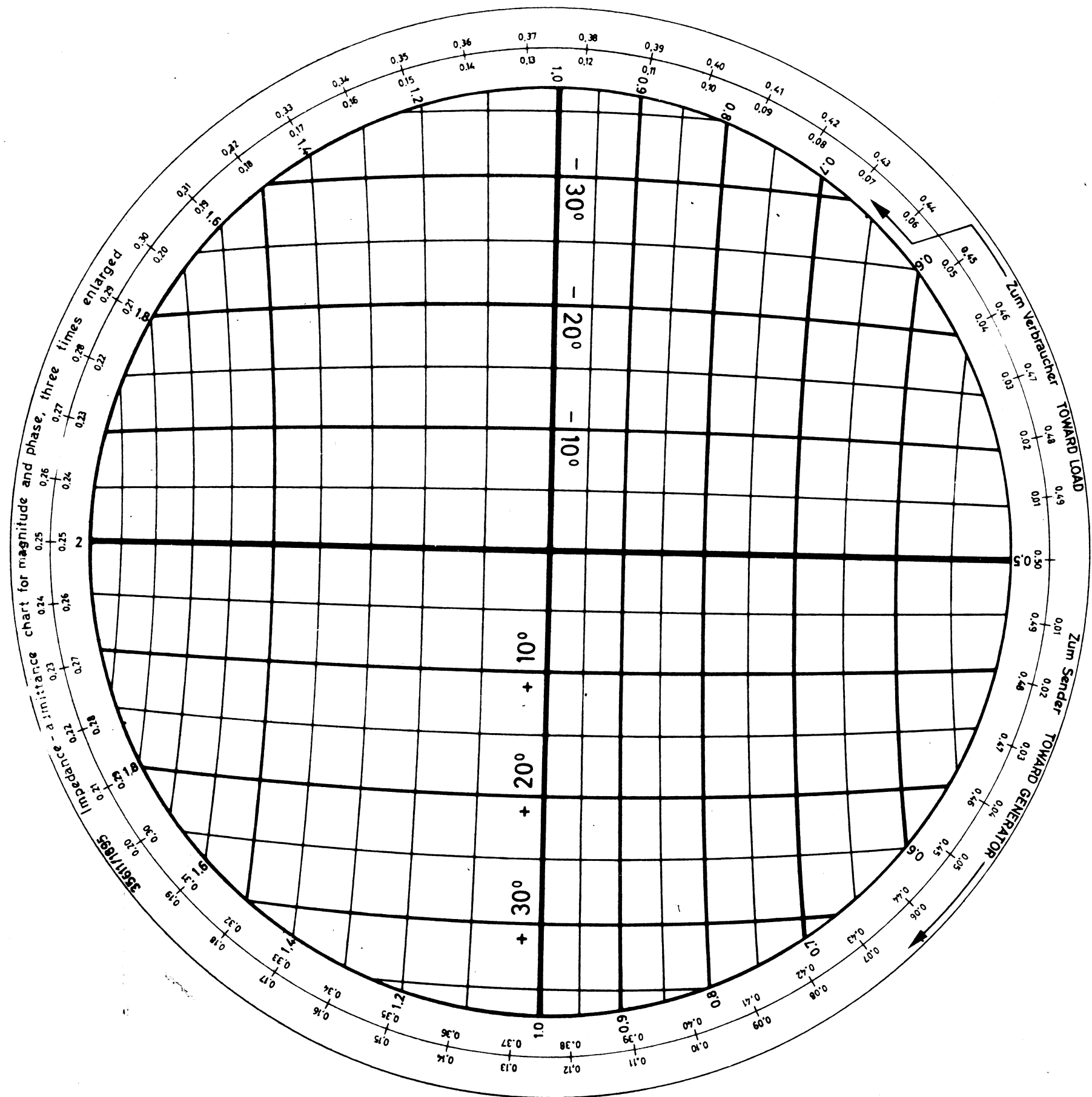


Fig. 26 Impedance - admittance chart
for magnitude and phase



R 10357
865
Bl. 117

Fig. 27 Impedance - admittance chart
for magnitude and phase,
three times enlarged

