KELVIN ELECTRONICS COMPANY
is a part of S. Smith & Sons (England) Ltd.
Kelvin House, Wembley Park Drive, Wembley Middlesex.
Tel. No. WEM. 8888

Unigor 1s

Made for

KELVIN ELECTRONICS COMPANY

by:

C. P. GOERZ ELECTRO AKTIENGESELLSCHAFT

Instruction manual

for

- Unigor 1 s -

Model 22 62 11

Contents

C. P. GOERZ ELECTRO AKTIENGESELLSCHAFT
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Printed in Austria

The new

— Unigor 1 s —

continues the tradition of the multirange instruments manufactured by C. P. GOERZ and is noted for a number of remarkable innovations:

contemporary style and practical construction of operational elements;

still greater reliability by use of Germanium diodes, and

increased overload protection by use of an additional fuse.

The solid construction and advantages due to special circuit features ensure that the new **Unigor 1 s** will meet the highest demands. Unigor 1 s is a measuring instrument especially suited for power engineering but also for the other fields of electrical engineering. The universal applicability of the instrument is due to the low power consumption and high accuracy.

Internal resistance

3333 ohms/volt on DC and AC

Accuracy

± 1 % for DC measurements
± 1.5 % for AC measurements

Moving Coil System

with shock resistant taut suspension movement (no pivot friction)

Mirrored Scale

88 mm length with linear graduations for all current and voltage ranges

Overload protection

is achieved by a very sensitive cut-out switch, fuse and a voltage suppressor for the Germanium diodes.

Special Circuit Features

A built-in current transformer enables a measurement of the DC and AC component of an alternating current with a superimposed direct current.

Built-in power supply for resistence measurements.

Well planned construction with printed circuit plates.

Technical data

Ranges

DC Ranges (—)			
Voltage	Internal resistance	Current	Intern. resist. approx.
1200 V	4 MΩ	30 A	0.004 Ω
600 V	2 MΩ	6 A	0.07 Ω
300 V	1 MΩ	1.2 A	0.16 Ω
120 V	400 kΩ	0.3 A	0.4 Ω
30 V	100 kΩ	0.06 A	1.6 Ω
12 V	40 kΩ	12 mA	7.5 Ω
3 V	10 kΩ	3 mA	29 Ω
0.6 V	2 kΩ	1.2 mA	69 Ω
60 mV	200 Ω	0.3 mA	200 Ω
12 mV	114 Ω	—	—

AC Ranges (~)			
Voltage	Internal resistance	Current	Intern. resist. approx.
1200 V	4 MΩ	30 A	0.004 Ω
600 V	2 MΩ	6 A	0.07 Ω
300 V	1 MΩ	1.2 A	0.16 Ω
120 V	400 kΩ	0.3 A	0.4 Ω
30 V	100 kΩ	0.06 A	1.5 Ω
12 V	10 kΩ	12 mA	50 Ω
3 V	1 kΩ	3 mA	70 Ω
0.6 V	50 Ω	1.2 mA	300 Ω
—	—	0.3 mA	3000 Ω

Temperature ranges		
Range	Range on Unigor	Thermocouple
0-220° C ΔT	12 mV	Fe-const. 2 Ω included in calibration; direct scale
0-900° C ΔT	12 mV a. 60 mV	Fe-const.
0-1200 (1600)° C ΔT	12 mV a. 60 mV	NiCr-Ni and PtRh-Pt

Resistance ranges			
Range		Centre Scale values	Voltage supply
Ω	0,1 Ω...100 Ω	6.7 Ω	1.5 V-battery
Ω×1	10 Ω... 10 kΩ	300 Ω	
Ω×10	100 Ω...100 kΩ	3000 Ω	
kΩ —	10 kΩ...10 MΩ	300 kΩ	100...130 V—
kΩ ~			100...240 V~

Extension of ranges

Extended range	with	Model
600 A— 120 A—	separate shunt class 0.5 600 A — 60 mV or 120 A — 12 mV	GE 52 17 H
600/6 A~ 120/1.2 A~ 30/0.3 A~	current transformer (100:1) at 500/5 A and 5 VA: class 0.2. Additional error with Unigor 1 smaller than 0.2% (45 . . . 65 c.p.s.)	GE 44 07
600/0.3 A~ 120/0.06 A~ 24/0.012 A~	Clip on current transformer (2000:1). Additional error with Unigor 1 smaller than 3%	GE 44 53
6000 V≂ (20 MΩ)	Voltage multiplier 4.8 kV (16 MΩ)	GE 41 55
220° C	Fe-const. Thermocouple Calibration based on German and Austrian standards (see next page)	GE 48 31 [1] GE 48 32

[1]) See section Temperature Measurement on page 19.

