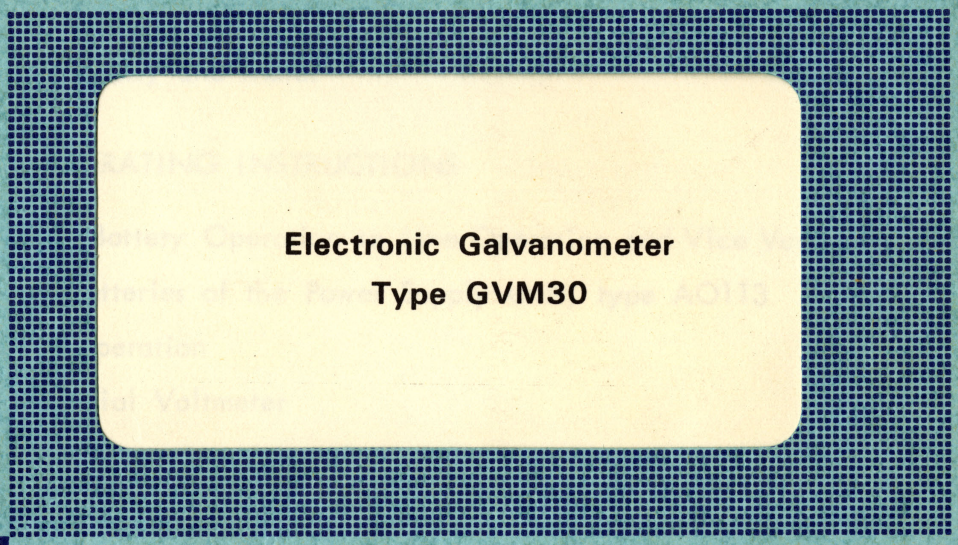
INSTRUCTION MANUAL



RADIOMETER

ELECTRONIC MEASURING INSTRUMENTS
FOR SCIENTIFIC AND INDUSTRIAL USE

Instruction Manual
for

Electronic Galvanometer
Type GVM30

1st edition

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Electronic Galvanometer Type GVM30

Section A. Introduction

Fig.A1. The Electronic Galvanometer, type GVM30.

The Electronic Galvanometer, type GVM30, is a portable, line- or battery-operated precision measuring instrument. It is based on a solid-state amplifier which is designed in accordance with the latest dc amplifier technique. Consequently, the Electronic Galvanometer can also be highly recommended as a handy laboratory instrument for dc work.

It measures from 30 pA to 300 μA f.s. with ±3% accuracy and with a voltage drop of only 100 μV, and from 1 mV to 300 V f.s., also with ±3% accuracy, at an input resistance of 10^{11} Ω or > 100 MΩ according to the range. A polarity switch provides for passing positive or negative currents or potentials. The input may be floated up to ±400 V with respect to chassis. Finally, the Electronic Galvanometer measures resistances from 1 kΩ to 300 MΩ f.s. within ±5%.

The Electronic Galvanometer, type GVM30, is provided with a recorder output, a very useful feature when monitoring, for example, environmental and reliability tests or other long-term measurements.

Section B. Specifications

CURRENT RANGE

Picoamps (f.s.d.):	30, 100, and 300
Nanoamps (f.s.d.):	1, 3, 10, 30, 100, and 300
Microamps (f.s.d.):	1, 3, 10, 30, 100, and 300
Accuracy:	±3%
Input voltage drop (f.s.d.):	about 100 μV
Terminal current:	<1 pA (0-50°C)
Max. input voltage:	50 V in all current ranges.
	Note: By using an external shunt of 1 Ω and the mV-range, it is possible to increase the measuring range up to, for example, 1 A according to the power rating of the shunt. The reading is then mA instead of mV.