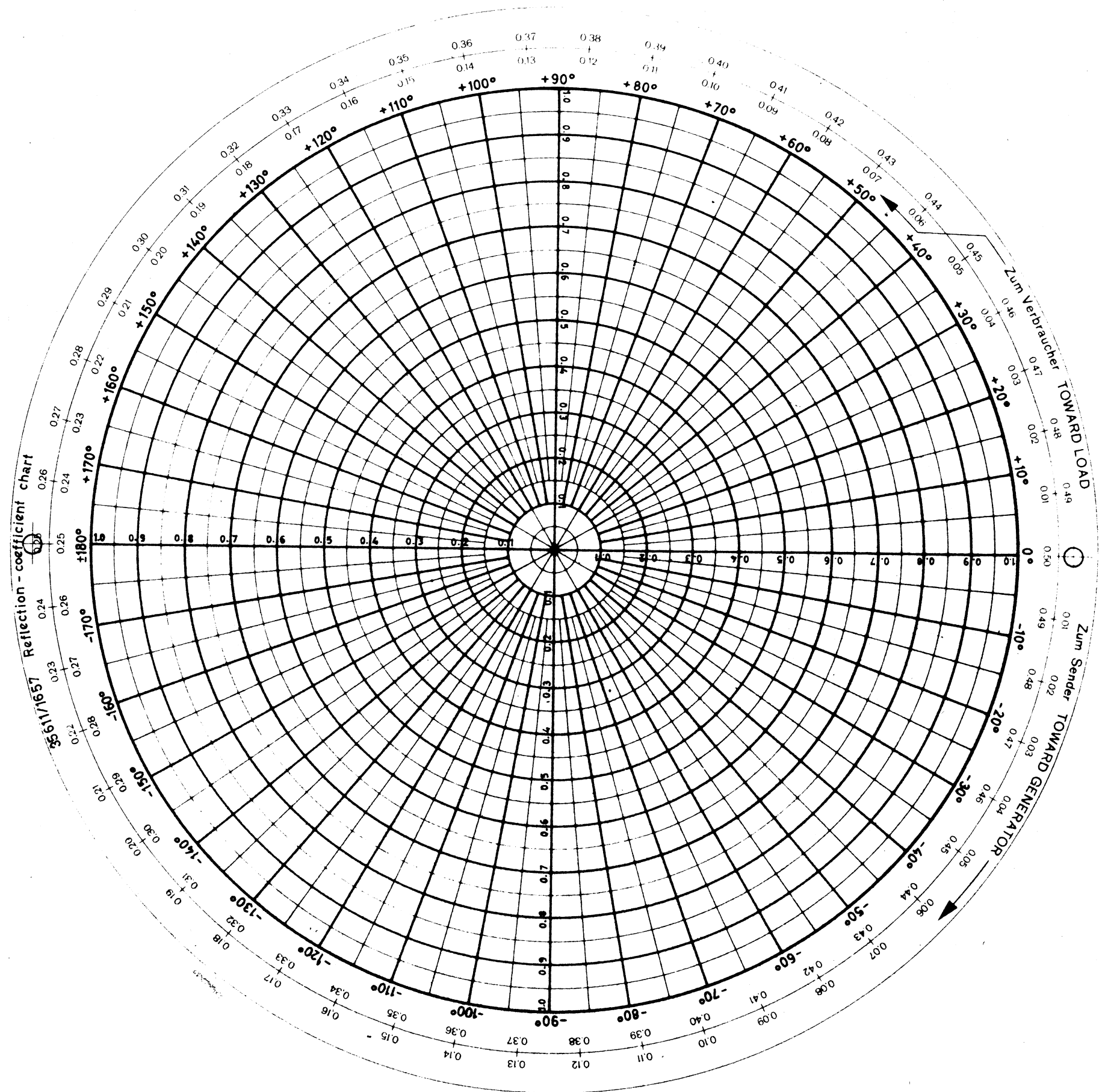


Fig. 28 Reflection-coefficient chart

R 10357
865
Bl. 119

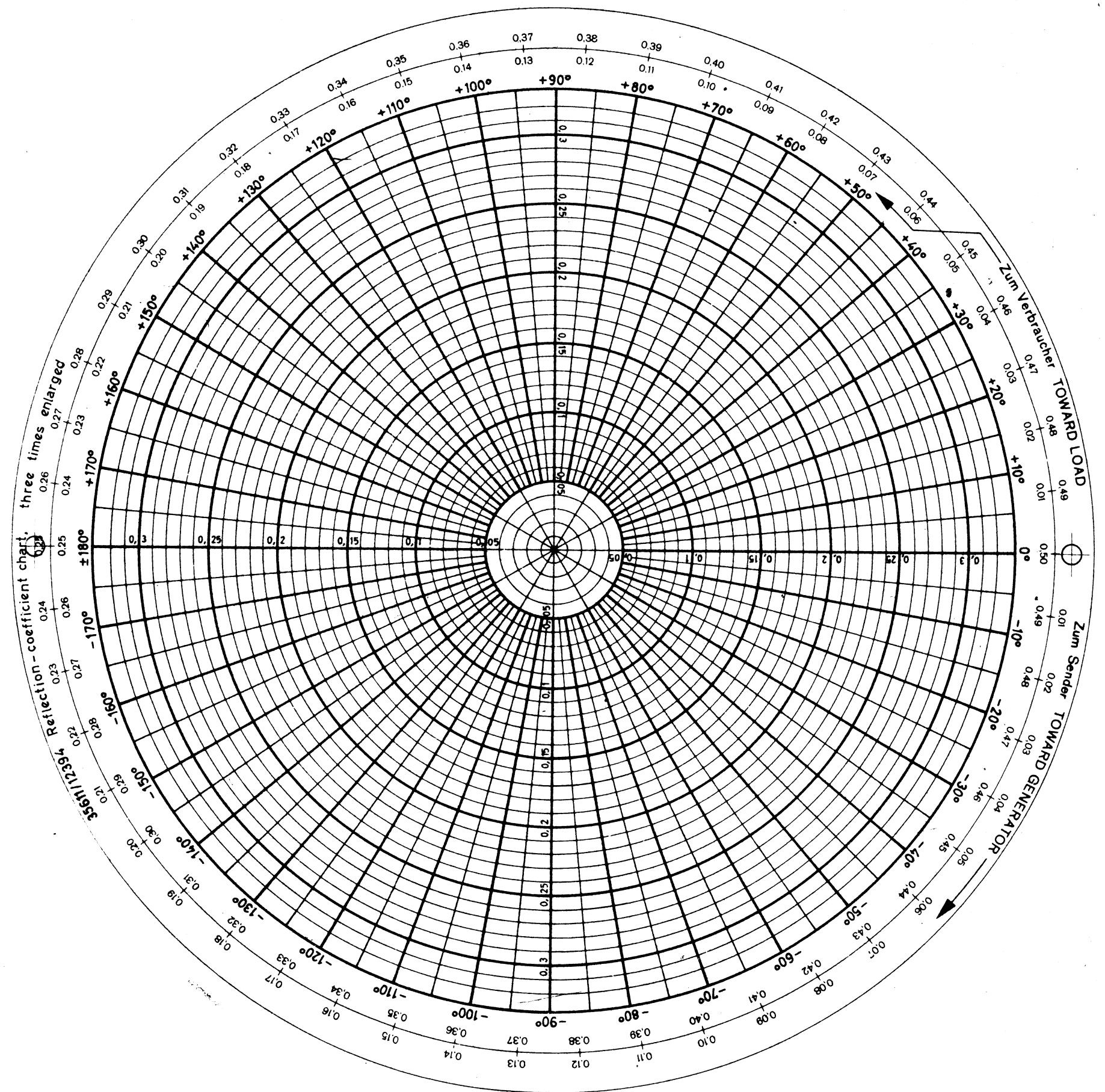


Fig. 29 Reflection-coefficient chart, three times enlarged

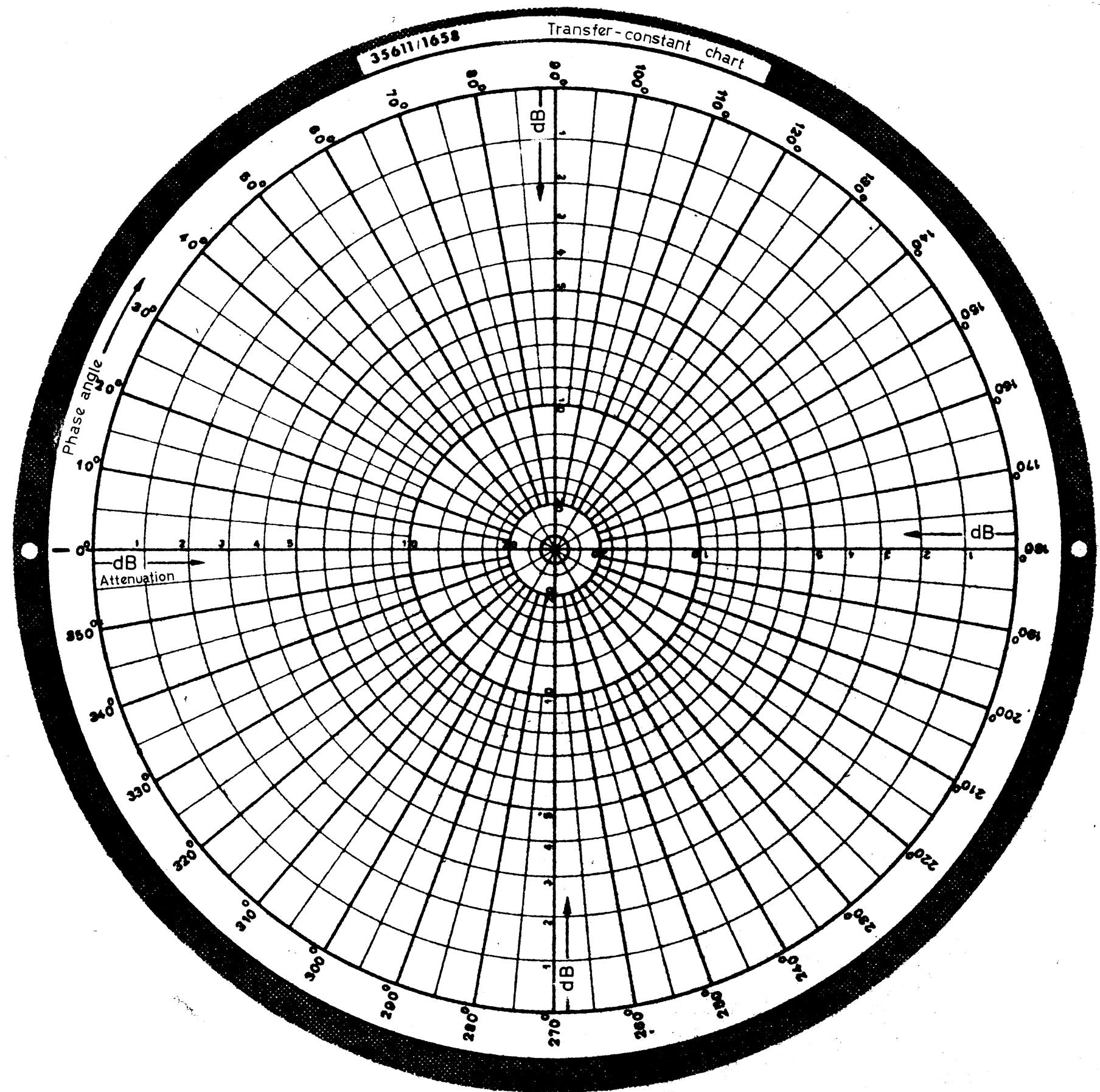



Fig. 30 Transfer-constant chart

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

1	2	3	4	5	6
1	2	3	4	5	6
C1		Kf-Kondensator	CKS 10000/250		
C2		Keramik-Kondensator	CCH 31/47 CCH 31/10 } parallel		
C3		Lufttrimmer	CV 63206		
C4		Keramik-Kondensator	CCH 68/150		
C5		Kf-Kondensator	CKS 10000/500		
C6		Kf-Kondensator	CKS 10000/125		
C7		Kf-Kondensator	CKS 10000/250		
C8		Kf-Kondensator	CKS 10000/250		
C9		Keramik-Kondensator	CCH 31/39 CCG 68/6 } parallel		
C10		Lufttrimmer	CV 63206		
C11		Keramik-Kondensator	CCH 68/150		
C12		Kf-Kondensator	CKS 10000/250		
C13		Kf-Kondensator	CKS 10000/125		
C14		Kf-Kondensator	CKS 10000/250		
C15		Keramik-Kondensator	CCG 68/5		
C16		Keramik-Kondensator	CCG 11/5		
C17		Keramik-Kondensator	CCH 68/150		
C18		Keramik-Kondensator	CCH 31/39 CCG 41/8 CCG 68/8 } parallel		
C19		Lufttrimmer	CV 63206		
C20		Keramik-Kondensator	CCH 68/150		
C21		Kf-Kondensator	CKS 10000/250		
C22		Kf-Kondensator	CKS 10000/250		
C23		Kf-Kondensator	CKS 10000/250		
C24		Lufttrimmer			enthalten in 3561-6
C25		Keramik-Kondensator	CCH 31/33 CCG 68/8 } parallel		
C26		Lufttrimmer	CV 63206		
C27		Keramik-Kondensator	CCH 68/150		


Vervielfältgs.-Pause

 ROHDE & SCHWARZ MÜNCHEN			Änd.-zust.	Änd.-Mittlg. Nr.	Tag	Name	Liste Nr. 3561 Sa	Liste besteht aus 21 Blatt Blatt Nr. 1
			m	5402	18.4.58	Volk		
EKE Tag Name	geschrieben bearbeitet geprüft normgeprüft	18.4.58 	Sz Volk 	p	7056	14.12.60	Volk	Ersatz für ersetzt durch Z-g-Diagraph Type ZDU
				r	7804	22.10.62	H.W	
				t	8856	24.4.64	H.W	
				u	10914	2.66	H.W	

Arbeitspause Nr.

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und Schadensersatzpflichtig.

Kenn- zeichen	Strück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
C28		Kf-Kondensator	CKS 10000/250		
C29		Kf-Kondensator	CKS 10000/250		
C30		Kf-Kondensator	CKS 10000/250		
C31		Lufttrimmer	CV 65225		
C32		Lufttrimmer	CV 65225		
C33		Keramik-Kondensator	CCH 31/18 CCG 41/2 } parallel		
C34		Lufttrimmer	CV 63206		
C35		Keramik-Kondensator	CCH 31/100		
C36		Keramik-Kondensator	CCH 31/150 CCG 55/150 } parallel		
C37		Keramik-Kondensator	CCG 41/4		
C38		Kf-Kondensator	CKS 10000/250		
C39		Kf-Kondensator	CKS 10000/250		
C40		Keramik-Kondensator	CCG 11/0,5		
C41		Ker.Df-Kondensator	CFS 2000		
C42		Lufttrimmer	CV 63206		
C43		Keramik-Kondensator	CCH 31/43 CCG 68/10 } parallel		
C44		Keramik-Kondensator	CCH 68/150		
C45		Keramik-Kondensator	CCH 31/22 CCG 55/3 } parallel		
C46		Lufttrimmer	CV 63206		
C47		Keramik-Kondensator	CCH 68/150		
C48		Kf-Kondensator	CKS 10000/250		
C49		Ker.Df-Kondensator	CFS 2000		
C50		Ker.Df-Kondensator	CFS 2000		
C51		MP-Kondensator	CMR 2/160/2		
C52		Keramik-Kondensator	CCG 68/5		
C53		Keramik-Kondensator	CCG 11/5		
C54		Ker.Df-Kondensator	CFR 1/5000/500		

 ROHDE & SCHWARZ MÜNCHEN		Änd.-zust.	Änd.-Mittlg. Nr.	Tag	Name	Liste Nr. 3561 Sa ersetzt durch Z-g-Diagraph Type ZDU	Liste besteht aus Blatt	
		m	5402	18.4.58	Volk		Blatt Nr. 2	
		n	6368	14.12.59	Volk			
		p	7056	14.12.60	Volk			
EKE	Tag	Name	Ersatz für				ersetzt durch	
geschrieben	21.4.58	Sz						
bearbeitet		Volk						
geprüft								
normgeprüft								

Vervielfältigs.-Pause Nr.

Arbeitspause Nr.

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.	Bemerkungen
1	2	3	4	5
C55		Ker.Df-Kondensator	CFR 1/5000/500	
C56		Ker.Df-Kondensator	CFR 1/5000/500	
C57		Ker.Df-Kondensator	CFR 1/5000/500	
C58		Ker.Df-Kondensator	CFR 1/5000/500	
C59		Ker.Df-Kondensator	CFR 1/5000/500	
C60		Ker.Df-Kondensator	CFR 1/5000/500	
C61		Ker.Df-Kondensator	CFR 1/5000/500	
C62		Ker.Df-Kondensator	CFR 1/5000/500	
C63		Ker.Df-Kondensator	CFR 1/5000/500	
C64		Ker.Df-Kondensator	CFR 1/5000/500	
C65		Ker.Df-Kondensator	CFR 1/5000/500	
C66		Ker.Df-Kondensator	CFR 1/5000/500	
C67		Ker.Df-Kondensator	CFR 1/5000/500	
C68		Ker.Df-Kondensator	CFS 2000	
C69		Ker.Df-Kondensator	CFR 1/5000/500	
C70		Ker.Df-Kondensator	CFR 1/5000/500	
C71		Ker.Df-Kondensator	CFR 1/5000/500	
C72		Kf-Kondensator	CKS 10000/500	
C73		Kf-Kondensator	CKS 2500/500	
C75		Klatschkondensator		30 pF; 115 V; Prüfspannung 1000 V-; enthalten in 3561-70,3;
C76		Klatschkondensator		115...120 pF; Prüfspannung 1000 V-; enthalten in 3561-70,3;
C77		Keramik-Kondensator	CCG 31/15 } parallel CCG 55/6 }	
C78		Keramik-Kondensator	CCG 94/1000	
C79		Kf-Kondensator	CKS 10000/125	
C81		Durchführungskondens.	CFS 2000/M 5	

Vervielfältigs.-Pause

ROHDE & SCHWARZ
MÜNCHEN

EKE Tag Name

geschrieb. 7.3.56 Sz
bearbeitet Volk
geprüft
normgepr.

Änd.- zust.	Änd.-Mittlg. Nr.	Tag	Name
g	3661	5.3.56	Volk
i	4338	26.3.57	Volk
m	5402	18.4.58	Volk
u	10914	2.66	H.W

Liste Nr.

3561 Sa

Liste besteht
aus Blatt

Blatt Nr. 3

Ersatz für

ersetzt durch


~~Stückliste~~ Schaltteilliste zu

Z-g-Diagraph Type Z D U

Arbeitspause Nr.

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.	Bemerkungen	
1	2	3	4	5	6
C82		Durchführungskondens.	CFS 2000/M 5		
C83		Durchführungskondens.	CFS 2000/M 5		
C84		Durchführungskondens.	CFS 2000/M 5		
C85		Durchführungskondens.	CFS 2000/M 5		
C86		Durchführungskondens.	CFS 2000/M 5		
C87		Durchführungskondens.	CFS 2000/M 5		
C88		Durchführungskondens.	CFS 2000/M 5		
C89		Klatschkondensator			=C 75 ± 1%; Prüfspannung 1000 V-; enthalten in 3561-70,2
C90		Klatschkondensator			=C 76 ± 1%; Prüfspannung 1000 V-; enthalten in 3561-70,2
C91		Keramik-Kondensator	CCH 31/15 } CCG 55/6 }	parallel	
C92		Keramik-Kondensator	CCG 94/1000		
C93		Kf-Kondensator	CKS 10000/125		
C95		Durchführungskondens.	CFS 2000/M 5		
C96		Durchführungskondens.	CFS 2000/M 5		
C97		Durchführungskondens.	CFS 2000/M 5		
C98		Durchführungskondens.	CFS 2000/M 5		
C99		Durchführungskondens.	CFS 2000/M 5		
C100		Durchführungskondens.	CFS 2000/M 5		
C101		Durchführungskondens.	CFS 2000/M 5		
C102		Durchführungskondens.	CFS 2000/M 5		
C103		Klatschkondensator			ca. 55 pF; Prüfspannung 1000 V-; enthalten in 3561-70,16
C104		Keramik-Kondensator	CCH 31/100 } CCH 31/ }	parallel	
C105		Klatschkondensator			450...520 pF; Prüfspannung 500 V-; enthalten in 3561-70,16
C106		Klatschkondensator			= C 105 ± 1%; Prüfspannung 500 V-; enthalten in 3561-70,16
C107		Klatschkondensator			ca. 25 pF; Prüfspannung 1000 V-; enthalten in 3561-70,16
C108		Klatschkondensator			= C 107 ± 1%; Prüfspannung 1000 V-; enthalten in 3561-70,16

 ROHDE & SCHWARZ MÜNCHEN			Änd.- zust.	Änd.-Mittlg. Nr.	Tag	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt																
			g	3661	5.3.56	Volk		Blatt Nr. 4																
<table border="1"> <tr> <td>EKE</td> <td>Tag</td> <td>Name</td> </tr> <tr> <td>geschrieb.</td> <td>7.3.56</td> <td>Sz</td> </tr> <tr> <td>bearbeitet</td> <td></td> <td>Volk</td> </tr> <tr> <td>geprüft</td> <td></td> <td></td> </tr> <tr> <td>normgepr.</td> <td></td> <td></td> </tr> </table>			EKE	Tag	Name	geschrieb.	7.3.56	Sz	bearbeitet		Volk	geprüft			normgepr.			k	4969	29.8.57	Volk	Ersatz für	ersetzt durch	
			EKE	Tag	Name																			
geschrieb.	7.3.56	Sz																						
bearbeitet		Volk																						
geprüft																								
normgepr.																								
m	5402	18.4.58	Volk																					
			u	10914	2.66	H.W	STÜCKLISTE / Schaltteilliste zu Z-g-Diagraph Type Z D U																	

Kenn- zeich.		Stück- zahl	Benennung	Sach-Nr.	Bemerkungen
1	2	3	4	5	6
C109			Keramik-Kondensator	CCG 11/0,5	
C110			Keramik-Kondensator	CCG 11/0,5	
C111			Drehkondensator		ca. 4...12 pF; Prüfspannung 750 V-; enthalten in 3561-70
C112			Klatschkondensator		ca. 7,5 pF; Prüfspannung 1000 V-; enthalten in 3561-70
C113			Klatschkondensator		> 50 pF; Prüfspannung 500 V-; enthalten in 3561-70
C115			Durchführungskondens.	CFS 2000/M 5	
C116			Durchführungskondens.	CFS 2000/M 5	
C117			Durchführungskondens.	CFS 2000/M 5	
C118			Durchführungskondens.	CFS 2000/M 5	
C119			Durchführungskondens.	CFS 2000/M 5	
C120			Durchführungskondens.	CFS 2000/M 5	
C121			Durchführungskondens.	CFS 2000/M 5	
C122			Durchführungskondens.	CFS 2000/M 5	
C123			Durchführungskondens.	CFS 2000	
C124			Durchführungskondens.	CFS 2000	
C128			Kf-Kondensator	CKS 10000/250	
C129			Keramik-Kondensator	CCH 31/47 CCH 3 } parallel	
C130			Lufttrimmer	CV 63206	
C131			Keramik-Kondensator	CCH 60/150	
C132			Kf-Kondensator	CKS 10000/250	
C133			Kf-Kondensator	CKS 10000/125	
C134			Kf-Kondensator	CKS 10000/250	
C135			Kf-Kondensator	CKS 10000/250	

Diese Zeichnung darf ohne unsere Genehmigung weder kopiert noch dritten Personen oder Konkurrenzfirmen mitgeteilt werden.
(§1 Ziffer 3 des Gesetzes vom 1. Juni 1901.)

Vervielfgs.-Pause Nr.

