

Instructions for the use of the NESTLER Slide Rule ELECTRONIC 0297

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offers the possibility to calculate basic electro-technical equations with correct digital values.

This essential advantage excludes with certainty decimal faults. The accuracy of calculation lies between 1 to 2%, being in the same category as the acknowledged tolerance limit of most electro-technical measuring apparatus. The tolerances of building materials are between 2 to 20% and thus considerably bigger.

The range of the 18 Scales is sufficient for application in the communication-technique as well as in Power technique.

The following examples give a compact picture of the applications:

I. Calculation with correct place value columns:

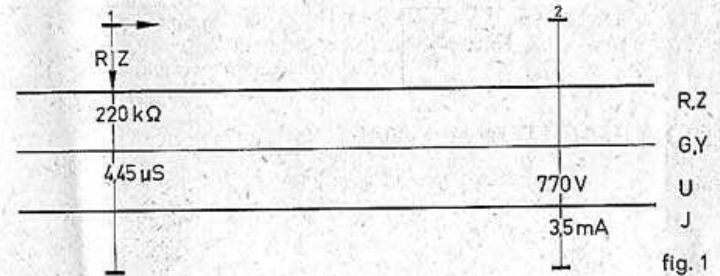
1. Ohm's law.
2. Output power law.
3. Apparent, effective and reactive power.
4. Amplification and Attenuation, linear and logarithmic in db and Np.
5. Conversion conditions of relays and transformers, transformation of R, G, Z, Y;
6. dbm-level.

II. Calculation without place value columns:

1. Parallel connections of resistance or inductance.
2. Series connections of conductance or capacitance.

1. OHM'S LAW

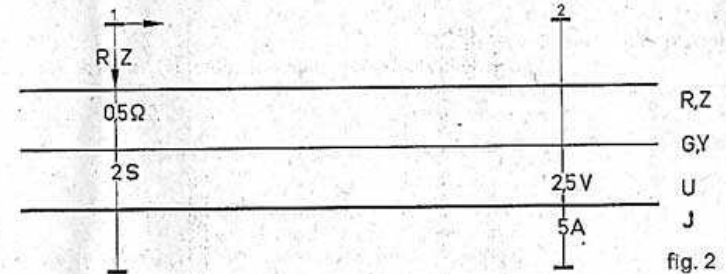
Example: $R = 220 \text{ k}\Omega$ ($G = 4,45 \text{ }\mu\text{S}$) $J = 3,5 \text{ mA}$
To find $U = 770 \text{ V}$



Calculation method: Front side R
1. Set resistance R (or Conductance value G) on the arrow mark ↓ (at R/Z).
2. Place cursor over current intensity J.
Read wanted voltage on Scale U.

$$U = J \cdot R$$

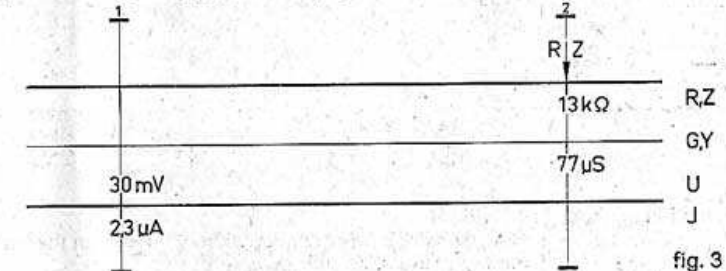
Example: $R = 0,5 \Omega$ ($G = 2 \text{ S}$) $U = 2,5 \text{ V}$ To find $J = 5 \text{ A}$



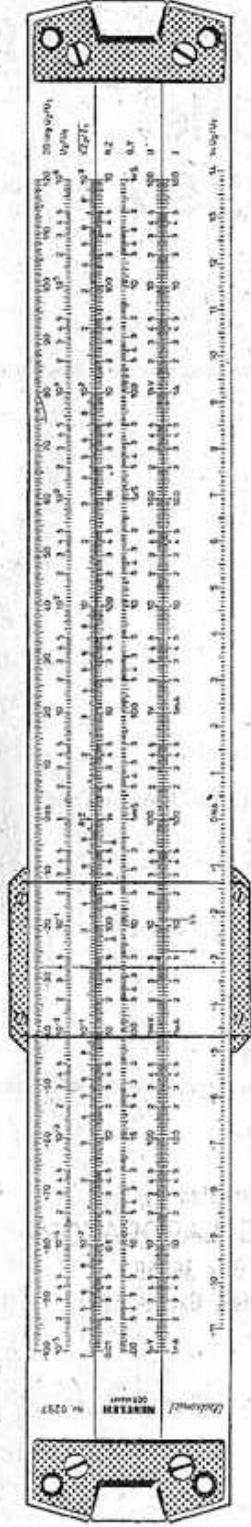
Calculation method: Front side R
1. Set resistance R (or conductance value G) on the arrow mark ↓ (at R/Z).
2. Place cursor over voltage U.
Read wanted current intensity on scale J.