Accuracy

Limits of error

The limits of error as stated below apply for horizontal position, at an ambient temperature of 20 deg. Centigrade, and for sinusoidal AC of 50 . . . 60 c.p.s.

Current and voltage ranges (V, A)

DC: ±1% of full scale
AC: ±1.5% of full scale

Resistance ranges

DC: ±1% of scale length
±4% of measured value at centre scale
AC: ±1.5% of scale length
±6% of measured value at centre scale

Temperature range ±5 deg. C when iron-constantan thermocouple of 2 ohms resistance is used.

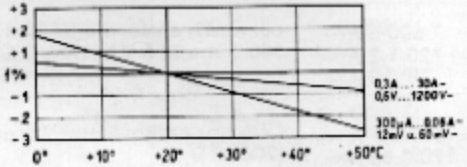
Calibration values:	50	100	150	200	220° C
	2.67	5.38	8.13	10.90	12.0 mV

Influence of temperature

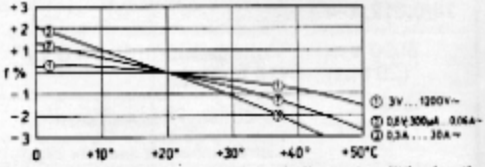
on DC a maximum of 1% of the rated value for every 10 deg. Centigrade
on AC a maximum of 1.5% of full scale

The approximate magnitude of the additional temperature error within a temperature range of 0 deg. Centigrade to +50 deg. Centigrade is shown by the following graphs.

Additional temperature error ft in % of true value for DC



Additional temperature error ft in % of full scale deflection for AC



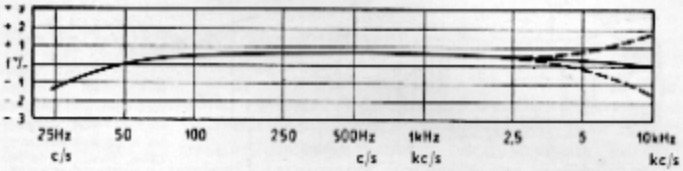
Note: A negative additional error means that the instrument indicates too little, i.e. the true value is obtained by adding the stated percentage to the reading.

Influence of frequency

The frequency error for voltage ranges up to 300 volts and current ranges up to 0.3 amperes is for

25 c.p.s. . . . 5,000 c.p.s.: 1.5% max. of full scale,
5,000 c.p.s. . . . 10,000 c.p.s.: 3% max. of full scale.

The approximate magnitude of the additional frequency error within a frequency range of 25 c.p.s. to 10,000 c.p.s. is shown by the following graph.



The maximum frequency error of 3% is also valid for voltage ranges above 300 volts in the frequency range up to 1,500 c.p.s. as well as for current ranges above 0.3 ampers up to 5,000 c.p.s. The input capacity of Unigor 1s is approximately 60 pF for all AC ranges.

External field influence

The influence of an external DC or AC field (50 c.p.s.) of 5 Gauss is negligible.

Influence of wave form

When calibrating Unigor in effective values the form factor (effective value divided by mean value) of 1.11 for sinusoidal waves was taken into account. A deviation from the sinusoidal form may cause an error. In general a peaked wave will cause a negative, a flat-topped wave a positive error.

Test voltage

5,000 volts according to IEC and VDE standards. The voltage test at 5,000 volts assures safe operation of the instrument at voltages up to 1,500 volts.