ROHDE & SCHWARZ
MÜNCHEN

EKE	Tag	Name
beschrieb.	11.8.53	Ey
bearbeitet		Volk
geprüft		
normgepr.		

Arbeitspause Nr.

Änd. zust.	Änd. Mitt. Nr.	Tag	Name
a	2426	11.11.53	Volk
d	2918	3.1.55	Volk
g	3661	5.3.56	Volk
k	4969	29.8.57	Volk
m	5402	18.4.58	Volk
p	7056	14.12.60	Volk
u			

Liste Nr.

3561 Sa

Liste besteht

aus Blatt

Blatt Nr. 5

Ersatz für


ersetzt durch

Stückliste / Schaltteilliste zu

Z-g-Diagraph Type Z D U

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.	Bemerkungen
1	2	3	4	5
C136		Keramik-Kondensator	CCH 31/39 CCG 41/4 CCG 68/8 CCG 41/3 } parallel	
C137		Lufttrimmer	CV 63206	
C138		Keramik-Kondensator	CCH 68/150	
C139		Kf-Kondensator	CKS 10000/250	
C140		Kf-Kondensator	CKS 10000/125	
C141		Kf-Kondensator	CKS 10000/250	
C142		Ker.Df-Kondensator	CFR 1/5000/500	
C143		Ker.Bp-Kondensator	CBR 1/1600/350	
C144		Keramik-Kondensator	CCH 68/150	
C145		Keramik-Kondensator	CCH 31/10 CCG 41/3 CCG 68/8 } parallel	
C146		Lufttrimmer	CV 63206	
C147		Keramik-Kondensator	CCH 31/150	
C148		Keramik-Kondensator	CCH 31/56	
C149		Keramik-Kondensator	CCH 68/150	
C150		Kf-Kondensator	CKS 10000/250	
C151		Kf-Kondensator	CKS 10000/250	
C152		Kf-Kondensator	CKS 10000/250	
C153		Keramik-Kondensator	CCG 41/8 CCG 55/2 } parallel	
C155		Keramik-Kondensator	CCH 31/39 CCG 41/3 CCG 68/8 } parallel	
C156		Lufttrimmer	CV 63206	
C157		Keramik-Kondensator	CCH 68/150	
C158		Kf-Kondensator	CKS 10000/250	
C159		Kf-Kondensator	CKS 10000/250	
C160		Kf-Kondensator	CKS 10000/250	
C161		Keramik-Kondensator	CCG 11/0,5	
C162		Keramik-Kondensator	CCH 31/22	

 ROHDE & SCHWARZ MÜNCHEN		Änd.- zust.	Änd.-Mittlg. Nr.	Tag	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt Blatt Nr. 6
		m	5402	18.4.58	Volke		
		p	7056	14.12.60	Volke		
		t	8856	24.4.64	H.W		
EKE	Tag	Name	u	10914	2.66	H.W	Ersatz für ersetzt durch
geschrieben	21.4.58	Sz	Ersatz für ersetzt durch				
bearbeitet		Volke	Z-g-Diagraph Type ZDU				
geprüft							
normgeprüft							

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

Dfak Mrk Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
C163		Lufttrimmer	CV 63206		
C164		Keramik-Kondensator	CCH 31/150 } parallel CCH 25/150 } CCH 68/150 }		
C165		Keramik-Kondensator	CCH 31/100		
C166		Kf-Kondensator	CKS 10000/250		
C169		Keramik-Kondensator	CCH 68/47		
C170		Kf-Kondensator	CKS 10000/250		
C171		Kf-Kondensator	CKS 1000/500		
C172		Ker.Df-Kondensator	CFS 2000		
C173		Kf-Kondensator	CKS 10000/125		
C174		Keramik-Kondensator	CCH 68/150		
C175		Keramik-Kondensator	CCH 31/22		
C176		Lufttrimmer	CV 63206		
C177		Kf-Kondensator	CKS 10000/250		
C178		Kf-Kondensator	CKS 10000/250		
C179		Ker.Df-Kondensator	CFR 1/5000/500		
C180		Keramik-Kondensator	CCH 68/150		
C181		Keramik-Kondensator	CCH 31/12		
C182		Lufttrimmer	CV 63206		
C185		Ker.Df-Kondensator	CFR 1/5000/500		
C186		Ker.Df-Kondensator	CFR 1/5000/500		
C187		Ker.Df-Kondensator	CFR 1/5000/500		
C188		Ker.Df-Kondensator	CFR 1/5000/500		
C189		Ker.Df-Kondensator	CFR 1/5000/500		



ROHDE & SCHWARZ
MÜNCHEN

Änd.- zust.	Änd.-Mittlg. Nr.	Tag	Name
m	5402	18.4.58	Volke
n	6368	14.12.59	Volke
p	7056	14.12.60	Volke

Liste Nr.

3561 Sa

Liste besteht

aus Blatt

Blatt Nr. 7

EKE Tag Name

geschrieben	21.4.58	Sz
bearbeitet		Volke
geprüft		
normgeprüft		

Ersatz für

ersetzt durch

Stückliste Schalteileliste zu


Z-g-Diagraph Type ZDU

Vervielfältigungs-Pause
Nr.

Arbeitspause Nr.

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und Schadenersatzpflichtig.

Lfd. Nr. Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
C190		Ker.Df-Kondensator	CFR 1/5000/500		
C191		Ker.Df-Kondensator	CFR 1/5000/500		
C192		Ker.Df-Kondensator	CFR 1/5000/500		
C193		Ker.Df-Kondensator	CFR 1/5000/500		
C194		Ker.Df-Kondensator	CFR 1/5000/500		
C195		Ker.Df-Kondensator	CFR 1/5000/500		
C196		Ker.Df-Kondensator	CFR 1/5000/500		
C197		Ker.Df-Kondensator	CFR 1/5000/500		
C198		Ker.Df-Kondensator	CFR 1/5000/500		
C199		Ker.Df-Kondensator	CFR 1/5000/500		
C200		Ker.Df-Kondensator	CFR 1/5000/500		
C201		Ker.Df-Kondensator	CFR 1/5000/500		
C202		Ker.Df-Kondensator	CFR 1/5000/500		
C203		Kf-Kondensator	CKS 10000/500		
C206		MP-Rundkondensator	CMR 1/250		
C207		MP-Rundkondensator	CMR 1/250		
C208		MP-Rundkondensator	CMR 1/250		
C209		MP-Rundkondensator	CMR 1/250		
C210		MP-Rundkondensator	CMR 1/250		
C211		MP-Rundkondensator	CMR 2/160 /2		
C212		MP-Rundkondensator MP-Rundkondensator	CMR 0,5/500 CMR 0,25/500	} parallel	
C213		Kf-Kondensator	CKS 15000/500		
C214		Papier-Kondensator	CPK 58004 n 100		
C215		MP-Rundkondensator	CMR 16/350		
C216		MP-Rundkondensator	CMR 16/350		


 ROHDE & SCHWARZ MÜNCHEN			Änd.- zust.	Änd.-Mitgl. Nr.	Tag	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt	
			e	3300	18.8.55	Volk		Blatt Nr. 8	
EKE Tag Name geschrieb. 20.8.55 Sz bearbeitet Volk geprüft normgepr.			g	3661	5.3.56	Volk	Ersatz für ersetzt durch Z-g-Diagraph Type Z D U		
			i	4338	26.3.57	Volk			
			k	4969	29.8.57	Volk			
			m	5402	18.4.58	Volk			
			u	10914	2.66	H.W			

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und Schadensersatzpflichtig.

KKS KKS Kenn- zeichen	Stück- zahl	Benennung	Soeh-Nr		Bemerkungen
1	2	3	4	5	6
C217		Kf-Kondensator	CKS 5000/500		
C220					
⋮		Rohrkondensator	CT 4,3 ± 1%		zusammen 106 Stück
C325					
G1 1		Kristall-Diode	GK/OA 95		
G1 2		Kristall-Diode	GK/OA 95		
G1 3		Kristall-Diode	GK 1111		
G1 4		Kristall-Diode	GK/OA 95		
G1 5		Kristall-Diode	GK/OA 95		
G1 6		Kristall-Diode	GK/OA 95		
G1 7		Kristall-Diode	GK/OA 95		
G1 8		Kristall-Diode	GK/OA 95		
G1 9		Kristall-Diode	GK 1011 C		
G110		Kristall-Diode	GK 1011 C		
G112		Kapazitäts-Diode	GK/BA 111		
G113		Zener-Diode	GK/Z 12		
J 1		Drehspul-Strommesser	JBS 10101		hierzu Rl 4
J 2		Lichtmarken- Drehspul-Strommesser	JG 2		
J 3		Drehspul-Strommesser	JBS 20201		hierzu Rl 5
K 1		HF-Kabel (Gr.)	3561 - 60		ohne eig.Zchnng.; bearb.aus 3561-40 o.eig.Zchnng., hierzu bes. Stückliste; 2x beschriftet mit K1;
K 2		HF-Kabel (Gr.)	3561 - 61		ohne eig.Zchnng.; bearb.aus 3561-40 o.eig.Zchnng., hierzu bes. Stückliste; 2x beschriftet mit K2;
K 3		HF-Kabel (Gr.)	3561 - 62		ohne eig.Zchnng.; bearb.aus 3561-41 o.eig.Zchnng., hierzu bes. Stückliste; 2x beschriftet mit K3;
K 4		HF-Kabel (Gr.)	3561 - 63		ohne eig.Zchnng.; bearb.aus 3561-12 hierzu bes.Stückliste; 2x beschriftet mit K4;
K 5		HF-Kabel (Gr.)	3561 - 64		ohne eig.Zchnng.; bearb.aus 3561-41 o.eig.Zchnng., hierzu bes. Stückliste; 2x beschriftet mit K5;
K 6		HF-Kabel	3561 - 55		bearb.aus LKF 52873/437


Arbeitspauze Nr.

Arbeitspauze Nr.

 ROHDE & SCHWARZ MÜNCHEN		Änd.- zust.	Änd.-Mittlg. Nr.	Datum	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt Blatt Nr. 9
		t	8856	24.4.64	H.W		
		u	10914	2.66	H.W		
EKE	Datum	Name					
geschrieben	24.4.64	Wü					Ersatz für Liste
bearbeitet		H.W					ersetzt durch Liste
geprüft							
normgeprüft							
Z-g-Diagraph Type Z D U							

Diese Zeichnung darf ohne unsere Genehmigung weder kopiert noch dritten Personen oder Konkurrenzfirmen mitgeteilt werden.
(§1 Ziffer 3 des Gesetzes vom 1. Juni 1901.)

Lfd.-Nr.		Kenn- zeich.		Stück- zahl	Benennung	Sach-Nr.	Bemerkungen
1		2		3	4	5	6
L1					Filterspule (Untergr.)	3561-6.15.3	hierzu bes.Stückliste
L2					Filterspule (Untergr.)	3561-6.16.3	hierzu bes.Stückliste
L3					Filterspule (Untergr.)	3561-6.16.3	hierzu bes.Stückliste
L4					Filterspule (Untergr.)	3561-6.16.3	hierzu bes.Stückliste
L5					Filterspule (Untergr.)	3561-6.18.1	hierzu bes.Stückliste
L6					Filterspule (Untergr.)	3561-6.18.1	hierzu bes.Stückliste
L7					Filterspule (Untergr.)	3561-6.19.5	hierzu bes.Stückliste
L8					HF-Drossel	DUF 311/20	
L9					HF-Drossel	DUF 311/20	
L10					HF-Drossel	DUF 311/20	
L11					ZF-Spule (Untergr.)	3561-70.2.9	hierzu bes.Stückliste
L12					ZF-Spule (Untergr.)	3561-70.2.9	hierzu bes.Stückliste
L13					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L14					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L15					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L16					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L17					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L18					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L19					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L20					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L21					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L22					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste
L23					HF-Drossel (Untergr.)	3561-7.4.8	hierzu bes.Stückliste


 ROHDE & SCHWARZ MUNCHEN	Änd. zust.		Änd. Mitt. Nr.	Tag	Name	Liste Nr.		Liste besteht aus Blatt	
			c	2669	14.1.54	Volk	3561 Sa		Blatt Nr. 10
			g	3661	5.3.56	Volk			
			k	4969	29.8.57	Volk			
EKE	Tag	Name	m	5402	18.4.58	Volk	Ersatz für		ersetzt durch
geschrieben	11.8.53	By	r	7804	22.10.62	H.W	Stückliste / Schaltteilliste zu		
bearbeitet		Volk	u	10914	2.66	H.W	Z-g-Diagraph Type Z D U		
geprüft									
normgepr.									

elfgs.-Pause Nr.

eiltpause Nr.


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 (§1 Ziffer 3 des Gesetzes vom 1. Juni 1901.)

Kenn- zeich.	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
L24		HF-Drossel (Untergr.)	3561-7.4.8		hierzu bes.Stückliste
L27		Saugkreisspule (U'Gr.)	3561-70.17		hierzu bes.Stückliste
L28		Oszillatorspule (U'Gr.)	3561-7.56		hierzu bes.Stückliste
L29		Oszillatorspule (U'Gr.)	3561-7.57		hierzu bes.Stückliste
L30		Oszillatorspule (U'Gr.)	3561-7.58		hierzu bes.Stückliste
L31		Oszillatorspule (U'Gr.)	3561-7.59		hierzu bes.Stückliste
L32		Oszillatorspule (U'Gr.)	3561-7.60		hierzu bes.Stückliste
L33		Oszillatorspule (U'Gr.)	3561-7.61		hierzu bes.Stückliste
L35		HF-Drossel (Untergr.)	3561-7.4.8		hierzu bes.Stückliste
L36		HF-Drossel (Untergr.)	3561-7.4.8		hierzu bes.Stückliste
L37		HF-Drossel (Untergr.)	3561-7.4.8		hierzu bes.Stückliste
L38		HF-Drossel (Untergr.)	3561-7.4.8		hierzu bes.Stückliste
L39		HF-Drossel (Untergr.)	3561-7.4.8		hierzu bes.Stückliste
L40		HF-Drossel (Untergr.)	3561-7.4.8		hierzu bes.Stückliste
L43		Filterspule (Untergr.)	3561-6.15.3		hierzu bes.Stückliste
L44		Filterspule (Untergr.)	3561-6.16.3		hierzu bes.Stückliste
L45		Filterspule (Untergr.)	3561-6.16.3		hierzu bes.Stückliste
L46		Filterspule (Untergr.)	3561-6.16.3		hierzu bes.Stückliste
L47		Filterspule (Untergr.)	3561-6.18.1		hierzu bes.Stückliste
L48		Filterspule (Untergr.)	3561-6.19.5		hierzu bes.Stückliste
L49		Filterspule (Untergr.)	3561-8.12.5		hierzu bes.Stückliste
L50		HF-Drossel	DUF 311/20		


 ROHDE & SCHWARZ MÜNCHEN		Änd. zust.	Änd. Mitt. Nr.	Tag	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt Blatt Nr. 11
		k	4969	29.8.57	Volk		
		s	8720	19.3.64	H.W		
Tag Name						Ersatz für	ersetzt durch
geschrieb. 11.8.53 Ey bearbeitet Volk geprüft normgepr.						Ersatz für Schaltteilliste zu Z-g-Diagraph Type Z D U	

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und Schadensersatzpflichtig.