$$J = \frac{U}{R}$$

Example: $U = 30 \text{ mV}$ $J = 2,3 \text{ }\mu\text{A}$ To find $R = 13 \text{ k}\Omega$



The NESTLER Slide Rule ELECTRONIC 0297



Front side

Decibel-Scale for Amplification and Attenuation
Relation scale for Amplification and Attenuation

Transformation Scale

Resistance Scale

Conductivity Scale

Voltage Scale

Current Scale

Neper Scale for Amplification and Attenuation

-100 ... 0 ... +120 db

$10^{-5} \dots 1 \dots 10^6$

$\bar{u} = 3 \cdot 10^{-3} \dots 1 \dots 10^3$

0,01 ... 1 G

100 S ... 1 nS

1 V ... 100 kV

1 nA ... 100 A

-11 ... 0 ... +14 Np

$20 \log U_2/U_1$

U_2/U_1

$\sqrt{Z_2/Z_1}$

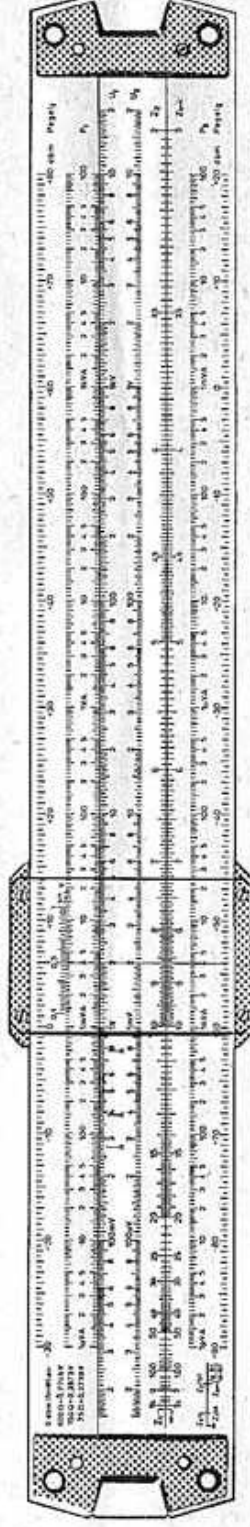
R, Z

G, Y

U

I

In U_2/U_1



Reverse Side

Level Scale, in relation to basic value of 1 mW

Power output Scale with double divisions

Voltage Scale

Voltage Scale

Z-Scale

Z-Scale

Power output Scale

Level Scale, in relation to basic value of 1 mW

Phase Angle Scale on Cursor

The upper divisions work together with the Cursor Scale of Sin, cos φ .

-30 ... +80 dbm

1 μ VA ... 100 kVA

15 mV ... 20 kV

15 μ V ... 20 V

1 K ... 3

1 K ... 3

1 pVA ... 100 mVA

-90 ... +20 dbm

0,1 ... 1

Pegel I

P_1

U_1

U_{II}

Z_2

Z_{ges}

P_{II}

Pegel II

Sin, cos φ

Calculation method: Front side R

1. Set voltage U over current intensity J.
2. Read resistance R (or conductance value G) at the arrow mark ↓.

$$R = \frac{U}{J}$$

2. POWER OUTPUT LAW

Example: $U = 220 \text{ V}$ $J = 0,75 \text{ A}$
To find $P = 165 \text{ W}$

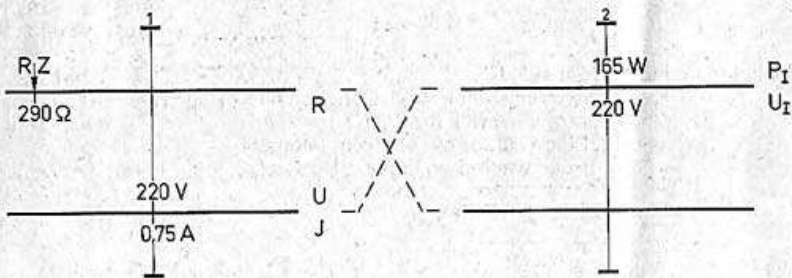


fig. 4

Calculation method: Front side R

1. Set voltage U over current intensity J. Turn slide rule over, Reverse side P

$$P = U \cdot J$$

2. Place cursor over voltage U (Scale U_I). Read wanted power from scale P_I . Corresponding Resistance R can be read at arrow mark ↓.

