3B SCIENTIFIC® PHYSICS

Electrometer U8531408

Instruction sheet

09/08 Hh

1 Docking point for SEG elements
2 Input socket “IN” for Faraday cup
3 Input socket “IN” for SEG elements
4 Earth socket (reference point) for input
5 Connection socket for handling rod with 4 mm hole
6 Recessed socket for 12 V AC mains adapter
7 “On” indicator light
8 Electrometer offset adjuster
9 Earth socket (reference point) for output
10 Output socket “OUT”
11 12 V AC mains adapter

1. Safety instructions

The ultra-high-resistance input circuit of the electrometer can be damaged by applying an excessive voltage:

- Do not exceed the maximum input voltage of ± 8 V!

A higher voltage is only permissible with the condition that if a person touches conducting parts it is instantly reduced to the above or a lower value. The voltage sources mentioned in this instruction sheet fulfil that condition.

- Do not connect any external voltage source to the output socket (10)!
- If a capacitative voltage-divider circuit is used to measure voltages above 10 V, it must be provided with an SEG capacitor that can withstand the full applied voltage!

2. Description

Impedance-changer with an extremely high input resistance for measuring very small charges and very small currents.

It is suitable for quasi-static measurement of voltages up to ± 8 V, for high-resistance measurement of voltages above ± 8 V using a resistive voltage divider, for quasi-static measurement of voltages above ± 8 V using a capacitative voltage divider, for measurement of very small currents using a high-resistance shunt, and for measurement of charges.

3. Technical data

Amplification factor:	1.00
Input resistance:	$> 10^{12}\ \Omega$
Output resistance:	$< 1\ k\Omega$
Input current:	< 10 pA
Input capacitance:	< 50 pF
Supply voltage:	12 V AC / 50-69 Hz / 100 mA
Overvoltage tolerated for voltage sources safe against accidental contact:	1 kV (sources with low output resistance) 10 kV (sources with high output resistance)
Connections:	4 mm safety sockets

4. Operation

- Plug the 12 V AC adaptor into the electrometer and switch the instrument on.
- Connect a suitable voltage meter with a mid-scale zero-setting adjustment, such as analogue multimeter AM50 (U17450), multimeter ESCOLA2 (U8531170), or multimeter ESCOLA10 (U8531160), to the output sockets of the multimeter.
- Select the 10 V DC range and set the zero point at the middle of the scale.
- Short-circuit the "IN" (3) input socket to the earth socket (4) with a 19 mm bridging plug, or:
- Discharge (short-circuit) the Faraday cup (U8496460) that is plugged into the input socket (2) by using the handling rod with 4 mm hole (U8430245) that is connected to the earth socket (5).
- While maintaining the short-circuit, adjust the offset of the output voltage at socket (10) to a minimum.
- Quickly carry out the measurement for the chosen experiment, before there is time for stray charges to build up at the input being measured.
- Before starting a new experiment, short-circuit the input to earth again, and if necessary readjust the offset.

5. Sample experiment

Measuring charges in electrostatics

Apparatus needed:

1	Electrometer	U8531408
1	Analogue multimeter AM50	U17450
1	Faraday cup	U8496460
1	Capacitor, 10 nF, 160 V	U8403501
2	Friction rods	U11053
1	Experiment lead, 75 cm	U13800
1	Handling rod with 4 mm hole	U8430245
1	Cloth for rubbing friction rods	

- Set up the experiment as shown in Figure 1.
- Plug the Faraday cup and the 10 nF capacitor into the appropriate 4 mm sockets.
- Connect the multimeter to the output socket "OUT" (10) and the corresponding earth socket (9).
- Select the 10 V DC range on the multimeter.
- Plug the experiment lead into the socket for the handling rod (5) and into the 4 mm hole in the rod.
- Take the handling rod in one hand and, without releasing it, discharge the Faraday cup.
- With the other hand, immerse the test object (e.g. the friction rod after rubbing) into the field-free interior of the Faraday cup so that the whole of its

charge is within, and “wipe” the charge onto the inner surface of the cup.

- Use the relationships given below to calculate the charge that has been transferred.
- For a capacitor of capacitance C, the relationship between the charge Q and the voltage U is:

  $$Q = C \cdot U$$

- Since $U_{OUT} = U_{IN}$, the output voltage from the electrometer gives a measure of the charge Q:

  $$Q = U_{OUT} \cdot C$$

- The capacitor U8403501 has the known capacitance $C = 10$ nF, and therefore the charge can be calculated.

Fig. 1 Experiment set-up for measuring charges in electrostatics