XX Ed. Nr. Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
L51		HF-Drossel	DUF 311/20		
L52		HF-Drossel	DUF 311/20		
L53		HF-Drossel	DUF 311/80		
L55		Ringspule			enth.in 3561-4.8
R 1		Schichtwiderstand	WFE 321 E 300		
R 2		Schichtwiderstand	WFE 321 k 200		
R 3		Schichtwiderstand	WFE 321 k 1		
R 4		Schichtwiderstand	WFE 321 E 200		
R 5		Schichtwiderstand	WFE 321 k 20		
R 6		Schichtwiderstand	WFE 321 E 300		
R 7		Schichtwiderstand	WFE 321 k 200		
R 8		Schichtwiderstand	WFE 321 k 1		
R 9		Schichtwiderstand	WFE 321 E 200		
R10		Schichtwiderstand	WFE 321 k 20		
R11		Schichtwiderstand	WFE 321 k 12,5		
R13		Schichtwiderstand	WFE 321 k 100		
R14		Schichtwiderstand	WFE 321 k 1		
R15		Schichtwiderstand	WFE 321 k 100		
R16		Schichtwiderstand	WFE 321 k 200		
R17		Schichtwiderstand	WFE 321 k 200		
R18		Schichtwiderstand	WFE 321 k 1		
R19		Schichtwiderstand	WFE 321 k 500		
R20		Schichtwiderstand	WFE 321 M 1		


 ROHDE & SCHWARZ MÜNCHEN			Änd.- zust.	Änd.-Mittlg. Nr.	Datum	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt Blatt Nr. 12
			u	10914	2.66	H.W		
EKE	Datum	Name					Ersatz für Liste Schalttafel / Schaltteilliste zu Z-g-Diagraph Type Z D U	
geschrieben	2.66	Wü						
bearbeitet		H.W						
geprüft								
normgeprüft								

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 Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
R21		Schichtwiderstand	WFE 321 k 100		
R22		Schichtwiderstand	WFE 321 E 500		
R23		Schichtwiderstand	WFE 321 k 125		
R24		Schichtwiderstand	WFE 341 E 585		
R25		Schichtwiderstand	WFE 321 k 200		
R26		Schichtwiderstand	WFE 321 k 1		
R27		Schichtwiderstand	WFE 321 k 50		
R28		Schichtwiderstand	WFE 321 k 20		
R29		Schichtwiderstand	WFE 321 k 1		
R30		Schichtwiderstand	WFE 321 k 100		
R31		Schichtwiderstand	WFE 321 k 100		
R32		Schichtwiderstand	WFE 321 k 100		
R33		Schichtwiderstand	WFE 321 k 50		
R34		Schichtwiderstand	WFE 321 E 100		
R35		Schichtwiderstand	WFE 321 k 1,25		
R36		Schichtwiderstand	WFE 321 k 5		
R37		Schicht-Drehwiderst.	WS 5122 F/250		
R40		Schichtwiderstand	WFE 321 E 500		
R41		Schichtwiderstand	WFE 321 E 500		
R42		Schichtwiderstand	WFE 321 E 500		
R43		Schichtwiderstand	WFE 321 E 500		
R44		Schichtwiderstand	WFE 321 k 100		
R45		Schichtwiderstand	WFE 321 E 500		
R46		Schichtwiderstand	WFE 321 k 10		
R47		Schicht-Drehwiderst.	WS 5122 F/100 k		

Vervielfält.-Pause Nr.

Arbeitspause Nr.

 ROHDE & SCHWARZ MÜNCHEN			Änd.- zust.	Änd.-Mittlg. Nr.	Datum	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt	
			u	10914	2.66	H.W		Blatt Nr. 13	
EKE	Datum	Name	Ersatz für Liste Z-g-Diagraph Type Z D U						
geschrieben	2.66	Wü							
bearbeitet		H.W							
geprüft									
normgeprüft									

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.	Bemerkungen
1	2	3	4	5
R48		Schichtwiderstand	WFE 321 E 500	
R49		Schichtwiderstand	WFE 321 E 500	
R52		Schichtwiderstand	WFE 321 E 160	
R53		Schichtwiderstand	WFE 321 k 1	Trimmwert
R54		Schichtwiderstand	WFE 321 k 50	
R55		Schichtwiderstand	WFK 511/100/1/0,08	
R57		Teilerwiderstand(U'G.)	3561 - 7.5.8/50	25,36 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R58		Teilerwiderstand(U'G.)	3561 - 7.5.8/50	25,36 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R59 } R60 }	50	Teilerwiderstand(U'G.)	3561 - 7.5.4/50	2x44,06 Ω \pm 0,5%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R61	3561	Teilerwiderstand(U'G.)	3561 - 7.5.8/50	25,36 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R62	BN	Teilerwiderstand(U'G.)	3561 - 7.5.8/50	25,36 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R63	für	Teilerwiderstand(U'G.)	3561 - 7.5.8/50	25,36 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R64	nur	Teilerwiderstand(U'G.)	3561 - 7.5.8/50	25,36 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R65 } R66 }		Teilerwiderstand(U'G.)	3561 - 7.5.4/50	2x44,06 Ω \pm 0,5%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R67		Teilerwiderstand(U'G.)	3561 - 7.5.8/50	25,36 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R68		Teilerwiderstand(U'G.)	3561 - 7.5.8/50	25,36 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R57	60	Teilerwiderstand(U'G.)	3561 - 7.5.8/60	30,43 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R58	3561	Teilerwiderstand(U'G.)	3561 - 7.5.8/60	30,43 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R59 } R60 }		Teilerwiderstand(U'G.)	3561 - 7.5.4/60	2x52,87 Ω \pm 0,5%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R61	BN	Teilerwiderstand(U'G.)	3561 - 7.5.8/60	30,43 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R62	für	Teilerwiderstand(U'G.)	3561 - 7.5.8/60	30,43 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R63	nur	Teilerwiderstand(U'G.)	3561 - 7.5.8/60	30,43 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R64		Teilerwiderstand(U'G.)	3561 - 7.5.8/60	30,43 Ω \pm 1%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste
R65 } R66 }		Teilerwiderstand(U'G.)	3561 - 7.5.4/60	2x52,87 Ω \pm 0,5%; wird v.Fa.Resista komplettiert; hierzu bes. Stückliste



ROHDE & SCHWARZ
MÜNCHEN

Änd.- zust.	Änd.-Mittlg. Nr.	Tag	Name
m	5402	17.4.58	Volk
u	10914	2.66	H.W

Liste Nr.

3561 Sa

Liste besteht
aus Blatt

Blatt Nr. 14

EKE	Tag	Name
geschrieben	18.4.58	Sz
bearbeitet		Volk
geprüft		
normgeprüft		

Ersatz für

ersetzt durch

Stückliste Schalteilliste zu

Z-g-Graph Type ZDU

Vervielfältigs.-Pause

Arbeitspause Nr.


DFK Nr. Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
R67		Teilerwiderstand(U'G.)	3561 - 7.5.8/60		30,43 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R68		Teilerwiderstand(U'G.)	3561 - 7.5.8/60		30,43 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R57		Teilerwiderstand(U'G.)	3561 - 7.5.8/75		38,05 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R58		Teilerwiderstand(U'G.)	3561 - 7.5.8/75		38,05 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R59 R60		Teilerwiderstand(U'G.)	3561 - 7.5.4/75		2x66,09 $\Omega \pm 0,5\%$;wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R61		Teilerwiderstand(U'G.)	3561 - 7.5.8/75		38,05 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R62		Teilerwiderstand(U'G.)	3561 - 7.5.8/75		38,05 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R63		Teilerwiderstand(U'G.)	3561 - 7.5.8/75		38,05 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R64		Teilerwiderstand(U'G.)	3561 - 7.5.8/75		38,05 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R65 R66		Teilerwiderstand(U'G.)	3561 - 7.5.4/75		2x66,09 $\Omega \pm 0,5\%$;wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R67		Teilerwiderstand(U'G.)	3561 - 7.5.8/75		38,05 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R68		Teilerwiderstand(U'G.)	3561 - 7.5.8/75		38,05 $\Omega \pm 1\%$; wird v.Fa.Resista komplettiert;hierzu bes.Stückliste
R89		Schichtwiderstand	WFE 321 E 160		
R90		Schichtwiderstand	WFE 321 k 1		Trimmwert
R91		Schichtwiderstand	WFE 321 k 50		
R92		Schichtwiderstand	WFK 511/100/1/0,08		
R94		Schichtwiderstand	WFE 321 E 600		
R95		Schichtwiderstand	WFE 321 E 600		
R96		Schichtwiderstand	WFE 321 k 20		
R97		Schichtwiderstand	WFE 321 k 20		
R98		Schichtwiderstand	WFE 221 k 1 WFE 321 k 6		in Serie
R99		Schichtwiderstand	WFE 521 E 300		


Vervielfältgs.-Pause
Nc.

Arbeitspause Nr.


			Änd.-zust.	Änd.-Mittlg. Nr.	Tag	Name	Liste Nr.	Liste besteht aus Blatt
ROHDE & SCHWARZ MÜNCHEN			m	5402	17.4.58	Volk	3561 Sa	
			u	10914	2.66	H.W		Blatt Nr. 15
EKE	Tag	Name					Ersatz für	ersetzt durch
geschrieben	18.4.58	Sz					Stückliste / Schaltteilliste zu	
bearbeitet		Volk					Z-g-Diagraph Type ZDU	
geprüft								
normgeprüft								

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.


 Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
R102		Schichtwiderstand	WFE 321 E 300		
R103		Schichtwiderstand	WFE 321 k 200		
R104		Schichtwiderstand	WFE 321 k 1		
R105		Schichtwiderstand	WFE 321 E 200		
R106		Schichtwiderstand	WFE 321 k 20		
R107		Schichtwiderstand	WFE 321 E 300		
R108		Schichtwiderstand	WFE 321 k 200		
R109		Schichtwiderstand	WFE 321 k 1		
R110		Schichtwiderstand	WFE 321 E 200		
R111		Schichtwiderstand	WFE 321 k 20		
R112		Schichtwiderstand	WFE 321 k 12,5		
R113		Schichtwiderstand	WFE 321 k 125		
R114		Schichtwiderstand	WFE 321 k 100		
R115		Schichtwiderstand	WFE 321 k 1		
R117		Schichtwiderstand	WFE 321 k 20		
R118		Schichtwiderstand	WFE 321 M 1,6		
R119		Schichtwiderstand	WFE 321 k 200		
R120		Schichtwiderstand	WFE 321 k 1		
R121		Schichtwiderstand	WFE 321 k 500		
R122		Schichtwiderstand	WFE 321 M 1		
R123		Schichtwiderstand	WFE 321 k 600		
R124		Schichtwiderstand	WFE 321 k 125		
R125		Schichtwiderstand	WFE 341 E 585		
R126		Schichtwiderstand	WFE 321 k 1		

 ROHDE & SCHWARZ MÜNCHEN			Änd.- zust.	Änd.-Mittlg. Nr.	Datum	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt Blatt Nr. 16
			u	10914	2.66	H.W		
EKE	Datum	Name					Ersatz für Liste Schaltteilliste zu Z-g-Diagraph Type Z D U	
geschrieben	2.66	Wü						
bearbeitet		H.W						
geprüft								
normgeprüft								

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

 Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
R129		Schichtwiderstand	WFE 321 k 125		
R130		Schichtwiderstand	WFE 321 k 100		
R131		Schichtwiderstand	WFE 521 k 3		
R132		Schichtwiderstand	WFE 521 k 50		
R133		Schichtwiderstand	WFE 521 k 1		
R134		Schichtwiderstand	WFE 321 E 160		
R135		Schichtwiderstand	WFE 321 k 200		
R136		Schichtwiderstand	WFE 321 k 1		
R137		Schichtwiderstand	WFE 321 k 50		
R138		Schichtwiderstand	WFE 521 k 20		
R139		Schichtwiderstand	WFE 321 k 100		
R140		Schichtwiderstand	WFE 321 k 100		
R142		Schichtwiderstand	WFE 321 E 300		
R143		Schichtwiderstand	WFE 321 E 500		
R144		Schichtwiderstand	WFE 321 E 500		
R146		Schichtwiderstand	WFE 321 M 1		
R147		Schichtwiderstand	WFE 321 k 160		
R148		Schichtwiderstand	WFE 321 E 500		
R149		Schichtwiderstand	WFE 321 E 500		
R150		Schichtwiderstand	WFE 321 E 500		
R151		Schichtwiderstand	WFE 321 M 4		
R152		Schichtwiderstand	WFE 321 k 100		
R154		Schichtwiderstand	WFE 341 k 10		
R155		Schichtwiderstand	WFE 341 k 10		

Vervielfält.-Pause Nr.