$$R = \frac{U^2}{P}$$

Example: $R = 33 \text{ k}\Omega$ ($G = 30 \mu\text{S}$) $U = 100 \text{ V}$
To find $P = 300 \text{ mW}$.

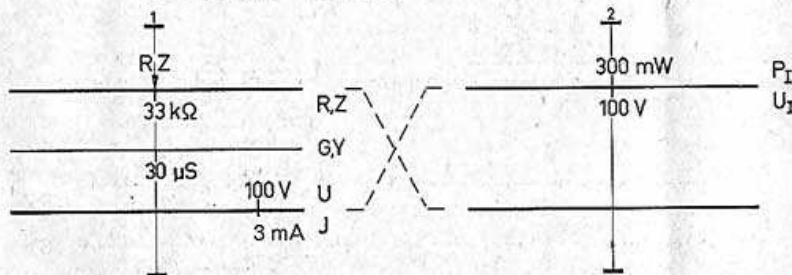


fig. 5

Calculation method: Front side R

1. Set resistance R (or conductance value G) on the arrow mark ↓. Turn slide rule over

$$P = \frac{U^2}{R}$$

Reverse side P

2. Place cursor over voltage U. Read wanted power from scale P. The corresponding current J flowing through resistance R can be read under voltage U.

$$J = \sqrt{\frac{P}{R}}$$

Example: $R = 10 \text{ M}\Omega$ ($G = 100 \text{ nS}$) $J = 200 \text{ nA}$
To find $P = 400 \text{ nW}$.

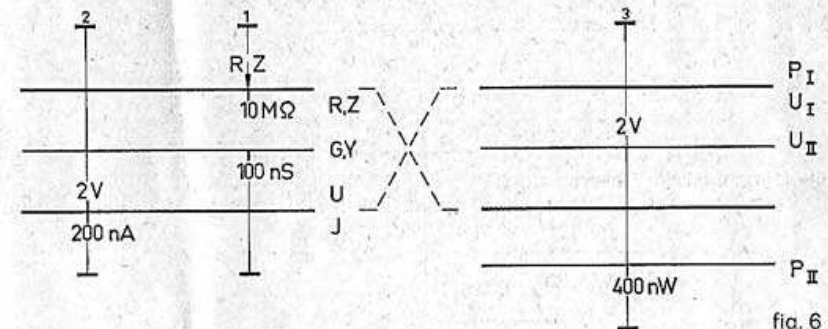


fig. 6

Calculation method: Front side R

2. Set resistance R (or conductance value G) on the arrow mark ↓. Read the voltage U over current J. Turn slide rule over.

$$P = J^2 \cdot R$$

2. Place cursor over voltage U. Read Power output on scale P.

$$U = \sqrt{P \cdot R}$$

The scales P_I and P_{II} , as well as scales U_I and U_{II} , supplement in continuation by overlapping each other. By positioning the scales on the slide you can read the five corresponding values P, U, J, R, G. R, G lie under ↓.

3. APPARENT, EFFECTIVE AND REACTIVE POWER

Example: $P_w = 80 \text{ W}$ $\cos \varphi = 0,6$ To find $P_s = 135 \text{ W}$

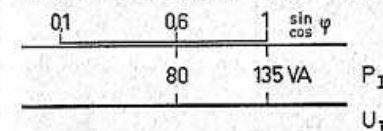


fig. 7

Calculation method: Reverse side P

1. Set the phase angle of the cursor scale over P_w value on the upper part of P_1 scale.
2. Read wanted apparent power P_s on P_1 under phase angle 1 (on right) of cursor scale.

$$P_s = \frac{P_w}{\cos \varphi}$$

Example: $P_s = 2 \text{ KVA}$ $\cos = 0,75$ To find $P_w = 1,5 \text{ kW}$.