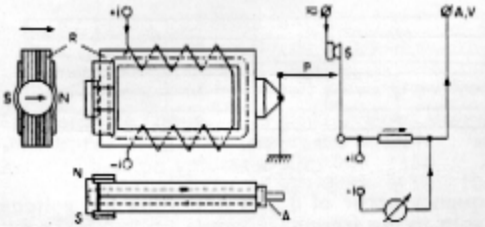
During measurements of higher voltages with a separate voltage multiplier the instrument must not be touched.

Overload protection

The Unigor 1s is protected by several independent means against damage due to faulty use and overloads.

Protective cut-out switch

A sensitive relay connected in series with the measuring movement opens a contact and breaks the measuring circuit when the instrument is subjected to an overload



The high sensitivity of the relay is due to the utilization of the principle of saturation blocking. The relay armature (A), which is attached to a contact spring (S), is held to the relay yoke (R) by a permanent magnetic flux. A certain excitation of the relay coil causes saturation in the yoke. The increase of magnetic resistance due to the saturation reduces the holding flux of the permanent magnet NS, so that the armature is moved away by the force (P) thereby opening the contact of the protective cut-out switch.

The overall breaking period from the moment of overload to the interruption of the measuring circuit is 0.005 to 0.01 sec. The relay operates both on DC and AC excitation. The actuating current is about 10 to 20 times as high as the current of the movement for full scale deflection. Thus, as a rule, the protection is effective at a measured value equalling 10 to 20 times the amount of the range selected.

The protective cut-out switch prevents furthermore a short in the 6 A position, should the range selector be erroneously turned from the 1200 V range to the 6 A range during a voltage measurement. In the position between the two ranges, marked by an asterisk (*) in the circuit diagram, the relay is directly connected to the input in series with a resistor to actuate the cut-out switch before the 6 A position is reached.

H.R.C. fuse: To protect the high current ranges, especially the 6 A range, at which the cut-out switch would only become operative between 60 and 120 A, a fuse rated at 6 A is inserted into the circuit, which also protects the instrument against a direct short in any current range.

Rectifier protection: A neon lamp with an especially low ignition voltage connected in parallel to the secondary of the instrument transformer, limits the damaging voltage peaks to permissible values, thus protecting the Germanium diodes.

Although the cut-out switch provides the instrument with an almost perfect overload protection the possibility of damage to the components has still to be considered should the instrument be subjected to very heavy overloads in worst cases of misuse.

The following rules should therefore be observed:

After the current range has been selected, the instrument must never be connected to voltage. A prolonged overload below the operating value of the cut-out switch or the H.R.C. fuse rating should under all circumstances be avoided because of the thermal strain on the electrical components. Furthermore, even momentary connections to voltages exceeding 1200 V should be avoided since the instrument is not designed for higher voltages (see also page 10).

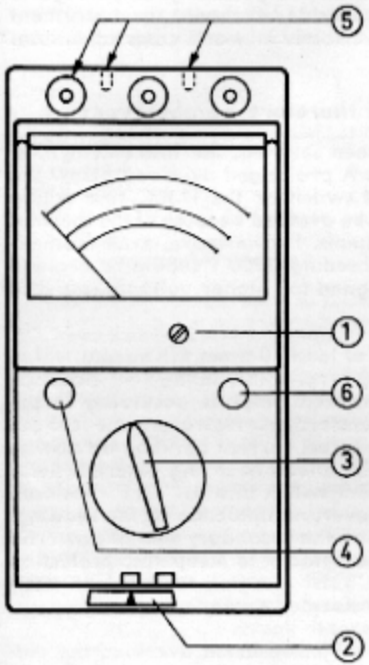
In cases of sudden overload of at least 40 times the normal value on DC (the AC-DC switch being erroneously in the "~" position) the relay is actuated by the current impulse occurring in the secondary winding of the transformer. However, the cut-out switch is not effective against a direct current building up slowly. Heavy mechanical shocks or the effects of strong external fields on the relay may trip the cut-out switch into its "OFF" position. Such external fields have, however, no influence on the reading. During current measurements on the secondary side of powerful instrument transformers it is advisable to keep the protection switch button depressed in its "ON" position to avoid an accidental interruption of the transformer secondary circuit.

After the instrument has been subjected to an overload the cut-out switch should not be reset before the cause for its actuation has been rectified.