 ROHDE & SCHWARZ MÜNCHEN		Änd.- zust.	Änd.-Mittlg. Nr.	Datum	Name
		u	10914	2.66	H.W
EKE	Datum	Name			
geschrieben	2.66	Wü			
bearbeitet		H.W			
geprüft					
normgeprüft					

Liste Nr.	Liste besteht aus Blatt
3561 Sa	Blatt Nr. 17

Arbeitspause Nr.

Ersatz für Liste	
Schaltteilleiste zu	


Z-g-Diagraph Type Z D U

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
R156		Schicht-Drehwiderst. Schichtwiderstand	WS 5122 F/25 k WFE 321 k 1		in Serie
R157		Schichtwiderstand	WFE 321 k 1 WFE 321 k 2		parallel
R158		Schichtwiderstand	WFE 321 M 2		
R159		Schichtwiderstand	WFE 321 k 400		
R160		Schichtwiderstand	WFE 321 M 1,6		
R161		Schichtwiderstand	WFE 321 k 100		
R162		Schichtwiderstand	WFE 321 k 50		
R163		Schichtwiderstand	WFE 321 k 800		
R164		Schichtwiderstand	WFE 321 k 10		
R165		Schichtwiderstand	WFE 321 k 2		
R166		Schichtwiderstand	WFE 321 E 50		
R167		Schichtwiderstand	WFE 321 k 200		
R168		Schicht-Drehwiderst.	WS 9122 F/10 k		
R170		Schichtwiderstand	WFE 321 M 1		
R171		Schichtwiderstand	WF 16 k/2		
R172		Schicht-Drehwiderst.	WS 5122 F/10 k		
R173		Schichtwiderstand	WFE 321 k 5		
R174		Schichtwiderstand	WFE 321 k 2		
R175		Drahtwiderstand	WDG 30 k/6		
R176		Schichtwiderstand	WFE 321 k 3		
R177		Schichtwiderstand	WFE 321 k 30		
R178		Schichtwiderstand	WFE 321 k 100		
R179		Schichtwiderstand	WFE 321 k 500		
R180		Schichtwiderstand	WFE 321 M 1		
R181		Schichtwiderstand	WFE 321 k 200		
R182		Schichtwiderstand	WFE 321 E 50		


Vervielfält.-Pause Nr.

Arbeitspause Nr.

 ROHDE & SCHWARZ MÜNCHEN			Änd.- zust.	Änd.-Mittlg. Nr.	Datum	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt	
			u	10914	2.66	H.W		Blatt Nr. 18	
EKE	Datum	Name	Ersatz für Liste Schalter Schalteilleiste zu Z-g-Diagraph Type Z D U						
geschrieben	2.66	Wü							
bearbeitet		H.W							
geprüft									
normgeprüft									

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und Schadensersatzpflichtig.

XXI. XII. Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
R183		Schichtwiderstand	WFE 321 k 10		
R184		Schichtwiderstand	WFE 321 E 50		
R185		Drahtwiderstand	WD 2,5 k/12		
R186		Schichtwiderstand	WFE 321 k 220		
R187		Drahtwiderstand	WD 4 k/4		
R188		Schicht-Drehwiderstand	WS 5122 F/10 k		
R189		Schicht-Drehwiderstand	WS 7126/10 k		Achs-L = 16
R190		Schichtwiderstand	WFE 321 k 8		
R191		Schichtwiderstand	WFE 521 k ...		Trimmwert
R192		Schichtwiderstand	WFE 521 k ...		Trimmwert
R193		Schichtwiderstand	WFE 521 k ...		Trimmwert
R194		Schichtwiderstand	WFE 521 k ...		Trimmwert
R195		Schichtwiderstand	WFE 521 k ...		Trimmwert
R196		Drahtwiderstand	WDG 15 k/4		
R197		Schichtwiderstand	WF 5 k/2		
R198		Schichtwiderstand	WF 5 k/2		
R199		Abgreifb. Drahtwiderst.	WV 4/50		
R200		Schichtwiderstand	WFE 321 k 5		
R201		Abgreifb. Drahtwiderst.	WV 4/100		
R202		Schichtwiderstand	WFE 321 k 50		
R203		Schichtwiderstand	WFE 521 k 1		
R204		Schicht-Drehwiderst. Schichtwiderstand	WS 5122 F/500 WFE 321 k 1		in Serie
R205		Schichtwiderstand	WFE 521 k 1		
R206		Schicht-Drehwiderst.	WS 5122 F/500		
R207		Schicht-Drehwiderst. Schichtwiderstand	WS 5122 F/500 k WFE 321 k 10		in Serie

 ROHDE & SCHWARZ MÜNCHEN			Änd.- zust.	Änd.-Mittlg. Nr.	Datum	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt	
			u	10914	2.66	H.W		Blatt Nr. 19	
EKE	Datum	Name						Ersatz für Liste	
geschrieben	2.66	Wü						Stückliste / Schaltteilliste zu	
bearbeitet		H.W						Z-g-Diagraph Type Z D U	
geprüft									
normgeprüft									

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

EKE MrX Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
R210		Schichtwiderstand	WFE 341 E 406,5		
R211		Schichtwiderstand	WFE 341 E 133,3		
R212		Schichtwiderstand	WFE 341 E 133,3		
R213		Schichtwiderstand	WFE 341 E 406,5		
Rö 1		Pentode	EF 80		
Rö 2		Pentode	EF 80		
Rö 3		Pentode	EF 80		
Rö 4		Pentode	EF 80		
Rö 5		Pentode	EF 80		
Rö 6		Pentode	EF 80		
Rö 7		Pentode	EF 800		
Rö 8		Pentode	EF 800		
Rö 9		Triode	EC 81		
Rö10		Pentode	EF 80		
Rö11		Pentode	EF 80		
Rö12		Duo-Diode	E 91 AA		
Rö13		Pentode	EF 80		
Rö14		Pentode	EF 80		
Rö15		Pentode	EF 80		
Rö16		Pentode	EF 80		
Rö17		Pentode	EF 80		
Rö18		End-Pentode	EL 84		
Rö20		Stabilisator	85 A 2		

Vervielfält.-Pause Nr.


ROHDE & SCHWARZ
MÜNCHEN

EKE	Datum	Name
geschrieben	2.66	Wü
bearbeitet		H.W
geprüft		
normgeprüft		

Arbeitspause Nr.

Änd.- zust.	Änd.-Mittlg. Nr.	Datum	Name
u	10914	2.66	H.W

Liste Nr.

Liste besteht
aus Blatt

3561 Sa

Blatt Nr.

20

Ersatz
für Liste

~~Stückliste~~ Schaltteilliste zu


Z-g-Diagraph Type Z D U

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.

LXX NKX Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
Rö21		Pentode	EF 80		
Rö22		End-Pentode	PL 81		
Rö23		End-Pentode	PL 81		
Rö24		Gleichrichter	EZ 80		
Rö25		Gleichrichter	EZ 80		
R1 1		Glühlampe	RL 93015	x)	
R1 2		Lichtwurflampe	RL 301	x)	
R1 3		Zwerg-Glimmlampe	RL 210	x)	
R1 4		Skalenlampe	RL 165 S	x)	zu J 1
R1 5		Skalenlampe	RL 165 S	x)	zu J 3
S 1		Spulenschalter			enth.in 3561-7
S 2		Schaltscheibe	3561 - 7.46		
S 3		Drucktaste	SR 62803		Tastenschalter 10051 - sw - F 12 Lieferer: Fa. Sasse
S 4		Scheibenschalter	SRN 324/2/32		Achs-L = 24
S 5		Spannungswähler	FD 60517		
S 6		Verbindungsflasche			enth.in 3561-3
Si 1		Schmelzeinsatz	M 2,5 E DIN 41571 x) M 1,6 E DIN 41571 x)		bei 115/125 V bei 220/235 V Netzspg.
Si 2		Schmelzeinsatz	M 0,25 C DIN 41571 x)		
Tr 1		Brückentrafo (U'Gr.)	3561 - 3.16		hierzu bes.Stückliste
Tr 2		Ausgangstrafo (U'Gr.)	3561 - 3.17		hierzu bes.Stückliste
Tr 3		Netztrafo (U'Gr.)	3561 - 3.15/2		hierzu bes.Stückliste
Tr 4		Netztrafo (U'Gr.)	3561 - 3.18/2		hierzu bes.Stückliste
			x) je 2 St.Ersatz		zusätzlich

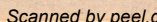
Vervielfält.-Pause Nr.

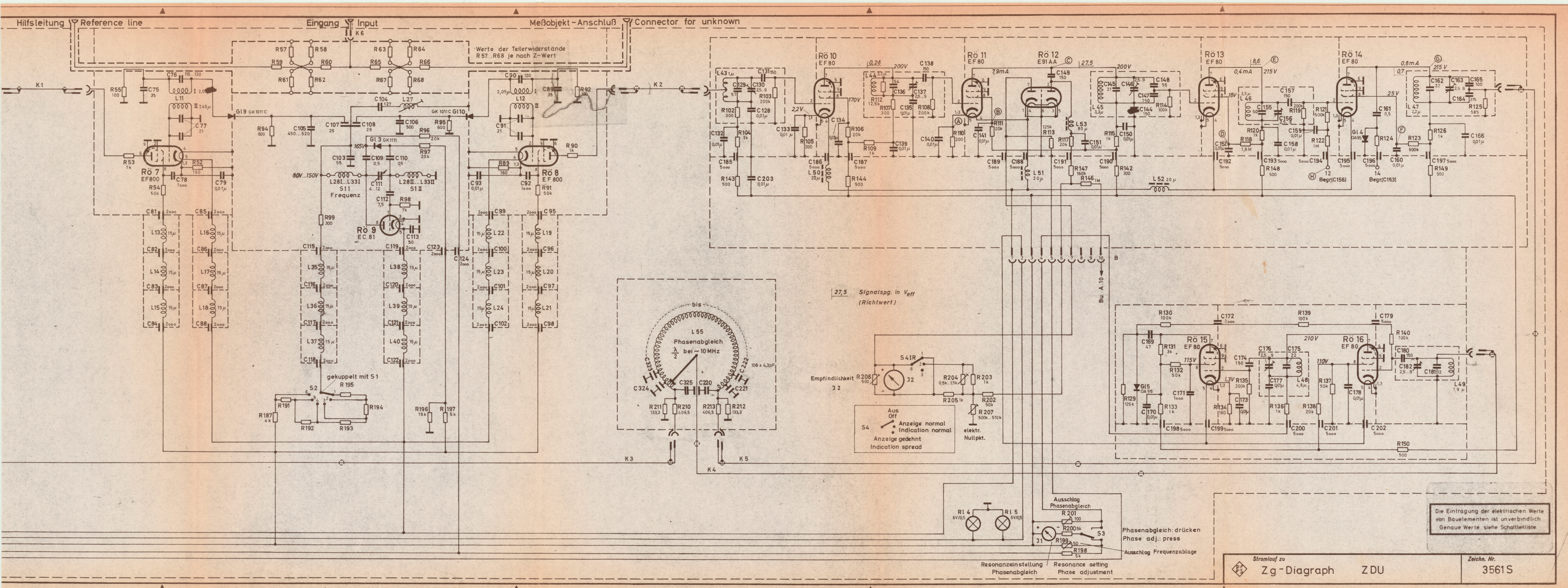
Arbeitspause Nr.

 ROHDE & SCHWARZ MÜNCHEN			Änd.- zust.	Änd.-Mittlg. Nr.	Datum	Name	Liste Nr. 3561 Sa	Liste besteht aus Blatt Blatt Nr. 21
			u	10914	2.66	H.W		
EKE	Datum	Name						
geschrieben	2.66	Wü					Ersatz für Liste	
bearbeitet		H.W					Stückliste / Schaltteilliste zu	
geprüft							Z-g-Diagraph Type Z D U	
normgeprüft								

Eike	Tag	Name	And.- zust.	And.- Hilf- Nr.	Tag	Name
garbretet	27.5.6	Wsh	n	—	10.2.65	H.W
bescheitet		H.W	o	10914	16.2.66	H.W
geprüft						
normgepr.						