VOLTAGE RANGE

Millivolts (f.s.d.):	1, 3, 10, 30, 100, and 300
Volts (f.s.d.):	1, 3, 10, 30, 100, and 300
Accuracy:	±3%
Input resistance:	> 10^{11} Ω (1 mV - 1 V) > 100 MΩ (3 V - 300 V)
Zero drift:	< 50 μV/°C
Terminal current:	< 1 pA (0-50°C)
Noise:	±25 μV max.
Max. input voltage:	500 V (in all ranges)

RESISTANCE RANGE

Kilohms (f.s.d.):	1, 3, 10, 30, 100, and 300
Megohms (f.s.d.):	1, 3, 10, 30, 100, and 300
Accuracy:	±5%
Test voltage:	max. 0.3 V
Max. voltage between LOW and HIGH terminal:	50 V in all resistance ranges.

RESPONSE TIME FOR 99% DEFLECTION

30, 100, and 300 pA:	approx. 15 s
1 mV:	approx. 5 s
Other ranges:	approx. 2 s

RECORDER OUTPUT

1 mV:	0.1 V	100 kΩ
3 mV:	0.3 V	
10 mV - 300 V:	1 V	
30 pA - 300 μA:	1 V	
1 kΩ - 300 MΩ:	0.3 V	

INSULATION

Circuit ground to chassis ground greater than 10^7 Ω shunted by 0.1 μF. Circuit ground may be floated up to ±400 V with respect to chassis ground.

DIMENSIONS AND WEIGHT

Height:	150 mm (6")
Width:	120 mm (4 3/4")
Depth:	230 mm (9 1/4")
Weight:	2.4 kilos (5 lbs.)

POWER SUPPLY

6 x 1.5 V batteries, type C

ACCESSORIES AVAILABLE:

Coaxial Cable (75 Ω), code 617-002, with UHF Plugs, type PL259.

2 MΩ Test Probe, type PB3

Test Lead with banana plug, type L301/1 m

1.5 V battery, code 430-101

Power Supply Unit, 115 V/50-60 Hz, type AO111

Power Supply Unit, for 110-220 V/50 H, type AO112

Power Supply Unit for 6 x 1.5 V batteries (supplied without batteries), type AO113.

Note: For details regarding the mounting of the three types of power supply, see SECTION D - OPERATING INSTRUCTIONS.

Section C. General Description

The input terminals of the Electronic Galvanometer, type GVM30, are the two UHF connectors LOW and HIGH. The shield of these connectors and the banana jack marked ⏚ are at chassis potential, whilst the inner lead of the LOW and HIGH terminals are used for feeding the signal, or coupling the unknown resistance to the instrument. The LOW and HIGH terminals are coupled to an operational amplifier circuitry featuring the extremely low input voltage drop and the high input resistance necessary for current and voltage measurements, respectively. The amplifier, in conjunction with a feedback network controlled by a function selector, constitutes the core of the instrument. The mode of coupling the feedback network to the amplifier determines the type of measurement which can be performed. The amplifier is followed by a meter circuit and a recorder output that delivers a signal proportional to the meter reading.

The operating principle of the Electronic Galvanometer in the three measuring modes, viz: voltage, current and resistance measurements, is as follows:

Voltage

The mode of coupling the feedback network to the amplifier for voltage measurements in the range 100 mV to 1 V is illustrated in Fig.C1. The terminal LOW is connected to circuit ground, and the terminal HIGH to the input of the amplifier. The feedback network consists of precision resistors forming a three-step voltage divider which is coupled via the RANGE selector to an array of series resistors. (For the sake of simplicity, the array is shown as one resistor R in Fig.C1.)

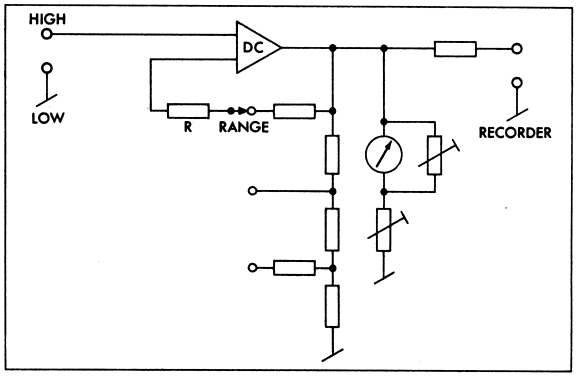


Fig.C1. Block-diagram illustrating voltage measurements in the range 100 mV to 1 V.