The fuse and spare cartridges are accessible after the removal of the base plate. Rated current 6 A, 5 mm dia., 25 mm long. The ranges 30 A~ and 12 mV— are not protected.

Measuring operations: general remarks

To avoid errors place Unigor in approximately horizontal position and not in the proximity of iron masses, external fields (busbars) or other moving coil instruments.



① With the current cut off check the zero position adjustment of the pointer. After cleaning the scale window the electrostatic charge should be neutralized by breathing on the glass or touching it or wiping it with a damp cloth.

② Set the AC-DC switch to the desired position: DC (—), AC (~), or for measuring resistances and capacitances to the central position (R). Changing from — to ~ through the "R" position during measurement permissible. This does not interrupt the circuit.

③ Set the range selector to the required range. When measuring current or voltage always begin with the highest and switch down to the most suitable smaller range. This does not interrupt the circuit.

④ Before connecting Unigor press push button into the "ON" position should it be in the "OFF" position.

⑤ ⑥ Connection of the instrument and operation of the R-knob according to the detailed instructions in the following paragraphs. There are abridged instructions on the base plate.

Please observe range limits. For measuring higher values always use separate voltage multiplier and shunt or instrument transformer or clip-on transformer.

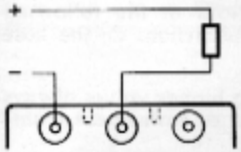
Earthing conditions and maximum voltages to earth will be discussed in detail in the instructions for the measurements of current and voltage.

When measuring DC voltages with non-repetitious or periodically repetitious superimposed voltage peaks exceeding 1,200 V a separate series resistor must be used. Otherwise flash-overs might occur which would impair the insulating quality of the internal circuit and cause burn-outs of essential components. Such peaks may occur e.g. in an iron core winding through which a direct current is flowing, when the circuit is suddenly interrupted. Excessively high voltage peaks may also occur during measurements of transducers or television sets.

After use the range selector is always to be set to the highest voltage range. Do not use the range selector to switch off the circuit, as the position between 1,200 V and 6 A is not an "OFF" position, but a protective position (see page 7).

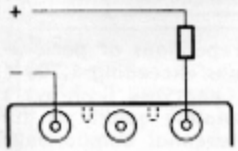
DC current measurements

direct connection for currents up to 6 A



Range selector: 6 A to 0.3 mA
AC-DC switch: "—"
Reading on : V, A scale

direct connection for currents up to 30 A

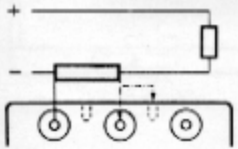


Range selector: 30 A
AC-DC switch: "—"
Reading on : V, A scale

Attention! 30 A range without overload protection!

with separate shunt for currents exceeding 30 A

For a better utilisation of the shunt 600 A/60 mV model GE 5217 H (see page 4) the 12 mV- and 60 mV-range can be used. By switching to 12 mV in case of 120 A and smaller a new current range of 120 A is created which has the same accuracy as the rated current range of 600 A.

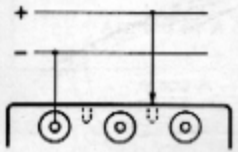


Voltage drop across shunt	0 . . . 60 mV	0 . . . 12 mV
AC-DC switch to "—" Range selector to	60 mV	60 mV
Connection to instrument	Terminals "⎓"	Terminal ⊖ & plug 12 mV
Reading on V, A scale Full scale deflection	600 A	120 A

Technical Data for the separate shunt 600 A (120 A)/60 mV (12 mV) see page 4.

DC voltage measurements

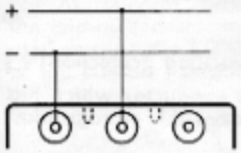
direct connection for voltages up to 12 mV (114 Ω)



Range selector: 60 mV
AC-DC switch: "—"
Reading on : V, A scale

Attention! 12 mV range without overload protection!