ROHDE & SCHWARZ · MÜNCHEN





R 10357
865
Bl. 121

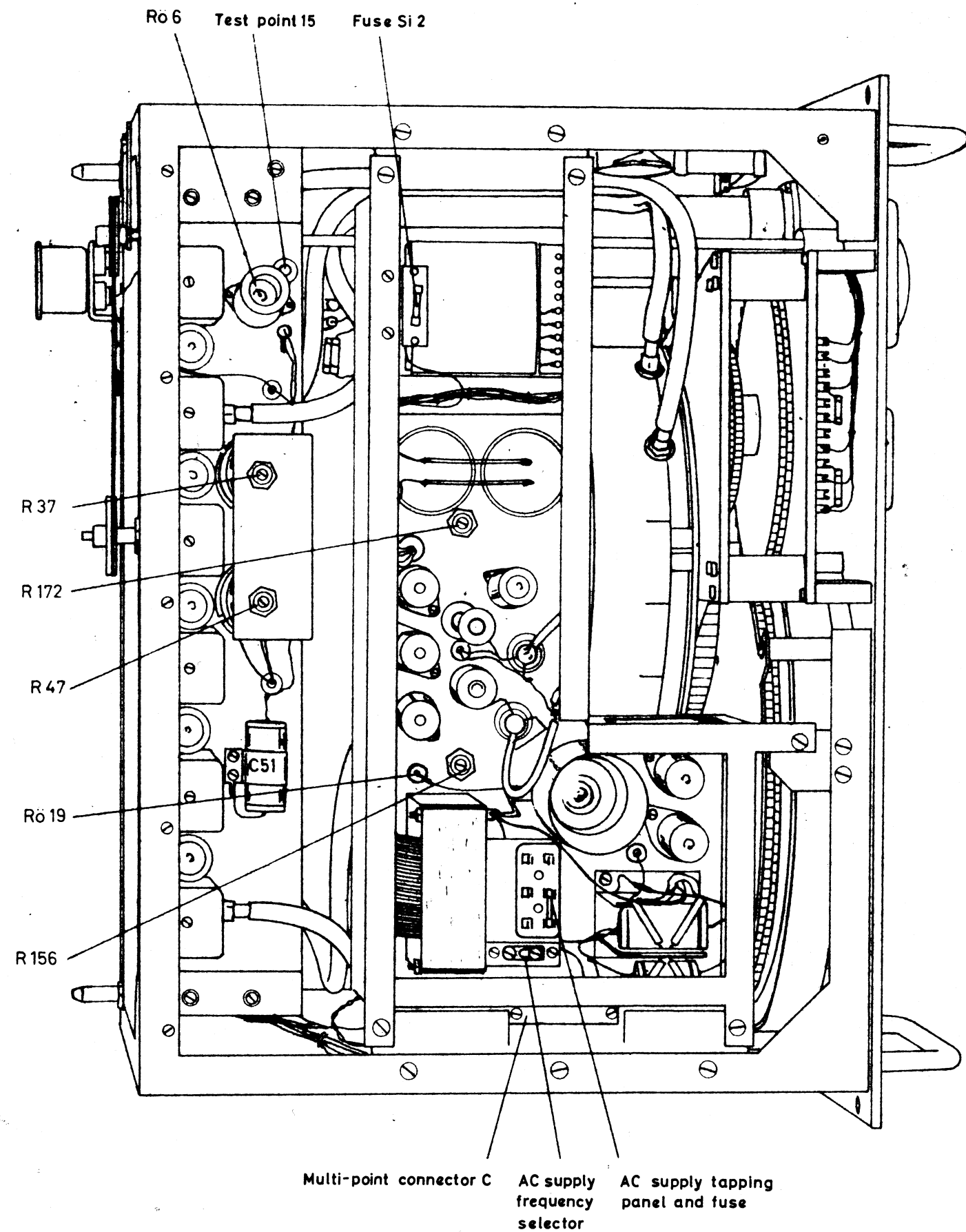


Fig. 31 Top view with power supply inserted

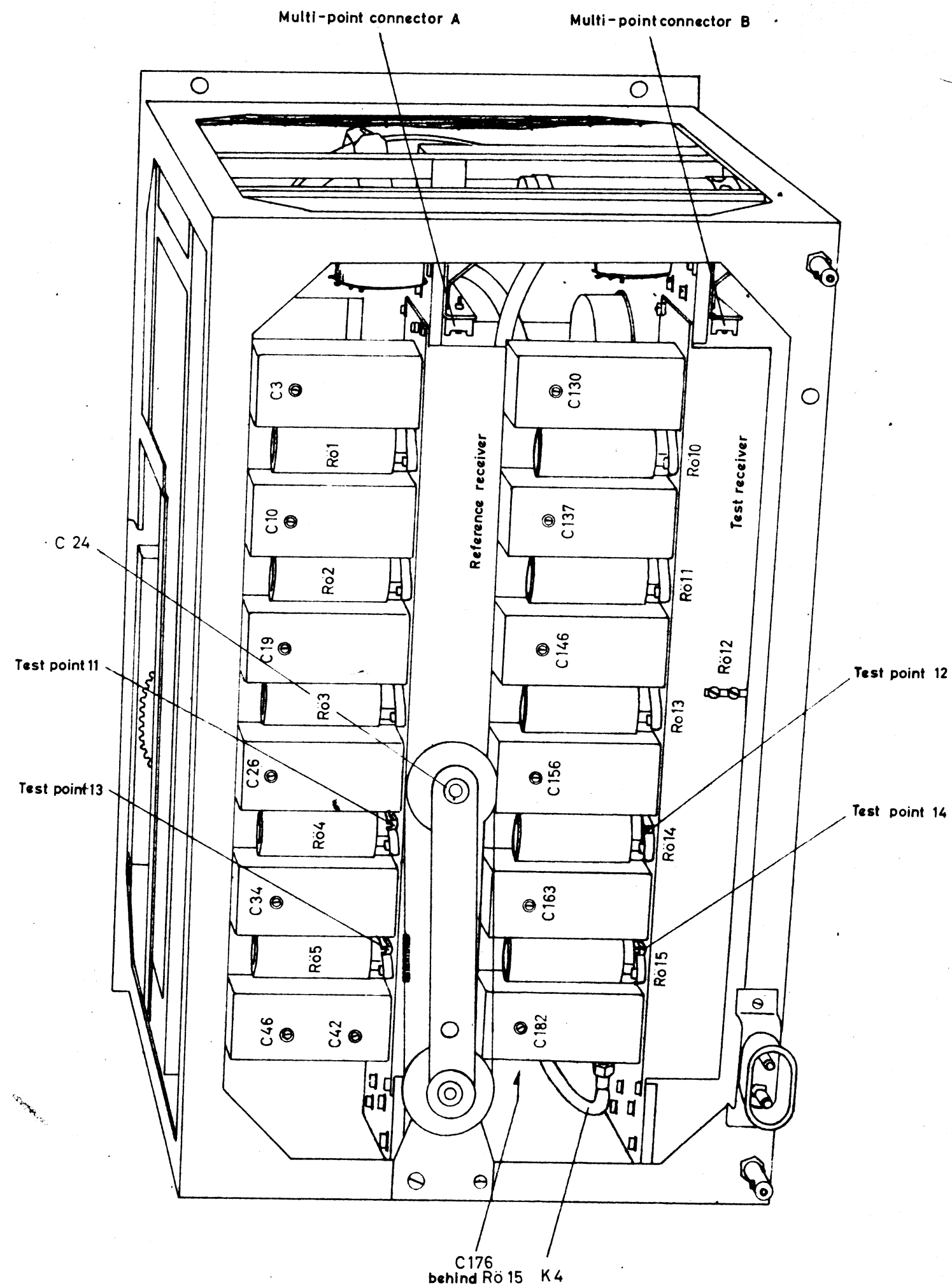


Fig. 32 Rear view

R 10357
865
Bl. 122

R 10357
865
Bl. 123

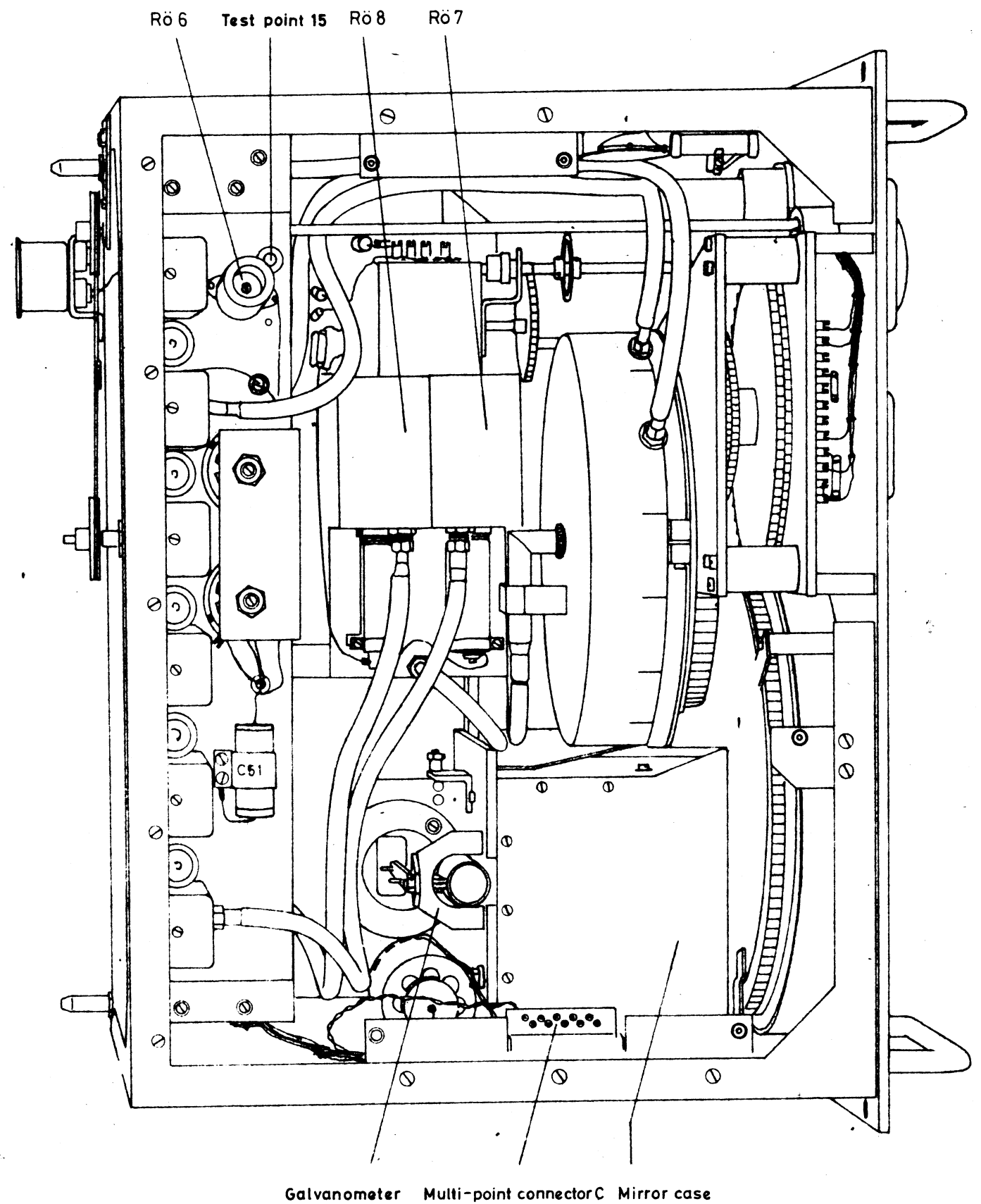


Fig. 33 Top view, power supply removed

R 10357
065
Bl. 124

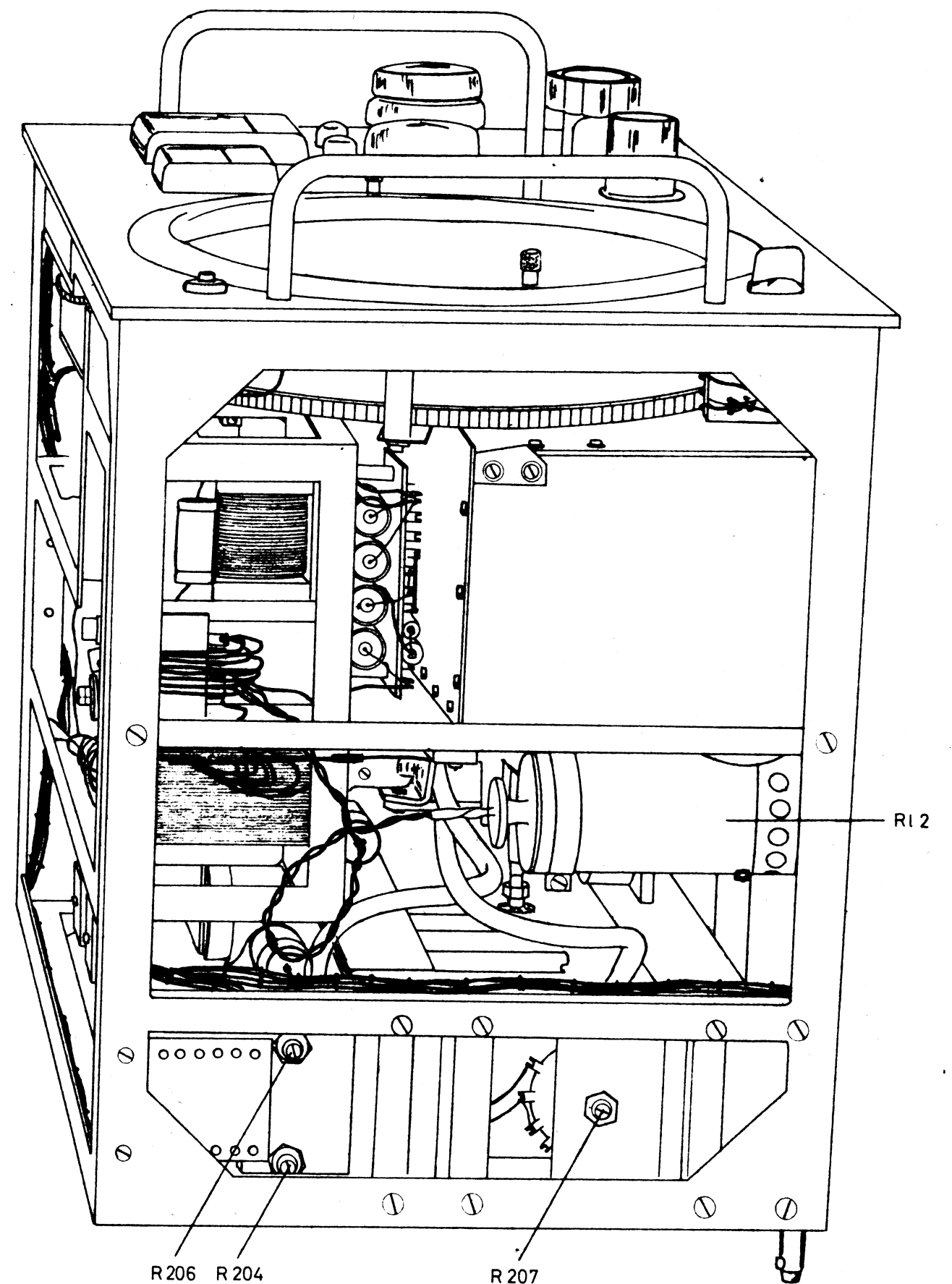


Fig. 34 Left-side view

R 10357
865
Bl. 125

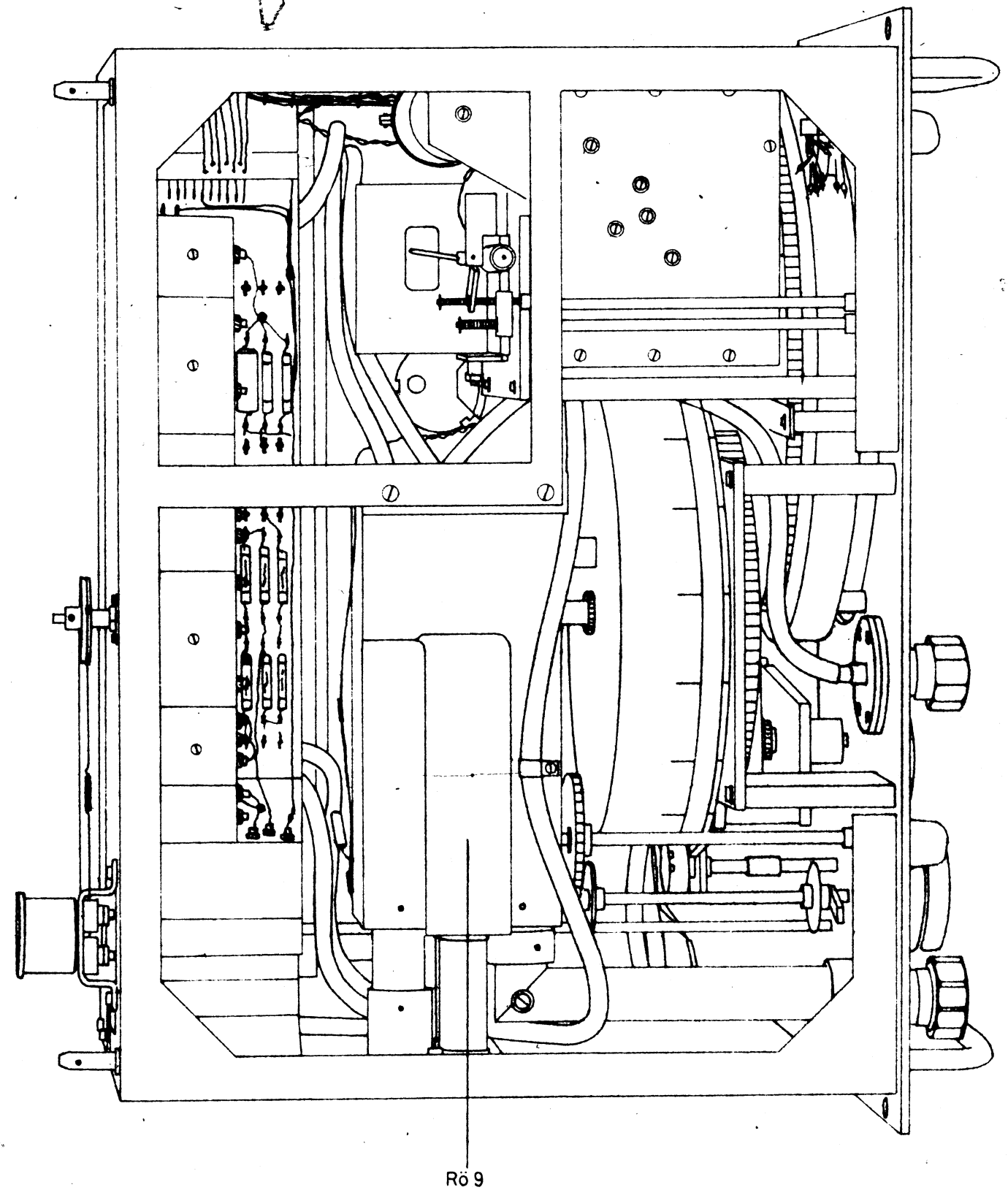


Fig. 35 Bottom view

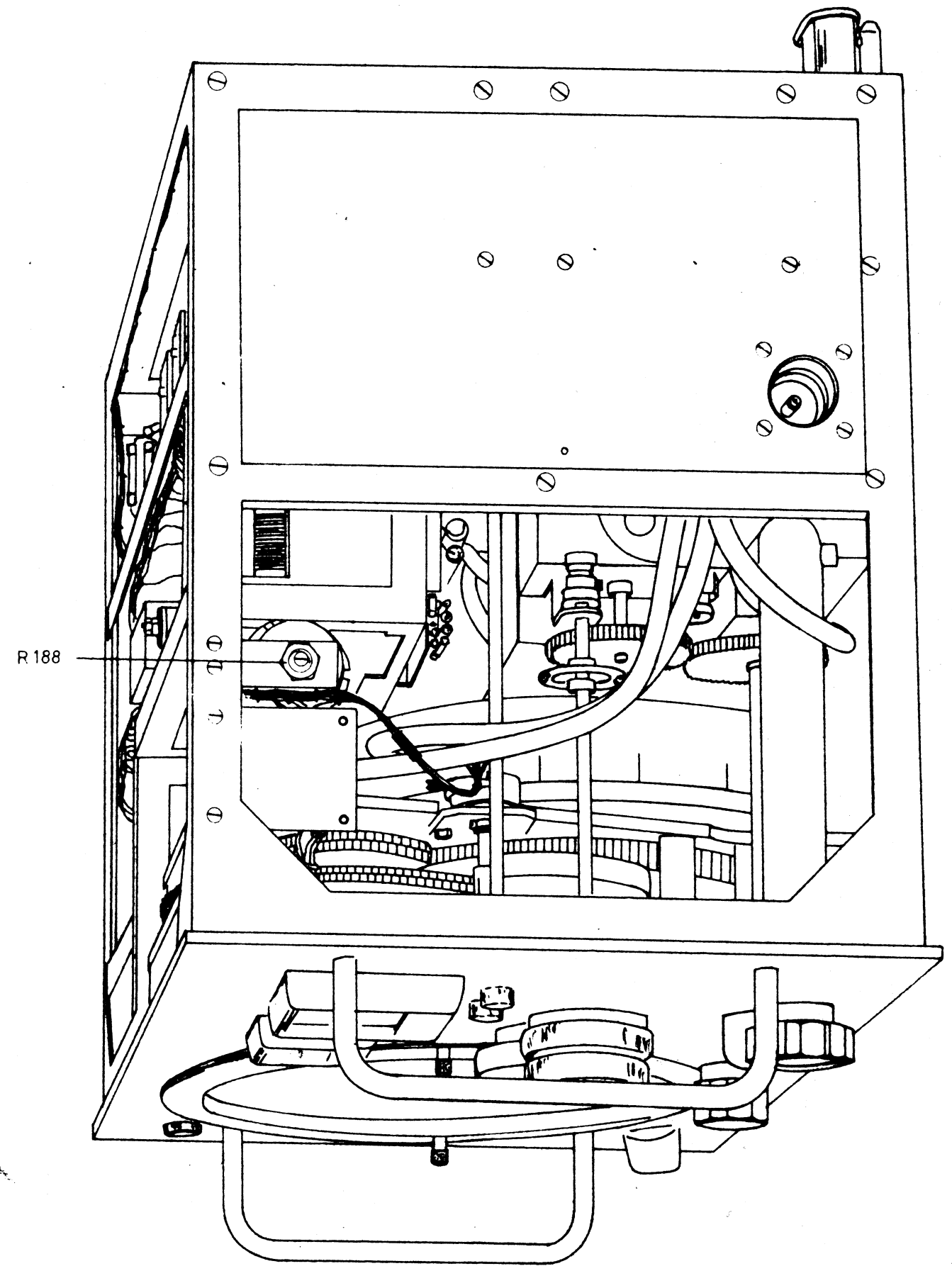


Fig. 36 Right-side view

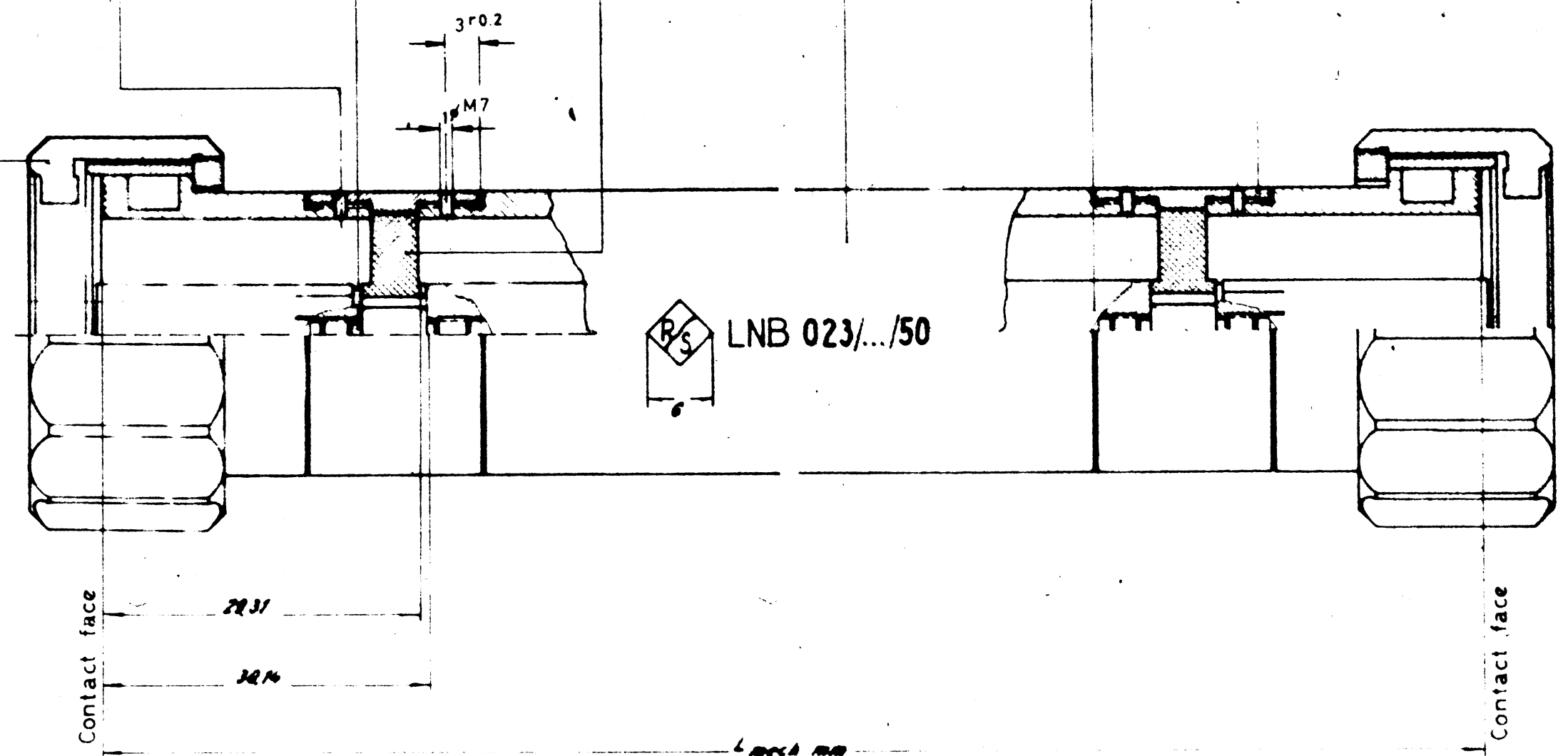
R 10357
865
Bl. 126

1 2
1017 2000

FMU 11950/50-4 1m 6x4 DIN 6325 FMU 11900/50-1 FMU 11900/50-2 LNB 023/L/50-1 LNB 023/L/50-2 FMU 11900/50-4

shortened to 2.5 mm



FS 503/50-3



4 mm ± 0.1 mm
6 mm ± 0.1 mm

Diese Zeichnung ist unser Eigentum. Verstoß gegen die Bestimmungen der Zeichnung ist strafbar und schadenverursachend.

R 10357
865
Bl. 128