Extension of voltage measurements up to 300 V is performed when the feedback network has the configuration illustrated in Fig.C2. Here the terminal LOW is still connected to circuit ground, but the terminal HIGH is connected to the input of the amplifier via an input attenuator. Only two steps of the three-step voltage divider are used.

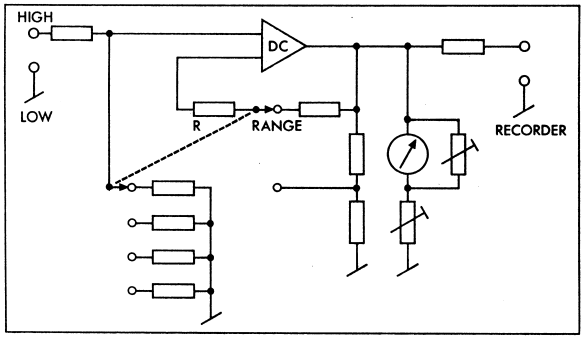


Fig. C2. Block-diagram illustrating voltage measurements in the range 3 V to 300 V.

Extension of voltage measurement down to 1 mV is performed when the feedback network has the configuration illustrated in Fig. C3. The terminals LOW and HIGH are connected as for voltage measurements in the range 100 mV to 1 V. Again, only two steps of the voltage divider are used, but here an additional resistor (R_A) is added. This additional resistor ensures reduction of the feedback. Furthermore, in the 1 and 3 mV ranges, the series resistor of the meter is stepwise reduced. This accounts for the different recorder output voltages, viz:

1 mV range: 0.1 V
3 mV range: 0.3 V

instead of 1 V as in the ranges 10 mV to 300 V.

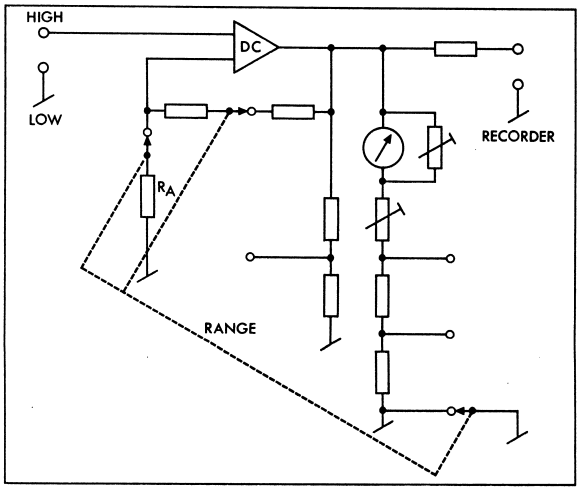


Fig. C3. Block-diagram illustrating voltage measurements in the range 1 to 30 mV.

Current

The mode of coupling the feedback network to the amplifier for current measurements in the whole range from 30 pA to 300 μA is illustrated in Fig. C4. The terminal LOW is connected to circuit ground, and the terminal HIGH to the input of the amplifier. The feedback network consists of precision resistors forming a three-step voltage divider which via the RANGE selector is coupled to one of the resistors in an array of series resistors.

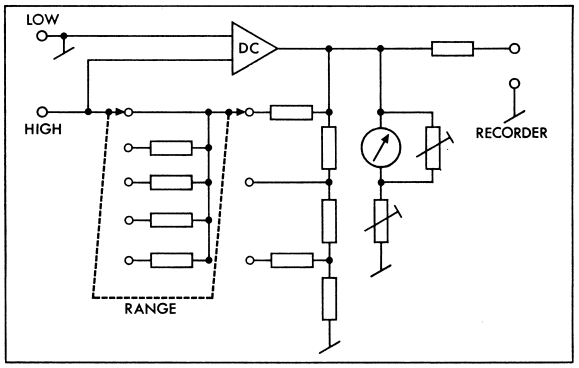


Fig. C4. Block-diagram illustrating current measurements.

Resistance

The mode of coupling the feedback network to the amplifier for resistance measurements in the whole range from 1 kΩ to 300 MΩ is illustrated in Fig. C5. The unknown resistor R_X is connected in the feedback loop between the LOW and HIGH terminals. The zener diode alongside with two voltage dividers and the series resistors forms a current generator which delivers a constant current in each range. This current is fed to the unknown resistor. The voltage drop across the unknown resistor determines the meter reading.