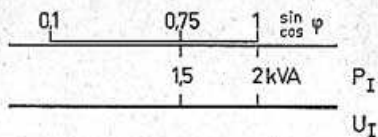


fig. 8

Calculation method: Reverse side P

1. Set the phase angle 1 of the cursor scale over the P_s value on the upper part of P_1 scale.

$$P_w = P_s \cdot \cos \varphi$$

2. Read effective (or reactive) power under the phase angle on P_1 scale.

$$P_b = P_s \cdot \sin \varphi$$

Example: $P_s = 12 \text{ VA}$ $P_w = 3 \text{ W}$ To find $\cos \varphi = 0,25$.

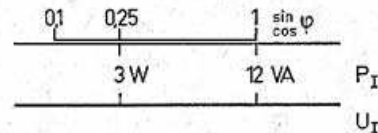


fig. 9

Calculation method: Reverse side P

1. Set the phase angle 1 of the cursor scale over the P_s value on the upper part of P_1 scale.

$$\cos \varphi = \frac{P_w}{P_s}$$

2. Read phase angle on the cursor scale over effective or reactive power.

$$\sin \varphi = \frac{P_b}{P_s}$$

After having extended the existing equations, the current I and apparent impedance Z calculated over Voltage U or the values initiated from Z .

4. AMPLIFICATION, ATTENUATION

Three scales are used to calculate Amplification and Attenuation in linear and logarithmic graduations. U_1 is the input voltage, U_2 the output voltage of an arbitrary 4-pole network. For Amplification n is >1 in linear or positive in logarithmic proportion scale. The same correspondingly applies for Attenuation when n should be <1 or negative.

Example: $U_1 = 10 \mu\text{V}$ $U_2 = 3 \text{ V}$ To find $V = 3 \cdot 10^5$
 $109,5 \text{ db}$ $12,6 \text{ Np}$

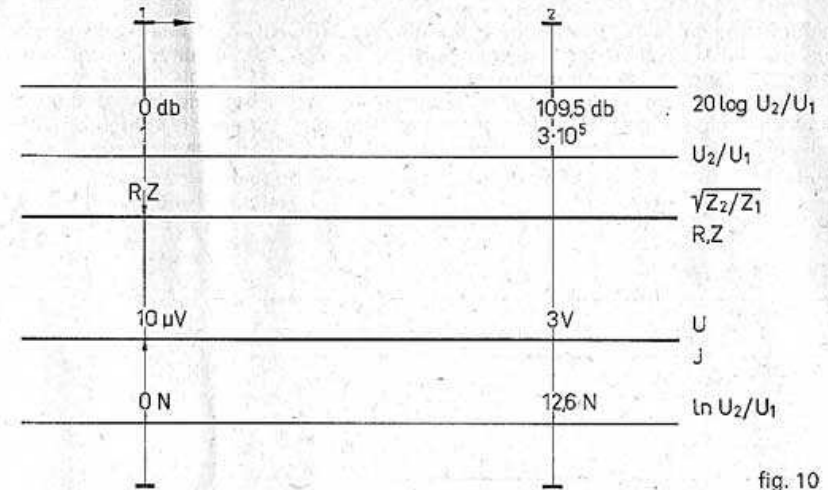


fig. 10

Calculation method: Front side R

1. Set U_1 under the arrow mark \downarrow (or scale $J = 100 \mu\text{A}$.)
2. Place cursor over U_2 value. Read Amplification in the desired unit of measurement on scale U_2/U_1 , $20 \log U_2/U_1$ or neper U_2/U_1 .

$$V = \frac{U_2}{U_1}$$

Example: Attenuation $n = -8 \text{ Np}$ $U_1 = 11 \text{ V}$ To find $U_2 = 3,65 \text{ mV}$