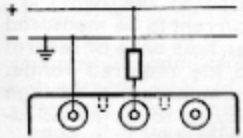
direct connection for voltages from 60 mV to 1200 V (3333 Ω/V)



Range selector: 1200 V to 60 mV
AC-DC switch: "—"
Reading on : V, A scale

with separate voltage multiplier up to 6000 V— (20 MΩ)

voltage multiplier 4.8 kV (16 MΩ), model GE 41 55



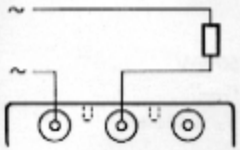
Range selector: 1200 V
AC-DC switch: "—"
Reading on : V, A scale

The following safety precautions should be taken when measuring voltages exceeding 1500 V:

Connect one of the two voltage terminals directly to earth. Where this is impossible other safety precautions must be taken. First connect the instrument and select range, then switch on the voltage.
Do not touch the instrument under voltage.

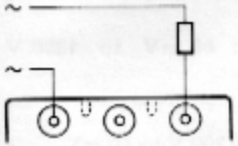
AC current measurements

direct connection for currents up to 6 A



Range selector: 6 A to 0.3 mA
AC-DC switch : "~"
Reading on : V, A scale

direct connection up to 30 A



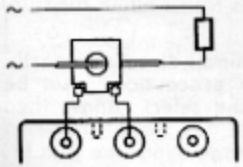
Range selector: 30 A
AC-DC switch : "~"
Reading on : V, A scale

Attention! 30 A range without overload protection!

Whenever possible connect Unigor to that conductor which has the lower voltage to earth. For safety reasons this voltage must never exceed 1,500 volts.

with separate current transformer up to 600 A

AC currents exceeding 30 A to be measured with a separate instrument transformer model GE 44 07 (see page 4).
The secondary winding is to be connected to the two "≂" terminals. The primary conductor for the current to be measured should be threaded through the transformer hole once or several times in the same direction according to the required range. The current transformer is tested for a maximum service voltage of 650 volts. When this voltage is exceeded do not touch the instrument or the connection leads to the transformer.



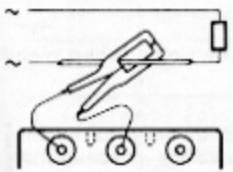
Range selector: According to table
AC-DC switch : "~"
Reading on : V, A scale

Extended current range at n primary turns				range on UNIGOR 1s
n=1	n=2	n=5	n=10	
600 A	300 A	120 A	60 A	6 A
120 A	60 A	24 A	12 A	1.2 A
30 A	15 A	6 A	3 A	0.3 A

The accuracy of the current transformer corresponds to class 0.2 for a secondary output up to 5 VA and a nominal current ratio of 500:5 A. The additional error due to the insertion of this transformer does not exceed 0.2% of the full range value at a frequency of 45 ... 65 c.p.s. This applies to all ranges listed in the chart.

with clip-on transformer up to 600 A

For AC current measurement without interrupting the circuit, the clip-on transformer model GE 44 53 (see page 4) should be used (turns ratio 2,000:1). Connect the two sockets in the handles of the clip-on transformer to the "≂" terminals of Unigor.



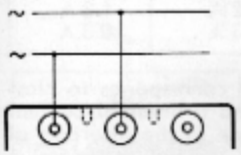
Clip-on transformer range : 600 A, 120 A, 24 A
Range selector: 0.3 A, 0.06 A, 12 mA
AC-DC switch : "~"
Reading on : V, A scale

The possible additional error due to the clip-on transformer will not exceed ±3% of full range, provided the surfaces of the plier core are in contact with each other practically without an airgap. It is therefore essential to keep the surfaces clean.

Use the clip-on transformer only for service voltages up to 650 volts.

AC voltage measurements

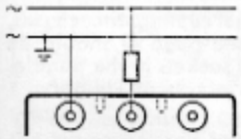
direct connection for voltages up to 1200 V



Internal resistance at 0.6 V: 50 Ω;
3 V: 1 kΩ;
12 V: 10 kΩ;
30 V ... 1200 V: 3333 Ω/V
Range selector: 1200 V to 0.6 V
AC-DC switch: "~"
Reading on : V, A scale

with separate voltage multiplier up to 6 kV (20 MΩ)

voltage multiplier 4.8 kV (16 MΩ), model GE 41 55



Range selector: 1200 V
AC-DC switch: "~"
Reading on : V, A scale

For reasons of safety the following should be noted when measuring voltages above 1500 volts:

Connect one of the two terminals used directly to earth potential. Where this is impossible other safety precautions have to be taken.
Connect instrument and select the desired range before switching on the voltage.