The input current to the amplifier is kept within certain limits when the RANGE selector is set to the correct value depending on the magnitude of the unknown resistor.

CONTROLS, TERMINALS, AND METER

General

As illustrated in Figs. C6 and C7, the Electronic Galvanometer, type GVM30,

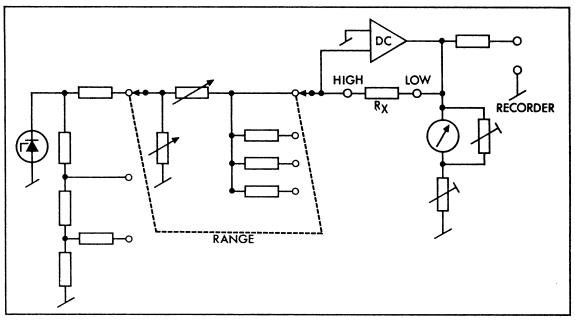


Fig. C5. Block-diagram illustrating resistance measurements:

is provided with the following controls, terminals and meter:

Operational Switch (1)

The operational switch consists of four push-buttons:

The button ON-OFF is used to switch the instrument on (engaged) or off (disengaged). Whenever the instrument is not in use, the ON-OFF button should be disengaged, i.e., in position OFF.

The button BATT. CHECK is used, when engaged, to check the batteries when a Power Supply Unit, type AO113, is utilized.

The button SET ZERO/MEASURE is used, when engaged, alongside with the ZERO knob (see below) when zero balancing

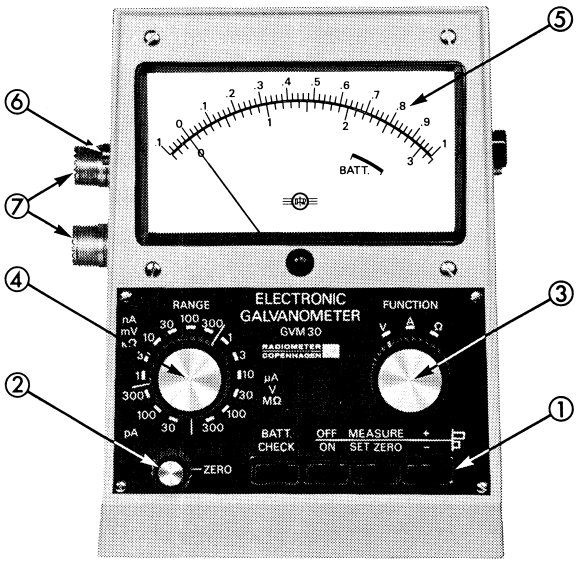


Fig. C6. The Electronic Galvanometer, type GVM30.

is required. When the SET ZERO/MEASURE button is disengaged, i.e., in position MEASURE, the instrument is ready to measure.

The button +,- is used to change the polarity of the terminals. The terminal HIGH is positive with respect to the terminal LOW when the button +,- is disengaged, and negative with respect to LOW when the button is engaged.

ZERO Knob (2)

The knob ZERO controls a variable capacitor used to set the zero balance. Zero balance can be checked on the meter when the SET ZERO/MEASURE button is engaged.

FUNCTION Selector (3)

The selector FUNCTION is a three-position rotary switch enabling selection of the type of measurement to be performed, viz., voltage measurement in position V, current measurement in position A, and resistance measurement in position Ω.

RANGE Selector (4)

The selector RANGE is a fifteen-position rotary switch providing for selection of the desired full-scale deflection range.

Meter (5)

The meter of the Electronic Galvanometer is of the taut-band suspension type, and it is provided with two scales calibrated from -0.1 to 1 and -0.03 to 0.3. Furthermore, a mark BATT. permits checking of the batteries' voltage which should fall within the mark.

Ground Terminal (6)

The terminal marked ⏚ is a banana jack at the same potential as chassis ground, and it is used to ground the instrument.