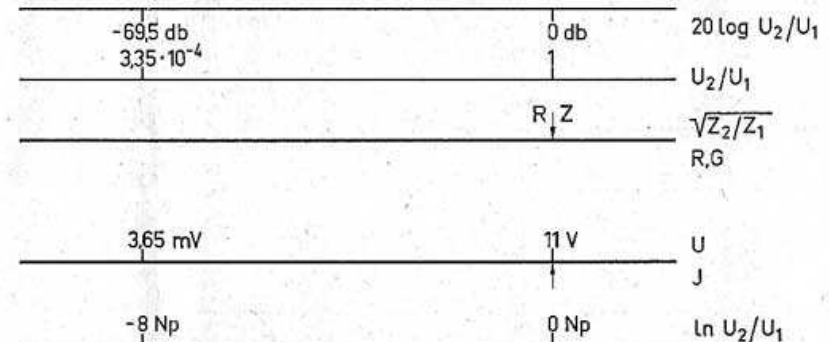


fig. 11

Calculation method: Front side R

1. Set U under the arrow mark ↓.
2. Place cursor over n . Read the wanted output voltage U_2 under the cursor line.

The three scale readings adjust simultaneously a conversion table from linear proportionality to both neper and logarithmic values.

5. TRANSFORMATION OF IMPEDANCE, CONDUCTANCE, VOLTAGE AND WINDING TURNS

Transformation calculations with the slide rule ELECTRONIC guarantee a clear and precise work. After choosing the definition, the ratio \ddot{u} for higher transformation becomes > 1 and for lower transformation < 1 .

Therefore the transformation ratio \ddot{u} is similar for both, but one has to decide whether the value is greater or less than 1 to determine whether it is high or low. For all calculations set Z_1 on the arrow mark ↓ or read it as the given result.

Example: $Z_1 = 8 \text{ k}\Omega$ $Z_2 = 5 \Omega$ To find $\ddot{u} = 2,5 \cdot 10^{-2}$
To find $\ddot{u}^2 = 6,25 \cdot 10^{-4}$

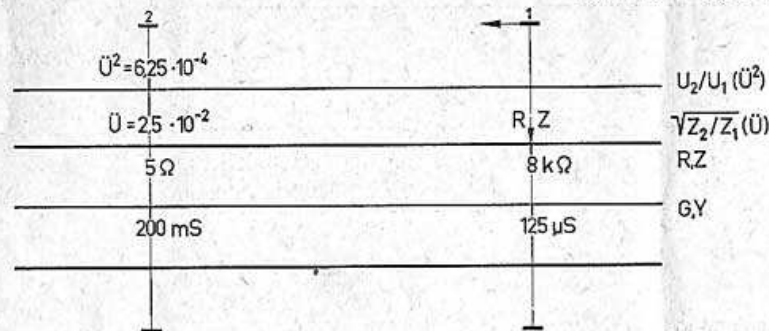


fig. 12

Calculation method: Front side R

1. Set Z_1 on the arrow mark ↓.
2. Read the wanted \ddot{u} over Z_2 or \ddot{u}^2 on the U_2/U_1 scale.

$$\ddot{u} = \sqrt{\frac{Z_2}{Z_1}}$$

In order to calculate the winding turns and voltage transformations, use scale $U_1/U_2 = \ddot{u}$ in relation to scale U.

Example: $U_1 = 31 \text{ V}$ or $n_1 = 260 \text{ Wdg.}$ $\ddot{u}^2 = 0,36$
To find $U_2 = 11,2 \text{ V}$ To find $n_2 = 94 \text{ Wdg.}$

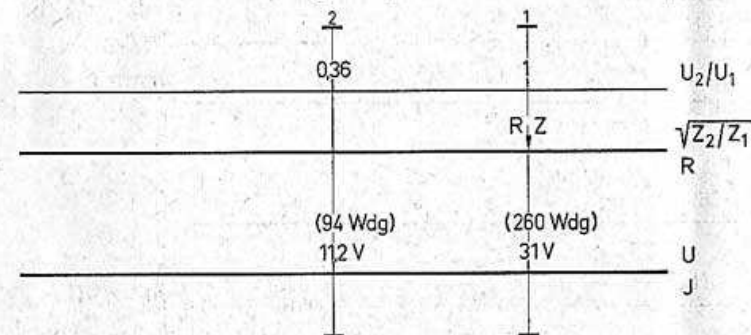


fig. 13

Calculation method: Front side R

1. Set U_1 or n_1 on the arrow mark.
2. Place the cursor over \ddot{u} of scale U_2/U_1 . Read U_2 or n_2 under the cursor line

$$\ddot{u}^2 = \frac{U_2}{U_1} = \frac{n_2}{n_1}$$

6. dbm - LEVEL

The dbm-level is the ratio of power in logarithmic scale between the power P_R with a load R and a power of 1 mW.

$$n_{\text{dbm}} = 10 \lg \frac{P_R}{P_{1\text{mW}}}$$

After setting the R on the arrow mark ↓, you can ensure in one reading the load R corresponding to power output P_R , Voltage U_R and the level measurement n dbm.