AC current and voltage measurements with frequencies up to 10000 c.p.s.

In order to guarantee an equally high accuracy for frequencies up to 10000 c.p.s. the terminal ⊖ should be earthed or connected to that measuring point which has the least potential to earth. At higher frequencies the input capacity causes a reduction of the internal resistance.
The input capacity is approx. 60 μμF.

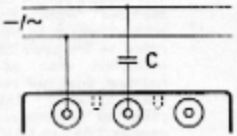
Measurement of superimposed DC and AC

without blocking off the DC component

By means of a built-in instrument transformer it is possible to determine the AC and DC components by a current or voltage measurement. The measurement is to be carried out in exactly the same manner as has been described in the preceding paragraphs for current and voltage measurements (page 11 to 15). To avoid overloading Unigor the selected range must not be smaller than the DC or AC component to be measured. It is therefore important to measure both, AC **and** DC component before selecting the next smaller range.

with the DC component blocked off

In many measurements in the audio frequency range of AC voltage with superimposed DC it is desirable to block off the DC component. This is achieved by connecting a suitable condenser in series to the instrument.[1]) To avoid destruction of the condenser, its working voltage has to exceed the superimposed DC voltage. Proceed now with the AC voltage measurements as previously described.



Owing to the condenser connected in series to the internal resistance of the instrument the reading will be influenced by the frequency in the lower frequency ranges.

The additional error will decrease with increasing frequency and selected range according to the formula $\triangle f = \frac{1.25 \times 10^{12}}{f^2 R^2 C^2}$

f signifies the frequency in c.p.s., R the internal resistance in ohms and C the capacity in μF. When a condenser of 0.3 μF is used the additional negative error, dependent on the frequency, in % of the indication will amount to:

Additional negative error △f in % of indication	in the ranges			
	12 V~	30 V~	120 V~	300 V~
≧0.5	≧550 c.p.s.	≧55 c.p.s.	≧25 c.p.s.	≧25 c.p.s.
≧1	≧400 c.p.s.	≧40 c.p.s.		
≧1.5	≧300 c.p.s.	≧30 c.p.s.		
≧2.5	≧250 c.p.s.	≧25 c.p.s.		

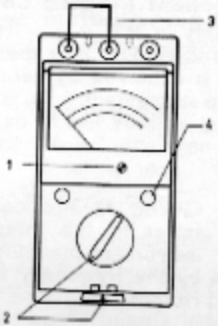
[1]) It is recommended to use a condenser of 0.3 μF 500 V service voltage, since such a condenser will also be best suited for capacity measurements (see page 17).

Resistance measurement with built-in battery

Before use a standard dry cell of 1.5 volt (approx. 20 dia. × ×37 mm) is to be inserted into the battery compartment. The battery compartment is located on the underside of the instrument and is easily accessible by unfastening the knurled screw and removing the base plate. The battery should be checked from time to time and be replaced if it starts to decompose, before it soils the battery compartment.

Adjustment of Unigor before measuring

Ranges: Ω, Ω×1, Ω×10

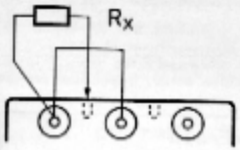


short circuit terminal ⊖ and ≂

Correct possible deviation of pointer from zero with zero adjuster

Adjust "R" knob to full scale deflection (0 on Ω, kΩ-scale). The battery should be replaced when the pointer cannot be adjusted to full scale or indication after adjustment does not remain constant. The range of adjustment: approx. 1.65 V to 1.3 V.