LOW and HIGH Terminals (7)

The terminals LOW and HIGH are two UHF sockets whose outer conductors are at the same potential as chassis ground, and whose inner conductors are used to feed the signal to the instrument.

RECORDER Terminals (See Fig. C7)

The terminals RECORDER are banana jacks used for connection to a recorder. The bottom jack is a grounding terminal.

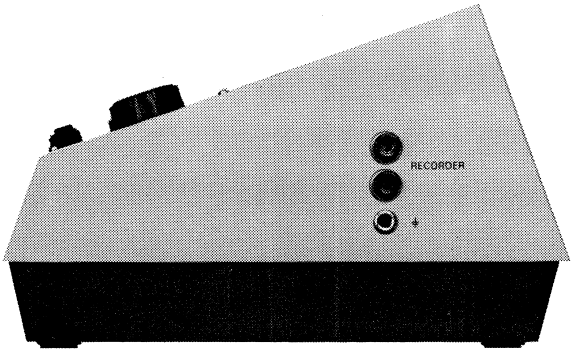


Fig. C7. Side view of the Galvanometer, type GVM30, showing the recorder terminals.

Section D. Operating Instructions

CHANGING FROM BATTERY OPERATION TO LINE OPERATION AND VICE VERSA

Three Power Supply Units are available, viz: type AO111 for 110V/50-60 Hz operation, type AO112 for 110/220V/ 50-60 Hz operation, and type AO113 for operation with six 1.5 V batteries. These three types of Power Supply Units are each embodied in a cast aluminium housing used at the same time as the bottom of the instrument and fastened by two screws. Exchanging Power Supply Units is readily performed by removing the two bottom screws and detaching the red, three-pole plug that ensures electrical connection between the two parts of the instrument, then connecting the new type of Power Supply Unit and refastening the two screws.

CHANGING THE BATTERIES OF THE POWER SUPPLY UNIT, TYPE AO113

1) Remove the two screws fastening the Power Supply Unit, type AO113, to the upper part of the Electronic Galvanometer, and separate the two parts.

2) Lift out the battery racks and replace the batteries by new ones. Correct positioning of the batteries is shown in the diagram inside the Power Supply Unit, type AO113. (See also Fig.D2.)

3) Push in the buttons ON and BATT. CHECK. Check that the voltage indicated on the meter is within the BATT. mark; if not, the new batteries may have been wrongly positioned or else they are out of order.

STEP-BY-STEP OPERATION

1) Push in the ON-OFF button.

2) Push in the BATT. CHECK button and check that the meter pointer deflects to the mark BATT.; otherwise the batteries must be inspected and replaced if, necessary.

3) Push in the SET ZERO button and bring the meter pointer to zero by means of the ZERO control.

4) By means of the FUNCTION selector, switch the instrument to the type of measurement required.

5) Connect the object under test to the Electronic Galvanometer. This is done by using the LOW and HIGH connectors on the left side of the instrument. If the connector HIGH is the positive pole, the button +,- must be out. If the connector LOW is the positive pole, the button +,- must be pushed in. Note that when measuring on resistances, the polarity of the terminals is reversed.

6) Push in the button SET ZERO so that the instrument is switched to MEASURE.

7) Rotate the RANGE selector until an appropriate meter deflection is obtained.

8) If necessary, reverse the polarity of the HIGH terminal by using the button +,-.

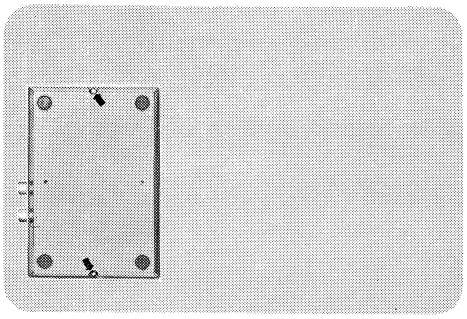
USE AS DIFFERENTIAL VOLTMETER

1) Proceed from step 1 to step 4, as above.