Example: $R = 600 \Omega$ $U_R = 11 \text{ V}$ To find $P_R = 200 \text{ mW}$
To find $n = +23 \text{ dbm}$

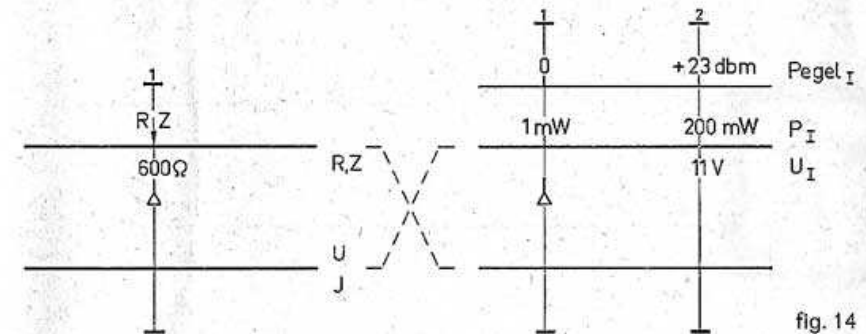


fig. 14

Calculation method: Front side R

1. Set the load resistance R on the arrow mark ↓. Turn the slide rule to reverse side. Reverse side P
2. Place the cursor over the voltage U. Read output power on scale P and n off scale dbm-level.

In the communication technique, the relative load value of 75 Ω , 150 Ω and 600 Ω are mostly used and the corresponding voltage values for 0 dbm are characterised by triangle marks.

7. PARALLEL CONNECTION OF RESISTANCES OR INDUCTANCES - SERIES CONNECTION OF CONDUCTANCES OR CAPACITANCES

The Z scale serves in general to solve the equation.

$$\frac{1}{a} + \frac{1}{b} = \frac{1}{c} \text{ etc. } c = \frac{a \cdot b}{a + b}$$

In the electro-technique with this equation the parallel connection of R or L and the series connection of C or G is thereby calculated. Unlike other scales of the slide

rule ELECTRONIC, the Z scale is without place value columns i.e., the scale values can be multiplied by necessary indicies of 10.

Example: $R_1 = 12 \Omega$ $R_2 = 18 \Omega$ To find $R_{ges} = 7,22 \Omega$

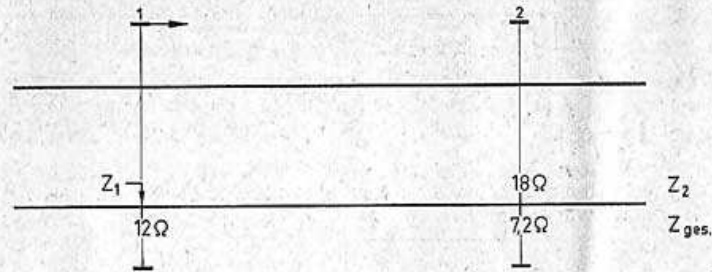


fig. 15

Calculation method: Reverse side P

1. Set Z_1 at the angular arrow mark.
 2. Place cursor over Z_2 .
- Read Z_{ges} under cursor.

Example: $R_{ges} = 53 \text{ k}\Omega$ $R_1 = 82 \text{ k}\Omega$ To find $R_2 = 150 \text{ k}\Omega$

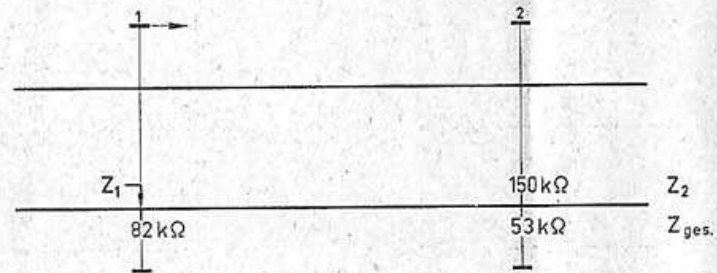


fig. 16

Calculation method: Reverse side P.

1. Set Z_1 with the angular arrow mark.
 2. Set cursor over Z_{ges} .
- Read Z_2 on the upper scale under cursor.