Set the AC-DC switch to "R" and select range required

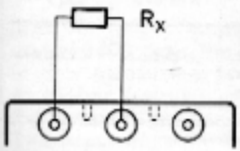


Carrying out the measurement

Range: Ω (0.1 Ω to 100 Ω)

Connections: Short circuit terminal ⊖ and terminal "≂", connect Rx to terminal ⊖ and socket Ω

Reading on: Ω scale in ohms



Range: Ω×1 (10 Ω to 10 kΩ)
Ω×10 (100 Ω to 100 kΩ)

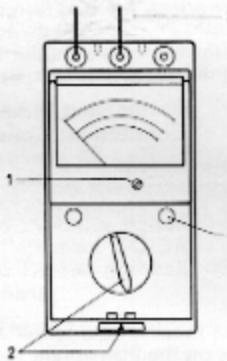
Connection: Rx to terminal ⊖ and "≂"

Reading on: Ω, kΩ scale in the Ω×1 range directly in ohms.
In the Ω×10 range the value of Rx is obtained by multiplying the reading by 10

Resistance and capacity measurements with external voltage supply

Adjustment of Unigor before measuring

Ranges: kΩ—: 100 to 130 V—
kΩ~, μF: 100 to 240 V~



Connect terminals ⊖ and ≂ to DC or AC voltage according to range selected. In capacity measurements the measuring voltage range is only valid from 45 to 65 c.p.s. The accuracy is independent of frequency

Correct possible deviation of pointer from zero with zero adjuster

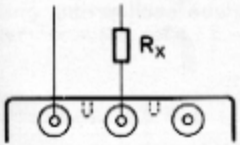
Adjust "R" knob to full scale deflection (0 on Ω, kΩ-scale)

Set the AC-DC switch to "R" and select range required

Carrying out the measurement

Range: kΩ—, kΩ~ (10 kΩ ... 10 MΩ)

100 ... 130 V—
100 ... 240 V~

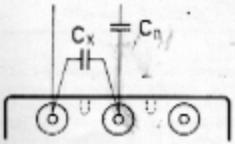


Connection: Insert resistance Rx between one pole of the **external DC or AC voltage** respectively and one terminal of the instrument

Reading on: Ω, kΩ-scale in kilo-ohms

Range: μμF×1,000 or μF:1,000
(10,000 μμF to 10 μF)

100 ... 240 V~
(45 ... 65 c.p.s.)



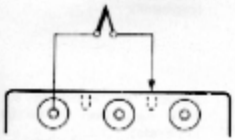
Connection: Insert condenser Cn of 0,3 μF and a working voltage of 500 V— between one pole of the AC voltage supply and one terminal of Unigor. After adjustment connect the condenser to be measured Cx to the instrument terminals "≂".

Reading on: Ω, kΩ-scale multiplied with 1,000 to obtain value in μμF and, divided by 1,000, to obtain the value in μF.

Temperature measurements

with surface temperature probe model GE 48 31
with immersion temperature probe model GE 48 32

These probes permit a direct measurement in the 12 mV range of a temperature difference ΔT up to 220° C between the iron-constantan thermocouple on the tip of the probe and the terminals on Unigor for the connection leads. The probe is calibrated for 2 ohms resistance.
The temperature T of the tip of the probe is the sum of the ambient temperature and the recorded temperature difference ΔT:



T = ambient temperature + ΔT
Connection: Constantan lead (blue) to terminal ⊖
iron lead (red) to +12 mV socket
Range selector: 60 mV
AC-DC switch: "—"
Reading on: ΔT scale in degree Centigrade

If the temperature to be measured is lower than the temperature of the connecting points on the instrument (ambient temperature), the connections to the instrument are to be reversed (red to ⊖, blue to +12 mV socket). In this case the indicated temperature difference ΔT will be negative.
A detailed instruction manual is supplied with each probe.

Temperature measurements with thermocouples

Iron-constantan (Fe-Const.) ..... up to 900° C
Nickelchromium-nickel (NiCr-Ni) ..... up to 1200° C
Platinum-rhodium-platinum (PtRh-Pt) ..... up to 1600° C

Either the 12 mV or 60 mV range is to be used according to the thermo-electric voltage expected. Within the 12 mV range thermo-electric voltage U in mV is obtained by multiplying by 0.1 the reading on the V, A-scale with numbering up to 120.

Within the 60 mV range U can be read directly in mV on the 60 division scale.