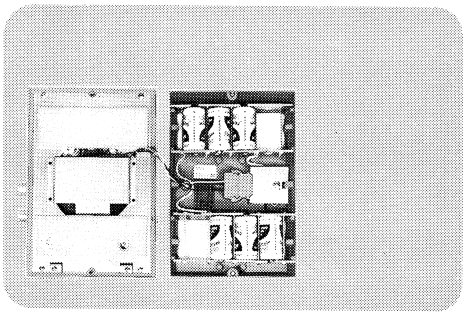
2) Connect the two voltages whose difference is to be measured, as shown in Fig.D3.

3) Proceed as indicated in steps 6 to 8 above.

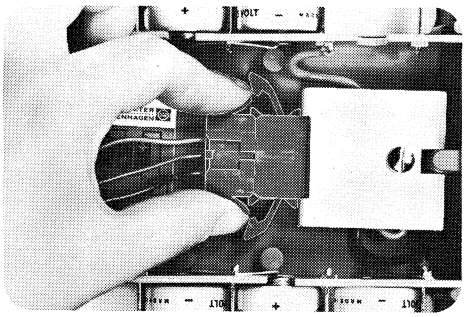
Note: Bear in mind that the maximum voltage which must be applied between the circuit ground and the chassis ground is ±400 V.



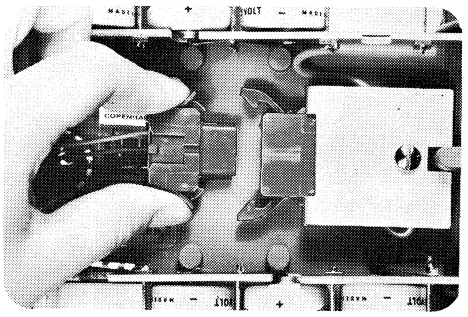
Remove the two screws on the bottom of the instrument.



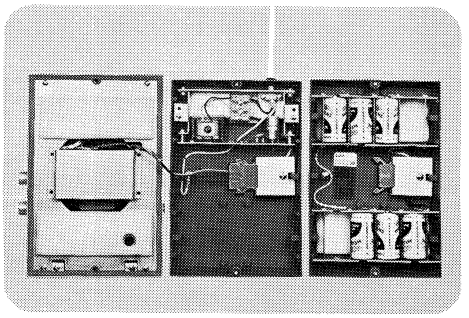
Separate the two parts.



With two fingers, spread the clamps and hold them back.



Pull out the red plug.



The plug is now easily inserted in the receptacle of the other Power Supply Unit type.

Fig.D1. How to exchange Power Supply Units.

Fig.D2. Interior of Power Supply, type AO113, showing battery positions and socket of connector from Power Supply Unit to Electronic Galvanometer.