 ROHDE & SCHWARZ MÜNCHEN		Halbzeug, Werkstoff		Untolerierte Maße		Zeichn. Nr. LNB 023/L/50	
				Maßstab 2:1		Ersatz für Zeichnung	
JEKO	Tag	Name	And. Zust.	And.-Mittg. Nr.	Tag	Name	Line section with Precision Dezifix B on both sides
gezeichnet	11.11.64						
bearbeitet							
geprüft		TE					
normgepr.							128

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und Schadensersatzpflichtig.

Lfd. Nr. Kennzeichen	Stückzahl	Benennung	Sach-Nr.	Bemerkungen	
1	2	3	4	5	6
1	1	Outer conductor tube	LNB 023/L/50-1		
2	1	Inner conductor	LNB 023/L/50-2		
5	2	Inner conductor	FMU 11900/50-1		
6	2	Insulating disc	FMU 11900/50-2		
7	2	Case	FMU 11900/50-4		
9	2	Case	FMU 11950/50-4		
11	2	Inner-conductor end section, springloaded	FS 503/50-3		
14	4	Pin	1 m 6 x 4 DIN 6325		

R 10357
865
Bl. 129

Vervielfält.-Pause Nr.


ROHDE & SCHWARZ
MÜNCHEN

	Datum	Name
geschrieben		
bearbeitet		
geprüft		
normgeprüft		

Änd.- zust.	Änd.-Mittig. Nr.	Datum	Name

Liste Nr.

LNB 023/L/50 St

Liste besteht
aus Blatt

Blatt Nr.