From the following formulae the thermo-electric e.m.f. E can be obtained, taking into account the resistance R[1]) in ohms of the thermocouple and the compensation leads, if used:

12 mV range: $E = U\left(1 + \frac{0.87}{100} \cdot R\right)$ in mV

60 mV range: $E = U\left(1 + \frac{0.5}{100} \cdot R\right)$ in mV

The temperature difference ΔT is obtained from the values of E using the millivolt-temperature conversion factor "k" of the thermocouple used: $E = k \cdot \Delta T$.

E [mV]		0—4	4—8	8—16	16—32	32—39	39—45	45—52
k [mV/°C]	Fe-Const.	0.053		0.054	0.055	0.056	0.057	0.058
	NiCr—Ni	0.041						
	PtRh—Pt	0.008	0.009	0.01				

[1]) The resistance R can be measured with a suitable resistance range of Unigor 1s. In the presence of a thermo-electric e.m.f. an incorrect reading for R could be obtained from a resistance measurement, especially if the thermocouple has already been subjected to a higher temperature. To avoid an error, two resistance measurements with the polarity of the compensation leads on the instrument reversed, should be made. The mean value should be used in the corresponding formulae.

Maintenance

The instrument does not require any special maintenance. It is, however, recommended to replace the battery as soon as its voltage is so low that the pointer cannot be adjusted to full scale deflection by means of the R-knob, or the indication does not remain constant after the adjustment. A discharged or decomposing battery should be removed from the battery compartment. The condition of the battery should therefore be checked from time to time. The battery is easily accessible after removing the base plate.

When the instrument is soiled by dust, liquids, etc. it should be cleaned with a dry, soft cloth, if necessary with alcohol or spirit. **Special care has to be taken to keep the surface between the terminals clean, since a heavy layer of dirt in this area will impair the insulation and may reduce the input resistance, especially in the high voltage ranges.**

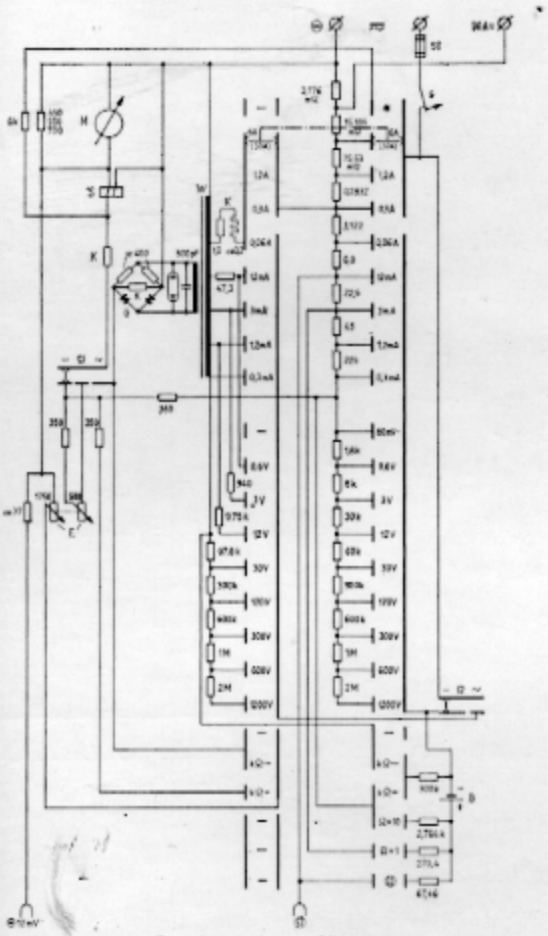
Description of circuit diagram on page 22

M = taut suspension movement
W = instrument transformer
G = rectifier bridge
S = cut-out switch relay
s = cut-out switch contact
Si = fuse
B = 1,5 V battery
E = adjuster for resistance and capacity ranges

The range marked * is inserted between the 1200 V and 6 A ranges as a protection range. As stated in the chapter on overload protection, it prevents a short circuit in the instrument when the selector is rotated beyond the 1200 V range to the current ranges, while the instrument is under voltage.

The resistors marked K are built in for the resistance adjustment of the measuring movement and the cut-out switch to 240 ohms as well as for the sensitivity adjustment of the AC ranges.

Circuit diagram



Description on page 21.