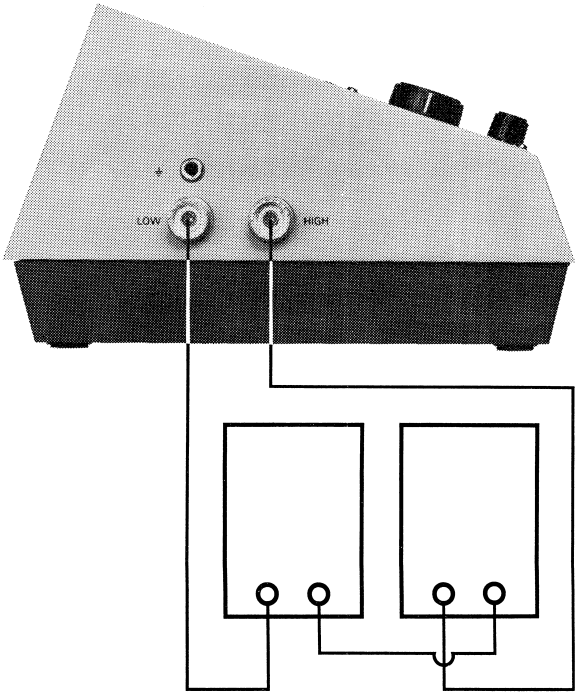
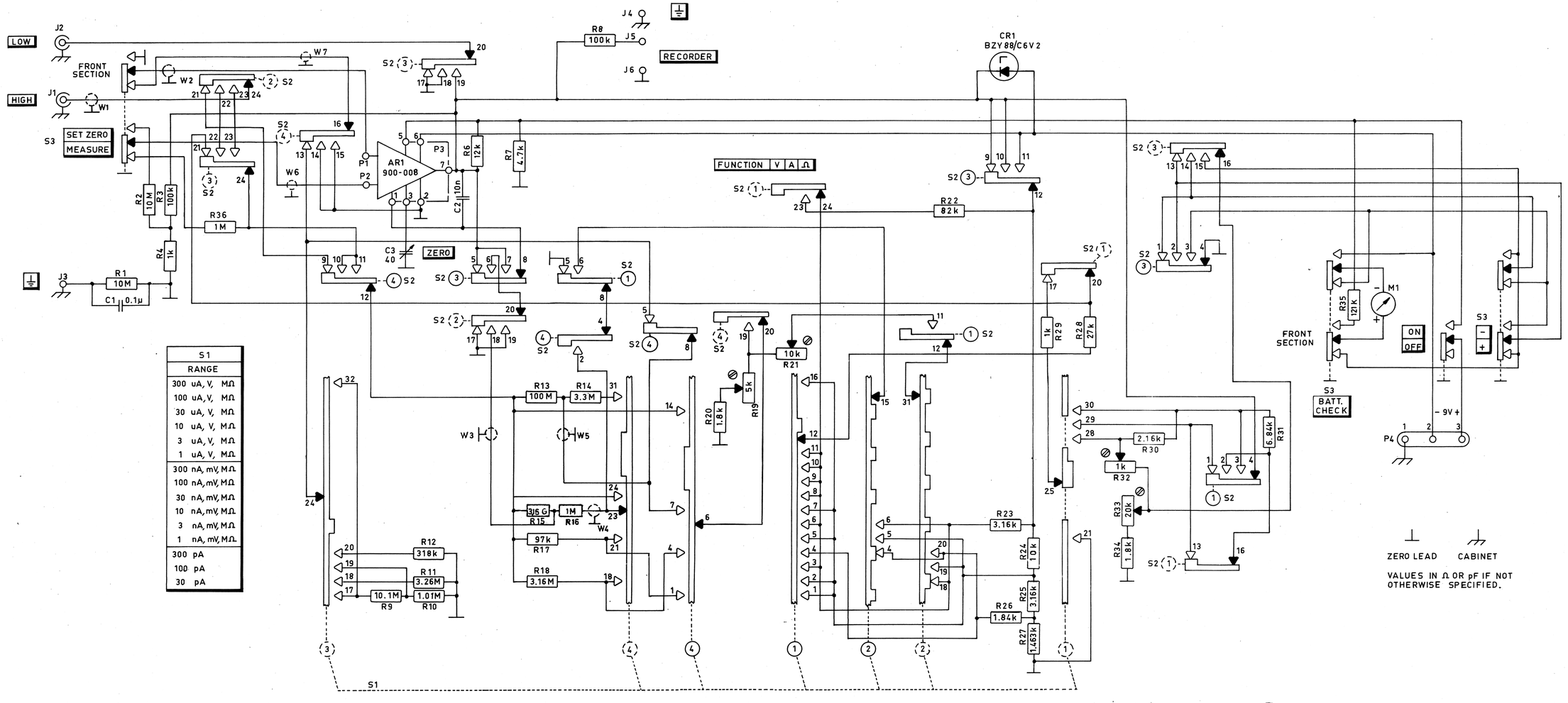


Fig.D3. How to connect the Electronic Galvanometer, type GVM30, when performing differential measurements.



VALUES IN Ω OR pF IF NOT OTHERWISE SPECIFIED.

Rif. Nr.	Ref. Nr.	Dato	Rt. af	Kont.	Norm.
3		9.9.68	SHM	Pwl	
2		2.9.68	EA	Pwl	Pk
1	133139	20/8-68	Je.	Pwl	

RADIOMETER COPENHAGEN
72 EMDRUPVEJ NV

Matestok /

Tegn.	EA	28.5.68
Kont.	056.	28.5.68.
Norm.	PK	30.5.68

ELECTRONIC GALVANOMETER
TYPE GVM 30-0 a
From no. to no.

Erstatter
1220-A1

Erstattes af