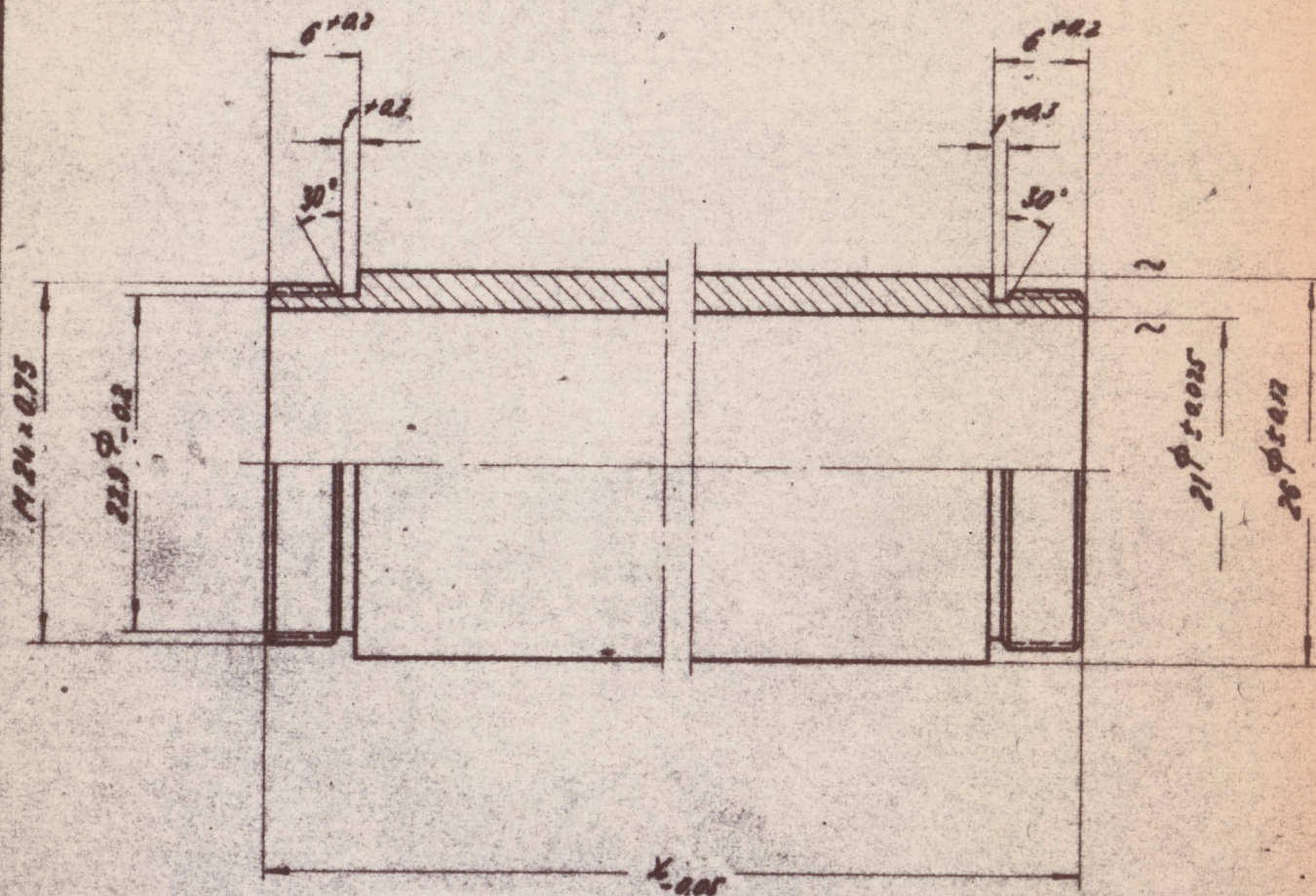
Ersatz
für Liste

Stückliste / Schaltteilliste zu

Line section with Precision Dezifix B
on both sides

129

▽ (~)
gal Ag



Determination of x

$$x = L - 5602$$

R 10357
865
Bl. 130

 ROHDE & SCHWARZ MÜNCHEN		Halbzeug, Werkstoff Rohr 26x25 W 32 Ms 63 hart Arbeitsanweisung A		Unterteilte Maße		Zeichn. Nr. LNB 023/L/50-1	
				Maßstab 2:1		Blatt 1 von 1	
JEK 8	Tag	Name	Ans. zust.	Ans. pers. fr.	Tag	Name	
gezeichnet	11.11.84	JK					
geprüft		JK					
gezeichnet							
geprüft							

Outer conductor tube

1, $\Phi M7 = 0.005$

FMU 11950/50-4 1m6=4 DIN 6325 FMU 11900/60-1 FMU 11900/60-2 LNB 023/L/50-1 LNB 023/L/60-1 FMU 11900/50-4

shortened to 2.5 mm

FS 503-3

LNB 023/.../60

Contact face

2831

3014

$L_{mech. mm}$

$L_{el.} = L_{mech} + 6 mm$

Contact face

Diese Zeichnung ist unser Eigentum. Vervielfältigung unbefugte Verwertung, Mitteilung an andere ist strafbar und Schadensersatzpflichtig.

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865
Bl. 132

K ROHDE & SCHWARZ MÜNCHEN		Halbzeug, Werkstoff		Untolerierte Maße		Zeichn. Nr. LNB 023/L/60	
				Maßstab 2:1			
SENB		Tag	Name	Änd. zust.	Änd.-Mittig Nr.	Tag	Name
gezeichnet		11.11.64	RE				
bearbeitet			7C				
geprüft							
normgepr.							
Line section with Precision Dezifix B on both sides							

132

Diese Zeichnung ist unser Eigentum. Vervielfältigung, unbefugte Verwertung, Mitteilung an andere ist strafbar und schadenersatzpflichtig.


Lfd. Nr. Kennzeichen	Stückzahl	Benennung	Sach-Nr.	Bemerkungen
1	2	3	4	5
1	1	Inner conductor	LNB 023/L/60-1	
3	1	Outer conductor tube	LNB 023/L/50-1	
6	2	Inner conductor	FMU 11900/60-1	
7	2	Insulating disc	FMU 11900/60-2	
9	2	Case	FMU 11900/50-4	
12	2	Case	FMU 11950/50-4	
14	2	Inner-conductor end section, spring-loaded	FS 503-3	
17	4	Pin	1 m 6 x 4 DIN 6325	

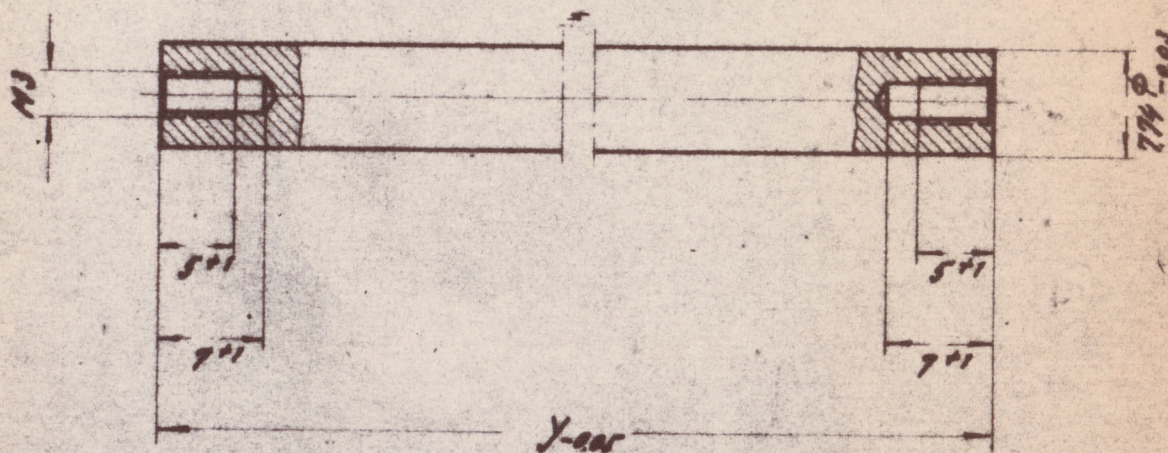
R 10357
9 65
Bl. 133

vielfält.-Pause Nr.

Arbeitspause Nr.


1; 0864; 100 S

 ROHDE & SCHWARZ MÜNCHEN		Änd.-zust.	Änd.-Mittlg. Nr.	Datum	Name	Liste Nr. LNB 023/L/60 St	Liste besteht aus Blatt
							Blatt Nr.
Datum	Name					Ersatz für Liste	
geschrieben						Stückliste / Schaltteilliste zu Line section with Precision Dezifix B on both sides	
bearbeitet							
geprüft							
normgeprüft							



Determination y
y = L-60.20

R 10357
865
Bl. 134

 ROHDE & SCHWARZ MÜNCHEN		Halbzeug, Werkstoff Ø 0 21/1756 M5 50 24		Untolerierte Maße Maßstab 2:1		Zeichn. Nr. LNB 023/L/60-1	
JEANB	Tag	Name	Änd. zust.	Änd. Mittlg. Nr.	Tag	Name	Erste f. Zeichen
gezeichnet	11.11.66	JS					
bearbeitet							
geprüft		TC					
normgepr.							


Inner conductor

1,047 - 0.008

FMU 10950/50-4 1m6x4 DIN 6325 FMU 11900/75-1 FMU 11900/75-2 LNB 023/L/50-1 LNB 023/L/75-1 FMU 11900/50-4

shortened to 25 mm

FMU 10951/75-3

 LNB 023/ /75

Contact face

28.31

30.14



Contact face

L_{mech} mm

$L_{el.} = L_{mech} + 6 \text{ mm}$

Diese Zeichnung ist unser Eigentum. Vervielfältigung, Verbreitung, Weitergabe, Nachdruck, Fälschung, Entwertung, Verwertung, Mithilfe an andere ist strafbar und schadenhaftig.

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Bl. 135

 ROHDE & SCHWARZ MÜNCHEN		Halbzeug, Werkstoff		Untolerierte Maße		Zeichn. Nr. LNB 023/L/75	
				Maßstab 2:1		Ersatz für Zeichnung	
SEM Tag Name		And. And.-Mittig zust. Nr.		Tag Name			
gezeichnet 11/11/64 						Line section with Precision Dezifix B on both sides	
bearbeitet							
geprüft							
normgeprüft							

Diese Zeichnung ist unser Eigentum. Vervielfältigung,
unbefugte Verwertung, Mitteilung an andere ist
strafbar und schadenersatzpflichtig.

Lfd. Nr. Kenn- zeichen	Stück- zahl	Benennung	Sach-Nr.		Bemerkungen
1	2	3	4	5	6
1	1	Inner conductor	LNB 023/L/75-1		
3	1	Outer conductor tube	LNB 023/L/50-1		
6	2	Inner conductor	FMU 11900/75-1		
7	2	Insulating disc	FMU 11900/75-2		
9	2	Case	FMU 11900/50-4		
12	2	Case	FMU 11950/50-4		
14	2	Inner-conductor end section, spring-loaded	FMU 10951/75-3		
17	4	Pin	1 m 6 x 4 DIN 6325		

R 10357

865

Bl. 136

Vervielfält.-Pause Nr.


ROHDE & SCHWARZ
MÜNCHEN

	Datum	Name
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Arbeitspause Nr.

geschrieben		
bearbeitet		
geprüft		
normgeprüft		

Änd.- zust.	Änd.-Mittig. Nr.	Datum	Name
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Liste Nr.

LNB 023/L/75 St

Liste besteht

aus Blatt

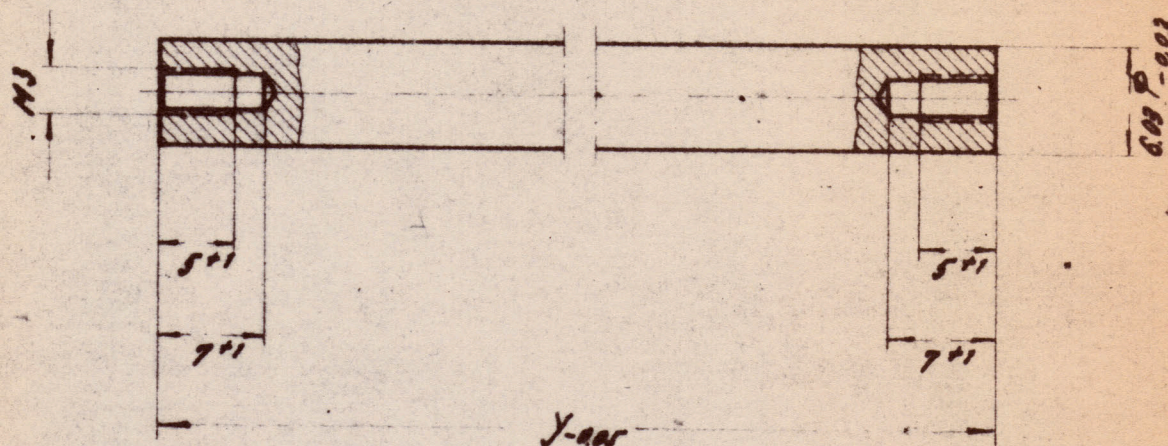
Blatt Nr.

Ersatz
für Liste


Stückliste / Schnittteilliste zu

Line section with Precision Dezifix B
on both sides

136



$y = 4 - 60.20$

 ROHDE & SCHWARZ MÜNCHEN		Maßzeug, Werkstoff <i>Ø 6,5 DIN 1756</i> <i>MJ 502A</i>		Untolerierte Maße		Zeichn. Nr. <i>LNB 023/L/75-1</i>
				Maßstab <i>2:1</i>		
SFB	Tag	Name	And. zust.	And.-Mittg. Nr.	Tag	Name
gezeichnet	<i>11.11.64</i>	<i>[Signature]</i>				
bearbeitet		<i>[Signature]</i>				
geprüft						
normgepr.						

Inner conductor

137

Zusammenstell-Vorschrift zur deutschen englischen Geräte-Einschub-Rahmen-Anlagen-Beschreibung für Type ZDU BN 35610/.. FNr. F 1870/1...50					
Name Cassani Berger 18.4.67	Datum 3.67. 4.67. 18.4.67	Rückenbeschriftung Register Nr. 4319-(11-10) Nr. 4320-(11-20) Nr. 4321-(21-30) Nr. 4322-(31-40)			
Zusammenstellung nach Pos.-Nr. Umschlag Karton mit Rückenbindung Kunststofferdrner-40mm Kunststofferdrner-60mm ohne, dafür 4fachlochung- mit Banderele					
Pos.-Nr.	Teil	Sach-Nr.	Blatt-Nr.	AZ	Bemerkung
1	Titelblatt	R 12162		-	
2	Beschreibung	R 10357	2...14	-	
3	Beiblatt	R 12163	1...5	-	
4	Beschreibung	R 10357	15...91	-	mit WF 3624 u. 5864 gedruckt auf Bl. 57
5	Beschreibung	R 10357	113...120	-	
6	Schaltteilliste	3561 Sa	1...21	u	
7	Stromlauf	3561 S		o	
8	Beschreibung	R 10357	121...126	-	
9	Zeichnungen	R 10357	128...137	-	